Web Applications with Spring Boot

Getting Started with Spring MVC & REST

1.18.5

Objectives

After completing this lesson, you should be able to do the following

- Explain how to create a Spring MVC application using Spring Boot
- Describe the basic request processing lifecycle for REST requests
- Create a simple RESTful controller to handle GET requests
- Configure for WAR or JAR deployment

Agenda

- **Spring Boot and Spring MVC**
- Details
  - Request Processing Lifecycle
  - Controllers
  - Message Converters
- JAR or WAR configurations
- Spring Boot Developer Tools
- Quick Start
- Lab
- Spring MVC Without Boot

Web Layer Support in Spring MVC and Spring Boot

- What is Spring MVC?
  - Web framework based on:
    - *Model/View/Controller (MVC)* pattern
    - POJO programming
    - Testable components
    - Uses Spring for configuration
  - Supports Server-side web rendering & REST

- Spring Boot can help you create web applications easily
  - Based on Spring MVC

We will focus on REST.

Types of Spring MVC Applications

- Web Servlet
  - Traditional approach
  - Based on Java EE Servlet Specification
    - Servlets
    - Filters
    - Listeners
    - Etc.
- Web Reactive
  - Newer, more efficient
  - Non-blocking approach
  - Netty, Undertow, Servlet 3.1+
  - Requires knowledge of Reactive programming (see appendix)

We will focus on traditional Web Servlet-based approach.

Traditional or Embedded Servlet Container

- Spring Boot supports embedded servlet containers
  - Packaging an embedded container within a deployment artifact in a ‘fat’ JAR
  - Run web applications from command line!

- Spring Boot can also implement traditional structure needed by Web containers
  - WAR packaging

We will focus on embedded approach.

Spring Web “Starter” Dependencies

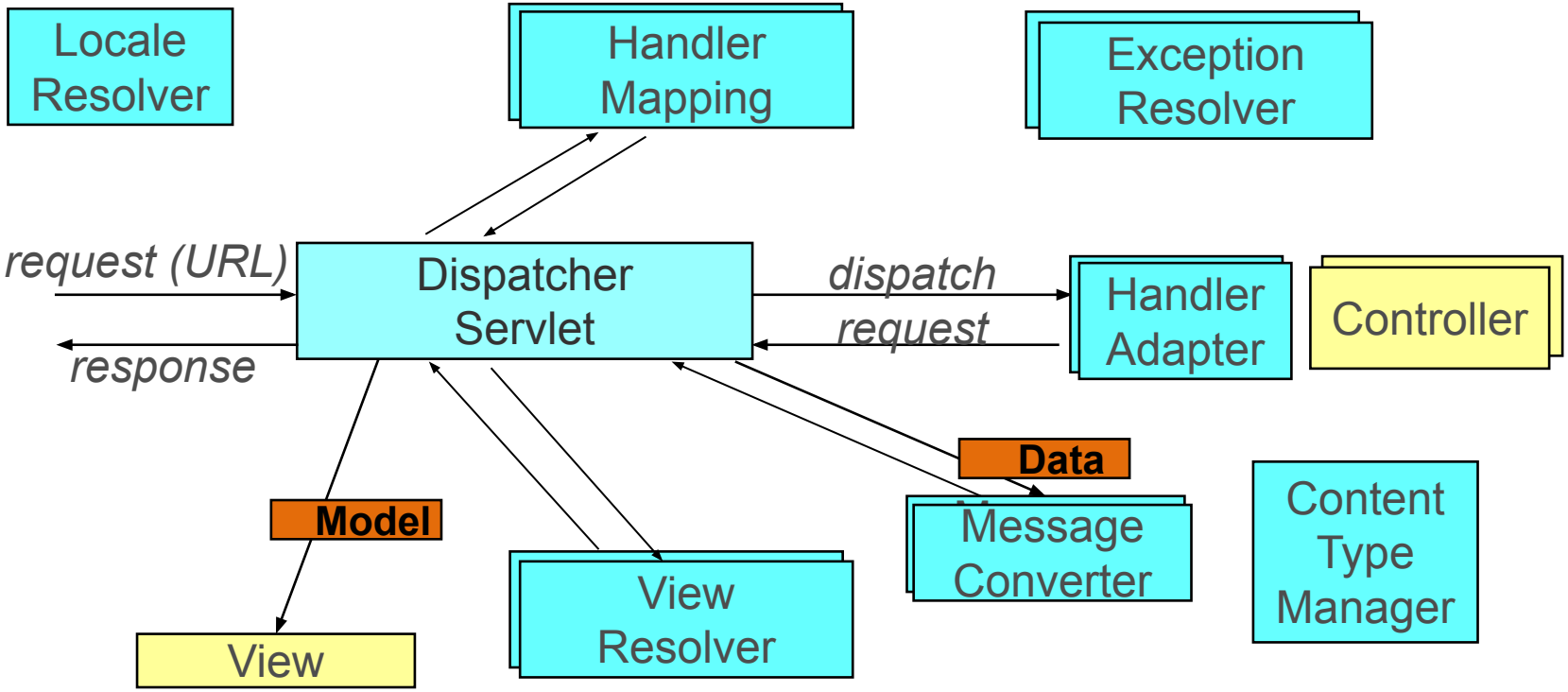
- Everything you need to develop a Spring MVC application

