Towards Using ROS in the RoboCup Humanoid Soccer League

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Technische Aspekte Multimodaler Systeme

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Motivation

Achieving exchangeable ROS [6] based software modules in the RoboCup Soccer context can lead to:

- Acceleration of development
- Increased comparability of different approaches
- Easier entry into the league for new teams
- Specialization of teams on certain sub areas
- Increased knowledge transfer with general research

[5]

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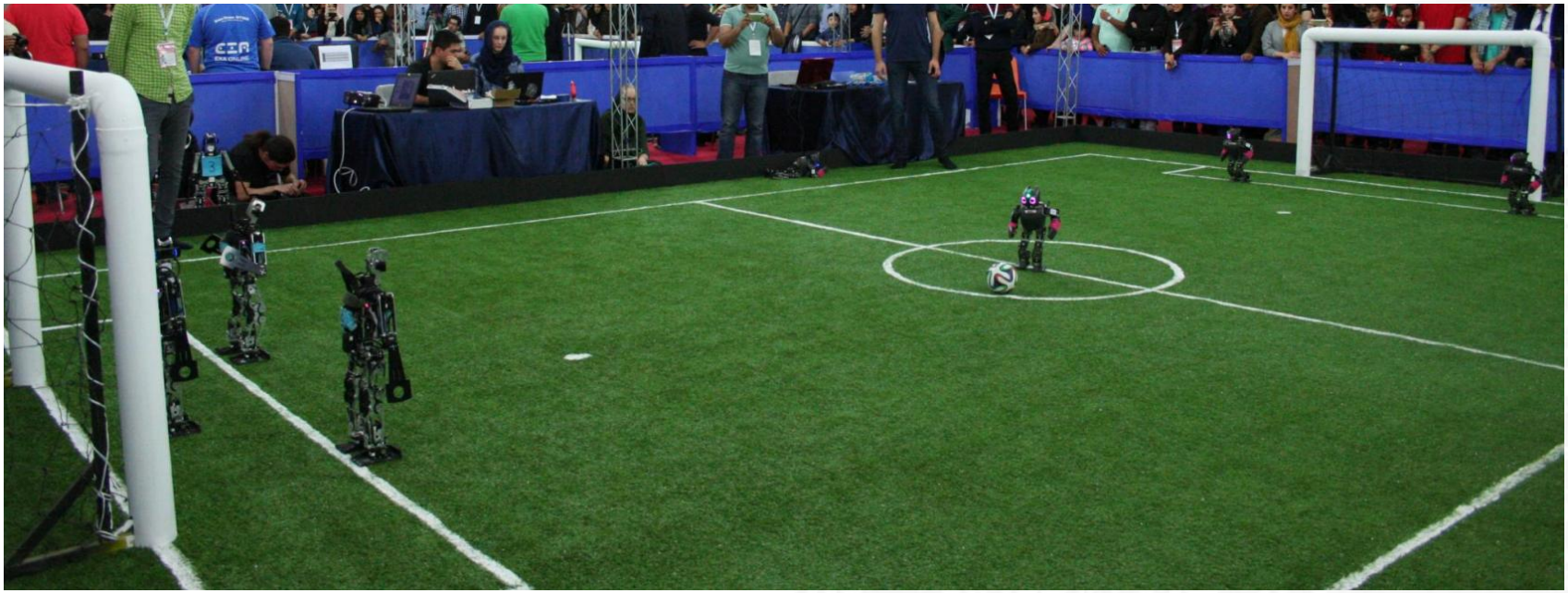
RoboCup

- Official Goal
  - Win against the soccer world champion with a team of robots in 2050
- Actual Goals
  - Accelerate research in robotics
  - Test approaches under realistic conditions
  - Make different approaches comparable
  - Promote robotics research to the public
- Organization
  - Yearly world championship and symposium
  - Multiple other competitions, workshops and summer schools
  - Different Leagues for different purposes

