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Using property-based testing to automate test case generation and diagnosis in web-based graphical user interfaces

joint work with Clara Benac, Henrique Ferreiro, Macías López, Miguel Ángel Francisco

Motivation

- **We wish we could auto-magically test at the GUI level, don't we?**

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 - It would be like having our users test our product, only without them being the ones facing crashes and other undesired behaviour

Motivation

- **We wish we could auto-magically test at the GUI level, don't we?**
 - Hiring human alpha/beta-testers is... tricky
 - Expensive
 - Difficult to communicate
 - Difficult to reproduce
 - Not exhaustive

Motivation

- **We wish we could auto-magically test at the GUI level, don't we?**
 - Automated monkey testing is... tricky too
 - Cheap, but inefficient
 - Difficult to debug
 - Not exhaustive

Motivation

- **We wish we could auto-magically test at the GUI level, don't we?**
 - Automated testing is... challenging
 - Models are difficult to write
 - Complete models are unfeasible

Motivation

- **What if we “smarted-up” monkey testing with property-based testing...**
 - ... so that testing would be automated, cheaper, easier to reproduce, more exhaustive, more effective, easier to model?

The idea

- **To test at the GUI level, we want to...**
 - interact in a random manner, performing any action available to the user
 - interact in a series of pattern-steps, when specific interaction-patterns are present
- **... let's combine the two!**

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system-level
validation**

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i.e.
follow link
click button
input text

