3rd Edition

by Example

Software Architecture Documentation in Practice

Gernot Starke
Hendrik Lösch
Michael Simons
Ralf D. Müller
Stefan Zörner

arc42 by Example

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Gernot Starke, Michael Simons, Stefan Zörner, Ralf D. Müller and Hendrik Lösch

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Contents

Preface

Acknowledgements

Gernot

Long ago, on a winters' day in 2004, I sat together with Peter Hruschka, a long-time friend of mine and discussed one[1] of our mutual favorite subjects - structure and concepts of software systems.

We reflected about an issue we both encountered often within our work, independent of client, domain and technology: Developers know their way around implementation technologies, managers theirs' around budgets and risk management. But when forced to communicate (or even document) the *architecture* of systems, they often started inventing their own specific ways of articulating structures, designs, concepts and decisions.

Peter talked about his experience in requirements engineering: He introduced me to a *template* for requirements, a pre-structured *cabinet* (or document) called VOLERE[2] which contains placeholders for everything that *might be* important for a specific requirements document. When working on requirements, engineers therefore needn't think long before they could *dump* their results in the right place - and others would be able to retrieve it later on… (as long as they knew about VOLEREs structure). This requirements template had been in industry use since several years, there even was a book available[3] on its usage and underlying methodology.

"If we only had a similar template for software architecture", Peter complained, and continued "countless IT projects could save big time and money"… My developer-soul added a silent wish: "If this was great, it could even take the ugliness out of documentation".

[1] Peter and Gernot both share a passion for cooking too, but you probably wouldn't share our sometimes exotic taste
[2] http://volere.co.uk
[3] http://www.volere.co.uk/book/mastering-the-requirements-process-getting-requirements-right

We both looked at each other, and within this second decided to create exactly this: A template for software architecture documentation (and communication), that is highly practical, allows for simple and efficient documentation, is usable for all kinds of stakeholders and could facilitate software architecture documentation. And of course, it had to be open source, completely free for organizations to use.

That's how the arc42 journey started.

Since then, Peter and myself have used arc42 in dozens of different IT systems within various domains. It has found significant acceptance within small, medium and large organizations throughout the world. We wrote more many articles around it, taught it to more than 1000 (!) IT professionals and included it in several of our software architecture-related books.

Thanx Peter for starting this wild ride with me. And, of course, for your lectures on cooking.

Thanx to my customers and clients - I learned an incredible lot by working together with you on your complex, huge, hard, interesting and sometimes stressful problems. Due to all these nondisclosure agreements I signed all my life, I'm not officially allowed to mention you all by name.

Thanx to my wife *Cheffe Uli* and my kids Lynn and Per for allowing dad to (once more) sit on the big red chair and ponder about another book project… You're the best, and I call myself incredibly lucky to have you!

Thanx to my parents, who, back in 1985, when the *computer stuff* was regarded to be something between crime and witchcraft, they encouraged my to buy one (an Apple-2, by the way) and didn't even object when I wanted to study computer science instead of something (by that time) more serious. You're great!

Michael

I've met Gernot and Peter (Hruschka) as instructors on a training at the end of 2015. The training was called "Mastering Software Architectures" and I learned an awful lot from both of them, not only the knowledge they shared but how they both shared it. By the end of the training I could call myself "Certified Professional for Software Architecture", but what I really took home was the wish structure, document and communicate my own projects like Peter and Gernot proposed and that's why the current documentation of my pet project biking2 was created.

Since then I used arc42 based documentations several times: As well as for in-house products and also at projects and consultancy gigs. The best feedback was something along the lines: "Wow, now we've got an actual idea about what is going on in this module." What helped that special project a lot was the fact that we set fully on Asciidoctor and the "Code as documentation and documentation as code"[4] approach I described in depth in my blog.

So here's to Gernot and Peter: Thanks for your inspiration and the idea for arc42.

StefanZ

Originally, DokChess is a case study from my German book[5] on documenting software architecture. Gernot has encouraged me to write it after I had told him about the chess example on a conference in Munich in 2011. Thank you especially for that, Gernot! (besides many valuable discussions and good times since then in Cologne, Zurich ...)

Thanks to Harm Gnoyke and my daughter Katharina for trying to save my miserable English. All mistakes are my fault, of course.

Ralf D. Müller

Quite a while ago, I discovered the arc42 template as MS Word document. It didn't take long to see how useful it is and I started to use it in my projects. Soon, I discovered that MS Word wasn't the best format for me as a developing architect. I started to experiment with various text-based formats like Markdown, AsciiDoc but also with Wikis. The JAX conference was the chance to exchange my ideas with Gernot. He told me that Jürgen Krey already created an AsciiDoc version of the arc42 template. We started to consider this template as the golden master and tried to generate all other formats needed (at this time, mainly MS Word and Confluence) from this template. The arc42-generator[6] was born, and a wonderful journey was about to start. The current peak of this journey is docToolchain[7] - the evolution of the arc42-generator. Read more about its architecture in this book.

[4] https://info.michael-simons.eu/2018/12/05/documentation-as-code-code-as-documentation/
[5] https://www.swadok.de
[6] https://github.com/arc42/arc42-generator
[7] https://doctoolchain.github.io/docToolchain/

On this journey, I have met many people who helped me along this way - impossible to name all of them.

However my biggest “Thanx!” goes out to Gernot who always encouraged me to do my next step and helped me along the way.

Thank you, Peter and Gernot for pushing my architectural skills to the next level through their superb training workshops.

Thanx to Jakub Jabłoński and Peter for their review of the architecture - You gave great feedback!

Last but not least, I have to thank my family for their patience while I spent too much time with my notebook!

Hendrik Lösch

Like some of my fellow authors, I met Gernot at conferences and then got to know him better in a workshop. At that time I had already specialized in restructuring legacy software and since I come from the field of cyber-physical systems, I noticed some peculiarities. Bold as I was, I suggested to Gernot that we could write a book together.

Fast-forward some years, I had created a video training about architecture documentation for LinkedIn Learning. Gernot took up the idea and asked me whether I would want to contribute to this book with the example I used in the video training. Lo and behold this is what happened.

My biggest thanks go to both Gernot and Stefan. The work of both has helped me very often in the past years. It is a great honor for me to be able to publish something together with them that helps other people in their work.

I also want to say a big thank you to Attila Bertok who reviewed my part of the book and was an invaluable help in translating it from German into English.

All of us

Thanx to our thorough reviewers that helped us improve the examples, especially Jerry Preissler, Roland Schimmack and Markus Schmitz.

Conventions

Chapter and Section Numbering:

We use roman chapter numbers (I, II, III etc), so we can have the arabic numbers within chapters in alignment with the arc42 sections...

In the sections within chapters, we add the chapter-prefix only for the top-level sections. That leads to the following structure:

Chapter II: HtmlSC

II.1 Introduction and Goals
II.2 Constraints
II.3 Context
...

Chapter III: Mass Market CRM

III.1 Introduction and Goals
III.2 Constraints
III.3 Context
...

> **Explanations:**
>
> The first example (HTML Sanity Checking) contains short explanations on the arc42 sections, formatted like this one.

In this book, we keep these explanations to a bare minimum, as there are other books extensively covering arc42 background and foundations.

This is Just a Sample of the Full Book

Dear Readers,

thanx for downloading this sample. It contains chapter I, most of chapter II and some excerpts of other chapters, to give you an impression what to expect in the full book[8]

Some internal references (hyperlinks) will not work in this sample …

[8] https://leanpub.com/arc42byexample

I - Introduction

This chapter explains the following topics

This book contains several examples of *Software Architecture Documentation* based upon the practical, economical, well-established and systematic arc42 approach.

It shows how you can *communicate* about software architectures, but it does *not* show how to develop or implement systems!

I.1 What is arc42?

arc42 is a template for architecture documentation.

It answers the following two questions in a pragmatic way, but can be tailored to your specific needs:

- *What* should we document/communicate about our architecture?
- *How* should we document/communicate?

Figure I.1 gives you the big picture: It shows a (slightly simplified) overview of the structure of arc42.

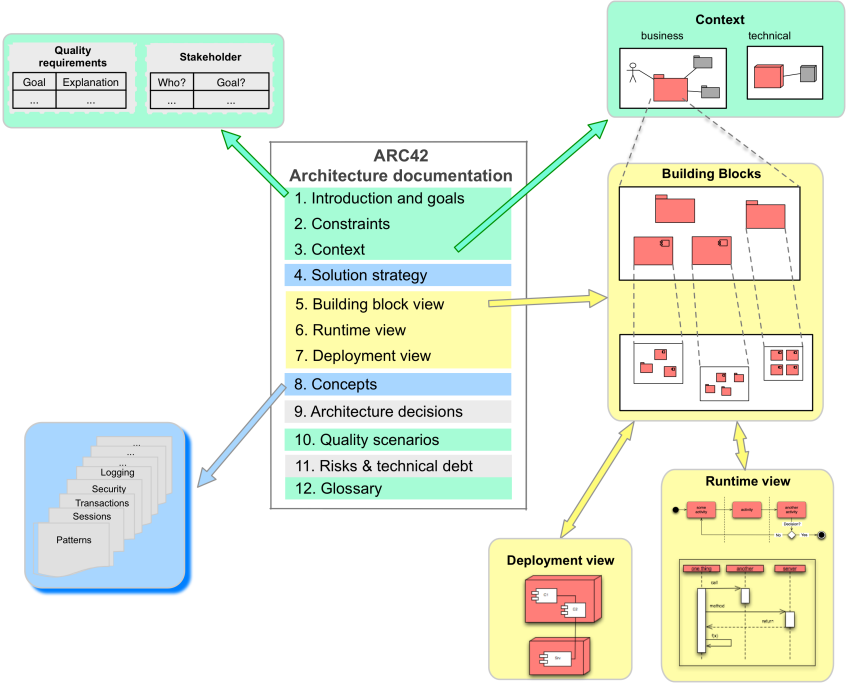
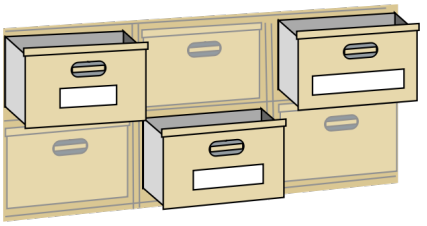


Figure I.1

Compare arc42 to a cabinet with drawers: the drawers are clearly marked with labels indicating the content of each drawer. arc42 contains 12 such drawers (a few more than you see in the picture above). The meaning of these arc42 drawers is easy to understand.



arc42 metaphor

Therefore, arc42 offers you a simple and clear structure to document and communicate your (complex!) system. Starting with the goals and requirements for your system and its embedding into its environment you can provide the important stakeholder of your system with adequate information about the architecture.

arc42 is optimized for understandability and adequacy. It naturally guides you to explain any kind of architecture information or decision in an understandable and reproducible context.

