Model-based Regression Testing of Autonomous Robots

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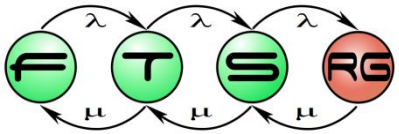

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CONTEXT AND MOTIVATION

Context: R3-COP and R5-COP projects

Household service robots

http://www.care-o-bot.de

Automated forklifts

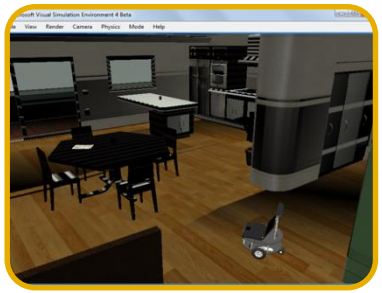
http://www.elettric80.com/

Search and rescue robots

http://www.piap.pl

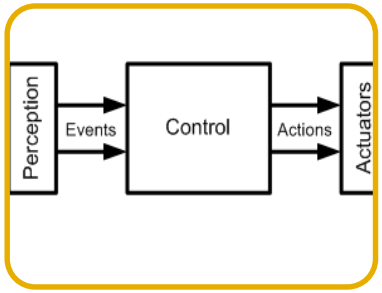
R5-COP

Testing approaches



Simulating robot and environment

- Not yet widespread (but changing)



Replaying captured sensor data

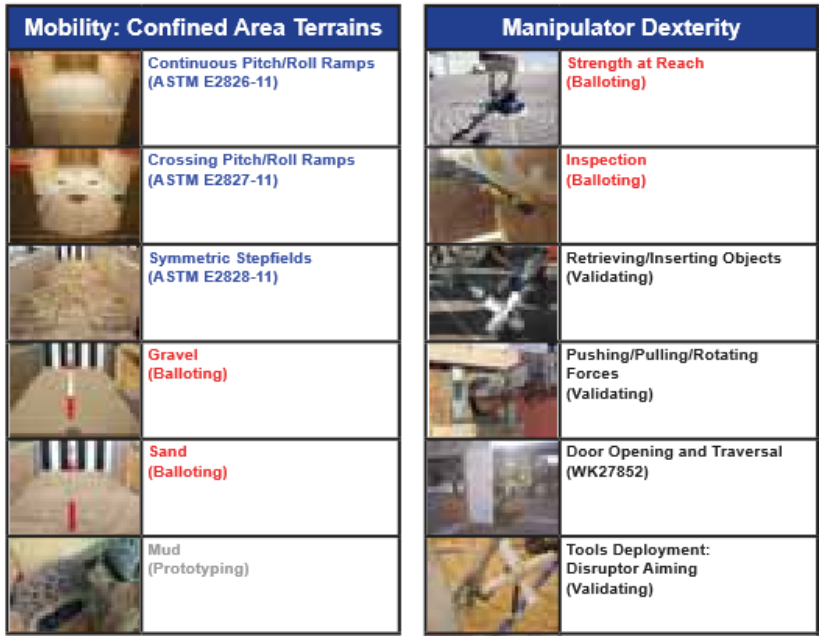
- Based on real data, but coverage?

