Universidad de Oviedo

EN
English

School of Computer Science

# Software Architecture
# Basic definitions




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# Contents

# What is architecture?

Ethimologically, from greek:

Architecture = ἀρχιτέκτων

- ἀρχι- "chief"
- τέκτων "creator"

Architecture = Process and the product of planning, designing, and constructing buildings or **other structures**.

# Vitruvius, "De architectura"

Written between 30 to 15 BC

3 pillars of good buildings

- Utilitas (usefulness):
  - Be useful and function well for the people using it.
- Firmitas (durability):
  - Stand up robustly and remain in good condition
- Venustas (elegance/beauty):
  - It should delight people

Can be applied to software systems

# What is software architecture? (1)

Architecture [ISO/IEC/IEEE 42010:2011, 3.2]

- Fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

Architecture description

- Explicit work product expressing an architecture of a system, usually via models, text and graphics.

Architecting:

- Process of creating an architecture

# What is Software architecture? (2)

Fundamental structures of a system...

...which comprise:

- software elements
- relations among them
- properties of both.

# Architecture vs Design

The distinction is not always clear-cut

Architecture focuses more on:

- High level structure of a software system
- Significant design decisions of a system that...
- ....if you have to change them ⇒ High cost

"All architecture is design but not all design is architecture"
G. Booch

# Buildings architecture vs software architecture

## Some similarities

- Complex systems
- Developed by teams/organizations
- Used by people
- Both employ styles, patterns, tactics...
- And are affected by trends

# Buildings architecture vs software architecture

## Some differences

### Buildings architecture

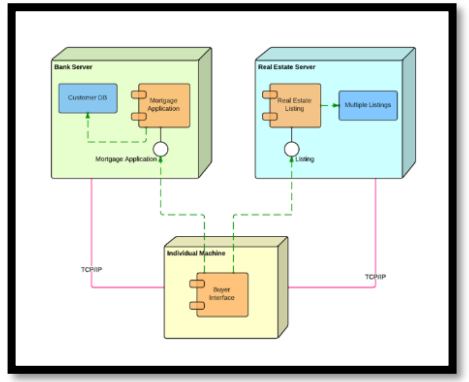
More stable environment
Physical product/service
Physical limits, difficult to change
Long tradition and history

Great examples to show

### Software architecture

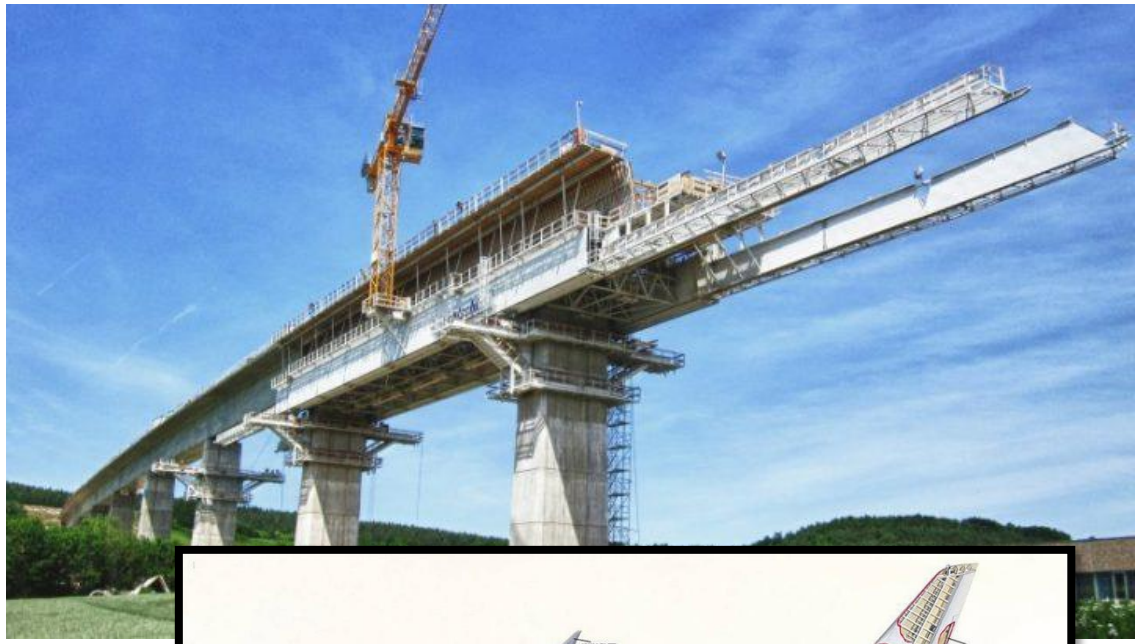
Environment changes very fast
Virtual product/service
No physical limits, easier to change
Relatively new discipline