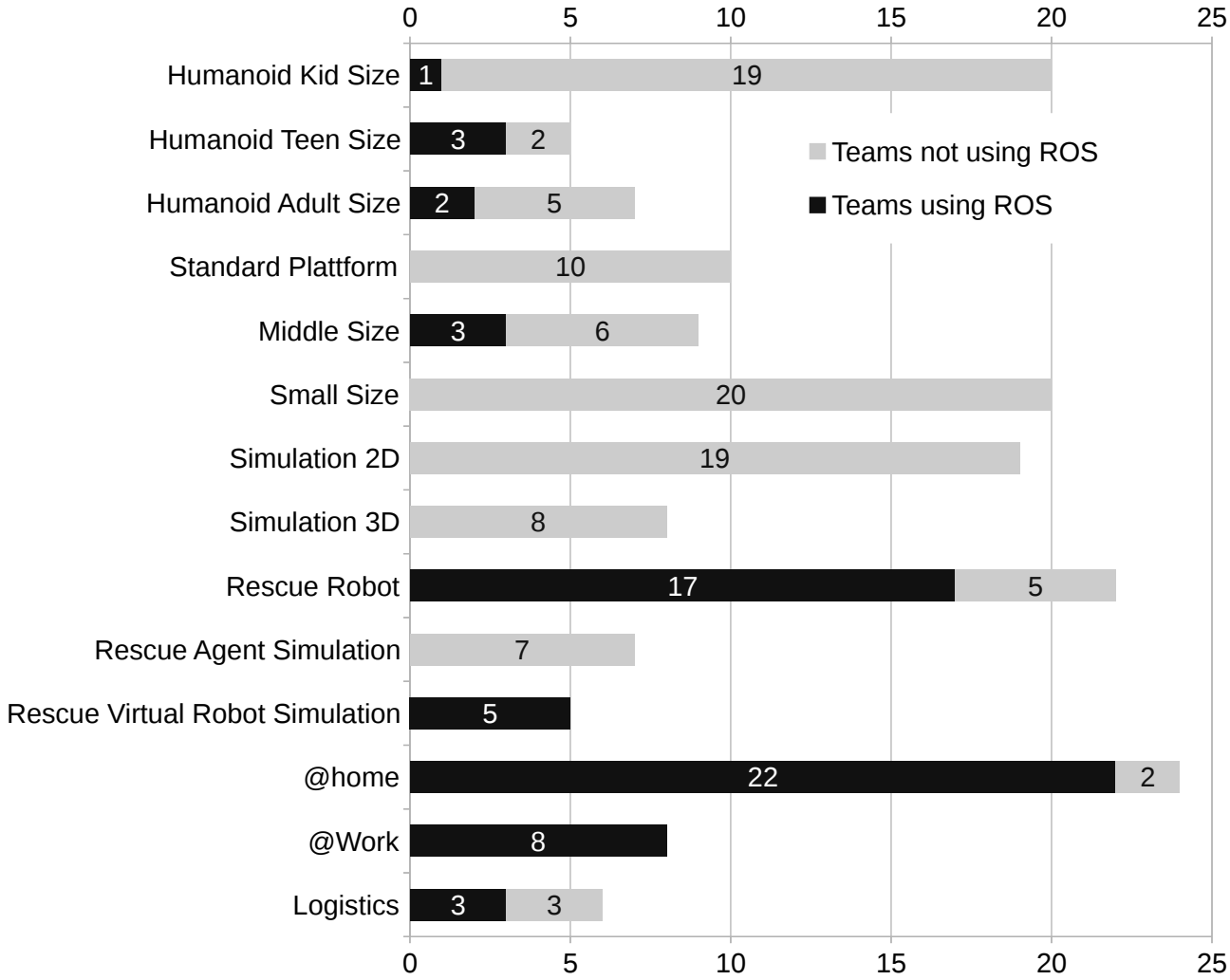
Humanoid Soccer League Field



[2]

Current State of Software Modularization

- Humanoid League
  - Almost only self made software frameworks
  - Low modularization
  - First teams starting to use ROS [4]
  - Exchange difficult due to different robot platforms
- Standard Platform League
  - Usage of the B-Human framework [7]
  - Higher level of games
  - ROS problematic on NAO
- Rescue Robot League
  - Initiative to use ROS invoked by team Hector
  - Now high use of ROS
  - Available software modules



Based on the team description papers [3]

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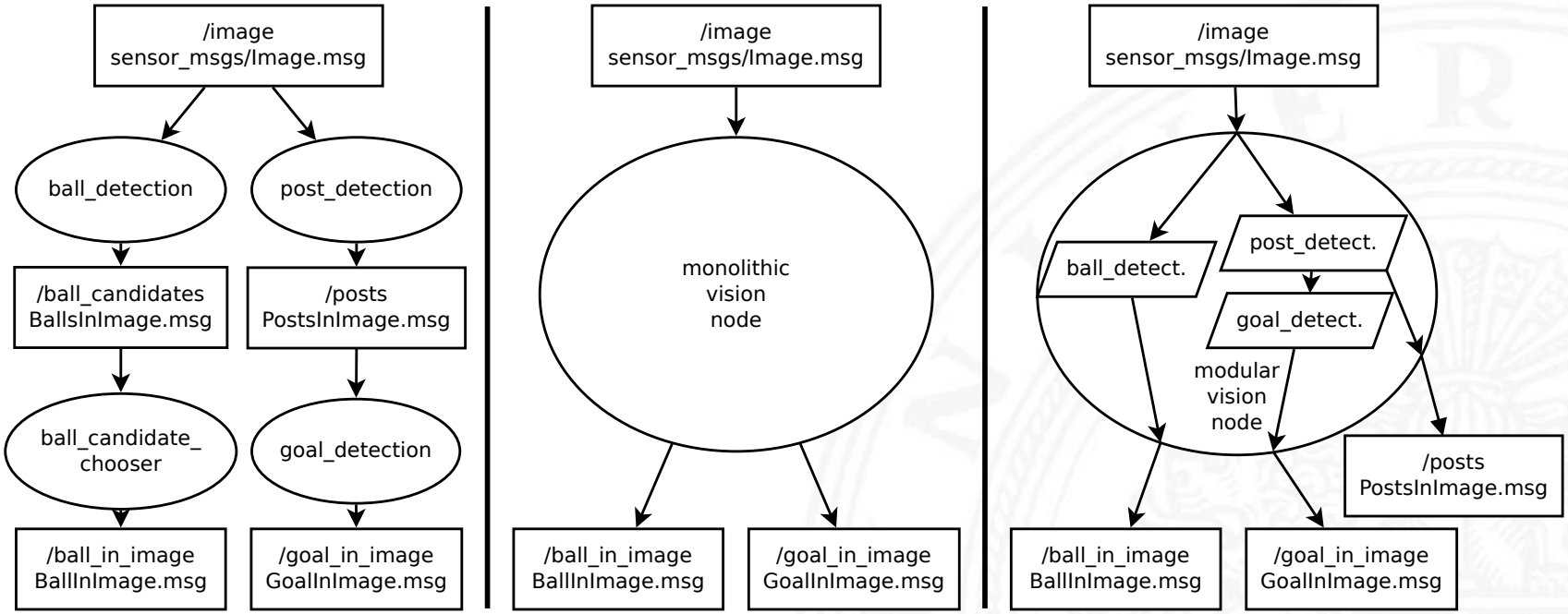
Approach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post_detect.
goal_detect.
modular
vision
node
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BallInImage.msg
/goal_in_image
GoalInImage.msg

