# **Spring Boot Reference Guide**

### **2.1.0.RELEASE**



Copies of this document may be made for your own use and for distribution to others, provided that you do not charge any fee for such copies and further provided that each copy contains this Copyright Notice, whether distributed in print or electronically.

Copyright © 2012-2018

## **Table of Contents**

i. Spring Boot Documentation	1
1. About the Documentation	2
2. Getting Help	3
3. First Steps	4
4. Working with Spring Boot	5
5. Learning about Spring Boot Features	6
6. Moving to Production	7
7. Advanced Topics	8
II. Getting Started	9
8. Introducing Spring Boot	
9. System Requirements	
9.1. Servlet Containers	11
10. Installing Spring Boot	12
10.1. Installation Instructions for the Java Developer	
Maven Installation	
Gradle Installation	13
10.2. Installing the Spring Boot CLI	13
Manual Installation	
Installation with SDKMAN!	14
OSX Homebrew Installation	14
MacPorts Installation	15
Command-line Completion	15
Windows Scoop Installation	15
Quick-start Spring CLI Example	15
10.3. Upgrading from an Earlier Version of Spring Boot	16
11. Developing Your First Spring Boot Application	17
11.1. Creating the POM	17
11.2. Adding Classpath Dependencies	18
11.3. Writing the Code	18
The @RestController and @RequestMapping Annotations	19
The @EnableAutoConfiguration Annotation	19
The "main" Method	19
11.4. Running the Example	19
11.5. Creating an Executable Jar	20
12. What to Read Next	22
III. Using Spring Boot	23
13. Build Systems	24
13.1. Dependency Management	24
13.2. Maven	24
Inheriting the Starter Parent	
Using Spring Boot without the Parent POM	25
Using the Spring Boot Maven Plugin	26
13.3. Gradle	26
13.4. Ant	26
13.5. Starters	27
14. Structuring Your Code	33
14.1. Using the "default" Package	33

		14.2. Locating the Main Application Class	33
	15.	Configuration Classes	35
		15.1. Importing Additional Configuration Classes	35
		15.2. Importing XML Configuration	35
	16.	Auto-configuration	
		16.1. Gradually Replacing Auto-configuration	
		16.2. Disabling Specific Auto-configuration Classes	
	17	Spring Beans and Dependency Injection	
		Using the @SpringBootApplication Annotation	
		Running Your Application	
	15.	19.1. Running from an IDE	
		19.2. Running as a Packaged Application	
		19.3. Using the Maven Plugin	
		19.4. Using the Gradle Plugin	
	20	19.5. Hot Swapping	
	∠0.	Developer Tools	
		20.1. Property Defaults	
		20.2. Automatic Restart	
		Logging changes in condition evaluation	
		Excluding Resources	
		Watching Additional Paths	
		Disabling Restart	
		Using a Trigger File	
		Customizing the Restart Classloader	
		Known Limitations	46
		20.3. LiveReload	46
		20.4. Global Settings	46
		20.5. Remote Applications	
		Running the Remote Client Application	47
		Remote Update	48
	21.	Packaging Your Application for Production	49
	22.	What to Read Next	50
V. S	Sprin	g Boot features	51
	23.	SpringApplication	52
		23.1. Startup Failure	52
		23.2. Customizing the Banner	53
		23.3. Customizing SpringApplication	54
		23.4. Fluent Builder API	
		23.5. Application Events and Listeners	
		23.6. Web Environment	
		23.7. Accessing Application Arguments	
		23.8. Using the ApplicationRunner or CommandLineRunner	
		23.9. Application Exit	
		23.10. Admin Features	
	24	Externalized Configuration	
	۷٦.	24.1. Configuring Random Values	
		24.2. Accessing Command Line Properties	
		·	
		24.3. Application Property Files	
		24.4. Profile-specific Properties	
		24.5. Placeholders in Properties	03

	24.6. Encrypting Properties	63
	24.7. Using YAML Instead of Properties	63
	Loading YAML	64
	Exposing YAML as Properties in the Spring Environment	64
	Multi-profile YAML Documents	64
	YAML Shortcomings	65
	24.8. Type-safe Configuration Properties	66
	Third-party Configuration	69
	Relaxed Binding	69
	Merging Complex Types	70
	Properties Conversion	72
	Converting durations	72
	Converting Data Sizes	73
	@ConfigurationProperties Validation	
	@ConfigurationProperties vs. @Value	
25.	rofiles	
	25.1. Adding Active Profiles	
	25.2. Programmatically Setting Profiles	
	25.3. Profile-specific Configuration Files	
26.	ogging	
	26.1. Log Format	
	26.2. Console Output	
	Color-coded Output	
	26.3. File Output	
	26.4. Log Levels	
	26.5. Log Groups	
	26.6. Custom Log Configuration	
	26.7. Logback Extensions	
	Profile-specific Configuration	
	Environment Properties	
27	SON	
21.	27.1. Jackson	
	27.2. Gson	
	27.3. JSON-B	
28	eveloping Web Applications	
20.	28.1. The "Spring Web MVC Framework"	
	Spring MVC Auto-configuration	
	HttpMessageConverters	
	Custom JSON Serializers and Deserializers	
	MessageCodesResolver	
	Static Content	
	Welcome Page	
	Custom Favicon	
	Path Matching and Content Negotiation	
	ConfigurableWebBindingInitializer	
	Template Engines	
	Error Handling	
	Custom Error Pages	
	Mapping Error Pages outside of Spring MVC	
	Spring HATEOAS	94

		CORS Support	
	28.2	. The "Spring WebFlux Framework"	
		Spring WebFlux Auto-configuration	
		HTTP Codecs with HttpMessageReaders and HttpMessageWriters	
		Static Content	
		Template Engines	
		Error Handling	98
		Custom Error Pages	
		Web Filters	99
	28.3	. JAX-RS and Jersey	99
	28.4	. Embedded Servlet Container Support	100
		Servlets, Filters, and listeners	101
		Registering Servlets, Filters, and Listeners as Spring Beans	101
		Servlet Context Initialization	101
		Scanning for Servlets, Filters, and listeners	102
		The ServletWebServerApplicationContext	102
		Customizing Embedded Servlet Containers	102
		Programmatic Customization	103
		Customizing ConfigurableServletWebServerFactory Directly	103
		JSP Limitations	104
	28.5	. Embedded Reactive Server Support	104
	28.6	. Reactive Server Resources Configuration	104
29.	Secur	ity	105
	29.1	MVC Security	105
	29.2	. WebFlux Security	106
	29.3	. OAuth2	106
		Client	106
		OAuth2 client registration for common providers	
		Resource Server	
		Authorization Server	
	29.4	. Actuator Security	
		Cross Site Request Forgery Protection	
30.	Worki	ng with SQL Databases	
		. Configure a DataSource	
		Embedded Database Support	
		Connection to a Production Database	
		Connection to a JNDI DataSource	
	30.2	. Using JdbcTemplate	
		. JPA and Spring Data JPA	
	00.0	Entity Classes	
		Spring Data JPA Repositories	
		Creating and Dropping JPA Databases	
		Open EntityManager in View	
	30.4	Spring Data JDBC	
		. Using H2's Web Console	
	50.5	Changing the H2 Console's Path	
	30 E	Using jOOQ	
	30.0	Code Generation	
		Using DSLContext	
		•	
		jOOQ SQL Dialect	117

Customizing jOOQ	117
31. Working with NoSQL Technologies	119
31.1. Redis	119
Connecting to Redis	119
31.2. MongoDB	
Connecting to a MongoDB Database	
MongoTemplate	
Spring Data MongoDB Repositories	
Embedded Mongo	
31.3. Neo4j	
Connecting to a Neo4j Database	
Using the Embedded Mode	
Neo4jSession	
Spring Data Neo4j Repositories	
31.4. Gemfire	
31.5. Solr	
Connecting to Solr	
Spring Data Solr Repositories	
31.6. Elasticsearch	
Connecting to Elasticsearch by REST clients	
Connecting to Elasticsearch by Using Jest	
Connecting to Elasticsearch by Using Spring Data	
Spring Data Elasticsearch Repositories	
31.7. Cassandra	
Connecting to Cassandra	
Spring Data Cassandra Repositories	
31.8. Couchbase	
Connecting to Couchbase	
Spring Data Couchbase Repositories	
31.9. LDAP	
Connecting to an LDAP Server	
Spring Data LDAP Repositories	
Embedded In-memory LDAP Server	
31.10. InfluxDB	
Connecting to InfluxDB	
32. Caching	
32.1. Supported Cache Providers	
Generic	
JCache (JSR-107)	
EhCache 2.x	
Hazelcast	
Infinispan	
Couchbase	
Redis	
Caffeine	
Simple	
None	
33. Messaging	
33.1. JMS	
ActiveMQ Support	

	Artemis Support	138
	Using a JNDI ConnectionFactory	139
	Sending a Message	139
	Receiving a Message	139
	33.2. AMQP	140
	RabbitMQ support	140
	Sending a Message	141
	Receiving a Message	142
	33.3. Apache Kafka Support	
	Sending a Message	143
	Receiving a Message	
	Kafka Streams	
	Additional Kafka Properties	
34.	Calling REST Services with RestTemplate	
	34.1. RestTemplate Customization	
35.	Calling REST Services with WebClient	
	35.1. WebClient Runtime	
	35.2. WebClient Customization	
36	Validation	
	Sending Email	
	Distributed Transactions with JTA	
50.	38.1. Using an Atomikos Transaction Manager	
	38.2. Using a Bitronix Transaction Manager	
	38.3. Using a Java EE Managed Transaction Manager	
	38.4. Mixing XA and Non-XA JMS Connections	
20	38.5. Supporting an Alternative Embedded Transaction Manager	
	Hazelcast	
	Quartz Scheduler	
	Task Execution and Scheduling	
	Spring Integration	
	Spring Session	
	Monitoring and Management over JMX	
45.	Testing	
	45.1. Test Scope Dependencies	
	45.2. Testing Spring Applications	
	45.3. Testing Spring Boot Applications	162
	Detecting Web Application Type	164
	Detecting Test Configuration	164
	Excluding Test Configuration	164
	Testing with a mock environment	165
	Testing with a running server	166
	Using JMX	167
	Mocking and Spying Beans	167
	Auto-configured Tests	168
	Auto-configured JSON Tests	
	Auto-configured Spring MVC Tests	
	Auto-configured Spring WebFlux Tests	
	Auto-configured Data JPA Tests	
	Auto-configured JDBC Tests	
	Auto-configured Data JDBC Tests	
	<b>~</b>	

	Auto-configured jOOQ Tests	175
	Auto-configured Data MongoDB Tests	176
	Auto-configured Data Neo4j Tests	177
	Auto-configured Data Redis Tests	178
	Auto-configured Data LDAP Tests	178
	Auto-configured REST Clients	179
	Auto-configured Spring REST Docs Tests	179
	Auto-configured Spring REST Docs Tests with Mock MVC	180
	Auto-configured Spring REST Docs Tests with REST Assured	181
	Additional Auto-configuration and Slicing	181
	User Configuration and Slicing	182
	Using Spock to Test Spring Boot Applications	183
	45.4. Test Utilities	183
	ConfigFileApplicationContextInitializer	183
	TestPropertyValues	183
	OutputCapture	183
	TestRestTemplate	184
46.	WebSockets	186
47.	Web Services	187
48.	Calling Web Services with WebServiceTemplate	188
49.	Creating Your Own Auto-configuration	189
	49.1. Understanding Auto-configured Beans	189
	49.2. Locating Auto-configuration Candidates	189
	49.3. Condition Annotations	189
	Class Conditions	190
	Bean Conditions	190
	Property Conditions	191
	Resource Conditions	191
	Web Application Conditions	191
	SpEL Expression Conditions	191
	49.4. Testing your Auto-configuration	191
	Simulating a Web Context	192
	Overriding the Classpath	193
	49.5. Creating Your Own Starter	193
	Naming	193
	autoconfigure Module	
	Starter Module	194
50.	Kotlin support	
	50.1. Requirements	
	50.2. Null-safety	
	50.3. Kotlin API	196
	runApplication	
	Extensions	
	50.4. Dependency management	
	50.5. @ConfigurationProperties	
	50.6. Testing	
	50.7. Resources	
	Further reading	
	Examples	
51	What to Read Next	199

٧.	Spring Boot Actuator: Production-ready features	
	52. Enabling Production-ready Features	. 201
	53. Endpoints	. 202
	53.1. Enabling Endpoints	. 203
	53.2. Exposing Endpoints	
	53.3. Securing HTTP Endpoints	. 205
	53.4. Configuring Endpoints	. 206
	53.5. Hypermedia for Actuator Web Endpoints	206
	53.6. CORS Support	207
	53.7. Implementing Custom Endpoints	207
	Receiving Input	207
	Input type conversion	208
	Custom Web Endpoints	. 208
	Web Endpoint Request Predicates	. 208
	Path	. 208
	HTTP method	208
	Consumes	209
	Produces	209
	Web Endpoint Response Status	209
	Web Endpoint Range Requests	
	Web Endpoint Security	
	Servlet endpoints	
	Controller endpoints	
	53.8. Health Information	
	Auto-configured HealthIndicators	
	Writing Custom HealthIndicators	
	Reactive Health Indicators	
	Auto-configured ReactiveHealthIndicators	
	53.9. Application Information	
	Auto-configured InfoContributors	
	Custom Application Information	
	Git Commit Information	
	Build Information	
	Writing Custom InfoContributors	
	54. Monitoring and Management over HTTP	
	54.1. Customizing the Management Endpoint Paths	
	54.2. Customizing the Management Server Port	
	54.3. Configuring Management-specific SSL	
	54.4. Customizing the Management Server Address	
	54.5. Disabling HTTP Endpoints	
	55. Monitoring and Management over JMX	
	55.1. Customizing MBean Names	
	55.2. Disabling JMX Endpoints	
	55.3. Using Jolokia for JMX over HTTP	
	Customizing Jolokia	
	Disabling Jolokia	
	56. Loggers	
	56.1. Configure a Logger	
	57. Metrics	
	57.1. Getting started	
	07.11. Octaing started	44

57.2. Supported monitoring systems	222
AppOptics	
Atlas	
Datadog	
Dynatrace	223
Elastic	223
Ganglia	223
Graphite	223
Humio	
Influx	
JMX	
KairosDB	
New Relic	
Prometheus	
SignalFx	225
Simple	225
StatsD	225
Wavefront	226
57.3. Supported Metrics	
Spring MVC Metrics	
Spring WebFlux Metrics	
Jersey Server Metrics	
HTTP Client Metrics	
Cache Metrics	
DataSource Metrics	230
Hibernate Metrics	230
RabbitMQ Metrics	230
57.4. Registering custom metrics	231
57.5. Customizing individual metrics	231
Common tags	
Per-meter properties	
57.6. Metrics endpoint	
·	
58. Auditing	
59. HTTP Tracing	
59.1. Custom HTTP tracing	
60. Process Monitoring	
60.1. Extending Configuration	236
60.2. Programmatically	236
61. Cloud Foundry Support	237
61.1. Disabling Extended Cloud Foundry Actuator Support	
61.2. Cloud Foundry Self-signed Certificates	
61.3. Custom context path	
62. What to Read Next	
VI. Deploying Spring Boot Applications	
63. Deploying to the Cloud	
63.1. Cloud Foundry	
Binding to Services	242
63.2. Heroku	243
63.3. OpenShift	244
63.4. Amazon Web Services (AWS)	244
<b>,</b> ,	

	AWS Elastic Beanstalk	244
	Using the Tomcat Platform	244
	Using the Java SE Platform	244
	Summary	245
	63.5. Boxfuse and Amazon Web Services	245
	63.6. Google Cloud	246
64	I. Installing Spring Boot Applications	248
	64.1. Supported Operating Systems	
	64.2. Unix/Linux Services	248
	Installation as an init.d Service (System V)	248
	Securing an init.d Service	
	Installation as a systemd Service	
	Customizing the Startup Script	
	Customizing the Start Script when It Is Written	
	Customizing a Script When It Runs	
	64.3. Microsoft Windows Services	
65	5. What to Read Next	
	ring Boot CLI	
	S. Installing the CLI	
	7. Using the CLI	
	67.1. Running Applications with the CLI	
	Deduced "grab" Dependencies	
	Deduced "grab" Coordinates	
	Default Import Statements	
	Automatic Main Method	
	Custom Dependency Management	
	67.2. Applications with Multiple Source Files	
	67.3. Packaging Your Application	
	67.4. Initialize a New Project	
	67.5. Using the Embedded Shell	
	67.6. Adding Extensions to the CLI	
68	B. Developing Applications with the Groovy Beans DSL	
	O. Configuring the CLI with settings.xml	
	). What to Read Next	
	ild tool plugins	
	I. Spring Boot Maven Plugin	
	71.1. Including the Plugin	
	71.2. Packaging Executable Jar and War Files	
72	2. Spring Boot Gradle Plugin	
	3. Spring Boot AntLib Module	
	73.1. Spring Boot Ant Tasks	
	spring-boot:exejar	
	Examples	
	73.2. spring-boot:findmainclass	
	Examples	
74	I. Supporting Other Build Systems	
	74.1. Repackaging Archives	
	74.2. Nested Libraries	
	74.3. Finding a Main Class	
	74.4. Example Repackage Implementation	
	, , , , , , , , , , , , , , , , , , , ,	

χi

75. What to Read Next	274
(. 'How-to' guides	275
76. Spring Boot Application	276
76.1. Create Your Own FailureAnalyzer	276
76.2. Troubleshoot Auto-configuration	276
76.3. Customize the Environment or ApplicationContext Before It Starts	277
76.4. Build an ApplicationContext Hierarchy (Adding a Parent or Root Context)	278
76.5. Create a Non-web Application	278
77. Properties and Configuration	279
77.1. Automatically Expand Properties at Build Time	279
Automatic Property Expansion Using Maven	279
Automatic Property Expansion Using Gradle	280
77.2. Externalize the Configuration of SpringApplication	280
77.3. Change the Location of External Properties of an Application	281
77.4. Use 'Short' Command Line Arguments	281
77.5. Use YAML for External Properties	282
77.6. Set the Active Spring Profiles	282
77.7. Change Configuration Depending on the Environment	
77.8. Discover Built-in Options for External Properties	
78. Embedded Web Servers	
78.1. Use Another Web Server	284
78.2. Disabling the Web Server	285
78.3. Change the HTTP Port	
78.4. Use a Random Unassigned HTTP Port	
78.5. Discover the HTTP Port at Runtime	
78.6. Enable HTTP Response Compression	286
78.7. Configure SSL	
78.8. Configure HTTP/2	
HTTP/2 with Undertow	
HTTP/2 with Jetty	287
HTTP/2 with Tomcat	287
HTTP/2 with Reactor Netty	287
78.9. Configure the Web Server	288
78.10. Add a Servlet, Filter, or Listener to an Application	
Add a Servlet, Filter, or Listener by Using a Spring Bean	
Disable Registration of a Servlet or Filter	
Add Servlets, Filters, and Listeners by Using Classpath Scanning	
78.11. Configure Access Logging	
78.12. Running Behind a Front-end Proxy Server	290
Customize Tomcat's Proxy Configuration	290
78.13. Enable Multiple Connectors with Tomcat	
78.14. Use Tomcat's LegacyCookieProcessor	
78.15. Enable Multiple Listeners with Undertow	292
78.16. Create WebSocket Endpoints Using @ServerEndpoint	
79. Spring MVC	
79.1. Write a JSON REST Service	
79.2. Write an XML REST Service	
79.3. Customize the Jackson ObjectMapper	
79.4. Customize the @ResponseBody Rendering	
79.5. Handling Multipart File Uploads	

	79.6. Switch Off the Spring MVC DispatcherServlet	296
	79.7. Switch off the Default MVC Configuration	296
	79.8. Customize ViewResolvers	296
80.	Testing With Spring Security	298
81.	Jersey	299
	81.1. Secure Jersey endpoints with Spring Security	
82.	HTTP Clients	300
	82.1. Configure RestTemplate to Use a Proxy	
83.	Logging	
	83.1. Configure Logback for Logging	
	Configure Logback for File-only Output	
	83.2. Configure Log4j for Logging	
	Use YAML or JSON to Configure Log4j 2	
84	Data Access	
04.	84.1. Configure a Custom DataSource	
	84.2. Configure Two DataSources	
	84.3. Use Spring Data Repositories	
	84.4. Separate @Entity Definitions from Spring Configuration	
	84.5. Configure JPA Properties	
	·	
	84.6. Configure Hibernate Naming Strategy	
	84.7. Configure Hibernate Second-Level Caching	
	84.8. Use Dependency Injection in Hibernate Components	
	84.9. Use a Custom EntityManagerFactory	
	84.10. Use Two EntityManagers	
	84.11. Use a Traditional persistence.xml File	
	84.12. Use Spring Data JPA and Mongo Repositories	
	84.13. Customize Spring Data's Web Support	
	84.14. Expose Spring Data Repositories as REST Endpoint	
	84.15. Configure a Component that is Used by JPA	
	84.16. Configure jOOQ with Two DataSources	
85.	Database Initialization	
	85.1. Initialize a Database Using JPA	
	85.2. Initialize a Database Using Hibernate	313
	85.3. Initialize a Database	313
	85.4. Initialize a Spring Batch Database	314
	85.5. Use a Higher-level Database Migration Tool	314
	Execute Flyway Database Migrations on Startup	314
	Execute Liquibase Database Migrations on Startup	315
86.	Messaging	316
	86.1. Disable Transacted JMS Session	316
87.	Batch Applications	317
	87.1. Execute Spring Batch Jobs on Startup	
88.	Actuator	
	88.1. Change the HTTP Port or Address of the Actuator Endpoints	
	88.2. Customize the 'whitelabel' Error Page	
	88.3. Sanitize sensible values	
89	Security	
55.	89.1. Switch off the Spring Boot Security Configuration	
	89.2. Change the UserDetailsService and Add User Accounts	
	89.3. Enable HTTPS When Running behind a Proxy Server	
	Co.S. Enable III II & Wholi Nahilling behind at long belief	010

90.1. Reload Static Content	320
90.2. Reload Templates without Restarting the Container	320
	320
Thymeleaf Templates	320
FreeMarker Templates	320
Groovy Templates	320
90.3. Fast Application Restarts	320
90.4. Reload Java Classes without Restarting the Container	321
91. Build 3	322
91.1. Generate Build Information	322
91.2. Generate Git Information	322
91.3. Customize Dependency Versions	323
91.4. Create an Executable JAR with Maven	323
91.5. Use a Spring Boot Application as a Dependency	324
91.6. Extract Specific Libraries When an Executable Jar Runs	
91.7. Create a Non-executable JAR with Exclusions	325
91.8. Remote Debug a Spring Boot Application Started with Maven	326
91.9. Build an Executable Archive from Ant without Using spring-boot-antlib 3	
92. Traditional Deployment	
92.1. Create a Deployable War File	328
92.2. Convert an Existing Application to Spring Boot	329
92.3. Deploying a WAR to WebLogic	
92.4. Use Jedis Instead of Lettuce	331
X. Appendices	333
A. Common application properties	334
B. Configuration Metadata	365
B.1. Metadata Format	365
Group Attributes	366
Property Attributes	367
Hint Attributes	369
Repeated Metadata Items	370
B.2. Providing Manual Hints	370
Value Hint	370
Value Providers	371
Any 3	371
Class Reference	372
Handle As	372
Logger Name	373
Spring Bean Reference	374
Spring Profile Name	375
D. 2. Consenting Vous Over Metadata by Using the Apparation Processor	375
B.3. Generating Your Own Metadata by Using the Annotation Processor	377
Nested Properties	
· · · ·	377
Nested Properties	
Nested Properties	378
Nested Properties	378 378
Nested Properties	378 378 382
Nested Properties  Adding Additional Metadata  C. Auto-configuration classes  C.1. From the "spring-boot-autoconfigure" module  C.2. From the "spring-boot-actuator-autoconfigure" module	378 378 382 386
Nested Properties  Adding Additional Metadata  C. Auto-configuration classes  C.1. From the "spring-boot-autoconfigure" module  C.2. From the "spring-boot-actuator-autoconfigure" module  D. Test auto-configuration annotations	378 378 382 386 389

The Executable War File Structure	389
E.2. Spring Boot's "JarFile" Class	390
Compatibility with the Standard Java "JarFile"	390
E.3. Launching Executable Jars	390
Launcher Manifest	391
Exploded Archives	391
E.4. PropertiesLauncher Features	391
E.5. Executable Jar Restrictions	393
E.6. Alternative Single Jar Solutions	393
F. Dependency versions	394

# **Part I. Spring Boot Documentation**

This section provides a brief overview of Spring Boot reference documentation. It serves as a map fo the rest of the document.

## 1. About the Documentation

The Spring Boot reference guide is available as

- HTML
- PDF
- EPUB

The latest copy is available at <a href="https://docs/current/reference">docs.spring.io/spring-boot/docs/current/reference</a>.

Copies of this document may be made for your own use and for distribution to others, provided that you do not charge any fee for such copies and further provided that each copy contains this Copyright Notice, whether distributed in print or electronically.

## 2. Getting Help

If you have trouble with Spring Boot, we would like to help.

- Try the <u>How-to documents</u>. They provide solutions to the most common questions.
- Learn the Spring basics. Spring Boot builds on many other Spring projects. Check the <a href="mailto:spring.io">spring.io</a> website for a wealth of reference documentation. If you are starting out with Spring, try one of the <a href="mailto:guides">guides</a>.
- Ask a question. We monitor <u>stackoverflow.com</u> for questions tagged with <u>spring-boot</u>.
- Report bugs with Spring Boot at <a href="mailto:github.com/spring-projects/spring-boot/issues">github.com/spring-projects/spring-boot/issues</a>.

#### Note

All of Spring Boot is open source, including the documentation. If you find problems with the docs or if you want to improve them, please <u>get involved</u>.

# 3. First Steps

If you are getting started with Spring Boot or 'Spring' in general, start with the following topics:

• From scratch: Overview | Requirements | Installation

• Tutorial: <u>Part 1</u> | <u>Part 2</u>

• Running your example: Part 1 | Part 2

## 4. Working with Spring Boot

Ready to actually start using Spring Boot? We have you covered:

- Build systems: Maven | Gradle | Ant | Starters
- Best practices: <u>Code Structure</u> | <u>@Configuration</u> | <u>@EnableAutoConfiguration</u> | <u>Beans and Dependency Injection</u>
- Running your code IDE | Packaged | Maven | Gradle
- Packaging your app: Production jars
- Spring Boot CLI: Using the CLI

## 5. Learning about Spring Boot Features

Need more details about Spring Boot's core features? The following content is for you:

• Core Features: SpringApplication | External Configuration | Profiles | Logging

• Web Applications: MVC | Embedded Containers

• Working with data: SQL | NO-SQL

• Messaging: Overview | JMS

• Testing: Overview | Boot Applications | Utils

• Extending: <u>Auto-configuration</u> | <u>@Conditions</u>

# 6. Moving to Production

When you are ready to push your Spring Boot application to production, we have <u>some tricks</u> that you might like:

• Management endpoints: Overview | Customization

• Connection options: <u>HTTP | JMX</u>

• Monitoring: Metrics | Auditing | Tracing | Process

# 7. Advanced Topics

Finally, we have a few topics for more advanced users:

- Spring Boot Applications Deployment: Cloud Deployment | OS Service
- Build tool plugins: Maven | Gradle
- Appendix: Application Properties | Auto-configuration classes | Executable Jars

# Part II. Getting Started

If you are getting started with Spring Boot, or "Spring" in general, start by reading this section. It answers the basic "what?", "how?" and "why?" questions. It includes an introduction to Spring Boot, along with installation instructions. We then walk you through building your first Spring Boot application, discussing some core principles as we go.

## 8. Introducing Spring Boot

Spring Boot makes it easy to create stand-alone, production-grade Spring-based Applications that you can run. We take an opinionated view of the Spring platform and third-party libraries, so that you can get started with minimum fuss. Most Spring Boot applications need very little Spring configuration.

You can use Spring Boot to create Java applications that can be started by using <code>java -jar</code> or more traditional war deployments. We also provide a command line tool that runs "spring scripts".

#### Our primary goals are:

- Provide a radically faster and widely accessible getting-started experience for all Spring development.
- Be opinionated out of the box but get out of the way quickly as requirements start to diverge from the defaults.
- Provide a range of non-functional features that are common to large classes of projects (such as embedded servers, security, metrics, health checks, and externalized configuration).
- Absolutely no code generation and no requirement for XML configuration.

# 9. System Requirements

Spring Boot 2.1.0.RELEASE requires <u>Java 8 or 9</u> and <u>Spring Framework 5.1.2.RELEASE</u> or above.

Explicit build support is provided for the following build tools:

Build Tool	Version
Maven	3.3+
Gradle	4.4+

### 9.1 Servlet Containers

Spring Boot supports the following embedded servlet containers:

Name	Servlet Version
Tomcat 9.0	4.0
Jetty 9.4	3.1
Undertow 2.0	4.0

You can also deploy Spring Boot applications to any Servlet 3.1+ compatible container.

## 10. Installing Spring Boot

Spring Boot can be used with "classic" Java development tools or installed as a command line tool. Either way, you need <u>Java SDK v1.8</u> or higher. Before you begin, you should check your current Java installation by using the following command:

```
$ java -version
```

If you are new to Java development or if you want to experiment with Spring Boot, you might want to try the <u>Spring Boot CLI</u> (Command Line Interface) first. Otherwise, read on for "classic" installation instructions.

### 10.1 Installation Instructions for the Java Developer

You can use Spring Boot in the same way as any standard Java library. To do so, include the appropriate <code>spring-boot-\*.jar</code> files on your classpath. Spring Boot does not require any special tools integration, so you can use any IDE or text editor. Also, there is nothing special about a Spring Boot application, so you can run and debug a Spring Boot application as you would any other Java program.

Although you *could* copy Spring Boot jars, we generally recommend that you use a build tool that supports dependency management (such as Maven or Gradle).

#### **Maven Installation**

Spring Boot is compatible with Apache Maven 3.3 or above. If you do not already have Maven installed, you can follow the instructions at <u>maven.apache.org</u>.

#### Tip

On many operating systems, Maven can be installed with a package manager. If you use OSX Homebrew, try brew install maven. Ubuntu users can run sudo apt-get install maven. Windows users with Chocolatey can run choco install maven from an elevated (administrator) prompt.

Spring Boot dependencies use the org.springframework.boot groupId. Typically, your Maven POM file inherits from the spring-boot-starter-parent project and declares dependencies to one or more <u>"Starters"</u>. Spring Boot also provides an optional <u>Maven plugin</u> to create executable jars.

The following listing shows a typical pom.xml file:

```
<dependencies>
 <dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-web</artifactId>
 </dependency>
</dependencies>
<!-- Package as an executable jar -->
<build>
 <plugins>
  <plugin>
   <groupId>org.springframework.boot</groupId>
   <artifactId>spring-boot-maven-plugin</artifactId>
  </plugin>
 </plugins>
</build>
</project>
```

#### Tip

The spring-boot-starter-parent is a great way to use Spring Boot, but it might not be suitable all of the time. Sometimes you may need to inherit from a different parent POM, or you might not like our default settings. In those cases, see the section called "Using Spring Boot without the Parent POM" for an alternative solution that uses an import scope.

#### **Gradle Installation**

Spring Boot is compatible with Gradle 4.4 and later. If you do not already have Gradle installed, you can follow the instructions at <u>gradle.org</u>.

Spring Boot dependencies can be declared by using the org.springframework.boot group. Typically, your project declares dependencies to one or more <u>"Starters"</u>. Spring Boot provides a useful <u>Gradle plugin</u> that can be used to simplify dependency declarations and to create executable jars.

#### **Gradle Wrapper**

The Gradle Wrapper provides a nice way of "obtaining" Gradle when you need to build a project. It is a small script and library that you commit alongside your code to bootstrap the build process. See <a href="docs.gradle.org/4.2.1/userguide/gradle\_wrapper.html">docs.gradle.org/4.2.1/userguide/gradle\_wrapper.html</a> for details.

More details on getting started with Spring Boot and Gradle can be found in the <u>Getting Started section</u> of the Gradle plugin's reference guide.

### 10.2 Installing the Spring Boot CLI

The Spring Boot CLI (Command Line Interface) is a command line tool that you can use to quickly prototype with Spring. It lets you run <u>Groovy</u> scripts, which means that you have a familiar Java-like syntax without so much boilerplate code.

You do not need to use the CLI to work with Spring Boot, but it is definitely the quickest way to get a Spring application off the ground.

#### **Manual Installation**

You can download the Spring CLI distribution from the Spring software repository:

spring-boot-cli-2.1.0.RELEASE-bin.zip

#### • spring-boot-cli-2.1.0.RELEASE-bin.tar.gz

Cutting edge <u>snapshot distributions</u> are also available.

Once downloaded, follow the <a href="INSTALL.txt">INSTALL.txt</a> instructions from the unpacked archive. In summary, there is a spring script (spring.bat for Windows) in a bin/directory in the .zip file. Alternatively, you can use java -jar with the .jar file (the script helps you to be sure that the classpath is set correctly).

#### Installation with SDKMAN!

SDKMAN! (The Software Development Kit Manager) can be used for managing multiple versions of various binary SDKs, including Groovy and the Spring Boot CLI. Get SDKMAN! from <a href="mailto:sdkman.io">sdkman.io</a> and install Spring Boot by using the following commands:

```
$ sdk install springboot
$ spring --version
Spring Boot v2.1.0.RELEASE
```

If you develop features for the CLI and want easy access to the version you built, use the following commands:

```
$ sdk install springboot dev /path/to/spring-boot/spring-boot-cli/target/spring-boot-cli-2.1.0.RELEASE-
bin/spring-2.1.0.RELEASE/
$ sdk default springboot dev
$ spring --version
Spring CLI v2.1.0.RELEASE
```

The preceding instructions install a local instance of spring called the dev instance. It points at your target build location, so every time you rebuild Spring Boot, spring is up-to-date.

You can see it by running the following command:

#### **OSX Homebrew Installation**

If you are on a Mac and use <u>Homebrew</u>, you can install the Spring Boot CLI by using the following commands:

```
$ brew tap pivotal/tap
$ brew install springboot
```

Homebrew installs spring to /usr/local/bin.

#### Note

If you do not see the formula, your installation of brew might be out-of-date. In that case, run brew update and try again.

#### **MacPorts Installation**

If you are on a Mac and use <u>MacPorts</u>, you can install the Spring Boot CLI by using the following command:

```
$ sudo port install spring-boot-cli
```

#### **Command-line Completion**

The Spring Boot CLI includes scripts that provide command completion for the <u>BASH</u> and <u>zsh</u> shells. You can source the script (also named spring) in any shell or put it in your personal or system-wide bash completion initialization. On a Debian system, the system-wide scripts are in /shell-completion/bash and all scripts in that directory are executed when a new shell starts. For example, to run the script manually if you have installed by using SDKMAN!, use the following commands:

```
$ . ~/.sdkman/candidates/springboot/current/shell-completion/bash/spring
$ spring <HIT TAB HERE>
    grab help jar run test version
```

#### Note

If you install the Spring Boot CLI by using Homebrew or MacPorts, the command-line completion scripts are automatically registered with your shell.

#### Windows Scoop Installation

If you are on a Windows and use <u>Scoop</u>, you can install the Spring Boot CLI by using the following commands:

```
> scoop bucket add extras
> scoop install springboot
```

Scoop installs spring to ~/scoop/apps/springboot/current/bin.

#### Note

If you do not see the app manifest, your installation of scoop might be out-of-date. In that case, run scoop update and try again.

#### **Quick-start Spring CLI Example**

You can use the following web application to test your installation. To start, create a file called app.groovy, as follows:

```
@RestController
class ThisWillActuallyRun {

    @RequestMapping("/")
    String home() {
        "Hello World!"
    }
}
```

Then run it from a shell, as follows:

```
$ spring run app.groovy
```

#### Note

The first run of your application is slow, as dependencies are downloaded. Subsequent runs are much quicker.

Open <u>localhost: 8080</u> in your favorite web browser. You should see the following output:

```
Hello World!
```

### 10.3 Upgrading from an Earlier Version of Spring Boot

If you are upgrading from an earlier release of Spring Boot, check the <u>"migration guide" on the project wiki</u> that provides detailed upgrade instructions. Check also the <u>"release notes"</u> for a list of "new and noteworthy" features for each release.

When upgrading to a new feature release, some properties may have been renamed or removed. Spring Boot provides a way to analyze your application's environment and print diagnostics at startup, but also temporarily migrate properties at runtime for you. To enable that feature, add the following dependency to your project:

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-properties-migrator</artifactId>
    <scope>runtime</scope>
</dependency>
```

#### Warning

Properties that are added late to the environment, such as when using @PropertySource, will not be taken into account.

#### Note

Once you're done with the migration, please make sure to remove this module from your project's dependencies.

To upgrade an existing CLI installation, use the appropriate package manager command (for example, brew upgrade) or, if you manually installed the CLI, follow the <u>standard instructions</u>, remembering to update your PATH environment variable to remove any older references.

## 11. Developing Your First Spring Boot Application

This section describes how to develop a simple "Hello World!" web application that highlights some of Spring Boot's key features. We use Maven to build this project, since most IDEs support it.

#### Tip

The <u>spring.io</u> web site contains many "Getting Started" <u>guides</u> that use Spring Boot. If you need to solve a specific problem, check there first.

You can shortcut the steps below by going to <u>start.spring.io</u> and choosing the "Web" starter from the dependencies searcher. Doing so generates a new project structure so that you can <u>start coding right away</u>. Check the <u>Spring Initializr documentation</u> for more details.

Before we begin, open a terminal and run the following commands to ensure that you have valid versions of Java and Mayen installed:

```
$ java -version
java version "1.8.0_102"
Java(TM) SE Runtime Environment (build 1.8.0_102-b14)
Java HotSpot(TM) 64-Bit Server VM (build 25.102-b14, mixed mode)

$ mvn -v
Apache Maven 3.5.4 (ledded0938998edf8bf061f1ceb3cfdeccf443fe; 2018-06-17T14:33:14-04:00)
Maven home: /usr/local/Cellar/maven/3.3.9/libexec
Java version: 1.8.0_102, vendor: Oracle Corporation
```

#### Note

This sample needs to be created in its own folder. Subsequent instructions assume that you have created a suitable folder and that it is your current directory.

### 11.1 Creating the POM

We need to start by creating a Maven pom.xml file. The pom.xml is the recipe that is used to build your project. Open your favorite text editor and add the following:

The preceding listing should give you a working build. You can test it by running mvn package (for now, you can ignore the "jar will be empty - no content was marked for inclusion!" warning).

#### Note

At this point, you could import the project into an IDE (most modern Java IDEs include built-in support for Maven). For simplicity, we continue to use a plain text editor for this example.

### 11.2 Adding Classpath Dependencies

Spring Boot provides a number of "Starters" that let you add jars to your classpath. Our sample application has already used spring-boot-starter-parent in the parent section of the POM. The spring-boot-starter-parent is a special starter that provides useful Maven defaults. It also provides a <u>dependency-management</u> section so that you can omit version tags for "blessed" dependencies.

Other "Starters" provide dependencies that you are likely to need when developing a specific type of application. Since we are developing a web application, we add a spring-boot-starter-web dependency. Before that, we can look at what we currently have by running the following command:

```
$ mvn dependency:tree
[INFO] com.example:myproject:jar:0.0.1-SNAPSHOT
```

The mvn dependency: tree command prints a tree representation of your project dependencies. You can see that spring-boot-starter-parent provides no dependencies by itself. To add the necessary dependencies, edit your pom.xml and add the spring-boot-starter-web dependency immediately below the parent section:

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

If you run mvn dependency: tree again, you see that there are now a number of additional dependencies, including the Tomcat web server and Spring Boot itself.

### 11.3 Writing the Code

To finish our application, we need to create a single Java file. By default, Maven compiles sources from src/main/java, so you need to create that folder structure and then add a file named src/main/java/Example.java to contain the following code:

```
import org.springframework.boot.*;
import org.springframework.boot.autoconfigure.*;
import org.springframework.web.bind.annotation.*;

@RestController
@EnableAutoConfiguration
public class Example {

    @RequestMapping("/")
    String home() {
    return "Hello World!";
    }

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

Although there is not much code here, quite a lot is going on. We step through the important parts in the next few sections.

#### The @RestController and @RequestMapping Annotations

The first annotation on our Example class is @RestController. This is known as a *stereotype* annotation. It provides hints for people reading the code and for Spring that the class plays a specific role. In this case, our class is a web @Controller, so Spring considers it when handling incoming web requests.

The <code>@RequestMapping</code> annotation provides "routing" information. It tells Spring that any HTTP request with the <code>/</code> path should be mapped to the <code>home</code> method. The <code>@RestController</code> annotation tells Spring to render the resulting string directly back to the caller.

#### Tip

}

The @RestController and @RequestMapping annotations are Spring MVC annotations. (They are not specific to Spring Boot.) See the MVC section in the Spring Reference Documentation for more details.

#### The @EnableAutoConfiguration Annotation

The second class-level annotation is @EnableAutoConfiguration. This annotation tells Spring Boot to "guess" how you want to configure Spring, based on the jar dependencies that you have added. Since spring-boot-starter-web added Tomcat and Spring MVC, the auto-configuration assumes that you are developing a web application and sets up Spring accordingly.

#### **Starters and Auto-configuration**

Auto-configuration is designed to work well with "Starters", but the two concepts are not directly tied. You are free to pick and choose jar dependencies outside of the starters. Spring Boot still does its best to auto-configure your application.

#### The "main" Method

The final part of our application is the main method. This is just a standard method that follows the Java convention for an application entry point. Our main method delegates to Spring Boot's SpringApplication class by calling run. SpringApplication bootstraps our application, starting Spring, which, in turn, starts the auto-configured Tomcat web server. We need to pass Example.class as an argument to the run method to tell SpringApplication which is the primary Spring component. The args array is also passed through to expose any command-line arguments.

### 11.4 Running the Example

At this point, your application should work. Since you used the spring-boot-starter-parent POM, you have a useful run goal that you can use to start the application. Type mvn spring-boot:run from the root project directory to start the application. You should see output similar to the following:

If you open a web browser to localhost:8080, you should see the following output:

```
Hello World!
```

To gracefully exit the application, press ctrl-c.

### 11.5 Creating an Executable Jar

We finish our example by creating a completely self-contained executable jar file that we could run in production. Executable jars (sometimes called "fat jars") are archives containing your compiled classes along with all of the jar dependencies that your code needs to run.

#### **Executable jars and Java**

Java does not provide a standard way to load nested jar files (jar files that are themselves contained within a jar). This can be problematic if you are looking to distribute a self-contained application.

To solve this problem, many developers use "uber" jars. An uber jar packages all the classes from all the application's dependencies into a single archive. The problem with this approach is that it becomes hard to see which libraries are in your application. It can also be problematic if the same filename is used (but with different content) in multiple jars.

Spring Boot takes a <u>different approach</u> and lets you actually nest jars directly.

To create an executable jar, we need to add the spring-boot-maven-plugin to our pom.xml. To do so, insert the following lines just below the dependencies section:

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

#### Note

The spring-boot-starter-parent POM includes <executions> configuration to bind the repackage goal. If you do not use the parent POM, you need to declare this configuration yourself. See the <u>plugin documentation</u> for details.

Save your pom.xml and run mvn package from the command line, as follows:

If you look in the target directory, you should see myproject-0.0.1-SNAPSHOT.jar. The file should be around 10 MB in size. If you want to peek inside, you can use jar tvf, as follows:

```
$ jar tvf target/myproject-0.0.1-SNAPSHOT.jar
```

You should also see a much smaller file named myproject-0.0.1-SNAPSHOT.jar.original in the target directory. This is the original jar file that Maven created before it was repackaged by Spring Boot.

To run that application, use the java -jar command, as follows:

As before, to exit the application, press ctrl-c.

### 12. What to Read Next

Hopefully, this section provided some of the Spring Boot basics and got you on your way to writing your own applications. If you are a task-oriented type of developer, you might want to jump over to <a href="mailto:spring.io">spring.io</a> and check out some of the <a href="mailto:getting\_started">getting\_started</a> guides that solve specific "How do I do that with Spring?" problems. We also have Spring Boot-specific "How-to" reference documentation.

The <u>Spring Boot repository</u> also has a <u>bunch of samples</u> you can run. The samples are independent of the rest of the code (that is, you do not need to build the rest to run or use the samples).

Otherwise, the next logical step is to read <u>Part III, "Using Spring Boot"</u>. If you are really impatient, you could also jump ahead and read about <u>Spring Boot features</u>.

# Part III. Using Spring Boot

This section goes into more detail about how you should use Spring Boot. It covers topics such as build systems, auto-configuration, and how to run your applications. We also cover some Spring Boot best practices. Although there is nothing particularly special about Spring Boot (it is just another library that you can consume), there are a few recommendations that, when followed, make your development process a little easier.

If you are starting out with Spring Boot, you should probably read the <u>Getting Started</u> guide before diving into this section.

## 13. Build Systems

It is strongly recommended that you choose a build system that supports <u>dependency management</u> and that can consume artifacts published to the "Maven Central" repository. We would recommend that you choose Maven or Gradle. It is possible to get Spring Boot to work with other build systems (Ant, for example), but they are not particularly well supported.

### 13.1 Dependency Management

Each release of Spring Boot provides a curated list of dependencies that it supports. In practice, you do not need to provide a version for any of these dependencies in your build configuration, as Spring Boot manages that for you. When you upgrade Spring Boot itself, these dependencies are upgraded as well in a consistent way.

#### Note

You can still specify a version and override Spring Boot's recommendations if you need to do so.

The curated list contains all the spring modules that you can use with Spring Boot as well as a refined list of third party libraries. The list is available as a standard <u>Bills of Materials (spring-boot-dependencies)</u> that can be used with both <u>Maven</u> and <u>Gradle</u>.

#### Warning

Each release of Spring Boot is associated with a base version of the Spring Framework. We **highly** recommend that you not specify its version.

#### 13.2 Maven

Maven users can inherit from the spring-boot-starter-parent project to obtain sensible defaults. The parent project provides the following features:

- Java 1.8 as the default compiler level.
- UTF-8 source encoding.
- A <u>Dependency Management section</u>, inherited from the spring-boot-dependencies pom, that
  manages the versions of common dependencies. This dependency management lets you omit

   version> tags for those dependencies when used in your own pom.
- An execution of the repackage goal with a repackage execution id.
- Sensible resource filtering.
- Sensible plugin configuration (exec plugin, Git commit ID, and shade).
- Sensible resource filtering for application.properties and application.yml including profile-specific files (for example, application-dev.properties and application-dev.yml)

Note that, since the application.properties and application.yml files accept Spring style placeholders (\${...}), the Maven filtering is changed to use @..@ placeholders. (You can override that by setting a Maven property called resource.delimiter.)

#### **Inheriting the Starter Parent**

To configure your project to inherit from the spring-boot-starter-parent, set the parent as follows:

#### Note

You should need to specify only the Spring Boot version number on this dependency. If you import additional starters, you can safely omit the version number.

With that setup, you can also override individual dependencies by overriding a property in your own project. For instance, to upgrade to another Spring Data release train, you would add the following to your pom.xml:

#### Tip

Check the <a href="mailto:spring-boot-dependencies.">spring-boot-dependencies.</a> pom for a list of supported properties.

### **Using Spring Boot without the Parent POM**

Not everyone likes inheriting from the spring-boot-starter-parent POM. You may have your own corporate standard parent that you need to use or you may prefer to explicitly declare all your Maven configuration.

If you do not want to use the <code>spring-boot-starter-parent</code>, you can still keep the benefit of the dependency management (but not the plugin management) by using a <code>scope=import</code> dependency, as follows:

The preceding sample setup does not let you override individual dependencies by using a property, as explained above. To achieve the same result, you need to add an entry in the dependencyManagement of your project before the spring-boot-dependencies entry. For instance, to upgrade to another Spring Data release train, you could add the following element to your pom.xml:

```
<dependencyManagement>
```

```
<dependencies>
 <!-- Override Spring Data release train provided by Spring Boot -->
  <groupId>org.springframework.data
  <artifactId>spring-data-releasetrain</artifactId>
  <version>Fowler-SR2</version>
  <type>pom</type>
  <scope>import</scope>
 </dependency>
 <dependency>
  <groupId>org.springframework.boot
  <artifactId>spring-boot-dependencies</artifactId>
  <version>2.1.0.RELEASE
  <type>pom</type>
  <scope>import</scope>
 </dependency>
</dependencies>
</dependencyManagement>
```

#### Note

In the preceding example, we specify a *BOM*, but any dependency type can be overridden in the same way.

#### **Using the Spring Boot Maven Plugin**

Spring Boot includes a <u>Maven plugin</u> that can package the project as an executable jar. Add the plugin to your <plugins> section if you want to use it, as shown in the following example:

#### Note

If you use the Spring Boot starter parent pom, you need to add only the plugin. There is no need to configure it unless you want to change the settings defined in the parent.

### 13.3 Gradle

To learn about using Spring Boot with Gradle, please refer to the documentation for Spring Boot's Gradle plugin:

- · Reference (HTML and PDF)
- API

#### 13.4 Ant

It is possible to build a Spring Boot project using Apache Ant+Ivy. The spring-boot-antlib "AntLib" module is also available to help Ant create executable jars.

To declare dependencies, a typical ivy.xml file looks something like the following example:

A typical build.xml looks like the following example:

```
oject
xmlns:ivy="antlib:org.apache.ivy.ant"
xmlns:spring-boot="antlib:org.springframework.boot.ant"
name="myapp" default="build">
cproperty name="spring-boot.version" value="2.1.0.RELEASE" />
<target name="resolve" description="--> retrieve dependencies with ivy">
 <ivy:retrieve pattern="lib/[conf]/[artifact]-[type]-[revision].[ext]" />
<target name="classpaths" depends="resolve">
 <path id="compile.classpath">
  <fileset dir="lib/compile" includes="*.jar" />
 </path>
</target>
<target name="init" depends="classpaths">
 <mkdir dir="build/classes" />
</target>
<target name="compile" depends="init" description="compile">
 <javac srcdir="src/main/java" destdir="build/classes" classpathref="compile.classpath" />
</target>
<target name="build" depends="compile">
 <spring-boot:exejar destfile="build/myapp.jar" classes="build/classes">
  <spring-boot:lib>
   <fileset dir="lib/runtime" />
  </spring-boot:lib>
 </spring-boot:exejar>
</target>
</project>
```

#### Tip

If you do not want to use the spring-boot-antlib module, see the <u>Section 91.9</u>, "Build an <u>Executable Archive from Ant without Using spring-boot-antlib"</u> "How-to".

#### 13.5 Starters

Starters are a set of convenient dependency descriptors that you can include in your application. You get a one-stop shop for all the Spring and related technologies that you need without having to hunt through sample code and copy-paste loads of dependency descriptors. For example, if you want to get started using Spring and JPA for database access, include the <code>spring-boot-starter-data-jpa</code> dependency in your project.

The starters contain a lot of the dependencies that you need to get a project up and running quickly and with a consistent, supported set of managed transitive dependencies.

#### What's in a name

All **official** starters follow a similar naming pattern; <code>spring-boot-starter-\*</code>, where \* is a particular type of application. This naming structure is intended to help when you need to find a starter. The Maven integration in many IDEs lets you search dependencies by name. For example, with the appropriate Eclipse or STS plugin installed, you can press <code>ctrl-space</code> in the POM editor and type "spring-boot-starter" for a complete list.

As explained in the "<u>Creating Your Own Starter</u>" section, third party starters should not start with <code>spring-boot</code>, as it is reserved for official Spring Boot artifacts. Rather, a third-party starter typically starts with the name of the project. For example, a third-party starter project called <code>thirdpartyproject</code> would typically be named <code>thirdpartyproject-spring-boot-starter</code>.

The following application starters are provided by Spring Boot under the org.springframework.boot group:

Table 13.1. Spring Boot application starters

Name	Description	Pom
spring-boot-starter	Core starter, including auto- configuration support, logging and YAML	<u>Pom</u>
spring-boot-starter- activemq	Starter for JMS messaging using Apache ActiveMQ	Pom
spring-boot-starter- amqp	Starter for using Spring AMQP and Rabbit MQ	Pom
spring-boot-starter-aop	Starter for aspect-oriented programming with Spring AOP and AspectJ	Pom
spring-boot-starter- artemis	Starter for JMS messaging using Apache Artemis	Pom
spring-boot-starter- batch	Starter for using Spring Batch	Pom
spring-boot-starter-cache	Starter for using Spring Framework's caching support	Pom
spring-boot-starter- cloud-connectors	Starter for using Spring Cloud Connectors which simplifies connecting to services in cloud platforms like Cloud Foundry and Heroku	Pom
spring-boot-starter- data-cassandra	Starter for using Cassandra distributed database and Spring Data Cassandra	Pom

Name	Description	Pom
spring-boot-starter- data-cassandra-reactive	Starter for using Cassandra distributed database and Spring Data Cassandra Reactive	Pom
spring-boot-starter- data-couchbase	Starter for using Couchbase document-oriented database and Spring Data Couchbase	Pom
spring-boot-starter- data-couchbase-reactive	Starter for using Couchbase document-oriented database and Spring Data Couchbase Reactive	Pom
spring-boot-starter- data-elasticsearch	Starter for using Elasticsearch search and analytics engine and Spring Data Elasticsearch	Pom
spring-boot-starter-data-jdbc	Starter for using Spring Data JDBC	Pom
spring-boot-starter- data-jpa	Starter for using Spring Data JPA with Hibernate	Pom
spring-boot-starter- data-ldap	Starter for using Spring Data LDAP	Pom
spring-boot-starter- data-mongodb	Starter for using MongoDB document-oriented database and Spring Data MongoDB	Pom
spring-boot-starter-data-mongodb-reactive	Starter for using MongoDB document-oriented database and Spring Data MongoDB Reactive	Pom
spring-boot-starter-data-neo4j	Starter for using Neo4j graph database and Spring Data Neo4j	Pom
spring-boot-starter- data-redis	Starter for using Redis key- value data store with Spring Data Redis and the Lettuce client	Pom
spring-boot-starter- data-redis-reactive	Starter for using Redis key- value data store with Spring Data Redis reactive and the Lettuce client	Pom
spring-boot-starter- data-rest	Starter for exposing Spring Data repositories over REST using Spring Data REST	Pom

Name	Description	Pom
spring-boot-starter-data-solr	Starter for using the Apache Solr search platform with Spring Data Solr	Pom
spring-boot-starter- freemarker	Starter for building MVC web applications using FreeMarker views	Pom
spring-boot-starter- groovy-templates	Starter for building MVC web applications using Groovy Templates views	Pom
spring-boot-starter- hateoas	Starter for building hypermedia- based RESTful web application with Spring MVC and Spring HATEOAS	Pom
spring-boot-starter- integration	Starter for using Spring Integration	Pom
spring-boot-starter- jdbc	Starter for using JDBC with the HikariCP connection pool	Pom
spring-boot-starter- jersey	Starter for building RESTful web applications using JAX-RS and Jersey. An alternative to spring-boot-starter-web	Pom
spring-boot-starter- jooq	Starter for using jOOQ to access SQL databases. An alternative to spring-boot-starter-data-jpa Or spring-boot-starter-jdbc	Pom
spring-boot-starter- json	Starter for reading and writing json	Pom
spring-boot-starter- jta-atomikos	Starter for JTA transactions using Atomikos	Pom
spring-boot-starter- jta-bitronix	Starter for JTA transactions using Bitronix	Pom
spring-boot-starter- mail	Starter for using Java Mail and Spring Framework's email sending support	Pom
spring-boot-starter- mustache	Starter for building web applications using Mustache views	Pom

Name	Description	Pom
spring-boot-starter- oauth2-client	Starter for using Spring Security's OAuth2/OpenID Connect client features	Pom
spring-boot-starter- oauth2-resource-server	Starter for using Spring Security's OAuth2 resource server features	Pom
spring-boot-starter- quartz	Starter for using the Quartz scheduler	Pom
spring-boot-starter- security	Starter for using Spring Security	Pom
spring-boot-starter- test	Starter for testing Spring Boot applications with libraries including JUnit, Hamcrest and Mockito	Pom
spring-boot-starter- thymeleaf	Starter for building MVC web applications using Thymeleaf views	<u>Pom</u>
spring-boot-starter- validation	Starter for using Java Bean Validation with Hibernate Validator	Pom
spring-boot-starter-web	Starter for building web, including RESTful, applications using Spring MVC. Uses Tomcat as the default embedded container	<u>Pom</u>
spring-boot-starter- web-services	Starter for using Spring Web Services	Pom
spring-boot-starter- webflux	Starter for building WebFlux applications using Spring Framework's Reactive Web support	Pom
spring-boot-starter- websocket	Starter for building WebSocket applications using Spring Framework's WebSocket support	<u>Pom</u>

In addition to the application starters, the following starters can be used to add *production ready* features:

Table 13.2. Spring Boot production starters

Name	Description	Pom
spring-boot-starter- actuator	Starter for using Spring Boot's Actuator which provides production ready features to help you monitor and manage your application	Pom

Finally, Spring Boot also includes the following starters that can be used if you want to exclude or swap specific technical facets:

Table 13.3. Spring Boot technical starters

Name	Description	Pom
spring-boot-starter- jetty	Starter for using Jetty as the embedded servlet container. An alternative to <pre>spring-boot-starter-tomcat</pre>	Pom
spring-boot-starter-log4j2	Starter for using Log4j2 for logging. An alternative to spring-boot-starter-logging	Pom
spring-boot-starter- logging	Starter for logging using Logback. Default logging starter	Pom
spring-boot-starter- reactor-netty	Starter for using Reactor Netty as the embedded reactive HTTP server.	Pom
spring-boot-starter- tomcat	Starter for using Tomcat as the embedded servlet container.  Default servlet container starter used by <a href="mailto:spring-boot-starter-web">spring-boot-starter-web</a>	<u>Pom</u>
spring-boot-starter- undertow	Starter for using Undertow as the embedded servlet container. An alternative to spring-boot-starter-tomcat	Pom

### Tip

For a list of additional community contributed starters, see the  $\underline{\sf README\,file}$  in the  $\underline{\sf spring-bootstarters}$  module on GitHub.

## 14. Structuring Your Code

Spring Boot does not require any specific code layout to work. However, there are some best practices that help.

### 14.1 Using the "default" Package

When a class does not include a package declaration, it is considered to be in the "default package". The use of the "default package" is generally discouraged and should be avoided. It can cause particular problems for Spring Boot applications that use the <code>@ComponentScan</code>, <code>@EntityScan</code>, or <code>@SpringBootApplication</code> annotations, since every class from every jar is read.

#### Tip

We recommend that you follow Java's recommended package naming conventions and use a reversed domain name (for example, com.example.project).

### 14.2 Locating the Main Application Class

We generally recommend that you locate your main application class in a root package above other classes. The <code>@SpringBootApplication</code> annotation is often placed on your main class, and it implicitly defines a base "search package" for certain items. For example, if you are writing a JPA application, the package of the <code>@SpringBootApplication</code> annotated class is used to search for <code>@Entity</code> items. Using a root package also allows component scan to apply only on your project.

#### Tip

If you don't want to use @SpringBootApplication, the @EnableAutoConfiguration and @ComponentScan annotations that it imports defines that behaviour so you can also use that instead.

The following listing shows a typical layout:

```
com
+- example
+- myapplication
+- Application.java
|
+- customer
| +- Customer.java
| +- CustomerController.java
| +- CustomerService.java
| +- CustomerRepository.java
| +- Order
+- Order
+- Order
+- Order.java
+- OrderController.java
+- OrderService.java
+- OrderRepository.java
```

The Application.java file would declare the main method, along with the basic @SpringBootApplication, as follows:

```
package com.example.myapplication;
import org.springframework.boot.SpringApplication;
```

```
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class Application {

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

## 15. Configuration Classes

Spring Boot favors Java-based configuration. Although it is possible to use SpringApplication with XML sources, we generally recommend that your primary source be a single @Configuration class. Usually the class that defines the main method is a good candidate as the primary @Configuration.

#### Tip

Many Spring configuration examples have been published on the Internet that use XML configuration. If possible, always try to use the equivalent Java-based configuration. Searching for Enable\* annotations can be a good starting point.

### 15.1 Importing Additional Configuration Classes

You need not put all your @Configuration into a single class. The @Import annotation can be used to import additional configuration classes. Alternatively, you can use @ComponentScan to automatically pick up all Spring components, including @Configuration classes.

### 15.2 Importing XML Configuration

If you absolutely must use XML based configuration, we recommend that you still start with a @Configuration class. You can then use an @ImportResource annotation to load XML configuration files.

## 16. Auto-configuration

Spring Boot auto-configuration attempts to automatically configure your Spring application based on the jar dependencies that you have added. For example, if HSQLDB is on your classpath, and you have not manually configured any database connection beans, then Spring Boot auto-configures an in-memory database.

You need to opt-in to auto-configuration by adding the <code>@EnableAutoConfiguration</code> or <code>@SpringBootApplication</code> annotations to one of your <code>@Configuration</code> classes.

#### Tip

You should only ever add one @SpringBootApplication or @EnableAutoConfiguration annotation. We generally recommend that you add one or the other to your primary @Configuration class only.

### 16.1 Gradually Replacing Auto-configuration

Auto-configuration is non-invasive. At any point, you can start to define your own configuration to replace specific parts of the auto-configuration. For example, if you add your own DataSource bean, the default embedded database support backs away.

If you need to find out what auto-configuration is currently being applied, and why, start your application with the --debug switch. Doing so enables debug logs for a selection of core loggers and logs a conditions report to the console.

### 16.2 Disabling Specific Auto-configuration Classes

If you find that specific auto-configuration classes that you do not want are being applied, you can use the exclude attribute of <code>@EnableAutoConfiguration</code> to disable them, as shown in the following example:

```
import org.springframework.boot.autoconfigure.*;
import org.springframework.boot.autoconfigure.jdbc.*;
import org.springframework.context.annotation.*;

@Configuration
@EnableAutoConfiguration(exclude={DataSourceAutoConfiguration.class})
public class MyConfiguration {
}
```

If the class is not on the classpath, you can use the <code>excludeName</code> attribute of the annotation and specify the fully qualified name instead. Finally, you can also control the list of auto-configuration classes to <code>exclude</code> by using the <code>spring.autoconfigure.exclude</code> property.

#### Tip

You can define exclusions both at the annotation level and by using the property.

## 17. Spring Beans and Dependency Injection

You are free to use any of the standard Spring Framework techniques to define your beans and their injected dependencies. For simplicity, we often find that using @ComponentScan (to find your beans) and using @Autowired (to do constructor injection) works well.

If you structure your code as suggested above (locating your application class in a root package), you can add @ComponentScan without any arguments. All of your application components (@Component, @Service, @Repository, @Controller etc.) are automatically registered as Spring Beans.

The following example shows a @Service Bean that uses constructor injection to obtain a required RiskAssessor bean:

```
package com.example.service;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Service;

@Service
public class DatabaseAccountService implements AccountService {
    private final RiskAssessor riskAssessor;
    @Autowired
    public DatabaseAccountService(RiskAssessor riskAssessor) {
        this.riskAssessor = riskAssessor;
    }

// ...
}
```

If a bean has one constructor, you can omit the @Autowired, as shown in the following example:

```
@Service
public class DatabaseAccountService implements AccountService {
   private final RiskAssessor riskAssessor;
   public DatabaseAccountService(RiskAssessor riskAssessor) {
     this.riskAssessor = riskAssessor;
   }
   // ...
}
```

#### Tip

Notice how using constructor injection lets the riskAssessor field be marked as final, indicating that it cannot be subsequently changed.

## 18. Using the @SpringBootApplication Annotation

Many Spring Boot developers like their apps to use auto-configuration, component scan and be able to define extra configuration on their "application class". A single @SpringBootApplication annotation can be used to enable those three features, that is:

- @EnableAutoConfiguration: enable Spring Boot's auto-configuration mechanism
- @ComponentScan: enable @Component scan on the package where the application is located (see the best practices)
- @Configuration: allow to register extra beans in the context or import additional configuration classes

The @SpringBootApplication annotation is equivalent to using @Configuration, @EnableAutoConfiguration, and @ComponentScan with their default attributes, as shown in the following example:

```
package com.example.myapplication;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication // same as @Configuration @EnableAutoConfiguration @ComponentScan
public class Application {

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

#### Note

@SpringBootApplication also provides aliases to customize the attributes of @EnableAutoConfiguration and @ComponentScan.

#### Note

None of these features are mandatory and you may choose to replace this single annotation by any of the features that it enables. For instance, you may not want to use component scan in your application:

```
package com.example.myapplication;
import org.springframework.boot.SpringApplication;
import org.springframework.context.annotation.ComponentScan
import org.springframework.context.annotation.Configuration;
import org.springframework.context.annotation.Import;

@Configuration
@EnableAutoConfiguration
@Import({ MyConfig.class, MyAnotherConfig.class })
public class Application {

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

In this example, Application is just like any other Spring Boot application except that @Component-annotated classes are not detected automatically and the user-defined beans are imported explicitly (see @Import).

## 19. Running Your Application

One of the biggest advantages of packaging your application as a jar and using an embedded HTTP server is that you can run your application as you would any other. Debugging Spring Boot applications is also easy. You do not need any special IDE plugins or extensions.

#### Note

This section only covers jar based packaging. If you choose to package your application as a war file, you should refer to your server and IDE documentation.

### 19.1 Running from an IDE

You can run a Spring Boot application from your IDE as a simple Java application. However, you first need to import your project. Import steps vary depending on your IDE and build system. Most IDEs can import Maven projects directly. For example, Eclipse users can select  $\mathtt{Import...} \rightarrow \mathtt{Existing}$  Maven  $\mathtt{Projects}$  from the File menu.

If you cannot directly import your project into your IDE, you may be able to generate IDE metadata by using a build plugin. Maven includes plugins for <u>Eclipse</u> and <u>IDEA</u>. Gradle offers plugins for <u>various IDEs</u>.

#### Tip

If you accidentally run a web application twice, you see a "Port already in use" error. STS users can use the Relaunch button rather than the Run button to ensure that any existing instance is closed.

## 19.2 Running as a Packaged Application

If you use the Spring Boot Maven or Gradle plugins to create an executable jar, you can run your application using java -jar, as shown in the following example:

```
$ java -jar target/myapplication-0.0.1-SNAPSHOT.jar
```

It is also possible to run a packaged application with remote debugging support enabled. Doing so lets you attach a debugger to your packaged application, as shown in the following example:

```
$ java -Xdebug -Xrunjdwp:server=y,transport=dt_socket,address=8000,suspend=n \
    -jar target/myapplication-0.0.1-SNAPSHOT.jar
```

## 19.3 Using the Maven Plugin

The Spring Boot Maven plugin includes a run goal that can be used to quickly compile and run your application. Applications run in an exploded form, as they do in your IDE. The following example shows a typical Maven command to run a Spring Boot application:

```
$ mvn spring-boot:run
```

You might also want to use the MAVEN\_OPTS operating system environment variable, as shown in the following example:

```
$ export MAVEN_OPTS=-Xmx1024m
```

### 19.4 Using the Gradle Plugin

The Spring Boot Gradle plugin also includes a bootRun task that can be used to run your application in an exploded form. The bootRun task is added whenever you apply the org.springframework.boot and java plugins and is shown in the following example:

```
$ gradle bootRun
```

You might also want to use the JAVA\_OPTS operating system environment variable, as shown in the following example:

```
$ export JAVA_OPTS=-Xmx1024m
```

### 19.5 Hot Swapping

Since Spring Boot applications are just plain Java applications, JVM hot-swapping should work out of the box. JVM hot swapping is somewhat limited with the bytecode that it can replace. For a more complete solution, <u>JRebel</u> can be used.

The spring-boot-devtools module also includes support for quick application restarts. See the <u>Chapter 20, Developer Tools</u> section later in this chapter and the <u>Hot swapping "How-to"</u> for details.

## 20. Developer Tools

Spring Boot includes an additional set of tools that can make the application development experience a little more pleasant. The <code>spring-boot-devtools</code> module can be included in any project to provide additional development-time features. To include devtools support, add the module dependency to your build, as shown in the following listings for Maven and Gradle:

#### Maven.

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

#### Gradle.

```
configurations {
  developmentOnly
  runtimeClasspath {
    extendsFrom developmentOnly
  }
}
dependencies {
  developmentOnly("org.springframework.boot:spring-boot-devtools")
}
```

#### **Note**

Developer tools are automatically disabled when running a fully packaged application. If your application is launched from <code>java -jar</code> or if it is started from a special classloader, then it is considered a "production application". Flagging the dependency as optional in Maven or using a custom developmentOnly configuration in Gradle (as shown above) is a best practice that prevents devtools from being transitively applied to other modules that use your project.

#### Tip

Repackaged archives do not contain devtools by default. If you want to use a <u>certain remote</u> <u>devtools feature</u>, you need to disable the <u>excludeDevtools</u> build property to include it. The property is supported with both the Maven and Gradle plugins.

## 20.1 Property Defaults

Several of the libraries supported by Spring Boot use caches to improve performance. For example, template engines cache compiled templates to avoid repeatedly parsing template files. Also, Spring MVC can add HTTP caching headers to responses when serving static resources.

While caching is very beneficial in production, it can be counter-productive during development, preventing you from seeing the changes you just made in your application. For this reason, spring-boot-devtools disables the caching options by default.

Cache options are usually configured by settings in your application.properties file. For example, Thymeleaf offers the spring.thymeleaf.cache property. Rather than needing to set

these properties manually, the spring-boot-devtools module automatically applies sensible development-time configuration.

Because you need more information about web requests while developing Spring MVC and Spring WebFlux applications, developer tools will enable DEBUG logging for the web logging group. This will give you information about the incoming request, which handler is processing it, the response outcome, etc. If you wish to log all request details (including potentially sensitive information), you can turn on the spring.http.log-request-details configuration property.

#### Note

If you don't want property defaults to be applied you can set spring.devtools.add-properties to false in your application.properties.

#### Tip

For a complete list of the properties that are applied by the devtools, see <a href="DevToolsPropertyDefaultsPostProcessor">DevToolsPropertyDefaultsPostProcessor</a>.

#### 20.2 Automatic Restart

Applications that use spring-boot-devtools automatically restart whenever files on the classpath change. This can be a useful feature when working in an IDE, as it gives a very fast feedback loop for code changes. By default, any entry on the classpath that points to a folder is monitored for changes. Note that certain resources, such as static assets and view templates, <u>do not need to restart the application</u>.

#### Triggering a restart

As DevTools monitors classpath resources, the only way to trigger a restart is to update the classpath. The way in which you cause the classpath to be updated depends on the IDE that you are using. In Eclipse, saving a modified file causes the classpath to be updated and triggers a restart. In IntelliJ IDEA, building the project (Build -> Build Project) has the same effect.

#### **Note**

As long as forking is enabled, you can also start your application by using the supported build plugins (Maven and Gradle), since DevTools needs an isolated application classloader to operate properly. By default, Gradle and Maven do that when they detect DevTools on the classpath.

#### Tip

Automatic restart works very well when used with LiveReload. <u>See the LiveReload section</u> for details. If you use JRebel, automatic restarts are disabled in favor of dynamic class reloading. Other devtools features (such as LiveReload and property overrides) can still be used.

#### Note

DevTools relies on the application context's shutdown hook to close it during a restart. It does not work correctly if you have disabled the shutdown hook (SpringApplication.setRegisterShutdownHook(false)).

#### Note

When deciding if an entry on the classpath should trigger a restart when it changes, DevTools automatically ignores projects named spring-boot, spring-boot-devtools, spring-boot-autoconfigure, spring-boot-actuator, and spring-boot-starter.

#### Note

DevTools needs to customize the ResourceLoader used by the ApplicationContext. If your application provides one already, it is going to be wrapped. Direct override of the getResource method on the ApplicationContext is not supported.

#### Restart vs Reload

The restart technology provided by Spring Boot works by using two classloaders. Classes that do not change (for example, those from third-party jars) are loaded into a *base* classloader. Classes that you are actively developing are loaded into a *restart* classloader. When the application is restarted, the *restart* classloader is thrown away and a new one is created. This approach means that application restarts are typically much faster than "cold starts", since the *base* classloader is already available and populated.

If you find that restarts are not quick enough for your applications or you encounter classloading issues, you could consider reloading technologies such as <u>JRebel</u> from ZeroTurnaround. These work by rewriting classes as they are loaded to make them more amenable to reloading.

### Logging changes in condition evaluation

By default, each time your application restarts, a report showing the condition evaluation delta is logged. The report shows the changes to your application's auto-configuration as you make changes such as adding or removing beans and setting configuration properties.

To disable the logging of the report, set the following property:

spring.devtools.restart.log-condition-evaluation-delta=false

### **Excluding Resources**

Certain resources do not necessarily need to trigger a restart when they are changed. For example, Thymeleaf templates can be edited in-place. By default, changing resources in /META-INF/maven, /META-INF/resources, /resources, /static, /public, or /templates does not trigger a restart but does trigger a live reload. If you want to customize these exclusions, you can use the spring.devtools.restart.exclude property. For example, to exclude only /static and /public you would set the following property:

spring.devtools.restart.exclude=static/\*\*,public/\*\*

#### Tip

If you want to keep those defaults and *add* additional exclusions, use the spring.devtools.restart.additional-exclude property instead.

#### **Watching Additional Paths**

You may want your application to be restarted or reloaded when you make changes to files that are not on the classpath. To do so, use the spring.devtools.restart.additional-paths property to configure additional paths to watch for changes. You can use the spring.devtools.restart.exclude property described earlier to control whether changes beneath the additional paths trigger a full restart or a live reload.

#### **Disabling Restart**

If you do not want to use the restart feature, you can disable it by using the spring.devtools.restart.enabled property. In most cases, you can set this property in your application.properties (doing so still initializes the restart classloader, but it does not watch for file changes).

If you need to *completely* disable restart support (for example, because it does not work with a specific library), you need to set the spring.devtools.restart.enabled System property to false before calling SpringApplication.run(...), as shown in the following example:

```
public static void main(String[] args) {
   System.setProperty("spring.devtools.restart.enabled", "false");
   SpringApplication.run(MyApp.class, args);
}
```

#### **Using a Trigger File**

If you work with an IDE that continuously compiles changed files, you might prefer to trigger restarts only at specific times. To do so, you can use a "trigger file", which is a special file that must be modified when you want to actually trigger a restart check. Changing the file only triggers the check and the restart only occurs if Devtools has detected it has to do something. The trigger file can be updated manually or with an IDE plugin.

To use a trigger file, set the spring.devtools.restart.trigger-file property to the path of your trigger file.

#### Tip

You might want to set spring.devtools.restart.trigger-file as a global setting, so that all your projects behave in the same way.

#### **Customizing the Restart Classloader**

As described earlier in the <u>Restart vs Reload</u> section, restart functionality is implemented by using two classloaders. For most applications, this approach works well. However, it can sometimes cause classloading issues.

By default, any open project in your IDE is loaded with the "restart" classloader, and any regular .jar file is loaded with the "base" classloader. If you work on a multi-module project, and not every module is imported into your IDE, you may need to customize things. To do so, you can create a META-INF/spring-devtools.properties file.

The spring-devtools.properties file can contain properties prefixed with restart.exclude and restart.include. The include elements are items that should be pulled up into the "restart"

classloader, and the <code>exclude</code> elements are items that should be pushed down into the "base" classloader. The value of the property is a regex pattern that is applied to the classpath, as shown in the following example:

```
restart.exclude.companycommonlibs=/mycorp-common-[\\w-]+\.jar
restart.include.projectcommon=/mycorp-myproj-[\\w-]+\.jar
```

#### Note

All property keys must be unique. As long as a property starts with restart.include. or restart.exclude. it is considered.

#### Tip

All META-INF/spring-devtools.properties from the classpath are loaded. You can package files inside your project, or in the libraries that the project consumes.

#### **Known Limitations**

Restart functionality does not work well with objects deserialized that are by using standard ObjectInputStream. lf you need to deserialize data, you may need to use Spring's ConfigurableObjectInputStream with in combination Thread.currentThread().getContextClassLoader().

Unfortunately, several third-party libraries deserialize without considering the context classloader. If you find such a problem, you need to request a fix with the original authors.

### 20.3 LiveReload

The spring-boot-devtools module includes an embedded LiveReload server that can be used to trigger a browser refresh when a resource is changed. LiveReload browser extensions are freely available for Chrome, Firefox and Safari from <u>livereload.com</u>.

If you do not want to start the LiveReload server when your application runs, you can set the spring.devtools.livereload.enabled property to false.

#### Note

You can only run one LiveReload server at a time. Before starting your application, ensure that no other LiveReload servers are running. If you start multiple applications from your IDE, only the first has LiveReload support.

## 20.4 Global Settings

You can configure global devtools settings by adding a file named .spring-boot-devtools.properties to your \$HOME folder (note that the filename starts with "."). Any properties added to this file apply to *all* Spring Boot applications on your machine that use devtools. For example, to configure restart to always use a trigger file, you would add the following property:

#### ~/.spring-boot-devtools.properties.

