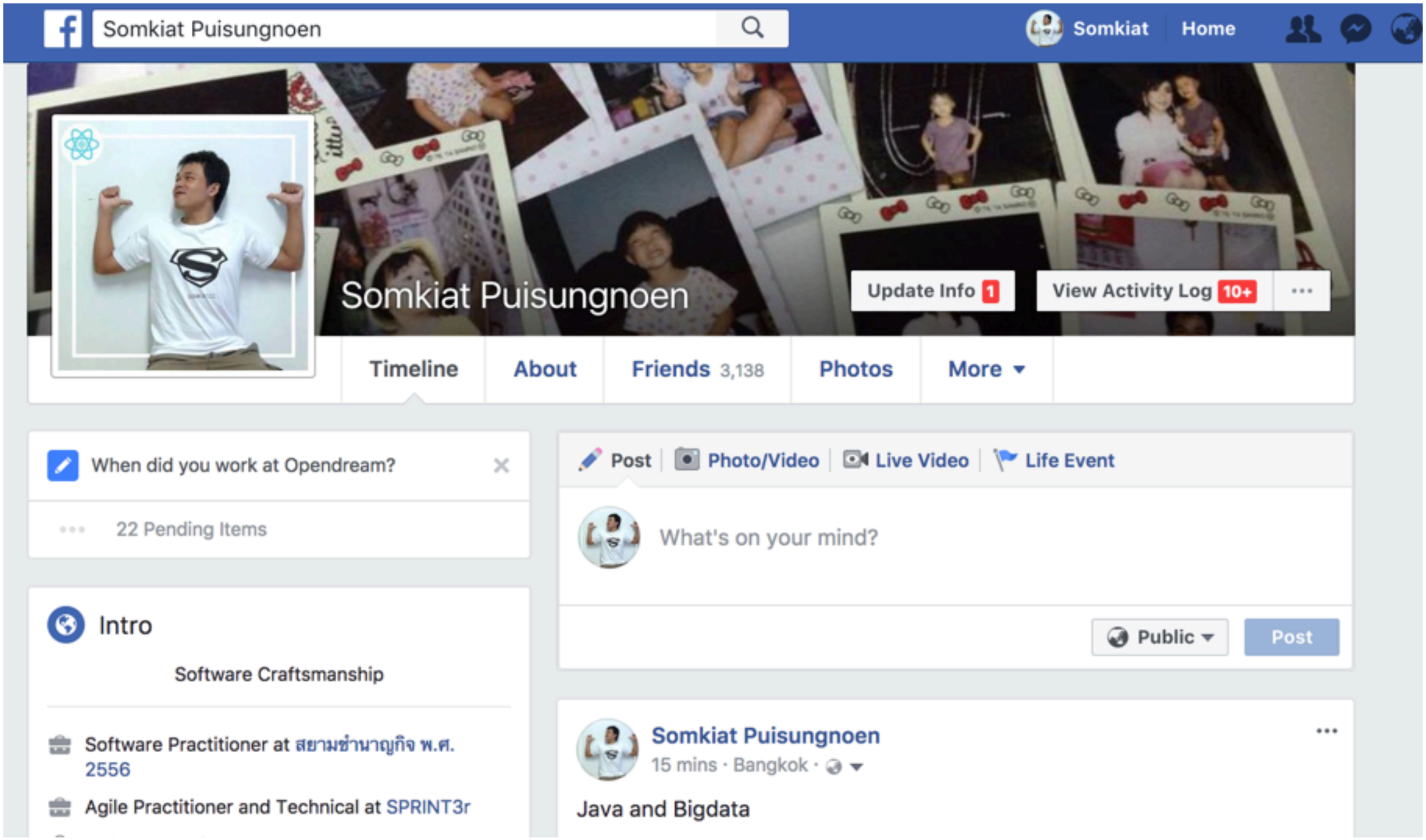
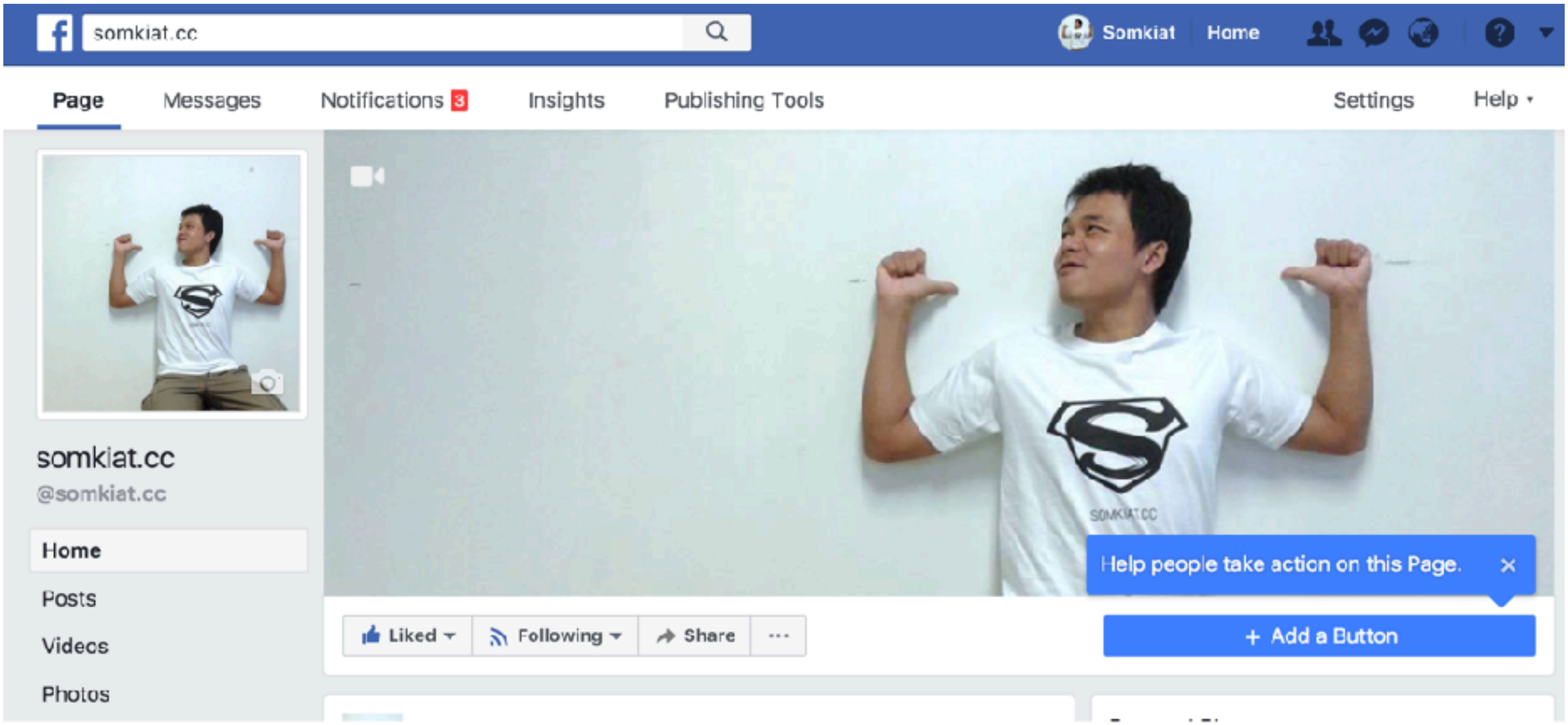
สยามชำนาญกิจ
SIAM CHAMNAN KIT

Java Framework





Agenda

- RESTful API
- Java frameworks
- Building RESTful API with Spring Boot
- Spring Boot with Spring Data (JDBC/JPA)
- Spring Boot with Spring Data (MongoDB)
- Testing with Spring Boot
- Q/A

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)

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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.

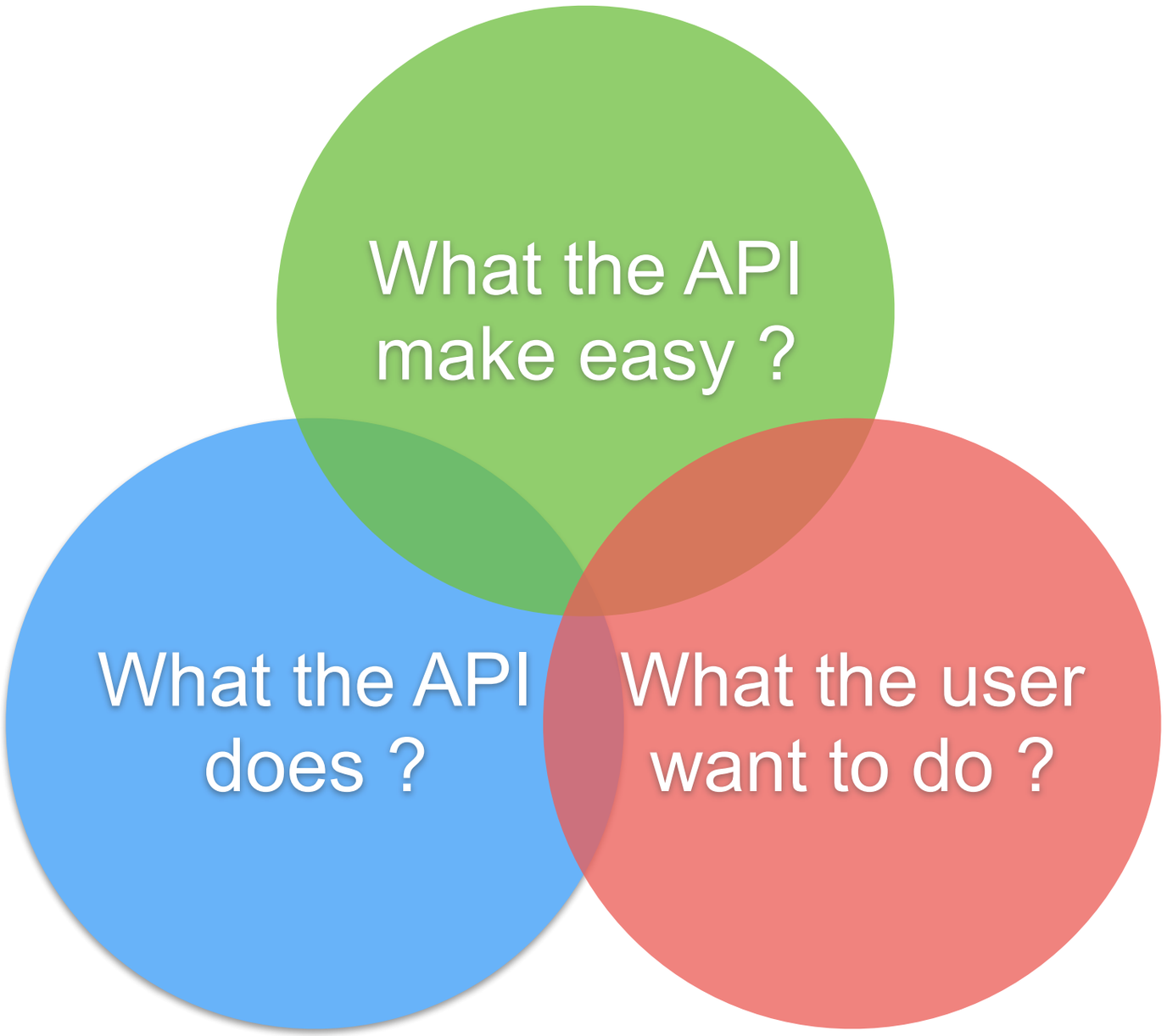
REST Request & Response

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

REST Easy

JAX-RS

Ratpack
A toolkit for JVM web applications

spring
by Pivotal

Spark

Restlet

akka

Apache CXF

STRUTS

play

NINJA
web framework

unirest
Lightweight HTTP Request Client Libraries

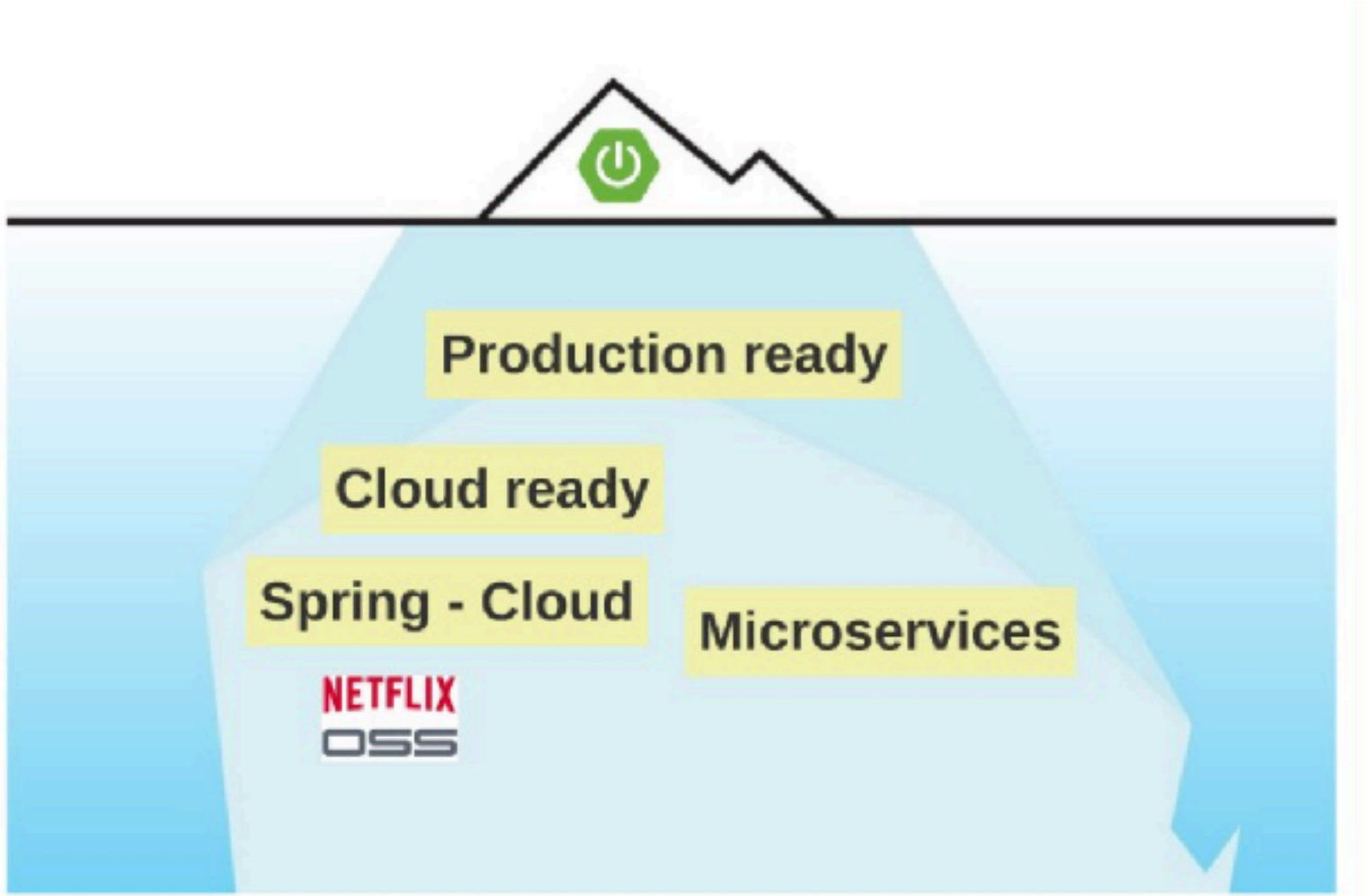
Dropwizard

ACT.framework

Hello Spring Boot 2.x

Why ?

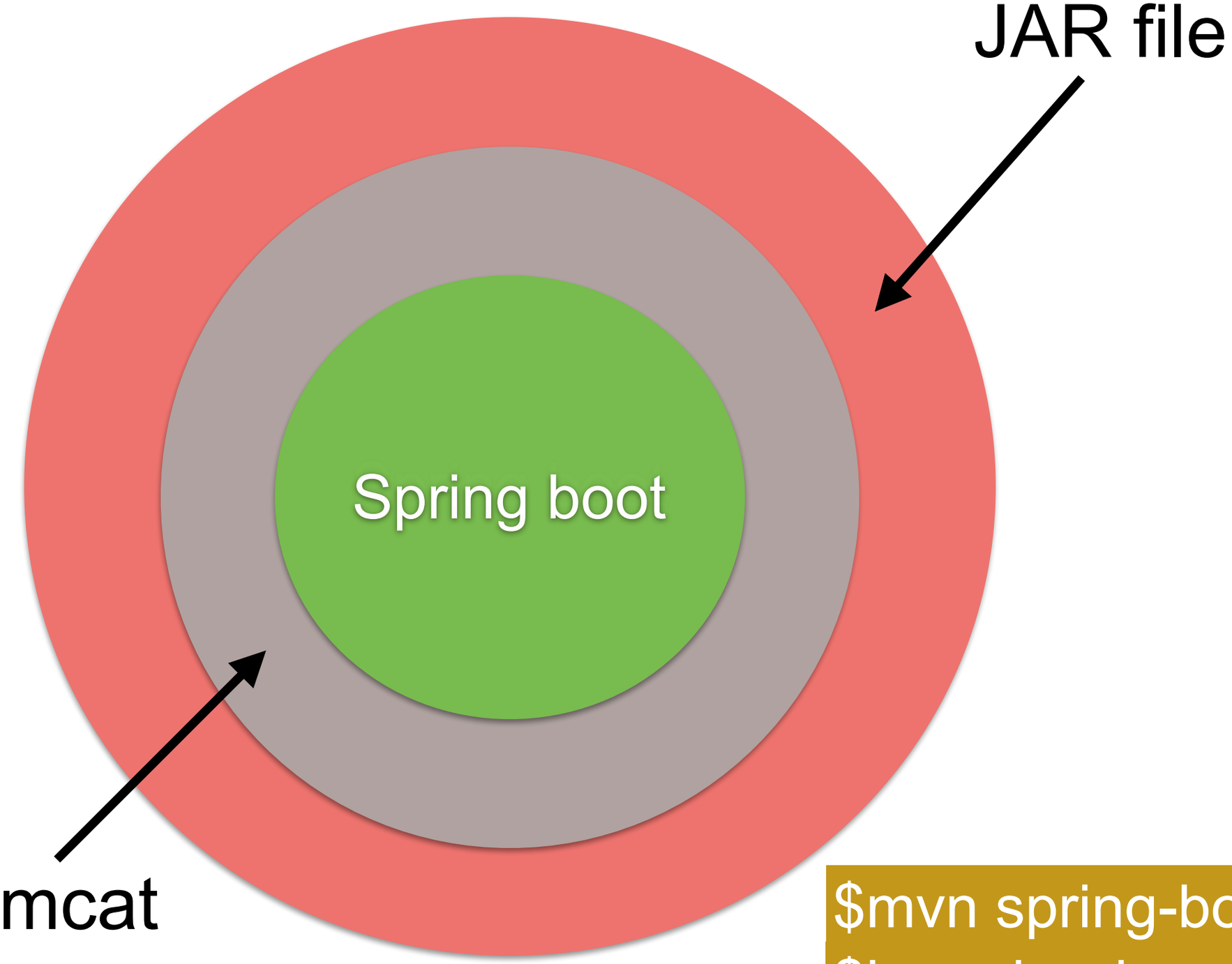
Application skeleton generator
Reduce effort to add new technologies



What ?

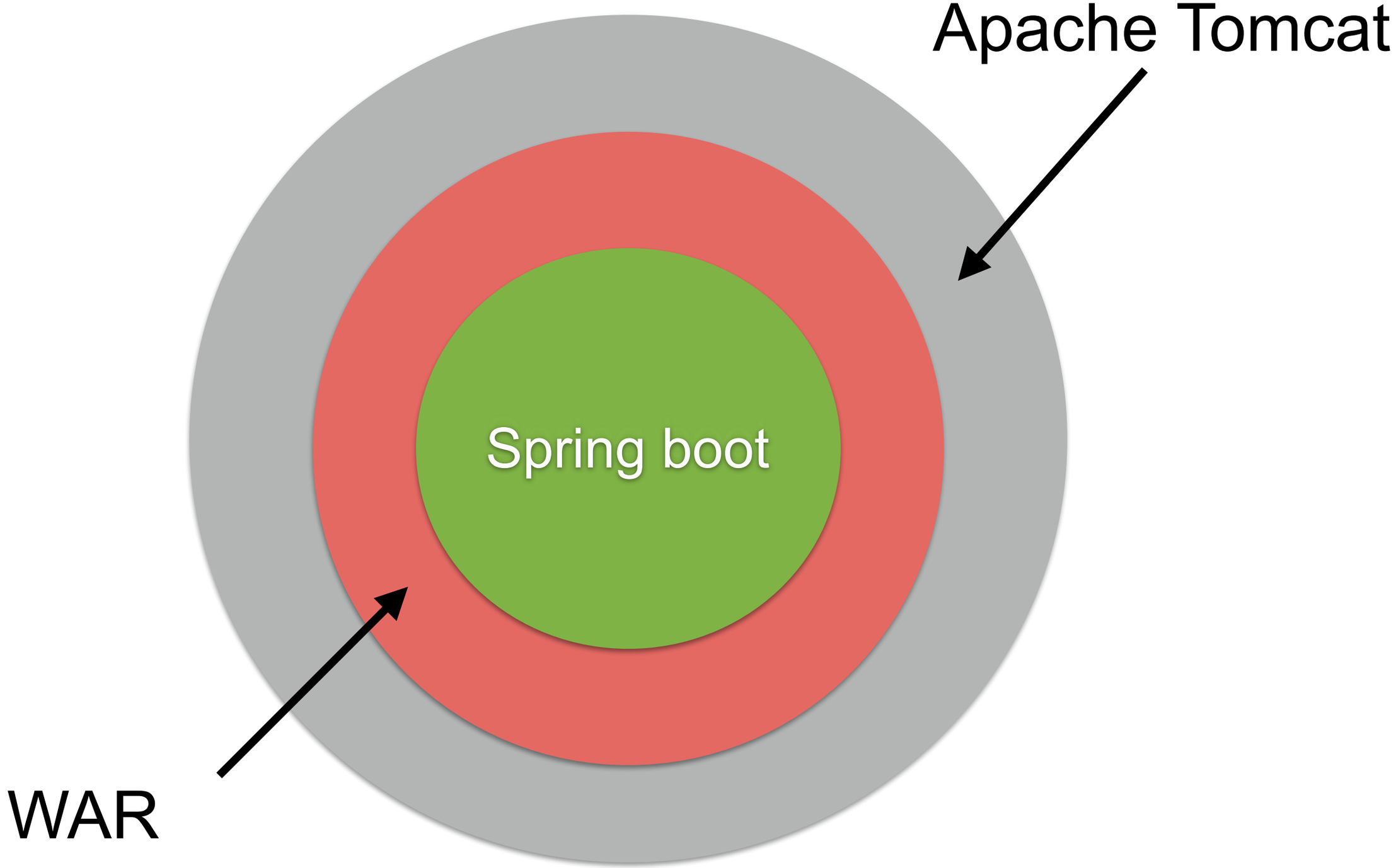
Embedded application server
Integration with tools/technologies (starter)
Production tools (monitoring, health check)
Configuration management
Dev tools
No source code generation, no XML

How ?



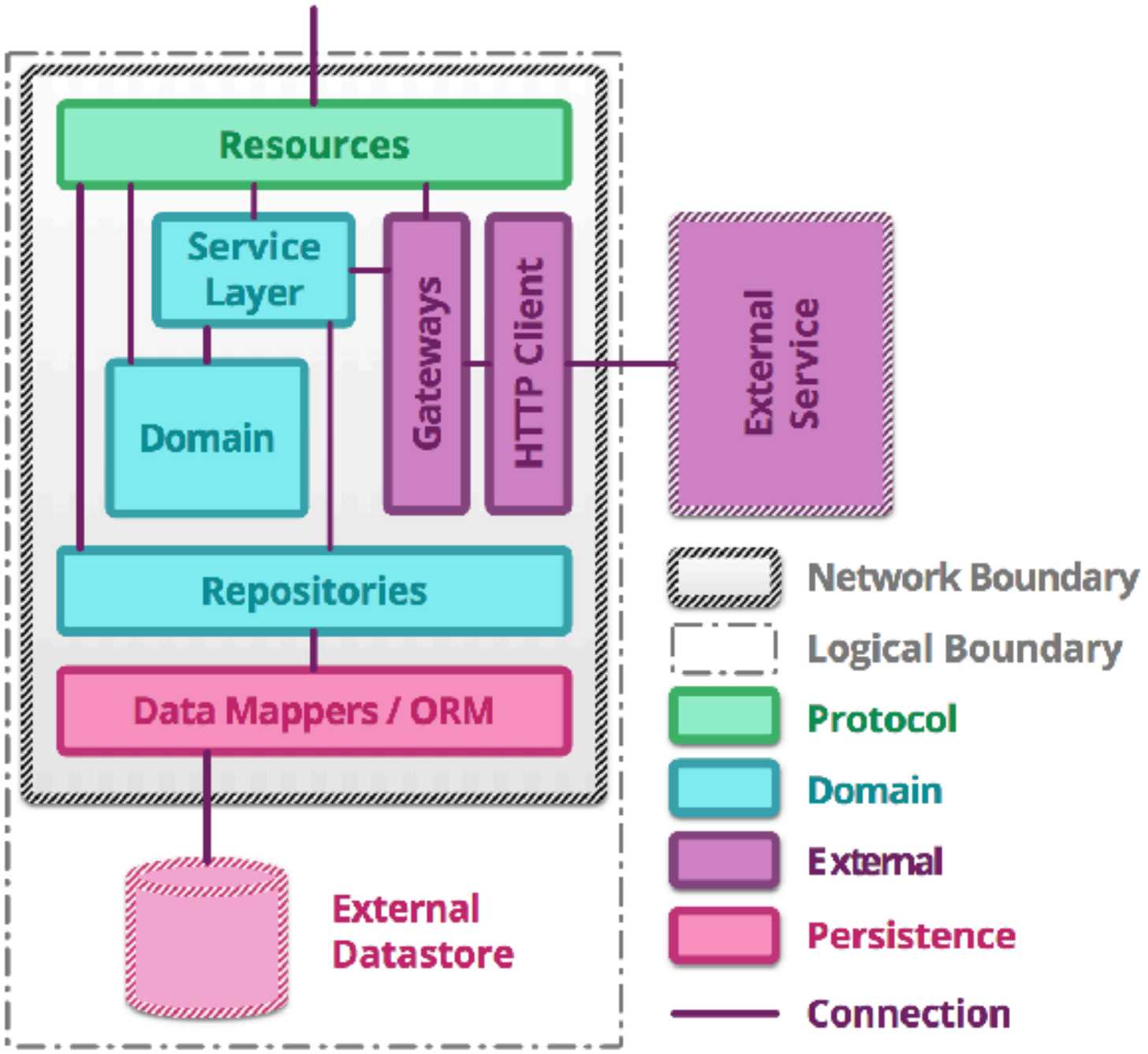

```
$mvn spring-boot:run
$java -jar demo.jar
```

How ?

