Pivotal

Testing with Spring's MockMVC Framework

Test the full MVC Stack in a JUnit test

Objectives

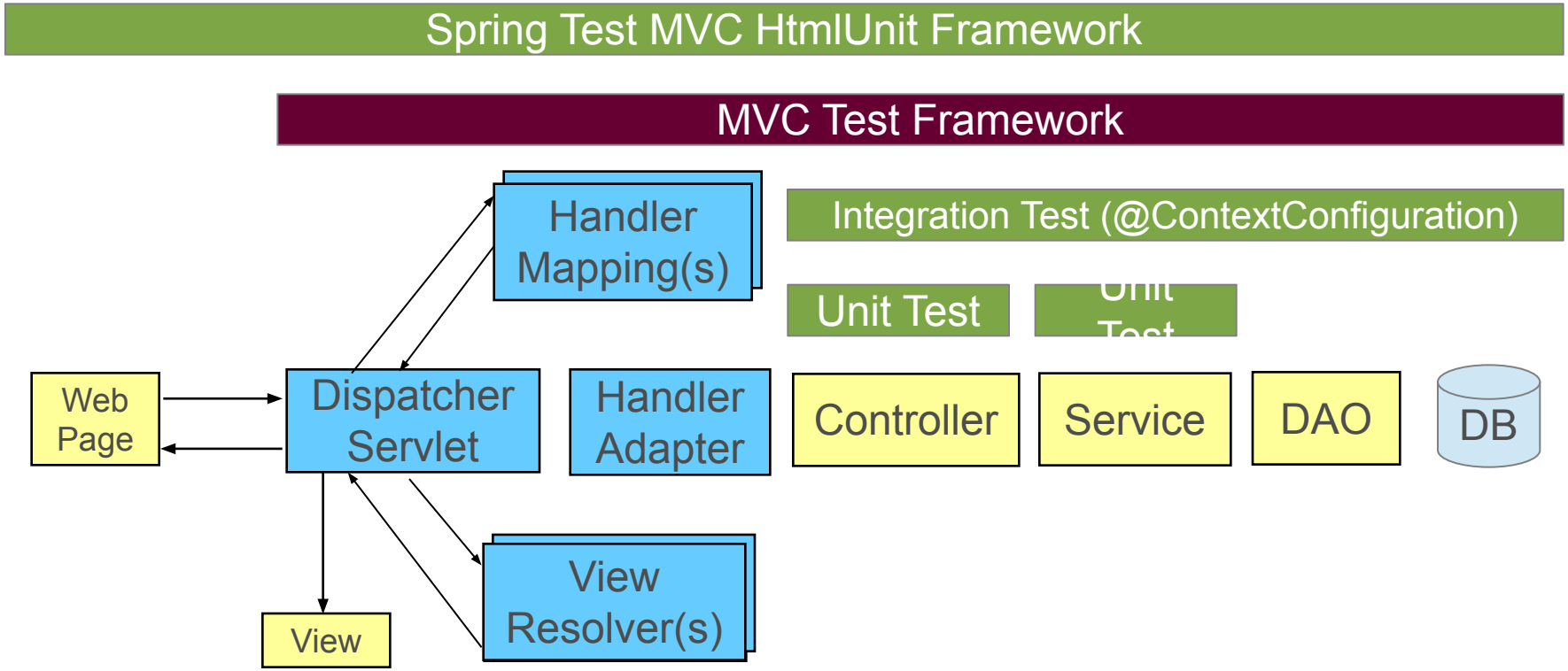
After completing this lesson, you should be able to

- Test the various Web Application components
- Describe the Spring MVC Test Framework
- Test Spring Boot applications

Agenda

- **Testing Web Applications**
- Spring MVC Test Framework
- Going Further
- Using HtmlUnit for Spring Testing
- Lab