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

Resolves

spring-web.jar
spring-webmvc.jar
spring-boot-starter.jar
jackson.jar*
tomcat-embed.jar*
…

At Startup Time, Spring Boot Creates Spring MVC Components

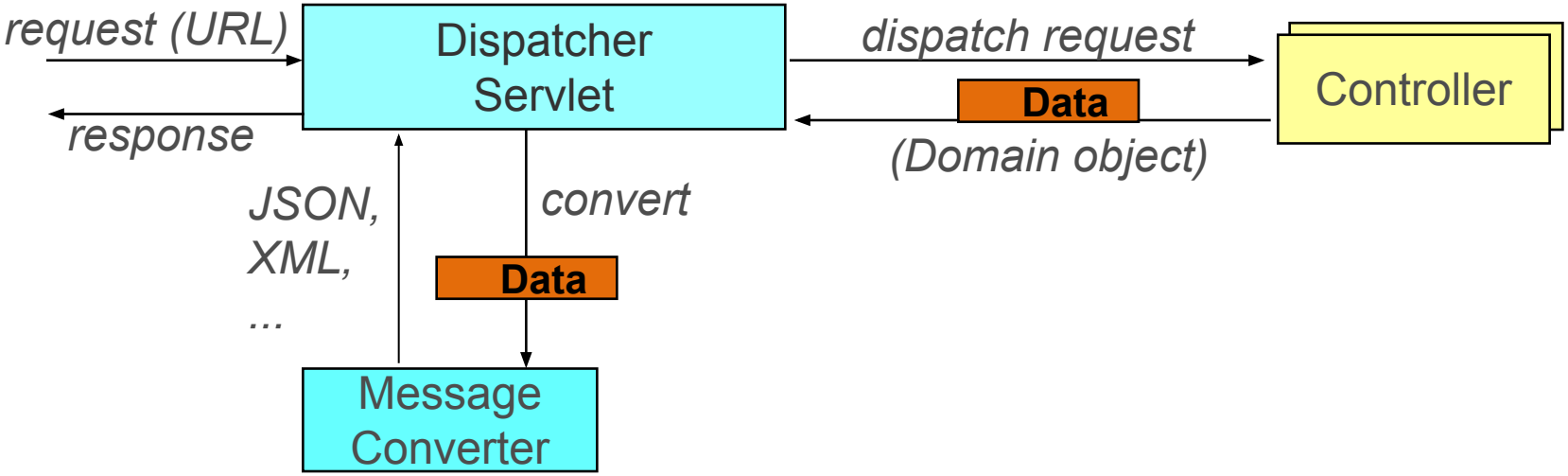


- Developers need to create only controllers and views (yellow-colored)

Agenda

- Spring Boot and Spring MVC
- **Details**
  - **Request Processing Lifecycle**
  - Controllers
  - Message Converters
- JAR or WAR configurations
- Spring Boot Developer Tools
- Quick Start
- Lab
- Spring MVC Without Boot

Request Processing Lifecycle - REST



- Developers need to create only controllers (yellow-colored)
- Common message-converters setup automatically – *if* found on the classpath
  - Jackson for JSON/XML, JAXB for XML, GSON for JSON ...

Agenda

- Spring Boot and Spring MVC
- **Details**
  - Request Processing Lifecycle
  - **Controllers**
  - Message Converters
- JAR or WAR configurations
- Spring Boot Developer Tools
- Quick Start
- Lab
- Spring MVC Without Boot

Controller Implementation

- Controllers are annotated with **`@Controller`**
  - **`@GetMapping`** tells Spring what method to use to process HTTP GET requests
  - **`@ResponseBody`** defines a *REST* response
    - Turns *off* the View handling subsystem

```
@Controller
public class AccountController {

    @GetMapping("/accounts")
    public @ResponseBody List<Account> list() {...}
}
```

