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Microservice architecture

A systems integration lecture

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MICROSERVICES

Introduction

Concepts
Small & autonomous, loose coupling & tight cohesion, Conway's law, resilience & scaling

Testing
Consumer-driven contracts, Canary releases, Semantic monitoring

Monitoring
Distributed logging, Correlation IDs, Distributed Tracing

Patterns
Timeouts, Circuit breakers, Bulkheads, Idempotency, Fail fast, Decoupling Middleware

Introduction

MICROSERVICES, THE TERM

‘07

‘09

“Fine grained SOA”
Adrian Cockcroft @
Netflix

‘11

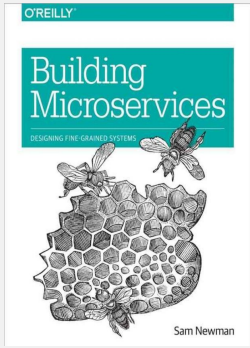
“microservice”
Venice software architects
workshop

‘12

“Micro services”
Java, the Unix Way,
James Lewis

33rd Degree,
Kraków

‘14



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NETFLIX STORY

- ...the very first piece of Netflix that was running in the cloud was the search auto-complete service. ... That ran as a service, there was no graphics around it. All of the website that was supporting that was still running in the datacenter. It's just that as you type that word in, it was sent off to a search index in the cloud.... .
- ..It's a trivial piece of technology, but it taught us everything about pushing production systems to the cloud, hooking them up to a load balancer and the tooling we needed to do it. Two or three engineers, I think, worked on getting that built in a month or so maybe. It was a very small piece of work, plus the tooling, but it proved certain things worked. Then, we got the first bits and pieces up and running in the cloud one piece at a time...

-- Adrian Cockcroft

JAVA, THE UNIX WAY

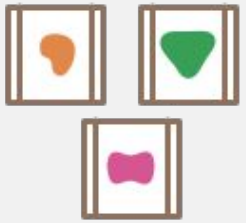
today. He put pipes into Unix." Thompson also had to change most of the programs, because up until that time, they couldn't take standard input. There wasn't really a need; they all had file arguments. "GREP had a file argument, CAT had a file argument."

The next morning, "we had this orgy of `one liners.' Everybody had a one liner. Look at this, look at that. ...Everybody started putting forth the UNIX philosophy. Write programs that do one thing and do it well. Write programs to work together. Write programs that handle text streams, because that is a universal interface." Those ideas which add up to the tool approach, were there in some unformed way before pipes, but they really came together afterwards. Pipes became the catalyst for this UNIX philosophy. "The tool thing has turned out to be actually successful. With pipes, many programs could work together, and they could work together at a distance."

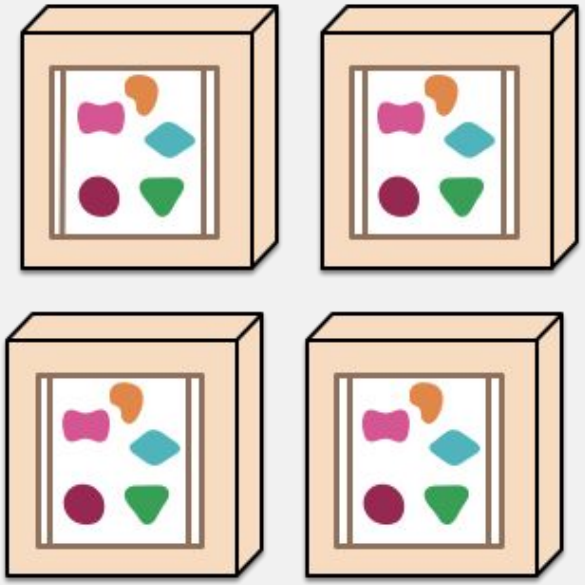
-- Lions commentary on UNIX 2nd Edition

A monolithic application puts all its functionality into a single process...

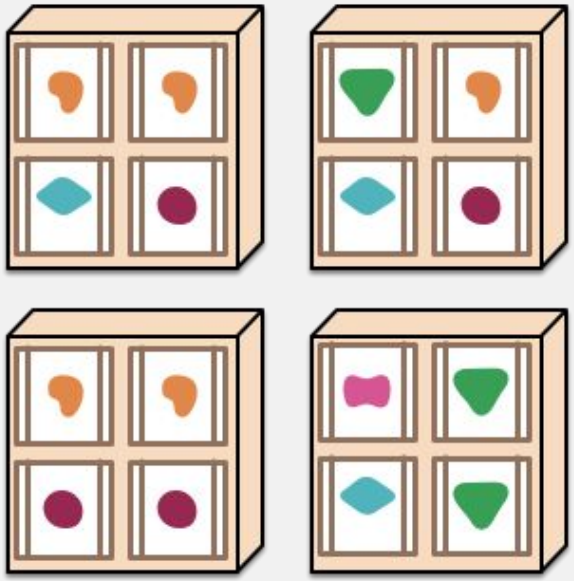
A microservices architecture puts each element of functionality into a separate service...



... and scales by replicating the monolith on multiple servers



... and scales by distributing these services across servers, replicating as needed.



Martin Fowler - **Microservices**
a definition of this new architectural term
https://martinfowler.com/articles/microservices.html

Concepts

SMALL AND AUTONOMOUS

Small

- Each application only does one thing
- Small enough to fit in your head

Packaging and Deployment

- single “fat jar” file
- independently testable
- installable as any system service
- containers
  - fat jar vs. shared layers

SMALL AND AUTONOMOUS

e.g. as a SystemD service

```
[Unit]
Description=Store Catalogue
After=network.service

[Service]
Environment=SPRING_DATASOURCE_URI=jbdc://foo/bar
ExecStart=/bin/sh -c 'java -jar /opt/store/catalogue.jar'
User=catalogue

[Install]
WantedBy=multi-user.target
```

LOOSE COUPLING

...and tight cohesion

- The Single Responsibility Principle
  - Gather together those things that change for the same reason, and separate those things that change for different reasons.
- Services separated via network calls
  - APIs
    - JSON/XML over HTTP (REST), Messaging
    - versioning

CONWAY'S LAW

Organizations which design systems are constrained to produce designs whose structure are copies of the communication structures of these organizations -- Melvin Conway 1968

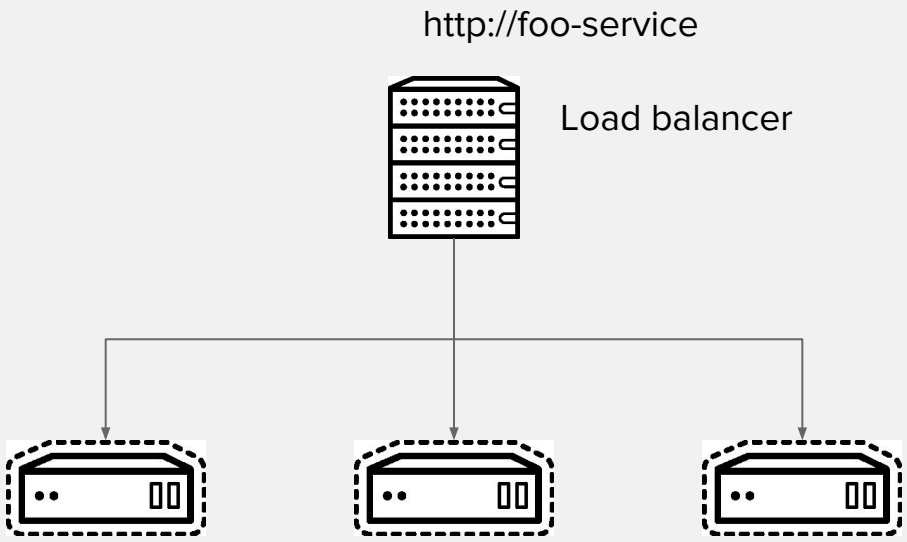
- Each application in separate source repository
  - Treat common code as any other shared library
- Mythical Man-Month
- 2 pizza rule

RESILIENCE AND SCALING

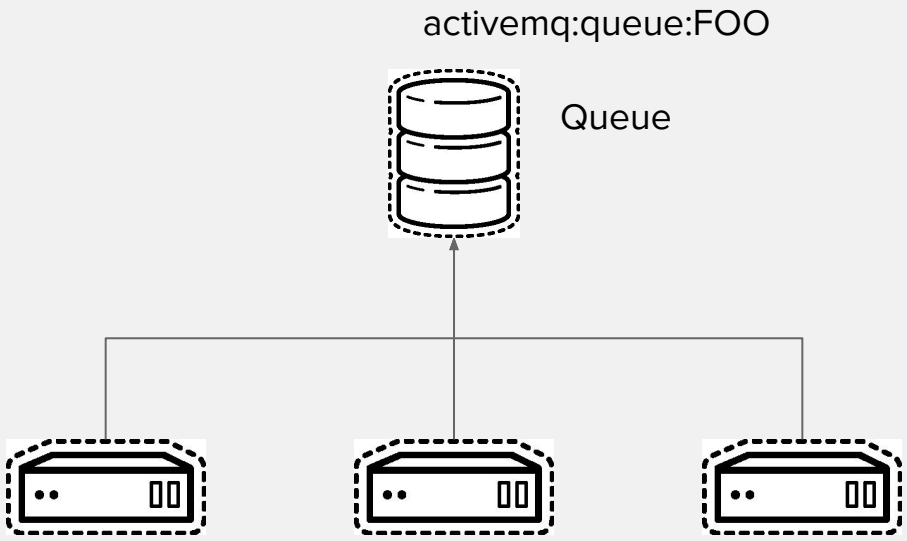
Design for failure

- Resilience
  - A resilient system keeps processing transactions, even when there are transient impulses, persistent stresses, or component failures disrupting normal processing.
  - Ability to contain a failure to the failing component.
- Scaling
  - horizontal scaling
    - fault tolerance via redundancy

