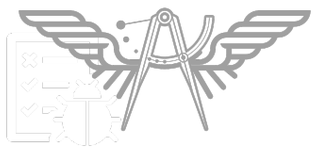
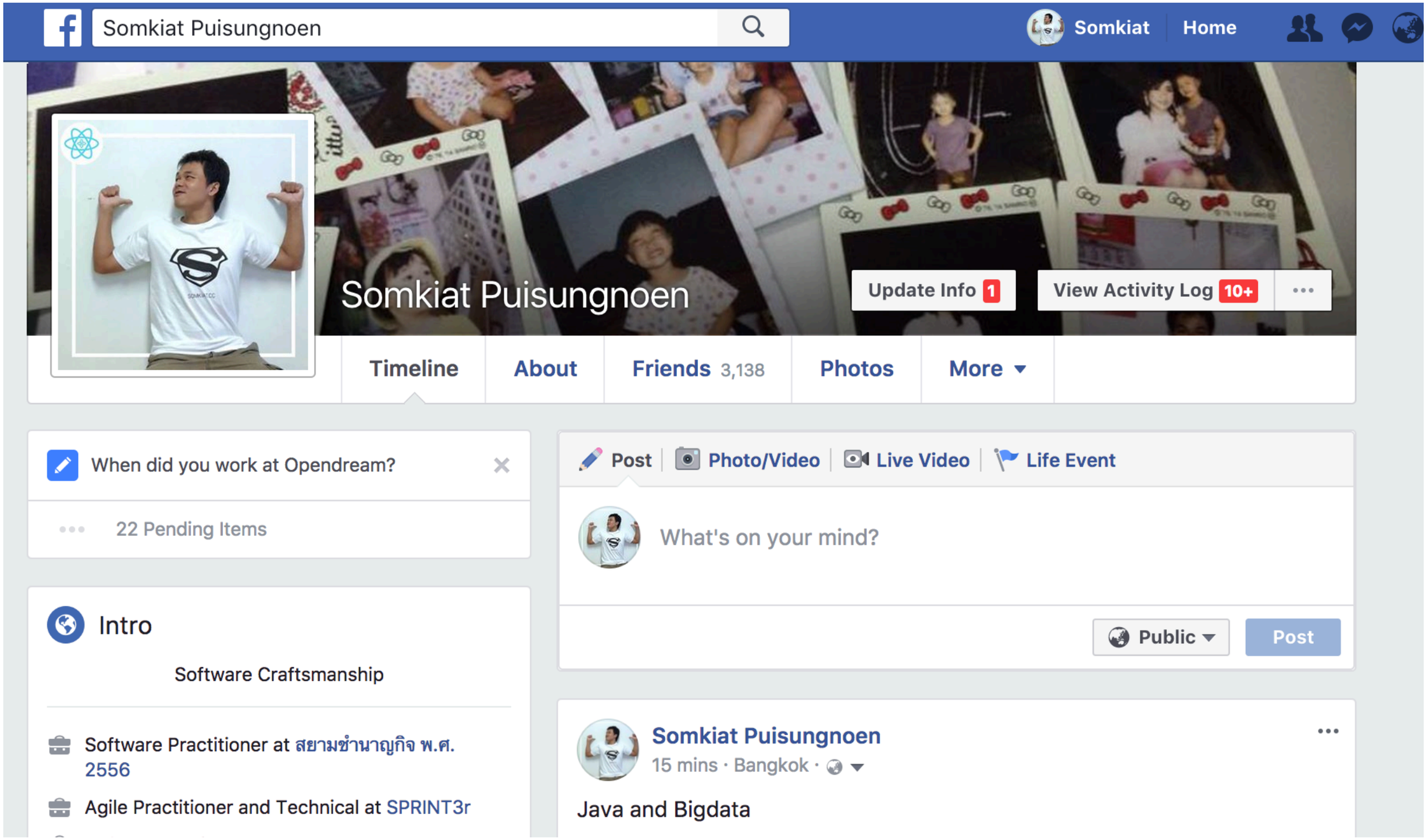
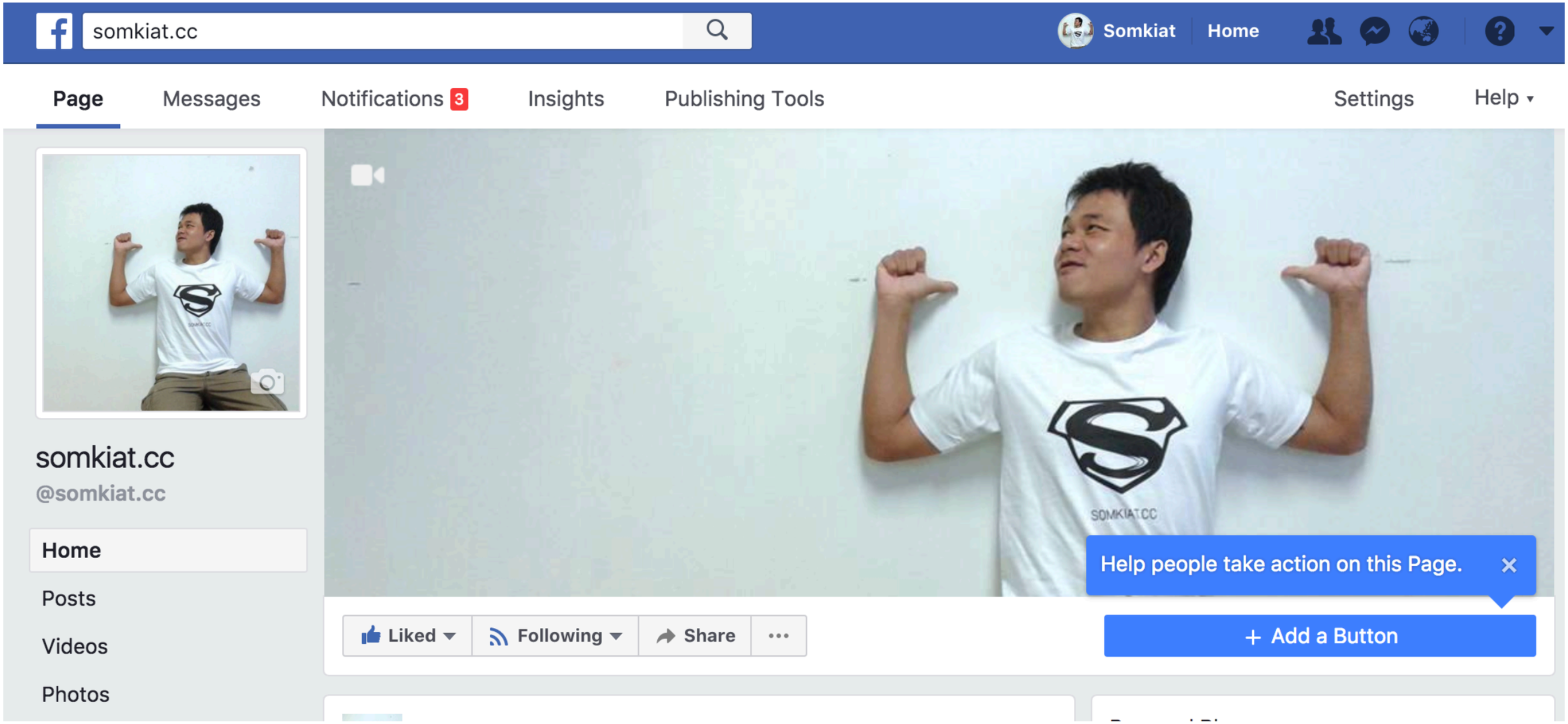
สยามชำนาญกิจ
SIAM CHAMNAN KIT

Test-Driven Development (TDD)
Spring Framework







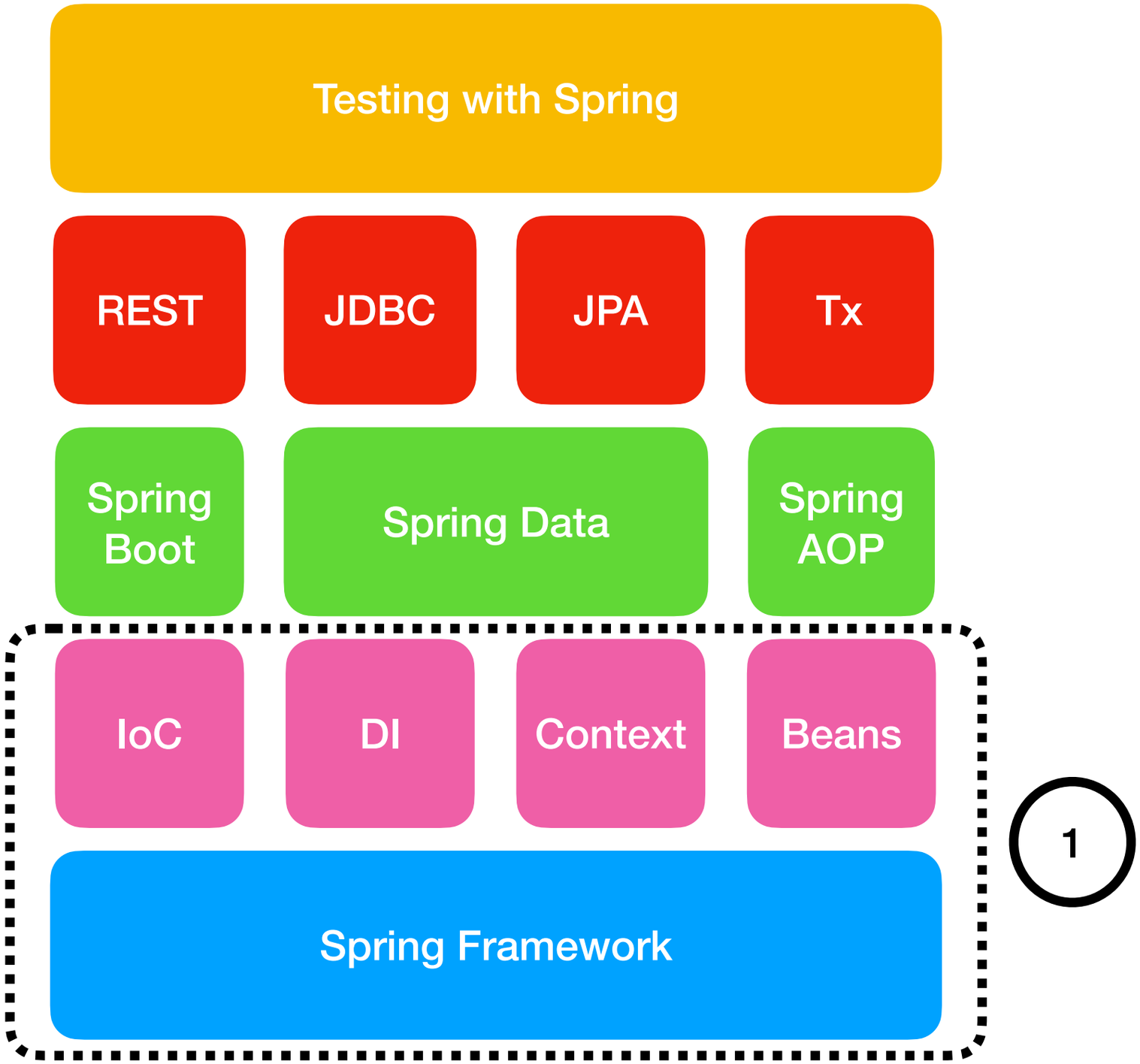
Agenda

Day 1 (Spring Framework)

Agenda

Introduction to Spring framework
Dependency Injection (DI)
Inversion of Control (IoC)
Spring Context and Bean
How to build project with Spring ?
Spring Configuration
Why we need Spring framework ?
Spring Modules and Project
SOLID for Object-Oriented Design

Workshop

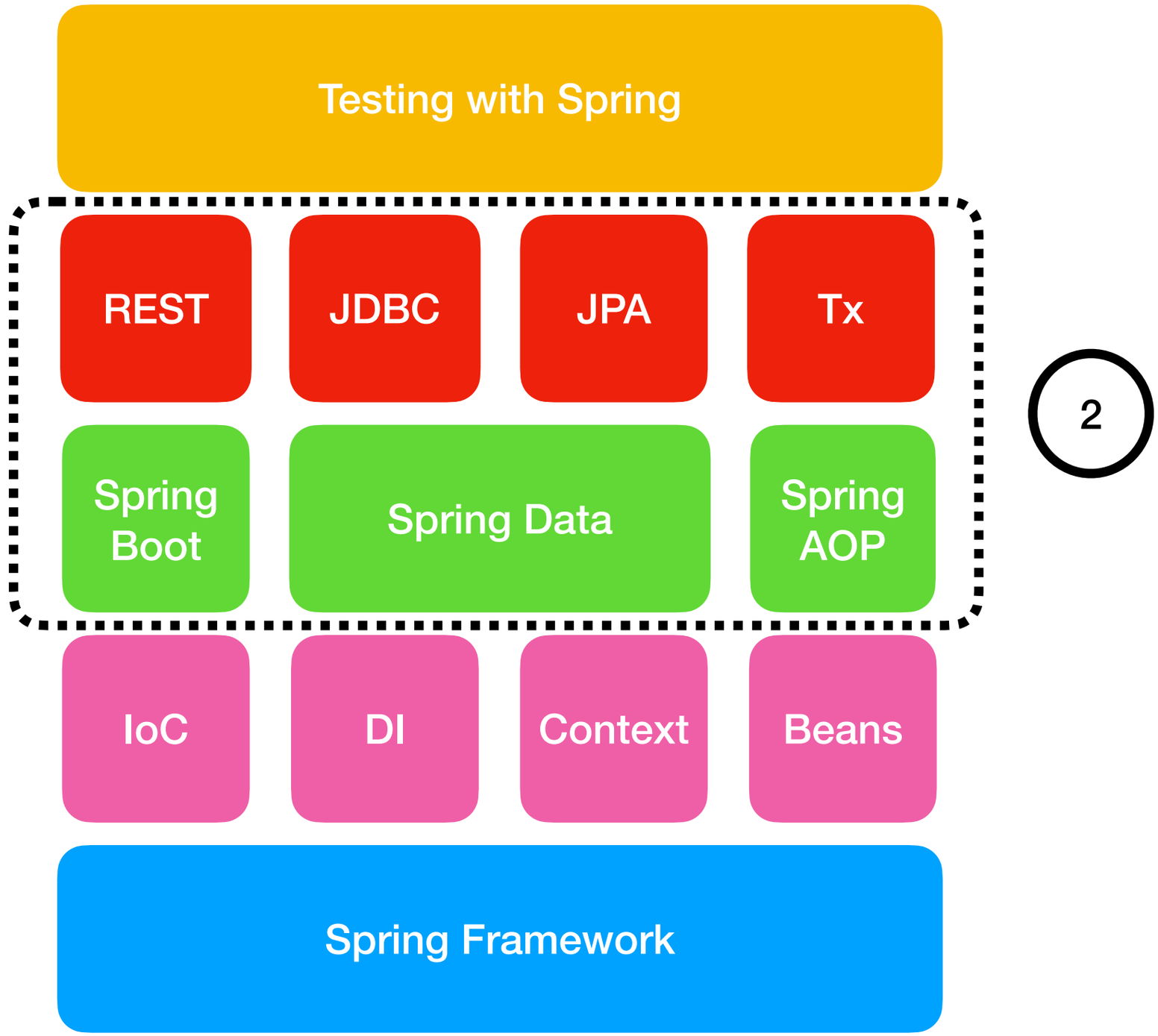


Day 2 (Spring Boot)

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)
Manage transaction

Workshop



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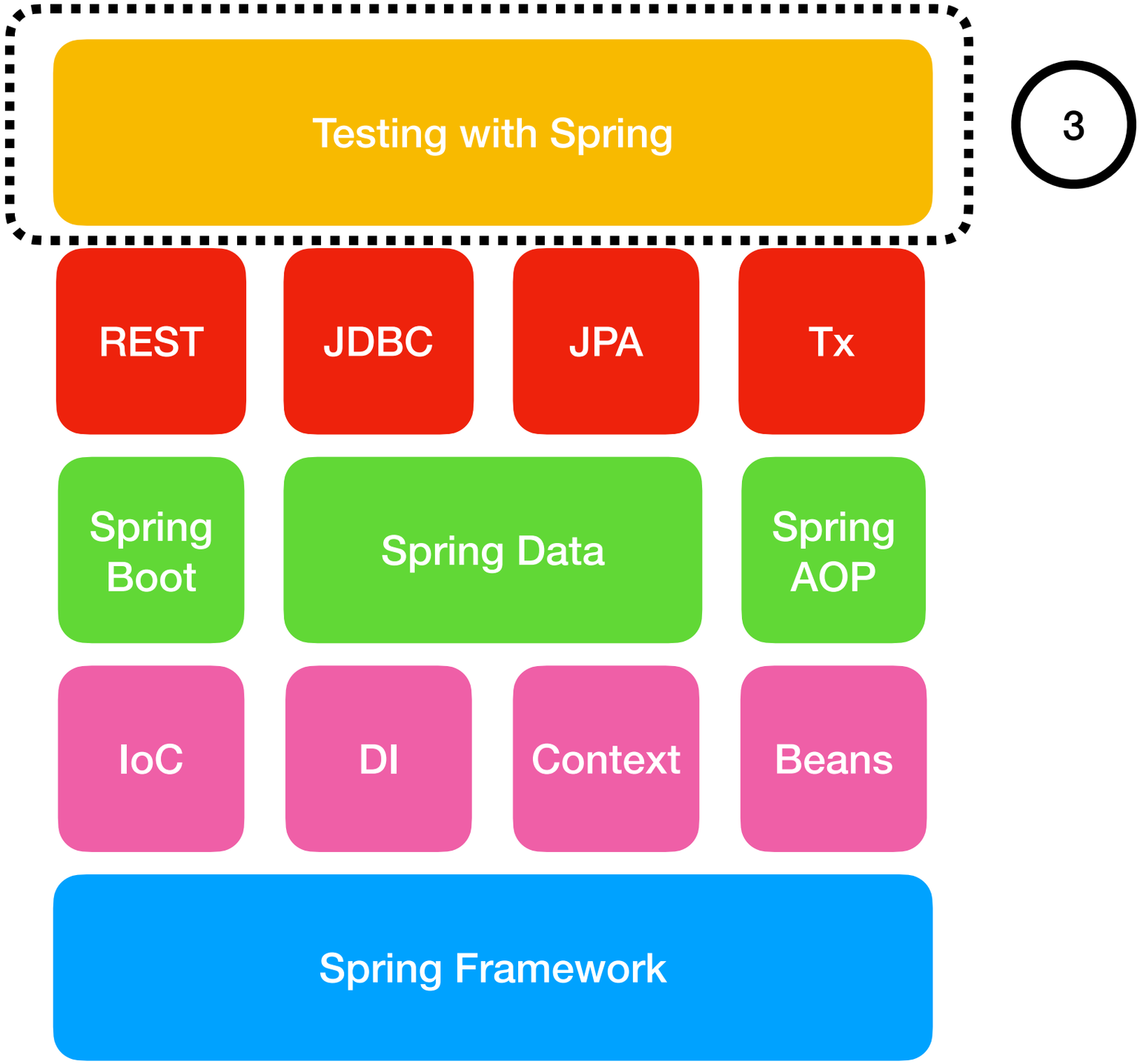
Day 3 (Spring Testing, TDD)

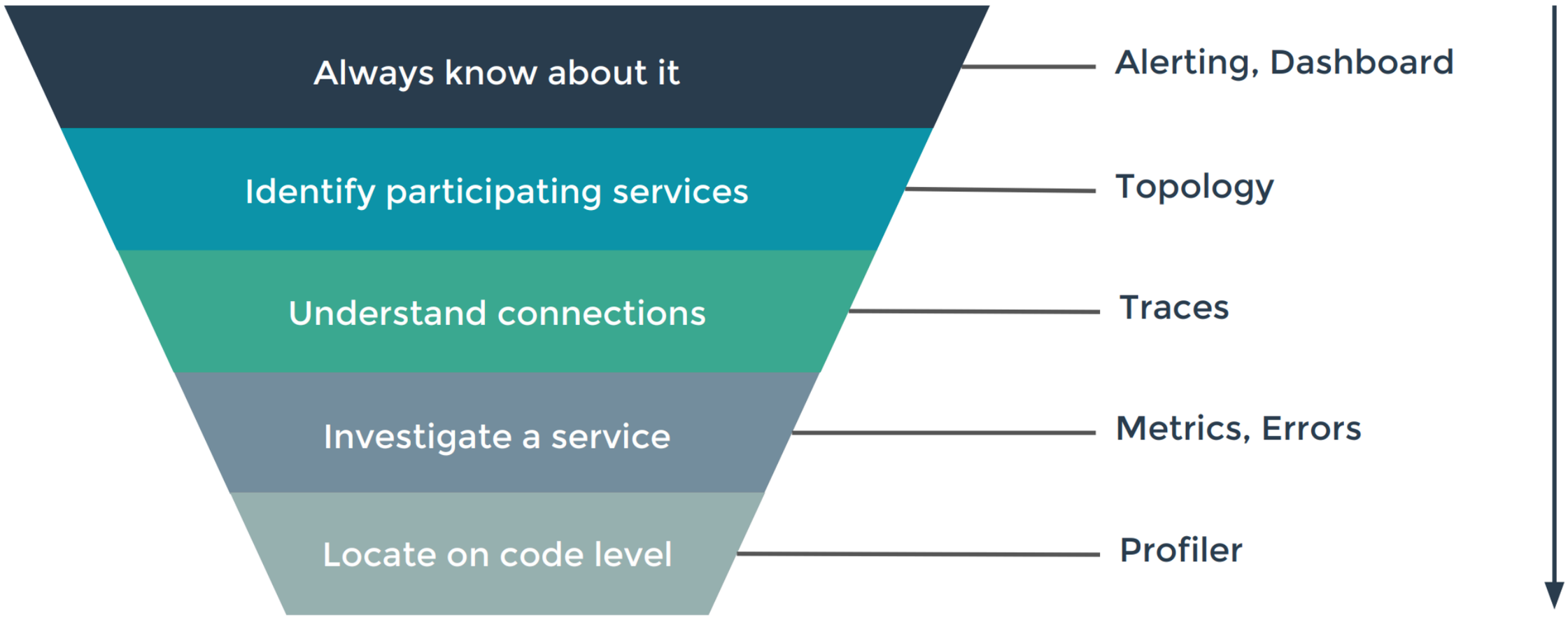
Agenda

Test-Driven Development (TDD)
Testing with Spring Boot
Controller testing
Service testing
Repository testing
Test double (Stub, Spy and Mocking)
Learn JUnit and Mockito
Code coverage

Workshop

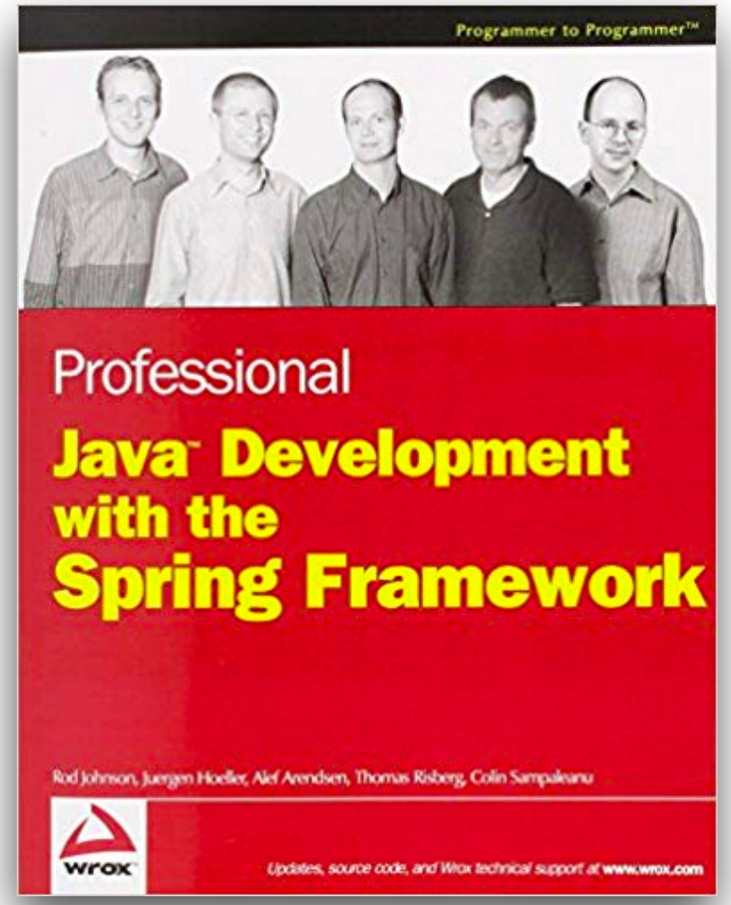


Workshop



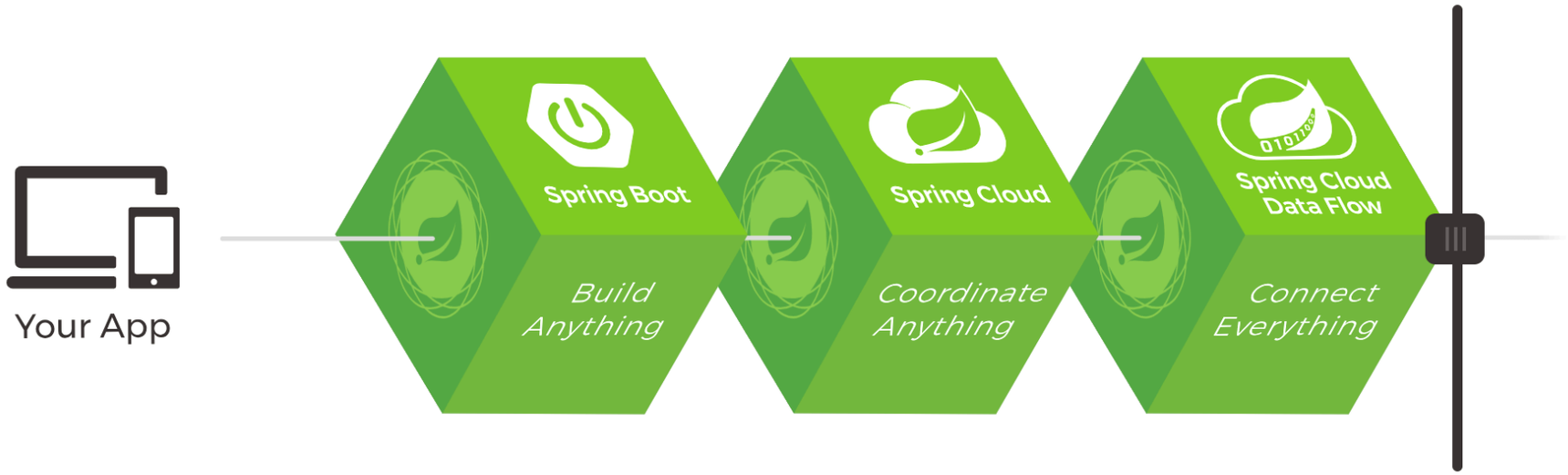
Introduction to Spring Framework

History



Spring ?

Spring: the source for modern java



Spring Boot

BUILD ANYTHING

Spring Boot is designed to get you up and running as quickly as possible, with minimal upfront configuration of Spring. Spring Boot takes an opinionated view of building production-ready applications.

Spring Cloud

COORDINATE ANYTHING

Built directly on Spring Boot's innovative approach to enterprise Java, Spring Cloud simplifies distributed, microservice-style architecture by implementing proven patterns to bring resilience, reliability, and coordination to your microservices.

Spring Cloud Data Flow

CONNECT ANYTHING

Connect the Enterprise to the Internet of Anything—mobile devices, sensors, wearables, automobiles, and more. Spring Cloud Data Flow provides a unified service for creating composable data microservices that

https://spring.io/

Spring Projects

Modular by design

Spring Framework	Spring Boot	Spring Data Flow
Spring Cloud	Spring Data	Spring Integration
Spring Batch	Spring Security	Spring AMQP
Spring LDAP	Spring WebFlow	Spring REST Doc

https://spring.io/projects

Spring Framework

What ?

Application development framework for Java

Create high performing, testable and reusable code without any lock-in

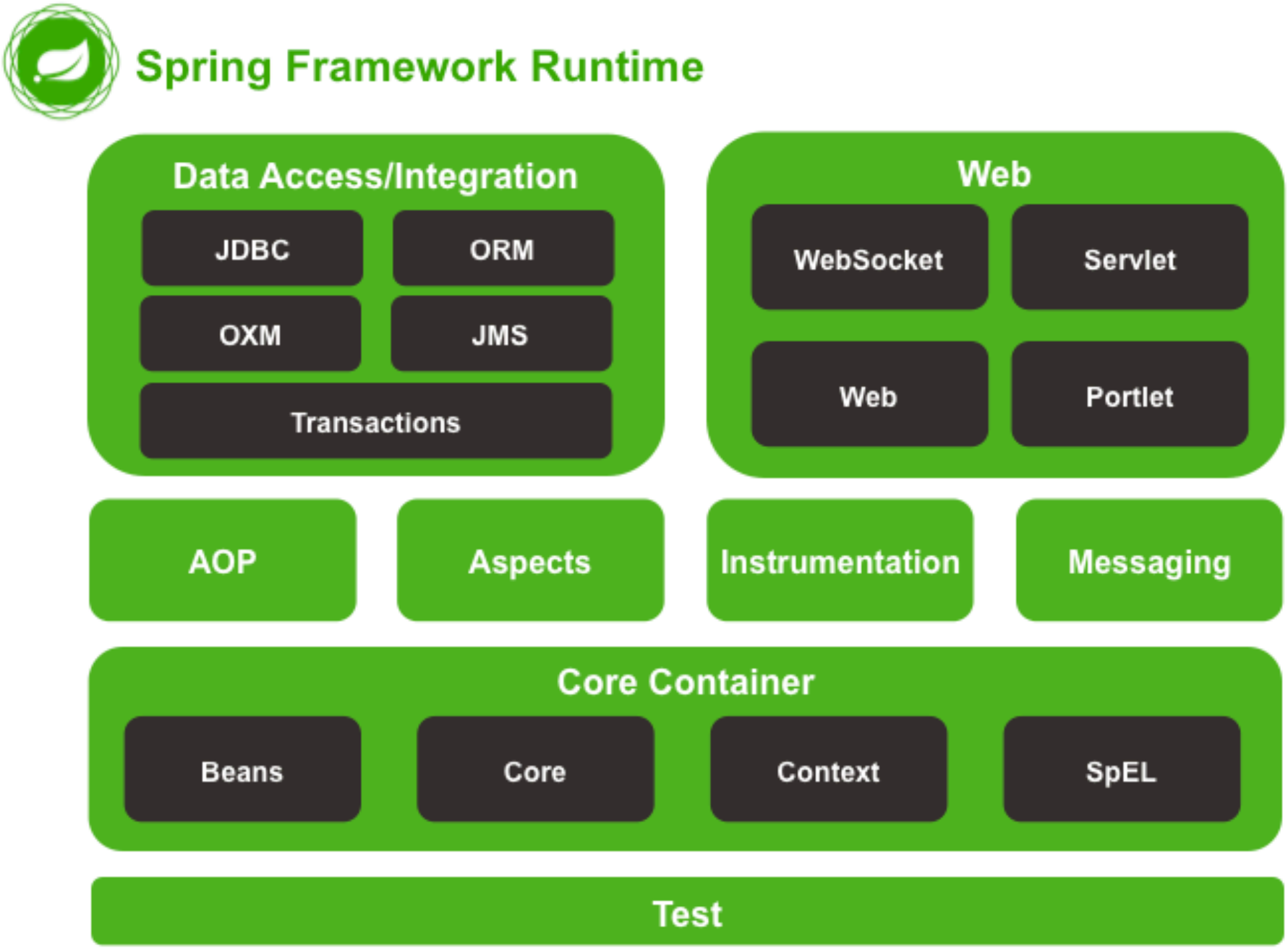
Open source since 2003

Reduce code and speed up development

Current version **5.x**

Required J**DK 8+**

Overview of Spring Framework

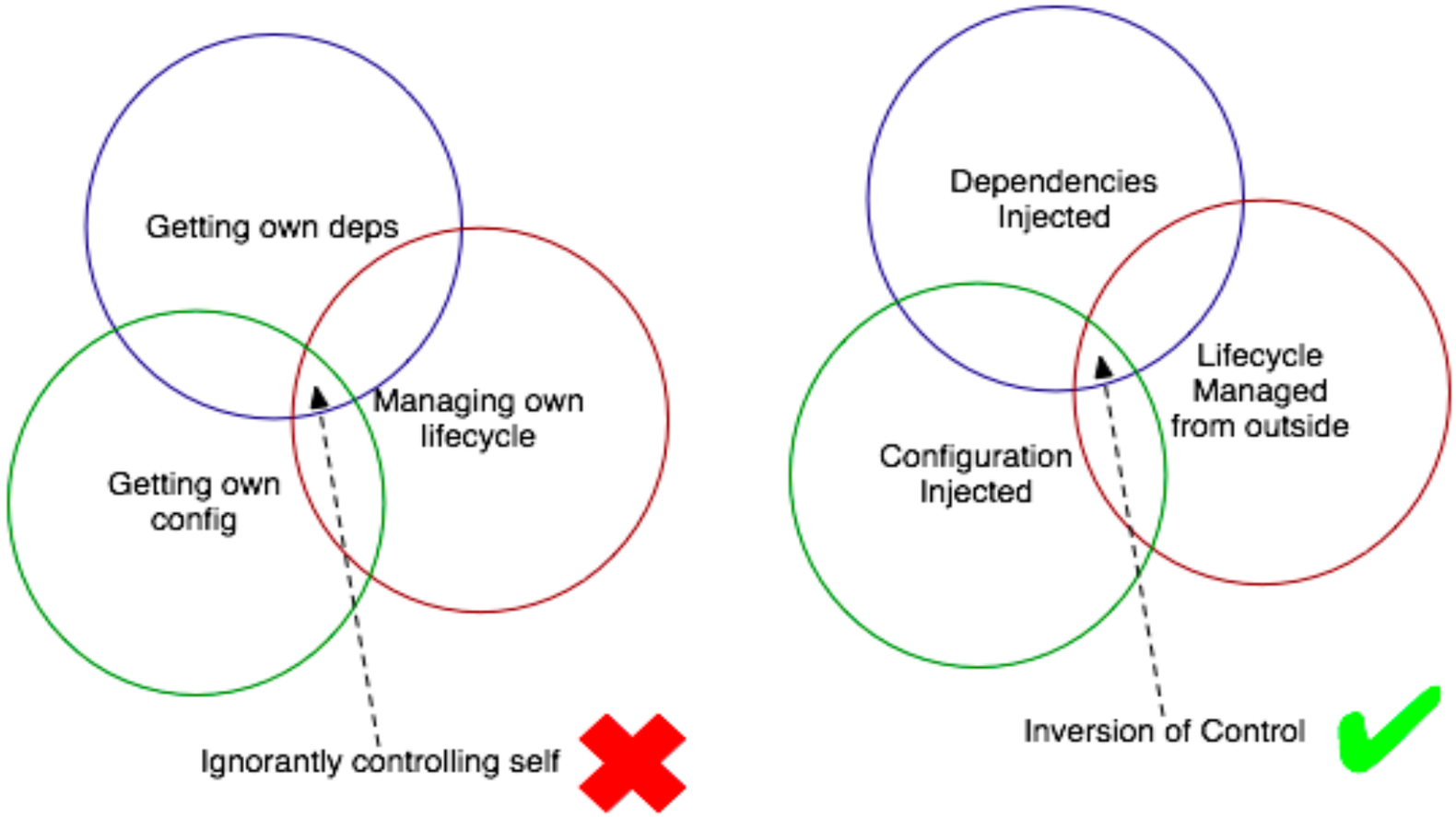


Core Container

Core and Beans
Context
Expression language

Core and Beans

Provide the fundamental parts of framework
Including **IoC** and **Dependency Injection**



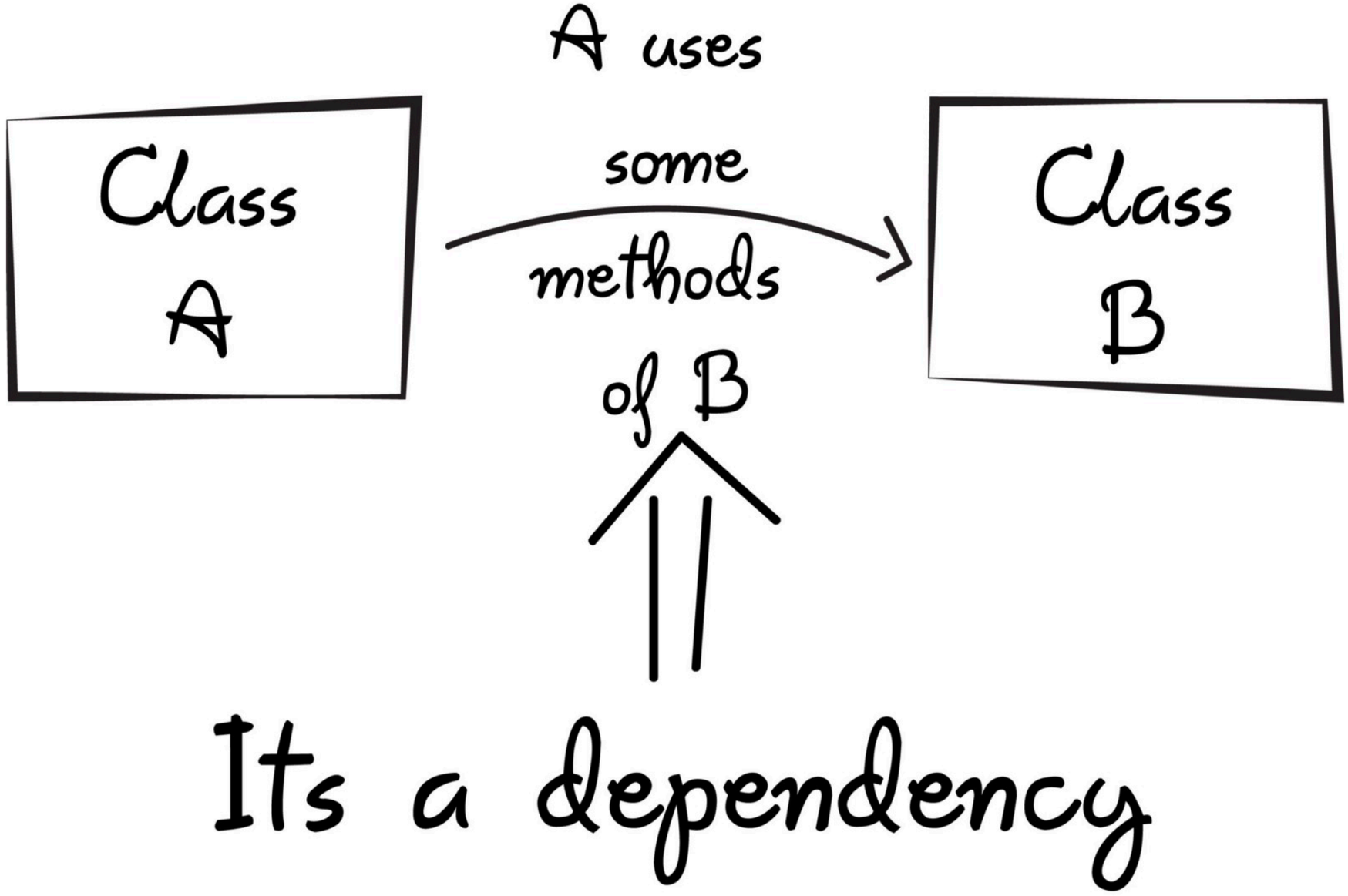
https://www.martinfowler.com/articles/injection.html

Inversion of Control (IoC)

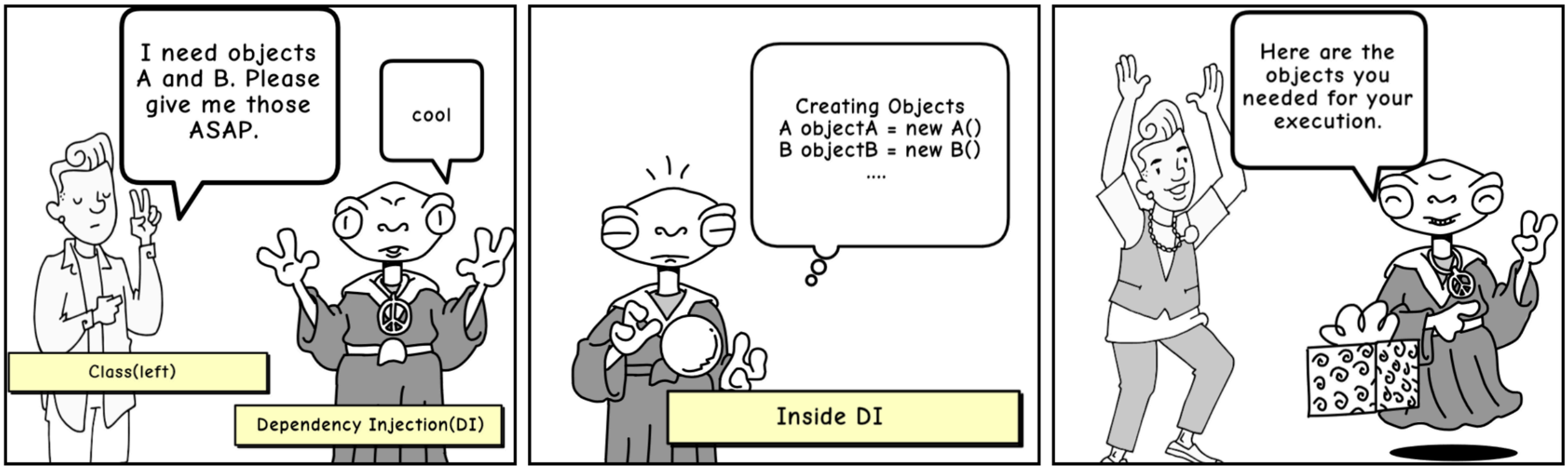
Concept in application development

Don’t call me, I will call you

Dependency Injection



Dependency Injection



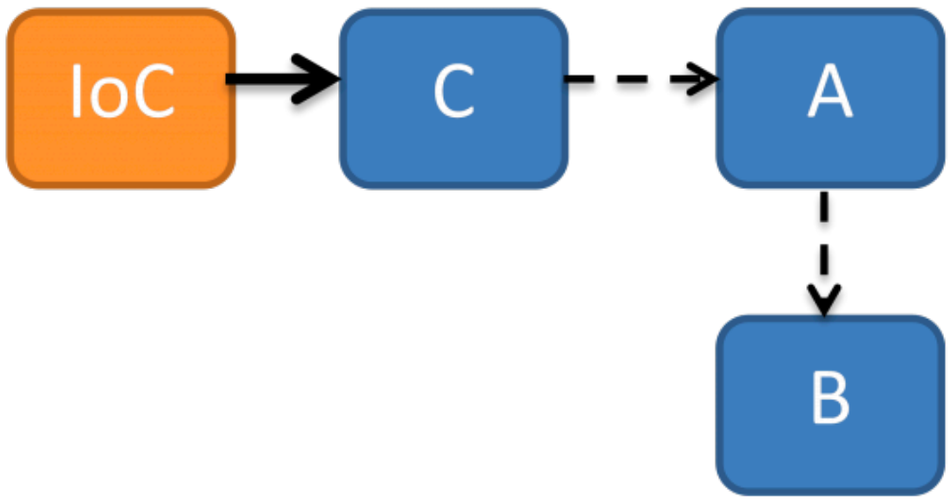
This comic was created at www.MakeBeliefsComix.com. Go there and make one now!

