Universidad de Oviedo

EN
English

School of Computer Science

Software Architecture
Basic definitions

SOFTWARE ARCHITECTURE

2023-24

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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

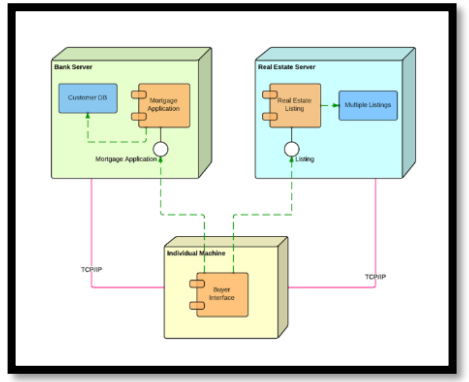
More stable environment
Physical product/service
Physical limits, difficult to change
Long tradition and history

Great examples to show

Software architecture

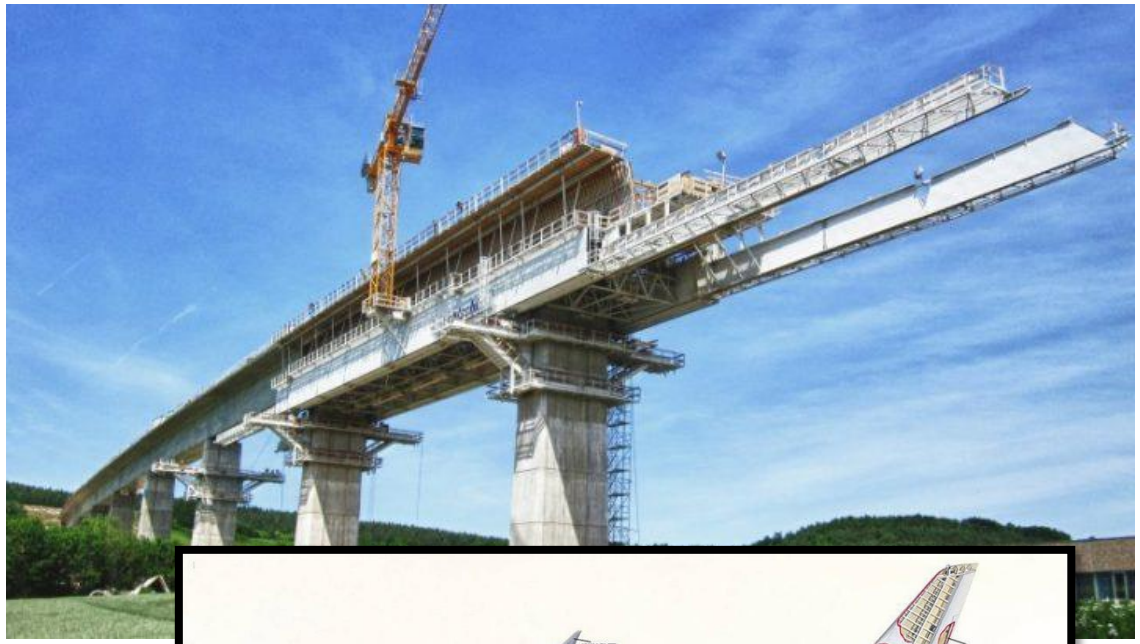
Environment changes very fast
Virtual product/service
No physical limits, easier to change
Relatively new discipline

