RoboStar Technology
Software Engineering for Robotics

Ana Cavalcanti

University of York, UK - RoboStar (www.cs.york.ac.uk/RoboStar)

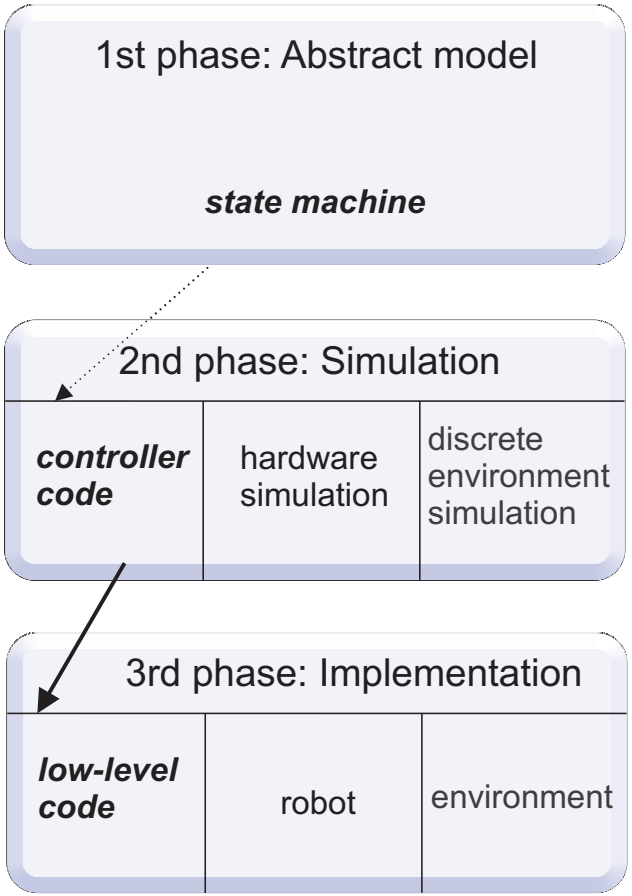
14th of November, 2019

Thanks: *Alvaro Miyazawa, Pedro Ribeiro, Augusto Sampaio, Jon Timmis*

Outline

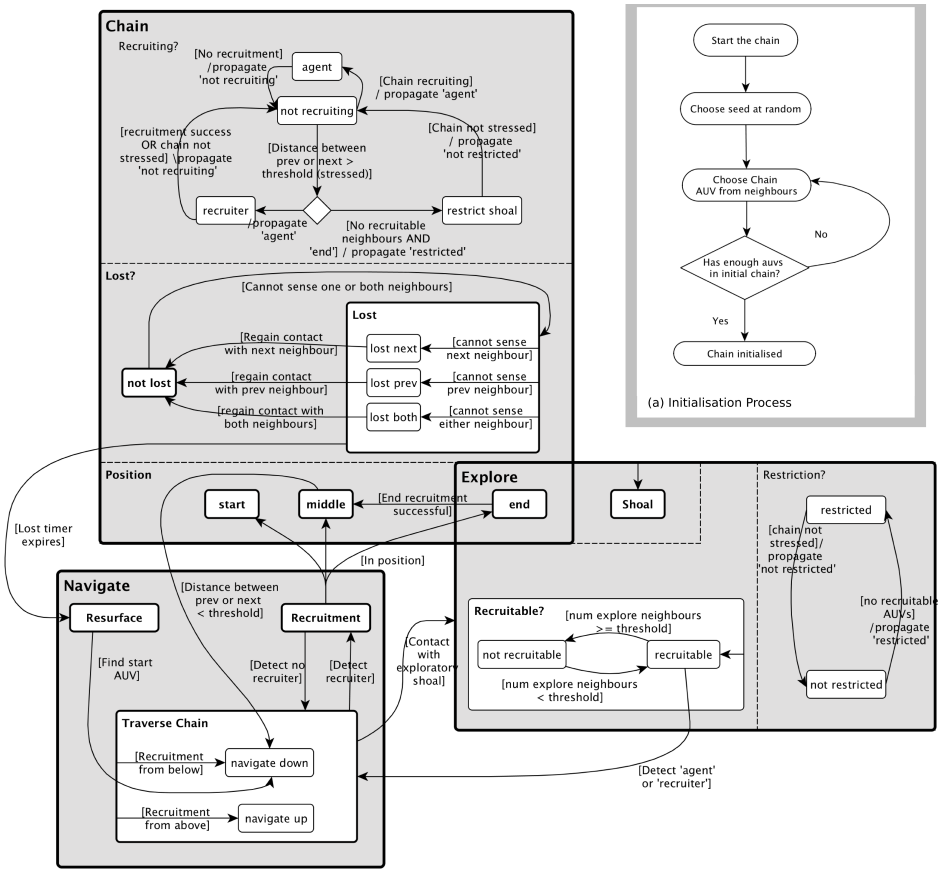
- Motivation: current approach
- Our approach
- Simulation generation
- RoboSim
- Physical modelling
- Future work

Current approach to development in robotics



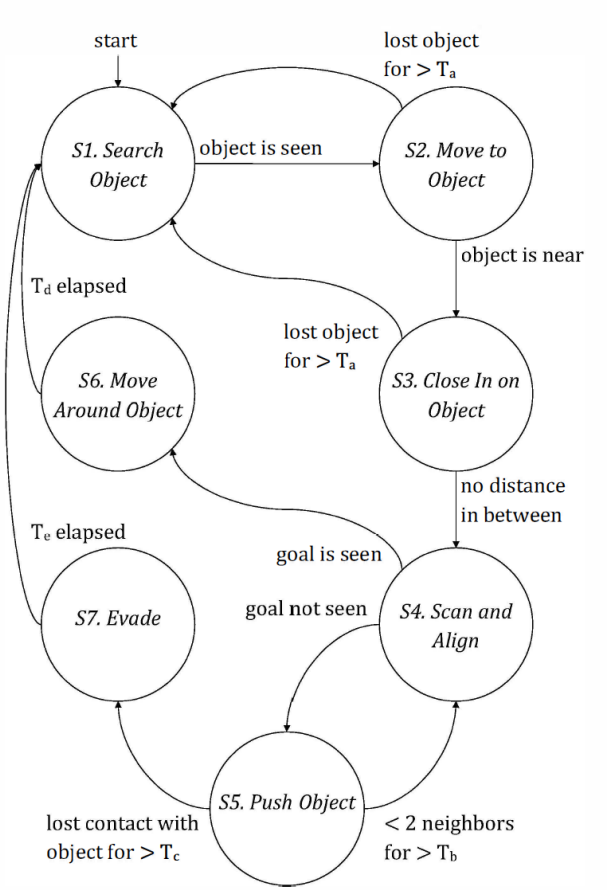
- Outdated
- No use of models
- No tool support
- Programming-based
- Trial-and-error based
- No assurance

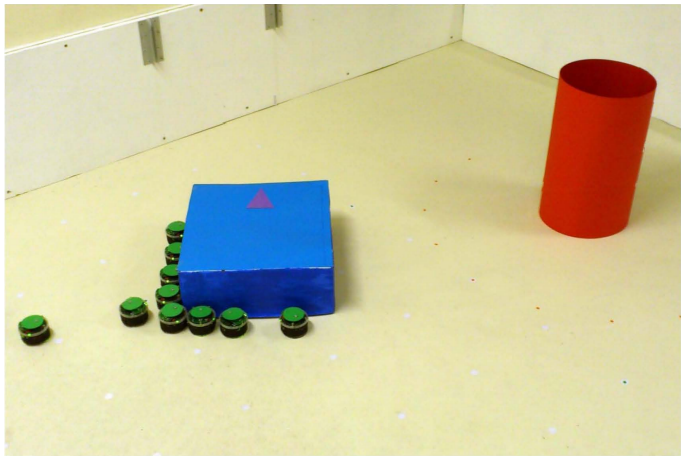
Example state machines



Becky Naylor, Mark Read, Jon Timmis, and Andy Tyrrell.
The Relay Chain: Communication between an Exploratory Underwater Shoal and a Surface Vehicle.
ALIFE 14: Proceedings of the 14th International Conference on the Synthesis and Simulation of Living Systems.

Example state machines

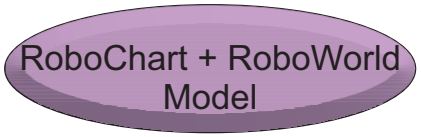




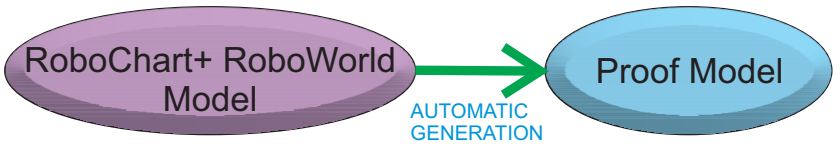
"A group of e-puck robots transporting an object (blue box) towards a goal (red cylinder)."

Jianing Chen, M. Gauci and R. Gross. "A strategy for transporting tall objects with a swarm of miniature mobile robots". In: Robotics and Automation (ICRA), 2013 IEEE International Conference on. 2013, pp. 863–869.