Testing with real robot in “real” environment

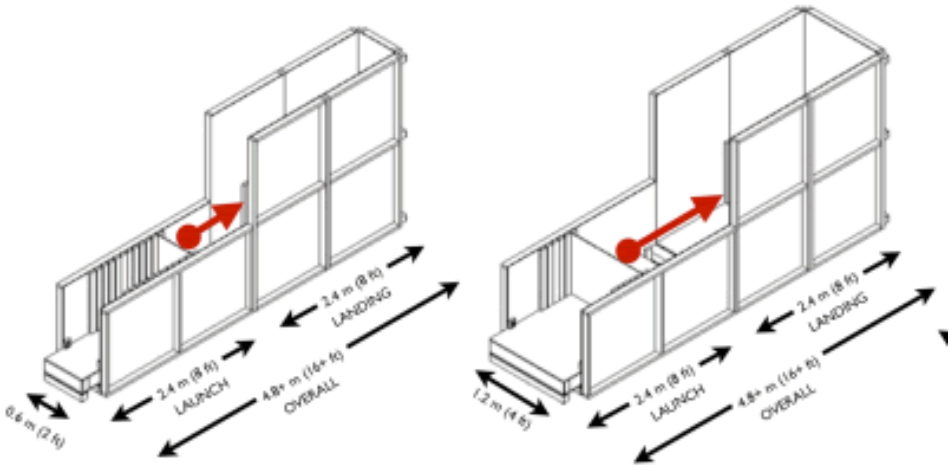
- Expert operators, experience-based
- Resource- and time-intensive

Standard test method: DHS-NIST-ATSM

- Testing robots in physical environment
- Standardized apparatus and procedure
- E.g.: ramp, gap, sand, sign, door opening

