Architecture for Large-Scale Innovation Experiment Systems

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Overview

Context

Problem statement

Research question

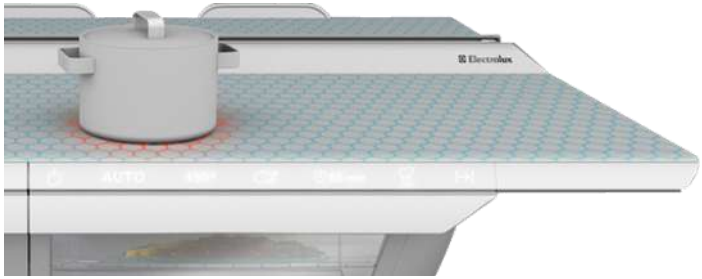
Conceptual solution

Validation: case study

Conclusion

Mass-produced embedded systems

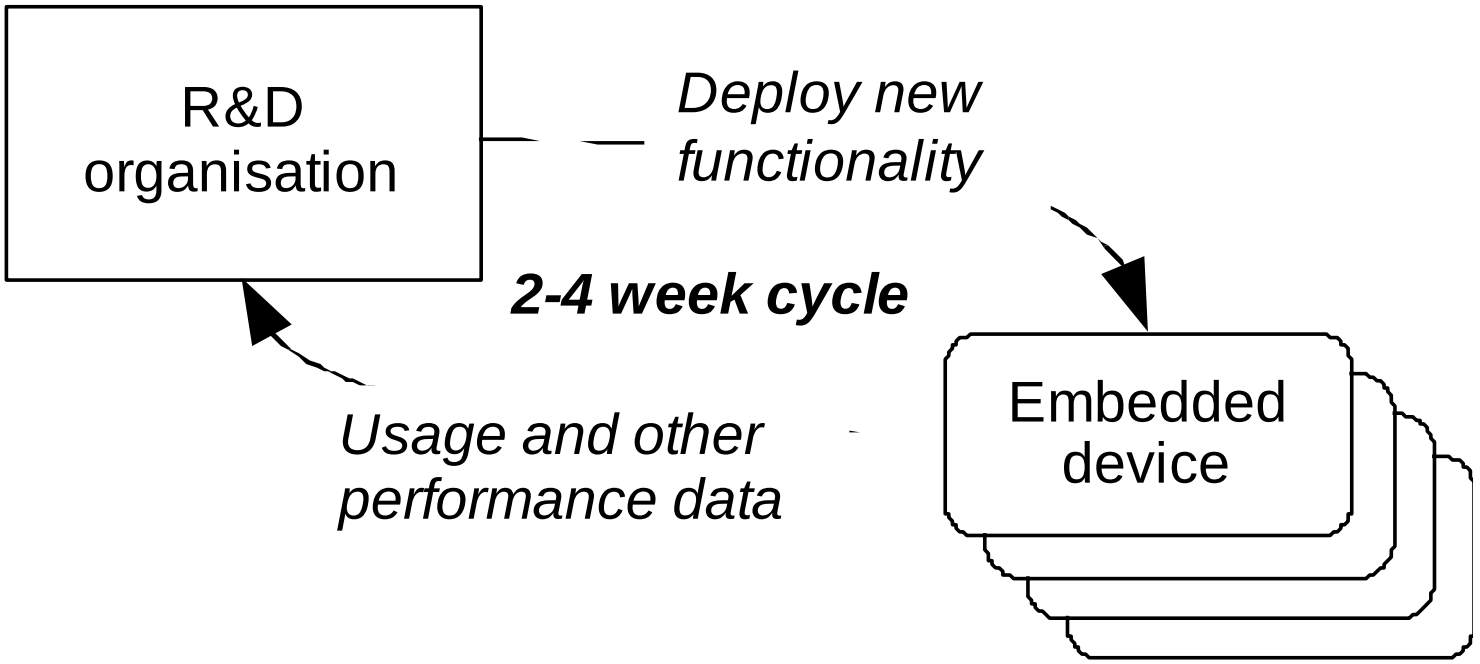
- Deep integration between hardware and software for significant parts of the functionality
- Strong focus on manufacturing aspects
  - E.g. by process gates
- Strong supplier involvement
- Some parts realise safety-critical functionality