```
spring.devtools.reload.trigger-file=.reloadtrigger
```

### 20.5 Remote Applications

The Spring Boot developer tools are not limited to local development. You can also use several features when running applications remotely. Remote support is opt-in. To enable it, you need to make sure that devtools is included in the repackaged archive, as shown in the following listing:

```
<build>
<plugins>
  <plugin>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-maven-plugin</artifactId>
  <configuration>
   <excludeDevtools>false</excludeDevtools>
  </configuration>
  </plugins>
</plugins>
</pullid>
```

Then you need to set a spring.devtools.remote.secret property, as shown in the following example:

```
spring.devtools.remote.secret=mysecret
```

#### Warning

Enabling spring-boot-devtools on a remote application is a security risk. You should never enable support on a production deployment.

Remote devtools support is provided in two parts: a server-side endpoint that accepts connections and a client application that you run in your IDE. The server component is automatically enabled when the <code>spring.devtools.remote.secret</code> property is set. The client component must be launched manually.

#### **Running the Remote Client Application**

The remote client application is designed to be run from within your IDE. You need to run org.springframework.boot.devtools.RemoteSpringApplication with the same classpath as the remote project that you connect to. The application's single required argument is the remote URL to which it connects.

For example, if you are using Eclipse or STS and you have a project named my-app that you have deployed to Cloud Foundry, you would do the following:

- Select Run Configurations... from the Run menu.
- Create a new Java Application "launch configuration".
- Browse for the my-app project.
- Use org.springframework.boot.devtools.RemoteSpringApplication as the main class.
- Add https://myapp.cfapps.io to the Program arguments (or whatever your remote URL is).

A running remote client might resemble the following listing:

```
======|_|======|__/=======|_/_/_/
:: Spring Boot Remote :: 2.1.0.RELEASE
2015-06-10 18:25:06.632 INFO 14938 --- [
                                            main] o.s.b.devtools.RemoteSpringApplication
Starting RemoteSpringApplication on pwmbp with PID 14938 (/Users/pwebb/projects/spring-boot/code/
spring-boot-devtools/target/classes started by pwebb in /Users/pwebb/projects/spring-boot/code/spring-
boot-samples/spring-boot-sample-devtools)
2015-06-10 18:25:06.671 INFO 14938 --- [
                                            main] s.c.a.AnnotationConfigApplicationContext :
Refreshing org.springframework.context.annotation.AnnotationConfigApplicationContext@2a17b7b6: startup
date [Wed Jun 10 18:25:06 PDT 2015]; root of context hierarchy
2015-06-10 18:25:07.043 WARN 14938 --- [
                                           main] o.s.b.d.r.c.RemoteClientConfiguration
\texttt{connection to http://localhost:8080 is insecure. You should use a URL starting with \verb|'https://|.}
2015-06-10 18:25:07.074 INFO 14938 --- [
                                           main] o.s.b.d.a.OptionalLiveReloadServer
LiveReload server is running on port 35729
2015-06-10 18:25:07.130 INFO 14938 --- [
                                           main] o.s.b.devtools.RemoteSpringApplication :
Started RemoteSpringApplication in 0.74 seconds (JVM running for 1.105)
```

#### Note

Because the remote client is using the same classpath as the real application it can directly read application properties. This is how the <code>spring.devtools.remote.secret</code> property is read and passed to the server for authentication.

#### Tip

It is always advisable to use https:// as the connection protocol, so that traffic is encrypted and passwords cannot be intercepted.

#### Tip

If you need to use a proxy to access the remote application, configure the spring.devtools.remote.proxy.host and spring.devtools.remote.proxy.port properties.

#### **Remote Update**

The remote client monitors your application classpath for changes in the same way as the <u>local restart</u>. Any updated resource is pushed to the remote application and (*if required*) triggers a restart. This can be helpful if you iterate on a feature that uses a cloud service that you do not have locally. Generally, remote updates and restarts are much quicker than a full rebuild and deploy cycle.

#### Note

Files are only monitored when the remote client is running. If you change a file before starting the remote client, it is not pushed to the remote server.

## 21. Packaging Your Application for Production

Executable jars can be used for production deployment. As they are self-contained, they are also ideally suited for cloud-based deployment.

For additional "production ready" features, such as health, auditing, and metric REST or JMX endpoints, consider adding spring-boot-actuator. See <u>Part V, "Spring Boot Actuator: Production-ready features"</u> for details.

## 22. What to Read Next

You should now understand how you can use Spring Boot and some best practices that you should follow. You can now go on to learn about specific <u>Spring Boot features</u> in depth, or you could skip ahead and read about the "<u>production ready</u>" aspects of Spring Boot.

# Part IV. Spring Boot features

This section dives into the details of Spring Boot. Here you can learn about the key features that you may want to use and customize. If you have not already done so, you might want to read the "Part II, "Getting Started" and "Part III, "Using Spring Boot" sections, so that you have a good grounding of the basics.

## 23. SpringApplication

The SpringApplication class provides a convenient way to bootstrap a Spring application that is started from a main() method. In many situations, you can delegate to the static SpringApplication.run method, as shown in the following example:

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

When your application starts, you should see something similar to the following output:

```
_ | '_ | '_| | '_ \/ _` | \ \ \
     ._|_| |_| |_\_, | / / / /
======|_|=======|___/=/_/_/
:: Spring Boot :: v2.1.0.RELEASE
2013-07-31 00:08:16.117 INFO 56603 --- [
                                               main] o.s.b.s.app.SampleApplication
Starting SampleApplication v0.1.0 on mycomputer with PID 56603 (/apps/myapp.jar started by pwebb)
2013-07-31 00:08:16.166 INFO 56603 --- [
                                              mainl
ationConfigServletWebServerApplicationContext : Refreshing
org.springframework.boot.web.servlet.context.AnnotationConfigServletWebServerApplicationContext@6e5a8246:
startup date [Wed Jul 31 00:08:16 PDT 2013]; root of context hierarchy
2014-03-04 13:09:54.912 INFO 41370 --- [
                                               main] .t.TomcatServletWebServerFactory : Server
initialized with port: 8080
2014-03-04 13:09:56.501 INFO 41370 --- [
                                              main] o.s.b.s.app.SampleApplication
Started SampleApplication in 2.992 seconds (JVM running for 3.658)
```

By default, INFO logging messages are shown, including some relevant startup details, such as the user that launched the application. If you need a log level other than INFO, you can set it, as described in Section 26.4, "Log Levels",

### 23.1 Startup Failure

If your application fails to start, registered FailureAnalyzers get a chance to provide a dedicated error message and a concrete action to fix the problem. For instance, if you start a web application on port 8080 and that port is already in use, you should see something similar to the following message:

```
*************************************

APPLICATION FAILED TO START

*****************************

Description:

Embedded servlet container failed to start. Port 8080 was already in use.

Action:

Identify and stop the process that's listening on port 8080 or configure this application to listen on another port.
```

#### Note

Spring Boot provides numerous FailureAnalyzer implementations, and you can add your own.

no failure analyzers are able to handle the exception, can still vou better understand display full conditions report to what went wrong. To

so, you need to <u>enable the debug property</u> or <u>enable DEBUG logging</u> for org.springframework.boot.autoconfigure.logging.ConditionEvaluationReportLoggingListener

For instance, if you are running your application by using java -jar, you can enable the debug property as follows:

```
$ java -jar myproject-0.0.1-SNAPSHOT.jar --debug
```

### 23.2 Customizing the Banner

The banner that is printed on start up can be changed by adding a banner.txt file to your classpath or by setting the spring.banner.location property to the location of such a file. If the file has an encoding other than UTF-8, you can set spring.banner.charset. In addition to a text file, you can also add a banner.gif, banner.jpg, or banner.png image file to your classpath or set the spring.banner.image.location property. Images are converted into an ASCII art representation and printed above any text banner.

Inside your banner.txt file, you can use any of the following placeholders:

Table 23.1. Banner variables

Variable	Description
\${application.version}	The version number of your application, as declared in MANIFEST.MF. For example, Implementation-Version: 1.0 is printed as 1.0.
\${application.formatted-version}	The version number of your application, as declared in MANIFEST.MF and formatted for display (surrounded with brackets and prefixed with $v$ ). For example (v1.0).
<pre>\${spring-boot.version}</pre>	The Spring Boot version that you are using. For example 2.1.0.RELEASE.
\${spring-boot.formatted-version}	The Spring Boot version that you are using, formatted for display (surrounded with brackets and prefixed with $v$ ). For example ( $v2.1.0.RELEASE$ ).
<pre>\${Ansi.NAME} (or \${AnsiColor.NAME}, \${AnsiBackground.NAME}, \${AnsiStyle.NAME})</pre>	Where NAME is the name of an ANSI escape code. See <a href="mailto:AnsiPropertySource">AnsiPropertySource</a> for details.
\${application.title}	The title of your application, as declared in MANIFEST.MF. For example Implementation-Title: MyApp is printed as MyApp.

#### Tip

The SpringApplication.setBanner(...) method can be used if you want to generate a banner programmatically. Use the org.springframework.boot.Banner interface and implement your own printBanner() method.

You can also use the spring.main.banner-mode property to determine if the banner has to be printed on System.out (console), sent to the configured logger (log), or not produced at all (off).

The printed banner is registered as a singleton bean under the following name: springBootBanner.

#### Note

YAML maps off to false, so be sure to add quotes if you want to disable the banner in your application, as shown in the following example:

```
spring:
main:
banner-mode: "off"
```

### 23.3 Customizing SpringApplication

If the SpringApplication defaults are not to your taste, you can instead create a local instance and customize it. For example, to turn off the banner, you could write:

```
public static void main(String[] args) {
   SpringApplication app = new SpringApplication(MySpringConfiguration.class);
   app.setBannerMode(Banner.Mode.OFF);
   app.run(args);
}
```

#### Note

The constructor arguments passed to SpringApplication are configuration sources for Spring beans. In most cases, these are references to @Configuration classes, but they could also be references to XML configuration or to packages that should be scanned.

It is also possible to configure the SpringApplication by using an application.properties file. See *Chapter 24, Externalized Configuration* for details.

For a complete list of the configuration options, see the <a href="SpringApplication\_Javadoc">SpringApplication\_Javadoc</a>.

### 23.4 Fluent Builder API

If you need to build an ApplicationContext hierarchy (multiple contexts with a parent/child relationship) or if you prefer using a "fluent" builder API, you can use the SpringApplicationBuilder.

The SpringApplicationBuilder lets you chain together multiple method calls and includes parent and child methods that let you create a hierarchy, as shown in the following example:

```
new SpringApplicationBuilder()
   .sources(Parent.class)
   .child(Application.class)
   .bannerMode(Banner.Mode.OFF)
   .run(args);
```

#### Note

There are some restrictions when creating an ApplicationContext hierarchy. For example, Web components **must** be contained within the child context, and the same Environment is

used for both parent and child contexts. See the <a href="SpringApplicationBuilder Javadoc">SpringApplicationBuilder Javadoc</a> for full details.

### 23.5 Application Events and Listeners

In addition to the usual Spring Framework events, such as <a href="ContextRefreshedEvent">ContextRefreshedEvent</a>, a <a href="SpringApplication">SpringApplication</a> sends some additional application events.

#### Note

Some events are actually triggered before the ApplicationContext is created, so you cannot register a listener on those as a @Bean. You can register them with the SpringApplication.addListeners(...) method or the SpringApplicationBuilder.listeners(...) method.

If you want those listeners to be registered automatically, regardless of the way the application is created, you can add a META-INF/spring.factories file to your project and reference your listener(s) by using the org.springframework.context.ApplicationListener key, as shown in the following example:

org.springframework.context.ApplicationListener=com.example.project.MyListener

Application events are sent in the following order, as your application runs:

- 1. An ApplicationStartingEvent is sent at the start of a run but before any processing, except for the registration of listeners and initializers.
- 2. An ApplicationEnvironmentPreparedEvent is sent when the Environment to be used in the context is known but before the context is created.
- 3. An ApplicationPreparedEvent is sent just before the refresh is started but after bean definitions have been loaded.
- 4. An ApplicationStartedEvent is sent after the context has been refreshed but before any application and command-line runners have been called.
- 5. An ApplicationReadyEvent is sent after any application and command-line runners have been called. It indicates that the application is ready to service requests.
- 6. An ApplicationFailedEvent is sent if there is an exception on startup.

#### Tip

You often need not use application events, but it can be handy to know that they exist. Internally, Spring Boot uses events to handle a variety of tasks.

Application events are sent by using Spring Framework's event publishing mechanism. Part of this mechanism ensures that an event published to the listeners in a child context is also published to the listeners in any ancestor contexts. As a result of this, if your application uses a hierarchy of SpringApplication instances, a listener may receive multiple instances of the same type of application event.

To allow your listener to distinguish between an event for its context and an event for a descendant context, it should request that its application context is injected and then compare the injected context with the context of the event. The context can be injected by implementing ApplicationContextAware or, if the listener is a bean, by using @Autowired.

#### 23.6 Web Environment

A SpringApplication attempts to create the right type of ApplicationContext on your behalf. The algorithm used to determine a WebApplicationType is fairly simple:

- If Spring MVC is present, an AnnotationConfigServletWebServerApplicationContext is used
- If Spring MVC is not present and Spring WebFlux is present, an AnnotationConfigReactiveWebServerApplicationContext is used
- Otherwise, AnnotationConfigApplicationContext is used

This means that if you are using Spring MVC and the new WebClient from Spring WebFlux in the same application, Spring MVC will be used by default. You can override that easily by calling setWebApplicationType(WebApplicationType).

It is also possible to take complete control of the ApplicationContext type that is used by calling setApplicationContextClass(...).

#### Tip

It is often desirable to call <code>setWebApplicationType(WebApplicationType.NONE)</code> when using <code>SpringApplication</code> within a <code>JUnit test</code>.

## 23.7 Accessing Application Arguments

If you need to access the application arguments that were passed to SpringApplication.run(...), you can inject a org.springframework.boot.ApplicationArguments bean. The ApplicationArguments interface provides access to both the raw String[] arguments as well as parsed option and non-option arguments, as shown in the following example:

```
import org.springframework.boot.*;
import org.springframework.beans.factory.annotation.*;
import org.springframework.stereotype.*;

@Component
public class MyBean {

@Autowired
public MyBean(ApplicationArguments args) {
  boolean debug = args.containsOption("debug");
  List<String> files = args.getNonOptionArgs();
  // if run with "--debug logfile.txt" debug=true, files=["logfile.txt"]
}
```

#### Tip

Spring Boot also registers a CommandLinePropertySource with the Spring Environment. This lets you also inject single application arguments by using the @Value annotation.

### 23.8 Using the ApplicationRunner or CommandLineRunner

If you need to run some specific code once the SpringApplication has started, you can implement the ApplicationRunner or CommandLineRunner interfaces. Both interfaces work in the same way and offer a single run method, which is called just before SpringApplication.run(...) completes.

The CommandLineRunner interfaces provides access to application arguments as a simple string array, whereas the ApplicationRunner uses the ApplicationArguments interface discussed earlier. The following example shows a CommandLineRunner with a run method:

```
import org.springframework.boot.*;
import org.springframework.stereotype.*;
@Component
public class MyBean implements CommandLineRunner {

public void run(String... args) {
    // Do something...
}
```

If several CommandLineRunner or ApplicationRunner beans are defined that must be called in a specific order, you can additionally implement the org.springframework.core.Ordered interface or use the org.springframework.core.annotation.Order annotation.

### 23.9 Application Exit

Each SpringApplication registers a shutdown hook with the JVM to ensure that the ApplicationContext closes gracefully on exit. All the standard Spring lifecycle callbacks (such as the DisposableBean interface or the @PreDestroy annotation) can be used.

In addition, beans may implement the org.springframework.boot.ExitCodeGenerator interface if they wish to return a specific exit code when SpringApplication.exit() is called. This exit code can then be passed to System.exit() to return it as a status code, as shown in the following example:

```
@SpringBootApplication
public class ExitCodeApplication {

@Bean
public ExitCodeGenerator exitCodeGenerator() {
  return () -> 42;
}

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

Also, the <code>ExitCodeGenerator</code> interface may be implemented by exceptions. When such an exception is encountered, Spring Boot returns the exit code provided by the implemented <code>getExitCode()</code> method.

## 23.10 Admin Features

for possible enable admin-related features the application by exposes specifying spring.application.admin.enabled This the property. the SpringApplicationAdminMXBean on the platform MBeanServer. You could use this feature to administer your Spring Boot application remotely. This feature could also be useful for any service wrapper implementation.

### Tip

If you want to know on which HTTP port the application is running, get the property with a key of local.server.port.

### Caution

Take care when enabling this feature, as the MBean exposes a method to shutdown the application.

# 24. Externalized Configuration

Spring Boot lets you externalize your configuration so that you can work with the same application code in different environments. You can use properties files, YAML files, environment variables, and command-line arguments to externalize configuration. Property values can be injected directly into your beans by using the @Value annotation, accessed through Spring's Environment abstraction, or be bound to structured objects through @ConfigurationProperties.

Spring Boot uses a very particular PropertySource order that is designed to allow sensible overriding of values. Properties are considered in the following order:

- 1. <u>Devtools global settings properties</u> on your home directory (~/.spring-boot-devtools.properties when devtools is active).
- 2. @TestPropertySource annotations on your tests.
- 3. properties attribute on your tests. Available on <a href="mailto:@SpringBootTest">@SpringBootTest</a> and the <a href="mailto:test">test annotations for testing a particular slice of your application</a>.
- 4. Command line arguments.
- 5. Properties from SPRING\_APPLICATION\_JSON (inline JSON embedded in an environment variable or system property).
- 6. ServletConfig init parameters.
- 7. ServletContext init parameters.
- 8. JNDI attributes from java:comp/env.
- Java System properties (System.getProperties()).
- 10.OS environment variables.
- 11A RandomValuePropertySource that has properties only in random. \*.
- 12<u>Profile-specific application properties</u> outside of your packaged jar (application-{profile}.properties and YAML variants).
- 13<u>Profile-specific application properties</u> packaged inside your jar (application-fprofile).properties and YAML variants).
- 14Application properties outside of your packaged jar (application.properties and YAML variants).
- 15Application properties packaged inside your jar (application.properties and YAML variants).
- $16 \underline{\texttt{@PropertySource}} \ annotations \ on \ your \ \underline{\texttt{@Configuration}} \ classes.$
- 17Default properties (specified by setting SpringApplication.setDefaultProperties).

To provide a concrete example, suppose you develop a @Component that uses a name property, as shown in the following example:

```
import org.springframework.stereotype.*;
import org.springframework.beans.factory.annotation.*;
```

```
@Component
public class MyBean {
    @Value("${name}")
    private String name;
    // ...
}
```

On your application classpath (for example, inside your jar) you can have an application.properties file that provides a sensible default property value for name. When running in a new environment, an application.properties file can be provided outside of your jar that overrides the name. For one-off testing, you can launch with a specific command line switch (for example, java -jar app.jar --name="Spring").

#### Tip

The SPRING\_APPLICATION\_JSON properties can be supplied on the command line with an environment variable. For example, you could use the following line in a UN\*X shell:

```
$ SPRING_APPLICATION_JSON='{"acme":{"name":"test"}}' java -jar myapp.jar
```

In the preceding example, you end up with acme.name=test in the Spring Environment. You can also supply the JSON as spring.application.json in a System property, as shown in the following example:

```
$ java -Dspring.application.json='{"name":"test"}' -jar myapp.jar
```

You can also supply the JSON by using a command line argument, as shown in the following example:

```
$ java -jar myapp.jar --spring.application.json='{"name":"test"}'
```

You can also supply the JSON as a JNDI variable, as follows: java:comp/env/spring.application.json.

# 24.1 Configuring Random Values

The RandomValuePropertySource is useful for injecting random values (for example, into secrets or test cases). It can produce integers, longs, uuids, or strings, as shown in the following example:

```
my.secret=${random.value}
my.number=${random.int}
my.bignumber=${random.long}
my.uuid=${random.uuid}
my.number.less.than.ten=${random.int(10)}
my.number.in.range=${random.int[1024,65536]}
```

The random.int\* syntax is OPEN value (, max) CLOSE where the OPEN, CLOSE are any character and value, max are integers. If max is provided, then value is the minimum value and max is the maximum value (exclusive).

# 24.2 Accessing Command Line Properties

By default, SpringApplication converts any command line option arguments (that is, arguments starting with --, such as --server.port=9000) to a property and adds them to the Spring

Environment. As mentioned previously, command line properties always take precedence over other property sources.

If you do not want command line properties to be added to the Environment, you can disable them by using SpringApplication.setAddCommandLineProperties(false).

# 24.3 Application Property Files

SpringApplication loads properties from application.properties files in the following locations and adds them to the Spring Environment:

- A /config subdirectory of the current directory
- 2. The current directory
- 3. A classpath /config package
- 4. The classpath root

The list is ordered by precedence (properties defined in locations higher in the list override those defined in lower locations).

#### Note

You can also <u>use YAML ('.yml') files</u> as an alternative to '.properties'.

If you do not like application.properties as the configuration file name, you can switch to another file name by specifying a spring.config.name environment property. You can also refer to an explicit location by using the spring.config.location environment property (which is a comma-separated list of directory locations or file paths). The following example shows how to specify a different file name:

```
$ java -jar myproject.jar --spring.config.name=myproject
```

The following example shows how to specify two locations:

```
$ java -jar myproject.jar --spring.config.location=classpath:/default.properties,classpath:/
override.properties
```

### Warning

spring.config.name and spring.config.location are used very early to determine which files have to be loaded, so they must be defined as an environment property (typically an OS environment variable, a system property, or a command-line argument).

If spring.config.location contains directories (as opposed to files), they should end in / (and, at runtime, be appended with the names generated from spring.config.name before being loaded, including profile-specific file names). Files specified in spring.config.location are used as-is, with no support for profile-specific variants, and are overridden by any profile-specific properties.

Config locations are searched in reverse order. By default, the configured locations are classpath:/,classpath:/config/,file:./,file:./config/. The resulting search order is the following:

1. file: ./config/

```
2. file:./
3. classpath:/config/
4. classpath:/
```

When custom config locations are configured by using spring.config.location, they replace the default locations. For example, if spring.config.location is configured with the value classpath:/custom-config/,file:./custom-config/, the search order becomes the following:

```
    file:./custom-config/
    classpath:custom-config/
```

Alternatively, when custom config locations are configured by using spring.config.additional-location, they are used in addition to the default locations. Additional locations are searched before the default locations. For example, if additional locations of classpath:/custom-config/,file:./custom-config/ are configured, the search order becomes the following:

```
    file:./custom-config/
    classpath:custom-config/
    file:./config/
    file:./
    classpath:/config/
    classpath:/
```

This search ordering lets you specify default values in one configuration file and then selectively override those values in another. You can provide default values for your application in application.properties (or whatever other basename you choose with spring.config.name) in one of the default locations. These default values can then be overridden at runtime with a different file located in one of the custom locations.

### Note

If you use environment variables rather than system properties, most operating systems disallow period-separated key names, but you can use underscores instead (for example, SPRING CONFIG NAME instead of spring.config.name).

### Note

If your application runs in a container, then JNDI properties (in <code>java:comp/env</code>) or servlet context initialization parameters can be used instead of, or as well as, environment variables or system properties.

# 24.4 Profile-specific Properties

In addition to application.properties files, profile-specific properties can also be defined by using the following naming convention: application-{profile}.properties. The Environment has

a set of default profiles (by default, [default]) that are used if no active profiles are set. In other words, if no profiles are explicitly activated, then properties from application-default.properties are loaded.

Profile-specific properties are loaded from the same locations as standard application.properties, with profile-specific files always overriding the non-specific ones, whether or not the profile-specific files are inside or outside your packaged jar.

If several profiles are specified, a last-wins strategy applies. For example, profiles specified by the spring.profiles.active property are added after those configured through the SpringApplication API and therefore take precedence.

### Note

If you have specified any files in spring.config.location, profile-specific variants of those files are not considered. Use directories in spring.config.location if you want to also use profile-specific properties.

# 24.5 Placeholders in Properties

The values in application.properties are filtered through the existing Environment when they are used, so you can refer back to previously defined values (for example, from System properties).

```
app.name=MyApp
app.description=${app.name} is a Spring Boot application
```

### Tip

You can also use this technique to create "short" variants of existing Spring Boot properties. See the <u>Section 77.4</u>, "Use 'Short' Command Line Arguments" how-to for details.

# 24.6 Encrypting Properties

Spring Boot does not provide any built in support for encrypting property values, however, it does provide the hook points necessary to modify values contained in the Spring Environment. The EnvironmentPostProcessor interface allows you to manipulate the Environment before the application starts. See Section 76.3, "Customize the Environment or ApplicationContext Before It Starts" for details.

If you're looking for a secure way to store credentials and passwords, the <u>Spring Cloud Vault</u> project provides support for storing externalized configuration in <u>HashiCorp Vault</u>.

# 24.7 Using YAML Instead of Properties

YAML is a superset of JSON and, as such, is a convenient format for specifying hierarchical configuration data. The SpringApplication class automatically supports YAML as an alternative to properties whenever you have the SnakeYAML library on your classpath.

## Note

If you use "Starters", SnakeYAML is automatically provided by spring-boot-starter.

## **Loading YAML**

Spring Framework provides two convenient classes that can be used to load YAML documents. The YamlPropertiesFactoryBean loads YAML as Properties and the YamlMapFactoryBean loads YAML as a Map.

For example, consider the following YAML document:

```
environments:
    dev:
        url: http://dev.example.com
        name: Developer Setup
    prod:
        url: http://another.example.com
        name: My Cool App
```

The preceding example would be transformed into the following properties:

```
environments.dev.url=http://dev.example.com
environments.dev.name=Developer Setup
environments.prod.url=http://another.example.com
environments.prod.name=My Cool App
```

YAML lists are represented as property keys with [index] dereferencers. For example, consider the following YAML:

```
my:
servers:
    dev.example.com
    another.example.com
```

The preceding example would be transformed into these properties:

```
my.servers[0]=dev.example.com
my.servers[1]=another.example.com
```

To bind to properties like that by using Spring Boot's Binder utilities (which is what @ConfigurationProperties does), you need to have a property in the target bean of type java.util.List (or Set) and you either need to provide a setter or initialize it with a mutable value. For example, the following example binds to the properties shown previously:

```
@ConfigurationProperties(prefix="my")
public class Config {
  private List<String> servers = new ArrayList<String>();
  public List<String> getServers() {
    return this.servers;
  }
}
```

# **Exposing YAML as Properties in the Spring Environment**

The YamlPropertySourceLoader class can be used to expose YAML as a PropertySource in the Spring Environment. Doing so lets you use the @Value annotation with placeholders syntax to access YAML properties.

## **Multi-profile YAML Documents**

You can specify multiple profile-specific YAML documents in a single file by using a spring.profiles key to indicate when the document applies, as shown in the following example:

```
server:
address: 192.168.1.100
---
spring:
profiles: development
server:
address: 127.0.0.1
---
spring:
profiles: production & eu-central
server:
address: 192.168.1.120
```

In the preceding example, if the development profile is active, the server address property is 127.0.0.1. Similarly, if the production **and** eu-central profiles are active, the server address property is 192.168.1.120. If the development, production and eu-central profiles are **not** enabled, then the value for the property is 192.168.1.100.

#### Note

spring.profiles can therefore contain a simple profile name (for example production) or a profile expression. A profile expression allows for more complicated profile logic to be expressed, for example production & (eu-central  $\mid$  eu-west). Check the reference guide for more details.

If none are explicitly active when the application context starts, the default profiles are activated. So, in the following YAML, we set a value for <code>spring.security.user.password</code> that is available **only** in the "default" profile:

```
server:
   port: 8000
---
spring:
   profiles: default
   security:
    user:
     password: weak
```

Whereas, in the following example, the password is always set because it is not attached to any profile, and it would have to be explicitly reset in all other profiles as necessary:

```
server:
  port: 8000
spring:
  security:
  user:
  password: weak
```

Spring profiles designated by using the spring.profiles element may optionally be negated by using the ! character. If both negated and non-negated profiles are specified for a single document, at least one non-negated profile must match, and no negated profiles may match.

# **YAML Shortcomings**

YAML files cannot be loaded by using the <code>@PropertySource</code> annotation. So, in the case that you need to load values that way, you need to use a properties file.

# 24.8 Type-safe Configuration Properties

Using the <code>@Value("\${property}")</code> annotation to inject configuration properties can sometimes be cumbersome, especially if you are working with multiple properties or your data is hierarchical in nature. Spring Boot provides an alternative method of working with properties that lets strongly typed beans govern and validate the configuration of your application, as shown in the following example:

```
package com.example;
import java.net.InetAddress;
import java.util.ArrayList;
import java.util.Collections;
import java.util.List;
import org.springframework.boot.context.properties.ConfigurationProperties;
@ConfigurationProperties("acme")
public class AcmeProperties {
private boolean enabled;
private InetAddress remoteAddress;
private final Security security = new Security();
public boolean isEnabled() { ... }
public void setEnabled(boolean enabled) { ... }
public InetAddress getRemoteAddress() { ... }
public void setRemoteAddress(InetAddress remoteAddress) { ... }
public Security getSecurity() { ... }
public static class Security {
 private String username;
 private String password;
 private List<String> roles = new ArrayList<>(Collections.singleton("USER"));
 public String getUsername() { ... }
 public void setUsername(String username) { ... }
 public String getPassword() { ... }
 public void setPassword(String password) { ... }
 public List<String> getRoles() { ... }
 public void setRoles(List<String> roles) { ... }
```

The preceding POJO defines the following properties:

- acme.enabled, with a value of false by default.
- acme.remote-address, with a type that can be coerced from String.

- acme.security.username, with a nested "security" object whose name is determined by the name of the property. In particular, the return type is not used at all there and could have been SecurityProperties.
- acme.security.password.
- acme.security.roles, with a collection of String.

#### Note

Getters and setters are usually mandatory, since binding is through standard Java Beans property descriptors, just like in Spring MVC. A setter may be omitted in the following cases:

- Maps, as long as they are initialized, need a getter but not necessarily a setter, since they can be mutated by the binder.
- Collections and arrays can be accessed either through an index (typically with YAML) or by
  using a single comma-separated value (properties). In the latter case, a setter is mandatory.
  We recommend to always add a setter for such types. If you initialize a collection, make sure
  it is not immutable (as in the preceding example).
- If nested POJO properties are initialized (like the Security field in the preceding example), a setter is not required. If you want the binder to create the instance on the fly by using its default constructor, you need a setter.

Some people use Project Lombok to add getters and setters automatically. Make sure that Lombok does not generate any particular constructor for such a type, as it is used automatically by the container to instantiate the object.

Finally, only standard Java Bean properties are considered and binding on static properties is not supported.

### Tip

See also the <u>differences between @Value and @ConfigurationProperties</u>.

You also need to list the properties classes to register in the <code>@EnableConfigurationProperties</code> annotation, as shown in the following example:

```
@Configuration
@EnableConfigurationProperties(AcmeProperties.class)
public class MyConfiguration {
}
```

#### Note

When the <code>@ConfigurationProperties</code> bean is registered that way, the bean has a conventional name: <code><prefix>-<fqn></code>, where <code><prefix></code> is the environment key prefix specified in the <code>@ConfigurationProperties</code> annotation and <code><fqn></code> is the fully qualified name of the bean. If the annotation does not provide any prefix, only the fully qualified name of the bean is used.

The bean name in the example above is acme-com.example.AcmeProperties.

Even if the preceding configuration creates a regular bean for AcmeProperties, we recommend that @ConfigurationProperties only deal with the environment and, in particular, does not inject other beans from the context. Having said that, the @EnableConfigurationProperties annotation is also automatically applied to your project so that any existing bean annotated with @ConfigurationProperties is configured from the Environment. You could shortcut MyConfiguration by making sure AcmeProperties is already a bean, as shown in the following example:

```
@Component
@ConfigurationProperties(prefix="acme")
public class AcmeProperties {

// ... see the preceding example
}
```

This style of configuration works particularly well with the SpringApplication external YAML configuration, as shown in the following example:

```
# application.yml
acme:
    remote-address: 192.168.1.1
    security:
    username: admin
    roles:
        - USER
        - ADMIN
# additional configuration as required
```

To work with @ConfigurationProperties beans, you can inject them in the same way as any other bean, as shown in the following example:

```
@Service
public class MyService {

private final AcmeProperties properties;

@Autowired
public MyService(AcmeProperties properties) {
    this.properties = properties;
}

//...

@PostConstruct
public void openConnection() {
    Server server = new Server(this.properties.getRemoteAddress());
    // ...
}
```

#### Tip

Using @ConfigurationProperties also lets you generate metadata files that can be used by IDEs to offer auto-completion for your own keys. See the <u>Appendix B</u>, <u>Configuration Metadata</u> appendix for details.

## **Third-party Configuration**

As well as using <code>@ConfigurationProperties</code> to annotate a class, you can also use it on public <code>@Bean</code> methods. Doing so can be particularly useful when you want to bind properties to third-party components that are outside of your control.

To configure a bean from the Environment properties, add @ConfigurationProperties to its bean registration, as shown in the following example:

```
@ConfigurationProperties(prefix = "another")
@Bean
public AnotherComponent anotherComponent() {
    ...
}
```

Any property defined with the another prefix is mapped onto that Another Component bean in manner similar to the preceding AcmeProperties example.

## **Relaxed Binding**

Spring Boot uses some relaxed rules for binding Environment properties to @ConfigurationProperties beans, so there does not need to be an exact match between the Environment property name and the bean property name. Common examples where this is useful include dash-separated environment properties (for example, context-path binds to contextPath), and capitalized environment properties (for example, PORT binds to port).

For example, consider the following @ConfigurationProperties class:

```
@ConfigurationProperties(prefix="acme.my-project.person")
public class OwnerProperties {

private String firstName;

public String getFirstName() {
   return this.firstName;
}

public void setFirstName(String firstName) {
   this.firstName = firstName;
}
```

In the preceding example, the following properties names can all be used:

Table 24.1. relaxed binding

Property	Note
acme.my- project.person name	Kebab case, which is recommended for use in .properties and .yml filesfirst-
acme.myProject	. Standarid Camet wase syntax.
acme.my_projec	t <b>Updersoore høtation</b> a <b>which is an alternative format for use in .</b> properties and .yml files.

Property	Note
ACME_MYPROJECT	_ խթթeoւ <u>sase format</u> with is recommended when using system environment variables.

#### Note

The prefix value for the annotation *must* be in kebab case (lowercase and separated by -, such as acme.my-project.person).

Table 24.2. relaxed binding rules per property source

<b>Property Source</b>	Simple	List
Properties Files	Camel case, kebab case, or underscore notation	Standard list syntax using [ ] or comma-separated values
YAML Files	Camel case, kebab case, or underscore notation	Standard YAML list syntax or comma- separated values
Environment Variables	Upper case format with underscore as the delimiter should not be used within a property name	Numeric values surrounded by underscores, such as MY_ACME_1_OTHER = my.acme[1].other
System properties	Camel case, kebab case, or underscore notation	Standard list syntax using [ ] or comma-separated values

### Tip

We recommend that, when possible, properties are stored in lower-case kebab format, such as my.property-name=acme.

When binding to Map properties, if the key contains anything other than lowercase alpha-numeric characters or –, you need to use the bracket notation so that the original value is preserved. If the key is not surrounded by [], any characters that are not alpha-numeric or – are removed. For example, consider binding the following properties to a Map:

```
acme:
    map:
    "[/key1]": value1
    "[/key2]": value2
    /key3: value3
```

The properties above will bind to a Map with /key1, /key2 and key3 as the keys in the map.

# **Merging Complex Types**

When lists are configured in more than one place, overriding works by replacing the entire list.

For example, assume a MyPojo object with name and description attributes that are null by default. The following example exposes a list of MyPojo objects from AcmeProperties:

```
@ConfigurationProperties("acme")
public class AcmeProperties {
```

```
private final List<MyPojo> list = new ArrayList<>();

public List<MyPojo> getList() {
  return this.list;
}
```

Consider the following configuration:

```
acme:
    list:
        - name: my name
        description: my description
---
spring:
    profiles: dev
acme:
    list:
        - name: my another name
```

If the dev profile is not active, AcmeProperties.list contains one MyPojo entry, as previously defined. If the dev profile is enabled, however, the list still contains only one entry (with a name of my another name and a description of null). This configuration does not add a second MyPojo instance to the list, and it does not merge the items.

When a List is specified in multiple profiles, the one with the highest priority (and only that one) is used. Consider the following example:

```
acme:
    list:
        - name: my name
        description: my description
        - name: another name
        description: another description
---
spring:
    profiles: dev
acme:
    list:
        - name: my another name
```

In the preceding example, if the dev profile is active, AcmeProperties.list contains one MyPojo entry (with a name of my another name and a description of null). For YAML, both comma-separated lists and YAML lists can be used for completely overriding the contents of the list.

For Map properties, you can bind with property values drawn from multiple sources. However, for the same property in multiple sources, the one with the highest priority is used. The following example exposes a Map<String, MyPojo> from AcmeProperties:

```
@ConfigurationProperties("acme")
public class AcmeProperties {

private final Map<String, MyPojo> map = new HashMap<>();

public Map<String, MyPojo> getMap() {
  return this.map;
}
```

Consider the following configuration:

```
acme:
    map:
    key1:
        name: my name 1
        description: my description 1
---
spring:
    profiles: dev
acme:
    map:
    key1:
        name: dev name 1
    key2:
        name: dev name 2
        description: dev description 2
```

If the dev profile is not active, AcmeProperties.map contains one entry with key key1 (with a name of my name 1 and a description of my description 1). If the dev profile is enabled, however, map contains two entries with keys key1 (with a name of dev name 1 and a description of my description 1) and key2 (with a name of dev name 2 and a description of dev description 2).

### Note

The preceding merging rules apply to properties from all property sources and not just YAML files.

## **Properties Conversion**

Spring Boot attempts to coerce the external application properties to the right type when it binds to the @ConfigurationProperties beans. If you need custom type conversion, you can provide a ConversionService bean (with a bean named conversionService) or custom property editors (through a CustomEditorConfigurer bean) or custom Converters (with bean definitions annotated as @ConfigurationPropertiesBinding).

### **Note**

As this bean is requested very early during the application lifecycle, make sure to limit the dependencies that your ConversionService is using. Typically, any dependency that you require may not be fully initialized at creation time. You may want to rename your custom ConversionService if it is not required for configuration keys coercion and only rely on custom converters qualified with @ConfigurationPropertiesBinding.

#### **Converting durations**

Spring Boot has dedicated support for expressing durations. If you expose a <code>java.time.Duration</code> property, the following formats in application properties are available:

- A regular long representation (using milliseconds as the default unit unless a @DurationUnit has been specified)
- The standard ISO-8601 format <u>used by java.util.Duration</u>
- A more readable format where the value and the unit are coupled (e.g. 10s means 10 seconds)

Consider the following example:

```
@ConfigurationProperties("app.system")
public class AppSystemProperties {
```

```
@DurationUnit(ChronoUnit.SECONDS)
private Duration sessionTimeout = Duration.ofSeconds(30);

private Duration readTimeout = Duration.ofMillis(1000);

public Duration getSessionTimeout() {
   return this.sessionTimeout;
}

public void setSessionTimeout(Duration sessionTimeout) {
   this.sessionTimeout = sessionTimeout;
}

public Duration getReadTimeout() {
   return this.readTimeout;
}

public void setReadTimeout(Duration readTimeout) {
   this.readTimeout = readTimeout;
}
```

To specify a session timeout of 30 seconds, 30, PT30S and 30s are all equivalent. A read timeout of 500ms can be specified in any of the following form: 500, PT0.5S and 500ms.

You can also use any of the supported units. These are:

- ns for nanoseconds
- us for microseconds
- ms for milliseconds
- s for seconds
- m for minutes
- h for hours
- d for days

The default unit is milliseconds and can be overridden using @DurationUnit as illustrated in the sample above.

### Tip

If you are upgrading from a previous version that is simply using Long to express the duration, make sure to define the unit (using @DurationUnit) if it isn't milliseconds alongside the switch to Duration. Doing so gives a transparent upgrade path while supporting a much richer format.

### **Converting Data Sizes**

Spring Framework has a DataSize value type that allows to express size in bytes. If you expose a DataSize property, the following formats in application properties are available:

- A regular long representation (using bytes as the default unit unless a @DataSizeUnit has been specified)
- A more readable format where the value and the unit are coupled (e.g. 10MB means 10 megabytes)

### Consider the following example:

```
@ConfigurationProperties("app.io")
public class AppIoProperties {

@DataSizeUnit(DataUnit.MEGABYTES)
private DataSize bufferSize = DataSize.ofMegabytes(2);

private DataSize sizeThreshold = DataSize.ofBytes(512);

public DataSize getBufferSize() {
   return this.bufferSize;
}

public void setBufferSize(DataSize bufferSize) {
   this.bufferSize = bufferSize;
}

public DataSize getSizeThreshold() {
   return this.sizeThreshold;
}

public void setSizeThreshold(DataSize sizeThreshold) {
   this.sizeThreshold = sizeThreshold;
}
```

To specify a buffer size of 10 megabytes, 10 and 10MB are equivalent. A size threshold of 256 bytes can be specified as 256 or 256B.

You can also use any of the supported units. These are:

- B for bytes
- KB for kilobytes
- MB for megabytes
- GB for gigabytes
- TB for terabytes

The default unit is bytes and can be overridden using @DataSizeUnit as illustrated in the sample above.

## Tip

If you are upgrading from a previous version that is simply using Long to express the size, make sure to define the unit (using @DataSizeUnit) if it isn't bytes alongside the switch to DataSize. Doing so gives a transparent upgrade path while supporting a much richer format.

## @ConfigurationProperties Validation

Spring Boot attempts to validate @ConfigurationProperties classes whenever they are annotated with Spring's @Validated annotation. You can use JSR-303 javax.validation constraint annotations directly on your configuration class. To do so, ensure that a compliant JSR-303 implementation is on your classpath and then add constraint annotations to your fields, as shown in the following example:

```
@ConfigurationProperties(prefix="acme")
```

```
@Validated
public class AcmeProperties {

@NotNull
private InetAddress remoteAddress;

// ... getters and setters
}
```

### Tip

You can also trigger validation by annotating the @Bean method that creates the configuration properties with @Validated.

Although nested properties will also be validated when bound, it's good practice to also annotate the associated field as @Valid. This ensure that validation is triggered even if no nested properties are found. The following example builds on the preceding AcmeProperties example:

```
@ConfigurationProperties(prefix="acme")
@Validated
public class AcmeProperties {

@NotNull
private InetAddress remoteAddress;

@Valid
private final Security security = new Security();

// ... getters and setters

public static class Security {

@NotEmpty
public String username;

// ... getters and setters
}
```

You can also add a custom Spring Validator by creating a bean definition called configurationPropertiesValidator. The @Bean method should be declared static. The configuration properties validator is created very early in the application's lifecycle, and declaring the @Bean method as static lets the bean be created without having to instantiate the @Configuration class. Doing so avoids any problems that may be caused by early instantiation. There is a property validation sample that shows how to set things up.

### Tip

The spring-boot-actuator module includes an endpoint that exposes all @ConfigurationProperties beans. Point your web browser to /actuator/configprops or use the equivalent JMX endpoint. See the "Production ready features" section for details.

# @ConfigurationProperties vs. @Value

The @Value annotation is a core container feature, and it does not provide the same features as type-safe configuration properties. The following table summarizes the features that are supported by @ConfigurationProperties and @Value:

Feature	@ConfigurationPrope@Walkse	
Relaxed binding	Yes	No
Meta-data support	Yes	No
SpEL evaluation	No	Yes

If you define a set of configuration keys for your own components, we recommend you group them in a POJO annotated with <code>@ConfigurationProperties</code>. You should also be aware that, since <code>@Value</code> does not support relaxed binding, it is not a good candidate if you need to provide the value by using environment variables.

Finally, while you can write a SpEL expression in @Value, such expressions are not processed from application property files.

# 25. Profiles

Spring Profiles provide a way to segregate parts of your application configuration and make it be available only in certain environments. Any @Component or @Configuration can be marked with @Profile to limit when it is loaded, as shown in the following example:

```
@Configuration
@Profile("production")
public class ProductionConfiguration {
   // ...
}
```

You can use a spring.profiles.active Environment property to specify which profiles are active. You can specify the property in any of the ways described earlier in this chapter. For example, you could include it in your application.properties, as shown in the following example:

```
spring.profiles.active=dev,hsqldb
```

You could also specify it on the command line by using the following switch: --spring.profiles.active=dev,hsqldb.

# 25.1 Adding Active Profiles

The spring.profiles.active property follows the same ordering rules as other properties: The highest PropertySource wins. This means that you can specify active profiles in application.properties and then **replace** them by using the command line switch.

Sometimes, it is useful to have profile-specific properties that **add** to the active profiles rather than replace them. The <code>spring.profiles.include</code> property can be used to unconditionally add active profiles. The <code>SpringApplication</code> entry point also has a Java API for setting additional profiles (that is, on top of those activated by the <code>spring.profiles.active</code> property). See the <code>setAdditionalProfiles()</code> method in <code>SpringApplication</code>.

For example, when an application with the following properties is run by using the switch, --spring.profiles.active=prod, the proddb and prodmq profiles are also activated:

```
my.property: fromyamlfile
---
spring.profiles: prod
spring.profiles.include:
- proddb
- prodmq
```

### Note

Remember that the spring.profiles property can be defined in a YAML document to determine when this particular document is included in the configuration. See <u>Section 77.7</u>, "Change Configuration Depending on the Environment" for more details.

# 25.2 Programmatically Setting Profiles

You can programmatically set active profiles by calling SpringApplication.setAdditionalProfiles(...) before your application runs. It is also possible to activate profiles by using Spring's ConfigurableEnvironment interface.

# 25.3 Profile-specific Configuration Files

Profile-specific variants of both application.properties (or application.yml) and files referenced through @ConfigurationProperties are considered as files and loaded. See "Section 24.4, "Profile-specific Properties" for details.

# 26. Logging

Spring Boot uses <u>Commons Logging</u> for all internal logging but leaves the underlying log implementation open. Default configurations are provided for <u>Java Util Logging</u>, <u>Log4J2</u>, and <u>Logback</u>. In each case, loggers are pre-configured to use console output with optional file output also available.

By default, if you use the "Starters", Logback is used for logging. Appropriate Logback routing is also included to ensure that dependent libraries that use Java Util Logging, Commons Logging, Log4J, or SLF4J all work correctly.

#### Tip

There are a lot of logging frameworks available for Java. Do not worry if the above list seems confusing. Generally, you do not need to change your logging dependencies and the Spring Boot defaults work just fine.

# 26.1 Log Format

The default log output from Spring Boot resembles the following example:

```
2014-03-05 10:57:51.112 INFO 45469 --- [ main] org.apache.catalina.core.StandardEngine : Starting Servlet Engine: Apache Tomcat/7.0.52
2014-03-05 10:57:51.253 INFO 45469 --- [ost-startStop-1] o.a.c.c.C.[Tomcat].[localhost].[/] : Initializing Spring embedded WebApplicationContext
2014-03-05 10:57:51.253 INFO 45469 --- [ost-startStop-1] o.s.web.context.ContextLoader : Root WebApplicationContext: initialization completed in 1358 ms
2014-03-05 10:57:51.698 INFO 45469 --- [ost-startStop-1] o.s.b.c.e.ServletRegistrationBean : Mapping servlet: 'dispatcherServlet' to [/]
2014-03-05 10:57:51.702 INFO 45469 --- [ost-startStop-1] o.s.b.c.embedded.FilterRegistrationBean : Mapping filter: 'hiddenHttpMethodFilter' to: [/*]
```

The following items are output:

- Date and Time: Millisecond precision and easily sortable.
- Log Level: ERROR, WARN, INFO, DEBUG, or TRACE.
- Process ID.
- A --- separator to distinguish the start of actual log messages.
- Thread name: Enclosed in square brackets (may be truncated for console output).
- Logger name: This is usually the source class name (often abbreviated).
- The log message.

### Note

Logback does not have a FATAL level. It is mapped to ERROR.

# 26.2 Console Output

The default log configuration echoes messages to the console as they are written. By default, ERROR-level, WARN-level, and INFO-level messages are logged. You can also enable a "debug" mode by starting your application with a --debug flag.

```
$ java -jar myapp.jar --debug
```

#### Note

You can also specify debug=true in your application.properties.

When the debug mode is enabled, a selection of core loggers (embedded container, Hibernate, and Spring Boot) are configured to output more information. Enabling the debug mode does *not* configure your application to log all messages with DEBUG level.

Alternatively, you can enable a "trace" mode by starting your application with a --trace flag (or trace=true in your application.properties). Doing so enables trace logging for a selection of core loggers (embedded container, Hibernate schema generation, and the whole Spring portfolio).

## **Color-coded Output**

If your terminal supports ANSI, color output is used to aid readability. You can set spring.output.ansi.enabled to a supported value to override the auto detection.

Color coding is configured by using the %clr conversion word. In its simplest form, the converter colors the output according to the log level, as shown in the following example:

```
%clr(%5p)
```

The following table describes the mapping of log levels to colors:

Level	Color
FATAL	Red
ERROR	Red
WARN	Yellow
INFO	Green
DEBUG	Green
TRACE	Green

Alternatively, you can specify the color or style that should be used by providing it as an option to the conversion. For example, to make the text yellow, use the following setting:

```
%clr(%d{yyyy-MM-dd HH:mm:ss.SSS}){yellow}
```

The following colors and styles are supported:

- blue
- cyan
- faint
- green
- magenta

- red
- yellow

# 26.3 File Output

By default, Spring Boot logs only to the console and does not write log files. If you want to write log files in addition to the console output, you need to set a logging.file or logging.path property (for example, in your application.properties).

The following table shows how the logging.\* properties can be used together:

Table 26.1. Logging properties

logging.fi	l <b>b</b> ogging.pa	t <b>E</b> xample	Description
(none)	(none)		Console only logging.
Specific file	(none)	my.log	Writes to the specified log file. Names can be an exact location or relative to the current directory.
(none)	Specific directory	/var/log	Writes spring.log to the specified directory. Names can be an exact location or relative to the current directory.

Log files rotate when they reach 10 MB and, as with console output, ERROR-level, WARN-level, and INFO-level messages are logged by default. Size limits can be changed using the logging.file.max-size property. Previously rotated files are archived indefinitely unless the logging.file.max-history property has been set.

#### Note

The logging system is initialized early in the application lifecycle. Consequently, logging properties are not found in property files loaded through @PropertySource annotations.

#### Tip

Logging properties are independent of the actual logging infrastructure. As a result, specific configuration keys (such as logback.configurationFile for Logback) are not managed by spring Boot.

# 26.4 Log Levels

All the supported logging systems can have the logger levels set in the Spring Environment (for example, in application.properties) by using logging.level.<logger-name>=<level> where level is one of TRACE, DEBUG, INFO, WARN, ERROR, FATAL, or OFF. The root logger can be configured by using logging.level.root.

The following example shows potential logging settings in application.properties:

```
logging.level.root=WARN
logging.level.org.springframework.web=DEBUG
logging.level.org.hibernate=ERROR
```

# 26.5 Log Groups

It's often useful to be able to group related loggers together so that they can all be configured at the same time. For example, you might commonly change the logging levels for *all* Tomcat related loggers, but you can't easily remember top level packages.

To help with this, Spring Boot allows you to define logging groups in your Spring Environment. For example, here's how you could define a "tomcat" group by adding it to your application.properties:

```
logging.group.tomcat=org.apache.catalina, org.apache.coyote, org.apache.tomcat
```

Once defined, you can change the level for all the loggers in the group with a single line:

```
logging.level.tomcat=TRACE
```

Spring Boot includes the following pre-defined logging groups that can be used out-of-the-box:

Name	Loggers
web	org.springframework.core.codec,org.springframework.http,org.springframework.web
sql	org.springframework.jdbc.core,org.hibernate.SQL

# 26.6 Custom Log Configuration

The various logging systems can be activated by including the appropriate libraries on the classpath and can be further customized by providing a suitable configuration file in the root of the classpath or in a location specified by the following Spring Environment property: logging.config.

You can force Spring Boot to use a particular logging system by using the org.springframework.boot.logging.LoggingSystem system property. The value should be the fully qualified class name of a LoggingSystem implementation. You can also disable Spring Boot's logging configuration entirely by using a value of none.

### Note

Since logging is initialized **before** the ApplicationContext is created, it is not possible to control logging from @PropertySources in Spring @Configuration files. The only way to change the logging system or disable it entirely is via System properties.

Depending on your logging system, the following files are loaded:

Logging System	Customization
Logback	<pre>logback-spring.xml, logback- spring.groovy, logback.xml, or logback.groovy</pre>
Log4j2	log4j2-spring.xml or log4j2.xml
JDK (Java Util Logging)	logging.properties

### Note

When possible, we recommend that you use the <code>-spring</code> variants for your logging configuration (for example, <code>logback-spring.xml</code> rather than <code>logback.xml</code>). If you use standard configuration locations, Spring cannot completely control log initialization.

### Warning

There are known classloading issues with Java Util Logging that cause problems when running from an 'executable jar'. We recommend that you avoid it when running from an 'executable jar' if at all possible.

To help with the customization, some other properties are transferred from the Spring Environment to System properties, as described in the following table:

Spring Environment	System Property	Comments
logging.exception-conversion-word	LOG_EXCEPTION_CONVERSION_	ឃុំក្នុងចេលversion word used when logging exceptions.
logging.file	LOG_FILE	If defined, it is used in the default log configuration.
logging.file.max-size	LOG_FILE_MAX_SIZE	Maximum log file size (if LOG_FILE enabled). (Only supported with the default Logback setup.)
logging.file.max- history	LOG_FILE_MAX_HISTORY	Maximum number of archive log files to keep (if LOG_FILE enabled). (Only supported with the default Logback setup.)
logging.path	LOG_PATH	If defined, it is used in the default log configuration.
logging.pattern.console	CONSOLE_LOG_PATTERN	The log pattern to use on the console (stdout). (Only supported with the default Logback setup.)
logging.pattern.dateform	aLOG_DATEFORMAT_PATTERN	Appender pattern for log date format. (Only supported with the default Logback setup.)
logging.pattern.file	FILE_LOG_PATTERN	The log pattern to use in a file (if LOG_FILE is enabled). (Only supported with the default Logback setup.)
logging.pattern.level	LOG_LEVEL_PATTERN	The format to use when rendering the log level (default %5p). (Only supported with the default Logback setup.)

Spring Environment	System Property	Comments
PID	PID	The current process ID (discovered if possible and when not already defined as an OS environment variable).

All the supported logging systems can consult System properties when parsing their configuration files. See the default configurations in spring-boot.jar for examples:

- Logback
- Log4j 2
- Java Util logging

#### Tip

If you want to use a placeholder in a logging property, you should use <u>Spring Boot's syntax</u> and not the syntax of the underlying framework. Notably, if you use Logback, you should use : as the delimiter between a property name and its default value and not use : -.

## Tip

You can add MDC and other ad-hoc content to log lines by overriding only the LOG\_LEVEL\_PATTERN (or logging.pattern.level with Logback). For example, if you use logging.pattern.level=user:%X{user} %5p, then the default log format contains an MDC entry for "user", if it exists, as shown in the following example.

```
2015-09-30 12:30:04.031 user:someone INFO 22174 --- [ nio-8080-exec-0] demo.Controller Handling authenticated request
```

# 26.7 Logback Extensions

Spring Boot includes a number of extensions to Logback that can help with advanced configuration. You can use these extensions in your logback-spring.xml configuration file.

#### Note

Because the standard logback.xml configuration file is loaded too early, you cannot use extensions in it. You need to either use logback-spring.xml or define a logging.config property.

### Warning

The extensions cannot be used with Logback's <u>configuration scanning</u>. If you attempt to do so, making changes to the configuration file results in an error similar to one of the following being logged:

```
ERROR in ch.qos.logback.core.joran.spi.Interpreter@4:71 - no applicable action for [springProperty], current ElementPath is [[configuration][springProperty]]

ERROR in ch.qos.logback.core.joran.spi.Interpreter@4:71 - no applicable action for [springProfile], current ElementPath is [[configuration][springProfile]]
```

## **Profile-specific Configuration**

The <code><springProfile></code> tag lets you optionally include or exclude sections of configuration based on the active Spring profiles. Profile sections are supported anywhere within the <code><configuration></code> element. Use the <code>name</code> attribute to specify which profile accepts the configuration. The <code><springProfile></code> tag can contain a simple profile name (for example <code>staging</code>) or a profile expression. A profile expression allows for more complicated profile logic to be expressed, for example <code>production & (eu-central | eu-west)</code>. Check the <code>reference guide</code> for more details. The following listing shows three sample profiles:

```
<springProfile name="staging">
   <!-- configuration to be enabled when the "staging" profile is active -->
   </springProfile>

<springProfile name="dev | staging">
    <!-- configuration to be enabled when the "dev" or "staging" profiles are active -->
   </springProfile>

<springProfile name="!production">
    <!-- configuration to be enabled when the "production" profile is not active -->
   </springProfile>
```

## **Environment Properties**

The <springProperty> tag lets you expose properties from the Spring Environment for use within Logback. Doing so can be useful if you want to access values from your application.properties file in your Logback configuration. The tag works in a similar way to Logback's standard cproperty> tag. However, rather than specifying a direct value, you specify the source of the property (from the Environment). If you need to store the property somewhere other than in local scope, you can use the scope attribute. If you need a fallback value (in case the property is not set in the Environment), you can use the defaultValue attribute. The following example shows how to expose properties for use within Logback:

### Note

The source must be specified in kebab case (such as my.property-name). However, properties can be added to the Environment by using the relaxed rules.

# **27. JSON**

Spring Boot provides integration with three JSON mapping libraries:

- Gson
- Jackson
- JSON-B

Jackson is the preferred and default library.

## 27.1 Jackson

Auto-configuration for Jackson is provided and Jackson is part of spring-boot-starter-json. When Jackson is on the classpath an ObjectMapper bean is automatically configured. Several configuration properties are provided for <u>customizing the configuration of the ObjectMapper</u>.

### 27.2 Gson

Auto-configuration for Gson is provided. When Gson is on the classpath a Gson bean is automatically configured. Several <code>spring.gson.\*</code> configuration properties are provided for customizing the configuration. To take more control, one or more <code>GsonBuilderCustomizer</code> beans can be used.

### 27.3 JSON-B

Auto-configuration for JSON-B is provided. When the JSON-B API and an implementation are on the classpath a Jsonb bean will be automatically configured. The preferred JSON-B implementation is Apache Johnzon for which dependency management is provided.

# 28. Developing Web Applications

Spring Boot is well suited for web application development. You can create a self-contained HTTP server by using embedded Tomcat, Jetty, Undertow, or Netty. Most web applications use the <code>spring-boot-starter-web</code> module to get up and running quickly. You can also choose to build reactive web applications by using the <code>spring-boot-starter-webflux</code> module.

If you have not yet developed a Spring Boot web application, you can follow the "Hello World!" example in the *Getting started* section.

# 28.1 The "Spring Web MVC Framework"

The <u>Spring Web MVC framework</u> (often referred to as simply "Spring MVC") is a rich "model view controller" web framework. Spring MVC lets you create special @Controller or @RestController beans to handle incoming HTTP requests. Methods in your controller are mapped to HTTP by using @RequestMapping annotations.

The following code shows a typical @RestController that serves JSON data:

```
@RestController
@RequestMapping(value="/users")
public class MyRestController {

@RequestMapping(value="/{user}", method=RequestMethod.GET)
public User getUser(@PathVariable Long user) {
    // ...
}

@RequestMapping(value="/{user}/customers", method=RequestMethod.GET)
List<Customer> getUserCustomers(@PathVariable Long user) {
    // ...
}

@RequestMapping(value="/{user}", method=RequestMethod.DELETE)
public User deleteUser(@PathVariable Long user) {
    // ...
}
```

Spring MVC is part of the core Spring Framework, and detailed information is available in the <u>reference</u> documentation. There are also several guides that cover Spring MVC available at spring.io/guides.

## **Spring MVC Auto-configuration**

Spring Boot provides auto-configuration for Spring MVC that works well with most applications.

The auto-configuration adds the following features on top of Spring's defaults:

- Inclusion of ContentNegotiatingViewResolver and BeanNameViewResolver beans.
- Support for serving static resources, including support for WebJars (covered <u>later in this document</u>)).
- Automatic registration of Converter, GenericConverter, and Formatter beans.
- Support for HttpMessageConverters (covered later in this document).
- Automatic registration of MessageCodesResolver (covered later in this document).

- Static index.html support.
- Custom Favicon support (covered <u>later in this document</u>).
- Automatic use of a ConfigurableWebBindingInitializer bean (covered <u>later in this</u> <u>document</u>).

If you want to keep Spring Boot MVC features and you want to add additional MVC configuration (interceptors, formatters, view controllers, and other features), you can add your own @Configuration class of type WebMvcConfigurer but without @EnableWebMvc. If you wish to provide custom instances of RequestMappingHandlerMapping, RequestMappingHandlerAdapter, or ExceptionHandlerExceptionResolver, you can declare a WebMvcRegistrationsAdapter instance to provide such components.

If you want to take complete control of Spring MVC, you can add your own @Configuration annotated with @EnableWebMvc.

## **HttpMessageConverters**

Spring MVC uses the HttpMessageConverter interface to convert HTTP requests and responses. Sensible defaults are included out of the box. For example, objects can be automatically converted to JSON (by using the Jackson library) or XML (by using the Jackson XML extension, if available, or by using JAXB if the Jackson XML extension is not available). By default, strings are encoded in UTF-8.

If you need to add or customize converters, you can use Spring Boot's HttpMessageConverters class, as shown in the following listing:

```
import org.springframework.boot.autoconfigure.web.HttpMessageConverters;
import org.springframework.context.annotation.*;
import org.springframework.http.converter.*;

@Configuration
public class MyConfiguration {

@Bean
public HttpMessageConverters customConverters() {
   HttpMessageConverter<?> additional = ...
   HttpMessageConverter<?> another = ...
   return new HttpMessageConverters(additional, another);
}
```

Any HttpMessageConverter bean that is present in the context is added to the list of converters. You can also override default converters in the same way.

### **Custom JSON Serializers and Deserializers**

If you use Jackson to serialize and deserialize JSON data, you might want to write your own <code>JsonSerializer</code> and <code>JsonDeserializer</code> classes. Custom serializers are usually registered with <code>Jackson</code> through a module, but Spring Boot provides an alternative <code>@JsonComponent</code> annotation that makes it easier to directly register Spring Beans.

You can use the @JsonComponent annotation directly on JsonSerializer or JsonDeserializer implementations. You can also use it on classes that contain serializers/deserializers as inner classes, as shown in the following example:

```
import java.io.*;
import com.fasterxml.jackson.core.*;
import com.fasterxml.jackson.databind.*;
import org.springframework.boot.jackson.*;

@JsonComponent
public class Example {

public static class Serializer extends JsonSerializer<SomeObject> {

// ...
}

public static class Deserializer extends JsonDeserializer<SomeObject> {

// ...
}
```

All @JsonComponent beans in the ApplicationContext are automatically registered with Jackson. Because @JsonComponent is meta-annotated with @Component, the usual component-scanning rules apply.

Spring Boot also provides <u>JsonObjectSerializer</u> and <u>JsonObjectDeserializer</u> base classes that provide useful alternatives to the standard Jackson versions when serializing objects. See <u>JsonObjectSerializer</u> and <u>JsonObjectDeserializer</u> in the Javadoc for details.

## MessageCodesResolver

Spring MVC has a strategy for generating error codes for rendering error messages from binding errors: MessageCodesResolver. If you set the spring.mvc.message-codes-resolver.format property PREFIX\_ERROR\_CODE or POSTFIX\_ERROR\_CODE, Spring Boot creates one for you (see the enumeration in <a href="mailto:DefaultMessageCodesResolver.Format">DefaultMessageCodesResolver.Format</a>).

### **Static Content**

By default, Spring Boot serves static content from a directory called /static (or /public or / resources or /META-INF/resources) in the classpath or from the root of the ServletContext. It uses the ResourceHttpRequestHandler from Spring MVC so that you can modify that behavior by adding your own WebMvcConfigurer and overriding the addResourceHandlers method.

In a stand-alone web application, the default servlet from the container is also enabled and acts as a fallback, serving content from the root of the ServletContext if Spring decides not to handle it. Most of the time, this does not happen (unless you modify the default MVC configuration), because Spring can always handle requests through the DispatcherServlet.

By default, resources are mapped on /\*\*, but you can tune that with the spring.mvc.static-path-pattern property. For instance, relocating all resources to /resources/\*\* can be achieved as follows:

```
spring.mvc.static-path-pattern=/resources/**
```

You can also customize the static resource locations by using the spring.resources.static-locations property (replacing the default values with a list of directory locations). The root Servlet context path, "/", is automatically added as a location as well.

In addition to the "standard" static resource locations mentioned earlier, a special case is made for <u>Webjars content</u>. Any resources with a path in /webjars/\*\* are served from jar files if they are packaged in the Webjars format.

#### Tip

Do not use the src/main/webapp directory if your application is packaged as a jar. Although
this directory is a common standard, it works only with war packaging, and it is silently ignored
by most build tools if you generate a jar.

Spring Boot also supports the advanced resource handling features provided by Spring MVC, allowing use cases such as cache-busting static resources or using version agnostic URLs for Webjars.

To use version agnostic URLs for Webjars, add the webjars-locator-core dependency. Then declare your Webjar. Using jQuery as an example, adding "/webjars/jquery/min.js" results in "/webjars/jquery/x.y.z/jquery.min.js". where x.y.z is the Webjar version.

#### Note

If you use JBoss, you need to declare the webjars-locator-jboss-vfs dependency instead of the webjars-locator-core. Otherwise, all Webjars resolve as a 404.

To use cache busting, the following configuration configures a cache busting solution for all static resources, effectively adding a content hash, such as href="/css/spring-2a2d595e6ed9a0b24f027f2b63b134d6.css"/>, in URLs:

```
spring.resources.chain.strategy.content.enabled=true
spring.resources.chain.strategy.content.paths=/**
```

#### Note

Links to resources are rewritten in templates at runtime, thanks to a ResourceUrlEncodingFilter that is auto-configured for Thymeleaf and FreeMarker. You should manually declare this filter when using JSPs. Other template engines are currently not automatically supported but can be with custom template macros/helpers and the use of the ResourceUrlProvider.

When loading resources dynamically with, for example, a JavaScript module loader, renaming files is not an option. That is why other strategies are also supported and can be combined. A "fixed" strategy adds a static version string in the URL without changing the file name, as shown in the following example:

```
spring.resources.chain.strategy.content.enabled=true
spring.resources.chain.strategy.content.paths=/**
spring.resources.chain.strategy.fixed.enabled=true
spring.resources.chain.strategy.fixed.paths=/js/lib/
spring.resources.chain.strategy.fixed.version=v12
```

With this configuration, JavaScript modules located under "/js/lib/" use a fixed versioning strategy ("/v12/js/lib/mymodule.js"), while other resources still use the content one (href="/css/spring-2a2d595e6ed9a0b24f027f2b63b134d6.css"/>).

See ResourceProperties for more supported options.

#### Tip

This feature has been thoroughly described in a dedicated <u>blog post</u> and in Spring Framework's reference documentation.

## **Welcome Page**

Spring Boot supports both static and templated welcome pages. It first looks for an index.html file in the configured static content locations. If one is not found, it then looks for an index template. If either is found, it is automatically used as the welcome page of the application.

### **Custom Favicon**

Spring Boot looks for a favicon.ico in the configured static content locations and the root of the classpath (in that order). If such a file is present, it is automatically used as the favicon of the application.

## **Path Matching and Content Negotiation**

Spring MVC can map incoming HTTP requests to handlers by looking at the request path and matching it to the mappings defined in your application (for example, @GetMapping annotations on Controller methods).

Spring Boot chooses to disable suffix pattern matching by default, which means that requests like "GET /projects/spring-boot.json" won't be matched to @GetMapping("/projects/spring-boot") mappings. This is considered as a best practice for Spring MVC applications. This feature was mainly useful in the past for HTTP clients which did not send proper "Accept" request headers; we needed to make sure to send the correct Content Type to the client. Nowadays, Content Negotiation is much more reliable.

There are other ways to deal with HTTP clients that don't consistently send proper "Accept" request headers. Instead of using suffix matching, we can use a query parameter to ensure that requests like "GET /projects/spring-boot?format=json" will be mapped to @GetMapping("/projects/spring-boot"):

```
# We can change the parameter name, which is "format" by default:
# spring.mvc.contentnegotiation.parameter-name=myparam

# We can also register additional file extensions/media types with:
spring.mvc.contentnegotiation.media-types.markdown=text/markdown
```

If you understand the caveats and would still like your application to use suffix pattern matching, the following configuration is required:

```
spring.mvc.contentnegotiation.favor-path-extension=true
spring.mvc.pathmatch.use-suffix-pattern=true
```

Alternatively, rather than open all suffix patterns, it's more secure to just support registered suffix patterns:

```
spring.mvc.contentnegotiation.favor-path-extension=true
spring.mvc.pathmatch.use-registered-suffix-pattern=true

# You can also register additional file extensions/media types with:
# spring.mvc.contentnegotiation.media-types.adoc=text/asciidoc
```

## ConfigurableWebBindingInitializer

Spring MVC uses a WebBindingInitializer to initialize a WebDataBinder for a particular request. If you create your own ConfigurableWebBindingInitializer @Bean, Spring Boot automatically configures Spring MVC to use it.

### **Template Engines**

As well as REST web services, you can also use Spring MVC to serve dynamic HTML content. Spring MVC supports a variety of templating technologies, including Thymeleaf, FreeMarker, and JSPs. Also, many other templating engines include their own Spring MVC integrations.

Spring Boot includes auto-configuration support for the following templating engines:

- FreeMarker
- Groovy
- Thymeleaf
- Mustache

### Tip

If possible, JSPs should be avoided. There are several <u>known limitations</u> when using them with embedded servlet containers.

When you use one of these templating engines with the default configuration, your templates are picked up automatically from src/main/resources/templates.

### Tip

Depending on how you run your application, IntelliJ IDEA orders the classpath differently. Running your application in the IDE from its main method results in a different ordering than when you run your application by using Maven or Gradle or from its packaged jar. This can cause Spring Boot to fail to find the templates on the classpath. If you have this problem, you can reorder the classpath in the IDE to place the module's classes and resources first. Alternatively, you can configure the template prefix to search every templates directory on the classpath, as follows: classpath\*:/templates/.

## **Error Handling**

By default, Spring Boot provides an /error mapping that handles all errors in a sensible way, and it is registered as a "global" error page in the servlet container. For machine clients, it produces a JSON response with details of the error, the HTTP status, and the exception message. For browser clients, there is a "whitelabel" error view that renders the same data in HTML format (to customize it, add a View that resolves to error). To replace the default behavior completely, you can implement ErrorController and register a bean definition of that type or add a bean of type ErrorAttributes to use the existing mechanism but replace the contents.

#### Tip

The BasicErrorController can be used as a base class for a custom ErrorController. This is particularly useful if you want to add a handler for a new content type (the default is to handle text/html specifically and provide a fallback for everything else). To do so, extend BasicErrorController, add a public method with a @RequestMapping that has a produces attribute, and create a bean of your new type.