Dependency Injection

Class Dependencies

Service Location / Active Calling

IoC / DI / Auto-Wiring / Passive Calling

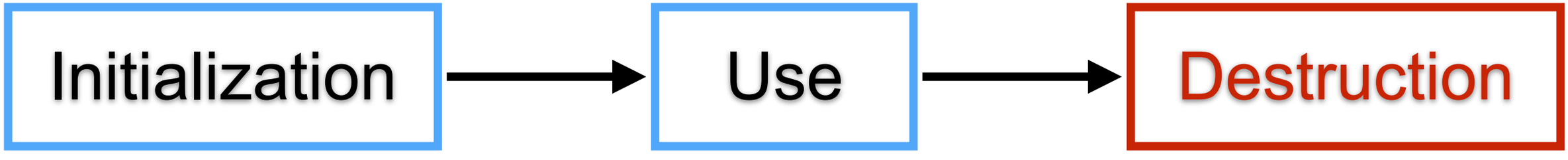


Types of Dependency Injection

Constructor injection
Property/Setter injection
Method injection
Interface injection

Back to Spring Framework

Application Lifecycle

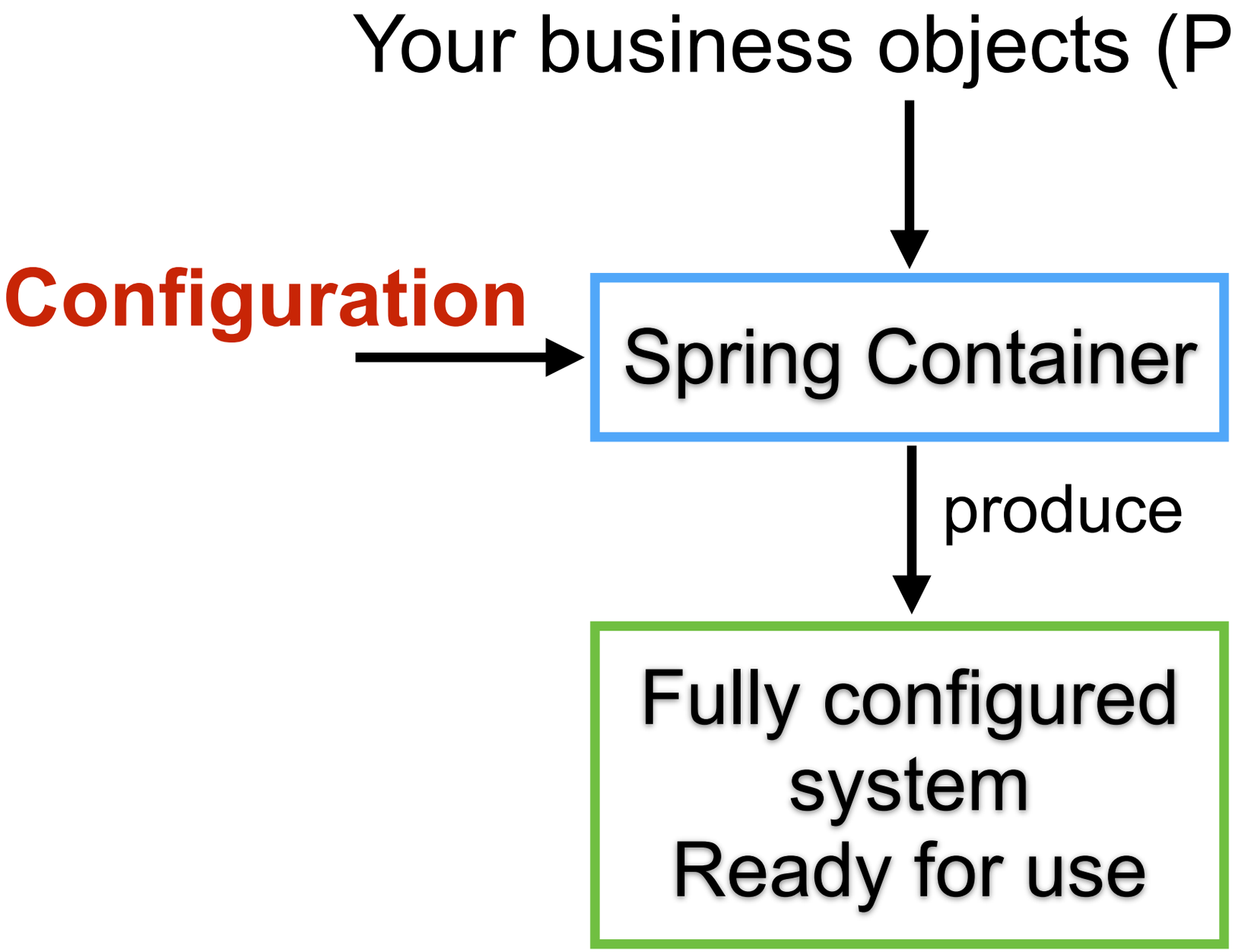


Create services
Allocate resources

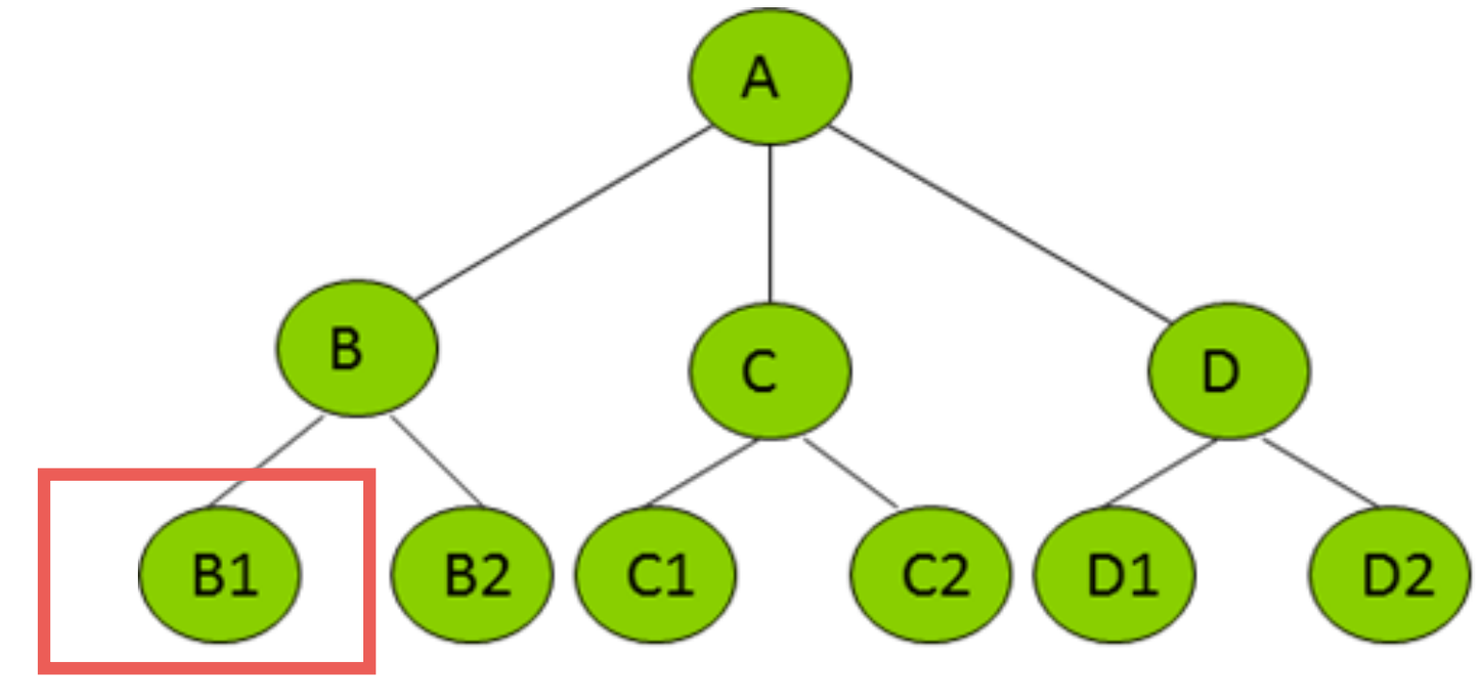
Process by requests

Shutdown
Release resources

Spring IoC container



Spring IoC container



Bean B1

Configuration

From XML file

Annotation-based configuration (2.5)

Java-based configuration (3.0)

Beans

Spring IoC container manages one of more beans
Beans are created with configuration

Bean Definitions

Package-qualified class name
Bean behavioral (scope, lifecycle, callback)
Reference to other beans
Other configuration setting to create new object

Bean Definitions

Property	Section
Class	Instantiating beans
Name	Naming beans
Scope	Beans scopes
Constructor arguments	Dependency Injection
Properties	Dependency Injection
Autowiring mode	Autowiring collaborators
Lazy initialization mode	Lazy-initialized beans

https://docs.spring.io/spring/docs/current/spring-framework-reference/core.html#beans-definition

Bean Scopes

Scope	Description
singleton	Single instance for each container
prototype	Single bean definition to any number of object instances.
request	HTTP request
session	HTTP session
application	ServletContext

https://docs.spring.io/spring/docs/current/spring-framework-reference/core.html#beans-factory-scopes

Change scope of bean

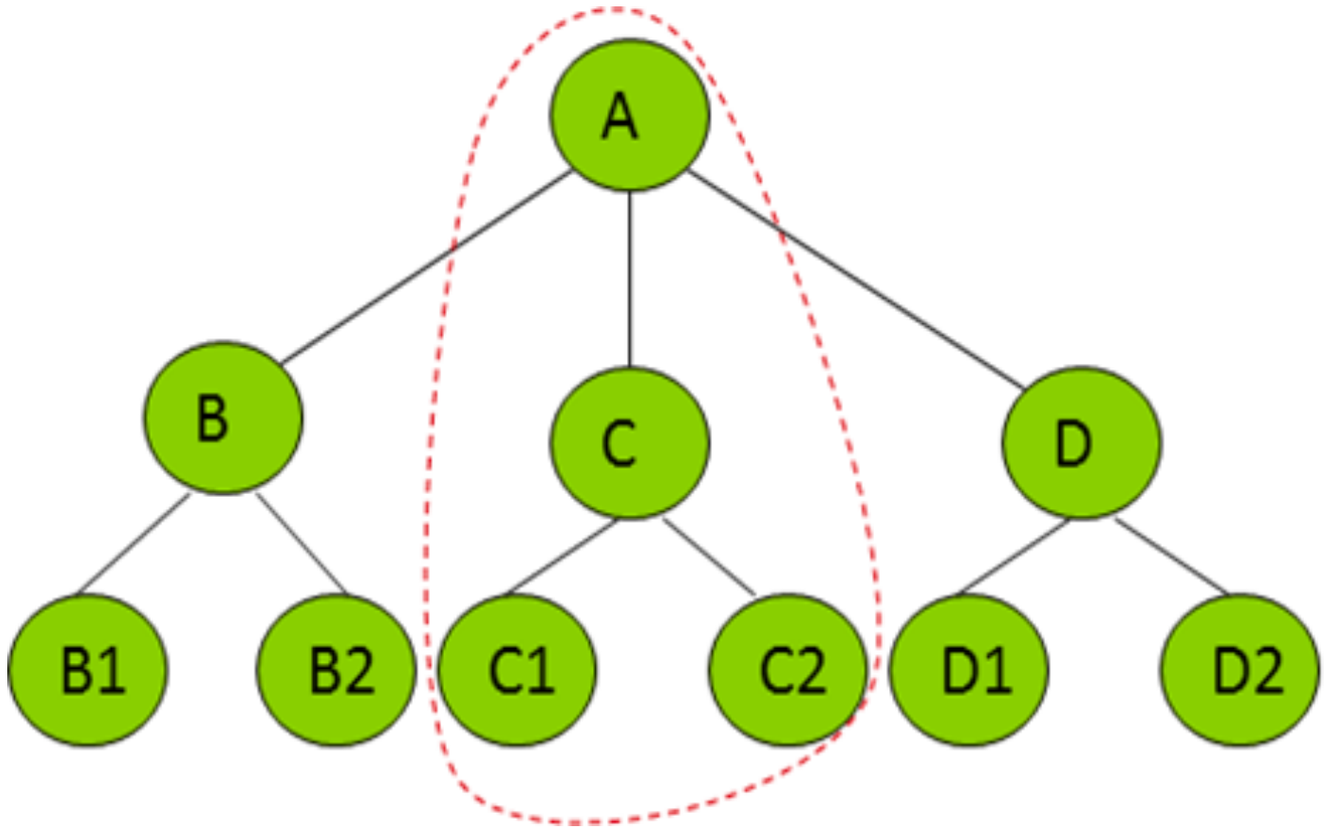
```
@Component
@Scope(ConfigurableBeanFactory.SCOPE_PROTOTYPE)
public class RealRandom implements MyRandom {

    public String number;

    @Override
    public int nextInt(int bound) {
        return new Random().nextInt(bound);
    }

}
```

Lazy-load dependencies



BeanFactory ?

Interface defines basic functionality for Spring container

Factory design pattern

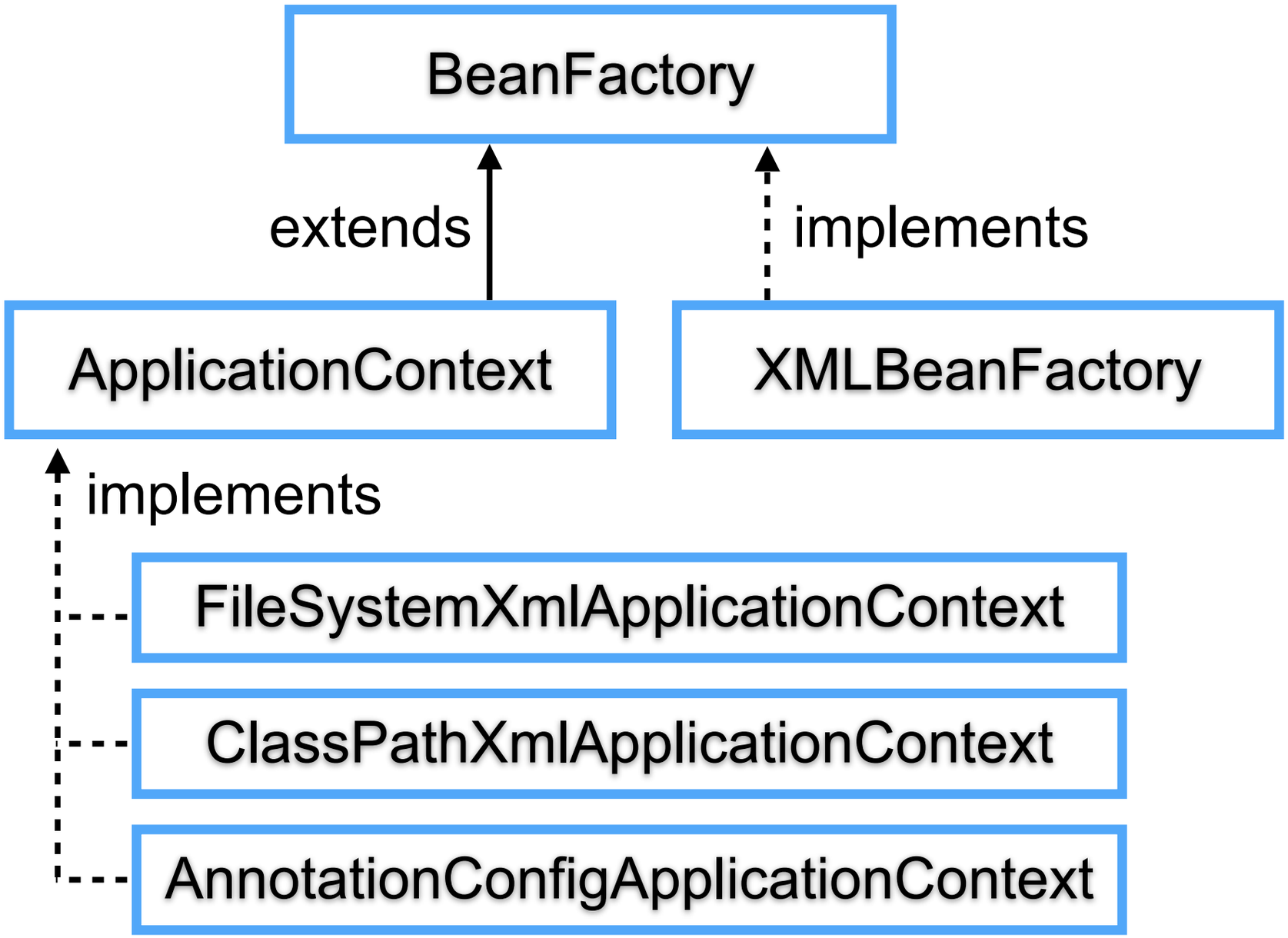
Load beans from configuration source

Instantiated the bean when requested

Wire dependencies and properties for beans

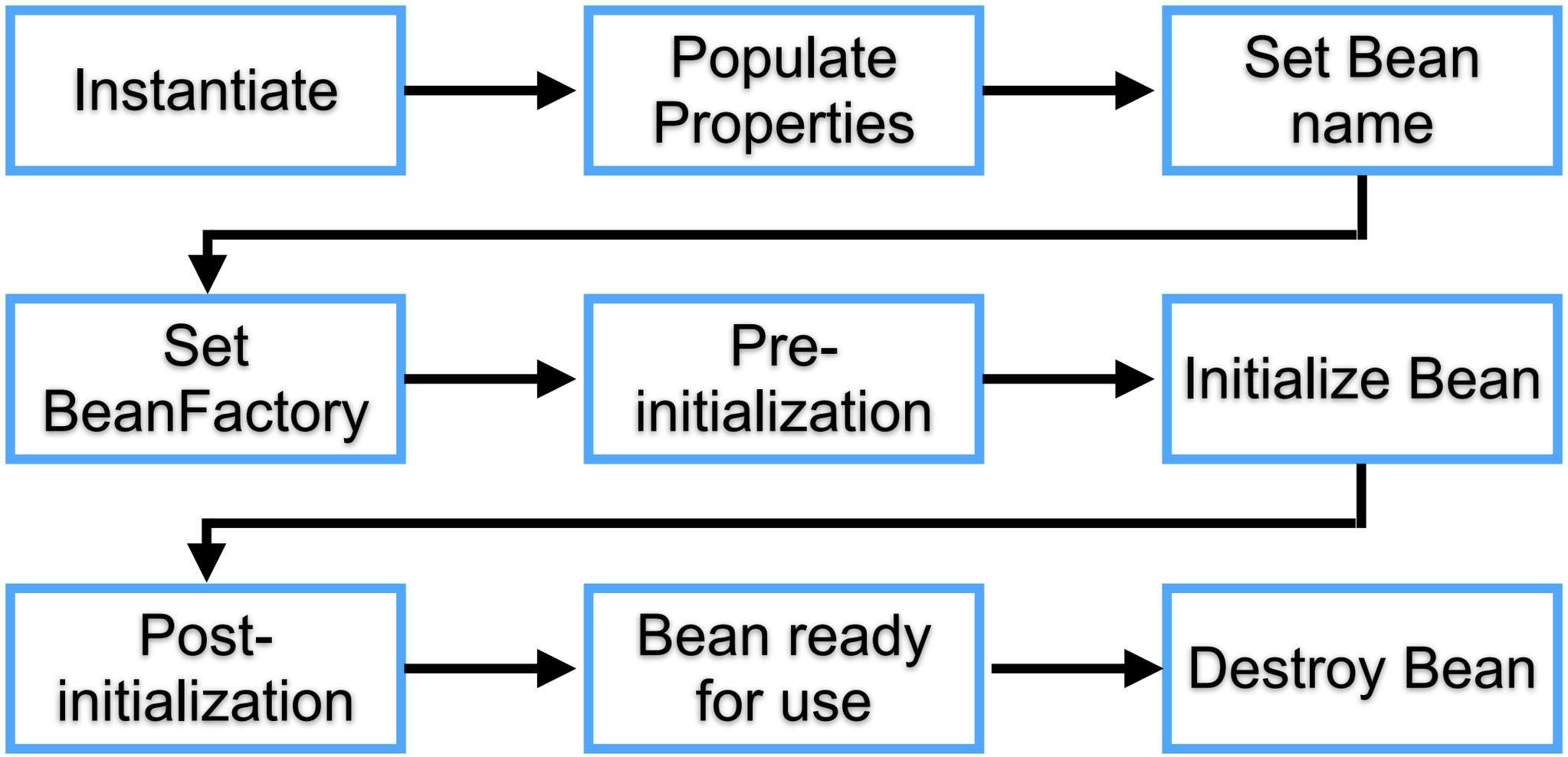
Manage the bean lifecycle

BeanFactory ?



https://docs.spring.io/spring-framework/docs/current/javadoc-api/org/springframework/context/ApplicationContext.html

Lifecycle of BeanFactory

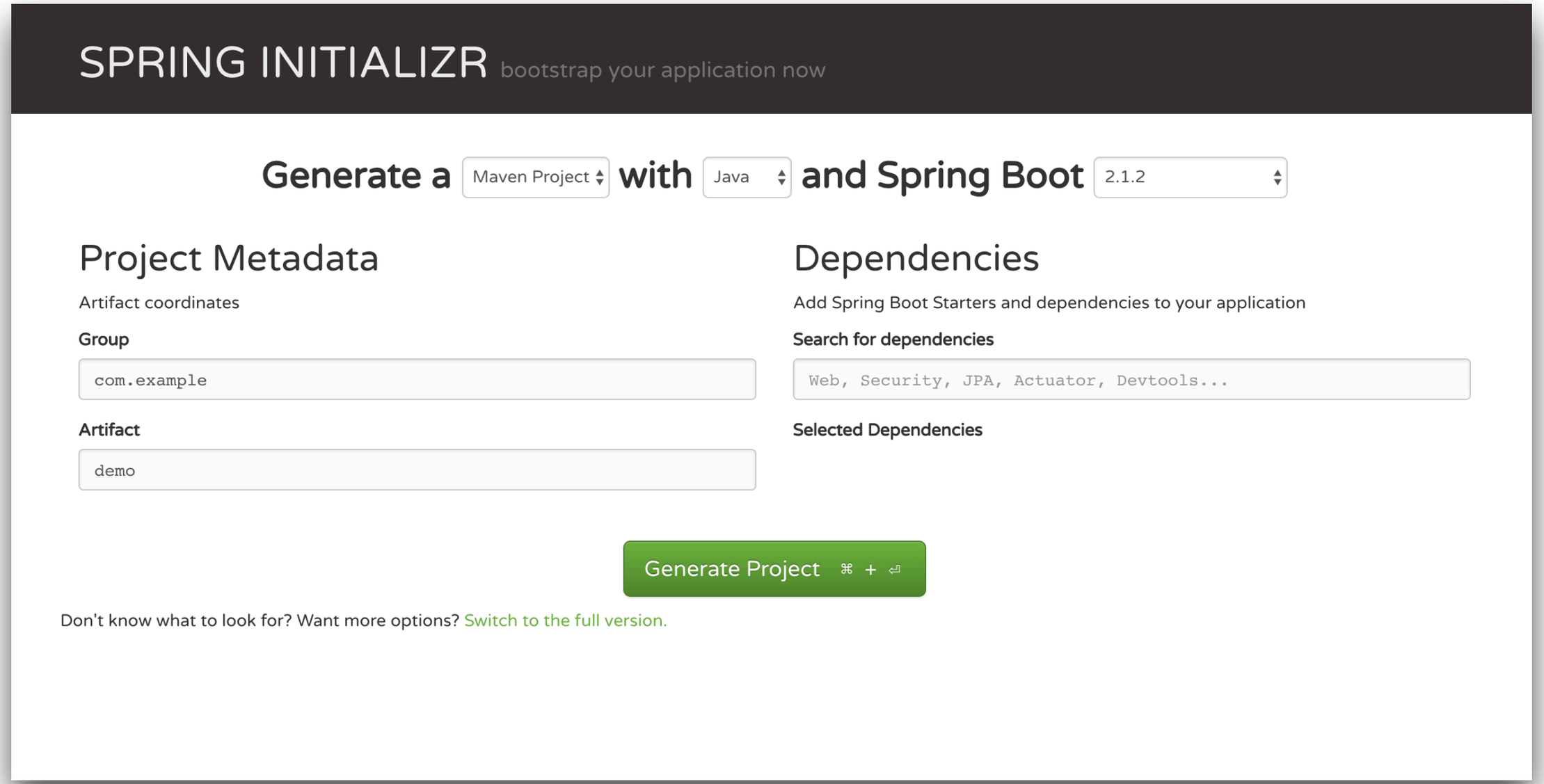


Let’s start Spring Framework

Workshop

Create new Project

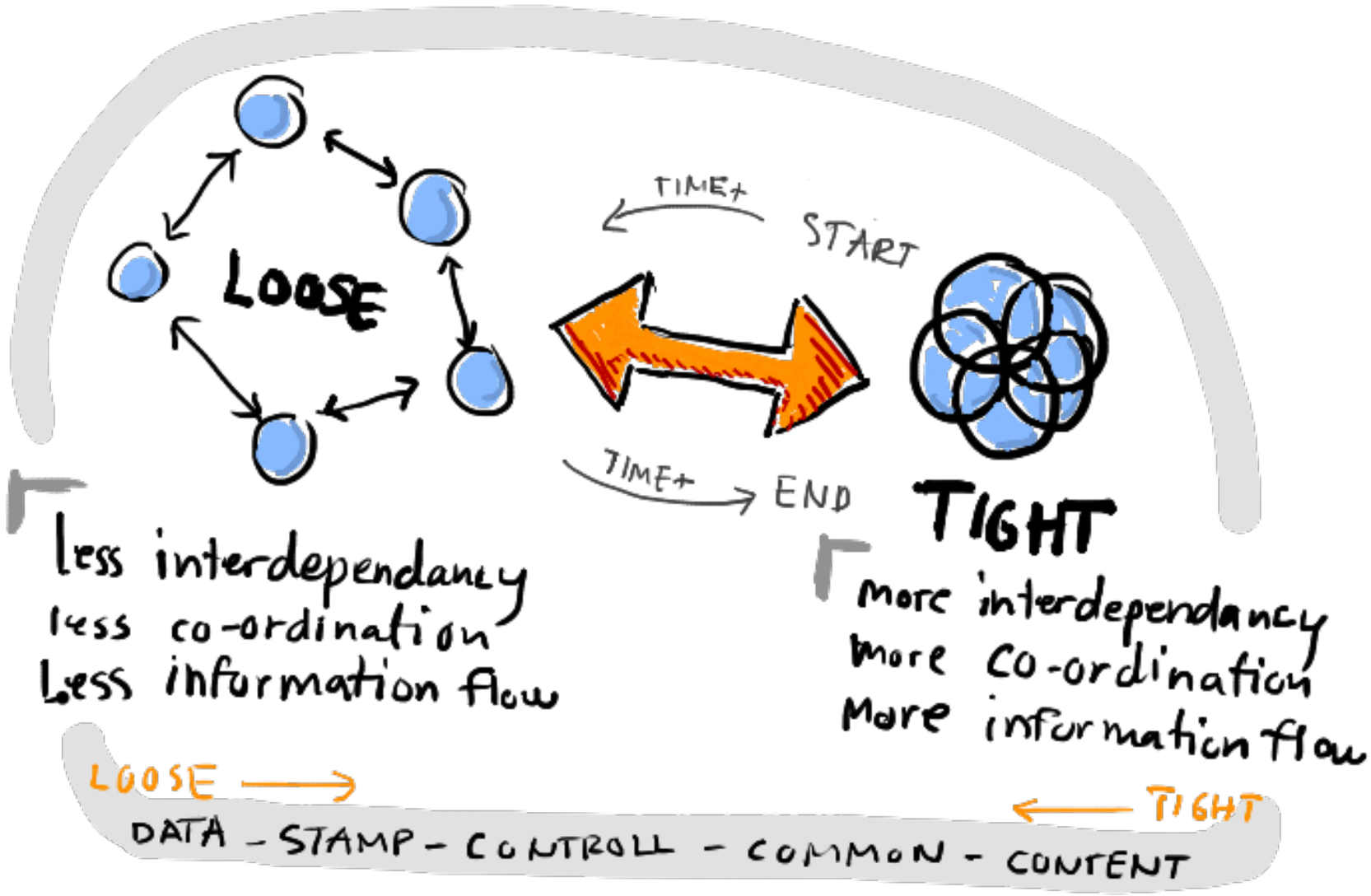
Use **spring initializr**



https://start.spring.io/

Understanding Dependency Injection

Tight coupling
Loose coupling



Using Spring to manage dependencies

@Component

@Autowired

Constructor and Setter injection

@Primary

@Qualifier

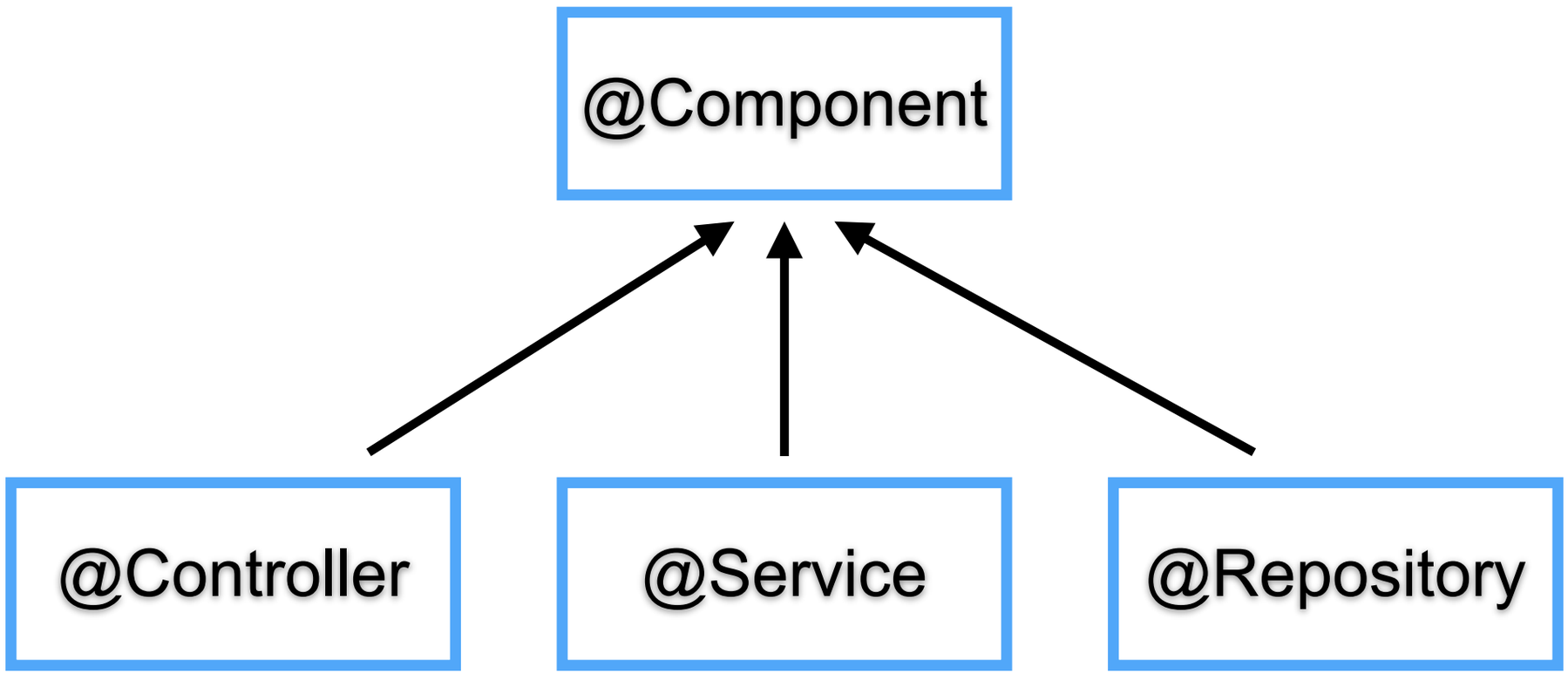
Scope of beans

Singleton
Prototype

What are difference of …

@Component
@Controller
@Service
@Repository

What are difference of …



Layer of application

What are difference of …

@Component

Generic stereotype for any component or bean

@Controller

Stereotype for the presentation layer (Spring MVC)

@Service

Stereotype for the service layer

@Repository

Stereotype for the persistence layer

Why Spring is popular ?

Enable testable code

No plumbing code

Flexible architecture

Staying current

Eclipse plug-in

https://infinitest.github.io/

Code Smell

Code Smells

– What? How can code "smell"??

– Well it doesn't have a nose... but it definitely can stink!

