

**Spring Boot
Spring Testing
RESTful API**





Somkiat Puisungnoen

Somkiat Puisungnoen

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... 22 Pending Items

Intro

Software Craftsmanship

Software Practitioner at สยามชัมนาณกิจ พ.ศ. 2556

Agile Practitioner and Technical at SPRINT3r

Post Photo/Video Live Video Life Event

What's on your mind?

Public Post

Somkiat Puisungnoen 15 mins · Bangkok · ⚙️

Java and Bigdata



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**[https://github.com/up1/
course-springboot-2020](https://github.com/up1/course-springboot-2020)**



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

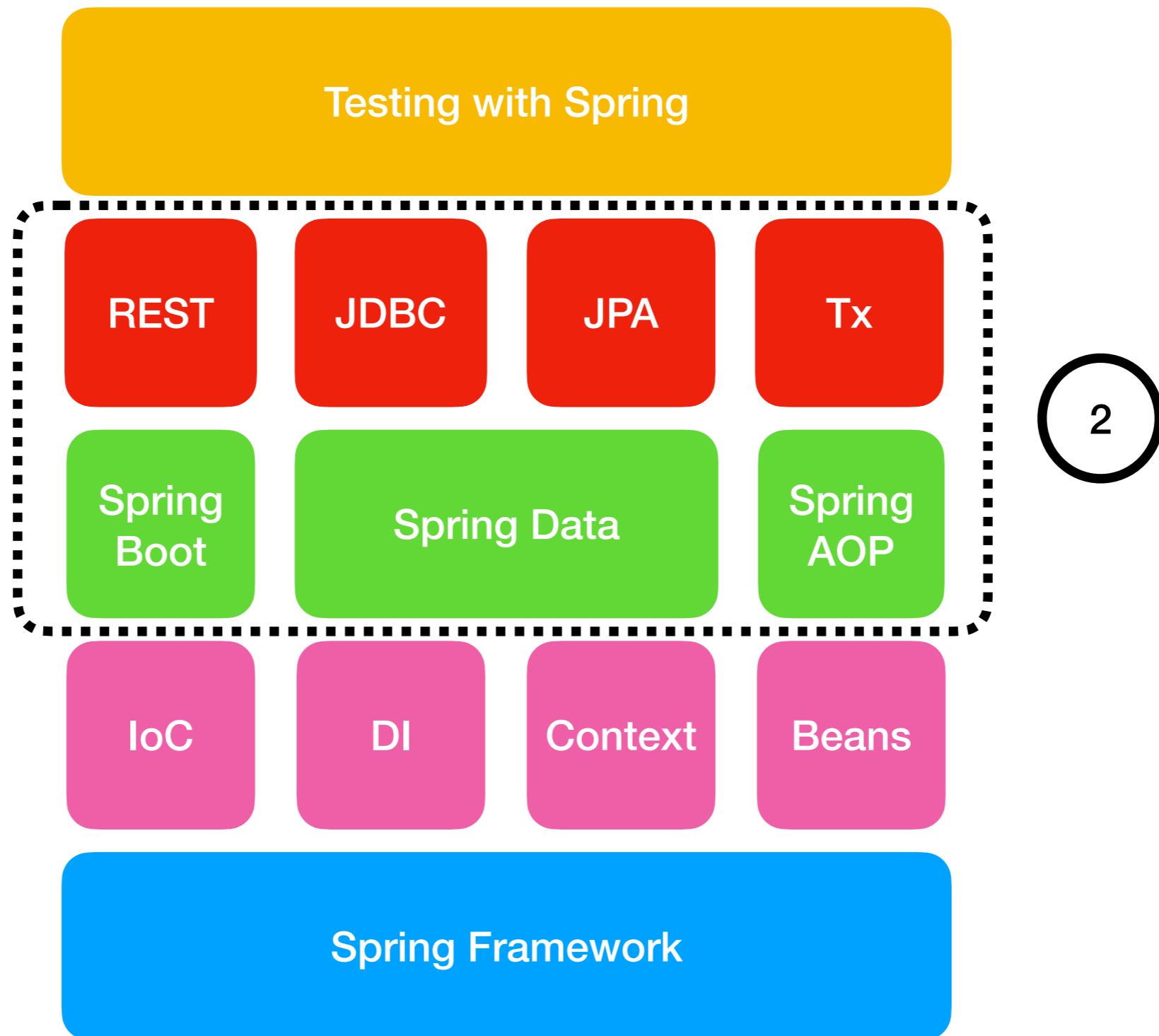
Layer in Spring Boot project

Working with Spring Data (JPA and JDBC)

Manage transaction



Workshop



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
Uniform Resource Identifiers (URI)



REST Request Messages

RESTful request is typically in form of
Uniform Resource Identifiers (URI)

Structure of URI depend on specific service



REST Request Messages

RESTful request is typically in form of
Uniform Resource Identifiers (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

Request Method

GET, POST, PUT, DELETE

Client

Server



Response Format

XML or JSON



HTTP Methods meaning

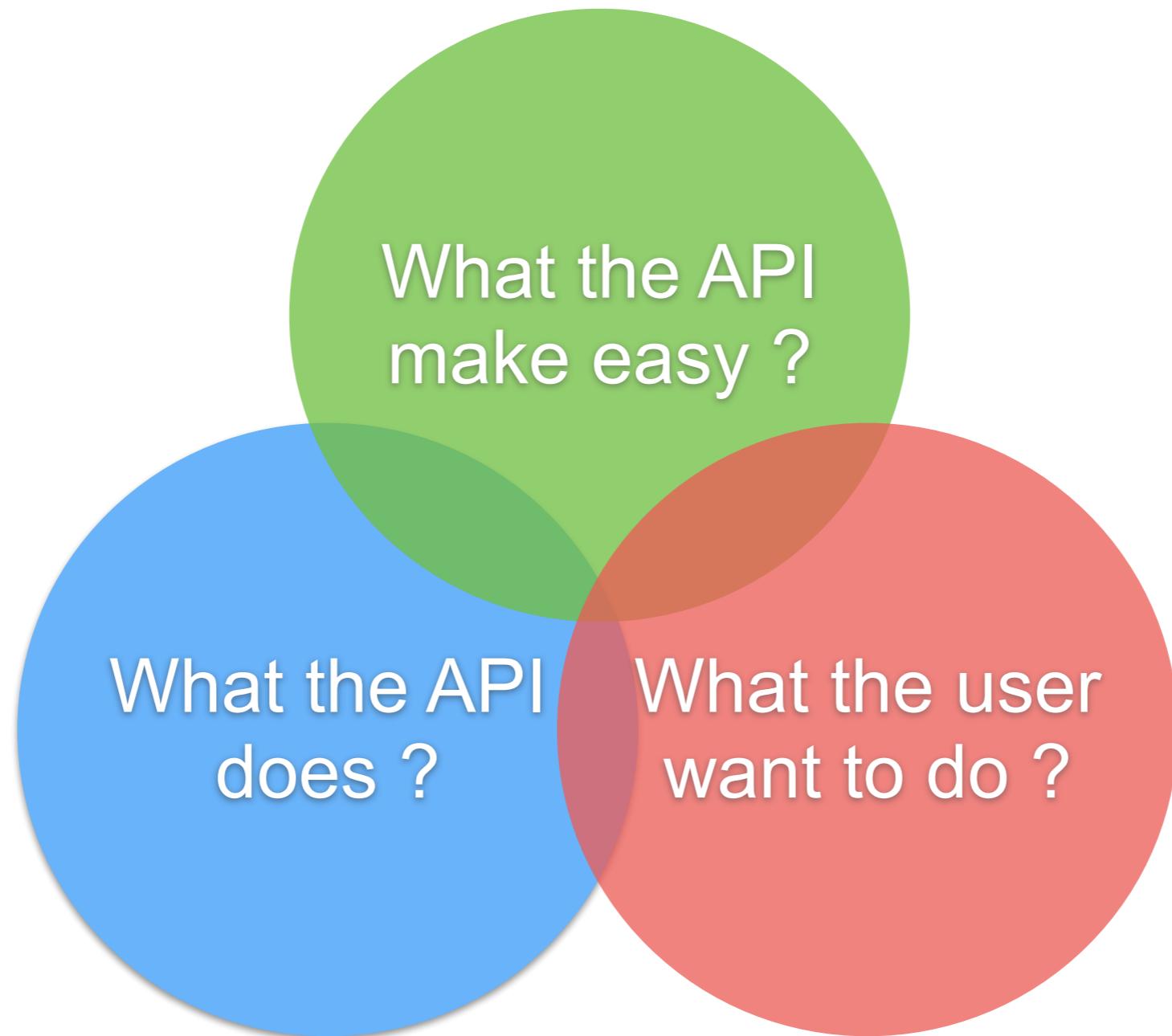
Method	Meaning
GET	Read data
POST	Create/Insert new data
PUT/PATCH	Update data or insert if a new id
DELETE	Delete data



Response format ?

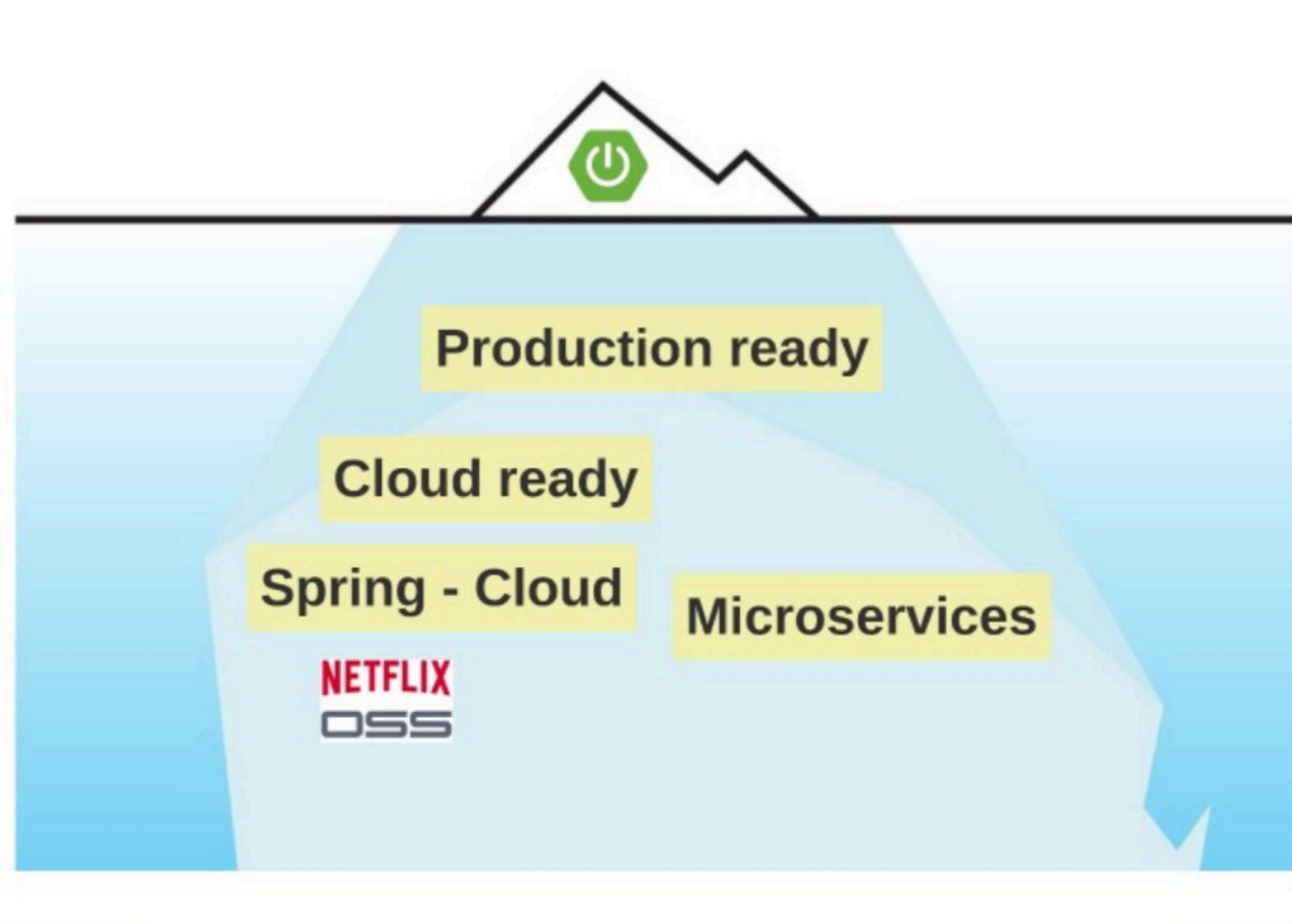


Good APIs ?



Why ?

Application skeleton generator
Reduce effort to add new technologies



What ?

Embedded application server

Integration with tools/technologies (starter)

Production tools (monitoring, health check)

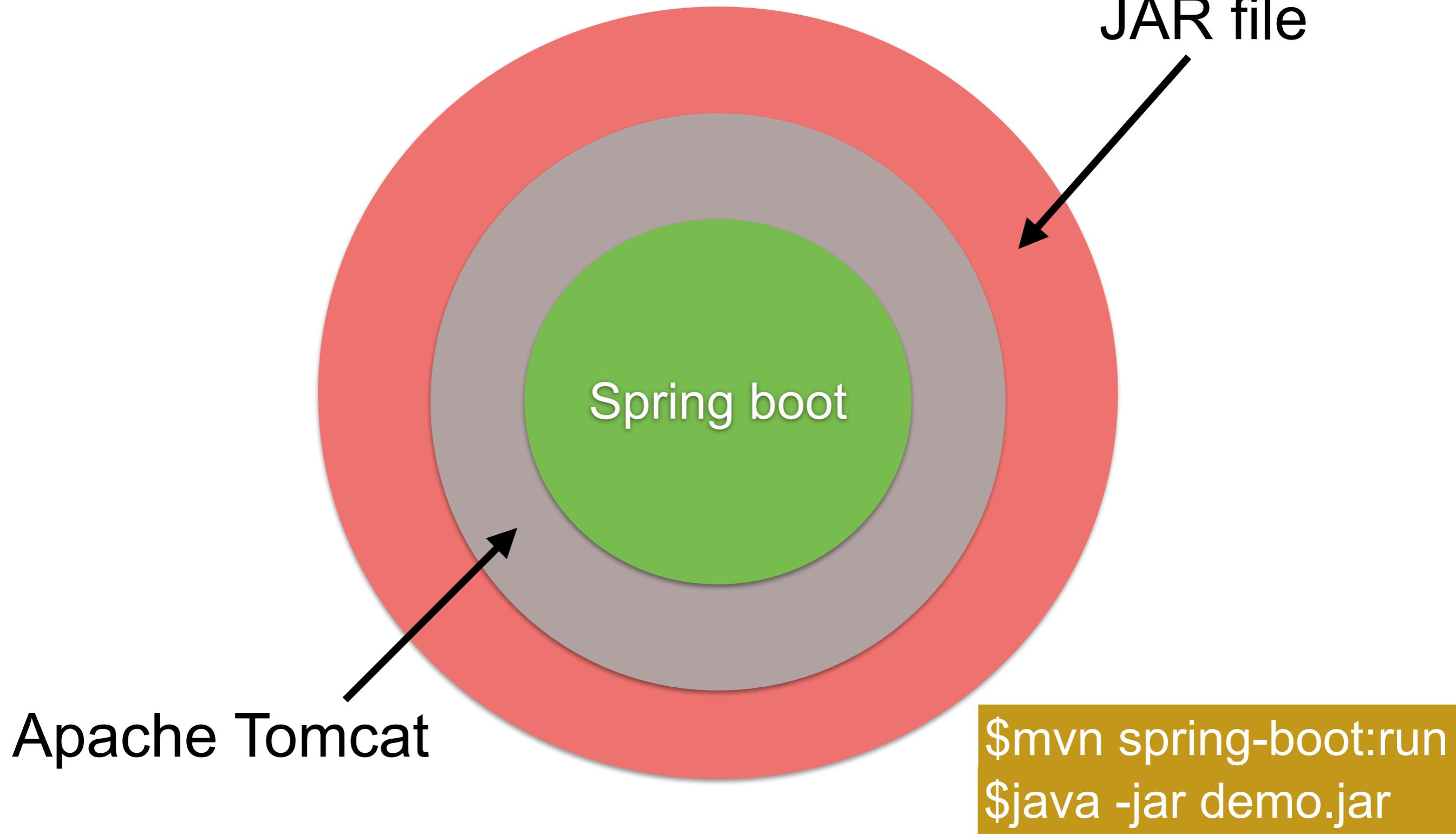
Configuration management

Dev tools

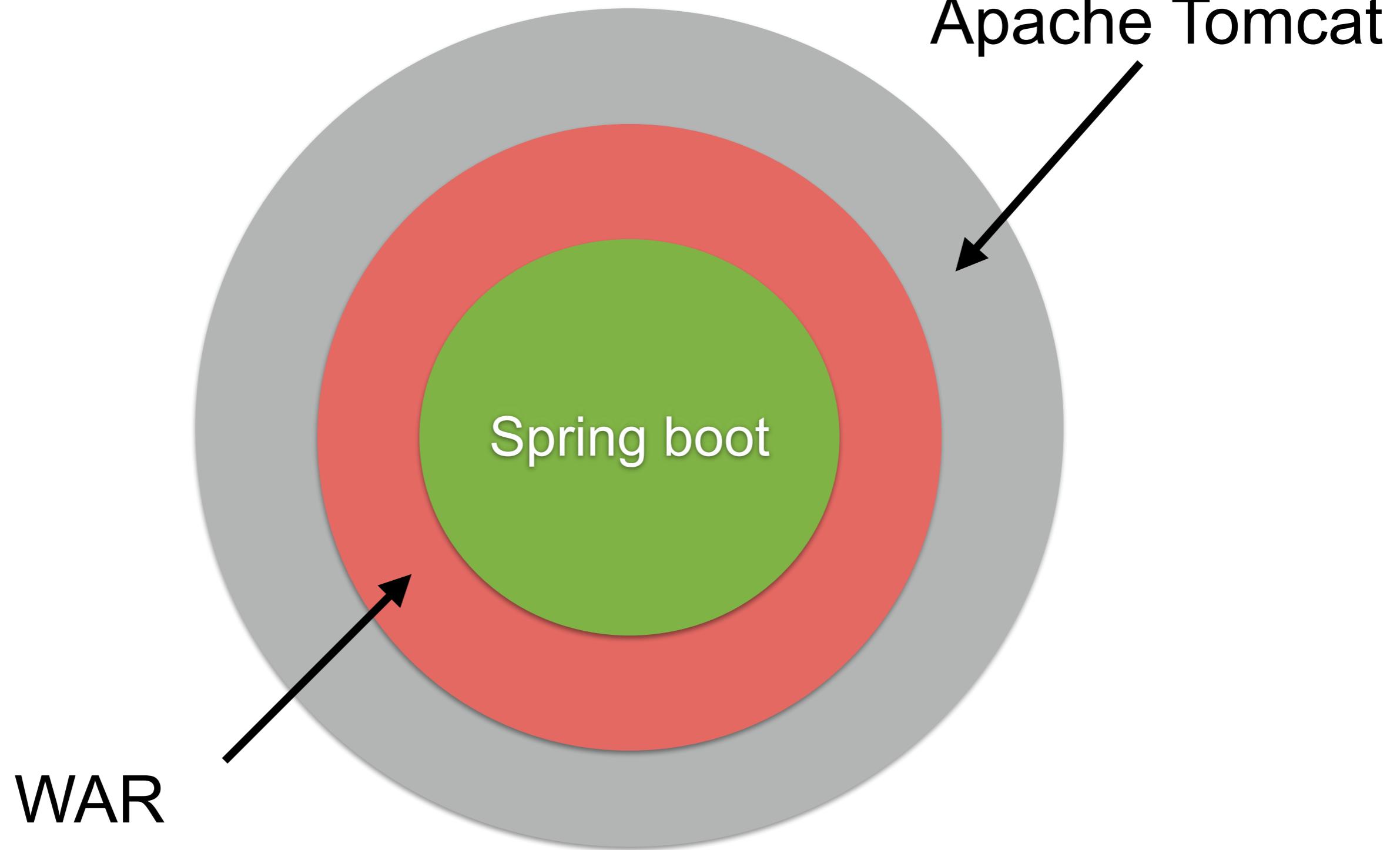
No source code generation, no XML



How ?



How ?



