Simulators for Humanoid Robots

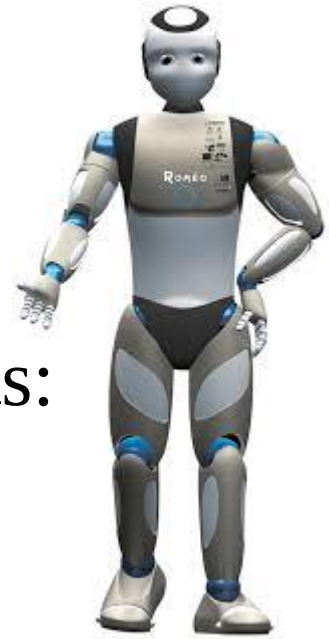
Olivier Stasse

Robotex TechDays 03/07/2013

LAAS-CNRS

Motivations

- DARPA Grand challenge
  - (GAZEBO)
- European Projects:
  - Koroibot
  - Euroc
  - Codyco
- New humanoid robots:
  - iCub
  - Romeo
  - TORO (OpenHRP)



LAAS-CNRS

Use case 1: Stepping over obstacles

Use case 1: Stepping over obstacles

Contact handling:

Penality base method:
Too far from reality !

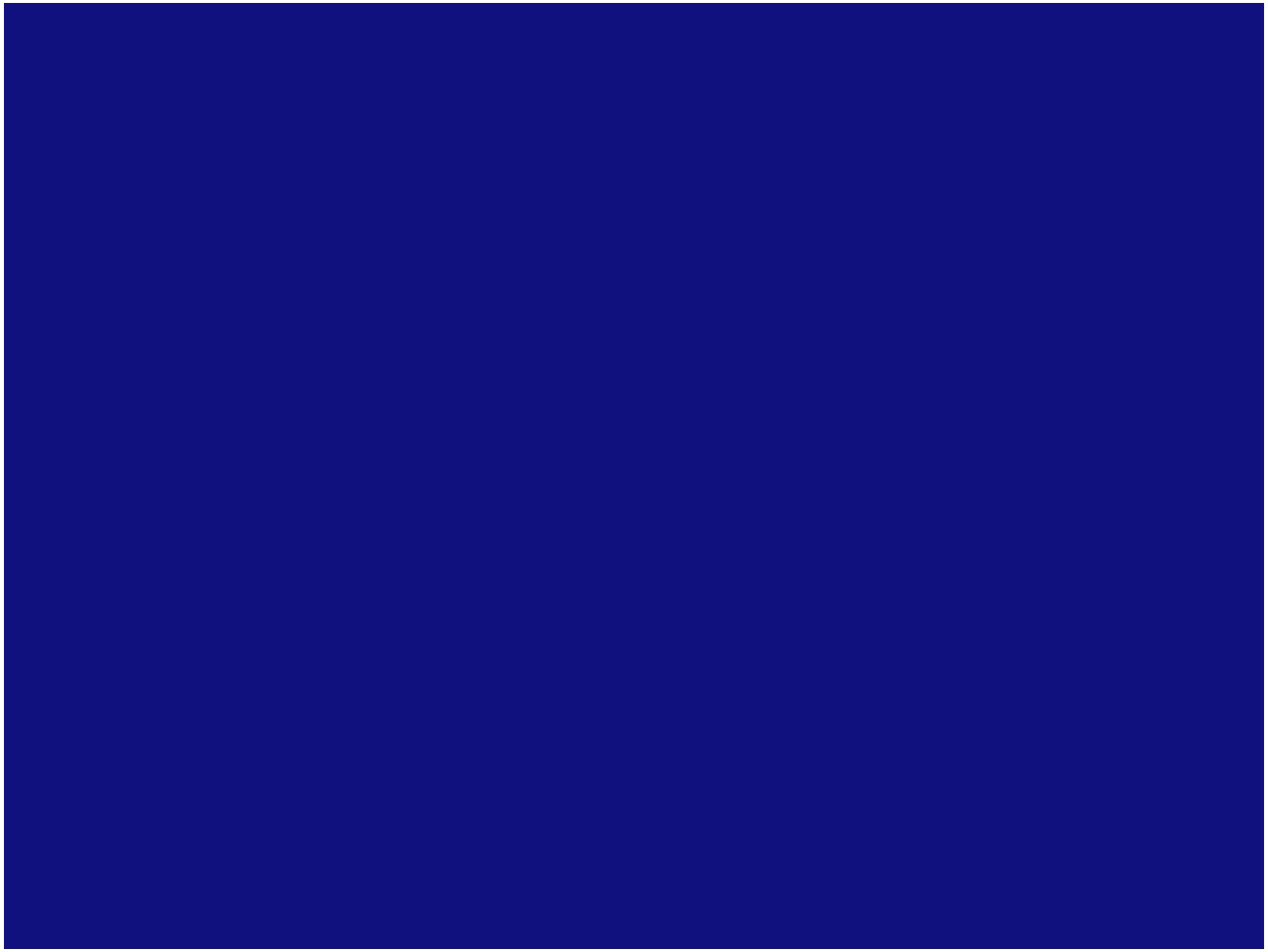
Linear Complementary Problem:
Close to reality !