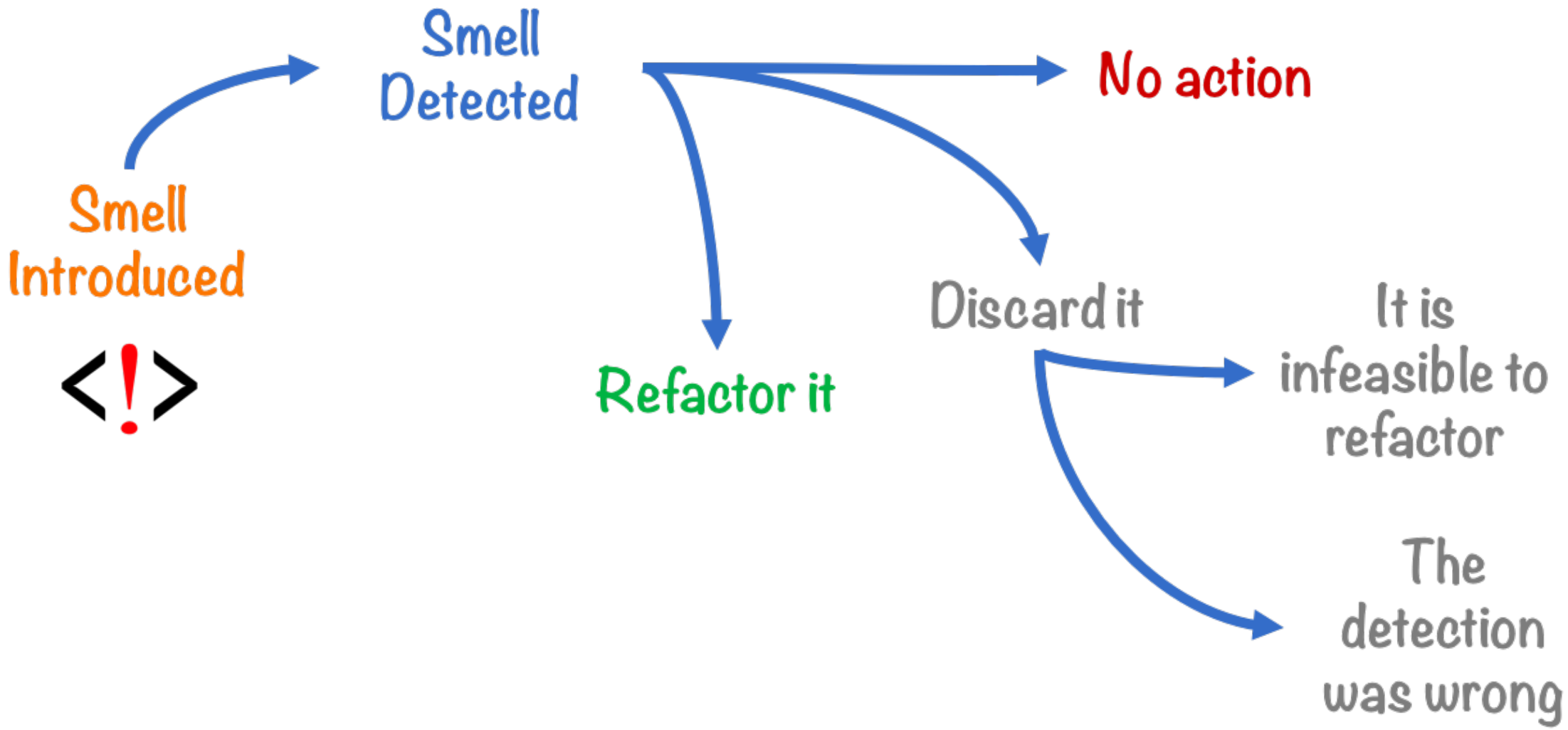
Bloaters

Bloaters are code, methods and classes that have increased to such gargantuan proportions that they are hard to work with. Usually these smells do not crop up right away, rather they accumulate over time as the program evolves (and especially when nobody makes an effort to eradicate them).

- Long Method
- Large Class
- Primitive Obsession
- Long Parameter List
- Data Clumps

https://sourcemaking.com/refactoring/smells

Code Smell



Testable structure/application

SOLID

Single Responsibility Principle

Open Closed Principle

Liskov Substitution Principle

Interface Segregation Principle

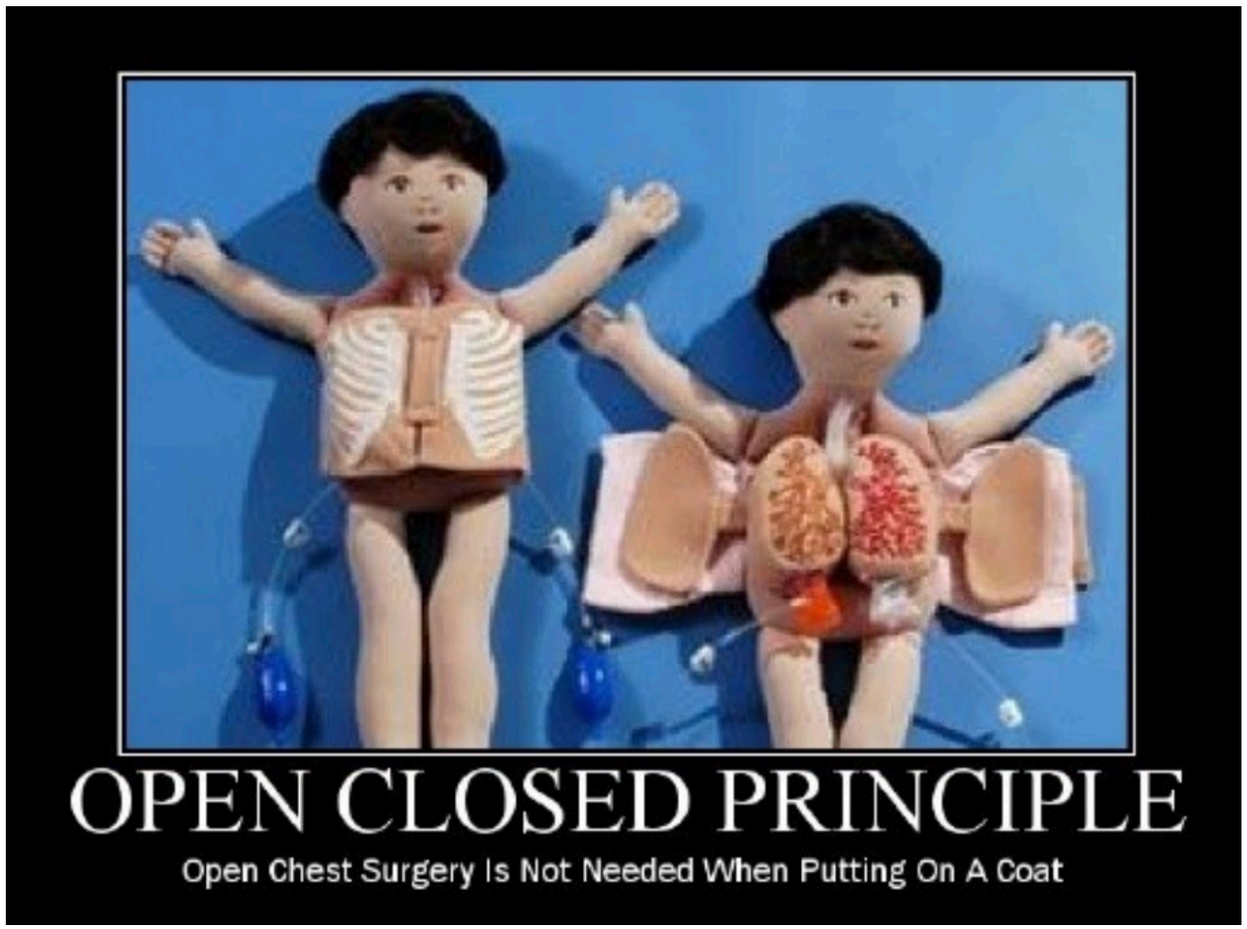
Dependency Inversion Principle

Single Responsibility Principle

A class should have one and only one reason to change

Open Closed Principle

Software entities should open for extension
But closed for modification

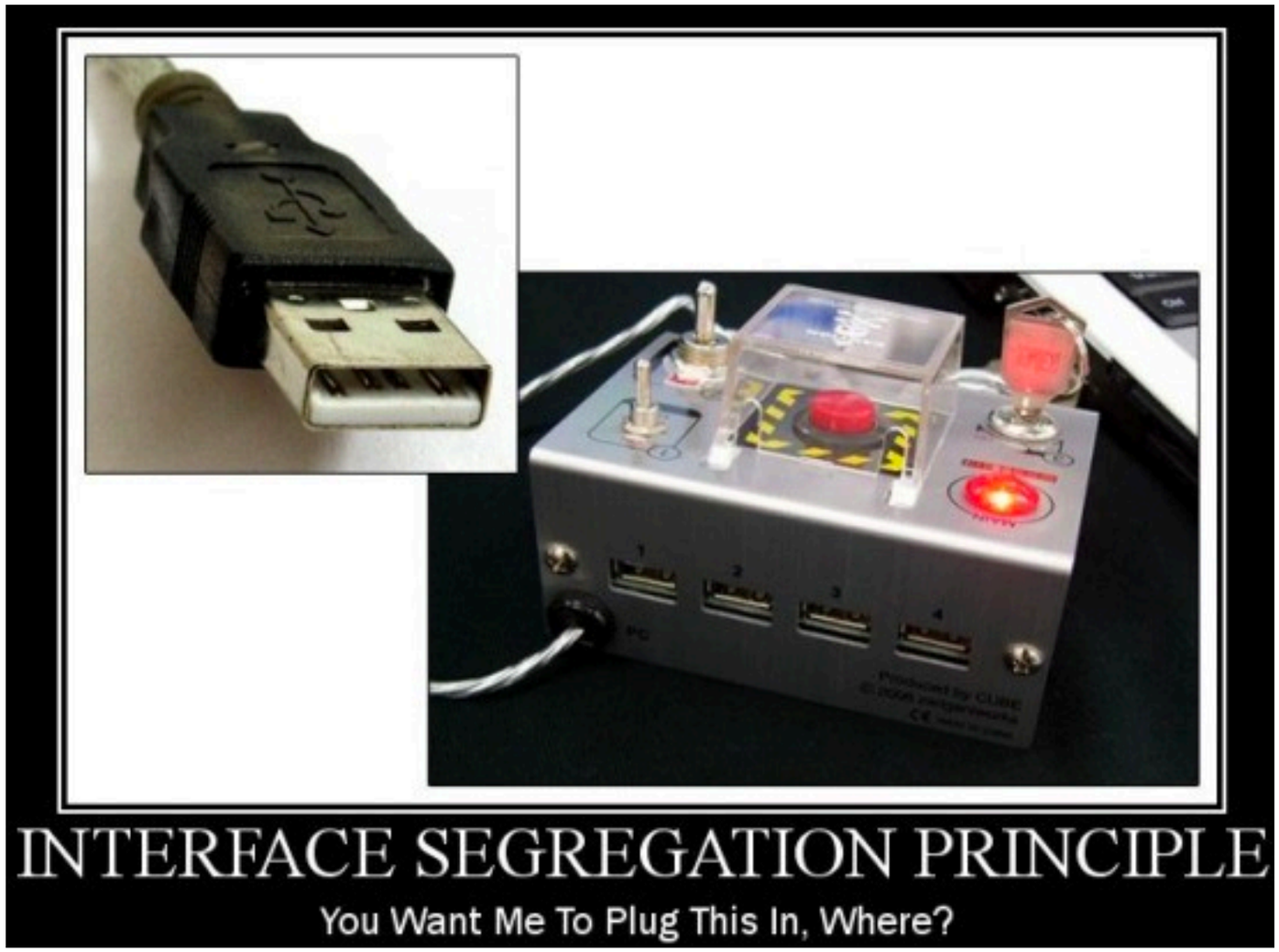


Liskov Substitution Principle

Child classes should never break the parent

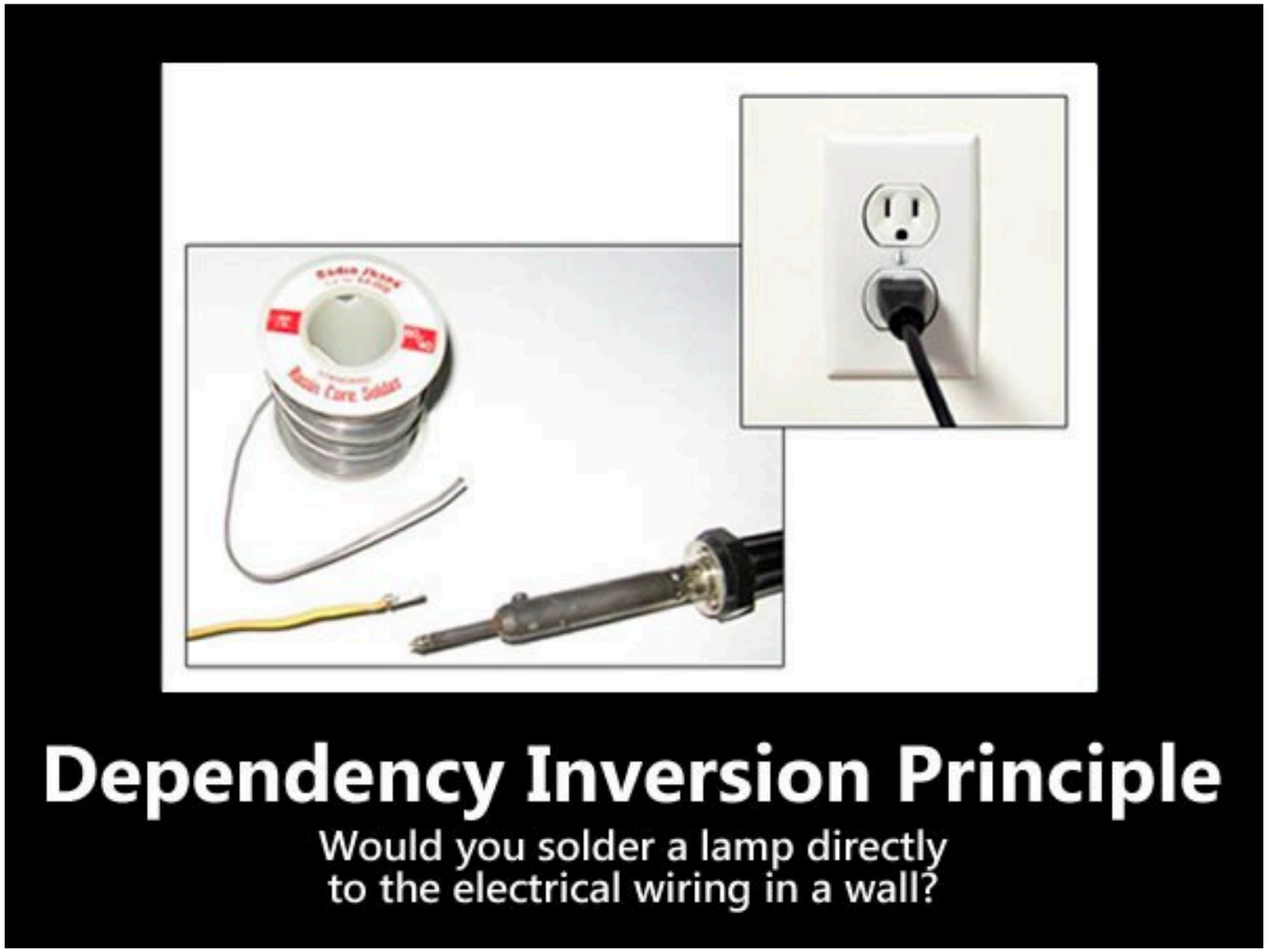
Interface Segregation Principle

Make fine grained interfaces that are client specific



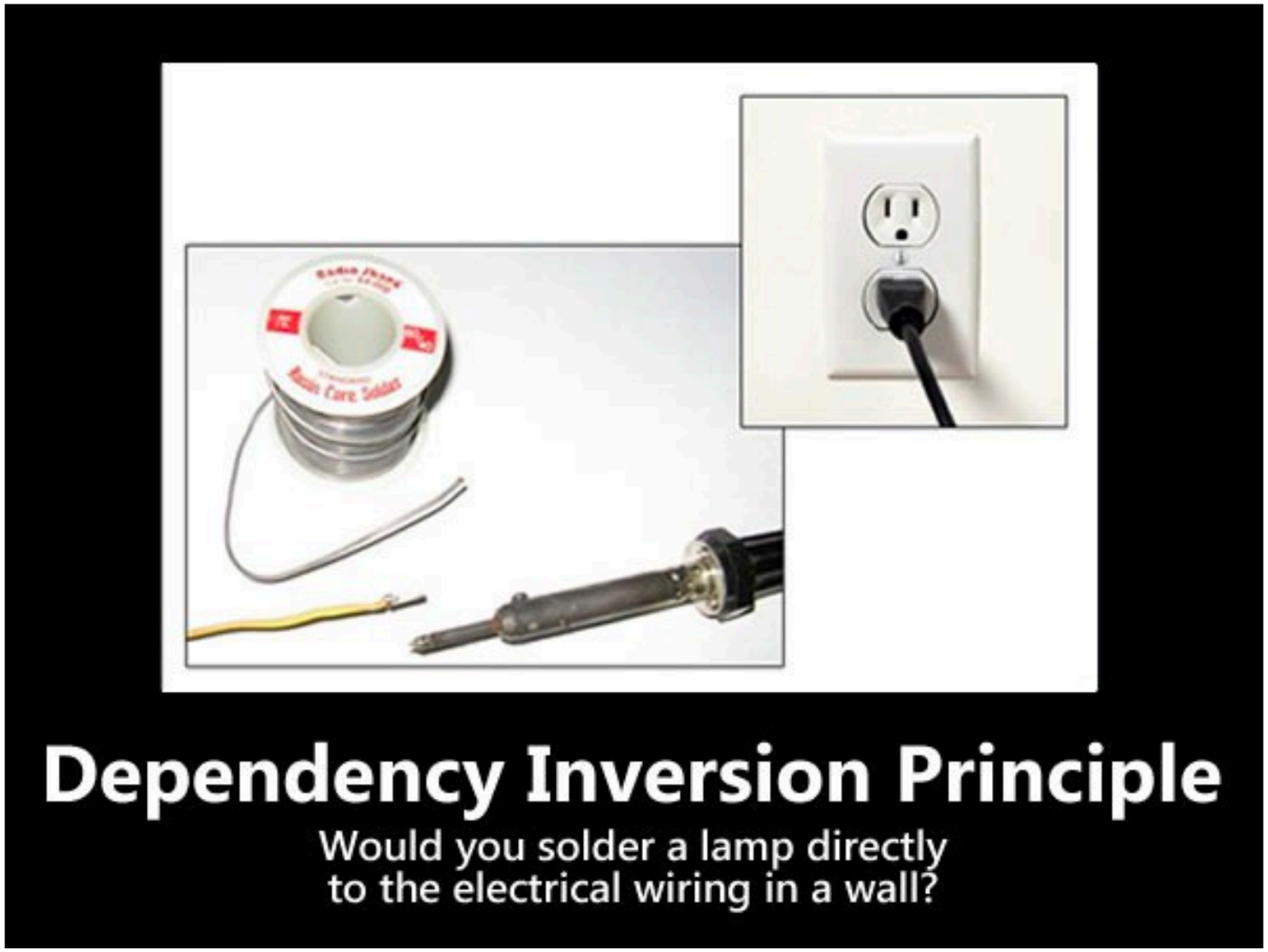
Dependency Inversion Principle

High-level module should not depend on low-level module



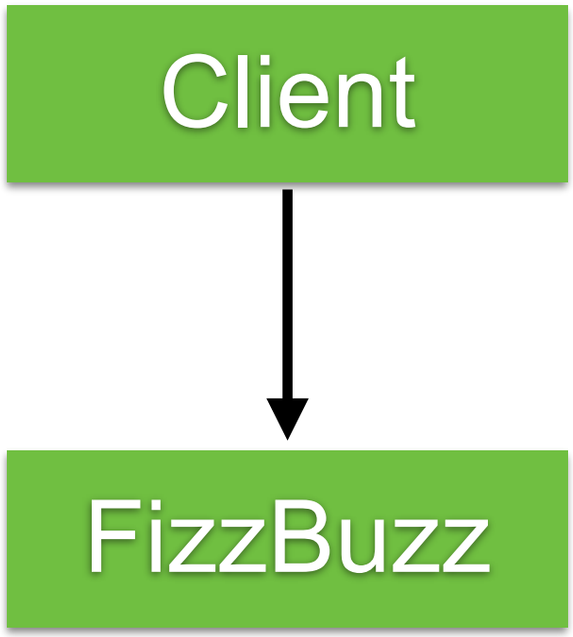
Dependency Inversion Principle

Abstraction layer should not depend on detail

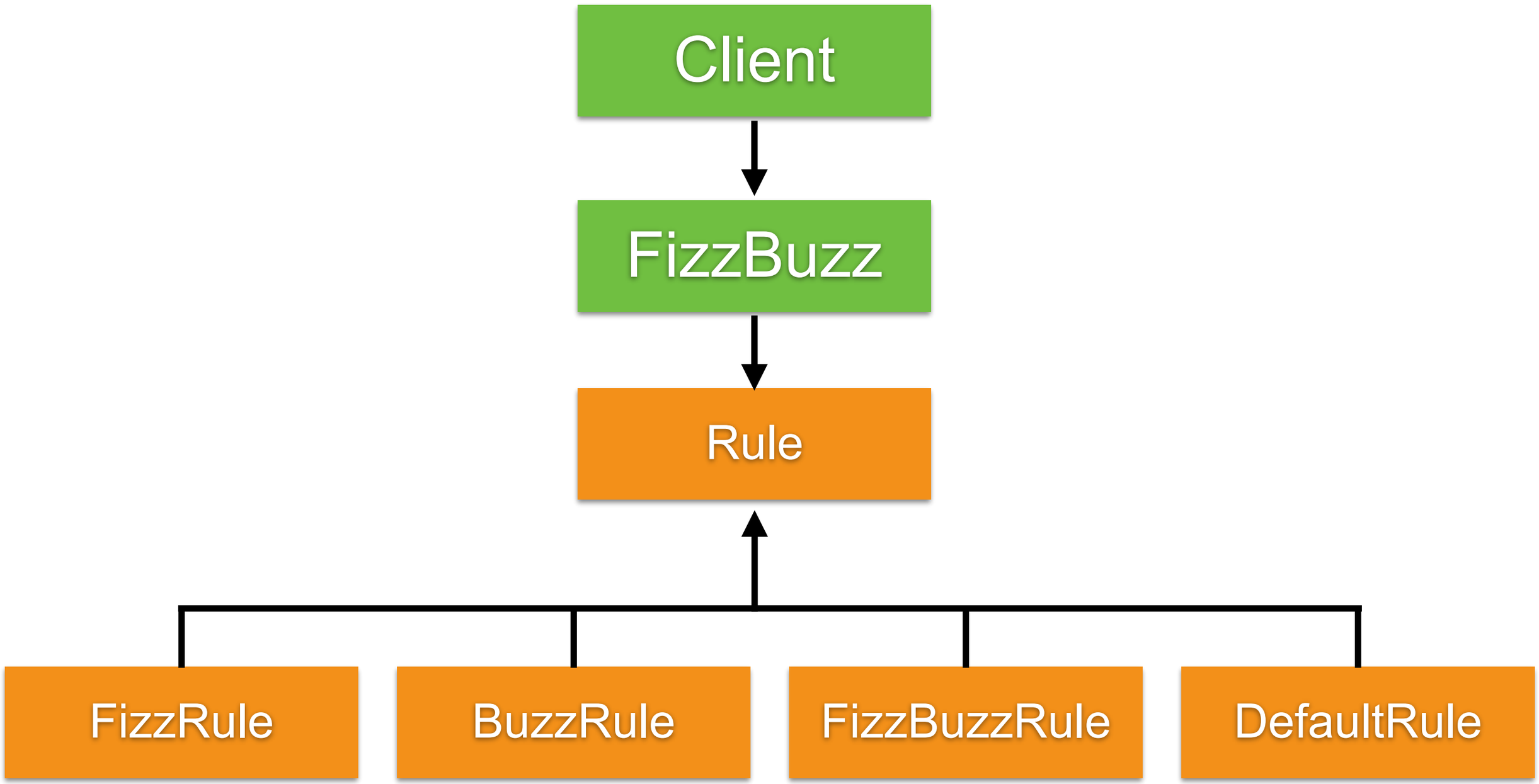


Workshop

FizzBuzz



FizzBuzz



Spring Boot

Spring Framework

Spring Boot

REST

REST

REpresentation **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

RESTful service

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

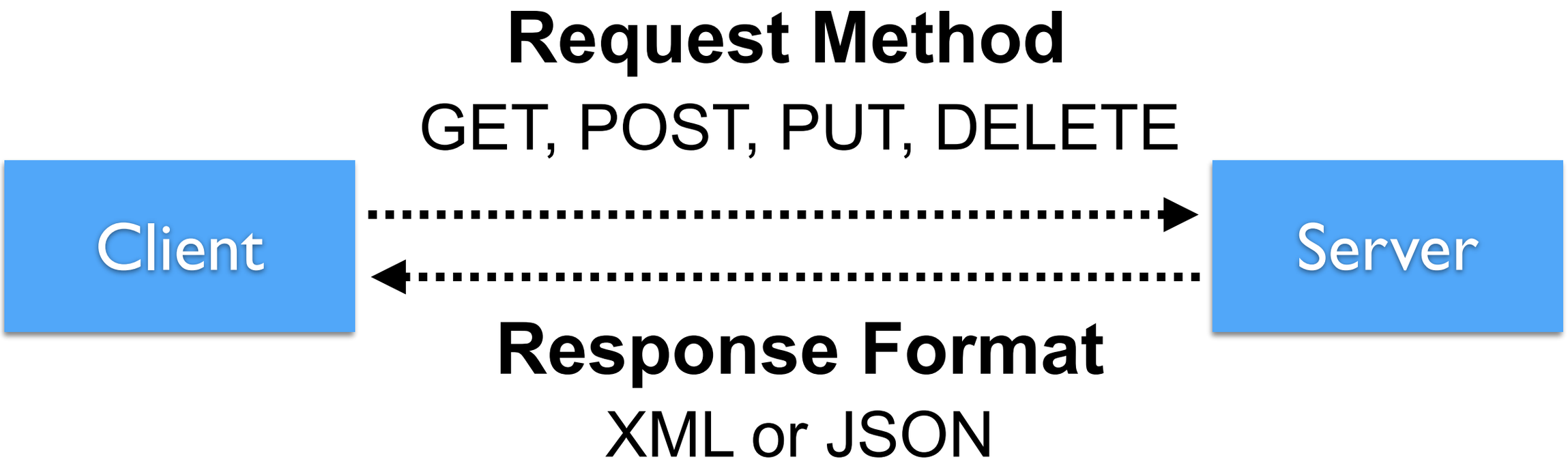
REST Request Messages

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

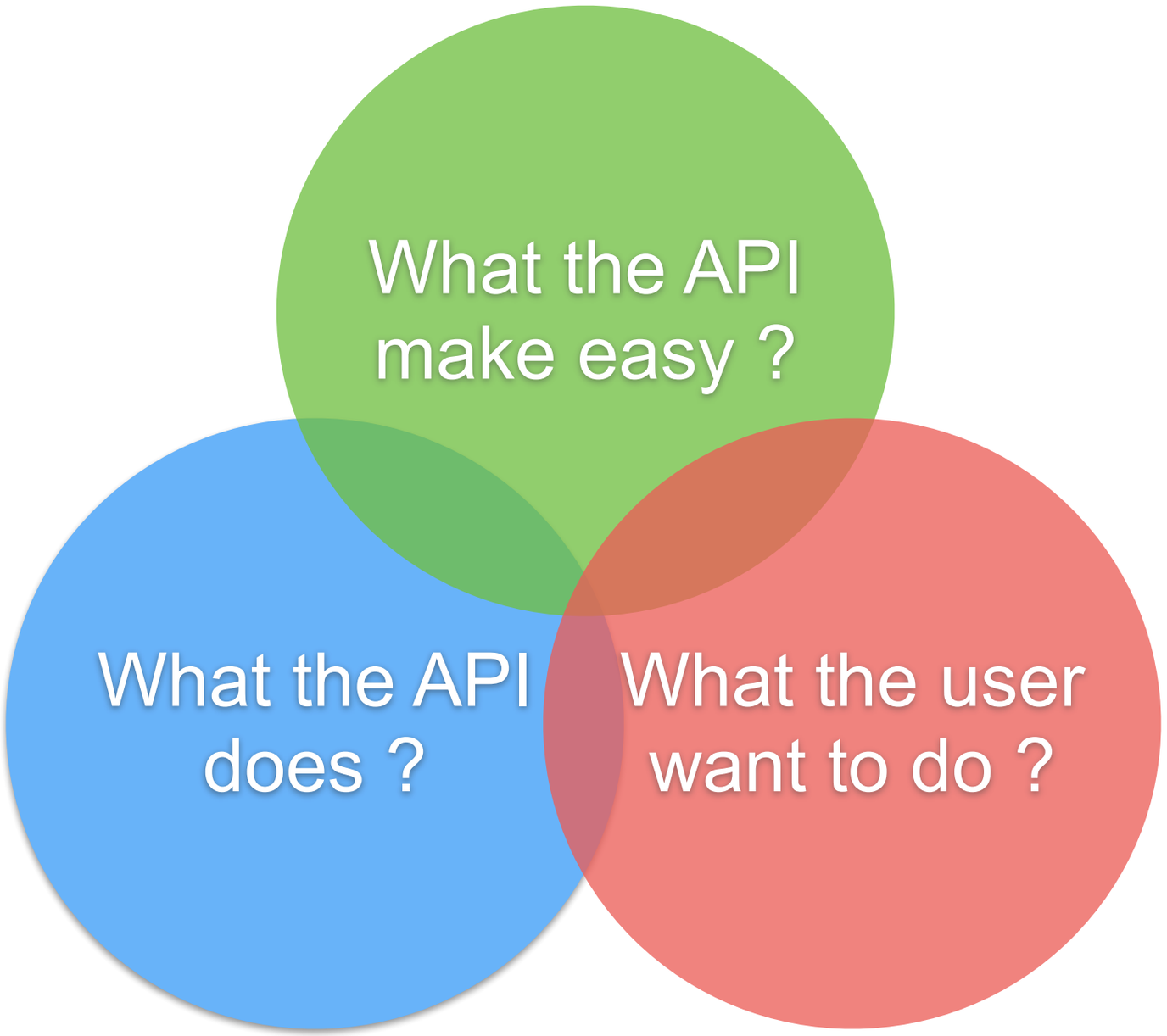


HTTP Methods meaning

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

Response format ?

Good APIs ?



Java Framework for RESTful

undertow

Jersey
RESTful Web Services in Java

WildFly SWARM

Java
J2EE

JAX-RS

Ratpack
A toolkit for JVM web applications

REST Easy

spring
by Pivotal

Spark

Restlet

akka

Apache CXF

STRUTS

play

unirest
Lightweight HTTP Request Client Libraries

Dropwizard

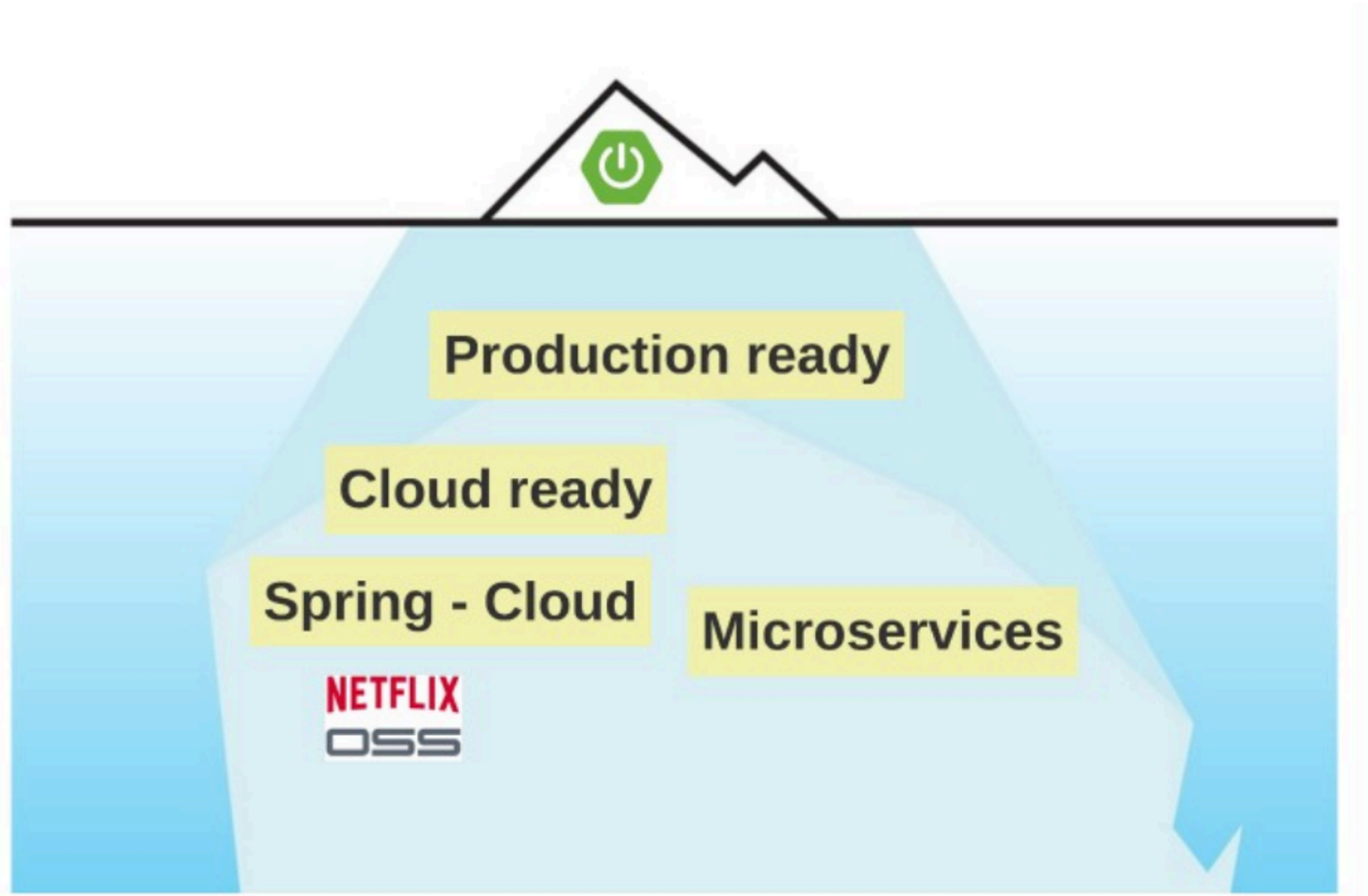
NINJA
web framework

ACT.framework

Hello Spring Boot 2.x

Why ?

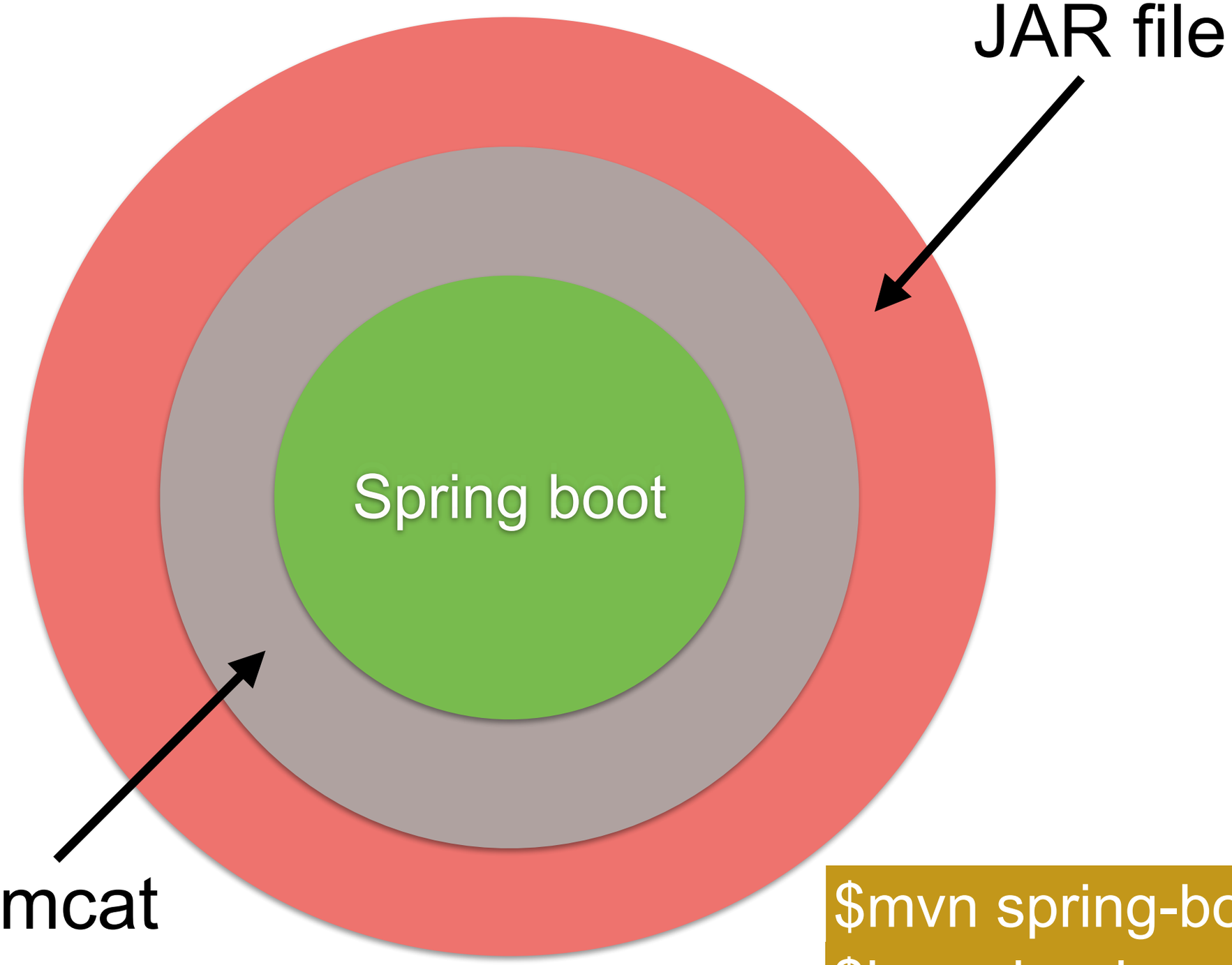
Application skeleton generator
Reduce effort to add new technologies



What ?

