ACP / 3 + 4

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Welcome again

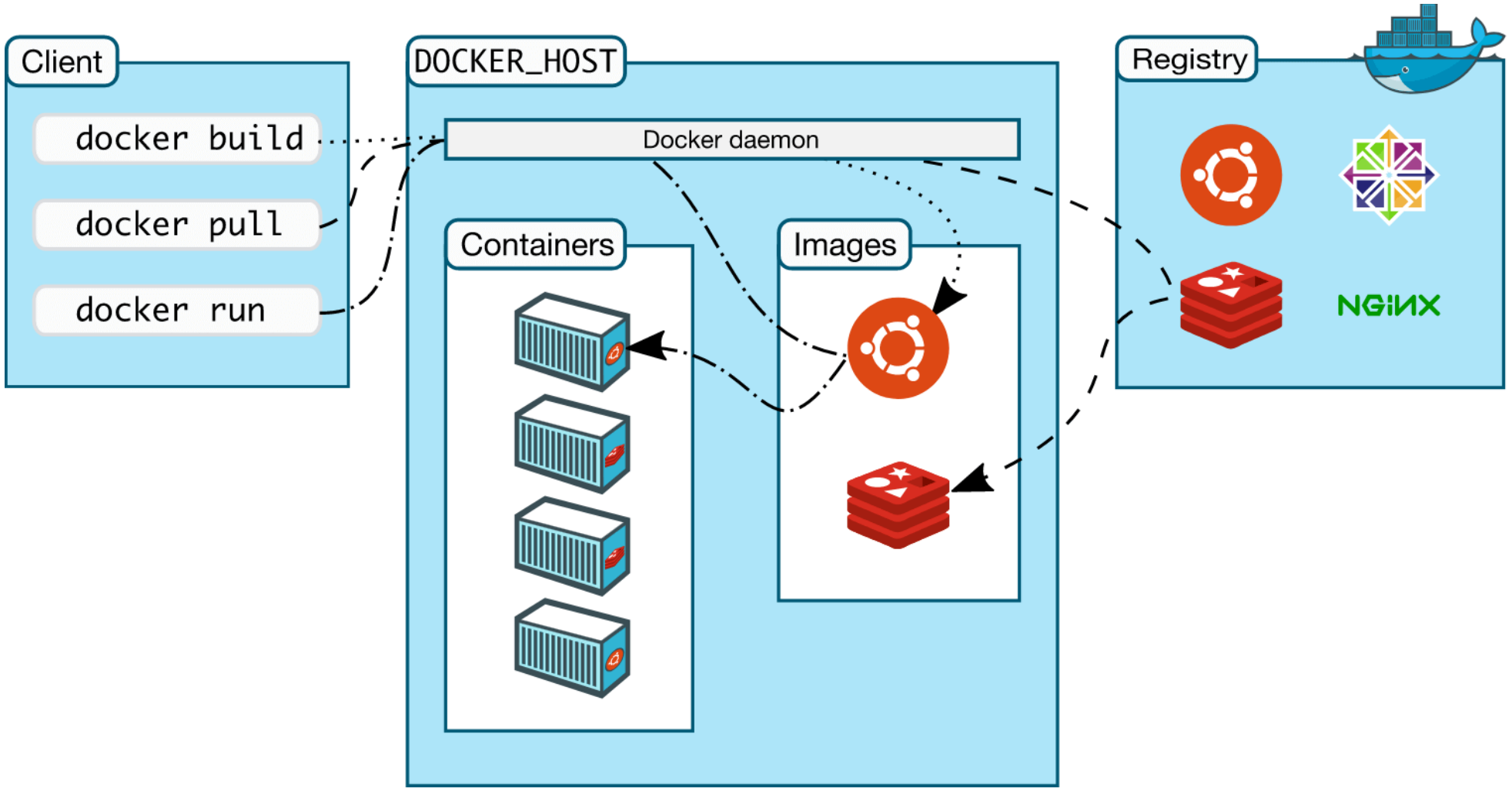
- A bit about containerization
- Introduction to microservices
- Communication protocols / patterns / methods
- JSON
- REST in more detail
- REST techniques

Containerization - how

- OCI based
  - https://opencontainers.org/about/overview/
  - https://opencontainers.org/community/overview/

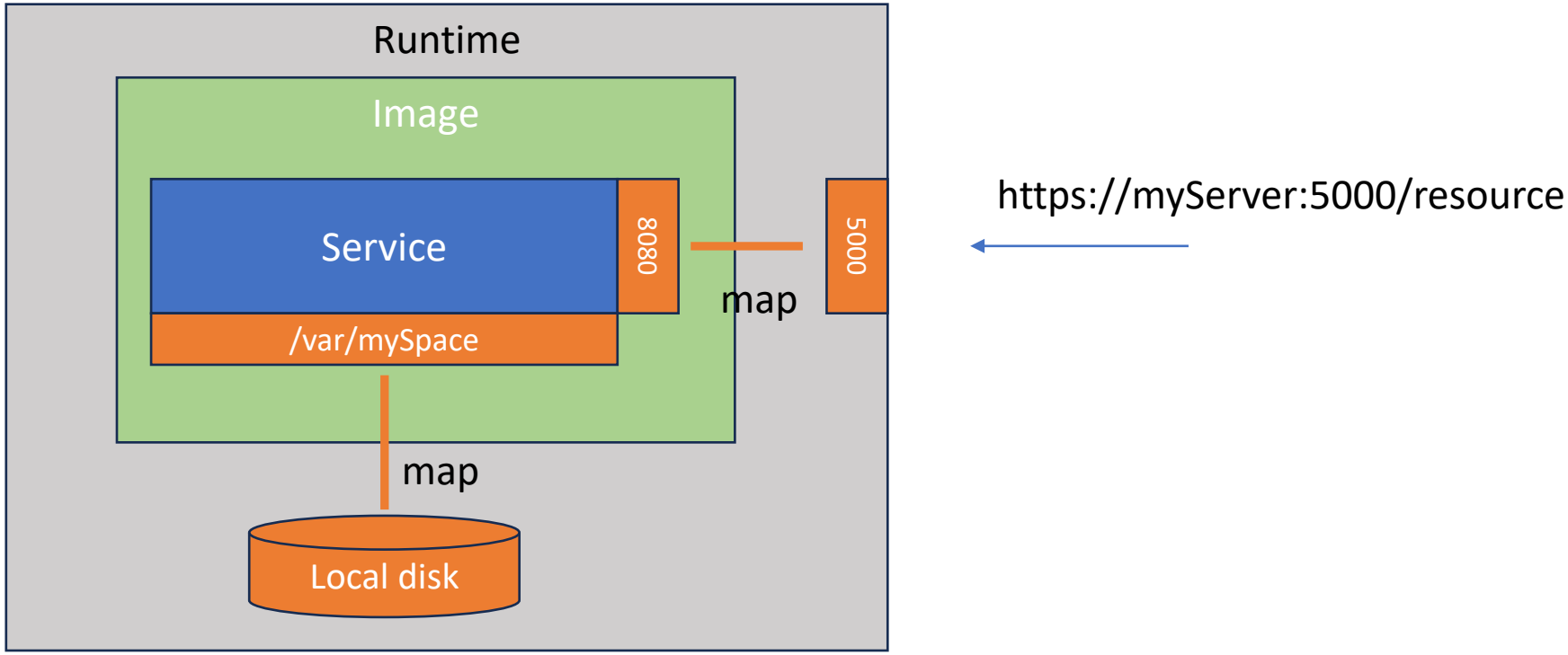
- Images form the runnable applications
- Are loaded on demand
- Executed when needed
- All networking is mapped
- File system access is mapped to volumes

