Universidad de Oviedo

EN
English

School of Computer Science

Achieving software architecture

SOFTWARE ARCHITECTURE

2025-26

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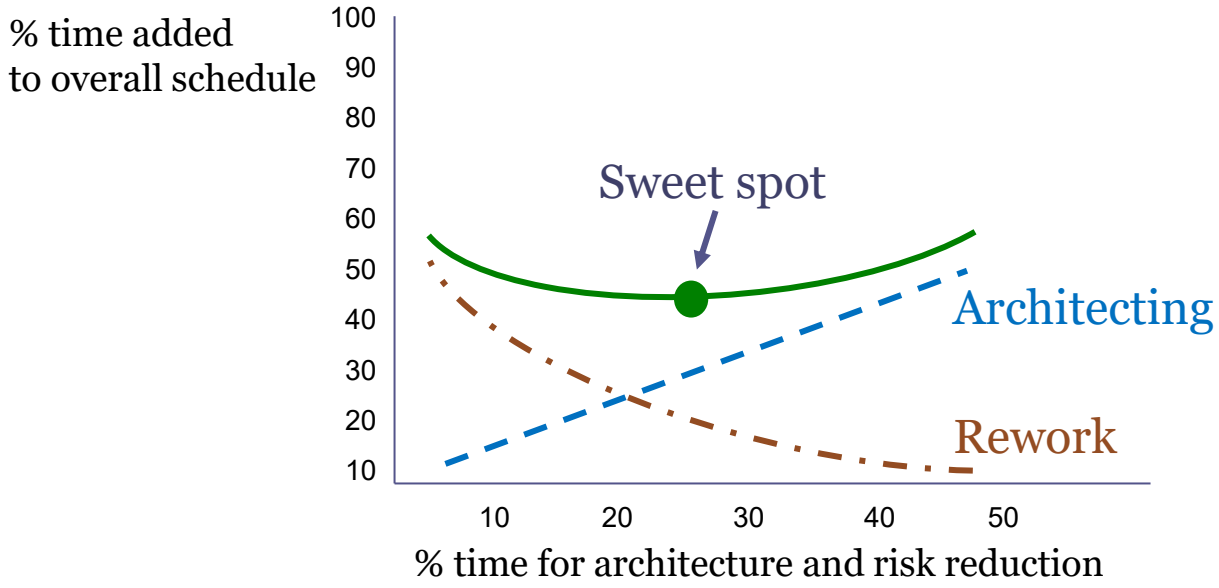
Achieving software architecture

- Methodologies
  - ADD
  - Risk driven architecture
- Making decisions
- Architectural issues
  - Risks, unknowns, problems, gaps, drift
- Architecture evaluation

How much architecture?

Sweet spot between too much architecture and too much rework

$$Total\ project\ time = \begin{cases} Development\ time + \\ Architecture\ time + \\ Rework\ time \end{cases}$$