Building RESTful API with Spring Boot



Create new project



Project	<input checked="" type="radio"/> Maven Project <input type="radio"/> Gradle Project	Language	<input checked="" type="radio"/> Java <input type="radio"/> Kotlin <input type="radio"/> Groovy
Spring Boot	<input type="radio"/> 2.5.0 (SNAPSHOT) <input type="radio"/> 2.4.2 (SNAPSHOT) <input checked="" type="radio"/> 2.4.1 <input type="radio"/> 2.3.8 (SNAPSHOT)	<input type="radio"/> 2.3.7	
Project Metadata			
Group	com.workshop		
Artifact	day2		
Name	day2		
Description	Demo project for Spring Boot		
Package name	com.workshop.day2		
Packaging	<input checked="" type="radio"/> Jar <input type="radio"/> War		
Java	<input type="radio"/> 15 <input type="radio"/> 11 <input checked="" type="radio"/> 8		

Dependencies

[ADD DEPENDENCIES... ⌘ + B](#)

Spring Web WEB

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

Spring Data JPA SQL

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

H2 Database SQL

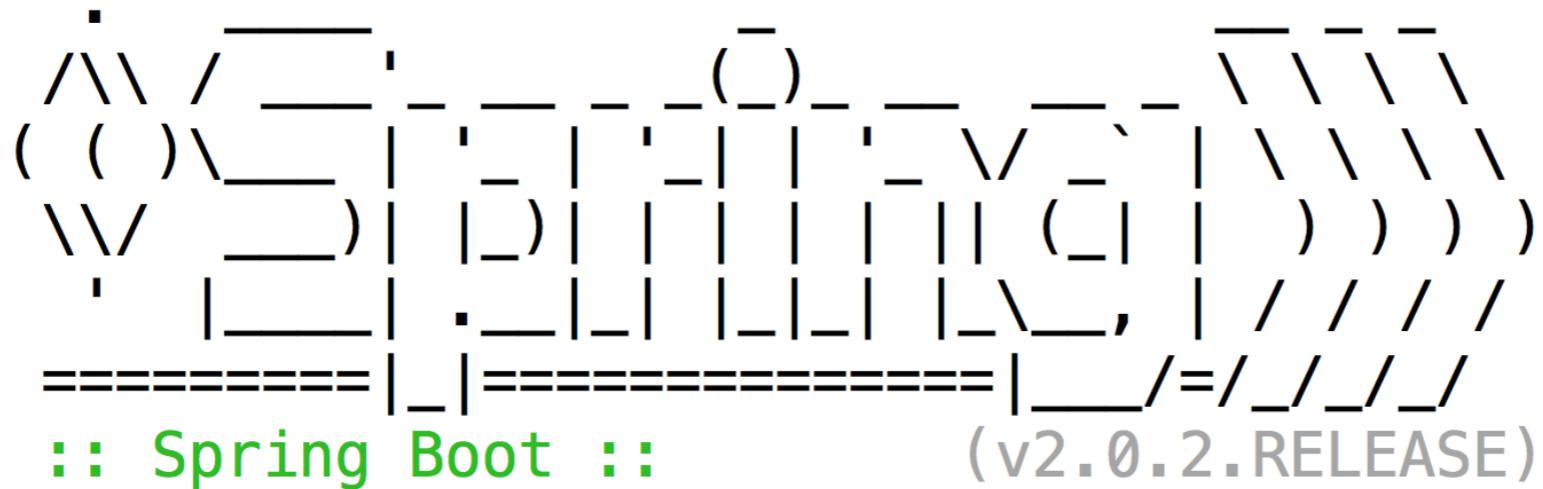
Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2mb) footprint. Supports embedded and server modes as well as a browser based console application.

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



Run project (Dev mode)

```
./mvnw spring-boot:run
```

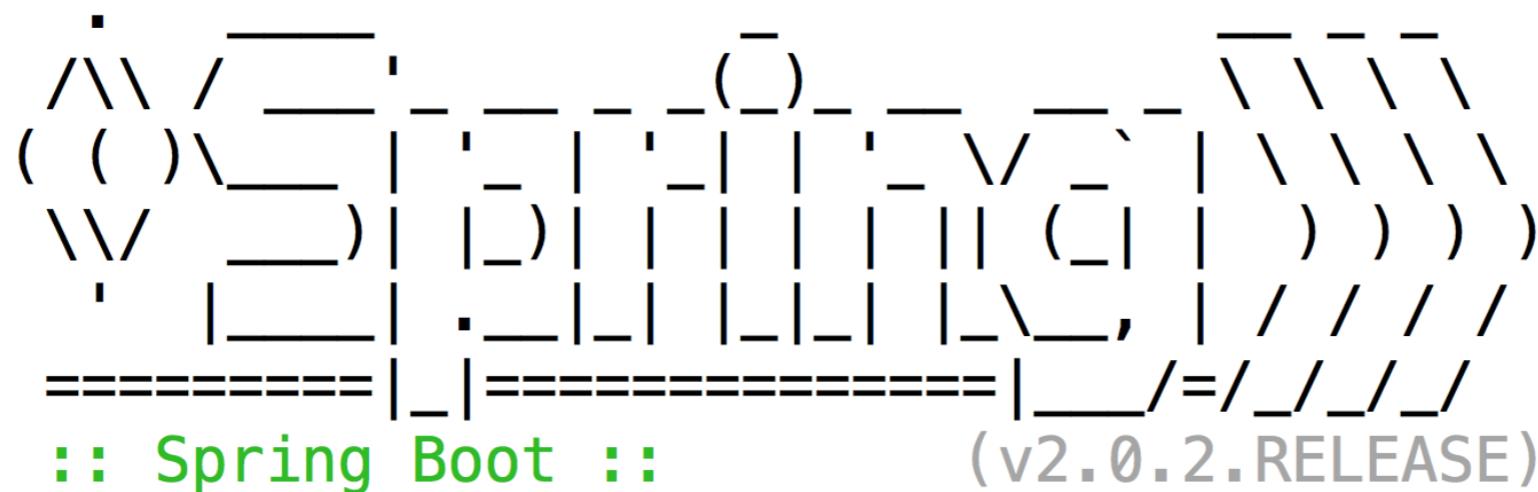


```
2018-06-07 13:03:30.412  INFO 12828 --- [  
  oApplication           : Starting DemoApplication on  
D 12828 (started by somkiat in /Users/somkiat/Down  
2018-06-07 13:03:30.418  INFO 12828 --- [  
  oApplication           : No active profile set, fall
```



Run project (production mode)

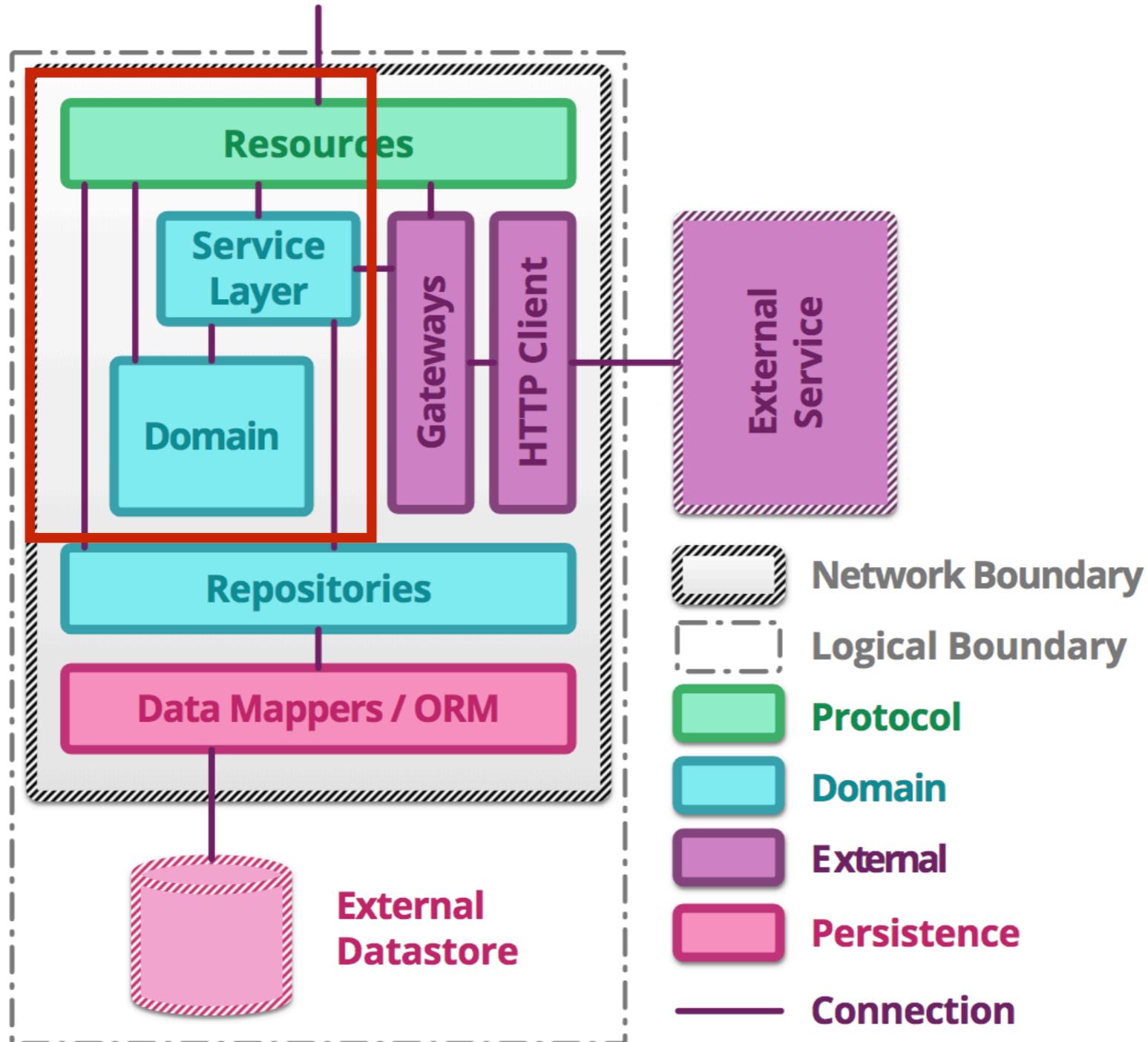
```
$./mvnw package  
$java -jar target/<file name>.jar
```



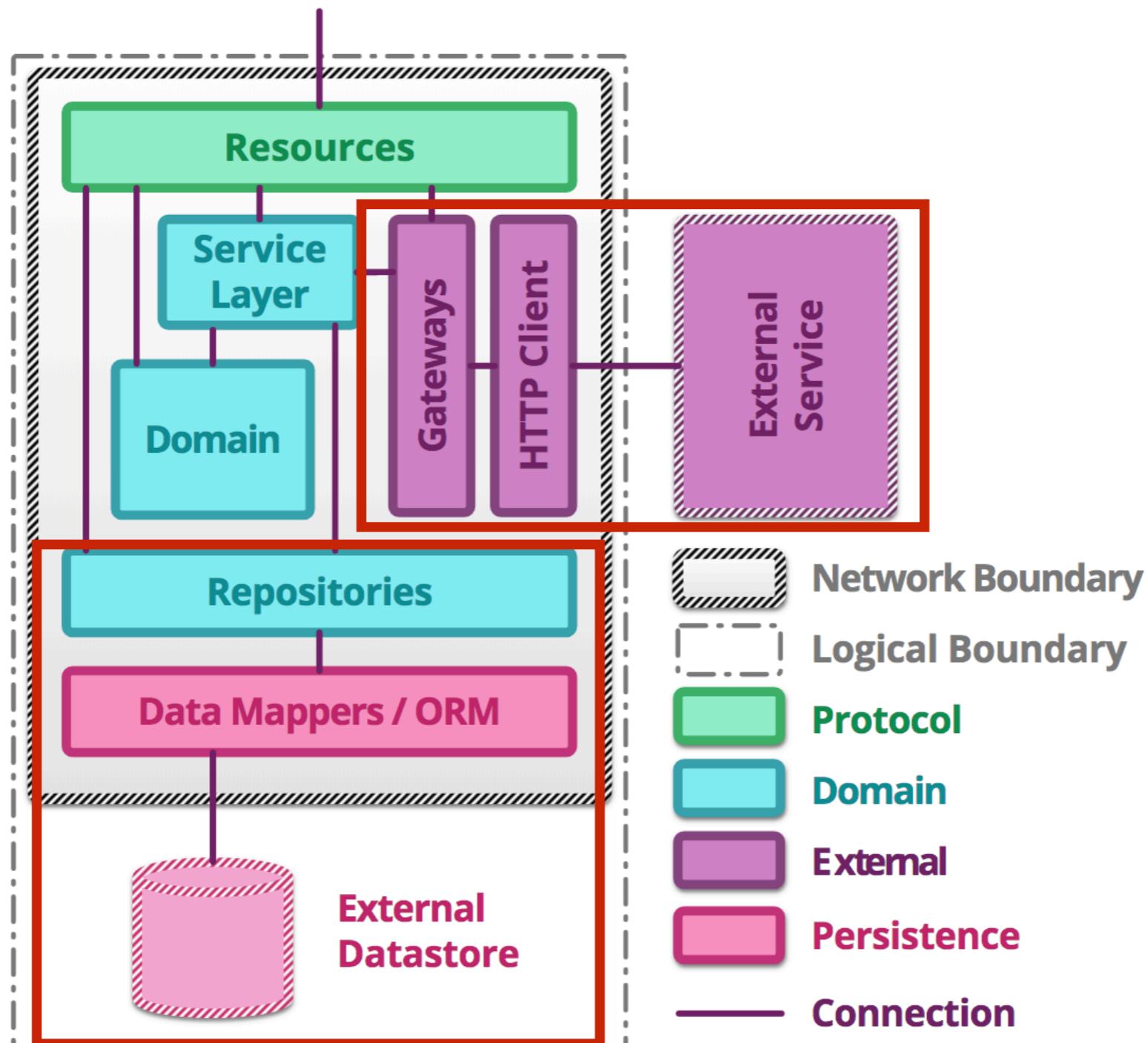
```
2018-06-07 13:03:30.412  INFO 12828 --- [  
  oApplication           : Starting DemoApplication on  
D 12828 (started by somkiat in /Users/somkiat/Down  
2018-06-07 13:03:30.418  INFO 12828 --- [  
  oApplication           : No active profile set, fall
```



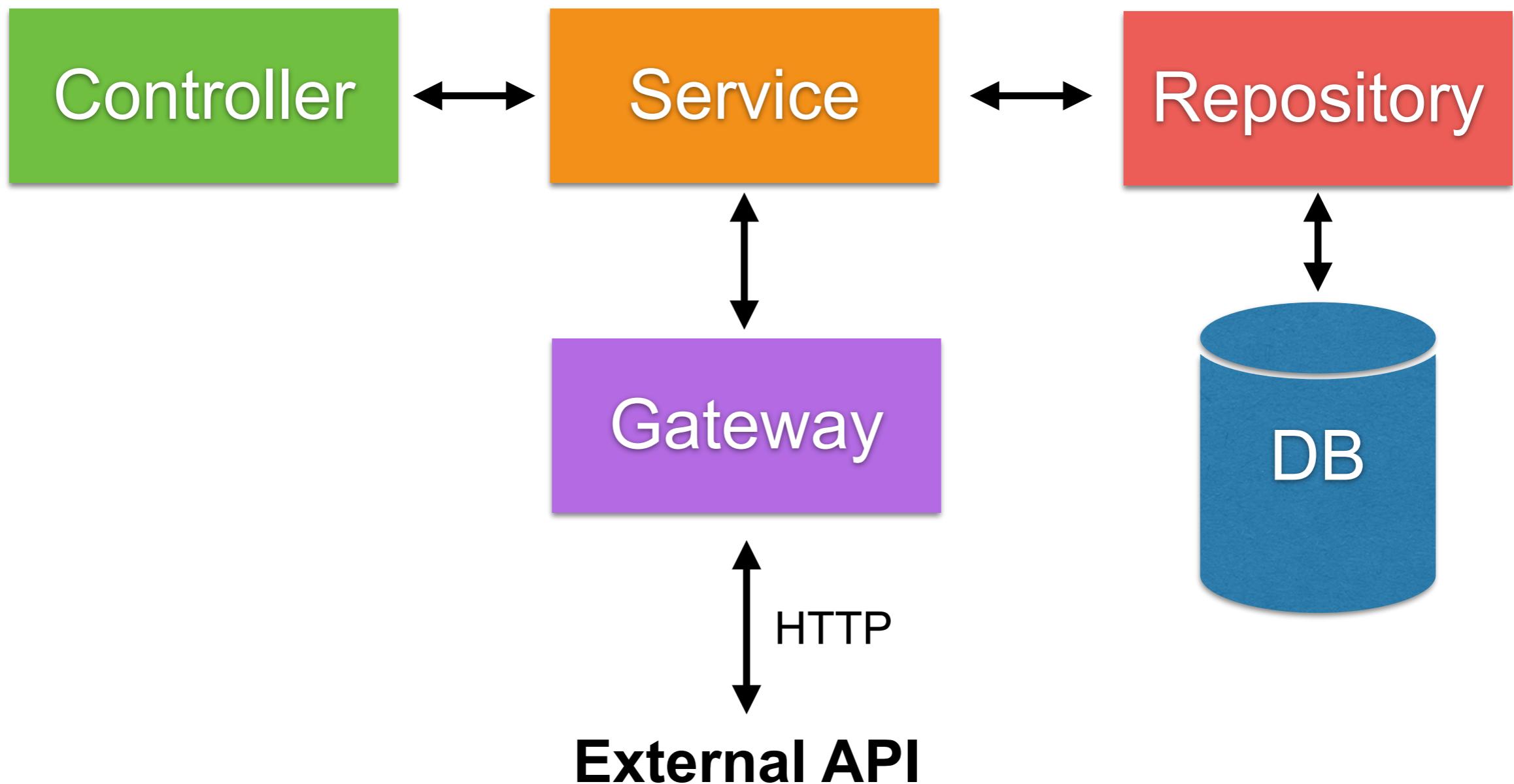
Service Structure



Service Structure



Structure of Spring Boot project



Controller

Request and Response
Validation input

Delegate to others classes such as service and repository



Service

Control the flow of main business logic
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

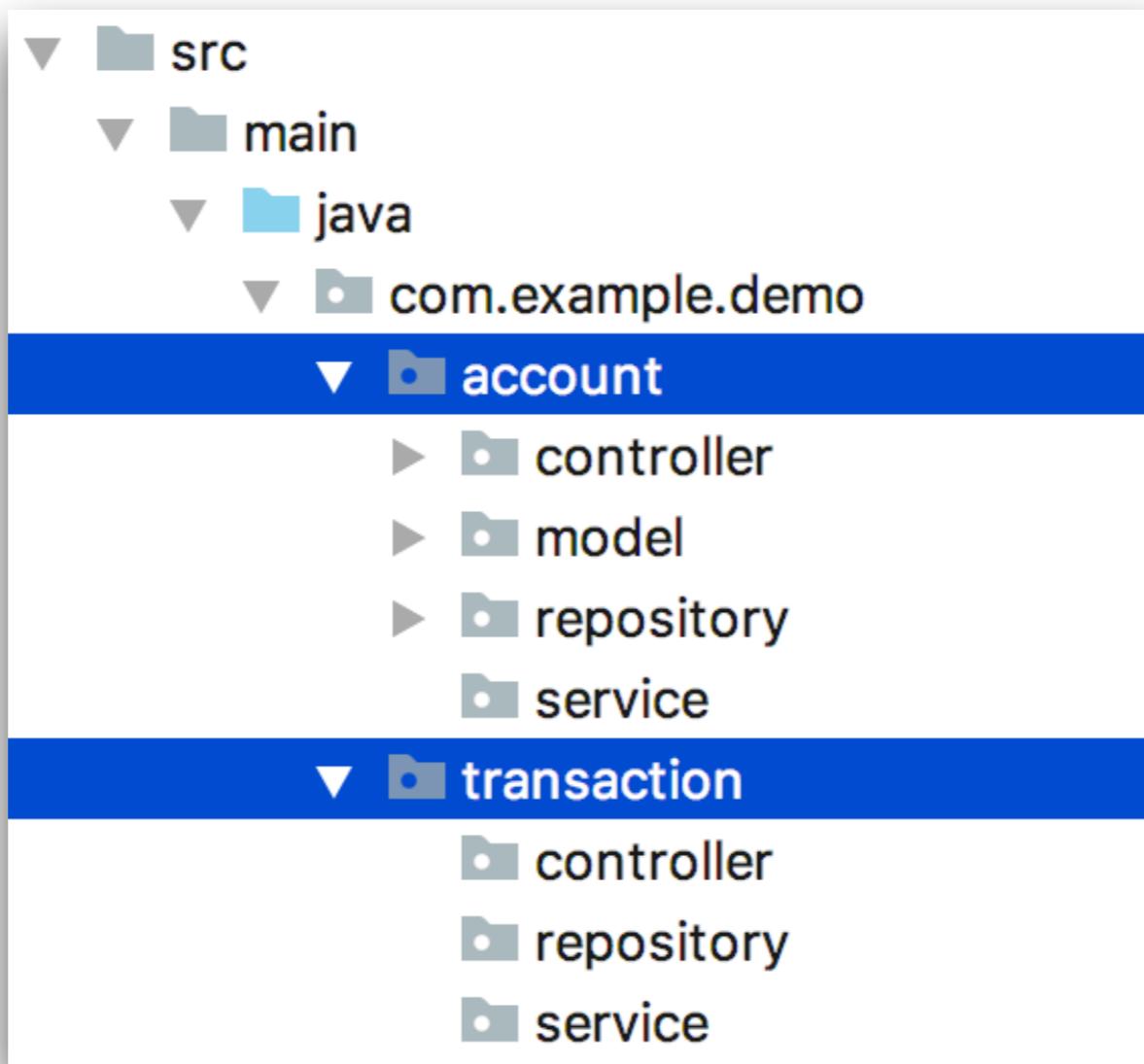
- feature1**
 - controller
 - service
 - repository
- feature2**
 - controller
 - service
 - repository