docker

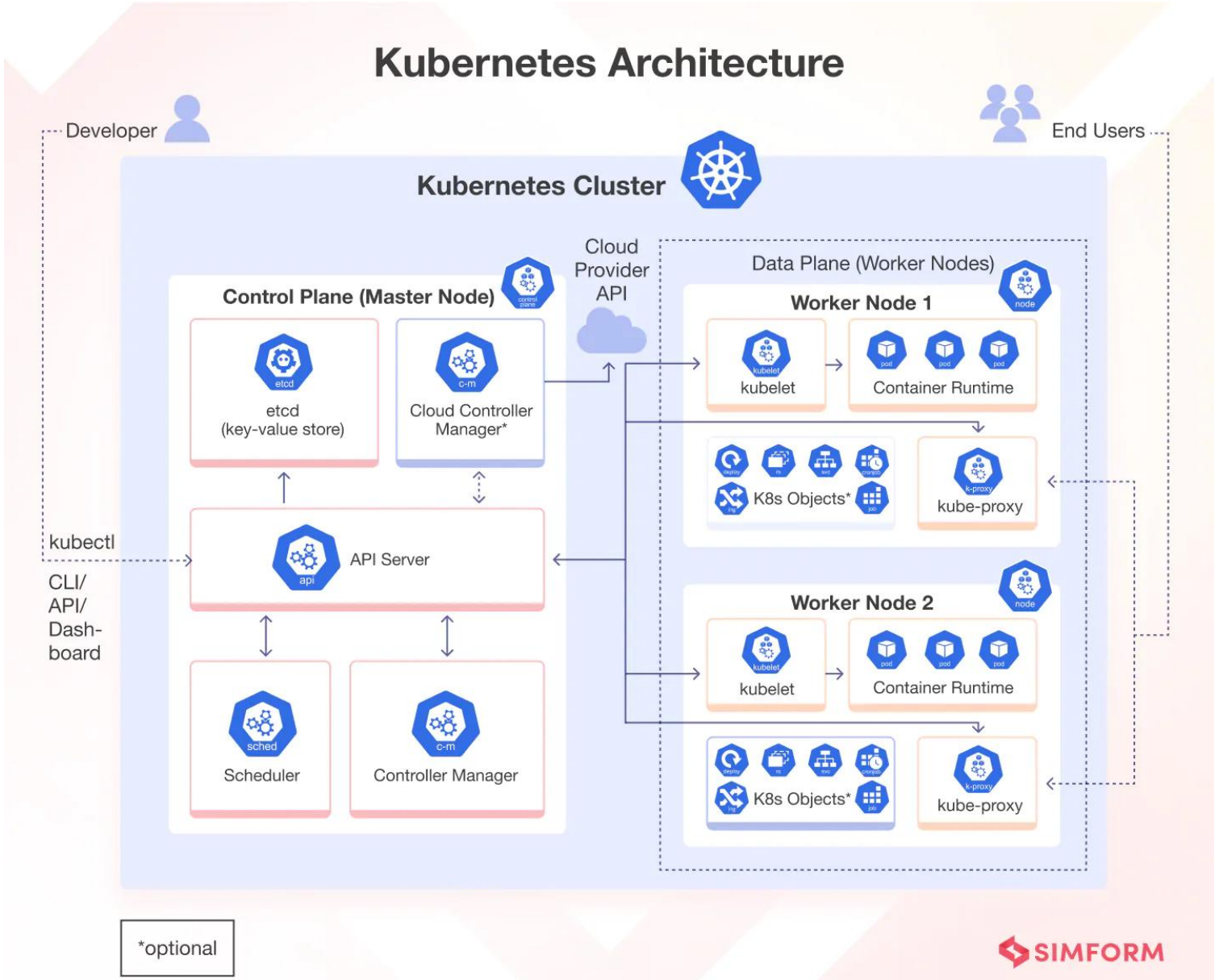


https://www.cherryservers.com/blog/a-complete-overview-of-docker-architecture

A microservice in docker



Kubernetes



https://www.simform.com/blog/kubernetes-architecture/

Communication styles in general

- Synchronous
- Asynchronous

Asynchronous

- One-to-one
  - Async request / response
  - One way notifications
- One-to-many
  - Publish / subscribe
  - Publish / async responses
- Issue Request - Response will arrive at some time
  - or never -> error handling is crucial
  - Sometimes "fire and forget" is intended (status updates) -> like UDP
  - Usually handled with promises (e.g. JavaScript and AJAX) in client-programming

Asynchronous

- True async response handling is tricky
  - Where does the server send the response to?
    - Web-Callback ajax, async await
    - Polling (yes, an ugly word, but sometimes useful and cheap – like a Spin-Lock Semaphore)
  - Signal-R (Chat, Async notifications, mostly done using UDP)
- Often the client starts a "sync" background thread to wait for the answer to simulate async behaviour
- Messaging is async by design (Kafka, MQ, AQMP, …)
  - And reliable

Synchronous

- Request -> Response with wait
  - Causes blocking of the requester until response arrives or timeout
- Can be achieved with "promises" in asynchronous manner as well
  - https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Promise
- Sometimes the easiest and most useful to do
  - e.g. logon -> you really want to wait until you get the response
- In general, avoid if you can
  - Load issues, scaling, resource blocking

Architectural styles (not all…)

- Monolith
  - Single process
  - Modular
  - Distributed
- Service oriented architectures (SOA)
  - Services collaborate to achieve some capabilities
  - Often shared databases
  - Larger logical blocks ("services")
  - Scaling often only on the service-level
    - not the service as such on several nodes / services often cannot be spread out