Attribute driven design

ADD: Attribute-Driven Design

Defines a software architecture based on QAs

Recursive decomposition process

At each stage, chose tactics and patterns to satisfy a set of QA scenarios

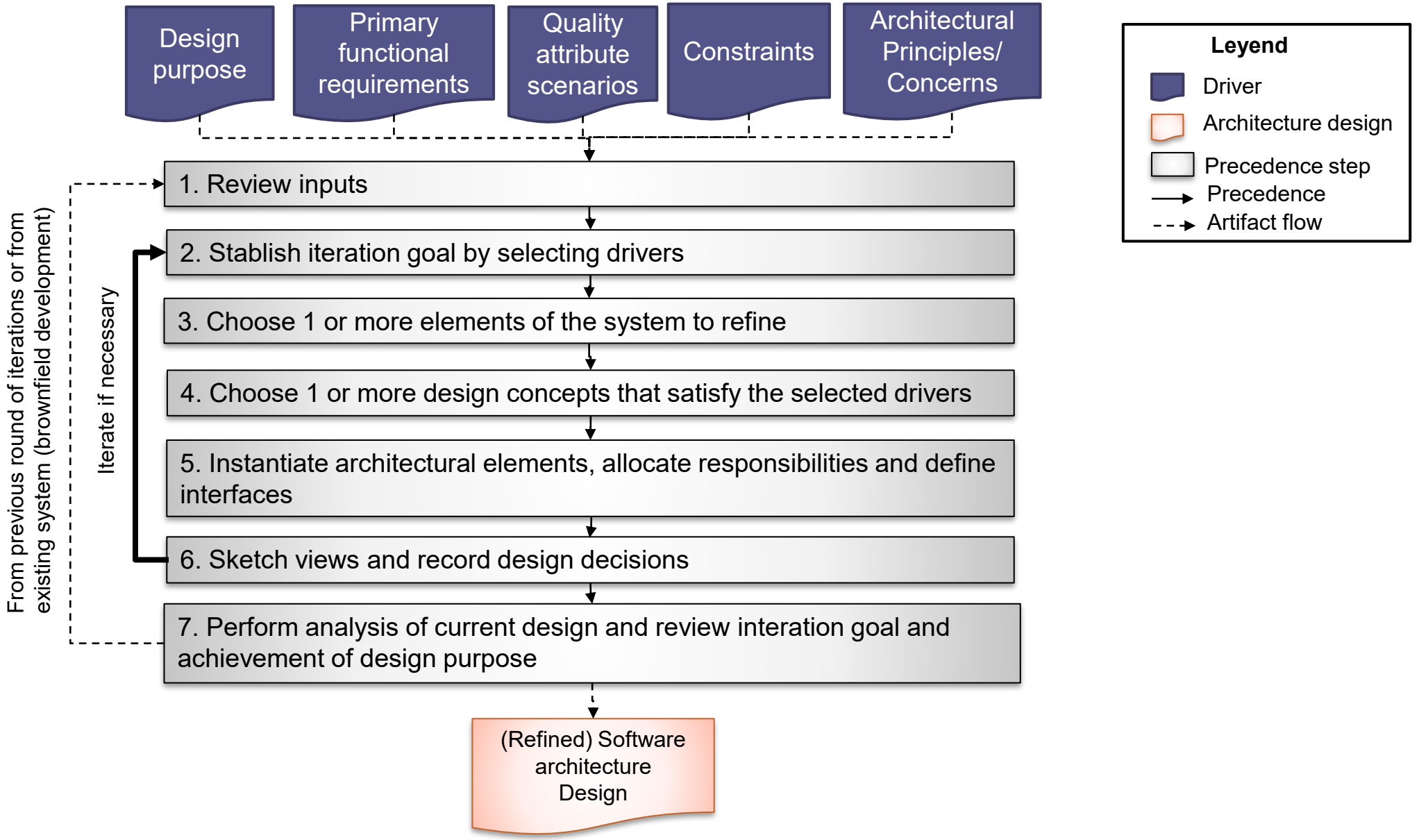
Input

- QA requirements
- Constraints
- Architectural significant functional requirements

Output

- First levels of module decomposition
- Various views of the system as appropriate
- Set of elements with assigned functionalities and the interactions among the elements

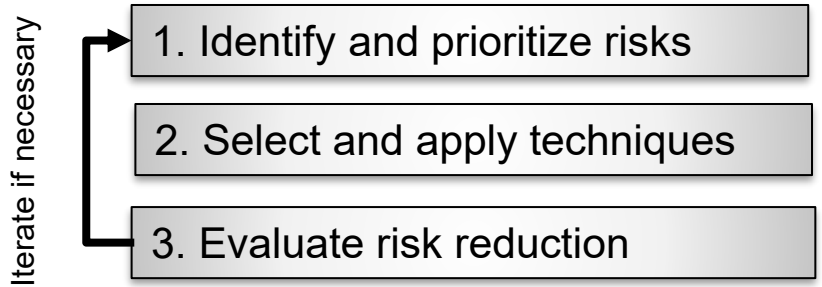
ADD 3.0


Design purpose
Primary functional requirements
Quality attribute scenarios
Constraints
Architectural Principles/ Concerns
1. Review inputs
2. Stablish iteration goal by selecting drivers
3. Choose 1 or more elements of the system to refine
4. Choose 1 or more design concepts that satisfy the selected drivers
5. Instantiate architectural elements, allocate responsibilities and define interfaces
6. Sketch views and record design decisions
7. Perform analysis of current design and review interation goal and achievement of design purpose
Iterate if necessary
From previous round of iterations or from existing system (brownfield development)
(Refined) Software architecture Design
Leyend
Driver
Architecture design
Precedence step
Precedence
Artifact flow

