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Applying Agile Development in Mass-Produced Embedded Systems

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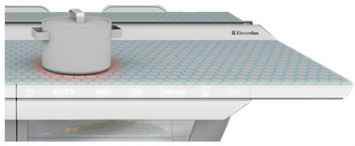
The domain of mass-produced embedded systems

- 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



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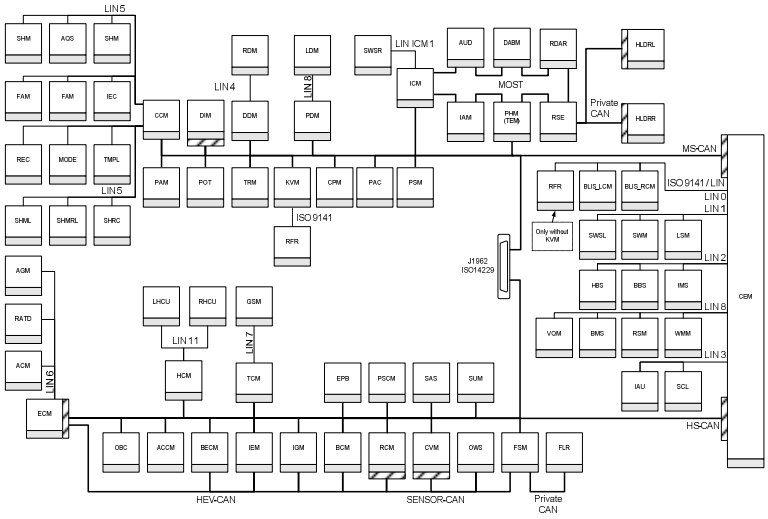
Computers in a car



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What is agile?

- Software is iteratively developed
  - Time-boxed periods of 2-6 weeks
- Each iteration results in running software
- The content to be implemented is continuously decided in each iteration
  - Thus influencing the final product content

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Research questions

- What are the critical factors when introducing agile software development in mass-produced embedded systems?
- How should we manage those factors?

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Background cases

- Case 1: Introduction of Distributed Software Architecture
- Case 2: Architecture Maintenance Process
- Case 3: Development Project of an Infotainment System
- All at Volvo Cars

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Vehicle electronics development process

Figure of Volvo development process for electronics and software removed on purpose

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Research data

Case	Data sources	Author role
1	Interviews with 20 developers + design documents	Insider observer
2	Interviews with 6 architects + design documents + personal notes	Participant / insider observer
3	Interviews with 6 key developers + design documents	Insider observer
4	All project & design documents of both product owner and Scrum team + personal notes	Participant / insider observer
5	Official meeting notes and presentations + personal notes	Participant / insider observer
6	Official meeting notes and presentations + personal notes	Participant / insider observer

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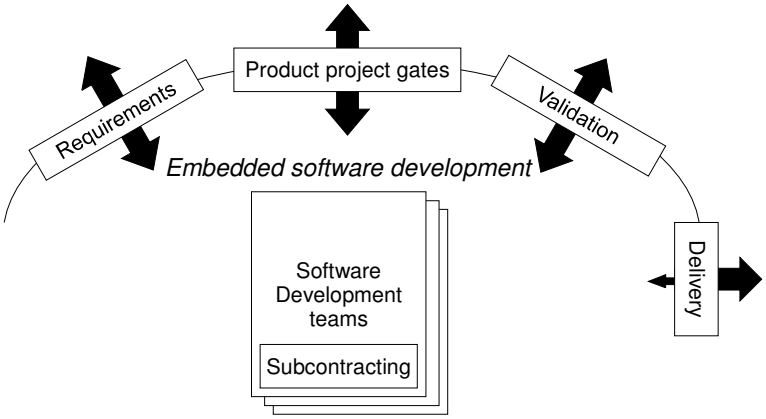
Embedded software development

Mechanics, hardware and systems development



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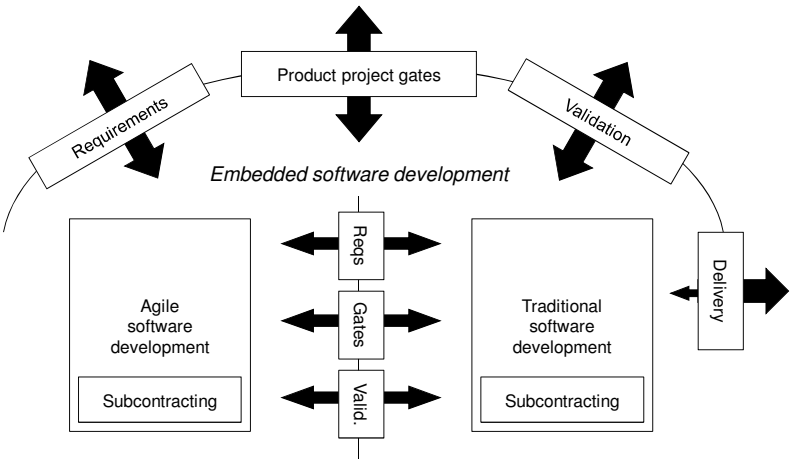
Model