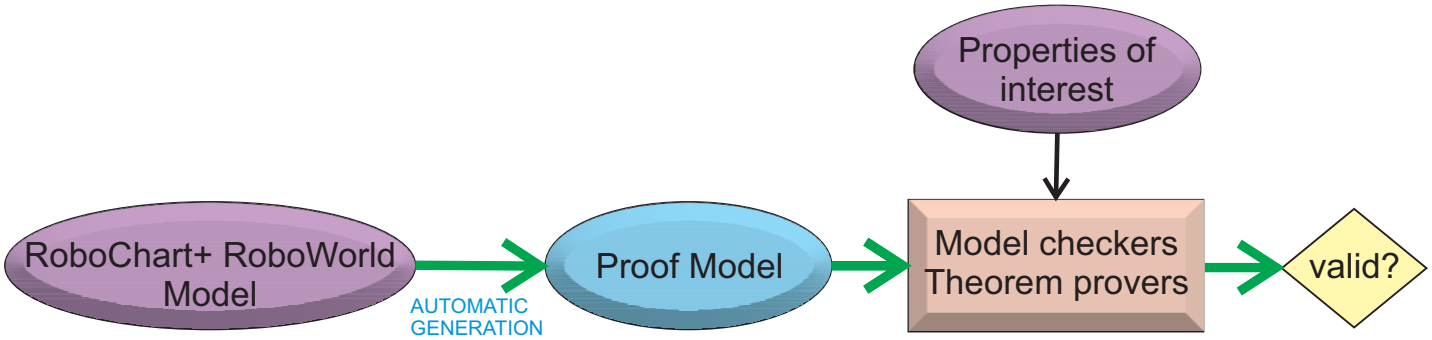
Our approach



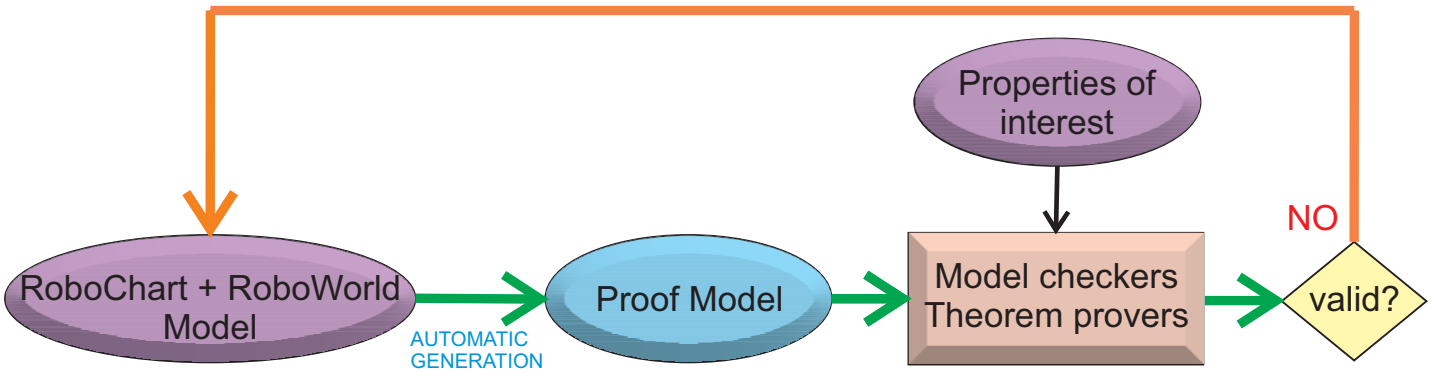
Our approach



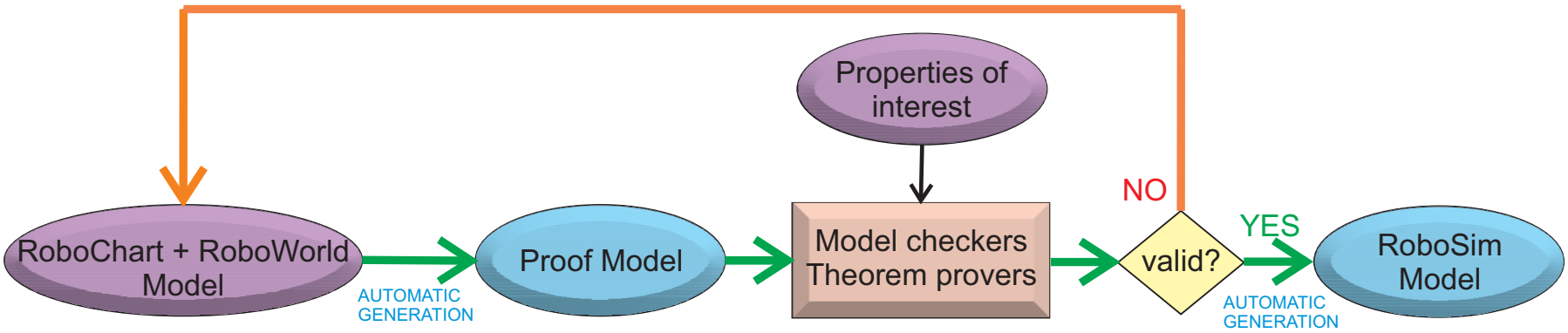
Our approach



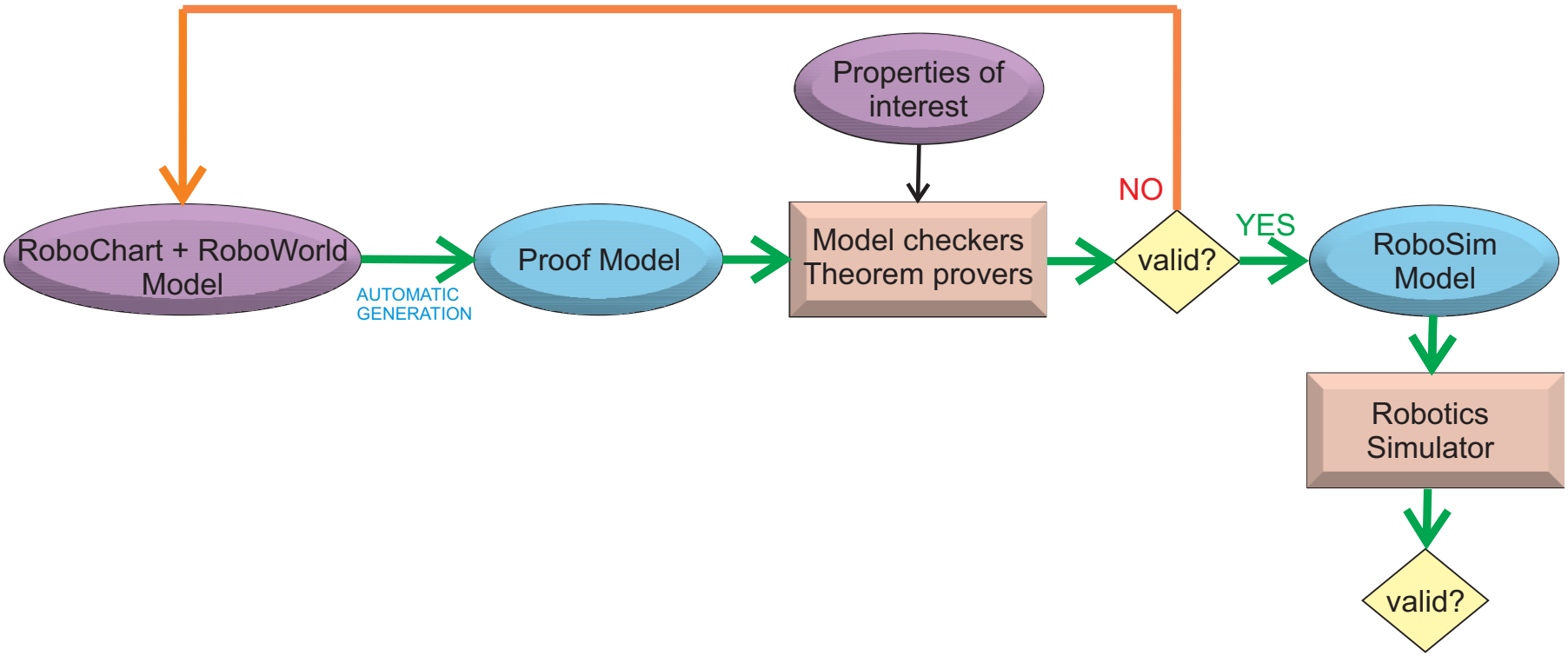
Our approach



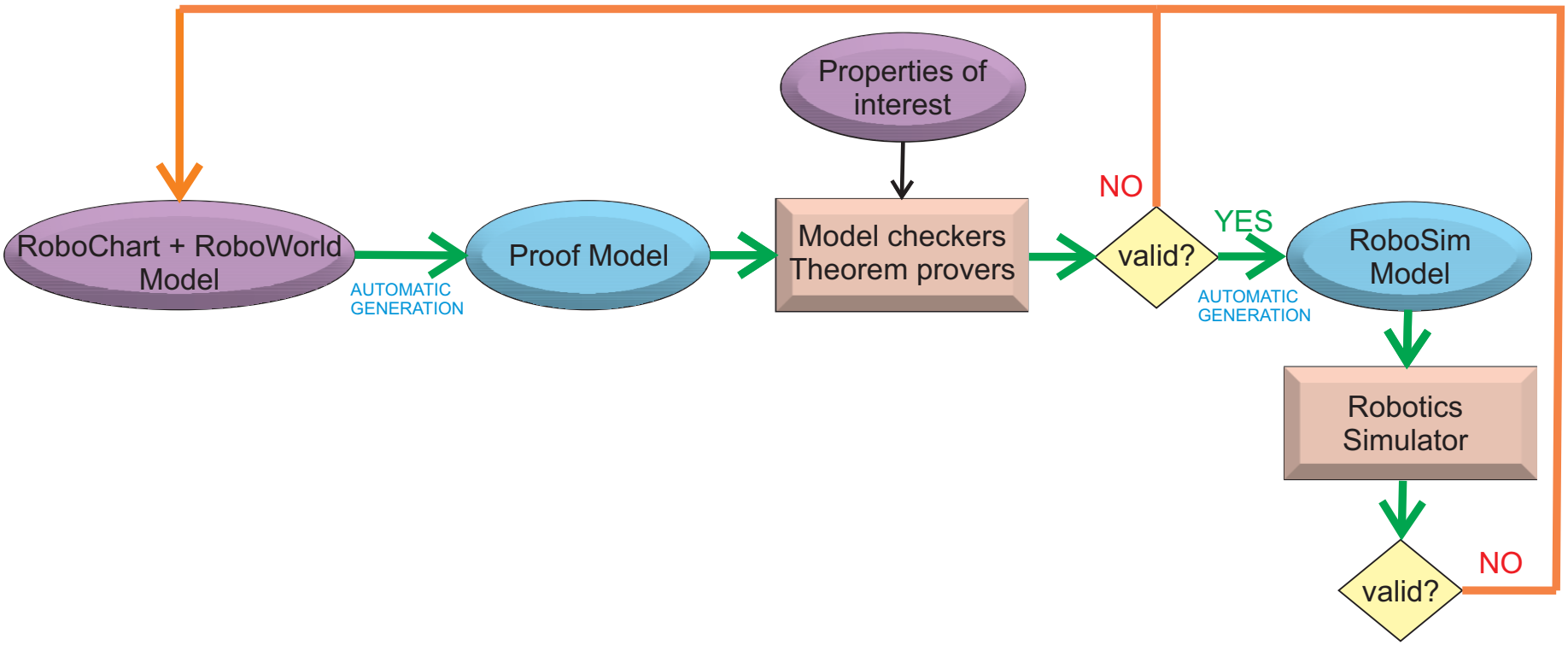
Our approach



