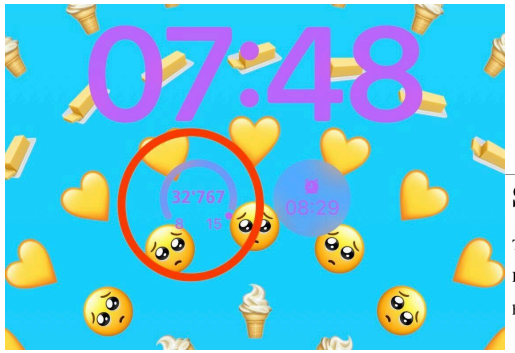
Einstieg

Internet of Bugs

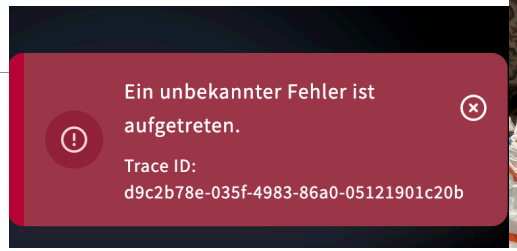


Service Unavailable - DNS failure

The server is temporarily unable to service your request. Please try again later.

Reference #11.84161502.1741077553.50f924e

https://errors.edgesuite.net/11.84161502.1741077553.50f924e

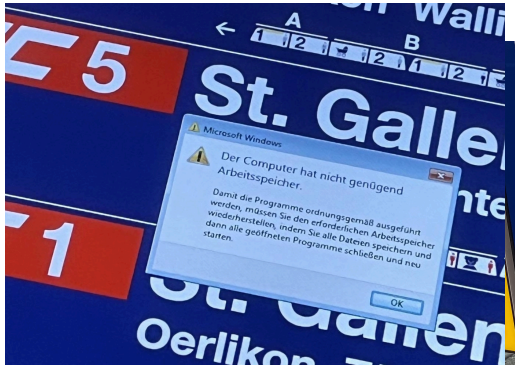


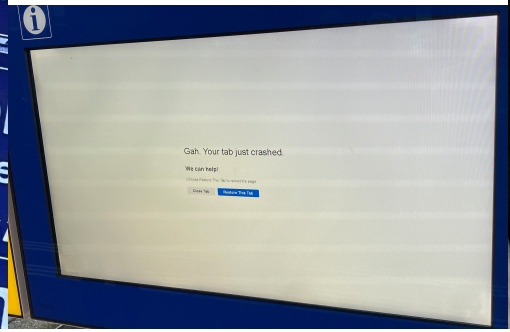
Genève Aéroport
about an hour ago

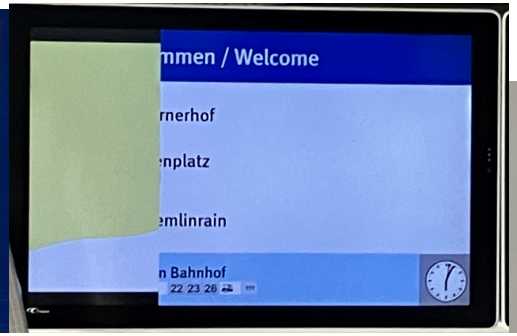
⚠️ Suite à une panne informatique, des retards sont à attendre au départ et à l'arrivée.

Nous sommes désolés pour les désagréments et faisons tout notre possible pour rétablir la situation.

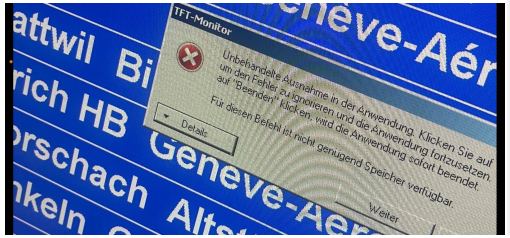
Nous demandons aux passagers de contacter leur compagnie aérienne. ... See more







Auf Grund technischen Problemen bleibt die Filiale momentan geschlossen



Logo DIE POST

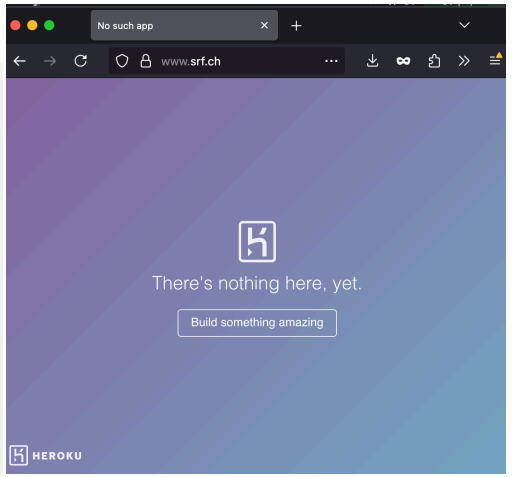
Falsche E-Mail mit Betreff «Lorem ipsum»

Lieber Herr Hirter

Sie haben gestern Abend von uns gegen 19 Uhr eine E-Mail mit dem Betreff «Lorem ipsum» erhalten.

Wir sprechen jetzt wieder Klartext – versprochen! Die betreffende E-Mail ist auf einen internen technischen Fehler zurückzuführen und Sie können sie direkt in Ihren digitalen Papierkorb verschieben. Bitte entschuldigen Sie daraus entstandene Unannehmlichkeiten.

Freundliche Grüsse
Ihre Post



Brooke Siren Systems (BSS) DPR-402 Stereo Compressor Limiter

9. Okt. 2025, 08:17 Uhr

Sofort-Kaufpreis
299.00

SOFORT KAUFEN

PREIS VORSCHLAGEN

ZU FAVORITEN HINZUFÜGEN

Lieferung
Paket B-Post, CHF 20.50
Abholung durch Käufer in 1202 Geneve, CHF 0.00

Verkäufer
T36 99.6%

Equalizertyp	Gespart	Zustand
Studiotechnik	78 kg CO_2	Gebraucht

AUF DEUTSCH ÜBERSETZEN

Used Phonics studio equalizer for sale. It offers a range of controls for precise sound shaping and is perfect for both recording and live applications.

TEILEN ÄHNLICHEN ARTIKEL VERKAUFEN

- 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

-- https://www.srf.ch/news/international/crowdstrike-softwarefehler-der-tag-an-dem-die-it-weltweit-verrueckt-spielte-ein-ueberblick

Google

Incident affecting API Gateway, Agent Assist, AlloyDB for PostgreSQL, Apigee, Apigee Edge Public Cloud, Apigee Hybrid, Cloud Data Fusion, Cloud Firestore, Cloud Logging, Cloud Memorystore, Cloud Monitoring, Cloud Run, Cloud Security Command Center, Cloud Shell, Cloud Spanner, Cloud Workstations, Contact Center AI Platform, Contact Center Insights, Data Catalog, Database Migration Service, Dataform, Dataplex, Dataproc Metastore, Datastream, Dialogflow CX, Dialogflow ES, Google App Engine, Google BigQuery, Google Cloud Bigtable, Google Cloud Composer, Google Cloud Console, Google Cloud DNS, Google Cloud Dataflow, Google Cloud Dataproc, Google Cloud Pub/Sub, Google Cloud SQL, Google Cloud Storage, Google Compute Engine, Identity Platform, Identity and Access Management, Looker Studio, Managed Service for Apache Kafka, Memorystore for Memcached, Memorystore for Redis, Memorystore for Redis Cluster, Persistent Disk, Personalized Service Health, Pub/Sub Lite, Speech-to-Text, Text-to-Speech, Vertex AI Online Prediction, Vertex AI Search, Vertex Gemini API, Vertex Imagen API, reCAPTCHA Enterprise

Multiple GCP products are experiencing Service issues.

Incident began at **2025-06-12 10:51** and ended at **2025-06-12 18:18** (all times are **US/Pacific**).

Previously affected location(s)

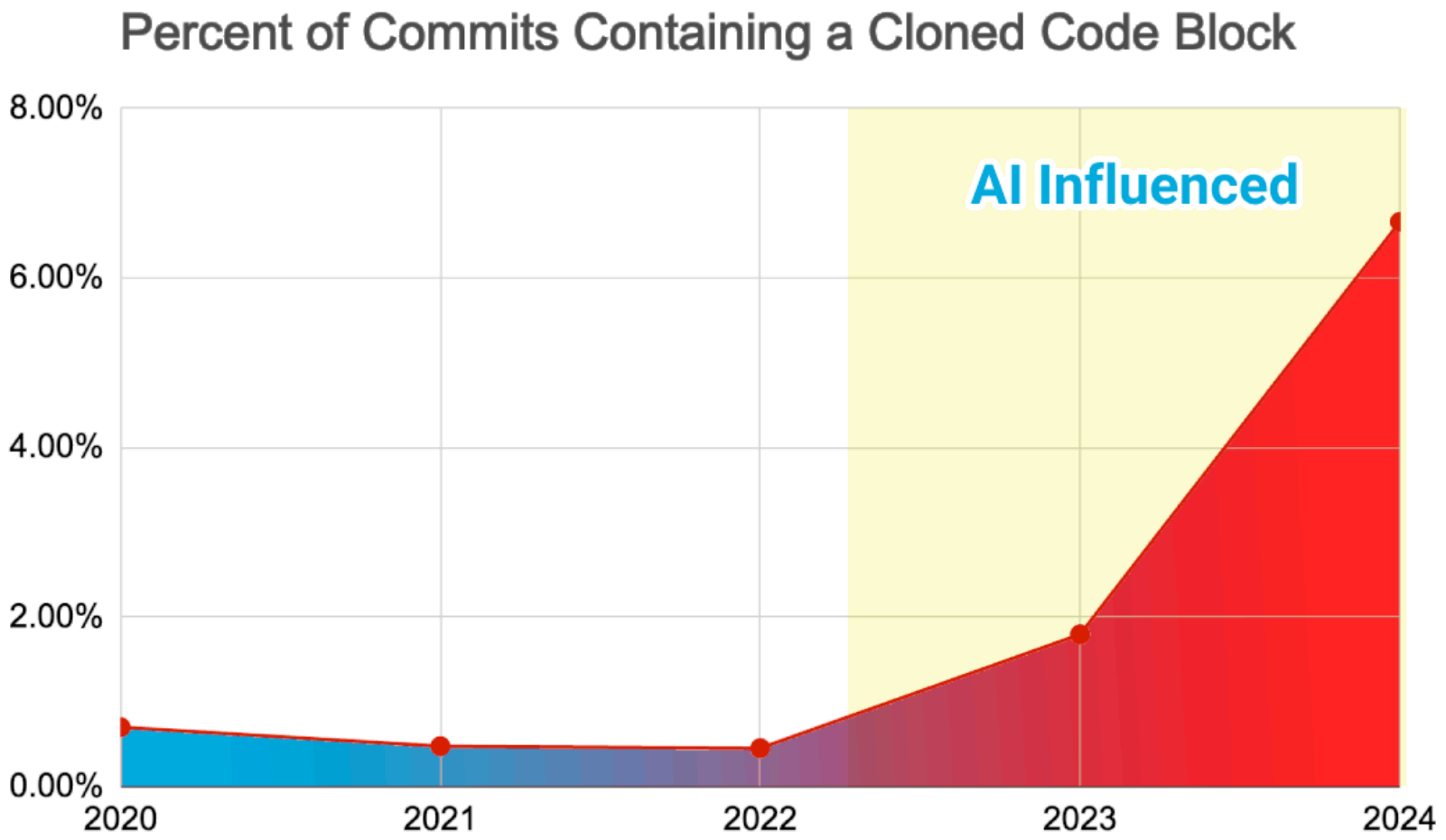
Johannesburg (africa-south1), Multi-region: asia, Taiwan (asia-east1), Hong Kong (asia-east2), Tokyo (asia-northeast1), Osaka (asia-northeast2), Seoul (asia-northeast3), Mumbai (asia-south1), Delhi (asia-south2), Singapore (asia-southeast1), Jakarta (asia-southeast2), Multi-region: asia1, Sydney (australia-southeast1), Melbourne (australia-southeast2), Multi-region: eu, Multi-region: eur3, Multi-region: eur4, Multi-region: eur5, Warsaw (europe-central2), Finland (europe-north1), Stockholm (europe-north2), Madrid (europe-southwest1), Belgium (europe-west1), Berlin (europe-west10), Turin (europe-west12), London (europe-west2), Frankfurt (europe-west3), Netherlands (europe-west4), Zurich (europe-west6), Milan (europe-west8), Paris (europe-west9), Global, Doha (me-central1), Dammam (me-central2), Tel Aviv (me-west1), Multi-region: nam-eur-asia1, Multi-region: nam10, Multi-region: nam11, Multi-region: nam12, Multi-region: nam13, Multi-region: nam3, Multi-region: nam5, Multi-region: nam6, Multi-region: nam7, Multi-region: nam8, Multi-region: nam9, Montréal (northamerica-northeast1), Toronto (northamerica-northeast2), Mexico (northamerica-south1), São Paulo (southamerica-east1), Santiago (southamerica-west1), Multi-region: us, Iowa (us-central1), South Carolina (us-east1), Northern Virginia (us-east4), Columbus (us-east5), Dallas (us-south1), Oregon (us-west1), Los Angeles (us-west2), Salt Lake City (us-west3), Las Vegas (us-west4)

