Software Engineering in der industriellen Praxis (SEIP)

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ARCHITECTURE FUNDAMENTALS

Architecture Principles

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AF 04.2

FL Factual Locality
Resources are as spatially and temporarily local-scoped to solution components as possible

ES Exclusive Sovereignty
Exclusive resource sovereignty by the enclosing component

LS Logical Separation
Separation of concerns between the components of a solution

SM Structural Modularity
Splitting of a solution into manageable structural components

CA Contextual Adequacy
Neither insufficient nor exaggerated solutions for each context

SP Solution-oriented Proportionality
Good expected proportionality in each solution context

LC Loose Coupling
Loose coupling in communication and referencing between solution components

SC Strong Cohesion
Strong relationship between functionalities within a single solution component

HC Holistic Consistency
Full consistency across all aspects of a solution

SH Structural Homogeneity
Maximum homogeneity in the structure of a solution

OE Open Extensibility
Solution components can be extended by third-parties at fixed interfaces

CC Closed Changeability
Solution components are protected against direct change by third-parties

CR Constructional Reusability
High reuse of proven structural components and partial solutions

FS Fulfilled Standards
Compliancy to standards as much as possible, as long as the benefits predominate the drawbacks

UI Unique Identification
Unique identification of all components of a solution

UA Uniform Addressing
Uniform addressing of all components of a solution

FA Functional Abstraction
Suitable level of abstraction across all functional aspects of a solution

FT Functional Traceability
Suitable traceability across all functional aspects of a solution

OS Overall Simplicity
All design aspects of a solution are as simple as possible and only as complicated as necessary

EC Encapsulated Complexity
Complex related aspects of a solution are encapsulated into a single responsible component

CI Communicative Interoperability
Maximum interoperability in communication between solutions

EH Environmental Harmony
Maximum harmony in the integration of the solution with its environment

LA Least Astonishment
All design aspects of a solution are as little astonishing as possible and only as esoteric as necessary

SD Self Documentation
All design aspects of a solution are preferably self-documenting

AR Avoided Redundancy
Minimum total number of copies of a single resource

MS Minimum Special-Cases
Minimum total number of special-cases in a solution

OD Operational Delight
The solution provides users true delight even on long-term operation

AA Artistic Aesthetics
The solution has holistic aesthetics and artistic love in details

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Component Design

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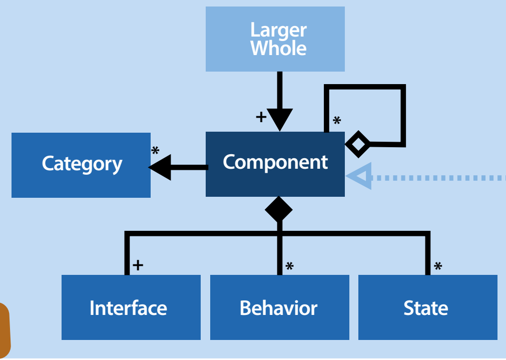
AF 05.1

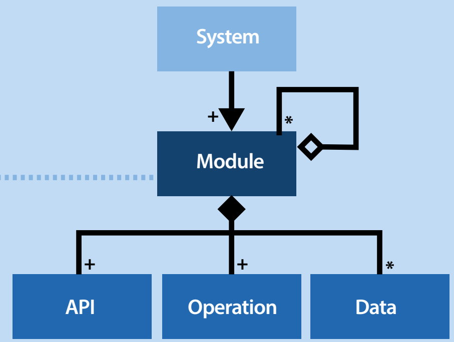
Definition of a Component (of a Larger Whole):
a **know-how encapsulating**, potentially **reusable** and **substitutable** **unit of hierarchical composition** with **explicit context dependencies**, which **hides the complexity** of its optional **behavior** and **state** realization behind **small contractually specified interfaces**, defines its **added value** in terms of **provided** and **consumed** interfaces and optionally belongs to zero or more **categories** of similar units.