You can also define a class annotated with <code>@ControllerAdvice</code> to customize the JSON document to return for a particular controller and/or exception type, as shown in the following example:

```
@ControllerAdvice(basePackageClasses = AcmeController.class)
public class AcmeControllerAdvice extends ResponseEntityExceptionHandler {

@ExceptionHandler(YourException.class)
@ResponseBody
ResponseEntity<?> handleControllerException(HttpServletRequest request, Throwable ex) {
   HttpStatus status = getStatus(request);
   return new ResponseEntity<>(new CustomErrorType(status.value(), ex.getMessage()), status);
}

private HttpStatus getStatus(HttpServletRequest request) {
   Integer statusCode = (Integer) request.getAttribute("javax.servlet.error.status_code");
   if (statusCode == null) {
      return HttpStatus.INTERNAL_SERVER_ERROR;
   }
   return HttpStatus.valueOf(statusCode);
}
```

In the preceding example, if YourException is thrown by a controller defined in the same package as AcmeController, a JSON representation of the CustomErrorType POJO is used instead of the ErrorAttributes representation.

### **Custom Error Pages**

If you want to display a custom HTML error page for a given status code, you can add a file to an /error folder. Error pages can either be static HTML (that is, added under any of the static resource folders) or be built by using templates. The name of the file should be the exact status code or a series mask.

For example, to map 404 to a static HTML file, your folder structure would be as follows:

```
src/
+- main/
+- java/
| + <source code>
+- resources/
+- public/
+- error/
| +- 404.html
+- <other public assets>
```

To map all 5xx errors by using a FreeMarker template, your folder structure would be as follows:

For more complex mappings, you can also add beans that implement the ErrorViewResolver interface, as shown in the following example:

```
public class MyErrorViewResolver implements ErrorViewResolver {
    @Override
    public ModelAndView resolveErrorView(HttpServletRequest request,
        HttpStatus status, Map<String, Object> model) {
```

```
// Use the request or status to optionally return a ModelAndView
return ...
}
```

You can also use regular Spring MVC features such as <a href="mailto:@ExceptionHandler\_methods">@ExceptionHandler\_methods</a> and <a href="mailto:@ControllerAdvice">@ControllerAdvice</a>. The ErrorController then picks up any unhandled exceptions.

### **Mapping Error Pages outside of Spring MVC**

For applications that do not use Spring MVC, you can use the ErrorPageRegistrar interface to directly register ErrorPages. This abstraction works directly with the underlying embedded servlet container and works even if you do not have a Spring MVC DispatcherServlet.

```
@Bean
public ErrorPageRegistrar errorPageRegistrar(){
   return new MyErrorPageRegistrar();
}

// ...
private static class MyErrorPageRegistrar implements ErrorPageRegistrar {
   @Override
   public void registerErrorPages(ErrorPageRegistry registry) {
      registry.addErrorPages(new ErrorPage(HttpStatus.BAD_REQUEST, "/400"));
   }
}
```

#### Note

If you register an ErrorPage with a path that ends up being handled by a Filter (as is common with some non-Spring web frameworks, like Jersey and Wicket), then the Filter has to be explicitly registered as an ERROR dispatcher, as shown in the following example:

```
@Bean
public FilterRegistrationBean myFilter() {
  FilterRegistrationBean registration = new FilterRegistrationBean();
  registration.setFilter(new MyFilter());
  ...
  registration.setDispatcherTypes(EnumSet.allOf(DispatcherType.class));
  return registration;
}
```

Note that the default FilterRegistrationBean does not include the ERROR dispatcher type.

CAUTION:When deployed to a servlet container, Spring Boot uses its error page filter to forward a request with an error status to the appropriate error page. The request can only be forwarded to the correct error page if the response has not already been committed. By default, WebSphere Application Server 8.0 and later commits the response upon successful completion of a servlet's service method. You should disable this behavior by setting com.ibm.ws.webcontainer.invokeFlushAfterService to false.

## **Spring HATEOAS**

If you develop a RESTful API that makes use of hypermedia, Spring Boot provides auto-configuration for Spring HATEOAS that works well with most applications. The auto-configuration replaces the need to use <code>@EnableHypermediaSupport</code> and registers a number of beans to ease building

hypermedia-based applications, including a LinkDiscoverers (for client side support) and an ObjectMapper configured to correctly marshal responses into the desired representation. The ObjectMapper is customized by setting the various spring.jackson.\* properties or, if one exists, by a Jackson2ObjectMapperBuilder bean.

You can take control of Spring HATEOAS's configuration by using @EnableHypermediaSupport. Note that doing so disables the ObjectMapper customization described earlier.

## **CORS Support**

<u>Cross-origin resource sharing</u> (CORS) is a <u>W3C specification</u> implemented by <u>most browsers</u> that lets you specify in a flexible way what kind of cross-domain requests are authorized, instead of using some less secure and less powerful approaches such as IFRAME or JSONP.

As of version 4.2, Spring MVC <u>supports CORS</u>. Using <u>controller method CORS configuration</u> with <u>@CrossOrigin</u> annotations in your Spring Boot application does not require any specific configuration. <u>Global CORS configuration</u> can be defined by registering a WebMvcConfigurer bean with a customized addCorsMappings(CorsRegistry) method, as shown in the following example:

```
@Configuration
public class MyConfiguration {

@Bean
public WebMvcConfigurer corsConfigurer() {
   return new WebMvcConfigurer() {
    @Override
   public void addCorsMappings(CorsRegistry registry) {
     registry.addMapping("/api/**");
   }
  };
};
```

# 28.2 The "Spring WebFlux Framework"

Spring WebFlux is the new reactive web framework introduced in Spring Framework 5.0. Unlike Spring MVC, it does not require the Servlet API, is fully asynchronous and non-blocking, and implements the Reactive Streams specification through the Reactor project.

Spring WebFlux comes in two flavors: functional and annotation-based. The annotation-based one is quite close to the Spring MVC model, as shown in the following example:

```
@RestController
@RequestMapping("/users")
public class MyRestController {

@GetMapping("/{user}")
public Mono<User> getUser(@PathVariable Long user) {
    // ...
}

@GetMapping("/{user}/customers")
public Flux<Customer> getUserCustomers(@PathVariable Long user) {
    // ...
}

@DeleteMapping("/{user}")
public Mono<User> deleteUser(@PathVariable Long user) {
    // ...
}
```

"WebFlux.fn", the functional variant, separates the routing configuration from the actual handling of the requests, as shown in the following example:

```
@Configuration
public class RoutingConfiguration {

@Bean
public RouterFunction<ServerResponse> monoRouterFunction(UserHandler userHandler) {
    return route(GET("/{user}").and(accept(APPLICATION_JSON)), userHandler::getUser)
    .andRoute(GET("/{user}/customers").and(accept(APPLICATION_JSON)), userHandler::getUserCustomers)
    .andRoute(DELETE("/{user}").and(accept(APPLICATION_JSON)), userHandler::deleteUser);
}

@Component
public class UserHandler {

public Mono<ServerResponse> getUser(ServerRequest request) {
    // ...
}

public Mono<ServerResponse> getUserCustomers(ServerRequest request) {
    // ...
}

public Mono<ServerResponse> deleteUser(ServerRequest request) {
    // ...
}
```

WebFlux is part of the Spring Framework and detailed information is available in its <u>reference</u> documentation.

### Tip

You can define as many RouterFunction beans as you like to modularize the definition of the router. Beans can be ordered if you need to apply a precedence.

To get started, add the spring-boot-starter-webflux module to your application.

### Note

Adding both spring-boot-starter-web and spring-boot-starter-webflux modules in your application results in Spring Boot auto-configuring Spring MVC, not WebFlux. This behavior has been chosen because many Spring developers add spring-boot-starter-webflux to their Spring MVC application to use the reactive WebClient. You can still enforce your choice by setting the chosen application type to SpringApplication.setWebApplicationType(WebApplicationType.REACTIVE).

# **Spring WebFlux Auto-configuration**

Spring Boot provides auto-configuration for Spring WebFlux that works well with most applications.

The auto-configuration adds the following features on top of Spring's defaults:

- Configuring codecs for HttpMessageReader and HttpMessageWriter instances (described <u>later</u> in this document).
- Support for serving static resources, including support for WebJars (described <u>later in this document</u>).

If you want to keep Spring Boot WebFlux features and you want to add additional <u>WebFlux</u> configuration, you can add your own @Configuration class of type WebFluxConfigurer but **without** @EnableWebFlux.

If you want to take complete control of Spring WebFlux, you can add your own @Configuration annotated with @EnableWebFlux.

## HTTP Codecs with HttpMessageReaders and HttpMessageWriters

Spring WebFlux uses the HttpMessageReader and HttpMessageWriter interfaces to convert HTTP requests and responses. They are configured with CodecConfigurer to have sensible defaults by looking at the libraries available in your classpath.

Spring Boot applies further customization by using CodecCustomizer instances. For example, spring.jackson.\* configuration keys are applied to the Jackson codec.

If you need to add or customize codecs, you can create a custom CodecCustomizer component, as shown in the following example:

You can also leverage Boot's custom JSON serializers and deserializers.

### **Static Content**

By default, Spring Boot serves static content from a directory called /static (or /public or / resources or /META-INF/resources) in the classpath. It uses the ResourceWebHandler from Spring WebFlux so that you can modify that behavior by adding your own WebFluxConfigurer and overriding the addResourceHandlers method.

By default, resources are mapped on /\*\*, but you can tune that by setting the spring.webflux.static-path-pattern property. For instance, relocating all resources to / resources/\*\* can be achieved as follows:

```
spring.webflux.static-path-pattern=/resources/**
```

You can also customize the static resource locations by using spring.resources.static-locations. Doing so replaces the default values with a list of directory locations. If you do so, the default welcome page detection switches to your custom locations. So, if there is an index.html in any of your locations on startup, it is the home page of the application.

In addition to the "standard" static resource locations listed earlier, a special case is made for <u>Webjars</u> <u>content</u>. Any resources with a path in /webjars/\*\* are served from jar files if they are packaged in the Webjars format.

### Tip

Spring WebFlux applications do not strictly depend on the Servlet API, so they cannot be deployed as war files and do not use the src/main/webapp directory.

### **Template Engines**

As well as REST web services, you can also use Spring WebFlux to serve dynamic HTML content. Spring WebFlux supports a variety of templating technologies, including Thymeleaf, FreeMarker, and Mustache.

Spring Boot includes auto-configuration support for the following templating engines:

- FreeMarker
- Thymeleaf
- Mustache

When you use one of these templating engines with the default configuration, your templates are picked up automatically from src/main/resources/templates.

## **Error Handling**

Spring Boot provides a WebExceptionHandler that handles all errors in a sensible way. Its position in the processing order is immediately before the handlers provided by WebFlux, which are considered last. For machine clients, it produces a JSON response with details of the error, the HTTP status, and the exception message. For browser clients, there is a "whitelabel" error handler that renders the same data in HTML format. You can also provide your own HTML templates to display errors (see the next section).

The first step to customizing this feature often involves using the existing mechanism but replacing or augmenting the error contents. For that, you can add a bean of type ErrorAttributes.

To change the error handling behavior, you can implement ErrorWebExceptionHandler and register a bean definition of that type. Because a WebExceptionHandler is quite low-level, Spring Boot also provides a convenient AbstractErrorWebExceptionHandler to let you handle errors in a WebFlux functional way, as shown in the following example:

For a more complete picture, you can also subclass <code>DefaultErrorWebExceptionHandler</code> directly and override specific methods.

### **Custom Error Pages**

If you want to display a custom HTML error page for a given status code, you can add a file to an / error folder. Error pages can either be static HTML (that is, added under any of the static resource folders) or built with templates. The name of the file should be the exact status code or a series mask.

For example, to map 404 to a static HTML file, your folder structure would be as follows:

To map all 5xx errors by using a Mustache template, your folder structure would be as follows:

```
src/
+- main/
+- java/
| + <source code>
+- resources/
+- templates/
+- error/
| +- 5xx.mustache
+- <other templates>
```

### **Web Filters**

Spring WebFlux provides a <code>WebFilter</code> interface that can be implemented to filter HTTP request-response exchanges. <code>WebFilter</code> beans found in the application context will be automatically used to filter each exchange.

Where the order of the filters is important they can implement Ordered or be annotated with @Order. Spring Boot auto-configuration may configure web filters for you. When it does so, the orders shown in the following table will be used:

Web Filter	Order
MetricsWebFilter	Ordered.HIGHEST_PRECEDENCE + 1
WebFilterChainProxy (Spring Security)	-100
HttpTraceWebFilter	Ordered.LOWEST_PRECEDENCE - 10

# 28.3 JAX-RS and Jersey

If you prefer the JAX-RS programming model for REST endpoints, you can use one of the available implementations instead of Spring MVC. <u>Jersey</u> and <u>Apache CXF</u> work quite well out of the box. CXF requires you to register its Servlet or Filter as a @Bean in your application context. Jersey has some native Spring support, so we also provide auto-configuration support for it in Spring Boot, together with a starter.

To get started with Jersey, include the spring-boot-starter-jersey as a dependency and then you need one @Bean of type ResourceConfig in which you register all the endpoints, as shown in the following example:

```
@Component
public class JerseyConfig extends ResourceConfig {

public JerseyConfig() {
  register(Endpoint.class);
  }
}
```

### Warning

Jersey's support for scanning executable archives is rather limited. For example, it cannot scan for endpoints in a package found in WEB-INF/classes when running an executable war file. To avoid this limitation, the packages method should not be used, and endpoints should be registered individually by using the register method, as shown in the preceding example.

For more advanced customizations, you can also register an arbitrary number of beans that implement ResourceConfigCustomizer.

All the registered endpoints should be @Components with HTTP resource annotations (@GET and others), as shown in the following example:

```
@Component
@Path("/hello")
public class Endpoint {

@GET
public String message() {
  return "Hello";
}
```

Since the Endpoint is a Spring @Component, its lifecycle is managed by Spring and you can use the @Autowired annotation to inject dependencies and use the @Value annotation to inject external configuration. By default, the Jersey servlet is registered and mapped to /\*. You can change the mapping by adding @ApplicationPath to your ResourceConfig.

By default, Jersey is set up as a Servlet in a <code>@Bean</code> of type <code>ServletRegistrationBean</code> named <code>jerseyServletRegistration</code>. By default, the servlet is initialized lazily, but you can customize that behavior by setting <code>spring.jersey.servlet.load-on-startup</code>. You can disable or override that bean by creating one of your own with the same name. You can also use a filter instead of a servlet by setting <code>spring.jersey.type=filter</code> (in which case, the <code>@Bean</code> to replace or override is <code>jerseyFilterRegistration</code>). The filter has an <code>@Order</code>, which you can set with <code>spring.jersey.filter.order</code>. Both the servlet and the filter registrations can be given init parameters by using <code>spring.jersey.init.\*</code> to <code>specify</code> a map of properties.

There is a <u>Jersey sample</u> so that you can see how to set things up.

# 28.4 Embedded Servlet Container Support

Spring Boot includes support for embedded <u>Tomcat</u>, <u>Jetty</u>, and <u>Undertow</u> servers. Most developers use the appropriate "Starter" to obtain a fully configured instance. By default, the embedded server listens for HTTP requests on port 8080.

## Warning

If you choose to use Tomcat on <u>CentOS</u>, be aware that, by default, a temporary directory is used to store compiled JSPs, file uploads, and so on. This directory may be deleted by tmpwatch while your application is running, leading to failures. To avoid this behavior, you may want to customize your tmpwatch configuration such that tomcat.\* directories are not deleted or configure server.tomcat.basedir such that embedded Tomcat uses a different location.

## Servlets, Filters, and listeners

When using an embedded servlet container, you can register servlets, filters, and all the listeners (such as HttpSessionListener) from the Servlet spec, either by using Spring beans or by scanning for Servlet components.

### Registering Servlets, Filters, and Listeners as Spring Beans

Any Servlet, Filter, or servlet \*Listener instance that is a Spring bean is registered with the embedded container. This can be particularly convenient if you want to refer to a value from your application.properties during configuration.

By default, if the context contains only a single Servlet, it is mapped to /. In the case of multiple servlet beans, the bean name is used as a path prefix. Filters map to /\*.

If convention-based mapping is not flexible enough, you can use the <code>ServletRegistrationBean</code>, <code>FilterRegistrationBean</code>, and <code>ServletListenerRegistrationBean</code> classes for complete control.

Spring Boot ships with many auto-configurations that may define Filter beans. Here are a few examples of Filters and their respective order (lower order value means higher precedence):

Servlet Filter	Order
OrderedCharacterEncodingFilter	Ordered.HIGHEST_PRECEDENCE
WebMvcMetricsFilter	Ordered.HIGHEST_PRECEDENCE + 1
ErrorPageFilter	Ordered.HIGHEST_PRECEDENCE + 1
HttpTraceFilter	Ordered.LOWEST_PRECEDENCE - 10

It is usually safe to leave Filter beans unordered.

If a specific order is required, you should avoid configuring a Filter that reads the request body at Ordered.HIGHEST\_PRECEDENCE, since it might go against the character encoding configuration of your application. If a Servlet filter wraps the request, it should be configured with an order that is less than or equal to OrderedFilter.REQUEST\_WRAPPER\_FILTER\_MAX\_ORDER.

### Servlet Context Initialization

Embedded servlet containers do not directly execute the Servlet 3.0+ javax.servlet.ServletContainerInitializer interface or Spring's org.springframework.web.WebApplicationInitializer interface. This is an intentional

design decision intended to reduce the risk that third party libraries designed to run inside a war may break Spring Boot applications.

lf you need to perform servlet context initialization in Spring application, Boot you should register а bean that implements the The org.springframework.boot.web.servlet.ServletContextInitializer interface. single onStartup method provides access to the ServletContext and, if necessary, can easily be used as an adapter to an existing WebApplicationInitializer.

### Scanning for Servlets, Filters, and listeners

When using an embedded container, automatic registration of classes annotated with @WebServlet, @WebFilter, and @WebListener can be enabled by using @ServletComponentScan.

### Tip

@ServletComponentScan has no effect in a standalone container, where the container's built-in discovery mechanisms are used instead.

## The ServletWebServerApplicationContext

Under the hood, Spring Boot uses a different type of ApplicationContext for embedded servlet container support. The ServletWebServerApplicationContext is a special type of WebApplicationContext that bootstraps itself by searching for a single ServletWebServerFactory bean. Usually a TomcatServletWebServerFactory, JettyServletWebServerFactory, or UndertowServletWebServerFactory has been autoconfigured.

### Note

You usually do not need to be aware of these implementation classes. Most applications are auto-configured, and the appropriate ApplicationContext and ServletWebServerFactory are created on your behalf.

## **Customizing Embedded Servlet Containers**

Common servlet container settings can be configured by using Spring Environment properties. Usually, you would define the properties in your application.properties file.

Common server settings include:

- Network settings: Listen port for incoming HTTP requests (server.port), interface address to bind to server.address, and so on.
- Session settings: Whether the session is persistent (server.servlet.session.persistence), session timeout (server.servlet.session.timeout), location of session data (server.servlet.session.store-dir), and session-cookie configuration (server.servlet.session.cookie.\*).
- Error management: Location of the error page (server.error.path) and so on.
- SSL

### • HTTP compression

Spring Boot tries as much as possible to expose common settings, but this is not always possible. For those cases, dedicated namespaces offer server-specific customizations (see server.tomcat and server.undertow). For instance, access logs can be configured with specific features of the embedded servlet container.

### Tip

See the <u>ServerProperties</u> class for a complete list.

### **Programmatic Customization**

lf you need programmatically configure your embedded servlet container, you can register Spring bean that implements the WebServerFactoryCustomizer interface. WebServerFactoryCustomizer provides access to the ConfigurableServletWebServerFactory, which includes numerous customization setter methods. The following example shows programmatically setting the port:

```
import org.springframework.boot.web.server.WebServerFactoryCustomizer;
import org.springframework.boot.web.servlet.server.ConfigurableServletWebServerFactory;
import org.springframework.stereotype.Component;

@Component
public class CustomizationBean implements
WebServerFactoryCustomizer<ConfigurableServletWebServerFactory> {

@Override
public void customize(ConfigurableServletWebServerFactory server) {
    server.setPort(9000);
}
```

### Note

TomcatServletWebServerFactory, JettyServletWebServerFactory and UndertowServletWebServerFactory are dedicated variants of ConfigurableServletWebServerFactory that have additional customization setter methods for Tomcat, Jetty and Undertow respectively.

### Customizing ConfigurableServletWebServerFactory Directly

If the preceding customization techniques are too limited, you can register the TomcatServletWebServerFactory, JettyServletWebServerFactory, or UndertowServletWebServerFactory bean yourself.

```
@Bean
public ConfigurableServletWebServerFactory webServerFactory() {
   TomcatServletWebServerFactory factory = new TomcatServletWebServerFactory();
   factory.setPort(9000);
   factory.setSessionTimeout(10, TimeUnit.MINUTES);
   factory.addErrorPages(new ErrorPage(HttpStatus.NOT_FOUND, "/notfound.html"));
   return factory;
}
```

Setters are provided for many configuration options. Several protected method "hooks" are also provided should you need to do something more exotic. See the <u>source code documentation</u> for details.

### **JSP Limitations**

When running a Spring Boot application that uses an embedded servlet container (and is packaged as an executable archive), there are some limitations in the JSP support.

- With Jetty and Tomcat, it should work if you use war packaging. An executable war will work when launched with java -jar, and will also be deployable to any standard container. JSPs are not supported when using an executable jar.
- Undertow does not support JSPs.
- Creating a custom error.jsp page does not override the default view for error handling. Custom
  error pages should be used instead.

There is a <u>JSP sample</u> so that you can see how to set things up.

## 28.5 Embedded Reactive Server Support

Spring Boot includes support for the following embedded reactive web servers: Reactor Netty, Tomcat, Jetty, and Undertow. Most developers use the appropriate "Starter" to obtain a fully configured instance. By default, the embedded server listens for HTTP requests on port 8080.

# 28.6 Reactive Server Resources Configuration

When auto-configuring a Reactor Netty or Jetty server, Spring Boot will create specific beans that will provide HTTP resources to the server instance: ReactorResourceFactory or JettyResourceFactory.

By default, those resources will be also shared with the Reactor Netty and Jetty clients for optimal performances, given:

- · the same technology is used for server and client
- the client instance is built using the WebClient.Builder bean auto-configured by Spring Boot

Developers can override the resource configuration for Jetty and Reactor Netty by providing a custom ReactorResourceFactory or JettyResourceFactory bean - this will be applied to both clients and servers.

You can learn more about the resource configuration on the client side in the WebClient Runtime section.

# 29. Security

If <u>Spring Security</u> is on the classpath, then web applications are secured by default. Spring Boot relies on Spring Security's content-negotiation strategy to determine whether to use httpBasic or formLogin. To add method-level security to a web application, you can also add @EnableGlobalMethodSecurity with your desired settings. Additional information can be found in the <u>Spring Security Reference Guide</u>.

The default UserDetailsService has a single user. The user name is user, and the password is random and is printed at INFO level when the application starts, as shown in the following example:

Using generated security password: 78fa095d-3f4c-48b1-ad50-e24c31d5cf35

#### Note

If you fine-tune your logging configuration, ensure that the org.springframework.boot.autoconfigure.security category is set to log INFO-level messages. Otherwise, the default password is not printed.

You can change the username and password by providing a spring.security.user.name and spring.security.user.password.

The basic features you get by default in a web application are:

- A UserDetailsService (or ReactiveUserDetailsService in case of a WebFlux application) bean with in-memory store and a single user with a generated password (see SecurityProperties.User for the properties of the user).
- Form-based login or HTTP Basic security (depending on Content-Type) for the entire application (including actuator endpoints if actuator is on the classpath).
- A DefaultAuthenticationEventPublisher for publishing authentication events.

You can provide a different Authentication Event Publisher by adding a bean for it.

# 29.1 MVC Security

The default security configuration is implemented in SecurityAutoConfiguration and UserDetailsServiceAutoConfiguration. SecurityAutoConfiguration imports SpringBootWebSecurityConfiguration for web security and UserDetailsServiceAutoConfiguration configures authentication, which is also relevant in non-web applications. To switch off the default web application security configuration completely, you can add a bean of type WebSecurityConfigurerAdapter (doing so does not disable the UserDetailsService configuration or Actuator's security).

To also switch off the UserDetailsService configuration, you can add a bean of type UserDetailsService, AuthenticationProvider, or AuthenticationManager. There are several secure applications in the <u>Spring Boot samples</u> to get you started with common use cases.

Access rules can be overridden by adding a custom WebSecurityConfigurerAdapter. Spring Boot provides convenience methods that can be used to override access rules for actuator endpoints and

static resources. EndpointRequest can be used to create a RequestMatcher that is based on the management.endpoints.web.base-path property. PathRequest can be used to create a RequestMatcher for resources in commonly used locations.

# 29.2 WebFlux Security

Similar to Spring MVC applications, you can secure your WebFlux applications by adding the spring-boot-starter-security dependency. The default security configuration is implemented in ReactiveSecurityAutoConfiguration and UserDetailsServiceAutoConfiguration. ReactiveSecurityAutoConfiguration imports WebFluxSecurityConfiguration for web security and UserDetailsServiceAutoConfiguration configures authentication, which is also relevant in non-web applications. To switch off the default web application security configuration completely, you can add a bean of type WebFilterChainProxy (doing so does not disable the UserDetailsService configuration or Actuator's security).

To also switch off the UserDetailsService configuration, you can add a bean of type ReactiveUserDetailsService Of ReactiveAuthenticationManager.

Access rules can be configured by adding a custom SecurityWebFilterChain. Spring Boot provides convenience methods that can be used to override access rules for actuator endpoints and static resources. EndpointRequest can be used to create a ServerWebExchangeMatcher that is based on the management.endpoints.web.base-path property.

PathRequest can be used to create a ServerWebExchangeMatcher for resources in commonly used locations.

For example, you can customize your security configuration by adding something like:

```
@Bean
public SecurityWebFilterChain springSecurityFilterChain(ServerHttpSecurity http) {
   return http
   .authorizeExchange()
   .matchers(PathRequest.toStaticResources().atCommonLocations()).permitAll()
   .pathMatchers("/foo", "/bar")
   .authenticated().and()
   .formLogin().and()
   .build();
}
```

### 29.3 OAuth2

OAuth2 is a widely used authorization framework that is supported by Spring.

### Client

If you have <code>spring-security-oauth2-client</code> on your classpath, you can take advantage of some auto-configuration to make it easy to set up an OAuth2/Open ID Connect clients. This configuration makes use of the properties under <code>OAuth2ClientProperties</code>. The same properties are applicable to both servlet and reactive applications.

You can register multiple OAuth2 clients and providers under the spring.security.oauth2.client prefix, as shown in the following example:

```
spring.security.oauth2.client.registration.my-client-1.client-id=abcd
spring.security.oauth2.client.registration.my-client-1.client-secret=password
```

```
spring.security.oauth2.client.registration.my-client-1.client-name=Client for user scope
spring.security.oauth2.client.registration.my-client-1.provider=my-oauth-provider
spring.security.oauth2.client.registration.my-client-1.scope=user
spring.security.oauth2.client.registration.my-client-1.redirect-uri-template=http://my-redirect-uri.com
spring.security.oauth2.client.registration.my-client-1.client-authentication-method=basic
spring.security.oauth2.client.registration.my-client-1.authorization-grant-type=authorization_code
spring.security.oauth2.client.registration.my-client-2.client-id=abcd
spring.security.oauth2.client.registration.my-client-2.client-secret=password
spring.security.oauth2.client.registration.my-client-2.client-name=Client for email scope
spring.security.oauth2.client.registration.my-client-2.provider=my-oauth-provider
spring.security.oauth2.client.registration.my-client-2.scope=email
spring.security.oauth2.client.registration.my-client-2.redirect-uri-template=http://my-redirect-uri.com
spring.security.oauth2.client.registration.my-client-2.client-authentication-method=basic
spring.security.oauth2.client.registration.my-client-2.authorization-grant-type=authorization_code
spring.security.oauth2.client.provider.my-oauth-provider.authorization-uri=http://my-auth-server/oauth/
spring.security.oauth2.client.provider.my-oauth-provider.token-uri=http://my-auth-server/oauth/token
spring.security.oauth2.client.provider.my-oauth-provider.user-info-uri=http://my-auth-server/userinfo
spring.security.oauth2.client.provider.my-oauth-provider.user-info-authentication-method=header
spring.security.oauth2.client.provider.my-oauth-provider.jwk-set-uri=http://my-auth-server/token_keys
spring.security.oauth2.client.provider.my-oauth-provider.user-name-attribute=name
```

For OpenID Connect providers that support <u>OpenID Connect discovery</u>, the configuration can be further simplified. The provider needs to be configured with an <code>issuer-uri</code> which is the URI that the it asserts as its Issuer Identifier. For example, if the <code>issuer-uri</code> provided is "https://example.com", then an <code>OpenID Provider Configuration Request will be made to "https://example.com/.well-known/openid-configuration". The result is expected to be an <code>OpenID Provider Configuration Response</code>. The following example shows how an <code>OpenID Connect Provider can be configured with the <code>issuer-uri</code>:</code></code>

```
spring.security.oauth2.client.provider.oidc-provider.issuer-uri=https://dev-123456.oktapreview.com/
oauth2/default/
```

By default, Spring Security's <code>OAuth2LoginAuthenticationFilter</code> only processes URLs matching <code>/login/oauth2/code/\*</code>. If you want to customize the <code>redirect-uri</code> to use a different pattern, you need to provide configuration to process that custom pattern. For example, for servlet applications, you can add your own <code>WebSecurityConfigurerAdapter</code> that resembles the following:

```
public class OAuth2LoginSecurityConfig extends WebSecurityConfigurerAdapter {

@Override
protected void configure(HttpSecurity http) throws Exception {
  http
    .authorizeRequests()
    .anyRequest().authenticated()
    .and()
    .oauth2Login()
    .redirectionEndpoint()
    .baseUri("/custom-callback");
}
```

## OAuth2 client registration for common providers

For common OAuth2 and OpenID providers, including Google, Github, Facebook, and Okta, we provide a set of provider defaults (google, github, facebook, and okta, respectively).

If you do not need to customize these providers, you can set the provider attribute to the one for which you need to infer defaults. Also, if the key for the client registration matches a default supported provider, Spring Boot infers that as well.

In other words, the two configurations in the following example use the Google provider:

```
spring.security.oauth2.client.registration.my-client.client-id=abcd
spring.security.oauth2.client.registration.my-client.client-secret=password
spring.security.oauth2.client.registration.my-client.provider=google
spring.security.oauth2.client.registration.google.client-id=abcd
spring.security.oauth2.client.registration.google.client-secret=password
```

### **Resource Server**

If you have <code>spring-security-oauth2-resource-server</code> on your classpath, Spring Boot can set up an OAuth2 Resource Server as long as a JWK Set URI or OIDC Issuer URI is specified, as shown in the following examples:

```
spring.security.oauth2.resourceserver.jwt.jwk-set-uri=https://example.com/oauth2/default/v1/keys
spring.security.oauth2.resourceserver.jwt.issuer-uri=https://dev-123456.oktapreview.com/oauth2/default/
```

The same properties are applicable for both servlet and reactive applications.

Alternatively, you can define your own JwtDecoder bean for servlet applications or a ReactiveJwtDecoder for reactive applications.

### **Authorization Server**

Currently, Spring Security does not provide support for implementing an OAuth 2.0 Authorization Server. However, this functionality is available from the <u>Spring Security OAuth</u> project, which will eventually be superseded by Spring Security completely. Until then, you can use the <u>spring-security-oauth2-autoconfigure</u> module to easily set up an OAuth 2.0 authorization server; see its <u>documentation</u> for instructions.

# 29.4 Actuator Security

For security purposes, all actuators other than /health and /info are disabled by default. The management.endpoints.web.exposure.include property can be used to enable the actuators.

If Spring Security is on the classpath and no other WebSecurityConfigurerAdapter is present, all actuators other than /health and /info are secured by Spring Boot auto-configuration. If you define a custom WebSecurityConfigurerAdapter, Spring Boot auto-configuration will back off and you will be in full control of actuator access rules.

### Note

Before setting the management.endpoints.web.exposure.include, ensure that the exposed actuators do not contain sensitive information and/or are secured by placing them behind a firewall or by something like Spring Security.

## **Cross Site Request Forgery Protection**

Since Spring Boot relies on Spring Security's defaults, CSRF protection is turned on by default. This means that the actuator endpoints that require a POST (shutdown and loggers endpoints), PUT or DELETE will get a 403 forbidden error when the default security configuration is in use.

## Note

We recommend disabling CSRF protection completely only if you are creating a service that is used by non-browser clients.

Additional information about CSRF protection can be found in the Spring Security Reference Guide.

# 30. Working with SQL Databases

The <u>Spring Framework</u> provides extensive support for working with SQL databases, from direct JDBC access using <code>JdbcTemplate</code> to complete "object relational mapping" technologies such as Hibernate. <u>Spring Data</u> provides an additional level of functionality: creating <code>Repository</code> implementations directly from interfaces and using conventions to generate queries from your method names.

# 30.1 Configure a DataSource

Java's <code>javax.sql.DataSource</code> interface provides a standard method of working with database connections. Traditionally, a 'DataSource' uses a <code>URL</code> along with some credentials to establish a database connection.

### Tip

See <u>the "How-to" section</u> for more advanced examples, typically to take full control over the configuration of the DataSource.

## **Embedded Database Support**

It is often convenient to develop applications by using an in-memory embedded database. Obviously, in-memory databases do not provide persistent storage. You need to populate your database when your application starts and be prepared to throw away data when your application ends.

#### Tip

The "How-to" section includes a section on how to initialize a database.

Spring Boot can auto-configure embedded <u>H2</u>, <u>HSQL</u>, and <u>Derby</u> databases. You need not provide any connection URLs. You need only include a build dependency to the embedded database that you want to use.

#### Note

If you are using this feature in your tests, you may notice that the same database is reused by your whole test suite regardless of the number of application contexts that you use. If you want to make sure that each context has a separate embedded database, you should set spring.datasource.generate-unique-name to true.

For example, the typical POM dependencies would be as follows:

#### Note

You need a dependency on spring-jdbc for an embedded database to be auto-configured. In this example, it is pulled in transitively through spring-boot-starter-data-jpa.

#### Tip

If, for whatever reason, you do configure the connection URL for an embedded database, take care to ensure that the database's automatic shutdown is disabled. If you use H2, you should use DB\_CLOSE\_ON\_EXIT=FALSE to do so. If you use HSQLDB, you should ensure that shutdown=true is not used. Disabling the database's automatic shutdown lets Spring Boot control when the database is closed, thereby ensuring that it happens once access to the database is no longer needed.

### Connection to a Production Database

Production database connections can also be auto-configured by using a pooling DataSource. Spring Boot uses the following algorithm for choosing a specific implementation:

- 1. We prefer <u>HikariCP</u> for its performance and concurrency. If HikariCP is available, we always choose it.
- 2. Otherwise, if the Tomcat pooling DataSource is available, we use it.
- 3. If neither HikariCP nor the Tomcat pooling datasource are available and if <u>Commons DBCP2</u> is available, we use it.

If you use the spring-boot-starter-jdbc or spring-boot-starter-data-jpa "starters", you automatically get a dependency to HikariCP.

#### Note

You can bypass that algorithm completely and specify the connection pool to use by setting the spring.datasource.type property. This is especially important if you run your application in a Tomcat container, as tomcat-jdbc is provided by default.

### Tip

Additional connection pools can always be configured manually. If you define your own DataSource bean, auto-configuration does not occur.

DataSource configuration is controlled by external configuration properties in spring.datasource.\*. For example, you might declare the following section in application.properties:

```
spring.datasource.url=jdbc:mysql://localhost/test
spring.datasource.username=dbuser
spring.datasource.password=dbpass
spring.datasource.driver-class-name=com.mysql.jdbc.Driver
```

### Note

You should at least specify the URL by setting the spring.datasource.url property. Otherwise, Spring Boot tries to auto-configure an embedded database.

### Tip

You often do not need to specify the driver-class-name, since Spring Boot can deduce it for most databases from the url.

#### Note

For a pooling DataSource to be created, we need to be able to verify that a valid Driver class is available, so we check for that before doing anything. In other words, if you set spring.datasource.driver-class-name=com.mysql.jdbc.Driver, then that class has to be loadable.

See <u>DataSourceProperties</u> for more of the supported options. These are the standard options that work regardless of the actual implementation. It is also possible to fine-tune implementation-specific settings by using their respective prefix (spring.datasource.hikari.\*, spring.datasource.tomcat.\*, and spring.datasource.dbcp2.\*). Refer to the documentation of the connection pool implementation you are using for more details.

For instance, if you use the <u>Tomcat connection pool</u>, you could customize many additional settings, as shown in the following example:

```
# Number of ms to wait before throwing an exception if no connection is available.
spring.datasource.tomcat.max-wait=10000

# Maximum number of active connections that can be allocated from this pool at the same time.
spring.datasource.tomcat.max-active=50

# Validate the connection before borrowing it from the pool.
spring.datasource.tomcat.test-on-borrow=true
```

### Connection to a JNDI DataSource

If you deploy your Spring Boot application to an Application Server, you might want to configure and manage your DataSource by using your Application Server's built-in features and access it by using JNDI.

The spring.datasource.jndi-name property can be used as an alternative to the spring.datasource.url, spring.datasource.username, and spring.datasource.password properties to access the DataSource from a specific JNDI location. For example, the following section in application.properties shows how you can access a JBoss AS defined DataSource:

```
spring.datasource.jndi-name=java:jboss/datasources/customers
```

# 30.2 Using JdbcTemplate

Spring's JdbcTemplate and NamedParameterJdbcTemplate classes are auto-configured, and you can @Autowire them directly into your own beans, as shown in the following example:

```
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.jdbc.core.JdbcTemplate;
import org.springframework.stereotype.Component;

@Component
public class MyBean {
    private final JdbcTemplate jdbcTemplate;
```

```
@Autowired
public MyBean(JdbcTemplate jdbcTemplate) {
  this.jdbcTemplate = jdbcTemplate;
}
// ...
```

You can customize some properties of the template by using the spring.jdbc.template.\* properties, as shown in the following example:

```
spring.jdbc.template.max-rows=500
```

### Note

The NamedParameterJdbcTemplate reuses the same JdbcTemplate instance behind the scenes. If more than one JdbcTemplate is defined and no primary candidate exists, the NamedParameterJdbcTemplate is not auto-configured.

# 30.3 JPA and Spring Data JPA

The Java Persistence API is a standard technology that lets you "map" objects to relational databases. The spring-boot-starter-data-jpa POM provides a quick way to get started. It provides the following key dependencies:

- Hibernate: One of the most popular JPA implementations.
- Spring Data JPA: Makes it easy to implement JPA-based repositories.
- Spring ORMs: Core ORM support from the Spring Framework.

### Tip

We do not go into too many details of JPA or <u>Spring Data</u> here. You can follow the <u>"Accessing Data with JPA"</u> guide from <u>spring.io</u> and read the <u>Spring Data JPA</u> and <u>Hibernate</u> reference documentation.

# **Entity Classes**

Traditionally, JPA "Entity" classes are specified in a persistence.xml file. With Spring Boot, this file is not necessary and "Entity Scanning" is used instead. By default, all packages below your main configuration class (the one annotated with @EnableAutoConfiguration or @SpringBootApplication) are searched.

Any classes annotated with <code>@Entity</code>, <code>@Embeddable</code>, or <code>@MappedSuperclass</code> are considered. A typical entity class resembles the following example:

```
package com.example.myapp.domain;
import java.io.Serializable;
import javax.persistence.*;
@Entity
public class City implements Serializable {
  @Id
```

```
@GeneratedValue
private Long id;
@Column(nullable = false)
private String name;
@Column(nullable = false)
private String state;
// ... additional members, often include @OneToMany mappings
protected City() {
 // no-args constructor required by JPA spec
 // this one is protected since it shouldn't be used directly
public City(String name, String state) {
 this.name = name;
 this.state = state;
public String getName() {
 return this.name;
public String getState() {
 return this.state;
// ... etc
```

### Tip

You can customize entity scanning locations by using the <code>@EntityScan</code> annotation. See the "Section 84.4, "Separate @Entity Definitions from Spring Configuration" how-to.

## **Spring Data JPA Repositories**

<u>Spring Data JPA</u> repositories are interfaces that you can define to access data. JPA queries are created automatically from your method names. For example, a <code>CityRepository</code> interface might declare a <code>findAllByState(String state)</code> method to find all the cities in a given state.

For more complex queries, you can annotate your method with Spring Data's <u>Query</u> annotation.

Spring Data repositories usually extend from the <u>Repository</u> or <u>CrudRepository</u> interfaces. If you use auto-configuration, repositories are searched from the package containing your main configuration class (the one annotated with @EnableAutoConfiguration or @SpringBootApplication) down.

The following example shows a typical Spring Data repository interface definition:

```
package com.example.myapp.domain;
import org.springframework.data.domain.*;
import org.springframework.data.repository.*;

public interface CityRepository extends Repository<City, Long> {
    Page<City> findAll(Pageable pageable);
    City findByNameAndStateAllIgnoringCase(String name, String state);
}
```

Spring Data JPA repositories support three different modes of bootstrapping: default, deferred, and lazy. To enable deferred or lazy bootstrapping, set the <code>spring.data.jpa.repositories.bootstrapmode</code> to <code>deferred</code> or <code>lazy</code> respectively. When using deferred or lazy bootstrapping, the autoconfigured <code>EntityManagerFactoryBuilder</code> will use the context's async task executor, if any, as the bootstrap executor.

### Tip

We have barely scratched the surface of Spring Data JPA. For complete details, see the <u>Spring</u> Data JPA reference documentation.

## **Creating and Dropping JPA Databases**

By default, JPA databases are automatically created **only** if you use an embedded database (H2, HSQL, or Derby). You can explicitly configure JPA settings by using spring.jpa.\* properties. For example, to create and drop tables you can add the following line to your application.properties:

spring.jpa.hibernate.ddl-auto=create-drop

#### Note

Hibernate's own internal property name for this (if you happen to remember it better) is hibernate.hbm2ddl.auto. You can set it, along with other Hibernate native properties, by using spring.jpa.properties.\* (the prefix is stripped before adding them to the entity manager). The following line shows an example of setting JPA properties for Hibernate:

 ${\tt spring.jpa.properties.hibernate.globally\_quoted\_identifiers=true}$ 

The line in the preceding example passes a value of true for the hibernate.globally\_quoted\_identifiers property to the Hibernate entity manager.

By default, the DDL execution (or validation) is deferred until the ApplicationContext has started. There is also a spring.jpa.generate-ddl flag, but it is not used if Hibernate auto-configuration is active, because the ddl-auto settings are more fine-grained.

### Open EntityManager in View

If you are running a web application, Spring Boot by default registers <a href="mailto:OpenEntityManagerInViewInterceptor">OpenEntityManagerInViewInterceptor</a> to apply the "Open EntityManager in View" pattern, to allow for lazy loading in web views. If you do not want this behavior, you should set spring. jpa.openin-view to false in your application.properties.

# 30.4 Spring Data JDBC

Spring Data includes repository support for JDBC and will automatically generate SQL for the methods on CrudRepository. For more advanced queries, a @Query annotation is provided.

Spring Boot will auto-configure Spring Data's JDBC repositories when the necessary dependencies are on the classpath. They can be added to your project with a single dependency on <code>spring-boot-starter-data-jdbc</code>. If necessary, you can take control of Spring Data JDBC's configuration by adding the <code>@EnableJdbcRepositories</code> annotation or a <code>JdbcConfiguration</code> subclass to your application.

### Tip

For complete details of Spring Data JDBC, please refer to the reference documentation.

# 30.5 Using H2's Web Console

The <u>H2 database</u> provides a <u>browser-based console</u> that Spring Boot can auto-configure for you. The console is auto-configured when the following conditions are met:

- · You are developing a servlet-based web application.
- com.h2database:h2 is on the classpath.
- You are using <u>Spring Boot's developer tools</u>.

### Tip

If you are not using Spring Boot's developer tools but would still like to make use of H2's console, you can configure the spring.h2.console.enabled property with a value of true.

### Note

The H2 console is only intended for use during development, so you should take care to ensure that spring.h2.console.enabled is not set to true in production.

## Changing the H2 Console's Path

By default, the console is available at /h2-console. You can customize the console's path by using the spring.h2.console.path property.

# 30.6 Using jOOQ

Java Object Oriented Querying (jOOQ) is a popular product from <u>Data Geekery</u> which generates Java code from your database and lets you build type-safe SQL queries through its fluent API. Both the commercial and open source editions can be used with Spring Boot.

### **Code Generation**

In order to use jOOQ type-safe queries, you need to generate Java classes from your database schema. You can follow the instructions in the jOOQ user manual. If you use the jooq-codegen-maven plugin and you also use the spring-boot-starter-parent "parent POM", you can safely omit the plugin's <version> tag. You can also use Spring Boot-defined version variables (such as h2.version) to declare the plugin's database dependency. The following listing shows an example:

## **Using DSLContext**

The fluent API offered by jOOQ is initiated through the org.jooq.DSLContext interface. Spring Boot auto-configures a DSLContext as a Spring Bean and connects it to your application DataSource. To use the DSLContext, you can @Autowire it, as shown in the following example:

```
@Component
public class JooqExample implements CommandLineRunner {

private final DSLContext create;

@Autowired
public JooqExample(DSLContext dslContext) {
    this.create = dslContext;
}
```

### Tip

The jOOQ manual tends to use a variable named create to hold the DSLContext.

You can then use the DSLContext to construct your queries, as shown in the following example:

```
public List<GregorianCalendar> authorsBornAfter1980() {
  return this.create.selectFrom(AUTHOR)
  .where(AUTHOR.DATE_OF_BIRTH.greaterThan(new GregorianCalendar(1980, 0, 1)))
  .fetch(AUTHOR.DATE_OF_BIRTH);
}
```

## jOOQ SQL Dialect

Unless the spring.jooq.sql-dialect property has been configured, Spring Boot determines the SQL dialect to use for your datasource. If Spring Boot could not detect the dialect, it uses DEFAULT.

### Note

Spring Boot can only auto-configure dialects supported by the open source version of jOOQ.

## **Customizing jOOQ**

More advanced customizations can be achieved by defining your own @Bean definitions, which is used when the jOOQ Configuration is created. You can define beans for the following jOOQ Types:

- ConnectionProvider
- ExecutorProvider

- TransactionProvider
- RecordMapperProvider
- RecordUnmapperProvider
- RecordListenerProvider
- ExecuteListenerProvider
- VisitListenerProvider
- TransactionListenerProvider

You can also create your own org.jooq.Configuration@Bean if you want to take complete control of the jOOQ configuration.

# 31. Working with NoSQL Technologies

Spring Data provides additional projects that help you access a variety of NoSQL technologies, including: MongoDB, Neo4J, Elasticsearch, Solr, Redis, Gemfire, Cassandra, Couchbase and LDAP. Spring Boot provides auto-configuration for Redis, MongoDB, Neo4j, Elasticsearch, Solr Cassandra, Couchbase, and LDAP. You can make use of the other projects, but you must configure them yourself. Refer to the appropriate reference documentation at projects.spring.io/spring-data.

### **31.1 Redis**

<u>Redis</u> is a cache, message broker, and richly-featured key-value store. Spring Boot offers basic auto-configuration for the <u>Lettuce</u> and <u>Jedis</u> client libraries and the abstractions on top of them provided by <u>Spring Data Redis</u>.

There is a spring-boot-starter-data-redis "Starter" for collecting the dependencies in a convenient way. By default, it uses <u>Lettuce</u>. That starter handles both traditional and reactive applications.

### Tip

we also provide a spring-boot-starter-data-redis-reactive "Starter" for consistency with the other stores with reactive support.

## **Connecting to Redis**

You can inject an auto-configured RedisConnectionFactory, StringRedisTemplate, or vanilla RedisTemplate instance as you would any other Spring Bean. By default, the instance tries to connect to a Redis server at localhost: 6379. The following listing shows an example of such a bean:

```
@Component
public class MyBean {

private StringRedisTemplate template;

@Autowired
public MyBean(StringRedisTemplate template) {
   this.template = template;
}

// ...
}
```

### Tip

You can also register an arbitrary number of beans that implement LettuceClientConfigurationBuilderCustomizer for more advanced customizations. If you use Jedis, JedisClientConfigurationBuilderCustomizer is also available.

If you add your own @Bean of any of the auto-configured types, it replaces the default (except in the case of RedisTemplate, when the exclusion is based on the bean name, redisTemplate, not its type). By default, if commons-pool2 is on the classpath, you get a pooled connection factory.

## 31.2 MongoDB

MongoDB is an open-source NoSQL document database that uses a JSON-like schema instead of traditional table-based relational data. Spring Boot offers several conveniences for working with MongoDB, including the spring-boot-starter-data-mongodb and spring-boot-starter-data-mongodb-reactive "Starters".

## **Connecting to a MongoDB Database**

To access Mongo databases, you can inject an auto-configured org.springframework.data.mongodb.MongoDbFactory. By default, the instance tries to connect to a MongoDB server at mongodb://localhost/test The following example shows how to connect to a MongoDB database:

```
import org.springframework.data.mongodb.MongoDbFactory;
import com.mongodb.DB;

@Component
public class MyBean {
    private final MongoDbFactory mongo;
    @Autowired
    public MyBean(MongoDbFactory mongo) {
        this.mongo = mongo;
    }

// ...
public void example() {
        DB db = mongo.getDb();
        // ...
}
```

You can set the spring.data.mongodb.uri property to change the URL and configure additional settings such as the *replica set*, as shown in the following example:

```
spring.data.mongodb.uri=mongodb://user:secret@mongol.example.com:12345,mongo2.example.com:23456/test
```

Alternatively, as long as you use Mongo 2.x, you can specify a host/port. For example, you might declare the following settings in your application.properties:

```
spring.data.mongodb.host=mongoserver
spring.data.mongodb.port=27017
```

If you have defined your own MongoClient, it will be used to auto-configure a suitable MongoDbFactory. Both com.mongodb.MongoClient and com.mongodb.client.MongoClient are supported.

### Note

If you use the Mongo 3.0 Java driver, spring.data.mongodb.host and spring.data.mongodb.port are not supported. In such cases, spring.data.mongodb.uri should be used to provide all of the configuration.

### Tip

If spring.data.mongodb.port is not specified, the default of 27017 is used. You could delete this line from the example shown earlier.

### Tip

If you do not use Spring Data Mongo, you can inject com.mongodb.MongoClient beans instead of using MongoDbFactory. If you want to take complete control of establishing the MongoDB connection, you can also declare your own MongoDbFactory or MongoClient bean.

#### Note

If you are using the reactive driver, Netty is required for SSL. The auto-configuration configures this factory automatically if Netty is available and the factory to use hasn't been customized already.

## MongoTemplate

<u>Spring Data MongoDB</u> provides a <u>MongoTemplate</u> class that is very similar in its design to Spring's JdbcTemplate. As with JdbcTemplate, Spring Boot auto-configures a bean for you to inject the template, as follows:

```
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.data.mongodb.core.MongoTemplate;
import org.springframework.stereotype.Component;

@Component
public class MyBean {
    private final MongoTemplate mongoTemplate;
    @Autowired
    public MyBean(MongoTemplate mongoTemplate) {
        this.mongoTemplate = mongoTemplate;
    }

// ...
}
```

See the MongoOperations Javadoc for complete details.

## **Spring Data MongoDB Repositories**

Spring Data includes repository support for MongoDB. As with the JPA repositories discussed earlier, the basic principle is that queries are constructed automatically, based on method names.

In fact, both Spring Data JPA and Spring Data MongoDB share the same common infrastructure. You could take the JPA example from earlier and, assuming that City is now a Mongo data class rather than a JPA @Entity, it works in the same way, as shown in the following example:

```
package com.example.myapp.domain;
import org.springframework.data.domain.*;
import org.springframework.data.repository.*;

public interface CityRepository extends Repository<City, Long> {
    Page<City> findAll(Pageable pageable);
    City findByNameAndStateAllIgnoringCase(String name, String state);
```

}

### Tip

You can customize document scanning locations by using the @EntityScan annotation.

### Tip

For complete details of Spring Data MongoDB, including its rich object mapping technologies, refer to its reference documentation.

## **Embedded Mongo**

Spring Boot offers auto-configuration for <u>Embedded Mongo</u>. To use it in your Spring Boot application, add a dependency on de.flapdoodle.embed:de.flapdoodle.embed.mongo.

The port that Mongo listens on can be configured by setting the spring.data.mongodb.port property. To use a randomly allocated free port, use a value of 0. The MongoClient created by MongoAutoConfiguration is automatically configured to use the randomly allocated port.

### Note

If you do not configure a custom port, the embedded support uses a random port (rather than 27017) by default.

If you have SLF4J on the classpath, the output produced by Mongo is automatically routed to a logger named org.springframework.boot.autoconfigure.mongo.embedded.EmbeddedMongo.

You can declare your own IMongodConfig and IRuntimeConfig beans to take control of the Mongo instance's configuration and logging routing.

# 31.3 Neo4j

Neo4j is an open-source NoSQL graph database that uses a rich data model of nodes connected by first class relationships, which is better suited for connected big data than traditional RDBMS approaches. Spring Boot offers several conveniences for working with Neo4j, including the spring-boot-starter-data-neo4j "Starter".

## Connecting to a Neo4j Database

To access a Neo4j server, you can inject an auto-configured org.neo4j.ogm.session.Session. By default, the instance tries to connect to a Neo4j server at localhost:7687 using the Bolt protocol. The following example shows how to inject a Neo4j Session:

```
@Component
public class MyBean {
  private final Session session;
  @Autowired
  public MyBean(Session session) {
    this.session = session;
  }
// ...
```

}

You can configure the uri and credentials to use by setting the spring.data.neo4j.\* properties, as shown in the following example:

```
spring.data.neo4j.uri=bolt://my-server:7687
spring.data.neo4j.username=neo4j
spring.data.neo4j.password=secret
```

You can take full control over the session creation by adding a org.neo4j.ogm.config.Configuration@Bean.Also, adding a @Bean of type SessionFactory disables the auto-configuration and gives you full control.

## **Using the Embedded Mode**

If you add org.neo4j:neo4j-ogm-embedded-driver to the dependencies of your application, Spring Boot automatically configures an in-process embedded instance of Neo4j that does not persist any data when your application shuts down.

#### Note

As the embedded Neo4j OGM driver does not provide the Neo4j kernel itself, you have to declare org.neo4j:neo4j as dependency yourself. Refer to the Neo4j OGM documentation for a list of compatible versions.

The embedded driver takes precedence over the other drivers when there are multiple drivers on the classpath. You can explicitly disable the embedded mode by setting spring.data.neo4j.embedded.enabled=false.

<u>Data Neo4j Tests</u> automatically make use of an embedded Neo4j instance if the embedded driver and Neo4j kernel are on the classpath as described above.

### Note

You can enable persistence for the embedded mode by providing a path to a database file in your configuration, e.g. spring.data.neo4j.uri=file://var/tmp/graph.db.

## Neo4jSession

By default, if you are running a web application, the session is bound to the thread for the entire processing of the request (that is, it uses the "Open Session in View" pattern). If you do not want this behavior, add the following line to your application.properties file:

```
spring.data.neo4j.open-in-view=false
```

### **Spring Data Neo4j Repositories**

Spring Data includes repository support for Neo4j.

Spring Data Neo4j shares the common infrastructure with Spring Data JPA as many other Spring Data modules do. You could take the JPA example from earlier and define City as Neo4j OGM @NodeEntity rather than JPA @Entity and the repository abstraction works in the same way, as shown in the following example:

```
package com.example.myapp.domain;
```

```
import java.util.Optional;
import org.springframework.data.neo4j.repository.*;
public interface CityRepository extends Neo4jRepository<City, Long> {
    Optional<City> findOneByNameAndState(String name, String state);
}
```

The spring-boot-starter-data-neo4j "Starter" enables the repository support as well as transaction management. You can customize the locations to look for repositories and entities by using @EnableNeo4jRepositories and @EntityScan respectively on a @Configuration-bean.

### Tip

For complete details of Spring Data Neo4j, including its object mapping technologies, refer to the reference documentation.

### 31.4 Gemfire

Spring Data Gemfire provides convenient Spring-friendly tools for accessing the <u>Pivotal Gemfire</u> data management platform. There is a spring-boot-starter-data-gemfire "Starter" for collecting the dependencies in a convenient way. There is currently no auto-configuration support for Gemfire, but you can enable Spring Data Repositories with a <u>single annotation: @EnableGemfireRepositories</u>.

## 31.5 Solr

<u>Apache Solr</u> is a search engine. Spring Boot offers basic auto-configuration for the Solr 5 client library and the abstractions on top of it provided by <u>Spring Data Solr</u>. There is a spring-boot-starter-data-solr "Starter" for collecting the dependencies in a convenient way.

## **Connecting to Solr**

You can inject an auto-configured SolrClient instance as you would any other Spring bean. By default, the instance tries to connect to a server at <a href="localhost:8983/solr">localhost:8983/solr</a>. The following example shows how to inject a Solr bean:

```
@Component
public class MyBean {
  private SolrClient solr;

@Autowired
public MyBean(SolrClient solr) {
  this.solr = solr;
}

// ...
}
```

If you add your own @Bean of type SolrClient, it replaces the default.

## **Spring Data Solr Repositories**

Spring Data includes repository support for Apache Solr. As with the JPA repositories discussed earlier, the basic principle is that queries are automatically constructed for \ you based on method names.

In fact, both Spring Data JPA and Spring Data Solr share the same common infrastructure. You could take the JPA example from earlier and, assuming that City is now a @SolrDocument class rather than a JPA @Entity, it works in the same way.

### Tip

For complete details of Spring Data Solr, refer to the reference documentation.

## 31.6 Elasticsearch

<u>Elasticsearch</u> is an open source, distributed, RESTful search and analytics engine. Spring Boot offers basic auto-configuration for Elasticsearch.

Spring Boot supports several HTTP clients:

- The official Java "Low Level" and "High Level" REST clients
- Jest

The transport client is still being used by <u>Spring Data Elasticsearch</u>, which you can start using with the spring-boot-starter-data-elasticsearch "Starter".

## Connecting to Elasticsearch by REST clients

Elasticsearch ships two different REST clients that you can use to query a cluster: the "Low Level" client and the "High Level" client.

If you have the org.elasticsearch.client:elasticsearch-rest-client dependency on the classpath, Spring Boot will auto-configure and register a RestClient bean that by default targets <a href="localhost:9200">localhost:9200</a>. You can further tune how RestClient is configured, as shown in the following example:

```
spring.elasticsearch.rest.uris=http://search.example.com:9200
spring.elasticsearch.rest.username=user
spring.elasticsearch.rest.password=secret
```

You can also register an arbitrary number of beans that implement RestClientBuilderCustomizer for more advanced customizations. To take full control over the registration, define a RestClient bean.

If you have the org.elasticsearch.client:elasticsearch-rest-high-level-client dependency on the classpath, Spring Boot will auto-configure a RestHighLevelClient, which wraps any existing RestClient bean, reusing its HTTP configuration.

### Connecting to Elasticsearch by Using Jest

If you have <code>Jest</code> on the classpath, you can inject an auto-configured <code>JestClient</code> that by default targets <code>localhost:9200</code>. You can further tune how the client is configured, as shown in the following example:

```
spring.elasticsearch.jest.uris=http://search.example.com:9200
spring.elasticsearch.jest.read-timeout=10000
spring.elasticsearch.jest.username=user
spring.elasticsearch.jest.password=secret
```

You can also register an arbitrary number of beans that implement HttpClientConfigBuilderCustomizer for more advanced customizations. The following example tunes additional HTTP settings:

```
static class HttpSettingsCustomizer implements HttpClientConfigBuilderCustomizer {
   @Override
   public void customize(HttpClientConfig.Builder builder) {
     builder.maxTotalConnection(100).defaultMaxTotalConnectionPerRoute(5);
   }
}
```

To take full control over the registration, define a JestClient bean.

## Connecting to Elasticsearch by Using Spring Data

To connect to Elasticsearch, you must provide the address of one or more cluster nodes. The address can be specified by setting the spring.data.elasticsearch.cluster-nodes property to a comma-separated host:port list. With this configuration in place, an ElasticsearchTemplate or TransportClient can be injected like any other Spring bean, as shown in the following example:

```
@Component
public class MyBean {
    private final ElasticsearchTemplate template;
    public MyBean(ElasticsearchTemplate template) {
        this.template = template;
    }
    // ...
}
```

If you add your own ElasticsearchTemplate or TransportClient @Bean, it replaces the default.

## **Spring Data Elasticsearch Repositories**

Spring Data includes repository support for Elasticsearch. As with the JPA repositories discussed earlier, the basic principle is that queries are constructed for you automatically based on method names.

In fact, both Spring Data JPA and Spring Data Elasticsearch share the same common infrastructure. You could take the JPA example from earlier and, assuming that City is now an Elasticsearch @Document class rather than a JPA @Entity, it works in the same way.

### Tip

For complete details of Spring Data Elasticsearch, refer to the reference documentation.

## 31.7 Cassandra

<u>Cassandra</u> is an open source, distributed database management system designed to handle large amounts of data across many commodity servers. Spring Boot offers auto-configuration for Cassandra and the abstractions on top of it provided by <u>Spring Data Cassandra</u>. There is a spring-boot-starter-data-cassandra "Starter" for collecting the dependencies in a convenient way.

## **Connecting to Cassandra**

You can inject an auto-configured CassandraTemplate or a Cassandra Session instance as you would with any other Spring Bean. The spring.data.cassandra.\* properties can be used to customize the connection. Generally, you provide keyspace-name and contact-points properties, as shown in the following example:

```
spring.data.cassandra.keyspace-name=mykeyspace
spring.data.cassandra.contact-points=cassandrahost1,cassandrahost2
```

You can also register an arbitrary number of beans that implement ClusterBuilderCustomizer for more advanced customizations.

The following code listing shows how to inject a Cassandra bean:

```
@Component
public class MyBean {

private CassandraTemplate template;

@Autowired
public MyBean(CassandraTemplate template) {
   this.template = template;
}

// ...
}
```

If you add your own @Bean of type CassandraTemplate, it replaces the default.

## **Spring Data Cassandra Repositories**

Spring Data includes basic repository support for Cassandra. Currently, this is more limited than the JPA repositories discussed earlier and needs to annotate finder methods with @Query.

### Tip

For complete details of Spring Data Cassandra, refer to the reference documentation.

### 31.8 Couchbase

<u>Couchbase</u> is an open-source, distributed, multi-model NoSQL document-oriented database that is optimized for interactive applications. Spring Boot offers auto-configuration for Couchbase and the abstractions on top of it provided by <u>Spring Data Couchbase</u>. There are spring-boot-starter-data-couchbase and spring-boot-starter-data-couchbase-reactive "Starters" for collecting the dependencies in a convenient way.

## **Connecting to Couchbase**

You can get a Bucket and Cluster by adding the Couchbase SDK and some configuration. The spring.couchbase.\* properties can be used to customize the connection. Generally, you provide the bootstrap hosts, bucket name, and password, as shown in the following example:

```
spring.couchbase.bootstrap-hosts=my-host-1,192.168.1.123
spring.couchbase.bucket.name=my-bucket
spring.couchbase.bucket.password=secret
```

### Tip

You need to provide *at least* the bootstrap host(s), in which case the bucket name is default and the password is an empty String. Alternatively, you can define your own org.springframework.data.couchbase.config.CouchbaseConfigurer @Bean to take control over the whole configuration.

It is also possible to customize some of the CouchbaseEnvironment settings. For instance, the following configuration changes the timeout to use to open a new Bucket and enables SSL support:

```
spring.couchbase.env.timeouts.connect=3000
spring.couchbase.env.ssl.key-store=/location/of/keystore.jks
spring.couchbase.env.ssl.key-store-password=secret
```

Check the spring.couchbase.env.\* properties for more details.

## **Spring Data Couchbase Repositories**

Spring Data includes repository support for Couchbase. For complete details of Spring Data Couchbase, refer to the reference documentation.

You can inject an auto-configured CouchbaseTemplate instance as you would with any other Spring Bean, provided a *default* CouchbaseConfigurer is available (which happens when you enable Couchbase support, as explained earlier).

The following examples shows how to inject a Couchbase bean:

```
@Component
public class MyBean {

private final CouchbaseTemplate template;

@Autowired
public MyBean(CouchbaseTemplate template) {
   this.template = template;
}

// ...
}
```

There are a few beans that you can define in your own configuration to override those provided by the auto-configuration:

- A CouchbaseTemplate @Bean with a name of couchbaseTemplate.
- An IndexManager @Bean with a name of couchbaseIndexManager.
- A CustomConversions @Bean with a name of couchbaseCustomConversions.

To avoid hard-coding those names in your own config, you can reuse BeanNames provided by Spring Data Couchbase. For instance, you can customize the converters to use, as follows:

```
@Configuration
public class SomeConfiguration {

@Bean(BeanNames.COUCHBASE_CUSTOM_CONVERSIONS)
public CustomConversions myCustomConversions() {
   return new CustomConversions(...);
}
// ...
```

```
}
```

### Tip

fully auto-configuration you want to bypass the for Spring Data Couchbase, provide implementation your own of org.springframework.data.couchbase.config.AbstractCouchbaseDataConfiguration.

### **31.9 LDAP**

<u>LDAP</u> (Lightweight Directory Access Protocol) is an open, vendor-neutral, industry standard application protocol for accessing and maintaining distributed directory information services over an IP network. Spring Boot offers auto-configuration for any compliant LDAP server as well as support for the embedded in-memory LDAP server from <u>UnboundID</u>.

LDAP abstractions are provided by <u>Spring Data LDAP</u>. There is a spring-boot-starter-data-ldap "Starter" for collecting the dependencies in a convenient way.

## Connecting to an LDAP Server

To connect to an LDAP server, make sure you declare a dependency on the spring-boot-starter-data-ldap "Starter" or spring-ldap-core and then declare the URLs of your server in your application.properties, as shown in the following example:

```
spring.ldap.urls=ldap://myserver:1235
spring.ldap.username=admin
spring.ldap.password=secret
```

If you need to customize connection settings, you can use the spring.ldap.base and spring.ldap.base-environment properties.

An LdapContextSource is auto-configured based on these settings. If you need to customize it, for instance to use a PooledContextSource, you can still inject the auto-configured LdapContextSource. Make sure to flag your customized ContextSource as @Primary so that the auto-configured LdapTemplate uses it.

## **Spring Data LDAP Repositories**

Spring Data includes repository support for LDAP. For complete details of Spring Data LDAP, refer to the <u>reference documentation</u>.

You can also inject an auto-configured LdapTemplate instance as you would with any other Spring Bean, as shown in the following example:

```
@Component
public class MyBean {
    private final LdapTemplate template;
    @Autowired
    public MyBean(LdapTemplate template) {
        this.template = template;
    }
// ...
}
```

## **Embedded In-memory LDAP Server**

For testing purposes, Spring Boot supports auto-configuration of an in-memory LDAP server from <u>UnboundID</u>. To configure the server, add a dependency to <code>com.unboundid:unboundid-ldapsdk</code> and declare a <code>base-dn</code> property, as follows:

```
spring.ldap.embedded.base-dn=dc=spring,dc=io
```

#### Note

It is possible to define multiple base-dn values, however, since distinguished names usually contain commas, they must be defined using the correct notation.

In yaml files, you can use the yaml list notation:

```
spring.ldap.embedded.base-dn:
    - dc=spring,dc=io
    - dc=pivotal,dc=io
```

In properties files, you must include the index as part of the property name:

```
spring.ldap.embedded.base-dn[0]=dc=spring,dc=io
spring.ldap.embedded.base-dn[1]=dc=pivotal,dc=io
```

By default, the server starts on a random port and triggers the regular LDAP support. There is no need to specify a spring.ldap.urls property.

If there is a schema.ldif file on your classpath, it is used to initialize the server. If you want to load the initialization script from a different resource, you can also use the spring.ldap.embedded.ldif property.

By default, a standard schema is used to validate LDIF files. You can turn off validation altogether by setting the spring.ldap.embedded.validation.enabled property. If you have custom attributes, you can use spring.ldap.embedded.validation.schema to define your custom attribute types or object classes.

#### 31.10 InfluxDB

<u>InfluxDB</u> is an open-source time series database optimized for fast, high-availability storage and retrieval of time series data in fields such as operations monitoring, application metrics, Internet-of-Things sensor data, and real-time analytics.

#### Connecting to InfluxDB

Spring Boot auto-configures an InfluxDB instance, provided the influxdb-java client is on the classpath and the URL of the database is set, as shown in the following example:

```
spring.influx.url=http://172.0.0.1:8086
```

If the connection to InfluxDB requires a user and password, you can set the spring.influx.user and spring.influx.password properties accordingly.

InfluxDB relies on OkHttp. If you need to tune the http client InfluxDB uses behind the scenes, you can register an InfluxDbOkHttpClientBuilderProvider bean.

# 32. Caching

The Spring Framework provides support for transparently adding caching to an application. At its core, the abstraction applies caching to methods, thus reducing the number of executions based on the information available in the cache. The caching logic is applied transparently, without any interference to the invoker. Spring Boot auto-configures the cache infrastructure as long as caching support is enabled via the <code>@EnableCaching</code> annotation.

#### Note

Check the <u>relevant section</u> of the Spring Framework reference for more details.

In a nutshell, adding caching to an operation of your service is as easy as adding the relevant annotation to its method, as shown in the following example:

```
import org.springframework.cache.annotation.Cacheable;
import org.springframework.stereotype.Component;

@Component
public class MathService {

@Cacheable("piDecimals")
public int computePiDecimal(int i) {
    // ...
}
```

This example demonstrates the use of caching on a potentially costly operation. Before invoking computePiDecimal, the abstraction looks for an entry in the piDecimals cache that matches the i argument. If an entry is found, the content in the cache is immediately returned to the caller, and the method is not invoked. Otherwise, the method is invoked, and the cache is updated before returning the value.

#### Caution

You can also use the standard JSR-107 (JCache) annotations (such as @CacheResult) transparently. However, we strongly advise you to not mix and match the Spring Cache and JCache annotations.

If you do not add any specific cache library, Spring Boot auto-configures a <u>simple provider</u> that uses concurrent maps in memory. When a cache is required (such as piDecimals in the preceding example), this provider creates it for you. The simple provider is not really recommended for production usage, but it is great for getting started and making sure that you understand the features. When you have made up your mind about the cache provider to use, please make sure to read its documentation to figure out how to configure the caches that your application uses. Nearly all providers require you to explicitly configure every cache that you use in the application. Some offer a way to customize the default caches defined by the spring.cache.cache-names property.

#### Tip

It is also possible to transparently <u>update</u> or <u>evict</u> data from the cache.

# 32.1 Supported Cache Providers

The cache abstraction does not provide an actual store and relies on abstraction materialized by the org.springframework.cache.Cache and org.springframework.cache.CacheManager interfaces.

If you have not defined a bean of type CacheManager or a CacheResolver named cacheResolver (see <u>CachingConfigurer</u>), Spring Boot tries to detect the following providers (in the indicated order):

- 1. Generic
- 2. JCache (JSR-107) (EhCache 3, Hazelcast, Infinispan, and others)
- 3. EhCache 2.x
- 4. Hazelcast
- 5. Infinispan
- 6. Couchbase
- 7. Redis
- 8. Caffeine
- 9. Simple

#### Tip

It is also possible to *force* a particular cache provider by setting the <code>spring.cache.type</code> property. Use this property if you need to <u>disable caching altogether</u> in certain environment (such as tests).

#### Tip

Use the spring-boot-starter-cache "Starter" to quickly add basic caching dependencies. The starter brings in spring-context-support. If you add dependencies manually, you must include spring-context-support in order to use the JCache, EhCache 2.x, or Guava support.

If the CacheManager is auto-configured by Spring Boot, you can further tune its configuration before it is fully initialized by exposing a bean that implements the CacheManagerCustomizer interface. The following example sets a flag to say that null values should be passed down to the underlying map:

```
@Bean
public CacheManagerCustomizer<ConcurrentMapCacheManager> cacheManagerCustomizer() {
   return new CacheManagerCustomizer<ConcurrentMapCacheManager>() {
    @Override
   public void customize(ConcurrentMapCacheManager cacheManager) {
      cacheManager.setAllowNullValues(false);
   }
};
```

#### Note

In the preceding example, an auto-configured ConcurrentMapCacheManager is expected. If that is not the case (either you provided your own config or a different cache provider was auto-

configured), the customizer is not invoked at all. You can have as many customizers as you want, and you can also order them by using @Order or Ordered.

#### Generic

Generic caching is used if the context defines at least one org.springframework.cache.Cache bean. A CacheManager wrapping all beans of that type is created.

## JCache (JSR-107)

<u>JCache</u> is bootstrapped through the presence of a <code>javax.cache.spi.CachingProvider</code> on the classpath (that is, a JSR-107 compliant caching library exists on the classpath), and the <code>JCacheCacheManager</code> is provided by the <code>spring-boot-starter-cache</code> "Starter". Various compliant libraries are available, and Spring Boot provides dependency management for Ehcache 3, Hazelcast, and Infinispan. Any other compliant library can be added as well.

It might happen that more than one provider is present, in which case the provider must be explicitly specified. Even if the JSR-107 standard does not enforce a standardized way to define the location of the configuration file, Spring Boot does its best to accommodate setting a cache with implementation details, as shown in the following example:

```
# Only necessary if more than one provider is present
spring.cache.jcache.provider=com.acme.MyCachingProvider
spring.cache.jcache.config=classpath:acme.xml
```

#### Note

When a cache library offers both a native implementation and JSR-107 support, Spring Boot prefers the JSR-107 support, so that the same features are available if you switch to a different JSR-107 implementation.

#### Tip

Spring Boot has general support for Hazelcast. If a single HazelcastInstance is available, it is automatically reused for the CacheManager as well, unless the spring.cache.jcache.config property is specified.

There are two ways to customize the underlying javax.cache.cacheManager:

- Caches can be created on startup by setting the spring.cache.cache-names property. If a custom javax.cache.configuration.Configuration bean is defined, it is used to customize them.
- org.springframework.boot.autoconfigure.cache.JCacheManagerCustomizer beans are invoked with the reference of the CacheManager for full customization.

