

The role of the architect

Advanced software architecture
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Ulrik Eklund, Volvo Car Corporation

Who am I?

- *Ulrik Eklund*
 - M.Sc. In Engineering Physics 1993
- Researcher in the Swedish space program 1993-1998
- Worked with various aspects of automotive software development since 1999
- System Architect at Volvo Cars since 2003
 - International cooperation with Ford, Jaguar and Land Rover
 - Hybrid vehicle logical architecture
 - Next generation Volvo platform
 - Infotainment development
- Developed undergraduate course in Software Architecture for Gothenburg University in 2006
- Also working part-time towards my PhD in Software Engineering since 2008

What is software architecture?

One perspective is to look at the definition:

Architecture

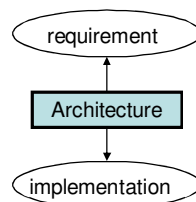
The fundamental organisation of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution. [IEEE 1471]

What is software architecture?

Another perspective:

Architecture

Is about bridging the semantic gap between Requirements and Implementation



*"Architecture is what
joins technology with
company values"
Senior architect at
Scania*

How are architectures developed?

The architecture = $f(\text{requirements, design method, experience, knowledge, patterns, intuition, ...})$

So how do you design an architecture from scratch?

1. Identify the important quality attributes
2. Understand the functional requirements
3. Classify the system and try to identify suitable style(s) and design solutions
4. Define architectural tactics and map these against the architecturally significant requirements
5. Define overall structures
6. Evaluate and develop the architecture further in a number of iterations

Defining the prerequisites

- Identify the important quality attributes
- Understand the functional requirements
- This means working with key stakeholders
 - Usually the *acquirer* and the *user(s)* in these two steps
- In reality you never get the complete prerequisites. The architect has to make progress anyway!
 - *Experience* and *domain knowledge* helps...
 - And so does a *Problem Domain Model*

Classify the system! But how?

- The ability to classify systems comes with experience!
 - One usually does not become a highly productive architect until after years of professional experience
- Usually one can never start with a blank slate
- Heavy constraints in the form of
 - Legacy
 - Platform choices
 - Schedule
 - Team skill/experience
 - Headcount

Classify the system! But how?

- *Experience* from working on different systems is a must
 - Not as an architect
 - Writing code is a good start
 - Working with testing is sometimes even better
- You also learn by working on systems with a bad (unsuitable) architecture
- Different architectural styles/patterns can be learned in a classroom or in a book

Define architectural tactics

- Define architectural tactics and map these against the architecturally significant requirements
 - Architecture books usually some tactics supporting various Quality Attributes
 - Do not try to implement all Quality Attributes
 - Make sure the Quality Attributes don't conflict!
- But same as before: The skill to find suitable tactics for a particular set of QA comes with experience!
 - You learn from what others have done before you
 - "Steal with pride"

Define overall structures

- Every architect has a toolbox based on his experiences
 - No architect knows every pattern, tactic or structure there is
 - But he is familiar with the standard solutions in his domain and can tweak these to fit the quality attributes at hand
 - Even more important: He also knows when *not* to use a certain tool in his toolbox
 - Example: MVC is a poor pattern for menu-intensive systems...
- You start with learning the standard solutions
 - Like embedded systems use a layered architecture with 3-5 layers depending on the domain

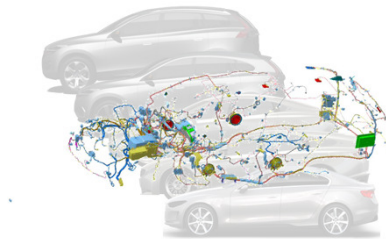
Evaluate and develop the architecture further

- Evaluate and develop the architecture further in a number of iterations
- This means working with the stakeholders, especially developers, over and over again
- I spend a lot more time giving presentations and participating in discussions than writing architecture specifications