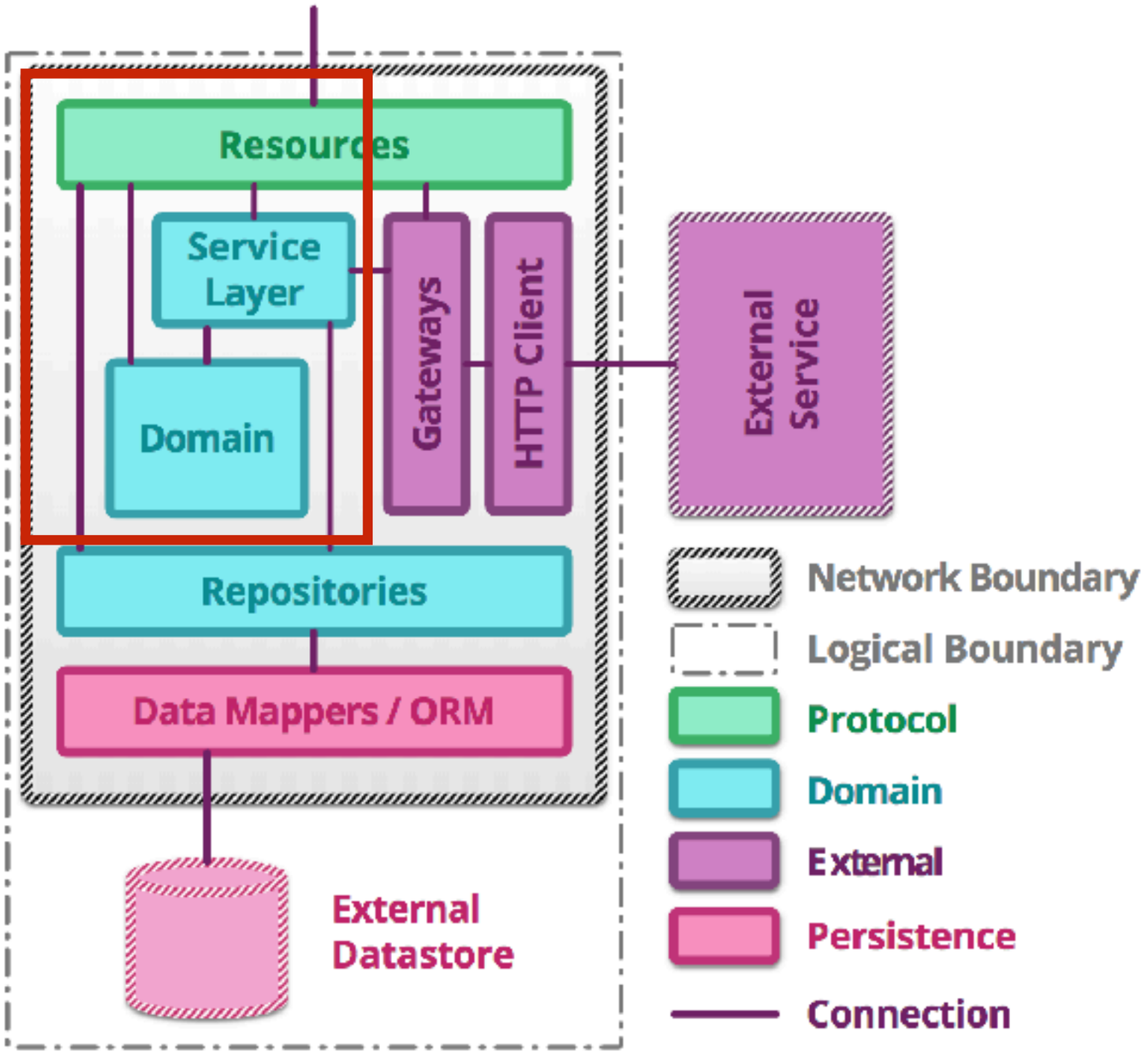


Building RESTful API with Spring Boot

Service Structure



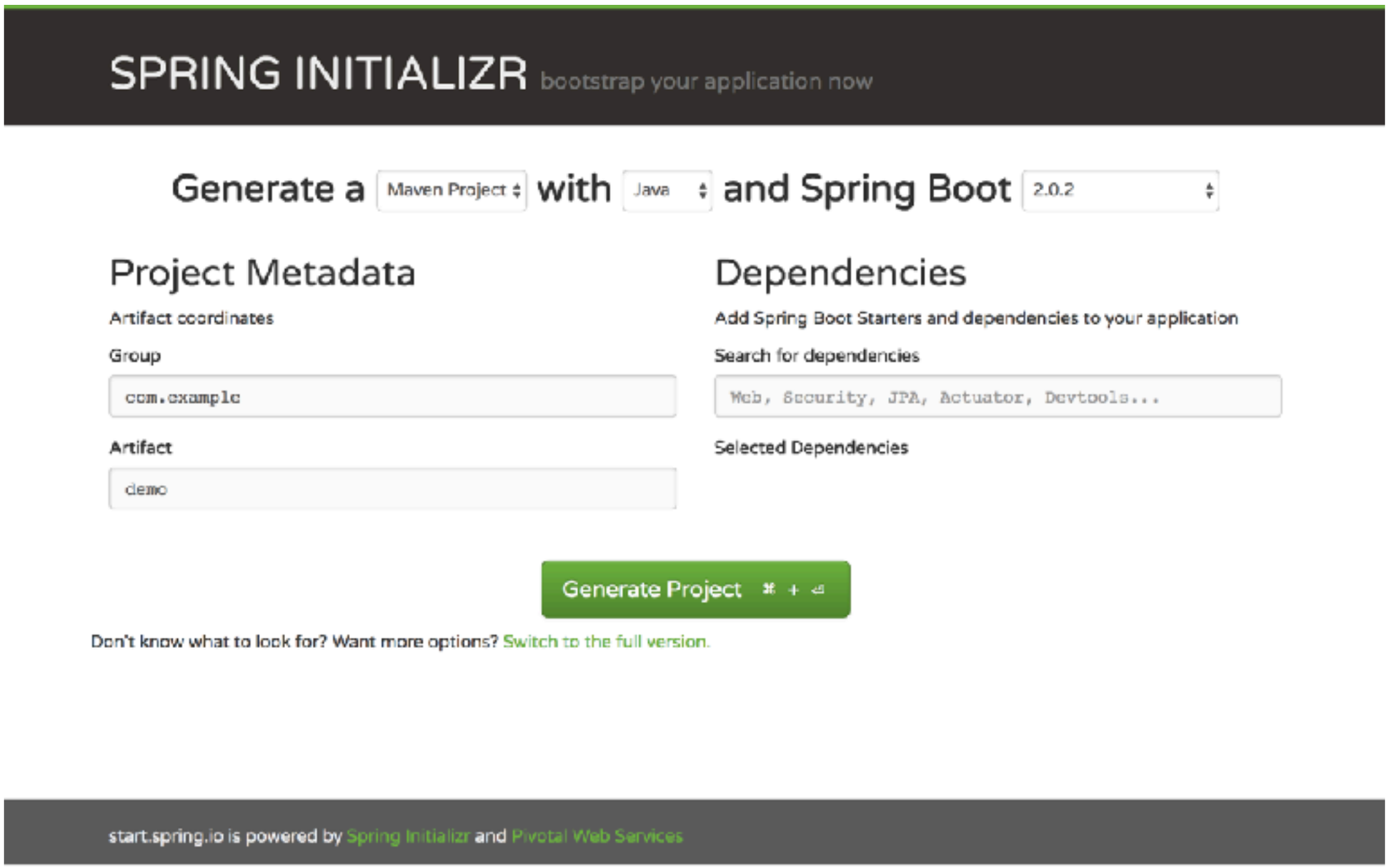
Service Structure



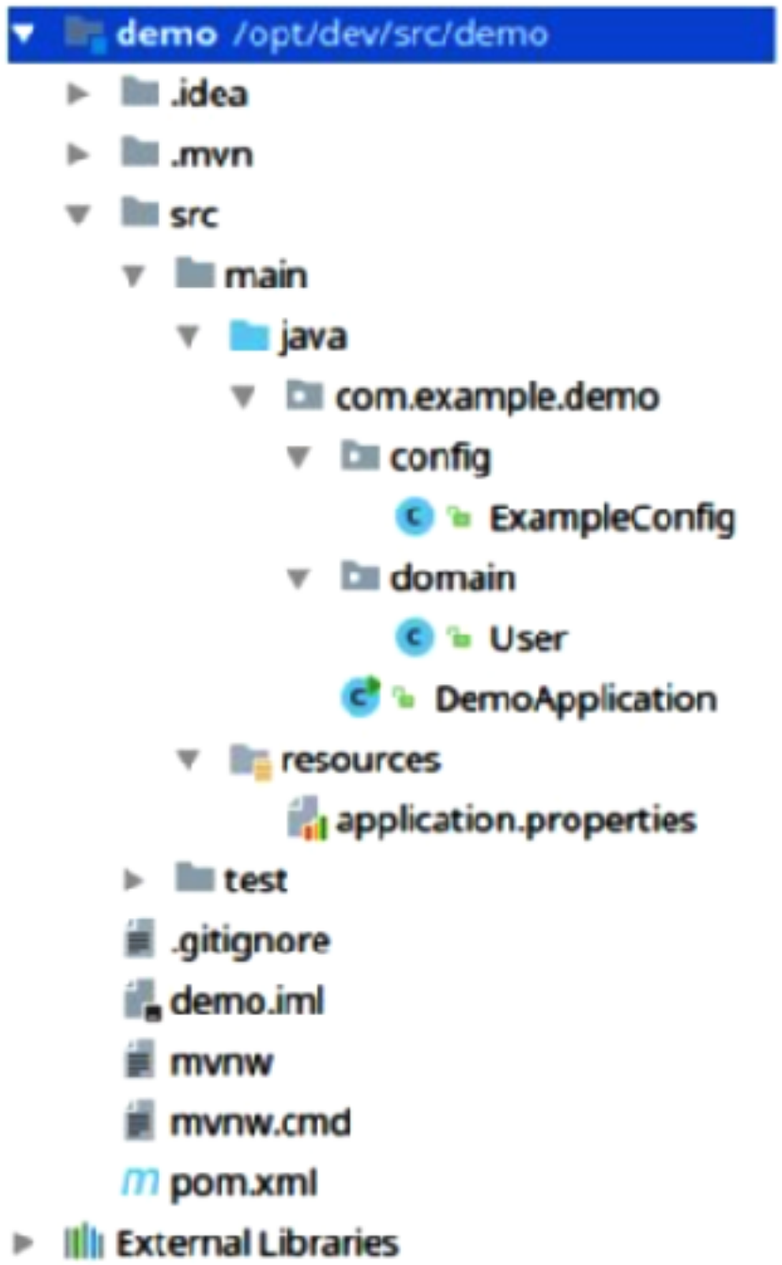
Create project with Spring Initializr

Spring Initializr

https://start.spring.io/



Structure of Spring Boot

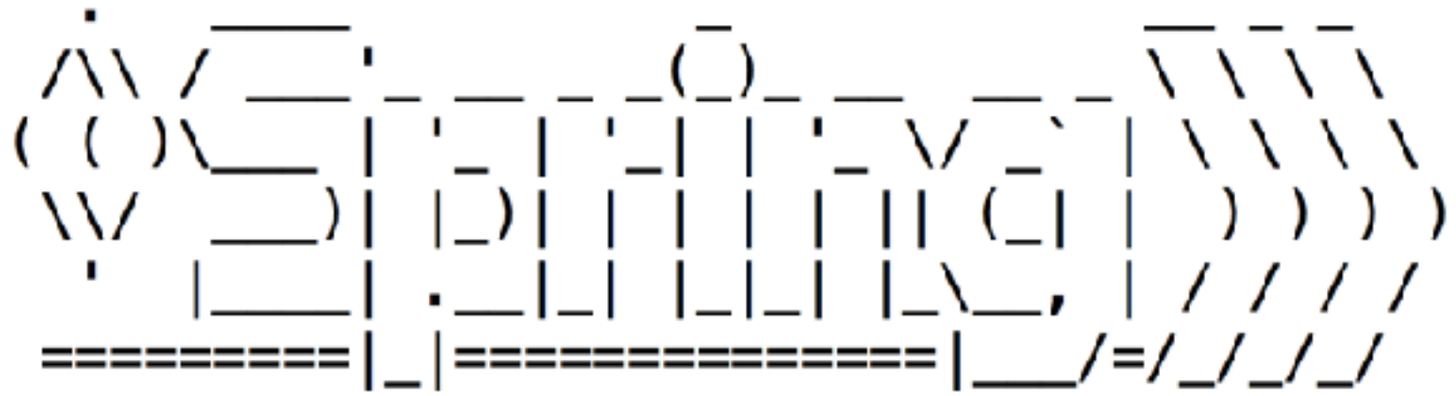


Spring Boot main class

```java
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




```
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
```

Custom Banner

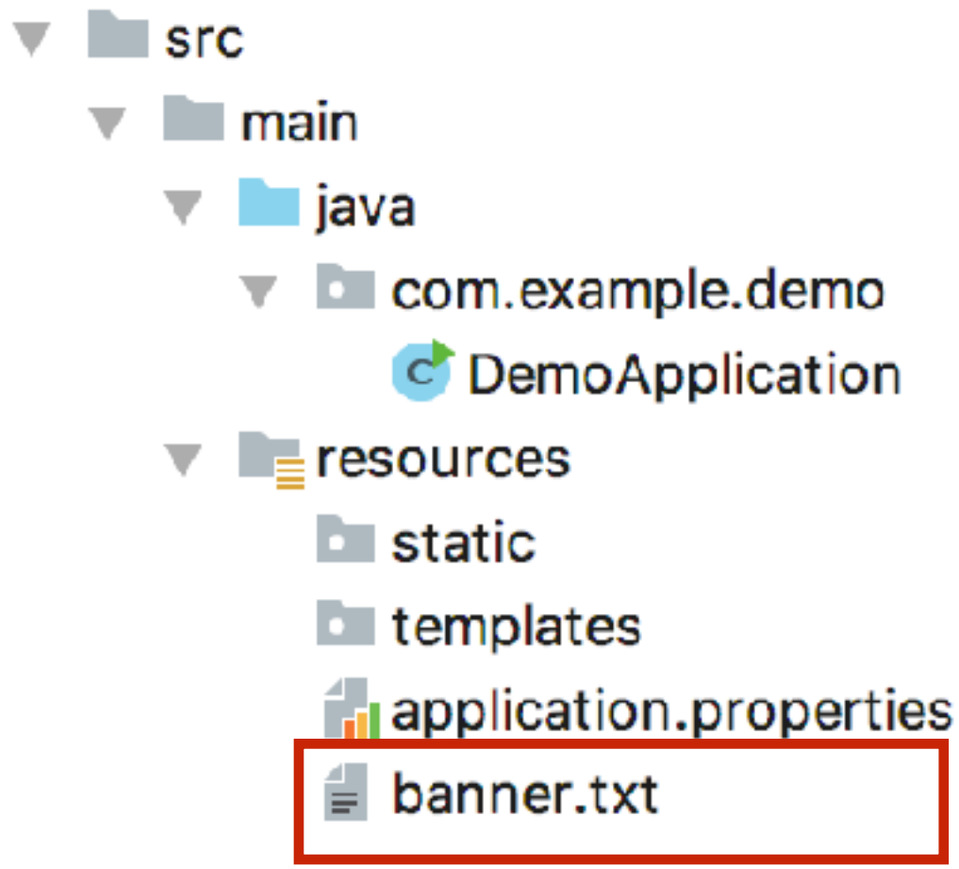
Custom banner

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

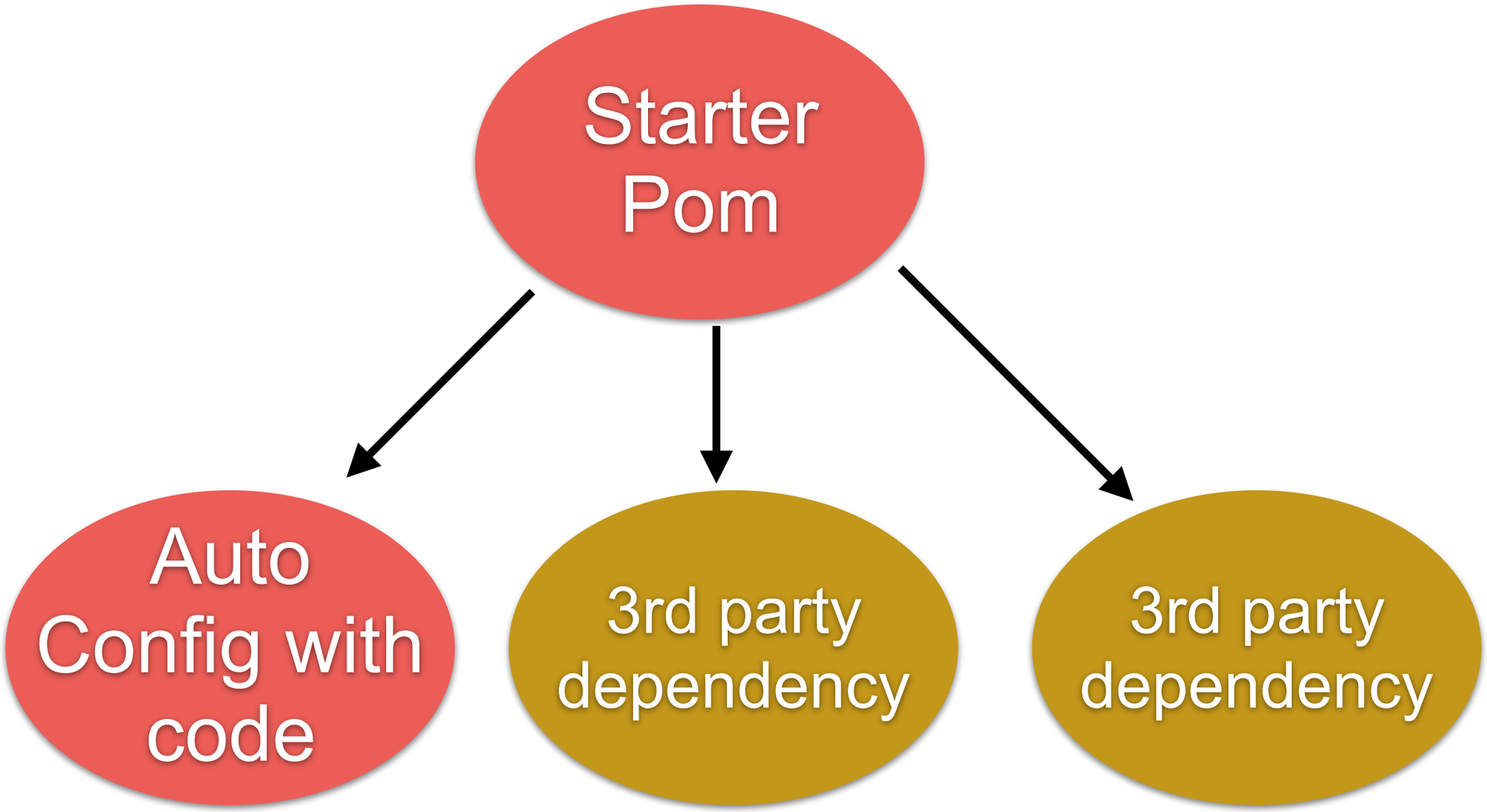
```
@SpringBootApplication
public class DemoApplication {

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

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

Disable banner

```java
@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)

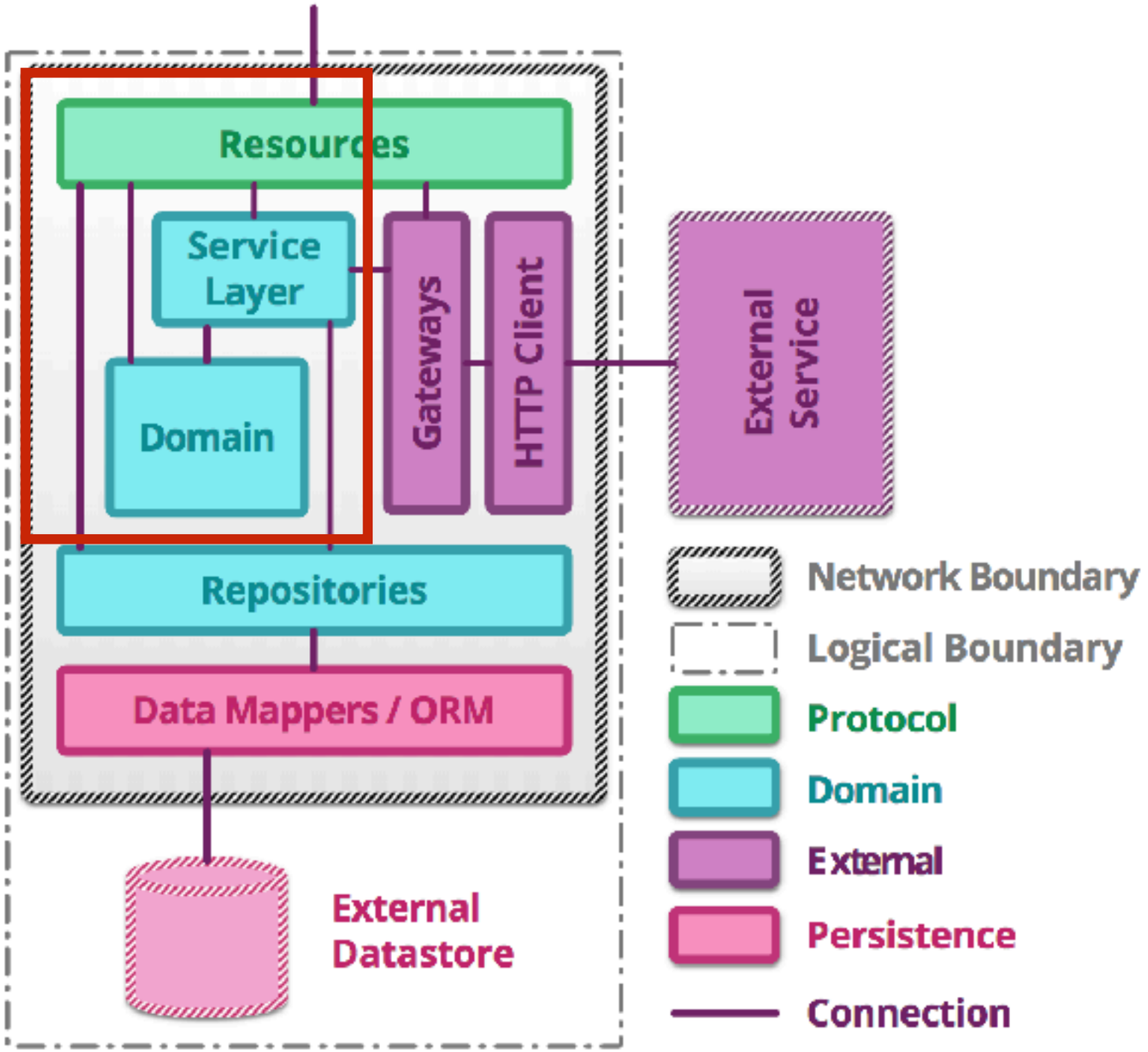
```xml
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.o
    <modelVersion>4.0.0</modelVersion>

    <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)

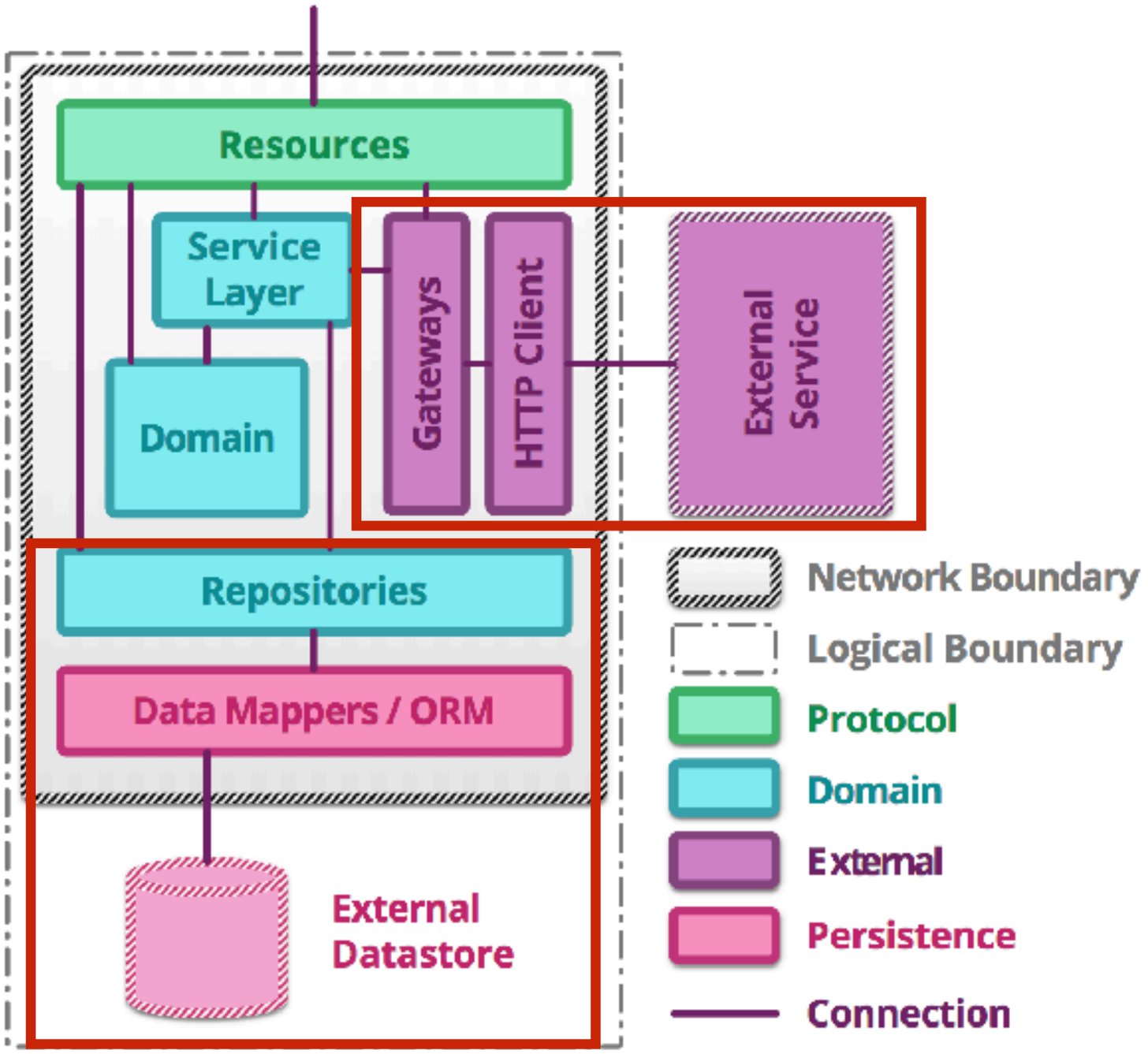
```xml
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>

    <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

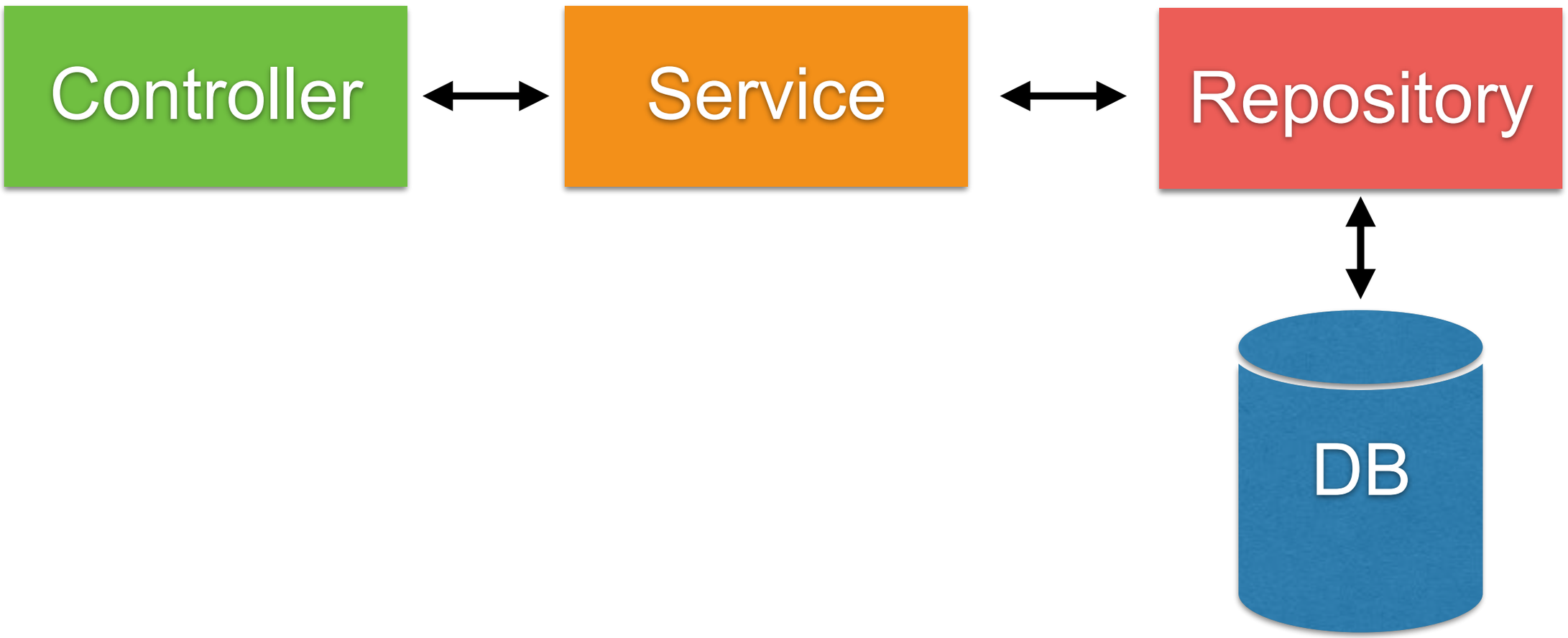
Service Structure



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

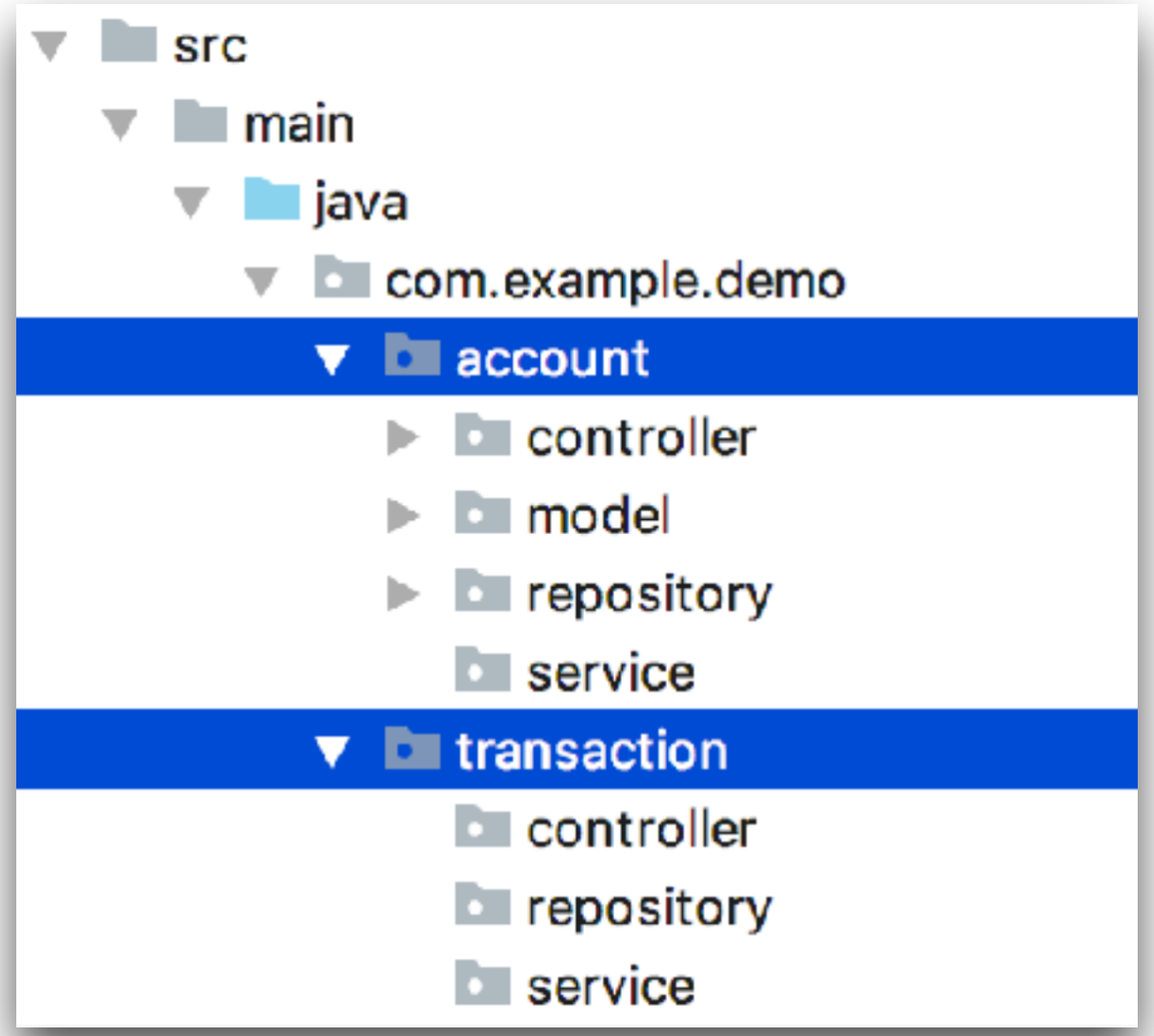
Spring Boot Structure (1)

Separate by function/domain/feature

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

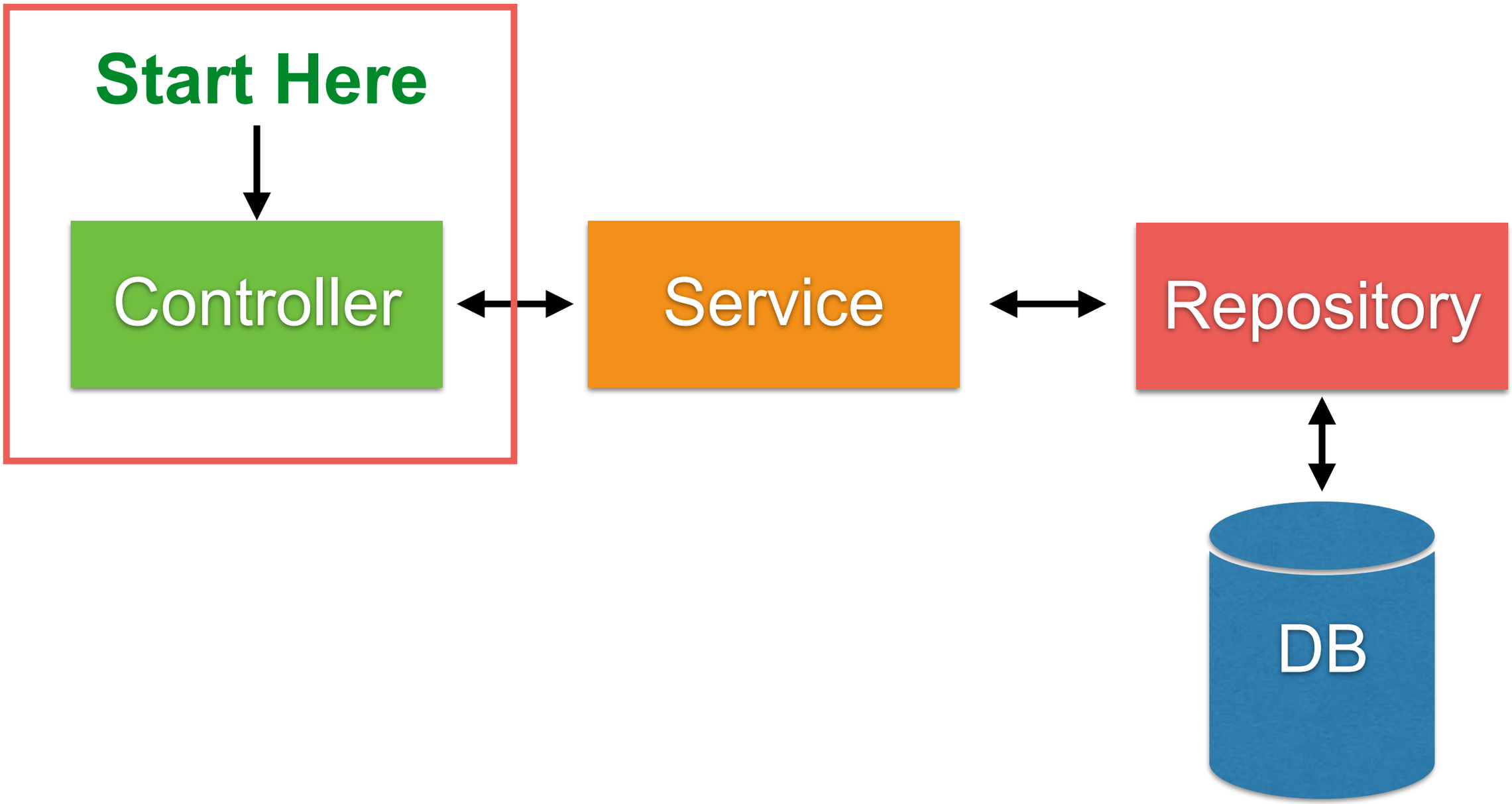
Spring Boot Structure (2)

Separate by function/domain/feature

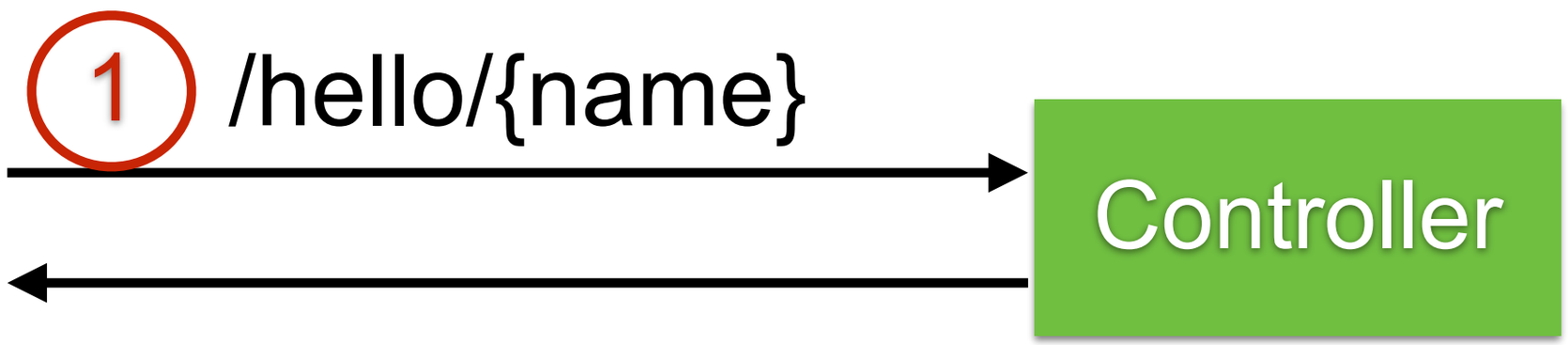


Create first RESTful API

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

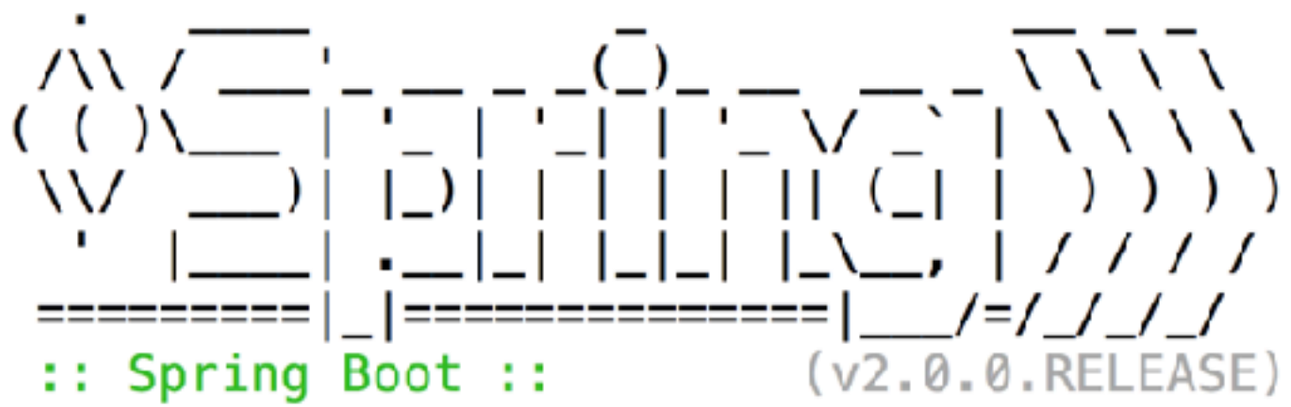
```
public class Hello {

