

**Software design
Software architecture
Microservices**





Somkiat Puisungnoen

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Intro

Software Craftsmanship

Software Practitioner at สยามชานาญกิจ พ.ศ. 2556

Agile Practitioner and Technical at SPRINT3r

Somkiat Puisungnoen 15 mins · Bangkok · ...

Java and Bigdata



Microservice



Module 1 : Design

Cloud Native Application

Evolution of architecture

Microservice architecture

How to decompose app to Microservice

Communication between service

Data consistency

Workshop



Module 2 : Develop + Testing

Recap Microservice

Properties of Microservice

Microservice 1.0 - 4.0 (4.5)

How to develop Microservice ?

How to test Microservice ?

12-factors app

Observable services



Module 3 : Deploy

How to deploy Microservice ?
Continuous Integration and Delivery
Practices of Continuous Integration
Deployment strategies
Working with containerization (Docker)
Workshop



“ Don’t use Microservice ”

Start with your **problems** ?



Design

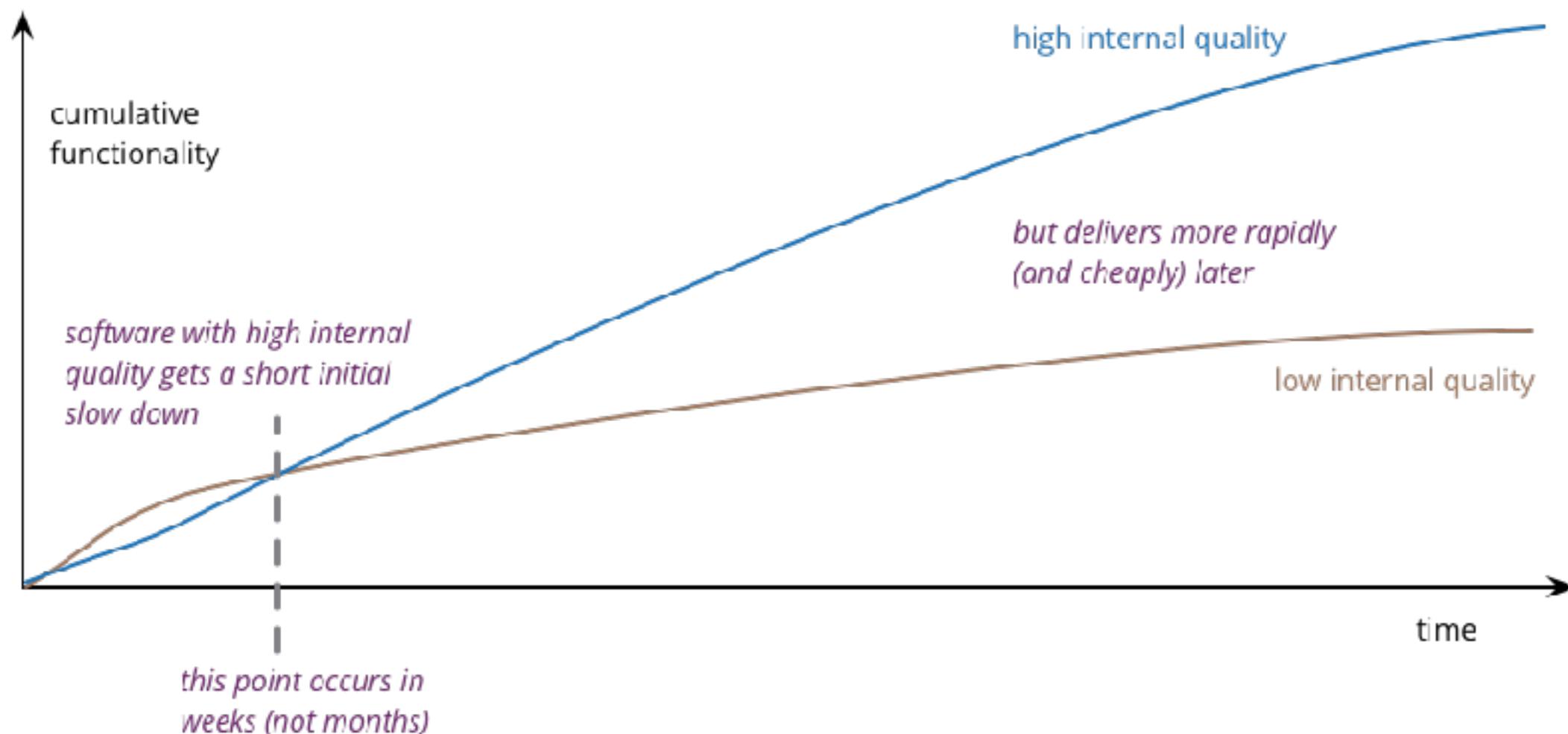
Develop
Test

Deploy

Observability

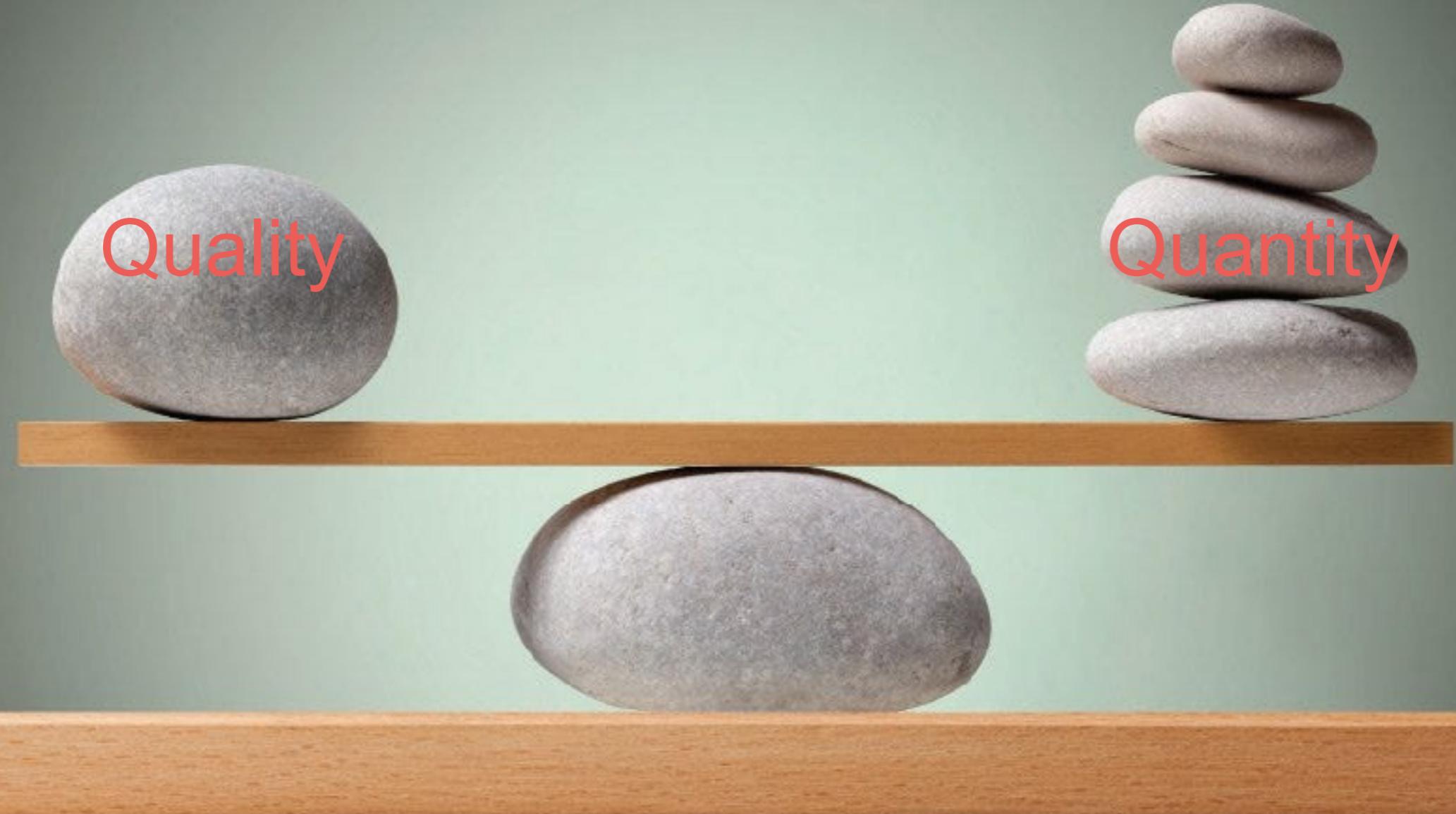
Continuous Integration/Delivery





<https://martinfowler.com/articles/is-quality-worth-cost.html>







Performance

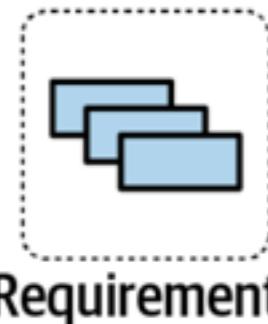


Scalability



Security

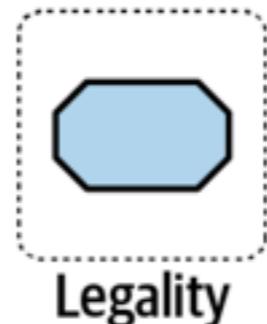
Software Architecture



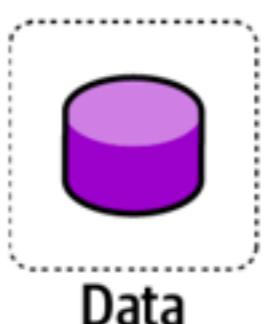
Requirements



Auditability

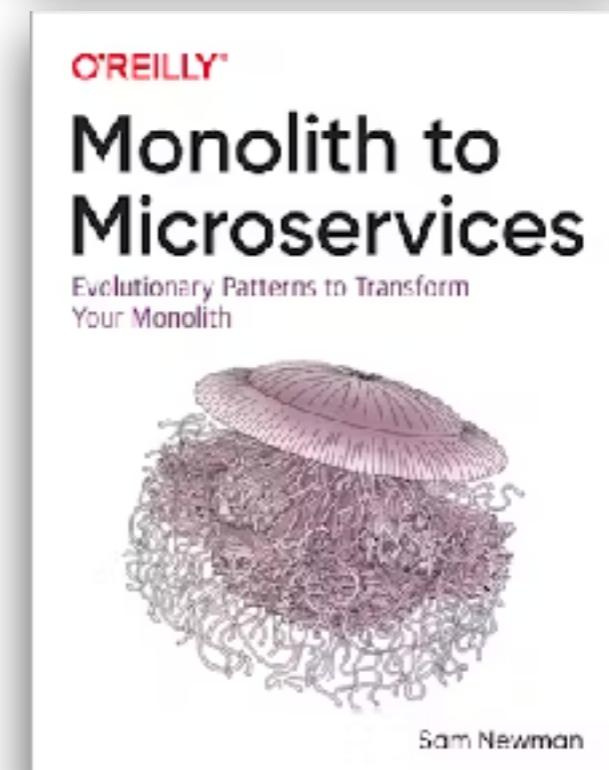
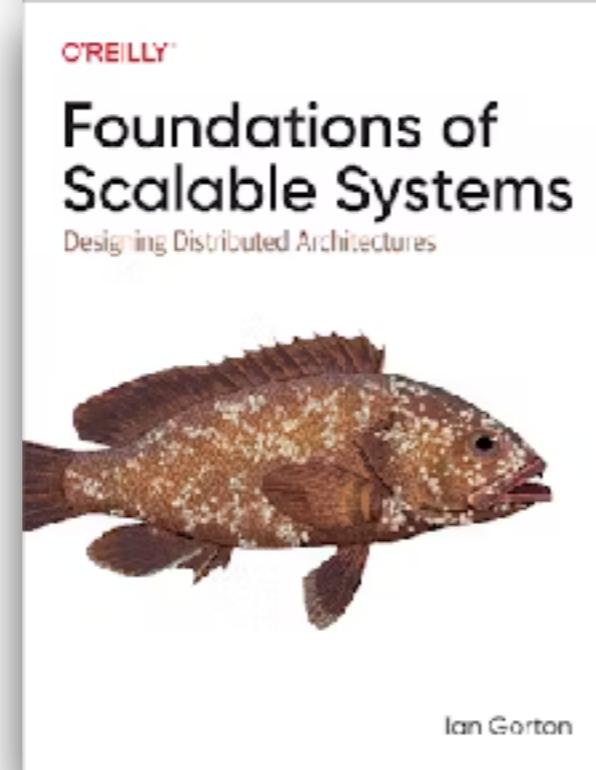
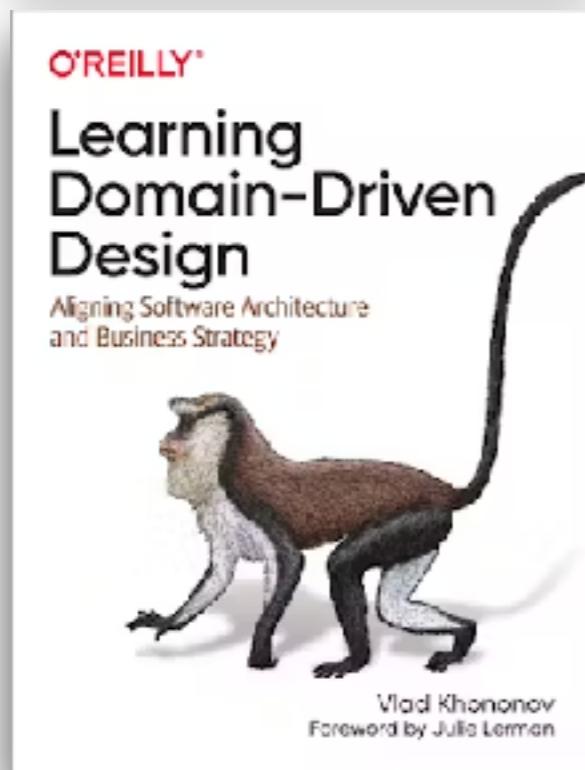
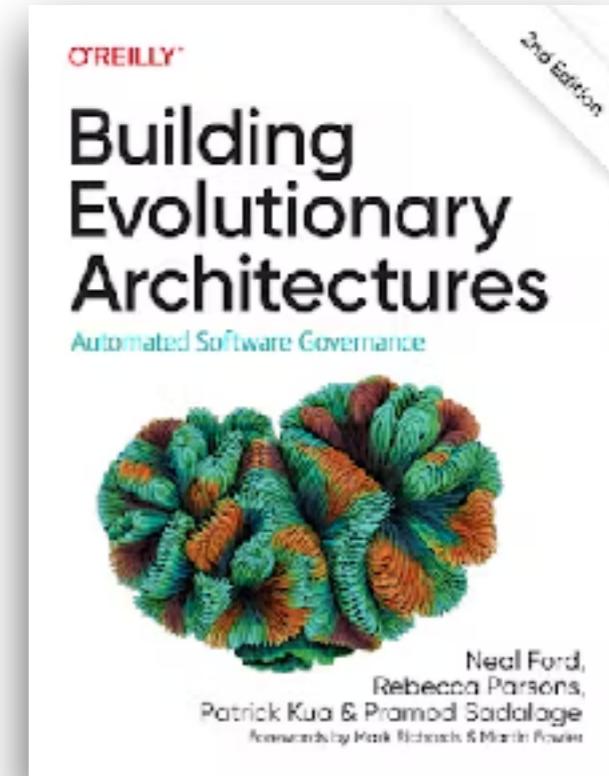
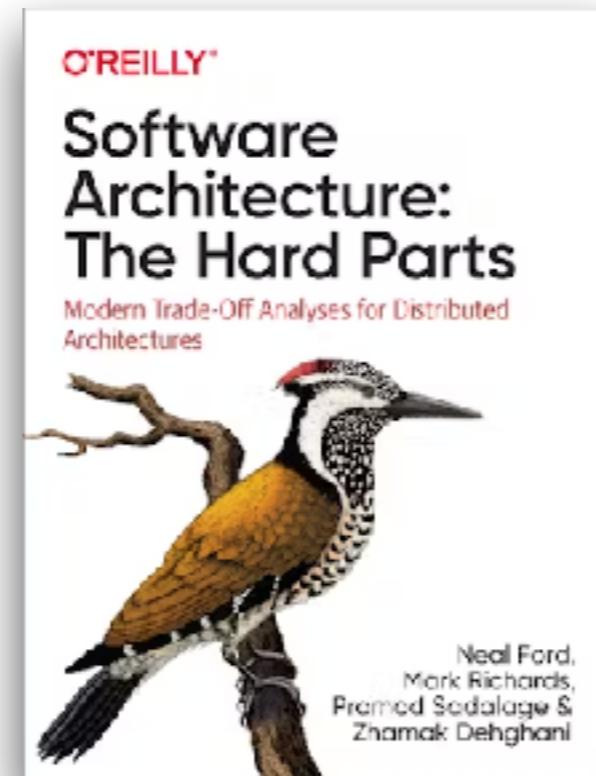
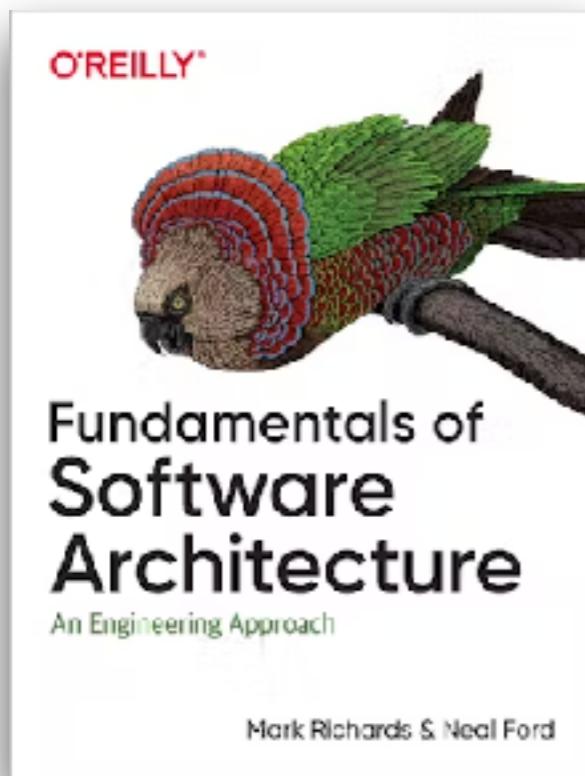


Legality



Data





<https://www.amazon.com/Fundamentals-Software-Architecture-Comprehensive-Characteristics/dp/1492043451>

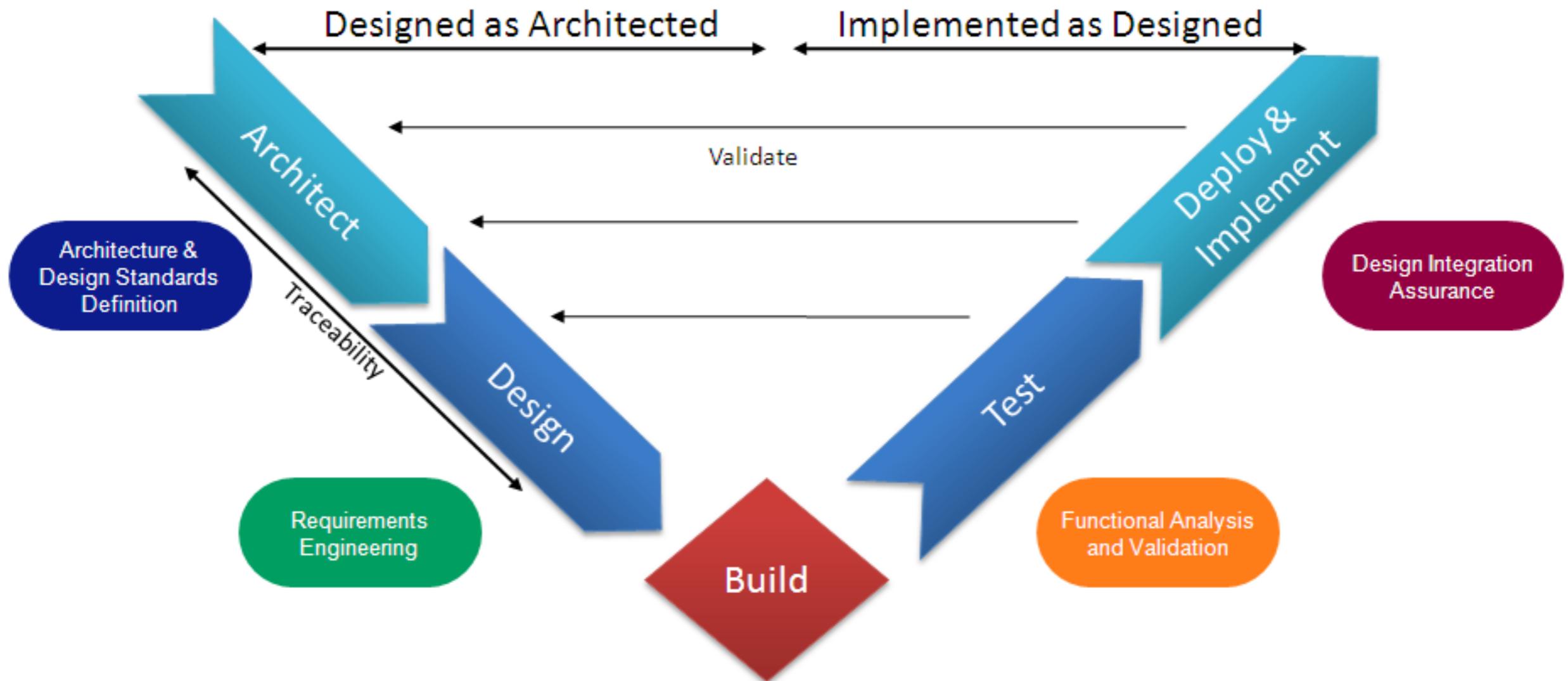


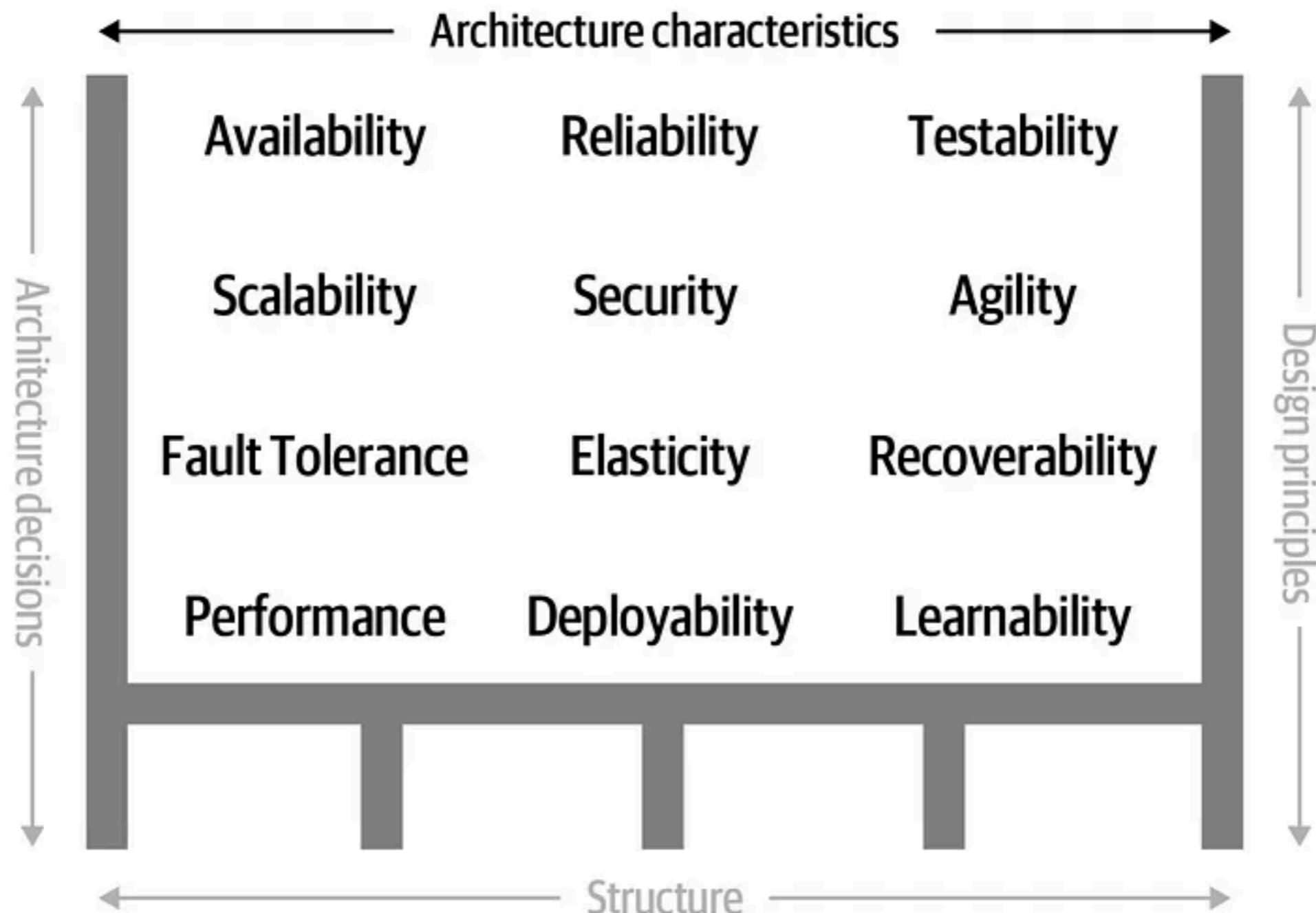
Microservices

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Traditional Process



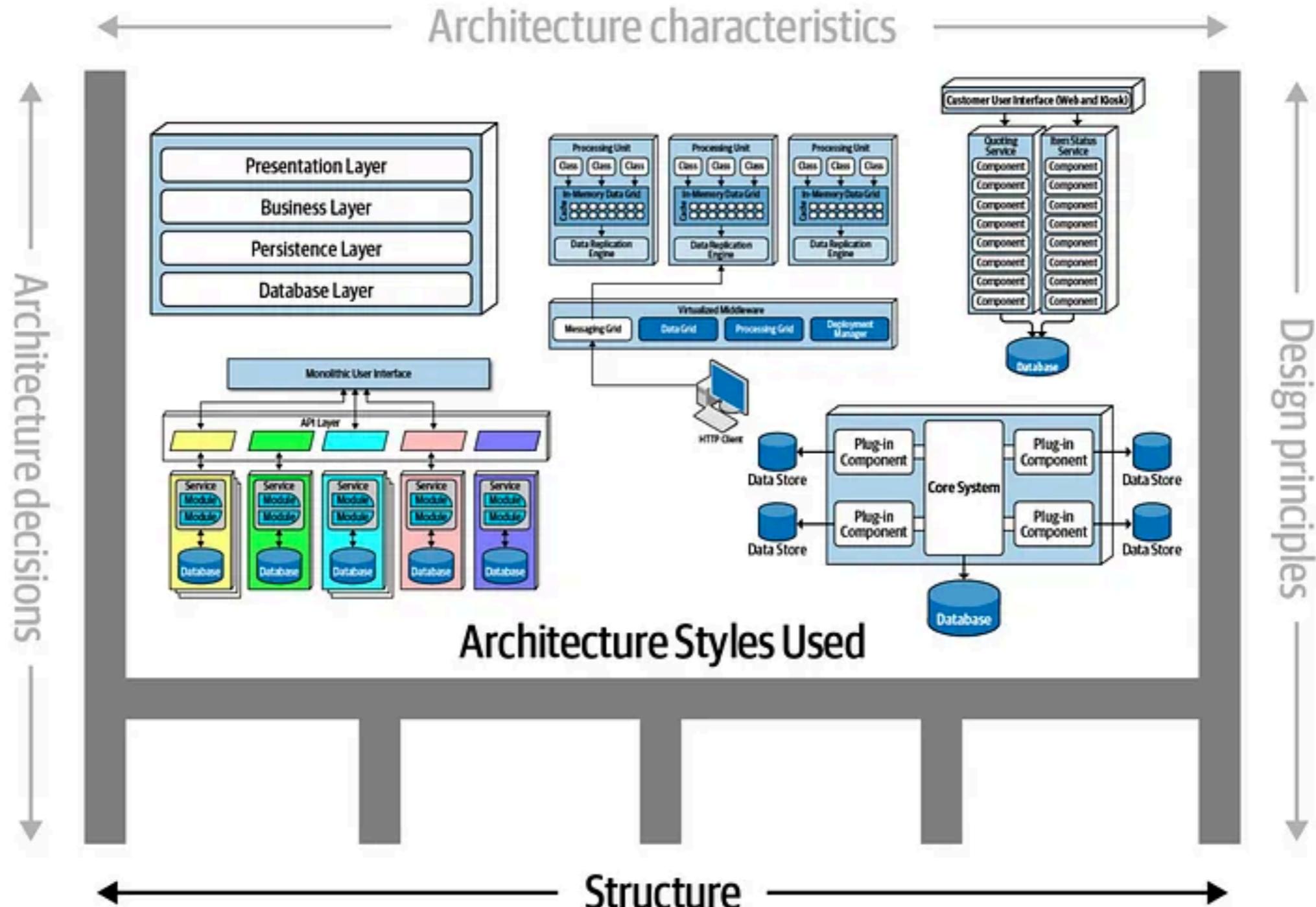


<https://www.amazon.com/Fundamentals-Software-Architecture-Comprehensive-Characteristics/dp/1492043451>



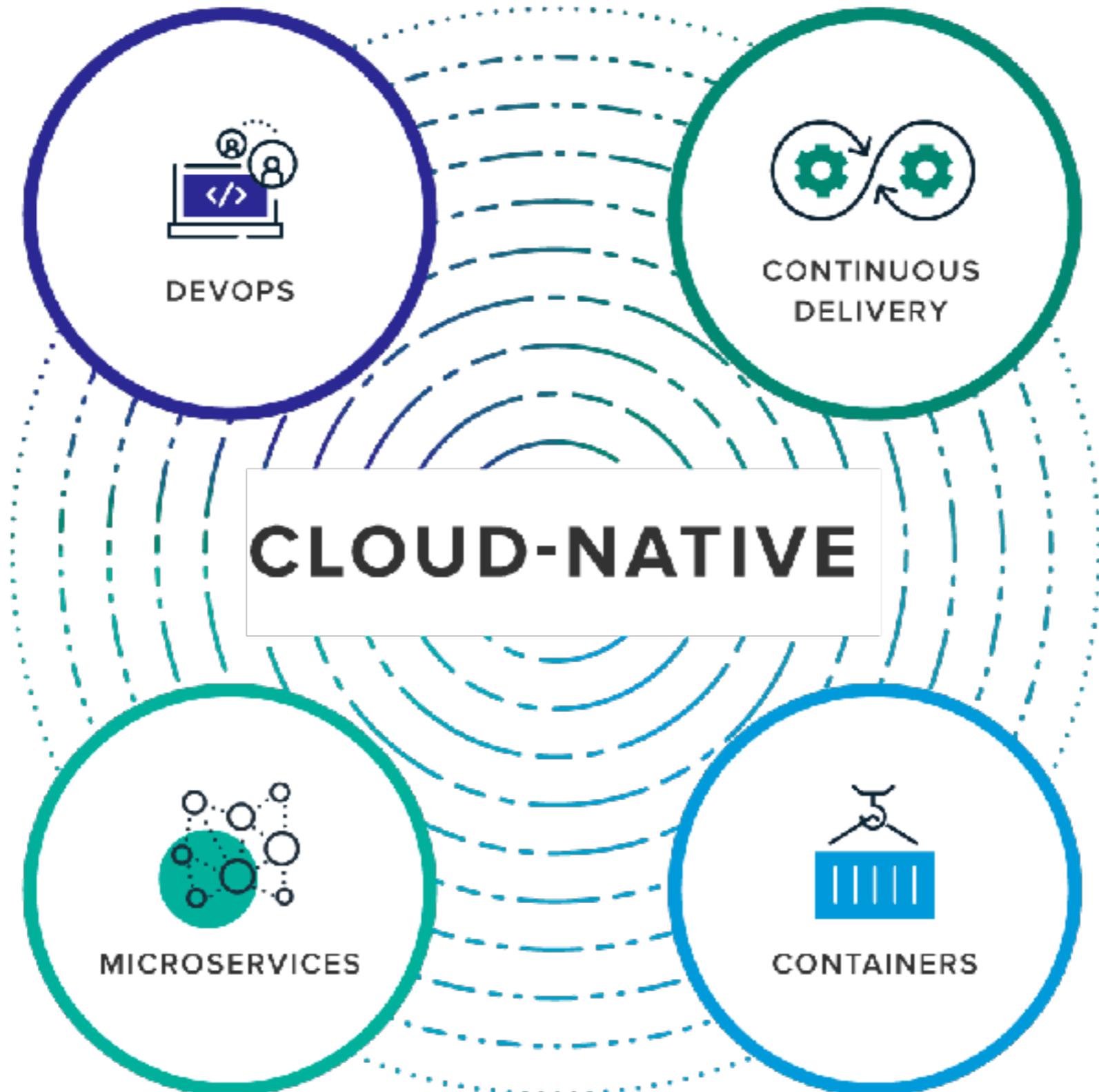
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Module 1 : Design





<https://pivotal.io/cloud-native>



Cloud Native ?

Build efficiency

Scalability

Portability

On-premise and On-cloud

Loosely
Coupled

Resilience

Manageable

Observable

<https://www.somkiat.cc/cloud-native-go-part-1/>



Software design is an exercise in human relationships

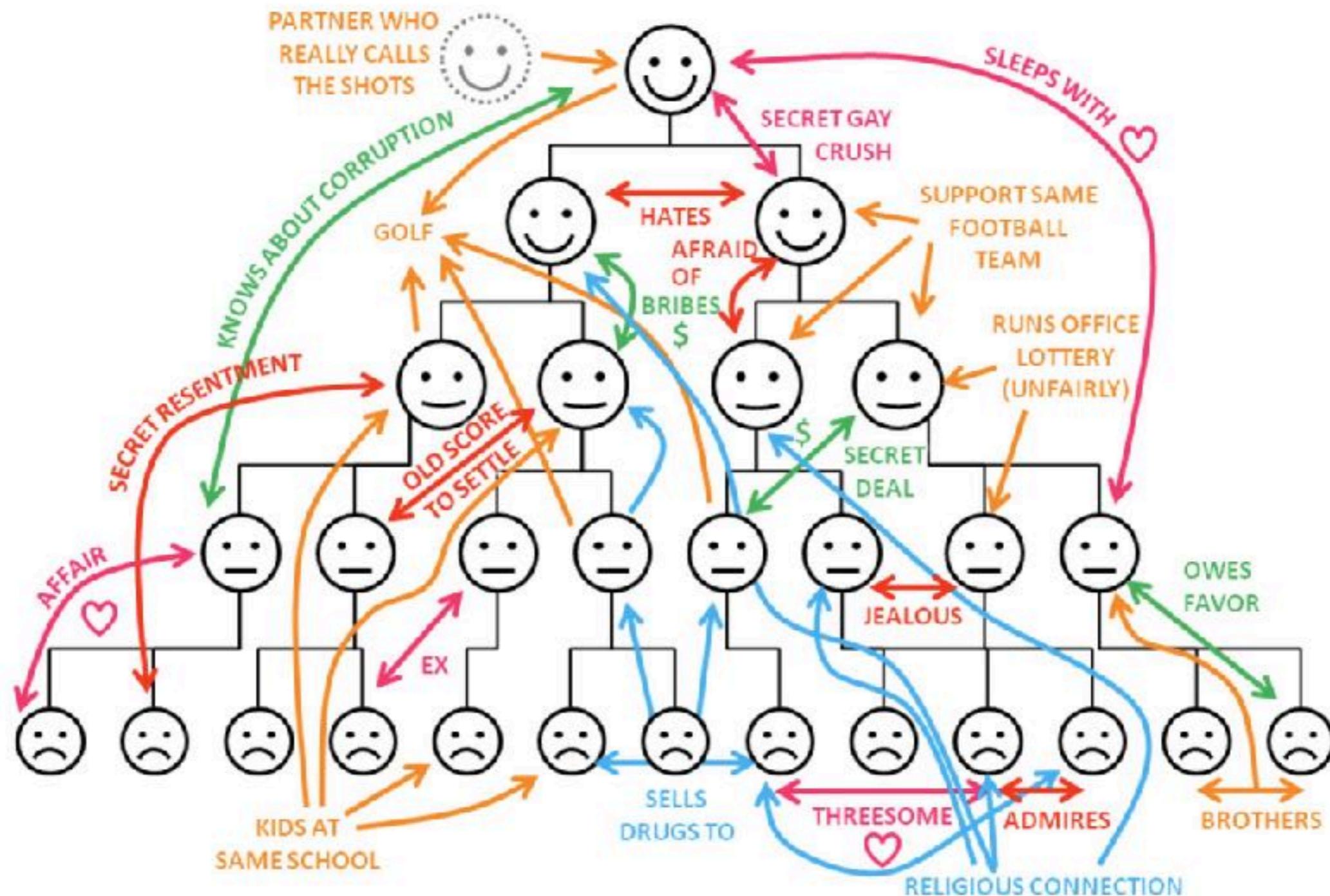


**Any organization that designs a system
will produce a design whose structure
is a copy of the organization's
communication structure.**

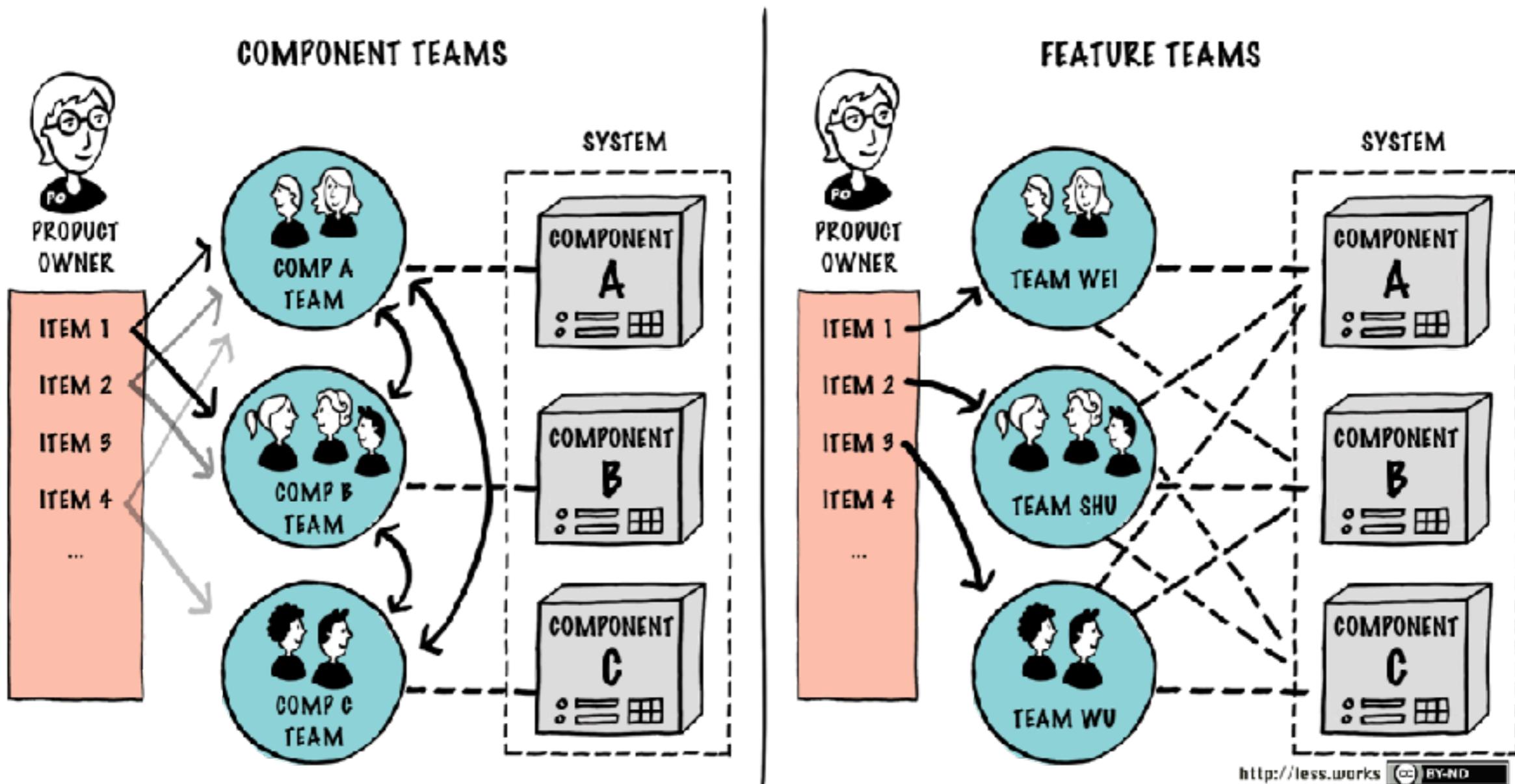
-- Melvin Conway



Organization Structure



Component vs Feature teams



<https://less.works/less/structure/feature-teams>

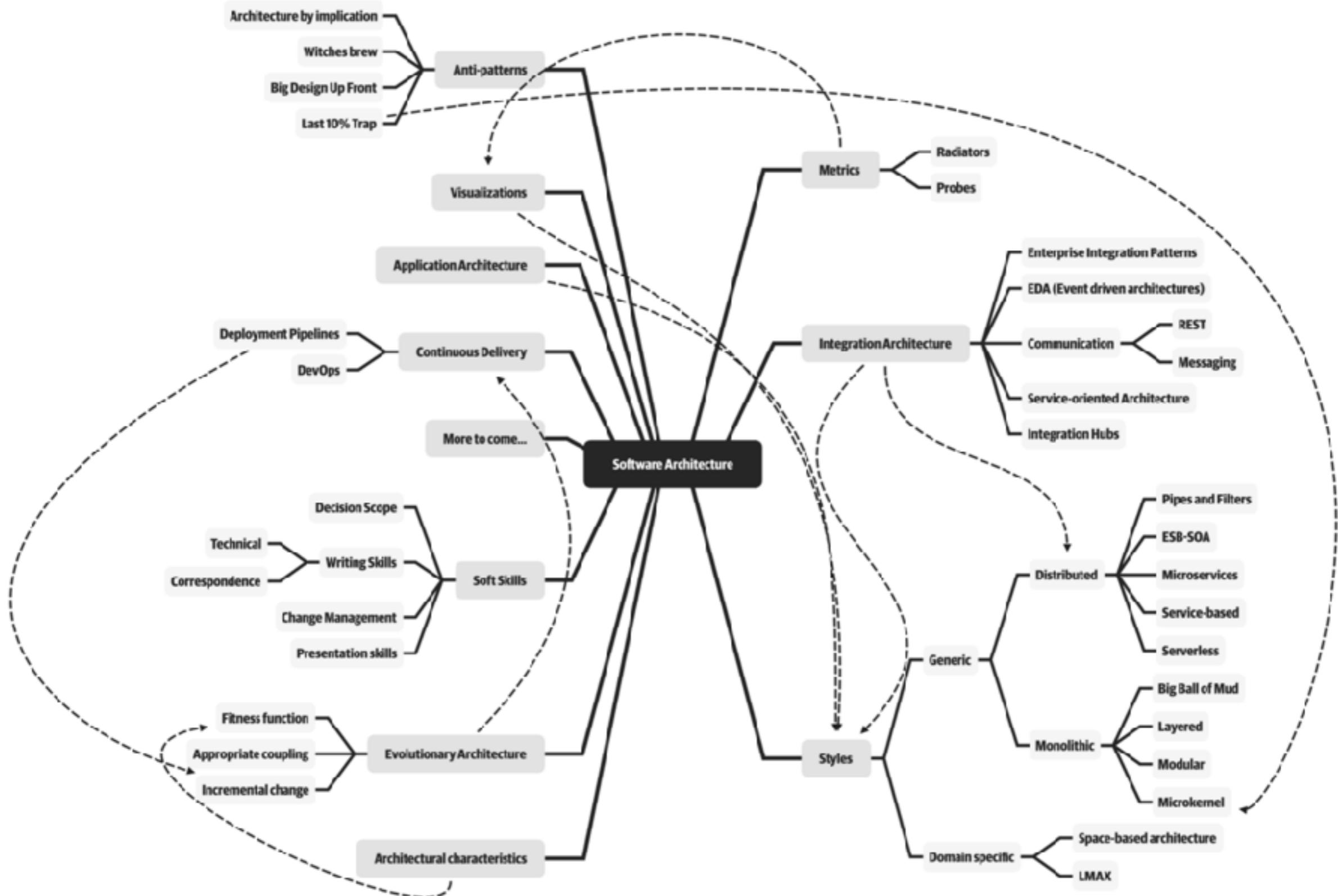


Problem vs Solution Space



Let's Start





Architecture Styles



Architecture Styles !!

Layered

Service
oriented

Distributed

Domain
driven

Event
driven

Data
centric

more ...



Evolution of Architecture



WANT TO KNOW THE BEST SOFTWARE ARCHITECTURE?



Pangaea
300M years ago

LOOK AT THE EVOLUTION OF THE EARTH.



nowadays

Daniel Stori {turnoff.us}



3 Pillars of Evolution Architecture

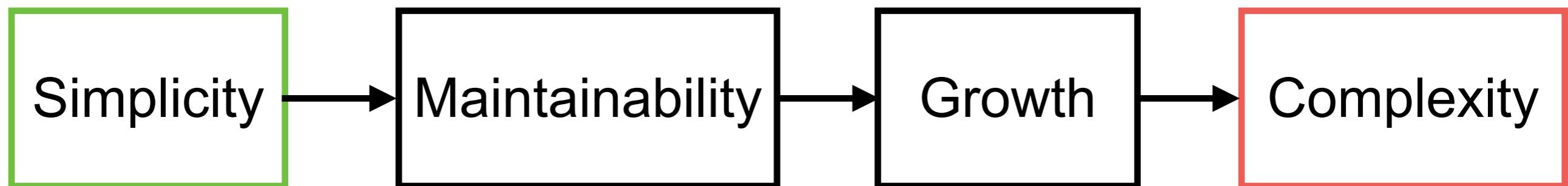
Solution
Structure

Infrastructure

Deployment
strategy



Steps of Evolutions

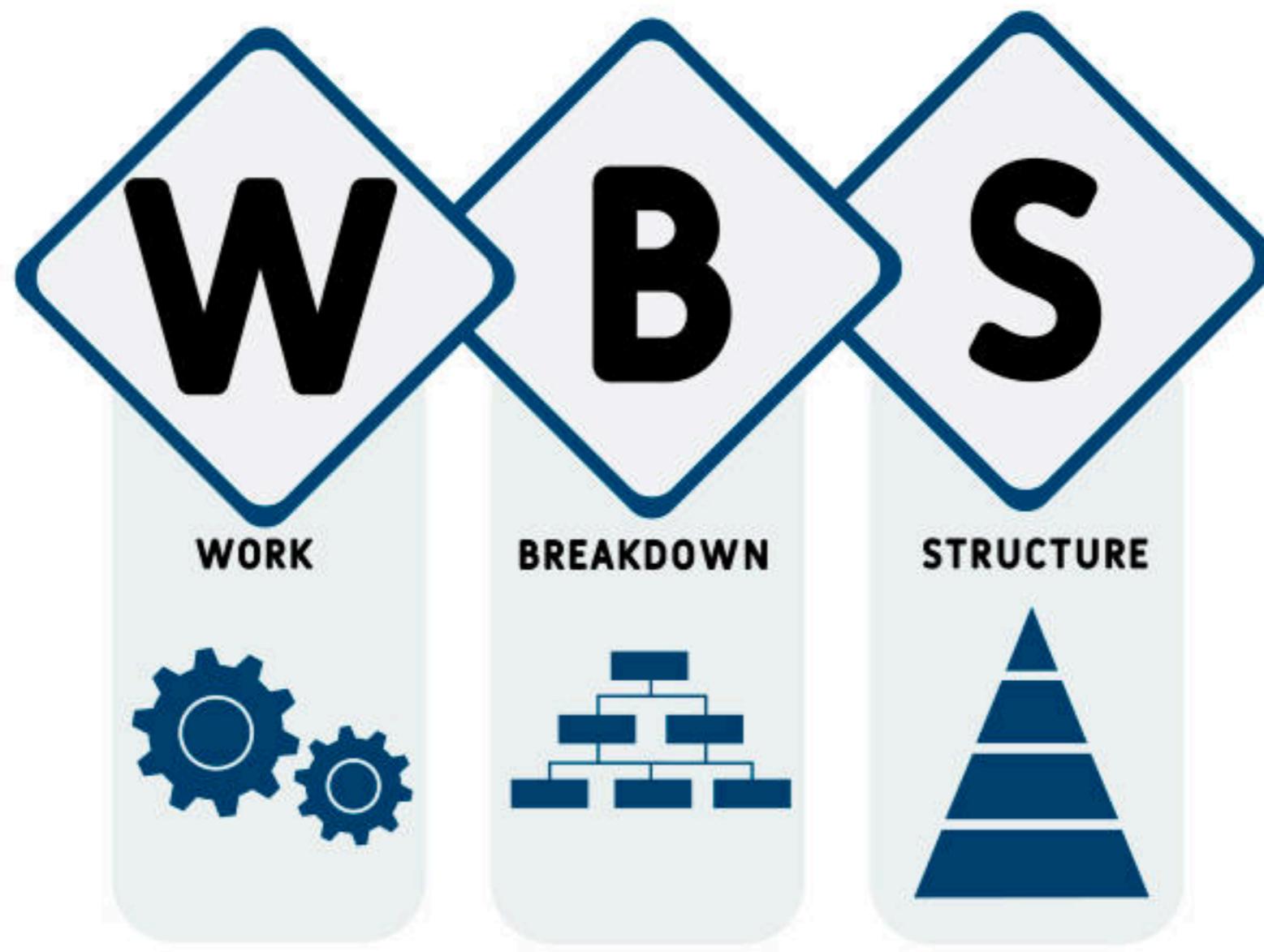


Monolith

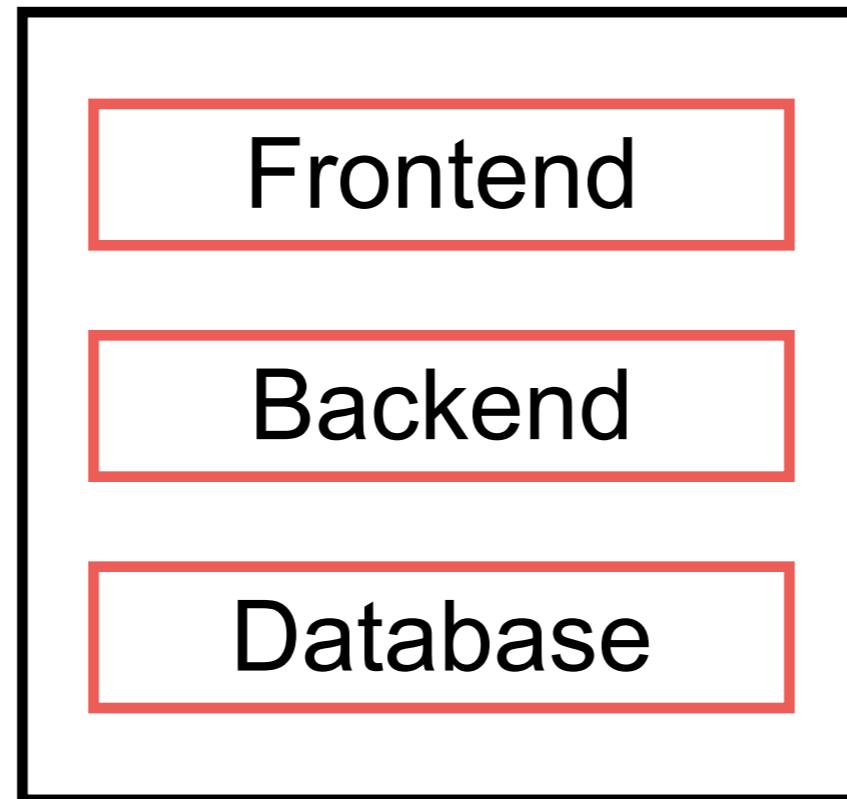
App



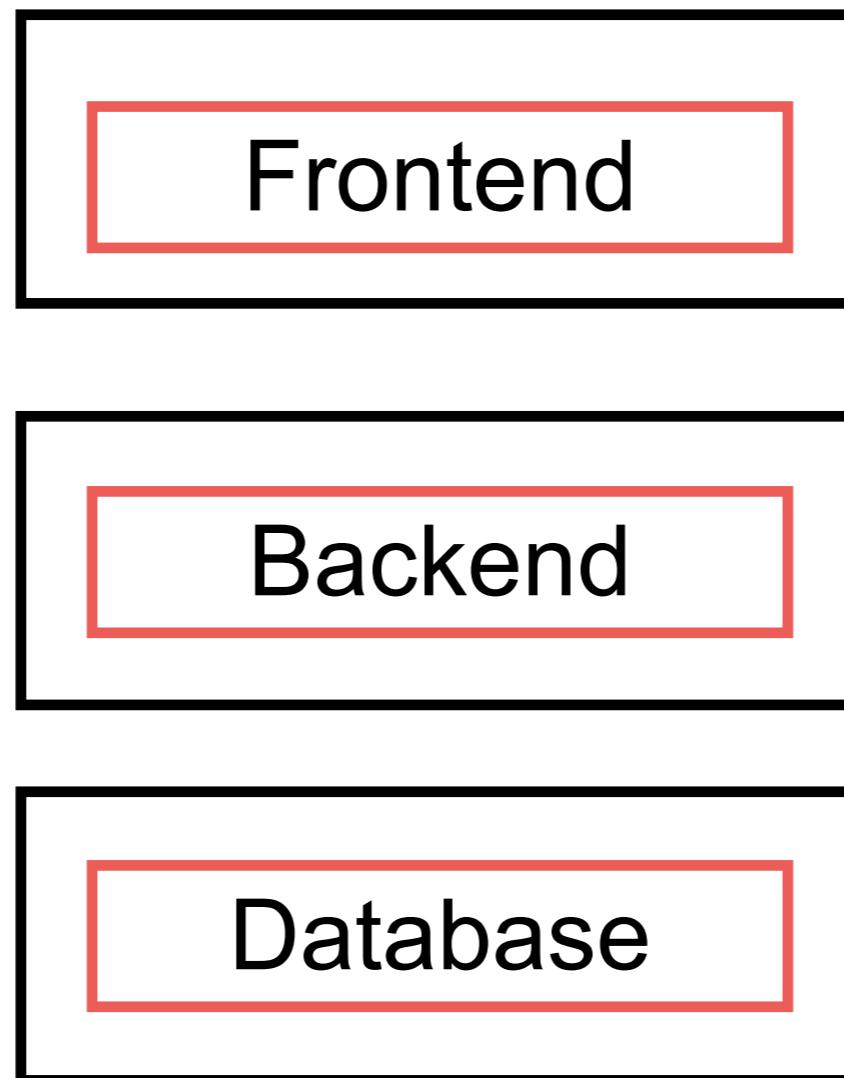
Work Breakdown Structure



Layers (inter-process)



Tiers (out-of-process)



More features ...

Frontend

Backend

Database



More features ...

Frontend

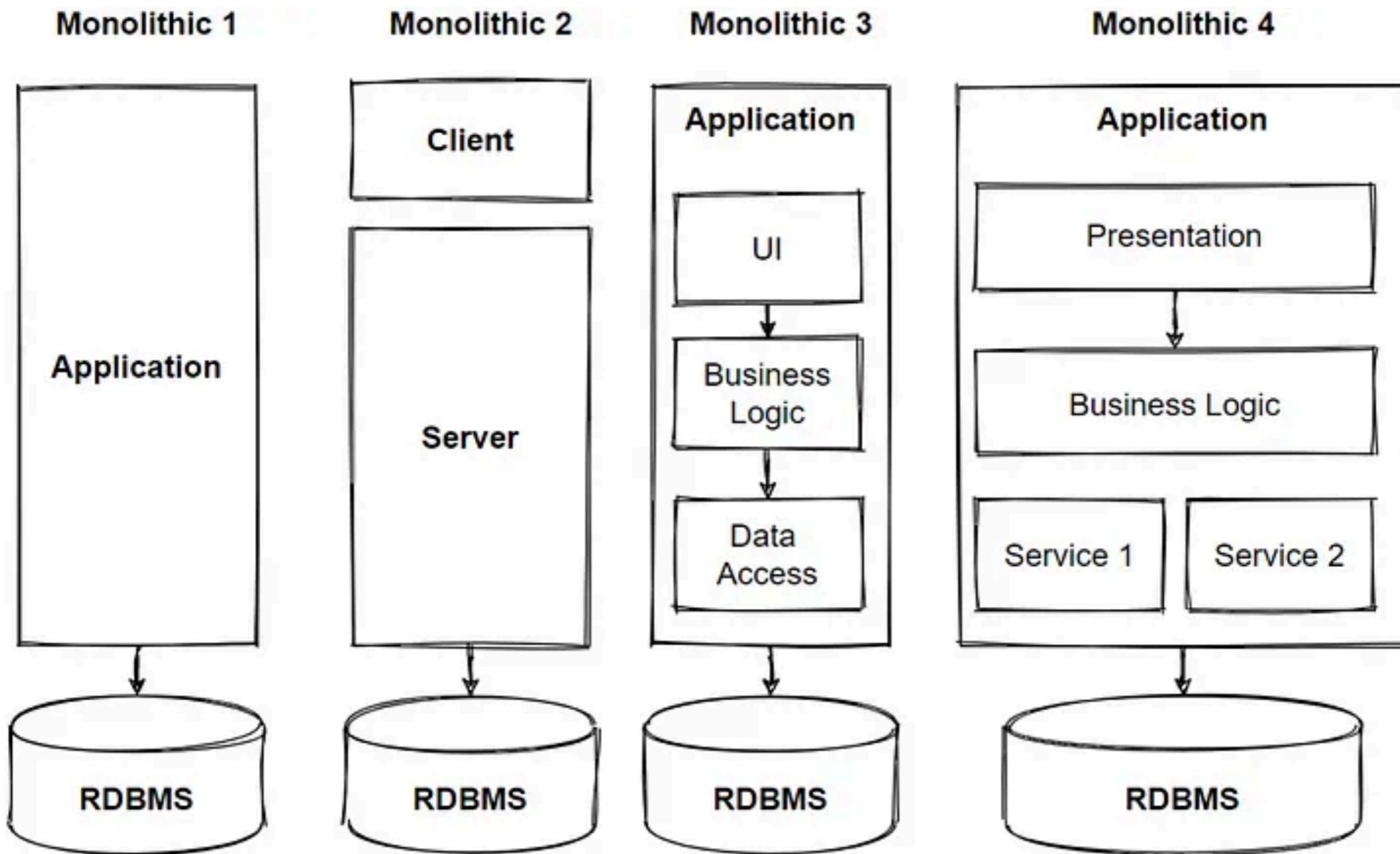


In spaghetti code, the relations between the pieces of code are so tangled that it is nearly impossible to add or change something without unpredictably breaking something somewhere else.

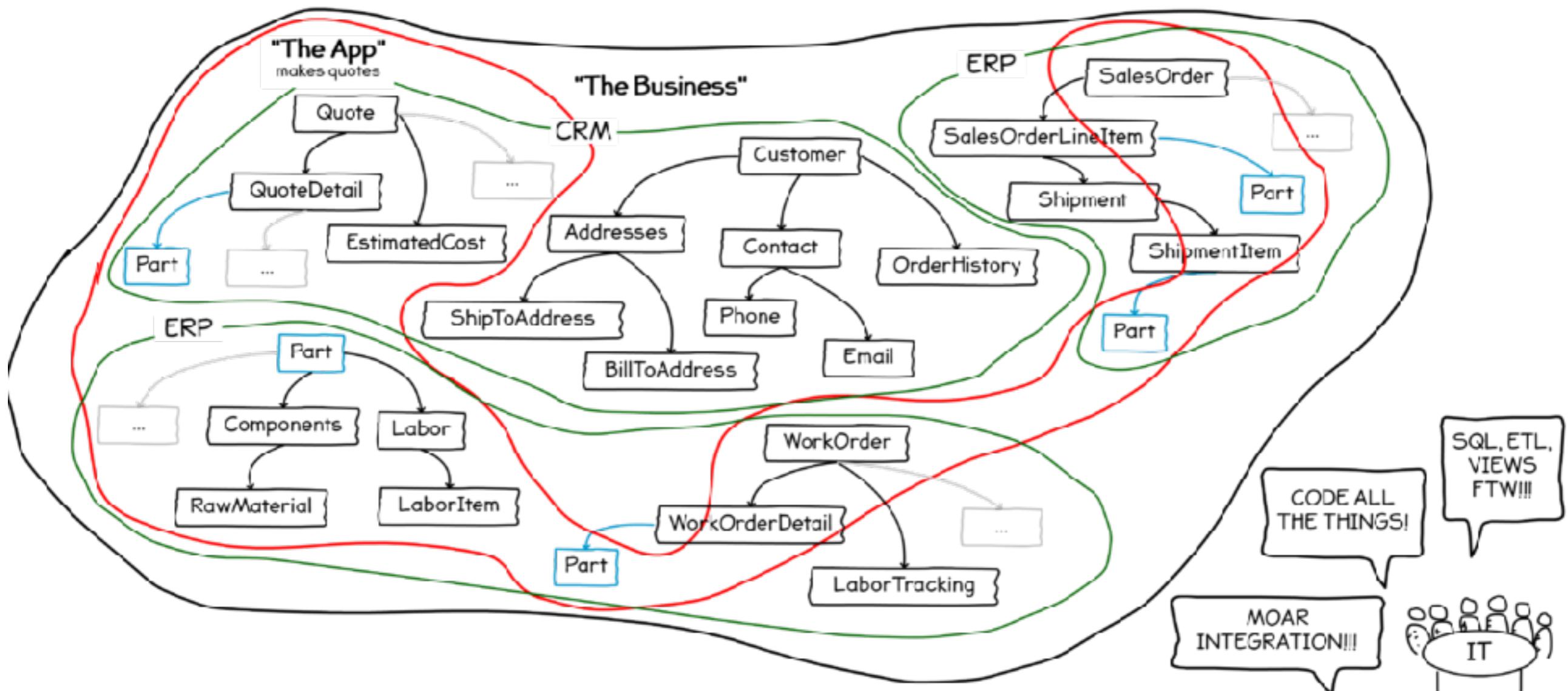
Database



Evolution of Monolith ...



Monolith Hell





Service Catalog

[GitHub](#)[Docs](#)[Plugins](#)[Blog](#)[Releases](#)[Demos](#)[Community](#) Search X K

An open source framework for building developer portals

Powered by a centralized software catalog, Backstage restores order to your infrastructure and enables your product teams to ship high-quality code quickly — without compromising autonomy.

[GITHUB](#)[OFFICE HOURS](#)

New Adopters

<https://backstage.io/>



Microservices

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Example of Service Catalog

The screenshot shows the Backstage Catalog interface. On the left is a dark sidebar with various navigation items: Backstage, Search, Home, Catalog, APIs, Docs, Create..., Explore, Tech Radar, Cost Insights, and GraphQL. The main area is titled "Backstage Catalog" and displays a table of "All components (16)". The table has columns for NAME, SYSTEM, OWNER, TYPE, LIFECYCLE, DESCRIPTION, TAGS, and ACTIONS. The components listed are:

NAME	SYSTEM	OWNER	TYPE	LIFECYCLE	DESCRIPTION	TAGS	ACTIONS
artist-lookup	artist-engagement-portal	team-a	service	experimental	Artist Lookup	java data	<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
backstage		cnf	library	experimental	Backstage is a...		<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
backstage-demo		backstage/maintainers	website	experimental	An example...		<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
dice-roller		guest	service	production	It rolls dice	go	<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
petstore		Team C	service	experimental	[The Petstore]...		<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
playback-order	audio-playback	Guest User	service	production	Playback Order	java playback	<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
playback-sdk	audio-playback	Team C	library	experimental	Audio and vid...		<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>
podcast-api	podcast	Team B	service	experimental	Podcast API	java	<input checked="" type="checkbox"/> <input type="button" value="edit"/> <input type="button" value="star"/>

<https://demo.backstage.io/>



Microservices

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OpenAPI

The screenshot shows the homepage of the Swagger website. At the top, there is a navigation bar with the Swagger logo (a green circle with white curly braces), the text "supported by SMARTBEAR", and menu items "Learn", "Tools", and "Resources". To the right of the menu are a search icon, a "Sign In" button, and a "Try Free" button. Below the navigation bar, there is a large green banner with the text "API Development for Everyone". Underneath the banner, a call-to-action text reads: "Simplify your API development with our open-source and professional tools, built to help you and your team efficiently design and document APIs at scale." Two buttons are present: "Find your tool" (blue) and "Read the docs →" (blue). On the left side of the main content area, there is a sidebar with various API-related links and snippets of code. On the right side, there is a circular inset showing a detailed view of an API endpoint's documentation, including method names (GET, POST, PUT, PATCH, DELETE, OPTIONS, HEAD) and their corresponding URLs and descriptions.

API Development for Everyone

Simplify your API development with our open-source and professional tools, built to help you and your team efficiently design and document APIs at scale.

Find your tool Read the docs →

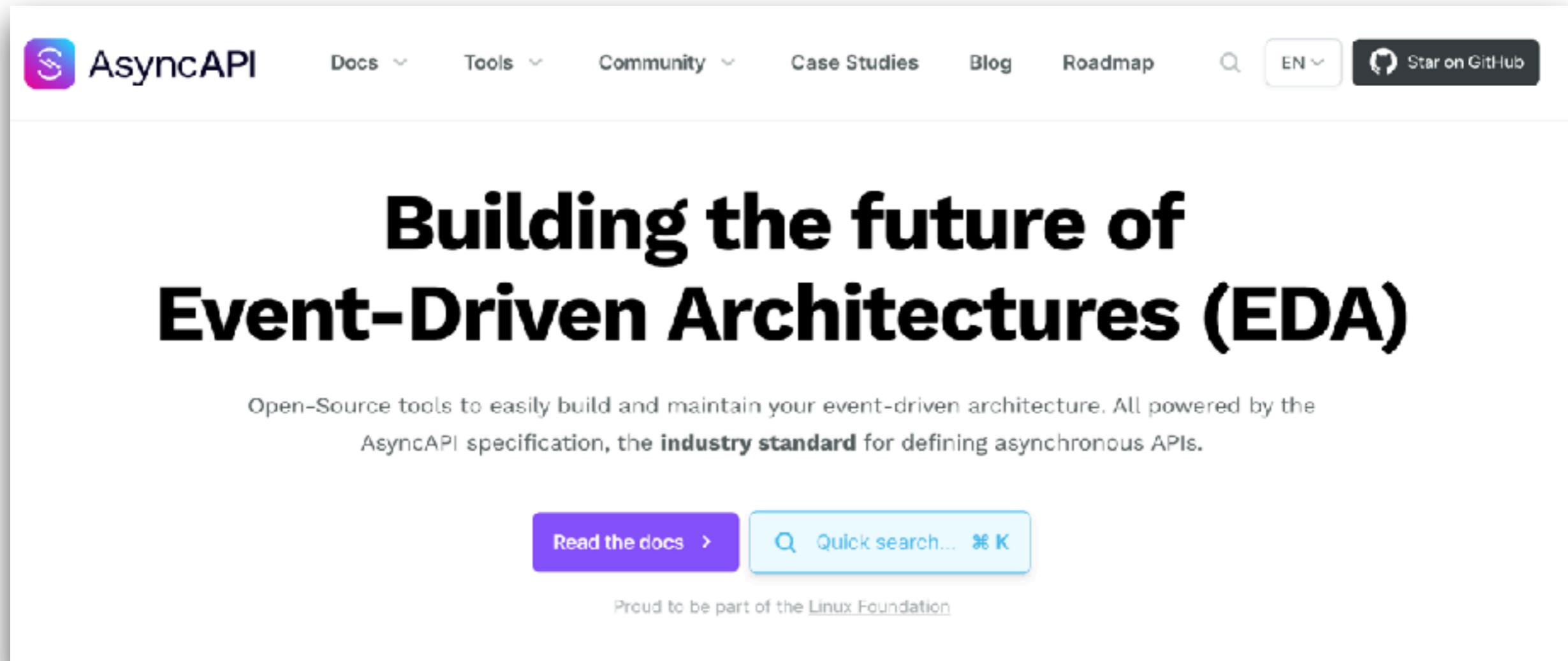
TRUSTED BY

Microsoft NATIONAL GEOGRAPHIC ZUORA

<https://swagger.io/>



AsyncAPI



The screenshot shows the AsyncAPI website homepage. At the top, there is a navigation bar with links for Docs, Tools, Community, Case Studies, Blog, and Roadmap. There is also a search icon, a language selector set to EN, and a GitHub star button. The main title "Building the future of Event-Driven Architectures (EDA)" is prominently displayed in large, bold, black font. Below the title, a subtitle explains the purpose: "Open-Source tools to easily build and maintain your event-driven architecture. All powered by the AsyncAPI specification, the **industry standard** for defining asynchronous APIs." Two buttons are visible: a purple "Read the docs" button and a light blue "Quick search..." button. A small note at the bottom states "Proud to be part of the [Linux Foundation](#)".

**Building the future of
Event-Driven Architectures (EDA)**

Open-Source tools to easily build and maintain your event-driven architecture. All powered by the AsyncAPI specification, the **industry standard** for defining asynchronous APIs.

[Read the docs](#) [Quick search... 36 K](#)

Proud to be part of the [Linux Foundation](#)

<https://www.asyncapi.com/en>



Microservices

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EventCatalog

Documentation tool for Event-Driven Architectures

EventCatalog is an Open Source project that helps you document your **events**, **services** and **domains**. Over **11,000** catalogs created.

Powered by markdown, components and plugins.