https://status.cloud.google.com/incidents/ow5i3PPK96RduMcb1SsW

AWS 20.10.25

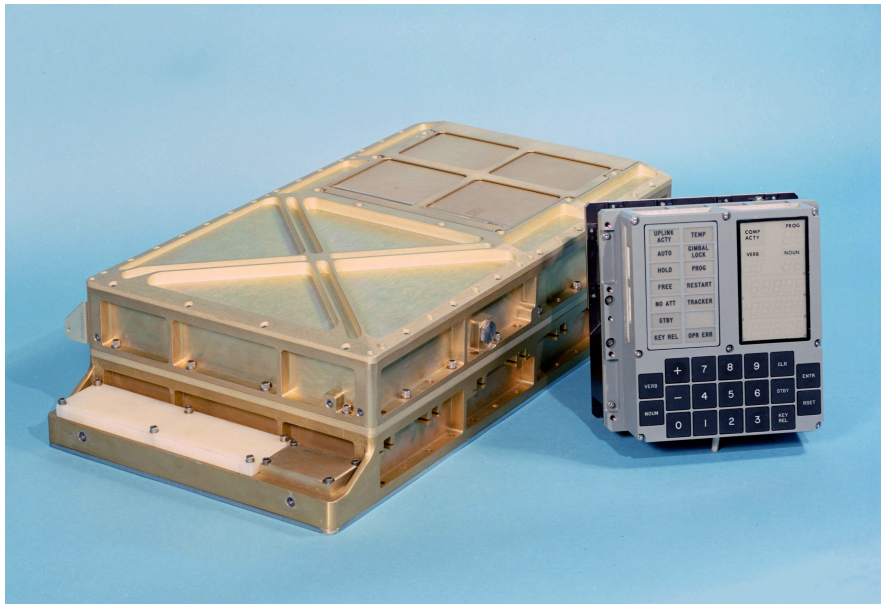
> Between **11:49 PM** PDT on October 19 and 2:24 AM PDT on October 20, we experienced increased error rates and latencies for AWS Services in the **US-EAST-1** Region. Additionally, services or features that rely on US-EAST-1 endpoints such as **IAM and DynamoDB** Global Tables also experienced issues during this time. At 12:26 AM on October 20, we identified the trigger of the event as **DNS resolution** issues for the regional DynamoDB service endpoints. [...] As we continued to work through EC2 instance launch impairments,[...] connectivity issues in multiple services such as **Lambda, DynamoDB, and CloudWatch**. [...] By **3:01 PM**, all AWS services returned to normal operations. [...]

-- https://health.aws.amazon.com/health/status



-- https://www.gitclear.com/ai_assistant_code_quality_2025_research

Ab 1961: Margaret Hamilton, Apollo Guidance Computer



> “I remember thinking, Oh my God, it worked,” the pioneering software engineer tells TIME. “I was so happy. But I was more happy about it working than about the fact that we landed.”

-- https://time.com/3948364/moon-landing-apollo-11-margaret-hamilton/

Anforderungen an (moderne) Software

> - the problems of achieving sufficient reliability in the data systems which are becoming increasingly integrated into the central activities of modern society
> - the difficulties of meeting schedules and specifications on large software projects
> - the education of software (or data systems) engineers

-- SOFTWARE ENGINEERING, Report on a conference sponsored by the NATO SCIENCE COMMITTEE, Garmisch, Germany, 7th to 11th October 1968
http://homepages.cs.ncl.ac.uk/brian.randell/NATO/nato1968.PDF

Agiles Manifest

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

2001, https://agilemanifesto.org/

Anforderungen an Software

Software soll den Kunden Mehrwert bringen

- Software soll zuverlässig sein
- Neue Features sollten schnell umgesetzt und nutzbar sein

Zuverlässigkeit

- 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

Softwarekrise

Softwaresysteme werden immer komplexer

> “[The major cause of the software crisis is] that the machines have become several orders of magnitude more powerful! To put it quite bluntly: as long as there were no machines, programming was no problem at all; when we had a few weak computers, programming became a mild problem, and now we have gigantic computers, programming has become an equally gigantic problem.”

-- Edsger Dijkstra: The Humble Programmer
https://www.cs.utexas.edu/~EWD/ewd03xx/EWD340.PDF, 1972

Software Engineering vs Software Architecture vs Software Development

> 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, Software Architektur und Softwareentwicklung ist fliessend.
- Grundsätzlich sollen alle Beteiligten in allen Bereichen bewandert sein.

Kommunikation

Mehrere Personen arbeiten am selben Softwareprojekt

- Fachkräftemangel
- Ausbildung ist sehr herausfordernd
- Wissenstransfer

Lernen

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

(vgl. Farley, 2022, S.4)

Komplexität "managen"

- 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)

Generative KI

- LLMs können inherent nur durchschnittliche Antworten generieren
- Je nach Fragestellung kann das hilfreich sein oder auch nicht
- Längere generierte Texte scheinen oft auf den ersten Blick sehr gut, bei genauerer Betrachtung aber inhaltsleer, inkorrekt und übermässig umfangreich.
- Offensichtlich generierte Texte stossen beim Empfänger oft auf starke Ablehnung.
- Datenschutztechnisch ist die Verwendung von LLMs sehr heikel.

in der Software-Entwicklung

- Die Kontextfenster sind oft zu klein für Software-Architektur.
- Bei Code werden oft Features implementiert, die nicht gefragt wurden oder übermässig komplizierte Lösungen entworfen.
- Der Nutzen durch die schnelle Code-Generierung wird durch längeres Debugging und Refactoring oft zunichtegemacht.
- Diskutieren von Architekturideen kann sehr hilfreich sein.

in der Bildung

- Wenn die inhaltliche Korrektheit wichtig ist (was sehr oft der Fall ist), muss der KI-Output vollständig überprüft werden.
- Voraussetzung dafür ist ein vollständiges Verstehen des Inhalts.
- In der Ausbildung ist dies meistens nicht der Fall.
- Der Lerneffekt ist gering, echtes Verständnis entsteht, wenn man sich intensiv mit einer Materie auseinandersetzt.
- Um auf dem Arbeitsmarkt erfolgreich zu sein, ist kritisches Denken essenziell.
- Ein Studium ist das ideale Umfeld, dies zu lernen.

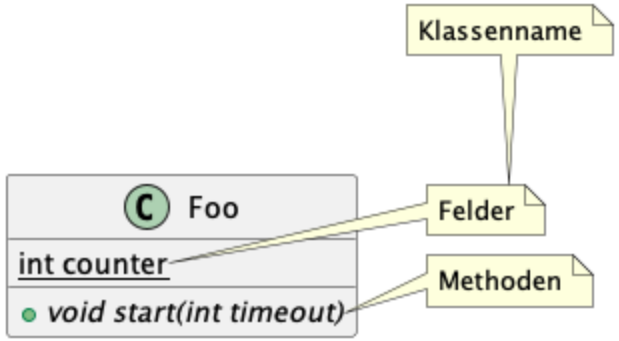
vgl. https://www.golem.de/news/produktivitaetssabotage-ki-muell-kostet-unternehmen-millionen-2509-200417.html

Konkrete Empfehlungen

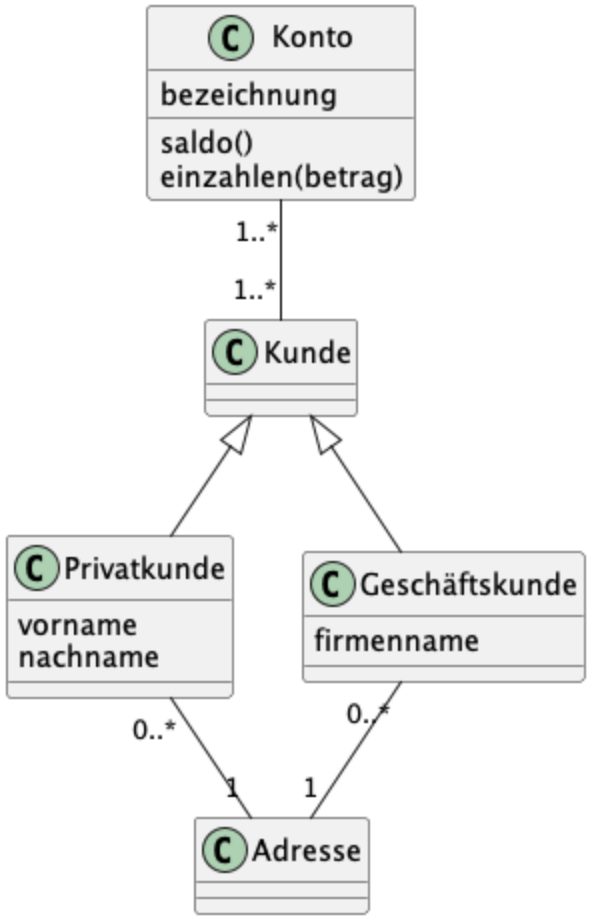
- KI verwenden für:
  - Analyse von Dokumenten(-sammlungen)
  - Boilerplate-Code
  - Formulierungen und Textkorrektur
  - Entwurf von Lösungsstrategien
- KI nicht verwenden für:
  - Schreiben von ganzen Dokumenten, Arbeiten, E-Mails
  - Schreiben von ganzen Funktionen und Klassen
  - Entwurf von ganzen Architekturen

Kommunikation

UML Klassendiagramm



PlantUML


Konto
bezeichnung
saldo()
einzahlen(betrag)
1..*
1..*
Kunde
Privatkunde
vorname
nachname
Geschäftskunde
firmenname
0..*
1
0..*
1
Adresse

