

Curriculum for
Certified Professional for
Software Architecture (CPSA)[®]

Foundation Level

2025.1-RC2-EN-20240917



Table of Contents

| | |
|--|----|
| List of Learning Goals | 2 |
| Introduction | 4 |
| What Does this Curriculum Contain | 4 |
| What Does a Foundation Level Training Convey? | 4 |
| Out of Scope | 5 |
| Prerequisites | 6 |
| Structure, Duration and Teaching Methods | 7 |
| Learning Goals and Relevance for the Examination | 8 |
| Current Version and Public Repository | 8 |
| 1. Basic Concepts of Software Architecture | 9 |
| Purpose | 9 |
| Relevant Terms | 9 |
| Learning Goals | 9 |
| References | 11 |
| 2. Requirements and Constraints | 12 |
| Purpose | 12 |
| Relevant Terms | 12 |
| Learning Goals | 12 |
| References | 14 |
| 3. Design and Development of Software Architectures | 15 |
| Purpose | 15 |
| Relevant Terms | 15 |
| Learning Goals | 15 |
| References | 20 |
| 4. Specification and Communication of Software Architectures | 21 |
| Purpose | 21 |
| Relevant Terms | 21 |
| Learning Goals | 21 |
| References | 23 |
| 5. Analysis and Assessment of Software Architectures | 24 |
| Purpose | 24 |
| Relevant Terms | 24 |
| Learning Goals | 24 |
| References | 25 |
| 6. Examples of Software Architectures | 26 |
| Learning Goals | 26 |
| References | 27 |

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List of Learning Goals

- LG 01-01: Discuss Definitions of Software Architecture (R1)
- LG 01-02: Understand and Explain the Goals and Benefits of Software Architecture (R1)
- LG 01-03 [ehemaliges LG 1-4]: Understand the Tasks and Responsibilities of Software Architects (R1)
- LG 01-04 [previously LG 1-09]: Distinction between Software Architecture and other Architectural Domains (R3)
- LG 01-05 [previously LG 01-05]: Relate the Role of Software Architects to Other Stakeholders (R1)
- LG 01-06: Importance and Design of Data Models (R2)
- LG 02-01: Understand Stakeholder Concerns (R1 - R3)
- LG 02-02 [previously LG 2-3]: Identify and Consider Requirements and Constraints (R1-R3)
- LG 02-03 [previously LG 4-1]: Understand and Explain Software System Qualities (R1)
- LG 02-04 [previously LG 04-03]: Formulate Requirements on Qualities (R1-R3)
- LG 02-05 [previously LG 1-08]: Prefer Explicit Statements over Implicit Assumptions (R1)
- LG 03-01 [previously LG 2-8, new content]: Fulfilling Requirements through Architecture (R1)
- LG 03-02 [previously LG 2-02]: Design Software Architectures (R1)
- LG 03-03 [previously LG 2-01]: Select and Use Approaches and Heuristics for Architecture Development (R1,R3)
- LG 03-04 [previously LG 2-06]: Explain and Use Design Principles (R1-R3)
- LG 03-05 [previously LG 1-06]: Correlation between Feedback Loops and Risks (R1, R2)
- LG 03-06 [previously LG 2-07]: Manage Dependencies between Building Blocks (R1)
- LG 03-07 [previously LG 2-09]: Design and Define Interfaces (R1-R3)
- LG 03-08 [previously LG 2-05]: Describe, Explain and Apply Important Architectural Patterns (R1, R3)
- LG 03-09 [previously LG 2-05]: Describe, Explain and Apply Important Design Patterns (R3)
- LG 03-10 [previously LG 2-04]: Identify, Design and Implement Cross-Cutting Concerns (R1)
- LG 03-11 [previously LG 2-10]: Know Fundamental Principles of Software Deployment (R3)
- LG 03-12 [previously LG 1-11]: Know the Challenges of Distributed Systems (R3)
- LG 04-01 [previously LG 3-01]: Explain and Consider the Requirements of Technical Documentation (R1)
- LG 04-02 [previously LG 3-02]: Describe and Communicate Software Architectures (R1-R3)
- LG 04-03 [previously LG 3-03]: Explain and Apply Notations/Models to Describe Software Architecture (R2-R3)
- LG 04-04 [new]: Learning Goal not Found (R3)
- LG 04-05 [previously LG 3-04]: Explain and Use Architectural Views (R1)
- LG 04-06 [previously LG 3-07]: Document Interfaces (R1)
- LG 04-07 [previously LG 3-06]: Document and Communicate Cross-Cutting Concerns (R2)
- LG 04-08 [previously LG 3-08]: Explain and Document Architectural Decisions (R1-R2)

- LG 04-09 [previously LG 3-09]: Know Additional Resources and Tools for Documentation (R3)
- LG 05-01: Know the Reasons for Architecture Analysis (R1)
- LG 05-02 [previously LG 4-3 and 4-4]: Analyze the Qualities of a Software System (R1, R3)
- LG 06-01: Know the Relation between Requirements, Constraints, and Solutions (R3)
- LG 06-02: Understand the technical implementation of a solution (R3)

Introduction

What Does this Curriculum Contain

This curriculum for the Certified Professional for Software Architecture – Foundation Level (CPSA-F) outlines the essential learning goals that should be mastered to take up the role of software architect.

