Automated Scenario-based Testing of Distributed and Heterogeneous Systems

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Agenda

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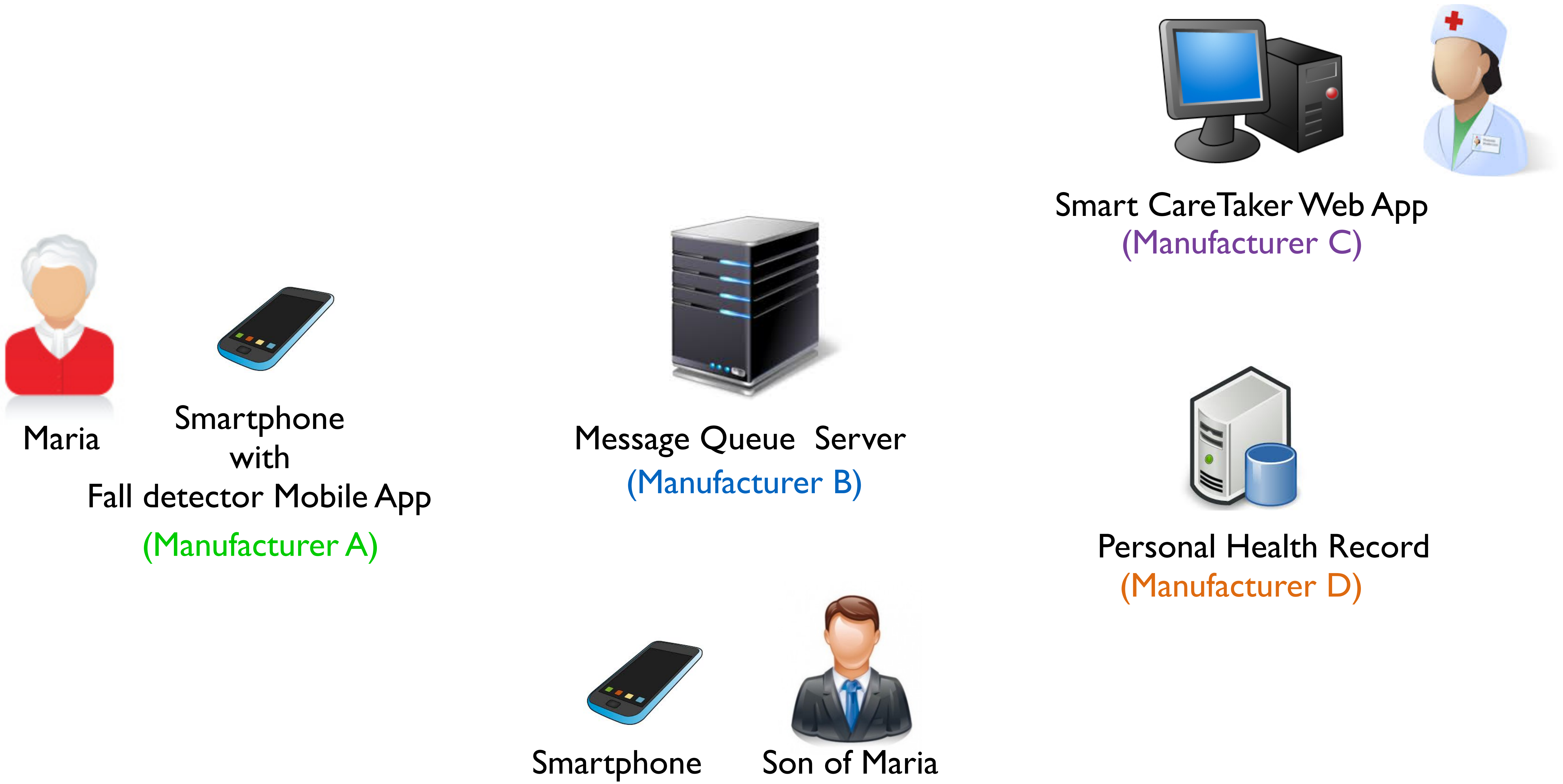
Conclusions and Future work

Motivational Example



Smart CareTaker Web App
(Manufacturer C)

Maria

Smartphone
with
Fall detector Mobile App
(Manufacturer A)

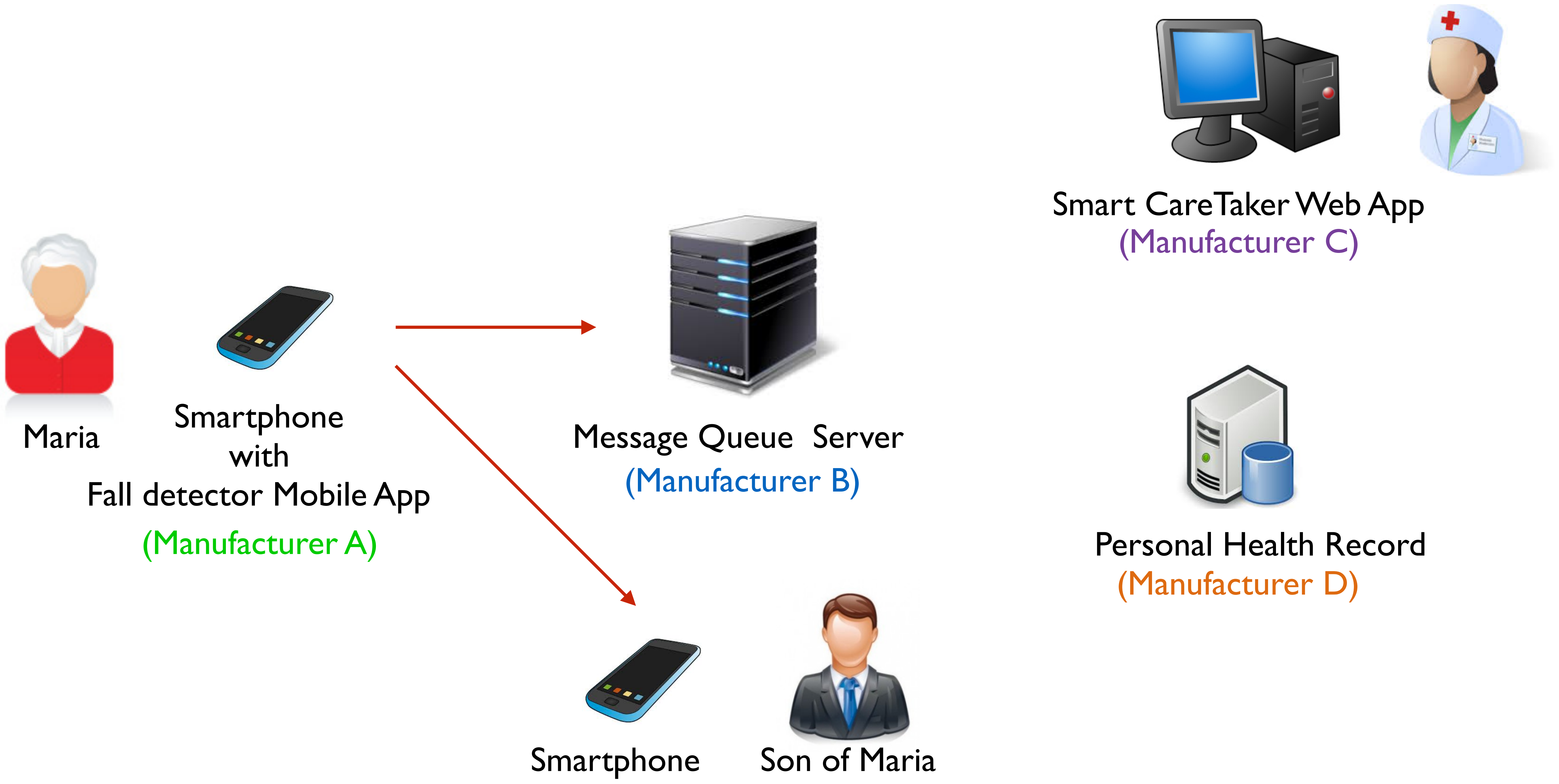
Message Queue Server
(Manufacturer B)