`@Controller` is an `@Component` so *will* be found by component-scanner

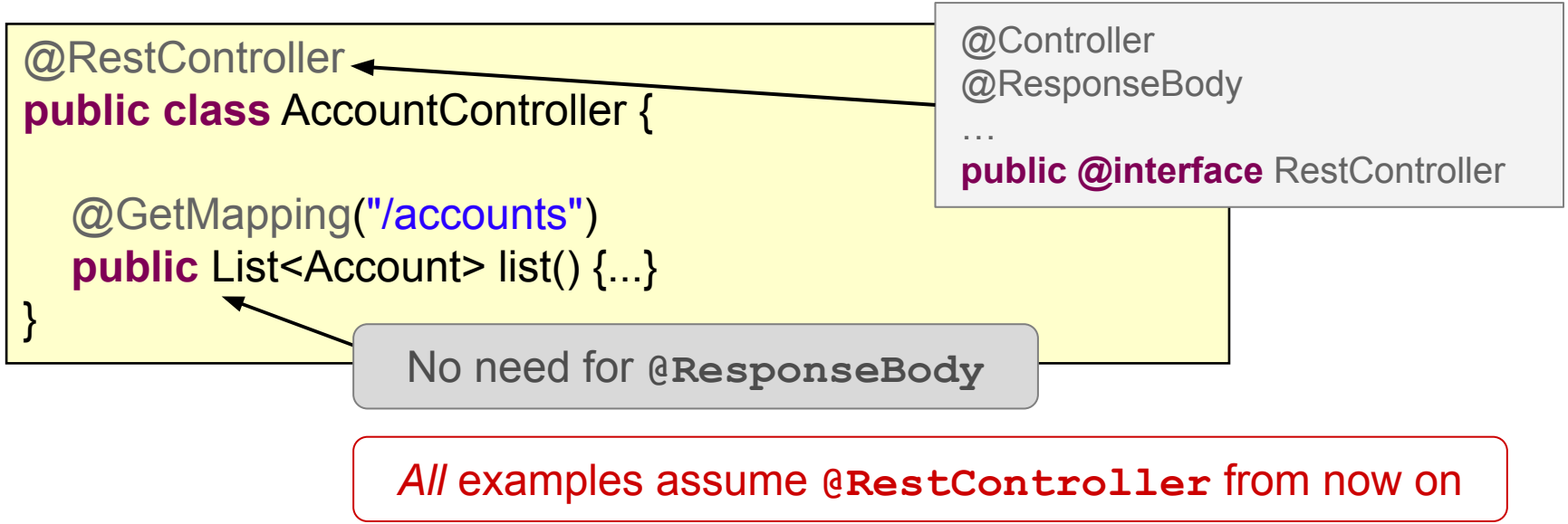
Example of calling URL: http://localhost:8080 / accounts

server

request mapping

@RestController Convenience

- Convenient “composed” annotation
  - Incorporates **`@Controller`** and **`@ResponseBody`**
  - Methods assumed to return REST response-data



Controller Method Arguments

- You pick the arguments you need, Spring injects them
  - **`HttpServletRequest`**, **`HttpSession`**, **`Principal`**,**`Locale`**, **`etc.`**
  - See Spring Reference, Controller Method Arguments

```
@RestController
public class AccountController {

    // Retrieve accounts of currently logged-in user
    @GetMapping("/accounts")
    public List<Account> list(Principal user) {
        ...
    }
}
```

Injected by Spring

Extracting Request Parameters

- Use **`@RequestParam`** annotation
  - Extracts request parameters from the request URL
  - Performs type conversion

```
@RestController
public class AccountController {

    @GetMapping("/account")
    public List<Account> list(@RequestParam(”userid") int userId) {
        …  // Fetch and return accounts for specified user
    }
}
```

Example of calling URL:
http://localhost:8080/account?**userid=1234**

URI Templates

- Values can be extracted from request URL
  - *Based on URI Templates*
  - Use {…} placeholders and **`@PathVariable`**

```
@RestController
public class AccountController {
    @GetMapping("/accounts/{accountId}")
    public Account find(@PathVariable("accountId") long id) {
        …  // Do something
    }
}
```

Example of calling URL: http://localhost:8080/accounts/**98765**

Naming Conventions

- Drop annotation value ***if*** it matches method parameter name

```
// Get user's overdrawn accounts
@GetMapping("/accounts/{userId}")
public List<Account> list(@PathVariable long userId,
                          @RequestParam boolean overdrawn)
```

*http://.../accounts/1234?**overdrawn**=true*

https://docs.oracle.com/javase/tutorial/reflect/member/methodparameterreflection.html