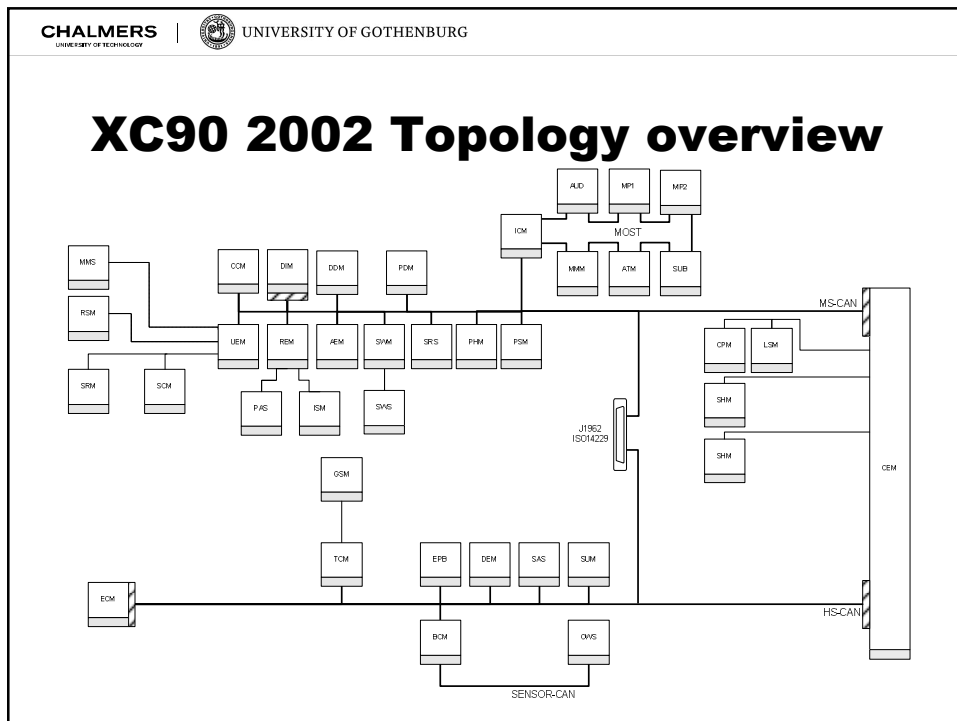
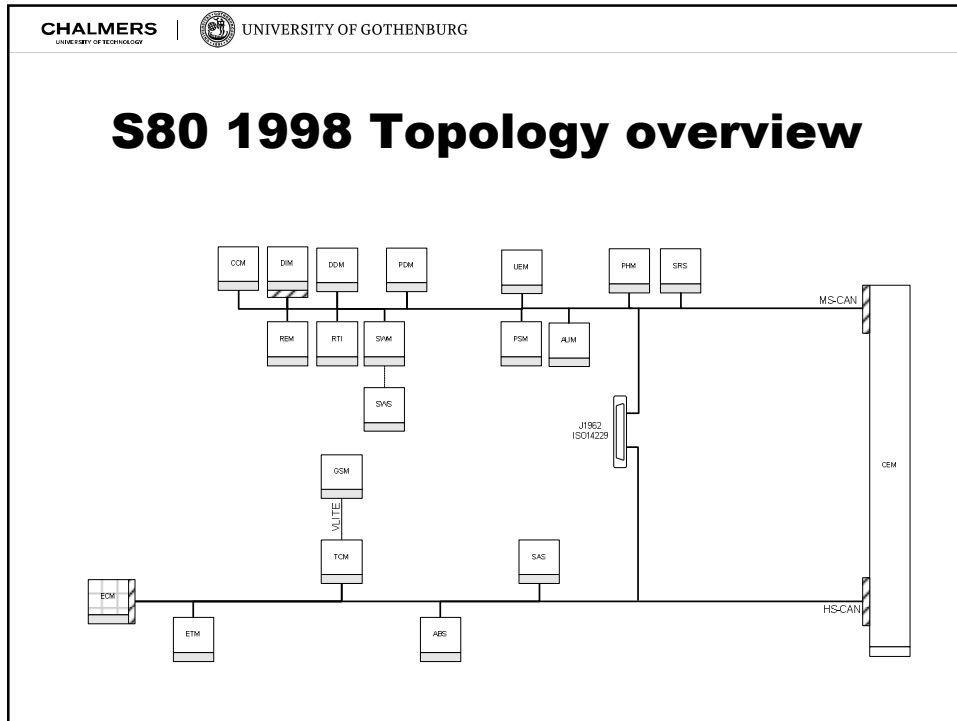
Architecture in vehicles