Personal Health Record
(Manufacturer D)

Smartphone

Son of Maria

Motivational Example



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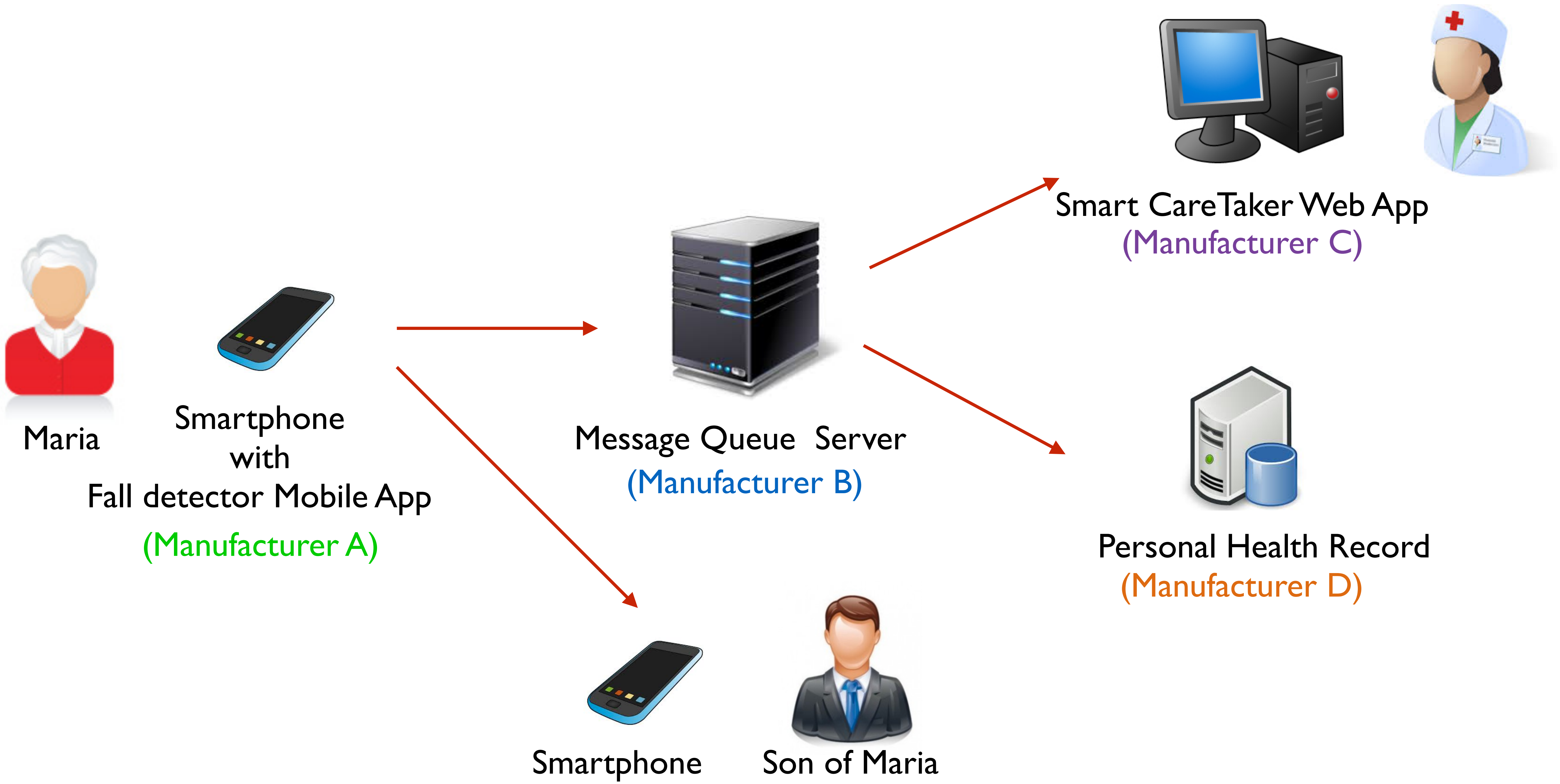
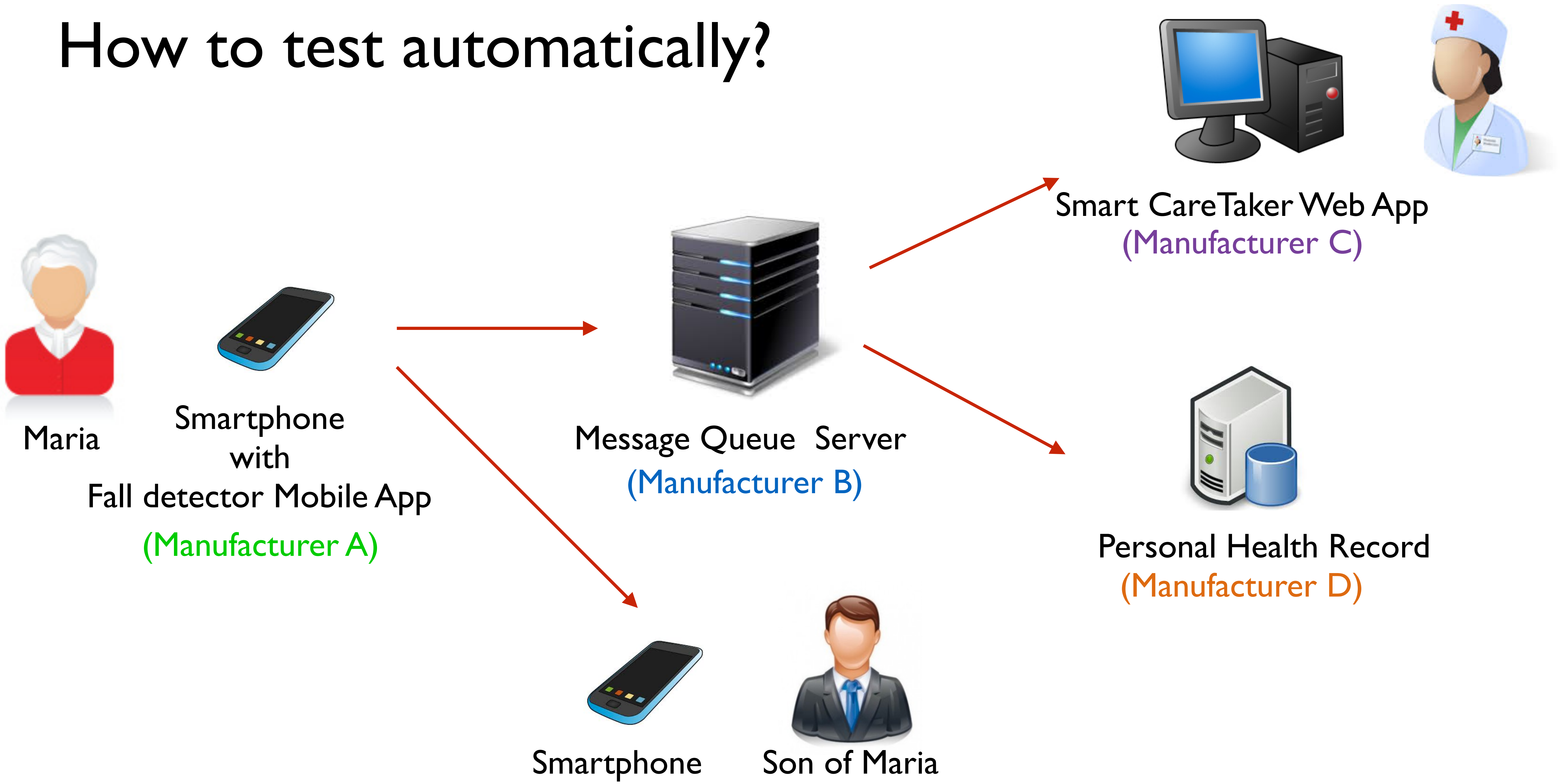