Risk based approach

Goal = Just enough software architecture

- Avoid Big design up front
- Integrate software architecture and agile methods



More info: https://www.methodsandtools.com/archive/agilesoftwarearchitecture.php

Architectural decisions

Significant decisions from the point of view of software architecture

Usually, decisions that affect

- Quality attributes
- Structure
- Dependencies
- Interfaces
- Construction techniques

Architecture decisions **anti-patterns (I)**

- Analysis paralysis
  - Decisions not taken
    - Fear of taking decisions
- Some strategies:
  - Evaluate decisions with team (and expect changes)
  - It can be good to wait until last responsible moment, but no longer

Architecture decisions **anti-patterns (II)**

- Trapped in time (groundhog day)
  - People don't know why a decision has taken
    - It keeps getting discussed over and over again
  - Advise: Always add proper justification
- Email-based decisions
  - People lose, forget or don't even know a decision
  - Advise: Architecture Decision Records

Record design decisions

Every design decision is *good enough* but seldom optimal

It is necessary to record justification and risks affected

Things to record:

- What evidence was provided to justify the decision?
- Who did that?
- What are the trade-offs/consequences?
- What are the main assumptions?

Driver	Design decisions and location	Rationale and assumptions
QA-1	Introduce concurrency (tactic) in the `TimeServerConnector` and `FaultDetectionService`	Concurrency should be introduced to be able to receive and process several events simultaneously
QA-2	Use of a messaging pattern through the introduction of a message queue in the communications layer	Although the use of a message queue may seem to go against the performance imposed by the scenario, it hill be helpful to support QA-3
. . .	. . .	. . .

Architectural decision records

Templates: https://adr.github.io/

Basic structure:

- Title
  - Short descriptive title
- Status
  - Proposed, accepted, superseded
- Context
  - What is forcing to make the decision
  - Include alternatives
- Decision
  - Decision and corresponding justification
- Consequences
  - Expected impact of the decision

Records should be immutable: If a change appears, create a new record that supersedes a previous one

For drafts, it may be useful to use RFCs (Request for comments)

Architectural issues

Architectural issues

Risks

Unknowns

Problems

Technical debt

Gaps in understanding

Erosion

Contextual drift

Risks

Risk = something bad that might happen but hasn't happened yet

Risks should be identified and recorded

- Risks can appear as part of QA scenarios

Risks can be mitigated or accepted

- If possible, identify mitigation tasks

Risk = perceived probability of failure × perceived impact

Risk assessment table

Assess risks in two dimensions:

- Impact/severity of risk
- Probability of risk occurring

Risk matrix 3x3:

- Simplify values as: low (1), medium (2), high (3)

Impact \ Probability	Low (1)	Medium (2)	High (3)
Low (1)	1	2	3
Medium (2)	2	4	6
High (3)	3	6	9

3x3 Risk matrix

Risk Criteria \ Area	Customer registration	Order Fulfillment
Scalability	2	1
Availability	3	2
Performance	4	3
Security	6	1
Data integrity	9	1

Example of risk assessment table

Risk storming: recommended exercise to collaboratively evaluate risks

Unknowns

Sometimes we don't have enough information to know if an architecture satisfies the requirements

- Under-specified requirements
- Implicit assumptions
- Changing requirements
- ...

Architecture evaluations can help turn unknown unknowns into known unknowns

Problems

- Problems are bad things that have already passed
  - They arise when one makes design decisions that just doesn't work out the desired way
  - They can also arise because the context changed
    - A decision that was a good idea but no longer makes sense
- Problems can be fixed or accepted
  - Problems that are not fixed can lead to technical debt

Technical debt

Debt accrued when wrong or non-optimal design decisions are taken

- Sometimes those decisions are taken knowing that they are wrong
- If one pays the instalments the debt is repaid and doesn't create further problems
- Otherwise, a penalty in the form of interest is applicable
  - If bill not paid for long time $\Rightarrow$ total debt is so large that must declare bankruptcy
- In software terms, it could mean the product is abandoned

Types of technical debt

Code debt:

- Bad or inconsistent coding style

Design debt:

- Design smells

Test debt:

- Lack of tests, inadequate test coverage,...