It is structured along the fundamental activities and responsibilities of software architecture as a role:

- Clarifying stakeholder requirements and constraints
- Designing and developing software architectures, thereby taking structural and conceptual decisions
- Communicating and documenting the architecture for various stakeholders
- Analyzing and assessing software architectures

What Does a Foundation Level Training Convey?

Licensed Certified Professional for Software Architecture – Foundation Level (CPSA-F) trainings will provide participants with the knowledge and skills required to design, specify and document a software architecture adequate to fulfil the respective requirements for small and medium-sized systems. Based upon their individual practical experience and existing skills participants will learn to derive architectural decisions from an existing system vision and adequately detailed requirements. CPSA-F trainings teach methods and principles for design, documentation and evaluation of software architectures, independent of specific development processes.

Focus is education and training of the following skills:

- discuss and reconcile fundamental architectural decisions with stakeholders from requirements, management, development, operations and test
- understand the essential activities of software architecture, and carry out those for small- to medium sized systems
- document and communicate software architectures based upon architectural views, architecture patterns and technical concepts.

In addition, such trainings cover:

- the term software architecture and its meaning
- the tasks and responsibilities of software architects
- the roles of software architects within development projects
- state-of-the-art methods and techniques for developing software architectures.

Out of Scope

This curriculum reflects the contents currently considered by the iSAQB members to be necessary and useful for achieving the learning goals of CPSA-F. It is not a comprehensive description of the entire domain of 'software architecture'.

The following topics or concepts are not part of CPSA-F:

- specific implementation technologies, frameworks or libraries
- programming or programming languages
- specific process models
- fundamentals of modelling notations (such as UML) or fundamentals of modelling itself
- system analysis and requirements engineering (please refer to the education and certification program by IREB e. V., <https://ireb.org>, International Requirements Engineering Board)
- software testing (please refer to the education and certification program by ISTQB e.V., <https://istqb.org>, International Software Testing Qualification Board)
- project or product management
- introduction to specific software tools.

The aim of the training is to provide the basics for acquiring the advanced knowledge and skills required for the respective application.

Prerequisites

The iSAQB e. V. may check the following prerequisites in certification examinations via corresponding questions.

Participants should have the following knowledge and/or experience. In particular, substantial practical experience from software development in a team is an important prerequisite for understanding the learning material and successful certification.

- more than 18 months of practical experience with software development, gained through team-based development of several systems outside of formal education
- knowledge of and practical experience with at least one higher programming language, especially:
 - concepts of
 - modularization (packages, namespaces, etc.)
 - parameter-passing (*call-by-value*, *call-by-reference*)
 - *scope*, i.e. of type and variable declaration and definition
 - basics of type systems (static vs. dynamic typing, generic data types)
 - error and exception handling in software
 - potential problems of global state and global variables
- Basic knowledge of:
 - modelling and abstraction
 - algorithms and data structures (i.e. Lists, Trees, HashTable, Dictionary, Map)
 - UML (class, package, component and sequence diagrams) and their relation to source code
 - approaches to testing of software (e.g. unit- and acceptance testing)

Furthermore, the following will be useful for understanding several concepts:

- basics and differences of imperative, declarative, object-oriented and functional programming
- practical experience in
 - a higher level programming language
 - designing and implementing distributed applications, such as client-server systems or web applications
 - technical documentation, especially documenting source code, system design or technical concepts

Structure, Duration and Teaching Methods

Study times given in the following sections of the curriculum are just recommendations. The duration of a training course should be at least three days, but may as well be longer. Providers may vary in their approach to duration, teaching methods, the type and structure of exercises as well as the detailed course outline. The types (domains and technologies) of examples and exercises can be determined individually by training providers.

| Content | Recommended Duration (min) |
|--|----------------------------|
| 1. Basic Concepts of Software Architecture | 120 |
| 2. Requirements and Constraints | 60 |
| 3. Design and Development | 420 |
| 4. Specification and Communication | 240 |
| 5. Analysis and Assessment | 60 |
| 6. Examples | 90 |
| Total | 990 |

Learning Goals and Relevance for the Examination

The structure of the curriculum's chapters follows a set of prioritized learning goals. For each learning goal, relevance for the examination of this learning goal or its sub-elements is clearly stated (by the R1, R2, R3 classification, see the table below). Every learning goal describes the contents to be taught including their key terms and concepts.