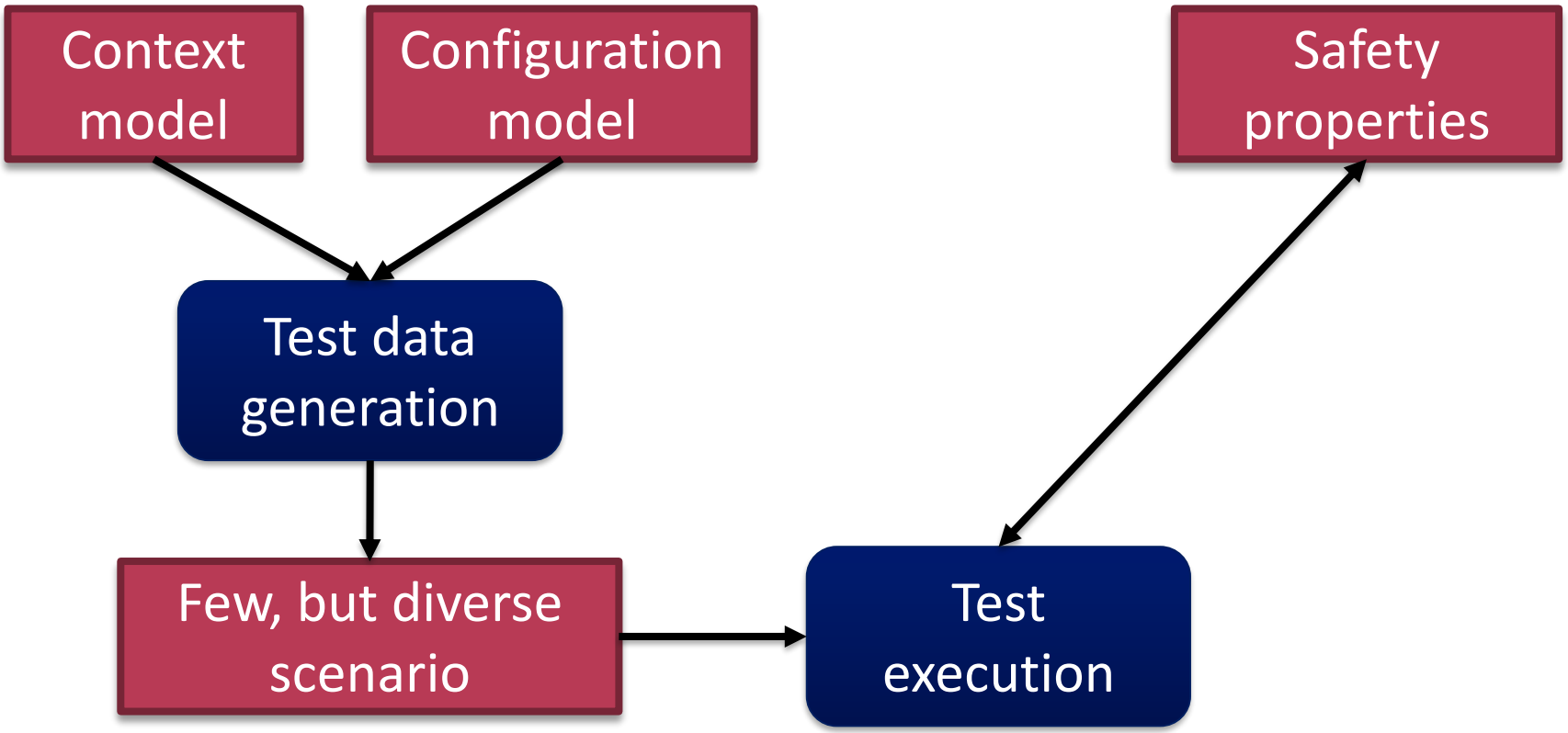


Source: NIST. Guide for Evaluating, Purchasing, and Training with Response Robots Using DHS-NIST-ASTM International Standard Test Methods, 2014



