Quarkus

Lab

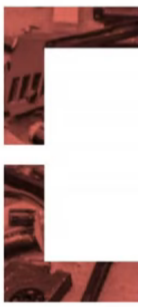
- Any IDE you feel comfortable with (eg. Intellij IDEA, Eclipse IDE, VS Code..)
- JDK 11 - https://www.oracle.com/java/technologies/javase-jdk11-downloads.html
- GraalVM 19.2.1 or 19.3.1 - https://www.graalvm.org/downloads/
- Maven 3.6.x - https://maven.apache.org/download.cgi
- Docker - https://www.docker.com/products/docker-desktop
- cURL (or any other command line HTTP client) or Postman

Introduction

Java was built in the '90s. The world has changed!

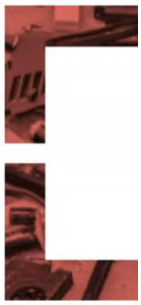
Old Java was made for...

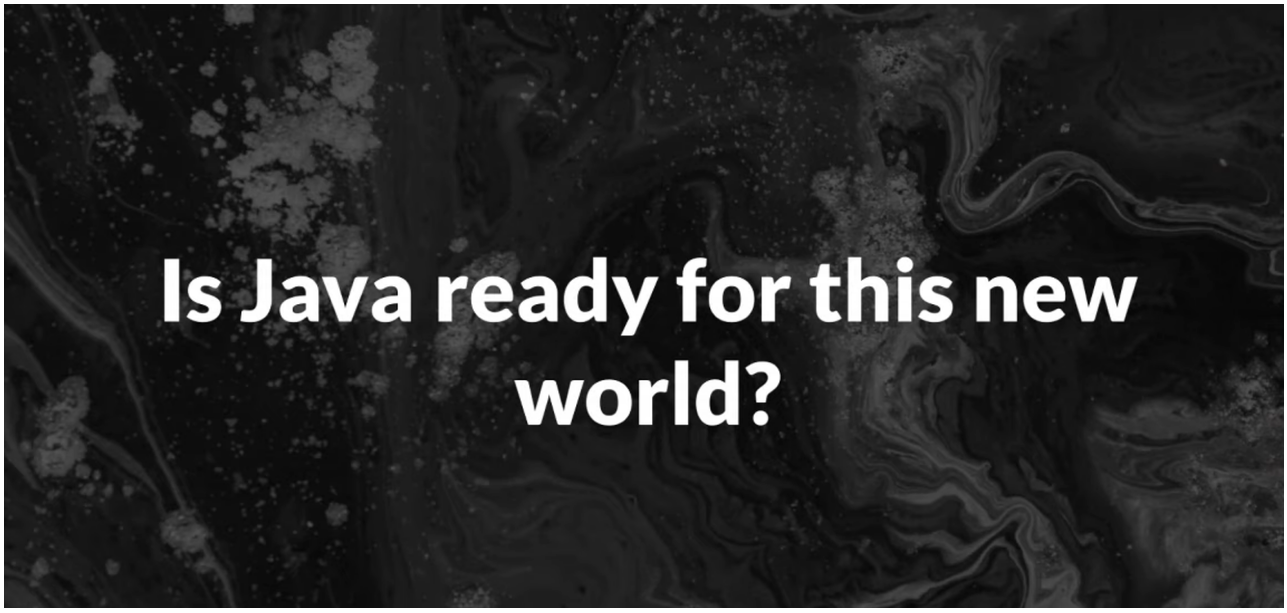
- Code once, run everywhere!
- Client applications running on different OSs.
- We didn't have control of the environment.



But the world now is more like:

- Container, container everywhere!
- We ship applications with their own environment.
- Cloud Computing.
- Serverless, microservices and cold start FaaS.
- Memory and CPU are now money.



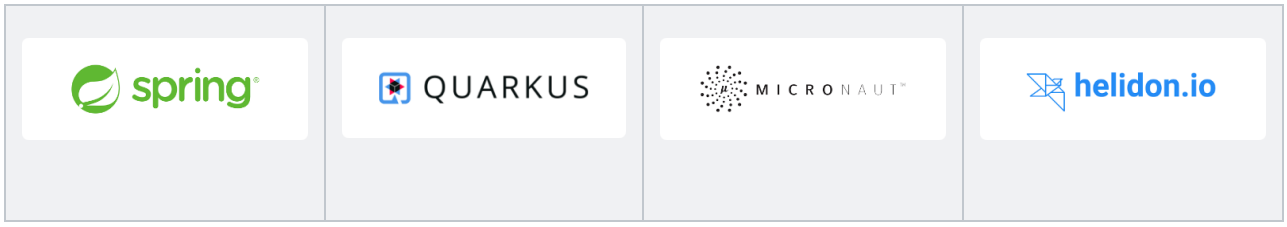


java application requires warm-up

Enemies of slow startup

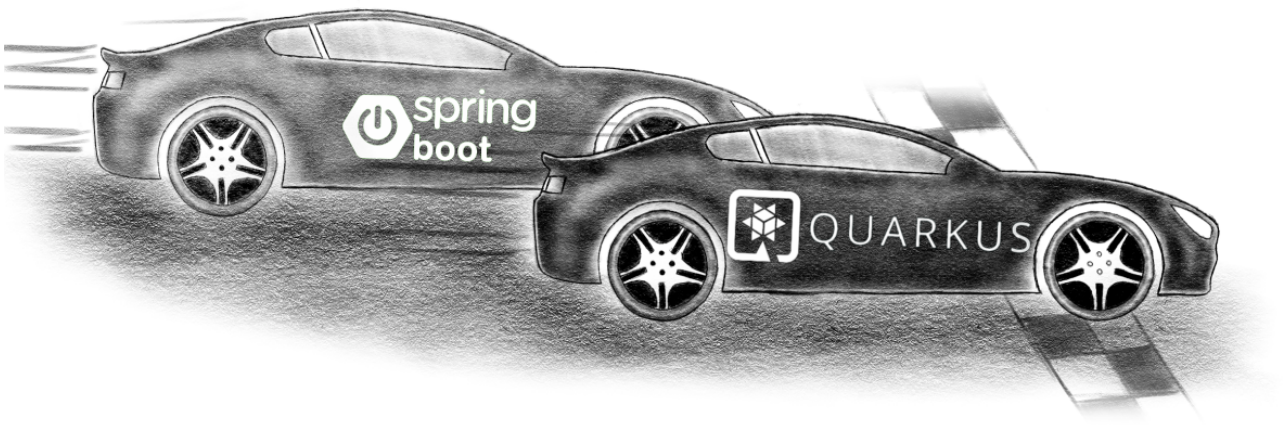
- continuous delivery
- elasticity, scale on cloud: trends, people, reality

Microservices frameworks for java developers



- Application start-up time
- Memory Usage
- Responsiveness

In terms of memory usage, the most interesting indicators are the **Resident Set Size (RSS)** and **Virtual memory Size.**
RSS is how much memory this process currently has in the main memory (RAM).
VSZ is how much virtual memory the process has in total. This includes all types of memory, both in RAM and swapped out.



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1. Spring - Java Application i.e application which are not following reactive concepts

Startup Time	**Memory Footprint**	**Responsiveness on high load**
6.348 seconds	Real memory : 541.9 MB	No => too many Blocking Threads on IO

What does a server / traditional java framework do at startup time? e.g spring framework

- Parse config files
- Classpath & classes scanning
  - For annotations, getters or other annotations
- Build framework metamodel objects
- Prepare reflection and build proxies
- **Start and open IO, threads etc**

How **Quarkus** work?

Move startup time activities to build time

Build time benefits

- Do the work once, not at each start
- All the bootstrap classes are no longer loaded
- Less time to start, less memory used
- Less or no reflection nor dynamic proxy

---

2. Quarkus - JVM Application

Startup Time	**Memory Footprint**	**Responsiveness on high traffic**
1.444s	real memory : 288	Yes - reactive

3. Quarkus - Native Application

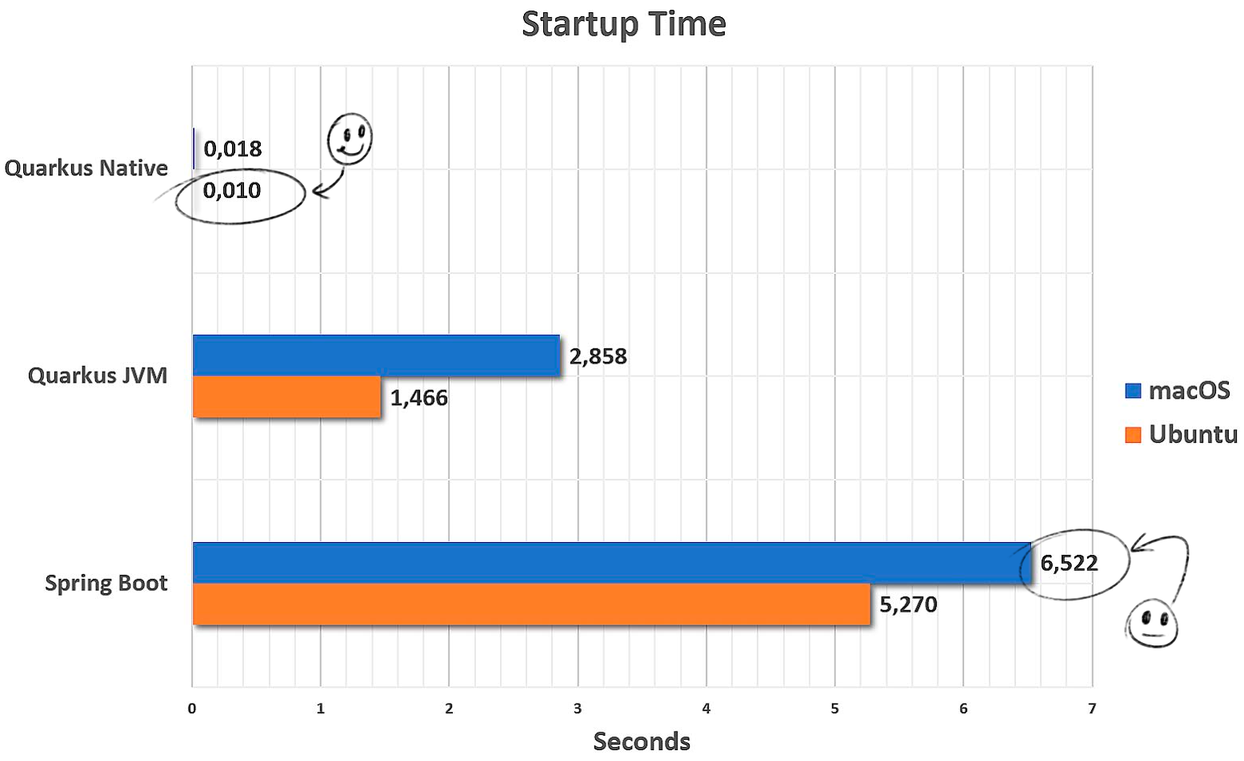
Startup Time	**Memory Footprint**
0.021s	real memory : 19.6 MB