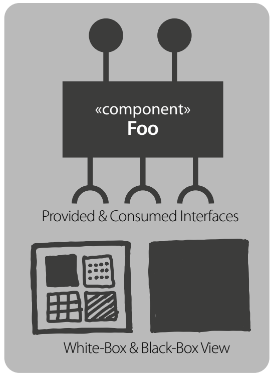
Definition of a Module (of a System):
a know-how encapsulating, potentially reusable and substitutable **source-code** unit of hierarchical composition with explicit context dependencies which hides the complexity of its **operation** and **data implementation** behind small contractually specified **Application Programming Interfaces (API)**, defines its added value in terms of provided and consumed **APIs** and optionally belongs to zero or more categories of similar units.

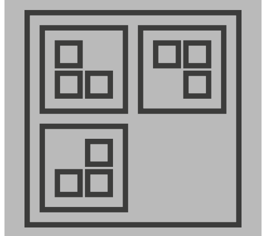
Example Categories of Components:
- Namespace
- Directory, File
- Configuration, Section, Directive
- Host, Virtual Machine, Container
- Process Group, Process, Thread
- Application, Microservice, Program
- Package, Class, Function
- Database, Schema, Table, Record
- Datamodel, Entity Group, Entity
- User Interface, Dialog, Widget

Any group of anything!





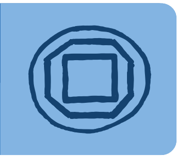




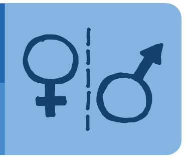
Hierarchical Composition

How to find Components (or Modules)?

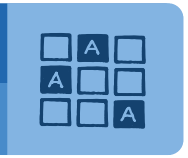
DCA Domain Concept Abstraction
Model domain concepts as entity components and then group at higher levels.



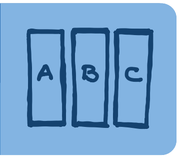
SOC Separation of Concerns
Build components for clearly distinct concerns.



USE Reusability Potential
Decide on components based on their reusability potential.

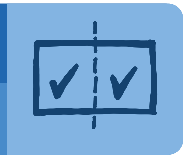


UCC Use-Case Clustering
Build domain components for each use-case or each logical use-case cluster.

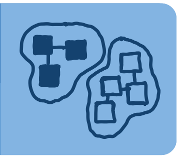


SRP Single Responsibility Principle
Build components for clearly distinct responsibilities.

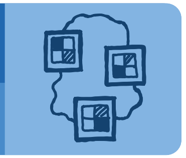
DCC Divide & Conquer Complexity
Master overall complexity by splitting larger things into smaller things.



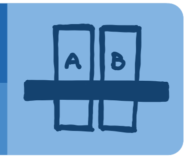
DDD Domain-Driven Design
Model domain "Bounded Contexts" through DDD and derive components from them.



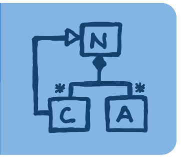
CNC Coupling and Cohesion
Decide on components based on their loose coupling and strong cohesion.



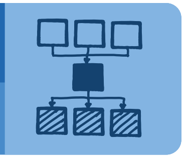
CCC Cross-Cutting Concerns
Build common cross-cutting concerns as cross-cutting components.



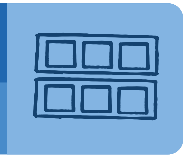
OOD Object-Oriented Design
Model Object-Oriented Design entities (and/or OOP constructs) as components.



DEP Dependency Encapsulation
Decide on components based on their encapsulation of dependencies.



PAT Architecture Patterns
Build inner components to comply to outer structure, slicing and clustering architectures.



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Interface Design

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Definition of an Interface: well-defined shielding and abstracting **boundary** of a passive, providing **component**, consisting of one or more distinguished, **outside-in** designed, **interaction endpoints**, each accessed and controlled by active, consuming components through the **exchange** of **input/output information** and operating under a certain **syntactical** and **semantical contract.**

Endpoint: Name, Directive, Command, Function, Method, Procedure, Address, Port, URL, Dialog, ...

Exchange: Option, Argument, Parameter, Return Value, Result, Request/Response Message, Error/Exception, Interaction, ...