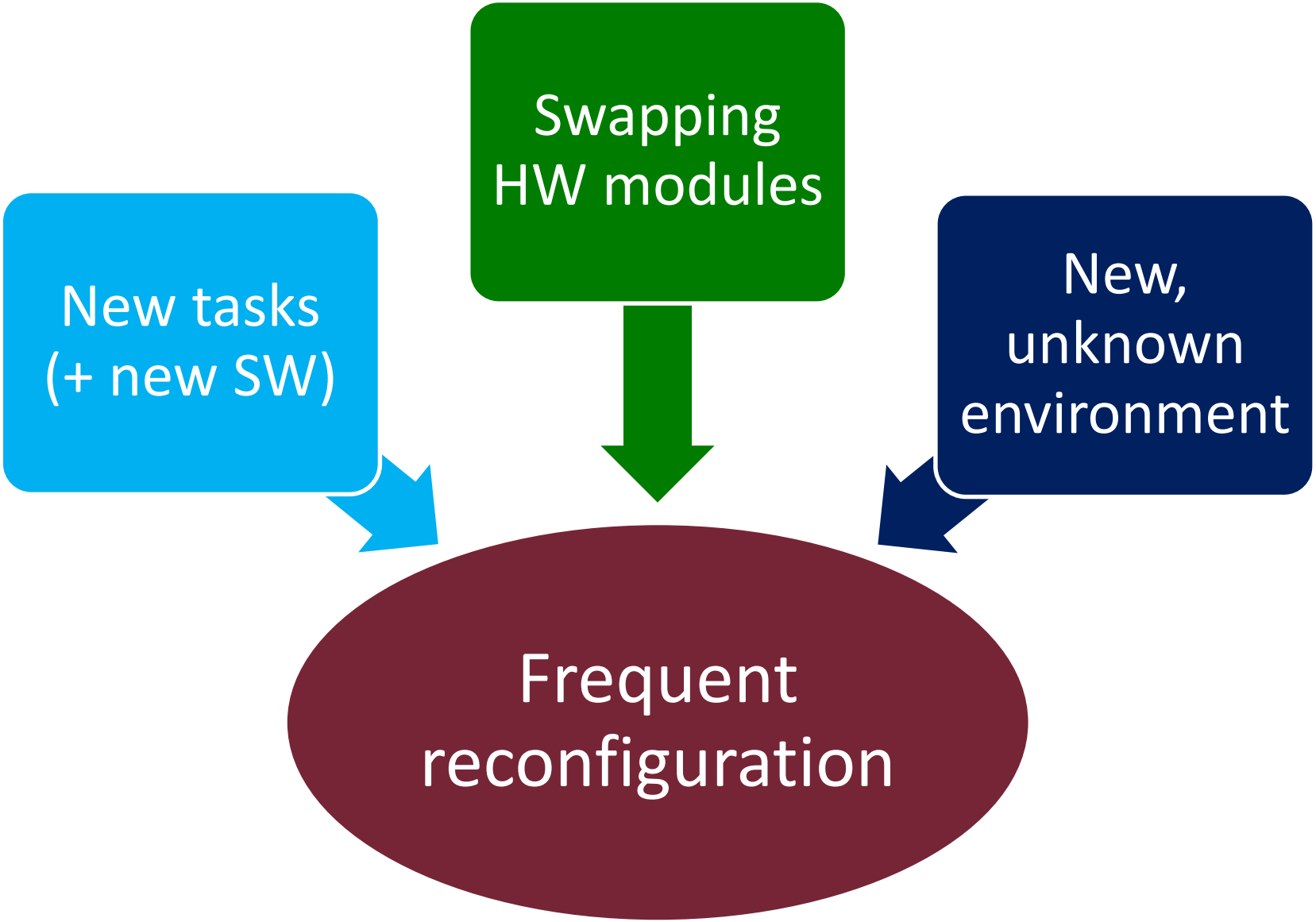
Source: ASTM E2801-11, Standard Test Method for Evaluating Emergency Response Robot Capabilities: Mobility: Confined Area Obstacles: Gaps, ASTM International, West Conshohocken, PA, 2011