Recent versions of Bullet and ODE uses LCP based methods.

Use case 2: Integration

LAAS-CNRS

Use case 3: Visual servoing



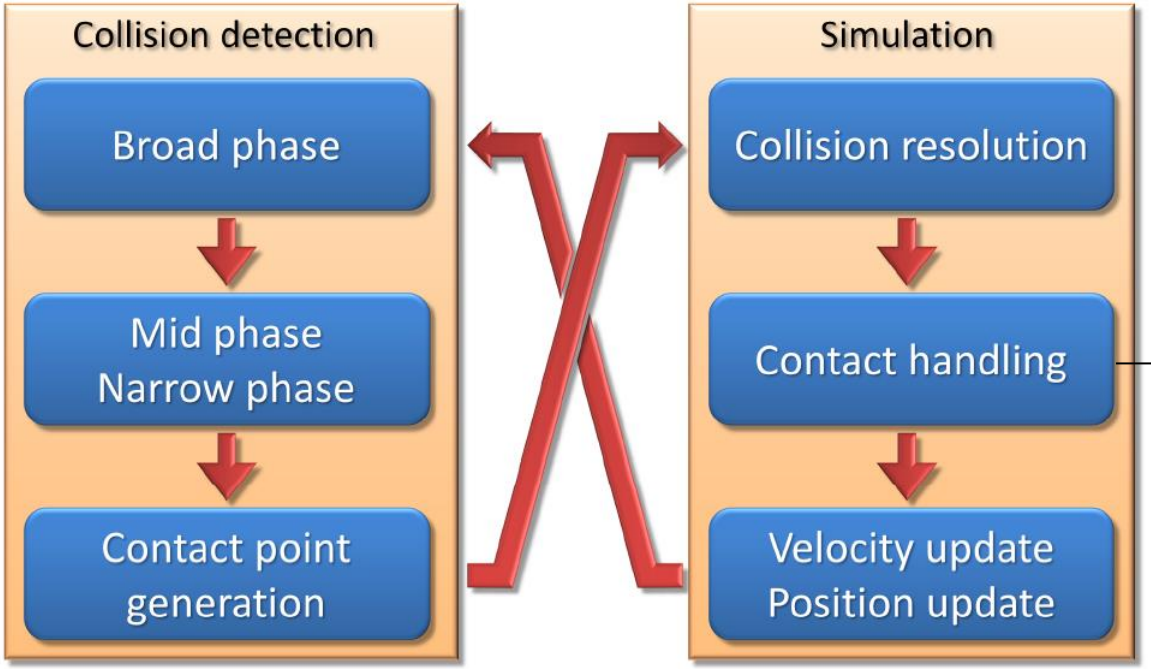
Needs (1/2)

- Realistic contact model:
  - Stable Manipulation
  - Prevent breaking robot
  - Preference for Iterative Gauss Seidel LCP resolution
  - Included in the last versions of Bullet and ODE.
- System simulator
  - Planner, Vision, SLAM, Decision (HFSM, Smash) Display for debugging, Controlling the safety mechanical (crane, cameras)
  - Rerun the data
- Integration with
  - ROS
  - YARP
  - Orocos

Needs (2/2)

