

Einstieg

Softwaredebakel

EJPD

- Kostenexplosion bei IT-Projekt: Finanzdelegation schlägt Alarm

VBS

- Schweizer Armee ohne krisensichere Logistik bis 2035
- Armee-Debakel: 300-Millionen-Projekt seit Monaten suspendiert

Kantonsverwaltung

- Wegen fehlerhafter Software braucht es mehr Haftplätze

Polizei

- Berner Polizisten beklagen sich über die neue IT

Crowdstrike

- Der Tag, an dem die IT weltweit verrückt spielte – ein Überblick

Kundenorientierung

Software soll den Kunden Mehrwert bringen

- Software soll stabil laufen
- Neue Features sollten schnell umgesetzt und nutzbar sein
- Softwaresysteme werden immer komplexer

When the cloud leaves the datacenter



Anforderungen an moderne Software

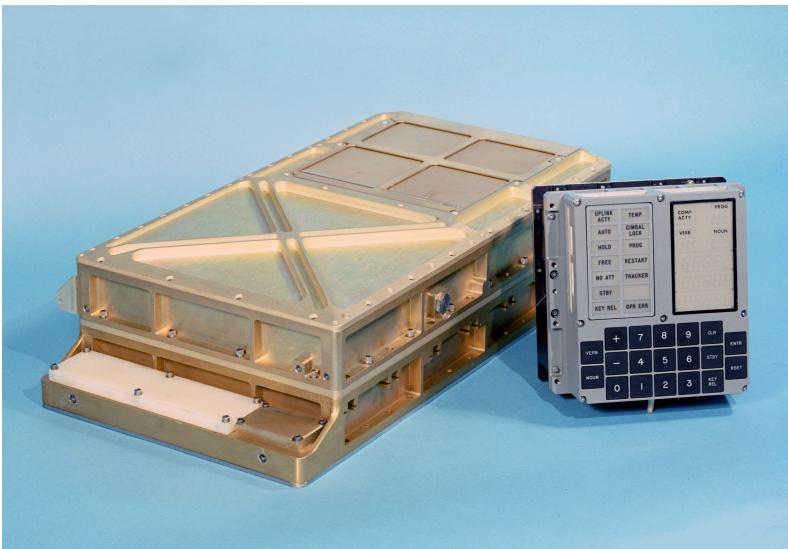
- Hohe Verfügbarkeit
- Skalierbarkeit
- Im Katastrophenfall sollen die Systeme schnell wiederhergestellt werden können
- Soll funktionieren, auch wenn Teile des Systems Offline sind (Resilienz)
- Kostengünstig
- Einfach
- Updates müssen einfach eingespielt werden können

Teamarbeit

Mehrere Personen arbeiten am selben Softwareprojekt

- Versionsverwaltung wird verwendet (Git, SVN)
- Konflikte entstehen und sind aufwendig

Ab 1961: Margaret Hamilton, Apollo Guidance Computer



2001: Manifesto for Agile Software Development

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

<https://agilemanifesto.org/>

Software Engineering / Software Architecture

Software engineering is the application of an empirical, scientific approach to finding efficient, economic solutions to practical problems in software

(Farley, 2022, S.4)

The goal of software architecture is to minimize the human resources required to build and maintain the required system

(Martin, 2018)

Übergang zwischen Software Entwicklung und Software Architektur ist fliessend

Learning

- Iteratives und inkrementelles Arbeiten
- Feedback
- Empirisches und experimentelles Arbeiten

(vgl. Farley, 2022, S.4)

Managing Complexity

- Modularity & Separation of Concerns
- Cohesion & Coupling
- Abstraction

(vgl. Farley, 2022, S.5)

Production Is Not Our Problem

- Softwareentwicklung ist meistens Kreativarbeit
- Die Herausforderung der "Produktion" existiert kaum

Space X Starship

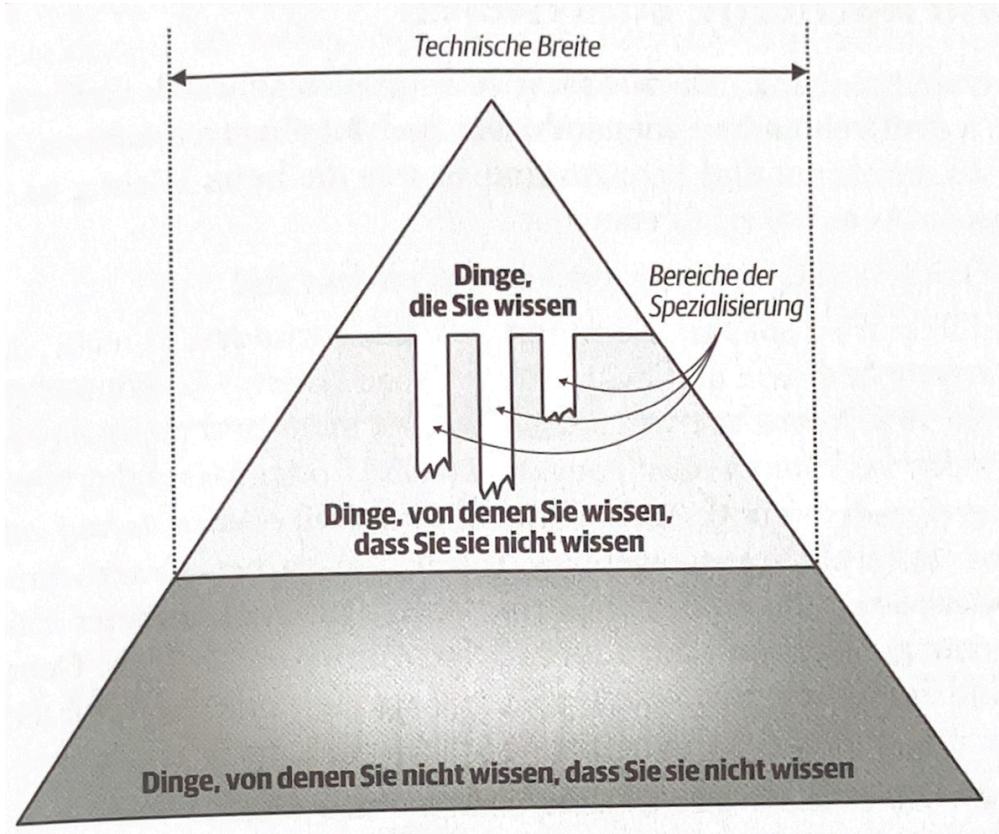
[How Not to Land an Orbital Rocket Booser, 2017](#)

[WOW! Watch SpaceX Catch A Starship Booster In Air, 2024](#)

Finanzierung: **ca 3 Mrd. Dollar**

Apollo-Programm: 1958 bis 1969, inflationsbereinigt: **163 Mrd. Dollar** (ohne Mercury und Gemini)

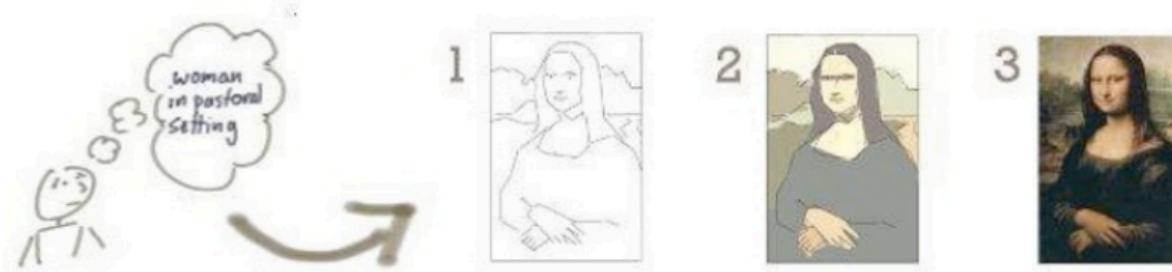
Lernen



(Richards, 2021, S.29)