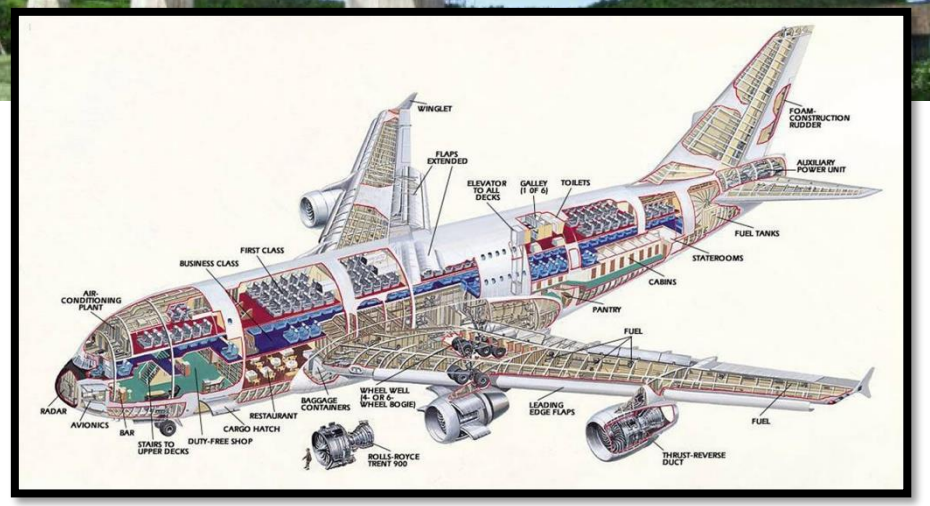
and we can learn a lot from others

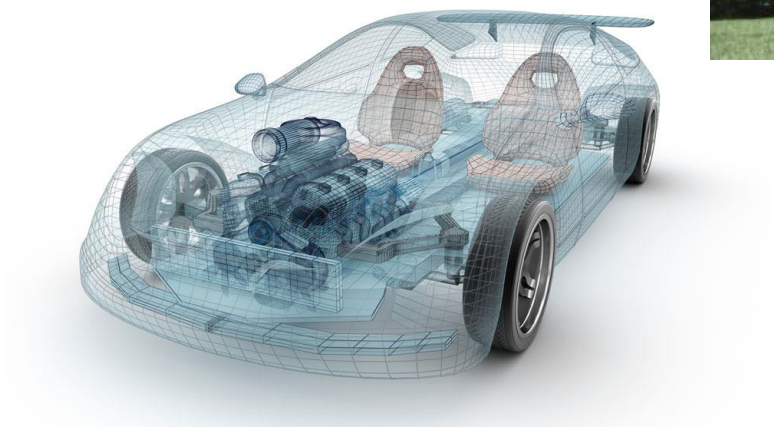


Other similar disciplines

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

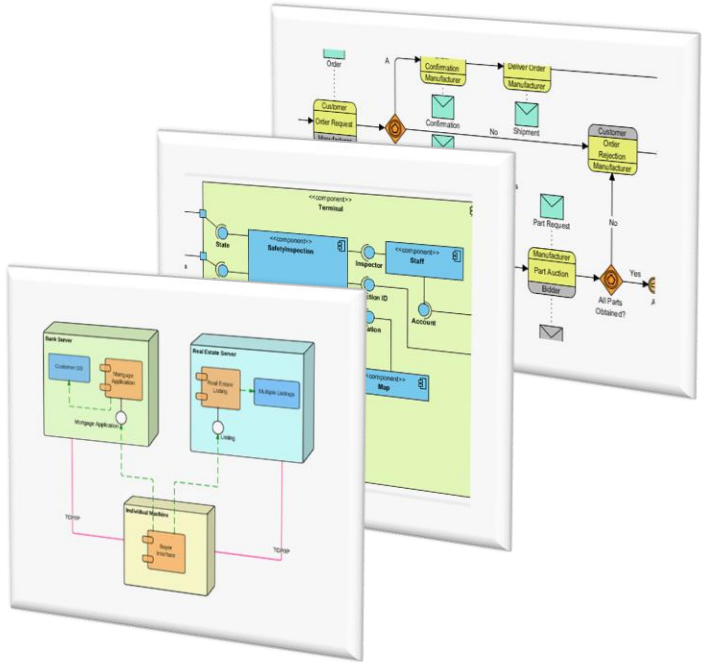
- Design Objectives
- Functional requirements
- Quality attributes
- Constraints
- Concerns

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:

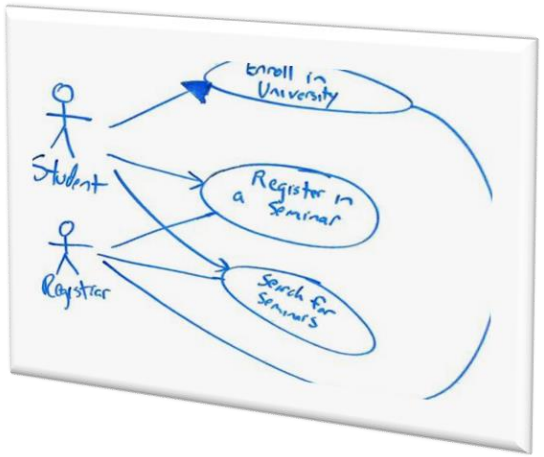
- **Pre-sales proposal**: rapid design of an initial solution in order to produce an estimate
- **Custom system** with established time and costs which may not evolve much once released
- **New increment** or release of a continuously evolving system

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

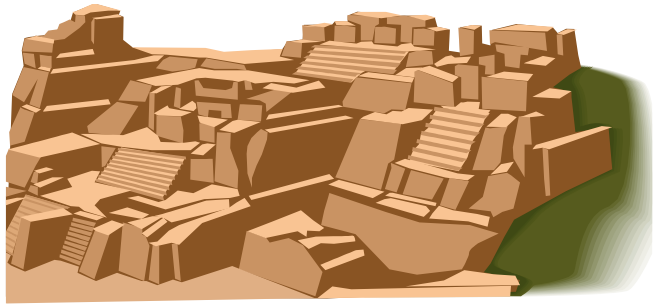
Changes to existing system

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