Contract: Syntax, Pre-Condition, Invariant, Post-Condition, Side-Effect, Idempotence, Determinism, Functionality, ...

Types of Software Interfaces

API — Application Programming Interface
Example: `foo("bar", 42)` (call and use)

SPI — Service Provider Interface
Example: `register("foo", (x,k) => ...)` (extend and implement)

SCI — Startup Configuration Interface
Examples: INI, Java Properties, TOML, YAML, JSON, XML, etc.

BPI — Batch Processing Interface
Examples: Unix at(1), Unix ts(1), GNU Batch, Spring Batch, Java Batch, SAP LO-BM, etc.

CLI — Command-Line Interface
Example: `foo -x --bar=baz quux`

GUI — Graphical User Interface
Examples: Windows/WPF, macOS/Cocoa, KDE/Qt, GNOME/GTK

RNI — Remote Network Interface
Examples: GraphQL-IO, HTTP/REST, SOAP, RMI, WebSockets, AMQP, MQTT, etc.

Characteristics of Good Interfaces

AP — Appropriate & Proportional
Appropriate to consumer requirements, proportional to provider functionality.

SA — Shielding & Abstracting
Shields from direct access, abstracts and hides implementation details.

IE — Inviting & Expressive
Invites through "outside – in" design, powerful in expressiveness.

IF — Intuitive & Foolproof
Intuitive to grasp and use, hard to misuse.

OC — Orthogonal & Concise
Supports combinatorial use-cases, causes minimum boilerplate.

TP — Tolerant & Predictable
Tolerant on input, predictable on output.

EC — Extensible & Compatible
Easy to extend for providers, backward/forward-compatible for consumers.

Selected Interface Design Patterns

IVF — Interface Version & Features
Provide version and feature information for algebraic comparison and feature detection.

2LF — Leaky Two-Layer Facade
Provide higher-level convenient use-case and lower-level orthogonal feature interface.

EVE — Event Emitter
Emit events to previously registered, interested consumers.

CTX — Multi-Context
Use contexts to distinguish between different usage scenarios and to carry common info.

CEF — Configure-Execute Flow
Spread use-cases onto a flow of configuration exchanges and a final executional exchange.

IOC — Inversion Of Control
Invert control on asynchronous operations via callbacks, promises or async. mechanisms.

HMR — Human/Machine Responses
Support humans and machines in outputs through both description and parsing-free info.

