Universidad de Oviedo

EN
English

School of Computer Science

Communicating Software Architecture

SOFTWARE ARCHITECTURE

2023-24

Jose E. Labra Gayo

Contents

- Communicating software architecture
  - Goal of documentation
  - Documentation stakeholders
  - Views
  - Documentation and agile projects
  - Guidelines
- Documentation approaches
  - Kuchten 4+1 views
  - Views and beyond
  - C4 model
  - Arc42

Comunicating Software architecture

Architecture is more than code

The code doesn't tell the whole story

Questions the code doesn't answer

- How the software fits into existing system landscape?
- Why were the technologies chosen?
- What's the overall structure of the system?
- Where are the components deployed at runtime?
- How do the components communicate?
- How and where to add new functionality?
- What common patterns and principles are used?
- How the interfaces with other systems work?
- How security/scalability/… has been achieved?
- . . .

Goal of documentation

Main goal: communicate the structure

- Understand the *big picture*

Create a **shared vision**: team and stakeholders

- Common vocabulary

Describe what the sofware is and how is being built

- Focus for **technical** conversations about new features
- Provide a **map** to navigate the source code

Justify design decisions

Help new developers that join the team

Documentation requirements

- Understandable by different stakeholders
  - Technical and non-technical stakeholders
- Reflect the reality
  - Be careful of the model-code gap
- Move fast and adapt to changes
  - Adapt to agile projects
  - Evolutionary architecture

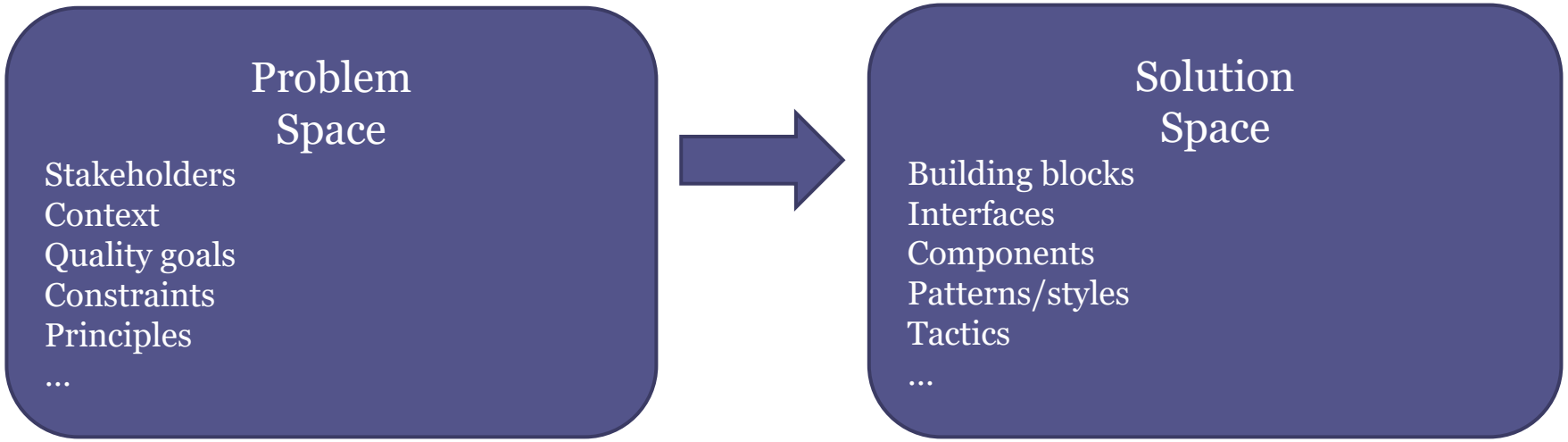
Rules for good documentation

- Write documentation from reader's point of view
  - Find who will be the readers and their expectations
- Avoid unnecessary repetition (DRY principle)
- Avoid ambiguity
  - Explain the notation (or use a standard one)
  - For diagrams, use legends
- Use a standard organization or template
  - Add TBD/To do when necessary
  - Organize for easy of reference/links
- Record rationale
- Keep documentation current

Problem vs Solution space

Software architecture = path from problem to solution

- Understand the problem
- Design a solution
  - Rationale for the solutions proposed
  - Record different design alternatives



Views & viewpoints

- Software architecture is a complex entity
  - It cannot be described in a single 1-dimension
  - It requires several views for different stakeholders
- View = A representation of a system with regards to some concerns
  - Different views support different goals and uses
- Viewpoint = A collection of patterns, templates and conventions for constructing a view
  - Examples: structure, behaviour, deployment

A view is what you see
A viewpoint is where you are looking from

Documenting views

- Introduction
  - Textual description of the view
- Diagram(s)
  - Add descriptive title including structures depicted
  - Create a legend to explain meaning of symbols
    - Don't forget to explain the lines/arrows
- List of elements and responsibilities
  - Give descriptive names
  - Define your terms (include a glossary)
- Rationale