LOAD BALANCING



WORKER BASED SCALING

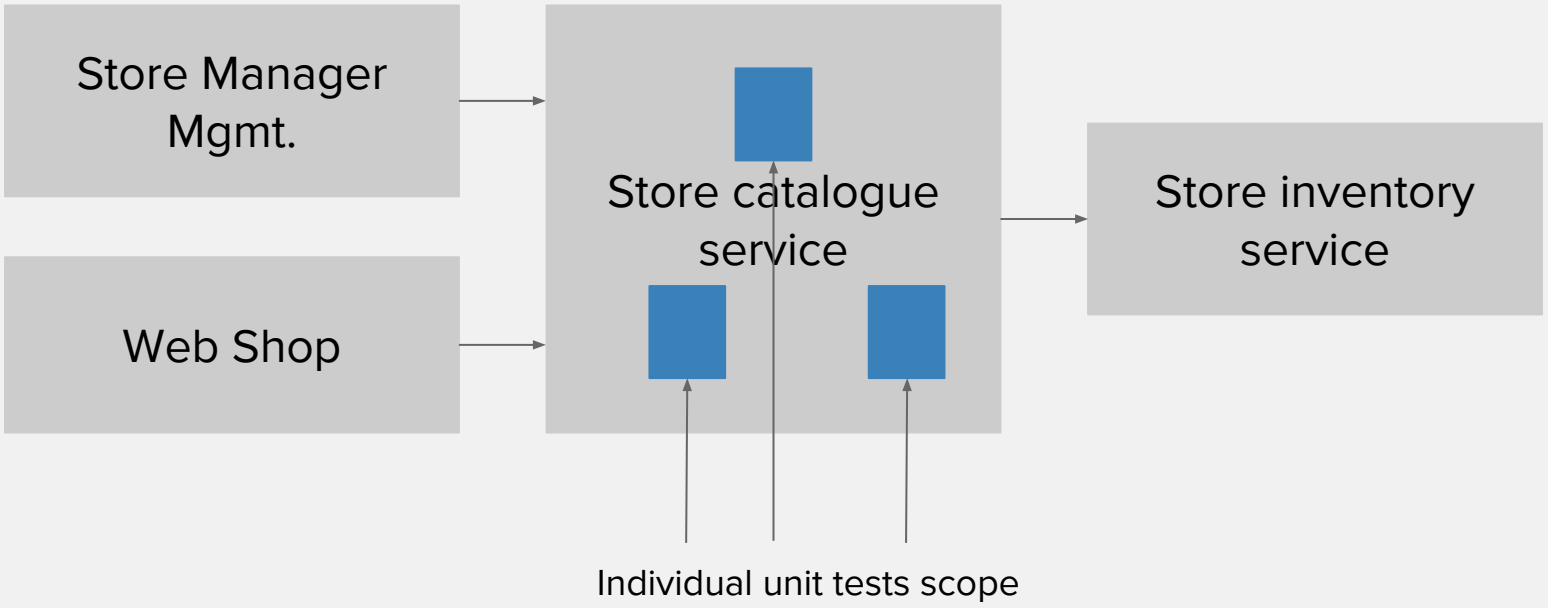


Testing

TEST CATEGORIES

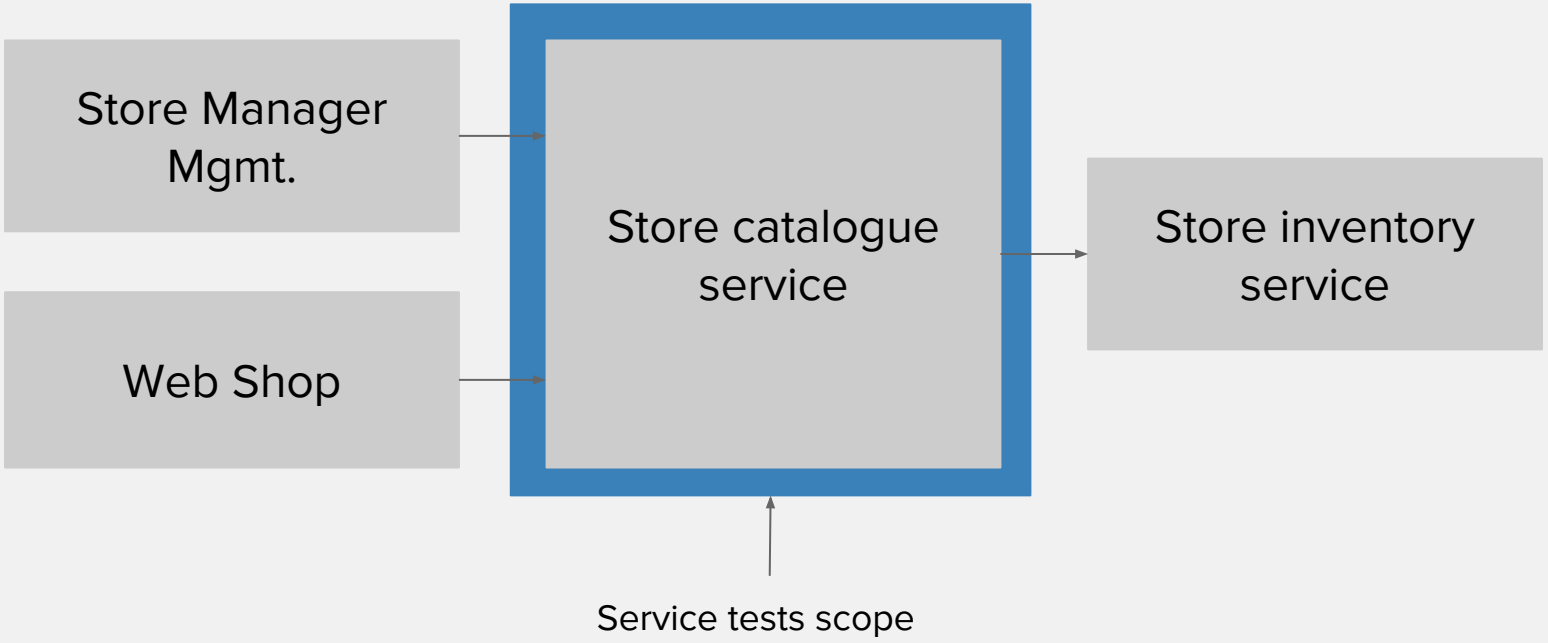
TEST CATEGORIES

Unit tests



TEST CATEGORIES

Service tests



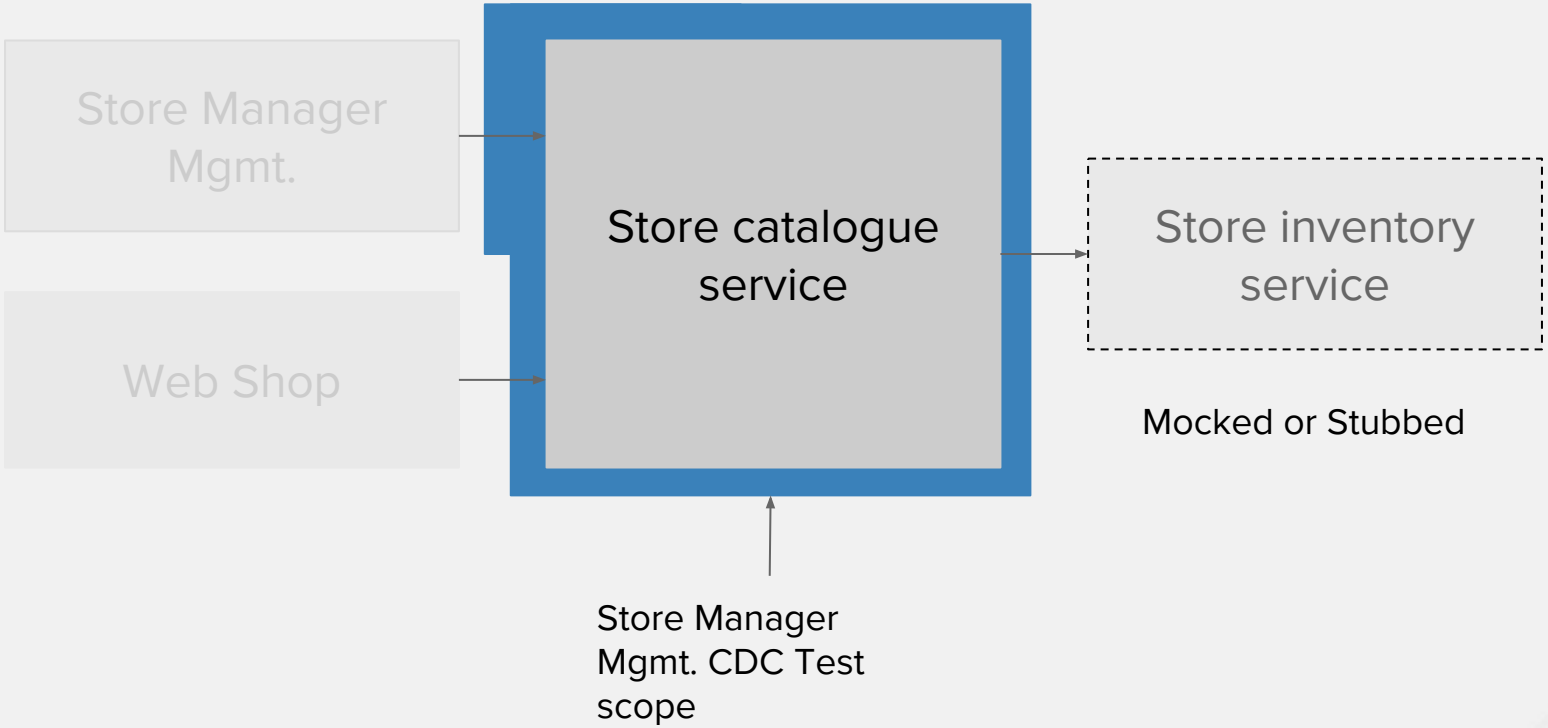
TEST CATEGORIES

End-to-end tests

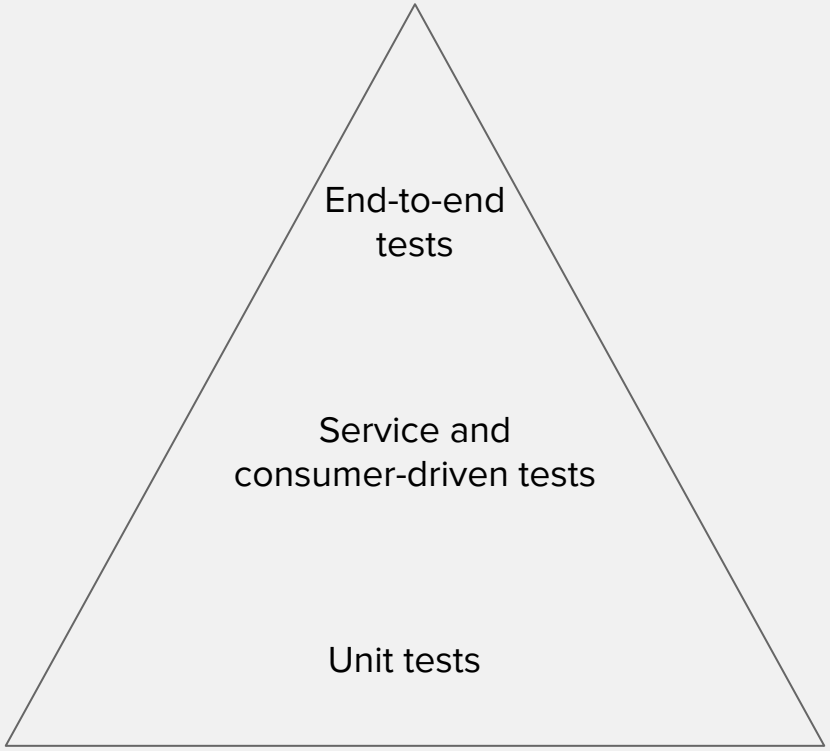
End-to-end tests scope

TEST CATEGORIES

Consumer-driven contracts



TEST CATEGORIES