Method Signature Examples

Example URLs

http://localhost:8080/accounts

```
@GetMapping("/accounts")
public List<Account> getAccounts()
```

http://.../orders/1234/items/2

```
@GetMapping("/orders/{id}/items/{itemId}")
public OrderItem item( @PathVariable(“id”) long orderId,
                       @PathVariable int itemId,
                       Locale locale,
                       @RequestHeader(“user-agent”) String agent )
```

http://.../suppliers?location=12345

```
@GetMapping("/suppliers")
public List<Supplier> getSuppliers(
        @RequestParam(required=false) Integer location,
        Principal user,
        HttpSession session )
```

Null if not specified

Agenda

- Spring Boot and Spring MVC
- **Details**
  - Request Processing Lifecycle
  - Controllers
  - **Message Converters**
- JAR or WAR configurations
- Spring Boot Developer Tools
- Quick Start
- Lab
- Spring MVC Without Boot

HTTP GET: Fetch a Resource

- *Requirement*
  - Respond *only* to GET requests
  - Return requested data in the HTTP Response
  - Determine requested response format

```
GET /store/orders/123
Host: shop.spring.io
Accept: application/json, ...
...
```

```
HTTP/1.1 200 OK
Date: …
Content-Length: 756
Content-Type: application/json

{
    "id": 123,
    "total": 200.00,
    "items": [ … ]
}
```

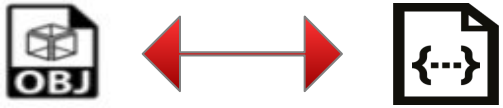
Generating Response Data

- **The Problem**
  - HTTP GET needs to return data in response body
    - Typically JSON or XML
  - Developers prefer to work with Java objects
  - Developers want to avoid manual conversion

- **The Solution**
  - Object to text conversion
    - Message-Converters
  - Annotate response data with **`@ResponseBody`**

```
HTTP/1.1 200 OK
Date: …
Content-Length: 756
Content-Type: application/json

{
   "id": 123,
   "total": 200.00,
   "items": [ … ]
}
```

HttpMessageConverter



- Converts HTTP request/response body data
  - XML: JAXP Source, JAXB2 mapped object*, Jackson-Dataformat-XML*
  - GSON*, Jackson JSON*
  - Feed data* such as Atom/RSS
  - Google protocol buffers*
  - Form-based data
  - **`Byte[]`**, **`String`**, **`BufferedImage`**
- Automatically setup by Spring Boot (except protocol buffers)
  - Manual configuration also possible

* Requires 3rd party libraries on classpath

What Return Format? *Accept* Request Header

```
@GetMapping("/store/orders/{id}")
public Order getOrder(@PathVariable("id") long id) {
   return orderService.findOrderById(id);
}
```

```
GET /store/orders/123
Host: shop.spring.io
Accept: application/xml
...
```

```
HTTP/1.1 200 OK
Date: …
Content-Length: 1456
Content-Type: application/xml
<order id="123">
  …
</orde
```

```
GET /store/orders/123
Host: shop.spring.io
Accept: application/json
...
```

```
HTTP/1.1 200 OK
Date: …
Content-Length: 756
Content-Type: application/json
{
   "id": 123,
   "total": 200.00,
   "items": [ … ]
}
```

Customizing GET Responses: ResponseEntity

- Build **GET** responses explicitly
  - More control
  - You can set headers or control response content

```
// ResponseEntity supports a "fluent" API for creating a
// response. Used to initialize the HttpServletResponse.
ResponseEntity<String> response =
      ResponseEntity.ok()
                    .contentType(MediaType.TEXT_PLAIN)
                    .body("Hello Spring");
```

Subclasses **HttpEntity** with fluent API

Setting Response Data with Domain object

```
@GetMapping("/store/orders/{id}")
public ResponseEntity<Order> getOrder(@PathVariable long id) {
  Order order = orderService.find(id);

  return ResponseEntity
              .ok()
              .lastModified(order.lastUpdated())
              .body(order);
}
```

HTTP Status 200 OK

Response body

Set existing or custom header

Agenda

- Spring Boot and Spring MVC
- Details
  - Request Processing Lifecycle
  - Controllers
  - Message Converters
- **JAR or WAR configurations**
- Spring Boot Developer Tools
- Quick Start
- Lab
- Spring MVC Without Boot

Spring Boot for Web Applications

- Use **`spring-boot-starter-web`**
  - Ensures Spring Web and Spring MVC are on classpath

- Spring Boot auto-configuration for Web applications
  - Sets up a **`DispatcherServlet`**
  - Sets up internal configuration to support controllers
  - Sets up default resource locations (images, CSS, JavaScript)
  - Sets up default Message Converters
  - And much, much more

Spring Boot Provides Web Container (Servlet Container)

- By default Spring Boot starts up an *embedded* web container
  - You can run a web application from the command line!
  - Tomcat is the default web container

Spring Boot's default behavior. Traditional WAR deployment available also.