Speed

- More and more embedded products are connected
- It is conceivable to develop, deploy and *measure* software in iterations which lengths are determined
  - by the speed of the individual software teams
  - not by the manufacturing setup and development of the hardware

R&D as an Experiment System



Claim

The company running
the most experiments against
the lowest cost per experiment
outcompete the others

Business and design decisions should be based on DATA, not opinions

Experiment Scenarios

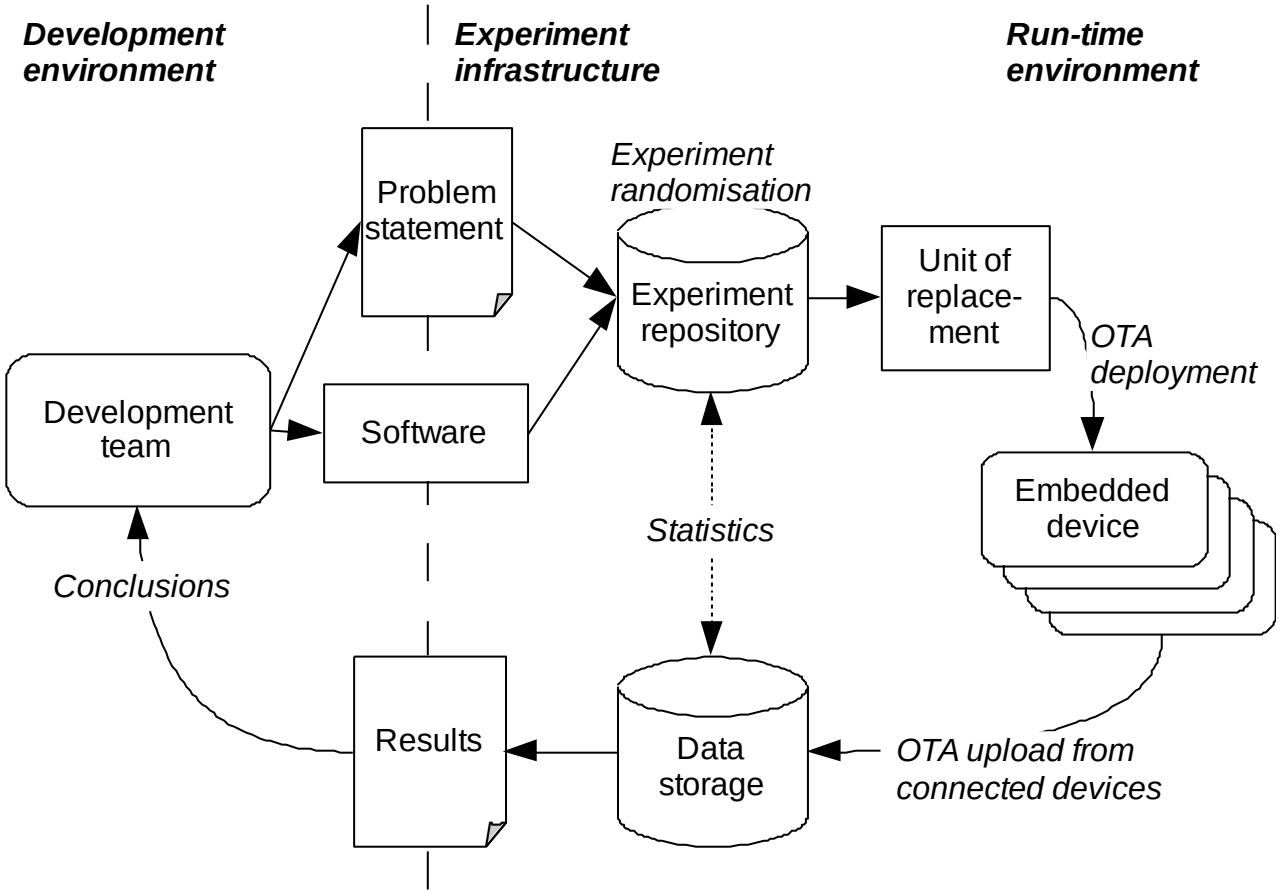
- How long does it take to . . .
- Which of . . . is most often used/accessed/. . .
- Identify behaviour that is not intended, e.g. menu selection followed by "back“
  - indicates that the user made a mistake
- Are there any features that are not used?