PlantUML

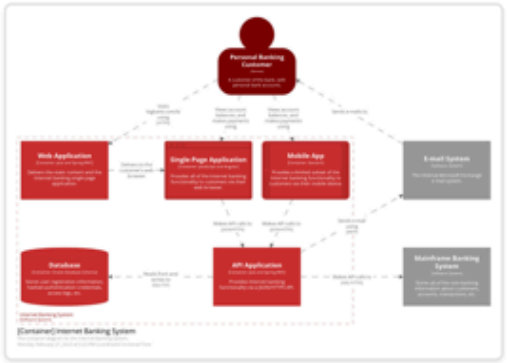
```
@startuml
class Konto {
    bezeichnung
    saldo()
    einzahlen(betrag)
}

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

- Ähnlich wie verschiedene Zoom-Stufen einer Landkarte werden Diagramme mit unterschiedlichem Umfang erstellt:
  - System Context
  - Container
  - Component
  - Code
- Die ersten beiden Diagramme (System Context, Container) sind dabei die wichtigsten, da diese Informationen enthalten, die schwer im Code sichtbar sind
- Component und Code Diagramme sind eher selten nötig, da Information, die gut aus dem Code gelesen werden kann dupliziert wird.

https://c4model.com/

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

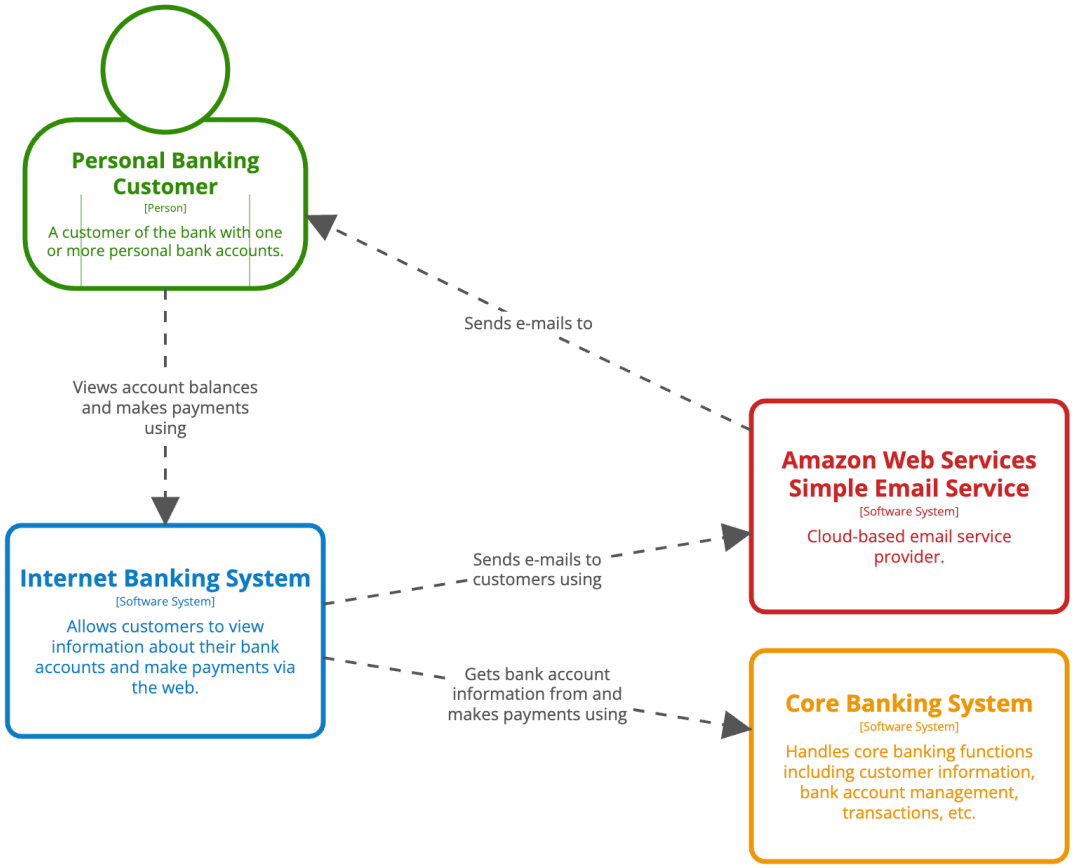


Level 2: A **Container** diagram zooms into the software system in scope, showing the high-level technical building blocks.