Iteratives und inkrementelles Arbeiten

Iterative



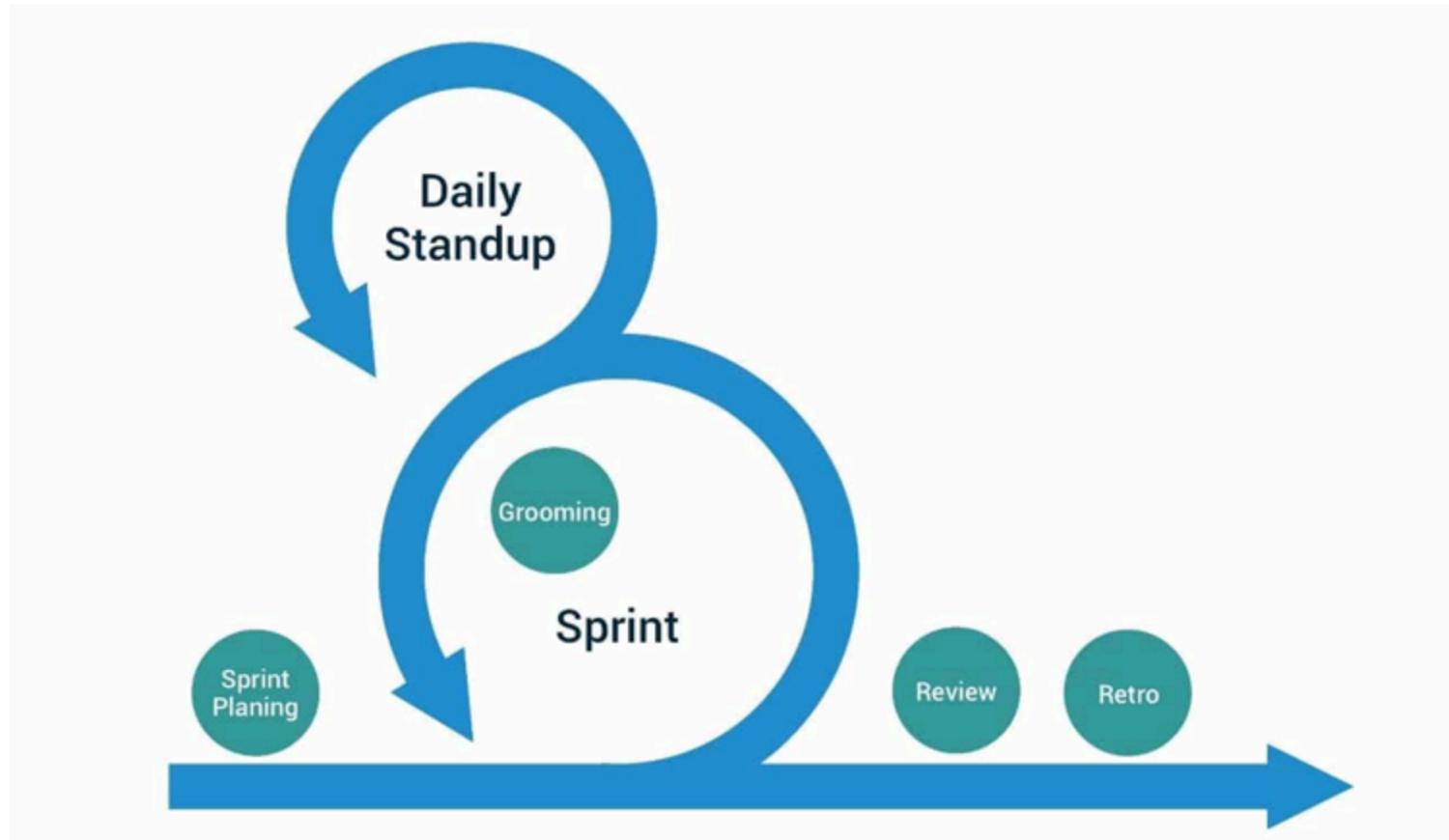
Incremental



Iterative &
Incremental



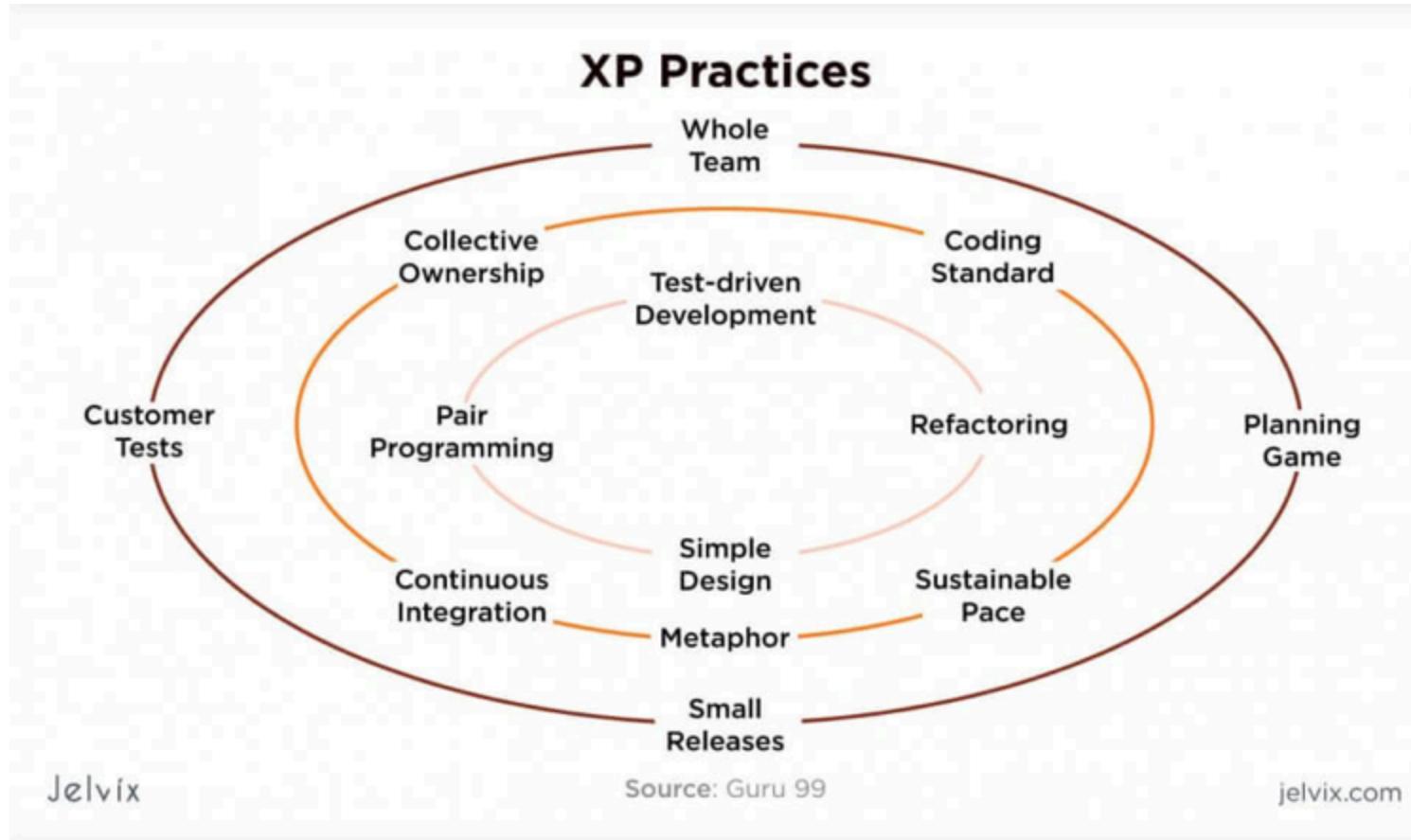
Iterationen



Embrace Change

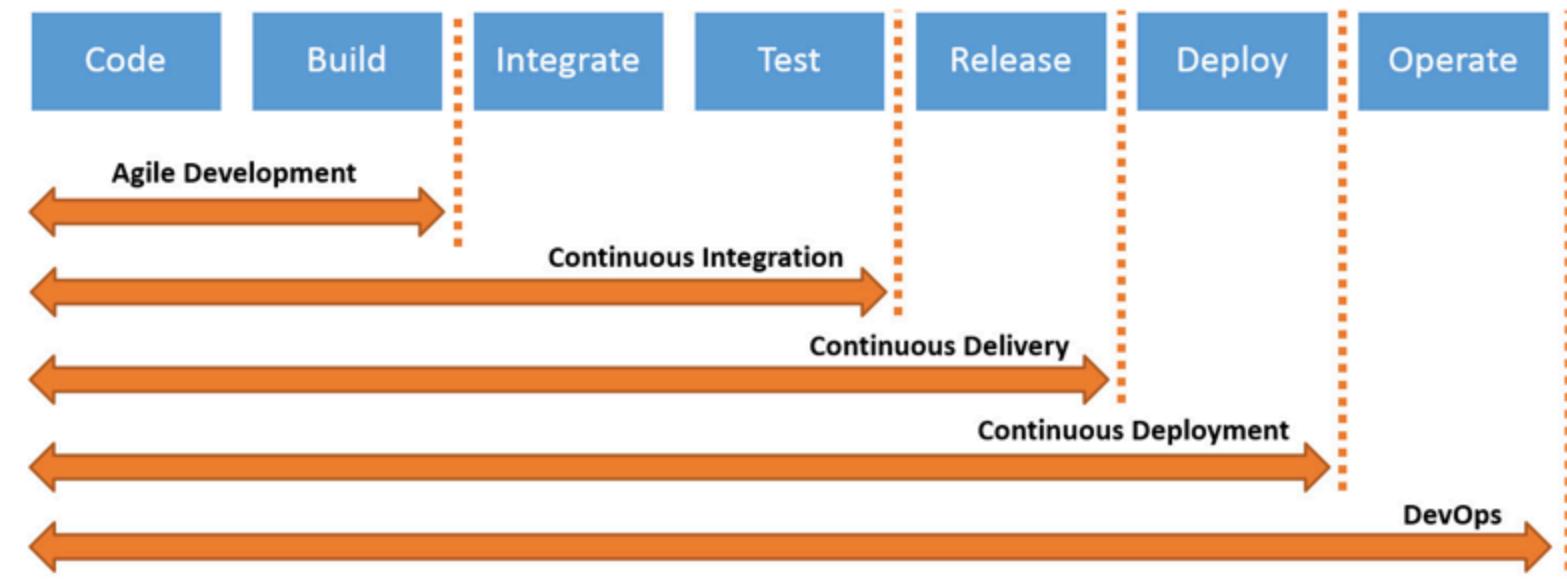


Extreme Programming



Feedback

CI/CD



Continuous Integration

- **Kein Branching**, alle Änderungen werden von allen Teammitgliedern **mehrmals täglich
** in den Master Branch eingeccheckt.
- Dieser Branch ist **jederzeit lauffähig**
- Dadurch werden die **Releases vereinfacht**
- Eine sehr hohe, **automatische Testabdeckung** ist zwingend