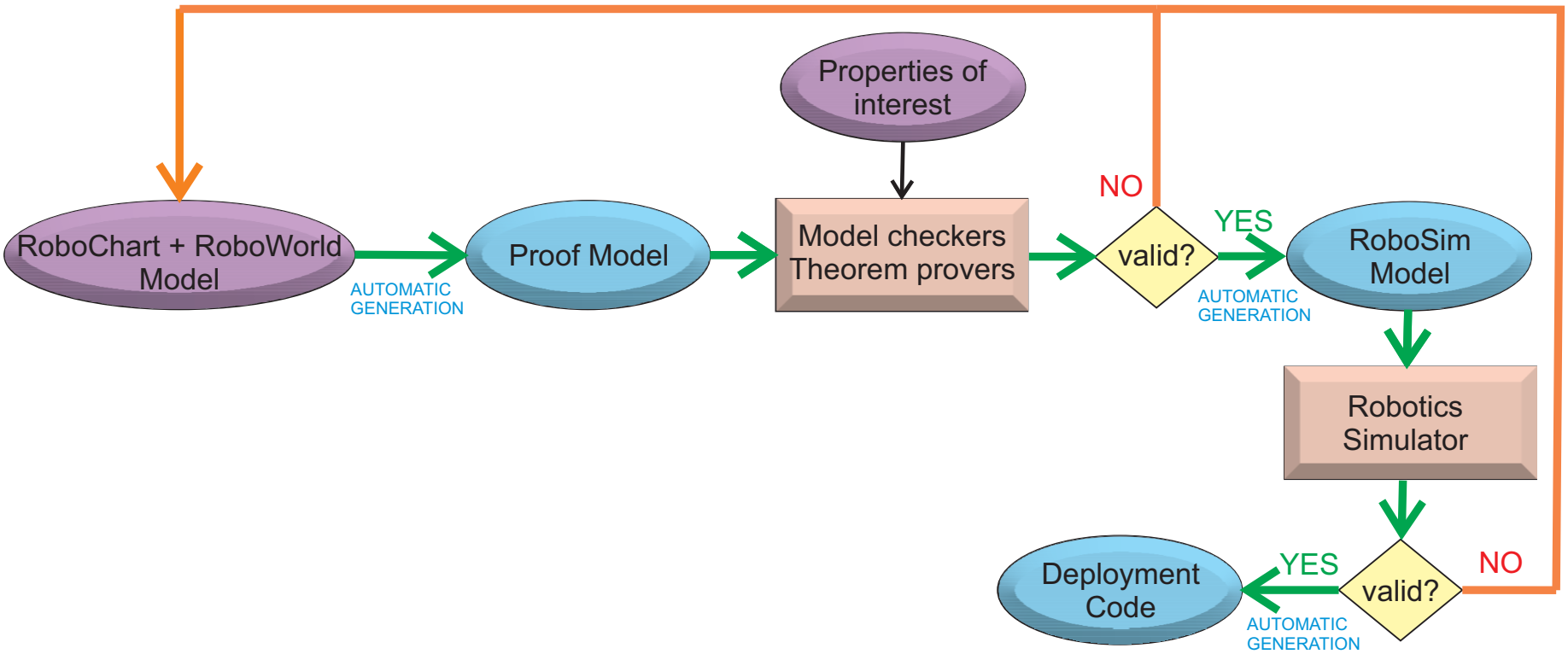
Our approach



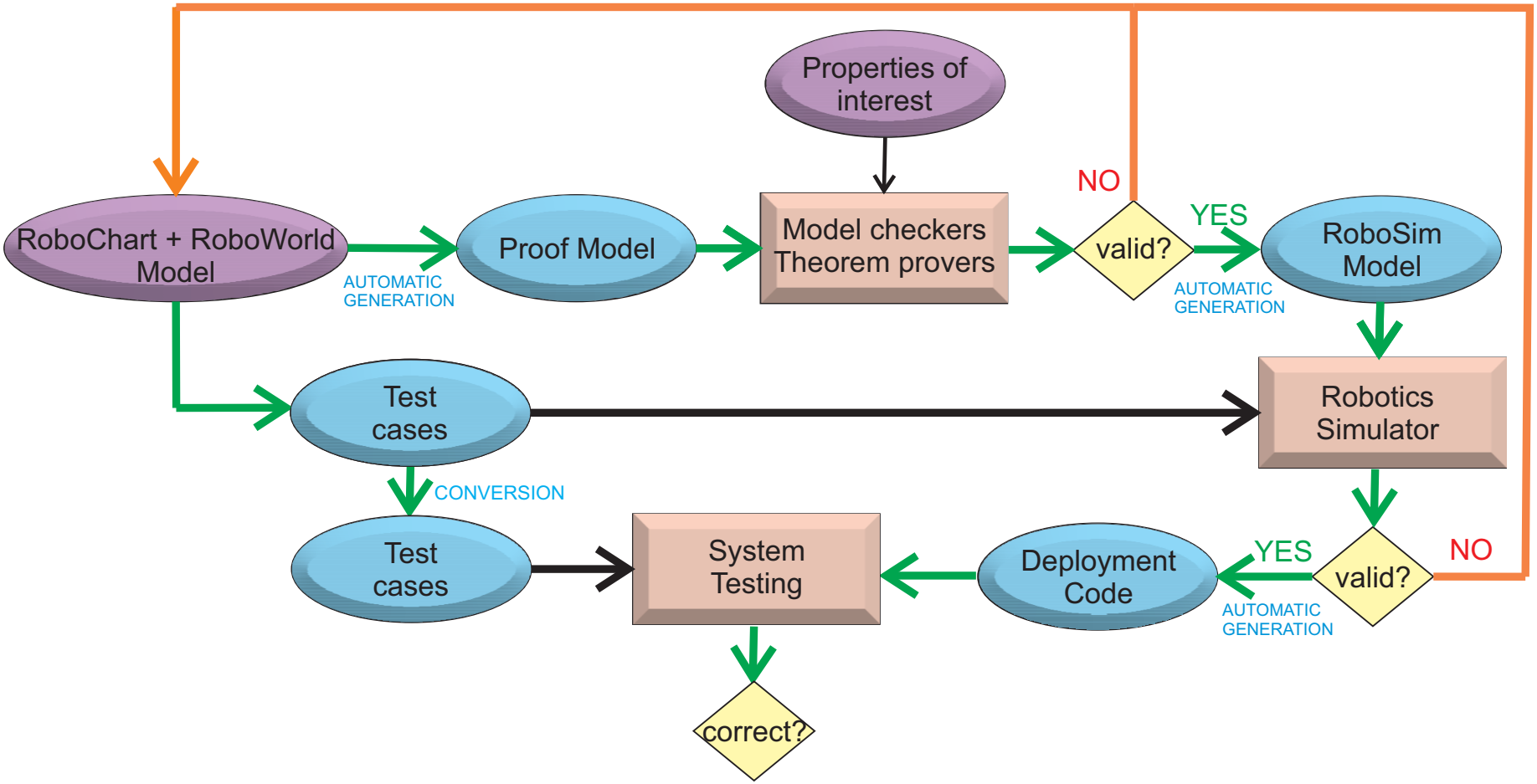
Our approach



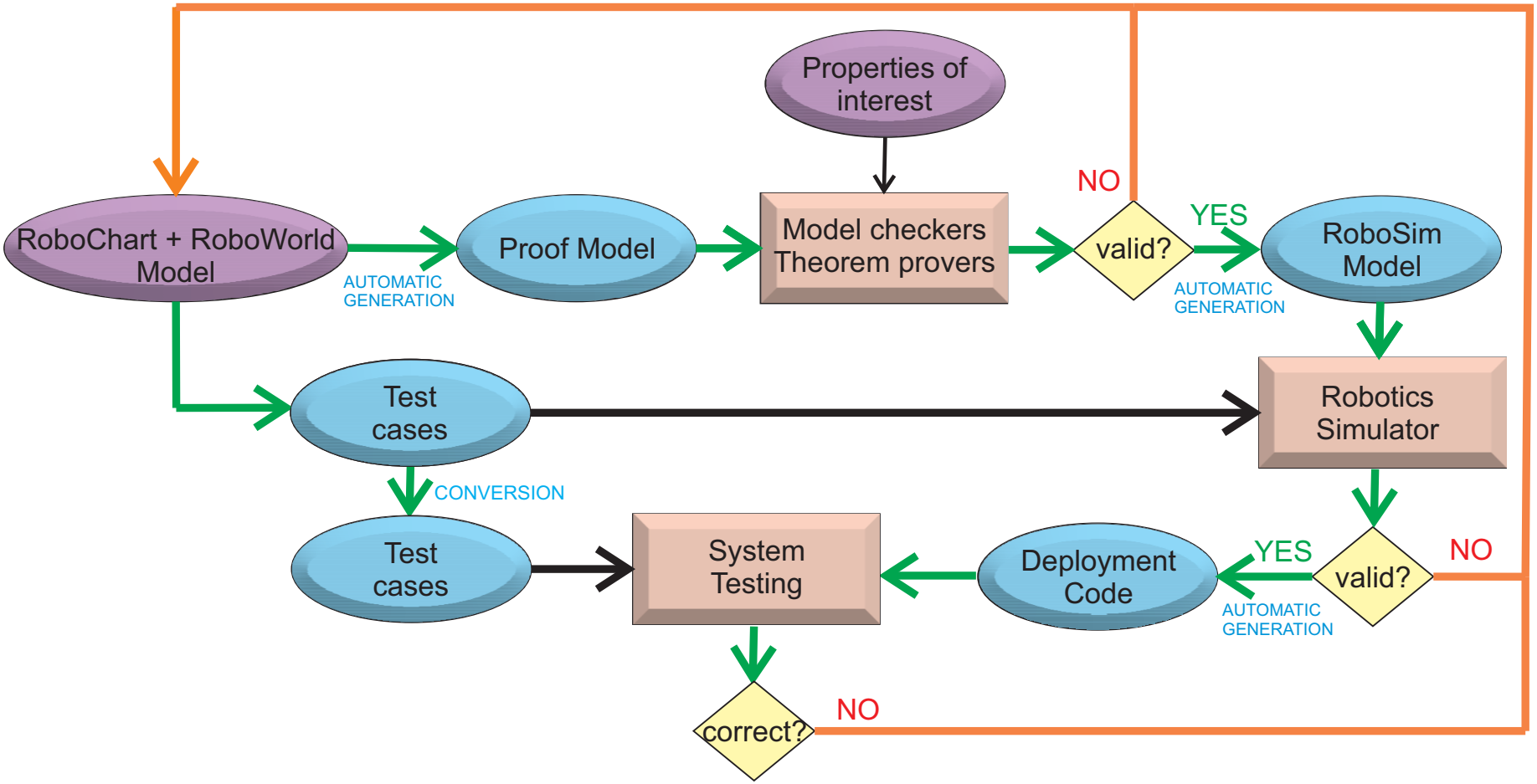
Our approach



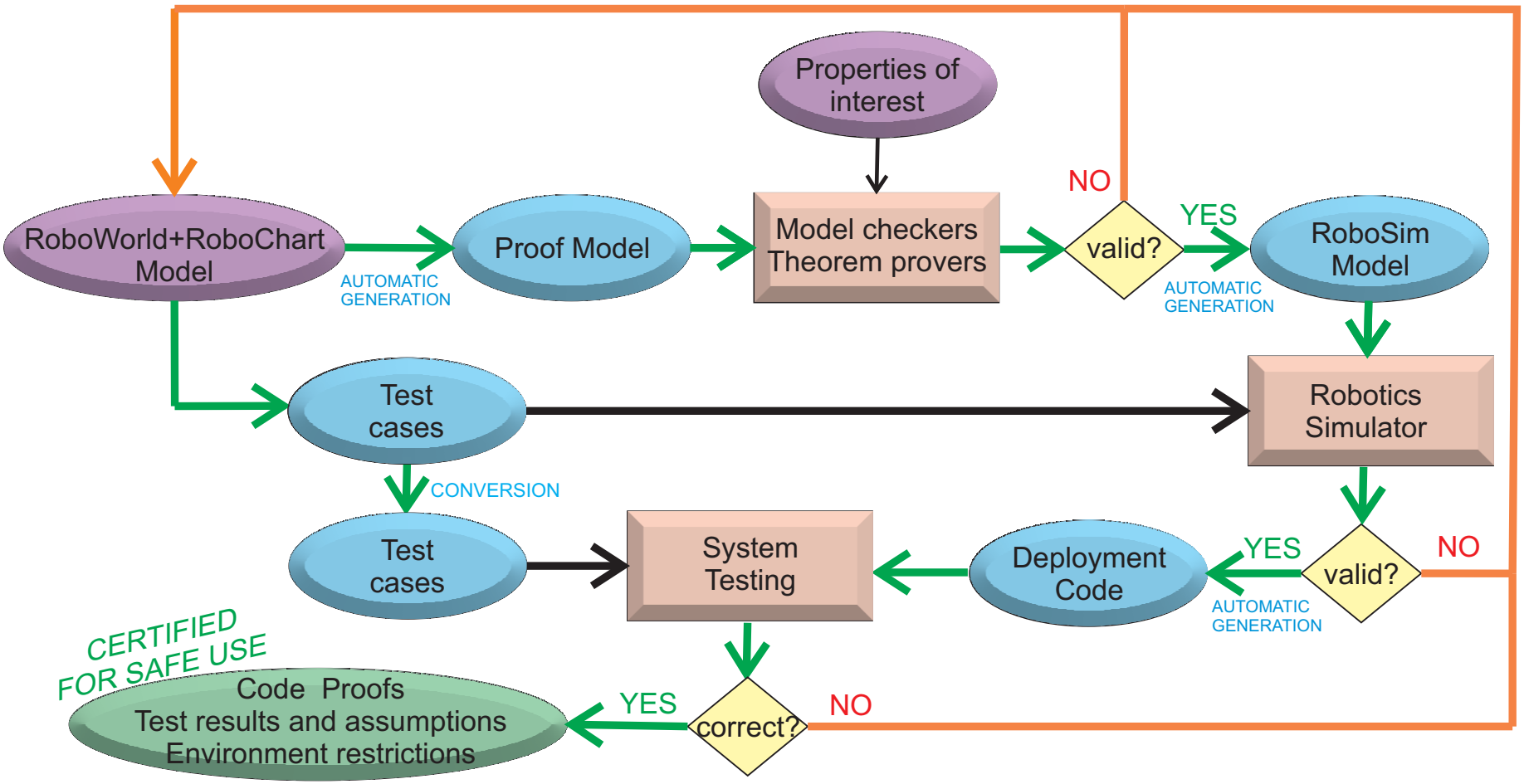
Our approach



Our approach

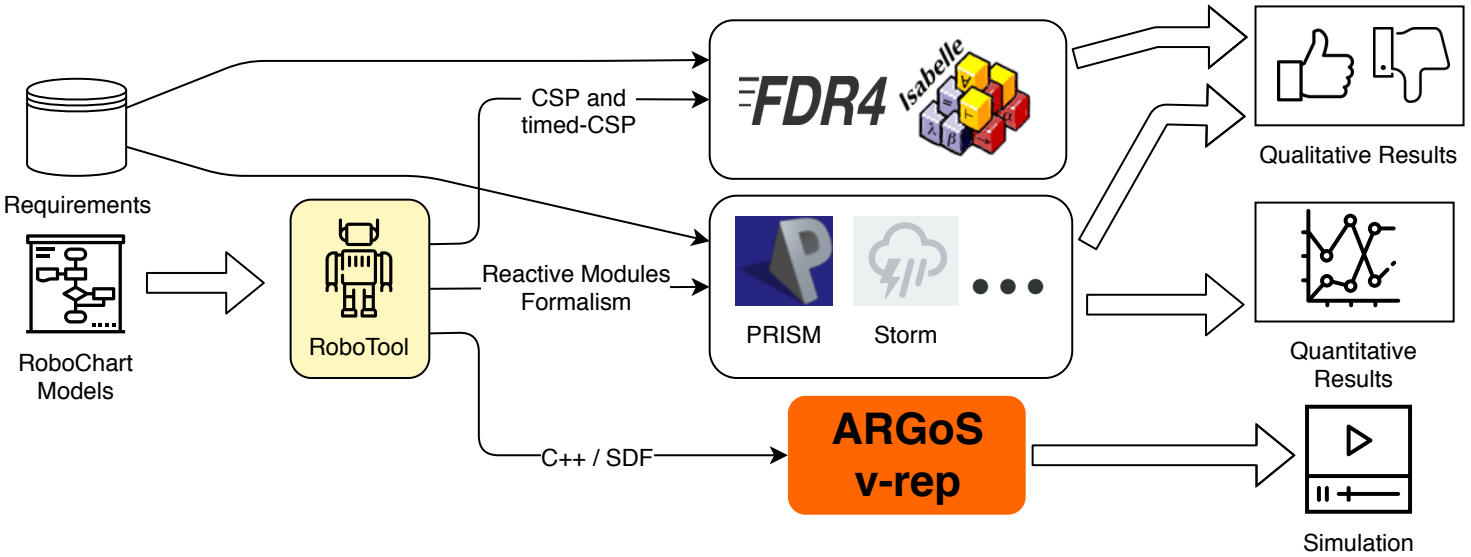