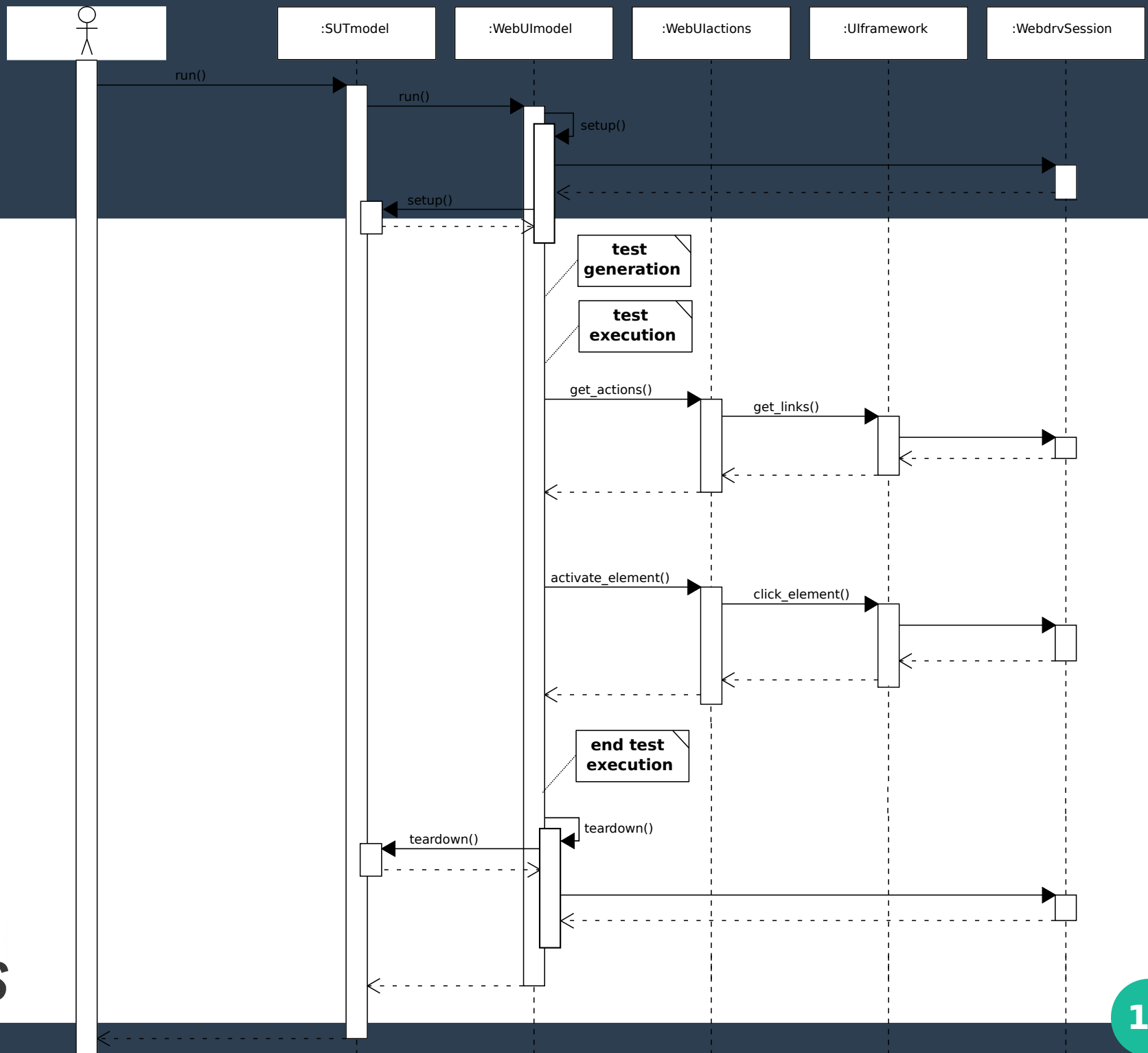
web-based