Individuals and organizations using arc42 especially like two things about it:

1. the *understandability* of the documentation resulting from its standardized structure (the *drawers*) and
2. the *manageable effort* to create such documentation. We call it "*painless documentation*".

Why 42?

You're kidding, aren't you? Ever heard of Douglas Adams, the (very British) and already deceased sci-fi writer… his novel "Hitchhikers Guide to The Galaxy" calls 42 the:

Answer to the Ultimate Question of Life, The Universe, and Everything[9]

arc42 aims at providing the answer to *everything* around your software architecture. (Yes, I know it's a little pretentious, but we couldn't think of a better name back in 2005.)

[9] https://en.wikipedia.org/wiki/Phrases_from_The_Hitchhiker's_Guide_to_the_Galaxy#Answer_to_the_Ultimate_Question_of_Life.2C_the_Universe.2C_and_Everything_.2842.29

Where to get additional information

With the latest release (V7) of arc42 in January 2017, the project now has extensive online help and FAQ (frequently asked questions) available:

- The documentation site docs.arc42.org[10] contains the full documentation plus many (more than 100) tips for efficient and effective usage.
- The FAQ site faq.arc42.org[11] answers more than 100 typical questions.

[10] https://docs.arc42.org
[11] https://faq.arc42.org

I.2 Why this Book?

> Examples are often better suited to show *how things can work* than lengthy explanations.

arc42 users have often asked for examples to complement the (quite extensive) conceptual documentation of the template that was, unfortunately, only available in German for several years.

There were a few approaches to illustrate how arc42 can be used in real-world applications, but those were (and still are) scattered around numerous sources, and not carefully curated.

After an incredibly successful (again, German only) experiment to publish one single example as a (very skinny) 40-page booklet we decided to publish a *collection of examples* on a modern publishing platform - so we can quickly react to user feedback and add further samples without any hassle.

I.3 What this Book is Not

In this book we focus on examples for arc42 to document and communicate software architectures. We only give a brief introduction to arc42 (in case you like more, see appendix B for details)

This book is *no* introduction to:

- Software architecture
- Architecture and Design Patterns
- Modeling, especially UML
- Chinese cooking (but propably you didn't expect that here...)

I.4 Overview of the Examples

We encountered exciting software and system architectures during our professional lifes. Several of those would have made instructive, interesting and highly relevant examples - too bad they were declared *confidential* by their respective owners. Our *nondisclosure agreements* stated that we're not allowed to even mention clients' names without violating these contracts…

Therefore it has been quite difficult to find practical examples which we can freely write and talk about.

Now let's get an overview of the examples that are waiting in the rest of this book…

HTML Sanity Checking

A tiny open source system to check HTML files for semantic errors, like broken cross references, missing images, unused images and similar stuff.

Gernot wrote the initial version of this system himself when working on a rather large (100+pages) documentation based upon the AsciiDoctor[12] markup language.

HtmlSanityCheck (or HtmlSC for short) is described in chapter II of this book.

Mass Market Customer Relationship Management

Gosh, what an awkward name - so let's shorten it to MaMa-CRM at first: *Mass market* refers to consumers of severl kinds of enterprises, like health insurance, mobile telecommunication or large real-estate companies.

We are reasonably sure you know these 86×54mm plastic cards (experts call them ISO/IEC 7810[13]). Chances are you even *own* several of these cards. In case it contains your portrait photo, chances are high it was produced by a system like MaMa-CRM…

MaMa-CRM takes the burden of (usually paper-based) customer contacts from the organizations working in such mass markets. It has been initially build by an

[12] https://asciidoctor.org
[13] https://en.wikipedia.org/wiki/ISO/IEC_7810

independent mid-sized data center to support the launch of the German (government-enforced) e-Health-Card - and later on used to support campaigns like telephone billing, electrical-power metering and similar stuff.

The architecture of MaMa-CRM is covered in chapter III.

biking2

biking2 or "*Michis milage*" is a web based application for tracking biking related activities. It allows the user to track the covered milage, collect GPS tracks of routes, convert them to different formats, track the location of the user and publish pictures of bike tours.

The architecture of biking2 is covered in chapter IV

DokChess - a Chess Engine

DokChess is a fully functional chess engine.

The architecture of DokChess is covered in chapter V

docToolchain

docToolchain[14] is a heavily used and highly practical implementation of the docs-as-code[15] approach: The basic idea is to facilitate creation and maintenance of technical documentation.

The architecture of docToolchain is covered in chapter VI

Foto Max

Foto Max is a made-up company that offers solutions for ordering photos. The software architecture in this book describes how the software is implemented to be used on the company's devices.

Foto Max can be found in chapter VII

[14] https://doctoolchain.github.io/docToolchain
[15] https://docs-as-co.de

MiniMenu

Surely one of the *leanest* architecture documentations you will ever encounter. Captures some design and implementation decisions for a tiny Mac-OS menu bar application.

The main goal is to show that arc42 even works for *very* small systems.

Skip to chapter VIII to see for yourself.

II. HTML Sanity Checking

By Gernot Starke.

> **Convention for this example**
>
> At the beginning of each section you find short explanations, formatted in boxes like this.

The system documented here is a small open source tool hosted on Github[16].

The full sourcecode is available - you might even configure your Gradle build to use this software. Just in case you're writing documentation based on Asciidoctor, that would be a great idea!

But enough preamble. Let's get started…

[16] https://github.com/aim42/htmlSanityCheck

II.1. Introduction and Goals

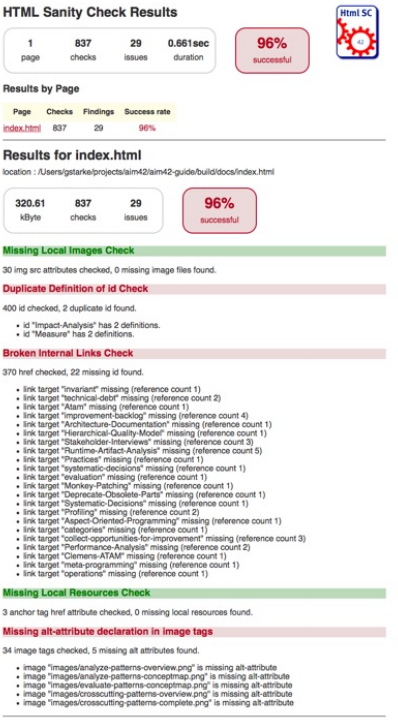
> **Content and Motivation**
>
> This section shows the driving forces for architecturally relevant decisions and important use-cases or features, summarized in a few sentences. If possible, refer to existing requirements documentation.
>
> The main goal of this section is enabling your stakeholders to understand the solution, which is detailed in arc42-sections 3 to 12.

HtmlSC supports authors creating digital formats by checking hyperlinks, images and similar resources.

1.1 Requirements Overview

> **Content and Motivation**
>
> You like to briefly explain important goals and requirements, use-cases or features of the system. If available, refer to existing requirements documentation.
>
> Most important: Readers can understand the central tasks of the system, before they encounter the architecture of the system (starting with arc42-section 3).

The overall goal of HtmlSC is to create neat and clear reports, showing errors within HTML files. Below you find a sample report.



HTML Sanity Check Results

1 page | 837 checks | 29 issues | 0.661sec duration | 96% successful

Results by Page

Page	Checks	Findings	Success rate
index.html	837	29	96%

Results for index.html

location : /Users/gstarke/projects/aim42/aim42-guide/build/docs/index.html

320.61 kByte | 837 checks | 29 issues | 96% successful

Missing Local Images Check

30 img src attributes checked, 0 missing image files found.

Duplicate Definition of id Check

400 id checked, 2 duplicate id found.

- id "Impact-Analysis" has 2 definitions.
- id "Measure" has 2 definitions.

Broken Internal Links Check

370 href checked, 22 missing id found.

- link target "invariant" missing (reference count 1)
- link target "technical-debt" missing (reference count 2)
- link target "Atam" missing (reference count 1)
- link target "improvement-backlog" missing (reference count 4)
- link target "Architecture-Documentation" missing (reference count 1)
- link target "Hierarchical-Quality-Model" missing (reference count 1)
- link target "Stakeholder-Interviews" missing (reference count 3)
- link target "Runtime-Artifact-Analysis" missing (reference count 5)
- link target "Practices" missing (reference count 1)
- link target "systematic-decisions" missing (reference count 1)
- link target "evaluation" missing (reference count 1)
- link target "Monkey-Patching" missing (reference count 1)
- link target "Deprecate-Obsolete-Parts" missing (reference count 1)
- link target "Systematic-Decisions" missing (reference count 1)
- link target "Profiling" missing (reference count 2)
- link target "Aspect-Oriented-Programming" missing (reference count 1)
- link target "categories" missing (reference count 1)
- link target "collect-opportunities-for-improvement" missing (reference count 3)
- link target "Performance-Analysis" missing (reference count 2)
- link target "Clemens-ATAM" missing (reference count 1)
- link target "meta-programming" missing (reference count 1)
- link target "operations" missing (reference count 1)

Missing Local Resources Check

3 anchor tag href attribute checked, 0 missing local resources found.