#### Tip

If a standard <code>javax.cache.CacheManager</code> bean is defined, it is wrapped automatically in an <code>org.springframework.cache.CacheManager</code> implementation that the abstraction expects. No further customization is applied to it.

#### EhCache 2.x

EhCache 2.x is used if a file named ehcache.xml can be found at the root of the classpath. If EhCache 2.x is found, the EhCacheCacheManager provided by the spring-boot-starter-cache "Starter" is used to bootstrap the cache manager. An alternate configuration file can be provided as well, as shown in the following example:

```
spring.cache.ehcache.config=classpath:config/another-config.xml
```

#### **Hazelcast**

Spring Boot has general support for Hazelcast. If a HazelcastInstance has been auto-configured, it is automatically wrapped in a CacheManager.

## Infinispan

<u>Infinispan</u> has no default configuration file location, so it must be specified explicitly. Otherwise, the default bootstrap is used.

```
spring.cache.infinispan.config=infinispan.xml
```

Caches can be created on startup by setting the spring.cache.cache-names property. If a custom ConfigurationBuilder bean is defined, it is used to customize the caches.

#### Note

The support of Infinispan in Spring Boot is restricted to the embedded mode and is quite basic. If you want more options, you should use the official Infinispan Spring Boot starter instead. See <a href="Infinispan's documentation">Infinispan's documentation</a> for more details.

#### Couchbase

If the <u>Couchbase</u> Java client and the <u>couchbase-spring-cache</u> implementation are available and Couchbase is <u>configured</u>, a <u>CouchbaseCacheManager</u> is auto-configured. It is also possible to create additional caches on startup by setting the <u>spring.cache.cache-names</u> property. These caches operate on the <u>Bucket</u> that was auto-configured. You can *also* create additional caches on another <u>Bucket</u> by using the <u>customizer</u>. Assume you need two caches (<u>cache1</u> and <u>cache2</u>) on the "main" <u>Bucket</u> and one (<u>cache3</u>) cache with a <u>custom</u> time to live of 2 seconds on the "another" <u>Bucket</u>. You can create the first two caches through configuration, as follows:

```
spring.cache.cache-names=cache1,cache2
```

Then you can define a @Configuration class to configure the extra Bucket and the cache3 cache, as follows:

```
@Configuration
public class CouchbaseCacheConfiguration {
    private final Cluster cluster;
    public CouchbaseCacheConfiguration(Cluster cluster) {
        this.cluster = cluster;
    }
    @Bean
    public Bucket anotherBucket() {
```

```
return this.cluster.openBucket("another", "secret");
}

@Bean
public CacheManagerCustomizer<CouchbaseCacheManager> cacheManagerCustomizer() {
  return c -> {
    c.prepareCache("cache3", CacheBuilder.newInstance(anotherBucket())
        .withExpiration(2));
  };
};
}
```

This sample configuration reuses the Cluster that was created through auto-configuration.

#### Redis

If <u>Redis</u> is available and configured, a <u>RedisCacheManager</u> is auto-configured. It is possible to create additional caches on startup by setting the <u>spring.cache.cache-names</u> property and cache defaults can be configured by using <u>spring.cache.redis.\*</u> properties. For instance, the following configuration creates <u>cache1</u> and <u>cache2</u> caches with a *time to live* of 10 minutes:

```
spring.cache.cache-names=cache1,cache2
spring.cache.redis.time-to-live=600000
```

#### Note

By default, a key prefix is added so that, if two separate caches use the same key, Redis does not have overlapping keys and cannot return invalid values. We strongly recommend keeping this setting enabled if you create your own RedisCacheManager.

#### Tip

You can take full control of the configuration by adding a RedisCacheConfiguration @Bean of your own. This can be useful if you're looking for customizing the serialization strategy.

#### Caffeine

<u>Caffeine</u> is a Java 8 rewrite of Guava's cache that supersedes support for Guava. If Caffeine is present, a CaffeineCacheManager (provided by the spring-boot-starter-cache "Starter") is auto-configured. Caches can be created on startup by setting the spring.cache.cache-names property and can be customized by one of the following (in the indicated order):

- 1. A cache spec defined by spring.cache.caffeine.spec
- 2. A com.github.benmanes.caffeine.cache.CaffeineSpec bean is defined
- 3. A com.github.benmanes.caffeine.cache.Caffeine bean is defined

For instance, the following configuration creates cache1 and cache2 caches with a maximum size of 500 and a *time to live* of 10 minutes

```
spring.cache.cache-names=cache1,cache2
spring.cache.caffeine.spec=maximumSize=500,expireAfterAccess=600s
```

If a com.github.benmanes.caffeine.cache.CacheLoader bean is defined, it is automatically associated to the CaffeineCacheManager. Since the CacheLoader is going to be associated with

all caches managed by the cache manager, it must be defined as CacheLoader<Object, Object>. The auto-configuration ignores any other generic type.

# **Simple**

If none of the other providers can be found, a simple implementation using a ConcurrentHashMap as the cache store is configured. This is the default if no caching library is present in your application. By default, caches are created as needed, but you can restrict the list of available caches by setting the cache-names property. For instance, if you want only cache1 and cache2 caches, set the cachenames property as follows:

spring.cache.cache-names=cache1,cache2

If you do so and your application uses a cache not listed, then it fails at runtime when the cache is needed, but not on startup. This is similar to the way the "real" cache providers behave if you use an undeclared cache.

#### None

When @EnableCaching is present in your configuration, a suitable cache configuration is expected as well. If you need to disable caching altogether in certain environments, force the cache type to none to use a no-op implementation, as shown in the following example:

spring.cache.type=none

# 33. Messaging

The Spring Framework provides extensive support for integrating with messaging systems, from simplified use of the JMS API using <code>JmsTemplate</code> to a complete infrastructure to receive messages asynchronously. Spring AMQP provides a similar feature set for the Advanced Message Queuing Protocol. Spring Boot also provides auto-configuration options for <code>RabbitTemplate</code> and RabbitMQ. Spring WebSocket natively includes support for STOMP messaging, and Spring Boot has support for that through starters and a small amount of auto-configuration. Spring Boot also has support for Apache Kafka.

## 33.1 JMS

The <code>javax.jms.ConnectionFactory</code> interface provides a standard method of creating a <code>javax.jms.Connection</code> for interacting with a JMS broker. Although Spring needs a <code>ConnectionFactory</code> to work with JMS, you generally need not use it directly yourself and can instead rely on higher level messaging abstractions. (See the <code>relevant section</code> of the Spring Framework reference documentation for details.) Spring Boot also auto-configures the necessary infrastructure to send and receive messages.

# **ActiveMQ Support**

When <u>ActiveMQ</u> is available on the classpath, Spring Boot can also configure a ConnectionFactory. If the broker is present, an embedded broker is automatically started and configured (provided no broker URL is specified through configuration).

#### Note

If you use spring-boot-starter-activemq, the necessary dependencies to connect or embed an ActiveMQ instance are provided, as is the Spring infrastructure to integrate with JMS.

ActiveMQ configuration is controlled by external configuration properties in spring.activemq.\*. For example, you might declare the following section in application.properties:

```
spring.activemq.broker-url=tcp://192.168.1.210:9876
spring.activemq.user=admin
spring.activemq.password=secret
```

By default, a CachingConnectionFactory wraps the native ConnectionFactory with sensible settings that you can control by external configuration properties in spring.jms.\*:

```
spring.jms.cache.session-cache-size=5
```

If you'd rather use native pooling, you can do so by adding a dependency to org.messaginghub:pooled-jms and configuring the JmsPoolConnectionFactory accordingly, as shown in the following example:

```
spring.activemq.pool.enabled=true
spring.activemq.pool.max-connections=50
```

#### Tip

See <u>ActiveMQProperties</u> for more of the supported options. You can also register an arbitrary number of beans that implement ActiveMQConnectionFactoryCustomizer for more advanced customizations.

By default, ActiveMQ creates a destination if it does not yet exist so that destinations are resolved against their provided names.

## **Artemis Support**

Spring Boot can auto-configure a ConnectionFactory when it detects that Artemis is available on the classpath. If the broker is present, an embedded broker is automatically started and configured (unless the mode property has been explicitly set). The supported modes are embedded (to make explicit that an embedded broker is required and that an error should occur if the broker is not available on the classpath) and native (to connect to a broker using the netty transport protocol). When the latter is configured, Spring Boot configures a ConnectionFactory that connects to a broker running on the local machine with the default settings.

#### Note

If you use spring-boot-starter-artemis, the necessary dependencies to connect to an existing Artemis instance are provided, as well as the Spring infrastructure to integrate with JMS. Adding org.apache.activemq:artemis-jms-server to your application lets you use embedded mode.

Artemis configuration is controlled by external configuration properties in spring.artemis.\*. For example, you might declare the following section in application.properties:

```
spring.artemis.mode=native
spring.artemis.host=192.168.1.210
spring.artemis.port=9876
spring.artemis.user=admin
spring.artemis.password=secret
```

When embedding the broker, you can choose if you want to enable persistence and list the destinations that should be made available. These can be specified as a commaseparated list to create them with the default options, or you can define bean(s) of type org.apache.activemq.artemis.jms.server.config.JMSQueueConfiguration or org.apache.activemq.artemis.jms.server.config.TopicConfiguration, for advanced queue and topic configurations, respectively.

By default, a CachingConnectionFactory wraps the native ConnectionFactory with sensible settings that you can control by external configuration properties in spring.jms.\*:

```
spring.jms.cache.session-cache-size=5
```

If you'd rather use native pooling, you can do so by adding a dependency to org.messaginghub:pooled-jms and configuring the JmsPoolConnectionFactory accordingly, as shown in the following example:

```
spring.artemis.pool.enabled=true
spring.artemis.pool.max-connections=50
```

See <a href="ArtemisProperties">ArtemisProperties</a> for more supported options.

No JNDI lookup is involved, and destinations are resolved against their names, using either the name attribute in the Artemis configuration or the names provided through configuration.

# Using a JNDI ConnectionFactory

If you are running your application in an application server, Spring Boot tries to locate a JMS ConnectionFactory by using JNDI. By default, the <code>java:/JmsXA</code> and <code>java:/XAConnectionFactory</code> location are checked. You can use the <code>spring.jms.jndi-name</code> property if you need to specify an alternative location, as shown in the following example:

```
spring.jms.jndi-name=java:/MyConnectionFactory
```

## Sending a Message

Spring's JmsTemplate is auto-configured, and you can autowire it directly into your own beans, as shown in the following example:

```
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.jms.core.JmsTemplate;
import org.springframework.stereotype.Component;

@Component
public class MyBean {
    private final JmsTemplate jmsTemplate;
    @Autowired
    public MyBean(JmsTemplate jmsTemplate) {
        this.jmsTemplate = jmsTemplate;
    }

// ...
}
```

#### Note

<u>JmsMessagingTemplate</u> can be injected in a similar manner. If a DestinationResolver or a MessageConverter bean is defined, it is associated automatically to the auto-configured JmsTemplate.

# Receiving a Message

When the JMS infrastructure is present, any bean can be annotated with @JmsListener to create a listener endpoint. If no JmsListenerContainerFactory has been defined, a default one is configured automatically. If a DestinationResolver or a MessageConverter beans is defined, it is associated automatically to the default factory.

By default, the default factory is transactional. If you run in an infrastructure where a <code>JtaTransactionManager</code> is present, it is associated to the listener container by default. If not, the <code>sessionTransacted</code> flag is enabled. In that latter scenario, you can associate your local data store transaction to the processing of an incoming message by adding <code>@Transactional</code> on your listener method (or a delegate thereof). This ensures that the incoming message is acknowledged, once the local transaction has completed. This also includes sending response messages that have been performed on the same JMS session.

The following component creates a listener endpoint on the someQueue destination:

```
@Component
public class MyBean {

@JmsListener(destination = "someQueue")
public void processMessage(String content) {
   // ...
}
```

#### Tip

See the Javadoc of @EnableJms for more details.

If you need to create more <code>JmsListenerContainerFactory</code> instances or if you want to override the default, Spring Boot provides a <code>DefaultJmsListenerContainerFactoryConfigurer</code> that you can use to initialize a <code>DefaultJmsListenerContainerFactory</code> with the same settings as the one that is auto-configured.

For instance, the following example exposes another factory that uses a specific MessageConverter:

```
@Configuration
static class JmsConfiguration {

@Bean
public DefaultJmsListenerContainerFactory myFactory(
   DefaultJmsListenerContainerFactoryConfigurer configurer) {
   DefaultJmsListenerContainerFactory factory =
        new DefaultJmsListenerContainerFactory();
   configurer.configure(factory, connectionFactory());
   factory.setMessageConverter(myMessageConverter());
   return factory;
}
```

Then you can use the factory in any @JmsListener-annotated method as follows:

```
@Component
public class MyBean {

@JmsListener(destination = "someQueue", containerFactory="myFactory")
public void processMessage(String content) {

// ...
}
```

#### **33.2 AMQP**

The Advanced Message Queuing Protocol (AMQP) is a platform-neutral, wire-level protocol for message-oriented middleware. The Spring AMQP project applies core Spring concepts to the development of AMQP-based messaging solutions. Spring Boot offers several conveniences for working with AMQP through RabbitMQ, including the <code>spring-boot-starter-amqp</code> "Starter".

#### RabbitMQ support

RabbitMQ is a lightweight, reliable, scalable, and portable message broker based on the AMQP protocol. Spring uses RabbitMQ to communicate through the AMQP protocol.

RabbitMQ configuration is controlled by external configuration properties in spring.rabbitmq.\*. For example, you might declare the following section in application.properties:

```
spring.rabbitmq.host=localhost
spring.rabbitmq.port=5672
spring.rabbitmq.username=admin
spring.rabbitmq.password=secret
```

If a ConnectionNameStrategy bean exists in the context, it will be automatically used to name connections created by the auto-configured ConnectionFactory. See <a href="RabbitProperties">RabbitProperties</a> for more of the supported options.

#### Tip

See <u>Understanding AMQP</u>, the protocol used by <u>RabbitMQ</u> for more details.

# Sending a Message

Spring's Amap Template and Amap Admin are auto-configured, and you can autowire them directly into your own beans, as shown in the following example:

```
import org.springframework.amqp.core.AmqpAdmin;
import org.springframework.amqp.core.AmqpTemplate;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Component;

@Component
public class MyBean {

   private final AmqpAdmin amqpAdmin;
   private final AmqpTemplate amqpTemplate;

   @Autowired
   public MyBean(AmqpAdmin amqpAdmin, AmqpTemplate amqpTemplate) {
     this.amqpAdmin = amqpAdmin;
     this.amqpTemplate = amqpTemplate;
   }

   // ...
}
```

#### Note

<u>RabbitMessagingTemplate</u> can be injected in a similar manner. If a MessageConverter bean is defined, it is associated automatically to the auto-configured AmqpTemplate.

If necessary, any org.springframework.amqp.core.Queue that is defined as a bean is automatically used to declare a corresponding queue on the RabbitMQ instance.

To retry operations, you can enable retries on the AmqpTemplate (for example, in the event that the broker connection is lost):

```
spring.rabbitmq.template.retry.enabled=true
spring.rabbitmq.template.retry.initial-interval=2s
```

Retries are disabled by default. You can also customize the RetryTemplate programmatically by declaring a RabbitRetryTemplateCustomizer bean.

## Receiving a Message

When the Rabbit infrastructure is present, any bean can be annotated with @RabbitListener to create a listener endpoint. If no RabbitListenerContainerFactory has been defined, a default SimpleRabbitListenerContainerFactory is automatically configured and you can switch to a direct container using the spring.rabbitmq.listener.type property. If a MessageConverter or a MessageRecoverer bean is defined, it is automatically associated with the default factory.

The following sample component creates a listener endpoint on the someQueue queue:

```
@Component
public class MyBean {

@RabbitListener(queues = "someQueue")
public void processMessage(String content) {

// ...
}
```

#### Tip

See the Javadoc of @EnableRabbit for more details.

If you need to create more RabbitListenerContainerFactory instances or if you want to override the default, Spring Boot provides a SimpleRabbitListenerContainerFactoryConfigurer and a DirectRabbitListenerContainerFactoryConfigurer that you can use to initialize a SimpleRabbitListenerContainerFactory and a DirectRabbitListenerContainerFactory with the same settings as the factories used by the auto-configuration.

#### Tip

It does not matter which container type you chose. Those two beans are exposed by the autoconfiguration.

For instance, the following configuration class exposes another factory that uses a specific MessageConverter:

```
@Configuration
static class RabbitConfiguration {

@Bean
public SimpleRabbitListenerContainerFactory myFactory(
   SimpleRabbitListenerContainerFactoryConfigurer configurer) {
   SimpleRabbitListenerContainerFactory factory =
    new SimpleRabbitListenerContainerFactory();
   configurer.configure(factory, connectionFactory);
   factory.setMessageConverter(myMessageConverter());
   return factory;
}
```

Then you can use the factory in any @RabbitListener-annotated method, as follows:

```
@Component
public class MyBean {
```

```
@RabbitListener(queues = "someQueue", containerFactory="myFactory")
public void processMessage(String content) {
   // ...
}
```

You can enable retries to handle situations where your listener throws an exception. By default, RejectAndDontRequeueRecoverer is used, but you can define a MessageRecoverer of your own. When retries are exhausted, the message is rejected and either dropped or routed to a dead-letter exchange if the broker is configured to do so. By default, retries are disabled. You can also customize the RetryTemplate programmatically by declaring a RabbitRetryTemplateCustomizer bean.

#### **Important**

By default, if retries are disabled and the listener throws an exception, the delivery is retried indefinitely. You can modify this behavior in two ways: Set the defaultRequeueRejected property to false so that zero re-deliveries are attempted or throw an AmqpRejectAndDontRequeueException to signal the message should be rejected. The latter is the mechanism used when retries are enabled and the maximum number of delivery attempts is reached.

# 33.3 Apache Kafka Support

Apache Kafka is supported by providing auto-configuration of the spring-kafka project.

Kafka configuration is controlled by external configuration properties in spring.kafka.\*. For example, you might declare the following section in application.properties:

```
spring.kafka.bootstrap-servers=localhost:9092
spring.kafka.consumer.group-id=myGroup
```

#### Tip

To create a topic on startup, add a bean of type NewTopic. If the topic already exists, the bean is ignored.

See <a href="KafkaProperties">KafkaProperties</a> for more supported options.

# Sending a Message

Spring's KafkaTemplate is auto-configured, and you can autowire it directly in your own beans, as shown in the following example:

```
@Component
public class MyBean {
    private final KafkaTemplate kafkaTemplate;
    @Autowired
    public MyBean(KafkaTemplate kafkaTemplate) {
        this.kafkaTemplate = kafkaTemplate;
    }
/// ...
}
```

#### Note

If the property spring.kafka.producer.transaction-id-prefix is defined, a KafkaTransactionManager is automatically configured. Also, if a RecordMessageConverter bean is defined, it is automatically associated to the autoconfigured KafkaTemplate.

# Receiving a Message

When the Apache Kafka infrastructure is present, any bean can be annotated with <code>@KafkaListener</code> to create a listener endpoint. If no <code>KafkaListenerContainerFactory</code> has been defined, a default one is automatically configured with keys defined in <code>spring.kafka.listener.\*</code>.

The following component creates a listener endpoint on the someTopic topic:

```
@Component
public class MyBean {

@KafkaListener(topics = "someTopic")
public void processMessage(String content) {

// ...
}
```

If a KafkaTransactionManager bean is defined, it is automatically associated to the container factory. Similarly, if a RecordMessageConverter, ErrorHandler or AfterRollbackProcessor bean is defined, it is automatically associated to the default factory.

#### Tip

A custom ChainedKafkaTransactionManager must be marked @Primary as it usually references the auto-configured KafkaTransactionManager bean.

#### Kafka Streams

Spring for Apache Kafka provides a factory bean to create a StreamsBuilder object and manage the lifecycle of its streams. Spring Boot auto-configures the required KafkaStreamsConfiguration bean as long as kafka-streams is on the classpath and Kafka Streams is enabled via the @EnableKafkaStreams annotation.

Enabling Kafka Streams means that the application id and bootstrap servers must be set. The former can be configured using spring.kafka.streams.application-id, defaulting to spring.application.name if not set. The latter can be set globally or specifically overridden just for streams.

Several additional properties are available using dedicated properties; other arbitrary Kafka properties can be set using the spring.kafka.streams.properties namespace. See also the section called "Additional Kafka Properties" for more information.

To use the factory bean, simply wire StreamsBuilder into your @Bean as shown in the following example:

```
@Configuration
@EnableKafkaStreams
static class KafkaStreamsExampleConfiguration {
```

```
@Bean
public KStream<Integer, String> kStream(StreamsBuilder streamsBuilder) {
  KStream<Integer, String> stream = streamsBuilder.stream("ks1In");
  stream.map((k, v) -> new KeyValue<>(k, v.toUpperCase())).to("ks1Out",
    Produced.with(Serdes.Integer(), new JsonSerde<>()));
  return stream;
}
```

By default, the streams managed by the StreamBuilder object it creates are started automatically. You can customize this behaviour using the spring.kafka.streams.auto-startup property.

## **Additional Kafka Properties**

The properties supported by auto configuration are shown in <u>Appendix A</u>, <u>Common application</u> <u>properties</u>. Note that, for the most part, these properties (hyphenated or camelCase) map directly to the Apache Kafka dotted properties. Refer to the Apache Kafka documentation for details.

The first few of these properties apply to all components (producers, consumers, admins, and streams) but can be specified at the component level if you wish to use different values. Apache Kafka designates properties with an importance of HIGH, MEDIUM, or LOW. Spring Boot auto-configuration supports all HIGH importance properties, some selected MEDIUM and LOW properties, and any properties that do not have a default value.

Only a subset of the properties supported by Kafka are available directly through the KafkaProperties class. If you wish to configure the producer or consumer with additional properties that are not directly supported, use the following properties:

```
spring.kafka.properties.prop.one=first
spring.kafka.admin.properties.prop.two=second
spring.kafka.consumer.properties.prop.three=third
spring.kafka.producer.properties.prop.four=fourth
spring.kafka.streams.properties.prop.five=fifth
```

This sets the common prop.one Kafka property to first (applies to producers, consumers and admins), the prop.two admin property to second, the prop.three consumer property to third, the prop.four producer property to fourth and the prop.five streams property to fifth.

You can also configure the Spring Kafka JsonDeserializer as follows:

```
spring.kafka.consumer.value-deserializer=org.springframework.kafka.support.serializer.JsonDeserializer
spring.kafka.consumer.properties.spring.json.value.default.type=com.example.Invoice
spring.kafka.consumer.properties.spring.json.trusted.packages=com.example,org.acme
```

Similarly, you can disable the JsonSerializer default behavior of sending type information in headers:

```
spring.kafka.producer.value-serializer=org.springframework.kafka.support.serializer.JsonSerializer
spring.kafka.producer.properties.spring.json.add.type.headers=false
```

#### **Important**

Properties set in this way override any configuration item that Spring Boot explicitly supports.

# 34. Calling REST Services with RestTemplate

If you need to call remote REST services from your application, you can use the Spring Framework's RestTemplate class. Since RestTemplate instances often need to be customized before being used, Spring Boot does not provide any single auto-configured RestTemplate bean. It does, however, auto-configure a RestTemplateBuilder, which can be used to create RestTemplate instances when needed. The auto-configured RestTemplateBuilder ensures that sensible HttpMessageConverters are applied to RestTemplate instances.

The following code shows a typical example:

```
@Service
public class MyService {

private final RestTemplate restTemplate;

public MyService(RestTemplateBuilder restTemplateBuilder) {
    this.restTemplate = restTemplateBuilder.build();
    }

public Details someRestCall(String name) {
    return this.restTemplate.getForObject("/{name}/details", Details.class, name);
}
```

#### Tip

RestTemplateBuilder includes a number of useful methods that can be used to quickly configure a RestTemplate. For example, to add BASIC auth support, you can use builder.basicAuthentication("user", "password").build().

# 34.1 RestTemplate Customization

There are three main approaches to RestTemplate customization, depending on how broadly you want the customizations to apply.

To make the scope of any customizations as narrow as possible, inject the auto-configured RestTemplateBuilder and then call its methods as required. Each method call returns a new RestTemplateBuilder instance, so the customizations only affect this use of the builder.

To make an application-wide, additive customization, use a RestTemplateCustomizer bean. All such beans are automatically registered with the auto-configured RestTemplateBuilder and are applied to any templates that are built with it.

The following example shows a customizer that configures the use of a proxy for all hosts except 192.168.0.5:

```
static class ProxyCustomizer implements RestTemplateCustomizer {

@Override
public void customize(RestTemplate restTemplate) {
   HttpHost proxy = new HttpHost("proxy.example.com");
   HttpClient httpClient = HttpClientBuilder.create()
        .setRoutePlanner(new DefaultProxyRoutePlanner(proxy) {

        @Override
        public HttpHost determineProxy(HttpHost target,
```

```
HttpRequest request, HttpContext context)
    throws HttpException {
    if (target.getHostName().equals("192.168.0.5")) {
        return null;
    }
    return super.determineProxy(target, request, context);
    }
} build();
restTemplate.setRequestFactory(
    new HttpComponentsClientHttpRequestFactory(httpClient));
}
```

Finally, the most extreme (and rarely used) option is to create your own RestTemplateBuilder bean. Doing so switches off the auto-configuration of a RestTemplateBuilder and prevents any RestTemplateCustomizer beans from being used.

# 35. Calling REST Services with WebClient

If you have Spring WebFlux on your classpath, you can also choose to use WebClient to call remote REST services. Compared to RestTemplate, this client has a more functional feel and is fully reactive. You can learn more about the WebClient in the dedicated section in the Spring Framework docs.

Spring Boot creates and pre-configures a <code>WebClient.Builder</code> for you; it is strongly advised to inject it in your components and use it to create <code>WebClient</code> instances. Spring Boot is configuring that builder to share HTTP resources, reflect codecs setup in the same fashion as the server ones (see <a href="WebFlux HTTP codecs auto-configuration">WebFlux HTTP codecs auto-configuration</a>), and more.

The following code shows a typical example:

## 35.1 WebClient Runtime

Spring Boot will auto-detect which ClientHttpConnector to use to drive WebClient, depending on the libraries available on the application classpath. For now, Reactor Netty and Jetty RS client are supported.

The spring-boot-starter-webflux starter depends on io.projectreactor.netty:reactor-netty by default, which brings both server and client implementations. If you choose to use Jetty as a reactive server instead, you should add a dependency on the Jetty Reactive HTTP client library, org.eclipse.jetty:jetty-reactive-httpclient. Using the same technology for server and client has it advantages, as it will automatically share HTTP resources between client and server.

Developers can override the resource configuration for Jetty and Reactor Netty by providing a custom ReactorResourceFactory or JettyResourceFactory bean - this will be applied to both clients and servers.

If you wish to override that choice for the client, you can define your own ClientHttpConnector bean and have full control over the client configuration.

You can learn more about the <u>WebClient</u> configuration options in the Spring Framework reference documentation.

## 35.2 WebClient Customization

There are three main approaches to WebClient customization, depending on how broadly you want the customizations to apply.

To make the scope of any customizations as narrow as possible, inject the auto-configured WebClient.Builder and then call its methods as required. WebClient.Builder instances are stateful: Any change on the builder is reflected in all clients subsequently created with it. If you want to create several clients with the same builder, you can also consider cloning the builder with WebClient.Builder other = builder.clone();

To make an application-wide, additive customization to all WebClient.Builder instances, you can declare WebClientCustomizer beans and change the WebClient.Builder locally at the point of injection.

Finally, you can fall back to the original API and use <code>WebClient.create()</code>. In that case, no autoconfiguration or <code>WebClientCustomizer</code> is applied.

# 36. Validation

The method validation feature supported by Bean Validation 1.1 is automatically enabled as long as a JSR-303 implementation (such as Hibernate validator) is on the classpath. This lets bean methods be annotated with <code>javax.validation</code> constraints on their parameters and/or on their return value. Target classes with such annotated methods need to be annotated with the <code>@Validated</code> annotation at the type level for their methods to be searched for inline constraint annotations.

For instance, the following service triggers the validation of the first argument, making sure its size is between 8 and 10:

```
@Service
@Validated
public class MyBean {

public Archive findByCodeAndAuthor(@Size(min = 8, max = 10) String code,
   Author author) {
   ...
}
```

# 37. Sending Email

The Spring Framework provides an easy abstraction for sending email by using the JavaMailSender interface, and Spring Boot provides auto-configuration for it as well as a starter module.

#### Tip

See the <u>reference documentation</u> for a detailed explanation of how you can use <code>JavaMailSender</code>.

If spring.mail.host and the relevant libraries (as defined by spring-boot-starter-mail) are available, a default JavaMailSender is created if none exists. The sender can be further customized by configuration items from the spring.mail namespace. See MailProperties for more details.

In particular, certain default timeout values are infinite, and you may want to change that to avoid having a thread blocked by an unresponsive mail server, as shown in the following example:

```
spring.mail.properties.mail.smtp.connectiontimeout=5000
spring.mail.properties.mail.smtp.timeout=3000
spring.mail.properties.mail.smtp.writetimeout=5000
```

It is also possible to configure a JavaMailSender with an existing Session from JNDI:

```
spring.mail.jndi-name=mail/Session
```

When a jndi-name is set, it takes precedence over all other Session-related settings.

# 38. Distributed Transactions with JTA

Spring Boot supports distributed JTA transactions across multiple XA resources by using either an <a href="Atomikos">Atomikos</a> or <a href="Bitronix">Bitronix</a> embedded transaction manager. JTA transactions are also supported when deploying to a suitable Java EE Application Server.

When a JTA environment is detected, Spring's JtaTransactionManager is used to manage transactions. Auto-configured JMS, DataSource, and JPA beans are upgraded to support XA transactions. You can use standard Spring idioms, such as @Transactional, to participate in a distributed transaction. If you are within a JTA environment and still want to use local transactions, you can set the spring.jta.enabled property to false to disable the JTA auto-configuration.

# 38.1 Using an Atomikos Transaction Manager

Atomikos is a popular open source transaction manager which can be embedded into your Spring Boot application. You can use the <code>spring-boot-starter-jta-atomikos</code> Starter to pull in the appropriate Atomikos libraries. Spring Boot auto-configures Atomikos and ensures that appropriate <code>depends-on</code> settings are applied to your Spring beans for correct startup and shutdown ordering.

By default, Atomikos transaction logs are written to a transaction-logs directory in your application's home directory (the directory in which your application jar file resides). You can customize the location of this directory by setting a spring.jta.log-dir property in your application.properties file. Properties starting with spring.jta.atomikos.properties can also be used to customize the Atomikos UserTransactionServiceImp. See the AtomikosProperties Javadoc for complete details.

#### Note

To ensure that multiple transaction managers can safely coordinate the same resource managers, each Atomikos instance must be configured with a unique ID. By default, this ID is the IP address of the machine on which Atomikos is running. To ensure uniqueness in production, you should configure the <code>spring.jta.transaction-manager-id</code> property with a different value for each instance of your application.

# 38.2 Using a Bitronix Transaction Manager

<u>Bitronix</u> is a popular open-source JTA transaction manager implementation. You can use the spring-boot-starter-jta-bitronix starter to add the appropriate Bitronix dependencies to your project. As with Atomikos, Spring Boot automatically configures Bitronix and post-processes your beans to ensure that startup and shutdown ordering is correct.

By default, Bitronix transaction log files (part1.btm and part2.btm) are written to a transaction-logs directory in your application home directory. You can customize the location of this directory by setting the spring.jta.log-dir property. Properties starting with spring.jta.bitronix.properties are also bound to the bitronix.tm.Configuration bean, allowing for complete customization. See the <u>Bitronix documentation</u> for details.

#### Note

To ensure that multiple transaction managers can safely coordinate the same resource managers, each Bitronix instance must be configured with a unique ID. By default, this ID is the IP address

of the machine on which Bitronix is running. To ensure uniqueness in production, you should configure the spring.jta.transaction-manager-id property with a different value for each instance of your application.

# 38.3 Using a Java EE Managed Transaction Manager

If you package your Spring Boot application as a war or ear file and deploy it to a Java EE application server, you can use your application server's built-in transaction manager. Spring Boot tries to auto-configure a transaction manager by looking at common JNDI locations (java:comp/UserTransaction, java:comp/TransactionManager, and so on). If you use a transaction service provided by your application server, you generally also want to ensure that all resources are managed by the server and exposed over JNDI. Spring Boot tries to auto-configure JMS by looking for a ConnectionFactory at the JNDI path (java:/JmsXA or java:/XAConnectionFactory), and you can use the <a href="mailto:spring.datasource.jndi-name property">spring.datasource.jndi-name property</a> to configure your DataSource.

# 38.4 Mixing XA and Non-XA JMS Connections

When using JTA, the primary JMS ConnectionFactory bean is XA-aware and participates in distributed transactions. In some situations, you might want to process certain JMS messages by using a non-XA ConnectionFactory. For example, your JMS processing logic might take longer than the XA timeout.

If you want to use a non-XA ConnectionFactory, you can inject the nonXaJmsConnectionFactory bean rather than the @Primary jmsConnectionFactory bean. For consistency, the jmsConnectionFactory bean is also provided by using the bean alias xaJmsConnectionFactory.

The following example shows how to inject ConnectionFactory instances:

```
// Inject the primary (XA aware) ConnectionFactory
@Autowired
private ConnectionFactory defaultConnectionFactory;

// Inject the XA aware ConnectionFactory (uses the alias and injects the same as above)
@Autowired
@Qualifier("xaJmsConnectionFactory")
private ConnectionFactory xaConnectionFactory;

// Inject the non-XA aware ConnectionFactory
@Autowired
@Qualifier("nonXaJmsConnectionFactory")
private ConnectionFactory nonXaConnectionFactory;
```

# 38.5 Supporting an Alternative Embedded Transaction Manager

The <u>XAConnectionFactoryWrapper</u> and <u>XADataSourceWrapper</u> interfaces can be used to support alternative embedded transaction managers. The interfaces are responsible for wrapping XAConnectionFactory and XADataSource beans and exposing them as regular ConnectionFactory and DataSource beans, which transparently enroll in the distributed transaction. DataSource and JMS auto-configuration use JTA variants, provided you have a JtaTransactionManager bean and appropriate XA wrapper beans registered within your ApplicationContext.

 $\label{thm:convex} The \ \underline{BitronixXAConnectionFactoryWrapper} \ and \ \underline{BitronixXADataSourceWrapper} \ provide \ good \ examples \ of \ how \ to \ write \ XA \ wrappers.$ 

# 39. Hazelcast

If <u>Hazelcast</u> is on the classpath and a suitable configuration is found, Spring Boot auto-configures a HazelcastInstance that you can inject in your application.

If you define a com.hazelcast.config.Config bean, Spring Boot uses that. If your configuration defines an instance name, Spring Boot tries to locate an existing instance rather than creating a new one.

You could also specify the hazelcast.xml configuration file to use through configuration, as shown in the following example:

```
spring.hazelcast.config=classpath:config/my-hazelcast.xml
```

Otherwise, Spring Boot tries to find the Hazelcast configuration from the default locations: hazelcast.xml in the working directory or at the root of the classpath. We also check if the hazelcast.config system property is set. See the <u>Hazelcast documentation</u> for more details.

If hazelcast-client is present on the classpath, Spring Boot first attempts to create a client by checking the following configuration options:

- The presence of a com.hazelcast.client.config.ClientConfig bean.
- A configuration file defined by the spring.hazelcast.config property.
- The presence of the hazelcast.client.config system property.
- A hazelcast-client.xml in the working directory or at the root of the classpath.

#### Note

Spring Boot also has <u>explicit caching support for Hazelcast</u>. If caching is enabled, the HazelcastInstance is automatically wrapped in a CacheManager implementation.

# 40. Quartz Scheduler

Spring Boot offers several conveniences for working with the <u>Quartz scheduler</u>, including the spring-boot-starter-quartz "Starter". If Quartz is available, a Scheduler is auto-configured (through the SchedulerFactoryBean abstraction).

Beans of the following types are automatically picked up and associated with the Scheduler:

- JobDetail: defines a particular Job. JobDetail instances can be built with the JobBuilder API.
- Calendar.
- Trigger: defines when a particular job is triggered.

By default, an in-memory JobStore is used. However, it is possible to configure a JDBC-based store if a DataSource bean is available in your application and if the spring.quartz.job-store-type property is configured accordingly, as shown in the following example:

```
spring.quartz.job-store-type=jdbc
```

When the JDBC store is used, the schema can be initialized on startup, as shown in the following example:

```
spring.quartz.jdbc.initialize-schema=always
```

#### Note

By default, the database is detected and initialized by using the standard scripts provided with the Quartz library. It is also possible to provide a custom script by setting the spring.quartz.jdbc.schema property.

To have Quartz use a DataSource other than the application's main DataSource, declare a DataSource bean, annotating its @Bean method with @QuartzDataSource. Doing so ensures that the Quartz-specific DataSource is used by both the SchedulerFactoryBean and for schema initialization.

By default, jobs created by configuration will not overwrite already registered jobs that have been read from a persistent job store. To enable overwriting existing job definitions set the spring.quartz.overwrite-existing-jobs property.

Quartz Scheduler configuration can be customized using spring.quartz properties and SchedulerFactoryBeanCustomizer beans, which allow programmatic SchedulerFactoryBean customization. Advanced Quartz configuration properties can be customized using spring.quartz.properties.\*.

#### Note

In particular, an Executor bean is not associated with the scheduler as Quartz offers a way to configure the scheduler via spring.quartz.properties. If you need to customize the task executor, consider implementing SchedulerFactoryBeanCustomizer.

Jobs can define setters to inject data map properties. Regular beans can also be injected in a similar manner, as shown in the following example:

```
public class SampleJob extends QuartzJobBean {
  private MyService myService;

private String name;

// Inject "MyService" bean
  public void setMyService(MyService myService) { ... }

// Inject the "name" job data property
  public void setName(String name) { ... }

@Override
  protected void executeInternal(JobExecutionContext context)
    throws JobExecutionException {
    ...
}
```

# 41. Task Execution and Scheduling

In the absence of a TaskExecutor bean in the context, Spring Boot auto-configures a ThreadPoolTaskExecutor with sensible defaults that can be automatically associated to asynchronous task execution (@EnableAsync) and Spring MVC asynchronous request processing.

The thread pool uses 8 core threads that can grow and shrink according to the load. Those default settings can be fine-tuned using the spring.task.execution namespace as shown in the following example:

```
spring.task.execution.pool.max-threads=16
spring.task.execution.pool.queue-capacity=100
spring.task.execution.pool.keep-alive=10s
```

This changes the thread pool to use a bounded queue so that when the queue is full (100 tasks), the thread pool increases to maximum 16 threads. Shrinking of the pool is more aggressive as threads are reclaimed when they are idle for 10 seconds (rather than 60 seconds by default).

A ThreadPoolTaskScheduler can also be auto-configured if need to be associated to scheduled task execution (@EnableScheduling). The thread pool uses one thread by default and those settings can be fine-tuned using the spring.task.scheduling namespace.

Both a TaskExecutorBuilder bean and a TaskSchedulerBuilder bean are made available in the context if a custom executor or scheduler needs to be created.

# 42. Spring Integration

Spring Boot offers several conveniences for working with <u>Spring Integration</u>, including the <u>spring-boot-starter-integration</u> "Starter". Spring Integration provides abstractions over messaging and also other transports such as HTTP, TCP, and others. If Spring Integration is available on your classpath, it is initialized through the <code>@EnableIntegration</code> annotation.

Spring Boot also configures some features that are triggered by the presence of additional Spring Integration modules. If <code>spring-integration-jmx</code> is also on the classpath, message processing statistics are published over JMX . If <code>spring-integration-jdbc</code> is available, the default database schema can be created on startup, as shown in the following line:

```
spring.integration.jdbc.initialize-schema=always
```

See the <a href="IntegrationAutoConfiguration">IntegrationProperties</a> classes for more details.

By default, if a Micrometer meterRegistry bean is present, Spring Integration metrics will be managed by Micrometer. If you wish to use legacy Spring Integration metrics, add a DefaultMetricsFactory bean to the application context.

# 43. Spring Session

Spring Boot provides <u>Spring Session</u> auto-configuration for a wide range of data stores. When building a Servlet web application, the following stores can be auto-configured:

- JDBC
- Redis
- Hazelcast
- MongoDB

When building a reactive web application, the following stores can be auto-configured:

- Redis
- MongoDB

If a single Spring Session module is present on the classpath, Spring Boot uses that store implementation automatically. If you have more than one implementation, you must choose the <a href="StoreType">StoreType</a> that you wish to use to store the sessions. For instance, to use JDBC as the back-end store, you can configure your application as follows:

spring.session.store-type=jdbc

#### Tip

You can disable Spring Session by setting the store-type to none.

Each store has specific additional settings. For instance, it is possible to customize the name of the table for the JDBC store, as shown in the following example:

```
spring.session.jdbc.table-name=SESSIONS
```

For setting the timeout of the session you can use the spring.session.timeout property. If that property is not set, the auto-configuration falls back to the value of server.servlet.session.timeout.

# 44. Monitoring and Management over JMX

Java Management Extensions (JMX) provide a standard mechanism to monitor and manage applications. By default, Spring Boot creates an MBeanServer bean with an ID of mbeanServer and exposes any of your beans that are annotated with Spring JMX annotations (@ManagedResource, @ManagedAttribute, Or @ManagedOperation).

See the <u>JmxAutoConfiguration</u> class for more details.

# 45. Testing

Spring Boot provides a number of utilities and annotations to help when testing your application. Test support is provided by two modules: spring-boot-test contains core items, and spring-boot-test-autoconfigure supports auto-configuration for tests.

Most developers use the spring-boot-starter-test "Starter", which imports both Spring Boot test modules as well as JUnit, AssertJ, Hamcrest, and a number of other useful libraries.

# 45.1 Test Scope Dependencies

The spring-boot-starter-test "Starter" (in the test scope) contains the following provided libraries:

- JUnit: The de-facto standard for unit testing Java applications.
- Spring Test & Spring Boot Test: Utilities and integration test support for Spring Boot applications.
- · AssertJ: A fluent assertion library.
- <u>Hamcrest</u>: A library of matcher objects (also known as constraints or predicates).
- Mockito: A Java mocking framework.
- JSONassert: An assertion library for JSON.
- JsonPath: XPath for JSON.

We generally find these common libraries to be useful when writing tests. If these libraries do not suit your needs, you can add additional test dependencies of your own.

# **45.2 Testing Spring Applications**

One of the major advantages of dependency injection is that it should make your code easier to unit test. You can instantiate objects by using the new operator without even involving Spring. You can also use *mock objects* instead of real dependencies.

Often, you need to move beyond unit testing and start integration testing (with a Spring ApplicationContext). It is useful to be able to perform integration testing without requiring deployment of your application or needing to connect to other infrastructure.

The Spring Framework includes a dedicated test module for such integration testing. You can declare a dependency directly to org.springframework:spring-test or use the spring-boot-starter-test "Starter" to pull it in transitively.

If you have not used the spring-test module before, you should start by reading the <u>relevant section</u> of the Spring Framework reference documentation.

# **45.3 Testing Spring Boot Applications**

A Spring Boot application is a Spring ApplicationContext, so nothing very special has to be done to test it beyond what you would normally do with a vanilla Spring context.

#### Note

External properties, logging, and other features of Spring Boot are installed in the context by default only if you use SpringApplication to create it.

Spring Boot provides a @SpringBootTest annotation, which can be used as an alternative to the standard spring-test @ContextConfiguration annotation when you need Spring Boot features. The annotation works by <u>creating the ApplicationContext used in your tests through SpringApplication</u>. In addition to @SpringBootTest a number of other annotations are also provided for <u>testing more specific slices</u> of an application.

#### Tip

If you are using JUnit 4, don't forget to also add <code>@RunWith(SpringRunner.class)</code> to your test, otherwise the annotations will be ignored. If you are using JUnit 5, there's no need to add the equivalent <code>@ExtendWith(SpringExtension)</code> as <code>@SpringBootTest</code> and the other <code>@...Test</code> annotations are already annotated with it.

By default, @SpringBootTest will not start a server. You can use the webEnvironment attribute of @SpringBootTest to further refine how your tests run:

- MOCK(Default): Loads a web ApplicationContext and provides a mock web environment.
   Embedded servers are not started when using this annotation. If a web environment is not available on your classpath, this mode transparently falls back to creating a regular non-web ApplicationContext. It can be used in conjunction with <a href="mailto:@AutoConfigureWebTestClient">@AutoConfigureWebTestClient</a> for mock-based testing of your web application.
- RANDOM\_PORT: Loads a WebServerApplicationContext and provides a real web environment. Embedded servers are started and listen on a random port.
- DEFINED\_PORT: Loads a WebServerApplicationContext and provides a real web environment. Embedded servers are started and listen on a defined port (from your application.properties) or on the default port of 8080.
- NONE: Loads an ApplicationContext by using SpringApplication but does not provide any web environment (mock or otherwise).

#### Note

If your test is @Transactional, it rolls back the transaction at the end of each test method by default. However, as using this arrangement with either RANDOM\_PORT or DEFINED\_PORT implicitly provides a real servlet environment, the HTTP client and server run in separate threads and, thus, in separate transactions. Any transaction initiated on the server does not roll back in this case.

#### **Note**

@SpringBootTest with webEnvironment = WebEnvironment.RANDOM\_PORT will also start the management server on a separate random port if your application uses a different port for the management server.

# **Detecting Web Application Type**

If Spring MVC is available, a regular MVC-based application context is configured. If you have only Spring WebFlux, we'll detect that and configure a WebFlux-based application context instead.

If both are present, Spring MVC takes precedence. If you want to test a reactive web application in this scenario, you must set the spring.main.web-application-type property:

```
@RunWith(SpringRunner.class)
@SpringBootTest(properties = "spring.main.web-application-type=reactive")
public class MyWebFluxTests { ... }
```

## **Detecting Test Configuration**

If you are familiar with the Spring Test Framework, you may be used to using <code>@ContextConfiguration(classes=...)</code> in order to specify which Spring <code>@Configuration</code> to load. Alternatively, you might have often used nested <code>@Configuration</code> classes within your test.

When testing Spring Boot applications, this is often not required. Spring Boot's @\*Test annotations search for your primary configuration automatically whenever you do not explicitly define one.

The search algorithm works up from the package that contains the test until it finds a class annotated with @SpringBootApplication or @SpringBootConfiguration. As long as you structured your code in a sensible way, your main configuration is usually found.

#### Note

If you use a <u>test annotation to test a more specific slice of your application</u>, you should avoid adding configuration settings that are specific to a particular area on the <u>main method's application class</u>.

The underlying component scan configuration of @SpringBootApplication defines exclude filters that are used to make sure slicing works as expected. If you are using an explicit @ComponentScan directive on your @SpringBootApplication-annotated class, be aware that those filters will be disabled. If you are using slicing, you should define them again.

If you want to customize the primary configuration, you can use a nested @TestConfiguration class. Unlike a nested @Configuration class, which would be used instead of your application's primary configuration, a nested @TestConfiguration class is used in addition to your application's primary configuration.

#### **Note**

Spring's test framework caches application contexts between tests. Therefore, as long as your tests share the same configuration (no matter how it is discovered), the potentially time-consuming process of loading the context happens only once.

## **Excluding Test Configuration**

If your application uses component scanning (for example, if you use @SpringBootApplication or @ComponentScan), you may find top-level configuration classes that you created only for specific tests accidentally get picked up everywhere.

As we <u>have seen earlier</u>, @TestConfiguration can be used on an inner class of a test to customize the primary configuration. When placed on a top-level class, @TestConfiguration indicates that

classes in src/test/java should not be picked up by scanning. You can then import that class explicitly where it is required, as shown in the following example:

```
@RunWith(SpringRunner.class)
@SpringBootTest
@Import(MyTestsConfiguration.class)
public class MyTests {

@Test
public void exampleTest() {
    ...
}
```

#### Note

If you directly use @ComponentScan (that is, not through @SpringBootApplication) you need to register the TypeExcludeFilter with it. See the Javadoc for details.

## Testing with a mock environment

By default, <code>@SpringBootTest</code> does not start the server. If you have web endpoints that you want to test against this mock environment, you can additionally configure <code>MockMvc</code> as shown in the following example:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.web.servlet.AutoConfigureMockMvc;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.test.web.servlet.MockMvc;
import static org.springframework.test.web.servlet.request.MockMvcRequestBuilders.get;
import static org.springframework.test.web.servlet.result.MockMvcResultMatchers.content;
import static org.springframework.test.web.servlet.result.MockMvcResultMatchers.status;
@RunWith(SpringRunner.class)
@SpringBootTest
@AutoConfigureMockMvc
public class MockMvcExampleTests {
@Autowired
private MockMvc mvc;
public void exampleTest() throws Exception {
  this.mvc.perform(get("/")).andExpect(status().isOk())
    .andExpect(content().string("Hello World"));
```

#### Tip

If you want to focus only on the web layer and not start a complete ApplicationContext, consider using @WebMvcTest instead.

Alternatively, you can configure a <u>WebTestClient</u> as shown in the following example:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.web.reactive.AutoConfigureWebTestClient;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.test.web.reactive.server.WebTestClient;
@RunWith(SpringRunner.class)
@SpringBootTest
@AutoConfigureWebTestClient
public class MockWebTestClientExampleTests {
@Autowired
private WebTestClient webClient;
public void exampleTest() {
 this.webClient.get().uri("/").exchange().expectStatus().isOk()
    .expectBody(String.class).isEqualTo("Hello World");
}
```

# Testing with a running server

If you need to start a full running server, we recommend that you use random ports. If you use @SpringBootTest(webEnvironment=WebEnvironment.RANDOM\_PORT), an available port is picked at random each time your test runs.

The @LocalServerPort annotation can be used to <u>inject the actual port used</u> into your test. For convenience, tests that need to make REST calls to the started server can additionally @Autowire a <u>WebTestClient</u>, which resolves relative links to the running server and comes with a dedicated API for verifying responses, as shown in the following example:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.boot.test.context.SpringBootTest.WebEnvironment;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.test.web.reactive.server.WebTestClient;
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment = WebEnvironment.RANDOM PORT)
public class RandomPortWebTestClientExampleTests {
@Autowired
private WebTestClient webClient;
public void exampleTest() {
 this.webClient.get().uri("/").exchange().expectStatus().isOk()
    .expectBody(String.class).isEqualTo("Hello World");
}
}
```

This setup requires <code>spring-webflux</code> on the classpath. If you can't or won't add webflux, Spring Boot also provides a <code>TestRestTemplate</code> facility:

```
import org.junit.Test;
import org.junit.runner.RunWith;
```

```
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.boot.test.web.client.TestRestTemplate;
import org.springframework.boot.test.web.client.TestRestTemplate;
import org.springframework.test.context.junit4.SpringRunner;
import static org.assertj.core.api.Assertions.assertThat;

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

@Autowired
private TestRestTemplate restTemplate;

@Test
public void exampleTest() {

String body = this.restTemplate.getForObject("/", String.class);
assertThat(body).isEqualTo("Hello World");
}

}
```

# **Using JMX**

As the test context framework caches context, JMX is disabled by default to prevent identical components to register on the same domain. If such test needs access to an MBeanServer, consider marking it dirty as well:

```
@RunWith(SpringRunner.class)
@SpringBootTest(properties = "spring.jmx.enabled=true")
@DirtiesContext
public class SampleJmxTests {

@Autowired
private MBeanServer mBeanServer;

@Test
public void exampleTest() {
    // ...
}
```

# **Mocking and Spying Beans**

When running tests, it is sometimes necessary to mock certain components within your application context. For example, you may have a facade over some remote service that is unavailable during development. Mocking can also be useful when you want to simulate failures that might be hard to trigger in a real environment.

Spring Boot includes a <code>@MockBean</code> annotation that can be used to define a Mockito mock for a bean inside your <code>ApplicationContext</code>. You can use the annotation to add new beans or replace a single existing bean definition. The annotation can be used directly on test classes, on fields within your test, or on <code>@Configuration</code> classes and fields. When used on a field, the instance of the created mock is also injected. Mock beans are automatically reset after each test method.

#### Note

If your test uses one of Spring Boot's test annotations (such as @SpringBootTest), this feature is automatically enabled. To use this feature with a different arrangement, a listener must be explicitly added, as shown in the following example:

```
@TestExecutionListeners(MockitoTestExecutionListener.class)
```

The following example replaces an existing RemoteService bean with a mock implementation:

```
import org.junit.*;
import org.junit.runner.*;
import org.springframework.beans.factory.annotation.*;
import org.springframework.boot.test.context.*;
import org.springframework.boot.test.mock.mockito.*;
import org.springframework.test.context.junit4.*;
import static org.assertj.core.api.Assertions.*;
import static org.mockito.BDDMockito.*;
@RunWith(SpringRunner.class)
@SpringBootTest
public class MyTests {
private RemoteService remoteService;
@Autowired
private Reverser reverser;
public void exampleTest() {
  // RemoteService has been injected into the reverser bean
 given(this.remoteService.someCall()).willReturn("mock");
 String reverse = reverser.reverseSomeCall();
 assertThat(reverse).isEqualTo("kcom");
```

Additionally, you can use @SpyBean to wrap any existing bean with a Mockito spy. See the <u>Javadoc</u> for full details.

#### Note

While Spring's test framework caches application contexts between tests and reuses a context for tests sharing the same configuration, the use of <code>@MockBean</code> or <code>@SpyBean</code> influences the cache key, which will most likely increase the number of contexts.

#### Tip

If you are using @SpyBean to spy on a bean with @Cacheable methods that refer to parameters by name, your application must be compiled with -parameters. This ensures that the parameter names are available to the caching infrastructure once the bean has been spied upon.

## **Auto-configured Tests**

Spring Boot's auto-configuration system works well for applications but can sometimes be a little too much for tests. It often helps to load only the parts of the configuration that are required to test a "slice" of your application. For example, you might want to test that Spring MVC controllers are mapping URLs correctly, and you do not want to involve database calls in those tests, or you might want to test JPA entities, and you are not interested in the web layer when those tests run.

The spring-boot-test-autoconfigure module includes a number of annotations that can be used to automatically configure such "slices". Each of them works in a similar way, providing a @...Test

annotation that loads the ApplicationContext and one or more @AutoConfigure... annotations that can be used to customize auto-configuration settings.

#### Note

Each slice restricts component scan to appropriate components and loads a very restricted set of auto-configuration classes. If you need to exclude one of them, most @...Test annotations provide an excludeAutoConfiguration attribute. Alternatively, you can use @ImportAutoConfiguration#exclude.

## Tip

It is also possible to use the <code>@AutoConfigure...</code> annotations with the standard <code>@SpringBootTest</code> annotation. You can use this combination if you are not interested in "slicing" your application but you want some of the auto-configured test beans.

# **Auto-configured JSON Tests**

To test that object JSON serialization and deserialization is working as expected, you can use the @JsonTest annotation. @JsonTest auto-configures the available supported JSON mapper, which can be one of the following libraries:

- Jackson ObjectMapper, any @JsonComponent beans and any Jackson Modules
- Gson
- Jsonb

#### Tip

A list of the auto-configurations that are enabled by @JsonTest can be found in the appendix.

If you need to configure elements of the auto-configuration, you can use the @AutoConfigureJsonTesters annotation.

Spring Boot includes AssertJ-based helpers that work with the JSONAssert and JsonPath libraries to check that JSON appears as expected. The <code>JacksonTester</code>, <code>GsonTester</code>, <code>JsonbTester</code>, and <code>BasicJsonTester</code> classes can be used for Jackson, Gson, Jsonb, and Strings respectively. Any helper fields on the test class can be <code>@Autowired</code> when using <code>@JsonTest</code>. The following example shows a test class for Jackson:

```
import org.junit.*;
import org.junit.runner.*;
import org.springframework.beans.factory.annotation.*;
import org.springframework.boot.test.autoconfigure.json.*;
import org.springframework.boot.test.json.*;
import org.springframework.boot.test.json.*;
import org.springframework.test.context.junit4.*;
import static org.assertj.core.api.Assertions.*;

@RunWith(SpringRunner.class)
@JsonTest
public class MyJsonTests {

@Autowired
private JacksonTester<VehicleDetails> json;
```

```
public void testSerialize() throws Exception {
    VehicleDetails details = new VehicleDetails("Honda", "Civic");
    // Assert against a `.json` file in the same package as the test
    assertThat(this.json.write(details)).isEqualToJson("expected.json");
    // Or use JSON path based assertions
    assertThat(this.json.write(details)).hasJsonPathStringValue("@.make");
    assertThat(this.json.write(details)).extractingJsonPathStringValue("@.make")
        .isEqualTo("Honda");
}

@Test
public void testDeserialize() throws Exception {
    String content = "{\"make\":\"Ford\",\"model\":\"Focus\"}";
    assertThat(this.json.parse(content))
        .isEqualTo(new VehicleDetails("Ford", "Focus"));
    assertThat(this.json.parseObject(content).getMake()).isEqualTo("Ford");
}
```

#### Note

JSON helper classes can also be used directly in standard unit tests. To do so, call the initFields method of the helper in your @Before method if you do not use @JsonTest.

# **Auto-configured Spring MVC Tests**

To test whether Spring MVC controllers are working as expected, use the <code>@WebMvcTest</code> annotation. <code>@WebMvcTest</code> auto-configures the Spring MVC infrastructure and limits scanned beans to <code>@Controller</code>, <code>@Controller</code>Advice, <code>@JsonComponent</code>, <code>Converter</code>, <code>GenericConverter</code>, <code>Filter</code>, <code>WebMvcConfigurer</code>, and <code>HandlerMethodArgumentResolver</code>. Regular <code>@Component</code> beans are not scanned when using this annotation.

#### Tip

A list of the auto-configuration settings that are enabled by @WebMvcTest can be found in the appendix.

#### Tip

If you need to register extra components, such as the Jackson Module, you can import additional configuration classes by using @Import on your test.

Often, @WebMvcTest is limited to a single controller and is used in combination with @MockBean to provide mock implementations for required collaborators.

@WebMvcTest also auto-configures MockMvc. Mock MVC offers a powerful way to quickly test MVC controllers without needing to start a full HTTP server.

#### Tip

You can also auto-configure MockMvc in a non-@WebMvcTest (such as @SpringBootTest) by annotating it with @AutoConfigureMockMvc. The following example uses MockMvc:

```
import org.junit.*;
```

```
import org.junit.runner.*;
import org.springframework.beans.factory.annotation.*;
import org.springframework.boot.test.autoconfigure.web.servlet.*;
import org.springframework.boot.test.mock.mockito.*;
import static org.assertj.core.api.Assertions.*;
import static org.mockito.BDDMockito.*;
import static org.springframework.test.web.servlet.request.MockMycRequestBuilders.*;
import static org.springframework.test.web.servlet.result.MockMvcResultMatchers.*;
@RunWith(SpringRunner.class)
@WebMvcTest(UserVehicleController.class)
public class MyControllerTests {
 @Autowired
private MockMvc mvc;
@MockBean
private UserVehicleService userVehicleService;
@Test
public void testExample() throws Exception {
 given(this.userVehicleService.getVehicleDetails("sboot"))
    .willReturn(new VehicleDetails("Honda", "Civic"));
 this.mvc.perform(get("/sboot/vehicle").accept(MediaType.TEXT_PLAIN))
    .andExpect(status().isOk()).andExpect(content().string("Honda Civic"));
}
```

#### Tip

If you need to configure elements of the auto-configuration (for example, when servlet filters should be applied) you can use attributes in the <code>@AutoConfigureMockMvc</code> annotation.

If you use HtmlUnit or Selenium, auto-configuration also provides an HTMLUnit WebClient bean and/ or a WebDriver bean. The following example uses HtmlUnit:

```
import com.gargoylesoftware.htmlunit.*;
import org.junit.*;
import org.junit.runner.*;
import org.springframework.beans.factory.annotation.*;
import org.springframework.boot.test.autoconfigure.web.servlet.*;
import org.springframework.boot.test.mock.mockito.*;
import static org.assertj.core.api.Assertions.*;
import static org.mockito.BDDMockito.*;
@RunWith(SpringRunner.class)
@WebMvcTest(UserVehicleController.class)
public class MyHtmlUnitTests {
private WebClient webClient;
 @MockBean
private UserVehicleService userVehicleService;
public void testExample() throws Exception {
 given(this.userVehicleService.getVehicleDetails("sboot"))
    .willReturn(new VehicleDetails("Honda", "Civic"));
 HtmlPage page = this.webClient.getPage("/sboot/vehicle.html");
 assertThat(page.getBody().getTextContent()).isEqualTo("Honda Civic");
```

#### Note

By default, Spring Boot puts WebDriver beans in a special "scope" to ensure that the driver exits after each test and that a new instance is injected. If you do not want this behavior, you can add @Scope("singleton") to your WebDriver @Bean definition.

#### Warning

The webDriver scope created by Spring Boot will replace any user defined scope of the same name. If you define your own webDriver scope you may find it stops working when you use @WebMvcTest.

If you have Spring Security on the classpath, <code>@WebMvcTest</code> will also scan <code>WebSecurityConfigurer</code> beans. Instead of disabling security completely for such tests, you can use Spring Security's test support. More details on how to use Spring Security's <code>MockMvc</code> support can be found in this <code>Chapter 80</code>, <code>Testing With Spring Security</code> how-to section.

#### Tip

Sometimes writing Spring MVC tests is not enough; Spring Boot can help you run <u>full end-to-end</u> tests with an actual server.

# **Auto-configured Spring WebFlux Tests**

To test that <u>Spring WebFlux</u> controllers are working as expected, you can use the @WebFluxTest annotation. @WebFluxTest auto-configures the Spring WebFlux infrastructure and limits scanned beans to @Controller, @ControllerAdvice, @JsonComponent, Converter, GenericConverter, and WebFluxConfigurer. Regular @Component beans are not scanned when the @WebFluxTest annotation is used.

## Tip

A list of the auto-configurations that are enabled by @WebFluxTest can be found in the appendix.

#### Tip

If you need to register extra components, such as Jackson Module, you can import additional configuration classes using @Import on your test.

Often, @WebFluxTest is limited to a single controller and used in combination with the @MockBean annotation to provide mock implementations for required collaborators.

<code>@WebFluxTest</code> also auto-configures <code>WebTestClient</code>, which offers a powerful way to quickly test WebFlux controllers without needing to start a full HTTP server.

#### Tip

You can also auto-configure WebTestClient in a non-@WebFluxTest (such as @SpringBootTest) by annotating it with @AutoConfigureWebTestClient. The following example shows a class that uses both @WebFluxTest and a WebTestClient:

import org.junit.Test;

```
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.web.reactive.WebFluxTest;
import org.springframework.http.MediaType;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.test.web.reactive.server.WebTestClient;
@RunWith(SpringRunner.class)
@WebFluxTest(UserVehicleController.class)
public class MyControllerTests {
@Autowired
private WebTestClient webClient;
private UserVehicleService userVehicleService;
public void testExample() throws Exception {
 given(this.userVehicleService.getVehicleDetails("sboot"))
   .willReturn(new VehicleDetails("Honda", "Civic"));
 this.webClient.get().uri("/sboot/vehicle").accept(MediaType.TEXT_PLAIN)
   .exchange()
   .expectStatus().isOk()
   .expectBody(String.class).isEqualTo("Honda Civic");
}
```

#### Tip

This setup is only supported by WebFlux applications as using WebTestClient in a mocked web application only works with WebFlux at the moment.

#### Note

@WebFluxTest cannot detect routes registered via the functional web framework. For testing RouterFunction beans in the context, consider importing your RouterFunction yourself via @Import or using @SpringBootTest.

## Tip

Sometimes writing Spring WebFlux tests is not enough; Spring Boot can help you run <u>full end-to-end tests</u> with an actual server.

# **Auto-configured Data JPA Tests**

You can use the @DataJpaTest annotation to test JPA applications. By default, it configures an inmemory embedded database, scans for @Entity classes, and configures Spring Data JPA repositories. Regular @Component beans are not loaded into the ApplicationContext.

#### Tip

A list of the auto-configuration settings that are enabled by @DataJpaTest can be found in the appendix.

By default, data JPA tests are transactional and roll back at the end of each test. See the <u>relevant section</u> in the Spring Framework Reference Documentation for more details. If that is not what you want, you can disable transaction management for a test or for the whole class as follows:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.boot.test.autoconfigure.orm.jpa.DataJpaTest;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.transaction.annotation.Propagation;
import org.springframework.transaction.annotation.Transactional;

@RunWith(SpringRunner.class)
@DataJpaTest
@Transactional(propagation = Propagation.NOT_SUPPORTED)
public class ExampleNonTransactionalTests {
}
```

Data JPA tests may also inject a <u>TestEntityManager</u> bean, which provides an alternative to the standard JPA EntityManager that is specifically designed for tests. If you want to use <u>TestEntityManager</u> outside of <code>@DataJpaTest</code> instances, you can also use the <code>@AutoConfigureTestEntityManager</code> annotation. A JdbcTemplate is also available if you need that. The following example shows the <code>@DataJpaTest</code> annotation in use:

```
import org.junit.*;
import org.junit.runner.*;
import org.springframework.boot.test.autoconfigure.orm.jpa.*;
import static org.assertj.core.api.Assertions.*;
@RunWith(SpringRunner.class)
@DataJpaTest
public class ExampleRepositoryTests {
@Autowired
private TestEntityManager entityManager;
@Autowired
private UserRepository repository;
public void testExample() throws Exception {
 this.entityManager.persist(new User("sboot", "1234"));
 User user = this.repository.findByUsername("sboot");
 assertThat(user.getUsername()).isEqualTo("sboot");
 assertThat(user.getVin()).isEqualTo("1234");
```

In-memory embedded databases generally work well for tests, since they are fast and do not require any installation. If, however, you prefer to run tests against a real database you can use the <code>@AutoConfigureTestDatabase</code> annotation, as shown in the following example:

```
@RunWith(SpringRunner.class)
@DataJpaTest
@AutoConfigureTestDatabase(replace=Replace.NONE)
public class ExampleRepositoryTests {

// ...
}
```

# **Auto-configured JDBC Tests**

@JdbcTest is similar to @DataJpaTest but is for tests that only require a DataSource and do not use Spring Data JDBC. By default, it configures an in-memory embedded database and a JdbcTemplate. Regular @Component beans are not loaded into the ApplicationContext.

#### Tip

A list of the auto-configurations that are enabled by @JdbcTest can be found in the appendix.

By default, JDBC tests are transactional and roll back at the end of each test. See the <u>relevant section</u> in the Spring Framework Reference Documentation for more details. If that is not what you want, you can disable transaction management for a test or for the whole class, as follows:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.boot.test.autoconfigure.jdbc.JdbcTest;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.transaction.annotation.Propagation;
import org.springframework.transaction.annotation.Transactional;

@RunWith(SpringRunner.class)
@JdbcTest
@Transactional(propagation = Propagation.NOT_SUPPORTED)
public class ExampleNonTransactionalTests {
}
```

If you prefer your test to run against a real database, you can use the <code>@AutoConfigureTestDatabase</code> annotation in the same way as for <code>DataJpaTest</code>. (See "the section called "Auto-configured Data JPA Tests"".)

# **Auto-configured Data JDBC Tests**

@DataJdbcTest is similar to @JdbcTest but is for tests that use Spring Data JDBC repositories. By default, it configures an in-memory embedded database, a JdbcTemplate, and Spring Data JDBC repositories. Regular @Component beans are not loaded into the ApplicationContext.

#### Tip

A list of the auto-configurations that are enabled by @DataJdbcTest can be found in the appendix.

By default, Data JDBC tests are transactional and roll back at the end of each test. See the <u>relevant section</u> in the Spring Framework Reference Documentation for more details. If that is not what you want, you can disable transaction management for a test or for the whole test class as <u>shown in the JDBC example</u>.

If you prefer your test to run against a real database, you can use the <code>@AutoConfigureTestDatabase</code> annotation in the same way as for <code>DataJpaTest</code>. (See "the section called "Auto-configured Data JPA Tests".)

# **Auto-configured jOOQ Tests**

You can use @JooqTest in a similar fashion as @JdbcTest but for jOOQ-related tests. As jOOQ relies heavily on a Java-based schema that corresponds with the database schema, the

existing DataSource is used. If you want to replace it with an in-memory database, you can use <code>@AutoConfigureTestDatabase</code> to override those settings. (For more about using jOOQ with Spring Boot, see "Section 30.6, "Using jOOQ", earlier in this chapter.) Regular <code>@Component</code> beans are not loaded into the <code>ApplicationContext</code>.

#### Tip

A list of the auto-configurations that are enabled by @JooqTest can be found in the appendix.

@JooqTest configures a DSLContext. Regular @Component beans are not loaded into the ApplicationContext. The following example shows the @JooqTest annotation in use:

```
import org.jooq.DSLContext;
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.boot.test.autoconfigure.jooq.JooqTest;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@JooqTest
public class ExampleJooqTests {

@Autowired
private DSLContext dslContext;
}
```

JOOQ tests are transactional and roll back at the end of each test by default. If that is not what you want, you can disable transaction management for a test or for the whole test class as <u>shown in the JDBC example</u>.

# **Auto-configured Data MongoDB Tests**

You can use @DataMongoTest to test MongoDB applications. By default, it configures an in-memory embedded MongoDB (if available), configures a MongoTemplate, scans for @Document classes, and configures Spring Data MongoDB repositories. Regular @Component beans are not loaded into the ApplicationContext. (For more about using MongoDB with Spring Boot, see "Section 31.2, "MongoDB", earlier in this chapter.)

## Tip

A list of the auto-configuration settings that are enabled by @DataMongoTest can be found in the appendix.

The following class shows the @DataMongoTest annotation in use:

```
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.data.mongo.DataMongoTest;
import org.springframework.data.mongodb.core.MongoTemplate;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@DataMongoTest
public class ExampleDataMongoTests {

@Autowired
private MongoTemplate mongoTemplate;

///
```

```
}
```

In-memory embedded MongoDB generally works well for tests, since it is fast and does not require any developer installation. If, however, you prefer to run tests against a real MongoDB server, you should exclude the embedded MongoDB auto-configuration, as shown in the following example:

```
import org.junit.runner.RunWith;
import org.springframework.boot.autoconfigure.mongo.embedded.EmbeddedMongoAutoConfiguration;
import org.springframework.boot.test.autoconfigure.data.mongo.DataMongoTest;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@DataMongoTest(excludeAutoConfiguration = EmbeddedMongoAutoConfiguration.class)
public class ExampleDataMongoNonEmbeddedTests {
}
```

# **Auto-configured Data Neo4j Tests**

You can use @DataNeo4jTest to test Neo4j applications. By default, it uses an in-memory embedded Neo4j (if the embedded driver is available), scans for @NodeEntity classes, and configures Spring Data Neo4j repositories. Regular @Component beans are not loaded into the ApplicationContext. (For more about using Neo4J with Spring Boot, see "Section 31.3, "Neo4j", earlier in this chapter.)

#### Tip

A list of the auto-configuration settings that are enabled by <code>@DataNeo4jTest</code> can be found in the appendix.

The following example shows a typical setup for using Neo4J tests in Spring Boot:

```
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.data.neo4j.DataNeo4jTest;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@DataNeo4jTest
public class ExampleDataNeo4jTests {

@Autowired
private YourRepository repository;

///
}
```

By default, Data Neo4j tests are transactional and roll back at the end of each test. See the <u>relevant section</u> in the Spring Framework Reference Documentation for more details. If that is not what you want, you can disable transaction management for a test or for the whole class, as follows:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.boot.test.autoconfigure.data.neo4j.DataNeo4jTest;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.transaction.annotation.Propagation;
import org.springframework.transaction.annotation.Transactional;

@RunWith(SpringRunner.class)
@DataNeo4jTest
@Transactional(propagation = Propagation.NOT_SUPPORTED)
public class ExampleNonTransactionalTests {
```

# **Auto-configured Data Redis Tests**

You can use @DataRedisTest to test Redis applications. By default, it scans for @RedisHash classes and configures Spring Data Redis repositories. Regular @Component beans are not loaded into the ApplicationContext. (For more about using Redis with Spring Boot, see "Section 31.1, "Redis", earlier in this chapter.)

#### Tip

A list of the auto-configuration settings that are enabled by @DataRedisTest can be found in the appendix.

The following example shows the @DataRedisTest annotation in use:

```
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.data.redis.DataRedisTest;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@DataRedisTest
public class ExampleDataRedisTests {

@Autowired
private YourRepository repository;

///
}
```

# **Auto-configured Data LDAP Tests**

You can use <code>@DataLdapTest</code> to test LDAP applications. By default, it configures an in-memory embedded LDAP (if available), configures an <code>LdapTemplate</code>, scans for <code>@Entry</code> classes, and configures Spring Data LDAP repositories. Regular <code>@Component</code> beans are not loaded into the <code>ApplicationContext</code>. (For more about using LDAP with Spring Boot, see "Section 31.9, "LDAP", earlier in this chapter.)

#### Tip

A list of the auto-configuration settings that are enabled by @DataLdapTest can be found in the appendix.

The following example shows the @DataLdapTest annotation in use:

```
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.data.ldap.DataLdapTest;
import org.springframework.ldap.core.LdapTemplate;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@DataLdapTest
public class ExampleDataLdapTests {

@Autowired
private LdapTemplate ldapTemplate;
```

```
//
}
```

In-memory embedded LDAP generally works well for tests, since it is fast and does not require any developer installation. If, however, you prefer to run tests against a real LDAP server, you should exclude the embedded LDAP auto-configuration, as shown in the following example:

```
import org.junit.runner.RunWith;
import org.springframework.boot.autoconfigure.ldap.embedded.EmbeddedLdapAutoConfiguration;
import org.springframework.boot.test.autoconfigure.data.ldap.DataLdapTest;
import org.springframework.test.context.junit4.SpringRunner;

@RunWith(SpringRunner.class)
@DataLdapTest(excludeAutoConfiguration = EmbeddedLdapAutoConfiguration.class)
public class ExampleDataLdapNonEmbeddedTests {
}
```

# **Auto-configured REST Clients**

You can use the <code>@RestClientTest</code> annotation to test REST clients. By default, it autoconfigures Jackson, GSON, and Jsonb support, configures a <code>RestTemplateBuilder</code>, and adds support for <code>MockRestServiceServer</code>. Regular <code>@Component</code> beans are not loaded into the <code>ApplicationContext</code>.