Documenting views

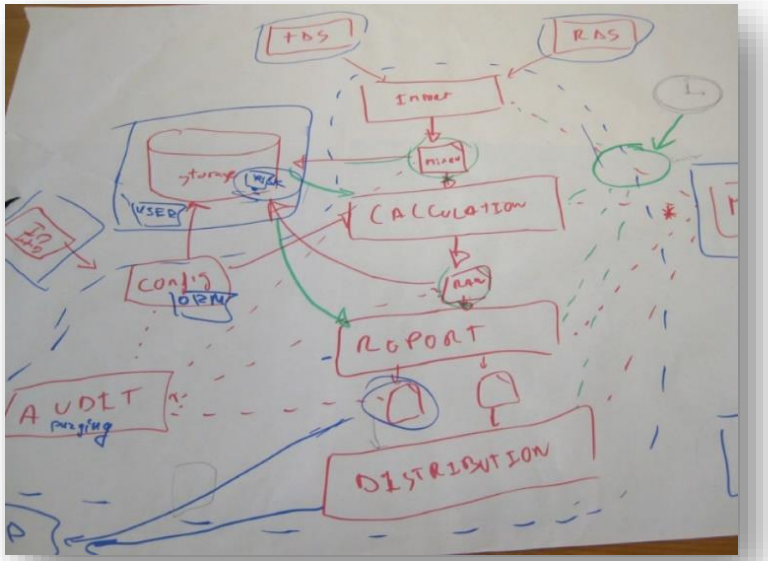
- Strive for Consistency and simplicity
- Keep elements consistent
  - Colours, shapes, arrows,…
    - If you use a colour scheme, follow it consistently
  - Check names across views,…
    - Record possible inconsistencies
- Avoid too many details
  - Remember Miller's law
    - Average person can keep 7 (± 2) elements in memory

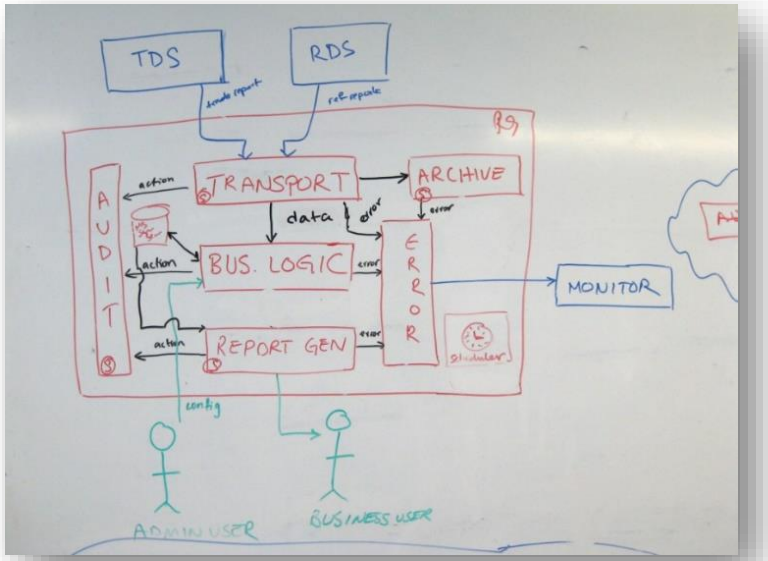
Tools for diagrams

- Sketches
- Drawing tools for diagrams
- Text-based diagramming tools
- Modeling tools
- Reverse-engineering the model
- Architecture description languages

Sketches

- Most people start with a sketch on paper or whiteboard
  - Great way to collaborate and exchange ideas
  - Usually intended for short lifespan
- But sooner or later, they must be recorded
  - Simple approach: Photos
  - And later conversion to diagrams or models

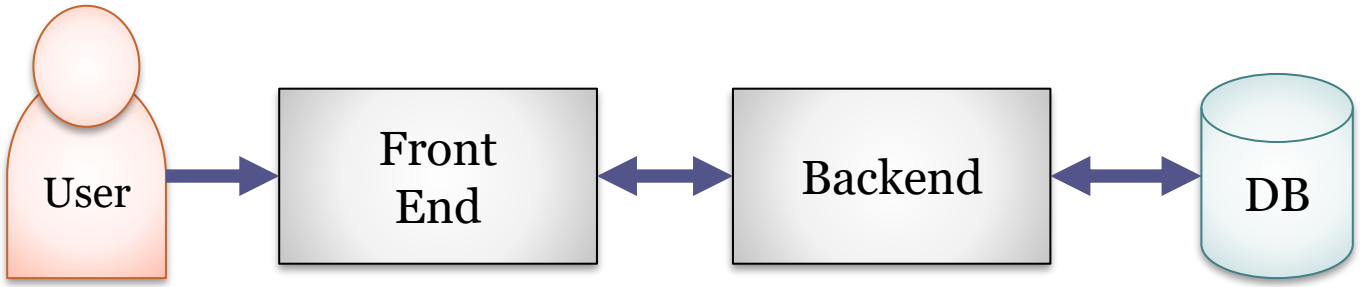




Fuente: https://c4model.com/

Drawing tools for Diagrams

- Desktop
  - Microsoft Visio, Omnigraffle, SimpleDiagrams, …
- Web-based:
  - draw.io, gliffy, LucidChart,…
- Drawing tools of general-purpose tools:
  - Word, **Powerpoint**, Keynote,…



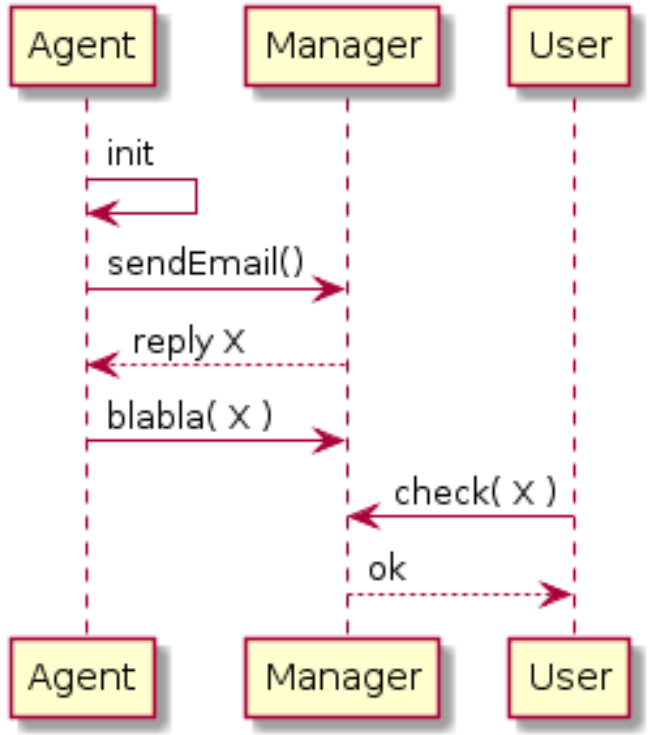
Text-based diagramming tools

Usually based on UML

WebSequenceDiagrams, yUML, nomnoml

PlantUML: http://plantuml.com/

```
@startuml
Agent -> Agent : init
Agent -> Manager : sendEmail()
Agent <-- Manager : reply X
Agent -> Manager : blabla( X )
User -> Manager : check( X )
User <-- Manager : ok
@enduml
```