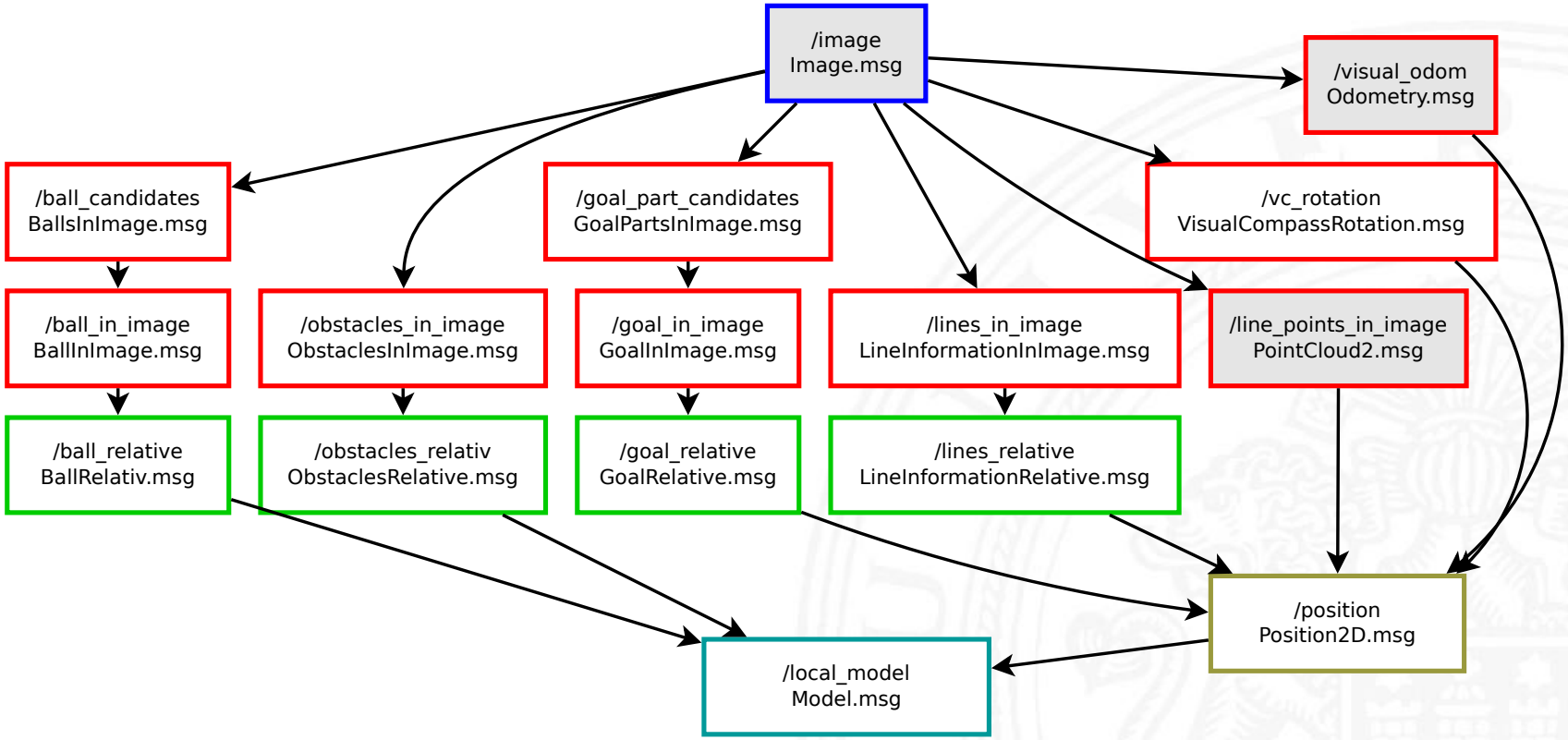
Goals

- Humanoid League
  - Definition of ROS messages for the RoboCup Soccer context
  - Provision of compatible software
    - Visualization tools
    - Simulation environment
    - League specific modules
- Hamburg Bit-Bots
  - Transfer of the robot control software to ROS
  - URDF model of the Minibot

Architecture

- Architecture defined by ROS messages
- Abstraction from concrete robot platform
- Usage of standard ROS messages (grey) as far as possible
- Three parts: sense, plan and act

Vision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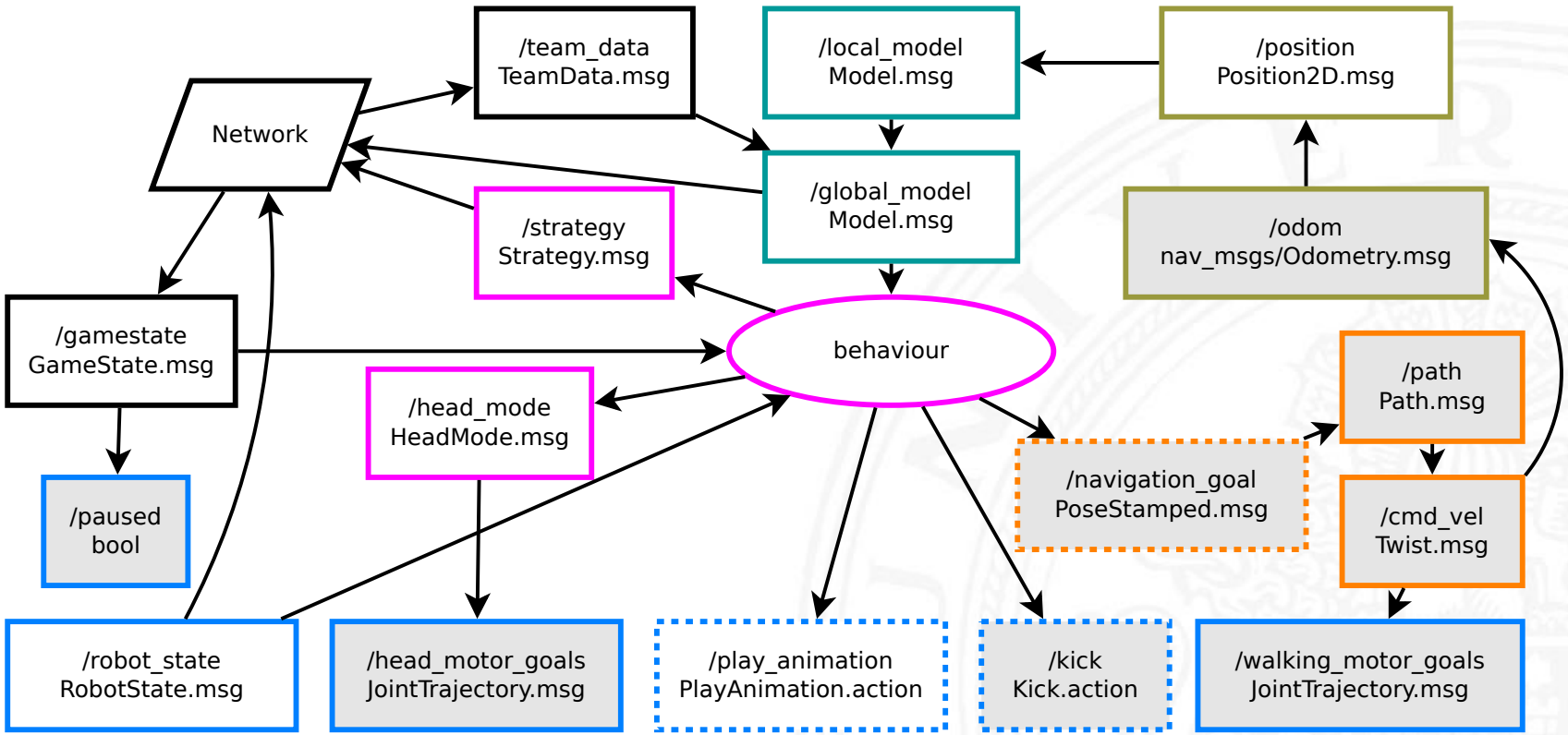
/local_model
Model.msg