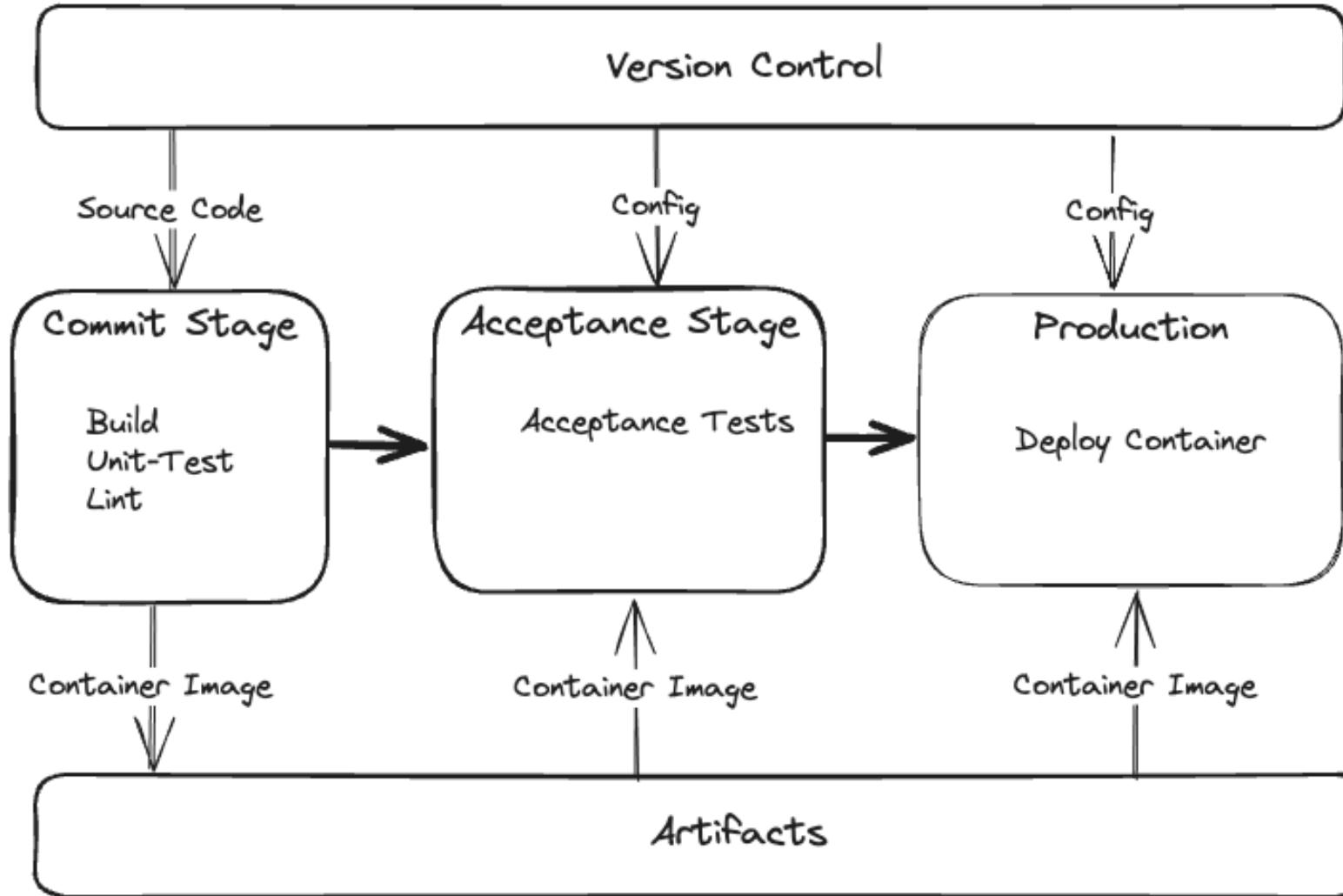
Continuous Deployment

- Ziel: **Releases werden vereinfacht**
- **Time to market ist kürzer**, neue Features sind sofort verfügbar
- Durch automatisierte Deployments ist der Aufwand initial höher, anschliessend jedoch sehr klein
- **Higher quality, Better products**
- Kaum mehr Release-Stress, **Happier teams**

<https://www连续部署.com/>

Modern Software Engineering

Deployment Pipelines



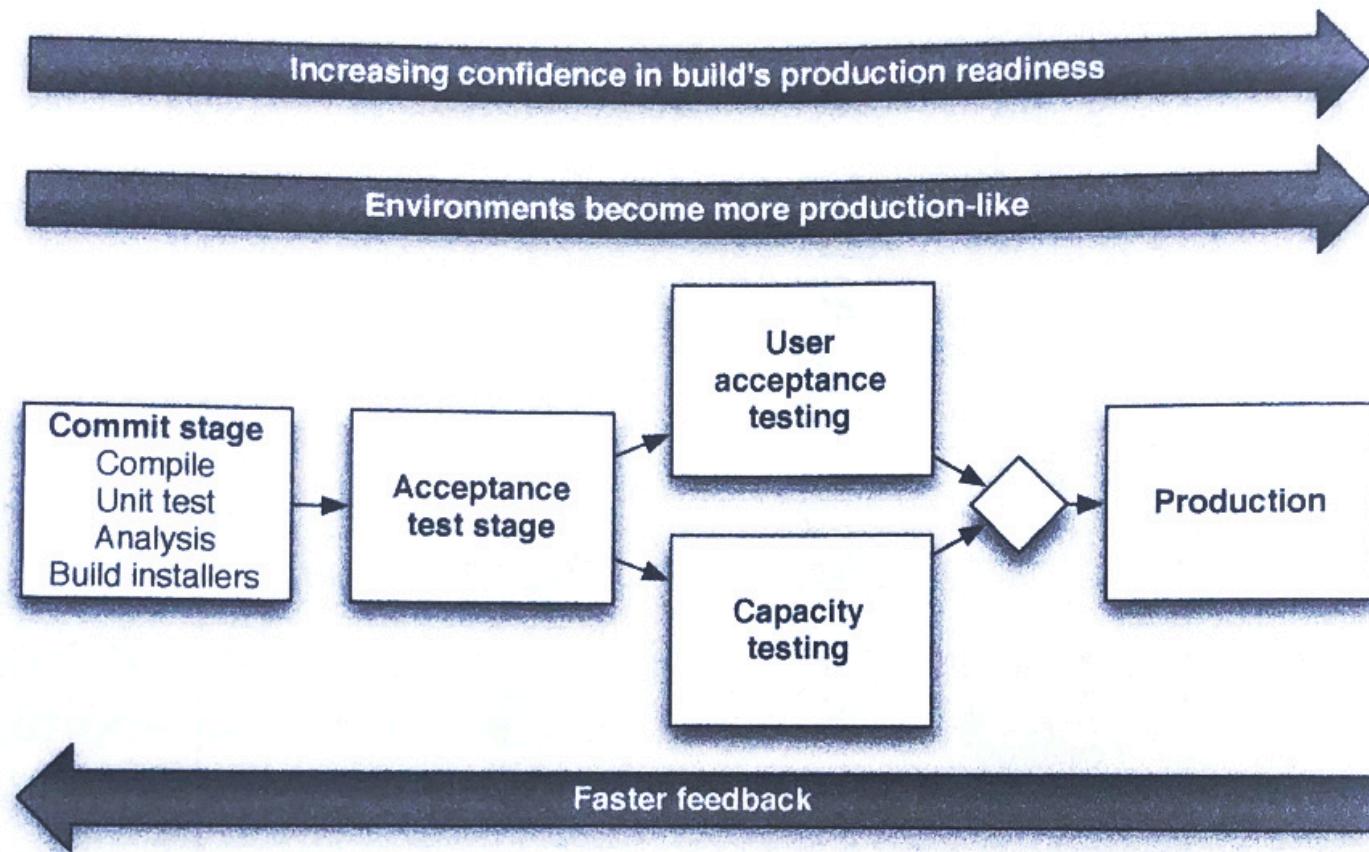
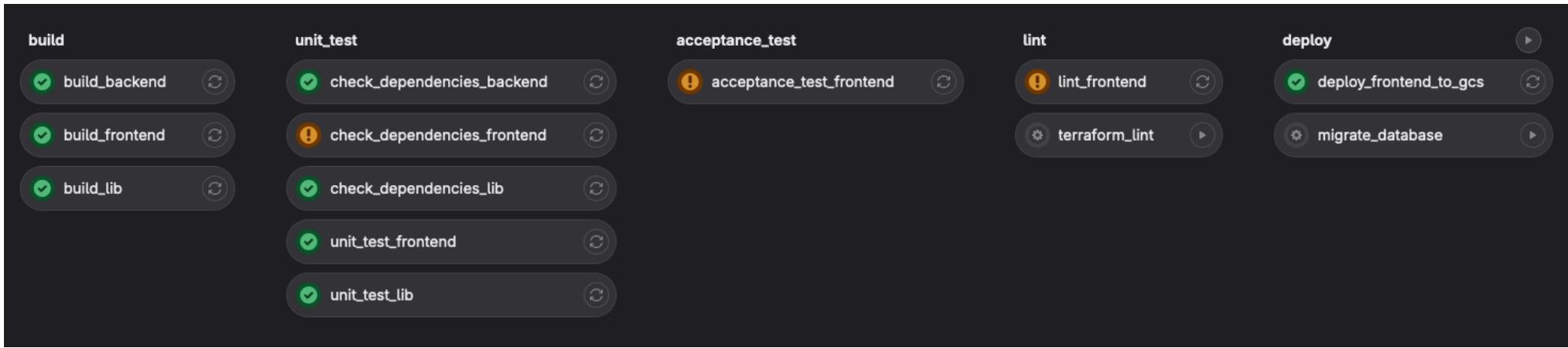
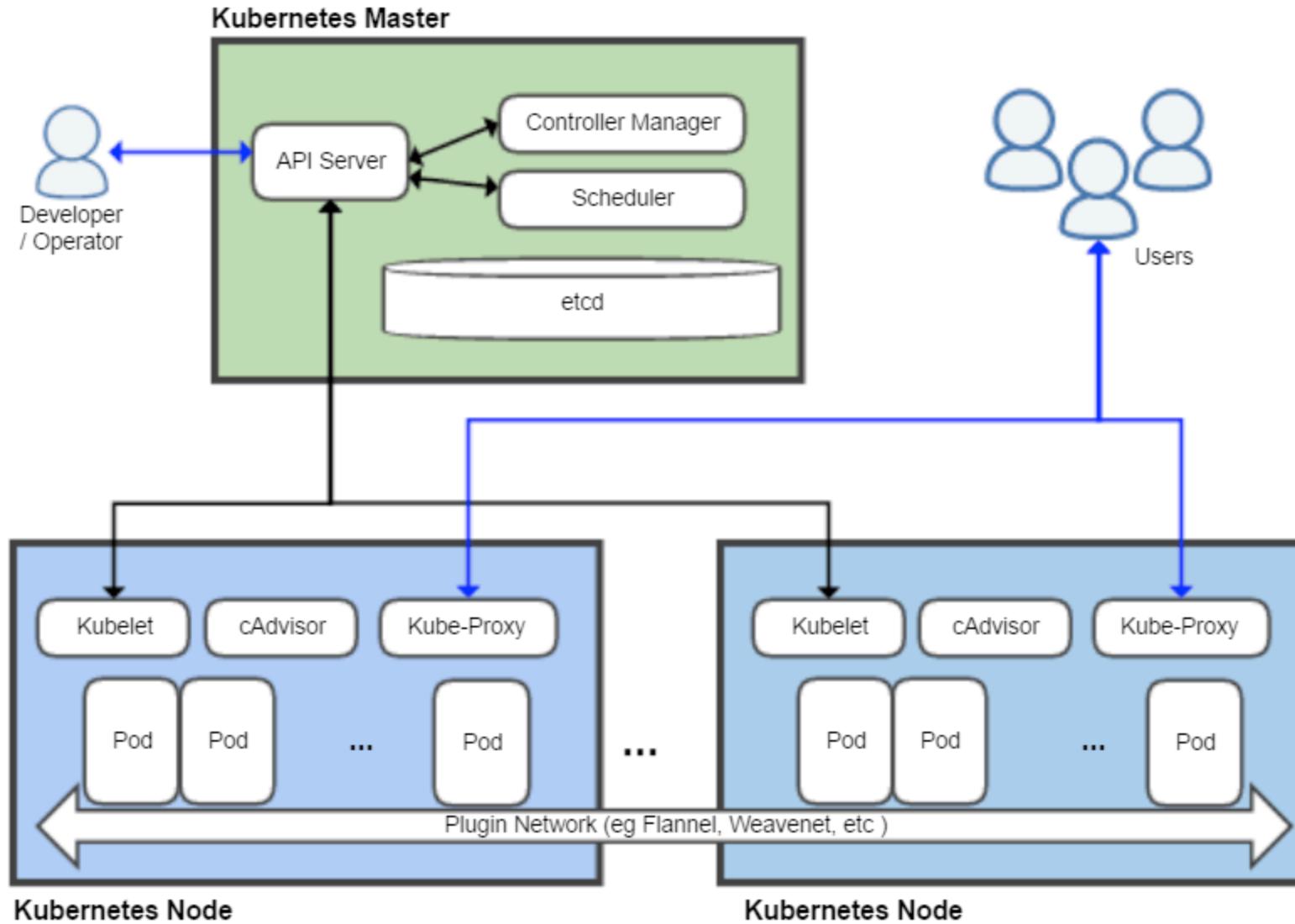