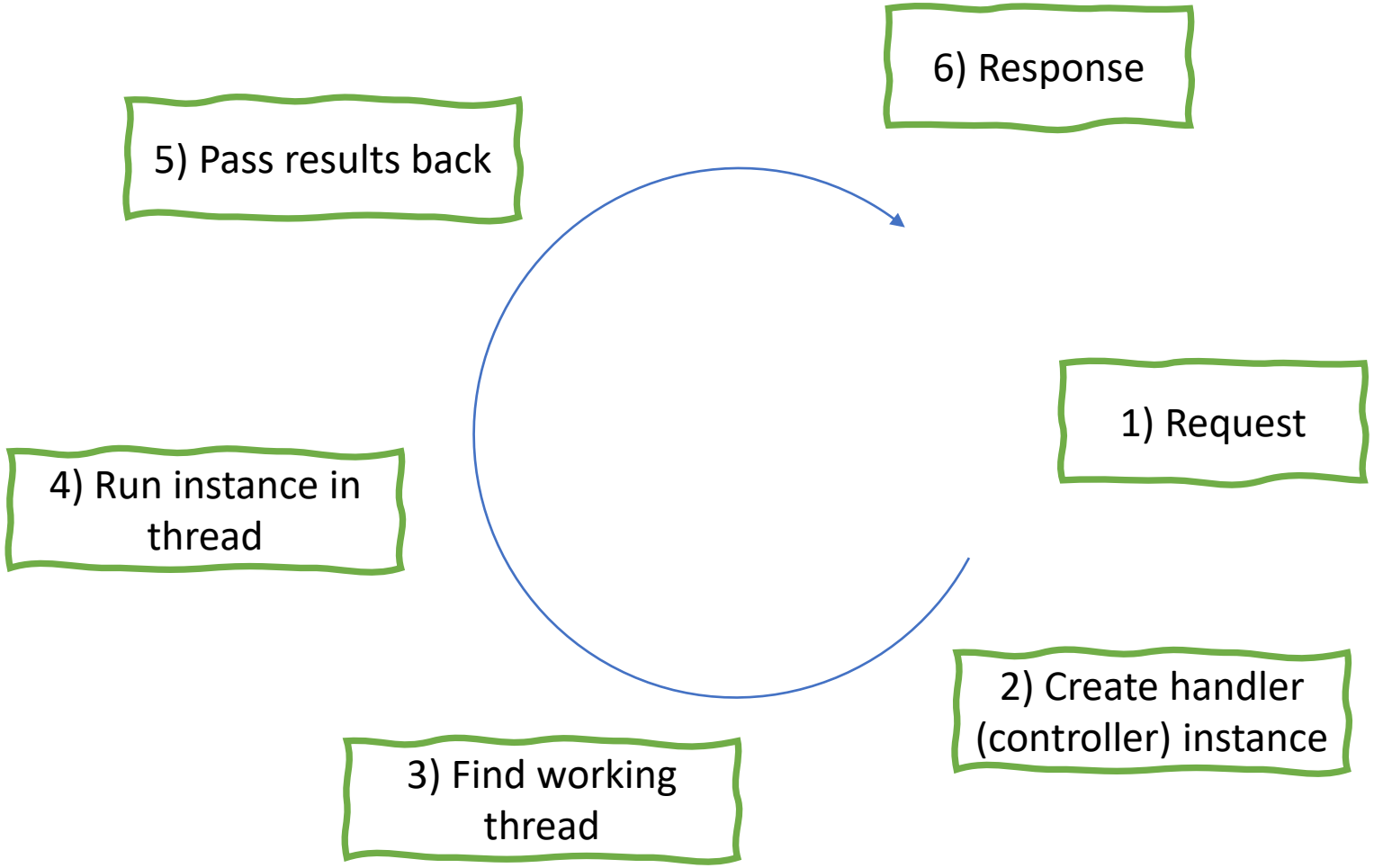
Architectural styles /2

- Microservices
  - Simple
  - Meshes
- Flow
  - Event based

Introduction to microservices

- https://microservices.io/
- Independent releasable / deployable services
- Should model a business domain - "DDD"
- All functionality and data is encapsulated
  - Each service has its own data / function
  - "Information hiding"
- All functionality and data is made available to others via networks (as API)
  - The word API is very confusing sometimes…
- Loose coupling / High Cohesion
- Be forgiving…

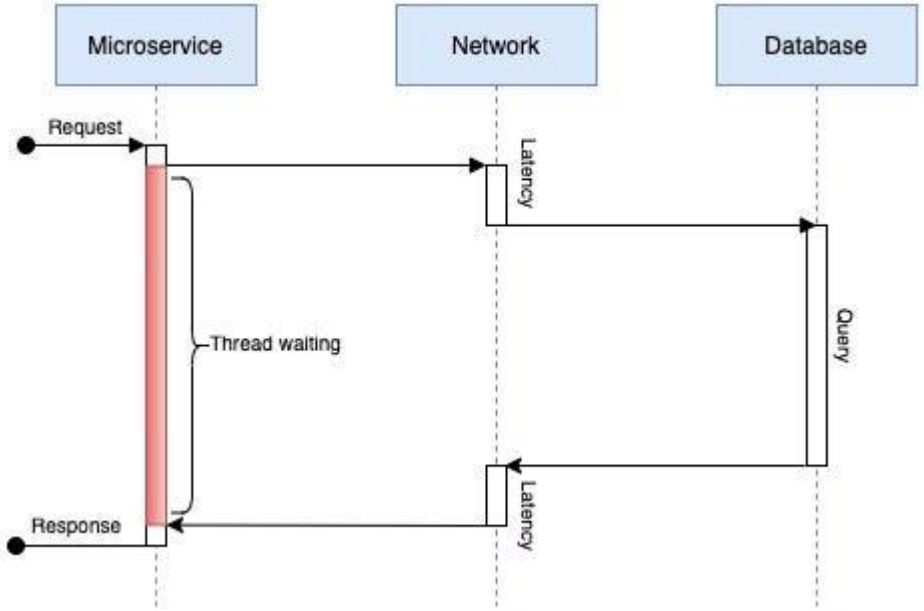
The structure of a microservice



Microservices structure

- Spring Boot uses Tomcat
  - Some limitations (https://oskar-uit-de-bos.medium.com/the-performance-challenge-in-java-microservices-e51cce3977e9)
- Blocking threads and consuming resources

Tomcat, which only has 200 thread pools and more load require horizontal or vertical scaling