TESTING IN PRODUCTION

Testing environment is never identical to production

- Blue/green deployment
- Canary release
- Semantic monitoring
- Chaos monkey

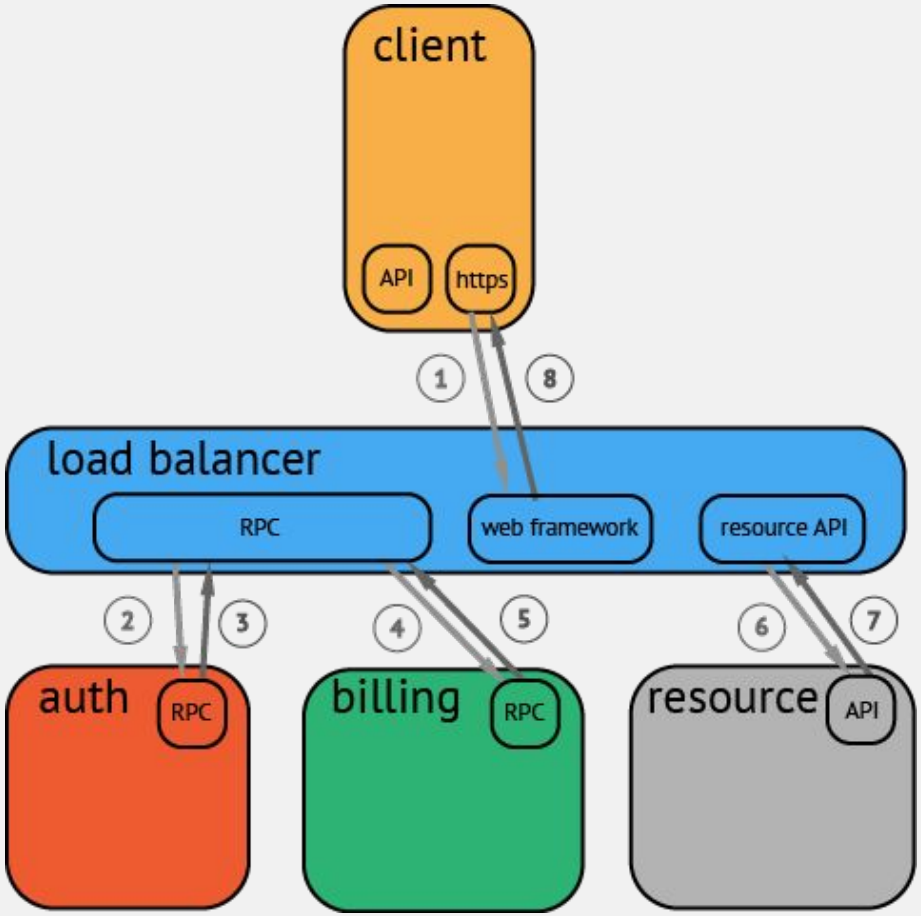
Monitoring

LOGGING

aggregation

- ELK / EFK
- Correlation ID
- Distributed Tracing

DISTRIBUTED TRACING



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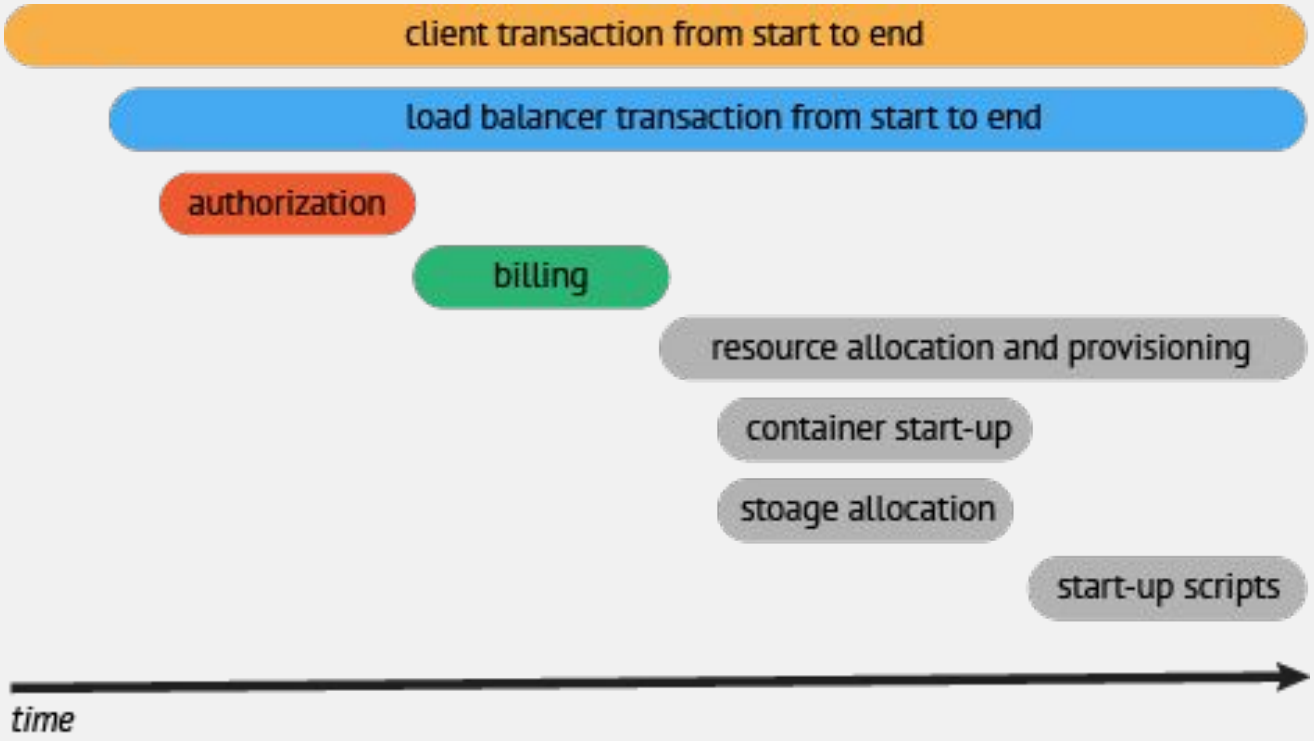
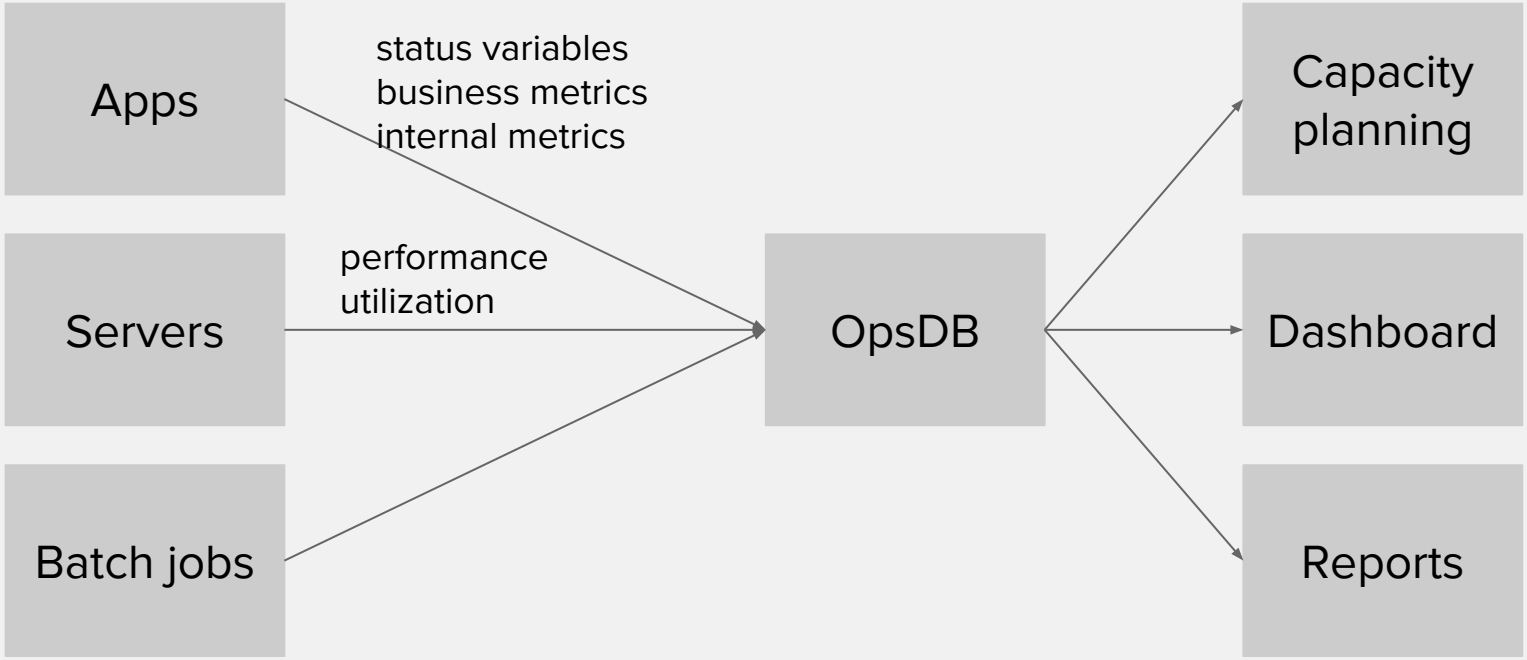