- Generating automatically models
  - Nao: dozens of version at Aldebaran
  - HRP-2: Robot evolves according to new hardware + DOFs addition
  - HRP-4
  - iCub (constantly evolving)
  - 30 DOFs
  - New actuators (Variable Stiffness actuator)
  - URDF is imposing itself as the standard

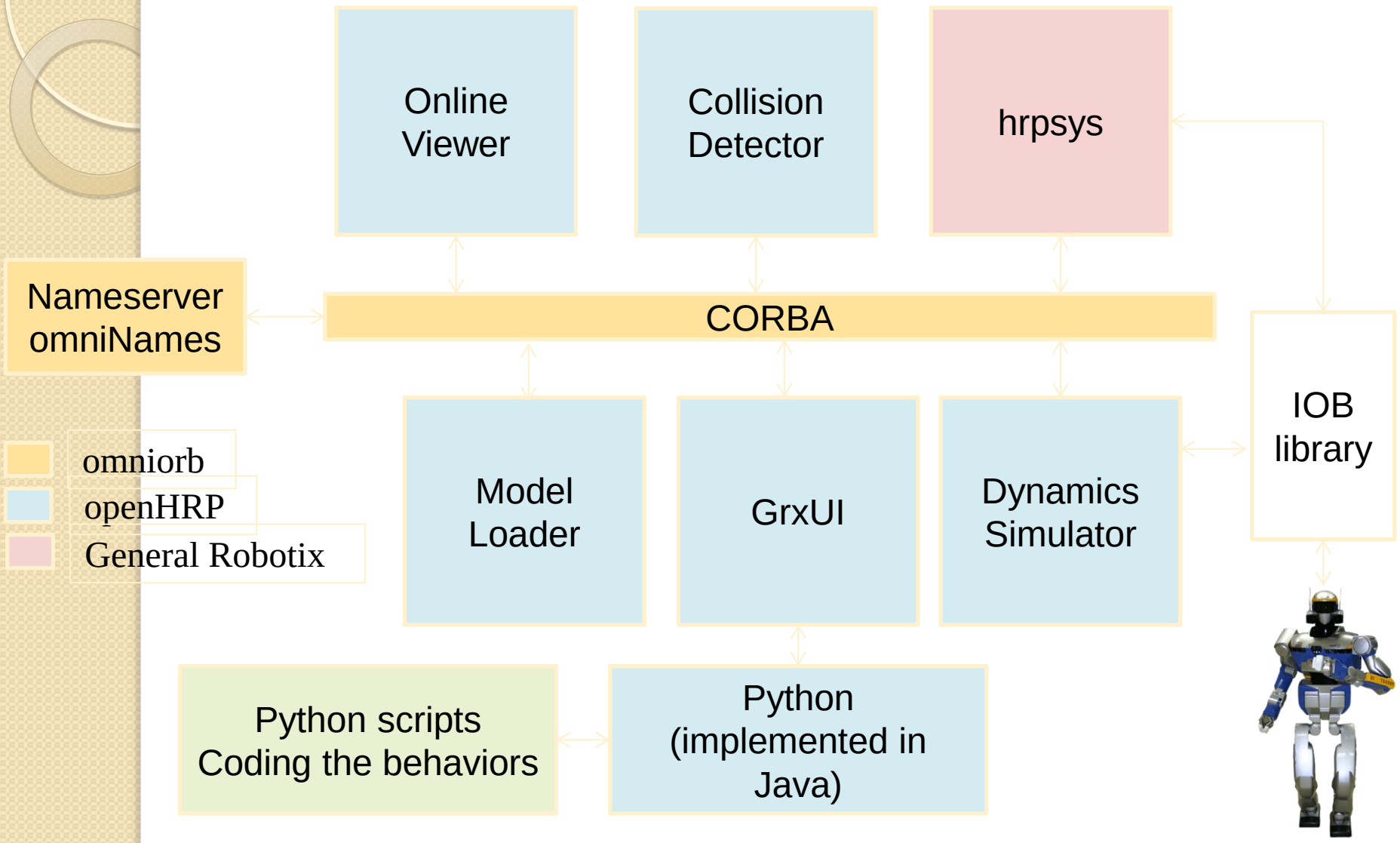
Simulator steps



If the LCP problem is too big, the joints constraints for the robots become unrealistic (Bullet & ODE)