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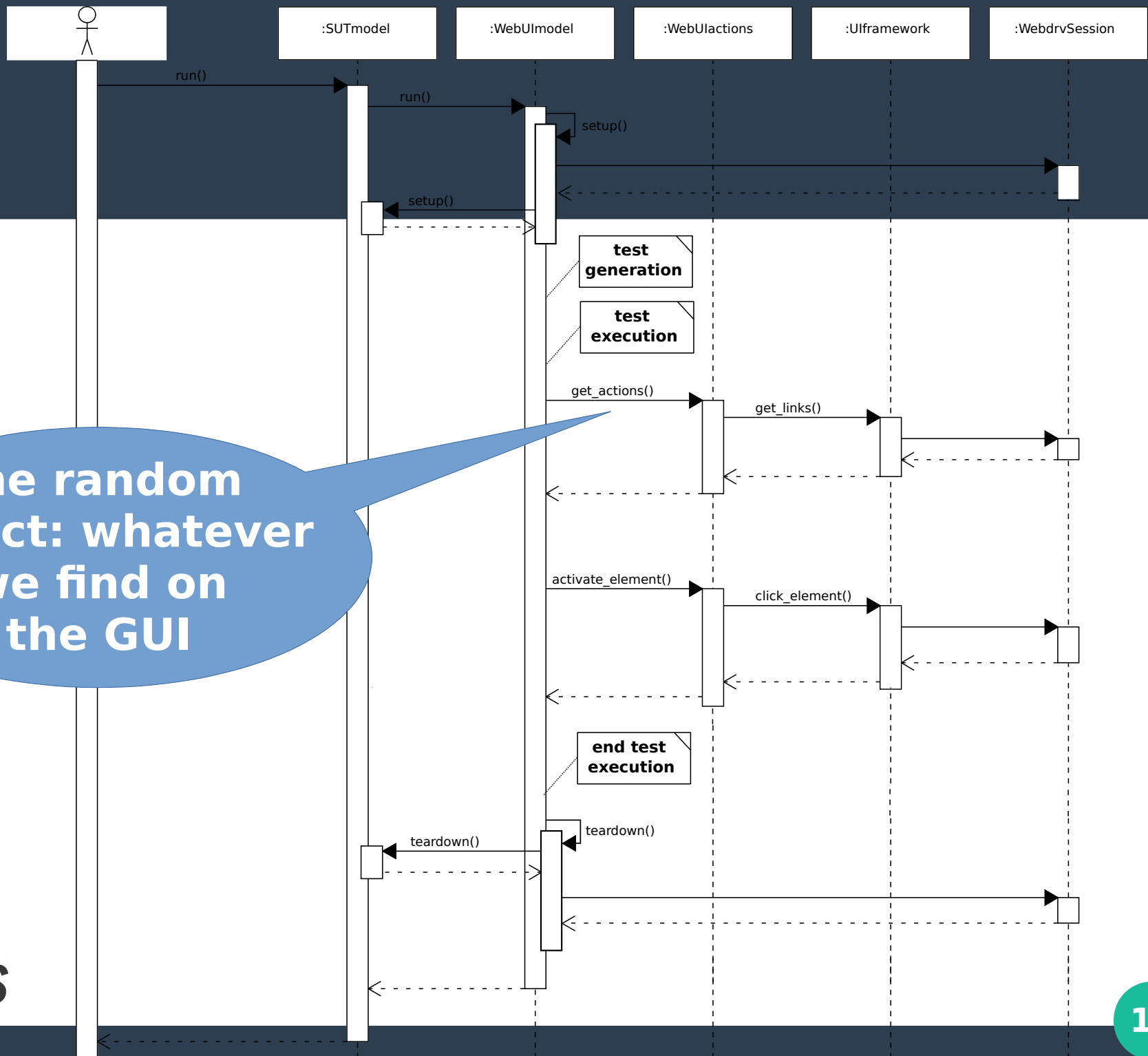
The idea