Figure 5.3 *Trade-offs in the deployment pipeline*



Kubernetes



```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: nginx:1.14.2
          ports:
            - containerPort: 80
```

Quellen

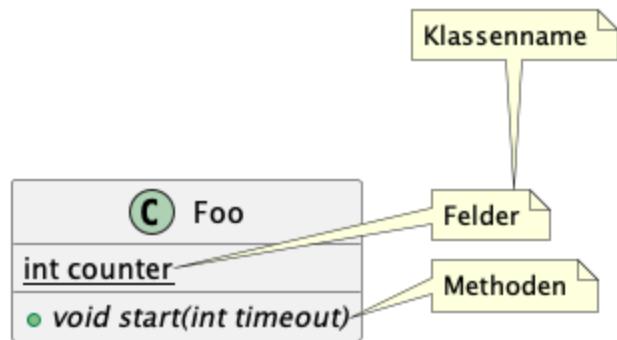
- [Youtube: Continuous Delivery - Deployment Pipelines](#)
- Jez Humble, David Farley (2010): Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Addison-Wesley Signature Series (Fowler)

Empirisches und experimentelles Arbeiten

Kommunikation

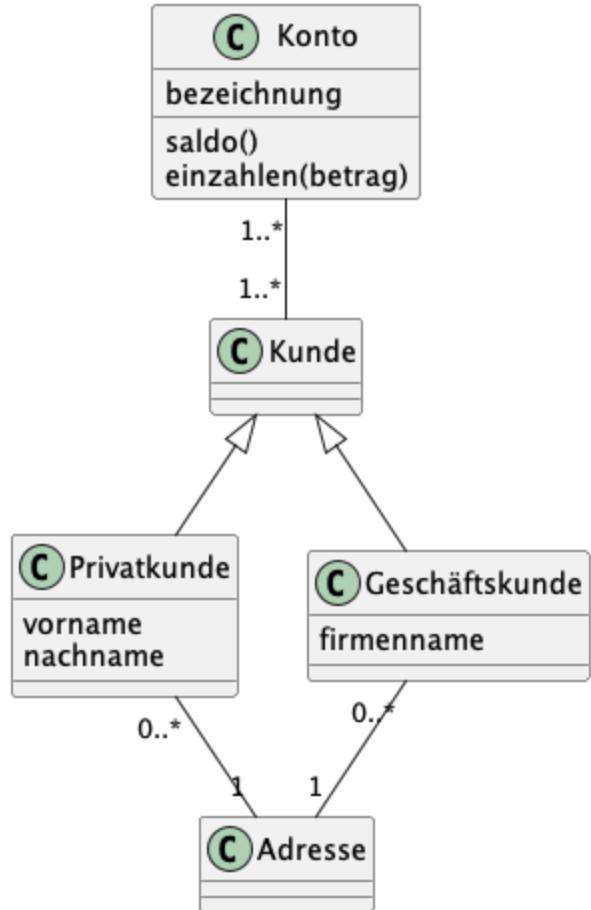
Domain Driven Design

UML Klassendiagramm



PlantUML

UML Klassendiagramm



PlantUML

```
@startuml
class Konto {
    bezeichnung
    saldo()
    einzahlen(betrag)
}

class Kunde {}

class Privatkunde {
    vorname
    nachname
}

class Geschäftskunde {
    firmenname
}

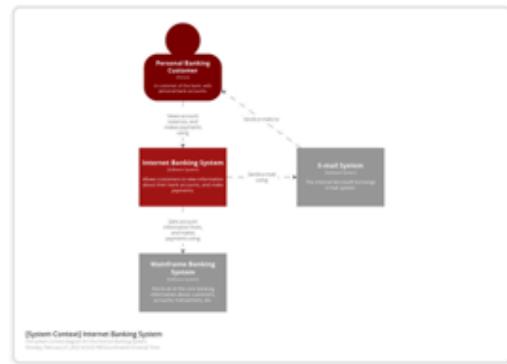
class Adresse {}

Kunde <|-- Privatkunde
Kunde <|-- Geschäftskunde

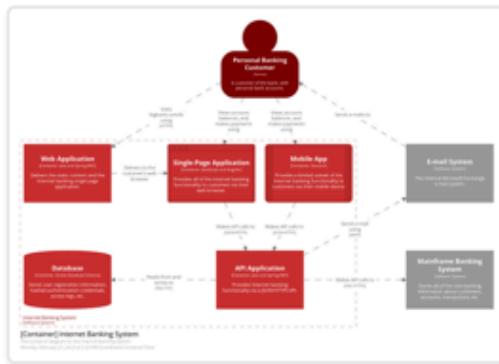
Privatkunde "0..*" -- "1" Adresse
Geschäftskunde "0..*" -- "1" Adresse

Konto "1..*" -- "1..*" Kunde
@enduml
```

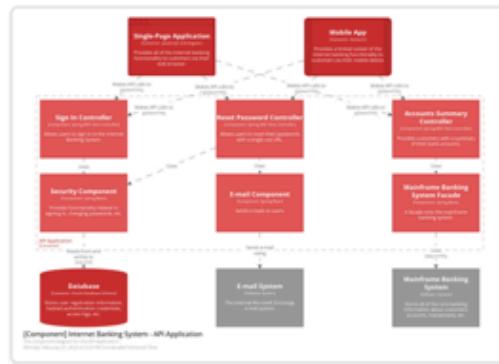
C4 Model



Level 1: A **System Context** diagram provides a starting point, showing how the software system in scope fits into the world around it.



Level 2: A **Container** diagram zooms into the software system in scope, showing the high-level technical building blocks.



Level 3: A **Component** diagram zooms into an individual container, showing the components inside it.

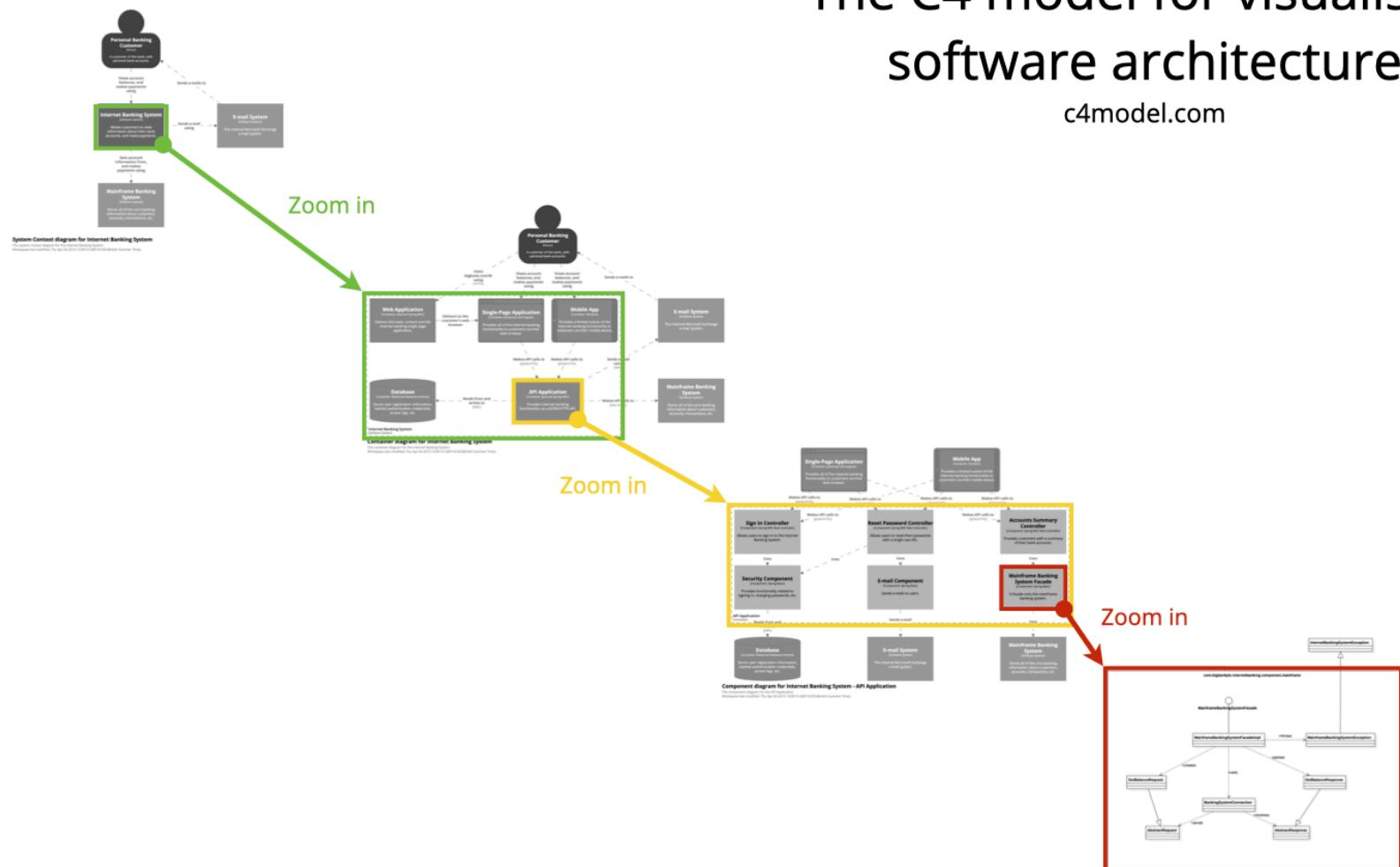


Level 4: A **code** (e.g. UML class) diagram can be used to zoom into an individual component, showing how that component is implemented.