<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



Design RESTful APIs

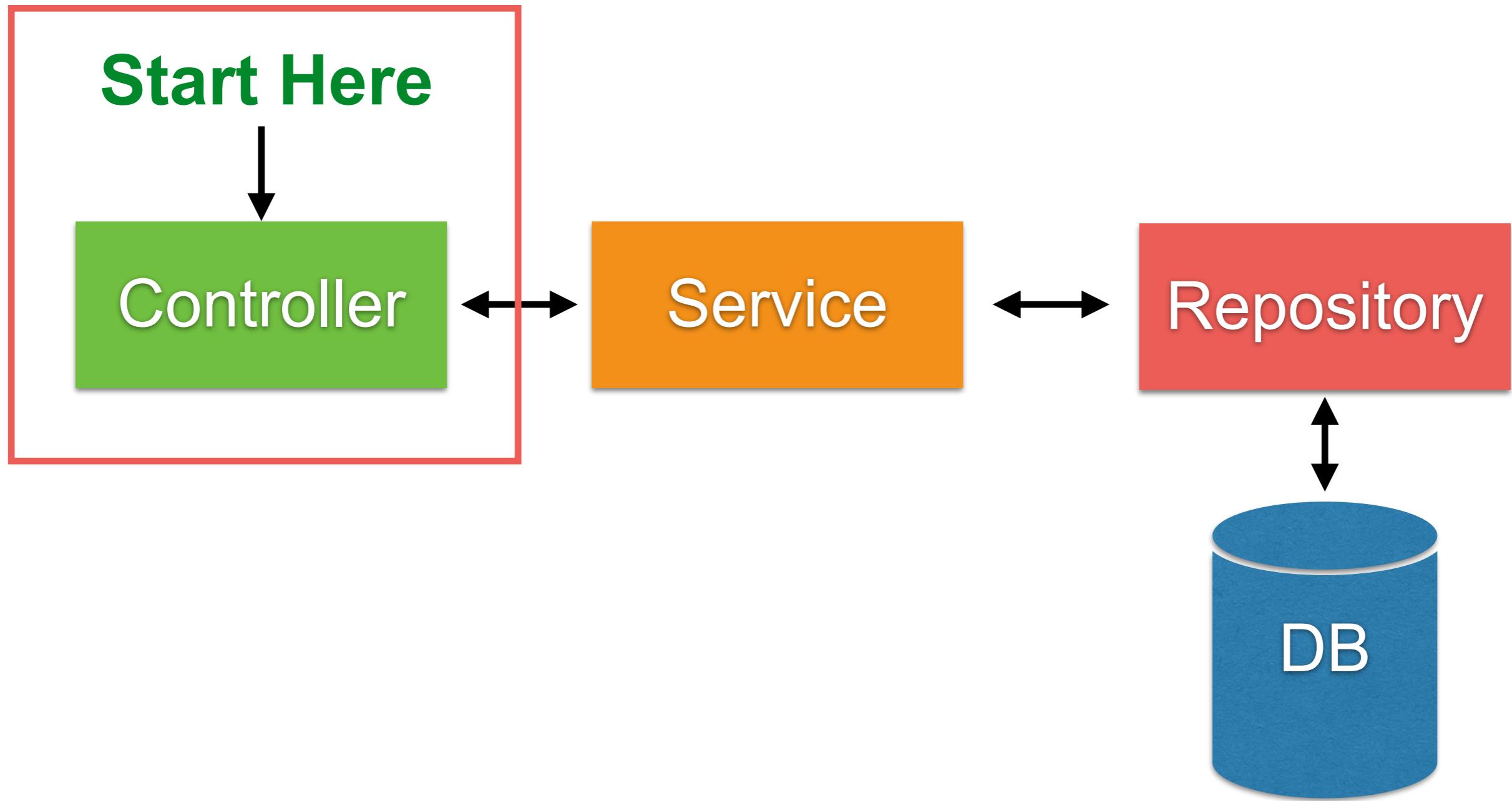


Users

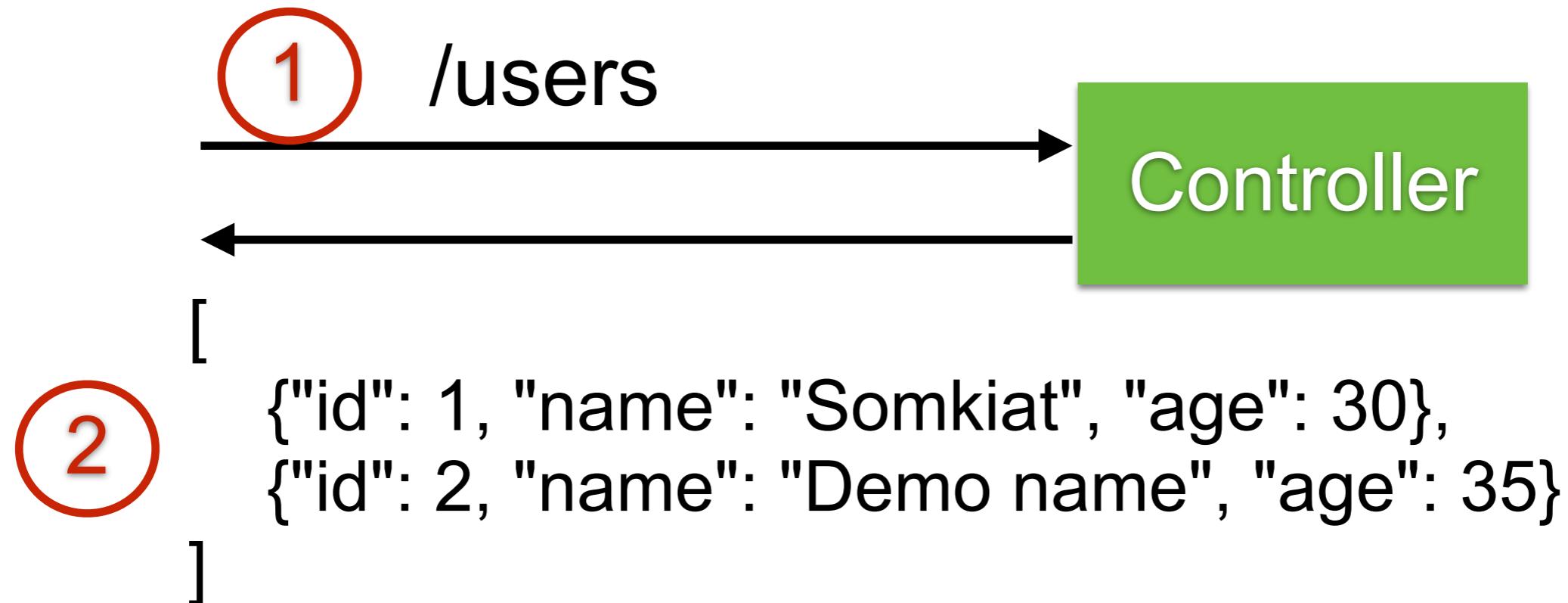
Method	Path	Description
GET	/users	Get all users
GET	/users/{id}	Get user by id
POST	/users	Create new user
PUT	/users/{id}	Update user
DELETE	/users/{id}	Delete user by id



Basic structure of Spring Boot



Get all users



1. Create REST Controller

UserController.java

```
@RestController
public class UserController {

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



2. Create model class

UserResponse.java

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



3. Compile and Packaging

\$mvnw clean package



4. Run

\$java -jar target/hello.jar

```
      .\_\_/\_\_\_'
      (( ))\_\_\_|'-----(( ))
      \_\_\_ ) | | | | | | | | | | | | | |
      ' | | | | | | | | | | | | | | |
      =====| | | | | | | | | | | | | |
      :: Spring Boot ::          (v2.0.0.RELEASE)

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



5. Open in browser

<http://localhost:8080/users>

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



Create more APIs

Get user by id

Create a new user

Update user by id

Delete user by id



Get user by id

GET /users/{id}

```
@GetMapping("/users/{id}")
public UserResponse getUserById(@PathVariable int id) {
    UserResponse userResponse = new UserResponse(id, "Demo", 40);
    return userResponse;
}
```



Create a new user

POST /users

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



Update user by id

PUT /users/{id}

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



Delete user by id

DELETE /users/{id}

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



How to test the User controller ?



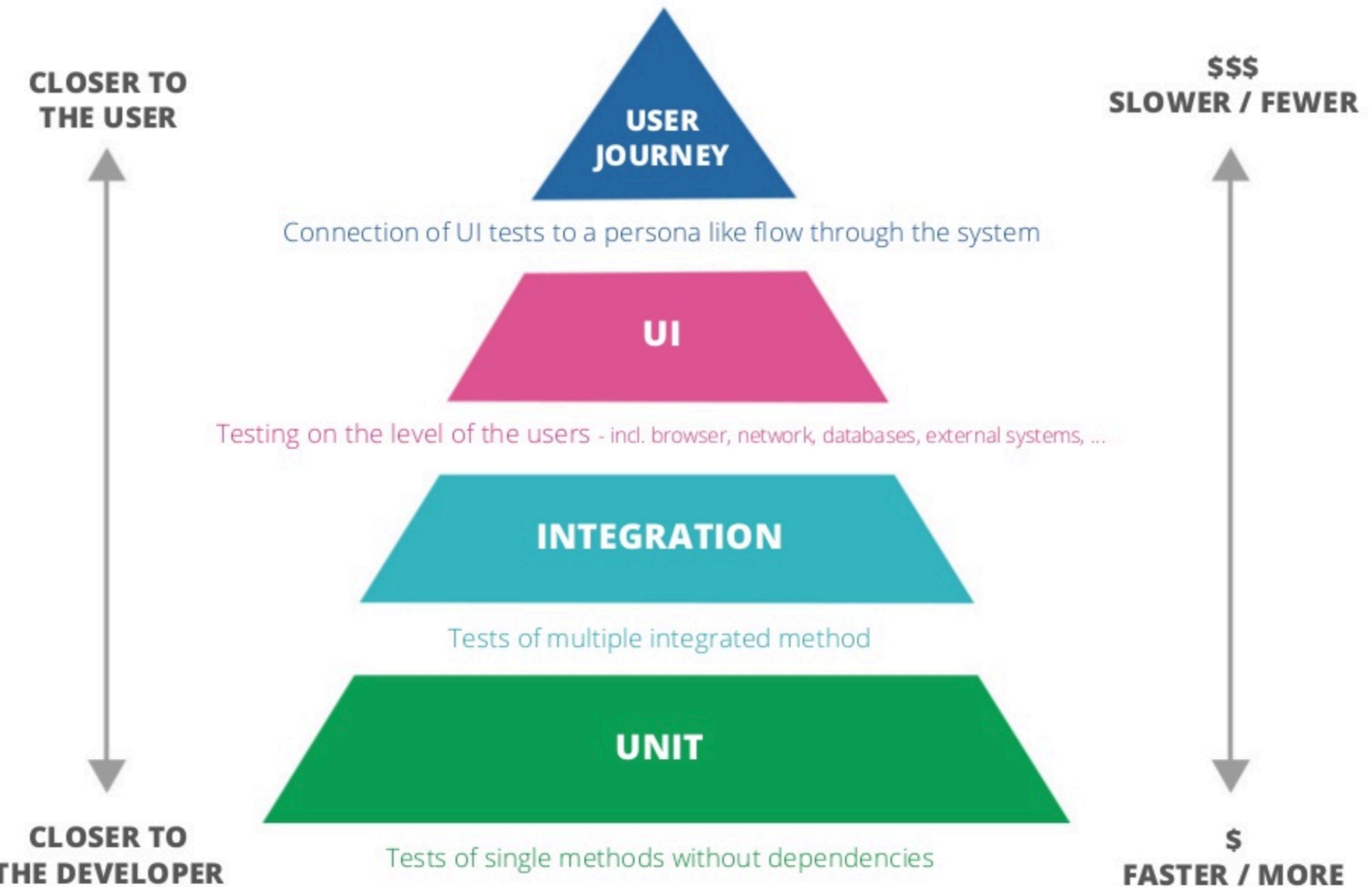
Postman



POSTMAN

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





Controller testing

How to testing with Spring Boot ?



