Pragmatic Software Architecture Documentation

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Outline

• What is software architecture?

• Introduction to software architecture documentation

• arc42 – A pragmatic template for software architecture documentation

• Software architecture documentation in the development process

• Summary
What is software architecture?
What is software architecture?

• "...an abstract system specification consisting primarily of functional components described in terms of their behaviors and interfaces and component-component interconnections." [Hayes-Roth]

• "Things that people perceive as hard to change." [Martin Fowler]

• "Software architecture is the set of design decisions which, if made incorrectly, may cause your project to be canceled." [Eoin Woods]

• "... Architecture represents the significant design decisions that shape a system, where significant is measured by cost of change." [Grady Booch]

• There are many more definitions but there is no generally accepted one.
• But there are recurring themes such as system structure, hard to change things, decisions including their rationale
What is software architecture? (Cont.)

• Software Architecture = Sum of all architectural decisions

• Architectural decisions = Fundamental decision which cannot be easily changed afterwards

• But what are these architectural decisions? How can I find them?
Control questions: a majority of „yes“ answers indicates architectural significance

Examples: It is **NOT** only about abstract things => its about important aspects including technology choices
Software architecture guides selection of a suitable solution

- Software architecture – as a process/activity – guides the solution selection
- The decision making is typically heavily influenced by quality requirements and constraints => make sure you are aware of them!
Introduction to software architecture documentation
Effective software architecture documentation

- Guides development
- Makes architecture comprehensible and evaluable
- Supports architectural work

But you have to take care that it does not turn into a useless burden!

Good software architecture documentation:
- Provides hints to developers how to accomplish certain tasks
- Shows which decisions have been taken including their rationale.
- Provides sufficient information to help analyzing its suitability.

Good software architecture documentation is particularly value when:
- New team members join
- Important knowledge carrier leave the team
- Larger changes have to be carried out

But typical problems include:
- Wrong, inconsistent, outdated or even useless information
- High creation and maintenance costs
Seven rules for sound (technical) documentation

1. Write documentation from the reader’s point of view
2. Avoid unnecessary repetition
3. Avoid ambiguity and explain your notation
4. Use a standard organization
5. Record rationale
6. Keep documentation current but not too current
7. Review documentation for fitness of purpose

Source: Paul Clements et al., “Documenting Software Architectures: Views and Beyond”, Addison Wesley 2010
Towards effective software architecture documentation

Less is more!
- Focus on a short, clear software architecture overview understandable for everyone involved

Luckily, there are already useful templates available that serve as a good starting point!
arc42 – A pragmatic template for software architecture documentation

Knowledge for Tomorrow
Overview:
- arc42: https://arc42.org
- Current version: 7.0
- Template for communication and documentation of software and system architectures
- Process- and tool-agnostic
- Made by practitioners
- Well documented, many examples and books are available
- Available in 4 different languages (DE, EN, ES, RU)
- Available in various formats: https://arc42.org/download
- Compatible with IEEE 1471
- Used in the iSAQB certification program
- License: CC BY-SA 4.0

Content structure / section meaning:
- For more information, please see: https://arc42.org/overview/
- Green => requirements-related sections
- Blue => solution-oriented sections
- Yellow => evaluation-oriented sections
The first table show exemplarily target groups and their goals with regard to the software architecture documentation.

The second table depicts their potential interest in certain aspects of the software architecture documentation.
The product vision explains the purpose and the main features of the software. In general, it sums up the main selling arguments/reason for the software systems/why the system is built. In Open Source software, this information is typically shown in the README file.

Solar Controller is a universal solar field control software. It allows the safe and efficient operation of the whole the solar field.

**Main features:**

- Set up of the solar field and definition of standard operation procedures for solar fields up to 10000 heliostats and 10 receivers
- Autonomous performance of standard operation procedures
- Integrated monitoring, evaluation and alert functionalities
- Support of a wide range of heliostat and receiver types
Software quality has to be explicitly constructed. Quality attributes offer a starting point but you need to interpret and prioritize them in context of your software. This is the purpose of quality goals.