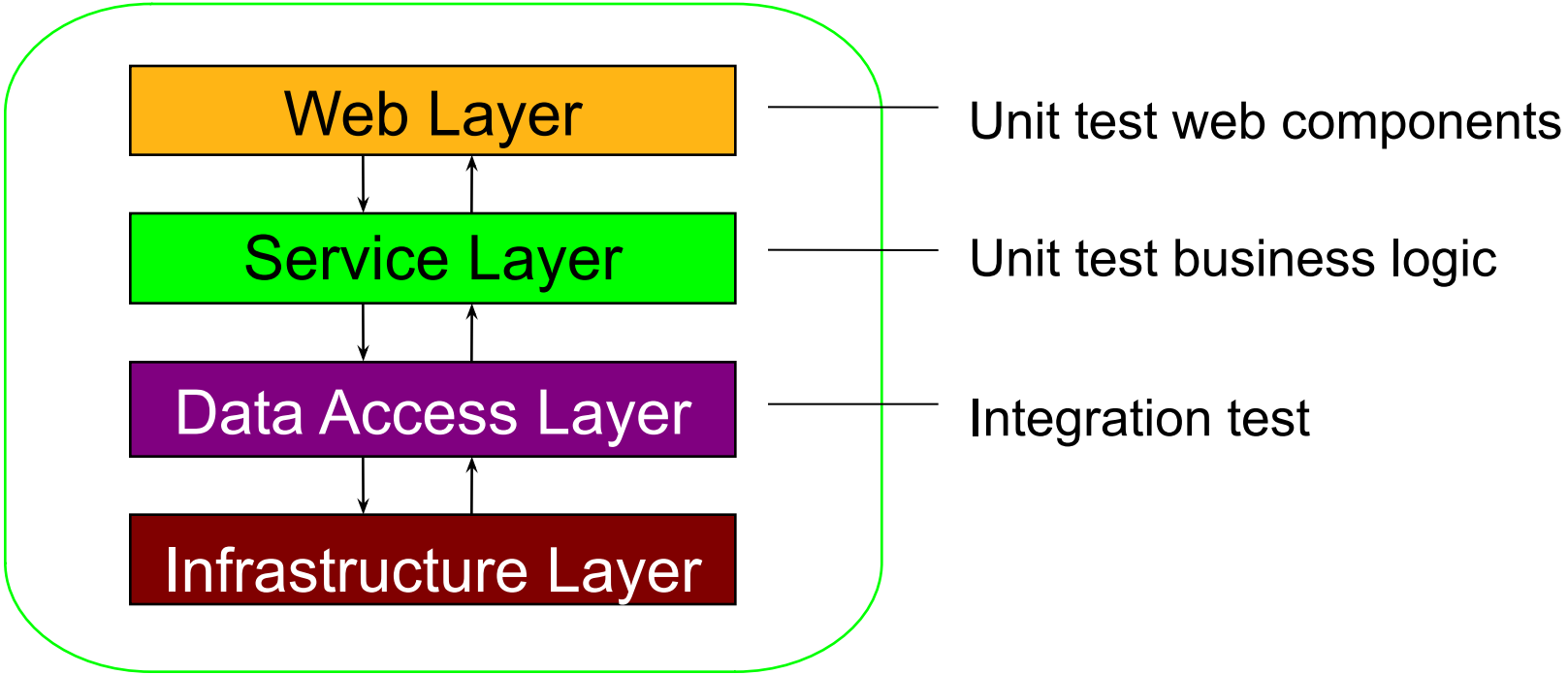
Testing Each Layer



Testing the Web Layer

- **Unit Tests**
  - One method at a time
  - Isolate dependencies (Mocking, Stubbing)
- **Integration Tests**
  - Component interaction scenarios
  - Configure dependencies with Spring
- **End to End Tests**
  - Exercise the application's user interface
  - Fully integrated system