Motivational Example

How to test automatically?



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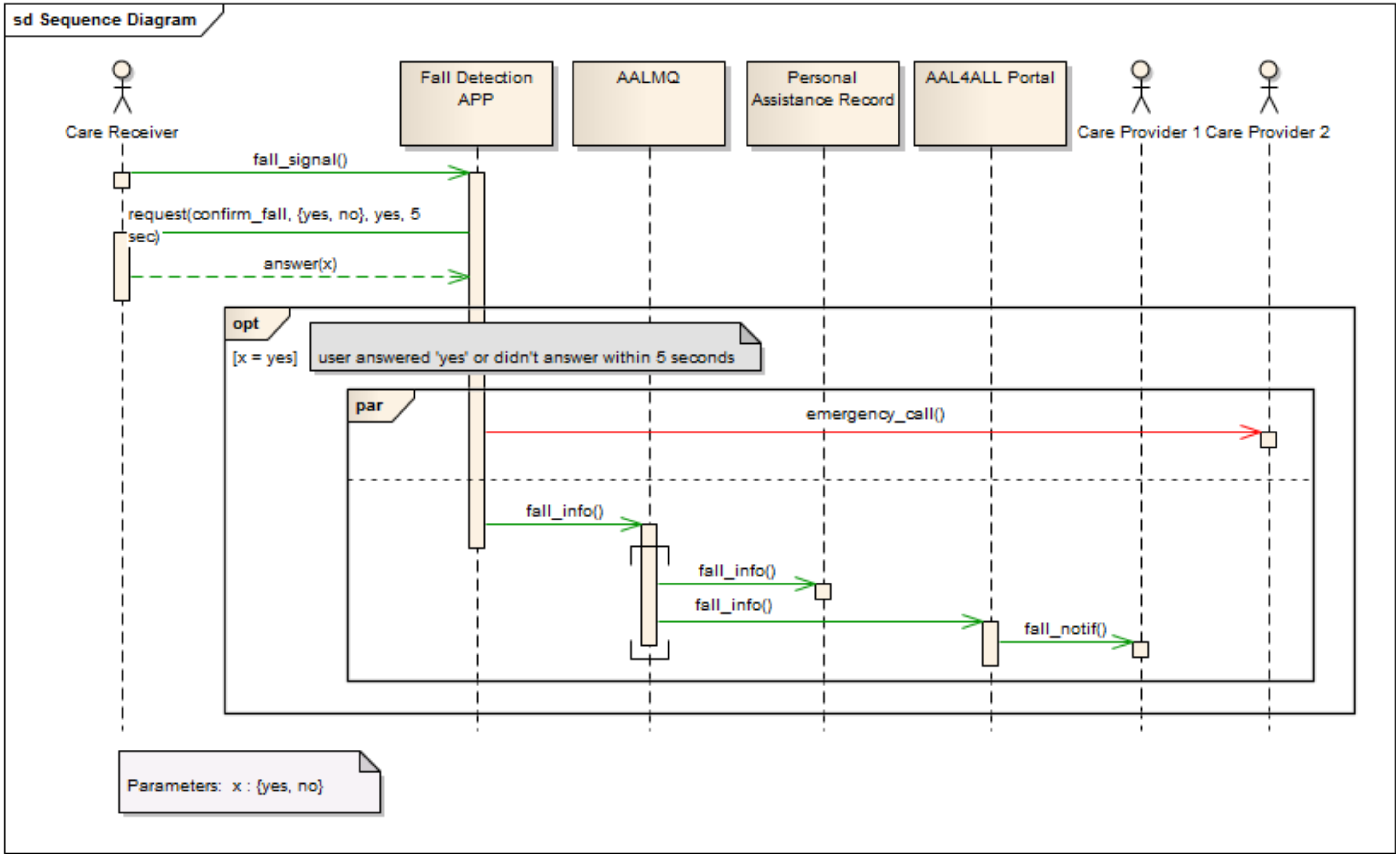
Motivational Example: Input Model