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Component Hierarchy

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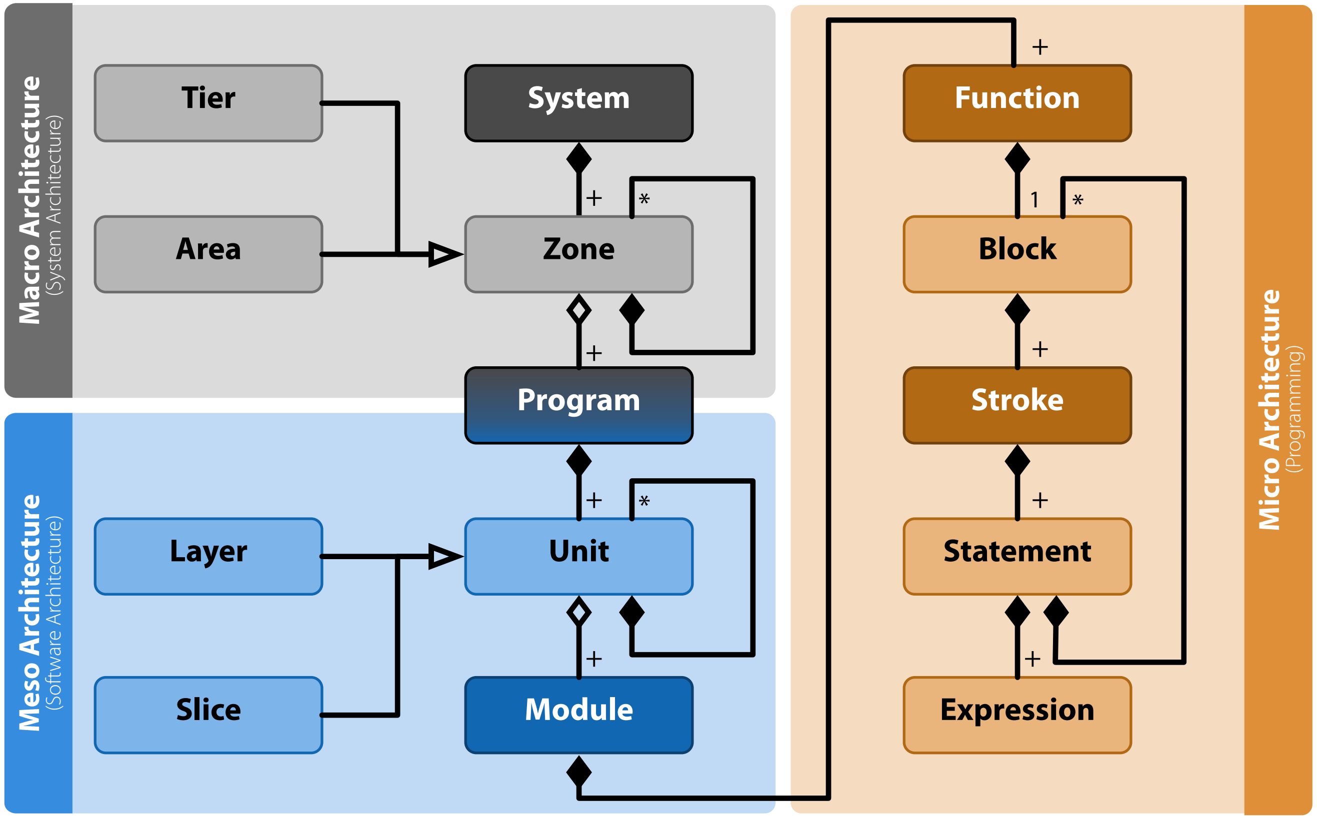

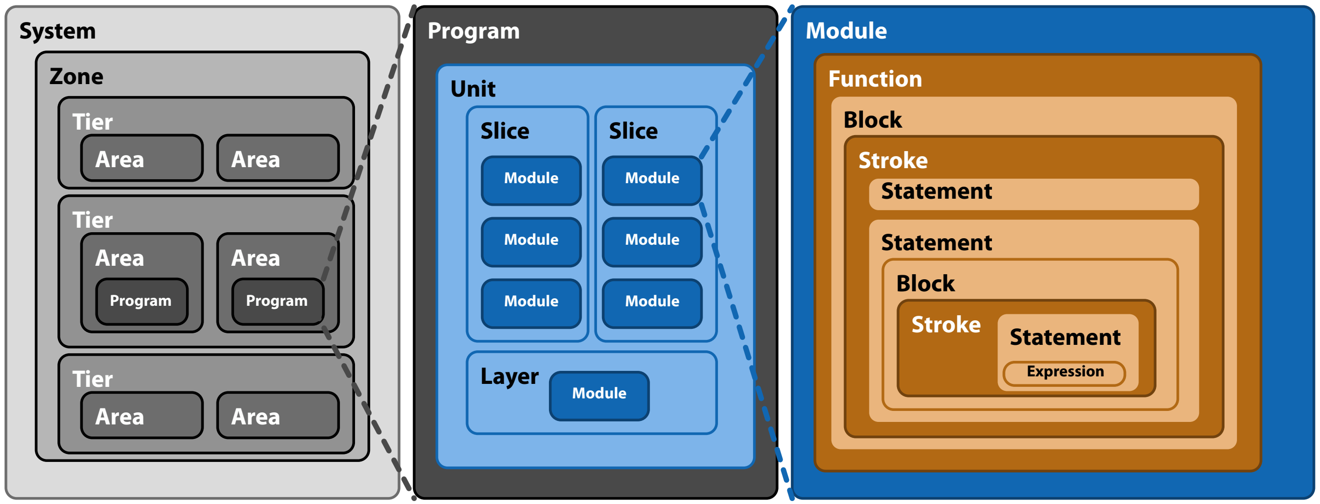

Zone:
Structuring **Tier** or **Area** within a **System** (or within an outer **Zone**).