PlantUML Online: https://www.planttext.com/

Modeling tools

- Allow to create a model of the software system
- Visual representations are generated from model
- Alternatives:
  - Sparx Enterprise Architect, **Visual Paradigm**, Archi, StarUML, ArgoUML, Modelio,…
- Usually support different notations
  - UML, SysML, BPMN, ArchiMate
- Useful for up-front design
- Good for refactoring & renaming components…

Reverse-engineering the model

Some of the previous modelling tools support this

Static analysis tools:

- Structure101, NDepend, Lattix, Sonargraph,…

Create the model based on existing code

- Useful to visualize existing codebases

Problem:

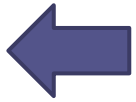
- Resulting diagrams tend to include too much details
- Difficult to see the architecture

Architecture Description Languages: ADLs

- Formally define the architecture of a system
  - Create textual descriptions instead of diagrams
    - Formal specification
    - Describes the structure and behaviour
- Mostly in academic environments
  - Not very popular in industrial settings
- Some examples:
  - xArch/xADL (http://isr.uci.edu/projects/xarchuci/)
  - ACME (http://www.cs.cmu.edu/~able/)
  - AADL (http://www.aadl.info/)

Software architecture templates

Several possibilities

- Kruchten 4+1 views
- Views & beyond
- C4 model
- Arc42 templates 
- . . .

Kruchten 4+1 views

Embraced as part of Rational Unified Process

5 concurrent views

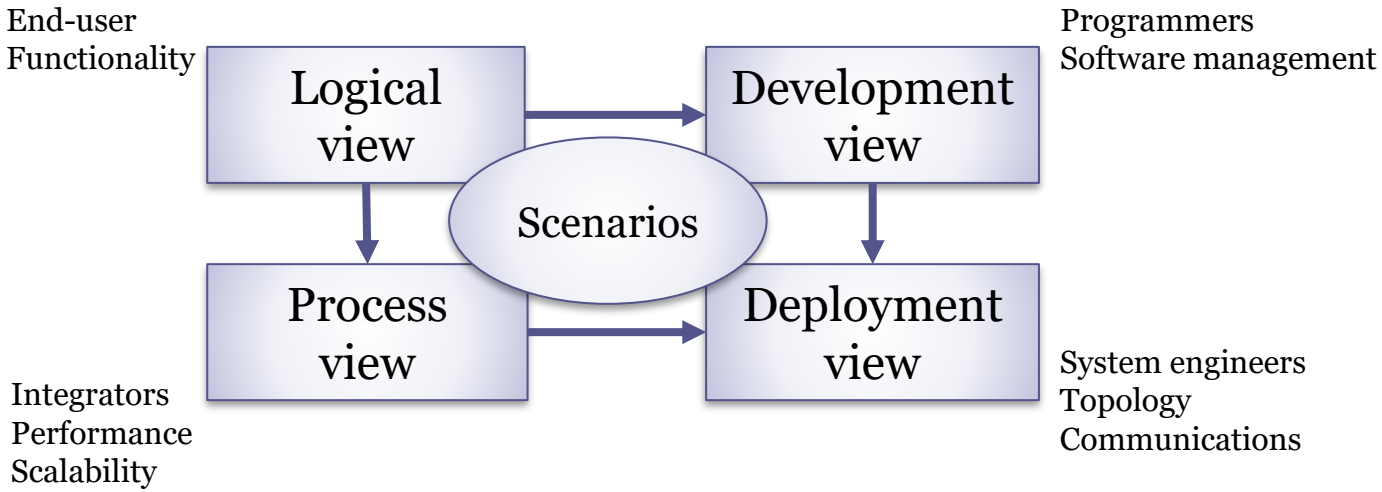
1 **Logical** view: functionality of the system

2 **Development** view: modules, layers,...

3 **Process** view: execution units, concurrency,…

4 **Physical** view: Infrastructure & deployment topology

(+1) **Scenarios** view: selected use cases or scenarios

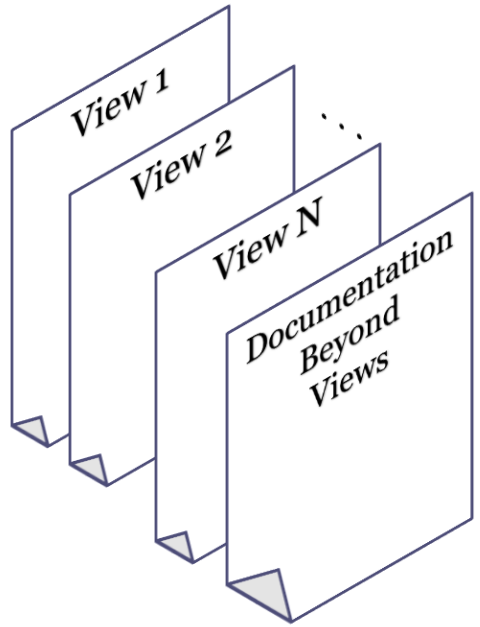


Views and beyond

Select a set of viewpoints
- According to stakeholder's needs

Define views according to those viewpoints

Add a "Beyond views" document
- Overall architecture
- Information about how views relate
- . . .