Missing alt-attribute declaration in image tags

34 image tags checked, 5 missing alt attributes found.

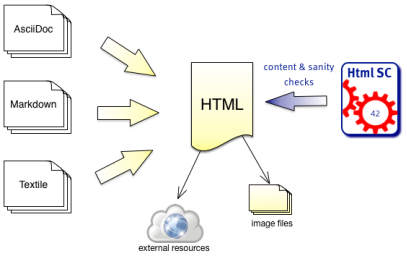
- image "images/analyze-patterns-overview.png" is missing alt-attribute
- image "images/analyze-patterns-conceptmap.png" is missing alt-attribute
- image "images/evaluate-patterns-conceptmap.png" is missing alt-attribute
- image "images/crosscutting-patterns-overview.png" is missing alt-attribute
- image "images/crosscutting-patterns-complete.png" is missing alt-attribute

Sample Report

HtmlSanityCheck (HtmlSC) checks HTML for semantic errors, like broken links and missing images. It has been created to support authors who create HTML as output format.

1. Authors write in formats like AsciiDoc[17], Markdown[18] or other formats, which are transformed to HTML by the corresponding generators.
2. HtmlSC checks the generated HTML for broken links, missing images and other semantic issues.
3. HtmlSC creates a test report, similar to the well-known unit test report.

[17] https://asciidoctor.org/docs/what-is-asciidoc/
[18] https://www.daringfireball.net/projects/markdown/syntax



HtmlSC goal: Semantic checking of HTML pages

Basic Usage

1. A user configures the location (directory and filename) of one or several HTML file(s), and the corresponding images directory.
2. HtmlSC performs various checks on the HTML and
3. reports its results either on the console or as HTML report.

HtmlSC can run from the command line or as Gradle plugin.

Basic Requirements

ID	Requirement	Explanation
G-1	Check HTML for semantic errors	HtmlSC checks HTML files for semantic errors, like broken links.
G-2	Gradle and Maven Plugin	HtmlSC can be run/used as Gradle and Maven plugin.
G-3	Multiple input files	Configurable for a set of files, processed in a single *run*, HtmlSC produces a joint report.
G-4	Suggestions	When HtmlSC detects errors, it shall identify suggestions or alternatives that might *repair* the error.
G-5	Configurable	Several features of checks shall be configurable, especially input files/location, output directory, timeouts and status-code behavior for checking external links etc.

Required Checks

HtmlSC shall provide the following checks in HTML files:

Check	Explanation
Missing images	Check all image tags if the referenced image files exist.
Broken internal links	Check all internal links from anchor-tags (‘href=”#XYZ”) if the link targets “XYZ” are defined.
Missing local resources	Check if referenced files (e.g. css, js, pdf) are missing.
Duplicate link targets	Check all link targets (… id=”XYZ”) if the id’s (“XYZ”)are unique.
Malformed links	Check all links for syntactical correctness.
Illegal link targets	Check for malformed or illegal anchors (link targets).

Check	Explanation
Broken external links	Check external links for both syntax and availability.
Broken ImageMaps	Though ImageMaps are a rarely used HTML construct, HtmlSC shall identify the most common errors in their usage.

1.2 Quality Goals

Content and Motivation

You want to understand the quality goals (aka architeture goals), so you can align architecture and design decisions with these goals.

These (usually *long term*) quality goals diverge from the (usually *short term*) goals of development projects. Mind the difference! See also arc42-section 10.

Priority	Quality Goal	Scenario
1	Correctness	Every broken internal link (cross reference) is found.
1	Correctness	Every potential semantic error is found and reported. In case of doubt[19], report and let the user decide.
1	Safety	Content of the files to be checked is *never* altered.
2	Flexibility	Multiple checking algorithms, report formats and clients. At least Gradle and command-line have to be supported.
2	Correctness	Correctness of every checker is automatically tested for positive AND negative cases.
3	Performance	Check of 100kB html file performed under 10 secs (excluding Gradle startup)

[19]Especially when checking external links, the correctness of links depends on external factors, like network availability, latency or server configuration, where HtmlSC cannot always identify the root cause of potential problems.

1.3 Stakeholders

Content and Motivation

You want an overview of persons, roles or organizations that affect, are affected by or can contribute to the system and its architecture. Make the concrete expectations of these stakeholders with respect to the architecture and its documentation explicit. Collect these in a simple table.

Remark: For our simple HtmlSC example we have an extremely limited number of stakeholders, in real-life you will most likely have many more stakeholders!

Role	Description	Goal, Intention
Documentation author	writes documentation with HTML output	wants to check that the resulting document contains good links, image references.
arc42 user	uses arc42 for architecture documentation	wants a small but practical example of *how to apply arc42*.
software developer		wants an example of pragmatic architecture documentation

II.2 Constraints

Content and Motivation

You want to know the constraints that restrict your freedom of design decisions or the development process. Such constraints are often imposed by organizations across several IT systems.

HtmlSC shall be:

- platform-independent and should run on the major operating systems (Windows(TM), Linux, and Mac-OS(TM))
- implemented in Java or Groovy
- integrated with the Gradle build tool
- runnable from the command line
- have minimal runtime and installation dependencies (a Java(TM) runtime may be required to run HtmlSC)
- developed under a liberal open-source license. In addition, all required dependencies/libraries shall be compatible with a CreativeCommons license. |

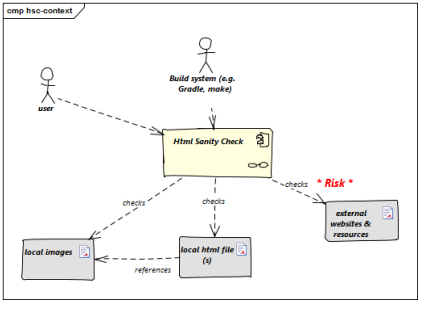
II.3 System Scope and Context

Content and Motivation

You want to know the boundaries and scope of the system to distinguish it from neighboring systems. The context identifies the systems relevant external interfaces.

3.1 Business Context

You want to identify all neighboring systems and the different kinds of (business) data or events that are exchanged between your system and its neighbors.



Business context

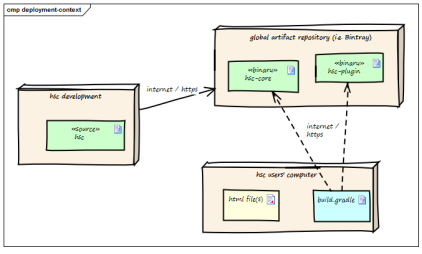
Neighbor	Description
user	documents software with toolchain that generates html. Wants to ensure that links within this HTML are valid.
build system	mostly Gradle[20]
local HTML files	HtmlSC reads and parses local HTML files and performs sanity checks within those.
local image files	HtmlSC checks if linked images exist as (local) files.
external web resources	HtmlSC can be configured to optionally check for the existence of external web resources. **Risk**: Due to the nature of web systems and the involved remote network operations, this check might need significant time and might yield invalid results due to network and latency issues.

[20] https://gradle.org

3.2 Deployment Context

> You like to know about the technical or physical infrastucture of your system, together with physical channels or protocols.

The following diagram shows the participating computers (nodes) with their technical connections plus the major artifacts of HtmlSC, the hsc-plugin-binary.



Deployment context

Node / Artifact	Description
hsc-development	where development of HtmlSC takes place
hsc-plugin-binary	compiled and packaged version of HtmlSC including required dependencies.
artifact repository	A global public *cloud* repository for binary artifacts, similar to MavenCentral[21], the Gradle Plugin Portal[22] or similar. HtmlSC binaries are uploaded to this server.
hsc user computer	where arbitrary documentation takes place with html as output formats.
build.gradle	Gradle build script configuring (among other things) the HtmlSC plugin to perform the HTML checking.

For details see the deployment-view.

[21] https://search.maven.org/
[22] https://plugins.gradle.com

II.4 Solution Strategy

Content and Motivation

You need a brief summary and explanation of the fundamental solution ideas and strategies. These key ideas should be familiar to everyone involved in development and architecture.

Briefly explain how you achieve the most important quality requirements.

1. Implement HtmlSC mostly in the Groovy programming language and partially in Java with minimal external dependencies.
2. We wrap this implementation into a Gradle plugin, so it can be used within automated builds. Details are given in the Gradle userguide[23]. (The Maven plugin is still under development).
3. Apply the *template-method-pattern*[24] to enable:
   - multiple checking algorithms. See the concept for checking algorithms,
   - both HTML (file) and text (console) output. See the reporting-concept.
4. Rely on standard Gradle and Groovy conventions for configuration, having a single configuration file.
   - For the Maven plugin, this might lead to problems.