Previous work: Model-based approach



Z. Micskei, Z. Szatmári, J. Oláh, I. Majzik: **A Concept for Testing Robustness and Safety of the Context-Aware Behaviour of Autonomous Systems,** TruMAS 2012. DOI

New challenges: autonomy, modularity…



PROPOSED APPROACH

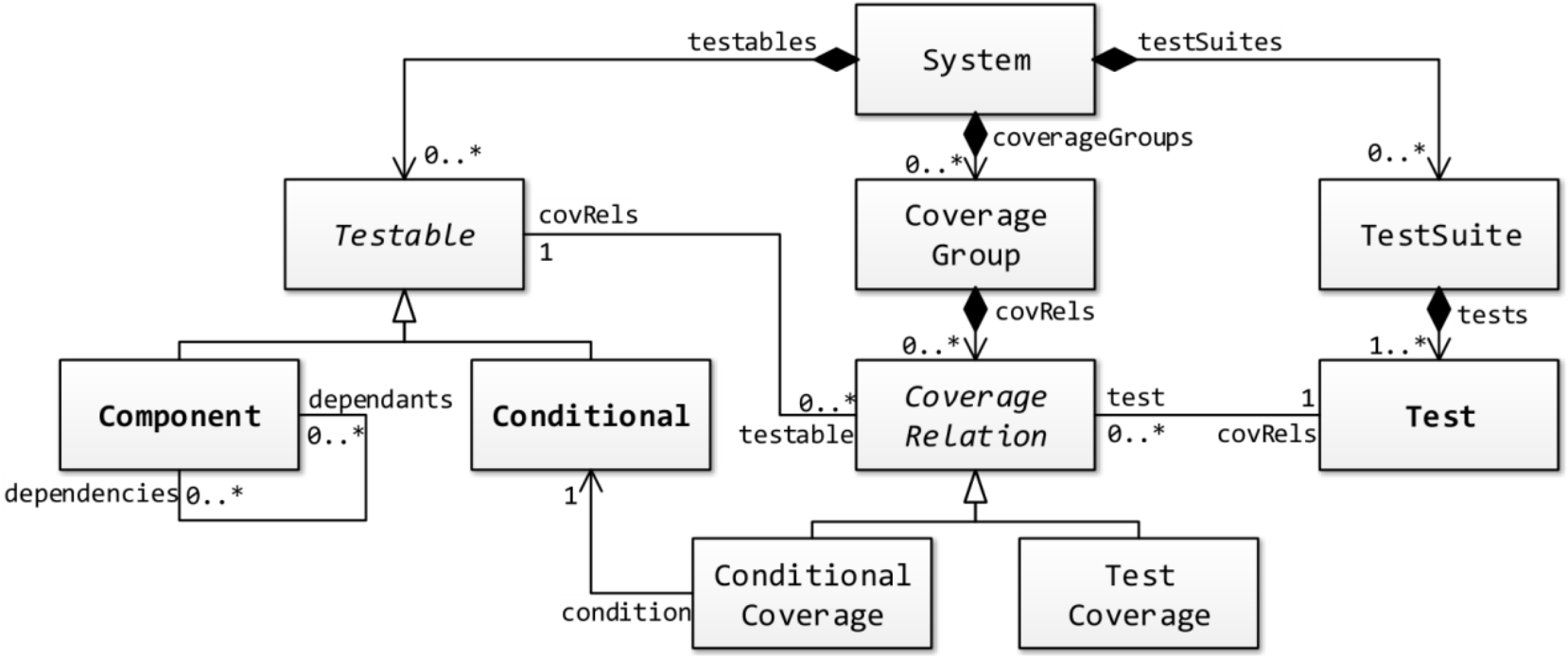
Reconfiguration → Regression testing

- Regression test selection (RTS)
  - Rich related work for code
  - Categorization: Re-usable, Re-testable, Obsolete, New
- Model-based development
  - Domain-specific languages (DSL)

How to perform regression test selection on DSLs?