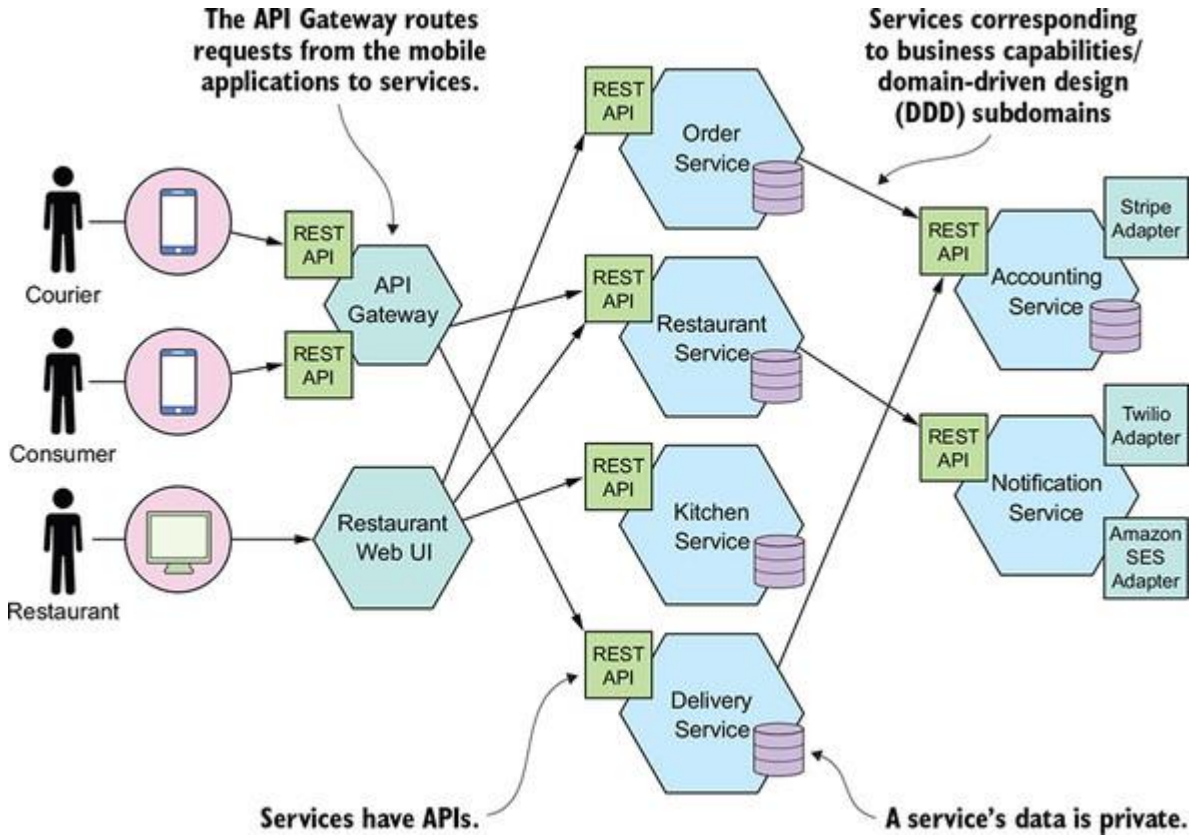


Microservice styles (some of them)

- Point to point (mesh)
- Event based

Point to point - mesh

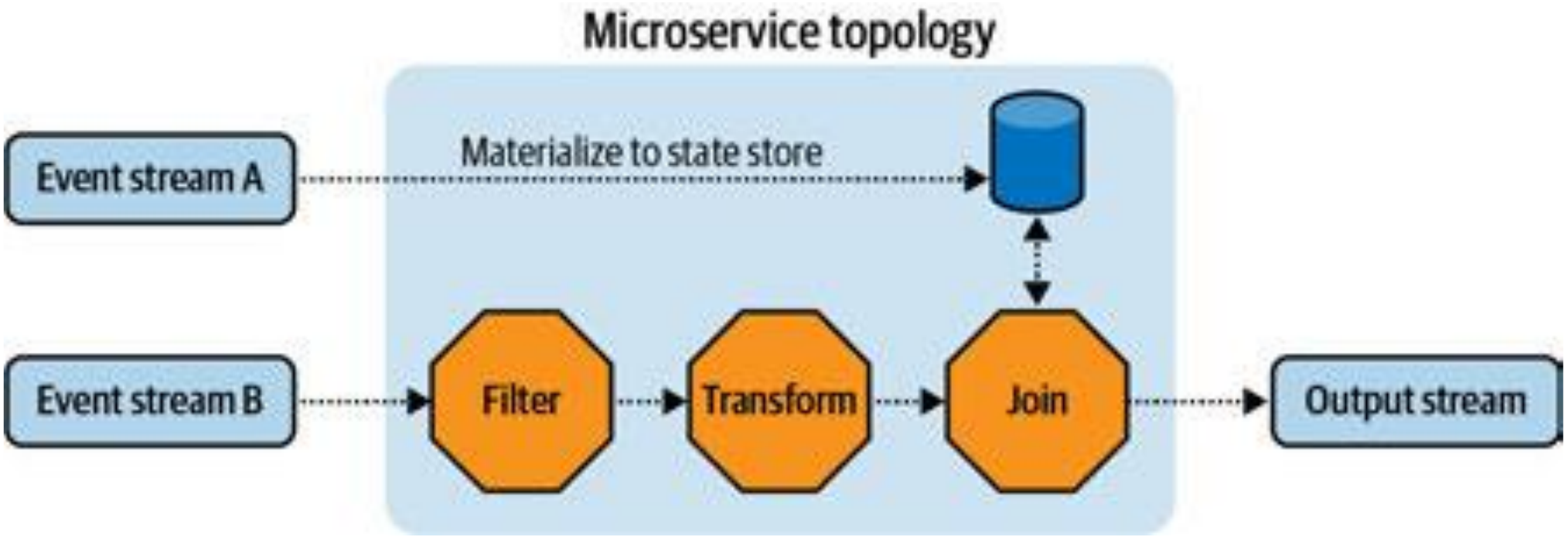
The issue with correlating logs of different services. Use correlation id