The tables shows how you can document the quality goals. You should reference the quality attribute and describe the goal in this regard. In addition, it is useful to reference relevant quality requirements (here captured as quality scenarios). These scenarios are more concrete and allow a better understanding of the actual requirements.

The order of the goals implies their priority. The most important goal is defined first.

You should limit the number of quality goals to 3 - 5.

Beware that quality attributes influence each other. For that reason, it is important to prioritize them.
Quality scenarios describe the desired quality attributes in an informal, discussable way. They drive the architectural work and capture the quality requirements.
- Event/stimulus is the source of change.
- System is the (software) system which we actually want to describe.
- Reaction illustrates the response of our system to the incoming event/stimulus.
- Metric provides a measure for the response.

There different types of quality scenarios:
- Usage scenarios describe how the system is used and how it behaves in such situations. Example: “The customer uses the article search (event). The search (system) shows first matching articles (reaction) after one second (metric).”
- Change scenarios describe changes of the system’s environment or operational infrastructure. Example: “The number of users doubles (event). The system (system) does not show significant performance decreases for typical actions (reaction + metric).”
- Failure scenarios describe failure situations of neighbor systems or the system’s operational infrastructure. Example: “A power plant indicates an overheat event (event). The control system (system) triggers the safe-mode immediately (metric).”
• For more information, please see: https://faq.arc42.org/questions/C-10-2/ and https://github.com/arc42/quality-requirements
Constraints

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent FireFox ESR version</td>
<td>The Web clients have to support recent FireFox ESR versions. It is the officially supported Web browser available at the customer site.</td>
</tr>
<tr>
<td>Apache Tomcat 8</td>
<td>We re-use an existing software of the customer which already is built with Tomcat 8. There is no budget to change this.</td>
</tr>
<tr>
<td>Non-permanent Internet connection</td>
<td>The control server has only permanent access to the Intranet. It is an operational constraint of the datacenter in which the server is hosted.</td>
</tr>
</tbody>
</table>

• Constraints are requirements which limit your choices in building / architecting the software system.
• It is important to collect, discuss, and communicate them. Otherwise the system might never find its way into production.
• **Beware:** Some constraints might only be a preference of someone involved!
• The table illustrates how you can document constraints. In this case three technical constraints are listed. Try to keep it short and reference other documents as needed. Particularly, you should explain the rational of the constraint.
Technical constraints are typically specifications concerning software, hardware, or operations.
Organizational constraints might concern the organization/structure of the project or the available resources. In addition, they might require you to comply with organizational standards or legal aspects.
Conventions include aspects such as programming or documentation guidelines.
For further details, please see the arc42 documentation and Gernot Starke: "Effektive Software-Architekturen", Auflage 8, 2017.
• The system context is used to differentiate what belongs into the system and what is outside the system. Particularly, it shows the involved stakeholders and third-party systems with which our software system has to interact.
• It is a very valuable view which should not change so often after the system is basically into production.
• The system context is a good starting point for architectural decisions.
• Make sure that you properly describe the diagram within your documentation!

**Explanation of the diagram:**
• In the middle is the software system we want to build (UML component).
• Lines show interactions with users/third-party systems outside the system.
You can differentiate between the business and the technical system context.

- Business context focuses on the domain.
- Technical context focuses on the technical protocols / details.
The building block view shows the decomposition of a system. Its static structure. Here we have used the UML component diagram syntax.

You can define further levels showing the details of a component. For instance, we could show the further decomposition of the component “Controller Core” which would be part of building block level 2.

There are different ways to approach the decomposition: domain-specific vs. technical decomposition. Here you see a typical technical decomposition.

**Tips:**
- Make sure that the names of the component can be directly mapped to your source code.
- You should avoid too many decomposition levels here - particularly when you create them manually. 1-2 level should be sufficient. Otherwise it is hard to keep them up-to-date.
- The C4 model (https://c4model.com/) is a good alternative as it allows you to generate those views from your source code.
- Make sure that you properly describe the diagram within your documentation!
• The diagrams shows a UML deployment diagram which shows how the system is operated.
In general, arc42 makes no assumption whether you use or you do not use UML.