- **The random aspect**
 - is easy to model, to automate
 - introduces variability into tests that escapes preconceptions and assumptions
- **The specific interactions**
 - are easier to model, since they focus on a specific task or subset of functionality
 - allow for more exhaustive testing

The idea

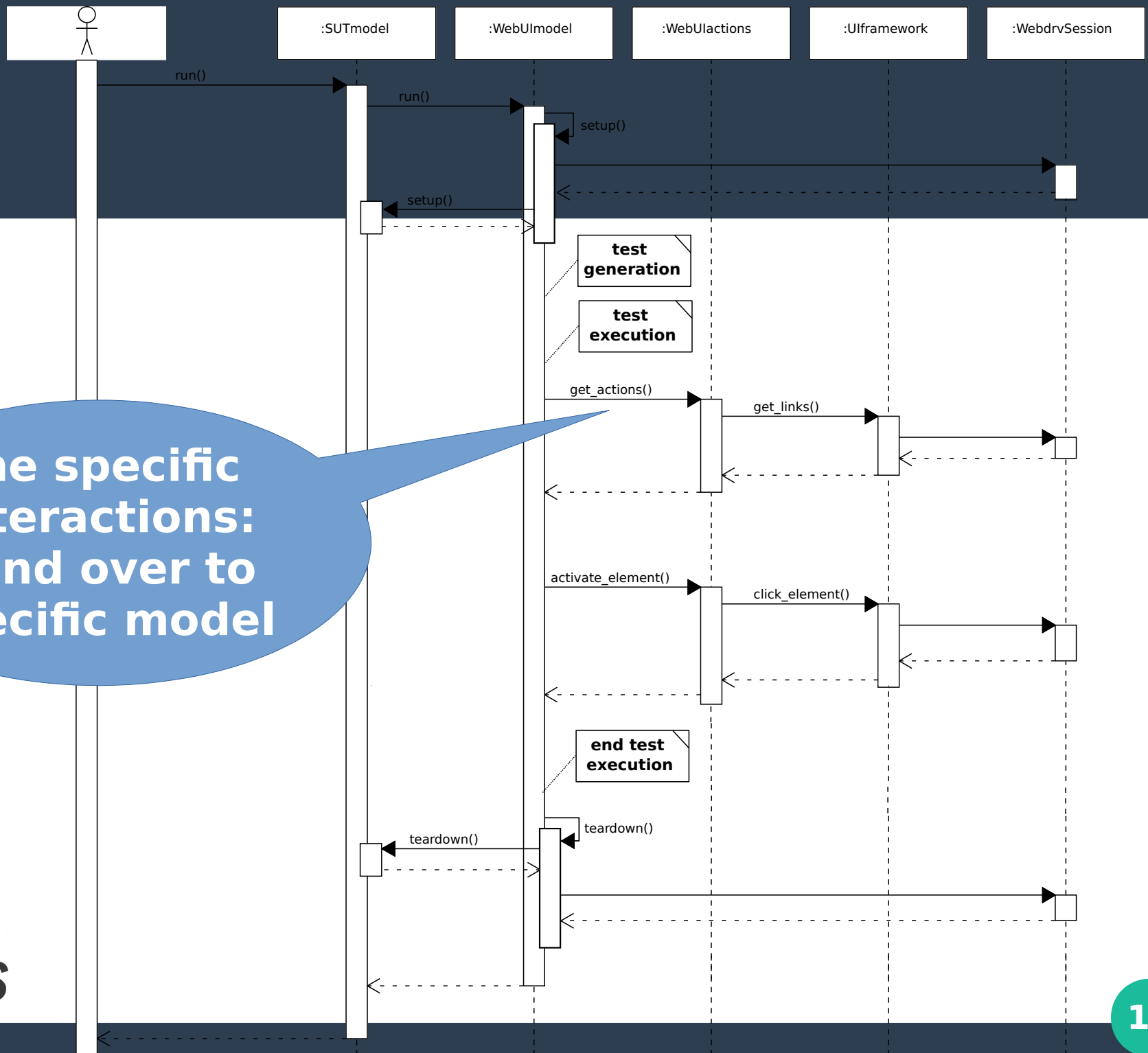


The idea

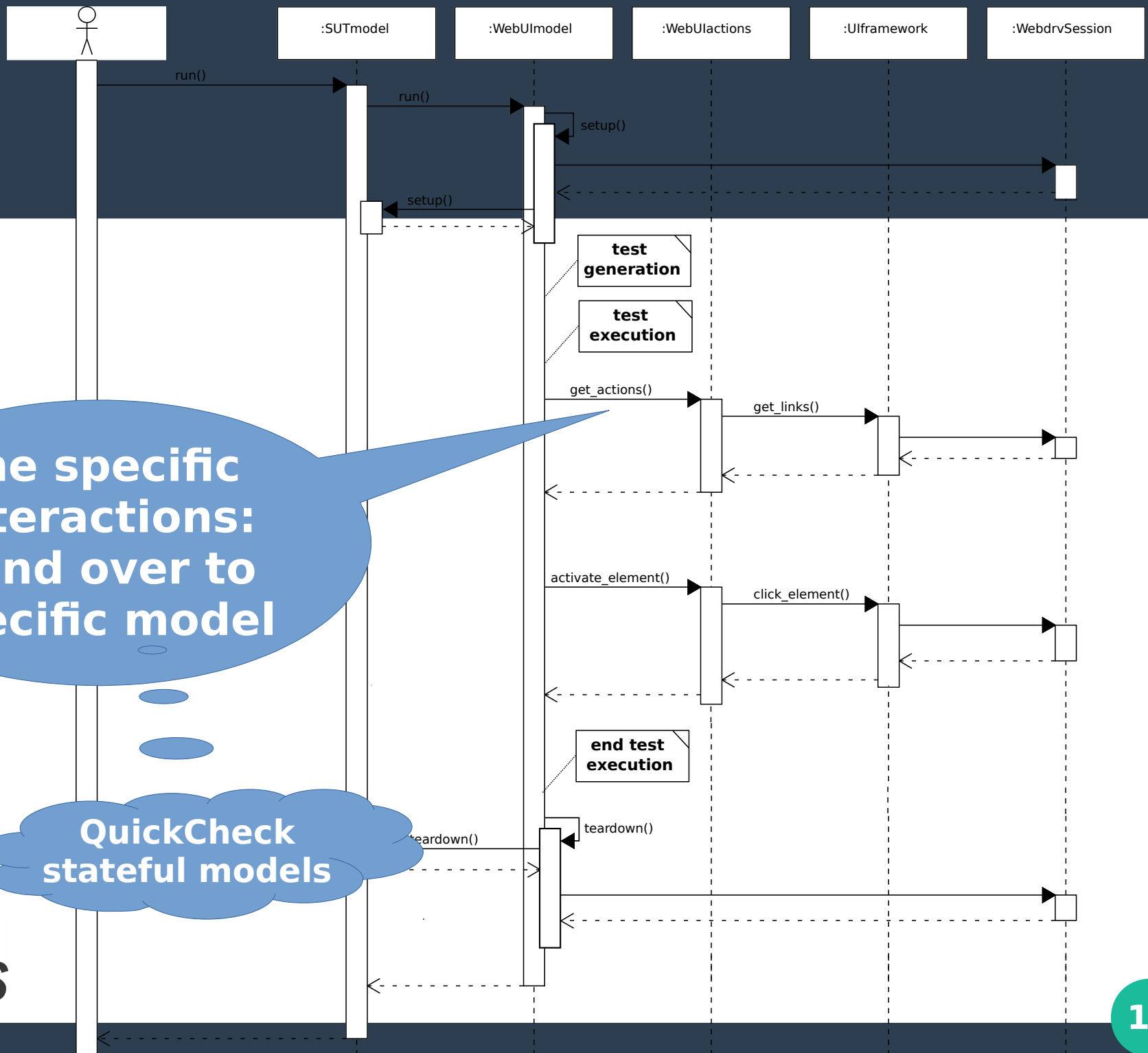


The idea

the specific interactions: hand over to specific model