Behaviour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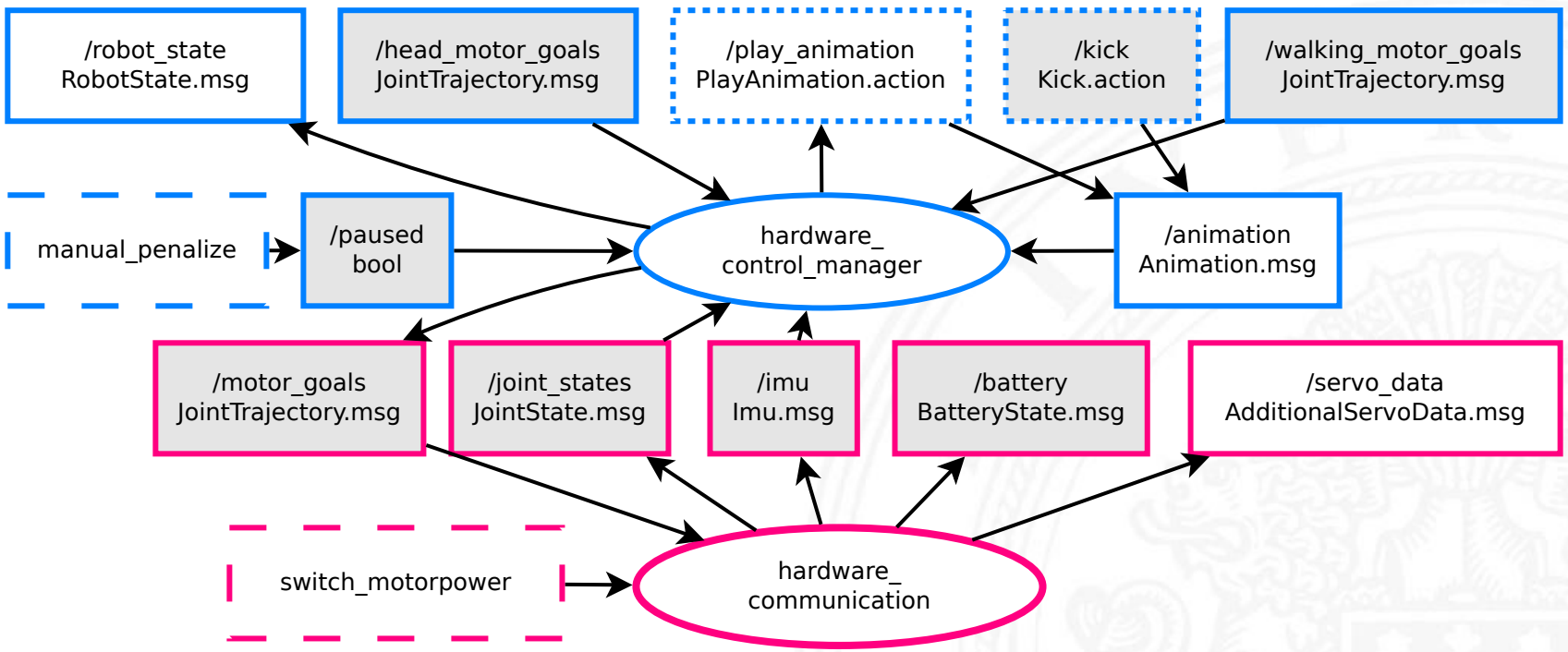
/kick
Kick.action
/walking_motor_goals
JointTrajectory.msg

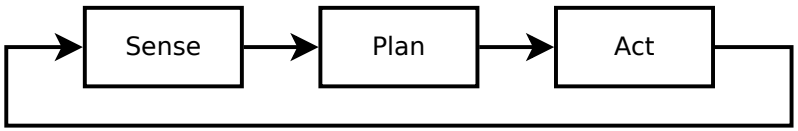
Robot Control



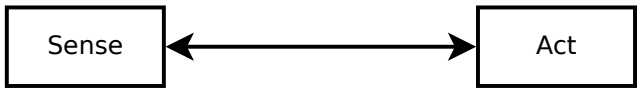
Robotic Paradigm

- Very similar to the hierarchical paradigm
- HCM can be seen as reactive behavior
- Behavior can consist of multiple reactive behaviors