Testing in Spring Boot

@SpringBootTest
@WebMVCTest
@JsonTest
@DataJpaTest
@RestClientTest



Testing in Spring Boot

@SpringBootTest

@WebMVC Test

@JsonTest

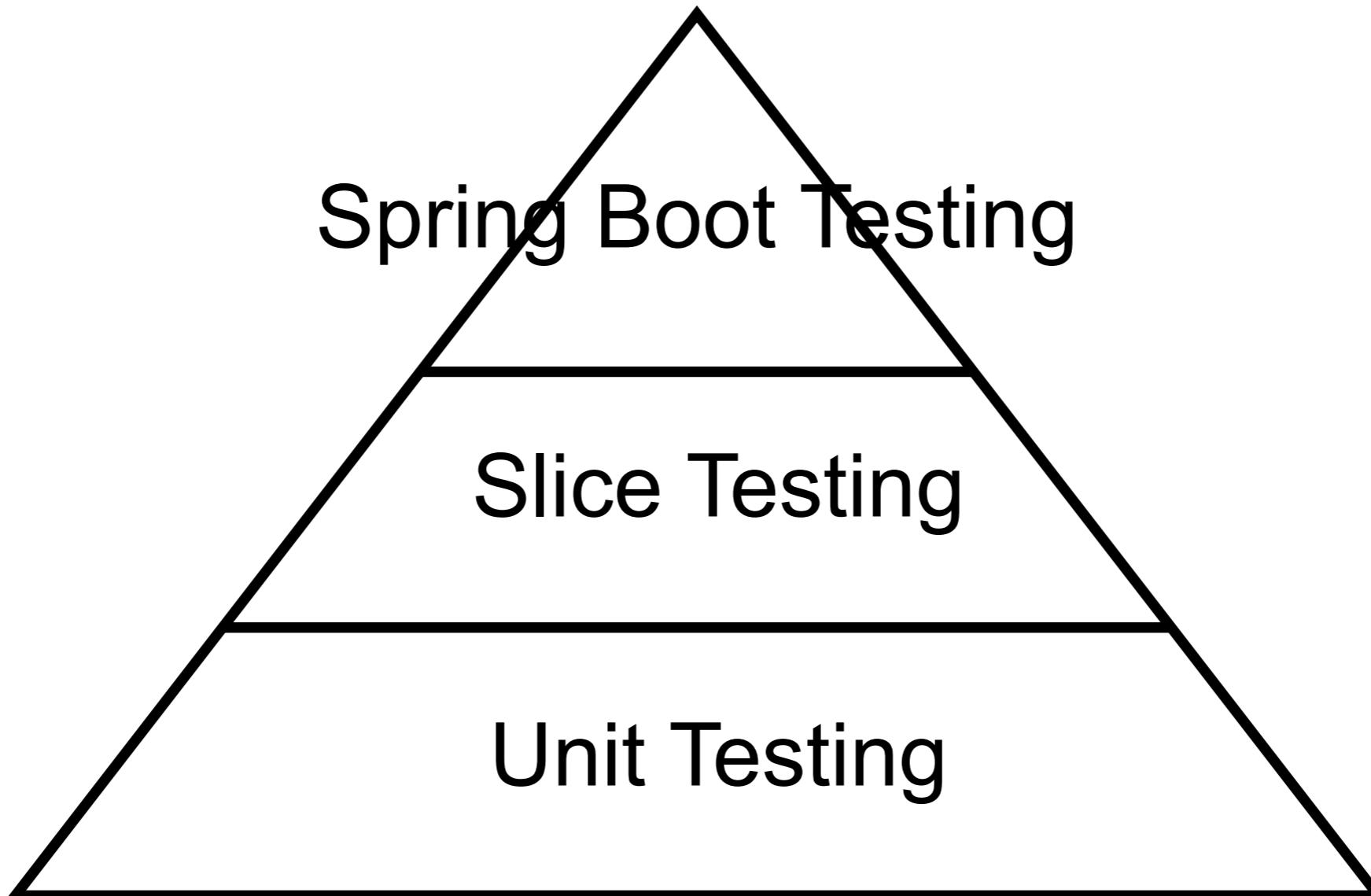
@DataJpaTest

@RestClientTest

Slice testing



Testing in Spring Boot



Controller testing

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



1. SpringBootTest

Application context

Controller Advice

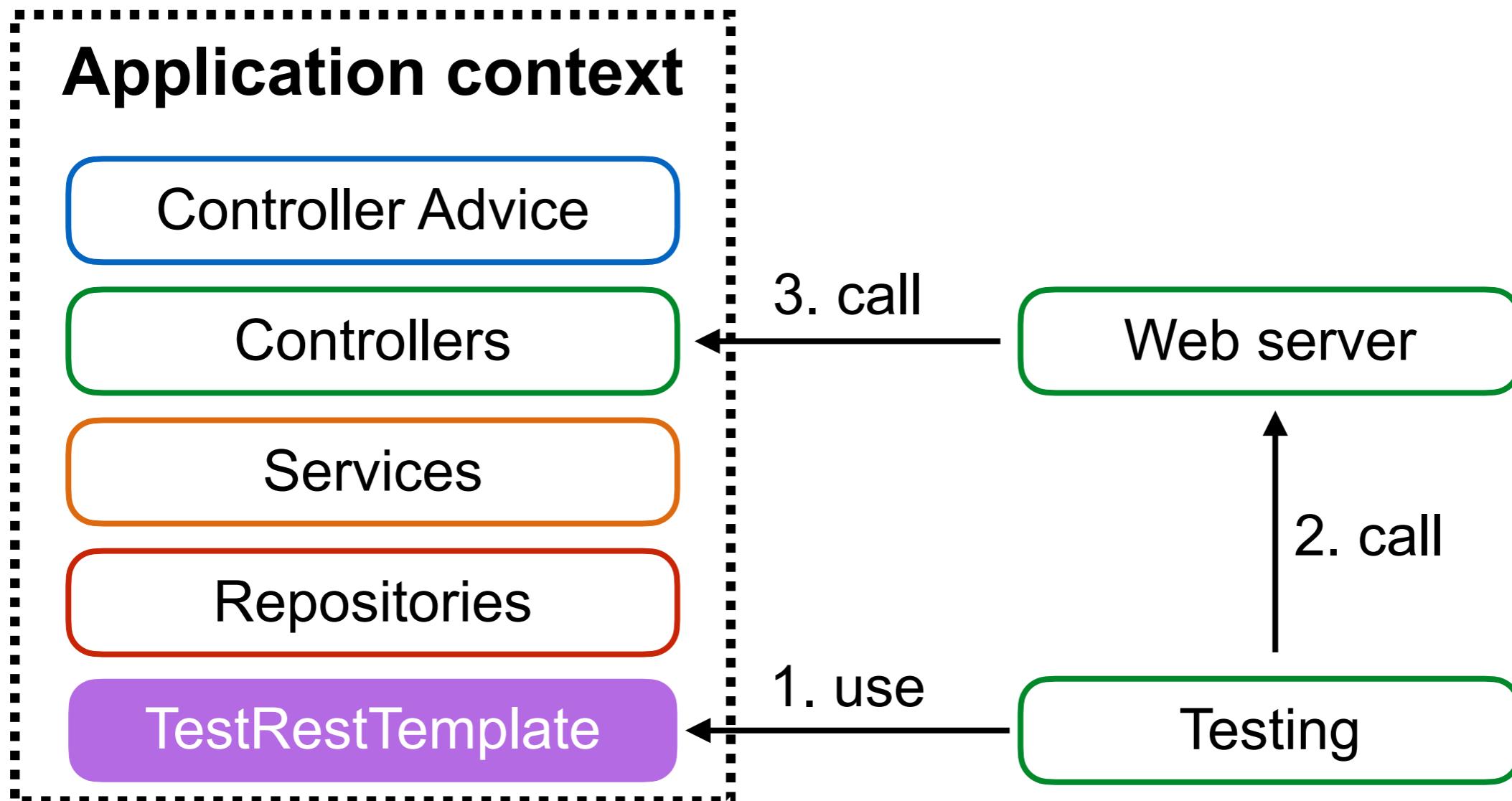
Controllers

Services

Repositories



1. SpringBootTest



SpringBootTest #1

```
@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

```
@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

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

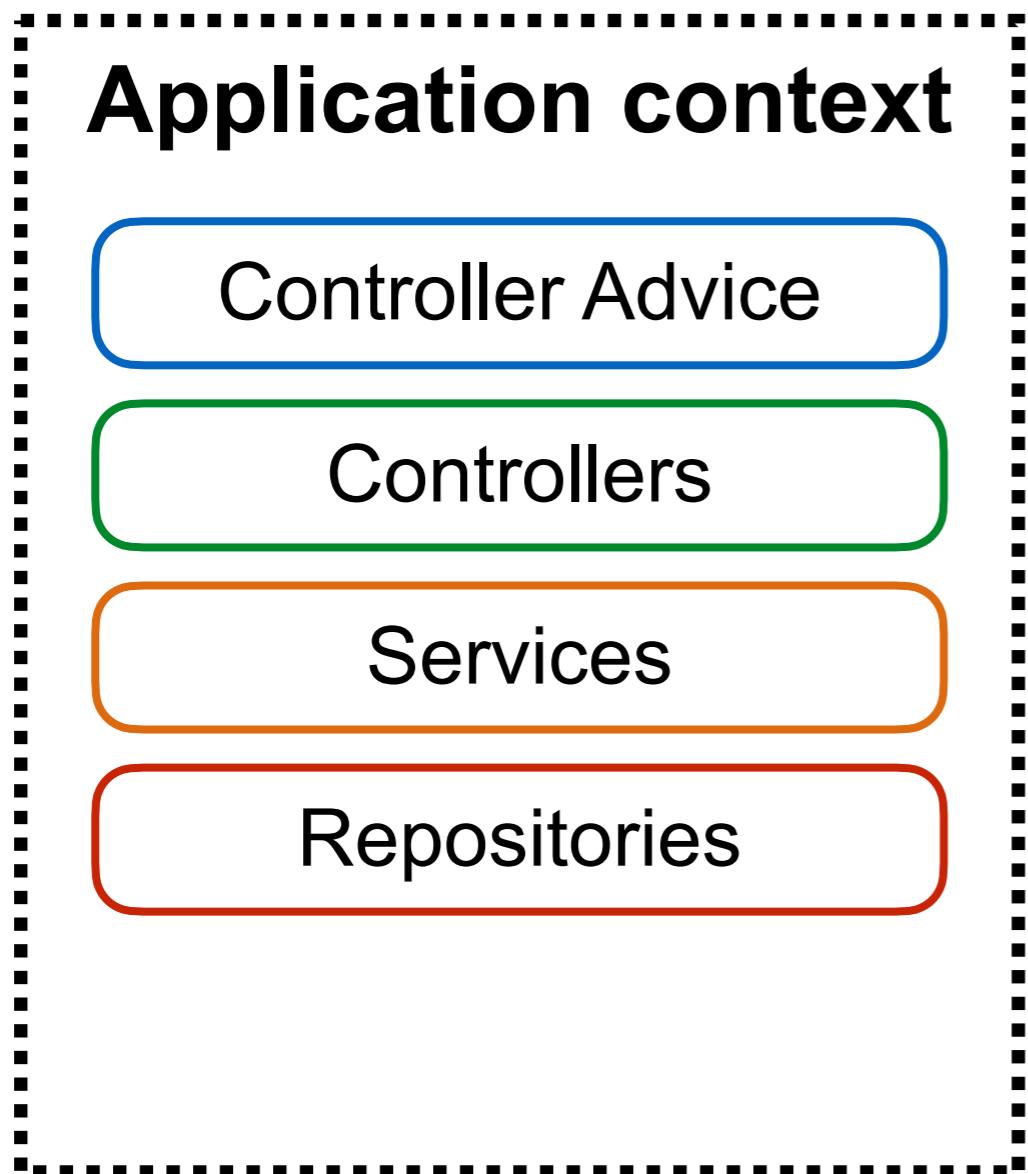
    @Autowired
    private TestRestTemplate testRestTemplate;

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

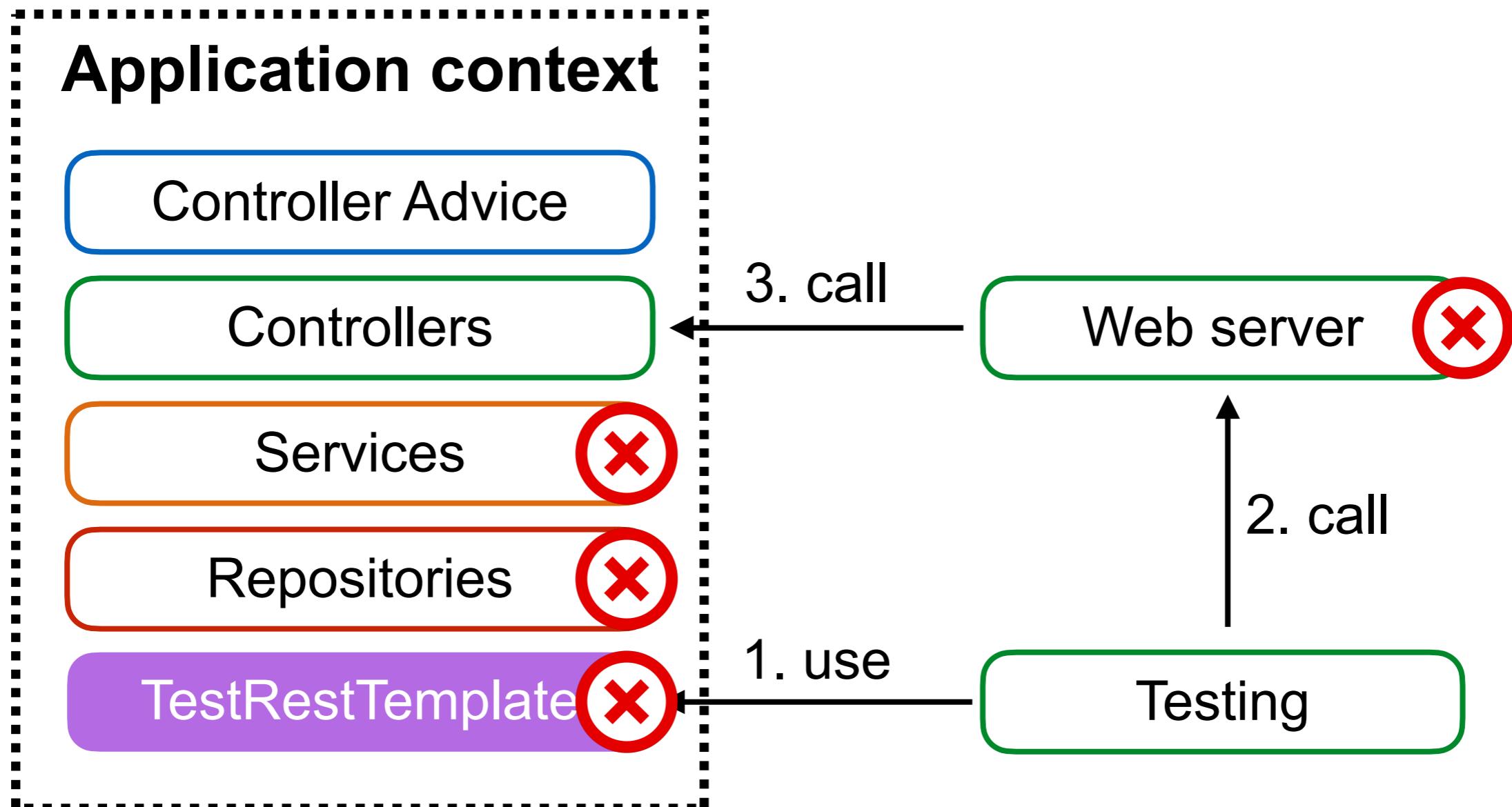
        // Assertion :: Check result with expected result
        assertEquals("Hello, somkiat", actualResult.getMessage());
    }
}
```



2. Slice Testing with MockMVC



2. Slice Testing with MockMVC



MockMvcTest #1

```
@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

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

    @MockBean
    private MyRandom stubRandom;

    @Autowired
    private MockMvc mvc;

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

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



MockMvcTest #3

Use ObjectMapper to convert JSON to object

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

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



3. Unit testing with Controller



Unit test

Use Test Double

In java, use Mockito library



<http://site.mockito.org/>



Unit testing with Mockito #1

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

    @Mock
    private MyRandom stubRandom;

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

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



Unit testing with Mockito #2

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

    @Mock
    private MyRandom stubRandom;