Alternative Web Containers: Jetty, Undertow

- *Example:* Jetty instead of Tomcat

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-web</artifactId>
  <exclusions>
    <exclusion>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-tomcat</artifactId>
    </exclusion>
  </exclusions>
</dependency>
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-jetty</artifactId>
</dependency>
```

Excludes Tomcat

Adds Jetty

Jetty automatically detected and used!

Running Within a Web Container (traditional)

Sub-classes Spring's *WebApplicationInitializer* – called by the web container (Servlet 3+ required)

```
@SpringBootApplication
public class Application extends SpringBootServletInitializer {

        // Specify the configuration class(es) to use
        protected SpringApplicationBuilder configure(
                        SpringApplicationBuilder application) {
                return application.sources(Application.class);
        }

}
```

*Don't forget to change artifact type to **war***

The above requires **no** *web.xml* file

Configure for a WAR *or* a JAR

```
@SpringBootApplication
public class Application extends SpringBootServletInitializer {

    protected SpringApplicationBuilder configure(
            SpringApplicationBuilder application) {
        return application.sources(Application.class);
    }

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

Web container support

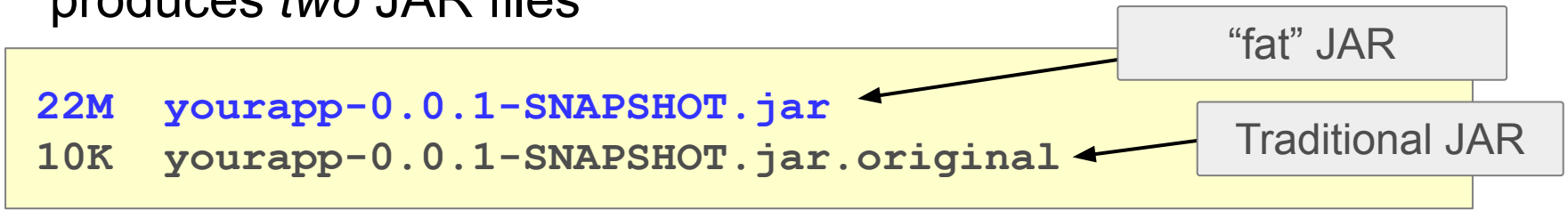
`main()` method run from CLI

JAR or WAR

- By default, both JAR and WAR forms can run from the command line
  - Based on embedded Tomcat (or Jetty) JARs
- However, embedded Tomcat JARs can cause conflicts when running WAR inside traditional web container
  - Example: running within different version of Tomcat
- Best Practice: Mark Tomcat dependencies as *provided* when building WARs for traditional containers

Spring Boot JAR Files

- Using Boot's plugin, **`mvn package`** or **`gradle assemble`** produces *two* JAR files



- "Fat" JAR executable with embedded Tomcat
  - using "**`java -jar yourapp.jar`**"

For details:
https://docs.spring.io/spring-boot/docs/current/maven-plugin/reference/htmlsingle/
and
https://docs.spring.io/spring-boot/docs/current/gradle-plugin/reference/htmlsingle/

Agenda

- Spring Boot and Spring MVC
- Details
  - Request Processing Lifecycle
  - Controllers
  - Message Converters
- JAR or WAR configurations
- **Spring Boot Developer Tools**
- Quick Start
- Lab
- Spring MVC Without Boot

Spring Boot Developer Tools

- A set of tools to help make Spring Boot development easier
  - Automatic restart - any time a class file changes (on re-compile) - faster than “cold restart”
  - Automatically disabled when it considers the app is running in “production”