The only manual activity should be the creation of the input model of the SUT (+ mapping info).

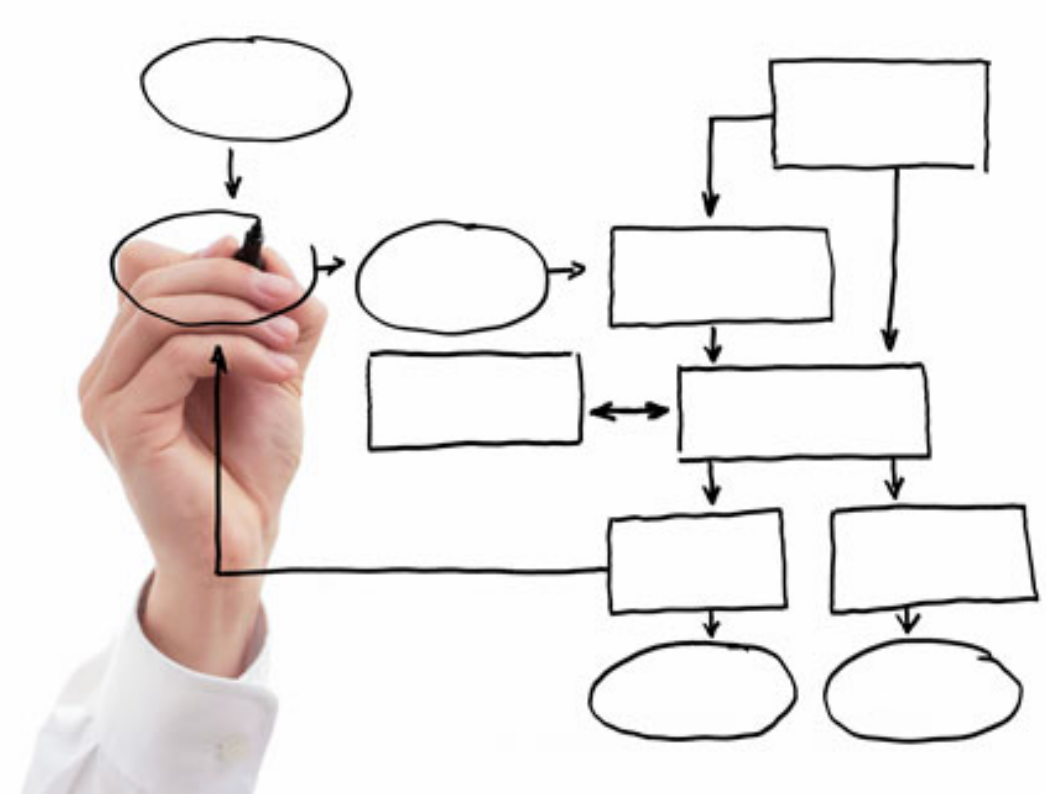
Motivation

Testing nowadays distributed and heterogeneous software systems or systems of systems, running over interconnected mobile and cloud based platforms, is particularly important and challenging.

Some of the challenges are:

- the difficulty to test the system as a whole due to the number and diversity of individual components;
- the difficulty to coordinate and synchronize the test participants and interactions, due to the distributed nature of the system;
- the difficulty to test the components individually, because of the dependencies on other components