Mechanics, hardware and systems development



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Individual agile teams

- Three relationships relevant to the teams introducing agile development
- Interface to the rest of the organisation outside software development
- Internal activity to the teams adopting agile development
- Interface to other teams doing (traditional) software development

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Measures to facilitate introduction

- Measures are related to two stages
  - Prerequisites for agile development
  - Activities during development
  - Beyond what “agile textbooks” say
- Measures relate to
  - Requirements
  - Project progress, i.e. stage gates
  - Integration & validation
  - Internal team activities

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Examples of prerequisite measures

- Appoint dedicated product owner (obviously!)
  - Replaces other project roles, what to do with those people?
- Align pulse between OEM and subcontractor
  - Integration and validation at OEM with software deliveries
- Start with an established platform used by the development team(s)
  - Otherwise no working software in early sprints
- + 7 more…

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Examples of activity measures

- Interact with existing PLM tools
  - Formal requirements of what information to store
- Fullfil quality assessments
  - E.g. automotive SPICE
- Meet product integration test schedule
  - Adjust backlog accordingly
- + 7 more…

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Validation cases

- Case 4: Agile Development of a Prototype Infotainment System
- Case 5: Climate Control Software
- Case 6: Next Generation Infotainment System

- Also all at Volvo Cars

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Case 4: Agile Development of a Prototype Infotainment System

- A small development team using Scrum
- The development team from EIS by Semcon had a supplier relationship to Volvo Cars as product owner
- Growth of features during the entire duration of the project
  - In contrast to the normal stage-gate processes at Volvo Cars
  - Clear change of focus from customer features to platform and architecture as the project progressed
  - Implementation of features reduced from a nominal leadtime of 1-3 years to 4-12 weeks.
- All project information was centrally managed with Trac
- An open architecture based on Android
  - with separation of feature development from platform and hardware development

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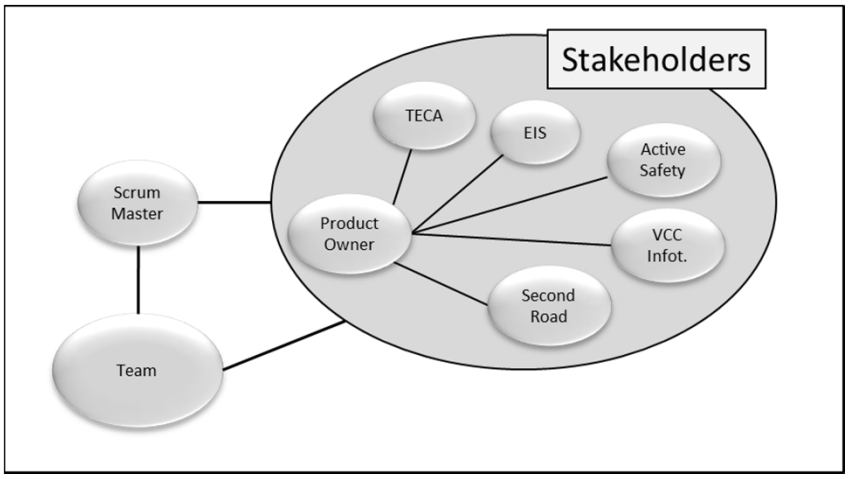
Project organisation



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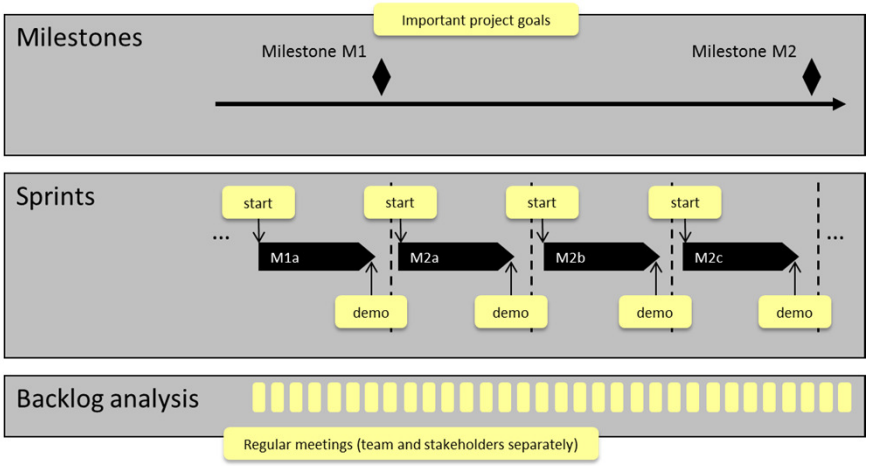
Project workflow