https://livebook.manning.com/book/microservices-patterns/chapter-1/106

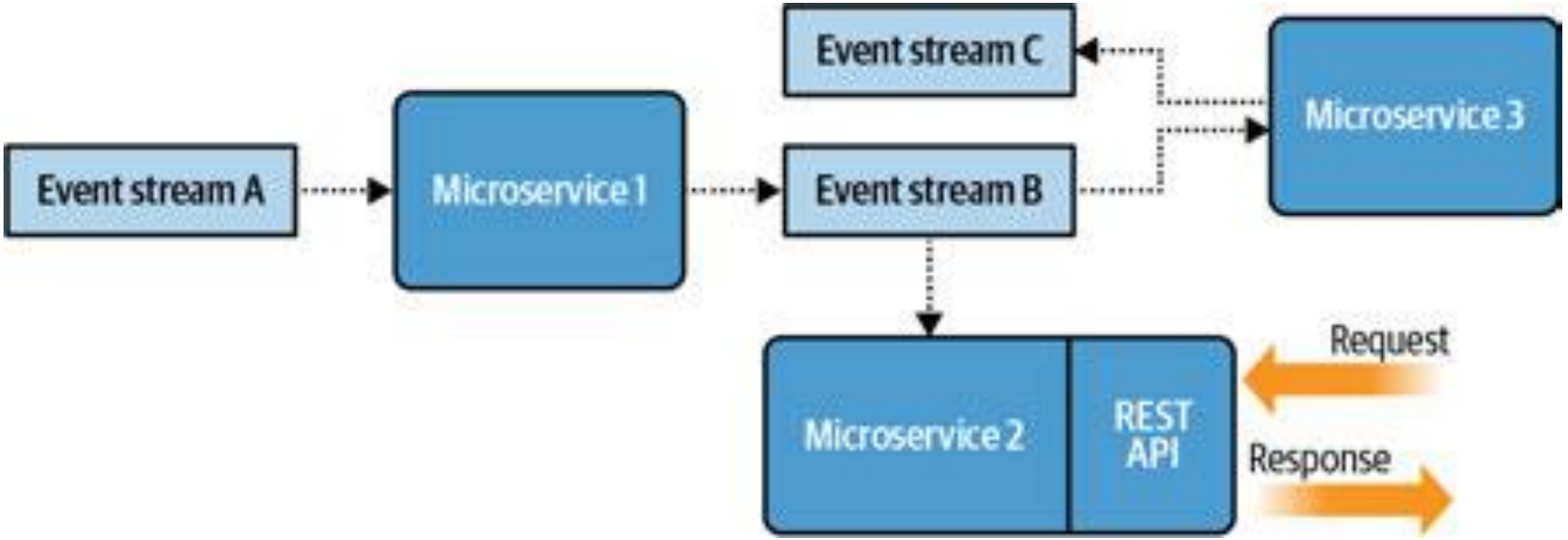
Event is created and it may or may not be executed

Event based architecture



https://eu01.alma.exlibrisgroup.com/leganto/public/44UOE_INST/citation/45644351890002466?auth=SAML

Event based architectures /2



https://eu01.alma.exlibrisgroup.com/leganto/public/44UOE_INST/citation/45644351890002466?auth=SAML

Alternatives to microservices

- Monolith
- Service Oriented Architecture (SOA)
  - Well, microservices are a kind of SOA
  - Sometimes, when microservices become macroservices (yes…) the border blurs
- Pure flow architectures (an extension to event based)

Monolith vs microservices

- Choose the right architecture for the right usage
- Monolith doesn't mean bad – it is a choice
- Can be super powerful, if done right
- Very little effort and loads of benefits
- Don't underestimate microservices – they are harder and more complex as it seems
- Not every new idea is "the killer" for older stuff

Communication protocols

- Request - Response
  - **gRPC**
  - http native
  - SOAP
  - **REST**
  - **GraphQL**
- Messaging
  - **Kafka**
  - MQTT
  - Pulsar
  - AMQP (RabbitMQ, …)

3 docker images needed, zookeeper, broker, connector, while AMQP is simpler protocol with only one docker image to run

Protocols / http based

- text-content
  - requests / responses in plain text

  - REST
  - SOAP
  - GraphQL

- gRPC
  - http/2
  - http/3

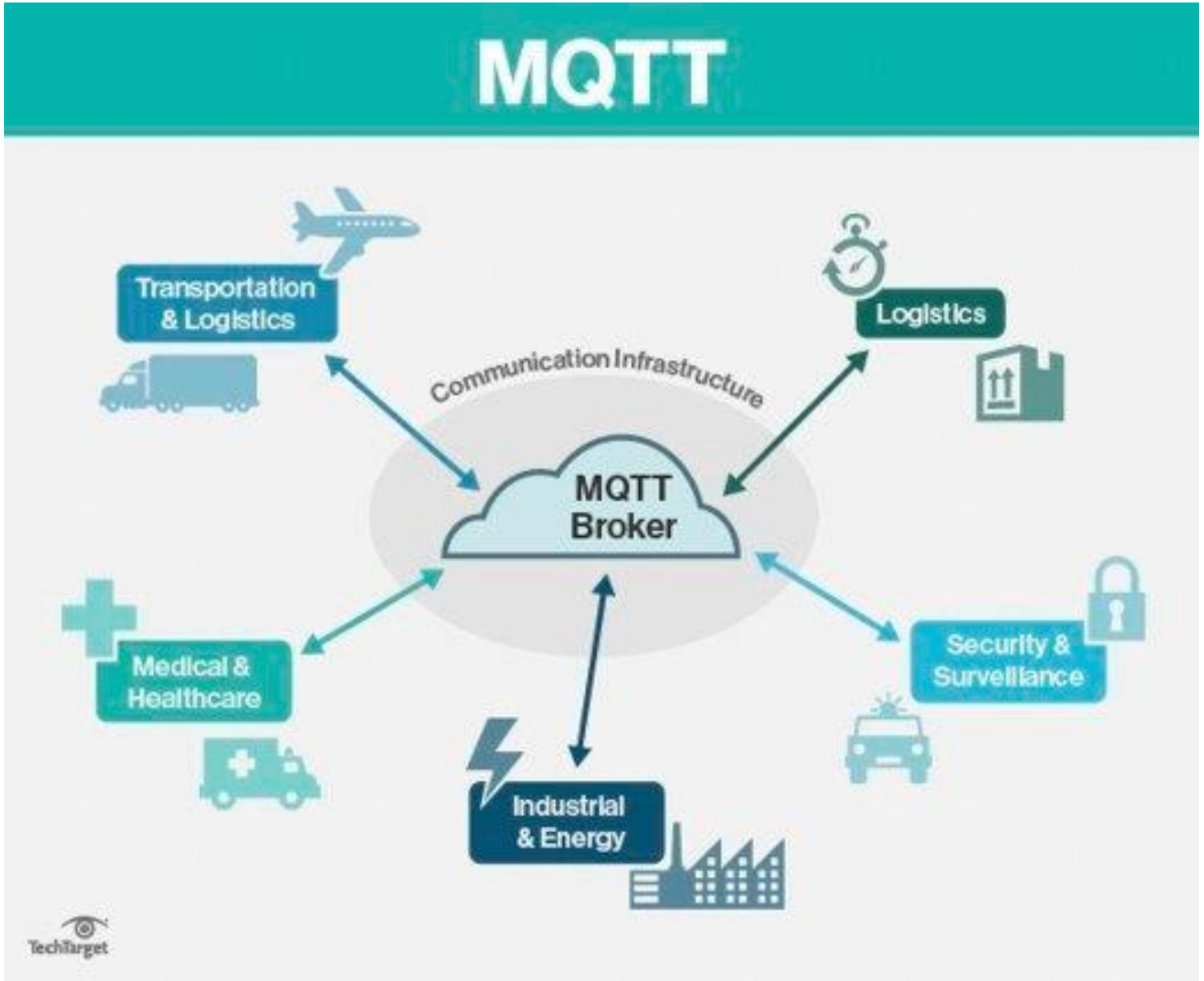
Supports stream

MQTT

- A lightweight (initially sending oil-rig telemetry data to a home-station via satellite) **publish / subscribe** messaging protocol for M2M communication
- http://www.steves-internet-guide.com/mqtt/