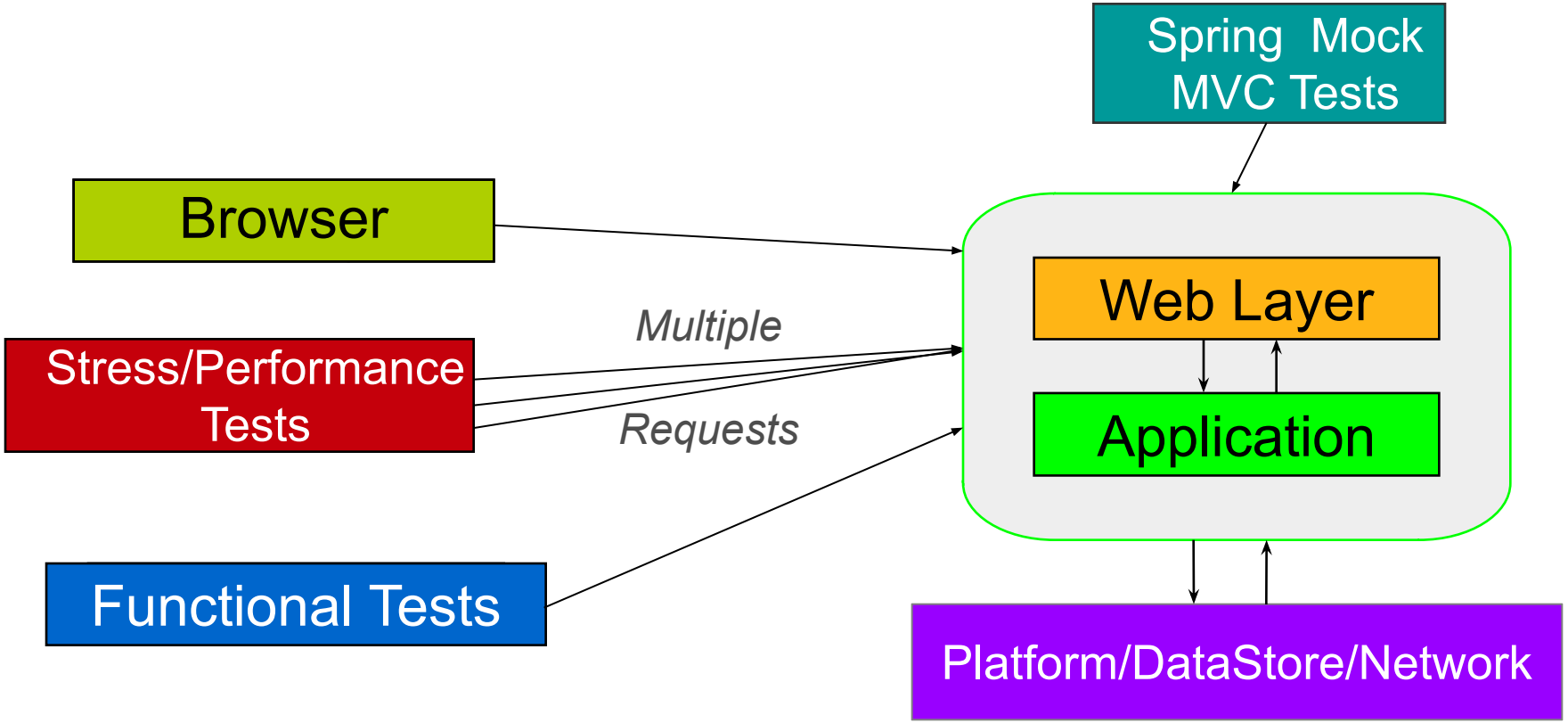
Testing Each Layer



Testing the Web Layer

- Unit test web components
  - controllers, interceptors, custom views
- Use stubs or mocks to isolate services
  - run fast and often
- What to test?
  - the logic adapting HTML requests to the service layer
  - input parameters, validation, etc.

Testing The Whole System



What Still Needs Verification?

- Client-side behavior
  - Browser/UI interactions
- End-To-End Testing
  - Exercise application running as a fully integrated system
    - Verify “no surprises” from underlying code
  - Performance/Load/Stress testing
- **Server-side configuration** ← *This section*
  - **Servlet container**
  - **Frameworks (Spring MVC)**

Browser

Functional Tests

Stress/Performance Tests

Spring Mock MVC Tests

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Need for Spring MVC Testing

- Consider the controller below, how can you verify:
  - `@PutMapping` results in a correct URL mapping?
  - `@Valid` is active? Expected validation checks happen?
  - Framework redirects where you expect?
  - ViewResolver chain translates “accounts/edit” to the correct View?
  - Any exception results in a display of the error page?

```
@PutMapping(path="/account")
public String save(@Valid Account acc, BindingResult result) {
    if (result.hasErrors()) return "accounts/edit”;

    accountManager.update(acc);
    return "redirect:" + acc();
}
```

MVC Test Framework Overview

- Part of Spring Framework
  - Found in **`spring-test.jar`**
- ***Goal:*** Provide first-class support for testing Spring MVC code
  - Fluent API
  - Process requests through DispatcherServlet
  - Does *not* require Web container to test

See: [Spring Framework Reference, Spring MVC Test Framework](http://docs.spring.io/spring/docs/current/spring-framework-reference/htmlsingle/#spring-mvc-test-framework)
http://docs.spring.io/spring/docs/current/spring-framework-reference/htmlsingle/#spring-mvc-test-framework