MONITORING

individual services

- Mechanisms
  - JMX / Jolokia
- Data
  - Traffic indicators
  - Resource pool health
  - DB connections health
  - Integration point health
  - Cache health

OPERATIONS DATABASE



Patterns

TIMEOUTS

networks are fallible

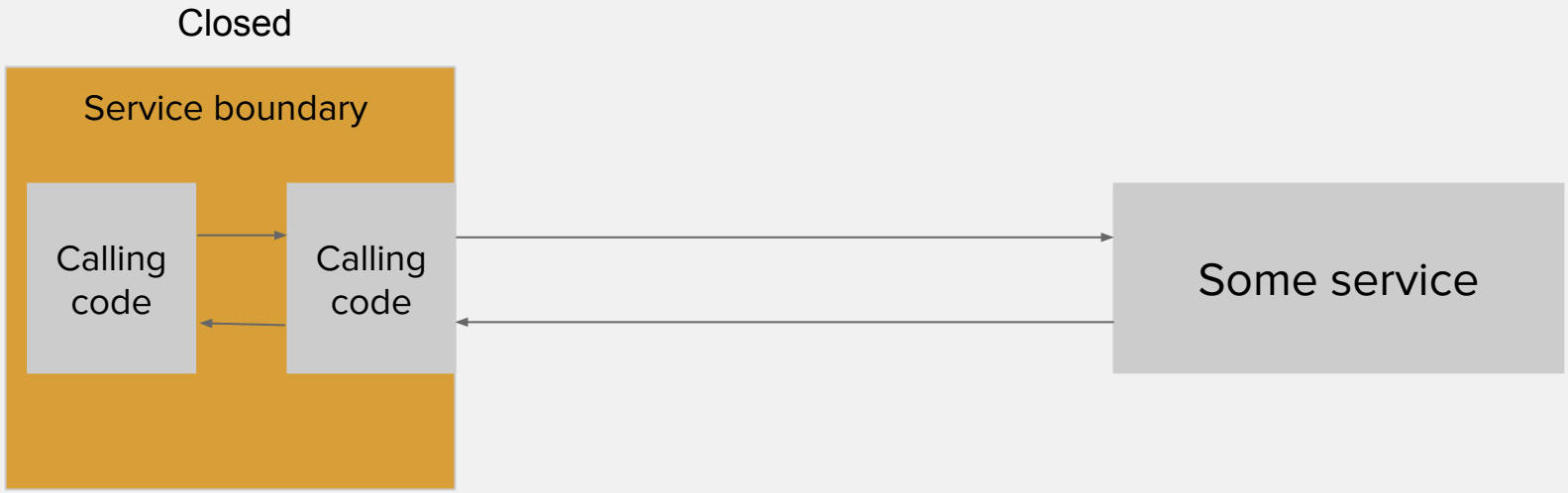
- prevents calls to integration points from causing blocked threads
  - cascading failures
- thread / connection pools
- consider delayed retries / queueing
  - Beware of Acts of self-denial

CIRCUIT BREAKER

“don’t do it if it hurts”