<https://c4model.com/>

The C4 model for visualising software architecture

c4model.com

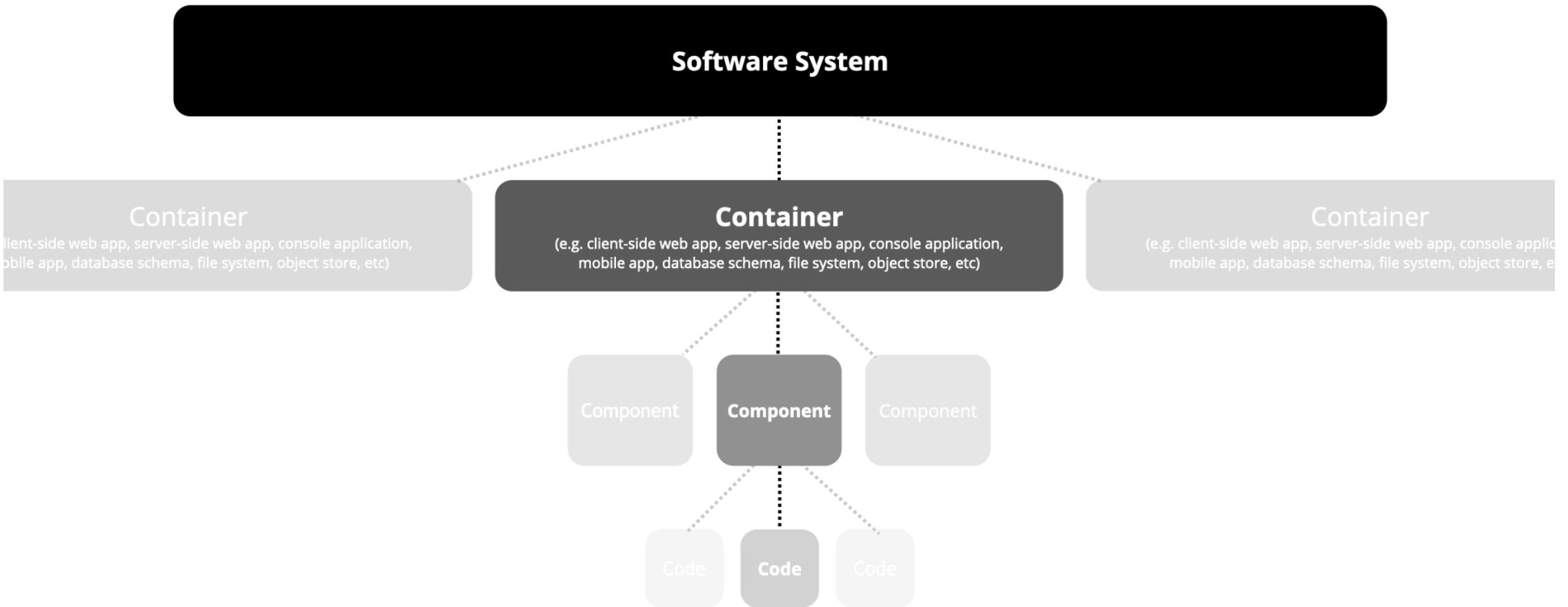


Level 1
Context

Level 2
Containers

Level 3
Components

Level 4
Code



A **software system** is made up of one or more **containers** (applications and data stores), each of which contains one or more **components**, which in turn are implemented by one or more **code** elements (classes, interfaces, objects, functions, etc).

Architectural Decision Records

```
# <!-- short title, representative of solved problem and found solution -->

## Context and Problem Statement

## Considered Options

## Decision Outcome

### Consequences
```

- <https://github.com/adr/madr/blob/4.0.0/template/adr-template-bare-minimal.md>
- <https://github.com/adr/madr/blob/4.0.0/template/adr-template-bare.md>

Templates

- Nygard: <https://github.com/joelparkerhenderson/architecture-decision-record/blob/main/locales/en/templates/decision-record-template-by-michael-nygard/index.md>
- MADR: <https://github.com/adr/madr/blob/4.0.0/template/adr-template.md>

Tools

- <https://github.com/npryce/adr-tools>
- <https://github.com/opinionated-digital-center/pyadr>

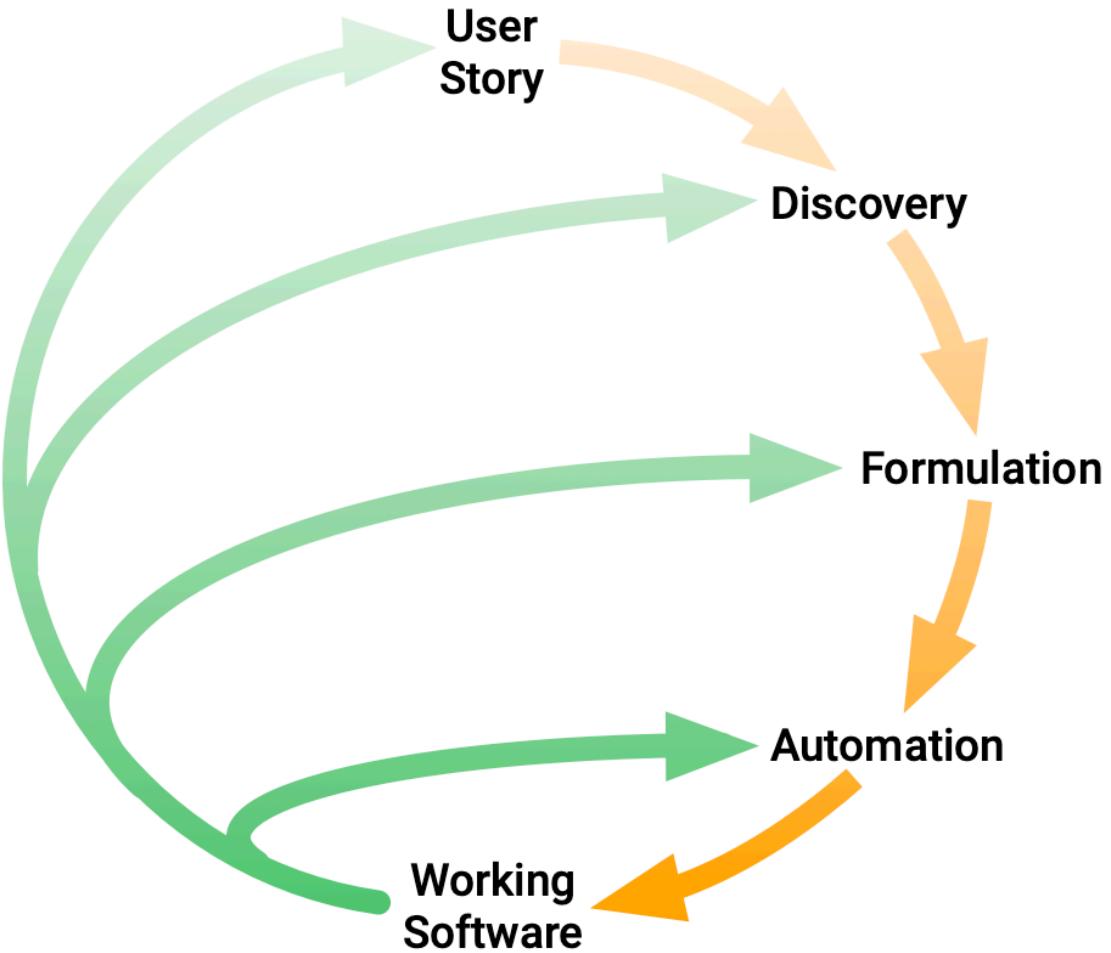
Komplexität

Modularity & Separation of Concerns

Testing

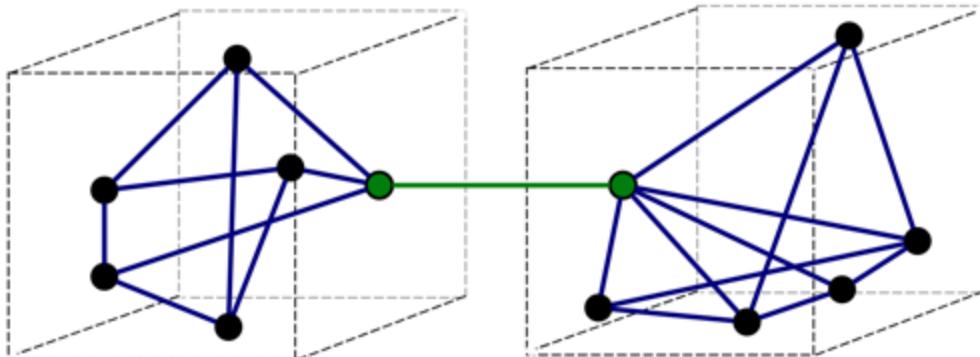
The hardest single part of building a software system is deciding precisely what to build.