Regression test selection metamodel

Represent changes in different DSLs in one model

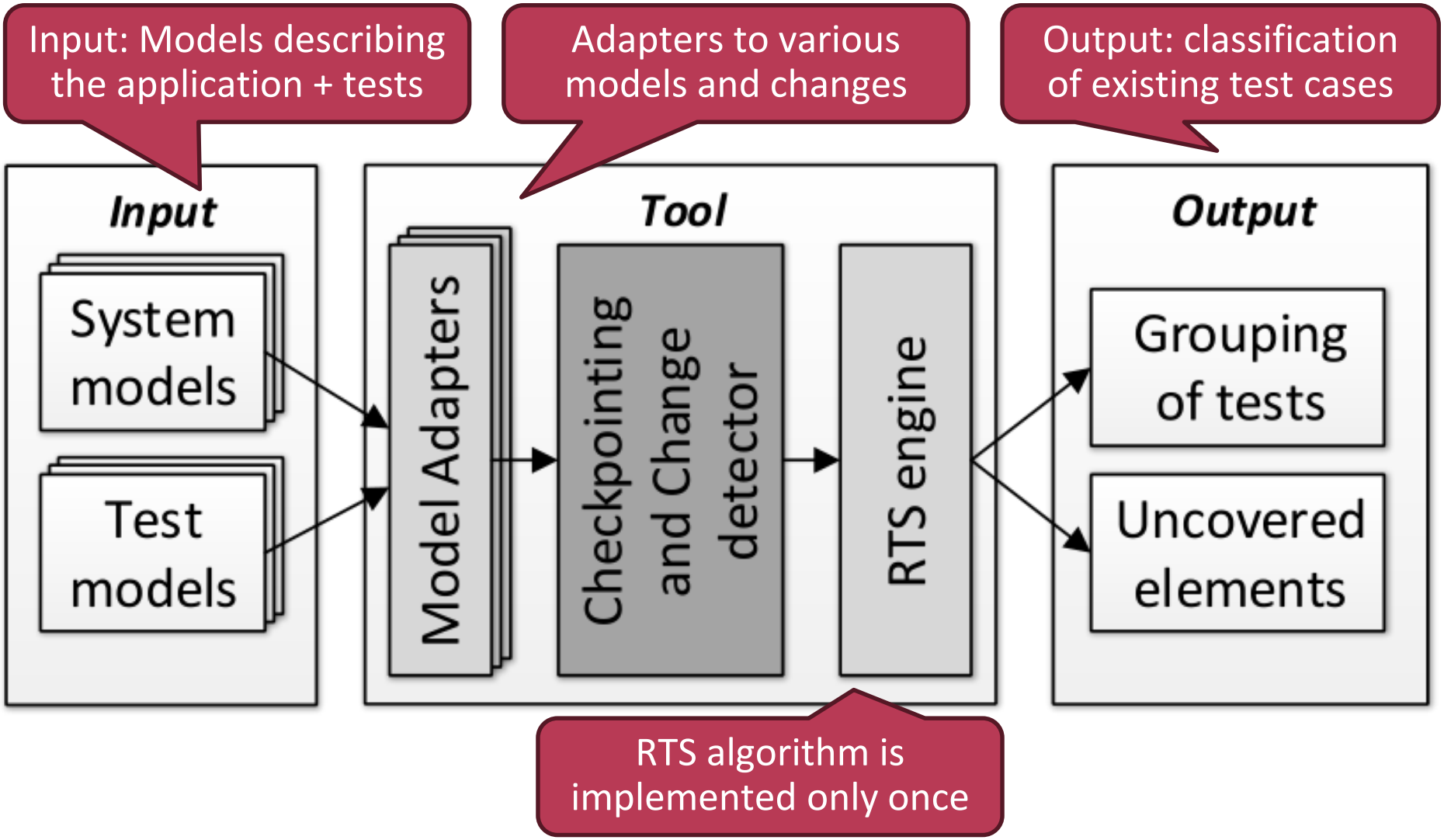