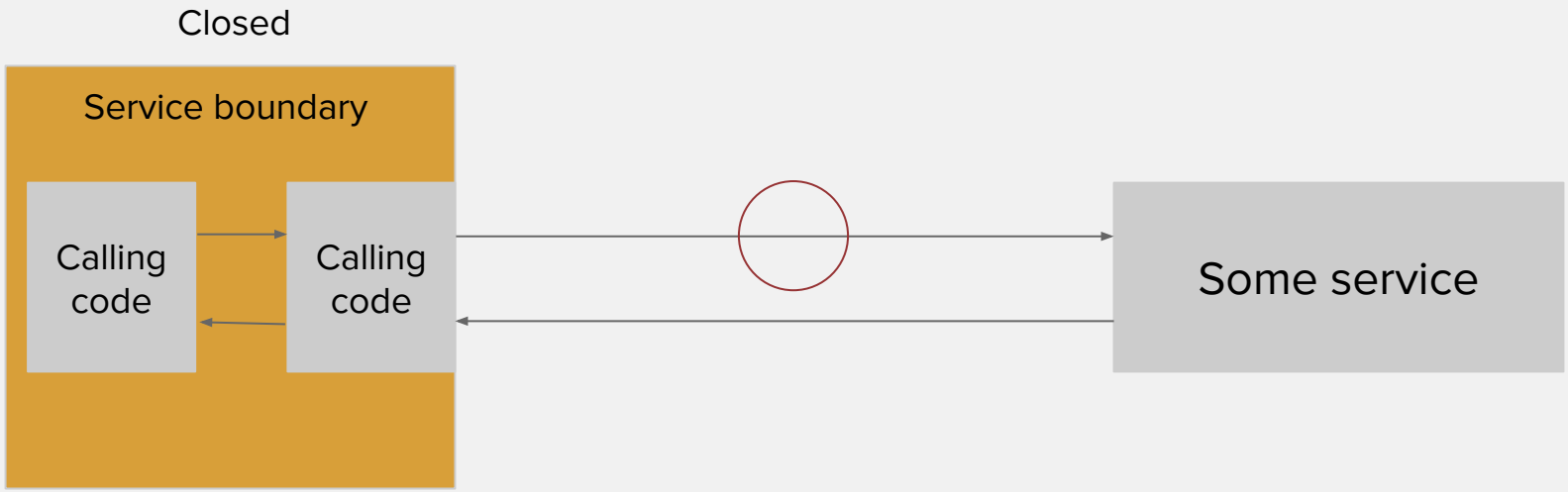
CIRCUIT BREAKER

Service functions normally



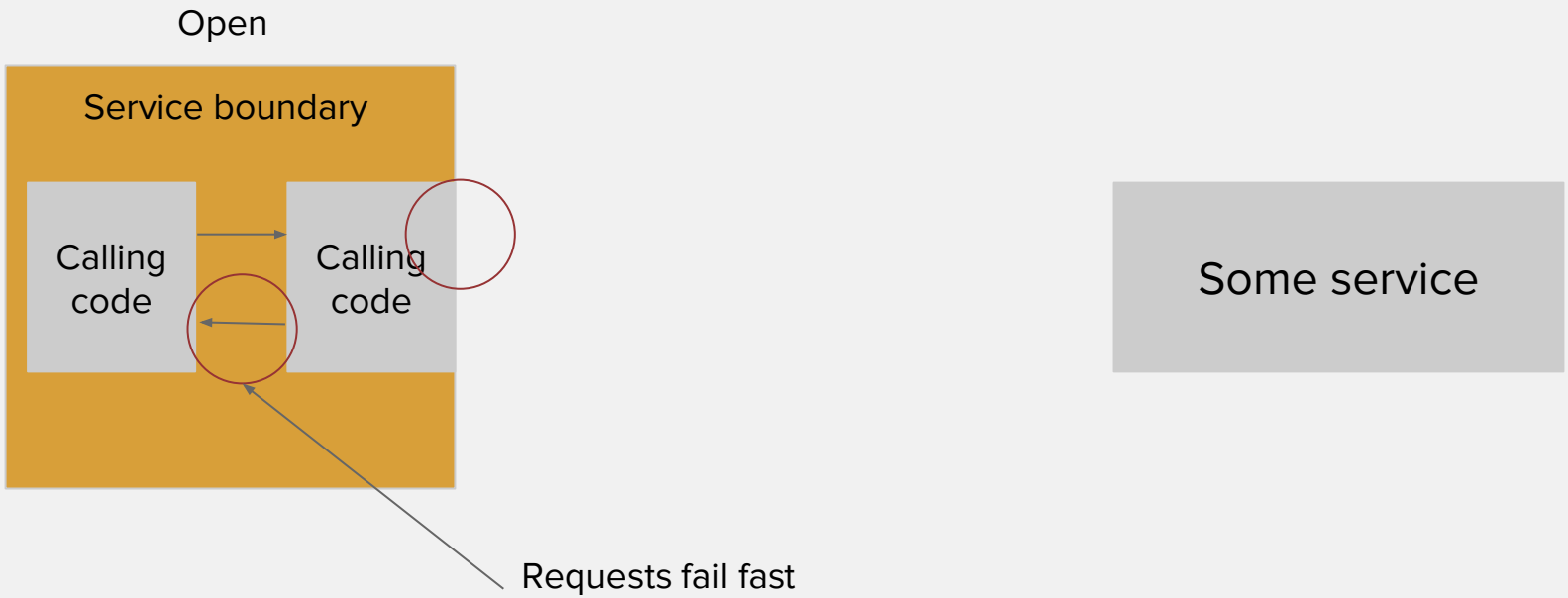
CIRCUIT BREAKER

Calls starting to timeout or returning errors



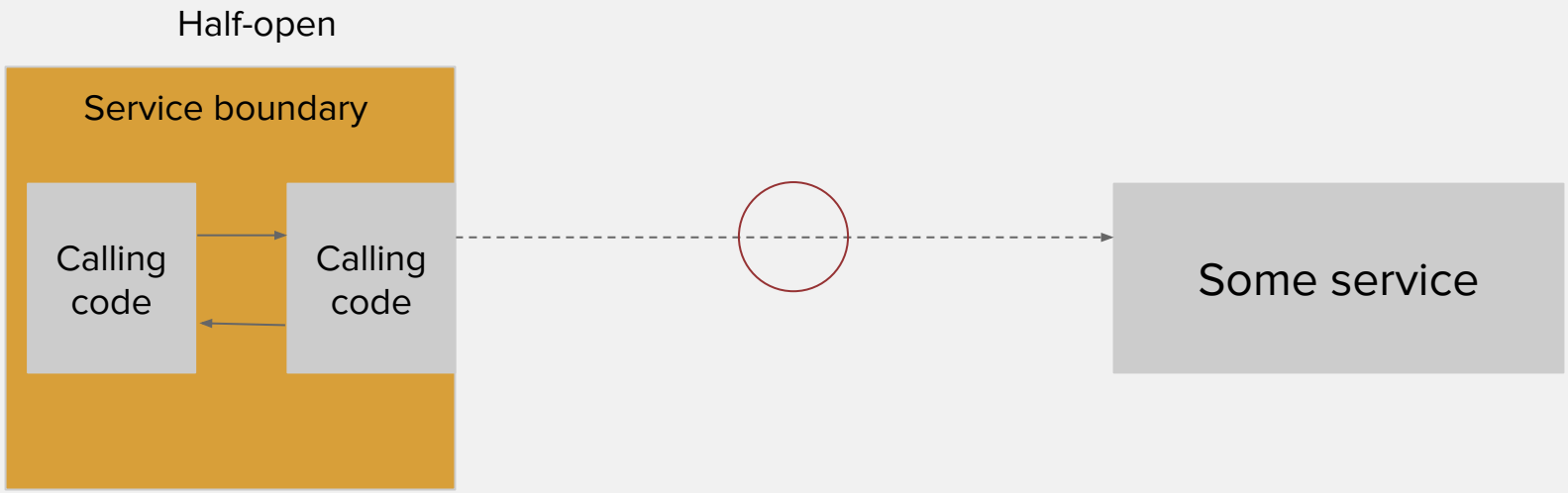
CIRCUIT BREAKER

Connection stopped when threshold reached



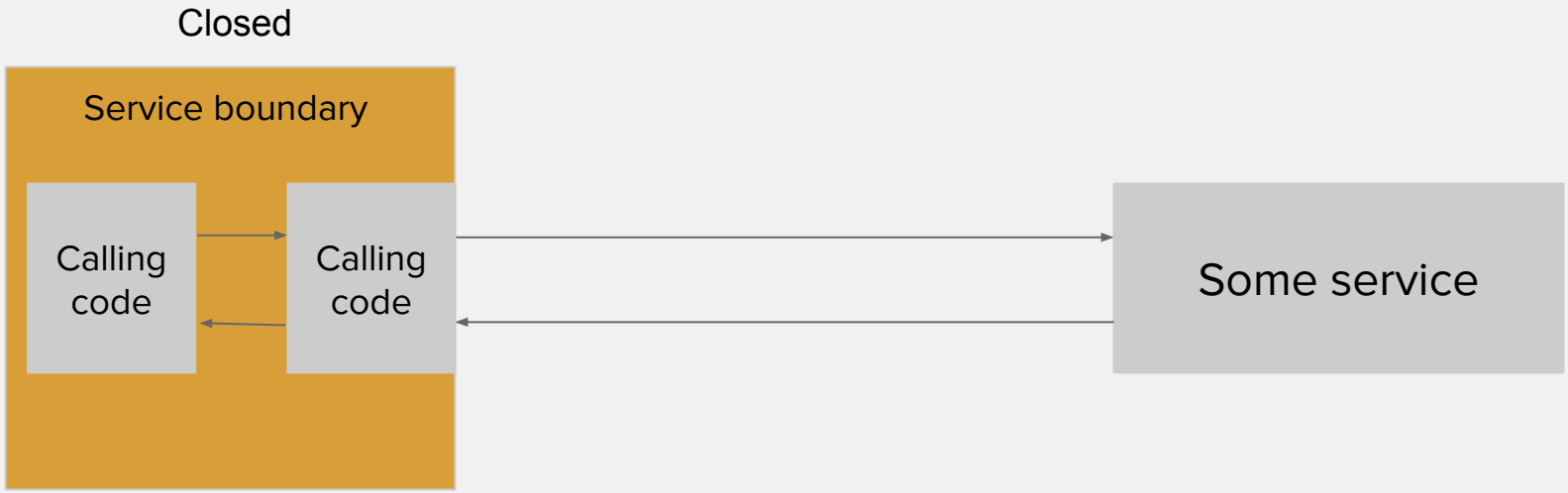
CIRCUIT BREAKER

Retry after grace period, or occasional health check



CIRCUIT BREAKER

Connection reset when healthy threshold reached

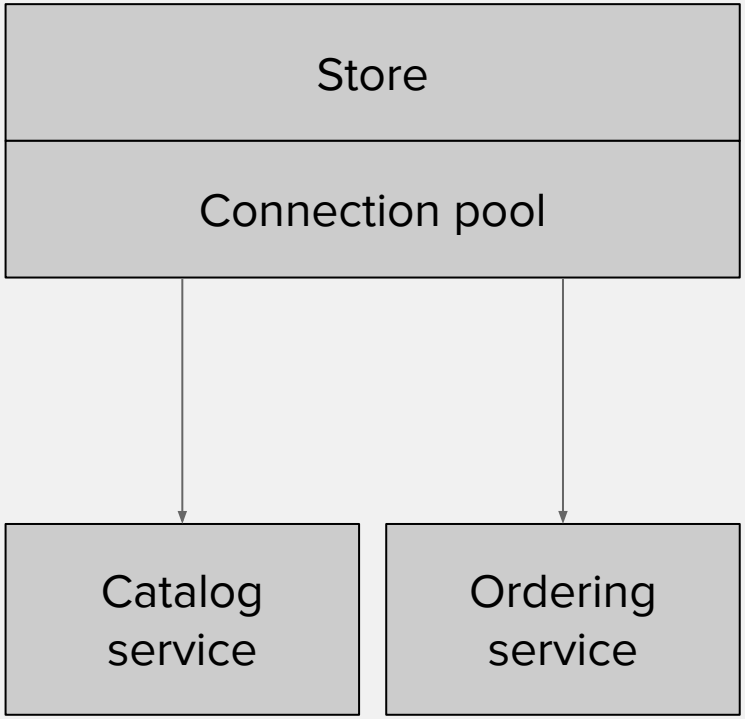


BULKHEADS

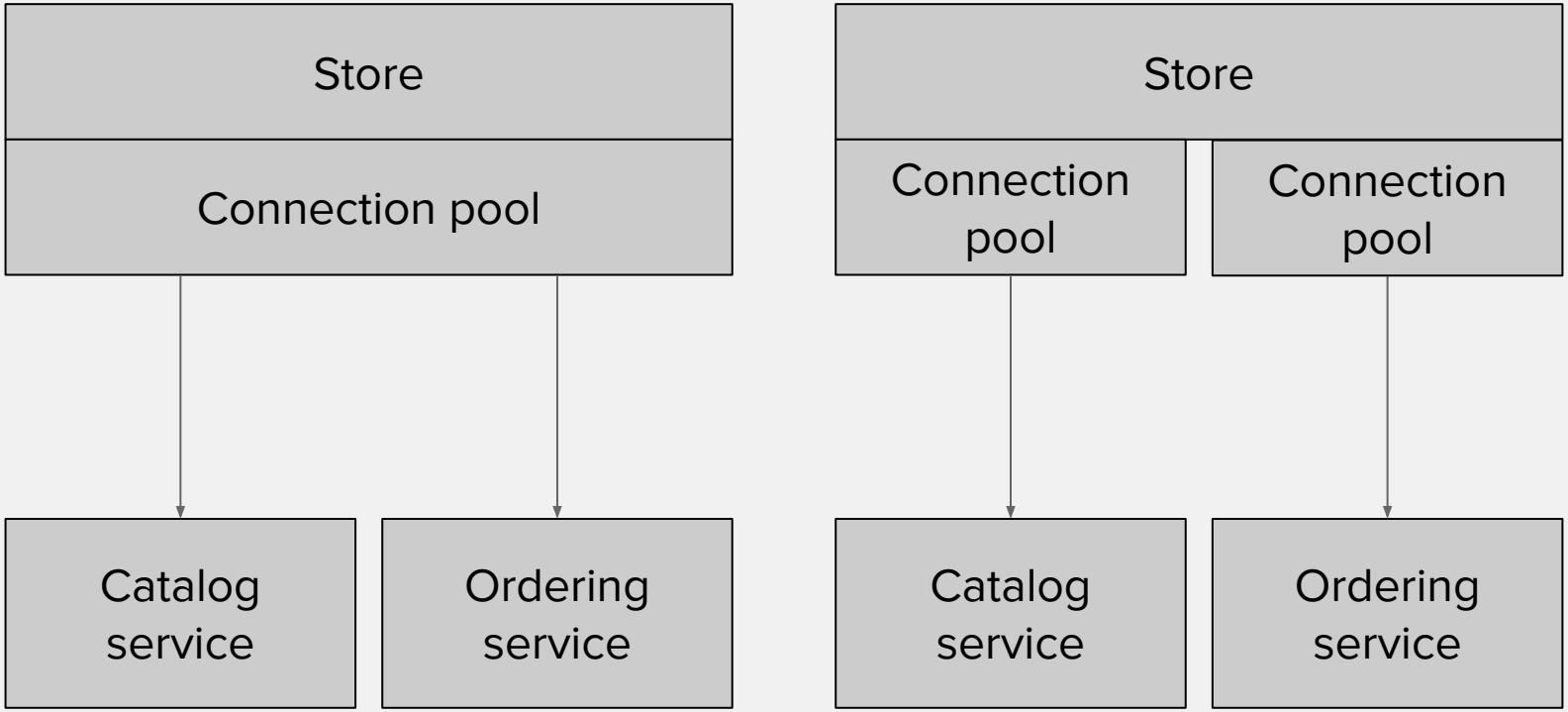
isolating from failure

- Separation of concerns (separate service)
- Separating thread/connection pools

BULKHEADS