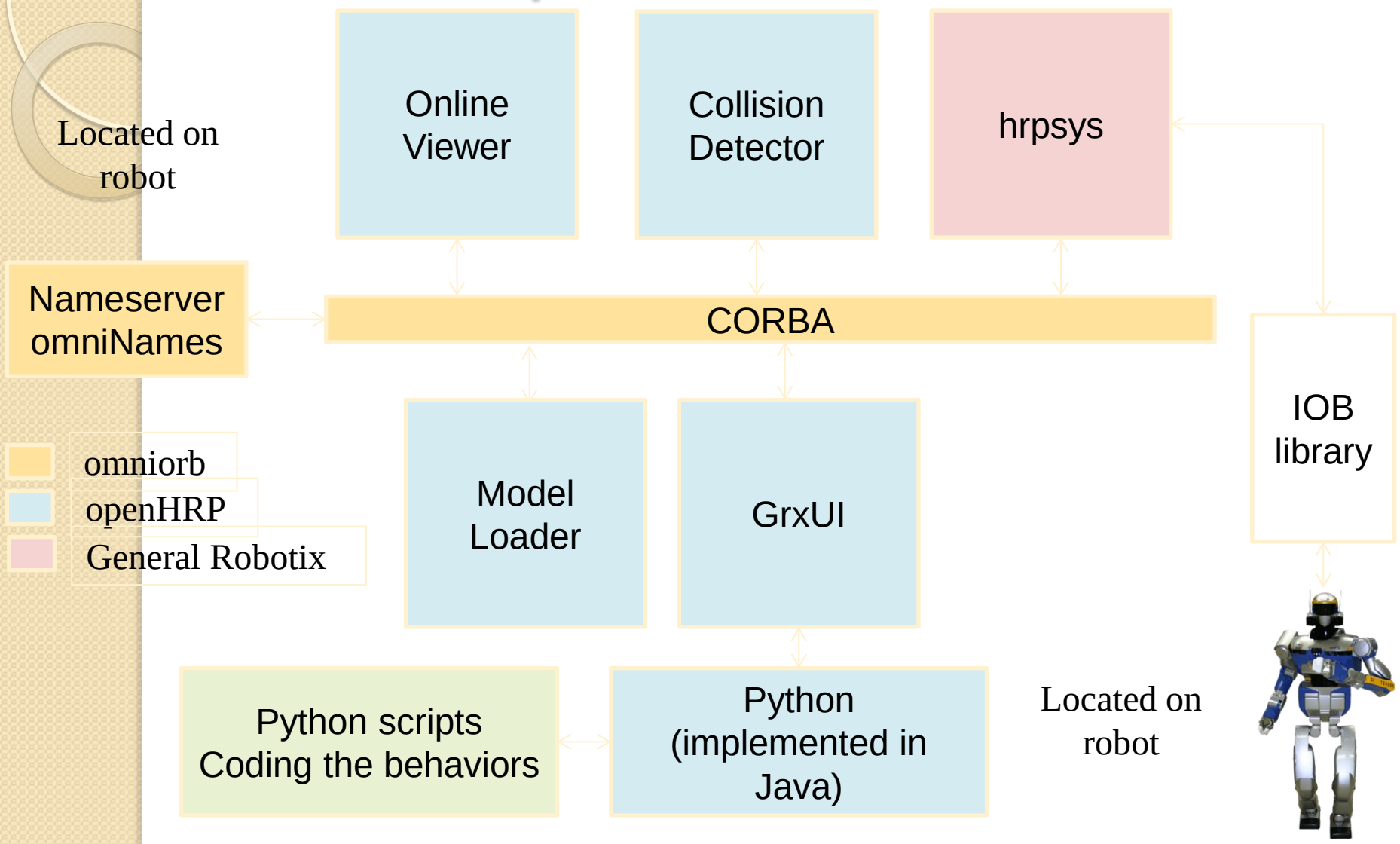
Needs to integrate kinematic tree for the robot