Example

```
@ExtendWith(SpringExtension.class)
@SpringBootTest(classes=MyApp.class)
public final class AccountControllerTests {
    @Autowired
    private WebApplicationContext context;
    private MockMvc mockMvc;

    @BeforeEach
    public void setup() {
        mockMvc = MockMvcBuilders.webAppContextSetup(context).build();
    }

    @Test
    public void testBasicGet() {
        mockMvc.perform(get("/accounts"))
                .andExpect(status().isOk());
    }
}
```

Setup the test – defaults to a Web-ApplicationContext

Inject application context

Define MockMvc field and initialize it

Perform tests on mockMvc instance

Unit Testing *vs* MVC Test Framework

- Unit Testing
  - Use to test logic of controllers
  - Create & populate model, test for proper views, model data, etc
- MVC Test Framework
  - Use to test MVC annotations (like **`@RequestMapping`**, **`@PathVariable`**, etc)
  - Also can perform integration tests with other Spring MVC beans such as View Resolvers, Interceptors, Filters …

Setting Up The Test Harness

```
import static org.springframework.test.web.servlet.request.MockMvcRequestBuilders.*;
import static org.springframework.test.web.servlet.result.MockMvcResultMatchers.*;

public final class AccountControllerTests {
    @Autowired
    private WebApplicationContext wac;
    private MockMvc mockMvc;

    @Before
    public void setup() {
        // Initialize mockMvc using WebApplicationContext
        mockMvc = MockMvcBuilders.webAppContextSetup(wac).build();
    }

    // Now perform tests using the mockMvc object
}
```

Static imports make it easier to invoke Builder & Matcher static methods

Setting Up Static Imports

- Static imports are key to fluid builders
  - **`MockMvcRequestBuilders.*`** and **`MockMvcResultMatchers.*`**
- You can add to Eclipse 'favorite static members' in preferences
  - Java → Editor → Content Assist → Favorites
  - Add to favorite static members
    - **`org.springframework.test.web.servlet.request.MockMvcRequestBuilders.get`**
    - **`org.springframework.test.web.servlet.result.MockMvcResultMatchers.status`**

Perform and Expect

`MockMvcRequestBuilders` methods go in **`perform()`**

- Argument to **`perform()`** dictates the action
  - **`perform()`** returns **`ResultActions`** object
  - Can chain **`expects`** together – fluid syntax

Options: *get*, *put*, *post*, *delete*, *fileUpload*

```
@Test
public void basicAccountDetailsRequest() {
 mockMvc.perform(get("/accounts/{acctId}", "123456001"))
            .andExpect(status().isOk())                    // Expect status code 200
            .andExpect(model().size(1))                    // Expect 1 model attribute
            .andExpect(view().name("accounts/show"))       // Expect this view returned
            .andExpect(forwardedUrl("/WEB-INF/accounts/show.jsp"));
}
```

`MockMvcResultMatchers` methods in *italics*

Matcher specific *assertion methods* go here

MockMvcRequestBuilders

Static Methods

- Standard HTTP get, put, post, delete operations
  - *fileUpload* also supported
  - Argument usually a URI template string
  - Returns a **`MockHttpServletRequestBuilder`** instance

```
// Perform a get using URI template style
mockMvc.perform(get("/accounts/{acctId}", "123456001"))

// Perform a get using request parameter style
mockMvc.perform(get("/accounts?myParam={acctId}", "123456001"))
```

MockHttpServletRequestBuilder

Static Methods

Method	Description
`param`	Add a request parameter – such as param(“myParam”, 123)
`requestAttr`	Add an object as a request attribute. Also, sessionAttr does the same for session scoped objects
`header`	Add a header variable to the request. Also see headers, which adds multiple headers
`contentType`	Set content type (Mime type) for body of the request
`accept`	Set the requested type (Mime type) for the expected response
`locale`	Set the local for making requests

MockHttpServletRequestBuilder Examples

- Adding Request Parameters

```
mockMvc.perform(post("/accounts/{acctId}","123456001")
            .param("name", “Some Name”            // Simulate form submission
            .param("dateOfBirth",  “2012-05-10”)
            ... // More parameters and/or other MockHttpServletResponseBuilder
                  // methods can be added
```

- Setting Accept Header

```
mockMvc.perform(get("/accounts/{acctId}","123456001")
            .accept("application/json;charset=UTF-8")  // Request JSON Response
            ...
```

MockMvcResultMatchers

Static Methods

- Returns Matchers providing specific assertions
  - Uses Hamcrest, see JavaDoc for details

Method	Matcher Returned	Description
`content`	ContentResultMatchers	Assertions relating to the HTTP response body
`model`	ModelResultMatchers	Assertions relating to the returned Model
`header`	HeaderResultMatchers	Assertions on HTTP headers
`view`	ViewResultMatchers	Assertions on returned view
`status`	StatusResultMatchers	Assertions on the HTTP status
`forwardedUrl`	ResultMatcher	Assertions on forwarded URL

Warning: “content” does *not* contain JSP output when running outside a container!