– Fred Brooks, *The mythical man-month*

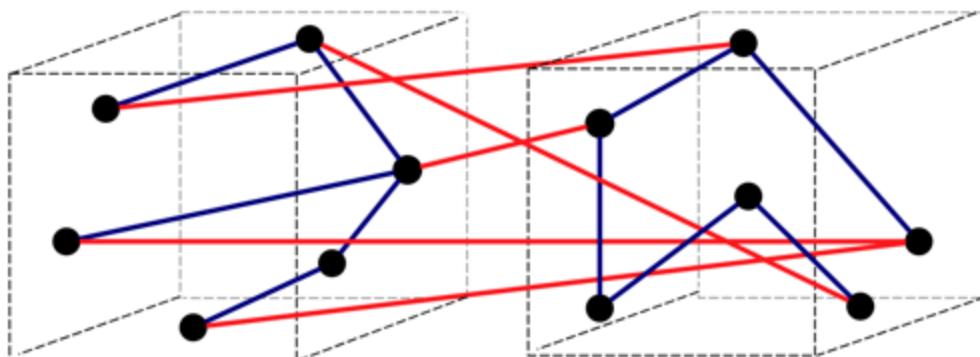


<https://cucumber.io/docs/bdd/>

Cohesion & Coupling



a) Good (loose coupling, high cohesion)

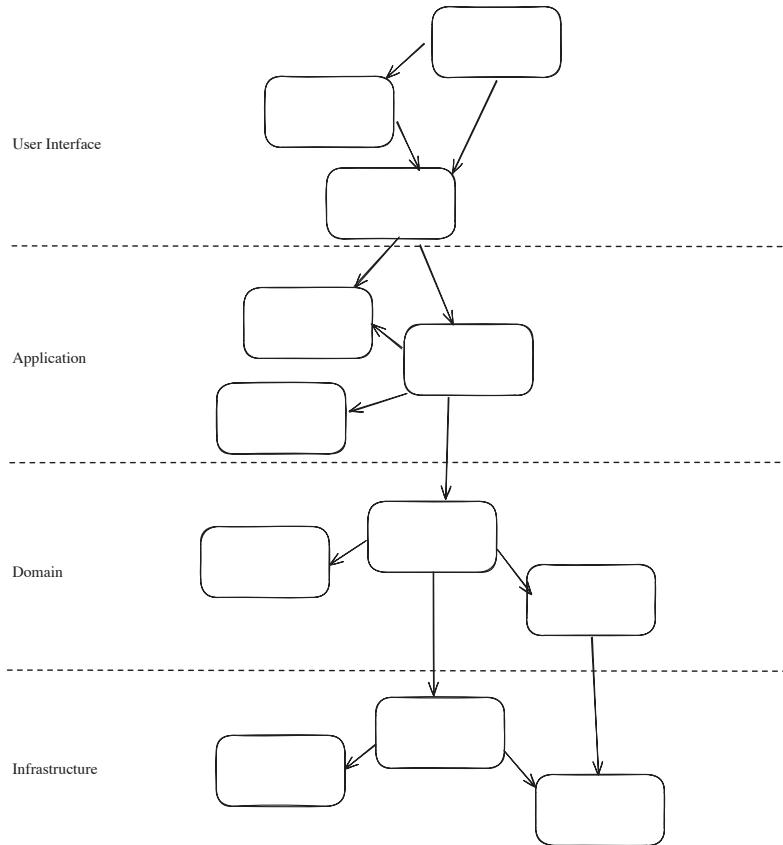


b) Bad (high coupling, low cohesion)