[23] https://docs.gradle.org/current/userguide/userguide.html
[24] https://sourcemaking.com/design_patterns/template_method/

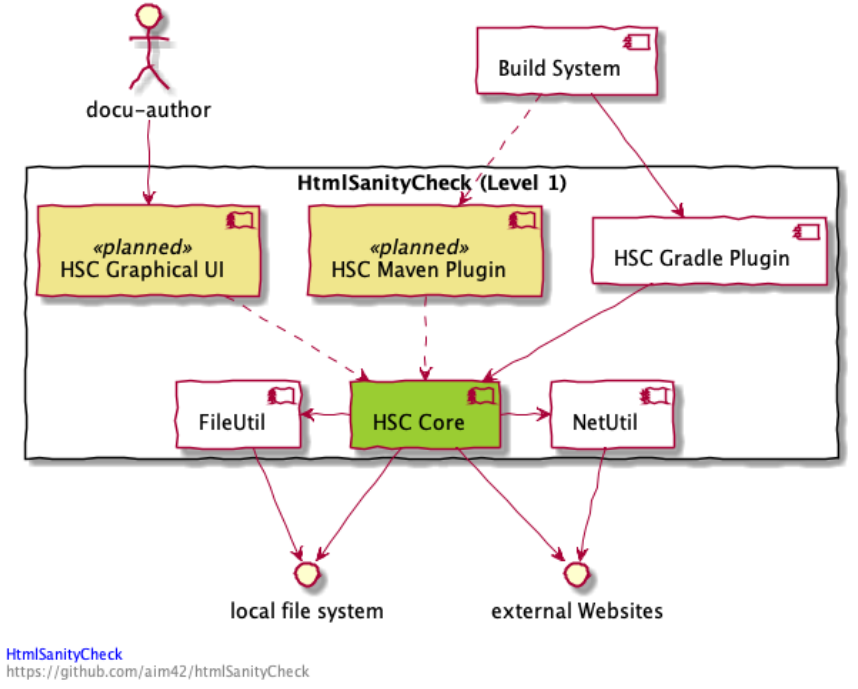
II.5 Building Block View

Content and Motivation

The building block view explains the static decomposition of the system into building blocks (modules, components, subsystems, packages…) and their relationships. It shows the overall structure of the source code.

This view is organized in a top-down hierarchy.

5.1 Whitebox HtmlSanityChecker



Whitebox (HtmlSC)

Rationale: We used *functional decomposition* to separate responsibilities:

- `HSC Core` shall encapsulate checking logic and HTML parsing/processing.
- `Plugins` and `GraphicalUI` encapsulate all *usage* aspects

Contained Blackboxes:

Building block	Description
`HSC Core`	HTML parsing and sanity checking
`HSC Gradle Plugin`	Exposes HtmlSC via a standard Gradle plugin, as described in the Gradle user guide[25]. Source: Package `org.aim42.htmlsanitycheck`, classes: `HtmlSanityCheckPlugin` and `HtmlSanityCheckTask`
`NetUtil`	package `org.aim42.inet`, checks for internet connectivity, configuration of http status codes
`FileUtil`	package `org.aim42.filesystem`, file extensions etc.
HSC Graphical UI	(planned, not implemented)

[25] https://docs.gradle.org/current/userguide/userguide.html

The full book contains a much more extensive description of the building blocks of HtmlSC…

II.6 Runtime View

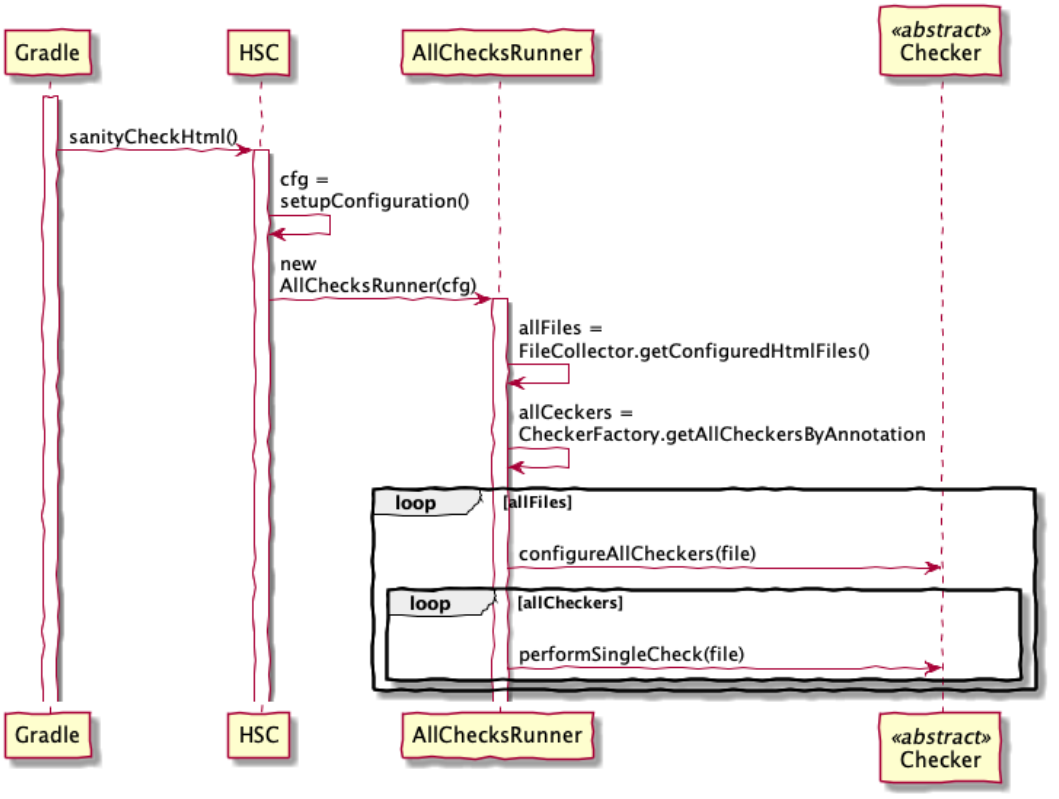
Content and Motivation

The runtime view shows behavior, interactions and runtime dependencies of the building blocks in form of concrete scenarios.

It helps you to understand *how* the building blocks of your systems fulfill their respective tasks at runtime, and *how* they communicate/interact with each other at runtime.

II.6.1 Execute all checks

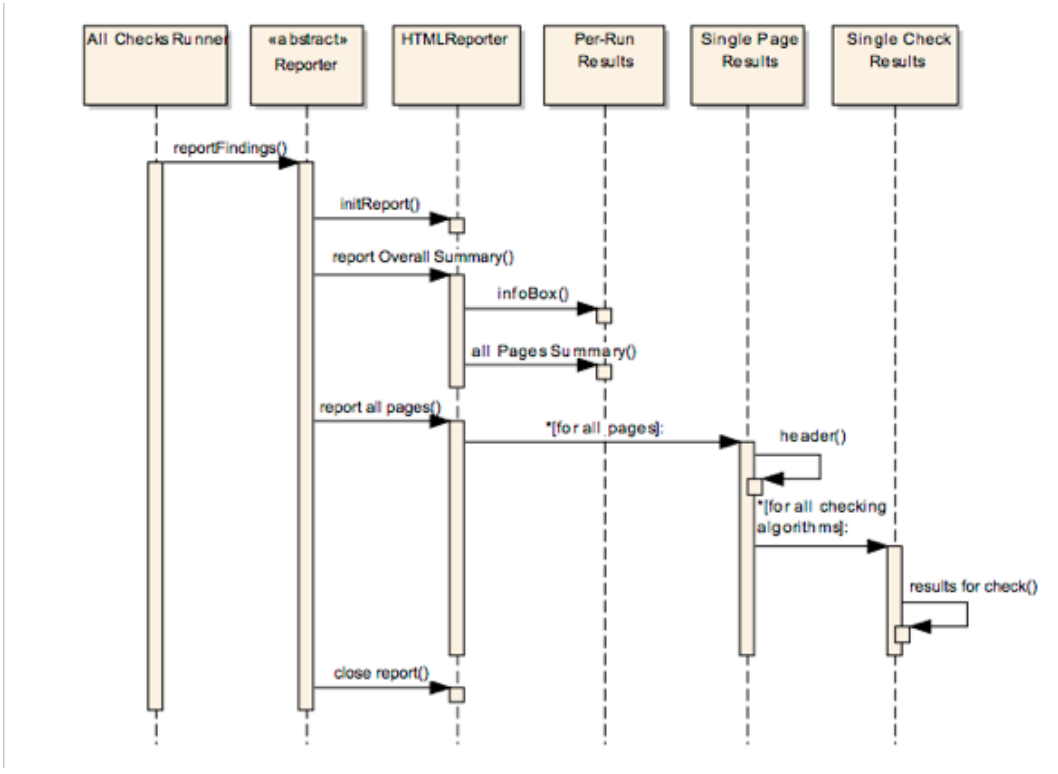
A typical scenario within HtmlSC is the execution of *all* available checking algorithms on a set of HTML pages.



Explanation:

1. User or build calls `htmlSanityCheck` build target.
2. Gradle (from within build) calls `sanityCheckHtml`
3. HSC configures input files and output directory
4. HSC creates an `AllChecksRunner` instance
5. gets all configured files into `allFiles`
6. (planned) get all available Checker classes based upon annotation
7. perform the checks, collecting the results

II.6.2 Report checking results



Sequence diagram: Report results

Reporting is done in the natural hierarchy of results (see the corresponding concept in section 8.2.1 for an example report).

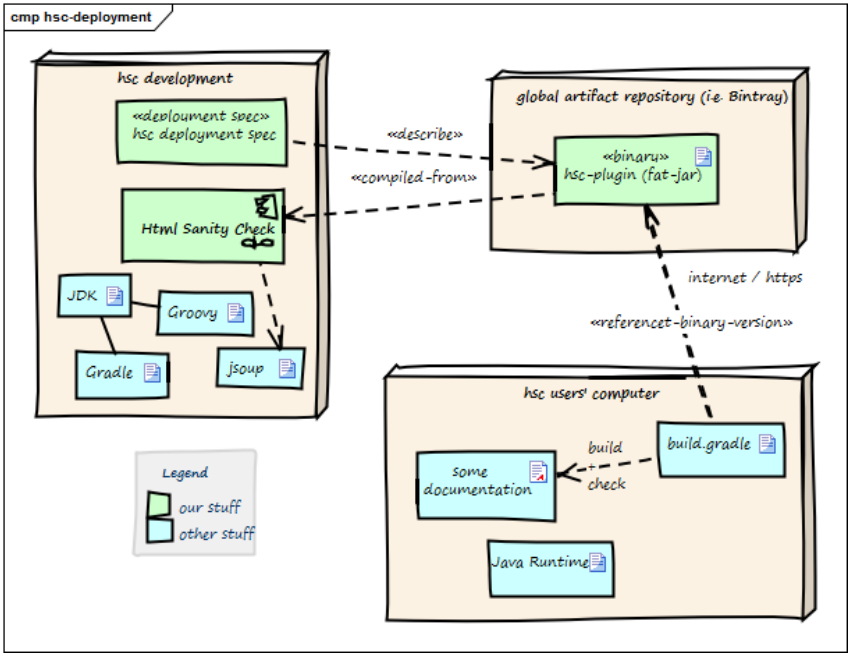
1. per "run" (`PerRunResults`): date/time of this run, files checked, some configuration info, summary of results
2. per "page" (`SinglePageResults`):
3. create page result header with summary of page name and results
4. for each check performed on this page create a section with `SingleCheckResults`
5. per "single check on this page" report the results for this particular check

II.7 Deployment view

Content and motivation

For stable operation, you need to know the technical infrastructure in which your system will run. This is especially important if your software is distributed or deployed on several different machines, application servers or containers.