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

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



Unit testing with Mockito #3

```
@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



ExceptionResponse

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

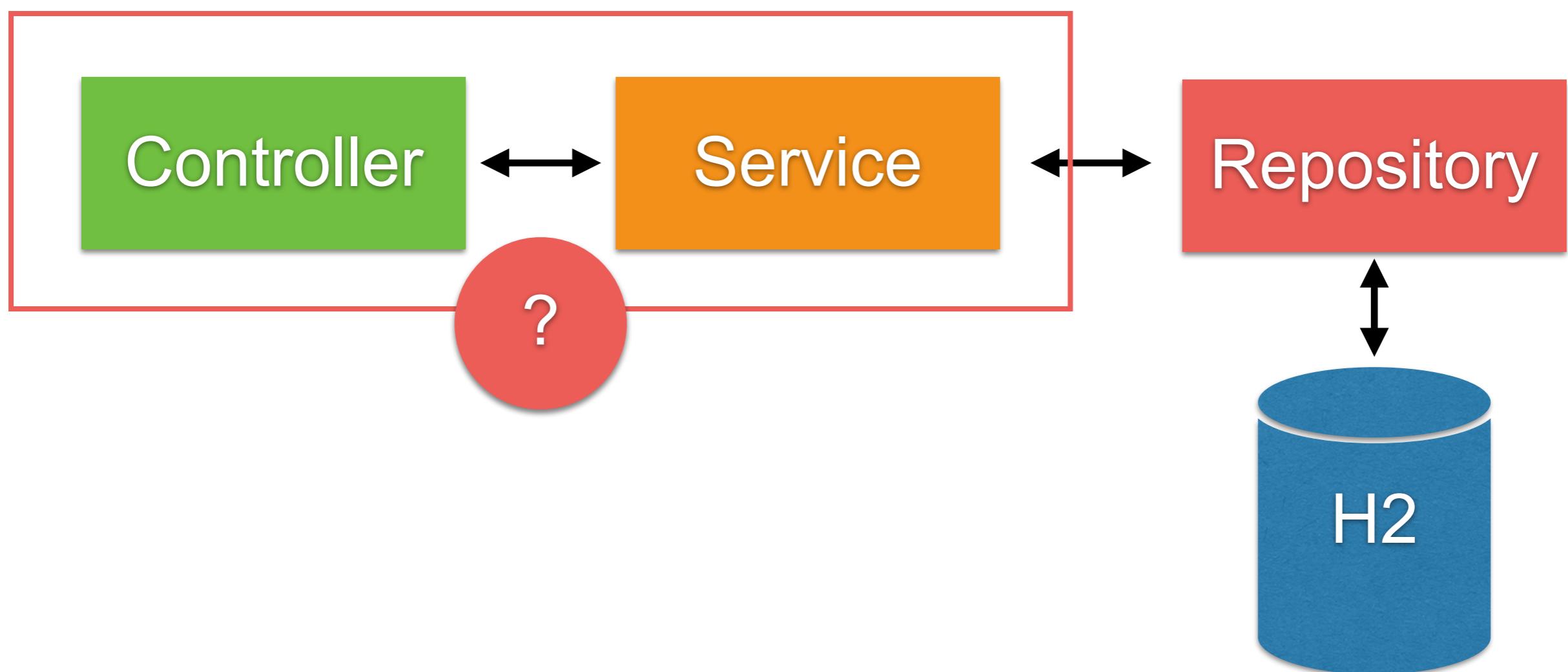
```
← → ⌂ ⓘ localhost:8888/account/2 🔍 ☆
{
  timestamp: "2018-09-15T15:25:44.776+0000",
  message: "Account id=[ 2 ] not found",
  detail: "More detail"
}
```



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

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

    @Mock
    private UserRepository userRepository;

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

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



Compile with testing

\$mvnw clean test

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



Code coverage



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

Paul Reilly, 2018, Kotlin TDD with Code Coverage



Code coverage

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



Code coverage

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



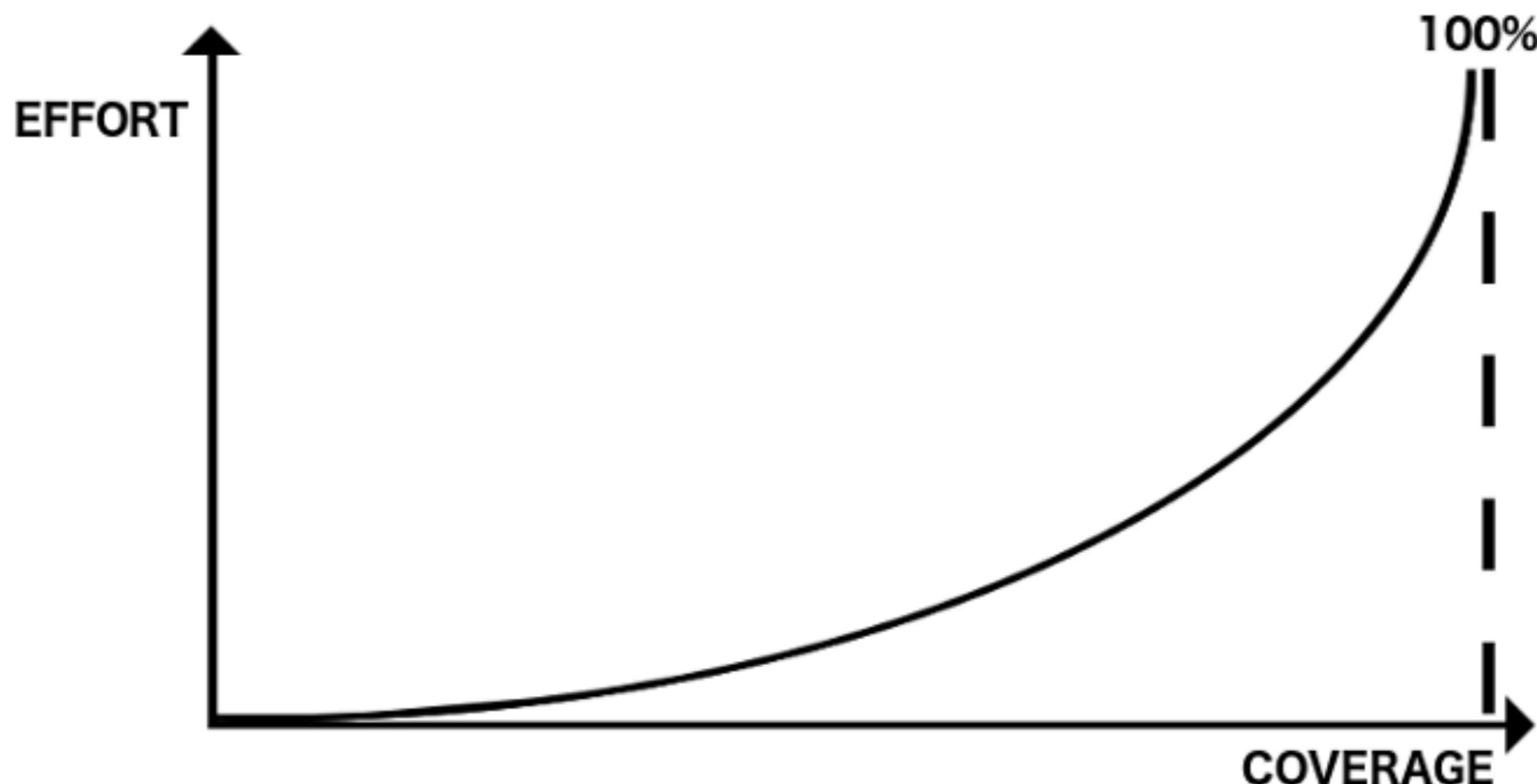
Code coverage

Powerful tool to improve the quality of your code

Code coverage != quality of tests



Code coverage 100% ?



% of Code/Test coverage



Code coverage with Java

Cobertura
Jacoco

<http://bit.ly/2DIlsDeX>



Run test again

\$mvnw clean package

Cobertura Report generation was successful.

Cobertura 2.1.1 - GNU GPL License (NO WARRANTY) - See COPYRIGHT file

Cobertura: Loaded information on 3 classes.

time: 125ms

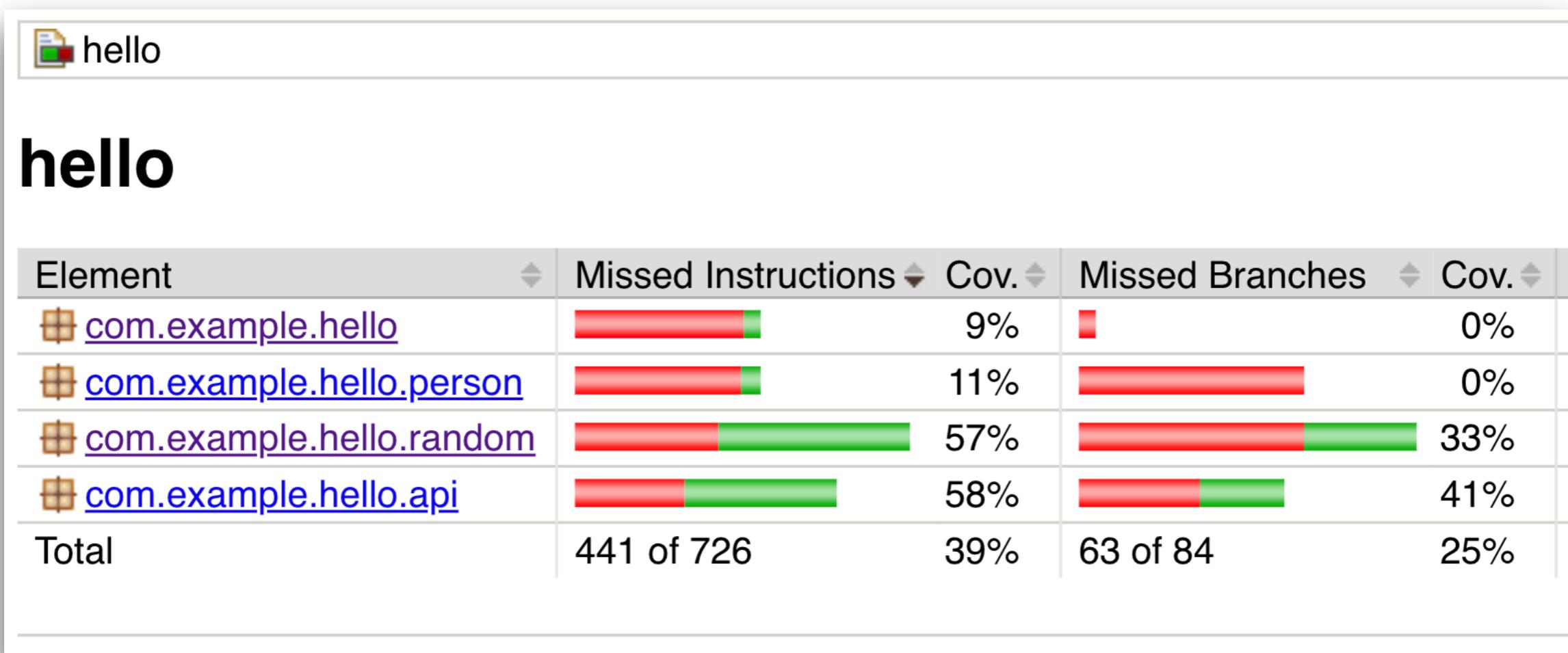
Cobertura Report generation was successful.

BUILD SUCCESS



Coverage report

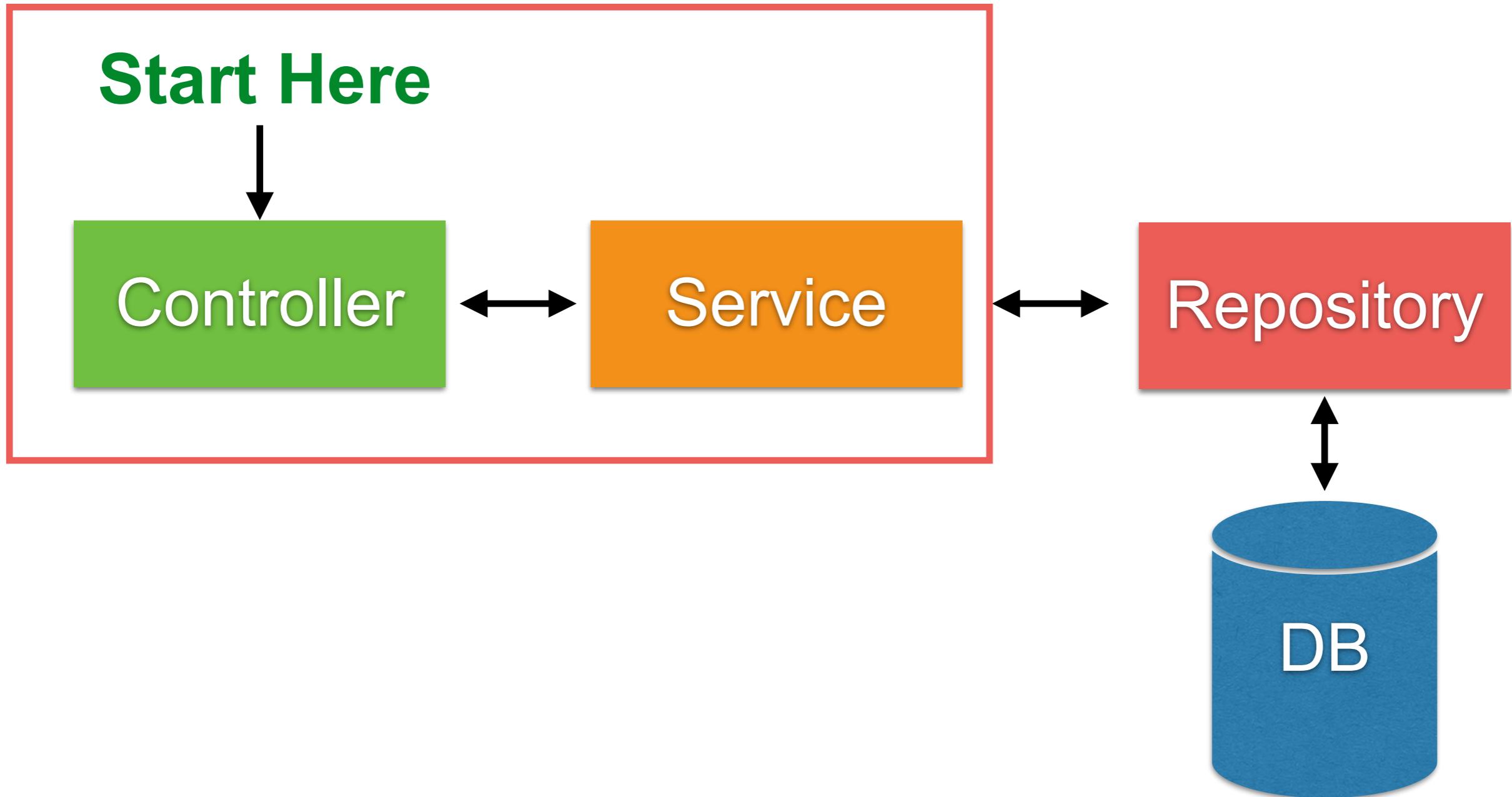
open target/site/jacoco/index.html



Move business logic to service

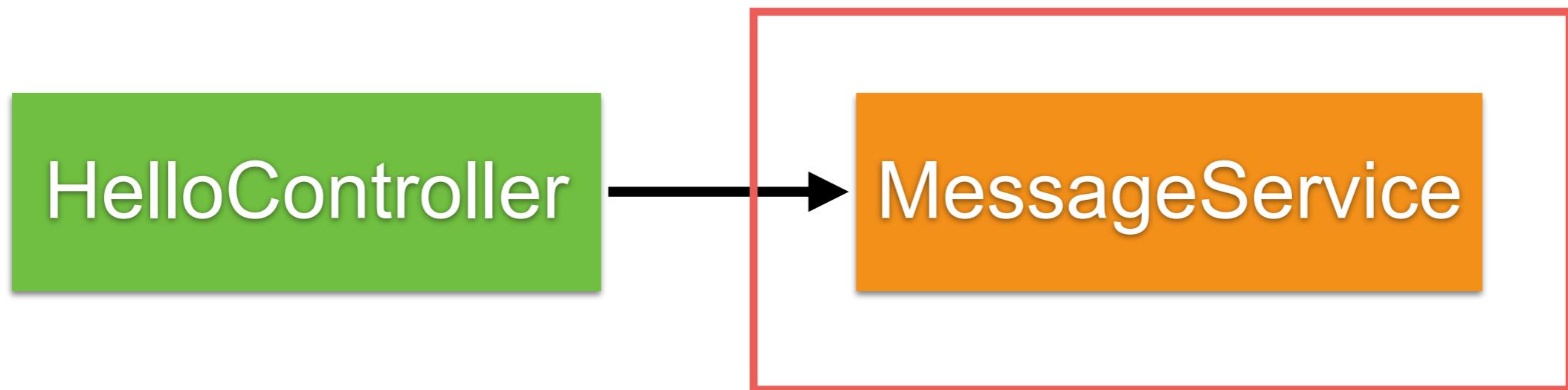


Working with service



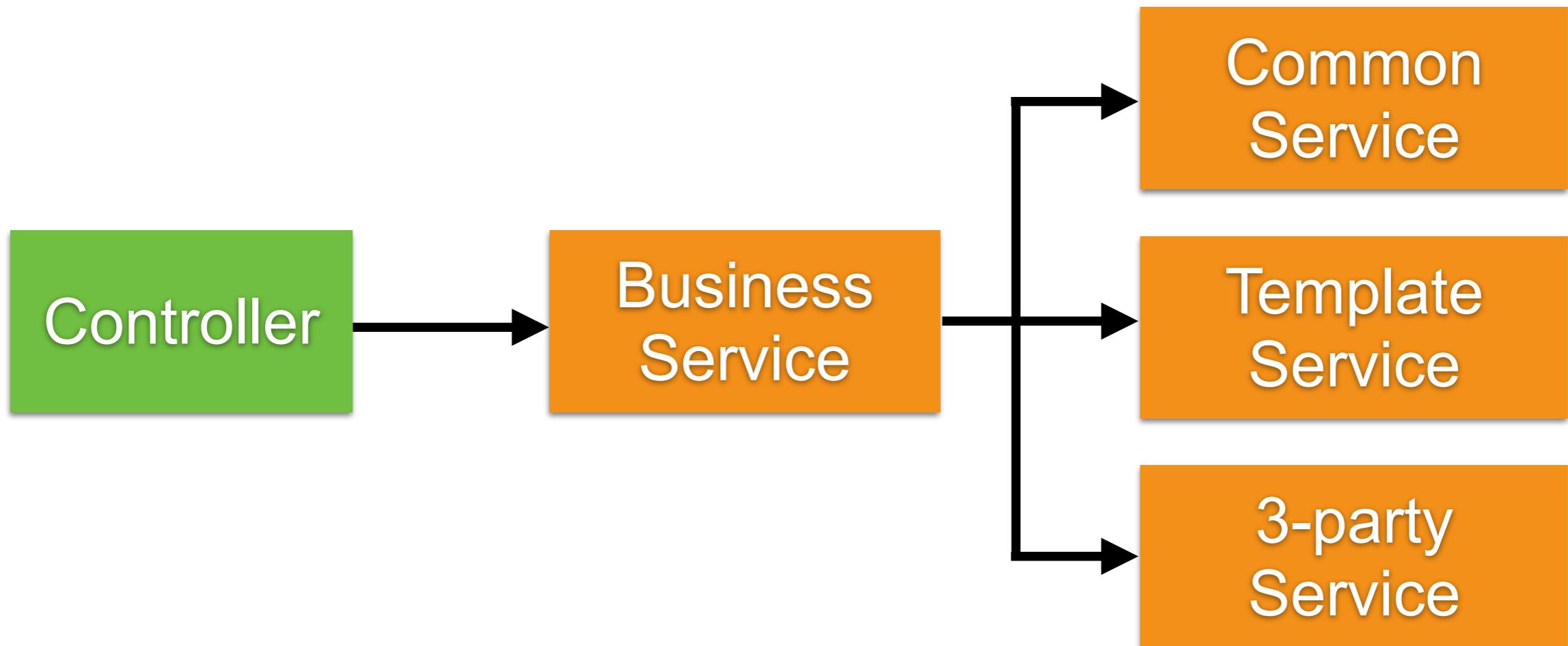
Move business logic to service

Service class or interface ?

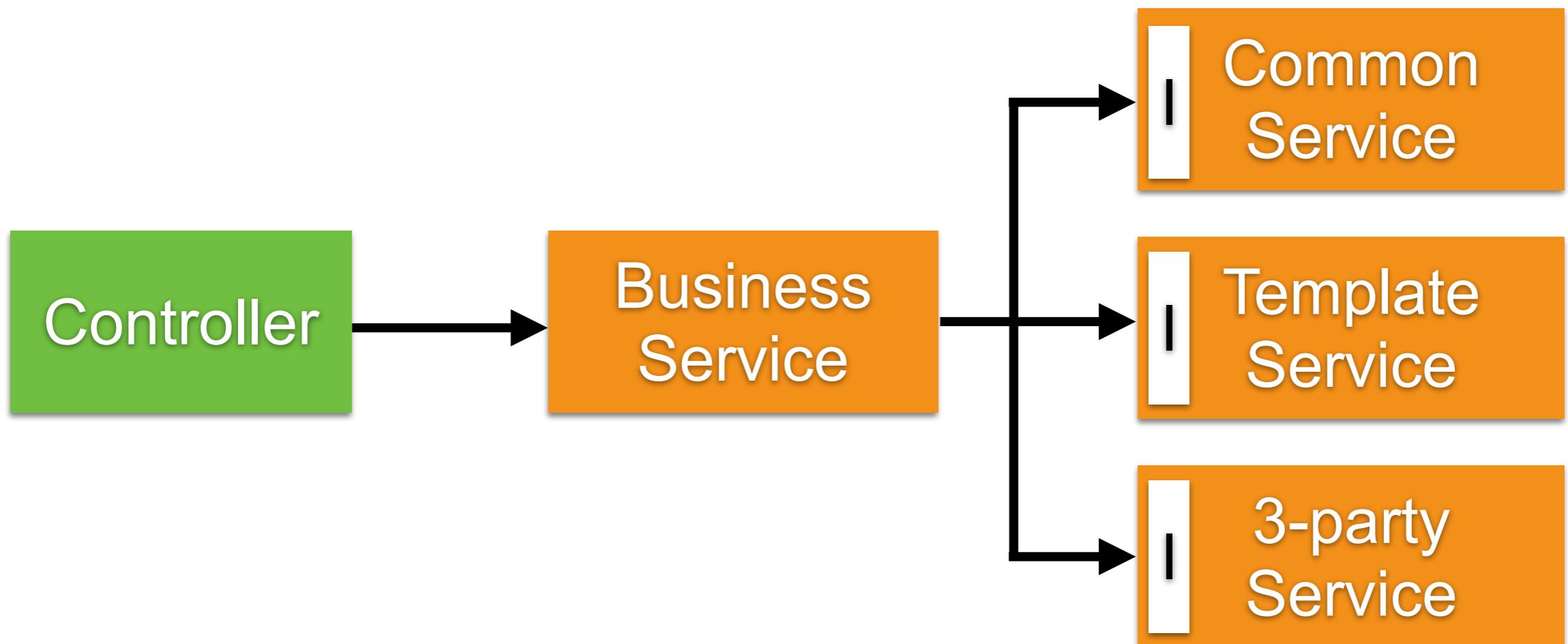


Types of service

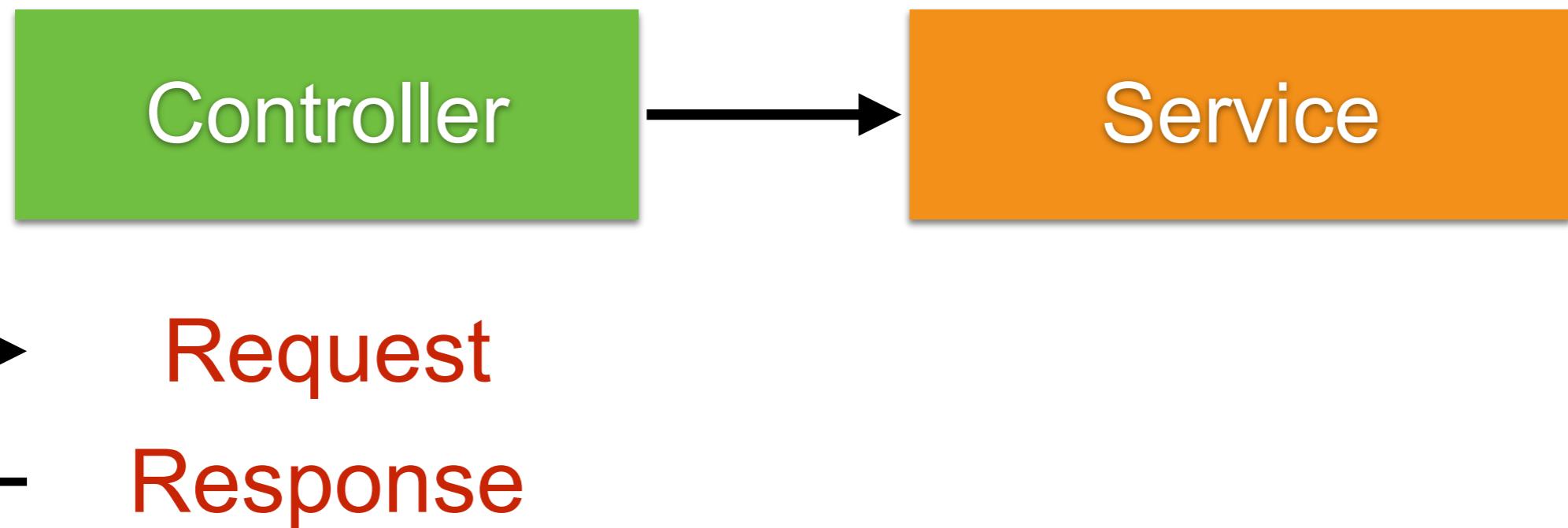
Business services (not reuse)
Common/Template/3-party services



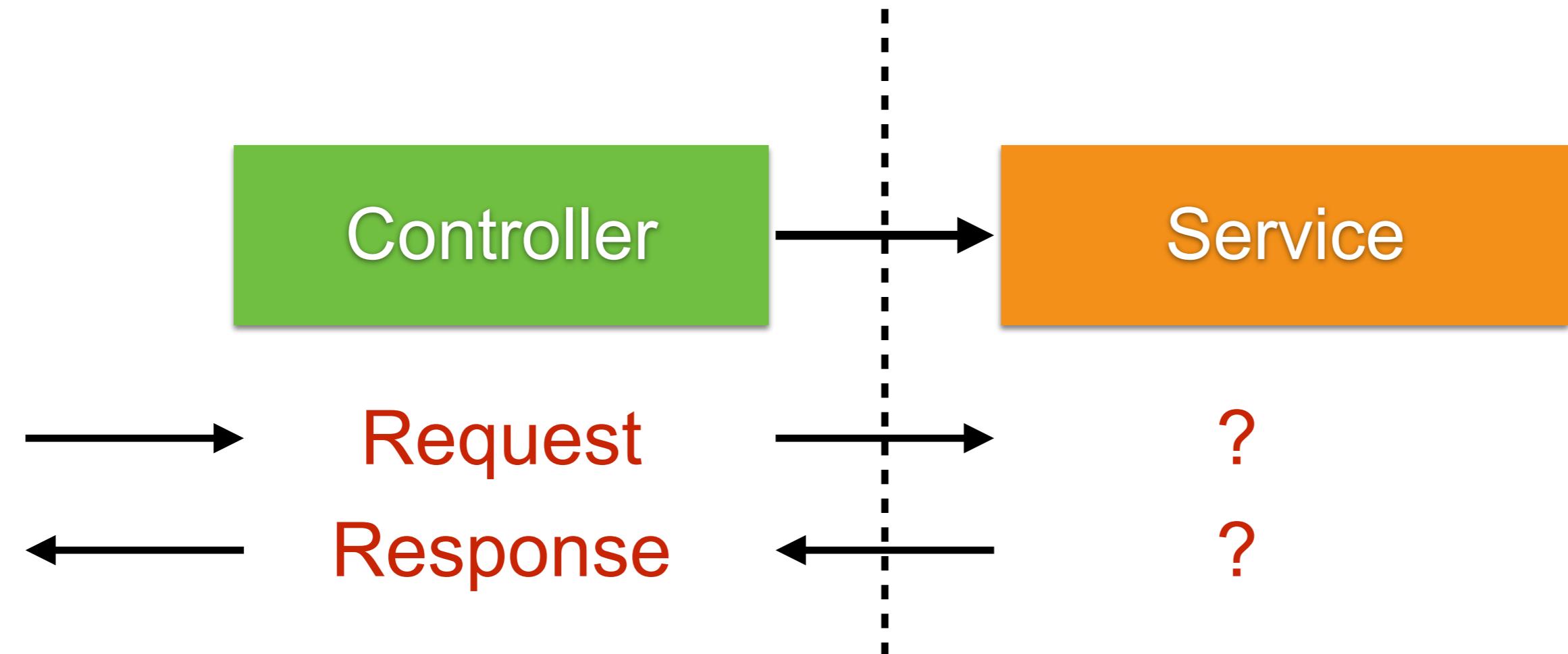
Interface for common service



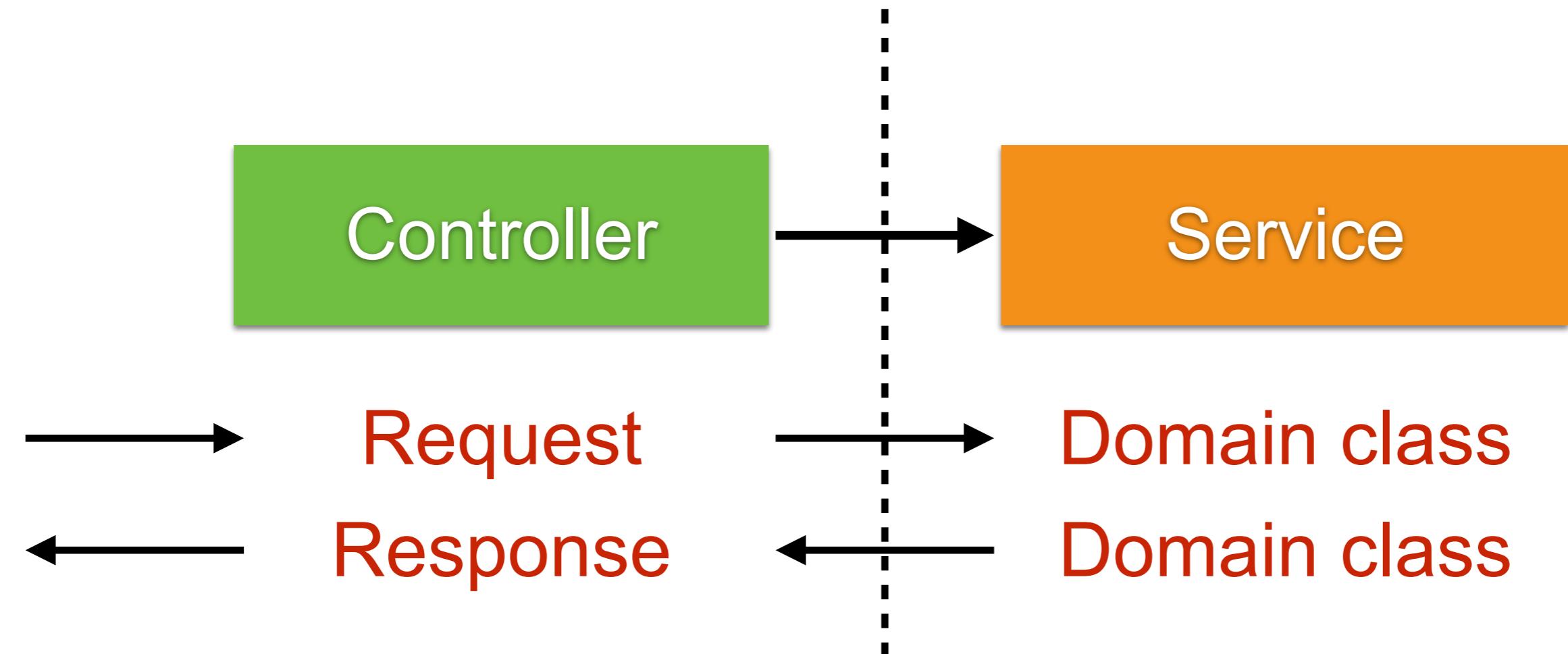
Data Model for service ?



Data Model ?

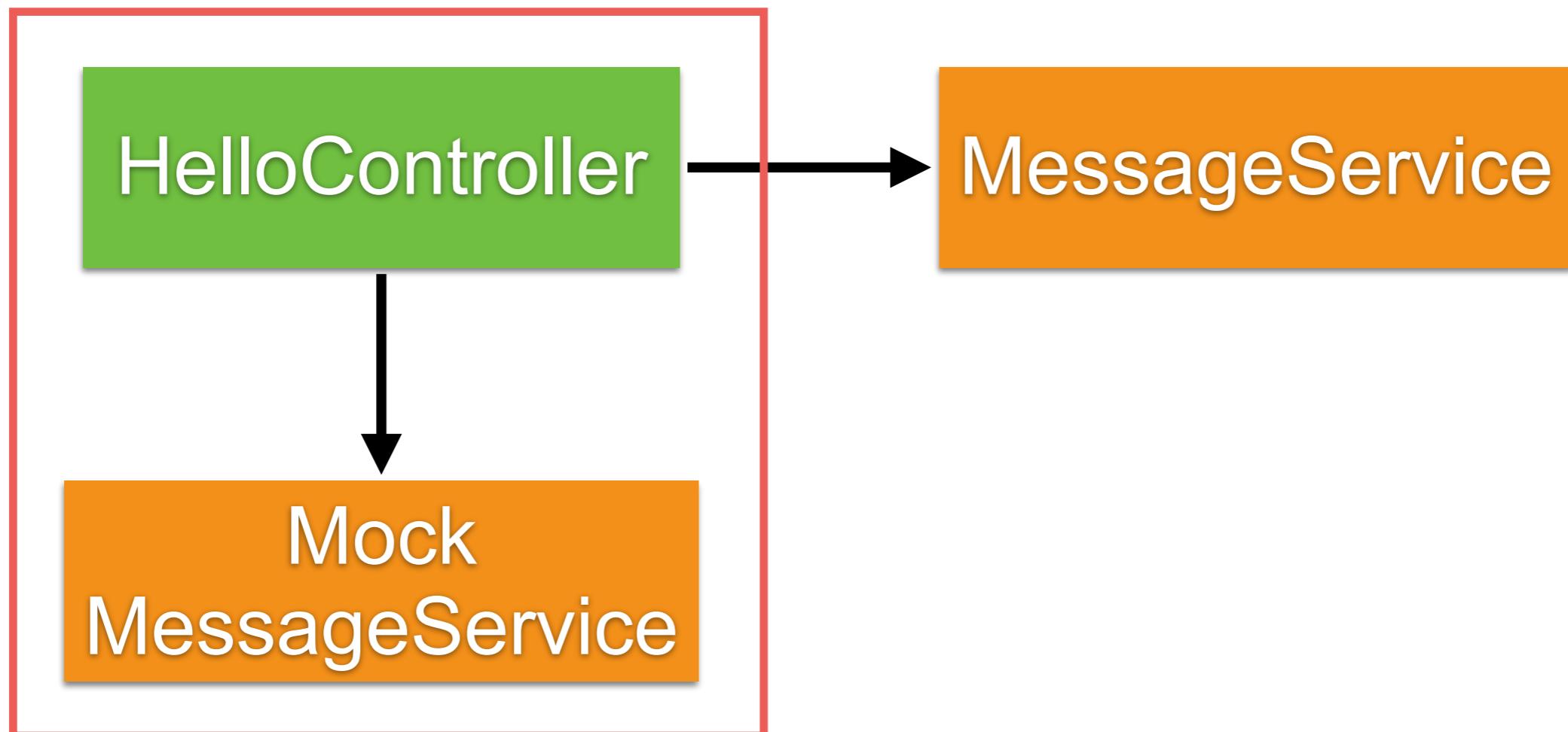


Data Model ?



Testing controller with service

Try to mocking service with Mockito



Run all tests !!

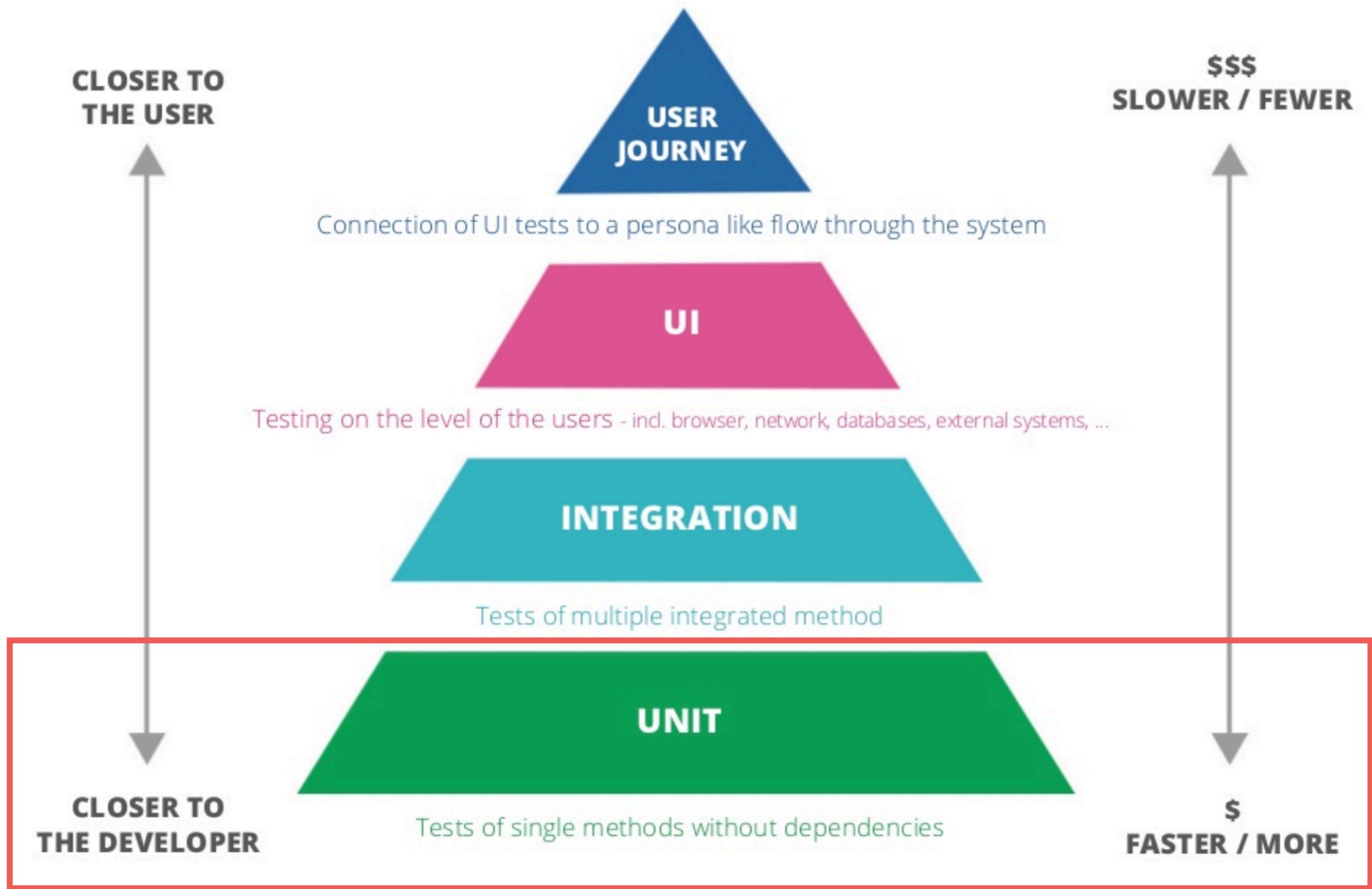
\$mvnw clean test

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

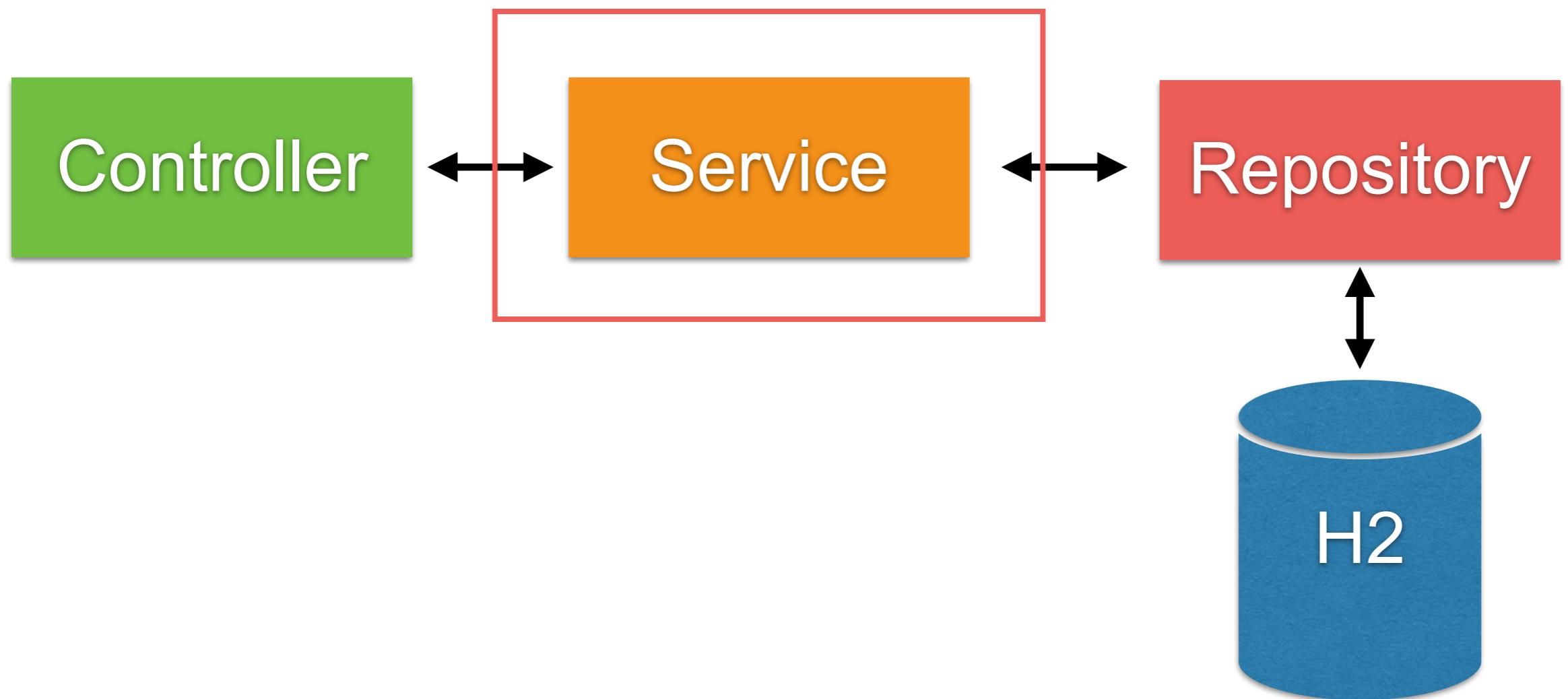


How to improve the speed of testing ?





Service Testing ?



Service Testing

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

    @Mock
    private AccountRepository accountRepository;

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

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

1



Service Testing