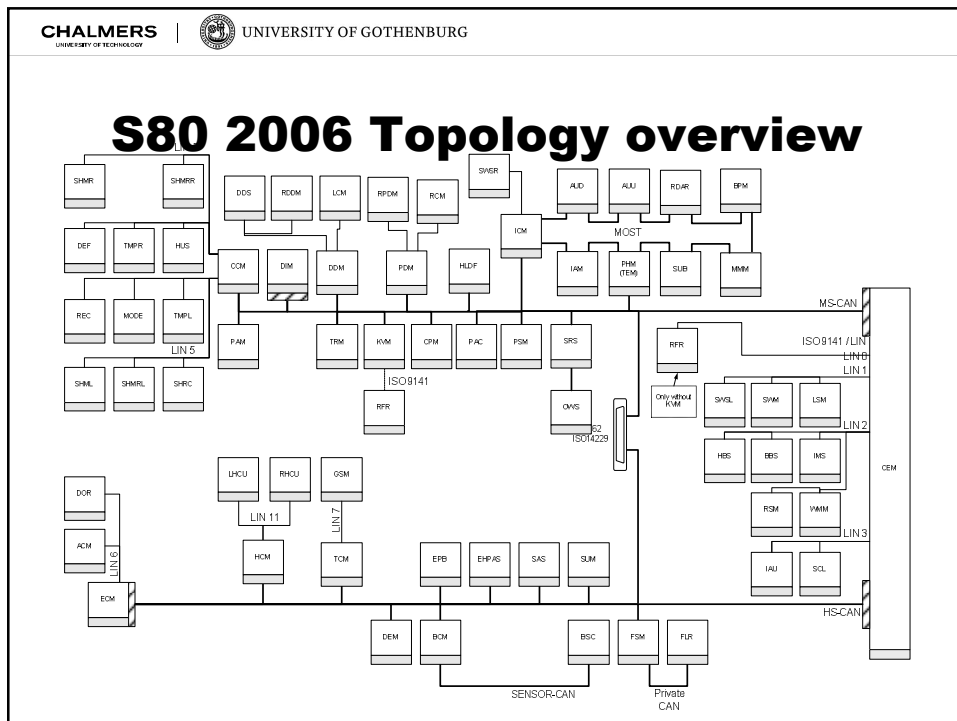
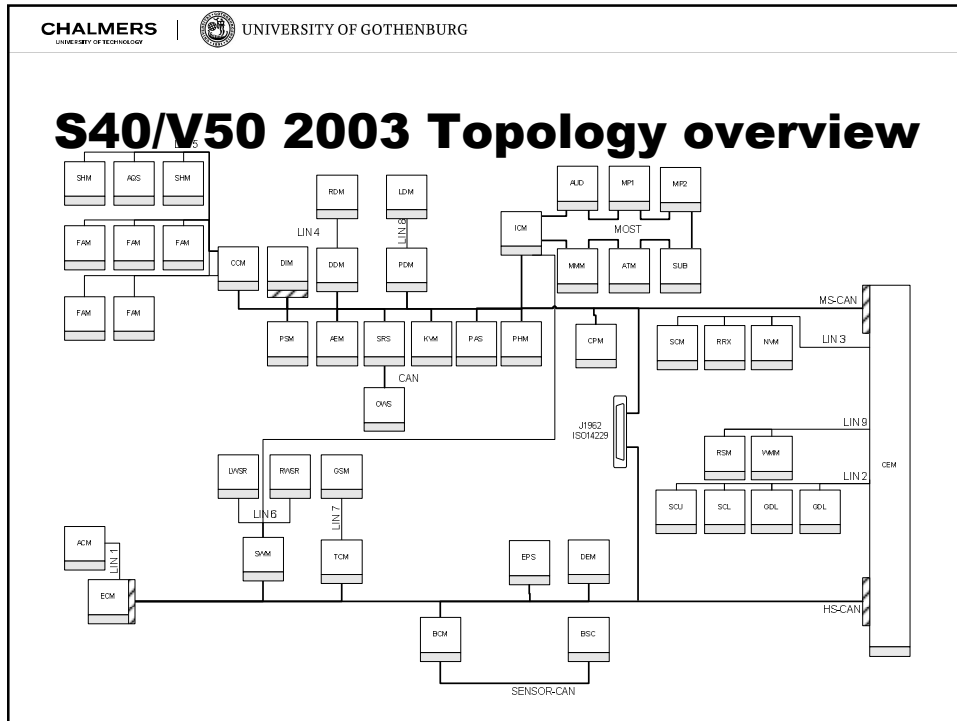
- System and software architecture for a vehicle platform
 - $\sim 10^5$ products manufactured each year
 - Platform in production: 7-10 years
 - Each vehicle is made to customer order = $> 3 \cdot 10^6$ possible configurations of software for Volvo S60