[Start Documenting →](#)[View Demo](#)

The screenshot shows the EventCatalog interface. On the left, there's a sidebar with navigation links: 'Events', 'Services', 'Overview Graph', 'Producers', 'Shipping API', 'Consumers', 'Customer Portal', 'Domains', 'Choosing', 'Event-Driven', 'David Bevan', 'Matthew Wilson', and 'Quarkus Schema'. The main area has a green header bar with three dots. Below it, there's a code block with event metadata:

```
---  
name: AddedItemToCart  
version: 0.0.3  
summary: |  
  Holds information about the item added to a shopping cart.  
producers:  
  - Basket  
consumers:  
  - Data  
owners:  
  - dboyr  
---  
dMermaid /A
```

Below this is a 'event Catalog' card for 'AddedItemToCart' with a URL: <https://localhost:3000/events/AddedItemToCart>. The card contains a description: 'Holds information about the item added to a shopping cart.', a note: 'When firing this event make sure you set the "service-version-id" in the headers.', and a sequence diagram:

```
sequenceDiagram
    participant ShippingAPI
    participant AddItemToCart
    participant CustomerPortal
    ShippingAPI->>AddItemToCart: 
    activate AddItemToCart
    AddItemToCart->>CustomerPortal: 
    deactivate AddItemToCart
    CustomerPortal->>ShippingAPI: 
```