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-devtools</artifactId>
    <scope>runtime</scope>
    <optional>true</optional>
  </dependency>
</dependencies>
```

Prevents devtools from being transitively applied to other modules that use your project

Agenda

- Spring Boot and Spring MVC
- Details
  - Request Processing Lifecycle
  - Controllers
  - Message Converters
- JAR or WAR configurations
- Spring Boot Developer Tools
- **Quick Start**
- Lab
- Spring MVC Without Boot

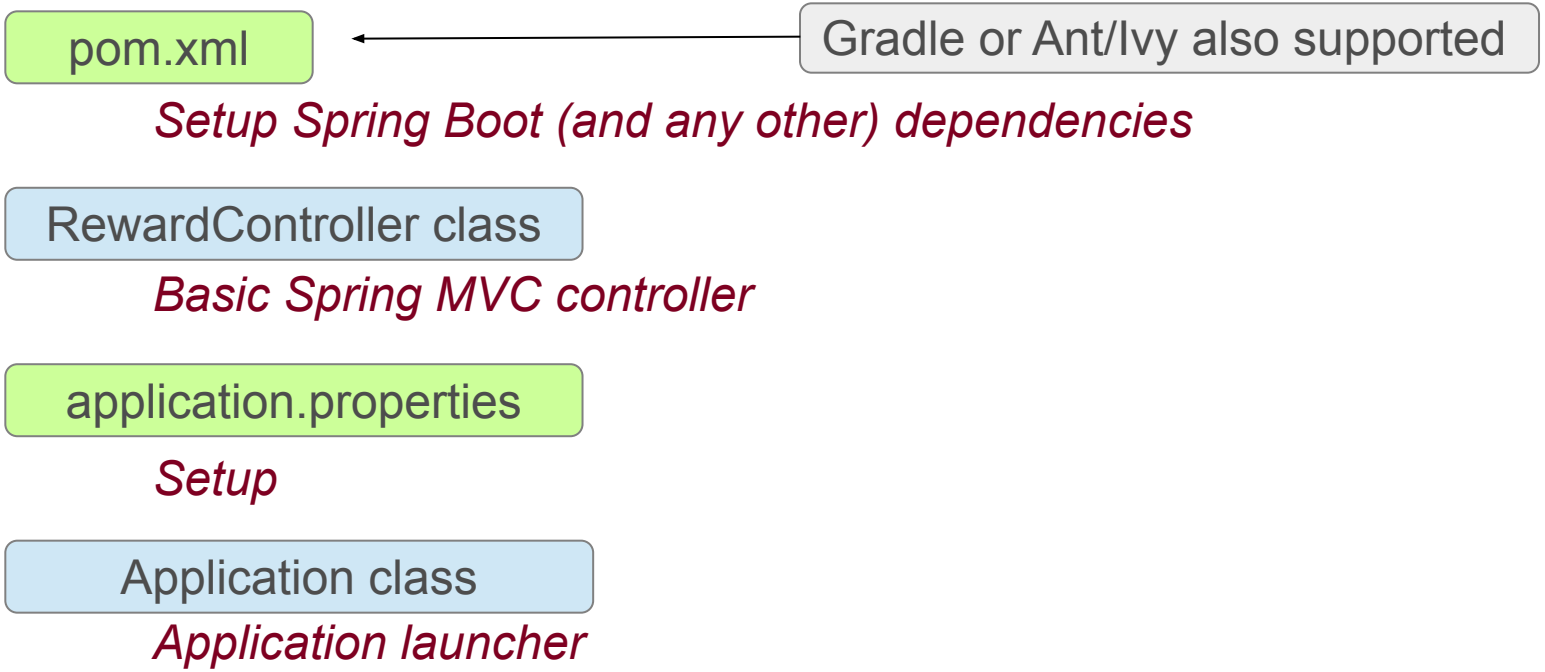
Revision: What We Have Covered

- Spring Web applications have *many* features
  - The **`DispatcherServlet`**
  - Setup Using Spring Boot
  - Writing a Controller
  - Using Message Converters
  - JARs vs WARs

- *But you don't need to worry about **most** of this to write a simple Spring Boot Web application …*
  - Typically you just write Controllers
  - Set some properties

Quick Start

- Only a few files to get a running Spring Web application



1a. Maven Descriptor

```
<parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>2.7.5</version>
</parent>
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
</dependencies>

<!-- Continued on next slide -->
```

Parent POM

Spring MVC, Embedded Tomcat, Jackson ...

pom.xml

1b. Maven Descriptor (continued)

- Will also use the Spring Boot plugin

pom.xml (continued)

