Testing Spring Boot Applications Demystified

Full-Day Workshop

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Discuss Exercises from Lab 2

Lab 3

Integration Testing: Testing against a full Spring TestContext

Full Context Testing Spring Boot Applications

Integration Testing Spring Boot Applications 101

- **Core Concept**: Start the entire Spring application context, often on a random local port, and test the application through its external interfaces (e.g., REST API).
- **Confidence Gained**: Validates the integration of all internal components working together as a complete application.
- **Best Practices**: Use `@SpringBootTest` to run the app on a local port.
- **Pitfalls**: Slower to run than unit or sliced tests. Managing the lifecycle of dependent services can be complex.
- **Tools**: JUnit, Mockito, Spring Test, Spring Boot, Testcontainers, WireMock (for mocking external HTTP services), Selenium (for browser-based UI testing)

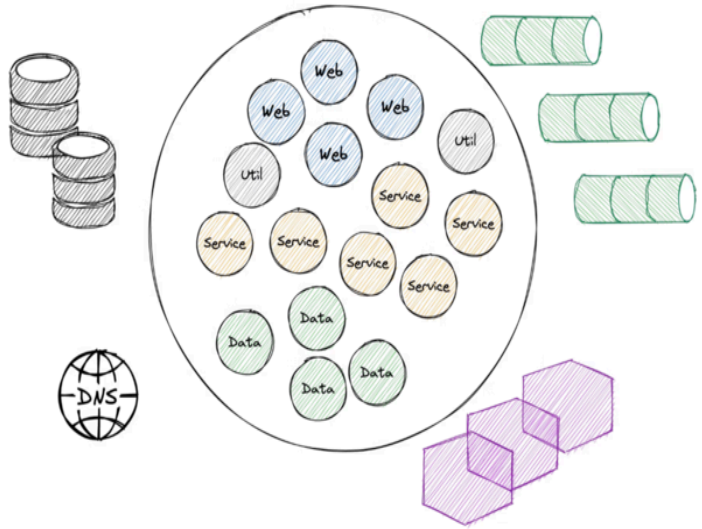
Starting Everything

Writing Tests Against a Complete Application Context

The Default Integration Test

Each new Spring Boot project comes with a default integration test:

```java
@SpringBootTest
class ApplicationTest {

  @Test
  void contextLoads() {
  }

}
```



Main Challenges of Full Context Integration Tests

- Starting the entire Spring context can be slow, repeated context starts will slow down the build
- External infrastructure components (databases, message brokers, etc.) need to be provided
- HTTP communication with other services needs to be stubbed both during startup and during runtime
- Test data management (setup and cleanup) is crucial to ensure test reliability

Starting the Entire Context

- Provide external infrastructure with Testcontainers
- Start Tomcat with: `@SpringBootTest(webEnvironment = WebEnvironment.RANDOM_PORT)`
- Test controller endpoints via: `MockMvc` (no real HTTP communication), `WebTestClient` (real HTTP communication), `TestRestTemplate` (real HTTP communication)
- Consider WireMock/MockServer for stubbing dependent HTTP services