On the right side, there's a 'Details' section with a note: 'This event can be triggered multiple times per customer. Everytime the customer interacts with their shopping cart and removes an item this event will be triggered.' Below that is an 'Event Schema' section with JSON code:

```
[{"id": 1, "label": "The event \"AddedItemToCart\" is triggered when a customer adds an item to their shopping cart.", "x": 100, "y": 100, "w": 300, "h": 100}, {"id": 2, "label": "Method: \"POST https://api.shoppingcart.com:2000/AddedItemToCart\"", "x": 300, "y": 150, "w": 300, "h": 100}, {"id": 3, "label": "Headers: \"Content-Type: application/json\"", "x": 300, "y": 200, "w": 300, "h": 100}, {"id": 4, "label": "Body: \"Item: {\"name\": \"\", \"quantity\": 1}\",\n  \"signature\": \"\"}", "x": 300, "y": 250, "w": 300, "h": 100}, {"id": 5, "label": "Description: \"This event is triggered when a customer adds an item to their shopping cart.\",\n  \"version\": \"0.0.3\"}", "x": 300, "y": 300, "w": 300, "h": 100}, {"id": 6, "label": "Producers: \"Basket\"", "x": 300, "y": 350, "w": 300, "h": 100}, {"id": 7, "label": "Consumers: \"Data\"", "x": 300, "y": 400, "w": 300, "h": 100}, {"id": 8, "label": "Owners: \"dboyr\"", "x": 300, "y": 450, "w": 300, "h": 100}, {"id": 9, "label": "Domain: 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Docs as Code



Write the Docs is a global community of people who care about documentation. We have a Slack community, conferences on 3 continents, and local meetups!

[Home](#) » [Software documentation guide](#) »

Docs as Code

author: [Eric Holscher](#) & the Write the Docs community

Documentation as Code (*Docs as Code*) refers to a philosophy that you should be writing documentation with the same tools as code:

- Issue Trackers
- Version Control (Git)
- Plain Text Markup (Markdown, reStructuredText, Asciidoc)
- Code Reviews
- Automated Tests

This means following the same workflows as development teams, and being integrated in the product team. It enables a culture where writers and developers both feel ownership of documentation, and work together to make it as good as possible.

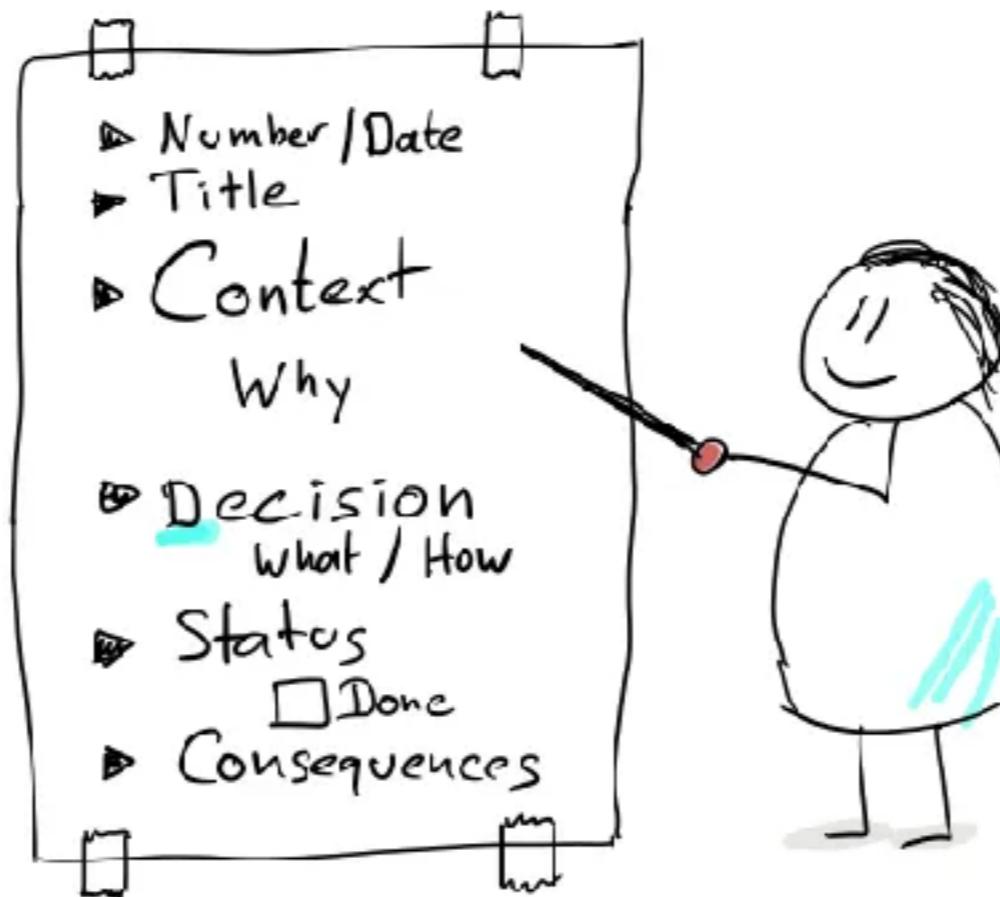
<https://www.writethedocs.org/guide/docs-as-code/>



Microservices

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Architectural Decision Records (ADR)



<https://adr.github.io/>

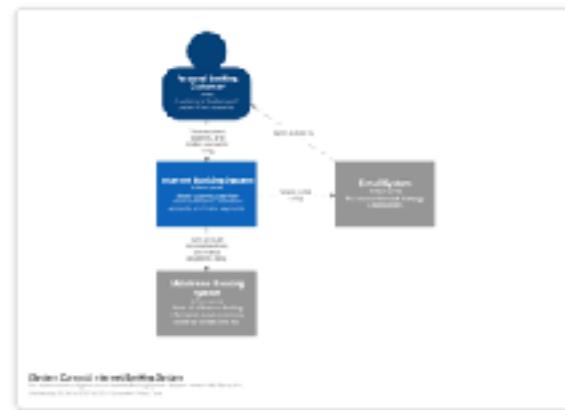


Overall architecture of system ?

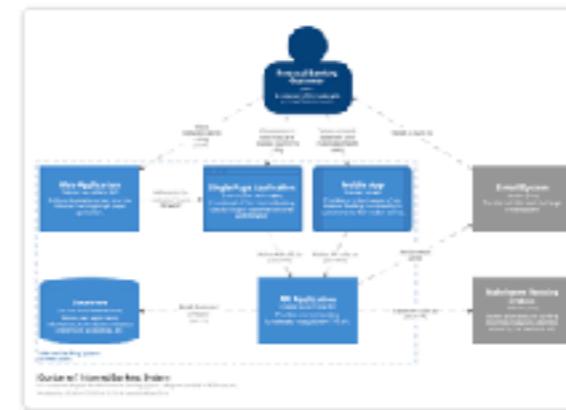


C4 Model

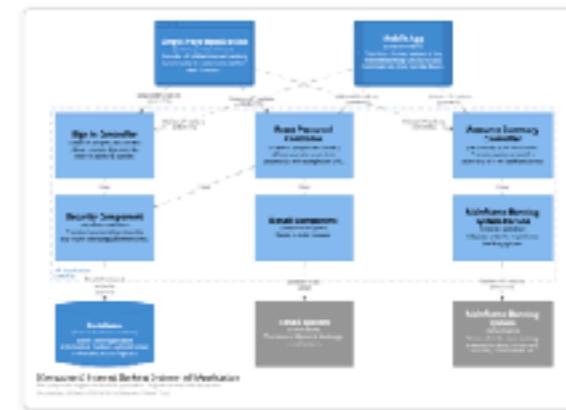
Visualizing software architecture



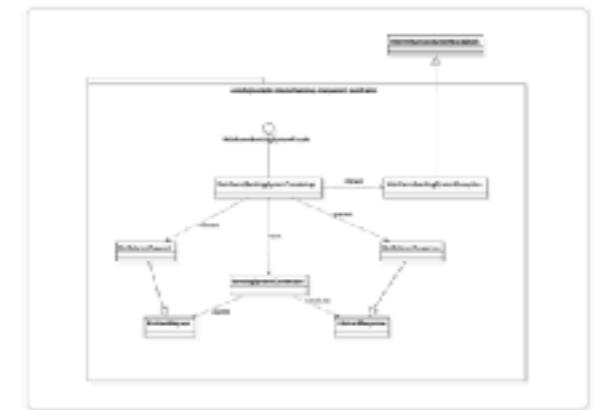
Level 1: A **System Context** diagram provides a starting point, showing how the software system in scope fits into the world around it.



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/>



Monolith problems ?

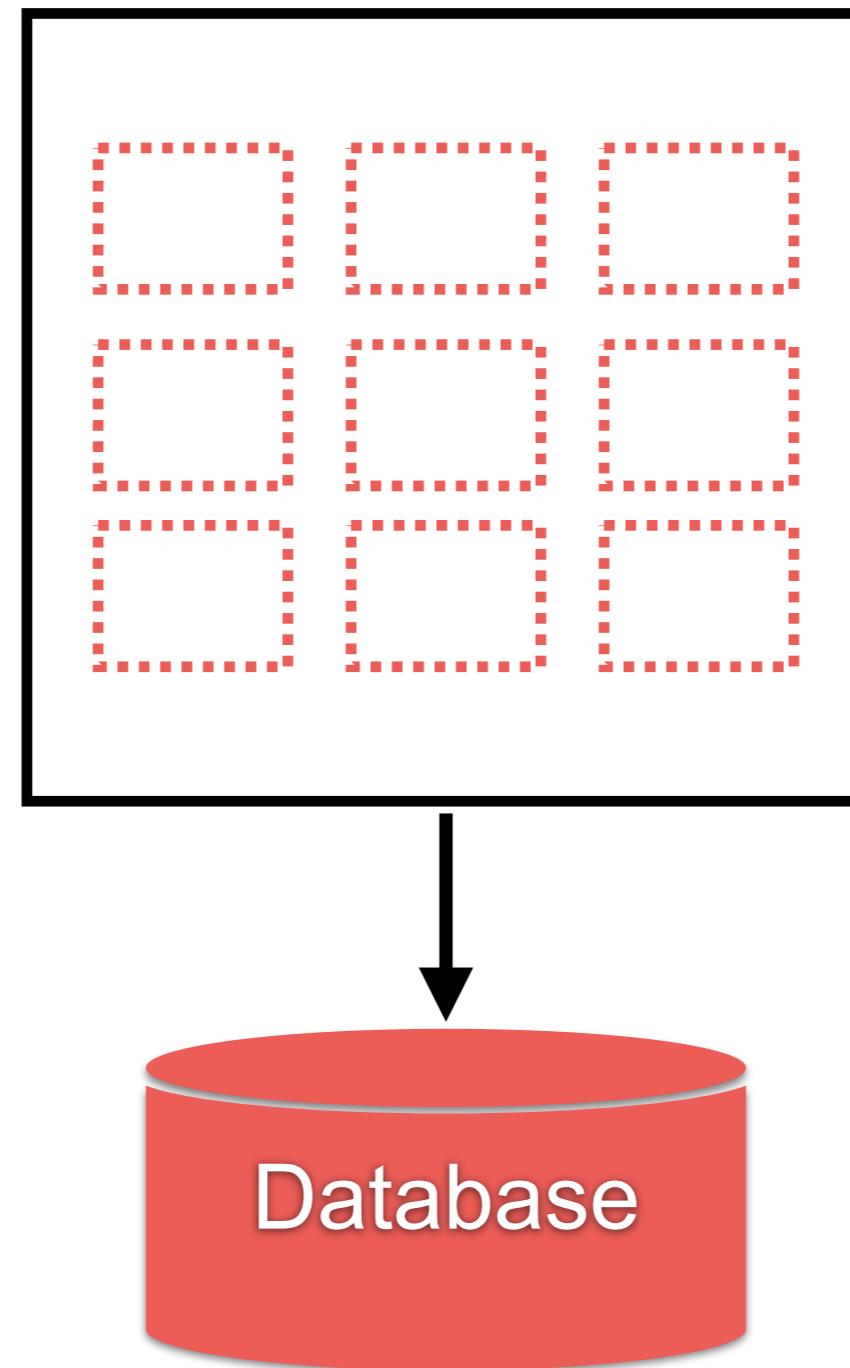
Build
Test
Deploy
Troubleshooting
Scale out (horizontal)

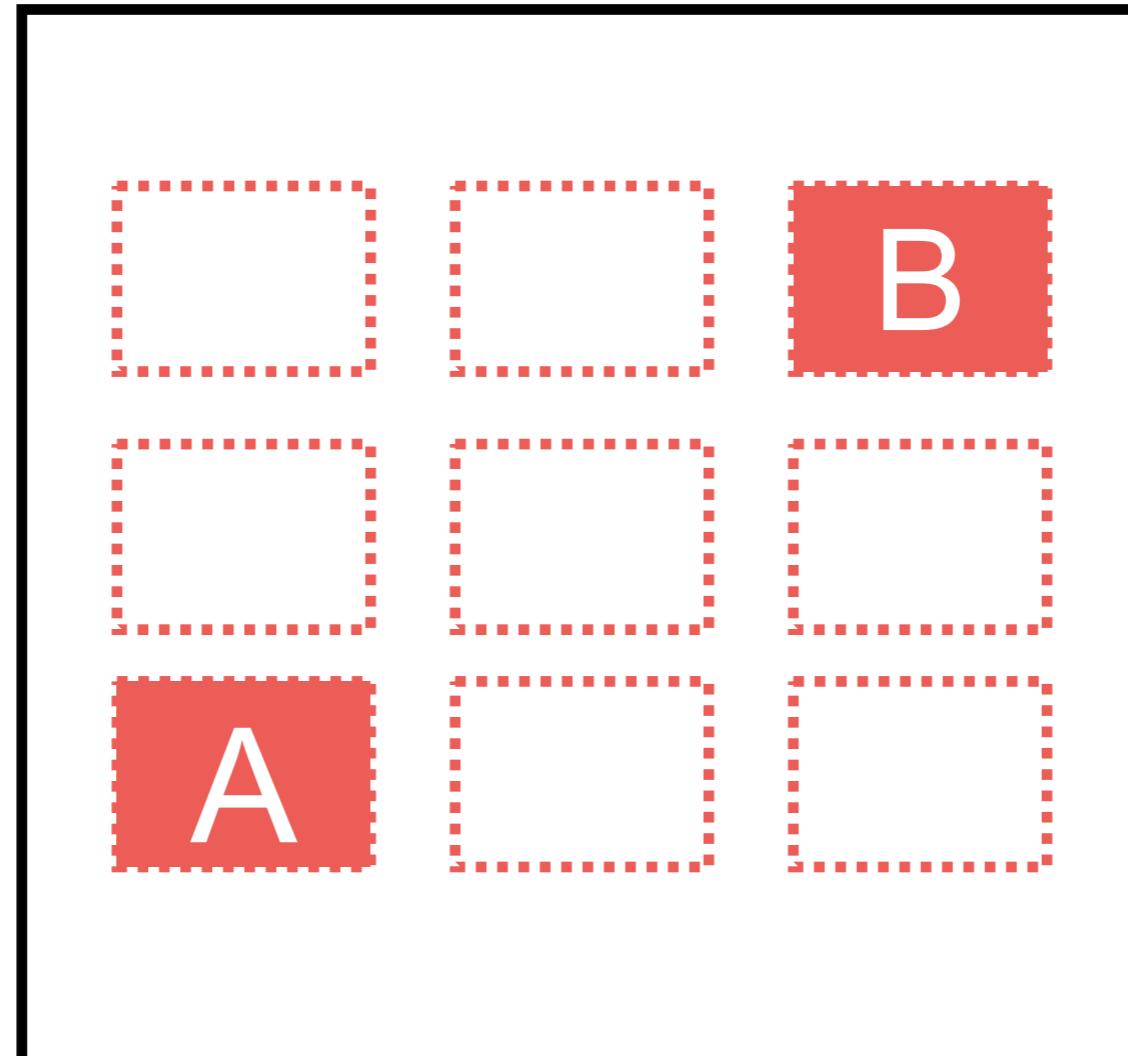


How to scale system ?



Service with Modular





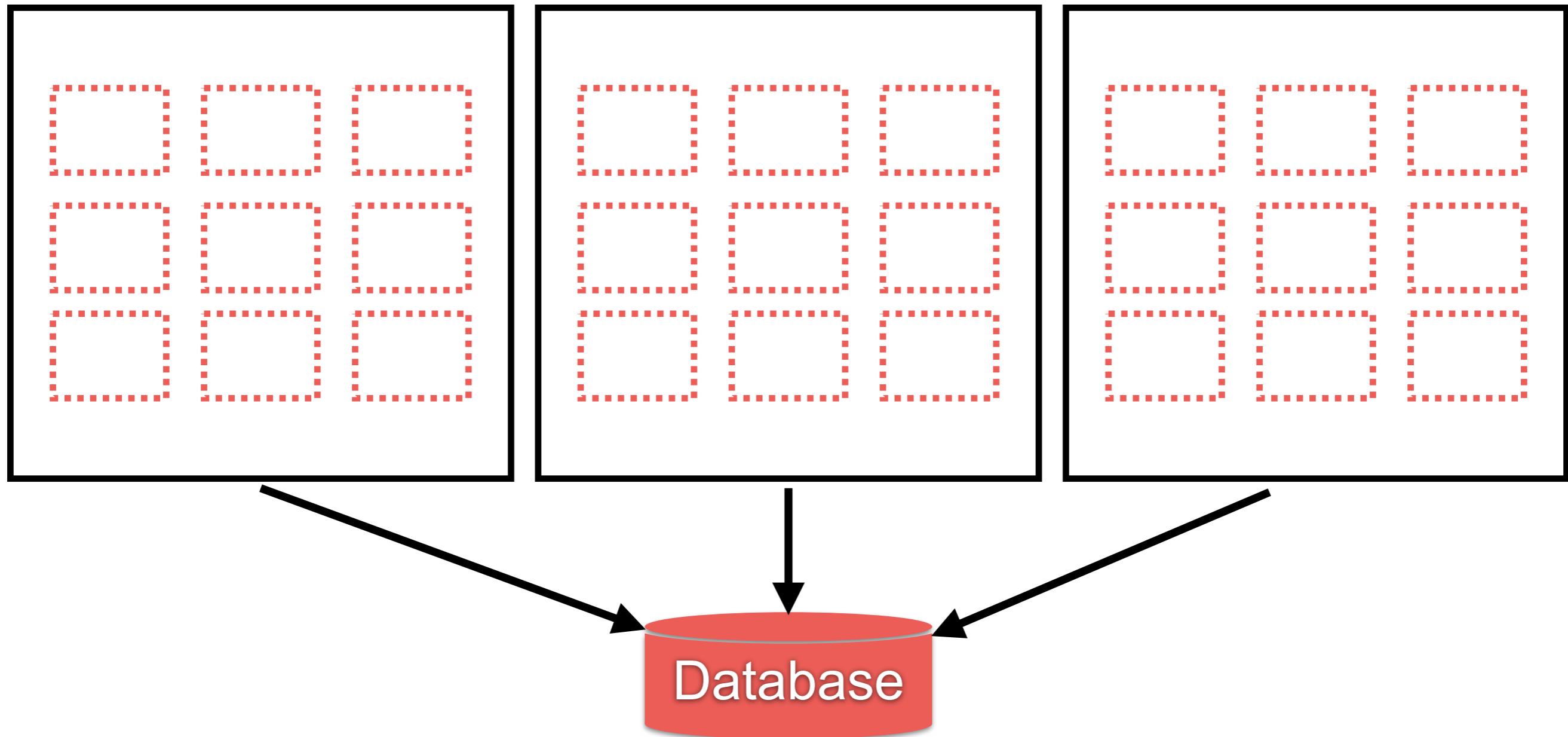
How to scale ?



Scale Up (Vertical)



Scale Out (Horizontal)



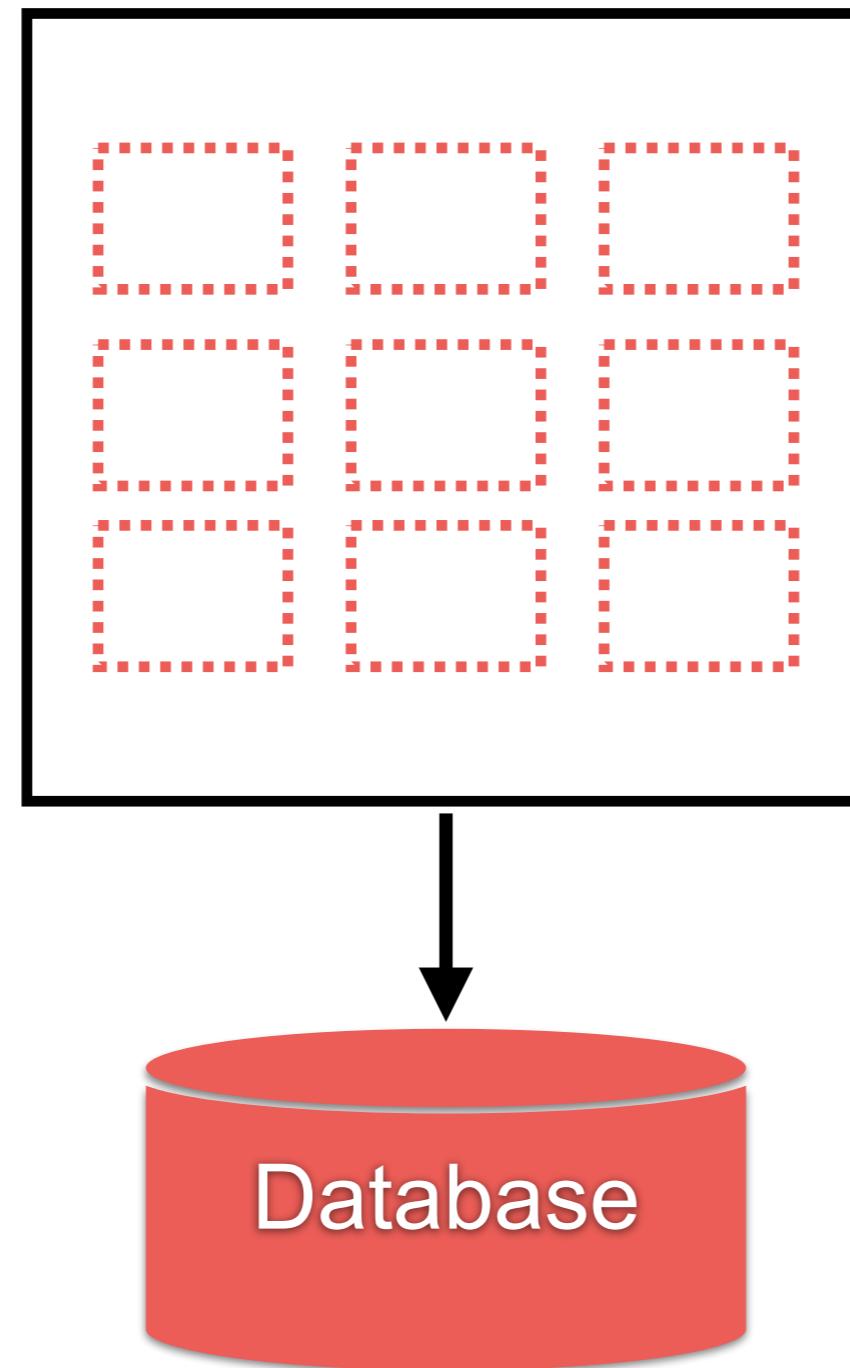
What happens when we need more servers ?



What if we don't use all modules equally ?



Database ?



How can we update individual models/database ?



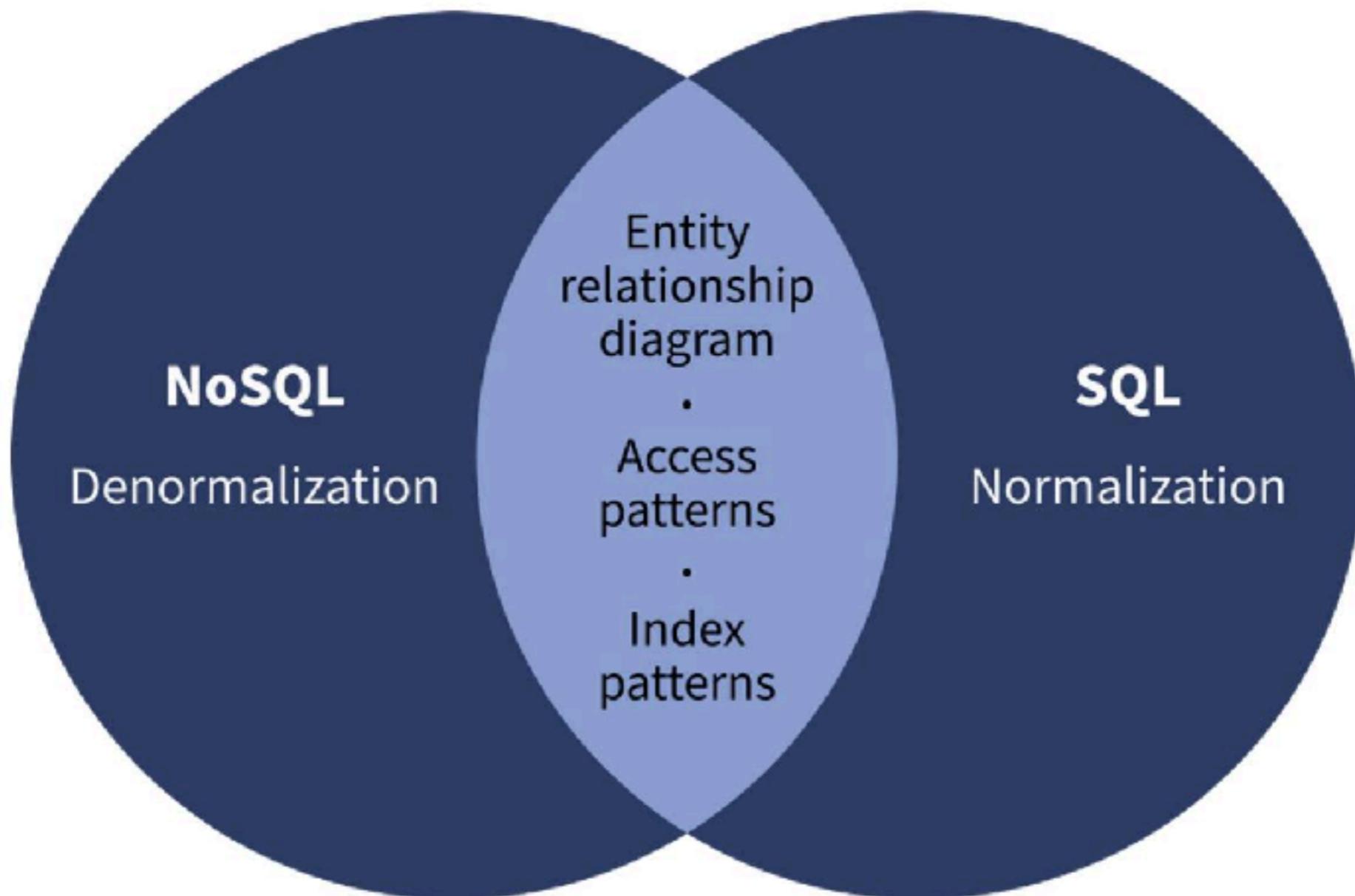
Scale up or Scale out ?



**Do all modules need to use the
same Database, Language and
Runtime ... ?**



Database ?



Database Models Ranking

424 systems in ranking, June 2025

Rank			DBMS	Database Model	Score		
Jun 2025	May 2025	Jun 2024			Jun 2025	May 2025	Jun 2024
1.	1.	1.	Oracle	Relational, Multi-model 	1230.38	+3.82	-13.70
2.	2.	2.	MySQL	Relational, Multi-model 	953.57	-11.41	-107.77
3.	3.	3.	Microsoft SQL Server	Relational, Multi-model 	776.75	+1.86	-44.81
4.	4.	4.	PostgreSQL 	Relational, Multi-model 	680.65	+6.34	+44.41
5.	5.	5.	MongoDB 	Document, Multi-model 	402.85	+0.33	-18.23
6.	6.	↑ 8.	Snowflake	Relational	174.49	+2.48	+44.13
7.	7.	↓ 6.	Redis	Key-value, Multi-model 	151.72	-0.47	-4.22
8.	8.	↑ 9.	IBM Db2	Relational, Multi-model 	125.13	-1.27	-0.77
9.	9.	↓ 7.	Elasticsearch	Multi-model 	121.28	-2.53	-11.55
10.	10.	10.	SQLite	Relational	117.03	-0.74	+5.63
11.	11.	↑ 12.	Apache Cassandra	Wide column, Multi-model 	108.27	+0.22	+9.44
12.	12.	↑ 15.	Databricks	Multi-model 	104.67	+2.02	+23.59
13.	↑ 14.	13.	MariaDB	Relational, Multi-model 	94.54	+0.93	+3.50
14.	↓ 13.	↓ 11.	Microsoft Access	Relational	88.28	-7.63	-12.88
15.	15.	↑ 17.	Amazon DynamoDB	Multi-model 	83.34	+4.04	+8.90

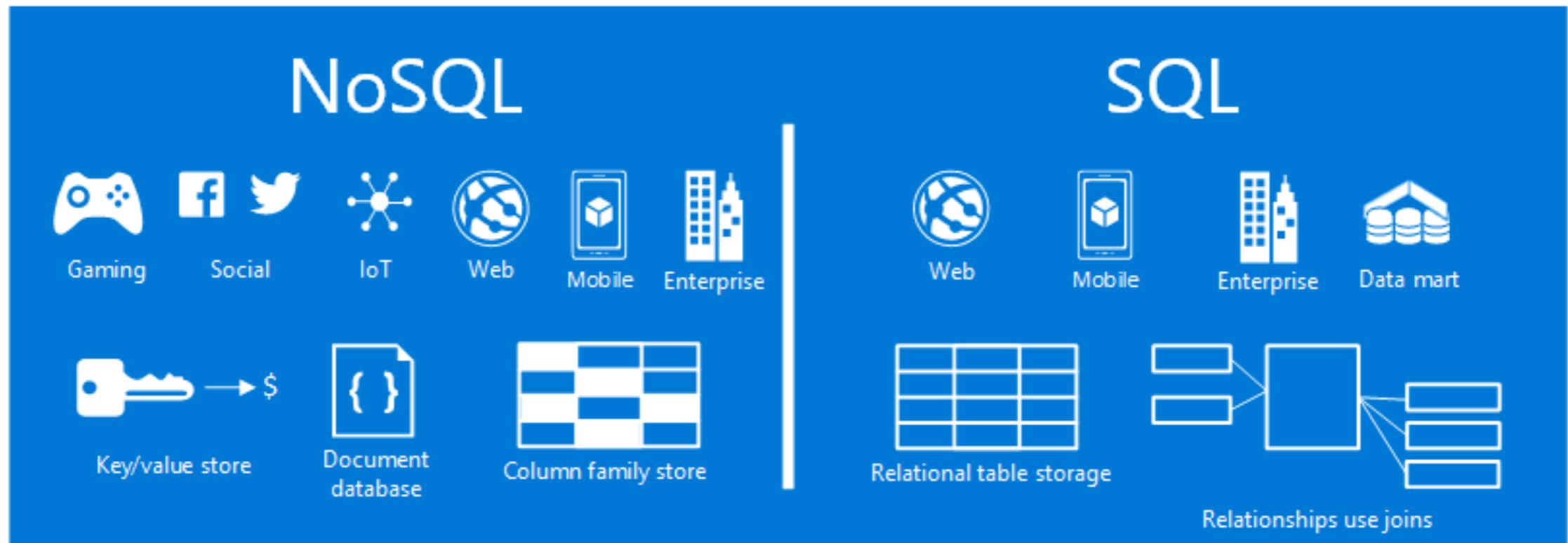
<https://db-engines.com/en/ranking>



Microservices

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Database Models



Database design

Design for read

Design for write

Pre-join tables or pre-aggregate data

Manage data size

Partitioning and Sharding

Caching data



We need to improve

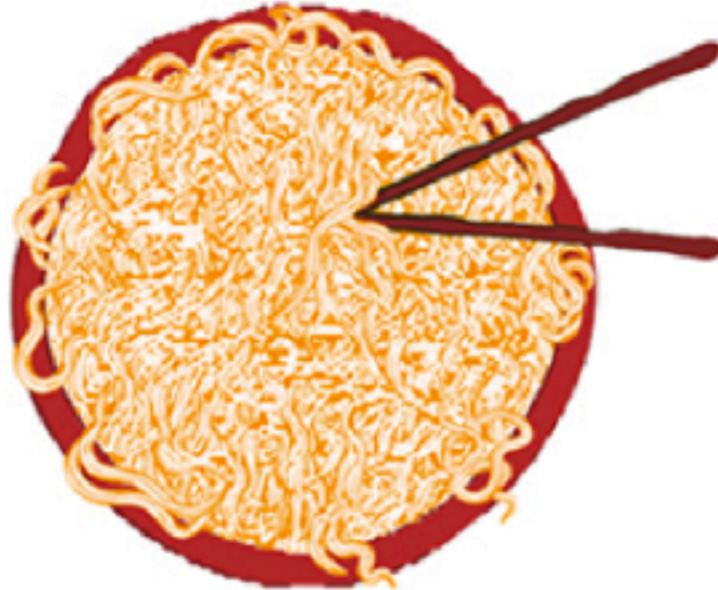
We need to get better



SOA

1990s and earlier

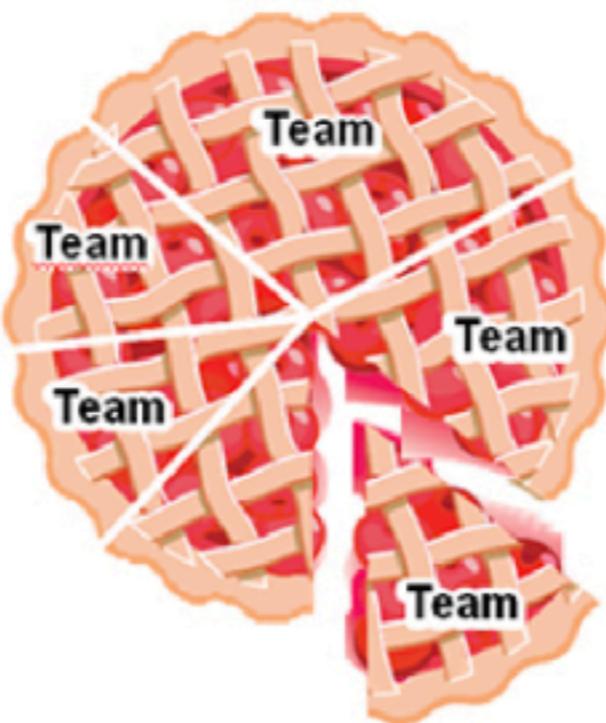
Pre-SOA (monolithic)
Tight coupling



For a monolith to change, all must agree on each change. Each change has unanticipated effects requiring careful testing beforehand.

2000s

Traditional SOA
Looser coupling



Elements in SOA are developed more autonomously but must be coordinated with others to fit into the overall design.

2010s

Microservices
Decoupled



Developers can create and activate new microservices without prior coordination with others. Their adherence to MSA principles makes continuous delivery of new or modified services possible.



Service-Oriented Architecture



What is service ?

Standalone and loosely couple

Independently deployable software component

Implement some useful functionality



Service-Oriented Architecture

SOA Manifesto

Service orientation is a paradigm that frames what you do.
Service-oriented architecture (SOA) is a type of architecture
that results from applying service orientation.

We have been applying service orientation to help organizations
consistently deliver sustainable business value, with increased agility
and cost effectiveness, in line with changing business needs.