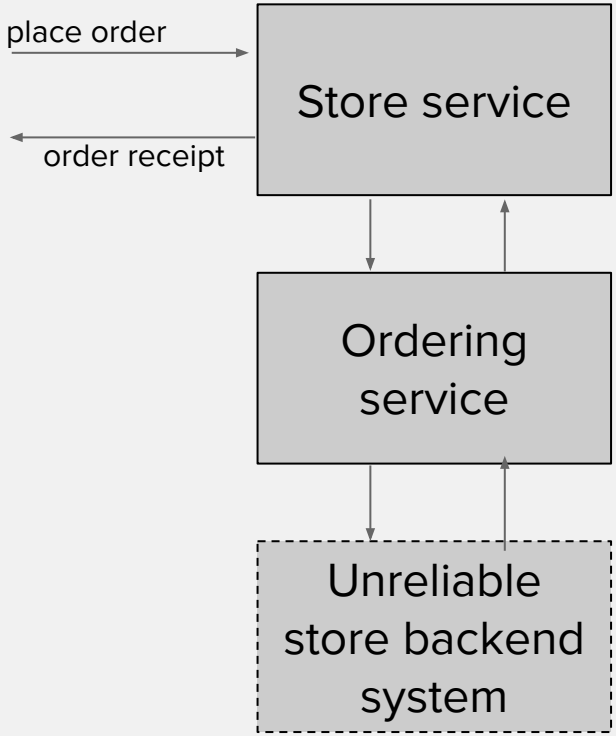


BULKHEADS



DECOUPLING MIDDLEWARE

enable message processing in different place and time



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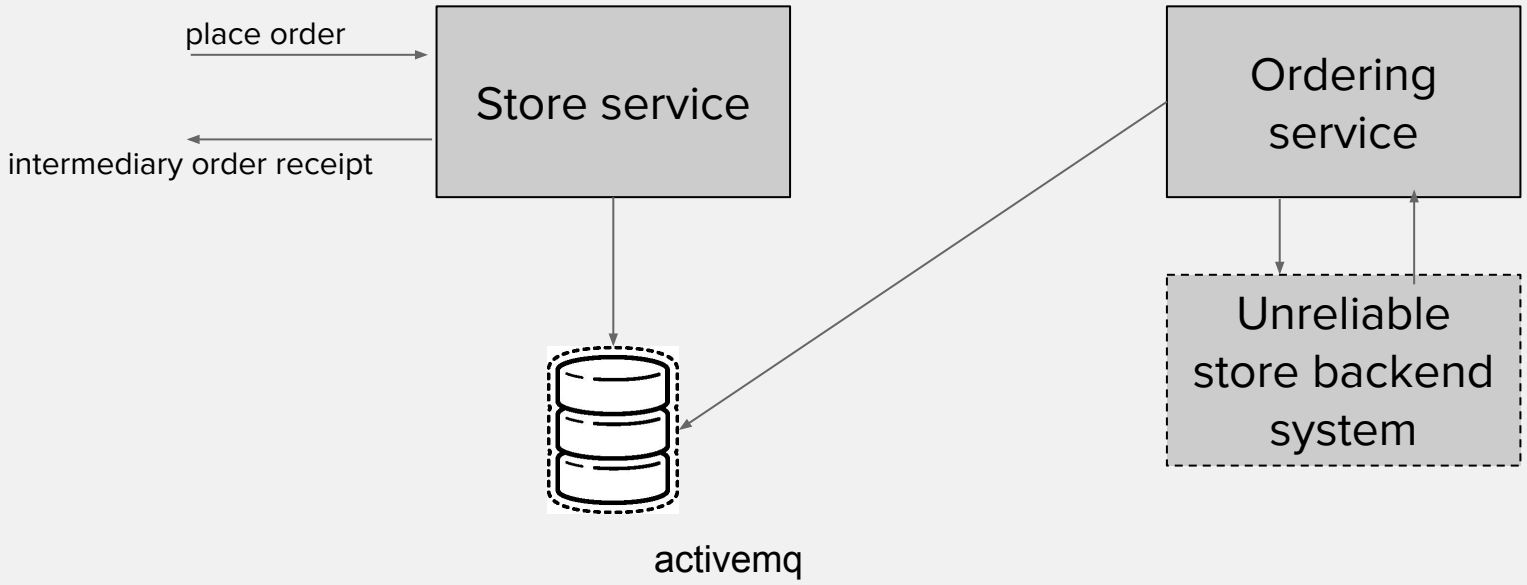


IDEMPOTENCY

and eventual consistency

IDEMPOTENCY

PUT http://order-service/order

```
{
  “customer”: {
    “name”: “John Doe”,
    ...
  },
  “items” = [
    {“storeId”: 1000, “itemPrice”: 99.90, “amount”: 2}
  ]
}
```

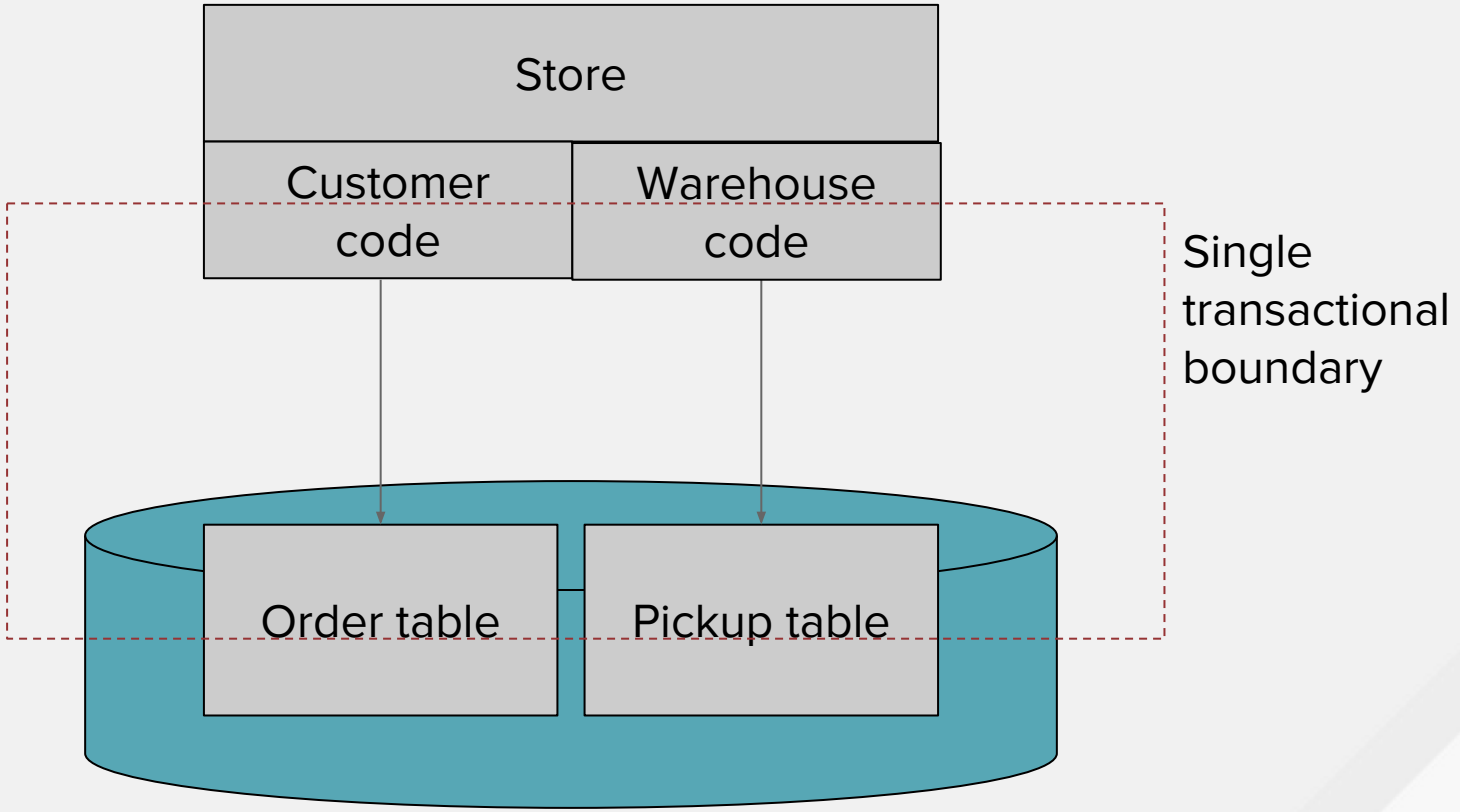
IDEMPOTENCY

PUT http://order-service/order

```
{
  “uuid”: “12de-adbe-ef42”,
  “customer”: {
    “name”: “John Doe”,
    ...
  },
  “items” = [
    {“storeId”: 1000, “itemPrice”: 99.90, “amount”: 2}
  ]
}
```