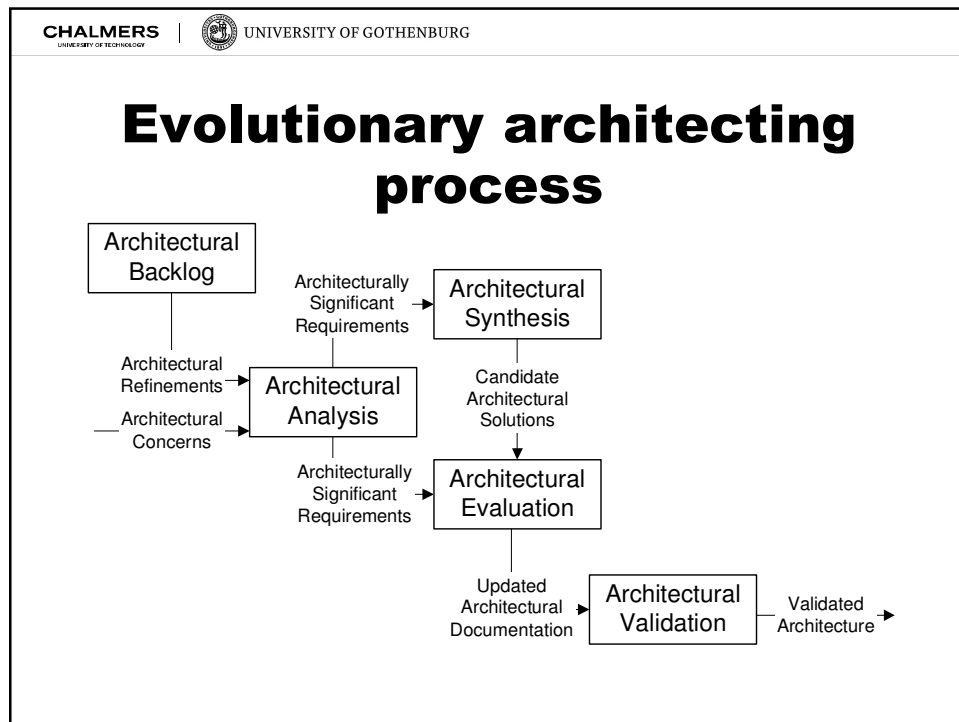


Architecture in vehicles

- Vehicle manufacturer makes a new architecture for the electrical system every 10th year
- The architects mainly deal with changes to an existing architecture
 - Changes are driven by e.g:
 - new features
 - legal requirements
 - cost reductions
- These changes are managed in projects targeted at a certain model year, or in some cases a new car model on an existing platform
- So it is more *evolutionary* architecting that revolutionary







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Reflect on this?