<http://www.soa-manifesto.org/>



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Service-Oriented Architecture

Through our work we have come to prioritize:

Business value over technical strategy

Strategic goals over project-specific benefits

Intrinsic interoperability over custom integration

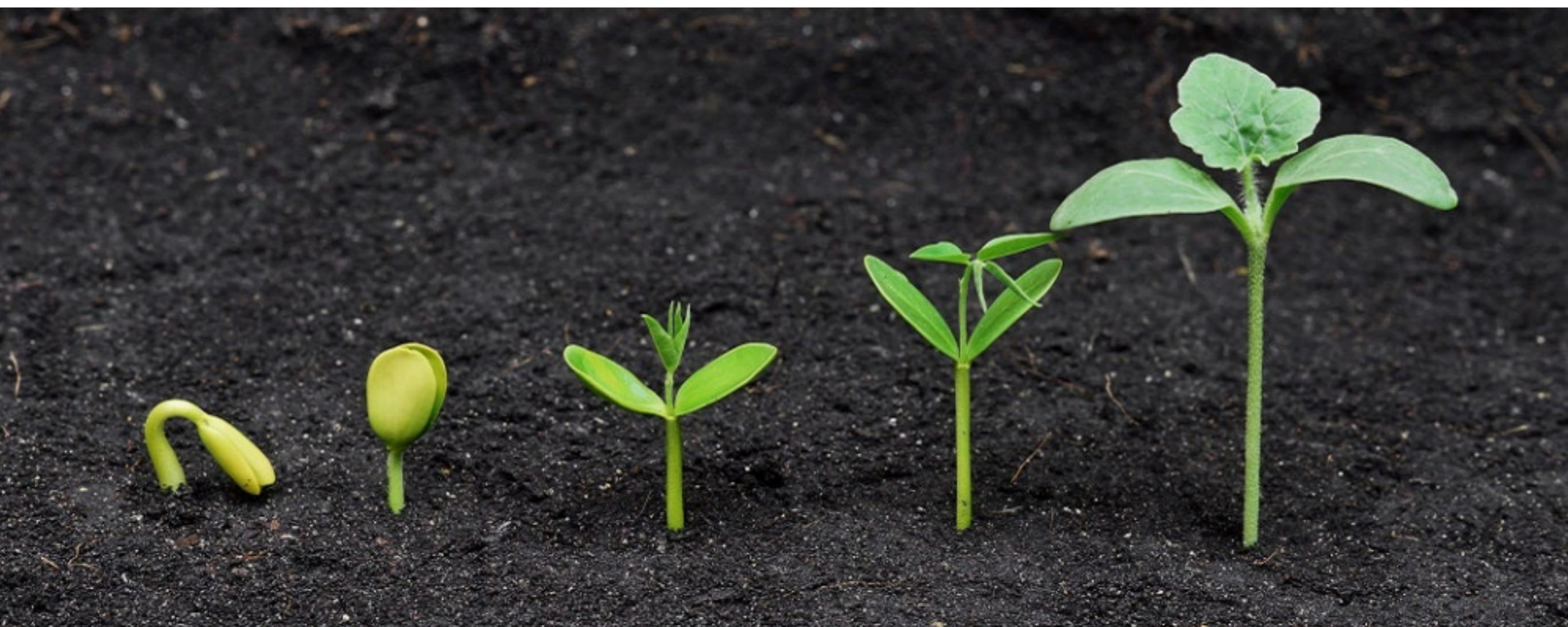
Shared services over specific-purpose implementations

Flexibility over optimization

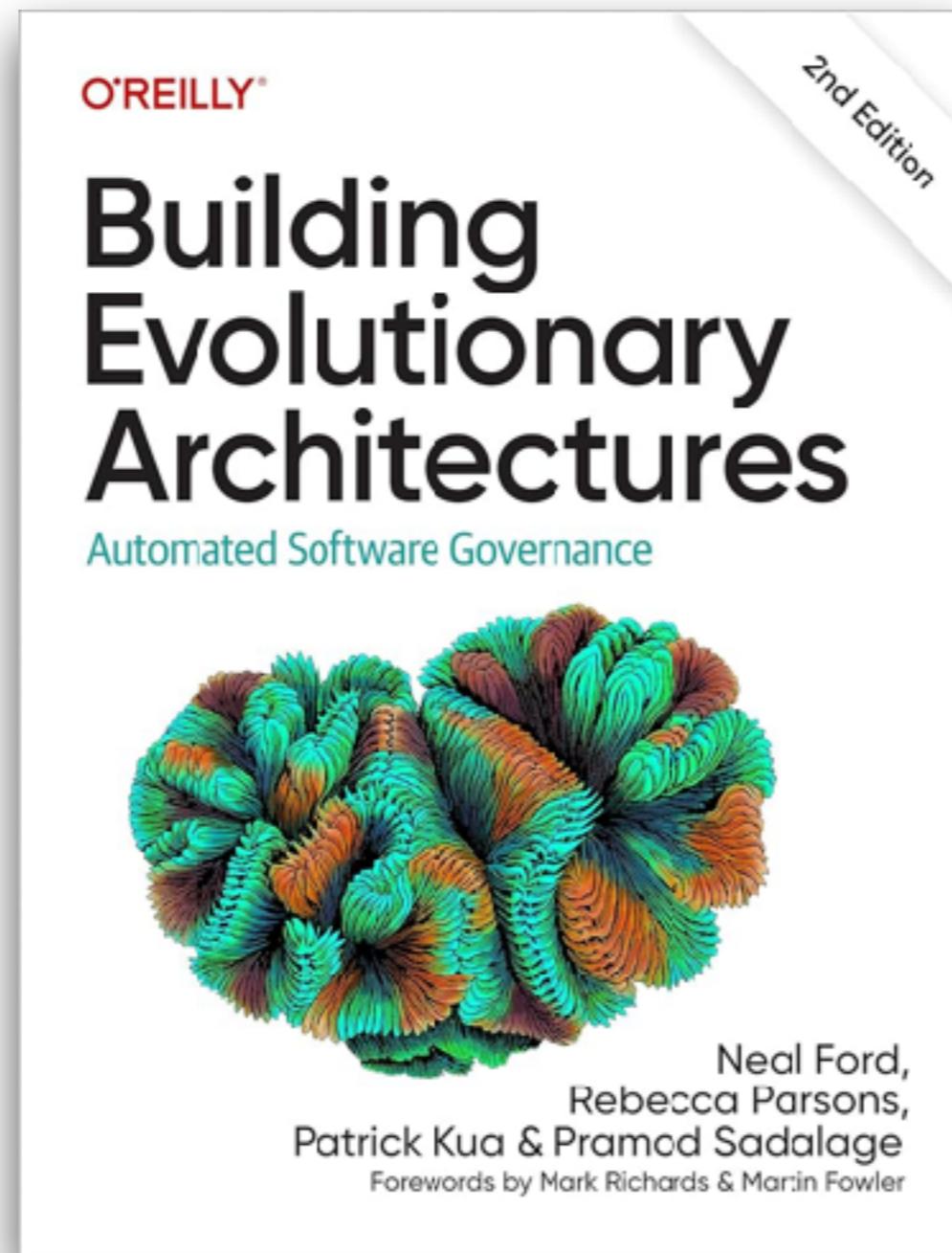
Evolutionary refinement over pursuit of initial perfection



Evolution design and continuous improvement



Building Evolutionary Architecture



<https://www.amazon.com/Building-Evolutionary-Architectures-Automated-Governance/dp/1492097543>



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Service-Oriented Architecture

Through our work we have come to prioritize:

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Intrinsic interoperability over custom integration

Shared services over specific-purpose implementations

Flexibility over optimization

Evolutionary refinement over pursuit of initial perfection

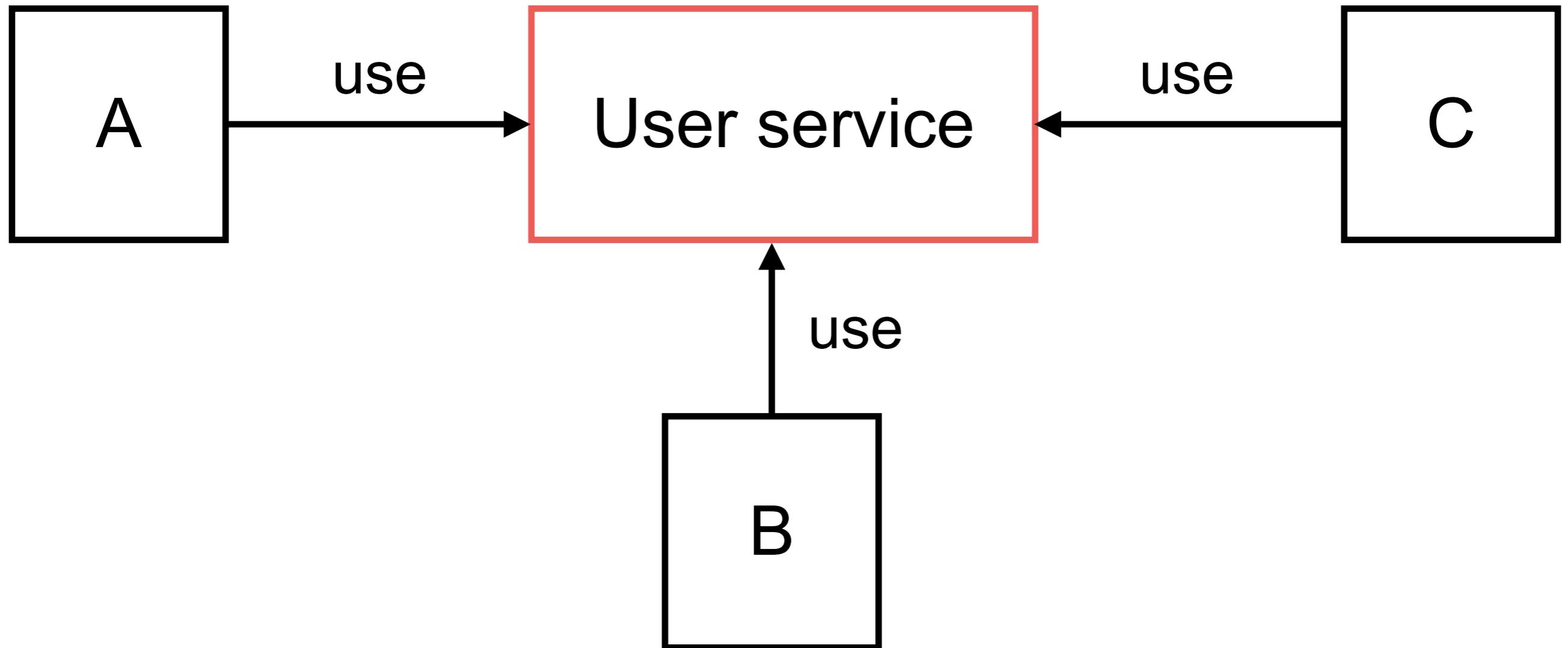
<http://www.soa-manifesto.org/>



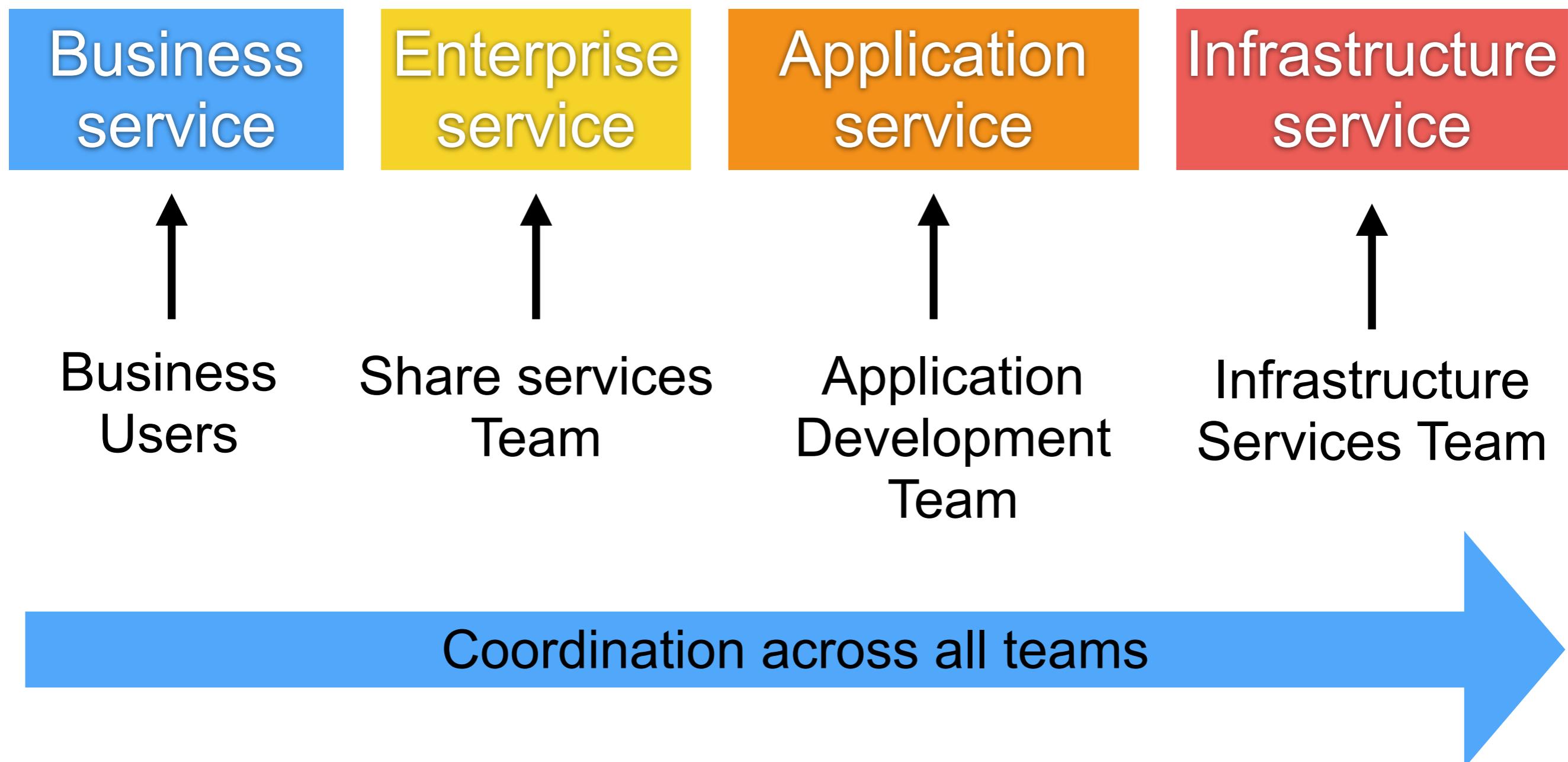
Microservices

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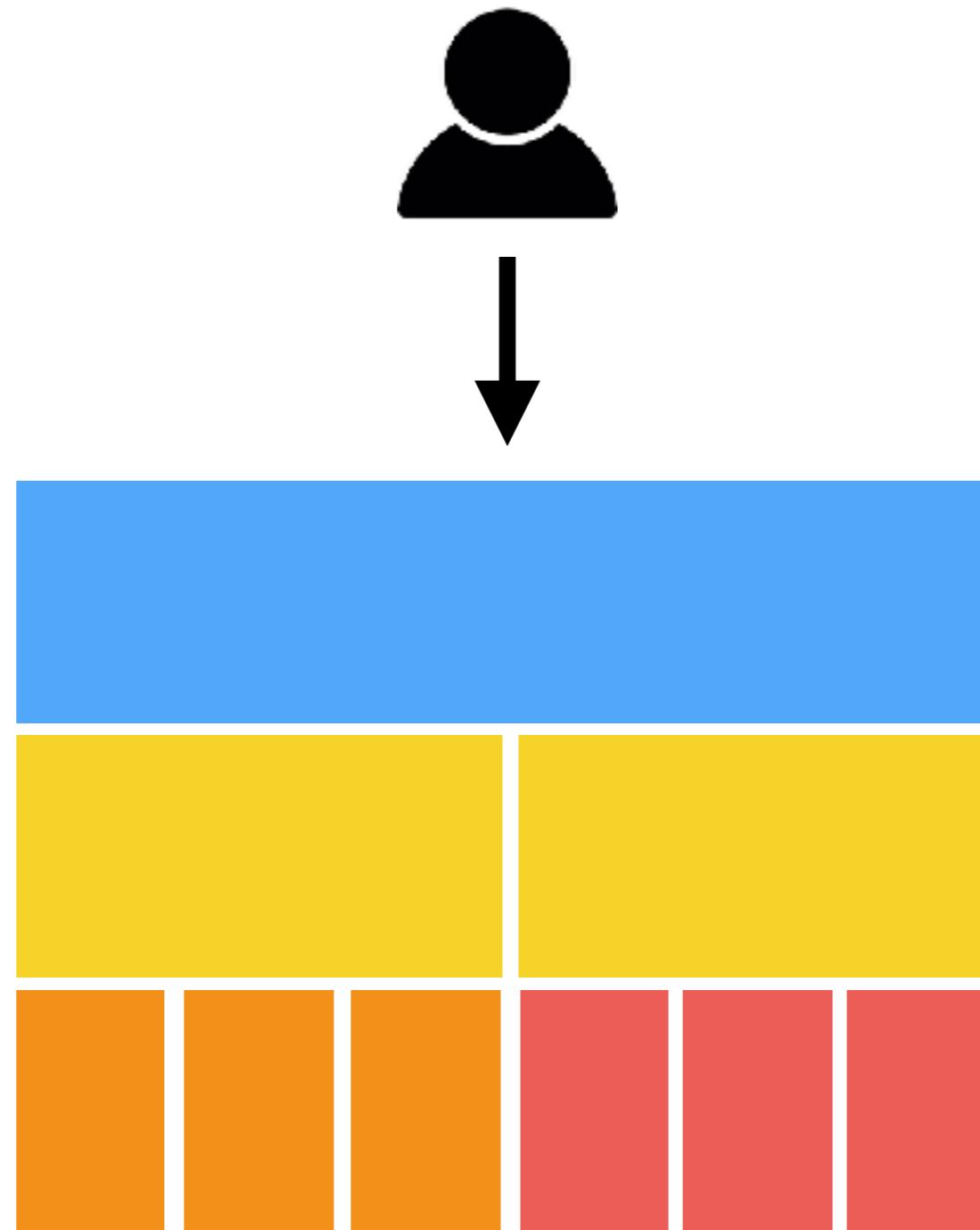
Shared service ?



Service-Oriented Architecture



Service-Oriented Architecture



We need to improve

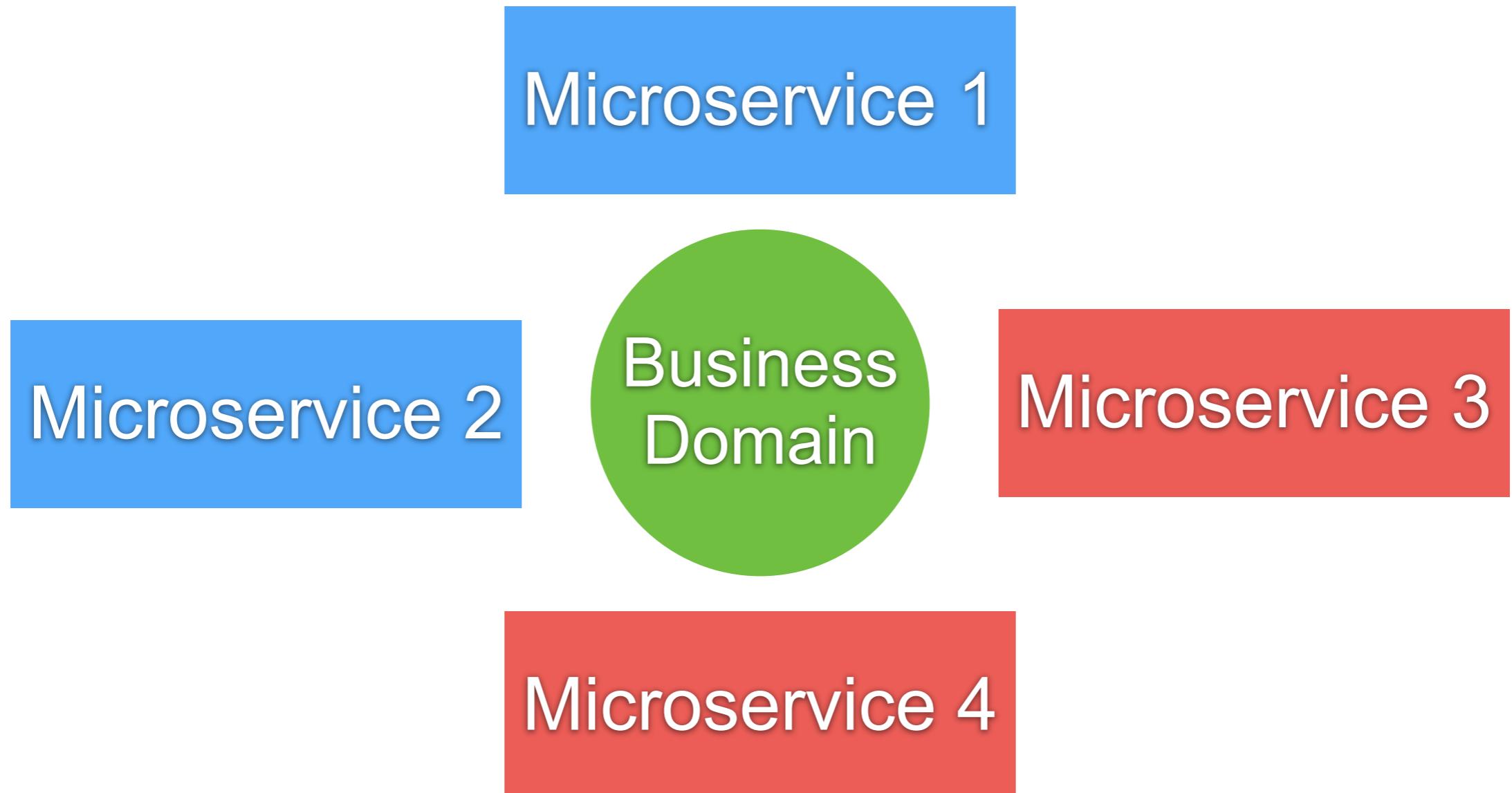
We need to get better



Microservice



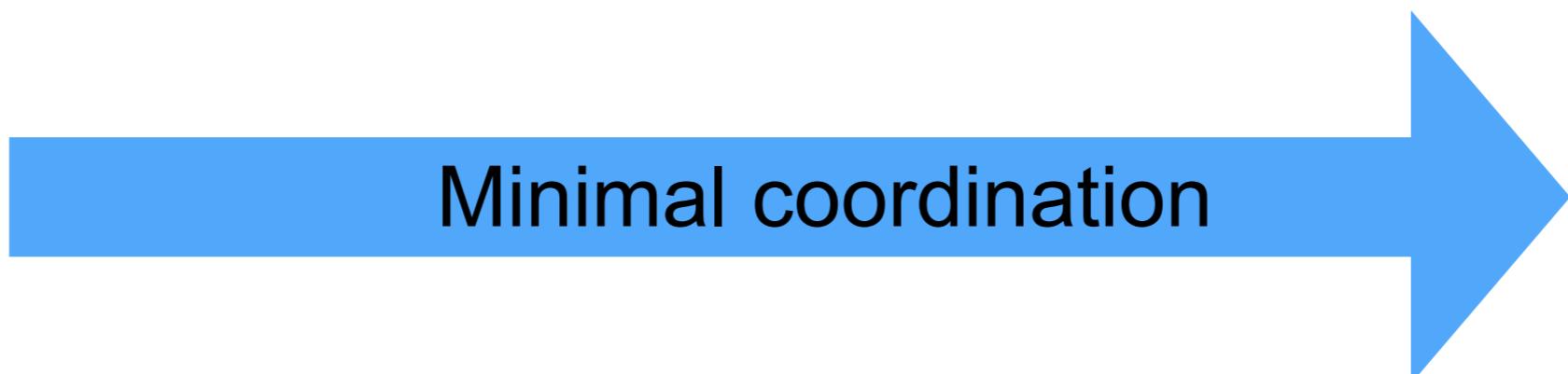
Microservice



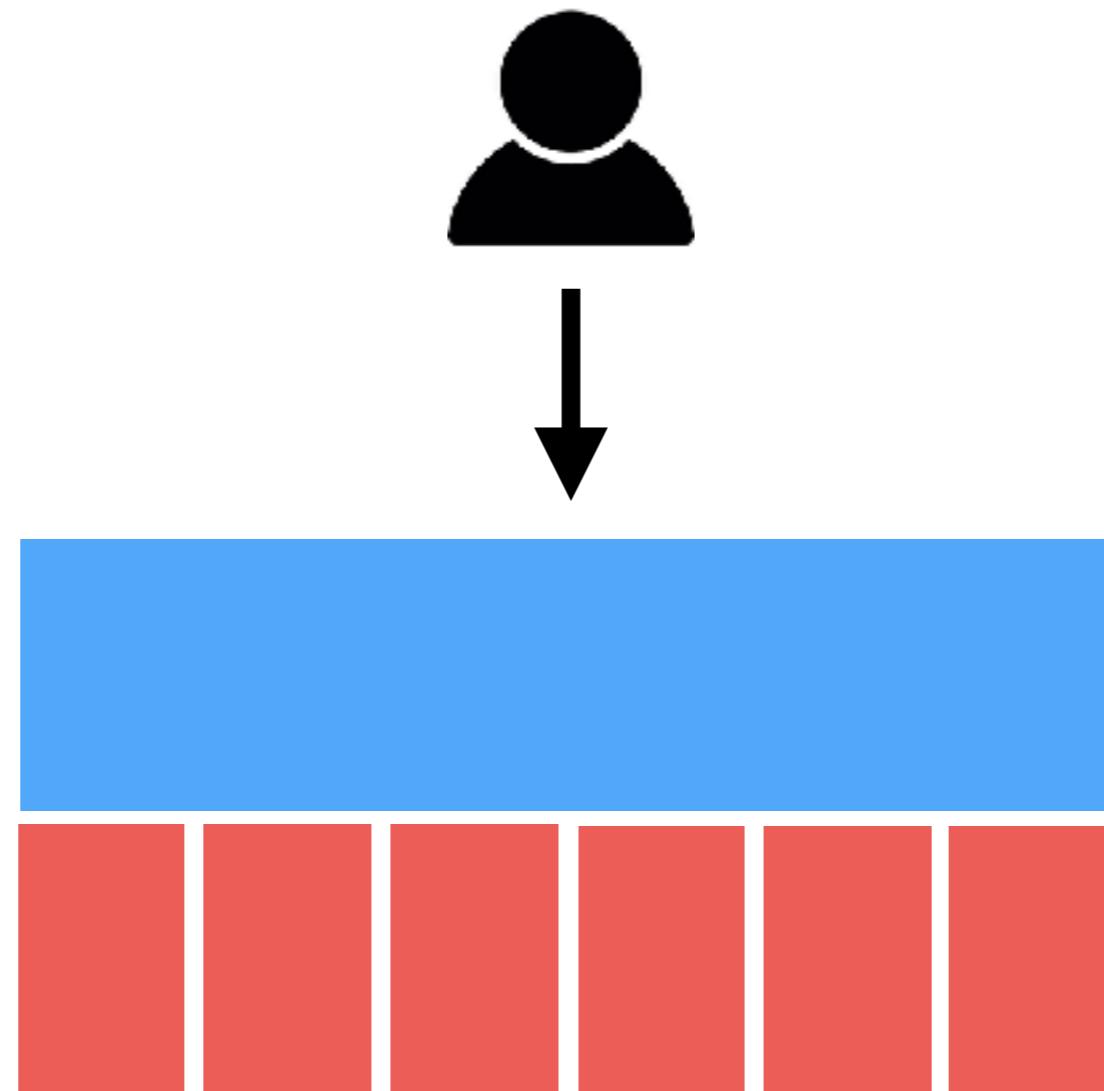
Microservice

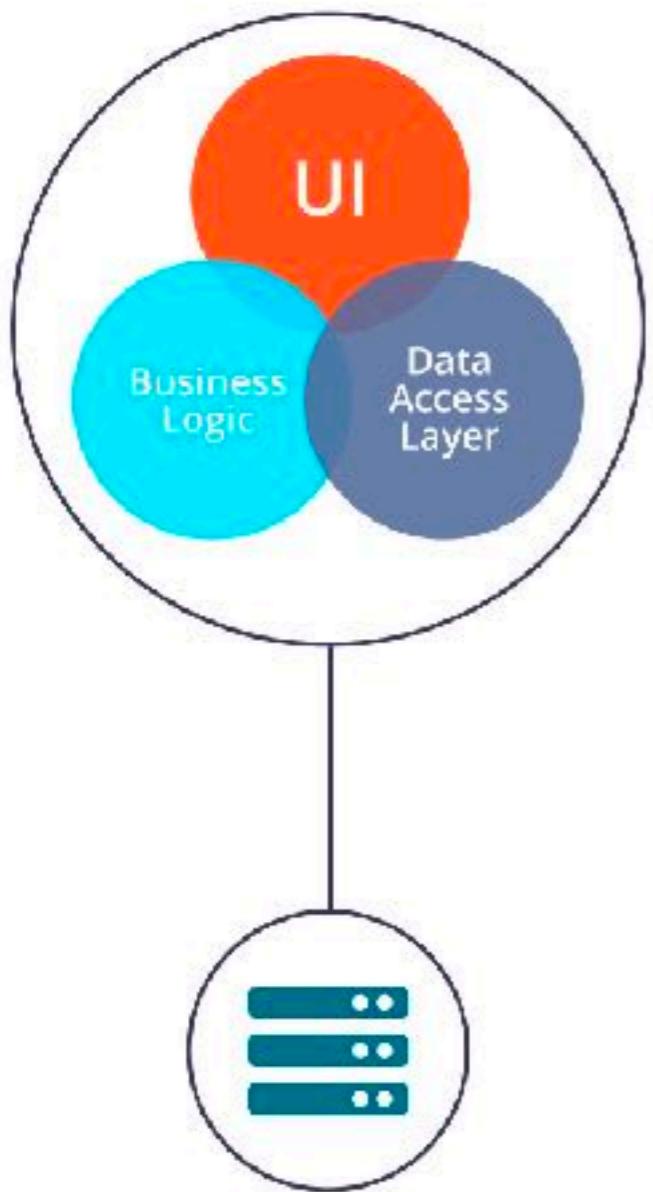


Application Development Team

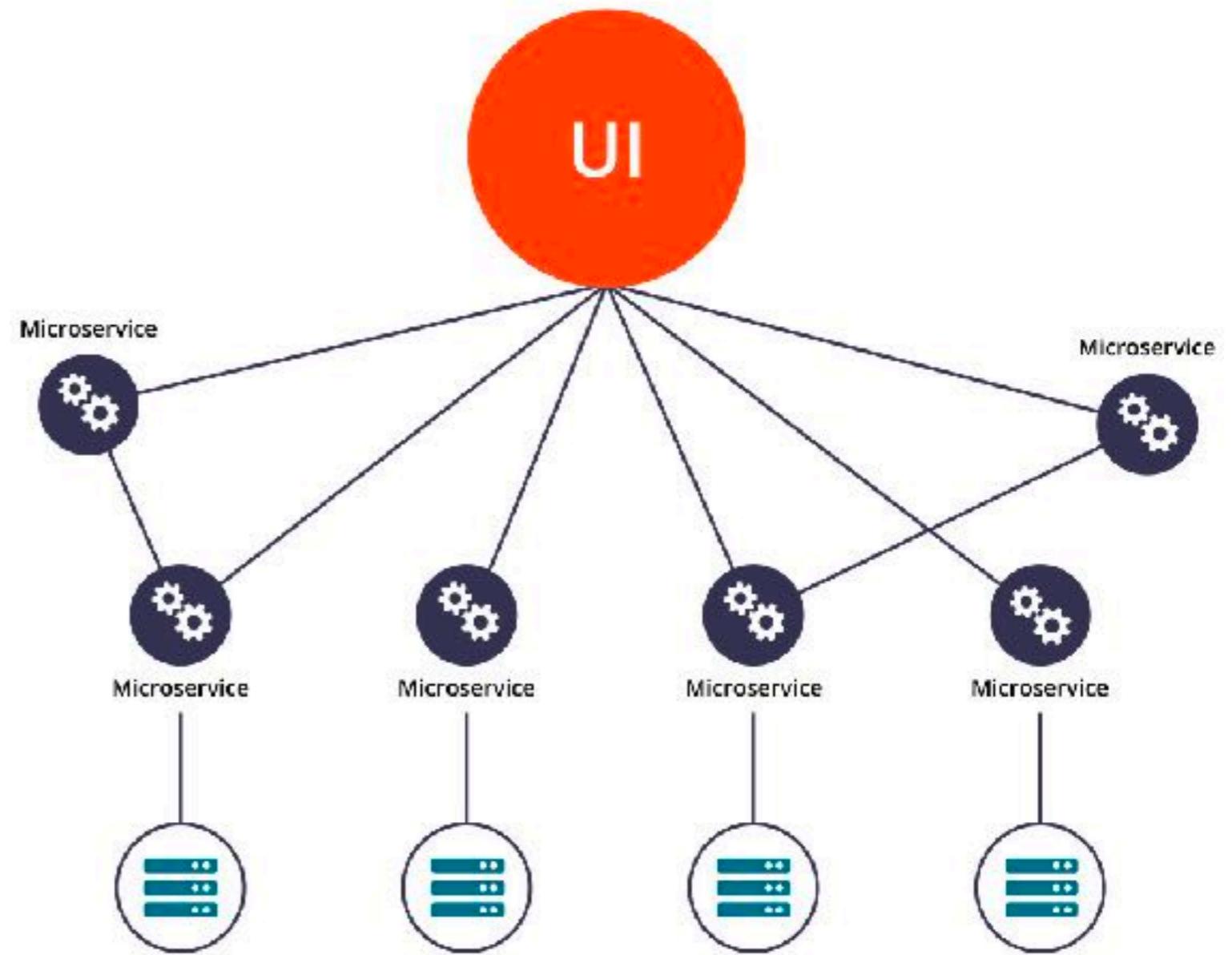


Microservice





Monolithic Architecture



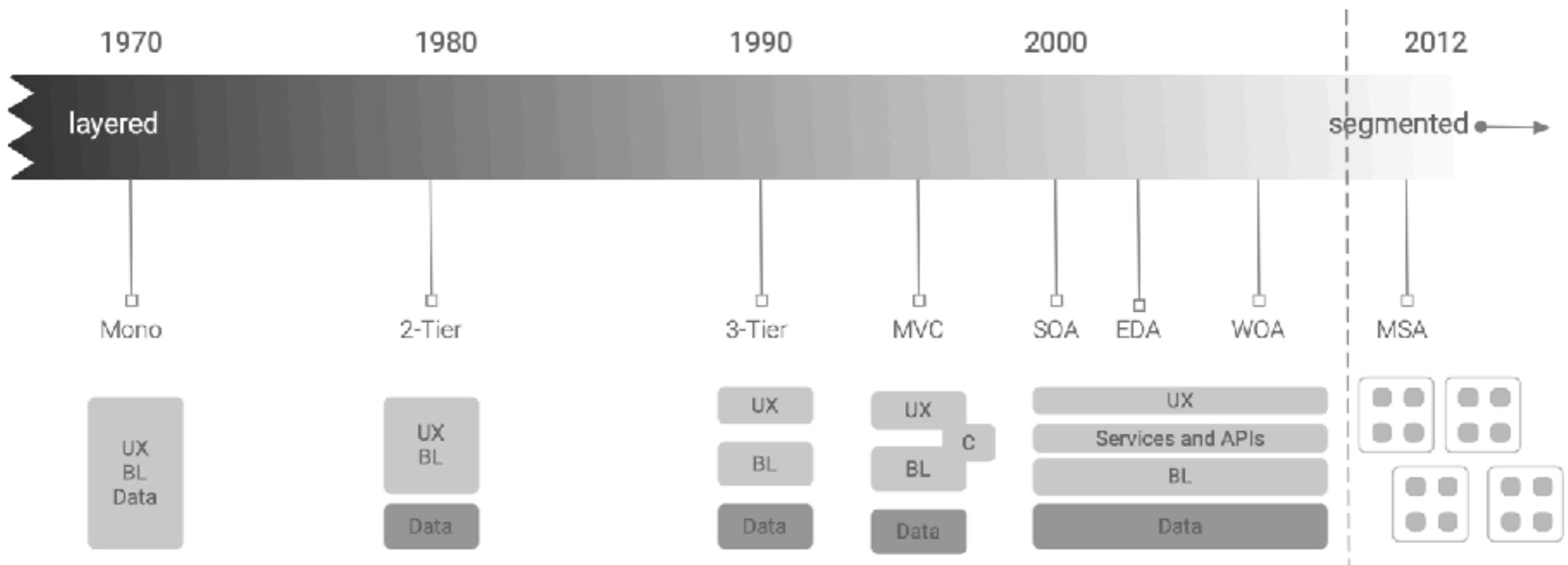
Microservice Architecture



Summary



Evolution of Architecture

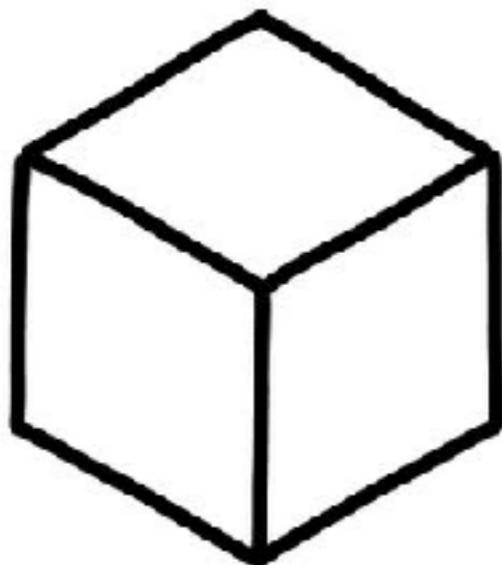


<https://github.com/wso2/reference-architecture/blob/master/reference-architecture-layered-segmented.md>



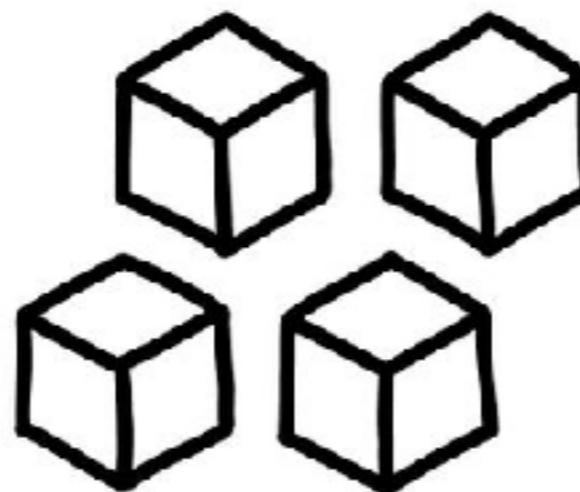
GRANULARITY OF SYSTEMS

Monolithic



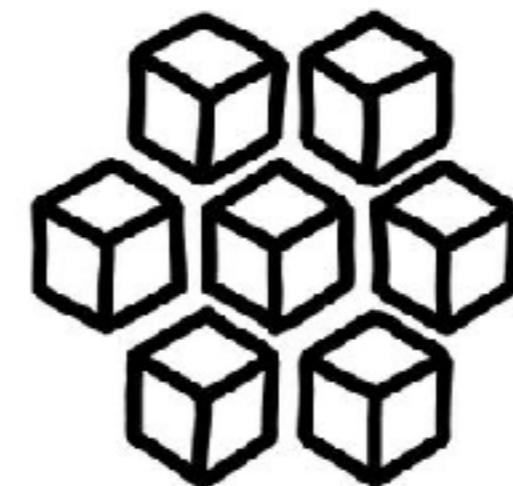
Single unit

SOA



Coarse-grained

Microservices

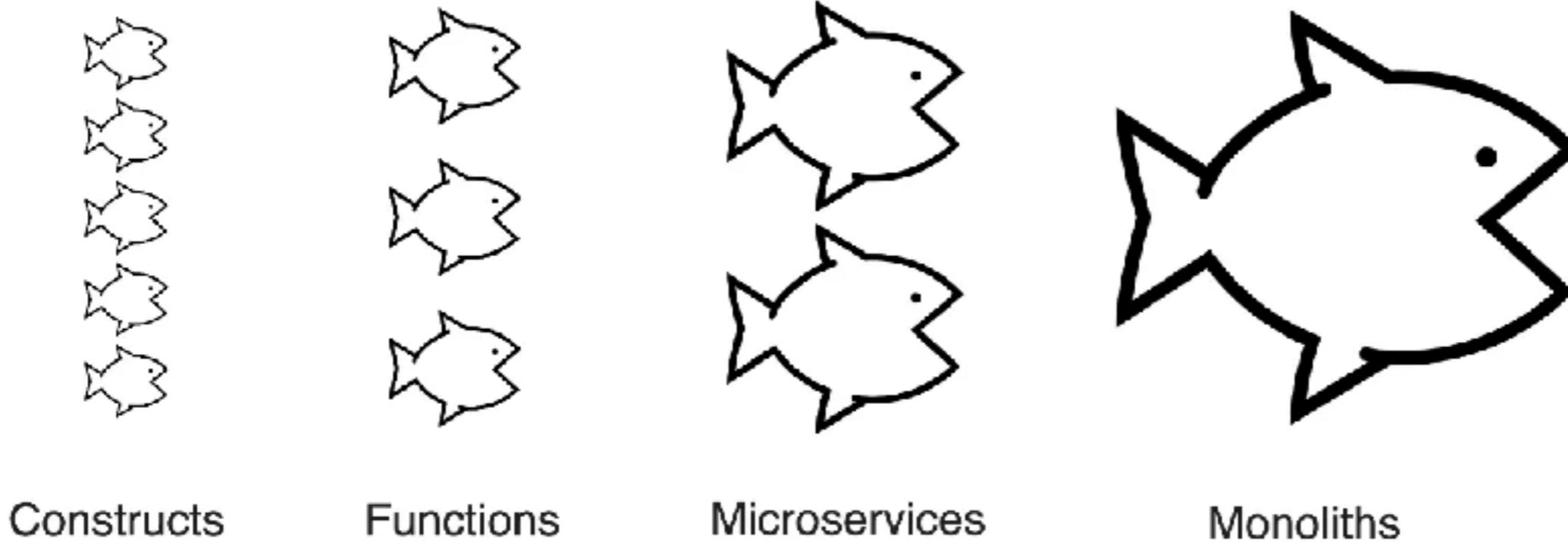
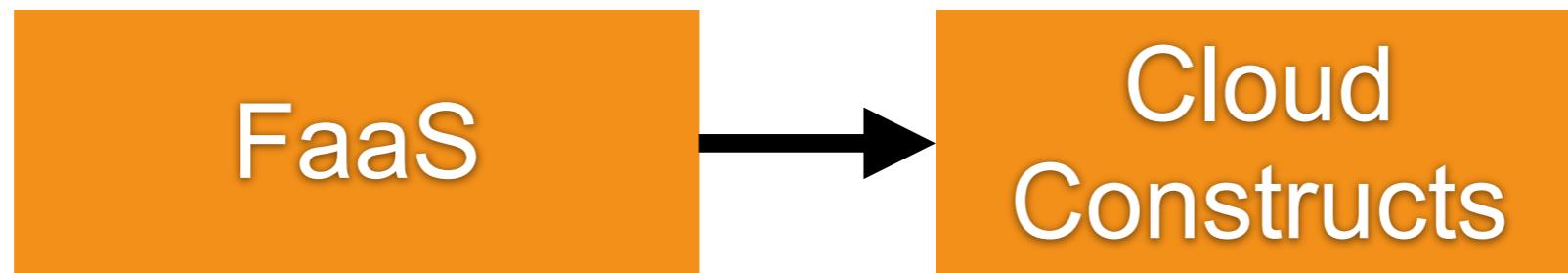


Fine-grained

<https://architecturenotes.co/p/granularity-of-systems>



Next !!!



<https://www.infoq.com/articles/cloud-computing-post-serverless-trends/>



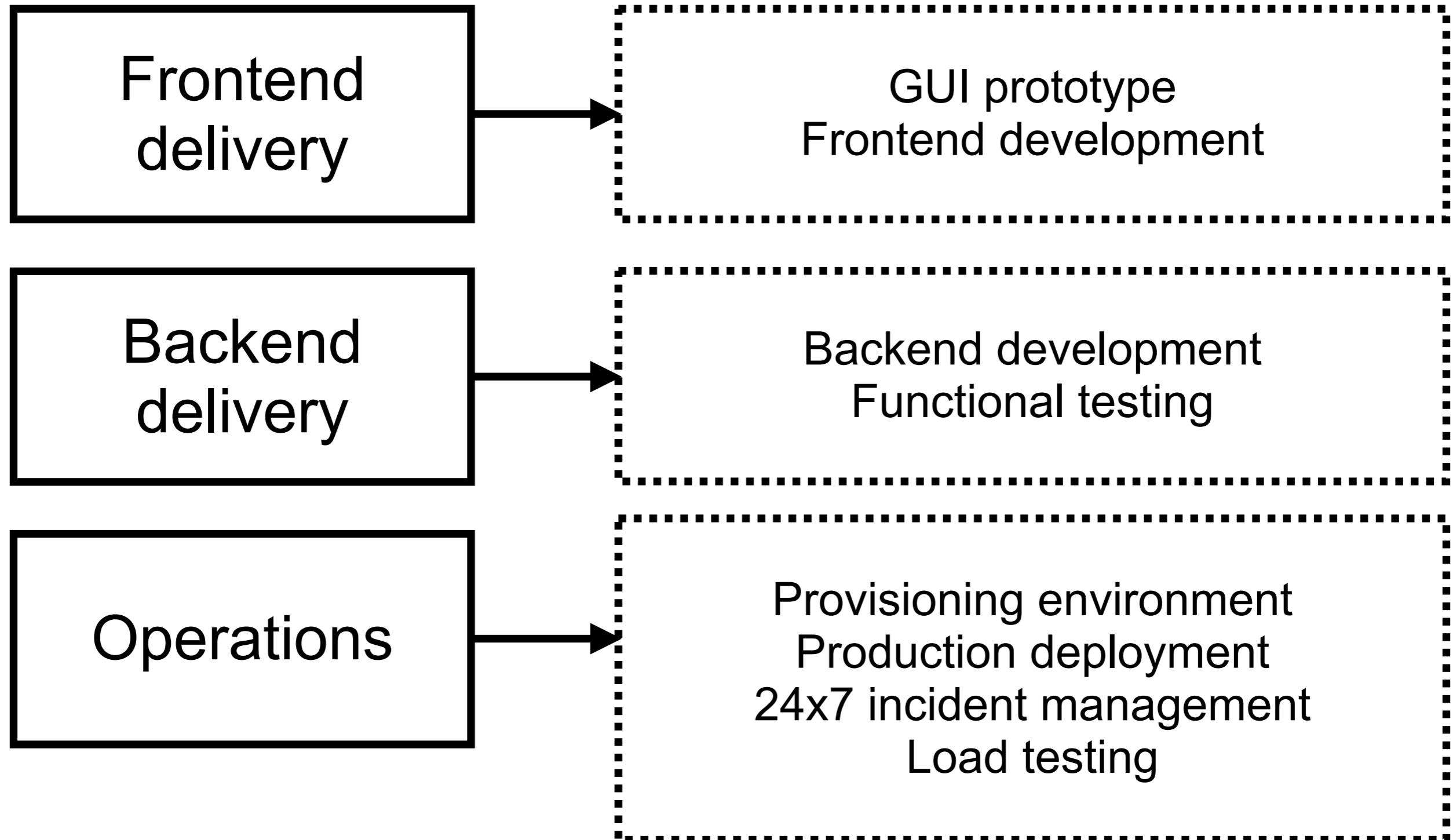
**WHAT'S
YOUR
PROBLEM?**



Delivery Problems



Delivery Responsibilities



Delivery Improvement ?



Better ?

Delivery Team

Frontend
delivery

Backend
delivery

Operations

GUI prototype
Frontend development
Backend development
Functional testing
Provisioning environment
Incident management (office hours)

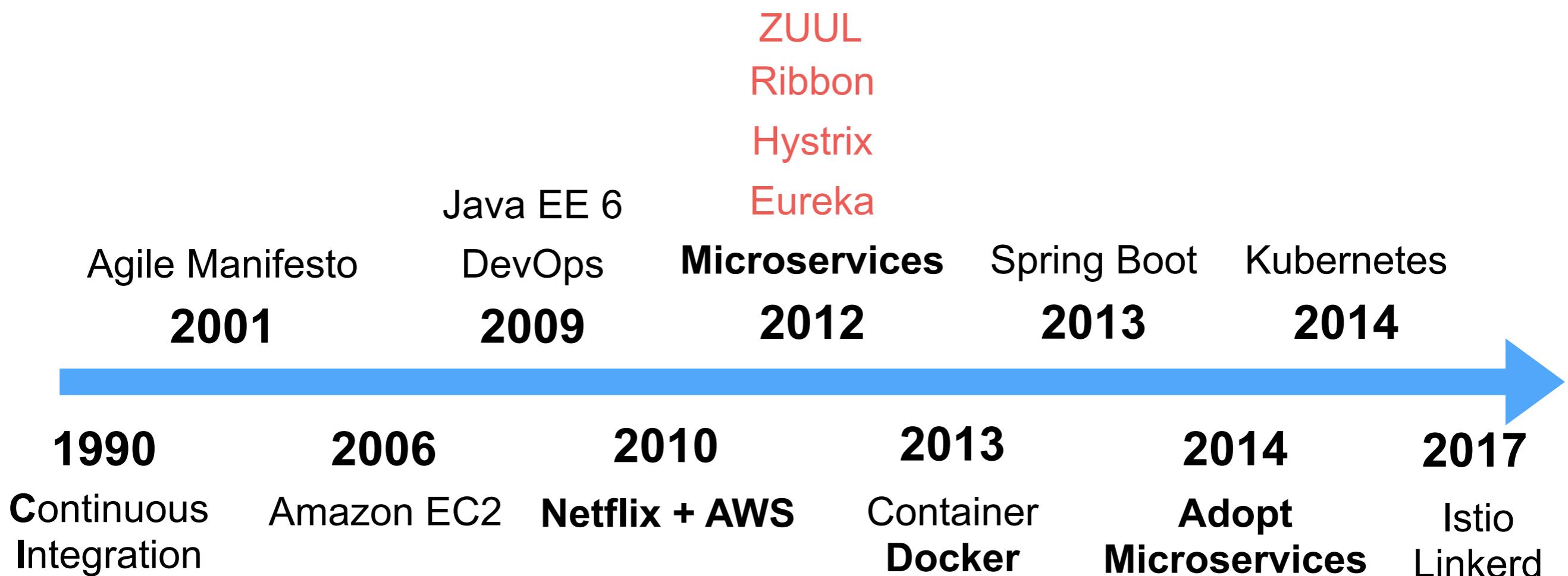
Incident management (off-office hours)
Load testing
Production deployment
Self-service platform



Microservice's History



History



Microservice

Small, Do one thing (Single Responsibility)

Modular

Easy to understand

Easy to develop

Easy to deploy

Easy to maintain

Scale independently



Design Microservice ?

Interface
segregation

Deployability

Event-driven

Loose coupling

Single
responsibility

Availability over
consistency

<https://www.infoq.com/articles/microservices-design-ideals/>



Goals

Increase the **velocity** of application release

By decomposing app to **small** services

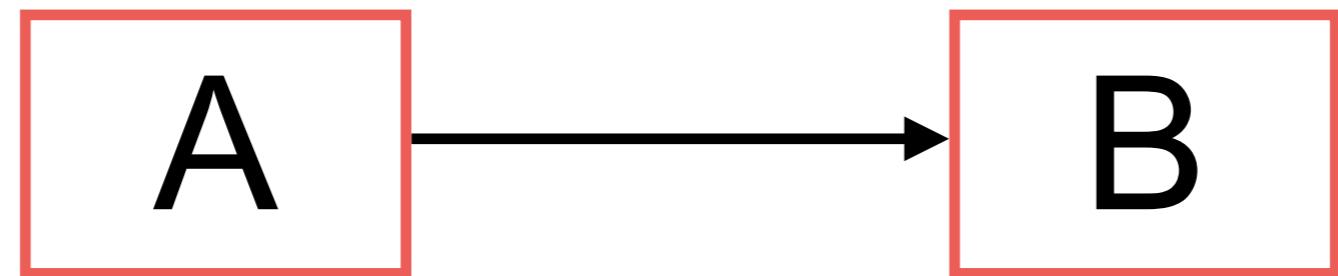
Autonomous services

Deploy independently



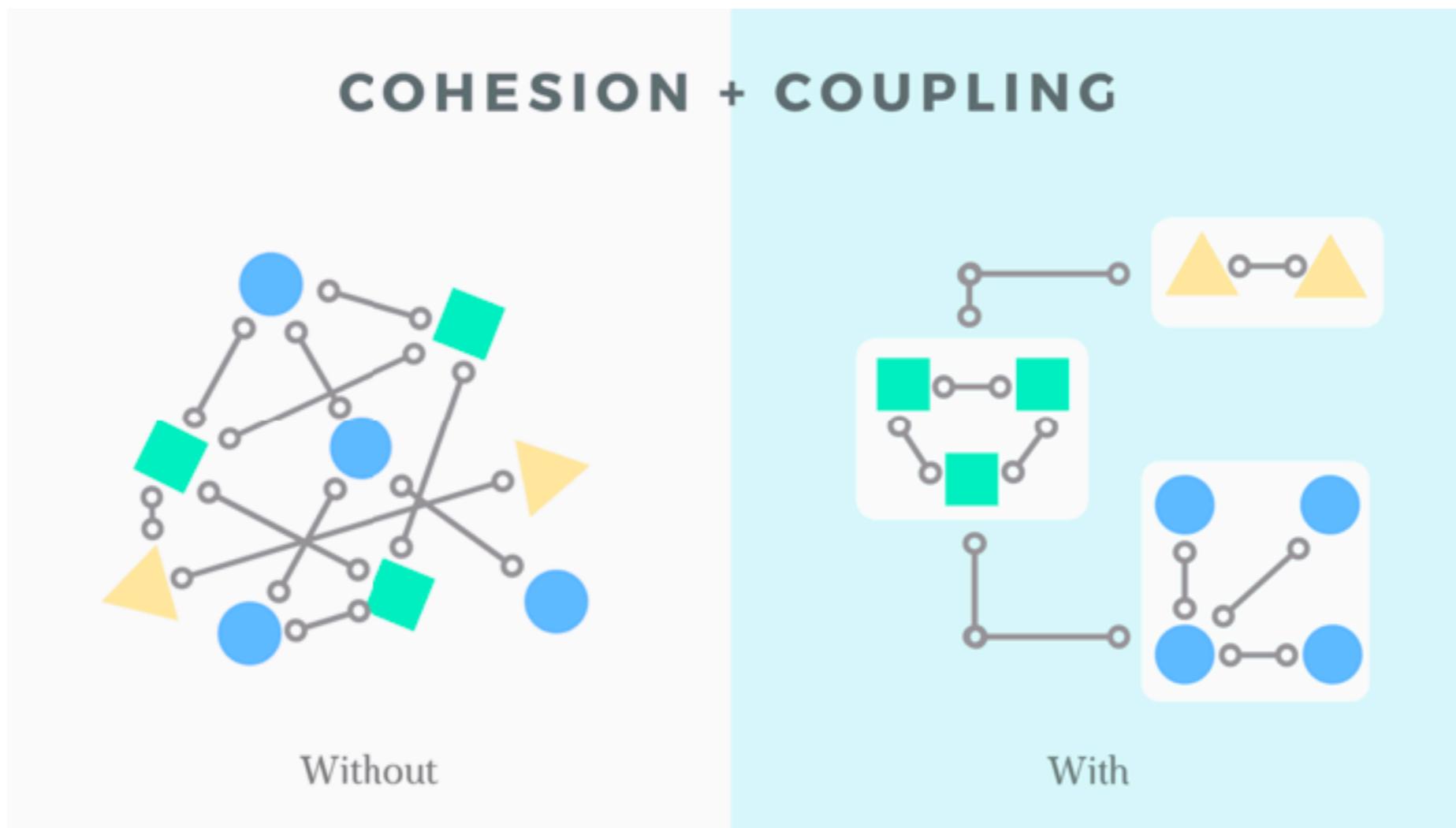
Independent

Replicable
Updatable
Scalable
Deployable

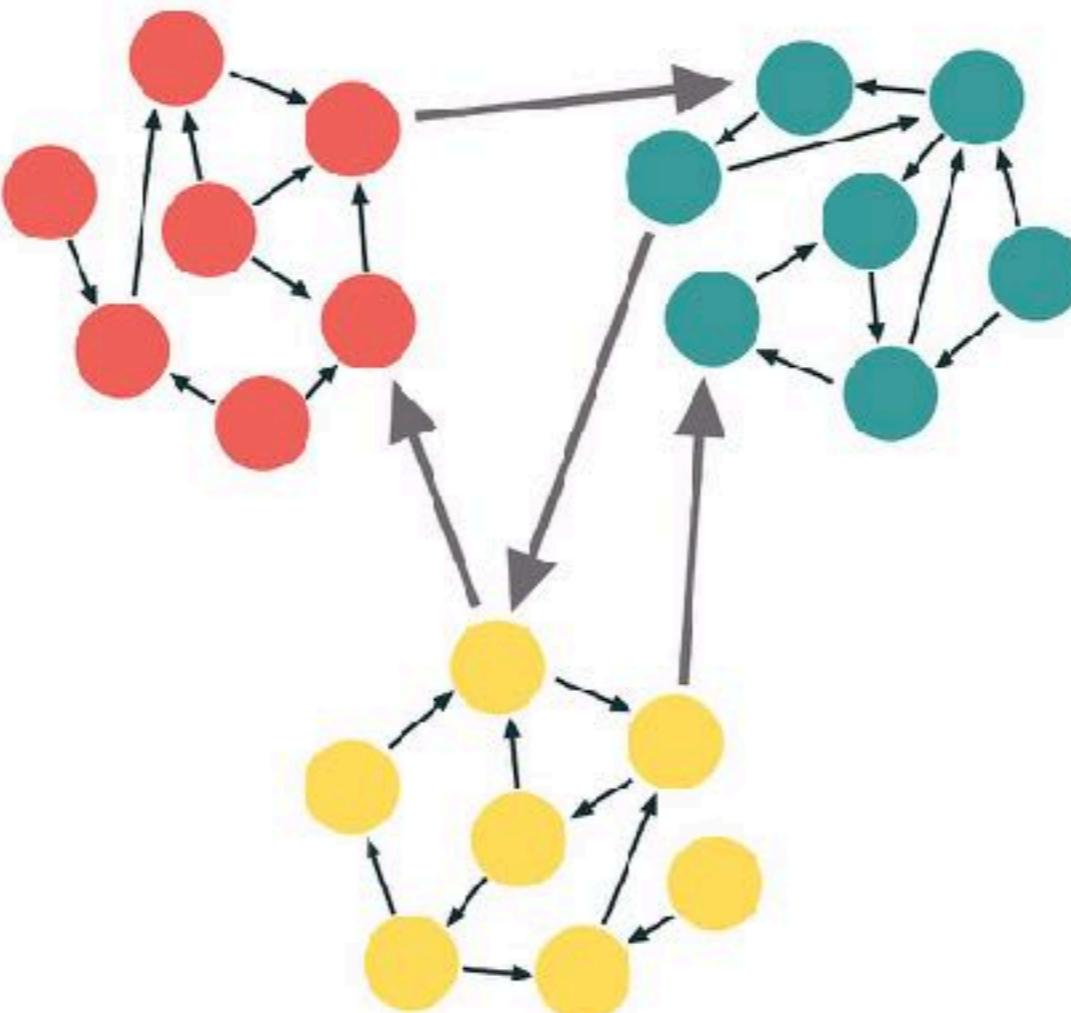


Better Architecture

Loose coupling
High cohesion



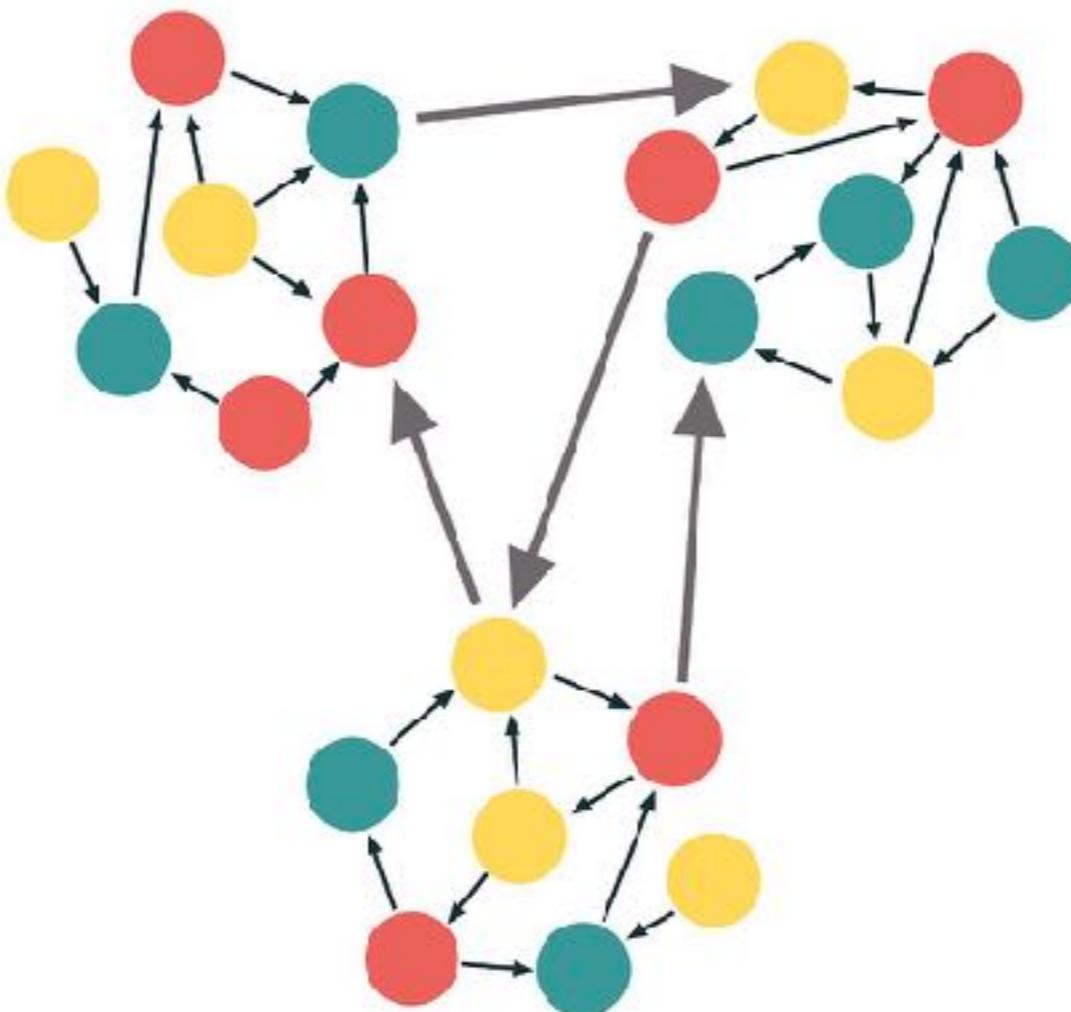
Coupling (Idea)



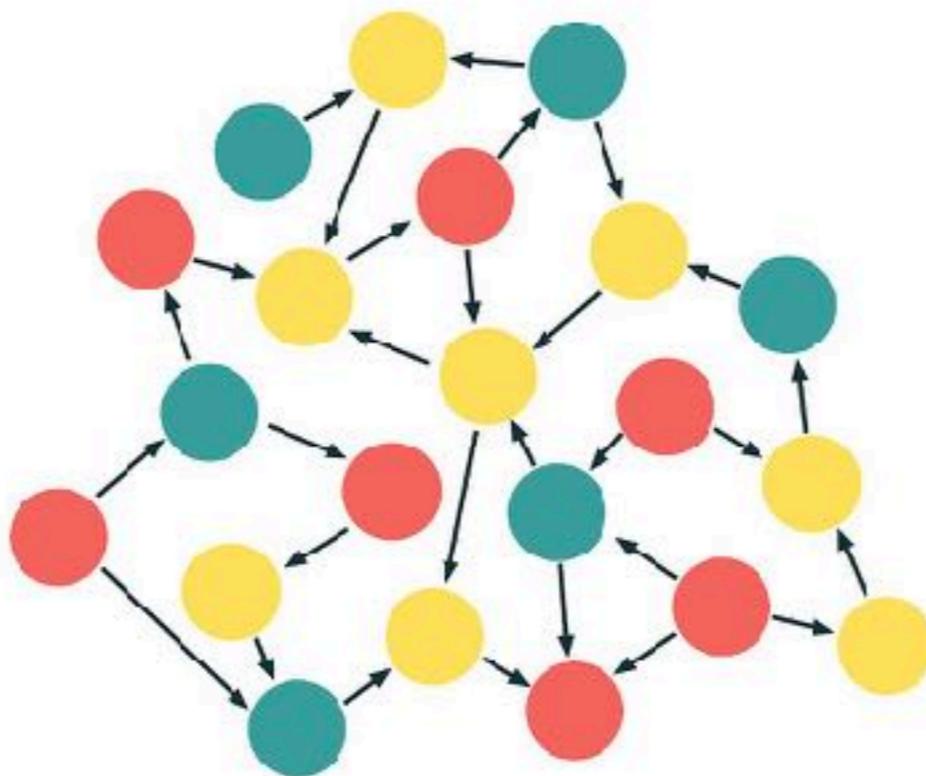
<https://enterprisecraftsmanship.com/posts/cohesion-coupling-difference/>



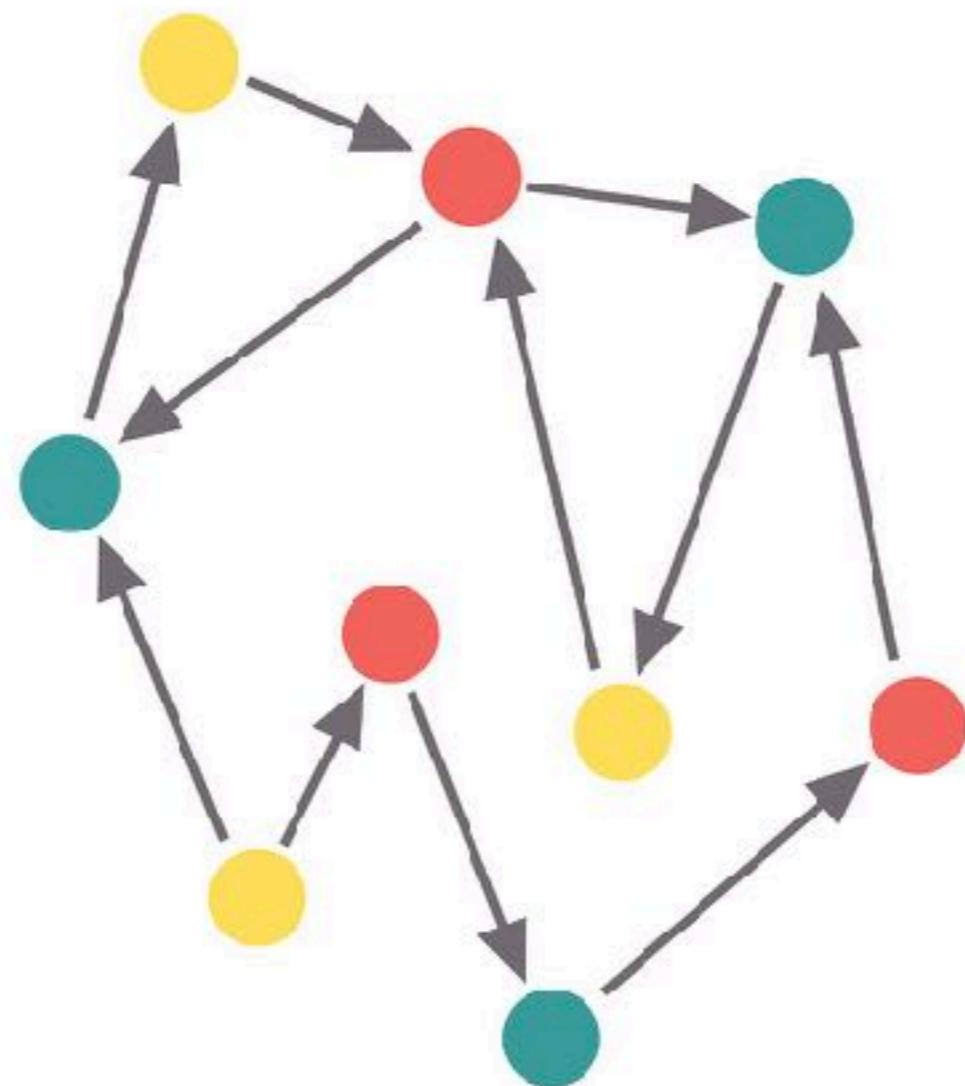
Coupling (Poorly boundary)



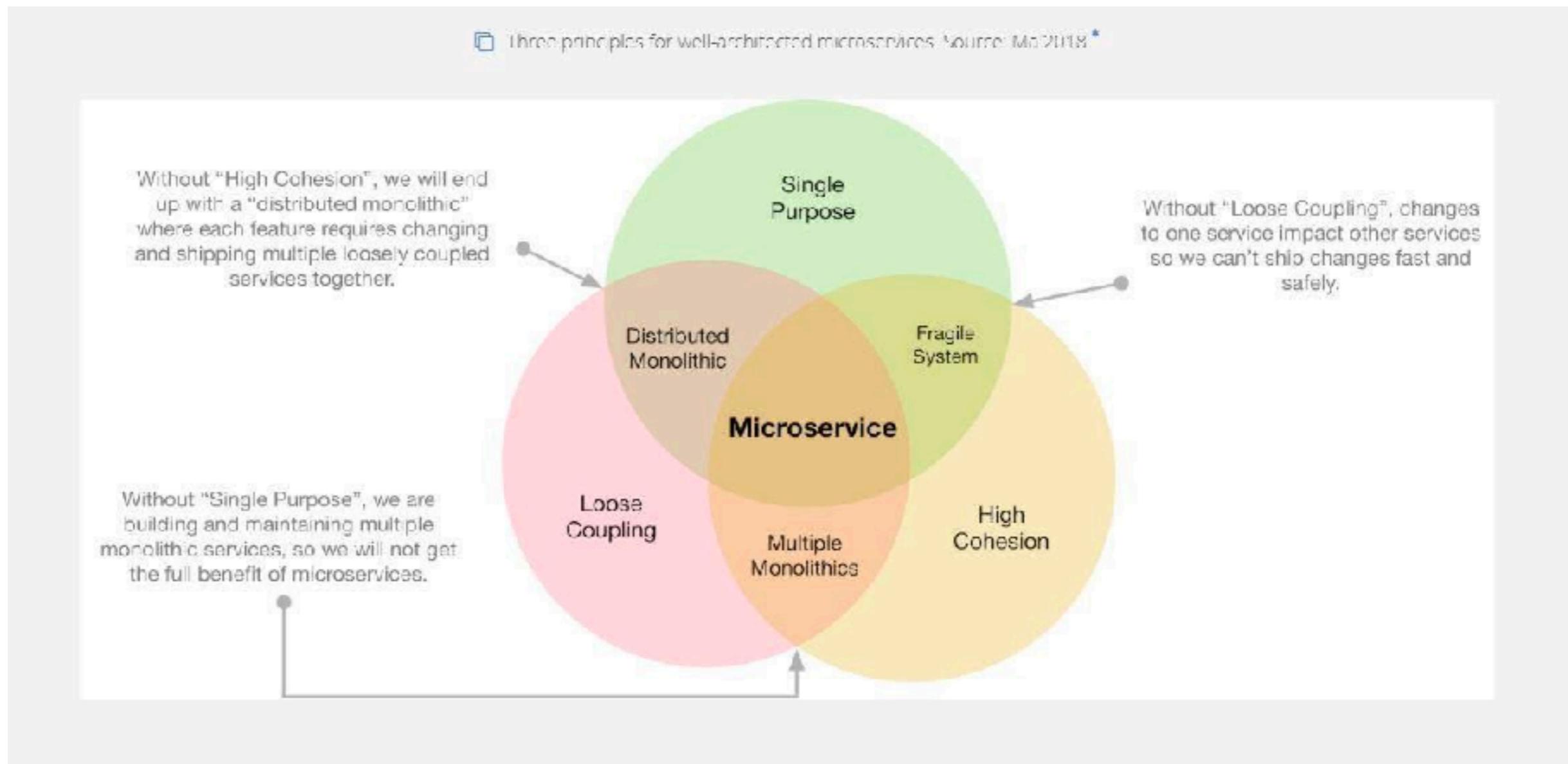
Coupling (God)



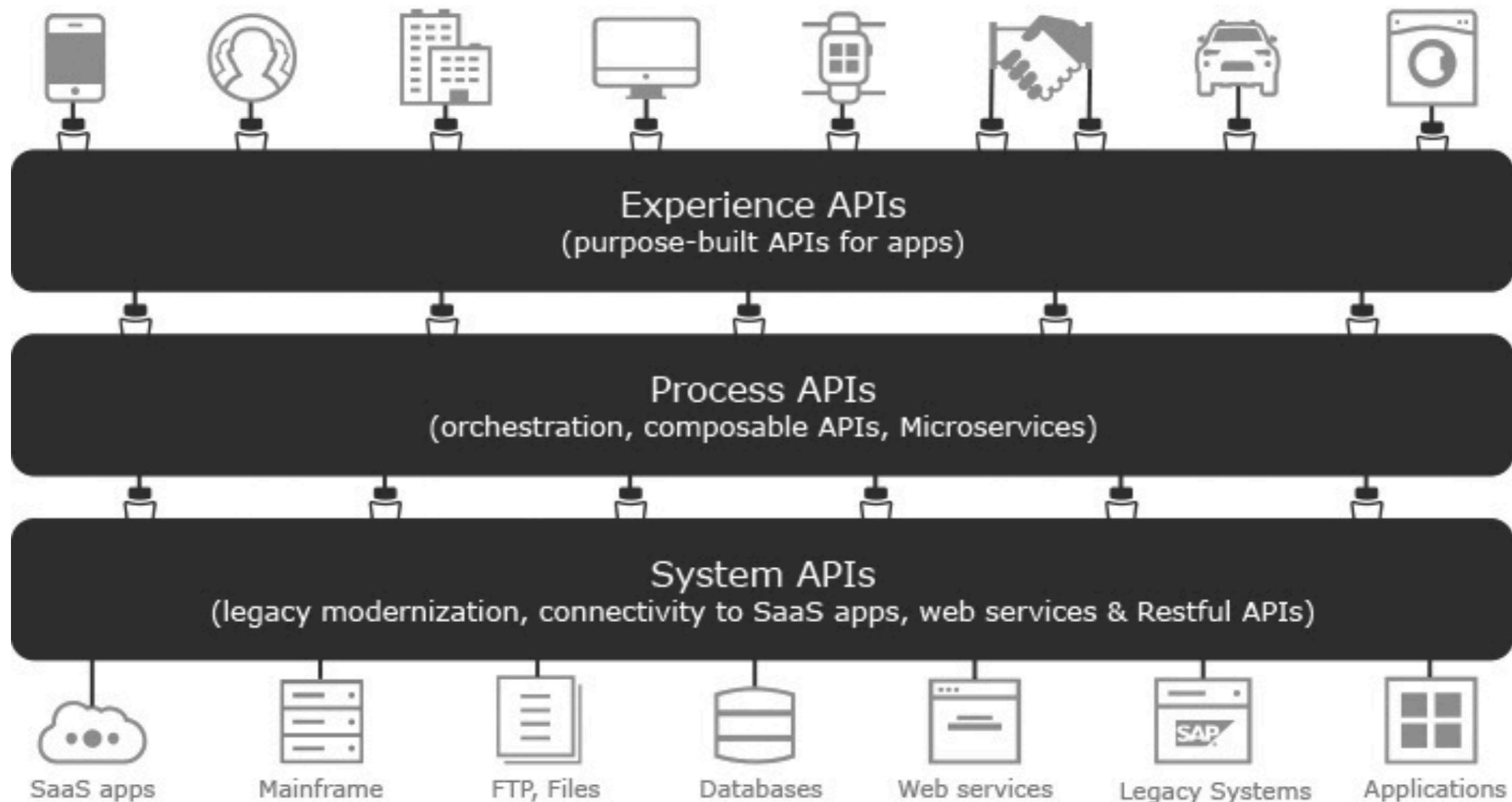
Coupling (Destructive decouple)



Better Architecture



Real World Architecture



<https://blogs.mulesoft.com/dev-guides/how-to-tutorials/api-templates-reusable-system-process-apis/>



Microservices

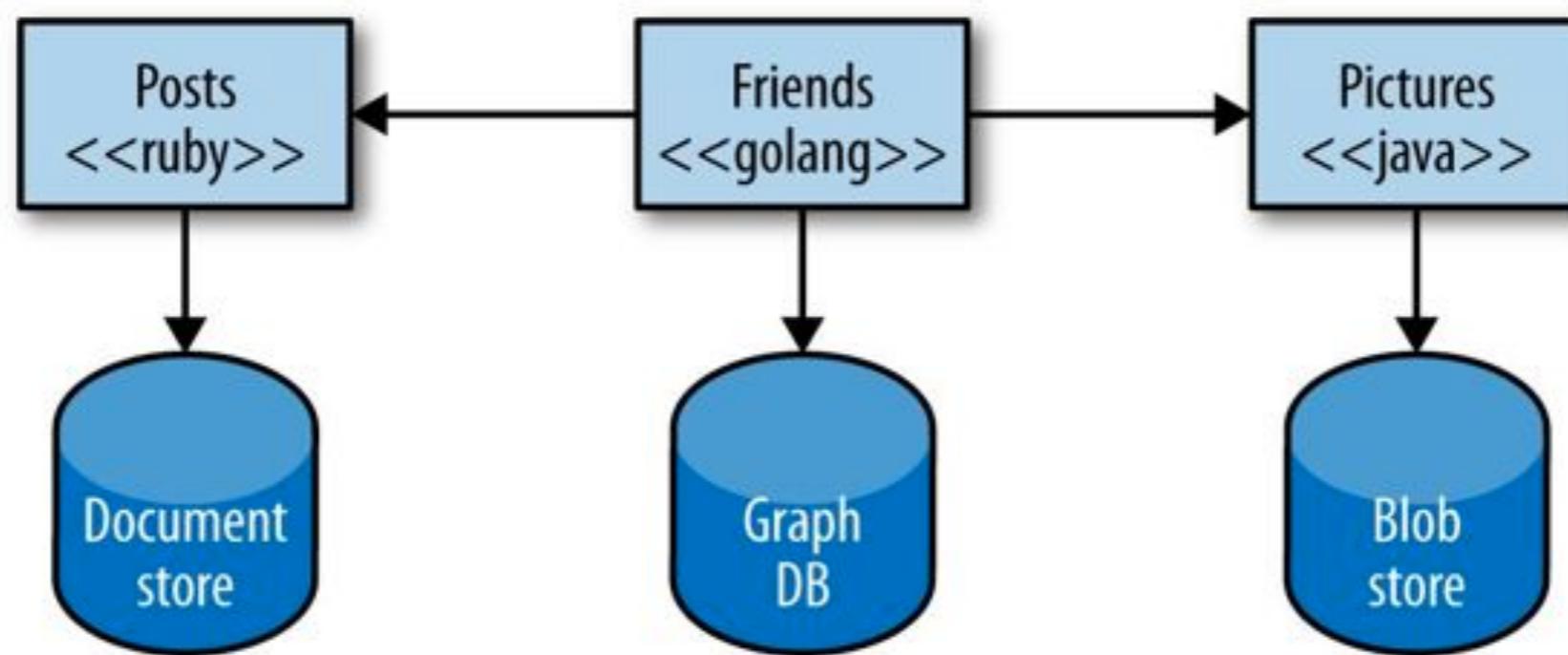
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Key Benefits

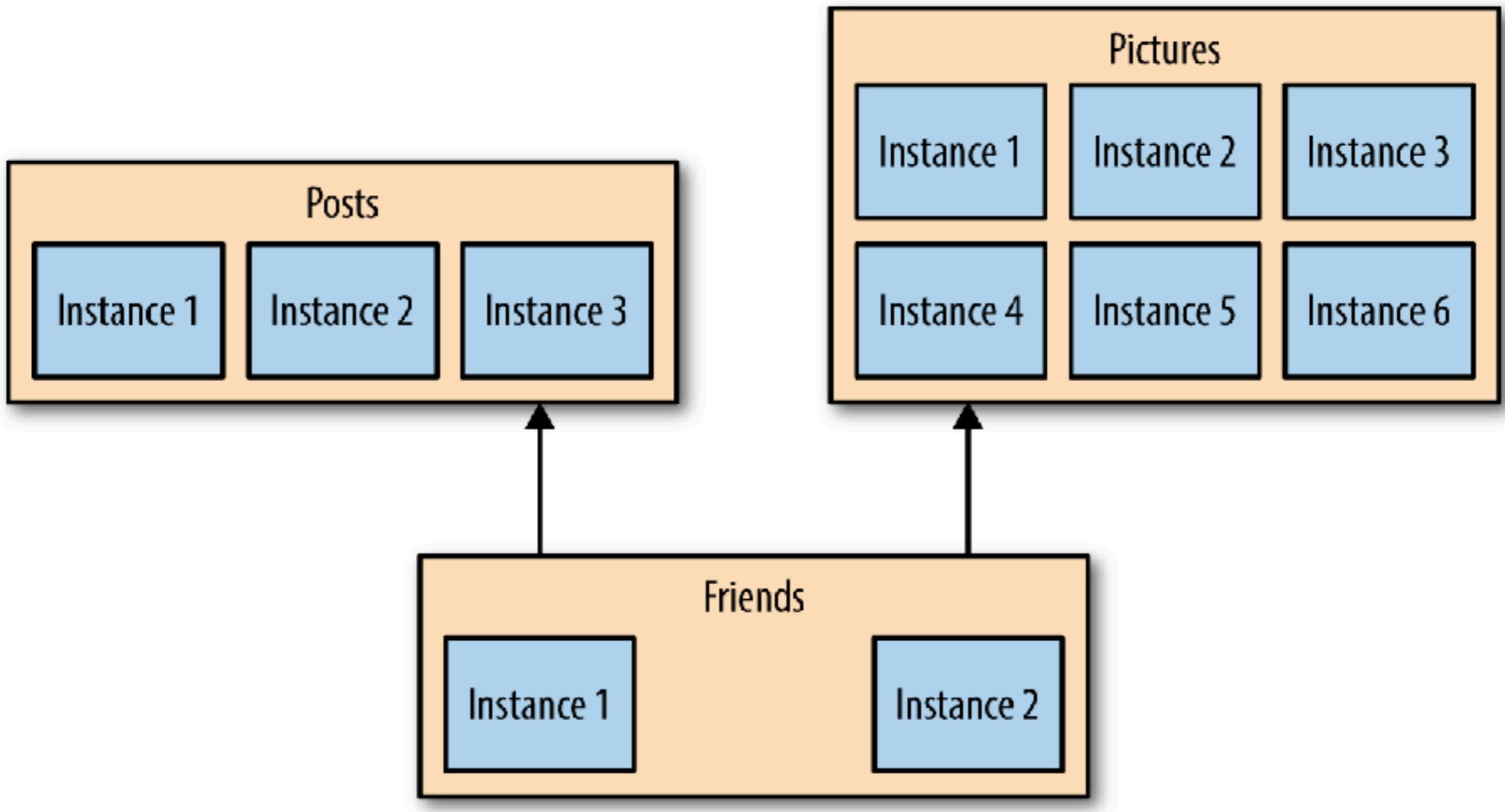


1. Technology heterogeneous

The right tool for each job
Allow easy experimenting and adoption of new technology

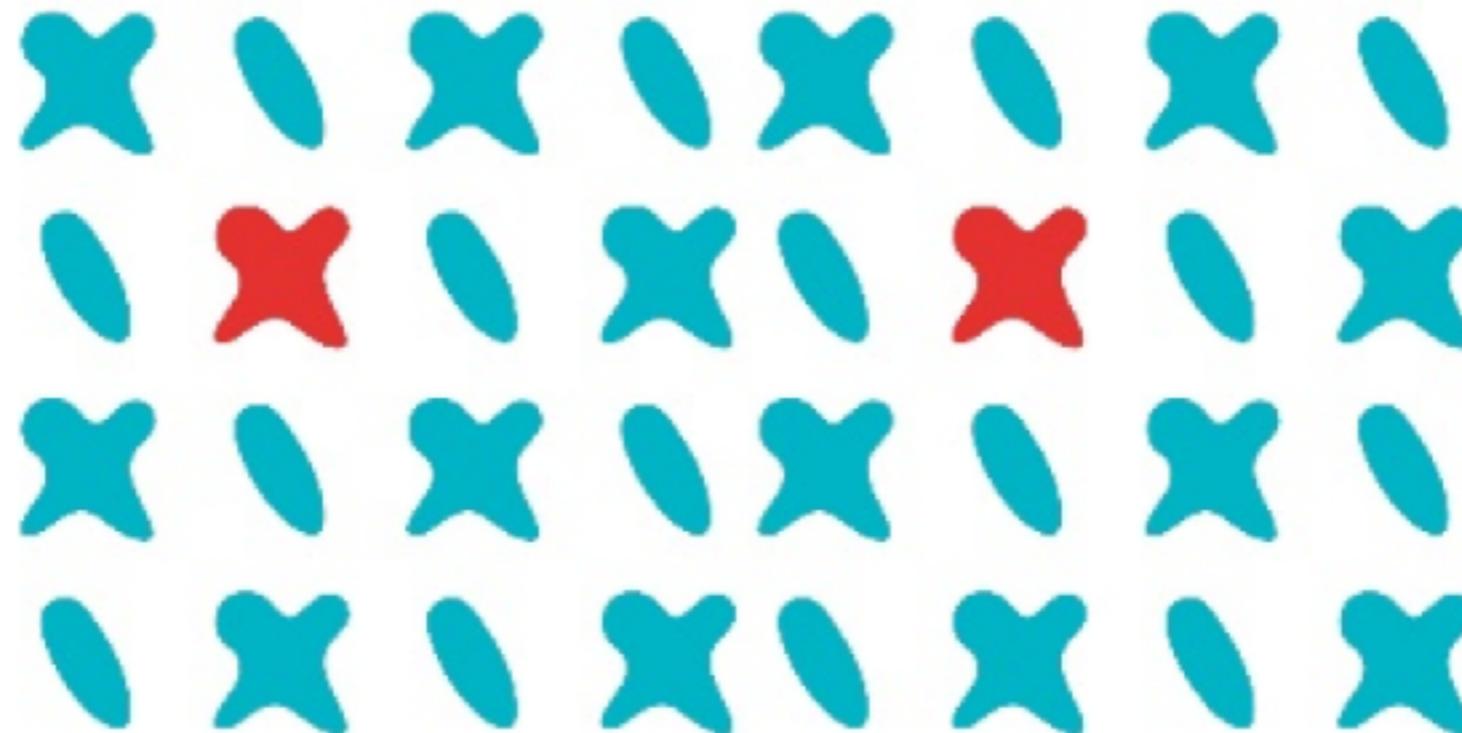


2. Scaling

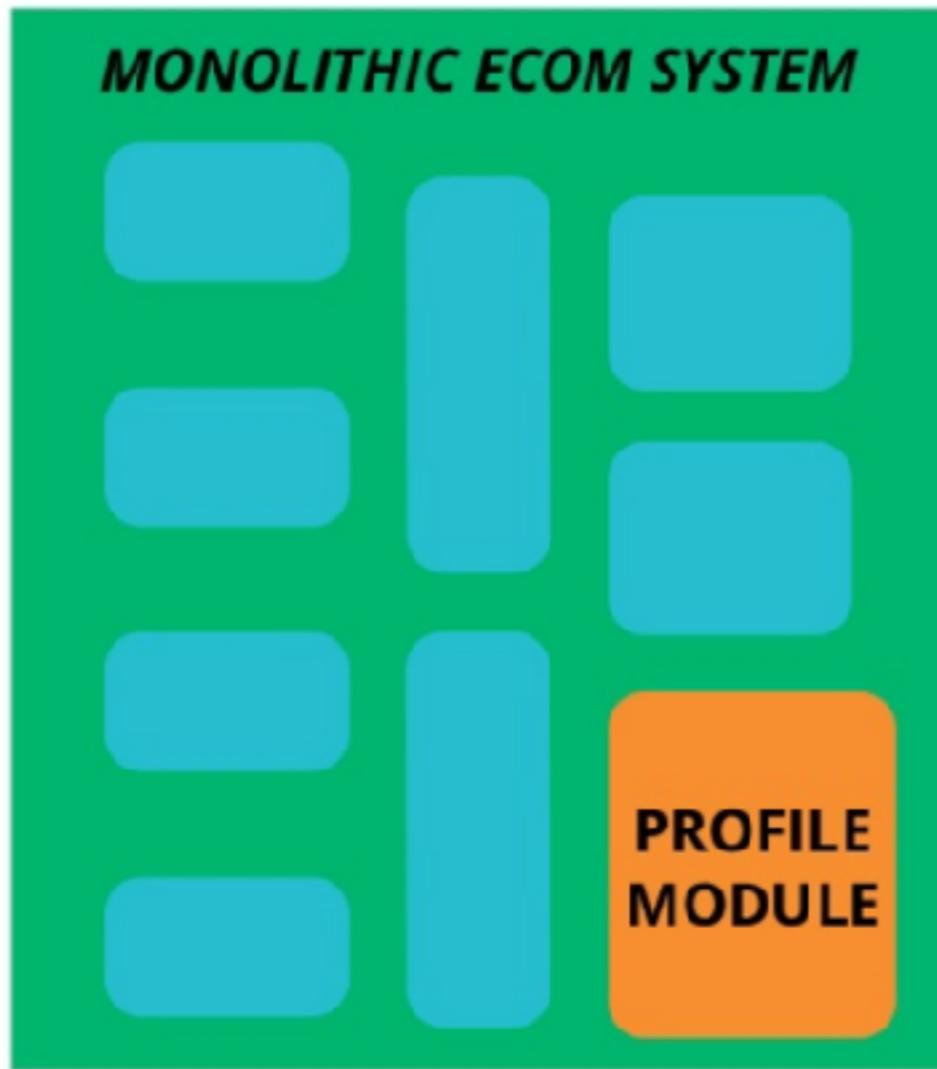


3. Ease of deployment

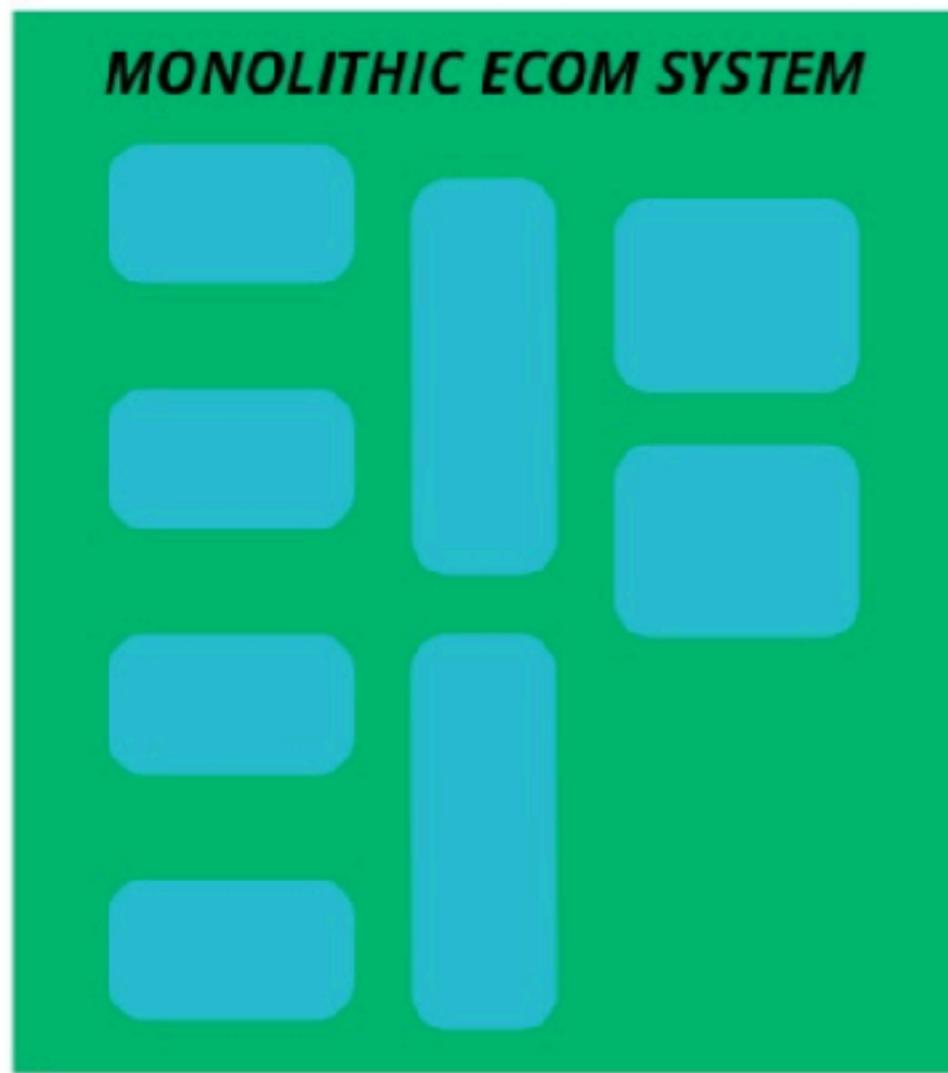
Deploys are faster, independent and problems can be isolated more easily



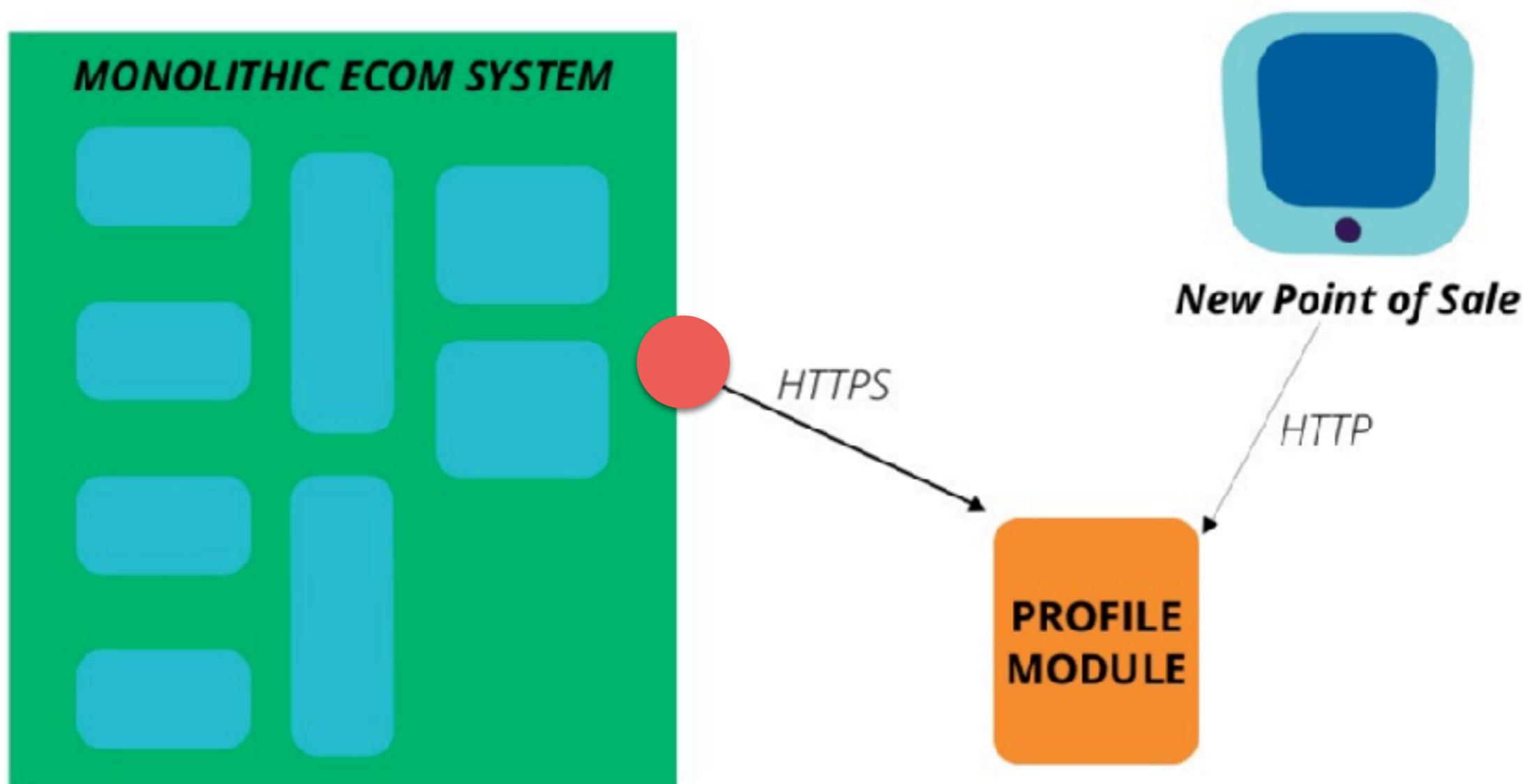
4. Composability and replaceability



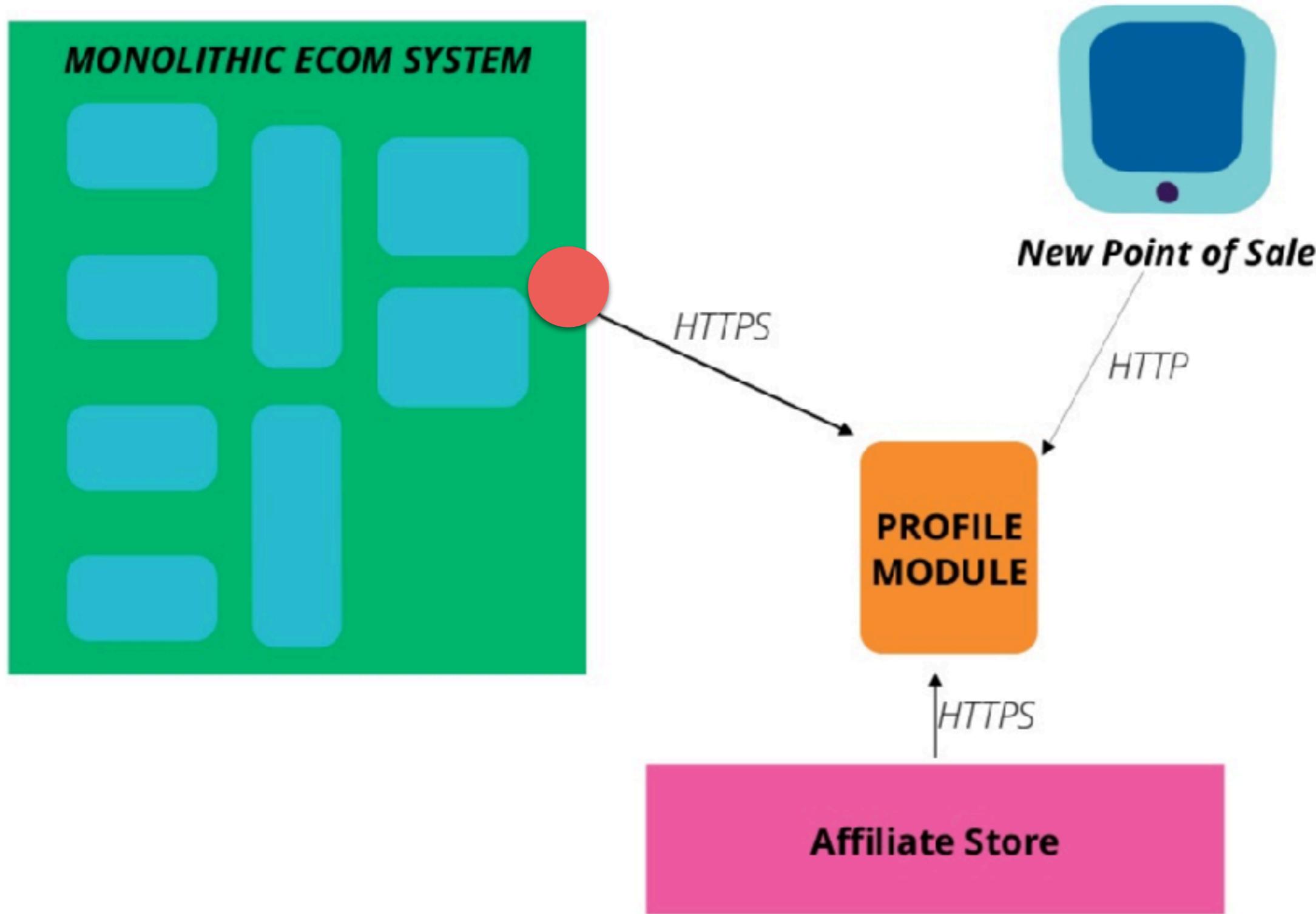
4. Composability and replaceability



4. Composability and replaceability



4. Composability and replaceability



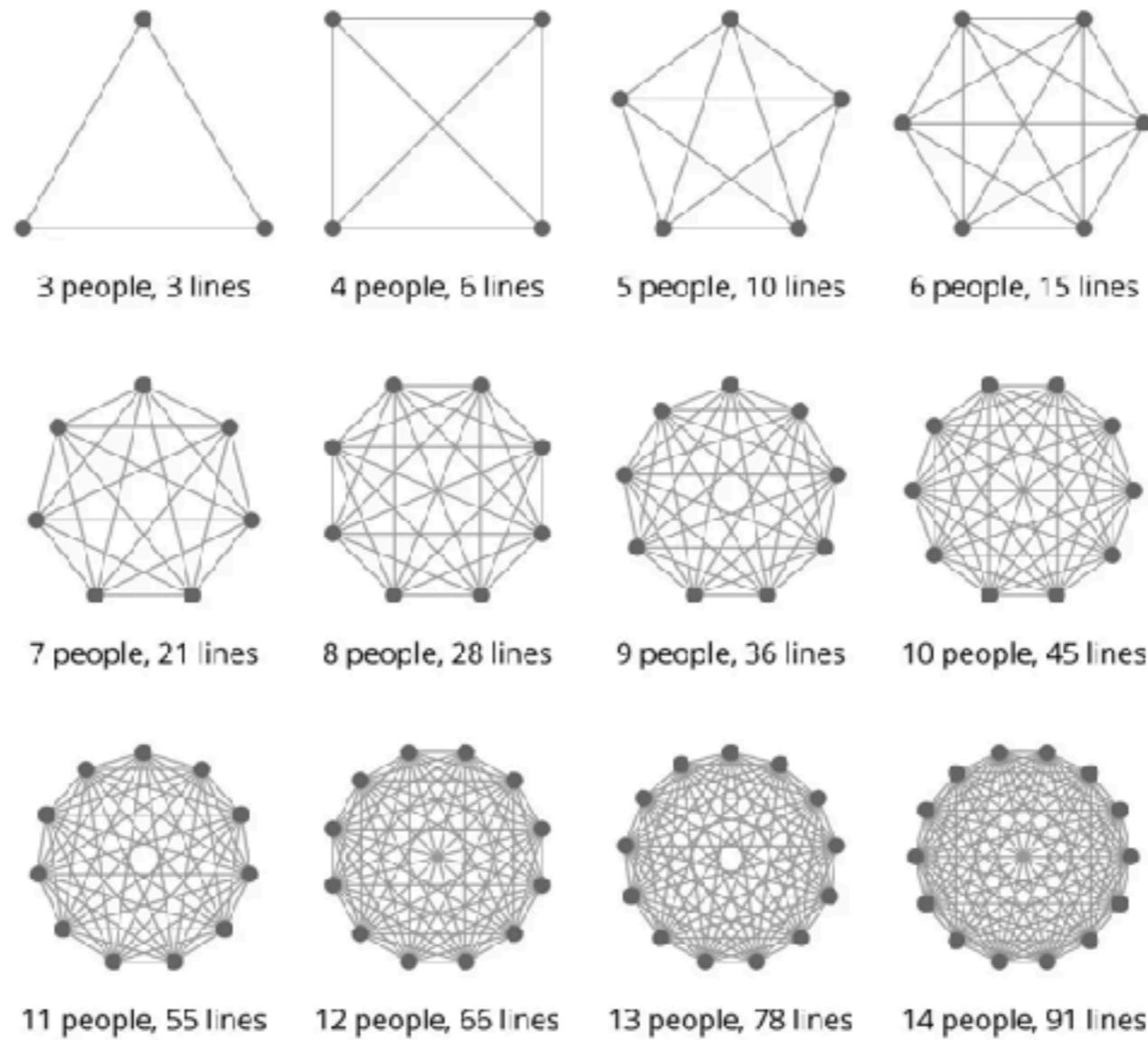
5. Organization alignment

Small teams and smaller codebases



Small team !!

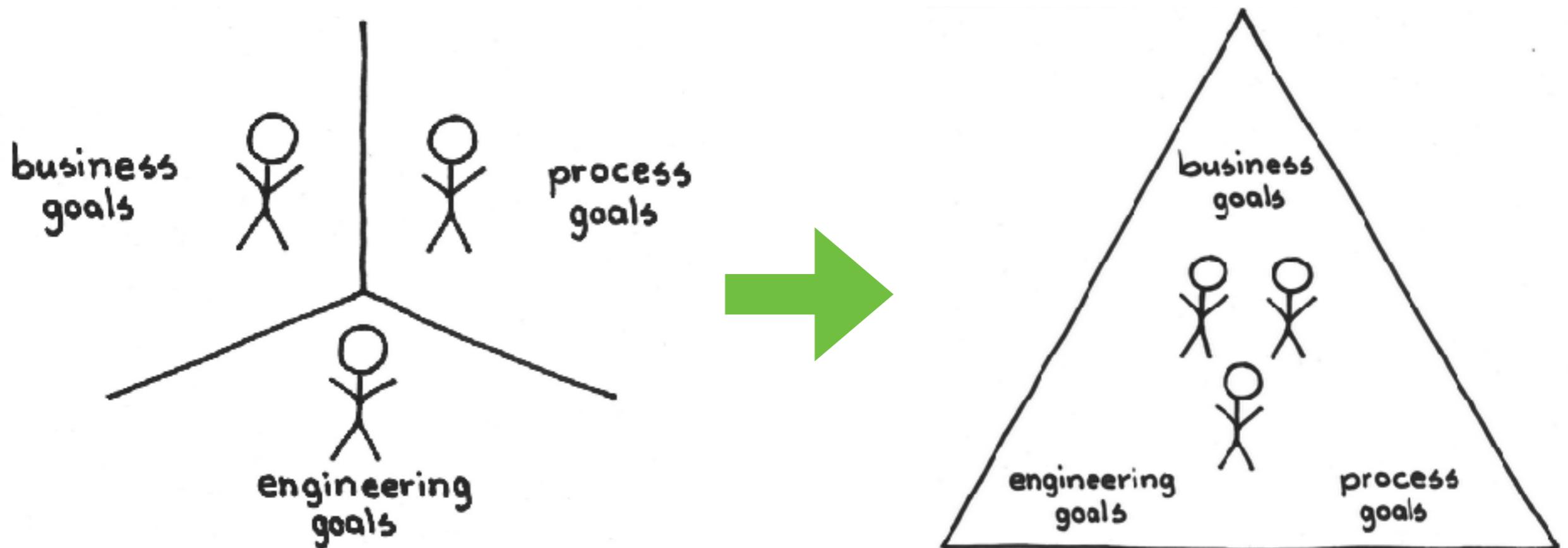
Line of communication and team size



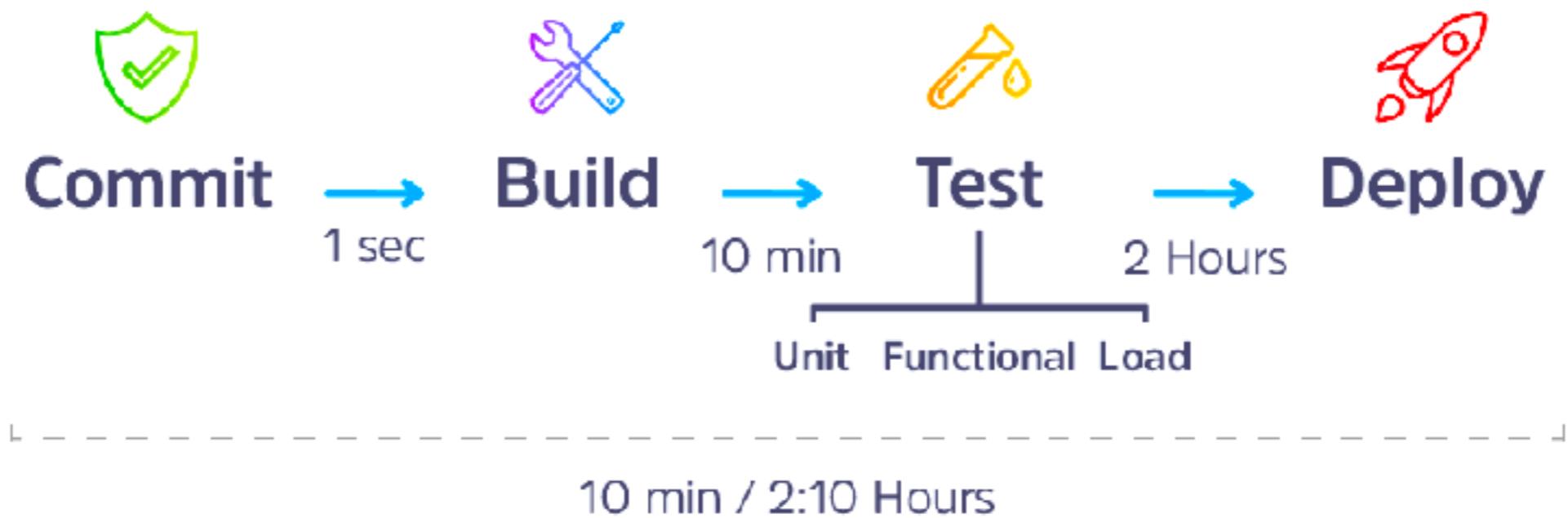
<https://www.leadingagile.com/2018/02/lines-of-communication-team-size-applying-brooks-law>



Autonomous team



Autonomous team



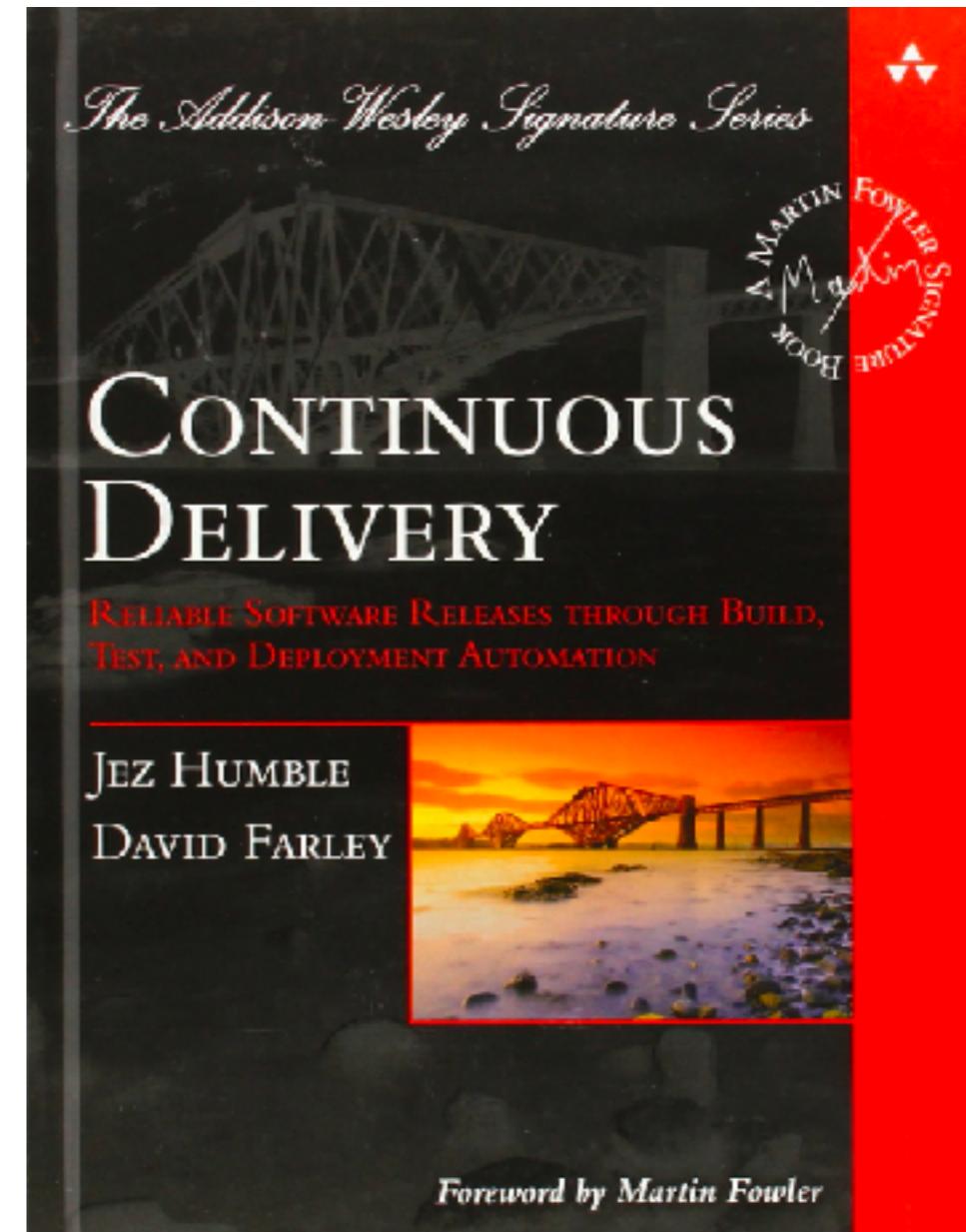
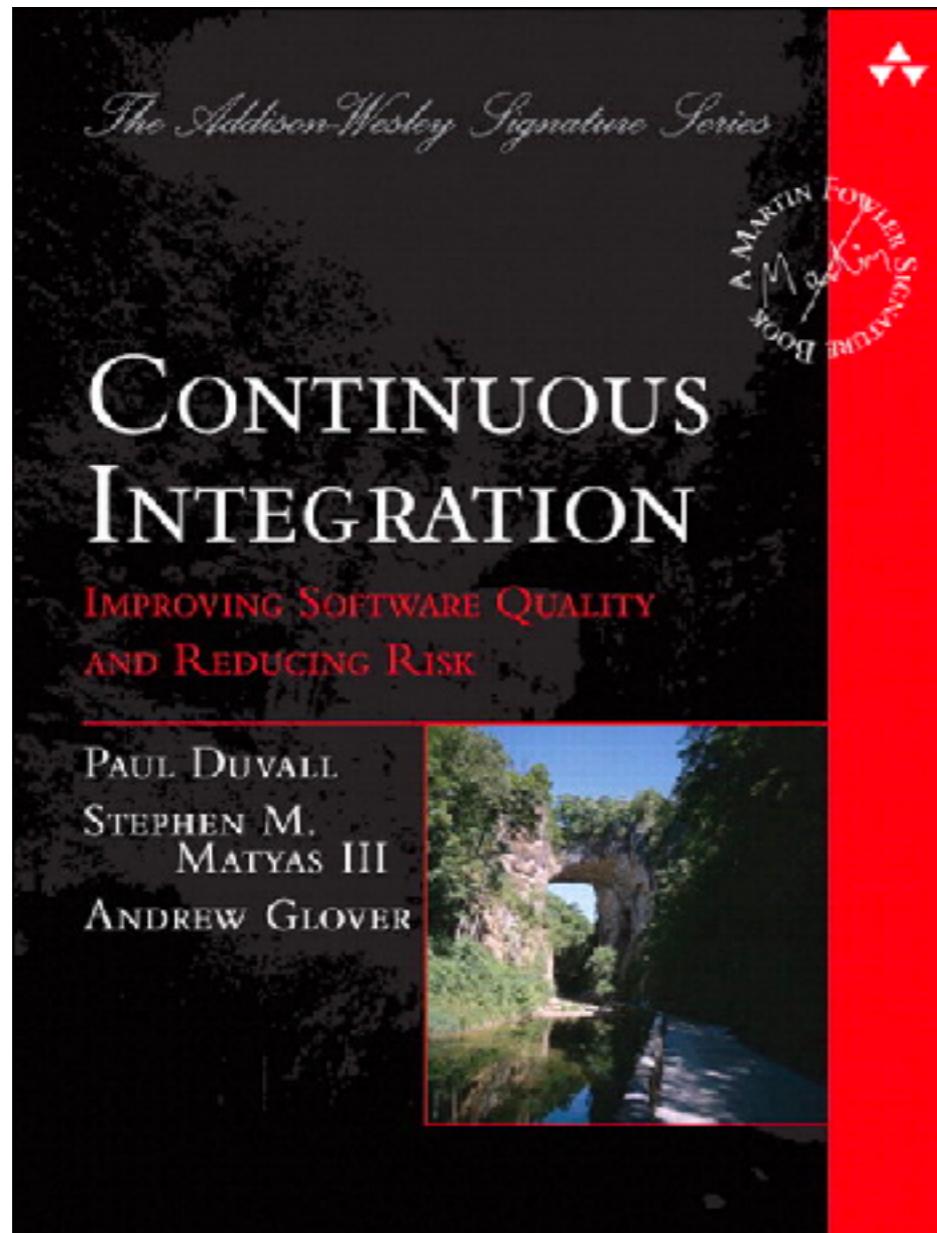
6. Enable Continuous Delivery

A part of DevOps

Set of practices for the **rapid, frequent and reliable delivery** software



Continuous Delivery/Deployment



Continuous Delivery/Deployment

Testability
Deployability
Autonomous team and loose coupling



Benefits of Continuous Delivery

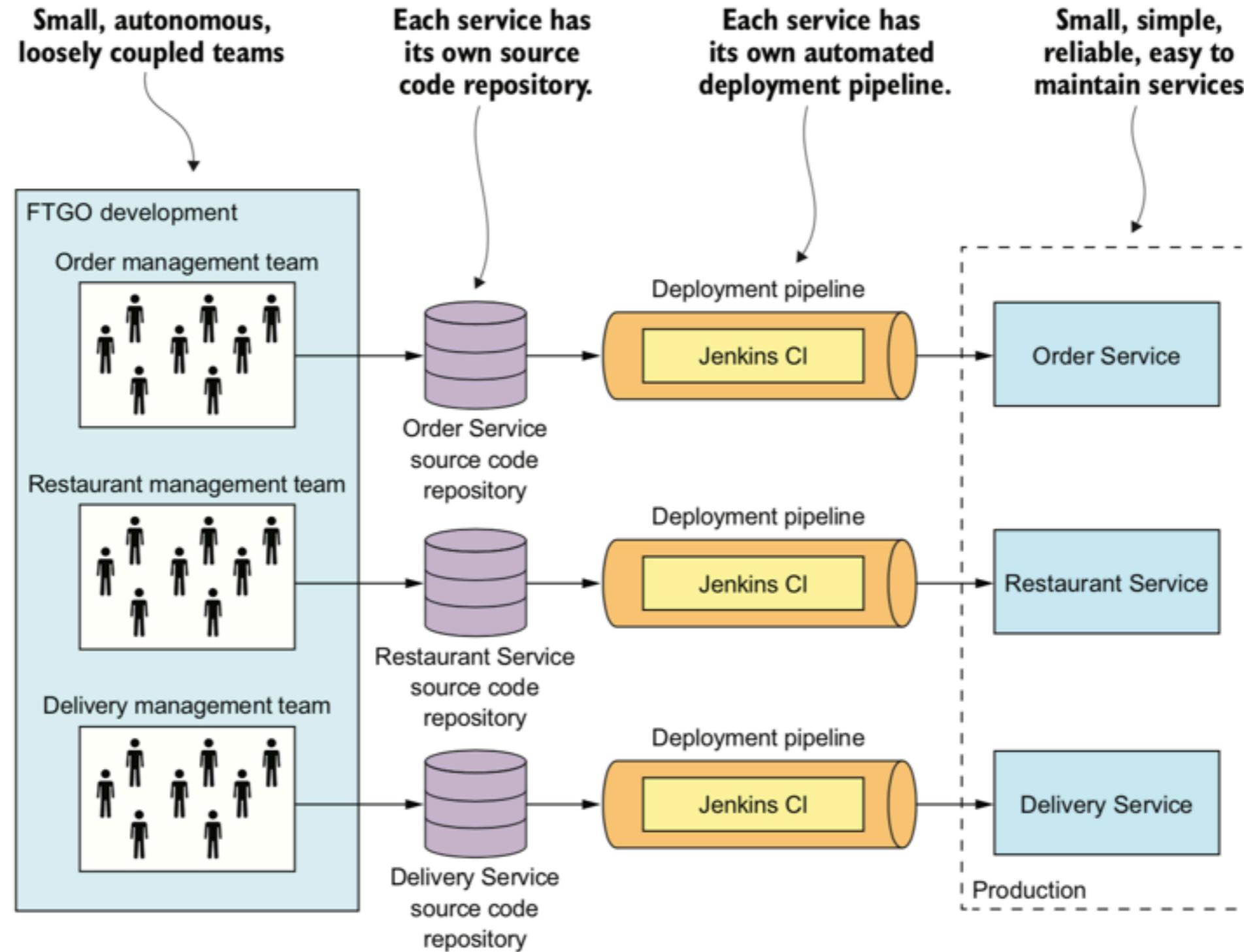
Reduce time to market

Enable **business** to provide reliable service

Employee satisfaction is higher



Continuous Delivery for service



Drawbacks of Microservice

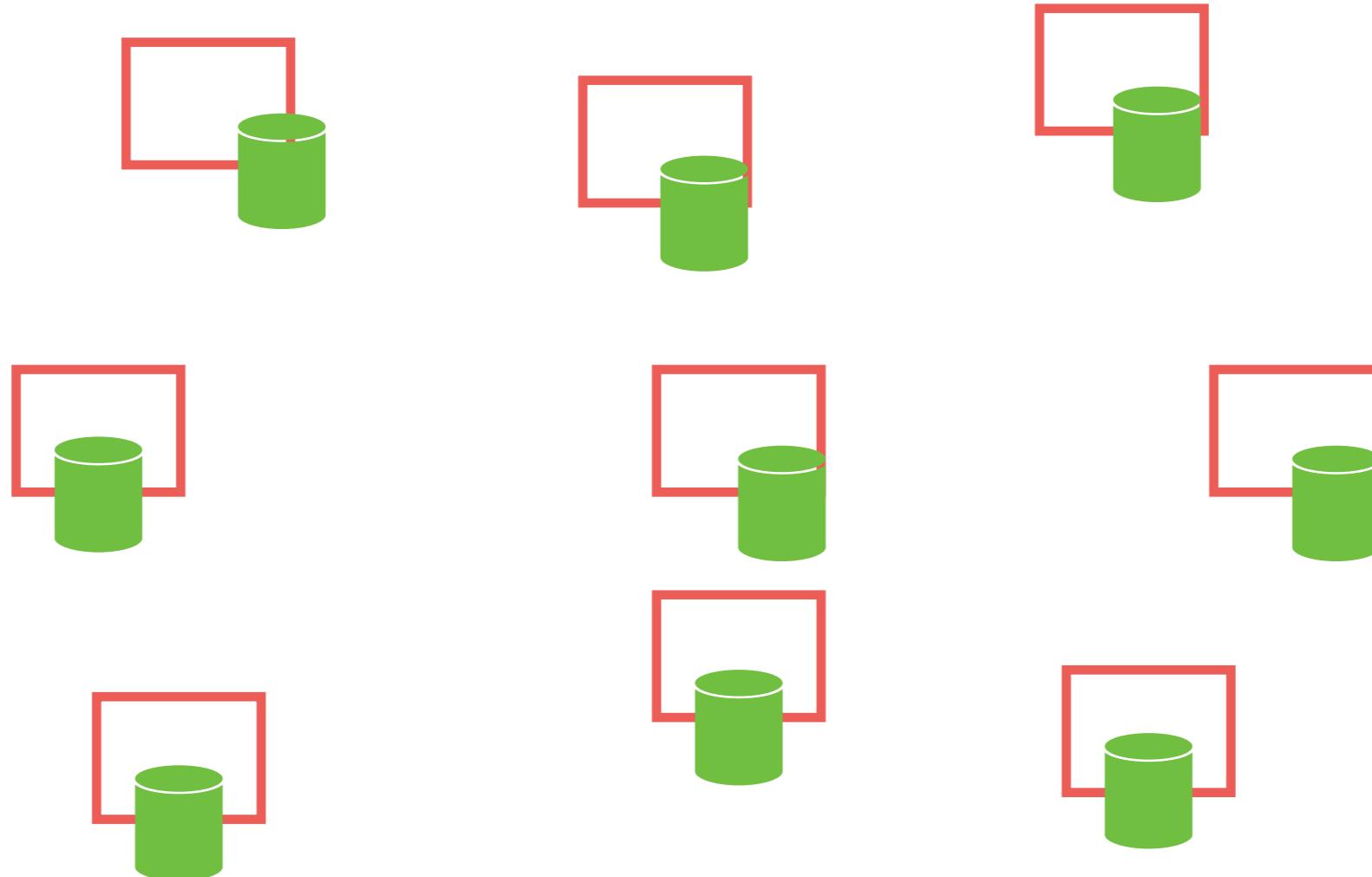


Drawbacks of Microservice

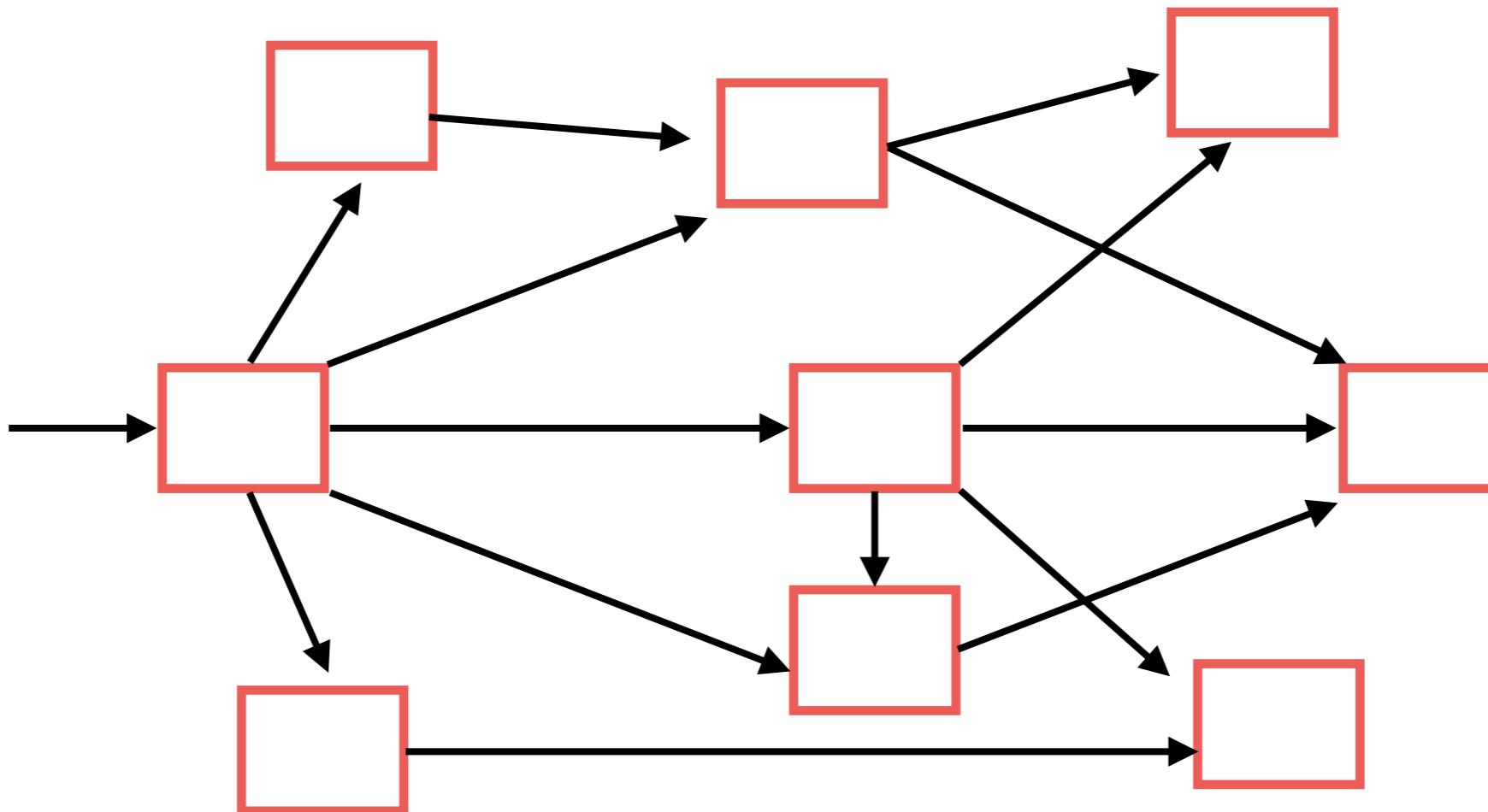
Find the right set of services
Distributed systems are complex
How to develop, testing and deploy ?