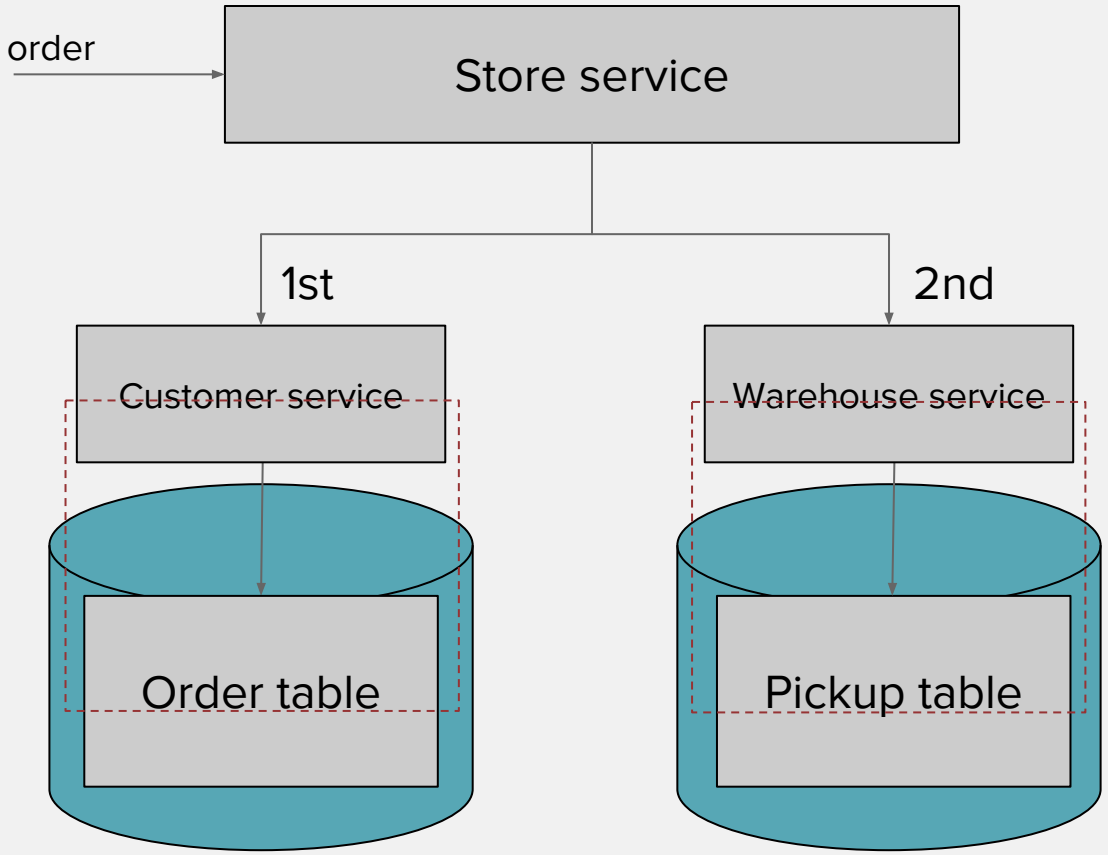
COMPENSATING TRANSACTIONS

Monolithic service



COMPENSATING TRANSACTIONS

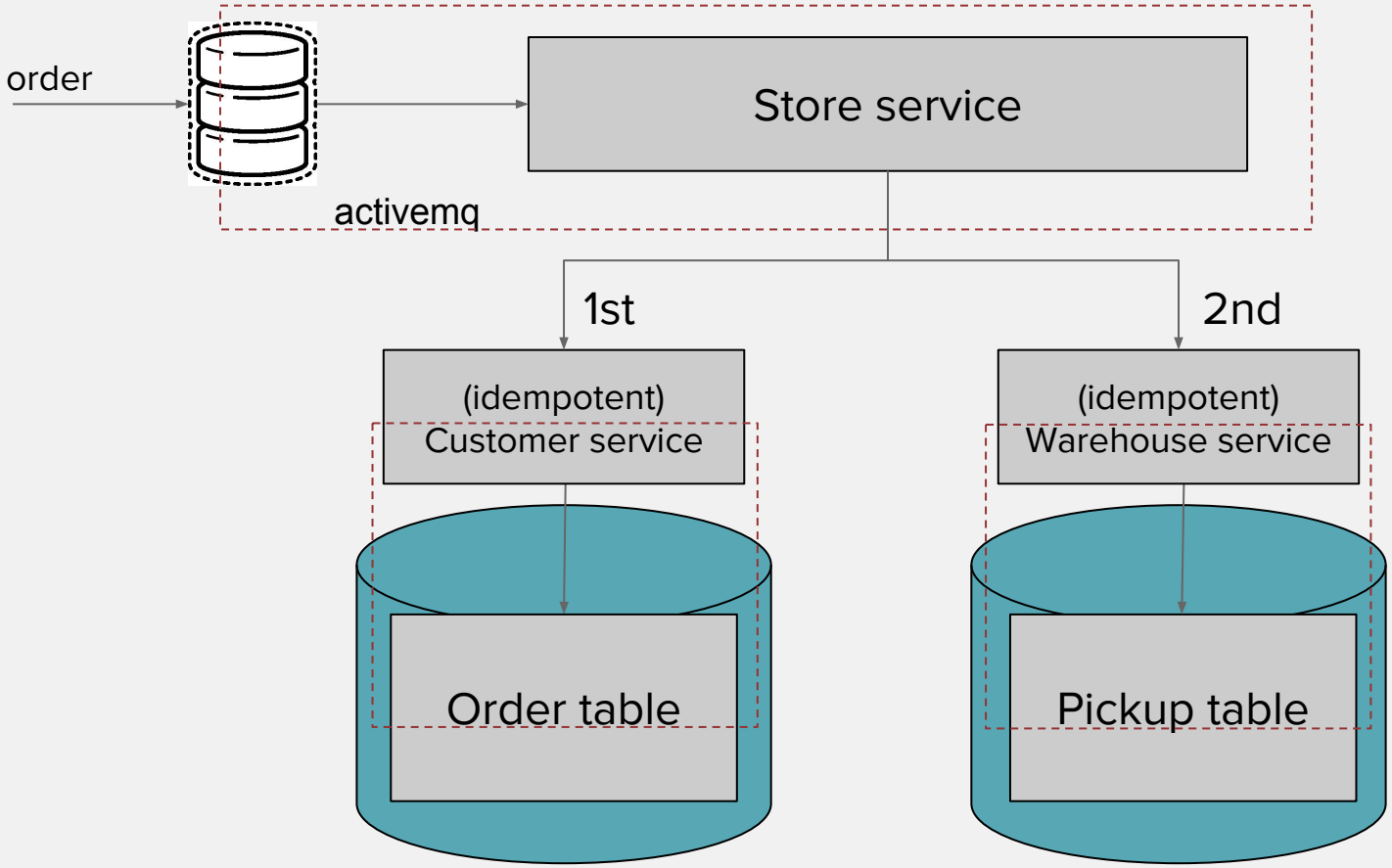
Separate services



Separate transactional boundaries

COMPENSATING TRANSACTIONS

Compensating Transactions



COMPENSATING TRANSACTIONS

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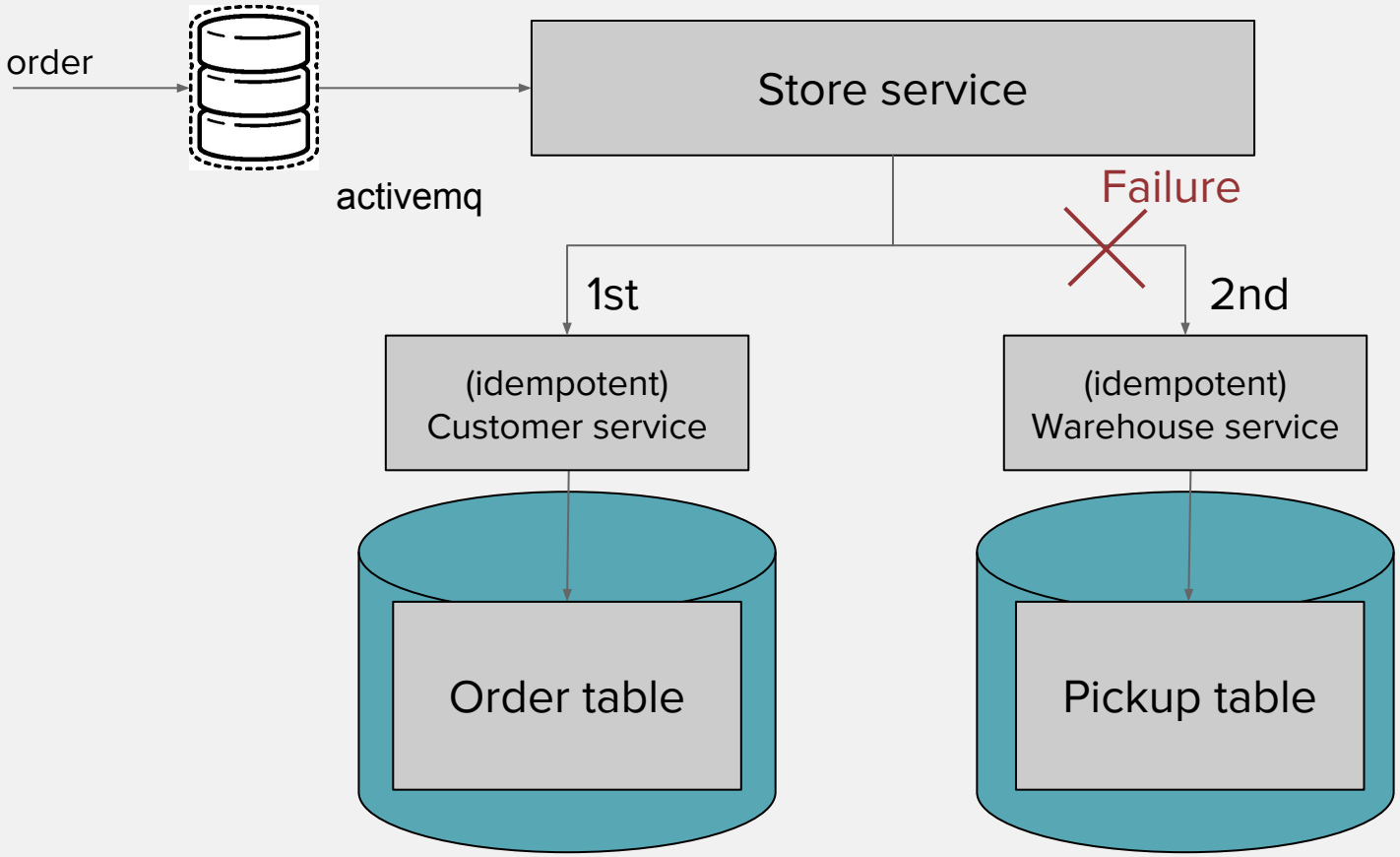

