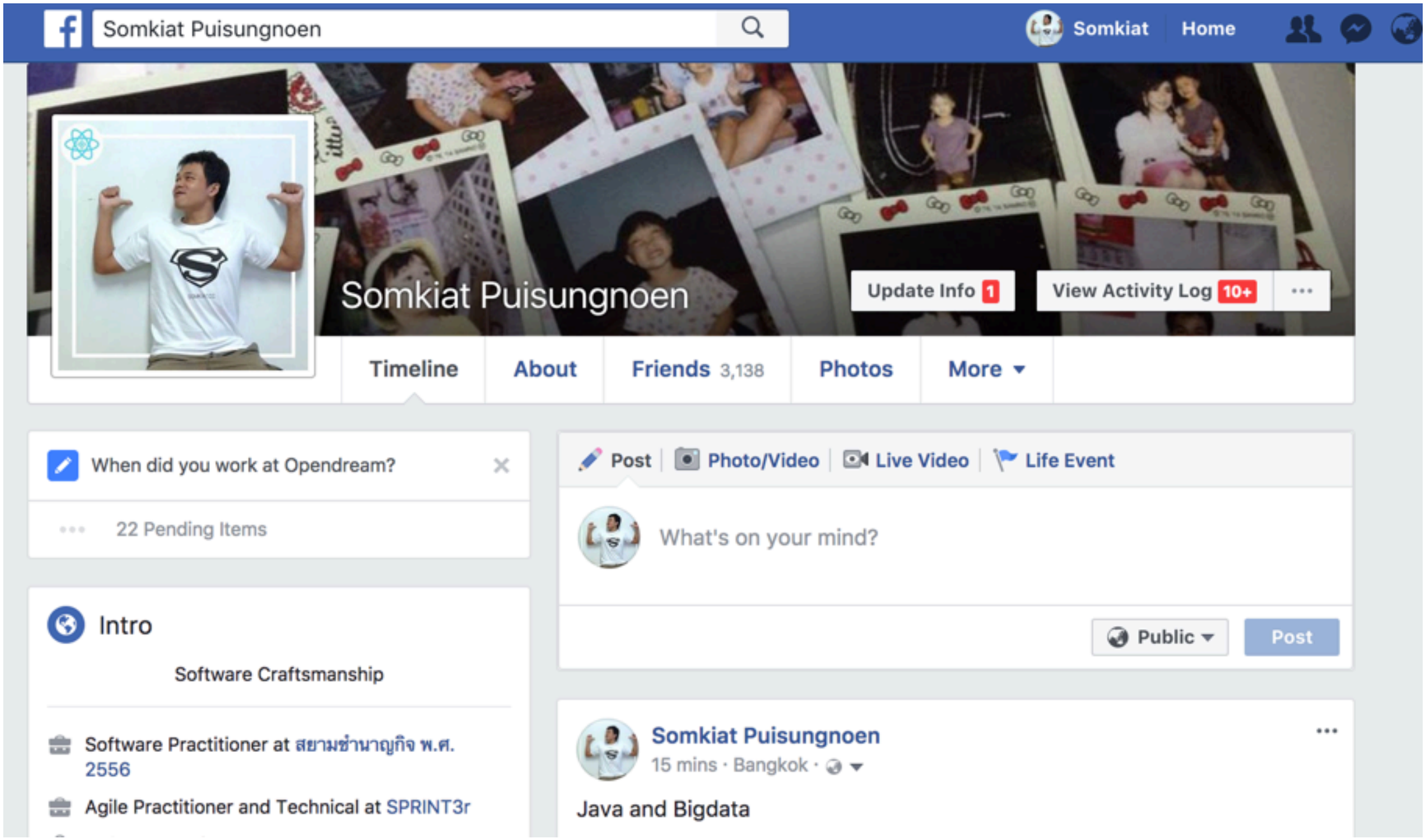
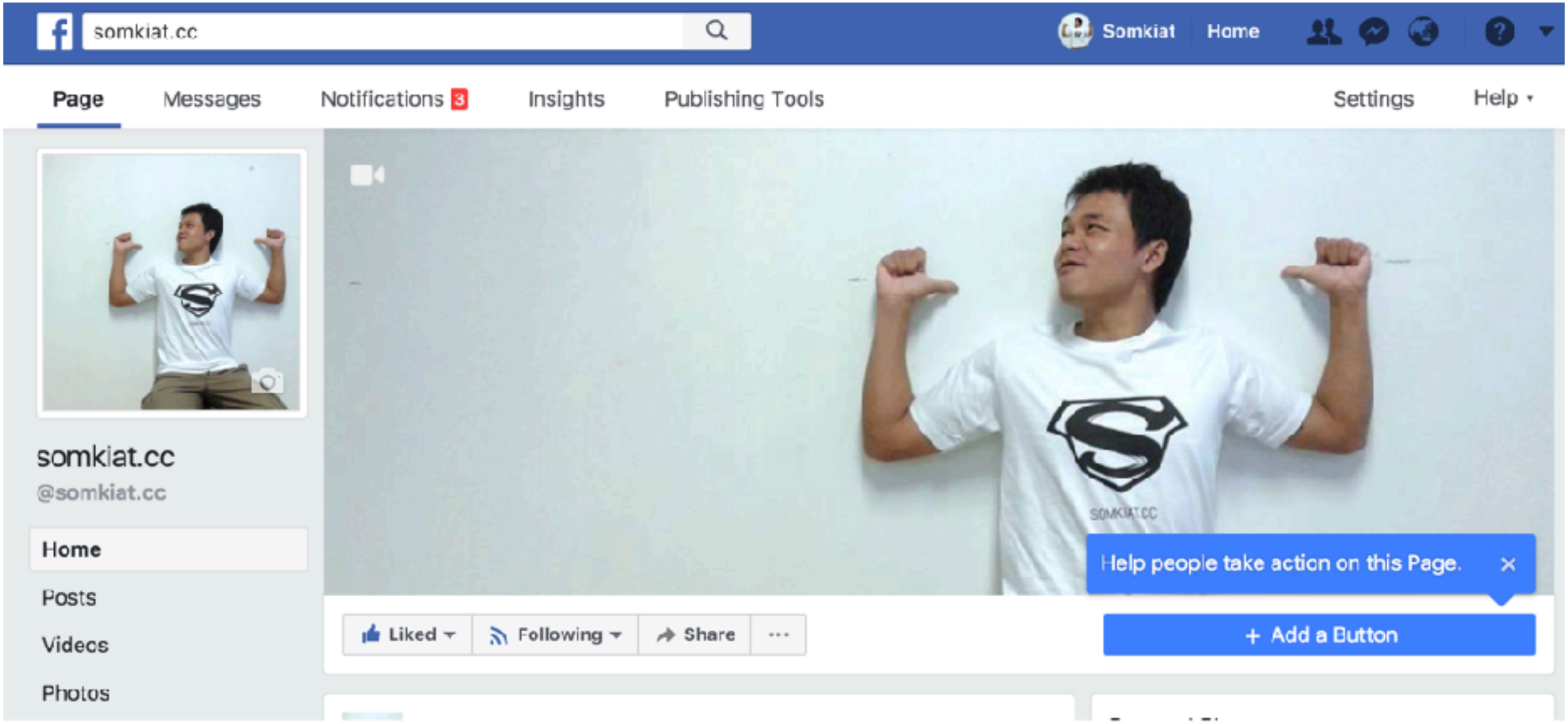
สยามชำนาญกิจ
SIAM CHAMNAN KIT

# Spring Boot
# Spring Testing
# RESTFul API



# https://github.com/up1/course-springboot-2024

# Spring Boot

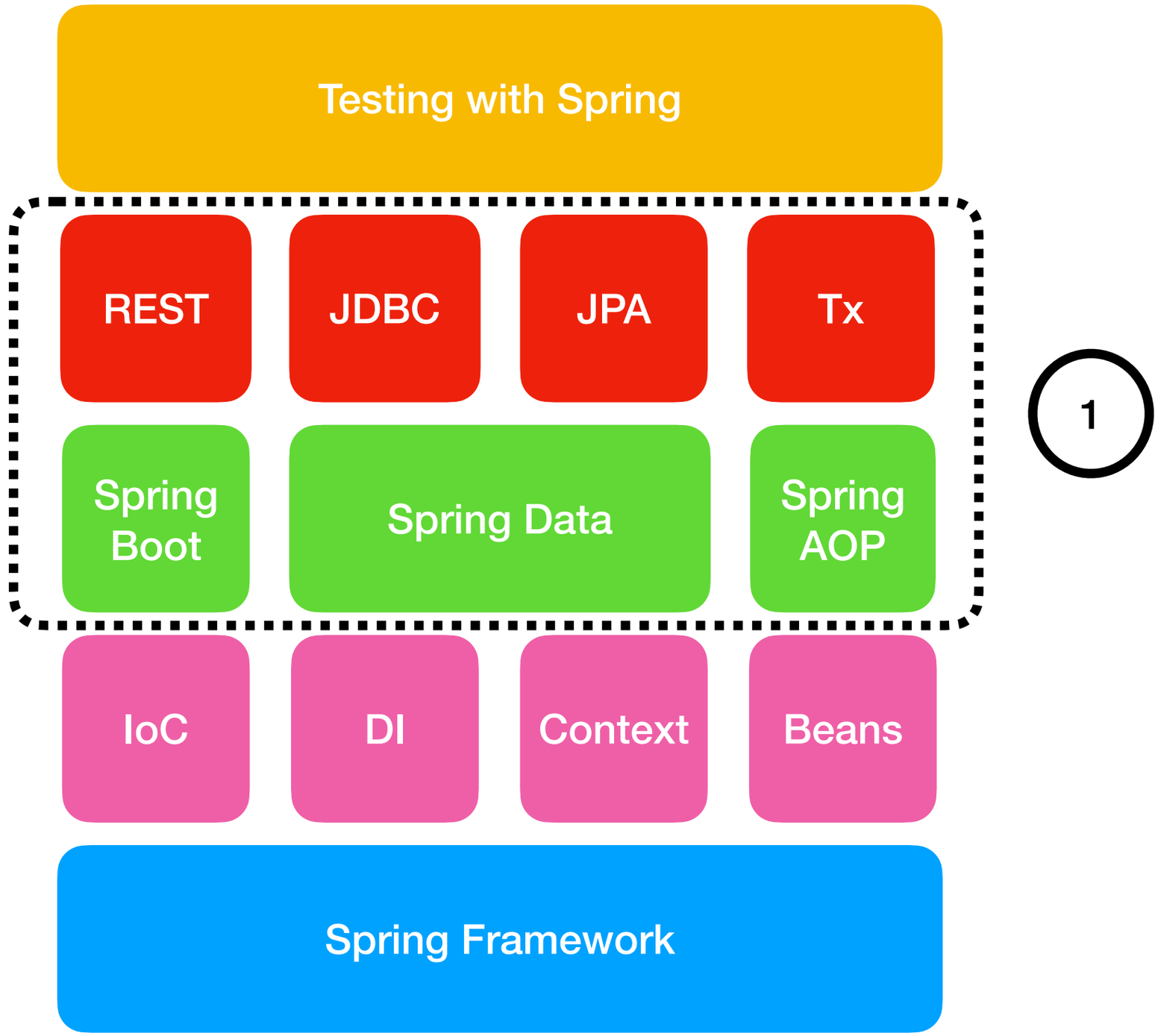
# Agenda

REST (REpresentational State Transfer)
Introduction to Spring Boot
Goals of Spring Boot
Better project structure of Spring Boot
Develop RESTful APIs
Error handling
Layer in Spring Boot project
Working with Spring Data (JPA and JDBC)

# Agenda

Manage transaction
Secure service with Spring Security
Observable service
Application metrics
Distributed tracing
Centralized logging

# Workshop

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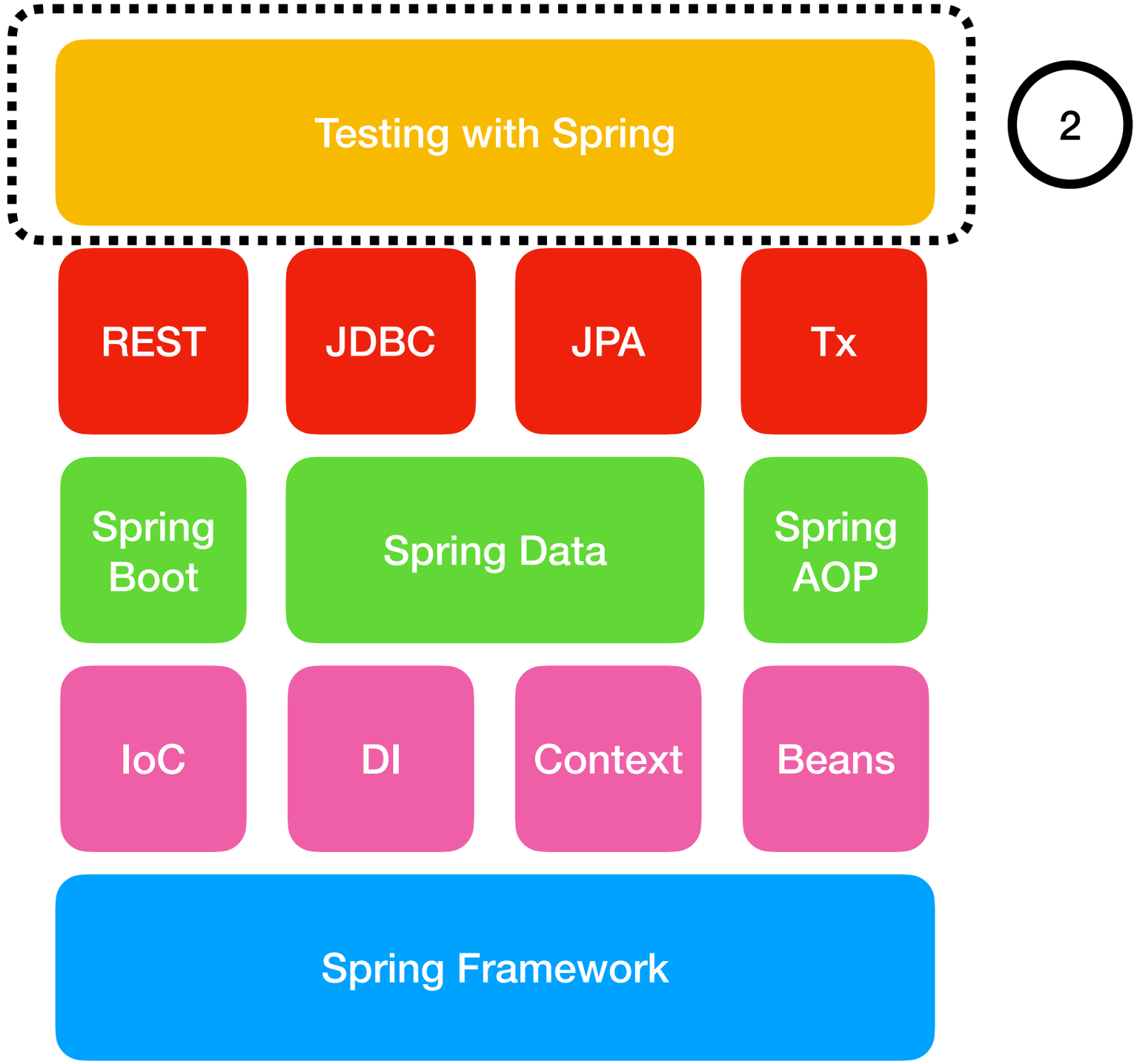
# Workshop

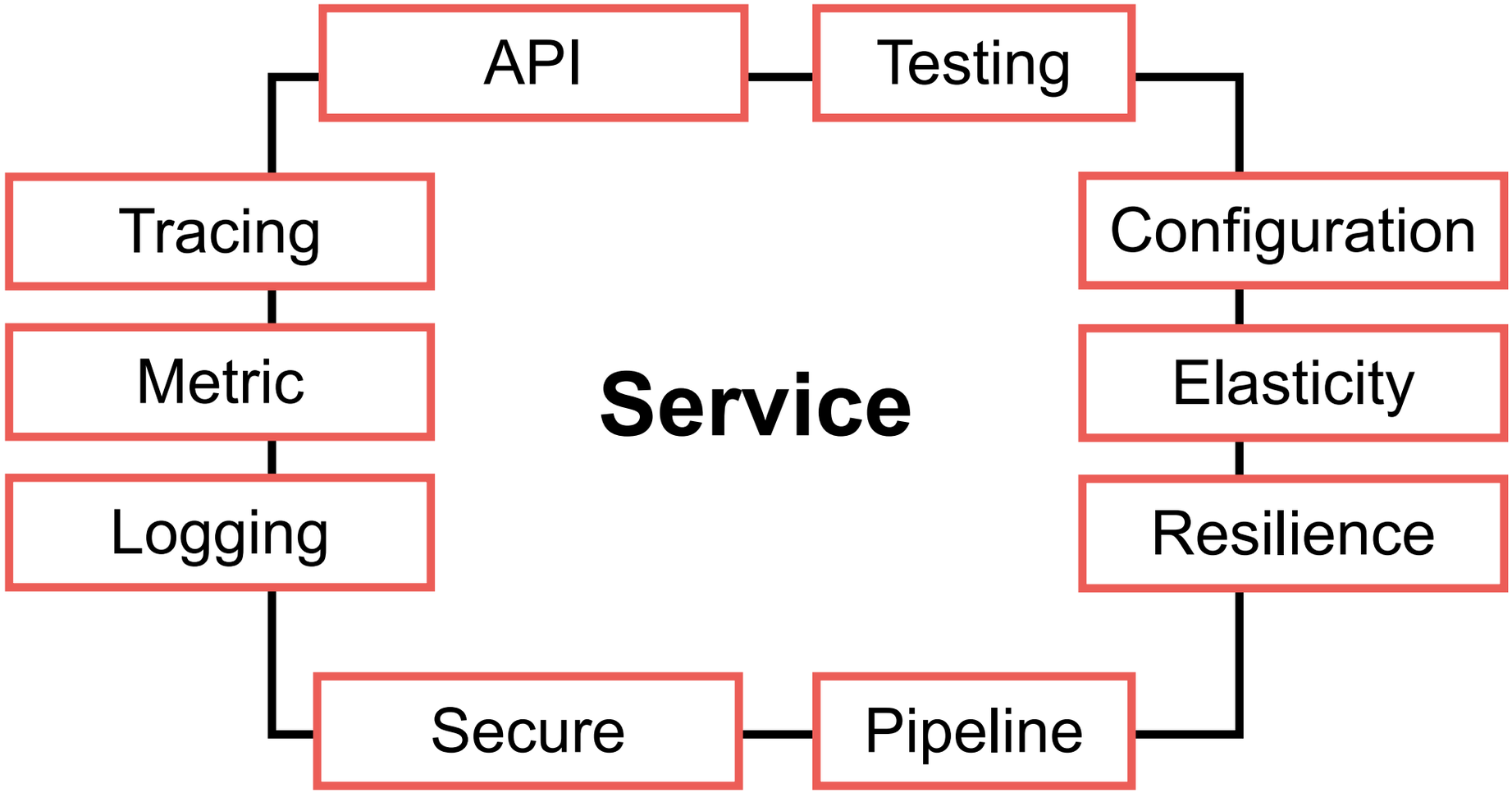


# My Rule

# Always write tests

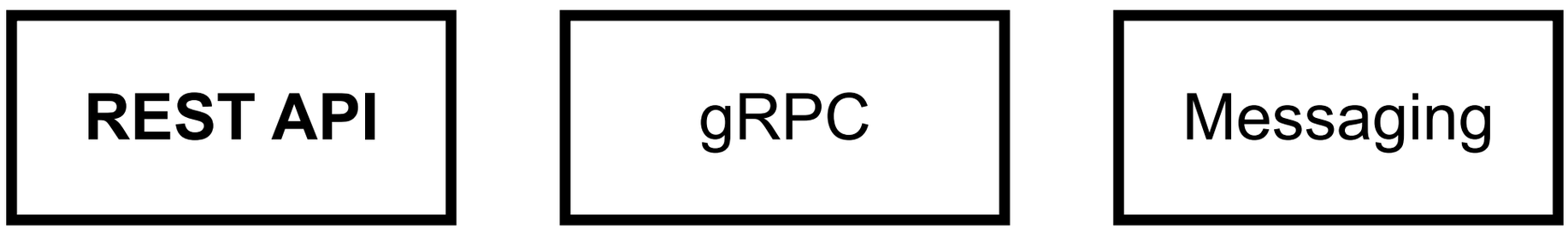
# Let’s start

# Properties of Service



# APIs

Application Programming Interface



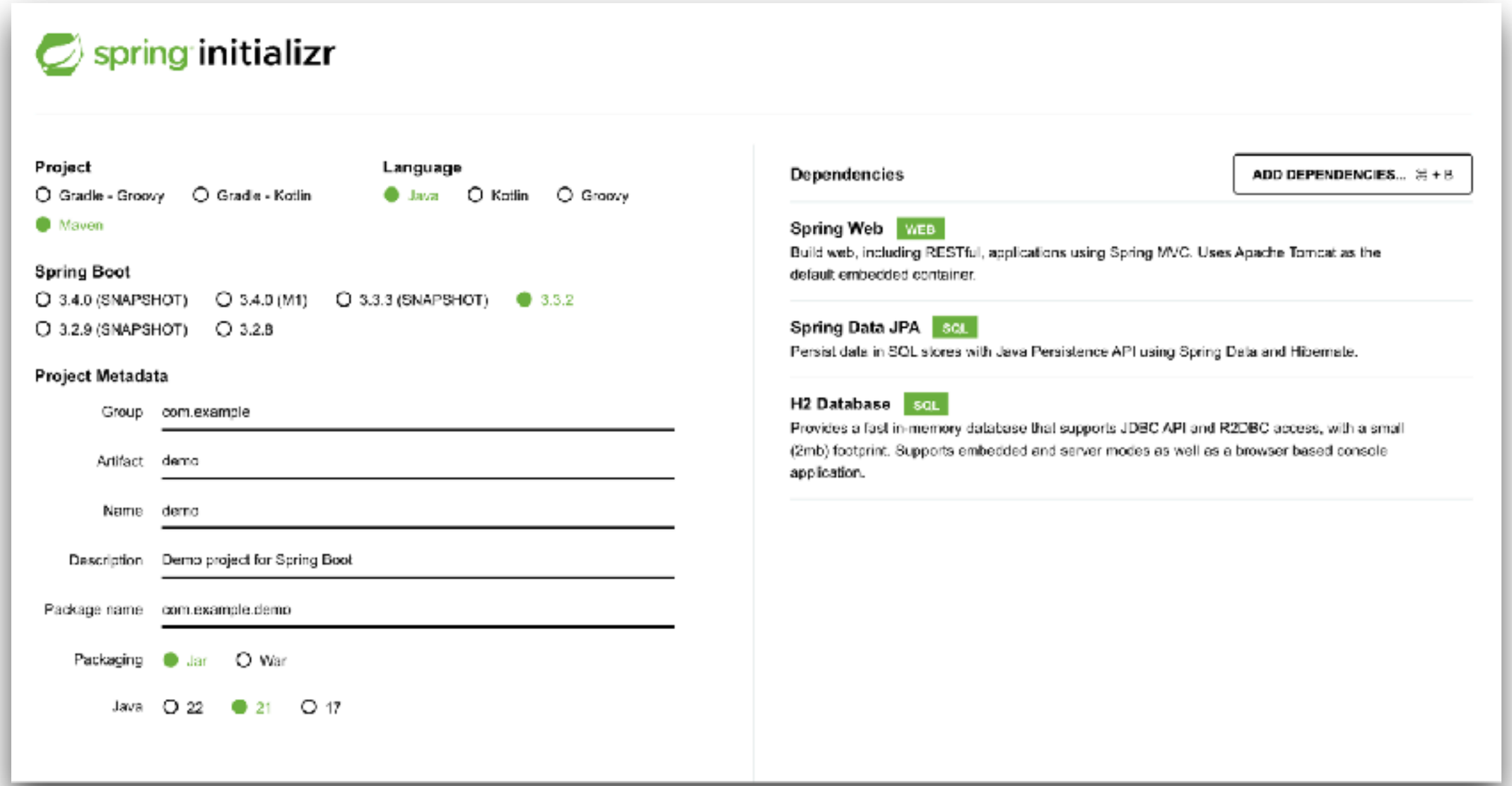
# Develop REST API


https://spring.io/projects/spring-boot

# Spring Framework

# Spring Boot

# Create Spring Boot project




https://start.spring.io/

# REST

**RE**presentation **S**tate **T**ransfer

The style of **software architecture** behind RESTful services

Defined in 2000 by Roy Fielding

https://www.ics.uci.edu/~fielding/pubs/dissertation/rest_arch_style.htm

# Goals

Scalability
Generality of interfaces
Independent deployment of components

# REST properties

Performance

Scalability

Simplicity

Modification

Visibility

Portability

Reliability

# REST constraints

Client-server

Stateless

Cacheable

Layer system

Uniform interface

Code on demand

eg. JavaScript

# RESTful service

Implementation from REST

# REST Request Messages

RESTful request is typically in form of **U**niform **R**esource **I**dentifiers (URI)

# REST Request Messages

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Structure of URI depend on specific service

# REST Request Messages

RESTful request is typically in form of **U**niform **R**esource **I**dentifiers (URI)

Structure of URI depend on specific service

Request can include parameter and data in body of request as XML, JSON etc.

# REST Request & Response

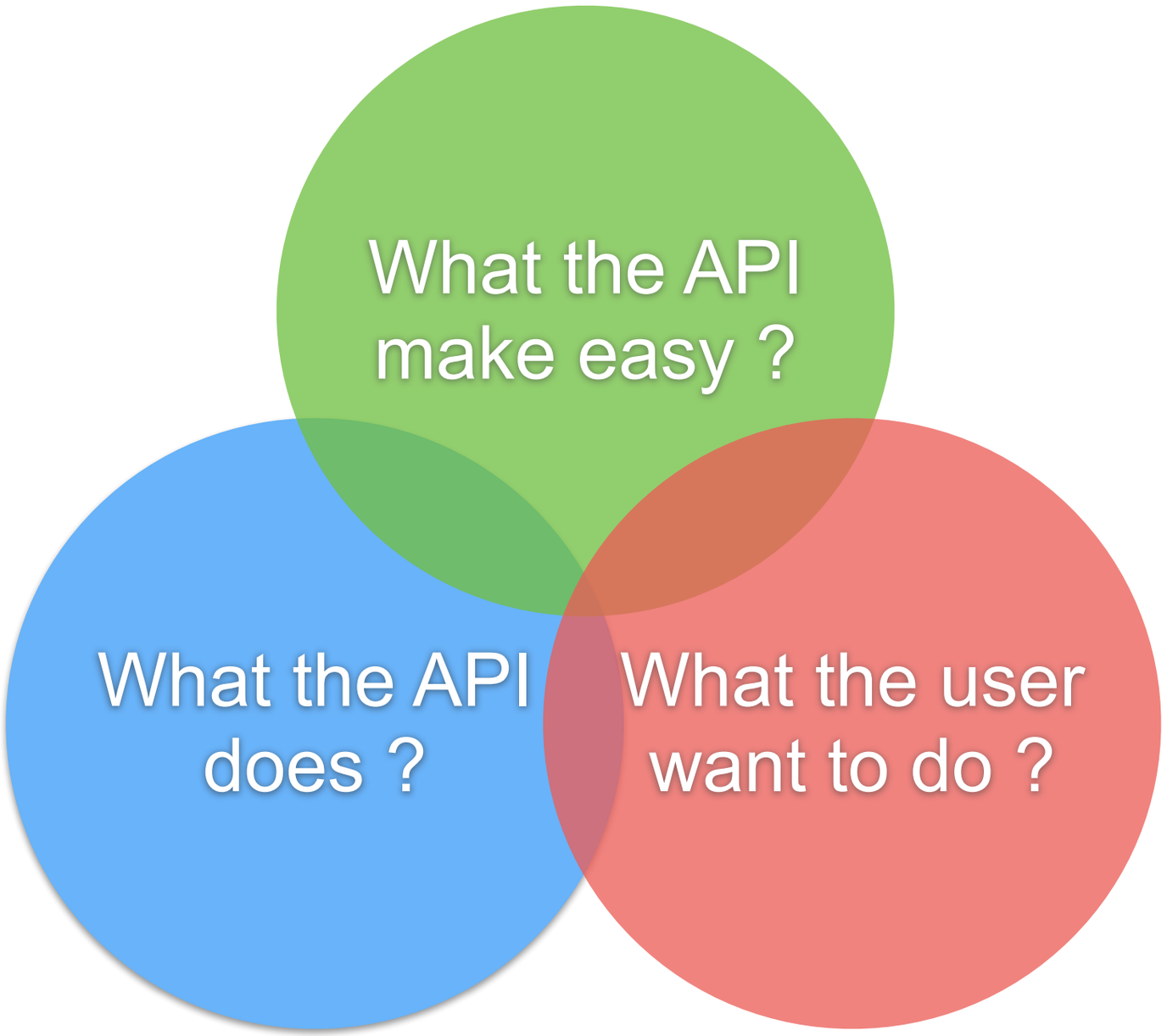
# Status Code

| Code | Description |
|---|---|
| 1xx | Information |
| 2xx | Successfu |
| 3xx | Redirection |
| 4xx | Client error |
| 5xx | Server error |

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

# Response format ?

# Good APIs ?



# Principles of API Design

# Principles of API Design

Consistency

Statelessness

Resource-oriented design

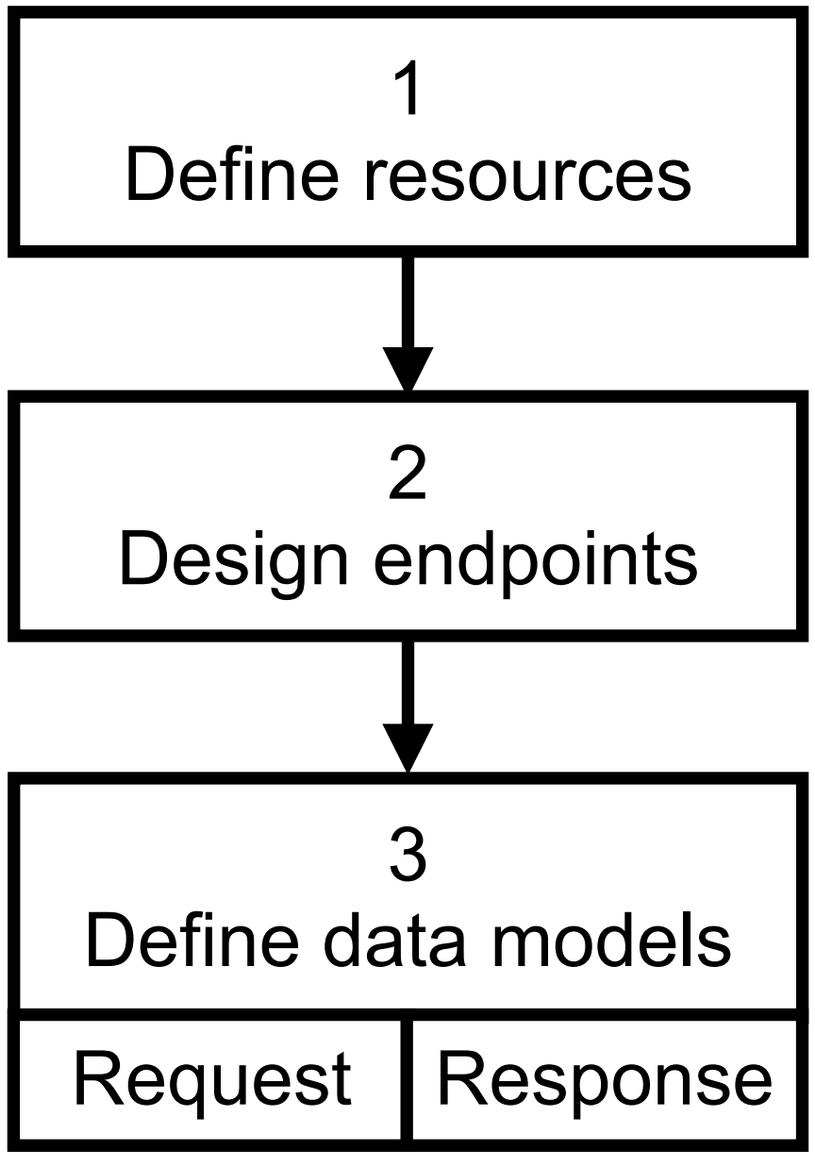
Use standard HTTP methods

Versioning

# HTTP Methods meaning

| Method | Meaning |
| --- | --- |
| GET | Read data |
| POST | Create/Insert new data |
| PUT/PATCH | Update data or insert if a new id |
| DELETE | Delete data |

# Steps to Design APIs



# More !!

Authentication
Authorization

Pagination and filtering

Rate Limiting

Pagination and filtering

Error handling

Documentation

Testing

Monitoring and Observability

# Implementation

Coding

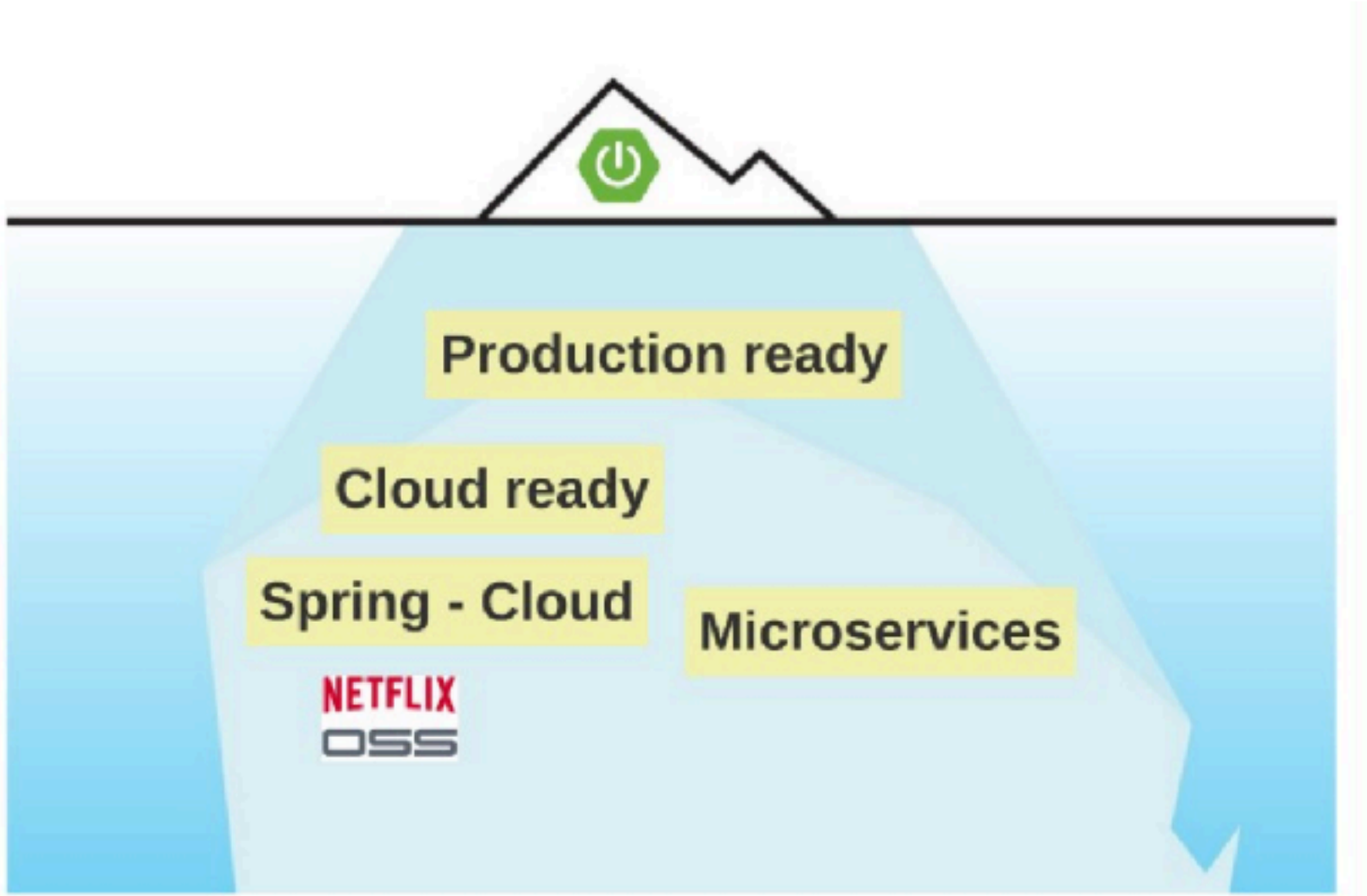
Testing

# Spring Boot

# 3.3.2 (current)

# Why Spring Boot ?

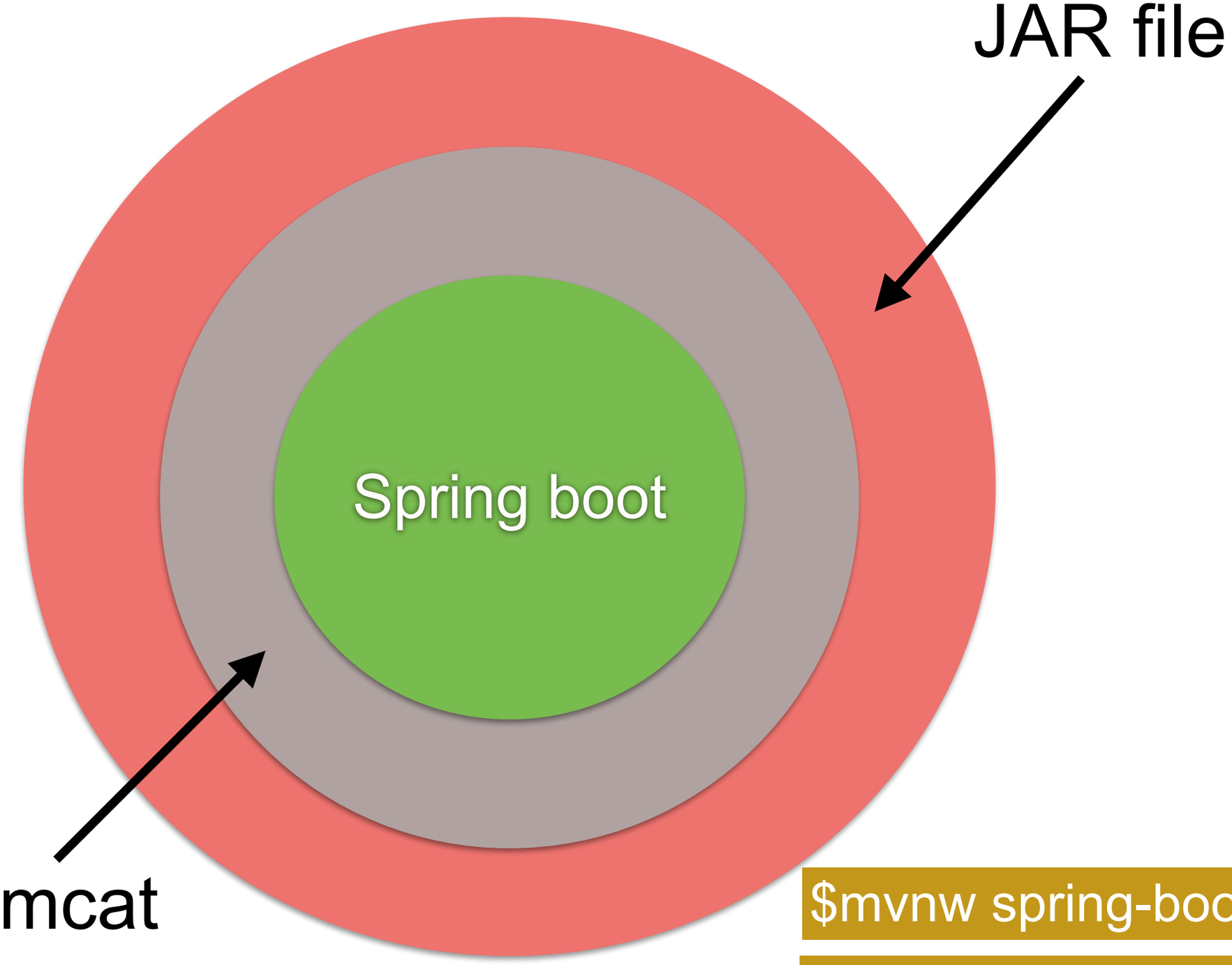
Application skeleton generator
Reduce effort to add new technologies



# What ?

Embedded application server
Integration with tools/technologies (starter)
Production tools (monitoring, health check)
Configuration management
Dev tools
No source code generation, no XML

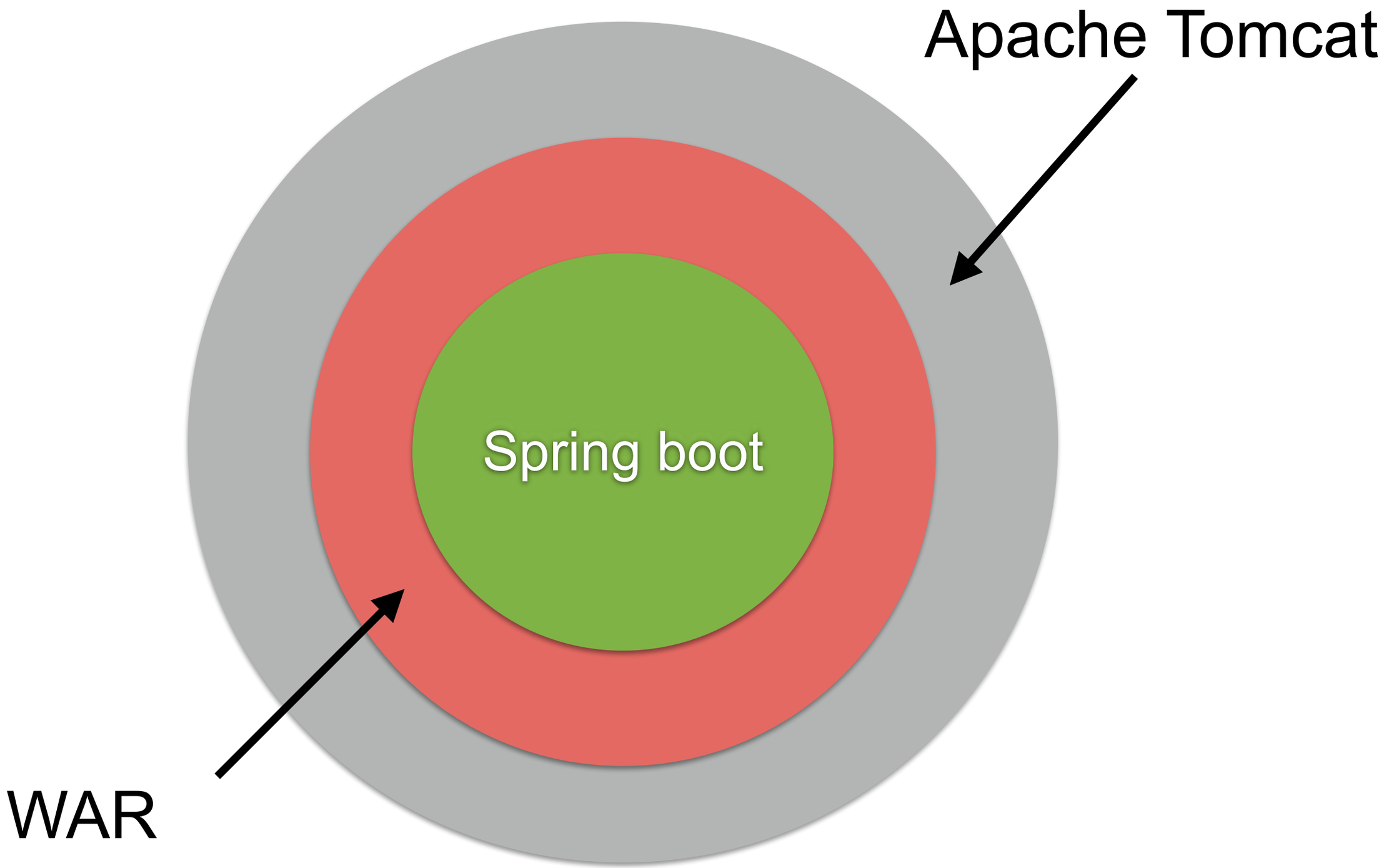
# How ?



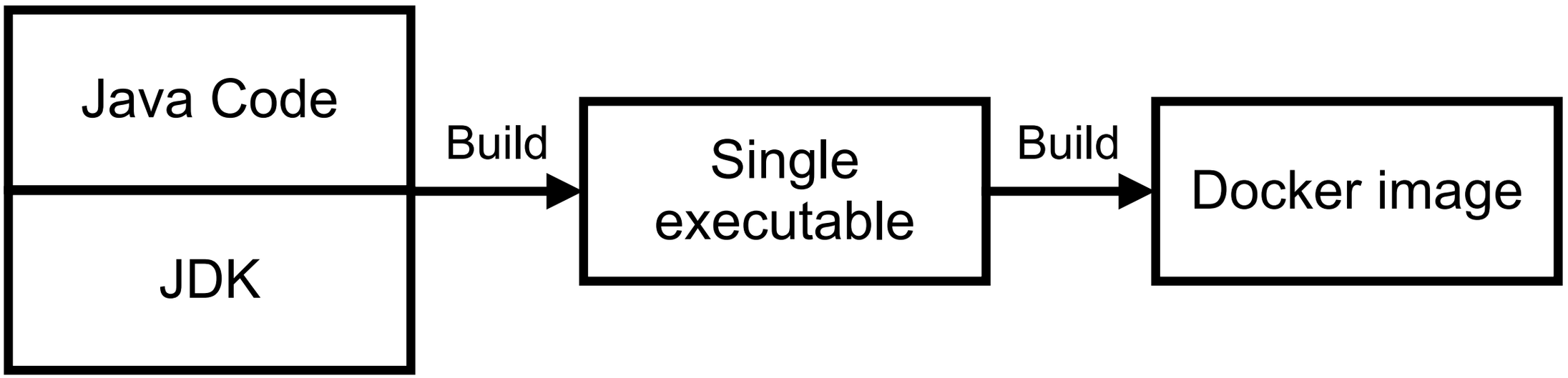

```
$mvnw spring-boot:run
```

```
$java -jar demo.jar
```

# Traditional Deployment

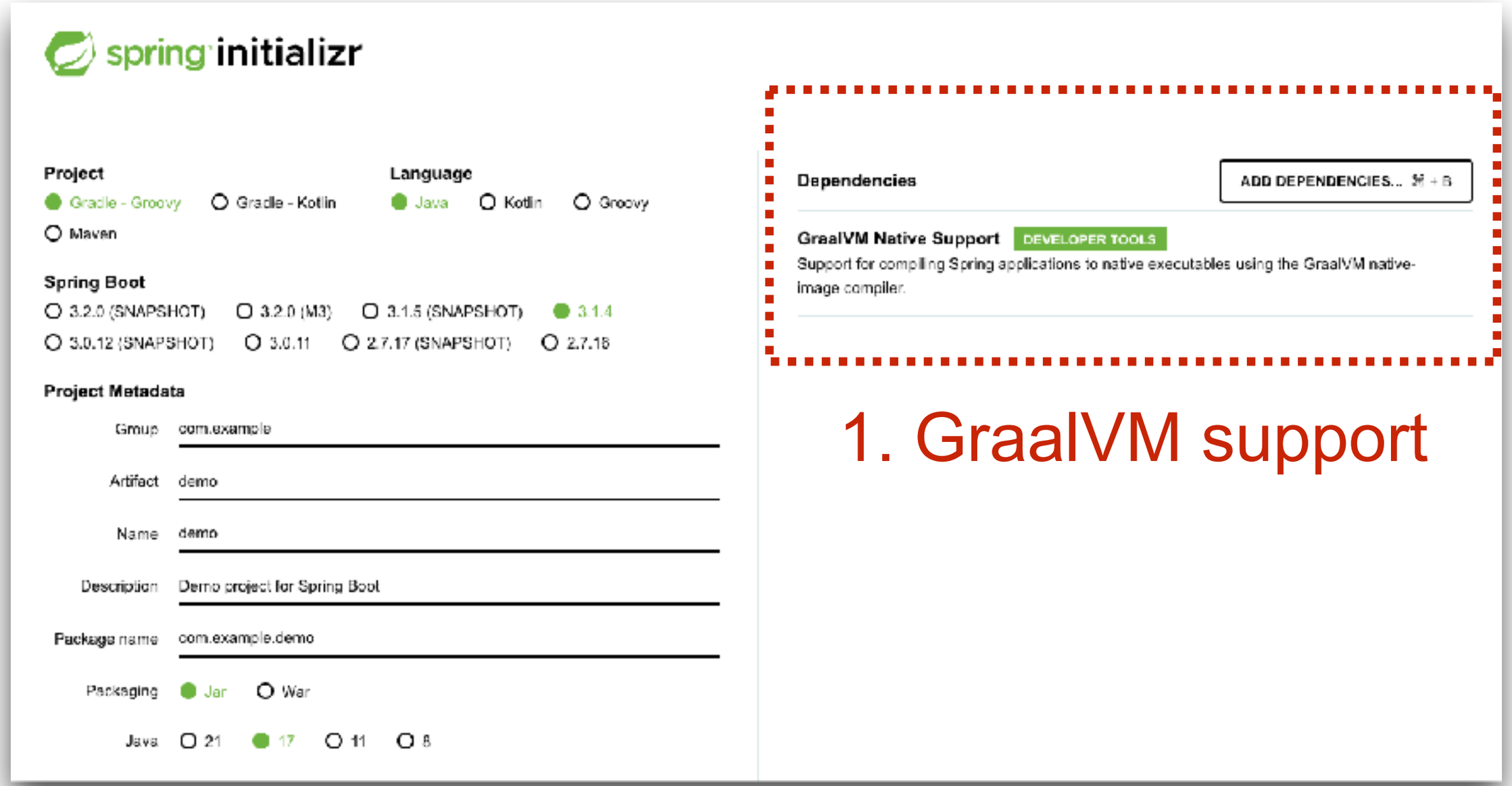


# GraalVM Native Support




https://www.graalvm.org/

# Add to Spring Boot project




https://docs.spring.io/spring-boot/docs/current/reference/html/native-image.html

# Building RESTful API with Spring Boot

# Create new project

spring initializr

**Project**
- Gradle - Groovy
- Gradle - Kotlin
- Maven

**Language**
- Java
- Kotlin
- Groovy

**Spring Boot**
- 3.2.0 (SNAPSHOT)
- 3.2.0 (M2)
- 3.1.4 (SNAPSHOT)
- 3.1.3
- 3.0.11 (SNAPSHOT)
- 3.0.10
- 2.7.16 (SNAPSHOT)
- 2.7.15

**Project Metadata**

| | |
|---|---|
| Group | com.example |
| Artifact | demo |
| Name | demo |
| Description | Demo project for Spring Boot |
| Package name | com.example.demo |
| Packaging | Jar / War |
| Java | 20 / 17 / 11 / 8 |

**Dependencies** — ADD DEPENDENCIES... ⌘ + B

**Spring Web** WEB
Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.

**H2 Database** SQL
Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2mb) footprint. Supports embedded and server modes as well as a browser based console application.