Software – OpenHRP 3.1.0



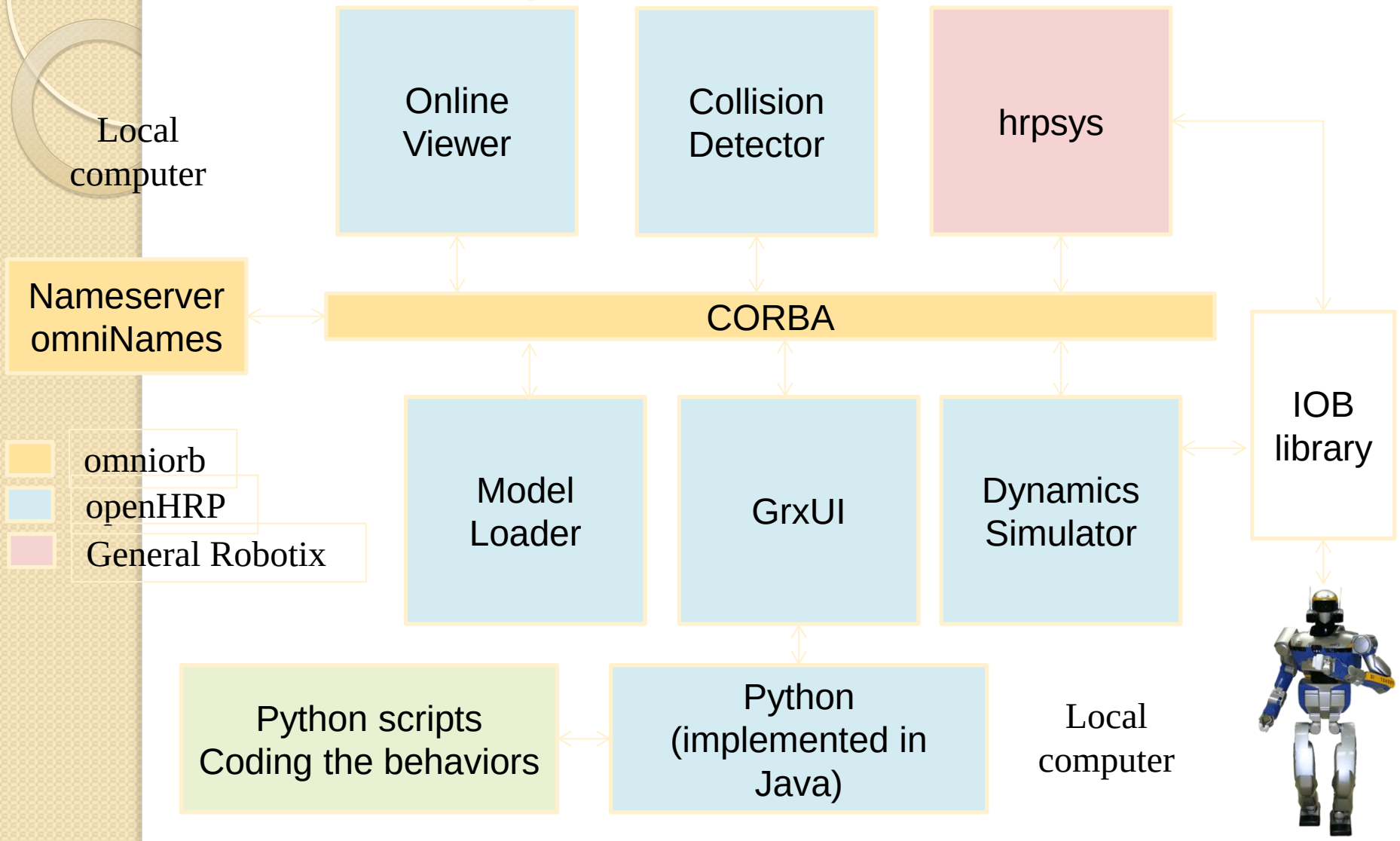
LAAS-CNRS

Software – OpenHRP 3.1.0 - Robot



LAAS-CNRS

Software – OpenHRP 3.1.0 - Simu



LAAS-CNRS

OpenHRP Dynamical simulator

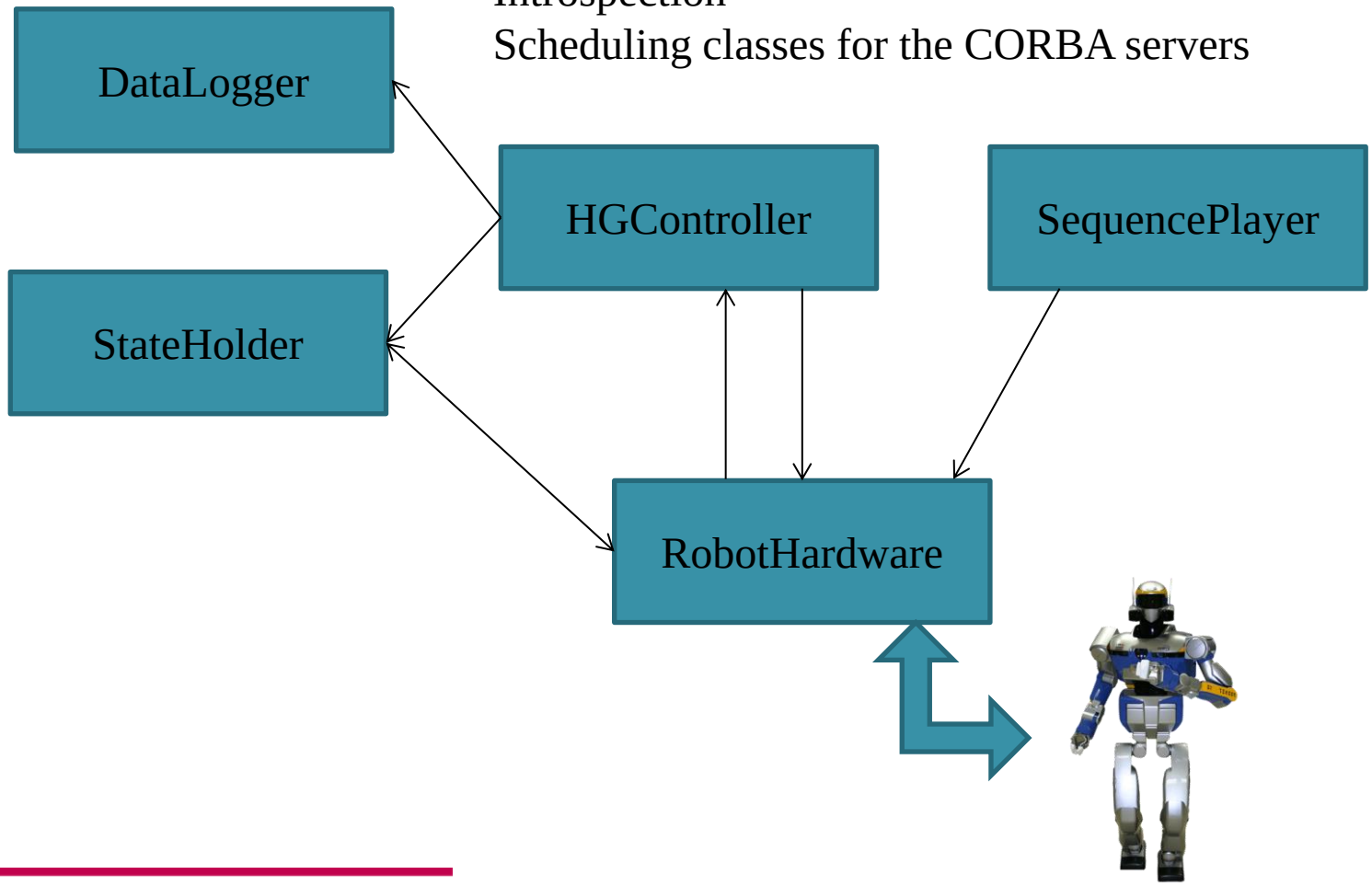
- Dynamic simulation: Feathersone's ABA
  - Mostly targeted towards Multibody rigid bodies
  - Takes the torques computed by PID
- Contact Model:
  - LCP
  - Resolution scheme: Gauss Seidel Pivot

    Very accurate !