Sometimes you need to know about different environments (e.g. development, test, production). For large commercial or web systems, aspects such as scalability, clustering, automatic provisioning, firewalls and load balancing also play an important role.



HtmlSC deployment (for use with Gradle)

Node / Artifact	Description
hsc plugin binary	Compiled version of HtmlSC, including required dependencies.
hsc-development	Development environment
artifact repository	Global public *cloud* repository for binary artifacts, similar to mavenCentral[26] HtmlSC binaries are uploaded to this server.
hsc user computer	Where documentation is created and compiled to HTML.
build.gradle	Gradle build script configuring (among other things) the HtmlSC plugin.

The three nodes (*computers*) shown in the diagram above are connected via Internet.

Prerequisites:

- HtmlSC developers need a Java development kit, Groovy, Gradle plus the JSoup HTML parser.
- HtmlSC users need a Java runtime (> 1.6) plus a build file named `build.gradle`. See below for a complete example.

Example for `build.gradle`

```
1  buildscript {
2      repositories {
3          mavenLocal()
4          maven {
5              url "https://plugins.gradle.org/m2/"
6          }
7      }
8      dependencies {
9          // in case of mavenLocal(), the following line is valid:
10         classpath(group: 'org.aim42',
11
12        // in case of using the official Gradle plugin repository:
```

[26] https://search.maven.org/

```
13          //classpath (group: 'gradle.plugin.org.aim42',
14        name: 'htmlSanityCheck', version: '1.0.0-RC-3')
15      }
16  }
17
18  plugins {
19      id 'org.asciidoctor.convert' version '1.5.8'
20  }
21
22
23  // ==== path definitions =====
24  ext {
25      srcDir = "$projectDir/src/docs/asciidoc"
26
27  // location of images used in AsciiDoc documentation
28      srcImagesPath = "$srcDir/images"
29
30  // (input for htmlSanityCheck)
31      htmlOutputPath = "$buildDir"
32
33      targetImagesPath = "$buildDir/images"
34  }
35
36  // ==== asciidoctor ==========
37  apply plugin: 'org.asciidoctor.convert'
38
39  asciidoctor {
40      outputDir = file(buildDir)
41      sourceDir = file(srcDir)
42
43      sources {
44          include "many-errors.adoc", "no-errors.adoc"  }
45
46      attributes = [
47              doctype     : 'book',
48              icons       : 'font',
```

```
49              sectlink    : true,
50              sectanchors: true ]
51
52      resources {
53          from(srcImagesPath) { include '**' }
54          into "./images"  }
55  }
56
57  // =======================================================
58  apply plugin: 'org.aim42.htmlSanityCheck'
59
60  htmlSanityCheck {
61      // ensure asciidoctor->html runs first
62      // and images are copied to build directory
63
64      dependsOn asciidoctor
65
66      sourceDir = new File("${buildDir}/html5")
67
68      // files to check, in Set-notation
69      sourceDocuments = ["many-errors.html", "no-errors.html"]
70
71      // fail the build if any error is encountered
72      failOnErrors = false
73
74      // set the http connection timeout to 2 secs
75      httpConnectionTimeout = 2000
76
77      ignoreLocalHost = false
78      ignoreIPAddresses = false
79  }
80
81  defaultTasks 'htmlSanityCheck'
```

III - Mass Market Customer Relationship Management

By Gernot Starke.

MaMa-CRM takes the burden of (usually paper-based) customer contacts from organizations working in mass markets, like insurance, credit-card providers, mobile telecommunication providers, energy and water providers or large real-estate companies (in MaMa speak these are called «Mandator»)

It has been initially ordered by an independent mid-sized data center to support the launch of the German (government-enforced) e-Health-Card - and later on used to support *campaigns* like telephone billing, electrical-power metering and similar stuff.

For every mandator, there is at least one completely independent MaMa-CRM instance running, which is specifically configured for its mandator and a campaign.

MaMa-CRM architecture documentation is quite heavy in the requirements part, describing several *aspects of flexibility* that triggered many central architecture decisions.

The team that built the system consisted of 7-10 persons working in 2-4 week iterations for about 15 months.

Me (Gernot Starke) had the honor to be part of that team in a responsible role. The original client allowed me to talk and write about the system without disclosing the company name. I was not allowed to use any of the original documentation or source code.

Thanx to Thorsten, Sven, Arno and a few unnamed other guys for great cooperation and a successful finish.

III.1 Introduction and Goals

This document describes the MaMa-CRM platform, a software product family to coordinate processes between mass-market-service-providers and their clients. MaMa-CRM provides the foundation for individual systems, which have to be customized or configured for specific CRM domains.

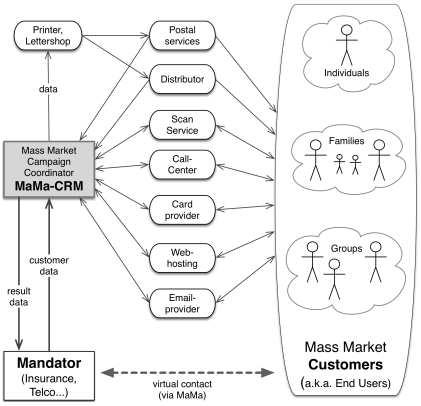
MaMa-CRM has been built and is being operated by an innovative datacenter (let's call it InDAC[27]) – a company providing a variety of hosted software services to its clients. Within business process outsourcing initiatives, InDAC is operating specific instances of MaMa-CRM for its customers.

Let's clarify MaMa-CRM's scope with a few brief examples (you'll find more details in the requirements overview):

- Telecommunication providers offer new or updated tariffs to their customers. These have several possibilities, like email, phone, letter or fax, to respond or issue support queries regarding such offers.
- Retail organizations send specific advertising or marketing material to certain parts of their customers. Again, these can react on several different communication channels. These kinds of advertisements are called *target group marketing*.
- Insurance companies propose modifications or enhancements of existing contracts to specific customer groups. Insured persons or organizations can react over different communication channels, like phone, mail, email or even in person. In case they accept this proposal, they have to submit a legally binding signature.

The following figure shows a generalized overview:

[27] The real company behind the MaMa-CRM system prefers not to be disclosed here. The name InDAC (= Innovative data center) is therefore pure fantasy. The original system wasn't called MaMa, but had a different name – I hope you don't mind.



MaMa - Generalized Overview

In that figure, the mandator represents an arbitrary company or organization serving mass market customers. MaMa, our system, can host CRM campaigns for many different mandators from different industries.

For an explanation of the terms campaign, activity, mandator and partner, please refer to the glossary in chapter 12

1.1 Requirements Overview

MaMa-CRM controls customer relationship CRM campaigns, which InDAC (the contractor of MaMa) conducts for his mandators. InDACs' mandators are companies like insurance or telco enterprises – which themselves offer services or products to mass market customers. These mandators outsource their CRM related business processes to InDAC.

MaMa-CRM shall support the following campaign types:

- Changes to tariffs or contracts for insurance companies, telecom and internet service providers and energy suppliers. You'll find a detailed example for this process below.
- Processing of billing information for call-by-call telephone service providers: Mandator submits billing data to MaMa, which coordinates printing, submission and support for the resulting invoices. Management or handling of payments is out-of-scope for MaMa-CRM.

- Management of binary images for credit card and insurance companies, which print cardholders' images onto the cards to prevent misuse. The German e-Health card belongs to this type.
- Meter reading for either energy or water providing companies or large-scale real-estate enterprises.

As MaMa is the foundation for a whole family of CRM systems, it shall be adaptable to a variety of different input and output interfaces and channels without any source code modification! This interface flexibility is detailed in section 1.1.2.

1.1.1 Campaign Example: Mobile Phone Contract Modification

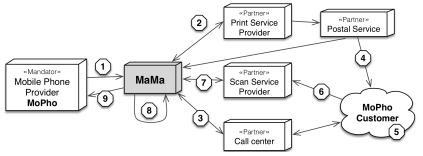
An example shall clarify the complex business and technical requirements to MaMa.

MoPho is a (hypothetical) mobile phone provider with a large customer base and a variety of different tariff options (flat fee, time-based, volume-based etc.). Some of these tariffs or tariff combinations are not marketable any longer (a shorthand for "MoPho does not earn its' desired profit from them… - but that's another story). Others are technically outdated.

In their ongoing effort to optimize their business, MoPho management decided to streamline their tariff landscape. Within a large campaign they contact every customer with outdated tariffs and offer upgrades to new and mostly more beneficial tariff options. Some customers get to pay less, but have to accept a longer contract duration. Others will have to pay a little more, but receive additional services, increased capacity, bandwidth or other benefits. In all cases where customers accept the new tariff offer, the formal contract between MoPho and the customer has to be updated, which requires a valid signature to be legally binding[28].