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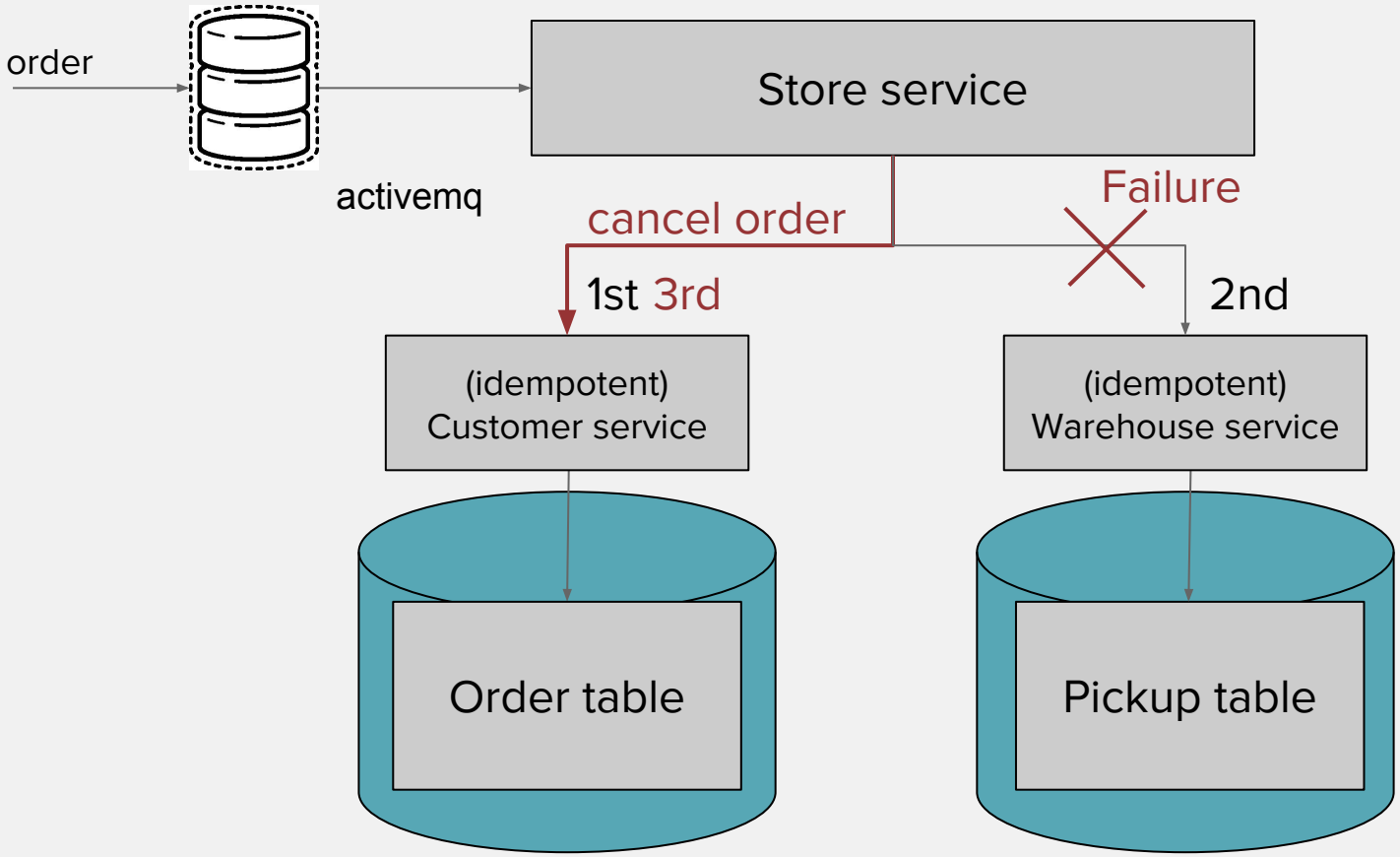


Summary

MICROSERVICE BENEFITS

INDEPENDENT COMPONENT SCALING

CONTINUOUS AND DECOUPLED DEPLOYMENTS

SMALL AND AGILE DEV TEAMS

MICROSERVICE TRADE-OFFS

DISTRIBUTED SYSTEM

EVENTUAL CONSISTENCY

OPERATIONAL COMPLEXITY

MICROSERVICE TRADE-OFFS

DISTRIBUTED SYSTEM

Design for failure

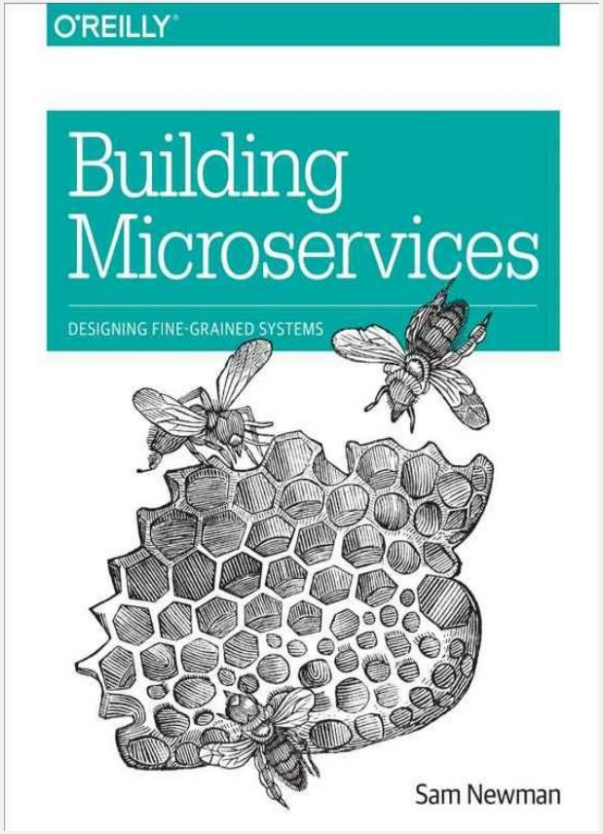
EVENTUAL CONSISTENCY

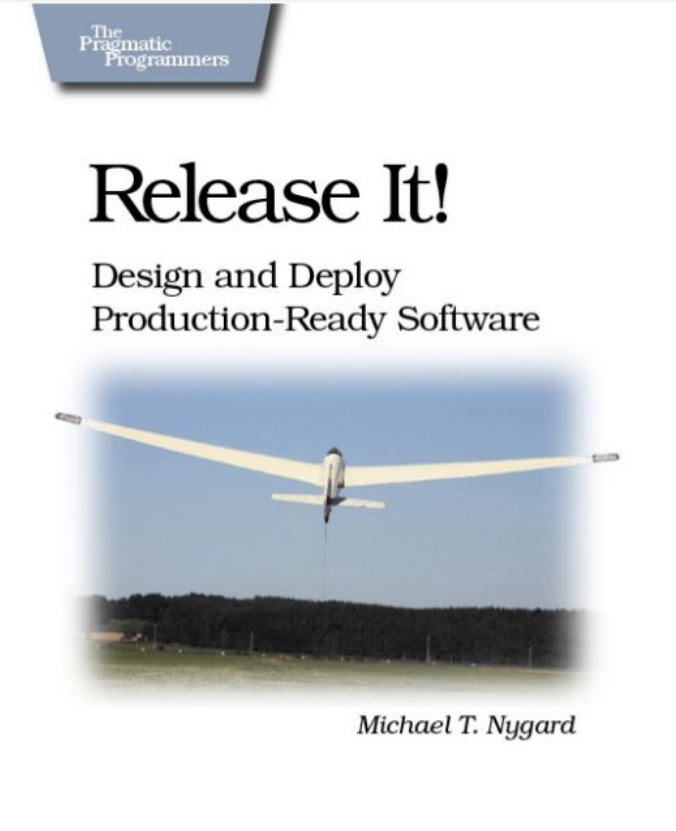
Carefully consider consistency requirements

OPERATIONAL COMPLEXITY

Embrace immutable infrastructure, automate

Further reading





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