C4 model (https://c4model.com/)

Describe

- **C**ontext: System or enterprise context diagram
- **C**ontainer diagram: high level shape
- **C**omponents diagram: zoom and decompose
- **C**ode: UML class diagrams, ER diagrams, …

Documentation guidebook

Context
Functional overview
Quality attributes
Constraints
Principles

Code
Data
Infrastructure architecture
Deployment
Development environment
Operation and support
Decision log

Arc42 https://arc42.org/

Structure to document software systems

Goal: Clear, simple and effective

Templates available for several systems

- **Asciidoc**
- Word (docx)
- Markdown
- LaTeX
- ReStructuredText
- Confluence
- . . .

Arc42 overview

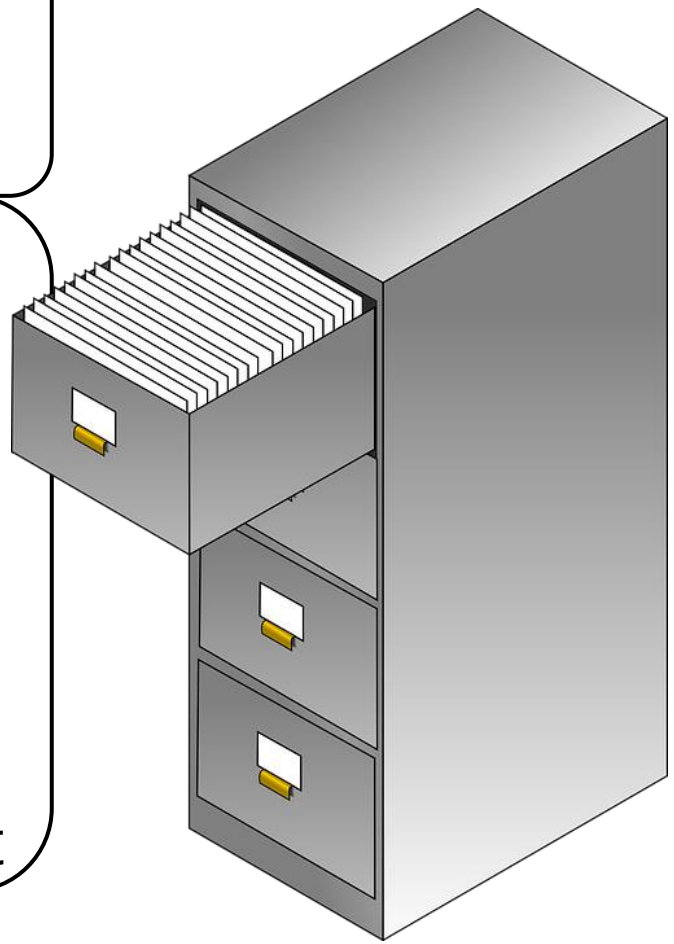
Problem

1.- Introduction and goals
2.- Constraints
3.- Context & scope

Solution

4.- Solution strategy
5.- Building block view
6.- Runtime view
7.- Deployment view
8.- Crosscutting concepts
9.- Architectural decisions
10.- Quality requirements
11.- Risks and technical debt

12.-Glossary



Picture source: https://commons.wikimedia.org/wiki/File:Ficherosclasicoscatalogo.JPG

1 - Introduction and goals

Short description of:
- Requirements
- Main quality goals
- Stakeholders

Picture source: https://arc42.org/overview/

1 Introduction and goals
1.1 Requirements overview

Short description of functional requirements

Use-case tables

It can link to existing requirements documents

- Full requirement documents are usually longer
- Select architecturally significant requirements

1 Introduction and goals
1.2 Main quality goals

Enumerate the main quality goals

Quality goals:

Main quality attributes that the system needs to achieve

Format: A simple table can suffice

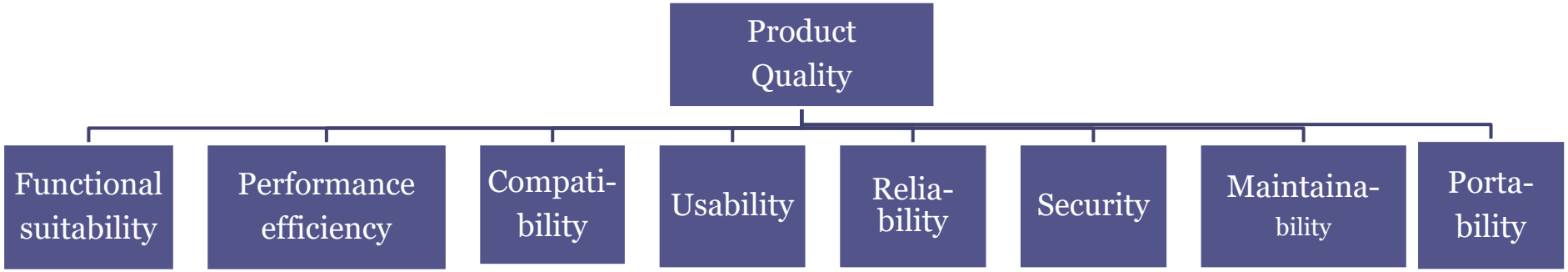
Example:
https://biking.michael-simons.eu/docs/index.html#_quality_goals

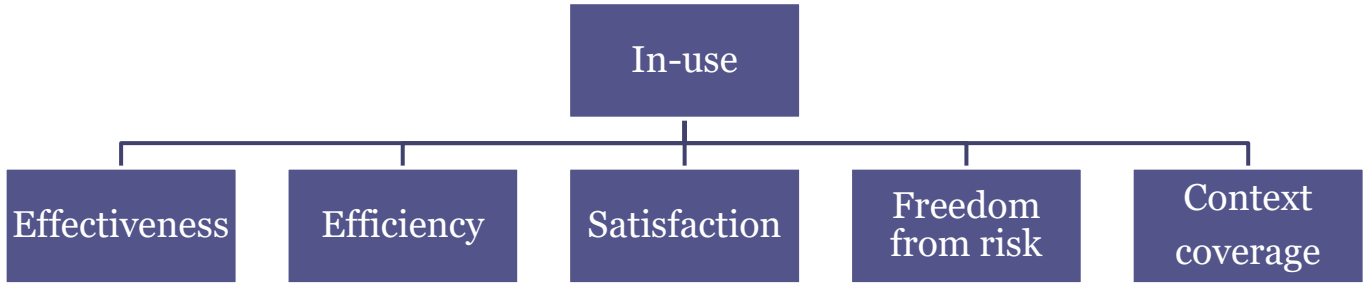
How to choose quality attributes?