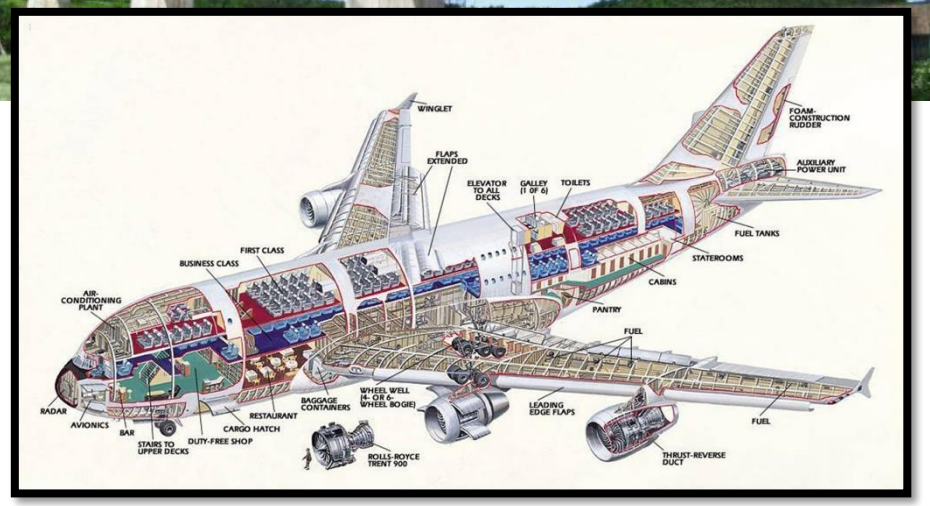
and we can learn a lot from others

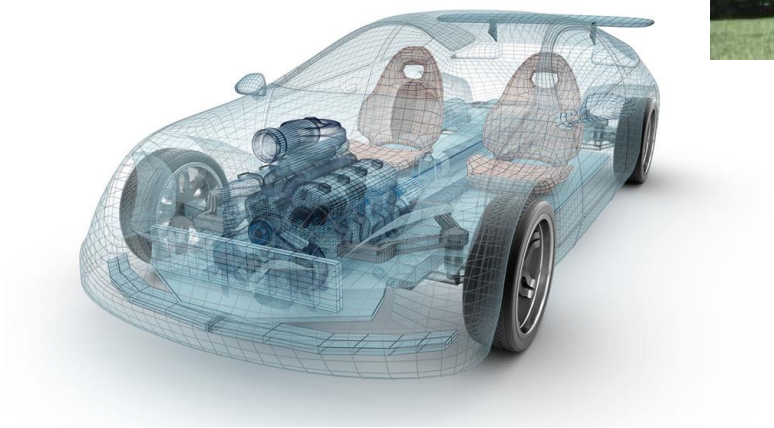


# Other similar disciplines

Civil engineering
Mechanical engineering
Aeronautics
...





# Other architectures

Business architecture
Enterprise architecture
Systems architecture
Information architecture
Data architecture
. . .
Common things about all: Structure and vision

# Benefits of software architecture

Provide a clear **vision and roadmap** for the team

Technical **leadership** and better **coordination**

Answer questions relating to **significant decisions**

- Quality attributes, constraints and other cross-cutting concerns.

**Identifying and mitigating risk**.

**Consistency** of approach and standards

- Leading to a well structured codebase.

**Firm foundations** for the product being built.

A structure to **communicate** the solution

- At different levels of abstraction to different audiences.

# Challenges of software architecture

- Architects at the ivory tower
  - Lack of communication
- Centralization of all decisions
  - Bottleneck
- Taking too many decisions
  - Deferring decisions may be better than reversing them
- Big design up front
  - Too much unneeded diagrams and docs
  - Delays caused by architecting process

# **Agile** software architecture

Architecture that can react to its environment

- Adapting to ever changing requirements
- Also known as evolutionary architectures
- Good architecture enables agility
- Better understanding of trade-offs and decisions

Common anti-pattern:

- Adopting agile software development techniques that create non-agile software architectures
- Caused by too much focus on delivering functionality

# Laws of software architecture (*)

1st law:

Everything in software architecture is a trade-off

> Corollary 1:
> If an architect thinks he has found something that is not a trade-off, more likely he just haven't identified the trade-off yet
> Corollary 2:
> All meaningful decisions have downsides

2nd law:

**Why** is more important than **how**

Question everything

Document architecture decisions

(*) Fundamentals of Software Architecture, M. Richards, N. Ford

# Architecture design

## Problem domain

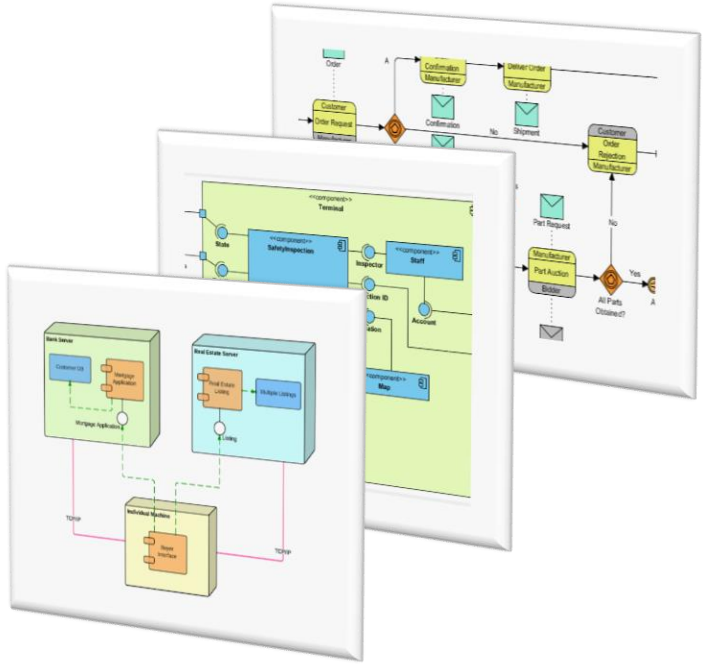
- Design Objectives
- Functional requirements
- Quality attributes
- Constraints
- Concerns