**Spring Data JPA** SQL
Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.

1. Spring Web
2. Spring Data JPA
3. H2 Database

# Run project (Dev mode)

$./mvnw spring-boot:run

```
  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::        (v2.0.2.RELEASE)

2018-06-07 13:03:30.412  INFO 12828 --- [
oApplication               : Starting DemoApplication on
D 12828 (started by somkiat in /Users/somkiat/Down
2018-06-07 13:03:30.418  INFO 12828 --- [
oApplication               : No active profile set, fall
```

# Run project (production mode)

$./mvnw package
$java -jar target/<file name>.jar

```
  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '   |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::        (v2.0.2.RELEASE)

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D 12828 (started by somkiat in /Users/somkiat/Down
2018-06-07 13:03:30.418  INFO 12828 --- [
oApplication               : No active profile set, fall
```
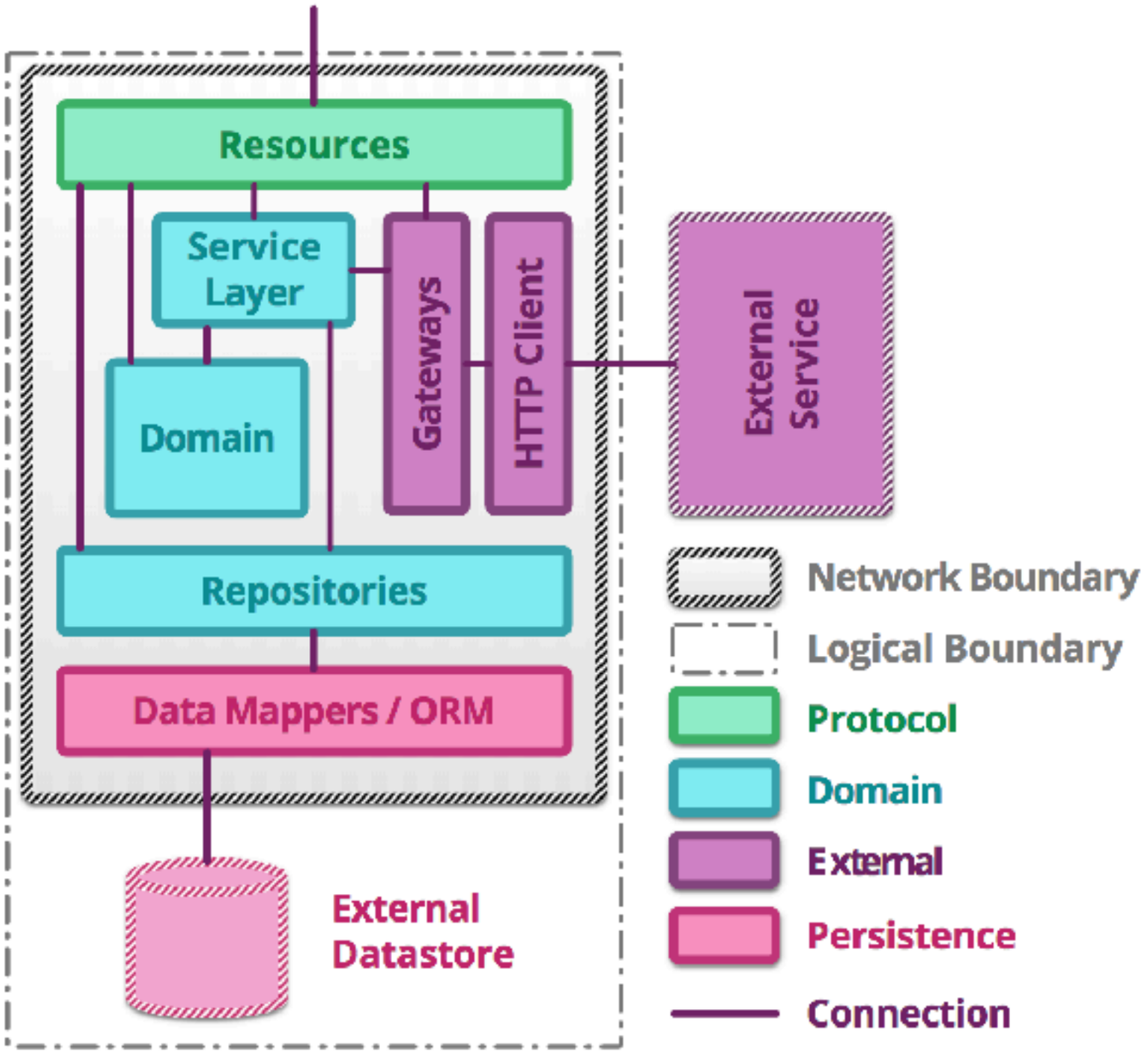
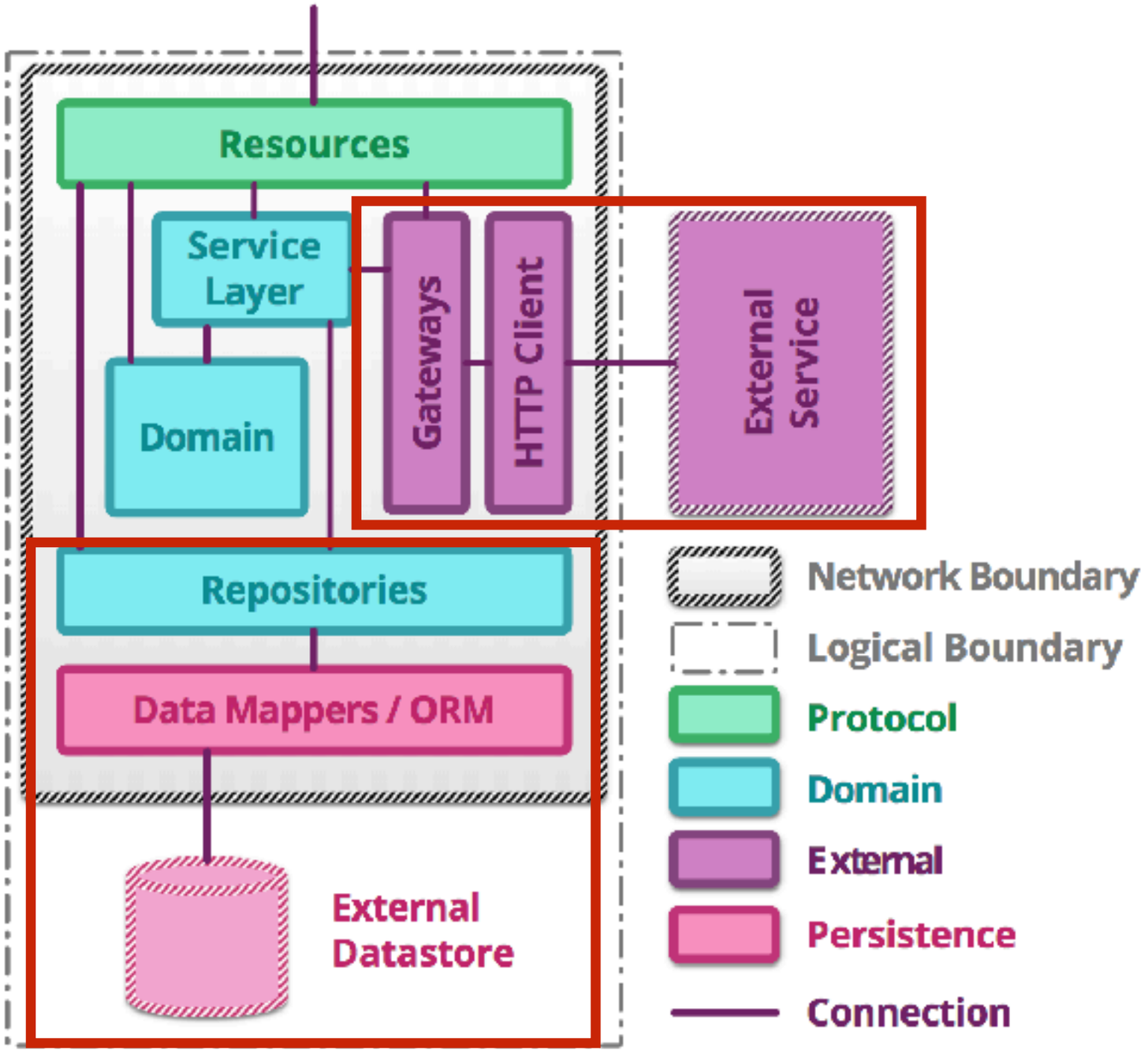
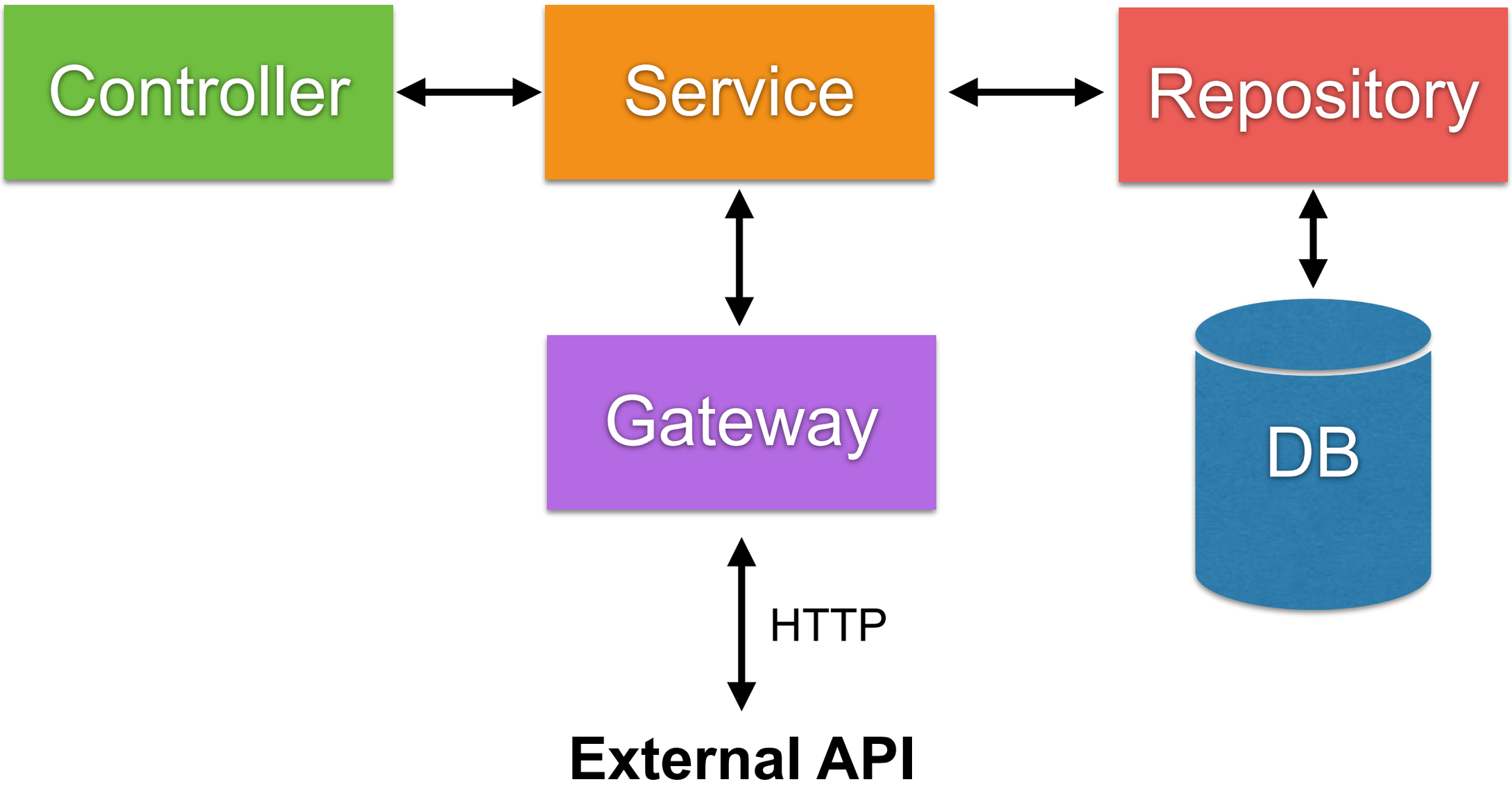

# Project Structure



# Service Structure



# Structure of Spring Boot project



# Controller

Request and Response
Validation input
Delegate to others classes such as service and repository

# Service

Control the flow of main business logics
Manage database transaction
Don’t reuse service

# Repository

Manage data in data store such as RDBMS and NoSQL

# Gateway

Call external service via network such as WebServices and RESTful APIs

# Spring Boot Structure (1)

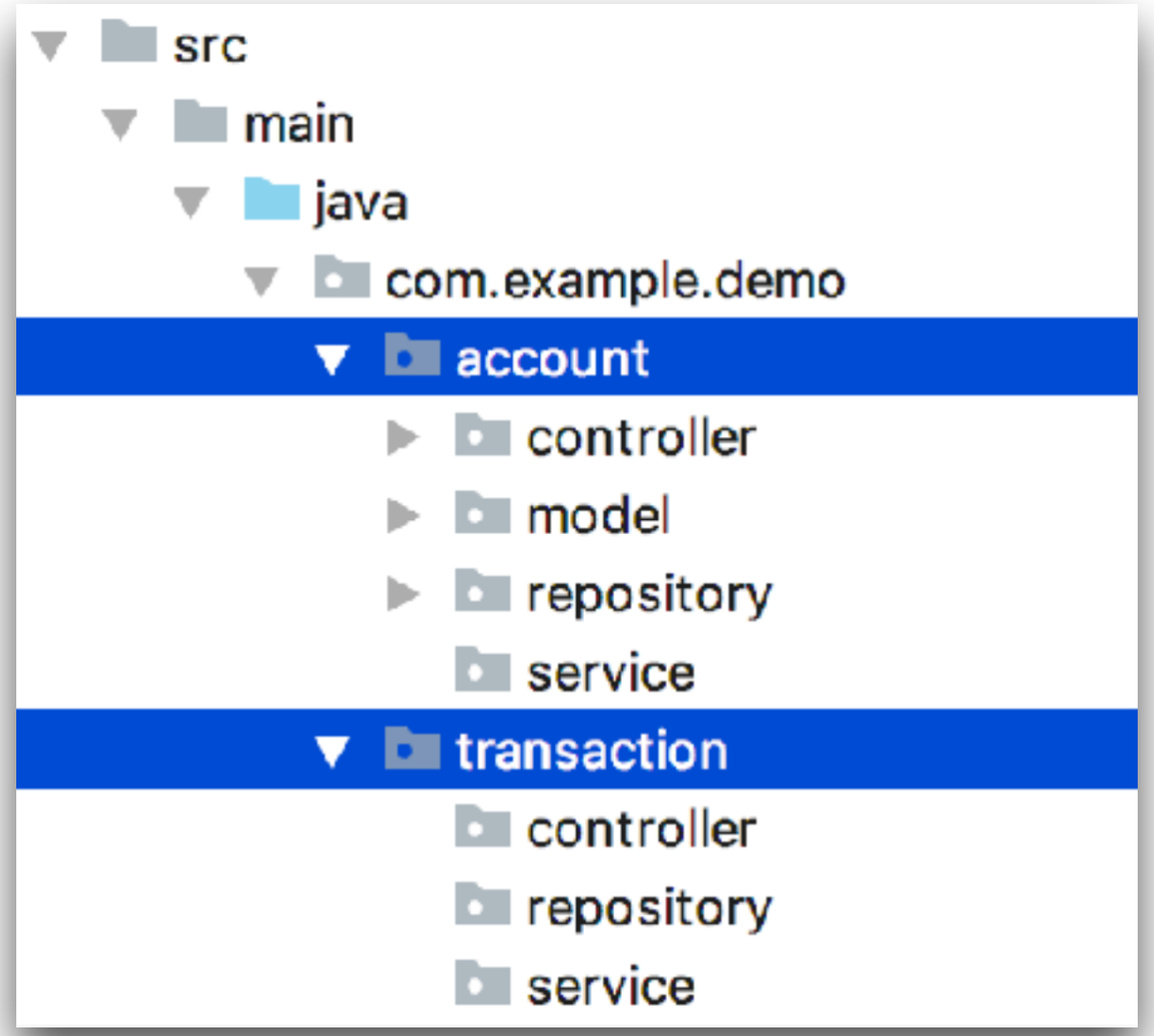
Separate by function/domain/feature

```
feature1
    - controller
    - service
    - repository
feature2
    - controller
    - service
    - repositor
```

https://docs.spring.io/spring-boot/reference/using/structuring-your-code.html

# Spring Boot Structure (2)

Separate by function/domain/feature



# Configurations

A twelve-factor app should externalize all such configurations that vary between deployments

**File application.properties**

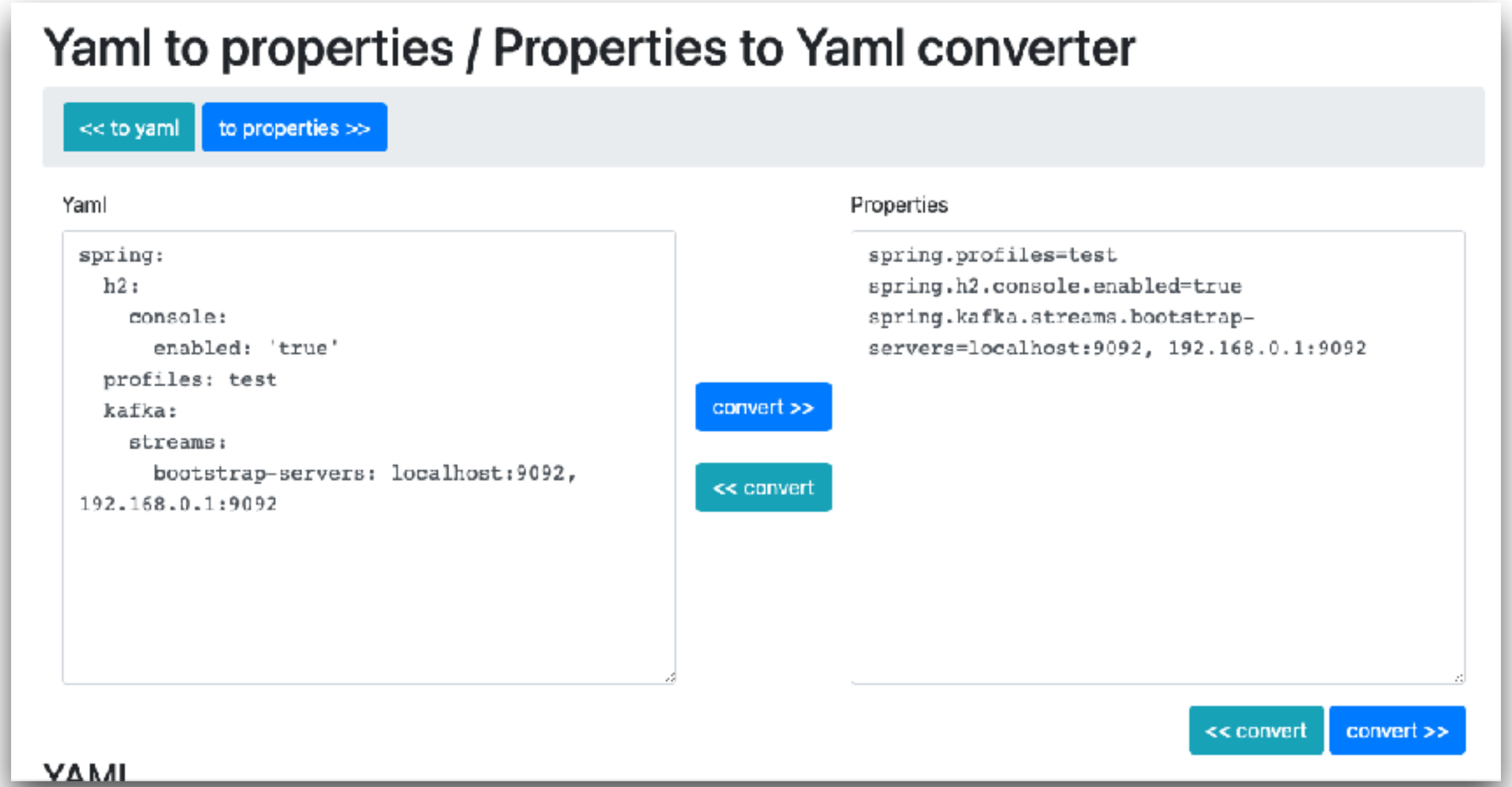
```
spring.datasource.url=jdbc:mysql://${MYSQL_HOST}:${MYSQL_PORT}/movies
spring.datasource.username=${MYSQL_USER}
spring.datasource.password=${MYSQL_PASSWORD}
```

**Usage**

```
set MYSQL_HOST=localhost
set MYSQL_PORT=3306
set MYSQL_USER=movies
set MYSQL_PASSWORD=password
```

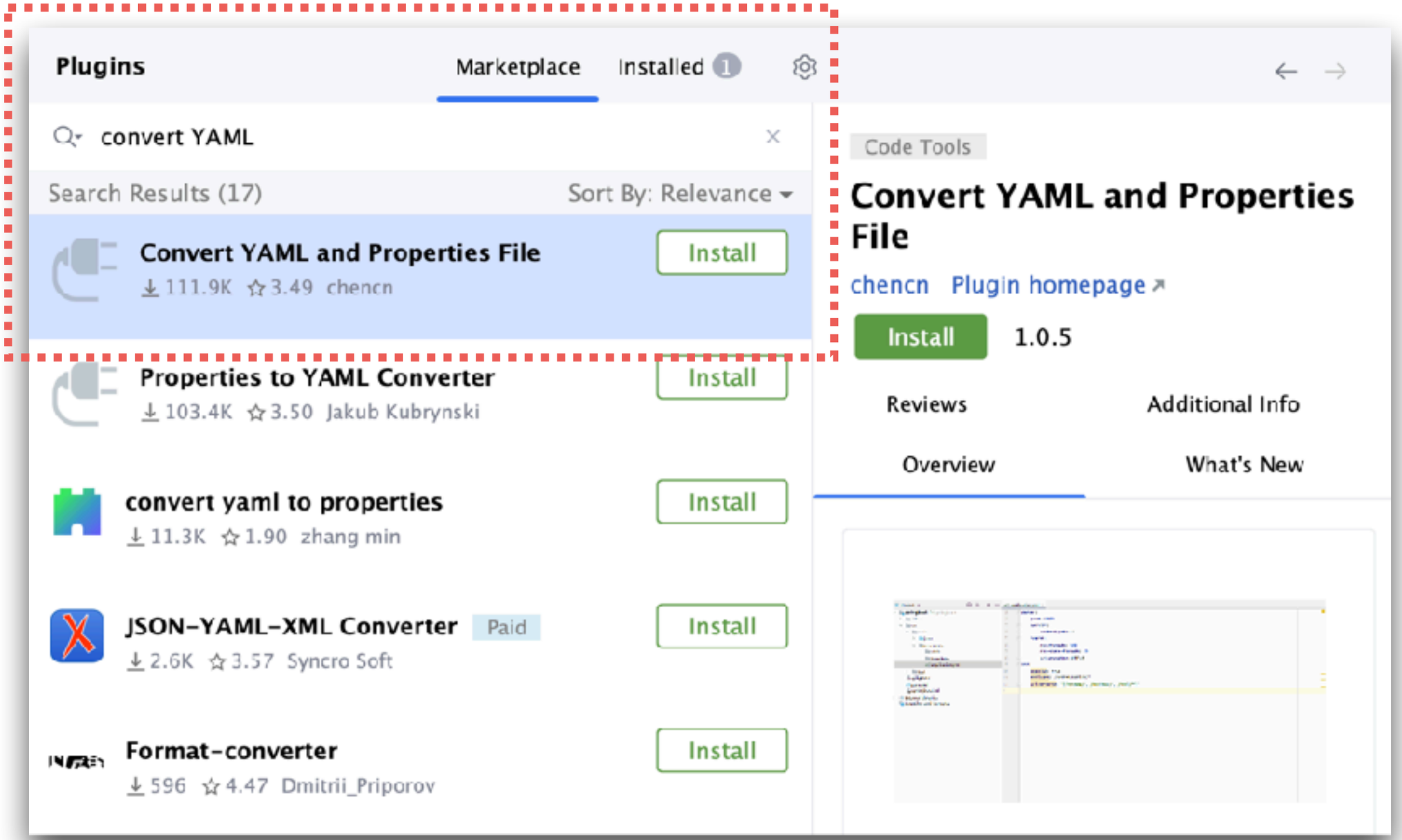
https://docs.spring.io/spring-boot/reference/features/external-config.html

# Convert from properties to YAML



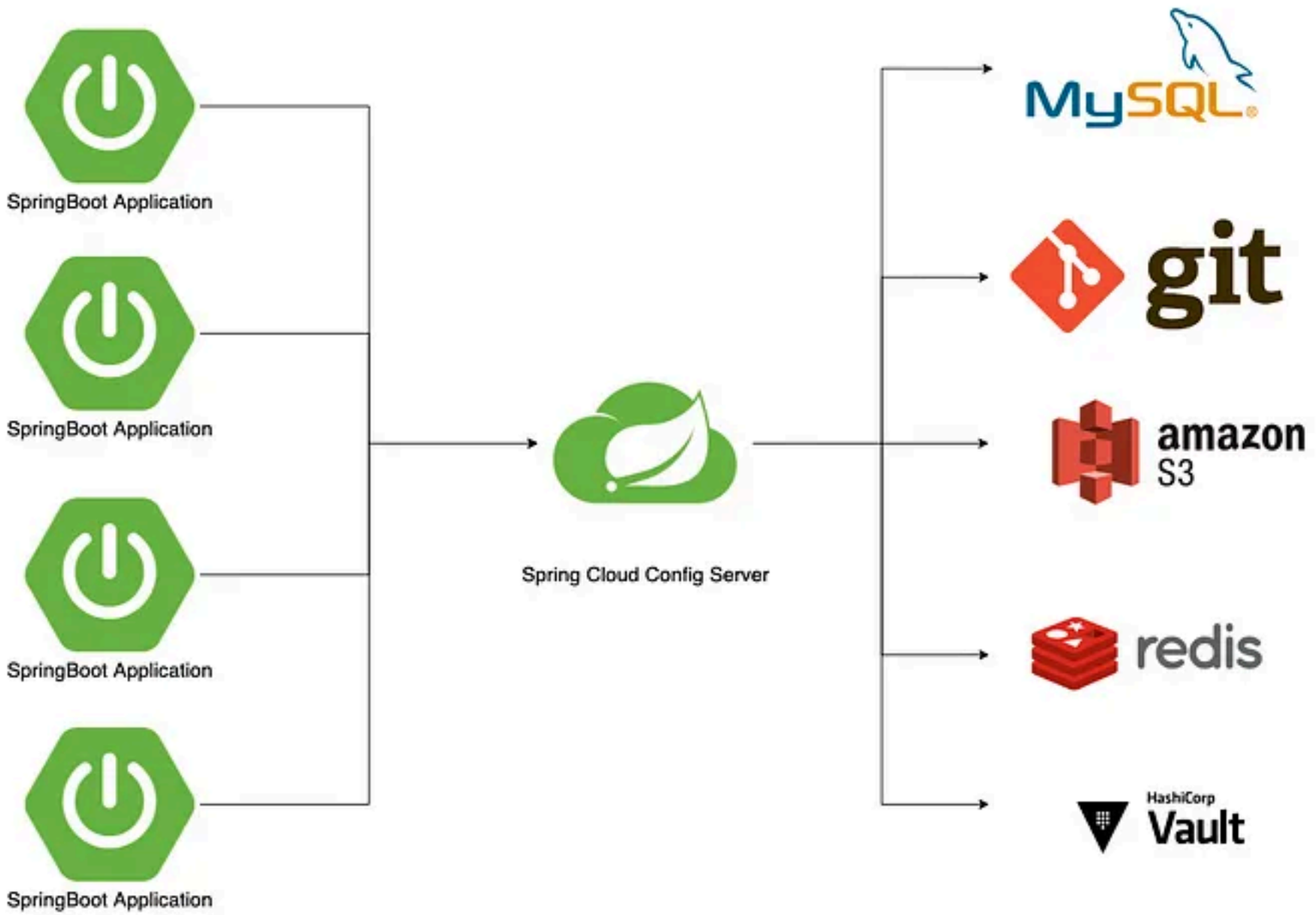

https://mageddo.com/tools/yaml-converter

# Convert in IntelliJ IDEA




https://plugins.jetbrains.com/plugin/13804-convert-yaml-and-properties-file

# Centralized Configuration




https://spring.io/projects/spring-cloud-config

# Design RESTFul APIs

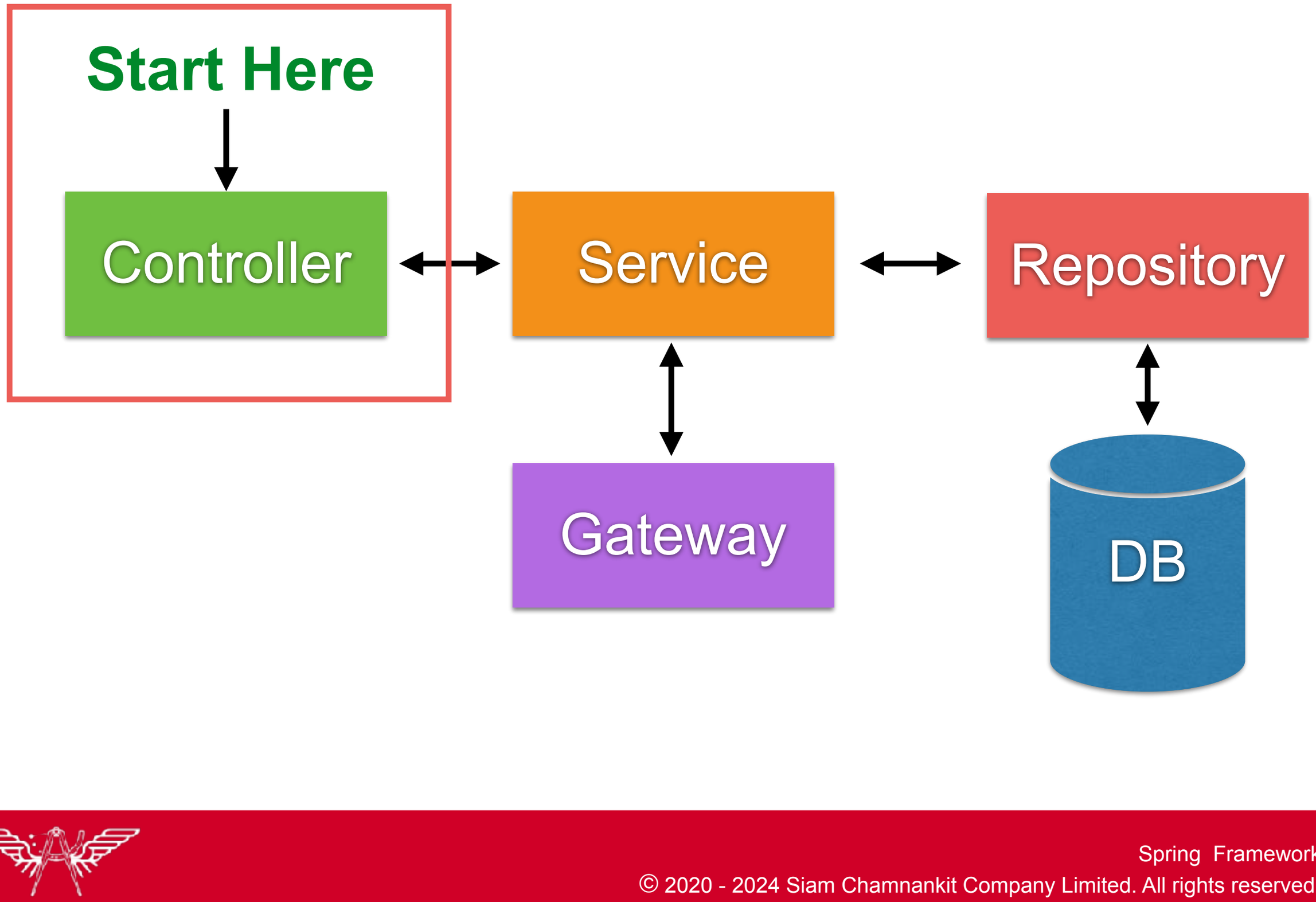
# Users

| Method | Path | Description |
|---|---|---|
| GET | /users | Get all users |
| GET | /users/{id} | Get user by id |
| POST | /users | Create new user |
| PUT | /users/{id} | Update user |
| DELETE | /users/{id} | Delete user by id |

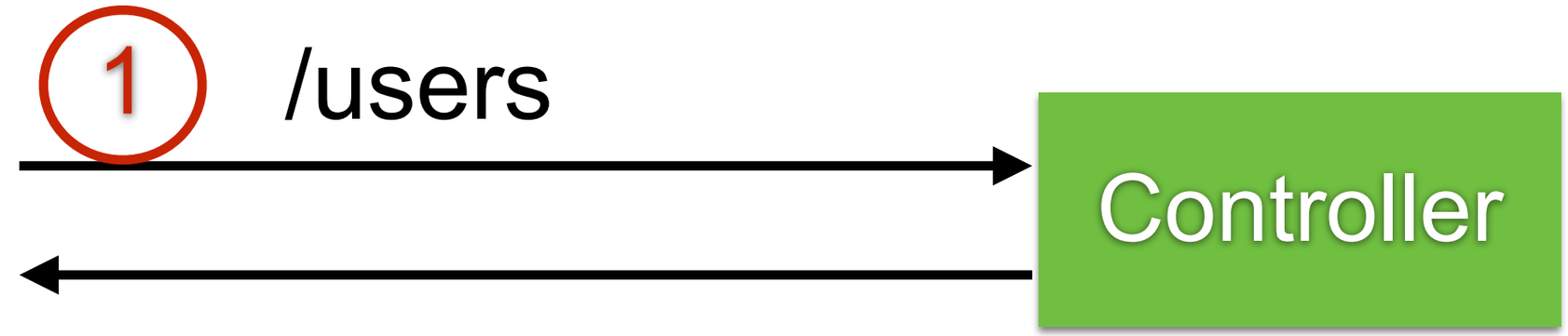
# HTTP status codes

| Code | Description | Example |
|---|---|---|
| 1xx | Informational responses | 100 = Continue<br>101 Switching protocols |
| 2xx | Success | 200 = OK<br>201 = Created |
| 3xx | Redirection | 300 = Multiple choices<br>301 = Moved permanently |
| 4xx | Client errors | 400 = Bad request<br>403 = Forbidden<br>404 = Not found |
| 5xx | Server errors | 500 = Internal server error<br>502 = Bad gateway<br>503 = Service unavailable |

# Basic structure of Spring Boot



# Get all users




```
[
    {"id": 1, "name": "Somkiat", "age": 30},
    {"id": 2, "name": "Demo name", "age": 35}
]
```

# 1. Create REST Controller

UserController.java

```java
@RestController
public class UserController {

    @GetMapping("/users")
    public List<UserResponse> getAllUsers() {
        List<UserResponse> userResponseList = new ArrayList<>();
        userResponseList.add(new UserResponse(1,"demo 1", 30));
        userResponseList.add(new UserResponse(2,"demo 2", 35));
        return userResponseList;
    }
```

# 2. Create model class

UserResponse.java

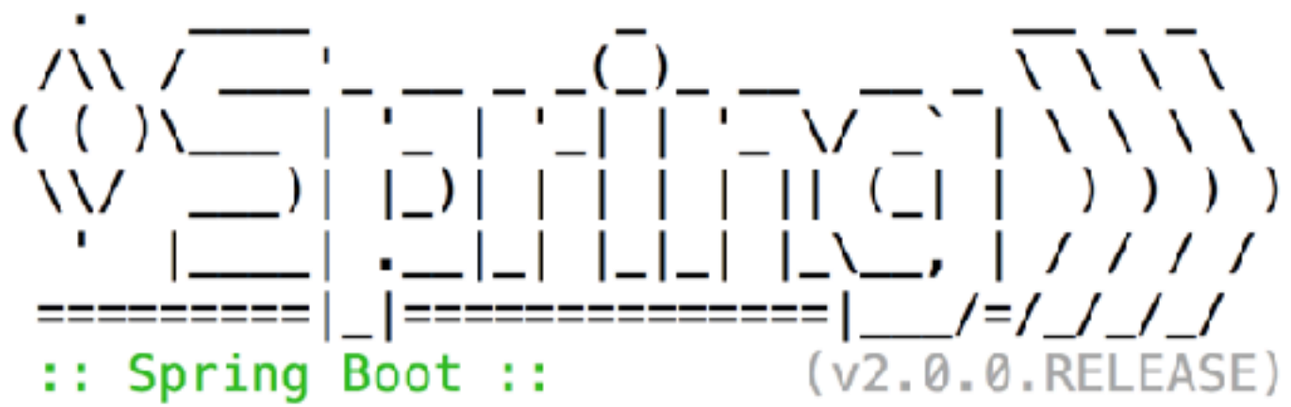
```java
public class UserResponse {
    private int id;
    private String name;
    private int age;

    public UserResponse() {
    }

    public UserResponse(int id, String name, int age) {
        this.id = id;
        this.name = name;
        this.age = age;
    }
```

# 3. Compile and Packaging

$mvnw clean package

# 4. Run

$java -jar target/hello.jar




```
2018-03-05 23:37:18.018  INFO 30560 --- [           mair
                    : Starting HelloApplication v1.0-SNAPSH(
th PID 30560 (/Users/somkiat/data/slide/microservice/sl:
op/course-microservice/slide/4days-workshop/workshop/he
 by somkiat in /Users/somkiat/data/slide/microservice/s
hop/course-microservice/slide/4days-workshop/workshop/he
2018-03-05 23:37:18.023  INFO 30560 --- [           mair
                    : No active profile set, falling back to
2018-03-05 23:37:18.138  INFO 30560 --- [           mair
```

# 5. Open in browser

http://localhost:8080/users


```
[
  {
    "id": 1,
    "name": "demo 1",
    "age": 30
  },
  {
    "id": 2,
    "name": "demo 2",
    "age": 35
  }
]
```


# Create more APIs

Get user by id
Create a new user
Update user by id
Delete user by id

# Get user by id

GET /users/{id}

```
@GetMapping("/users/{id}")
public UserResponse getUserById(
          @PathVariable int id) {

    UserResponse userResponse = new UserResponse(id, "Demo", 40);
    return userResponse;

}
```

# Create UserResponse

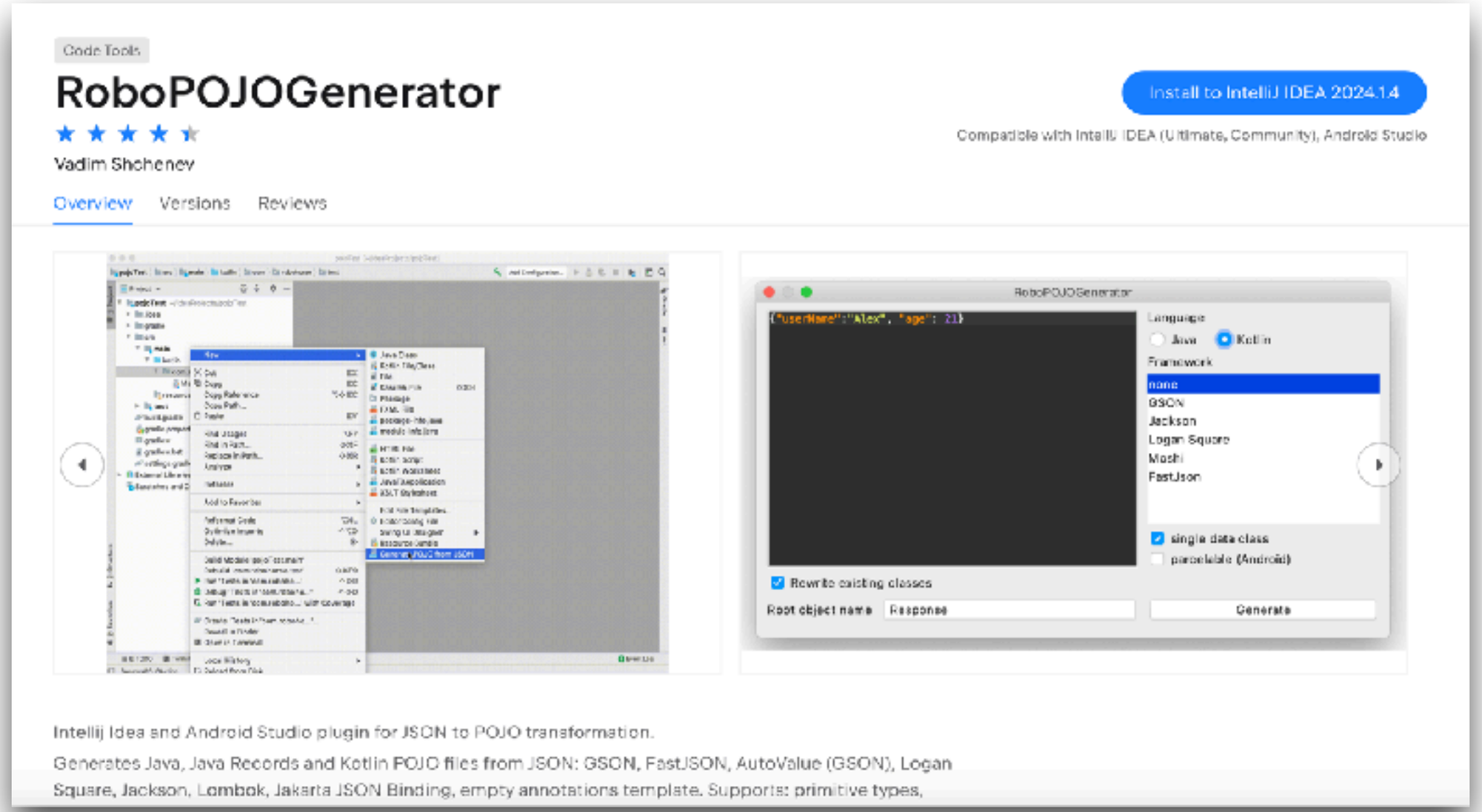
**POJO**
Setter/Getter

**Lombok**

**Record**
Java 14+

# Convert JSON to POJO

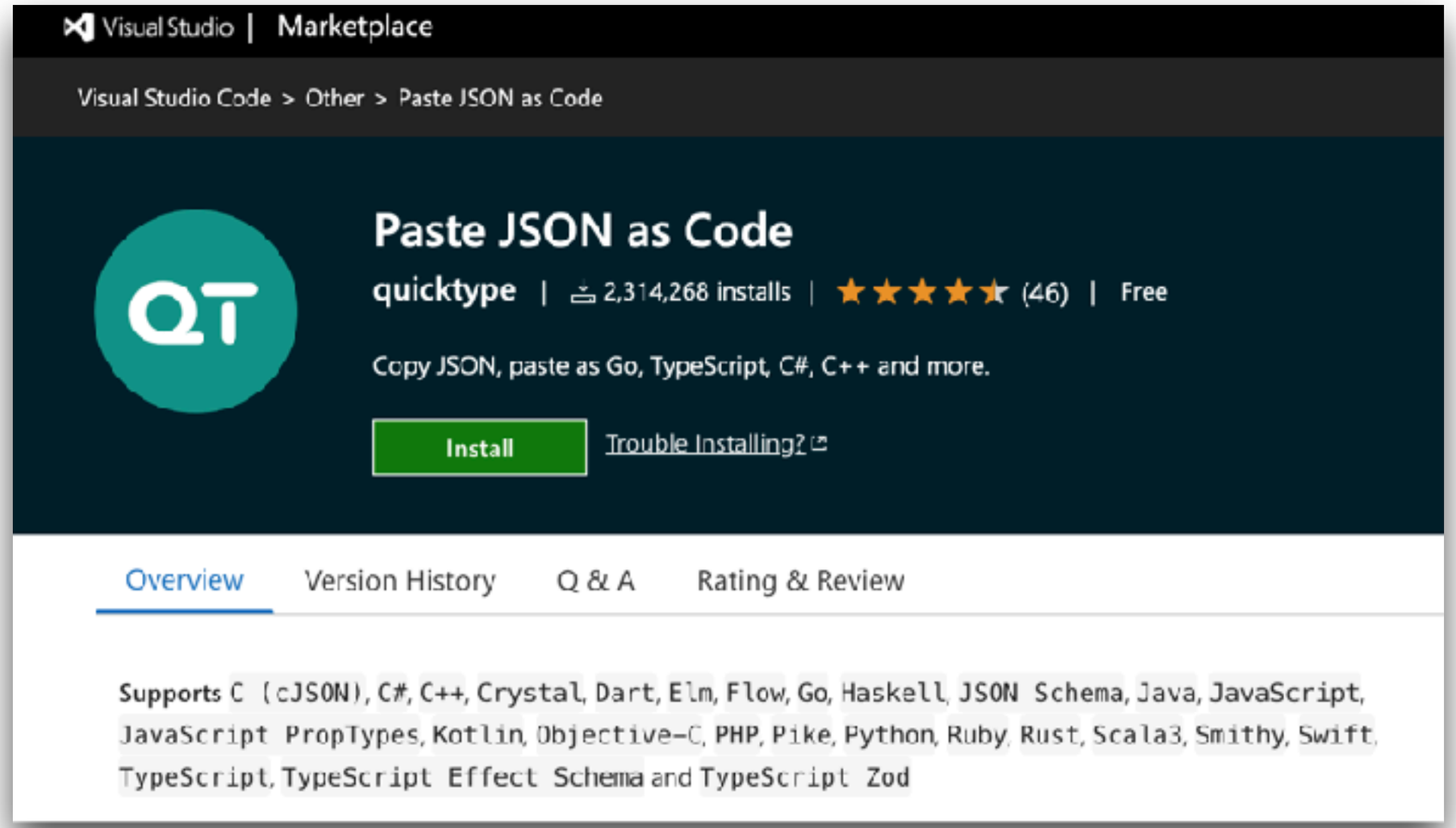
## IntelliJ IDEA




https://plugins.jetbrains.com/plugin/8634-robopojogenerator

# Convert JSON to POJO

## VS Code



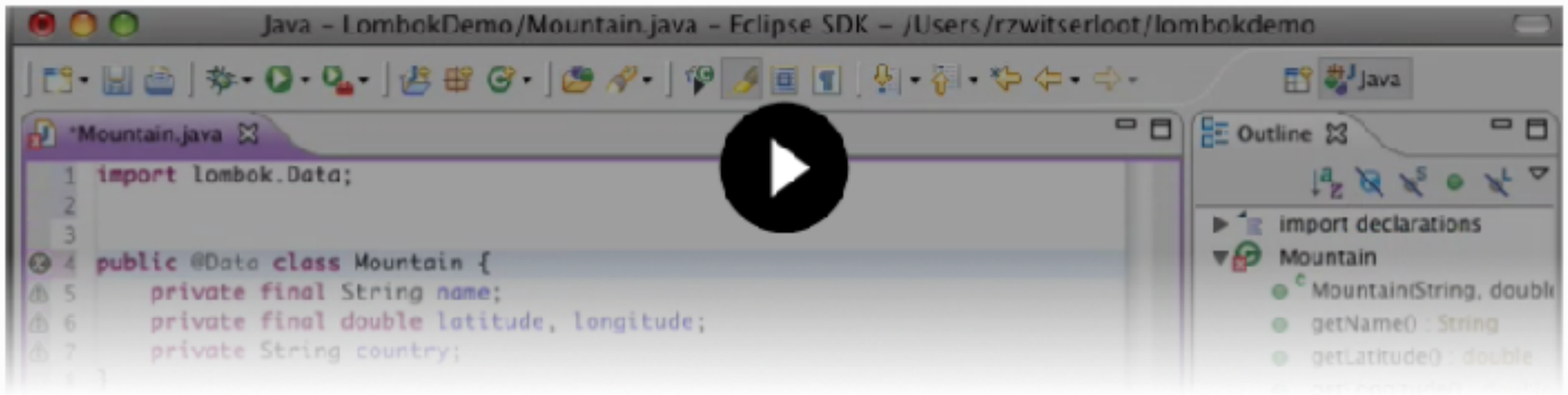

https://marketplace.visualstudio.com/items?itemName=quicktype.quicktype

# Lombok

# Using Lombok

## Project Lombok

Project Lombok is a Java library that automatically plugs into your editor and build tools, spicing up your java.
Never write another getter or equals method again, with one annotation your class has a fully featured builder,
Automate your logging variables, and much more.