Regarding relevance for the examination, the following categories are used in this curriculum:

| ID | Learning-goal category | Meaning | Relevance for examination |
|----|------------------------|--|--|
| R1 | Being able to | These are the contents participants will be expected to be able to put into practice independently upon completion of the course. Within the course, these contents will be covered through exercises and discussions. | Contents will be part of the examination. |
| R2 | Understanding | These are the contents participants are expected to understand in principle. They will normally not be the primary focus of exercises in training. | Contents may be part of the examination. |
| R3 | Knowing | These contents (terms, concepts, methods, practices or similar) can enhance understanding and motivate the topic. They may be covered in training if required. | Contents will not be part of examination. |

If required, the learning goals include references to further reading, standards or other sources. The sections "Terms and Concepts" of each chapter list words that are associated with the contents of the chapter. Some of them are used in the descriptions of learning goals.

Current Version and Public Repository

You find the most current version of this document on the official [download page](https://isaqb-org.github.io/) on <https://isaqb-org.github.io/>.

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Chapter 1. Basic Concepts of Software Architecture

| | |
|--------------------|-----------------|
| Duration: 120 min. | Exercises: none |
|--------------------|-----------------|

Purpose

The purpose of this section is to equip training participants with a foundational understanding of key terms and concepts in software architecture. They become familiar with various definitions and their commonalities, understand the essential goals and benefits of software architecture and can communicate these to other stakeholders. Furthermore, they will be able to name and explain the most important tasks and responsibilities of software architects. Additionally, the section explores the role of software architects in the broader architectural context and their interactions with other stakeholders, preparing participants to effectively contribute to diverse software development projects.

Relevant Terms

[Software architecture](#); architecture domains; [structure](#); [building blocks](#); [components](#); [interfaces](#); [relationships](#); [cross-cutting-concerns](#); software architects and their responsibilities; tasks and required skills; stakeholders and their concerns; requirements; [constraints](#); influencing factors; types of IT systems (embedded systems; real-time systems; information systems etc.)

Learning Goals

LG 01-01: Discuss Definitions of Software Architecture (R1)

Software architects know the commonalities of many definitions of software architecture [\[ISO 42010\]](#) [\[Bass+ 2021\]](#) [\[Kruchten 2004\]](#):

- components/building blocks with interfaces and relationships
- building blocks as a general term, components as a special form thereof
- structures, cross-cutting concerns, principles
- architecture decisions and their consequences on the entire systems and its lifecycle

LG 01-02: Understand and Explain the Goals and Benefits of Software Architecture (R1)

Software architects can justify the following essential goals and benefits of software architecture:

- support the design, implementation, maintenance, and operation of systems
- achieve functional requirements or ensure that they can be met
- achieve requirements such as reliability, maintainability, changeability, security, energy efficiency etc.
- ensure that the system's structures and concepts are understood by all relevant stakeholders
- systematically reduce complexity
- specify architecturally relevant guidelines for implementation and operation

LG 01-03 [ehemaliges LG 1-4]: Understand the Tasks and Responsibilities of Software Architects (R1)

Software architects are responsible for meeting requirements and creating the architecture design of a solution. Depending on the actual approach or process model used, they must align this responsibility with the overall responsibilities of project management and/or other roles.

Tasks and responsibilities of software architects:

- clarify and scrutinize requirements and constraints, and refine them if necessary, including *required features* and *required constraints*
- decide how to decompose the system into building blocks, while determining dependencies and interfaces between the building blocks
- decide on cross-cutting concerns (for instance persistence, communication, GUI etc.)
- communicate and document software architecture based on views, architectural patterns, cross-cutting concerns, and technical concerns
- accompany the realization and implementation of the architecture; integrate feedback from relevant stakeholders into the architecture if necessary; review and ensure the consistency of source code and software architecture
- analyze and evaluate software architecture, especially with respect to risks that involve meeting the requirements.
- identify, highlight, and justify the consequences of architectural decisions to other stakeholders

They should independently recognize the necessity of iterations in all tasks and point out possibilities for appropriate and relevant feedback.

LG 01-04 [previously LG 1-09]: Distinction between Software Architecture and other Architectural Domains (R3)

The focus of the iSAQB CPSA Foundation Level is on structures and concepts of individual software systems.

In addition, software architects are familiar with other architectural domains, for example:

- enterprise IT architecture: Structure of application landscapes
- business and process architecture: Structure of, among other things, business processes
- information architecture: cross-system structure and use of information and data
- data architecture: semantics and organization of data
- infrastructure or technology architecture: Structure of the technical infrastructure, hardware, networks, etc.
- hardware or processor architecture (for hardware-related systems)
- system architecture (can have various semantics, depending on the definition of "system")

These architectural domains are not the content focus of CPSA-F.