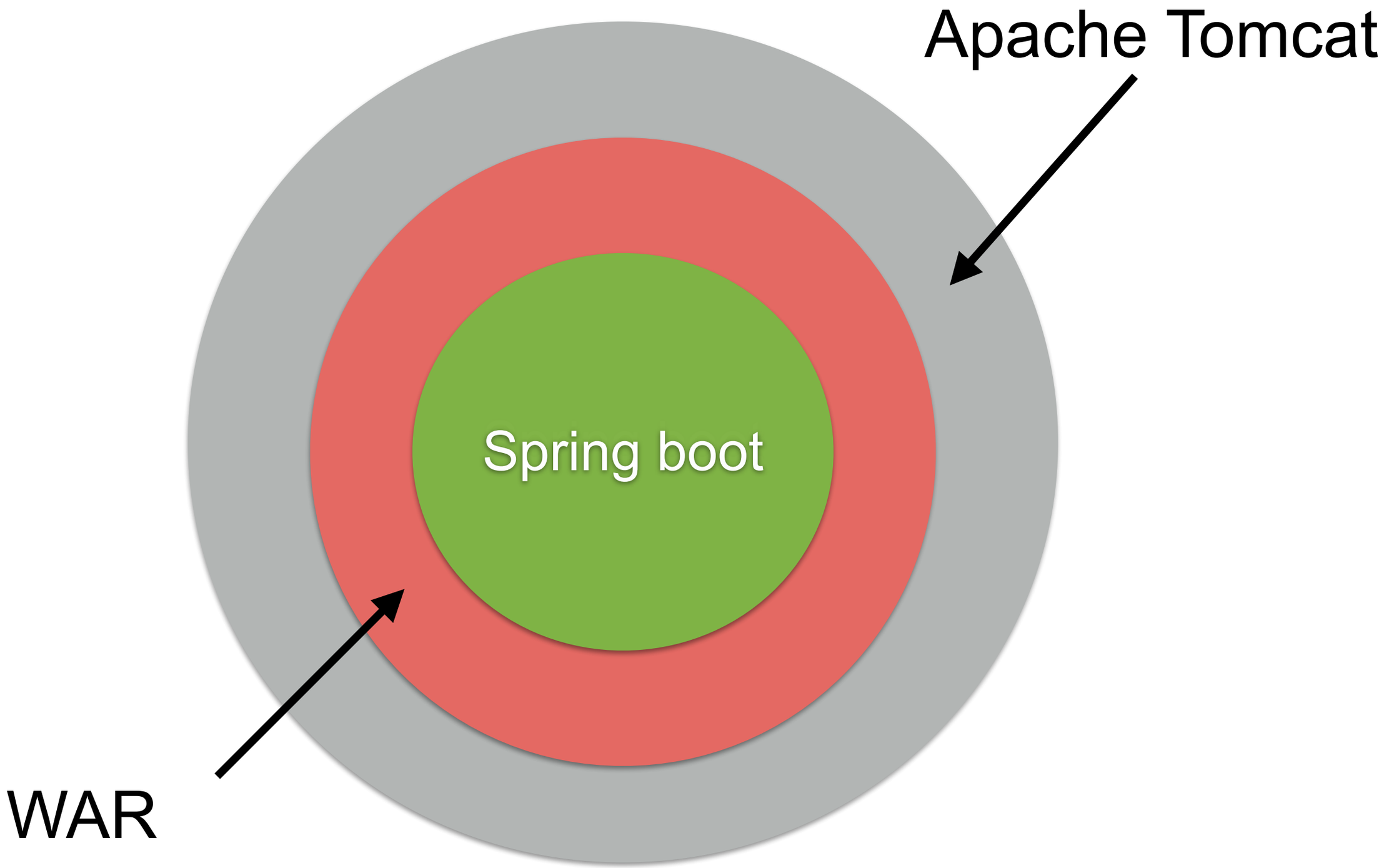
Embedded application server
Integration with tools/technologies (starter)
Production tools (monitoring, health check)
Configuration management
Dev tools
No source code generation, no XML

How ?



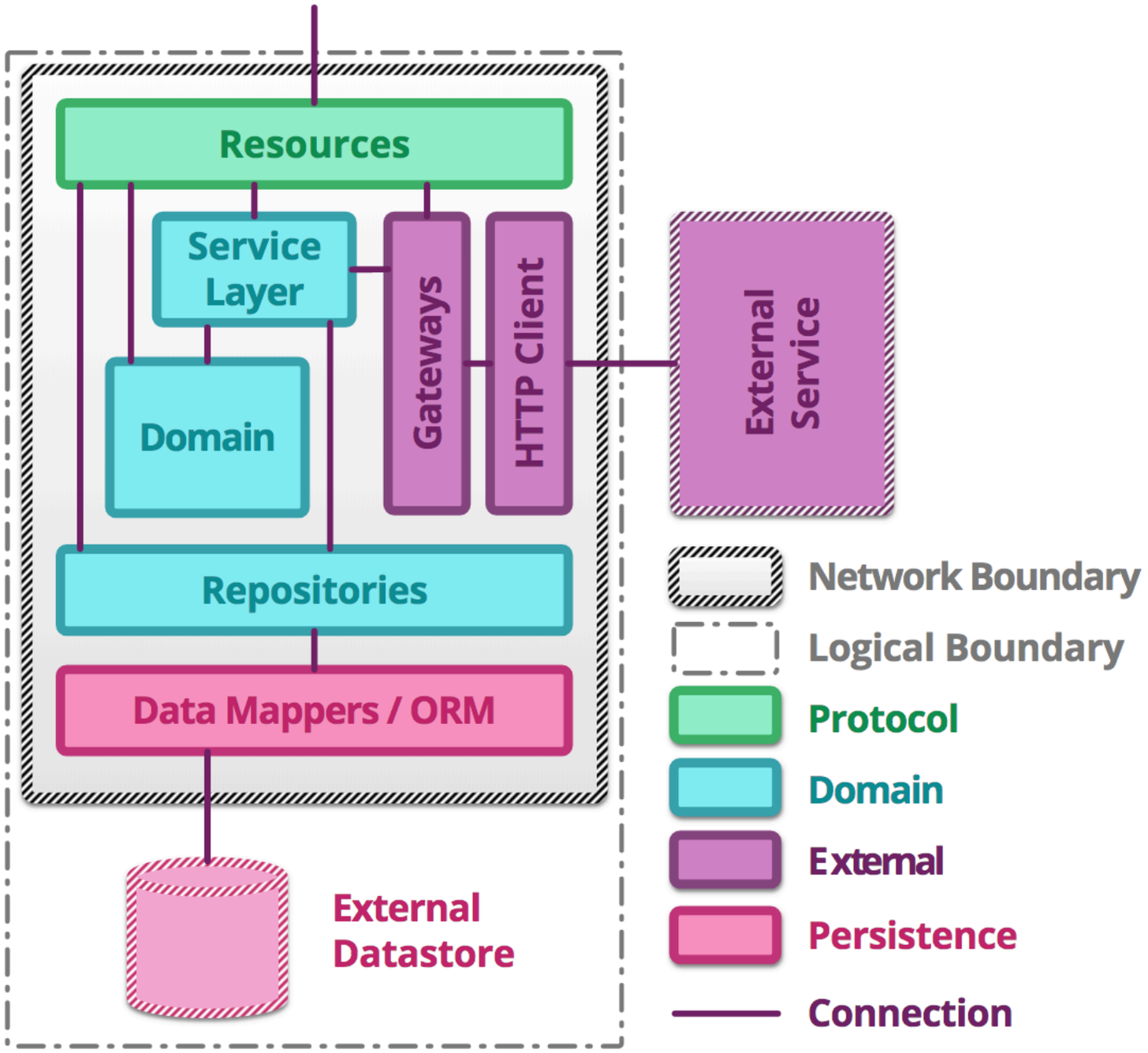

```
$mvn spring-boot:run
$java -jar demo.jar
```

How ?

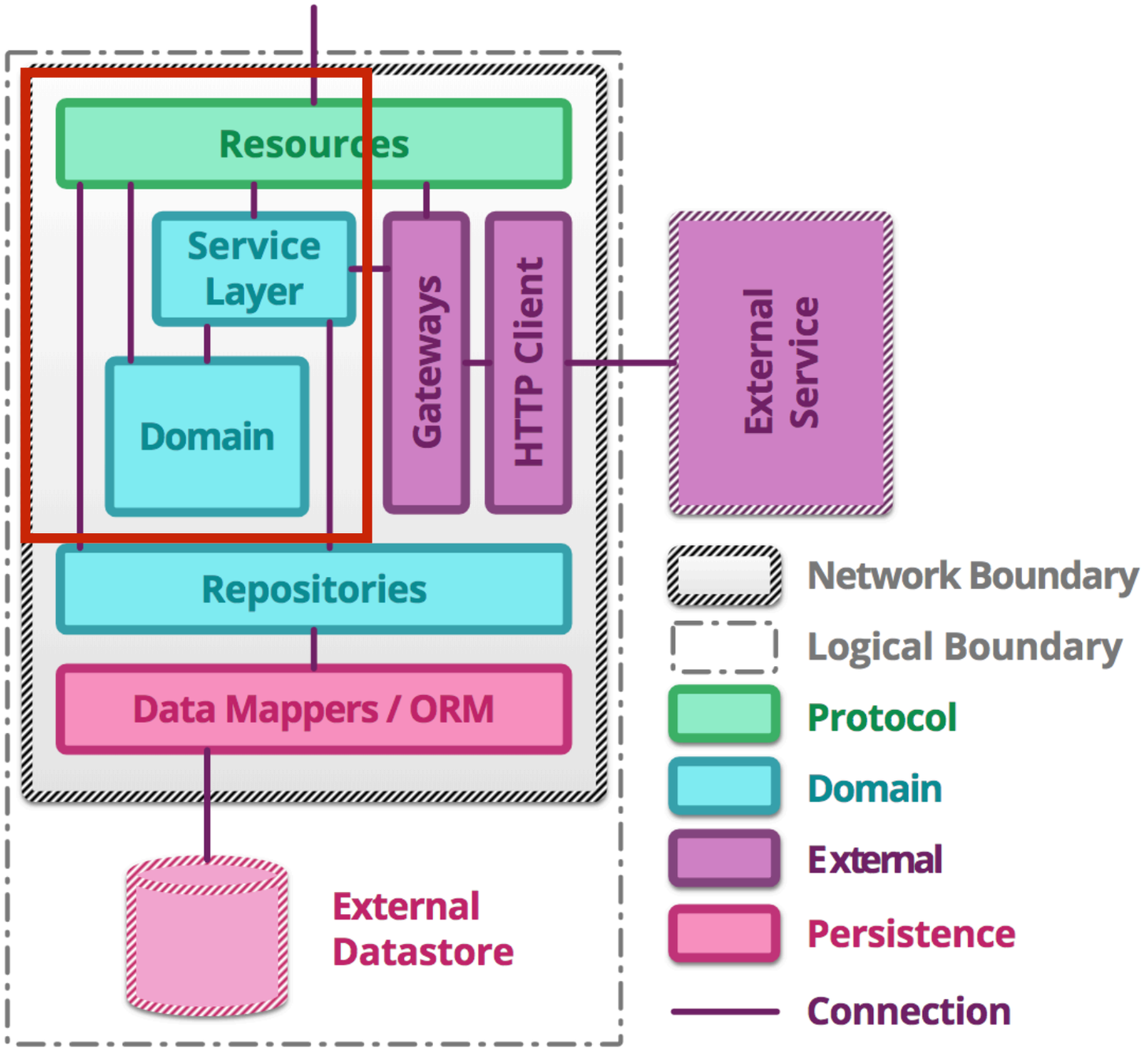


Building RESTful API with Spring Boot

Service Structure



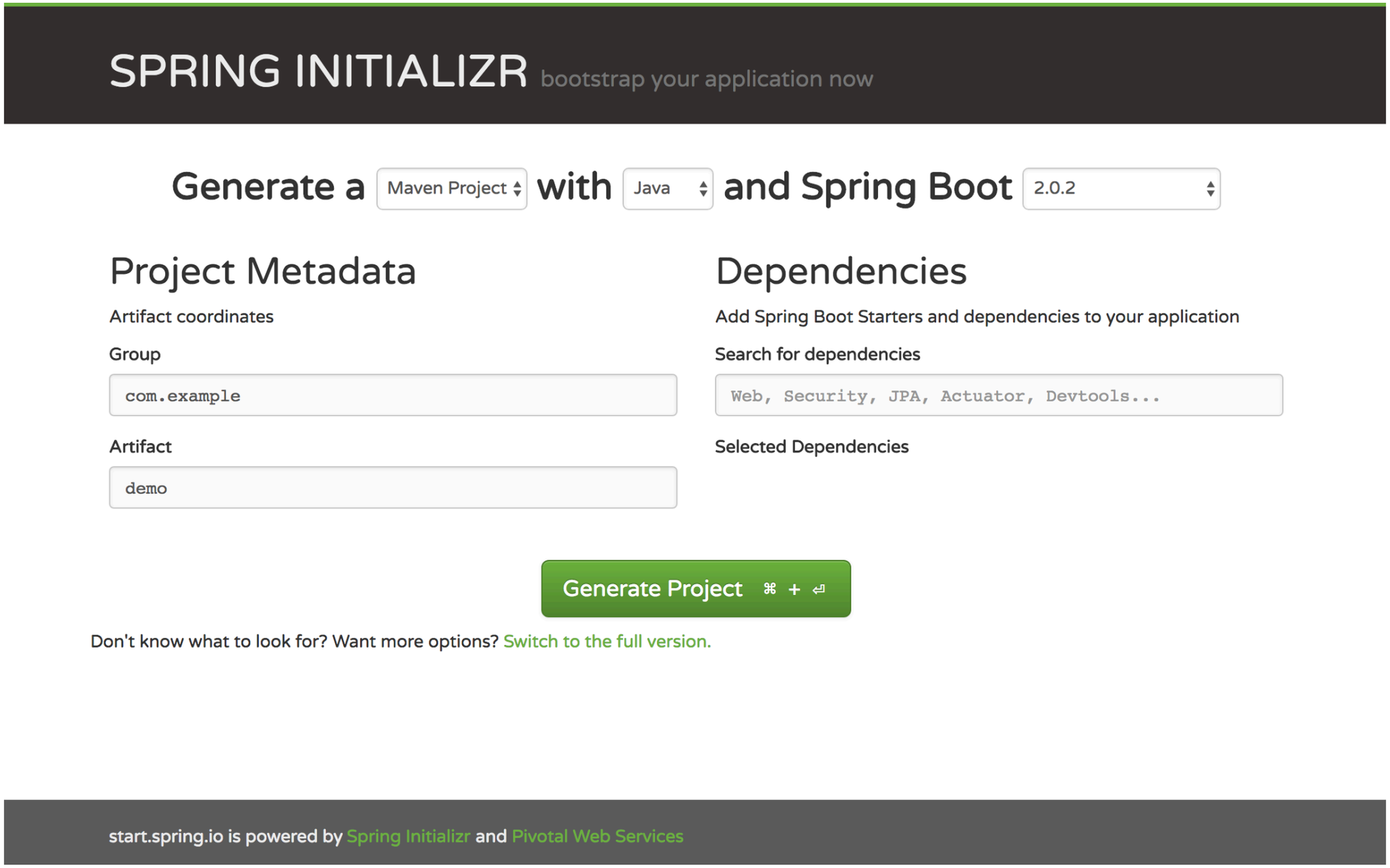
Service Structure



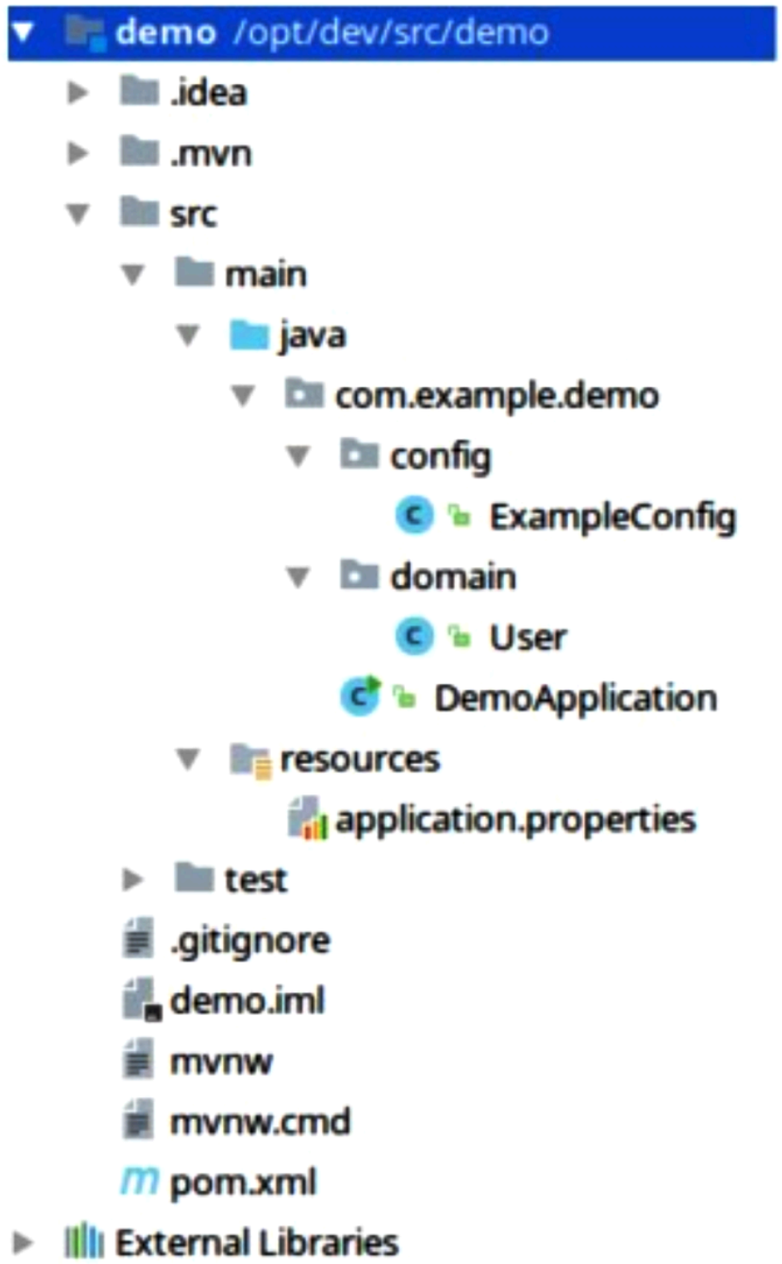
Create project with Spring Initializr

Spring Initializr

https://start.spring.io/



Structure of Spring Boot



Spring Boot main class

```
package com.example.demo;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class DemoApplication {

    public static void main(String[] args) {
        SpringApplication.run(DemoApplication.class, args);
    }
}
```

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)

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
```

Display all beans !!

```
@SpringBootApplication
public class DemoApplication {

    public static void main(String[] args) {
        ApplicationContext context
                = SpringApplication.run(DemoApplication.class,

        for (String name: context.getBeanDefinitionNames()) {
            System.out.println(name);
        }
    }

}
```

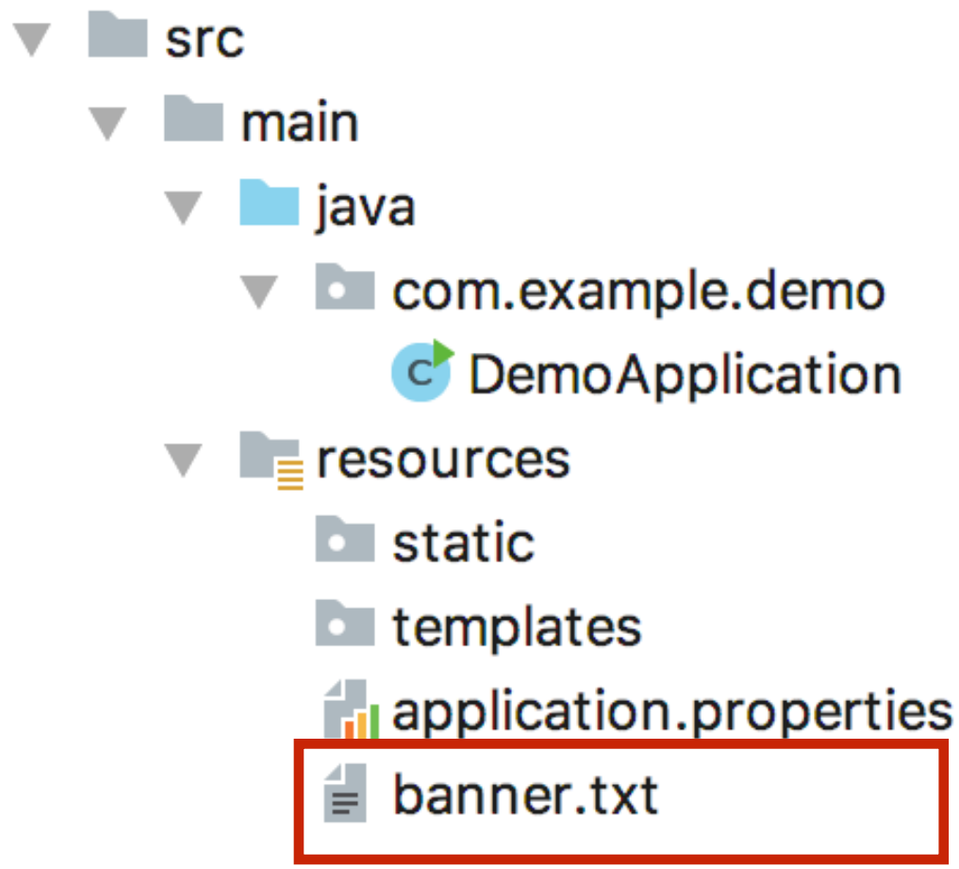
Custom Banner

Custom banner

```
  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: 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
```

Custom banner (1)

Create file banner.txt or banner.png in resources folder



Custom banner (2)

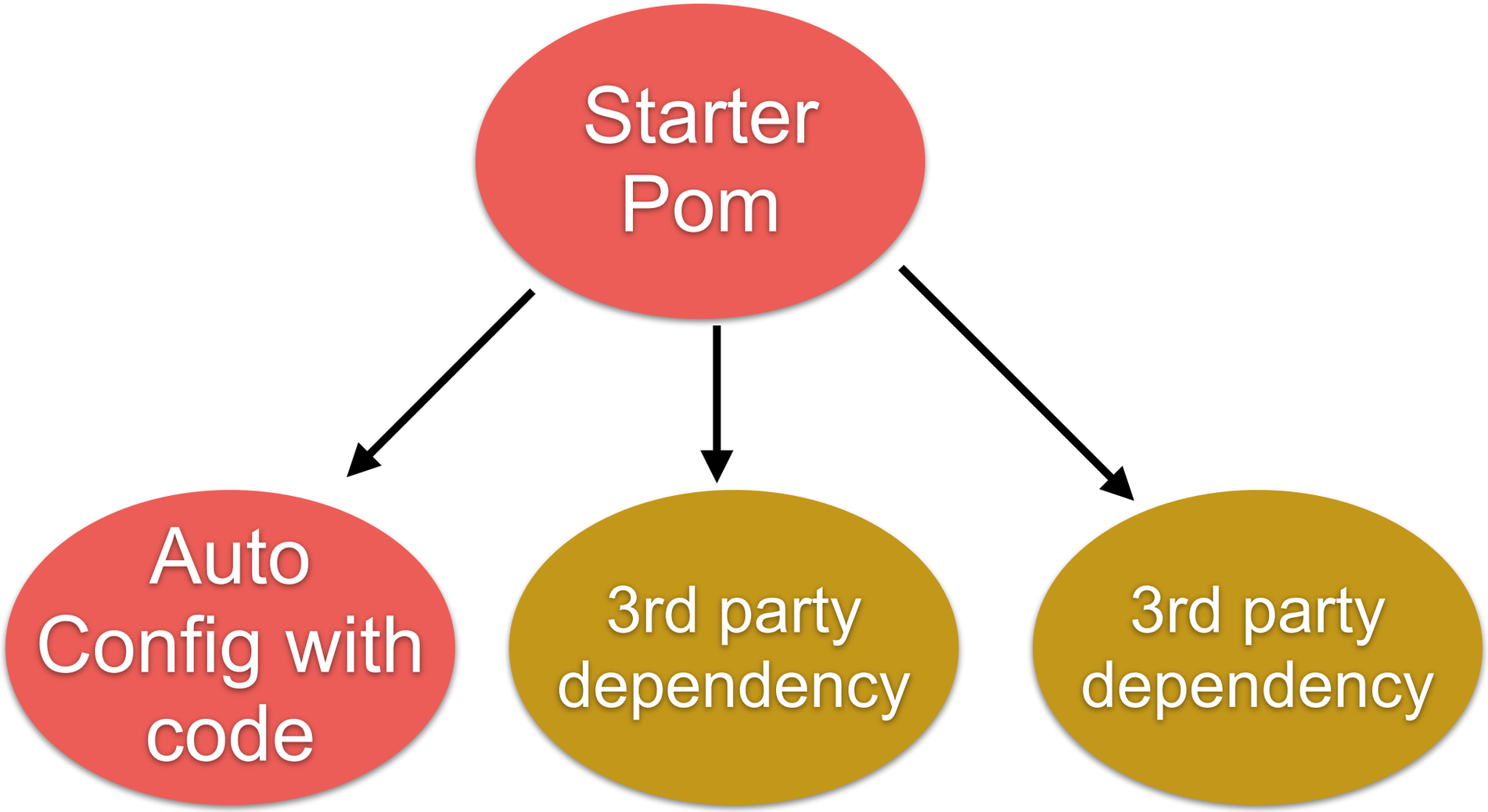
```
@SpringBootApplication
public class DemoApplication {

    public static void main(String[] args) {
        ImageBanner banner = new ImageBanner(
                new ClassPathResource("try.png"));

        new SpringApplicationBuilder()
                .sources(DemoApplication.class)
                .banner(banner)
                .run();
    }
}
```

Disable banner

```
@SpringBootApplication
public class DemoApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder()
        .sources(DemoApplication.class)
        .bannerMode(Banner.Mode.OFF)
        .run(args);
    }
}
```

Anatomy of Starter

Anatomy of Starter



Configuration management

Properties/XML/YAML

Config server (App, Spring cloud config, git)

17 ways !!!

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

Look at POM.xml

POM.xml (1)

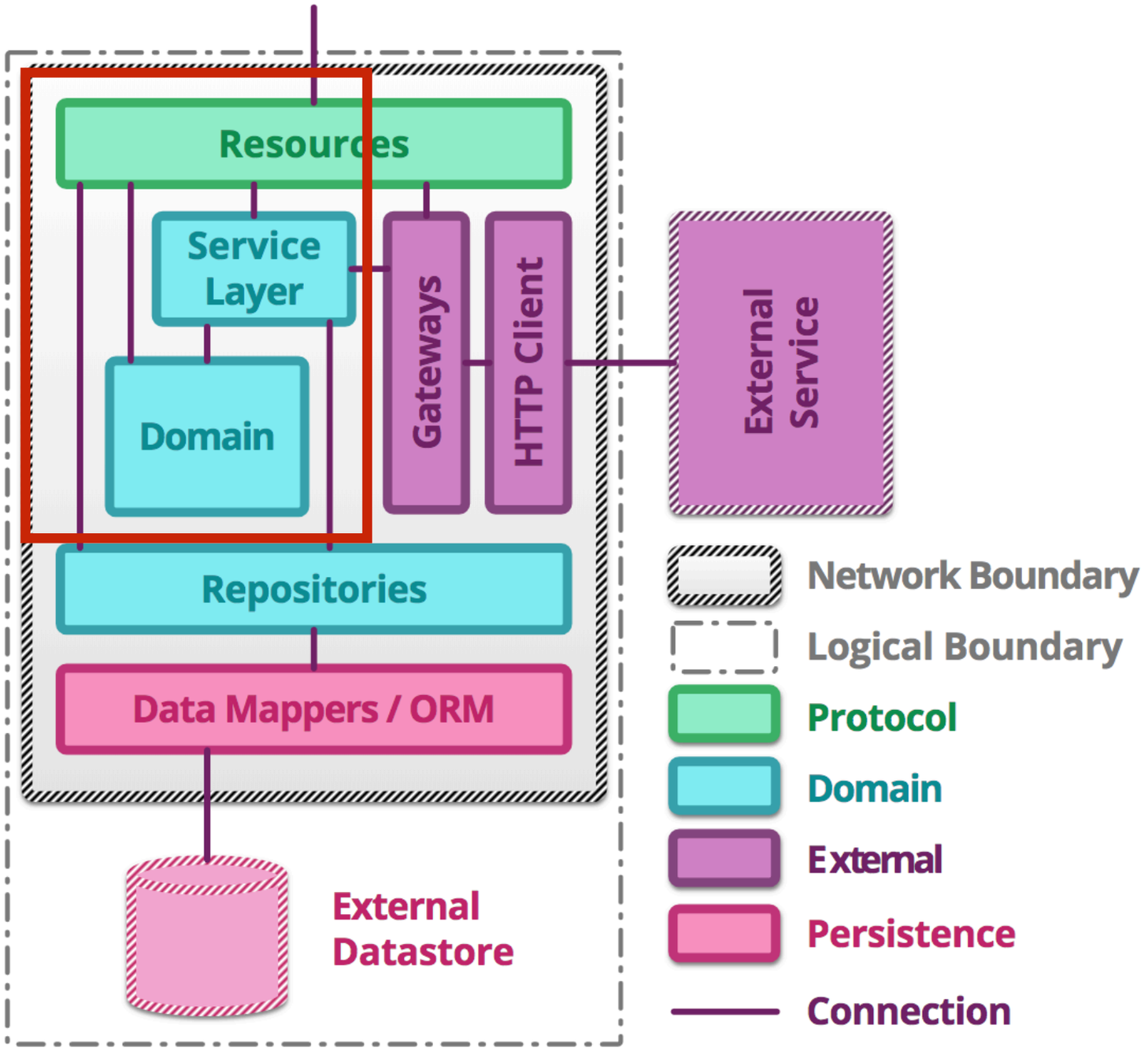
```xml
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.o
    <modelVersion>4.0.0</modelVersion>

    <groupId>hello</groupId>
    <artifactId>hello</artifactId>
    <version>1.0-SNAPSHOT</version>
    <packaging>jar</packaging>

    <parent>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-parent</artifactId>
        <version>2.0.0.RELEASE</version>
        <relativePath/> <!-- lookup parent from repository -->
    </parent>

    <properties>
        <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
        <project.reporting.outputEncoding>UTF-8</project.reporting.outputEncoding>
        <java.version>1.8</java.version>
    </properties>
```

POM.xml (2)

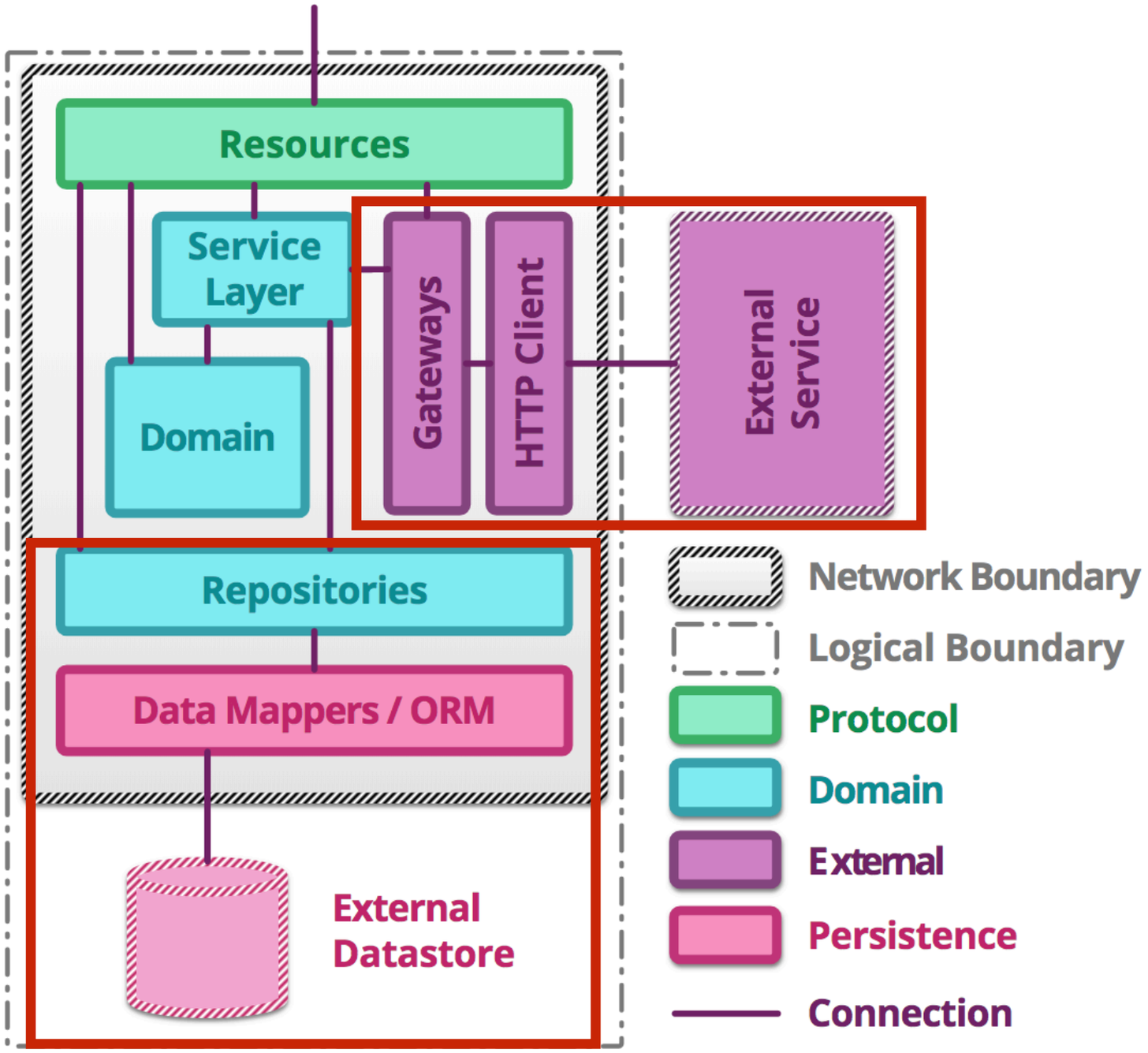
```xml
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>