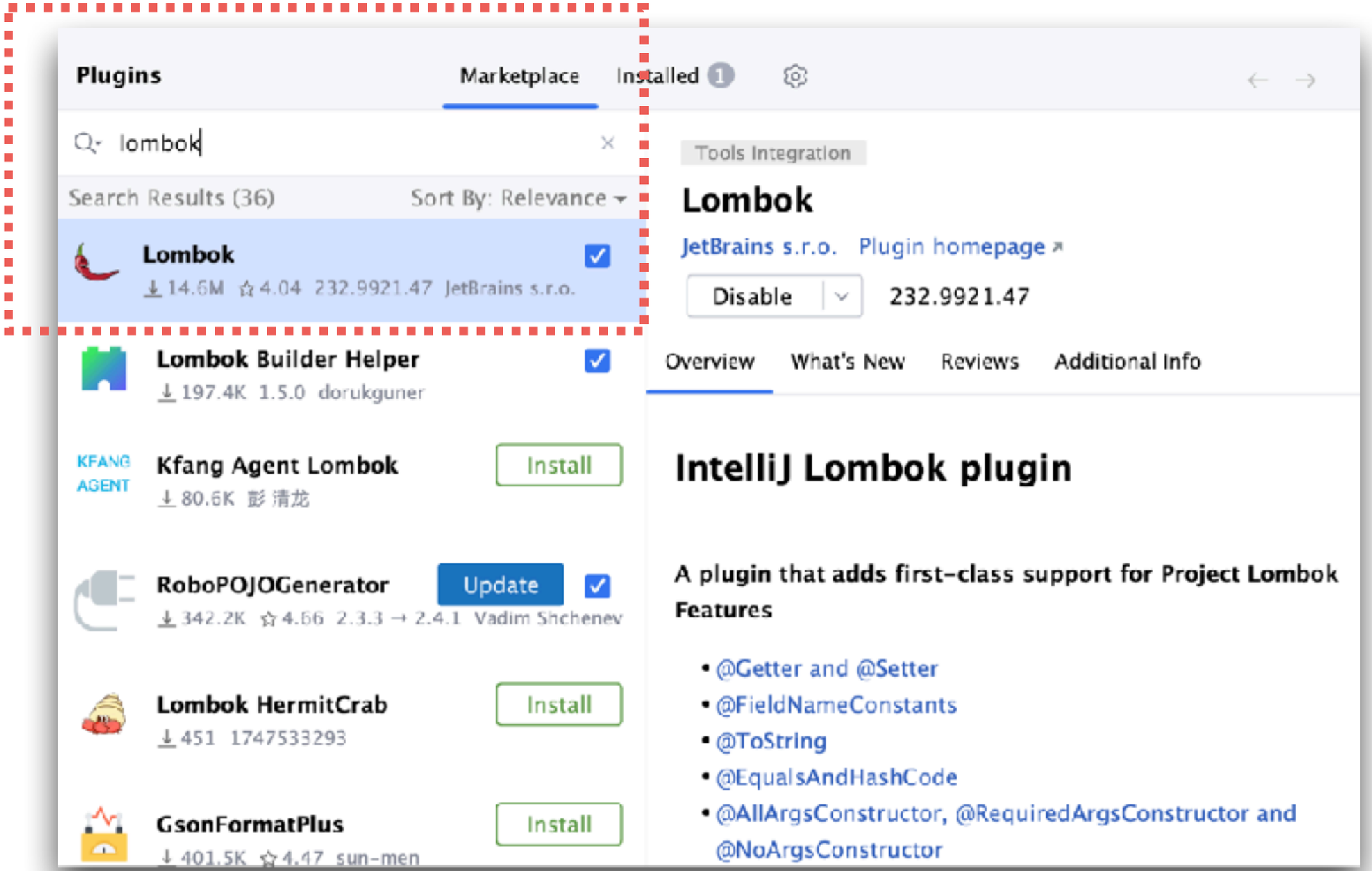



Show me a text and images based explanation and tutorial instead!

Project Lombok is powered by:

https://projectlombok.org/

# IntelliJ IDEA plug-in




https://plugins.jetbrains.com/plugin/6317-lombok

# Use Lombok

```java
@Data
@Builder
@NoArgsConstructor
@AllArgsConstructor
public class UserRequest {
    private String email;
    private String password;
}
```

# Create more controller ..

# Create a new user

POST /users

```
@PostMapping("/users")
public UserResponse createNewUser(
            @RequestBody UserRequest newUser) {
    UserResponse newUserResponse = new UserResponse(
             1,
             newUser.getName(),
             newUser.getAge());
    return newUserResponse;
}
```

# Update user by id

## PUT /users/{id}

```
@PutMapping("/users/{id}")
public UserResponse updateUser(@RequestBody UserRequest newUser,
                               @PathVariable int id) {
    // TODO
    // 1. find by id
    // 2. found => update user
    // 3. not found => ?? (create ? or throw error)
    UserResponse updatedUserResponse = new UserResponse(
            id,
            newUser.getName(),
            newUser.getAge());
    return updatedUserResponse;
}
```

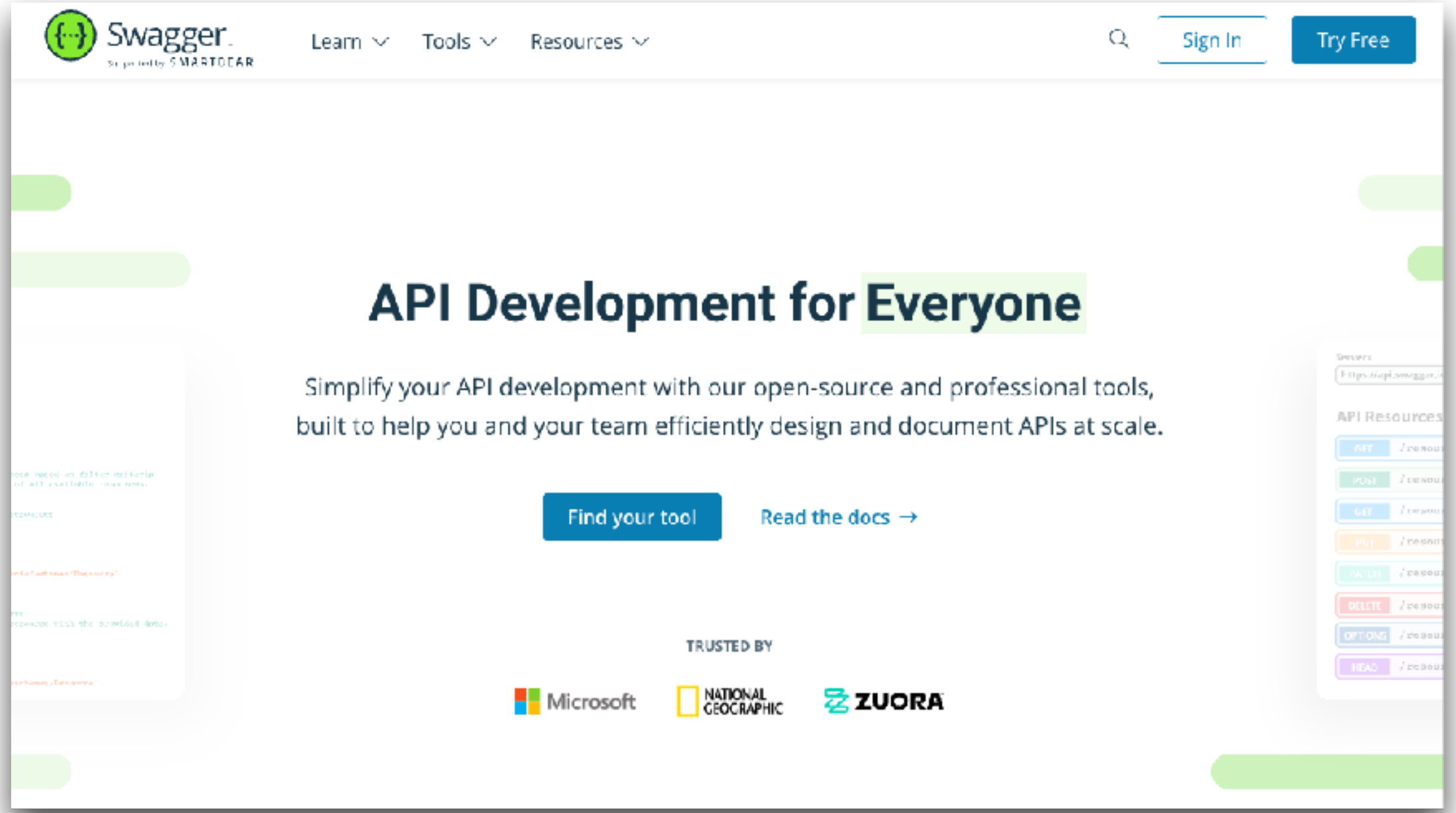
# Delete user by id

DELETE /users/{id}

```
@DeleteMapping("/users/{id}")
public void deleteUser(@PathVariable int id) {
    // TODO
}
```

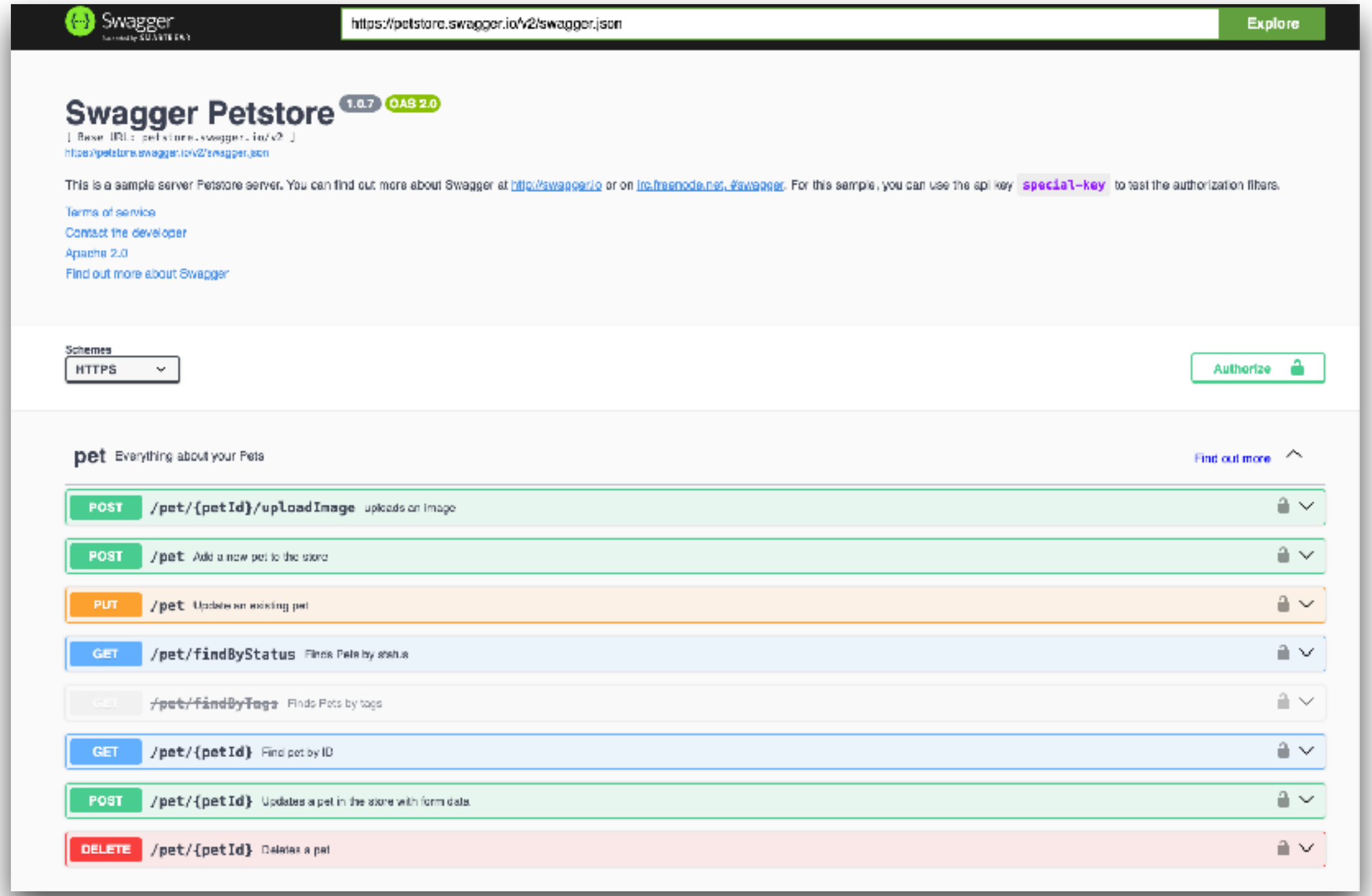
# API Documentation

# Swagger/ Open API




https://swagger.io/

# Example



# Swagger + Spring Boot 3

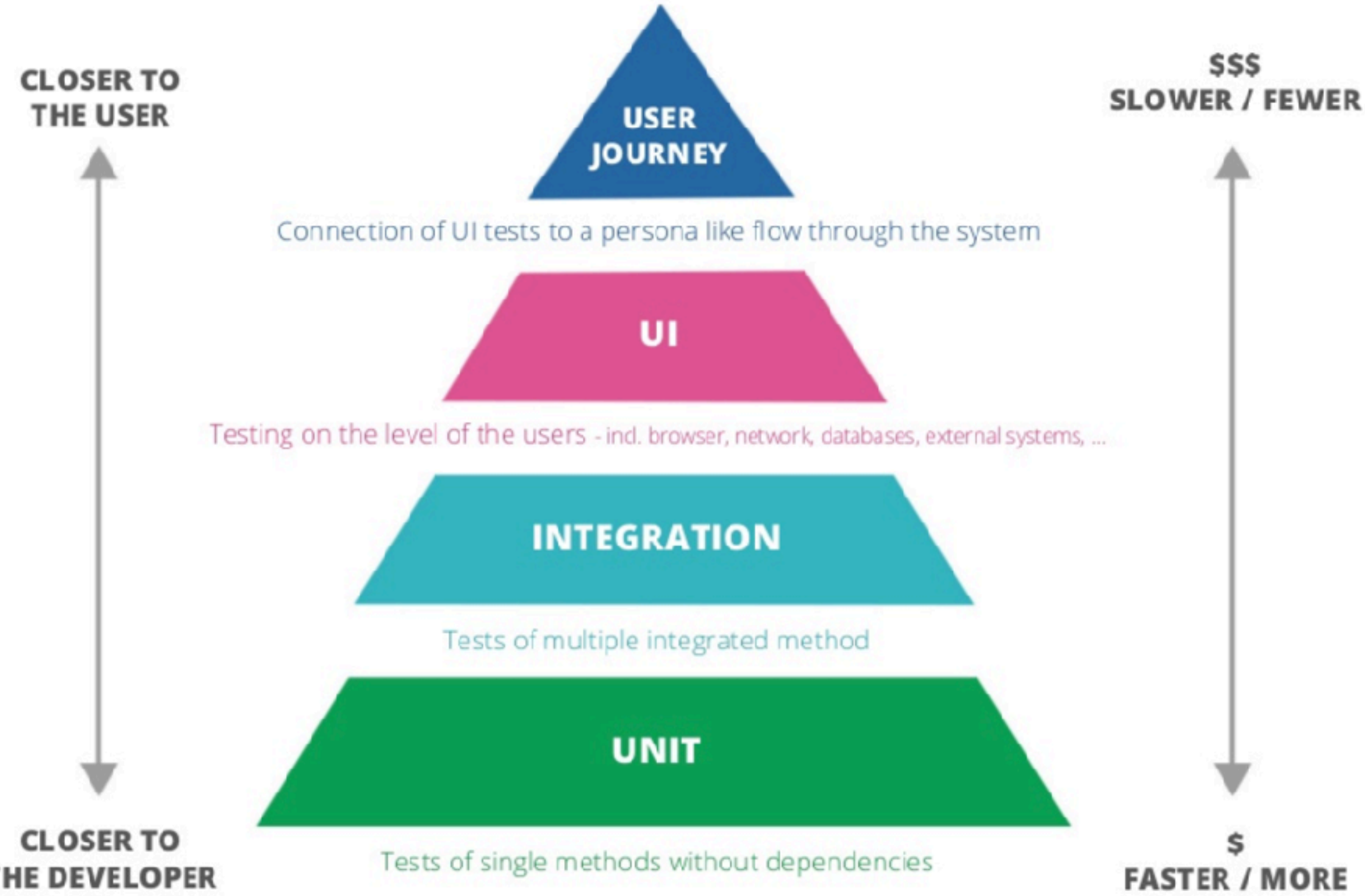
## Spring Doc


https://springdoc.org/

# How to test UserController ?

# Postman


https://www.postman.com/downloads/



# Controller testing

How to testing with Spring Boot ?

```xml
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
</dependency>
```

https://docs.spring.io/spring-boot/docs/current/reference/html/features.html#features.testing

# Spring Boot Testing

```xml
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
</dependency>
```



https://docs.spring.io/spring-boot/docs/current/reference/html/features.html#features.testing

# Testing in Spring Boot

**@SpringBootTest**
@WebMVCTest
@JsonTest
@DataJpaTest
@RestClientTest

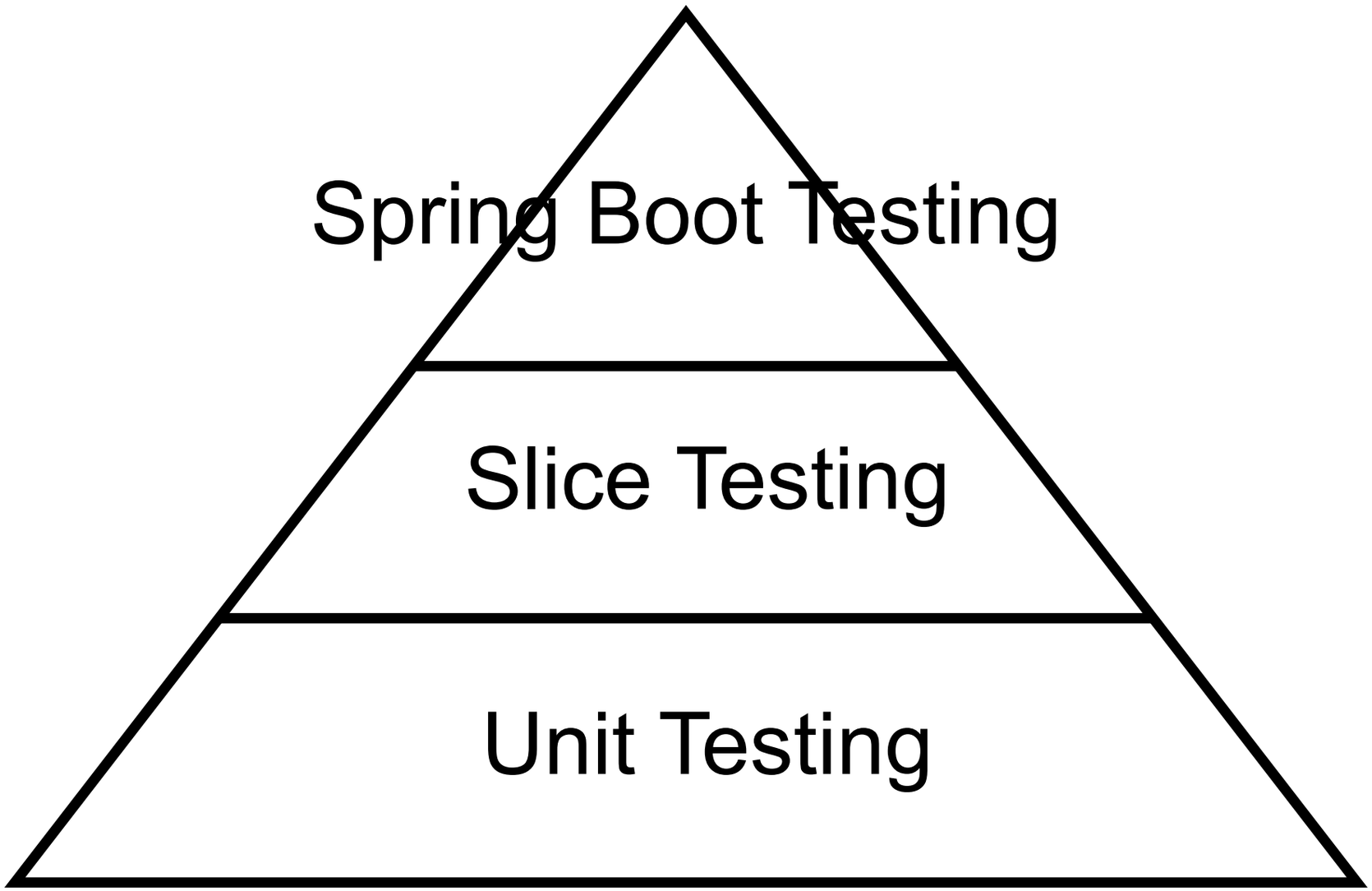
# Testing in Spring Boot

@SpringBootTest

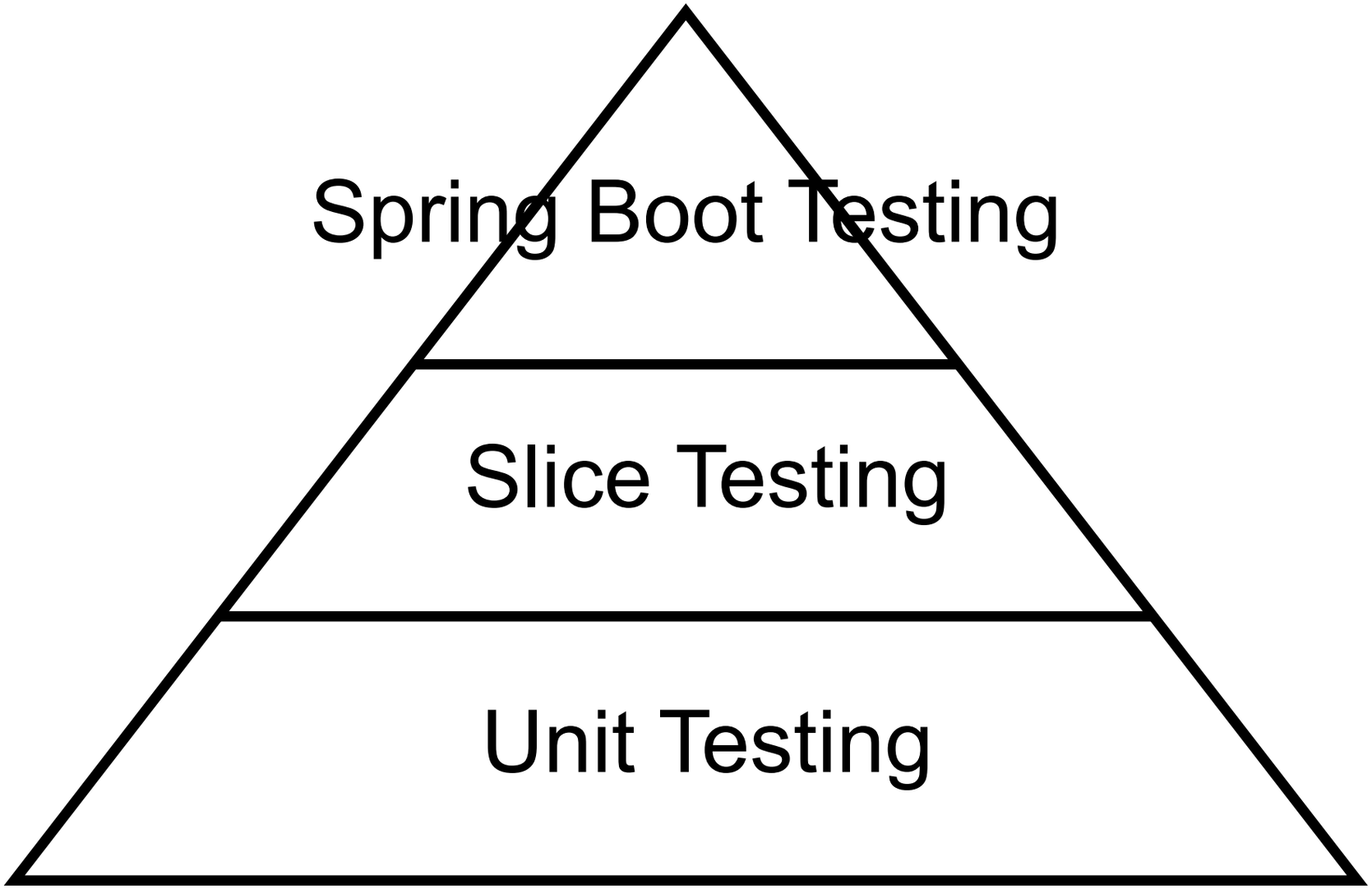
@WebMVCTest
@JsonTest
@DataJpaTest
@RestClientTest

**Slice testing**

# Testing in Spring Boot



# Testing in Spring Boot

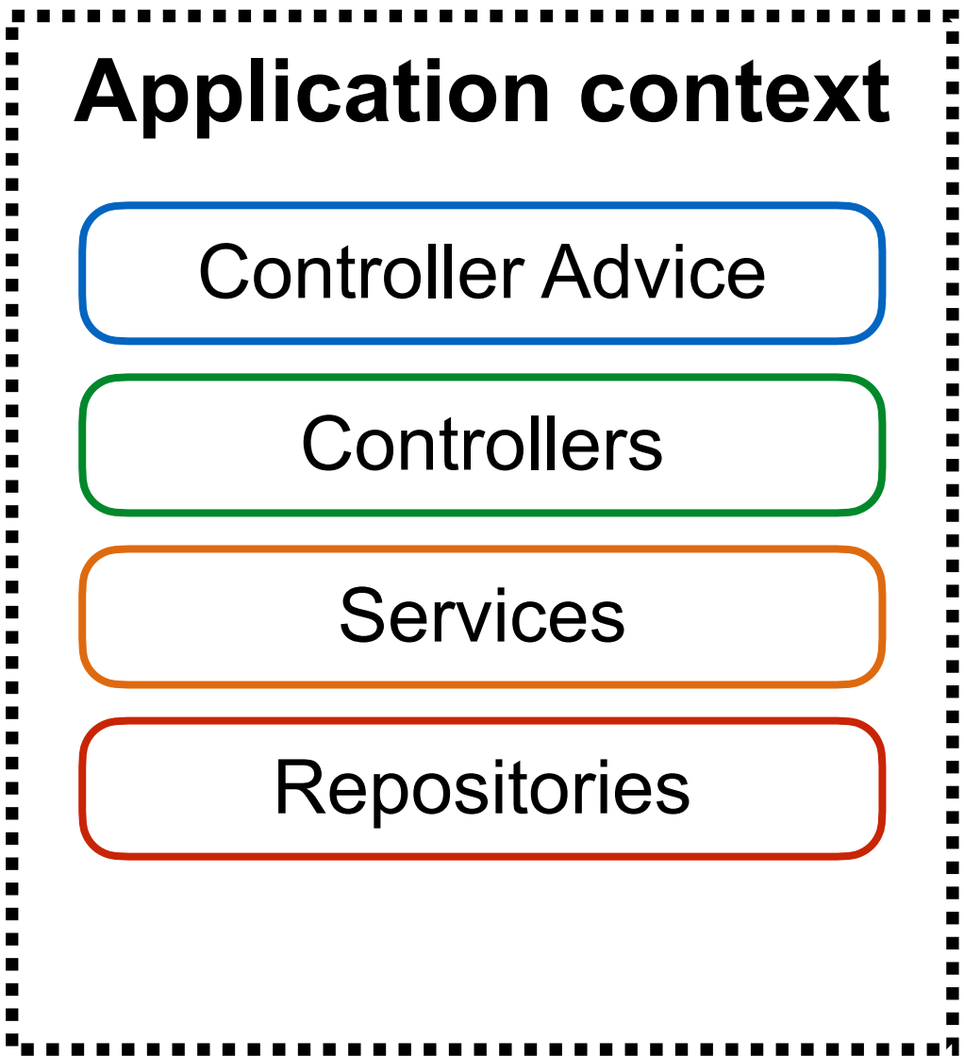



Mockito

# Controller testing

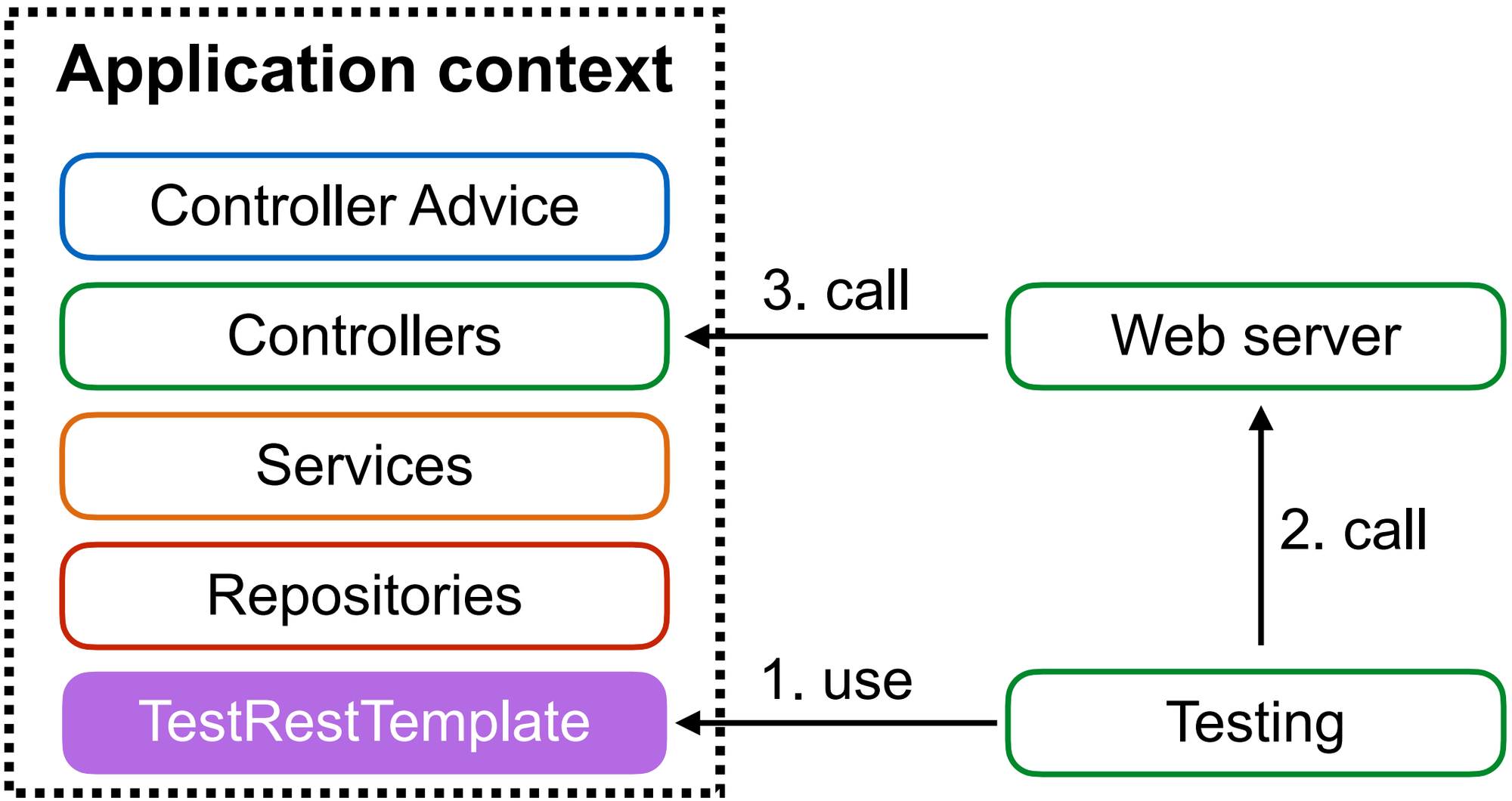
1. Spring Boot Testing
2. Slice Testing with MockMvc
3. Unit Testing

# 1. SpringBootTest




https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#features.testing

# 1. SpringBootTest



# SpringBootTest #1

```java
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment
        = SpringBootTest.WebEnvironment.RANDOM_PORT)
public class HelloControllerTest {

    @Autowired
    private TestRestTemplate testRestTemplate;

    @Test
    public void sayHi() {
        // Action :: Call controller
        Hello actualResult
                = testRestTemplate.getForObject("/hello/somkiat",
                                                Hello.class);

        // Assertion :: Check result with expected result
        assertEquals("Hello, somkiat", actualResult.getMessage());

    }
}
```

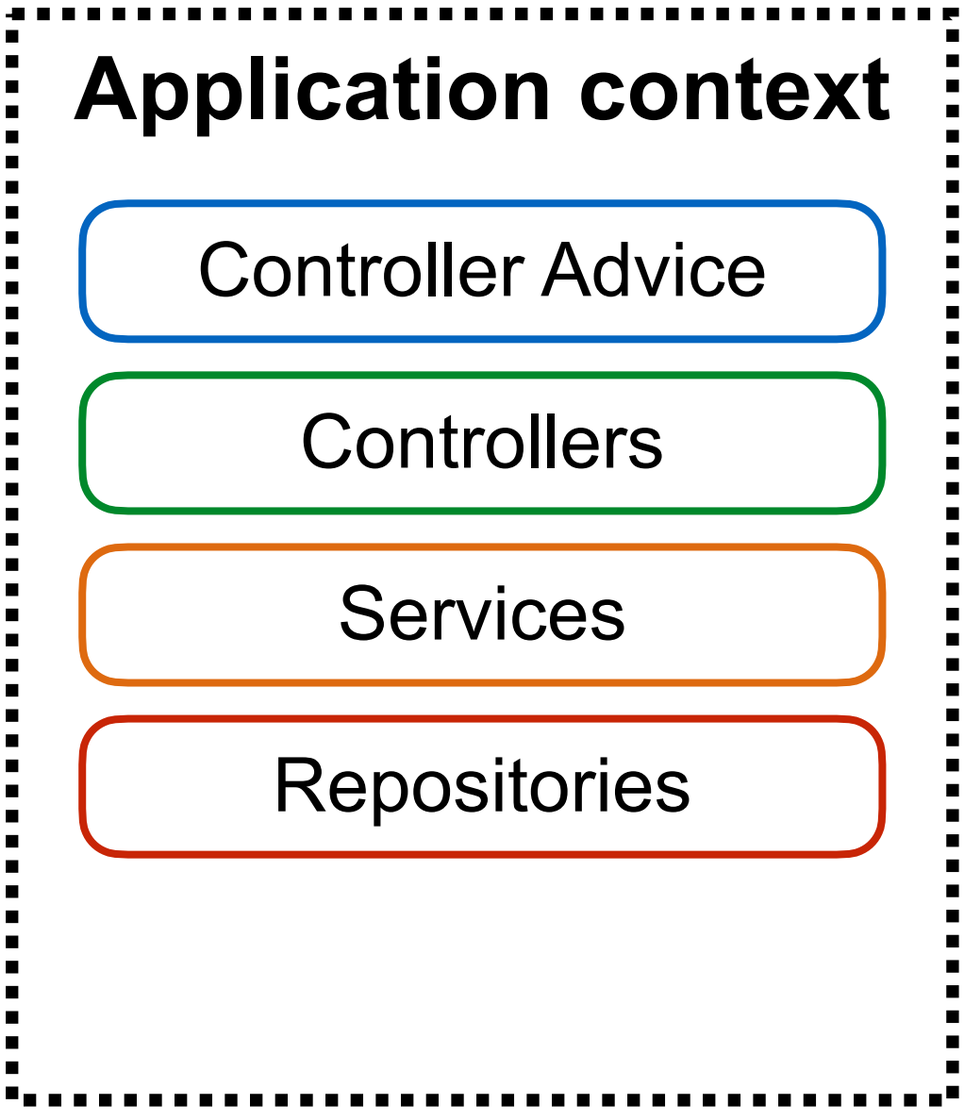
# SpringBootTest #2

```java
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment
        = SpringBootTest.WebEnvironment.RANDOM_PORT)
public class HelloControllerTest {

    @Autowired
    private TestRestTemplate testRestTemplate;

    @Test
    public void sayHi() {
        // Action :: Call controller
        Hello actualResult
                = testRestTemplate.getForObject("/hello/somkiat",
                                                Hello.class);

        // Assertion :: Check result with expected result
        assertEquals("Hello, somkiat", actualResult.getMessage());

    }
}
```

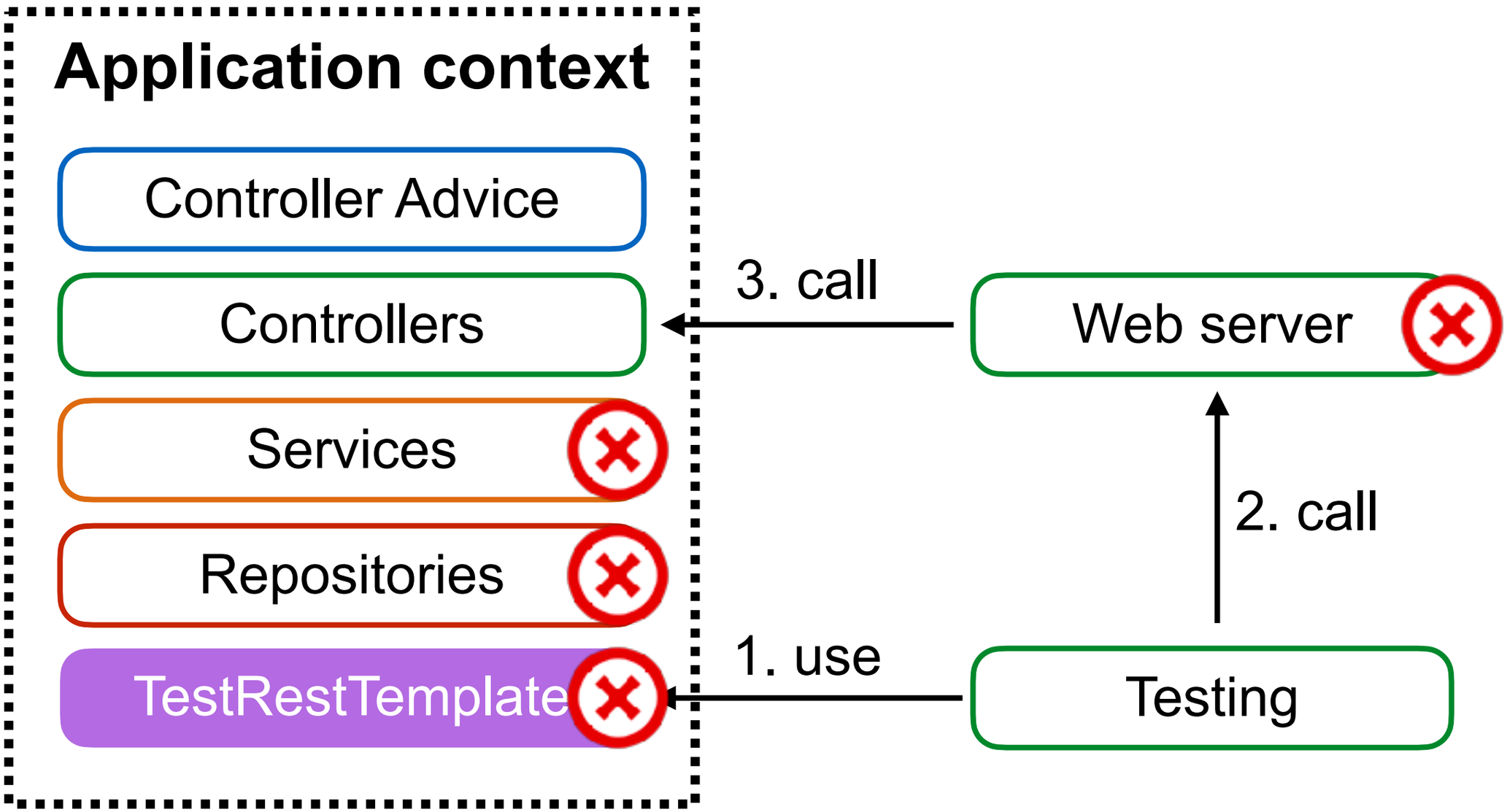
# SpringBootTest #3

```java
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment
        = SpringBootTest.WebEnvironment.RANDOM_PORT)
public class HelloControllerTest {

    @Autowired
    private TestRestTemplate testRestTemplate;

    @Test
    public void sayHi() {
        // Action :: Call controller
        Hello actualResult
                = testRestTemplate.getForObject("/hello/somkiat",
                                                Hello.class);

        // Assertion :: Check result with expected result
        assertEquals("Hello, somkiat", actualResult.getMessage());

    }
}
```

# 2. Slice Testing with MockMVC



# 2. Slice Testing with MockMVC



# MockMvcTest #1

```java
@RunWith(SpringRunner.class)
@WebMvcTest(NumberController.class)
public class NumberControllerMockMvcTest {

    @MockBean
    private MyRandom stubRandom;

    @Autowired
    private MockMvc mvc;

    @Test
    public void success() throws Exception {
        NumberControllerResponse expected
            = new NumberControllerResponse("5555");

        // Stub
        given(stubRandom.nextInt(10)).willReturn(5555);
```

# MockMvcTest #2

```java
@RunWith(SpringRunner.class)
@WebMvcTest(NumberController.class)
public class NumberControllerMockMvcTest {

    @MockBean
    private MyRandom stubRandom;

    @Autowired
    private MockMvc mvc;

    @Test
    public void success() throws Exception {
        NumberControllerResponse expected
            = new NumberControllerResponse("5555");

        // Stub
        given(stubRandom.nextInt(10)).willReturn(5555);
```

# MockMvcTest #3

Use **ObjectMapper** to convert JSON to object

```
// Call API HTTP response code = 200
String response =
        this.mvc.perform(get("/number"))
        .andExpect(status().isOk())
        .andReturn()
        .getResponse().getContentAsString();

// Convert JSON message to Object
ObjectMapper mapper = new ObjectMapper();
NumberControllerResponse actual =
                        mapper.readValue(response,
                                NumberControllerResponse.class);
```

# 3. Unit testing with Controller

# Unit test

Use Test Double

In java, use Mockito library


http://site.mockito.org/

# Unit testing with Mockito #1

```
@ExtendWith(MockitoExtension.class)
public class NumberControllerUnitTest {

    @Mock
    private MyRandom stubRandom;

    @Test
    public void success() throws Exception {
        NumberControllerResponse expected
                = new NumberControllerResponse("5555");

        // Stub
        given(stubRandom.nextInt(10)).willReturn(5555);
```

# Unit testing with Mockito #2

@ExtendWith(MockitoExtension.class)

```
public class NumberControllerUnitTest {

    @Mock
    private MyRandom stubRandom;

    @Test
    public void success() throws Exception {
        NumberControllerResponse expected
                    = new NumberControllerResponse("5555");

        // Stub
        given(stubRandom.nextInt(10)).willReturn(5555);
```

# Unit testing with Mockito #3

```java
@Test
public void success() throws Exception {
    NumberControllerResponse expected
                = new NumberControllerResponse("5555");

    // Stub
    given(stubRandom.nextInt(10)).willReturn(5555);

    // Call
    NumberController controller = new NumberController(stubRandom);
    NumberControllerResponse actual = controller.randomNumber();

    // Assert
    assertEquals("5555", actual.getValue());
    assertEquals(expected, actual);
}
```