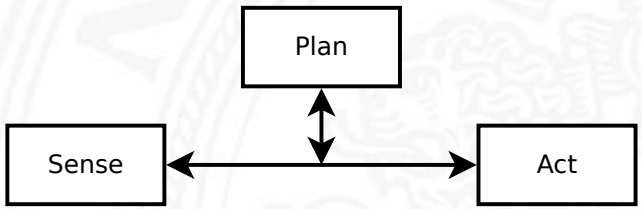
Hierarchical/Deliberative Paradigm



Reactive Paradigm



Hybrid Deliberative/Reactive Paradigm



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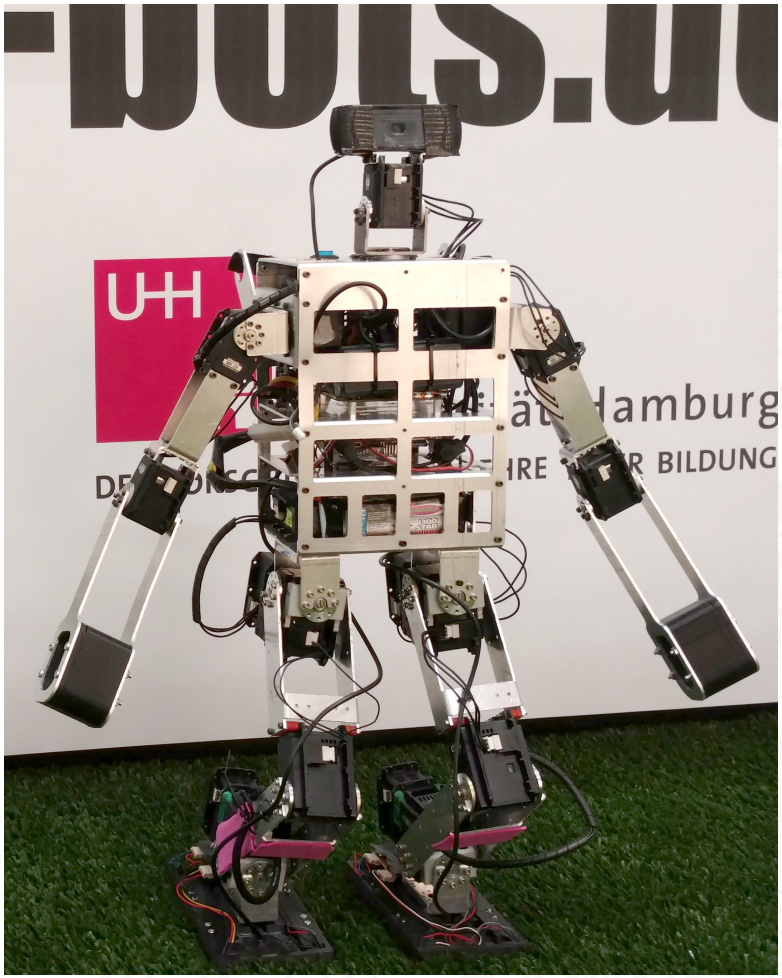
Used Platform

- Minibot
- Own construction
- Upscaled kinematic layout of the Darwin-OP
- 20 degrees of freedom
- Typical design in the HL
- Odroid XU-3 (8 cores)



Implemented Software

- Humanoid League
  - Messages
  - Game state receiver
  - Team communication
  - rqt plug-ins
  - Gazebo world
- Hamburg Bit-Bots
  - Hardware control manager
  - Walking
  - Animation
  - Hardware communication
  - Minibot URDF

Live Demo

- Walking
- Animation
- URDF
- Gazebo
- Visualizations
  - image
  - relative
  - field

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Comparission

- Compared to the old framework
  - Usage of more than two cores
  - Better visualization and debug tools
  - Modules are more independent
  - Documentation
- Compared to the existing ROS frameworks in the HL
  - Closer to ROS standards (messages, tools, naming conventions)
  - Higher degree of modularization
  - Abstraction of used robot platform

Working with other teams

- WF Wolves already changed to the architecture
- Rhoban FC will until next year
- Standardized team communication will be obligatory next year
  - The mitecom protocol will be used
  - Usage of the implemented team com. package will be proposed
- Mixed team with WF Wolves during Iran Open
- Exchanged software modules with WF Wolves

Performance

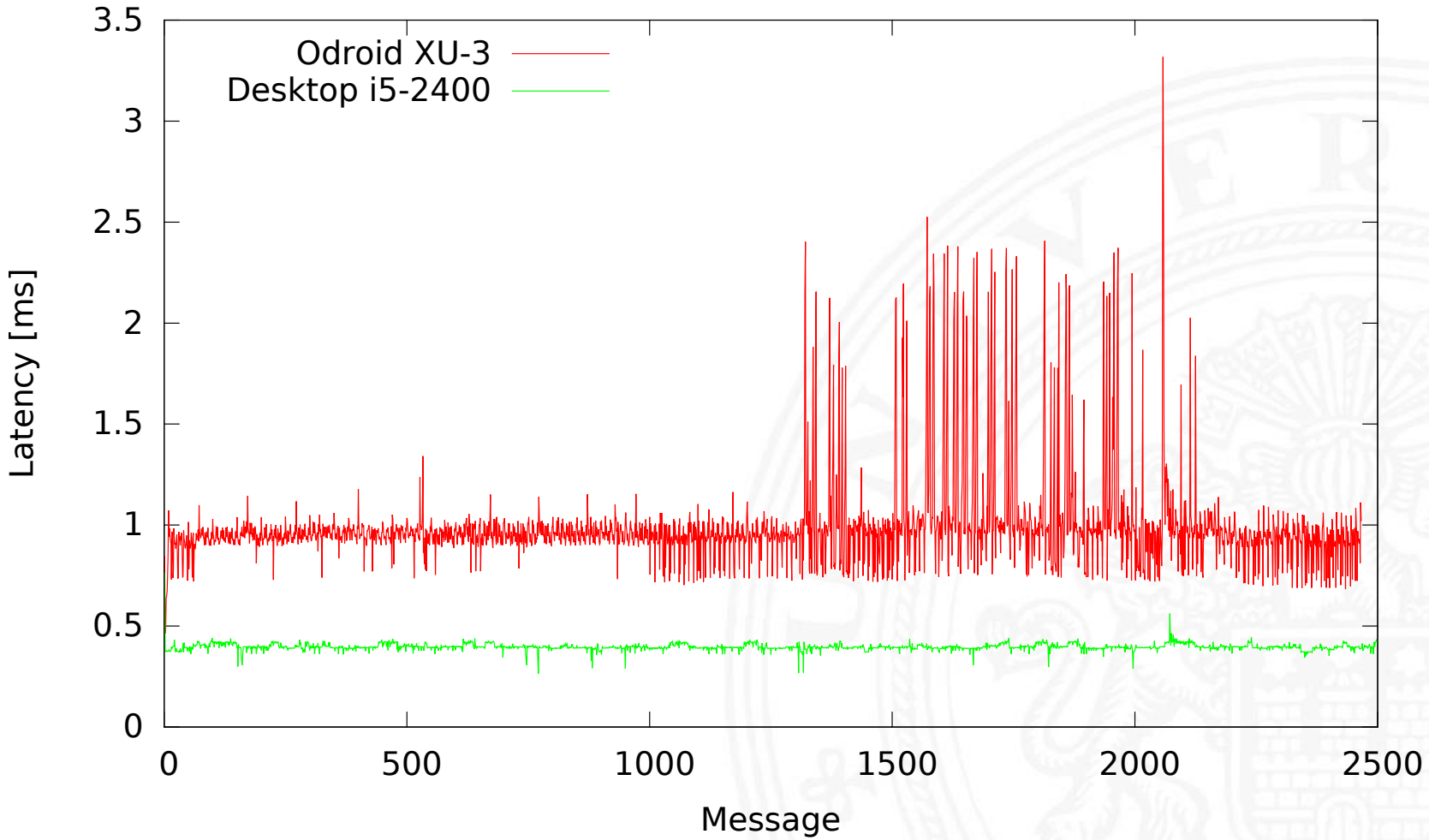
	Standing	Animation	Walking
cm730	58%	58%	58%
joint_state_publisher	4%	4%	4%
hcm	10%	20%	20%
walking	12%	12%	40%
animation	7%	46%	7%
pause	0%	0%	0%
buttons	0%	0%	0%
Sum of all nodes	91%	140%	129%
previous motion	45%	50%	60%