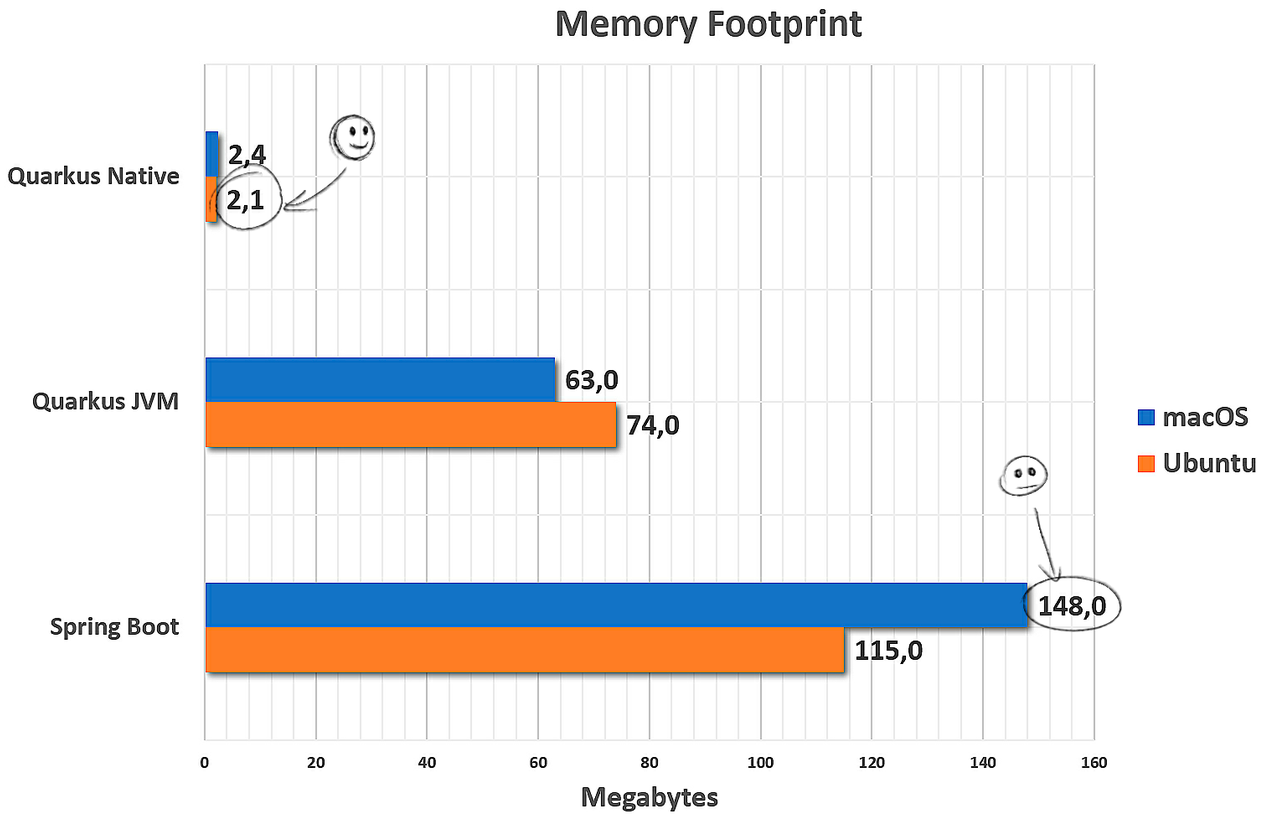
4. Quarkus - Java Application on docker container

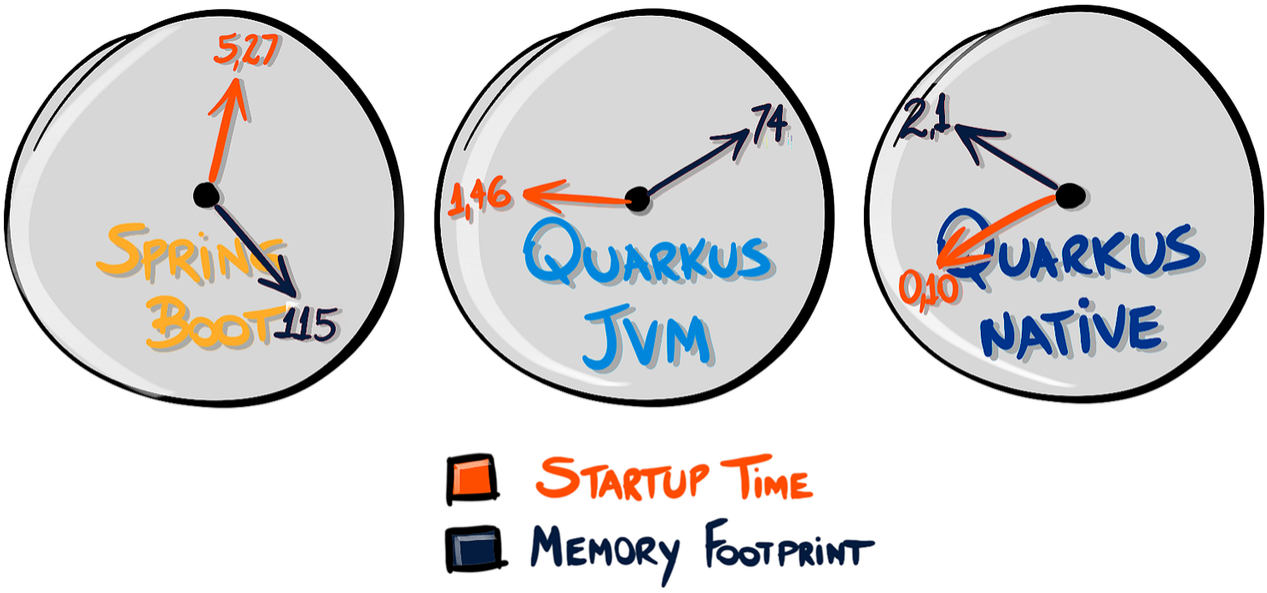
Startup Time	**Memory Footprint**
1.466s	RSS - 81.86MiB

5. Quarkus - Native Application on docker container platform

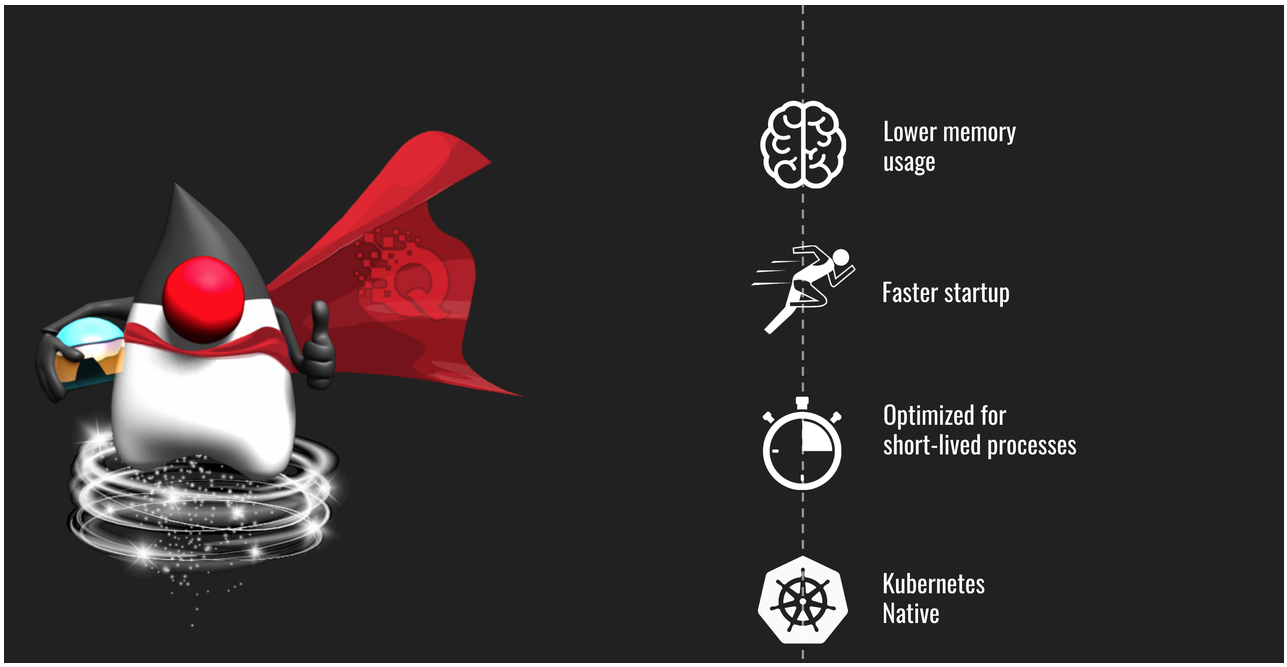
Startup Time	Memory Footprint
0.036s	real memory : 4.2MiB