# Error handling

# Working with Error Responses

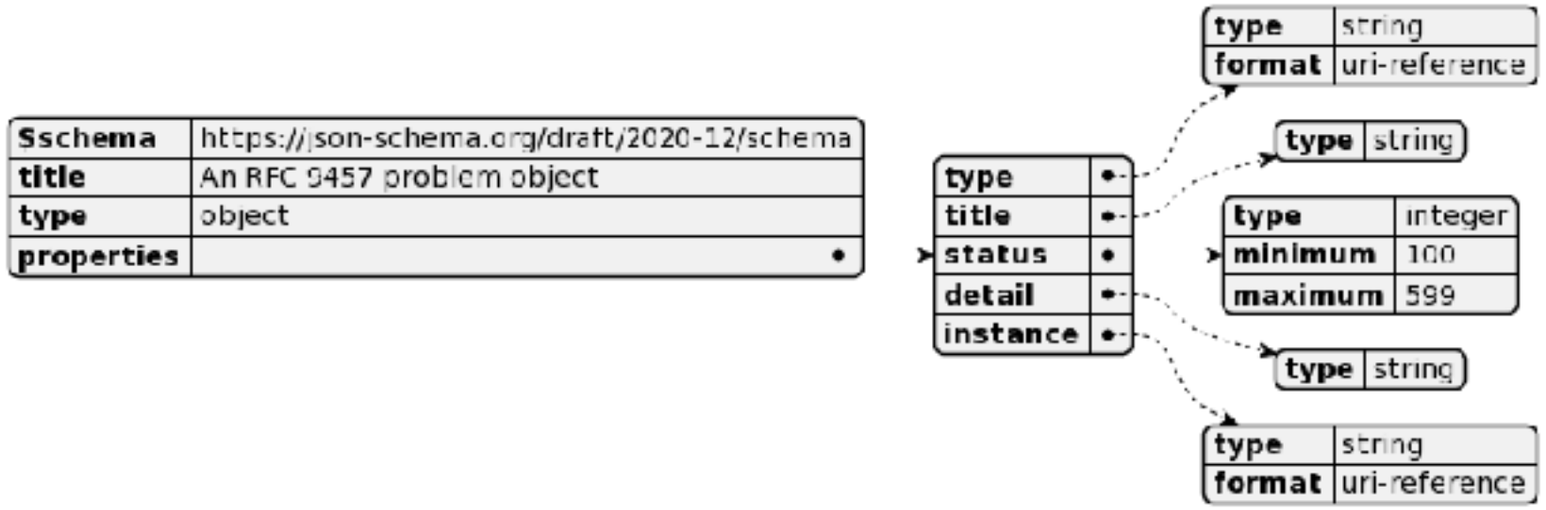
**ErrorResponse**

**ProblemDetail**

**Customization**

https://docs.spring.io/spring-framework/reference/web/webmvc/mvc-ann-rest-exceptions.html

# ProblemDetail




```
{
  "type":"https://problems-registry.smartbear.com/missing-body-property",
  "status":400,
  "title":"Missing body property",
  "detail":"The request is missing an expected body property.",
  "code":"400-09",
  "instance":"/logs/regisrations/d24b2953-ce05-488e-bf31-67de50d3d085",
  "errors":[
    {
        "detail":"The body property {name} is required",
        "pointer":"/name"
    }
  ]
}
```

https://docs.spring.io/spring-framework/docs/current/javadoc-api/org/springframework/http/ProblemDetail.html

# ProblemDetail

Enable ProblemDetail for error by default

**application.properties**

```
spring.mvc.problemdetails.enabled=true
```

# Example in ControllerAdvice

```
@RestControllerAdvice
class HelloControllerAdvice {

    @ExceptionHandler(InvalidInputException.class)
    public ProblemDetail handleInvalidInputException(
            InvalidInputException e, WebRequest request) {

        ProblemDetail problemDetail
                = ProblemDetail
                .forStatusAndDetail(HttpStatus.BAD_REQUEST, e.getMessage());
        problemDetail.setInstance(URI.create("demo-instance"));
        problemDetail.setTitle("demo");

        return problemDetail;
    }
}
```

# Error handling

```
@Service
public class UserService {

    private AccountRepository accountRepository;

    @Autowired
    public UserService(AccountRepository accountRepository) {
        this.accountRepository = accountRepository;
    }
```

```
public Account getAccount(int id) {
    Optional<Account> account = accountRepository.findById(id);
    if(account.isPresent()) {
        return account.get();
    }
    throw new MyAccountNotFoundException(
            String.format("Account id=[%d] not found", id));
}
```

# MyAccountNotFoundException

```
public class MyAccountNotFoundException
                extends RuntimeException {

    public MyAccountNotFoundException(String message) {
        super(message);
    }

}
```

# Response Status

404 = Not Found

| Status | Description |
|---|---|
| 400 | Request body doesn’t meet API spec |
| 401 | Authentication/Authorization fail |
| 403 | User can’t perform the operation |
| 404 | Resource does not exist |
| 405 | Unsupported operation |
| 500 | Error on server |

# Handling error in Spring Boot

```java
@RestControllerAdvice
public class AccountControllerHandler {

    @ExceptionHandler(MyAccountNotFoundException.class)
    public ResponseEntity<ExceptionResponse> accountNotFound(
            MyAccountNotFoundException exception) {

        ExceptionResponse response =
                new ExceptionResponse(exception.getMessage(),
                                      "More detail");

        return new ResponseEntity<ExceptionResponse>(response,
                                                     HttpStatus.NOT_FOUND);

    }

}
```

1

# Handling error in Spring Boot

```
@RestControllerAdvice
public class AccountControllerHandler {

    @ExceptionHandler(MyAccountNotFoundException.class)
    public ResponseEntity<ExceptionResponse> accountNotFound(
            MyAccountNotFoundException exception) {

        ExceptionResponse response =
                new ExceptionResponse(exception.getMessage(),
                                      "More detail");

        return new ResponseEntity<ExceptionResponse>(response,
                                                     HttpStatus.NOT_FOUND);

    }

}
```

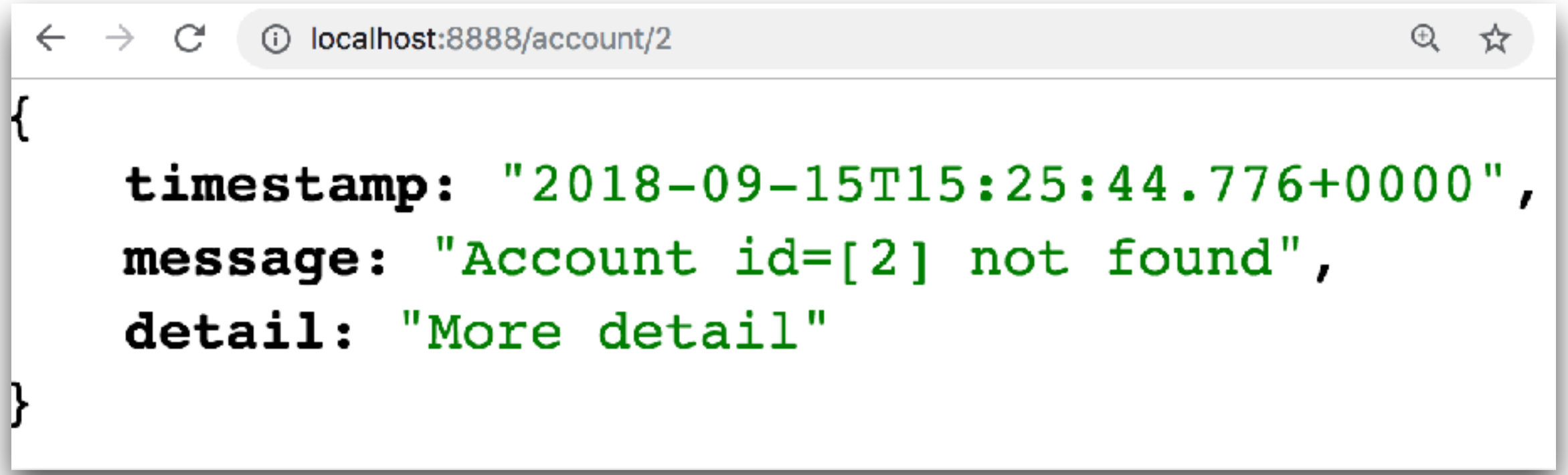
2

# ExceptionReponse

Response format of error

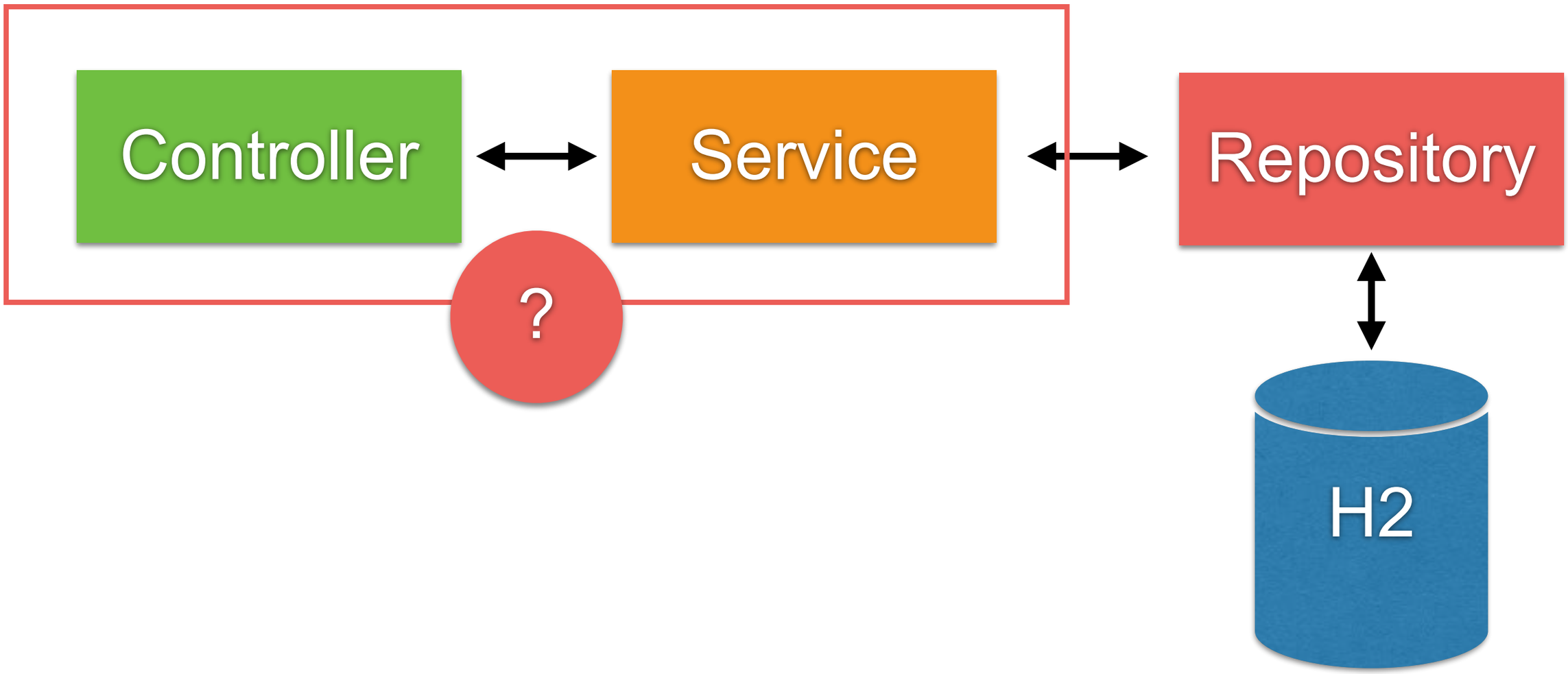
```
public class ExceptionResponse{

    private Date timestamp = new Date();
    private String message;
    private String detail;

public ExceptionResponse(String message, String detail) {
    this.message = message;
    this.detail = detail;
}
```

# Result of API



# How to test ?

# How to test with Error/Exception ?



# Testing with WebMvcTest and MockMvc

Try to check data in response

```
@Test
public void getByIdWithNotFoundAccount() throws Exception {
    // Stub
    given(userService.getAccount(2))
            .willThrow(new MyAccountNotFoundException("Not found"));

    mockMvc.perform(
        get("/account/2")
                .accept(MediaType.APPLICATION_JSON))
        .andExpect(status().isNotFound())
        .andExpect(content().contentType(MediaType.APPLICATION_JSON_UTF8))
        .andExpect(jsonPath("$.message", is("Not found")));

}
```

1

# Testing with WebMvcTest and MockMvc

Try to check data in response

```
@Test
public void getByIdWithNotFoundAccount() throws Exception {
    // Stub
    given(userService.getAccount(2))
            .willThrow(new MyAccountNotFoundException("Not found"));

    mockMvc.perform(
        get("/account/2")
                .accept(MediaType.APPLICATION_JSON))
        .andExpect(status().isNotFound())
        .andExpect(content().contentType(MediaType.APPLICATION_JSON_UTF8))
        .andExpect(jsonPath("$.message", is("Not found")));
}
```

2

# Testing with Service

## Try to check exception

```java
@ExtendWith(MockitoExtension.class)
public class UserServiceTest {

    @Mock
    private UserRepository userRepository;

    @Test
    public void user_not_found_with_exception() {
        given(userRepository.findById(1))
                .willReturn(Optional.empty());
        UserService userService = new UserService();
        userService.setRepository(userRepository);

        Assertions.assertThrows(RuntimeException.class, () -> {
            userService.getData(1);
        });
    }
```

# Compile with testing

$mvnw clean test

```
[INFO]
[INFO] Results:
[INFO]
[INFO] Tests run: 2, Failures: 0, Errors: 0, Skipped: 0
[INFO]
[INFO]
```

# Code coverage

**"Code coverage can show the high risk areas in a program, but never the risk-free."**

Paul Reilly, 2018, Kotlin TDD with Code Coverage

# Code coverage

A tool to measure how much of your code is covered by tests that break down into classes, methods and lines.

# Code coverage

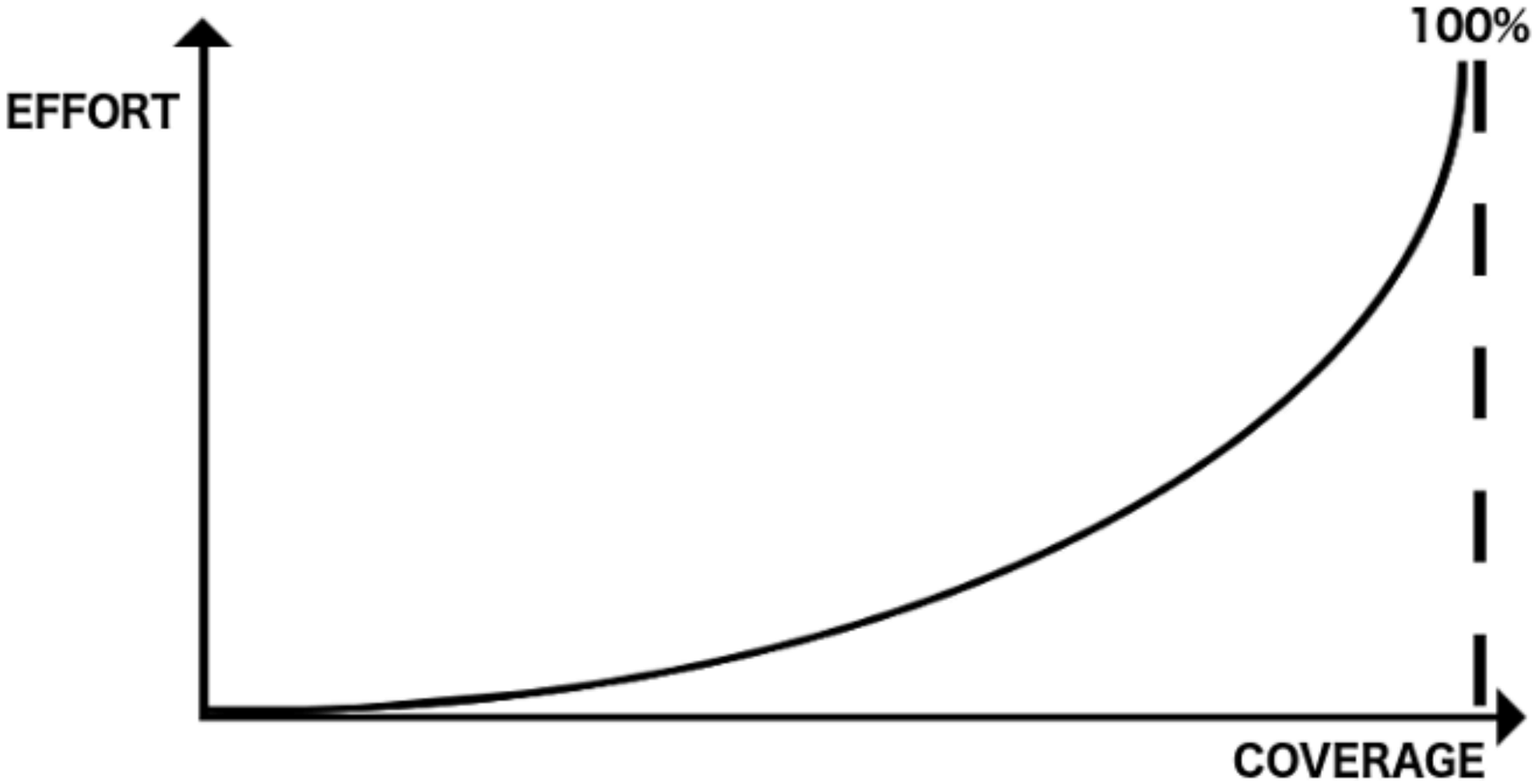
But 100% of code coverage **does not mean** that your code is 100% correct

# Code coverage

Powerful tool to improve the quality of your code

**Code coverage != quality of tests**

# Code coverage 100% ?



# % of Code/Test coverage

# Code coverage with Java

Cobertura
**Jacoco**

http://bit.ly/2DIsDeX

# Run test again

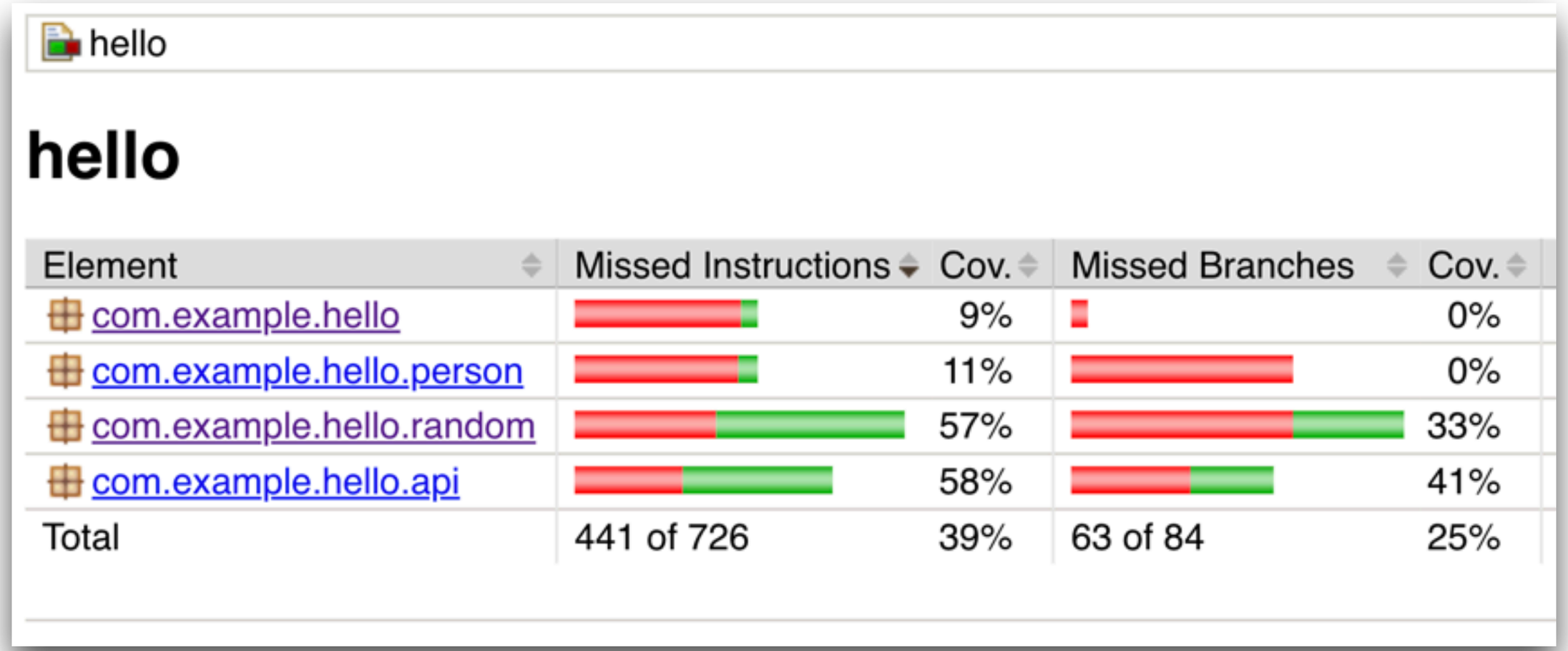
$mvnw clean package

```
Cobertura Report generation was successful.
Cobertura 2.1.1 - GNU GPL License (NO WARRANTY) - See COPYRIGHT file
Cobertura: Loaded information on 3 classes.
time: 125ms
```

```
Cobertura Report generation was successful.
------------------------------------------------------------------------
BUILD SUCCESS
------------------------------------------------------------------------
```

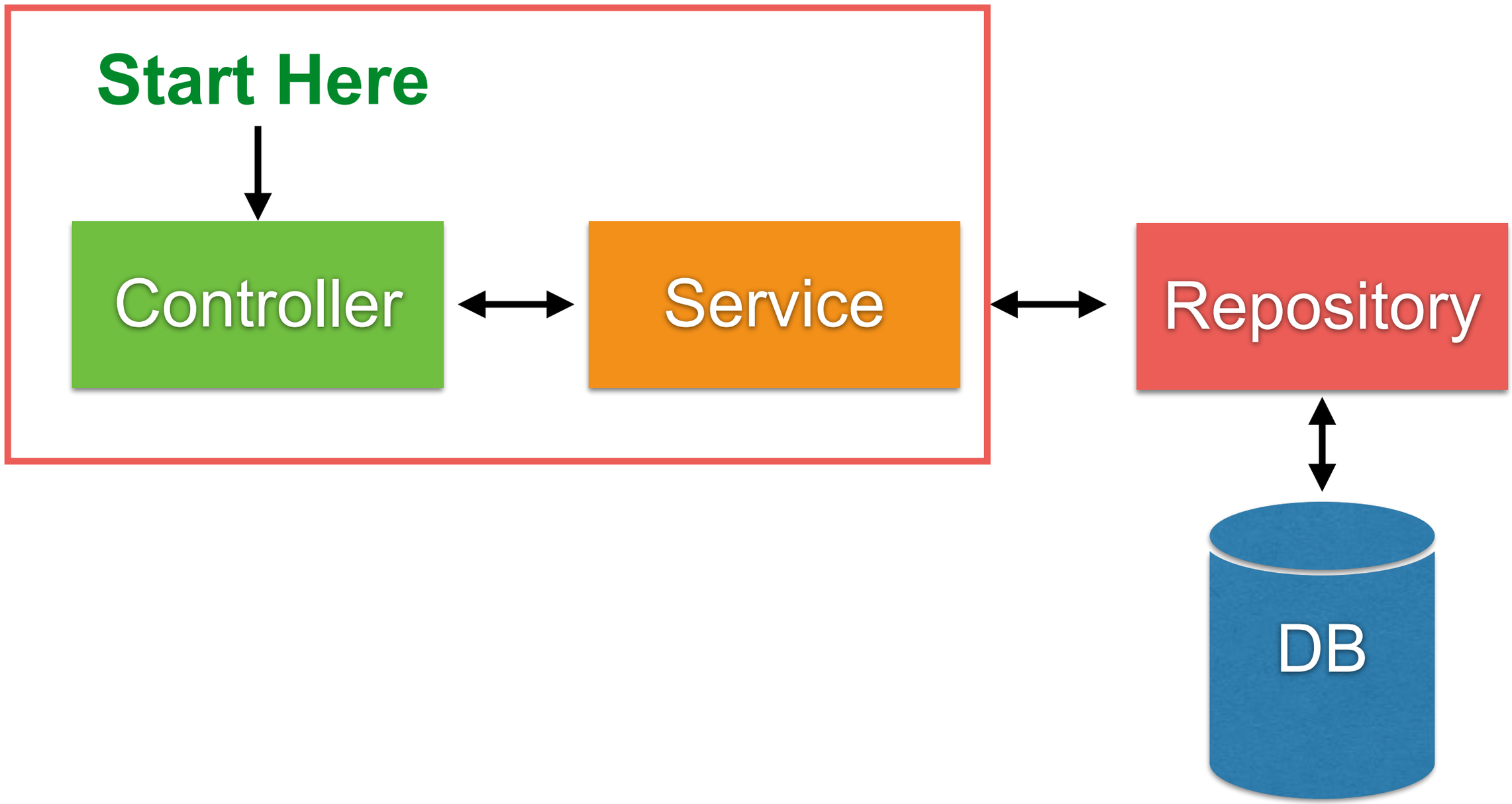
# Coverage report

open target/site/jacoco/index.html



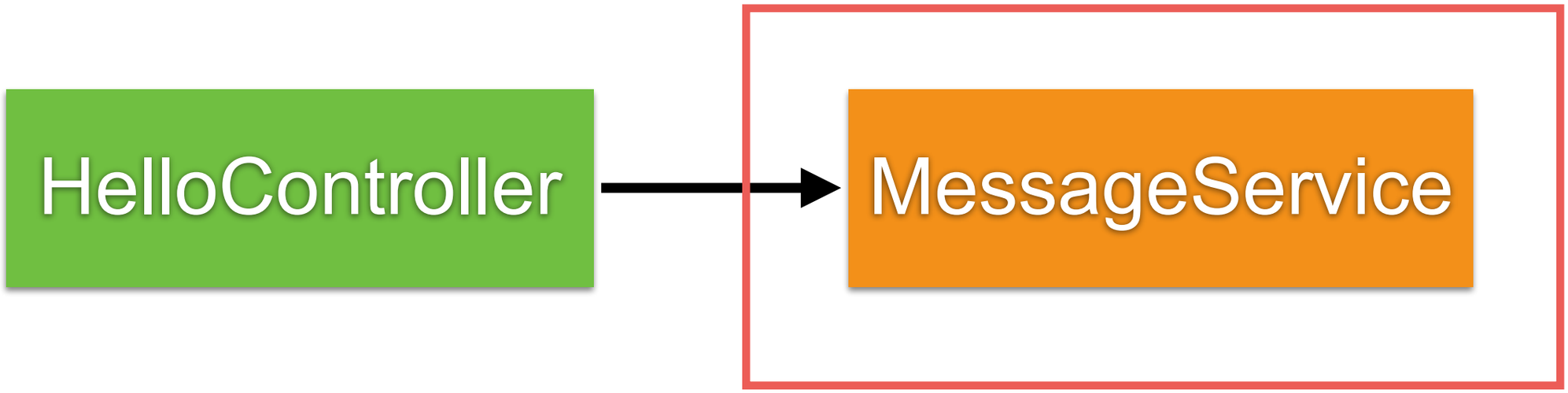
# Move business logic to service

# Working with service



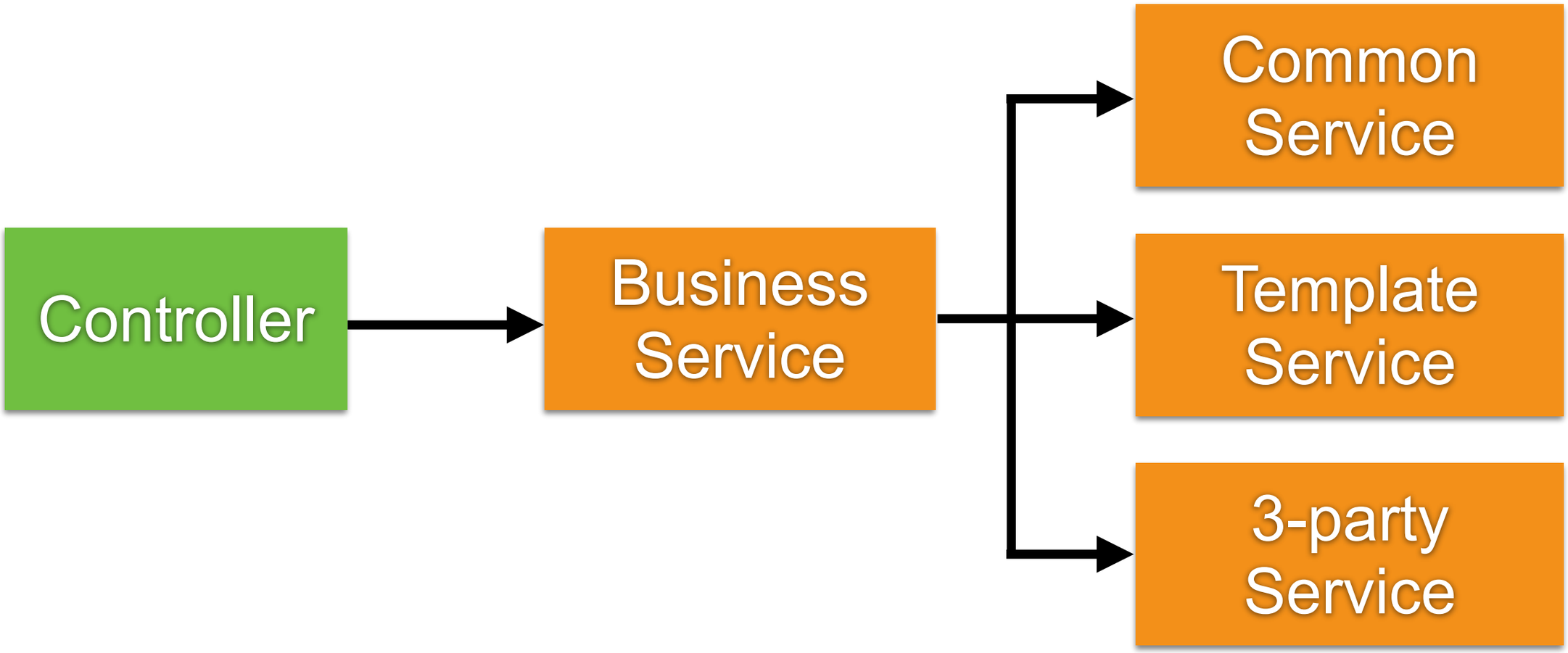
# Move business logic to service

Service class or interface ?

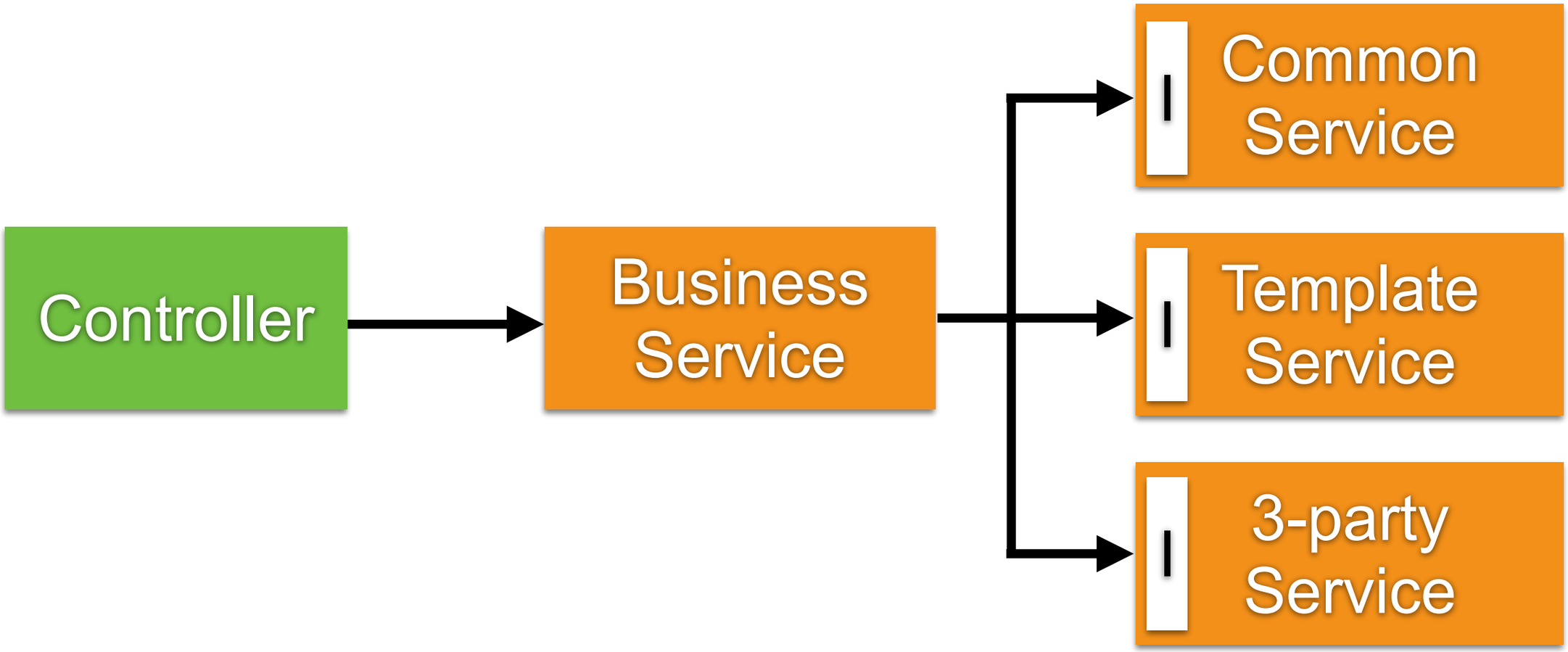


# Types of service

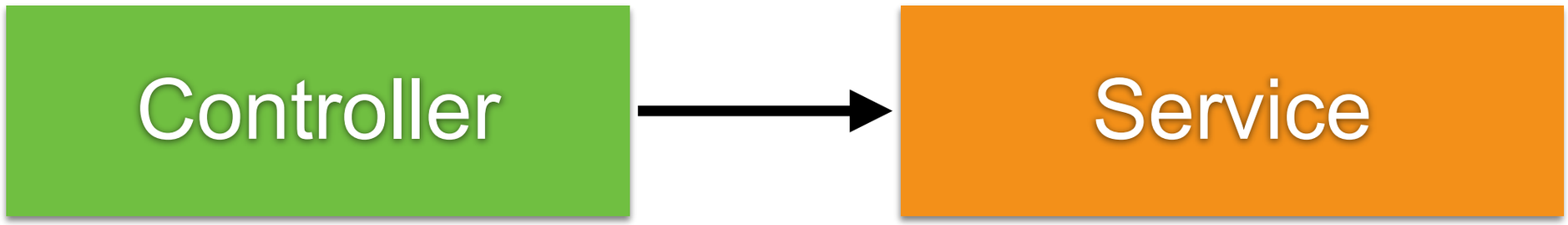
Business services (not reuse)
Common/Template/3-party services



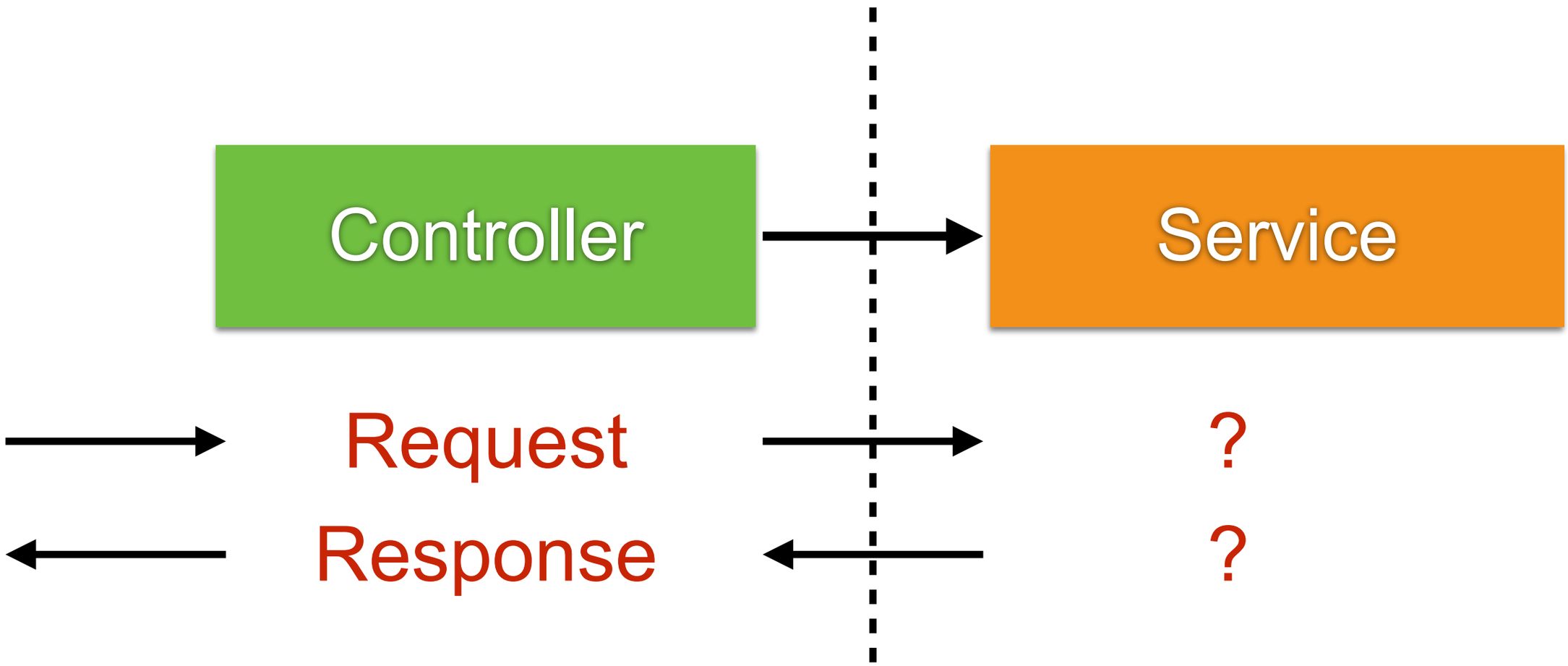
# Interface for common service



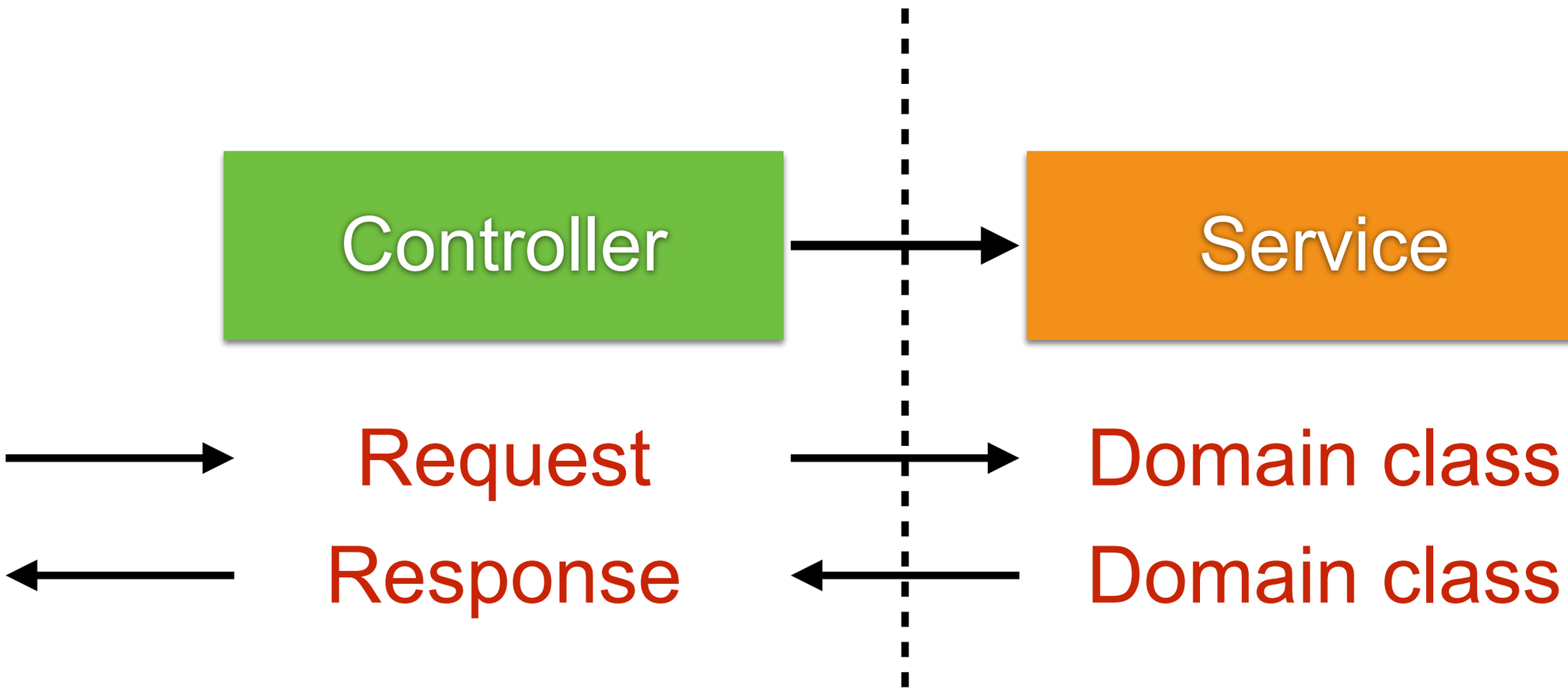
# Data Model for service ?