LG 01-05 [previously LG 01-05]: Relate the Role of Software Architects to Other Stakeholders (R1)

Software architects are able to explain their role. They should adapt their contribution to a software development in a specific context and in relation to other stakeholders and organizational units, in particular to:

- product management and product owners
- project managers

- requirement engineers (requirements- or business analysts, requirements managers, system analysts, business owners, subject-matter experts, etc.)
- developers
- quality assurance and testers
- IT operators and administrators (applies primarily to production environment or data centers for information systems),
- hardware developers
- enterprise architects and architecture board members

LG 01-06: Importance and Design of Data Models (R2)

Software architects understand the importance of data models for the architecture. They

- can identify data models that have significant impact on the architecture.
- can design such data models systematically.
- understand the difference between products and sums in data modelling.
- understand the importance of decoupling data models from their representation in databases, files, and transmission protocols.

References

[\[Bass+ 2021\]](#), [\[Gharbi+2024\]](#), [\[iSAQB References\]](#), [\[Starke+2021\]](#), [\[Starke 2024\]](#), [\[vanSteen+Tanenbaum\]](#), [\[Felleisen+2014\]](#), [\[Sperber+Klaeren\]](#)

Chapter 2. Requirements and Constraints

Duration: 60 min.

Exercises: 60 min.

Purpose

This section deepens participants' understanding of stakeholder concerns, requirements, and system qualities in software architecture. Participants learn to identify stakeholders and their influence on architectural decisions, discerning conflicts and synergies in the context of development projects. By exploring diverse requirements and constraints, they gain insight into effectively addressing stakeholders' needs and project constraints. Additionally, they recognize the significance of software system qualities as drivers for architectural design. They can formulate such requirements using scenarios.

Relevant Terms

Quality; quality characteristics (also called quality attributes); DIN/ISO 25010; Q42; quality scenarios

Learning Goals

LG 02-01: Understand Stakeholder Concerns (R1 - R3)

Architects can identify stakeholders and their concerns, as well as their impact on the software architecture or the design and development process. (R2)

Examples of stakeholders and concerns (R3):

| Stakeholder | Stakeholder Concern |
|---------------------------------------|--|
| product management and product owners | e.g., required time for the implementation of the requirements |
| project managers | e.g., required time and budget for the implementation, associated risks of the chosen architectural approach |
| requirement engineers | e.g., fulfillment of the requirements |
| developers | e.g., components and interfaces to be implemented, protocols, technology constraints |
| quality assurance and testers | e.g., isolated testing of components |
| operations | e.g., infrastructure requirements related to operating the system |

Software architects can explain potential conflicts between short-term and long-term goals, in order to resolve potential conflicts (e.g., business and project goals vs. architecture and maintainability goals). (R1)

Architects understand that not all stakeholder concerns can or will be translated into requirements, but may nevertheless need to be considered. (R3)

Architects can use stakeholder concerns to discover missing or conflicting requirements and/or validate requirements and constraints on the architecture, e.g., in stakeholder interviews. (R3)

LG 02-02 [previously LG 2-3]: Identify and Consider Requirements and Constraints (R1-R3)

Software architects understand that both requirements and constraints can have an impact on the

architecture and the architecture work (R2). They are able to clarify requirements and constraints and take them into account in the architectural design and development process. They know that their decisions can lead to additional requirements.

They should recognize and account for the impact of:

- product-related requirements such as (R1)
 - functional requirements
 - quality requirements
- technological constraints such as
 - existing or planned hardware and software infrastructure (R1)
 - technological constraints on data structures and interfaces (R2)
 - reference architectures, libraries, components, and frameworks (R1)
 - programming languages (R2)
- organizational constraints such as
 - organizational structure of the development team and of the customer (R1), in particular Conway's law (R2).
 - company and team cultures (R3)
 - partnerships and cooperation agreements (R2)
 - standards, guidelines, and process models (e.g. approval and release processes) (R2)
 - available resources like budget, time, and staff (R1)
 - availability, skill set, and commitment of staff (R1)
- regulatory constraints such as (R2)
 - local and international legal constraints
 - contract and liability issues
 - data protection and privacy laws
 - compliance issues or obligations to provide burden of proof
- trends such as (R3)
 - market trends
 - technology trends (Blockchain, Microservices)
 - methodology trends (Agile)

Software architects are able to describe how those factors can influence design decisions and can elaborate on the consequences of changing influencing factors by providing examples for some of them (R2).

LG 02-03 [previously LG 4-1]: Understand and Explain Software System Qualities (R1)

Software architects can explain:

- that the term "quality" is used differently in different contexts - referring to "excellence" in the context of quality management, and referring to a specific property (of a software system) in others (and in

this section)

- that several taxonomies categorizing qualities of software systems exist (such as [\[ISO 25010\]](#), [\[Bass+ 2021\]](#), or [\[Q42\]](#))
- that some categorizations distinguish between functionality and quality
- that software architecture can impact a software system's qualities,
- that impacting one quality can impact others, necessitating trade-offs, such as:
 - configurability versus reliability
 - memory requirements versus performance efficiency
 - security versus usability
 - runtime flexibility versus maintainability.