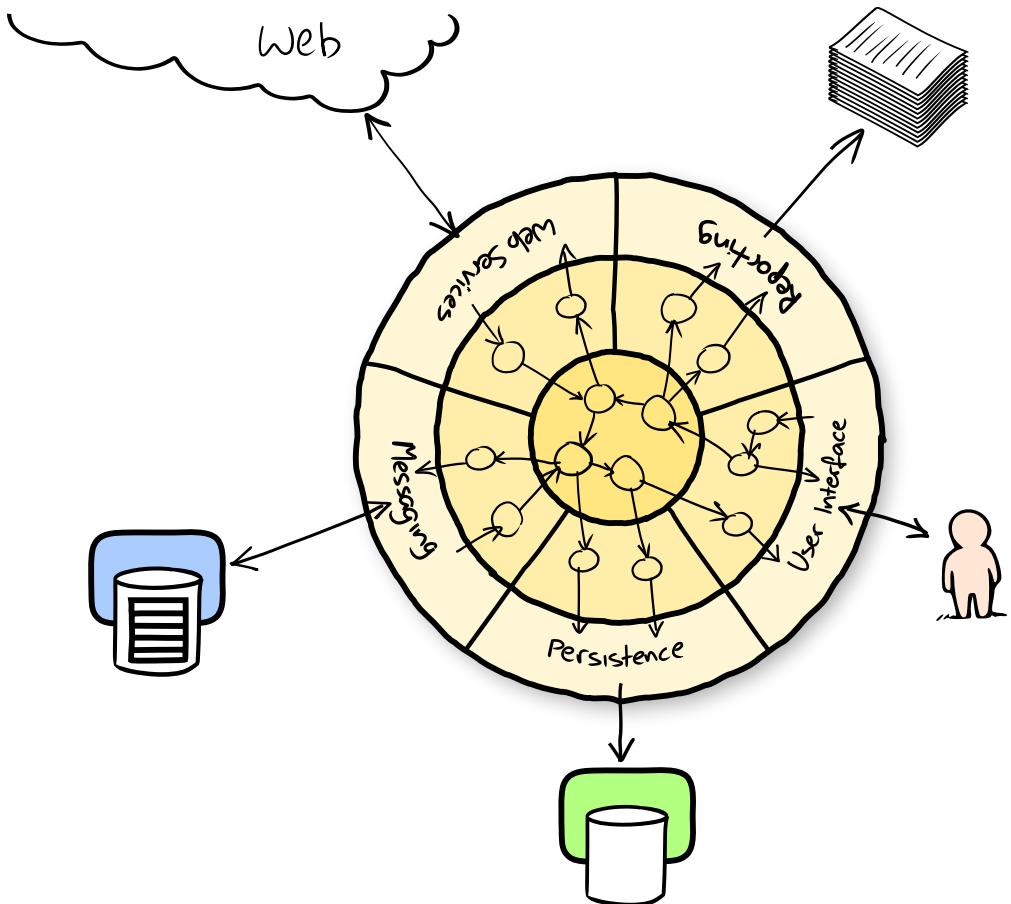
Abstraction

Architekturen

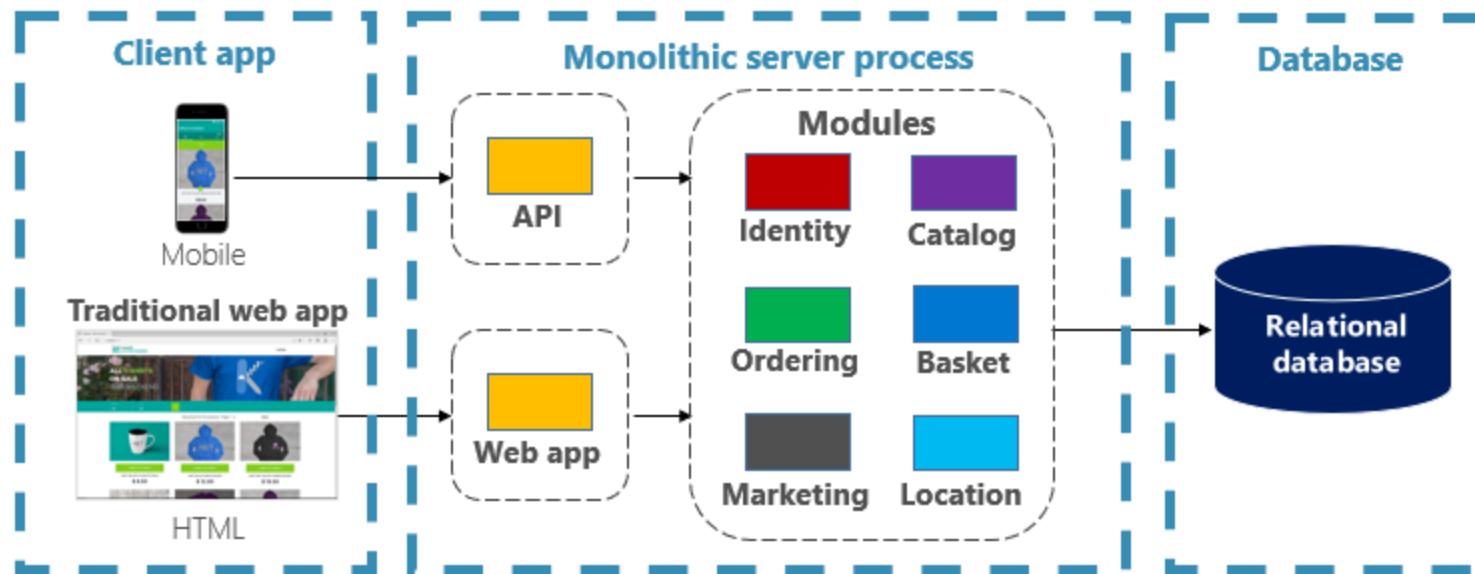
Schichtenarchitektur



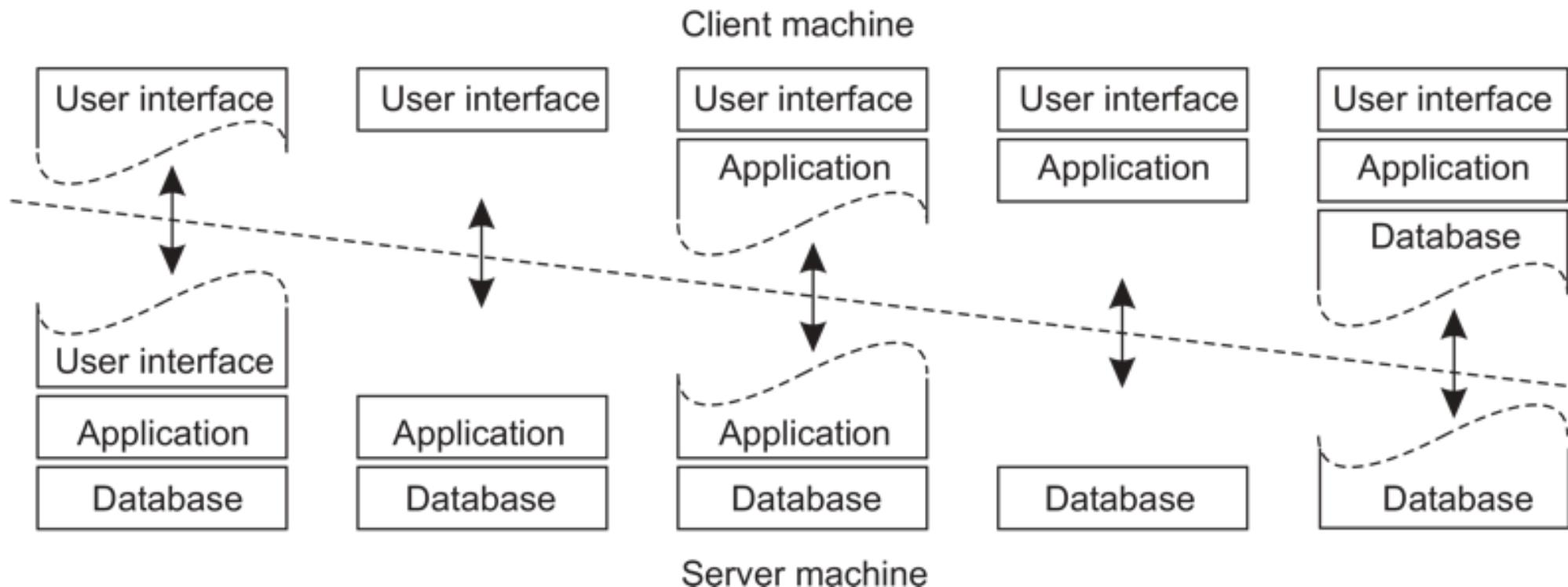
Ports and Adapters



Traditional Monolithic Design



Schichtenarchitektur im Client Server Modell



Microservices

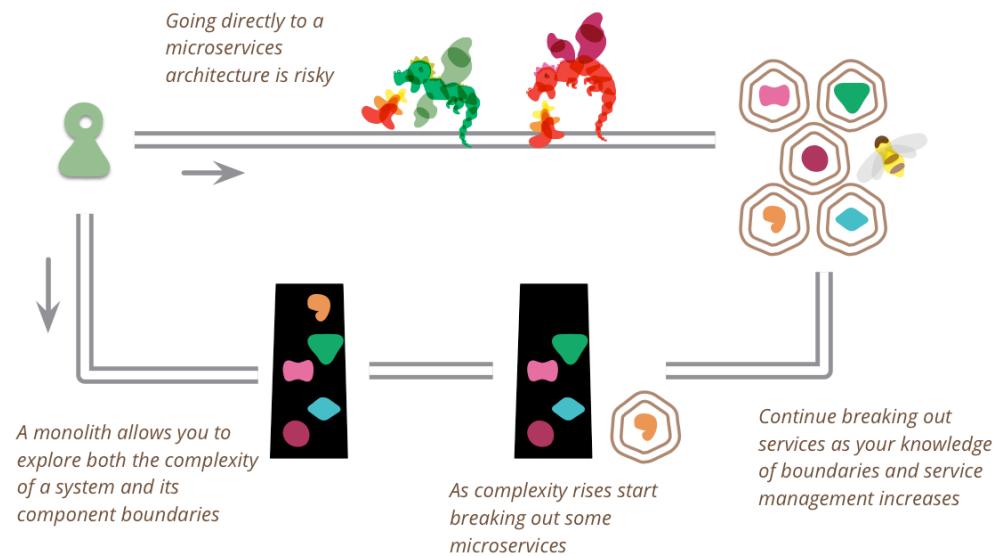
- Maximale Skalierbarkeit
- Einzelne Services können von **kleinen[^1]** Teams **unabhängig entwickelt und deployed** werden
- Bessere Wart- und Erweiterbarkeit
- Unterschiedliche Technologien können eingesetzt werden
- Kommunikation nicht trivial
- Höhere Wahrscheinlichkeit eines Ausfalls
- **Hohe Komplexität**

martinfowler.com/articles/microservices.html

[^1]: "We try to create teams that are no larger than can be fed by two pizzas"

Monolith First

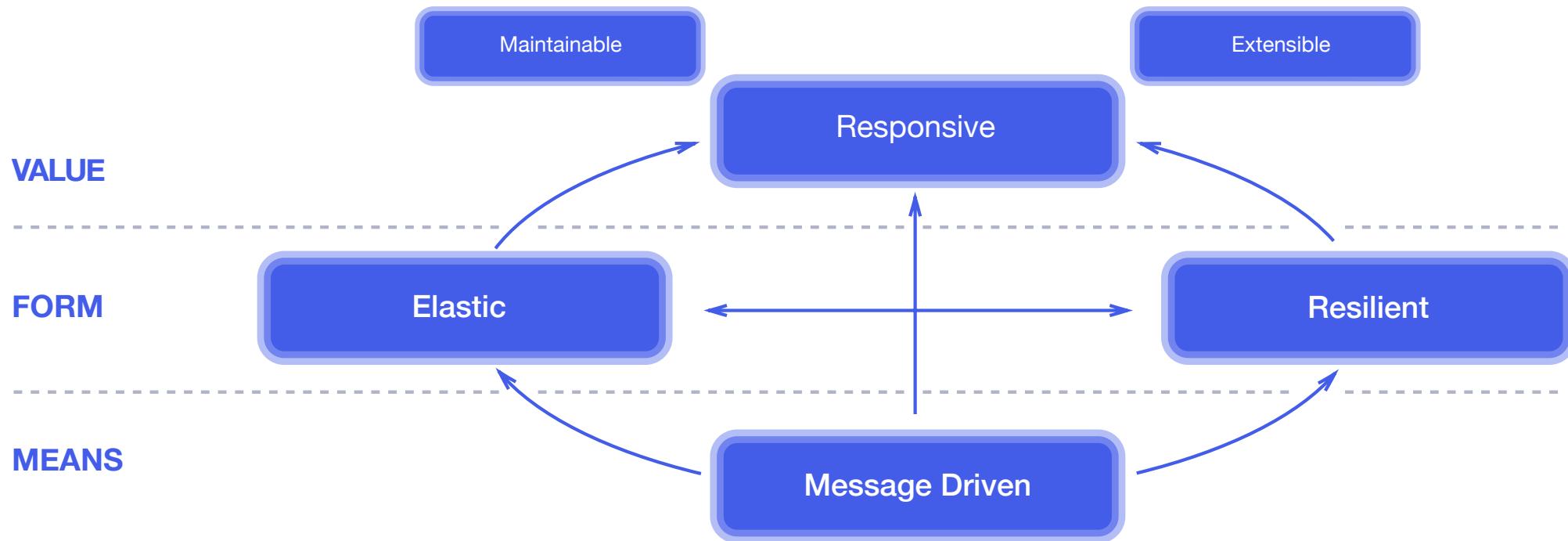
- Vorsicht vor **Cargo-Kult**: Amazon, Google, Meta etc. haben heute andere Herausforderungen als Startups
- Technologien oder Architekturen wählen, "weil Google macht das auch so" ist ein schlechter Grund



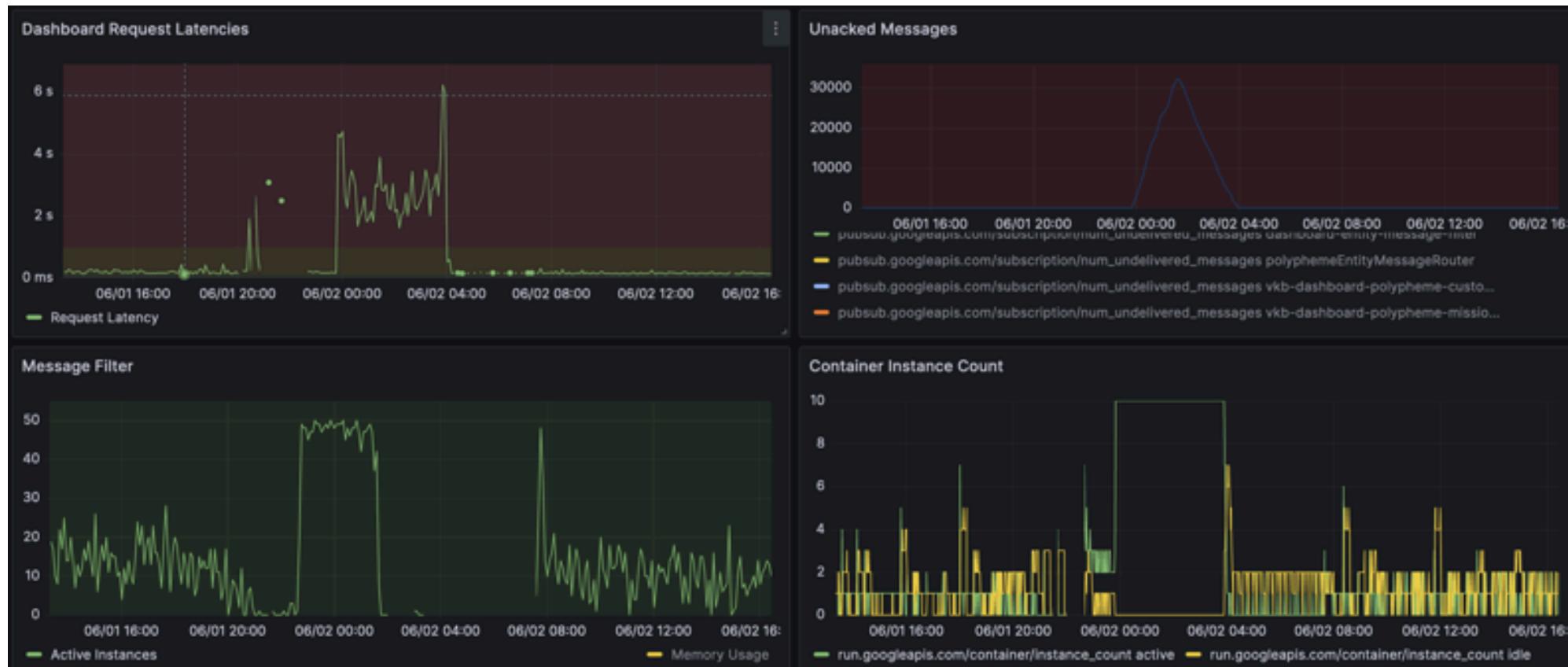
martinfowler.com/bliki/MonolithFirst.html