# Data Model ?

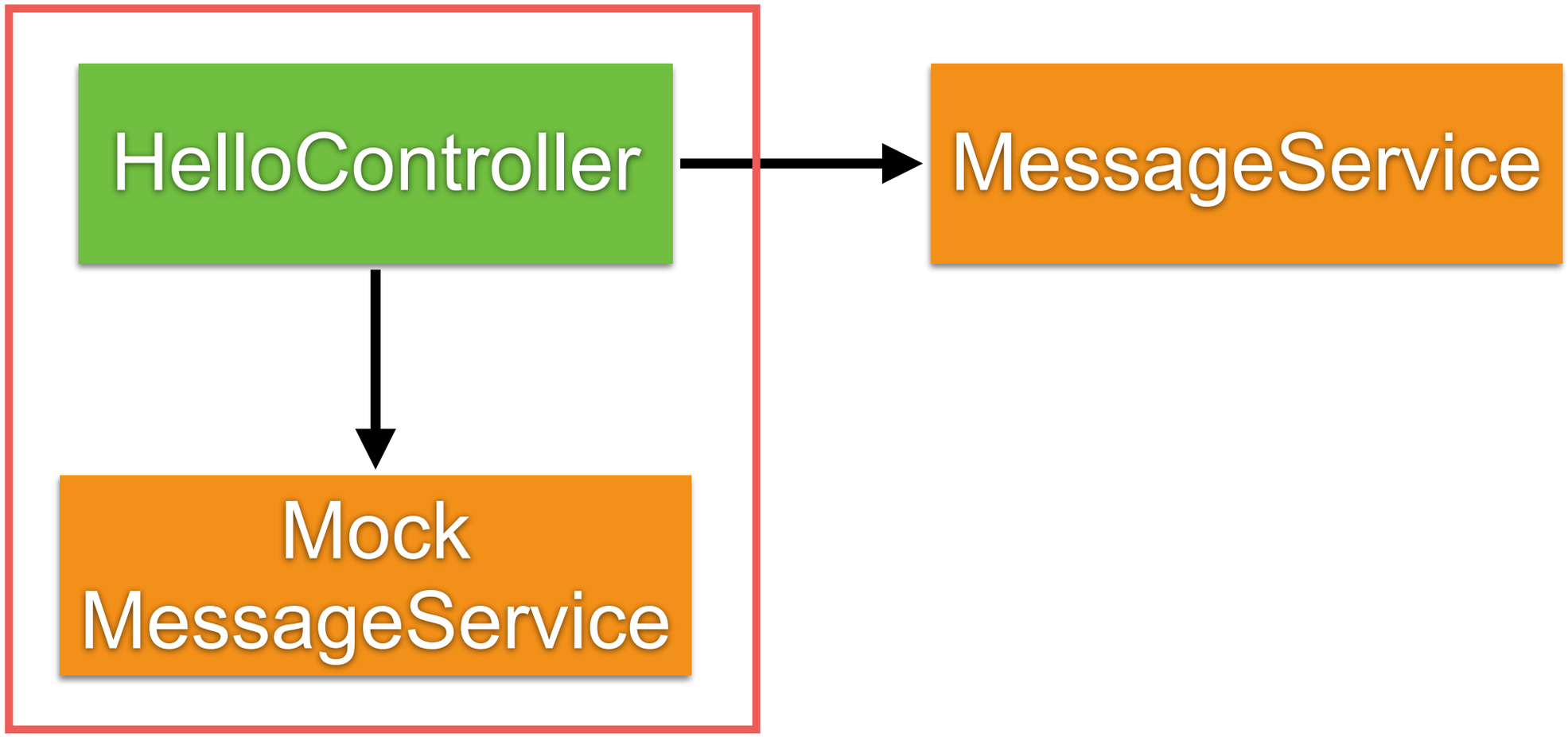


# Data Model ?



# Testing controller with service

Try to mocking service with Mockito

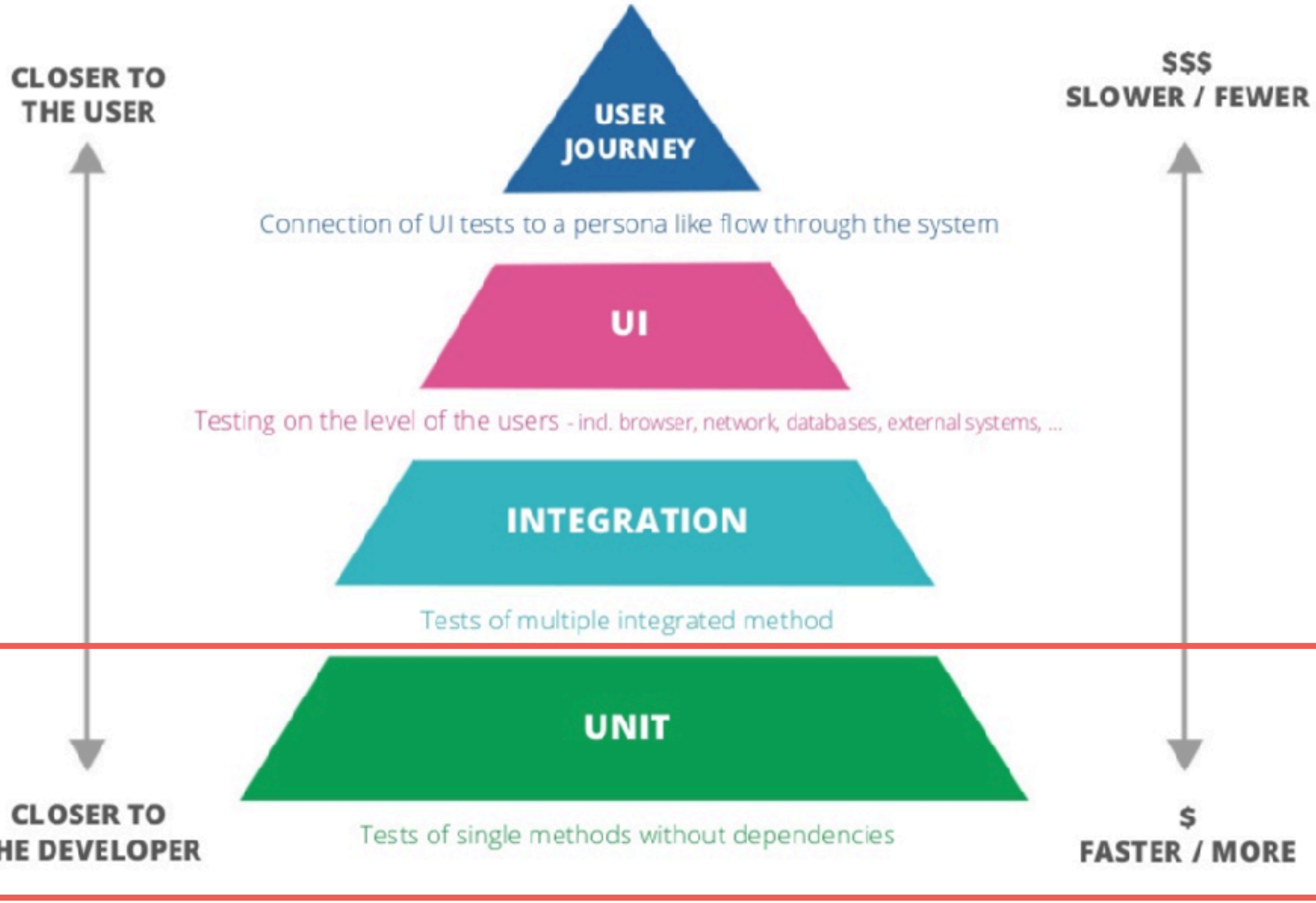


# Run all tests !!

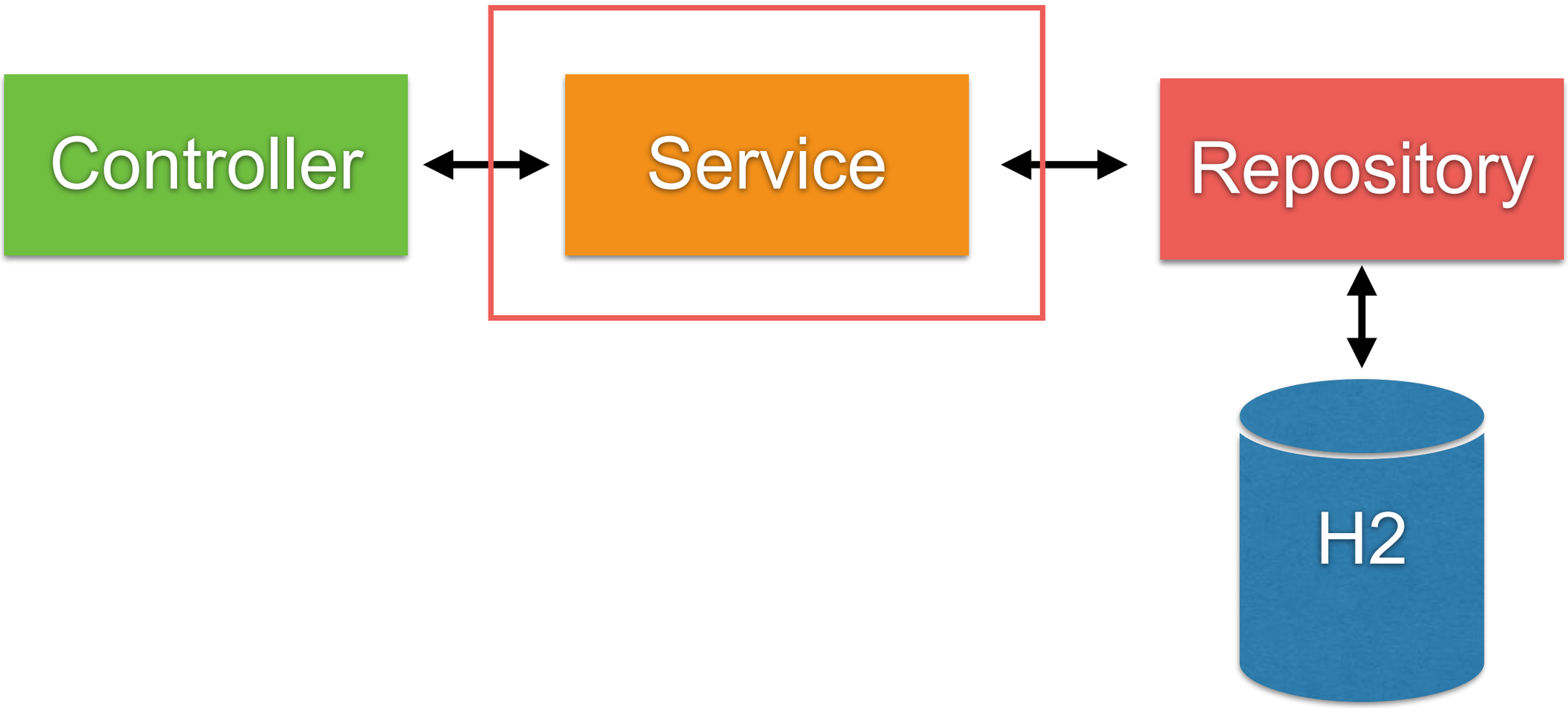
$mvnw clean test

```
[INFO]
[INFO] Results:
[INFO]
[WARNING] Tests run: 10, Failures: 0, Errors: 0,
[INFO]
[INFO] ------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time: 18.299 s
[INFO] Finished at: 2018-08-20T23:36:31+07:00
[INFO] ------------------------------------------------------------------------
```

# How to improve the speed of testing ?



# Service Testing ?



# Service Testing

```java
@ExtendWith(MockitoExtension.class)
public class UserServiceTest {

    @Mock
    private AccountRepository accountRepository;

    @Test
    public void getAccount() {
        // Stub
        Account account = new Account();
        account.setUserName("user");
        account.setPassword("pass");
        account.setSalary(1000);
        given(accountRepository.findById(1))
                .willReturn(Optional.of(account));

        UserService userService = new UserService(accountRepository);
        Account actualAccount = userService.getAccount(1);
        assertNotNull(actualAccount);
    }

}
```

1

# Service Testing

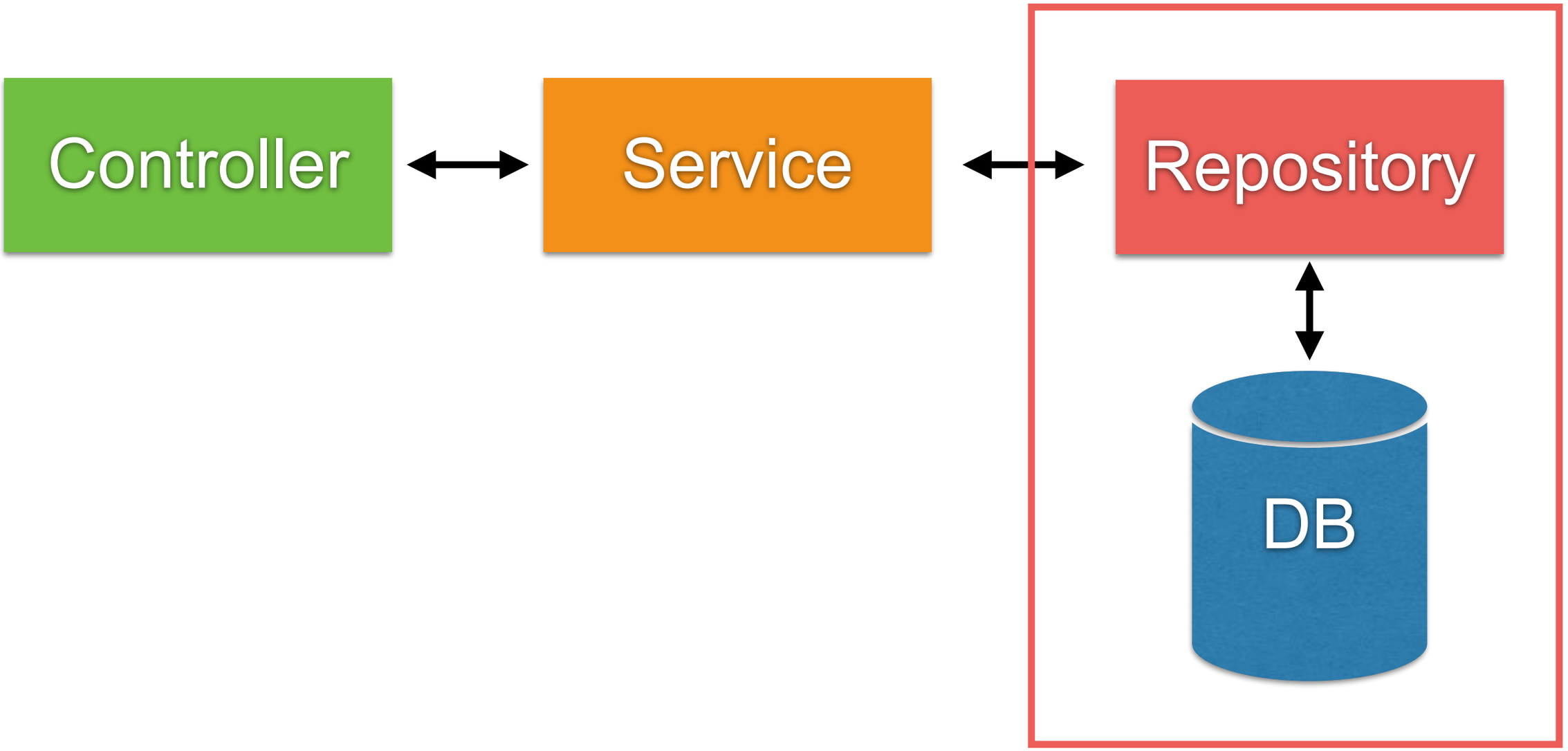
@ExtendWith(MockitoExtension.class)

```
public class UserServiceTest {

    @Mock
    private AccountRepository accountRepository;

    @Test
    public void getAccount() {
        // Stub
        Account account = new Account();
        account.setUserName("user");
        account.setPassword("pass");
        account.setSalary(1000);
        given(accountRepository.findById(1))
                .willReturn(Optional.of(account));

        UserService userService = new UserService(accountRepository);
        Account actualAccount = userService.getAccount(1);
        assertNotNull(actualAccount);
    }

}
```

2

# Working with Repository

# Working with repository



# Basic of JDBC

```
// 1. Load jdbc driver
Class.forName("postgresql");

// 2. Create connection
Connection connection = DriverManager.getConnection("", "", "");

// 3. Prepared Statement
String sql = "SELECT * FROM TABLE WHERE name=?";
PreparedStatement pStmt = connection.prepareStatement(sql);

// 4. Query
ResultSet resultSet = pStmt.executeQuery();
while(resultSet.next()) {

}

// 5. Release resource
if(resultSet != null) {
    resultSet.close();
    resultSet = null;
}
```

# Framework !!

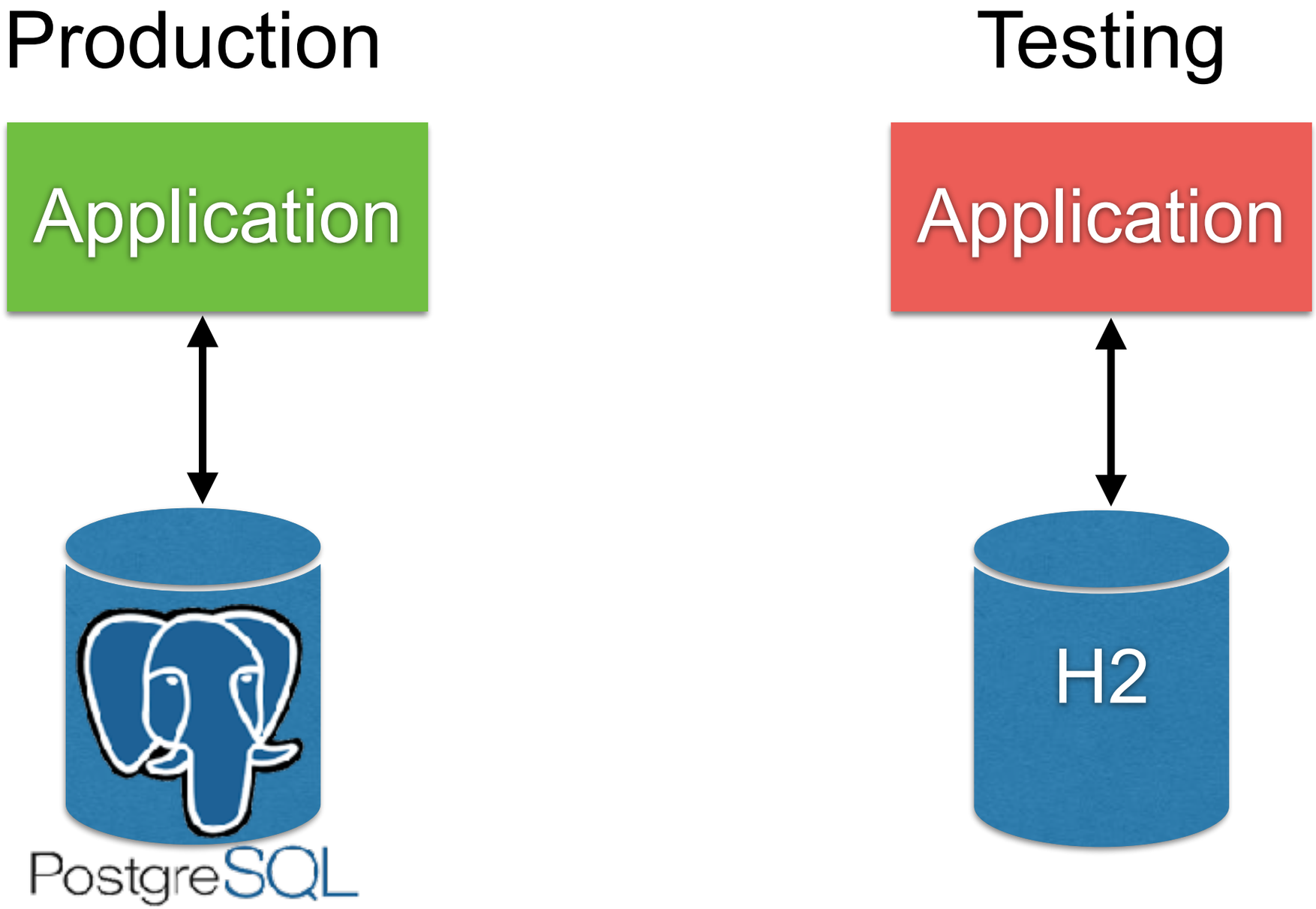
```
// 1. Load jdbc driver
Class.forName("postgresql");

// 2. Create connection
Connection connection = DriverManager.getConnection("", "", "");
```

Manage by Framework

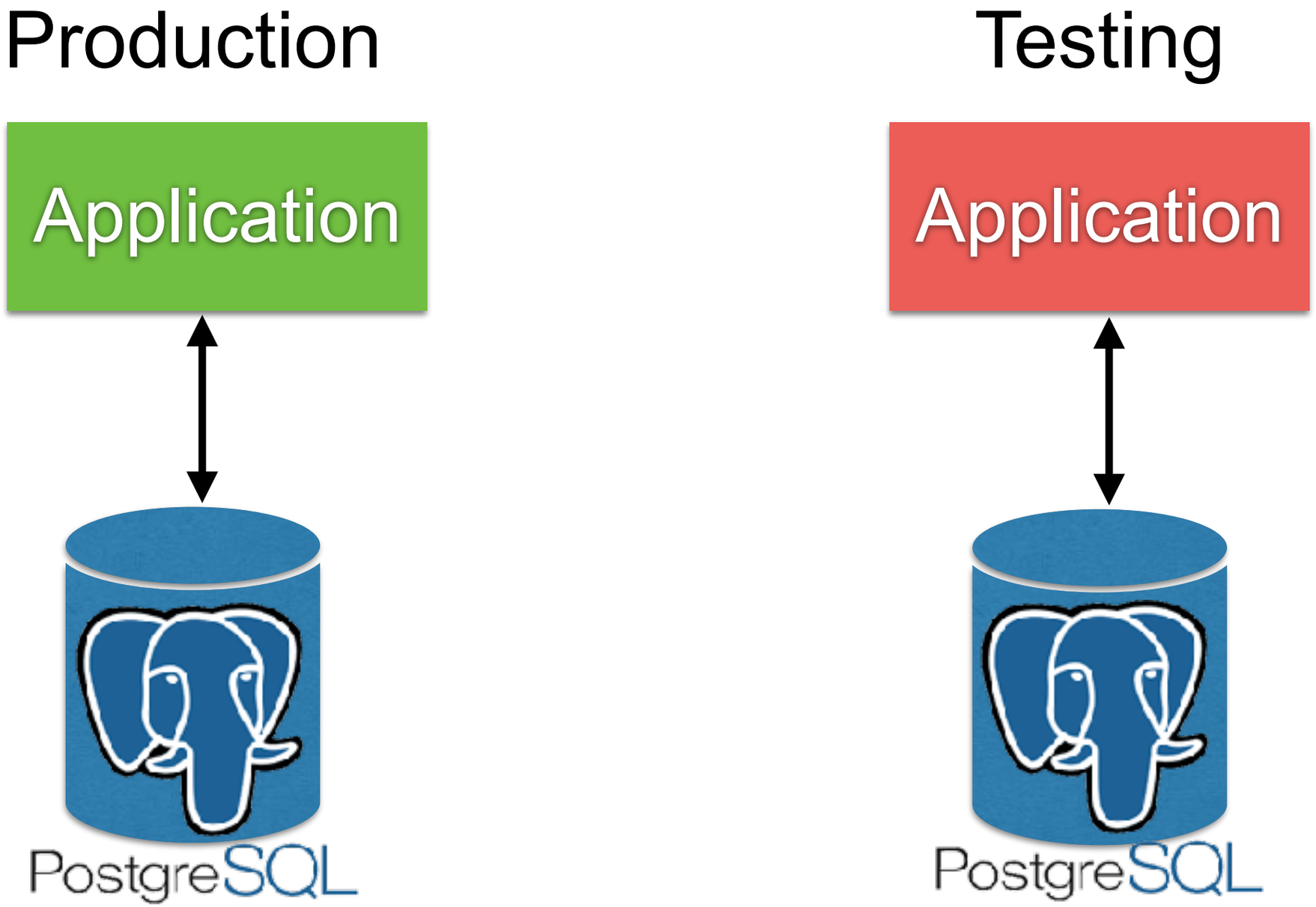
```
// 3. Prepared Statement
String sql = "SELECT * FROM TABLE WHERE name=?";
PreparedStatement pStmt = connection.prepareStatement(sql);

// 4. Query
ResultSet resultSet = pStmt.executeQuery();
while(resultSet.next()) {

}

// 5. Release resource
if(resultSet != null) {
    resultSet.close();
    resultSet = null;
}
```

Manage by Framework

# Working with Database ?

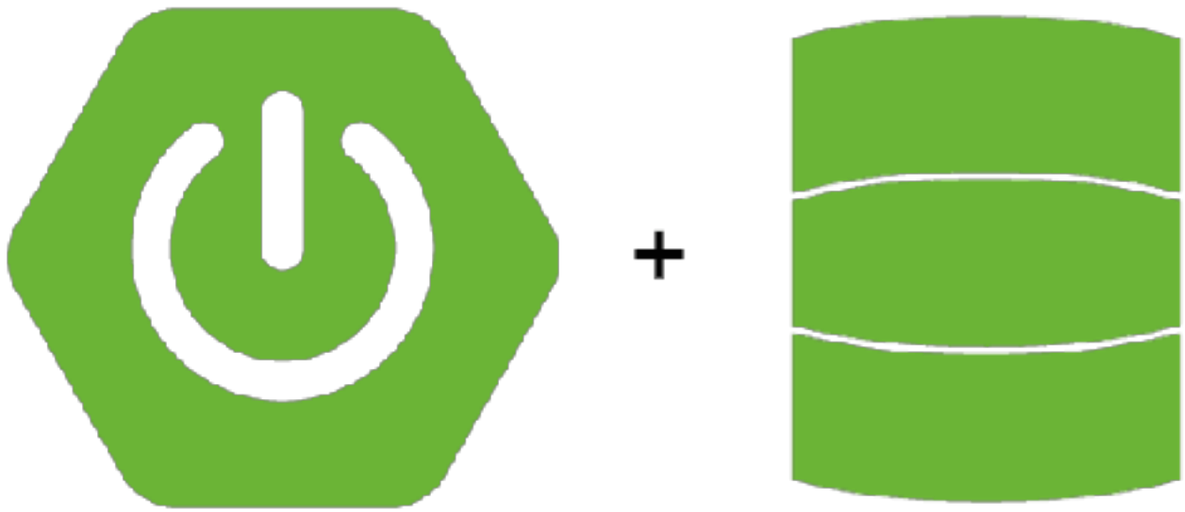


# Working with Database ?



# Working with repository

We’re using Spring Data



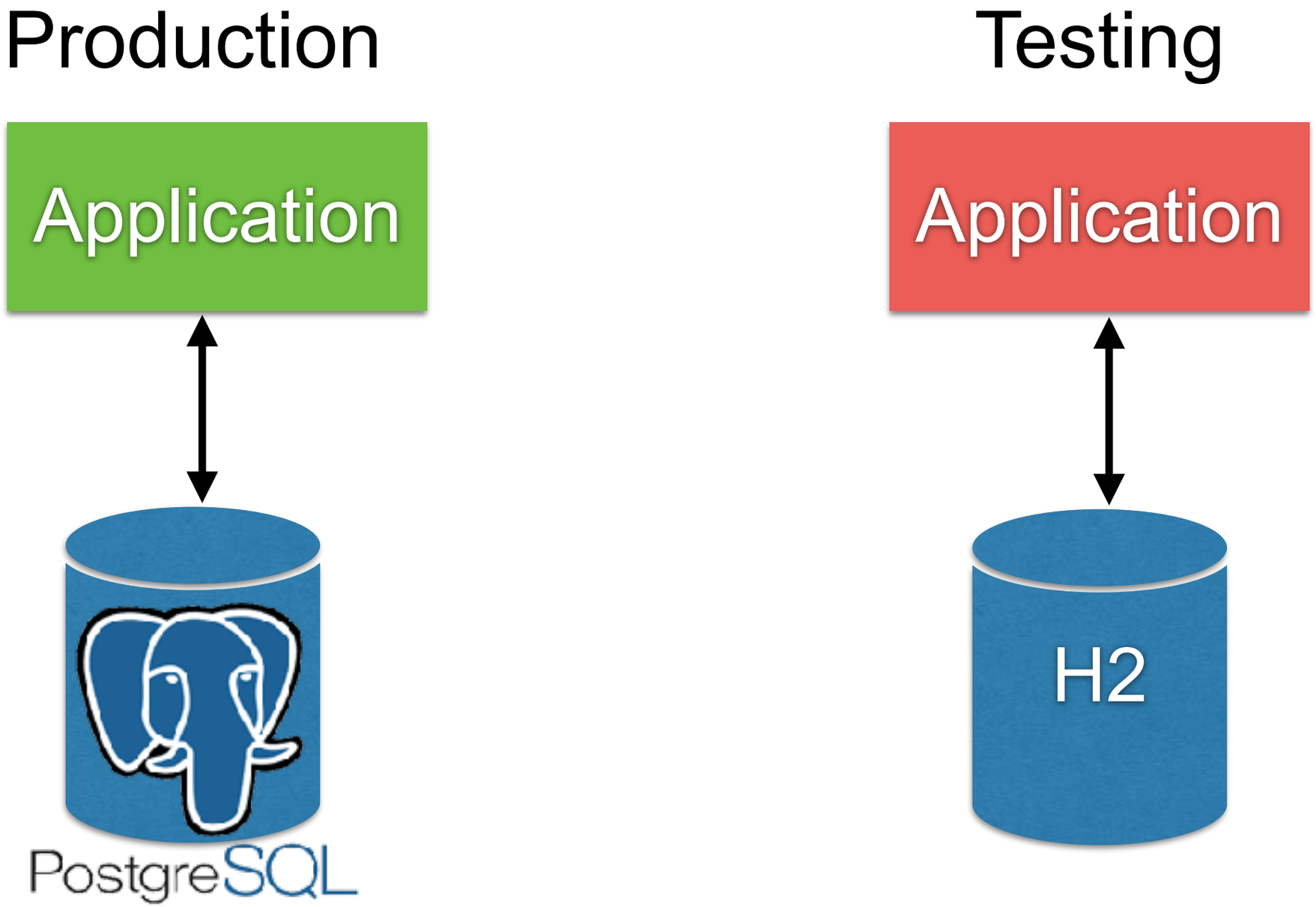
https://spring.io/projects/spring-data

# Spring Data

JDBC
**JPA**
MongoDB
Redis
more …

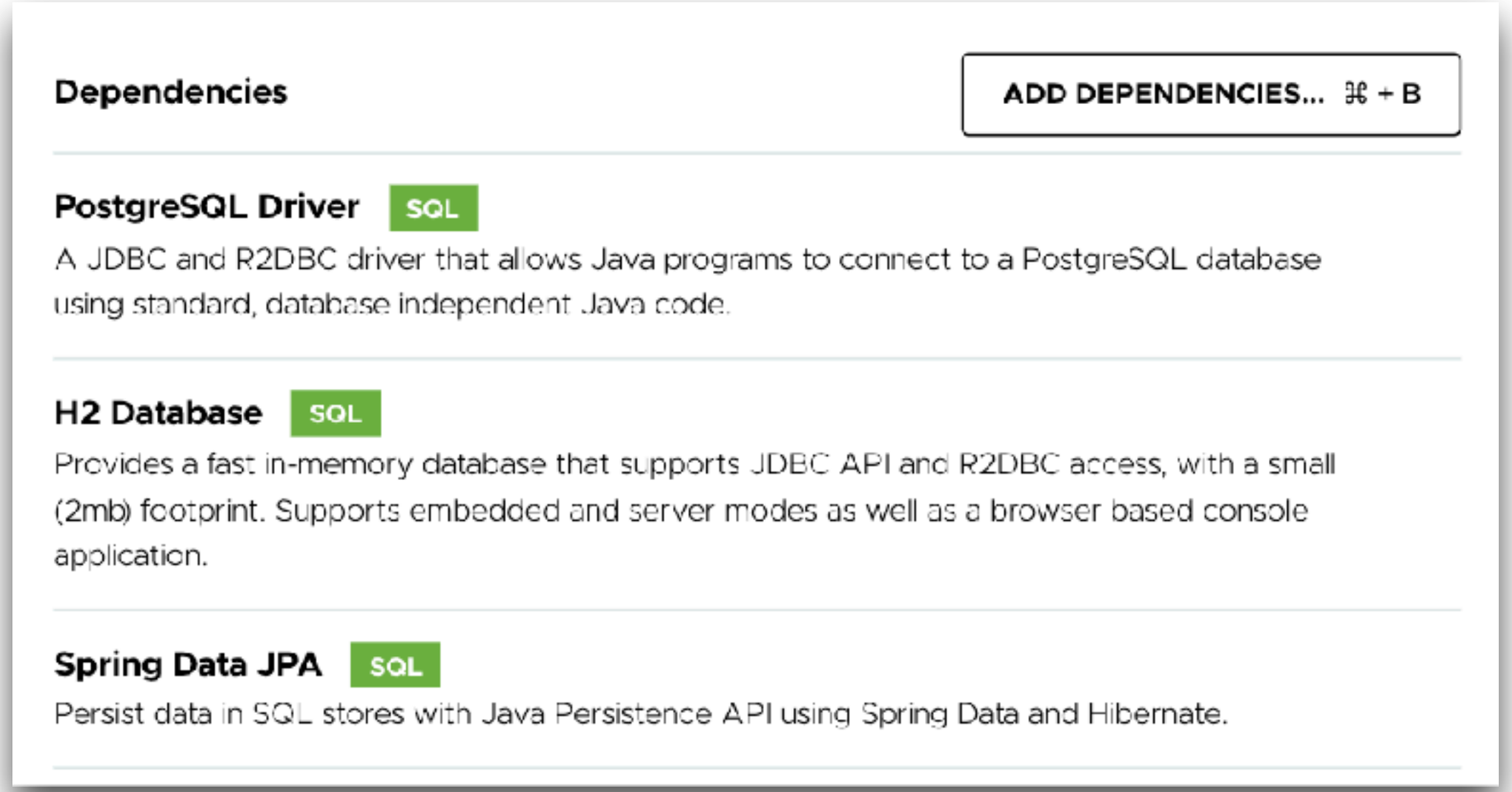
# Working with Spring Data JPA

# Working with Database



# Modify pom.xml

## Add library of Spring Data JPA, PostgreSQL, H2




https://start.spring.io/

# Modify pom.xml

## H2 for testing

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>

<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <scope>test</scope>
</dependency>

<dependency>
    <groupId>org.postgresql</groupId>
    <artifactId>postgresql</artifactId>
    <scope>runtime</scope>
</dependency>
```

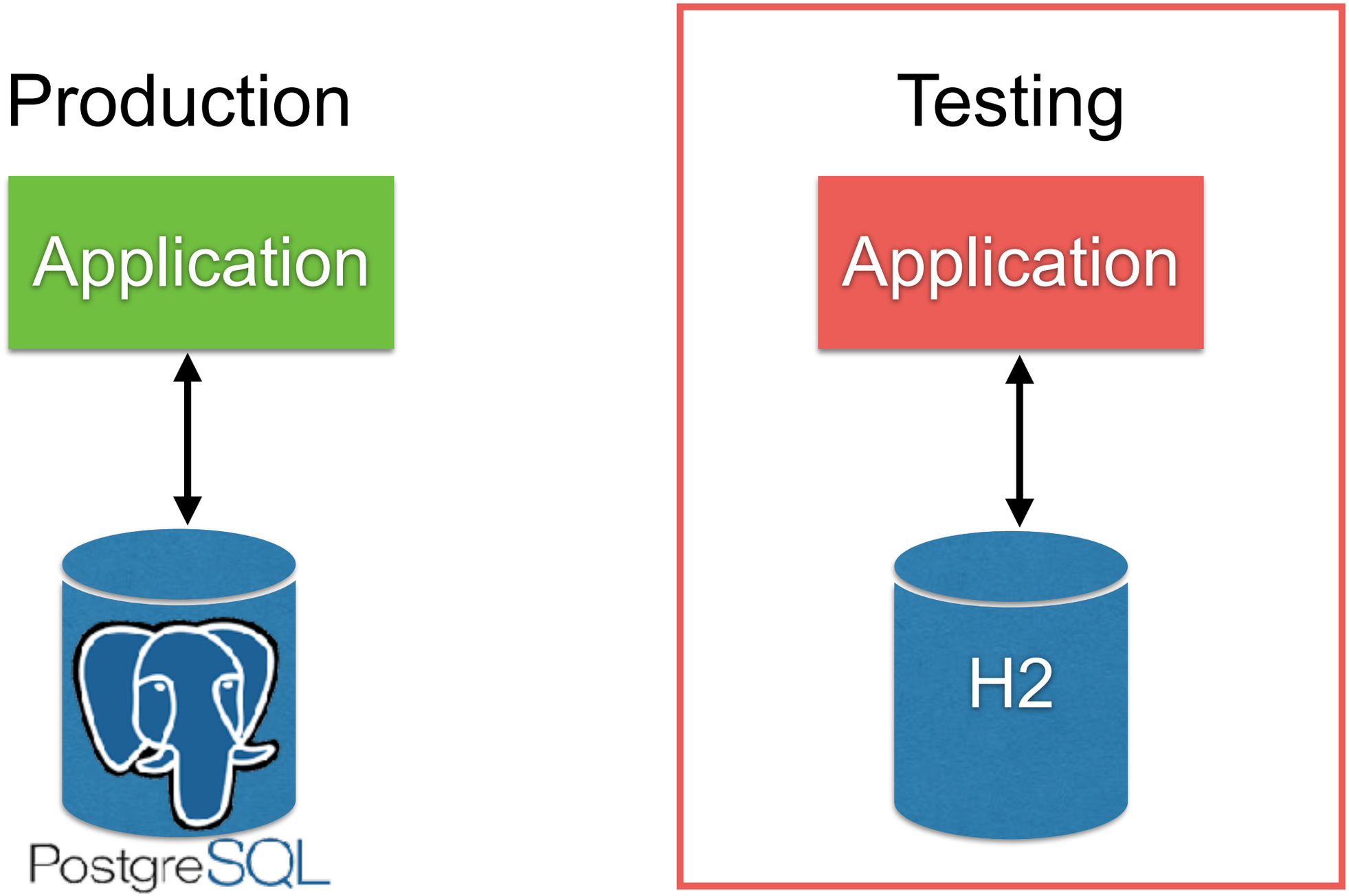
# Modify pom.xml

## PostgreSQL for production

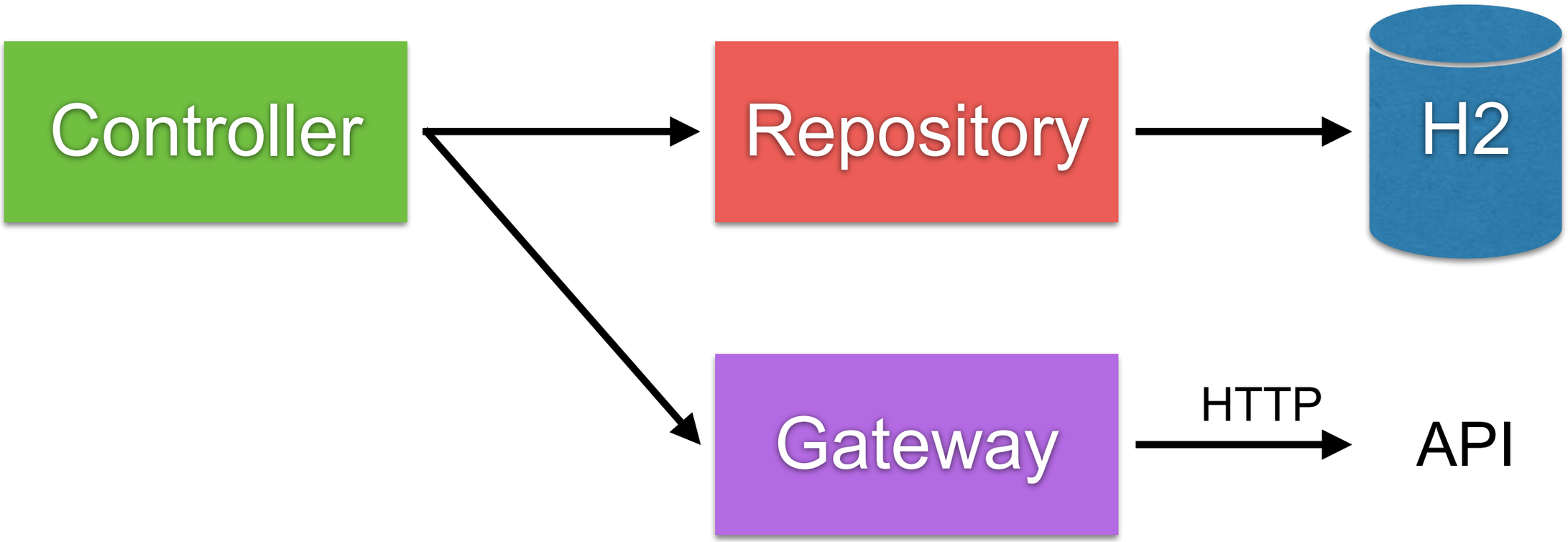
```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>

<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <scope>test</scope>
</dependency>
```

```
<dependency>
    <groupId>org.postgresql</groupId>
    <artifactId>postgresql</artifactId>
    <scope>runtime</scope>
</dependency>
```

# Start in testing scope

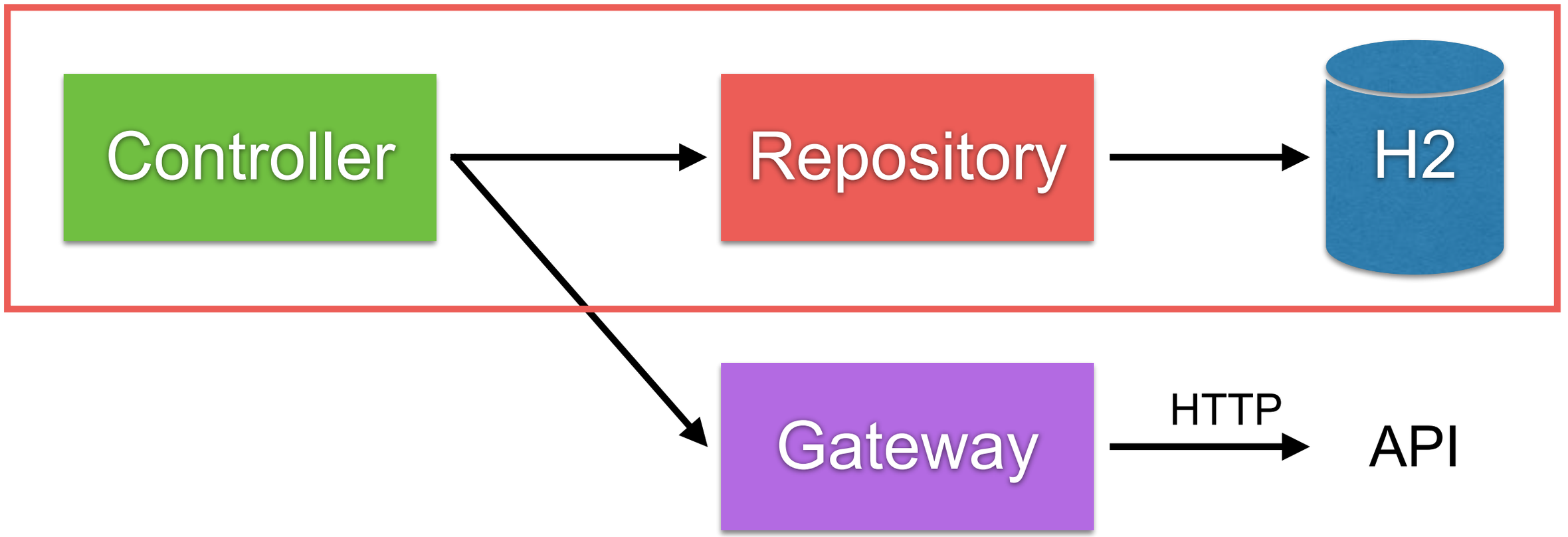


# Use cases



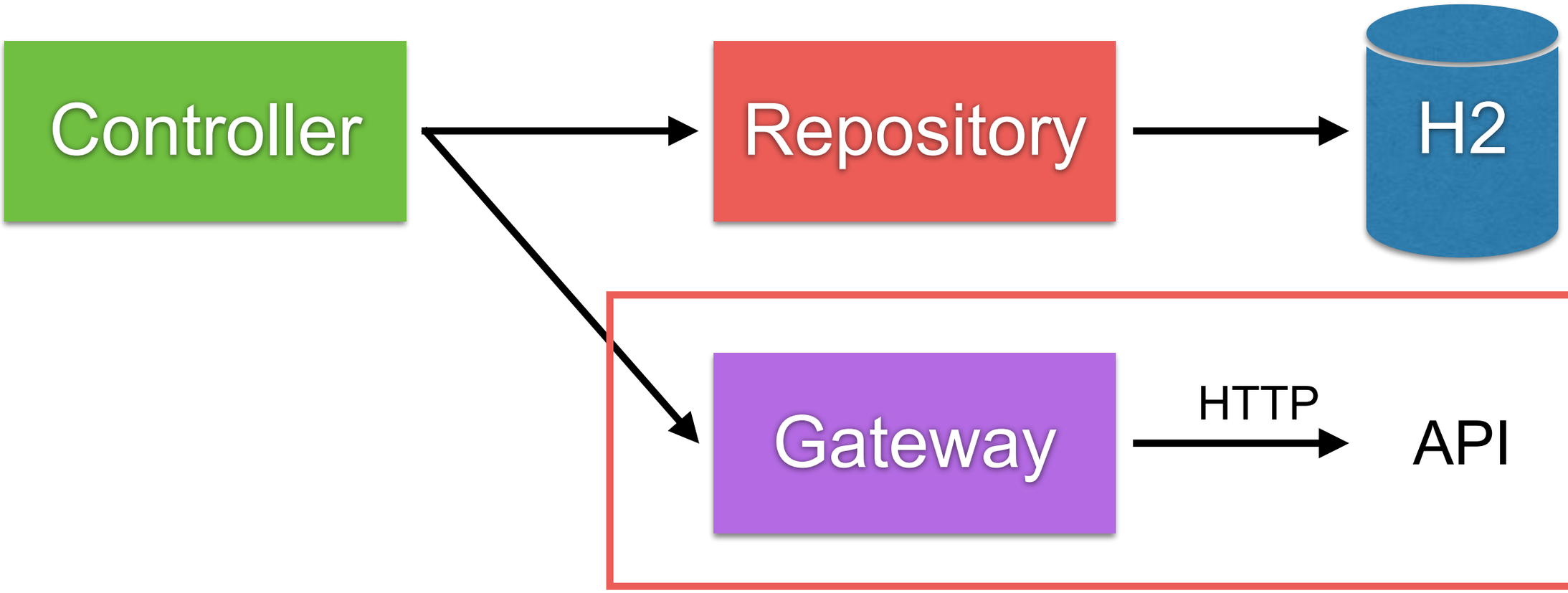
# Use case 1

Working with repository



# Use case 2

Working with API

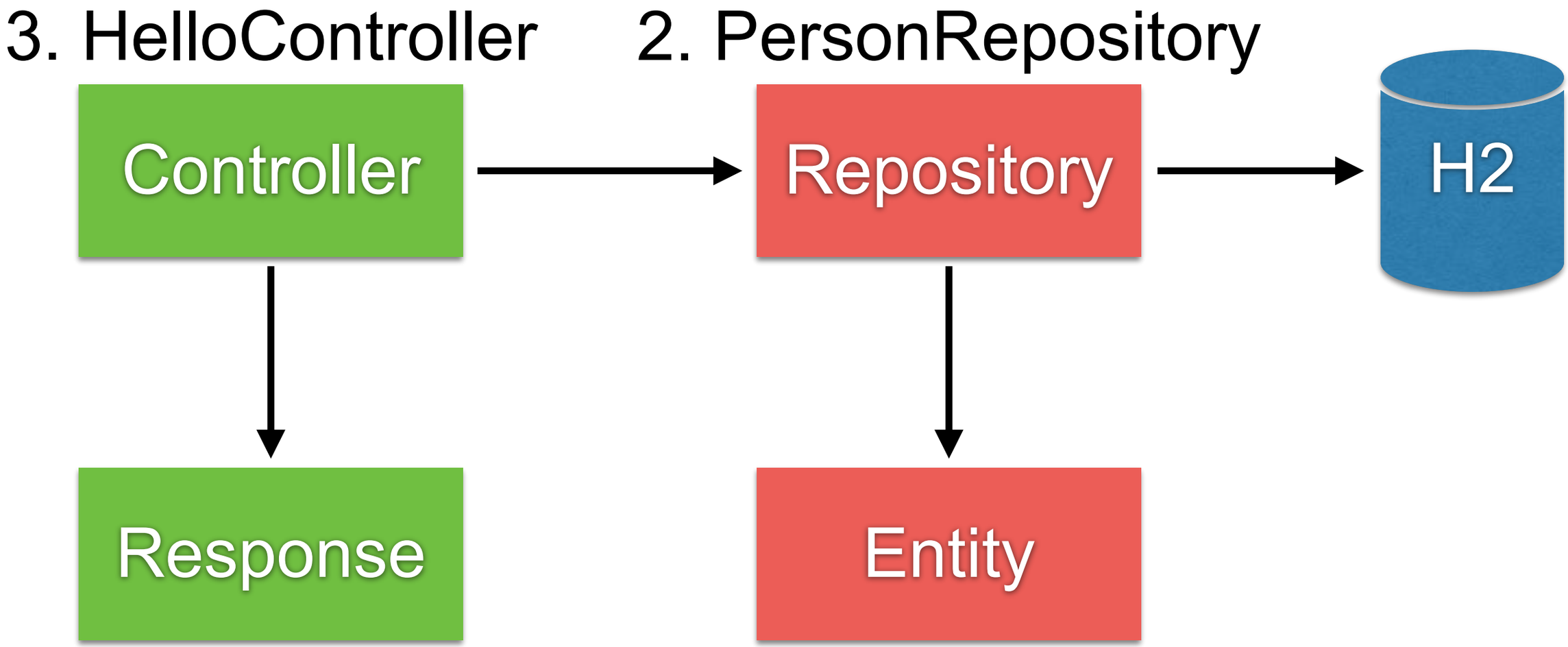


# Use case 1

Working with Database

# Use case 1

Working with repository



# 1. Create Entity class

In package **person**

```
@Entity
public class Person {

    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private long id;
    private String firstName;
    private String lastName;

    public Person() {
    }
```

# 2. Create repository with JPA

PersonRepository.java

```
import java.util.Optional;

import org.springframework.data.repository.CrudRepository;

public interface PersonRepository
                    extends CrudRepository<Person, Long> {

    Optional<Person> findByLastName(String lastName);

}
```

# 2. Create repository with JPA

PersonRepository.java

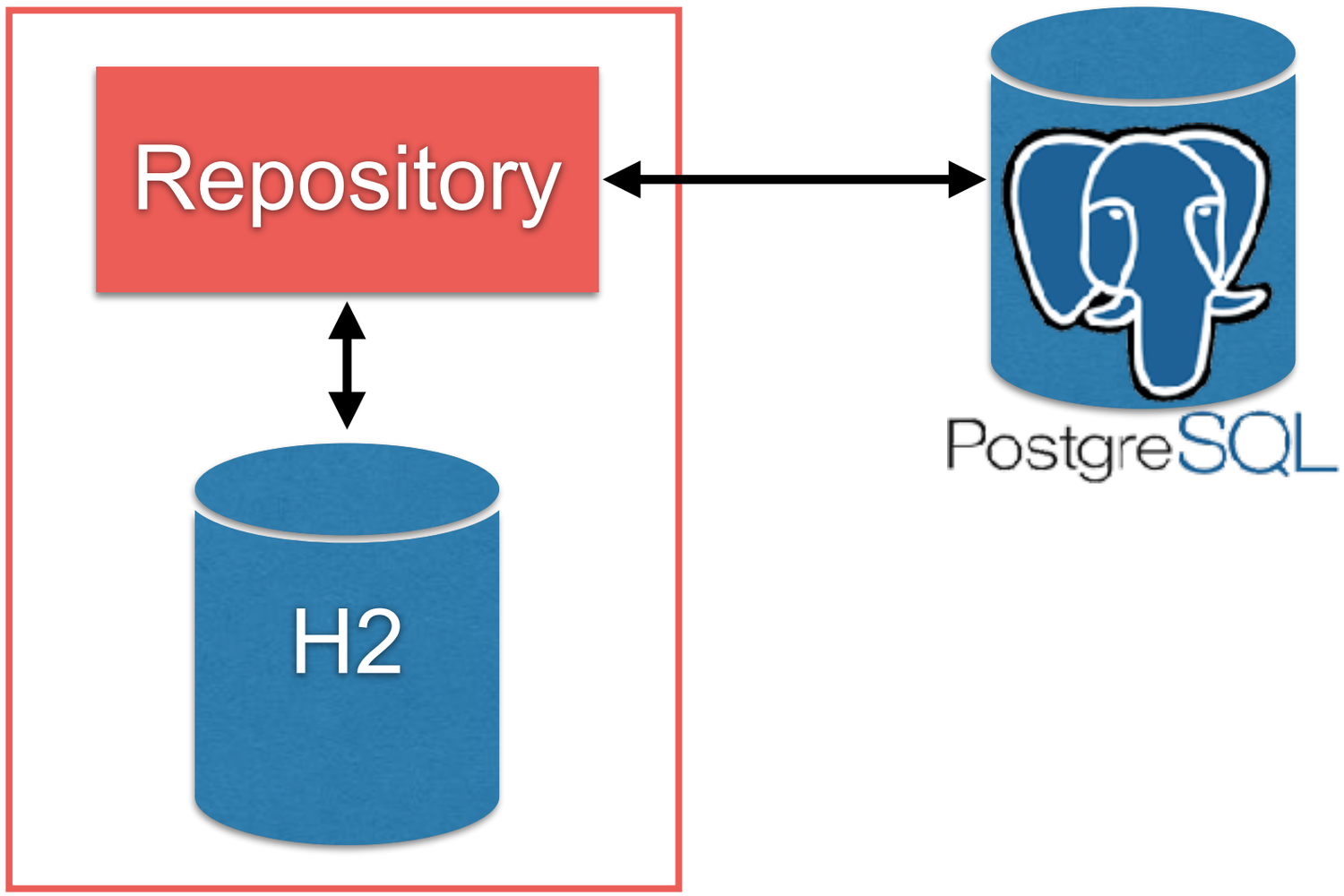
```
import java.util.Optional;

import org.springframework.data.repository.CrudRepository;

public interface PersonRepository
                extends CrudRepository<Person, Long> {

    Optional<Person> findByLastName(String lastName);

}
```

*SELECT * FROM Person WHERE LastName=?*

# How to testing repository ?

# Repository Testing

Using @DataJpaTest  (slice testing)




Working with In-memory database

# Repository Testing #1

Setup test with @DataJpaTest