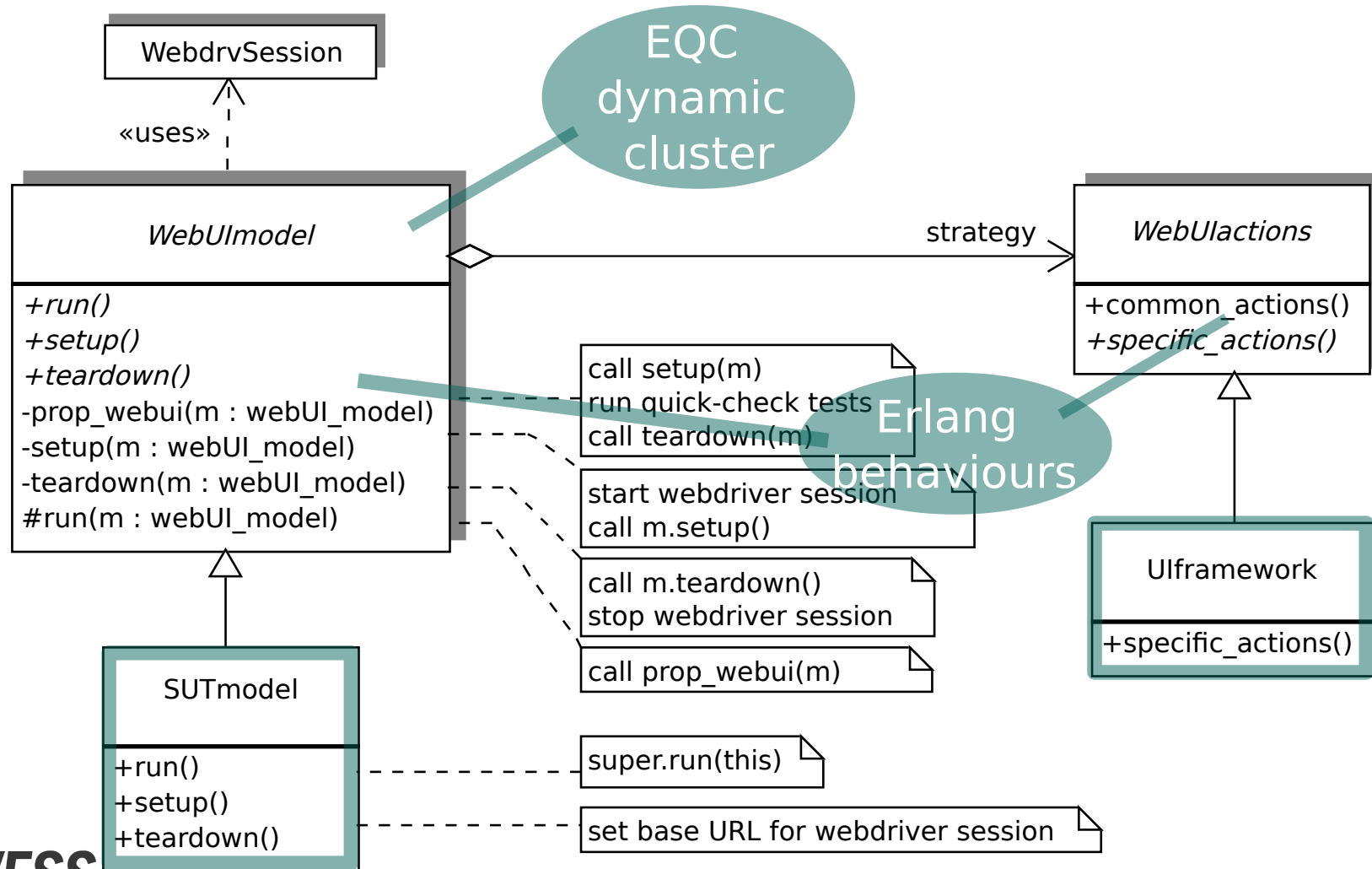
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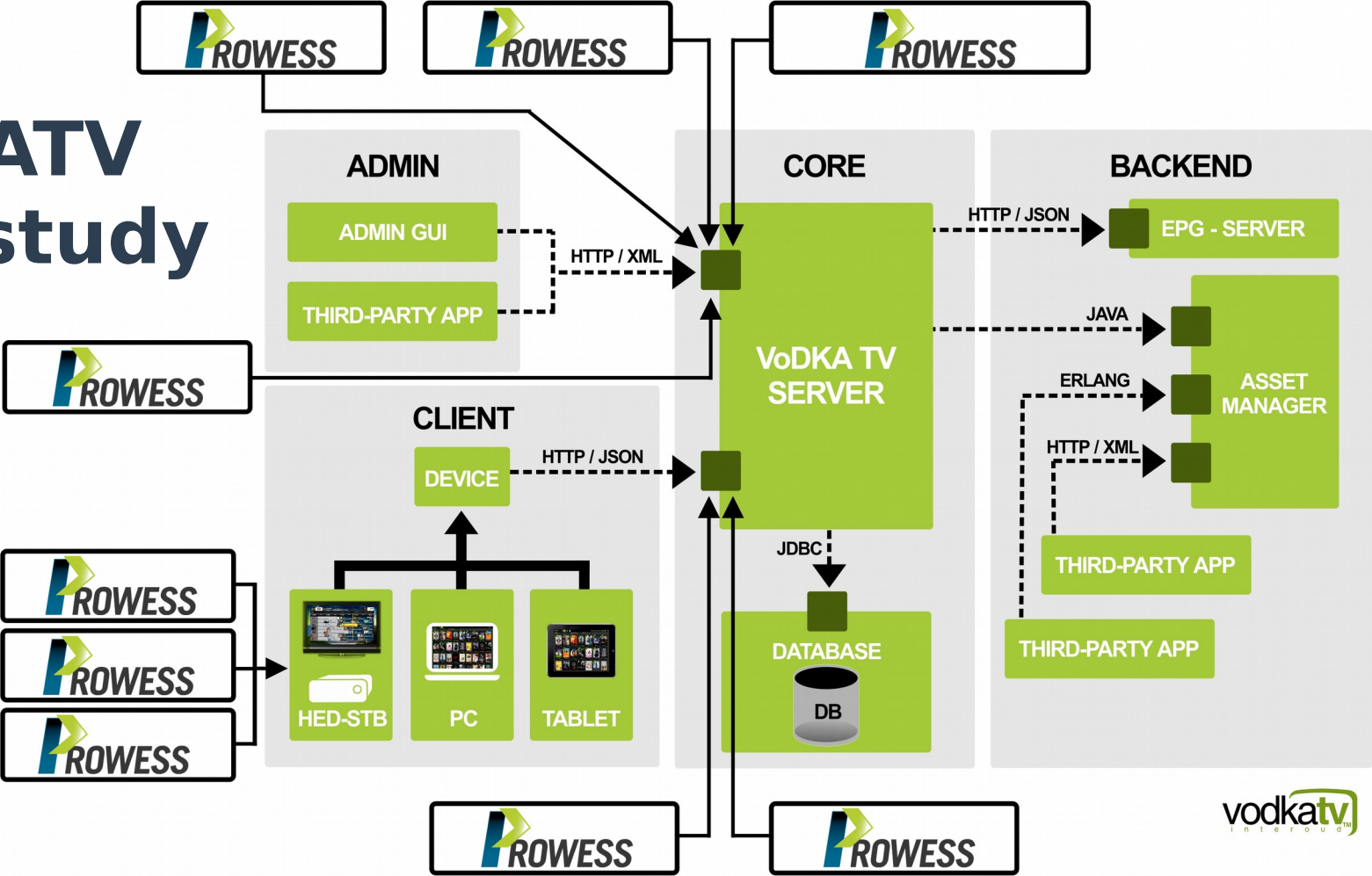
QuickCheck stateful models