#### Tip

A list of the auto-configuration settings that are enabled by @RestClientTest can be found in the appendix.

The specific beans that you want to test should be specified by using the value or components attribute of @RestClientTest, as shown in the following example:

```
@RunWith(SpringRunner.class)
@RestClientTest(RemoteVehicleDetailsService.class)
public class ExampleRestClientTest {

@Autowired
private RemoteVehicleDetailsService service;

@Autowired
private MockRestServiceServer server;

@Test
public void getVehicleDetailsWhenResultIsSuccessShouldReturnDetails()
    throws Exception {
    this.server.expect(requestTo("/greet/details"))
        .andRespond(withSuccess("hello", MediaType.TEXT_PLAIN));
    String greeting = this.service.callRestService();
    assertThat(greeting).isEqualTo("hello");
}
```

# **Auto-configured Spring REST Docs Tests**

You can use the <code>@AutoConfigureRestDocs</code> annotation to use <u>Spring REST Docs</u> in your tests with Mock MVC or REST Assured. It removes the need for the JUnit rule in Spring REST Docs.

@AutoConfigureRestDocs can be used to override the default output directory (target/generated-snippets if you are using Maven or build/generated-snippets if you are using

Gradle). It can also be used to configure the host, scheme, and port that appears in any documented URIs.

## **Auto-configured Spring REST Docs Tests with Mock MVC**

@AutoConfigureRestDocs customizes the MockMvc bean to use Spring REST Docs. You can inject it by using @Autowired and use it in your tests as you normally would when using Mock MVC and Spring REST Docs, as shown in the following example:

```
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.web.servlet.WebMycTest;
import org.springframework.http.MediaType;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.test.web.servlet.MockMvc;
import static org.springframework.restdocs.mockmvc.MockMvcRestDocumentation.document;
import static orq.springframework.test.web.servlet.request.MockMvcRequestBuilders.get;
import static org.springframework.test.web.servlet.result.MockMvcResultMatchers.*;
@RunWith(SpringRunner.class)
@WebMvcTest(UserController.class)
@AutoConfigureRestDocs
public class UserDocumentationTests {
@Autowired
private MockMvc mvc;
public void listUsers() throws Exception {
  this.mvc.perform(get("/users").accept(MediaType.TEXT_PLAIN))
    .andExpect(status().isOk())
    .andDo(document("list-users"));
}
}
```

If you require more control over Spring REST Docs configuration than offered by the attributes of @AutoConfigureRestDocs, you can use a RestDocsMockMvcConfigurationCustomizer bean, as shown in the following example:

```
@TestConfiguration
static class CustomizationConfiguration
  implements RestDocsMockMvcConfigurationCustomizer {

@Override
public void customize(MockMvcRestDocumentationConfigurer configurer) {
  configurer.snippets().withTemplateFormat(TemplateFormats.markdown());
}
```

If you want to make use of Spring REST Docs support for a parameterized output directory, you can create a RestDocumentationResultHandler bean. The auto-configuration calls alwaysDo with this result handler, thereby causing each MockMvc call to automatically generate the default snippets. The following example shows a RestDocumentationResultHandler being defined:

```
@TestConfiguration
static class ResultHandlerConfiguration {

@Bean
public RestDocumentationResultHandler restDocumentation() {
   return MockMvcRestDocumentation.document("{method-name}");
}
```

```
}
}
```

#### **Auto-configured Spring REST Docs Tests with REST Assured**

@AutoConfigureRestDocs makes a RequestSpecification bean, preconfigured to use Spring REST Docs, available to your tests. You can inject it by using @Autowired and use it in your tests as you normally would when using REST Assured and Spring REST Docs, as shown in the following example:

```
import io.restassured.specification.RequestSpecification;
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.restdocs.AutoConfigureRestDocs;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.boot.test.context.SpringBootTest.WebEnvironment;
import org.springframework.boot.web.server.LocalServerPort;
import org.springframework.test.context.junit4.SpringRunner;
import static io.restassured.RestAssured.given;
import static org.hamcrest.CoreMatchers.is;
import static org.springframework.restdocs.restassured3.RestAssuredRestDocumentation.document;
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment = WebEnvironment.RANDOM_PORT)
@AutoConfigureRestDocs
public class UserDocumentationTests {
@LocalServerPort
private int port;
@Autowired
private RequestSpecification documentationSpec;
@Test
public void listUsers() {
 \verb|given(this.documentationSpec).filter(document("list-users")).when()|
    .port(this.port).get("/").then().assertThat().statusCode(is(200));
}
```

If you require more control over Spring REST Docs configuration than offered by the attributes of <code>@AutoConfigureRestDocs</code>, <code>aRestDocsRestAssuredConfigurationCustomizer</code> bean can be used, as shown in the following example:

```
@TestConfiguration
public static class CustomizationConfiguration
  implements RestDocsRestAssuredConfigurationCustomizer {
  @Override
  public void customize(RestAssuredRestDocumentationConfigurer configurer) {
    configurer.snippets().withTemplateFormat(TemplateFormats.markdown());
  }
}
```

# **Additional Auto-configuration and Slicing**

Each slice provides one or more @AutoConfigure... annotations that namely defines the auto-configurations that should be included as part of a slice. Additional auto-configurations can be added by

creating a custom @AutoConfigure... annotation or simply by adding @ImportAutoConfiguration to the test as shown in the following example:

```
@RunWith(SpringRunner.class)
@JdbcTest
@ImportAutoConfiguration(IntegrationAutoConfiguration.class)
public class ExampleJdbcTests {
}
```

#### Note

Make sure to not use the regular @Import annotation to import auto-configurations as they are handled in a specific way by Spring Boot.

# **User Configuration and Slicing**

If you <u>structure your code</u> in a sensible way, your @SpringBootApplication class is <u>used by default</u> as the configuration of your tests.

It then becomes important not to litter the application's main class with configuration settings that are specific to a particular area of its functionality.

Assume that you are using Spring Batch and you rely on the auto-configuration for it. You could define your @SpringBootApplication as follows:

```
@SpringBootApplication
@EnableBatchProcessing
public class SampleApplication { ... }
```

Because this class is the source configuration for the test, any slice test actually tries to start Spring Batch, which is definitely not what you want to do. A recommended approach is to move that areaspecific configuration to a separate @Configuration class at the same level as your application, as shown in the following example:

```
@Configuration
@EnableBatchProcessing
public class BatchConfiguration { ... }
```

#### Note

Depending on the complexity of your application, you may either have a single @Configuration class for your customizations or one class per domain area. The latter approach lets you enable it in one of your tests, if necessary, with the @Import annotation.

Another source of confusion is classpath scanning. Assume that, while you structured your code in a sensible way, you need to scan an additional package. Your application may resemble the following code:

```
@SpringBootApplication
@ComponentScan({ "com.example.app", "org.acme.another" })
public class SampleApplication { ... }
```

Doing so effectively overrides the default component scan directive with the side effect of scanning those two packages regardless of the slice that you chose. For instance, a @DataJpaTest seems to suddenly

scan components and user configurations of your application. Again, moving the custom directive to a separate class is a good way to fix this issue.

#### Tip

If this is not an option for you, you can create a @SpringBootConfiguration somewhere in the hierarchy of your test so that it is used instead. Alternatively, you can specify a source for your test, which disables the behavior of finding a default one.

# **Using Spock to Test Spring Boot Applications**

If you wish to use Spock to test a Spring Boot application, you should add a dependency on Spock's spock-spring module to your application's build. spock-spring integrates Spring's test framework into Spock. It is recommended that you use Spock 1.1 or later to benefit from a number of improvements to Spock's Spring Framework and Spring Boot integration. See the documentation for Spock's Spring module for further details.

# 45.4 Test Utilities

A few test utility classes that are generally useful when testing your application are packaged as part of spring-boot.

# ConfigFileApplicationContextInitializer

ConfigFileApplicationContextInitializer is an ApplicationContextInitializer that you can apply to your tests to load Spring Boot application.properties files. You can use it when you do not need the full set of features provided by @SpringBootTest, as shown in the following example:

```
@ContextConfiguration(classes = Config.class,
initializers = ConfigFileApplicationContextInitializer.class)
```

#### Note

Using <code>ConfigFileApplicationContextInitializer</code> alone does not provide support for <code>@Value("\${...}")</code> injection. Its only job is to ensure that application.properties files are loaded into Spring's <code>Environment</code>. For <code>@Value</code> support, you need to either additionally configure a <code>PropertySourcesPlaceholderConfigurer</code> or use <code>@SpringBootTest</code>, which auto-configures one for you.

# **TestPropertyValues**

TestPropertyValues lets you quickly add properties to a ConfigurableEnvironment or ConfigurableApplicationContext. You can call it with key=value strings, as follows:

```
TestPropertyValues.of("org=Spring", "name=Boot").applyTo(env);
```

## **OutputCapture**

OutputCapture is a JUnit Rule that you can use to capture System.out and System.err output. You can declare the capture as a @Rule and then use toString() for assertions, as follows:

```
import org.junit.Rule;
```

```
import org.junit.Test;
import org.springframework.boot.test.rule.OutputCapture;

import static org.hamcrest.Matchers.*;
import static org.junit.Assert.*;

public class MyTest {

@Rule
   public OutputCapture capture = new OutputCapture();

@Test
   public void testName() throws Exception {
        System.out.println("Hello World!");
        assertThat(capture.toString(), containsString("World"));
   }
}
```

# **TestRestTemplate**

#### Tip

Spring Framework 5.0 provides a new WebTestClient that works for WebFlux integration tests and both WebFlux and MVC end-to-end testing. It provides a fluent API for assertions, unlike TestRestTemplate.

TestRestTemplate is a convenience alternative to Spring's RestTemplate that is useful in integration tests. You can get a vanilla template or one that sends Basic HTTP authentication (with a username and password). In either case, the template behaves in a test-friendly way by not throwing exceptions on server-side errors. It is recommended, but not mandatory, to use the Apache HTTP Client (version 4.3.2 or better). If you have that on your classpath, the TestRestTemplate responds by configuring the client appropriately. If you do use Apache's HTTP client, some additional test-friendly features are enabled:

- Redirects are not followed (so you can assert the response location).
- Cookies are ignored (so the template is stateless).

TestRestTemplate can be instantiated directly in your integration tests, as shown in the following example:

```
public class MyTest {

private TestRestTemplate template = new TestRestTemplate();

@Test
public void testRequest() throws Exception {

HttpHeaders headers = this.template.getForEntity(
    "http://myhost.example.com/example", String.class).getHeaders();
    assertThat(headers.getLocation()).hasHost("other.example.com");
}
```

Alternatively, if you use the @SpringBootTest annotation with WebEnvironment.RANDOM\_PORT or WebEnvironment.DEFINED\_PORT, you can inject a fully configured TestRestTemplate and start using it. If necessary, additional customizations can be applied through the RestTemplateBuilder bean. Any URLs that do not specify a host and port automatically connect to the embedded server, as shown in the following example:

```
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment = WebEnvironment.RANDOM_PORT)
public class SampleWebClientTests {
@Autowired
private TestRestTemplate template;
@Test
public void testRequest() {
 HttpHeaders headers = this.template.getForEntity("/example", String.class)
   .getHeaders();
 assertThat(headers.getLocation()).hasHost("other.example.com");
@TestConfiguration
static class Config {
 public RestTemplateBuilder restTemplateBuilder() {
  return new RestTemplateBuilder().setConnectTimeout(Duration.ofSeconds(1))
    .setReadTimeout(Duration.ofSeconds(1));
 }
```

# 46. WebSockets

Spring Boot provides WebSockets auto-configuration for embedded Tomcat, Jetty, and Undertow. If you deploy a war file to a standalone container, Spring Boot assumes that the container is responsible for the configuration of its WebSocket support.

Spring Framework provides <u>rich WebSocket support</u> for MVC web applications that can be easily accessed through the <code>spring-boot-starter-websocket module</code>.

WebSocket support is also available for <u>reactive web applications</u> and requires to include the WebSocket API alongside <code>spring-boot-starter-webflux</code>:

```
<dependency>
<groupId>javax.websocket</groupId>
<artifactId>javax.websocket-api</artifactId>
</dependency>
```

# 47. Web Services

Spring Boot provides Web Services auto-configuration so that all you must do is define your Endpoints.

The <u>Spring Web Services features</u> can be easily accessed with the spring-boot-starter-webservices module.

SimpleWsdl11Definition and SimpleXsdSchema beans can be automatically created for your WSDLs and XSDs respectively. To do so, configure their location, as shown in the following example:

spring.webservices.wsdl-locations=classpath:/wsdl

# 48. Calling Web Services with

# WebServiceTemplate

If you need to call remote Web services from your application, you can use the <u>WebServiceTemplate</u> class. Since WebServiceTemplate instances often need to be customized before being used, Spring Boot does not provide any single auto-configured WebServiceTemplate bean. It does, however, auto-configure a WebServiceTemplateBuilder, which can be used to create WebServiceTemplate instances when needed.

The following code shows a typical example:

```
@Service
public class MyService {

private final WebServiceTemplate webServiceTemplate;

public MyService(WebServiceTemplateBuilder webServiceTemplateBuilder) {
    this.webServiceTemplate = webServiceTemplateBuilder.build();
    }

public DetailsResp someWsCall(DetailsReq detailsReq) {
    return (DetailsResp) this.webServiceTemplate.marshalSendAndReceive(detailsReq, new SoapActionCallback(ACTION));
}
```

By default, WebServiceTemplateBuilder detects a suitable HTTP-based WebServiceMessageSender using the available HTTP client libraries on the classpath. You can also customize read and connection timeouts as follows:

```
@Bean
public WebServiceTemplate webServiceTemplate(WebServiceTemplateBuilder builder) {
  return builder.messageSenders(new HttpWebServiceMessageSenderBuilder()
    .setConnectTimeout(5000).setReadTimeout(2000).build()).build();
}
```

# 49. Creating Your Own Auto-configuration

If you work in a company that develops shared libraries, or if you work on an open-source or commercial library, you might want to develop your own auto-configuration. Auto-configuration classes can be bundled in external jars and still be picked-up by Spring Boot.

Auto-configuration can be associated to a "starter" that provides the auto-configuration code as well as the typical libraries that you would use with it. We first cover what you need to know to build your own auto-configuration and then we move on to the <u>typical steps required to create a custom starter</u>.

#### Tip

A <u>demo project</u> is available to showcase how you can create a starter step-by-step.

# 49.1 Understanding Auto-configured Beans

Under the hood, auto-configuration is implemented with standard @Configuration classes. Additional @Conditional annotations are used to constrain when the auto-configuration should apply. Usually, auto-configuration classes use @ConditionalOnClass and @ConditionalOnMissingBean annotations. This ensures that auto-configuration applies only when relevant classes are found and when you have not declared your own @Configuration.

You can browse the source code of <a href="mailto:spring-boot-autoconfigure">spring-boot-autoconfigure</a> to see the @Configuration classes that Spring provides (see the <a href="mailto:mETA-INF/spring.factories">META-INF/spring.factories</a> file).

# **49.2 Locating Auto-configuration Candidates**

Spring Boot checks for the presence of a META-INF/spring.factories file within your published jar. The file should list your configuration classes under the EnableAutoConfiguration key, as shown in the following example:

```
org.springframework.boot.autoconfigure.EnableAutoConfiguration=\
com.mycorp.libx.autoconfigure.LibXAutoConfiguration,\
com.mycorp.libx.autoconfigure.LibXWebAutoConfiguration
```

You can use the <u>@AutoConfigureAfter</u> or <u>@AutoConfigureBefore</u> annotations if your configuration needs to be applied in a specific order. For example, if you provide web-specific configuration, your class may need to be applied after WebMvcAutoConfiguration.

If you want to order certain auto-configurations that should not have any direct knowledge of each other, you can also use <code>@AutoConfigureOrder</code>. That annotation has the same semantic as the regular <code>@Order</code> annotation but provides a dedicated order for auto-configuration classes.

#### Note

Auto-configurations must be loaded that way *only*. Make sure that they are defined in a specific package space and that, in particular, they are never the target of component scanning.

## 49.3 Condition Annotations

You almost always want to include one or more @Conditional annotations on your auto-configuration class. The @ConditionalOnMissingBean annotation is one common example that is used to allow developers to override auto-configuration if they are not happy with your defaults.

Spring Boot includes a number of @Conditional annotations that you can reuse in your own code by annotating @Configuration classes or individual @Bean methods. These annotations include:

- the section called "Class Conditions"
- the section called "Bean Conditions"
- the section called "Property Conditions"
- · the section called "Resource Conditions"
- the section called "Web Application Conditions"
- the section called "SpEL Expression Conditions"

#### **Class Conditions**

The @ConditionalOnClass and @ConditionalOnMissingClass annotations let configuration be included based on the presence or absence of specific classes. Due to the fact that annotation metadata is parsed by using <u>ASM</u>, you can use the value attribute to refer to the real class, even though that class might not actually appear on the running application classpath. You can also use the name attribute if you prefer to specify the class name by using a String value.

#### Tip

If you use <code>@ConditionalOnClass</code> or <code>@ConditionalOnMissingClass</code> as a part of a meta-annotation to compose your own composed annotations, you must use <code>name</code> as referring to the class in such a case is not handled.

#### **Bean Conditions**

The @ConditionalOnBean and @ConditionalOnMissingBean annotations let a bean be included based on the presence or absence of specific beans. You can use the value attribute to specify beans by type or name to specify beans by name. The search attribute lets you limit the ApplicationContext hierarchy that should be considered when searching for beans.

When placed on a @Bean method, the target type defaults to the return type of the method, as shown in the following example:

```
@Configuration
public class MyAutoConfiguration {

    @Bean
    @ConditionalOnMissingBean
    public MyService myService() { ... }
}
```

In the preceding example, the myService bean is going to be created if no bean of type MyService is already contained in the ApplicationContext.

## Tip

You need to be very careful about the order in which bean definitions are added, as these conditions are evaluated based on what has been processed so far. For this reason,

we recommend using only @ConditionalOnBean and @ConditionalOnMissingBean annotations on auto-configuration classes (since these are guaranteed to load after any user-defined bean definitions have been added).

#### **Note**

@ConditionalOnBean and @ConditionalOnMissingBean do not prevent @Configuration classes from being created. The only difference between using these conditions at the class level and marking each contained @Bean method with the annotation is that the former prevents registration of the @Configuration class as a bean if the condition does not match.

# **Property Conditions**

The <code>@ConditionalOnProperty</code> annotation lets configuration be included based on a Spring Environment property. Use the <code>prefix</code> and <code>name</code> attributes to specify the property that should be checked. By default, any property that exists and is not equal to <code>false</code> is matched. You can also create more advanced checks by using the <code>havingValue</code> and <code>matchlfMissing</code> attributes.

## **Resource Conditions**

The @ConditionalOnResource annotation lets configuration be included only when a specific resource is present. Resources can be specified by using the usual Spring conventions, as shown in the following example: file:/home/user/test.dat.

# **Web Application Conditions**

The @ConditionalOnWebApplication and @ConditionalOnNotWebApplication annotations let configuration be included depending on whether the application is a "web application". A web application is any application that uses a Spring WebApplicationContext, defines a session scope, or has a StandardServletEnvironment.

## **SpEL Expression Conditions**

The @ConditionalOnExpression annotation lets configuration be included based on the result of a <u>SpEL expression</u>.

# 49.4 Testing your Auto-configuration

An auto-configuration can be affected by many factors: user configuration (@Bean definition and Environment customization), condition evaluation (presence of a particular library), and others. Concretely, each test should create a well defined ApplicationContext that represents a combination of those customizations. ApplicationContextRunner provides a great way to achieve that.

ApplicationContextRunner is usually defined as a field of the test class to gather the base, common configuration. The following example makes sure that UserServiceAutoConfiguration is always invoked:

```
private final ApplicationContextRunner contextRunner = new ApplicationContextRunner()
.withConfiguration(AutoConfigurations.of(UserServiceAutoConfiguration.class));
```

#### Tip

If multiple auto-configurations have to be defined, there is no need to order their declarations as they are invoked in the exact same order as when running the application.

Each test can use the runner to represent a particular use case. For instance, the sample below invokes a user configuration (UserConfiguration) and checks that the auto-configuration backs off properly. Invoking run provides a callback context that can be used with Assert4J.

It is also possible to easily customize the Environment, as shown in the following example:

```
@Test
public void serviceNameCanBeConfigured() {
    this.contextRunner.withPropertyValues("user.name=test123").run((context) -> {
        assertThat(context).hasSingleBean(UserService.class);
        assertThat(context.getBean(UserService.class).getName()).isEqualTo("test123");
    });
}
```

The runner can also be used to display the <code>ConditionEvaluationReport</code>. The report can be printed at <code>INFO</code> or <code>DEBUG</code> level. The following example shows how to use the <code>ConditionEvaluationReportLoggingListener</code> to print the report in auto-configuration tests.

```
@Test
public void autoConfigTest {
  ConditionEvaluationReportLoggingListener initializer = new ConditionEvaluationReportLoggingListener(
    LogLevel.INFO);
  ApplicationContextRunner contextRunner = new ApplicationContextRunner()
    .withInitializer(initializer).run((context) -> {
        // Do something...
    });
}
```

## Simulating a Web Context

auto-configuration lf you need to test that only operates in Servlet Reactive web application context, use the WebApplicationContextRunner ReactiveWebApplicationContextRunner respectively.

# **Overriding the Classpath**

It is also possible to test what happens when a particular class and/or package is not present at runtime. Spring Boot ships with a FilteredClassLoader that can easily be used by the runner. In the following example, we assert that if UserService is not present, the auto-configuration is properly disabled:

```
@Test
public void serviceIsIgnoredIfLibraryIsNotPresent() {
   this.contextRunner.withClassLoader(new FilteredClassLoader(UserService.class))
    .run((context) -> assertThat(context).doesNotHaveBean("userService"));
}
```

# 49.5 Creating Your Own Starter

A full Spring Boot starter for a library may contain the following components:

- The autoconfigure module that contains the auto-configuration code.
- The starter module that provides a dependency to the autoconfigure module as well as the library and any additional dependencies that are typically useful. In a nutshell, adding the starter should provide everything needed to start using that library.

#### Tip

You may combine the auto-configuration code and the dependency management in a single module if you do not need to separate those two concerns.

# **Naming**

You should make sure to provide a proper namespace for your starter. Do not start your module names with <code>spring-boot</code>, even if you use a different Maven <code>groupId</code>. We may offer official support for the thing you auto-configure in the future.

As a rule of thumb, you should name a combined module after the starter. For example, assume that you are creating a starter for "acme" and that you name the auto-configure module acme-spring-boot-autoconfigure and the starter acme-spring-boot-starter. If you only have one module that combines the two, name it acme-spring-boot-starter.

Also, if your starter provides configuration keys, use a unique namespace for them. In particular, do not include your keys in the namespaces that Spring Boot uses (such as server, management, spring, and so on). If you use the same namespace, we may modify these namespaces in the future in ways that break your modules.

Make sure to <u>trigger meta-data generation</u> so that IDE assistance is available for your keys as well. You may want to review the generated meta-data (META-INF/spring-configuration-metadata.json) to make sure your keys are properly documented.

#### autoconfigure Module

The autoconfigure module contains everything that is necessary to get started with the library. It may also contain configuration key definitions (such as @ConfigurationProperties) and any callback interface that can be used to further customize how the components are initialized.

#### Tip

You should mark the dependencies to the library as optional so that you can include the autoconfigure module in your projects more easily. If you do it that way, the library is not provided and, by default, Spring Boot backs off.

Spring Boot uses an annotation processor to collect the conditions on auto-configurations in a metadata file (META-INF/spring-autoconfigure-metadata.properties). If that file is present, it is used to eagerly filter auto-configurations that do not match, which will improve startup time. It is recommended to add the following dependency in a module that contains auto-configurations:

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-autoconfigure-processor</artifactId>
  <optional>true</optional>
  </dependency>
```

With Gradle 4.5 and earlier, the dependency should be declared in the compileOnly configuration, as shown in the following example:

```
dependencies {
  compileOnly "org.springframework.boot:spring-boot-autoconfigure-processor"
}
```

With Gradle 4.6 and later, the dependency should be declared in the annotationProcessor configuration, as shown in the following example:

```
dependencies {
  annotationProcessor "org.springframework.boot:spring-boot-autoconfigure-processor"
}
```

#### **Starter Module**

The starter is really an empty jar. Its only purpose is to provide the necessary dependencies to work with the library. You can think of it as an opinionated view of what is required to get started.

Do not make assumptions about the project in which your starter is added. If the library you are autoconfiguring typically requires other starters, mention them as well. Providing a proper set of *default* dependencies may be hard if the number of optional dependencies is high, as you should avoid including dependencies that are unnecessary for a typical usage of the library. In other words, you should not include optional dependencies.

#### Note

Either way, your starter must reference the core Spring Boot starter (spring-boot-starter) directly or indirectly (i.e. no need to add it if your starter relies on another starter). If a project is created with only your custom starter, Spring Boot's core features will be honoured by the presence of the core starter.

# 50. Kotlin support

<u>Kotlin</u> is a statically-typed language targeting the JVM (and other platforms) which allows writing concise and elegant code while providing <u>interoperability</u> with existing libraries written in Java.

Spring Boot provides Kotlin support by leveraging the support in other Spring projects such as Spring Framework, Spring Data, and Reactor. See the <u>Spring Framework Kotlin support documentation</u> for more information.

The easiest way to start with Spring Boot and Kotlin is to follow this comprehensive tutorial. You can create new Kotlin projects via <u>start.spring.io</u>. Feel free to join the #spring channel of <u>Kotlin Slack</u> or ask a question with the <u>spring</u> and <u>kotlin</u> tags on <u>Stack Overflow</u> if you need support.

# 50.1 Requirements

Spring Boot supports Kotlin 1.2.x. To use Kotlin, org.jetbrains.kotlin:kotlin-stdlib and org.jetbrains.kotlin:kotlin-reflect must be present on the classpath. The kotlin-stdlib variants kotlin-stdlib-jdk7 and kotlin-stdlib-jdk8 can also be used.

Since Kotlin classes are final by default, you are likely to want to configure kotlin-spring plugin in order to automatically open Spring-annotated classes so that they can be proxied.

<u>Jackson's Kotlin module</u> is required for serializing / deserializing JSON data in Kotlin. It is automatically registered when found on the classpath. A warning message is logged if Jackson and Kotlin are present but the Jackson Kotlin module is not.

## Tip

These dependencies and plugins are provided by default if one bootstraps a Kotlin project on <u>start.spring.io</u>.

# 50.2 Null-safety

One of Kotlin's key features is <u>null-safety</u>. It deals with <u>null values</u> at compile time rather than deferring the problem to runtime and encountering a <u>NullPointerException</u>. This helps to eliminate a common source of bugs without paying the cost of wrappers like <u>Optional</u>. Kotlin also allows using functional constructs with nullable values as described in this <u>comprehensive guide to null-safety in Kotlin</u>.

Although Java does not allow one to express null-safety in its type system, Spring Framework, Spring Data, and Reactor now provide null-safety of their API via tooling-friendly annotations. By default, types from Java APIs used in Kotlin are recognized as <u>platform types</u> for which null-checks are relaxed. <u>Kotlin's support for JSR 305 annotations</u> combined with nullability annotations provide null-safety for the related Spring API in Kotlin.

The JSR 305 checks can be configured by adding the -xjsr305 compiler flag with the following options:  $-xjsr305 = \{strict | warn | ignore \}$ . The default behavior is the same as -xjsr305 = warn. The strict value is required to have null-safety taken in account in Kotlin types inferred from Spring API but should be used with the knowledge that Spring API nullability declaration could evolve even between minor releases and more checks may be added in the future).

#### Warning

Generic type arguments, varargs and array elements nullability are not yet supported. See <u>SPR-15942</u> for up-to-date information. Also be aware that Spring Boot's own API is <u>not yet</u> annotated.

# 50.3 Kotlin API

# runApplication

Spring Boot provides an idiomatic way to run an application with runApplication
runApplication</pr>
(\*args) as shown in the following example:

```
import org.springframework.boot.autoconfigure.SpringBootApplication
import org.springframework.boot.runApplication

@SpringBootApplication
class MyApplication

fun main(args: Array<String>) {
   runApplication

runApplication

runApplication

runApplication

runApplication

runApplication

fun main(args: Array<String>) {
   runApplication

runApplication

main(args: Array<String>) {
   runApplication

runApplication

main(args: Array<String>) {
   runApplication

runApplication

runApplication

runApplication

main(args: Array<String>) {
   runApplication

runApplication

fun main(args: Array<String>) {
   runApplication

runApplication

main(args: Array<String>) {
   runApp
```

This is a drop-in replacement for SpringApplication.run(MyApplication::class.java, \*args). It also allows customization of the application as shown in the following example:

```
runApplication<MyApplication>(*args) {
  setBannerMode(OFF)
}
```

#### **Extensions**

Kotlin <u>extensions</u> provide the ability to extend existing classes with additional functionality. The Spring Boot Kotlin API makes use of these extensions to add new Kotlin specific conveniences to existing APIs.

TestRestTemplate extensions, similar to those provided by Spring Framework for RestOperations in Spring Framework, are provided. Among other things, the extensions make it possible to take advantage of Kotlin reified type parameters.

# 50.4 Dependency management

In order to avoid mixing different version of Kotlin dependencies on the classpath, dependency management of the following Kotlin dependencies is provided:

- kotlin-reflect
- kotlin-runtime
- kotlin-stdlib
- kotlin-stdlib-jdk7
- kotlin-stdlib-jdk8
- kotlin-stdlib-jre7
- kotlin-stdlib-jre8

With Maven, the Kotlin version can be customized via the kotlin.version property and plugin management is provided for kotlin-maven-plugin. With Gradle, the Spring Boot plugin automatically aligns the kotlin.version with the version of the Kotlin plugin.

# 50.5 @ConfigurationProperties

@ConfigurationProperties currently only works with lateinit or nullable var properties (the former is recommended), since immutable classes initialized by constructors are <u>not yet supported</u>.

```
@ConfigurationProperties("example.kotlin")
class KotlinExampleProperties {

lateinit var name: String

lateinit var description: String

val myService = MyService()

class MyService {

lateinit var apiToken: String

lateinit var uri: URI

}
```

#### Tip

To generate <u>your own metadata</u> using the annotation processor, <u>kapt should be configured</u> with the spring-boot-configuration-processor dependency.

# 50.6 Testing

While it is possible to use JUnit 4 (the default provided by spring-boot-starter-test) to test Kotlin code, JUnit 5 is recommended. JUnit 5 enables a test class to be instantiated once and reused for all of the class's tests. This makes it possible to use <code>@BeforeAll</code> and <code>@AfterAll</code> annotations on non-static methods, which is a good fit for Kotlin.

To use JUnit 5, exclude junit: junit dependency from spring-boot-starter-test, add JUnit 5 dependencies, and configure the Maven or Gradle plugin accordingly. See the <u>JUnit 5 documentation</u> for more details. You also need to <u>switch test instance lifecycle to "per-class"</u>.

# 50.7 Resources

#### **Further reading**

- Kotlin language reference
- Kotlin Slack (with a dedicated #spring channel)
- Stackoverflow with spring and kotlin tags
- Try Kotlin in your browser
- Kotlin blog

- Awesome Kotlin
- Tutorial: building web applications with Spring Boot and Kotlin
- Developing Spring Boot applications with Kotlin
- A Geospatial Messenger with Kotlin, Spring Boot and PostgreSQL
- Introducing Kotlin support in Spring Framework 5.0
- Spring Framework 5 Kotlin APIs, the functional way

# **Examples**

- spring-boot-kotlin-demo: regular Spring Boot + Spring Data JPA project
- mixit: Spring Boot 2 + WebFlux + Reactive Spring Data MongoDB
- <u>spring-kotlin-fullstack</u>: WebFlux Kotlin fullstack example with Kotlin2js for frontend instead of JavaScript or TypeScript
- spring-petclinic-kotlin: Kotlin version of the Spring PetClinic Sample Application
- spring-kotlin-deepdive: a step by step migration for Boot 1.0 + Java to Boot 2.0 + Kotlin

# 51. What to Read Next

If you want to learn more about any of the classes discussed in this section, you can check out the <u>Spring</u> <u>Boot API documentation</u> or you can browse the <u>source code directly</u>. If you have specific questions, take a look at the <u>how-to</u> section.

If you are comfortable with Spring Boot's core features, you can continue on and read about <u>production-ready features</u>.

# Part V. Spring Boot Actuator: Production-ready features

Spring Boot includes a number of additional features to help you monitor and manage your application when you push it to production. You can choose to manage and monitor your application by using HTTP endpoints or with JMX. Auditing, health, and metrics gathering can also be automatically applied to your application.

# 52. Enabling Production-ready Features

The <u>spring-boot-actuator</u> module provides all of Spring Boot's production-ready features. The simplest way to enable the features is to add a dependency to the <u>spring-boot-starter-actuator</u> 'Starter'.

#### **Definition of Actuator**

An actuator is a manufacturing term that refers to a mechanical device for moving or controlling something. Actuators can generate a large amount of motion from a small change.

To add the actuator to a Maven based project, add the following 'Starter' dependency:

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

For Gradle, use the following declaration:

```
dependencies {
  compile("org.springframework.boot:spring-boot-starter-actuator")
}
```

# 53. Endpoints

Actuator endpoints let you monitor and interact with your application. Spring Boot includes a number of built-in endpoints and lets you add your own. For example, the health endpoint provides basic application health information.

Each individual endpoint can be <u>enabled or disabled</u>. This controls whether or not the endpoint is created and its bean exists in the application context. To be remotely accessible an endpoint also has to be <u>exposed via JMX or HTTP</u>. Most applications choose HTTP, where the ID of the endpoint along with a prefix of /actuator is mapped to a URL. For example, by default, the health endpoint is mapped to /actuator/health.

The following technology-agnostic endpoints are available:

ID	Description	Enabled by default
auditevents	Exposes audit events information for the current application.	Yes
beans	Displays a complete list of all the Spring beans in your application.	Yes
caches	Exposes available caches.	Yes
conditions	Shows the conditions that were evaluated on configuration and auto-configuration classes and the reasons why they did or did not match.	Yes
configprops	Displays a collated list of all @ConfigurationProperties.	Yes
env	Exposes properties from Spring's ConfigurableEnvironment.	Yes
flyway	Shows any Flyway database migrations that have been applied.	Yes
health	Shows application health information.	Yes
httptrace	Displays HTTP trace information (by default, the last 100 HTTP request-response exchanges).	Yes
info	Displays arbitrary application info.	Yes
integrationgraph	Shows the Spring Integration graph.	Yes
loggers	Shows and modifies the configuration of loggers in the application.	Yes
liquibase	Shows any Liquibase database migrations that have been applied.	Yes
metrics	Shows 'metrics' information for the current application.	Yes
mappings	Displays a collated list of all @RequestMapping paths.	Yes

ID	Description	Enabled by default
scheduledtasks	Displays the scheduled tasks in your application.	Yes
sessions	Allows retrieval and deletion of user sessions from a Spring Session-backed session store. Not available when using Spring Session's support for reactive web applications.	Yes
shutdown	Lets the application be gracefully shutdown.	No
threaddump	Performs a thread dump.	Yes

If your application is a web application (Spring MVC, Spring WebFlux, or Jersey), you can use the following additional endpoints:

ID	Description	Enabled by default
heapdump	Returns a GZip compressed hprof heap dump file.	Yes
jolokia	Exposes JMX beans over HTTP (when Jolokia is on the classpath, not available for WebFlux).	Yes
logfile	Returns the contents of the logfile (if logging.file or logging.path properties have been set).  Supports the use of the HTTP Range header to retrieve part of the log file's content.	Yes
prometheus	Exposes metrics in a format that can be scraped by a Prometheus server.	Yes

To learn more about the Actuator's endpoints and their request and response formats, please refer to the separate API documentation (<u>HTML</u> or <u>PDF</u>).

# 53.1 Enabling Endpoints

By default, all endpoints except for <code>shutdown</code> are enabled. To configure the enablement of an endpoint, use its <code>management.endpoint.<id>.enabled</code> property. The following example enables the <code>shutdown</code> endpoint:

```
management.endpoint.shutdown.enabled=true
```

If you prefer endpoint enablement to be opt-in rather than opt-out, set the management.endpoints.enabled-by-default property to false and use individual endpoint enabled properties to opt back in. The following example enables the info endpoint and disables all other endpoints:

```
management.endpoints.enabled-by-default=false
management.endpoint.info.enabled=true
```

#### Note

Disabled endpoints are removed entirely from the application context. If you want to change only the technologies over which an endpoint is exposed, use the <u>include and exclude properties</u> instead.

# **53.2 Exposing Endpoints**

Since Endpoints may contain sensitive information, careful consideration should be given about when to expose them. The following table shows the default exposure for the built-in endpoints:

ID	JMX	Web
auditevents	Yes	No
beans	Yes	No
caches	Yes	No
conditions	Yes	No
configprops	Yes	No
env	Yes	No
flyway	Yes	No
health	Yes	Yes
heapdump	N/A	No
httptrace	Yes	No
info	Yes	Yes
integrationgraph	Yes	No
jolokia	N/A	No
logfile	N/A	No
loggers	Yes	No
liquibase	Yes	No
metrics	Yes	No
mappings	Yes	No
prometheus	N/A	No
scheduledtasks	Yes	No
sessions	Yes	No
shutdown	Yes	No
threaddump	Yes	No

To change which endpoints are exposed, use the following technology-specific include and exclude properties:

Property	Default
management.endpoints.jmx.exposure.exclude	
management.endpoints.jmx.exposure.include	*

Property	Default
management.endpoints.web.exposure.exclude	
management.endpoints.web.exposure.include	info, health

The include property lists the IDs of the endpoints that are exposed. The exclude property lists the IDs of the endpoints that should not be exposed. The exclude property takes precedence over the include property. Both include and exclude properties can be configured with a list of endpoint IDs.

For example, to stop exposing all endpoints over JMX and only expose the health and info endpoints, use the following property:

```
management.endpoints.jmx.exposure.include=health,info
```

\* can be used to select all endpoints. For example, to expose everything over HTTP except the env and beans endpoints, use the following properties:

```
management.endpoints.web.exposure.include=*
management.endpoints.web.exposure.exclude=env,beans
```

#### Note

\* has a special meaning in YAML, so be sure to add quotes if you want to include (or exclude) all endpoints, as shown in the following example:

```
management:
  endpoints:
  web:
    exposure:
    include: "*"
```

### Note

If your application is exposed publicly, we strongly recommend that you also <u>secure your endpoints</u>.

### Tip

If you want to implement your own strategy for when endpoints are exposed, you can register an <code>EndpointFilter</code> bean.

# **53.3 Securing HTTP Endpoints**

You should take care to secure HTTP endpoints in the same way that you would any other sensitive URL. If Spring Security is present, endpoints are secured by default using Spring Security's content-negotiation strategy. If you wish to configure custom security for HTTP endpoints, for example, only allow users with a certain role to access them, Spring Boot provides some convenient RequestMatcher objects that can be used in combination with Spring Security.

A typical Spring Security configuration might look something like the following example:

```
@Configuration
public class ActuatorSecurity extends WebSecurityConfigurerAdapter {
    @Override
    protected void configure(HttpSecurity http) throws Exception {
```

```
http.requestMatcher(EndpointRequest.toAnyEndpoint()).authorizeRequests()
    .anyRequest().hasRole("ENDPOINT_ADMIN")
    .and()
    .httpBasic();
}
```

The preceding example uses <code>EndpointRequest.toAnyEndpoint()</code> to match a request to any endpoint and then ensures that all have the <code>ENDPOINT\_ADMIN</code> role. Several other matcher methods are also available on <code>EndpointRequest</code>. See the API documentation (<a href="https://example.com/html/html">HTML</a> or <a href="https://example.com/html">PDF</a>) for details.

If you deploy applications behind a firewall, you may prefer that all your actuator endpoints can be accessed without requiring authentication. You can do so by changing the management.endpoints.web.exposure.include property, as follows:

### application.properties.

```
management.endpoints.web.exposure.include=*
```

Additionally, if Spring Security is present, you would need to add custom security configuration that allows unauthenticated access to the endpoints as shown in the following example:

```
@Configuration
public class ActuatorSecurity extends WebSecurityConfigurerAdapter {

@Override
protected void configure(HttpSecurity http) throws Exception {
  http.requestMatcher(EndpointRequest.toAnyEndpoint()).authorizeRequests()
  .anyRequest().permitAll();
}
```

# 53.4 Configuring Endpoints

Endpoints automatically cache responses to read operations that do not take any parameters. To configure the amount of time for which an endpoint will cache a response, use its cache.time-to-live property. The following example sets the time-to-live of the beans endpoint's cache to 10 seconds:

### application.properties.

```
management.endpoint.beans.cache.time-to-live=10s
```

### Note

The prefix management.endpoint.<name> is used to uniquely identify the endpoint that is being configured.

### Note

When making an authenticated HTTP request, the Principal is considered as input to the endpoint and, therefore, the response will not be cached.

# 53.5 Hypermedia for Actuator Web Endpoints

A "discovery page" is added with links to all the endpoints. The "discovery page" is available on / actuator by default.

When a custom management context path is configured, the "discovery page" automatically moves from /actuator to the root of the management context. For example, if the management context path is / management, then the discovery page is available from /management. When the management context path is set to /, the discovery page is disabled to prevent the possibility of a clash with other mappings.

## **53.6 CORS Support**

<u>Cross-origin resource sharing</u> (CORS) is a <u>W3C specification</u> that lets you specify in a flexible way what kind of cross-domain requests are authorized. If you use Spring MVC or Spring WebFlux, Actuator's web endpoints can be configured to support such scenarios.

CORS support is disabled by default and is only enabled once the management.endpoints.web.cors.allowed-origins property has been set. The following configuration permits GET and POST calls from the example.com domain:

```
management.endpoints.web.cors.allowed-origins=http://example.com
management.endpoints.web.cors.allowed-methods=GET,POST
```

### Tip

See <u>CorsEndpointProperties</u> for a complete list of options.

# **53.7 Implementing Custom Endpoints**

If you add a <code>@Bean</code> annotated with <code>@Endpoint</code>, any methods annotated with <code>@ReadOperation</code>, <code>@WriteOperation</code>, or <code>@DeleteOperation</code> are automatically exposed over JMX and, in a web application, over HTTP as well. Endpoints can be exposed over HTTP using Jersey, Spring MVC, or Spring WebFlux.

You can also write technology-specific endpoints by using @JmxEndpoint or @WebEndpoint. These endpoints are restricted to their respective technologies. For example, @WebEndpoint is exposed only over HTTP and not over JMX.

You can write technology-specific extensions by using <code>@EndpointWebExtension</code> and <code>@EndpointJmxExtension</code>. These annotations let you provide technology-specific operations to augment an existing endpoint.

Finally, if you need access to web-framework-specific functionality, you can implement Servlet or Spring @Controller and @RestController endpoints at the cost of them not being available over JMX or when using a different web framework.

## **Receiving Input**

Operations on an endpoint receive input via their parameters. When exposed via the web, the values for these parameters are taken from the URL's query parameters and from the JSON request body. When exposed via JMX, the parameters are mapped to the parameters of the MBean's operations. Parameters are required by default. They can be made optional by annotating them with @org.springframework.lang.Nullable.

Each root property in the JSON request body can be mapped to a parameter of the endpoint. Consider the following JSON request body:

```
{
    "name": "test",
    "counter": 42
}
```

This can be used to invoke a write operation that takes String name and int counter parameters.

### Tip

Because endpoints are technology agnostic, only simple types can be specified in the method signature. In particular declaring a single parameter with a custom type defining a name and counter properties is not supported.

#### **Note**

To allow the input to be mapped to the operation method's parameters, Java code implementing an endpoint should be compiled with -parameters, and Kotlin code implementing an endpoint should be compiled with -java-parameters. This will happen automatically if you are using Spring Boot's Gradle plugin or if you are using Maven and spring-boot-starter-parent.

### Input type conversion

The parameters passed to endpoint operation methods are, if necessary, automatically converted to the required type. Before calling an operation method, the input received via JMX or an HTTP request is converted to the required types using an instance of ApplicationConversionService.

## **Custom Web Endpoints**

Operations on an @Endpoint, @WebEndpoint, or @EndpointWebExtension are automatically exposed over HTTP using Jersey, Spring MVC, or Spring WebFlux.

### **Web Endpoint Request Predicates**

A request predicate is automatically generated for each operation on a web-exposed endpoint.

### Path

The path of the predicate is determined by the ID of the endpoint and the base path of web-exposed endpoints. The default base path is /actuator. For example, an endpoint with the ID sessions will use /actuator/sessions as its path in the predicate.

The path can be further customized by annotating one or more parameters of the operation method with <code>@Selector</code>. Such a parameter is added to the path predicate as a path variable. The variable's value is passed into the operation method when the endpoint operation is invoked.

### **HTTP** method

The HTTP method of the predicate is determined by the operation type, as shown in the following table:

Operation	HTTP method
@ReadOperation	GET

Operation	HTTP method
@WriteOperation	POST
@DeleteOperation	DELETE

### **Consumes**

For a @WriteOperation (HTTP POST) that uses the request body, the consumes clause of the predicate is application/vnd.spring-boot.actuator.v2+json, application/json. For all other operations the consumes clause is empty.

#### **Produces**

The produces clause of the predicate can be determined by the produces attribute of the @DeleteOperation, @ReadOperation, and @WriteOperation annotations. The attribute is optional. If it is not used, the produces clause is determined automatically.

If the operation method returns void or Void the produces clause is empty. If the operation method returns a org.springframework.core.io.Resource, the produces clause is application/octet-stream. For all other operations the produces clause is application/vnd.spring-boot.actuator.v2+json, application/json.

### Web Endpoint Response Status

The default response status for an endpoint operation depends on the operation type (read, write, or delete) and what, if anything, the operation returns.

A @ReadOperation returns a value, the response status will be 200 (OK). If it does not return a value, the response status will be 404 (Not Found).

If a @WriteOperation or @DeleteOperation returns a value, the response status will be 200 (OK). If it does not return a value the response status will be 204 (No Content).

If an operation is invoked without a required parameter, or with a parameter that cannot be converted to the required type, the operation method will not be called and the response status will be 400 (Bad Request).

### **Web Endpoint Range Requests**

An HTTP range request can be used to request part of an HTTP resource. When using Spring MVC or Spring Web Flux, operations that return a org.springframework.core.io.Resource automatically support range requests.

### Note

Range requests are not supported when using Jersey.

### **Web Endpoint Security**

An operation on a web endpoint or a web-specific endpoint extension can receive the current java.security.Principal or org.springframework.boot.actuate.endpoint.SecurityContext as a method parameter. The former is typically used in conjunction with @Nullable to provide different behaviour for

authenticated and unauthenticated users. The latter is typically used to perform authorization checks using its <code>isUserInRole(String)</code> method.

## Servlet endpoints

A Servlet can be exposed as an endpoint by implementing a class annotated with @ServletEndpoint that also implements Supplier<EndpointServlet>. Servlet endpoints provide deeper integration with the Servlet container but at the expense of portability. They are intended to be used to expose an existing Servlet as an endpoint. For new endpoints, the @Endpoint and @WebEndpoint annotations should be preferred whenever possible.

## **Controller endpoints**

@ControllerEndpoint and @RestControllerEndpoint can be used to implement an endpoint that is only exposed by Spring MVC or Spring WebFlux. Methods are mapped using the standard annotations for Spring MVC and Spring WebFlux such as @RequestMapping and @GetMapping, with the endpoint's ID being used as a prefix for the path. Controller endpoints provide deeper integration with Spring's web frameworks but at the expense of portability. The @Endpoint and @WebEndpoint annotations should be preferred whenever possible.

### 53.8 Health Information

You can use health information to check the status of your running application. It is often used by monitoring software to alert someone when a production system goes down. The information exposed by the health endpoint depends on the management.endpoint.health.show-details property which can be configured with one of the following values:

Name	Description
never	Details are never shown.
when-authorized	Details are only shown to authorized users. Authorized roles can be configured using management.endpoint.health.roles.
always	Details are shown to all users.

The default value is never. A user is considered to be authorized when they are in one or more of the endpoint's roles. If the endpoint has no configured roles (the default) all authenticated users are considered to be authorized. The roles can be configured using the management.endpoint.health.roles property.

## Note

If you have secured your application and wish to use always, your security configuration must permit access to the health endpoint for both authenticated and unauthenticated users.

Health information is collected from the content of a <a href="HealthIndicatorRegistry">HealthIndicator</a> instances defined in your ApplicationContext. Spring Boot includes a number of auto-configured HealthIndicators and you can also write your own. By default, the final system state is derived by the HealthAggregator which sorts the statuses from each HealthIndicator based on an ordered list of statuses. The first status in the sorted list is used as the overall health status. If no HealthIndicator returns a status that is known to the HealthAggregator, an UNKNOWN status is used.

### Tip

The HealthIndicatorRegistry can be used to register and unregister health indicators at runtime.

## **Auto-configured HealthIndicators**

The following HealthIndicators are auto-configured by Spring Boot when appropriate:

Name	Description
CassandraHealthIndicator	Checks that a Cassandra database is up.
CouchbaseHealthIndicator	Checks that a Couchbase cluster is up.
DiskSpaceHealthIndicator	Checks for low disk space.
<u>DataSourceHealthIndicator</u>	Checks that a connection to DataSource can be obtained.
ElasticsearchHealthIndicator	Checks that an Elasticsearch cluster is up.
InfluxDbHealthIndicator	Checks that an InfluxDB server is up.
<u>JmsHealthIndicator</u>	Checks that a JMS broker is up.
MailHealthIndicator	Checks that a mail server is up.
MongoHealthIndicator	Checks that a Mongo database is up.
Neo4jHealthIndicator	Checks that a Neo4j server is up.
RabbitHealthIndicator	Checks that a Rabbit server is up.
RedisHealthIndicator	Checks that a Redis server is up.
SolrHealthIndicator	Checks that a Solr server is up.

## Tip

You can disable them all by setting the management.health.defaults.enabled property.

## **Writing Custom HealthIndicators**

To provide custom health information, you can register Spring beans that implement the <a href="HealthIndicator">HealthIndicator</a> interface. You need to provide an implementation of the health() method and return a Health response. The Health response should include a status and can optionally include additional details to be displayed. The following code shows a sample HealthIndicator implementation:

```
import org.springframework.boot.actuate.health.Health?
import org.springframework.boot.actuate.health.HealthIndicator;
import org.springframework.stereotype.Component;

@Component
public class MyHealthIndicator implements HealthIndicator {

@Override
```

```
public Health health() {
  int errorCode = check(); // perform some specific health check
  if (errorCode != 0) {
    return Health.down().withDetail("Error Code", errorCode).build();
  }
  return Health.up().build();
}
```

#### Note

The identifier for a given  ${\tt HealthIndicator}$  is the name of the bean without the  ${\tt HealthIndicator}$  suffix, if it exists. In the preceding example, the health information is available in an entry named  ${\tt my}$ .

In addition to Spring Boot's predefined <u>Status</u> types, it is also possible for <u>Health</u> to return a custom <u>Status</u> that represents a new system state. In such cases, a custom implementation of the <u>HealthAggregator</u> interface also needs to be provided, or the default implementation has to be configured by using the <u>management.health.status.order</u> configuration property.

For example, assume a new Status with code FATAL is being used in one of your HealthIndicator implementations. To configure the severity order, add the following property to your application properties:

```
management.health.status.order=FATAL, DOWN, OUT_OF_SERVICE, UNKNOWN, UP
```

The HTTP status code in the response reflects the overall health status (for example, UP maps to 200, while OUT\_OF\_SERVICE and DOWN map to 503). You might also want to register custom status mappings if you access the health endpoint over HTTP. For example, the following property maps FATAL to 503 (service unavailable):

```
management.health.status.http-mapping.FATAL=503
```

### Tip

If you need more control, you can define your own HealthStatusHttpMapper bean.

The following table shows the default status mappings for the built-in statuses:

Status	Mapping
DOWN	SERVICE_UNAVAILABLE (503)
OUT_OF_SERVICE	SERVICE_UNAVAILABLE (503)
UP	No mapping by default, so http status is 200
UNKNOWN	No mapping by default, so http status is 200

### **Reactive Health Indicators**

For reactive applications, such as those using Spring WebFlux, ReactiveHealthIndicator provides a non-blocking contract for getting application health. Similar to a traditional HealthIndicator, health information is collected from the content of a \_ReactiveHealthIndicatorRegistry (by default all HealthIndicator and \_ReactiveHealthIndicator instances defined in your

ApplicationContext. Regular HealthIndicator that do not check against a reactive API are executed on the elastic scheduler.

### Tip

In a reactive application, The ReactiveHealthIndicatorRegistry can be used to register and unregister health indicators at runtime.

To provide custom health information from a reactive API, you can register Spring beans that implement the <a href="ReactiveHealthIndicator">ReactiveHealthIndicator</a> interface. The following code shows a sample ReactiveHealthIndicator implementation:

### Tip

To handle the error automatically, consider extending from AbstractReactiveHealthIndicator.

## **Auto-configured ReactiveHealthIndicators**

The following ReactiveHealthIndicators are auto-configured by Spring Boot when appropriate:

Name	Description
CassandraReact	i <del>Cheeks that a:Cassand</del> ra database is up.
CouchbaseReact	i Chreeks that acCouchbase cluster is up.
MongoReactiveH	e <u>€hecks that a⊧Mø</u> ngo database is up.
RedisReactiveH	e <u>€hecks thatatRe</u> dis server is up.

### Tip

If necessary, reactive indicators replace the regular ones. Also, any HealthIndicator that is not handled explicitly is wrapped automatically.

# 53.9 Application Information

Application information exposes various information collected from all <u>InfoContributor</u> beans defined in your ApplicationContext. Spring Boot includes a number of auto-configured InfoContributor beans, and you can write your own.

## **Auto-configured InfoContributors**

The following InfoContributor beans are auto-configured by Spring Boot, when appropriate:

Name	Description
EnvironmentInf	Exposes any key from the Environment under the info key.
GitInfoContrib	ս <b>Exp</b> oses git information if a git.properties file is available.
BuildInfoContr	i Exposes build information if a META-INF/build-info.properties file is available.

### Tip

It is possible to disable them all by setting the management.info.defaults.enabled property.

## **Custom Application Information**

You can customize the data exposed by the info endpoint by setting info.\* Spring properties. All Environment properties under the info key are automatically exposed. For example, you could add the following settings to your application.properties file:

```
info.app.encoding=UTF-8
info.app.java.source=1.8
info.app.java.target=1.8
```

### Tip

Rather than hardcoding those values, you could also expand info properties at build time.

Assuming you use Maven, you could rewrite the preceding example as follows:

```
info.app.encoding=@project.build.sourceEncoding@
info.app.java.source=@java.version@
info.app.java.target=@java.version@
```

### **Git Commit Information**

Another useful feature of the info endpoint is its ability to publish information about the state of your git source code repository when the project was built. If a GitProperties bean is available, the git.branch, git.commit.id, and git.commit.time properties are exposed.

### Tip

A GitProperties bean is auto-configured if a git.properties file is available at the root of the classpath. See "Generate git information" for more details.

If you want to display the full git information (that is, the full content of git.properties), use the management.info.git.mode property, as follows:

```
management.info.git.mode=full
```

### **Build Information**

If a BuildProperties bean is available, the info endpoint can also publish information about your build. This happens if a META-INF/build-info.properties file is available in the classpath.

### Tip

The Maven and Gradle plugins can both generate that file. See "Generate build information" for more details.

## **Writing Custom InfoContributors**

To provide custom application information, you can register Spring beans that implement the <a href="InfoContributor">InfoContributor</a> interface.

The following example contributes an example entry with a single value:

If you reach the info endpoint, you should see a response that contains the following additional entry:

```
{
    "example": {
        "key": "value"
    }
}
```

# 54. Monitoring and Management over HTTP

If you are developing a web application, Spring Boot Actuator auto-configures all enabled endpoints to be exposed over HTTP. The default convention is to use the id of the endpoint with a prefix of / actuator as the URL path. For example, health is exposed as /actuator/health. TIP: Actuator is supported natively with Spring MVC, Spring WebFlux, and Jersey.

## 54.1 Customizing the Management Endpoint Paths

Sometimes, it is useful to customize the prefix for the management endpoints. For example, your application might already use /actuator for another purpose. You can use the management.endpoints.web.base-path property to change the prefix for your management endpoint, as shown in the following example:

```
management.endpoints.web.base-path=/manage
```

The preceding application.properties example changes the endpoint from /actuator/{id} to /manage/{id} (for example, /manage/info).

#### Note

Unless the management port has been configured to expose endpoints by using a different HTTP port, management.endpoints.web.base-path is relative to server.servlet.context-path. If management.server.port is configured, management.endpoints.web.base-path is relative to management.server.servlet.context-path.

If you want to map endpoints to a different path, you can use the management.endpoints.web.path-mapping property.

The following example remaps /actuator/health to /healthcheck:

### application.properties.

```
management.endpoints.web.base-path=/
management.endpoints.web.path-mapping.health=healthcheck
```

# 54.2 Customizing the Management Server Port

Exposing management endpoints by using the default HTTP port is a sensible choice for cloud-based deployments. If, however, your application runs inside your own data center, you may prefer to expose endpoints by using a different HTTP port.

You can set the management.server.port property to change the HTTP port, as shown in the following example:

```
management.server.port=8081
```

# 54.3 Configuring Management-specific SSL

When configured to use a custom port, the management server can also be configured with its own SSL by using the various management.server.ssl.\* properties. For example, doing so lets a management server be available over HTTP while the main application uses HTTPS, as shown in the following property settings:

```
server.port=8443
server.ssl.enabled=true
server.ssl.key-store=classpath:store.jks
server.ssl.key-password=secret
management.server.port=8080
management.server.ssl.enabled=false
```

Alternatively, both the main server and the management server can use SSL but with different key stores, as follows:

```
server.port=8443
server.ssl.enabled=true
server.ssl.key-store=classpath:main.jks
server.ssl.key-password=secret
management.server.port=8080
management.server.ssl.enabled=true
management.server.ssl.key-store=classpath:management.jks
management.server.ssl.key-password=secret
```

# 54.4 Customizing the Management Server Address

You can customize the address that the management endpoints are available on by setting the management.server.address property. Doing so can be useful if you want to listen only on an internal or ops-facing network or to listen only for connections from localhost.

### Note

You can listen on a different address only when the port differs from the main server port.

The following example application.properties does not allow remote management connections:

```
management.server.port=8081
management.server.address=127.0.0.1
```

# 54.5 Disabling HTTP Endpoints

If you do not want to expose endpoints over HTTP, you can set the management port to -1, as shown in the following example:

```
management.server.port=-1
```

This can be achieved using the management.endpoints.web.exposure.exclude property as well, as shown in following example:

```
management.endpoints.web.exposure.exclude=*
```

# 55. Monitoring and Management over JMX

Java Management Extensions (JMX) provide a standard mechanism to monitor and manage applications. By default, Spring Boot exposes management endpoints as JMX MBeans under the org.springframework.boot domain.

## 55.1 Customizing MBean Names

The name of the MBean is usually generated from the id of the endpoint. For example, the health endpoint is exposed as org.springframework.boot:type=Endpoint,name=Health.

If your application contains more than one Spring ApplicationContext, you may find that names clash. To solve this problem, you can set the spring.jmx.unique-names property to true so that MBean names are always unique.

You can also customize the JMX domain under which endpoints are exposed. The following settings show an example of doing so in application.properties:

```
spring.jmx.unique-names=true
management.endpoints.jmx.domain=com.example.myapp
```

## 55.2 Disabling JMX Endpoints

If you do not want to expose endpoints over JMX, you can set the management.endpoints.jmx.exposure.exclude property to \*, as shown in the following example:

```
management.endpoints.jmx.exposure.exclude=*
```

# 55.3 Using Jolokia for JMX over HTTP

Jolokia is a JMX-HTTP bridge that provides an alternative method of accessing JMX beans. To use Jolokia, include a dependency to org.jolokia:jolokia-core. For example, with Maven, you would add the following dependency:

```
<dependency>
<groupId>org.jolokia</groupId>
<artifactId>jolokia-core</artifactId>
</dependency>
```

The Jolokia endpoint can then be exposed by adding <code>jolokia</code> or \* to the management.endpoints.web.exposure.include property. You can then access it by using / actuator/jolokia on your management HTTP server.

## **Customizing Jolokia**

Jolokia has a number of settings that you would traditionally configure by setting servlet parameters. With Spring Boot, you can use your application.properties file. To do so, prefix the parameter with management.endpoint.jolokia.config., as shown in the following example:

```
management.endpoint.jolokia.config.debug=true
```

# **Disabling Jolokia**

If you use Jolokia but do not want Spring Boot to configure it, set the management.endpoint.jolokia.enabled property to false, as follows:

management.endpoint.jolokia.enabled=false

# 56. Loggers

Spring Boot Actuator includes the ability to view and configure the log levels of your application at runtime. You can view either the entire list or an individual logger's configuration, which is made up of both the explicitly configured logging level as well as the effective logging level given to it by the logging framework. These levels can be one of:

- TRACE
- DEBUG
- INFO
- WARN
- ERROR
- FATAL
- OFF
- null

null indicates that there is no explicit configuration.

# 56.1 Configure a Logger

To configure a given logger, POST a partial entity to the resource's URI, as shown in the following example:

```
{
    "configuredLevel": "DEBUG"
}
```

### Tip

To "reset" the specific level of the logger (and use the default configuration instead), you can pass a value of null as the configuredLevel.

# 57. Metrics

Spring Boot Actuator provides dependency management and auto-configuration for <u>Micrometer</u>, an application metrics facade that supports numerous monitoring systems, including:

- AppOptics
- Atlas
- Datadog
- Dynatrace
- Elastic
- Ganglia
- Graphite
- Humio
- Influx
- JMX
- KairosDB
- New Relic
- Prometheus
- SignalFx
- Simple (in-memory)
- StatsD
- Wavefront

### Tip

To learn more about Micrometer's capabilities, please refer to its <u>reference documentation</u>, in particular the <u>concepts section</u>.

# 57.1 Getting started

Spring Boot auto-configures a composite MeterRegistry and adds a registry to the composite for each of the supported implementations that it finds on the classpath. Having a dependency on micrometer-registry-{system} in your runtime classpath is enough for Spring Boot to configure the registry.

Most registries share common features. For instance, you can disable a particular registry even if the Micrometer registry implementation is on the classpath. For instance, to disable Datadog:

```
management.metrics.export.datadog.enabled=false
```

Spring Boot will also add any auto-configured registries to the global static composite registry on the Metrics class unless you explicitly tell it not to:

```
management.metrics.use-global-registry=false
```

You can register any number of MeterRegistryCustomizer beans to further configure the registry, such as applying common tags, before any meters are registered with the registry:

```
@Bean
MeterRegistryCustomizer<MeterRegistry> metricsCommonTags() {
   return registry -> registry.config().commonTags("region", "us-east-1");
}
```

You can apply customizations to particular registry implementations by being more specific about the generic type:

```
@Bean
MeterRegistryCustomizer<GraphiteMeterRegistry> graphiteMetricsNamingConvention() {
   return registry -> registry.config().namingConvention(MY_CUSTOM_CONVENTION);
}
```

With that setup in place you can inject MeterRegistry in your components and register metrics:

```
@Component
public class SampleBean {
  private final Counter counter;

public SampleBean(MeterRegistry registry) {
    this.counter = registry.counter("received.messages");
  }

public void handleMessage(String message) {
    this.counter.increment();
    // handle message implementation
  }
}
```

Spring Boot also <u>configures built-in instrumentation</u> (i.e. MeterBinder implementations) that you can control via configuration or dedicated annotation markers.

# 57.2 Supported monitoring systems

## **AppOptics**

By default, the AppOptics registry pushes metrics to <a href="www.appoptics.com/">www.appoptics.com/</a> periodically. To export metrics to SaaS <a href="AppOptics">AppOptics</a>, your API token must be provided:

```
management.metrics.export.appoptics.api-token=YOUR_TOKEN
```

### **Atlas**

By default, metrics are exported to <u>Atlas</u> running on your local machine. The location of the <u>Atlas server</u> to use can be provided using:

```
management.metrics.export.atlas.uri=http://atlas.example.com:7101/api/v1/publish
```

### **Datadog**

Datadog registry pushes metrics to <u>datadoghq</u> periodically. To export metrics to <u>Datadog</u>, your API key must be provided:

```
management.metrics.export.datadog.api-key=YOUR_KEY
```

You can also change the interval at which metrics are sent to Datadog:

```
management.metrics.export.datadog.step=30s
```

## **Dynatrace**

Dynatrace registry pushes metrics to the configured URI periodically. To export metrics to <u>Dynatrace</u>, your API token, device ID, and URI must be provided:

```
management.metrics.export.dynatrace.api-token=YOUR_TOKEN
management.metrics.export.dynatrace.device-id=YOUR_DEVICE_ID
management.metrics.export.dynatrace.uri=YOUR_URI
```

You can also change the interval at which metrics are sent to Dynatrace:

```
management.metrics.export.dynatrace.step=30s
```

### **Elastic**

By default, metrics are exported to <u>Elastic</u> running on your local machine. The location of the Elastic server to use can be provided using the following property:

```
management.metrics.export.elastic.host=http://elastic.example.com:8086
```

## Ganglia

By default, metrics are exported to <u>Ganglia</u> running on your local machine. The <u>Ganglia server</u> host and port to use can be provided using:

```
management.metrics.export.ganglia.host=ganglia.example.com
management.metrics.export.ganglia.port=9649
```

### **Graphite**

By default, metrics are exported to <u>Graphite</u> running on your local machine. The <u>Graphite server</u> host and port to use can be provided using:

```
management.metrics.export.graphite.host=graphite.example.com
management.metrics.export.graphite.port=9004
```

Micrometer provides a default HierarchicalNameMapper that governs how a dimensional meter id is mapped to flat hierarchical names.

### Tip

To take control over this behaviour, define your <code>GraphiteMeterRegistry</code> and supply your own <code>HierarchicalNameMapper</code>. An auto-configured <code>GraphiteConfig</code> and <code>Clock</code> beans are provided unless you define your own:

```
@Bean
public GraphiteMeterRegistry graphiteMeterRegistry(GraphiteConfig config, Clock clock) {
  return new GraphiteMeterRegistry(config, clock, MY_HIERARCHICAL_MAPPER);
}
```

### Humio

By default, the Humio registry pushes metrics to <u>cloud.humio.com</u> periodically. To export metrics to SaaS Humio, your API token must be provided:

```
management.metrics.export.humio.api-token=YOUR_TOKEN
```

You should also configure one or more tags to identify the data source to which metrics will be pushed:

```
management.metrics.export.humio.tags.alpha=a
management.metrics.export.humio.tags.bravo=b
```

### Influx

By default, metrics are exported to <u>Influx</u> running on your local machine. The location of the <u>Influx server</u> to use can be provided using:

```
management.metrics.export.influx.uri=http://influx.example.com:8086
```

### **JMX**

Micrometer provides a hierarchical mapping to <u>JMX</u>, primarily as a cheap and portable way to view metrics locally. By default, metrics are exported to the metrics JMX domain. The domain to use can be provided using:

```
management.metrics.export.jmx.domain=com.example.app.metrics
```

Micrometer provides a default HierarchicalNameMapper that governs how a dimensional meter id is mapped to flat hierarchical names.

### Tip

To take control over this behaviour, define your JmxMeterRegistry and supply your own HierarchicalNameMapper. An auto-configured JmxConfig and Clock beans are provided unless you define your own:

```
@Bean
public JmxMeterRegistry jmxMeterRegistry(JmxConfig config, Clock clock) {
  return new JmxMeterRegistry(config, clock, MY_HIERARCHICAL_MAPPER);
}
```

### **KairosDB**

By default, metrics are exported to <u>KairosDB</u> running on your local machine. The location of the <u>KairosDB server</u> to use can be provided using:

```
management.metrics.export.kairos.uri=http://kairosdb.example.com:8080/api/v1/datapoints
```

### **New Relic**

New Relic registry pushes metrics to <u>New Relic</u> periodically. To export metrics to <u>New Relic</u>, your API key and account id must be provided:

```
management.metrics.export.newrelic.api-key=YOUR_KEY
management.metrics.export.newrelic.account-id=YOUR_ACCOUNT_ID
```

You can also change the interval at which metrics are sent to New Relic:

```
management.metrics.export.newrelic.step=30s
```

### **Prometheus**

<u>Prometheus</u> expects to scrape or poll individual app instances for metrics. Spring Boot provides an actuator endpoint available at /actuator/prometheus to present a <u>Prometheus scrape</u> with the appropriate format.

### Tip

The endpoint is not available by default and must be exposed, see <u>exposing endpoints</u> for more details.

Here is an example scrape\_config to add to prometheus.yml:

```
scrape_configs:
  - job_name: 'spring'
metrics_path: '/actuator/prometheus'
static_configs:
  - targets: ['HOST:PORT']
```

## **SignalFx**

SignalFx registry pushes metrics to <u>SignalFx</u> periodically. To export metrics to <u>SignalFx</u>, your access token must be provided:

```
management.metrics.export.signalfx.access-token=YOUR_ACCESS_TOKEN
```

You can also change the interval at which metrics are sent to SignalFx:

```
management.metrics.export.signalfx.step=30s
```

## **Simple**

Micrometer ships with a simple, in-memory backend that is automatically used as a fallback if no other registry is configured. This allows you to see what metrics are collected in the <u>metrics endpoint</u>.

The in-memory backend disables itself as soon as you're using any of the other available backend. You can also disable it explicitly:

```
management.metrics.export.simple.enabled=false
```

### **StatsD**

The StatsD registry pushes metrics over UDP to a StatsD agent eagerly. By default, metrics are exported to a <u>StatsD</u> agent running on your local machine. The StatsD agent host and port to use can be provided using:

```
management.metrics.export.statsd.host=statsd.example.com
management.metrics.export.statsd.port=9125
```

You can also change the StatsD line protocol to use (default to Datadog):

```
management.metrics.export.statsd.flavor=etsy
```

### Wavefront

Wavefront registry pushes metrics to <u>Wavefront</u> periodically. If you are exporting metrics to <u>Wavefront</u> directly, your API token must be provided:

```
management.metrics.export.wavefront.api-token=YOUR_API_TOKEN
```

Alternatively, you may use a Wavefront sidecar or an internal proxy set up in your environment that forwards metrics data to the Wavefront API host:

```
management.metrics.export.wavefront.uri=proxy://localhost:2878
```

### Tip

If publishing metrics to a Wavefront proxy (as described in the documentation), the host must be in the proxy://HOST:PORT format.

You can also change the interval at which metrics are sent to Wavefront:

management.metrics.export.wavefront.step=30s

# **57.3 Supported Metrics**

Spring Boot registers the following core metrics when applicable:

- JVM metrics, report utilization of:
  - · Various memory and buffer pools
  - · Statistics related to garbage collection
  - · Threads utilization
  - · Number of classes loaded/unloaded
- · CPU metrics
- · File descriptor metrics
- Kafka consumer metrics
- Log4j2 metrics: record the number of events logged to Log4j2 at each level
- · Logback metrics: record the number of events logged to Logback at each level
- Uptime metrics: report a gauge for uptime and a fixed gauge representing the application's absolute start time
- Tomcat metrics
- Spring Integration metrics

## **Spring MVC Metrics**

Auto-configuration enables the instrumentation of requests handled by Spring MVC. When management.metrics.web.server.auto-time-requests is true, this instrumentation occurs

for all requests. Alternatively, when set to false, you can enable instrumentation by adding @Timed to a request-handling method:

```
@RestController
@Timed ①
public class MyController {

    @GetMapping("/api/people")
    @Timed(extraTags = { "region", "us-east-1" }) ②
    @Timed(value = "all.people", longTask = true) ③
    public List<Person> listPeople() { ... }
}
```

- A controller class to enable timings on every request handler in the controller.
- A method to enable for an individual endpoint. This is not necessary if you have it on the class, but can be used to further customize the timer for this particular endpoint.
- A method with longTask = true to enable a long task timer for the method. Long task timers require a separate metric name, and can be stacked with a short task timer.

By default, metrics are generated with the name, http.server.requests. The name can be customized by setting the management.metrics.web.server.requests-metric-name property.

By default, Spring MVC-related metrics are tagged with the following information:

Tag	Description
exception	Simple class name of any exception that was thrown while handling the request.
method	Request's method (for example, GET or POST)
outcome	Request's outcome based on the status code of the response. 1xx is INFORMATIONAL, 2xx is SUCCESS, 3xx is REDIRECTION, 4xx CLIENT_ERROR, and 5xx is SERVER_ERROR
status	Response's HTTP status code (for example, 200 or 500)
uri	Request's URI template prior to variable substitution, if possible (for example, /api/person/{id})

To customize the tags, provide a @Bean that implements WebMvcTagsProvider.

## Spring WebFlux Metrics

Auto-configuration enables the instrumentation of all requests handled by WebFlux controllers and functional handlers.

By default, metrics are generated with the name http.server.requests. You can customize the name by setting the management.metrics.web.server.requests-metric-name property.

By default, WebFlux-related metrics are tagged with the following information:

Tag	Description
exception	Simple class name of any exception that was thrown while handling the request.
method	Request's method (for example, GET or POST)
outcome	Request's outcome based on the status code of the response. 1xx is INFORMATIONAL, 2xx is SUCCESS, 3xx is REDIRECTION, 4xx CLIENT_ERROR, and 5xx is SERVER_ERROR
status	Response's HTTP status code (for example, 200 or 500)
uri	Request's URI template prior to variable substitution, if possible (for example, /api/person/{id})

To customize the tags, provide a @Bean that implements WebFluxTagsProvider.

## **Jersey Server Metrics**

Auto-configuration enables the instrumentation of requests handled by the Jersey JAX-RS implementation. When management.metrics.web.server.auto-time-requests is true, this instrumentation occurs for all requests. Alternatively, when set to false, you can enable instrumentation by adding @Timed to a request-handling method:

```
@Component
@Path("/api/people")
@Timed ①
public class Endpoint {
    @GET
    @Timed(extraTags = { "region", "us-east-1" }) ②
    @Timed(value = "all.people", longTask = true) ③
    public List<Person> listPeople() { ... }
}
```

- On a resource class to enable timings on every request handler in the resource.
- On a method to enable for an individual endpoint. This is not necessary if you have it on the class, but can be used to further customize the timer for this particular endpoint.
- On a method with longTask = true to enable a long task timer for the method. Long task timers require a separate metric name, and can be stacked with a short task timer.

By default, metrics are generated with the name, http.server.requests. The name can be customized by setting the management.metrics.web.server.requests-metric-name property.

By default, Jersey server metrics are tagged with the following information:

Tag	Description
exception	Simple class name of any exception that was thrown while handling the request.
method	Request's method (for example, GET or POST)

Tag	Description
outcome	Request's outcome based on the status code of the response. 1xx is INFORMATIONAL, 2xx is SUCCESS, 3xx is REDIRECTION, 4xx CLIENT_ERROR, and 5xx is SERVER_ERROR
status	Response's HTTP status code (for example, 200 or 500)
uri	Request's URI template prior to variable substitution, if possible (for example, /api/person/{id})

To customize the tags, provide a @Bean that implements JerseyTagsProvider.

### **HTTP Client Metrics**

Spring Boot Actuator manages the instrumentation of both RestTemplate and WebClient. For that, you have to get injected with an auto-configured builder and use it to create instances:

- RestTemplateBuilder for RestTemplate
- WebClient.Builder for WebClient

It is also possible to apply manually the customizers responsible for this instrumentation, namely MetricsRestTemplateCustomizer and MetricsWebClientCustomizer.

By default, metrics are generated with the name, http.client.requests. The name can be customized by setting the management.metrics.web.client.requests-metric-name property.

By default, metrics generated by an instrumented client are tagged with the following information:

- method, the request's method (for example, GET or POST).
- uri, the request's URI template prior to variable substitution, if possible (for example, /api/person/ {id}).
- status, the response's HTTP status code (for example, 200 or 500).
- clientName, the host portion of the URI.

To customize the tags, and depending on your choice of client, you can provide a <code>@Bean</code> that implements RestTemplateExchangeTagsProvider or WebClientExchangeTagsProvider. There are convenience static functions in RestTemplateExchangeTags and WebClientExchangeTags.

### **Cache Metrics**

Auto-configuration enables the instrumentation of all available Caches on startup with metrics prefixed with cache. Cache instrumentation is standardized for a basic set of metrics. Additional, cache-specific metrics are also available.

The following cache libraries are supported:

- Caffeine
- EhCache 2
- Hazelcast
- Any compliant JCache (JSR-107) implementation

Metrics are tagged by the name of the cache and by the name of the CacheManager that is derived from the bean name.

#### Note

Only caches that are available on startup are bound to the registry. For caches created on-the-fly or programmatically after the startup phase, an explicit registration is required. A CacheMetricsRegistrar bean is made available to make that process easier.

### **DataSource Metrics**

Auto-configuration enables the instrumentation of all available <code>DataSource</code> objects with a metric named <code>jdbc</code>. Data source instrumentation results in gauges representing the currently active, maximum allowed, and minimum allowed connections in the pool. Each of these gauges has a name that is prefixed by <code>jdbc</code>.

Metrics are also tagged by the name of the DataSource computed based on the bean name.

### Tip

By default, Spring Boot provides metadata for all supported data sources; you can add additional DataSourcePoolMetadataProvider beans if your favorite data source isn't supported out of the box. See DataSourcePoolMetadataProvidersConfiguration for examples.

Also, Hikari-specific metrics are exposed with a hikaricp prefix. Each metric is tagged by the name of the Pool (can be controlled with spring.datasource.name).

### **Hibernate Metrics**

Auto-configuration enables the instrumentation of all available Hibernate EntityManagerFactory instances that have statistics enabled with a metric named hibernate.

Metrics are also tagged by the name of the EntityManagerFactory that is derived from the bean name.

To enable statistics, the standard JPA property hibernate.generate\_statistics must be set to true. You can enable that on the auto-configured EntityManagerFactory as shown in the following example:

spring.jpa.properties.hibernate.generate\_statistics=true

### RabbitMQ Metrics

Auto-configuration will enable the instrumentation of all available RabbitMQ connection factories with a metric named rabbitmq.

## 57.4 Registering custom metrics

To register custom metrics, inject MeterRegistry into your component, as shown in the following example:

```
class Dictionary {
  private final List<String> words = new CopyOnWriteArrayList<>();
  Dictionary(MeterRegistry registry) {
   registry.gaugeCollectionSize("dictionary.size", Tags.empty(), this.words);
  }
  // ...
}
```

If you find that you repeatedly instrument a suite of metrics across components or applications, you may encapsulate this suite in a MeterBinder implementation. By default, metrics from all MeterBinder beans will be automatically bound to the Spring-managed MeterRegistry.

## 57.5 Customizing individual metrics

If you need to apply customizations to specific Meter instances you can use the io.micrometer.core.instrument.config.MeterFilter interface. By default, all MeterFilter beans will be automatically applied to the micrometer MeterRegistry.Config.

For example, if you want to rename the mytag.region tag to mytag.area for all meter IDs beginning with com.example, you can do the following:

```
@Bean
public MeterFilter renameRegionTagMeterFilter() {
  return MeterFilter.renameTag("com.example", "mytag.region", "mytag.area");
}
```

## Common tags

Common tags are generally used for dimensional drill-down on the operating environment like host, instance, region, stack, etc. Commons tags are applied to all meters and can be configured as shown in the following example:

```
management.metrics.tags.region=us-east-1
management.metrics.tags.stack=prod
```

The example above adds region and stack tags to all meters with a value of us-east-1 and prod respectively.

### Note

The order of common tags is important if you are using Graphite. As the order of common tags cannot be guaranteed using this approach, Graphite users are advised to define a custom MeterFilter instead.

## Per-meter properties

In addition to MeterFilter beans, it's also possible to apply a limited set of customization on a permeter basis using properties. Per-meter customizations apply to any all meter IDs that start with the given name. For example, the following will disable any meters that have an ID starting with example.remote

```
management.metrics.enable.example.remote=false
```

The following properties allow per-meter customization:

Table 57.1. Per-meter customizations

Property	Description
management.metrics.enable	Whether to deny meters from emitting any metrics.
management.metrics.distribution.perce	enWhether to publish a histogram suitable for computing aggregable (across dimension) percentile approximations.
<pre>management.metrics.distribution.minim expected-value, management.metrics.distribution.maxim expected-value</pre>	range of expected values.
management.metrics.distribution.perce	application
management.metrics.distribution.sla	Publish a cumulative histogram with buckets defined by your SLAs.

For more details on concepts behind percentiles—histogram, percentiles and sla refer to the "Histograms and percentiles" section of the micrometer documentation.

# 57.6 Metrics endpoint

Spring Boot provides a metrics endpoint that can be used diagnostically to examine the metrics collected by an application. The endpoint is not available by default and must be exposed, see <u>exposing endpoints</u> for more details.

Navigating to /actuator/metrics displays a list of available meter names. You can drill down to view information about a particular meter by providing its name as a selector, e.g. /actuator/metrics/jvm.memory.max.

### Tip

The name you use here should match the name used in the code, not the name after it has been naming-convention normalized for a monitoring system it is shipped to. In other words, if jvm.memory.max appears as jvm\_memory\_max in Prometheus because of its snake case naming convention, you should still use jvm.memory.max as the selector when inspecting the meter in the metrics endpoint.

You can also add any number of tag=KEY:VALUE query parameters to the end of the URL to dimensionally drill down on a meter, e.g. /actuator/metrics/jvm.memory.max? tag=area:nonheap.

### Tip

The reported measurements are the *sum* of the statistics of all meters matching the meter name and any tags that have been applied. So in the example above, the returned "Value" statistic is the sum of the maximum memory footprints of "Code Cache", "Compressed Class Space", and "Metaspace" areas of the heap. If you just wanted to see the maximum size for the "Metaspace", you could add an additional tag=id:Metaspace, i.e. /actuator/metrics/jvm.memory.max?tag=area:nonheap&tag=id:Metaspace.

# 58. Auditing

Once Spring Security is in play, Spring Boot Actuator has a flexible audit framework that publishes events (by default, "authentication success", "failure" and "access denied" exceptions). This feature can be very useful for reporting and for implementing a lock-out policy based on authentication failures. To customize published security events, you can provide your own implementations of AbstractAuthenticationAuditListener and AbstractAuthorizationAuditListener.

You can also use the audit services for your own business events. To do so, either inject the existing AuditEventRepository into your own components and use that directly or publish an AuditApplicationEvent with the Spring ApplicationEventPublisher (by implementing ApplicationEventPublisherAware).

# 59. HTTP Tracing

Tracing is automatically enabled for all HTTP requests. You can view the httptrace endpoint and obtain basic information about the last 100 request-response exchanges.

# 59.1 Custom HTTP tracing

To customize the items that are included in each trace, use the management.trace.http.include configuration property. For advanced customization, consider registering your own HttpExchangeTracer implementation.

By default, an InMemoryHttpTraceRepository that stores traces for the last 100 request-response exchanges is used. If you need to expand the capacity, you can define your own instance of the InMemoryHttpTraceRepository bean. You can also create your own alternative HttpTraceRepository implementation.

# **60. Process Monitoring**

In the spring-boot module, you can find two classes to create files that are often useful for process monitoring:

- ApplicationPidFileWriter creates a file containing the application PID (by default, in the application directory with a file name of application.pid).
- WebServerPortFileWriter creates a file (or files) containing the ports of the running web server (by default, in the application directory with a file name of application.port).

By default, these writers are not activated, but you can enable:

- By Extending Configuration
- Section 60.2, "Programmatically"

# **60.1 Extending Configuration**

In the META-INF/spring.factories file, you can activate the listener(s) that writes a PID file, as shown in the following example:

```
org.springframework.context.ApplicationListener=\
org.springframework.boot.context.ApplicationPidFileWriter,\
org.springframework.boot.web.context.WebServerPortFileWriter
```

# **60.2 Programmatically**

You can also activate a listener by invoking the SpringApplication.addListeners(...) method and passing the appropriate Writer object. This method also lets you customize the file name and path in the Writer constructor.

# **61. Cloud Foundry Support**

Spring Boot's actuator module includes additional support that is activated when you deploy to a compatible Cloud Foundry instance. The /cloudfoundryapplication path provides an alternative secured route to all @Endpoint beans.

The extended support lets Cloud Foundry management UIs (such as the web application that you can use to view deployed applications) be augmented with Spring Boot actuator information. For example, an application status page may include full health information instead of the typical "running" or "stopped" status.

### Note

The /cloudfoundryapplication path is not directly accessible to regular users. In order to use the endpoint, a valid UAA token must be passed with the request.

## 61.1 Disabling Extended Cloud Foundry Actuator Support

If you want to fully disable the /cloudfoundryapplication endpoints, you can add the following setting to your application.properties file:

### application.properties.