- Quality attribute workshops
  - Involve stakeholders to prioritize quality attributes
- It may be helpful to distinguish
  - Runtime quality attributes
    - Performance, security, availability, usability,…
  - Non-runtime quality attributes
    - Modifiability, portability, reusability,testability
  - Business quality attributes
    - Cost, schedule, time-to-market, …

How to choose quality attributes?

ISO-25010 Software Quality Model
2 parts: Product quality, Quality in-use





1 Introduction and goals

1.3 Stakeholders

Stakeholder: person who affects, is affected or can contribute to the system and its architecture

Make explicit expectations and motivation

Format: table or map

Stakeholder	Description	Expectations, motivations
. . .	. . .	. . .

2 - Constraints

Anything that constrains teams in design and implementation decisions

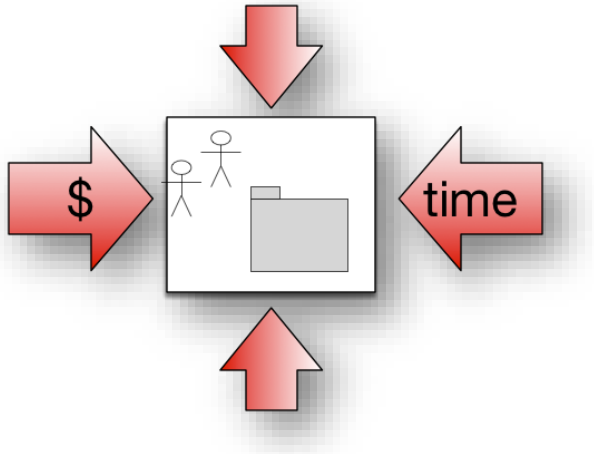
Sometimes at organization level

Decisions already taken

Format: a table with explanations

Can be divided in organizational, technical, etc.

Constraint	Explanation
. . .	. . .



Picture source: https://arc42.org/overview/

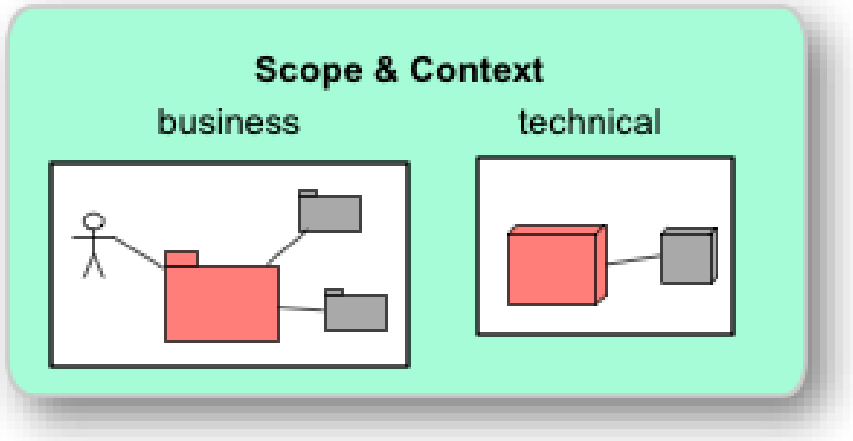
3 - Context and scope

Delimits the system from external partners

- Neighbouring users and systems

Specifies the external interfaces

Business and technical perspective



Picture source: https://arc42.org/overview/

3. Context and Scope

3.1 Business context

Specify all partners involved in the environment

Format: Diagram or table

- Diagrams that show the system as a black box

Optional: Explanation of external interfaces

NOTE:
The business context is mandatory

3 Context and scope
3.2 Technical context

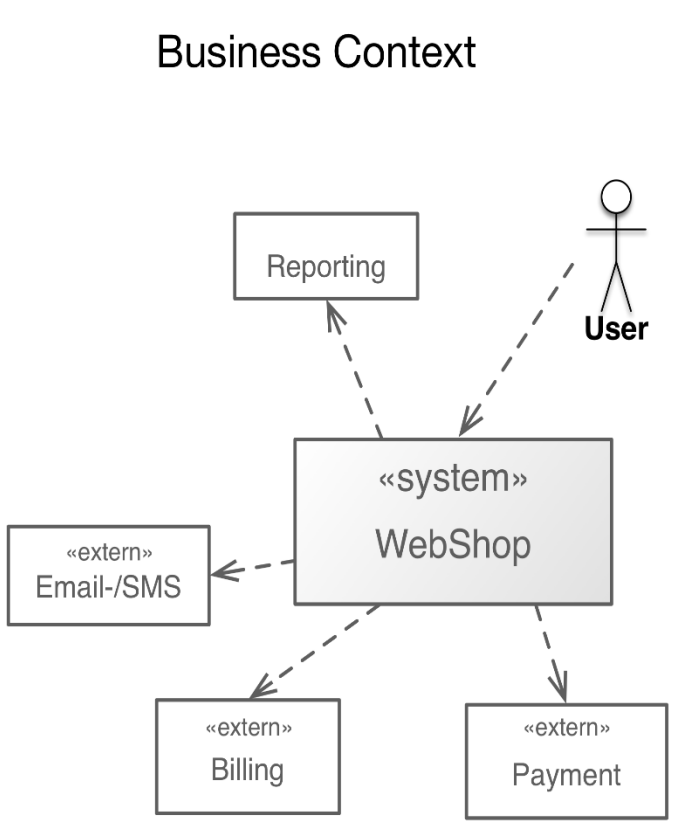
Specify Technical interfaces that link the system with the environment