Unit:
Structuring **Layer** or **Slice** within a **Program** (or within an outer **Unit**).

Tier:
Special kind of ranked **Zone** for horizontally grouping (logically or spatially distinct and network-linked) **Programs** or other **Tiers** and **Areas**.

Layer:
Special kind of ranked **Unit** for horizontally grouping (logically distinct and memory-linked) **Modules** or other **Slices** and **Layers**.

Area:
Special kind of unranked **Zone** for vertically grouping (logically or spatially distinct and network-linked) **Programs** or other **Tiers** and **Areas**.

Slice:
Special kind of unranked **Unit** for vertically grouping (logically distinct and memory-linked) **Modules** or other **Slices** and **Layers**.

System:
One or more network-linked **Programs**, forming a solution as a whole and the primary unit of thinking at the level of Macro Architecture.

Module:
Know-how encapsulating, potentially reusable group of **Functions** and primary unit of thinking at the level of Meso Architecture.

Program:
Stand-alone, self-contained, executable piece of software and primary unit of thinking at the level of both Macro and Meso Architecture.

Function:
Operation of a **Module**, with a well-defined interface, and one of the two primary units of thinking at the level of Micro Architecture.

Statement:
Execution of a single action, specified through one or more **Expressions** and zero or more inner **Blocks**.

Stroke:
Logical sequence of **Statements** in a **Block** and one of the two primary units of thinking at the level of Micro Architecture.

Block:
Sequence of one or more **Strokes** within a **Function** or an outer **Statement** and scope for variables of inner **Statements**.

Expression:
Simple or complex representation of a single data value.