MoPho intends to inform certain customers via printed letters of the new tariff offerings. Customers can react via letter, fax, phone or in person at one of MoPho's many sales outlets. As MoPho's core competency are *phone services*, it doesn't want to bother with printing letters, scanning and processing replies, answering phone inquiries and dealing with other out-of-scope activities. Therefore they employ MaMa-CRM as an all-around carefree solution. Look at MaMa's approach to this scenario:

[28] In some countries or for some contract types there might be simpler solutions than a written signature. Please ignore that for the moment.



Telecommunication Example Scenario

The 9 steps depicted in that scenario need some explanation:

1. MoPho selects pertained customers from its internal IT systems. We're talking about a 30+ million customer base and approximately 10 million of those customers will be part of this campaign. MoPho exports their address-, contract- and tariff data and transmits these to MaMa-CRM. MaMa imports this customer data.
2. MaMa forwards only the relevant parts of customer data to the print service provider (a «Partner»). This company creates personalized letters from address and tariff data, prints those letters and finally delivers them to the postal service (which ensures the letters finally end up in customers' mailboxes).
3. MaMa now informs the call center (also a «Partner») participating in this campaign, so they can prepare for the customers reaction.
4. In the meantime the print service has delivered the letters to the postal service, which delivers letters to the customers. This is more difficult than it sounds: 1-5% of addresses tend to change within 12 month, depending on the customer base. Some customers refuse to accept marketing letters. The postal service informs MaMa about all the problematic cases (address unknown, forwarding request etc.), so MaMa can decide on further activities.
5. The customers decide what to do with the letter: There's a multitude of options here:
    - Customer fills out the enclosed reply form and signs it.
    - Customer fills out the reply form, but forgets to sign it.
    - Customer does not understand this offer and sends written inquiry by letter.
    - Customer inquires by phone call.
    - Customer ignores letter and does not react at all.
    - There are additional special cases (customer is not contractually capable, has a custodian or legal guardian, is under-age, deceased or temporarily unavailable…).

6. Let's assume the customer accepts and sends the letter back via postal service. These letters will be forwarded to the scan service provider (again, a «Partner»), which scans them and performs optical character recognition.
7. MaMa imports the scan-results from the scan service provider. Again, several cases are possible.
8. MaMa distinguishes between all possible cases and takes appropriate actions:
   - The form is completely filled and signed.
   - The form is completely filled, but customer forgot to sign.
   - Customer signed, but forgot to fill other important fields in the form…
   - If the form is not returned within an appropriate period of time, MaMa might decide to resend the letter, maybe even with a different wording, layout or even a different contractual offer.
   - Surely you can imagine several other possible options…
9. Finally, for every customer who accepted the changed tariff agreement, MaMa sends back the appropriate information, so the mandator MoPho can internally change the corresponding master data, namely contracts and tariffs and take all other required actions (activities in MaMa).

For the phone service provider MoPho, the primary advantage is the centralized interface to all customer interaction: All processes required to conduct this crucial campaign are handled by MaMa-CRM, without intervention by MoPho. Very practical for MoPho is the nearly unlimited flexibility of MaMa-CRM to import and export a variety of different data formats. This flexibility enables MaMa-CRM to easily incorporate new campaign partners (like a second scan service provider, an additional email-service provider or web hosting partner).

1.1.2 Campaign Configuration

MaMa provides the software foundation for *campaign instances* that have to be extensively configured to operate for a specific mandator with a number of specific partners.

The following section gives an overview of such a configuration for the MoPho campaign described in the previous section.

1.Configure client master data

Define and configure required data attributes and additional classes, usually this information is completely provided by the mandator.

This data (e.g. contract-, tariff-, offer- and other business-specific entities or attributes) are *modeled* as extensions of the MaMa base model in UML.

In the MoPho telecommunications example, this data includes:

- Existing tariff
- List of potential new tariffs
- Contract number
- Validity period of existing tariff
- Validity period of new tariff

2. Configure communication channels

- Define and exchange security credentials (passwords, certificates, user-ids).
- Determine contact address, especially for handling technical and process issues.

3. Define campaign meta data

- start- and end dates,
- target dates for specific activities,
- reply address for letters, reply email address,
- phone number for call center,

4. Define campaign activities

Campaign activities[29] can be either input-, output- and MaMa-internal activities.

- Output-activities *export* data to partners or the mandator, e.g:
  - PrintLetter
  - DataToCallCenter
  - DataToScanServiceProvider
  - ResultsToMandator

[29] See the MaMa-CRM Glossary for definitions of these term.

  - ProductionOrderToCardProvider
- Input-activities *import* data provided by the mandator or partners, e.g.:
  - MasterDataFromMandatorImport
  - ScanDataImport
  - CallCenterImport
  - SalesOutletImport
- Internal activities define data maintenance operations, e.g.:
  - Delete customer data 60 days after completion.
  - Delete all campaign data 120 days after campaign termination.

5. **Model campaign flows**

What is the required flow of activities, what needs to happen under which conditions (including plausibility checks).

1.1.3 Activities Subject to Charge

Some activities result in charges, for example:

- sending letters via postal service results in postal charges
- producing e-Health cards results in card production charges

As we are talking about potentially millions of clients respectively activities, these charges will amount to a significant flow of money:

MaMa-CRM does NOT handle billing and payment processes.

Instead these are handled parallel to MaMa-campaigns by InDACs' finance department[30].

[30] In the real system, billing and payment was usually processed by the mandators (!) - but these 3-party processes are not significant for the software architecture, and therefore left out of this documentation.

1.1.4 Additional Requirements

Status and Financial Reporting

MaMa has to campaign reports containing all campaign activities and their results (e.g. how many letters were printed, how many calls from clients were processes in the call center, how many clients sent their return letter etc.)

It's especially important to report about activities subject to a charge (aka having financial consequences). Although MaMa-CRM is not responsible for the resulting billing and payment processes, mandators and partners need reliable and trustworthy reports about such activities.

MaMa shall offer adequate standard reports covering these cases.

Client Data Belongs To Mandators

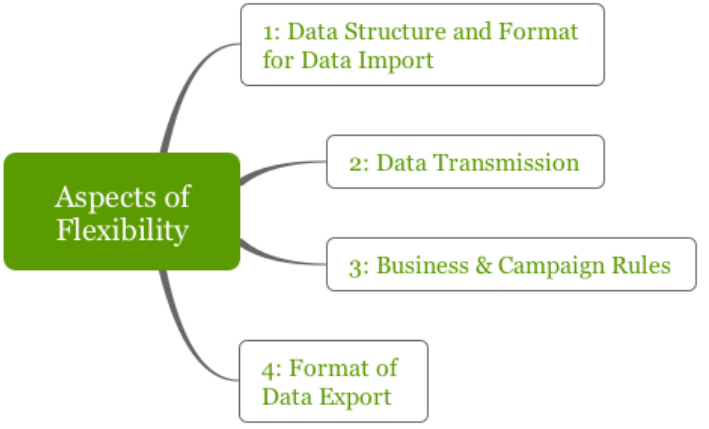
MaMa-CRM follows a very strict data protection policy: All data processes in campaigns is somehow related to clients and needs to be kept strictly confidential. Mandators always remain owners of all such data, from whatever partner it is transferred to MaMa by whatever activities.

After a campaign officially ends, all (!) data including backups, configurations, data and metadata needs to be deleted[31].

[31]Effectively this requirement forbade the use of the well-known version control systems "subversion" (svn), as by development time of MaMa-CRM, svn could not reliably *purge* files from version history! Therefore a campaign-spanning svn repository was not allowed.

1.2 Quality Goals

1.2.1 Flexibility First



Simply stated, MaMa is a data hub with flexibility in several aspects: It imports data (aspect 1) coming over various transmission channels (aspect 2) executes a set of specific business rules (aspect 3) to determine further activities to be performed with this data. Such activities consist of data exports (aspect 4) to certain business partners (like print-, scan- or fax service providers, call centers and the like).

MaMa has to be flexible concerning all these aspects.

Aspect 1: Flexibility in Data Structure and Format

MaMa always deals with variants of `client`data - the most simple version could look like an instance of the following class definition:

Generic Definition of Client Record

```
public class Client
  String primaryKey
  String lastName
  String firstName
  Date birthDate
  String title
  Address postalAddress
```

MaMa needs to import such data from various campaign partners. These partners operates their own IT systems with their own data formats. They will export the affected data records in some format (see below) of their choice. MaMa needs to handle many such formats:

- Comma separated value (CSV): attributes are separated by a (configurable) delimiter, e.g.: “id01”, “starke”, “gernot”, “23-jul-1963”, “willi-lauf”, “D-50858”, “cologne”, “germany”
- Field order and delimiter can vary.
- Elements could be enclosed in either “ or ‘ or even «».
- Fix length formats, where every data record has a fixed length. Shorter entries are padded with empty strings or zeroes.
- XML dialects, either conforming to an appropriate schema or DTD.

Regardless of format, data elements need to comply to validation or plausibility rules. Good news: No serialized objects from programming language runtimes (e.g. from a java virtual machine) have to be processed.

Aspect 2: Flexibility in Transmission Formats and Modes

MaMa needs to handle the following transmission-related aspects:

- Standard transmission protocols (ftp, sftp, http, https) as both client and server
- Compressed,
- Encrypted
- Creation of checksums, at least with counters, MD5 and SHA-1
- Mandator- or campaign specific credentials for secure transmission
- Transmission metadata, i.e.: Count the number of successful transmissions and send the number of the last successful transmissions as a prefix to the next transmission.

Aspect 3: Flexibility in Business / Campaign Rules

MaMa needs to support several categories of campaign rules (sometimes called business rules)

- What are required and possible activities in this campaign?
- In what order shall these activities be executed?
- Certain types of activities (especially data import activities) are sometimes triggered by «Partner» organizations. What kind of event triggers what activities?
- How often to remind clients/customers by letter?
- When to call clients/customers by phone?
- What data is mandatory from the customer and what is optional?
- How long to keep data records, when to delete or archive data records?
- Whom to contact when certain (data) conditions arise?