```
@ExtendWith(MockitoExtension.class)
```

```
public class UserServiceTest {
```

```
@Mock
```

```
private AccountRepository accountRepository;
```

```
@Test
```

```
public void getAccount() {
```

```
// Stub
```

```
Account account = new Account();
```

```
account.setUserName("user");
```

```
account.setPassword("pass");
```

```
account.setSalary(1000);
```

```
given(accountRepository.findById(1))
```

```
.willReturn(Optional.of(account));
```



2

```
UserService userService = new UserService(accountRepository);
```

```
Account actualAccount = userService.getAccount(1);
```

```
assertNotNull(actualAccount);
```

```
}
```

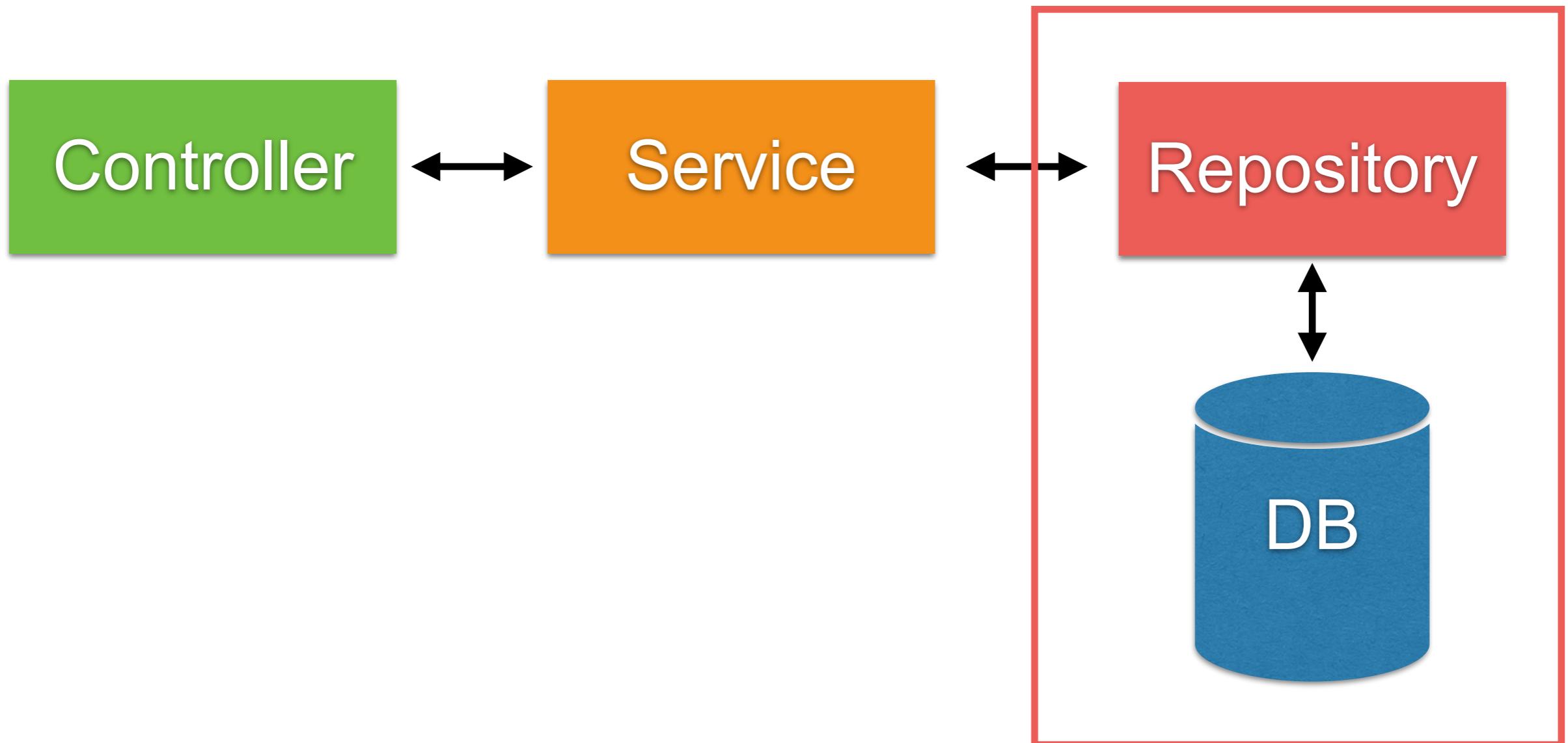
```
}
```



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()) {  
}
```

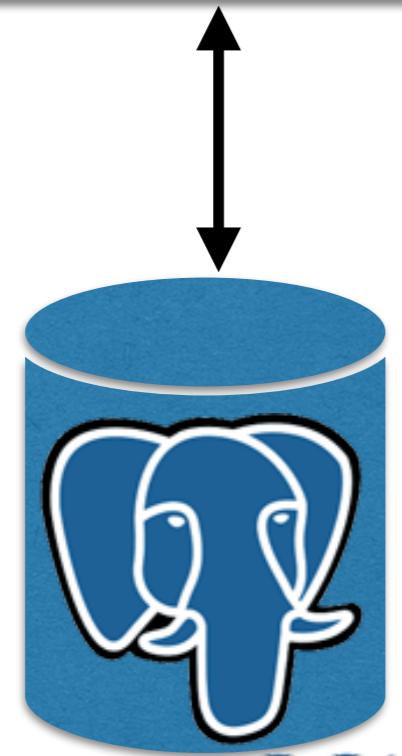
```
// 5. Release resource  
if(resultSet != null) {  
    resultSet.close();  
    resultSet = null;  
}
```

Manage by Framework



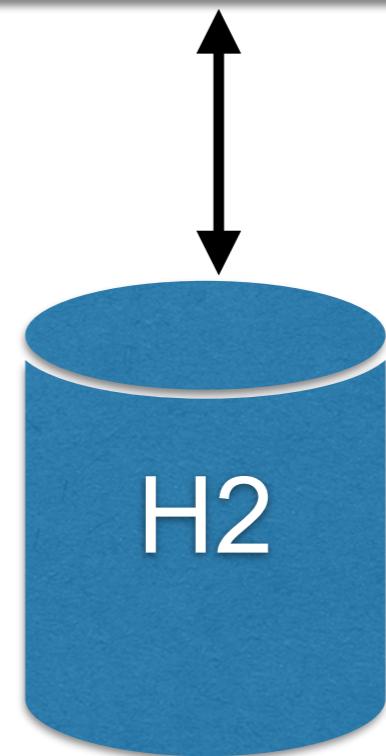
Working with Database ?

Production



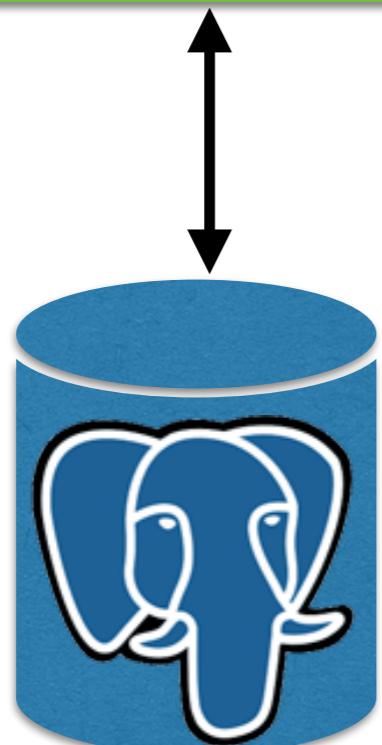
PostgreSQL

Testing



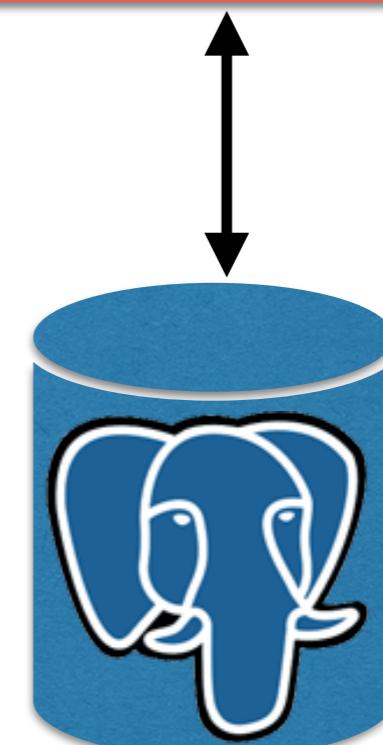
Working with Database ?

Production



PostgreSQL

Testing

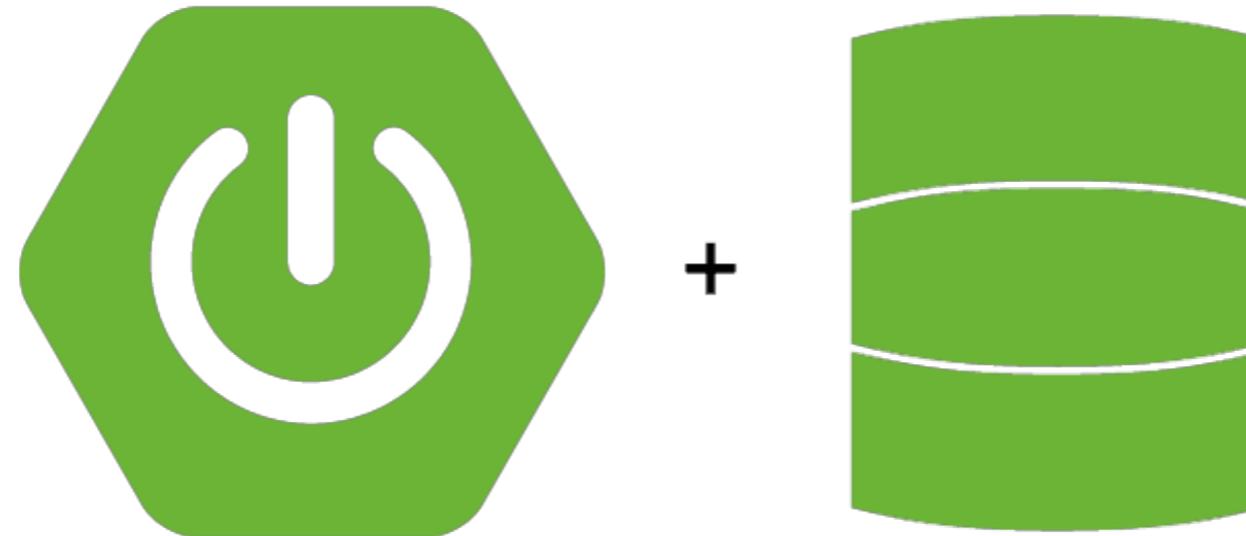


PostgreSQL



Working with repository

We're using Spring Data



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



Spring Data

JDBC

JPA

MongoDB

Redis

more ...