    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

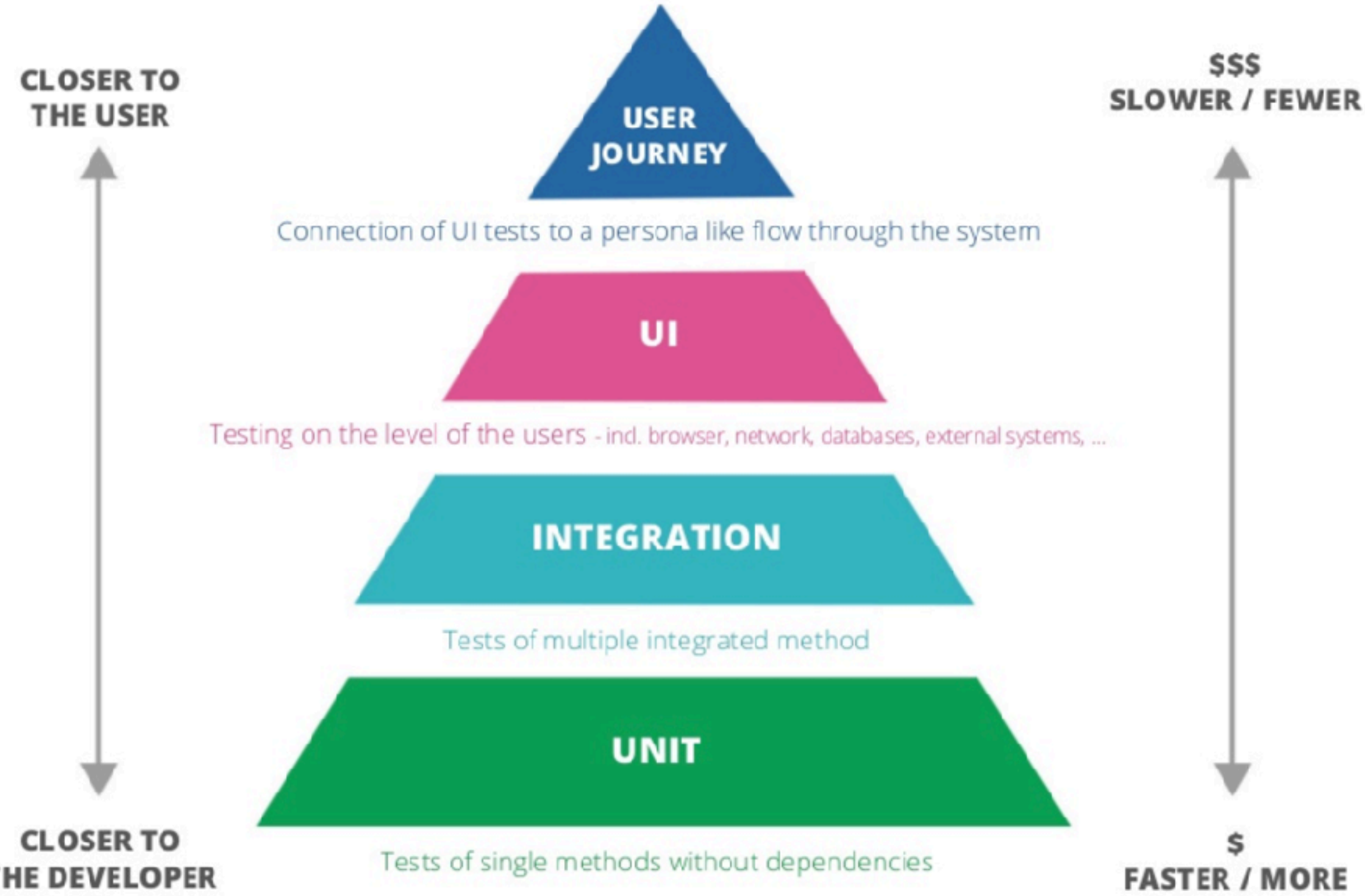



```
2018-03-05 23:37:18.018  INFO 30560 --- [           mair
                    : Starting HelloApplication v1.0-SNAPSH(
th PID 30560 (/Users/somkiat/data/slide/microservice/sl:
op/course-microservice/slide/4days-workshop/workshop/he
 by somkiat in /Users/somkiat/data/slide/microservice/s
hop/course-microservice/slide/4days-workshop/workshop/he
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/hello/somkiat

How to test the Hello service ?



Unit tests

How to use model ?

```java
public class HelloTest {

    @Test
    public void success_to_create_model_with_constructor() {
        Hello hello = new Hello("Somkiat");
        assertEquals( expected: "Somkiat", hello.getMessage());
    }

}
```

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

SpringBootTest

```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());

    }
}
```

MockMvcTest #1

```java
@RunWith(SpringRunner.class)
@WebMvcTest(controllers = HelloController.class)
public class HelloControllerTest {

    @Autowired
    private MockMvc mockMvc;

    @Test
    public void shouldReturnHelloSomkiat() throws Exception {
        mockMvc.perform(get( urlTemplate: "/hello/somkiat"))
                .andExpect(
                        jsonPath( expression: "$.message")
                                .value( expectedValue: "Hello somkiat"))
                .andExpect(status().is2xxSuccessful());
    }

}
```

MockMvcTest #2

```java
@RunWith(SpringRunner.class)
@WebMvcTest(controllers = HelloController.class)
public class HelloController2Test {

    @Autowired
    private MockMvc mockMvc;

    @Test
    public void success_with_statuscode_200() throws Exception {
        MockHttpServletResponse response
                = mockMvc.perform(get("/hello/somkiat"))
                        .andReturn().getResponse();

        assertEquals(HttpStatus.OK.value(), response.getStatus());
    }
```

MockMvcTest #2

Use **JacksonTester** to convert object to JSON message

```
private JacksonTester<Hello> jsonHello;

@Test
public void success_with_correct_json_data() throws Exception {
    JacksonTester.initFields(this, new ObjectMapper());

    MockHttpServletResponse response = mockMvc.perform(get("/hello/somkiat"))
            .andReturn().getResponse();

    String expected = jsonHello.write(new Hello("somkiat")).getJson();
    assertEquals(expected, response.getContentAsString());

}
```

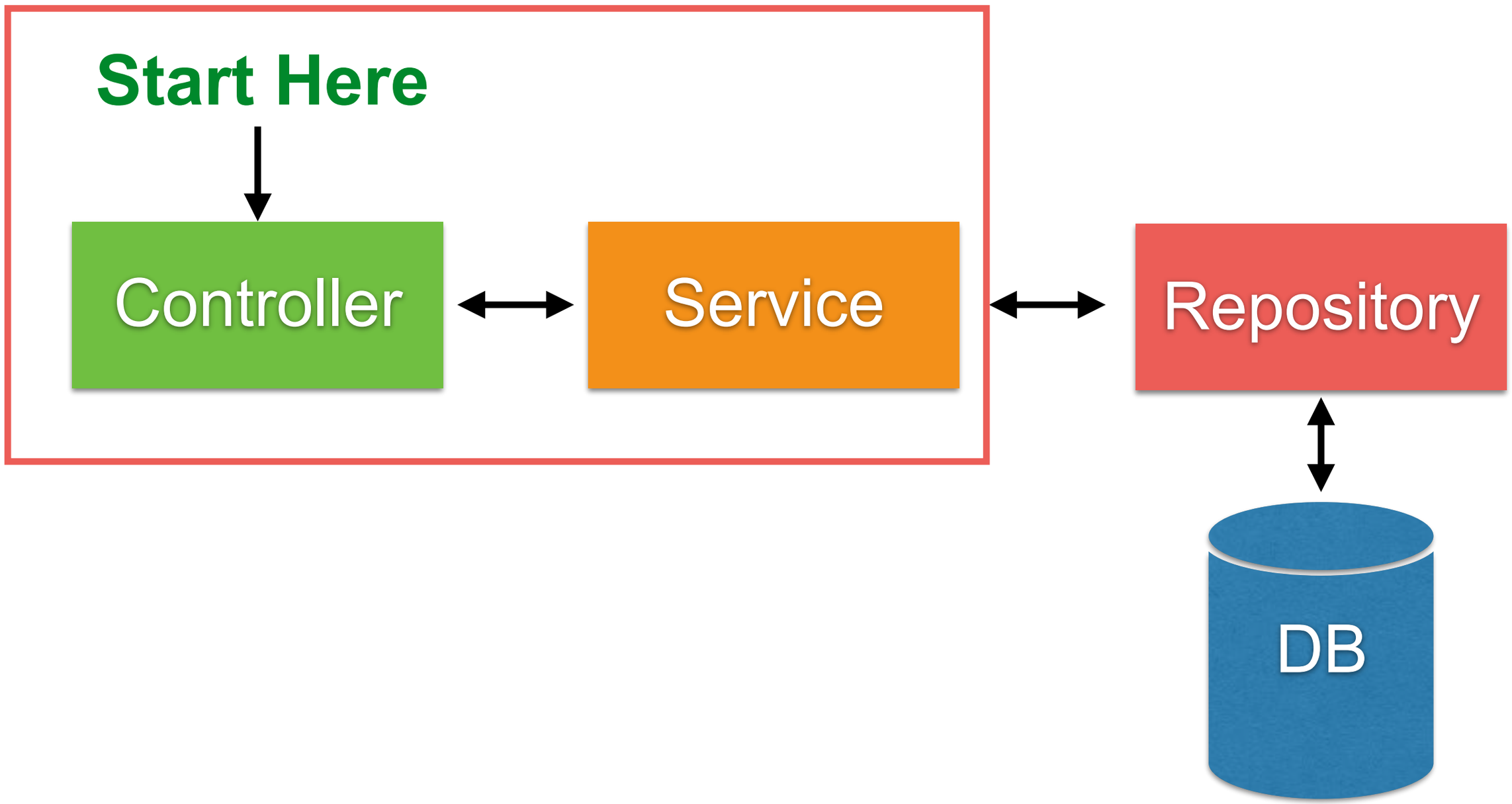
Compile with testing

$mvn clean test

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

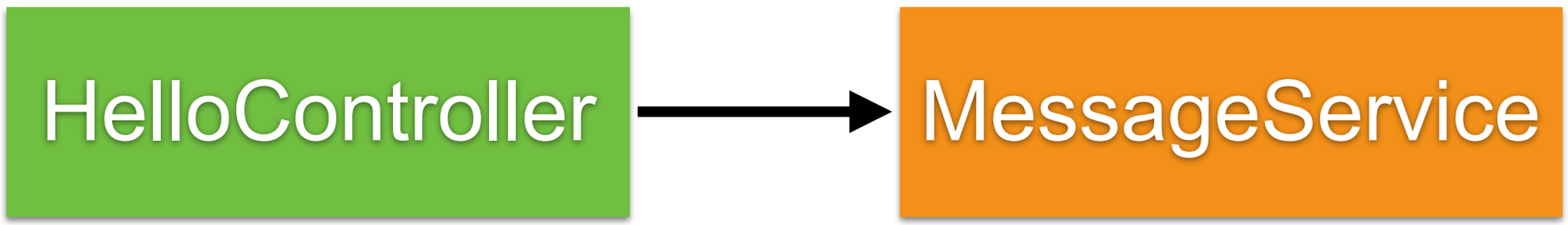
Move business logic to service

Working with service



Move business logic to service

MessageService.java



MessageService.java

```java
@Service
public class MessageService {

    public String concat(String name) {
        return "Hello, " + name;
    }

}
```

Edit HelloController.java

Call method from service

```
@Autowired
private MessageService messageService;

@GetMapping("/hello/{name}")
public HelloResponse
      sayHi(@PathVariable String name) {
      String result = messageService.concat(name);
      return new HelloResponse(result);
}
```

Run all tests !!

$mvnw clean test

Fix fail test cases

Testing controller with service

Working with @WebMvcTest

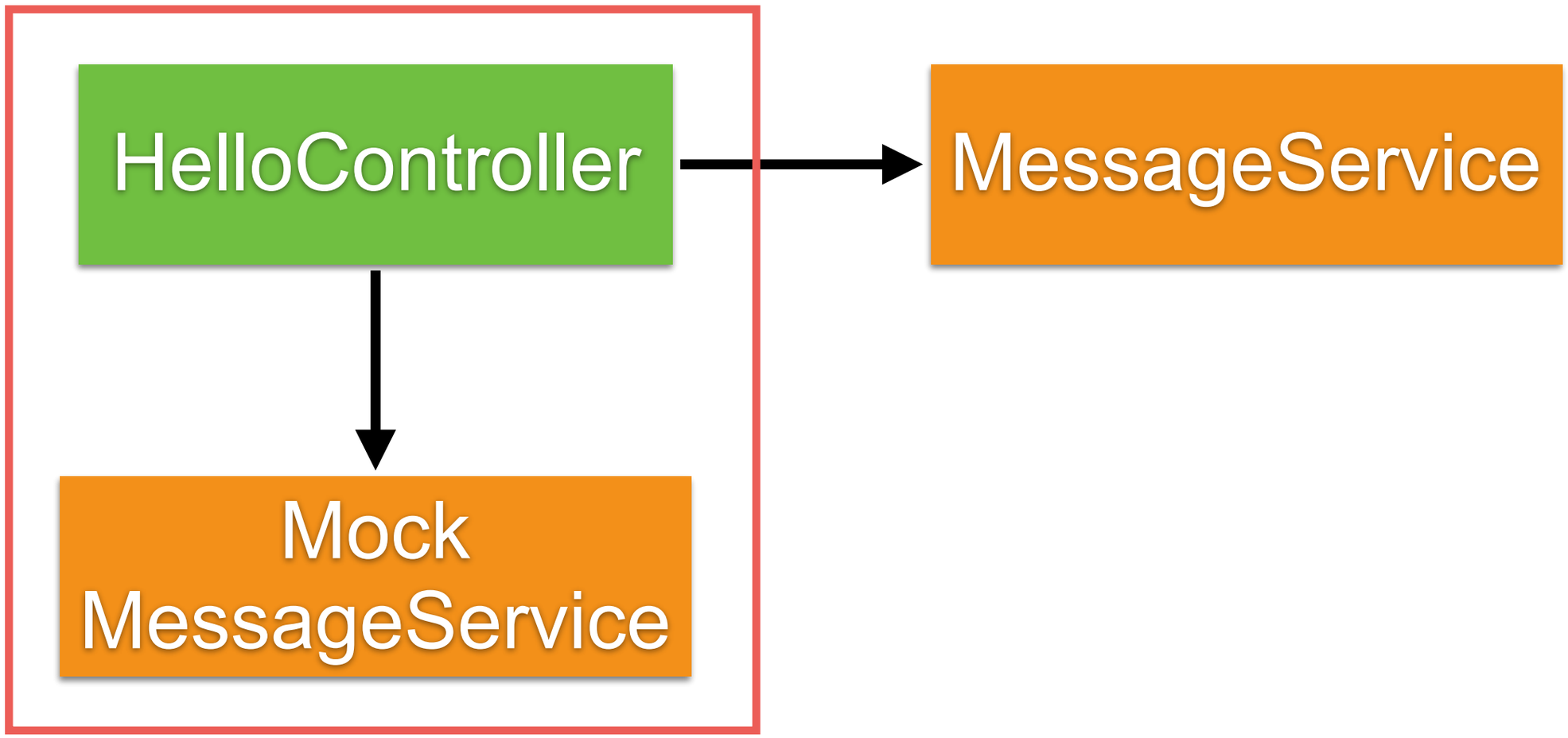
```
@Autowired
private MockMvc mockMvc;

@MockBean
private MessageService messageService;

private JacksonTester<HelloResponse> tester;

@Before
public void initial() {
    JacksonTester.initFields(this, new ObjectMapper());
    given(messageService.concat("somkiat"))
        .willReturn("Hello, somkiat");
}
```

1

2

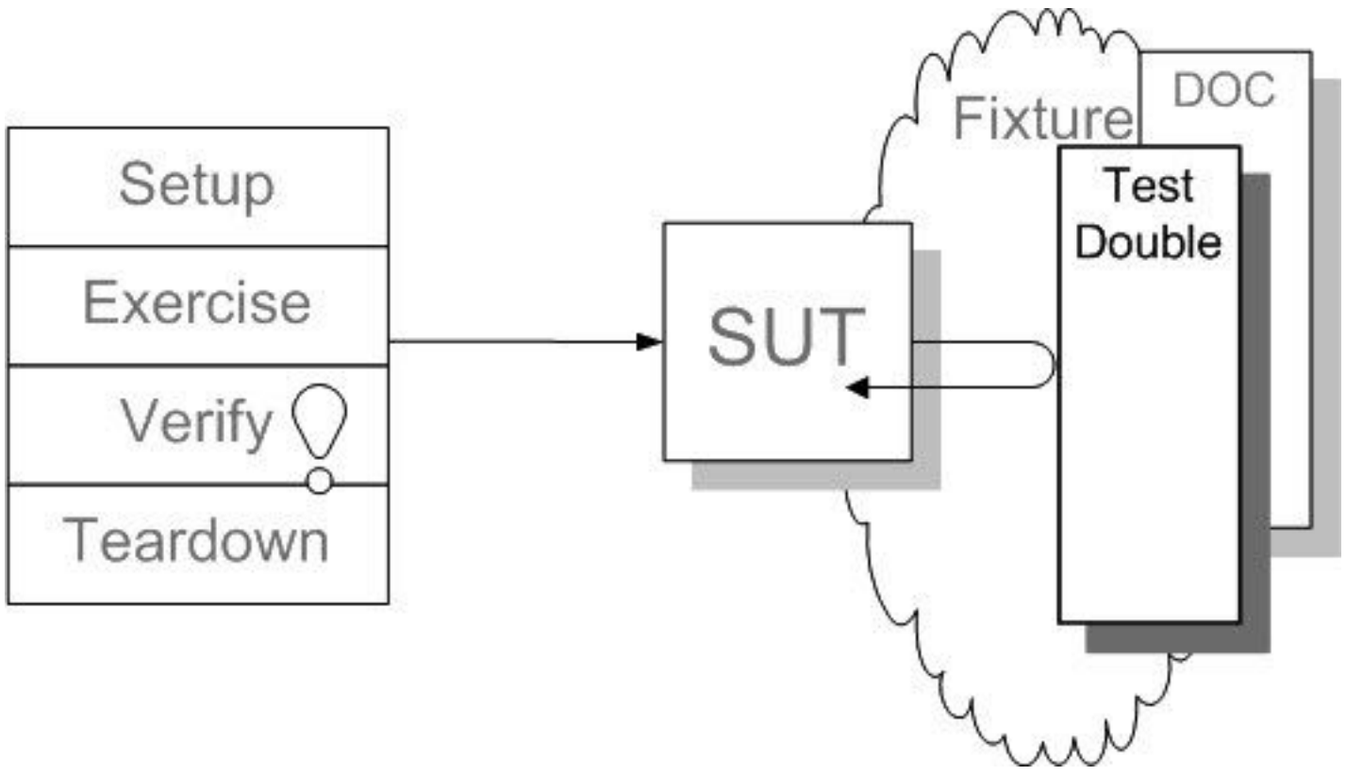
Testing controller with service

Try to mocking service with Mockito



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

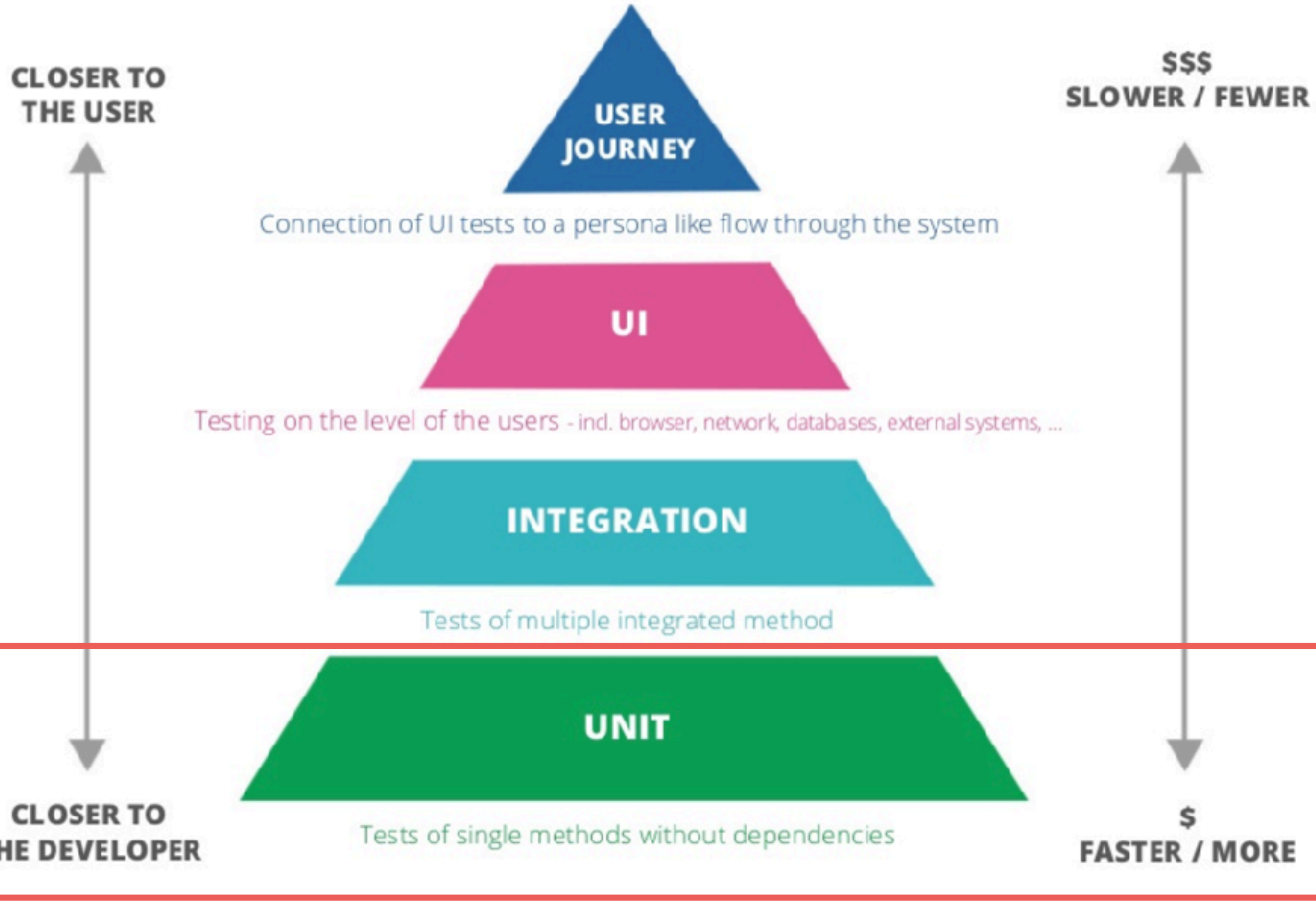
Run all tests !!

$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] ------------------------------------------------------------------------
```

Slow Test ?