Aspect 4: Flexibility in Data Export

Now that MaMa has received and processed data (by import, transmission and rule processing), it needs to send data to the campaign partners. Analogous to data import, these receiving partners have very specific requirements concerning data formats.

It is pretty common for MaMa to receive data from a partner company or mandator in CSV format, import it into its own relational database, process it record-by-record, export some records in XML to one partner and some other records in a fix format to another partner.

1.2.2 Quality Goals (Scenarios)

Prio 1: Flexibility

MaMa-CRM can:

- import and export (configurable) CSV and fix-record-length data.
- import and export data via ftp, sftp, http and https, as client and server.
- handle compressed data. Compression algorithm is configurable per activity, standard lossless have to be supported.
- handle encrypted data. Security credentials need to be exchanged between parties prior to campaigns during campaign setup. PGP or derivatives are recommended.
- handle hashes or similar transmission metadata, configurable per campaign.

For all these topics, InDAC administrators can fully configure all campaign-specific aspects within one workday.

Prio 2: Security

MaMa will keep all its client and campaign related data safe. It shall never be possible for campaign-external parties to access data or metadata.

InDAC Administrators need to sign nondisclosure contracts to be allowed to administer campaign data. This organizational issue is out-of-scope for MaMa.

Prio 3: Runtime Performance

MaMa can fully process 250.000 scanned return letters within 24 hours.

1.2.3 Non-Goals (Out of Scope)

- MaMa shall be exclusively operated by InDAC. It shall not evolve into a marketable product.
- MaMa shall not replace conventional CRM systems, like Siebel™, salesforce.com™ or others.
- MaMa does not handle billing and payment of any charges generated by its activities, e.g. sending letters or others. See section 1.1.3

In the full book[a], MaMa-CRM is completely documented. Especially the architecture decisions and solution concepts that support the enormous flexibility may be worth a read :-)

[a] https://leanpub.com/arc42byexample

IV - biking2

By Michael Simons.

biking2 or “Michis milage” is primarily a web based application for tracking biking related activities. It allows the user to track the covered milage, collect GPS tracks of routes, convert them to different formats, track the location of the user and publish pictures of bike tours.

The secondary goal if this application is to have a topic to experiment with various technologies, for example Spring Boot on the server side and AngularJS, JavaFX and others on the client side.

As such biking2 has been around since 2009 and in it’s current Java based form since 2014. Defining production as full filling the primary goal it’s been in production ever since.

The project is published under *Apache License* on GitHub[32], use it however you like. Though I’ve been blogging regularly about this pet project, the documentation in its current form was created after I met Gernot and Peter at an awesome workshop in Munich.

[32] https://github.com/michael-simons/biking2

IV.4 Solution Strategy

At the core of *biking2* is a simple yet powerful domain model based on a few entities of which a “Bike” and it’s “Milage” are the most important.

Although data centric, the application resigns from using too much SQL for creating reports, summaries and such but tries to achieve that with new Java 8 features around streams, lambdas and map/reduce functions.

Building the application with Spring Boot is an obvious choice as one of the main quality goals is learning about it. But furthermore using Spring Boot as a “framework” for Spring Framework allows concentration on the business logic. On the one hand there is no need to understand a complex XML configuration and on the other hand all building blocks are still put together using dependency injection.

Regarding dependency injection and testability: All injection should be done via constructor injection, setter injection is only allowed when there’s no other technical way. This hopefully prevents centralized “god classes” that control pretty much every other aspect of the application.

Spring Boot applications can be packaged as single, “fat jar” files. Since Spring Boot 1.3 those files contain a startup script and can be directly linked to `/etc/init.d` on a standard Linux systems which serves TC4.

Interoperability will be achieved by using JSON over simple http protocol for the main API. Security is not the main focus of this application. It should be secure enough to prevent others from tempering with the data, confidentiality is not a main concern (read: passwords can be transmitted in plain over http).

The internal single page application shall be implemented using AngularJS. The deployable artifact will contain this application so there is no need for hosting a second webserver for the static files.

For real time tracking the MQTT protocol will be used which is part of Apache ActiveMQ, supported out of the box by Spring Messaging.

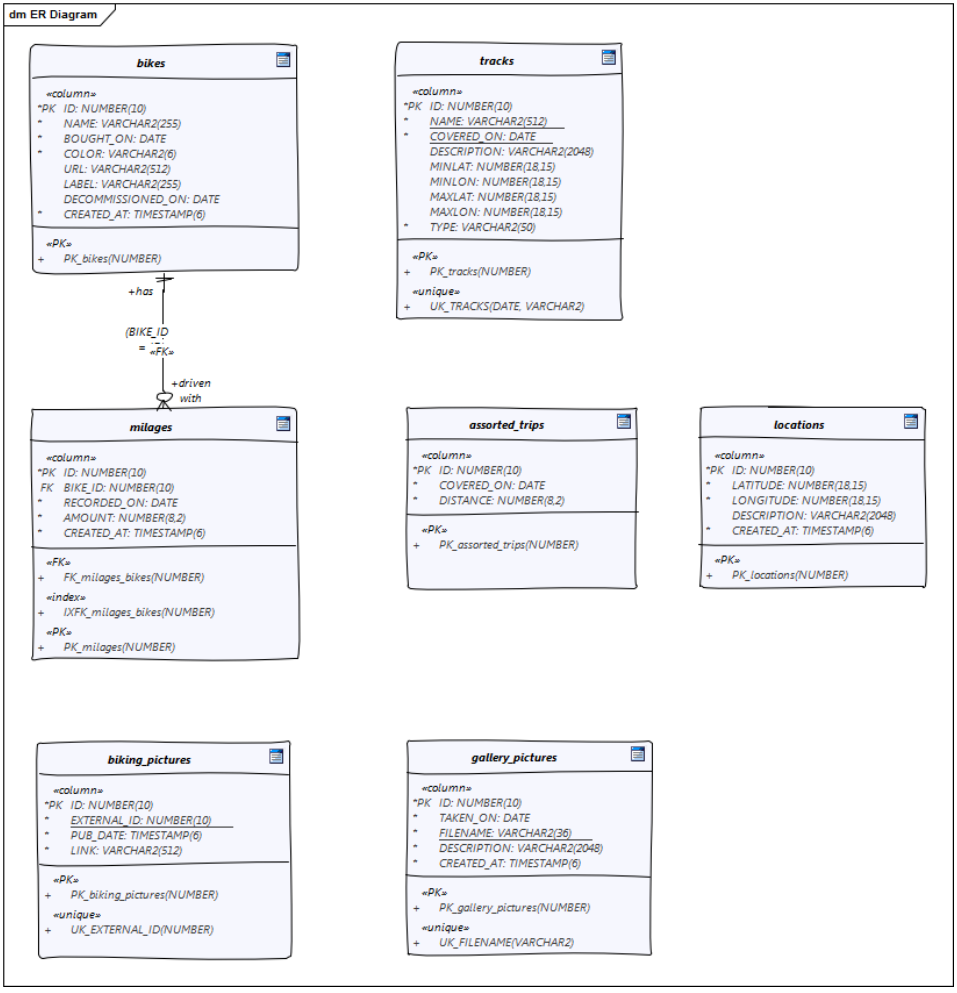
Graphing should not be implemented here but instead the Highcharts[33] library should be used. The configuration for all charts should be computed server side.

[33] https://www.highcharts.com

IV.8 Cross-cutting Concepts

Domain Models

biking2 is a datacentric application, therefore everything is based around those entities that manifest as tables.



Entities in biking2

Tables

Name	Description
bikes	Stores the bikes. Contains dates when the bike was bought and decomissioned, an optional link, color for the charts and also an auditing column when a row was created.
milages	Stores milages for a bike (when and how much).
tracks	Stores GPS tracks recorded and uploaded with an optional description. For each day the track names must be unique. The columns *minlat*, *minlon*, *maxlat* and *maxlon* store the encapsulating rectangle for the track. The *type* column is constrainted to “biking” and “running”.
assorted_trips	Stores a date and a distance on that day. Multiple distances per day are allowed.
locations	Stores arbitrary locations (latitude and longitude based) for given timestamp with an optional description.
biking_pictures	Stores pictures collected from *Daily Fratze* together with their original date of publication, their unique external id and a link to the page the picture originaly appeared.
gallery_pictures	Stores all pictures uploaded by the user with a description and the date the picture was taken. The *filename* column contains a single, computed filename without path information.

In the full book[a], each drawer of the arc42 cabinet is filled.

You’ll read more about the requirements and the constraints that have been put on the application as well as the full context.

Especially the full chapters 8 and 9 contains several interesting architecture decisions.

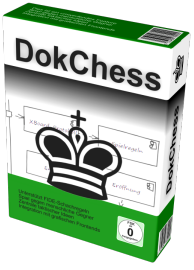
[a] https://leanpub.com/arc42byexample

V - DokChess

By Stefan Zörner.

> *"Someday computers will make us all obsolete."*
>
> Robert ("Bobby") Fisher, World Chess Champion 1972-1975, in 1975.

This chapter describes the architecture of the chess program *DokChess*. I originally created it as an example for presentations and training on software architecture and design. Later on, I implemented it in Java and refined it for a German book on documenting software architectures (see www.swadok.de[34]). The source code is available on GitHub and more information, including this architectural overview in both English and German, can be found on www.dokchess.de[35].



With the following architectural overview, you will be able to understand the important design decisions of DokChess. It shows the requirements relevant to the structure and design, basic solutions to problems, the structure of the software and the interaction of key elements. The outline of the content follows the arc42 template.

The target audience of this architectural overview is primarily software architects seeking advice and examples on how to document architecture appropriately.