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

<build>
    <finalName>hello</finalName>
    <plugins>
        <plugin>
            <groupId>org.springframework.boot</groupId>
            <artifactId>spring-boot-maven-plugin</artifactId>
        </plugin>
    </plugins>
</build>
```

Basic structure of Spring Boot

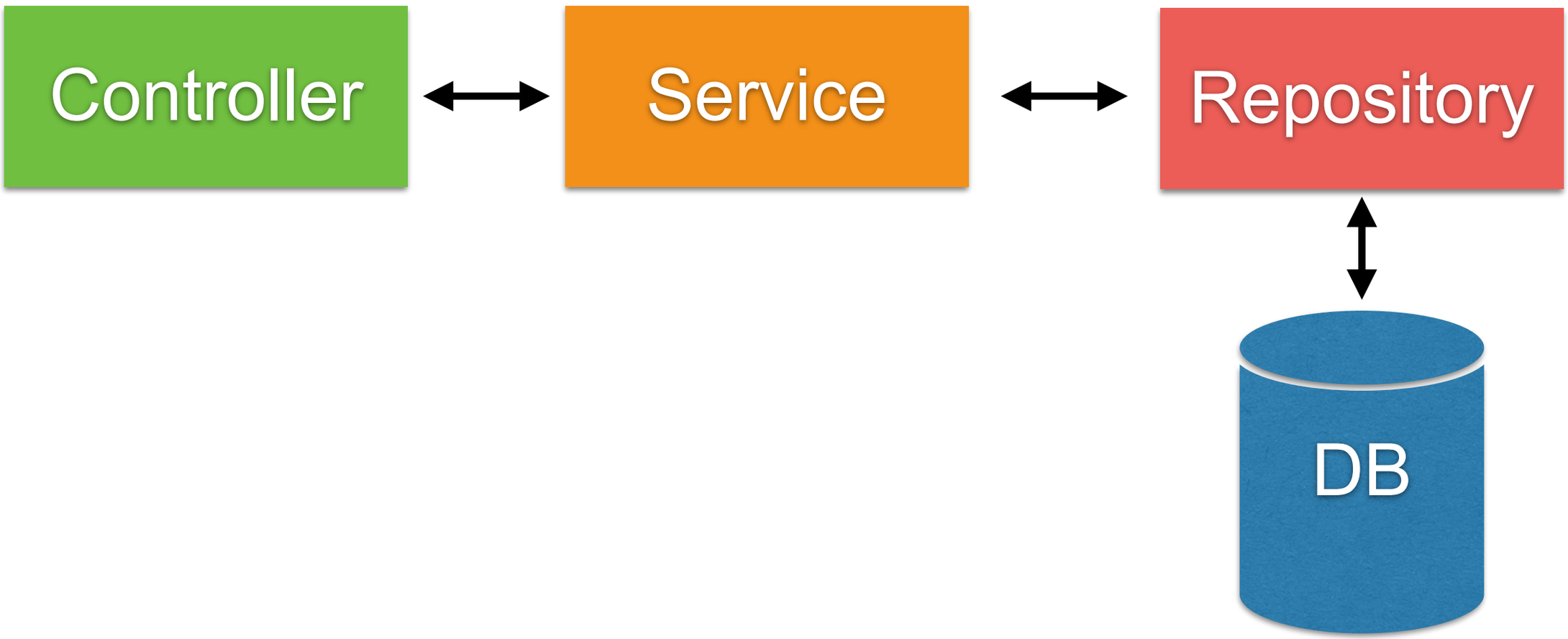
Service Structure



Service Structure



Basic structure of Spring Boot



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)

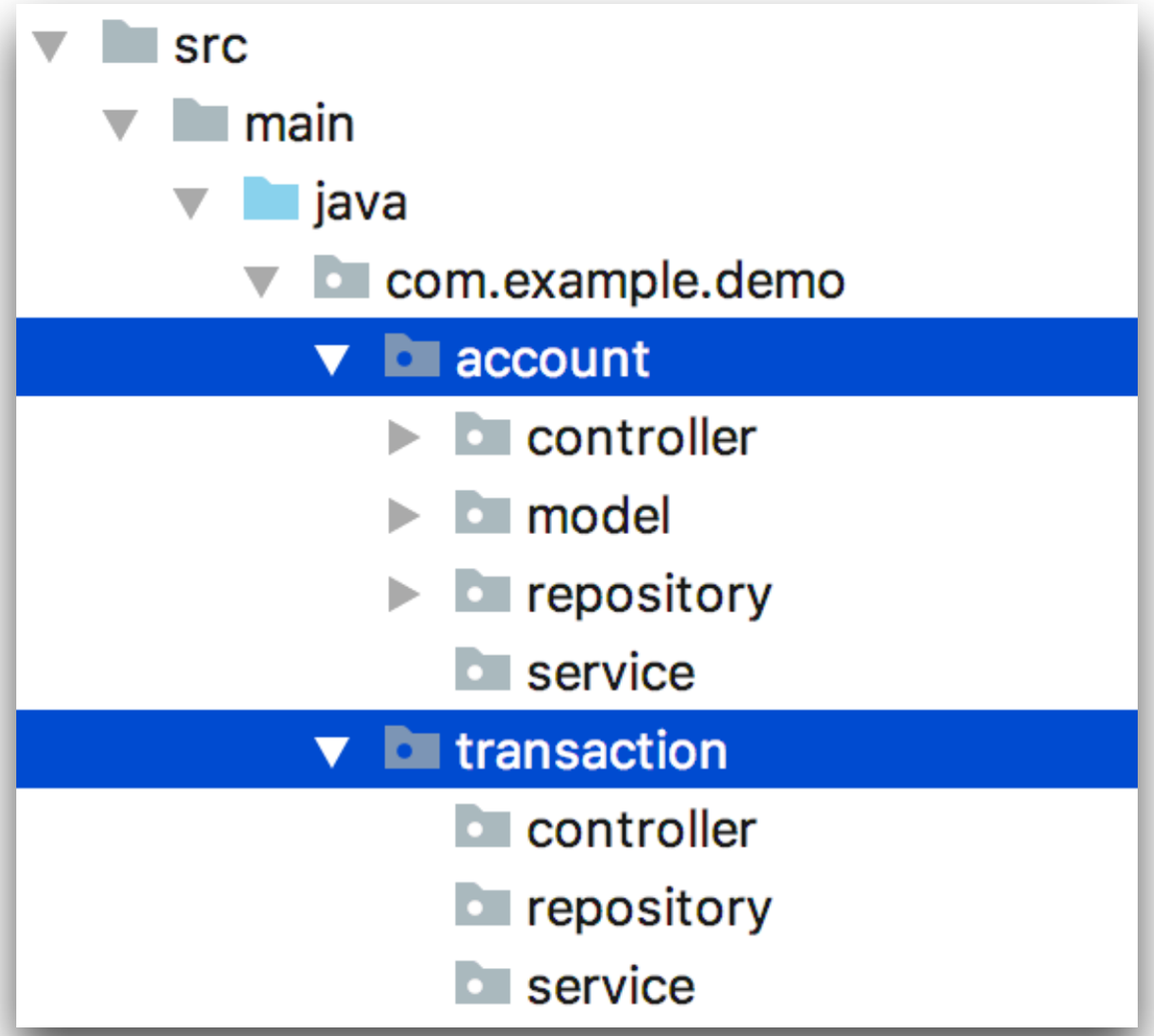
Separate by function/domain/feature

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

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

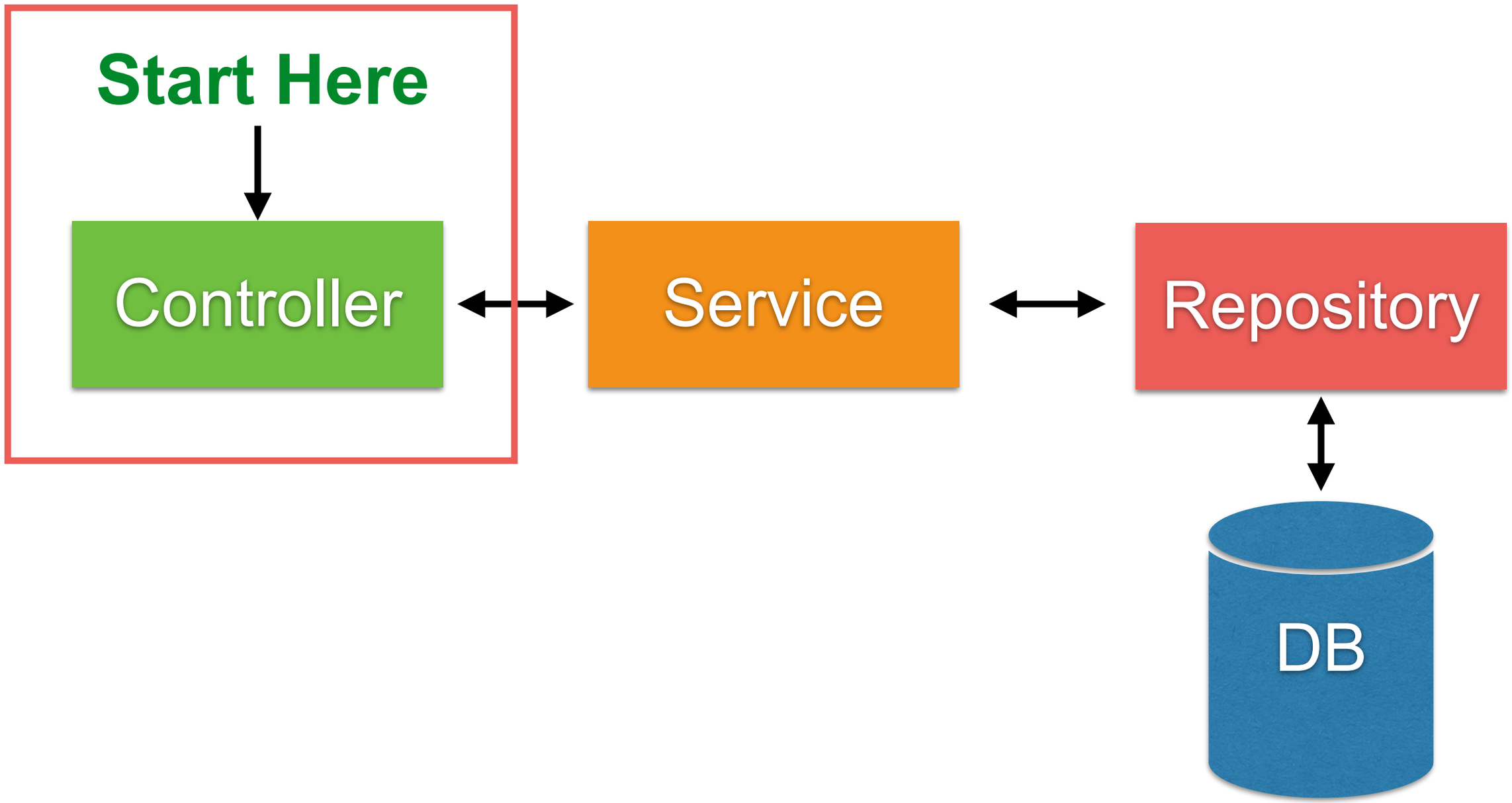
Spring Boot Structure (2)

Separate by function/domain/feature

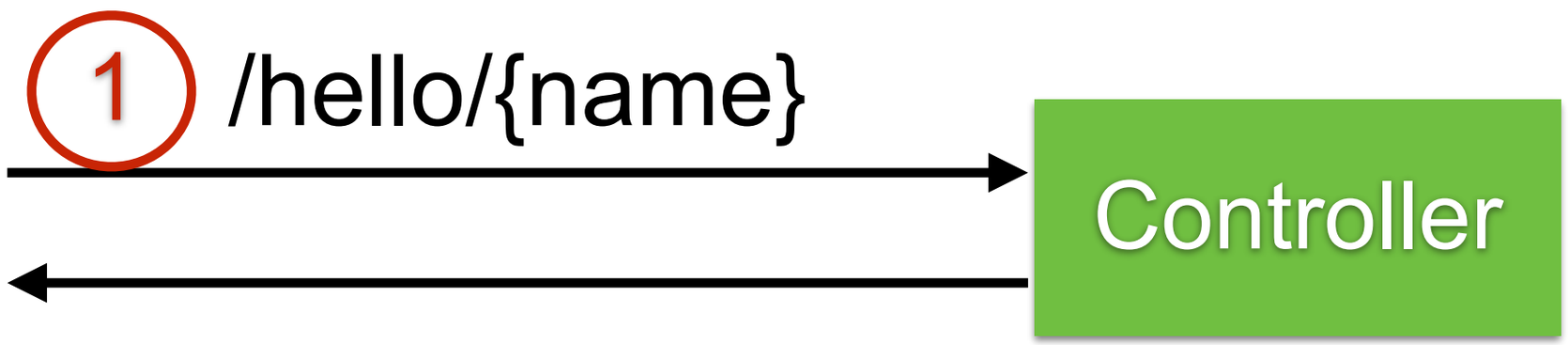


Create first RESTful API

Basic structure of Spring Boot



Hello API




```
{
    "message": "Hello, somkiat"
}
```

2

1. Create REST Controller

HelloController.java

```java
@RestController
public class HelloController {

    @GetMapping("/hello/{name}")
    public Hello sayHi(@PathVariable String name) {
        return new Hello("Hello, " + name);
    }

}
```

2. Create model class

Hello.java

```
public class Hello {

    private String message;

    Hello(String message) {
        this.message = message;
    }

    public String getMessage() {
        return message;
    }

    public void setMessage(String message) {
        this.message = message;
    }
}
```

3. Compile and Packaging

$mvnw clean package

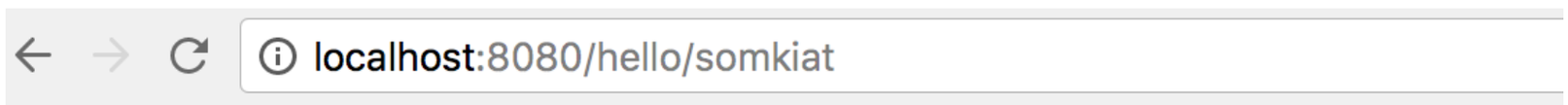
4. Run

$java -jar target/hello.jar

```
  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::        (v2.0.0.RELEASE)

2018-03-05 23:37:18.018  INFO 30560 --- [           mai
                    : Starting HelloApplication v1.0-SNAPSH(
th PID 30560 (/Users/somkiat/data/slide/microservice/sl:
op/course-microservice/slide/4days-workshop/workshop/he1
 by somkiat in /Users/somkiat/data/slide/microservice/s1
hop/course-microservice/slide/4days-workshop/workshop/he
2018-03-05 23:37:18.023  INFO 30560 --- [           mai
                    : No active profile set, falling back t(
2018-03-05 23:37:18.138  INFO 30560 --- [           mai
```

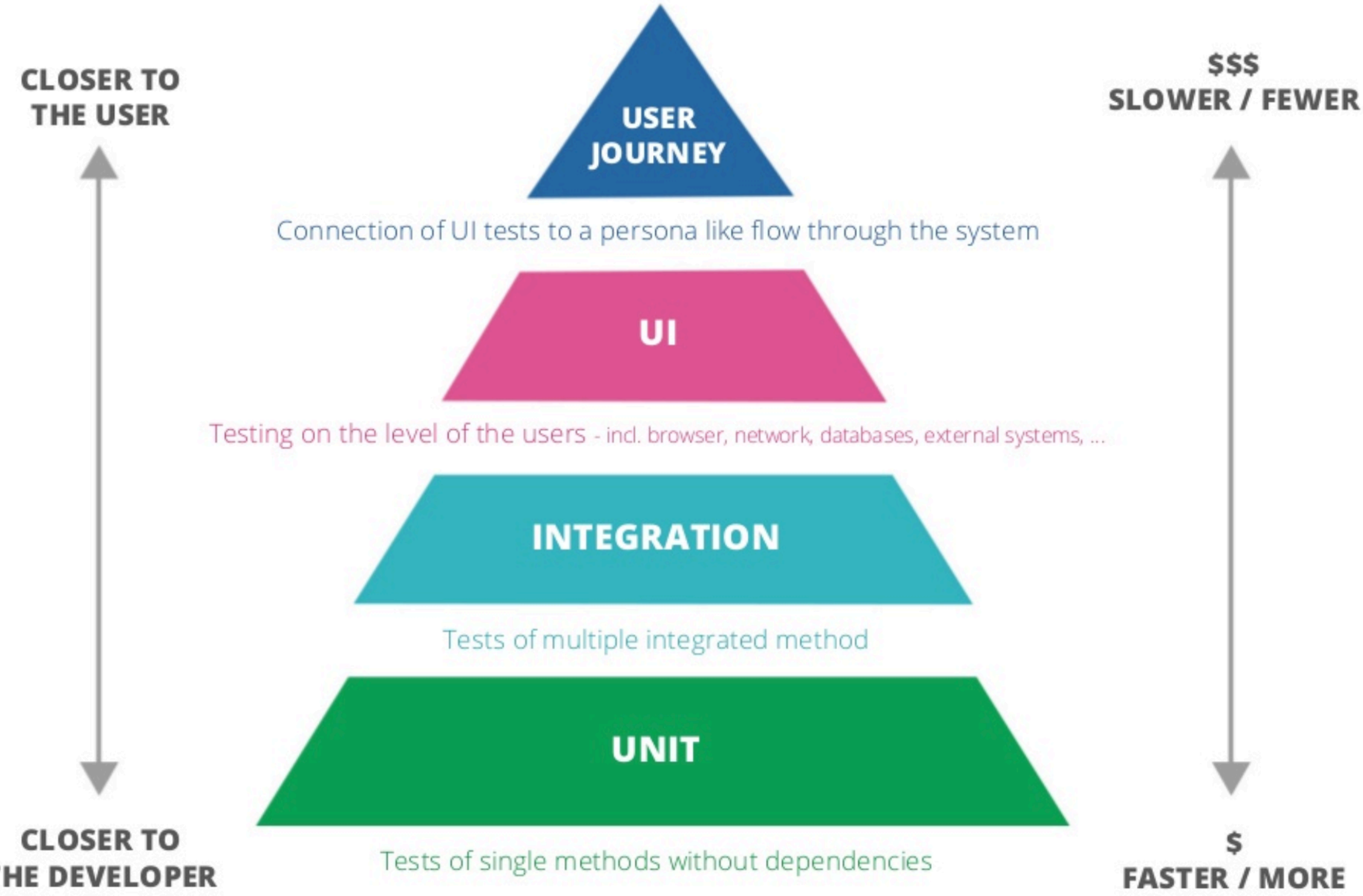
5. Open in browser

http://localhost:8080/hello/somkiat



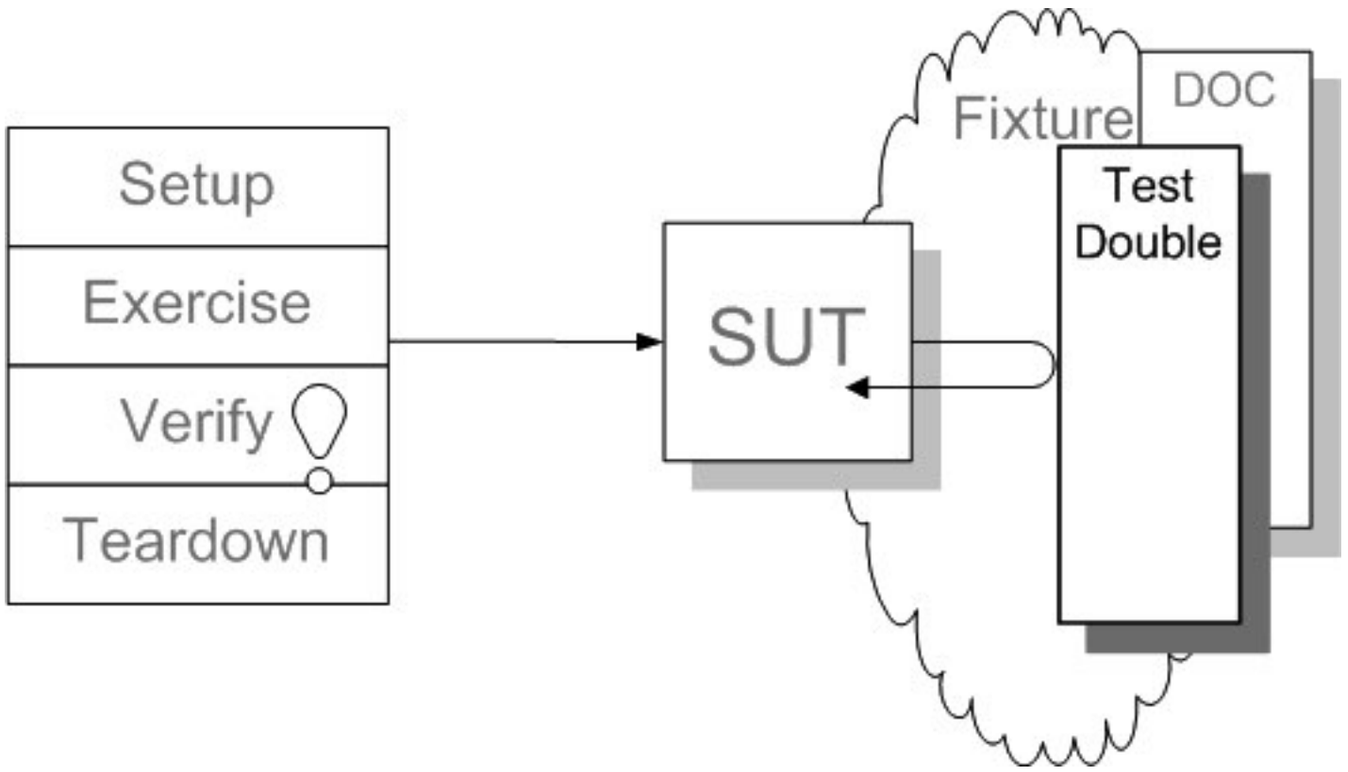
{"message":"Hello somkiat"}

How to test the Hello controller ?



Test Double

How can we verify logic independently ?
How can we avoid Slow tests ?



http://xunitpatterns.com/Test%20Double.html

Types of Test Double

Based on **how** and **why** we use it !!

Dummy object	Test stub	Test spy	Mock object	Fake object

Controller testing

How to testing with Spring Boot ?

Testing in Spring Boot

@SpringBootTest
@WebMVCTest
@JsonTest
@DataJpaTest
@RestClientTest

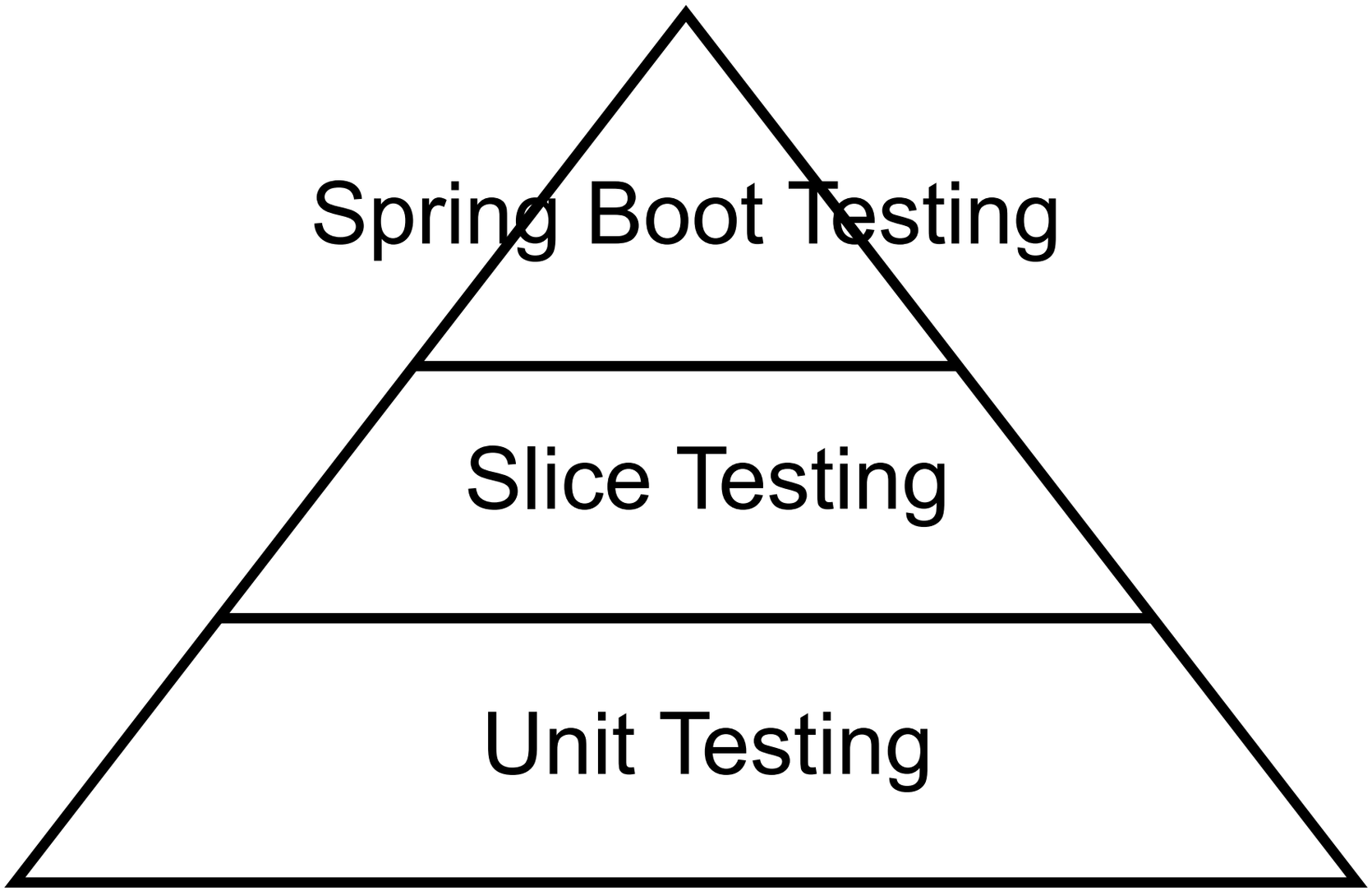
Testing in Spring Boot

@SpringBootTest

@WebMVCTest
@JsonTest
@DataJpaTest
@RestClientTest

Slice testing

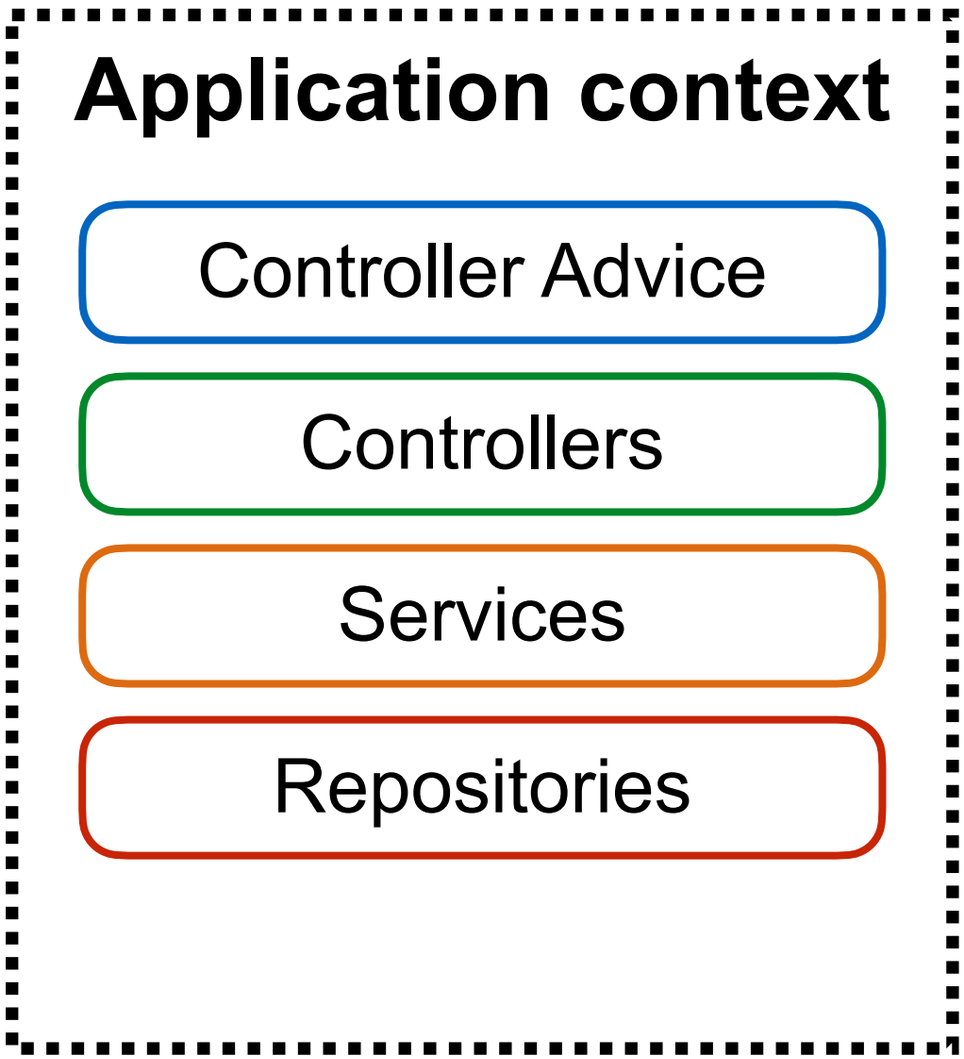
Testing in Spring Boot



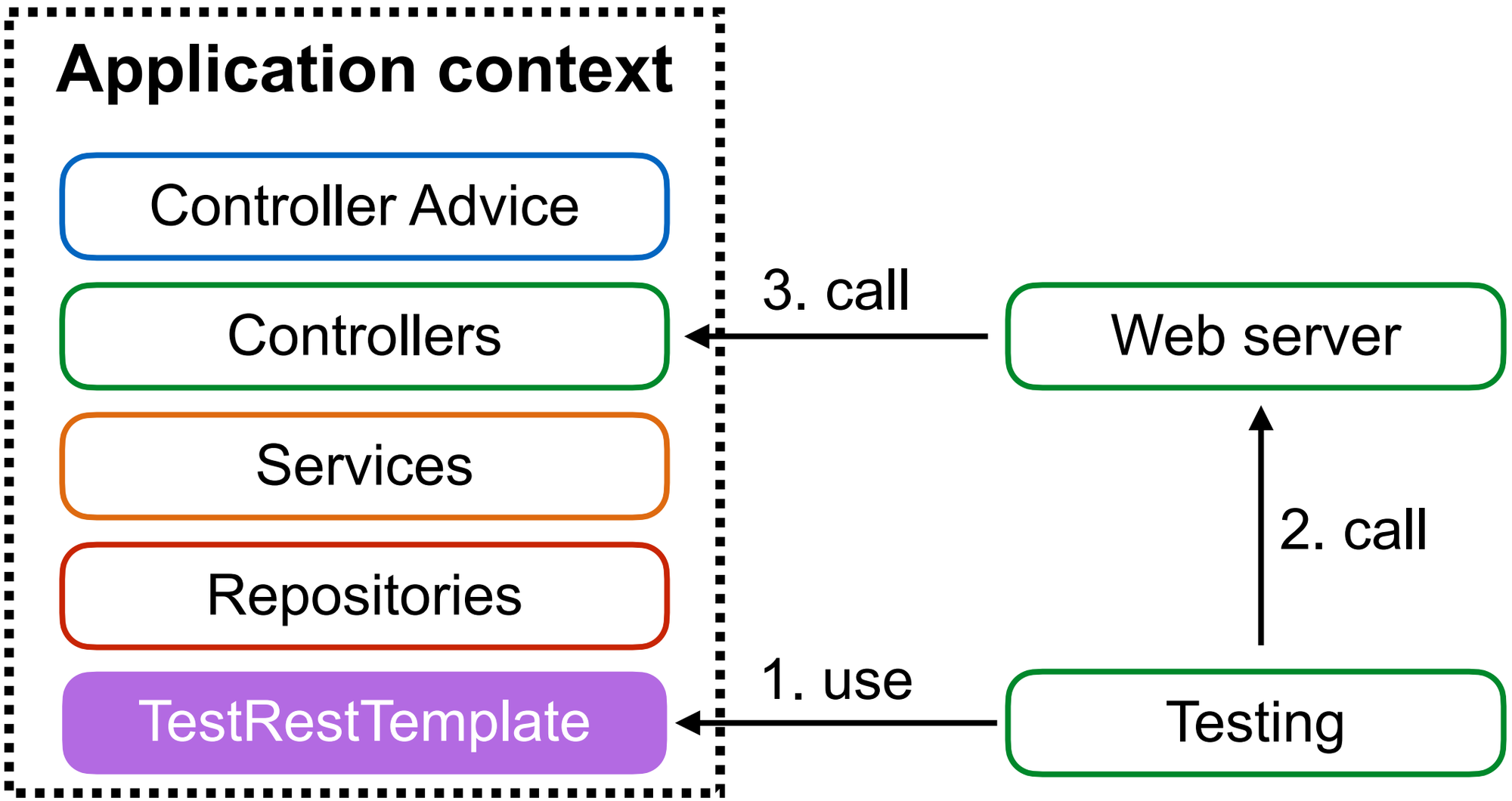
Controller testing

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

1. SpringBootTest



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());

    }
}
```

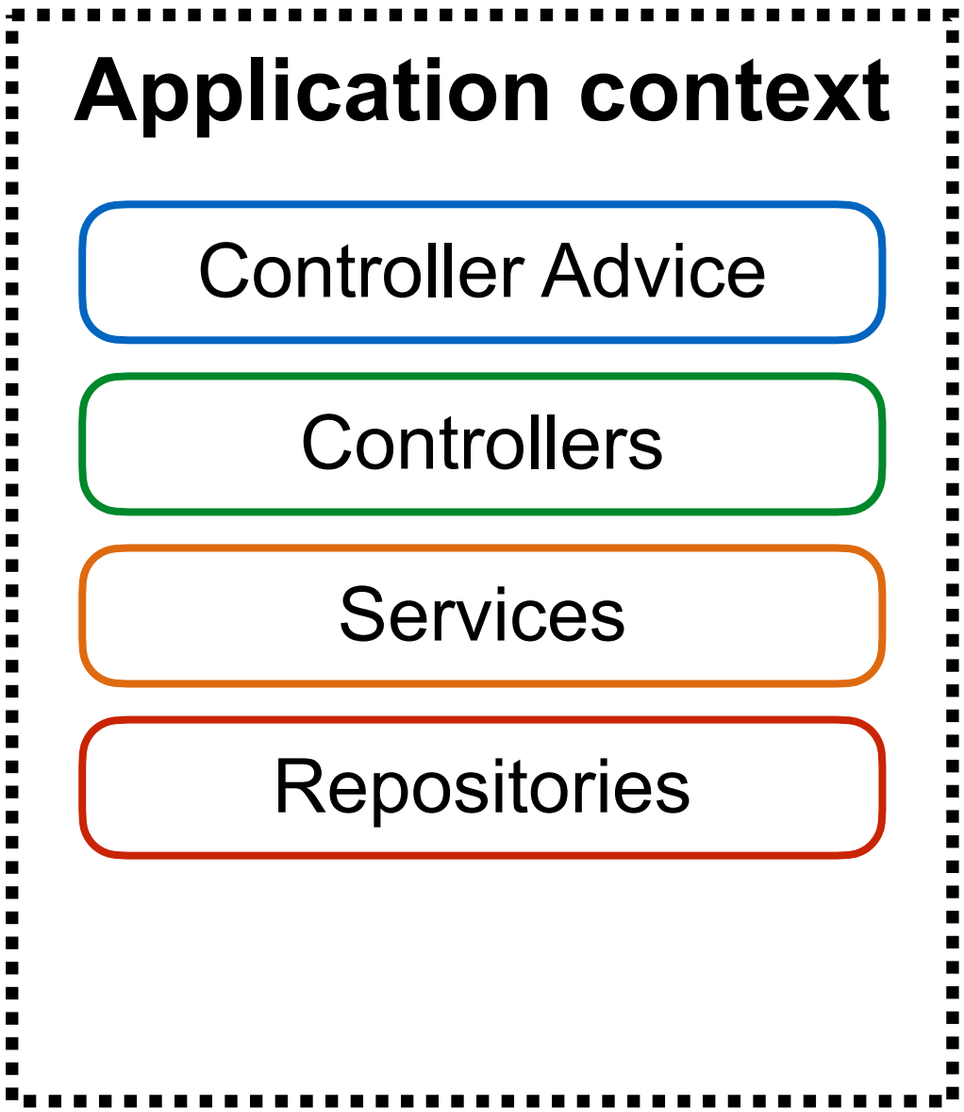
SpringBootTest #2

```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());

    }
}
```

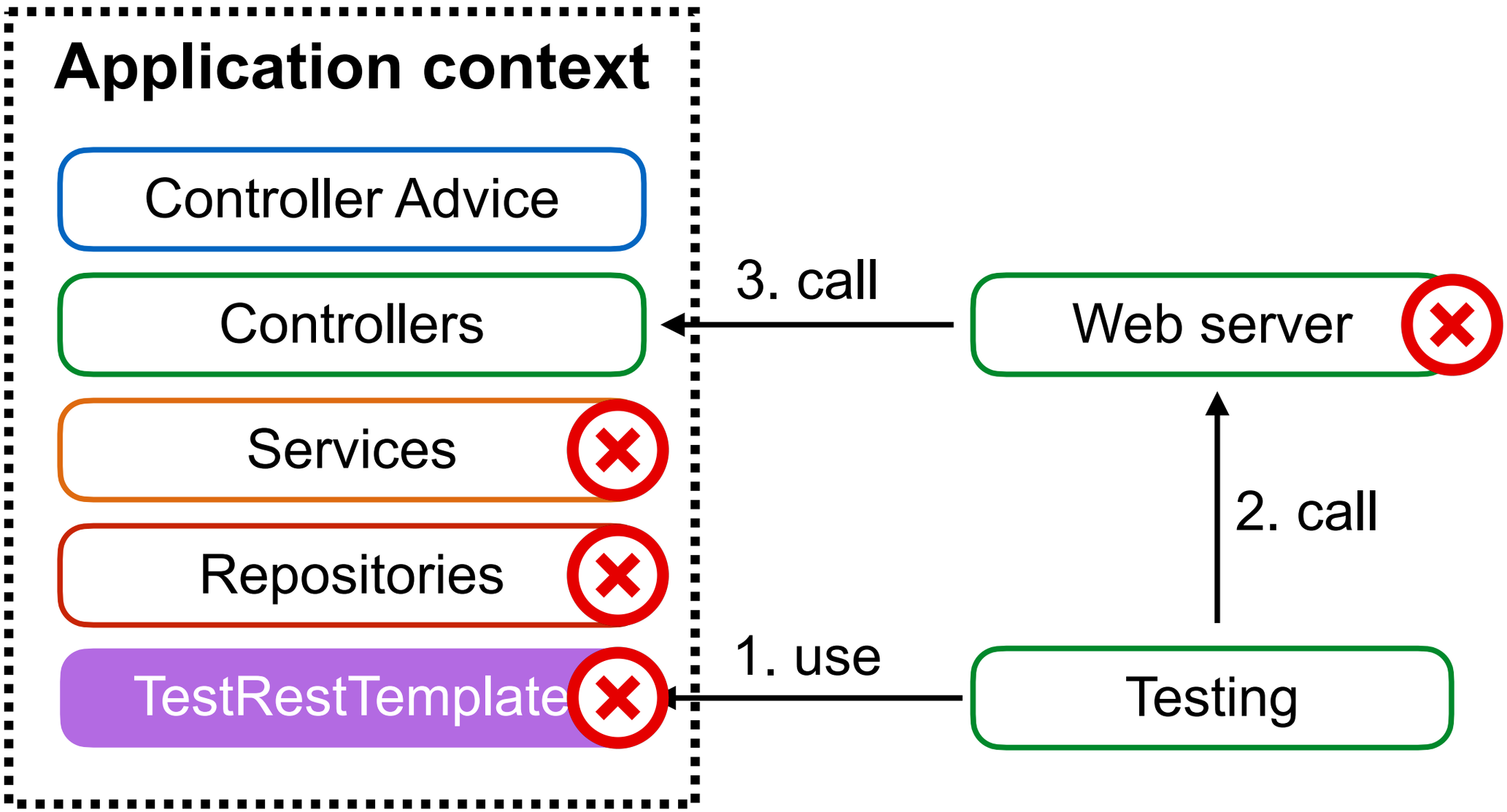
SpringBootTest #3

```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

```
@RunWith(MockitoJUnitRunner.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

```
@RunWith(MockitoJUnitRunner.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

```
@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

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

```
@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);

    }

}
```