They understand that

- some categorizations distinguish between "quality requirements" and functional requirements, e.g. IREB [\[IREB Foundation\]](#) (R1)
- a single requirement might pertain to several qualities (R1)

LG 02-04 [previously LG 04-03]: Formulate Requirements on Qualities (R1-R3)

Software architects:

- can formulate scenarios for given qualities containing context, stimulus, and reaction or method of measurement (R1)
- understand that a requirement for a given quality should specify a method of analysis (see [LG 05-02 \[previously LG 4-3 and 4-4\]: Analyze the Qualities of a Software System \(R1, R3\)](#)) (R1)
- know that the use of a metric as a target can lead to its invalidation (R2), as described, e.g., by Goodhart's law (R3)

LG 02-05 [previously LG 1-08]: Prefer Explicit Statements over Implicit Assumptions (R1)

Software architects:

- know that implicit assumptions can lead to misunderstandings between stakeholders
- assumptions should be made explicit

References

[\[Bass+ 2021\]](#), [\[Clements+ 2002\]](#), [\[Gharbi+2024\]](#), [\[Starke+2021\]](#), [\[Starke 2024\]](#)

Chapter 3. Design and Development of Software Architectures

| | |
|--------------------|--------------------|
| Duration: 330 min. | Exercices: 90 min. |
|--------------------|--------------------|

Purpose

This section aims to enable participants to take architectural decisions in a way that fulfills stakeholder requirements while respecting the given constraints of the system context. They will learn to develop architectural designs, make informed decisions on system decomposition and shape dependencies between building blocks. To this end, they learn to apply basic approaches and heuristics in architecture development. They recognize the importance of design principles and solution patterns and are able to apply them. In addition, this section addresses the management of cross-cutting concerns, the principles of software deployment and the challenges of distributed systems.

Relevant Terms

Design; design approach; design decision; views; [interfaces](#); technical and [cross-cutting concerns](#); architectural patterns; pattern languages; design principles; dependencies; coupling; cohesion; top-down and bottom-up approaches; model-based design; iterative/incremental design; domain-driven design

Learning Goals

LG 03-01 [previously LG 2-8, new content]: Fulfilling Requirements through Architecture (R1)

Software architects:

- understand that architectural activities should be driven by the need to improve specific qualities
- can propose an architecture design suitable for fulfilling requirements
- can assess which qualities they improve through a specific architectural activity
- can identify and communicate possible trade-offs between designs and their associated risks

LG 03-02 [previously LG 2-02]: Design Software Architectures (R1)

Software architects are able to:

- design and appropriately communicate and document software architectures based upon known functional and quality requirements for software systems that are neither safety- nor business-critical
- make structure-relevant decisions regarding system decomposition and building-block structure and deliberately design dependencies between building blocks
- recognize and justify interdependencies and trade-offs of design decisions
- explain the terms *black box* and *white box* and apply them purposefully
- apply stepwise refinement and specify building blocks
- design architecture views, especially building-block view, runtime view and deployment view
- explain the consequences of these decisions on the corresponding source code
- separate technical and domain-related elements of architectures and justify these decisions
- identify risks related to architecture decisions.

LG 03-03 [previously LG 2-01]: Select and Use Approaches and Heuristics for Architecture Development (R1,R3)

Software architects are able to name, explain, and use fundamental approaches of architecture development, for example:

- top-down and bottom-up approaches to design, see [Gharbi+2024], [Starke 2024] (R1)
- view-based architecture development, see [Rozanski+11], [Kruchten 1995] (R1)
- domain-driven design, see [Evans 2004] (R3)
- evolutionary architecture, see [Ford 2017] (R3)
- global analysis, see [Hofmeister et. al 1999] (R3)
- model-driven architecture (R3)

LG 03-04 [previously LG 2-06]: Explain and Use Design Principles (R1-R3)

Software architects are able to explain what design principles are. They can outline their general objectives and applications with regard to software architecture. (R2)

Software architects are able to:

- explain the design principles listed below and can illustrate them with examples
- explain how those principles are to be applied
- explain how the requirements determine which principles should be applied
- explain the impact of design principles on the implementation
- analyze source code and architecture designs to evaluate whether these design principles have been applied or should be applied

Abstraction (R2)

- in the sense of a means for deriving useful generalizations
- as a design technique, where building blocks are dependent on the abstractions rather than depending on implementations
- interfaces as abstractions

Modularization (R1-R3)

- information hiding and encapsulation (R1)
- separation of concerns - SoC (R1)
- loose, but functionally sufficient, coupling (R1) of building blocks
- high cohesion (R1)
- Open/closed principle (R1)
- Dependency inversion principle (R1) by means of interfaces or similar abstractions

Conceptual integrity (R2)

- meaning uniformity (homogeneity, consistency) of solutions for similar problems (R2)

- as a means to achieve the principle of least surprise (R3)

Complexity reduction (R3)