How to improve the speed of testing ?



Unit testing with Controller

Unit test

Use Test Double

In java, use Mockito library

http://site.mockito.org/

Unit test with Mockito (1)

Setup dependency and controller

```
public class HelloControllerUnitTest {

    private HelloController helloController;

    @Mock
    private MessageService messageService;
```

1

```
    @Before
    public void initial() {
        initMocks(this);
        helloController = new HelloController();
        helloController.setMessageService(messageService);
    }
```

2

Unit test with Mockito (2)

Testing by call method from controller

```
@Test
public void test() {
    given(messageService.concat("somkiat"))
    .willReturn("Hello, somkiat");

    HelloResponse response
                = helloController.sayHi("somkiat");

    assertEquals("Hello, somkiat", response.getMessage());

}
```

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

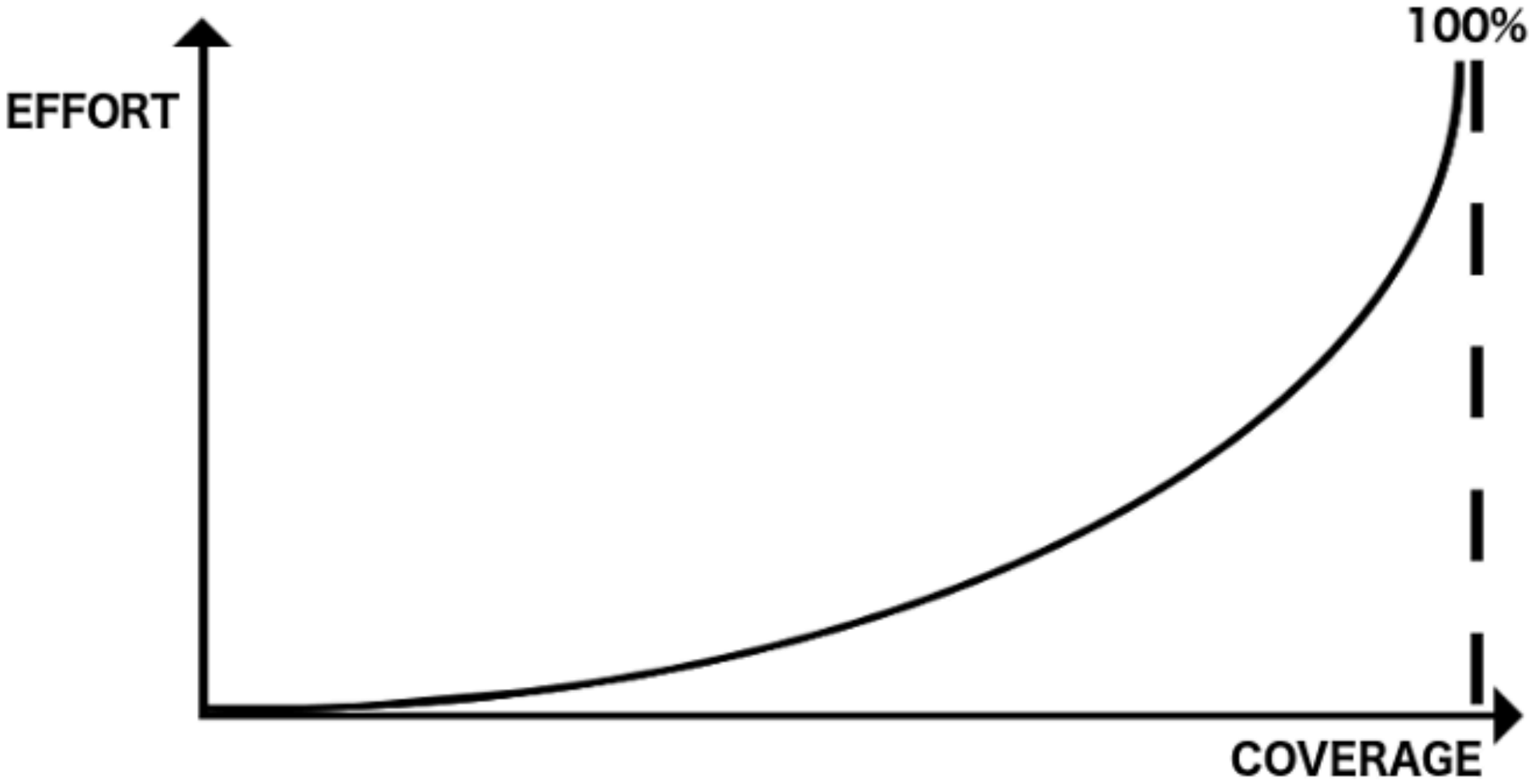
But 100% of code coverage **does not mean** that your code is 100% correct

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

Add coverage to pom.xml (1)

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

        <plugin>
            <artifactId>maven-compiler-plugin</artifactId>
            <version>2.5.1</version>
            <configuration>
                <source>${java.version}</source>
                <target>${java.version}</target>
                <encoding>${project.build.sourceEncoding}</encoding>
            </configuration>
        </plugin>
```

Add coverage to pom.xml (2)

```xml
<plugin>
    <groupId>org.codehaus.mojo</groupId>
    <artifactId>cobertura-maven-plugin</artifactId>
    <version>2.7</version>
    <configuration>
        <formats>
            <format>html</format>
            <format>xml</format>
        </formats>
    </configuration>
    <executions>
        <execution>
            <phase>package</phase>
            <goals>
                <goal>cobertura</goal>
            </goals>
        </execution>
    </executions>
    <dependencies>
        <dependency>
            <groupId>org.ow2.asm</groupId>
            <artifactId>asm</artifactId>
            <version>5.0.3</version>
        </dependency>
    </dependencies>
</plugin>
```

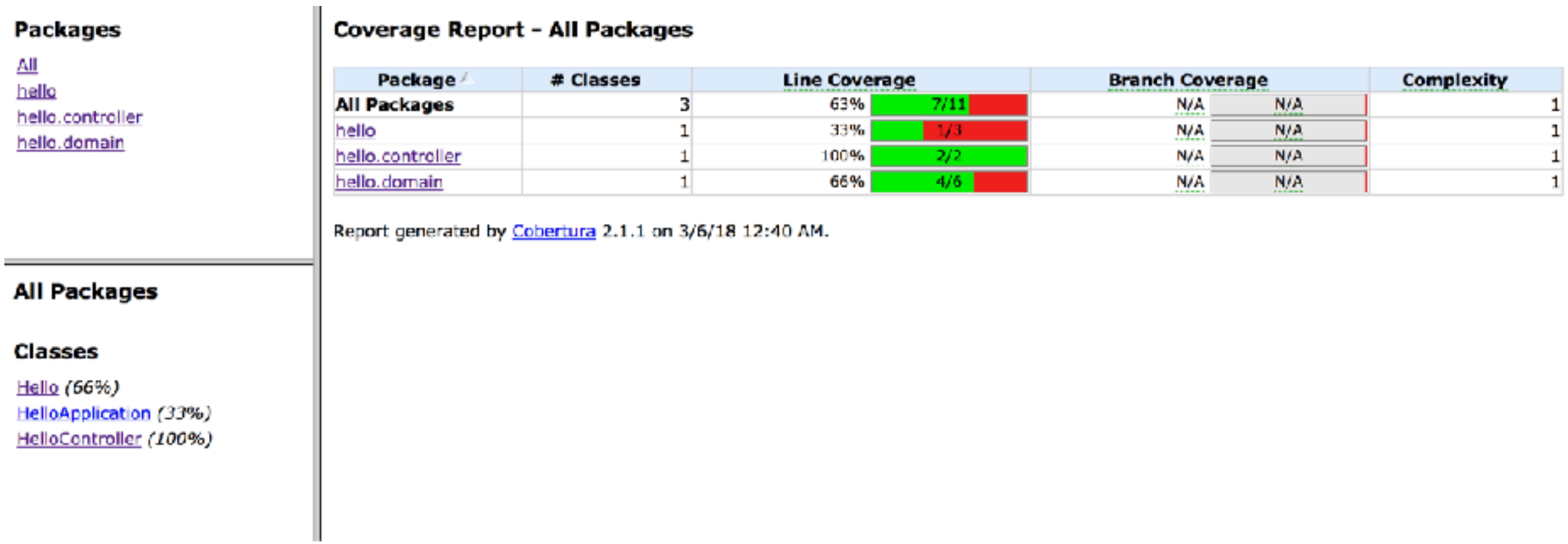
Run test again

$mvn 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
------------------------------------------------------------------------
```

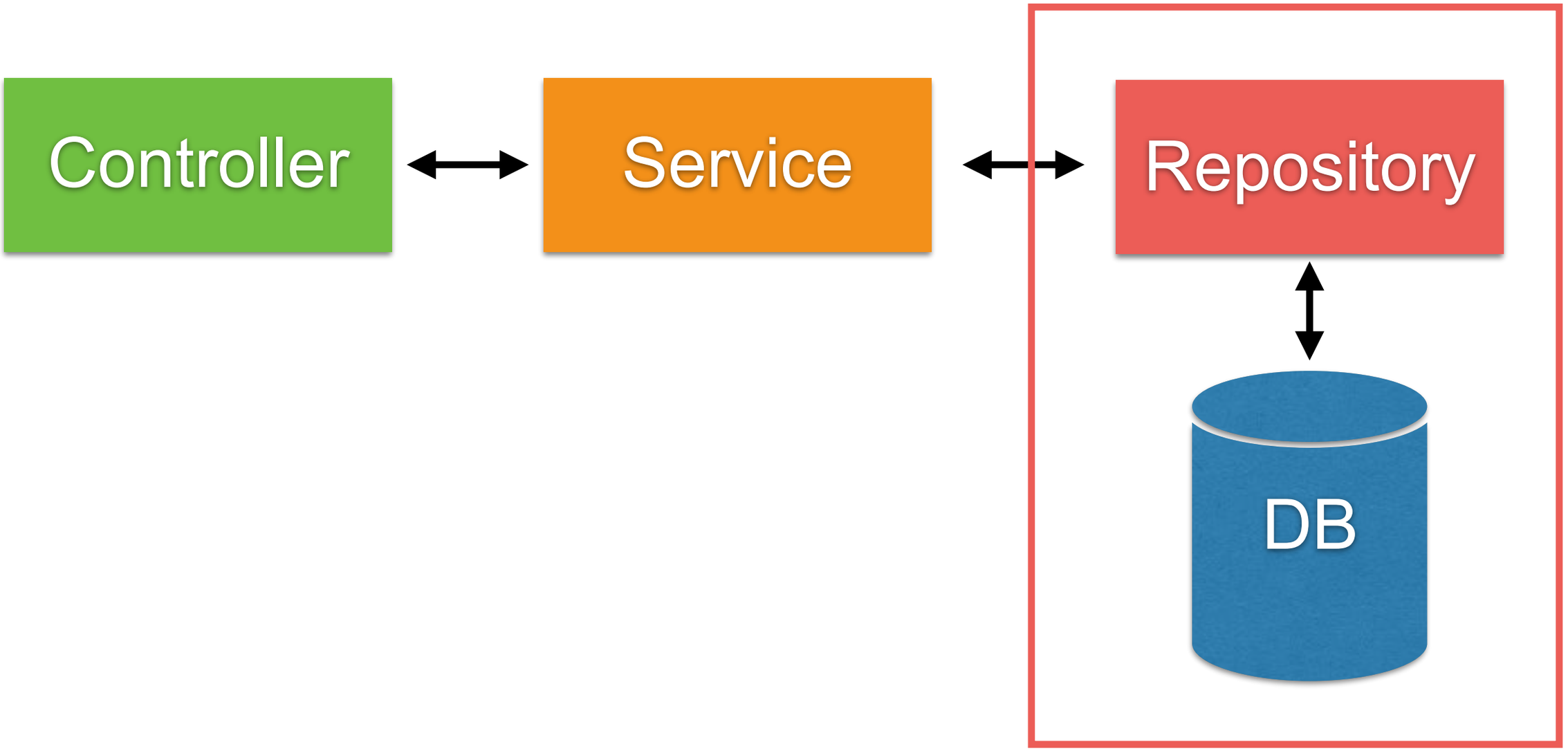
Coverage report

open target/site/cobertura/index.html



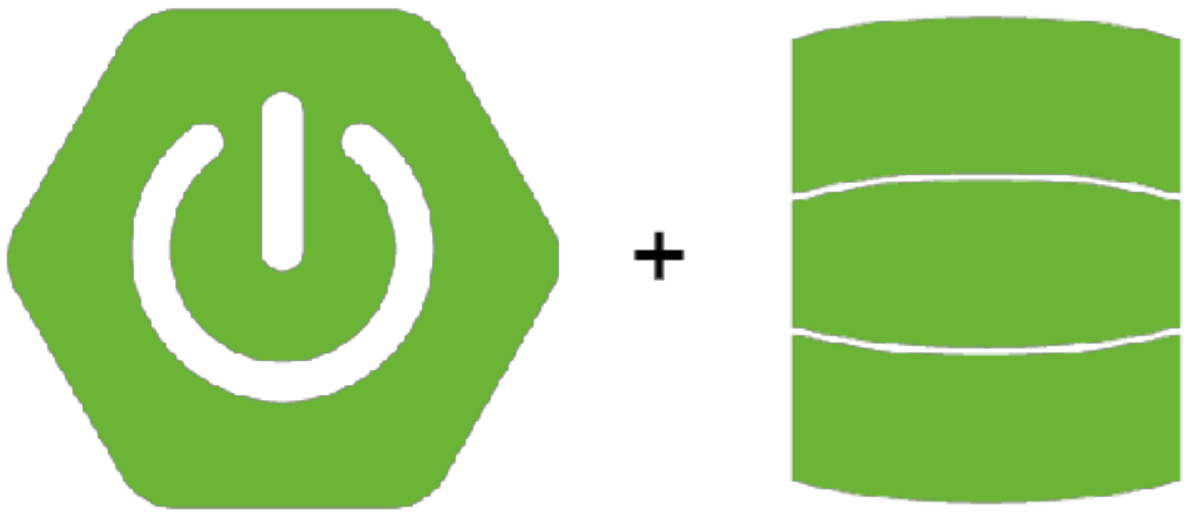
Working with Repository

Working with repository



Working with repository

We're using Spring Data



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

1. Modify pom.xml

Add library of Spring Data such as JPA

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

2. Modify pom.xml (1)

Add library of data store such as **MariaDB**

```
<dependency>
    <groupId>org.mariadb.jdbc</groupId>
    <artifactId>mariadb-java-client</artifactId>
    <version>2.2.6</version>
</dependency>
```

https://mvnrepository.com/artifact/org.mariadb.jdbc/mariadb-java-client

2. Modify pom.xml (2)

Add library of data store such as **PostgreSQL**

```
<dependency>
    <groupId>org.postgresql</groupId>
    <artifactId>postgresql</artifactId>
    <version>42.2.4</version>
</dependency>
```

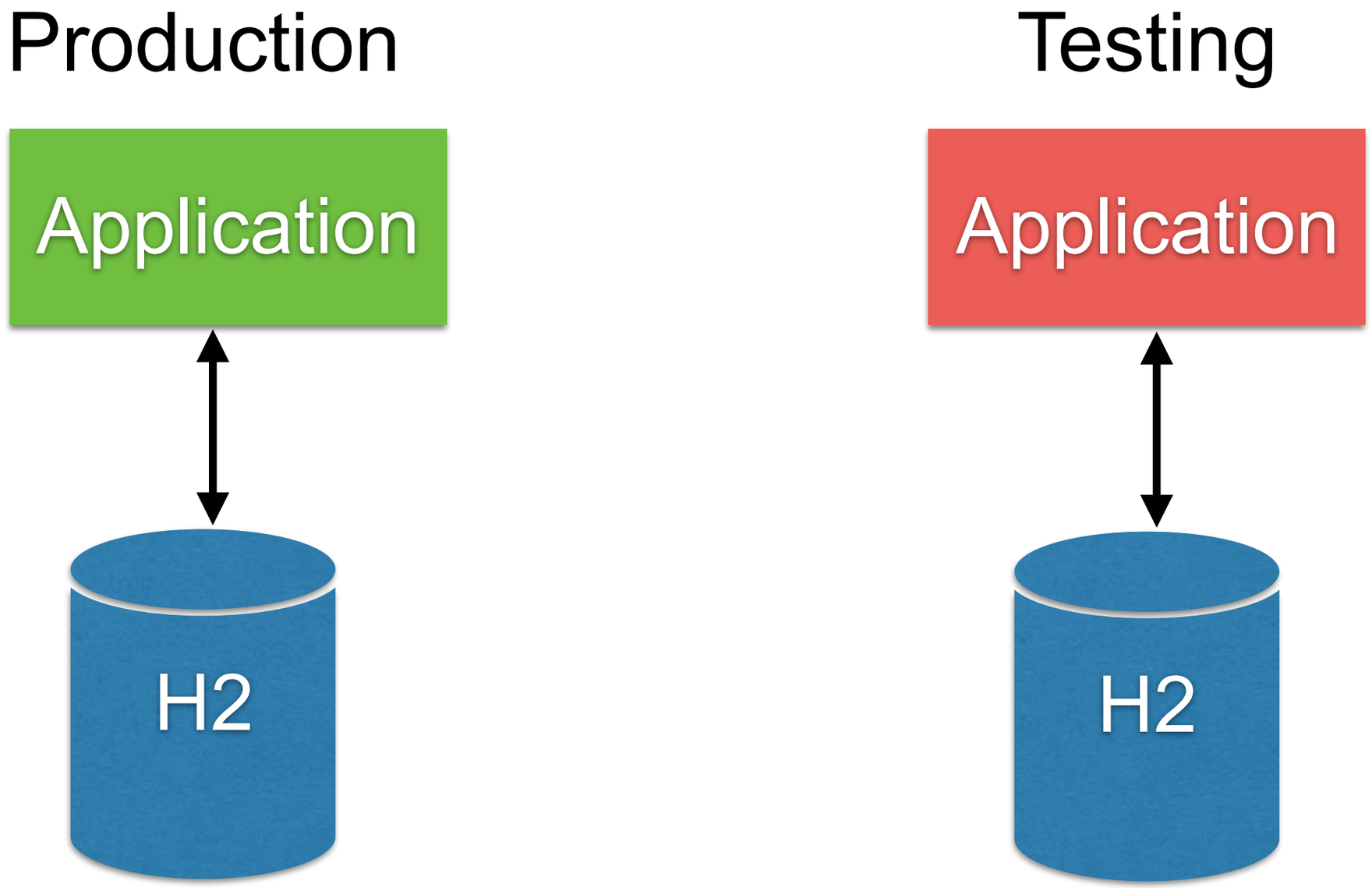
https://mvnrepository.com/artifact/org.postgresql/postgresql

3. Add configuration of database

In src/main/resources/application.properties

spring.jpa.hibernate.ddl-auto=create
spring.datasource.url=<url>
spring.datasource.username=<user>
spring.datasource.password=<password>

Working with H2 Database



Working with H2 database

Add library of data store such as **H2**

```
<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <version>1.4.197</version>
</dependency>
```

https://mvnrepository.com/artifact/com.h2database/h2/

Create repository with JPA

MessageRepository.java

```
public interface MessageRepository
        extends CrudRepository<Message, Integer> {

}
```

Create Entity class

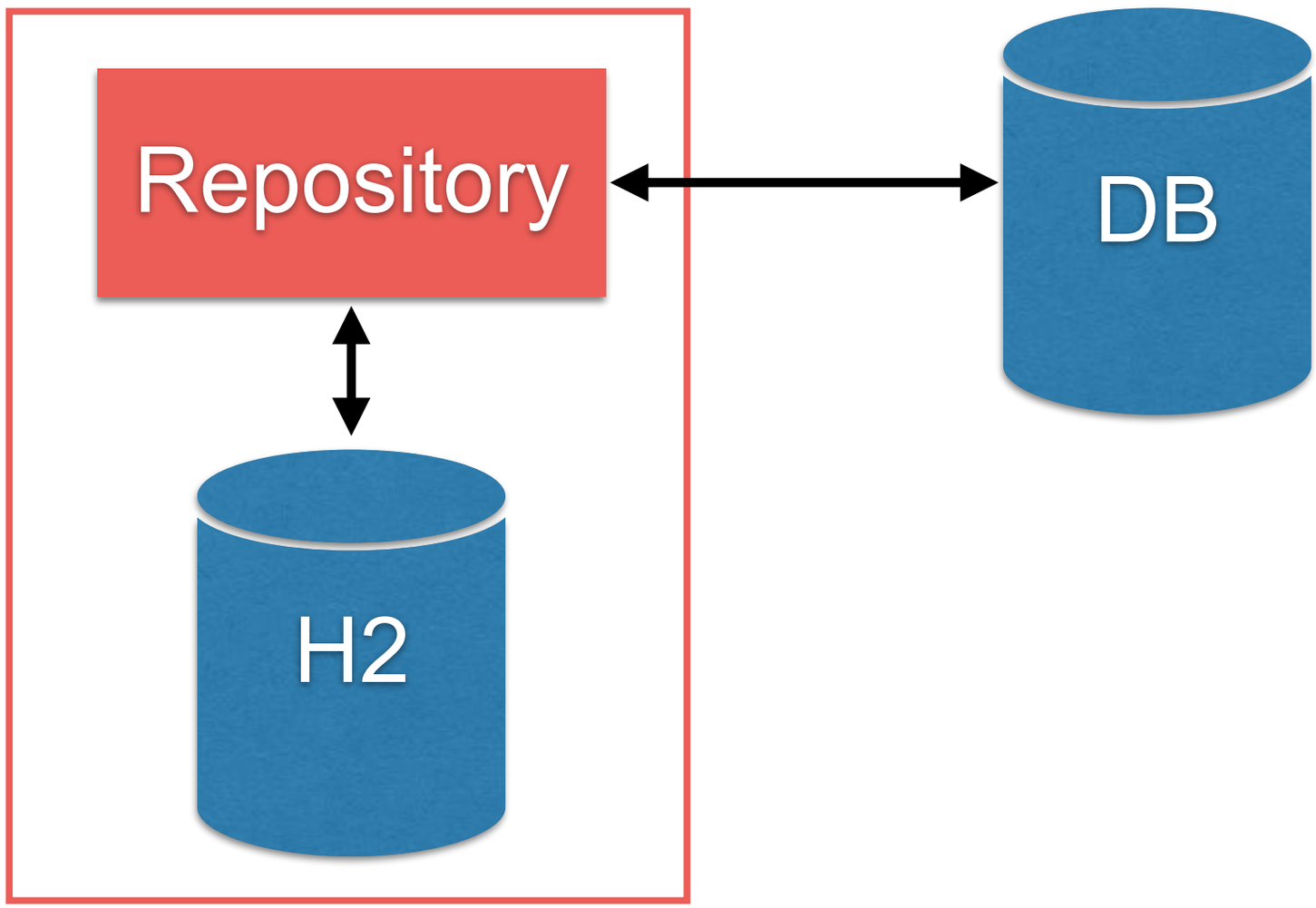
Message.java

```
@Entity
public class Message {

    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private int id;
    private String data;
```

How to testing repository ?

Repository Testing

Using @DataJpaTest (slice testing)



Working with In-memory database

Spring boot provide DataJpaTest

should be add H2 library to pom.xml

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

Repository Testing (1)

Setup test with @DataJpaTest

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

    @Autowired
    private MessageRepository messageRepository;
```

Repository Testing (2)

Add a test case

```
@Test
public void create_and_fetch_message() {
    Message newMessage = new Message("somkiat");
    messageRepository.save(newMessage);

    Optional<Message> actualMessage
            = messageRepository.findById(1);

    assertEquals("somkiat", actualMessage.get().getData());
}
```

Repository Testing (3)

Add a test case

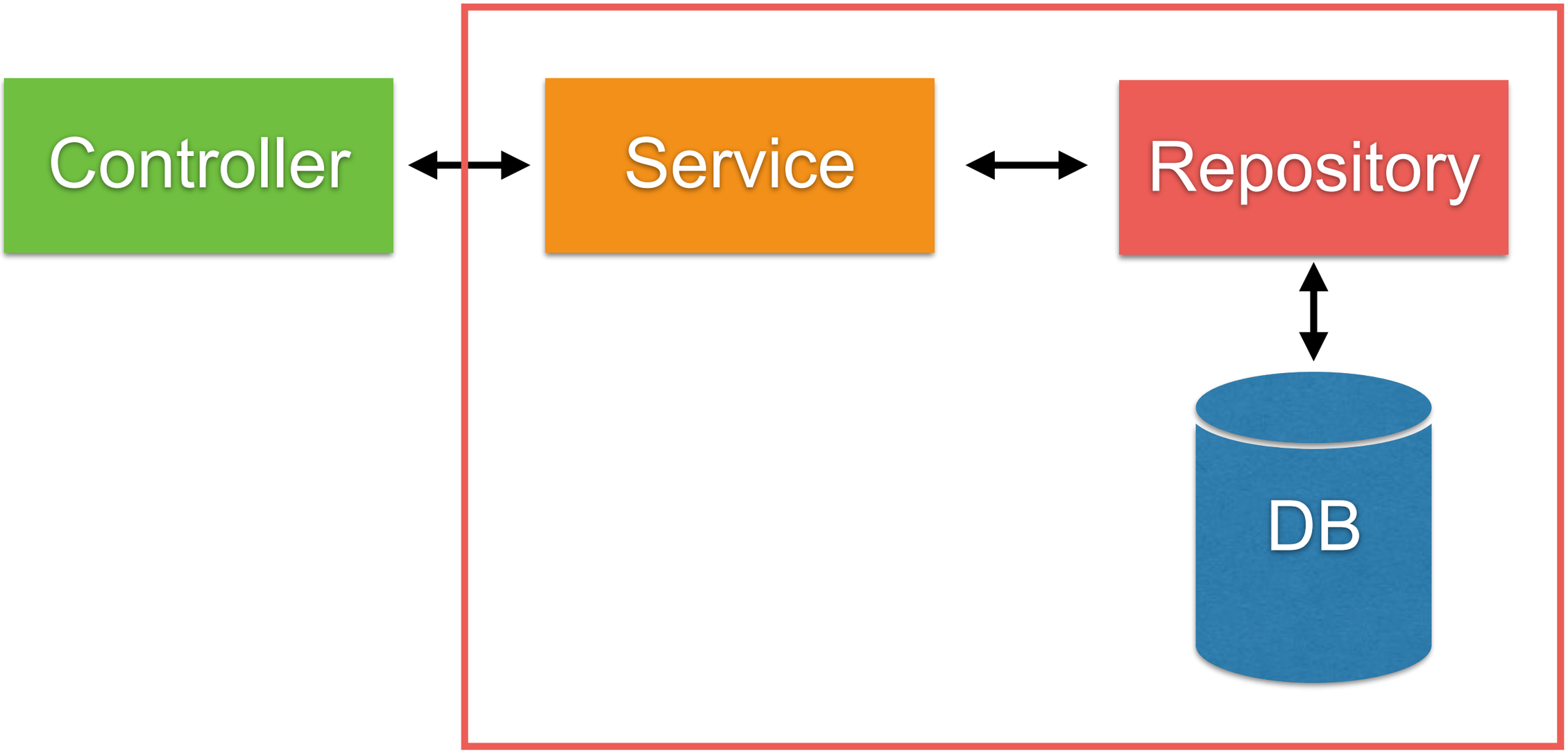
```
@Test
public void create_and_count_message() {
    Message newMessage = new Message("somkiat");
    messageRepository.save(newMessage);

    long allRecord = messageRepository.count();
    assertEquals(1, allRecord);
}
```

Run test

$mvn clean test

Integrate repository with service

Service use repository ?



Service call repository

Edit MessageService.java

```
@Service
public class MessageService {

    @Autowired
    private MessageRepository messageRepository;

    public String concat(String name) {
        Optional<Message> result = messageRepository.findById(1);
        if(result.isPresent()) {
            return "Hello, " + name;
        } else {
            return "Not found";
        }
    }

}
```

Run spring boot

$mvnw spring-boot:run

Service call repository

```java
@Service
public class UserService {

    private AccountRepository accountRepository;

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

1

```java
    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));
    }
```

Service call repository

```java
@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));
    }
```

