

Design and Evaluation of Software Architectures

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Aim of the talk

Series of seminars on software architecture

- Overview of Software Architecture (SA)
Definition of SA, topics and concepts of SA, CBSE
- Design and Evaluation of Software Architectures
Architecture requirements, design process, evaluation of quality attributes
- The PCM Design and Evaluation Framework
Architecture design, performance prediction, reliability evaluation

Notice: Some of the slides are inspired by Software Architecture lectures of Uni Karlsruhe, ©R. Reussner



① Introduction

Why software architectures?

What is a software architecture?

What should be part of architecture design?

② Requirements

Functional and extra-functional

③ Design of SA

Architectural models

Developer roles

Development process

④ Evaluation of SA

Quality attributes of SA

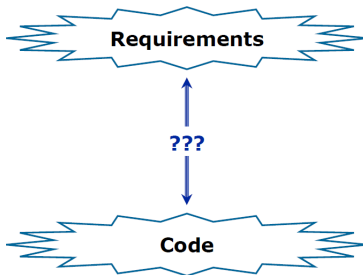
⑤ Conclusion



The problem

Why software architectures?

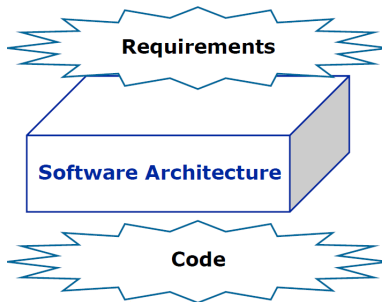
- How to bridge the gap between requirements and code?



The solution

The role of software architecture

- System-level abstractions
- Coarse-grained structure of the system



What constitutes a Software architecture?

Three core views that need to be described

- **Module view** = system components
i.e. computational software units, often concurrent (tasks, threads)
- **Connector view** = communication styles
e.g. pipe-and-filter, shared-data, publish-subscribe, client-server (synchronous vs. asynchronous)
- **Allocation view** = mapping to hardware (or software) resources



What should be part of architecture design?

Three main activities in architecture design

- Requirements specification
Functional and extra-functional
- Design of the architecture
Architectural models
Developer roles
Development process
- Evaluation of the architecture
Quality attributes of SA



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Architecture requirements

Functional requirements

- Execution of `serviceA()` should not need more than 10 other components.
- Each opened transaction needs to be closed before the component starts another one.
- A component must not get blocked when executing a service.

Extra-functional requirements

- Guaranteed response time (in $X\%$ of cases)
- Availability of $X\%$ within each month
- Hardware or software compatibility



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Architectural views and models

- **Module view** = system components
 1. **Static structure model**
- **Connector view** = communication styles
 2. **Dynamic process model**
- **Allocation view** = mapping to hardware/software resources
 3. **Deployment model**

What about the design of a single component, and information needed for the evaluation of the design?



Developer roles

- **Component developer**
Implementation and documentation of individual components
- **Software architect**
Static structure and dynamic proc. models of the architecture
- **System deployer**
Deployment model
- **Domain expert**
Usage scenarios for the system
- **Quality manager**
Evaluation model of architecture quality



Development process

A general architecture development process

- 1 Identify system **components**
- 2 Identify component **interfaces**
- 3 Design **connectors**
- 4 Identify **partitions** that should be allocated to the same host
- 5 **Validate/evaluate** the architecture



Architecture design practices

Top-down approach

- **Levels of refinement** – third-party components, coded components, model-driven refinement

Bottom-up approach

- **Libraries of components** – design for reusability, own vs. third party components

Good practices

- Architectural patterns
- Measures of design quality
- Correctness by construction



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Quality attributes of SA

Quality attributes of SA

- Qualitative vs. quantitative attributes
- Functional vs. extra-functional attributes

Extra-functional quality attributes

- **Performance** – throughput, response time, deadlines
- **Reliability** – failure-free operation, HW and SW propagation
- **Availability** – software and hardware
- **Security** – authentication, authorization, encryption, integrity
- **Scalability** – request load, simultaneous connections, data size
- **Modifiability and maintainability**



Methods of quality evaluation

Methods of quality evaluation

- **Monitoring and testing** – not exhaustive, better after implementation, possible also in model simulation
- **Quality prediction** – good for quantitative attributes, for both design and run time
- **Formal verification** – good for qualitative attributes, for both design and run time

Limits of automated methods

- Time and memory consuming
- Need to be executed on system abstraction



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Lessons learned

What should be part of architecture design?

- Requirements specification
Functional and extra-functional
- Design of the architecture
Architectural models
Developer roles
Development process
- Evaluation of the architecture
Quality attributes of SA



Thank you

Thank you for your attention!
Any **questions?**