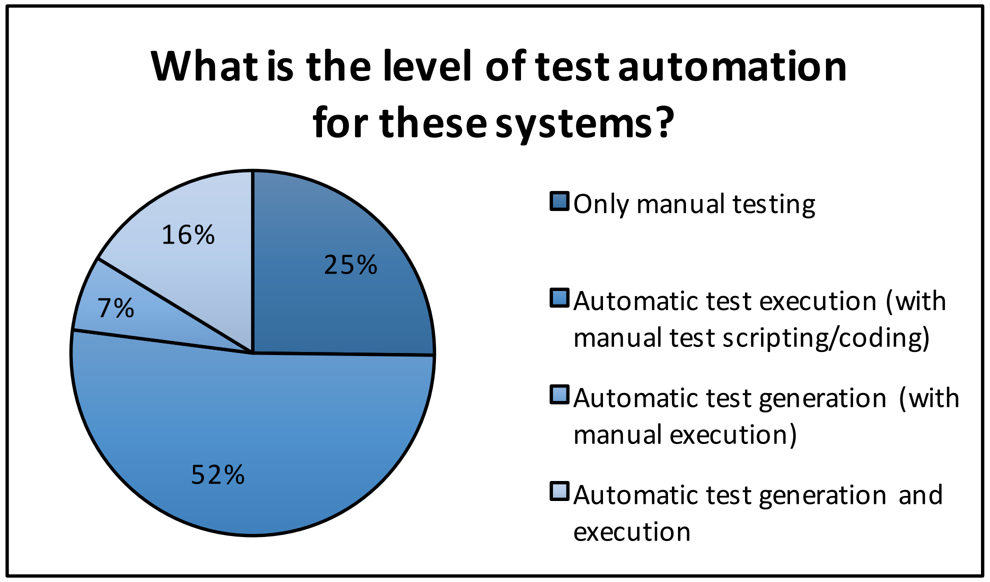
Goals

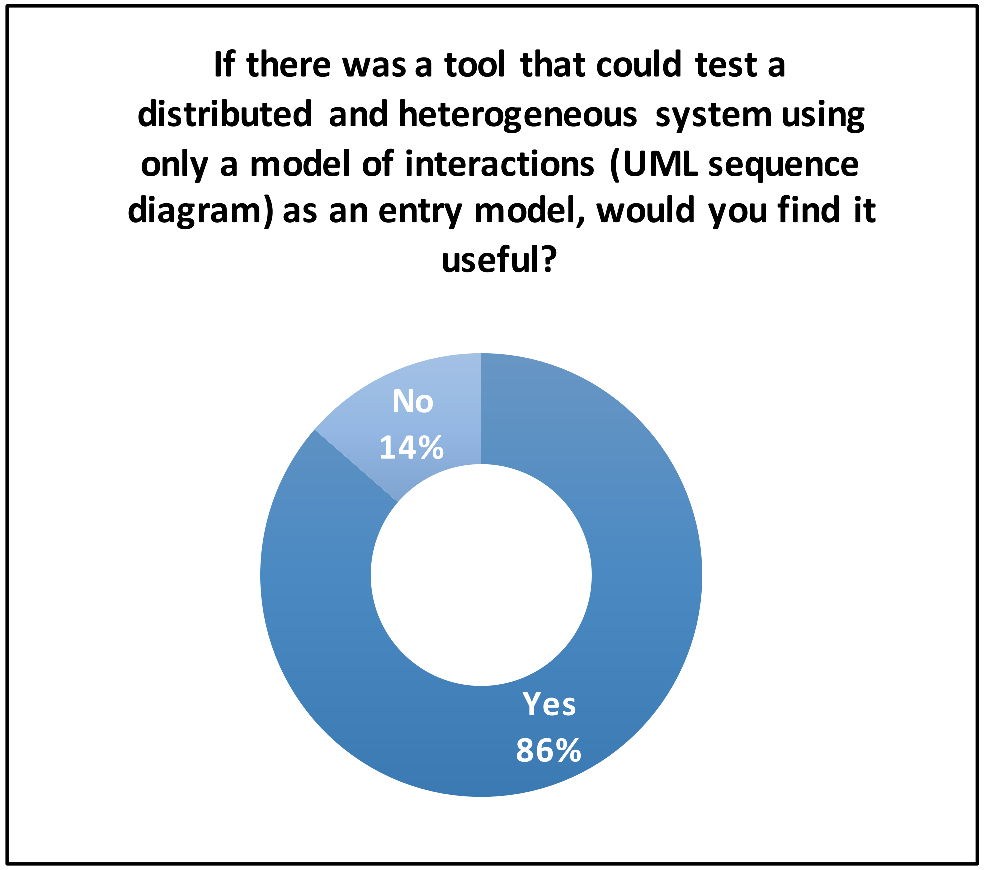


Propose an approach to automate the whole process of model-based testing of distributed and heterogeneous systems in a seamless way, with a focus on integration testing, but supporting also unit (component) and system testing.

Results to Date

Survey





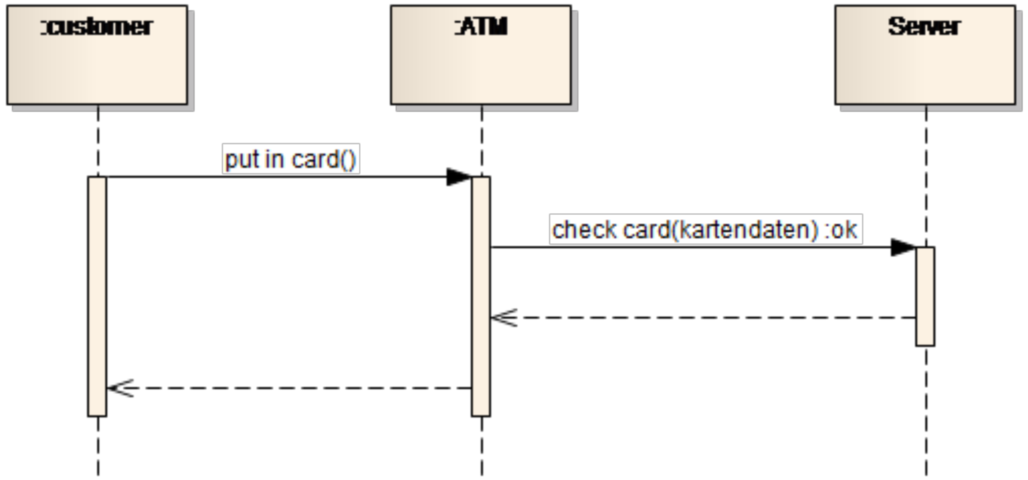
We conducted **a survey on “Testing Distributed and Heterogeneous Systems – State of the practice”**, that was distributed to the participants of two industry-oriented conferences in the software testing area (TESTING Portugal 2015 and UCAAT 2015 - ETSI User Conference on Advanced Automated Testing) and was **responded by 147 persons**.

The survey allowed us to **confirm the high relevance of DHS in software testing practice**, confirm and prioritize the relevance of testing features characteristics of DHS, **confirm the existence of a significant gap between the current and the desired status of test automation for DHS**, and confirm and prioritize the relevance of test automation features for DHS.