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.

System Context

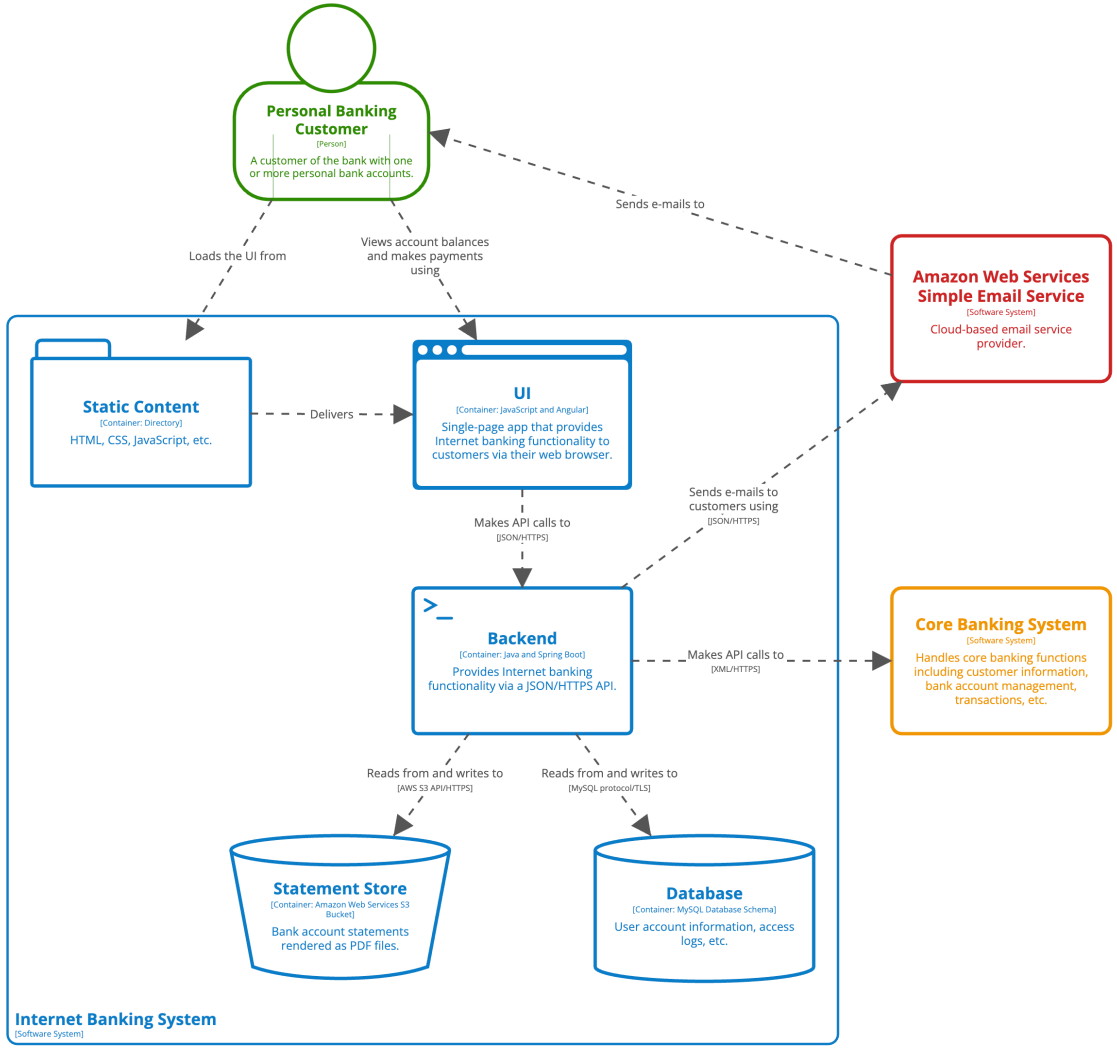


System Context View: Internet Banking System

The system context diagram for a fictional Internet Banking System | Simon Brown | c4model.com | License: CC BY 4.0

https://c4model.com/diagrams/system-context

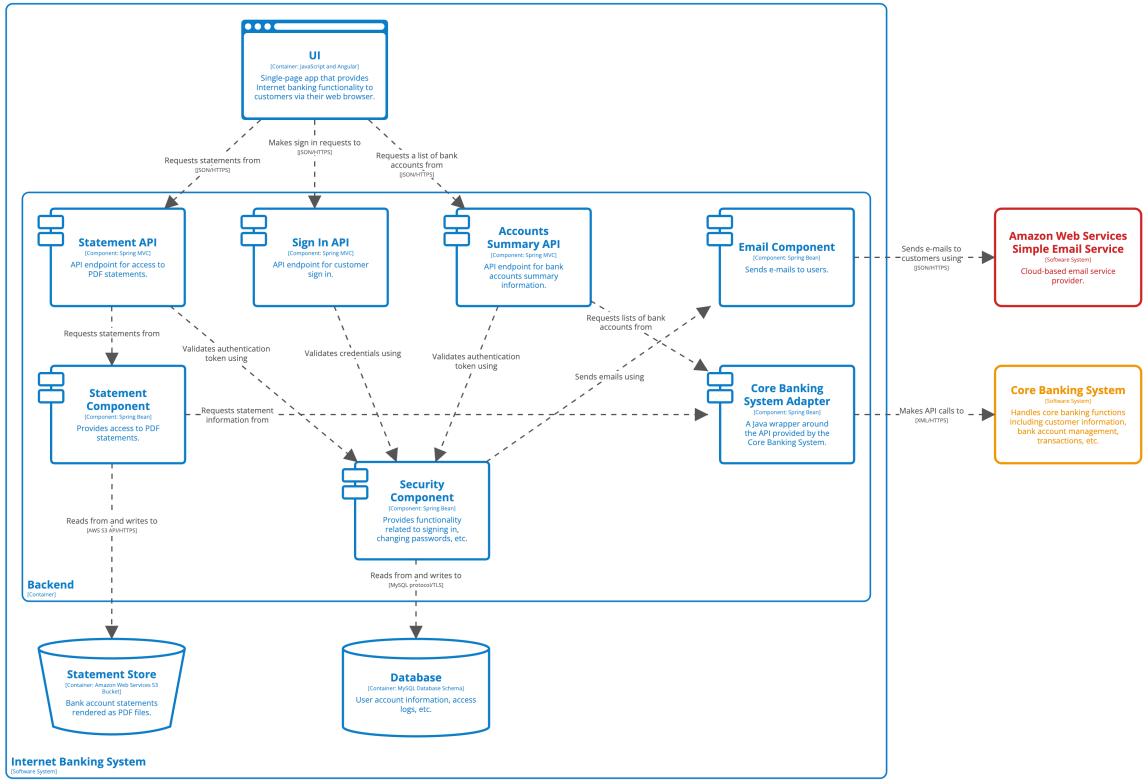
Container Diagram



Container View: Internet Banking System

The container diagram for the Internet Banking System | Simon Brown | c4model.com | License: CC BY 4.0

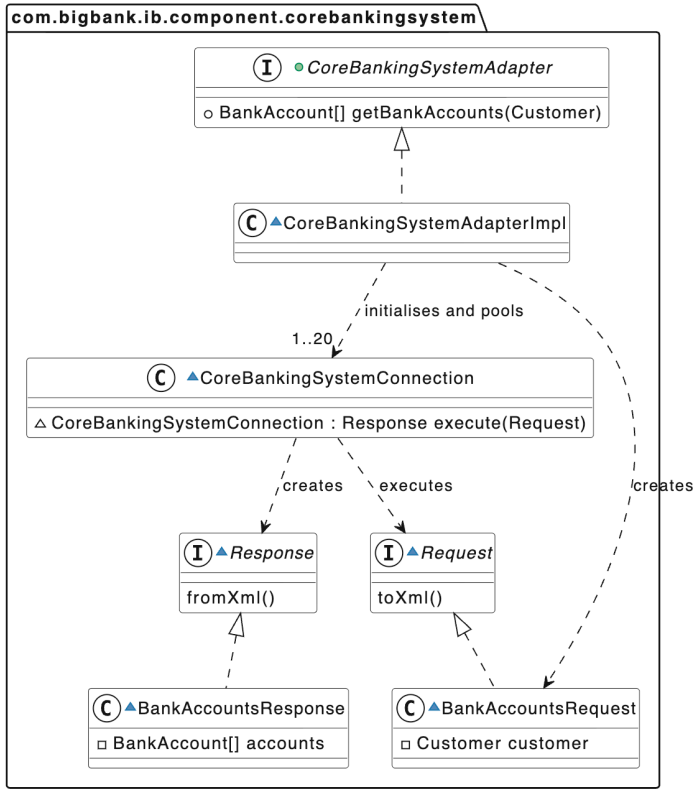
Component Diagram



Component View: Internet Banking System - Backend

The component diagram for the Internet Banking System Backend | Simon Brown | c4model.com | License: CC BY 4.0

Code Diagram



Code View: Internet Banking System - Backend - Core Banking System Adapter