```
@RunWith(SpringRunner.class)
@DataJpaTest
public class PersonRepositoryTest {

    @Autowired
    private PersonRepository repository;

    @After
    public void tearDown() throws Exception {
        repository.deleteAll();
    }

}
```

# Repository Testing #2

Auto wired repository for testing

```
@RunWith(SpringRunner.class)
@DataJpaTest
public class PersonRepositoryTest {

    @Autowired
    private PersonRepository repository;

    @After
    public void tearDown() throws Exception {
        repository.deleteAll();
    }

}
```

# Repository Testing #3

Clear data in table after executed each test case

```
@RunWith(SpringRunner.class)
@DataJpaTest
public class PersonRepositoryTest {

    @Autowired
    private PersonRepository repository;

    @After
    public void tearDown() throws Exception {
        repository.deleteAll();
    }

}
```

# Repository Testing #3

Write your first test case

```
@Test
public void should_save_fetch_a_person() {

    Person somkiat = new Person("Somkiat", "Pui");
    repository.save(somkiat);

    Optional<Person> maybeSomkiat
                        = repository.findByLastName("Pui");

    assertEquals(maybeSomkiat, Optional.of(somkiat));

}
```

# Run test

## $mvnw clean test

```
Hibernate: drop table person if exists
Hibernate: drop sequence if exists hibernate_sequence

Hibernate: create sequence hibernate_sequence start with 1 increment by 1
Hibernate: create table person (id varchar(255) not null, first_name varchar(255),
last_name varchar(255), primary key (id))
```

Insert data

```
Hibernate: call next value for hibernate_sequence
Hibernate: insert into person (first_name, last_name, id) values (?, ?, ?)
```

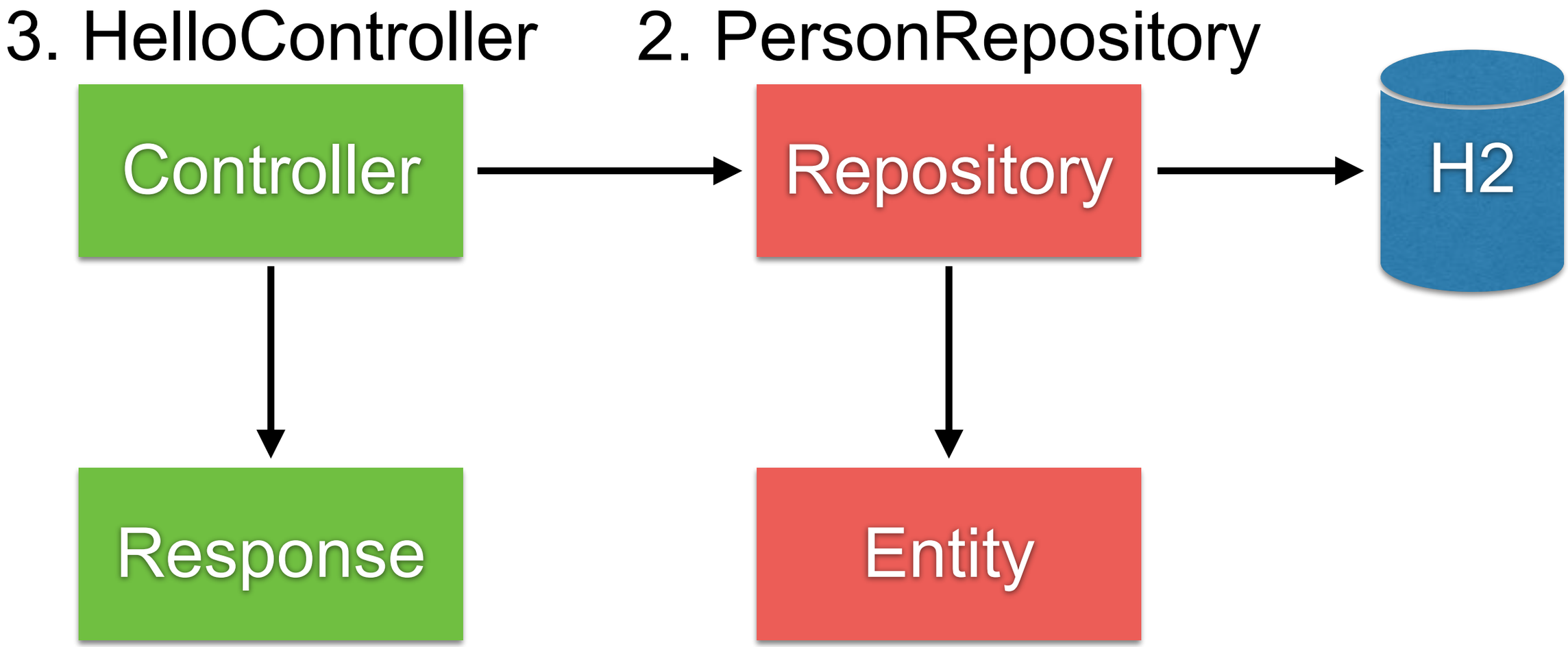
```
Hibernate: select person0_.id as id1_0_, person0_.first_name as first_na2_0_,
person0_.last_name as last_nam3_0_ from person person0_ where
person0_.last_name=?
Hibernate: select person0_.id as id1_0_, person0_.first_name as first_na2_0_,
person0_.last_name as last_nam3_0_ from person person0_
2
```

Query data

```
Hibernate: drop table person if exists
Hibernate: drop sequence if exists hibernate_sequence
```

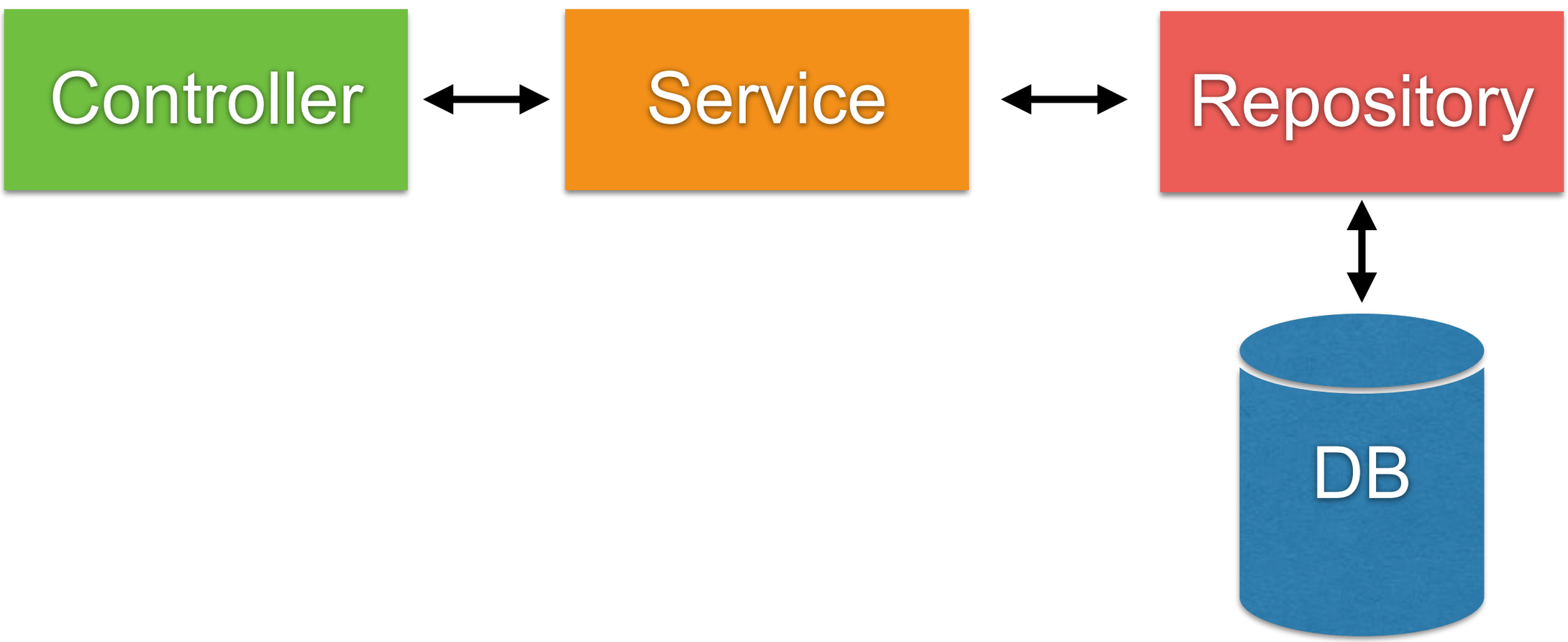
# Use case 1

Integrate repository with controller

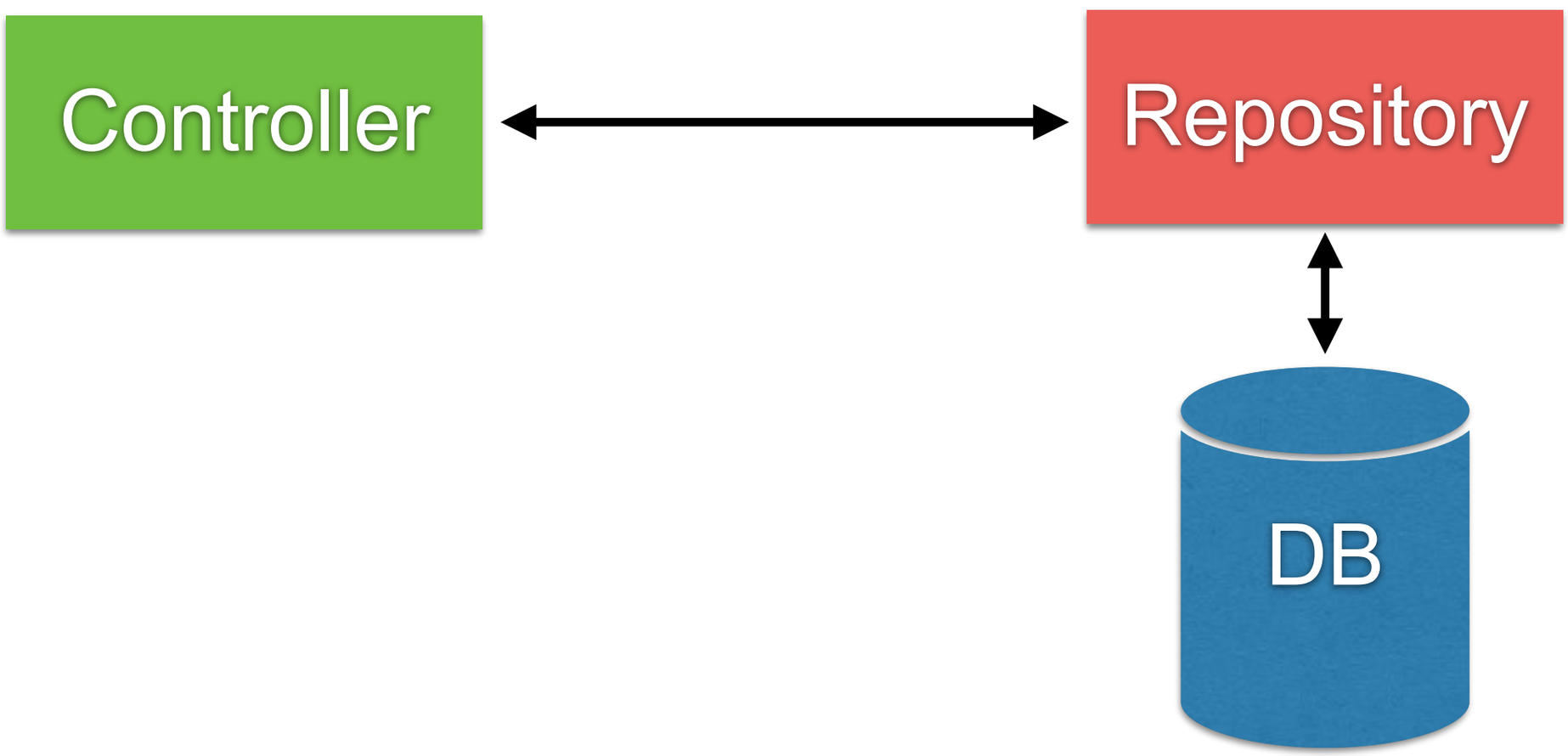


# Integrate repository with service/controller

# Service use repository ?



# Controller use repository ?



# Controller call repository

## Create HelloController.java

```java
@RestController
public class HelloController {

    private final PersonRepository personRepository;

    @Autowired
    public HelloController(final PersonRepository personRepository) {
        this.personRepository = personRepository;
    }
```

# Controller call repository

Create HelloController.java

```
@GetMapping("/hello/{lastName}")
public HelloResponse hello(@PathVariable final String lastName) {

    Optional<Person> foundPerson
                = personRepository.findByLastName(lastName);

    return foundPerson
            .map(person ->
                    new HelloResponse(person.getFirstName(),
                                      person.getLastName()))
            .orElseThrow(() -> new RuntimeException());
}
```

# Run spring boot

$mvnw spring-boot:run

# Fix !!!

## Modify src/main/resources/**application.properties**

```
server.port=8088

spring.datasource.url=jdbc:postgresql://127.0.0.1:15432/postgres
spring.datasource.username=testuser
spring.datasource.password=password
spring.datasource.platform=POSTGRESQL

spring.jpa.show-sql=true
spring.jpa.hibernate.ddl-auto=create-drop
spring.jpa.database-platform=org.hibernate.dialect.PostgreSQLDialect
```

Start database server !!

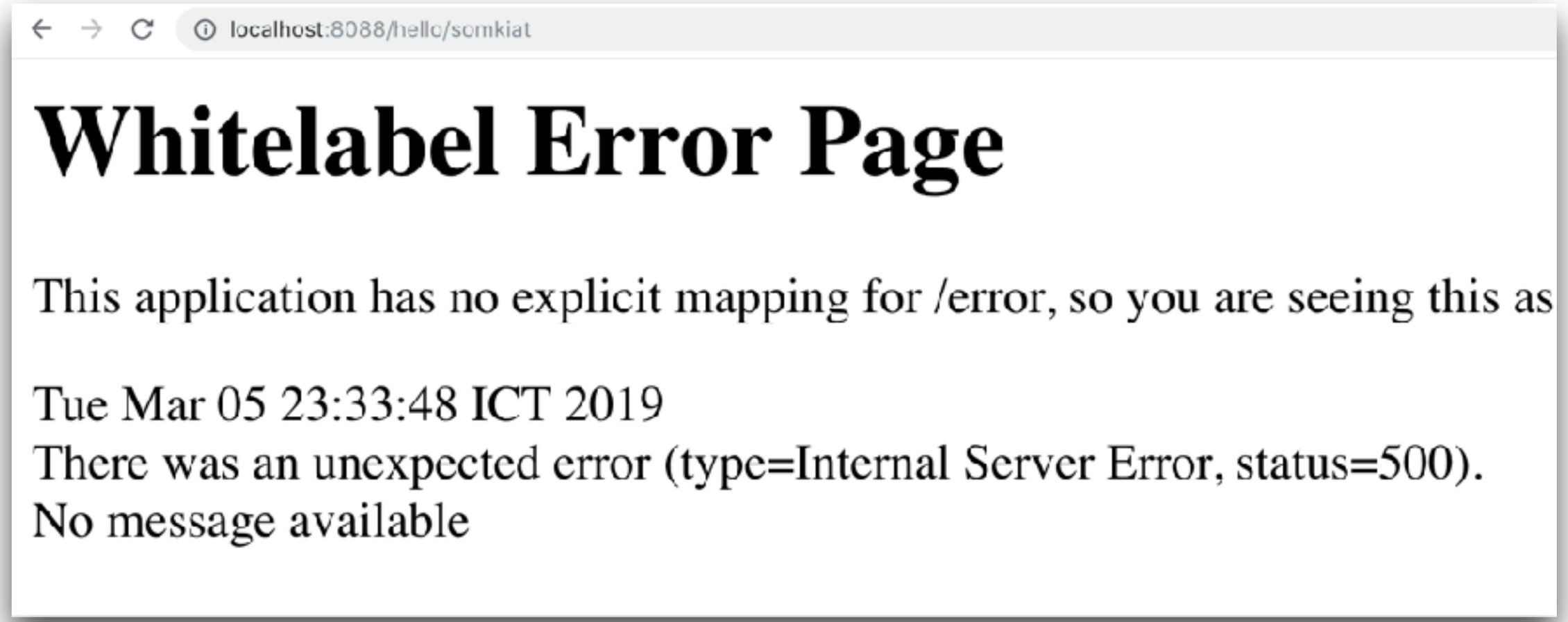
# Fix !!!

Modify pom.xml
Delete or comment postgresql dependency

```
<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <scope>runtime</scope>
</dependency>

<!-- <dependency>
    <groupId>org.postgresql</groupId>
    <artifactId>postgresql</artifactId>
    <scope>runtime</scope>
</dependency> -->
```

# Run spring boot

$mvnw spring-boot:run



# Initial data in database

# Initial database #1

Using @Bean and CommandLineRunner

```
@Bean
public CommandLineRunner initialData(MessageRepository repository) {
    return new CommandLineRunner() {

        @Override
        public void run(String... args) throws Exception {
            repository.save(new Message("somkiat1"));
            repository.save(new Message("somkiat2"));
        }
    };
}
```

# Initial database #2

Using @PostConstruct

```
@PostConstruct
public void initData() {
    Account account1 = new Account();
    account1.setAccountId("01");
    accountRepository.save(account1);
    Account account2 = new Account();
    account2.setAccountId("02");
    accountRepository.save(account2);
}
```

# Initial database #3

**Schema** (resources/schema.sql)

**Data** (resources/data.sql)

## Schema.sql

```sql
CREATE TABLE account(
  id BIGINT AUTO_INCREMENT PRIMARY KEY,
  account_Id VARCHAR(16) NOT NULL UNIQUE,
  mobile_No VARCHAR(10),
  name VARCHAR(50),
  account_Type CHAR(2)
);
```

## Data.sql

```sql
INSERT INTO account (account_Id) VALUES ('01');
INSERT INTO account (account_Id) VALUES ('02');
```

# Initial database 2

Disable auto generate DDL from JPA in file application.yml

```
spring:
  jpa:
    show-sql: true
    hibernate:
      ddl-auto: none
```

# Initial database 2

Problem with naming strategy !!

```
spring:
  jpa:
    show-sql: true
    hibernate:
        ddl-auto: none
        naming:
          physical-strategy:
org.springframework.boot.orm.jpa.hibernate.SpringPhysicalNamingStrategy
          implicit-strategy:
org.springframework.boot.orm.jpa.hibernate.SpringImplicitNamingStrategy
```

https://github.com/spring-projects/spring-boot/tree/master/spring-boot-project/spring-boot/src/main/java/org/springframework/boot/orm/jpa/hibernate

# Run and see from logging

Execute file schema.sql and data.sql

```
.datasource.init.ScriptUtils     : Executing SQL script from URL [file:/Users/somki
.datasource.init.ScriptUtils     : Executed SQL script from URL [file:/Users/somkia
.datasource.init.ScriptUtils     : Executing SQL script from URL [file:/Users/somki
.datasource.init.ScriptUtils     : Executed SQL script from URL [file:/Users/somkia
```

# Run spring boot

$mvnw spring-boot:run

# Write controller testing ?

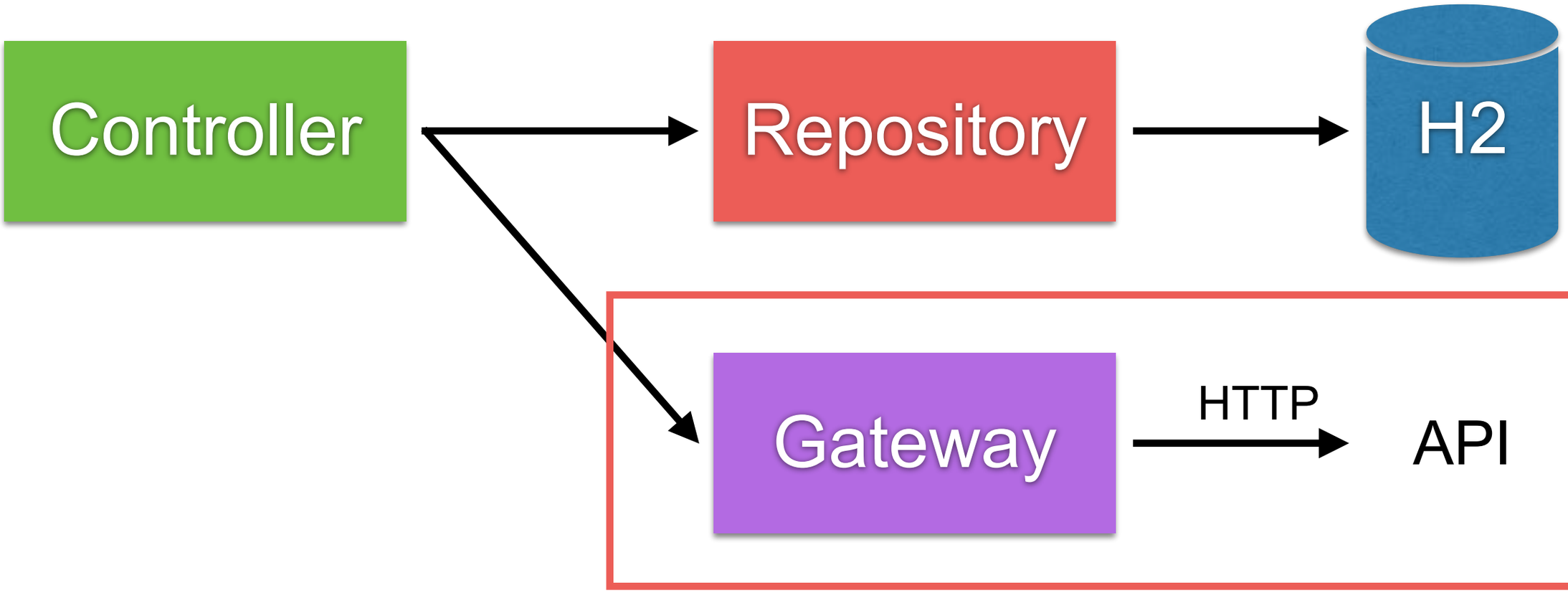
$mvnw clean test

# Use case 2

Working with API

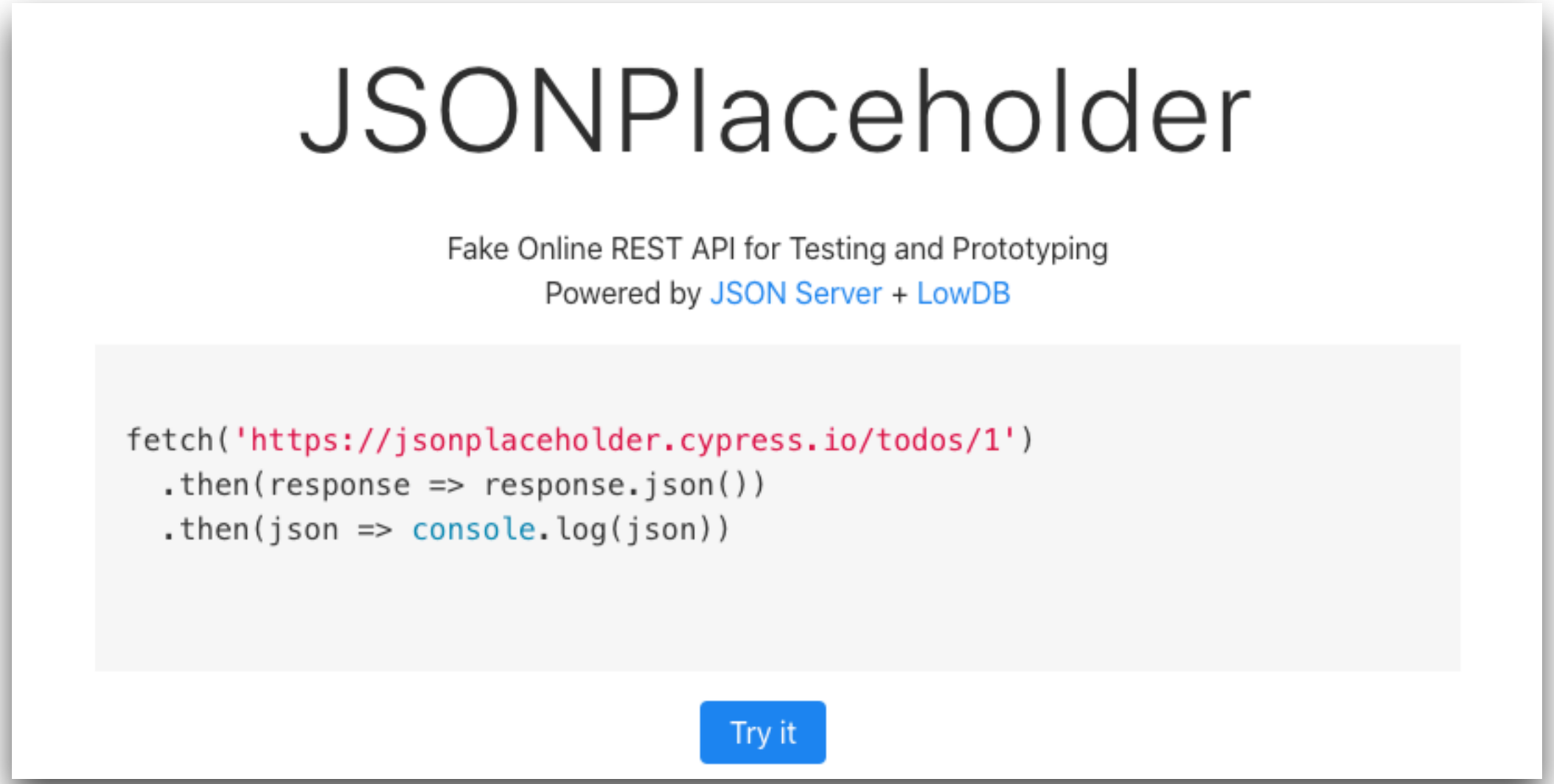
# Use case 2

Working with API

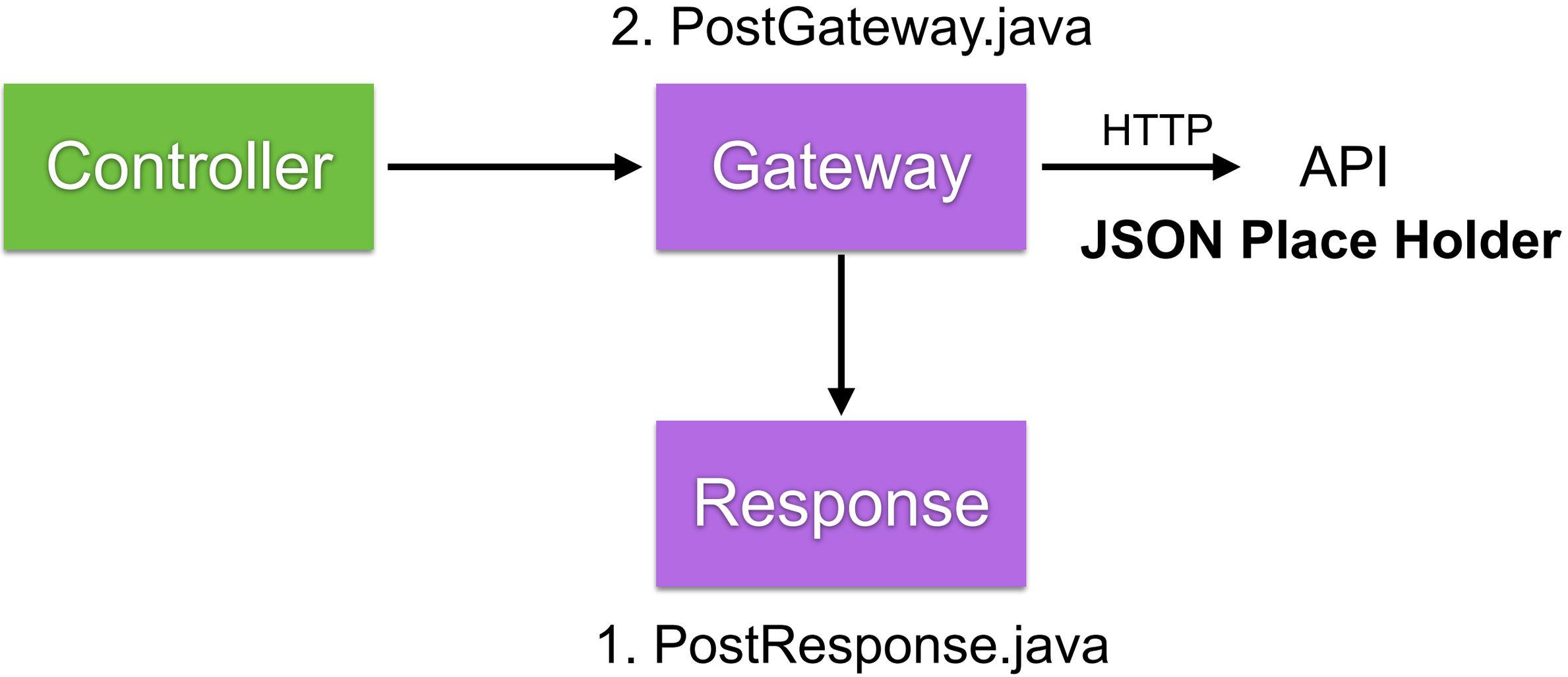


# JSON Place Holder

https://jsonplaceholder.cypress.io/posts/1



# Working with API



# Library to call external APIs

Rest Template

OpenFeign

HTTP Interface

Spring framework 6

# 1. Create Response class

In package **post**

```
public class PostResponse {
    private int id;
    private int userId;
    private String title;
    private String body;
```

# 2. Create PostGateway class #1

In package **post**

```
@Component
public class PostGateway {

    private final RestTemplate restTemplate;
    private final String postApiUrl;

    @Autowired
    public PostGateway(final RestTemplate restTemplate,
                       @Value("${post.api.url}") final String postApiUrl) {
        this.restTemplate = restTemplate;
        this.postApiUrl = postApiUrl;
    }
```

# 2. Create PostGateway class #1

In package **post**

```
@Component
public class PostGateway {

    private final RestTemplate restTemplate;
    private final String postApiUrl;

    @Autowired
    public PostGateway(final RestTemplate restTemplate,
                       @Value("${post.api.url}") final String postApiUrl) {
        this.restTemplate = restTemplate;
        this.postApiUrl = postApiUrl;
    }
```

Configuration ?

# Configuration

Configuration in file application.properties

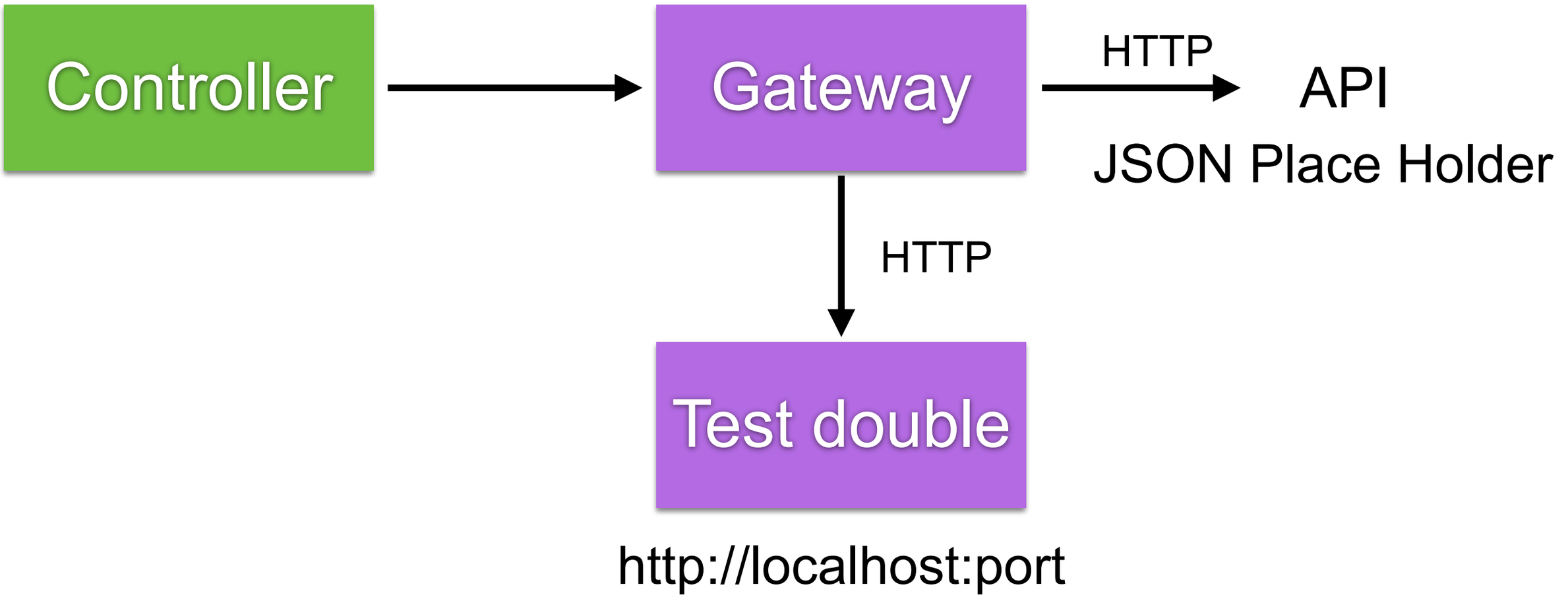
```
post.api.url=https://jsonplaceholder.cypress.io
```

# 2. Create PostGateway class #2

Get data from API

```
public Optional<PostResponse> getPostById(int id) {
    String url = String.format("%s/posts/%d", postApiUrl, id);

    try {
        return Optional.ofNullable(
                restTemplate.getForObject(url, PostResponse.class));
    } catch (RestClientException e) {
        return Optional.empty();
    }
}
```

# Testing with API



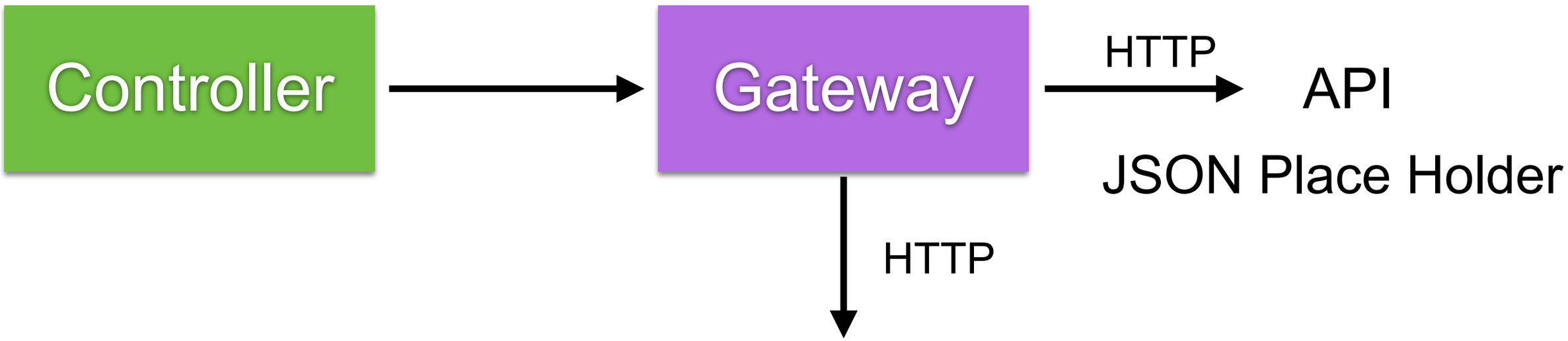
# Testing with API

Unit testing with Mockito

**Component testing with WireMock**

Consumer testing with Pact

# Component testing with WireMock




**/src/test/resources/application.properties**

```
post.api.url=http://localhost:9999
```

# Component testing #1

## Working with WireMock

```
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment = WebEnvironment.RANDOM_PORT)
@AutoConfigureWireMock(port = 9999)
public class PostGatewayComponentTest {

    @Autowired
    private PostGateway postGateway;
```

*“Default port = 9999”*

# Component testing #2

## Success case

Stub response

```
@Test
public void getPostById() throws IOException {
    stubFor(get(urlPathEqualTo("/posts/1"))
            .willReturn(aResponse()
                    .withBody(read("classpath:postApiResponse.json"))
                    .withHeader(CONTENT_TYPE, MediaType.APPLICATION_JSON_VALUE)
                    .withStatus(200)));

    Optional<PostResponse> postResponse = postGateway.getPostById(1);
    assertEquals(11, postResponse.get().getId());
    assertEquals(11, postResponse.get().getUserId());
    assertEquals("Test Title", postResponse.get().getTitle());
    assertEquals("Test Body", postResponse.get().getBody());
}
```

# Component testing #3

Read data from resources folder

```
public static String read(String filePath) throws IOException {
    File file = ResourceUtils.getFile(filePath);
    return new String(Files.readAllBytes(file.toPath()));
}
```

# Component testing #4

File postApiResponse.json

```
{
  "userId": 11,
  "id": 11,
  "title": "Test Title",
  "body": "Test Body"
}
```

# Write controller testing ?

$mvnw clean test

# Separate tests with jUnit

https://semaphoreci.com/community/tutorials/how-to-split-junit-tests-in-a-continuous-integration-environment

# Separate test with jUnit

# Working with jUnit 4 Category

Create interface in each category

```java
package com.lotto.lotto.category;

public interface UnitTest {
}
```

```java
package com.lotto.lotto.category;

public interface SlicingTest {
}
```

```java
package com.lotto.lotto.category;

public interface IntegrationTest {
}
```

# Add category in each test class

```java
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment = WebEnvironment.RANDOM_PORT)
@Category(IntegrationTest.class)
public class AccountControllerTest {

    @Autowired
    private TestRestTemplate testRestTemplate;

    @MockBean
    private UserService userService;
```

# Run test by category

$mvnw clean  test
-Dgroups="com.lotto.lotto.category.UnitTest"

# jUnit 5 Tagging and Filtering

```java
import org.junit.jupiter.api.Tag;
import org.junit.jupiter.api.Test;