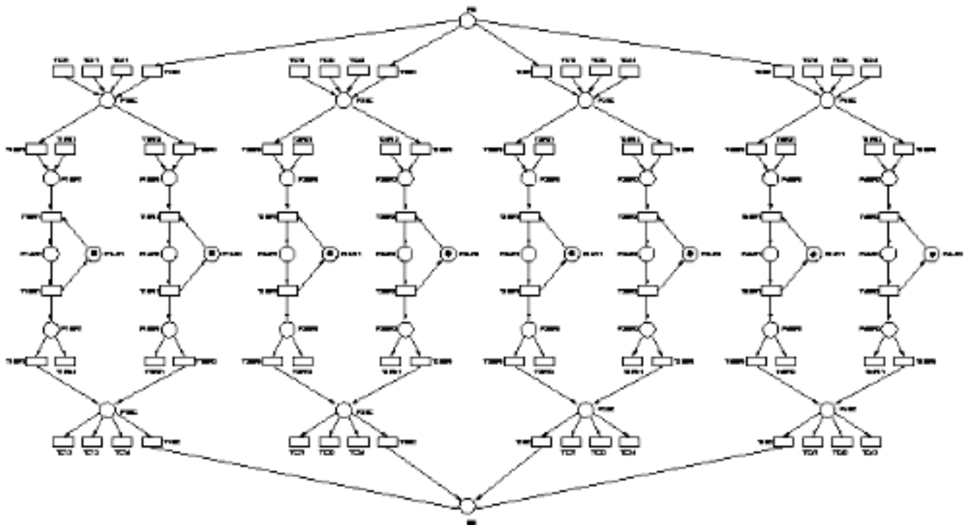
Results to Date

Approach - Main ideas

1 - different 'frontend' and 'backend' modeling notations, with automatic translation between both notations



automatic translation



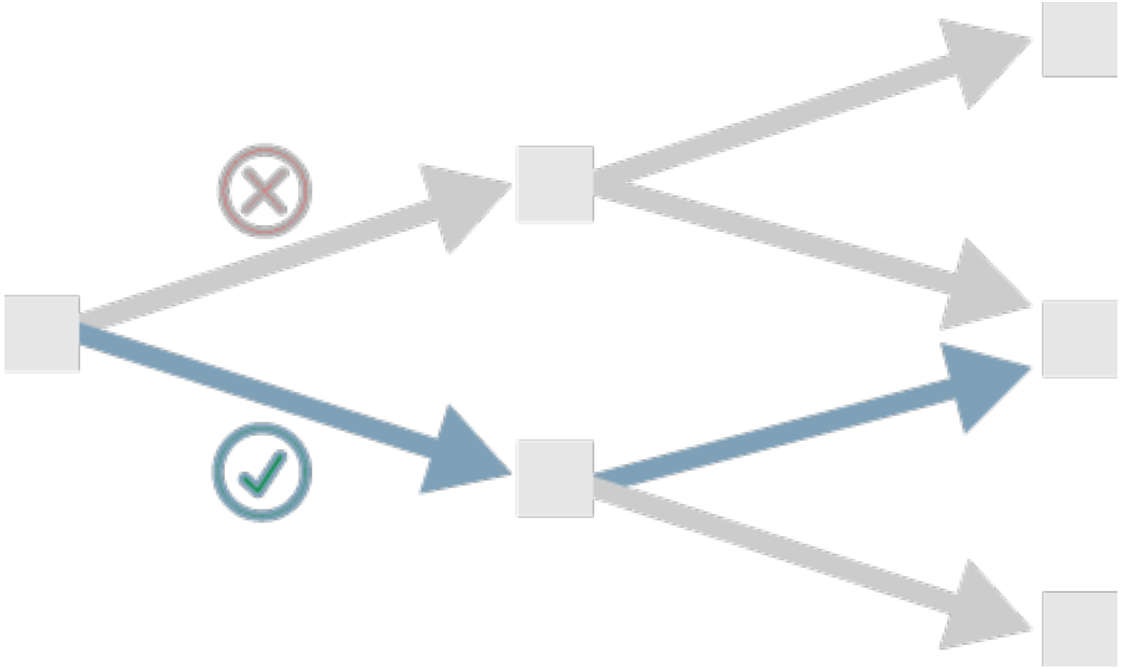
The input behavioral models created by the user in an **accessible 'frontend' notation** (using industry standards such as UML [2])

Formal **'backend' notation amenable for incremental execution at runtime** (such as extended Petri Nets as in our previous work for object-oriented systems [3])