Introducing: Microservice HTTP Communication

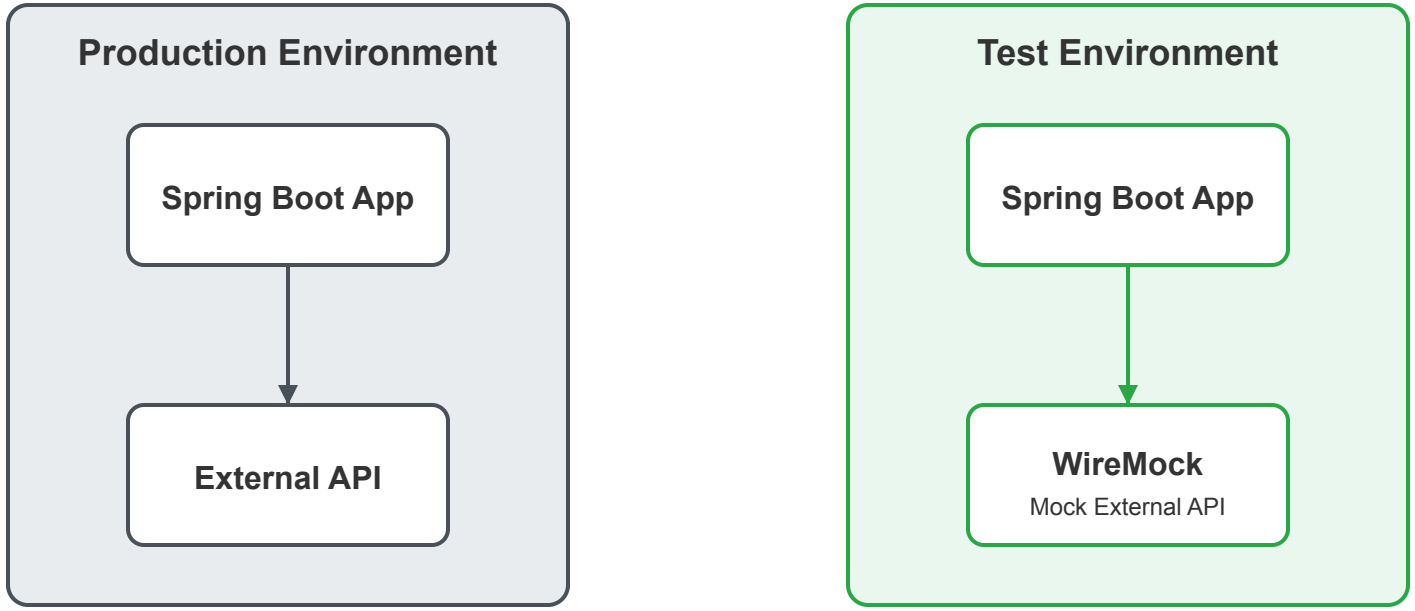
Our library application got a new feature. We now fetch book metadata from a remote service:

```
webClient.get()
  .uri(
    "/api/books",
    uriBuilder ->
      uriBuilder
        .queryParam("jscmd", "data")
        .queryParam("format", "json")
        .queryParam("bibkeys", isbn)
        .build())
  .retrieve();
}
```

HTTP Communication During Tests

- Unreliable when performing real HTTP responses during tests
- Sample data?
- Authentication?
- Cleanup?
- No airplane-mode testing possible anymore
- Solution: Stub the HTTP responses for remote system

WireMock: HTTP Service Stubbing for Testing



Key Benefits of WireMock

- Controlled test environment
- No network dependency
- Predictable responses
- Simulate error conditions
- Fast test execution
- Java integration

Introducing WireMock

- In-memory (or container) Jetty to stub HTTP responses
- Simulate failures, slow responses, etc.
- Stateful setups possible (scenarios): first request fails, then succeeds
- Alternatives: MockServer, MockWebServer, etc.

```
wireMockServer.stubFor(
  get(urlPathEqualTo("/api/books/" + isbn))
     // ... query param matchers
    .willReturn(aResponse()
      .withHeader(HttpHeaders.CONTENT_TYPE, MediaType.APPLICATION_JSON_VALUE)
      .withBodyFile(isbn + "-success.json"))
);
```

Making Our Application Context Start

Next challenge: Our application makes HTTP calls during startup to fetch some initial data.

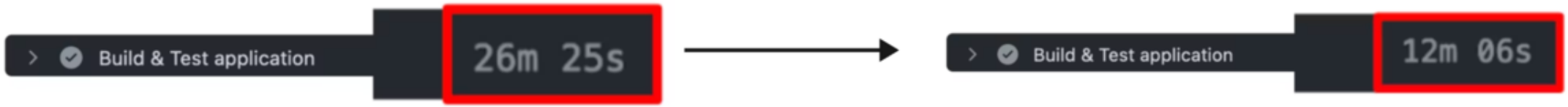
- We need to stub HTTP responses during the launch of our Spring Context
- Introducing a new concept: `ContextInitializer`

```
WireMockServer wireMockServer = new WireMockServer(WireMockConfiguration.wireMockConfig().dynamicPort());

wireMockServer.start();

// Register a shutdown hook to stop WireMock when the context is closed
applicationContext.addApplicationListener(event -> {
  if (event instanceof ContextClosedEvent) {
    logger.info("Stopping WireMock server");
    wireMockServer.stop();
  }
});

TestPropertyValues.of(
  "book.metadata.api.url=http://localhost:" + wireMockServer.port()
).applyTo(applicationContext);
```