MQTT

power or transformation stations have small radio links on the roof.
Most of them use Mqtt because it's a very small bandwidth protocol.
You can use it over. GPRS. Easily.
You can easily even use it with 9,600 baud

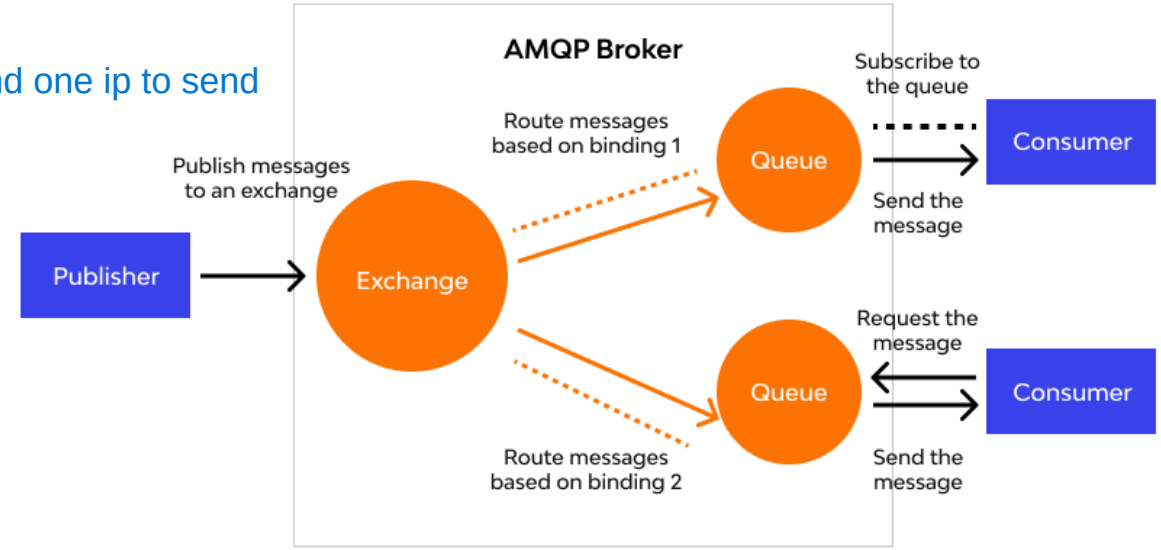


https://www.techtarget.com/iotagenda/definition/MQTT-MQ-Telemetry-Transport

AMQP

- AMQP = Advanced Message Queuing Protocol
- Similar in many things to i.e. Kafka
- RabbitMQ (and easier than Kafka)

Simple compared to Kafka as it only required one docker image and one ip to send and receive message. Suitable for coupling two systems



Messaging alternatives

Feature	RabbitMQ	Apache Kafka	ActiveMQ
Messaging Model	Traditional	Publish/Subscribe	Traditional
Scalability	Clustering/Network of Brokers	Partitioning	Clustering/Network of Brokers
Performance	Moderate	High	High
Data Persistence	On Disk (default), In-memory	On Disk	On Disk (default), Database
Integration	Programming Languages, Databases, Web Servers	Data Processing Systems, Databases, Data Sources	JMS Clients, Apache Camel, Apache CXF
Suitable For	Strict Ordering, Reliable Delivery, Moderate-High Message Rates	Streaming Data, High Message Rates	High Data Durability, High Performance

https://medium.com/javarevisited/difference-between-rabbitmq-apache-kafka-and-activemq-65e26b923114

JSON

- https://www.json.org/json-en.html
- Lightweight, human readable data-interchange format
- JSON vs XML: https://json.org/example.html
- Downsides:
  - No error handling
  - Less expressive and flexible than XML
  - No comments, namespaces, attributes (hard to add metadata)
  - No versioning
  - No security
  - No XSD
- But… Everybody knows it, everybody uses it…

Tools to test microservices

- REST
  - Postman
  - curl
  - Swagger

Fiddler for testing network packets that are exchanged which is not available in Postman

- gRPC
  - gRPCurl
  - Postman

- Kafka
  - Command line (shell) tools

Running a microservice in docker

- One service / image
- Sidecar as an option
- Showing a small example

Technically a sidecar is just another container that shares resources like network and disk, etc. with another container. It's just a pattern, so you could replicate it if you like. However. If your use of docker is getting to the point where you want to start following a pattern like sidecars. I would recommend you start using something like kubernetes to orchestrate.

Example microservice in Java

- Main entry point: https://github.com/mglienecke/IlpTutorialRestService/blob/main/src/main/java/uk/ac/ed/inf/ilptutorialrestservice/IlpTutorialRestServiceApplication.java

Example microservice in C#

- https://learn.microsoft.com/en-us/dotnet/architecture/microservices/multi-container-microservice-net-applications/data-driven-crud-microservice

Example microservice in Go

- https://github.com/PacktPublishing/Microservices-with-Go

- Main entry point: https://github.com/PacktPublishing/Microservices-with-Go/blob/main/Chapter02/src/movie/cmd/main.go

How does this map to the Azure Blob API?

- https://learn.microsoft.com/en-us/rest/api/storageservices/blob-service-rest-api
- Azure Blob is a collection of endpoints in REST
- There presumably are several "controllers" which instantiate handlers for requests
- These perform the actual request and return the results

REST details

- HTTP methods: https://restfulapi.net/http-methods/
- Style
- URL
- Exchanging URLs (remote / local)
- Mocking
- Unit testing

General

- REST <> http
- REST is
  - Uniform
  - Stateless
  - Client-Server
  - Cacheable
- URL
  - Syntax: https://www.w3.org/Addressing/URL/url-spec.html#:~:text=URL%20syntax,in%20an%20a%20later%20section.
  - BNF: https://www.w3.org/Addressing/URL/5_BNF.html

http-methods

- https://restfulapi.net/http-methods/
- Mainly used is:
  - GET
  - POST
- Sometimes
  - PUT
  - DELETE (most businesses either use POST or do a "soft-delete" approach)
- Almost never
  - PATCH

REST-styles

- Query string
- Body (not for GET!)