Results to Date

Approach - Main ideas

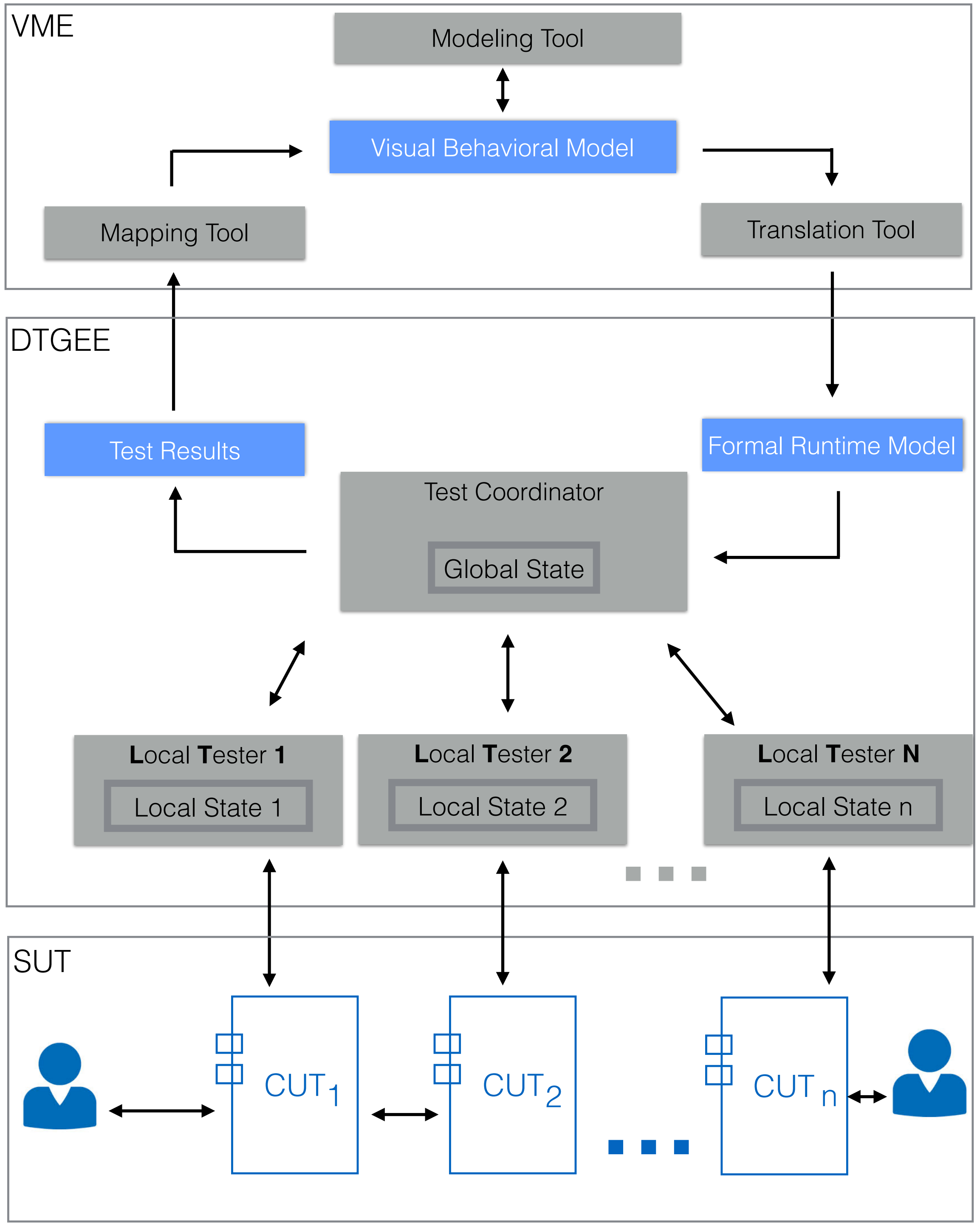
2 - online and adaptive test strategy



Where the next test input depends on the sequence of events that has been observed so far and the resulting execution state of the formal backend model, to allow for non-determinism in either the specification or the SUT [4]

Results to Date

Approach - Main ideas



3 - Distributed test architecture and algorithms

We adopt a **hybrid test monitoring and control approach,** combining a centralized 'tester' and a local 'tester' at each port (component interaction point) of the SUT

This is **more effective** than a purely centralized approach or a purely distributed approach, meaning that more conformance errors can be detected

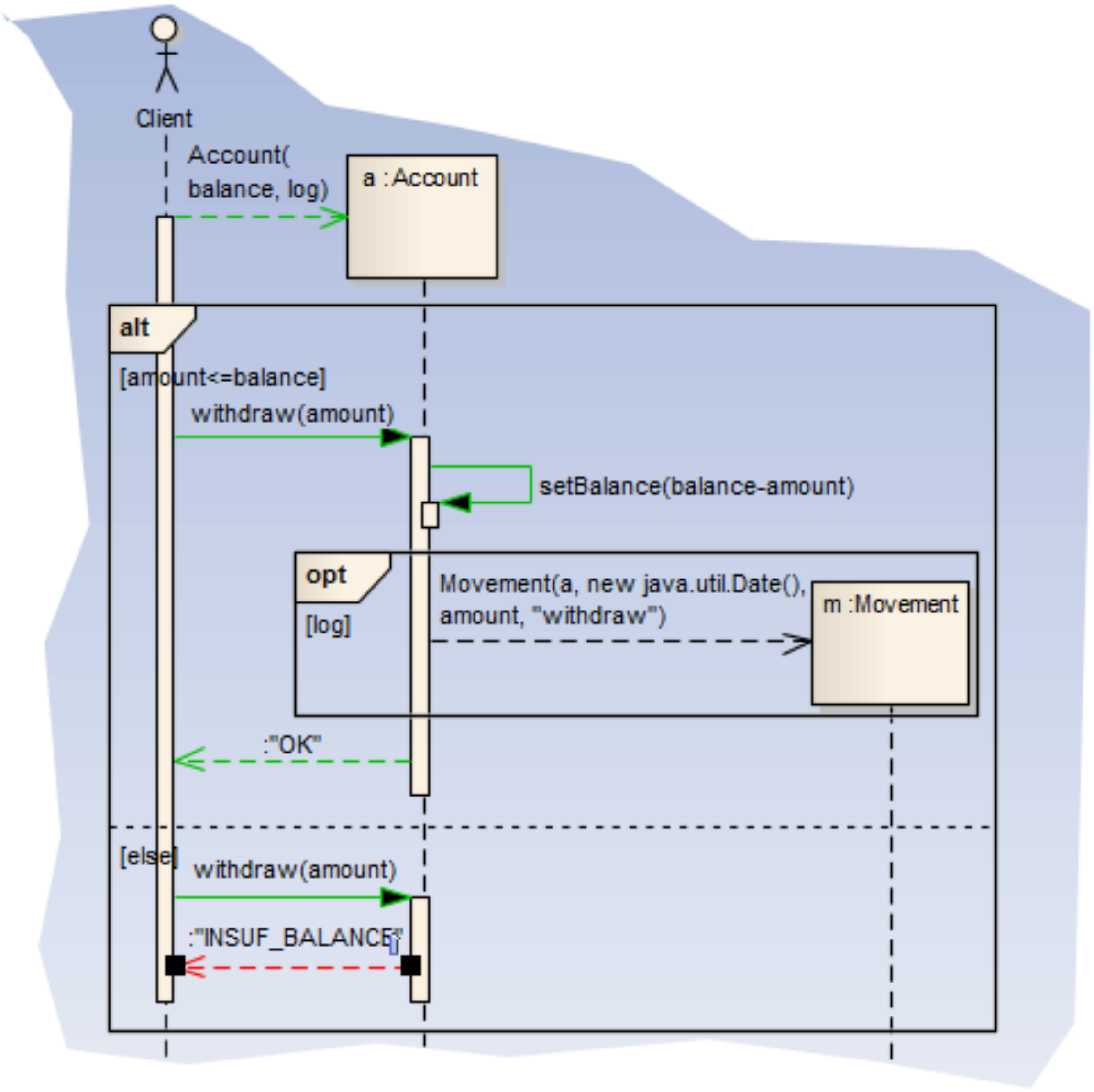
The following functions are distributed:

- test monitoring & control
- model execution
- conformance checking

Results to Date

Approach - Main ideas

4 - automatic mapping of test results



Coverage and errors are automatically mapped to the ‘frontend’ modeling layer.

Open Research Questions

RQ1 - Which extensions of Petri Nets should be used?

RQ2 - How to translate temporal constraints from UML SDs to Petri Nets?

RQ3 - How to partition the Petri Net for distributed execution?

RQ4 - How to choose the next test action in a distributed environment?

RQ5 - How to translate the results back to the UML SD?