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Application Composition

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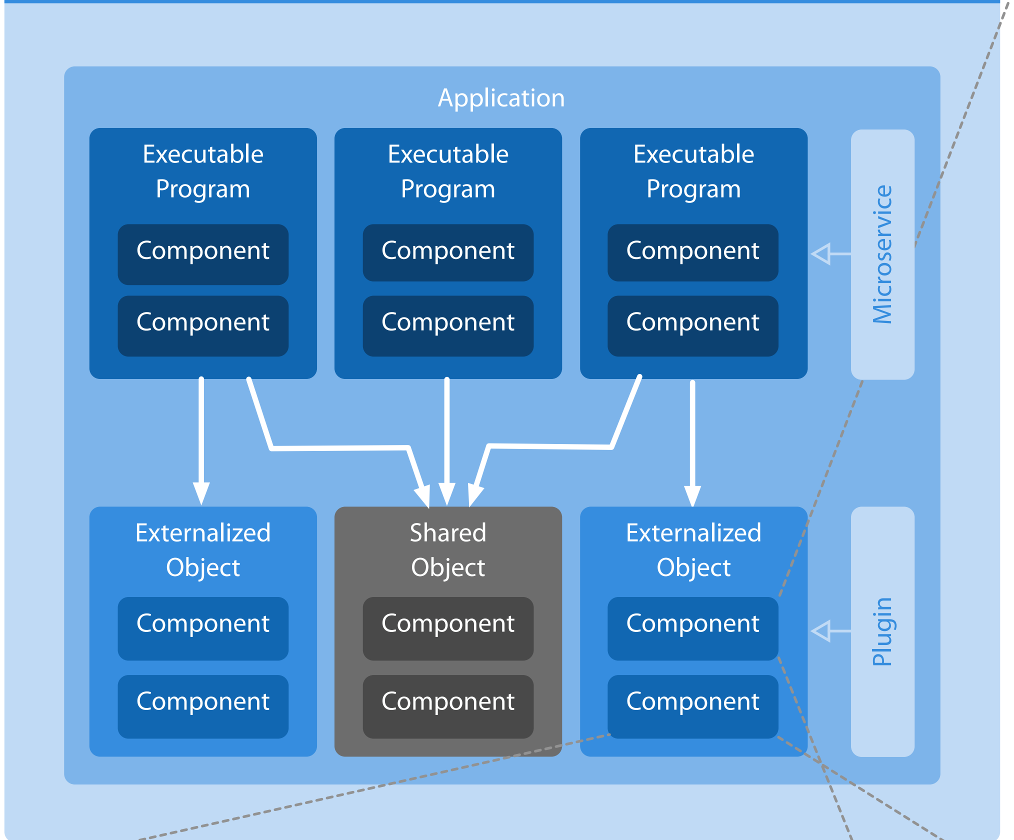
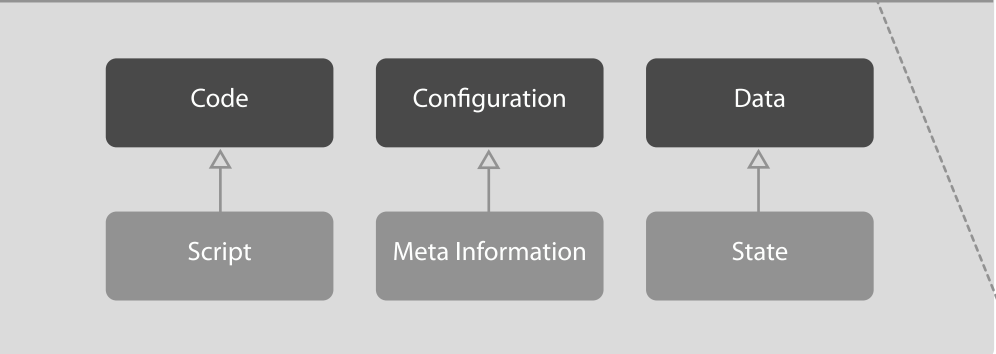
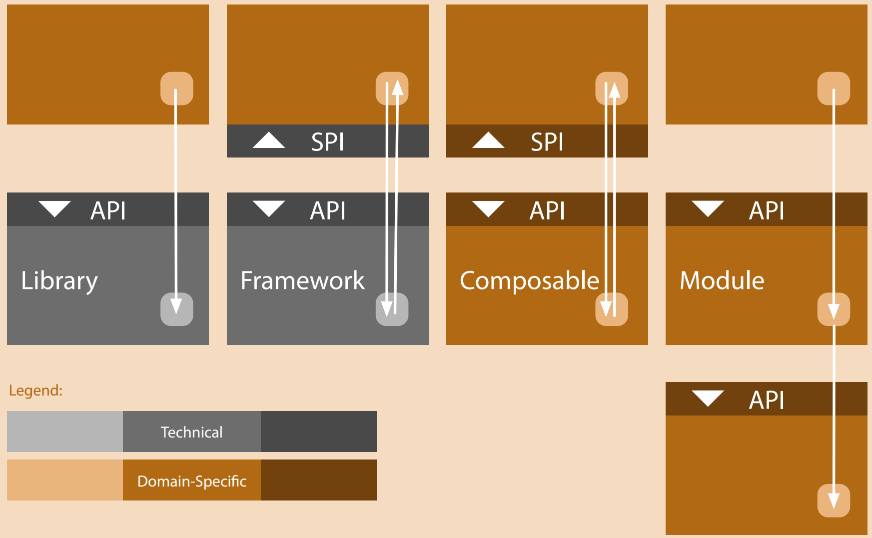
Application Structure



Component Assets



Component Types



Applications are composed out of one or more *Executable Programs*.

An *Executable Program* in turn can leverage zero or more (dedicated) *Externalised Objects* and/or (reusable) *Shared Objects*. Both *Executable Programs, Externalised Objects* and *Shared Objects* are composed through one or more *Components*.

Components are comprised of the assets *Code, Configuration* and *Data* and are of four distinct types: *Library, Framework, Composable* and *Module*, which are distinguished by their particular combination of characterizing aspects.

	data persistence	own life-cycle	requires integration	self-contained	invasive	passive	active	technical	domain-specific	reusable
Library				X		X		X		X
Framework		X	X	X	X	X	X	X		X
Composable	X	X	X	X			X		X	X
Module	X						X		X	

AF 11.3