Latencies

From	To	Message Type	Latency
cm730	hcm	Imu.msg	7.45 ms
animation	hcm	Animation.msg	17.74 ms
walking	hcm	JointTrajectory.msg	16.90 ms
hcm	cm730	JointTrajectory.msg	32.51 ms

- Latencies are higher than expected
  - rospy
  - ARM architecture
  - Old kernel (3.10)

Latency Comparission - Imu.msg with 100Hz



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Conclusion

- The proposed architecture was successfully implemented and tested
- Improvement to previous architecture
- Easier to adapt and closer to ROS standards as others
- Already actively used by two teams
- Possible advantages in the future for the HL

Further Work

- Further work on visualization tools
- Getting more teams to use the software
- Lowering latency
- One way UDP connection for games

References

[1] https://github.com/Pold87/academic-keyword-occurrence.

[2] Taken by Hamburg Bit-Bots during Iran Open 2016,.

[3] http://www.robocup2016.org/de/symposium/team-description-papers/.

[4] Philipp Allgeuer, Max Schwarz, Julio Pastrana, Sebastian Schueller, Marcell Missura, and Sven Behnke.
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[5] Leonardo Leottau Forero, José Miguel Yánez, and Javier Ruiz-del Solar.
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[6] Morgan Quigley, Ken Conley, Brian Gerkey, Josh Faust, Tully Foote, Jeremy Leibs, Rob Wheeler, and Andrew Y Ng.
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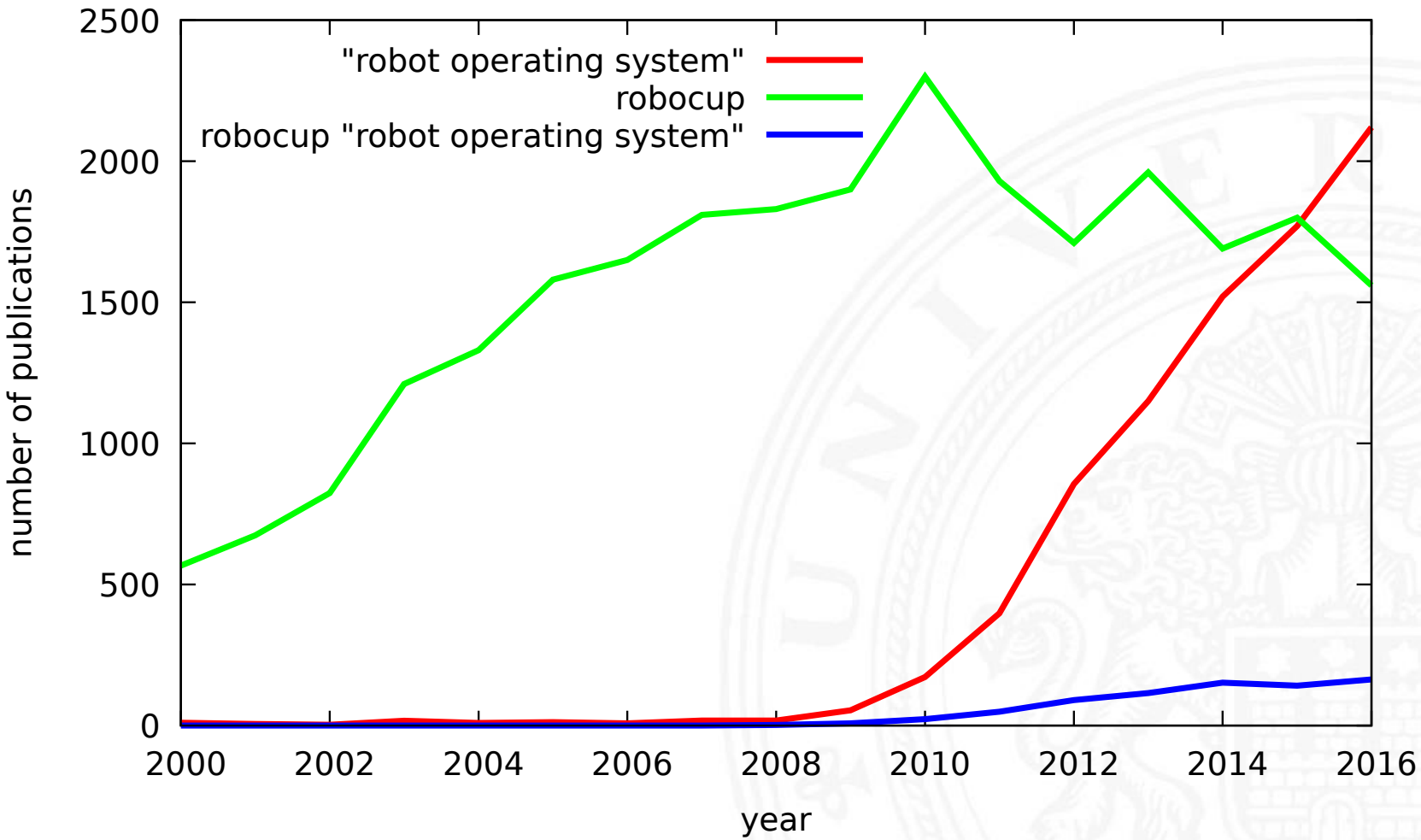
In *ICRA workshop on open source software*, volume 3, page 5. Kobe, Japan, 2009.