2

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
```

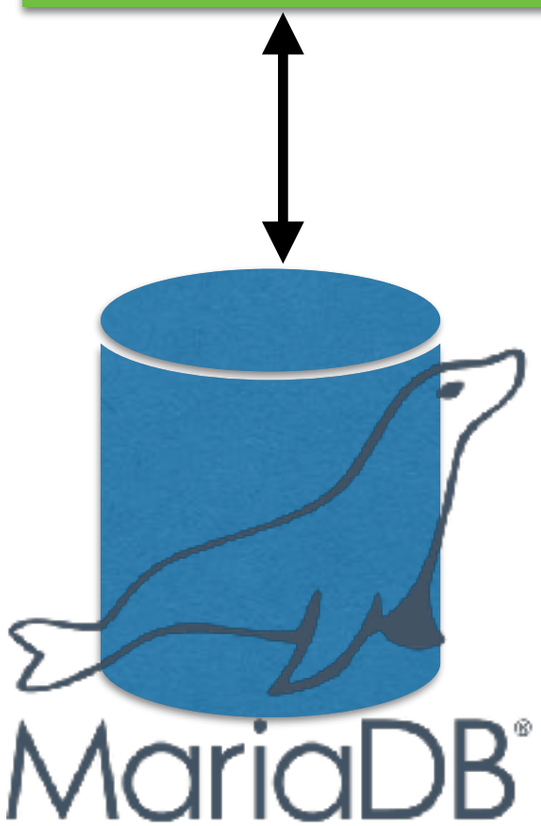
Run spring boot

$mvnw spring-boot:run

Working with Real Database

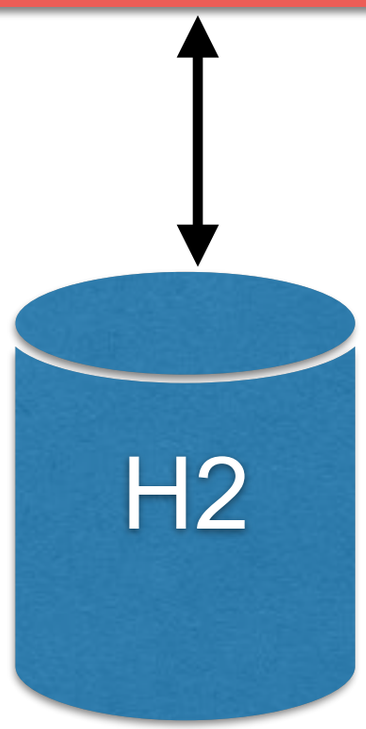
Production

Application



Testing

Application



Add database dependency

In file pom.xml

```
<dependency>
    <groupId>org.mariadb.jdbc</groupId>
    <artifactId>mariadb-java-client</artifactId>
    <version>2.2.5</version>
</dependency>
```

https://mariadb.com/kb/en/library/about-mariadb-connector-j/

Config database in application

In file resources/application.yml

```
spring:
  datasource:
    driver-class-name: org.mariadb.jdbc.Driver
    url: jdbc:mariadb://35.198.254.195:3306/account
    username: user01
    password: password
    initialization-mode: always
    testWhileIdle: true
    validationQuery: SELECT 1
jpa:
    show-sql: true
    properties:
        hibernate:
          dialect: org.hibernate.dialect.MySQL5InnoDBDialect
```

Config database in application

Required config for database

```
spring:
  datasource:
    driver-class-name: org.mariadb.jdbc.Driver
    url: jdbc:mariadb://35.198.254.195:3306/account
    username: user01
    password: password
    initialization-mode: always
    testWhileIdle: true
    validationQuery: SELECT 1
jpa:
  show-sql: true
  properties:
      hibernate:
        dialect: org.hibernate.dialect.MySQL5InnoDBDialect
```

Config database in application

Required config for database

```
spring:
  datasource:
    driver-class-name: org.mariadb.jdbc.Driver
    url: jdbc:mariadb://35.198.254.195:3306/account
    username: user01
    password: password
    initialization-mode: always
    testWhileIdle: true
    validationQuery: SELECT 1
jpa:
  show-sql: true
  properties:
      hibernate:
        dialect: org.hibernate.dialect.MySQL5InnoDBDialect
```

By default not run

Run service

http://localhost:8080/account/0868696209

Check your test ?

$mvnw clean test

Step to test

Stop the real database before run test

See result

Error ?

Spring boot try to connect to the real database ?

Fix Error

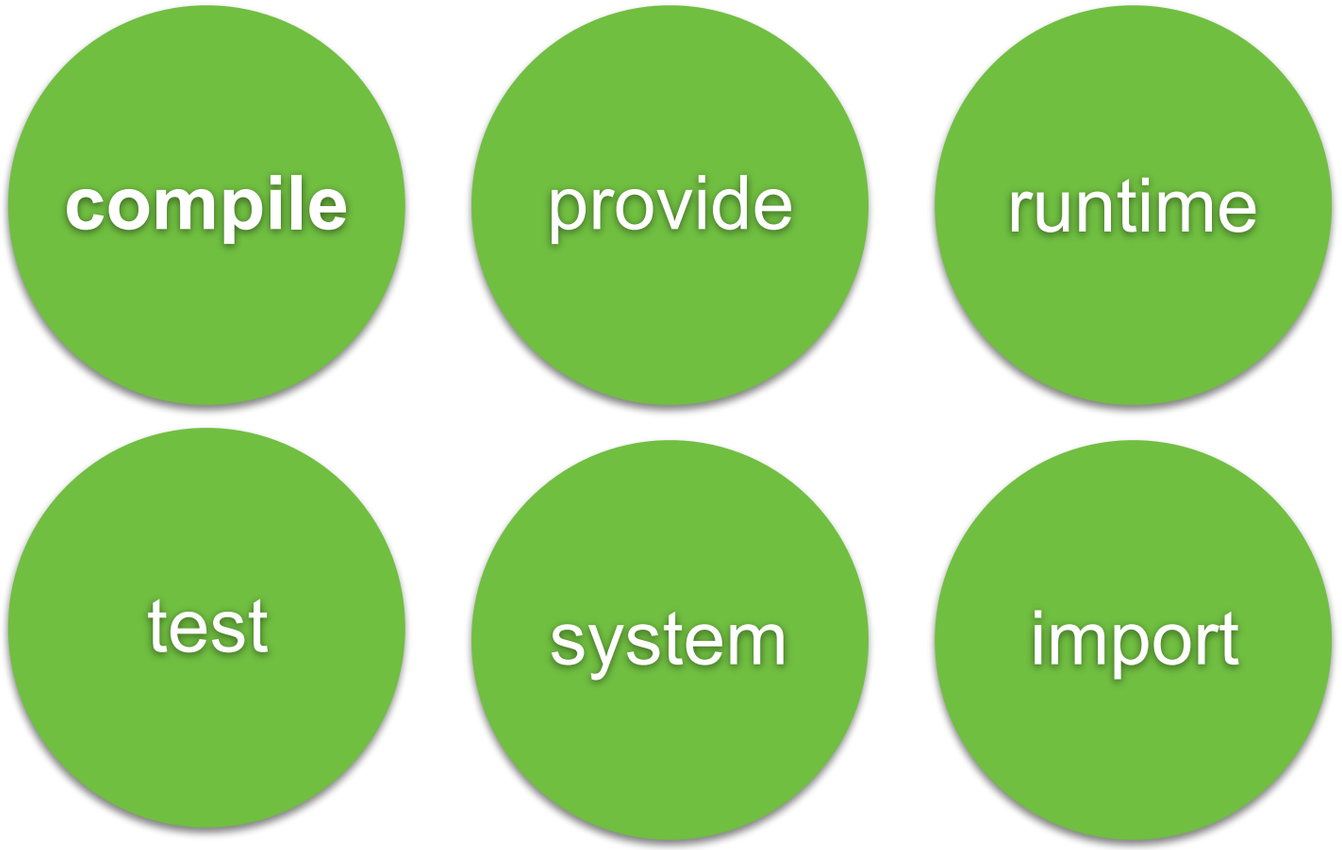
Create file /resources/application.yml in test folder

config of H2 database

```
spring:
  datasource:
    driver-class-name: org.h2.Driver
    url: jdbc:h2:mem:db;DB_CLOSE_DELAY=-1
    username: sa
    password: sa
jpa:
  show-sql: true
  properties:
      hibernate:
        dialect: org.hibernate.dialect.H2Dialect
```

Question ?

Dependency Scopes in file pom.xml runtime ?



https://maven.apache.org/guides/introduction/introduction-to-dependency-mechanism.html#Dependency_Scope

Question ?

show_sql=true not working ?

```
jpa:
  show_sql: true
  hibernate:
    ddl-auto: none
  properties:
    hibernate:
      format_sql: true
      dialect: org.hibernate.dialect.MySQL5InnoDBDialect
```

Beautiful sql format

```
logging:
  level:
    org.hibernate.SQL: DEBUG
```

Default log level = INFO

http://www.baeldung.com/sql-logging-spring-boot

Result of logging message

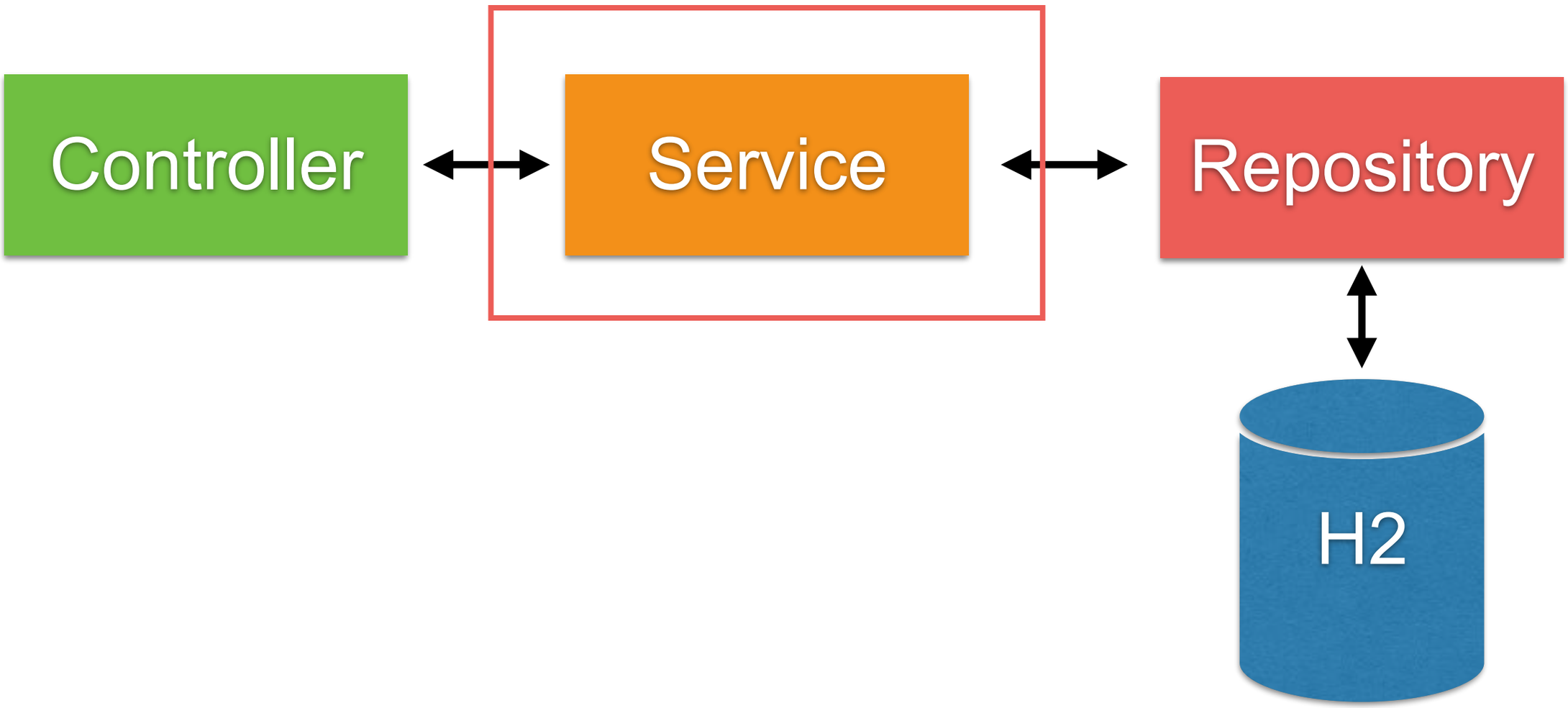
```
 13:18:36.336  INFO 79616 --- [nio-8080-exec-2] o.s.web.servlet.Dispatc
FrameworkServlet 'dispatcherServlet': initialization completed in 37 ms
 13:18:36.864  INFO 79616 --- [nio-8080-exec-2] o.h.h.i.QueryTranslator
HHH000397: Using ASTQueryTranslatorFactory
 13:18:37.138 DEBUG 79616 --- [nio-8080-exec-2] org.hibernate.SQL
select account0_.id as id1_0_, account0_.account_id as account_2_0_, ac
 as account_3_0_, account0_.mobile_no as mobile_n4_0_, account0_.name a
unt account0_
```

Log Levels

Level	Color
FATAL	Red
ERROR	Red
WARN	Yellow
INFO (default)	Green
DEBUG	Green
TRACE	Green

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

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

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

```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);

    }

}
```

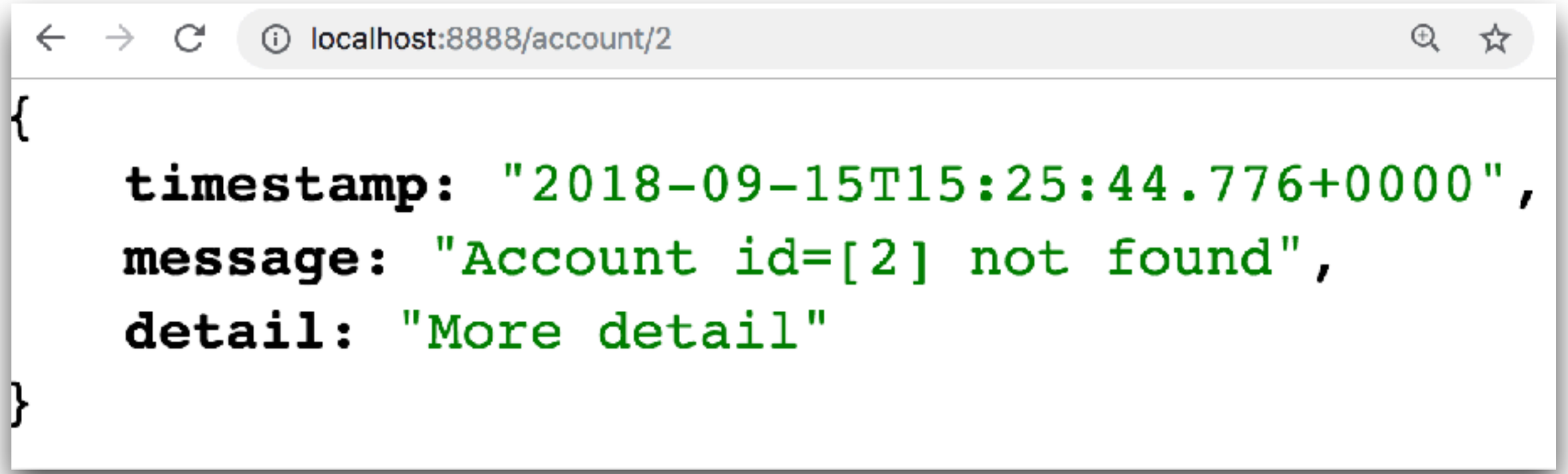
2

ExceptionReponse

Response format of error

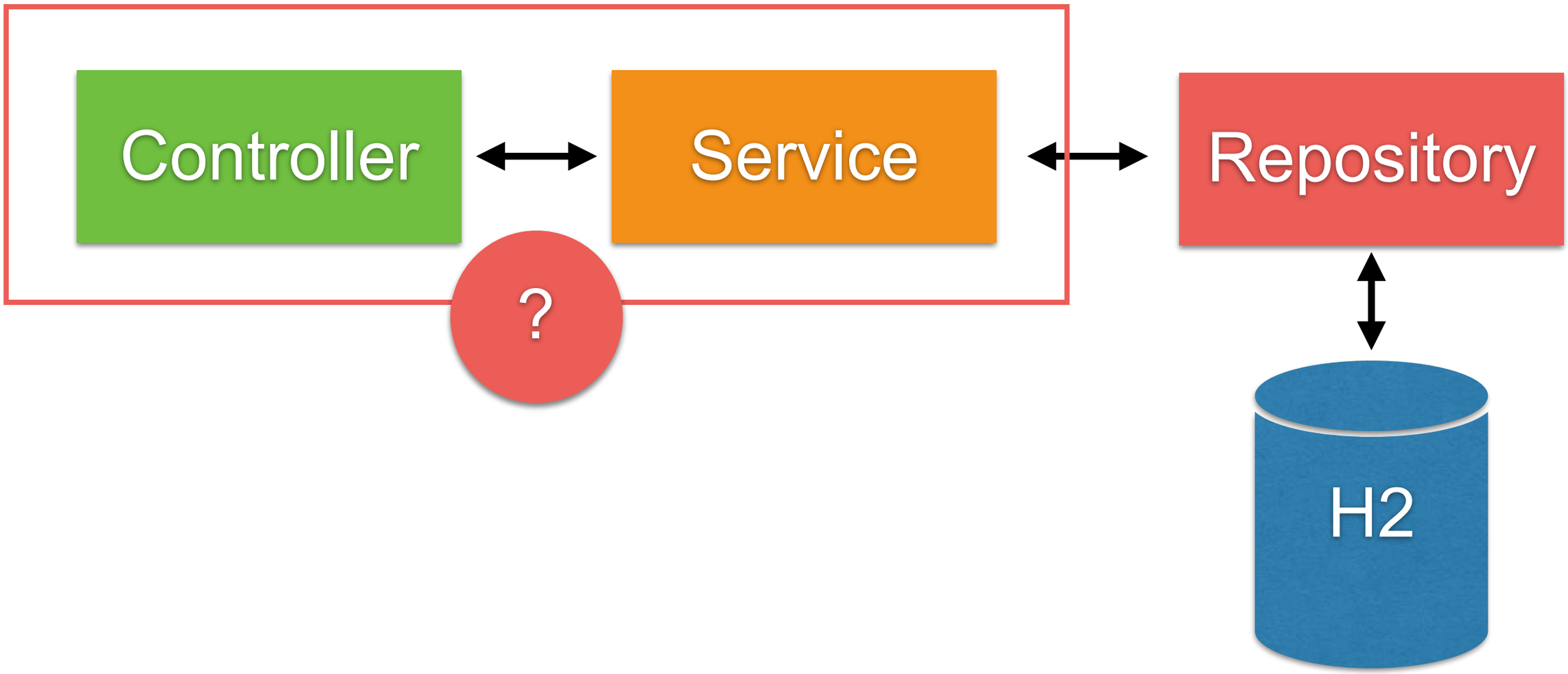
```
public class ExceptionResponse{

    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

```
@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);
    }

}
```