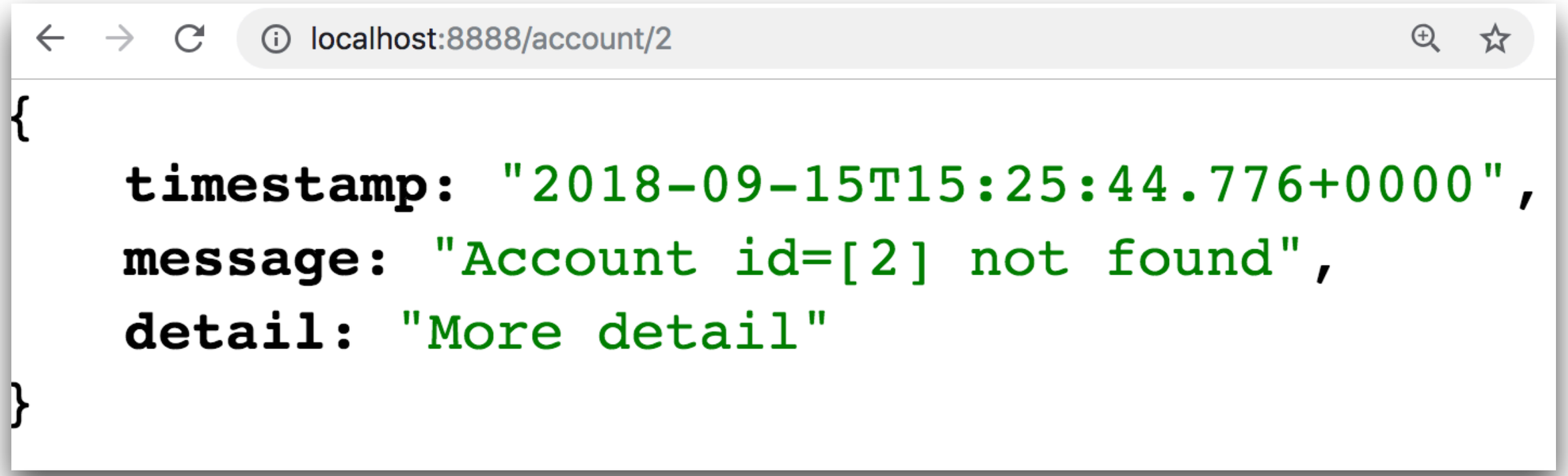
2

ExceptionReponse

Response format of error

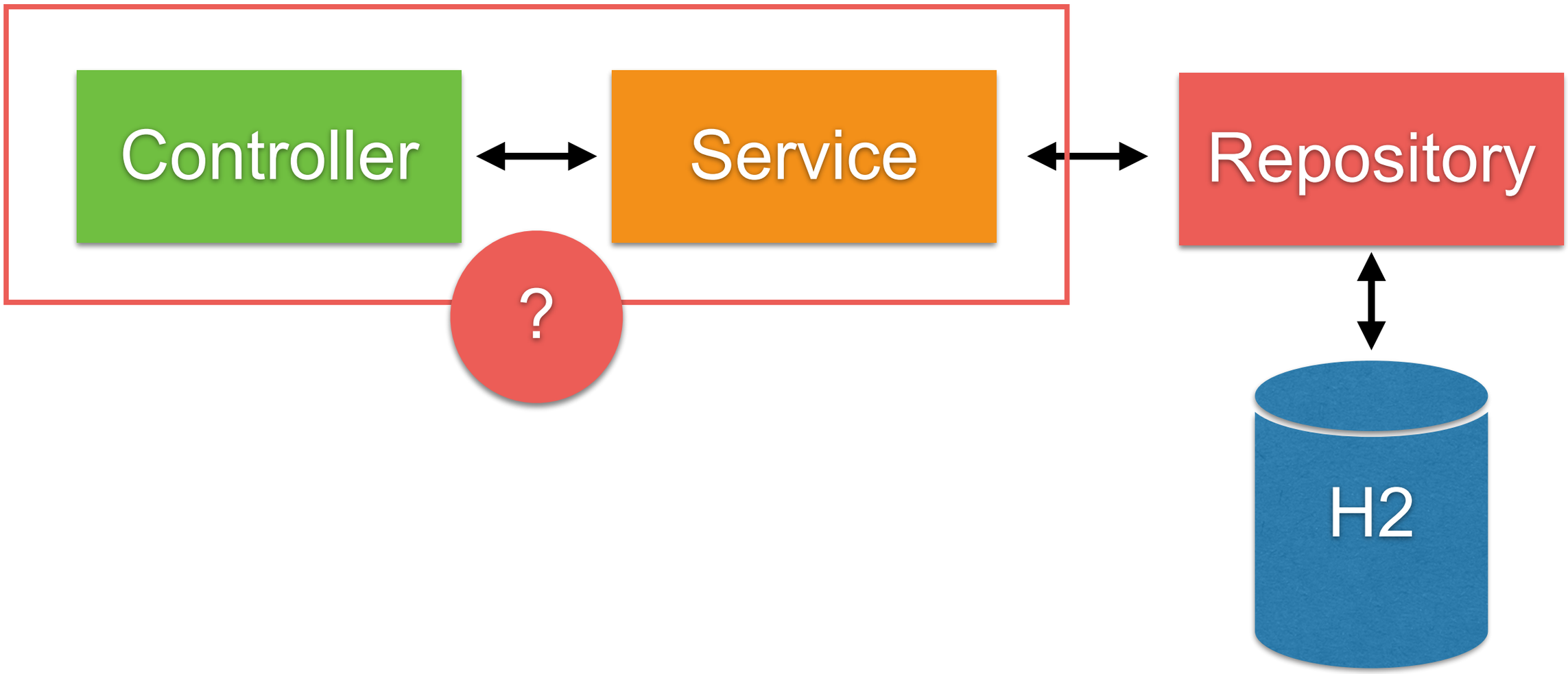
```
public class ExceptionResponse{

    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

```
@RunWith(MockitoJUnitRunner.class)
public class UserServiceWithExceptionTest {

    @Mock
    private AccountRepository accountRepository;

    @Test(expected = MyAccountNotFoundException.class)
    public void getAccountWithException() {
        // Stub
        given(accountRepository.findById(1))
                .willThrow(new MyAccountNotFoundException("Not found"));

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

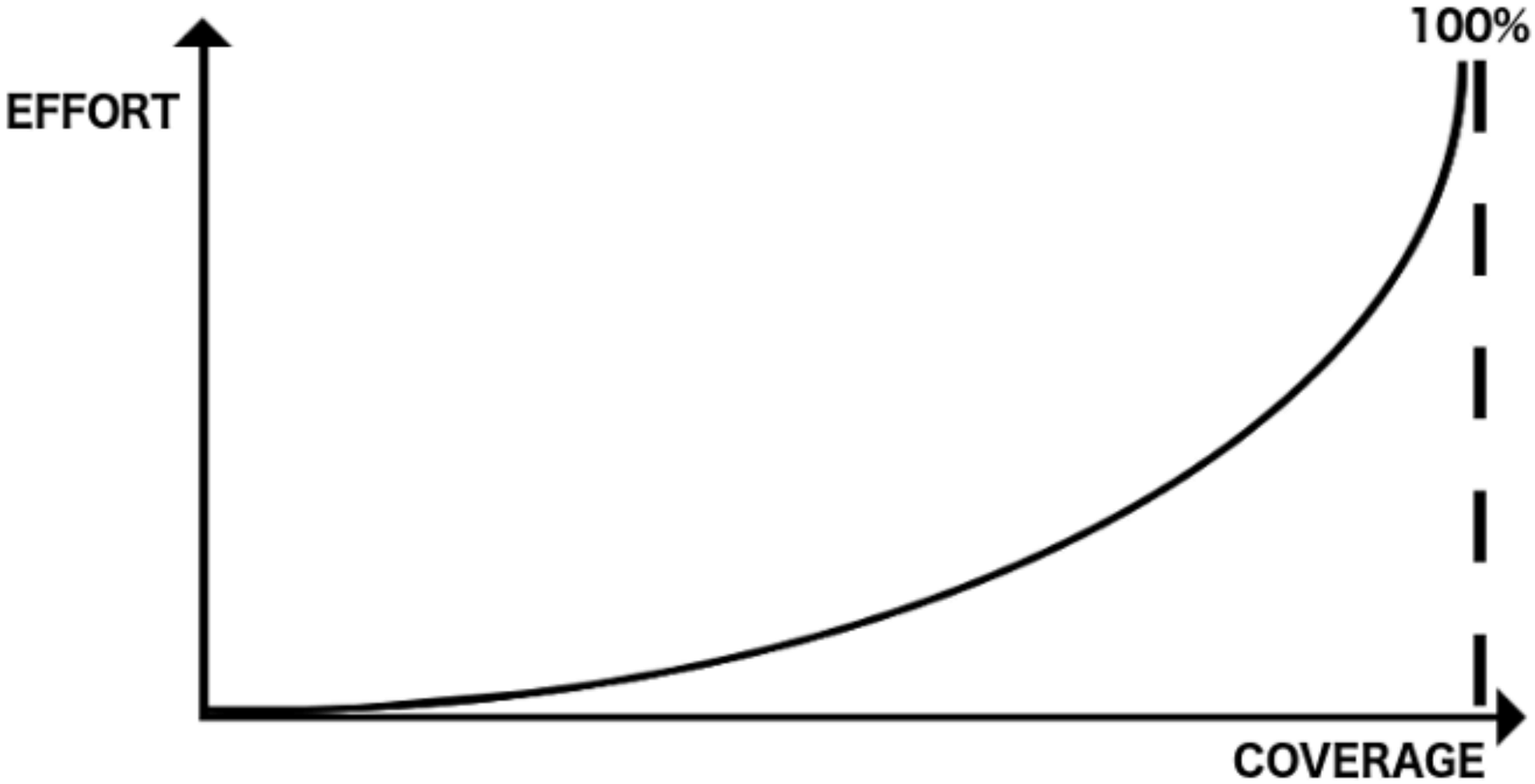
But 100% of code coverage **does not mean** that your code is 100% correct

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

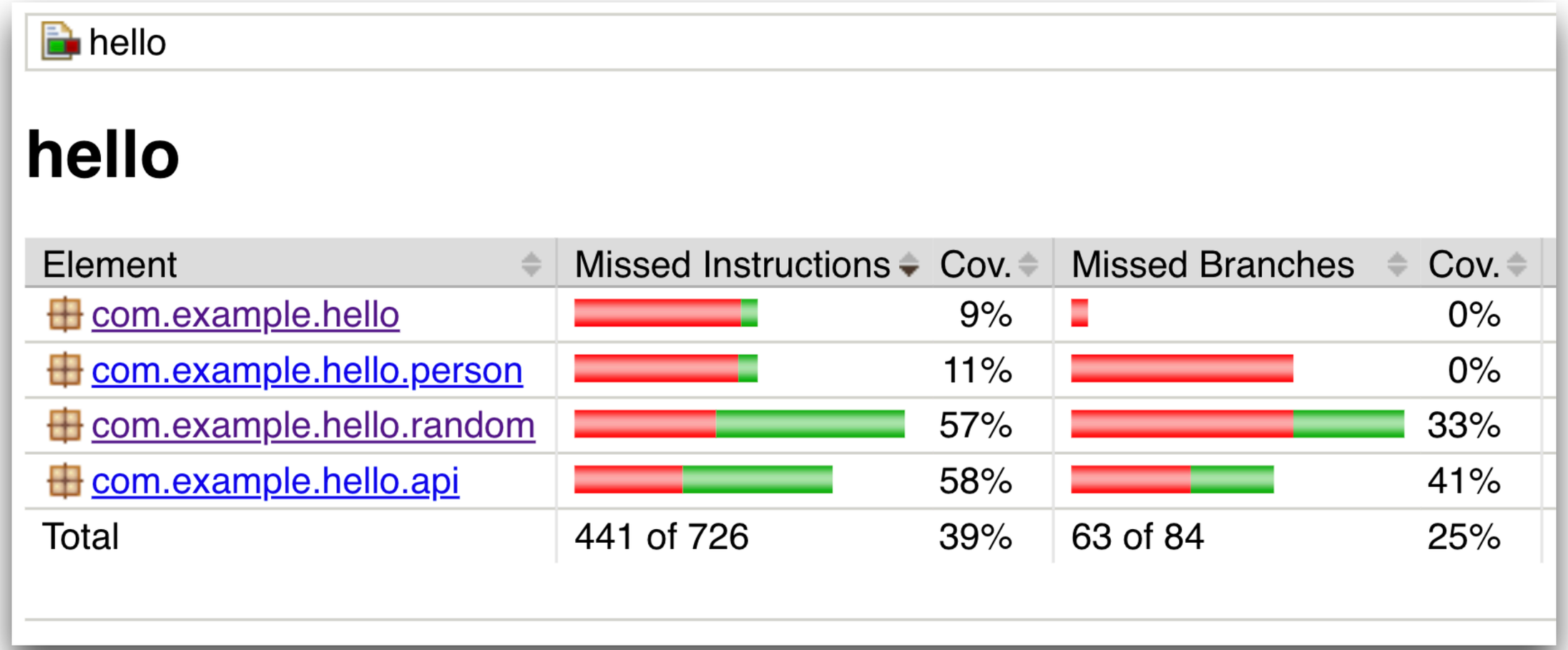
Run test again

$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
------------------------------------------------------------------------
```

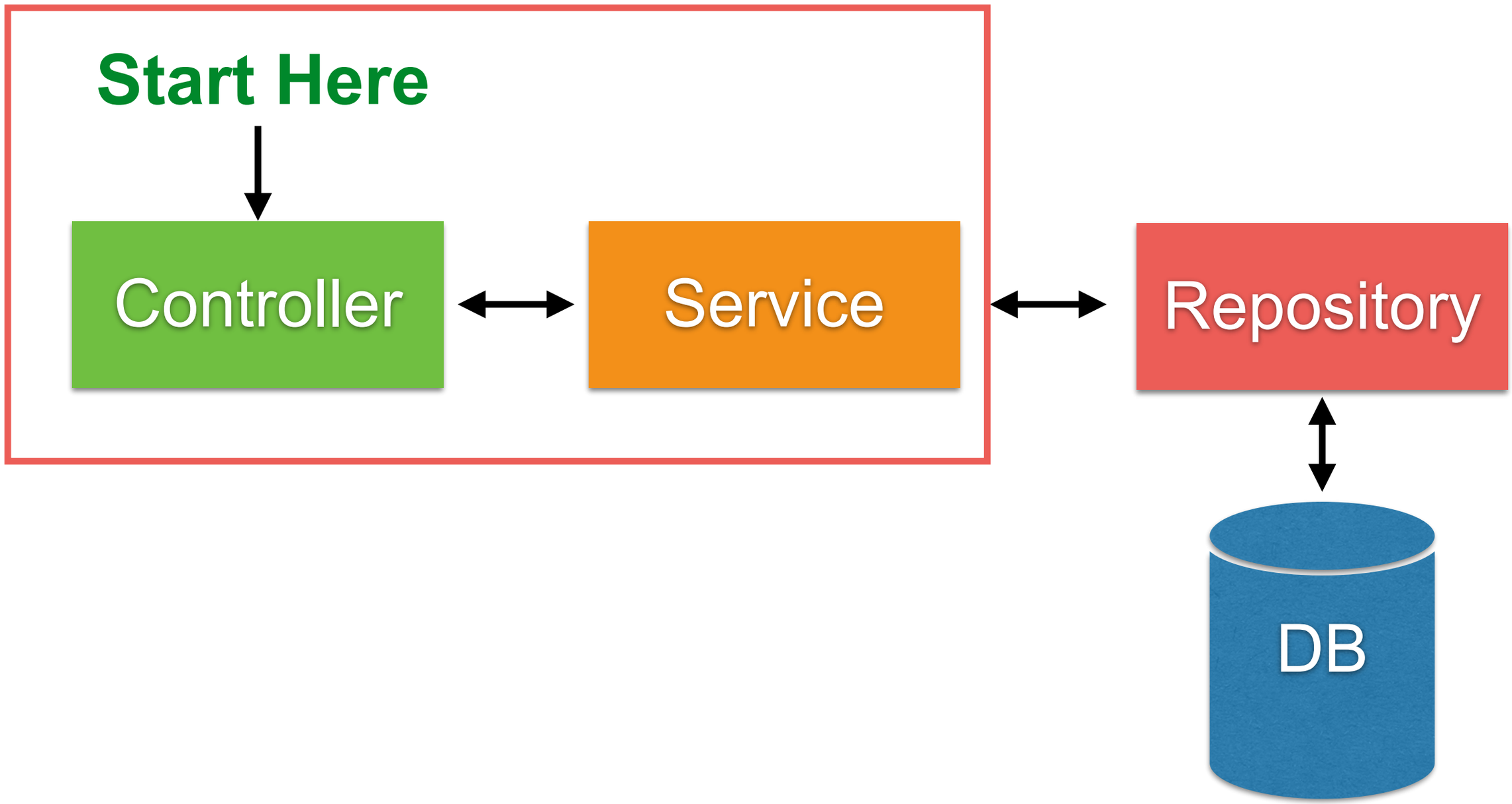
Coverage report

open target/site/jacoco/index.html



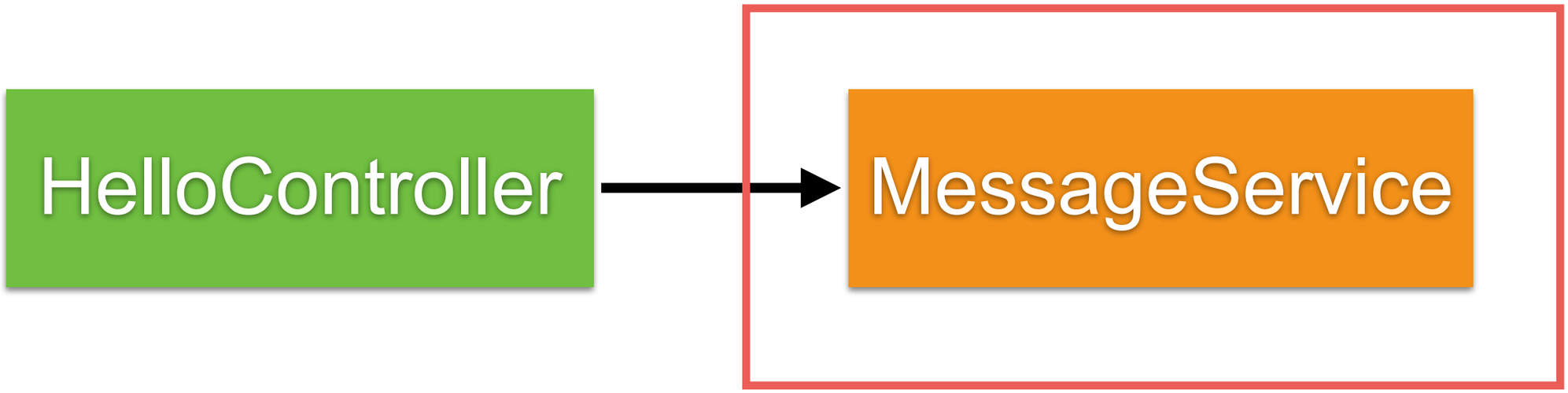
Move business logic to service

Working with service



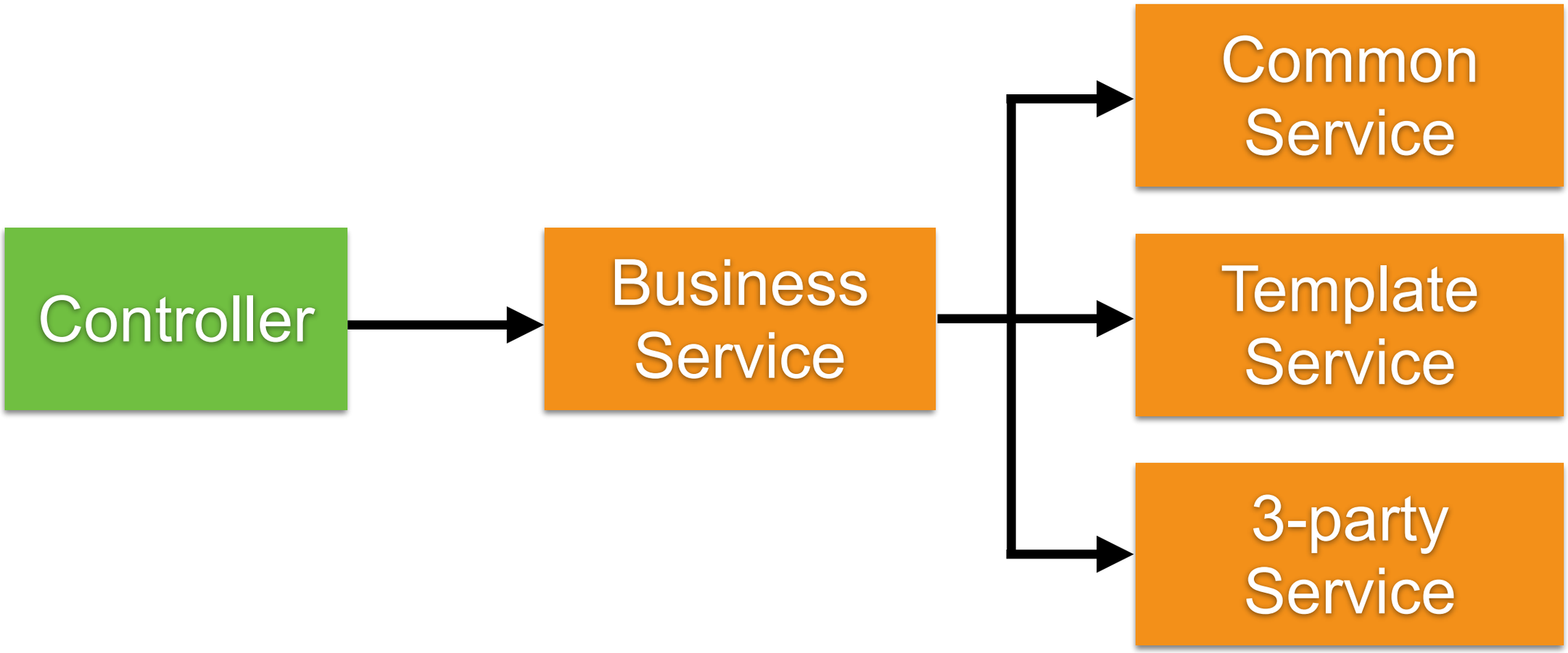
Move business logic to service

Service class or interface ?

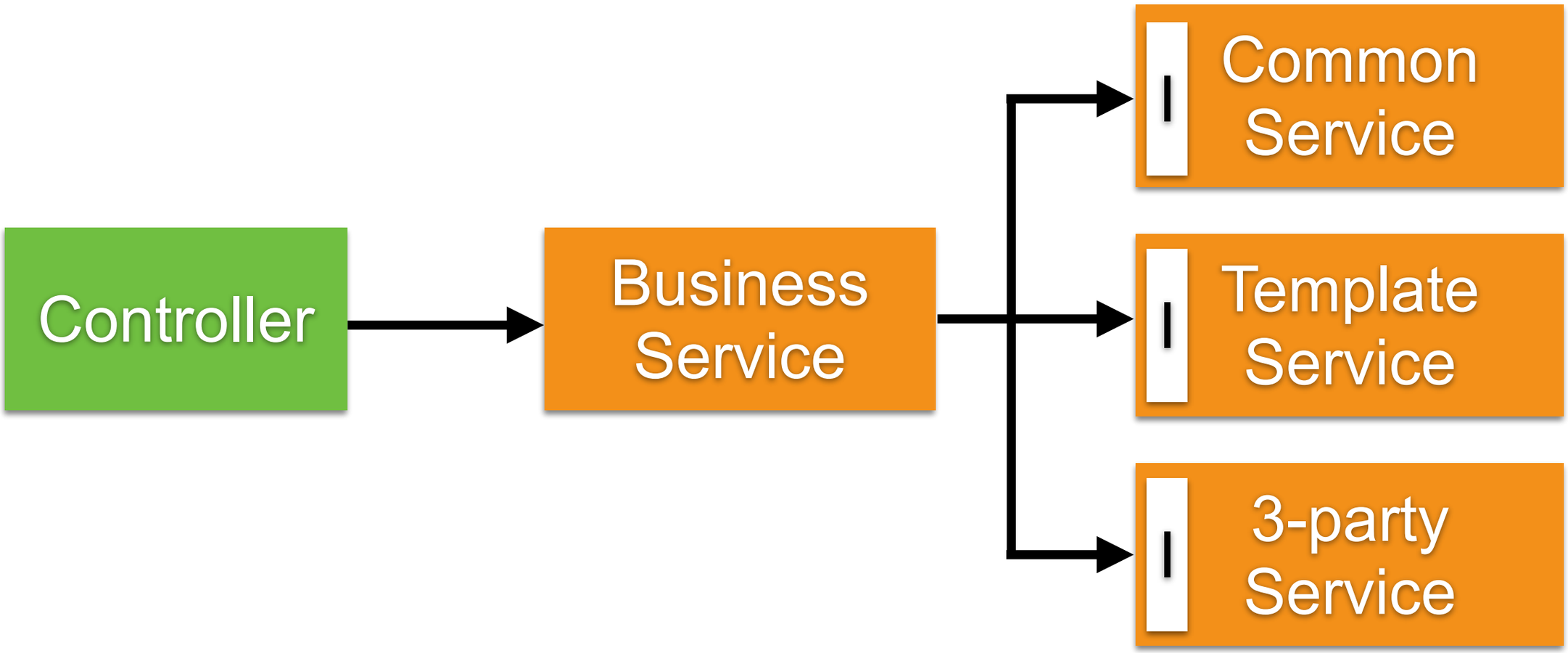


Types of service

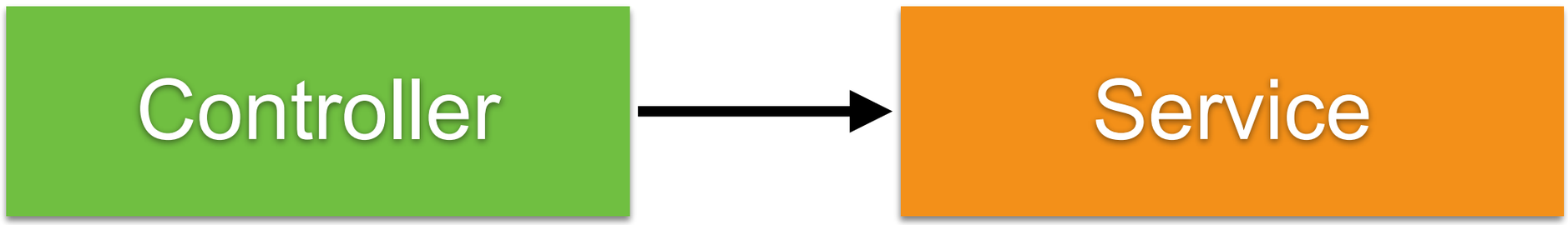
Business services (not reuse)
Common/Template/3-party services



Interface for common service



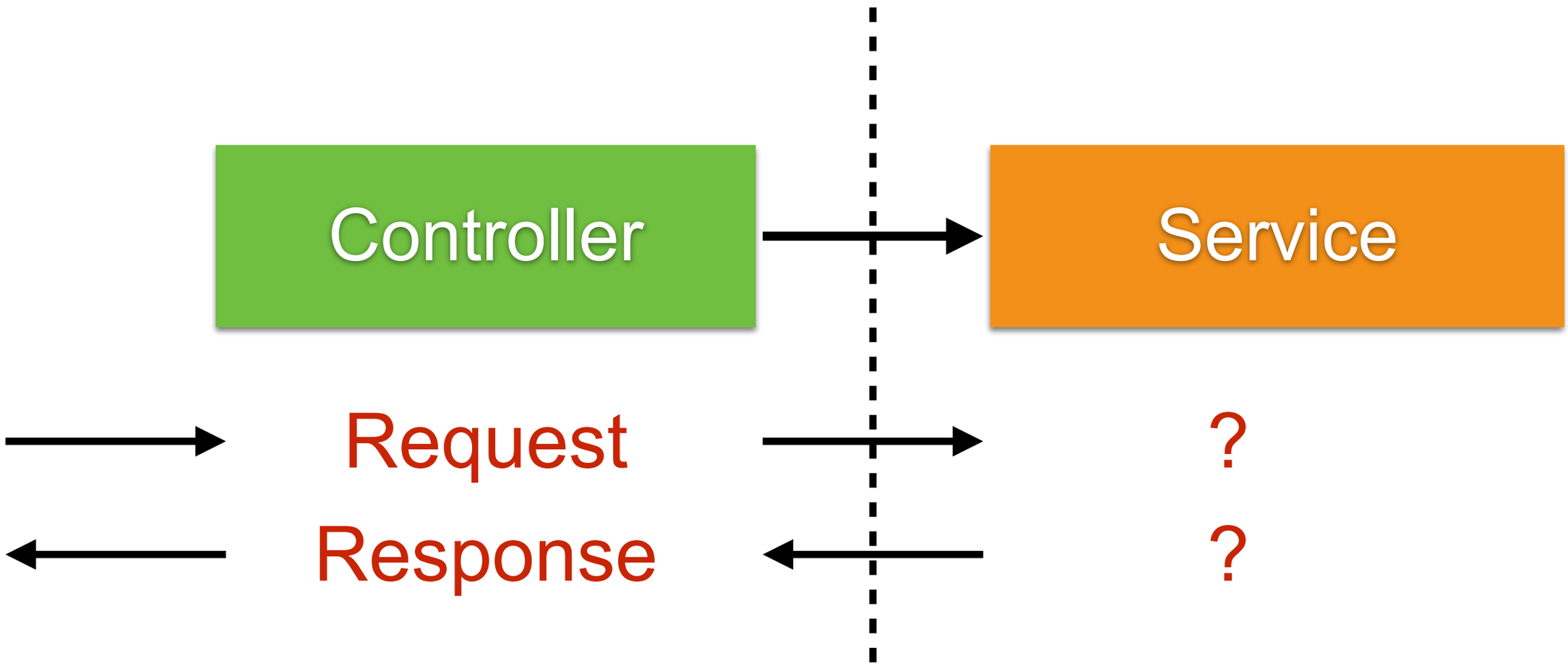
Data Model for service ?



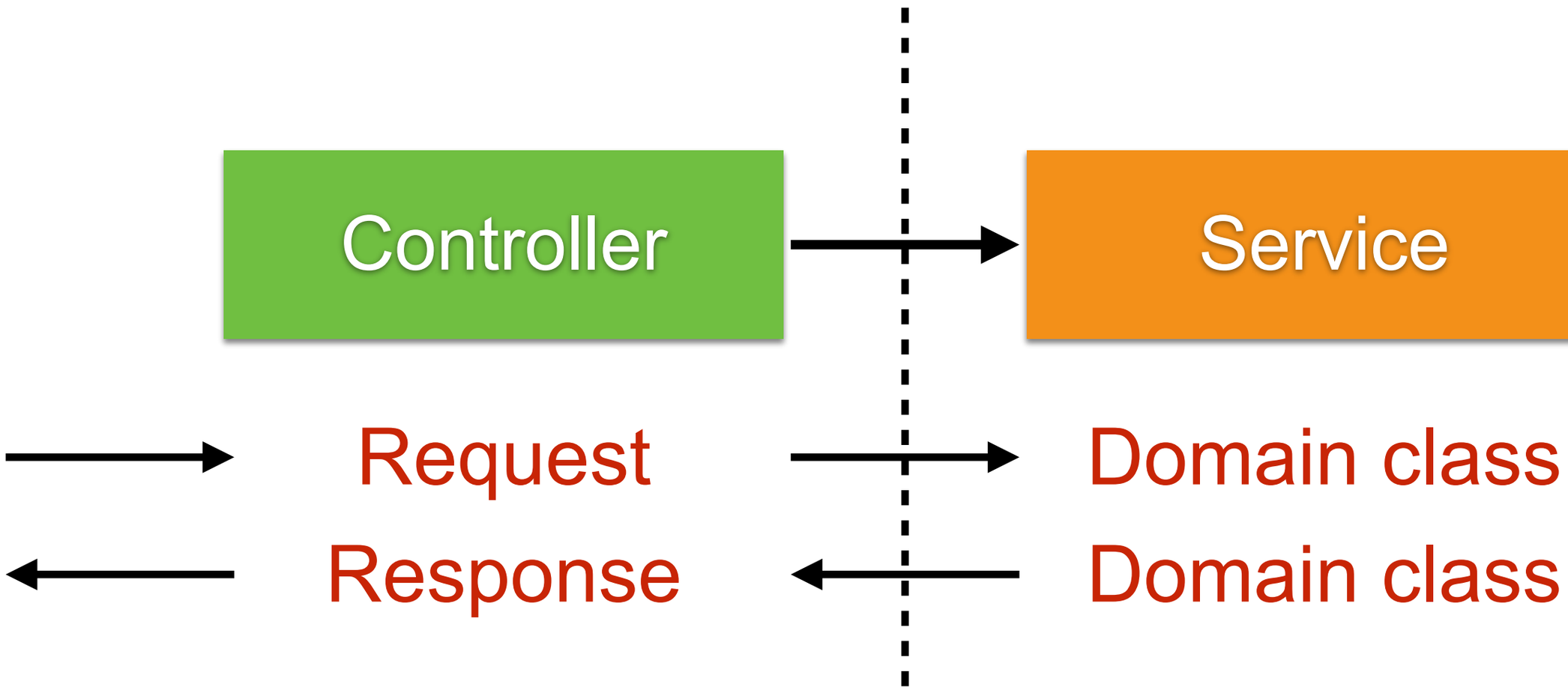
Request

Response

Data Model ?

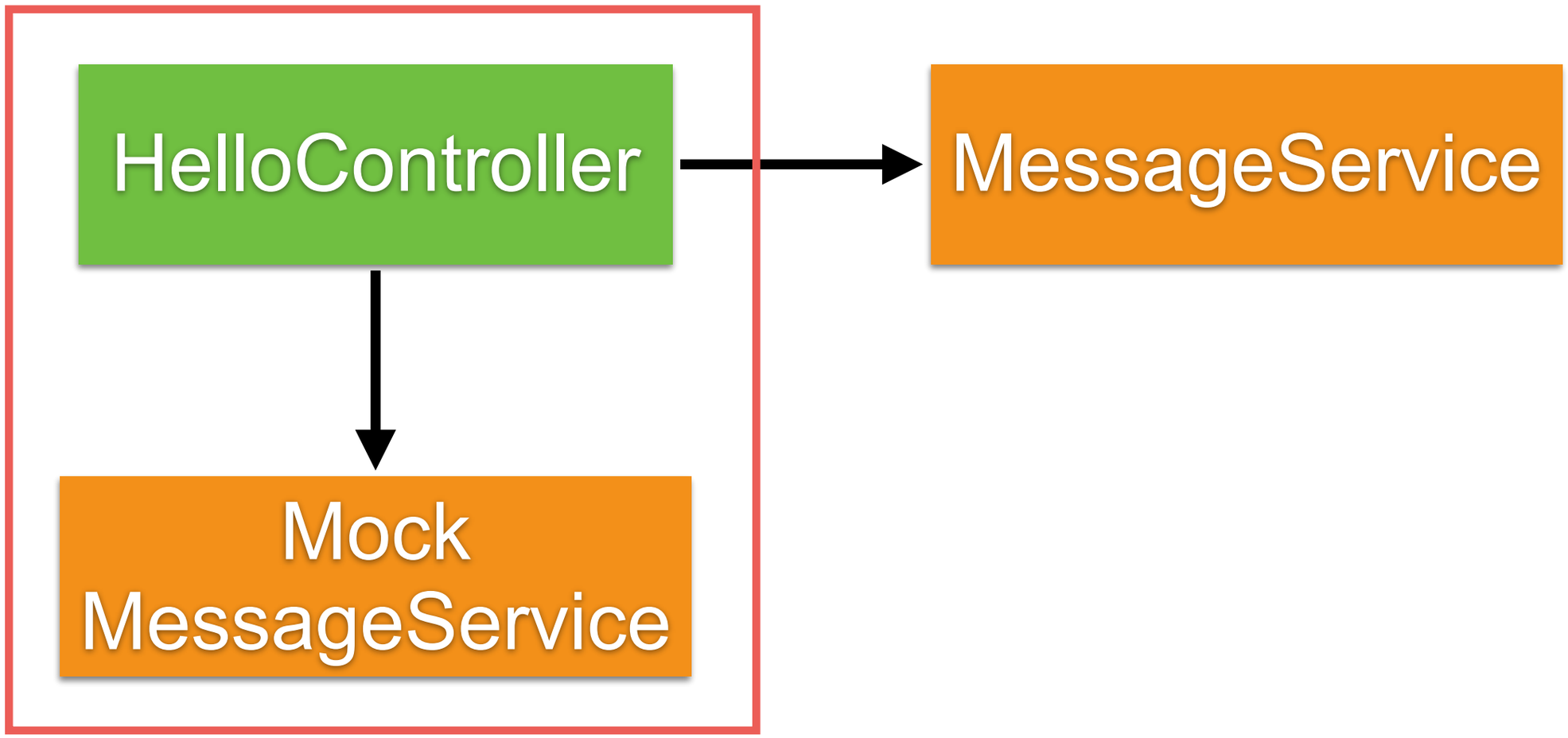


Data Model ?



Testing controller with service

Try to mocking service with Mockito

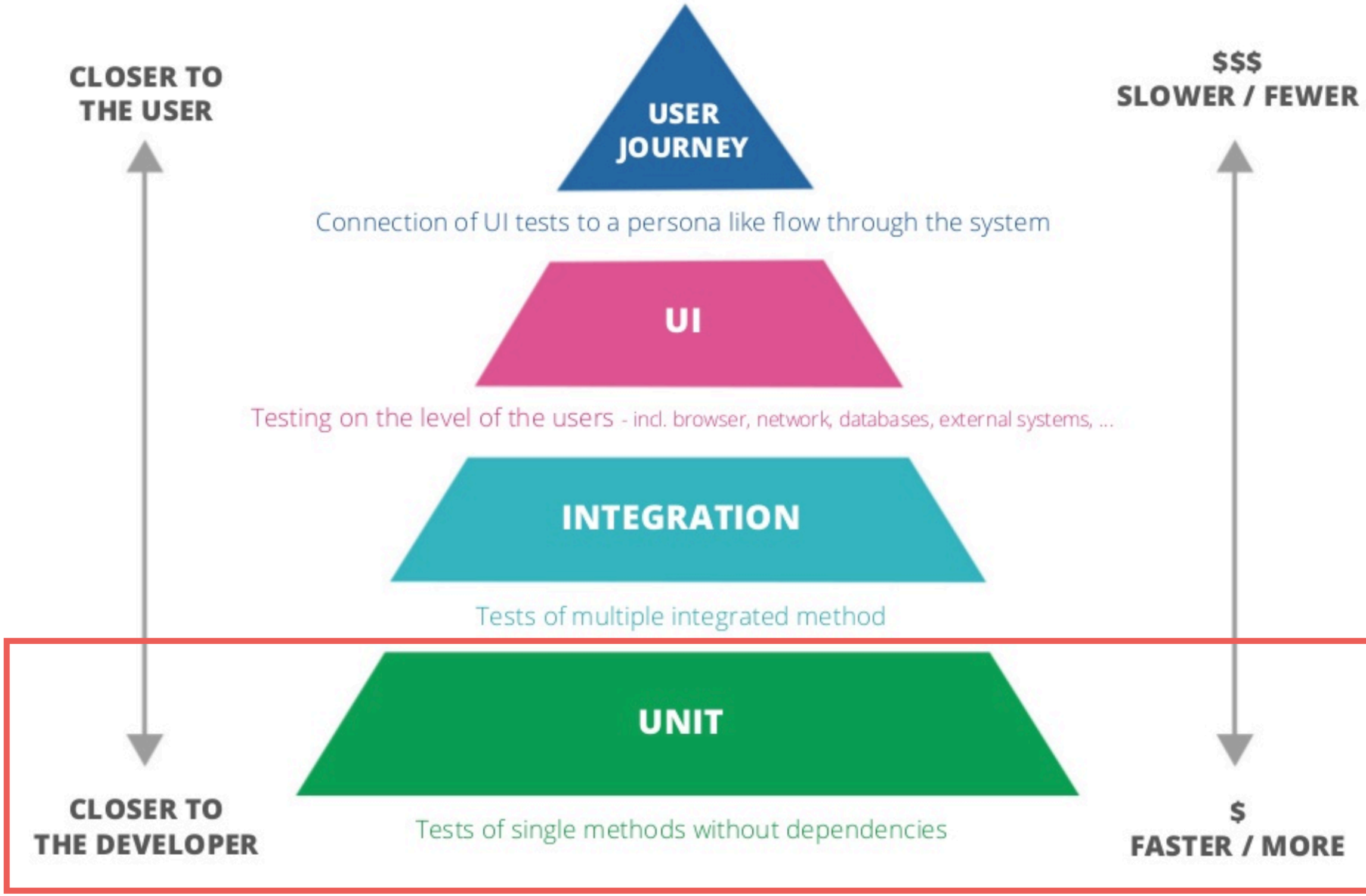


Run all tests !!

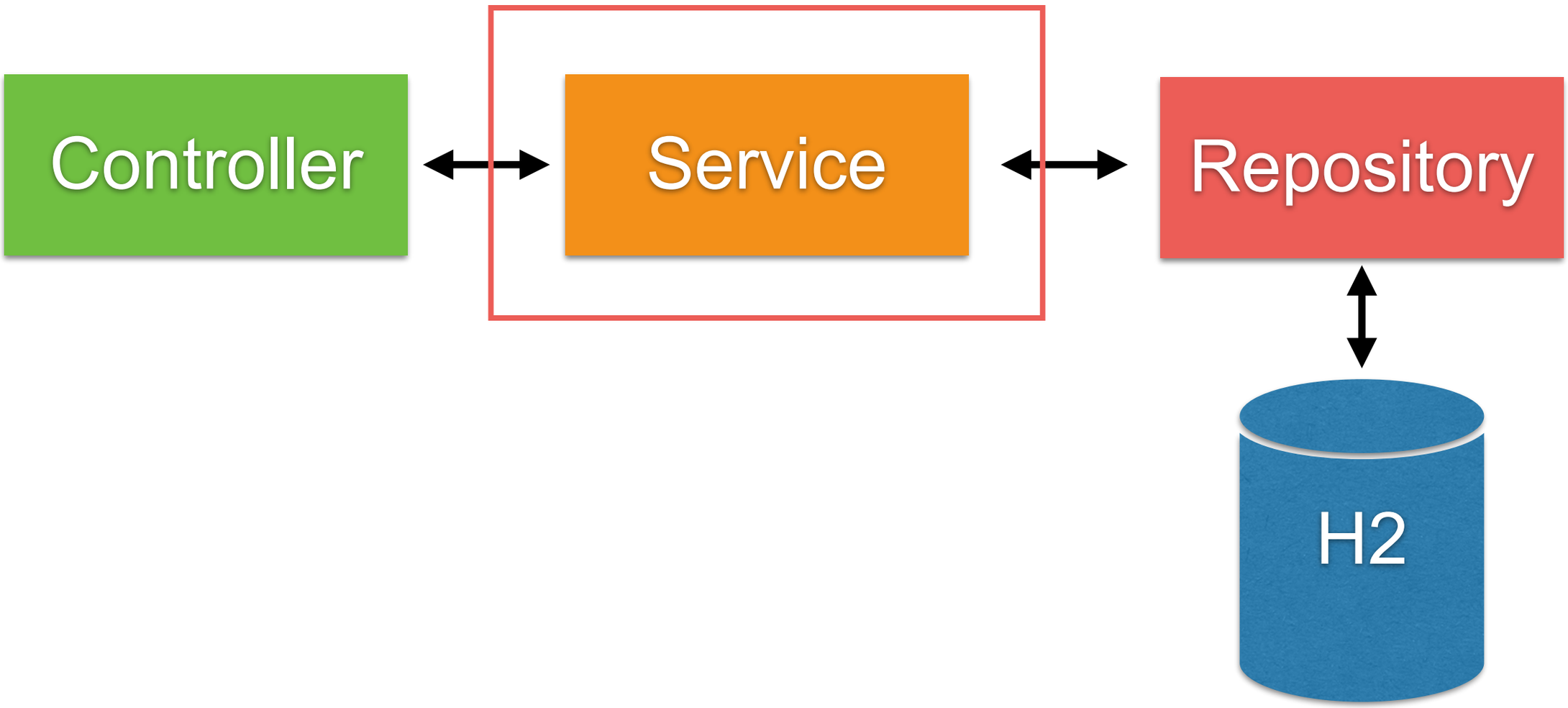
$mvnw clean test