E.g.: (Config) Robot has a motor.

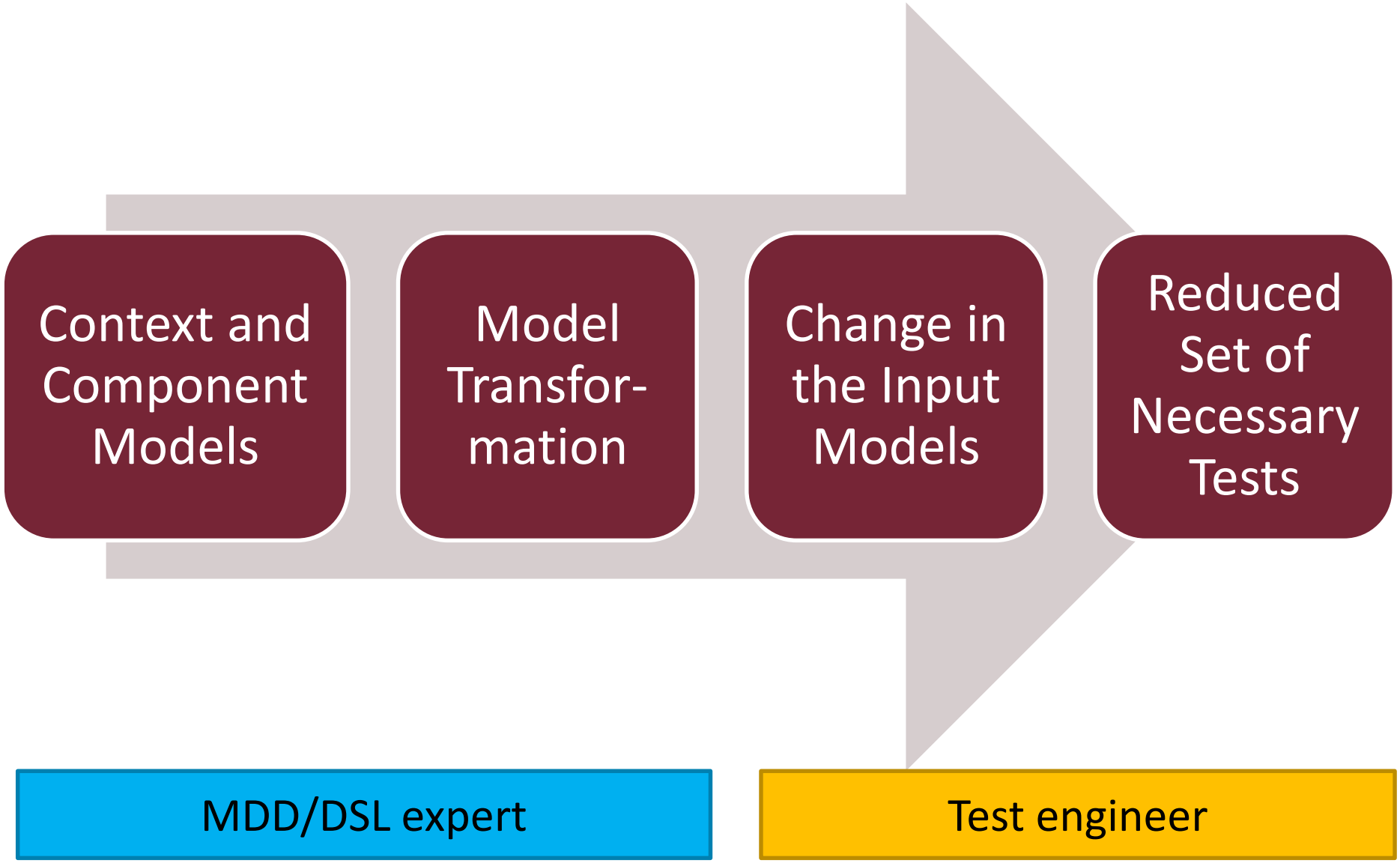
(Context) Test scenario 1 has sand terrain.