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

```java
@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

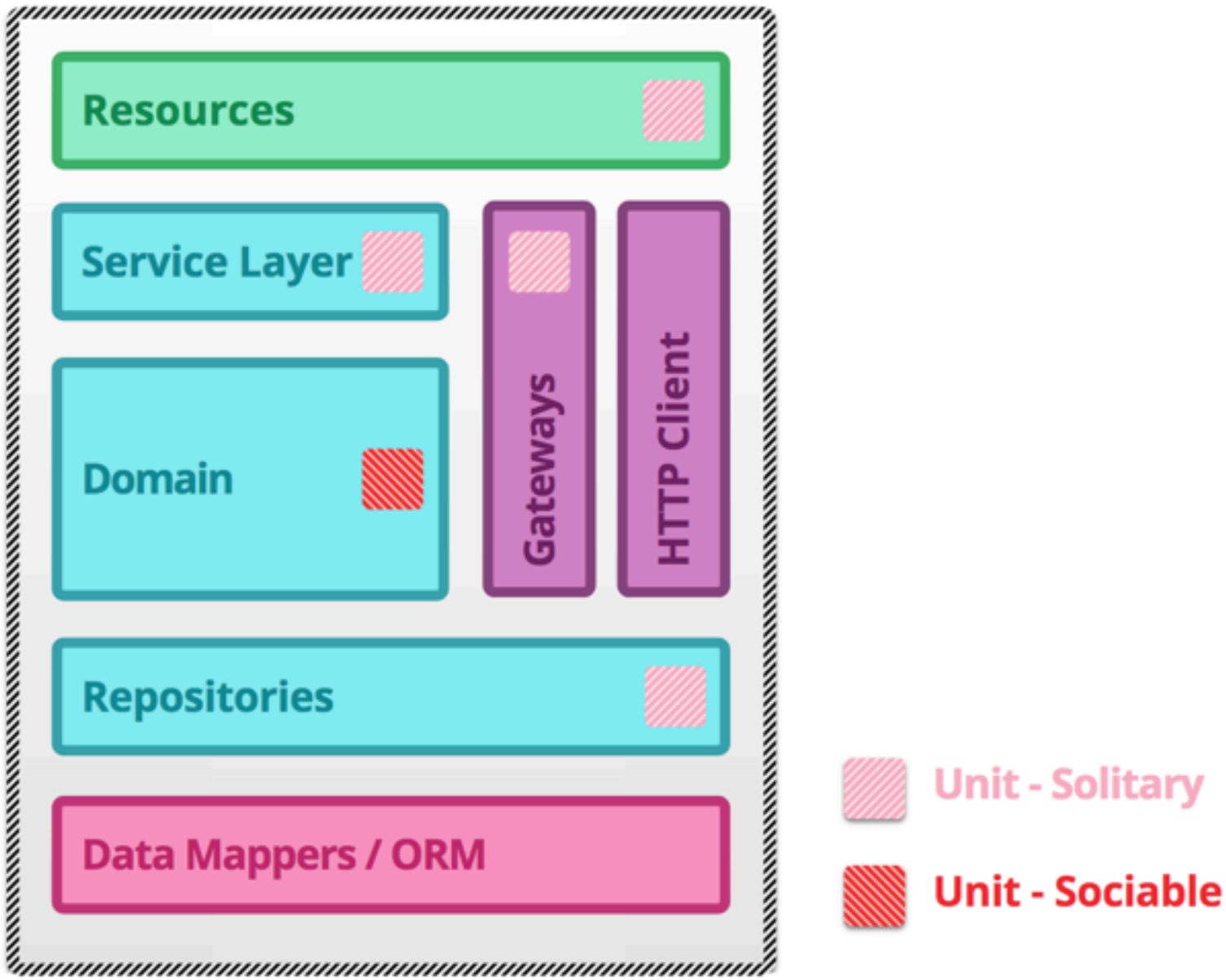
$mvnw clean test
-Dgroups=“com.lotto.lotto.category.UnitTest"

More ...

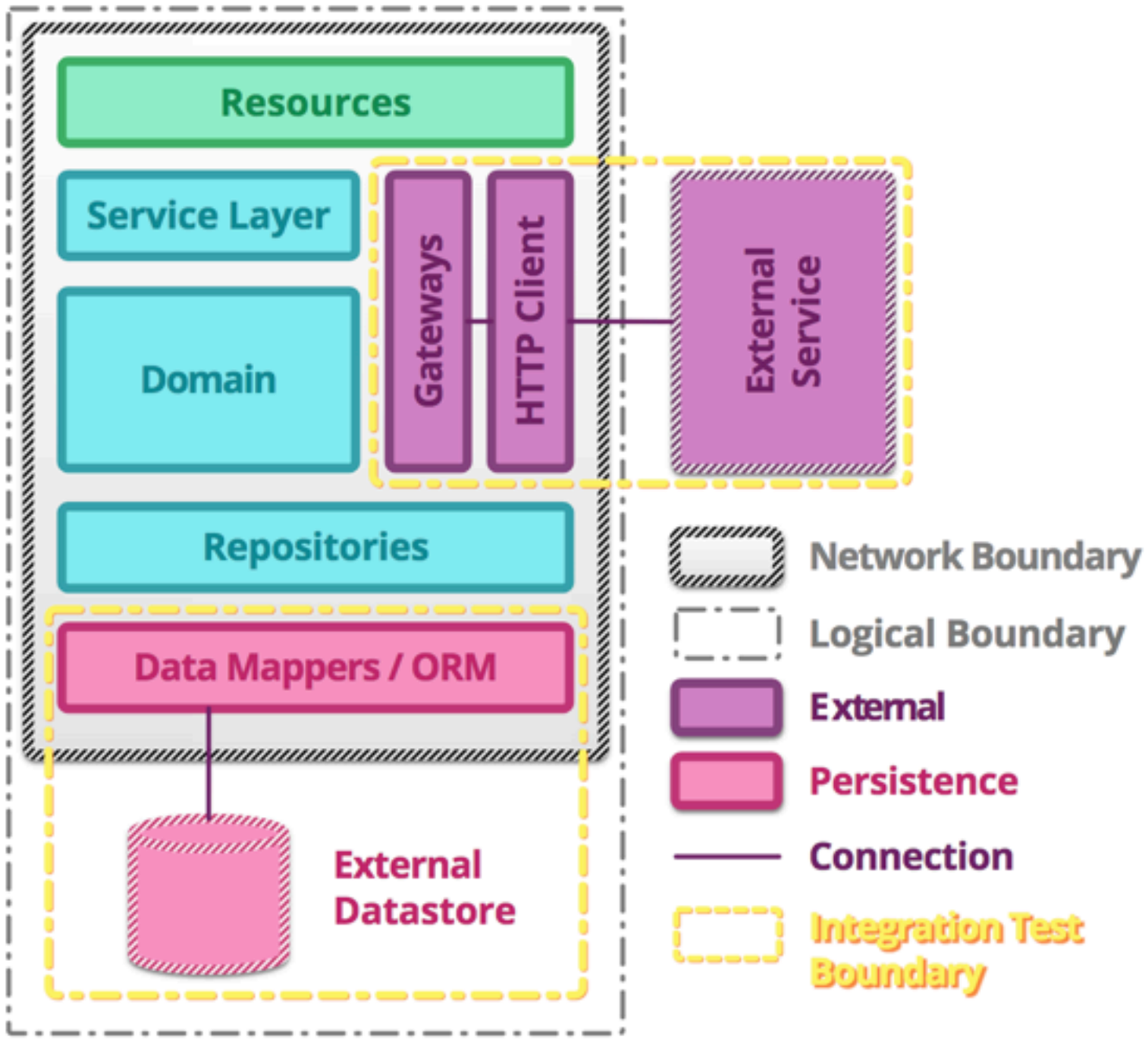
Working with transaction !!

Testing Strategies

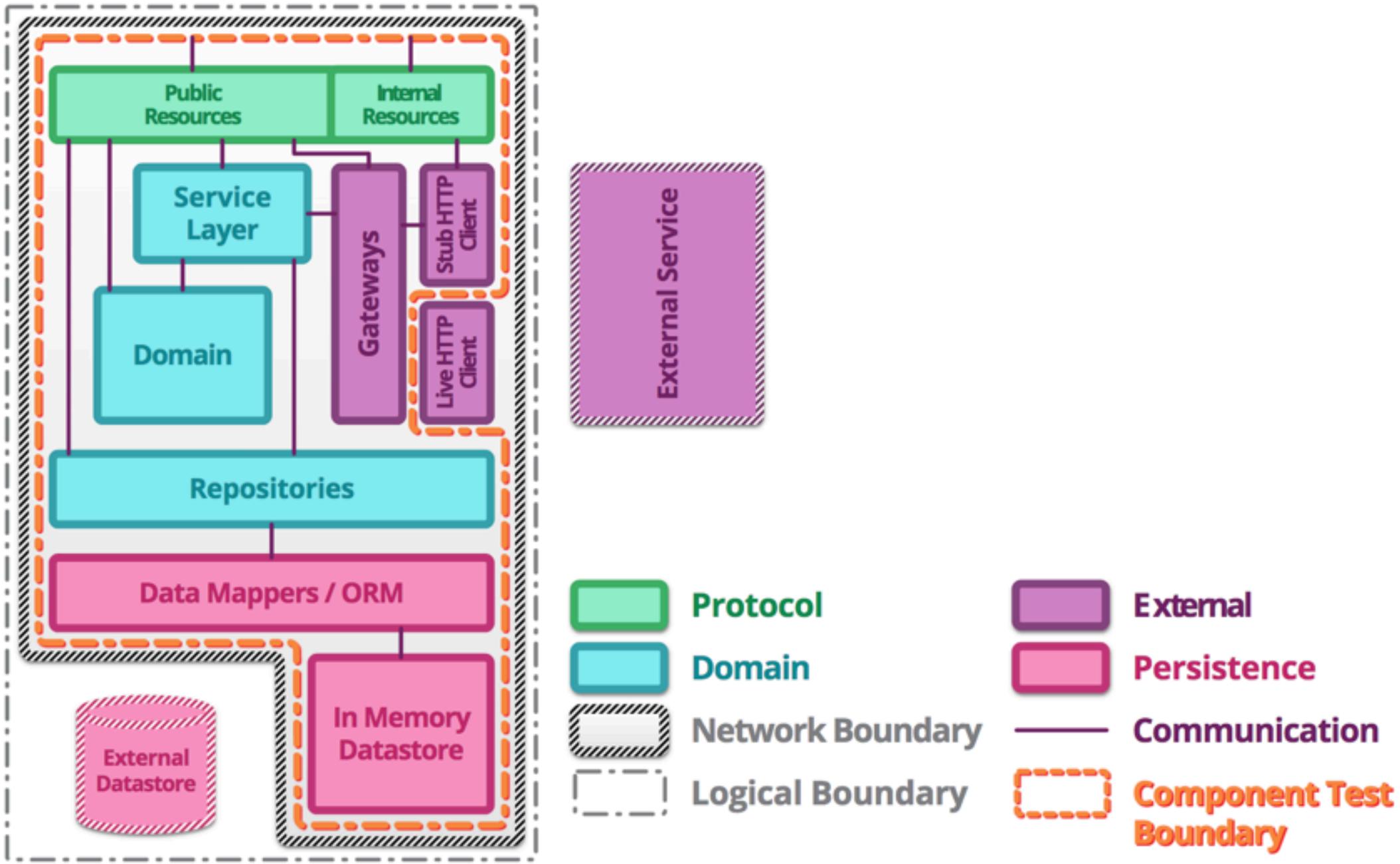
Unit testing



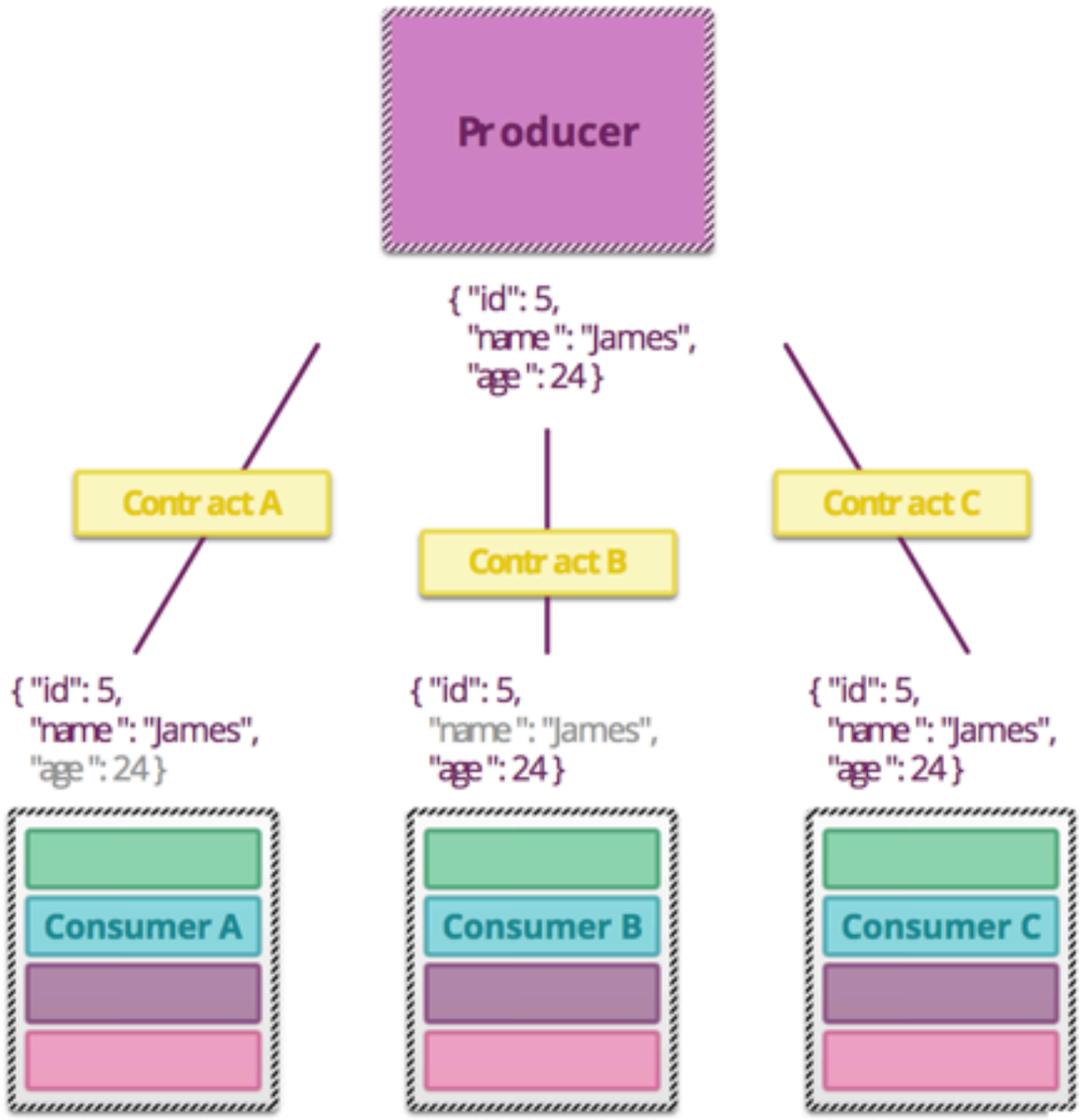
Integration testing



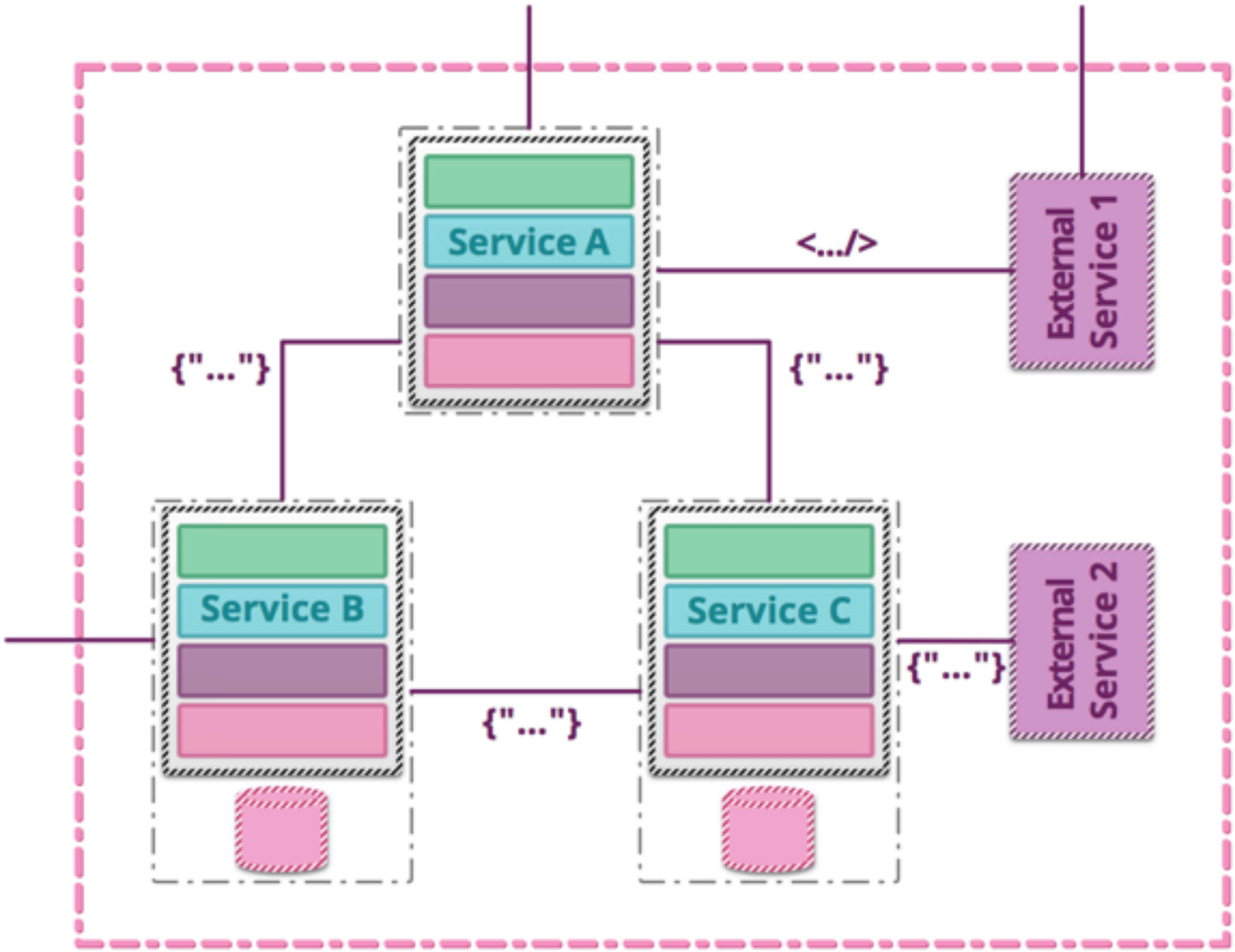
Component testing



Contract testing



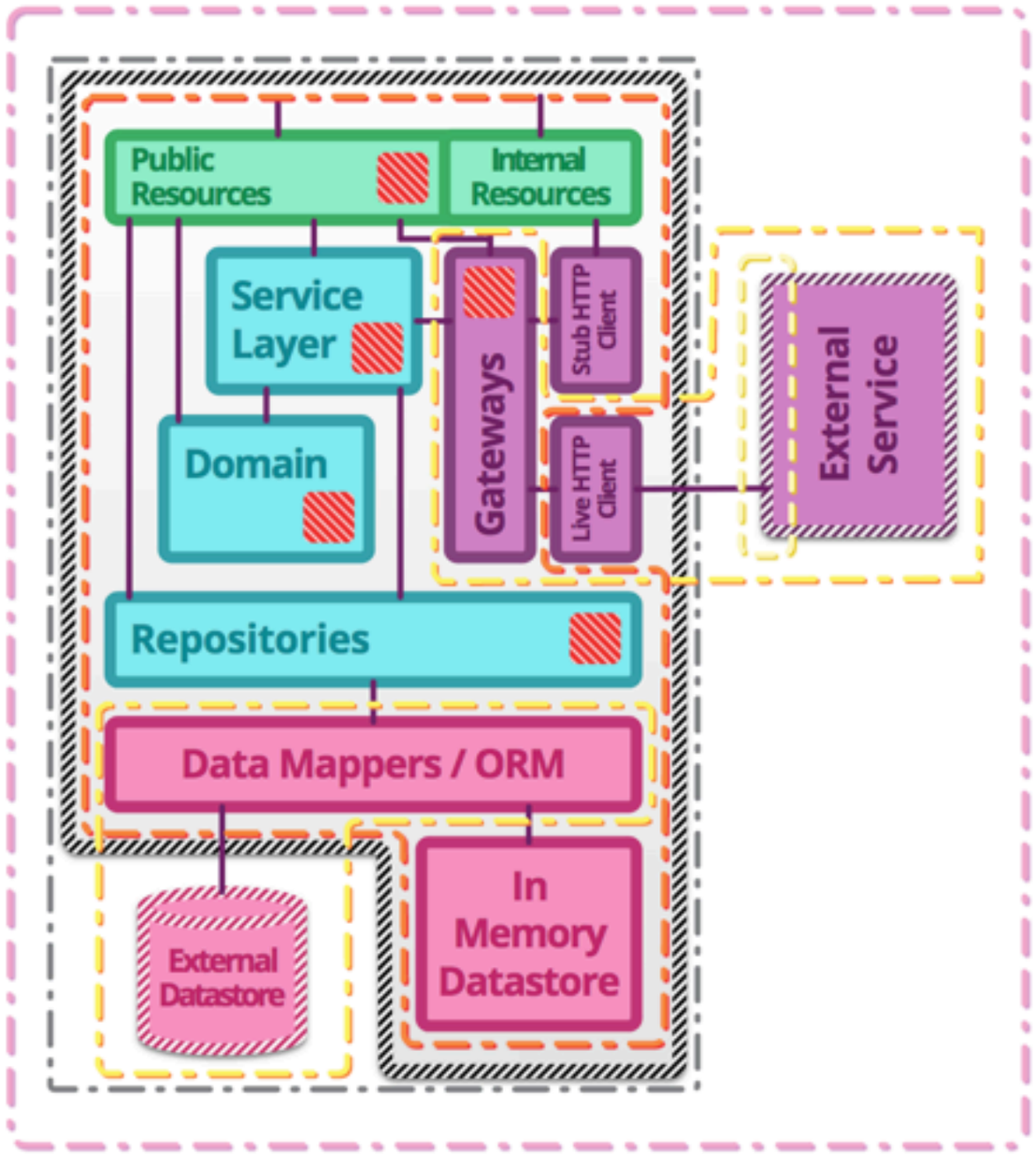
End-to-End testing



Summary

Unit tests : exercise the smallest pieces of testable software in the application to determine whether they behave as expected.

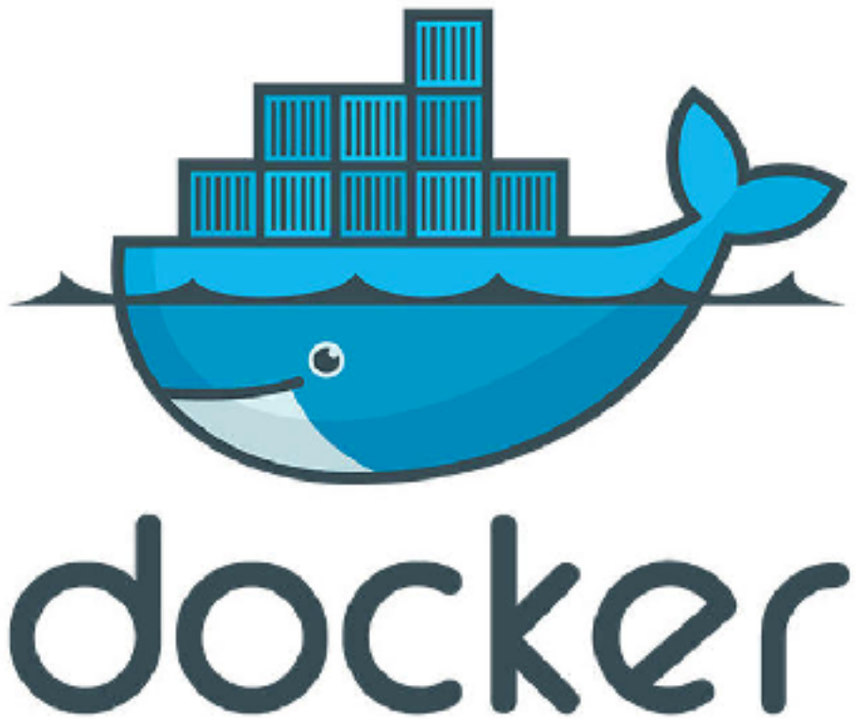
Integration tests : verify the communication paths and interactions between components to detect interface defects.



Component tests : limit the scope of the exercised software to a portion of the system under test, manipulating the system through internal code interfaces and using test doubles to isolate the code under test from other components.

Contract tests : verify interactions at the boundary of an external service asserting that it meets the contract expected by a consuming service.

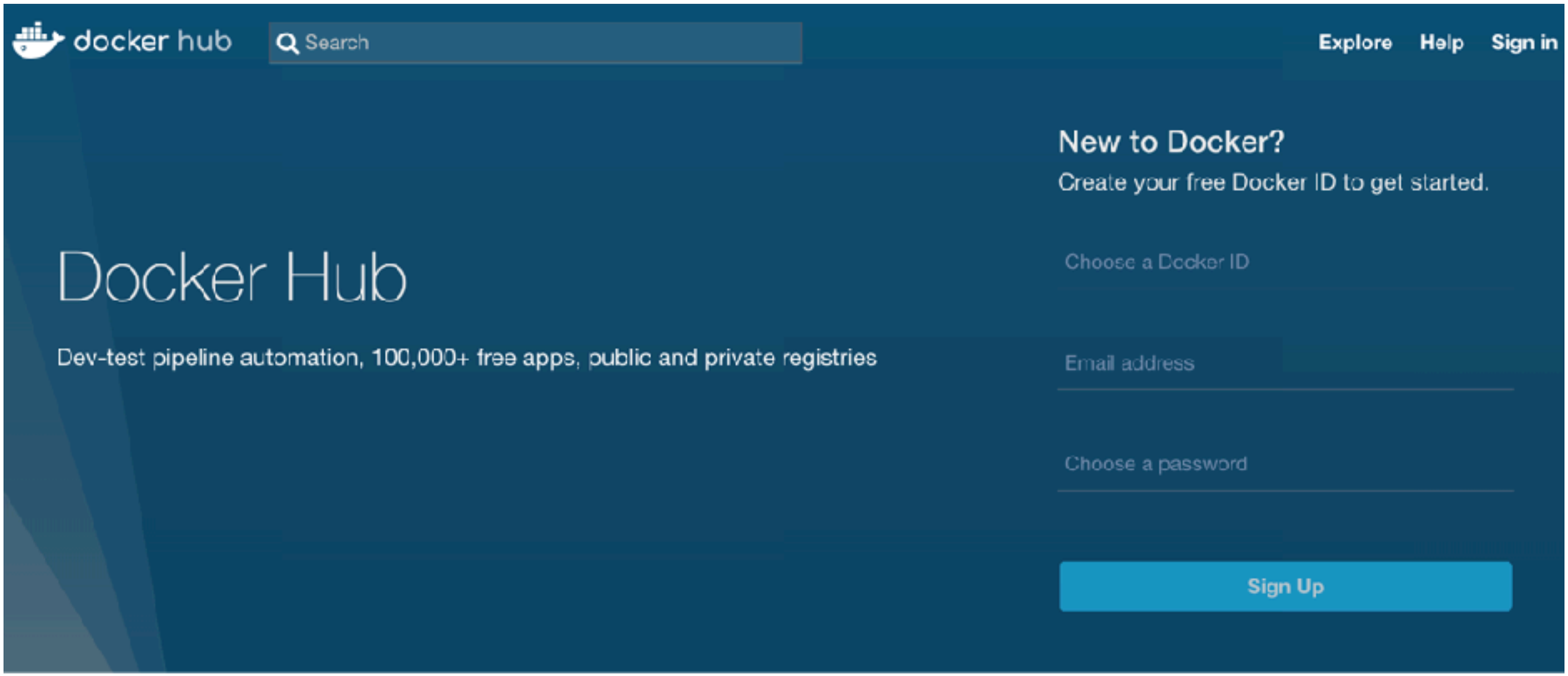
End-to-end tests : verify that a system meets external requirements and achieves its goals, testing the entire system, from end to end.



Working with container

Choose your image

from hub.docker.com



Images in workshop

Java => **OpenJDK**

Apache Maven => **maven**

PostgreSQL => **progrès**

Java => OpenJDK

OFFICIAL REPOSITORY

openjdk ☆

Last pushed: 5 days ago

Repo Info | Tags

Short Description

OpenJDK is an open-source implementation of the Java Platform, Standard Edition

Docker Pull Command

```
docker pull openjdk
```

Full Description

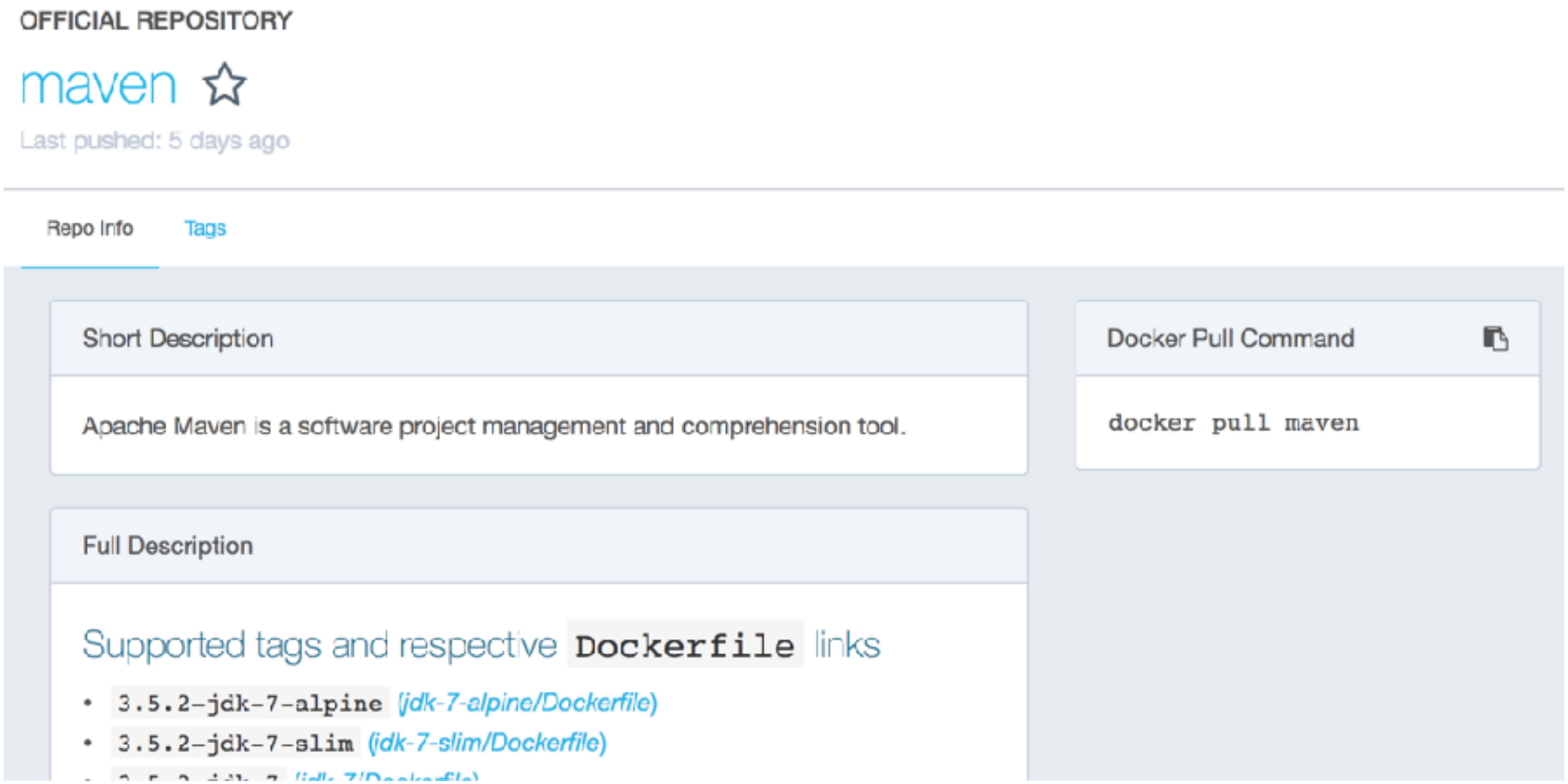
Supported tags and respective `Dockerfile` links

Simple Tags

- `10-ea-32-jre-experimental`, `10-ea-jre-experimental`, `10-jre-`

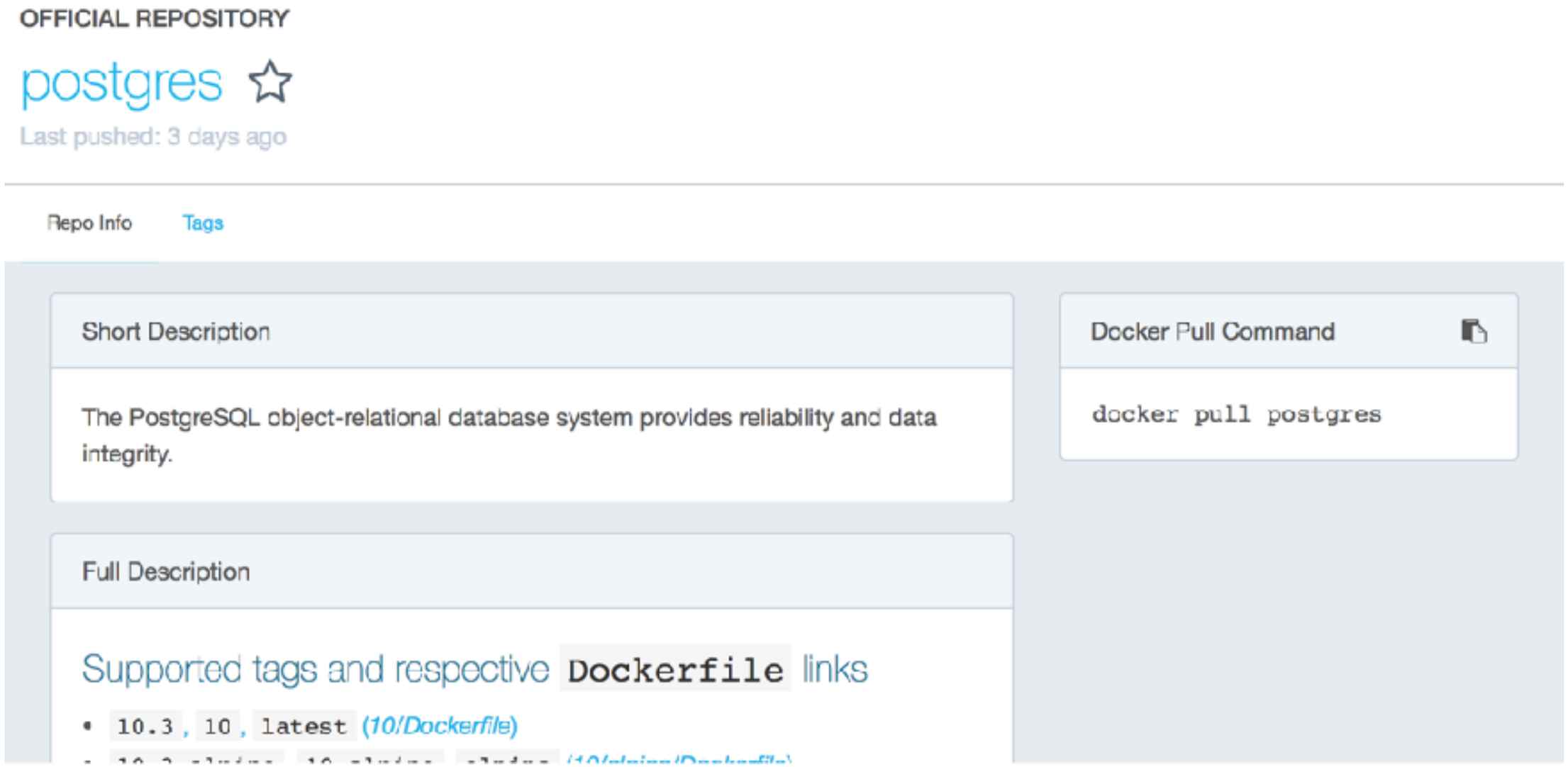
https://hub.docker.com/_/openjdk/

Apache Maven => maven



https://hub.docker.com/_/maven/

PostgreSQL => progrès



https://hub.docker.com/_/postgres/

Pull images from Docker Hub

$docker image pull openjdk:<tag>
$docker image pull maven:<tag>
$docker image pull postgres:<tag>

Create container to run Spring Boot

Create container to run Spring Boot

```
$docker container run -d
  -v $(pwd)/target/toystore.jar:/xxx/toystore.jar
  -p 8080:8080
  --name web
  openjdk:8-jre java -jar /xxx/toystore.jar
```

Create new Docker image (1)

from Dockerfile

```
FROM openjdk:8-jre
COPY ./target/toystore.jar /xxx/toystore.jar
CMD java -jar /xxx/toystore.jar
```

Create new Docker image (2)

Build image from Dockerfile

$docker image build -t toystore:0.1 .