[7] Thomas Röfer and Tim Laue.
On B-human's code releases in the standard platform league–software architecture and impact.
In *Robot Soccer World Cup*, pages 648–655. Springer, 2013.

Questions

Questions?

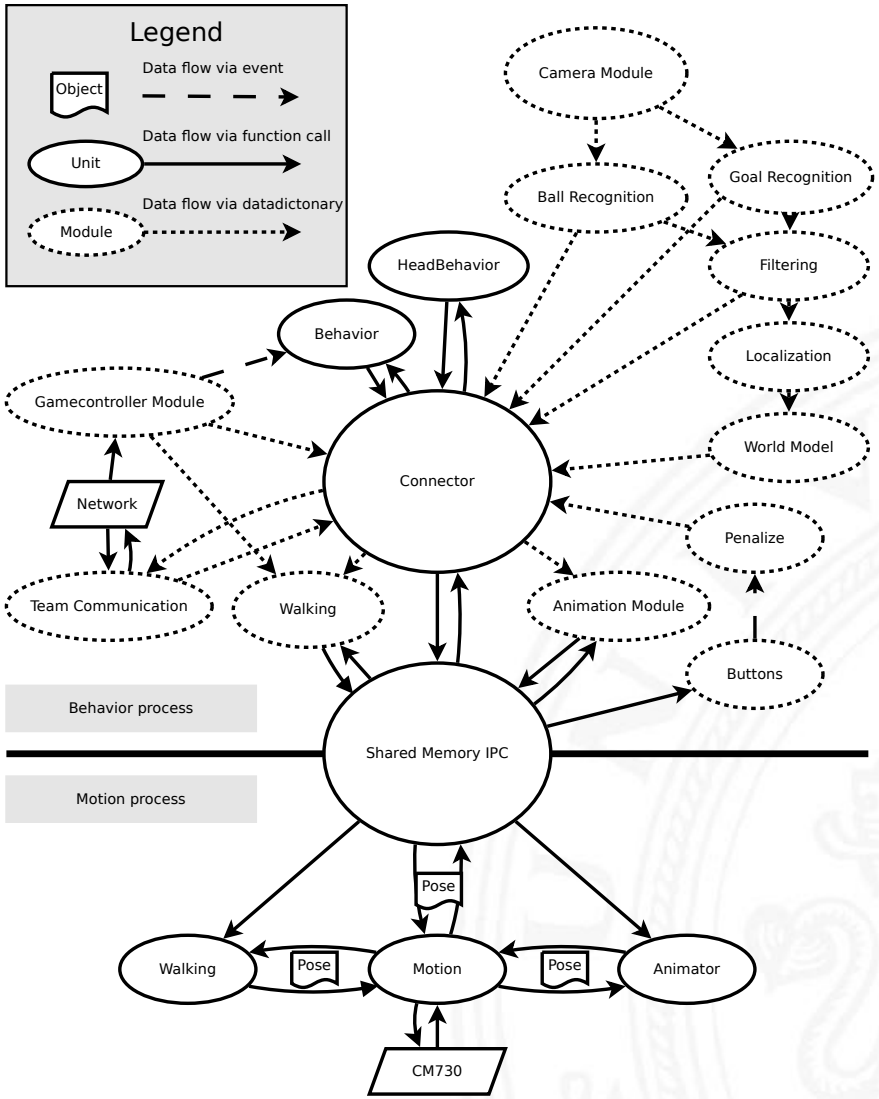
Relevance

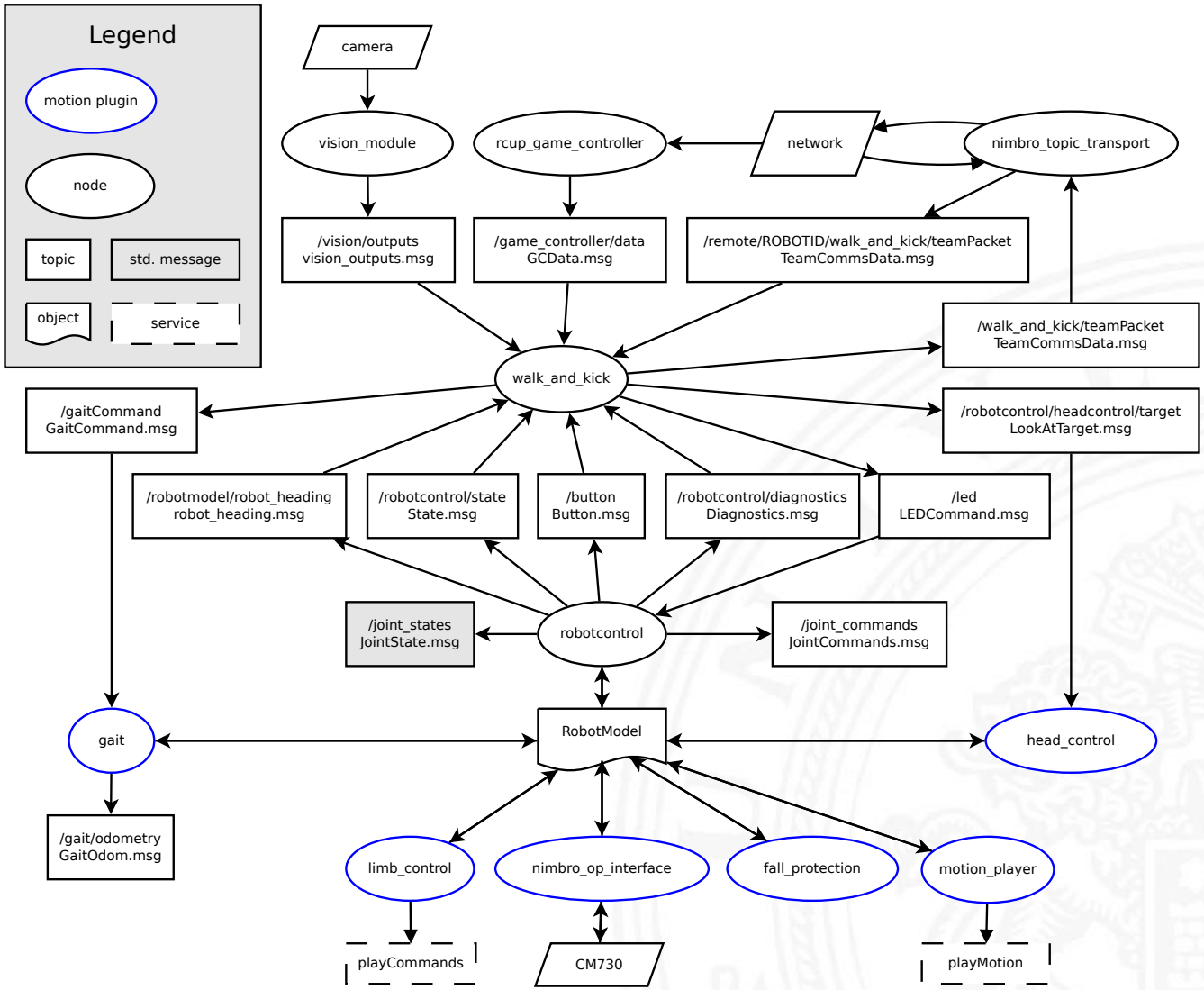

"robot operating system"
robocup
robocup "robot operating system"
number of publications
year
0
500
1000
1500
2000
2500
2000
2002
2004
2006
2008
2010
2012
2014
2016

[1]

RoboCup Leagues

RoboCupSoccer	Humanoid Standard Platform Middle Size Small Size Simulation
RoboCupRescue	Robot Simulation
RoboCup@Home	Open Platform Domestic Standard Platform Social Standard Platform
RoboCupIndustial	@Work Logistics


Legend
Data flow via event
Object
Data flow via function call
Unit
Data flow via datadictonary
Module
Camera Module
Goal Recognition