Simulating Complete Form Submission

```
@Test  public void testPutAccountSuccess() {
  mockMvc.perform( put("/accounts/{acctId}","123456001")
    .param("name", “Some Name”) // Simulate form submission
    .param("dateOfBirth",  “2012-05-10”)
    .param("email", “testEmail@someaddress.com”)
    .param("receiveNewsletter",  "1")
    .param("receiveMonthlyEmailUpdate",  "1") )
    .andExpect(status().isFound()) // Because this is a redirect
    .andExpect(redirectedUrl("123456001"));
}
```

Redirect URL from controller

```
@PutMapping("/accounts/{acctId}")
public String save(@Valid Account account, BindingResult result) {
  if (result.hasErrors()) { return "accounts/edit"; }
  accountManager.update(account);
  return "redirect:" + account.getNumber();
}
```

Checking for Validation and Binding Errors

Testing same Controller method

```
@Test
public void testPutAccountFailValidation() throws Exception {
  mockMvc.perform( put("/accounts/{acctId}","123456001")
    .param("email", "bogusemail")
      ... // Other parameters as previous slide
    .andExpect(model().attributeHasErrors("account"))
    .andExpect(model().attributeErrorCount("account", 1))
    .andExpect(model().attributeHasFieldErrors("account", "email"))
    .andExpect(status().isOk())
        // Because this is a forward to the same view
    .andExpect(view().name("accounts/edit"));
        // The redirect URL provided by the controller
}
```

Bad email – error expected

Printing Debug Information

- Sometimes you want to know what happened
  - **`andDo()`** performs action on **`MvcResult`**
  - **`print()`** sends the **`MvcResult`** to output stream
  - Or use **`andReturn()`** to get the **`MvcResult`** object

```
// Use this to access the print() method
import static org.springframework.test.web.servlet.result.MockMvcResult.*;

// Other static imports as well
// Use print() method in test to get debug information
mockMvc.perform(get("/accounts/{acctId}","123456001")
            .andDo(print())      // Add this line to print debug info to the console
                …
```

Agenda

- Testing Web Applications
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- **Going Further**
- Using HtmlUnit for Spring Testing
- Lab
- Optional/Advanced …

Testing RESTful Controllers I

- Can also test RESTful interactions
  - Need to specify expected contentType and accept values for representation

```
@GetMapping(produces="application/json")
public @RequestBody Account get(@PathVariable String number) {
    return accountManager.findAccount(number);
}
```

```
{
   "entityId": 1,
   "number": "123456001",
   "creditCardNumber": "1234123412340001",
   ...
}
```

JSON representation

Testing RESTful Controllers II

- Note use of **`accept()`** and **`jsonPath()`**
  - Assertions use JsonPath – like XPath for JSON
    - See https://code.google.com/p/json-path

```
@Test
public void testRestfulGet() throws Exception {
  mockMvc.perform(get("/accounts/{acctId}","123456001")
                .accept(MediaType.APPLICATION_JSON))
                .andExpect(content().contentType("application/json"))
                .andExpect(jsonPath("$.number").value("123456001"));
}
```

For more on JsonPath see: https://code.google.com/p/json-path

Spring Boot Testing

- Spring Boot provides additional testing options
  - **`@WebMvcTest`**
    - Component scanner only creates *web* beans
    - **`@Controller`**, **`@ControllerAdvice`**, **`Filter`**, **`@JsonComponent`**, **`WebMvcConfigurer`** …
    - *No* Service, Repository beans created
  - **`@MockBean`**
    - Define mocks
    - *Example:* mock the service(s) your Controller(s) rely on