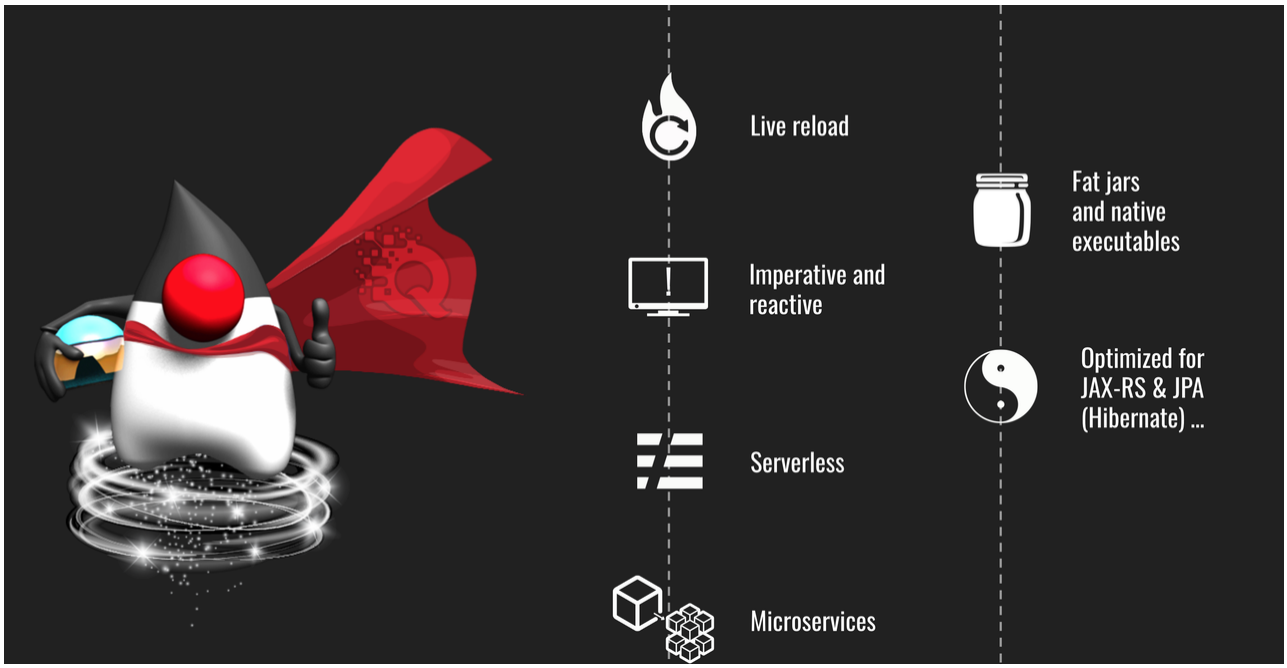



Memory Footprint
Quarkus Native
2,4
2,1
Quarkus JVM
63,0
74,0
Spring Boot
148,0
115,0
0
20
40
60
80
100
120
140
160
Megabytes
macOS
Ubuntu


5,27
SPRING BOOT
115
1,146
74
QUARKUS JVM
2,1
0,10
QUARKUS NATIVE
STARTUP TIME
MEMORY FOOTPRINT


QUARKUS
!?!?


Lower memory usage
Faster startup
Optimized for short-lived processes
Kubernetes Native



References

https://www.graalvm.org/

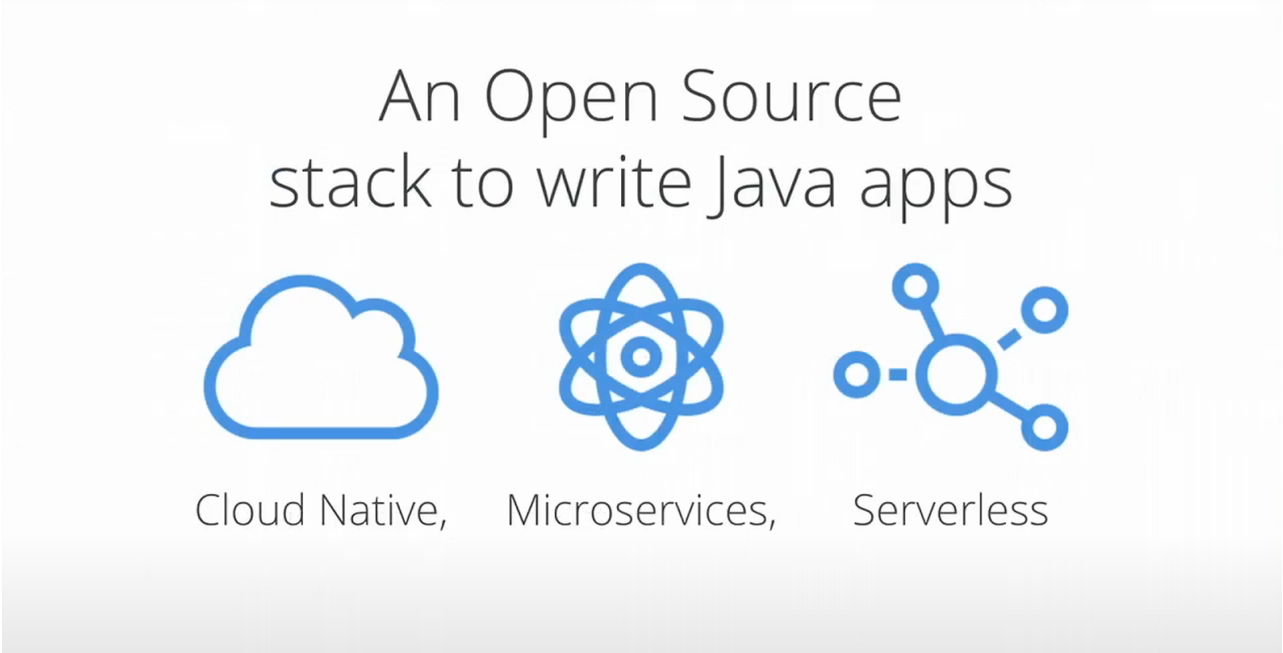
GraalVM Community • www.graalvm.org

https://simply-how.com/quarkus-vs-spring-boot-production-performance

https://www.logicmonitor.com/blog/quarkus-vs-spring

Quarkus vs. Spring | LogicMonitor • www.logicmonitor.com

Quarkus is :



Quarkus core

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1. Scaffolding a Quarkus Project with Maven

```
mvn io.quarkus:quarkus-maven-plugin:1.9.1.Final:create \
    -DprojectGroupId=org.acme \
    -DprojectArtifactId=getting-started \
    -DclassName="org.acme.getting.started.GreetingResource" \
    -Dpath="/hello"
cd getting-started
```

2. Scaffolding a Quarkus Project with Gradle

```
mvn io.quarkus:quarkus-maven-plugin:1.9.1.Final:create \
    -DprojectGroupId=org.acme \
    -DprojectArtifactId=getting-started \
    -DclassName="org.acme.getting.started.GreetingResource" \
    -Dpath="/hello"
    -DbuildTool=gradle
cd getting-started
```

3. Scaffolding a Quarkus Project with the Quarkus Start Coding Website

https://code.quarkus.io/

4. Scaffolding a Quarkus Project with IDE

“Live Reloading with Dev Mode”

Configuring quarkus with **Microprofile** config specification

- [ ] How to configure a Quarkus service
- [ ] How to inject configuration parameters in the service
- [ ] How to apply values depending on the environment
- [ ] How to correctly configure the logging system
- [ ] How to create customizations for the configuration system

1. Configuring the Application with Custom Properties
2. Configuring the Application with Custom Properties with YML

```
mvn quarkus:add-extension -Dextensions="config-yaml"
```

3. Accessing Configuration Properties Programmatically
4. Overwriting configuration values externally
   a. environment variable (300)
   b. system property (400). e.g -Dprop.name=value
   c. properties or yaml file (500)

5. configuring with profiles

   Quarkus comes with three built-in profiles.

   dev
   Activated when in development mode (i.e., quarkus:dev).

   test
   Activated when running tests.

   prod

The default profile when not running in development or test mode; you don't need to set it in application.properties, as it is implicitly set

6. creating custom config sources (file | database | REST)

---

1. Changing Logger Configuration
2. Adding Application Logs
   a. JDK java.util.Logging
   b. Jboss Logging
   c. SL4J
   d. Apache common Logging
3. Advanced Logging for centralized Logging Tools i.e ELK tools

```
mvn quarkus:add-extension -Dextensions="logging-json"

mvn quarkus:add-extension -Dextensions="logging-gelf"
```

Problem
You want to inject dependencies into your classes.

Solution
Use Contexts and Dependency Injection (**CDI**)

QUARKUS - CONTEXTS AND DEPENDENCY INJECTION

Quarkus DI solution is based on the [Contexts and Dependency Injection for Java 2.0](#) specification

https://quarkus.io/guides/cdi

Quarkus - Introduction to Contexts and Dependency Injection • quarkus.io

- [ ] Injecting Dependencies
- [ ] Creating Factories
- [ ] Executing Object Life Cycle Events
- [ ] Executing Application Life Cycle Events
- [ ] Using a Named/Custom Qualifier
- [ ] Creating Interceptors

> *what is quarkus, how it different from existing soln*
> *how to scaffold quarkus applications*
> *how to configure quarkus applications*
> *quarkus programming model ==> CDI*

```
@Inject    ==> DI
@Named     ==> predifined Qualifier
@ApplicationScoped / @Singleton ==> single instance
@Dependent                      ==> new instance for each depe
ndent
@RequestScoped
@SessionScoped
```

```
@Produces                          ==> creates beans from factory method
@PostConstruct,@PreDestroy         ==> bean lifecycle methods
method(@Observes EventType event)
```

Packaging Quarkus Applications

- [ ] How to package a Quarkus application for running in the JVM
- [ ] How to package a Quarkus application in a native executable
- [ ] How to containerize a Quarkus application

1. Running in Command Mode (ignore)
2. Creating a Runnable JAR file

```
./mvnw package
```

3. Über-JAR Packaging

```
./mvnw package -Dquarkus.package.uber-jar=true
```

4. “Building a Native Executable”

```
./mvnw package -Pnative
```

5. Building a Docker Container for JAR File

```
mvn package
docker build -f src/main/docker/Dockerfile.jvm -t quarkus/quarkus-hello-service-jvm .
docker run -i --rm -p 8080:8080 quarkus/quarkus-hello-service-jvm
```

6. Building a Docker Container for Native File

```
mvn package -Pnative -Dquarkus.native.container-build=true
docker build -f src/main/docker/Dockerfile.native -t nagabhushanamn/quarkus-hello-service .
```

Quarkus web

Quarkus integrates with RESTEasy, a JAX-RS implementation to define REST APIs.