```
management.cloudfoundry.enabled=false
```

## 61.2 Cloud Foundry Self-signed Certificates

By default, the security verification for /cloudfoundryapplication endpoints makes SSL calls to various Cloud Foundry services. If your Cloud Foundry UAA or Cloud Controller services use self-signed certificates, you need to set the following property:

### application.properties.

```
management.cloudfoundry.skip-ssl-validation=true
```

# 61.3 Custom context path

If the server's context-path has been configured to anything other than /, the Cloud Foundry endpoints will not be available at the root of the application. For example, if server.servlet.context-path=/app, Cloud Foundry endpoints will be available at /app/cloudfoundryapplication/\*.

If you expect the Cloud Foundry endpoints to always be available at /cloudfoundryapplication/\*, regardless of the server's context-path, you will need to explicitly configure that in your application. The configuration will differ depending on the web server in use. For Tomcat, the following configuration can be added:

```
@Bean
public TomcatServletWebServerFactory servletWebServerFactory() {
   return new TomcatServletWebServerFactory() {
    @Override
   protected void prepareContext(Host host,
        ServletContextInitializer[] initializers) {
        super.prepareContext(host, initializers);
    }
}
```

```
StandardContext child = new StandardContext();
           child.addLifecycleListener(new Tomcat.FixContextListener());
           child.setPath("/cloudfoundryapplication");
           ServletContainerInitializer initializer = getServletContextInitializer(
                   getContextPath());
           \verb|child.addServletContainerInitializer(initializer, Collections.emptySet())|;\\
           child.setCrossContext(true);
         host.addChild(child);
  };
}
private ServletContainerInitializer getServletContextInitializer(String contextPath) {
  return (c, context) -> {
     Servlet servlet = new GenericServlet() {
           @Override
           public void service(ServletRequest req, ServletResponse res)
                  throws ServletException, IOException {
              ServletContext context = req.getServletContext()
                     .getContext(contextPath);
              \verb|context.getRequestDispatcher|| \textit{"}/\textit{cloudfoundryapplication"}|). for ward (\verb|req|, \verb|req|, \|req|, \|req
                      res);
     };
     context.addServlet("cloudfoundry", servlet).addMapping("/*");
   };
```

## 62. What to Read Next

If you want to explore some of the concepts discussed in this chapter, you can take a look at the actuator <u>sample applications</u>. You also might want to read about graphing tools such as <u>Graphite</u>.

Otherwise, you can continue on, to read about 'deployment options' or jump ahead for some in-depth information about Spring Boot's *build tool plugins*.

# Part VI. Deploying Spring Boot Applications

Spring Boot's flexible packaging options provide a great deal of choice when it comes to deploying your application. You can deploy Spring Boot applications to a variety of cloud platforms, to container images (such as Docker), or to virtual/real machines.

(such as Docker), or to virtual/real machines.		
This section covers some of the more common deployment scenarios.		

## 63. Deploying to the Cloud

Spring Boot's executable jars are ready-made for most popular cloud PaaS (Platform-as-a-Service) providers. These providers tend to require that you "bring your own container". They manage application processes (not Java applications specifically), so they need an intermediary layer that adapts *your* application to the *cloud's* notion of a running process.

Two popular cloud providers, Heroku and Cloud Foundry, employ a "buildpack" approach. The buildpack wraps your deployed code in whatever is needed to *start* your application. It might be a JDK and a call to <code>java</code>, an embedded web server, or a full-fledged application server. A buildpack is pluggable, but ideally you should be able to get by with as few customizations to it as possible. This reduces the footprint of functionality that is not under your control. It minimizes divergence between development and production environments.

Ideally, your application, like a Spring Boot executable jar, has everything that it needs to run packaged within it.

In this section, we look at what it takes to get the <u>simple application that we developed</u> in the "Getting Started" section up and running in the Cloud.

## 63.1 Cloud Foundry

Cloud Foundry provides default buildpacks that come into play if no other buildpack is specified. The Cloud Foundry <u>Java buildpack</u> has excellent support for Spring applications, including Spring Boot. You can deploy stand-alone executable jar applications as well as traditional .war packaged applications.

Once you have built your application (by using, for example, mvn clean package) and have installed the cf command line tool, deploy your application by using the cf push command, substituting the path to your compiled . jar. Be sure to have logged in with your cf command line client before pushing an application. The following line shows using the cf push command to deploy an application:

```
$ cf push acloudyspringtime -p target/demo-0.0.1-SNAPSHOT.jar
```

#### Note

In the preceding example, we substitute acloudyspringtime for whatever value you give cf as the name of your application.

See the <u>cf\_push\_documentation</u> for more options. If there is a Cloud Foundry <u>manifest.yml</u> file present in the same directory, it is considered.

At this point, cf starts uploading your application, producing output similar to the following example:

```
-----> Downloading Container Certificate Trust Store 1.0.0_RELEASE from https://java-buildpack.cloudfoundry.org/container-certificate-trust-store/container-certificate-trust-store-1.0.0_RELEASE.jar (found in cache)
    Adding certificates to .java-buildpack/container_certificate_trust_store/truststore.jks (0.6s)
-----> Downloading Spring Auto Reconfiguration 1.10.0_RELEASE from https://java-buildpack.cloudfoundry.org/auto-reconfiguration/auto-reconfiguration-1.10.0_RELEASE.jar (found in cache)
Checking status of app 'acloudyspringtime'...
0 of 1 instances running (1 starting)
...
0 of 1 instances running (1 starting)
...
1 of 1 instances running (1 starting)
App started
```

Congratulations! The application is now live!

Once your application is live, you can verify the status of the deployed application by using the cf apps command, as shown in the following example:

Once Cloud Foundry acknowledges that your application has been deployed, you should be able to find the application at the URI given. In the preceding example, you could find it at http://acloudyspringtime.cfapps.io/.

#### **Binding to Services**

By default, metadata about the running application as well as service connection information is exposed to the application as environment variables (for example: \$VCAP\_SERVICES). This architecture decision is due to Cloud Foundry's polyglot (any language and platform can be supported as a buildpack) nature. Process-scoped environment variables are language agnostic.

Environment variables do not always make for the easiest API, so Spring Boot automatically extracts them and flattens the data into properties that can be accessed through Spring's Environment abstraction, as shown in the following example:

```
@Component
class MyBean implements EnvironmentAware {
    private String instanceId;
    @Override
    public void setEnvironment(Environment environment) {
        this.instanceId = environment.getProperty("vcap.application.instance_id");
    }
    // ...
}
```

All Cloud Foundry properties are prefixed with vcap. You can use vcap properties to access application information (such as the public URL of the application) and service information (such as database credentials). See the 'CloudFoundryVcapEnvironmentPostProcessor' Javadoc for complete details.

#### Tip

The <u>Spring Cloud Connectors</u> project is a better fit for tasks such as configuring a DataSource. Spring Boot includes auto-configuration support and a spring-boot-starter-cloud-connectors starter.

#### 63.2 Heroku

Heroku is another popular PaaS platform. To customize Heroku builds, you provide a Procfile, which provides the incantation required to deploy an application. Heroku assigns a port for the Java application to use and then ensures that routing to the external URI works.

You must configure your application to listen on the correct port. The following example shows the Procfile for our starter REST application:

```
web: java -Dserver.port=$PORT -jar target/demo-0.0.1-SNAPSHOT.jar
```

Spring Boot makes -D arguments available as properties accessible from a Spring Environment instance. The server.port configuration property is fed to the embedded Tomcat, Jetty, or Undertow instance, which then uses the port when it starts up. The \$PORT environment variable is assigned to us by the Heroku PaaS.

This should be everything you need. The most common deployment workflow for Heroku deployments is to git push the code to production, as shown in the following example:

```
$ git push heroku master
Initializing repository, done.
Counting objects: 95, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (78/78), done.
Writing objects: 100% (95/95), 8.66 MiB | 606.00 KiB/s, done.
Total 95 (delta 31), reused 0 (delta 0)
----> Java app detected
----> Installing OpenJDK 1.8... done
----> Installing Maven 3.3.1... done
----> Installing settings.xml... done
----> Executing: mvn -B -DskipTests=true clean install
       [INFO] Scanning for projects...
       Downloading: https://repo.spring.io/...
       Downloaded: https://repo.spring.io/... (818 B at 1.8 KB/sec)
       Downloaded: http://s3pository.heroku.com/jvm/... (152 KB at 595.3 KB/sec)
       [INFO] Installing /tmp/build_0c35a5d2-a067-4abc-a232-14b1fb7a8229/target/...
       [INFO] Installing /tmp/build_0c35a5d2-a067-4abc-a232-14b1fb7a8229/pom.xml ...
       [INFO] -----
       [INFO] BUILD SUCCESS
       [INFO] -----
       [INFO] Total time: 59.358s
       [INFO] Finished at: Fri Mar 07 07:28:25 UTC 2014
       [INFO] Final Memory: 20M/493M
       [INFO] -----
----> Discovering process types
       Procfile declares types -> web
----> Compressing... done, 70.4MB
----> Launching... done, v6
       \verb|http://agile-sierra-1405.herokuapp.com/| \textbf{deployed to Heroku}|
To git@heroku.com:agile-sierra-1405.git
```

```
* [new branch]
```

master -> master

Your application should now be up and running on Heroku.

## 63.3 OpenShift

<u>OpenShift</u> is the Red Hat public (and enterprise) extension of the Kubernetes container orchestration platform. Similarly to Kubernetes, OpenShift has many options for installing Spring Boot based applications.

OpenShift has many resources describing how to deploy Spring Boot applications, including:

- Using the S2I builder
- · Architecture guide
- Running as a traditional web application on Wildfly
- OpenShift Commons Briefing

## 63.4 Amazon Web Services (AWS)

Amazon Web Services offers multiple ways to install Spring Boot-based applications, either as traditional web applications (war) or as executable jar files with an embedded web server. The options include:

- · AWS Elastic Beanstalk
- AWS Code Deploy
- AWS OPS Works
- AWS Cloud Formation
- AWS Container Registry

Each has different features and pricing models. In this document, we describe only the simplest option: AWS Elastic Beanstalk.

#### **AWS Elastic Beanstalk**

As described in the official <u>Elastic Beanstalk Java guide</u>, there are two main options to deploy a Java application. You can either use the "Tomcat Platform" or the "Java SE platform".

#### **Using the Tomcat Platform**

This option applies to Spring Boot projects that produce a war file. No special configuration is required. You need only follow the official guide.

#### Using the Java SE Platform

This option applies to Spring Boot projects that produce a jar file and run an embedded web container. Elastic Beanstalk environments run an nginx instance on port 80 to proxy the actual application, running on port 5000. To configure it, add the following line to your application.properties file:

server.port=5000

#### Upload binaries instead of sources

By default, Elastic Beanstalk uploads sources and compiles them in AWS. However, it is best to upload the binaries instead. To do so, add lines similar to the following to your .elasticbeanstalk/config.yml file:

```
deploy:
    artifact: target/demo-0.0.1-SNAPSHOT.jar
```

#### Reduce costs by setting the environment type

By default an Elastic Beanstalk environment is load balanced. The load balancer has a significant cost. To avoid that cost, set the environment type to "Single instance", as described in <a href="the Amazon documentation">the Amazon documentation</a>. You can also create single instance environments by using the CLI and the following command:

```
eb create -s
```

#### Summary

This is one of the easiest ways to get to AWS, but there are more things to cover, such as how to integrate Elastic Beanstalk into any CI / CD tool, use the Elastic Beanstalk Maven plugin instead of the CLI, and others. There is a <u>blog post</u> covering these topics more in detail.

#### 63.5 Boxfuse and Amazon Web Services

<u>Boxfuse</u> works by turning your Spring Boot executable jar or war into a minimal VM image that can be deployed unchanged either on VirtualBox or on AWS. Boxfuse comes with deep integration for Spring Boot and uses the information from your Spring Boot configuration file to automatically configure ports and health check URLs. Boxfuse leverages this information both for the images it produces as well as for all the resources it provisions (instances, security groups, elastic load balancers, and so on).

Once you have created a <u>Boxfuse account</u>, connected it to your AWS account, installed the latest version of the Boxfuse Client, and ensured that the application has been built by Maven or Gradle (by using, for example, mvn clean package), you can deploy your Spring Boot application to AWS with a command similar to the following:

```
$ boxfuse run myapp-1.0.jar -env=prod
```

See the <u>boxfuse run documentation</u> for more options. If there is a <u>boxfuse.conf</u> file present in the current directory, it is considered.

#### Tip

By default, Boxfuse activates a Spring profile named boxfuse on startup. If your executable jar or war contains an <u>application-boxfuse.properties</u> file, Boxfuse bases its configuration on the properties it contains.

At this point, boxfuse creates an image for your application, uploads it, and configures and starts the necessary resources on AWS, resulting in output similar to the following example:

```
Fusing Image for myapp-1.0.jar ...
Image fused in 00:06.838s (53937 K) -> axelfontaine/myapp:1.0
Creating axelfontaine/myapp ...
Pushing axelfontaine/myapp:1.0 ...
Verifying axelfontaine/myapp:1.0 ...
Creating Elastic IP ...
Mapping myapp-axelfontaine.boxfuse.io to 52.28.233.167 ...
Waiting for AWS to create an AMI for axelfontaine/myapp:1.0 in eu-central-1 (this may take up to 50
seconds) ...
AMI created in 00:23.557s -> ami-d23f38cf
Creating security group boxfuse-sg_axelfontaine/myapp:1.0 ...
Launching t2.micro instance of axelfontaine/myapp:1.0 (ami-d23f38cf) in eu-central-1 ...
Instance launched in 00:30.306s -> i-92ef9f53
Waiting for AWS to boot Instance i-92ef9f53 and Payload to start at http://52.28.235.61/ ...
Payload started in 00:29.266s -> http://52.28.235.61/
Remapping Elastic IP 52.28.233.167 to i-92ef9f53 ...
Waiting 15s for AWS to complete Elastic IP Zero Downtime transition ...
Deployment completed successfully. axelfontaine/myapp:1.0 is up and running at http://myapp-
axelfontaine.boxfuse.io/
```

Your application should now be up and running on AWS.

See the blog post on <u>deploying Spring Boot apps on EC2</u> as well as the <u>documentation for the Boxfuse Spring Boot integration</u> to get started with a Maven build to run the app.

## 63.6 Google Cloud

Google Cloud has several options that can be used to launch Spring Boot applications. The easiest to get started with is probably App Engine, but you could also find ways to run Spring Boot in a container with Container Engine or on a virtual machine with Compute Engine.

To run in App Engine, you can create a project in the UI first, which sets up a unique identifier for you and also sets up HTTP routes. Add a Java app to the project and leave it empty and then use the <u>Google Cloud SDK</u> to push your Spring Boot app into that slot from the command line or CI build.

App Engine Standard requires you to use WAR packaging. Follow <u>these steps</u> to deploy App Engine Standard application to Google Cloud.

Alternatively, App Engine Flex requires you to create an app.yaml file to describe the resources your app requires. Normally, you put this file in src/main/appengine, and it should resemble the following file:

```
service: default

runtime: java
env: flex

runtime_config:
    jdk: openjdk8

handlers:
- url: /.*
    script: this field is required, but ignored

manual_scaling:
    instances: 1

health_check:
    enable_health_check: False

env_variables:
    ENCRYPT_KEY: your_encryption_key_here
```

You can deploy the app (for example, with a Maven plugin) by adding the project ID to the build configuration, as shown in the following example:

Then deploy with mvn appengine:deploy (if you need to authenticate first, the build fails).

## 64. Installing Spring Boot Applications

In addition to running Spring Boot applications by using <code>java -jar</code>, it is also possible to make fully executable applications for Unix systems. A fully executable jar can be executed like any other executable binary or it can be <a href="registered with init.dorsystemd">registered with init.dorsystemd</a>. This makes it very easy to install and manage Spring Boot applications in common production environments.

#### Caution

Fully executable jars work by embedding an extra script at the front of the file. Currently, some tools do not accept this format, so you may not always be able to use this technique. For example, <code>jar-xf</code> may silently fail to extract a jar or war that has been made fully executable. It is recommended that you make your jar or war fully executable only if you intend to execute it directly, rather than running it with <code>java-jar</code> or deploying it to a servlet container.

To create a 'fully executable' jar with Maven, use the following plugin configuration:

```
<plugin>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-maven-plugin</artifactId>
<configuration>
  <executable>true</executable>
</configuration>
</plugin>
```

The following example shows the equivalent Gradle configuration:

```
bootJar {
  launchScript()
}
```

You can then run your application by typing . /my-application.jar (where my-application is the name of your artifact). The directory containing the jar is used as your application's working directory.

## **64.1 Supported Operating Systems**

The default script supports most Linux distributions and is tested on CentOS and Ubuntu. Other platforms, such as OS X and FreeBSD, require the use of a custom <code>embeddedLaunchScript</code>.

#### 64.2 Unix/Linux Services

Spring Boot application can be easily started as Unix/Linux services by using either init.d or systemd.

#### Installation as an init.d Service (System V)

If you configured Spring Boot's Maven or Gradle plugin to generate a <u>fully executable jar</u>, and you do not use a custom <code>embeddedLaunchScript</code>, your application can be used as an <code>init.d</code> service. To do so, symlink the jar to <code>init.d</code> to support the standard <code>start</code>, <code>stop</code>, <code>restart</code>, and <code>status</code> commands.

The script supports the following features:

- Starts the services as the user that owns the jar file
- Tracks the application's PID by using /var/run/<appname>/<appname>.pid

• Writes console logs to /var/log/<appname>.log

Assuming that you have a Spring Boot application installed in /var/myapp, to install a Spring Boot application as an init.d service, create a symlink, as follows:

```
$ sudo ln -s /var/myapp/myapp.jar /etc/init.d/myapp
```

Once installed, you can start and stop the service in the usual way. For example, on a Debian-based system, you could start it with the following command:

```
$ service myapp start
```

#### Tip

If your application fails to start, check the log file written to /var/log/<appname>.log for errors.

You can also flag the application to start automatically by using your standard operating system tools. For example, on Debian, you could use the following command:

```
$ update-rc.d myapp defaults <priority>
```

#### Securing an init.d Service

#### Note

The following is a set of guidelines on how to secure a Spring Boot application that runs as an init.d service. It is not intended to be an exhaustive list of everything that should be done to harden an application and the environment in which it runs.

When executed as root, as is the case when root is being used to start an init.d service, the default executable script runs the application as the user who owns the jar file. You should never run a Spring Boot application as root, so your application's jar file should never be owned by root. Instead, create a specific user to run your application and use chown to make it the owner of the jar file, as shown in the following example:

```
$ chown bootapp:bootapp your-app.jar
```

In this case, the default executable script runs the application as the bootapp user.

#### Tip

To reduce the chances of the application's user account being compromised, you should consider preventing it from using a login shell. For example, you can set the account's shell to /usr/sbin/nologin.

You should also take steps to prevent the modification of your application's jar file. Firstly, configure its permissions so that it cannot be written and can only be read or executed by its owner, as shown in the following example:

```
$ chmod 500 your-app.jar
```

Second, you should also take steps to limit the damage if your application or the account that's running it is compromised. If an attacker does gain access, they could make the jar file writable and change its

contents. One way to protect against this is to make it immutable by using chattr, as shown in the following example:

```
$ sudo chattr +i your-app.jar
```

This will prevent any user, including root, from modifying the jar.

If root is used to control the application's service and you <u>use a .conf file</u> to customize its startup, the .conf file is read and evaluated by the root user. It should be secured accordingly. Use chmod so that the file can only be read by the owner and use chown to make root the owner, as shown in the following example:

```
$ chmod 400 your-app.conf
$ sudo chown root:root your-app.conf
```

#### Installation as a systemd Service

systemd is the successor of the System V init system and is now being used by many modern Linux distributions. Although you can continue to use init.d scripts with systemd, it is also possible to launch Spring Boot applications by using systemd 'service' scripts.

Assuming that you have a Spring Boot application installed in <code>/var/myapp</code>, to install a Spring Boot application as a <code>systemd</code> service, create a script named <code>myapp.service</code> and place it in <code>/etc/systemd/system</code> directory. The following script offers an example:

```
[Unit]
Description=myapp
After=syslog.target

[Service]
User=myapp
ExecStart=/var/myapp/myapp.jar
SuccessExitStatus=143

[Install]
WantedBy=multi-user.target
```

#### **Important**

Remember to change the Description, User, and ExecStart fields for your application.

#### **Note**

The ExecStart field does not declare the script action command, which means that the run command is used by default.

Note that, unlike when running as an init.d service, the user that runs the application, the PID file, and the console log file are managed by systemd itself and therefore must be configured by using appropriate fields in the 'service' script. Consult the service unit configuration man page for more details.

To flag the application to start automatically on system boot, use the following command:

```
$ systemctl enable myapp.service
```

Refer to man systematl for more details.

#### **Customizing the Startup Script**

The default embedded startup script written by the Maven or Gradle plugin can be customized in a number of ways. For most people, using the default script along with a few customizations is usually enough. If you find you cannot customize something that you need to, use the <code>embeddedLaunchScript</code> option to write your own file entirely.

#### **Customizing the Start Script when It Is Written**

It often makes sense to customize elements of the start script as it is written into the jar file. For example, init.d scripts can provide a "description". Since you know the description up front (and it need not change), you may as well provide it when the jar is generated.

To customize written elements, use the <code>embeddedLaunchScriptProperties</code> option of the Spring Boot Maven or Gradle plugins.

The following property substitutions are supported with the default script:

Name	Description	Gradle default	Maven default
mode	The script mode.	auto	auto
initInf	oTheo Pridesides section of "INIT INFO"	\${task.baseName}	<pre>\${project.artifactId}</pre>
initInf	o <del>Reguiimed Stantt</del> section of "INIT INFO".	<pre>\$remote_fs \$syslog \$network</pre>	<pre>\$remote_fs \$syslog \$network</pre>
initInf	எ <del>ணழய்imæilsttap</del> p section of "INIT INFO".	<pre>\$remote_fs \$syslog \$network</pre>	<pre>\$remote_fs \$syslog \$network</pre>
initInf	dDeffaulltt-Stantt section of "INIT INFO".	2 3 4 5	2 3 4 5
initInf	<del>വരണ്ടെ</del> ഡ <del>ി!t Sttop</del> p section of "INIT INFO".	0 1 6	0 1 6
initInf	c#frontt-Desscriigttiicm section of "INIT INFO".	Single-line version of \${project.description} (falling back to \${task.baseName})	<pre>\${project.name}</pre>
initInf	dDescorringttiicomsection of "INIT INFO".	<pre>\${project.description} (falling back to \${task.baseName})</pre>	<pre>\${project.description} (falling back to \${project.name})</pre>
initInf	outlikeconffigsection of "INIT INFO"	2345 99 01	2345 99 01
confFol	The default value for CONF_FOLDER	Folder containing the jar	Folder containing the jar
inlined	Reference to a file script that should be inlined in the default launch script.		

Name	Description	Gradle default	Maven default
	This can be used to set environmental variables such as JAVA_OPTS before any external config files are loaded		
logFold	Default value for LOG_FOLDER. Only valid for an init.d service		
logFile	erDefault value for LOG_FILENAME. Only valid for an init.d service		
pidFold	Default value for PID_FOLDER. Only valid for an init.d service		
pidFile	rDefault value for the name of the PID file in PID_FOLDER. Only valid for an init.d service		
useStar	daemon command, when it's available, should be used to control the process	true	true
stopWai	tDefault value for STOP_WAIT_TIME in seconds. Only valid for an init.d service	60	60

## **Customizing a Script When It Runs**

For items of the script that need to be customized *after* the jar has been written, you can use environment variables or a <u>config file</u>.

The following environment properties are supported with the default script:

Variable	Description	
MODE	The "mode" of operation. The default depends on the way the jar was built but is usually auto (meaning it tries to guess if it is an init script by checking if it is a symlink in a directory called init.d). You can explicitly set it to service so that the stop start status restart commands work or to run if you want to run the script in the foreground.	
USE_START_	Stable therethere tart-stop-daemon command, when it's available, should be used to control the process. Defaults to true.	
PID_FOLDER	The root name of the pid folder (/var/run by default).	

Variable	Description
LOG_FOLDER	The name of the folder in which to put log files (/var/log by default).
CONF_FOLDE	RThe name of the folder from which to read .conf files (same folder as jar-file by default).
LOG_FILENA	MEhe name of the log file in the LOG_FOLDER ( <appname>.log by default).</appname>
APP_NAME	The name of the app. If the jar is run from a symlink, the script guesses the app name. If it is not a symlink or you want to explicitly set the app name, this can be useful.
RUN_ARGS	The arguments to pass to the program (the Spring Boot app).
JAVA_HOME	The location of the java executable is discovered by using the PATH by default, but you can set it explicitly if there is an executable file at \$JAVA_HOME/bin/java.
JAVA_OPTS	Options that are passed to the JVM when it is launched.
JARFILE	The explicit location of the jar file, in case the script is being used to launch a jar that it is not actually embedded.
DEBUG	If not empty, sets the $-\mathbf{x}$ flag on the shell process, making it easy to see the logic in the script.
STOP_WAIT_	Time time in seconds to wait when stopping the application before forcing a shutdown (60 by default).

#### Note

The PID\_FOLDER, LOG\_FOLDER, and LOG\_FILENAME variables are only valid for an init.d service. For systemd, the equivalent customizations are made by using the 'service' script. See the service unit configuration man page for more details.

With the exception of JARFILE and APP\_NAME, the settings listed in the preceding section can be configured by using a .conf file. The file is expected to be next to the jar file and have the same name but suffixed with .conf rather than .jar. For example, a jar named /var/myapp/myapp.jar uses the configuration file named /var/myapp/myapp.conf, as shown in the following example:

#### myapp.conf.

JAVA\_OPTS=-Xmx1024M LOG\_FOLDER=/custom/log/folder

#### Tip

If you do not like having the config file next to the jar file, you can set a CONF\_FOLDER environment variable to customize the location of the config file.

To learn about securing this file appropriately, see the guidelines for securing an init.d service.

#### 64.3 Microsoft Windows Services

A Spring Boot application can be started as a Windows service by using winsw.

A (<u>separately maintained sample</u>) describes step-by-step how you can create a Windows service for your Spring Boot application.

## 65. What to Read Next

Check out the <u>Cloud Foundry</u>, <u>Heroku</u>, <u>OpenShift</u>, and <u>Boxfuse</u> web sites for more information about the kinds of features that a PaaS can offer. These are just four of the most popular Java PaaS providers. Since Spring Boot is so amenable to cloud-based deployment, you can freely consider other providers as well.

The next section goes on to cover the <u>Spring Boot CLI</u>, or you can jump ahead to read about <u>build</u> <u>tool plugins</u>.

## Part VII. Spring Boot CLI

The Spring Boot CLI is a command line tool that you can use if you want to quickly develop a Spring application. It lets you run Groovy scripts, which means that you have a familiar Java-like syntax without so much boilerplate code. You can also bootstrap a new project or write your own command for it.

## 66. Installing the CLI

The Spring Boot CLI (Command-Line Interface) can be installed manually by using SDKMAN! (the SDK Manager) or by using Homebrew or MacPorts if you are an OSX user. See <u>Section 10.2</u>, "<u>Installing the Spring Boot CLI"</u> in the "Getting started" section for comprehensive installation instructions.

## 67. Using the CLI

Once you have installed the CLI, you can run it by typing spring and pressing Enter at the command line. If you run spring without any arguments, a simple help screen is displayed, as follows:

You can type spring help to get more details about any of the supported commands, as shown in the following example:

```
$ spring help run
spring run - Run a spring groovy script
usage: spring run [options] <files> [--] [args]
Option
                          Description
--autoconfigure [Boolean] Add autoconfigure compiler
                            transformations (default: true)
transformations (default: t --classpath, -cp Additional classpath entries
                        Open the file with the default system
                           editor
--no-guess-dependencies Do not attempt to guess dependencies
--no-guess-imports Do not attempt to guess imports
-q, --quiet
-v, --verbose
                          Quiet logging
                          Verbose logging of dependency
                            resolution
--watch
                          Watch the specified file for changes
```

The version command provides a quick way to check which version of Spring Boot you are using, as follows:

```
$ spring version
Spring CLI v2.1.0.RELEASE
```

## 67.1 Running Applications with the CLI

You can compile and run Groovy source code by using the run command. The Spring Boot CLI is completely self-contained, so you do not need any external Groovy installation.

The following example shows a "hello world" web application written in Groovy:

#### hello.groovy.

```
@RestController
class WebApplication {

@RequestMapping("/")
String home() {
  "Hello World!"
}
```

To compile and run the application, type the following command:

```
$ spring run hello.groovy
```

To pass command-line arguments to the application, use -- to separate the commands from the "spring" command arguments, as shown in the following example:

```
$ spring run hello.groovy -- --server.port=9000
```

To set JVM command line arguments, you can use the JAVA\_OPTS environment variable, as shown in the following example:

```
$ JAVA_OPTS=-Xmx1024m spring run hello.groovy
```

#### Note

When setting JAVA\_OPTS on Microsoft Windows, make sure to quote the entire instruction, such as set "JAVA\_OPTS=-Xms256m -Xmx2048m". Doing so ensures the values are properly passed to the process.

#### **Deduced "grab" Dependencies**

Standard Groovy includes a @Grab annotation, which lets you declare dependencies on third-party libraries. This useful technique lets Groovy download jars in the same way as Maven or Gradle would but without requiring you to use a build tool.

Spring Boot extends this technique further and tries to deduce which libraries to "grab" based on your code. For example, since the <code>WebApplication</code> code shown previously uses <code>@RestController</code> annotations, Spring Boot grabs "Tomcat" and "Spring MVC".

The following items are used as "grab hints":

Items	Grabs
JdbcTemplate, NamedParameterJdbcTemplate, DataSource	JDBC Application.
@EnableJms	JMS Application.
@EnableCaching	Caching abstraction.
@Test	JUnit.
@EnableRabbit	RabbitMQ.
extends Specification	Spock test.
@EnableBatchProcessing	Spring Batch.
@MessageEndpoint @EnableIntegration	Spring Integration.
@Controller @RestController @EnableWebMvc	Spring MVC + Embedded Tomcat.
@EnableWebSecurity	Spring Security.

Items	Grabs
@EnableTransactionManagement	Spring Transaction Management.

#### Tip

See subclasses of <u>CompilerAutoConfiguration</u> in the Spring Boot CLI source code to understand exactly how customizations are applied.

## **Deduced "grab" Coordinates**

Spring Boot extends Groovy's standard @Grab support by letting you specify a dependency without a group or version (for example, @Grab('freemarker')). Doing so consults Spring Boot's default dependency metadata to deduce the artifact's group and version.

#### Note

The default metadata is tied to the version of the CLI that you use. it changes only when you move to a new version of the CLI, putting you in control of when the versions of your dependencies may change. A table showing the dependencies and their versions that are included in the default metadata can be found in the <u>appendix</u>.

#### **Default Import Statements**

To help reduce the size of your Groovy code, several import statements are automatically included. Notice how the preceding example refers to @Component, @RestController, and @RequestMapping without needing to use fully-qualified names or import statements.

#### Tip

Many Spring annotations work without using import statements. Try running your application to see what fails before adding imports.

#### **Automatic Main Method**

Unlike the equivalent Java application, you do not need to include a public static void main(String[] args) method with your Groovy scripts. A SpringApplication is automatically created, with your compiled code acting as the source.

#### **Custom Dependency Management**

By default, the CLI uses the dependency management declared in spring-boot-dependencies when resolving @Grab dependencies. Additional dependency management, which overrides the default dependency management, can be configured by using the @DependencyManagementBom annotation. The annotation's value should specify the coordinates (groupId:artifactId:version) of one or more Mayen BOMs.

For example, consider the following declaration:

@DependencyManagementBom("com.example.custom-bom:1.0.0")

The preceding declaration picks up custom-bom-1.0.0.pom in a Maven repository under com/example/custom-versions/1.0.0/.

When you specify multiple BOMs, they are applied in the order in which you declare them, as shown in the following example:

```
@DependencyManagementBom(["com.example.custom-bom:1.0.0",
    "com.example.another-bom:1.0.0"])
```

The preceding example indicates that the dependency management in another-bom overrides the dependency management in custom-bom.

You can use @DependencyManagementBom anywhere that you can use @Grab. However, to ensure consistent ordering of the dependency management, you can use @DependencyManagementBom at most once in your application. A useful source of dependency management (which is a superset of Spring Boot's dependency management) is the <a href="Spring IO Platform">Spring IO Platform</a>, which you might include with the following line:

```
@DependencyManagementBom('io.spring.platform:platform-bom:1.1.2.RELEASE')
```

## 67.2 Applications with Multiple Source Files

You can use "shell globbing" with all commands that accept file input. Doing so lets you use multiple files from a single directory, as shown in the following example:

```
$ spring run *.groovy
```

## **67.3 Packaging Your Application**

You can use the jar command to package your application into a self-contained executable jar file, as shown in the following example:

```
$ spring jar my-app.jar *.groovy
```

The resulting jar contains the classes produced by compiling the application and all of the application's dependencies so that it can then be run by using <code>java -jar</code>. The jar file also contains entries from the application's classpath. You can add and remove explicit paths to the jar by using <code>--include</code> and <code>--exclude</code>. Both are comma-separated, and both accept prefixes, in the form of "+" and "-", to signify that they should be removed from the defaults. The default includes are as follows:

```
public/**, resources/**, static/**, templates/**, META-INF/**, *
```

The default excludes are as follows:

```
.*, repository/**, build/**, target/**, **/*.jar, **/*.groovy
```

Type spring help jar on the command line for more information.

## 67.4 Initialize a New Project

The init command lets you create a new project by using <u>start.spring.io</u> without leaving the shell, as shown in the following example:

```
$ spring init --dependencies=web,data-jpa my-project
Using service at https://start.spring.io
Project extracted to '/Users/developer/example/my-project'
```

The preceding example creates a my-project directory with a Maven-based project that uses spring-boot-starter-web and spring-boot-starter-data-jpa. You can list the capabilities of the service by using the --list flag, as shown in the following example:

The init command supports many options. See the help output for more details. For instance, the following command creates a Gradle project that uses Java 8 and war packaging:

```
$ spring init --build=gradle --java-version=1.8 --dependencies=websocket --packaging=war sample-app.zip
Using service at https://start.spring.io
Content saved to 'sample-app.zip'
```

## 67.5 Using the Embedded Shell

Spring Boot includes command-line completion scripts for the BASH and zsh shells. If you do not use either of these shells (perhaps you are a Windows user), you can use the shell command to launch an integrated shell, as shown in the following example:

```
$ spring shell
Spring Boot (v2.1.0.RELEASE)
Hit TAB to complete. Type \'help' and hit RETURN for help, and \'exit' to quit.
```

From inside the embedded shell, you can run other commands directly:

```
$ version
Spring CLI v2.1.0.RELEASE
```

The embedded shell supports ANSI color output as well as tab completion. If you need to run a native command, you can use the ! prefix. To exit the embedded shell, press ctrl-c.

## 67.6 Adding Extensions to the CLI

You can add extensions to the CLI by using the install command. The command takes one or more sets of artifact coordinates in the format group:artifact:version, as shown in the following example:

```
$ spring install com.example:spring-boot-cli-extension:1.0.0.RELEASE
```

In addition to installing the artifacts identified by the coordinates you supply, all of the artifacts' dependencies are also installed.

To uninstall a dependency, use the uninstall command. As with the install command, it takes one or more sets of artifact coordinates in the format of group:artifact:version, as shown in the following example:

```
$ spring uninstall com.example:spring-boot-cli-extension:1.0.0.RELEASE
```

It uninstalls the artifacts identified by the coordinates you supply and their dependencies.

To uninstall all additional dependencies, you can use the --all option, as shown in the following example:

```
$ spring uninstall --all
```

## 68. Developing Applications with the Groovy Beans DSL

Spring Framework 4.0 has native support for a beans {} "DSL" (borrowed from <u>Grails</u>), and you can embed bean definitions in your Groovy application scripts by using the same format. This is sometimes a good way to include external features like middleware declarations, as shown in the following example:

```
@Configuration
class Application implements CommandLineRunner {

@Autowired
SharedService service

@Override
void run(String... args) {
  println service.message
}

}

import my.company.SharedService

beans {
  service(SharedService) {
  message = "Hello World"
  }
}
```

You can mix class declarations with beans {} in the same file as long as they stay at the top level, or, if you prefer, you can put the beans DSL in a separate file.

## 69. Configuring the CLI with settings.xml

The Spring Boot CLI uses Aether, Maven's dependency resolution engine, to resolve dependencies. The CLI makes use of the Maven configuration found in  $\sim/.m2/settings.xml$  to configure Aether. The following configuration settings are honored by the CLI:

- Offline
- Mirrors
- Servers
- Proxies
- Profiles
  - Activation
  - Repositories
- · Active profiles

See Maven's settings documentation for further information.

## 70. What to Read Next

There are some <u>sample groovy scripts</u> available from the GitHub repository that you can use to try out the Spring Boot CLI. There is also extensive Javadoc throughout the <u>source code</u>.

If you find that you reach the limit of the CLI tool, you probably want to look at converting your application to a full Gradle or Maven built "Groovy project". The next section covers Spring Boot's "Build tool plugins", which you can use with Gradle or Maven.

## Part VIII. Build tool plugins

Spring Boot provides build tool plugins for Maven and Gradle. The plugins offer a variety of features, including the packaging of executable jars. This section provides more details on both plugins as well as some help should you need to extend an unsupported build system. If you are just getting started, you might want to read "Chapter 13, Build Systems" from the "Part III, "Using Spring Boot" section first.

## 71. Spring Boot Maven Plugin

The <u>Spring Boot Maven Plugin</u> provides Spring Boot support in Maven, letting you package executable jar or war archives and run an application "in-place". To use it, you must use Maven 3.2 (or later).

#### **Note**

See the Spring Boot Maven Plugin Site for complete plugin documentation.

## 71.1 Including the Plugin

To use the Spring Boot Maven Plugin, include the appropriate XML in the plugins section of your pom.xml, as shown in the following example:

```
<?xml version="1.0" encoding="UTF-8"?>
xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
<modelVersion>4.0.0</modelVersion>
<build>
 <plugins>
  <plugin>
  <groupId>org.springframework.boot
  <artifactId>spring-boot-maven-plugin</artifactId>
  <version>2.1.0.RELEASE
   <execution>
    <goals>
     <goal>repackage</goal>
   </execution>
  </executions>
  </plugin>
 </plugins>
</build>
</project>
```

The preceding configuration repackages a jar or war that is built during the package phase of the Maven lifecycle. The following example shows both the repackaged jar as well as the original jar in the target directory:

```
$ mvn package
$ ls target/*.jar
target/myproject-1.0.0.jar target/myproject-1.0.0.jar.original
```

If you do not include the <execution/> configuration, as shown in the prior example, you can run the plugin on its own (but only if the package goal is used as well), as shown in the following example:

```
$ mvn package spring-boot:repackage
$ ls target/*.jar
target/myproject-1.0.0.jar target/myproject-1.0.0.jar.original
```

If you use a milestone or snapshot release, you also need to add the appropriate pluginRepository elements, as shown in the following listing:

```
<pluginRepositories>
<pluginRepository>
<id>spring-snapshots</id>
<url>https://repo.spring.io/snapshot</url>
</pluginRepository>
<pluginRepository></pluginRepository></pl
```

```
<id>spring-milestones</id>
<url>https://repo.spring.io/milestone</url>
</pluginRepository>
</pluginRepositories>
```

## 71.2 Packaging Executable Jar and War Files

Once spring-boot-maven-plugin has been included in your pom.xml, it automatically tries to rewrite archives to make them executable by using the spring-boot:repackage goal. You should configure your project to build a jar or war (as appropriate) by using the usual packaging element, as shown in the following example:

Your existing archive is enhanced by Spring Boot during the package phase. The main class that you want to launch can be specified either by using a configuration option or by adding a Main-Class attribute to the manifest in the usual way. If you do not specify a main class, the plugin searches for a class with a public static void main(String[] args) method.

To build and run a project artifact, you can type the following:

```
$ mvn package
$ java -jar target/mymodule-0.0.1-SNAPSHOT.jar
```

To build a war file that is both executable and deployable into an external container, you need to mark the embedded container dependencies as "provided", as shown in the following example:

#### Tip

See the "Section 92.1, "Create a Deployable War File"" section for more details on how to create a deployable war file.

Advanced configuration options and examples are available in the plugin info page.

## 72. Spring Boot Gradle Plugin

The Spring Boot Gradle Plugin provides Spring Boot support in Gradle, letting you package executable jar or war archives, run Spring Boot applications, and use the dependency management provided by spring-boot-dependencies. It requires Gradle 4.4 or later. Please refer to the plugin's documentation to learn more:

- Reference (HTML and PDF)
- API

## 73. Spring Boot AntLib Module

The Spring Boot AntLib module provides basic Spring Boot support for Apache Ant. You can use the module to create executable jars. To use the module, you need to declare an additional spring-boot namespace in your build.xml, as shown in the following example:

You need to remember to start Ant using the -lib option, as shown in the following example:

```
$ ant -lib <folder containing spring-boot-antlib-2.1.0.RELEASE.jar>
```

#### Tip

The "Using Spring Boot" section includes a more complete example of <u>using Apache Ant with spring-boot-antlib</u>.

## 73.1 Spring Boot Ant Tasks

Once the spring-boot-antlib namespace has been declared, the following additional tasks are available:

- the section called "spring-boot:exejar"
- Section 73.2, "spring-boot:findmainclass"

#### spring-boot:exejar

You can use the <code>exejar</code> task to create a Spring Boot executable jar. The following attributes are supported by the task:

Attribute	Description	Required
destfile	The destination jar file to create	Yes
classes	The root directory of Java class files	Yes
start-class	The main application class to run	No (the default is the first class found that declares a main method)

The following nested elements can be used with the task:

Element	Description	
resources	One or more Resource Collections describing a set of Resources that should be added to the content of the created jar file.	
lib	One or more Resource Collections that should be added to the set of jar libraries that make up the runtime dependency classpath of the application.	

#### **Examples**

This section shows two examples of Ant tasks.

#### Specify start-class.

#### Detect start-class.

```
<exejar destfile="target/my-application.jar" classes="target/classes">
  b>
    <fileset dir="lib" />
    </lib>
  </exejar>
```

## 73.2 spring-boot:findmainclass

The findmainclass task is used internally by exejar to locate a class declaring a main. If necessary, you can also use this task directly in your build. The following attributes are supported:

Attribute	Description	Required
classesroot	The root directory of Java class files	Yes (unless mainclass is specified)
mainclass	Can be used to short-circuit the main class search	No
property	The Ant property that should be set with the result	No (result will be logged if unspecified)

#### **Examples**

This section contains three examples of using findmainclass.

#### Find and log.

```
<findmainclass classesroot="target/classes" />
```

#### Find and set.

```
<findmainclass classesroot="target/classes" property="main-class" />
```

#### Override and set.

```
<findmainclass mainclass="com.example.MainClass" property="main-class" />
```

## 74. Supporting Other Build Systems

If you want to use a build tool other than Maven, Gradle, or Ant, you likely need to develop your own plugin. Executable jars need to follow a specific format and certain entries need to be written in an uncompressed form (see the "executable jar format" section in the appendix for details).

The Spring Boot Maven and Gradle plugins both make use of spring-boot-loader-tools to actually generate jars. If you need to, you may use this library directly.

## 74.1 Repackaging Archives

To repackage an existing archive so that it becomes a self-contained executable archive, use org.springframework.boot.loader.tools.Repackager. The Repackager class takes a single constructor argument that refers to an existing jar or war archive. Use one of the two available repackage() methods to either replace the original file or write to a new destination. Various settings can also be configured on the repackager before it is run.

#### 74.2 Nested Libraries

When repackaging an archive, you can include references to dependency files by using the org.springframework.boot.loader.tools.Libraries interface. We do not provide any concrete implementations of Libraries here as they are usually build-system-specific.

If your archive already includes libraries, you can use Libraries.NONE.

## 74.3 Finding a Main Class

If you do not use Repackager.setMainClass() to specify a main class, the repackager uses ASM to read class files and tries to find a suitable class with a public static void main(String[] args) method. An exception is thrown if more than one candidate is found.

## 74.4 Example Repackage Implementation

The following example shows a typical repackage implementation:

```
Repackager repackager = new Repackager(sourceJarFile);
repackager.setBackupSource(false);
repackager.repackage(new Libraries() {
    @Override
    public void doWithLibraries(LibraryCallback callback) throws IOException {
        // Build system specific implementation, callback for each dependency
        // callback.library(new Library(nestedFile, LibraryScope.COMPILE));
    }
});
```

# 75. What to Read Next

If you are interested in how the build tool plugins work, you can look at the spring-boot-tools module on GitHub. More technical details of the executable jar format are covered in the appendix.

If you have specific build-related questions, you can check out the "how-to" guides.

# Part IX. 'How-to' guides

This section provides answers to some common 'how do I do that...' questions that often arise when using Spring Boot. Its coverage is not exhaustive, but it does cover quite a lot.

If you have a specific problem that we do not cover here, you might want to check out <u>stackoverflow.com</u> to see if someone has already provided an answer. This is also a great place to ask new questions (please use the <u>spring-boot</u> tag).

We are also more than happy to extend this section. If you want to add a 'how-to', send us a <u>pull request</u>.

# 76. Spring Boot Application

This section includes topics relating directly to Spring Boot applications.

### 76.1 Create Your Own FailureAnalyzer

<u>FailureAnalyzer</u> is a great way to intercept an exception on startup and turn it into a human-readable message, wrapped in a <u>FailureAnalysis</u>. Spring Boot provides such an analyzer for application-context-related exceptions, JSR-303 validations, and more. You can also create your own.

AbstractFailureAnalyzer is a convenient extension of FailureAnalyzer that checks the presence of a specified exception type in the exception to handle. You can extend from that so that your implementation gets a chance to handle the exception only when it is actually present. If, for whatever reason, you cannot handle the exception, return null to give another implementation a chance to handle the exception.

FailureAnalyzer implementations must be registered in META-INF/spring.factories. The following example registers ProjectConstraintViolationFailureAnalyzer:

```
org.springframework.boot.diagnostics.FailureAnalyzer=\
com.example.ProjectConstraintViolationFailureAnalyzer
```

#### **Note**

If you need access to the BeanFactory or the Environment, your FailureAnalyzer can simply implement BeanFactoryAware or EnvironmentAware respectively.

# 76.2 Troubleshoot Auto-configuration

The Spring Boot auto-configuration tries its best to "do the right thing", but sometimes things fail, and it can be hard to tell why.

There is a really useful <code>ConditionEvaluationReport</code> available in any Spring Boot <code>ApplicationContext</code>. You can see it if you enable <code>DEBUG</code> logging output. If you use the <code>springboot-actuator</code> (see the Actuator chapter), there is also a <code>conditions</code> endpoint that renders the report in JSON. Use that endpoint to debug the application and see what features have been added (and which have not been added) by Spring Boot at runtime.

Many more questions can be answered by looking at the source code and the Javadoc. When reading the code, remember the following rules of thumb:

- Look for classes called \*AutoConfiguration and read their sources. Pay special attention to the @Conditional\* annotations to find out what features they enable and when. Add --debug to the command line or a System property -Ddebug to get a log on the console of all the auto-configuration decisions that were made in your app. In a running Actuator app, look at the conditions endpoint (/actuator/conditions or the JMX equivalent) for the same information.
- Look for classes that are @ConfigurationProperties (such as <u>ServerProperties</u>) and read from there the available external configuration options. The @ConfigurationProperties annotation has a name attribute that acts as a prefix to external properties. Thus, ServerProperties has prefix="server" and its configuration properties are server.port, server.address, and others. In a running Actuator app, look at the configprops endpoint.

- Look for uses of the bind method on the Binder to pull configuration values explicitly out of the Environment in a relaxed manner. It is often used with a prefix.
- Look for @Value annotations that bind directly to the Environment.
- Look for @ConditionalOnExpression annotations that switch features on and off in response to SpEL expressions, normally evaluated with placeholders resolved from the Environment.

# 76.3 Customize the Environment or ApplicationContext Before It Starts

A SpringApplication has ApplicationListeners and ApplicationContextInitializers that are used to apply customizations to the context or environment. Spring Boot loads a number of such customizations for use internally from META-INF/spring.factories. There is more than one way to register additional customizations:

- Programmatically, per application, by calling the addListeners and addInitializers methods on SpringApplication before you run it.
- Declaratively, per application, by setting the context.initializer.classes or context.listener.classes properties.
- Declaratively, for all applications, by adding a META-INF/spring.factories and packaging a jar file that the applications all use as a library.

The SpringApplication sends some special ApplicationEvents to the listeners (some even before the context is created) and then registers the listeners for events published by the ApplicationContext as well. See "Section 23.5, "Application Events and Listeners" in the 'Spring Boot features' section for a complete list.

It is also possible to customize the Environment before the application context is refreshed by using EnvironmentPostProcessor. Each implementation should be registered in META-INF/spring.factories, as shown in the following example:

```
org.springframework.boot.env.EnvironmentPostProcessor=com.example.YourEnvironmentPostProcessor
```

The implementation can load arbitrary files and add them to the Environment. For instance, the following example loads a YAML configuration file from the classpath:

```
public class EnvironmentPostProcessorExample implements EnvironmentPostProcessor {
   private final YamlPropertySourceLoader loader = new YamlPropertySourceLoader();

   @Override
   public void postProcessEnvironment(ConfigurableEnvironment environment,
        SpringApplication application) {
        Resource path = new ClassPathResource("com/example/myapp/config.yml");
        PropertySource<?> propertySource = loadYaml(path);
        environment.getPropertySources().addLast(propertySource);
    }

   private PropertySource<?> loadYaml(Resource path) {
        if (!path.exists()) {
            throw new IllegalArgumentException("Resource " + path + " does not exist");
        }
        try {
            return this.loader.load("custom-resource", path).get(0);
        }
}
```

```
catch (IOException ex) {
  throw new IllegalStateException(
   "Failed to load yaml configuration from " + path, ex);
}
}
```

#### Tip

The Environment has already been prepared with all the usual property sources that Spring Boot loads by default. It is therefore possible to get the location of the file from the environment. The preceding example adds the <code>custom-resource</code> property source at the end of the list so that a key defined in any of the usual other locations takes precedence. A custom implementation may define another order.

#### Caution

While using @PropertySource on your @SpringBootApplication may seem to be a convenient and easy way to load a custom resource in the Environment, we do not recommend it, because Spring Boot prepares the Environment before the ApplicationContext is refreshed. Any key defined with @PropertySource is loaded too late to have any effect on autoconfiguration.

# 76.4 Build an ApplicationContext Hierarchy (Adding a Parent or Root Context)

You can use the ApplicationBuilder class to create parent/child ApplicationContext hierarchies. See "Section 23.4, "Fluent Builder API" in the 'Spring Boot features' section for more information.

# 76.5 Create a Non-web Application

Not all Spring applications have to be web applications (or web services). If you want to execute some code in a main method but also bootstrap a Spring application to set up the infrastructure to use, you can use the SpringApplication features of Spring Boot. A SpringApplication changes its ApplicationContext class, depending on whether it thinks it needs a web application or not. The first thing you can do to help it is to leave server-related dependencies (e.g. servlet API) off the classpath. If you cannot do that (for example, you run two applications from the same code base) then you can explicitly call setWebApplicationType(WebApplicationType.NONE) on your SpringApplication instance or set the applicationContextClass property (through the Java API or with external properties). Application code that you want to run as your business logic can be implemented as a CommandLineRunner and dropped into the context as a @Bean definition.

# 77. Properties and Configuration

This section includes topics about setting and reading properties and configuration settings and their interaction with Spring Boot applications.

# 77.1 Automatically Expand Properties at Build Time

Rather than hardcoding some properties that are also specified in your project's build configuration, you can automatically expand them by instead using the existing build configuration. This is possible in both Maven and Gradle.

### **Automatic Property Expansion Using Maven**

You can automatically expand properties from the Maven project by using resource filtering. If you use the <code>spring-boot-starter-parent</code>, you can then refer to your Maven 'project properties' with @..@ placeholders, as shown in the following example:

```
app.encoding=@project.build.sourceEncoding@
app.java.version@
```

#### Note

Only production configuration is filtered that way (in other words, no filtering is applied on src/test/resources).

#### Tip

If you enable the addResources flag, the spring-boot:run goal can add src/main/resources directly to the classpath (for hot reloading purposes). Doing so circumvents the resource filtering and this feature. Instead, you can use the exec: java goal or customize the plugin's configuration. See the plugin usage page for more details.

If you do not use the starter parent, you need to include the following element inside the <build/> element of your pom.xml:

```
<resources>
<resource>
  <directory>src/main/resources</directory>
  <filtering>true</filtering>
  </resource>
</resources>
```

You also need to include the following element inside <plugins/>:

```
<plugin>
  <groupId>org.apache.maven.plugins</groupId>
  <artifactId>maven-resources-plugin</artifactId>
  <version>2.7</version>
  <configuration>
    <delimiters>
        <delimiters>
        <delimiters>
        </delimiters>
        </delimiters>
        <useDefaultDelimiters>false</useDefaultDelimiters>
        </configuration>
        </plugin>
```

#### Note

The useDefaultDelimiters property is important if you use standard Spring placeholders (such as \${placeholder}) in your configuration. If that property is not set to false, these may be expanded by the build.

### **Automatic Property Expansion Using Gradle**

You can automatically expand properties from the Gradle project by configuring the Java plugin's processResources task to do so, as shown in the following example:

```
processResources {
  expand(project.properties)
}
```

You can then refer to your Gradle project's properties by using placeholders, as shown in the following example:

```
app.name=${name}
app.description=${description}
```

#### Note

Gradle's expand method uses Groovy's SimpleTemplateEngine, which transforms  $\{...\}$  tokens. The  $\{...\}$  style conflicts with Spring's own property placeholder mechanism. To use Spring property placeholders together with automatic expansion, escape the Spring property placeholders as follows:  $\{...\}$ .

# 77.2 Externalize the Configuration of SpringApplication

A SpringApplication has bean properties (mainly setters), so you can use its Java API as you create the application to modify its behavior. Alternatively, you can externalize the configuration by setting properties in spring.main.\*. For example, in application.properties, you might have the following settings:

```
spring.main.web-application-type=none
spring.main.banner-mode=off
```

Then the Spring Boot banner is not printed on startup, and the application is not starting an embedded web server.

Properties defined in external configuration override the values specified with the Java API, with the notable exception of the sources used to create the ApplicationContext. Consider the following application:

```
new SpringApplicationBuilder()
   .bannerMode(Banner.Mode.OFF)
   .sources(demo.MyApp.class)
   .run(args);
```

Now consider the following configuration:

```
spring.main.sources=com.acme.Config,com.acme.ExtraConfig
spring.main.banner-mode=console
```

The actual application *now* shows the banner (as overridden by configuration) and uses three sources for the ApplicationContext (in the following order): demo.MyApp, com.acme.Config, and com.acme.ExtraConfig.

# 77.3 Change the Location of External Properties of an Application

By default, properties from different sources are added to the Spring Environment in a defined order (see "Chapter 24, Externalized Configuration" in the 'Spring Boot features' section for the exact order).

A nice way to augment and modify this ordering is to add @PropertySource annotations to your application sources. Classes passed to the SpringApplication static convenience methods and those added using setSources() are inspected to see if they have @PropertySources. If they do, those properties are added to the Environment early enough to be used in all phases of the ApplicationContext lifecycle. Properties added in this way have lower priority than any added by using the default locations (such as application.properties), system properties, environment variables, or the command line.

You can also provide the following System properties (or environment variables) to change the behavior:

- spring.config.name (SPRING\_CONFIG\_NAME): Defaults to application as the root of the file name.
- spring.config.location (SPRING\_CONFIG\_LOCATION): The file to load (such as a classpath
  resource or a URL). A separate Environment property source is set up for this document and it can
  be overridden by system properties, environment variables, or the command line.

No matter what you set in the environment, Spring Boot always loads application.properties as described above. By default, if YAML is used, then files with the '.yml' extension are also added to the list.

Spring Boot logs the configuration files that are loaded at the DEBUG level and the candidates it has not found at TRACE level.

See <u>ConfigFileApplicationListener</u> for more detail.

# 77.4 Use 'Short' Command Line Arguments

Some people like to use (for example) --port=9000 instead of --server.port=9000 to set configuration properties on the command line. You can enable this behavior by using placeholders in application.properties, as shown in the following example:

server.port=\${port:8080}

#### Tip

If you inherit from the spring-boot-starter-parent POM, the default filter token of the maven-resources-plugins has been changed from \${\*} to @ (that is, @maven.token@ instead of \${maven.token}) to prevent conflicts with Spring-style placeholders. If you have enabled Maven filtering for the application.properties directly, you may want to also change the default filter token to use other delimiters.

#### Note

In this specific case, the port binding works in a PaaS environment such as Heroku or Cloud Foundry. In those two platforms, the PORT environment variable is set automatically and Spring can bind to capitalized synonyms for Environment properties.

# 77.5 Use YAML for External Properties

YAML is a superset of JSON and, as such, is a convenient syntax for storing external properties in a hierarchical format, as shown in the following example:

```
spring:
application:
name: cruncher
datasource:
    driverClassName: com.mysql.jdbc.Driver
    url: jdbc:mysql://localhost/test
server:
port: 9000
```

Create a file called application.yml and put it in the root of your classpath. Then add snakeyaml to your dependencies (Maven coordinates org.yaml:snakeyaml, already included if you use the spring-boot-starter). A YAML file is parsed to a Java Map<String,Object> (like a JSON object), and Spring Boot flattens the map so that it is one level deep and has period-separated keys, as many people are used to with Properties files in Java.

The preceding example YAML corresponds to the following application.properties file:

```
spring.application.name=cruncher
spring.datasource.driverClassName=com.mysql.jdbc.Driver
spring.datasource.url=jdbc:mysql://localhost/test
server.port=9000
```

See "Section 24.7, "Using YAML Instead of Properties" in the 'Spring Boot features' section for more information about YAML.

# 77.6 Set the Active Spring Profiles

The Spring Environment has an API for this, but you would normally set a System property (spring.profiles.active) or an OS environment variable (SPRING\_PROFILES\_ACTIVE). Also, you can launch your application with a -D argument (remember to put it before the main class or jar archive), as follows:

```
$ java -jar -Dspring.profiles.active=production demo-0.0.1-SNAPSHOT.jar
```

In Spring Boot, you can also set the active profile in application.properties, as shown in the following example:

```
spring.profiles.active=production
```

A value set this way is replaced by the System property or environment variable setting but not by the SpringApplicationBuilder.profiles() method. Thus, the latter Java API can be used to augment the profiles without changing the defaults.

See "Chapter 25, Profiles" in the "Spring Boot features" section for more information.

# 77.7 Change Configuration Depending on the Environment

A YAML file is actually a sequence of documents separated by --- lines, and each document is parsed separately to a flattened map.

If a YAML document contains a spring.profiles key, then the profiles value (a comma-separated list of profiles) is fed into the Spring Environment.acceptsProfiles() method. If any of those profiles is active, that document is included in the final merge (otherwise, it is not), as shown in the following example:

```
server:
  port: 9000
---
spring:
  profiles: development
server:
  port: 9001
---
spring:
  profiles: production
server:
  port: 0
```

In the preceding example, the default port is 9000. However, if the Spring profile called 'development' is active, then the port is 9001. If 'production' is active, then the port is 0.

#### Note

The YAML documents are merged in the order in which they are encountered. Later values override earlier values.

To do the same thing with properties files, you can use application-\${profile}.properties to specify profile-specific values.

# 77.8 Discover Built-in Options for External Properties

Spring Boot binds external properties from application.properties (or .yml files and other places) into an application at runtime. There is not (and technically cannot be) an exhaustive list of all supported properties in a single location, because contributions can come from additional jar files on your classpath.

A running application with the Actuator features has a configprops endpoint that shows all the bound and bindable properties available through @ConfigurationProperties.

The appendix includes an <u>application.properties</u> example with a list of the most common properties supported by Spring Boot. The definitive list comes from searching the source code for <code>@ConfigurationProperties</code> and <code>@Value</code> annotations as well as the occasional use of <code>Binder</code>. For more about the exact ordering of loading properties, see "<u>Chapter 24</u>, <u>Externalized Configuration</u>".

### 78. Embedded Web Servers

Each Spring Boot web application includes an embedded web server. This feature leads to a number of how-to questions, including how to change the embedded server and how to configure the embedded server. This section answers those questions.

#### 78.1 Use Another Web Server

Many Spring Boot starters include default embedded containers.

- For servlet stack applications, the spring-boot-starter-web includes Tomcat by including spring-boot-starter-tomcat, but you can use spring-boot-starter-jetty or spring-boot-starter-undertow instead.
- For reactive stack applications, the spring-boot-starter-webflux includes Reactor Netty by including spring-boot-starter-reactor-netty, but you can use spring-boot-starter-tomcat, spring-boot-starter-jetty, or spring-boot-starter-undertow instead.

When switching to a different HTTP server, you need to exclude the default dependencies in addition to including the one you need. Spring Boot provides separate starters for HTTP servers to help make this process as easy as possible.

The following Maven example shows how to exclude Tomcat and include Jetty for Spring MVC:

```
properties>
<servlet-api.version>3.1.0</servlet-api.version>
</properties>
<dependency>
<groupId>org.springframework.boot
<artifactId>spring-boot-starter-web</artifactId>
<exclusions>
 <!-- Exclude the Tomcat dependency -->
 <exclusion>
  <groupId>org.springframework.boot
  <artifactId>spring-boot-starter-tomcat</artifactId>
 </exclusion>
</exclusions>
</dependency>
<!-- Use Jetty instead -->
<dependency>
<groupId>org.springframework.boot
<artifactId>spring-boot-starter-jetty</artifactId>
</dependency>
```

#### Note

The version of the Servlet API has been overridden as, unlike Tomcat 9 and Undertow 2.0, Jetty 9.4 does not support Servlet 4.0.

The following Gradle example shows how to exclude Netty and include Undertow for Spring WebFlux:

```
configurations {
  // exclude Reactor Netty
  compile.exclude module: 'spring-boot-starter-reactor-netty'
}
dependencies {
  compile 'org.springframework.boot:spring-boot-starter-webflux'
  // Use Undertow instead
  compile 'org.springframework.boot:spring-boot-starter-undertow'
```

```
// ...
}
```

#### Note

spring-boot-starter-reactor-netty is required to use the WebClient class, so you may need to keep a dependency on Netty even when you need to include a different HTTP server.

# 78.2 Disabling the Web Server

If your classpath contains the necessary bits to start a web server, Spring Boot will automatically start it. To disable this behaviour configure the WebApplicationType in your application.properties, as shown in the following example:

```
spring.main.web-application-type=none
```

# 78.3 Change the HTTP Port

In a standalone application, the main HTTP port defaults to 8080 but can be set with server.port (for example, in application.properties or as a System property). Thanks to relaxed binding of Environment values, you can also use SERVER\_PORT (for example, as an OS environment variable).

To switch off the HTTP endpoints completely but still create a WebApplicationContext, use server.port=-1. (Doing so is sometimes useful for testing.)

For more details, see "the section called "Customizing Embedded Servlet Containers"" in the 'Spring Boot features' section, or the <u>ServerProperties</u> source code.

# 78.4 Use a Random Unassigned HTTP Port

To scan for a free port (using OS natives to prevent clashes) use server.port=0.

### 78.5 Discover the HTTP Port at Runtime

You can access the port the server is running on from log output or from the ServletWebServerApplicationContext through its WebServer. The best way to get that and be sure that it has been initialized is to add a @Bean of type ApplicationListener<ServletWebServerInitializedEvent> and pull the container out of the event when it is published.

Tests that use @SpringBootTest(webEnvironment=WebEnvironment.RANDOM\_PORT) can also inject the actual port into a field by using the @LocalServerPort annotation, as shown in the following example:

```
@RunWith(SpringJUnit4ClassRunner.class)
@SpringBootTest(webEnvironment=WebEnvironment.RANDOM_PORT)
public class MyWebIntegrationTests {

@Autowired
ServletWebServerApplicationContext server;

@LocalServerPort
int port;

// ...
}
```

#### Note

<code>@LocalServerPort</code> is a meta-annotation for <code>@Value("\${local.server.port}")</code>. Do not try to inject the port in a regular application. As we just saw, the value is set only after the container has been initialized. Contrary to a test, application code callbacks are processed early (before the value is actually available).

# 78.6 Enable HTTP Response Compression

HTTP response compression is supported by Jetty, Tomcat, and Undertow. It can be enabled in application.properties, as follows:

```
server.compression.enabled=true
```

By default, responses must be at least 2048 bytes in length for compression to be performed. You can configure this behavior by setting the server.compression.min-response-size property.

By default, responses are compressed only if their content type is one of the following:

- text/html
- text/xml
- text/plain
- text/css
- text/javascript
- application/javascript
- application/json
- application/xml

You can configure this behavior by setting the server.compression.mime-types property.

# 78.7 Configure SSL

SSL can be configured declaratively by setting the various <code>server.ssl.\*</code> properties, typically in application.properties or application.yml. The following example shows setting SSL properties in application.properties:

```
server.port=8443
server.ssl.key-store=classpath:keystore.jks
server.ssl.key-store-password=secret
server.ssl.key-password=another-secret
```

See Ssl for details of all of the supported properties.

Using configuration such as the preceding example means the application no longer supports a plain HTTP connector at port 8080. Spring Boot does not support the configuration of both an HTTP connector and an HTTPS connector through application.properties. If you want to have both, you need to configure one of them programmatically. We recommend using application.properties to

configure HTTPS, as the HTTP connector is the easier of the two to configure programmatically. See the <a href="mailto:spring-boot-sample-tomcat-multi-connectors">spring-boot-sample-tomcat-multi-connectors</a> sample project for an example.

# 78.8 Configure HTTP/2

You can enable HTTP/2 support in your Spring Boot application with the server.http2.enabled configuration property. This support depends on the chosen web server and the application environment, since that protocol is not supported out-of-the-box by JDK8.

#### Note

Spring Boot does not support h2c, the cleartext version of the HTTP/2 protocol. So you must configure SSL first.

#### HTTP/2 with Undertow

As of Undertow 1.4.0+, HTTP/2 is supported without any additional requirement on JDK8.

### HTTP/2 with Jetty

As of Jetty 9.4.8, HTTP/2 is also supported with the <u>Conscrypt library</u>. To enable that support, your application needs to have two additional dependencies: org.eclipse.jetty:jetty-alpn-conscrypt-server and org.eclipse.jetty.http2-server.

### HTTP/2 with Tomcat

Spring Boot ships by default with Tomcat 9.0.x which supports HTTP/2 out of the box when using JDK 9 or later. Alternatively, HTTP/2 can be used on JDK 8 if the libtcnative library and its dependencies are installed on the host operating system.

The library folder must be made available, if not already, to the JVM library path. You can do so with a JVM argument such as -Djava.library.path=/usr/local/opt/tomcat-native/lib. More on this in the official Tomcat documentation.

Starting Tomcat 9.0.x on JDK 8 without that native support logs the following error:

```
ERROR 8787 --- [ main] o.a.coyote.http11.Http11NioProtocol : The upgrade handler [org.apache.coyote.http2.Http2Protocol] for [h2] only supports upgrade via ALPN but has been configured for the ["https-jsse-nio-8443"] connector that does not support ALPN.
```

This error is not fatal, and the application still starts with HTTP/1.1 SSL support.

#### HTTP/2 with Reactor Netty

The spring-boot-webflux-starter is using by default Reactor Netty as a server. Reactor Netty can be configured for HTTP/2 using the JDK support with JDK 9 or later. For JDK 8 environments, or for optimal runtime performance, this server also supports HTTP/2 with native libraries. To enable that, your application needs to have an additional dependency.

Spring Boot manages the version for the io.netty:netty-tcnative-boringssl-static "uber jar", containing native libraries for all platforms. Developers can choose to import only the required dependencies using a classifier (see <a href="tel:the.Netty-official documentation">the.Netty-tcnative-boringssl-static "uber jar", containing native libraries for all platforms. Developers can choose to import only the required dependencies using a classifier (see <a href="tel:the.Netty-official documentation">the.Netty-tcnative-boringssl-static "uber jar", containing native libraries for all platforms. Developers can choose to import only the required dependencies using a classifier (see <a href="tel:the.Netty-official documentation">the.Netty-tcnative-boringssl-static</a> "uber jar", containing native libraries for all platforms. Developers can choose to import only the required dependencies using a classifier (see <a href="tel:the.Netty-official documentation">the.Netty-official documentation</a>).

### 78.9 Configure the Web Server

Generally, you should first consider using one of the many available configuration keys and customize your web server by adding new entries in your application.properties (or application.yml, or environment, etc. see "Section 77.8, "Discover Built-in Options for External Properties"). The server.\* namespace is quite useful here, and it includes namespaces like server.tomcat.\*, server.jetty.\* and others, for server-specific features. See the list of Appendix A, Common application properties.

The previous sections covered already many common use cases, such as compression, SSL or HTTP/2. However, if a configuration key doesn't exist for your use case, you should then look at <a href="MebServerFactoryCustomizer">WebServerFactoryCustomizer</a>. You can declare such a component and get access to the server factory relevant to your choice: you should select the variant for the chosen Server (Tomcat, Jetty, Reactor Netty, Undertow) and the chosen web stack (Servlet or Reactive).

The example below is for Tomcat with the spring-boot-starter-web (Servlet stack):

```
@Component
public class MyTomcatWebServerCustomizer
  implements WebServerFactoryCustomizer<TomcatServletWebServerFactory> {
  @Override
  public void customize(TomcatServletWebServerFactory factory) {
    // customize the factory here
  }
}
```

In addition Spring Boot provides:

Server	Servlet stack	Reactive stack
Tomcat	TomcatServletWebServerFactory	TomcatReactiveWebServerFactory
Jetty	JettyServletWebServerFactory	JettyReactiveWebServerFactory
Undertow	UndertowServletWebServerFacto	rVndertowReactiveWebServerFactor
Reactor	N/A	NettyReactiveWebServerFactory

Once you've got access to a WebServerFactory, you can often add customizers to it to configure specific parts, like connectors, server resources, or the server itself - all using server-specific APIs.

As a last resort, you can also declare your own WebServerFactory component, which will override the one provided by Spring Boot. In this case, you can't rely on configuration properties in the server namespace anymore.

# 78.10 Add a Servlet, Filter, or Listener to an Application

In a servlet stack application, i.e. with the spring-boot-starter-web, there are two ways to add Servlet, Filter, ServletContextListener, and the other listeners supported by the Servlet API to your application:

- the section called "Add a Servlet, Filter, or Listener by Using a Spring Bean"
- the section called "Add Servlets, Filters, and Listeners by Using Classpath Scanning"

### Add a Servlet, Filter, or Listener by Using a Spring Bean

To add a Servlet, Filter, or Servlet \*Listener by using a Spring bean, you must provide a @Bean definition for it. Doing so can be very useful when you want to inject configuration or dependencies. However, you must be very careful that they do not cause eager initialization of too many other beans, because they have to be installed in the container very early in the application lifecycle. (For example, it is not a good idea to have them depend on your DataSource or JPA configuration.) You can work around such restrictions by initializing the beans lazily when first used instead of on initialization.

In the case of Filters and Servlets, you can also add mappings and init parameters by adding a FilterRegistrationBean or a ServletRegistrationBean instead of or in addition to the underlying component.

#### Note

If no dispatcherType is specified on a filter registration, REQUEST is used. This aligns with the Servlet Specification's default dispatcher type.

Like any other Spring bean, you can define the order of Servlet filter beans; please make sure to check the "the section called "Registering Servlets, Filters, and Listeners as Spring Beans"" section.

#### Disable Registration of a Servlet or Filter

As <u>described earlier</u>, any <u>Servlet</u> or <u>Filter</u> beans are registered with the servlet container automatically. To disable registration of a particular <u>Filter</u> or <u>Servlet</u> bean, create a registration bean for it and mark it as disabled, as shown in the following example:

```
@Bean
public FilterRegistrationBean registration(MyFilter filter) {
  FilterRegistrationBean registration = new FilterRegistrationBean(filter);
  registration.setEnabled(false);
  return registration;
}
```

### Add Servlets, Filters, and Listeners by Using Classpath Scanning

<code>@WebServlet</code>, <code>@WebFilter</code>, and <code>@WebListener</code> annotated classes can be automatically registered with an embedded servlet container by annotating a <code>@Configuration</code> class with <code>@ServletComponentScan</code> and specifying the package(s) containing the components that you want to register. By default, <code>@ServletComponentScan</code> scans from the package of the annotated class.

# 78.11 Configure Access Logging

Access logs can be configured for Tomcat, Undertow, and Jetty through their respective namespaces.

For instance, the following settings log access on Tomcat with a <u>custom pattern</u>.