- Be able to evaluate competing designs based on the answers above
  - i.e. A/B testing (AKA. split testing)

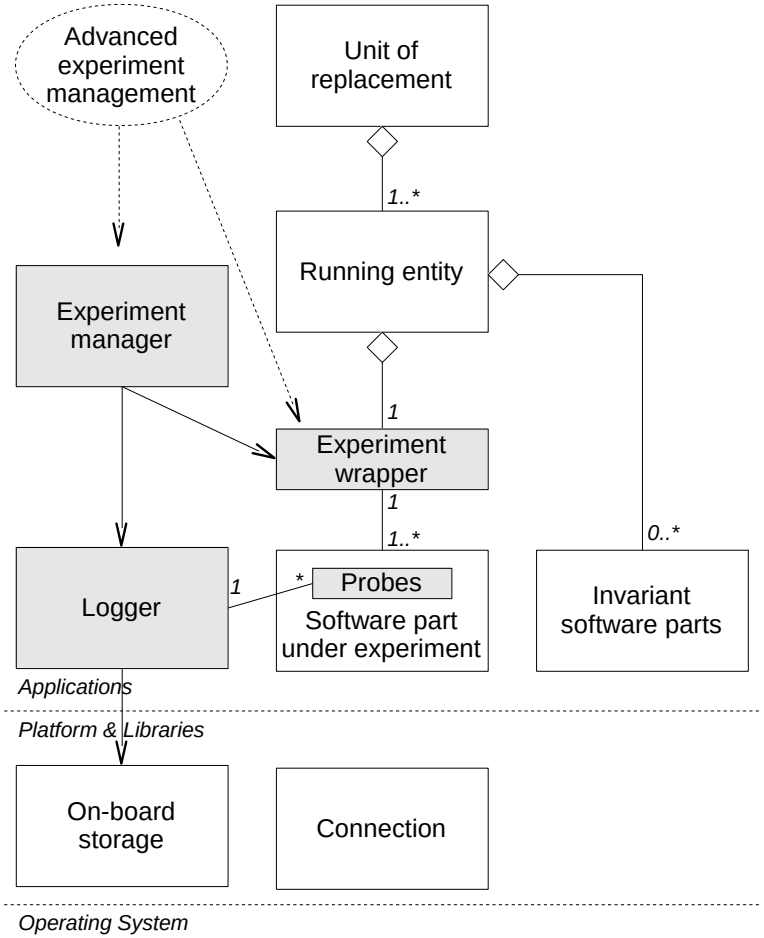
Research problem

What are the software architecture principles to realise a large-scale innovation experiment system of mass-produced embedded systems?

Experiment infrastructure



On-board architecture



Case: Open Infotainment Labs

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- Feature development with short lead-times from decision to implementation?
  - From a nominal lead-time of 1-3 years to 4-12 weeks?
- Small development team using Scrum
  - Consultancy firm with automotive software experience
  - Supplier relationship to Volvo Car Corporation as product owner
- Working software was continuously validated in “real” environments
  - installed in both a driving simulator and real test cars
  - users evaluated the system

The Experiment

- 1st sprint: Implementation of measurement/logging of usage
- 4th sprint: A/B experiment
  - Evaluating two layouts of the start screen
    - Implemented as two different launchers in Android
  - Mounted in a vehicle
  - 7 test drivers in total (3 used A, 4 used B)
  - Off-board analysis of logged data, e.g:
    - Time spent in each launcher screen
    - How many applications are installed?
    - What apps are launched?

Conclusion

- Innovation experiment systems is an evolution of current R&D practices, enabled by:
  - Embedded systems are increasingly connected
  - Design decisions based on real-life data and not opinions
  - Development, deployment and evaluation of new software in short iterations
- Proof of-concept of architecture and implementation
  - Real vehicle with 7 users
  - A/B testing