```
Sending build context to Docker daemon  33.47MB
Step 1/3 : FROM openjdk:8-jre
 ---> e956268fd4ed
Step 2/3 : COPY ./target/toystore.jar /xxx/toystore.jar
 ---> 3dd837b158eb
Step 3/3 : CMD java -jar /xxx/toystore.jar
 ---> Running in 06994b290e74
Removing intermediate container 06994b290e74
 ---> 0bc2054f4ba8
Successfully built 0bc2054f4ba8
Successfully tagged toystore:0.1
```

Create container to run Spring Boot

$docker container run -d -p 8080:8080 **toystore:0.1**

$docker container run -d -p 8081:8080 **toystore:0.1**

$docker container run -d -p 8082:8080 **toystore:0.1**

Create container
to run Build Maven Project

Create container to build

```
$docker container run --rm
  -v $(pwd):/xxx
  -w /xxx
  maven:3.5.2-alpine mvn clean package
```

Run your application

$java -jar target/hello.jar

```
org.postgresql.util.PSQLException: Connection to 127.0.0.1:15432 refused. Check that th
 the postmaster is accepting TCP/IP connections.
        at org.postgresql.core.v3.ConnectionFactoryImpl.openConnectionImpl(ConnectionFa
jar!/:42.1.1]
        at org.postgresql.core.ConnectionFactory.openConnection(ConnectionFactory.java:
        at org.postgresql.jdbc.PgConnection.<init>(PgConnection.java:194) ~[postgresql-
at org.postgresql.Driver.makeConnection(Driver.java:450) ~[postgresql-42.1.1.ja
at org.postgresql.Driver.connect(Driver.java:252) ~[postgresql-42.1.1.jar!/:42.
at com.zaxxer.hikari.util.DriverDataSource.getConnection(DriverDataSource.java:
at com.zaxxer.hikari.util.DriverDataSource.getConnection(DriverDataSource.java:
at com.zaxxer.hikari.pool.PoolBase.newConnection(PoolBase.java:365) [HikariCP-2
at com.zaxxer.hikari.pool.PoolBase.newPoolEntry(PoolBase.java:194) [HikariCP-2.
at com.zaxxer.hikari.pool.HikariPool.createPoolEntry(HikariPool.java:460) [Hika
at com.zaxxer.hikari.pool.HikariPool.checkFailFast(HikariPool.java:534) [Hikari
at com.zaxxer.hikari.pool.HikariPool.<init>(HikariPool.java:115) [HikariCP-2.7.
at com.zaxxer.hikari.HikariDataSource.getConnection(HikariDataSource.java:112)
```

Create container of PostgreSQL

Create container of PostgreSQL

```
$docker container run
  -p 15432:5432
  -e POSTGRES_USER=user
  -e POSTGRES_PASSWORD=password
  postgres:10.3-alpine
```

Run your application again !!

$java -jar target/hello.jar

```
Hibernate: create sequence hibernate_sequence start 1 increment 1
Hibernate: create table person (id int4 not null, first_name varchar(255), last_name varchar(255), primary key (id))
2018-03-06 19:45:41.115  INFO 56495 --- [           main] o.h.t.schema.internal.SchemaCreatorImpl  : HHH000476: Executing import script 'org.hibernate.tool.schema.internal.exec.Scri
ptSourceInputNonExistentImpl@7e990ed7'
2018-03-06 19:45:41.121  INFO 56495 --- [           main] j.LocalContainerEntityManagerFactoryBean : Initialized JPA EntityManagerFactory for persistence unit 'default'
2018-03-06 19:45:42.592  INFO 56495 --- [           main] s.w.s.m.m.a.RequestMappingHandlerAdapter : Looking for @ControllerAdvice: org.springframework.boot.web.servlet.context.Anno
tationConfigServletWebServerApplicationContext@7cef4e59: startup date [Tue Mar 06 19:45:34 ICT 2018]; root of context hierarchy
2018-03-06 19:45:42.746  WARN 56495 --- [           main] aWebConfiguration$JpaWebMvcConfiguration : spring.jpa.open-in-view is enabled by default. Therefore, database queries may b
e performed during view rendering. Explicitly configure spring.jpa.open-in-view to disable this warning
2018-03-06 19:45:42.857  INFO 56495 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "{[/hello/{name}],methods=[GET]}" onto public toystore.domain.Hello toyst
ore.controller.HelloController.sayHi(java.lang.String)
2018-03-06 19:45:42.881  INFO 56495 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "{[/hello/data/{name}],methods=[GET]}" onto public toystore.domain.Hello
toystore.controller.HelloWithRepositoryController.sayHi(java.lang.String)
2018-03-06 19:45:42.889  INFO 56495 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "{[/error]}" onto public org.springframework.http.ResponseEntity<java.uti
l.Map<java.lang.String, java.lang.Object>> org.springframework.boot.autoconfigure.web.servlet.error.BasicErrorController.error(javax.servlet.http.HttpServletRequest)
2018-03-06 19:45:42.893  INFO 56495 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "{[/error],produces=[text/html]}" onto public org.springframework.web.ser
vlet.ModelAndView org.springframework.boot.autoconfigure.web.servlet.error.BasicErrorController.errorHtml(javax.servlet.http.HttpServletRequest,javax.servlet.http.HttpServletRespons
e)
2018-03-06 19:45:43.046  INFO 56495 --- [           main] o.s.w.s.handler.SimpleUrlHandlerMapping  : Mapped URL path [/webjars/**] onto handler of type [class org.springframework.we
b.servlet.resource.ResourceHttpRequestHandler]
2018-03-06 19:45:43.046  INFO 56495 --- [           main] o.s.w.s.handler.SimpleUrlHandlerMapping  : Mapped URL path [/**] onto handler of type [class org.springframework.web.servle
t.resource.ResourceHttpRequestHandler]
2018-03-06 19:45:43.168  INFO 56495 --- [           main] o.s.w.s.handler.SimpleUrlHandlerMapping  : Mapped URL path [/**/favicon.ico] onto handler of type [class org.springframewor
k.web.servlet.resource.ResourceHttpRequestHandler]
2018-03-06 19:45:43.783  INFO 56495 --- [           main] o.s.j.e.a.AnnotationMBeanExporter        : Registering beans for JMX exposure on startup
2018-03-06 19:45:43.785  INFO 56495 --- [           main] o.s.j.e.a.AnnotationMBeanExporter        : Bean with name 'dataSource' has been autodetected for JMX exposure
2018-03-06 19:45:43.793  INFO 56495 --- [           main] o.s.j.e.a.AnnotationMBeanExporter        : Located MBean 'dataSource': registering with JMX server as MBean [com.zaxxer.hik
ari:name=dataSource,type=HikariDataSource]
2018-03-06 19:45:43.873  INFO 56495 --- [           main] o.s.b.w.embedded.tomcat.TomcatWebServer  : Tomcat started on port(s): 8080 (http) with context path ''
2018-03-06 19:45:43.877  INFO 56495 --- [           main] toystore.ToyStoreApplication             : Started ToyStoreApplication in 10.18 seconds (JVM running for 10.912)
2018-03-06 19:45:47.875  INFO 56495 --- [nio-8080-exec-1] o.a.c.c.C.[Tomcat].[localhost].[/]       : Initializing Spring FrameworkServlet 'dispatcherServlet'
2018-03-06 19:45:47.876  INFO 56495 --- [nio-8080-exec-1] o.s.web.servlet.DispatcherServlet        : FrameworkServlet 'dispatcherServlet': initialization started
2018-03-06 19:45:47.917  INFO 56495 --- [nio-8080-exec-1] o.s.web.servlet.DispatcherServlet        : FrameworkServlet 'dispatcherServlet': initialization completed in 41 ms
```

Monitoring and Metric

Metric in Spring Boot

Spring Boot **Actuator** for Spring Boot 1.x

MicroMeter for Spring Boot 2.0

Spring Boot Actuator (1)

Add library to pom.xml

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

Spring Boot Actuator (2)

Enabled endpoint in application.properties

```
info.app.name=Toy Store
info.app.description=This is my first spring boot application
info.app.version=1.0.0

management.endpoints.web.exposure.include=health,info,metrics,httptrace
```

Spring Boot Actuator (3)

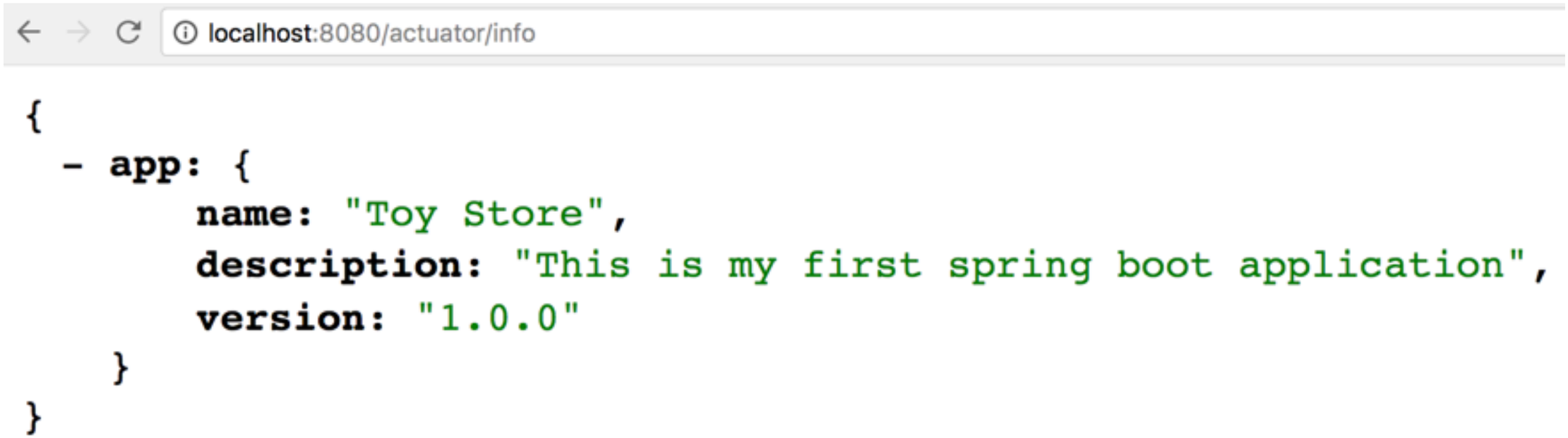
List of endpoints = /actuator/

localhost:8080/actuator/


```
{
  - _links: {
      - self: {
            href: "http://localhost:8080/actuator",
            templated: false
        },
      - health: {
            href: "http://localhost:8080/actuator/health",
            templated: false
        },
      - info: {
            href: "http://localhost:8080/actuator/info",
            templated: false
        },
      - metrics-requiredMetricName: {
            href: "http://localhost:8080/actuator/metrics/{requiredMetricName}",
            templated: true
        },
      - metrics: {
            href: "http://localhost:8080/actuator/metrics",
            templated: false
        },
      - httptrace: {
            href: "http://localhost:8080/actuator/httptrace",
            templated: false
        }
    }
}
```

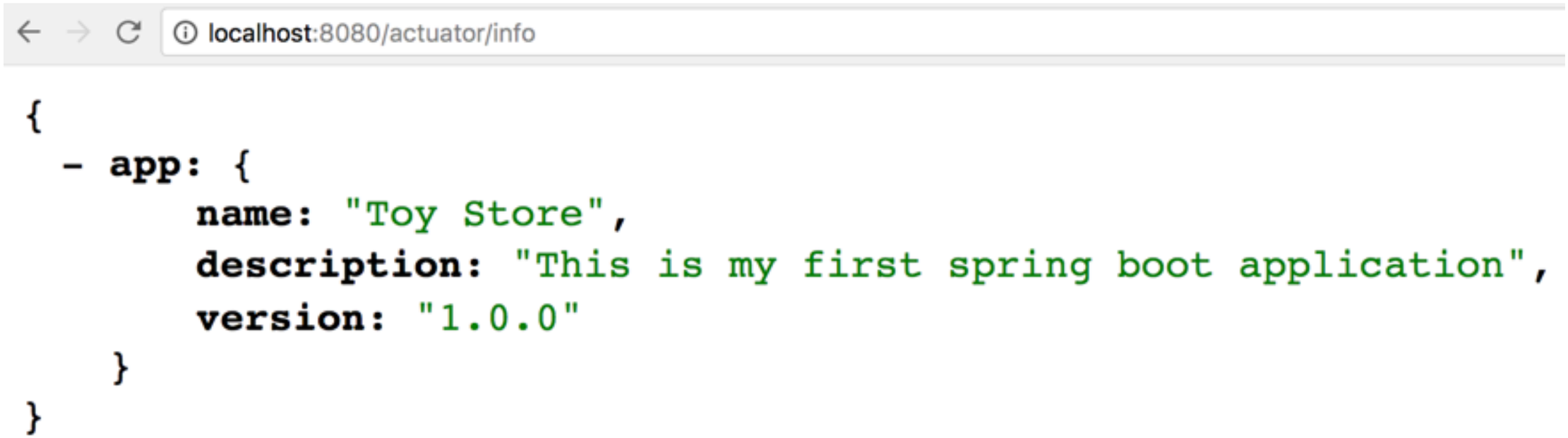

Spring Boot Actuator (4)

Info endpoint = /actuator/info



Spring Boot Actuator (5)

Info endpoint = /actuator/info



Spring Boot Actuator (6)

Info endpoint = /actuator/httptrace

localhost:8080/actuator/httptrace


```
{
  - traces: [
      - {
            timestamp: "2018-03-06T13:33:02.800Z",
            principal: null,
            session: null,
          - request: {
                method: "GET",
                uri: "http://localhost:8080/prometheus",
              - headers: {
                  - host: [
                        "localhost:8080"
                    ],
                  - user-agent: [
                        "Prometheus/2.0.0"
                    ],
                  - accept: [
                        "text/plain;version=0.0.4;q=1,*/*;q=0.1"
                    ],
                  - accept-encoding: [
                        "gzip"
                    ],
                  - x-prometheus-scrape-timeout-seconds: [
                        "5.000000"
                    ]
                },
                remoteAddress: null
            },
```

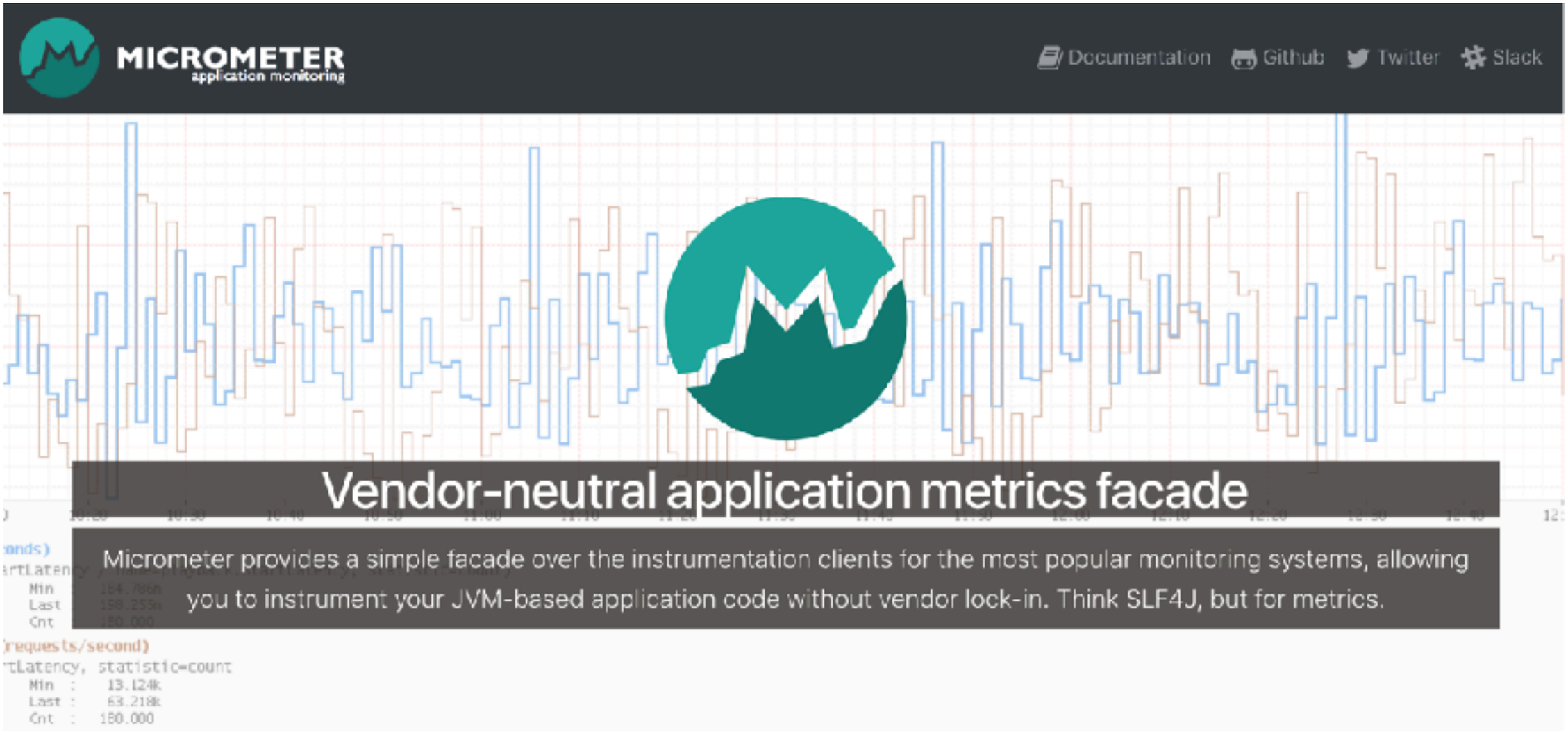
Spring Boot Actuator (7)

List of metrics endpoint = /actuator/metrics

Spring Boot Actuator (8)

/actuator/metrics/http.server.requests

Spring Boot 2.0 with MicroMeter

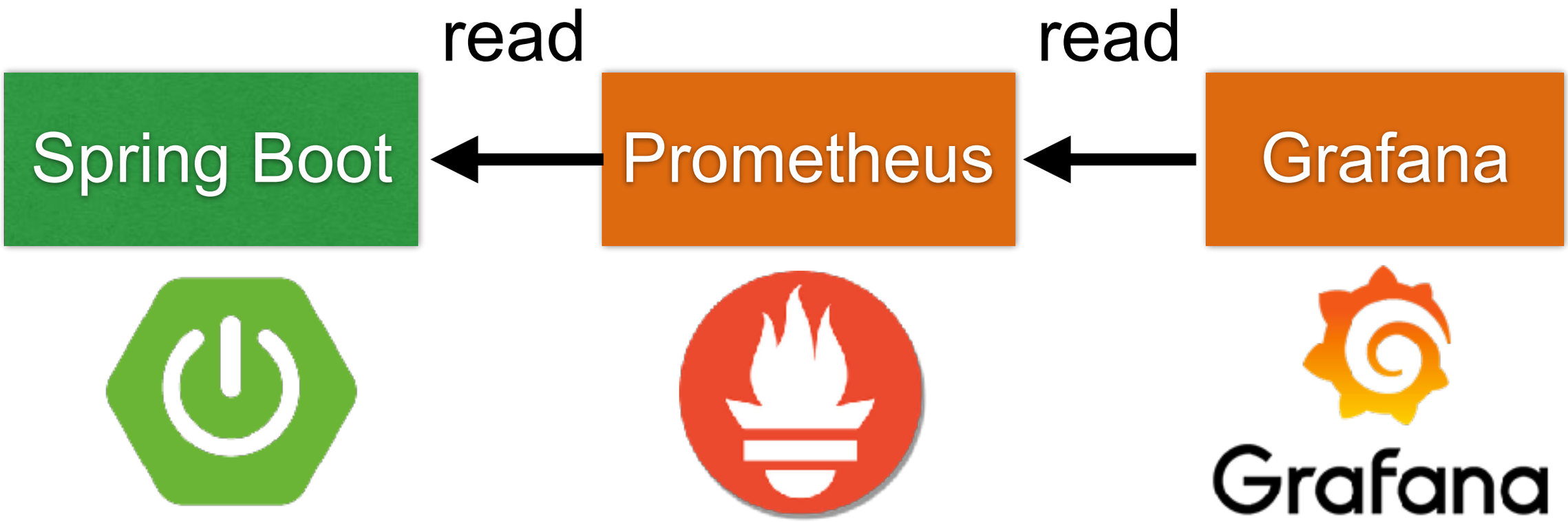


https://micrometer.io/

Keep and Visualize Metric of Spring Boot Services

Sample Architecture

Sample Architecture



Service metric for Prometheus

Enable Prometheus (1)

Add library to pom.xml

```
<dependency>
    <groupId>io.micrometer</groupId>
    <artifactId>micrometer-registry-prometheus</artifactId>
    <version>1.0.1</version>
</dependency>
```

Enable Prometheus (2)

Enabled endpoint in application.properties

management.endpoints.web.exposure.include =….,**prometheus**

Enable Prometheus (3)

New endpoint = actuator/prometheus

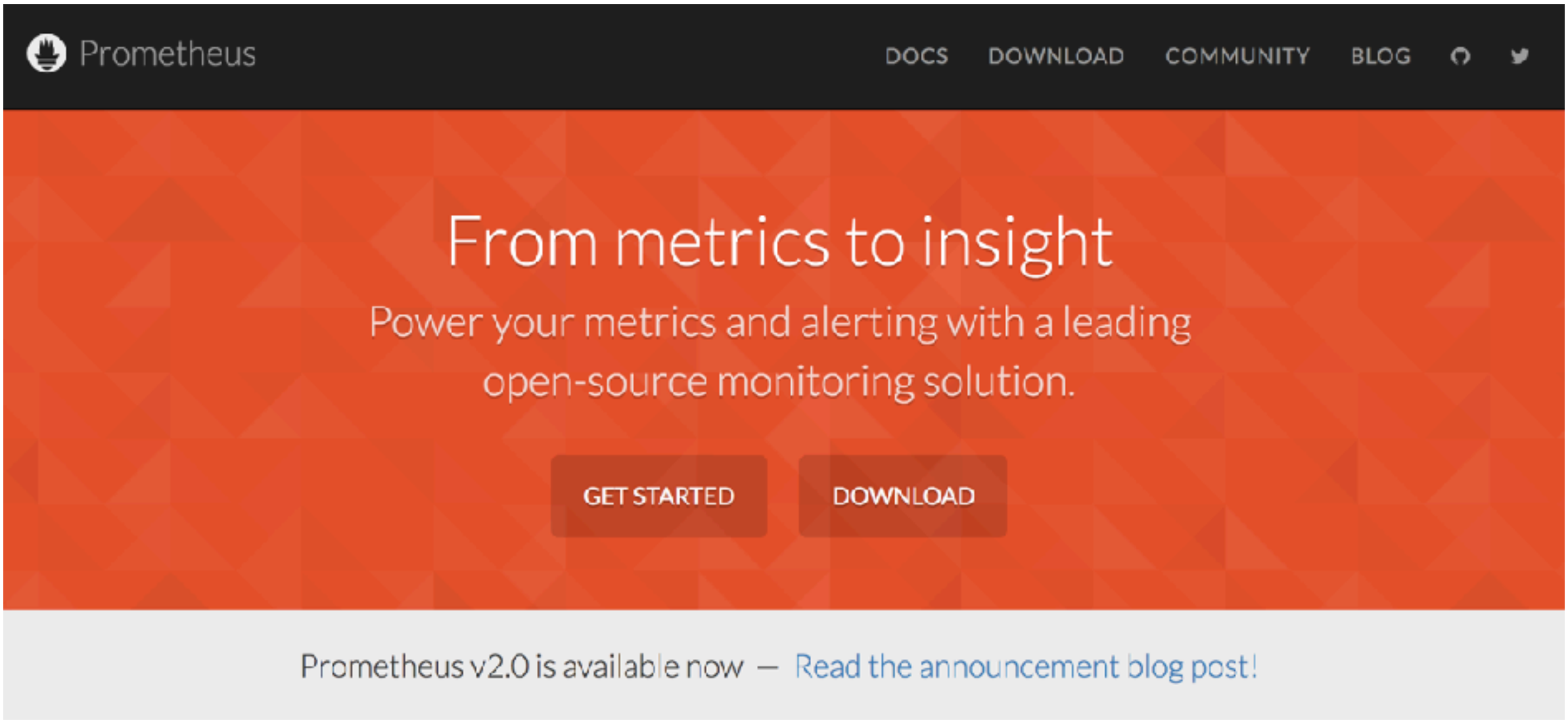
localhost:8080/actuator/prometheus

```
# HELP jvm_memory_used_bytes The amount of used memory
# TYPE jvm_memory_used_bytes gauge
jvm_memory_used_bytes{area="nonheap",id="Code Cache",} 1.49056E7
jvm_memory_used_bytes{area="nonheap",id="Metaspace",} 5.6766712E7
jvm_memory_used_bytes{area="nonheap",id="Compressed Class Space",} 7617096.0
jvm_memory_used_bytes{area="heap",id="PS Eden Space",} 1.7135864E7
jvm_memory_used_bytes{area="heap",id="PS Survivor Space",} 1.6235192E7
jvm_memory_used_bytes{area="heap",id="PS Old Gen",} 2.1936456E7
# HELP hikaricp_connections_idle Idle connections
# TYPE hikaricp_connections_idle gauge
hikaricp_connections_idle{pool="HikariPool-1",} NaN
# HELP tomcat_threads_config_max
# TYPE tomcat_threads_config_max gauge
tomcat_threads_config_max{name="http-nio-8080",} 200.0
# HELP tomcat_servlet_error_total
# TYPE tomcat_servlet_error_total counter
tomcat_servlet_error_total{name="default",} 0.0
# HELP jvm_threads_peak The peak live thread count since the Java virtual machine start
# TYPE jvm_threads_peak gauge
jvm_threads_peak 28.0
# HELP hikaricp_connections_pending Pending threads
# TYPE hikaricp_connections_pending gauge
hikaricp_connections_pending{pool="HikariPool-1",} NaN
# HELP system_cpu_count The number of processors available to the Java virtual machine
```

Keep data in Prometheus

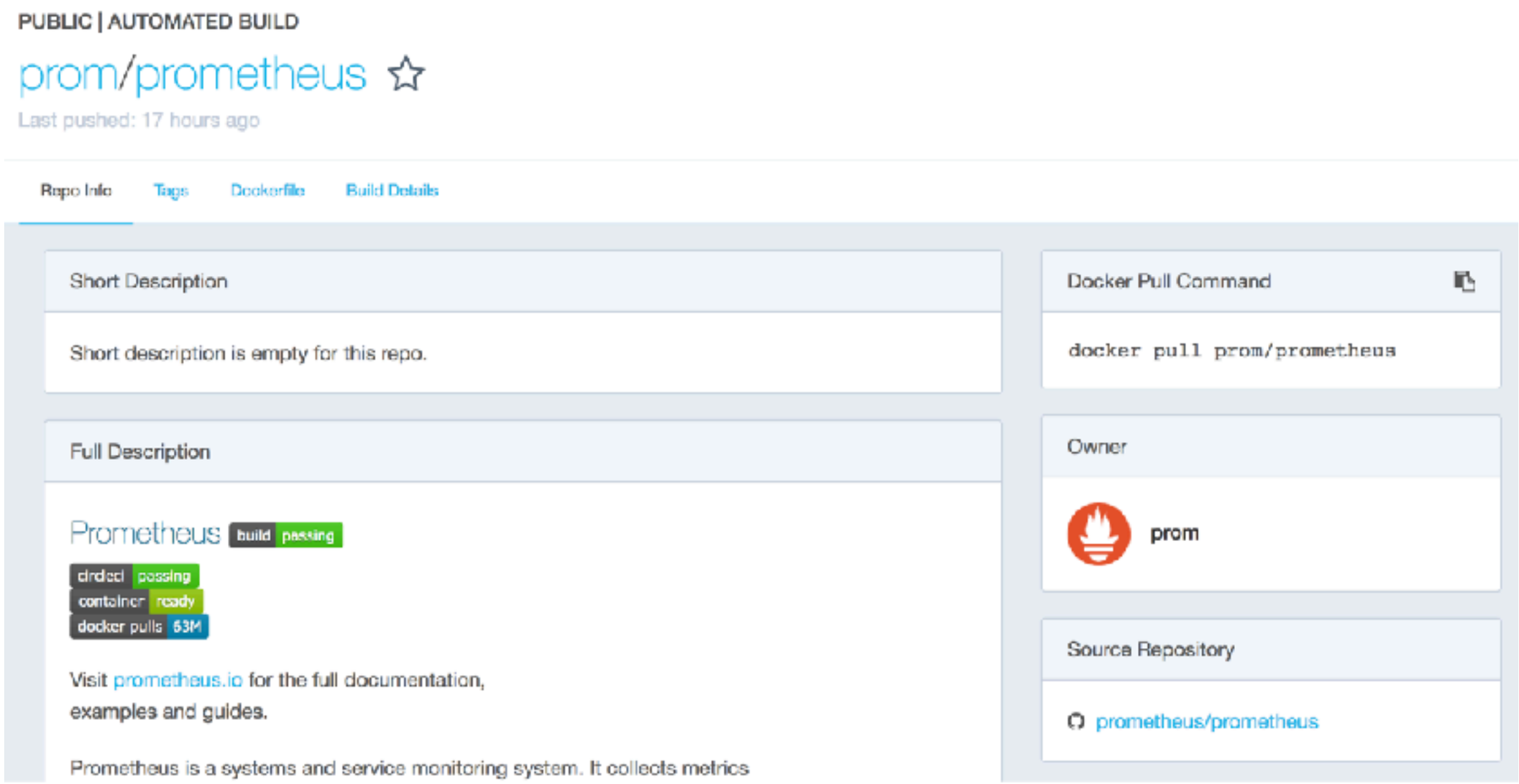
https://prometheus.io/

Prometheus



https://prometheus.io/

Prometheus



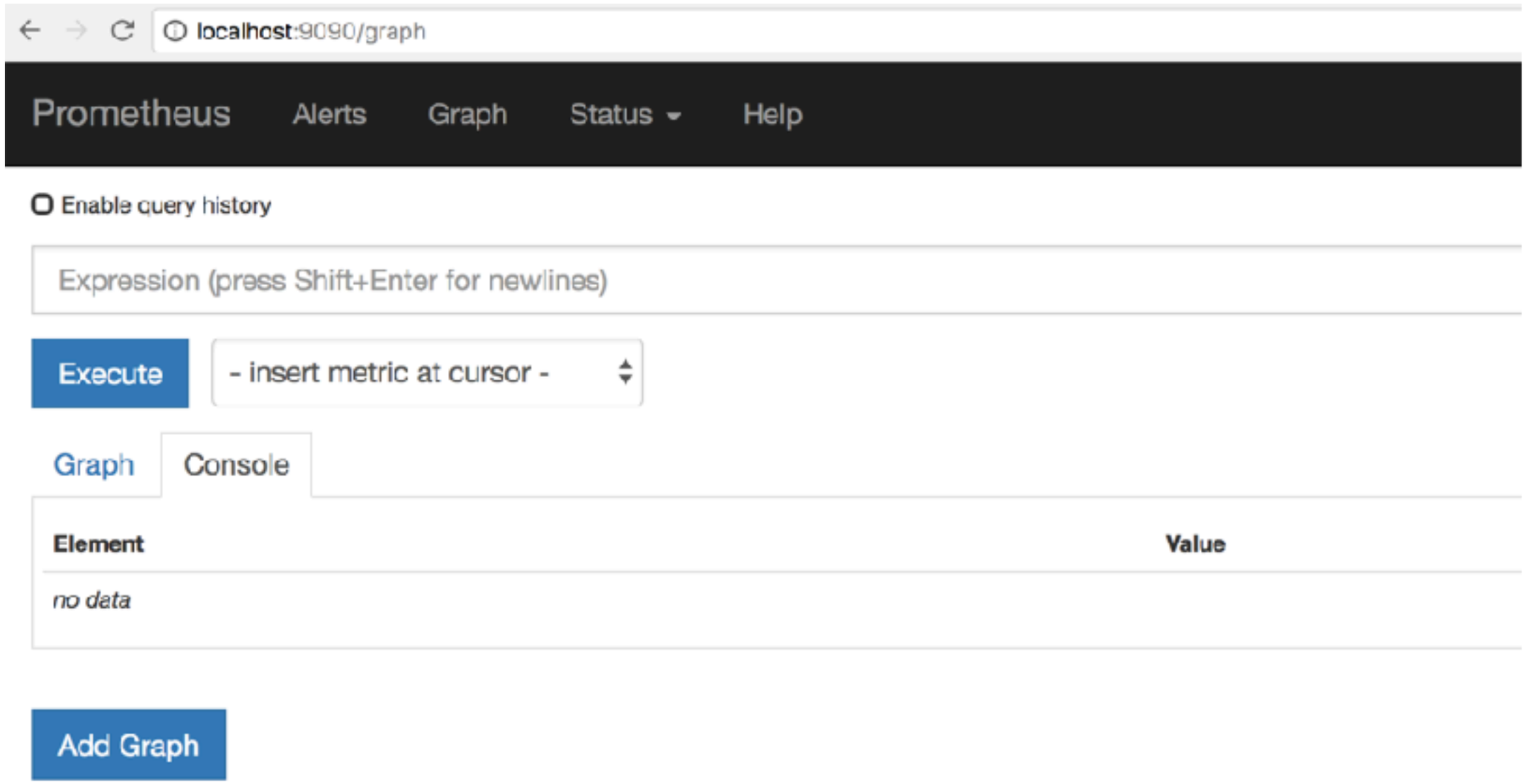
https://hub.docker.com/r/prom/prometheus/

Create container of Prometheus