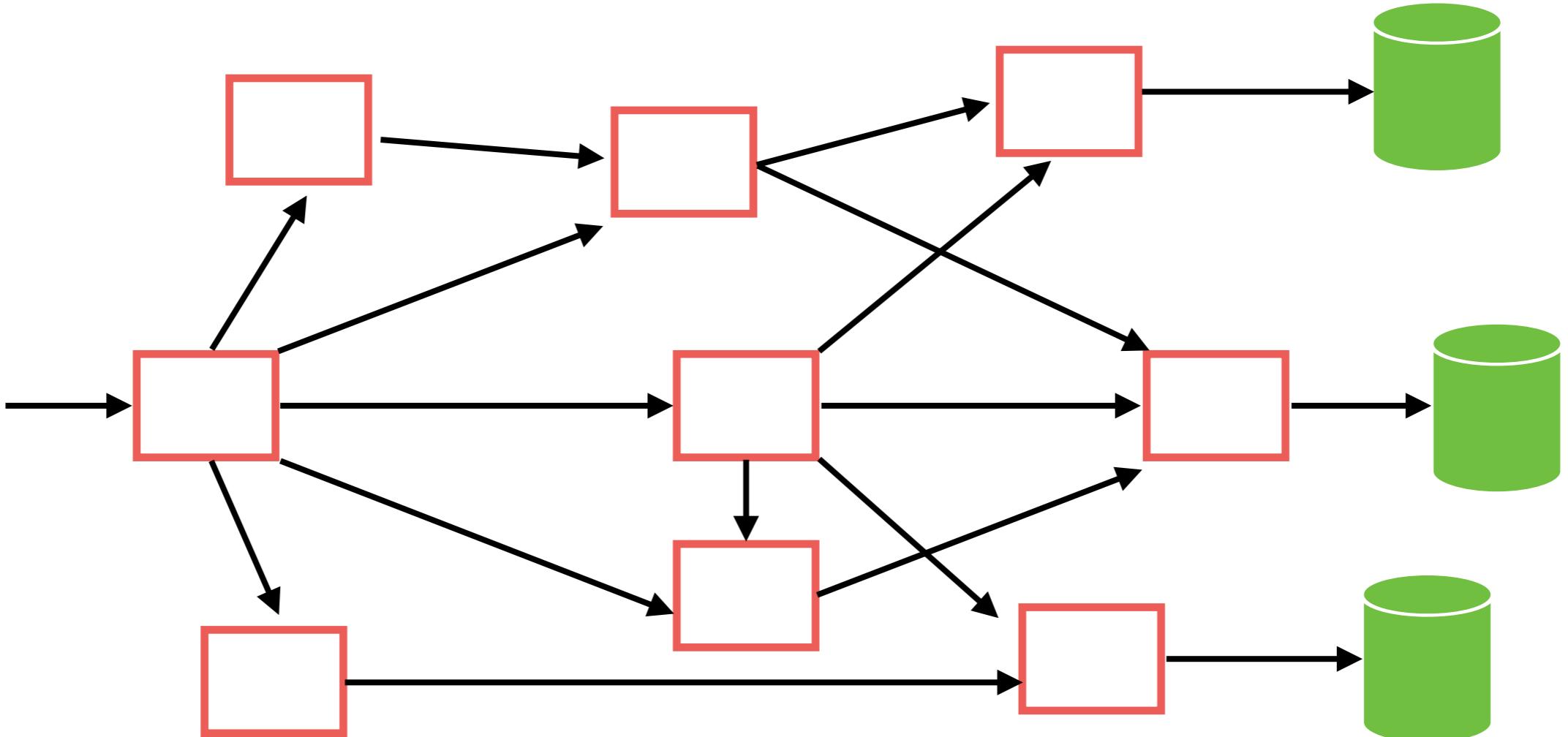
Microservice (Loosely coupled)



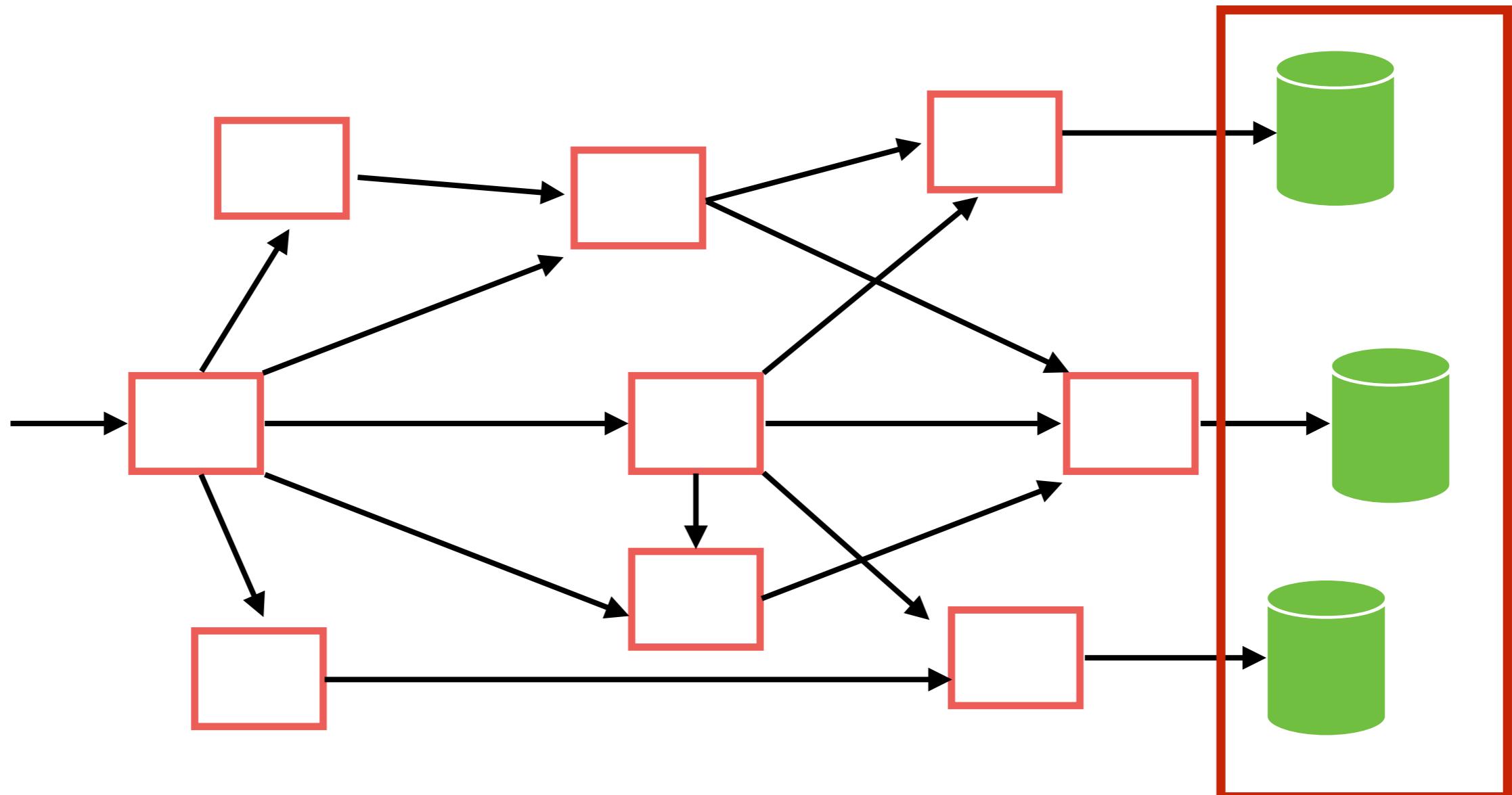
Microservice (Tightly coupled)



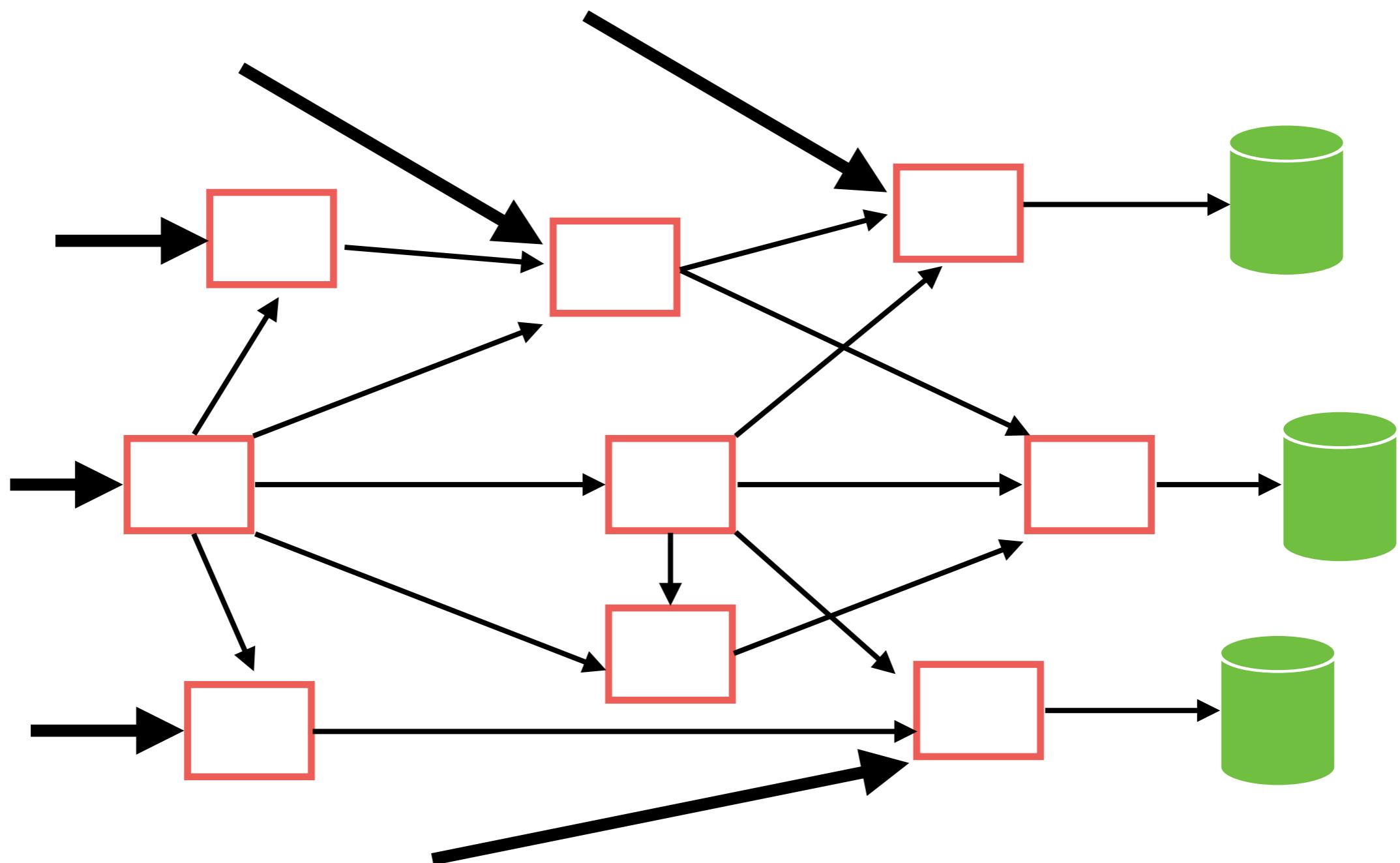
Own data



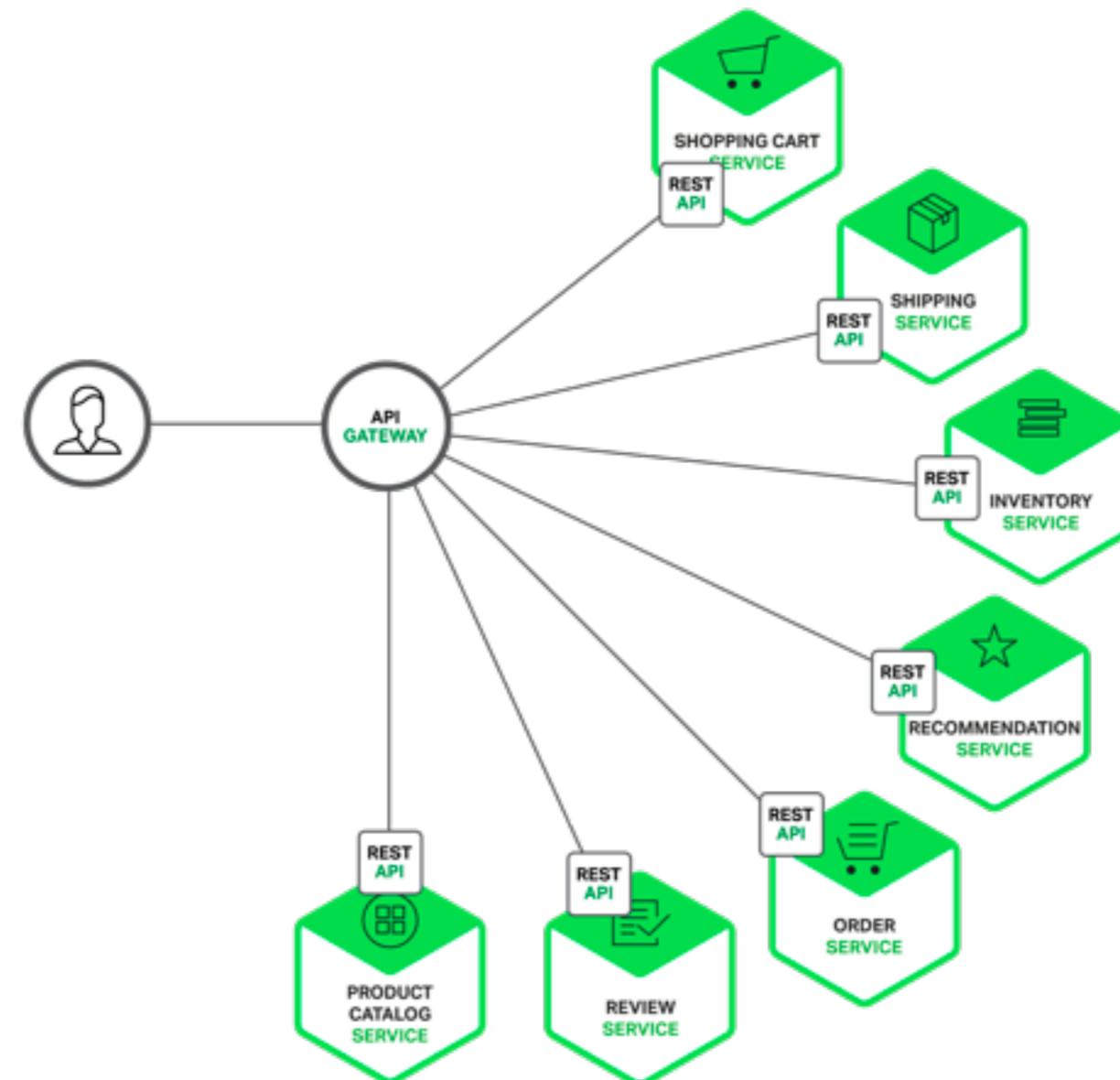
Data consistency !!



Multiple entry points



Working with API gateway



<https://www.nginx.com>



Features of API gateway

Authentication

Authorization

Rate limiting

Caching

Metrics collection

Request logging

Load balancing

Circuit breaking



Benefits

Encapsulation interface structure
Client talk to service via gateway
Reduce round trip between service

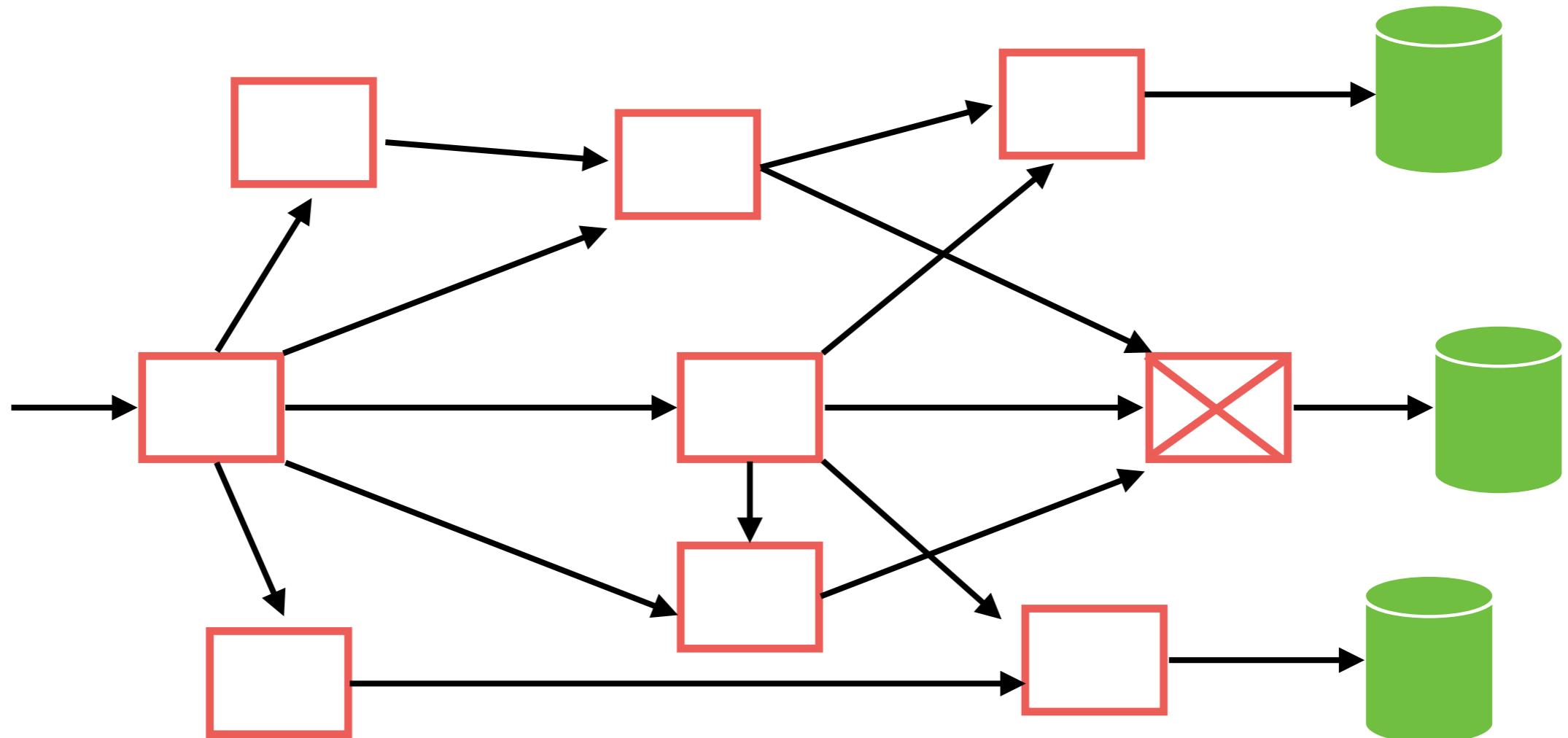


Drawbacks

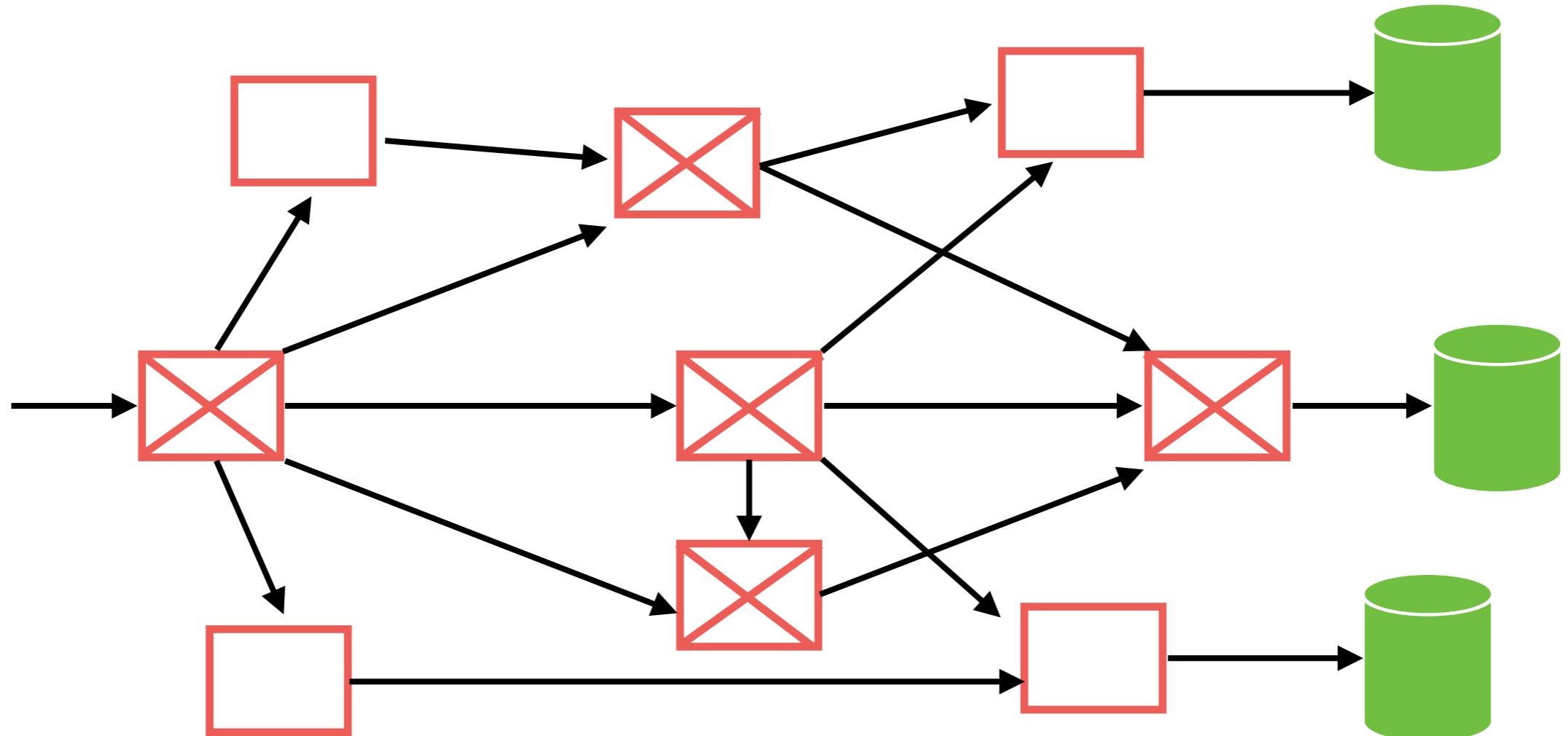
Development/Performance bottleneck
Single point of failure
Waiting for update data in gateway



Failure !!



Cascading Failure !!



Solutions for Resilience ?

Timeout

Retry

Rate Limit

Queue messaging

Circuit breaker

Bulkhead

Auto-scale

<https://learn.microsoft.com/en-us/azure/well-architected/resiliency/reliability-patterns>



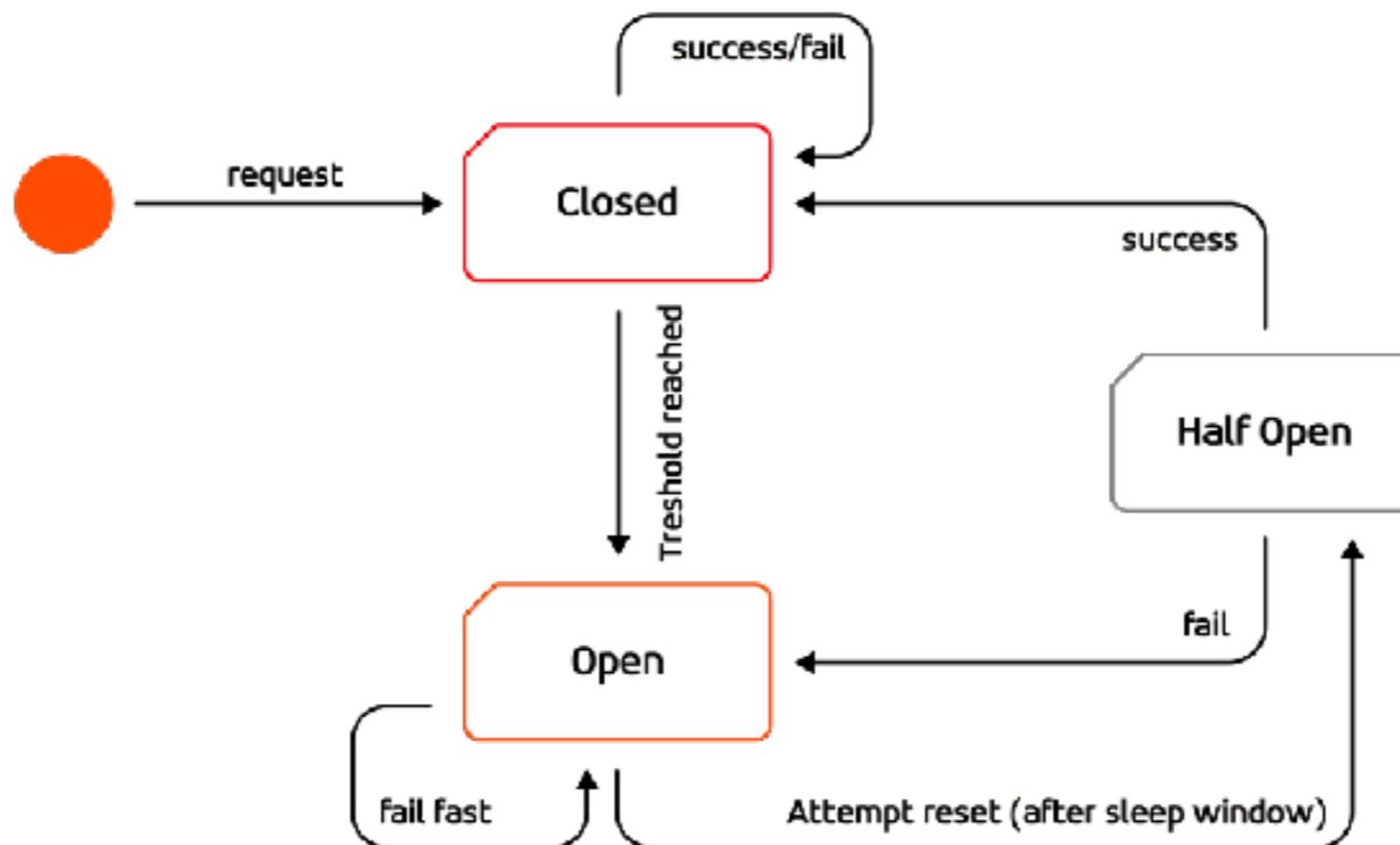
Microservices

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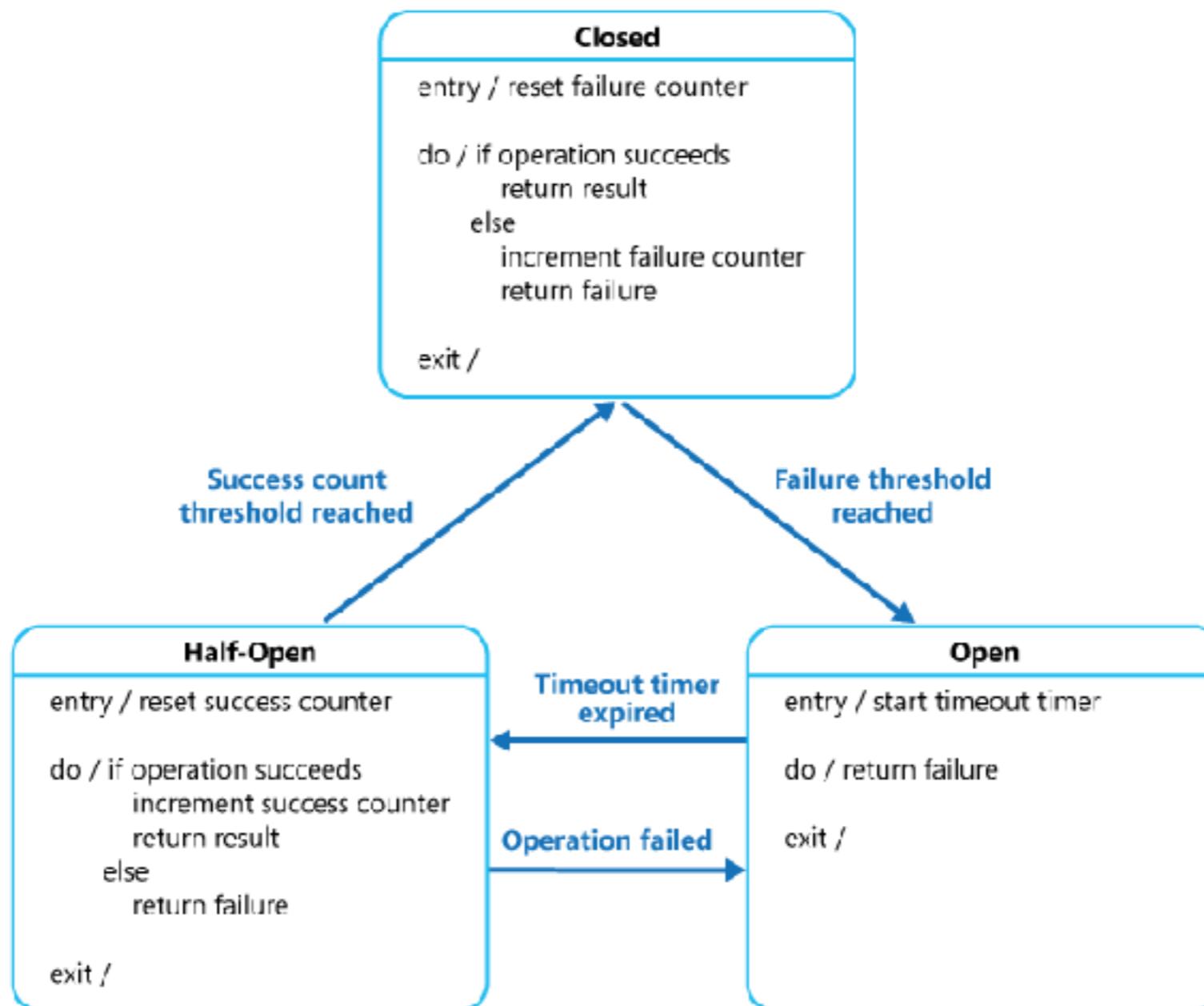
Circuit Breaker pattern

Track the number of success and failure

***If error rate exceed some threshold
then enable circuits breaker***



Circuit Breaker pattern

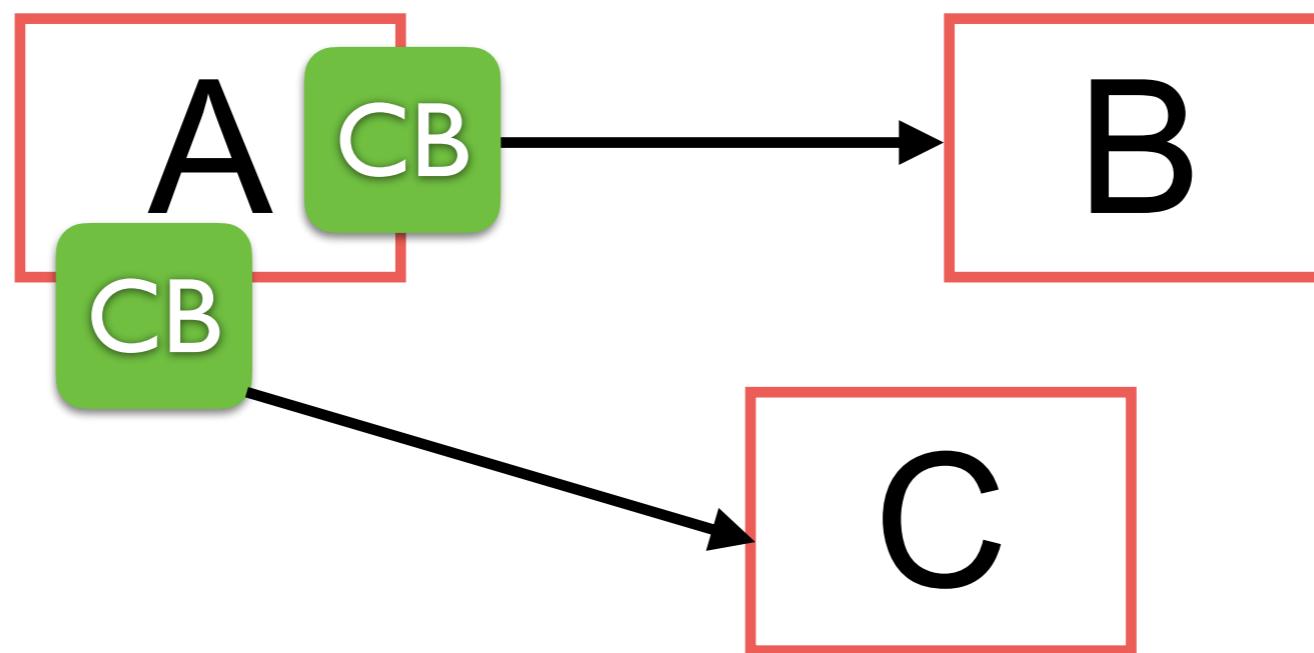
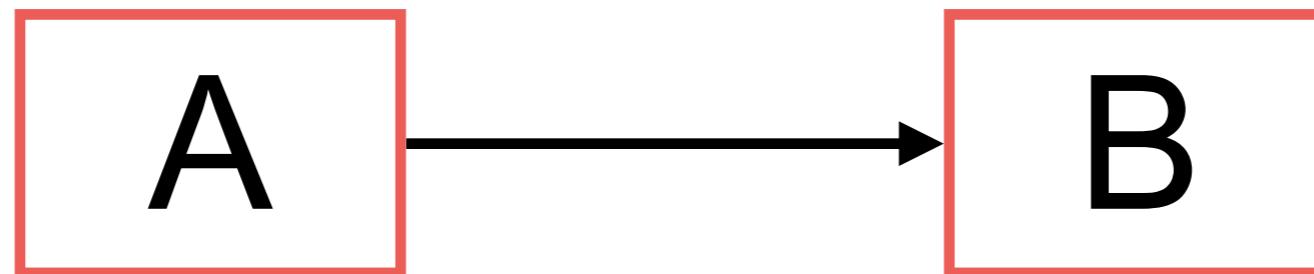


<https://learn.microsoft.com/en-us/azure/architecture/patterns/circuit-breaker>

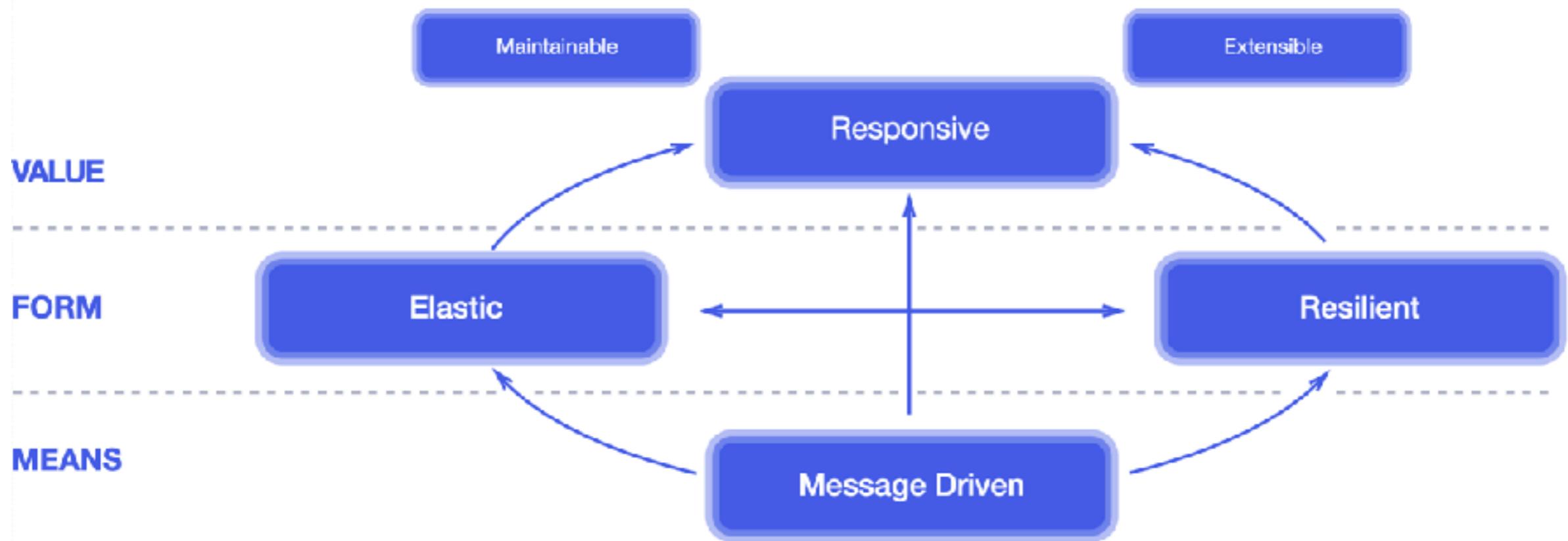


Circuit Breaker pattern

How to handling partial failure ?



Reactive Architecture



<https://www.reactivemanifesto.org/>



Service Principles



Service Principles

Creation

Interface

Testing

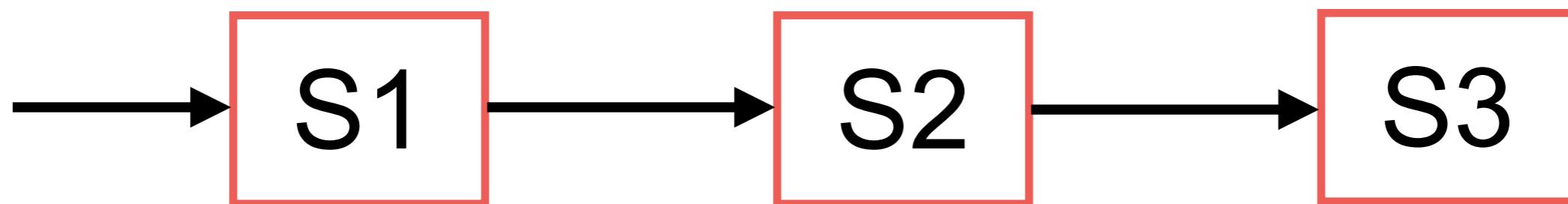
Operation

<https://github.com/Yelp/service-principles>



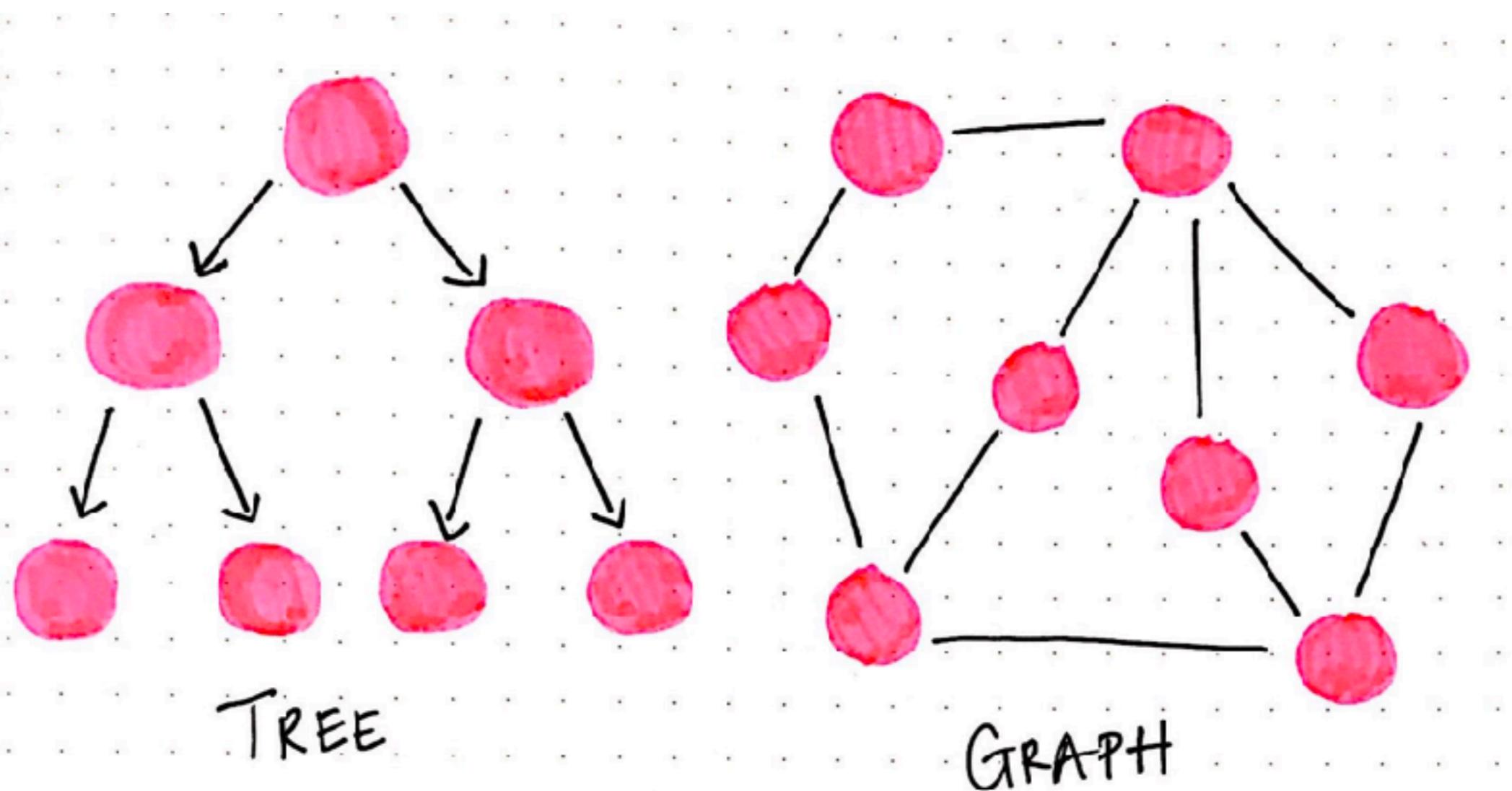
Drawbacks of Microservice

Deploy feature that required multiple service ?



Service Principles

Minimize the depth of the service call-graph



<https://github.com/Yelp/service-principles>

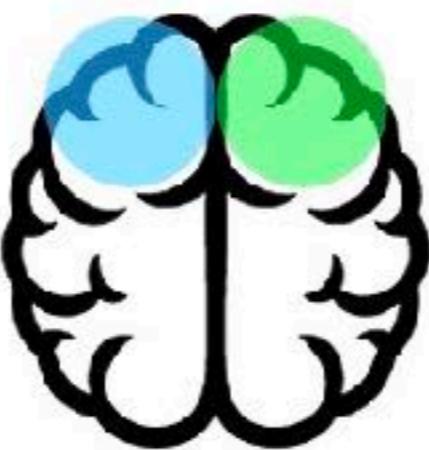


Service Principles

Minimize the number of services owned by your team

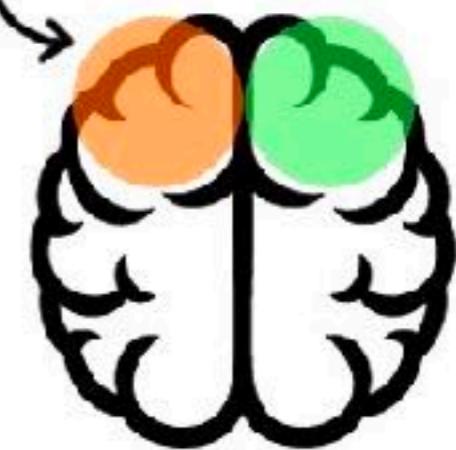


SINGLE TASK



TWO TASKS

THE 3RD TASK IS REPLACING
ONE OF THE 3 TASKS



THREE TASKS

<https://github.com/Yelp/service-principles>



Service Interfaces

APIs => HTTP, Messaging
Backward compatibility
Versioning
Design standard

JSON Schema

Kafka Schema
Registry



Testing strategies for Services

Unit testing

Integration testing

Component testing

Contract testing

End-to-End testing

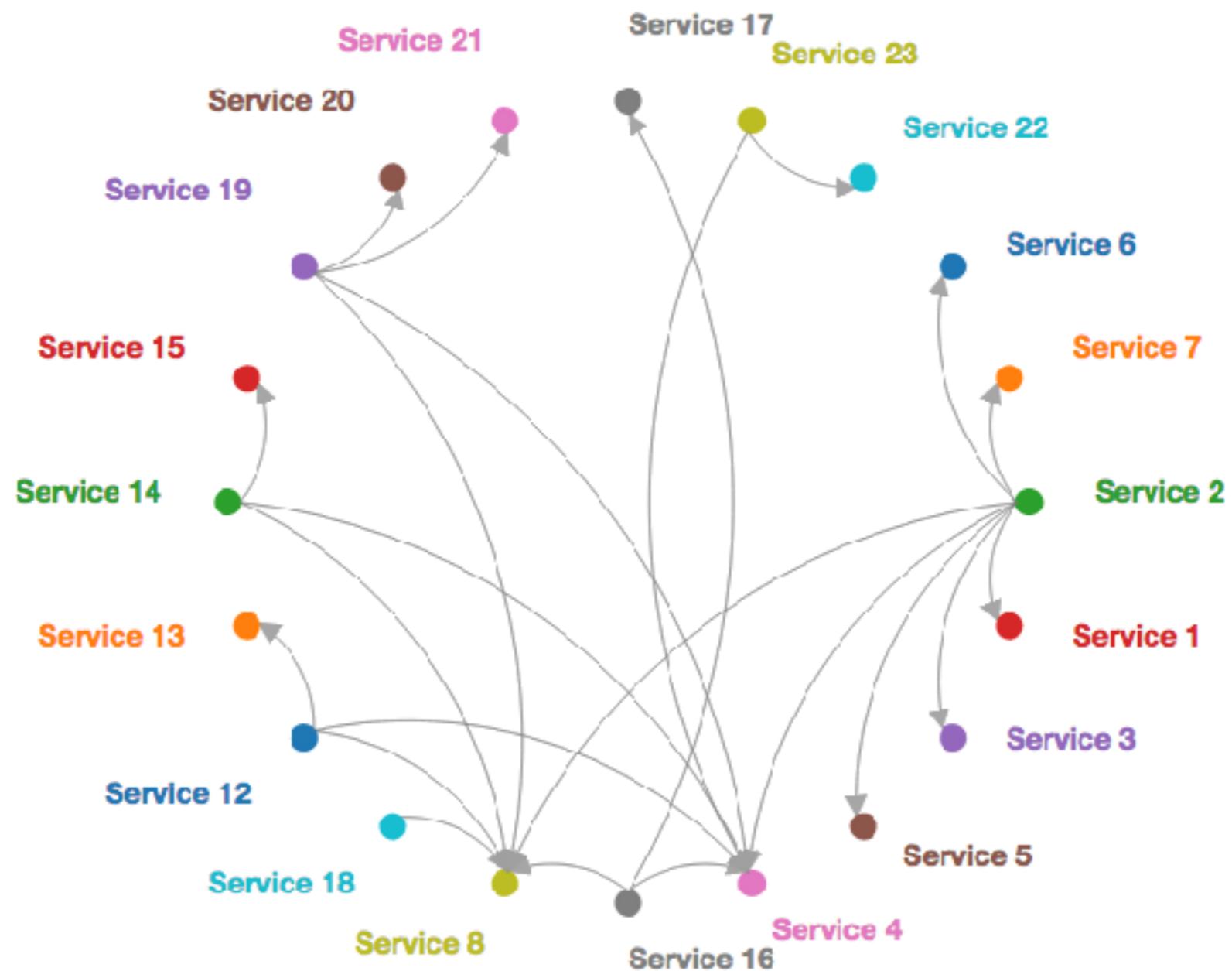
Chaos testing

Performance
testing

Security
testing



Testing strategies for Services



https://docs.pact.io/pact_broker



Operation for Services

How to deploy ?
Observable services
Plan for failures !!



Microservice architecture patterns

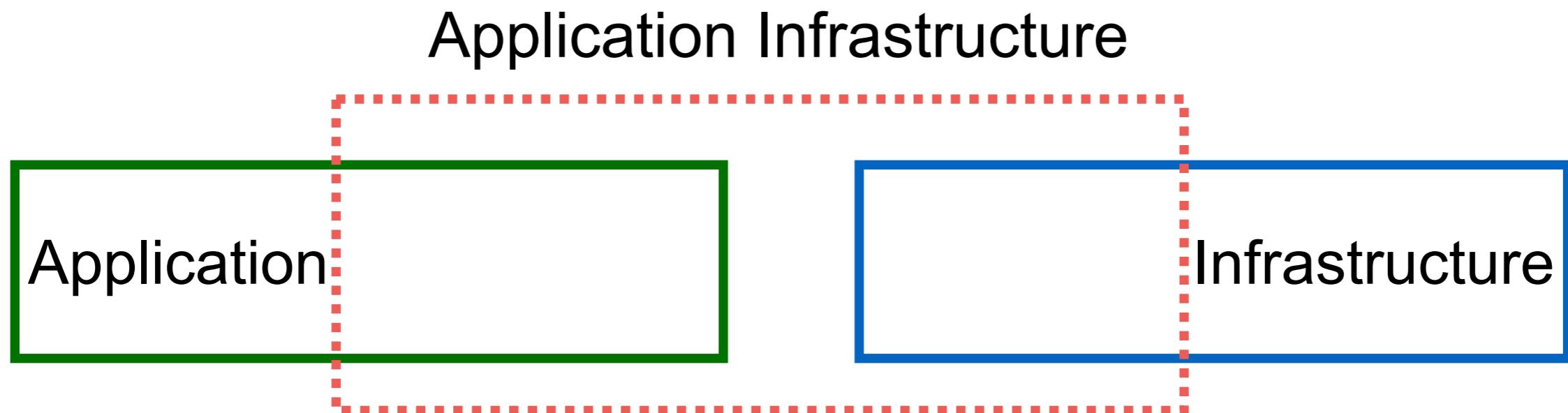


3 Layers of service patterns

Application patterns

Application infrastructure pattern

Infrastructure pattern



<https://microservices.io/>



Decompose application into small services !!



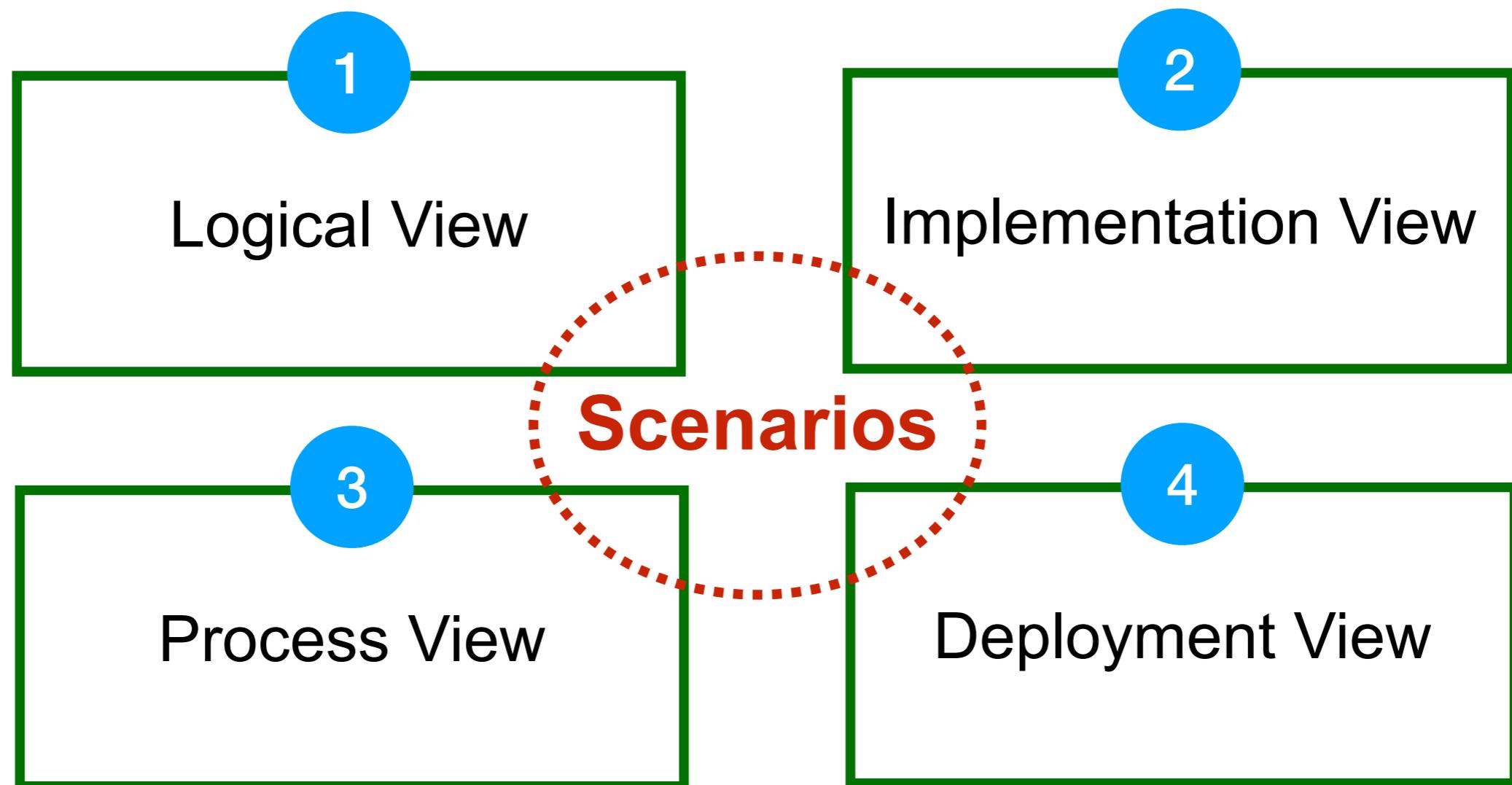
Premature splitting is the root of
all evil.



Every time you make the decision
to split out a new microservice,
there's a **risk** of ending up with a
bloated app.



4 View model of Software Architecture



Decompose application into services

By business capability ?

By subdomain/technical ?

By team ?



Step to define services

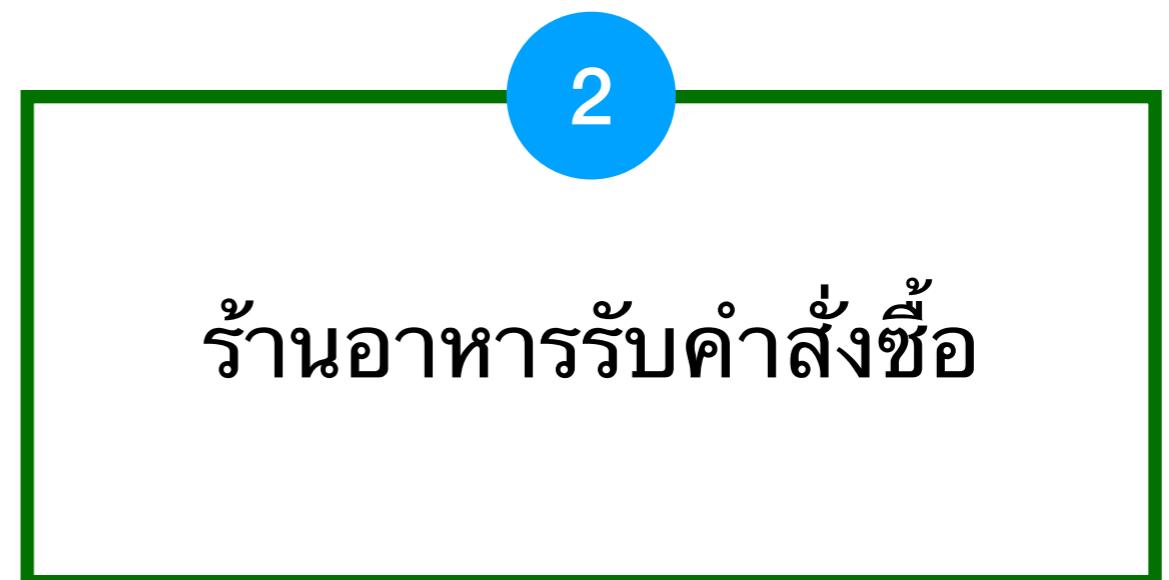
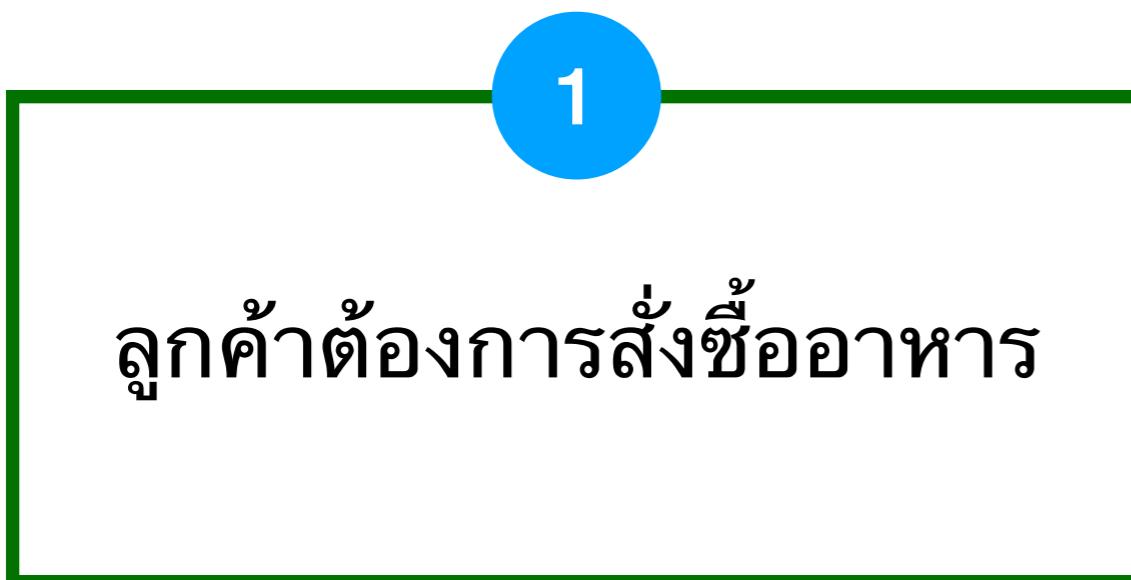
1. Identify system operations
2. Identify services
3. Define service APIs and collaboration



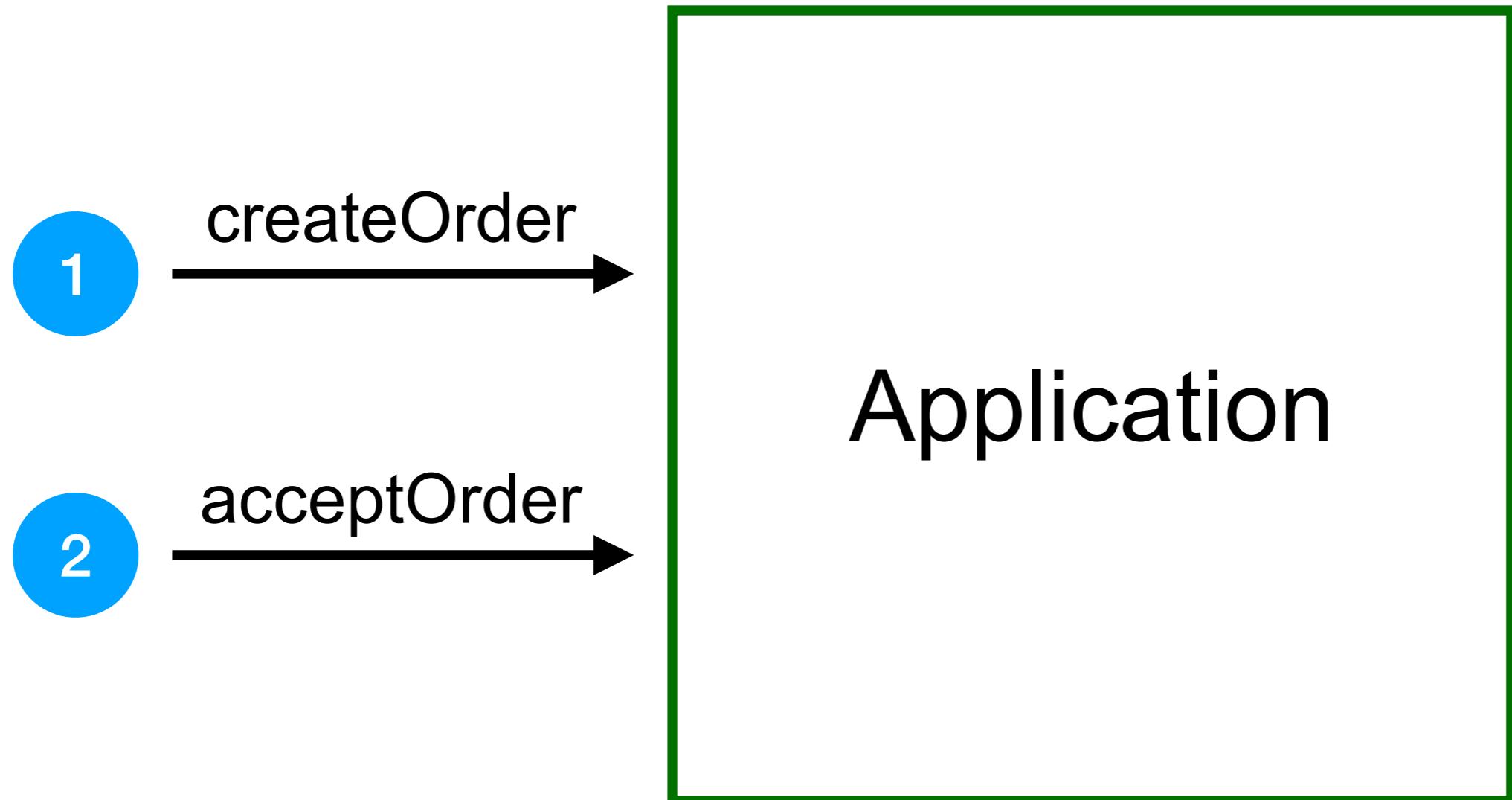
1. Identify system operations

Start with functional requirements

User story



1. Identify system operations



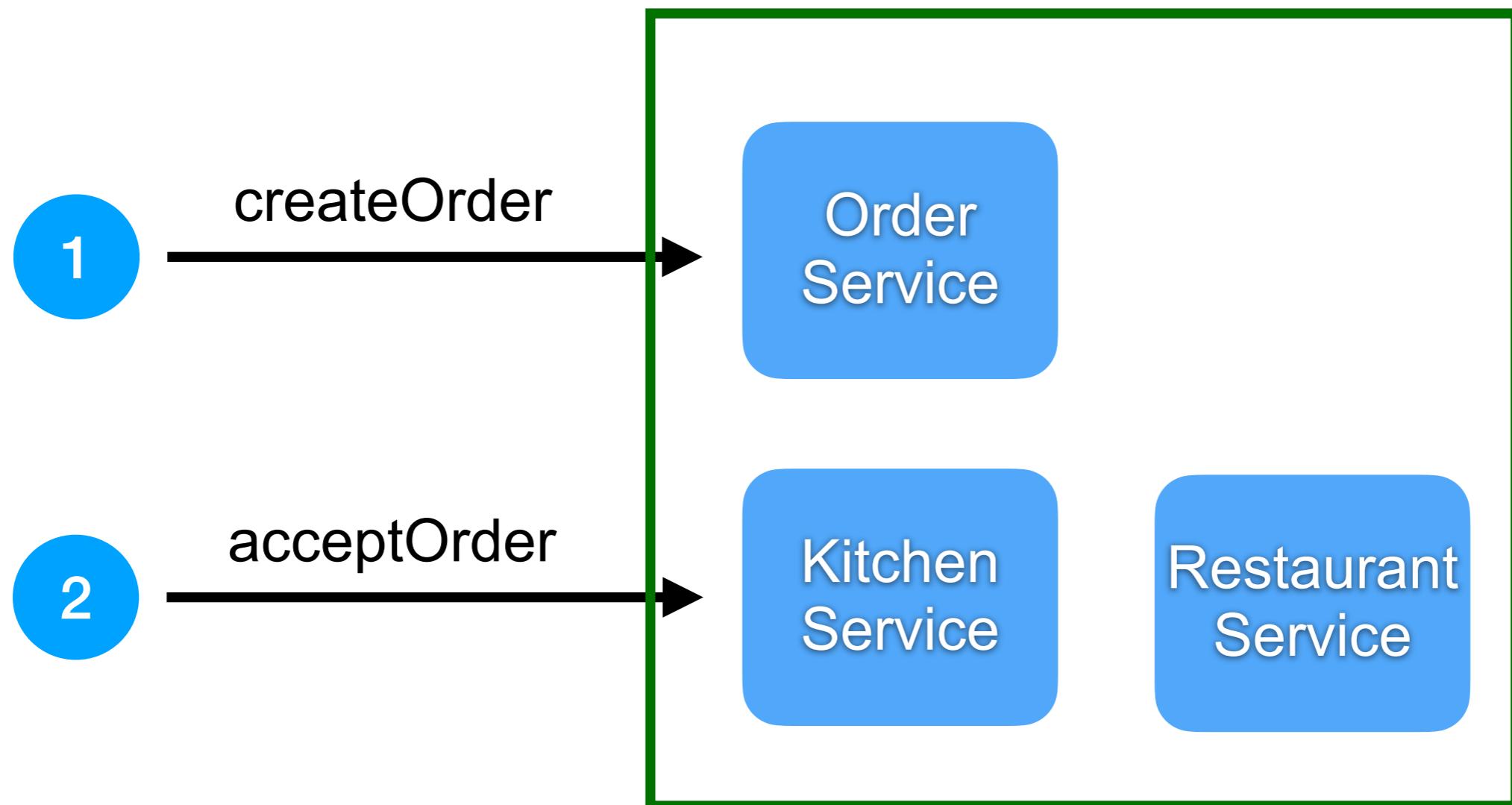
2. Identify services

Try to decomposition into services

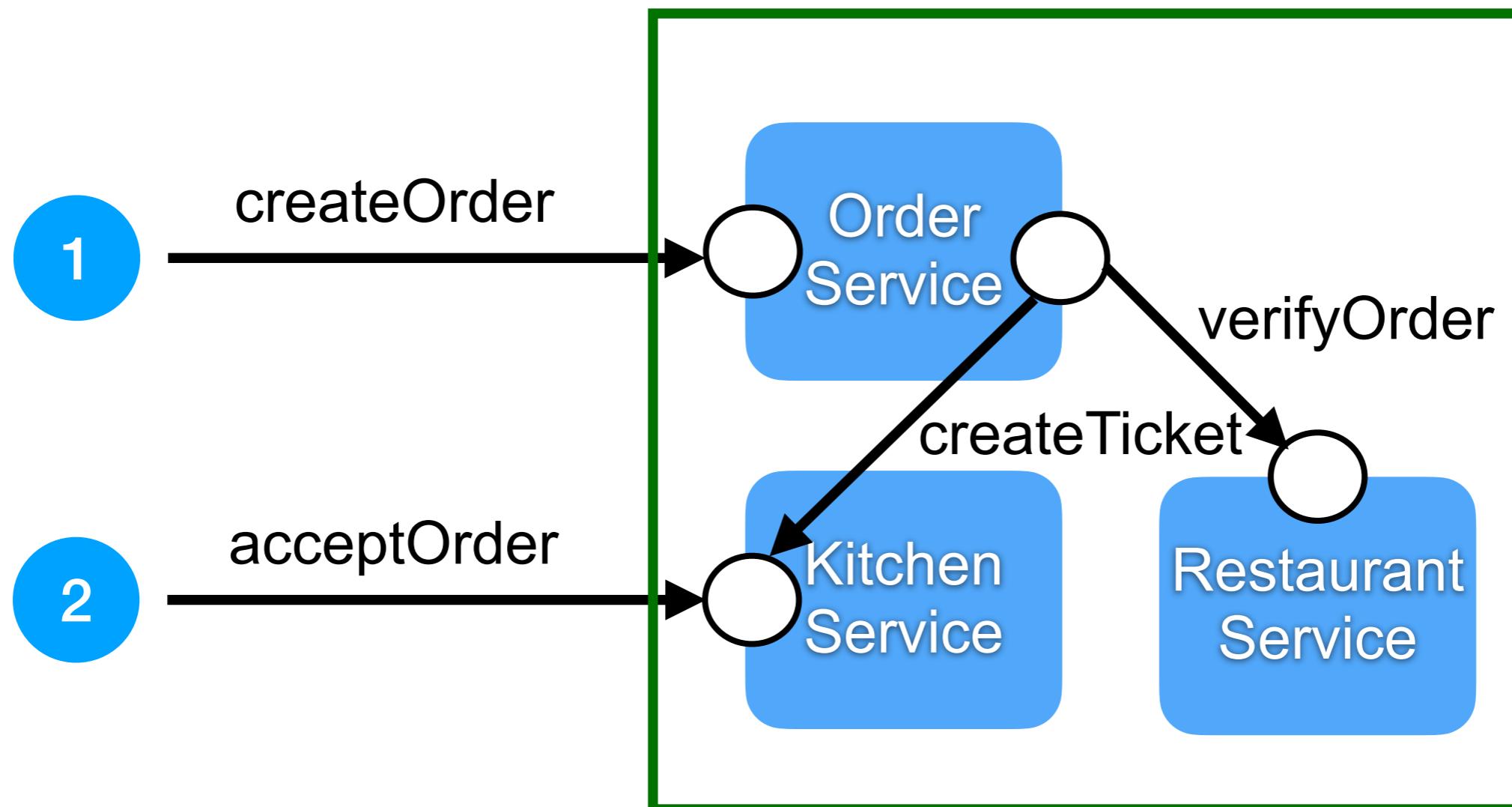
Business > Technical concept
What > How



2. Identify services



3. Define service APIs and collaborations



Problems when decompose services ?

Network latency

Reliability of communication

Maintain data consistency

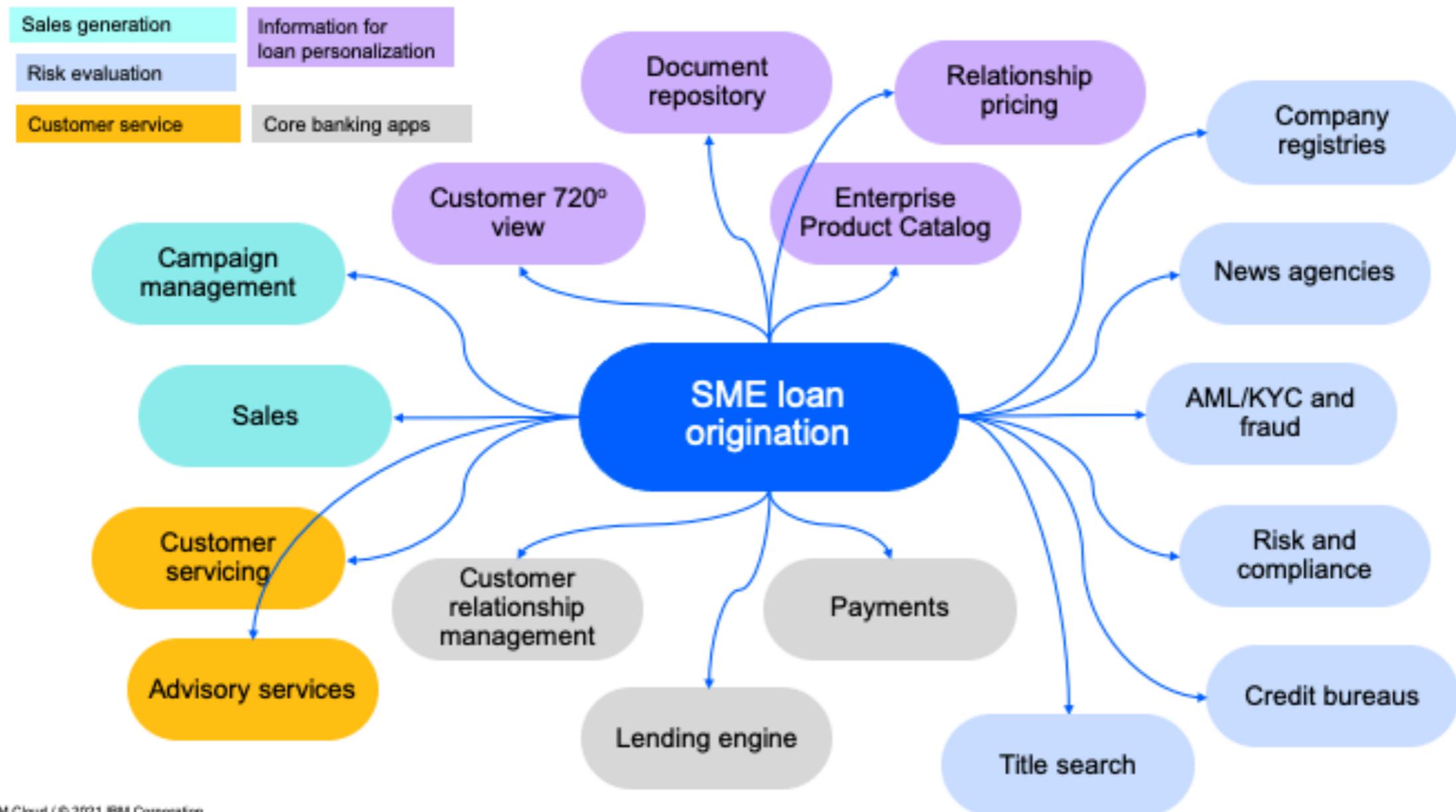
God services !!

Microlith !!



Example of System Context

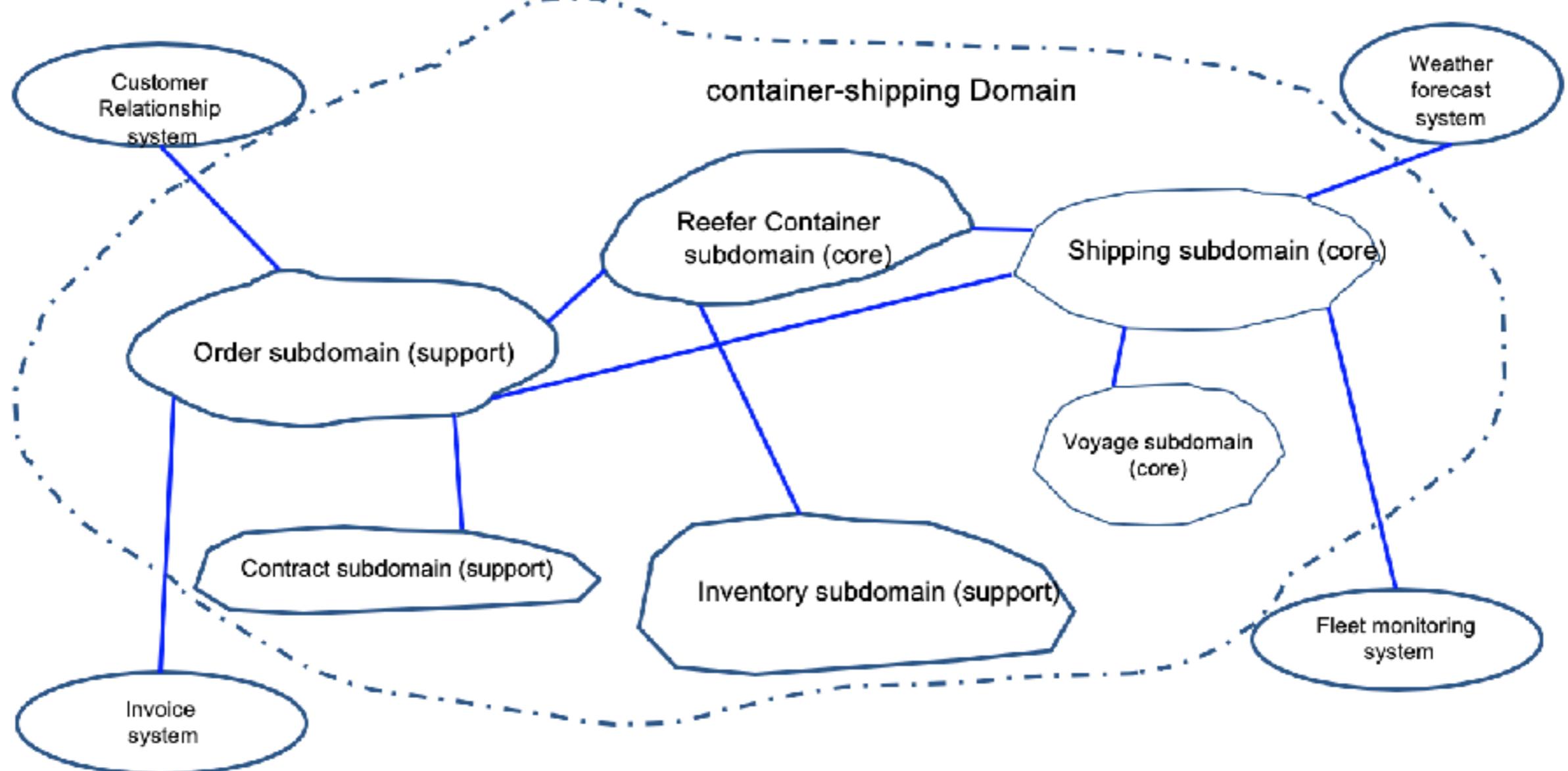
System context



IBM Cloud / © 2021 IBM Corporation



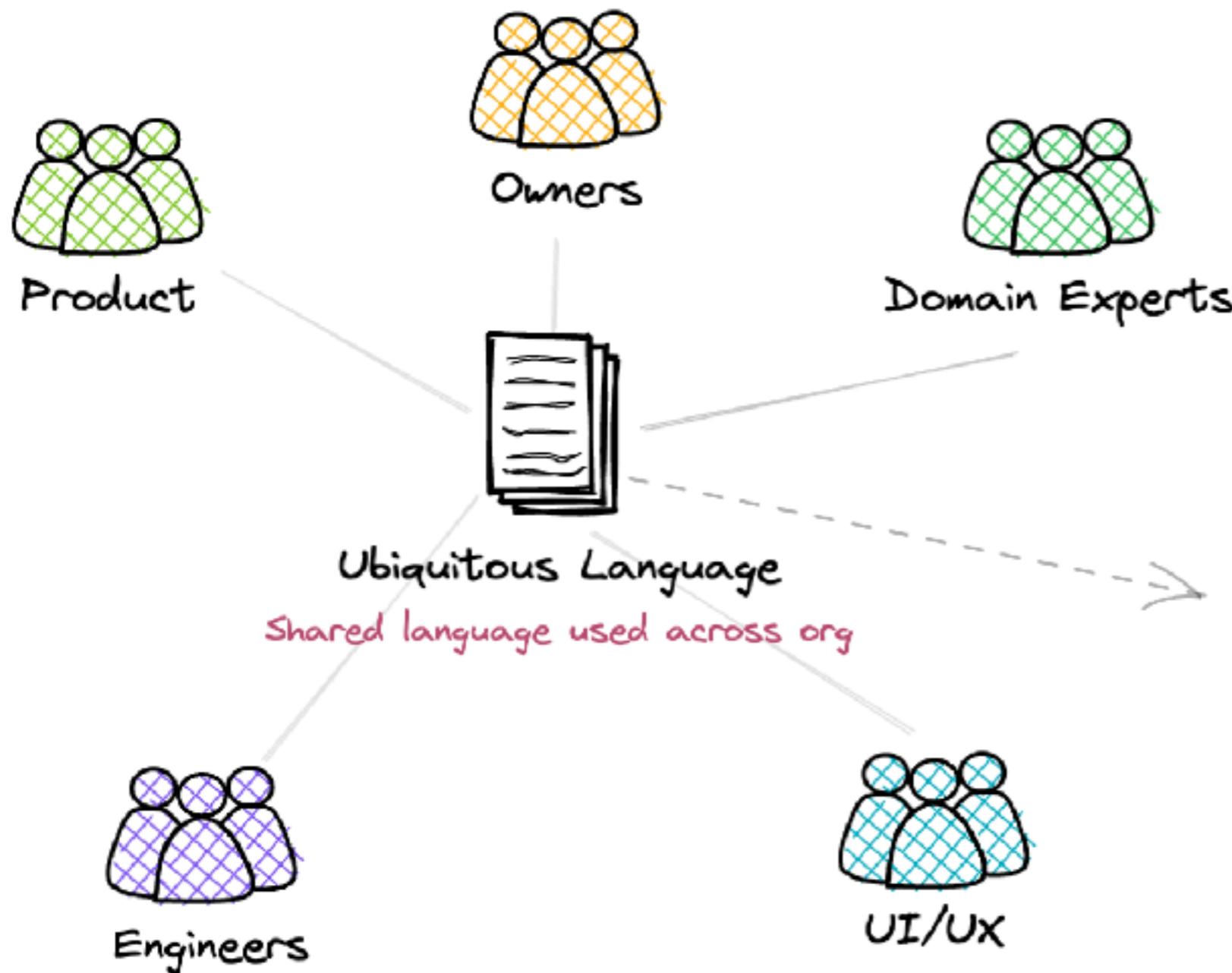
Assess domains and sub-domains



Define the ubiquitous language



Define the ubiquitous language



What is Ubiquitous Language

1. Language of the business
2. Reduces domain translations
3. Improve communication
4. Single Language
5. Terms easy to understand
6. Precise and consistent
7. Eliminate the need for assumptions
8. Single meaning for each term
9. Part of DDD
10. Use when describing business domain

@boyney123

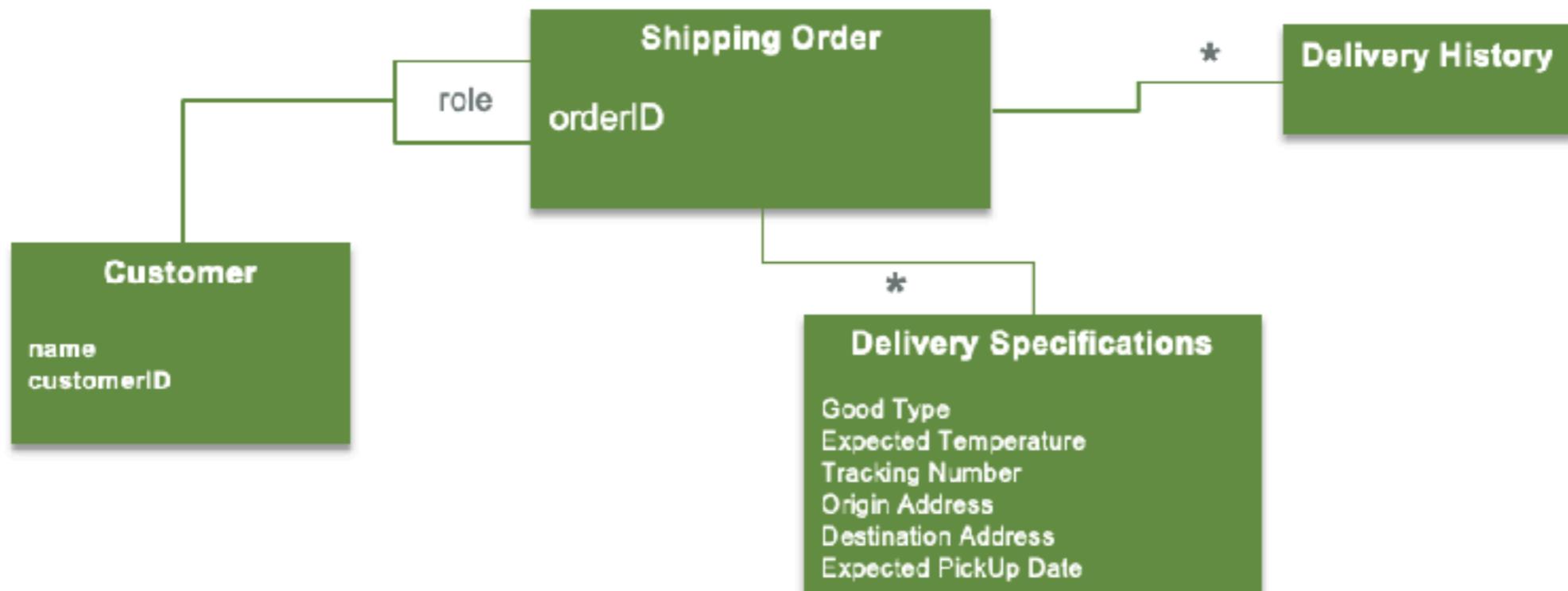
<https://serverlessland.com/event-driven-architecture/visuals/ubiquitous-language>



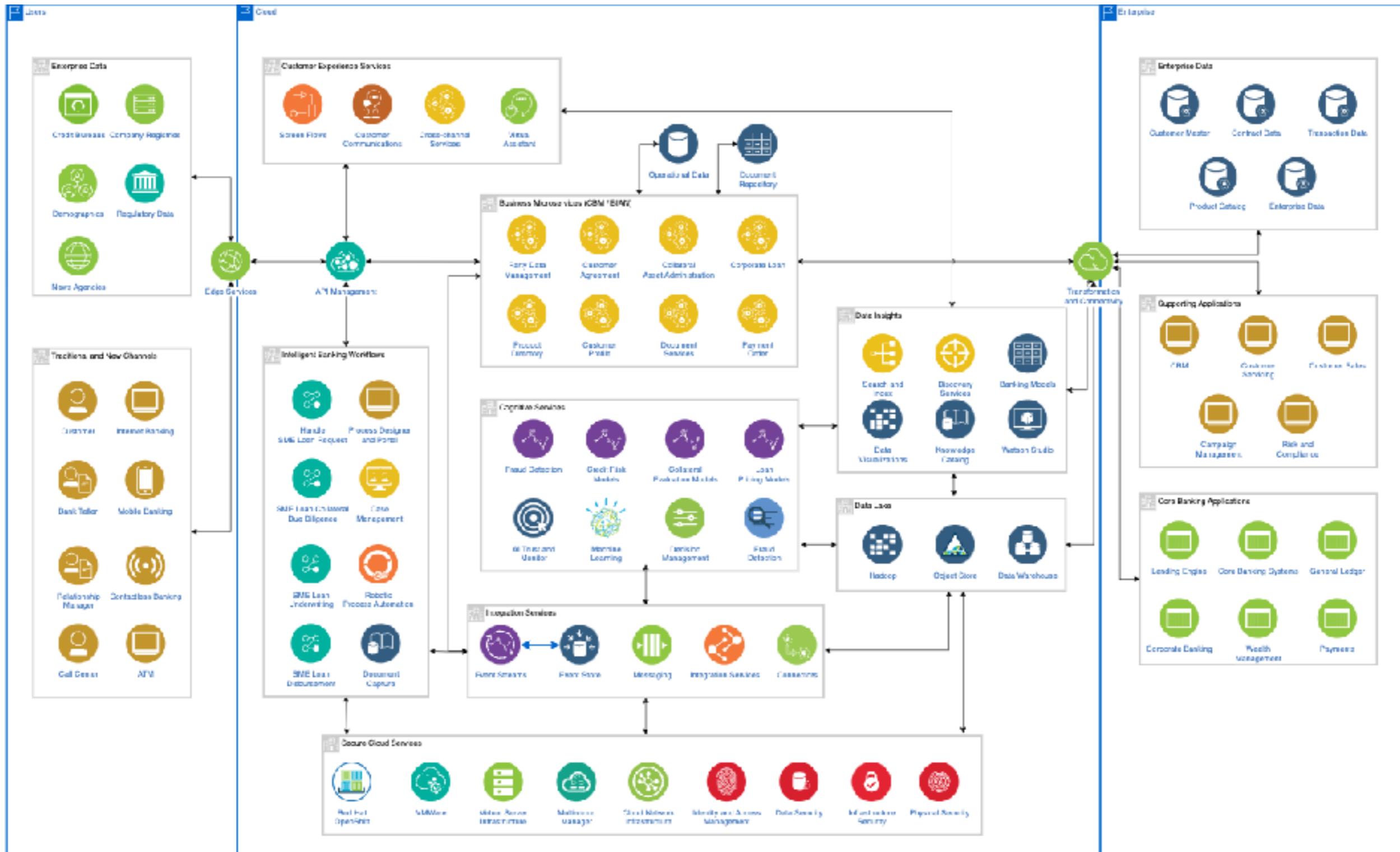
Microservices

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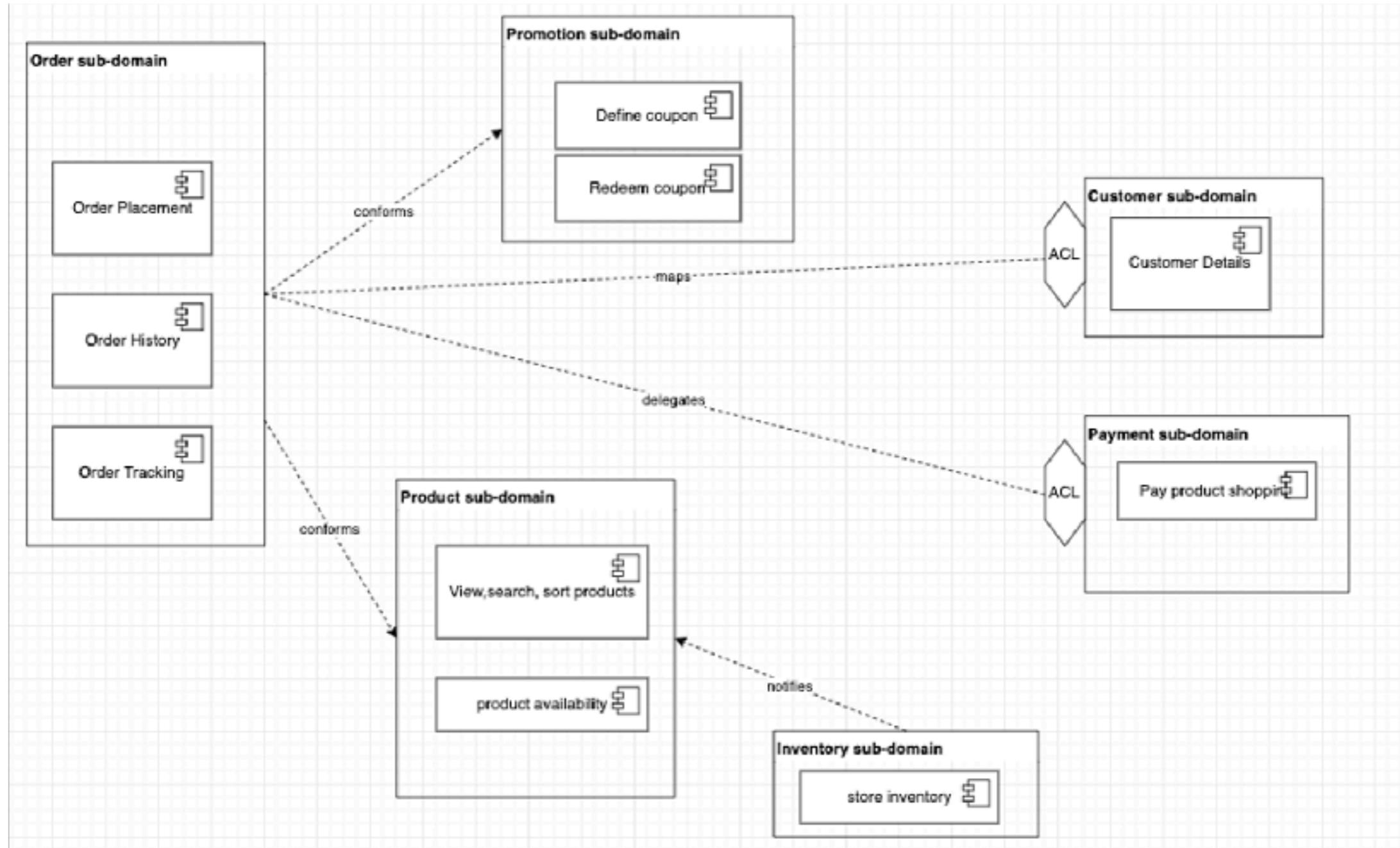
Structure of data



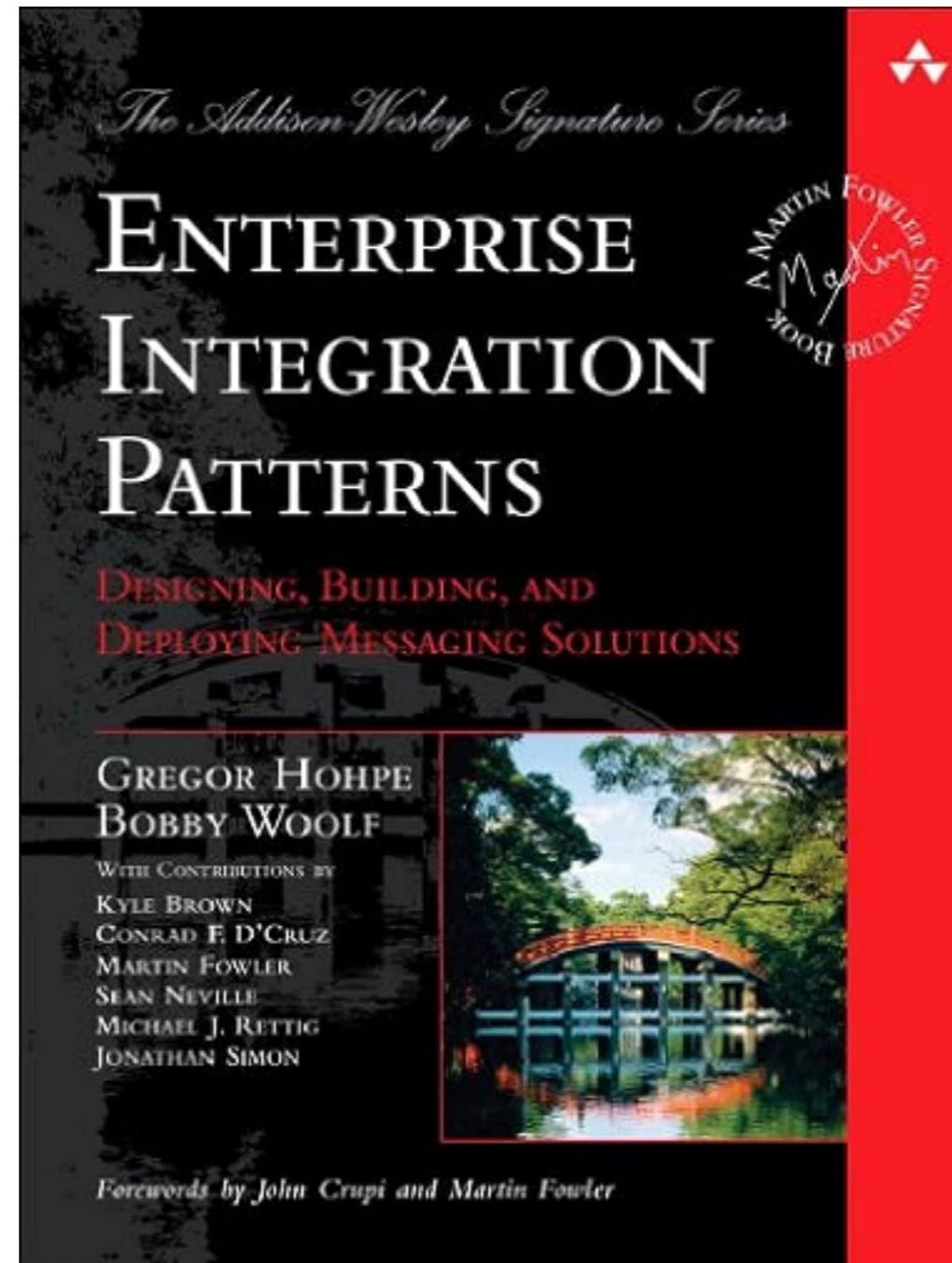
Grouping services



Communication types ?



Enterprise Integration Patterns



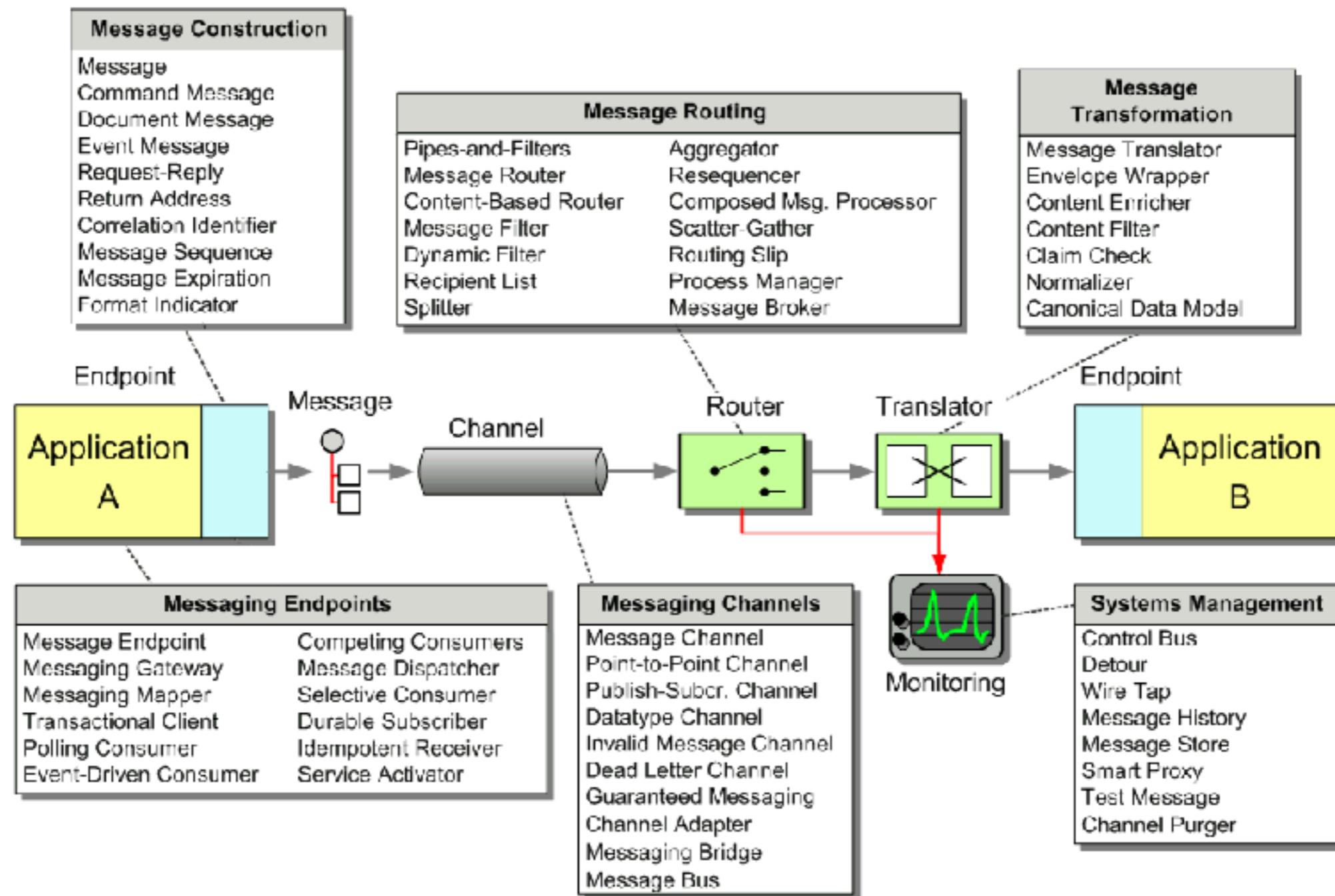
<https://www.amazon.com/Enterprise-Integration-Patterns-Designing-Deploying/dp/0321200683>



Microservices

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Integration Pattern Language



<https://www.enterpriseintegrationpatterns.com/patterns/messaging/>



Microservices

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Communication between services



Interaction Styles

	One-to-one	One-to-many
Synchronous	Request/response	-
Asynchronous	Async request/response	Publish/subscribe
	Notification	Publish/async response



Synchronous Communication

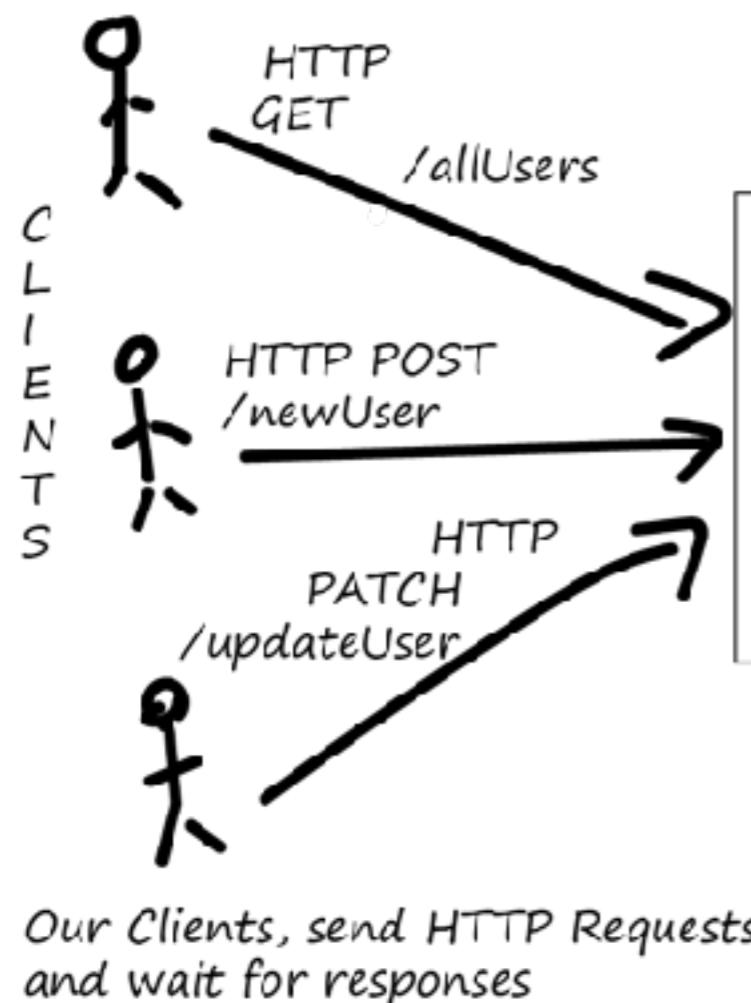
REST
gRPC

Handling failure with Circuit breaker
Service discovery

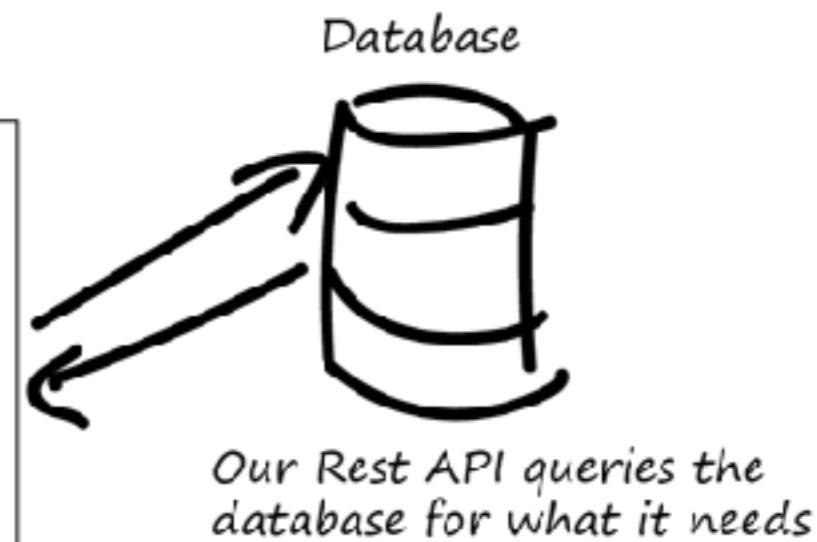


REpresentational State Transfer

Rest API Basics



Typical HTTP Verbs:
GET → Read from Database
PUT → Update/Replace row in Database
PATCH → Update/Modify row in Database
POST → Create a new record in the database
DELETE → Delete from the database



Response: When the Rest API has what it needs, it sends back a response to the clients. This would typically be in JSON or XML format.



REST :: mapping with HTTP verbs

Activity	HTTP Method
Retrieve data	GET
Create new data	POST
Update data	PUT
Delete data	DELETE



API Documentation



API Development for Everyone

Simplify your API development with our open-source and professional tools, built to help you and your team efficiently design and document APIs at scale.

[Find your tool](#)[Read the docs →](#)

TRUSTED BY



Servers	https://api.swagger.io
API Resources	
GET	/resource
POST	/resource
PUT	/resource
PATCH	/resource
DELETE	/resource
OPTIONS	/resource
HEAD	/resource

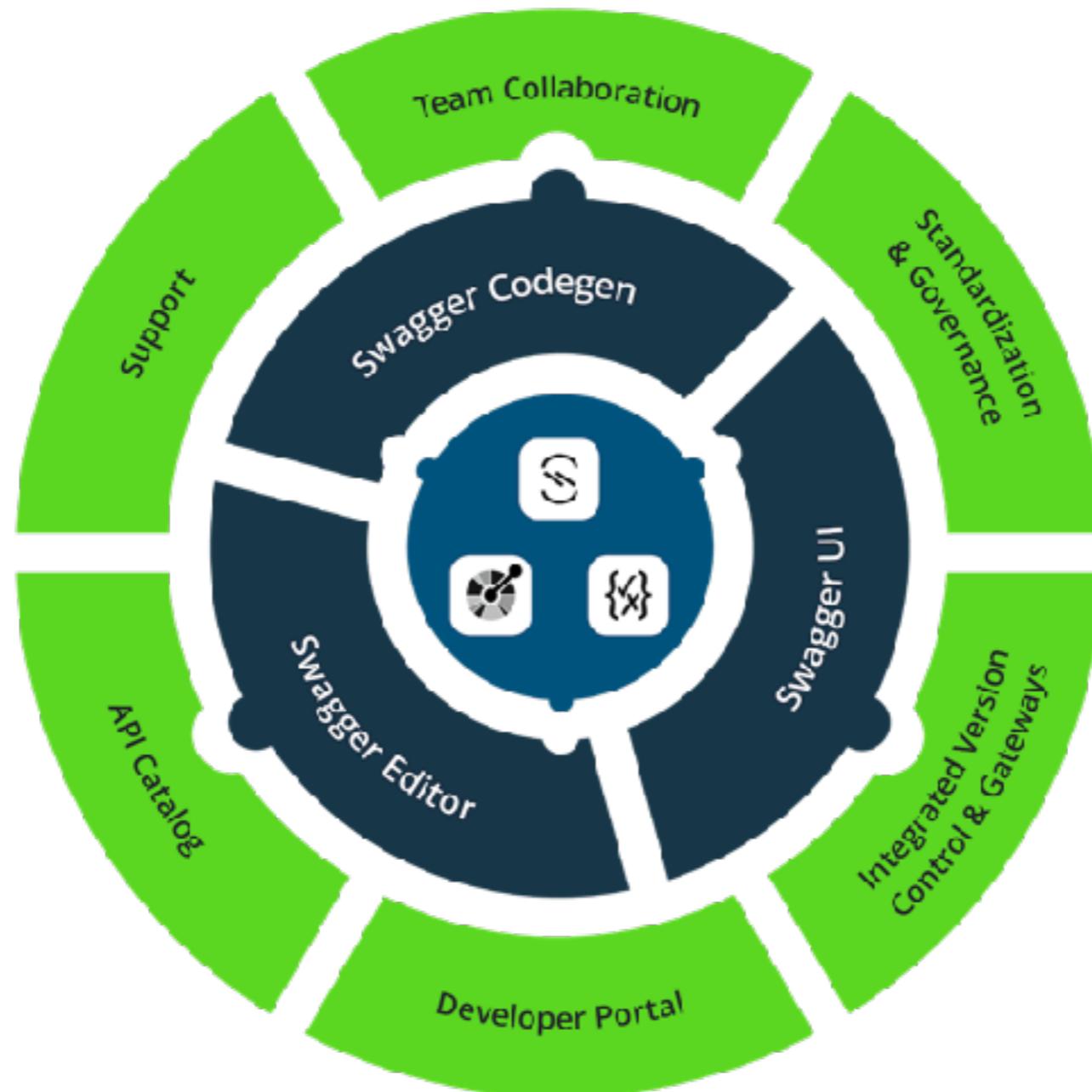
<https://swagger.io/>



Microservices

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Swagger/OpenAPI



<https://swagger.io/>



Swagger/OpenAPI

The screenshot shows the Swagger Editor interface. On the left, the OpenAPI 3.0 specification for the Petstore API is displayed in a code editor. The specification includes details like the title "Swagger Petstore - OpenAPI 3.0", a detailed description of the Pet Store Server, and links to GitHub repositories. On the right, the API operations are listed under two main categories: "pet" and "store".

pet Everything about your Pets

- PUT** /pet Update an existing pet
- POST** /pet Add a new pet to the store
- GET** /pet/findByStatus Finds Pets by status
- GET** /pet/findByTags Finds Pets by tags
- GET** /pet/{petId} Find pet by ID
- POST** /pet/{petId} Updates a pet in the store with form data
- DELETE** /pet/{petId} Deletes a pet
- POST** /pet/{petId}/uploadImage uploads an image

store Access to Petstore orders

- GET** /store/inventory Returns pet inventories by status

<https://swagger.io/>



Microservices

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How to design your API ?

Design first

Code first



gRPC



A high performance, open source universal RPC framework

[Learn more](#)

Get started!

Go

C++

Java

Python

...

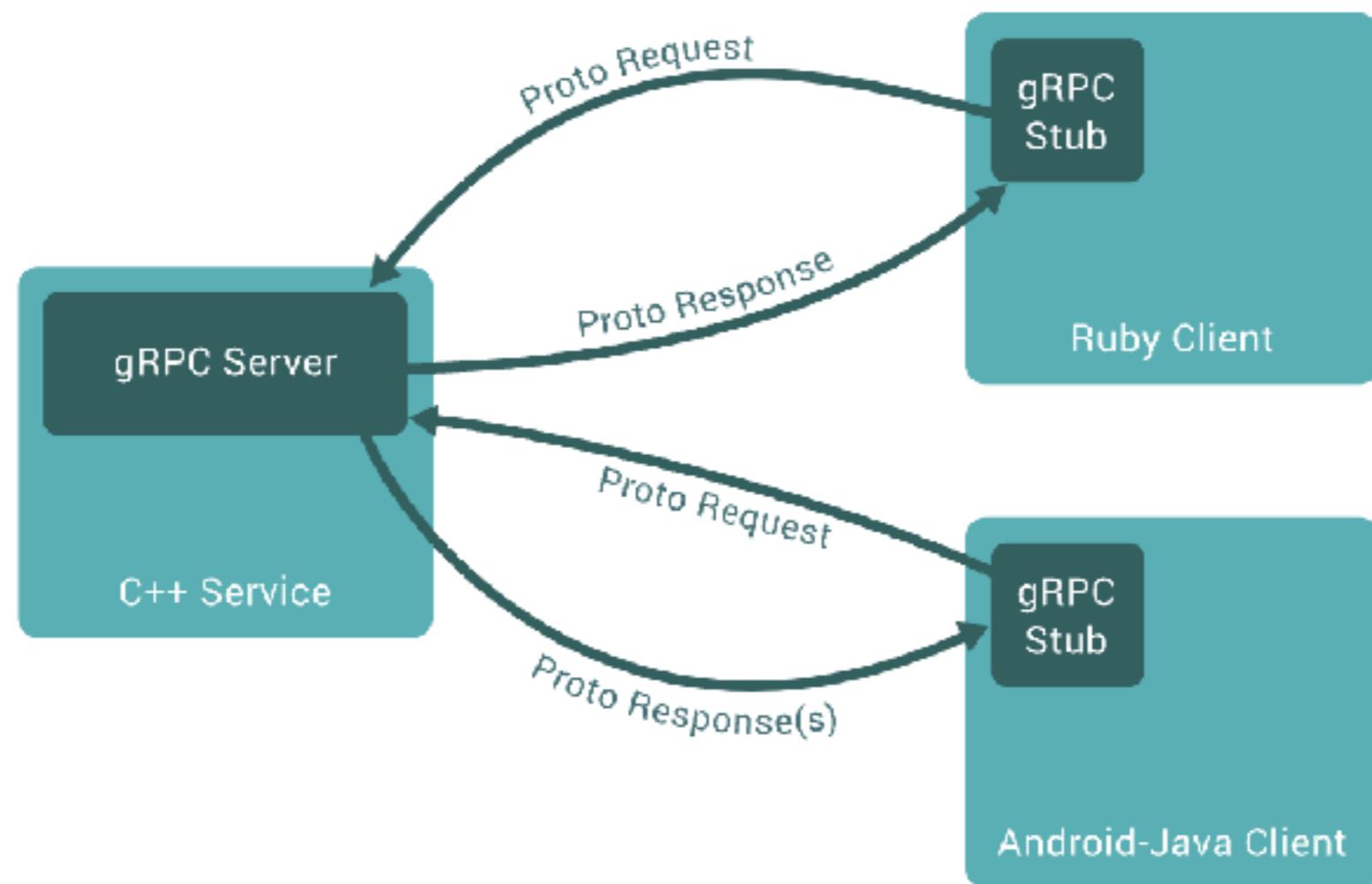
<https://grpc.io/>



Microservices

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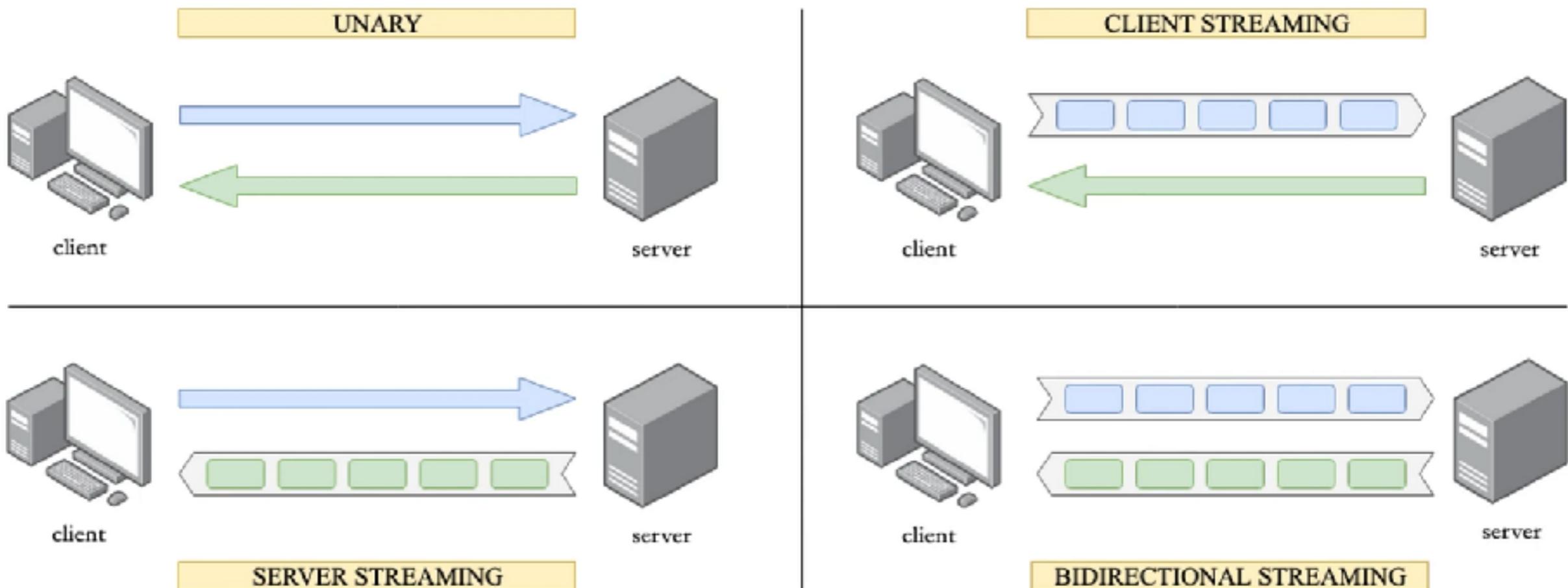
gRPC



<https://grpc.io/>



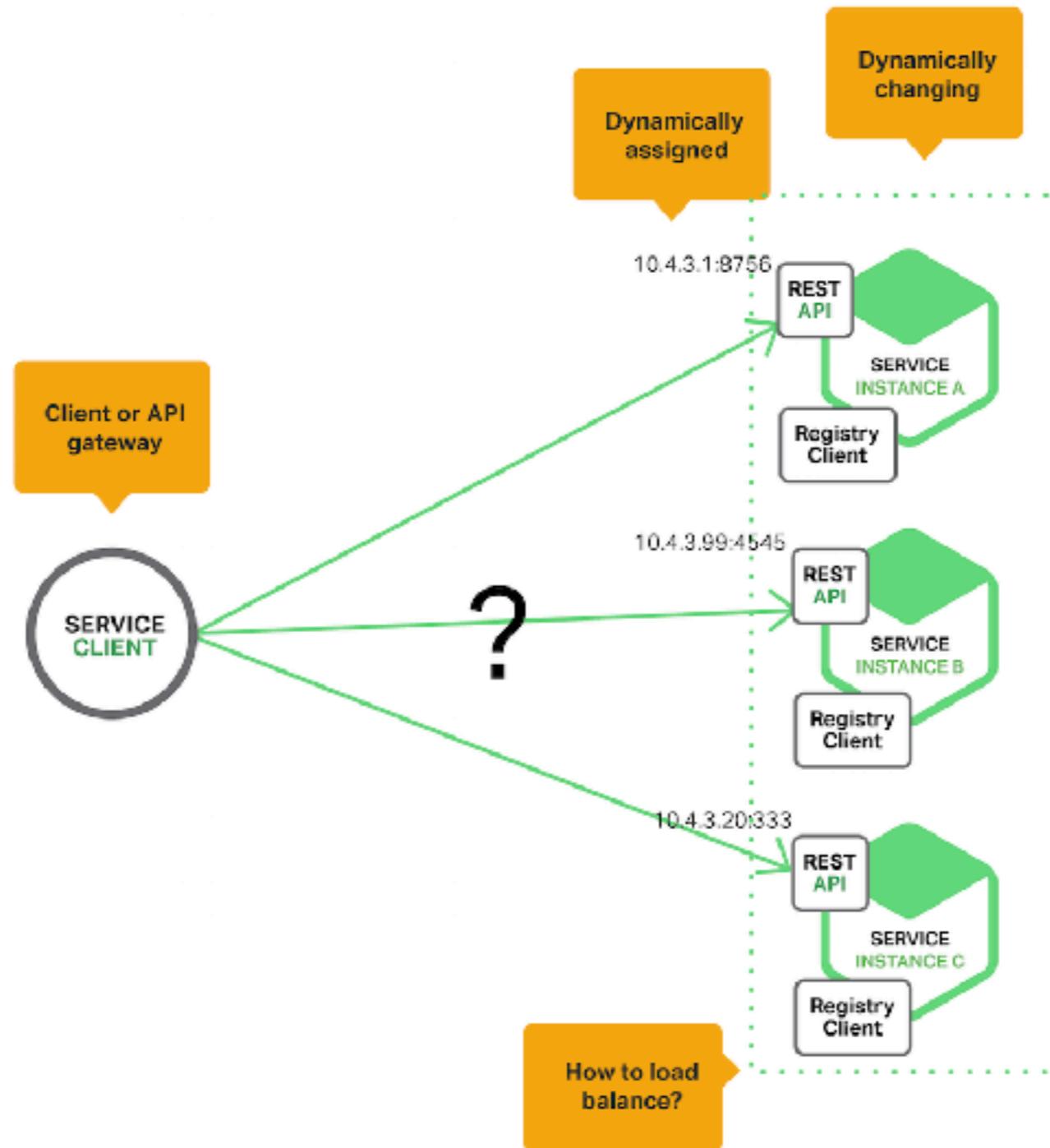
gRPC



<https://grpc.io/>



Service Discovery ?



<https://www.nginx.com/blog/service-discovery-in-a-microservices-architecture/>

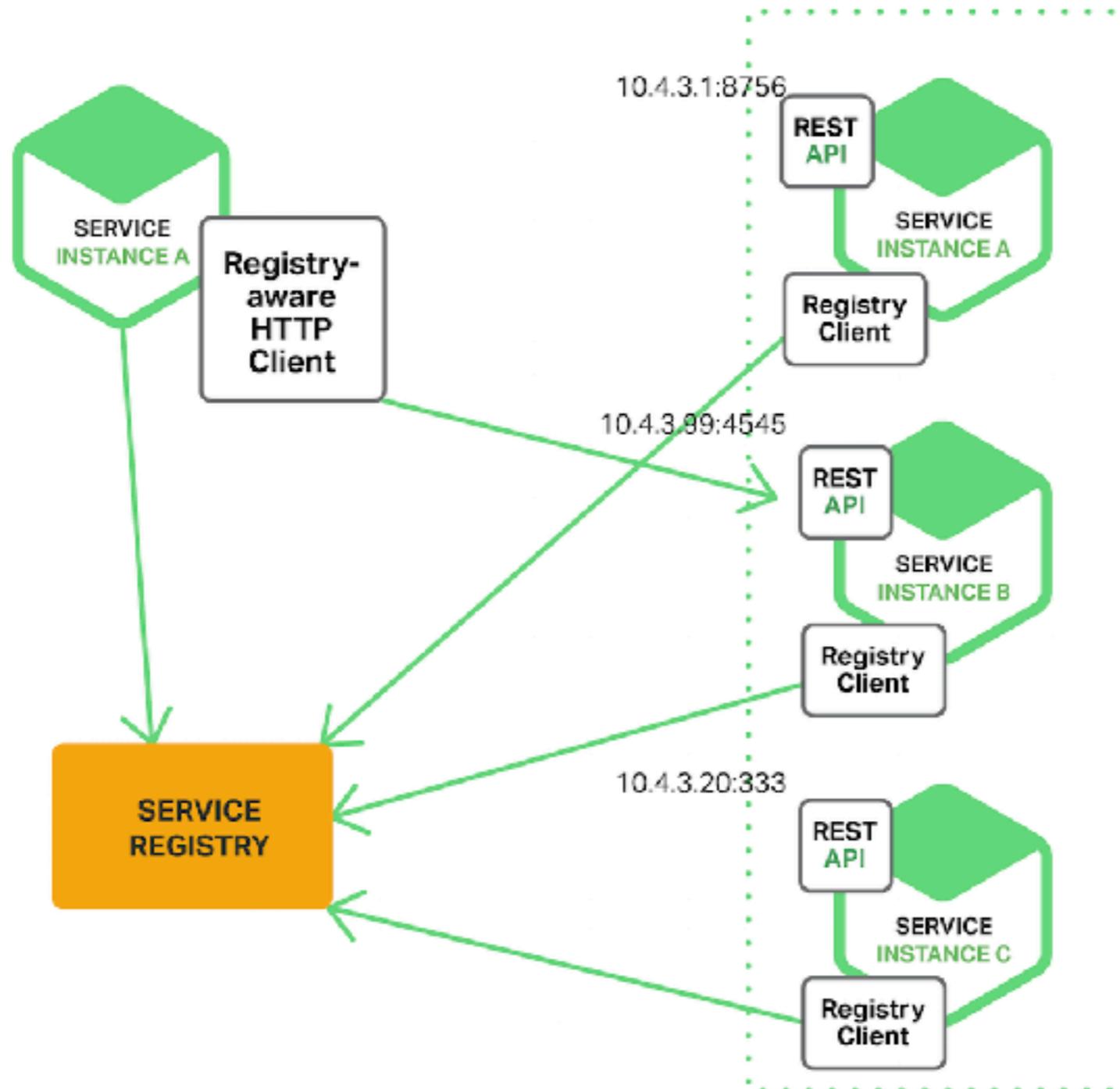


Service Discovery ?

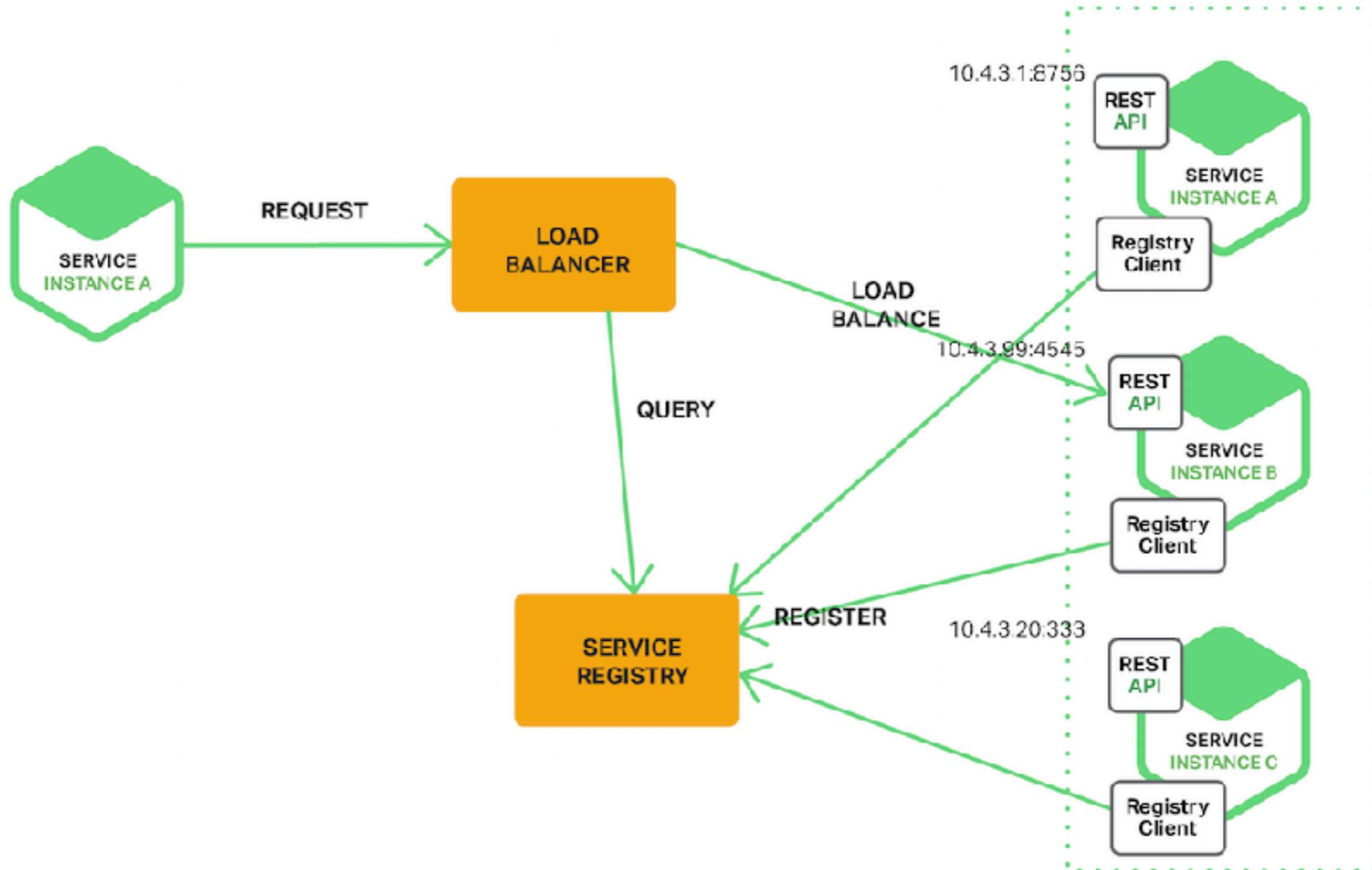
Client-side
Server-side



Client-side Discovery



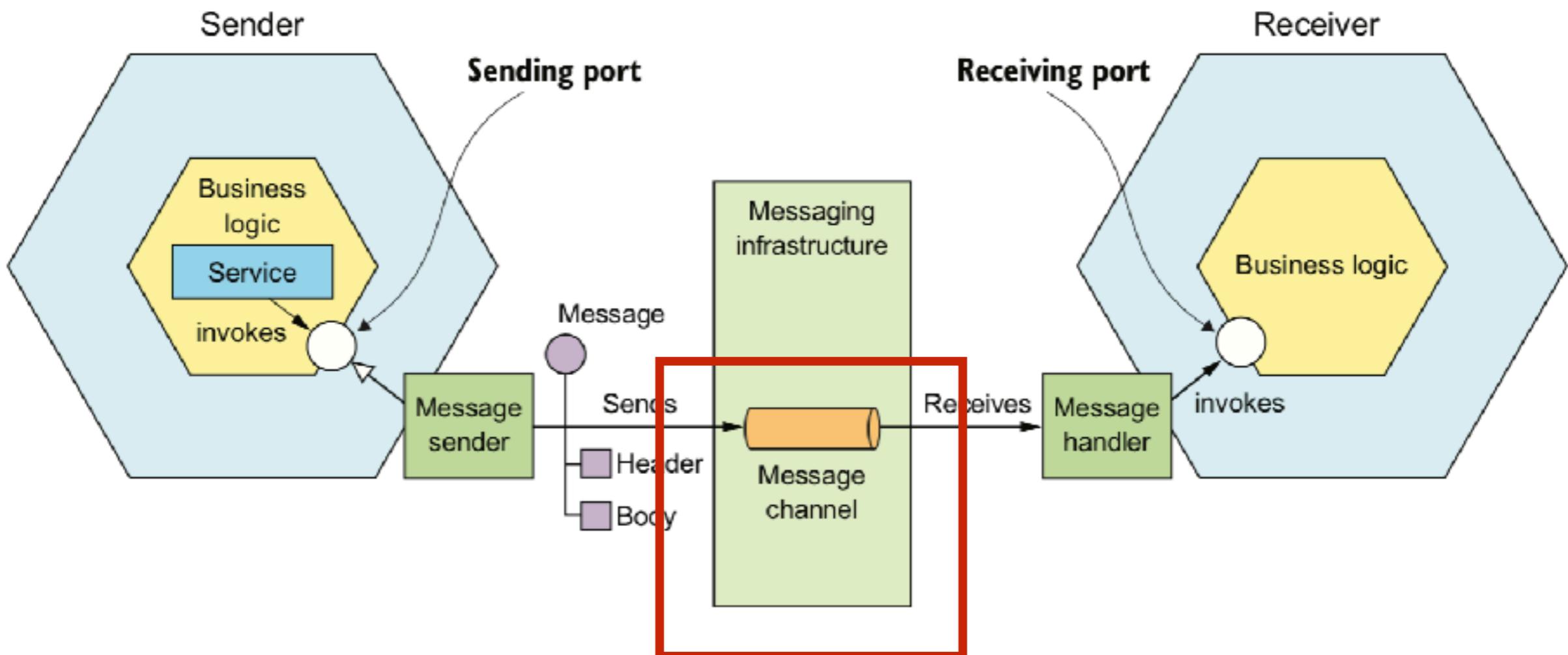
Server-side Discovery



Asynchronous communication

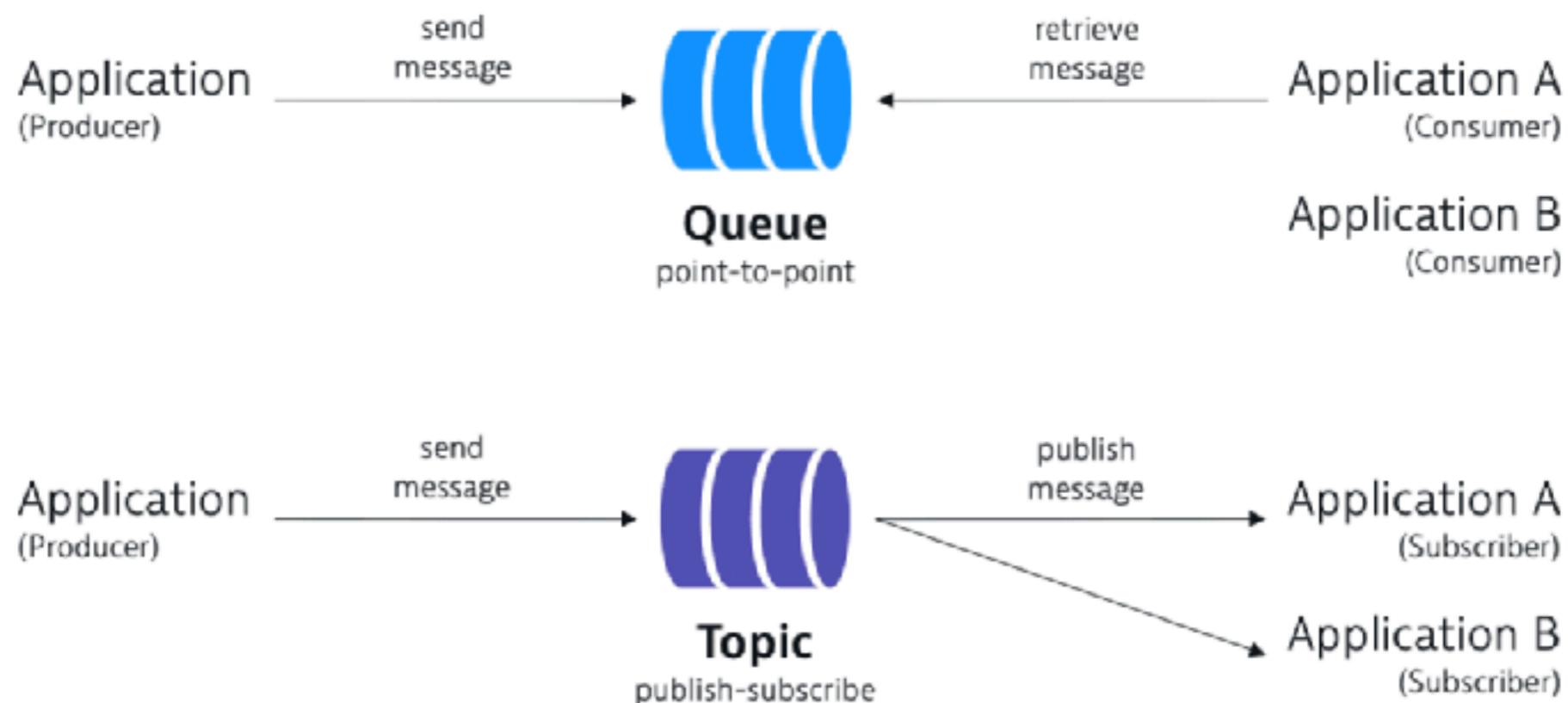


Asynchronous messaging pattern



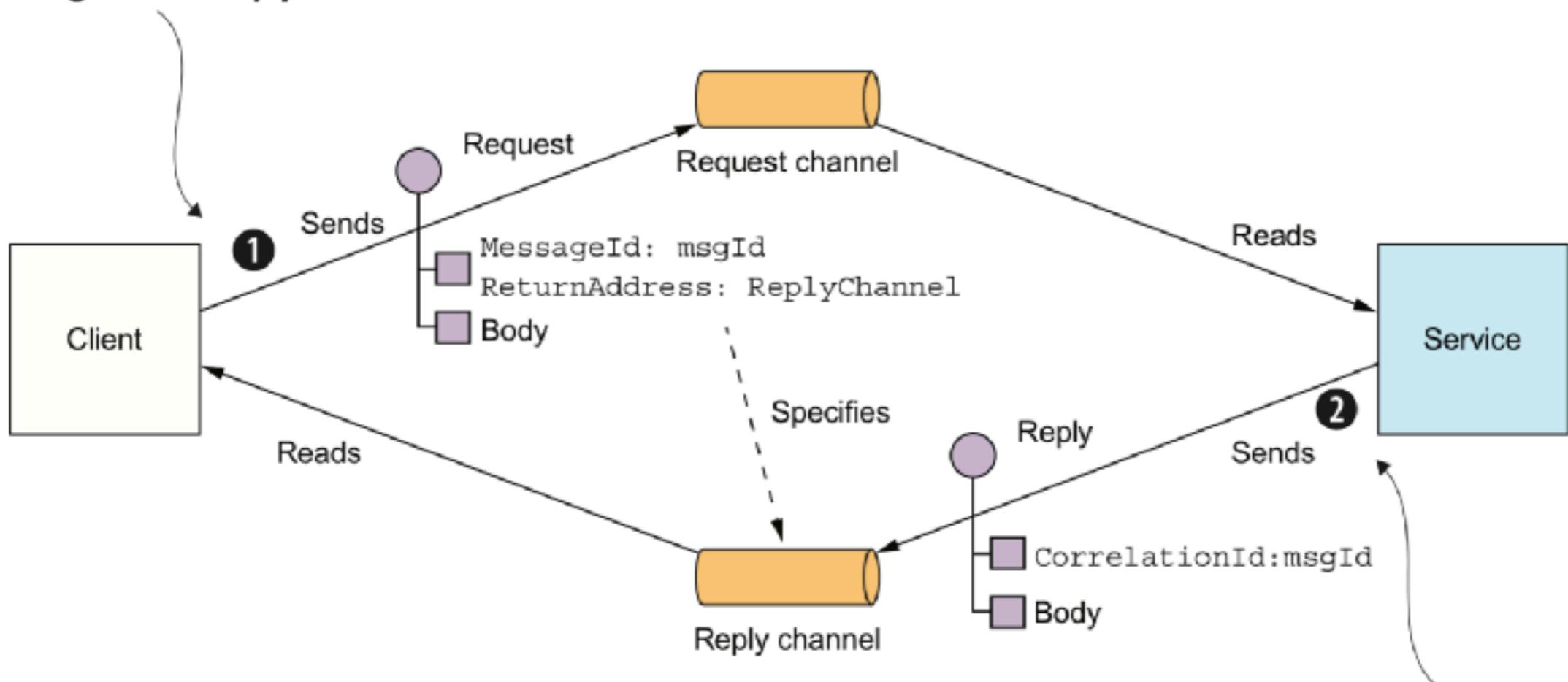
Messaging channels

Publish-subscribe Point-to-point



Async request/response (1)

Client sends message containing msgId and a reply channel.



Service sends reply to the specified reply channel. The reply contains a correlationId, which is the request's msgId.



Message brokers



Benefits

Loose-coupling
Message buffer
Flexible communication



Drawbacks

Performance bottleneck
Single point of failure
Operational complexity
Testing
Monitoring

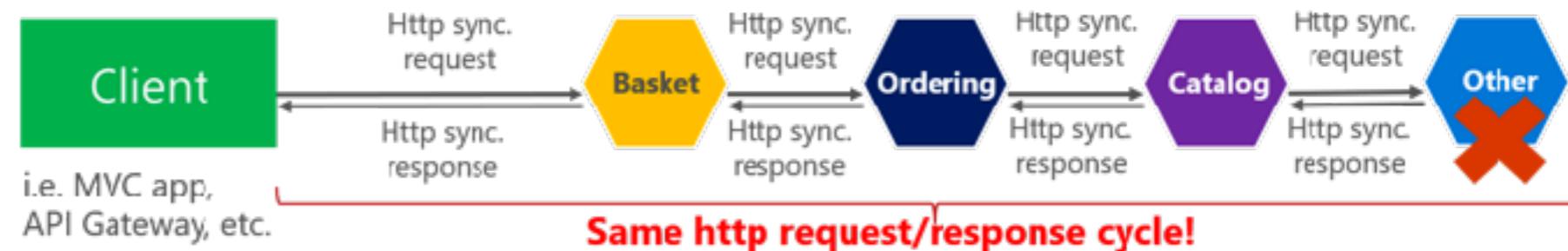


Communication !!

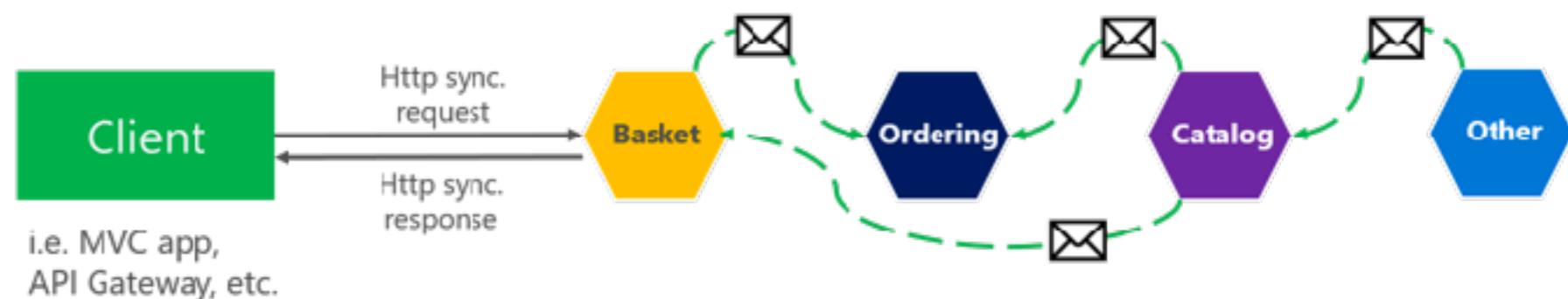
Synchronous vs. async communication across microservices

Anti-pattern

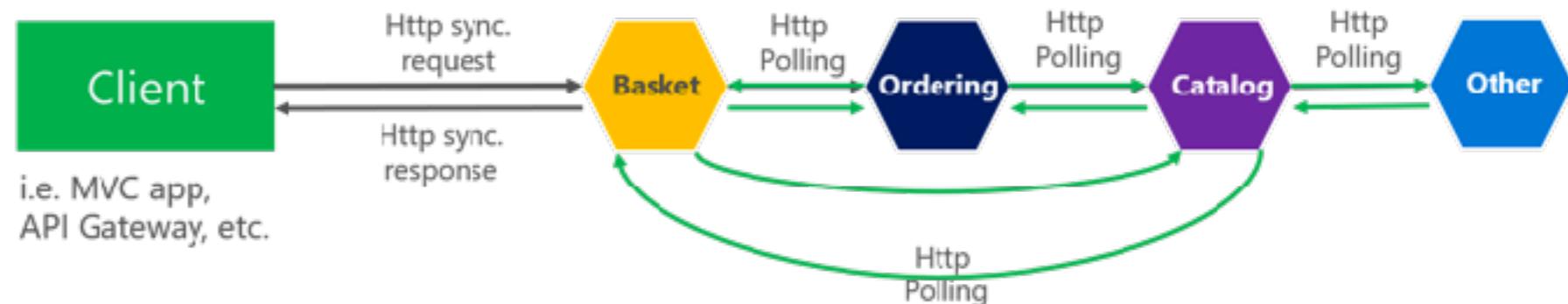
Synchronous
all req./resp. cycle



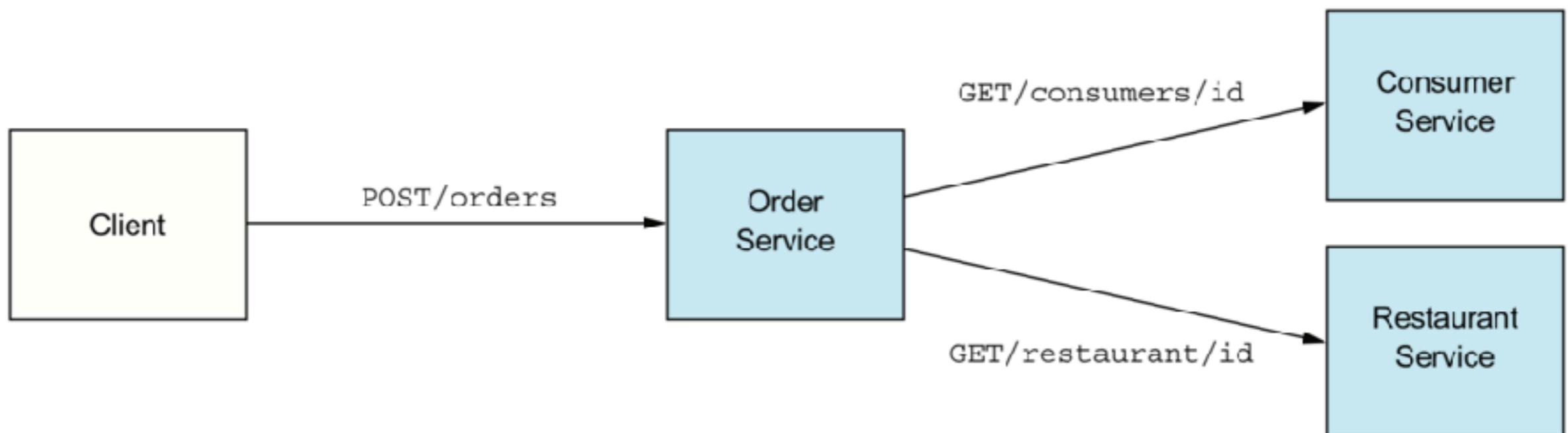
Asynchronous
Comm. across
internal microservices
(EventBus: i.e. **AMQP**)



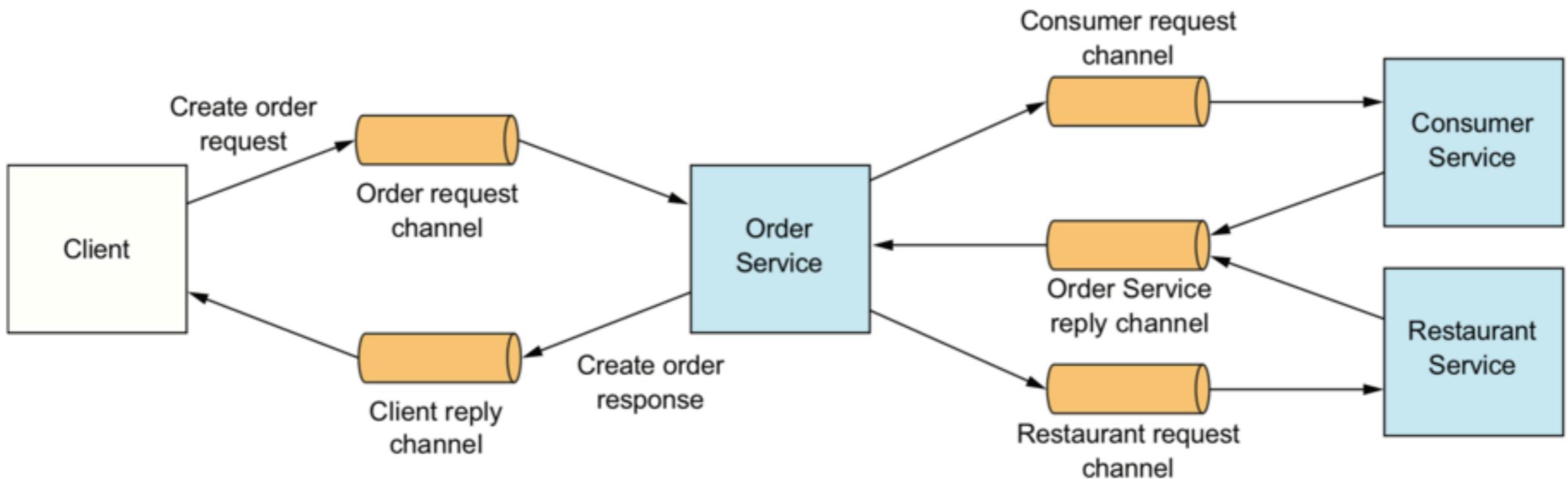
"Asynchronous"
Comm. across
internal microservices
(Polling: **Http**)



Synchronous reduce availability



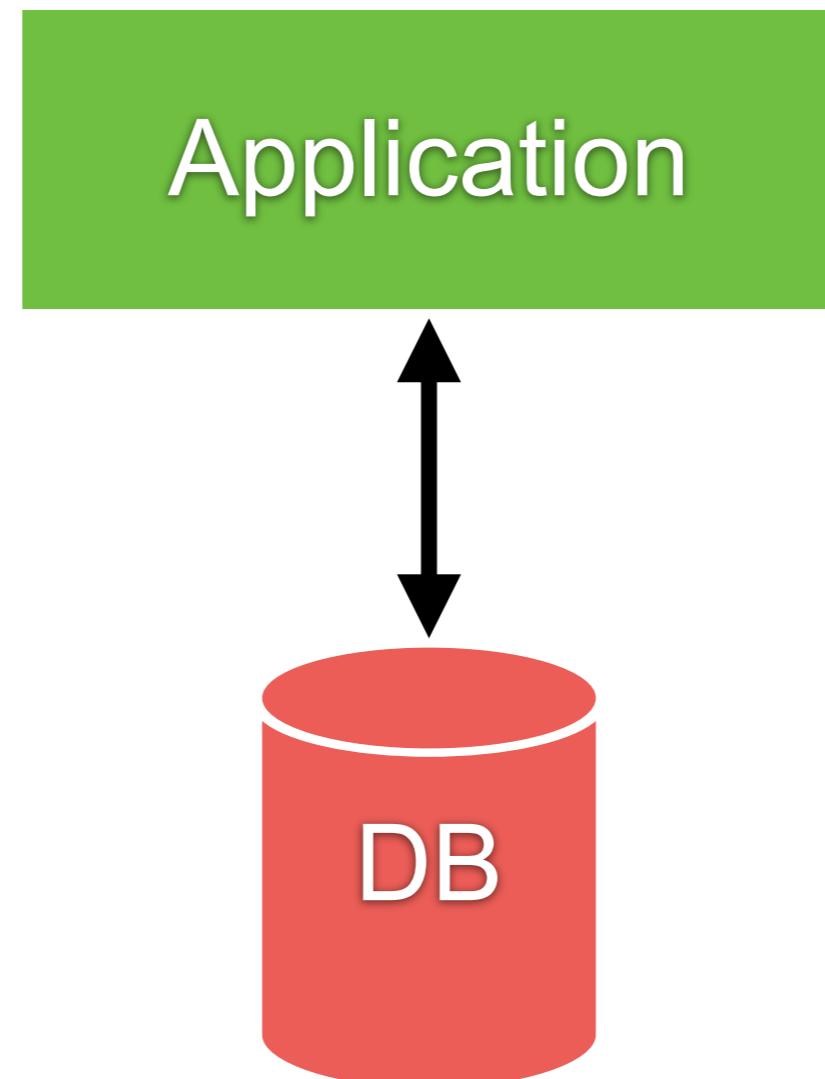
Replace with asynchronous



Manage Data Consistency

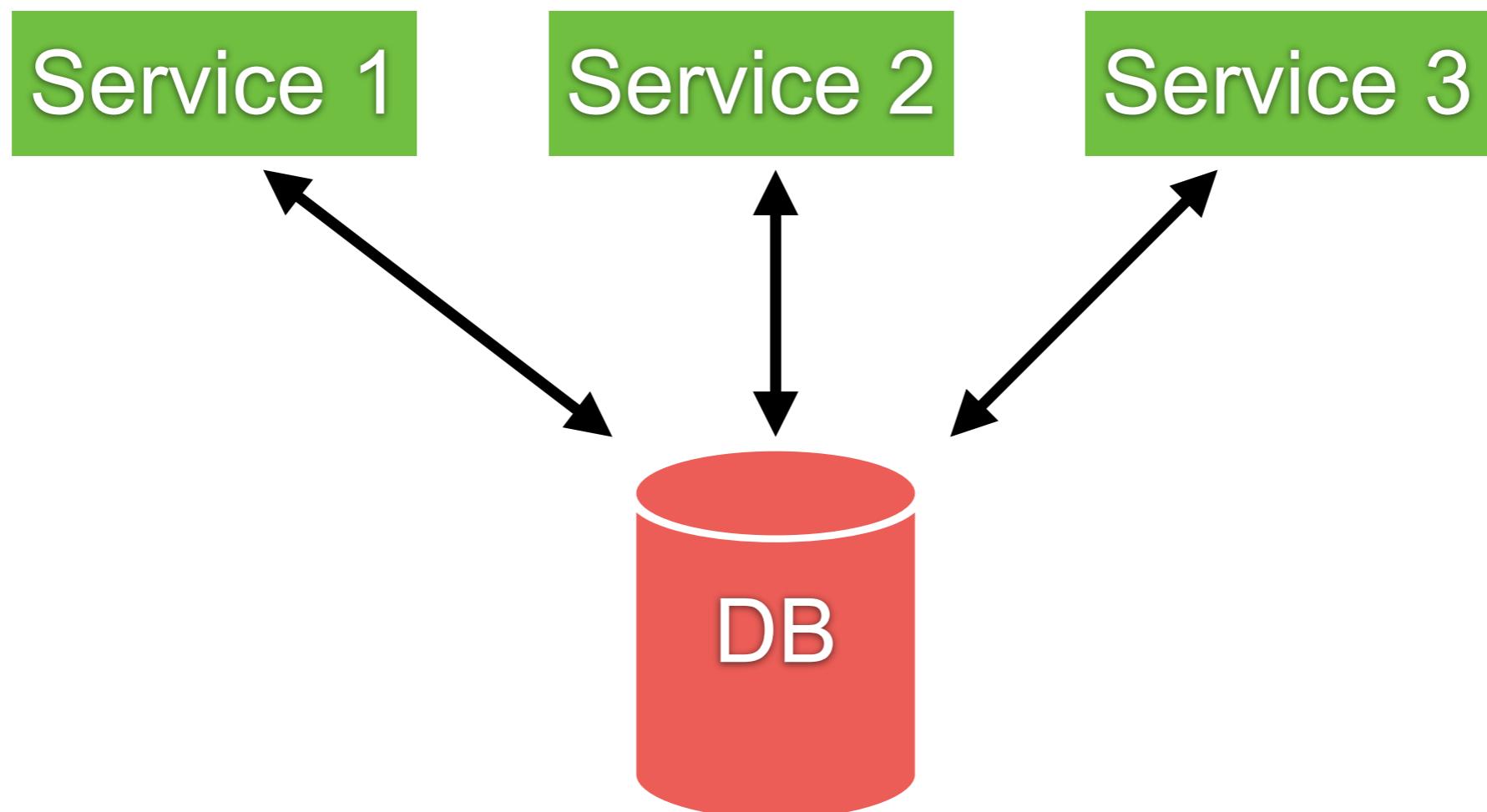


Monolithic



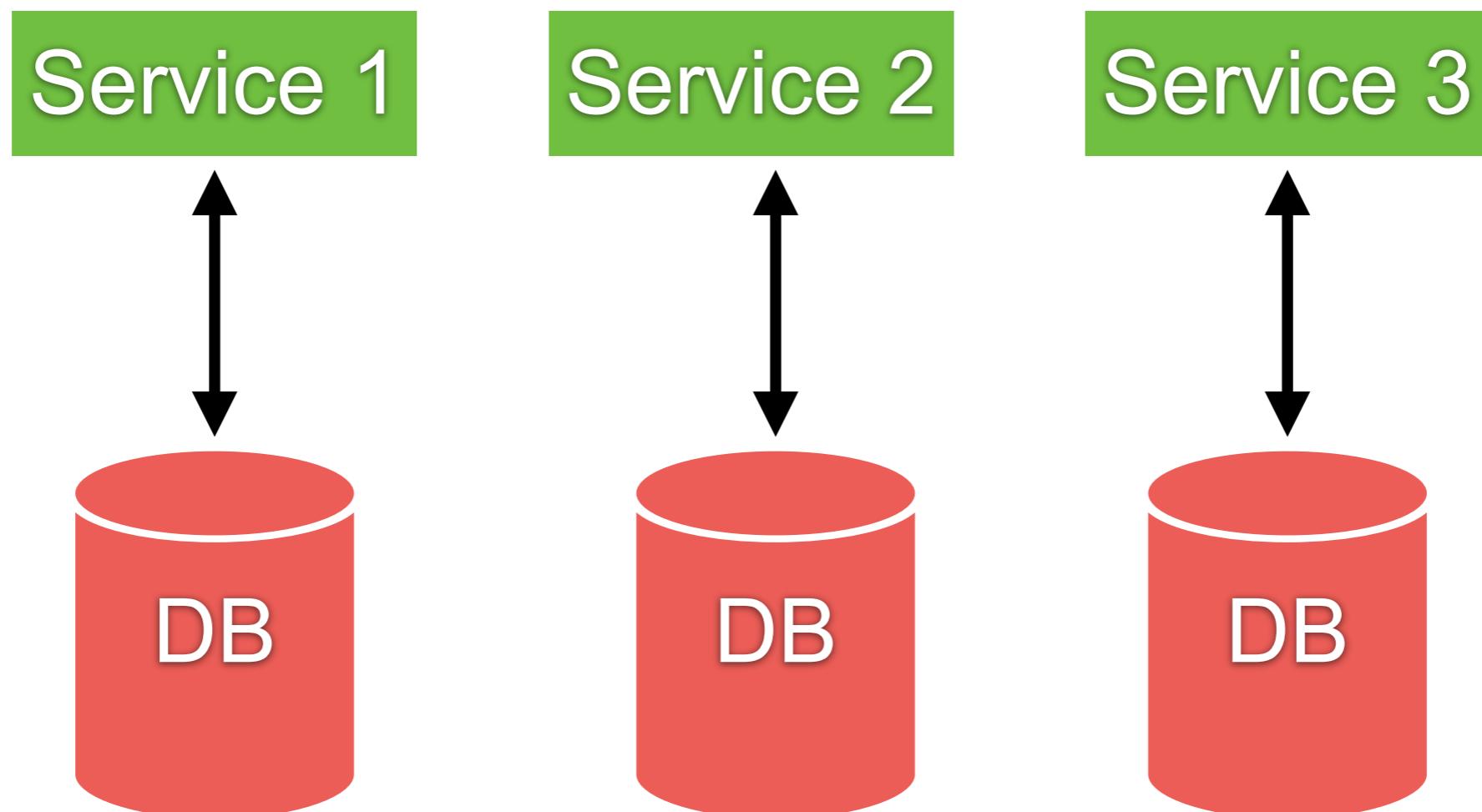
Microservices

Shared database

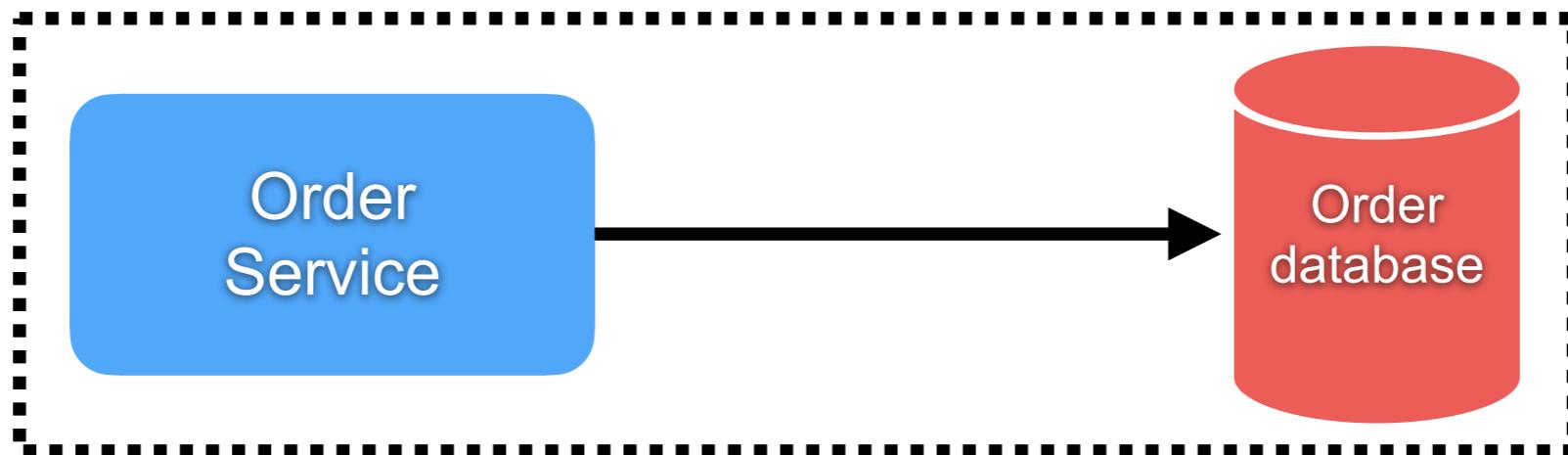


Microservices

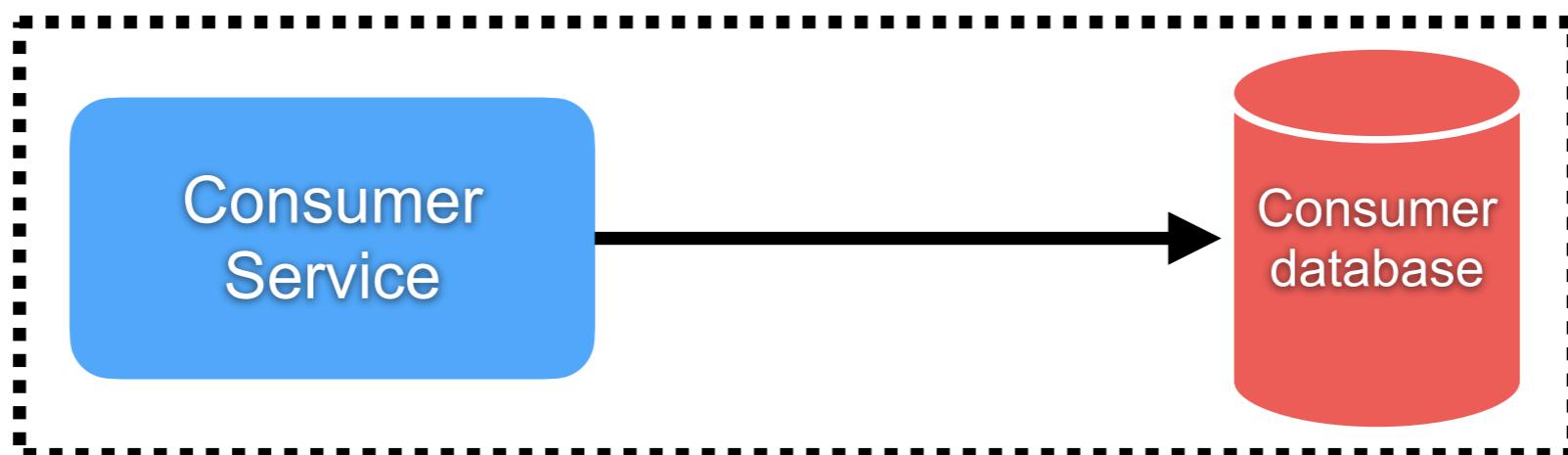
Database per service



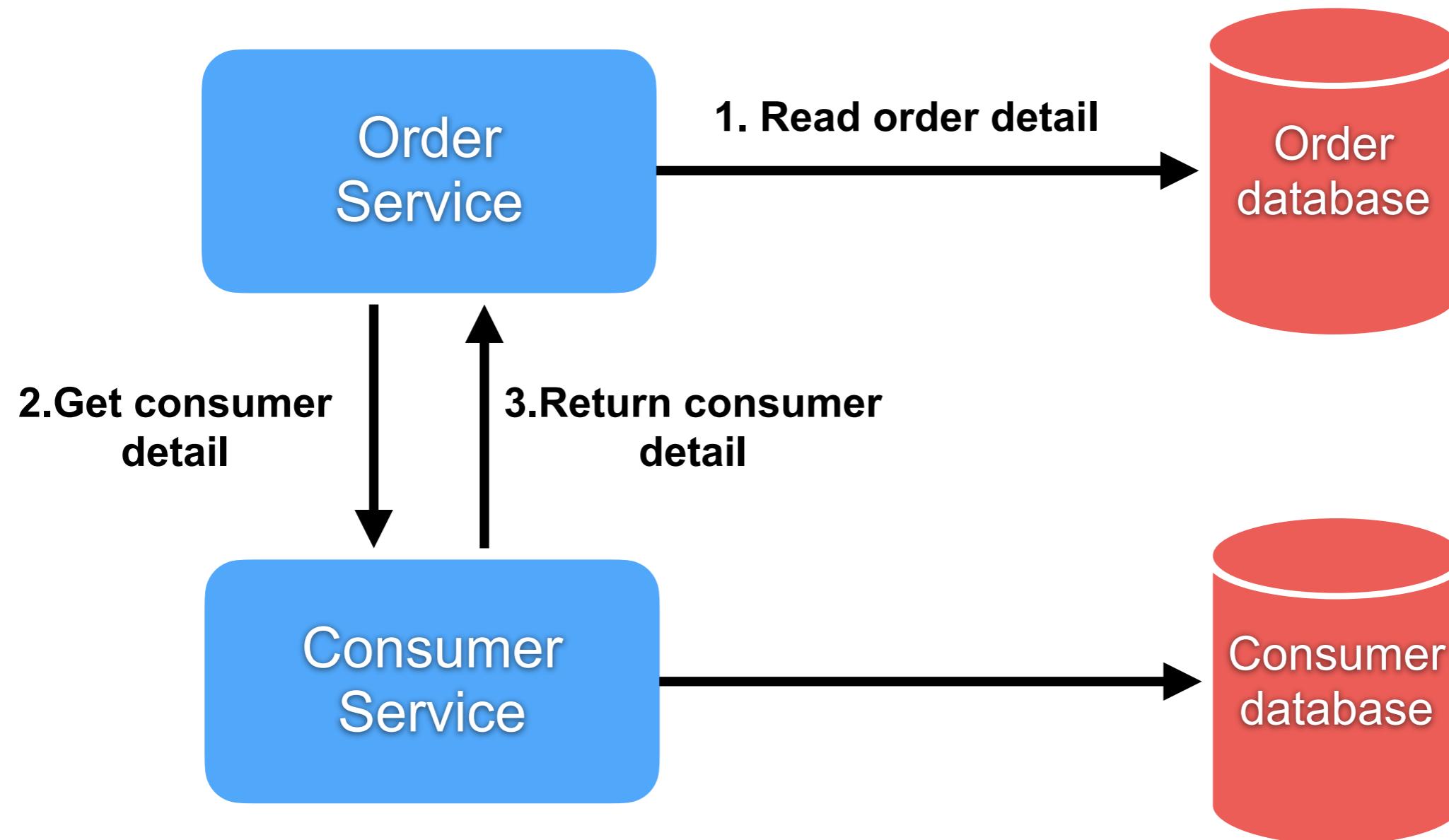
Database per service



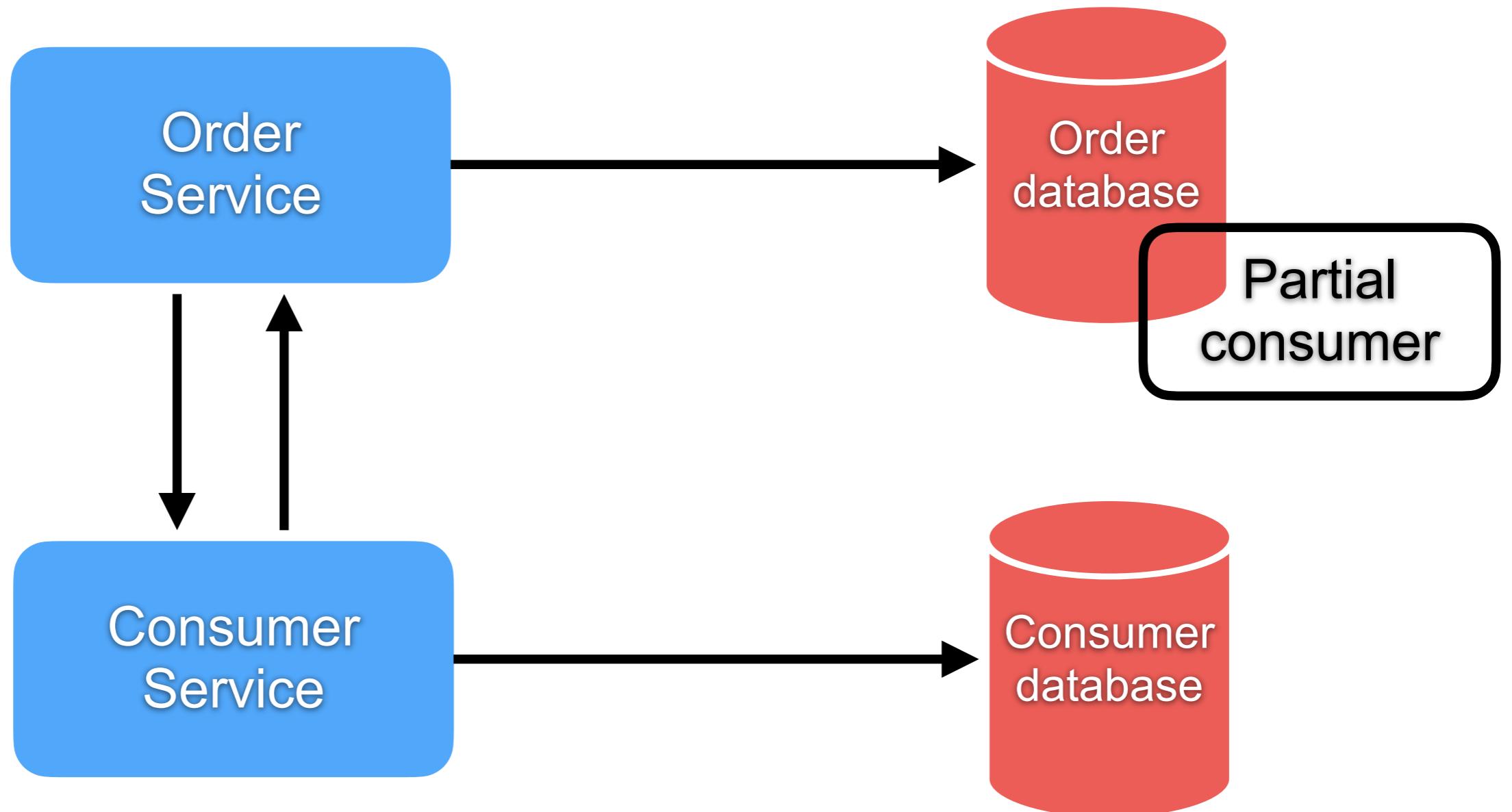
Strong Boundary



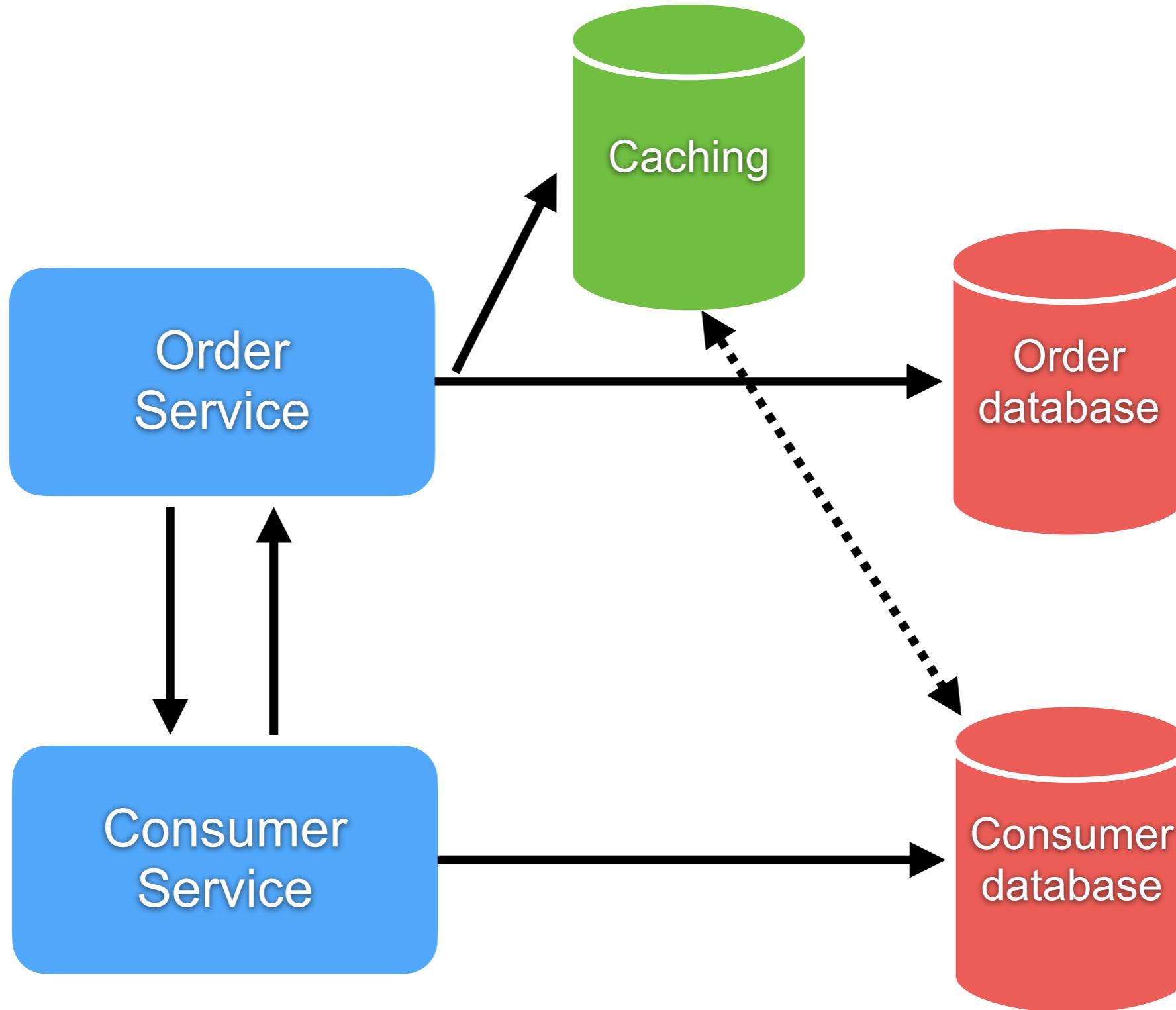
Loose coupling = encapsulation data



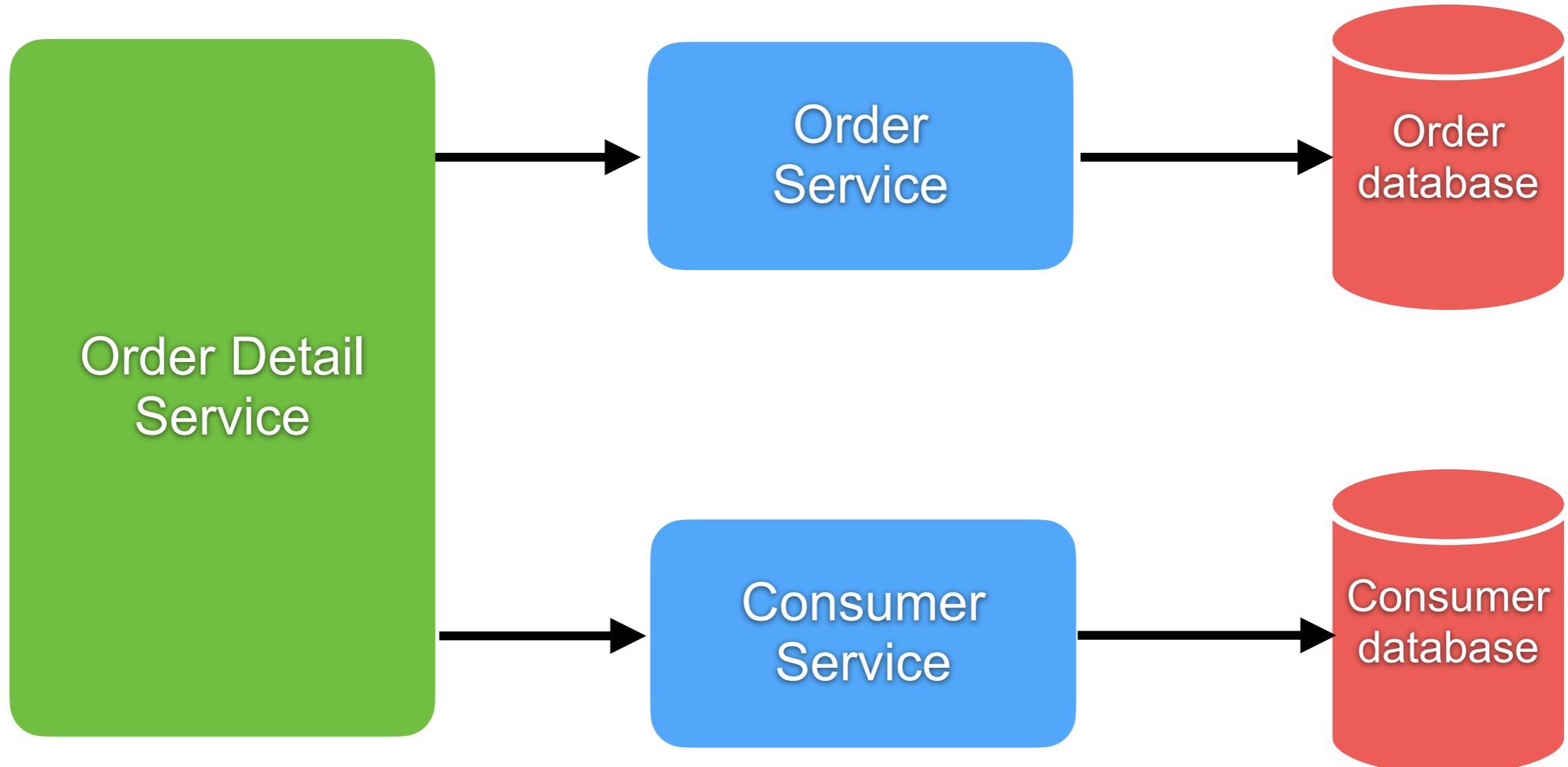
Store partial data



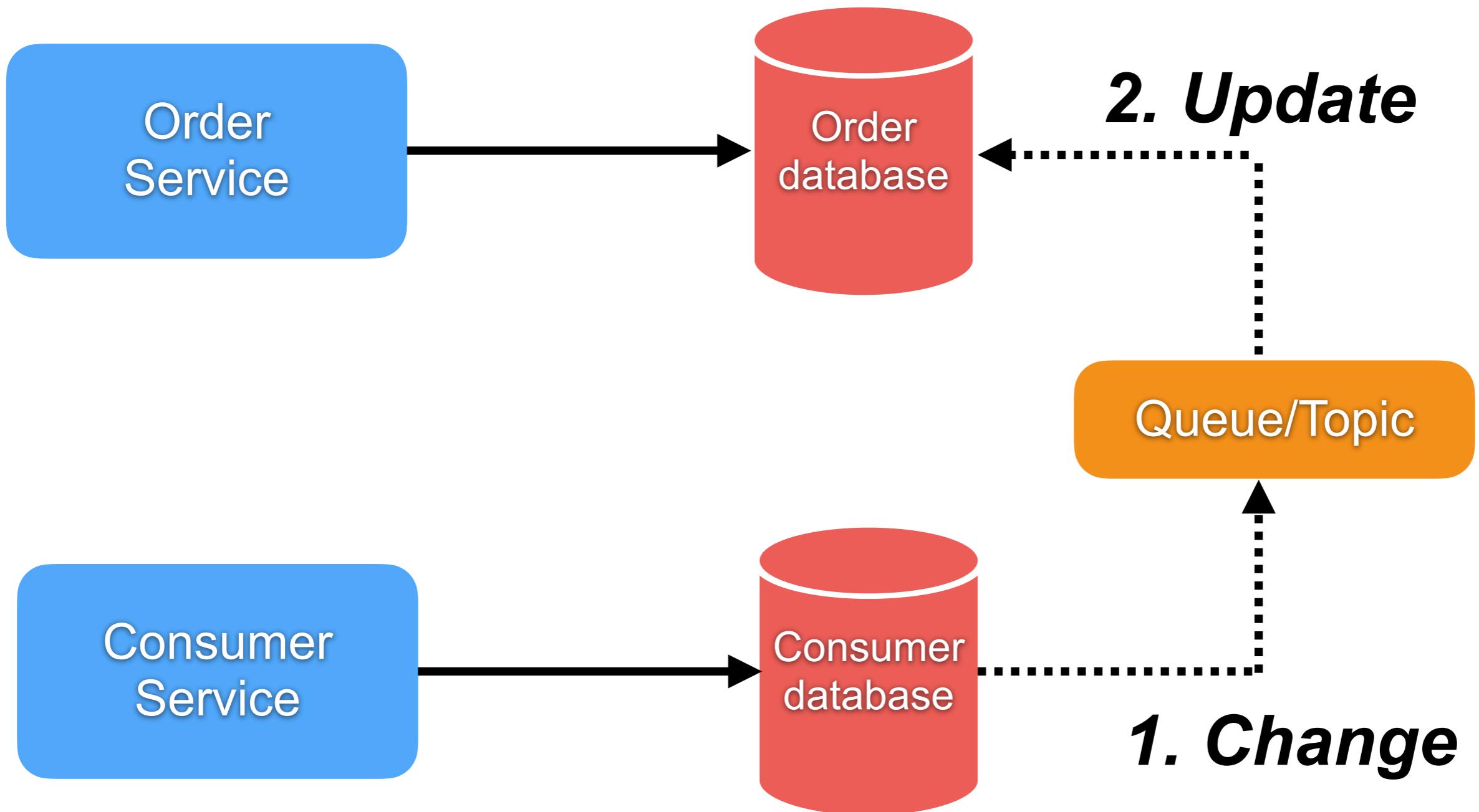
Caching data



Order detail orchestration service



Use messaging to shared data



Database per service

High complexity

Query data across multiple databases

Challenge “How to join data ?”

Maintain database consistency

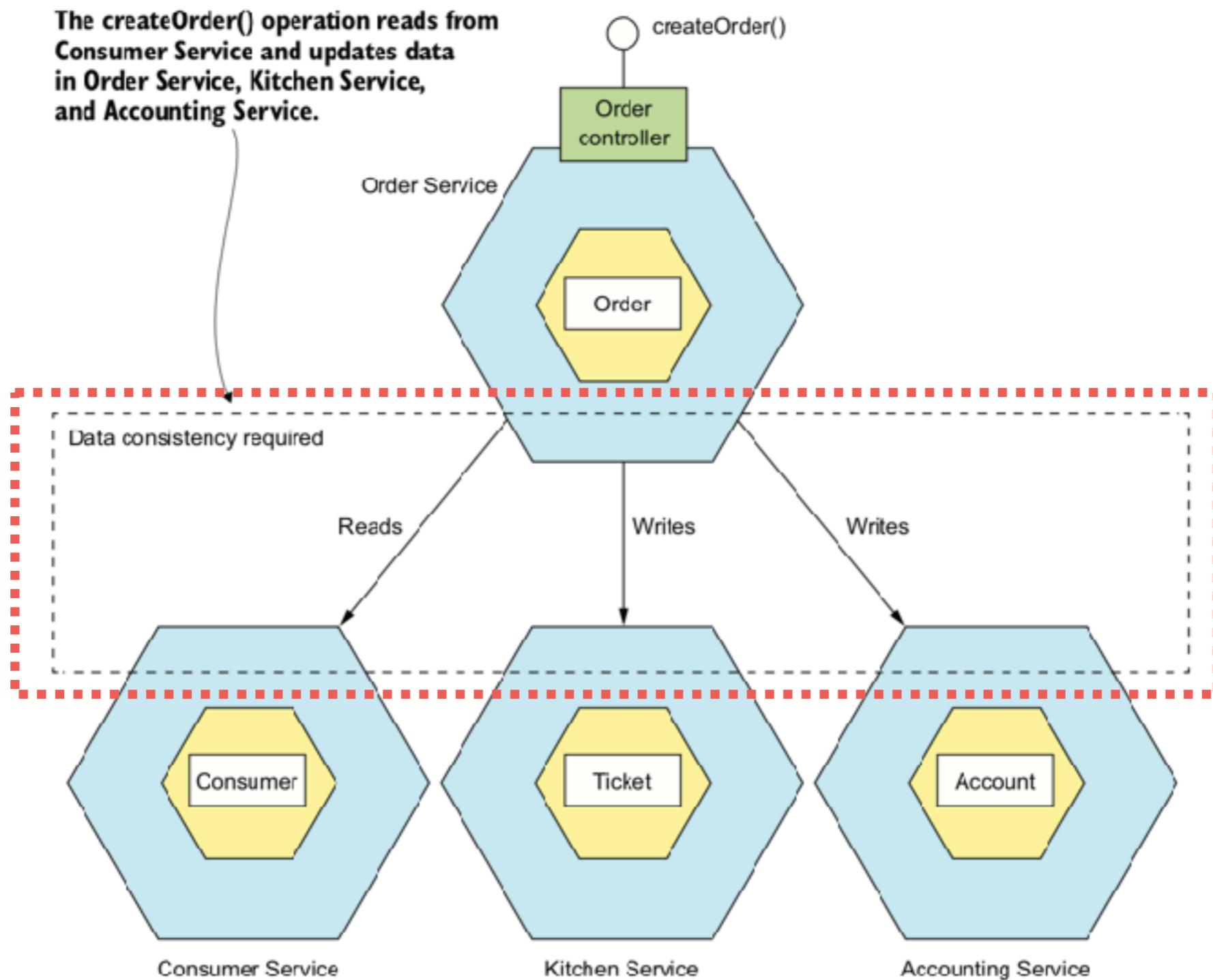


Manage transaction ?

Manage data consistency ?



Distributed process failure !!



Can't use **ACID** transaction !!



A - Atomicity

All or Nothing Transactions

C - Consistency

Guarantees Committed Transaction State

I - Isolation

Transactions are Independent

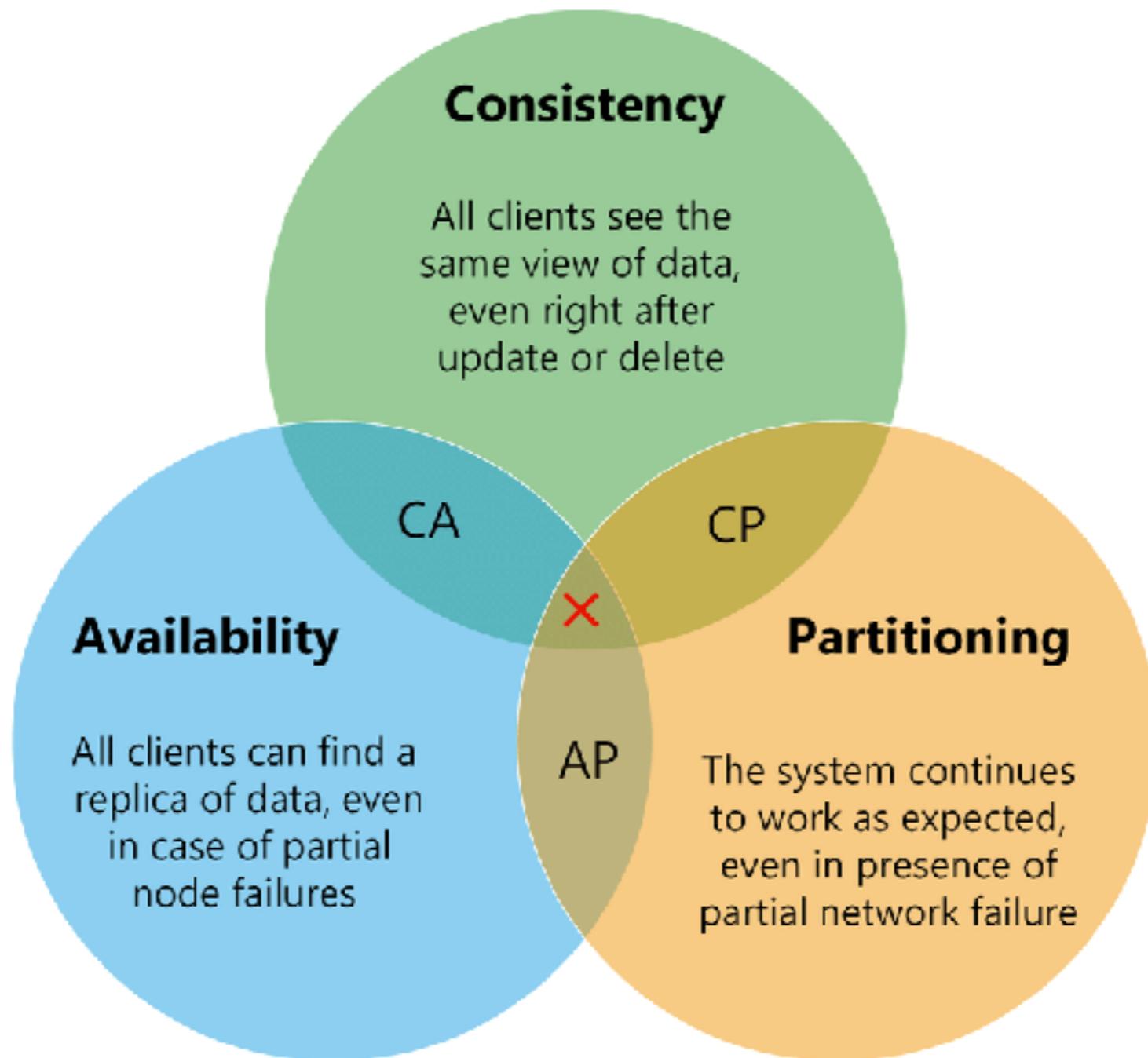
D – Durability

Committed Data is Never Lost

(c) <http://blog.sqlauthority.com>



CAP Theorem



BASE

Basic Available
Soft state
Eventually consistent



ACID vs BASE

ACID	BASE
Scale up (vertical)	Scale out (horizontal)
Strong consistency	Weak/Eventual consistency
Isolation	Last write win, availability first
Transaction	Application transaction
Fix schema	Flexible schema
Expensive joins and relations	Free



Distributed transaction

Common approach is Two-phase commit(2PC)

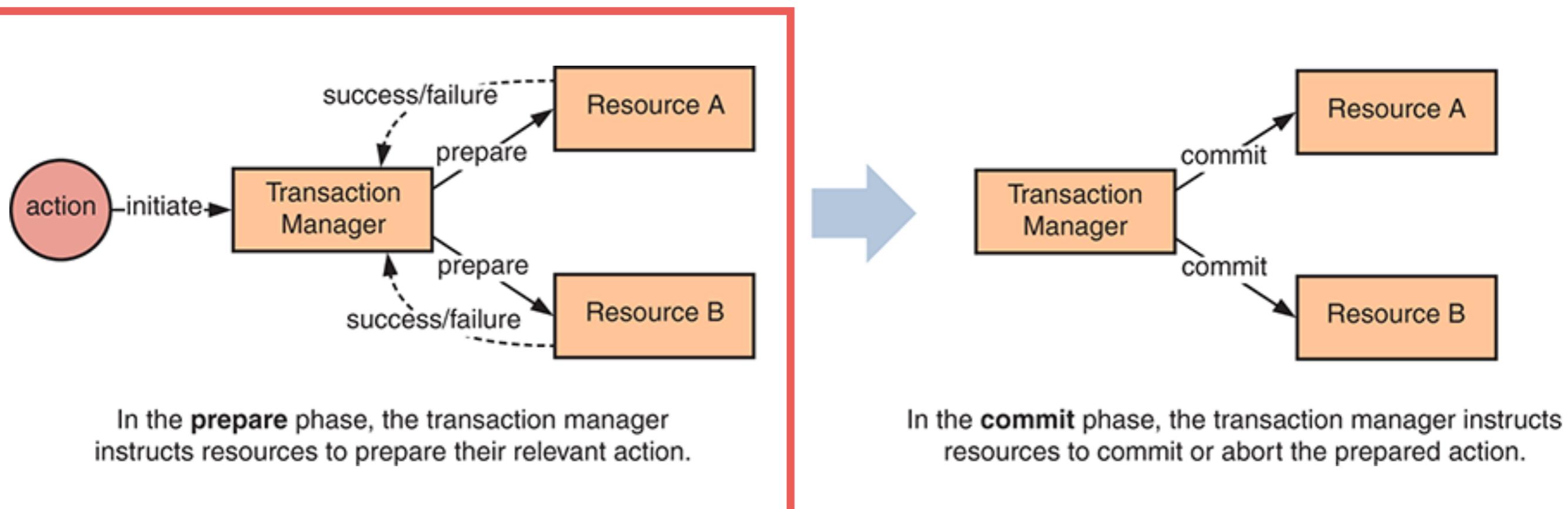
Use transaction manager to split operations across multiple resources in 2 phases

- 1. Prepare*
- 2. Commit*



Two-phase commit

Phase 1: prepare

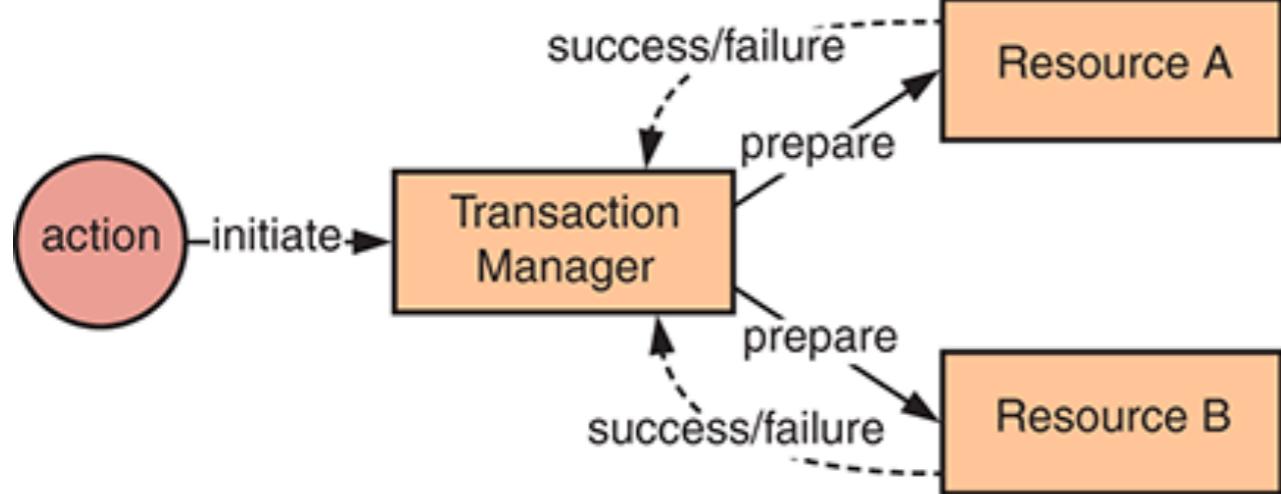


https://en.wikipedia.org/wiki/Two-phase_commit_protocol

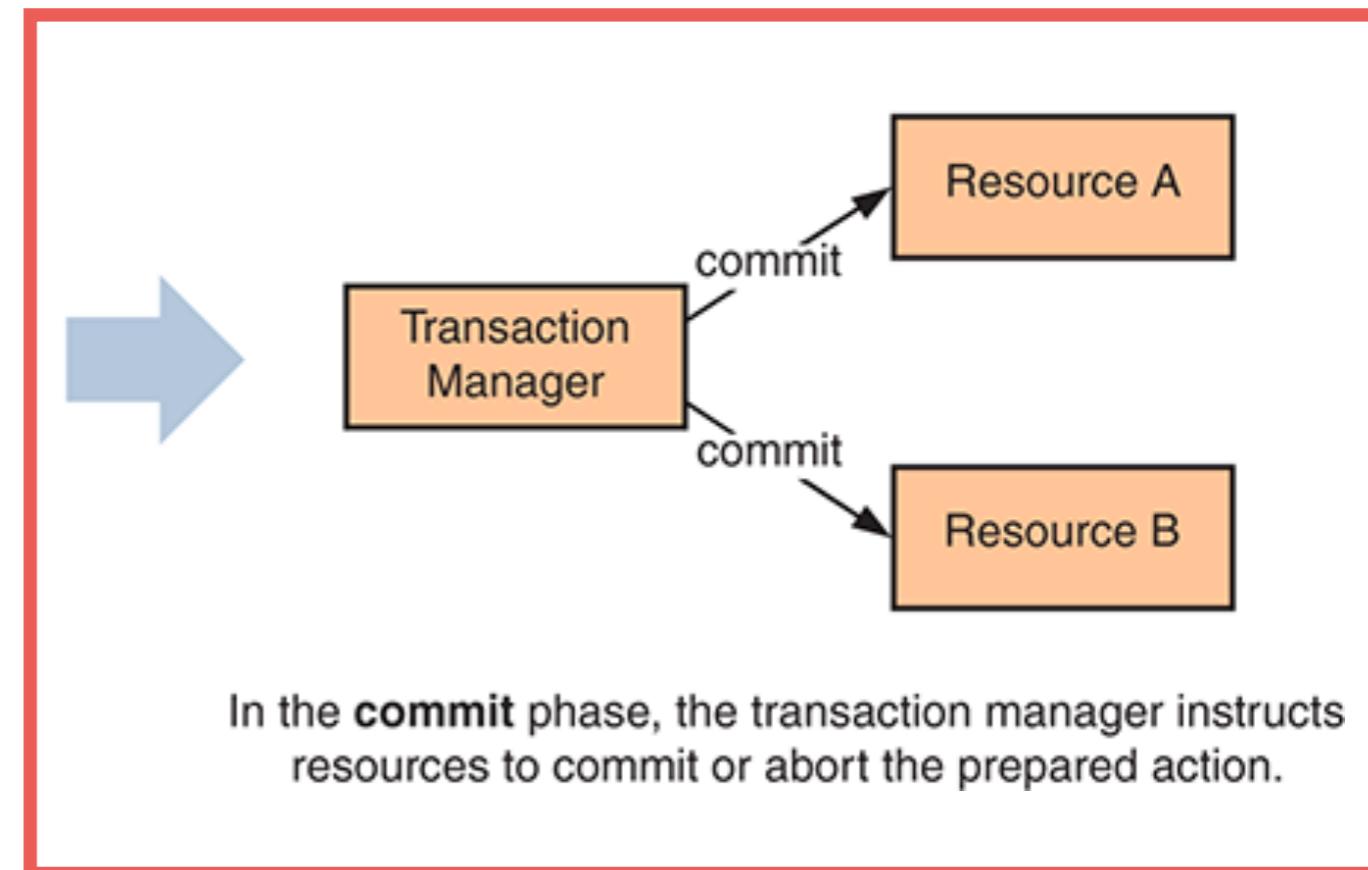


Two-phase commit

Phase 2: commit



In the **prepare** phase, the transaction manager instructs resources to prepare their relevant action.



In the **commit** phase, the transaction manager instructs resources to commit or abort the prepared action.