- [ ] How to use JAX-RS for creating CRUD services

1. Creating a Simple REST API Endpoint

```
import javax.ws.rs.GET;
import javax.ws.rs.Path;
import javax.ws.rs.Produces;
import javax.ws.rs.core.MediaType;

@Path("/hello")
public class GreetingResource {
    @GET
    @Produces(MediaType.TEXT_PLAIN)
    public String hello() {
        return "hello";
    }
    @POST
    @Consumes(MediaType.TEXT_PLAIN)
    public void create(String message) {
        System.out.println("Create");
    }
```

```
    @PUT
    @Consumes(MediaType.TEXT_PLAIN)
    @Produces(MediaType.TEXT_PLAIN)
    public String update(String message) {
        System.out.println("Update");
        return message;
    }

    @DELETE
    public void delete() {
        System.out.println("Delete");
    }

}
```

2. Extracting Request Parameters

- @QueryParam - to filter resources
- @PathParam - to identify resource
- @HeaderParam
- @FormParam
- @CookieParam
- @MatrixParam
- @Context

```
public static enum Order {
    desc, asc;
}
@GET
@Produces(MediaType.TEXT_PLAIN)
```

```
public String hello(
                @Context UriInfo uriInfo,
                @QueryParam("order") Order order,
                @NotBlank @HeaderParam("authorization") String
authorization
                ) {
                //...
                return "..."
                }
```

3. Using Semantic HTTP Response Status Codes

https://developer.mozilla.org/en-US/docs/Web/HTTP/Status


HTTP response status codes • developer.mozilla.org

4. Binding HTTP Methods

5. Enabling Cross-Origin Resource Sharing (CORS)

```
quarkus.http.cors=true
quarkus.http.cors.origins=http://example.com
quarkus.http.cors.methods=GET,PUT,POST,DELETE
quarkus.http.cors.headers=accept,authorization,content-type,x-
requested-with
```

7. Marshalling/Unmarshalling JSON

https://quarkus.io/guides/rest-json


Quarkus - Writing JSON REST Services • quarkus.io

8. Marshalling/Unmarshalling XML
9. Validating Input and Output Values

https://quarkus.io/guides/validation


Quarkus - Validation with Hibernate Validator • quarkus.io

Quarkus data

- [ ] Configure datasources
- [ ] Deal with transactions
- [ ] Make use of the Panache API
- [ ] Interact with NoSQL data stores

```
mvn quarkus:add-extension -Dextensions="jdbc-xxxx"
```

1. Defining a Datasource

```
quarkus.datasource.db-kind=postgresql
```

```
quarkus.datasource.username=<your username>
quarkus.datasource.password=<your password>

quarkus.datasource.jdbc.url=jdbc:postgresql://localhost:5432/hibernate_orm_test
quarkus.datasource.jdbc.max-size=16
```

2. Using Multiple Datasources

```
quarkus.datasource.driver=org.h2.Driver
quarkus.datasource.url=jdbc:h2:tcp://localhost/mem:default
quarkus.datasource.username=username-default
quarkus.datasource.min-size=3
quarkus.datasource.max-size=13

quarkus.datasource.users.driver=org.h2.Driver
quarkus.datasource.users.url=jdbc:h2:tcp://localhost/mem:users
quarkus.datasource.users.username=username1
quarkus.datasource.users.min-size=1
quarkus.datasource.users.max-size=11

quarkus.datasource.inventory.driver=org.h2.Driver
quarkus.datasource.inventory.url=jdbc:h2:tcp://localhost/mem:inventory
quarkus.datasource.inventory.username=username2
quarkus.datasource.inventory.min-size=2
quarkus.datasource.inventory.max-size=12
```

3. Adding Datasource Health Check

```
mvn quarkus:add-extension -Dextensions="quarkus-smallrye-healt
h"
```

4. Defining Transaction Boundaries Declaratively

```
@javax.transaction.Transactional
```

5. Setting a Transaction Context

@Transactional(REQUIRED) (default)
Starts a transaction if none was started; otherwise, stays with the existing one

@Transactional(REQUIRES_NEW)
Starts a transaction if none was started; if an existing one was started, suspends it and starts a new one for the boundary of that method

@Transactional(MANDATORY)
Fails if no transaction was started; otherwise, works within the existing transaction

@Transactional(SUPPORTS)
If a transaction was started, joins it; otherwise, works with no transaction

@Transactional(NOT_SUPPORTED)
If a transaction was started, suspends it and works with no transaction for the boundary of the method; otherwise, works with no transaction

@Transactional(NEVER)
If a transaction was started, raises an exception; otherwise, works with no transaction

6. Programmatic Transaction Control

```
@Inject
UserTransaction userTransaction

begin()
commit()
rollback()
setRollbackOnly()
getStatus()
setTransactionTimeout(int)
```

7. Setting and Modifying a Transaction Timeout

```
@io.quarkus.narayana.jta.runtime.TransactionConfiguration
```

8. Persisting Data with Panache

https://quarkus.io/guides/hibernate-orm-panache

 Quarkus - Simplified Hibernate ORM with Panache • quarkus.io

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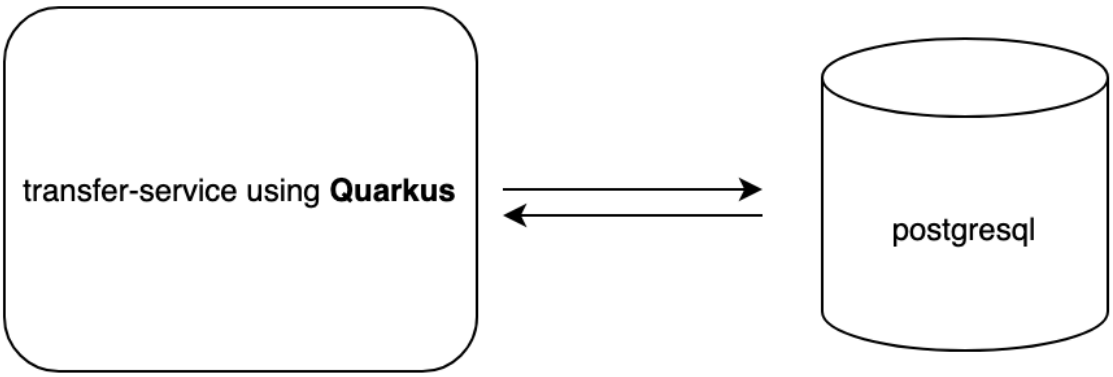
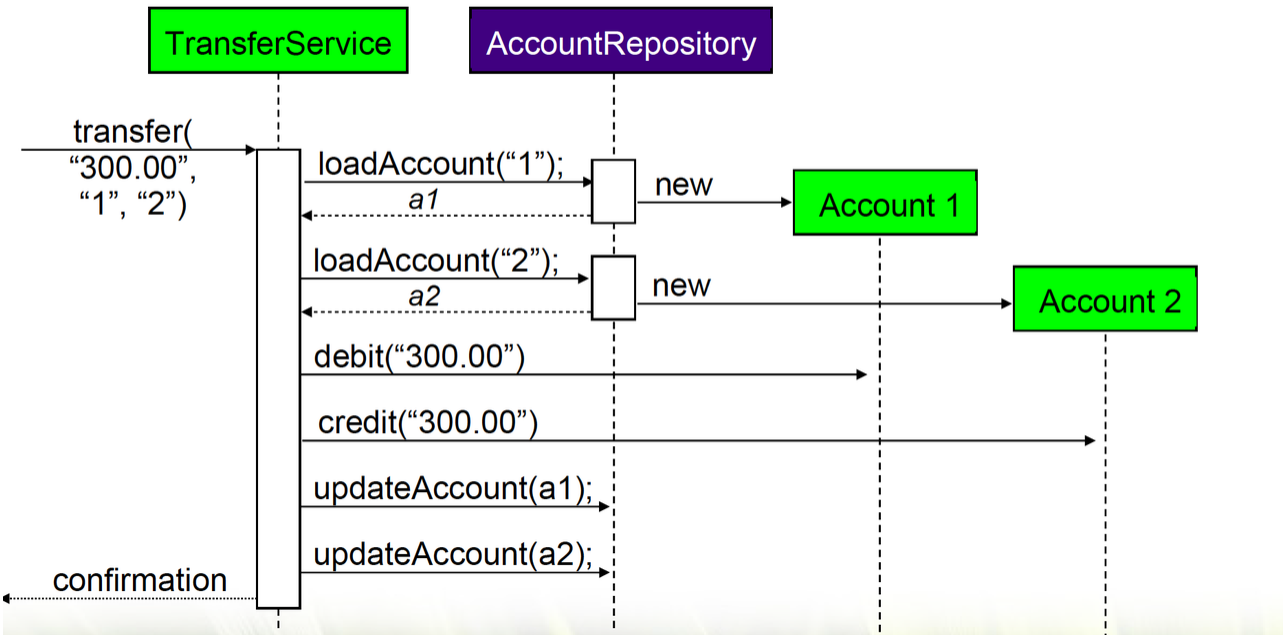
Exercise