```
$docker container run --rm
  -p 9090:9090
  -v $(pwd)/prometheus.yml:/etc/prometheus/
prometheus.yml
  --name monitor prom/prometheus
```

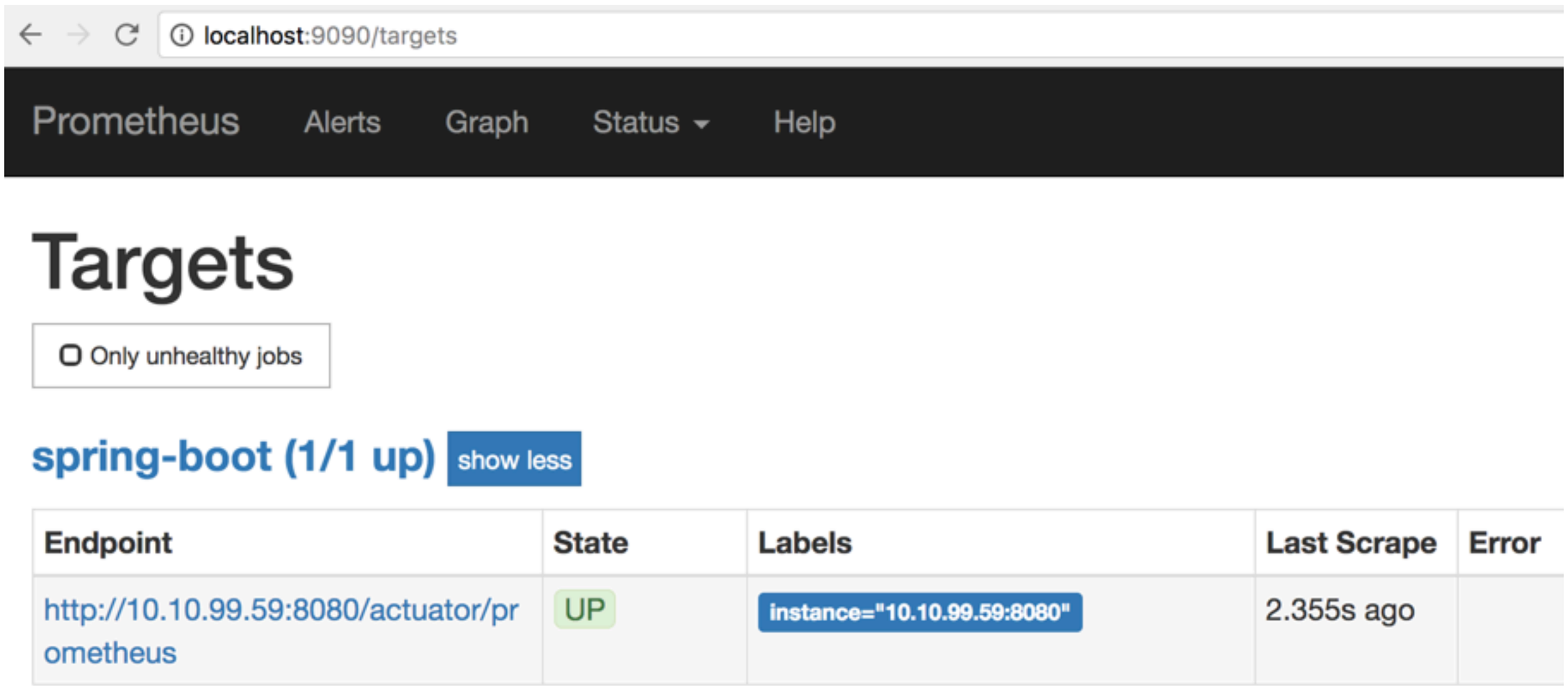
Check Data in Prometheus

http://localhost:9090/



Check Target in Prometheus

Status -> Targets



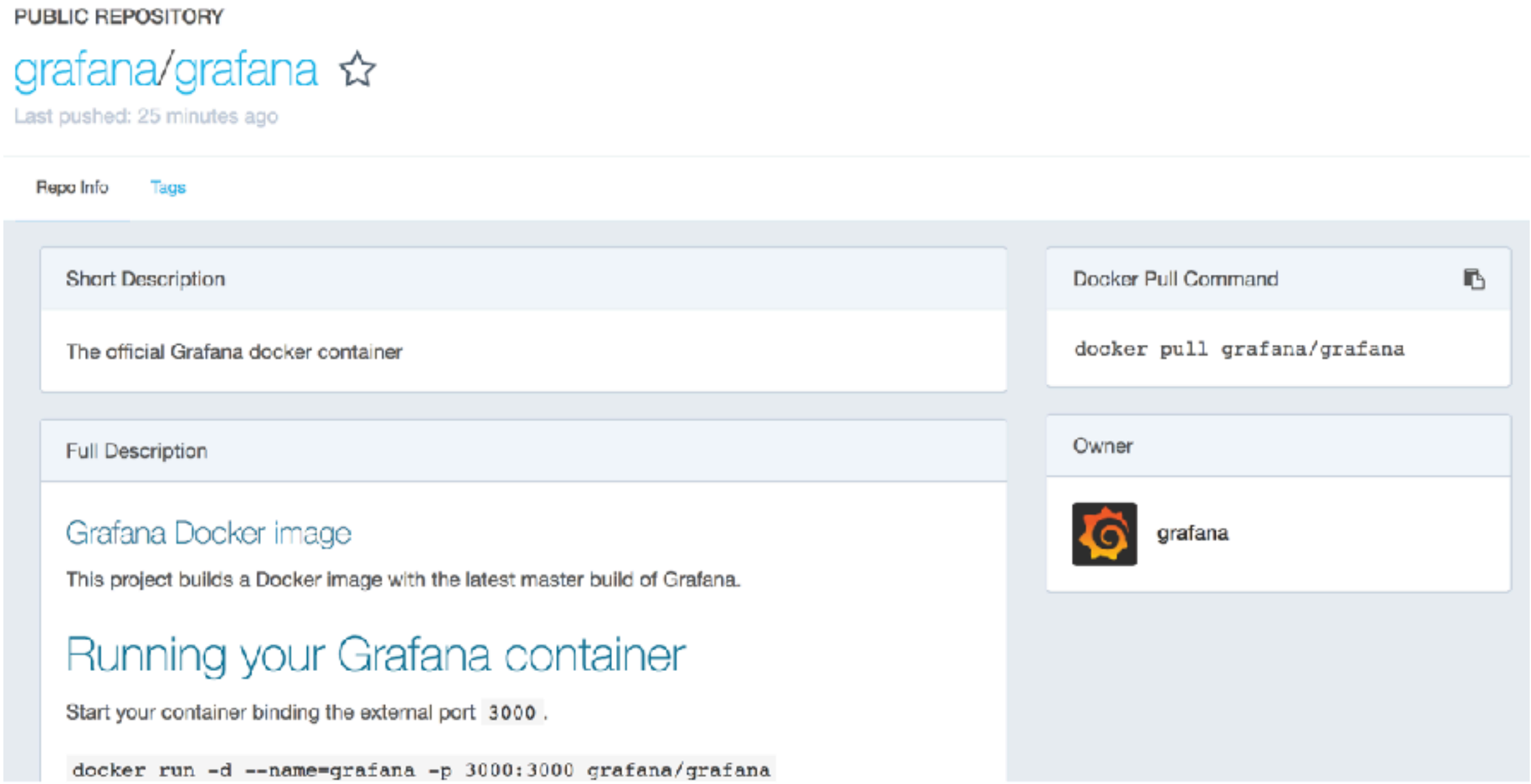
Show data in Grafana

https://grafana.com/

Grafana

https://grafana.com/

Grafana



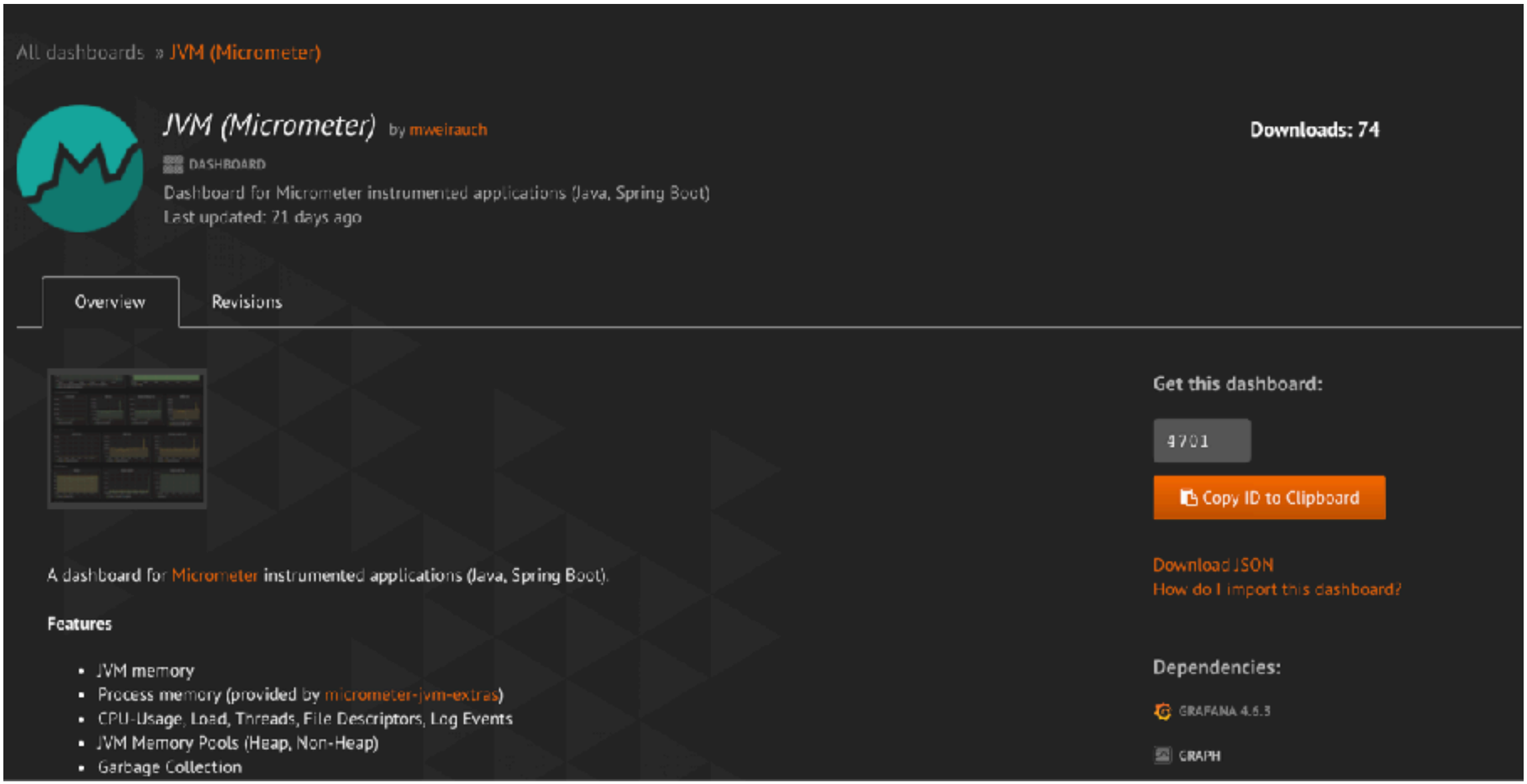
https://hub.docker.com/r/grafana/grafana/

Create container of Grafana

```
$docker container run
  --name=grafana
  -p 3000:3000 grafana/grafana
```

Grafana Dashboard

https://grafana.com/dashboards/4701



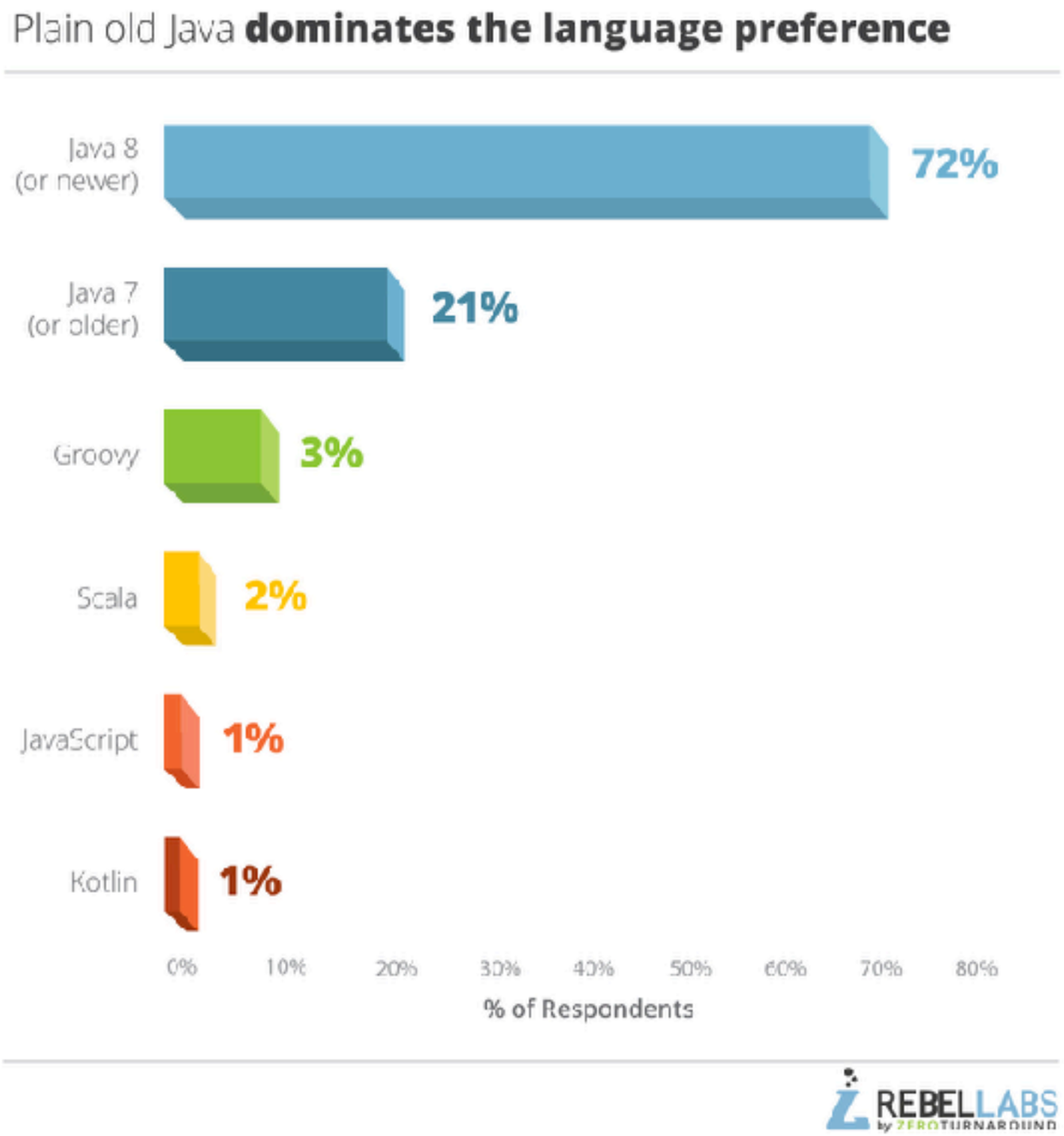
Take to your home

Always improve, always practice

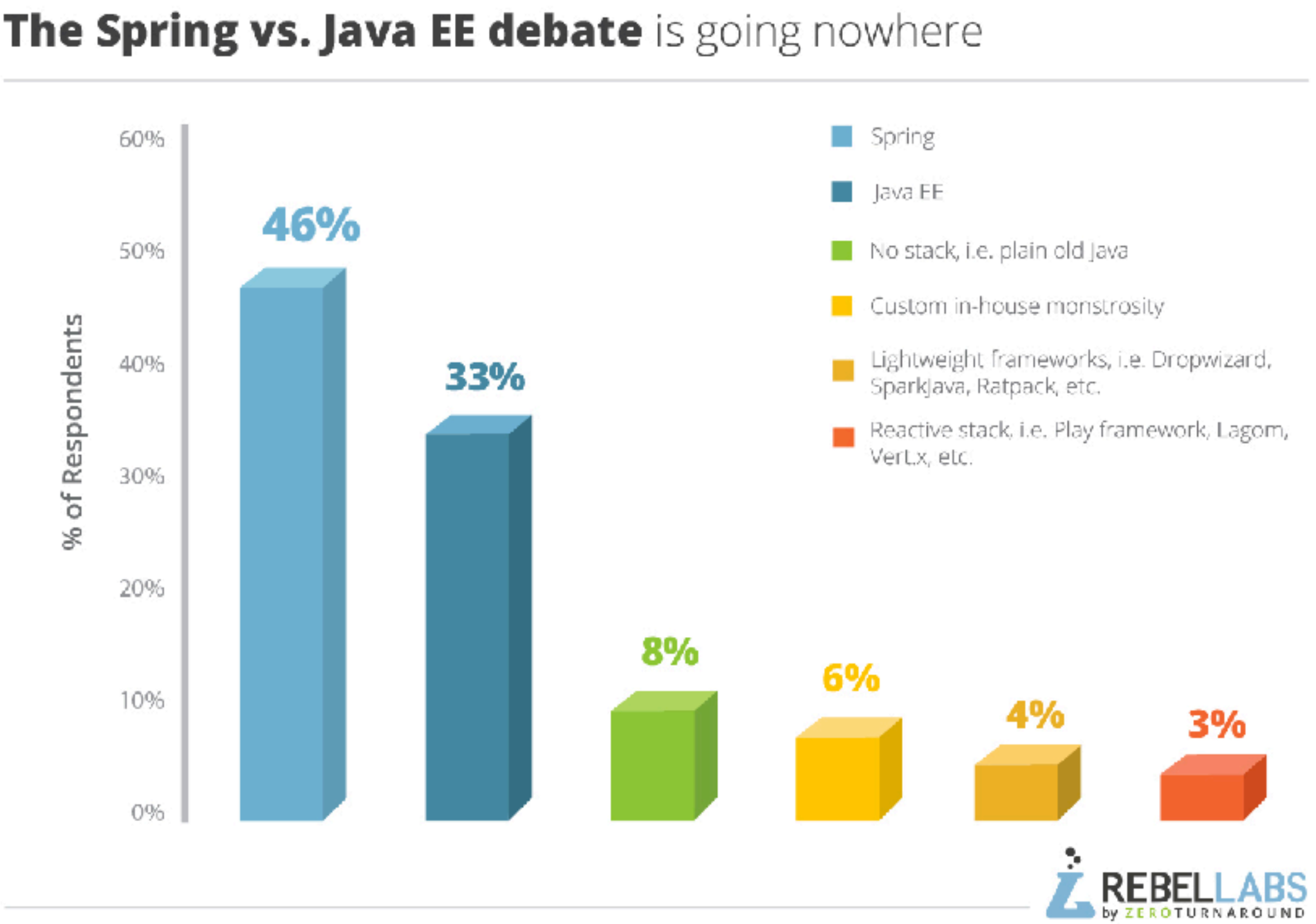
Developer productivity report

https://zeroturnaround.com/

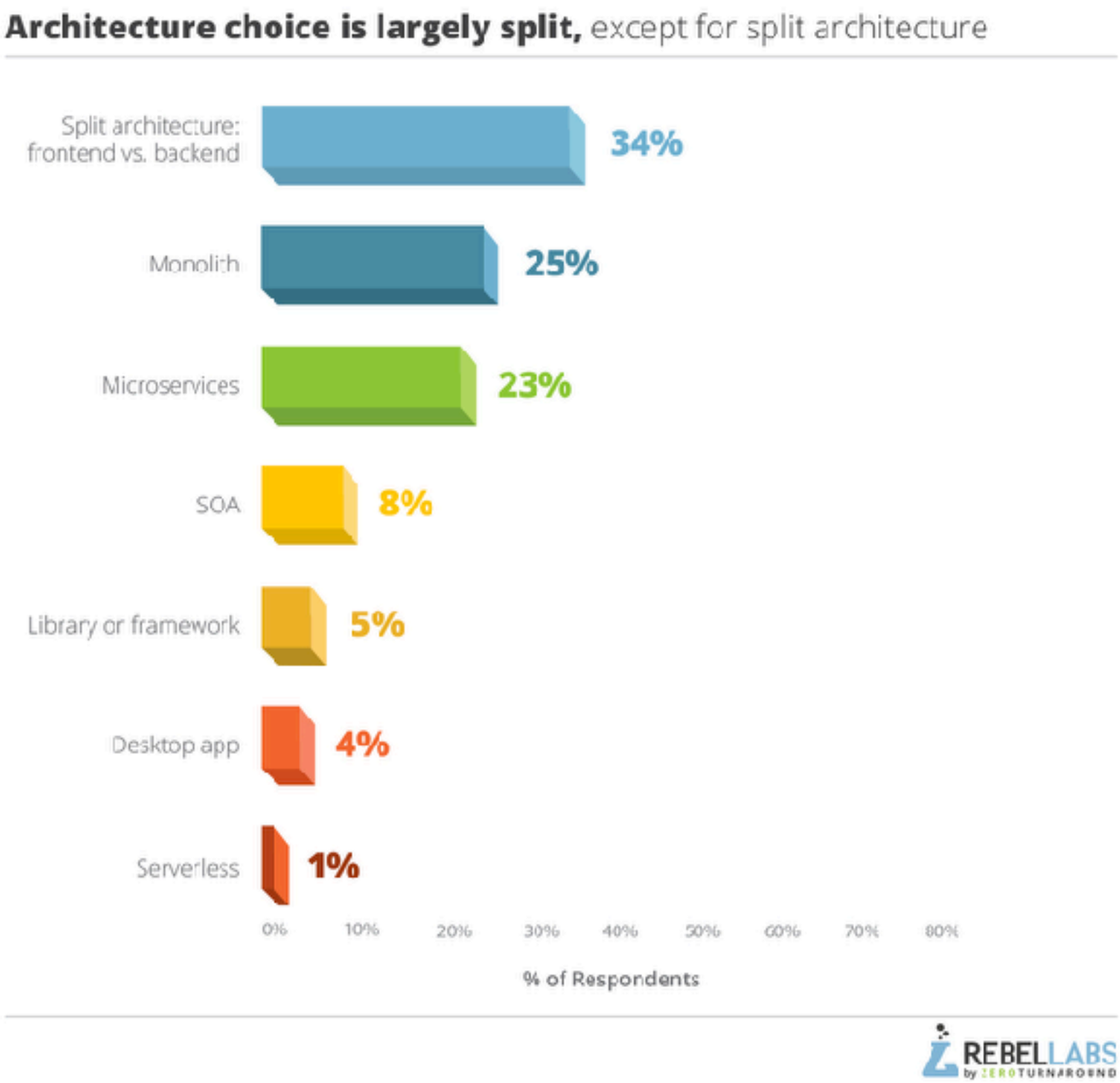
JVM languages



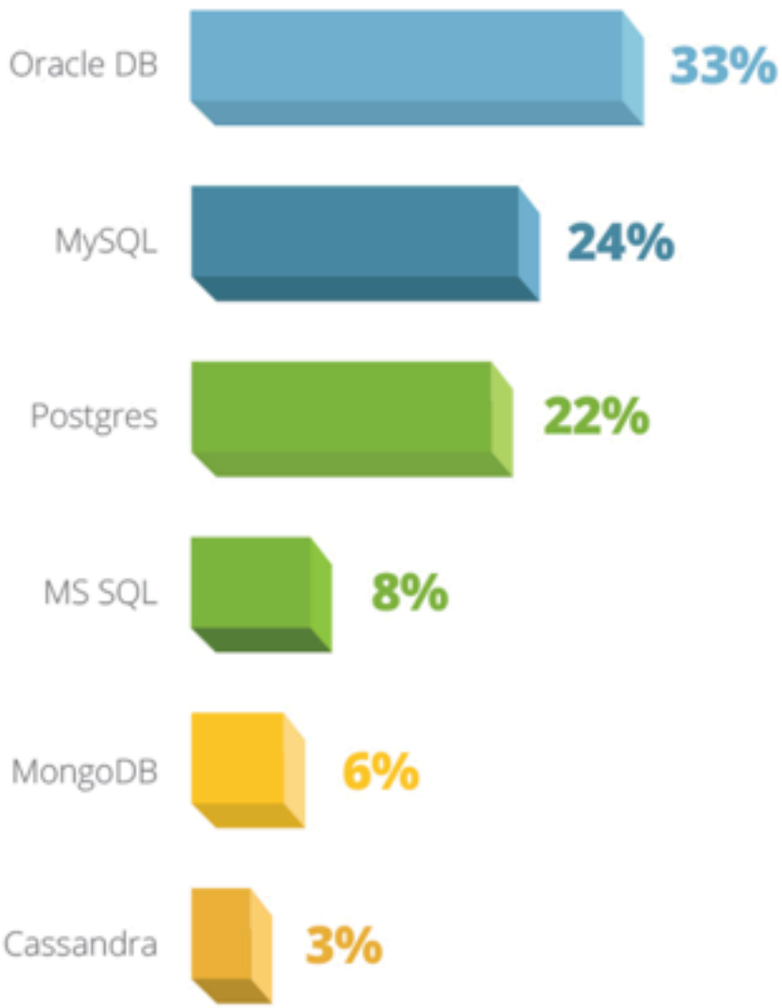
Java frameworks



Architecture ?

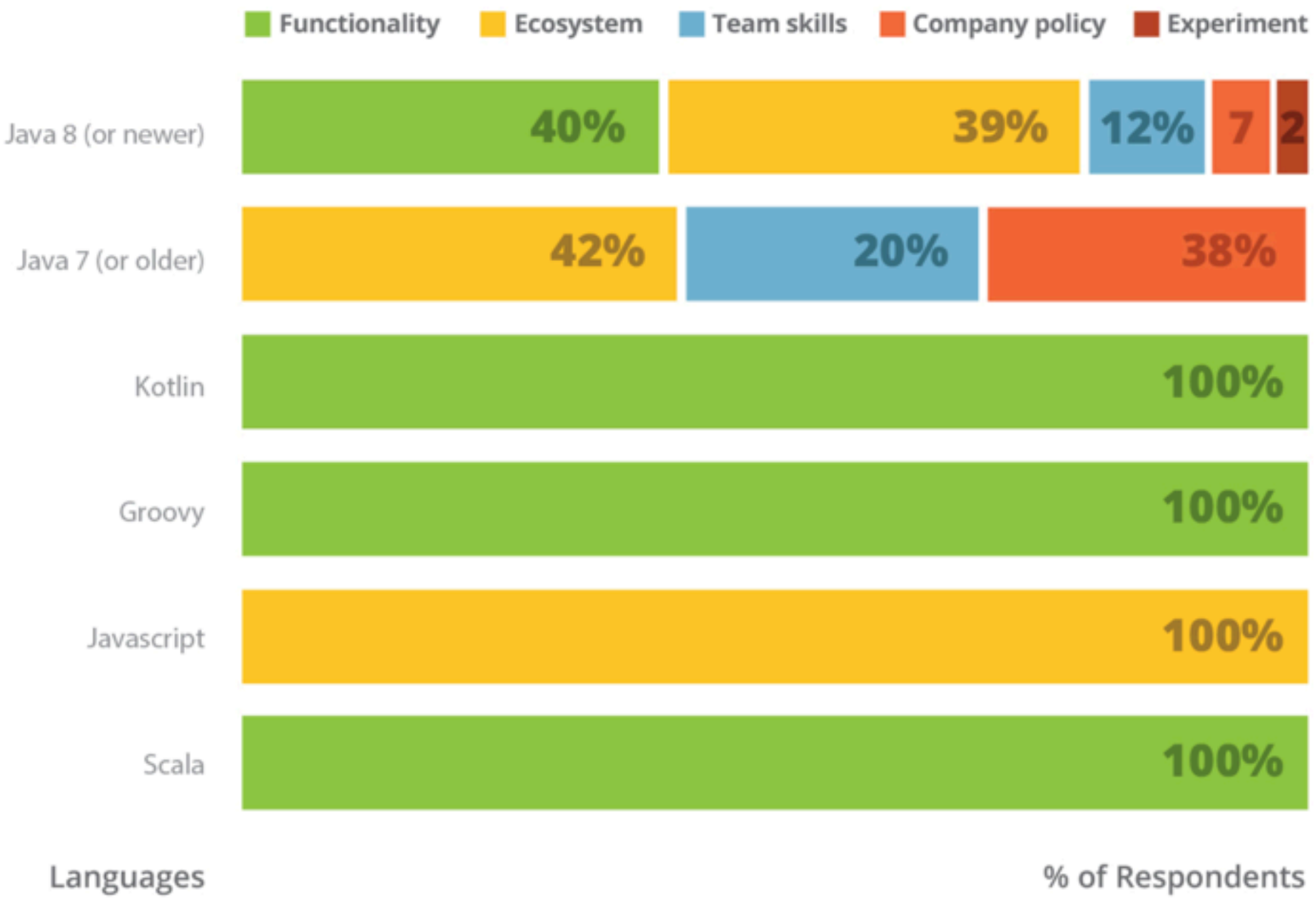


Database



Other languages

Reasons to use



Thank you
Q/A