The implementation



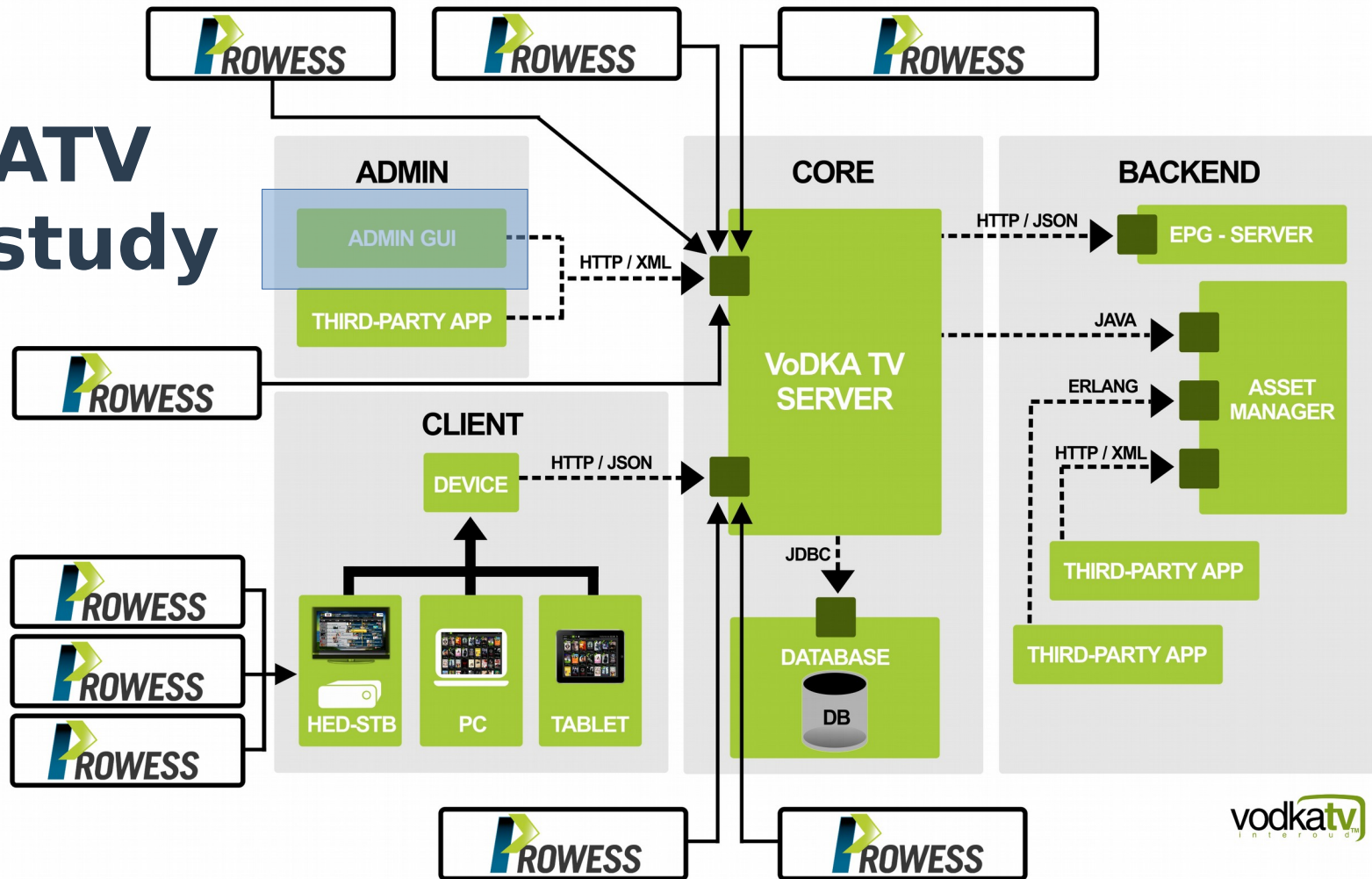
The validation

VoDKATV pilot study



The validation

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The validation

- **VoDKATV pilot study**

- Web-based GUI for configuration and administration
 - 36% of the GUI involves form-like interactions
 - 48% of the GUI involves table-like interactions

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**easy-to-write
reusable models**

The validation

- **VoDKATV pilot study**
 - Form-like interaction

Update

Editing configuration parameters	
Milliseconds STBCache:	<input type="text" value="300000"/>
Message Checking Interval:	<input type="text" value="30"/>
Hdmicec Default Mode:	<input type="checkbox"/>
Outputs Protection:	<input checked="" type="checkbox"/>
Firmware Server URL:	<input type="text"/>

The validation

- **VoDKATV pilot study**
 - Table-like interaction

Delete

user Agent	name	device Class.visual Name
<input checked="" type="checkbox"/> (.)HED(.)	001_STB	STB (HED)
<input type="checkbox"/> (.)Mozilla(.)	002_Mozilla	PC
<input type="checkbox"/> (.)	999_Other	Other device

Total Items: 3 Page Size: 25 1 / 1

New →
← Create

DEVICETYPES

user Agent

name

device Class

Create Cancel

↑ Update
↓ Edit

DEVICETYPES

user Agent

name

device Class

Update Delete Cancel

The validation

- **VoDKATV pilot study**

- Traditional GUI-level is manual, ~1h per functionality/iteration, poor regression testing, no negative testing
- Three bugs in the last 8 months vs. three bugs in one week of testing with new method & tool
- Test model reuse (migration to new admin GUI)
- Cheaper, unattended, easy to reproduce

Wrap-up

- **We have designed a new approach to GUI-level testing**
 - PBT-based, enables automated test case generation, execution and diagnosis
 - allows for test-effort reuse and liberates from test-case design
- **We have implemented it into a testing framework**
 - combines a model for random browsing with stateful PBT models for common interaction scenarios
- **We have validated it in an industrial system**
 - we found several bugs that have slipped into production after more traditional testing

Wrap-up

Framework available at

- <https://github.com/prowessproject/webui-test>

Thanks for your attention!
Questions?