@Tag("fast")
@Tag("model")
class TaggingDemo {

    @Test
    @Tag("taxes")
    void testingTaxCalculation() {
    }

}
```

https://junit.org/junit5/docs/current/user-guide/#writing-tests-tagging-and-filtering

# Run test by tag

$mvnw clean  test
-Dgroups="fast, model"

# Aspect-Oriented Programming AOP

# Aspects ?

Reusable blocks of code that are injected into application at runtime

Powerful tools for adding behavior

Solve cross-cutting concerns in one place

# Common Applications of Aspects

Logging
Transaction management
Caching
Security
Execute time

# Why use Aspects ?

Reduce code duplication

DRY (Don’t Repeat Yourself)

Maintain application logic

# Example of Execute time

# Working with transaction

https://github.com/up1/course-springboot-2022/wiki/Transaction-Management

# Important Quality Service

# Important Quality Service

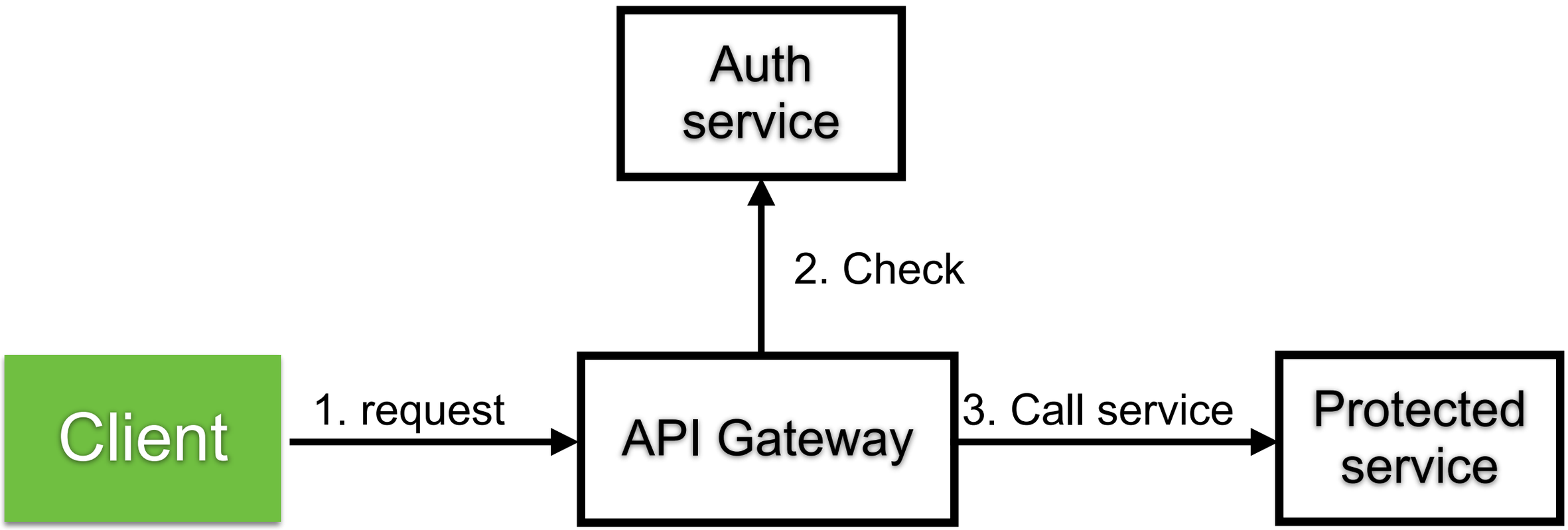
Security
Observability
Configurability

# Secure Service

# Secure Service

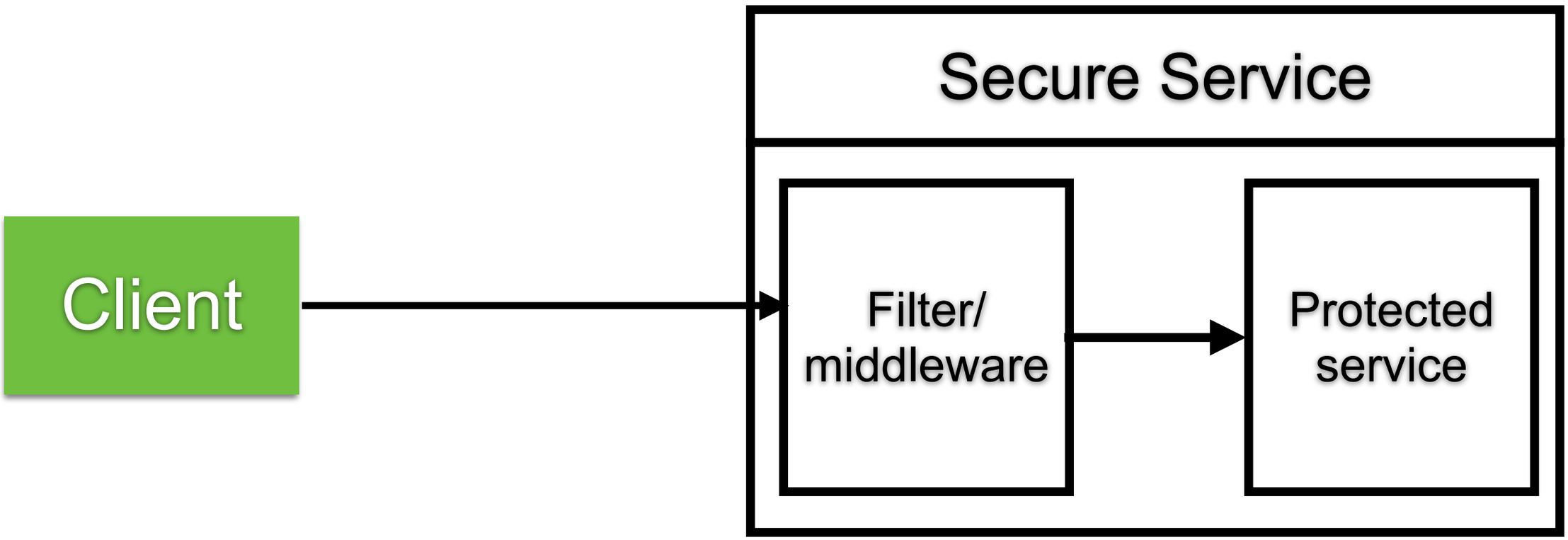
API Gateway
Within service

# API Gateway





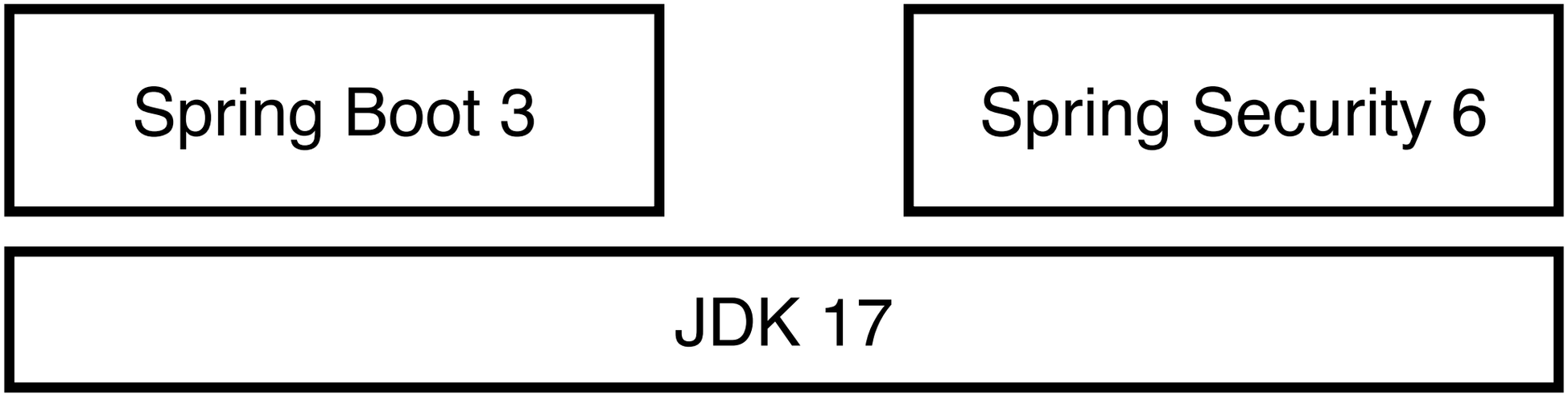
# Within service




https://github.com/up1/demo-spring-security

# Secure Service with Spring

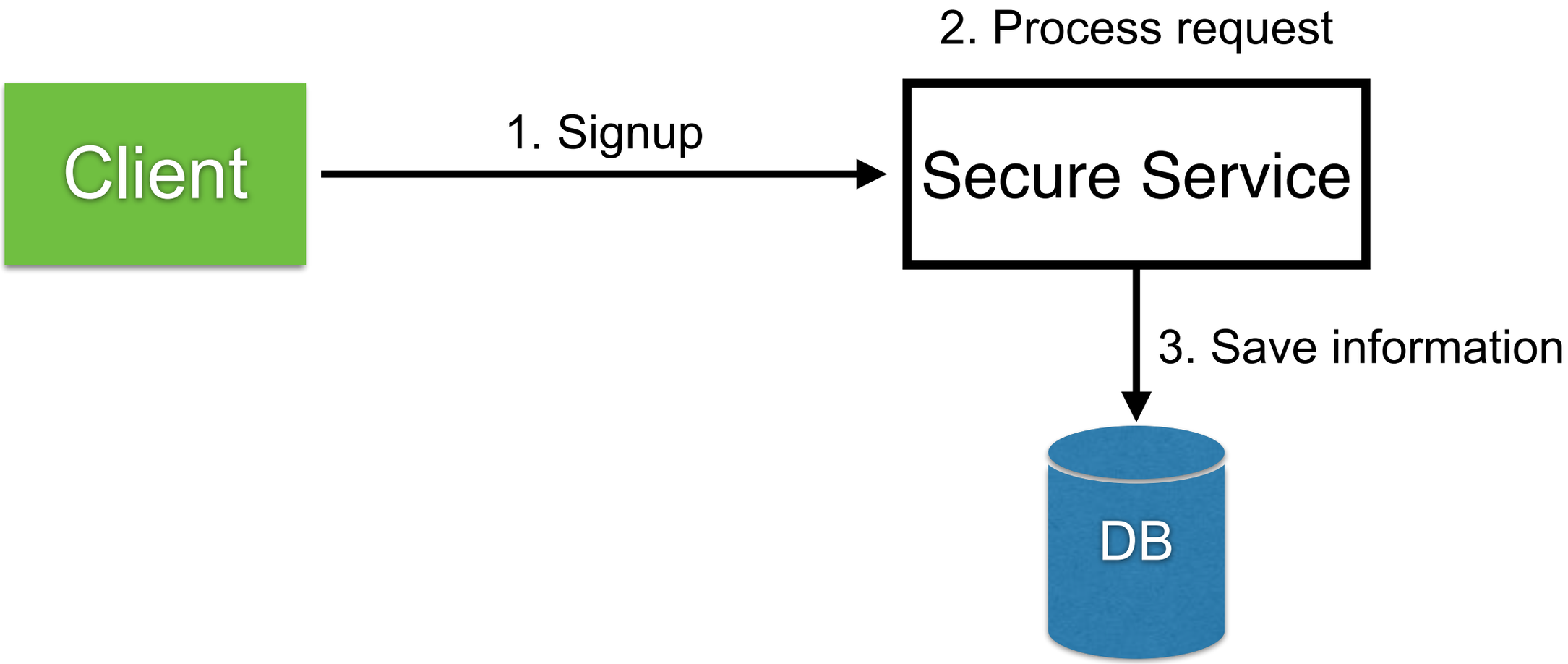
Working with Spring Security
Support authentication and authorization



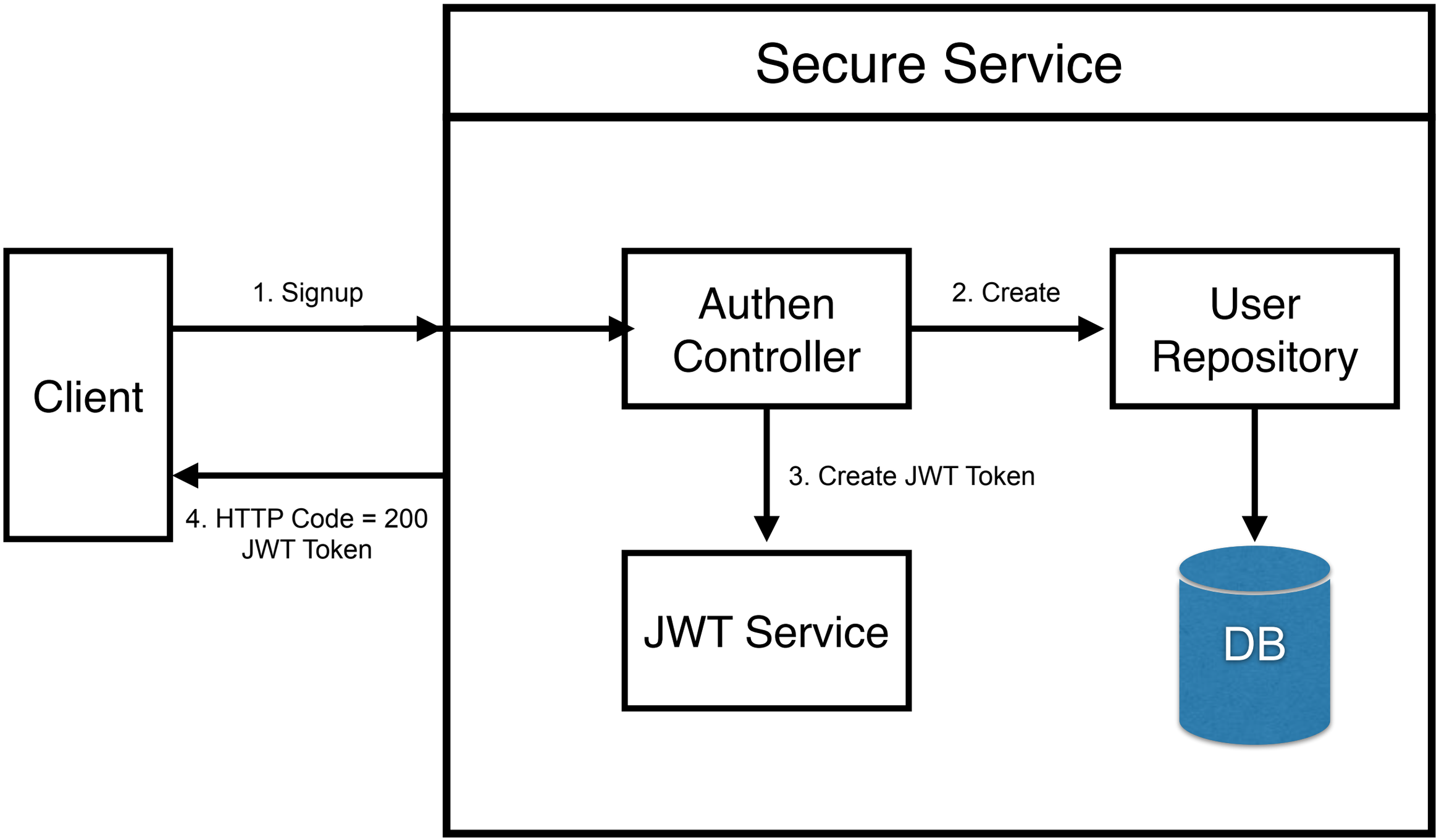

https://spring.io/projects/spring-security

# Simple Flow of Secure Service

## Step 1 :: Signup process

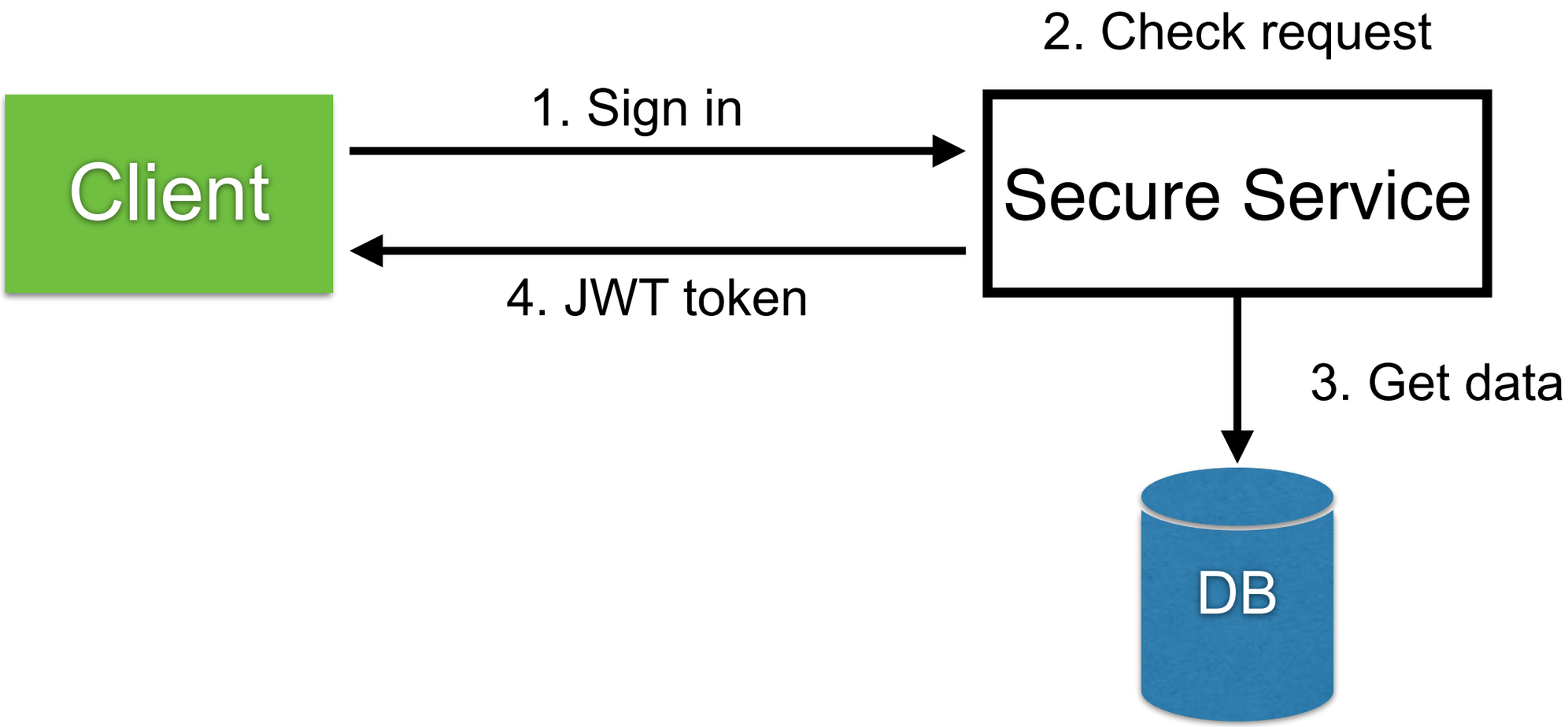


# Flow diagram of Signup

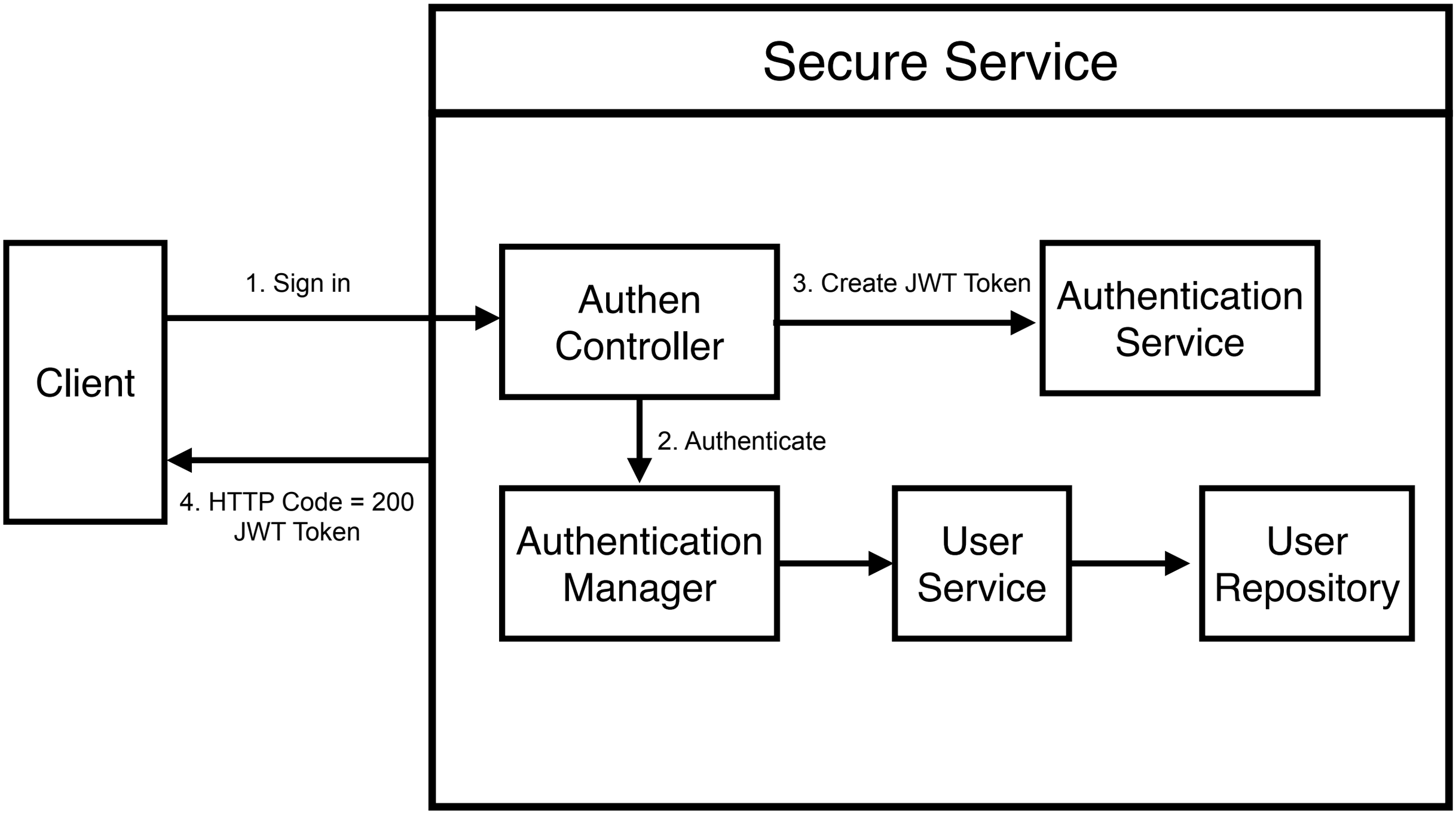


# Simple Flow of Secure Service

## Step 2 :: Sign in process

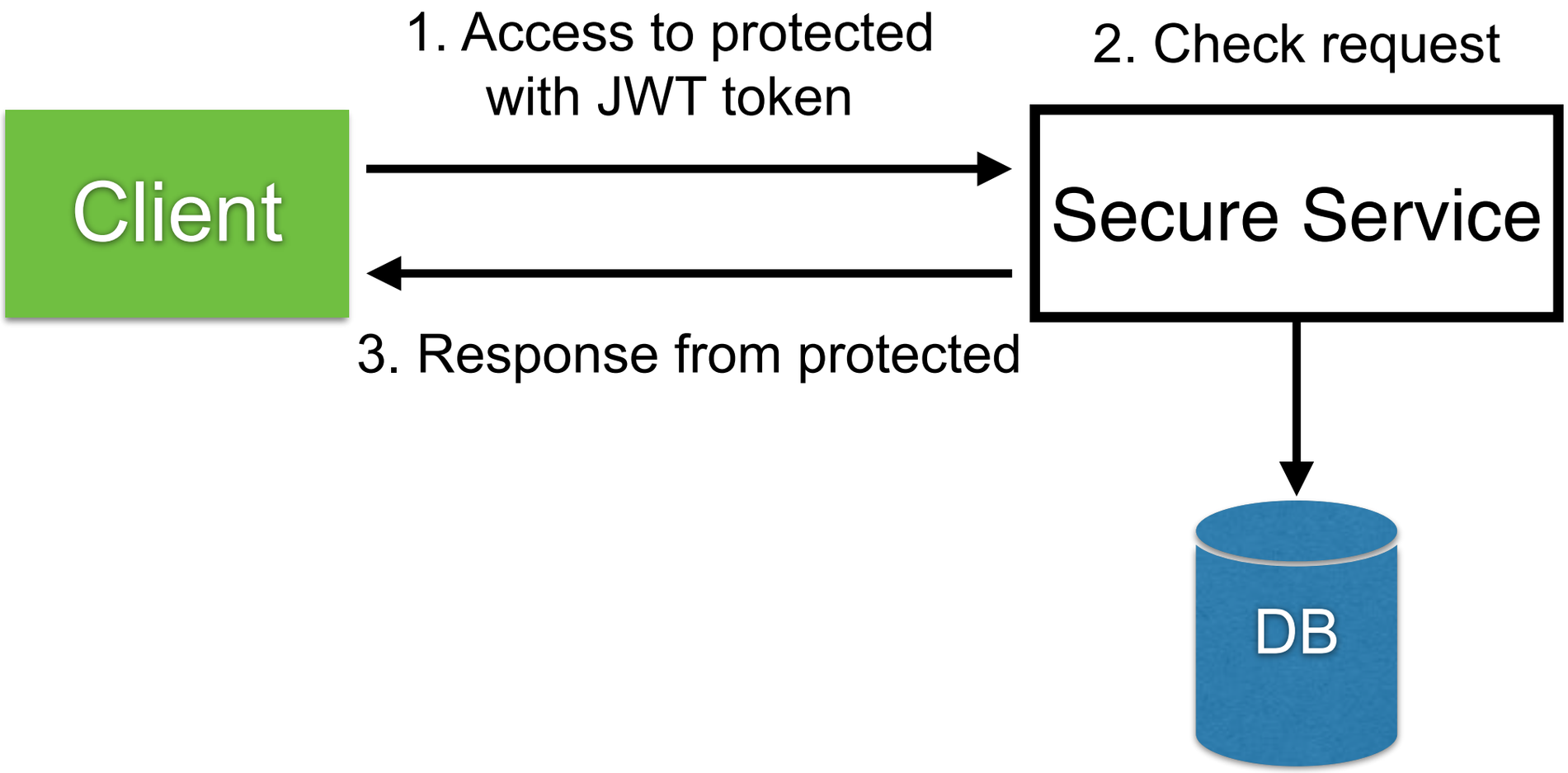


# Flow diagram of Sign in

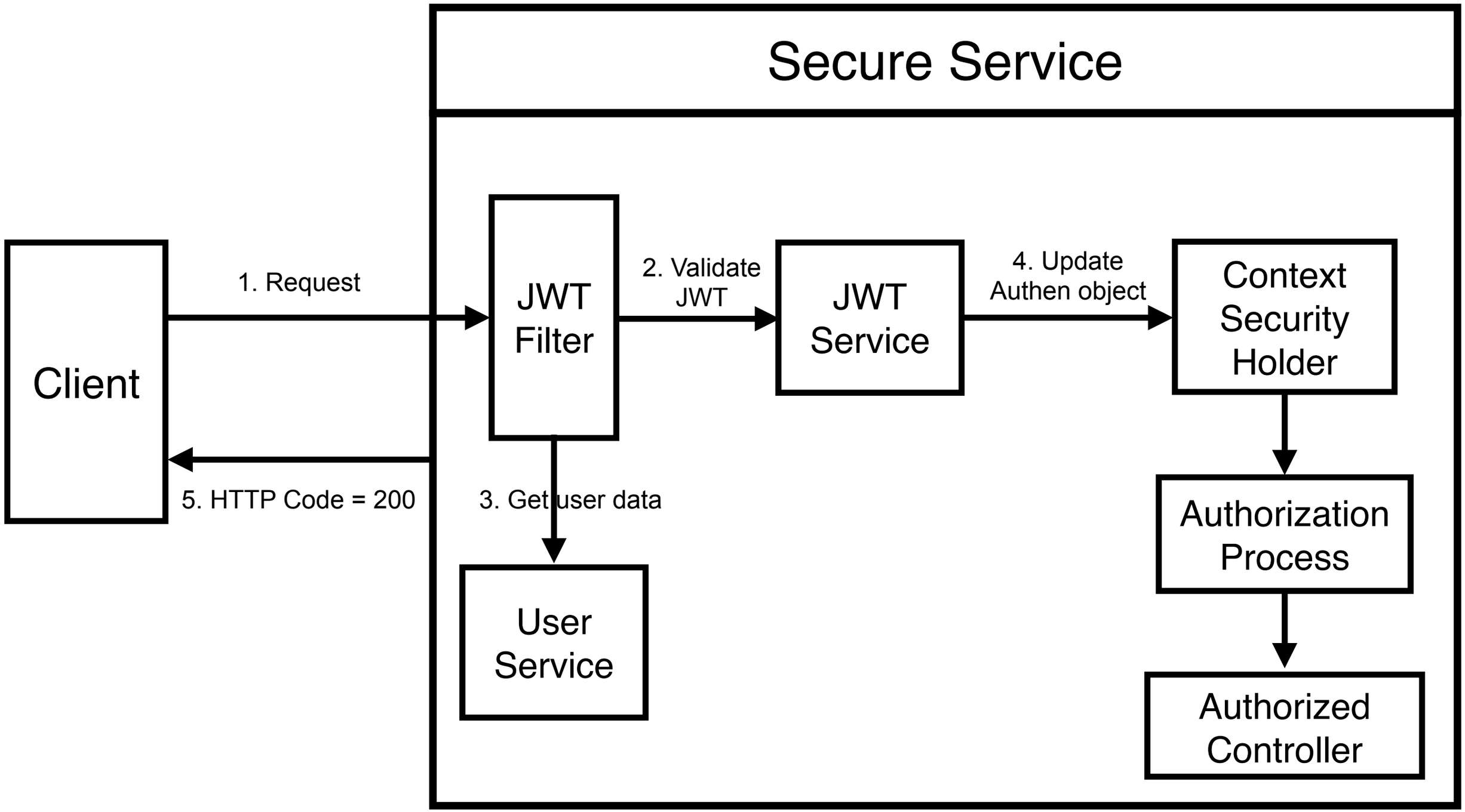


# Simple Flow of Secure Service

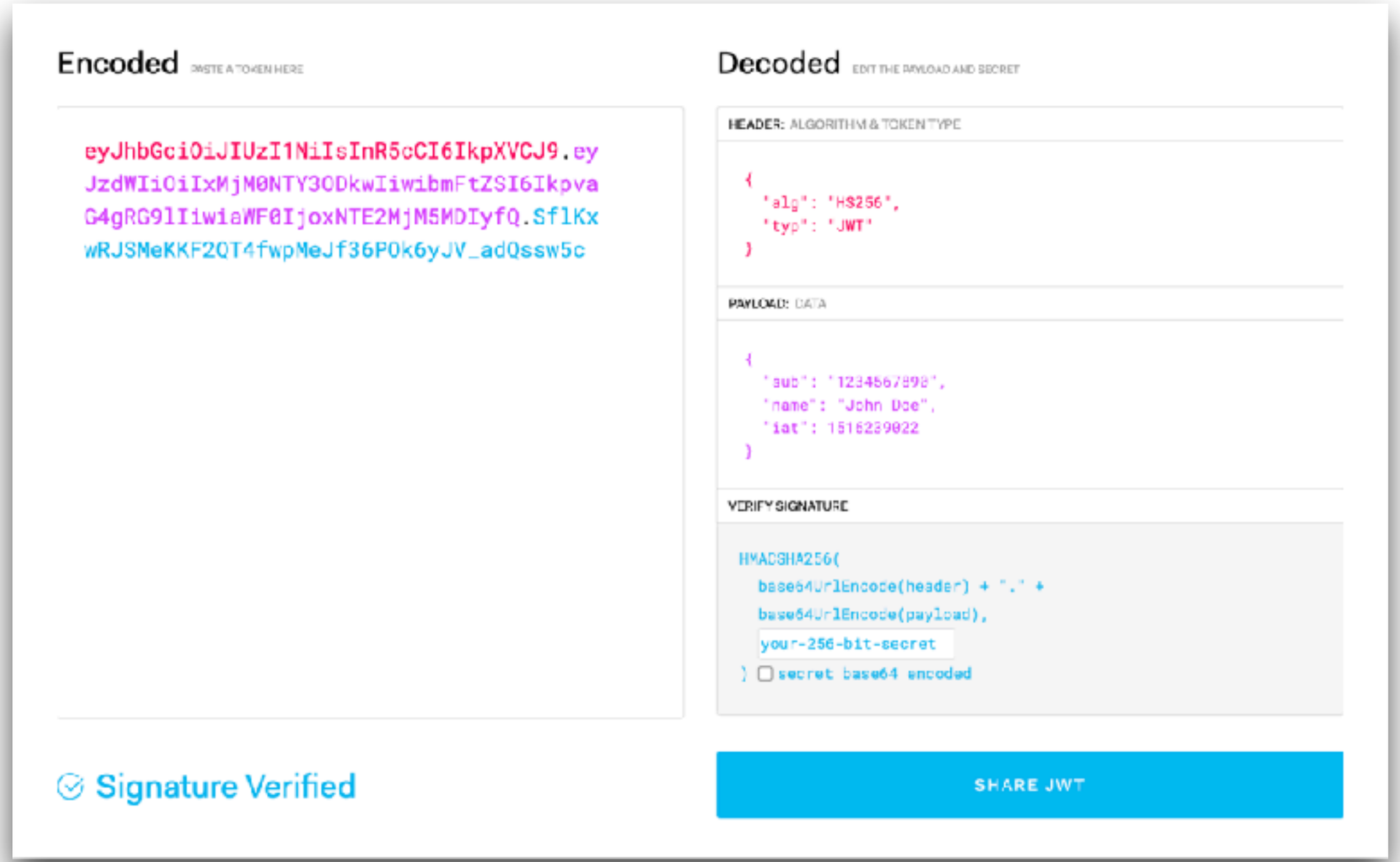
## Step 3 :: Access to protected services



# Flow diagram of call service

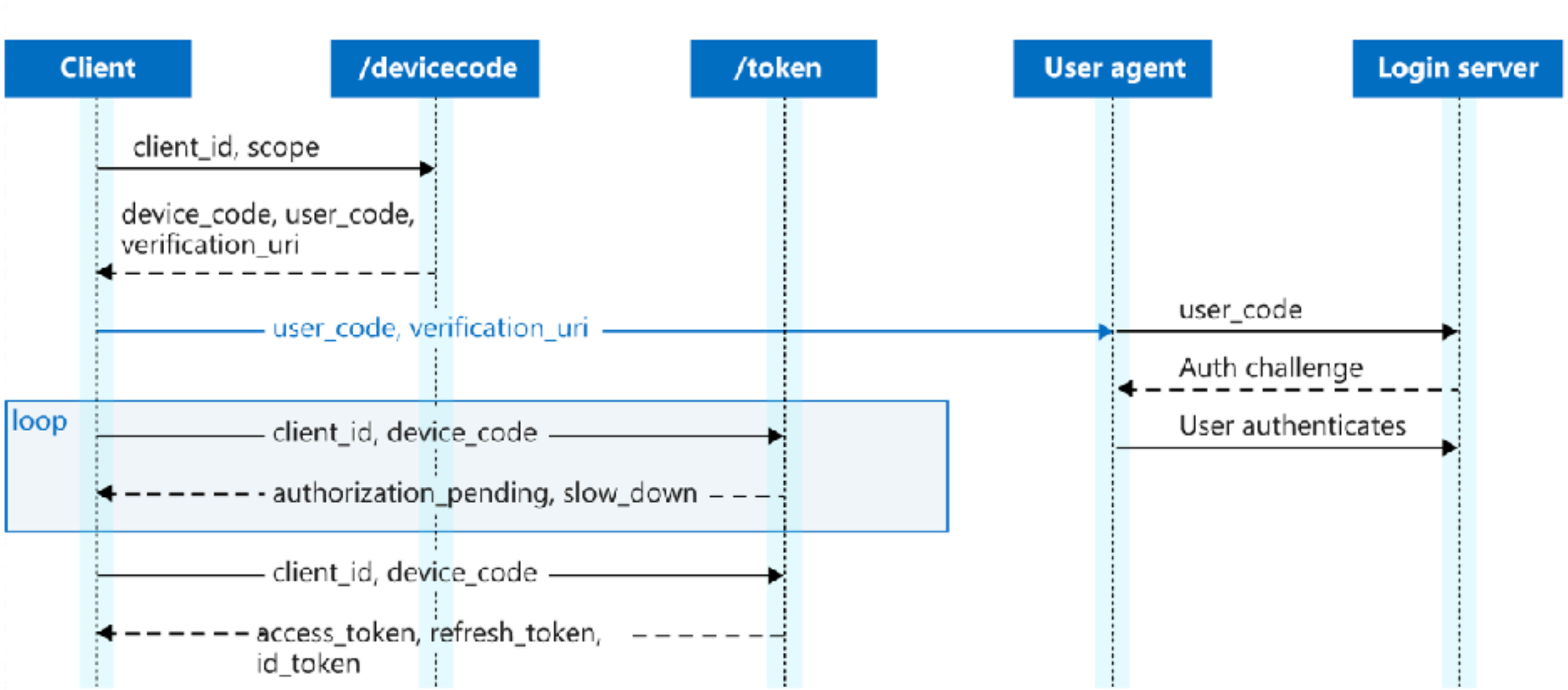


# JSON Web Tokens (JWT)




https://jwt.io/

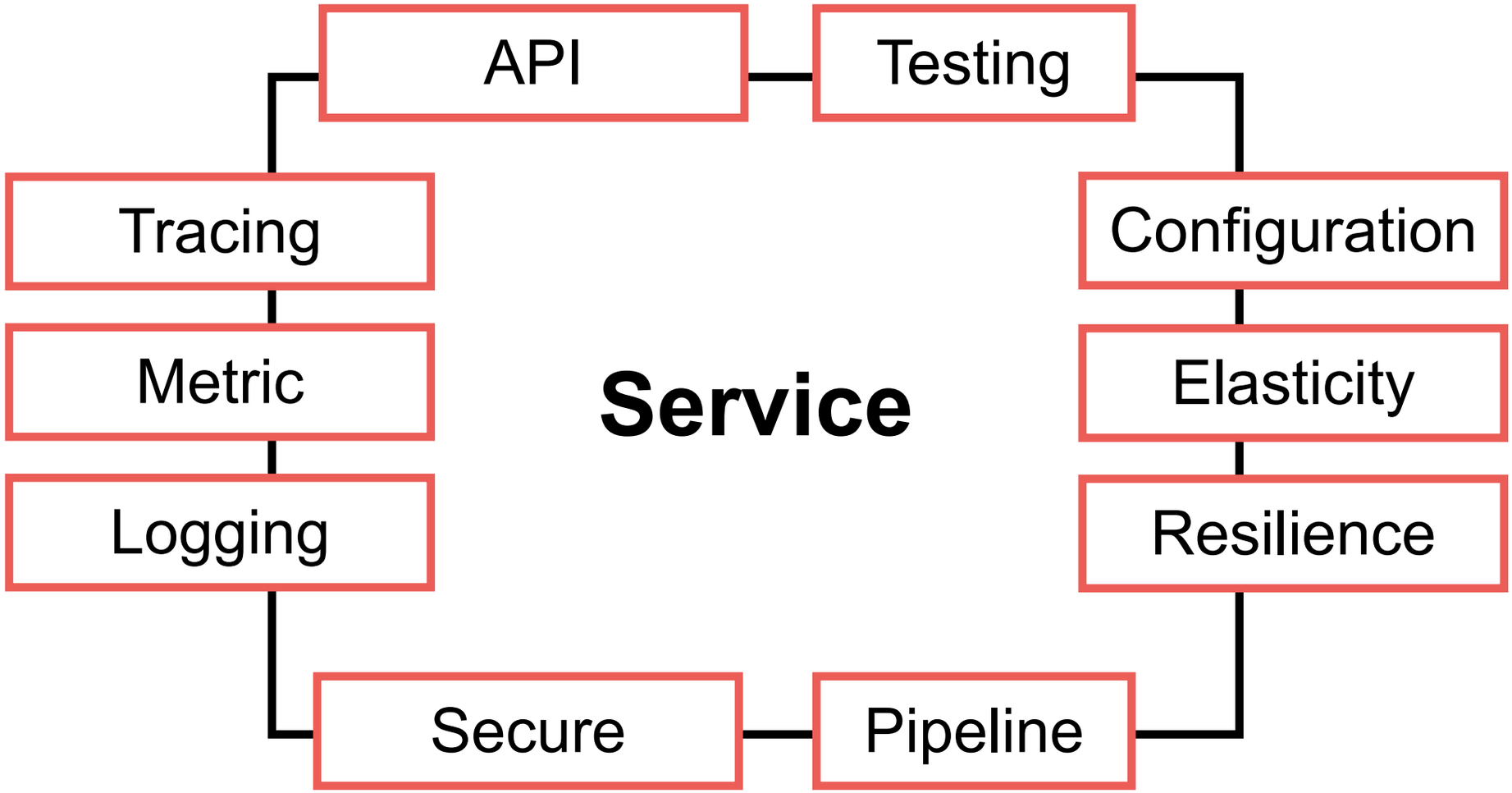
# Example



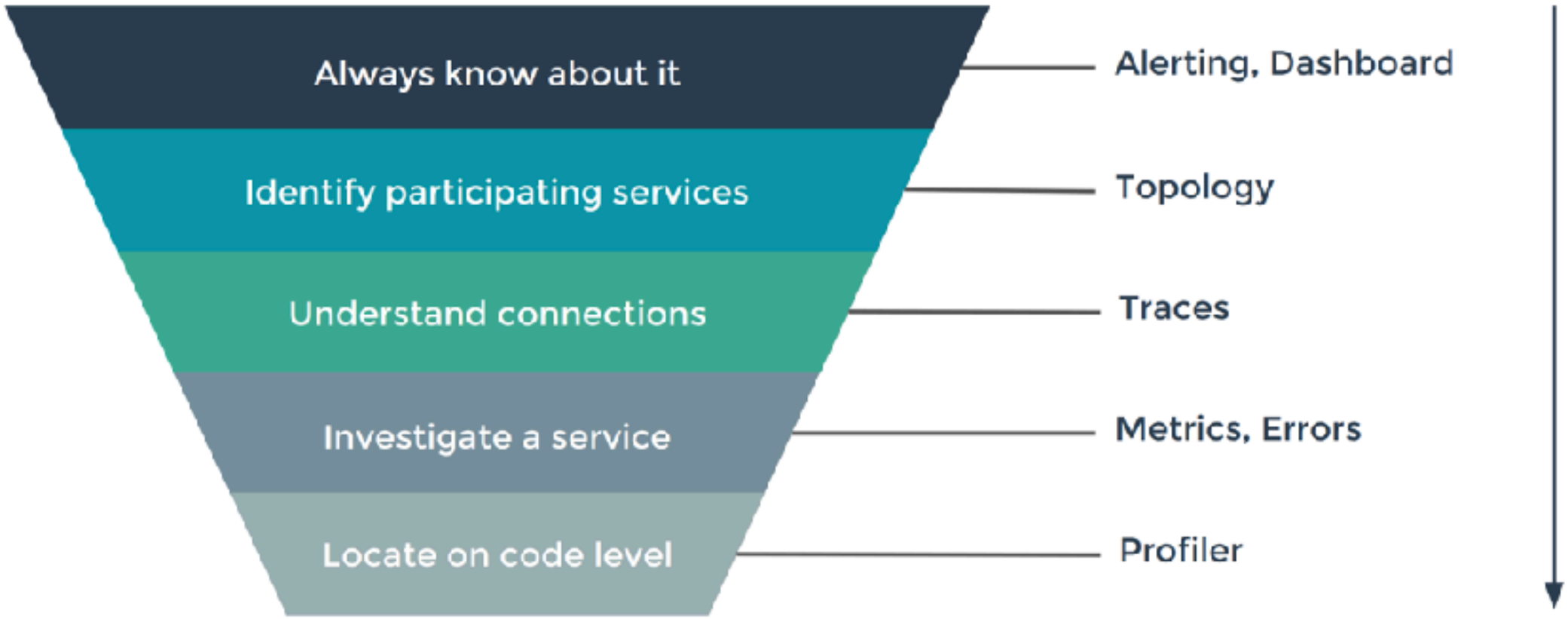

https://learn.microsoft.com/en-us/azure/active-directory/develop/v2-oauth2-device-code

# Observable Service

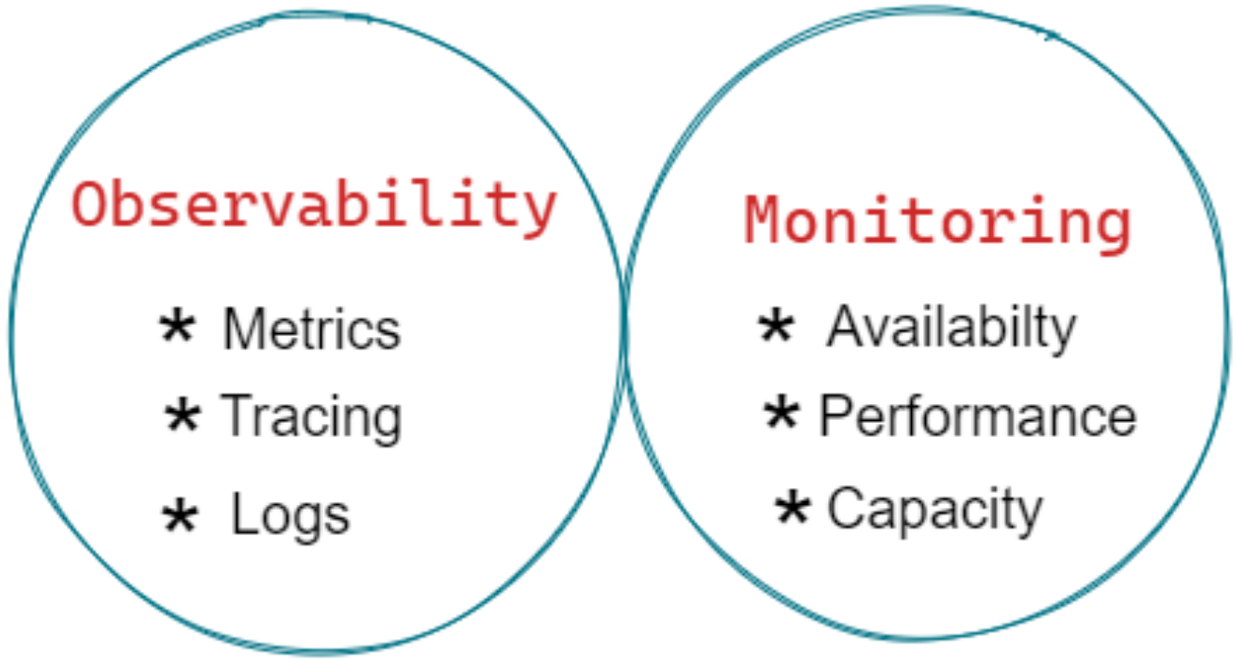
# Properties of Service



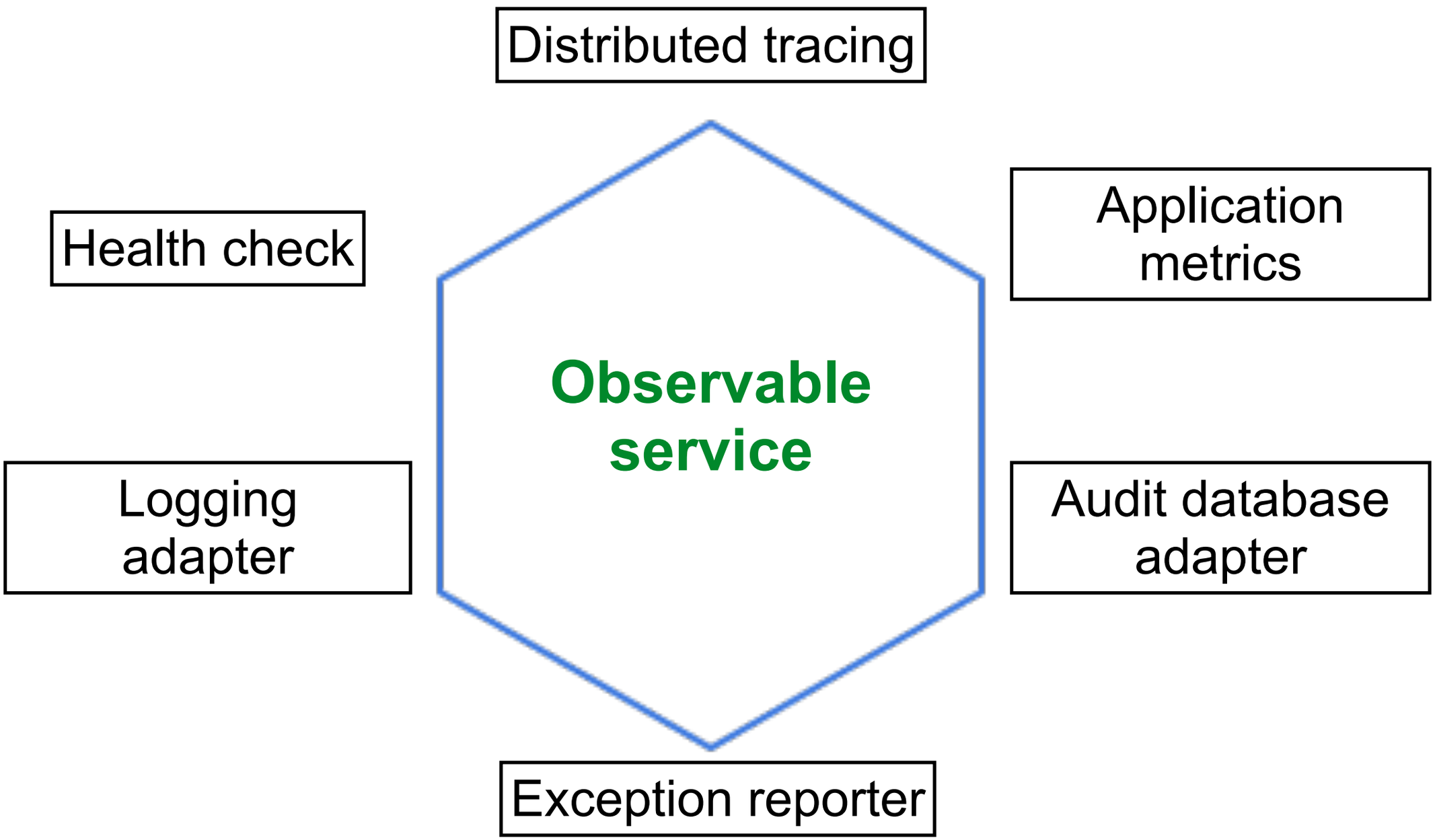
# How to find an issue ?



# Observability vs Monitoring

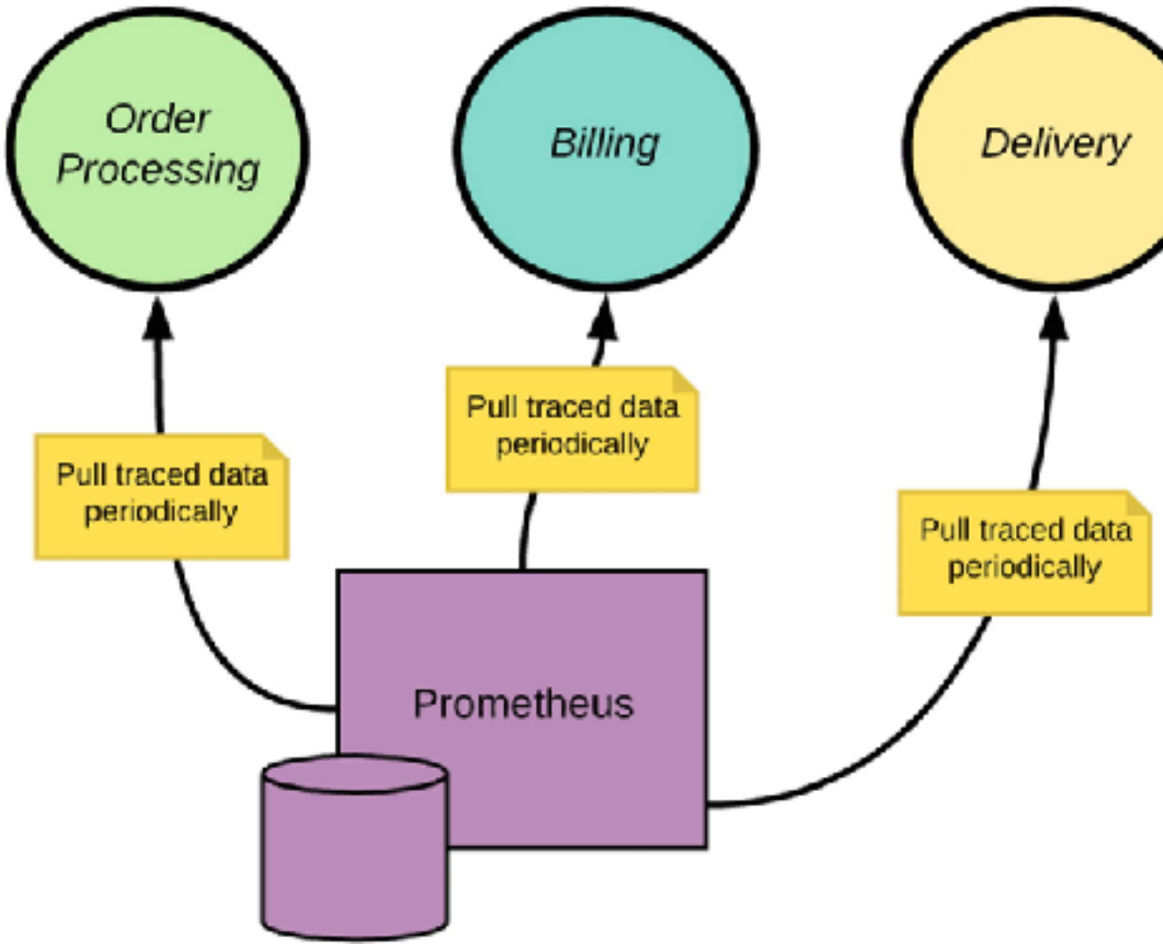


# Observable services

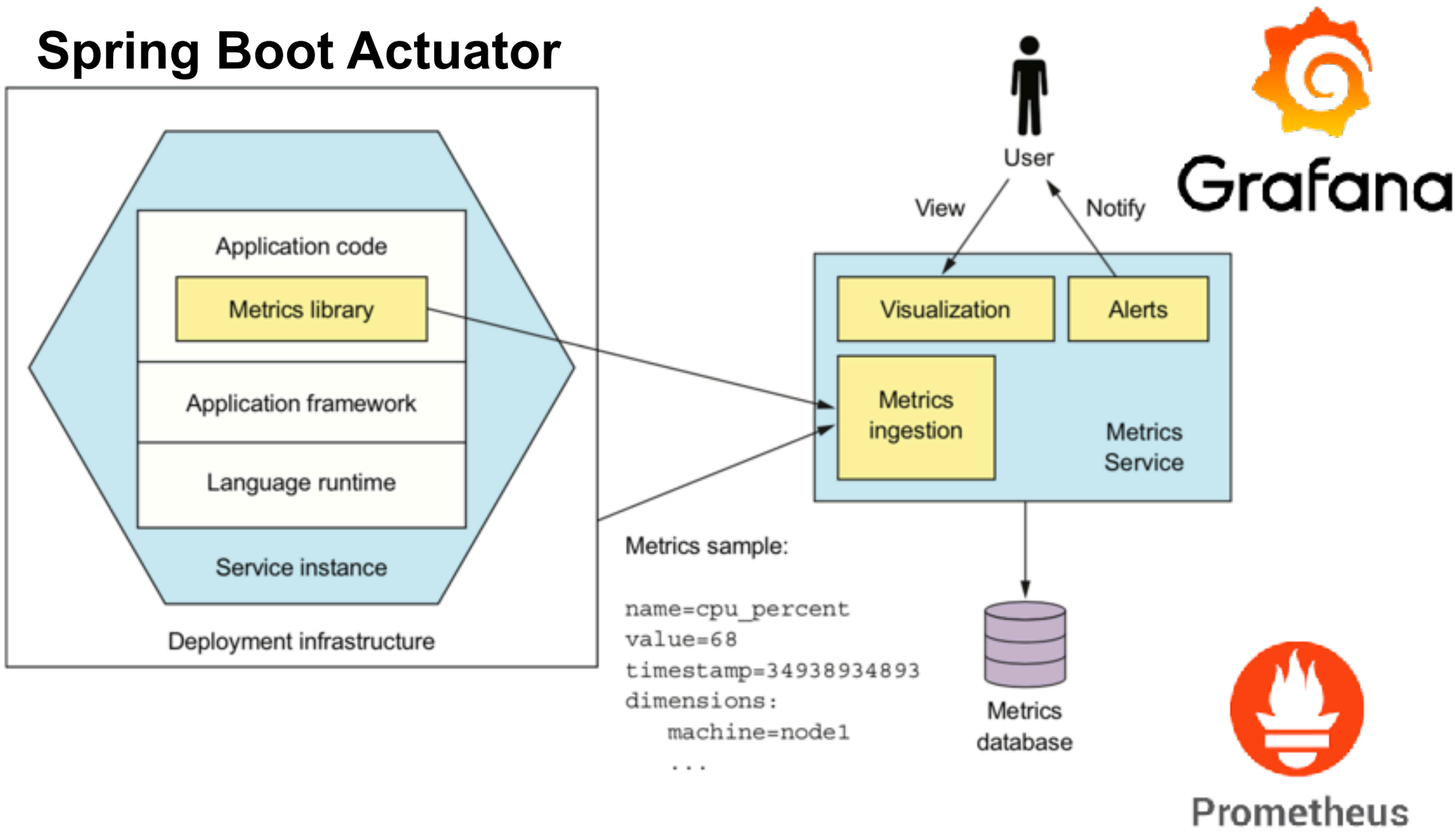


# Application metrics

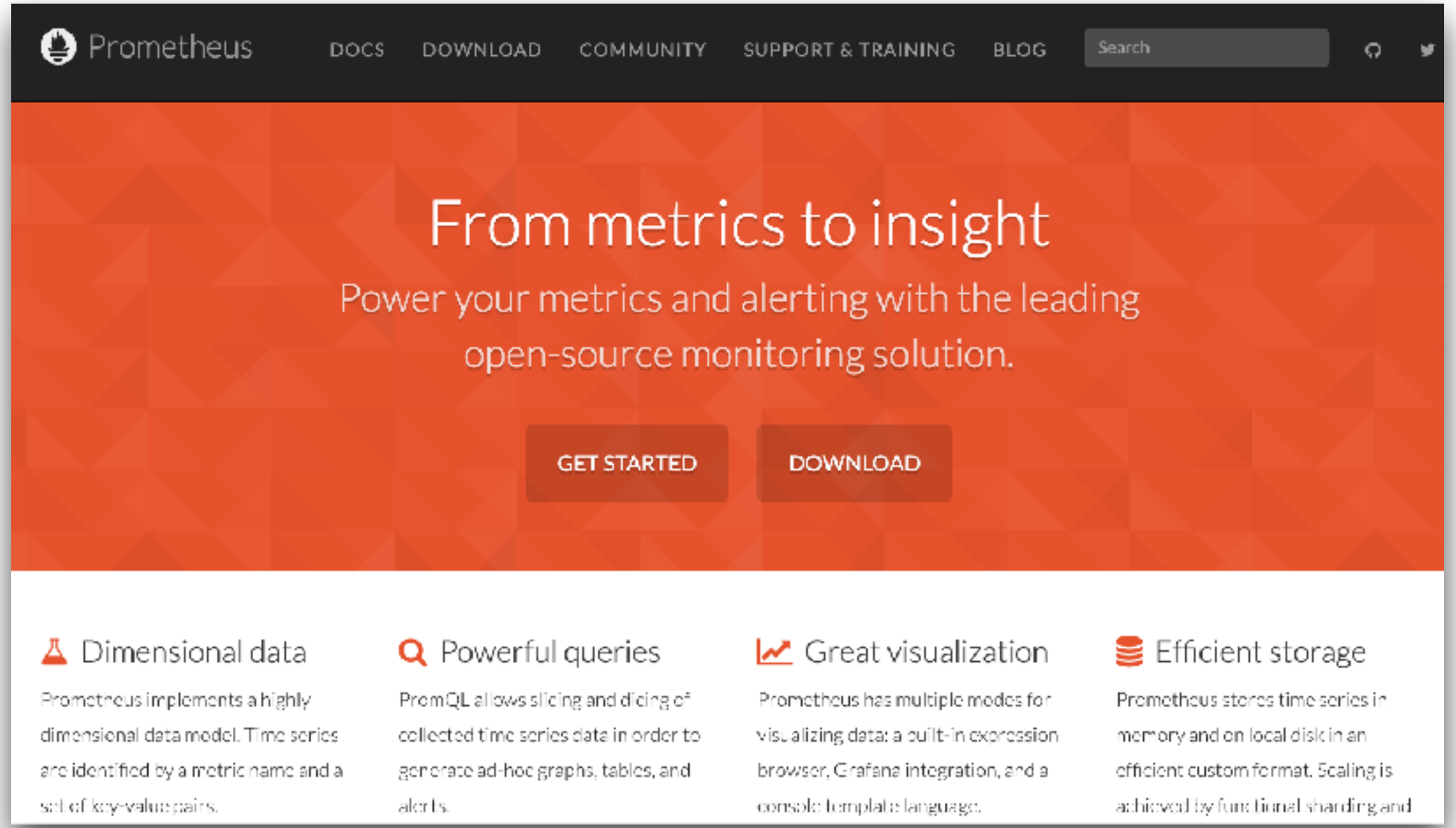
Services maintain metrics and expose to metric server (counters, gauges)



# Application metrics tools

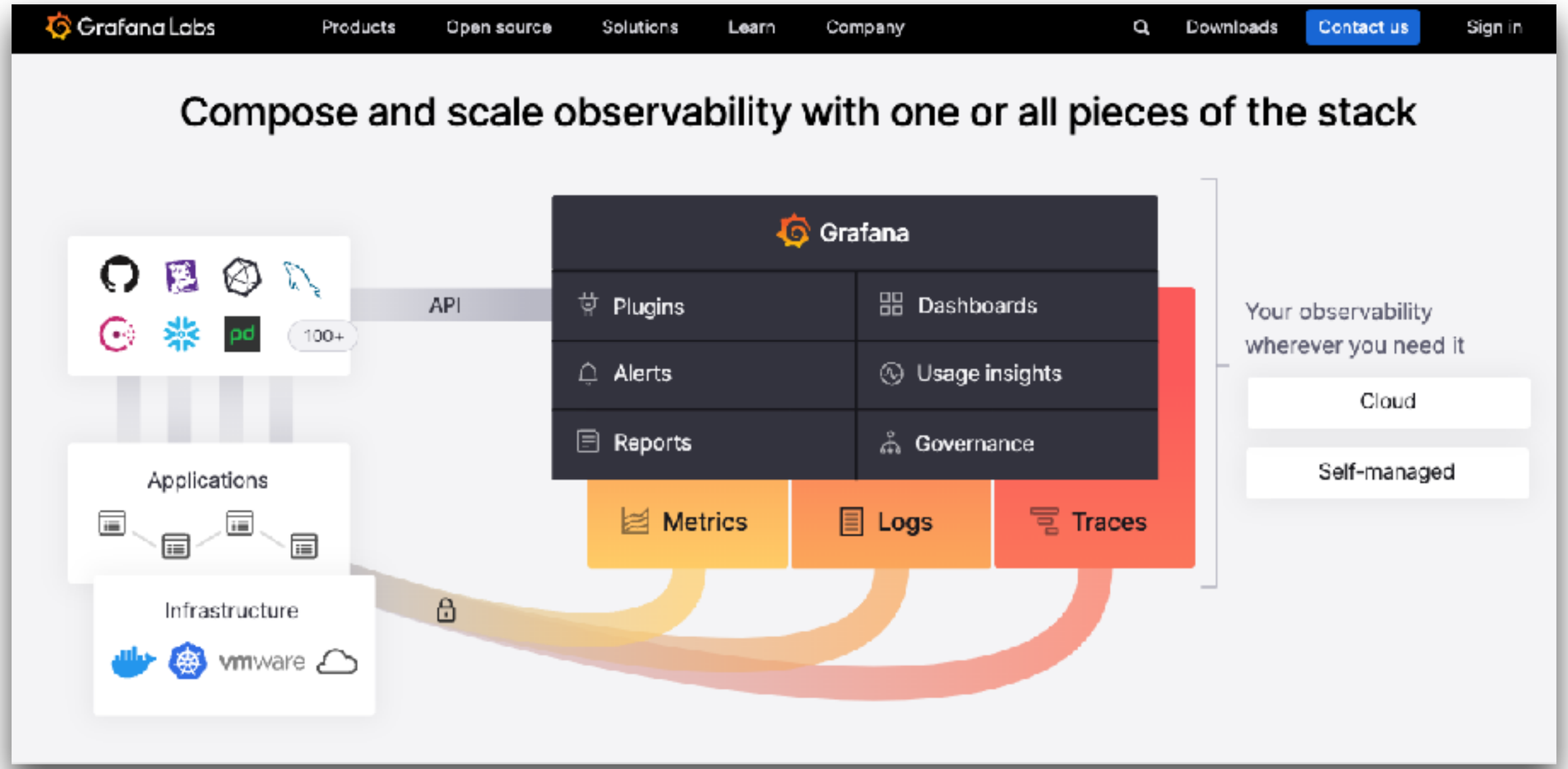


# Prometheus




https://prometheus.io/

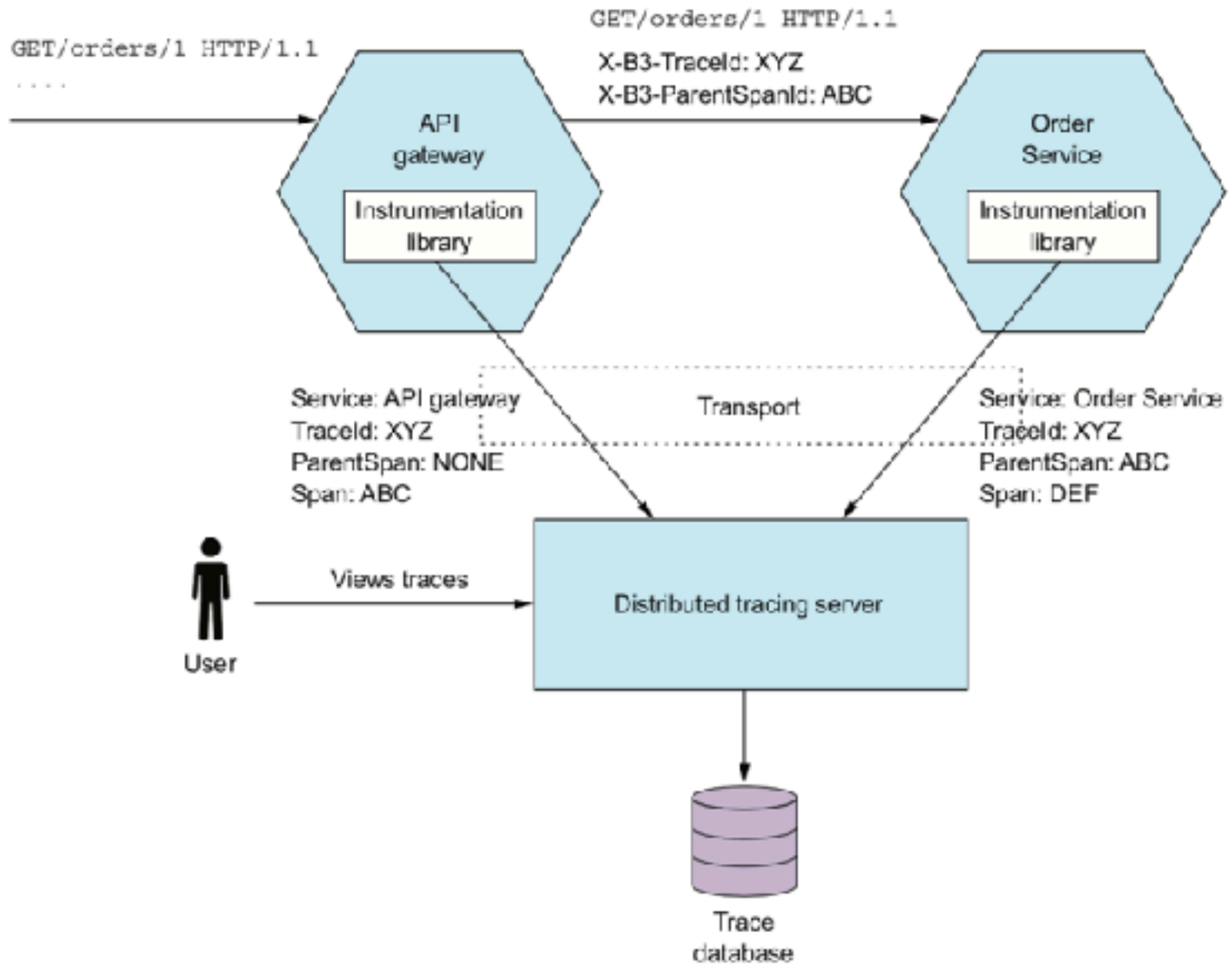
# Grafana




https://grafana.com/

# Distributed tracing

Assign each external request a **unique ID** and trace requests as flow between services



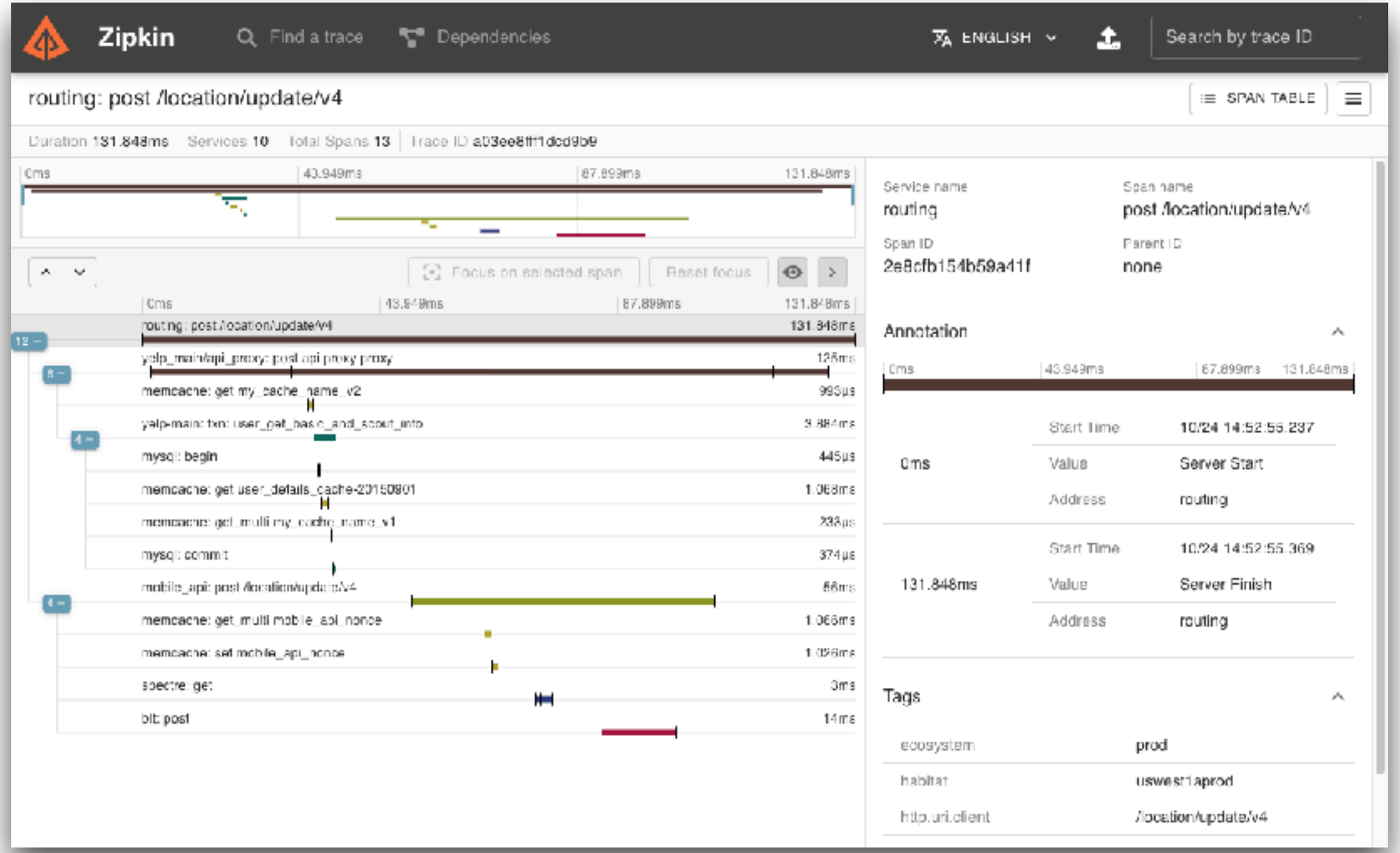
# Distributed tracing tools

Format standard with OpenTelemetry
Zipkin, Jaeger, Tempo, AWS X-Ray, Elastic APM


JAEGER

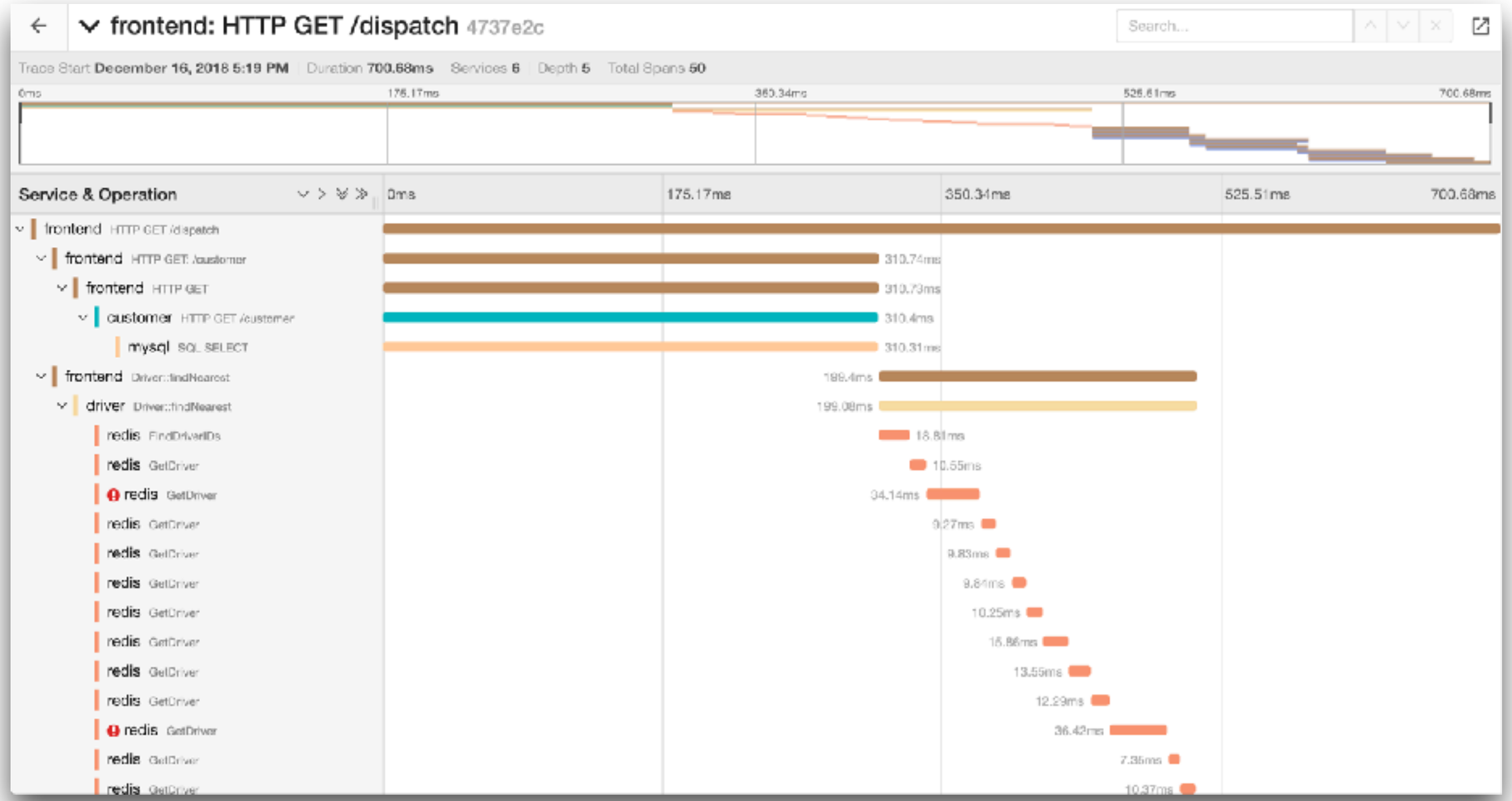
Grafana Tempo

# Zipkin




https://zipkin.io/

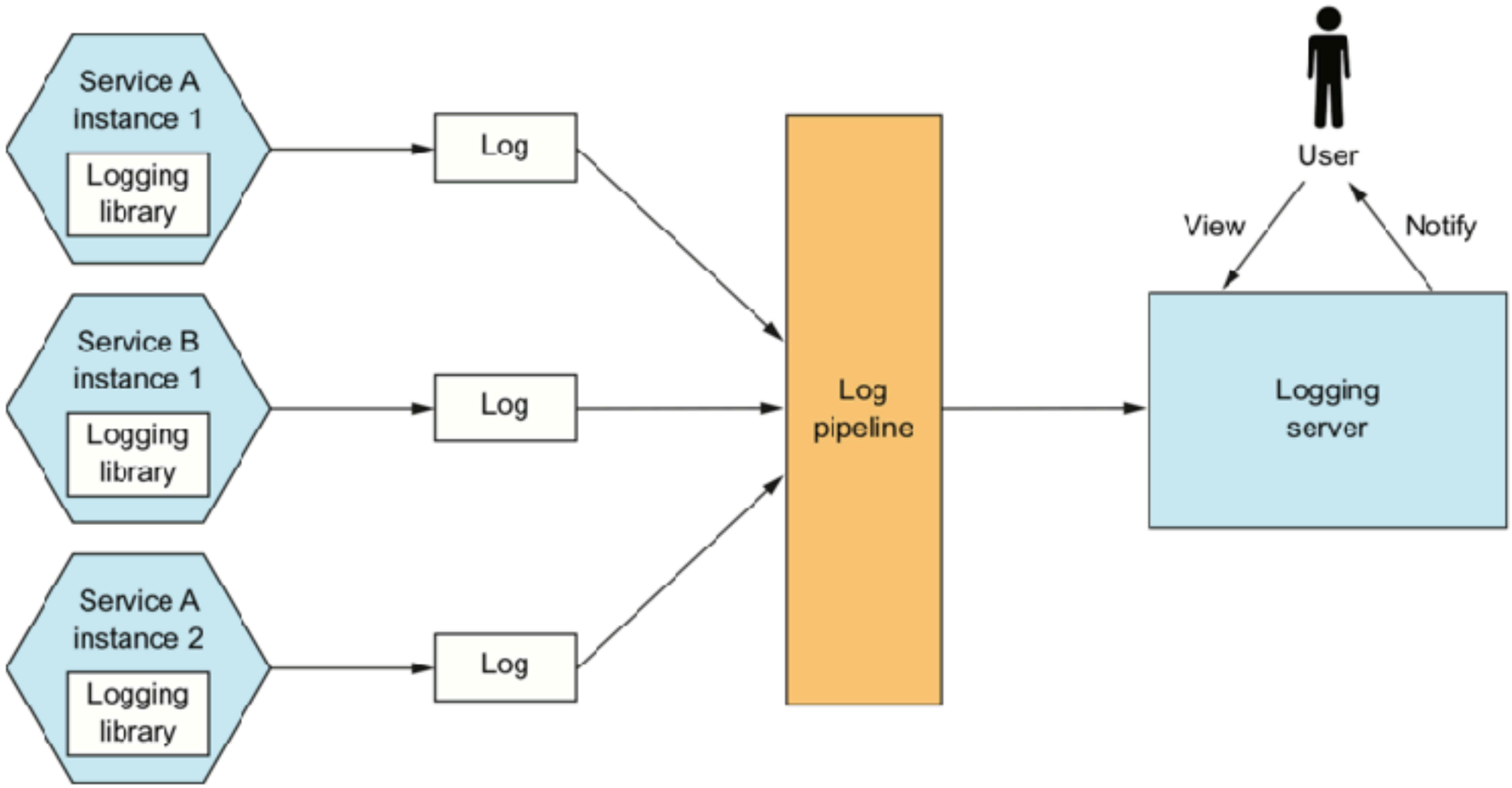
# Jaeger




https://www.jaegertracing.io

# Centralized logging

Log service activity and write logs into a centralized logging server. (searching, alerting)



# Effective Logging

Define event to log
Use structured logging
Exclude sensitive information
Log at the correct level
Be specific in your message
Don’t log large message
Make sure you keep trace Id in the log

https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Logging_Cheat_Sheet.md

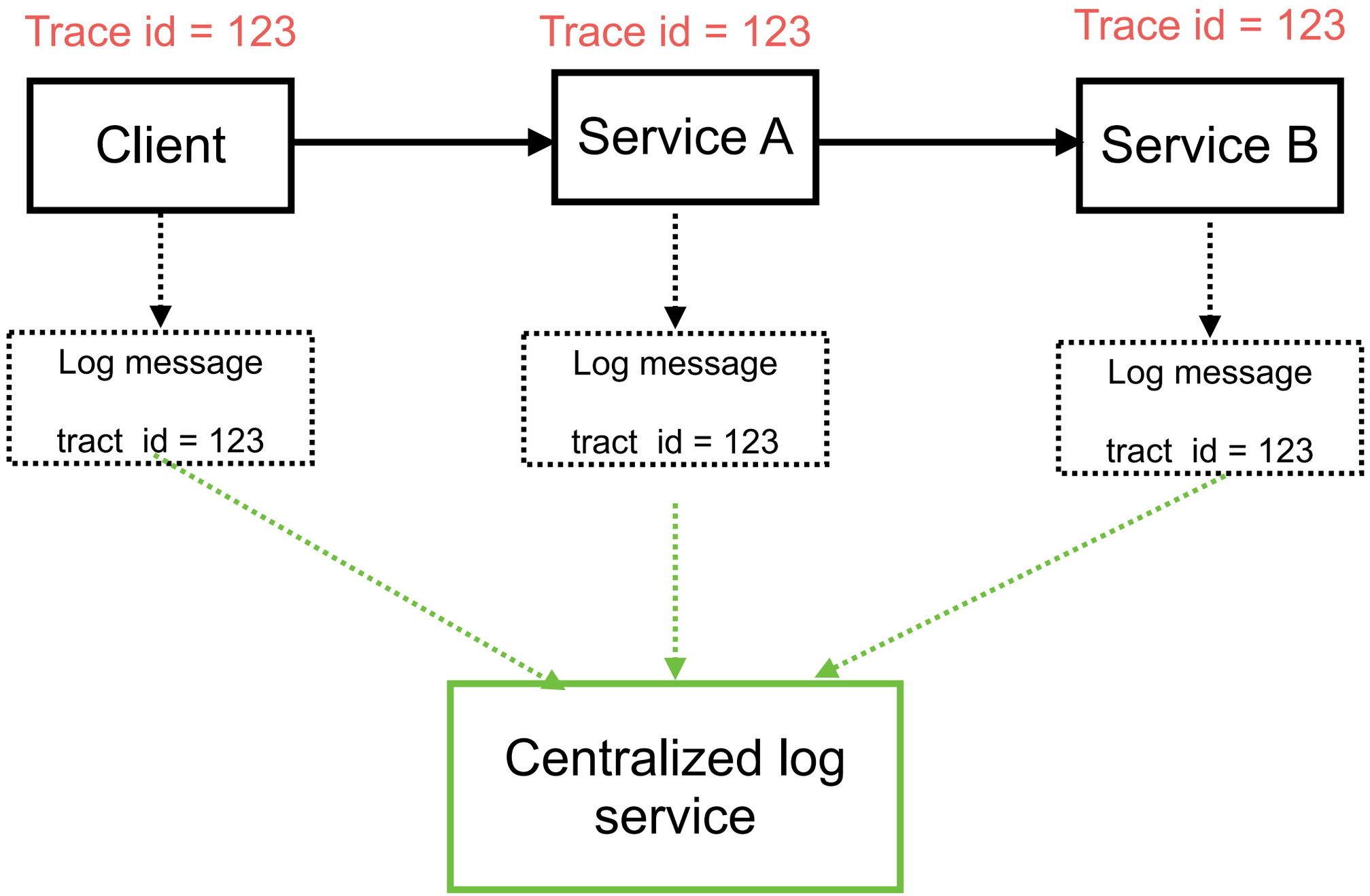
# Consistent Structure across all logs

| 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.ArithmeticException: 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
```