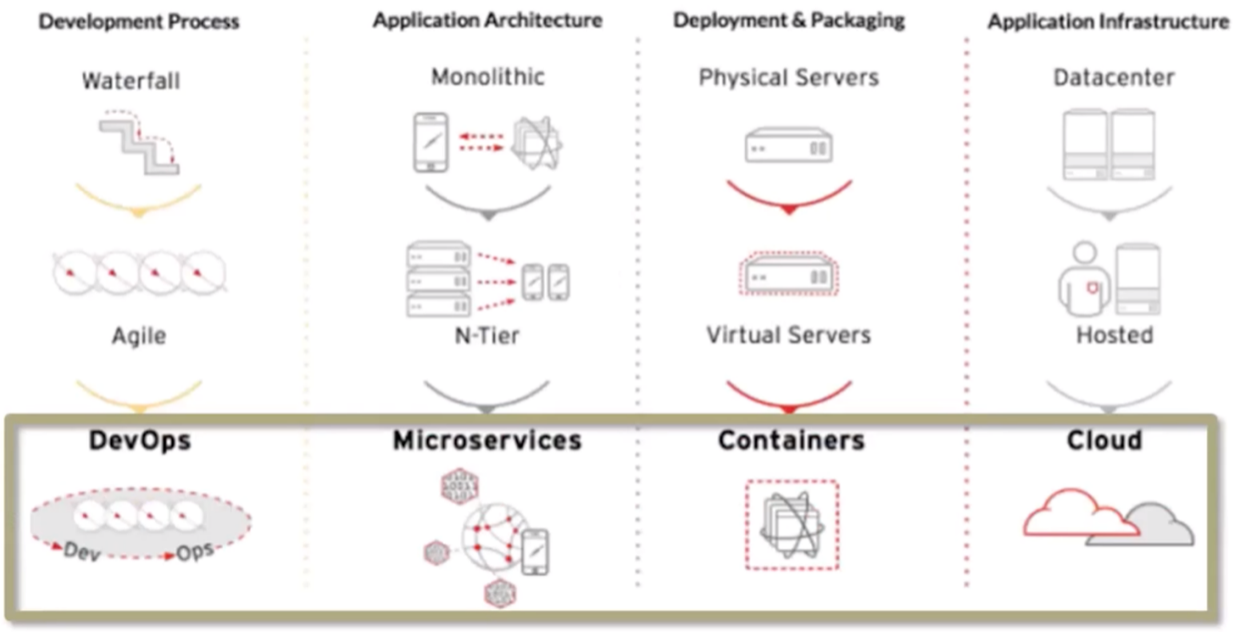
Ex. transfer-service api





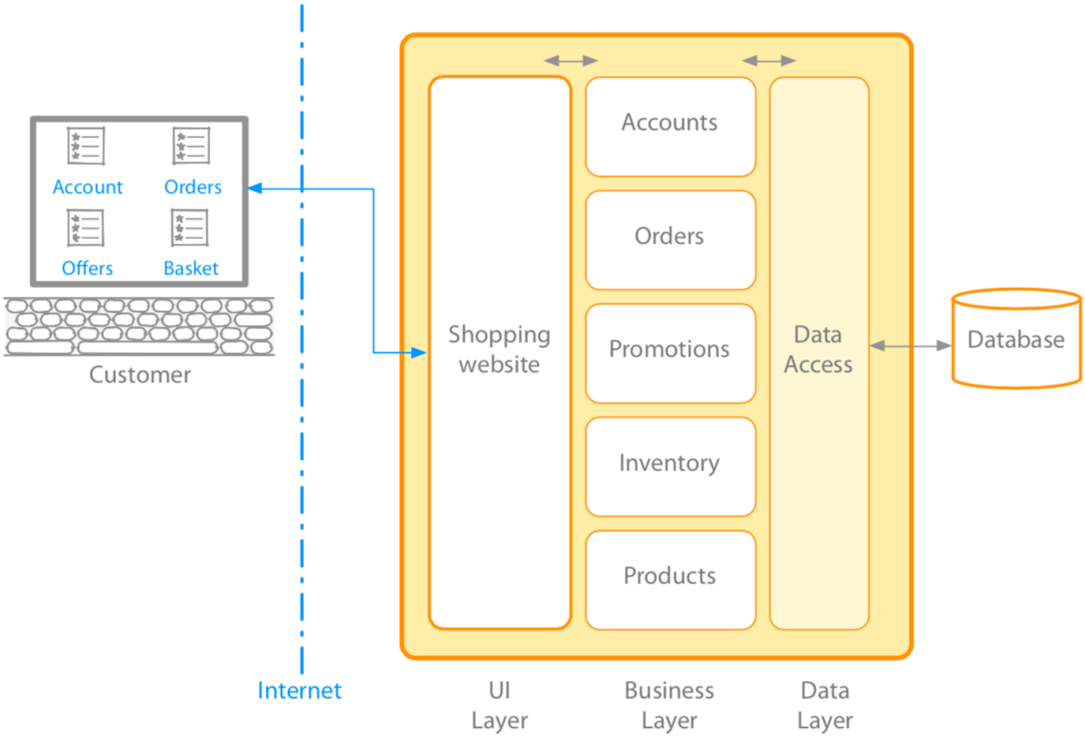
Microservices

Software Engineering evolution



Monolithic architecture

Ex.



Monolithic architecture - pros

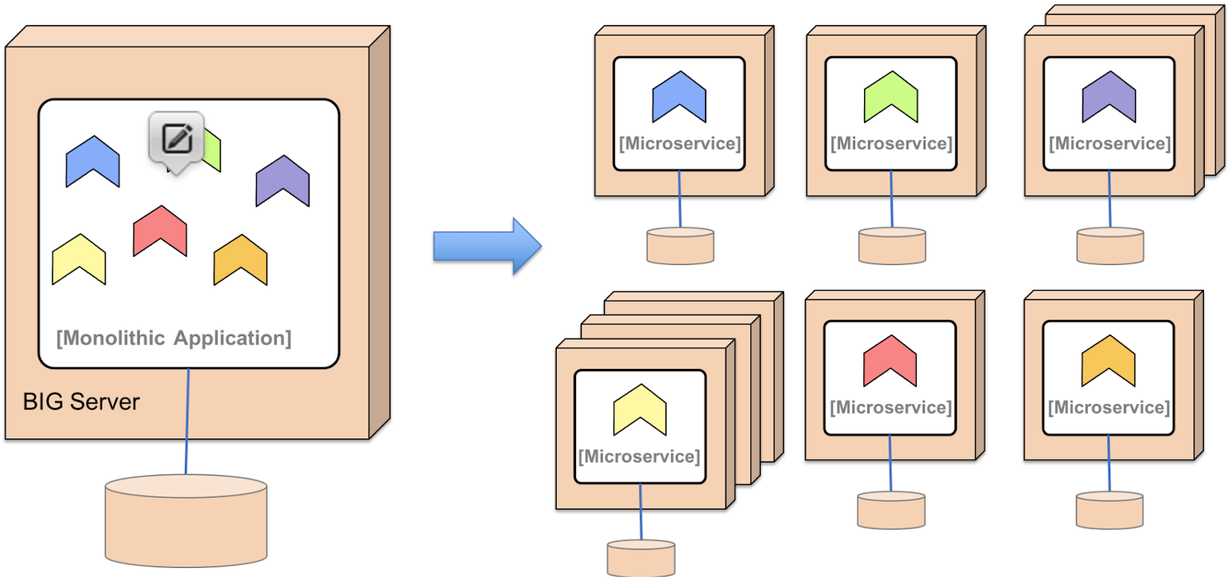
- Simpler development & deployment
- Fewer cross-cutting concerns
- Better performance

Monolithic architecture - cons

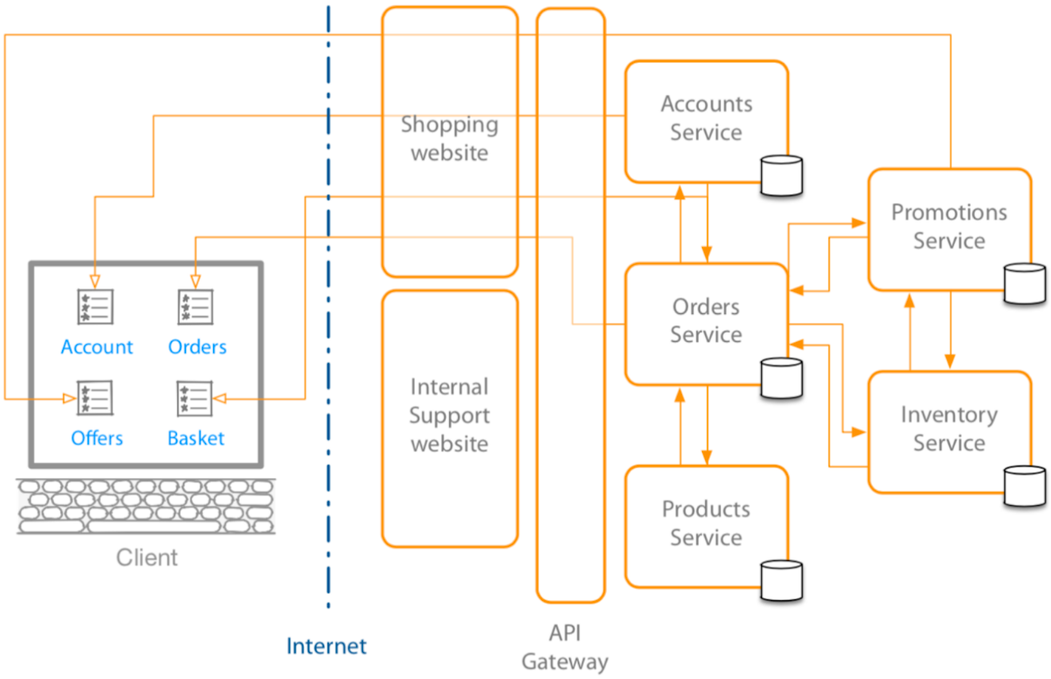
- Larger codebase
- Difficult to adopt new technologies
- Failure could affect whole system
- Scaling requires duplication of the whole
- Limited agility
  - every small update requires a full redeployment
  - all developers have to wait until it's done

- When several teams are working on the same project, agility can be reduced greatly.

Enter Microservices



Ex.



Microservice - characteristics

- Must conforms to a shared-nothing architecture
- Must only communicate with well defined interfaces (REST Api calls / message / events / streams)
- Must be deployed as separate runtime process e.g Docker containers
- Microservice instances are stateless

Microservice - benefits

- Easy to develop,test and deploy
- Increased agility
- Ability to scale horizontally

Challenges with microservices

- Synchronous communication issues i.e blocking IO , cascade failure
- Keeping the configuration up to date
- It's hard to track a request
- Analyzing the usage of hardware resources on a component level
- Management of many small components can become costly and error-prone