(Mapping) Motor is tested by sand in test scenario 1.

Architecture of the prototype tool



Proposed Workflow

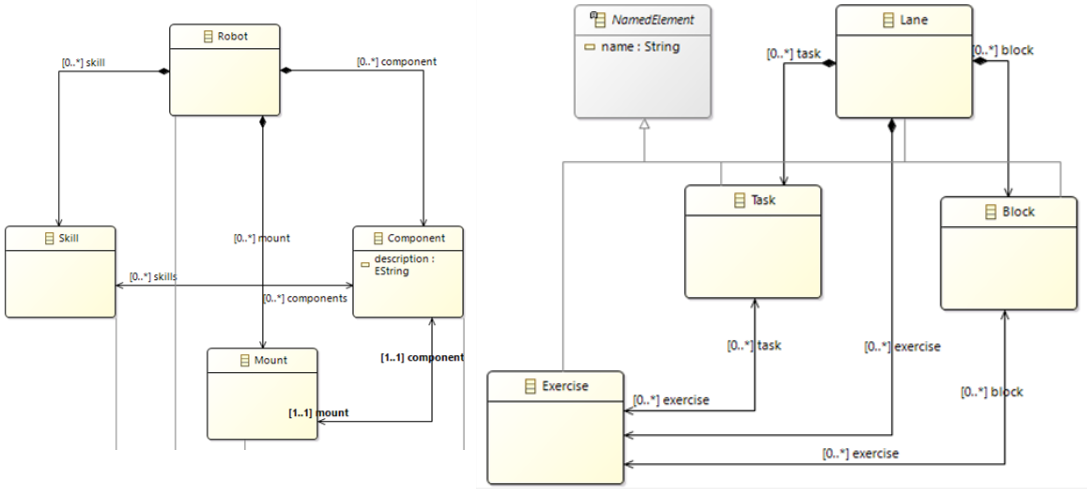


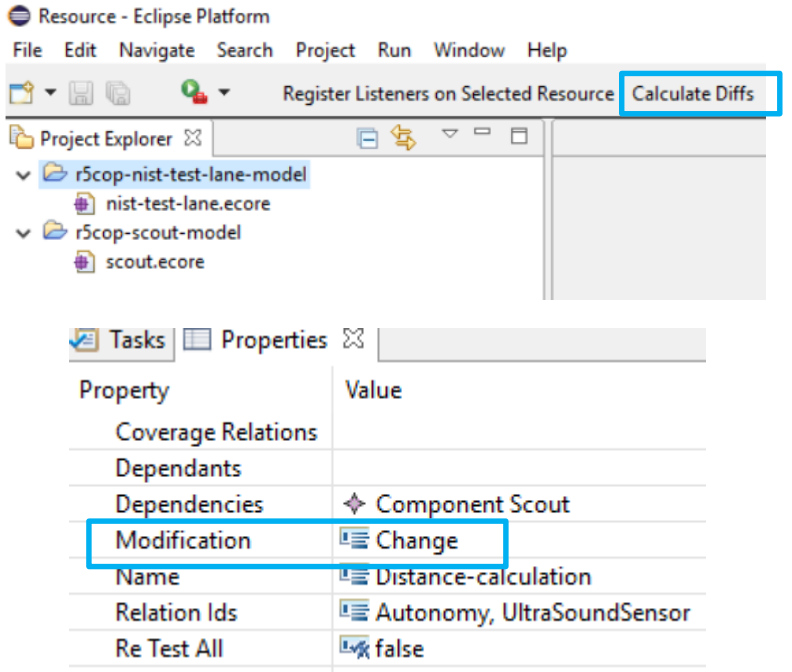
EXPERIENCES AND EVALUATIONS

Experiences

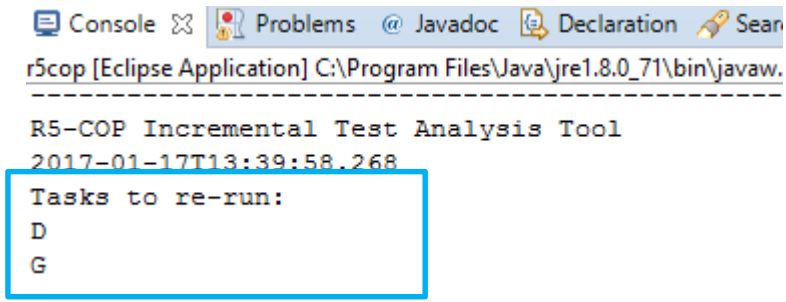
- Used technologies scale well (EMF, VIATRA…) (see paper for evaluations)
- Generic approach proved useful
  - Several DSLs, several iterations
- Not easy to get abstraction level right

Model-based regression testing in action





- Capability Mapping Gripping:Grab-cone
- Capability Mapping Lighting:Path-narrow-line-follow-low-light
- Capability Mapping Precision-movement:Path-narrow-line-follow
- Capability Mapping Precision-movement:Path-narrow-line-follow-low-light
- Capability Mapping Line-following:Path-narrow-line-follow
- Capability Mapping Line-following:Path-line-follow



Input

Output

Summary

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R3-COP

R5-COP

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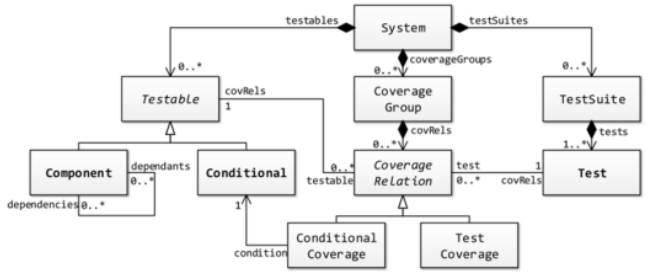

Example: Motor is tested by sand in test scenario 1.

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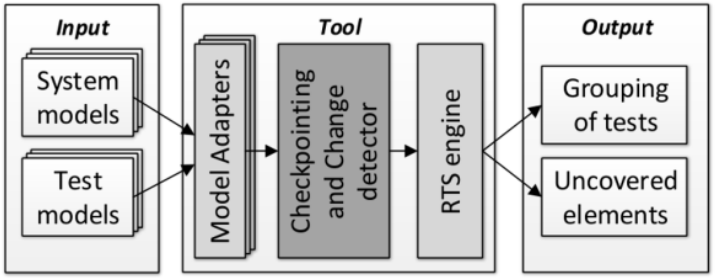

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