Documentation debt:

- Outdated documentation
- No documentation for important concerns

Gaps in understanding

- Gaps arise when what stakeholders think about an architecture doesn't match the design
  - In rapidly evolving architectures gaps can arise quickly and without warning
- Gaps can be addressed through education
  - Presenting the architecture
  - Asking questions to stakeholders

Architectural erosion (drift)

Gap between designed and as-built architecture

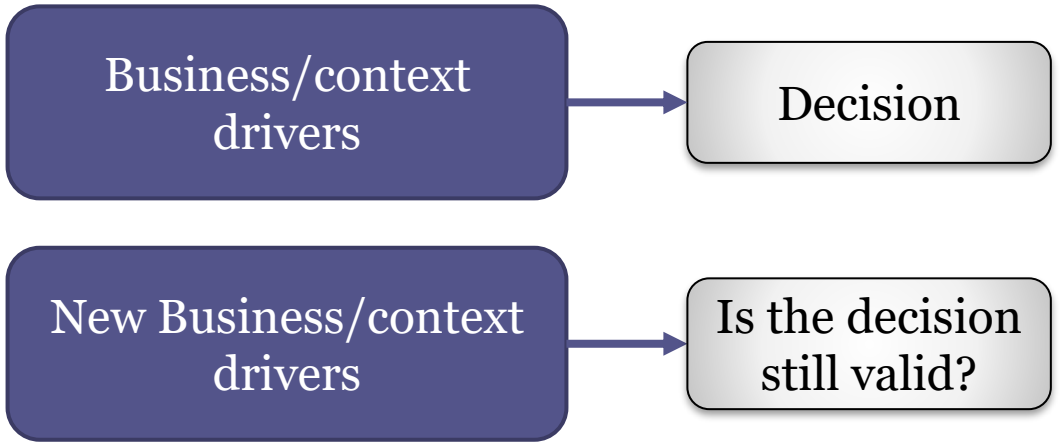
- The implemented system almost never turns out the way the architect imagined it
- Without vigilance, architecture drifts from planned design a little bit every day until implemented system bears little resemblance to the plan

Architecturally evident code can mitigate drift

Contextual drift

It happens any time business or context drivers change after a design decision has been taken

- It is necessary to continually revisit requirements
- Concept of evolutionary architecture



Architecture evaluation methods

Architecture evaluation

ATAM (Architecture Trade-off Analysis Method)

Architecture evaluation method

Simplified version of ATAM:

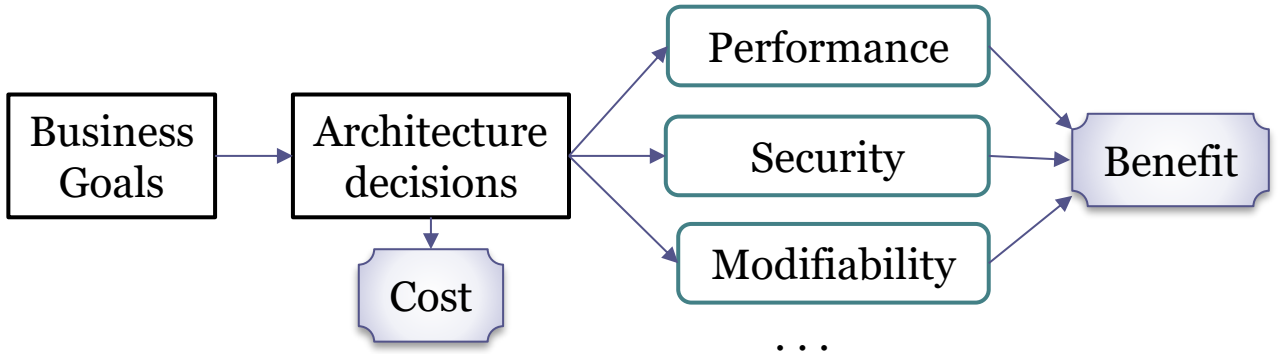
- Present business drivers
- Present architecture
- Identify architecture approaches
- Generate quality attribute utility tree
- Analyse architectural approaches
- Present results

Cost Benefit Analysis Method (CBAM)

1. Choose scenarios and architectural strategies
2. Assess quality attribute benefits
3. Quantify the benefits of each strategy
4. Quantify the costs and schedule implications
5. Calculate the desirability of each option

$$VFC\ (Value\ For\ Cost) = \frac{Benefit}{Cost}$$

6. Make architectural design decisions



The end

Other slides

4 principles of design thinking

- Design for humans
  - All design is human in nature
- Design for change
  - Delay some decisions until least responsible moment
- All design is redesign
  - Explore patterns, styles and past designs
- Make the architecture tangible
  - Communicate the architecture