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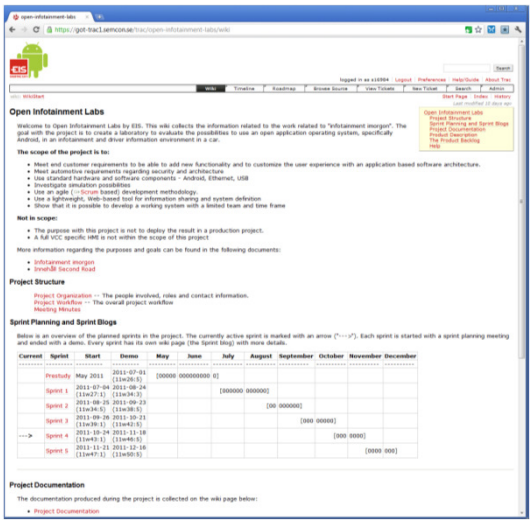
Project website



Source code at: http://trac.edgewall.org/

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Case 5: Climate Control Software

- Insourcing of previously outsourced control software
- "Scrummish"
  - Backlog, morning meetings, burndown charts, etc
  - Used MS sharepoint add-on to manage backlog
- Code generated from Simulink models
  - Model execution independent of the hardware platform
- AUTOSAR architecture platform
  - Developed by HVAC hardware supplier

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Results of going agile

- Problems
  - Organizational separation between team and product owner
    - EESE and interior department respectively
  - Difficult finding somebody to act as product owner
    - Development team probably the group with best domain knowledge in entire company
- Benefits
  - Smooth transition for the team
  - Better tracking of progress than ever before
  - Could give quantitative estimates of deadline fulfilment already after 3 sprints

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Case 6: Next Generation Infotainment System

- Outsourced development
- Very complex requirements, balance between
  - new customer features
  - Integration with rest of vehicle
  - Changes, defects, etc.

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Case 6: Next Generation Infotainment System

- The product owner role is held by a duo
  - one from product planning/marketing
  - the other from R&D (EESE)
- The sprint planning and goals were aligned with the test vehicle builds
  - Enable test vehicles
- A system anatomy was defined
  - Establish order of integration
- The interfaces to other subsystems have been identified with the help of the architecture group

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Issues encountered

- A lot of stakeholders
  - Difficult to get acceptance for a singe (duo) product owner
  - Complex governance structure
- Size of system
  - Feature definition involved ~10 teams
  - Backlog consists of ~2000 items!
- Supplier relationship
  - Commercial agreement on fixed content for fixed cost, at fixed time
  - Transparency: How agile is the developer really?

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Agile approach to SPI

Figure of Volvo backlog for implementation of agile measures removed on purpose

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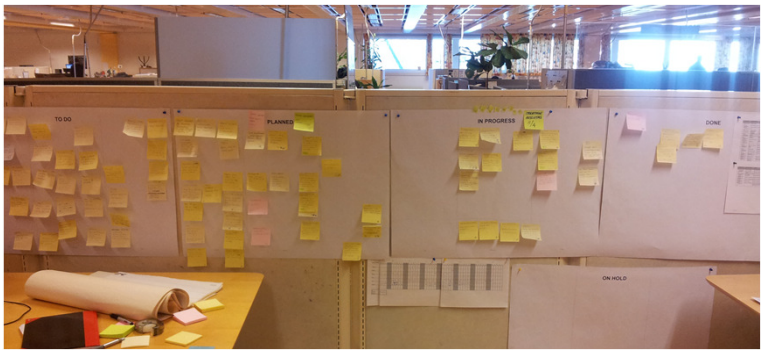
Agile approach to SPI



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Summary

- Manufacturing concerns drive the project logic for the embedded product
  - Software just tags along if nothing is done
- Defined 4 critical factors for introducing agile on team level in large embedded projects:
  - Requirements
  - Project planning & control (e.g. project stage gates)
  - Integration & Validation
  - Software deliver (to customer)