```
<!-- Continued from previous slide -->
<build>
    <plugins>
        <plugin>
            <groupId>org.springframework.boot</groupId>
            <artifactId>spring-boot-maven-plugin</artifactId>
        </plugin>
    </plugins>
</build>
```

Makes “fat” *executable* jars/wars

Remember: Maven, Gradle, Ant/Ivy are all supported

1c. Spring Boot sets up Spring MVC

- As Spring web JARs are on classpath ...
  - Spring Boot sets up Spring MVC
  - Deploys a **`DispatcherServlet`**

- Typical URLs:

  http://localhost:8080/accounts
  http://localhost:8080/rewards
  http://localhost:8080/rewards/1

  - We will implement the last example

2. Implement the Controller

RewardController.java

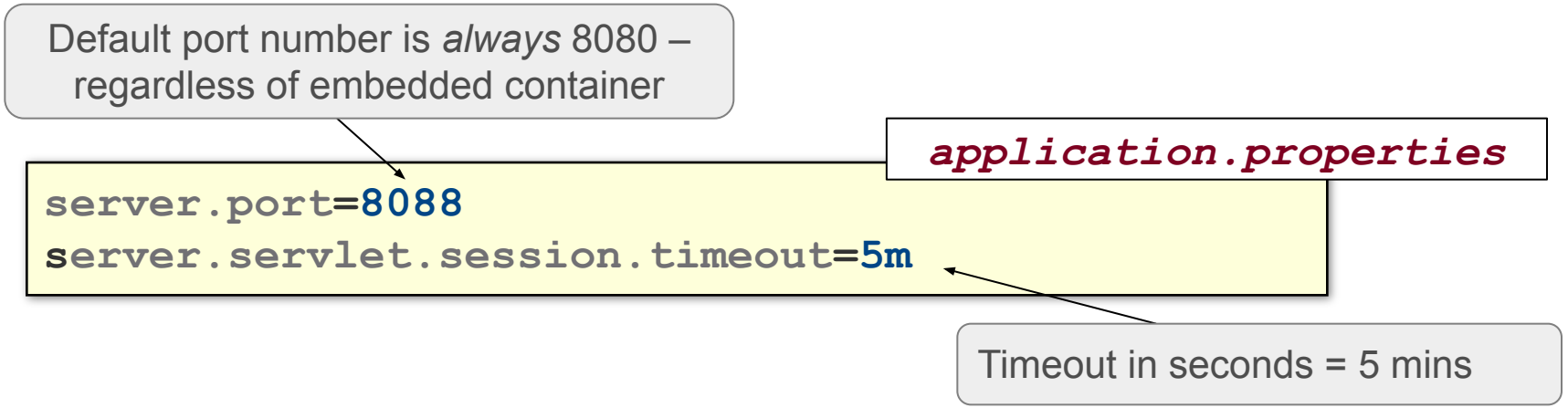
```
@RestController
public class RewardController {
    private RewardLookupService lookupService;

    public RewardController(RewardLookupService svc) {
        this.lookupService = svc;
    }

    @GetMapping("/rewards/{id}")
    public Reward show(@PathVariable("id") long id) {
        return lookupService.lookupReward(id);
    }
}
```

Depends on an application service

Returns Reward

3. Setting Properties

- Can configure web server using Boot properties
  - Not needed for this simple application
  - Let's set some common properties as examples



4. Application Class

- **`@SpringBootApplication`** annotation
  - Enables Spring Boot running Tomcat embedded

```
@SpringBootApplication
public class Application {

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

Application.java

Component scanner runs automatically, will find **`RewardsController`** if it is located in same or sub-package