Conclusions and Future Work

We presented a research plan and a summary of preliminary results of a Ph.D. work on test automation for distributed and heterogeneous systems.

As next steps we intend to design and validate appropriate notations and algorithms for supporting the proposed approach. To experimentally assess the benefits of the approach and toolset, industrial level case studies will be conducted, with at least one in the AAL domain [5].

References

[1] Dias Neto, A. C., Subramanyan, R., Vieira, M., and Travas- sos, G. H. (2007). A Survey on Model-based Testing Approaches: A Systematic Review. In Proceedings of the 1st ACM International Workshop on Empirical Assessment of Software Engineering Languages and Technologies: Held in Conjunction with the 22Nd IEEE/ACM International Conference on Auto- mated Software Engineering (ASE) 2007, WEASEL- Tech '07, pages 31–36, New York, NY, USA. ACM

[2] OMG (2011). OMG Unified Modeling LanguageTM (OMG UML), Superstructure. Technical report, Ob- ject Management Group.

[3] Faria, J. and Paiva, A. (2014). A toolset for conformance testing against UML sequence diagrams based on event-driven colored Petri nets. *International Journal on Software Tools for Technology Transfer*, pages 1–20.

[4] Hierons, R. M. (2014). Combining Centralised and Distributed Testing. *ACM Trans. Softw. Eng. Methodol.*, 24(1):5:1–5:29.

[5] AAL4ALL (2015). Ambient Assisted Living For All. http://www.aal4all.org.

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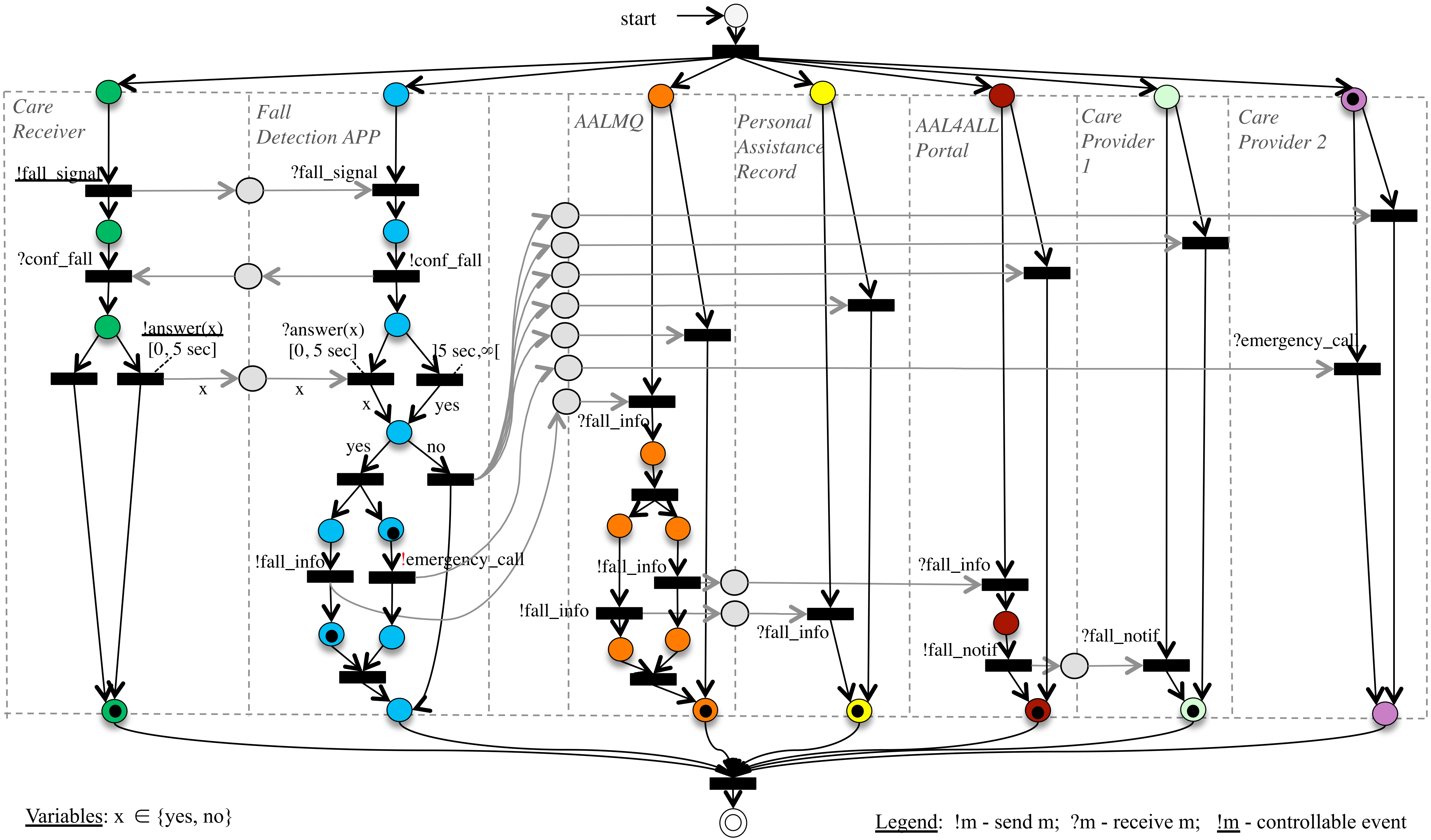

Variables: x ∈ {yes, no}

Legend: !m - send m; ?m - receive m; !m - controllable event

State of the art

Model-based testing

Model-based testing approaches found in the literature suffer from **several limitations** [1].

The most common limitation is the **lack of integrated support** for the whole test process.

Other common problems are the **difficulty to avoid the explosion of the number of test cases** generated and the **difficulty to bridge the gap between the model and the implementation**.

State of the art

Test automation for distributed systems

Although we didn’t find in the literature MBT approaches supporting in an integrated fashion the whole test automation process for distributed systems, we found several works supporting parts of the process, that can help in the construction of an integrated approach and toolset.

Research Hypothesis

Using a scenario-oriented model-based adaptive (online) testing approach, with extended Petri Nets at runtime, on top of a hybrid test execution architecture, it is possible to fully automate the testing of distributed and heterogeneous systems, at the integration, unit and system level, in an effective, efficient and accessible way.