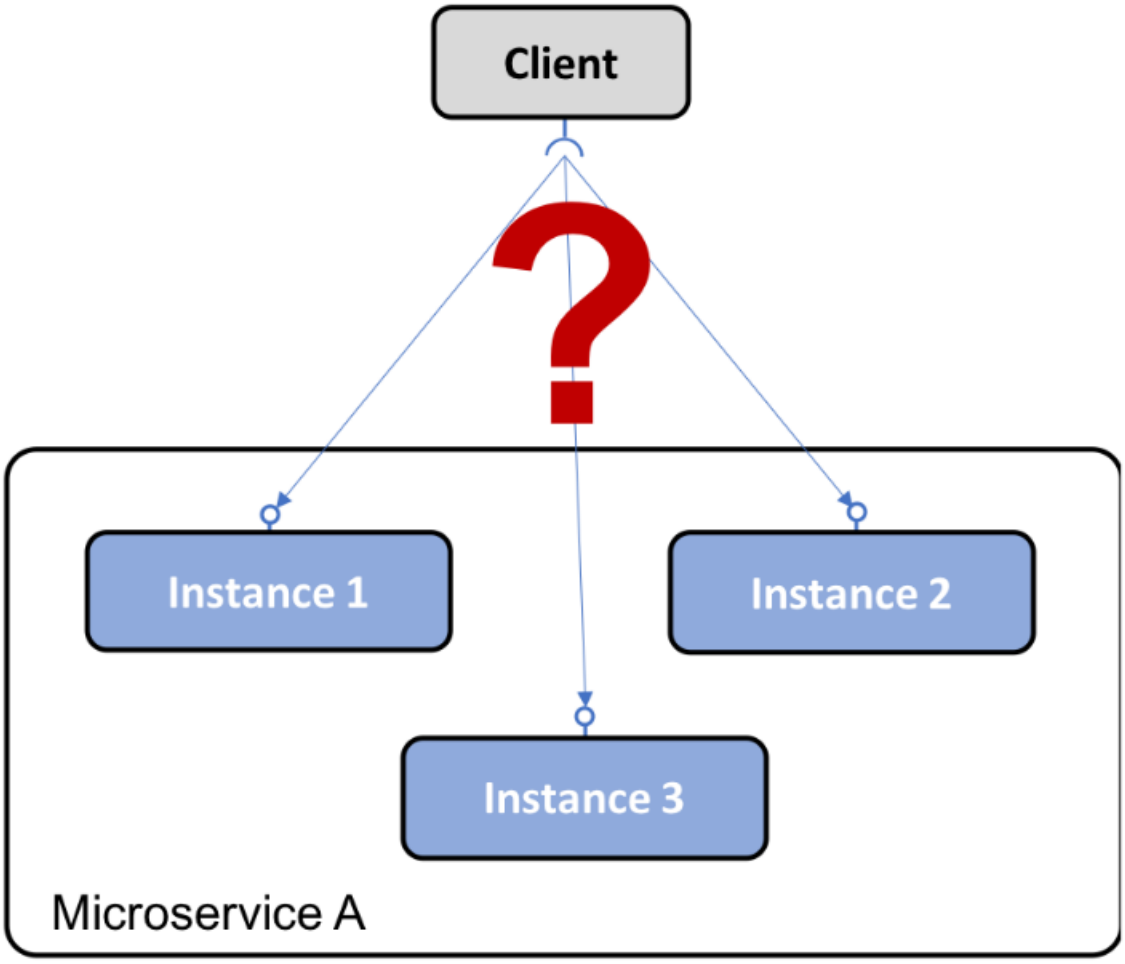
The 8 fallacies of distributed computing

1. The network is reliable
2. Latency is zero
3. Bandwidth is infinite
4. The network is secure
5. Topology doesn't change
6. There is one administrator
7. Transport cost is zero
8. The network is homogeneous

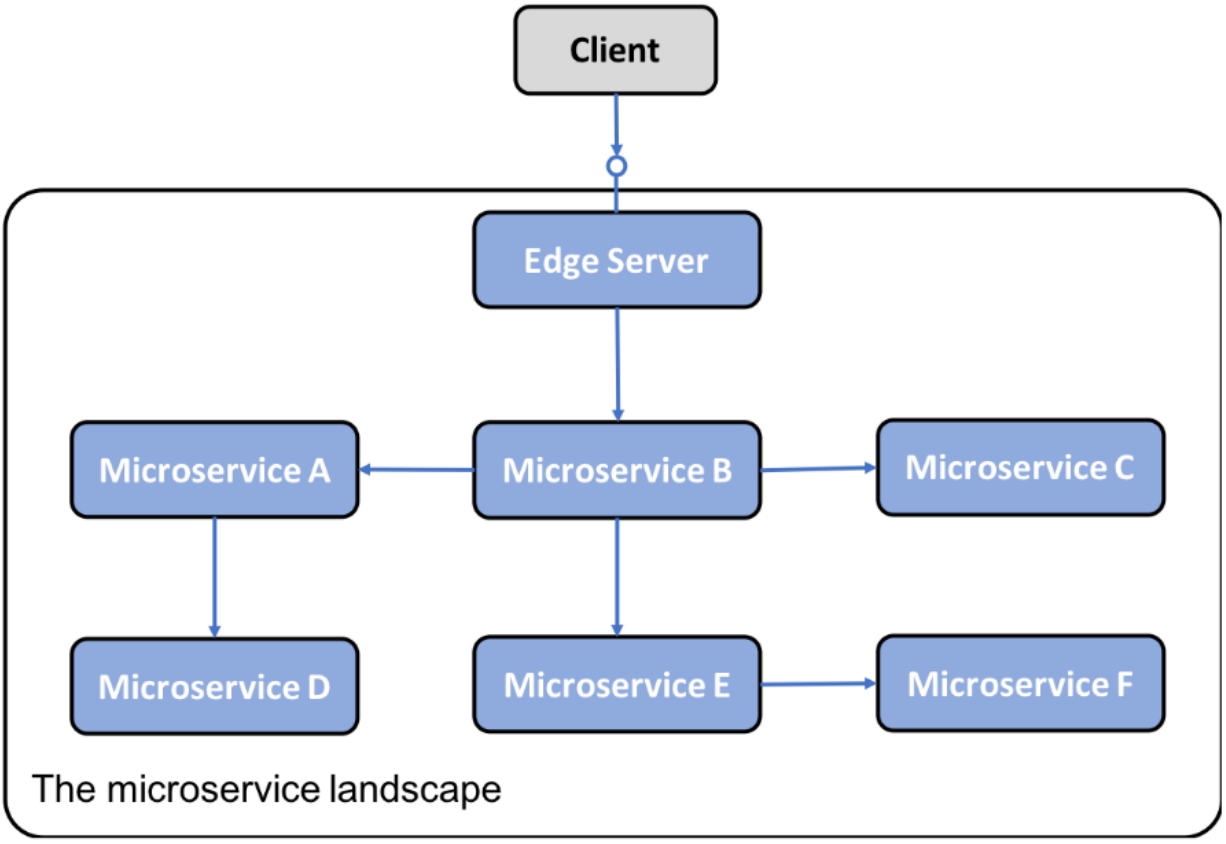
https://www.rgoarchitects.com/Files/fallacies.pdf