- Can you think of other domains with similar architecture challenges as automotive?
 - Why do you think they are similar?
 - What differs from automotive?
- Can you think of examples where the architecture is never updated once it is created?
- Discuss with your neighbours for 5 minutes...

What do architects do?

- But designing artefacts is actually a minor part of the daily work
- I spend a lot more time giving presentations and participating in discussions than writing architecture specifications
- <http://money.cnn.com/pf/best-jobs/2012/snapshots/3.html>

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BEST JOBS IN AMERICA CNNMoney/PayScale.com's list of great careers 2012

3. Software Architect 3 of 100 << BACK NEXT >>

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Median pay: \$119,000
Top pay: \$162,000
10-year job growth: 24.6%
Total jobs: 3,426,000

What they do all day? Great software architects are designers and diplomats. They create innovative and valuable programs, but they also translate highly technical plans into a vision the C-suite can understand. They are a crucial link between a company's tech unit and management.

How to get the job? Unless one's last name is Gates or Zuckerberg, a computer-related degree is strongly advised. A high-level position, it requires lots of experience, technical smarts and fluid communication skills.

What makes it great? It's an opportunity to create and shape a company's computer strategy. More responsibility also brings higher pay for a designer who wants to trade a PC screen for the conference room.

What's the catch? Tech teams and management often speak very different languages that can lead to misunderstandings and even flare-ups. Putting out fires on both sides is crucial. —T.Z.

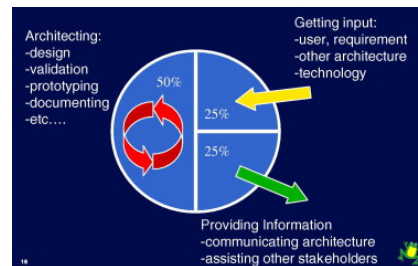
Quality of life ratings:

Personal satisfaction	Low stress	Benefit to society	Flexibility
B	C	C	A



Internal vs. external focus

- “Internal focus: About 50% of their time focused on architectural design, prototyping, evaluating, documenting, etc.
- External focus: About 50% of their time interacting with other stakeholders.
 - Inwards: 25% getting input from the outside world: listening to customers, users, product manager, and other stakeholders (developers, distributors, customer support, etc.). Learning about technologies, other systems' architecture, and architectural practices.
 - Outwards: 25% providing information or help to other stakeholders or organizations: communicating the architecture: project management, product definition.



Philippe Kruchten, What do software architects really do?, *Journal of Systems and Software*, Vo.81, Nr. 12, 2008,
<http://www.sciencedirect.com/science/article/B6V0N-4T9VP3B-1/2/87e1d35af393246c0571394a9d70a337>

Reflect on this?

- What skills and knowledge do you think a successful architect needs?
- Technical knowledge?
- “Soft” skills?
- Discuss with your neighbours for 5 minutes...

Architect's skills

- Communication skills
 - Pedagogical skills
 - Presentation skills
- Interpersonal skills
- Work skills
 - Leadership
 - Managing workload
 - Maneuvering in the corporate environment
 - Handling a lot of information
- Personal skills
 - Personal qualities
 - Comfortable working with unknown factors
 - Can handle unexpected developments
 - Learns continuously