- as the driving factor behind KISS, YAGNI, and CUPID [[Terhorst-North 2022](#)]

Expect errors (R2-R3)

- as a means to design for robust and resilient systems (R3)
- as a generalization of the robustness principle (*Postel's law*) (R2)

LG 03-05 [previously LG 1-06]: Correlation between Feedback Loops and Risks (R1, R2)

Software architects understand the necessity of iterations, especially when decision-making is affected by uncertainties. They

- are able to explain the influence of iterative approaches on architectural decisions (with regard to risks and predictability). (R1)
- can work and make decisions incrementally and iteratively. (R1)
- understand the necessity for feedback on design decisions. (R1)
- can systematically obtain feedback from other stakeholders. (R2)

LG 03-06 [previously LG 2-07]: Manage Dependencies between Building Blocks (R1)

Software architects understand dependencies and coupling between building blocks and can use them in a targeted manner. They:

- know and understand different types of dependencies of building blocks (e.g. coupling via use/delegation, messaging/events, composition, creation, inheritance, temporal coupling, coupling via data, data types or hardware)
- understand how dependencies increase coupling
- can differentiate between at least the following categories of coupling:
 - static and dynamic coupling [[Ford+2021](#)]
 - efferent and afferent coupling [[Ford+2021](#)]
 - other types of coupling (e.g. hardware/infrastructure, temporal, data, data structure etc.)
- know that forgoing static dependencies in favor of dynamic dependencies does not necessarily reduce the underlying coupling
- can use such types of coupling in a targeted manner and can assess the consequences of such dependencies
- know and can apply possibilities to reduce or eliminate coupling, for example:
 - patterns
 - fundamental design principles
 - externalization of dependencies, i.e. defining concrete dependencies at installation- or runtime, for example by using [Dependency Injection](#).

LG 03-07 [previously LG 2-09]: Design and Define Interfaces (R1-R3)

Software architects know about the importance of interfaces. They are able to design or specify interfaces between architectural building blocks as well as external interfaces between the system and elements outside of the system.

They know:

- desired characteristics of interfaces and can use them in the design:
 - easy to learn, easy to use, easy to extend
 - hard to misuse
 - functionally complete from the perspective of users or building blocks using them.
- the necessity to treat internal and external interfaces differently
- the distinction between interface and implementation:
 - implementations can be exchanged if required.
 - Liskov's substitution principle [Liskov 1994] as a way to achieve consistency and conceptual integrity (R3).
- different approaches for implementing interfaces (R3):
 - resource oriented approach (REST, Representational State Transfer)
 - service oriented approach (see WS-*/SOAP-based web services.

LG 03-08 [previously LG 2-05]: Describe, Explain and Apply Important Architectural Patterns (R1, R3)

Software architects can explain and provide examples for the following architectural patterns (R1):

- [Layer](#)
- [Pipes and Filters](#)
- [Microservice](#)

Software architects can explain several of the following architectural patterns, explain their relevance for concrete systems, and provide examples. (R3)

- [Blackboard](#)
- [Broker](#)
- [CQRS \(Command-Query-Responsibility-Segregation\)](#)
- [Event sourcing](#)
- Integration and messaging patterns (e.g. from [Hohpe+2004])
- [MVC](#) (Model View Controller), [MVVM](#) (Model View ViewModel), [MVU](#) (Model View Update), [PAC](#) (Presentation Abstraction Control)
- [Plugin](#)
- [Ports and Adapters](#) (synonyms: Onion Architecture, Hexagonal Architecture, Clean Architecture)
- [SOA](#) (Service-Oriented Architecture)

Software architects know essential sources for architectural patterns, such as POSA (e.g. [Buschmann+1996]) and PoEAA ([Fowler 2002]) (for information systems). (R3)

LG 03-09 [previously LG 2-05]: Describe, Explain and Apply Important Design Patterns (R3)

Software architects know the difference between architectural and design patterns. They can explain several of the following design patterns, explain their relevance for concrete systems, and provide examples. (R3)

- [Combinator](#)
- Interfacing patterns like [Adapter](#), [Facade](#), and [Proxy](#). Architects should know that these patterns can be used independently of a particular programming language or framework.
- [Interpreter](#)
- [Observer](#)
- [Remote procedure call](#)
- [Template Method](#) and [strategy](#)
- [Visitor](#)

Software architects know essential sources for design patterns, such as [GOF](#) and [POSA](#). (R3)

They know (R3):

- that patterns are a way of achieving certain qualities for given problems and requirements within given contexts.
- that there are different categories of patterns.
- additional sources of patterns that relate to their specific technical or application domain.

LG 03-10 [previously LG 2-04]: Identify, Design and Implement Cross-Cutting Concerns (R1)

Software architects are able to:

- explain the significance of such cross-cutting concerns
- identify such cross-cutting concerns
- design cross-cutting concepts, for example persistence, communication, GUI, error handling, concurrency, energy efficiency
- identify and assess potential interdependencies.