Designing an API in REST

- Do it very careful as it will remain for a long time and cannot be easily changed
- API Management is a big issue in the industry
- RPC based designs
  - POST https://..../createOrder JSON data in Body
  - POST https://..../createOrderPosition JSON data in Body
- Resource based designs
  - GET https://.../resource/sub/identifier
  - PUT https://.../orders/ JSON data in Body
  - PUT https://.../orders/1/position JSON data in Body

Testing

- Unit-testing
- Integration-testing
- Round-trip testing System test

- Fitness functions

Mocking

- Development takes time – services even longer
- UI depends on services and often needs something to work with
- Mock to the rescue
- What is mocking?

gRPC

- https://piotrminkowski.com/2023/08/29/introduction-to-grpc-with-spring-boot/
- Protobuf as definition
- grpcUrl
- Sample proto files

Create a service with REST and gRPC

Combined services (multi-protocol)

- The ability to handle several protocols in the same service
- Often REST + gRPC
- Alternative is:
  - Conversion layers (REST to gRPC) - BFF
  - Separate layers for e.g. GraphQL to gRPC
  - …

BFF (patterns)

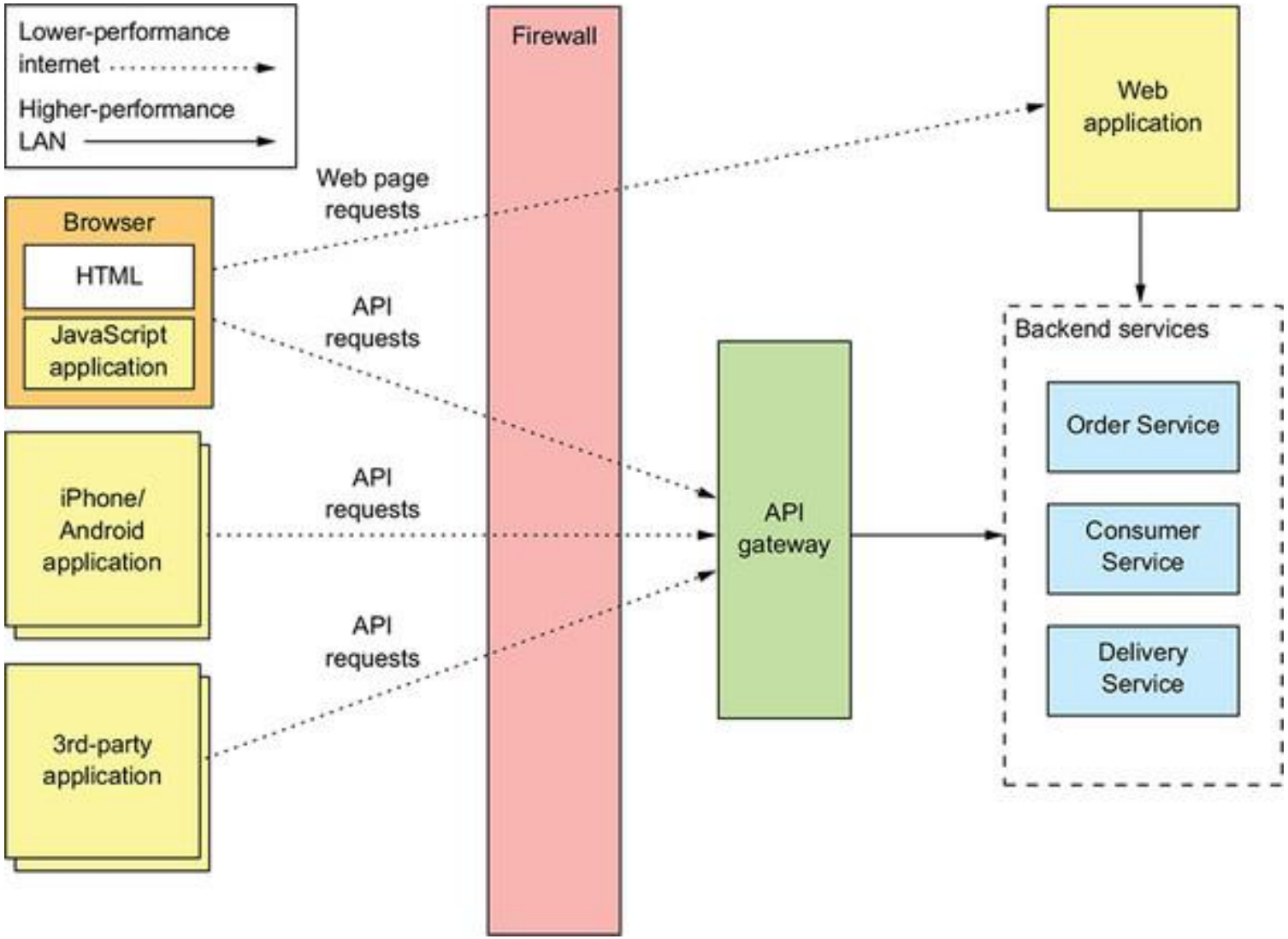
- Backend for frontend (BFF) pattern
- One frontend access point for each unique frontend technology / style
- Often
  - a limiter to a larger service API
  - A conversion bridge (REST – gRPC)

- Authorization / data segregation is sometimes handled here as well
- Quite a lot of repetitive boilerplate code (esp. gRPC – REST is mostly converting data structures)