Design patterns for microservices

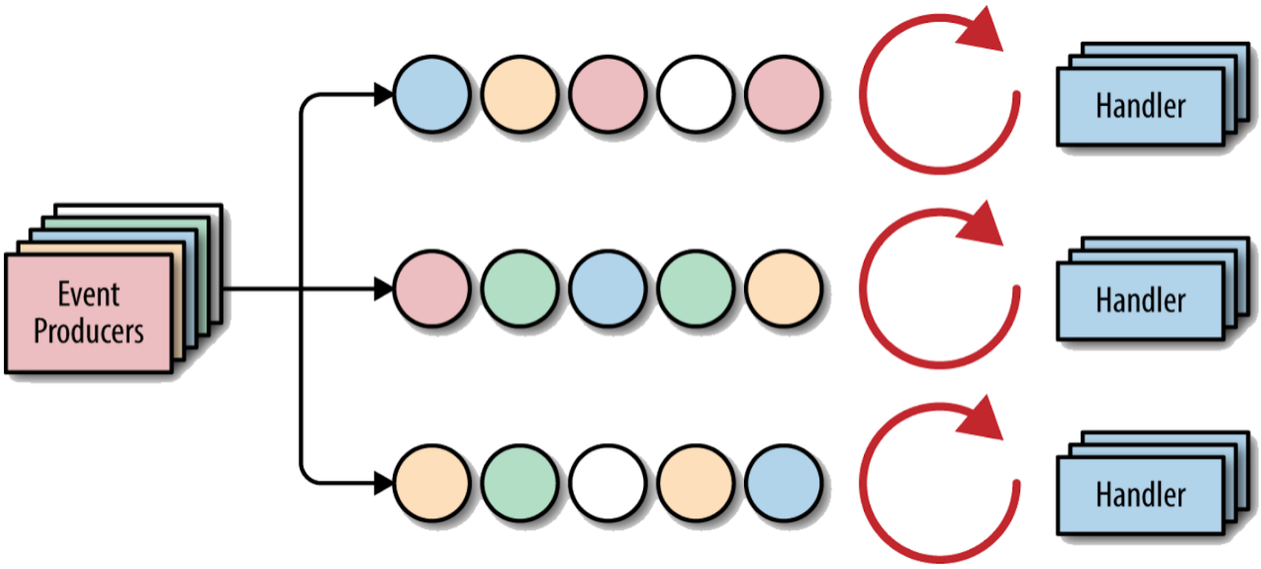
1. Service Discovery



2. Edge (Gateway/Load Balancer) Server



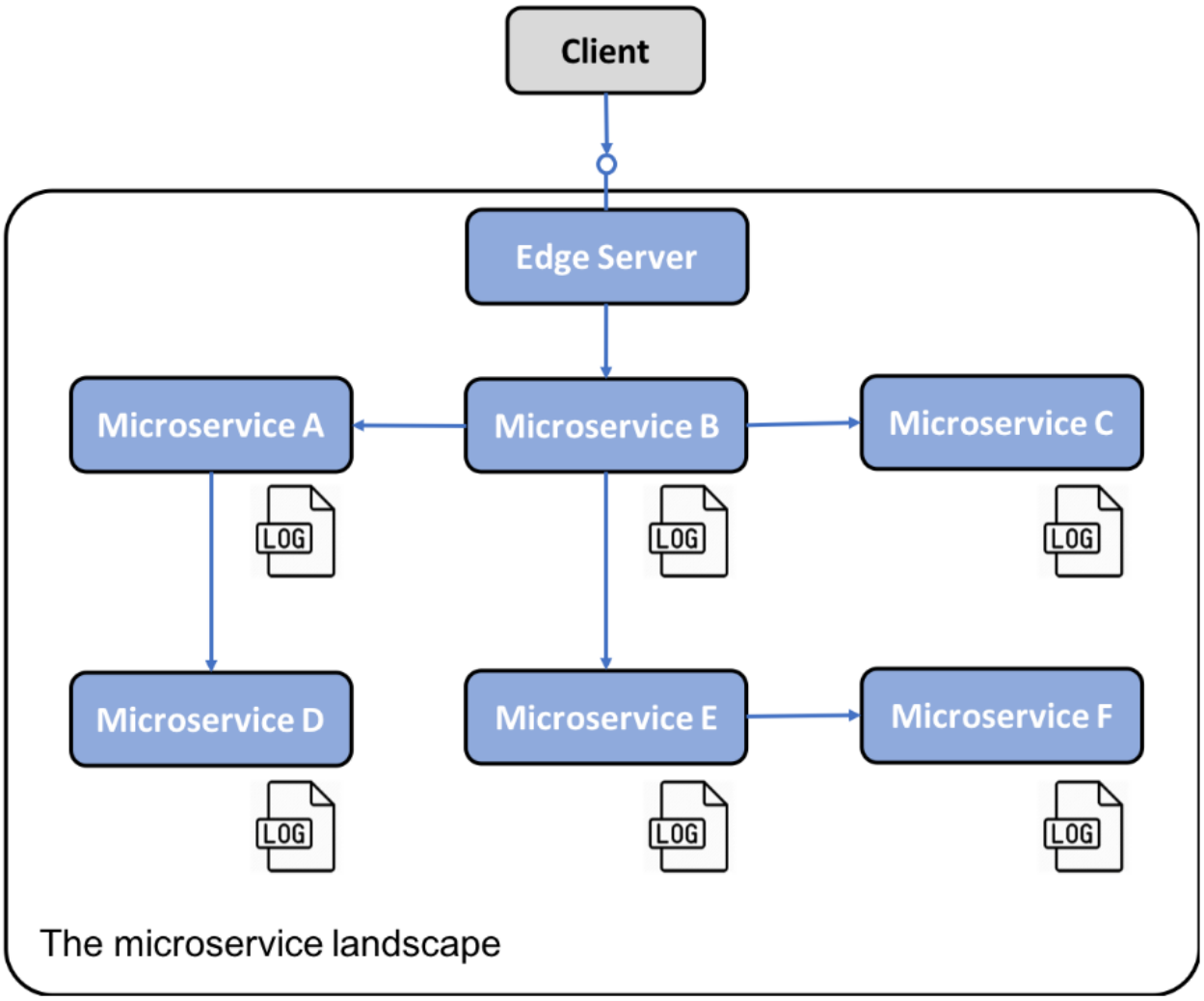
3. Reactive Microservices



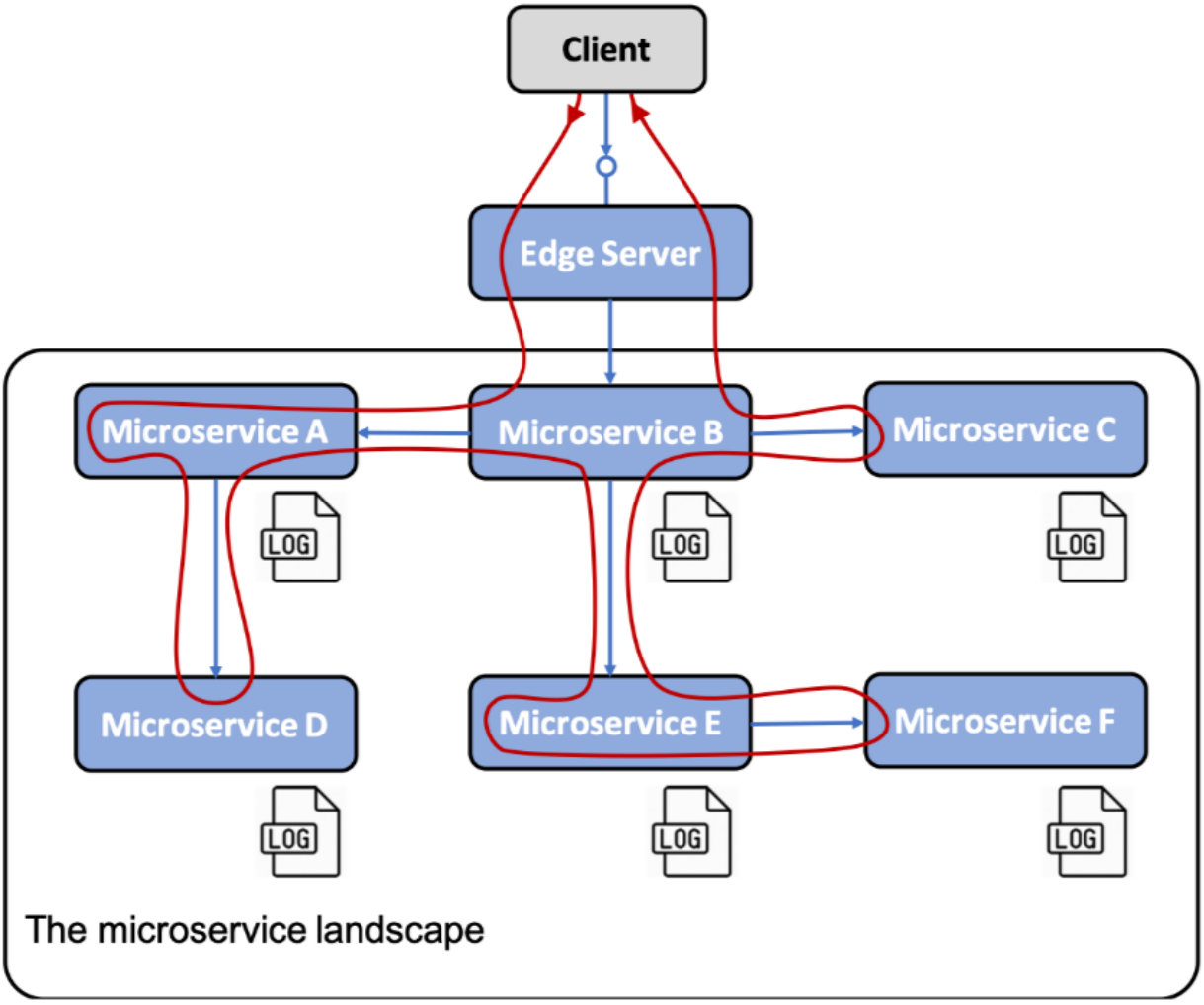
4. Central Configuration

Add a new component,
a **configuration** server, to the system landscape to store the configuration of all the microservices.

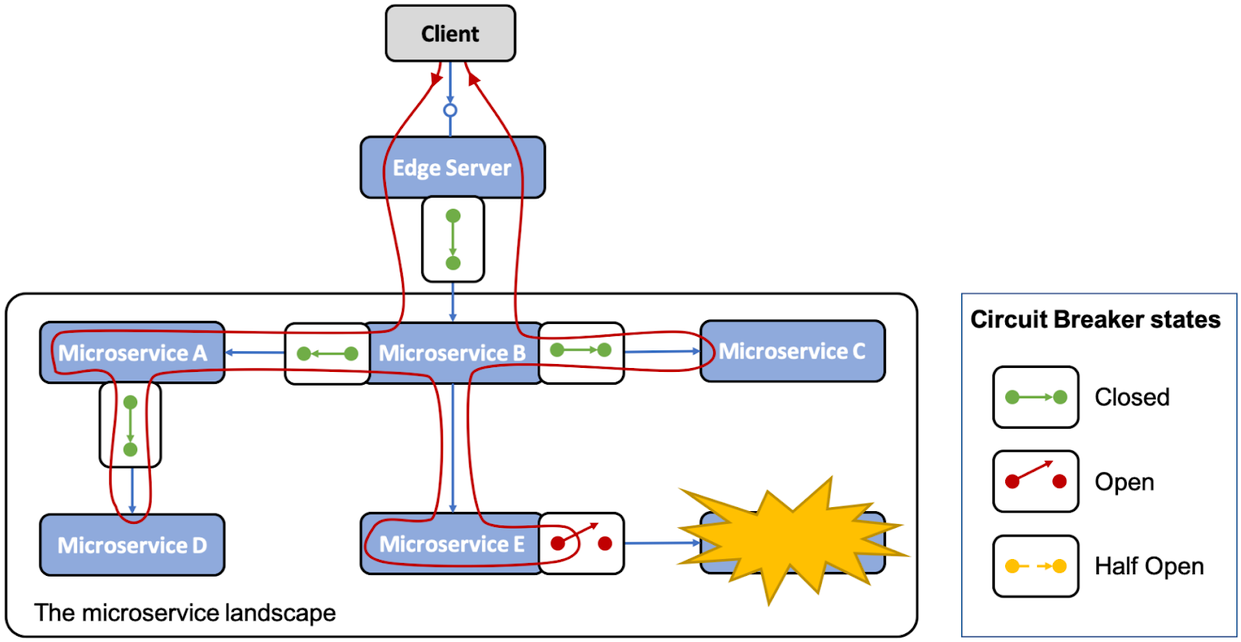
5. Centralized Log Analysis



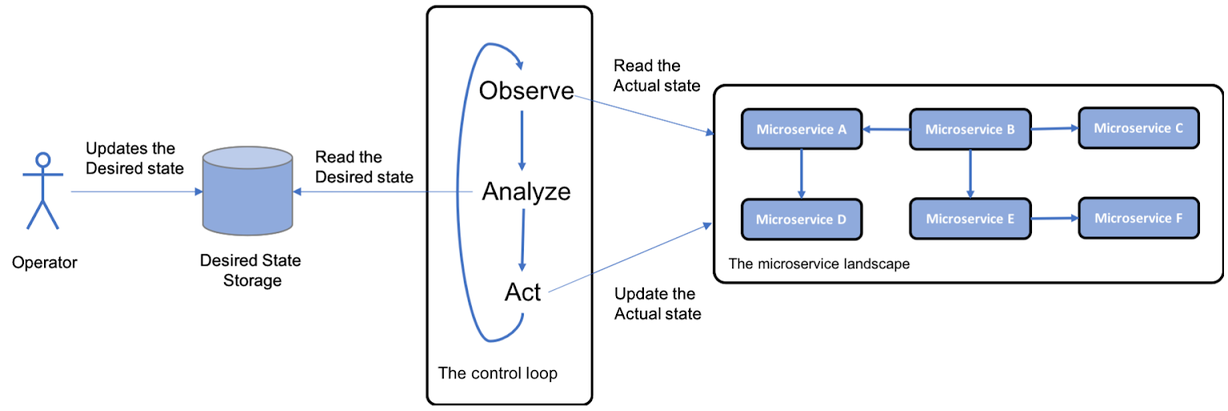
6. Distributed Tracing



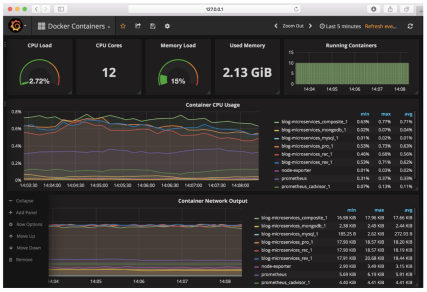
7. Circuit Breaker



8. Control Loop



9. Centralized monitoring & alarms



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https://docs.google.com/presentation/d/1B7a5dZhB7ERQsqESvKRskukPlEB6pG5HcCIVOa3BPFw/edit

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Eclipse MicroProfile specifications

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https://projects.eclipse.org/projects/technology.microprofile

https://download.eclipse.org/microprofile/microprofile-2.2/microprofile-spec-2.2.html

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Quarkus Workshop (super-heroes)

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workshop - superheroes

Welcome to Super Heroes Fight!