    Detect problematic situation.
- Software integration:
  - Maintained by AIST (required by the Japanese government)
  - Eclipse
  - Windows, Linux binaries availables
- System simulator

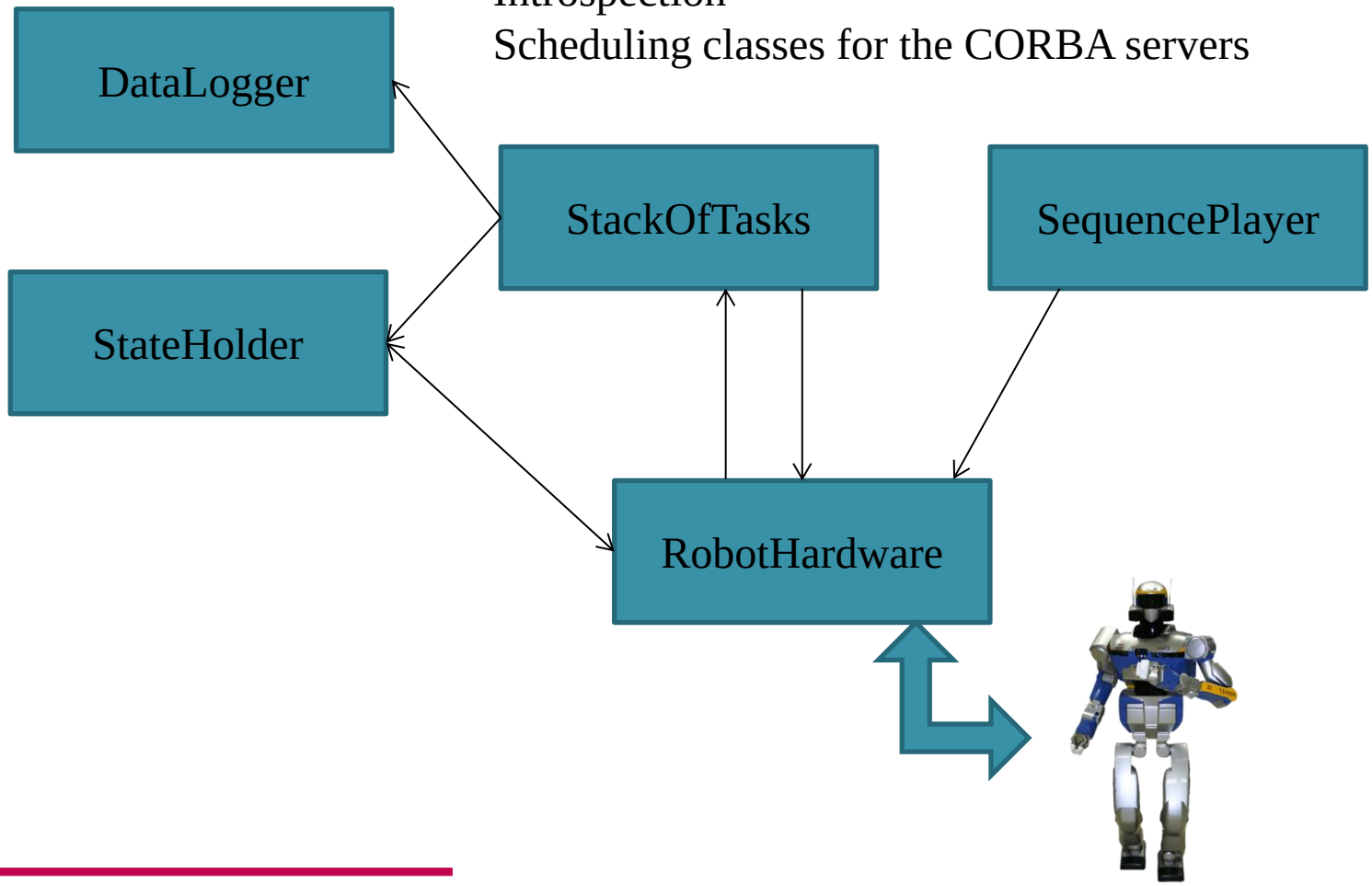
Hrpsys – OpenRTM

Input – output ports
Service ports
Introspection
Scheduling classes for the CORBA servers