A summary of the implementation details for the Core Banking System Adapter component | Simon Brown | c4model.com | License: CC BY 4.0

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

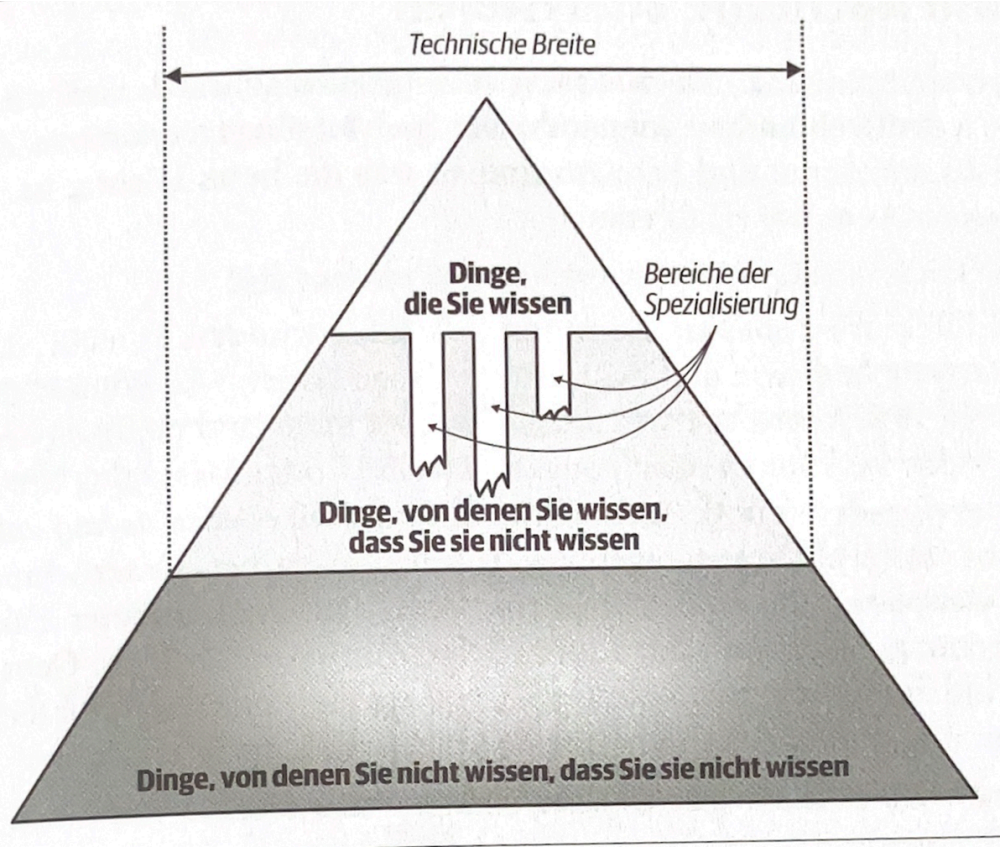
Templates

- 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

Lernen



(Richards, 2021, S.29)

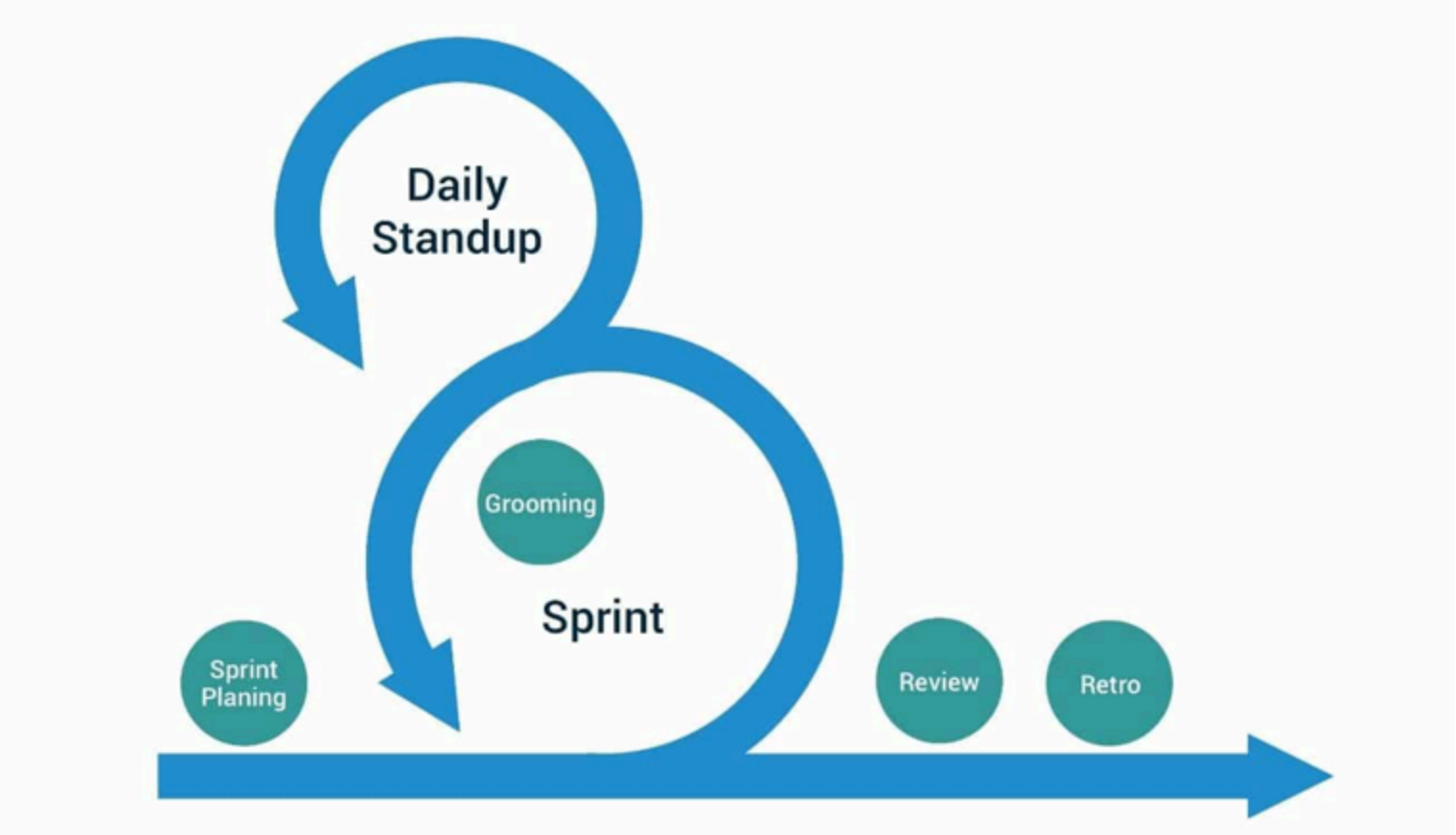
Iteratives und inkrementelles Arbeiten

Iterative

Incremental

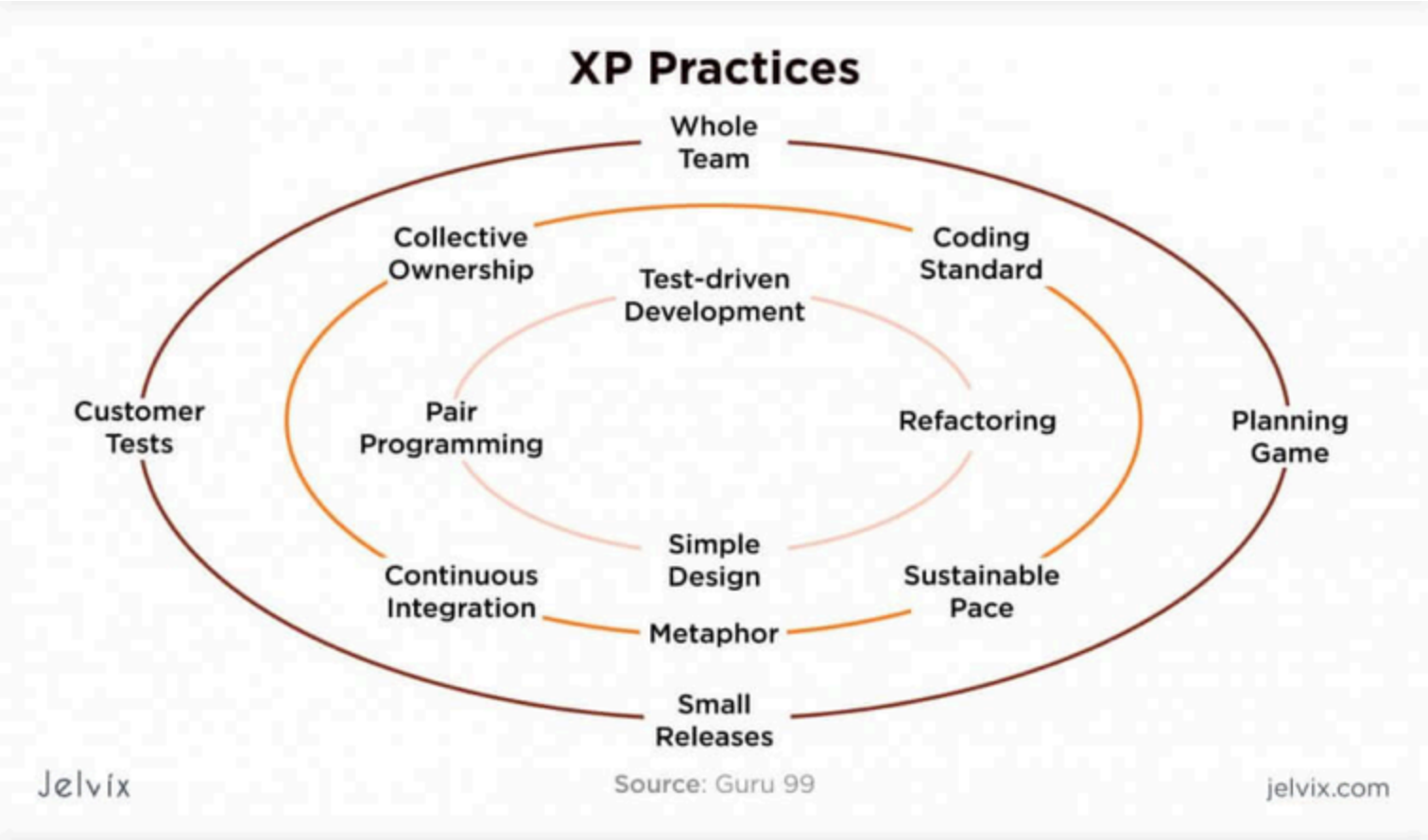
Iterative & Incremental

Iterationen



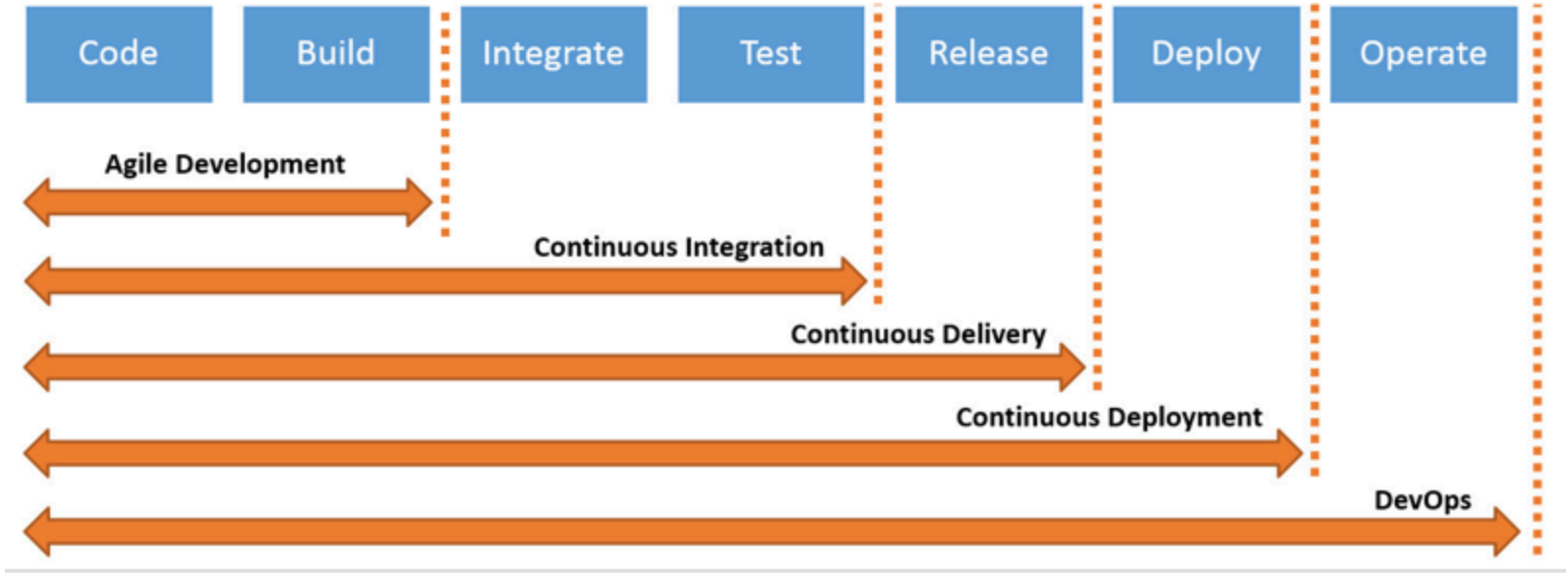
Embrace Change

Extreme Programming



Feedback

CI/CD


Code
Build
Integrate
Test
Release
Deploy
Operate
Agile Development
Continuous Integration
Continuous Delivery
Continuous Deployment
DevOps

Continuous Integration

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

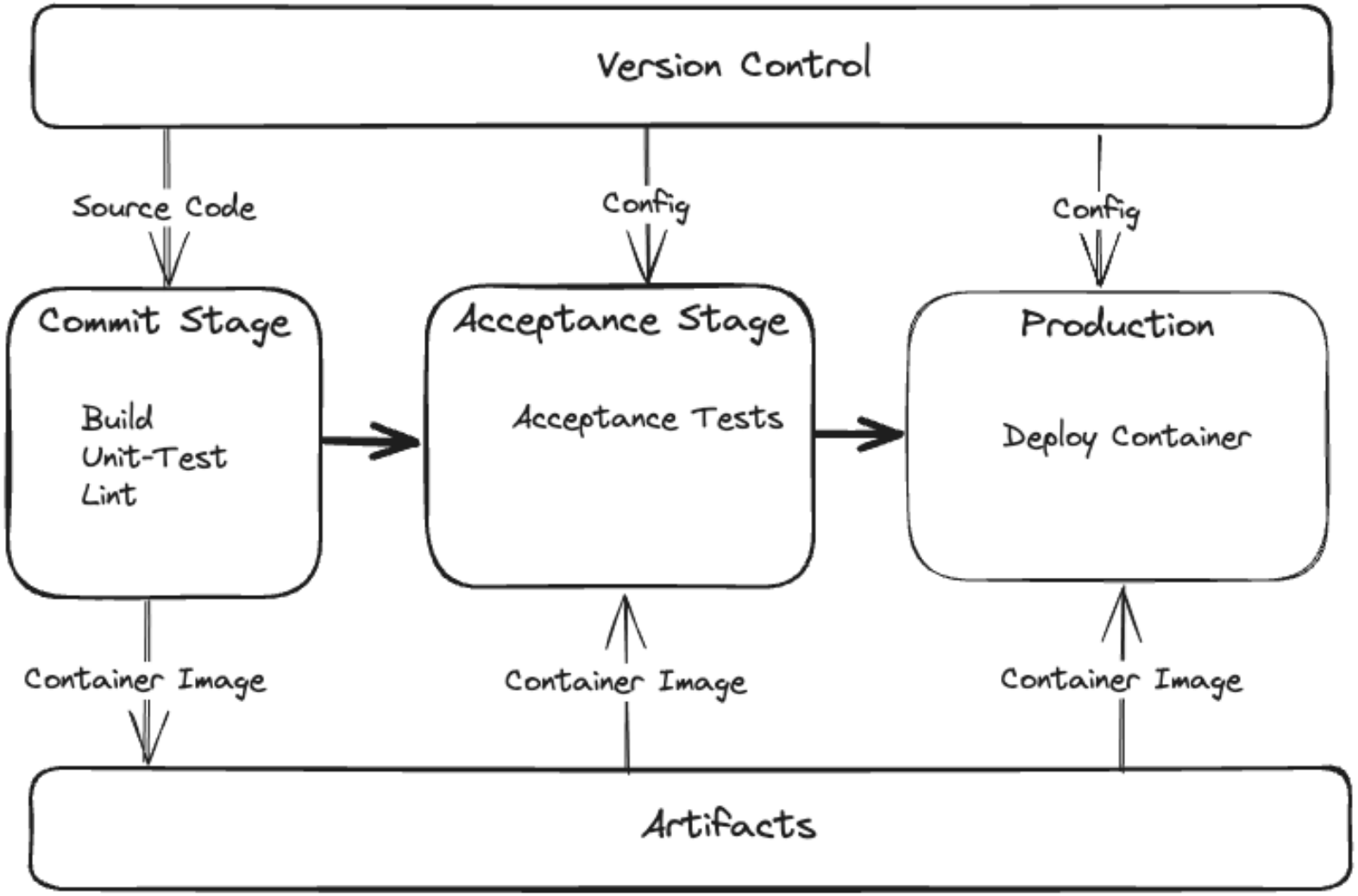
Continuous Deployment