Software developers who plan to create a chess program of their own receive valuable tips and learn about software architecture too.

[34] https://www.swadok.de
[35] https://www.dokchess.de

The full book[a] contains the documentation for this chess engine, optimized for *understandability* (not for execution speed or playing strength) Surely worth a read!!

[a] https://leanpub.com/arc42byexample

The Authors

Gernot Starke

Dr. Gernot Starke (innoQ[36] Fellow) is co-founder and longstanding user of the (open source) arc42[37] documentation template. For more than 20 years he works as software architect, coach and consultant, conquering the challenges of creating effective software architectures for clients from various industries.

In 2008 Gernot co-founded the International Software Architecture Qualification Board (iSAQB e.V.[38]) and since then supports it as an active member.

2014 he founded the (open source) Architecture Improvement Method aim42[39].

Gernot has authored several (German) books on software architecture and related topics.

Gernot studied computer science at the Institute of Technology in Aachen (RWTH Aachen) and finished with a Diploma. He then worked as a developer and consultant for smaller software companies, before coming back to university for international research on methodical software engineering. 1995 he received his PhD from Johannes Kepler University of Linz, Austria (Prof. Gerhard Chroust for his thesis on "Software Process Modeling".

He then joined Schumann AG in Cologne and did consulting and development work for several years. He became technical director of the "Object Reality Center", a joint-venture of Sun Microsystems and Schumann Consulting

[36] https://innoq.com
[37] https://arc42.org
[38] https://isaqb.org
[39] https://aim42.org

AG and lead the first European Java Project (the Janatol project for Hypobank in Munich).

Since then he has consulted and coached numerous clients from various domains, mainly finance, insurance, telecommunication, logistics, automotive and industry on topics around software engineering, software development and development process organization.

Gernot was an early adopter of the agile movement and has successfully worked as Scrum master in agile projects.

He lives in Cologne with his wife (*Cheffe Uli*) and his two (nearly grown-up) kids, two cats and a few Macs.

Email Gernot Starke[40] or contact him via Twitter @gernotstarke[41].

[40] mailto:gernot.starke@innoq.com?subject=arc42%20By%20Example
[41] https://twitter.com/gernotstarke

Michael Simons

Michael Simons is a father of two, husband, geek, programmer and passionate cyclist.

Michael took his apprenticeship at the FZ Jülich[42] and studies at FH Aachen: Campus Jülich. He is a PRINCE2 ® Registered Practitioner and sometimes torn between the roles of an architect and project manager. In 2018, he was announced a Java Champion.

Nowadays, Michael works as a Senior Software engineer at Neo4j[43] in the Spring Data team. In a previous life he worked at ENERKO INFORMATIK, an Aachen based company dealing with GIS system and has a background focussed on geographic information systems for utilities and price calculation at the energy market. In his brief time at INNOQ he helped customers modernize their application systems. Michael is known for having a certain passion for SQL and Spring. You can buy Michaels book about modern software development with Spring Boot here: here[44]

Michael is a dedicated blogger and engaged in various open source projects. You'll find his stuff starting at michael-simons.eu[45].

You can reach Michael via email[46] or on Twitter as @rotnroll666[47].

[42] https://www.fz-juelich.de/portal/DE/Home/home_node.html
[43] https://neo4j.com
[44] http://springbootbuch.de
[45] http://michael-simons.eu
[46] mailto:michael@simons.ac
[47] https://twitter.com/rotnroll666

Stefan Zörner

From the Bayer AG via IBM and oose to embarc. Stefan Zörner[48] has twenty years of experience in IT and still looks forward to the future with excitement. He supports clients in solving architecture and implementation problems. In interesting workshops he demonstrates how to use practical design tools as well as spreading enthusiasm for real life architectural work.

About embarc

Hamburg-based embarc[49] is your first choice for architectural projects. We are an independent consulting company, working creatively to find the best solution for you. Our customers trust us because we actively shape their systems, technologies and platforms as needed. This meets the long-term goal to gain optimum value from your IT investments.

Our team of consultants are generally recognized experts, with hands-on experience from various international projects. Technical and professional expertise, combined with efficient approaches are the leading characteristics of our architectural and engineering work.

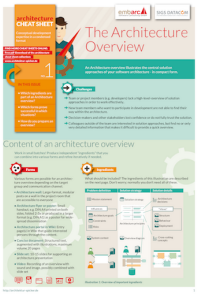
> *Document your software architecture decisions and principles effectively and thoroughly!*

Do you want to build a strong foundation for architecture documentation across your organization? Do you want to use a standardized template like e.g. arc42?

Architecture documentation isn't what you might think of first: baroque diagrams, large concepts, etc. Start your architectural overview with only a few basic 'ingredients'. Our cheat sheet[50] gives you a quick and helpful introduction.

[48] mailto:stefan.zoerner@embarc.de
[49] https://www.embarc.de
[50] https://www.embarc.de/architektur-spicker/

We also support you with specific coaching, workshops or initial presentations for documentation topics. Key benefits for your team:



- A common understanding of architecture decisions / concepts / solutions.
- Appropriate communication to different target audiences.
- A proper basis for discussions / reflection / architecture reviews.
- Get new team members efficiently up to speed.
- Learn from our best practices from many other projects.

Please find more information on our website[51].

[51] https://www.embarc.de/themen/dokumentation/

Ralf D. Müller

More than twenty years of experience in web development have shaped Ralf D. Müller[52]'s experience and thinking. And as trained Six Sigma Black Belt, the productivity of the whole is most important for him. That's why he dedicated much of his spare time to make the process to document a software project even easier. No question that the arc42 template is at the heart of this process. In addition, docToolchain[53] helps development and architecture teams to implement the Docs-as-Code[54] approach.

[52] mailto:ralf.d.mueller@docs-as-co.de
[53] https://github.com/docToolchain/docToolchain
[54] https://docs-as-co.de

Contacting the Authors

In case you have questions or suggestions concerning the examples, arc42 or software architecture stuff in general, please let us know.

Gernot Starke
: Just email Gernot Starke[55] or contact him via Twitter as @gernotstarke[56].

Hendrik Lösch
: Just email Hendrik Lösch[57] or contact him via his website hendrik-loesch.de[58].

Michael Simons
: Just email Michael Simons[59] or contact him via Twitter as @rotnroll666[60].

Ralf D. Müller
: Just email Ralf D. Müller[61] or contact him via Twitter: @RalfDMueller[62].

Stefan Zörner
: Just email Stefan Zörner[63] or contact him via Twitter: @StefanZoerner[64].

[55] mailto:gernot.starke@innoq.com?subject=arc42%20By%20Example
[56] https://twitter.com/gernotstarke
[57] mailto:mail@hendrik-loesch.de?subject=arc42%20By%20Example
[58] https://hendrik-loesch.de
[59] mailto:misi@planet-punk.de?subject=arc42%20By%20Example
[60] https://twitter.com/rotnroll666
[61] mailto:ralf.d.mueller@docs-as-co.de
[62] https://twitter.com/RalfDMueller
[63] mailto:stefan.zoerner@embarc.de
[64] https://twitter.com/StefanZoerner

Further Reading

If you liked the way we explained, communicated and documented software architectures, you might want to know more about arc42.

Communicating Software Architectures

This practical guide shows how you can effectively apply the practical and well-proven arc42 template to design, develop and document your software architecture.

It contains more than 200 practical tips how to improve your architecture communication and documentation:

- immediately actionable tips
- arc42 for practical software development
- effective communication and documentation of software architectures
- arc42 to construct, design and implement new systems
- arc42 to document existing system
- arc42 for { large | medium | small } systems

- tools for arc42: wikis, asciidoc, modeling tools an others
- frequently asked questions around arc42

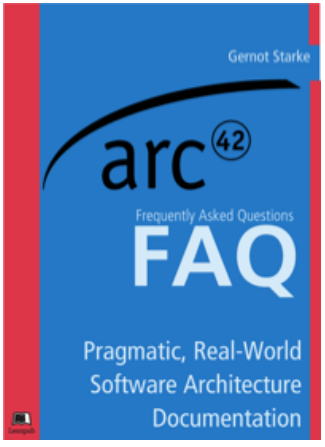
You find it on https://leanpub.com/arc42inpractice[65].

[65] https://leanpub.com/arc42inpractice

arc42 FAQ (Frequently Asked Questions)

More than 150 questions around arc42 topics - available for free as eBook and online[66].

NEW: FAQ has now a searchable public (free!) website at https://faq.arc42.org[67]



Contains questions in the following categories:

- General: Cost, license, contributing
- Methodology: minimal amount of documentation,where-does-what-info-belong, notations, UML
- arc42 sections: quality requirements, context,building blocks, runtime scenarios, deployment, concepts etc.
- Modelling: UML, diagrams, interfaces, ports, understandability, consistency, clarity
- arc42 and Agility: Scrum, Kanban, definition-of-done, minimal, lean, economical documentation
- Tools for arc42
- Versioning and variants: versioning documents, variants of systems
- Traceability: tracing requirements to solution decisions and vice-versa

[66] https://leanpub.com/arc42-faq/read
[67] https://faq.arc42.org

- Management: very large systems, standardization, governance, checklists, access-rights
- Customizing arc42: tailoring and customizing, known adaptions of arc42

Glossary of Software Architecture Terminology

An extensive (and free!) collection of terms used in software architecture. Created and maintained by the iSAQB e.V., the association for software architecture education.

In addition to definitions this eBook also contains translation tables, currently for German and English.

You find it on https://leanpub.com/isaqbglossary[68].

[68] https://leanpub.com/isaqbglossary

(German:) arc42 in Aktion

The German original of the previously mentioned eBook… for those who both understand German *and* like to hold books in their hands…

You get it at your local bookstore or online[69].

[69] https://www.amazon.de/arc42-Aktion-Praktische-Tipps-Architekturdokumentation/dp/3446448012