Our approach



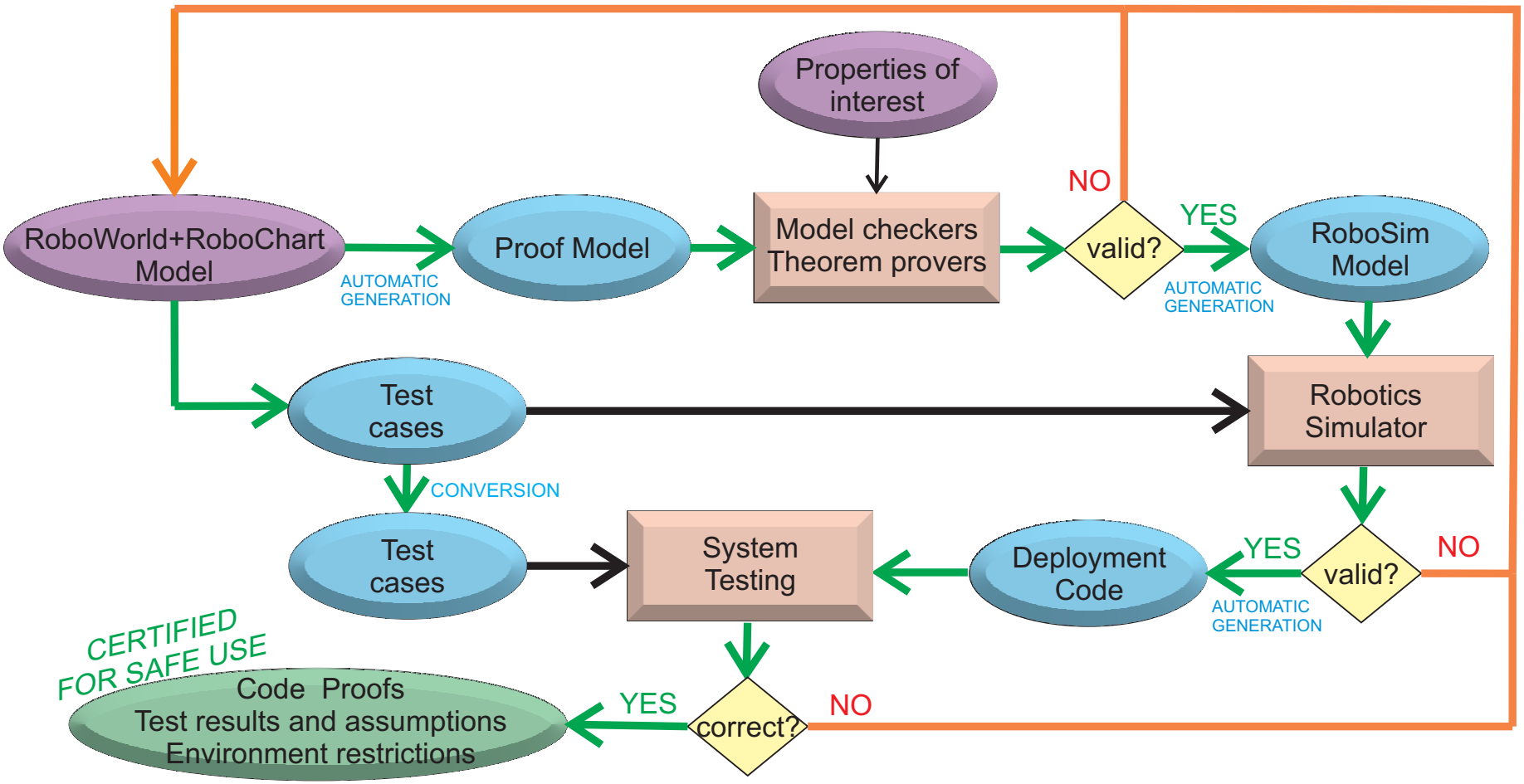
RoboTool support for our approach

Eclipse plug-ins: `www.cs.york.ac.uk/robostar/`

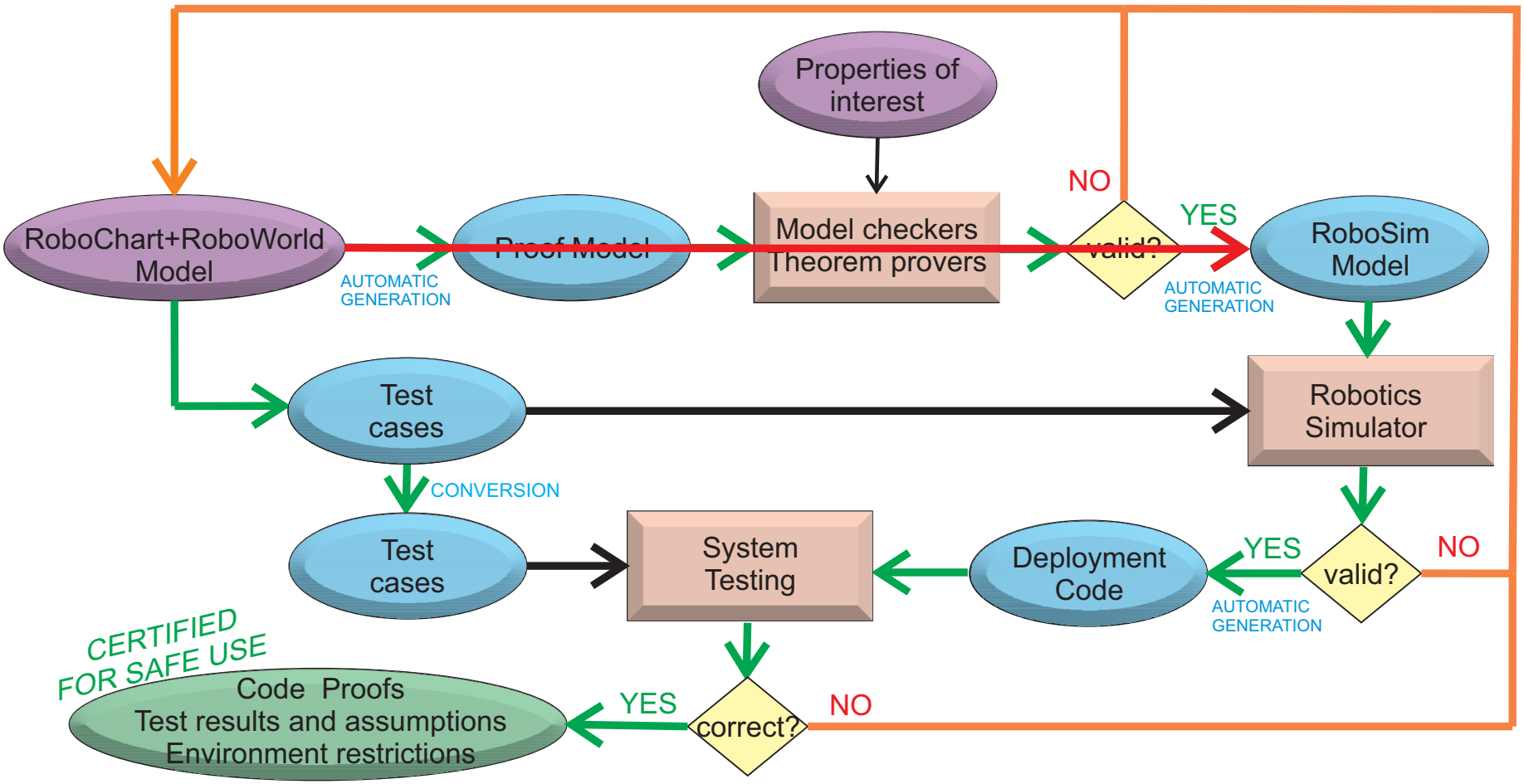


chemical detector - autonomous pod - transporter - solar vacuum cleaner - ...