```
server.tomcat.basedir=my-tomcat
server.tomcat.accesslog.enabled=true
server.tomcat.accesslog.pattern=%t %a "%r" %s (%D ms)
```

#### Note

The default location for logs is a logs directory relative to the Tomcat base directory. By default, the logs directory is a temporary directory, so you may want to fix Tomcat's base directory or use

an absolute path for the logs. In the preceding example, the logs are available in my-tomcat/logs relative to the working directory of the application.

Access logging for Undertow can be configured in a similar fashion, as shown in the following example:

```
server.undertow.accesslog.enabled=true
server.undertow.accesslog.pattern=%t %a "%r" %s (%D ms)
```

Logs are stored in a logs directory relative to the working directory of the application. You can customize this location by setting the server.undertow.accesslog.directory property.

Finally, access logging for Jetty can also be configured as follows:

```
server.jetty.accesslog.enabled=true
server.jetty.accesslog.filename=/var/log/jetty-access.log
```

By default, logs are redirected to System.err. For more details, see the Jetty documentation.

# 78.12 Running Behind a Front-end Proxy Server

Your application might need to send 302 redirects or render content with absolute links back to itself. When running behind a proxy, the caller wants a link to the proxy and not to the physical address of the machine hosting your app. Typically, such situations are handled through a contract with the proxy, which adds headers to tell the back end how to construct links to itself.

If the proxy adds conventional X-Forwarded-For and X-Forwarded-Proto headers (most proxy servers do so), the absolute links should be rendered correctly, provided server.use-forward-headers is set to true in your application.properties.

#### Note

If your application runs in Cloud Foundry or Heroku, the server.use-forward-headers property defaults to true. In all other instances, it defaults to false.

### **Customize Tomcat's Proxy Configuration**

If you use Tomcat, you can additionally configure the names of the headers used to carry "forwarded" information, as shown in the following example:

```
server.tomcat.remote-ip-header=x-your-remote-ip-header
server.tomcat.protocol-header=x-your-protocol-header
```

Tomcat is also configured with a default regular expression that matches internal proxies that are to be trusted. By default, IP addresses in 10/8, 192.168/16, 169.254/16 and 127/8 are trusted. You can customize the valve's configuration by adding an entry to application.properties, as shown in the following example:

```
server.tomcat.internal-proxies=192\\ \verb|\|.168\\|.\\|d\{1,3\}\\|.\\|d\{1,3\}
```

#### Note

The double backslashes are required only when you use a properties file for configuration. If you use YAML, single backslashes are sufficient, and a value equivalent to that shown in the preceding example would be  $192 \setminus .168 \setminus .d\{1,3\} \setminus .d\{1,3\}$ .

#### Note

You can trust all proxies by setting the internal-proxies to empty (but do not do so in production).

You can take complete control of the configuration of Tomcat's RemoteIpValve by switching the automatic one off (to do so, set server.use-forward-headers=false) and adding a new valve instance in a TomcatServletWebServerFactory bean.

### 78.13 Enable Multiple Connectors with Tomcat

You can add an org.apache.catalina.connector.Connector to the TomcatServletWebServerFactory, which can allow multiple connectors, including HTTP and HTTPS connectors, as shown in the following example:

```
@Bean
public ServletWebServerFactory servletContainer() {
TomcatServletWebServerFactory tomcat = new TomcatServletWebServerFactory();
tomcat.addAdditionalTomcatConnectors(createSslConnector());
return tomcat;
private Connector createSslConnector() {
Connector connector = new Connector("org.apache.coyote.http11.Http11NioProtocol");
Http11NioProtocol protocol = (Http11NioProtocol) connector.getProtocolHandler();
 File keystore = new ClassPathResource("keystore").getFile();
 File truststore = new ClassPathResource("keystore").getFile();
  connector.setScheme("https");
 connector.setSecure(true);
 connector.setPort(8443);
 protocol.setSSLEnabled(true);
 protocol.setKeystoreFile(keystore.getAbsolutePath());
 protocol.setKeystorePass("changeit");
 protocol.setTruststoreFile(truststore.getAbsolutePath());
 protocol.setTruststorePass("changeit");
 protocol.setKeyAlias("apitester");
 return connector;
 catch (IOException ex) {
  throw new IllegalStateException("can't access keystore: [" + "keystore"
    + "] or truststore: [" + "keystore" + "]", ex);
```

# 78.14 Use Tomcat's LegacyCookieProcessor

By default, the embedded Tomcat used by Spring Boot does not support "Version 0" of the Cookie format, so you may see the following error:

```
java.lang.IllegalArgumentException: An invalid character [32] was present in the Cookie value
```

If at all possible, you should consider updating your code to only store values compliant with later Cookie specifications. If, however, you cannot change the way that cookies are written, you can instead configure Tomcat to use a LegacyCookieProcessor. To switch to the LegacyCookieProcessor, use an WebServerFactoryCustomizer bean that adds a TomcatContextCustomizer, as shown in the following example:

```
@Bean
public WebServerFactoryCustomizer<TomcatServletWebServerFactory> cookieProcessorCustomizer() {
  return (factory) -> factory.addContextCustomizers(
```

```
(context) -> context.setCookieProcessor(new LegacyCookieProcessor()));
}
```

# 78.15 Enable Multiple Listeners with Undertow

Add an UndertowBuilderCustomizer to the UndertowServletWebServerFactory and add a listener to the Builder, as shown in the following example:

```
@Bean
public UndertowServletWebServerFactory servletWebServerFactory() {
   UndertowServletWebServerFactory factory = new UndertowServletWebServerFactory();
   factory.addBuilderCustomizers(new UndertowBuilderCustomizer() {
    @Override
   public void customize(Builder builder) {
      builder.addHttpListener(8080, "0.0.0.0");
   }
   });
   return factory;
}
```

# 78.16 Create WebSocket Endpoints Using @ServerEndpoint

If you want to use @ServerEndpoint in a Spring Boot application that used an embedded container, you must declare a single ServerEndpointExporter @Bean, as shown in the following example:

```
@Bean
public ServerEndpointExporter serverEndpointExporter() {
   return new ServerEndpointExporter();
}
```

The bean shown in the preceding example registers any @ServerEndpoint annotated beans with the underlying WebSocket container. When deployed to a standalone servlet container, this role is performed by a servlet container initializer, and the ServerEndpointExporter bean is not required.

# 79. Spring MVC

Spring Boot has a number of starters that include Spring MVC. Note that some starters include a dependency on Spring MVC rather than include it directly. This section answers common questions about Spring MVC and Spring Boot.

#### 79.1 Write a JSON REST Service

Any Spring @RestController in a Spring Boot application should render JSON response by default as long as Jackson2 is on the classpath, as shown in the following example:

```
@RestController
public class MyController {

@RequestMapping("/thing")
public MyThing thing() {
   return new MyThing();
}
```

As long as MyThing can be serialized by Jackson2 (true for a normal POJO or Groovy object), then <a href="https://localhost:8080/thing">localhost:8080/thing</a> serves a JSON representation of it by default. Note that, in a browser, you might sometimes see XML responses, because browsers tend to send accept headers that prefer XML.

### 79.2 Write an XML REST Service

If you have the Jackson XML extension (jackson-dataformat-xml) on the classpath, you can use it to render XML responses. The previous example that we used for JSON would work. To use the Jackson XML renderer, add the following dependency to your project:

```
<dependency>
<groupId>com.fasterxml.jackson.dataformat</groupId>
<artifactId>jackson-dataformat-xml</artifactId>
</dependency>
```

You may also want to add a dependency on Woodstox. It is faster than the default StAX implementation provided by the JDK and also adds pretty-print support and improved namespace handling. The following listing shows how to include a dependency on <u>Woodstox</u>:

```
<dependency>
  <groupId>org.codehaus.woodstox</groupId>
  <artifactId>woodstox-core-asl</artifactId>
</dependency>
```

If Jackson's XML extension is not available, JAXB (provided by default in the JDK) is used, with the additional requirement of having MyThing annotated as @XmlRootElement, as shown in the following example:

```
@XmlRootElement
public class MyThing {
  private String name;
  // .. getters and setters
}
```

To get the server to render XML instead of JSON, you might have to send an Accept: text/xml header (or use a browser).

### 79.3 Customize the Jackson ObjectMapper

Spring MVC (client and server side) uses HttpMessageConverters to negotiate content conversion in an HTTP exchange. If Jackson is on the classpath, you already get the default converter(s) provided by Jackson2ObjectMapperBuilder, an instance of which is auto-configured for you.

The ObjectMapper (or XmlMapper for Jackson XML converter) instance (created by default) has the following customized properties:

- MapperFeature.DEFAULT\_VIEW\_INCLUSION is disabled
- DeserializationFeature.FAIL\_ON\_UNKNOWN\_PROPERTIES is disabled
- SerializationFeature.WRITE\_DATES\_AS\_TIMESTAMPS is disabled

Spring Boot also has some features to make it easier to customize this behavior.

You can configure the ObjectMapper and XmlMapper instances by using the environment. Jackson provides an extensive suite of simple on/off features that can be used to configure various aspects of its processing. These features are described in six enums (in Jackson) that map onto properties in the environment:

Enum	Property	Values
com.fasterxml.jackson.da	taþrndgDjaeksahideséonādat	z <b>arėe</b> nf <b>aīse</b> ture_name>
com.fasterxml.jackson.com	rep#singGejaeksonrgEmerater	. <b>էfeețti</b> គម <u>ៃន</u> eame>
com.fasterxml.jackson.da	t <b>sþridgMappksBaamapp</b> er. <fe< td=""><td>earure<u>f</u>alme&gt;</td></fe<>	earure <u>f</u> alme>
com.fasterxml.jackson.com	repītsingPajzsksoMepauser. <f< td=""><td>earure<u>f</u>alme&gt;</td></f<>	earure <u>f</u> alme>
com.fasterxml.jackson.da	t <b>s</b> þrindgSg <b>z</b> rkksonaseonRedtat	c <b>éon</b> e≮ <b>faàse</b> re_name>
com.fasterxml.jackson.an	n <b>spætingnjāsksōncdedeult</b> elu property-inclusion	ndeways, non_null, non_absent, non_default, non_empty

For example, to enable pretty print, set spring.jackson.serialization.indent\_output=true. Note that, thanks to the use of relaxed binding, the case of indent\_output does not have to match the case of the corresponding enum constant, which is INDENT\_OUTPUT.

This environment-based configuration is applied to the auto-configured <code>Jackson2ObjectMapperBuilder</code> bean and applies to any mappers created by using the builder, including the auto-configured <code>ObjectMapper</code> bean.

The context's Jackson2ObjectMapperBuilder can be customized by one or more Jackson2ObjectMapperBuilderCustomizer beans. Such customizer beans can be ordered (Boot's own customizer has an order of 0), letting additional customization be applied both before and after Boot's customization.

Any beans of type <code>com.fasterxml.jackson.databind.Module</code> are automatically registered with the auto-configured <code>Jackson2ObjectMapperBuilder</code> and are applied to any <code>ObjectMapper</code> instances that it creates. This provides a global mechanism for contributing custom modules when you add new features to your application.

If you want to replace the default <code>ObjectMapper</code> completely, either define a <code>@Bean</code> of that type and mark it as <code>@Primary</code> or, if you prefer the builder-based approach, define a <code>Jackson2ObjectMapperBuilder</code> <code>@Bean</code>. Note that, in either case, doing so disables all autoconfiguration of the <code>ObjectMapper</code>.

If you provide any <code>@Beans</code> of type <code>MappingJackson2HttpMessageConverter</code>, they replace the default value in the MVC configuration. Also, a convenience bean of type <code>HttpMessageConverters</code> is provided (and is always available if you use the default MVC configuration). It has some useful methods to access the default and user-enhanced message converters.

See the "Section 79.4, "Customize the @ResponseBody Rendering"" section and the WebMvcAutoConfiguration source code for more details.

# 79.4 Customize the @ResponseBody Rendering

Spring uses HttpMessageConverters to render @ResponseBody (or responses from @RestController). You can contribute additional converters by adding beans of the appropriate type in a Spring Boot context. If a bean you add is of a type that would have been included by default anyway (such as MappingJackson2HttpMessageConverter for JSON conversions), it replaces the default value. A convenience bean of type HttpMessageConverters is provided and is always available if you use the default MVC configuration. It has some useful methods to access the default and user-enhanced message converters (For example, it can be useful if you want to manually inject them into a custom RestTemplate).

As in normal MVC usage, any WebMvcConfigurer beans that you provide can also contribute converters by overriding the configureMessageConverters method. However, unlike with normal MVC, you can supply only additional converters that you need (because Spring Boot uses the same mechanism to contribute its defaults). Finally, if you opt out of the Spring Boot default MVC configuration by providing your own @EnableWebMvc configuration, you can take control completely and do everything manually by using getMessageConverters from WebMvcConfigurationSupport.

See the  ${\tt WebMvcAutoConfiguration}$  source code for more details.

# 79.5 Handling Multipart File Uploads

Spring Boot embraces the Servlet 3 javax.servlet.http.Part API to support uploading files. By default, Spring Boot configures Spring MVC with a maximum size of 1MB per file and a maximum of 10MB of file data in a single request. You may override these values, the location to which intermediate data is stored (for example, to the /tmp directory), and the threshold past which data is flushed to disk by using the properties exposed in the MultipartProperties class. For example, if you want to specify that files be unlimited, set the spring.servlet.multipart.max-file-size property to -1.

The multipart support is helpful when you want to receive multipart encoded file data as a <code>@RequestParam-annotated</code> parameter of type <code>MultipartFile</code> in a Spring MVC controller handler method.

See the MultipartAutoConfiguration source for more details.

#### Note

It is recommended to use the container's built-in support for multipart uploads rather than introducing an additional dependency such as Apache Commons File Upload.

# 79.6 Switch Off the Spring MVC DispatcherServlet

By default, all content is served from the root of your application (/). If you would rather map to a different path, you can configure one as follows:

spring.mvc.servlet.path=/acme

If you have additional servlets you can declare a <code>@Bean</code> of type <code>Servlet</code> or <code>ServletRegistrationBean</code> for each and Spring Boot will register them transparently to the container. Because servlets are registered that way, they can be mapped to a sub-context of the <code>DispatcherServlet</code> without invoking it.

Configuring the DispatcherServlet yourself is unusual but if you really need to do it, a @Bean of type DispatcherServletPath must be provided as well to provide the path of your custom DispatcherServlet.

### 79.7 Switch off the Default MVC Configuration

The easiest way to take complete control over MVC configuration is to provide your own <code>@Configuration</code> with the <code>@EnableWebMvc</code> annotation. Doing so leaves all MVC configuration in your hands.

### 79.8 Customize ViewResolvers

A ViewResolver is a core component of Spring MVC, translating view names in @Controller to actual View implementations. Note that ViewResolvers are mainly used in UI applications, rather than REST-style services (a View is not used to render a @ResponseBody). There are many implementations of ViewResolver to choose from, and Spring on its own is not opinionated about which ones you should use. Spring Boot, on the other hand, installs one or two for you, depending on what it finds on the classpath and in the application context. The DispatcherServlet uses all the resolvers it finds in the application context, trying each one in turn until it gets a result, so, if you add your own, you have to be aware of the order and in which position your resolver is added.

WebMvcAutoConfiguration adds the following ViewResolvers to your context:

- An InternalResourceViewResolver named 'defaultViewResolver'. This one locates physical resources that can be rendered by using the DefaultServlet (including static resources and JSP pages, if you use those). It applies a prefix and a suffix to the view name and then looks for a physical resource with that path in the servlet context (the defaults are both empty but are accessible for external configuration through spring.mvc.view.prefix and spring.mvc.view.suffix). You can override it by providing a bean of the same type.
- A BeanNameViewResolver named 'beanNameViewResolver'. This is a useful member of the view
  resolver chain and picks up any beans with the same name as the View being resolved. It should
  not be necessary to override or replace it.
- A ContentNegotiatingViewResolver named 'viewResolver' is added only if there **are** actually beans of type View present. This is a 'master' resolver, delegating to all the others and attempting to find a match to the 'Accept' HTTP header sent by the client. There is a useful blog about ContentNegotiatingViewResolver that you might like to study to learn more, and you might also look at the source code for detail. You can switch off the auto-configured ContentNegotiatingViewResolver by defining a bean named 'viewResolver'.

- If you use Thymeleaf, you also have a ThymeleafViewResolver named 'thymeleafViewResolver'. It looks for resources by surrounding the view name with a prefix and suffix. The prefix is spring.thymeleaf.prefix, and the suffix is spring.thymeleaf.suffix. The values of the prefix and suffix default to 'classpath:/templates/' and '.html', respectively. You can override ThymeleafViewResolver by providing a bean of the same name.
- If you use FreeMarker, you also have a FreeMarkerViewResolver named 'freeMarkerViewResolver'. It looks for resources in a loader path (which is externalized to spring.freemarker.templateLoaderPath and has a default value of 'classpath:/templates/') by surrounding the view name with a prefix and a suffix. The prefix is externalized to spring.freemarker.prefix, and the suffix is externalized to spring.freemarker.suffix. The default values of the prefix and suffix are empty and '.ftl', respectively. You can override FreeMarkerViewResolver by providing a bean of the same name.
- If you use Groovy templates (actually, if <code>groovy-templates</code> is on your classpath), you also have a <code>GroovyMarkupViewResolver</code> named 'groovyMarkupViewResolver'. It looks for resources in a loader path by surrounding the view name with a prefix and suffix (externalized to <code>spring.groovy.template.prefix</code> and <code>spring.groovy.template.suffix</code>). The prefix and suffix have default values of 'classpath:/templates/' and '.tpl', respectively. You can override <code>GroovyMarkupViewResolver</code> by providing a bean of the same name.

#### For more detail, see the following sections:

- WebMvcAutoConfiguration
- ThymeleafAutoConfiguration
- FreeMarkerAutoConfiguration
- <u>GroovyTemplateAutoConfiguration</u>

# 80. Testing With Spring Security

Spring Security provides support for running tests as a specific user. For example, the test in the snippet below will run with an authenticated user that has the ADMIN role.

```
@Test
@WithMockUser(roles="ADMIN")
public void requestProtectedUrlWithUser() throws Exception {
    mvc
    .perform(get("/"))
    ...
}
```

Spring Security provides comprehensive integration with Spring MVC Test and this can also be used when testing controllers using the <code>@WebMvcTest</code> slice and <code>MockMvc</code>.

For additional details on Spring Security's testing support, refer to Spring Security's reference documentation).

# 81. Jersey

# 81.1 Secure Jersey endpoints with Spring Security

Spring Security can be used to secure a Jersey-based web application in much the same way as it can be used to secure a Spring MVC-based web application. However, if you want to use Spring Security's method-level security with Jersey, you must configure Jersey to use setStatus(int) rather sendError(int). This prevents Jersey from committing the response before Spring Security has had an opportunity to report an authentication or authorization failure to the client.

The jersey.config.server.response.setStatusOverSendError property must be set to true on the application's ResourceConfig bean, as shown in the following example:

```
@Component
public class JerseyConfig extends ResourceConfig {

public JerseyConfig() {
  register(Endpoint.class);
  setProperties(Collections.singletonMap(
    "jersey.config.server.response.setStatusOverSendError", true));
}
```

### 82. HTTP Clients

Spring Boot offers a number of starters that work with HTTP clients. This section answers questions related to using them.

# 82.1 Configure RestTemplate to Use a Proxy

As described in <u>Section 34.1</u>, <u>"RestTemplate Customization"</u>, you can use a RestTemplateCustomizer with RestTemplateBuilder to build a customized RestTemplate. This is the recommended approach for creating a RestTemplate configured to use a proxy.

The exact details of the proxy configuration depend on the underlying client request factory that is being used. The following example configures HttpComponentsClientRequestFactory with an HttpClient that uses a proxy for all hosts except 192.168.0.5:

```
static class ProxyCustomizer implements RestTemplateCustomizer {
 @Override
 public void customize(RestTemplate restTemplate) {
 HttpHost proxy = new HttpHost("proxy.example.com");
 HttpClient httpClient = HttpClientBuilder.create()
    .setRoutePlanner(new DefaultProxyRoutePlanner(proxy) {
    @Override
     public HttpHost determineProxy(HttpHost target,
      HttpRequest request, HttpContext context)
      throws HttpException {
      if (target.getHostName().equals("192.168.0.5")) {
      return null;
      return super.determineProxy(target, request, context);
    }).build();
  \verb"restTemplate.setRequestFactory" (
    new HttpComponentsClientHttpRequestFactory(httpClient));
```

# 83. Logging

Spring Boot has no mandatory logging dependency, except for the Commons Logging API, which is typically provided by Spring Framework's <code>spring-jcl</code> module. To use <code>Logback</code>, you need to include it and <code>spring-jcl</code> on the classpath. The simplest way to do that is through the starters, which all depend on <code>spring-boot-starter-logging</code>. For a web application, you need only <code>spring-boot-starter-web</code>, since it depends transitively on the logging starter. If you use Maven, the following dependency adds logging for you:

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

Spring Boot has a LoggingSystem abstraction that attempts to configure logging based on the content of the classpath. If Logback is available, it is the first choice.

If the only change you need to make to logging is to set the levels of various loggers, you can do so in application.properties by using the "logging.level" prefix, as shown in the following example:

```
logging.level.org.springframework.web=DEBUG
logging.level.org.hibernate=ERROR
```

You can also set the location of a file to which to write the log (in addition to the console) by using "logging.file".

To configure the more fine-grained settings of a logging system, you need to use the native configuration format supported by the LoggingSystem in question. By default, Spring Boot picks up the native configuration from its default location for the system (such as classpath:logback.xml for Logback), but you can set the location of the config file by using the "logging.config" property.

# 83.1 Configure Logback for Logging

If you put a logback.xml in the root of your classpath, it is picked up from there (or from logback-spring.xml, to take advantage of the templating features provided by Boot). Spring Boot provides a default base configuration that you can include if you want to set levels, as shown in the following example:

```
<?xml version="1.0" encoding="UTF-8"?>
<configuration>
<include resource="org/springframework/boot/logging/logback/base.xml"/>
<logger name="org.springframework.web" level="DEBUG"/>
</configuration>
```

If you look at base.xml in the spring-boot jar, you can see that it uses some useful System properties that the LoggingSystem takes care of creating for you:

- \${PID}: The current process ID.
- \${LOG\_FILE}: Whether logging.file was set in Boot's external configuration.
- \${LOG\_PATH}: Whether logging.path (representing a directory for log files to live in) was set in Boot's external configuration.
- \${LOG\_EXCEPTION\_CONVERSION\_WORD}: Whether logging.exception-conversion-word was set in Boot's external configuration.

Spring Boot also provides some nice ANSI color terminal output on a console (but not in a log file) by using a custom Logback converter. See the default base.xml configuration for details.

If Groovy is on the classpath, you should be able to configure Logback with logback.groovy as well. If present, this setting is given preference.

### **Configure Logback for File-only Output**

If you want to disable console logging and write output only to a file, you need a custom logback-spring.xml that imports file-appender.xml but not console-appender.xml, as shown in the following example:

You also need to add logging.file to your application.properties, as shown in the following example:

```
logging.file=myapplication.log
```

# 83.2 Configure Log4j for Logging

Spring Boot supports <u>Log4j 2</u> for logging configuration if it is on the classpath. If you use the starters for assembling dependencies, you have to exclude Logback and then include log4j 2 instead. If you do not use the starters, you need to provide (at least) spring-jcl in addition to Log4j 2.

The simplest path is probably through the starters, even though it requires some jiggling with excludes. The following example shows how to set up the starters in Maven:

```
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-web</artifactId>
</dependency>
<dependency>
<groupId>org.springframework.boot
<artifactId>spring-boot-starter</artifactId>
<exclusions>
 <exclusion>
  <groupId>org.springframework.boot
  <artifactId>spring-boot-starter-logging</artifactId>
 </exclusion>
</exclusions>
</dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-log4j2</artifactId>
</dependency>
```

And the following example shows one way to set up the starters in Gradle:

```
dependencies {
  compile 'org.springframework.boot:spring-boot-starter-web'
  compile 'org.springframework.boot:spring-boot-starter-log4j2'
```

```
configurations {
  all {
    exclude group: 'org.springframework.boot', module: 'spring-boot-starter-logging'
  }
}
```

#### Note

The Log4j starters gather together the dependencies for common logging requirements (such as having Tomcat use <code>java.util.logging</code> but configuring the output using Log4j 2). See the Actuator Log4j 2 samples for more detail and to see it in action.

#### Note

To ensure that debug logging performed using java.util.logging is routed into Log4j 2, configure its <u>JDK logging adapter</u> by setting the java.util.logging.manager system property to org.apache.logging.log4j.jul.LogManager.

### Use YAML or JSON to Configure Log4j 2

In addition to its default XML configuration format, Log4j 2 also supports YAML and JSON configuration files. To configure Log4j 2 to use an alternative configuration file format, add the appropriate dependencies to the classpath and name your configuration files to match your chosen file format, as shown in the following example:

Format	Dependencies	File names
YAML	<pre>com.fasterxml.jackson.core:jackson-databind com.fasterxml.jackson.dataformat:jackson-dataformat- yaml</pre>	log4j2.yaml
JSON	com.fasterxml.jackson.core:jackson-databind	log4j2.json

### 84. Data Access

Spring Boot includes a number of starters for working with data sources. This section answers questions related to doing so.

### 84.1 Configure a Custom DataSource

To configure your own DataSource, define a @Bean of that type in your configuration. Spring Boot reuses your DataSource anywhere one is required, including database initialization. If you need to externalize some settings, you can bind your DataSource to the environment (see "the section called "Third-party Configuration").

The following example shows how to define a data source in a bean:

```
@Bean
@ConfigurationProperties(prefix="app.datasource")
public DataSource dataSource() {
  return new FancyDataSource();
}
```

The following example shows how to define a data source by setting properties:

```
app.datasource.url=jdbc:h2:mem:mydb
app.datasource.username=sa
app.datasource.pool-size=30
```

Assuming that your FancyDataSource has regular JavaBean properties for the URL, the username, and the pool size, these settings are bound automatically before the DataSource is made available to other components. The regular <u>database initialization</u> also happens (so the relevant sub-set of spring.datasource.\* can still be used with your custom configuration).

Spring Boot also provides a utility builder class, called DataSourceBuilder, that can be used to create one of the standard data sources (if it is on the classpath). The builder can detect the one to use based on what's available on the classpath. It also auto-detects the driver based on the JDBC URL.

The following example shows how to create a data source by using a DataSourceBuilder:

```
@Bean
@ConfigurationProperties("app.datasource")
public DataSource dataSource() {
  return DataSourceBuilder.create().build();
}
```

To run an app with that DataSource, all you need is the connection information. Pool-specific settings can also be provided. Check the implementation that is going to be used at runtime for more details.

The following example shows how to define a JDBC data source by setting properties:

```
app.datasource.url=jdbc:mysql://localhost/test
app.datasource.username=dbuser
app.datasource.password=dbpass
app.datasource.pool-size=30
```

However, there is a catch. Because the actual type of the connection pool is not exposed, no keys are generated in the metadata for your custom <code>DataSource</code> and no completion is available in your IDE (because the <code>DataSource</code> interface exposes no properties). Also, if you happen to have Hikari on

the classpath, this basic setup does not work, because Hikari has no url property (but does have a jdbcUrl property). In that case, you must rewrite your configuration as follows:

```
app.datasource.jdbc-url=jdbc:mysql://localhost/test
app.datasource.username=dbuser
app.datasource.password=dbpass
app.datasource.maximum-pool-size=30
```

You can fix that by forcing the connection pool to use and return a dedicated implementation rather than DataSource. You cannot change the implementation at runtime, but the list of options will be explicit.

The following example shows how create a HikariDataSource with DataSourceBuilder:

```
@Bean
@ConfigurationProperties("app.datasource")
public HikariDataSource dataSource() {
  return DataSourceBuilder.create().type(HikariDataSource.class).build();
}
```

You can even go further by leveraging what <code>DataSourceProperties</code> does for you—that is, by providing a default embedded database with a sensible username and password if no URL is provided. You can easily initialize a <code>DataSourceBuilder</code> from the state of any <code>DataSourceProperties</code> object, so you could also inject the <code>DataSource</code> that Spring Boot creates automatically. However, that would split your configuration into two namespaces: <code>url</code>, <code>username</code>, <code>password</code>, <code>type</code>, and <code>driver</code> on <code>spring</code>. datasource and the rest on your custom namespace (<code>app.datasource</code>). To avoid that, you can redefine a custom <code>DataSourceProperties</code> on your custom namespace, as shown in the following example:

```
@Bean
@Primary
@ConfigurationProperties("app.datasource")
public DataSourceProperties dataSourceProperties() {
    return new DataSourceProperties();
}

@Bean
@ConfigurationProperties("app.datasource.configuration")
public HikariDataSource dataSource(DataSourceProperties properties) {
    return properties.initializeDataSourceBuilder().type(HikariDataSource.class)
    .build();
}
```

This setup puts you *in sync* with what Spring Boot does for you by default, except that a dedicated connection pool is chosen (in code) and its settings are exposed in the app.datasource.configuration sub namespace. Because DataSourceProperties is taking care of the url/jdbcUrl translation for you, you can configure it as follows:

```
app.datasource.url=jdbc:mysql://localhost/test
app.datasource.username=dbuser
app.datasource.password=dbpass
app.datasource.configuration.maximum-pool-size=30
```

#### Tip

Spring Boot will expose Hikari-specific settings to spring.datasource.hikari. This example uses a more generic configuration sub namespace as the example does not support multiple datasource implementations.

#### Note

Because your custom configuration chooses to go with Hikari, app.datasource.type has no effect. In practice, the builder is initialized with whatever value you might set there and then overridden by the call to .type().

See "<u>Section 30.1</u>, "<u>Configure a DataSource</u>"" in the "Spring Boot features" section and the DataSourceAutoConfiguration class for more details.

# 84.2 Configure Two DataSources

If you need to configure multiple data sources, you can apply the same tricks that are described in the previous section. You must, however, mark one of the <code>DataSource</code> instances as <code>@Primary</code>, because various auto-configurations down the road expect to be able to get one by type.

If you create your own DataSource, the auto-configuration backs off. In the following example, we provide the *exact* same feature set as the auto-configuration provides on the primary data source:

#### Tip

firstDataSourceProperties has to be flagged as @Primary so that the database initializer feature uses your copy (if you use the initializer).

Both data sources are also bound for advanced customizations. For instance, you could configure them as follows:

```
app.datasource.first.url=jdbc:mysql://localhost/first
app.datasource.first.username=dbuser
app.datasource.first.password=dbpass
app.datasource.first.configuration.maximum-pool-size=30

app.datasource.second.url=jdbc:mysql://localhost/second
app.datasource.second.username=dbuser
app.datasource.second.password=dbpass
app.datasource.second.max-total=30
```

You can apply the same concept to the secondary DataSource as well, as shown in the following example:

```
@Bean
@Primary
@ConfigurationProperties("app.datasource.first")
public DataSourceProperties firstDataSourceProperties() {
return new DataSourceProperties();
@Bean
@Primary
@ConfigurationProperties("app.datasource.first.configuration")
public HikariDataSource firstDataSource() {
return firstDataSourceProperties().initializeDataSourceBuilder()
   .type(HikariDataSource.class).build();
@ConfigurationProperties("app.datasource.second")
public DataSourceProperties secondDataSourceProperties() {
return new DataSourceProperties();
@ConfigurationProperties("app.datasource.second.configuration")
public BasicDataSource secondDataSource() {
return secondDataSourceProperties().initializeDataSourceBuilder()
   .type(BasicDataSource.class).build();
```

The preceding example configures two data sources on custom namespaces with the same logic as Spring Boot would use in auto-configuration. Note that each configuration sub namespace provides advanced settings based on the chosen implementation.

# 84.3 Use Spring Data Repositories

Spring Data can create implementations of <code>@Repository</code> interfaces of various flavors. Spring Boot handles all of that for you, as long as those <code>@Repositories</code> are included in the same package (or a sub-package) of your <code>@EnableAutoConfiguration</code> class.

For many applications, all you need is to put the right Spring Data dependencies on your classpath (there is a spring-boot-starter-data-jpa for JPA and a spring-boot-starter-data-mongodb for Mongodb) and create some repository interfaces to handle your @Entity objects. Examples are in the JPA sample and the Mongodb sample.

Spring Boot tries to guess the location of your @Repository definitions, based on the @EnableAutoConfiguration it finds. To get more control, use the @EnableJpaRepositories annotation (from Spring Data JPA).

For more about Spring Data, see the Spring Data project page.

# 84.4 Separate @Entity Definitions from Spring Configuration

Spring Boot tries to guess the location of your @Entity definitions, based on the @EnableAutoConfiguration it finds. To get more control, you can use the @EntityScan annotation, as shown in the following example:

```
@Configuration
@EnableAutoConfiguration
@EntityScan(basePackageClasses=City.class)
public class Application {
    //...
```

# 84.5 Configure JPA Properties

Spring Data JPA already provides some vendor-independent configuration options (such as those for SQL logging), and Spring Boot exposes those options and a few more for Hibernate as external configuration properties. Some of them are automatically detected according to the context so you should not have to set them.

The spring.jpa.hibernate.ddl-auto is a special case, because, depending on runtime conditions, it has different defaults. If an embedded database is used and no schema manager (such as Liquibase or Flyway) is handling the DataSource, it defaults to create-drop. In all other cases, it defaults to none.

The dialect to use is also automatically detected based on the current DataSource, but you can set spring.jpa.database yourself if you want to be explicit and bypass that check on startup.

#### Note

Specifying a database leads to the configuration of a well-defined Hibernate dialect. Several databases have more than one Dialect, and this may not suit your needs. In that case, you can either set spring.jpa.database to default to let Hibernate figure things out or set the dialect by setting the spring.jpa.database-platform property.

The most common options to set are shown in the following example:

```
spring.jpa.hibernate.naming.physical-strategy=com.example.MyPhysicalNamingStrategy spring.jpa.show-sql=true
```

In addition, all properties in spring.jpa.properties.\* are passed through as normal JPA properties (with the prefix stripped) when the local EntityManagerFactory is created.

### Tip

If you need to apply advanced customization to Hibernate properties, consider registering a HibernatePropertiesCustomizer bean that will be invoked prior to creating the EntityManagerFactory. This takes precedence to anything that is applied by the autoconfiguration.

# 84.6 Configure Hibernate Naming Strategy

Hibernate uses two different naming strategies to map names from the object model to the corresponding database names. The fully qualified class name of the physical and the implicit strategy implementations can be configured by setting the spring.jpa.hibernate.naming.physical-strategy and spring.jpa.hibernate.naming.implicit-strategy properties, respectively. Alternatively, if ImplicitNamingStrategy or PhysicalNamingStrategy beans are available in the application context, Hibernate will be automatically configured to use them.

By default, Spring Boot configures the physical naming strategy with SpringPhysicalNamingStrategy. This implementation provides the same table structure as Hibernate 4: all dots are replaced by underscores and camel casing is replaced by underscores as well.

By default, all table names are generated in lower case, but it is possible to override that flag if your schema requires it.

For example, a TelephoneNumber entity is mapped to the telephone\_number table.

If you prefer to use Hibernate 5's default instead, set the following property:

```
spring.jpa.hibernate.naming.physical-
strategy=org.hibernate.boot.model.naming.PhysicalNamingStrategyStandardImpl
```

Alternatively, you can configure the following bean:

```
@Bean
public PhysicalNamingStrategy physicalNamingStrategy() {
  return new PhysicalNamingStrategyStandardImpl();
}
```

See HibernateJpaAutoConfiguration and JpaBaseConfiguration for more details.

# 84.7 Configure Hibernate Second-Level Caching

Hibernate <u>second-level cache</u> can be configured for a range of cache providers. Rather than configuring Hibernate to lookup the cache provider again, it is better to provide the one that is available in the context whenever possible.

If you're using JCache, this is pretty easy. First, make sure that org.hibernate:hibernate-jcache is available on the classpath. Then, add a HibernatePropertiesCustomizer bean as shown in the following example:

This customizer will configure Hibernate to use the same CacheManager as the one that the application uses. It is also possible to use separate CacheManager instances, refer to the Hibernate user guide.

# 84.8 Use Dependency Injection in Hibernate Components

By default, Spring Boot registers a BeanContainer implementation that uses the BeanFactory so that converters and entity listeners can use regular dependency injection.

You can disable or tune this behaviour by registering a HibernatePropertiesCustomizer that removes or changes the hibernate.resource.beans.container property.

# 84.9 Use a Custom EntityManagerFactory

To take full control of the configuration of the EntityManagerFactory, you need to add a <code>@Bean</code> named 'entityManagerFactory'. Spring Boot auto-configuration switches off its entity manager in the presence of a bean of that type.

# 84.10 Use Two EntityManagers

Even if the default EntityManagerFactory works fine, you need to define a new one. Otherwise, the presence of the second bean of that type switches off the default. To make it easy to do, you can use the convenient EntityManagerBuilder provided by Spring Boot. Alternatively, you can just the LocalContainerEntityManagerFactoryBean directly from Spring ORM, as shown in the following example:

```
// add two data sources configured as above
public LocalContainerEntityManagerFactoryBean customerEntityManagerFactory(
      EntityManagerFactoryBuilder builder) {
   return builder
               .dataSource(customerDataSource())
             .packages(Customer.class)
               .persistenceUnit("customers")
                .build();
@Bean
{\tt public} \  \, {\tt LocalContainerEntityManagerFactoryBean} \  \, {\tt orderEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactor)(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactory(ContainerEntityManagerFactor)(ContainerEntityManagerFactory(ContainerEntityManagerFactor)(C
       EntityManagerFactoryBuilder builder) {
   return builder
              .dataSource(orderDataSource())
               .packages(Order.class)
                .persistenceUnit("orders")
               .build();
}
```

The configuration above almost works on its own. To complete the picture, you need to configure TransactionManagers for the two EntityManagers as well. If you mark one of them as @Primary, it could be picked up by the default JpaTransactionManager in Spring Boot. The other would have to be explicitly injected into a new instance. Alternatively, you might be able to use a JTA transaction manager that spans both.

If you use Spring Data, you need to configure @EnableJpaRepositories accordingly, as shown in the following example:

```
@Configuration
@EnableJpaRepositories(basePackageClasses = Customer.class,
    entityManagerFactoryRef = "customerEntityManagerFactory")
public class CustomerConfiguration {
    ...
}
@Configuration
@EnableJpaRepositories(basePackageClasses = Order.class,
    entityManagerFactoryRef = "orderEntityManagerFactory")
public class OrderConfiguration {
    ...
}
```

# 84.11 Use a Traditional persistence.xml File

Spring Boot will not search for or use a META-INF/persistence.xml by default. If you prefer to use a traditional persistence.xml, you need to define your own @Bean of type LocalEntityManagerFactoryBean (with an ID of 'entityManagerFactory') and set the persistence unit name there.

See <u>JpaBaseConfiguration</u> for the default settings.

# 84.12 Use Spring Data JPA and Mongo Repositories

Spring Data JPA and Spring Data Mongo can both automatically create Repository implementations for you. If they are both present on the classpath, you might have to do some extra configuration to tell Spring Boot which repositories to create. The most explicit way to do that is to use the standard Spring Data @EnableJpaRepositories and @EnableMongoRepositories annotations and provide the location of your Repository interfaces.

There are also flags (spring.data.\*.repositories.enabled and spring.data.\*.repositories.type) that you can use to switch the auto-configured repositories on and off in external configuration. Doing so is useful, for instance, in case you want to switch off the Mongo repositories and still use the auto-configured Mongo Template.

The same obstacle and the same features exist for other auto-configured Spring Data repository types (Elasticsearch, Solr, and others). To work with them, change the names of the annotations and flags accordingly.

# 84.13 Customize Spring Data's Web Support

Spring Data provides web support that simplifies the use of Spring Data repositories in a web application. Spring Boot provides properties in the <code>spring.data.web</code> namespace for customizing its configuration. Note that if you are using Spring Data REST, you must use the properties in the <code>spring.data.rest</code> namespace instead.

# 84.14 Expose Spring Data Repositories as REST Endpoint

Spring Data REST can expose the Repository implementations as REST endpoints for you, provided Spring MVC has been enabled for the application.

Spring Boot exposes a set of useful properties (from the spring.data.rest namespace) that customize the <u>RepositoryRestConfiguration</u>. If you need to provide additional customization, you should use a <u>RepositoryRestConfigurer</u> bean.

#### **Note**

If you do not specify any order on your custom RepositoryRestConfigurer, it runs after the one Spring Boot uses internally. If you need to specify an order, make sure it is higher than 0.

# 84.15 Configure a Component that is Used by JPA

If you want to configure a component that JPA uses, then you need to ensure that the component is initialized before JPA. When the component is auto-configured, Spring Boot takes care of this for you. For example, when Flyway is auto-configured, Hibernate is configured to depend upon Flyway so that Flyway has a chance to initialize the database before Hibernate tries to use it.

If you are configuring a component yourself, you can use an EntityManagerFactoryDependsOnPostProcessor subclass as a convenient way of setting up the necessary dependencies. For example, if you use Hibernate Search with Elasticsearch as its index manager, any EntityManagerFactory beans must be configured to depend on the elasticsearchClient bean, as shown in the following example:

```
/**
  * {@link EntityManagerFactoryDependsOnPostProcessor} that ensures that
  * {@link EntityManagerFactory} beans depend on the {@code elasticsearchClient} bean.
  */
  @Configuration
  static class ElasticsearchJpaDependencyConfiguration
    extends EntityManagerFactoryDependsOnPostProcessor {

ElasticsearchJpaDependencyConfiguration() {
    super("elasticsearchClient");
}
```

# 84.16 Configure jOOQ with Two DataSources

If you need to use jOOQ with multiple data sources, you should create your own DSLContext for each one. Refer to <u>JooqAutoConfiguration</u> for more details.

#### Tip

In particular, JooqExceptionTranslator and SpringTransactionProvider can be reused to provide similar features to what the auto-configuration does with a single DataSource.

# 85. Database Initialization

An SQL database can be initialized in different ways depending on what your stack is. Of course, you can also do it manually, provided the database is a separate process.

# 85.1 Initialize a Database Using JPA

JPA has features for DDL generation, and these can be set up to run on startup against the database. This is controlled through two external properties:

- spring.jpa.generate-ddl (boolean) switches the feature on and off and is vendor independent.
- spring.jpa.hibernate.ddl-auto (enum) is a Hibernate feature that controls the behavior in a
  more fine-grained way. This feature is described in more detail later in this guide.

# 85.2 Initialize a Database Using Hibernate

You can set spring.jpa.hibernate.ddl-auto explicitly and the standard Hibernate property values are none, validate, update, create, and create-drop. Spring Boot chooses a default value for you based on whether it thinks your database is embedded. It defaults to create-drop if no schema manager has been detected or none in all other cases. An embedded database is detected by looking at the Connection type. hsqldb, h2, and derby are embedded, and others are not. Be careful when switching from in-memory to a 'real' database that you do not make assumptions about the existence of the tables and data in the new platform. You either have to set ddl-auto explicitly or use one of the other mechanisms to initialize the database.

#### Note

You can output the schema creation by enabling the org.hibernate.SQL logger. This is done for you automatically if you enable the <u>debug mode</u>.

In addition, a file named import.sql in the root of the classpath is executed on startup if Hibernate creates the schema from scratch (that is, if the ddl-auto property is set to create or create-drop). This can be useful for demos and for testing if you are careful but is probably not something you want to be on the classpath in production. It is a Hibernate feature (and has nothing to do with Spring).

#### 85.3 Initialize a Database

Spring Boot can automatically create the schema (DDL scripts) of your DataSource and initialize it (DML scripts). It loads SQL from the standard root classpath locations: schema.sql and data.sql, respectively. In addition, Spring Boot processes the schema-\${platform}.sql and data-\${platform}.sql files (if present), where platform is the value of spring.datasource.platform. This allows you to switch to database-specific scripts if necessary. For example, you might choose to set it to the vendor name of the database (hsqldb, h2, oracle, mysql, postgresql, and so on).

#### Note

Spring Boot automatically creates the schema of an embedded DataSource. This behaviour can be customized by using the spring.datasource.initialization-mode property. For instance, if you want to always initialize the DataSource regardless of its type:

```
spring.datasource.initialization-mode=always
```

By default, Spring Boot enables the fail-fast feature of the Spring JDBC initializer. This means that, if the scripts cause exceptions, the application fails to start. You can tune that behavior by setting spring.datasource.continue-on-error.

#### Note

In a JPA-based app, you can choose to let Hibernate create the schema or use schema.sql, but you cannot do both. Make sure to disable spring.jpa.hibernate.ddl-auto if you use schema.sql.

# 85.4 Initialize a Spring Batch Database

If you use Spring Batch, it comes pre-packaged with SQL initialization scripts for most popular database platforms. Spring Boot can detect your database type and execute those scripts on startup. If you use an embedded database, this happens by default. You can also enable it for any database type, as shown in the following example:

```
spring.batch.initialize-schema=always
```

You can also switch off the initialization explicitly by setting spring.batch.initialize-schema=never.

# 85.5 Use a Higher-level Database Migration Tool

Spring Boot supports two higher-level migration tools: Flyway and Liquibase.

### **Execute Flyway Database Migrations on Startup**

To automatically run Flyway database migrations on startup, add the org.flywaydb:flyway-core to your classpath.

The migrations are scripts in the form V<VERSION>\_\_<NAME>.sql (with <VERSION> an underscore-separated version, such as '1' or '2\_1'). By default, they are in a folder called classpath:db/migration, but you can modify that location by setting spring.flyway.locations. This is a comma-separated list of one or more classpath: or filesystem: locations. For example, the following configuration would search for scripts in both the default classpath location and the /opt/migration directory:

```
spring.flyway.locations=classpath:db/migration,filesystem:/opt/migration
```

You can also add a special {vendor} placeholder to use vendor-specific scripts. Assume the following:

```
spring.flyway.locations=classpath:db/migration/{vendor}
```

Rather than using db/migration, the preceding configuration sets the folder to use according to the type of the database (such as db/migration/mysql for MySQL). The list of supported databases is available in <a href="mailto:patabaseDriver">patabaseDriver</a>.

<u>FlywayProperties</u> provides most of Flyway's settings and a small set of additional properties that can be used to disable the migrations or switch off the location checking. If you need more control over the configuration, consider registering a FlywayConfigurationCustomizer bean.

Spring Boot calls Flyway.migrate() to perform the database migration. If you would like more control, provide a @Bean that implements FlywayMigrationStrategy.

Flyway supports SQL and Java <u>callbacks</u>. To use SQL-based callbacks, place the callback scripts in the <code>classpath:db/migration</code> folder. To use Java-based callbacks, create one or more beans that implement <code>Callback</code>. Any such beans are automatically registered with <code>Flyway</code>. They can be ordered by using <code>@Order</code> or by implementing <code>Ordered</code>. Beans that implement the deprecated <code>FlywayCallback</code> interface can also be detected, however they cannot be used alongside <code>Callback</code> beans.

By default, Flyway autowires the (@Primary) DataSource in your context and uses that for migrations. If you like to use a different DataSource, you can create one and mark its @Bean as @FlywayDataSource. If you do so and want two data sources, remember to create another one and mark it as @Primary. Alternatively, you can use Flyway's native DataSource by setting spring.flyway.[url,user,password] in external properties. Setting either spring.flyway.url or spring.flyway.user is sufficient to cause Flyway to use its own DataSource. If any of the three properties has not be set, the value of its equivalent spring.datasource property will be used.

There is a Flyway sample so that you can see how to set things up.

You can also use Flyway to provide data for specific scenarios. For example, you can place test-specific migrations in src/test/resources and they are run only when your application starts for testing. Also, you can use profile-specific configuration to customize spring.flyway.locations so that certain migrations run only when a particular profile is active. For example, in application-dev.properties, you might specify the following setting:

```
spring.flyway.locations=classpath:/db/migration,classpath:/dev/db/migration
```

With that setup, migrations in dev/db/migration run only when the dev profile is active.

#### **Execute Liquibase Database Migrations on Startup**

To automatically run Liquibase database migrations on startup, add the org.liquibase:liquibase-core to your classpath.

By default, the master change log is read from db/changelog/db.changelog-master.yaml, but you can change the location by setting spring.liquibase.change-log. In addition to YAML, Liquibase also supports JSON, XML, and SQL change log formats.

By default, Liquibase autowires the (@Primary) DataSource in your context and uses that for migrations. If you need to use a different DataSource, you can create one and mark its @Bean as @LiquibaseDataSource. If you do so and you want two data sources, remember to create another one and mark it as @Primary. Alternatively, you can use Liquibase's native DataSource by setting spring.liquibase.[url,user,password] in external properties. Setting either spring.liquibase.url or spring.liquibase.user is sufficient to cause Liquibase to use its own DataSource. If any of the three properties has not be set, the value of its equivalent spring.datasource property will be used.

See <u>LiquibaseProperties</u> for details about available settings such as contexts, the default schema, and others.

There is a Liquibase sample so that you can see how to set things up.

# 86. Messaging

Spring Boot offers a number of starters that include messaging. This section answers questions that arise from using messaging with Spring Boot.

#### 86.1 Disable Transacted JMS Session

If your JMS broker does not support transacted sessions, you have to disable the support of transactions altogether. If you create your own <code>JmsListenerContainerFactory</code>, there is nothing to do, since, by default it cannot be transacted. If you want to use the <code>DefaultJmsListenerContainerFactoryConfigurer</code> to reuse Spring Boot's default, you can disable transacted sessions, as follows:

```
public DefaultJmsListenerContainerFactory jmsListenerContainerFactory(
   ConnectionFactory connectionFactory,
   DefaultJmsListenerContainerFactoryConfigurer configurer) {
   DefaultJmsListenerContainerFactory listenerFactory =
        new DefaultJmsListenerContainerFactory();
   configurer.configure(listenerFactory, connectionFactory);
   listenerFactory.setTransactionManager(null);
   listenerFactory.setSessionTransacted(false);
   return listenerFactory;
}
```

The preceding example overrides the default factory, and it should be applied to any other factory that your application defines, if any.

# 87. Batch Applications

This section answers questions that arise from using Spring Batch with Spring Boot.

#### Note

By default, batch applications require a DataSource to store job details. If you want to deviate from that, you need to implement BatchConfigurer. See <u>The Javadoc of @EnableBatchProcessing for more details.</u>

For more about Spring Batch, see the Spring Batch project page.

# 87.1 Execute Spring Batch Jobs on Startup

Spring Batch auto-configuration is enabled by adding @EnableBatchProcessing (from Spring Batch) somewhere in your context.

By default, it executes **all** Jobs in the application context on startup (see <u>JobLauncherCommandLineRunner</u> for details). You can narrow down to a specific job or jobs by specifying spring.batch.job.names (which takes a comma-separated list of job name patterns).

If the application context includes a JobRegistry, the jobs in spring.batch.job.names are looked up in the registry instead of being autowired from the context. This is a common pattern with more complex systems, where multiple jobs are defined in child contexts and registered centrally.

See <u>BatchAutoConfiguration</u> and <u>@EnableBatchProcessing</u> for more details.

## 88. Actuator

Spring Boot includes the Spring Boot Actuator. This section answers questions that often arise from its use.

# 88.1 Change the HTTP Port or Address of the Actuator Endpoints

In a standalone application, the Actuator HTTP port defaults to the same as the main HTTP port. To make the application listen on a different port, set the external property: management.server.port. To listen on a completely different network address (such as when you have an internal network for management and an external one for user applications), you can also set management.server.address to a valid IP address to which the server is able to bind.

For more detail, see the <u>ManagementServerProperties</u> source code and "<u>Section 54.2</u>, "<u>Customizing the Management Server Port"</u>" in the "Production-ready features" section.

# 88.2 Customize the 'whitelabel' Error Page

Spring Boot installs a 'whitelabel' error page that you see in a browser client if you encounter a server error (machine clients consuming JSON and other media types should see a sensible response with the right error code).

#### Note

Set server.error.whitelabel.enabled=false to switch the default error page off. Doing so restores the default of the servlet container that you are using. Note that Spring Boot still tries to resolve the error view, so you should probably add your own error page rather than disabling it completely.

Overriding the error page with your own depends on the templating technology that you use. For example, if you use Thymeleaf, you can add an error.html template. If you use FreeMarker, you can add an error.ftl template. In general, you need a View that resolves with a name of error or a @Controller that handles the /error path. Unless you replaced some of the default configuration, you should find a BeanNameViewResolver in your ApplicationContext, so a @Bean named error would be a simple way of doing that. See <a href="ErrorMvcAutoConfiguration">ErrorMvcAutoConfiguration</a> for more options.

See also the section on "Error Handling" for details of how to register handlers in the servlet container.

#### 88.3 Sanitize sensible values

Information returned by the env and configprops endpoints can be somewhat sensitive so keys matching a certain pattern are sanitized by default (i.e. their values are replaced by \*\*\*\*\*).

Spring Boot uses sensible defaults for such keys: for instance, any key ending with the word "password", "secret", "key" or "token" is sanitized. It is also possible to use a regular expression instead, such as \*credentials.\* to sanitize any key that holds the word credentials as part of the key.

The patterns to use can be customized using the management.endpoint.env.keys-to-sanitize and management.endpoint.configprops.keys-to-sanitize respectively.

# 89. Security

This section addresses questions about security when working with Spring Boot, including questions that arise from using Spring Security with Spring Boot.

For more about Spring Security, see the Spring Security project page.

# 89.1 Switch off the Spring Boot Security Configuration

If you define a @Configuration with a WebSecurityConfigurerAdapter in your application, it switches off the default webapp security settings in Spring Boot.

# 89.2 Change the UserDetailsService and Add User Accounts

If you provide a <code>@Bean</code> of type <code>AuthenticationManager</code>, <code>AuthenticationProvider</code>, or <code>UserDetailsService</code>, the default <code>@Bean</code> for <code>InMemoryUserDetailsManager</code> is not created, so you have the full feature set of Spring Security available (such as various authentication options).

The easiest way to add user accounts is to provide your own UserDetailsService bean.

# 89.3 Enable HTTPS When Running behind a Proxy Server

Ensuring that all your main endpoints are only available over HTTPS is an important chore for any application. If you use Tomcat as a servlet container, then Spring Boot adds Tomcat's own RemotelpValve automatically if it detects some environment settings, and you should be able to rely on the HttpServletRequest to report whether it is secure or not (even downstream of a proxy server that handles the real SSL termination). The standard behavior is determined by the presence or absence of certain request headers (x-forwarded-for and x-forwarded-proto), whose names are conventional, so it should work with most front-end proxies. You can switch on the valve by adding some entries to application.properties, as shown in the following example:

```
server.tomcat.remote-ip-header=x-forwarded-for
server.tomcat.protocol-header=x-forwarded-proto
```

(The presence of either of those properties switches on the valve. Alternatively, you can add the RemotelpValve by adding a TomcatServletWebServerFactory bean.)

To configure Spring Security to require a secure channel for all (or some) requests, consider adding your own WebSecurityConfigurerAdapter that adds the following HttpSecurity configuration:

```
@Configuration
public class SslWebSecurityConfigurerAdapter extends WebSecurityConfigurerAdapter {

@Override
protected void configure(HttpSecurity http) throws Exception {

// Customize the application security
http.requiresChannel().anyRequest().requiresSecure();
}
```

# 90. Hot Swapping

Spring Boot supports hot swapping. This section answers questions about how it works.

#### 90.1 Reload Static Content

There are several options for hot reloading. The recommended approach is to use <a href="mailto:spring-boot-devtools">spring-boot-devtools</a>, as it provides additional development-time features, such as support for fast application restarts and LiveReload as well as sensible development-time configuration (such as template caching). Devtools works by monitoring the classpath for changes. This means that static resource changes must be "built" for the change to take affect. By default, this happens automatically in Eclipse when you save your changes. In IntelliJ IDEA, the Make Project command triggers the necessary build. Due to the default restart exclusions, changes to static resources do not trigger a restart of your application. They do, however, trigger a live reload.

Alternatively, running in an IDE (especially with debugging on) is a good way to do development (all modern IDEs allow reloading of static resources and usually also allow hot-swapping of Java class changes).

Finally, the <u>Maven and Gradle plugins</u> can be configured (see the addResources property) to support running from the command line with reloading of static files directly from source. You can use that with an external css/js compiler process if you are writing that code with higher-level tools.

# 90.2 Reload Templates without Restarting the Container

Most of the templating technologies supported by Spring Boot include a configuration option to disable caching (described later in this document). If you use the <code>spring-boot-devtools</code> module, these properties are <u>automatically configured</u> for you at development time.

#### **Thymeleaf Templates**

If you use Thymeleaf, set spring.thymeleaf.cache to false. See <a href="https://doi.org/10.15">ThymeleafAutoConfiguration</a> for other Thymeleaf customization options.

#### FreeMarker Templates

If you use FreeMarker, set spring.freemarker.cache to false. See <a href="FreeMarkerAutoConfiguration">FreeMarkerAutoConfiguration</a> for other FreeMarker customization options.

#### **Groovy Templates**

If you use Groovy templates, set spring.groovy.template.cache to false. See GroovyTemplateAutoConfiguration for other Groovy customization options.

# 90.3 Fast Application Restarts

The spring-boot-devtools module includes support for automatic application restarts. While not as fast as technologies such as <u>JRebel</u> it is usually significantly faster than a "cold start". You should probably give it a try before investigating some of the more complex reload options discussed later in this document.

For more details, see the Chapter 20, Developer Tools section.

# 90.4 Reload Java Classes without Restarting the Container

Many modern IDEs (Eclipse, IDEA, and others) support hot swapping of bytecode. Consequently, if you make a change that does not affect class or method signatures, it should reload cleanly with no side effects.

## 91. Build

Spring Boot includes build plugins for Maven and Gradle. This section answers common questions about these plugins.

#### 91.1 Generate Build Information

Both the Maven plugin and the Gradle plugin allow generating build information containing the coordinates, name, and version of the project. The plugins can also be configured to add additional properties through configuration. When such a file is present, Spring Boot auto-configures a BuildProperties bean.

To generate build information with Maven, add an execution for the build-info goal, as shown in the following example:

```
<build>
<plugins>
 <plugin>
  <groupId>org.springframework.boot
  <artifactId>spring-boot-maven-plugin</artifactId>
  <version>2.1.0.RELEASE
  <executions>
   <execution>
    <goals>
     <goal>build-info</goal>
    </goals>
   </execution>
  </executions>
 </plugin>
 </plugins>
</build>
```

#### Tip

See the Spring Boot Maven Plugin documentation for more details.

The following example does the same with Gradle:

```
springBoot {
  buildInfo()
}
```

#### Tip

See the Spring Boot Gradle Plugin documentation for more details.

#### 91.2 Generate Git Information

Both Maven and Gradle allow generating a git.properties file containing information about the state of your git source code repository when the project was built.

For Maven users, the spring-boot-starter-parent POM includes a pre-configured plugin to generate a git.properties file. To use it, add the following declaration to your POM:

```
<build>
<plugins>
```

```
<plugin>
  <groupId>pl.project13.maven</groupId>
  <artifactId>git-commit-id-plugin</artifactId>
  </plugin>
  </plugins>
</build>
```

Gradle users can achieve the same result by using the <a href="mailto:gradle-git-properties">gradle-git-properties</a> plugin, as shown in the following example:

```
plugins {
  id "com.gorylenko.gradle-git-properties" version "1.5.1"
}
```

#### Tip

The commit time in git.properties is expected to match the following format: yyyy-MM-dd'T'HH:mm:ssZ. This is the default format for both plugins listed above. Using this format lets the time be parsed into a Date and its format, when serialized to JSON, to be controlled by Jackson's date serialization configuration settings.

# 91.3 Customize Dependency Versions

If you use a Maven build that inherits directly or indirectly from spring-boot-dependencies (for instance, spring-boot-starter-parent) but you want to override a specific third-party dependency, you can add appropriate cproperties> elements. Browse the spring-boot-dependencies POM for a complete list of properties. For example, to pick a different slf4j version, you would add the following property:

```
<slf4j.version>1.7.5<slf4j.version>
```

#### Note

Doing so only works if your Maven project inherits (directly or indirectly) from spring-boot-dependencies. If you have added spring-boot-dependencies in your own dependencyManagement section with <scope>import</scope>, you have to redefine the artifact yourself instead of overriding the property.

#### Warning

Each Spring Boot release is designed and tested against this specific set of third-party dependencies. Overriding versions may cause compatibility issues.

To override dependency versions in Gradle, see this section of the Gradle plugin's documentation.

#### 91.4 Create an Executable JAR with Maven

The spring-boot-maven-plugin can be used to create an executable "fat" JAR. If you use the spring-boot-starter-parent POM, you can declare the plugin and your jars are repackaged as follows:

```
<build>
```

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

If you do not use the parent POM, you can still use the plugin. However, you must additionally add an <executions> section, as follows:

```
<build>
  <plugins>
  <plugin>
   <groupId>org.springframework.boot</groupId>
   <artifactId>spring-boot-maven-plugin</artifactId>
   <version>2.1.0.RELEASE</version>
   <executions>
   <execution>
   <goals>
        <goal>repackage</goal>
        </goals>
        </execution>
   </execution>
   </execution>
   </execution>
   </execution>
   </plugin>
   </plugins>
</build>
```

See the <u>plugin documentation</u> for full usage details.

# 91.5 Use a Spring Boot Application as a Dependency

Like a war file, a Spring Boot application is not intended to be used as a dependency. If your application contains classes that you want to share with other projects, the recommended approach is to move that code into a separate module. The separate module can then be depended upon by your application and other projects.

If you cannot rearrange your code as recommended above, Spring Boot's Maven and Gradle plugins must be configured to produce a separate artifact that is suitable for use as a dependency. The executable archive cannot be used as a dependency as the <u>executable jar format</u> packages application classes in BOOT-INF/classes. This means that they cannot be found when the executable jar is used as a dependency.

To produce the two artifacts, one that can be used as a dependency and one that is executable, a classifier must be specified. This classifier is applied to the name of the executable archive, leaving the default archive for use as a dependency.

To configure a classifier of exec in Maven, you can use the following configuration:

# 91.6 Extract Specific Libraries When an Executable Jar Runs

Most nested libraries in an executable jar do not need to be unpacked in order to run. However, certain libraries can have problems. For example, JRuby includes its own nested jar support, which assumes that the <code>jruby-complete.jar</code> is always directly available as a file in its own right.

To deal with any problematic libraries, you can flag that specific nested jars should be automatically unpacked to the "temp folder" when the executable jar first runs.

For example, to indicate that JRuby should be flagged for unpacking by using the Maven Plugin, you would add the following configuration:

```
<build>
<plugins>
 <plugin>
  <groupId>org.springframework.boot
  <artifactId>spring-boot-maven-plugin</artifactId>
  <configuration>
   <requiresUnpack>
    <dependency>
     <groupId>org.jruby</groupId>
     <artifactId>jruby-complete</artifactId>
    </dependency>
   </requiresUnpack>
  </configuration>
 </plugin>
</plugins>
</build>
```

#### 91.7 Create a Non-executable JAR with Exclusions

Often, if you have an executable and a non-executable jar as two separate build products, the executable version has additional configuration files that are not needed in a library jar. For example, the application.yml configuration file might by excluded from the non-executable JAR.

In Maven, the executable jar must be the main artifact and you can add a classified jar for the library, as follows:

```
<build>
<plugins>
 <plugin>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-mayen-plugin</artifactId>
  </plugin>
  <plugin>
  <artifactId>maven-jar-plugin</artifactId>
  <executions>
    <execution>
    <id>lib</id>
    <phase>package</phase>
    <goals>
     <goal>jar</goal>
    </goals>
    <configuration>
     <classifier>lib</classifier>
     <excludes>
      <exclude>application.yml</exclude>
     </excludes>
    </configuration>
    </execution>
  </executions>
 </plugin>
</plugins>
</build>
```

# 91.8 Remote Debug a Spring Boot Application Started with Mayen

To attach a remote debugger to a Spring Boot application that was started with Maven, you can use the jvmArguments property of the maven plugin.

See this example for more details.

# 91.9 Build an Executable Archive from Ant without Using spring-boot-antlib

To build with Ant, you need to grab dependencies, compile, and then create a jar or war archive. To make it executable, you can either use the spring-boot-antlib module or you can follow these instructions:

- 1. If you are building a jar, package the application's classes and resources in a nested BOOT-INF/classes directory. If you are building a war, package the application's classes in a nested WEB-INF/classes directory as usual.
- 2. Add the runtime dependencies in a nested BOOT-INF/lib directory for a jar or WEB-INF/lib for a war. Remember **not** to compress the entries in the archive.
- 3. Add the provided (embedded container) dependencies in a nested BOOT-INF/lib directory for a jar or WEB-INF/lib-provided for a war. Remember **not** to compress the entries in the archive.
- 4. Add the spring-boot-loader classes at the root of the archive (so that the Main-Class is available).
- 5. Use the appropriate launcher (such as <code>JarLauncher</code> for a jar file) as a <code>Main-Class</code> attribute in the manifest and specify the other properties it needs as manifest entries principally, by setting a <code>Start-Class</code> property.

The following example shows how to build an executable archive with Ant:

```
<target name="build" depends="compile">
<jar destfile="target/${ant.project.name}-${spring-boot.version}.jar" compress="false">
 <mappedresources>
  <fileset dir="target/classes" />
  <globmapper from="*" to="BOOT-INF/classes/*"/>
 </mappedresources>
 <mappedresources>
  <fileset dir="src/main/resources" erroronmissingdir="false"/>
  <globmapper from="*" to="BOOT-INF/classes/*"/>
 <mappedresources>
  <fileset dir="${lib.dir}/runtime" />
  <globmapper from="*" to="BOOT-INF/lib/*"/>
 </mappedresources>
 <zipfileset src="${lib.dir}/loader/spring-boot-loader-jar-${spring-boot.version}.jar" />
  <attribute name="Main-Class" value="org.springframework.boot.loader.JarLauncher" />
   <attribute name="Start-Class" value="${start-class}" />
 </manifest>
</jar>
</target>
```

The Ant Sample has a build.xml file with a manual task that should work if you run it with the following command:

\$ ant -lib <folder containing ivy-2.2.jar> clean manual

Then you can run the application with the following command:

\$ java -jar target/\*.jar

# 92. Traditional Deployment

Spring Boot supports traditional deployment as well as more modern forms of deployment. This section answers common questions about traditional deployment.

# 92.1 Create a Deployable War File

#### Warning

Because Spring WebFlux does not strictly depend on the Servlet API and applications are deployed by default on an embedded Reactor Netty server, War deployment is not supported for WebFlux applications.

The first step in producing a deployable war file is to provide a SpringBootServletInitializer subclass and override its configure method. Doing so makes use of Spring Framework's Servlet 3.0 support and lets you configure your application when it is launched by the servlet container. Typically, you should update your application's main class to extend SpringBootServletInitializer, as shown in the following example:

```
@SpringBootApplication
public class Application extends SpringBootServletInitializer {

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

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

The next step is to update your build configuration such that your project produces a war file rather than a jar file. If you use Maven and spring-boot-starter-parent (which configures Maven's war plugin for you), all you need to do is to modify pom.xml to change the packaging to war, as follows:

```
<packaging>war</packaging>
```

If you use Gradle, you need to modify build.gradle to apply the war plugin to the project, as follows:

```
apply plugin: 'war'
```

The final step in the process is to ensure that the embedded servlet container does not interfere with the servlet container to which the war file is deployed. To do so, you need to mark the embedded servlet container dependency as being provided.