Software architects know that such cross-cutting concerns may be re-used across systems.

LG 03-11 [previously LG 2-10]: Know Fundamental Principles of Software Deployment (R3)

Software architects:

- know that software deployment is the process of making new or updated software available to its users
- are able to name and explain fundamental concepts of software deployment, for example:
 - automated deployments
 - repeatable builds
 - consistent environments (e.g. use immutable and disposable infrastructure)

- put everything under version-control
- releases are easy-to-undo

LG 03-12 [previously LG 1-11]: Know the Challenges of Distributed Systems (R3)

Software architects are able to:

- identify distribution in a given software architecture
- analyze consistency criteria for a given business problem
- explain causality of events in a distributed system

Software architects know:

- communication may fail in a distributed system
- limitations regarding consistency in real-world databases
- what the "split-brain" problem is and why it is difficult
- that it is impossible to determine the temporal order of events in a distributed system

References

[Bass+ 2021], [Fowler 2002], [Gharbi+2024], [Gamma+94], [Hohpe+2004], [Buschmann+ 1996], [Buschmann+ 2007], [Starke 2024], [Lilienthal 2024], [Starke+2021]

Chapter 4. Specification and Communication of Software Architectures

| | |
|--------------------|--------------------|
| Duration: 180 min. | Exercises: 60 min. |
|--------------------|--------------------|

Purpose

The purpose of this section is to enable participants to document and communicate software architectures in a way that meets the needs of important stakeholders and supports the development process. The focus is on understanding the essential requirements of technical documentation, using appropriate models and notations to describe architectures, and applying key architectural views. Additionally, participants will learn to document key architectural decisions, interfaces, and cross-cutting concerns, ensuring clear, correct, and stakeholder-relevant documentation.

Relevant Terms

(Architectural) Views; structures; (technical) concepts; documentation; communication; description; stakeholder-oriented, meta structures and templates for description and communication; system context; building blocks; building-block view; runtime view; deployment view; node; channel; deployment artifacts; mapping building blocks onto deployment artifacts; description of interfaces and design decisions; UML, tools for documentation

Learning Goals

LG 04-01 [previously LG 3-01]: Explain and Consider the Requirements of Technical Documentation (R1)

Software architects know the requirements of technical documentation and can consider and fulfil them when documenting systems:

- understandability, correctness, efficiency, appropriateness, maintainability
- form, content, and level of detail tailored to the stakeholders

They know that only the target audiences can assess the understandability of technical documentation.

LG 04-02 [previously LG 3-02]: Describe and Communicate Software Architectures (R1-R3)

Software architects use documentation to support the design, implementation and further development (also called *maintenance* or *evolution*) of systems (R2)

Software architects are able to (R1):

- document and communicate architectures for corresponding stakeholder concerns, thereby addressing different target groups, e.g. management, development teams, QA, other software architects, and possibly additional stakeholders
- consolidate and harmonise the style and content of contributions from different groups of authors
- develop and implement measures to support the convergence of written and verbal communication, and balance one against the other appropriately

Software architects know (R1):

- the benefits of template-based documentation

- that various properties of documentation depend on specific properties of the system, its requirements, risks, development process, organization or other factors.

For example, software architects can adjust the following documentation characteristics according to the situation (R3):

- the amount and level of detail of documentation needed
- the documentation format
- the accessibility of the documentation
- formality of documentation (e.g. diagrams compliant to a meta model or simple drawings)
- formal reviews and sign-off processes for documentation

LG 04-03 [previously LG 3-03]: Explain and Apply Notations/Models to Describe Software Architecture (R2-R3)

Software architects know at least the following UML (see [\[UML\]](#)) diagrams to describe architectural views:

- class, package, component (all R2) and composite-structure diagrams (R3)
- deployment diagrams (R2)
- sequence and activity diagrams (R2)
- state machine diagrams (R3)

Software architects know alternative notations to UML diagrams, for example: (R3)

- Archimate, see [\[Archimate\]](#)
- SysML, see [\[SysML\]](#)
- C4, see [\[Brown\]](#)
- for runtime views for example flow charts, numbered lists or business-process-modeling-notation (BPMN).

LG 04-04 [new]: Learning Goal not Found (R3)

Software architects are able to gracefully deal with unexpected situations.

(See [\[IETF HTTP\]](#))

LG 04-05 [previously LG 3-04]: Explain and Use Architectural Views (R1)

Software architects are able to use the following architectural views (see [\[Kruchten 1995\]](#), [\[Rozanski+11\]](#), [\[Starke+2021\]](#), [\[arc42\]](#), [\[Brown\]](#)):

- context view
 - depict the context of systems, e.g. in the form of context diagrams with explanations
 - represent external interfaces of systems in the context view
 - differentiate business and technical context
- building block or component view (composition of software building blocks)

- runtime view (dynamic view, interaction between software building blocks at runtime, state machines)
- deployment view (hardware and technical infrastructure as well as the mapping of software building blocks onto the infrastructure)

LG 04-06 [previously LG 3-07]: Document Interfaces (R1)

Software architects are able to document and specify both internal and external interfaces.