Astérix

9

Dexterity, Intelligence, Jump, Peak Human Condition, Reflexes, Stamina, Super Speed, Super Strength

NEW FIGHTERS

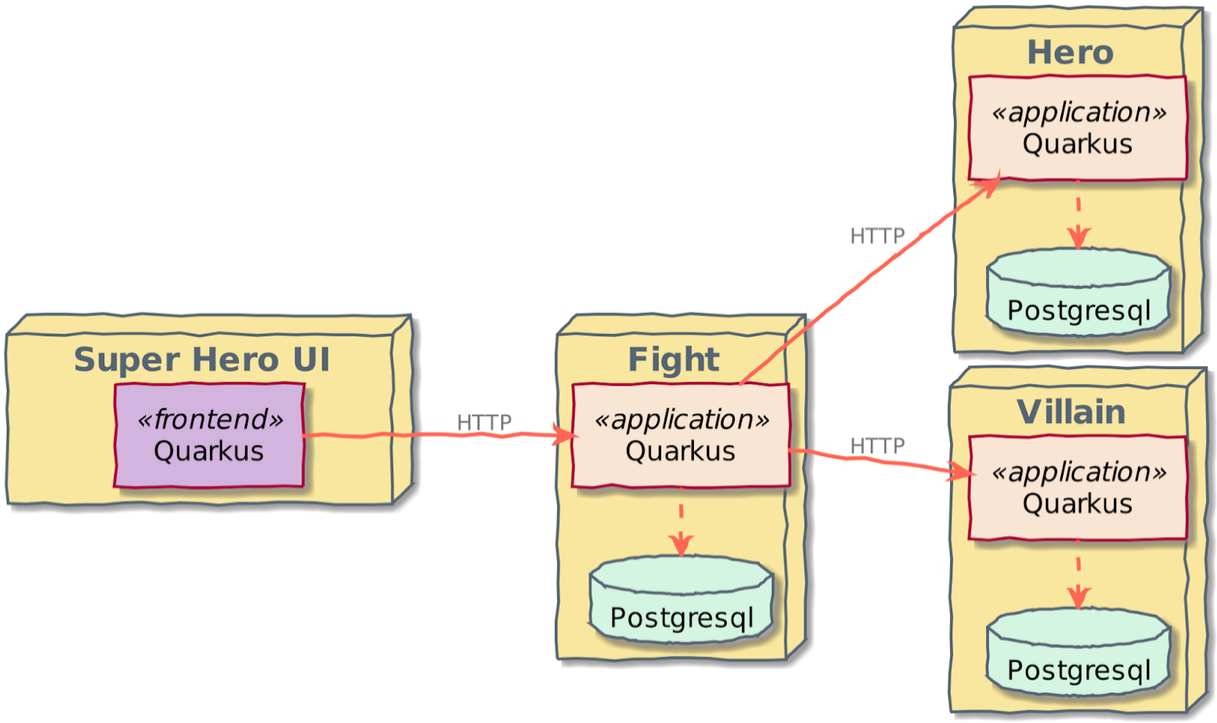
FIGHT !

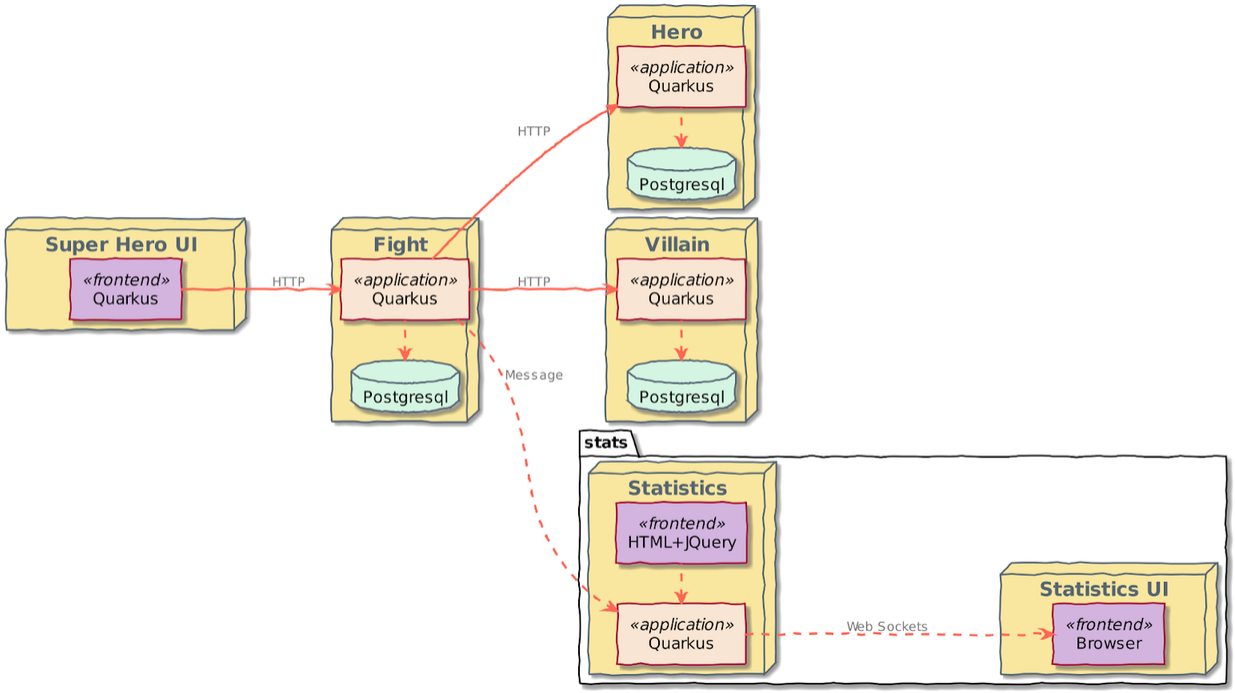
Match

14

Accelerated Healing, Durability, Energy Absorption, Energy Blasts, Enhanced Hearing, Flight, Invulnerability, Jump, Super Breath, Super Speed, Super Strength, Telekinesis, Vision - Heat, Vision - Telescopic, Vision - X-Ray

Id	Fight Date	Winner	Loser
10	Oct 14, 2019, 11:04:22 AM	Black Canary	Superman
9	Oct 14, 2019, 11:04:22 AM	Tanker Bug	Shuri
8	Oct 14, 2019, 11:04:22 AM	Moondragon	Darth Plagueis
7	Oct 14, 2019, 11:04:22 AM	The Eraser	Gandalf The White


Hero
«application»
Quarkus
Postgresql
HTTP
Super Hero UI
«frontend»
Quarkus
HTTP
Fight
«application»
Quarkus
Postgresql
HTTP
Villain
«application»
Quarkus
Postgresql


Hero
«application»
Quarkus
Postgresql
HTTP
Super Hero UI
«frontend»
Quarkus
HTTP
Fight
«application»
Quarkus
Postgresql
HTTP
Villain
«application»
Quarkus
Postgresql
Message
stats
Statistics
«frontend»
HTML+JQuery
«application»
Quarkus
Web Sockets
Statistics UI
«frontend»
Browser

Super heroes

What you are going to learn:

- What is Quarkus and how you can use it
- How to build an HTTP endpoint (REST API) with Quarkus
- How to access a database
- How you can use Swagger and OpenAPI
- How you test your microservice
- How you improve the resilience of your service
- How to build event-driven and reactive microservices with Kafka
- How to build native executable
- How to extend Quarkus with extensions
- And many more

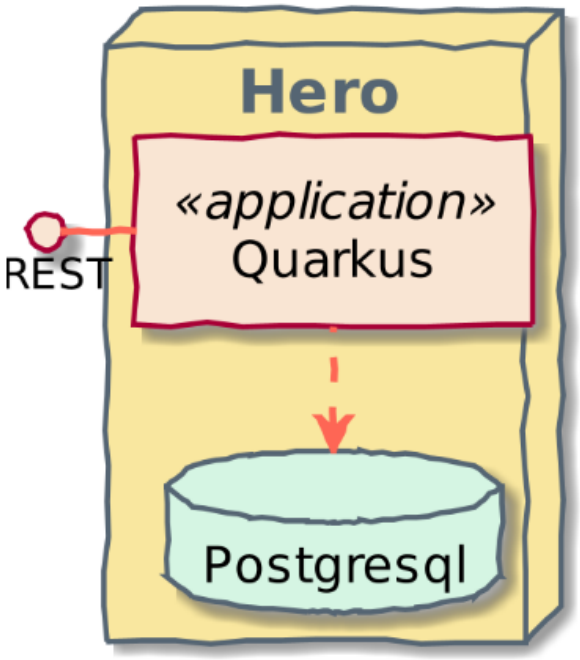
Ready? Here we go!

Software Requirements

This workshop will make use of the following software, tools, frameworks that you will need to install and now (more or less) how it works:

- Any IDE you feel comfortable with (eg. Intellij IDEA, Eclipse IDE, VS Code..)
- JDK 8 / 11
- GraalVM 19.2.1 or 19.3.1
- Maven 3.6.x
- Docker
- cURL (or any other command line HTTP client)
- Node JS (optional, only if you are in a *frontend* mood)

Creating a REST/HTTP Microservice



you learn:

- how to create a new Quarkus application
- how to implement REST API using JAX-RS
- how to compose your application using CDI beans
- how to access your database using Hibernate with Panache
- how to use transactions
- how to enable OpenAPI and Swagger-UI

Quarkus - Custom Extension

Most of the Quarkus magic happens inside extensions.
The goal of an extension is to compute ***just enough bytecode*** to start the services that the application requires, and drop everything else.
So, when writing an extension, you need to distinguish the action that:

- Can be done at build time
- Must be done at runtime

Because of this distinction, extensions are divided into 2 parts: a build time augmentation and a runtime.

The augmentation part is responsible for all the metadata processing, annotation scanning, XML parsing...The output of this augmentation is **recorded bytecode**, which, then, is executed at runtime to instantiate the relevant services.

The extension framework

To build an extension, Quarkus provides a framework to:

- read configuration from the `application.properties` file and map it to objects,
- read metadata from classes without having to load them, this includes classpath and annotation scanning,
- generate bytecode if needed (for proxies for instance),
- pass sensible defaults to the application,
- make the application compatible with GraalVM (resources, reflection, substitutions),
- implement hot-reload

Eclipse Vertx

Eclipse Vertx **with Quarkus**

Serverless application with Quarkus