```
[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
@RunWith(MockitoJUnitRunner.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

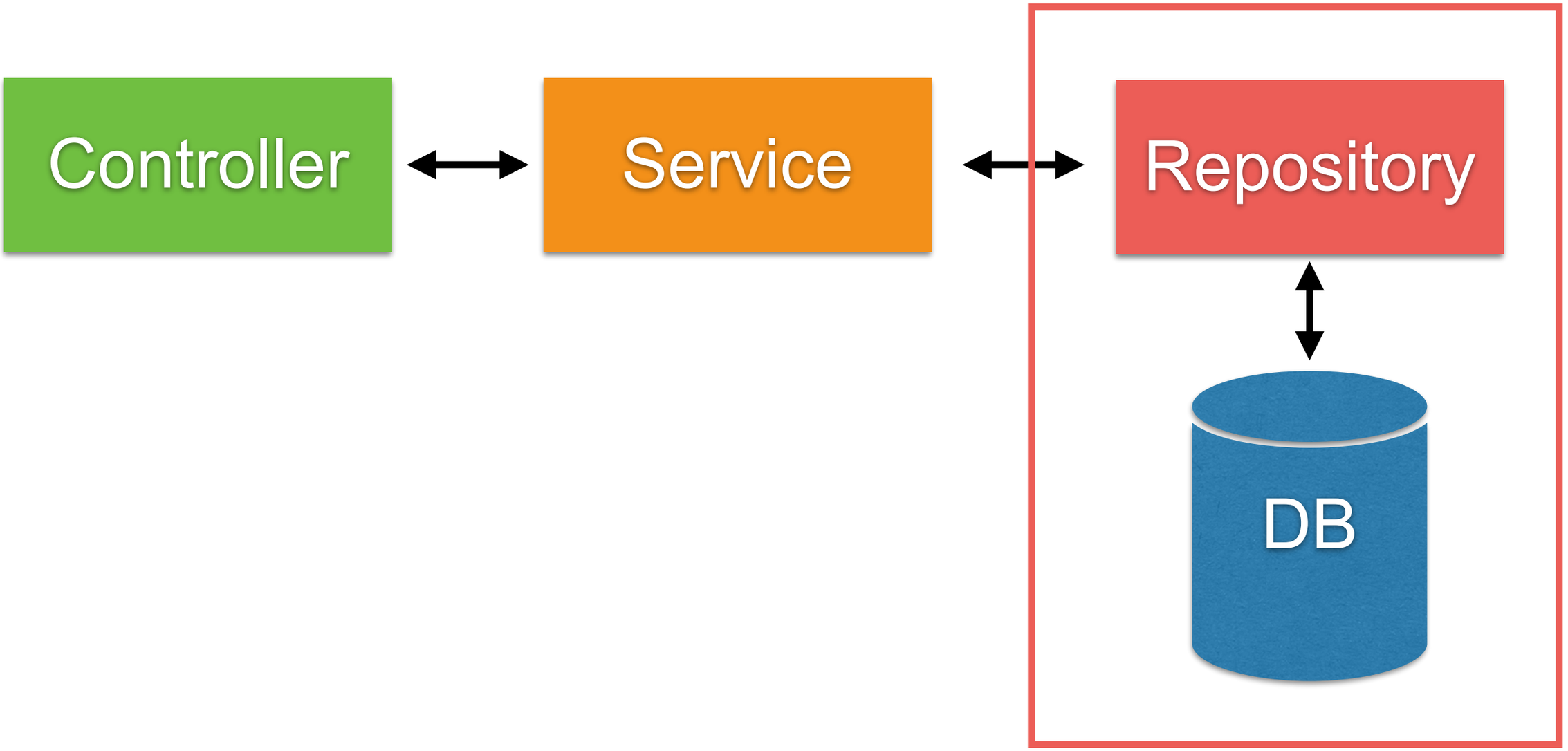
Service Testing

```java
@RunWith(MockitoJUnitRunner.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 !!

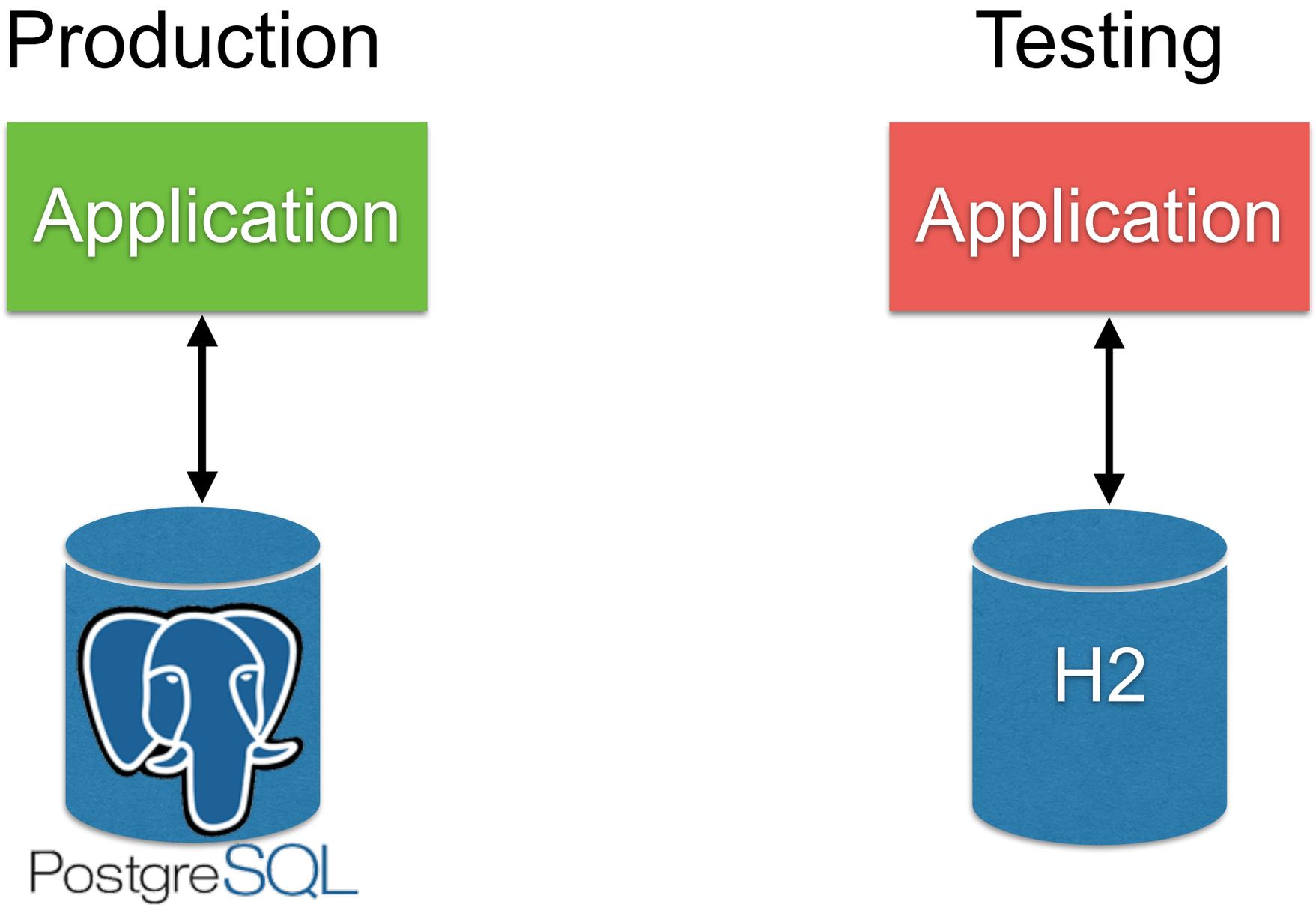
```
// 1. Load jdbc driver
Class.forName("postgresql");

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

Manage by Framework

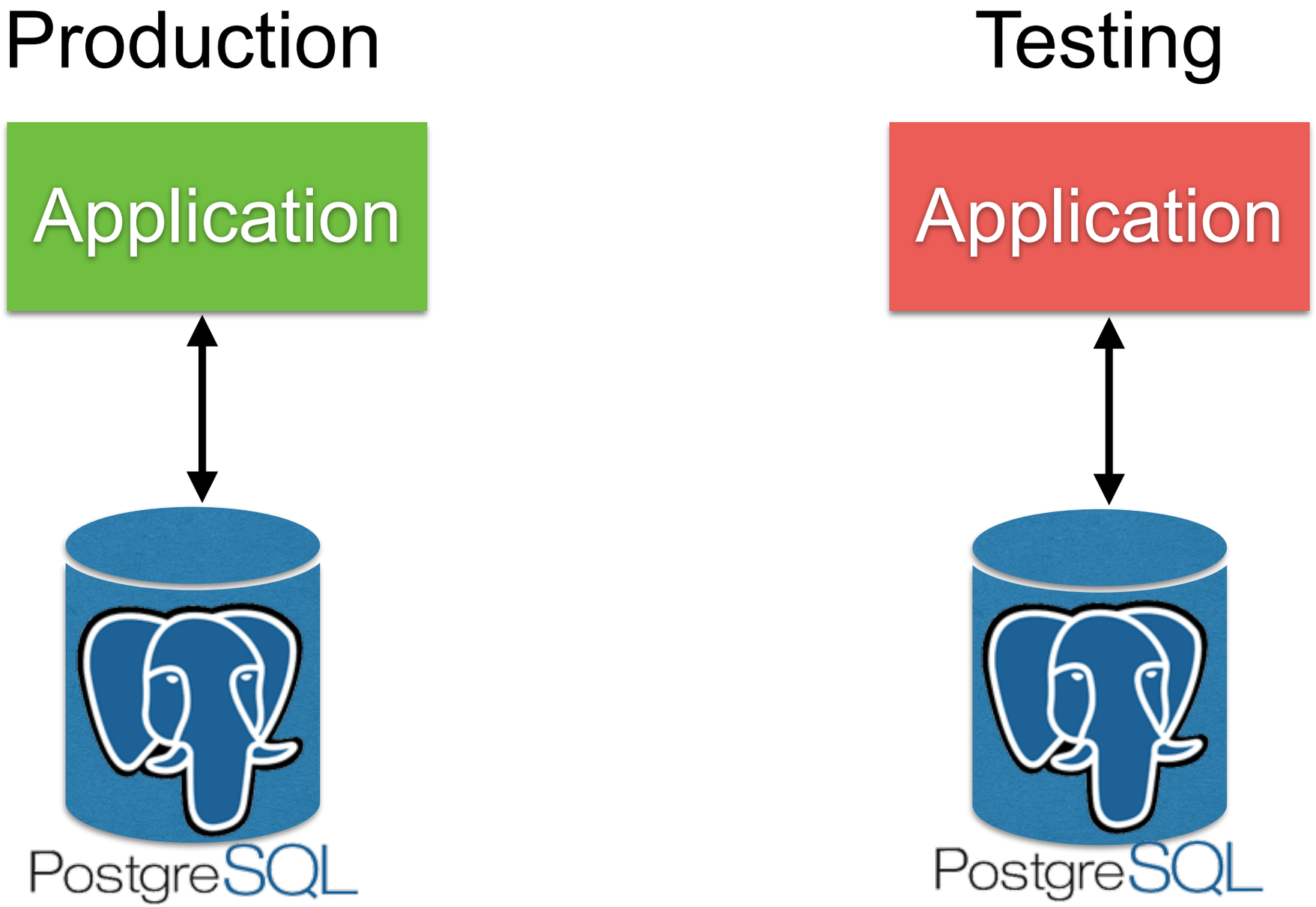
```
// 3. Prepared Statement
String sql = "SELECT * FROM TABLE WHERE name=?";
PreparedStatement pStmt = connection.prepareStatement(sql);

// 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 ?

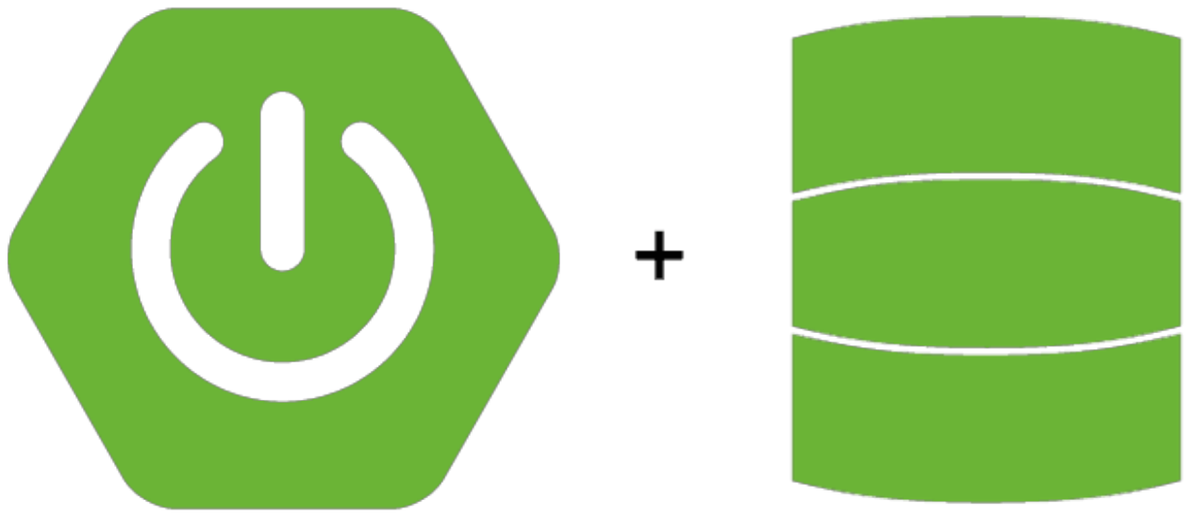


Working with Database ?



Working with repository

We’re using Spring Data



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

Spring Data

JDBC

JPA

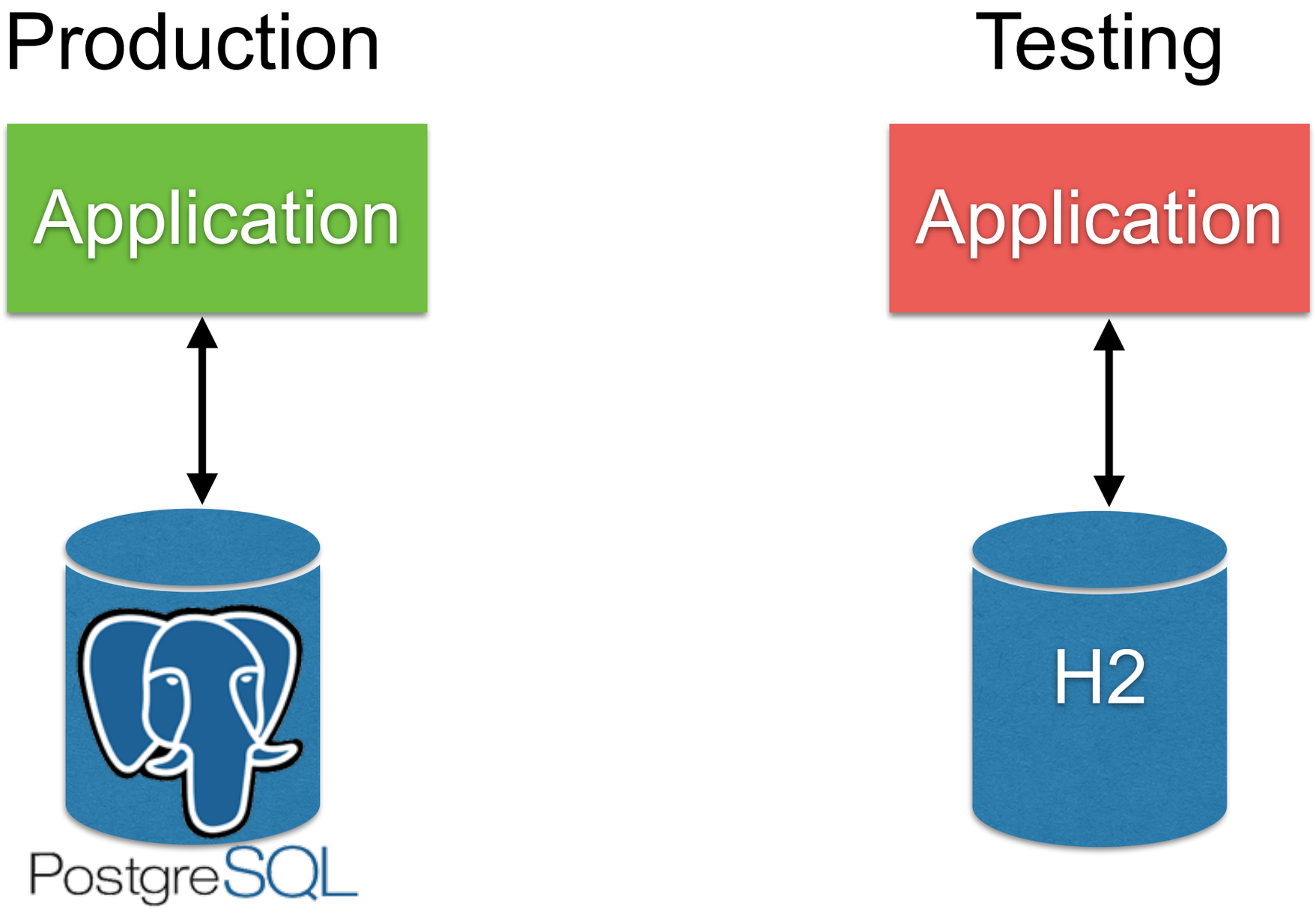
MongoDB

Redis

more …

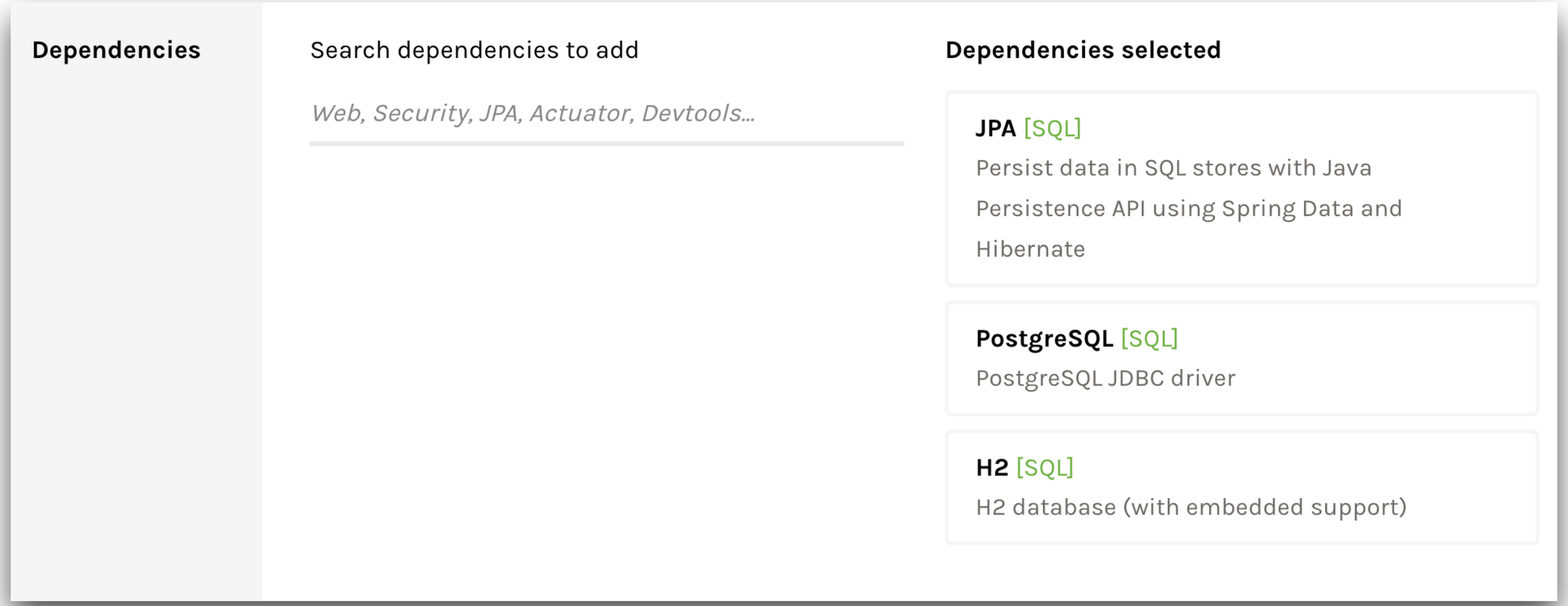
Working with Spring Data JPA

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>
```

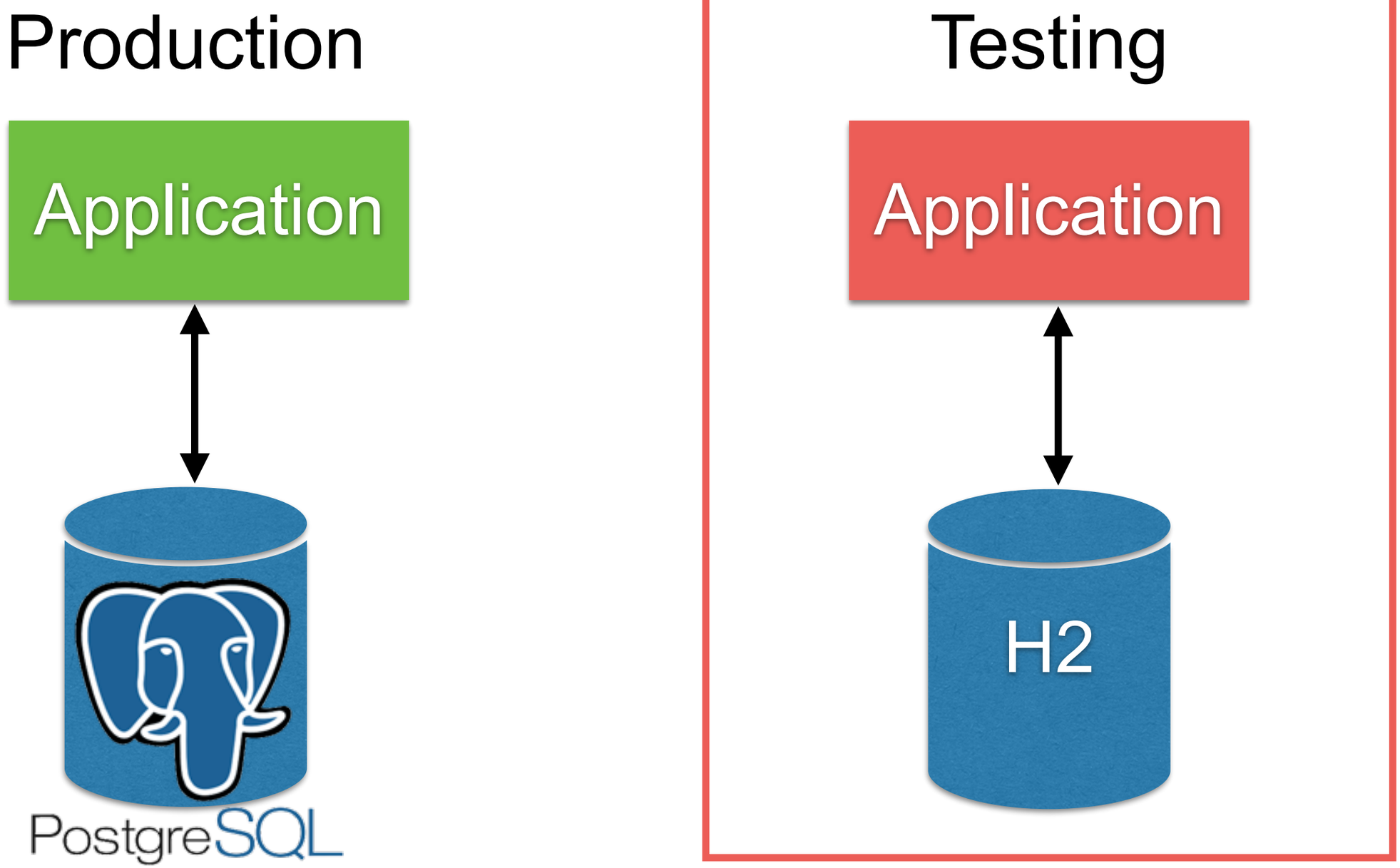
Modify pom.xml

PostgreSQL for production

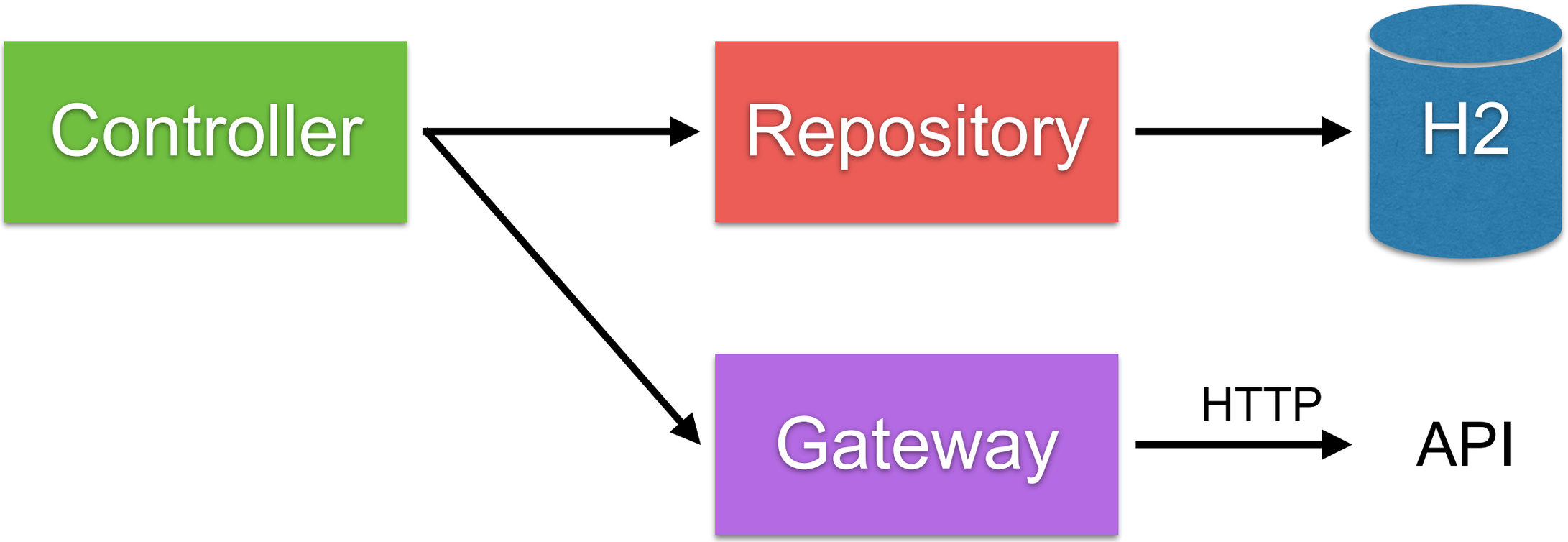
```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>

<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

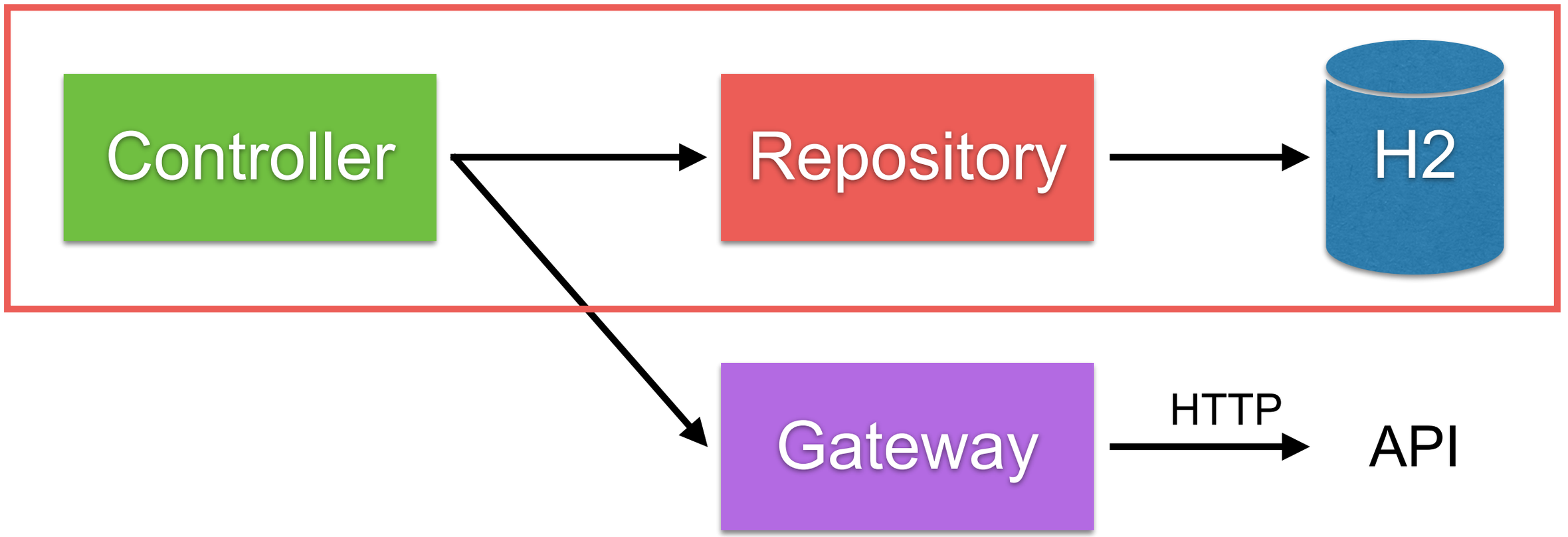


Use cases



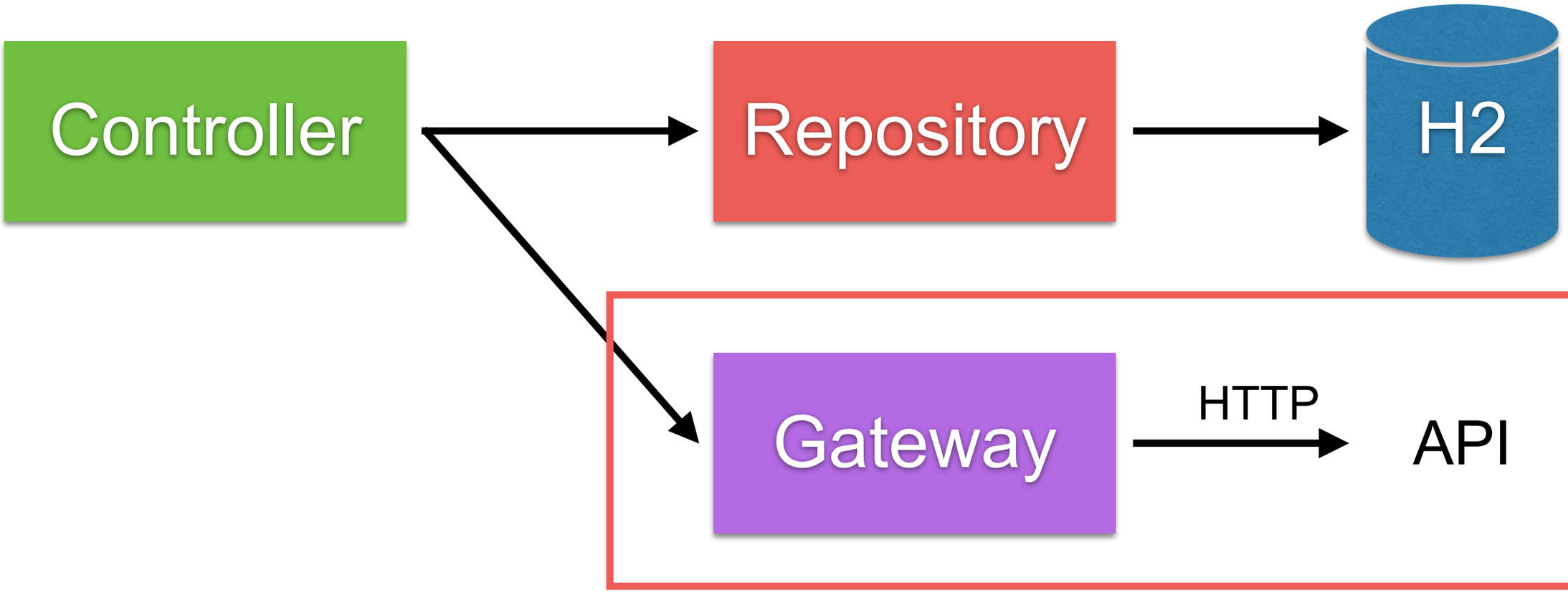
Use case 1

Working with repository



Use case 2

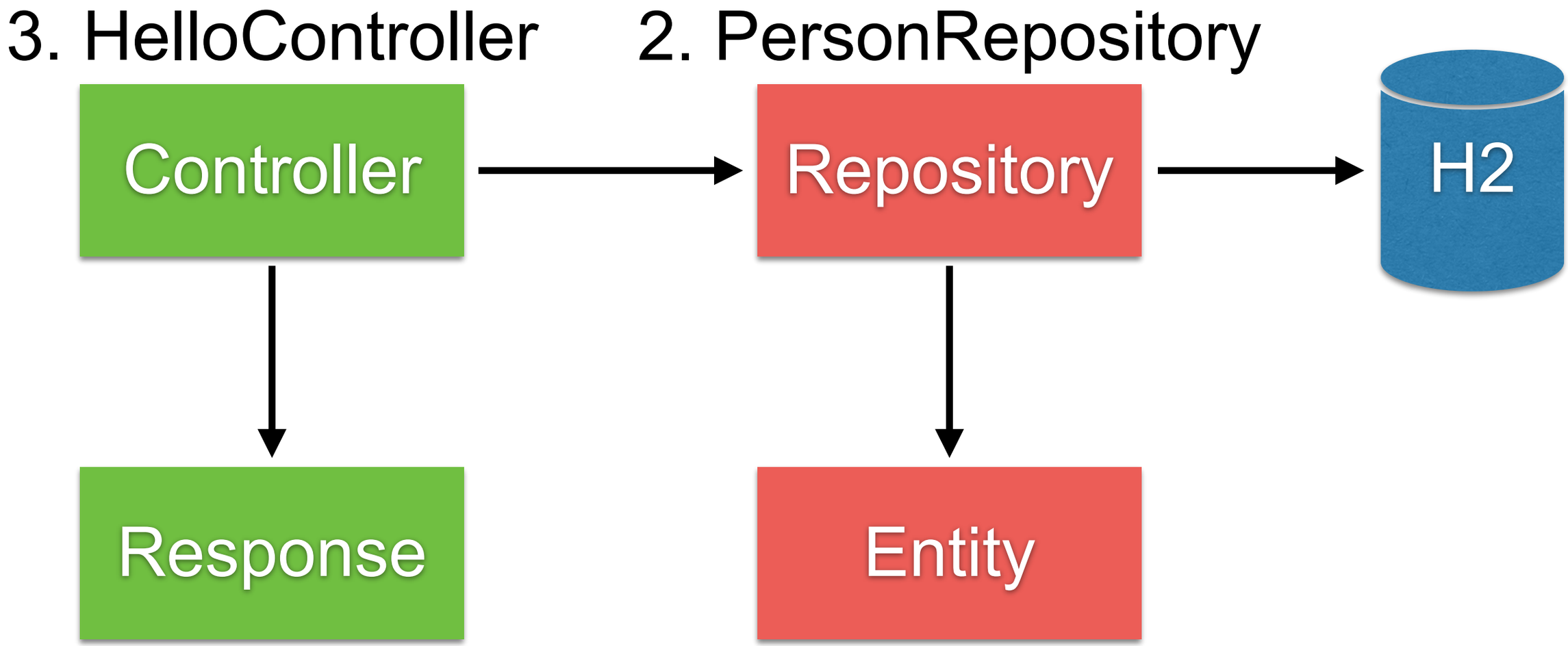
Working with API



Use case 1

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

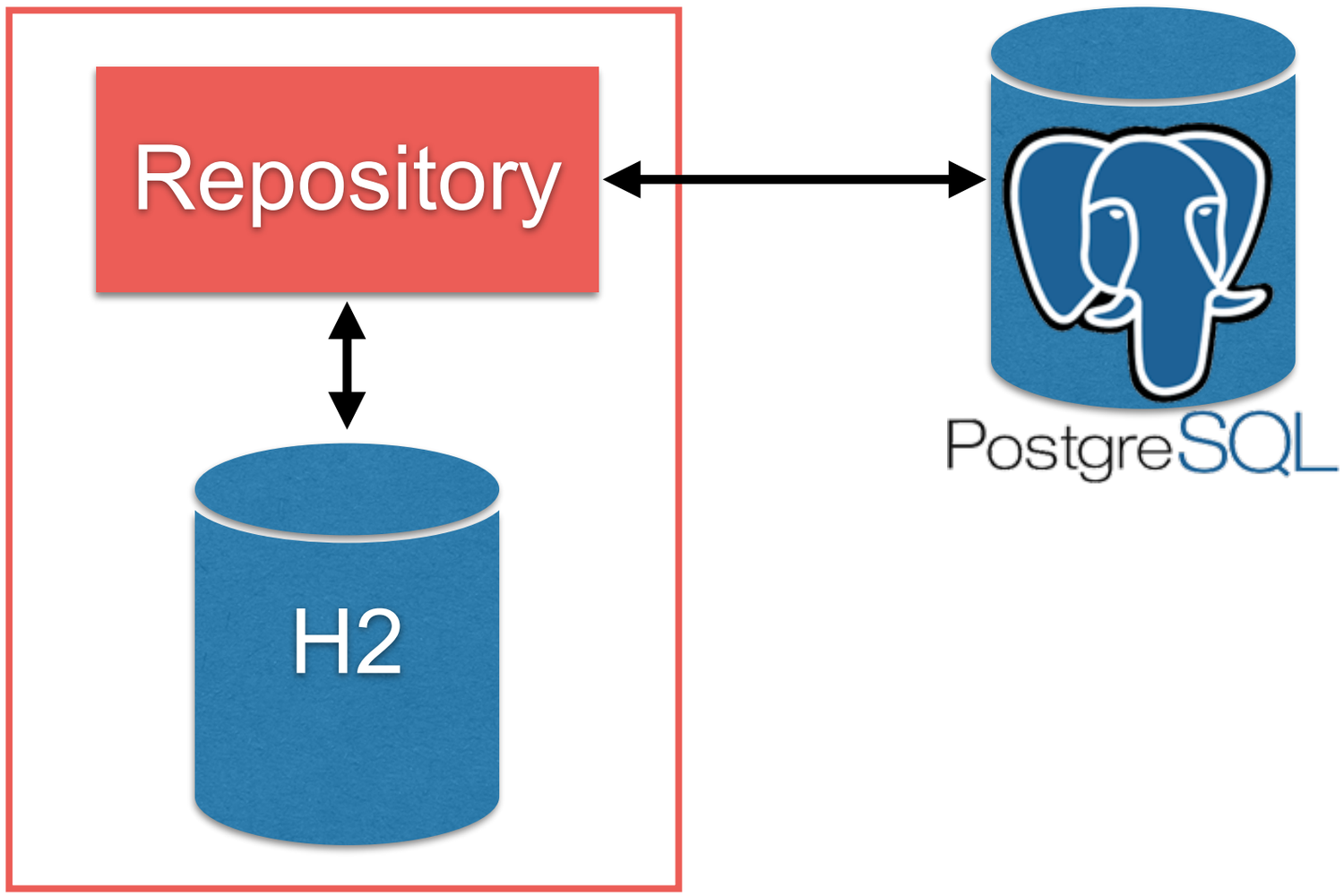
```
import java.util.Optional;