There are also alternatives available such as C4 model https://c4model.com/ (focus on structure)

PlantUML is a textual UML tool which is widely supported by different tools (e.g., editors/IDEs, development platforms, Wiki): https://plantuml.com/
Architecture decision records offer a compact/lean format to document architectural decisions. In addition, they offer you a way/template to approach those decisions.

For more information, see Michael Nygard blog: http://thinkrelevance.com/blog/2011/11/15/documenting-architecture-decisions

A good collection for ADR tools/templates is available here: https://github.com/joelparkerhenderson/architecture_decision_record
Decision

`adr-tools` will use the ISO 8601 format for dates: `yyyy-mm-dd`

Consequences

Dates are displayed in a standard, culture-neutral format.

The UK-style and ISO 8601 formats can be distinguished by their separator character. The UK-style dates used a slash (`/`), while the ISO dates use a hyphen (`-`).

Prior to this decision, `adr-tools` was deployed using the UK format for dates. After adopting the ISO 8601 format, existing deployments of `adr-tools` must do one of the following:

- Accept mixed formatting of dates within their documentation library.
- Update existing documents to use ISO 8601 dates by running `adr upgrade-repository`

ADRstrs are the very minimum that you should really create!
Seven rules for sound (technical) documentation

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2. Avoid unnecessary repetition
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4. Use a standard organization
5. Record rationale
6. Keep documentation current but not too current
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Source: Paul Clements et al., “Documenting Software Architectures: Views and Beyond”, Addison Wesley 2010
Software architecture documentation in the development process
In the 90s, the focus has been on rigorous planning (BUFD) which could easily lead to analysis paralysis.

The introduction of agile methods shifted the focus. Unfortunately, in the direction of having no plan at all.

To sum: You should have a plan (see also: iteration 0 etc.) but should keep its creation lean.
## Architectural vision

### What?

- ✔ System context
- ✔ Constraints
- ✔ Quality goals
  - Quality Scenarios
  - Risks

### How?

- ✔ Technology stack
- ✔ Architectural style
- ✔ Design principles
  - Building block level 1
  - Domain model

Interactive workshops for requirement collection and performing architectural work are very effective ways to collect/create architectural content.

- You should involve all important stakeholders and should focus on interactive formats such as group work, brain writing etc.
- These workshops are particularly effective for prioritization and decision making.
- Stefan Toth: „Vorgehensmuster für Software-Architekturn“ provides some good ideas in this regard.
Documentation as code

Basic approach:
• Writing content using plain text formats
• Store content in a version control system
• Review content meticulously
• Apply automation for creation, validation, publication

Handle documentation content like your code!

• The “Write the Docs” community provides a good overview about it: https://www.writethedocs.org/guide/docs-as-code/
• Suitable markup languages include AsciiDoc, MarkDown, and RestructredText.
• docToolchain provides an implementation of this approach: https://doctoolchain.github.io/docToolchain/
Documentation as code (Cont.)

- **Build script / pipeline automates recurring tasks**
- **Documentation is checked as part of the usual reviews**
- **Creation / updates of content is part of the usual work**
- **Retrospectives help to find issues with the overall process**
- **Iteration closing**
Summary

- **Software architecture** is the sum of all important decisions
- **Software architecture documentation** helps to communicate them including the surrounding concepts
- **arc42** is a good starting point but think carefully about:
  - Target groups
  - Development process
  - Tools
- **Documentation as code** helps to keep documentation up-to-date and fit for purpose
Further readings

• Stefan Zörner: "Softwarearchitekturen dokumentieren und kommunizieren", 2015
• Simon Brown: “Software Architecture for Developers”, 2018
• Anne Gentle: "Docs Like Code“, 2018
• Carola Lilienthal: "Langlebige Software-Architekturen - Technische Schulden analysieren, begrenzen und abbauen", 2017
• Stefan Toth: "Vorgehensmuster für Software-Architektur", 2015
• Gernot Starke: "Effektive Software-Architekturen", 2017
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Thank you!

Questions?

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