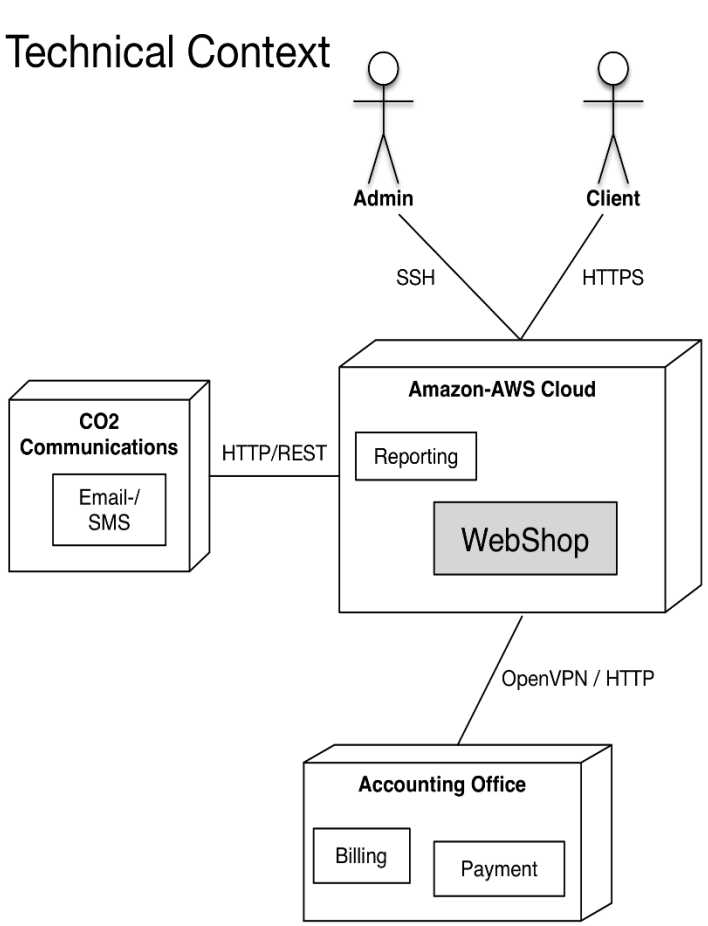
Format: Diagram or table

- Usually: UML deployment diagrams

NOTE:
The technical context diagram is optional
The deployment view can be enough

Business context vs technical context





4 - Solution strategy

Summary of fundamental decisions and strategies
Can include:

- Technology
- Top-level decomposition
- Approaches to achieve top quality goals
- Relevant organizational decisions.

Format: short text description

Keep explanations of key decisions short

Picture source: https://commons.wikimedia.org/wiki/File:Light_Bulb_or_Idea_Flat_Icon_Vector.svg

5 - Bulding block view

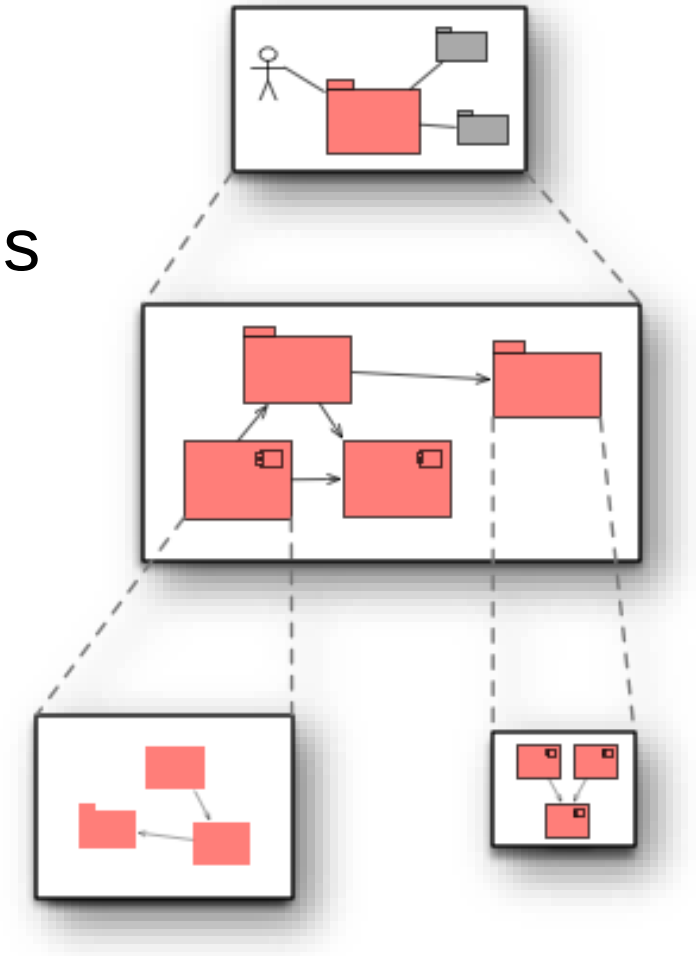
Static decomposition of system

- Modules of the system

Hierarchy of white boxes containing black boxes

Format:

- Start with overall overview diagram
- Decompose into other diagrams
  - Usually: UML Component diagrams