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

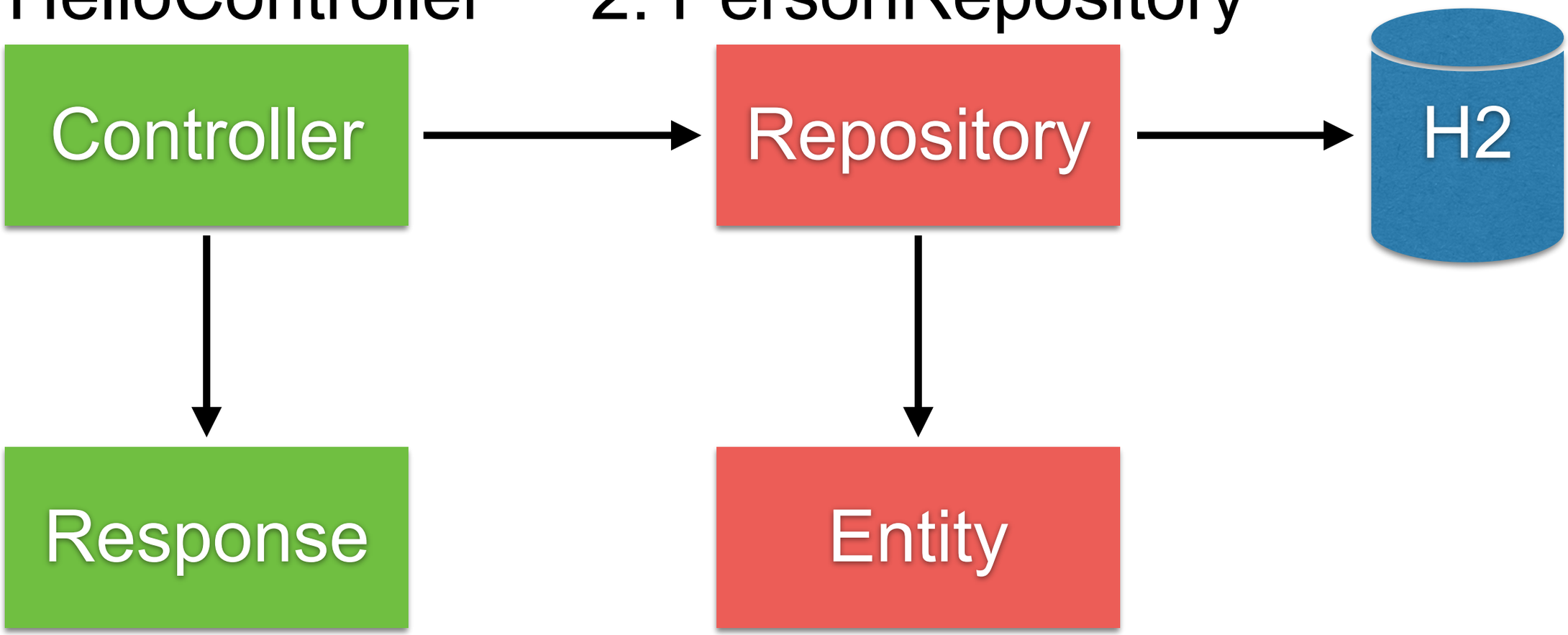
```
Hibernate: drop table person if exists
Hibernate: drop sequence if exists hibernate_sequence
```

Use case 1

Integrate repository with controller

3. HelloController

2. PersonRepository

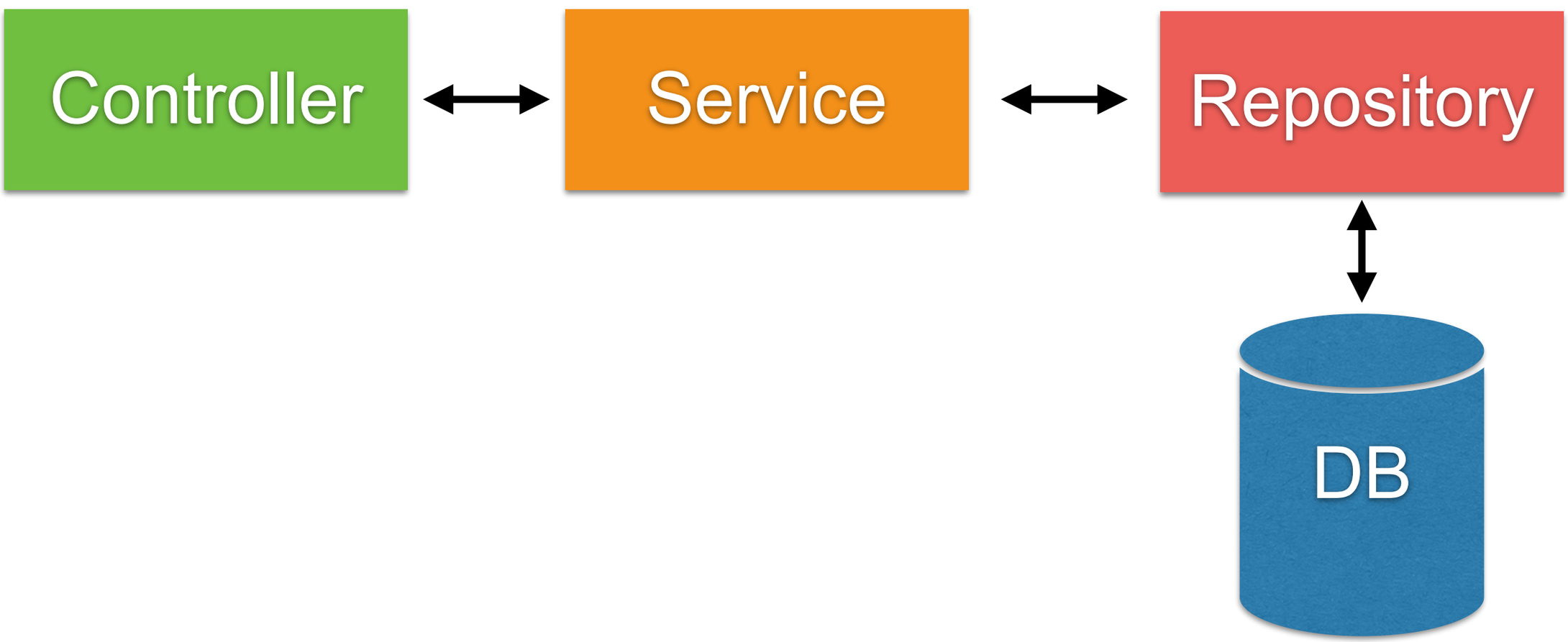


4. PersonResponse

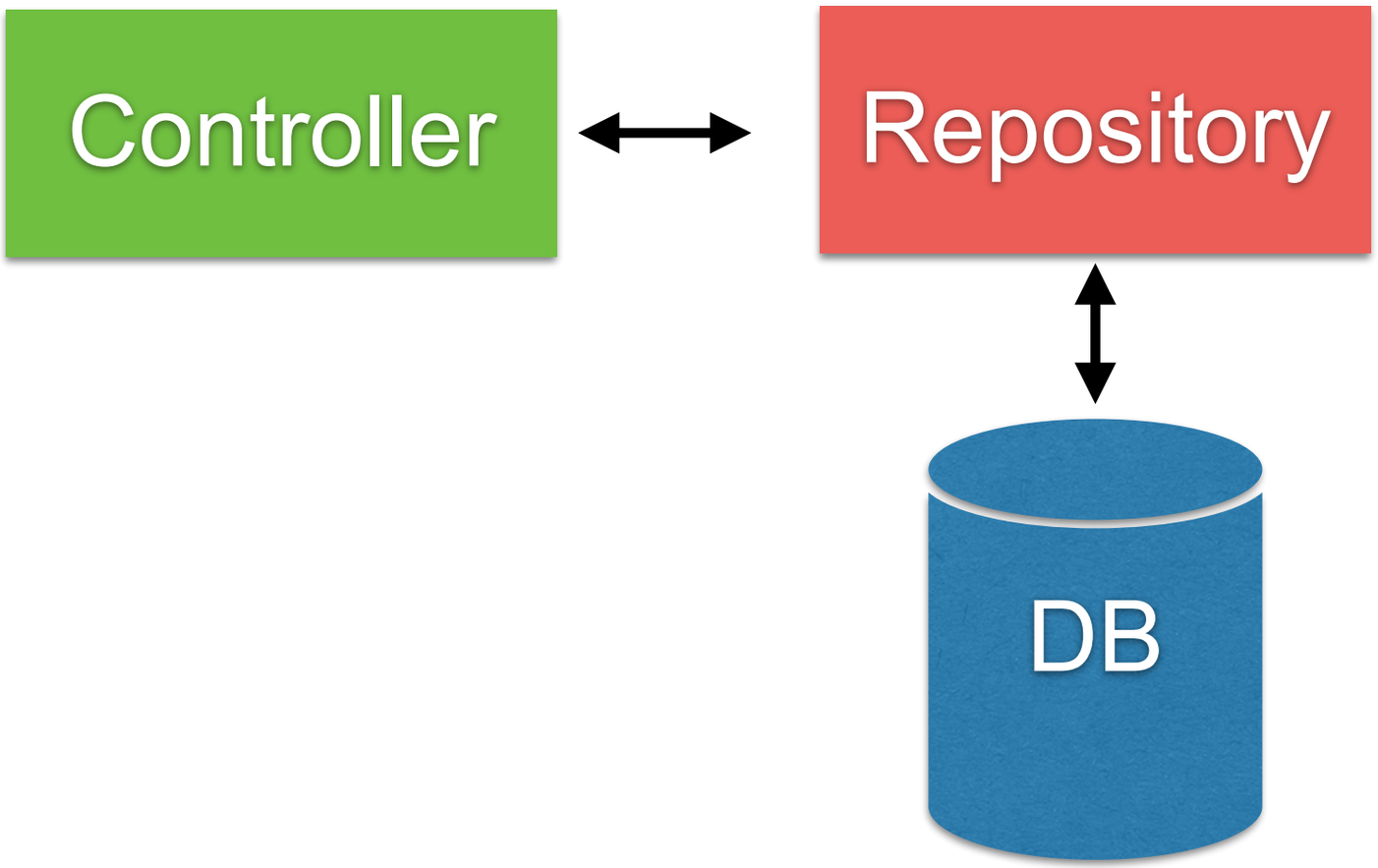
1. Person

Integrate repository with service/controller

Service use repository ?



Controller use repository ?



Controller call repository

Create HelloController.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 !!

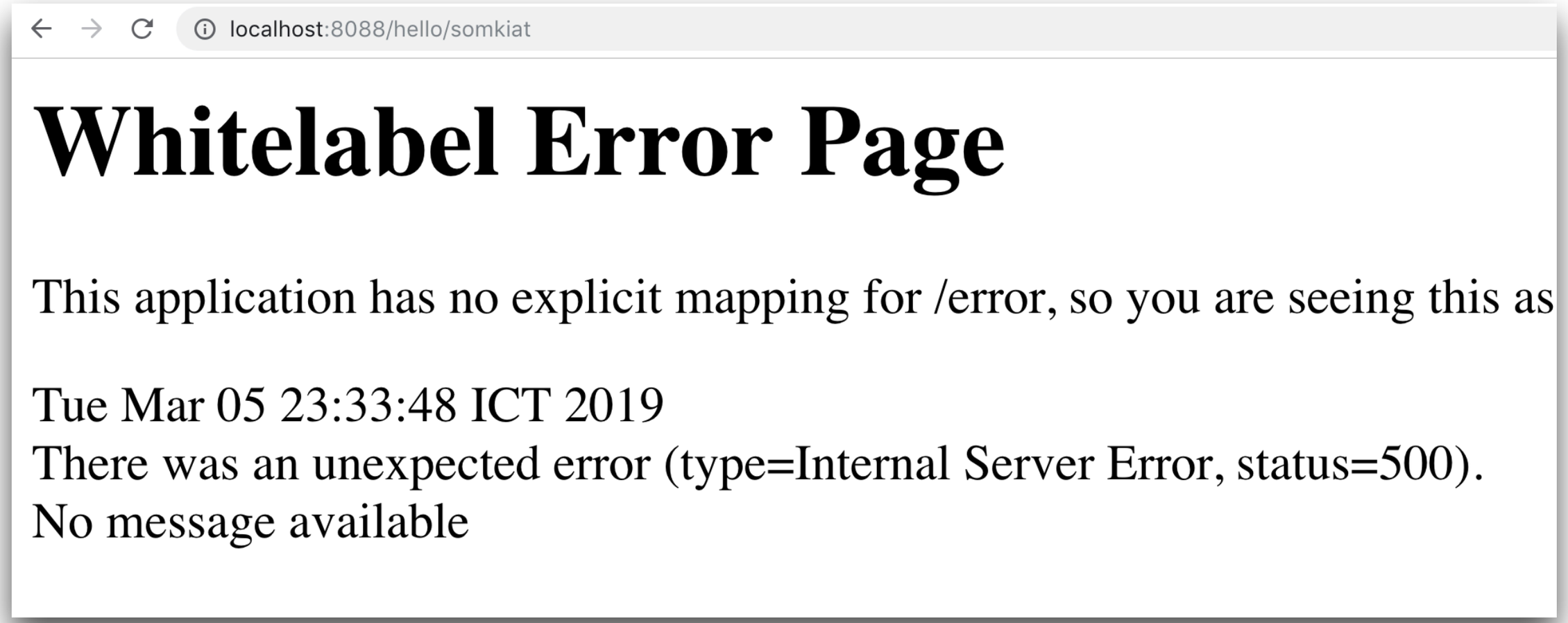
Fix !!!

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

```
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

```
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

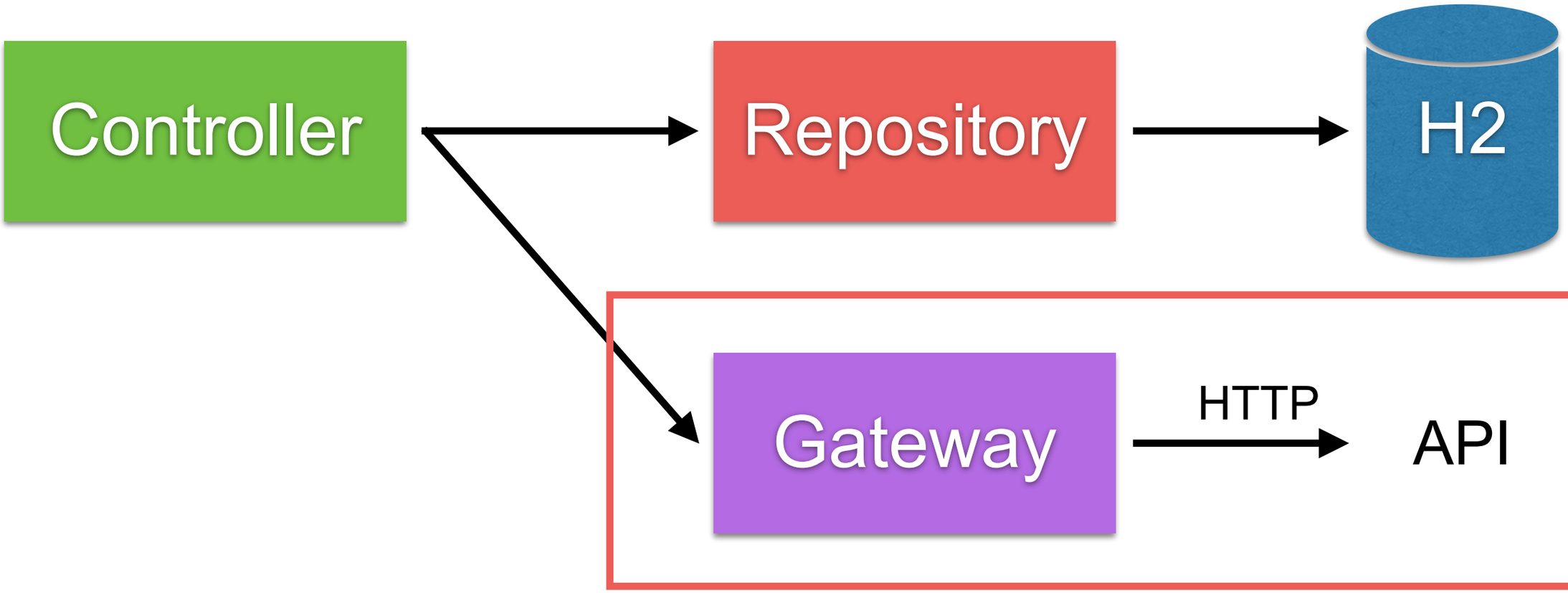
Write controller testing ?

$mvnw clean test

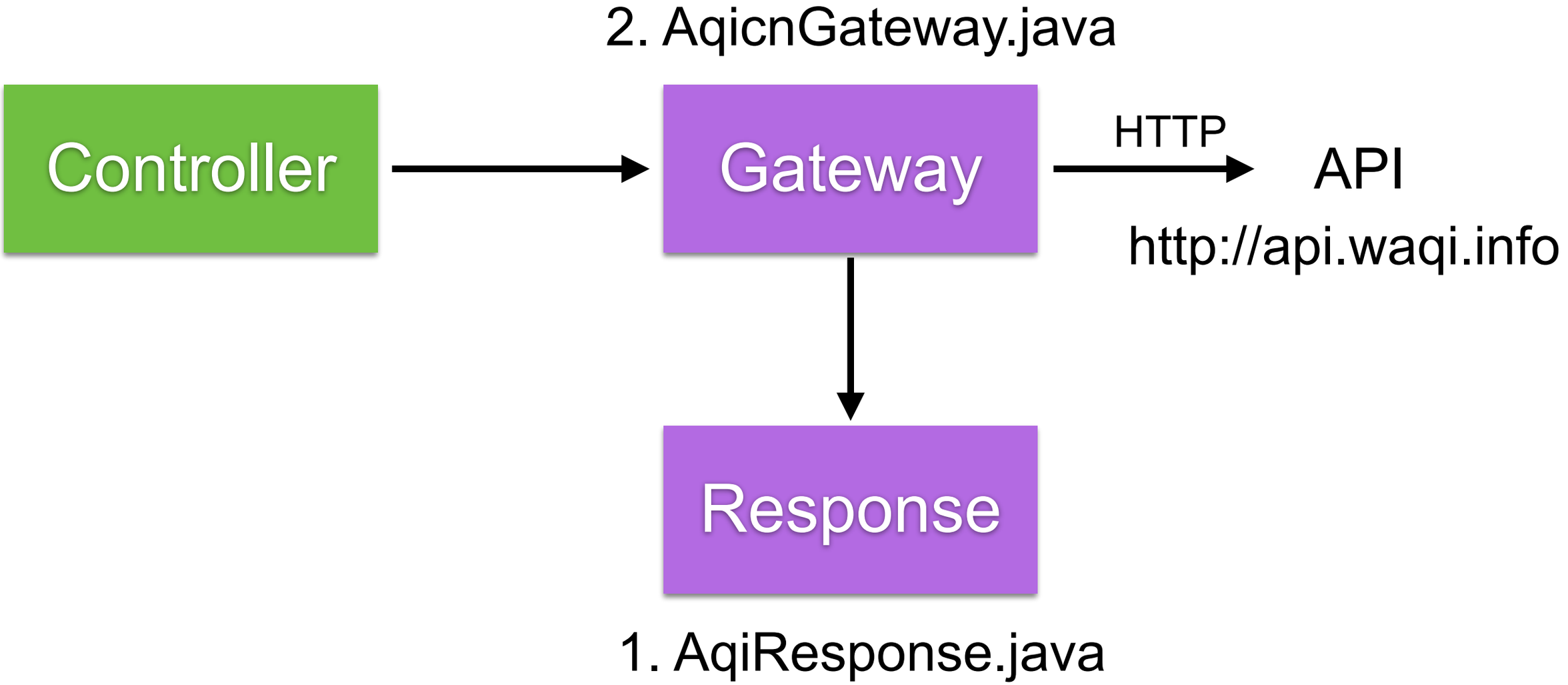
Use case 2

Use case 2

Working with API



Working with API



1. Create Response class

In package **ahi**

```
public class AqiResponse {

    private Data data;

    public AqiResponse() {
    }

    public AqiResponse(Data data) {
        this.data = data;
    }
```

```
public class Data {

    private int aqi;

    public Data() {
    }

    public Data(int aqi) {
        this.aqi = aqi;
    }
```

2. Create AqicnGateway class #1

In package **ahi**

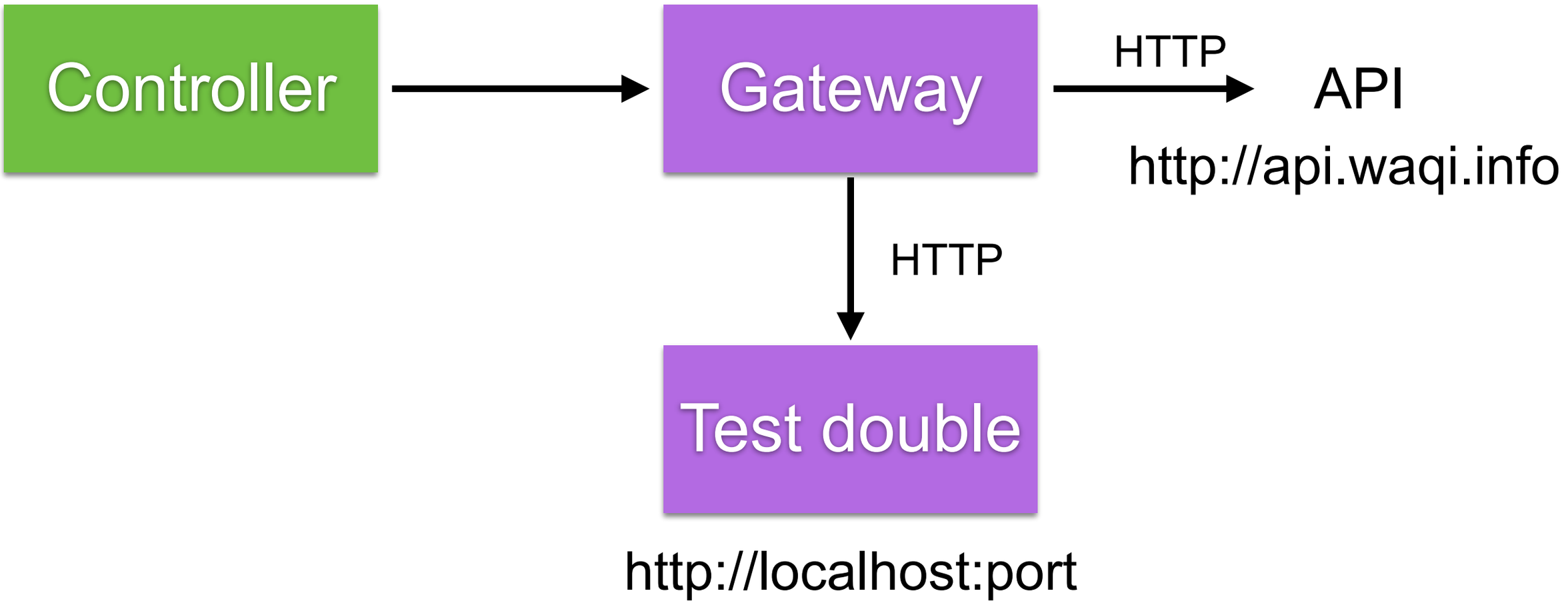
```
@Component
public class AqicnGateway {

    private final RestTemplate restTemplate;
    private final String url;
    private final String token;

    @Autowired
    public AqicnGateway(final RestTemplate restTemplate,
                        @Value("${aqicn.org.url}") final String url,
                        @Value("${aqicn.org.token}") final String token) {
        this.restTemplate = restTemplate;
        this.url = url;
        this.token = token;
    }
```

2. Create AqicnGateway class #2

Get data from API

```
public Optional<AqiResponse> fetchData(String target) {

    String targetUrl
            = String.format("%s/%s/?token=%s", url, target, token);

    try {

        return Optional.ofNullable(restTemplate.getForObject(
                                                targetUrl, AqiResponse.class));

    } catch (RestClientException e) {
        return Optional.empty();
    }
}
```

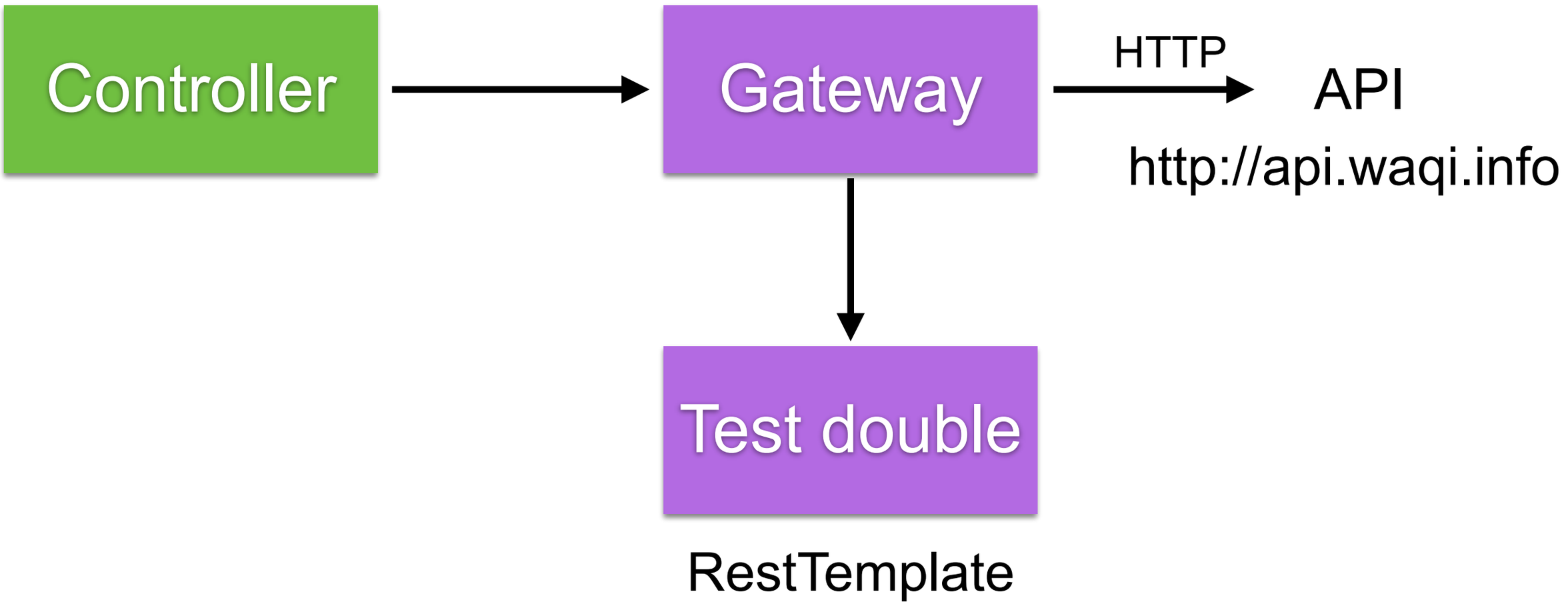
Testing with API



Testing with API

Unit testing with Mockito
Integration testing with WireMock
Consumer testing with Pact

Unit test with Mockito



1. Unit testing #1

Call API with RestTemplate

```
@RunWith(MockitoJUnitRunner.class)
public class AqicnGatewayTest {

    @Mock
    private RestTemplate restTemplate;

    private AqicnGateway gateway;
```

1. Unit testing #2

Success case

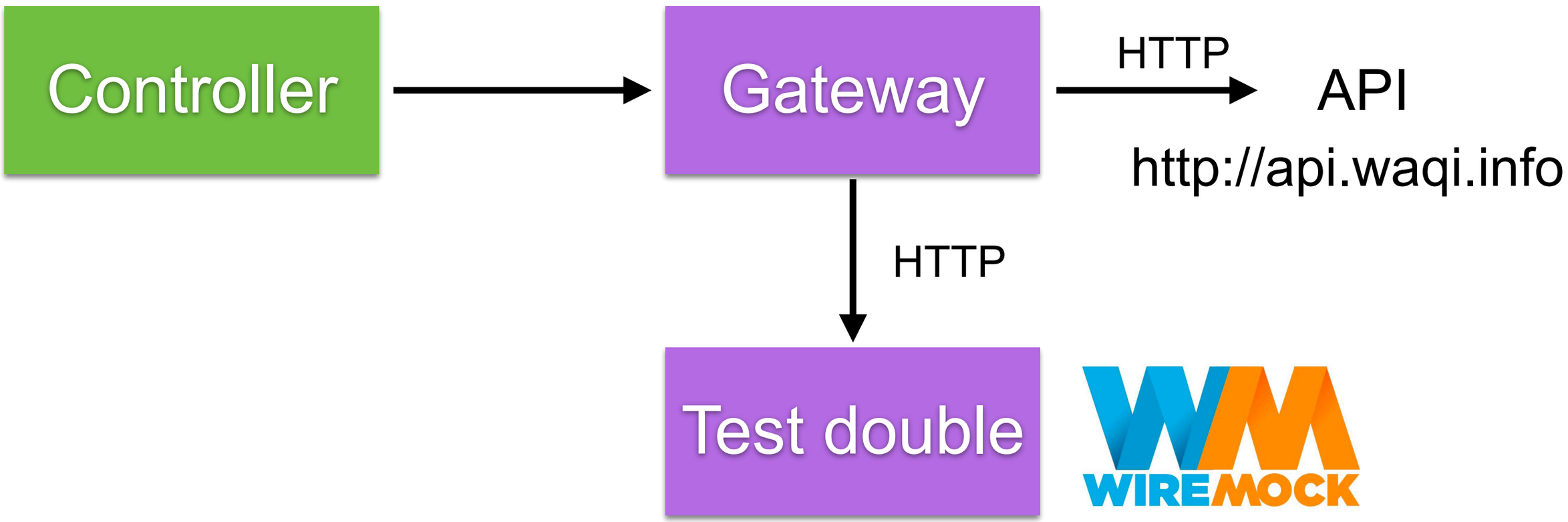
```
@Test
public void shouldCallService() throws Exception {
    gateway = new AqicnGateway(restTemplate, "http://localhost", "xxxx");

    String target = "thailand/pathum-thani/bangkok-university-rangsit-campus";
    AqiResponse expectedResponse = new AqiResponse(new Data(1));

    String targetUrl = "http://localhost/"+ target +"/?token=xxxx";
    given(restTemplate.getForObject(targetUrl, AqiResponse.class))
            .willReturn(expectedResponse);

    Optional<AqiResponse> actualResponse = gateway.fetchData(target);

    assertEquals(actualResponse, Optional.of(expectedResponse));
}
```

1. Unit testing #3

Failure case

```
@Test
public void shouldReturnEmptyWherServiceIsUnavailable() throws Exception {
    gateway = new AqicnGateway(restTemplate, "http://localhost", "xxxx");

    String target = "thailand/pathum-thani/bangkok-university-rangsit-campus";
    String targetUrl = "http://localhost/"+ target +"/?token=xxxx";
    given(restTemplate.getForObject(targetUrl, AqiResponse.class))
        .willThrow(new RestClientException("something went wrong"));

    Optional<AqiResponse> actualResponse = gateway.fetchData(target);

    assertEquals(actualResponse, Optional.empty());
}
```

Integration test with WireMock



/src/test/resources/application.properties

```
aqicn.org.url=http://localhost:8888
aqicn.org.token=xxxx
```

2. Integration testing #1

Working with WireMock

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

    @Autowired
    private AqicnGateway gateway;
```

Default port = 8888

```
@Rule
public WireMockRule wireMockRule = new WireMockRule(8888);
```

2. Integration testing #2

Success case

```
@Test
public void shouldCallService() throws Exception {
    String target = "thailand/pathum-thani/bangkok-university-rangsit-campus";

    wireMockRule.stubFor(get(urlPathEqualTo("/"+target+"/"))
            .withQueryParam("token", equalTo("xxxx"))
            .willReturn(aResponse()
                    .withBody(read("classpath:apiResponse.json"))
                    .withHeader(CONTENT_TYPE, MediaType.APPLICATION_JSON_VALUE)
                    .withStatus(200)));

    Optional<AqiResponse> response = gateway.fetchData(target);

    Data data = new Data(80);
    Optional<AqiResponse> expectedResponse = Optional.of(new AqiResponse(data));
    assertEquals(expectedResponse, response);
}
```

Stub response

2. Integration 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()));
}
```

Write controller testing ?

$mvnw clean test

Working with transaction !!

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 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

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

    @Autowired
    private TestRestTemplate testRestTemplate;

    @MockBean
    private UserService userService;
```

Run with category

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

Thank you
Q/A