- 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.continuousdelivery.com/

Modern Software Engineering

Deployment Pipelines



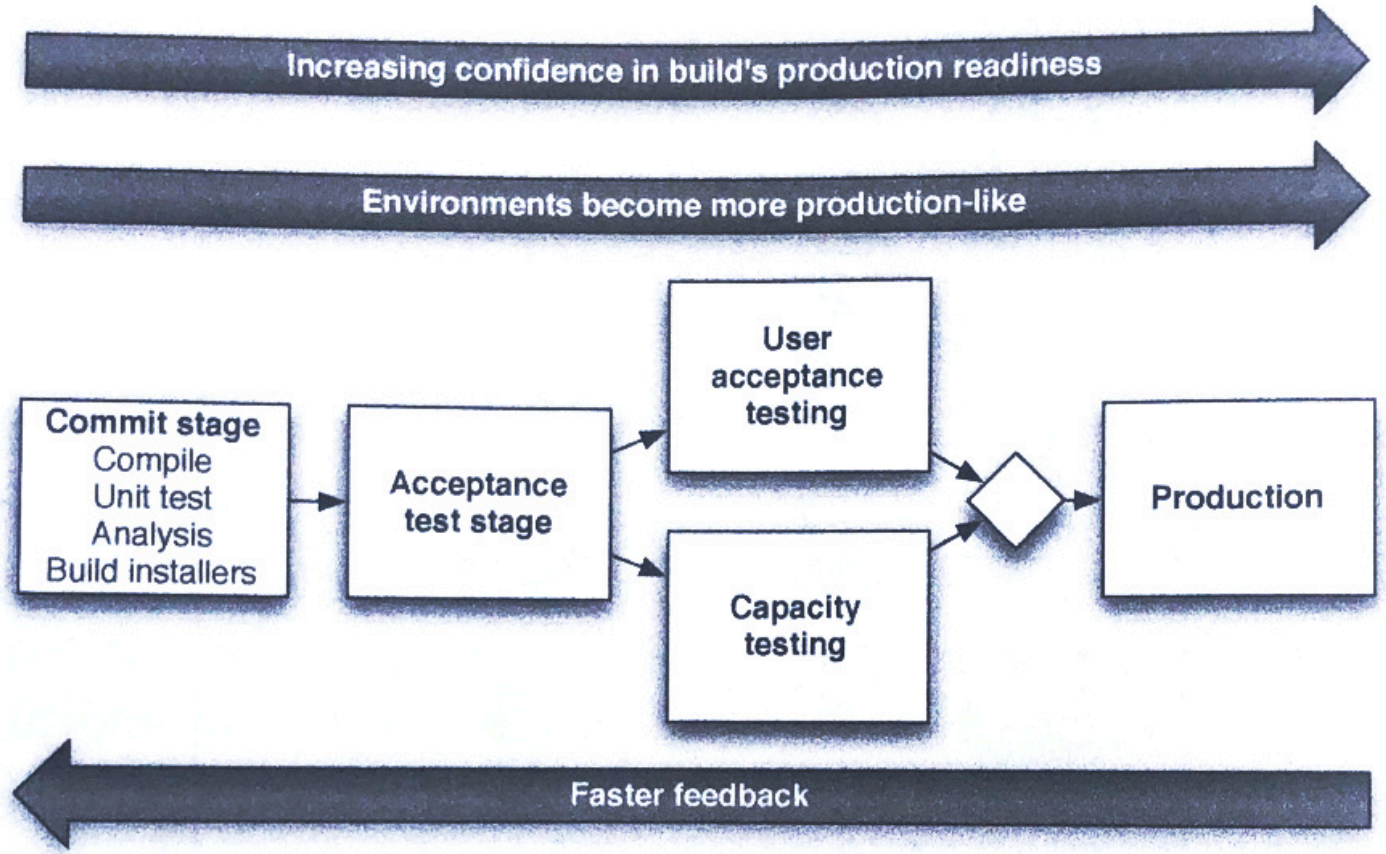
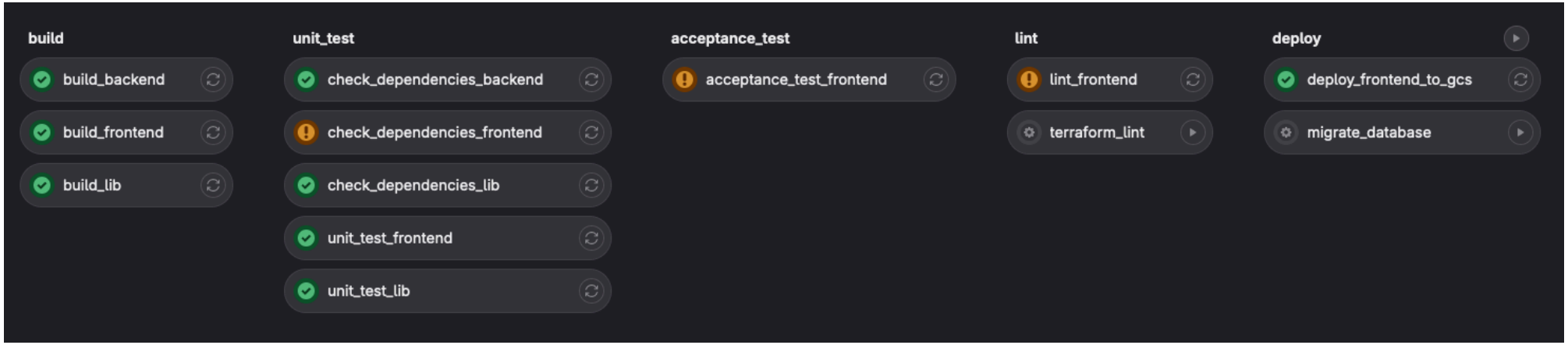
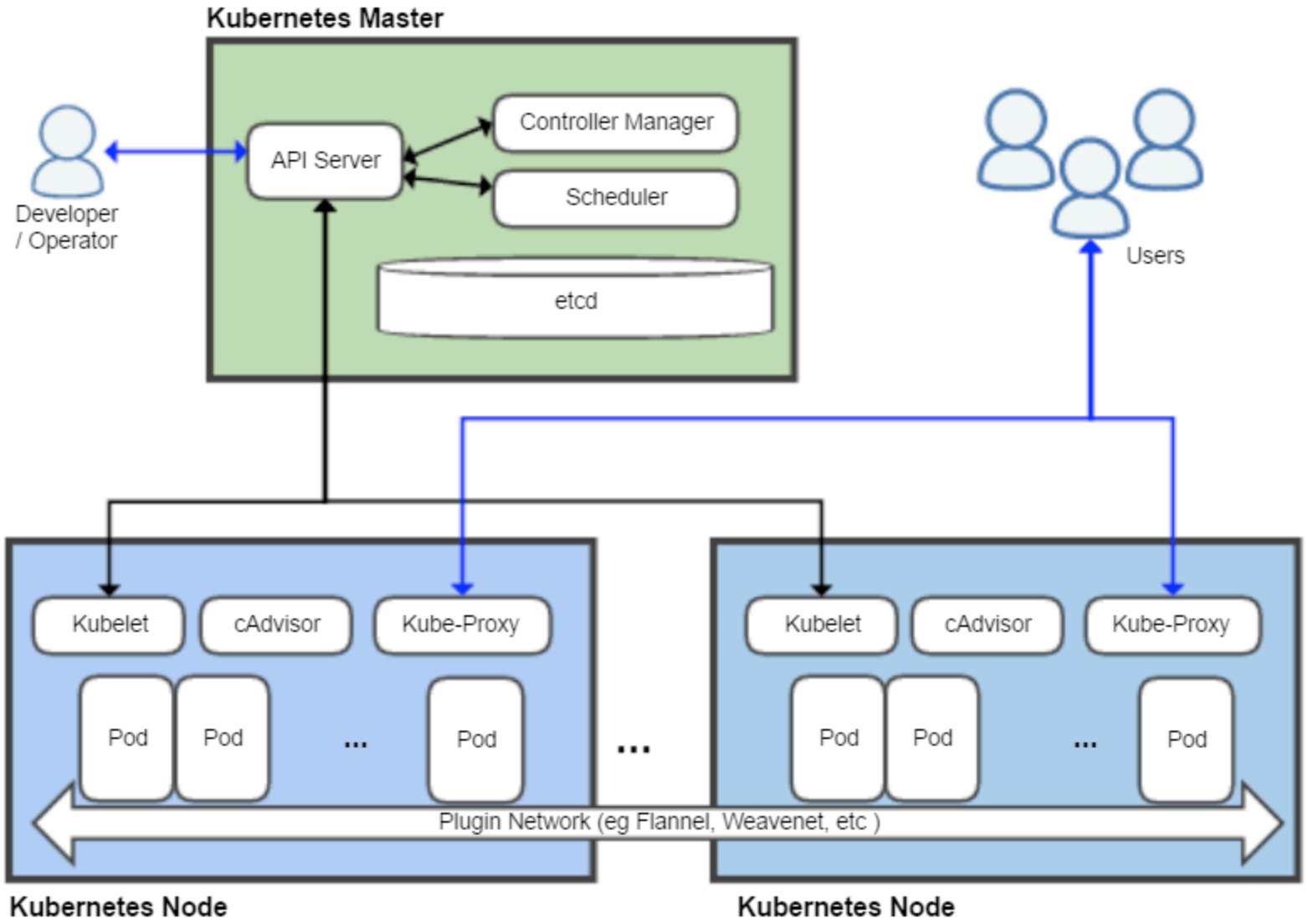


Figure 5.3 *Trade-offs in the deployment pipeline*

(Jez Humble, David Farley (2010): Continuous Delivery)


build
build_backend
build_frontend
build_lib
unit_test
check_dependencies_backend
check_dependencies_frontend
check_dependencies_lib
unit_test_frontend
unit_test_lib
acceptance_test
acceptance_test_frontend
lint
lint_frontend
terraform_lint
deploy
deploy_frontend_to_gcs
migrate_database

Kubernetes


Kubernetes Master
Developer
/ Operator
API Server
Controller Manager
Scheduler
etcd
Users
Kubelet
cAdvisor
Kube-Proxy
Pod
Pod
...
Pod
...
Kubelet
cAdvisor
Kube-Proxy
Pod
Pod
...
Pod
Plugin Network (eg Flannel, Weavenet, etc)
Kubernetes Node
Kubernetes Node