# Centralized logging



# Observable Service Workshop

Metric

Tracing

Logging

https://github.com/up1/demo-spring-observability

# Distributed Tracing



https://zipkin.io/

# Create project with Tracing

org.springframework.boot:spring-boot-starter-actuator
io.micrometer:micrometer-tracing-bridge-otel
io.opentelemetry:opentelemetry-exporter-zipkin

Actuator

Micrometer
Tracing Otel

Opentelemetry
zipkin exporter

https://docs.spring.io/spring-boot/docs/3.2.0/reference/html//actuator.html#actuator.micrometer-tracing

# Spring Boot 3.2.0

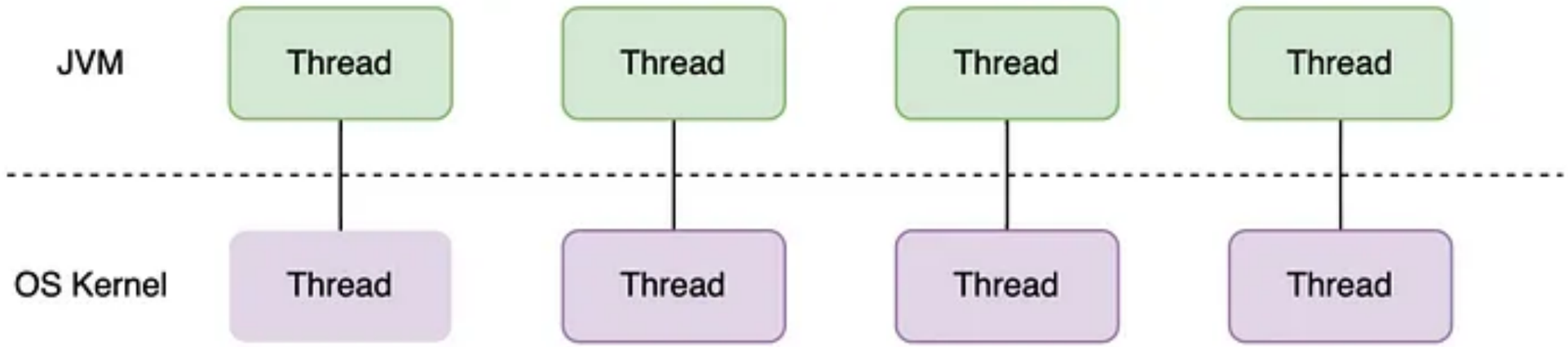
# Virtual Threads

https://openjdk.org/jeps/425

https://spring.io/blog/2023/09/09/all-together-now-spring-boot-3-2-graalvm-native-images-java-21-and-virtual

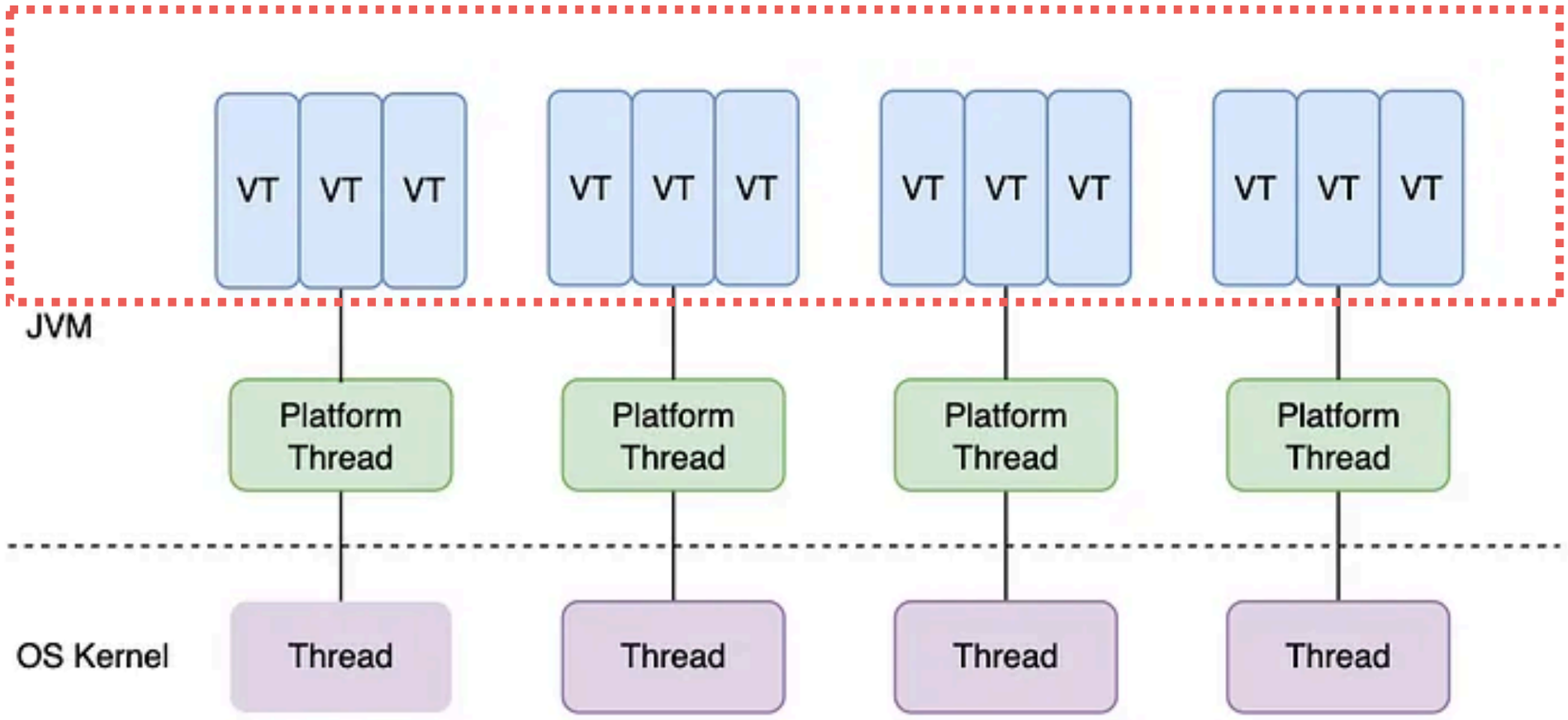
# Java Threads

## Thread pools



# Support Virtual Threads

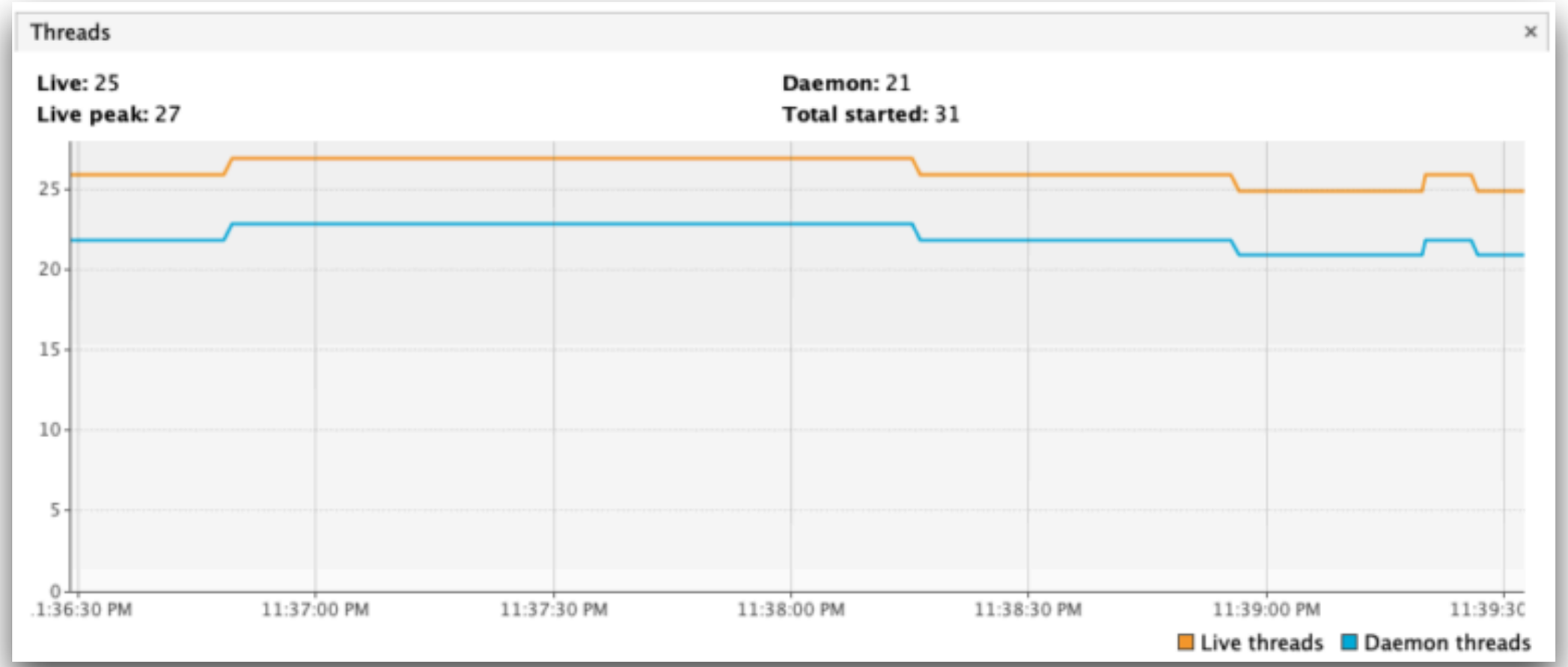
## Thread pools



# Enable Virtual Thread in Spring Boot

## application.properties

```
spring.threads.virtual.enabled=true
```



# Spring Boot 3.2.0

# GraalVM native image support

https://www.graalvm.org/

https://docs.spring.io/spring-boot/docs/current/reference/html/native-image.html

spring initializr

**Project**
- Gradle - Groovy
- Gradle - Kotlin
- Maven

**Language**
- Java
- Kotlin
- Groovy

**Spring Boot**
- 3.2.1 (SNAPSHOT)
- 3.2.0
- 3.1.7 (SNAPSHOT)
- 3.1.6

**Project Metadata**

| | |
|---|---|
| Group | com.example |
| Artifact | demo |
| Name | demo |
| Description | Demo project for Spring Boot |
| Package name | com.example.demo |
| Packaging | Jar / War |
| Java | 21 / 17 |

**Dependencies** ADD DEPENDENCIES... ⌘ + B

**Spring Web** WEB
Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.

**GraalVM Native Support** DEVELOPER TOOLS
Support for compiling Spring applications to native executables using the GraalVM native-image compiler.

https://start.spring.io/

# Spring Boot 3.2.0

# Docker compose

https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#features.docker-compose

spring initializr

**Project**
- Gradle - Groovy
- Gradle - Kotlin
- Maven

**Language**
- Java
- Kotlin
- Groovy

**Spring Boot**
- 3.2.1 (SNAPSHOT)
- 3.2.0
- 3.1.7 (SNAPSHOT)
- 3.1.6

**Project Metadata**

| | |
|---|---|
| Group | com.example |
| Artifact | demo |
| Name | demo |
| Description | Demo project for Spring Boot |
| Package name | com.example.demo |
| Packaging | Jar / War |
| Java | 21 / 17 |

**Dependencies** ADD DEPENDENCIES... ⌘ + B

**Docker Compose Support** DEVELOPER TOOLS
Provides docker compose support for enhanced development experience.

**Testcontainers** TESTING
Provide lightweight, throwaway instances of common databases, Selenium web browsers, or anything else that can run in a Docker container.

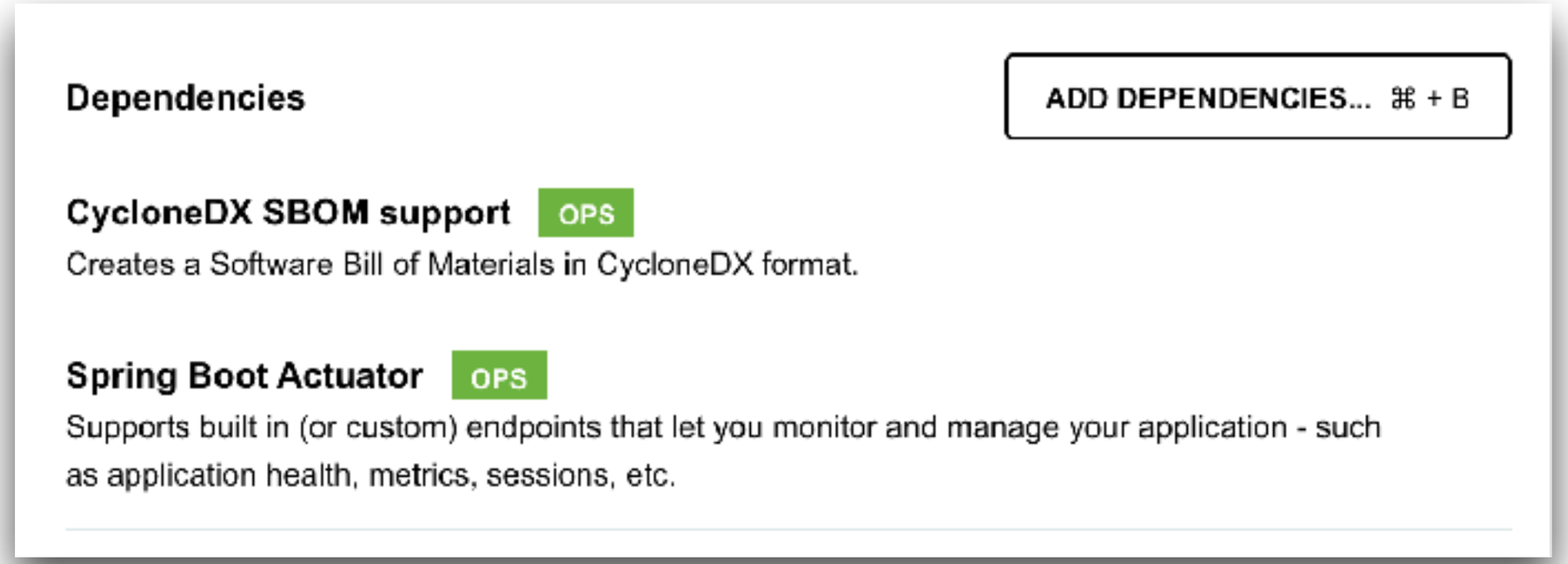
https://github.com/up1/demo-spring-docker-compose

# Spring Boot 3.3.0

# SBOM (Software Bill of Materials)

https://spring.io/blog/2024/05/24/sbom-support-in-spring-boot-3-3

# Enable SBOM in project



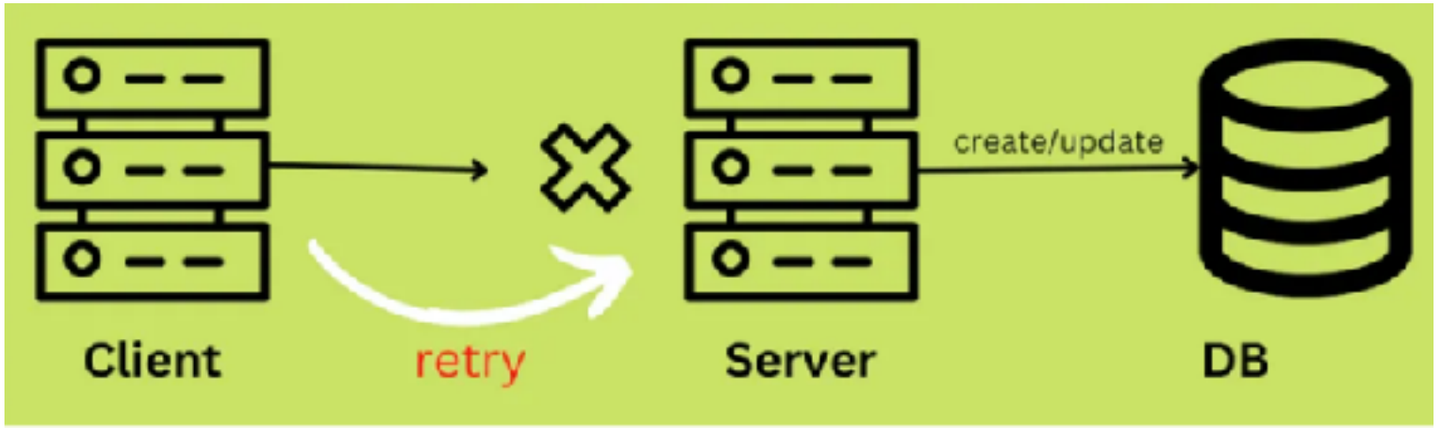

## application.properties

```
management.endpoints.web.exposure.include=health,sbom
```

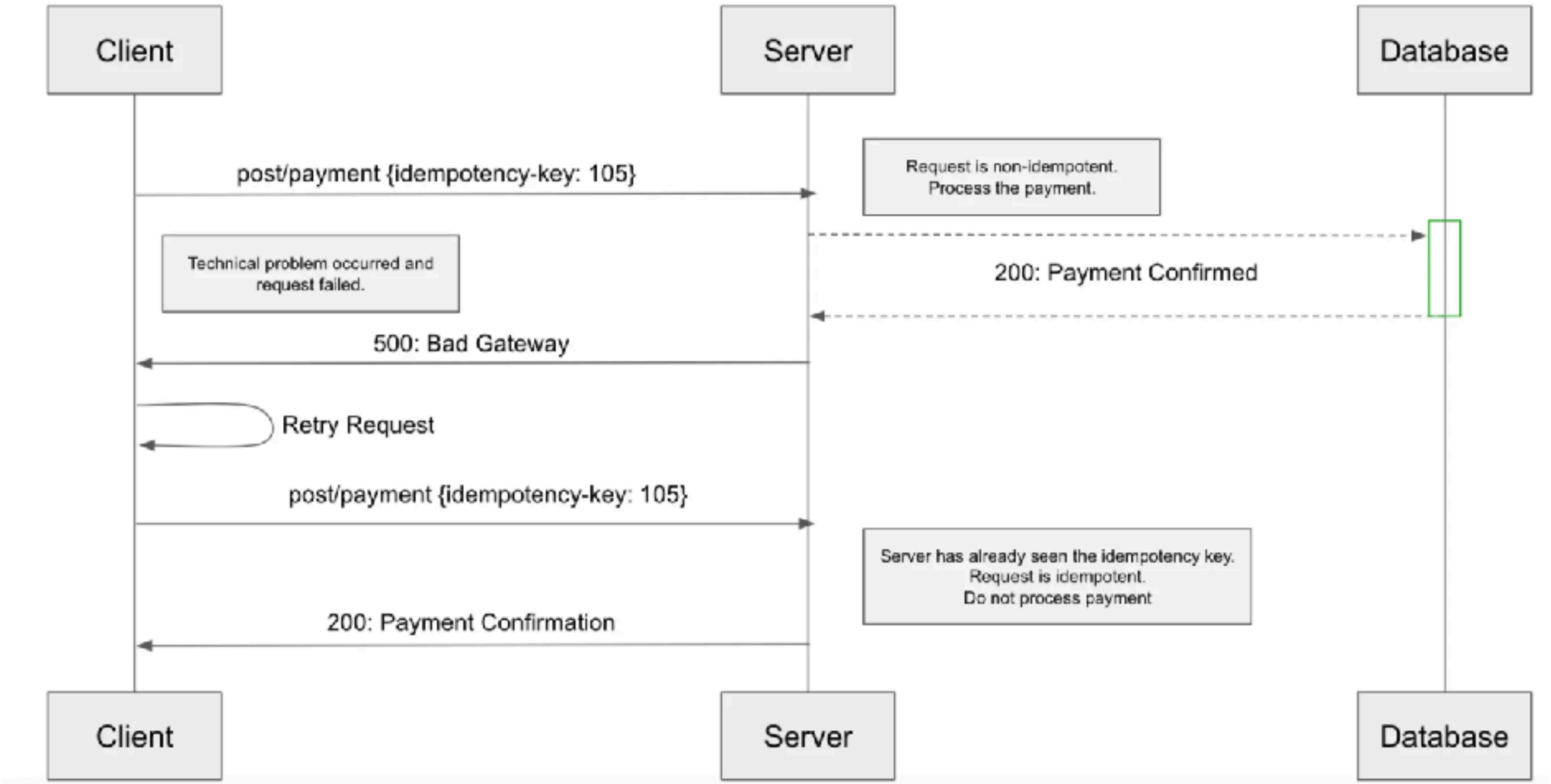
# Build project

$mvnw clean package

# Idempotent for APIs



# Flow of Payment API



# Q/A

# Spring Boot 3.4.0

# Next ...