Architecture drivers (inputs)

Architect

Design activity

## Solution domain



Design of the architecture (output)

# Architeture drivers

Inputs of the software architecture process

- Design objectives
- Functional requirements
- Quality attributes
- Constraints
- Concerns

# Design objectives

What are the business goals?

***Why*** you are designing that software?

Some examples:

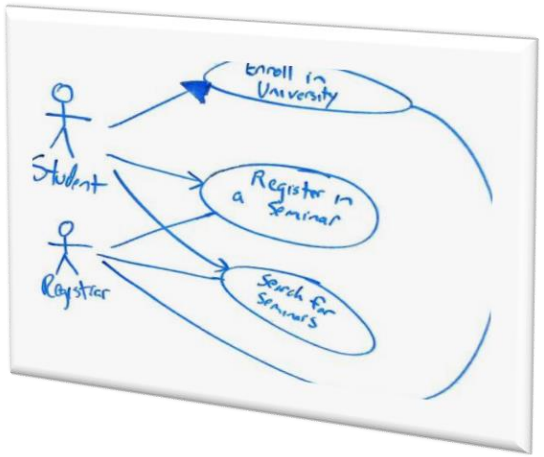
- **Pre-sales proposal**: rapid design of an initial solution in order to produce an estimate
- **Custom system** with established time and costs which may not evolve much once released
- **New increment** or release of a continuously evolving system

# Functional requirements

Functionality that supports the business goals

List of requirements as use cases or user stories

## Use cases




## User stories

# Quality attributes

- Measurable features of interest to users/developers
  - Also known as non-functional requirements
  - Performance, availability, modifiability, testability,…
    - Also known as -ilities
  - Can be specified with scenarios
    - Stimulus-response technique
      - *“If an internal failure occurs during normal operation, the system resumes operation in less than 30seconds, and no data is lost”*
  - ISO 25010: list of some non-functional requirements
  - List: https://en.wikipedia.org/wiki/List_of_system_quality_attributes

# Quality attributes

- Quality attributes determine most architectural design decisions
  - If the only concern is functionality, a monolithic system would suffice
  - However, it is quite common to see:
    - Redundancy structures to increase **reliability**
    - Concurrency to increase **perfomance**
    - Layers for **modifiability**
    - …
- Quality attributes must be prioritized
  - By the client to consider system's success
  - By the architect to consider technical risk

# Constraints

- Pre-specified design decisions
  - Very little software has total freedom
  - May be technical or organizational
  - May originate from the customer but also from the development organization
  - Usually limit the alternatives that can be considered for particular design decisions
  - Examples:
    - Frameworks, programming languages, DBMS,…
  - They can act as “friends”
    - Identifying them can avoid pointless disagreements

# Concerns

Design decisions that should be made

- Even if they are not stated explicitly

Examples:

- Input validation
- Exception management and logging
- Data migration and backup
- Code styles…
- …

# Creativity vs Method

**Creativity**
Fun
Risk
Can offer new solutions
Can be unnecessary

**Method**
Efficient in familiar domains
Predictable result
Not always the best solution
Proven quality techniques

Architect

# Types of systems

Greenfield systems in novel domains

E.g. Google, WhatsApp,…

Less well known domains, more innovative

Greenfield systems in mature domains

E.g. "*traditional*" enterprise applications, standard mobile apps

Well known domain, less innovative

Brownfield domains

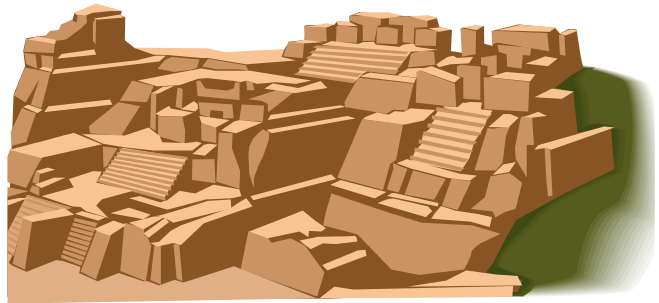
Changes to existing system

# Software architect

Discipline evolves

Architect must be aware of

- New development techniques
- Styles and patterns
  - Best tool = experience (*no silver bullet*)
    - Self experience
    - Experience from community



Architect

# Role of software architect