Patterns in general

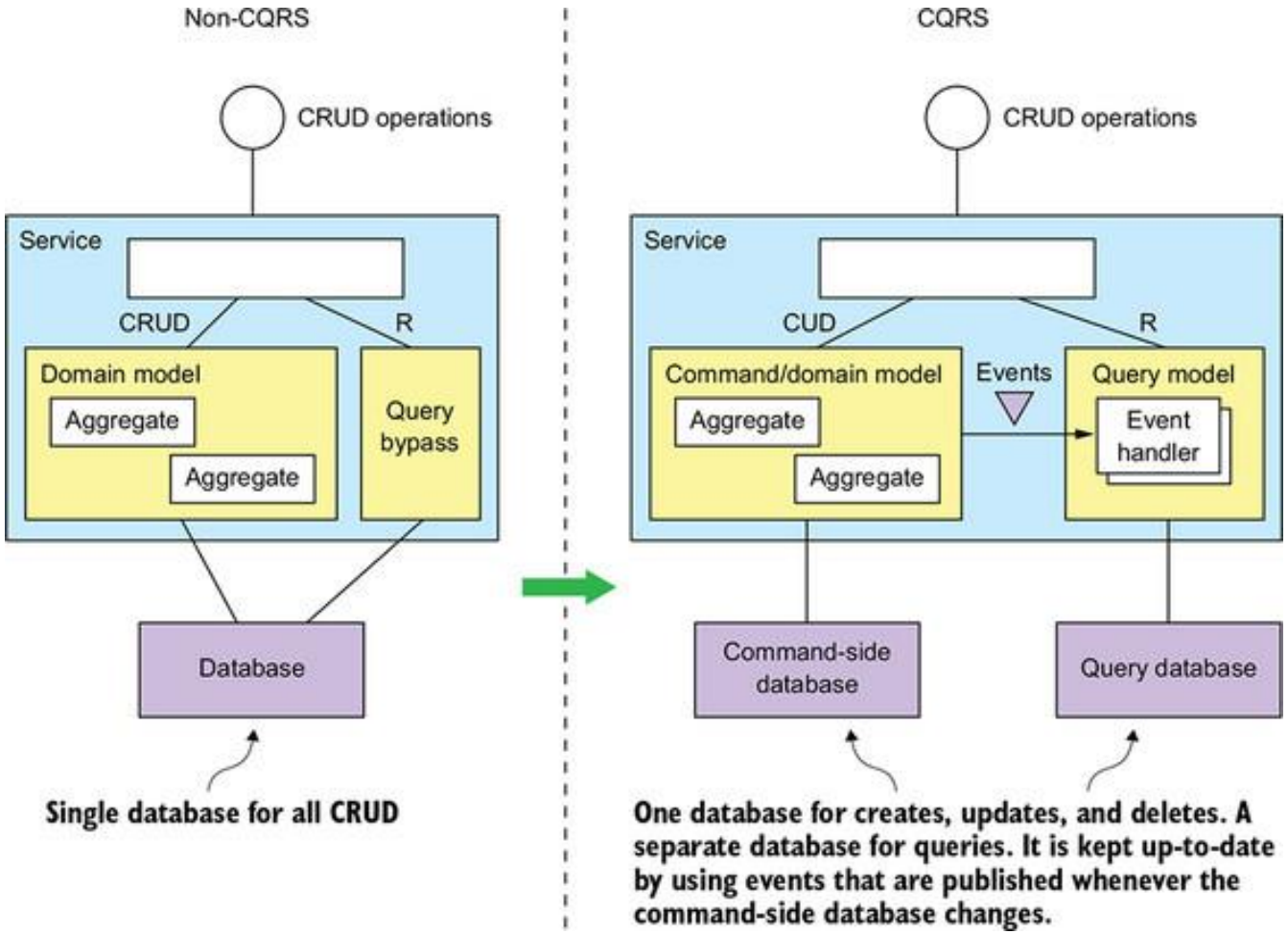
- API Gateway
- CQRS
- Circuit Braker

API Gateway



https://livebook.manning.com/book/microservices-patterns/chapter-8/59

CQRS
Command Query Responsibility Segregation



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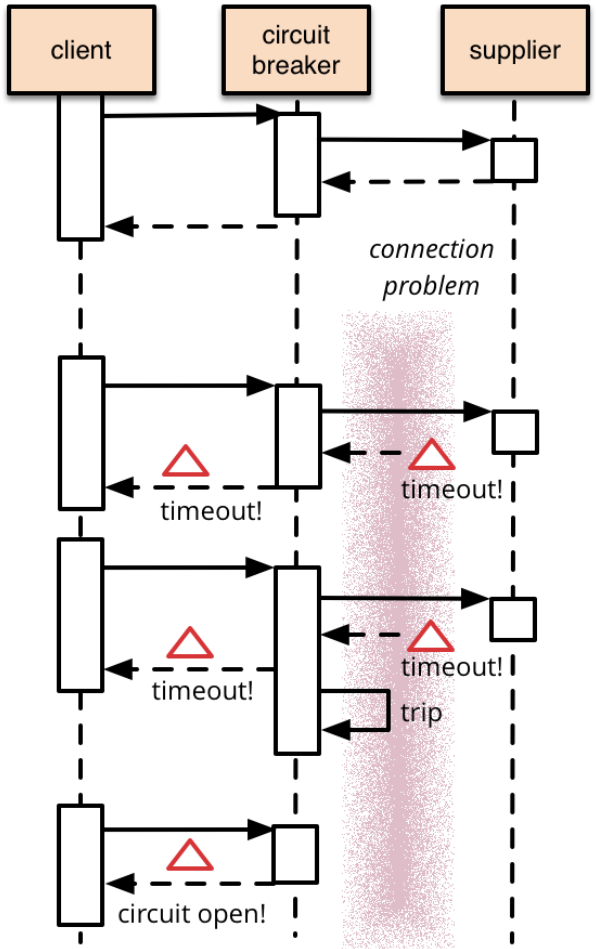
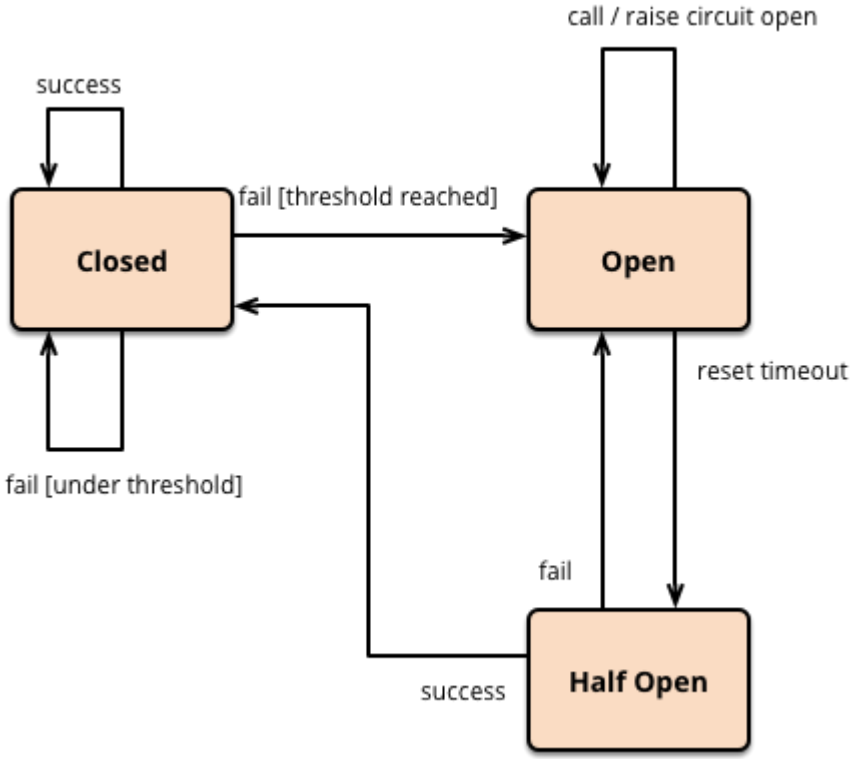
CQRS Pros / Cons

- Enables the efficient implementation of queries in a microservice architecture
- Enables the efficient implementation of diverse queries
- Makes querying possible in an event sourcing-based application
- Improves separation of concerns

- More complex architecture
- Dealing with the replication lag

Circuit Braker





https://martinfowler.com/bliki/CircuitBreaker.html