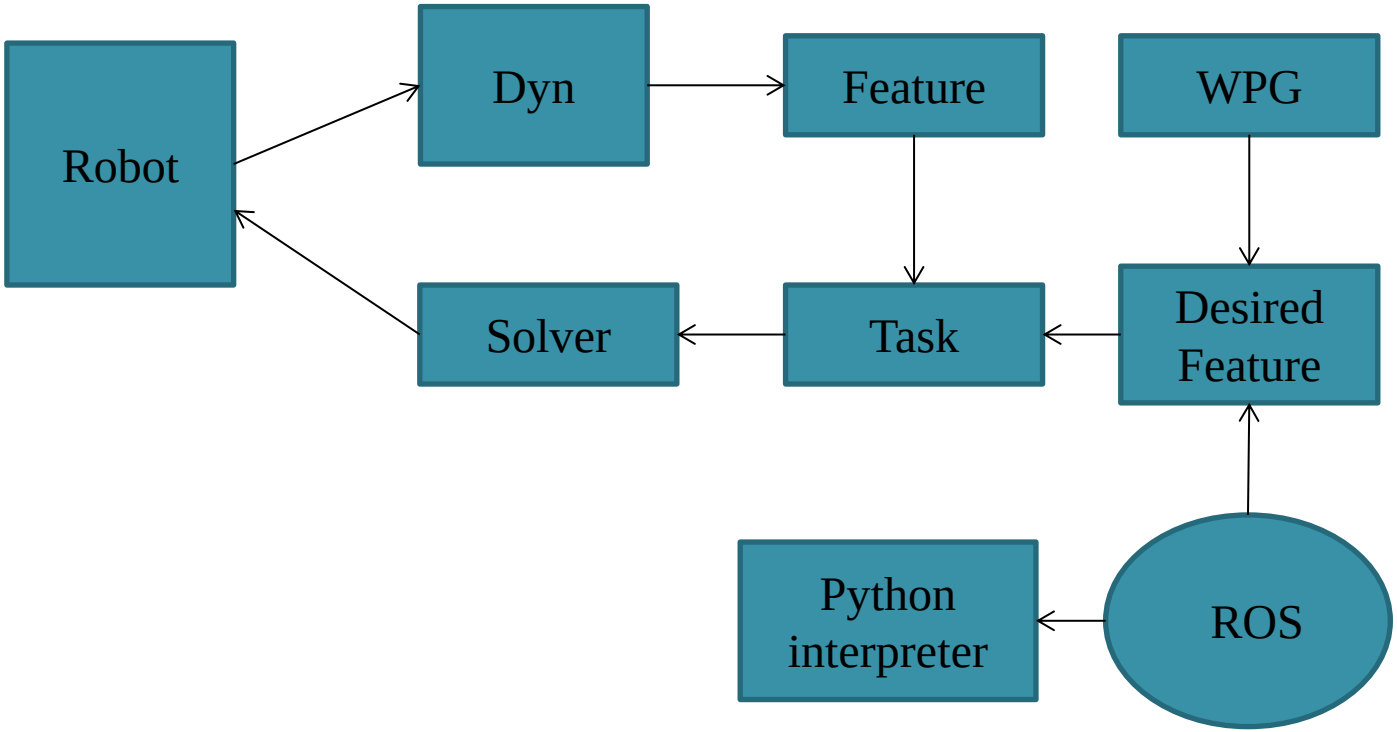


Hrpsys – OpenRTM

Input – output ports
Service ports
Introspection
Scheduling classes for the CORBA servers



Stack Of Tasks



C++ framework
Data flow
Graph control through python

LAAS-CNRS

Control simulation

- Inverse dynamics for control usually different from simulation

- Metapod – Template C++ for RNEA 6us for a 35 DOFs humanoid robot
  - LGPL
  - Aldebaran support
  - Semi-symbolic

Comparison

	System	Control Inv. Dyn.	Vision	Contact Solver	Handling ragdolls	Open Source	Scene graph	Control Scheme
OpenSIM		X		LCP	X	X		X
Gazebo	X		X	Bullet		X	X	
Morse	X		X	Bullet		X	X	
OpenHRP	X	X	x	LCP	X	X	x	
XDE	X	X	x	LCP	X		X	X
Humans		X			X	x		X
Robotran		X				X		
Mujoco		X			X			X

LAAS-CNRS

Conclusion

- There is a need for a complete solution:
  - System simulator
  - Accurate Physical Model in the vicinity of the robot
- A full complete solution do not exist yet:
  - There is an opportunity to build up a common tool !