L. Bass et al., *Models for Evaluating and Improving Architecture Competence*, 2008.

<http://www.sei.cmu.edu/library/abstracts/reports/08tr006.cfm>

Knowledge

More than a general programmer

- | | |
|--|---|
| <ul style="list-style-type: none"> • People knowledge <ul style="list-style-type: none"> — Leadership — Teamwork — Communication — Negotiation — accepting direction — Mentoring — Consulting — and so forth • Architecture techniques: <ul style="list-style-type: none"> — large-scale synthesis — complexity management (abstraction, decomposition, etc.) — Synthesis — Analysis — Patterns — Evaluation — and so forth | <ul style="list-style-type: none"> • Business knowledge • Requirements engineering • Software project management: deployment, process, estimation, and so forth • Architecture documentation • Reuse and integration • Domain knowledge |
|--|---|

Less than a “new” programmers

- Programming
- Platform technology: databases, networks, embedded, enterprise, integration tools

Which role has the architect at Volvo Cars

- Which role has the architect towards other developers?
- According to the architects themselves:
 - Analyses changes and how they affect
 - The electrical system and it's components (S/W and H/W)
 - Groups, teams and persons
 - Balance properties (not without controversy), mostly non-functional
 - Explicit product properties
 - Cost
 - Performance
 - ...
 - Against properties such as
 - Extensibility
 - Flexibility
 - Robustness
 - ...

Which role has the architect?

- According to the architects at Volvo Cars:
- Defines strategies and design guidelines
- Defines top-level design (not without controversy)
 - Network topology
 - Logical partitioning
 - Energy management and common running modes
- Reviews interface changes on public in-vehicle networks

How are the architects viewed at Volvo?

- How are the architects viewed by the rest of Volvo Cars' development organisation?
 - *"Why do you block a potential cost saver to Ford Motor Company?"*
 - *"Tala om signalgränssnittet så jag kan börja konstruera"*
 - *"Vi har inte budgeterat för nån förändring"*
 - *"Vi på EI undrar vad ni arkitekter gör?"*

How are the architects viewed?

- Are the architects seen as lacking in understanding of the "real" issues?
 - Do the architects miss vital knowledge, e.g. about current consumption?
 - Architects must have solid technical knowledge to get respect / authority
- The trade-offs the architects make are always questioned
 - Most developers don't know/care of concerns outside their area

How are the architects viewed?

- The architects are sometimes seen as overcomplicating solutions
 - The architect tries to manage the tension between present project(s) and future needs
 - Works in a project but are not bound by it
- It is not obvious to other stakeholders what the contribution is from the architects
 - Run-time quality attributes are clearly visible and often explicit
 - Implementation attributes are explicit for some stakeholders
 - Business attributes are almost always implicit

How are the architects viewed?

- The architects interacts with the rest of the organisation, but are still seen as isolated
 - Physical proximity is vital!
 - Poor ratio of architects vs. other developers
- Management awareness at Volvo Cars has varied over time
 - New platform architectures gain attention due to potential risks
 - Leaps in architecture, technologies and processes
- Architecture group gained authority when they got their own deliverable
 - beyond just documenting what others had done
 - prescriptive vs. descriptive architecture!
 - Volvo Cars is an artefact-focused development organisation...

How are the architects viewed?

- Almost all permanently employed architects are recruited internally – previously had other roles at VCC
 - Is knowledge about the organisation critical?
 - Is it important to be recognised in the organisation?
- Contrast to Scania where most architects are recruited externally with previous architecting experience
- Several architects in new/future platform projects are consultants with experience from Volvo Cars
 - Not unique that key roles (e.g. architects) are filled with consultants
- Varying focus / experience of software development among the architects
 - System architects vs. Software architects
 - “Old school” background in EDS design
 - “New school” background in software engineering

Personal traits of Volvo architect

- Architects vary in their emphasis on guide & control vs. support
 - Based on personality as well as type and phase of project(s)
- Integrity is important for the architecture group
 - Important that the architects share the same values?
 - Uncertain how internal conflicts among architects can be handled?
 - Feeling of “Us and Them”?
- Pedagogical skills are key!
 - Present / communicate
 - But must be based on solid technical knowledge