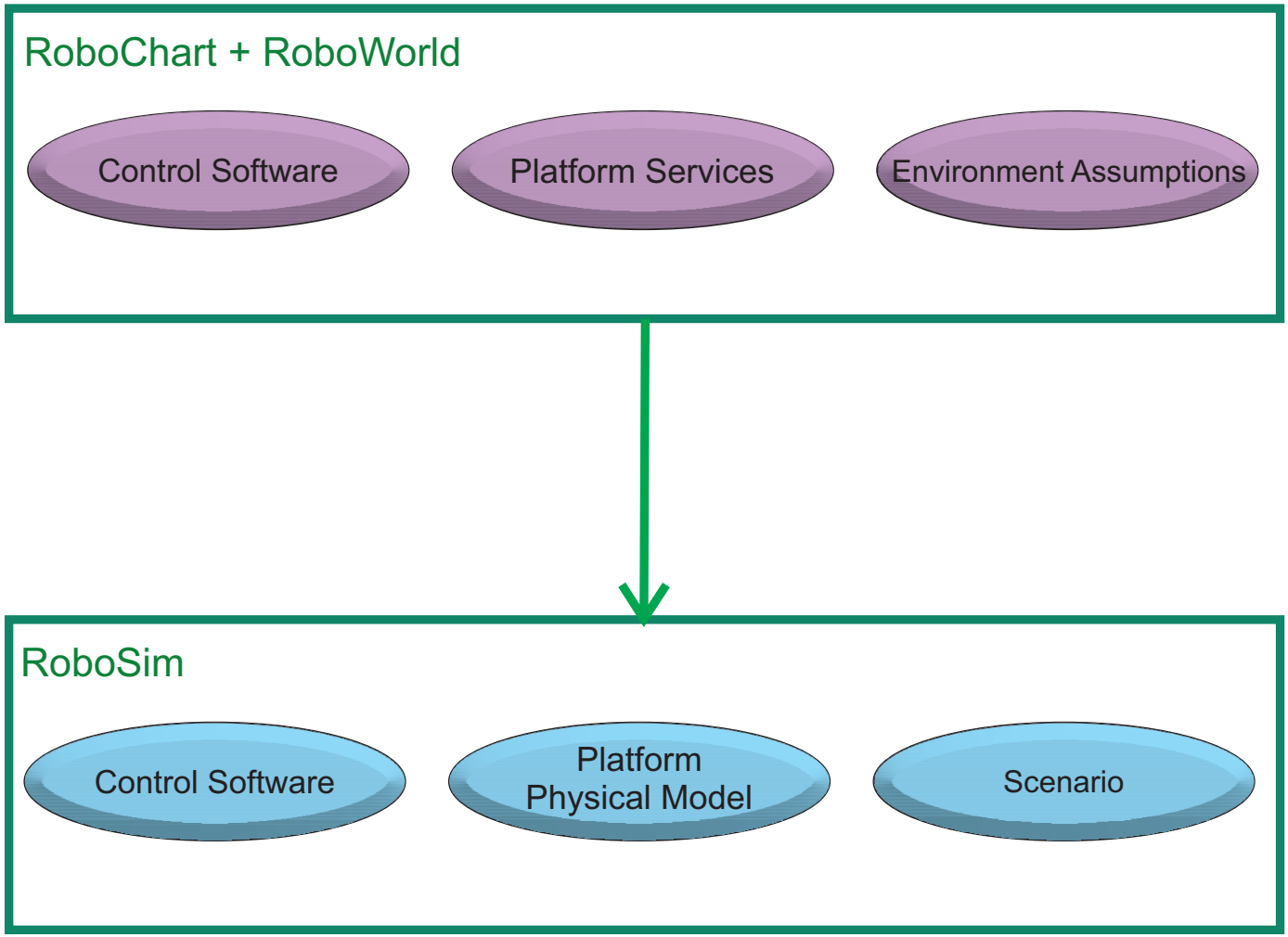
Our approach: more detail



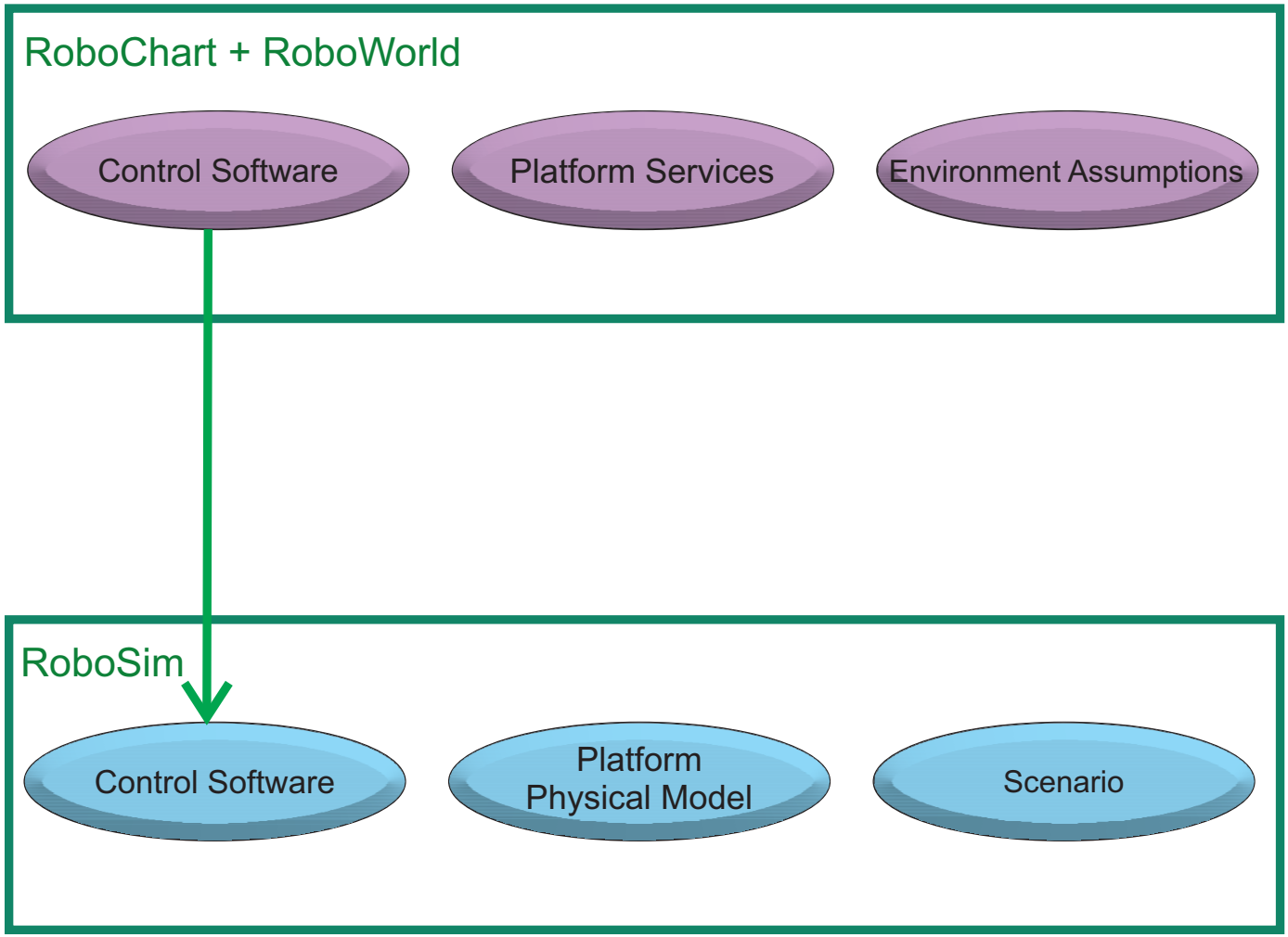
Our approach: more detail



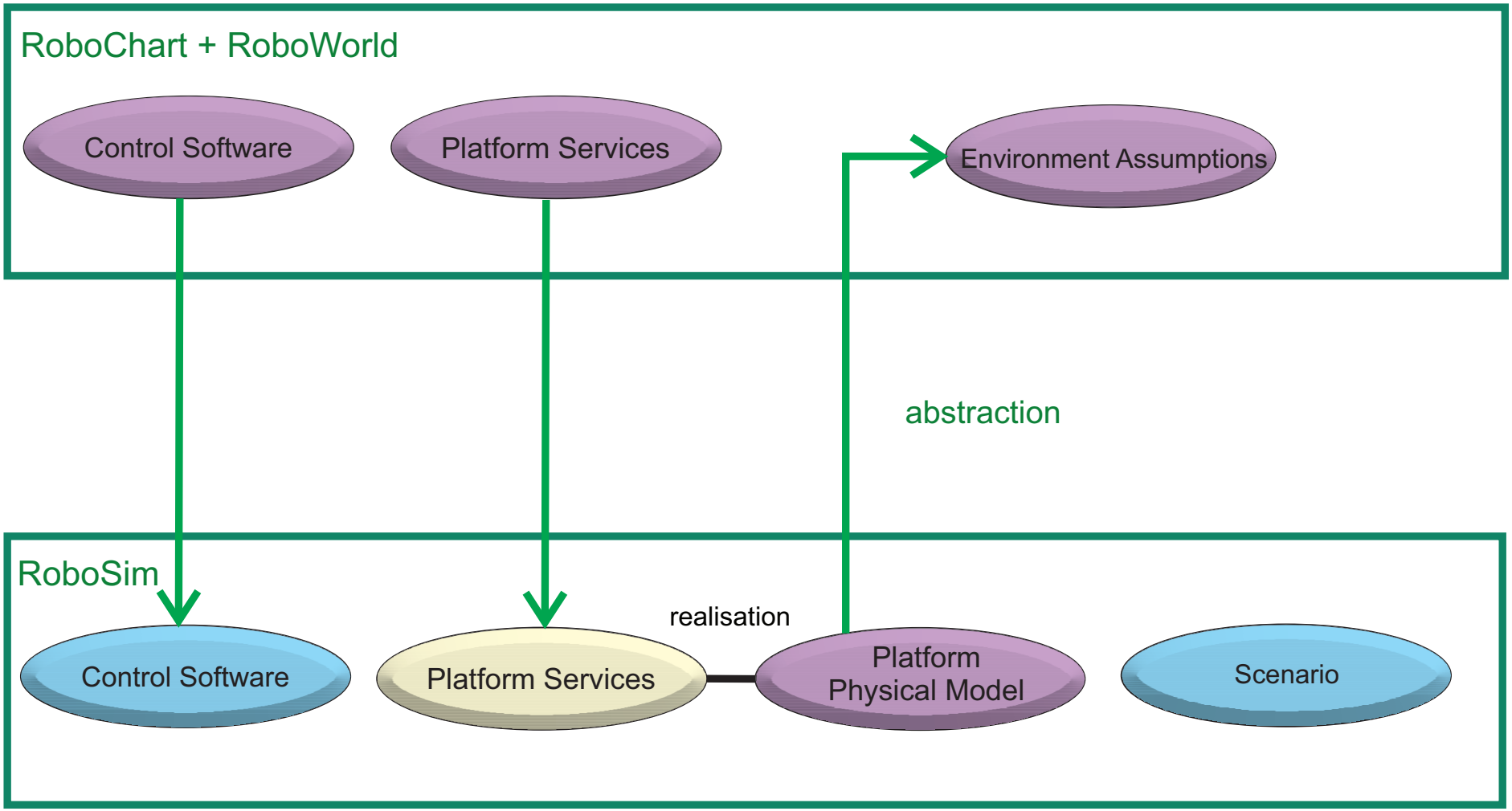
Our approach



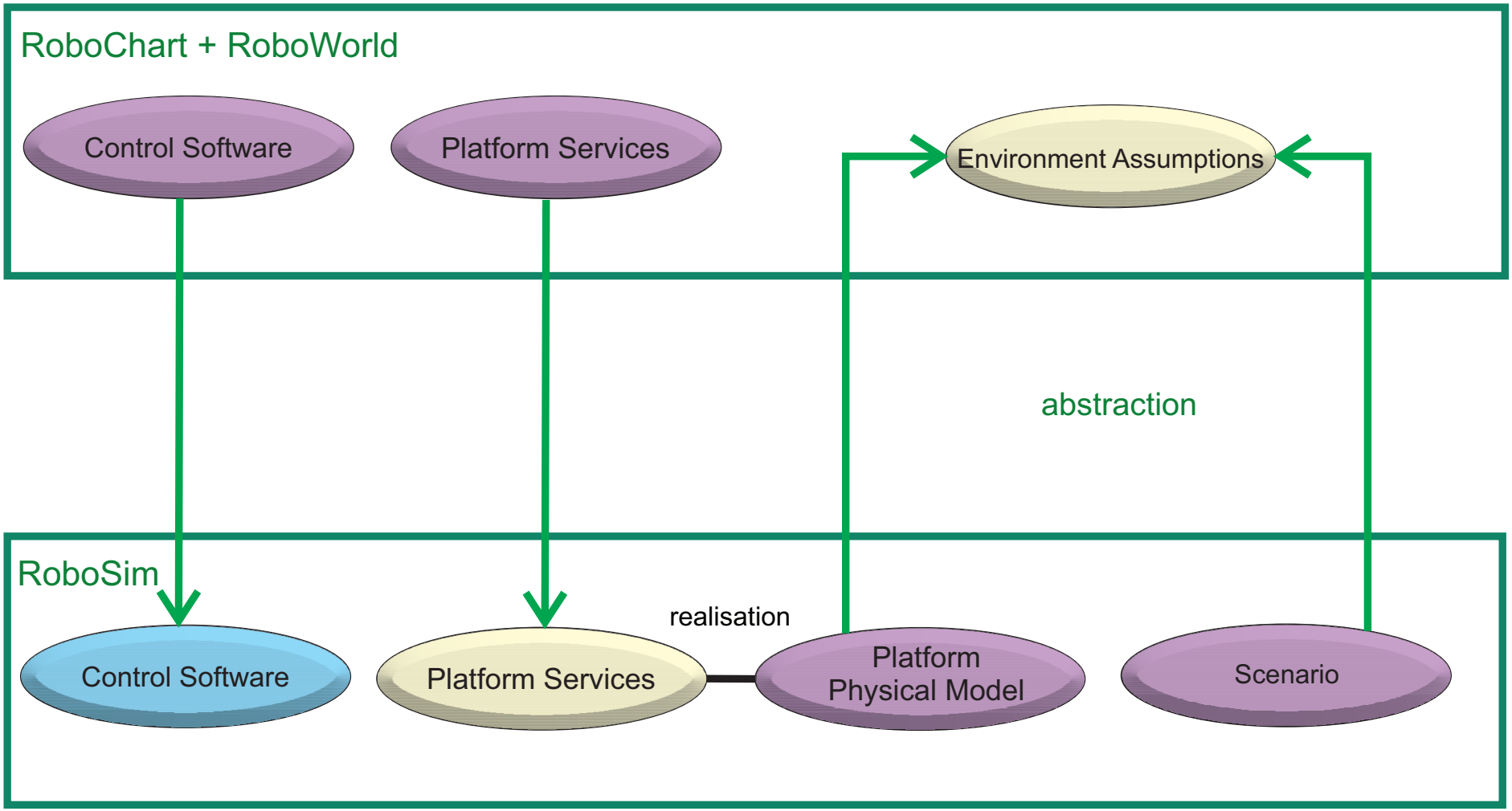
Our approach



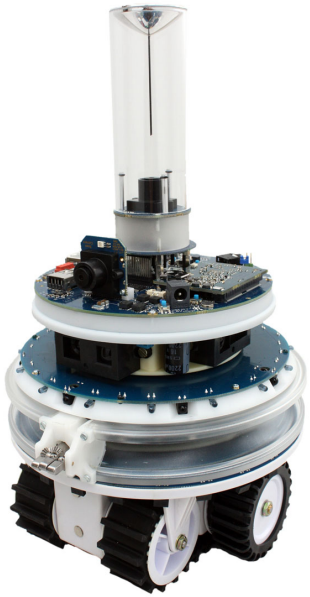
Our approach

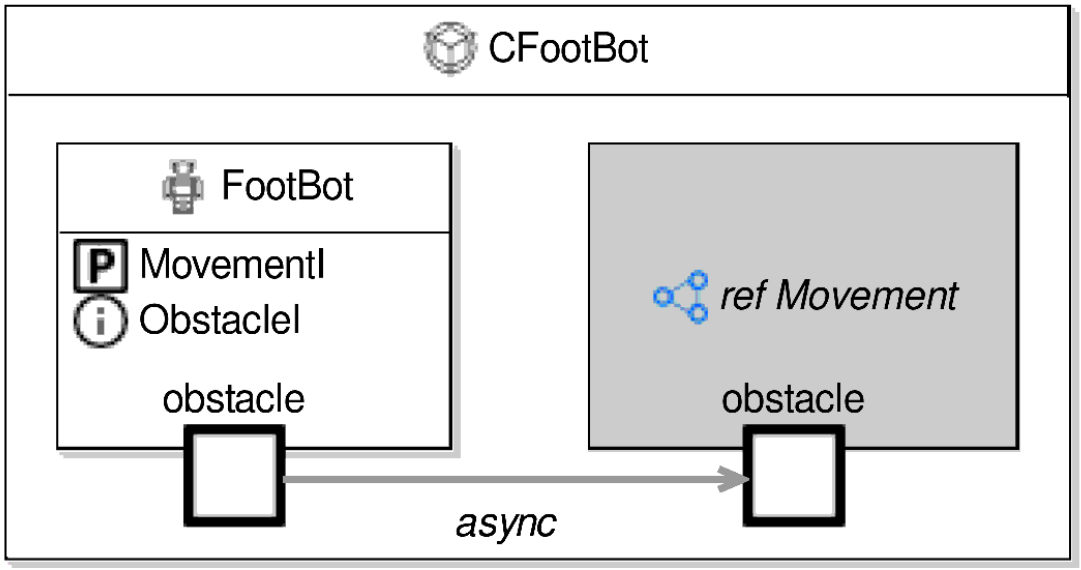


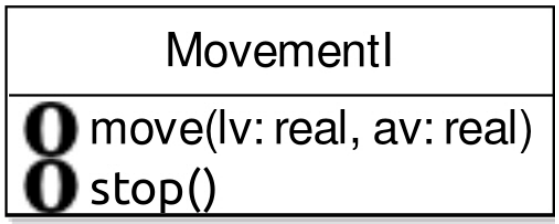
Our approach

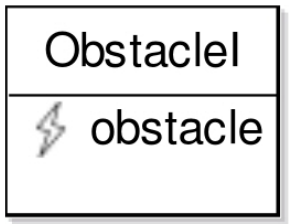