https://en.wikipedia.org/wiki/Two-phase_commit_protocol



**Distributed transaction places
a lock on resources under
transaction to ensure isolation**



Inappropriate for long-running operations



Increase risk of contention and deadlock

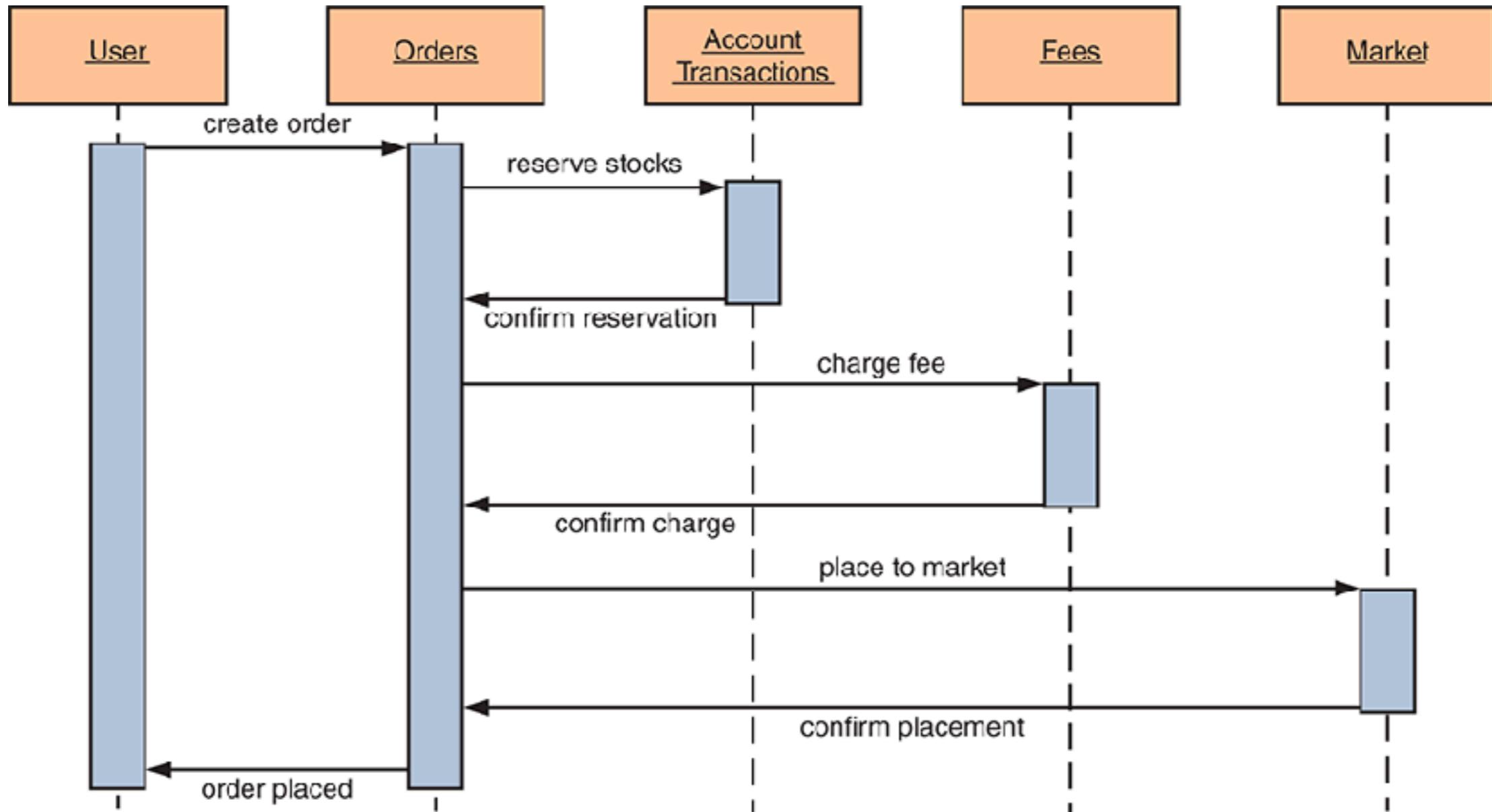


We need ...

Don't need distributed transaction
Reduce complexity of code
Reliable



Synchronous process

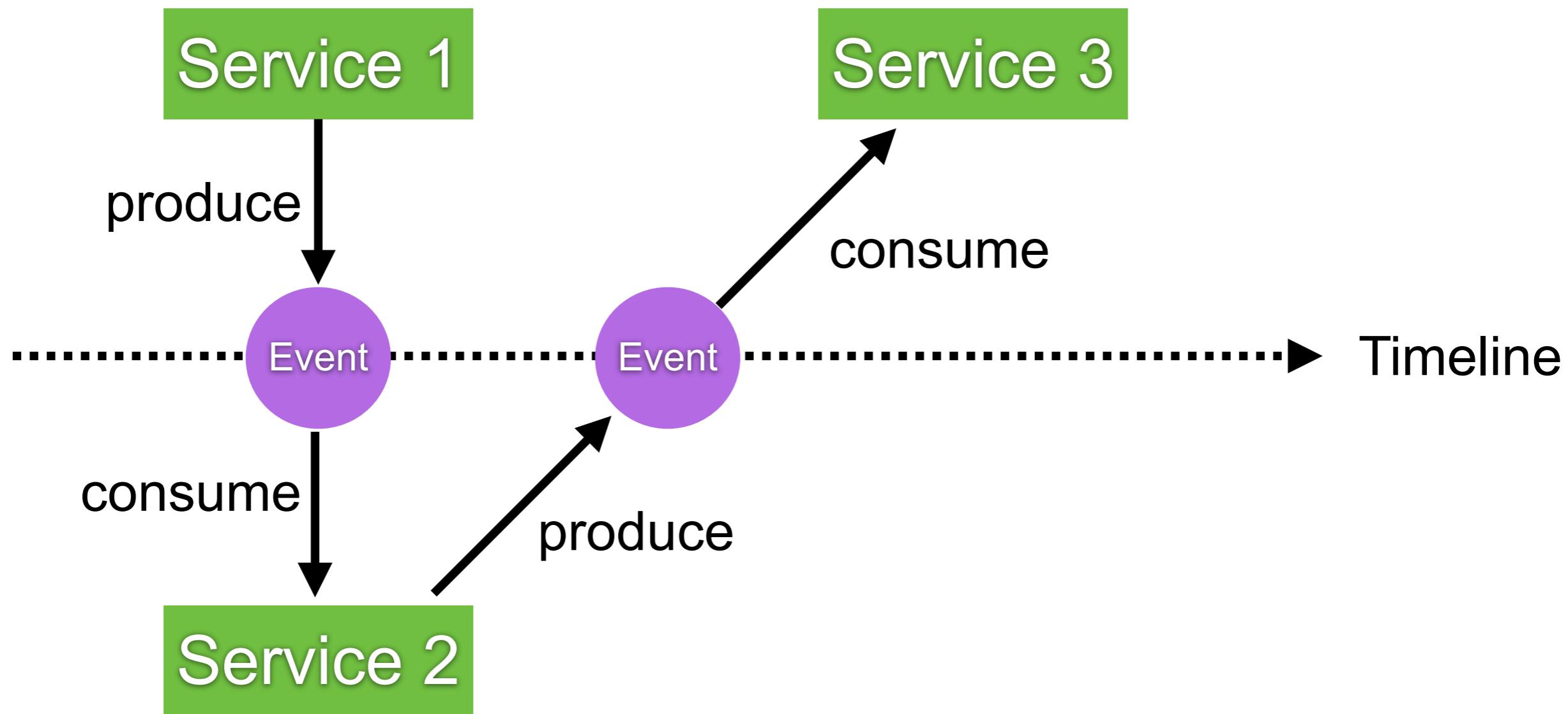


Event-Driven Architecture (EDA)



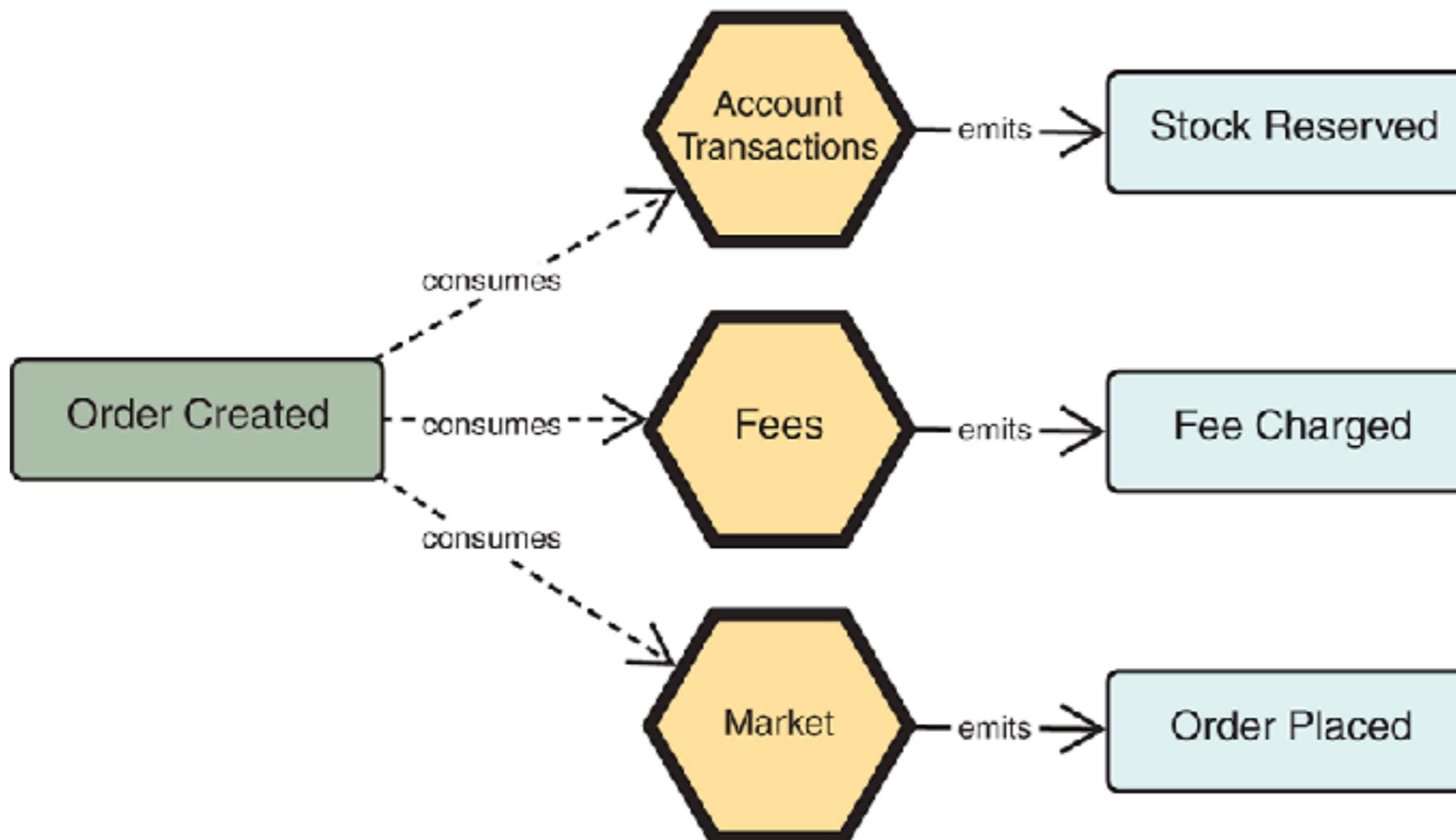
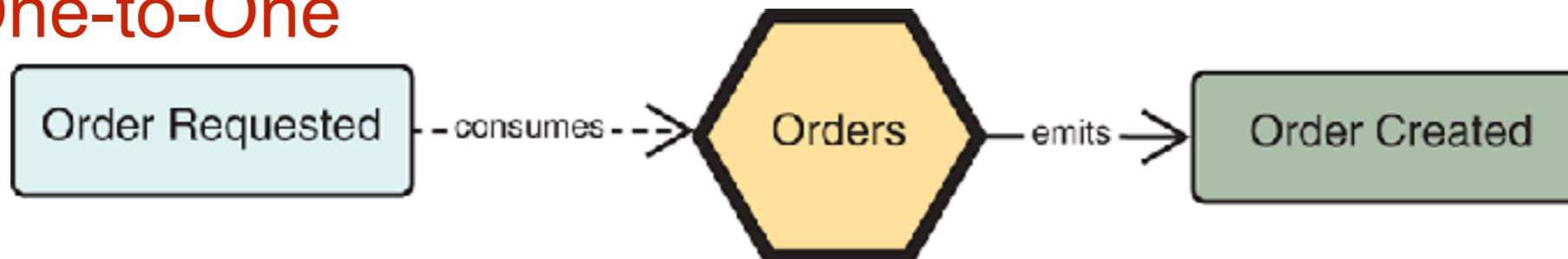
Choreography pattern

Sequence of Tx and emit **event** or **message** that trigger the next process in Tx

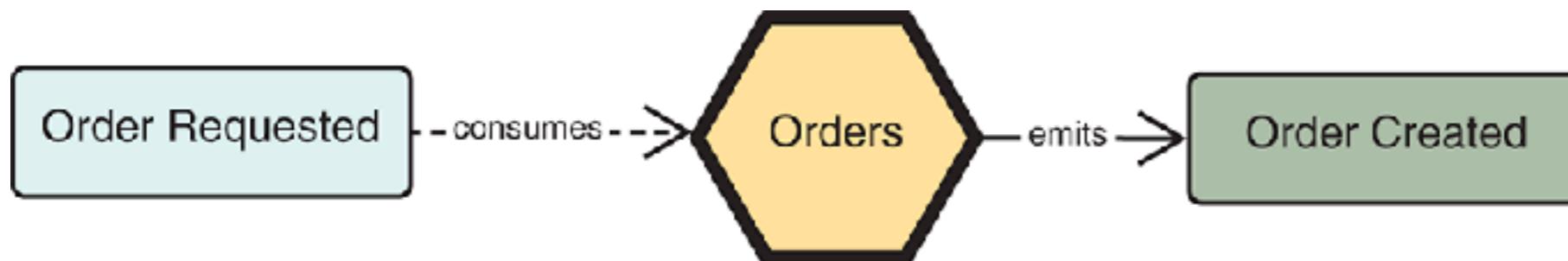


Service consume and emit event

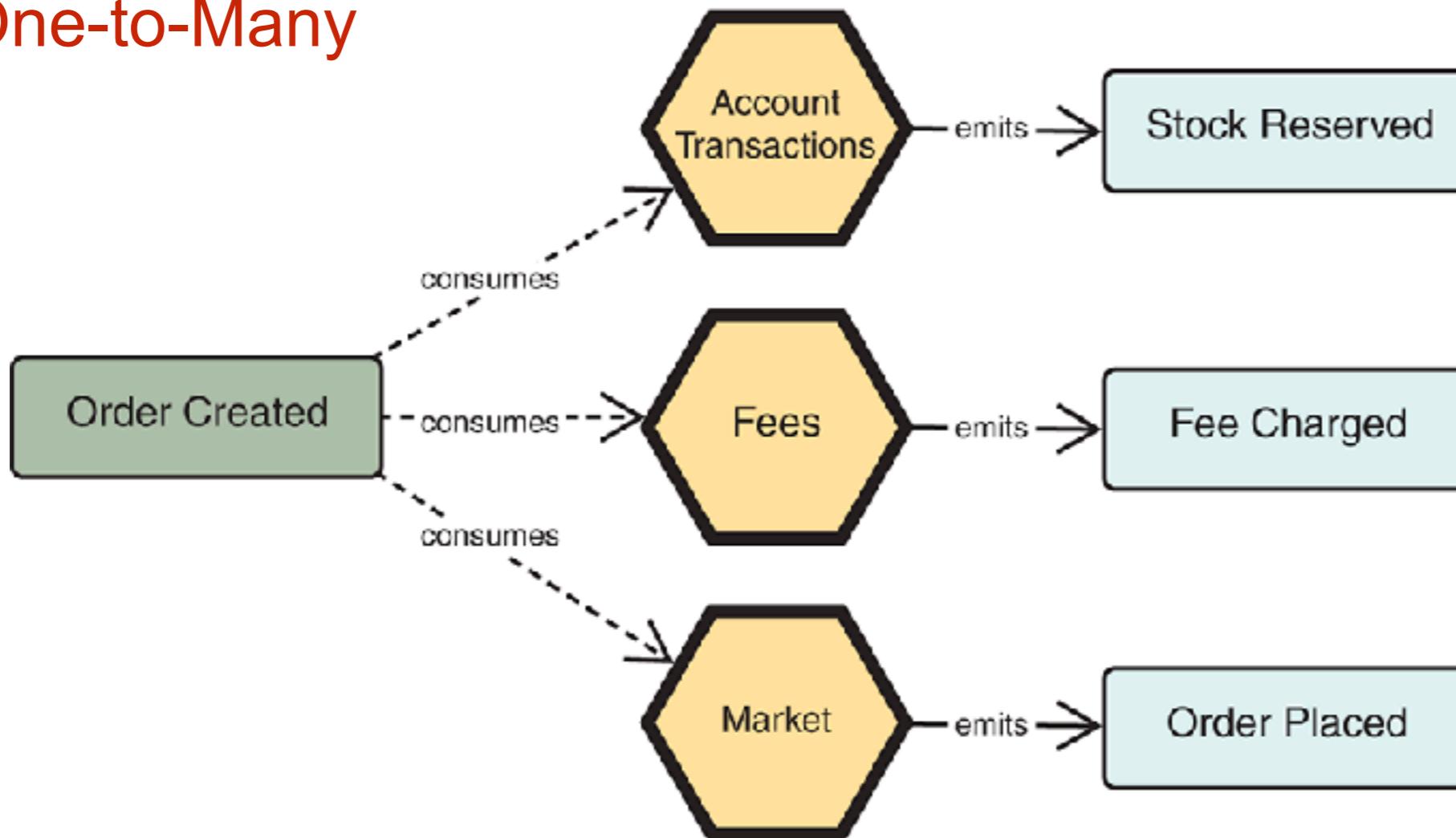
One-to-One



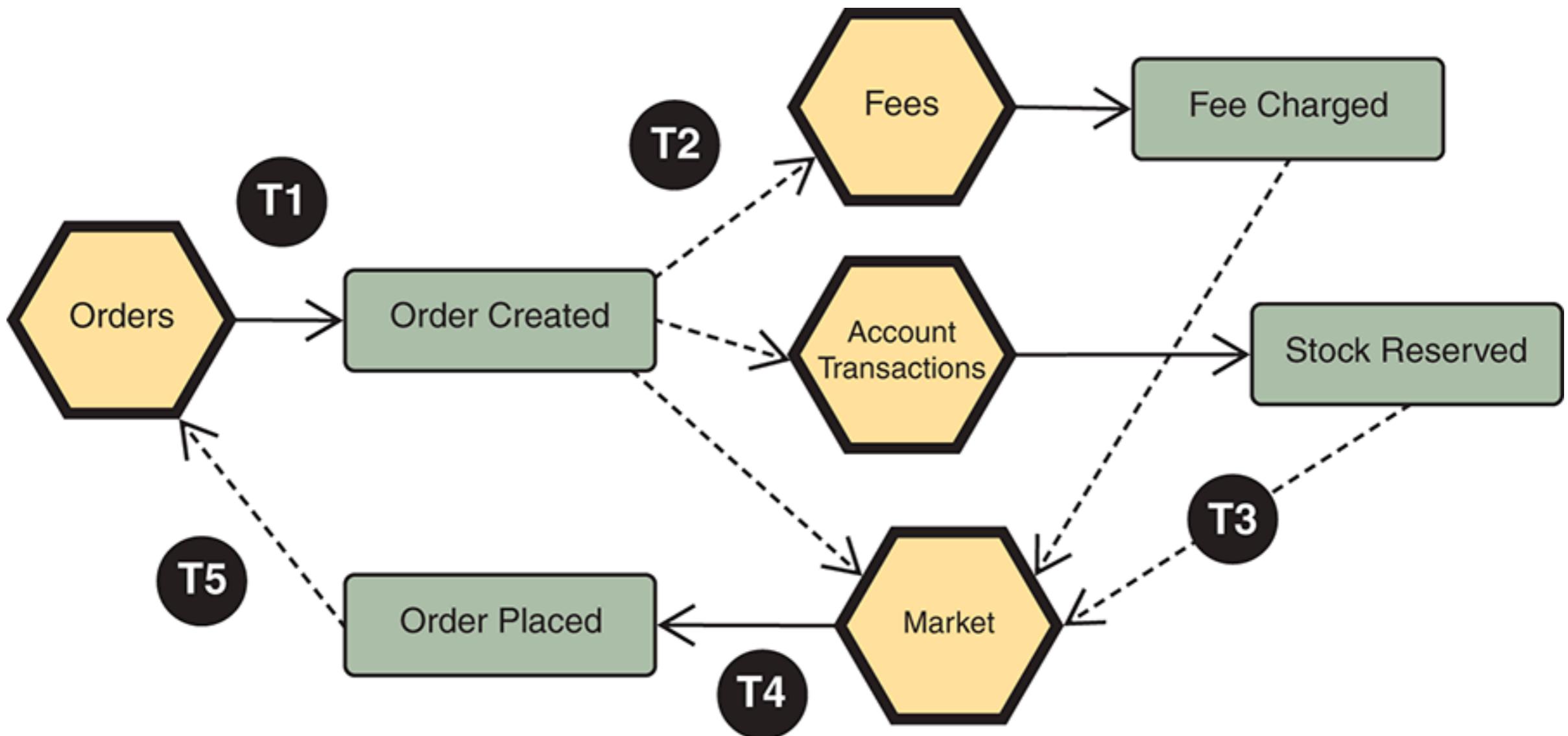
Service consume and emit event



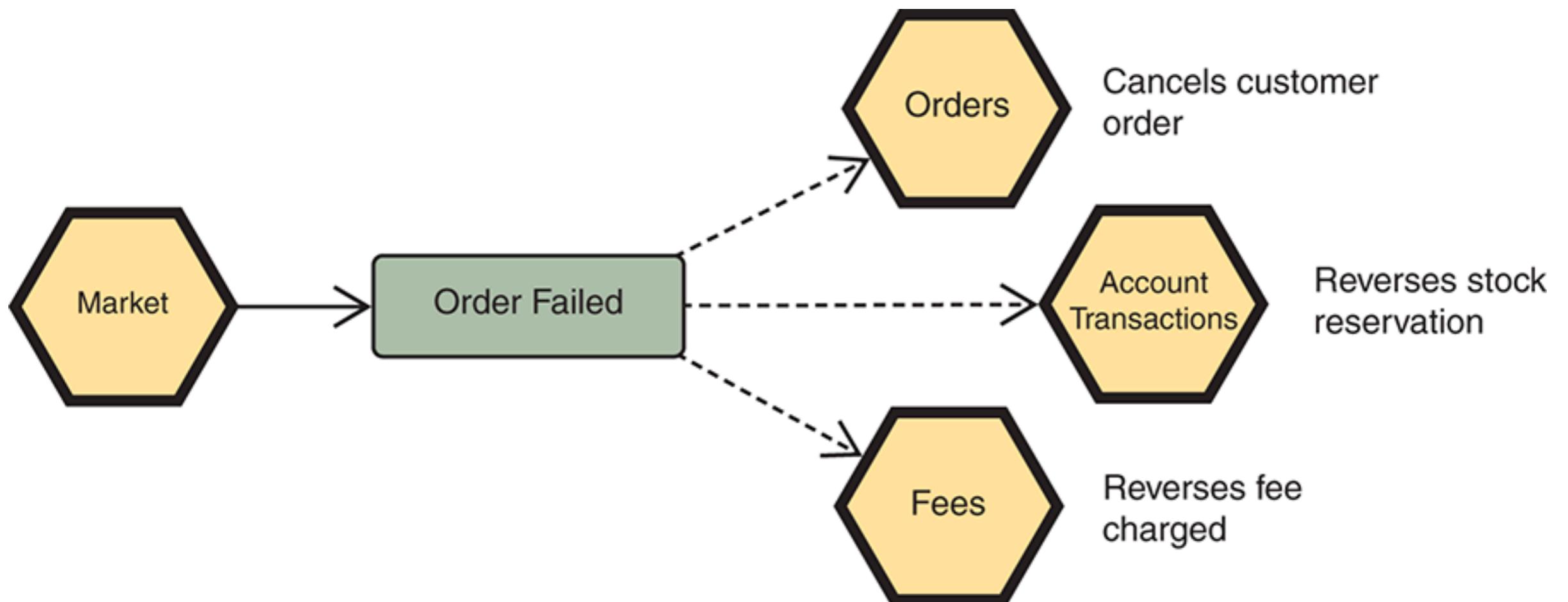
One-to-Many



Example (Success)

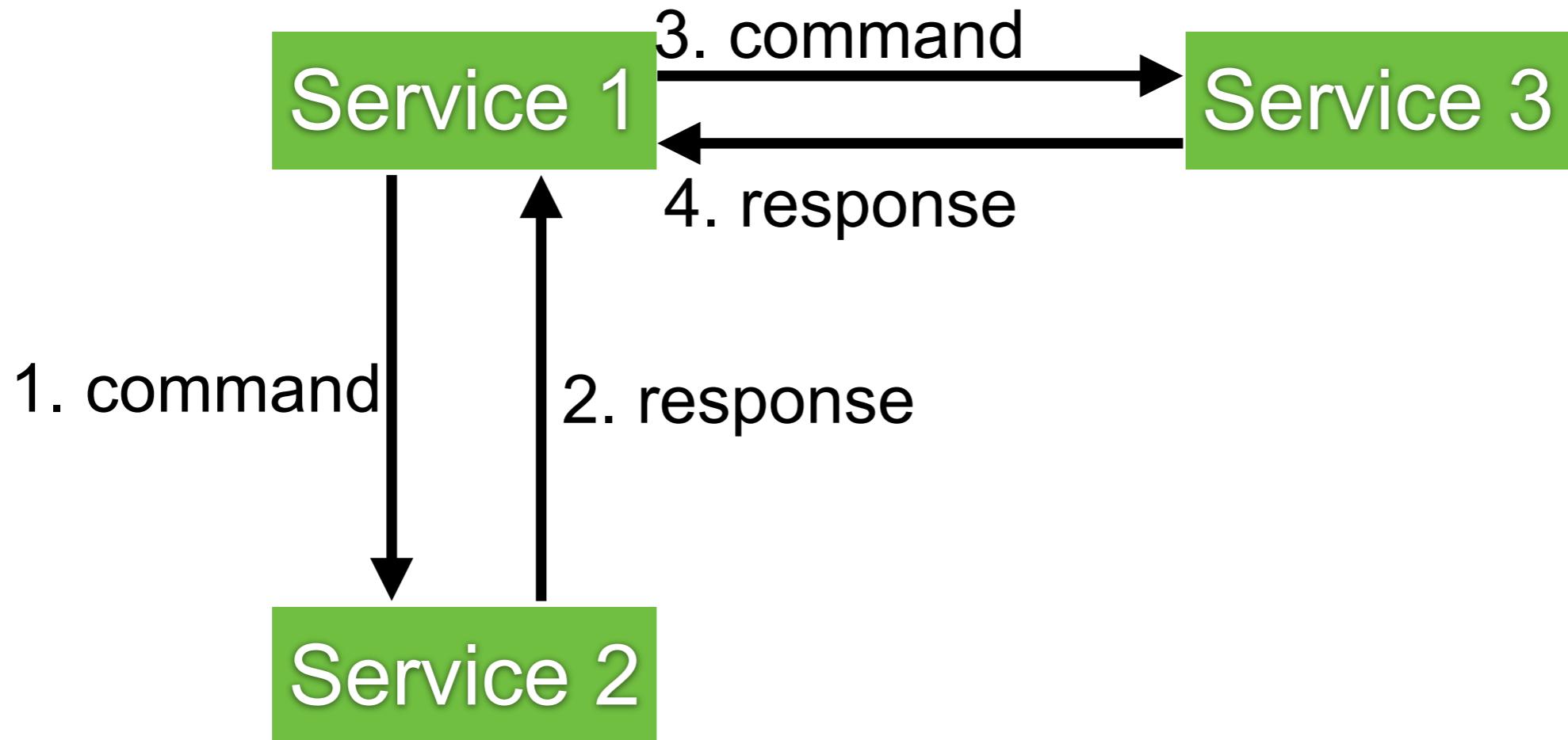


Example (Fail)

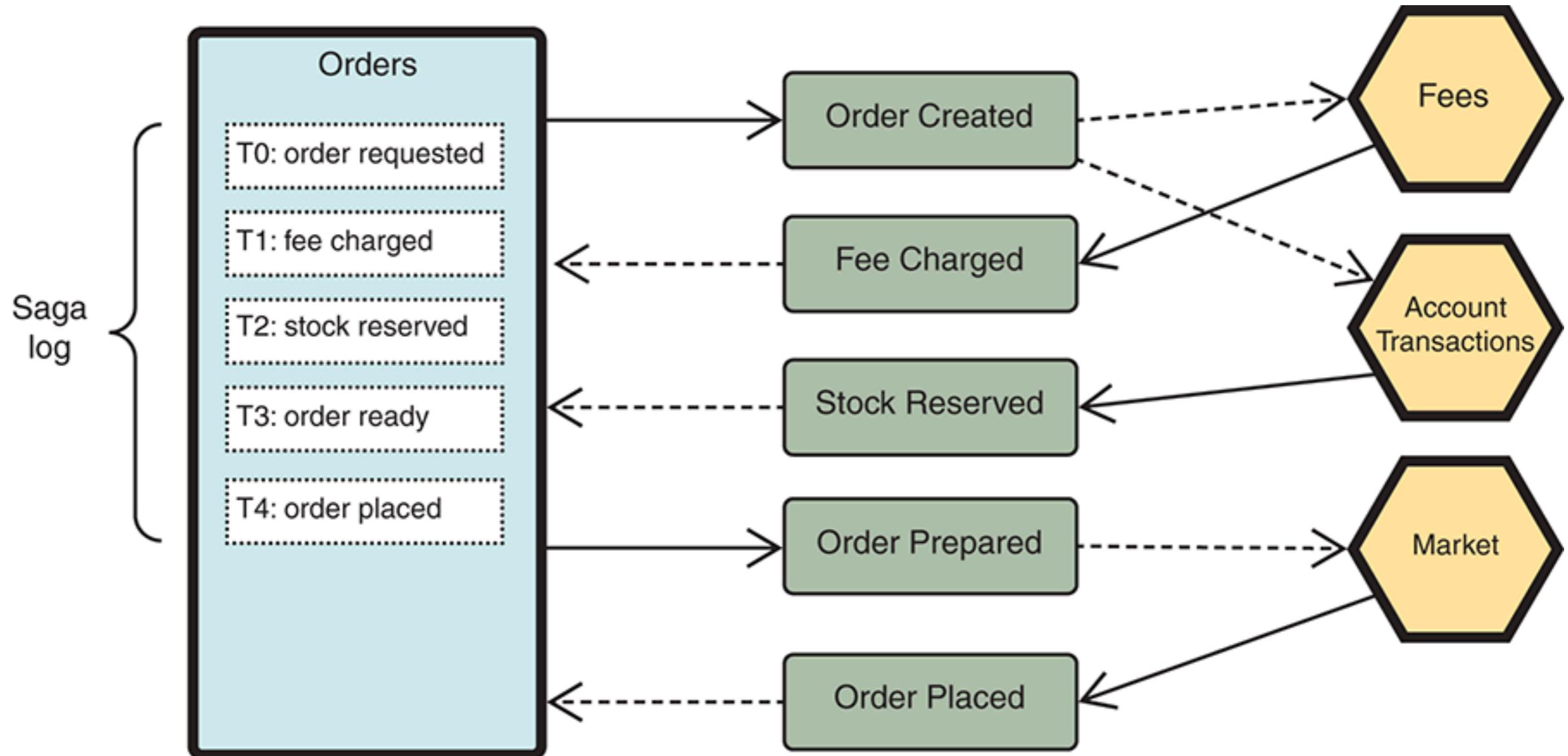


Orchestrate pattern

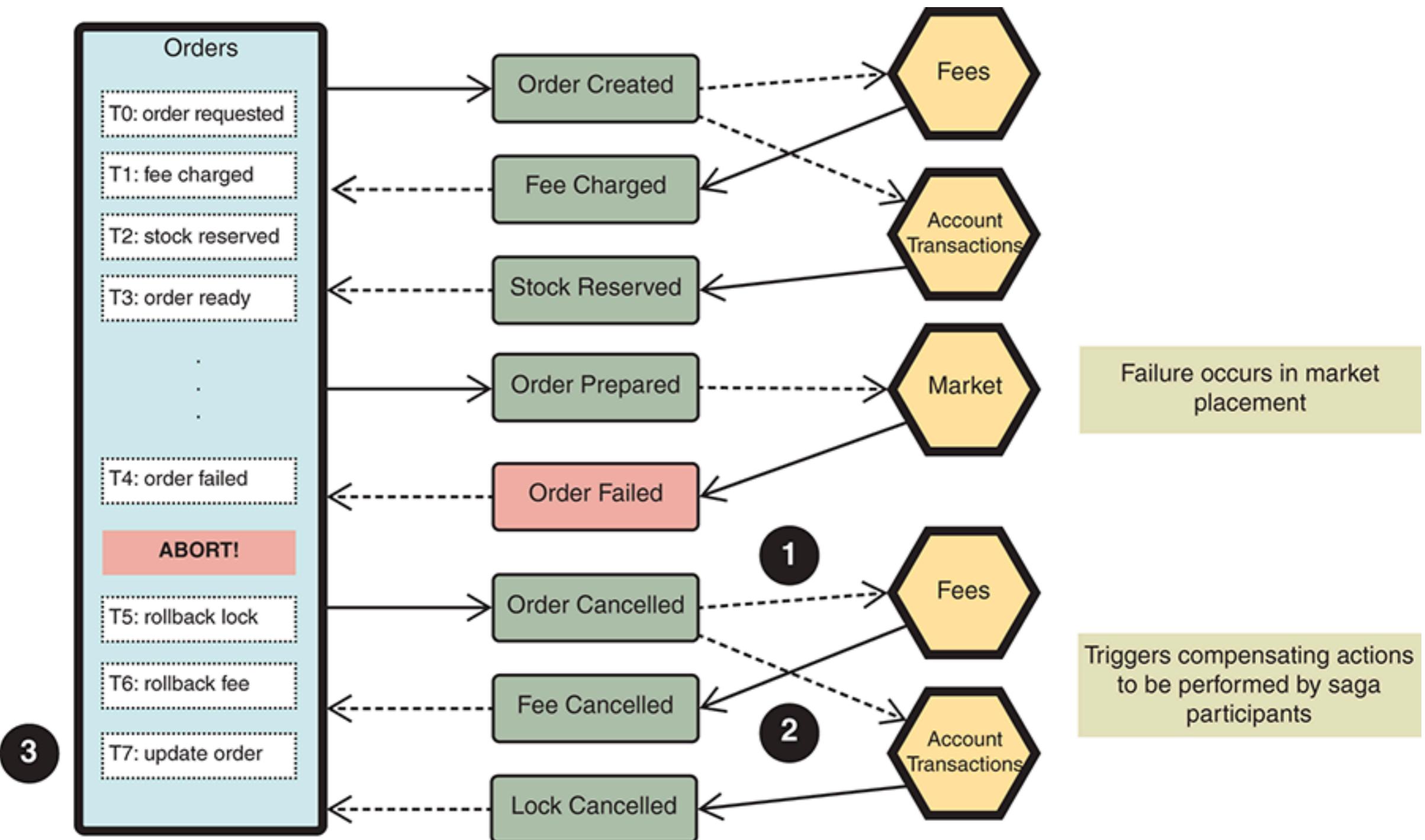
Sequence of Tx and emit **event** or **message** that trigger the next process in Tx



Example (Success)



Example (Fail)



Consistency patterns

Name	Strategy
Compensating action	Perform action that undo prior action(s)
Retry	Retry until success or timeout
Ignore	Do nothing in the event of errors
Restart	Reset to the original state and start again
Tentative operation	Perform a tentative operation and confirm (or cancel) later



“Saga”



Message vs Event

Message is addressed to someone

Event is something that happen and someone can react to that



Event sourcing

Maintain source of truth of business
Immutable sequence of events

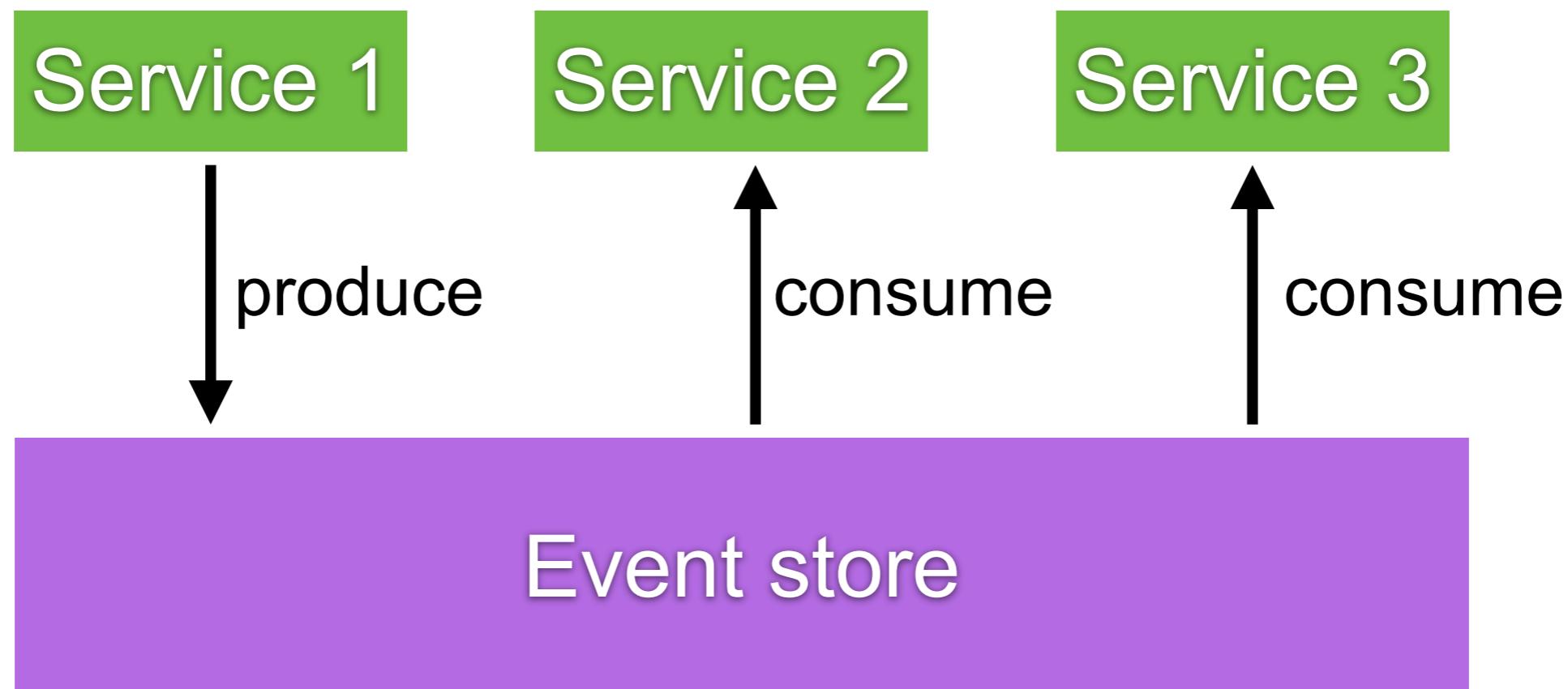


Sequence of event is keep in **Event store**



Event store

Keep events in order
Broadcast new event

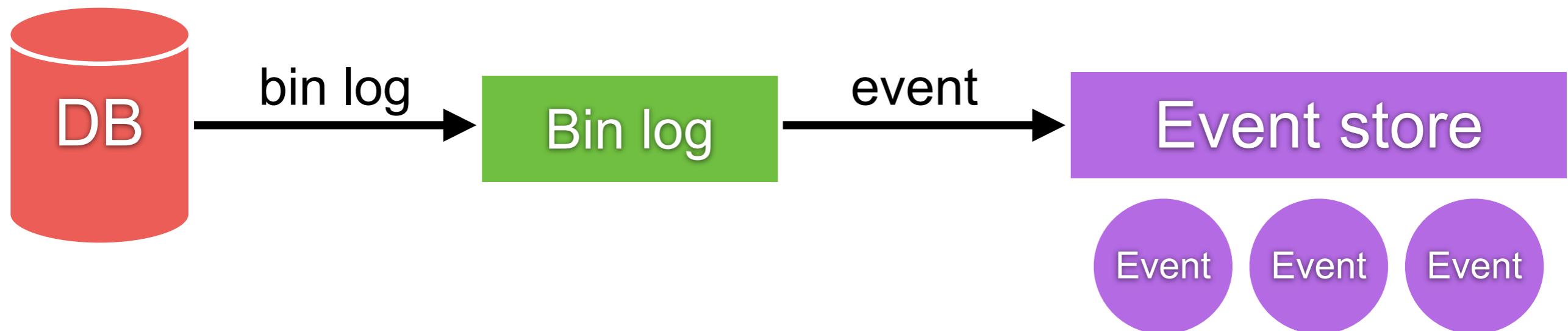


**With Event sourcing, we can
decouple services (query and
command)**



Event sourcing with database

Working with database



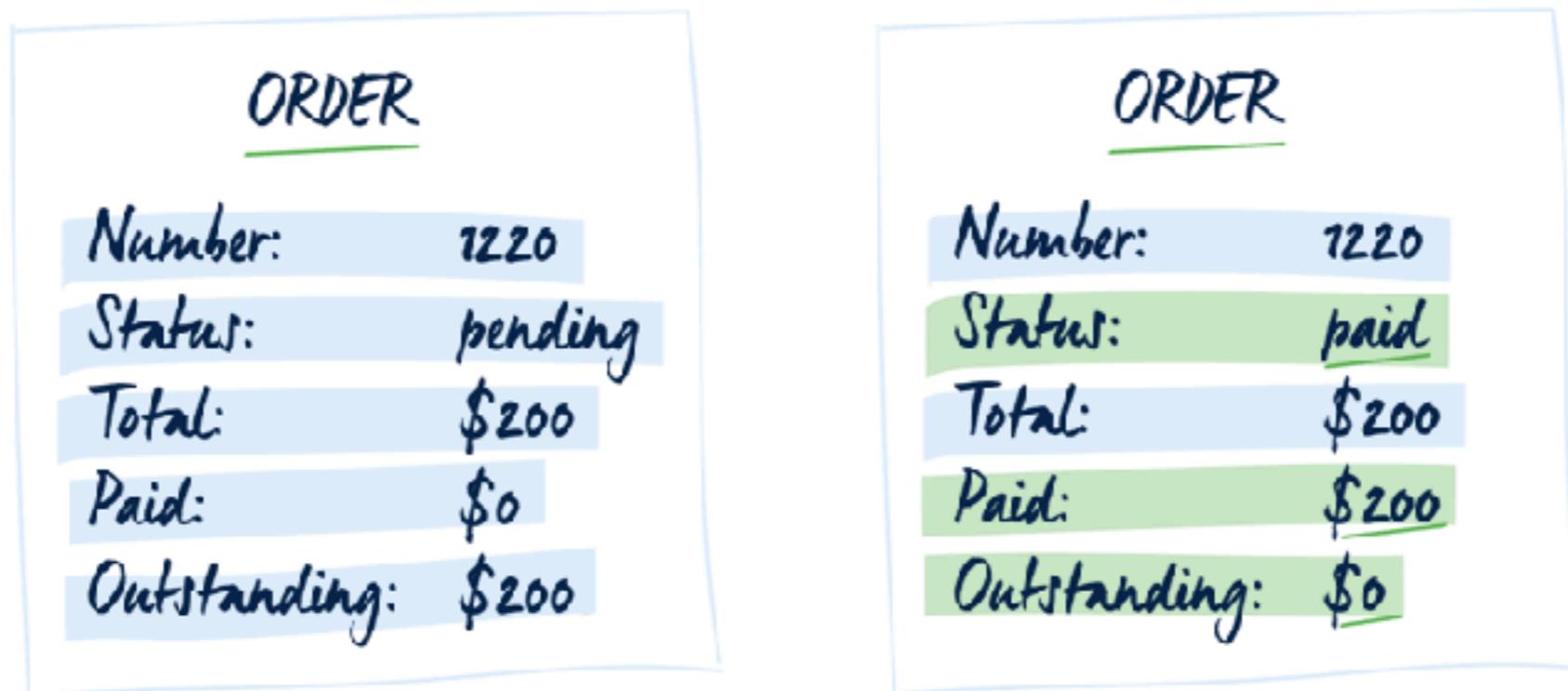
Binlog or Binary log event is information about data modification made to database



Example of Events



Order payment



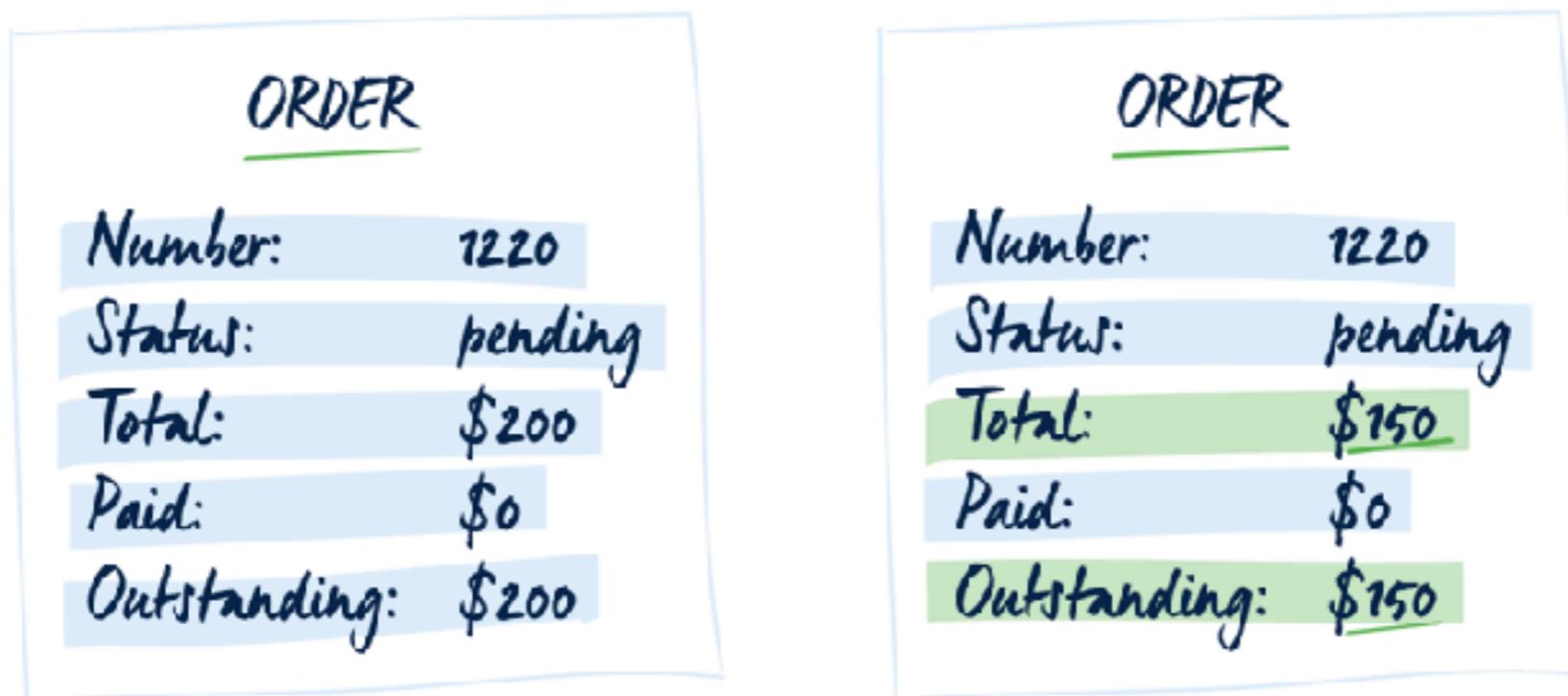
Order Payment Received

Order number: 1220
Payment amount: 200
Currency: USD

<https://www.eventstore.com/event-sourcing>



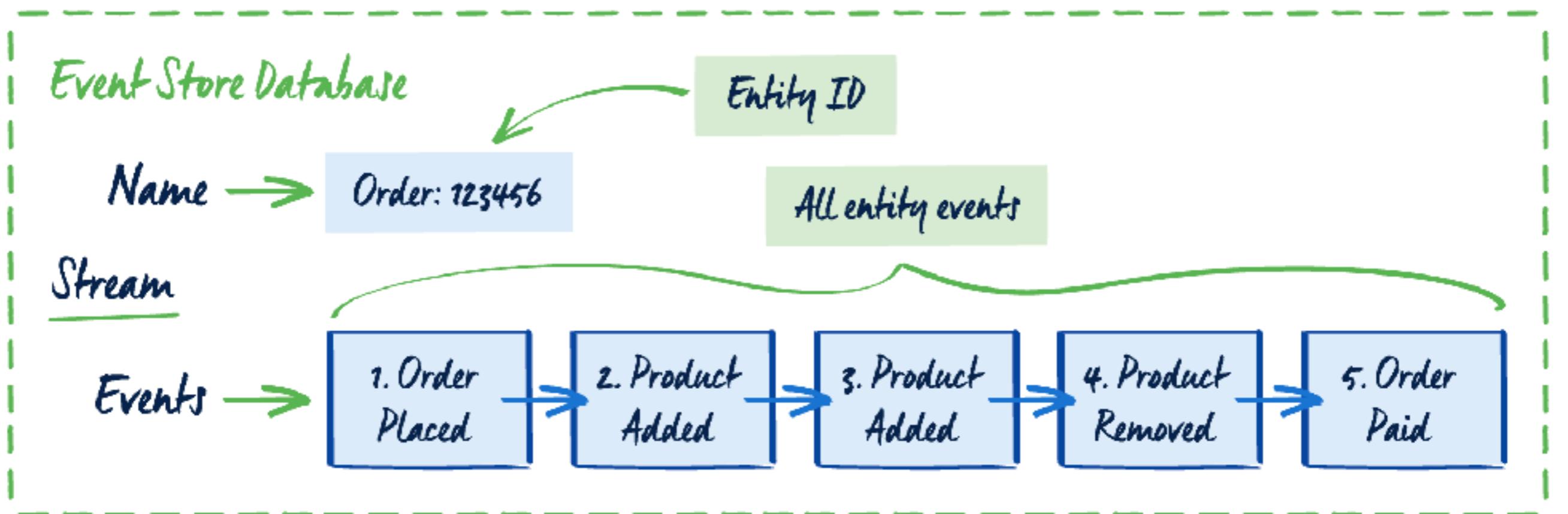
Apply discount



<https://www.eventstore.com/event-sourcing>



Event sourcing



<https://www.eventstore.com/event-sourcing>



How to implement queries data ?



Query data from multiple services

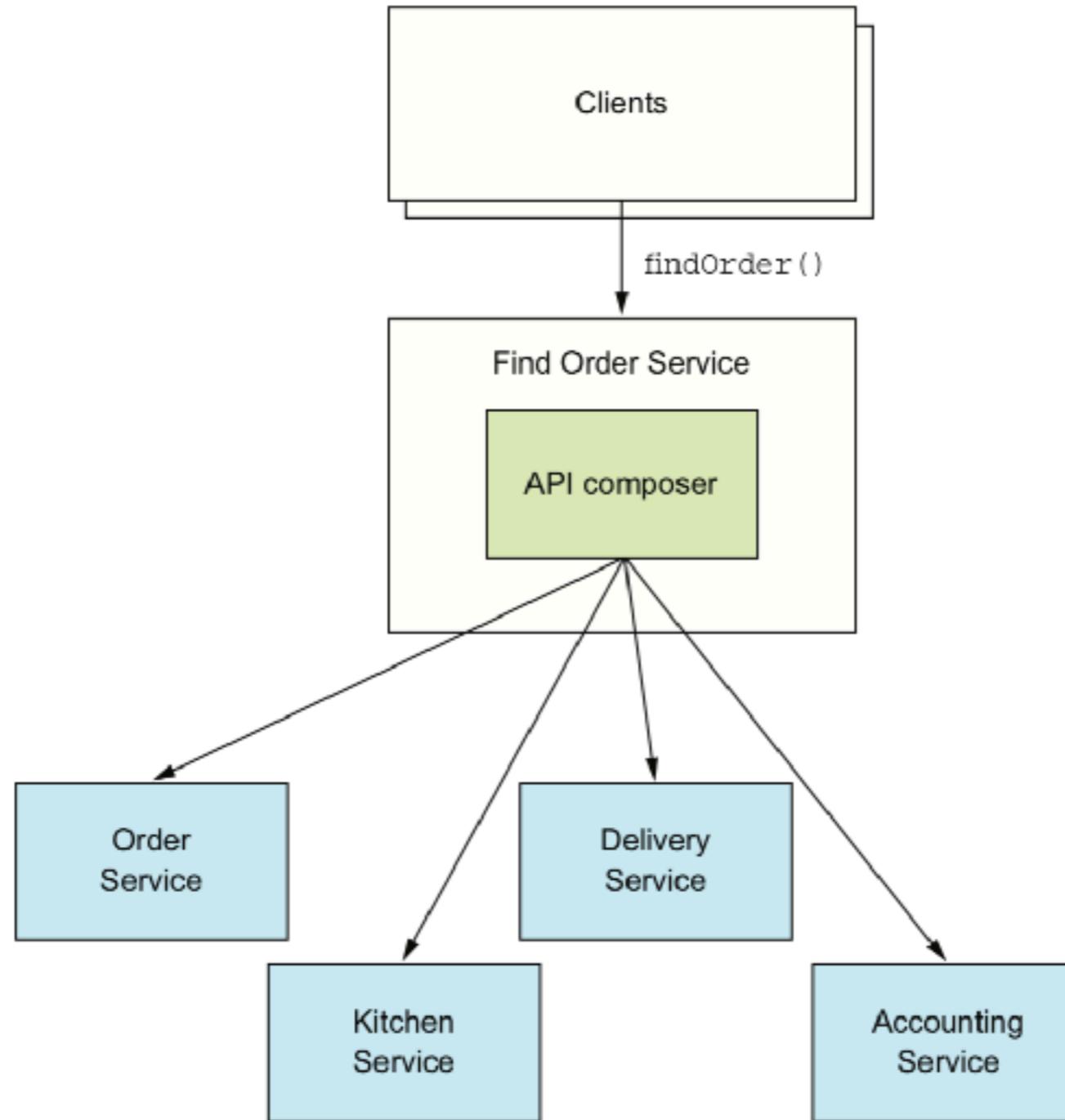
API composition

Cold data from services

CQRS (Command Query Responsibility Segregation)



API composition pattern



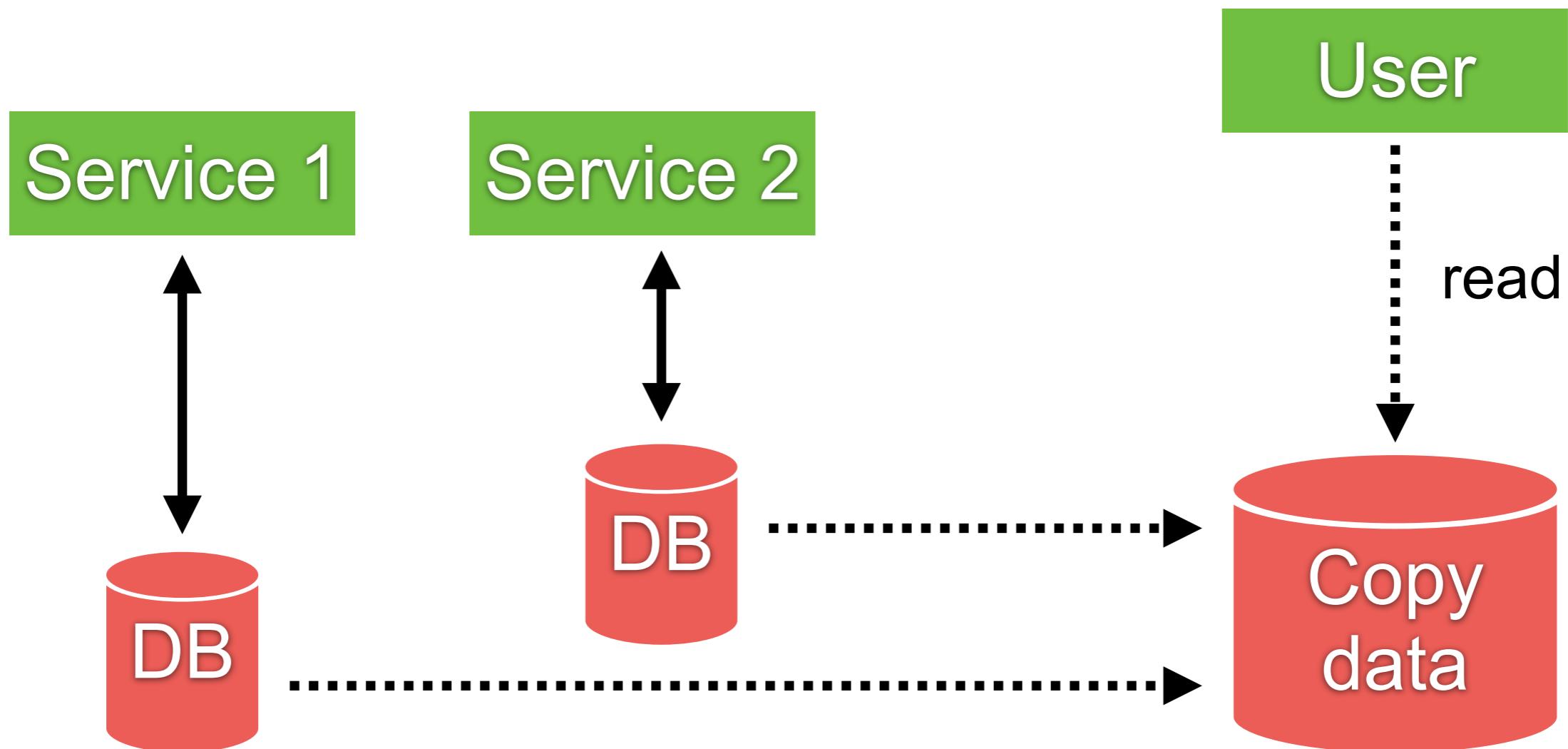
Drawbacks

Increase overhead
Lack of transactional data consistency
Reduce availability



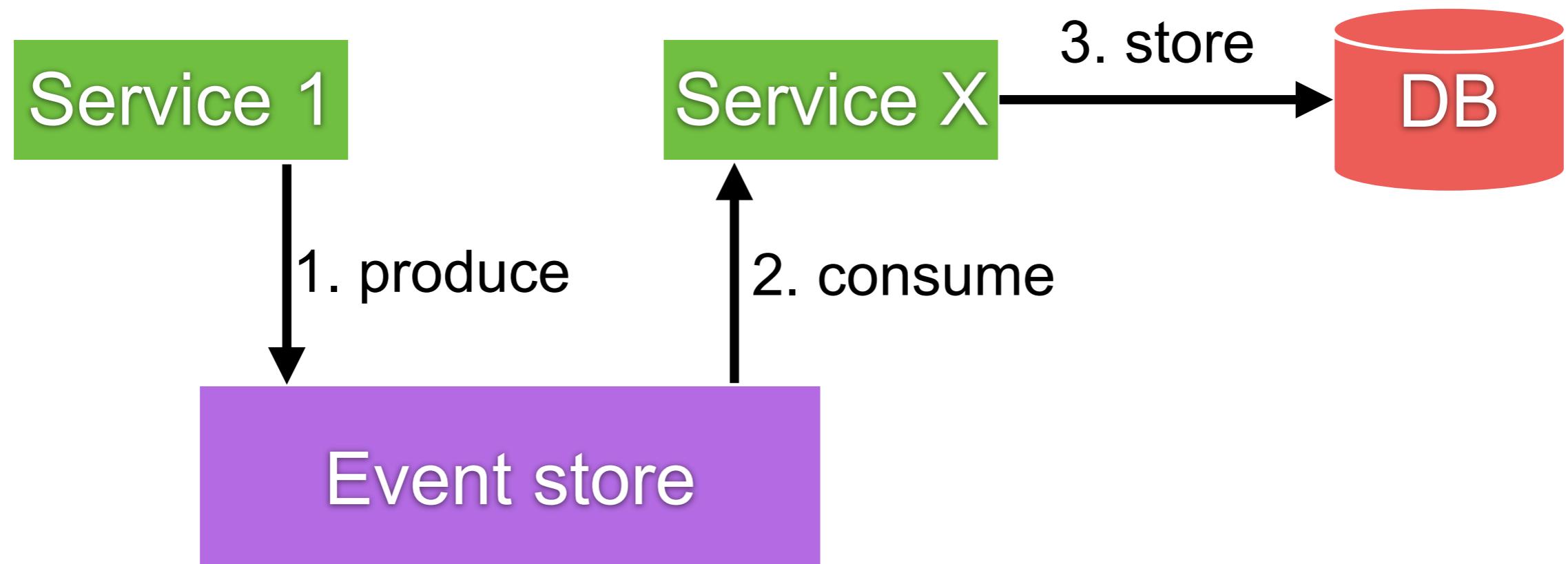
Storing copy data

Copy or caching data to other database



Working with Event-based

Publish event to store copy data

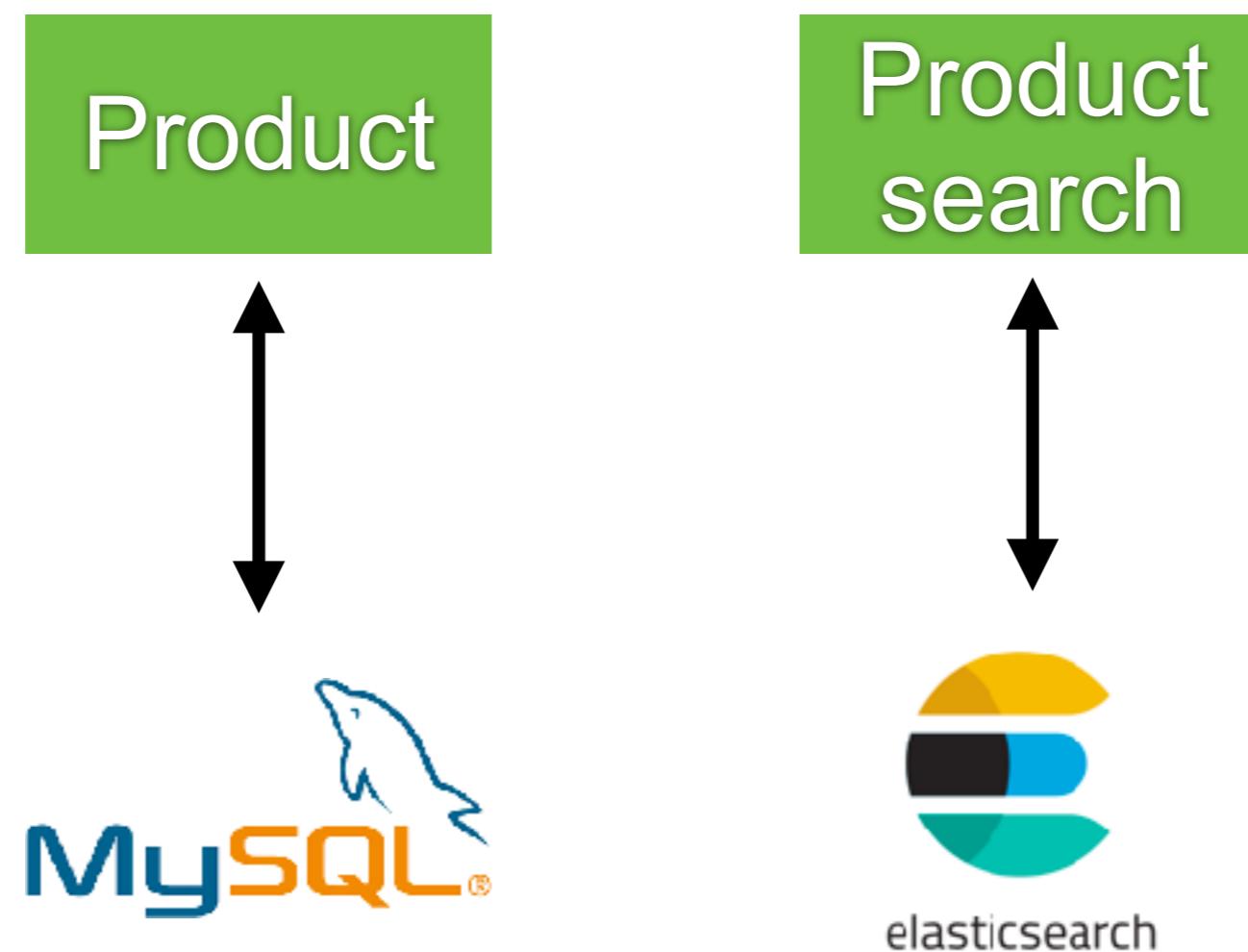


Separate query and command



Separate data for read and write

For example MySQL to write, Elasticsearch to search

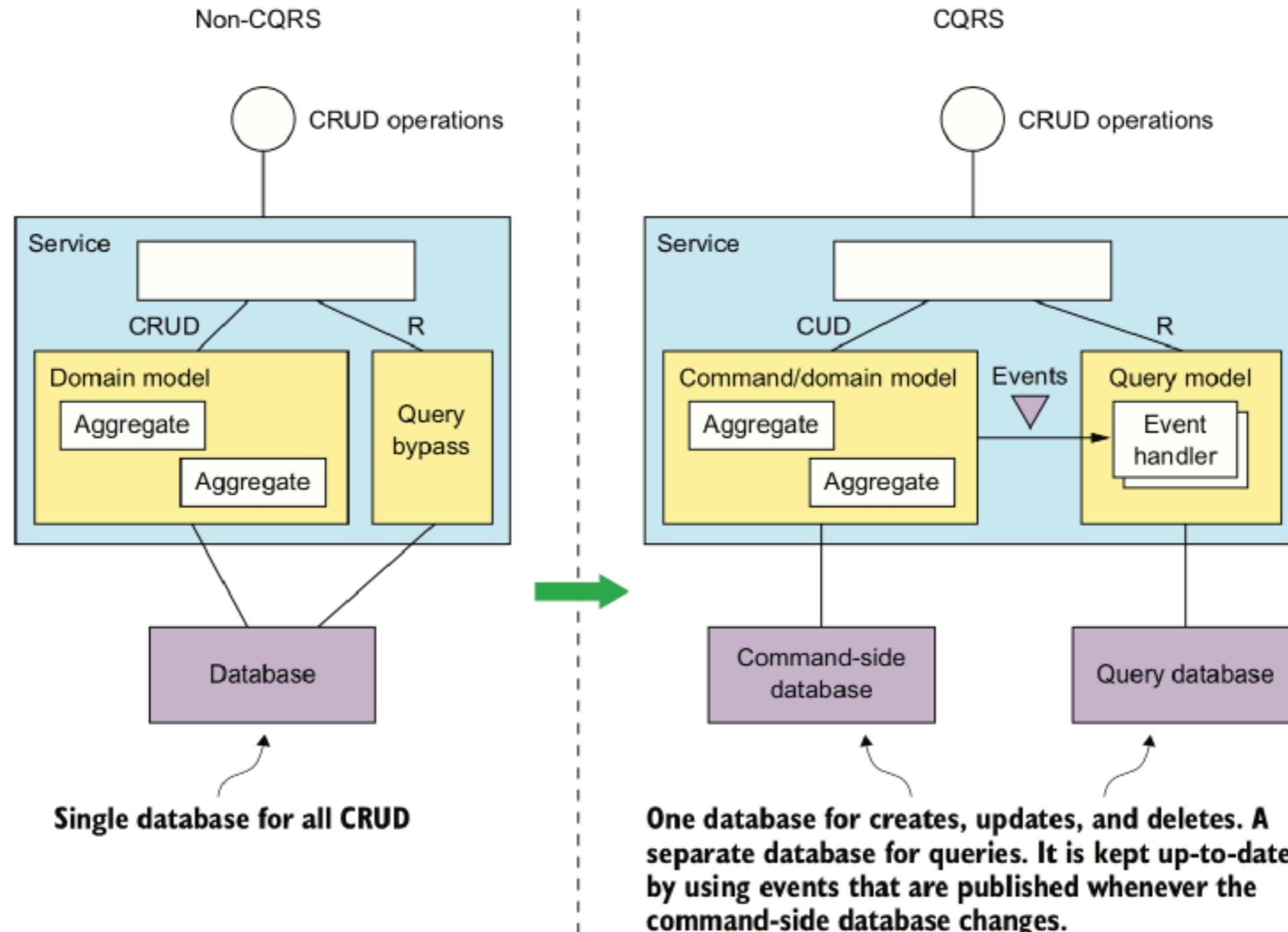


CQRS

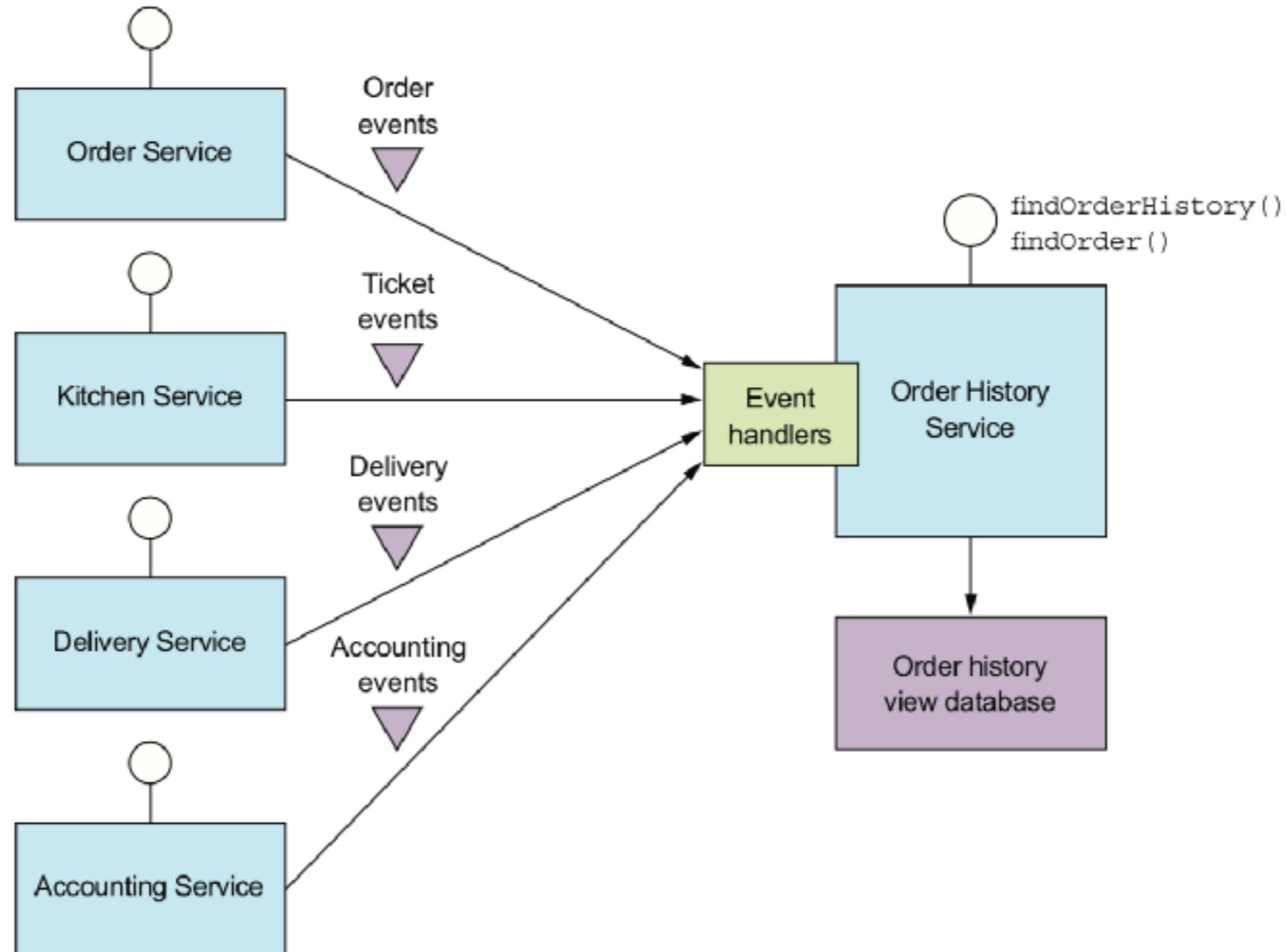
Command Query Responsibility Segregation



CQRS = Separate command from query



CQRS = Query-side service



Benefits

Improve separation of concern
Efficiency query



Drawbacks

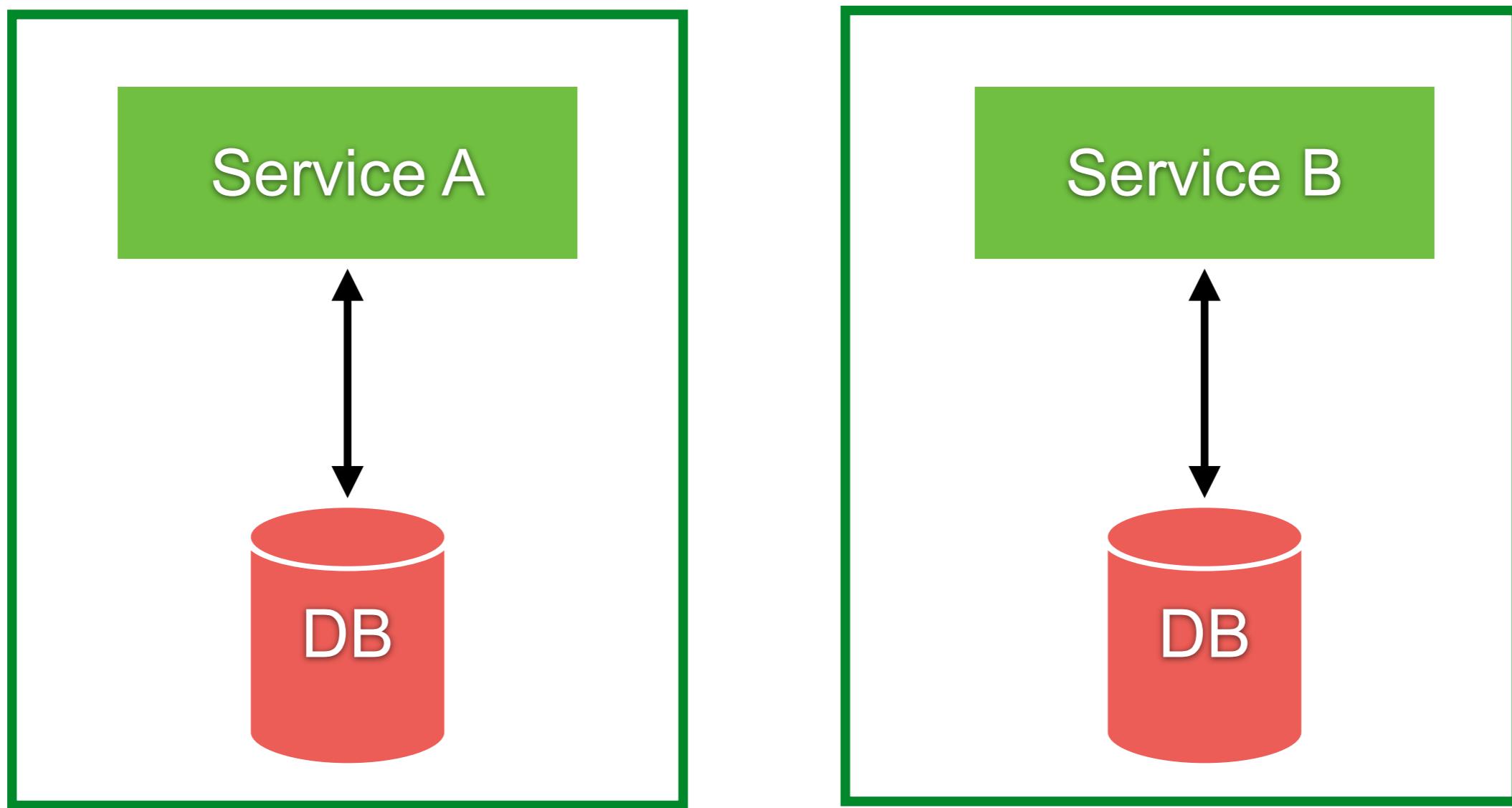
More complex

Lag between **command** and **query** side

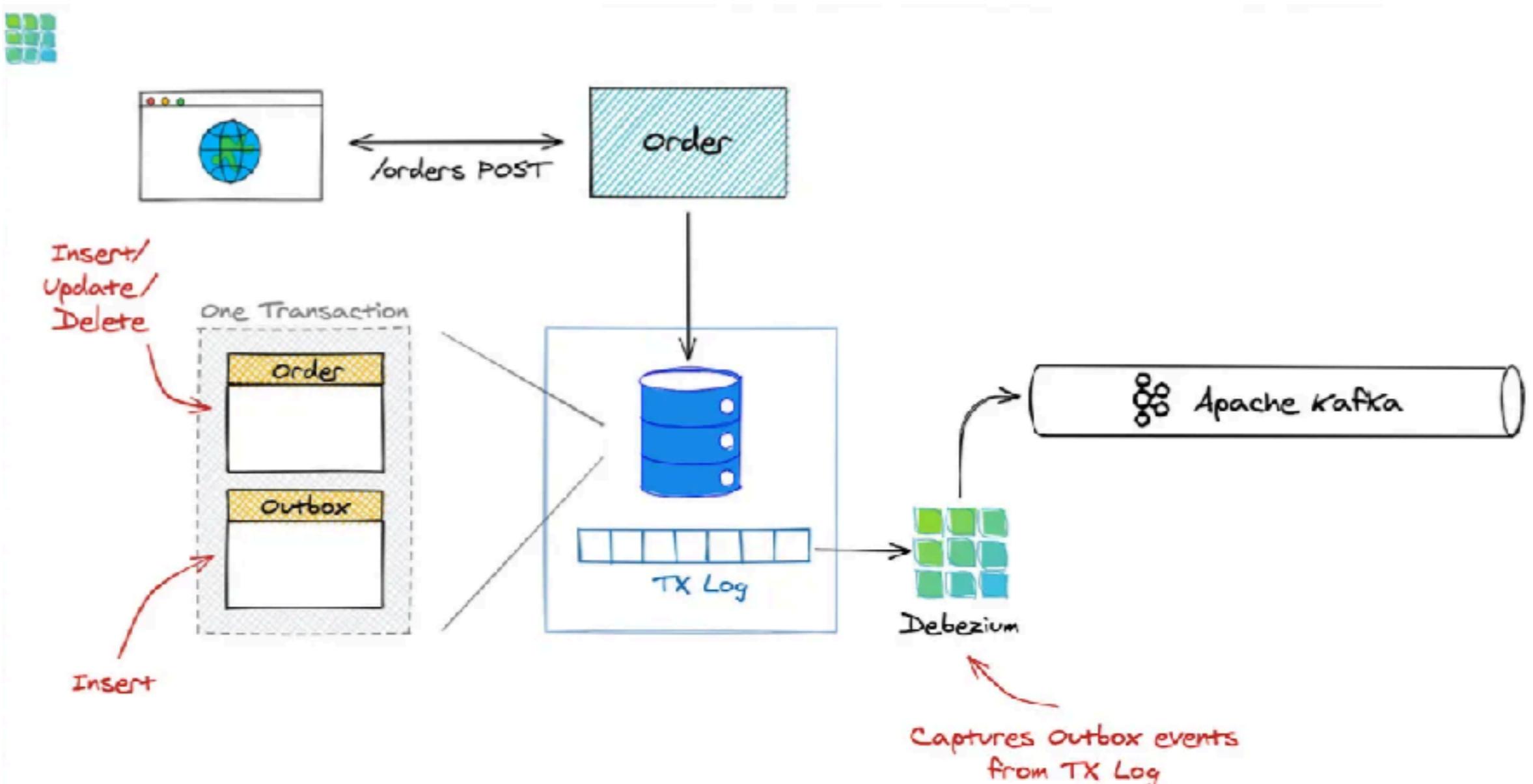


Outbox pattern

Decouple services using Pub/Sub
to exchange data between services



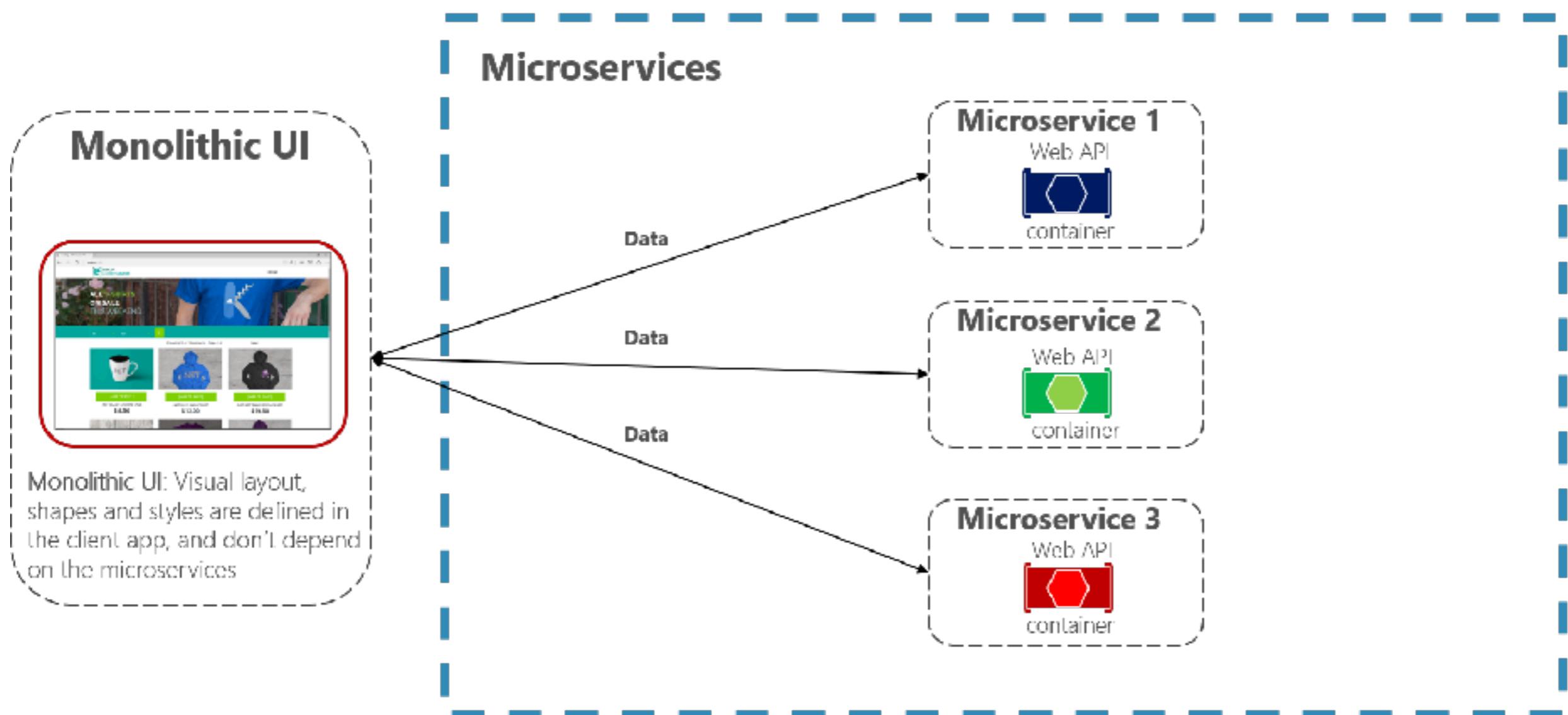
Example of Outbox pattern



Integrate services with User Interface



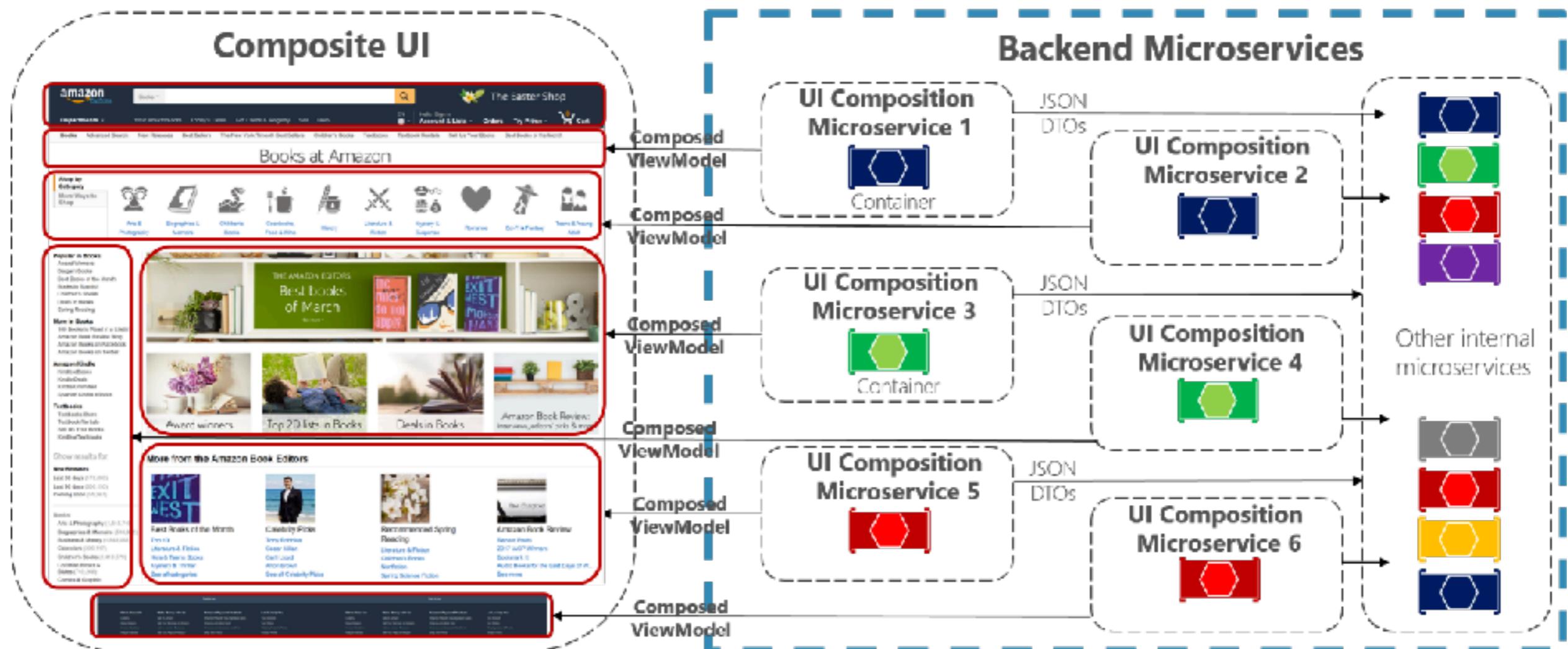
Monolithic UI consuming microservices



<https://docs.microsoft.com>



Composite UI generated by microservices



<https://docs.microsoft.com>

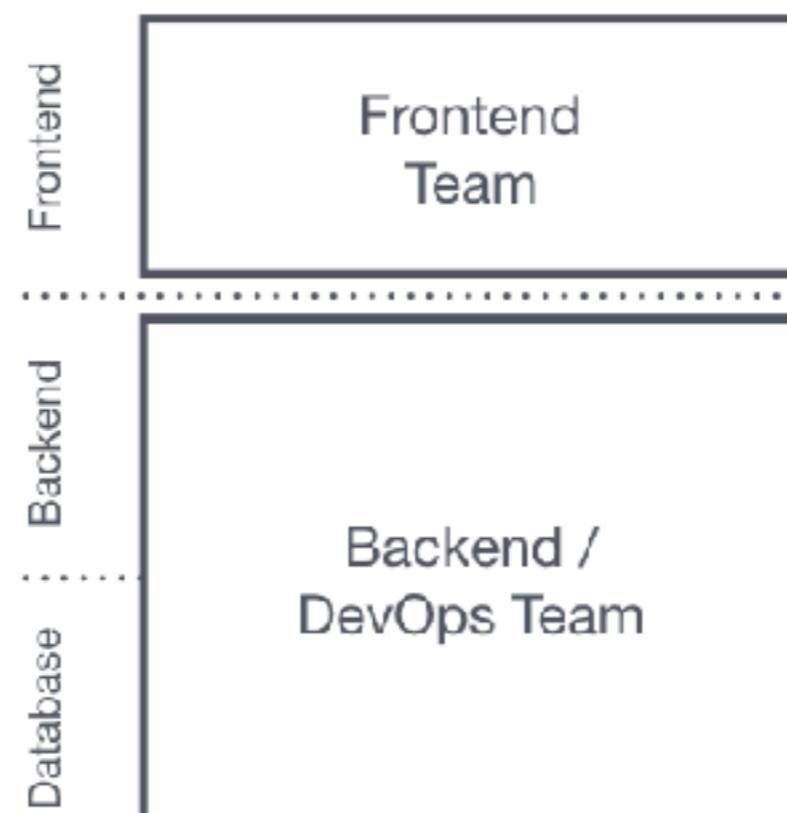


Monolith frontend

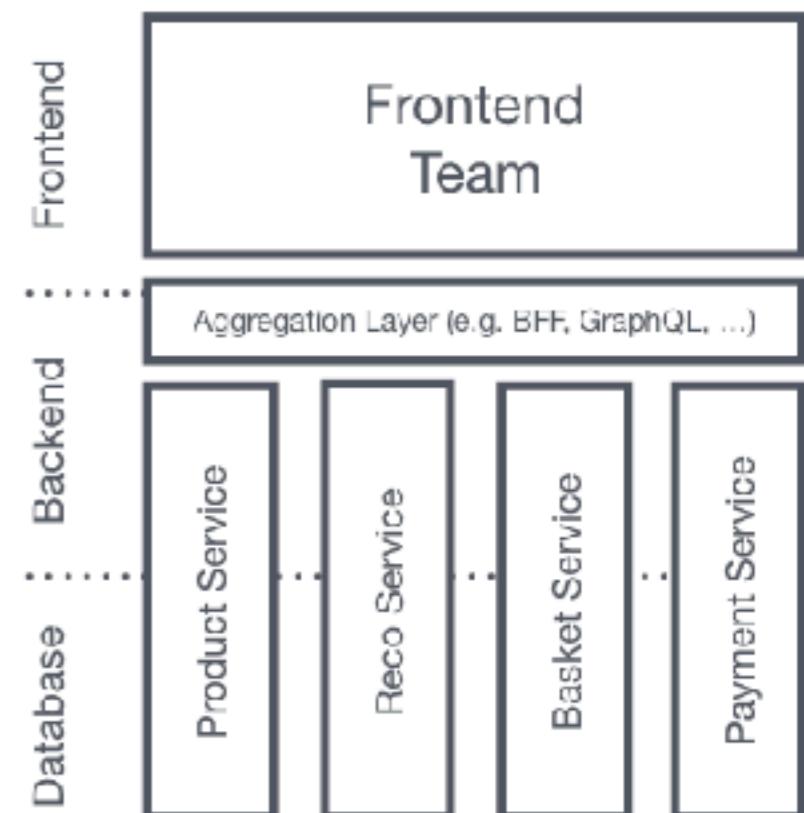
The Monolith



Front & Back



Microservices

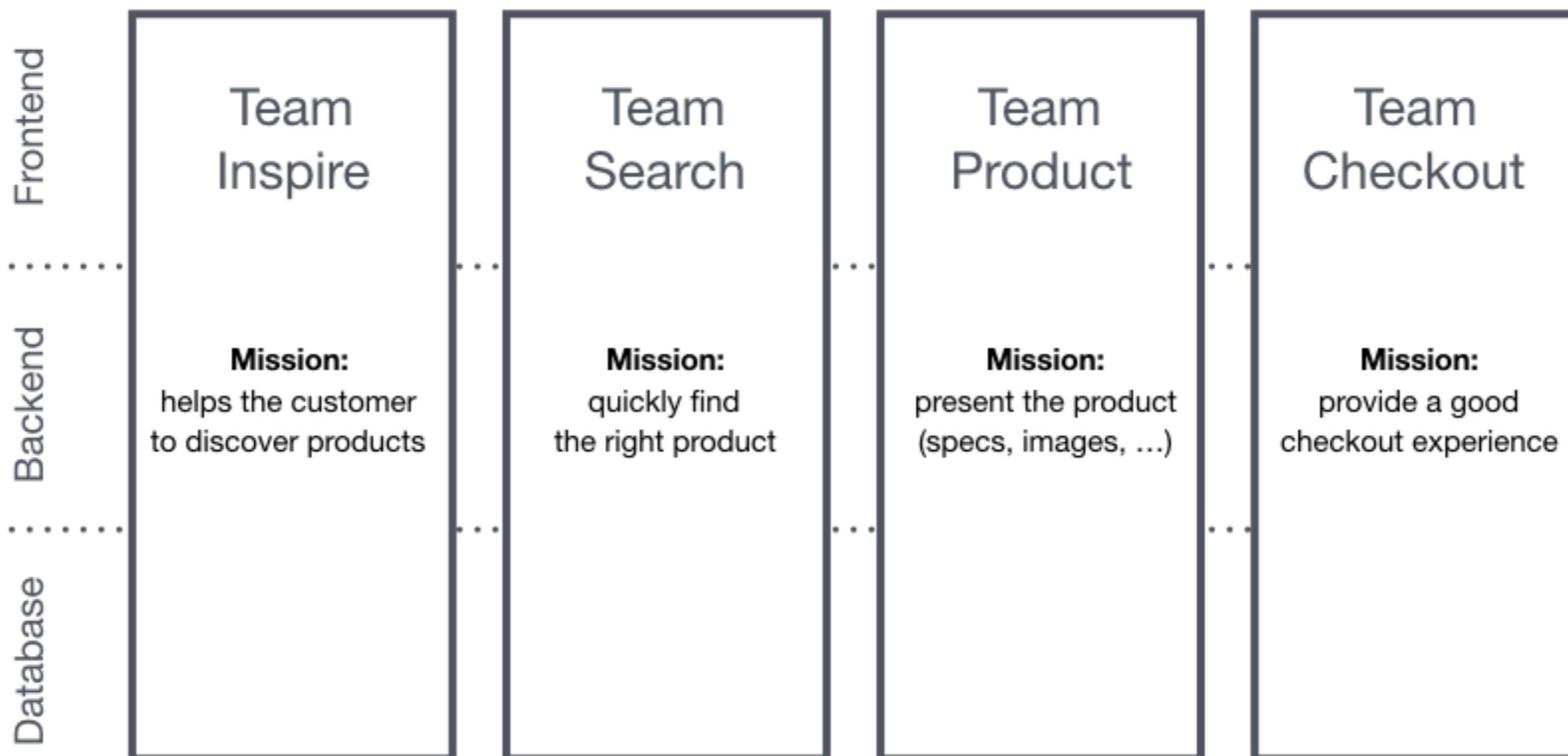


<https://micro-frontends.org/>



Micro frontend

End-to-End Teams with Micro Frontends



<https://micro-frontends.org/>



Observability of services

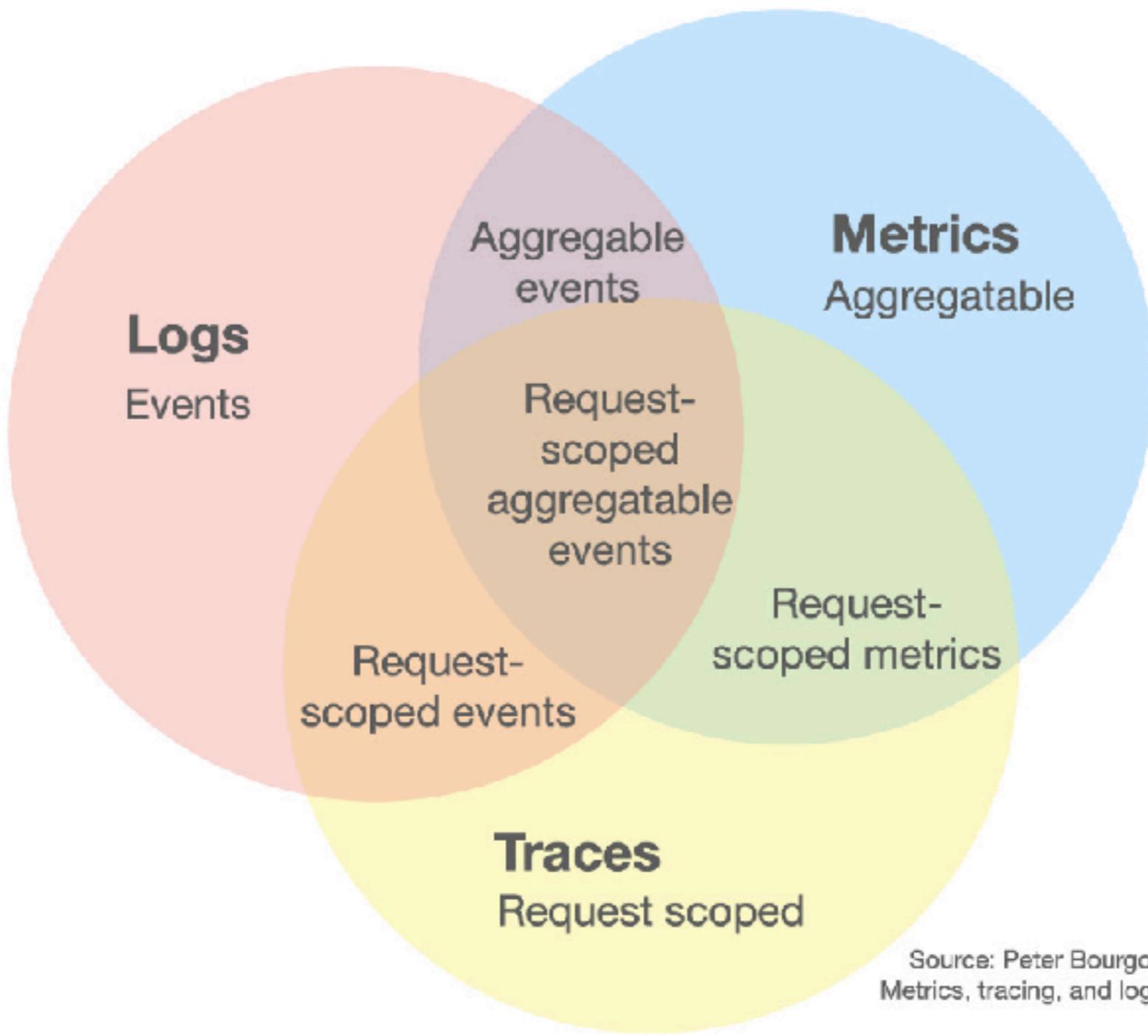


Observability of services

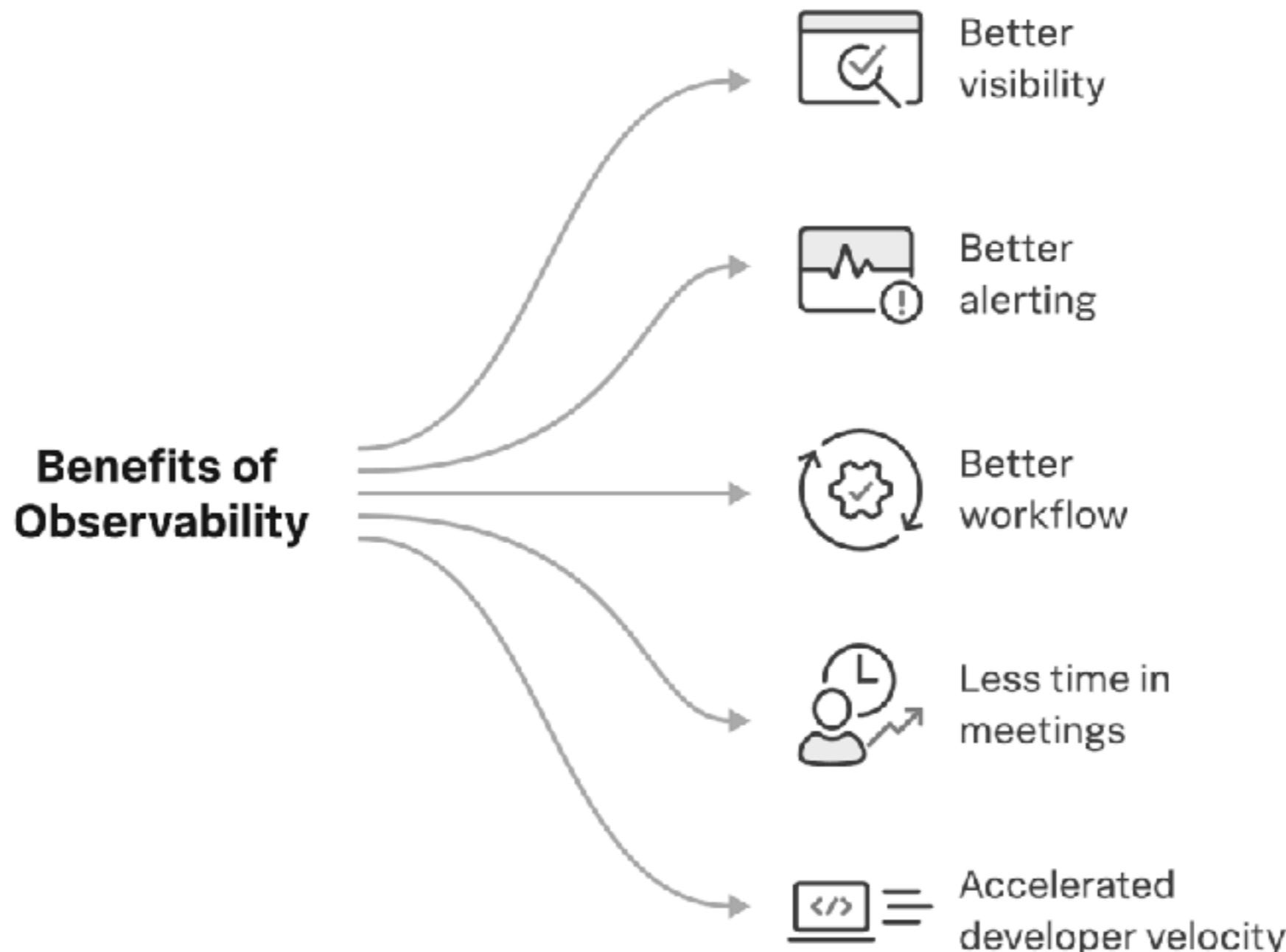
Application metrics
Distributed tracing
Log aggregation
Alert system
Exception tracking



Observability of services



Observability of services



Application metrics

Metrics represent logs numerically over intervals of time

Request rate

Error rate

Health

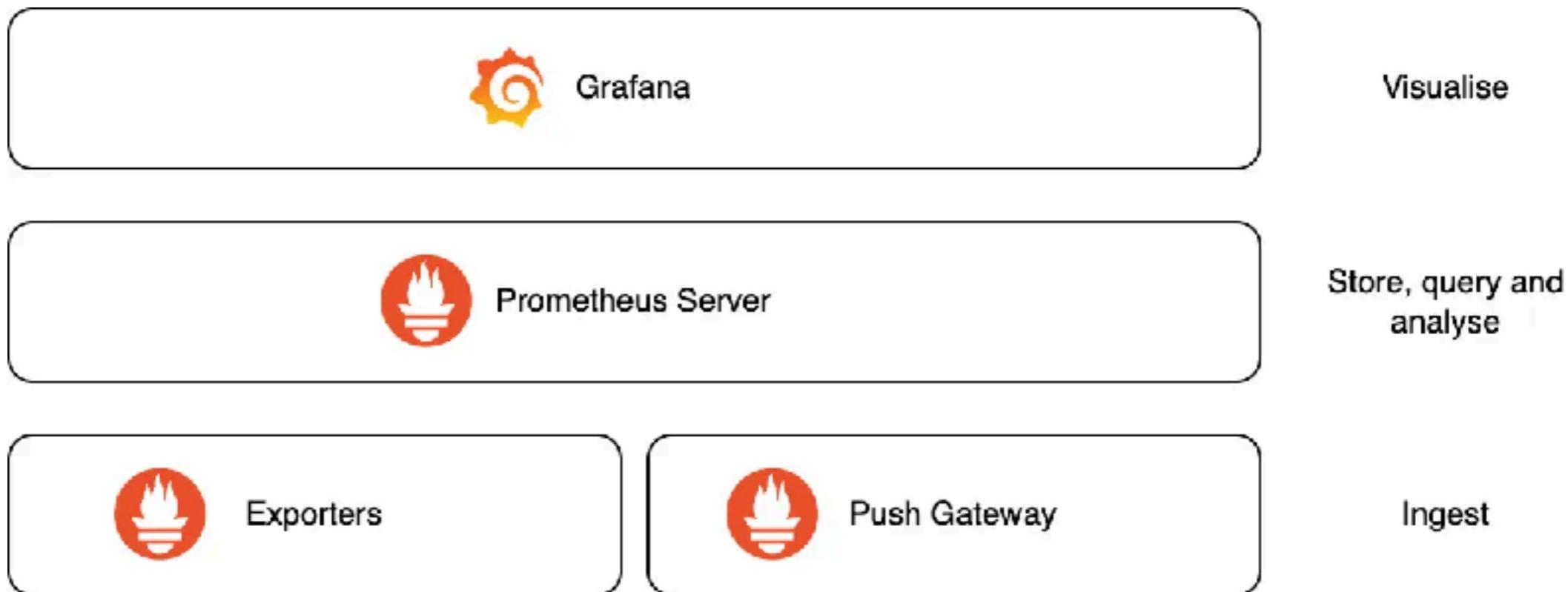
Latency

Utilization

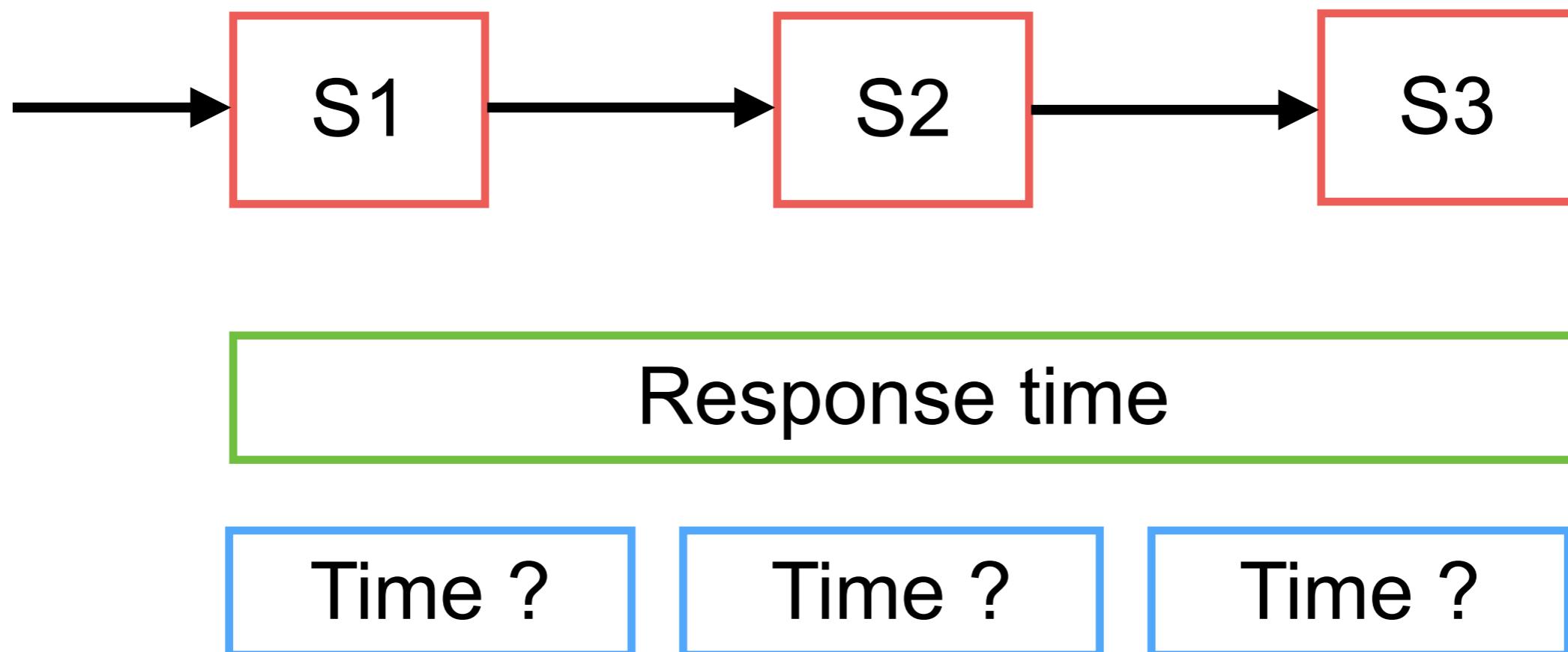
Availability



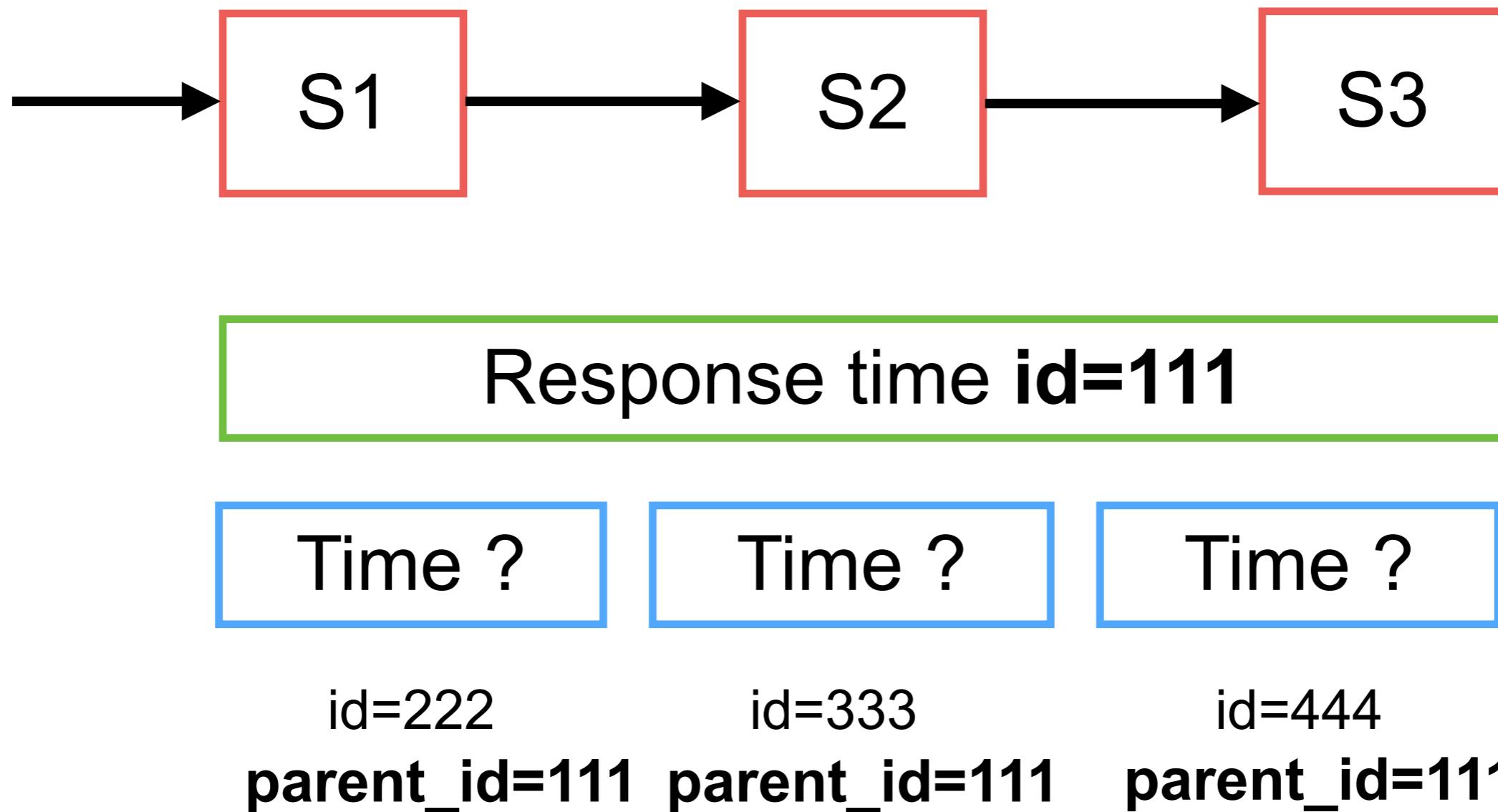
Application metrics



Distributed tracing



Correlation IDs





OpenTelemetry

High-quality, ubiquitous, and portable telemetry to enable effective observability

[Learn more](#)[Try the demo](#)

Get started based on your role

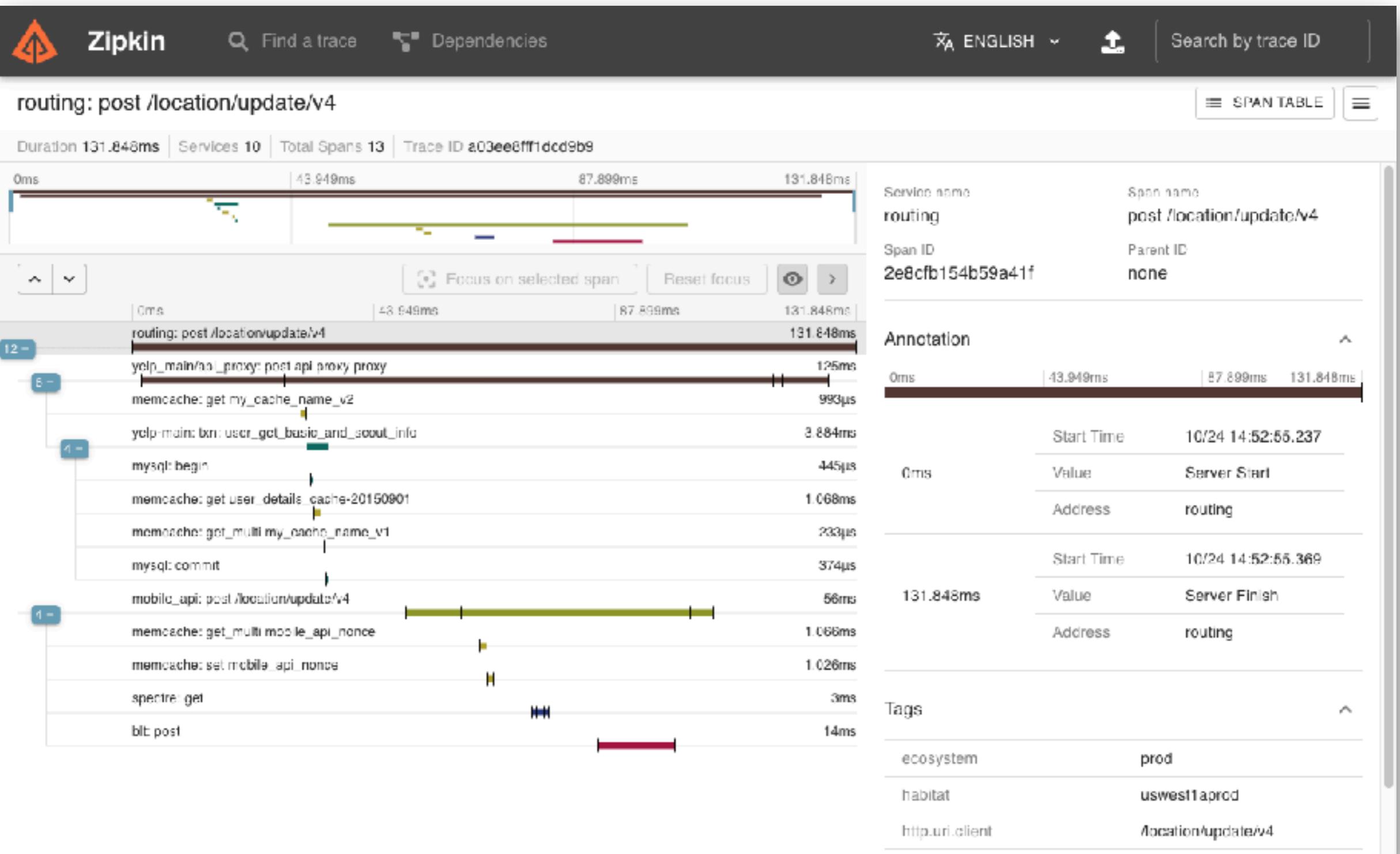
[Dev](#)[Ops](#)

<https://opentelemetry.io/>



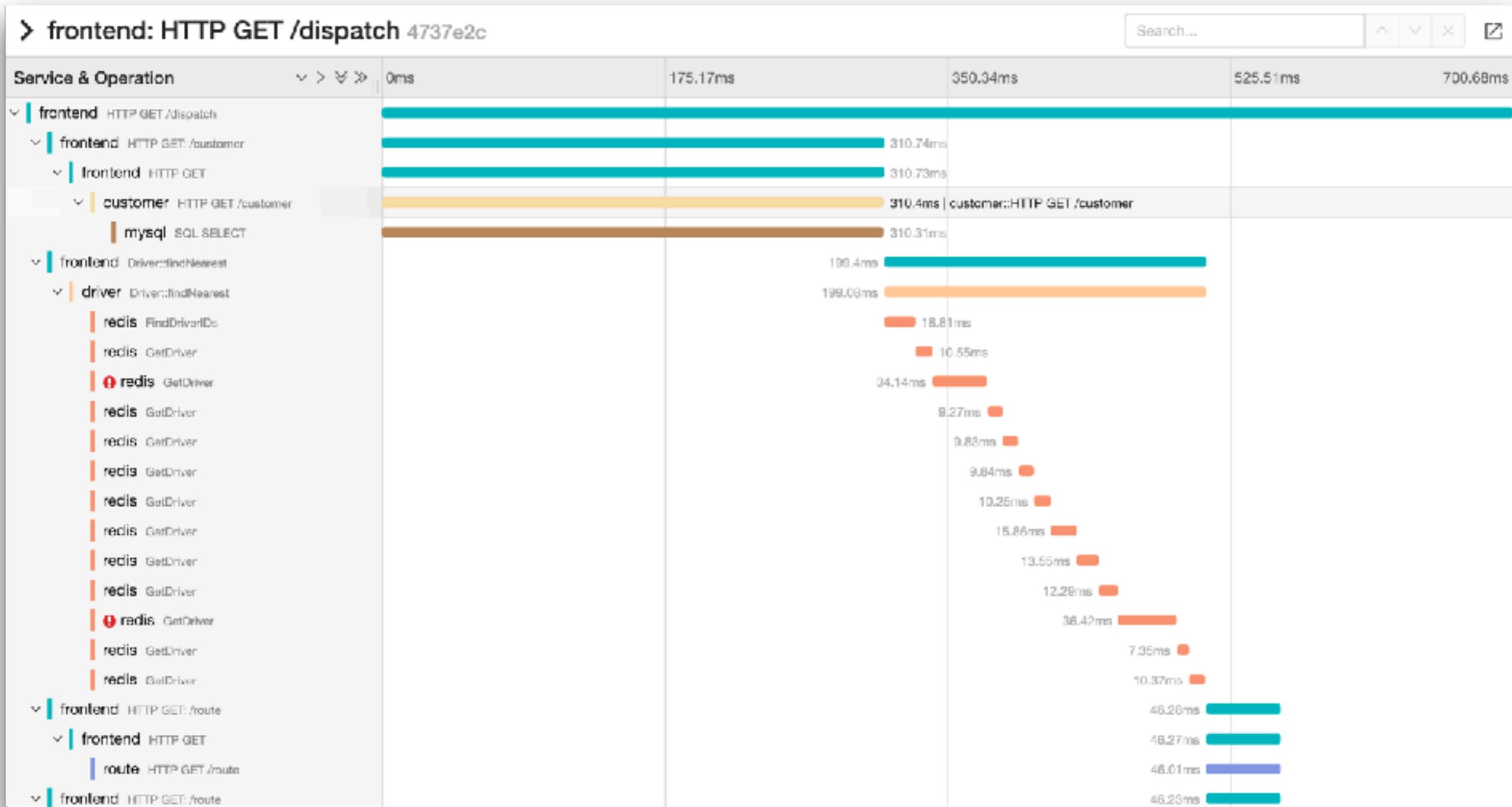
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<https://zipkin.io/>





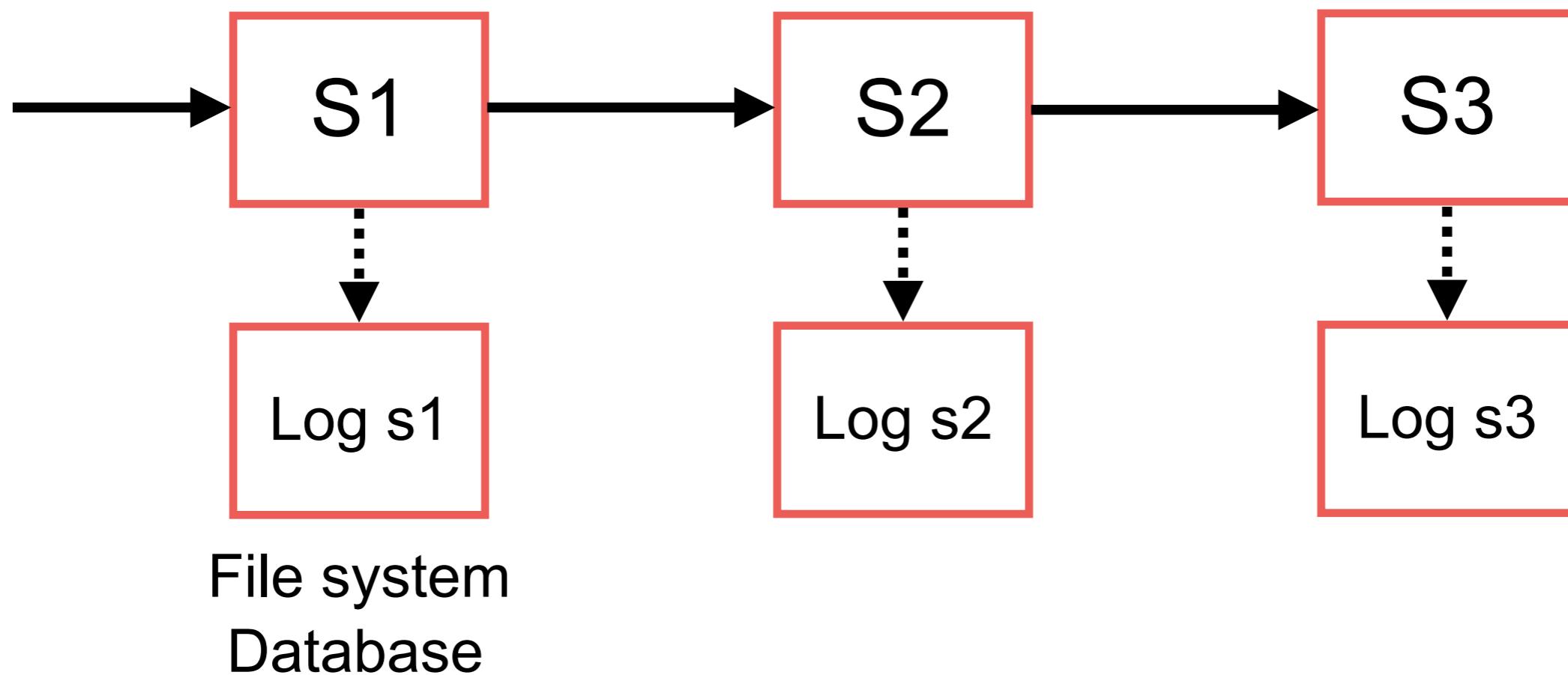
<https://www.jaegertracing.io/>



Microservices

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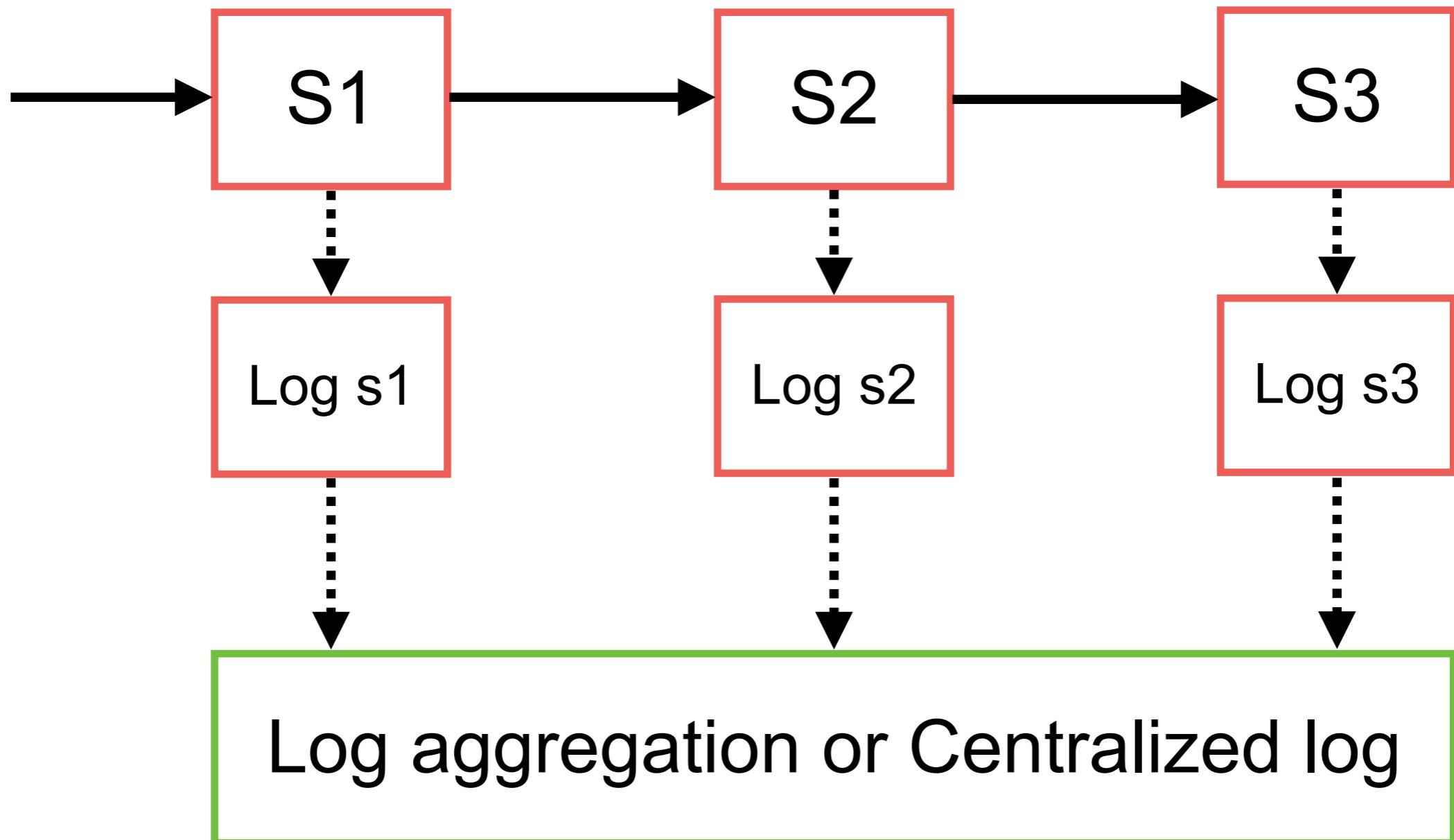
Log aggregation



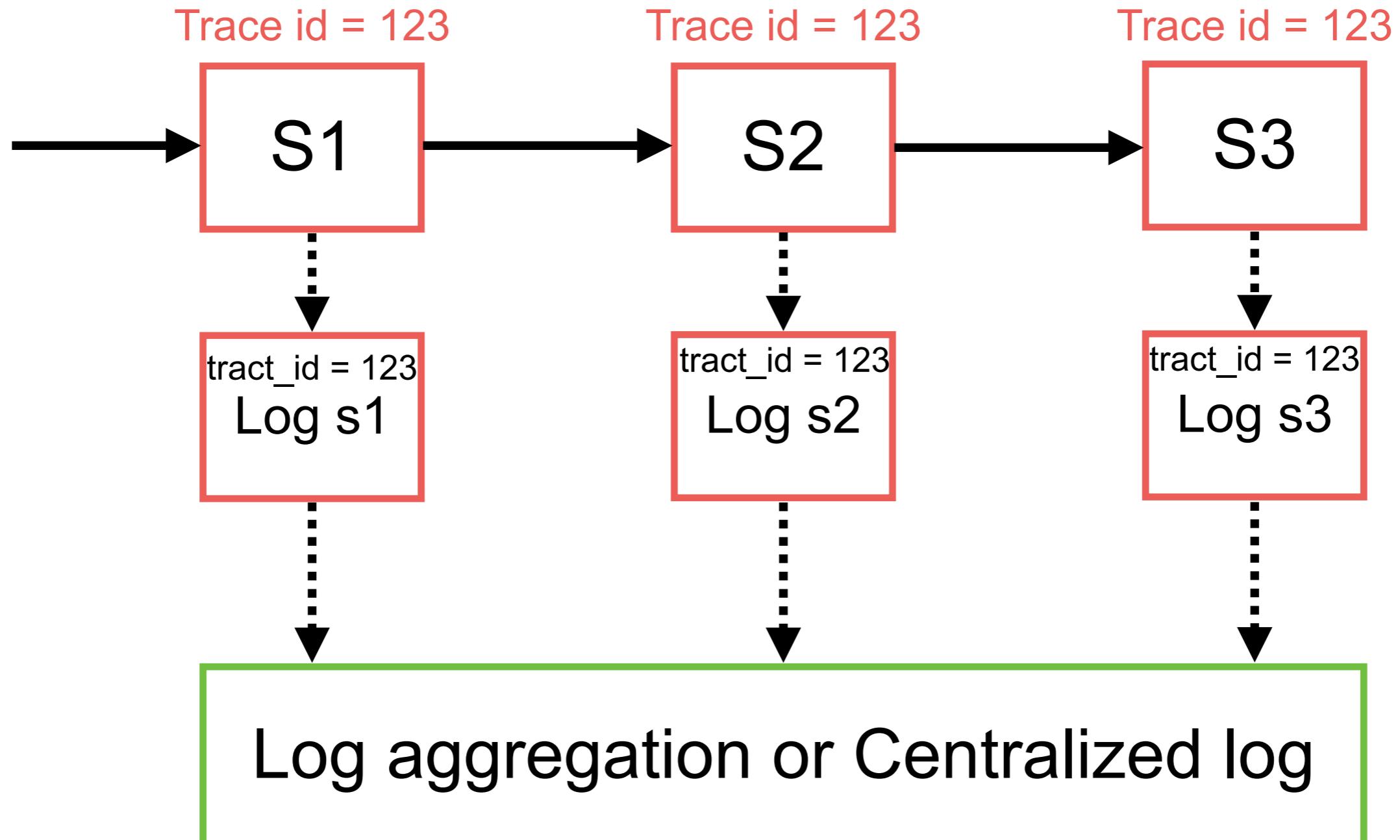
How to find errors from log ?



Log aggregation



Log aggregation + Correlation IDs



Consistent Structure Logs

Property	Description	Example
Timestamp	Date and time of the log	2023-07-01
Log level	DEBUG, INFO, ERROR	
Trace Id or Correlation Id	Unique identifier that refer to other logs from all services	
Event/Action Name	Identify to event or action of log	Authentication fail
Service ID/ Name	Identify to service	
Request path	Path for the request	/api/products

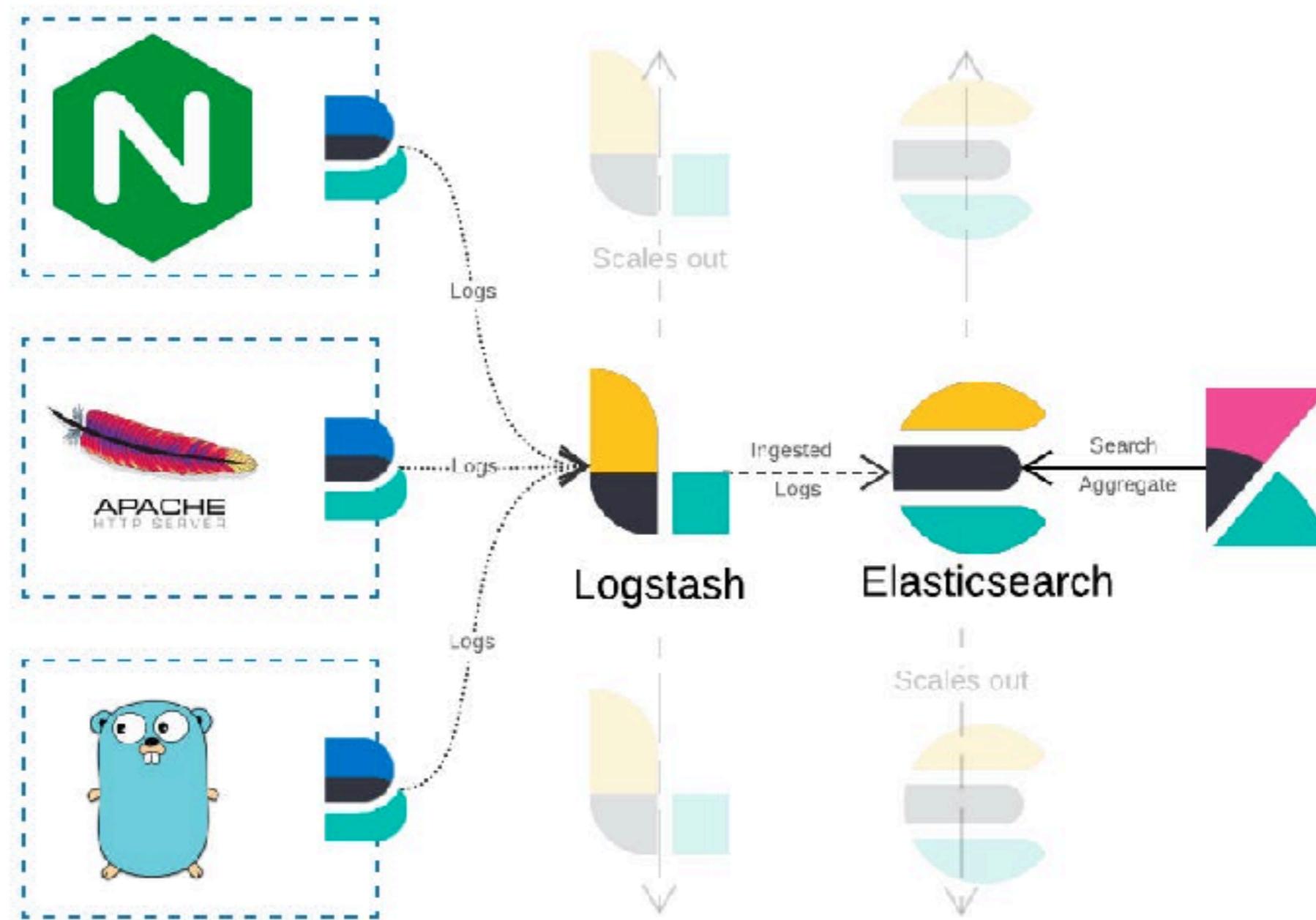


Don't keep !!