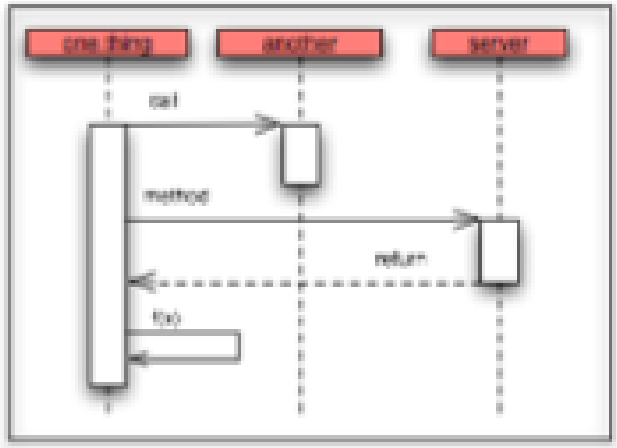


Source: https://arc42.org/overview/

6 - Runtime view

Behavior of building blocks as scenarios
Important use cases or features
Interactions at critical external interfaces
- Error and exception behavior.

Format:
- Many notations
  - Natural language (list of steps)
  - UML sequence diagrams
  - Flowcharts
  - BPMN
  - …



Source: https://arc42.org/overview/

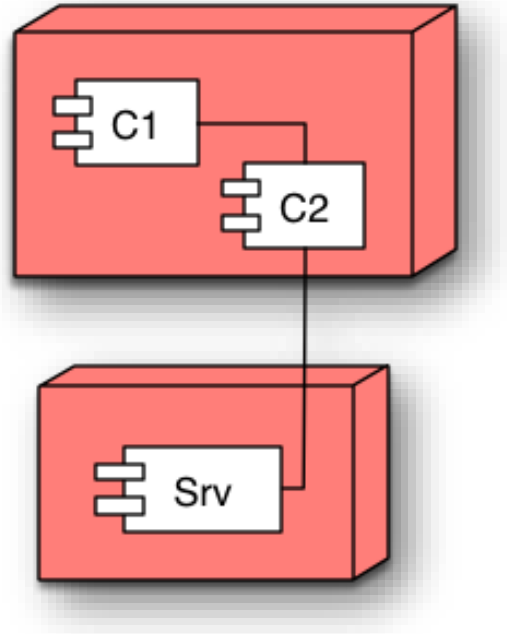
7 - Deployment view

Technical infrastructure with environments, computers, processors, topologies.

Mapping of (software) building blocks to infrastructure

Format:

- Usually: UML deployment diagrams
- Add mapping tables



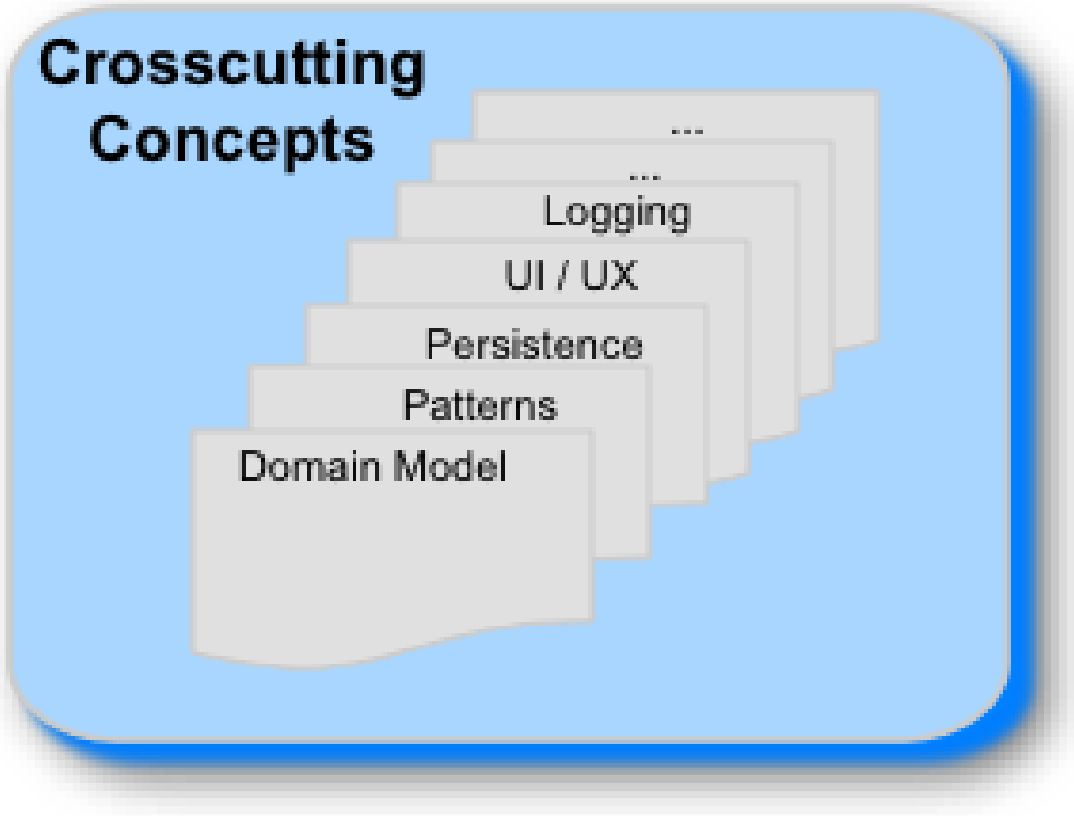
Source: https://arc42.org/overview/

8 - Crosscutting concepts

Approaches relevant in multiple parts of system

Topics like:

- Domain model
- Architecture pattern and styles
- Specific rules

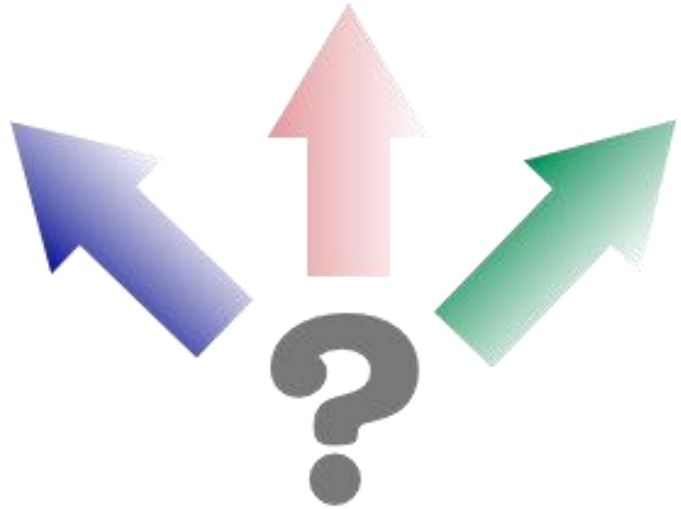


Source: https://arc42.org/overview/

9 Architectural decisions

Important, expensive, critical, large scale or risky architecture decisions
Include rationale for the decisions
Format:

- List or table ordered by importance
- Architecture decision record for important decisions

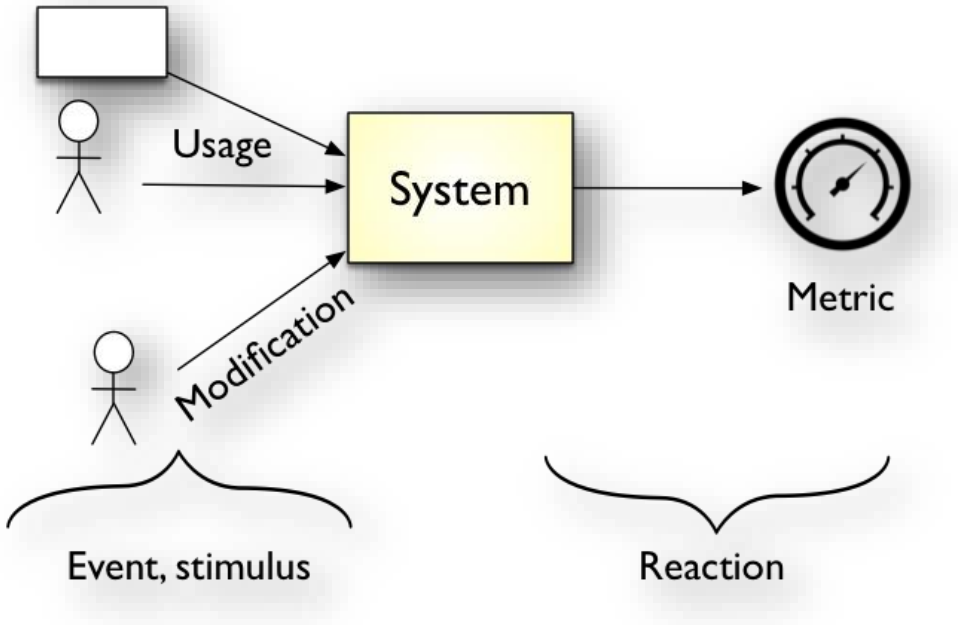


Source: https://arc42.org/overview/

10 - Quality requirements

Quality requirements as scenarios

- Quality tree to provide high-level overview
- The most important quality goals should have been described in section 1 (quality goals)



10. Quality requirements
10.1 Quality tree

A quality tree with quality scenarios as leafs

Include priorities for an overview

Sometimes, large number of quality requirements.

Format:

- A mind map with quality categories as branches
- Include links to scenarios of the following section

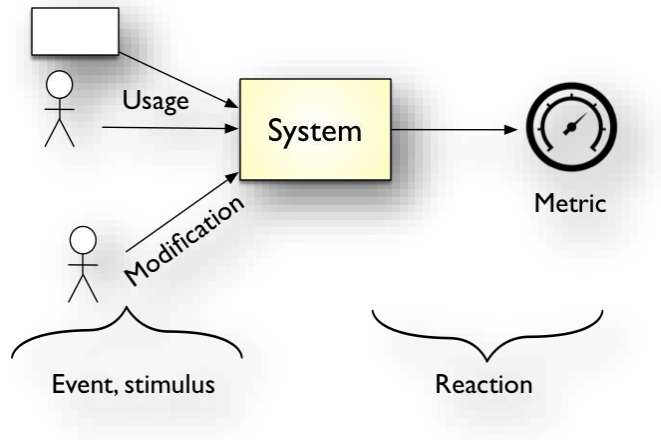
10. Quality requirements
10.2 Quality scenarios

Scenarios describe what should happen when a stimulus arrives at the system.

2 types:

- Usage: runtime reaction to a certain stimulus.
  - "The system reacts to a user's request within 1 sec."
- Change: modification of the system or its environment
  - "A new user type must be added"

Format: Tabular or free form text.



Source: https://arc42.org/overview/

11 - Risks and technical debt

- Known technical risks or technical debt
  - What potential problems exist?
  - What does the development team feel miserable about?
- Format:
  - List or risks/technical debts
    - Include suggested measures to minimize, mitigate or avoid risks or reduce technical debts.

Source: https://arc42.org/overview/

12 - Glossary

Important domain and technical terms

- Terms used by stakeholders when discussing the system
  - Common vocabulary
- Translation reference in multi-language environments
- Format: table

Term	Definition
. . .	. . .

Source: https://arc42.org/overview/

Architecturally evident coding style

- Drop hints about architecture in the code
  - Allow readers to infer the design from the code
  - The code should reflect the architecture
- Examples:
  - Components as packages
  - Modules in different repos/folders
- Some tools that check/enforce architectural constraints
  - https://www.lattix.com/, https://structurizr.com/