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
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

R&D organisation

Deploy new functionality

2-4 week cycle

Usage and other performance data

Embedded device
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
Case: Open Infotainment Labs

- 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