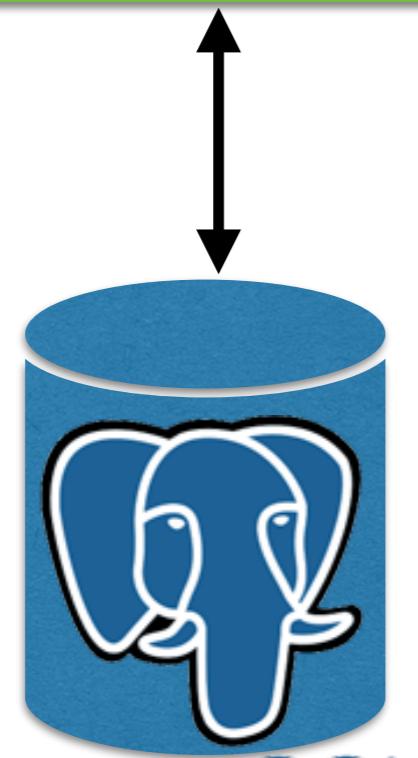


Working with Spring Data JPA



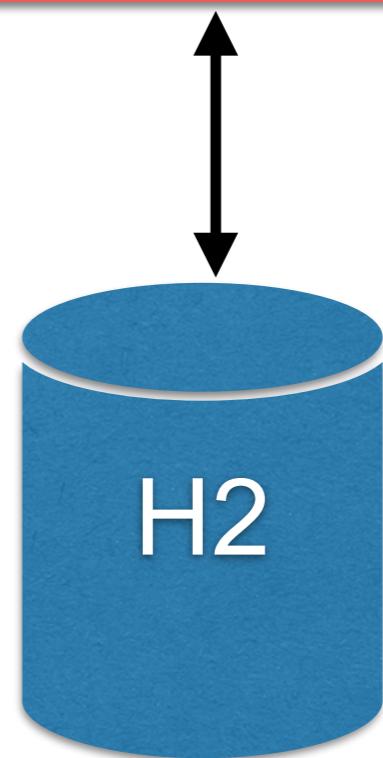
Working with Database

Production



Postgre**SQ**L

Testing



Modify pom.xml

Add library of Spring Data JPA, PostgreSQL, H2

The screenshot shows a web-based dependency selector tool. On the left, a sidebar labeled "Dependencies" contains a search bar with placeholder text "Search dependencies to add" and a list of suggestions: "Web, Security, JPA, Actuator, Devtools...". To the right, a main area titled "Dependencies selected" lists three chosen dependencies, each in its own box:

- JPA [SQL]**: Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.
- PostgreSQL [SQL]**: PostgreSQL JDBC driver.
- H2 [SQL]**: H2 database (with embedded support).

<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>

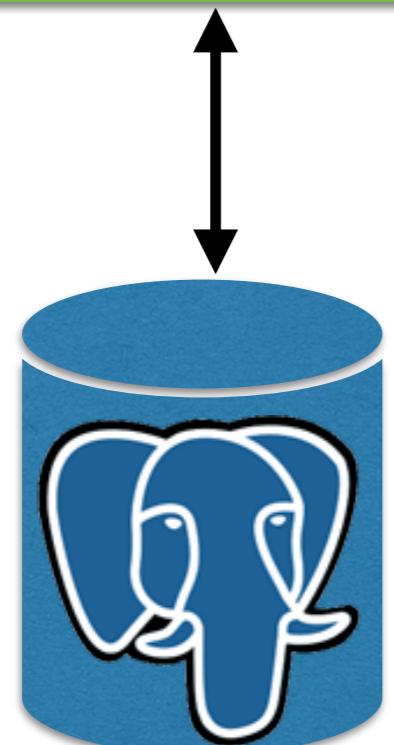
<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <scope>test</scope>
</dependency>

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



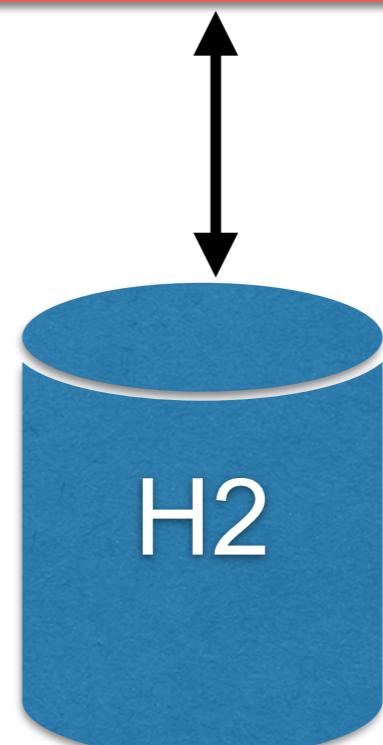
Start in testing scope

Production

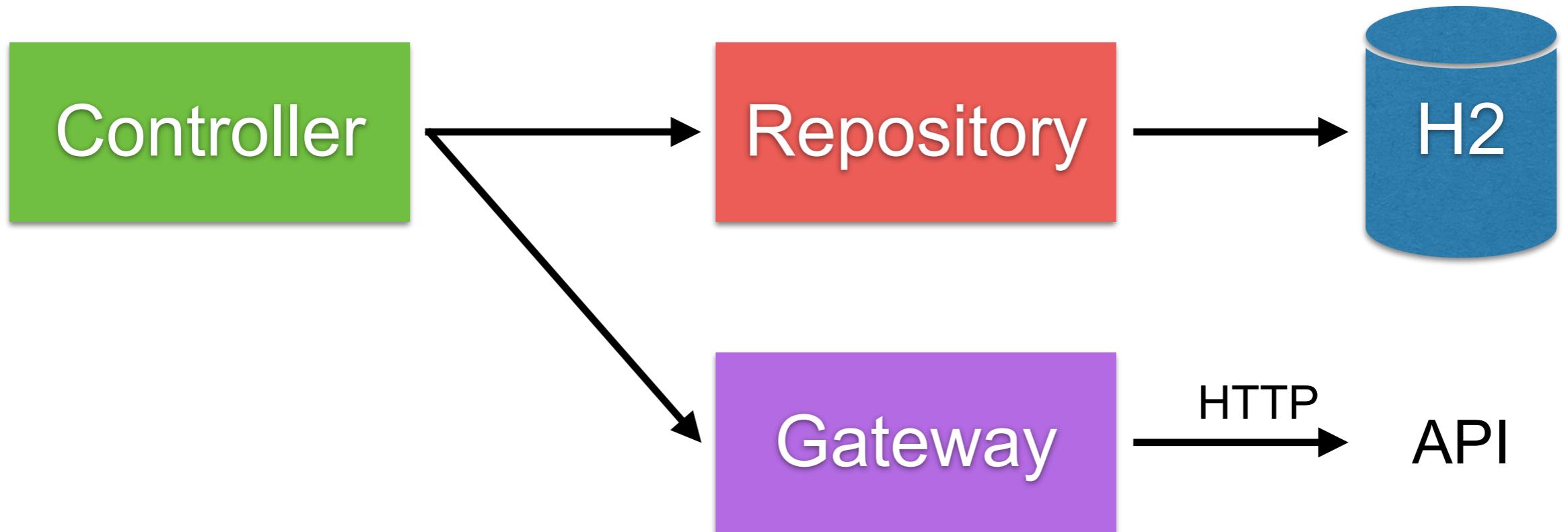


Postgre**SQ**L

Testing

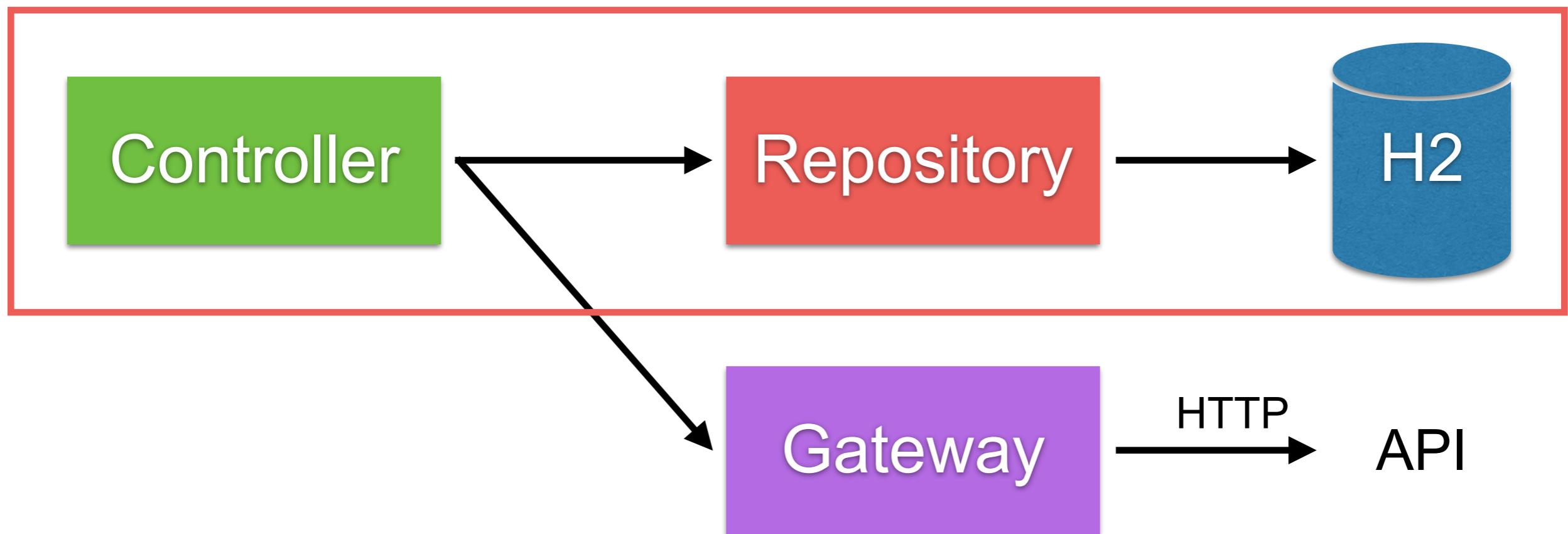


Use cases



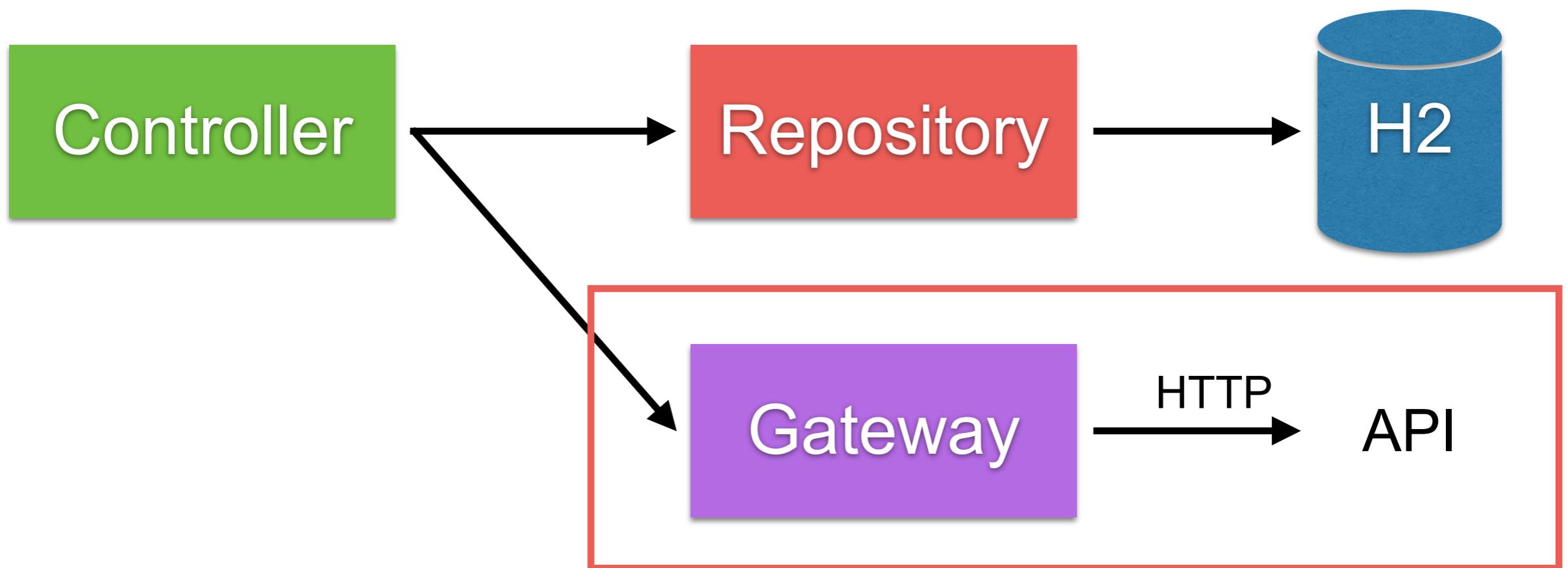
Use case 1

Working with repository



Use case 2

Working with API



Use case 1



Use case 1

Working with repository

3. HelloController



2. PersonRepository



Controller

Repository

H2



1. Person

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=?*

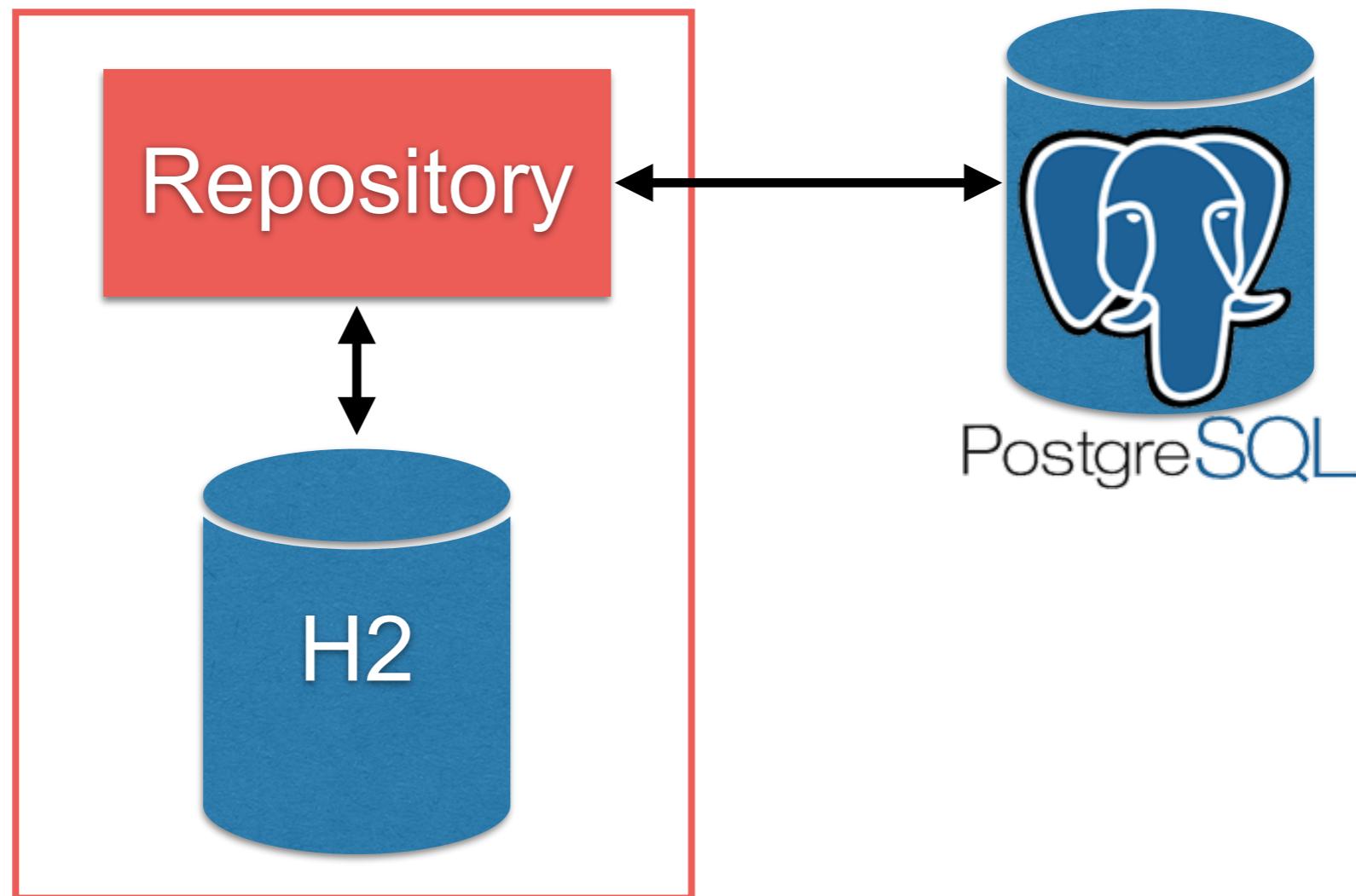


How to testing repository ?



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

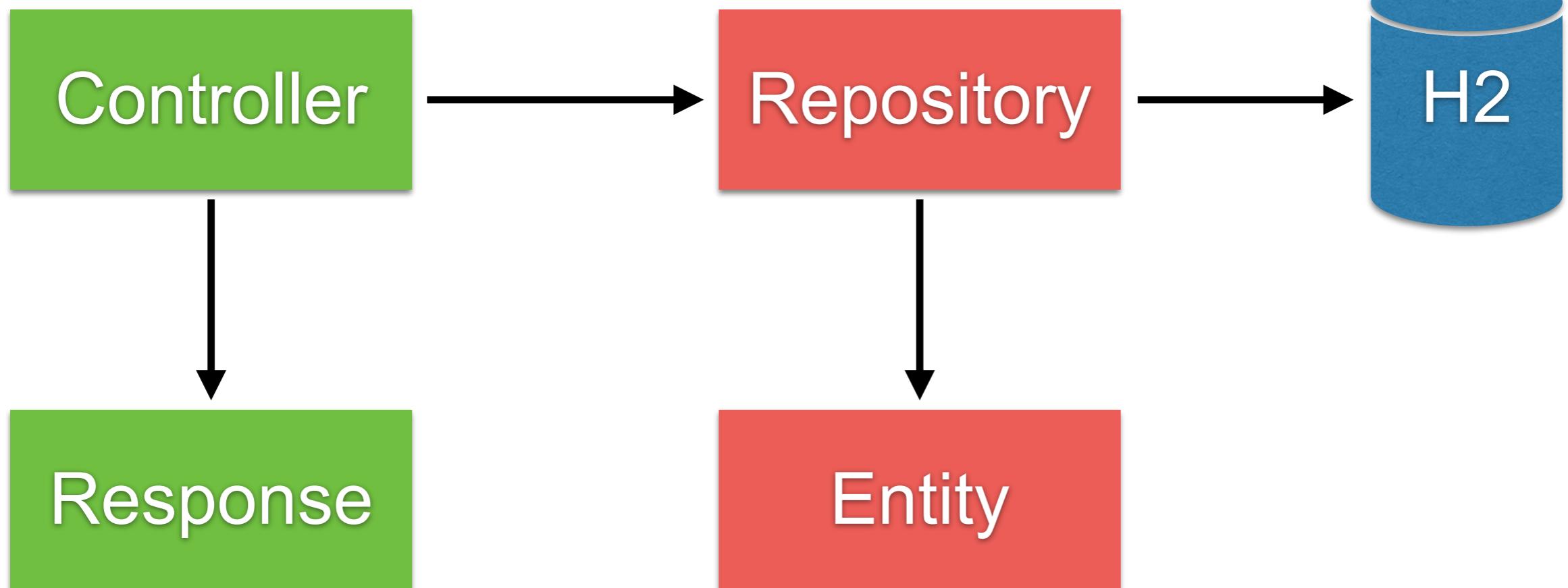
Hibernate: drop sequence if exists hibernate_sequence