Ball Recognition
Filtering
HeadBehavior
Behavior
Localization
Gamecontroller Module
World Model
Connector
Network
Penalize
Team Communication
Walking
Animation Module
Buttons
Behavior process
Shared Memory IPC
Motion process
Pose
Walking
Pose
Motion
Pose
Animator
CM730


Legend
motion plugin
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std. message
object
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rcup_game_controller
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GCData.msg
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Button.msg
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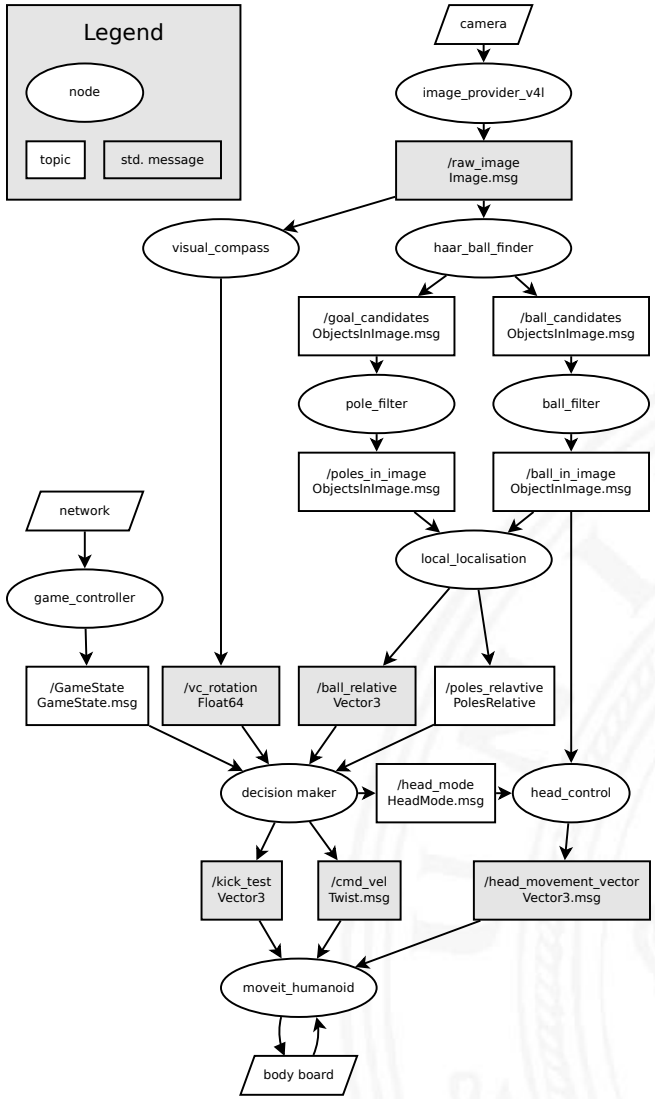
CM730
playMotion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Vector3
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Vector3.msg
moveit_humanoid
body board