A very small RoboSim example - d-model

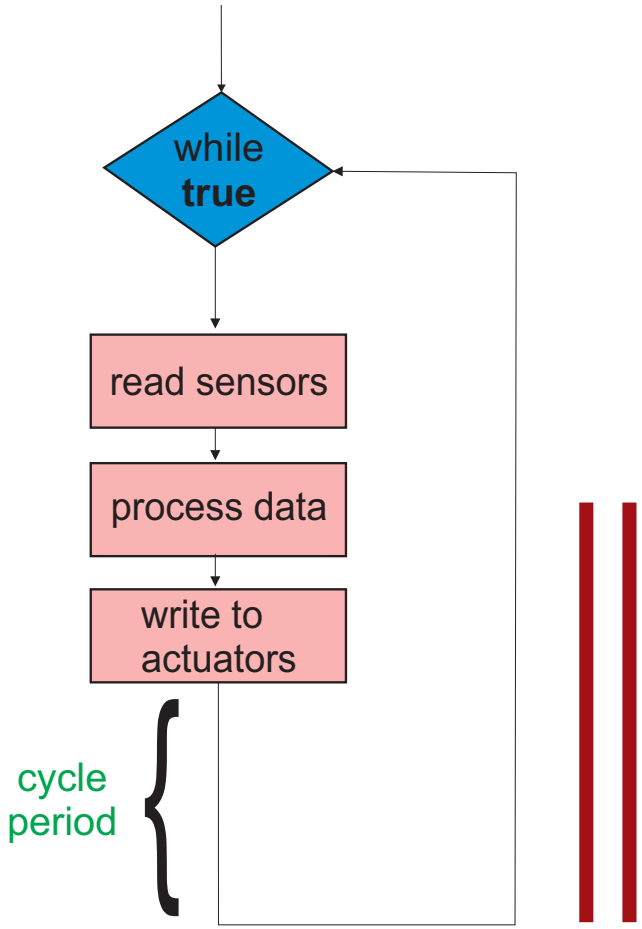




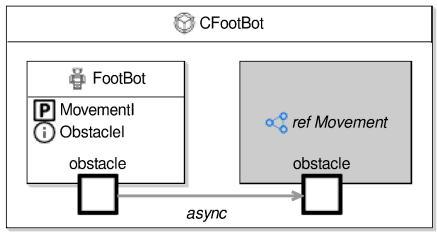




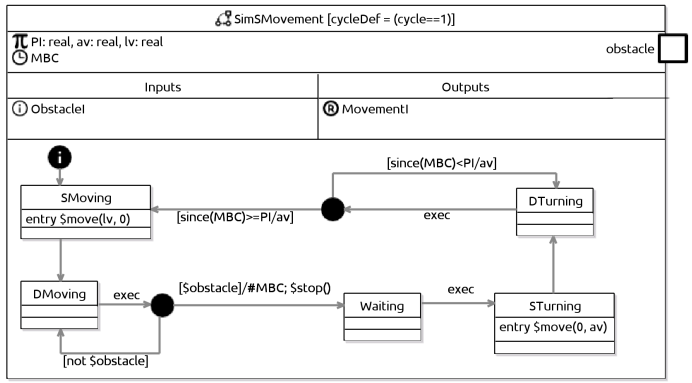
Behaviour for RoboSim: cycle || simulation



||



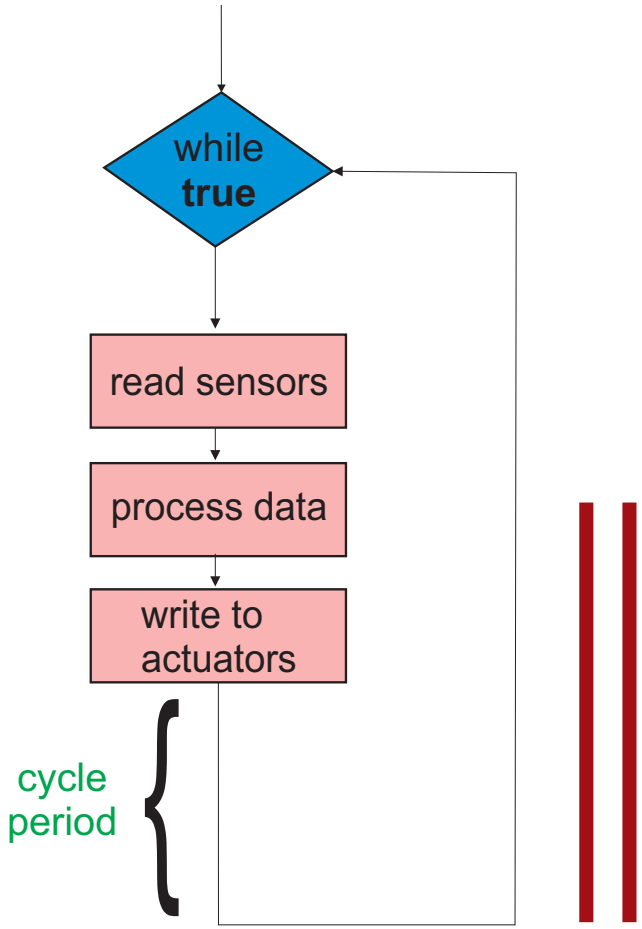
...



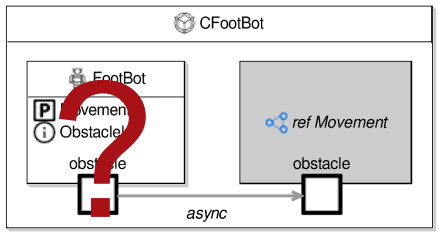
Buffered parallelism

Visible behaviour: registerRead and registerWrite

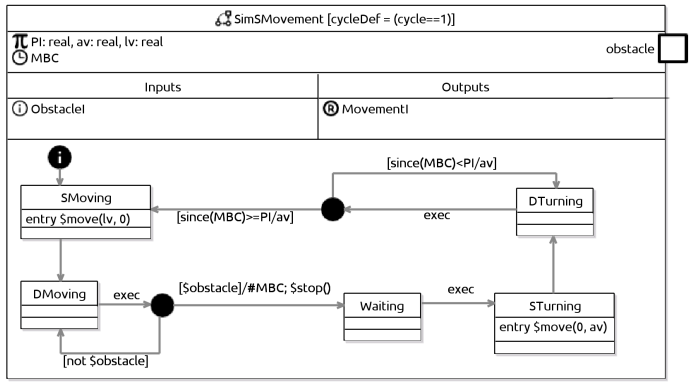
Behaviour for RoboSim: cycle || simulation



||



...