5. Deploy and Test

```
mvn package
```

Maven command to generate an archive file

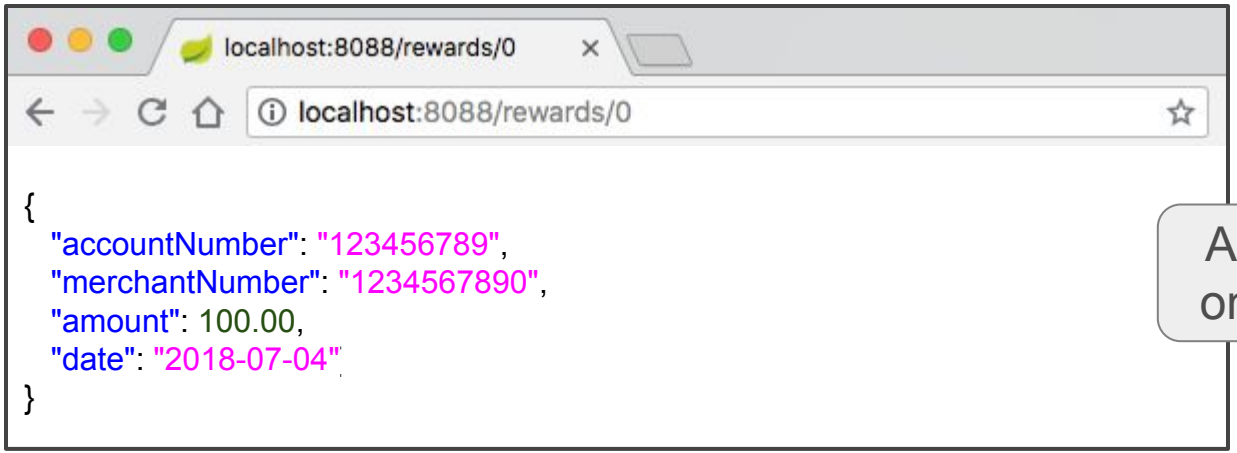
```
helloApp-0.0.1-SNAPSHOT.jar
```

generated file

Generated “fat” *executable* JAR

```
java -jar helloApp-0.0.1-SNAPSHOT.jar
```

App started from command line

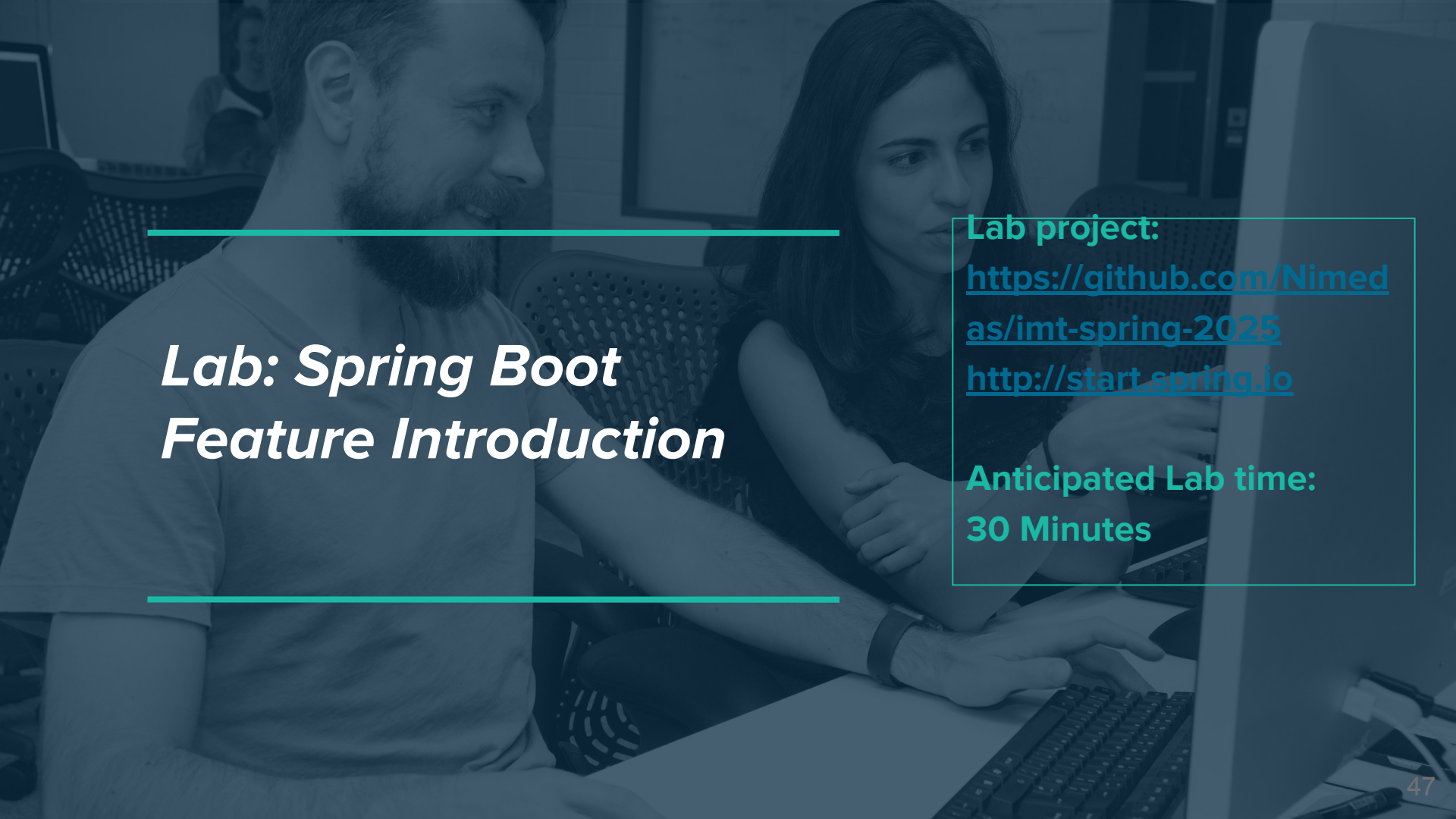


App running on port 8088

Summary

- Spring MVC is Spring's web framework
  - **`@Controller`** and **`@RestController`** handle HTTP requests
  - URL information available via **`@RequestParam`**, **`@PathVariable`**
- Spring Boot simplifies web application development
  - Embedded server, JAR and WAR packaging, Starters
- Multiple response formats supported
  - **`MessageConverters`** - support JSON ,XML …

Extensive documentation on Spring MVC available at:
https://docs.spring.io/spring-framework/docs/current/spring-framework-reference/web.html#spring-web



Lab: Spring Boot Feature Introduction

Lab project:
https://github.com/Nimedas/imt-spring-2025
http://start.spring.io

Anticipated Lab time:
30 Minutes