```yaml
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
```

(https://kubernetes.io/docs/concepts/workloads/controllers/deployment/)

Quellen

- Youtube: Continous 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

> Rule 1. You can't tell where a program is going to spend its time. Bottlenecks occur in surprising places, so don't try to second guess and put in a speed hack until you've proven that's where the bottleneck is.
>
> Rule 2. Measure. Don't tune for speed until you've measured, and even then don't unless one part of the code overwhelms the rest.
>
> Rule 3. Fancy algorithms are slow when n is small, and n is usually small. Fancy algorithms have big constants. Until you know that n is frequently going to be big, don't get fancy. (Even if n does get big, use Rule 2 first.)
>
> Rule 4. Fancy algorithms are buggier than simple ones, and they're much harder to implement. Use simple algorithms as well as simple data structures.

-- Rob Pike http://www.catb.org/~esr/writings/taoup/html/ch01s06.html

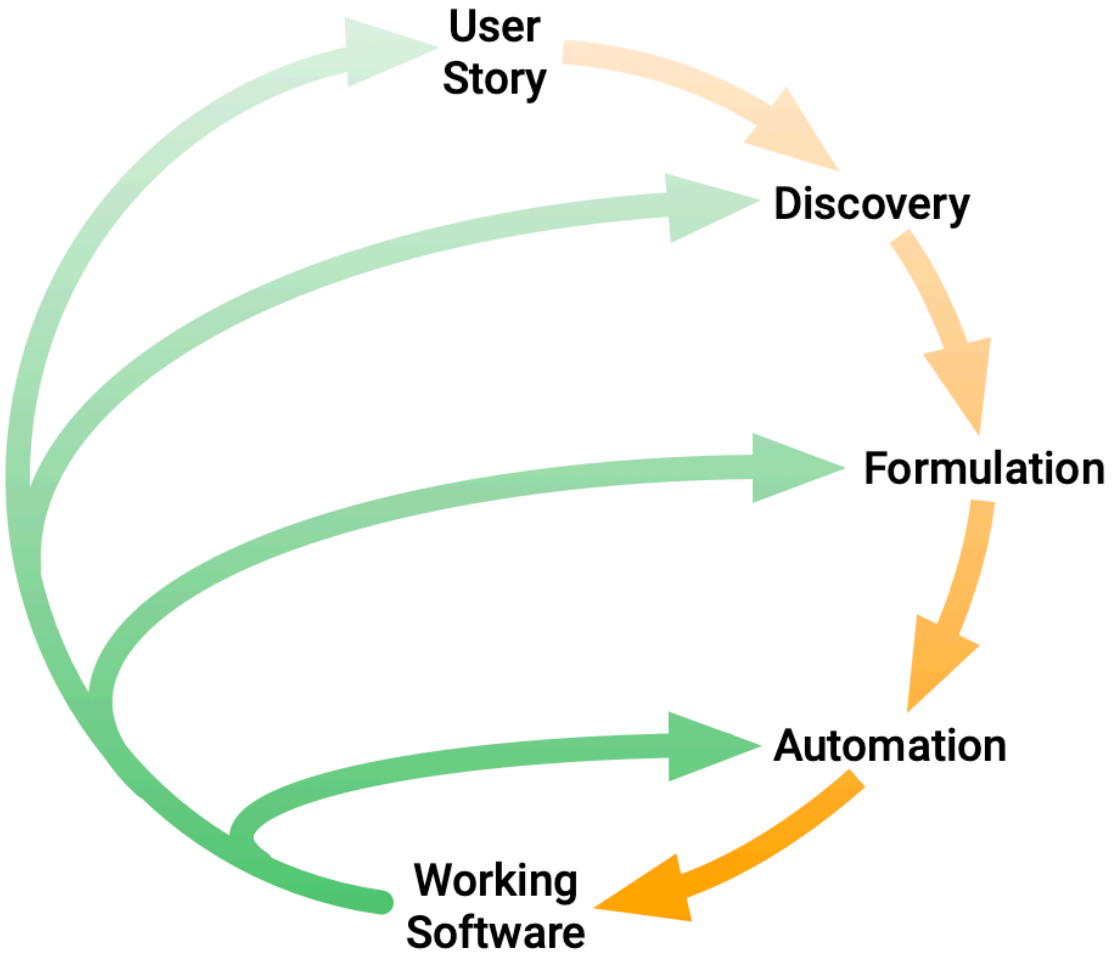
Komplexität

Modularity & Separation of Concerns

Testing

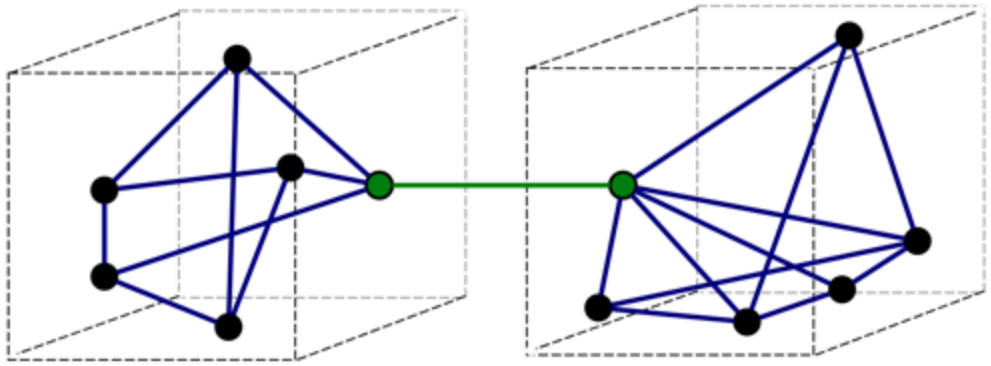
> The hardest single part of building a software system is deciding precisely what to build.

– Fred Brooks, The mythical man-month

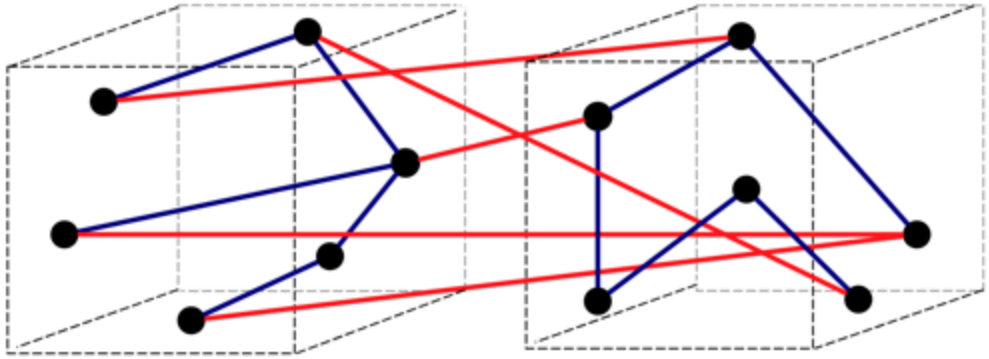


https://cucumber.io/docs/bdd/

Cohesion & Coupling



a) Good (loose coupling, high cohesion)

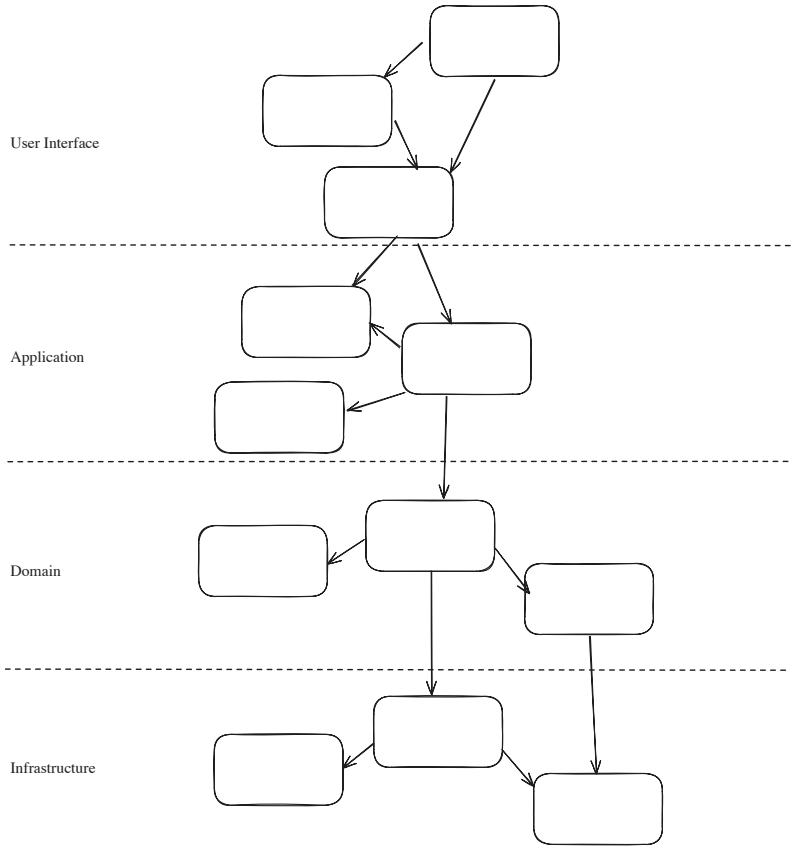


b) Bad (high coupling, low cohesion)