LG 04-07 [previously LG 3-06]: Document and Communicate Cross-Cutting Concerns (R2)

Software architects are able to adequately document and communicate typical cross-cutting concerns (synonym: *cross-cutting concepts, aspects*), e. g., persistence, workflow management, UI, deployment/integration, logging.

LG 04-08 [previously LG 3-08]: Explain and Document Architectural Decisions (R1-R2)

Software architects are able to:

- systematically make, justify, communicate, and document architectural decisions
- identify, communicate, and document interdependencies between design decisions

Software architects know about Architecture-Decision-Records (ADR, see [\[Nygard 2011\]](#)) and can apply these to document decisions (R2).

LG 04-09 [previously LG 3-09]: Know Additional Resources and Tools for Documentation (R3)

Software architects know:

- basics of several published frameworks for the description of software architectures, for example:
 - ISO/IEC/IEEE 42010, see [\[ISO 42010\]](#)
 - arc42, see [\[arc42\]](#)
 - C4, see [\[Brown\]](#)
 - FMC, see [\[FMC\]](#)
- ideas and examples of checklists for the creation, documentation, and testing of software architectures
- possible tools for creating and maintaining architectural documentation

References

[\[arc42\]](#), [\[Archimate\]](#), [\[Bass+ 2021\]](#), [\[Brown\]](#), [\[Clements+ 2010\]](#), [\[FMC\]](#), [\[Gharbi+2024\]](#), [\[Kruchten 1995\]](#), [\[Starke+2021\]](#), [\[Nygard 2011\]](#), [\[Starke 2024\]](#), [\[UML\]](#), [\[Zörner 2021\]](#)

Chapter 5. Analysis and Assessment of Software Architectures

| | |
|--------------------|--------------------|
| Duration: 180 min. | Exercises: 60 min. |
|--------------------|--------------------|

Purpose

The purpose of this section is to equip software architects with the skills and knowledge needed to effectively perform architecture analysis. They learn to identify risks, evaluate conformance to architectural decisions, and assess the overall quality of a system based on its design and implementation. By understanding various analysis methods, such as acceptance testing, architecture metrics, and cost-benefit analysis, architects can ensure that a software architecture meets stakeholder requirements and is aligned with the intended design.

Relevant Terms

Architecture analysis; Risk identification; Quality analysis methods; Scenarios; Metrics; Tool-supported analysis

Learning Goals

LG 05-01: Know the Reasons for Architecture Analysis (R1)

Software architects understand that there are different possible reasons for performing architecture analysis, for example:

- identify risks and possible improvements in the architecture design (before, during, or after implementation)
- determine if the architecture design fulfills, or will fulfill, the requirements
- assess conformance of the implementation to the architecture decisions and design
- address stakeholder concerns regarding the architecture

LG 05-02 [previously LG 4-3 and 4-4]: Analyze the Qualities of a Software System (R1, R3)

Software architects

- understand that, for any given quality, different analysis methods might be available for a particular software system, such as
 - analysis of the results of acceptance testing (R1)
 - quantitative measurement of run-time behaviour (R1)
 - qualitative evaluation via interviews, surveys, penetration tests etc. (R1)
 - scenarios (R1)
 - architecture metrics for coupling such as the degree of inbound and outbound dependencies (R1)
 - cost-benefit analysis (R3)
 - Architecture Trade-Off Analysis Method [Bass+ 2021] (R3)
- know sources of information for a quality analysis (R2):
 - requirements documentation (R1)

- architecture documentation (R1)
- architecture and design models (R1)
- source code (R1)
- source-code-related metrics such as lines of code, (cyclomatic) complexity (R1)
- test cases and test results (R1)
- errors and their locations in the source code, especially error clusters (R1)
- other documentation of the system, such as operational or test (R1) documentation (R1)
- run-time event logs and metrics (R1)
- revision history, such as the rate of change per component (R3)

LZ 05-03: Evaluate Conformance to Architectural Decisions (R2)

Software architects are able to assess whether the system's implementation aligns with the architectural design and decisions, using methods such as code and architecture reviews or tool-supported analysis.

References

Chapter 6. Examples of Software Architectures

| | |
|-------------------|-----------------|
| Duration: 90 min. | Exercises: none |
|-------------------|-----------------|

This section is not relevant for for the exam.

Learning Goals

LG 06-01: Know the Relation between Requirements, Constraints, and Solutions (R3)

Software architects are expected to recognize and comprehend the correlation between requirements and constraints, and the chosen solutions using at least one example.

LG 06-02: Understand the technical implementation of a solution (R3)

Software architects understand the technical realization (implementation, technical concepts, products used, architectural decisions, solution strategies) of at least one solution.

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