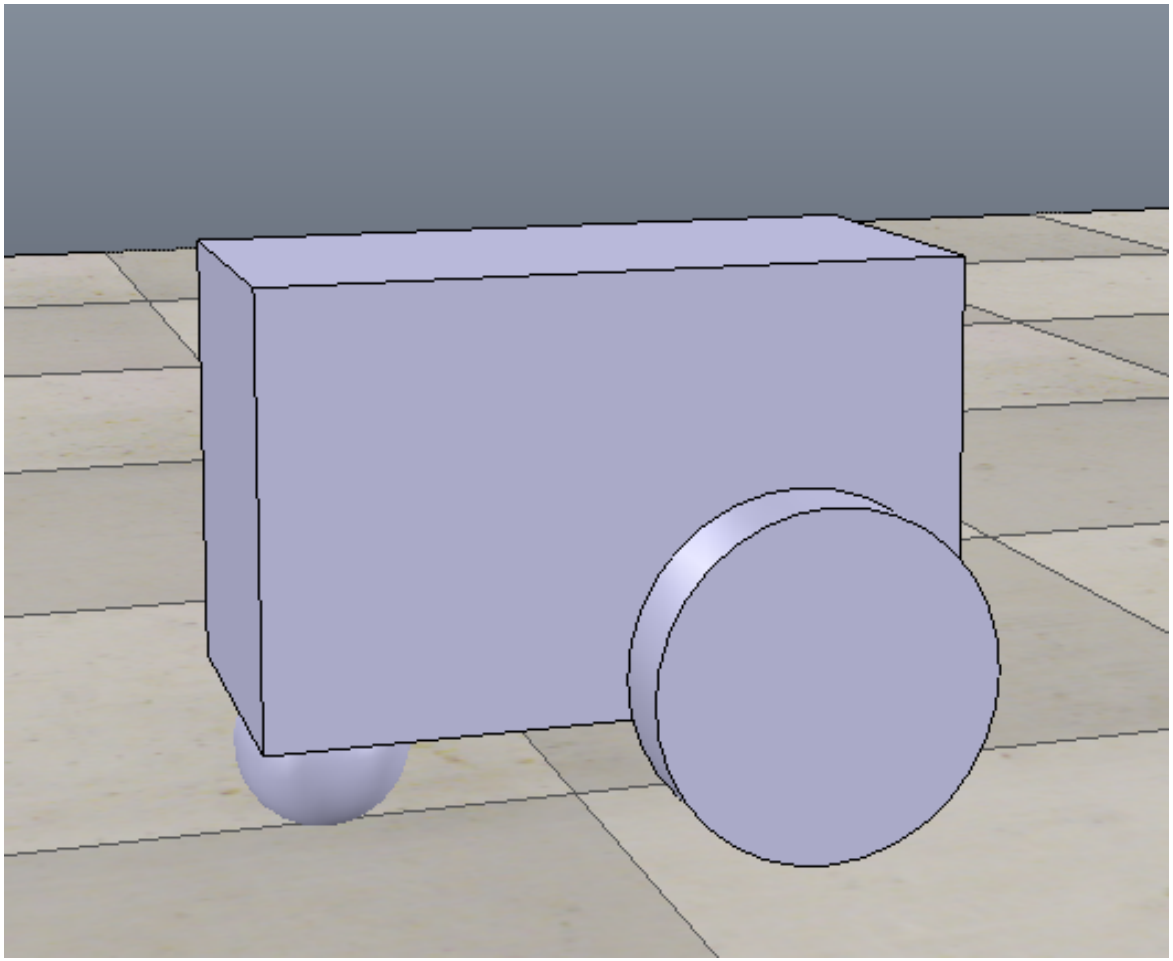
Buffered parallelism

Visible behaviour: registerRead and registerWrite

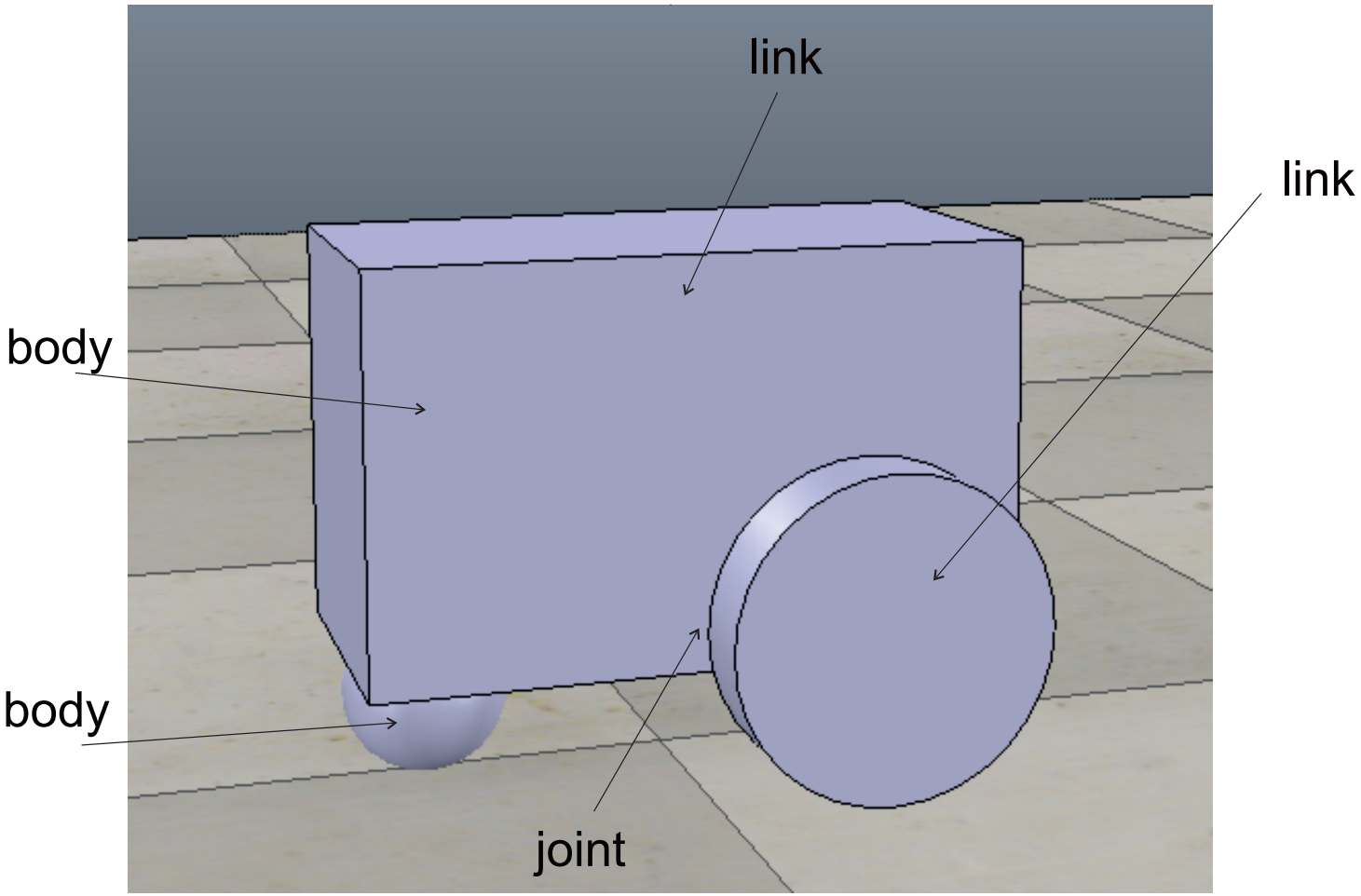
p-model: physical model

- Inspired by facilities offered by simulators
- Basic notions: links, joints, sensors, actuators
- Sensors, actuators, joints: system of differential algebraic equations
- Diagrammatic notation: block diagram
- Linked to a module: platform mapping
- Sensors and actuators $\rightarrow$ Variables, events, and operations
- Automatic generation
  - XML-based SDF for simulation
  - CSP-based model for reasoning

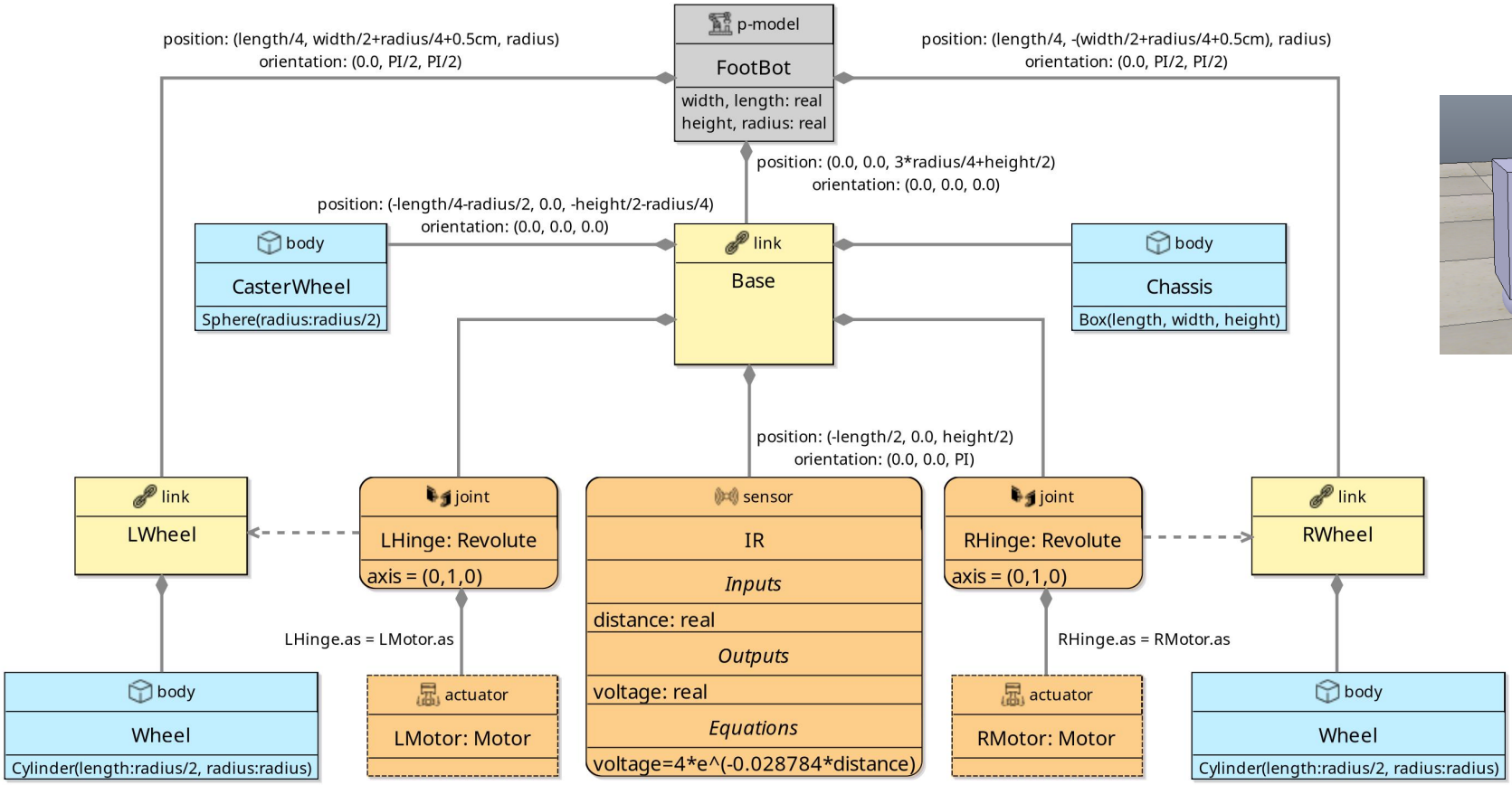
A very small example - Not the footbot

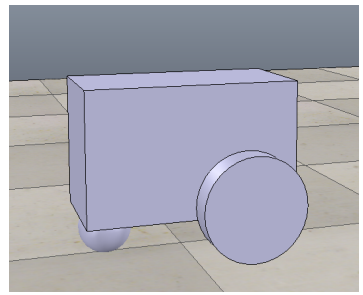


A very small example - Not the footbot



A very small example - Not the footbot

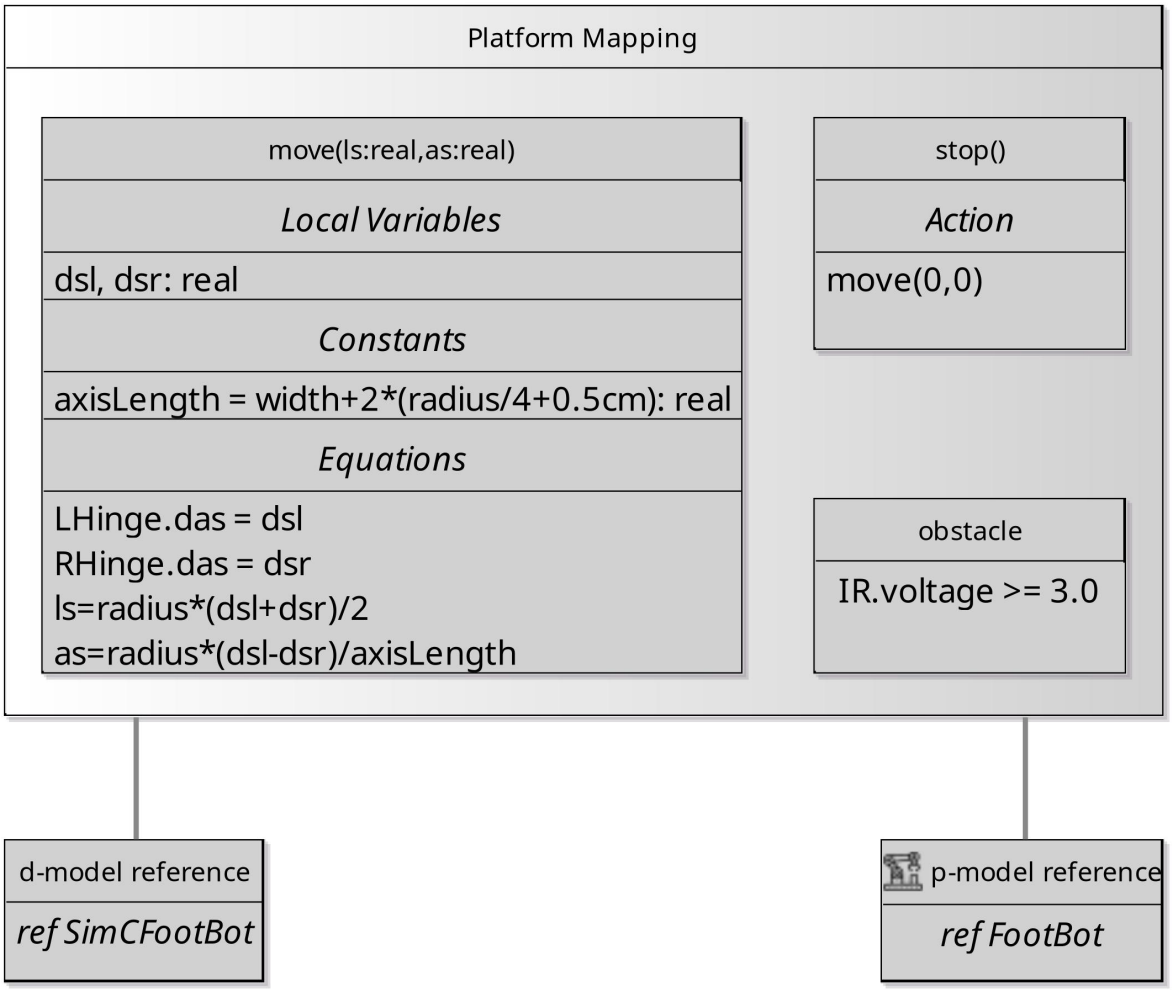




Platform mappings

- Association between d-model and p-model
- Defines variables, events, and operations
- Variable: input to actuators
- Input events: predicate and communicated values, if any
- Output events: assignment to inputs of actuators
- Operations: actions or DAE systems
- Very simple definitions: no time

Platform mapping - a small example



Generating simulations and mathematical models

Translation to SDF

- Automatic
- Useful tool for validation
- Various physics engines
- Equations are (mostly) ignored

Translation to Hybrid CSP

- Automatic
- Useful tool for proof
- Equations are used
- Proof with Isabelle/UTP

So, what next?

RoboSim

- Implementation
- Refinement technique
- Soundness
- Case studies

Support to user

- Properties language
- Modelling of environment
- Test generation