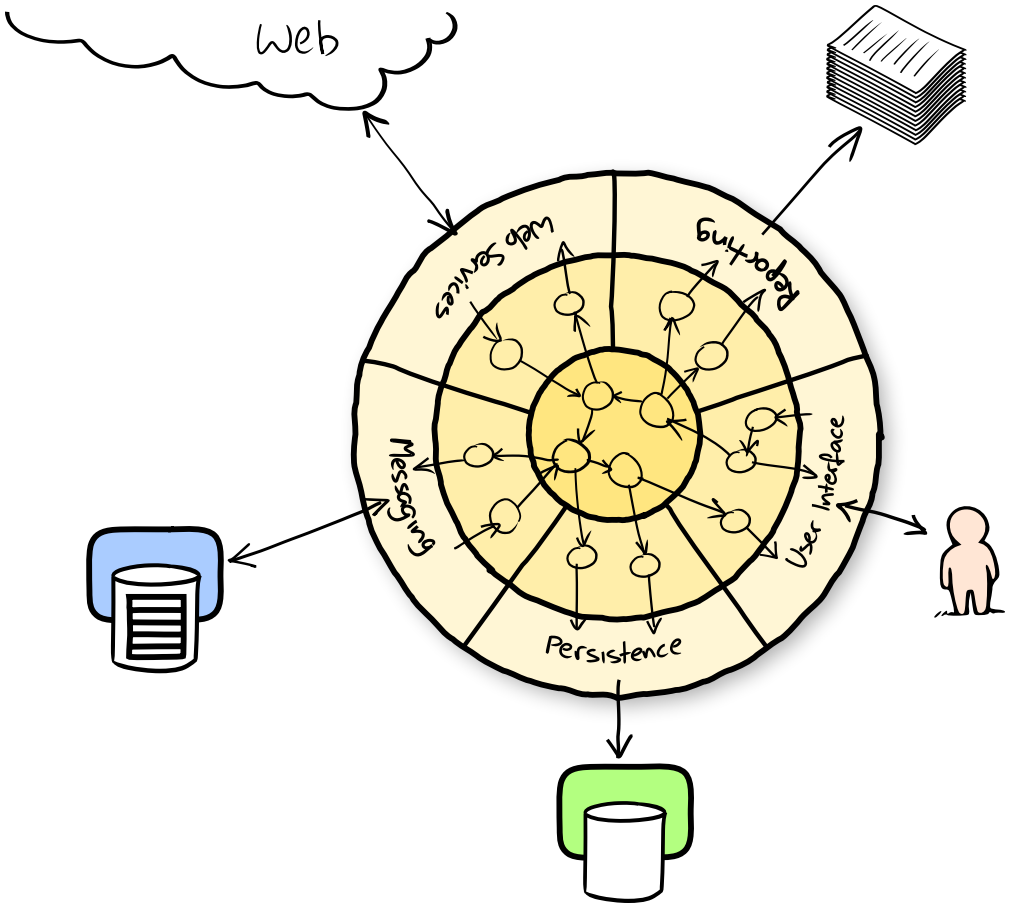
Abstraction

Architekturen

Schichtenarchitektur

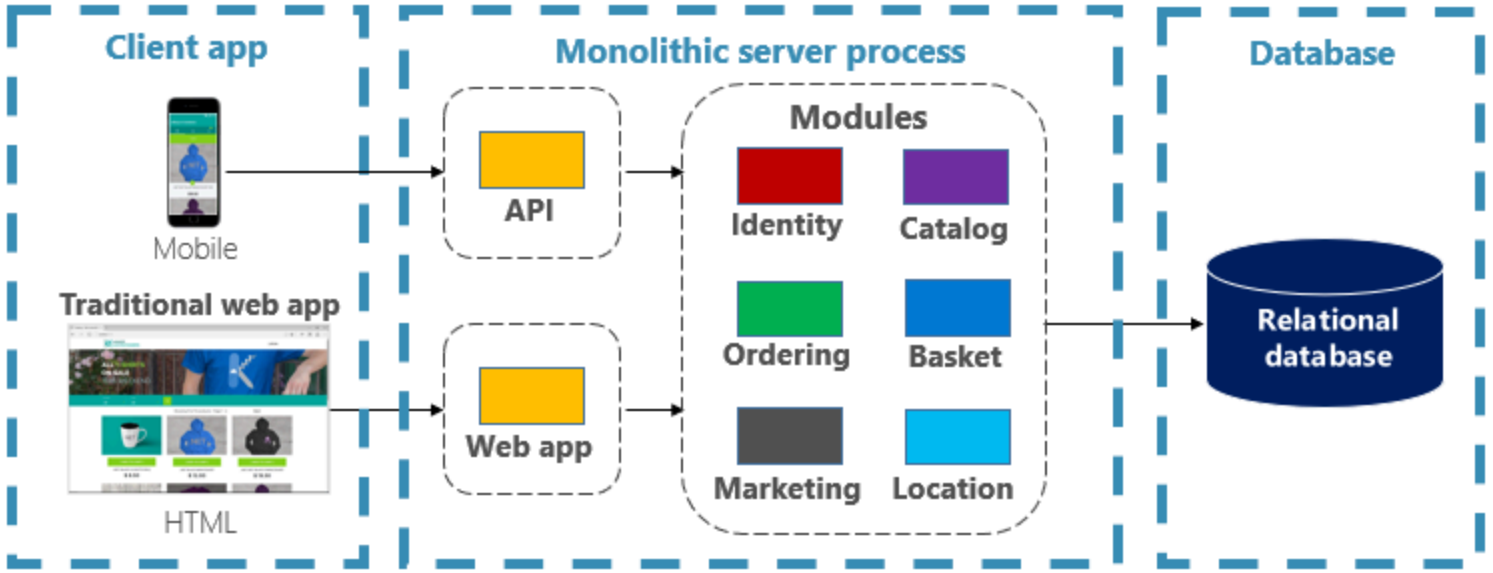


Ports and Adapters

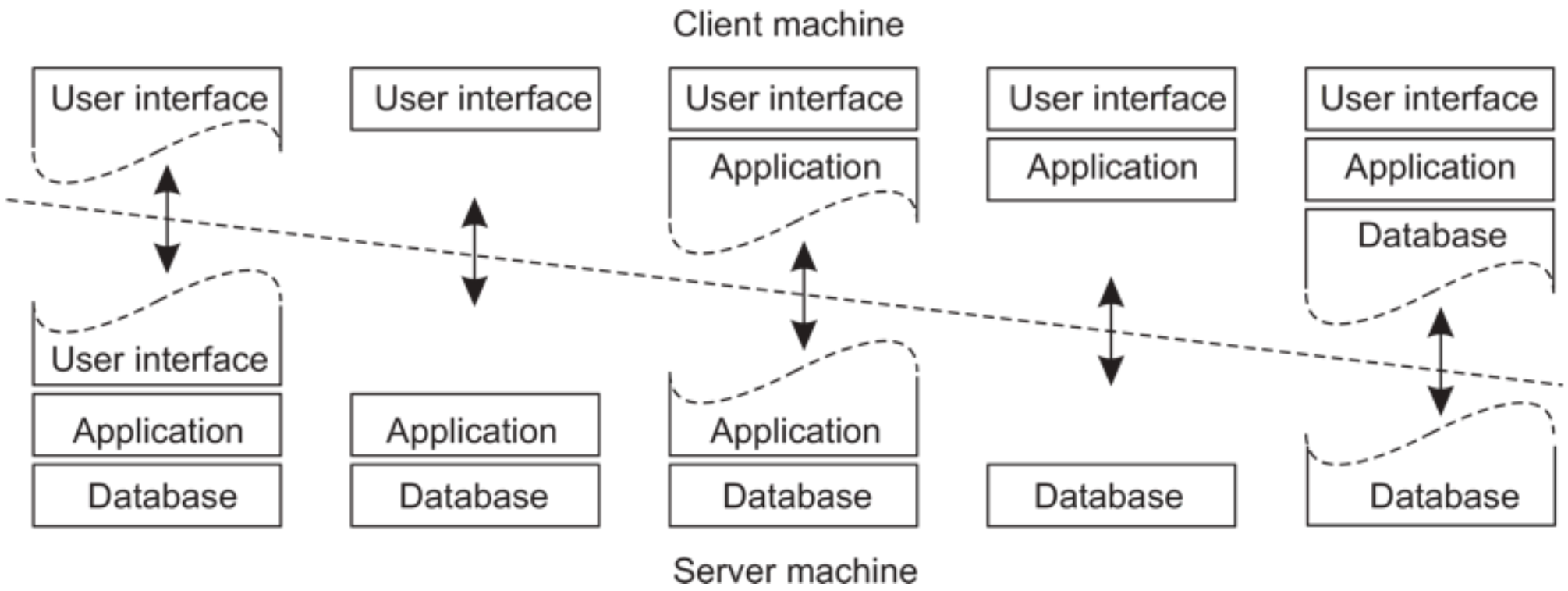


growing-object-oriented-software.com

Traditional Monolithic Design



Schichtenarchitektur im Client Server Modell



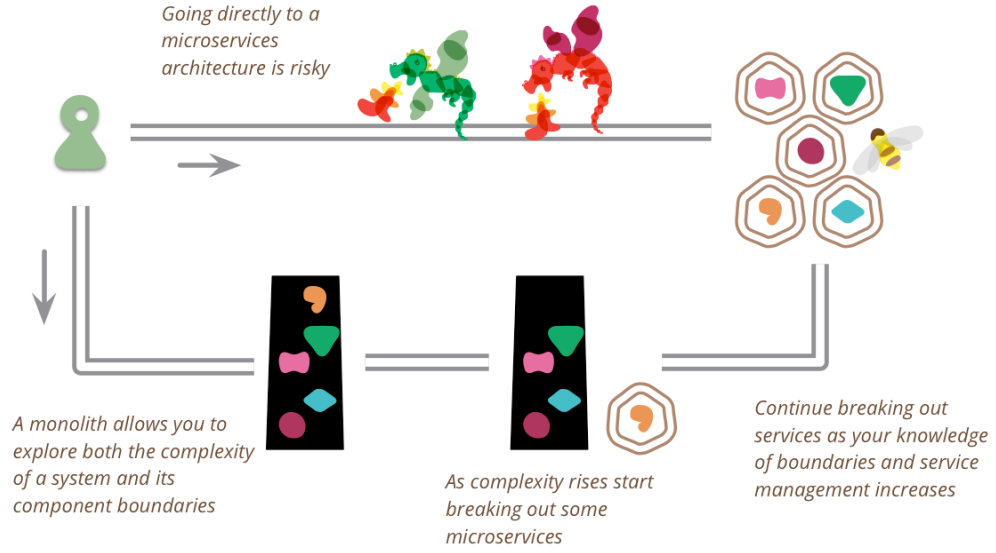
Microservices

- 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

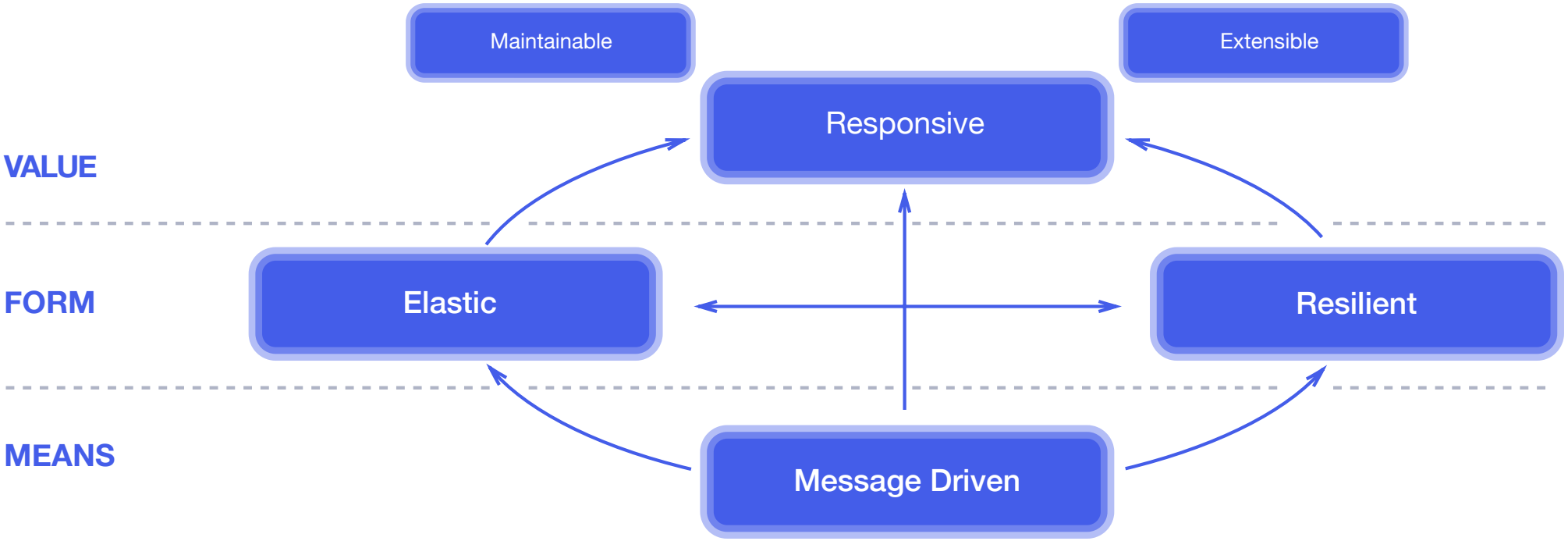
- Vorsicht vor Cargo-Kult: Amazon, Google, Meta etc. haben heute andere Herausforderungen als Startups
- Technologien oder Architekturen wählen, "weil Google macht das auch so" ist ein schlechter Grund



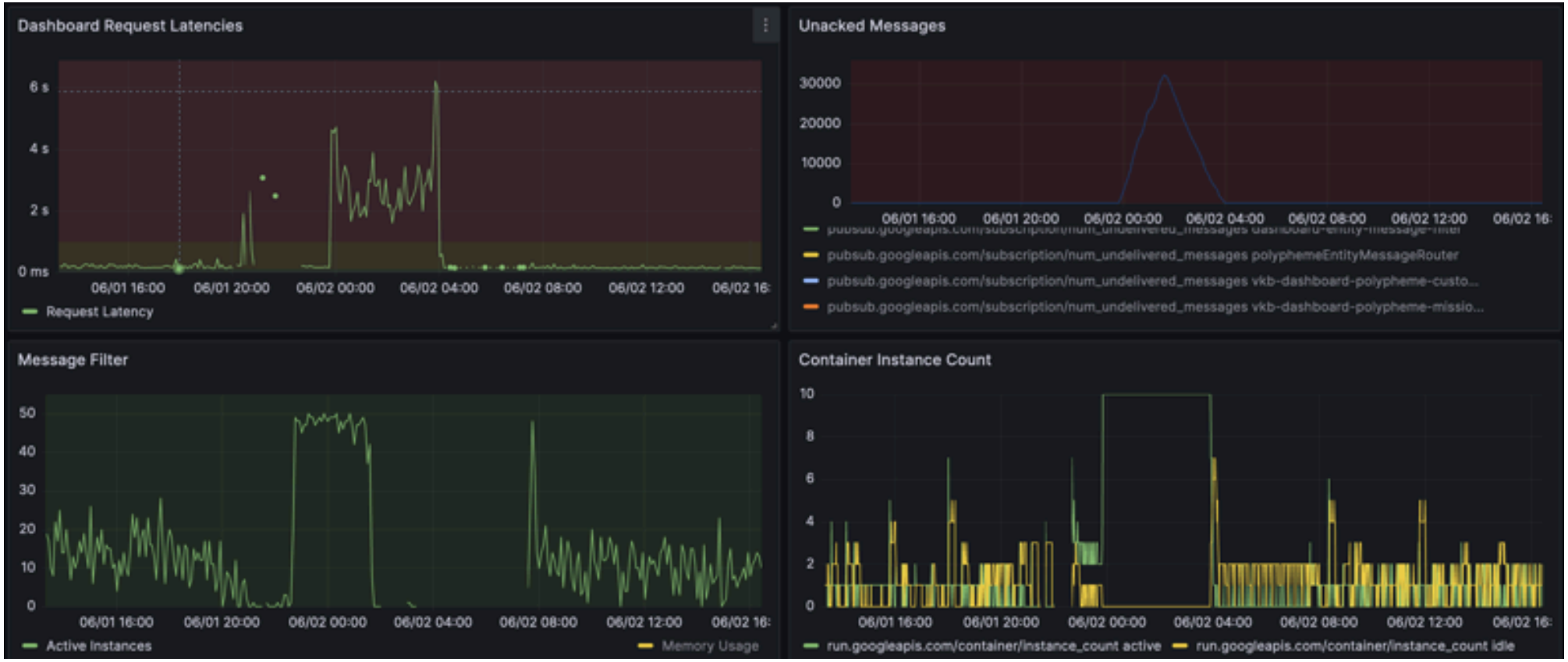
martinfowler.com/bliki/MonolithFirst.html

Event Driven Architecture

Reactive Systems



Fallstudie


Dashboard Request Latencies
6 s
4 s
2 s
0 ms
06/01 16:00
06/01 20:00
06/02 00:00
06/02 04:00
06/02 08:00
06/02 12:00
Request Latency
Unacked Messages
30000
20000
10000
0
pubsub.googleapis.com/subscription/num_undelivered_messages polypheme
pubsub.googleapis.com/subscription/num_undelivered_messages vkb-dashboard-polypheme-custo...
pubsub.googleapis.com/subscription/num_undelivered_messages vkb-dashboard-polypheme-missio...
Message Filter
50
40
30
20
10
0
Active Instances
Memory Usage
Container Instance Count
10
8
6
4
2
0
run.googleapis.com/container/instance_count active
run.googleapis.com/container/instance_count idle

Quellen

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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