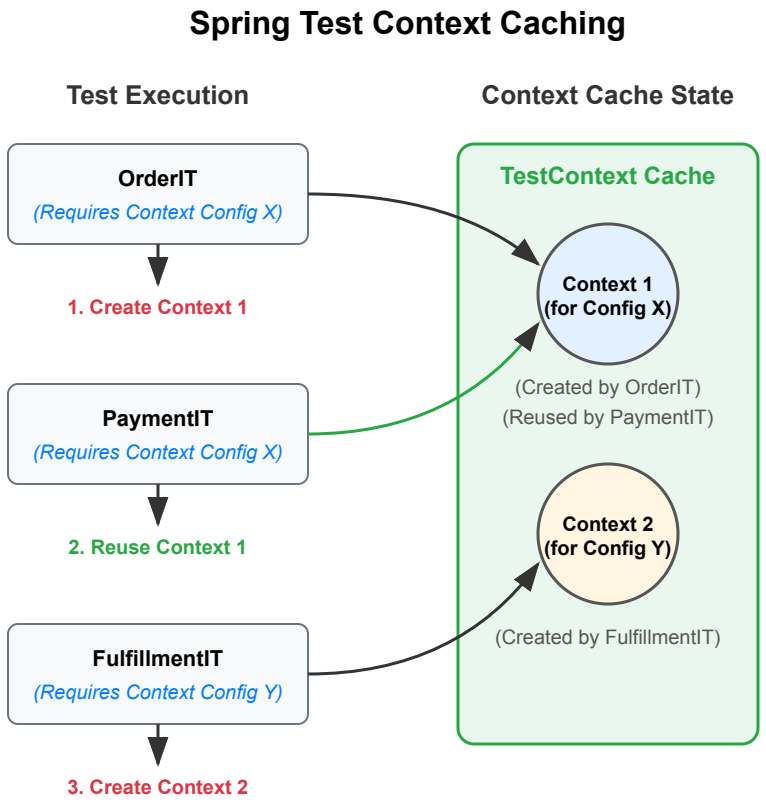
Spring Test `TestContext` Caching

- Part of Spring Test (automatically part of every Spring Boot project via `spring-boot-starter-test`)
- Spring Test caches an already started Spring `ApplicationContext` for later reuse
- Cache retrieval is usually faster than a cold context start
- Configurable cache size (default is 32) with LRU (least recently used) strategy

Speed up your build:



Caching is King

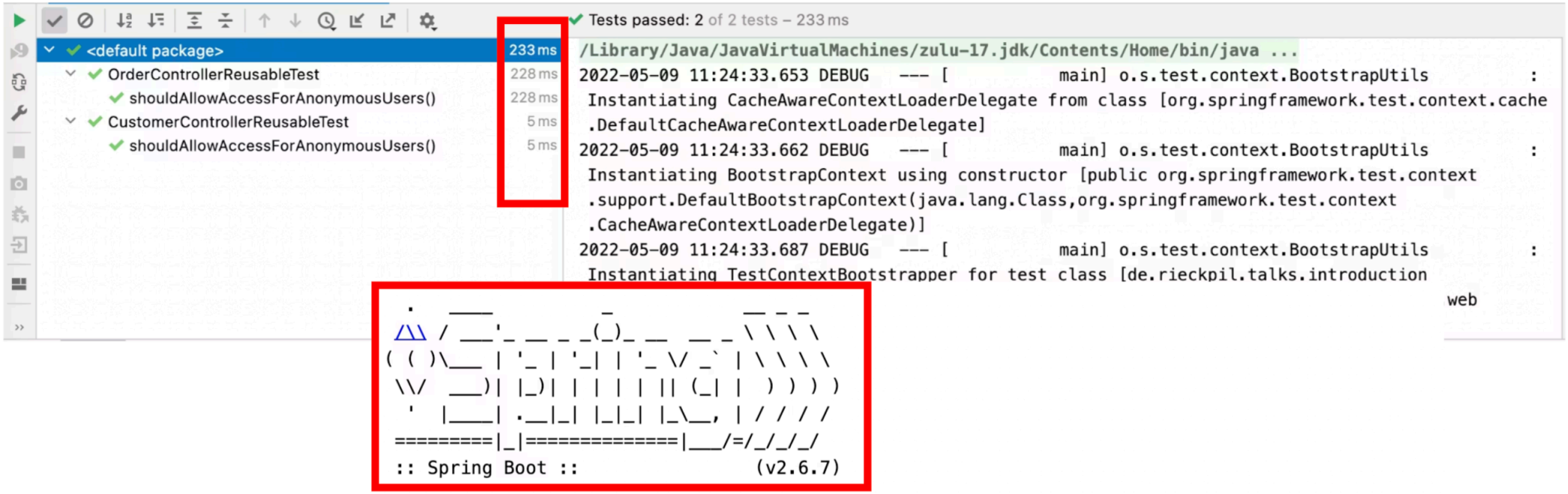


How the Cache Key is Built

This goes into the cache key (`MergedContextConfiguration`):

- activeProfiles (`@ActiveProfiles`)
- contextInitializersClasses (`@ContextConfiguration`)
- propertySourceLocations (`@TestPropertySource`)
- propertySourceProperties (`@TestPropertySource`)
- contextCustomizer (`@MockitoBean` , `@MockBean` , `@DynamicPropertySource` , ...)

Identify Context Restarts



Investigate the Logs

```
<logger name="org.springframework.test.context" level="TRACE" />
```

```
2022-05-05 14:27:38.136 DEBUG 42500 --- [           main] org.springframework.test.context.cache   : Spring test
 ApplicationContext cache statistics: [DefaultContextCache@68e62b3b size = 1, maxSize = 32, parentContextCount = 0,
 hitCount = 11, missCount = 1]
2022-05-05 14:27:38.136 DEBUG 42500 --- [           main] tractDirtiesContextTestExecutionListener : After test class:
 context [DefaultTestContext@325bb9a6 testClass = ApplicationIT, testInstance = [null], testMethod = [null], testException
  = [null], mergedContextConfiguration = [WebMergedContextConfiguration@1d12b024 testClass = ApplicationIT, locations =
 '{}', classes = '{class de.rieckpil.talks.Application}', contextInitializerClasses = '[]', activeProfiles = '{}',
 propertySourceLocations = '{}', propertySourceProperties = '{org.springframework.boot.test.context
 .SpringBootTestContextBootstrapper=true, server.port=0}', contextCustomizers = set[org.springframework.boot.test.context
 .filter.ExcludeFilterContextCustomizer@5215cd9a, org.springframework.boot.test.json
 .DuplicateJsonObjectContextCustomizerFactory$DuplicateJsonObjectContextCustomizer@9257031, org.springframework.boot.test
```

Spring Test Profiler

A Spring Test utility that provides visualization and insights for Spring Test execution, with a focus on Spring context caching statistics.

Overall goal: Identify optimization opportunities in your Spring Test suite to speed up your builds and ship to production faster and with more confidence.

Spot the Issues for Context Caching

```java
@DirtiesContext
@Testcontainers
@ActiveProfiles("integration-test")
@SpringBootTest(webEnvironment = SpringBootTest.WebEnvironment.RANDOM_PORT)
abstract class AbstractIntegrationTest {
```

What's "bad" for context caching here?

```java
@ActiveProfiles("integration-test")
@Import(SomeTestConfiguration.class)
@ContextConfiguration(initializers = CustomInitializer.class)
@SpringBootTest(properties = {"features.login-enabled=true", "custom.message=duke42"})
class ShowcaseIT {

  @MockBean
  private OrderService orderService;

  @SpyBean
  private CustomerService customerService;

  @Test
  void shouldInitializeContext(@Autowired ApplicationContext applicationContext) {
    assertThat(applicationContext)
            .isNotNull();
  }
}
```

Context Caching Issues

Common problems that break caching:

1. Different context configurations
2. `@DirtiesContext` usage
3. Modifying beans in tests
4. Different property settings
5. Different active profiles

Make the Most of the Caching Feature

- Avoid `@DirtiesContext` when possible, especially at `AbstractIntegrationTest` classes
- Understand how the cache key is built
- Monitor and investigate the context restarts
- Align the number of unique context configurations for your test suite

Time For Some Exercises

Lab 3

- Work with the same repository as in lab 1/lab 2
- Navigate to the `labs/lab-3` folder in the repository and complete the tasks as described in the `README` file of that folder
- Time boxed until the end of the coffee break (15:30 AM)