Testing Controllers with Mocks

```
@ExtendWith(SpringExtension.class)
@SpringBootTest(AccountController.class)
public class MyControllerTests {
  @Autowired private MockMvc mvc;
  @MockBean private AccountService accountService;
  private static final String ACCOUNT_ID = "123456789";

  @Test
  public void testExample() throws Exception {
    given(this.accountService.getAccount(ACCOUNT_ID))
        .willReturn(new Account(ACCOUNT_ID, "Keith and Keri Donald"));

    mvc.perform(get("/accounts/{id}", ACCOUNT_ID))
      .accept(MediaType.TEXT_PLAIN))
      .andExpect(status().isOk())
      .andExpect(jsonPath("$.number").value(ACCOUNT_ID));
  }
```

Will mock the Account Service

Performing Security Testing – 1

```
public class AccountControllerIntegrationTests {
  @Autowired private WebApplicationContext context;
  @Autowired private FilterChainProxy springSecurityFilterChain;
  private MockMvc mockMvc;

  @Before
  public void setup() {
    mockMvc = webAppContextSetup(context).
      addFilter(springSecurityFilterChain).build();
  }
  @Test
  public void requiresAuthentication() throws Exception {
    mockMvc.perform(get("/"))
      .andExpect(redirectedUrl("http://localhost/login"));
  }
}
```

Inject `SpringSecurityFilterChain` and add as a filter

Assert unauthenticated access redirects to the configured login page

Performing Security Testing – 2

```
import static
    org.springframework.security.test.web.servlet.setup.SecurityMockMvcConfigurers.*;
public class AccountControllerIntegrationTests {
  @Autowired private WebApplicationContext context;
  private MockMvc mockMvc;

  @BeforeEach
  public void setup() {
    mockMvc = webAppContextSetup(context).apply(springSecurity()).build();
  }

  @Test
  @WithMockUser(username="admin",roles={"USER","ADMIN"})
  public void requiresAuthentication() throws Exception {
     mockMvc.perform(get("/")).andExpect(status().isOk());
   }
}
```

Adds **`springSecurityFilterChain`** as a filter

Run with this user having roles

No redirect this time – logged in as “admin” with required role

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What Is It For?

- Easily test web-pages using familiar tools
  - Integration testing without starting an application server
  - Supports HtmlUnit, WebDriver, and Geb
  - Support testing of JavaScript
  - Optionally test using mock services for faster testing
- **Note:** MockMvc only works fully with view technologies that do not rely on a Servlet Container
  - Thymeleaf, Freemarker, Velocity, …
  - Does not render JSPs or Tiles

Setup an HttpUnit WebClient

- Integrates WebClient with MockMvc
  - Requests to *localhost* processed “out-of-server” by MockMVC framework

```
@Autowired
WebApplicationContext context;

WebClient webClient;

@Before
public void setup() {
        webClient = MockMvcWebClientBuilder
                .webAppContextSetup(context).build();
}
```

Run a Test

- Use WebClient in the usual way

```
HtmlPage accountPage =
        webClient.getPage("http://localhost/accounts/123456789");
```

- Request processed by your Spring MVC application
  - Without using a container

Submit a Form

- 100% HttpUnit – no Spring

```
HtmlPage searchPage = webClient.getPage("http://localhost/accounts/search");

HtmlForm form = searchPage.getHtmlElementById("searchForm");
HtmlTextInput summaryInput = searchPage.getHtmlElementById("search");
summaryInput.setValueAttribute("Keith");

HtmlSubmitInput submit =
        form.getOneHtmlElementByAttribute("input", "type", "submit");
HtmlPage accountPage = submit.click();
```

Verify Result

- Again, standard HttpUnit

```
// Ensure the page returned is the right one
assertThat(accountPage.getUrl().
   toString()).endsWith("/accounts/123456789");

// Check account has the right name
String name = accountPage.getHtmlElementById("name").getTextContent();
assertThat(name).isEqualTo("Keith and Keri Donald");
```

http://docs.spring.io/spring/docs/current/spring-framework-reference/htmlsingle/#spring-mvc-test-server-resources

Additional Testing Capabilities

- Testing content negotiation
- Client side can be tested as well

- Additional references
  - Spring Reference Guide – Testing Chapter
    http://docs.spring.io/spring/docs/current/spring-framework-reference/html/testing.html
  - Spring Boot Testing
    https://docs.spring.io/spring-boot/docs/current/reference/html/boot-features-testing.html

Summary

- After completing this lesson, you should have learned that:
- Browsers provide many tools for developers
  - JavaScript debugging, logging
- Web application testing is essential part of a developer's responsibilities
- The Spring MVC Test framework offers an enhanced ability to test not just method calls but annotations, view resolution, status codes and more