Use case 1

Integrate repository with controller

3. HelloController 2. PersonRepository



1. Person

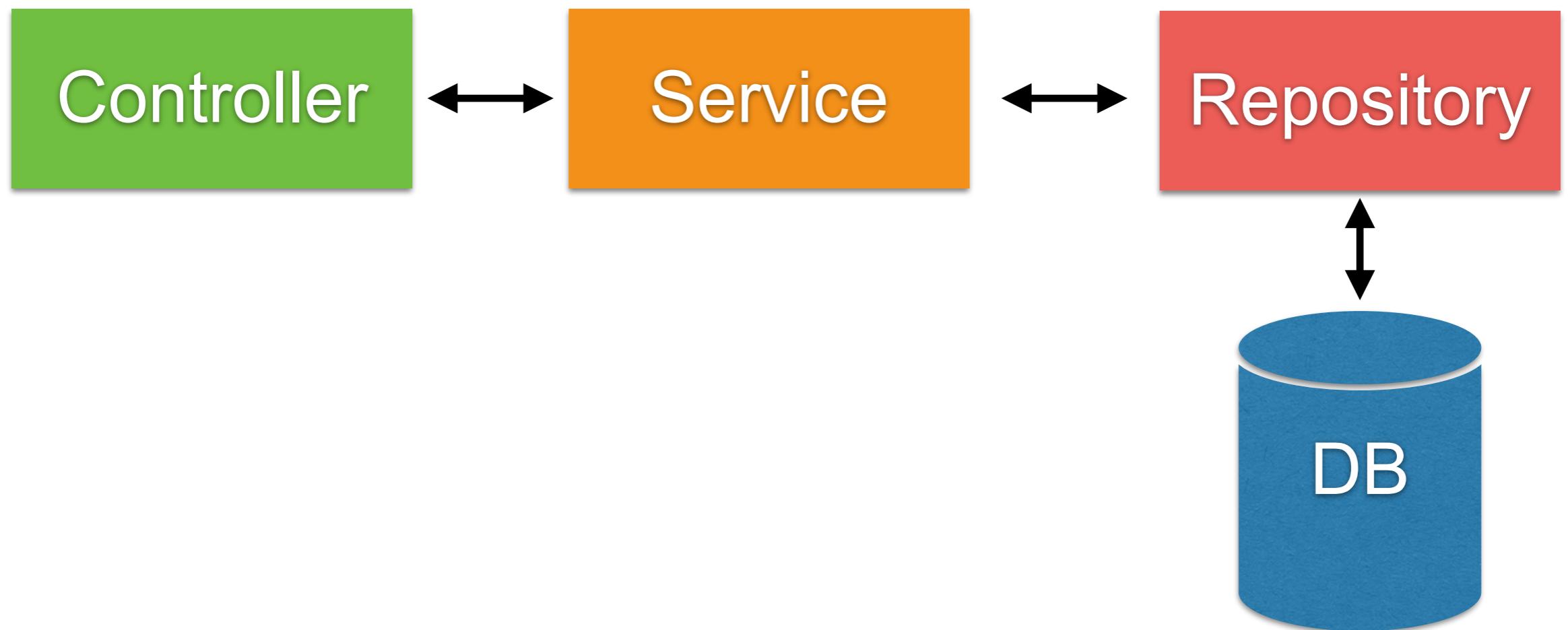
4. PersonResponse



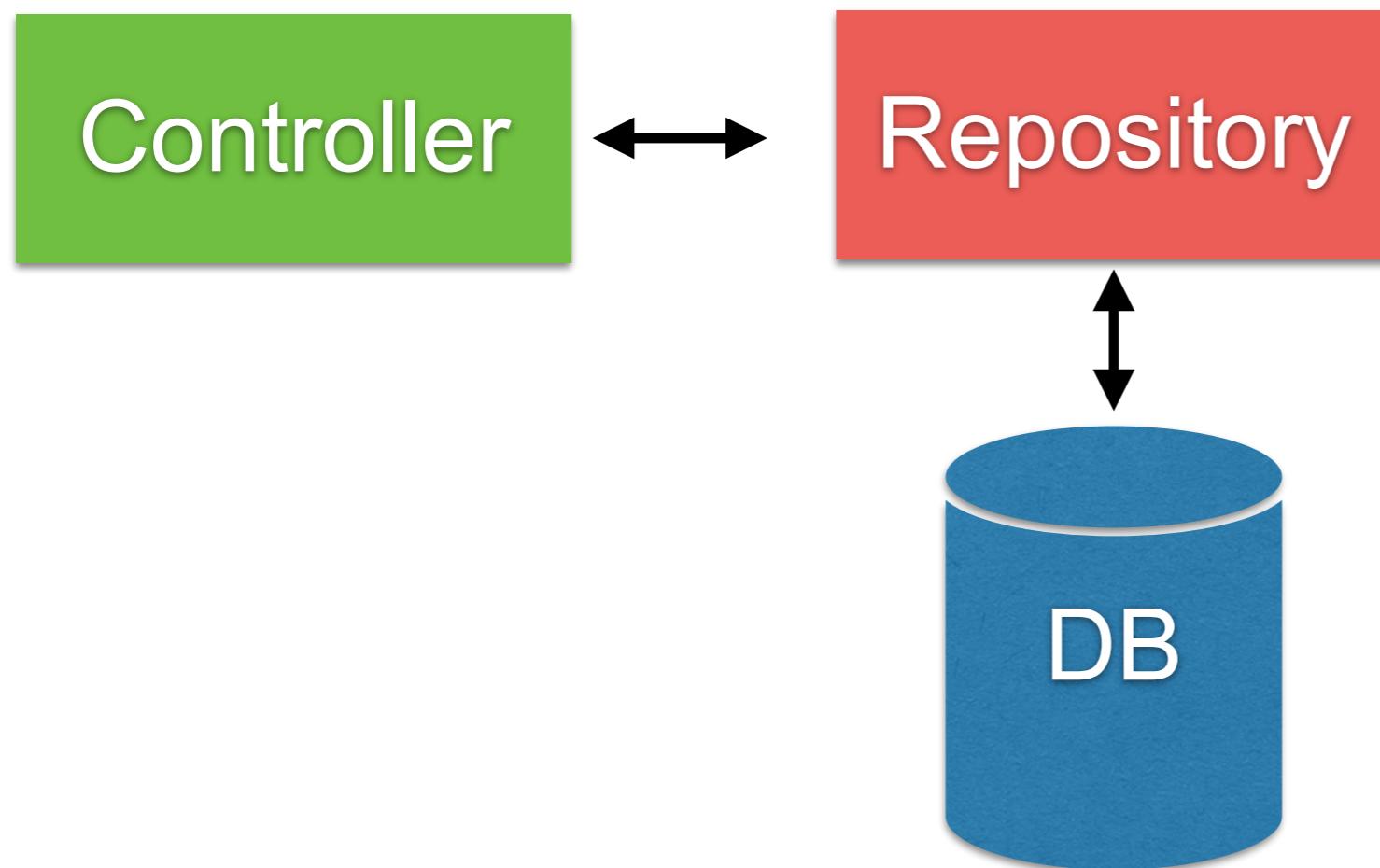
Integrate repository with service/controller



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

localhost:8088/hello/somkiat

Whitelabel Error Page

This application has no explicit mapping for /error, so you are seeing this as

Tue Mar 05 23:33:48 ICT 2019

There was an unexpected error (type=Internal Server Error, status=500).

No message available



Initial data in database



Initial database #1

Using @Bean and CommandLineRunner

```
@Bean  
public CommandLineRunner initData(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/somki...  
.datasource.init.ScriptUtils      : Executing SQL script from URL [file:/Users/somki...  
.datasource.init.ScriptUtils      : Executed SQL script from URL [file:/Users/somki...
```



Run spring boot

\$mvnw spring-boot:run



Write controller testing ?

\$mvnw clean test

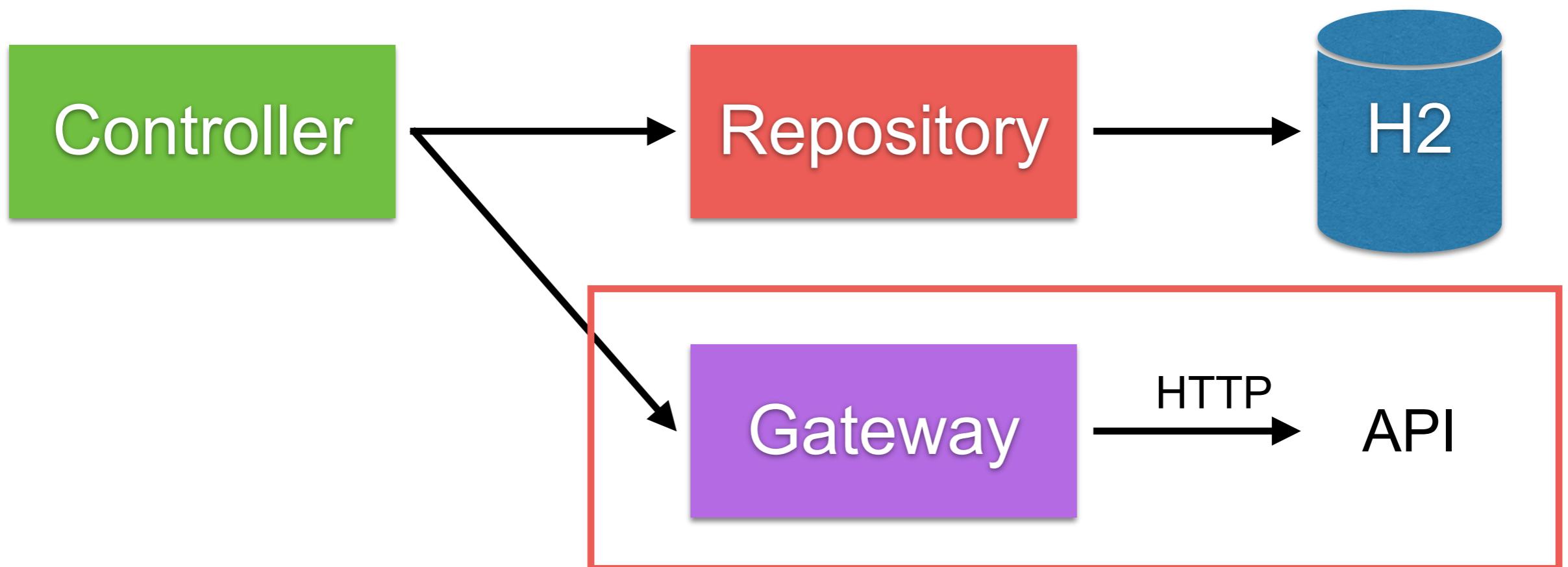


Use case 2



Use case 2

Working with API



JSON Place Holder

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

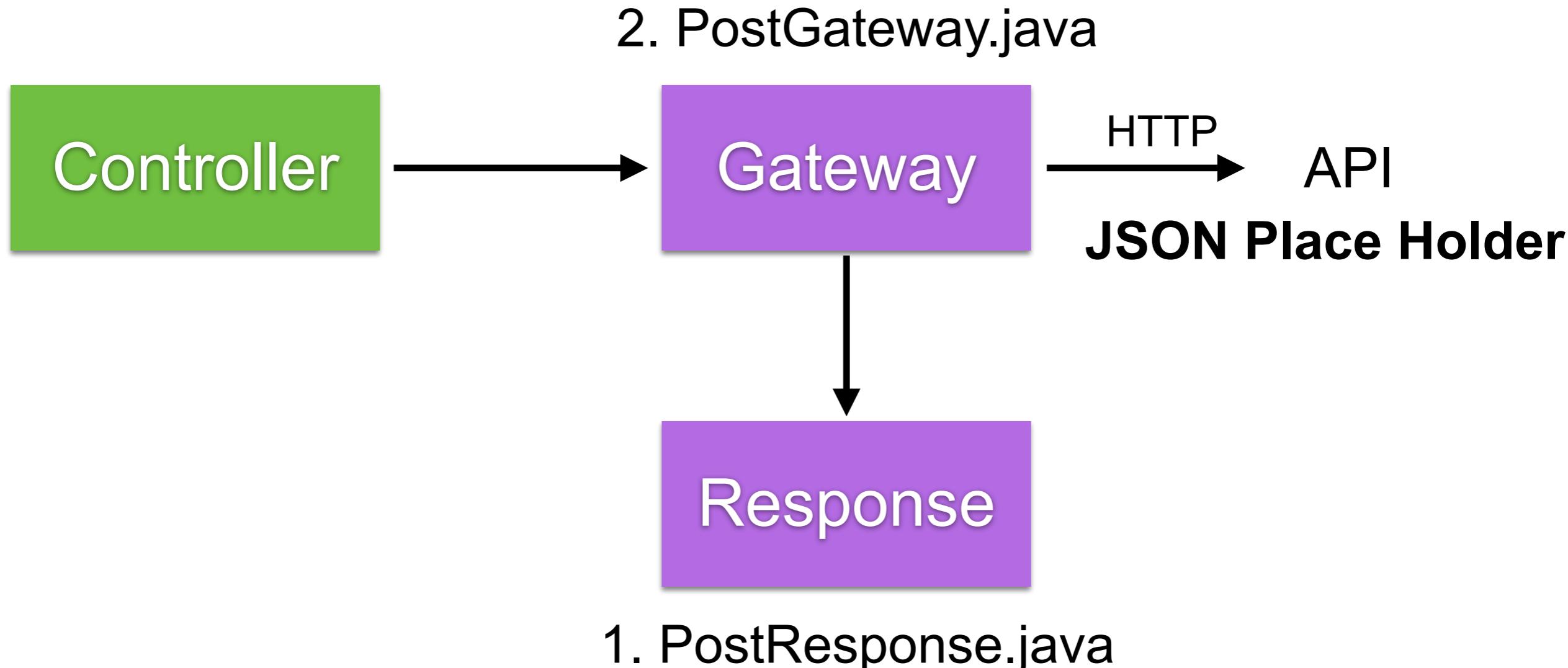
The screenshot shows the homepage of the JSONPlaceholder API. The title "JSONPlaceholder" is prominently displayed at the top. Below it, a subtitle reads "Fake Online REST API for Testing and Prototyping" and "Powered by [JSON Server + LowDB](#)". A code snippet in a light gray box demonstrates a fetch request:

```
fetch('https://jsonplaceholder.cypress.io/todos/1')
  .then(response => response.json())
  .then(json => console.log(json))
```

A blue "Try it" button is located at the bottom of the code box.



Working with API



1. Create Response class

In package post

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



2. Create PostGateway class #1

In package post

```
@Component
public class PostGateway {

    private final RestTemplate restTemplate;
    private final String postApiUrl;

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



2. Create PostGateway class #1

In package post

```
@Component
public class PostGateway {

    private final RestTemplate restTemplate;
    private final String postApiUrl;

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

Configuration ?



Configuration

Configuration in file application.properties

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



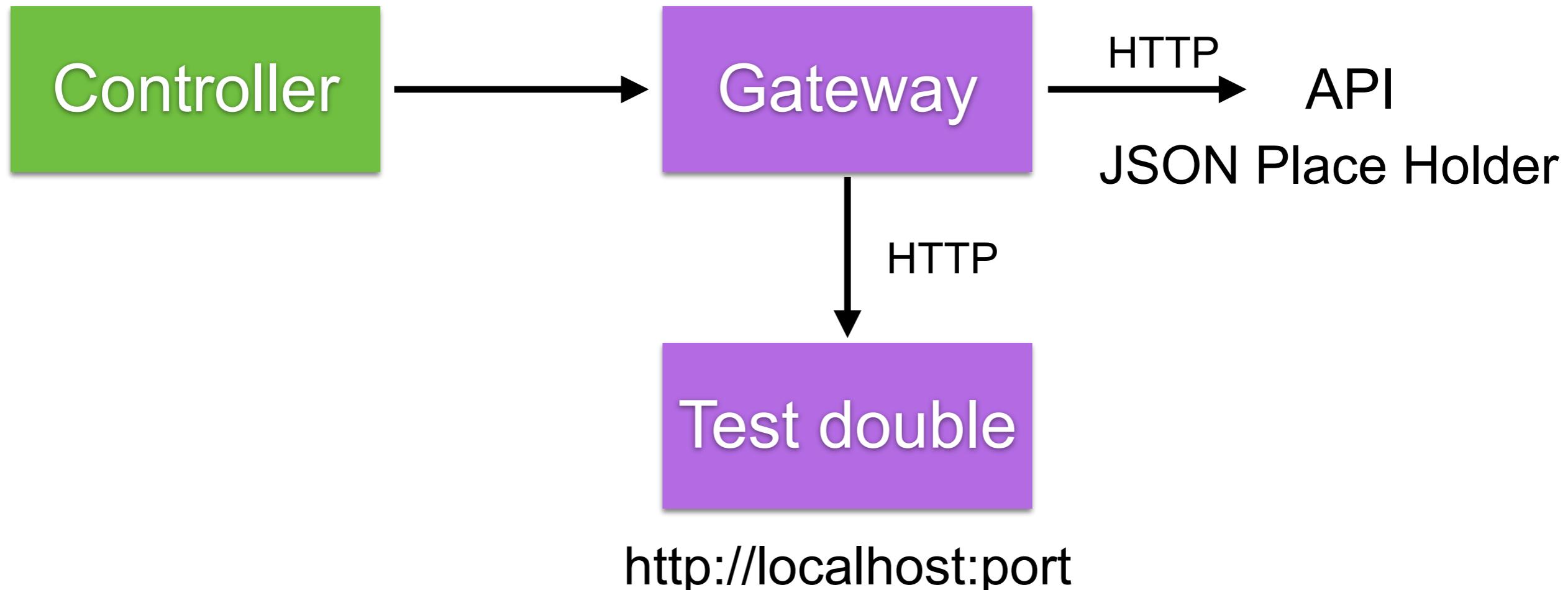
2. Create PostGateway class #2

Get data from API

```
public Optional<PostResponse> getPostById(int id) {  
    String url = String.format("%s/posts/%d", postApiUrl, id);  
  
    try {  
        return Optional.ofNullable(  
            restTemplate.getForObject(url, PostResponse.class));  
    } catch (RestClientException e) {  
        return Optional.empty();  
    }  
}
```



Testing with API



Testing with API

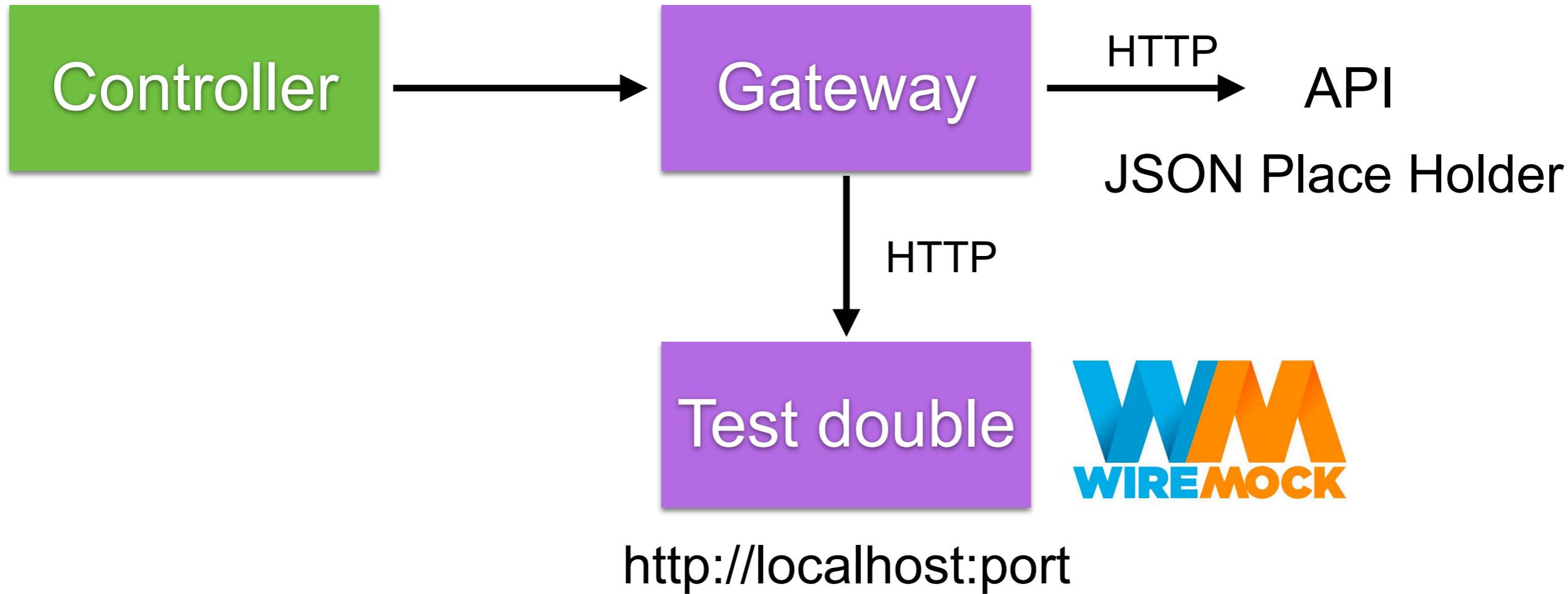
Unit testing with Mockito

Component testing with WireMock

Consumer testing with Pact



Component testing with WireMock



/src/test/resources/application.properties

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



Component testing #1

Working with WireMock

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

    @Autowired
    private PostGateway postGateway;
```

“Default port = 9999”



Component testing #2

Success case

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

Stub response

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



Component testing #3

Read data from resources folder

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



Component testing #4

File postApiResponse.json

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



Write controller testing ?

\$mvnw clean test



Separate tests with jUnit



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



Separate test with jUnit



Working with jUnit Category

Create interface in each category

```
package com.lotto.lotto.category;  
  
public interface UnitTest {  
}
```

```
package com.lotto.lotto.category;  
  
public interface SlicingTest {  
}
```

```
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"
```



Aspect-Oriented Programming

AOP



Aspects ?

Reusable blocks of code that are injected into application at runtime

Powerful tools for adding behavior

Solve cross-cutting concerns in one place



Common Applications of Aspects

Logging
Transaction management
Caching
Security



Why use Aspects ?

Reduce code duplication

DRY (Don't Repeat Yourself)

Maintain application logic



Parts of Spring Aspect

Join Point
Pointcut
Advice
Aspect



Working with transaction



Working with logging



Are you too busy to improve?



Thank you
Q/A