```
com.framework.FrameworkException: Error in web request
  at com.framework.ApplicationStarter.lambda$start$0(ApplicationStarter.java:15)
  at spark.RouteImpl$1.handle(RouteImpl.java:72)
  at spark.http.matching.Routes.execute(Routes.java:61)
  at spark.http.matching.MatcherFilter.doFilter(MatcherFilter.java:134)
  at spark.embeddedserver.jetty.JettyHandler.doHandle(JettyHandler.java:50)
  at org.eclipse.jetty.server.session.SessionHandler.doScope(SessionHandler.java:1568)
  at org.eclipse.jetty.server.handler.ScopedHandler.handle(ScopedHandler.java:144)
  at org.eclipse.jetty.server.handler.HandlerWrapper.handle(HandlerWrapper.java:132)
  at org.eclipse.jetty.server.Server.handle(Server.java:503)
  at org.eclipse.jetty.server.HttpChannel.handle(HttpChannel.java:364)
  at org.eclipse.jetty.server.HttpConnection.onFillable(HttpConnection.java:260)
  at org.eclipse.jetty.io.AbstractConnection$ReadCallback.succeeded(AbstractConnection.java:305)
  at org.eclipse.jetty.io.FillInterest.fillable(FillInterest.java:103)
  at org.eclipse.jetty.io.ChannelEndPoint$2.run(ChannelEndPoint.java:118)
  at org.eclipse.jetty.util.thread.QueuedThreadPool.runJob(QueuedThreadPool.java:765)
  at org.eclipse.jetty.util.thread.QueuedThreadPool$2.run(QueuedThreadPool.java:683)
  at java.base/java.lang.Thread.run(Thread.java:834)
Caused by: com.project.module.MyProjectFooBarException: The number of FooBars cannot be zero
  at com.project.module.MyProject.anotherMethod(MyProject.java:20)
  at com.project.module.MyProject.someMethod(MyProject.java:12)
  at com.framework.ApplicationStarter.lambda$start$0(ApplicationStarter.java:13)
  ... 16 more
Caused by: java.lang.ArithmaticException: The denominator must not be zero
  at org.apache.commons.lang3.math.Fraction.getFraction(Fraction.java:143)
  at com.project.module.MyProject.anotherMethod(MyProject.java:18)
  ... 18 more
```



ELK stack



More ...



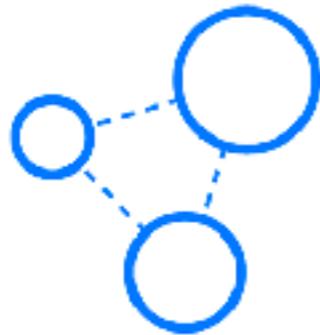
How to develop ?
How to test ?
How to deploy ?



Summary



Beyond Microservice Process and Organization



Flexible organizational structure

With clear roles and accountabilities



Efficient meeting formats

Geared toward action and eliminating over-analysis



More autonomy to teams and individuals

Individuals solve issues directly without bureaucracy



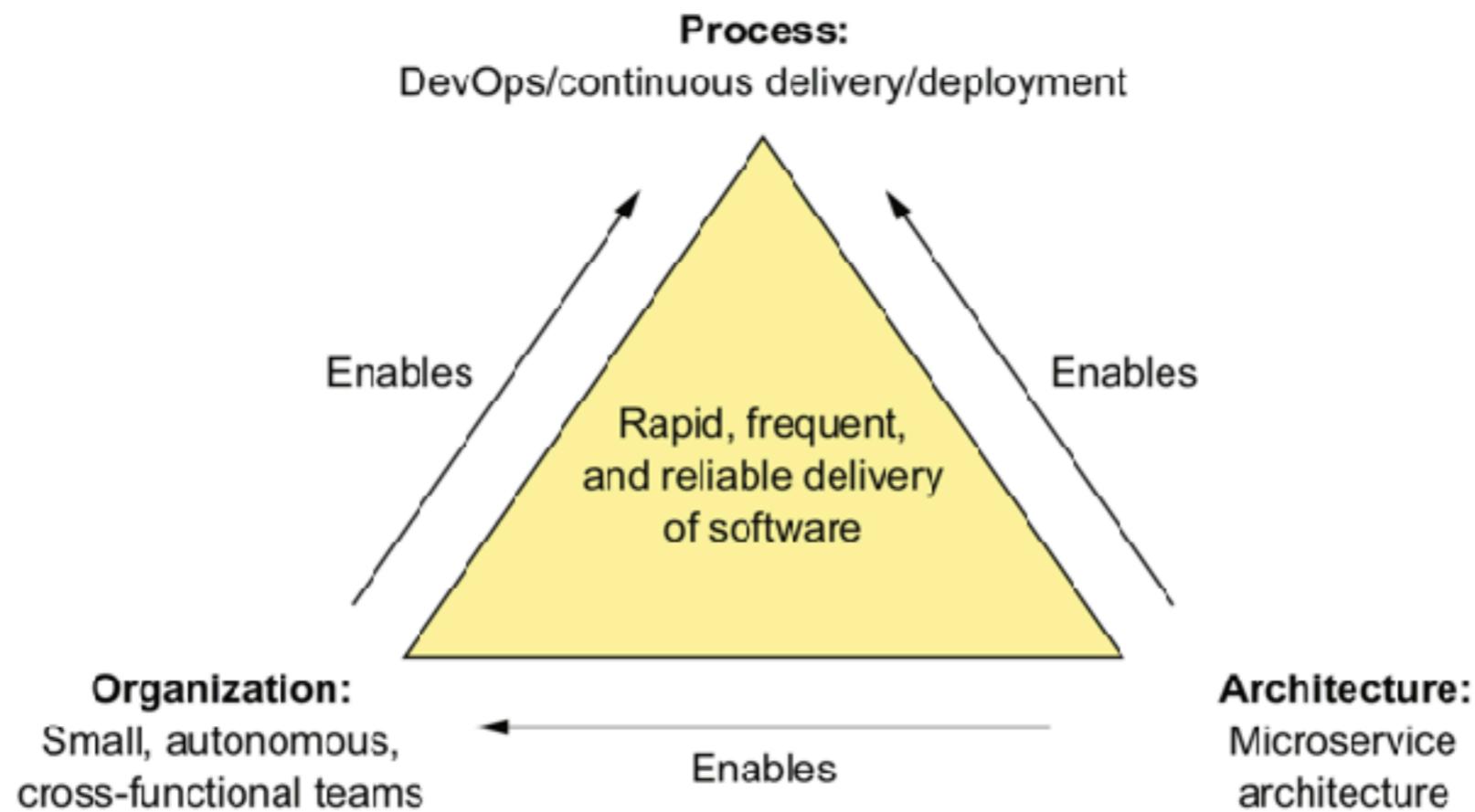
Unique decision-making process

To continuously evolve the organization's structure.

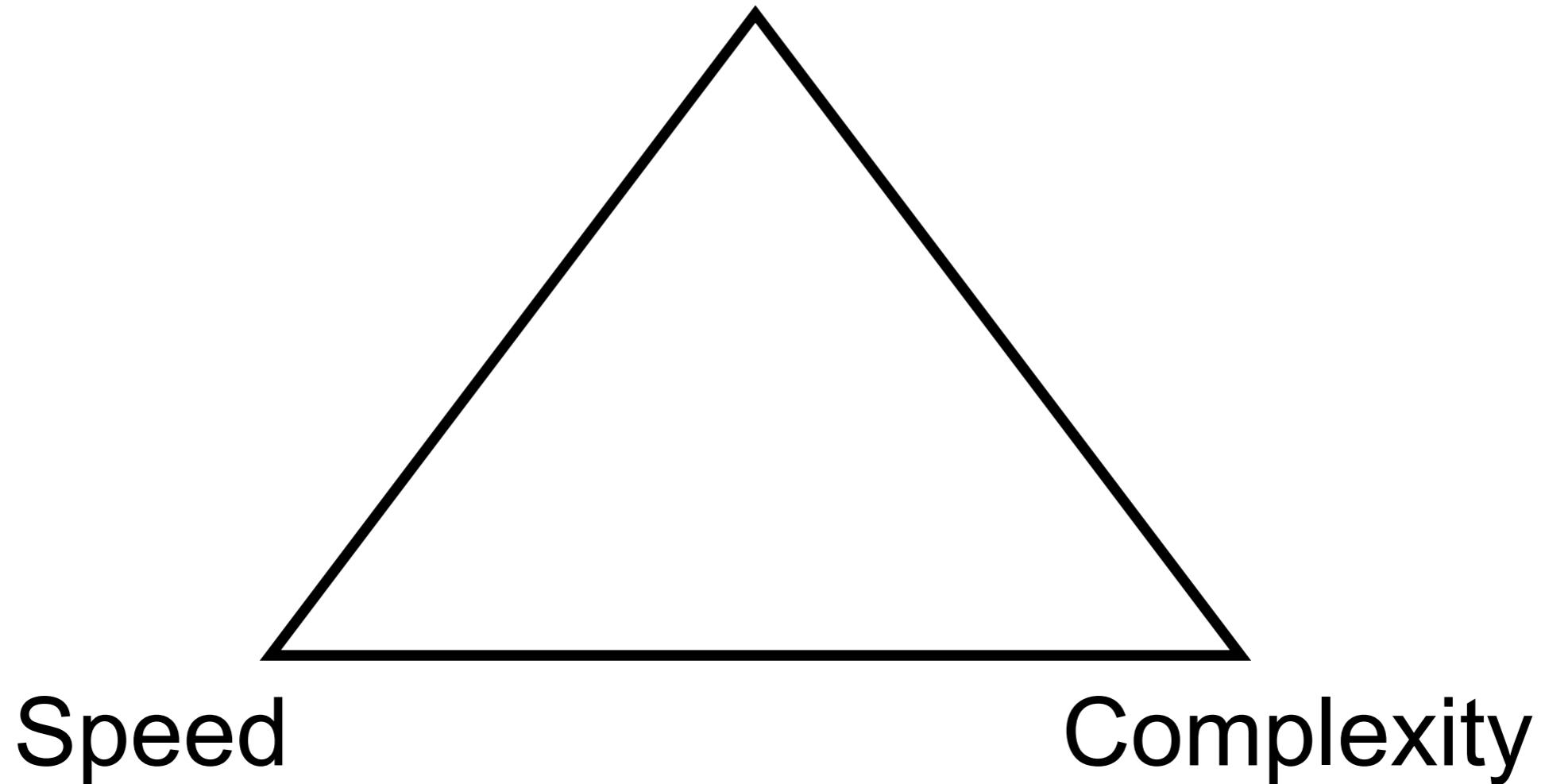


Success project needs ...

Organization process
Development process
Delivery process



Customer value



Don't forget about the human side when adopt Microservice



Let's start with good monolith



Module 1

Module 2

Module 3

Module 4

Module 5

Module 6



Find your problems



Module 1

Module 2

Module 3

Module 4

Module 5

Module 6



Module 1

Module 2

Module 3

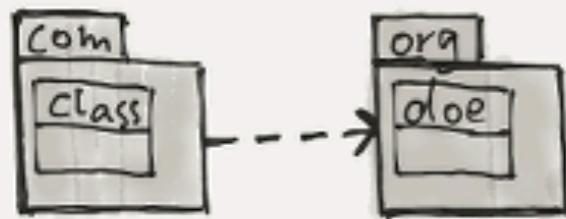
Module 5

Module 6

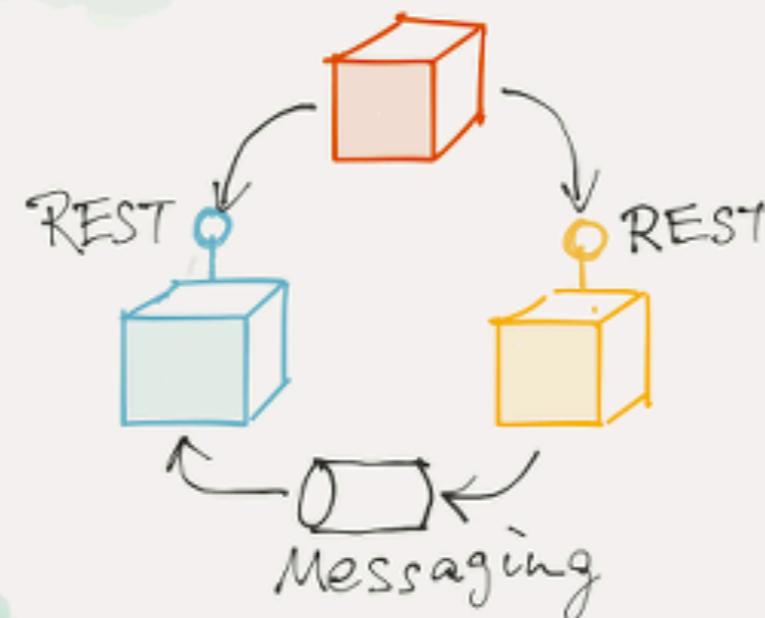
Module 4



Architecture



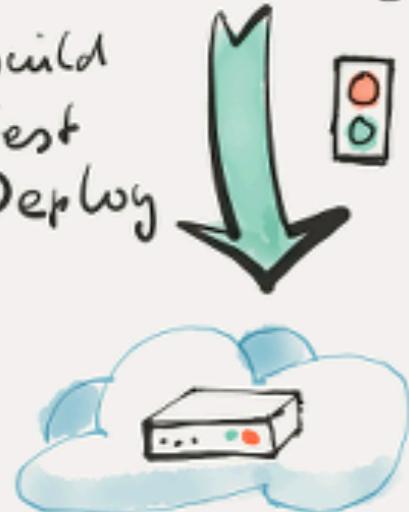
Microservices



Deployment

Continuous Delivery

`{ var i=1; }`
Build
Test
Deploy



Infrastructure

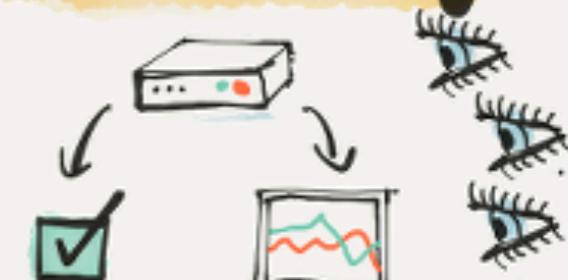


People & Teams



Communication
Collaboration

Monitoring

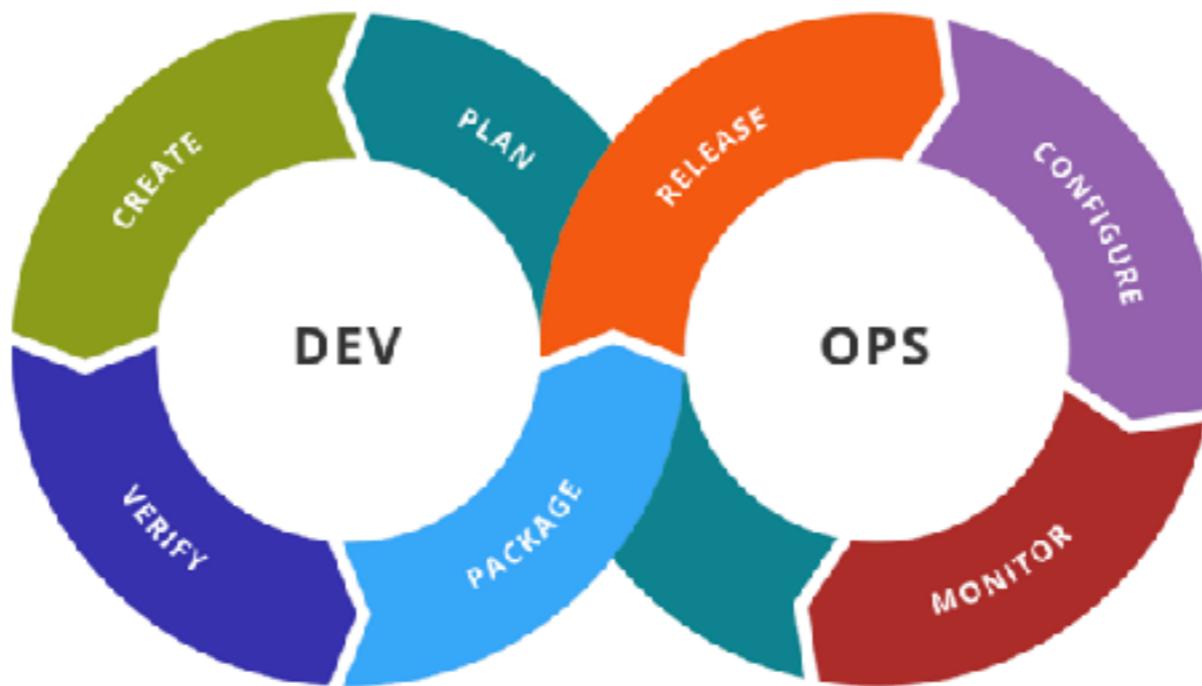


Features & Technology



Microservice prerequisites

Rapid provisioning
Basic monitoring
Rapid Application Deployment
DevOps culture



Let's start your journey !!