Event Driven Architecture

Reactive Systems



Fallstudie

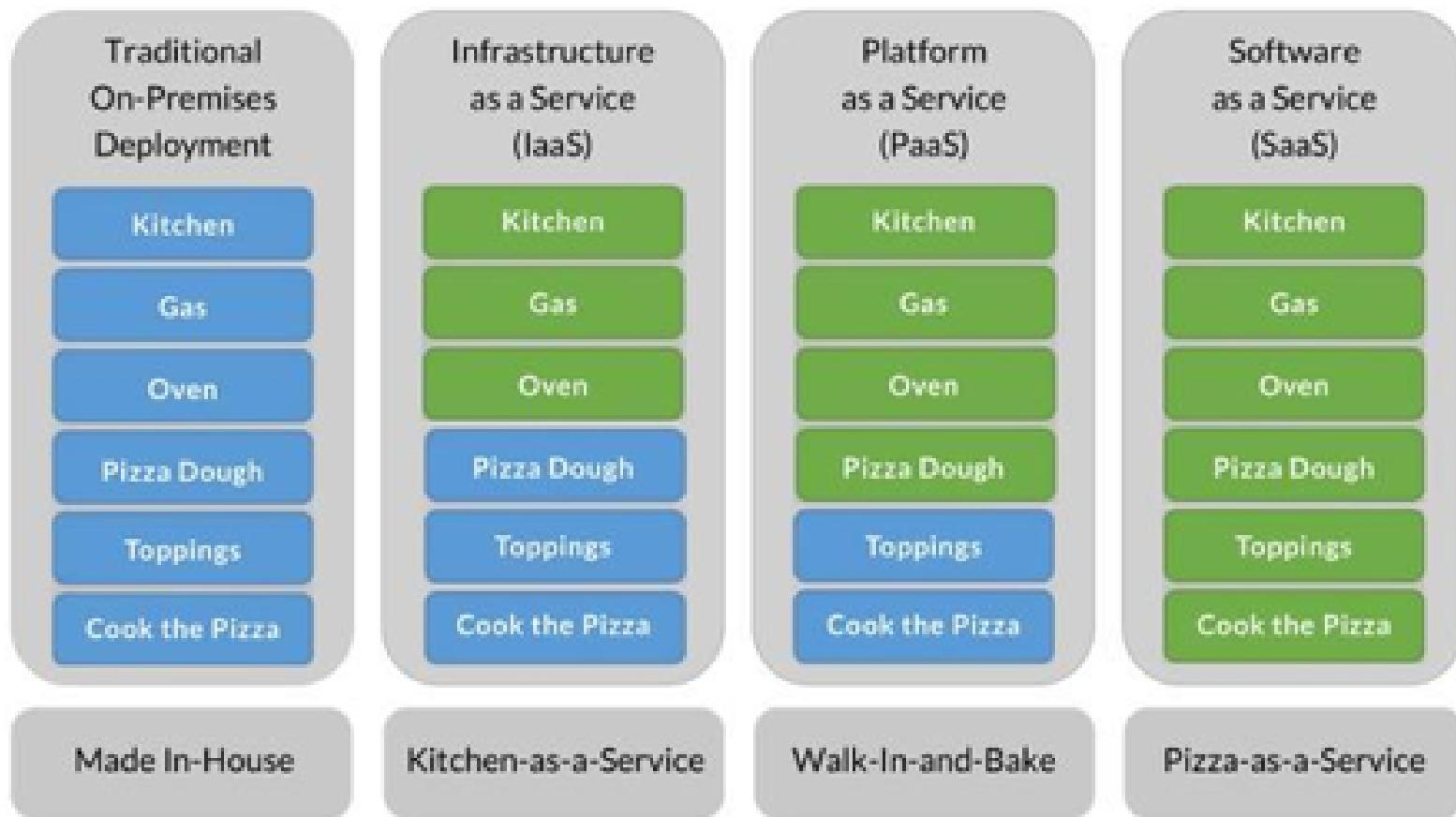


Cloud Computing

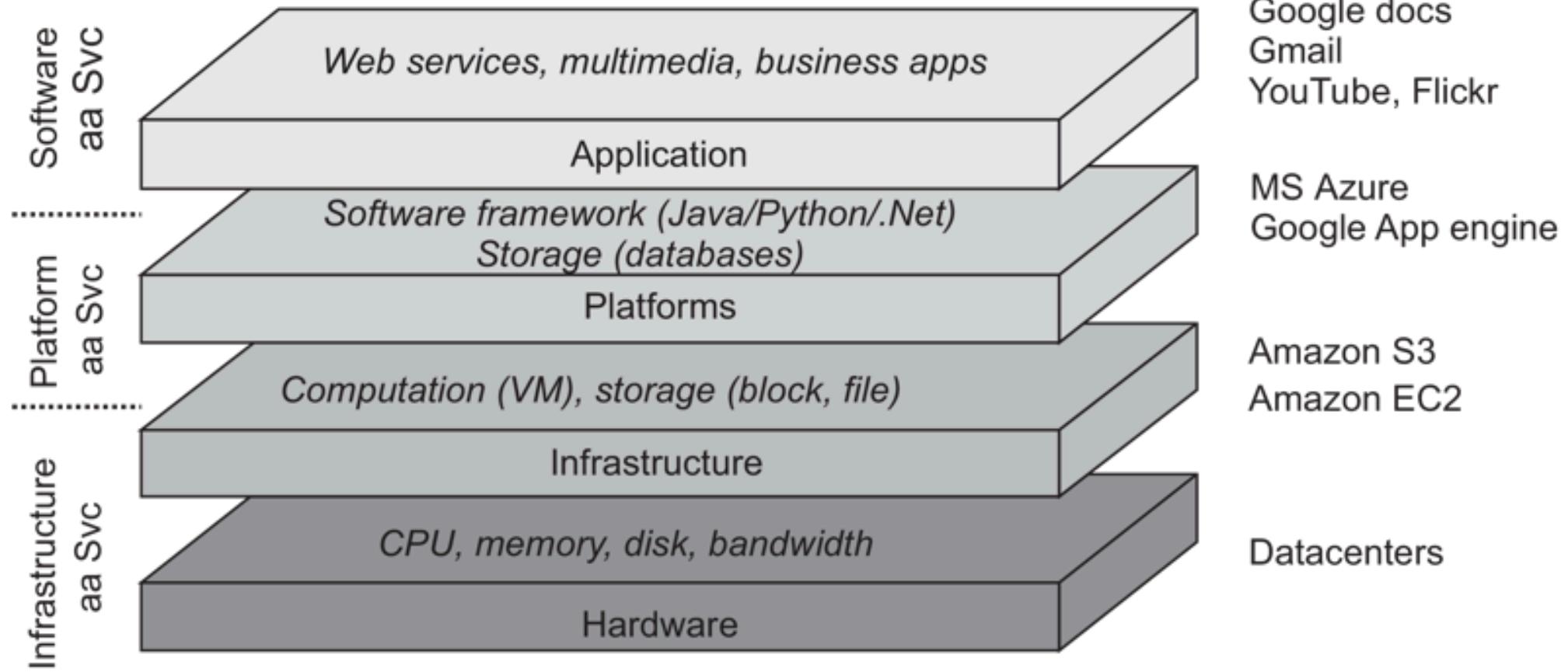
The entire history of software engineering is that of the rise in levels of abstraction.

-- Grady Booch

New Pizza as a Service



Abstractions



(VanSteen, 2017, S. 30)

XaaS

IaaS	CaaS	PaaS	FaaS	
Functions	Functions	Functions	Functions	Customer Managed
Application	Application	Application	Application	Customer Managed Unit of Scale
Runtime	Runtime	Runtime	Runtime	Abstracted by Vendor
Containers (optional)	Containers	Containers	Containers	
Operating System	Operating System	Operating System	Operating System	
Virtualization	Virtualization	Virtualization	Virtualization	
Hardware	Hardware	Hardware	Hardware	

What is a Cloud Native application?

A "cloud native" application, like all native species, has adapted and evolved to be maximally efficient in its environment: the cloud.

The cloud is a harsher environment for applications than those of the past, in particular, than the idealistic environment of a dedicated single node system.

In the cloud, an application becomes distributed. Thus, it is forced to be resilient to hardware/network unpredictability and unreliability, i.e., from varying performance to all-out failure.

<https://www.reactiveprinciples.org/cloud-native/index.html>

The bad news is that ensuring responsiveness and reliability in this harsh environment is difficult.

The good news is that the applications we build after embracing this environment better match how the real world actually works.

This in turn, provides better experiences for our users, whether humans or software.

<https://www.reactiveprinciples.org/cloud-native/index.html>

The constraints of the cloud environment, that make up the "cloud operating model," include:

- Applications are limited in the ability to scale vertically on commodity hardware which typically leads to having many isolated autonomous services (often called microservices).
- All inter-service communication takes place over unreliable networks.
- You must operate under the assumption that the underlying hardware can fail or be restarted or moved at any time.
- The services need to be able to detect and manage failure of their peers—including partial failures.
- Strong consistency and transactions are expensive. Because of the coordination required, it is difficult to make services that manage data available, performant, and scalable.

Therefore, a Cloud Native application is designed to leverage the cloud operating model.

It is predictable, decoupled from the infrastructure, right-sized for capacity, and enables tight collaboration

between development and operations.

It can be decomposed into loosely-coupled, independently-operating services that are resilient from failures, driven by data, and operate intelligently across geographic regions.

While Cloud Native applications always have a clean separation of state and compute,
there are two major classes of
Cloud Native applications: stateful and stateless.

Each class addresses and excels in a different set of use-cases;
non-trivial modern Cloud Native applications are usually a combination and composition of
the two.

Quellen

Farley, 2022

: David Farley (2022): Modern Software Engineering: Doing What Works to Build Better Software Faster, Addison-Wesley

Martin, 2018

: Robert C. Martin (2018): Clean Architecture: A Craftman's Guide to Software Structure and Design, Prentice Hall

Richards, 2021

: Mark Richards, Neal Ford (2021): Handbuch moderner Softwarearchitektur: Architekturstile, Patterns und Best Practices,
O'Reilly, 978-3-96009-149-3