If you use Maven, the following example marks the servlet container (Tomcat, in this case) as being provided:

```
</dependencies>
```

If you use Gradle, the following example marks the servlet container (Tomcat, in this case) as being provided:

```
dependencies {
  // ...
  providedRuntime 'org.springframework.boot:spring-boot-starter-tomcat'
  // ...
}
```

#### Tip

providedRuntime is preferred to Gradle's compileOnly configuration. Among other limitations, compileOnly dependencies are not on the test classpath, so any web-based integration tests fail.

If you use the <u>Spring Boot build tools</u>, marking the embedded servlet container dependency as provided produces an executable war file with the provided dependencies packaged in a <u>lib-provided</u> directory. This means that, in addition to being deployable to a servlet container, you can also run your application by using <u>java</u> -jar on the command line.

#### Tip

Take a look at Spring Boot's sample applications for a <u>Maven-based example</u> of the previously described configuration.

# 92.2 Convert an Existing Application to Spring Boot

For a non-web application, it should be easy to convert an existing Spring application to a Spring Boot application. To do so, throw away the code that creates your ApplicationContext and replace it with calls to SpringApplication or SpringApplicationBuilder. Spring MVC web applications are generally amenable to first creating a deployable war application and then migrating it later to an executable war or jar. See the <u>Getting Started Guide on Converting a jar to a war</u>.

To create a deployable war by extending <code>SpringBootServletInitializer</code> (for example, in a class called <code>Application</code>) and adding the <code>SpringBootApplication</code> annotation, use code similar to that shown in the following example:

```
@SpringBootApplication
public class Application extends SpringBootServletInitializer {

@Override
protected SpringApplicationBuilder configure(SpringApplicationBuilder application) {

// Customize the application or call application.sources(...) to add sources

// Since our example is itself a @Configuration class (via @SpringBootApplication)

// we actually don't need to override this method.
return application;
}
```

Remember that, whatever you put in the sources is merely a Spring ApplicationContext. Normally, anything that already works should work here. There might be some beans you can remove later and let Spring Boot provide its own defaults for them, but it should be possible to get something working before you need to do that.

Static resources can be moved to /public (or /static or /resources or /META-INF/resources) in the classpath root. The same applies to messages.properties (which Spring Boot automatically detects in the root of the classpath).

Vanilla usage of Spring DispatcherServlet and Spring Security should require no further changes. If you have other features in your application (for instance, using other servlets or filters), you may need to add some configuration to your Application context, by replacing those elements from the web.xml, as follows:

- A @Bean of type Servlet or ServletRegistrationBean installs that bean in the container as if it were a <servlet/> and <servlet-mapping/> in web.xml.
- A @Bean of type Filter or FilterRegistrationBean behaves similarly (as a <filter/> and <filter-mapping/>).
- An ApplicationContext in an XML file can be added through an @ImportResource in your Application. Alternatively, simple cases where annotation configuration is heavily used already can be recreated in a few lines as @Bean definitions.

Once the war file is working, you can make it executable by adding a main method to your Application, as shown in the following example:

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

#### Note

If you intend to start your application as a war or as an executable application, you need to share the customizations of the builder in a method that is both available to the SpringBootServletInitializer callback and in the main method in a class similar to the following:

```
@SpringBootApplication
public class Application extends SpringBootServletInitializer {

@Override
protected SpringApplicationBuilder configure(SpringApplicationBuilder builder) {
    return configureApplication(builder);
}

public static void main(String[] args) {
    configureApplication(new SpringApplicationBuilder()).run(args);
}

private static SpringApplicationBuilder configureApplication(SpringApplicationBuilder) {
    return builder.sources(Application.class).bannerMode(Banner.Mode.OFF);
}

}
```

Applications can fall into more than one category:

- Servlet 3.0+ applications with no web.xml.
- Applications with a web.xml.
- Applications with a context hierarchy.

· Applications without a context hierarchy.

All of these should be amenable to translation, but each might require slightly different techniques.

Servlet 3.0+ applications might translate pretty easily if they already use the Spring Servlet 3.0+ initializer support classes. Normally, all the code from an existing WebApplicationInitializer can be moved into a SpringBootServletInitializer. If your existing application has more than one ApplicationContext (for example, if it uses AbstractDispatcherServletInitializer) then you might be able to combine all your context sources into a single SpringApplication. The main complication you might encounter is if combining does not work and you need to maintain the context hierarchy. See the entry on building a hierarchy for examples. An existing parent context that contains web-specific features usually needs to be broken up so that all the ServletContextAware components are in the child context.

Applications that are not already Spring applications might be convertible to Spring Boot applications, and the previously mentioned guidance may help. However, you may yet encounter problems. In that case, we suggest asking questions on Stack Overflow with a tag of spring-boot.

# 92.3 Deploying a WAR to WebLogic

To deploy a Spring Boot application to WebLogic, you must ensure that your servlet initializer **directly** implements WebApplicationInitializer (even if you extend from a base class that already implements it).

A typical initializer for WebLogic should resemble the following example:

```
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.boot.web.servlet.support.SpringBootServletInitializer;
import org.springframework.web.WebApplicationInitializer;

@SpringBootApplication
public class MyApplication extends SpringBootServletInitializer implements WebApplicationInitializer {
}
```

If you use Logback, you also need to tell WebLogic to prefer the packaged version rather than the version that was pre-installed with the server. You can do so by adding a WEB-INF/weblogic.xml file with the following contents:

```
<?xml version="1.0" encoding="UTF-8"?>
<wls:weblogic-web-app
xmlns:wls="http://xmlns.oracle.com/weblogic/weblogic-web-app"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://java.sun.com/xml/ns/javaee
http://java.sun.com/xml/ns/javaee/ejb-jar_3_0.xsd
http://xmlns.oracle.com/weblogic/weblogic-web-app
http://xmlns.oracle.com/weblogic/weblogic-web-app
http://xmlns.oracle.com/weblogic/weblogic-web-app/1.4/weblogic-web-app.xsd">
<wls:container-descriptor>
<wls:prefer-application-packages>
</wls:prefer-application-packages>
</wls:container-descriptor>
</wls:veblogic-web-app>
```

#### 92.4 Use Jedis Instead of Lettuce

By default, the Spring Boot starter (spring-boot-starter-data-redis) uses <u>Lettuce</u>. You need to exclude that dependency and include the <u>Jedis</u> one instead. Spring Boot manages these dependencies to help make this process as easy as possible.

#### The following example shows how to do so in Maven:

#### The following example shows how to do so in Gradle:

```
configurations {
  compile.exclude module: "lettuce"
}
dependencies {
  compile("redis.clients:jedis")
  // ...
}
```

# Part X. Appendices

# Appendix A. Common application properties

Various properties can be specified inside your application.properties file, inside your application.yml file, or as command line switches. This appendix provides a list of common Spring Boot properties and references to the underlying classes that consume them.

#### Tip

Spring Boot provides various conversion mechanism with advanced value formatting, make sure to review the properties conversion section.

#### Note

Property contributions can come from additional jar files on your classpath, so you should not consider this an exhaustive list. Also, you can define your own properties.

#### Warning

This sample file is meant as a guide only. Do **not** copy and paste the entire content into your application. Rather, pick only the properties that you need.

```
# COMMON SPRING BOOT PROPERTIES
# This sample file is provided as a guideline. Do NOT copy it in its
# entirety to your own application.
# ______
# CORE PROPERTIES
debug=false # Enable debug logs.
trace=false # Enable trace logs.
logging.config= # Location of the logging configuration file. For instance, `classpath:logback.xml` for
logging.exception-conversion-word=%wEx # Conversion word used when logging exceptions.
logging.file= # Log file name (for instance, `myapp.log`). Names can be an exact location or relative to
the current directory.
logging.file.max-history=0 # Maximum of archive log files to keep. Only supported with the default
logback setup.
logging.file.max-size=10MB # Maximum log file size. Only supported with the default logback setup.
logging.group.*= # Log groups to quickly change multiple loggers at the same time. For instance,
 `logging.level.db=org.hibernate,org.springframework.jdbc`.
logging.level.*= # Log levels severity mapping. For instance, `logging.level.org.springframework=DEBUG`.
logging.path= # Location of the log file. For instance, `/var/log`
logging.pattern.console= # Appender pattern for output to the console. Supported only with the default
logging.pattern.dateformat=yyyy-MM-dd HH:mm:ss.SSS # Appender pattern for log date format. Supported
logging.pattern.file= # Appender pattern for output to a file. Supported only with the default Logback
logging.pattern.level=%5p # Appender pattern for log level. Supported only with the default Logback
logging.register-shutdown-hook=false # Register a shutdown hook for the logging system when it is
```

```
# AOP
spring.aop.auto=true # Add @EnableAspectJAutoProxy.
spring.aop.proxy-target-class=true # Whether subclass-based (CGLIB) proxies are to be created (true), as
opposed to standard Java interface-based proxies (false).
# IDENTITY (ContextIdApplicationContextInitializer)
spring.application.name = # Application name.
# ADMIN (SpringApplicationAdminJmxAutoConfiguration)
spring.application.admin.enabled=false # Whether to enable admin features for the application.
spring.application.admin.jmx-name=org.springframework.boot:type=Admin,name=SpringApplication # JMX name
of the application admin MBean.
# AUTO-CONFIGURATION
spring.autoconfigure.exclude= # Auto-configuration classes to exclude.
spring.banner.charset=UTF-8 # Banner file encoding.
spring.banner.location=classpath:banner.txt # Banner text resource location.
spring.banner.image.location=classpath:banner.gif # Banner image file location (jpg or png can also be
spring.banner.image.width=76 # Width of the banner image in chars.
spring.banner.image.height= # Height of the banner image in chars (default based on image height).
spring.banner.image.margin=2 # Left hand image margin in chars.
spring.banner.image.invert=false # Whether images should be inverted for dark terminal themes.
# SPRING CORE
spring.beaninfo.ignore=true # Whether to skip search of BeanInfo classes.
# SPRING CACHE (CacheProperties)
spring.cache.cache-names= # Comma-separated list of cache names to create if supported by the underlying
cache manager.
spring.cache.caffeine.spec= # The spec to use to create caches. See CaffeineSpec for more details on the
spec format.
spring.cache.couchbase.expiration= # Entry expiration. By default the entries never expire. Note that
this value is ultimately converted to seconds.
spring.cache.ehcache.config= # The location of the configuration file to use to initialize EhCache.
spring.cache.infinispan.config= # The location of the configuration file to use to initialize
Infinispan.
spring.cache.jcache.config= # The location of the configuration file to use to initialize the cache
manager.
spring.cache.jcache.provider= # Fully qualified name of the CachingProvider implementation to use to
retrieve the JSR-107 compliant cache manager. Needed only if more than one JSR-107 implementation is
available on the classpath.
spring.cache.redis.cache-null-values=true # Allow caching null values.
spring.cache.redis.key-prefix= # Key prefix.
spring.cache.redis.time-to-live= # Entry expiration. By default the entries never expire.
spring.cache.redis.use-key-prefix=true # Whether to use the key prefix when writing to Redis.
spring.cache.type= # Cache type. By default, auto-detected according to the environment.
# SPRING CONFIG - using environment property only (ConfigFileApplicationListener)
spring.config.additional-location= # Config file locations used in addition to the defaults.
spring.config.location= # Config file locations that replace the defaults.
spring.config.name=application # Config file name.
# HAZELCAST (HazelcastProperties)
spring.hazelcast.config= # The location of the configuration file to use to initialize Hazelcast.
# PROJECT INFORMATION (ProjectInfoProperties)
spring.info.build.encoding=UTF-8 # File encoding.
spring.info.build.location=classpath:META-INF/build-info.properties # Location of the generated build-
info.properties file
spring.info.git.encoding=UTF-8 # File encoding.
spring.info.git.location=classpath:git.properties # Location of the generated git.properties file.
# ,TMX
spring.jmx.default-domain= # JMX domain name.
spring.imx.enabled=true # Expose management beans to the JMX domain.
spring.jmx.server=mbeanServer # MBeanServer bean name.
spring.jmx.unique-names=false # Whether unique runtime object names should be ensured.
```

```
# Email (MailProperties)
spring.mail.default-encoding=UTF-8 # Default MimeMessage encoding.
spring.mail.host= # SMTP server host. For instance, `smtp.example.com`.
spring.mail.jndi-name= # Session JNDI name. When set, takes precedence over other Session settings.
spring.mail.password= # Login password of the SMTP server.
spring.mail.port= # SMTP server port.
spring.mail.properties.*= # Additional JavaMail Session properties.
spring.mail.protocol=smtp # Protocol used by the SMTP server.
spring.mail.test-connection=false # Whether to test that the mail server is available on startup.
spring.mail.username= # Login user of the SMTP server.
# APPLICATION SETTINGS (SpringApplication)
spring.main.allow-bean-definition-overriding=false # Whether bean definition overriding, by registering
 a definition with the same name as an existing definition, is allowed.
spring.main.banner-mode=console # Mode used to display the banner when the application runs.
spring.main.sources= # Sources (class names, package names, or XML resource locations) to include in the
ApplicationContext.
spring.main.web-application-type= # Flag to explicitly request a specific type of web application. If
not set, auto-detected based on the classpath.
# FILE ENCODING (FileEncodingApplicationListener)
spring.mandatory-file-encoding= # Expected character encoding the application must use.
# INTERNATIONALIZATION (MessageSourceProperties)
spring.messages.always-use-message-format=false # Whether to always apply the MessageFormat rules,
parsing even messages without arguments.
spring.messages.basename=messages # Comma-separated list of basenames (essentially a fully-qualified
classpath location), each following the ResourceBundle convention with relaxed support for slash based
spring.messages.cache-duration= # Loaded resource bundle files cache duration. When not set, bundles are
cached forever. If a duration suffix is not specified, seconds will be used.
spring.messages.encoding=UTF-8 # Message bundles encoding.
spring.messages.fallback-to-system-locale=true # Whether to fall back to the system Locale if no files
for a specific Locale have been found.
spring.messages.use-code-as-default-message=false # Whether to use the message code as the default
message instead of throwing a "NoSuchMessageException". Recommended during development only.
spring.output.ansi.enabled=detect # Configures the ANSI output.
# PID FILE (ApplicationPidFileWriter)
spring.pid.fail-on-write-error= # Fails if ApplicationPidFileWriter is used but it cannot write the PID
file.
spring.pid.file= # Location of the PID file to write (if ApplicationPidFileWriter is used).
# PROFILES
spring.profiles.active= # Comma-separated list of active profiles. Can be overridden by a command line
spring.profiles.include= # Unconditionally activate the specified comma-separated list of profiles (or
list of profiles if using YAML).
# QUARTZ SCHEDULER (QuartzProperties)
spring.quartz.auto-startup=true # Whether to automatically start the scheduler after initialization.
spring.quartz.jdbc.comment-prefix=-- # Prefix for single-line comments in SQL initialization scripts.
spring.quartz.jdbc.initialize-schema=embedded # Database schema initialization mode.
spring.quartz.jdbc.schema=classpath:org/quartz/impl/jdbcjobstore/tables_@@platform@@.sql # Path to the
SQL file to use to initialize the database schema.
spring.quartz.job-store-type=memory # Quartz job store type.
spring.quartz.overwrite-existing-jobs=false # Whether configured jobs should overwrite existing job
definitions.
spring.quartz.properties.*= # Additional Quartz Scheduler properties.
spring.quartz.scheduler-name=quartzScheduler # Name of the scheduler.
spring.quartz.startup-delay=0s # Delay after which the scheduler is started once initialization
completes.
spring.quartz.wait-for-jobs-to-complete-on-shutdown=false # Whether to wait for running jobs to complete
on shutdown.
# REACTOR (ReactorCoreProperties)
spring.reactor.stacktrace-mode.enabled=false # Whether Reactor should collect stacktrace information at
runtime.
```

```
# SENDGRID (SendGridAutoConfiguration)
spring.sendgrid.api-key= # SendGrid API key.
spring.sendgrid.proxy.host= # SendGrid proxy host.
spring.sendgrid.proxy.port= # SendGrid proxy port.
# TASK EXECUTION (TaskExecutionProperties)
spring.task.execution.pool.allow-core-thread-timeout=true # Whether core threads are allowed to time
out. This enables dynamic growing and shrinking of the pool.
spring.task.execution.pool.core-size=8 # Core number of threads.
spring.task.execution.pool.keep-alive=60s # Time limit for which threads may remain idle before being
terminated.
spring.task.execution.pool.max-size= # Maximum allowed number of threads. If tasks are filling up the
queue, the pool can expand up to that size to accommodate the load. Ignored if the queue is unbounded.
spring.task.execution.pool.queue-capacity= # Queue capacity. An unbounded capacity does not increase the
pool and therefore ignores the "max-size" property.
spring.task.execution.thread-name-prefix=task- # Prefix to use for the names of newly created threads.
# TASK SCHEDULING (TaskSchedulingProperties)
spring.task.scheduling.pool.size=1 # Maximum allowed number of threads.
spring.task.scheduling.thread-name-prefix=scheduling- # Prefix to use for the names of newly created
# WEB PROPERTIES
# EMBEDDED SERVER CONFIGURATION (ServerProperties)
server.address= # Network address to which the server should bind.
server.compression.enabled=false # Whether response compression is enabled.
server.compression.excluded-user-agents= # Comma-separated list of user agents for which responses
should not be compressed.
server.compression.mime-types=text/html,text/xml,text/plain,text/css,text/javascript,application/
javascript,application/json,application/xml # Comma-separated list of MIME types that should be
compressed.
server.compression.min-response-size=2KB # Minimum "Content-Length" value that is required for
compression to be performed.
server.connection-timeout= # Time that connectors wait for another HTTP request before closing the
connection. When not set, the connector's container-specific default is used. Use a value of -1 to
indicate no (that is, an infinite) timeout.
server.error.include-exception=false # Include the "exception" attribute.
server.error.include-stacktrace=never # When to include a "stacktrace" attribute.
server.error.path=/error # Path of the error controller.
server.error.whitelabel.enabled=true # Whether to enable the default error page displayed in browsers in
case of a server error
server.http2.enabled=false # Whether to enable HTTP/2 support, if the current environment supports it.
server.jetty.acceptors=-1 # Number of acceptor threads to use. When the value is -1, the default, the
number of acceptors is derived from the operating environment.
server.jetty.accesslog.append=false # Append to log.
server.jetty.accesslog.date-format=dd/MMM/yyyy:HH:mm:ss Z # Timestamp format of the request log.
server.jetty.accesslog.enabled=false # Enable access log.
server.jetty.accesslog.extended-format=false # Enable extended NCSA format.
server.jetty.accesslog.file-date-format= # Date format to place in log file name.
server.jetty.accesslog.filename= # Log filename. If not specified, logs redirect to "System.err".
server.jetty.accesslog.locale= # Locale of the request log.
server.jetty.accesslog.log-cookies=false # Enable logging of the request cookies.
server.jetty.accesslog.log-latency=false # Enable logging of request processing time.
server.jetty.accesslog.log-server=false # Enable logging of the request hostname.
server.jetty.accesslog.retention-period=31 # Number of days before rotated log files are deleted.
server.jetty.accesslog.time-zone=GMT # Timezone of the request log.
server.jetty.max-http-post-size=200000B # Maximum size of the HTTP post or put content.
server.jetty.selectors=-1 # Number of selector threads to use. When the value is -1, the default, the
number of selectors is derived from the operating environment.
server.max-http-header-size=8KB # Maximum size of the HTTP message header.
server.port=8080 # Server HTTP port.
server.server-header= # Value to use for the Server response header (if empty, no header is sent).
server.use-forward-headers= # Whether X-Forwarded-* headers should be applied to the HttpRequest.
server.servlet.context-parameters.*= # Servlet context init parameters.
server.servlet.context-path= # Context path of the application.
server.servlet.application-display-name=application # Display name of the application.
```

```
server.servlet.jsp.class-name=org.apache.jasper.servlet.JspServlet # Class name of the servlet to use
server.servlet.jsp.init-parameters.*= # Init parameters used to configure the JSP servlet.
server.servlet.jsp.registered=true # Whether the JSP servlet is registered.
server.servlet.session.cookie.comment= # Comment for the session cookie.
server.servlet.session.cookie.domain= # Domain for the session cookie.
server.servlet.session.cookie.http-only= # Whether to use "HttpOnly" cookies for session cookies.
server.servlet.session.cookie.max-age= # Maximum age of the session cookie. If a duration suffix is not
specified, seconds will be used.
server.servlet.session.cookie.name= # Session cookie name.
server.servlet.session.cookie.path= # Path of the session cookie.
server.servlet.session.cookie.secure= # Whether to always mark the session cookie as secure.
server.servlet.session.persistent=false # Whether to persist session data between restarts.
server.servlet.session.store-dir= # Directory used to store session data.
server.servlet.session.timeout=30m # Session timeout. If a duration suffix is not specified, seconds
 will be used.
server.servlet.session.tracking-modes= # Session tracking modes.
server.ssl.ciphers= # Supported SSL ciphers.
server.ssl.client-auth= # Whether client authentication is wanted ("want") or needed ("need"). Requires
a trust store
server.ssl.enabled=true # Whether to enable SSL support.
server.ssl.enabled-protocols= # Enabled SSL protocols.
server.ssl.key-alias= # Alias that identifies the key in the key store.
server.ssl.key-password= # Password used to access the key in the key store.
server.ssl.key-store= # Path to the key store that holds the SSL certificate (typically a jks file).
server.ssl.key-store-password= # Password used to access the key store.
server.ssl.key-store-provider= # Provider for the key store.
server.ssl.key-store-type= # Type of the key store.
server.ssl.protocol=TLS # SSL protocol to use.
server.ssl.trust-store= # Trust store that holds SSL certificates.
server.ssl.trust-store-password= # Password used to access the trust store.
server.ssl.trust-store-provider= # Provider for the trust store.
server.ssl.trust-store-type= # Type of the trust store.
server.tomcat.accept-count=100 # Maximum queue length for incoming connection requests when all possible
 request processing threads are in use.
server.tomcat.accesslog.buffered=true # Whether to buffer output such that it is flushed only
periodically.
server.tomcat.accesslog.directory=logs # Directory in which log files are created. Can be absolute or
 relative to the Tomcat base dir
server.tomcat.accesslog.enabled=false # Enable access log.
server.tomcat.accesslog.file-date-format=.yyyy-MM-dd # Date format to place in the log file name.
server.tomcat.accesslog.pattern=common # Format pattern for access logs.
server.tomcat.accesslog.prefix=access_log # Log file name prefix.
server.tomcat.accesslog.rename-on-rotate=false # Whether to defer inclusion of the date stamp in the
file name until rotate time.
server.tomcat.accesslog.request-attributes-enabled=false # Set request attributes for the IP address,
Hostname, protocol, and port used for the request
server.tomcat.accesslog.rotate=true # Whether to enable access log rotation.
server.tomcat.accesslog.suffix=.log # Log file name suffix.
server.tomcat.additional-tld-skip-patterns= # Comma-separated list of additional patterns that match
 jars to ignore for TLD scanning
server.tomcat.background-processor-delay=10s # Delay between the invocation of backgroundProcess
methods. If a duration suffix is not specified, seconds will be used.
server.tomcat.basedir= # Tomcat base directory. If not specified, a temporary directory is used.
server.tomcat.internal-proxies=10\\.\\d{1,3}\\.\\d{1,3}\\.\\d{1,3}\\.\\d
  169\\.254\\.\\d{1,3}\\.\\d{1,3}|\\
  127\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\d{1,3}\.\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}\d{1,3}
  172\\.1[6-9]{1}\\.\\d{1,3}\\.\\d{1,3}|\\
  172\.2[0-9]{1}\.\d{1,3}\.\d{1,3}\.
  0:0:0:0:0:0:0:1
  ::1 # Regular expression that matches proxies that are to be trusted.
server.tomcat.max-connections=10000 # Maximum number of connections that the server accepts and
processes at any given time
server.tomcat.max-http-post-size=2MB # Maximum size of the HTTP post content
server.tomcat.max-swallow-size=2MB # Maximum amount of request body to swallow.
server.tomcat.max-threads=200 # Maximum amount of worker threads.
server.tomcat.min-spare-threads=10 # Minimum amount of worker threads.
server.tomcat.port-header=X-Forwarded-Port # Name of the HTTP header used to override the original port
value.
```

```
server.tomcat.protocol-header= # Header that holds the incoming protocol, usually named "X-Forwarded-
Proto"
server.tomcat.protocol-header-https-value-https # Value of the protocol header indicating whether the
incoming request uses SSL.
server.tomcat.redirect-context-root=true # Whether requests to the context root should be redirected by
appending a / to the path.
server.tomcat.remote-ip-header= # Name of the HTTP header from which the remote IP is extracted. For
instance, `X-FORWARDED-FOR'
server.tomcat.resource.allow-caching=true # Whether static resource caching is permitted for this web
application.
server.tomcat.resource.cache-ttl= # Time-to-live of the static resource cache.
server.tomcat.uri-encoding=UTF-8 # Character encoding to use to decode the URI.
server.tomcat.use-relative-redirects= # Whether HTTP 1.1 and later location headers generated by a call
to sendRedirect will use relative or absolute redirects.
server.undertow.accesslog.dir= # Undertow access log directory.
server.undertow.accesslog.enabled=false # Whether to enable the access log.
server.undertow.accesslog.pattern=common # Format pattern for access logs.
server.undertow.accesslog.prefix=access log. # Log file name prefix.
server.undertow.accesslog.rotate=true # Whether to enable access log rotation.
server.undertow.accesslog.suffix=log # Log file name suffix.
server.undertow.buffer-size= # Size of each buffer.
server.undertow.direct-buffers= # Whether to allocate buffers outside the Java heap. The default is
derived from the maximum amount of memory that is available to the JVM.
server.undertow.eager-filter-init=true # Whether servlet filters should be initialized on startup.
server.undertow.io-threads= # Number of I/O threads to create for the worker. The default is derived
from the number of available processors.
server.undertow.max-http-post-size=-1B # Maximum size of the HTTP post content. When the value is -1,
the default, the size is unlimited.
server.undertow.worker-threads= # Number of worker threads. The default is 8 times the number of I/O
# FREEMARKER (FreeMarkerProperties)
spring.freemarker.allow-request-override=false # Whether HttpServletRequest attributes are allowed to
override (hide) controller generated model attributes of the same name.
spring.freemarker.allow-session-override=false # Whether HttpSession attributes are allowed to override
(hide) controller generated model attributes of the same name.
spring.freemarker.cache=false # Whether to enable template caching.
spring.freemarker.charset=UTF-8 # Template encoding.
spring.freemarker.check-template-location=true # Whether to check that the templates location exists.
spring.freemarker.content-type=text/html # Content-Type value.
spring.freemarker.enabled=true # Whether to enable MVC view resolution for this technology.
spring.freemarker.expose-request-attributes=false # Whether all request attributes should be added to
the model prior to merging with the template.
spring.freemarker.expose-session-attributes=false # Whether all HttpSession attributes should be added
to the model prior to merging with the template.
spring.freemarker.expose-spring-macro-helpers=true # Whether to expose a RequestContext for use by
Spring's macro library, under the name "springMacroRequestContext"
spring.freemarker.prefer-file-system-access=true # Whether to prefer file system access for template
loading. File system access enables hot detection of template changes.
spring.freemarker.prefix= # Prefix that gets prepended to view names when building a URL.
spring.freemarker.request-context-attribute= # Name of the RequestContext attribute for all views.
spring.freemarker.settings.*= # Well-known FreeMarker keys which are passed to FreeMarker's
Configuration.
spring.freemarker.suffix=.ftl # Suffix that gets appended to view names when building a URL.
spring.freemarker.template-loader-path=classpath:/templates/ # Comma-separated list of template paths.
spring.freemarker.view-names= # White list of view names that can be resolved.
# GROOVY TEMPLATES (GroovyTemplateProperties)
spring.groovy.template.allow-request-override=false # Whether HttpServletRequest attributes are allowed
to override (hide) controller generated model attributes of the same name.
spring.groovy.template.allow-session-override=false # Whether HttpSession attributes are allowed to
 verride (hide) controller generated model attributes of the same name
spring.groovy.template.cache=false # Whether to enable template caching.
spring.groovy.template.charset=UTF-8 # Template encoding.
spring.groovy.template.check-template-location=true # Whether to check that the templates location
spring.groovy.template.configuration.*= # See GroovyMarkupConfigurer
spring.groovy.template.content-type=text/html # Content-Type value.
spring.groovy.template.enabled=true # Whether to enable MVC view resolution for this technology.
spring.groovy.template.expose-request-attributes=false # Whether all request attributes should be added
to the model prior to merging with the template.
```

```
spring.groovy.template.expose-session-attributes=false # Whether all HttpSession attributes should be
added to the model prior to merging with the template.
spring.groovy.template.expose-spring-macro-helpers=true # Whether to expose a RequestContext for use by
Spring's macro library, under the name "springMacroRequestContext".
spring.groovy.template.prefix= # Prefix that gets prepended to view names when building a URL.
spring.groovy.template.request-context-attribute= # Name of the RequestContext attribute for all views.
spring.groovy.template.resource-loader-path=classpath:/templates/ # Template path.
spring.groovy.template.suffix=.tpl # Suffix that gets appended to view names when building a URL.
spring.groovy.template.view-names= # White list of view names that can be resolved.
# SPRING HATEOAS (HateoasProperties)
spring.hateoas.use-hal-as-default-json-media-type=true # Whether application/hal+json responses should
be sent to requests that accept application/json.
# HTTP (HttpProperties)
spring.http.converters.preferred-json-mapper= # Preferred JSON mapper to use for HTTP message
conversion. By default, auto-detected according to the environment.
spring.http.encoding.charset=UTF-8 # Charset of HTTP requests and responses. Added to the "Content-Type"
header if not set explicitly.
spring.http.encoding.enabled=true # Whether to enable http encoding support.
spring.http.encoding.force= # Whether to force the encoding to the configured charset on HTTP requests
and responses.
spring.http.encoding.force-request= # Whether to force the encoding to the configured charset on HTTP
requests. Defaults to true when "force" has not been specified.
spring.http.encoding.force-response= # Whether to force the encoding to the configured charset on HTTP
responses.
spring.http.encoding.mapping= # Locale in which to encode mapping.
spring.http.log-request-details=false # Whether logging of (potentially sensitive) request details at
DEBUG and TRACE level is allowed.
# MULTIPART (MultipartProperties)
spring.servlet.multipart.enabled=true # Whether to enable support of multipart uploads.
spring.servlet.multipart.file-size-threshold=0B # Threshold after which files are written to disk.
spring.servlet.multipart.location= # Intermediate location of uploaded files.
spring.servlet.multipart.max-file-size=1MB # Max file size.
spring.servlet.multipart.max-request-size=10MB # Max request size.
spring.servlet.multipart.resolve-lazily=false # Whether to resolve the multipart request lazily at the
time of file or parameter access.
# JACKSON (JacksonProperties)
spring.jackson.date-format= # Date format string or a fully-qualified date format class name. For
instance, `yyyy-MM-dd HH:mm:ss`
spring.jackson.default-property-inclusion= # Controls the inclusion of properties during serialization.
Configured with one of the values in Jackson's JsonInclude.Include enumeration.
spring.jackson.deserialization.*= # Jackson on/off features that affect the way Java objects are
spring.jackson.generator.*= # Jackson on/off features for generators.
spring.jackson.joda-date-time-format= # Joda date time format string. If not configured, "date-format"
is used as a fallback if it is configured with a format string.
spring. jackson.locale = # Locale used for formatting.
spring.jackson.mapper.*= # Jackson general purpose on/off features.
spring.jackson.parser.*= # Jackson on/off features for parsers.
spring.jackson.property-naming-strategy= # One of the constants on Jackson's PropertyNamingStrategy. Can
also be a fully-qualified class name of a PropertyNamingStrategy subclass.
spring.jackson.serialization.*= # Jackson on/off features that affect the way Java objects are
spring.jackson.time-zone= # Time zone used when formatting dates. For instance, "America/Los Angeles"
spring.jackson.visibility.*= # Jackson visibility thresholds that can be used to limit which methods
(and fields) are auto-detected.
# GSON (GsonProperties)
spring.gson.date-format= # Format to use when serializing Date objects.
spring.gson.disable-html-escaping= # Whether to disable the escaping of HTML characters such as '<',
'>', etc.
spring.gson.disable-inner-class-serialization= # Whether to exclude inner classes during serialization.
spring.gson.enable-complex-map-key-serialization= # Whether to enable serialization of complex map keys
(i.e. non-primitives)
spring.gson.exclude-fields-without-expose-annotation= # Whether to exclude all fields from consideration
for serialization or deserialization that do not have the "Expose" annotation.
```

```
spring.gson.field-naming-policy= # Naming policy that should be applied to an object's field during
serialization and deserialization.
spring.gson.generate-non-executable-json= # Whether to generate non executable JSON by prefixing the
output with some special text.
spring.gson.lenient= # Whether to be lenient about parsing JSON that doesn't conform to RFC 4627.
spring.gson.long-serialization-policy= # Serialization policy for Long and long types.
spring.gson.pretty-printing= # Whether to output serialized JSON that fits in a page for pretty
printing.
spring.gson.serialize-nulls= # Whether to serialize null fields.
# JERSEY (JerseyProperties)
spring.jersey.application-path= # Path that serves as the base URI for the application. If specified,
overrides the value of "@ApplicationPath".
spring.jersey.filter.order=0 # Jersey filter chain order.
spring.jersey.init.*= # Init parameters to pass to Jersey through the servlet or filter.
spring.jersey.servlet.load-on-startup=-1 # Load on startup priority of the Jersey servlet.
spring.jersey.type=servlet # Jersey integration type.
# SPRING LDAP (LdapProperties)
spring.ldap.anonymous-read-only=false # Whether read-only operations should use an anonymous
spring.ldap.base= # Base suffix from which all operations should originate.
spring.ldap.base-environment.*= # LDAP specification settings.
spring.ldap.password= # Login password of the server.
spring.ldap.urls= # LDAP URLs of the server.
spring.ldap.username= # Login username of the server.
# EMBEDDED LDAP (EmbeddedLdapProperties)
spring.ldap.embedded.base-dn= # List of base DNs.
spring.ldap.embedded.credential.username= # Embedded LDAP username.
spring.ldap.embedded.credential.password= # Embedded LDAP password.
spring.ldap.embedded.ldif=classpath:schema.ldif # Schema (LDIF) script resource reference.
spring.ldap.embedded.port=0 # Embedded LDAP port.
spring.ldap.embedded.validation.enabled=true # Whether to enable LDAP schema validation.
spring.ldap.embedded.validation.schema= # Path to the custom schema.
# MUSTACHE TEMPLATES (MustacheAutoConfiguration)
spring.mustache.allow-request-override=false # Whether HttpServletRequest attributes are allowed to
override (hide) controller generated model attributes of the same name.
spring.mustache.allow-session-override=false # Whether HttpSession attributes are allowed to override
(hide) controller generated model attributes of the same name.
spring.mustache.cache=false # Whether to enable template caching.
spring.mustache.charset=UTF-8 # Template encoding.
spring.mustache.check-template-location=true # Whether to check that the templates location exists.
spring.mustache.content-type=text/html # Content-Type value.
spring.mustache.enabled=true # Whether to enable MVC view resolution for this technology.
spring.mustache.expose-request-attributes=false # Whether all request attributes should be added to the
model prior to merging with the template.
spring.mustache.expose-session-attributes=false # Whether all HttpSession attributes should be added to
the model prior to merging with the template.
spring.mustache.expose-spring-macro-helpers=true # Whether to expose a RequestContext for use by
Spring's macro library, under the name "springMacroRequestContext".
spring.mustache.prefix=classpath:/templates/ # Prefix to apply to template names.
spring.mustache.request-context-attribute= # Name of the RequestContext attribute for all views.
spring.mustache.suffix=.mustache # Suffix to apply to template names.
spring.mustache.view-names= # White list of view names that can be resolved.
# SPRING MVC (WebMvcProperties)
spring.mvc.async.request-timeout= # Amount of time before asynchronous request handling times out.
spring.mvc.contentnegotiation.favor-parameter=false # Whether a request parameter ("format" by default)
should be used to determine the requested media type.
spring.mvc.contentnegotiation.favor-path-extension=false # Whether the path extension in the URL path
should be used to determine the requested media type
spring.mvc.contentnegotiation.media-types.*= # Map file extensions to media types for content
negotiation. For instance, yml to text/yaml.
spring.mvc.contentnegotiation.parameter-name= # Query parameter name to use when "favor-parameter" is
enabled
spring.mvc.date-format= # Date format to use. For instance, `dd/MM/yyyy`.
spring.myc.dispatch-trace-request=false # Whether to dispatch TRACE requests to the FrameworkServlet
doService method.
```

```
spring.mvc.dispatch-options-request=true # Whether to dispatch OPTIONS requests to the FrameworkServlet
doService method.
spring.mvc.favicon.enabled=true # Whether to enable resolution of favicon.ico.
spring.mvc.formcontent.filter.enabled=true # Whether to enable Spring's FormContentFilter.
spring.mvc.hiddenmethod.filter.enabled=true # Whether to enable Spring's HiddenHttpMethodFilter.
spring.mvc.ignore-default-model-on-redirect=true # Whether the content of the "default" model should be
 ignored during redirect scenarios.
spring.mvc.locale= # Locale to use. By default, this locale is overridden by the "Accept-Language"
spring.myc.locale-resolver=accept-header # Define how the locale should be resolved.
spring.mvc.log-resolved-exception=false # Whether to enable warn logging of exceptions resolved by a
 "HandlerExceptionResolver", except for "DefaultHandlerExceptionResolver".
spring.mvc.message-codes-resolver-format= # Formatting strategy for message codes. For instance,
 PREFIX ERROR CODE
spring.mvc.pathmatch.use-registered-suffix-pattern=false # Whether suffix pattern matching should work
only against extensions registered with "spring.mvc.contentnegotiation.media-types.*
spring.mvc.pathmatch.use-suffix-pattern=false # Whether to use suffix pattern match (".*") when matching
patterns to requests.
spring.mvc.servlet.load-on-startup=-1 # Load on startup priority of the dispatcher servlet.
spring.mvc.servlet.path=/ # Path of the dispatcher servlet.
spring.mvc.static-path-pattern=/** # Path pattern used for static resources.
spring.mvc.throw-exception-if-no-handler-found=false # Whether a "NoHandlerFoundException" should be
thrown if no Handler was found to process a request.
spring.mvc.view.prefix= # Spring MVC view prefix.
spring.mvc.view.suffix= # Spring MVC view suffix.
# SPRING RESOURCES HANDLING (ResourceProperties)
spring.resources.add-mappings=true # Whether to enable default resource handling.
spring.resources.cache.cachecontrol.cache-private= # Indicate that the response message is intended for
a single user and must not be stored by a shared cache.
spring.resources.cache.cachecontrol.cache-public= # Indicate that any cache may store the response.
spring.resources.cache.cachecontrol.max-age= # Maximum time the response should be cached, in seconds if
no duration suffix is not specified.
spring.resources.cache.cachecontrol.must-revalidate= # Indicate that once it has become stale, a cache
must not use the response without re-validating it with the server.
spring.resources.cache.cachecontrol.no-cache= # Indicate that the cached response can be reused only if
re-validated with the server.
spring.resources.cache.cachecontrol.no-store= # Indicate to not cache the response in any case.
spring.resources.cache.cachecontrol.no-transform= # Indicate intermediaries (caches and others) that
they should not transform the response content.
spring.resources.cache.cachecontrol.proxy-revalidate= # Same meaning as the "must-revalidate" directive,
except that it does not apply to private caches.
spring.resources.cache.cachecontrol.s-max-age= # Maximum time the response should be cached by shared
caches, in seconds if no duration suffix is not specified.
spring.resources.cache.cachecontrol.stale-if-error= # Maximum time the response may be used when errors
are encountered, in seconds if no duration suffix is not specified.
spring.resources.cache.cachecontrol.stale-while-revalidate= # Maximum time the response can be served
after it becomes stale, in seconds if no duration suffix is not specified.
spring.resources.cache.period= # Cache period for the resources served by the resource handler. If a
duration suffix is not specified, seconds will be used.
spring.resources.chain.cache=true # Whether to enable caching in the Resource chain.
spring.resources.chain.compressed=false # Whether to enable resolution of already compressed resources
(gzip, brotli).
spring.resources.chain.enabled= # Whether to enable the Spring Resource Handling chain. By default,
disabled unless at least one strategy has been enabled.
spring.resources.chain.html-application-cache=false # Whether to enable HTML5 application cache manifest
rewriting.
spring.resources.chain.strategy.content.enabled=false # Whether to enable the content Version Strategy.
spring.resources.chain.strategy.content.paths=/** # Comma-separated list of patterns to apply to the
content Version Strategy
spring.resources.chain.strategy.fixed.enabled=false # Whether to enable the fixed Version Strategy.
spring.resources.chain.strategy.fixed.paths=/** # Comma-separated list of patterns to apply to the fixed
Version Strategy
spring.resources.chain.strategy.fixed.version= # Version string to use for the fixed Version Strategy.
spring.resources.static-locations=classpath:/META-INF/resources/.classpath:/resources/.classpath:/
static/,classpath:/public/ # Locations of static resources.
# SPRING SESSION (SessionProperties)
spring.session.store-type= # Session store type.
spring.session.timeout= # Session timeout. If a duration suffix is not specified, seconds will be used.
spring.session.servlet.filter-order=-2147483598 # Session repository filter order.
```

```
spring.session.servlet.filter-dispatcher-types=async,error,request # Session repository filter
dispatcher types.
# SPRING SESSION HAZELCAST (HazelcastSessionProperties)
spring.session.hazelcast.flush-mode=on-save # Sessions flush mode.
spring.session.hazelcast.map-name=spring:session:sessions # Name of the map used to store sessions.
# SPRING SESSION JDBC (JdbcSessionProperties)
spring.session.jdbc.cleanup-cron=0 * * * * * # Cron expression for expired session cleanup job.
spring.session.jdbc.initialize-schema=embedded # Database schema initialization mode.
spring.session.jdbc.schema=classpath:org/springframework/session/jdbc/schema-@@platform@@.sql # Path to
the SQL file to use to initialize the database schema.
spring.session.jdbc.table-name=SPRING_SESSION # Name of the database table used to store sessions.
# SPRING SESSION MONGODB (MongoSessionProperties)
spring.session.mongodb.collection-name=sessions # Collection name used to store sessions.
# SPRING SESSION REDIS (RedisSessionProperties)
spring.session.redis.cleanup-cron=0 * * * * * # Cron expression for expired session cleanup job.
spring.session.redis.flush-mode=on-save # Sessions flush mode.
spring.session.redis.namespace=spring:session # Namespace for keys used to store sessions.
# THYMELEAF (ThymeleafAutoConfiguration)
spring.thymeleaf.cache=true # Whether to enable template caching.
spring.thymeleaf.check-template=true # Whether to check that the template exists before rendering it.
spring.thymeleaf.check-template-location=true # Whether to check that the templates location exists.
spring.thymeleaf.enabled=true # Whether to enable Thymeleaf view resolution for Web frameworks.
spring.thymeleaf.enable-spring-el-compiler=false # Enable the SpringEL compiler in SpringEL expressions.
spring.thymeleaf.encoding=UTF-8 # Template files encoding.
spring.thymeleaf.excluded-view-names= # Comma-separated list of view names (patterns allowed) that
should be excluded from resolution.
spring.thymeleaf.mode=HTML # Template mode to be applied to templates. See also Thymeleaf's TemplateMode
spring.thymeleaf.prefix=classpath:/templates/ # Prefix that gets prepended to view names when building a
spring.thymeleaf.reactive.chunked-mode-view-names= # Comma-separated list of view names (patterns
allowed) that should be the only ones executed in CHUNKED mode when a max chunk size is set.
spring.thymeleaf.reactive.full-mode-view-names= # Comma-separated list of view names (patterns allowed)
that should be executed in FILL, mode even if a max chunk size is set
spring.thymeleaf.reactive.max-chunk-size=0B # Maximum size of data buffers used for writing to the
spring.thymeleaf.reactive.media-types= # Media types supported by the view technology.
spring.thymeleaf.render-hidden-markers-before-checkboxes=false # Whether hidden form inputs acting as
markers for checkboxes should be rendered before the checkbox element itself.
spring.thymeleaf.servlet.content-type=text/html # Content-Type value written to HTTP responses.
spring.thymeleaf.servlet.produce-partial-output-while-processing=true # Whether Thymeleaf should start
writing partial output as soon as possible or buffer until template processing is finished.
spring.thymeleaf.suffix=.html # Suffix that gets appended to view names when building a URL.
spring.thymeleaf.template-resolver-order= # Order of the template resolver in the chain.
spring.thymeleaf.view-names= # Comma-separated list of view names (patterns allowed) that can be
resolved.
# SPRING WEBFLUX (WebFluxProperties)
spring.webflux.date-format= # Date format to use. For instance, `dd/MM/yyyy`
spring.webflux.hiddenmethod.filter.enabled=true # Whether to enable Spring's HiddenHttpMethodFilter.
spring.webflux.static-path-pattern=/** # Path pattern used for static resources.
# SPRING WEB SERVICES (WebServicesProperties)
spring.webservices.path=/services # Path that serves as the base URI for the services.
spring.webservices.servlet.init= # Servlet init parameters to pass to Spring Web Services.
spring.webservices.servlet.load-on-startup=-1 # Load on startup priority of the Spring Web Services
spring.webservices.wsdl-locations= # Comma-separated list of locations of WSDLs and accompanying XSDs to
be exposed as beans.
# SECURITY PROPERTIES
# SECURITY (SecurityProperties)
spring.security.filter.order=-100 # Security filter chain order.
```

```
spring.security.filter.dispatcher-types=async,error,request # Security filter chain dispatcher types.
spring.security.user.name=user # Default user name.
spring.security.user.password= # Password for the default user name.
spring.security.user.roles= # Granted roles for the default user name.
# SECURITY OAUTH2 CLIENT (OAuth2ClientProperties)
spring.security.oauth2.client.provider.*= # OAuth provider details.
spring.security.oauth2.client.registration.*= # OAuth client registrations.
# SECURITY OAUTH2 RESOURCE SERVER (OAuth2ResourceServerProperties)
spring.security.oauth2.resourceserver.jwt.jwk-set-uri= # JSON Web Key URI to use to verify the JWT
  spring.security.oauth2.resourceserver.jwt.issuer-uri= # URI that an OpenID Connect Provider asserts
as its Issuer Identifier.
# DATA PROPERTIES
# FLYWAY (FlywayProperties)
spring.flyway.baseline-description=<< Flyway Baseline >> # Description to tag an existing schema with
when applying a baseline.
spring.flyway.baseline-on-migrate=false # Whether to automatically call baseline when migrating a non-
empty schema.
spring.flyway.baseline-version=1 # Version to tag an existing schema with when executing baseline.
spring.flyway.check-location=true # Whether to check that migration scripts location exists.
spring.flyway.clean-disabled=false # Whether to disable cleaning of the database.
spring.flyway.clean-on-validation-error=false # Whether to automatically call clean when a validation
error occurs.
spring.flyway.connect-retries=0 # Maximum number of retries when attempting to connect to the database.
spring.flyway.enabled=true # Whether to enable flyway.
spring.flyway.encoding=UTF-8 # Encoding of SQL migrations.
spring.flyway.group=false # Whether to group all pending migrations together in the same transaction
when applying them.
spring.flyway.ignore-future-migrations=true # Whether to ignore future migrations when reading the
schema history table.
spring.flyway.ignore-ignored-migrations=false # Whether to ignore ignored migrations when reading the
schema history table.
spring.flyway.ignore-missing-migrations=false # Whether to ignore missing migrations when reading the
schema history table.
spring.flyway.ignore-pending-migrations=false # Whether to ignore pending migrations when reading the
schema history table.
spring.flyway.init-sqls= # SQL statements to execute to initialize a connection immediately after
obtaining it.
spring.flyway.installed-by= # Username recorded in the schema history table as having applied the
spring.flyway.locations=classpath:db/migration # Locations of migrations scripts. Can contain the
special "{vendor}" placeholder to use vendor-specific locations.
spring.flyway.mixed=false # Whether to allow mixing transactional and non-transactional statements
within the same migration.
spring.flyway.out-of-order=false # Whether to allow migrations to be run out of order.
spring.flyway.password= # Login password of the database to migrate.
spring.flyway.placeholder-prefix=${ # Prefix of placeholders in migration scripts.
spring.flyway.placeholder-replacement=true # Perform placeholder replacement in migration scripts.
spring.flyway.placeholder-suffix=} # Suffix of placeholders in migration scripts.
spring.flyway.placeholders= # Placeholders and their replacements to apply to sql migration scripts.
spring.flyway.repeatable-sql-migration-prefix=R # File name prefix for repeatable SQL migrations.
spring.flyway.schemas= # Scheme names managed by Flyway (case-sensitive)
spring.flyway.skip-default-callbacks=false # Whether to skip default callbacks. If true, only custom
callbacks are used
spring.flyway.skip-default-resolvers=false # Whether to skip default resolvers. If true, only custom
spring.flyway.sql-migration-prefix=V # File name prefix for SOL migrations.
spring.flyway.sql-migration-separator=__ # File name separator for SQL migrations.
spring.flyway.sql-migration-suffixes=.sql # File name suffix for SQL migrations.
spring.flyway.table=flyway_schema_history # Name of the schema schema history table that will be used by
Flvwav
spring.flyway.target= # Target version up to which migrations should be considered.
spring.flyway.url= # JDBC url of the database to migrate. If not set, the primary configured data source
spring.flyway.user= # Login user of the database to migrate.
```

```
spring.flyway.validate-on-migrate=true # Whether to automatically call validate when performing a
migration.
# LIQUIBASE (LiquibaseProperties)
spring.liquibase.change-log=classpath:/db/changelog/db.changelog-master.yaml # Change log configuration
spring.liquibase.check-change-log-location=true # Whether to check that the change log location exists.
spring.liquibase.contexts= # Comma-separated list of runtime contexts to use.
spring.liquibase.database-change-log-lock-table=DATABASECHANGELOGLOCK # Name of table to use for
tracking concurrent Liquibase usage.
spring.liquibase.database-change-log-table=DATABASECHANGELOG # Name of table to use for tracking change
history
spring.liquibase.default-schema= # Default database schema.
spring.liquibase.drop-first=false # Whether to first drop the database schema.
spring.liquibase.enabled=true # Whether to enable Liquibase support
spring.liquibase.labels = # Comma-separated list of runtime labels to use.
spring.liquibase.liquibase-schema= # Schema to use for Liquibase objects.
spring.liquibase.liquibase-tablespace= # Tablespace to use for Liquibase objects.
spring.liquibase.parameters.*= # Change log parameters.
spring.liquibase.password= # Login password of the database to migrate.
spring.liquibase.rollback-file= # File to which rollback SQL is written when an update is performed.
spring.liquibase.test-rollback-on-update=false # Whether rollback should be tested before update is
spring.liquibase.url= # JDBC URL of the database to migrate. If not set, the primary configured data
source is used.
spring.liquibase.user= # Login user of the database to migrate.
# COUCHBASE (CouchbaseProperties)
spring.couchbase.bootstrap-hosts= # Couchbase nodes (host or IP address) to bootstrap from.
spring.couchbase.bucket.name=default # Name of the bucket to connect to.
spring.couchbase.bucket.password= # Password of the bucket.
spring.couchbase.env.endpoints.key-value=1 # Number of sockets per node against the key/value service.
spring.couchbase.env.endpoints.queryservice.min-endpoints=1 # Minimum number of sockets per node.
spring.couchbase.env.endpoints.queryservice.max-endpoints=1 # Maximum number of sockets per node.
spring.couchbase.env.endpoints.viewservice.min-endpoints=1 # Minimum number of sockets per node.
spring.couchbase.env.endpoints.viewservice.max-endpoints=1 # Maximum number of sockets per node.
spring.couchbase.env.ssl.enabled= # Whether to enable SSL support. Enabled automatically if a "keyStore"
is provided unless specified otherwise.
spring.couchbase.env.ssl.key-store= # Path to the JVM key store that holds the certificates.
spring.couchbase.env.ssl.key-store-password= # Password used to access the key store.
spring.couchbase.env.timeouts.connect=5000ms # Bucket connections timeouts.
spring.couchbase.env.timeouts.key-value=2500ms # Blocking operations performed on a specific key
spring.couchbase.env.timeouts.query=7500ms # N1QL query operations timeout.
spring.couchbase.env.timeouts.socket-connect=1000ms # Socket connect connections timeout.
spring.couchbase.env.timeouts.view=7500ms # Regular and geospatial view operations timeout.
# DAO (PersistenceExceptionTranslationAutoConfiguration)
spring.dao.exceptiontranslation.enabled=true # Whether to enable the
PersistenceExceptionTranslationPostProcessor.
# CASSANDRA (CassandraProperties)
spring.data.cassandra.cluster-name= # Name of the Cassandra cluster.
spring.data.cassandra.compression=none # Compression supported by the Cassandra binary protocol.
spring.data.cassandra.connect-timeout= # Socket option: connection time out.
spring.data.cassandra.consistency-level= # Queries consistency level.
spring.data.cassandra.contact-points=localhost # Cluster node addresses.
spring.data.cassandra.fetch-size= # Queries default fetch size
spring.data.cassandra.imx-enabled=false # Whether to enable JMX reporting.
spring.data.cassandra.keyspace-name= # Keyspace name to use.
spring.data.cassandra.port= # Port of the Cassandra server.
spring.data.cassandra.password= # Login password of the server.
spring.data.cassandra.pool.heartbeat-interval=30s # Heartbeat interval after which a message is sent on
an idle connection to make sure it's still alive. If a duration suffix is not specified, seconds will
be used.
spring.data.cassandra.pool.idle-timeout=120s # Idle timeout before an idle connection is removed. If a
duration suffix is not specified, seconds will be used.
spring.data.cassandra.pool.max-queue-size=256 # Maximum number of requests that get queued if no
connection is available
spring.data.cassandra.pool.pool-timeout=5000ms # Pool timeout when trying to acquire a connection from a
host's pool.
```

```
spring.data.cassandra.read-timeout= # Socket option: read time out.
spring.data.cassandra.repositories.type=auto # Type of Cassandra repositories to enable.
spring.data.cassandra.serial-consistency-level= # Queries serial consistency level.
spring.data.cassandra.schema-action=none # Schema action to take at startup.
spring.data.cassandra.ssl=false # Enable SSL support.
spring.data.cassandra.username= # Login user of the server.
# DATA COUCHBASE (CouchbaseDataProperties)
spring.data.couchbase.auto-index=false # Automatically create views and indexes.
spring.data.couchbase.consistency=read-your-own-writes # Consistency to apply by default on generated
spring.data.couchbase.repositories.type=auto # Type of Couchbase repositories to enable.
# ELASTICSEARCH (ElasticsearchProperties)
spring.data.elasticsearch.cluster-name=elasticsearch # Elasticsearch cluster name
spring.data.elasticsearch.cluster-nodes= # Comma-separated list of cluster node addresses.
spring.data.elasticsearch.properties.*= # Additional properties used to configure the client.
spring.data.elasticsearch.repositories.enabled=true # Whether to enable Elasticsearch repositories.
spring.data.jdbc.repositories.enabled=true # Whether to enable JDBC repositories.
spring.data.ldap.repositories.enabled=true # Whether to enable LDAP repositories.
# MONGODB (MongoProperties)
spring.data.mongodb.authentication-database= # Authentication database name.
spring.data.mongodb.database # Database name.
spring.data.mongodb.field-naming-strategy= # Fully qualified name of the FieldNamingStrategy to use.
spring.data.mongodb.grid-fs-database= # GridFS database name.
spring.data.mongodb.host= # Mongo server host. Cannot be set with URI.
spring.data.mongodb.password= # Login password of the mongo server. Cannot be set with URI.
spring.data.mongodb.port= # Mongo server port. Cannot be set with URI.
spring.data.mongodb.repositories.type=auto # Type of Mongo repositories to enable.
spring.data.mongodb.uri=mongodb://localhost/test # Mongo database URI. Cannot be set with host, port and
credentials.
spring.data.mongodb.username= # Login user of the mongo server. Cannot be set with URI.
spring.data.redis.repositories.enabled=true # Whether to enable Redis repositories.
# NEO4J (Neo4 iProperties)
spring.data.neo4j.auto-index=none # Auto index mode.
spring.data.neo4j.embedded.enabled=true # Whether to enable embedded mode if the embedded driver is
spring.data.neo4j.open-in-view=true # Register OpenSessionInViewInterceptor. Binds a Neo4j Session to
the thread for the entire processing of the request.
spring.data.neo4j.password= # Login password of the server.
spring.data.neo4j.repositories.enabled=true # Whether to enable Neo4j repositories.
spring.data.neo4j.uri= # URI used by the driver. Auto-detected by default.
spring.data.neo4j.username= # Login user of the server.
# DATA REST (RepositoryRestProperties)
spring.data.rest.base-path= # Base path to be used by Spring Data REST to expose repository resources.
spring.data.rest.default-media-type= # Content type to use as a default when none is specified.
spring.data.rest.default-page-size= # Default size of pages.
spring.data.rest.detection-strategy=default # Strategy to use to determine which repositories get
exposed.
spring.data.rest.enable-enum-translation= # Whether to enable enum value translation through the Spring
Data REST default resource bundle.
spring.data.rest.limit-param-name= # Name of the URL query string parameter that indicates how many
  esults to return at once
spring.data.rest.max-page-size= # Maximum size of pages.
spring.data.rest.page-param-name= # Name of the URL query string parameter that indicates what page to
return.
spring.data.rest.return-body-on-create= # Whether to return a response body after creating an entity.
spring.data.rest.return-body-on-update= # Whether to return a response body after updating an entity.
spring.data.rest.sort-param-name= # Name of the URL query string parameter that indicates what direction
to sort results.
# SOLR (SolrProperties)
```

```
spring.data.solr.host=http://127.0.0.1:8983/solr # Solr host. Ignored if "zk-host" is set.
spring.data.solr.repositories.enabled=true # Whether to enable Solr repositories.
spring.data.solr.zk-host= # ZooKeeper host address in the form HOST:PORT.
# DATA WEB (SpringDataWebProperties)
spring.data.web.pageable.default-page-size=20 # Default page size.
spring.data.web.pageable.max-page-size=2000 # Maximum page size to be accepted.
spring.data.web.pageable.one-indexed-parameters=false # Whether to expose and assume 1-based page number
spring.data.web.pageable.page-parameter=page # Page index parameter name.
spring.data.web.pageable.prefix= # General prefix to be prepended to the page number and page size
parameters.
spring.data.web.pageable.qualifier-delimiter=_ # Delimiter to be used between the qualifier and the
actual page number and size properties.
spring.data.web.pageable.size-parameter=size # Page size parameter name.
spring.data.web.sort.sort-parameter=sort # Sort parameter name.
# DATASOURCE (DataSourceAutoConfiguration & DataSourceProperties)
spring.datasource.continue-on-error=false # Whether to stop if an error occurs while initializing the
spring.datasource.data= # Data (DML) script resource references.
spring.datasource.data-username= # Username of the database to execute DML scripts (if different).
spring.datasource.data-password= # Password of the database to execute DML scripts (if different).
spring.datasource.dbcp2.*= # Commons DBCP2 specific settings
spring.datasource.driver-class-name= # Fully qualified name of the JDBC driver. Auto-detected based on
the URL by default.
spring.datasource.generate-unique-name=false # Whether to generate a random datasource name.
spring.datasource.hikari.*= # Hikari specific settings
spring.datasource.initialization-mode=embedded # Initialize the datasource with available DDL and DML
spring.datasource.jmx-enabled=false # Whether to enable JMX support (if provided by the underlying
pool)
spring.datasource.jndi-name= # JNDI location of the datasource. Class, url, username & password are
ignored when set.
spring.datasource.name= # Name of the datasource. Default to "testdb" when using an embedded database.
spring.datasource.password= # Login password of the database.
spring.datasource.platform=all # Platform to use in the DDL or DML scripts (such as schema-
${platform}.sql or data-${platform}.sql).
spring.datasource.schema= # Schema (DDL) script resource references.
spring.datasource.schema-username= # Username of the database to execute DDL scripts (if different).
spring.datasource.schema-password= # Password of the database to execute DDL scripts (if different).
spring.datasource.separator=; # Statement separator in SQL initialization scripts.
spring.datasource.sql-script-encoding= # SQL scripts encoding.
spring.datasource.tomcat.*= # Tomcat datasource specific settings
spring.datasource.type= # Fully qualified name of the connection pool implementation to use. By default,
it is auto-detected from the classpath.
spring.datasource.url= # JDBC URL of the database.
spring.datasource.username= # Login username of the database.
spring.datasource.xa.data-source-class-name= # XA datasource fully qualified name.
spring.datasource.xa.properties= # Properties to pass to the XA data source.
# JEST (Elasticsearch HTTP client) (JestProperties)
spring.elasticsearch.jest.connection-timeout=3s # Connection timeout.
spring.elasticsearch.jest.multi-threaded=true # Whether to enable connection requests from multiple
execution threads.
spring.elasticsearch.jest.password= # Login password.
spring.elasticsearch.jest.proxy.host= # Proxy host the HTTP client should use.
spring.elasticsearch.jest.proxy.port= # Proxy port the HTTP client should use.
spring.elasticsearch.jest.read-timeout=3s # Read timeout.
spring.elasticsearch.jest.uris=http://localhost:9200 # Comma-separated list of the Elasticsearch
instances to use
spring.elasticsearch.jest.username= # Login username
# Elasticsearch REST clients (RestClientProperties)
spring.elasticsearch.rest.password= # Credentials password.
   spring.elasticsearch.rest.uris=http://localhost:9200 # Comma-separated list of the Elasticsearch
instances to use.
  spring.elasticsearch.rest.username= # Credentials username.
# H2 Web Console (H2ConsoleProperties)
spring.h2.console.enabled=false # Whether to enable the console.
```

```
spring.h2.console.path=/h2-console # Path at which the console is available.
spring.h2.console.settings.trace=false # Whether to enable trace output.
spring.h2.console.settings.web-allow-others=false # Whether to enable remote access.
# InfluxDB (InfluxDbProperties)
spring.influx.password= # Login password.
spring.influx.url= # URL of the InfluxDB instance to which to connect.
spring.influx.user= # Login user.
# JOOO (JoogProperties)
spring.jooq.sql-dialect= # SQL dialect to use. Auto-detected by default.
# JDBC (JdbcProperties)
spring.jdbc.template.fetch-size=-1 # Number of rows that should be fetched from the database when more
rows are needed.
spring.jdbc.template.max-rows=-1 # Maximum number of rows.
spring.jdbc.template.query-timeout= # Query timeout. Default is to use the JDBC driver's default
configuration. If a duration suffix is not specified, seconds will be used.
# JPA (JpaBaseConfiguration, HibernateJpaAutoConfiguration)
spring.data.jpa.repositories.bootstrap-mode=default # Bootstrap mode for JPA repositories.
spring.data.jpa.repositories.enabled=true # Whether to enable JPA repositories.
spring.jpa.database= # Target database to operate on, auto-detected by default. Can be alternatively set
using the "databasePlatform" property.
spring.jpa.database-platform= # Name of the target database to operate on, auto-detected by default. Can
be alternatively set using the "Database" enum.
spring.jpa.generate-ddl=false # Whether to initialize the schema on startup.
spring.jpa.hibernate.ddl-auto= # DDL mode. This is actually a shortcut for the "hibernate.hbm2ddl.auto"
property. Defaults to "create-drop" when using an embedded database and no schema manager was detected.
Otherwise, defaults to "none"
spring.jpa.hibernate.naming.implicit-strategy= # Fully qualified name of the implicit naming strategy.
spring.jpa.hibernate.naming.physical-strategy= # Fully qualified name of the physical naming strategy.
spring.jpa.hibernate.use-new-id-generator-mappings= # Whether to use Hibernate's newer
IdentifierGenerator for AUTO, TABLE and SEQUENCE.
spring.jpa.mapping-resources= # Mapping resources (equivalent to "mapping-file" entries in
persistence.xml).
spring.jpa.open-in-view=true # Register OpenEntityManagerInViewInterceptor. Binds a JPA EntityManager to
the thread for the entire processing of the request.
spring.jpa.properties.*= # Additional native properties to set on the JPA provider.
spring.jpa.show-sql=false # Whether to enable logging of SQL statements.
# JTA (JtaAutoConfiguration)
spring.jta.enabled=true # Whether to enable JTA support.
spring.jta.log-dir= # Transaction logs directory.
spring.jta.transaction-manager-id= # Transaction manager unique identifier.
# ATOMIKOS (AtomikosProperties)
spring.jta.atomikos.connectionfactory.borrow-connection-timeout=30 # Timeout, in seconds, for borrowing
connections from the pool.
spring.jta.atomikos.connectionfactory.ignore-session-transacted-flag=true # Whether to ignore the
transacted flag when creating session.
spring.jta.atomikos.connectionfactory.local-transaction-mode=false # Whether local transactions are
desired.
spring.jta.atomikos.connectionfactory.maintenance-interval=60 # The time, in seconds, between runs of
the pool's maintenance thread.
spring.jta.atomikos.connectionfactory.max-idle-time=60 # The time, in seconds, after which connections
are cleaned up from the pool.
spring.jta.atomikos.connectionfactory.max-lifetime=0 # The time, in seconds, that a connection can be
pooled for before being destroyed. O denotes no limit
spring.jta.atomikos.connectionfactory.max-pool-size=1 # The maximum size of the pool.
spring.jta.atomikos.connectionfactory.min-pool-size=1 # The minimum size of the pool.
spring.jta.atomikos.connectionfactory.reap-timeout=0 # The reap timeout, in seconds, for borrowed
connections. O denotes no limit.
spring.jta.atomikos.connectionfactory.unique-resource-name=jmsConnectionFactory # The unique name used
to identify the resource during recovery.
spring.jta.atomikos.connectionfactory.xa-connection-factory-class-name= # Vendor-specific implementation
of XAConnectionFactory.
spring.jta.atomikos.connectionfactory.xa-properties= # Vendor-specific XA properties.
spring.ita.atomikos.datasource.borrow-connection-timeout=30 # Timeout, in seconds, for borrowing
connections from the pool.
```

```
spring.jta.atomikos.datasource.concurrent-connection-validation= # Whether to use concurrent connection
validation.
spring.jta.atomikos.datasource.default-isolation-level= # Default isolation level of connections
provided by the pool.
spring.jta.atomikos.datasource.login-timeout= # Timeout, in seconds, for establishing a database
connection.
spring.jta.atomikos.datasource.maintenance-interval=60 # The time, in seconds, between runs of the
pool's maintenance thread.
spring.jta.atomikos.datasource.max-idle-time=60 # The time, in seconds, after which connections are
cleaned up from the pool.
spring.jta.atomikos.datasource.max-lifetime=0 # The time, in seconds, that a connection can be pooled
for before being destroyed. O denotes no limit.
spring.jta.atomikos.datasource.max-pool-size=1 # The maximum size of the pool.
spring.jta.atomikos.datasource.min-pool-size=1 # The minimum size of the pool.
spring.jta.atomikos.datasource.reap-timeout=0 # The reap timeout, in seconds, for borrowed connections.
0 denotes no limit
spring.jta.atomikos.datasource.test-query= # SQL query or statement used to validate a connection before
returning it.
spring.jta.atomikos.datasource.unique-resource-name=dataSource # The unique name used to identify the
resource during recovery.
spring.jta.atomikos.datasource.xa-data-source-class-name= # Vendor-specific implementation of
XAConnectionFactory.
spring.jta.atomikos.datasource.xa-properties= # Vendor-specific XA properties.
spring.jta.atomikos.properties.allow-sub-transactions=true # Specify whether sub-transactions are
allowed.
spring.jta.atomikos.properties.checkpoint-interval=500 # Interval between checkpoints, expressed as the
number of log writes between two checkpoints.
spring.jta.atomikos.properties.default-jta-timeout=10000ms # Default timeout for JTA transactions.
spring.jta.atomikos.properties.default-max-wait-time-on-shutdown=9223372036854775807 # How long should
normal shutdown (no-force) wait for transactions to complete.
spring.jta.atomikos.properties.enable-logging=true # Whether to enable disk logging.
spring.jta.atomikos.properties.force-shutdown-on-vm-exit=false # Whether a VM shutdown should trigger
forced shutdown of the transaction core.
spring.jta.atomikos.properties.log-base-dir= # Directory in which the log files should be stored.
spring.jta.atomikos.properties.log-base-name=tmlog # Transactions log file base name.
spring.jta.atomikos.properties.max-actives=50 # Maximum number of active transactions.
spring.jta.atomikos.properties.max-timeout=300000ms # Maximum timeout that can be allowed for
spring.jta.atomikos.properties.recovery.delay=10000ms # Delay between two recovery scans.
spring.jta.atomikos.properties.recovery.forget-orphaned-log-entries-delay=86400000ms # Delay after which
recovery can cleanup pending ('orphaned') log entries.
spring.jta.atomikos.properties.recovery.max-retries=5 # Number of retry attempts to commit the
transaction before throwing an exception.
spring.jta.atomikos.properties.recovery.retry-interval=10000ms # Delay between retry attempts.
spring.jta.atomikos.properties.serial-jta-transactions=true # Whether sub-transactions should be joined
when possible
spring.jta.atomikos.properties.service= # Transaction manager implementation that should be started.
spring.jta.atomikos.properties.threaded-two-phase-commit=false # Whether to use different (and
concurrent) threads for two-phase commit on the participating resources.
spring.jta.atomikos.properties.transaction-manager-unique-name= # The transaction manager's unique name.
# BITRONIX
spring.jta.bitronix.connectionfactory.acquire-increment=1 # Number of connections to create when growing
spring.ita.bitronix.connectionfactory.acquisition-interval=1 # Time, in seconds, to wait before trying
to acquire a connection again after an invalid connection was acquired.
spring.jta.bitronix.connectionfactory.acquisition-timeout=30 # Timeout, in seconds, for acquiring
connections from the pool.
spring.jta.bitronix.connectionfactory.allow-local-transactions=true # Whether the transaction manager
should allow mixing XA and non-XA transactions.
spring.jta.bitronix.connectionfactory.apply-transaction-timeout=false # Whether the transaction timeout
 should be set on the XAResource when it is enlisted
spring.jta.bitronix.connectionfactory.automatic-enlisting-enabled=true # Whether resources should be
enlisted and delisted automatically.
spring.jta.bitronix.connectionfactory.cache-producers-consumers=true # Whether producers and consumers
should be cached.
spring.ita.bitronix.connectionfactory.class-name= # Underlying implementation class name of the XA
spring.ita.bitronix.connectionfactory.defer-connection-release=true # Whether the provider can run many
transactions on the same connection and supports transaction interleaving.
```

```
spring.jta.bitronix.connectionfactory.disabled= # Whether this resource is disabled, meaning it's
temporarily forbidden to acquire a connection from its pool.
spring.jta.bitronix.connectionfactory.driver-properties= # Properties that should be set on the
underlying implementation.
spring.jta.bitronix.connectionfactory.failed= # Mark this resource producer as failed.
spring.jta.bitronix.connectionfactory.ignore-recovery-failures=false # Whether recovery failures should
spring.ita.bitronix.connectionfactory.max-idle-time=60 # The time, in seconds, after which connections
are cleaned up from the pool.
spring.ita.bitronix.connectionfactory.max-pool-size=10 # The maximum size of the pool, 0 denotes no
spring.jta.bitronix.connectionfactory.min-pool-size=0 # The minimum size of the pool.
spring.jta.bitronix.connectionfactory.password= # The password to use to connect to the JMS provider.
spring.jta.bitronix.connectionfactory.share-transaction-connections=false # Whether connections in the
 ACCESSIBLE state can be shared within the context of a transaction.
spring.jta.bitronix.connectionfactory.test-connections=true # Whether connections should be tested when
acquired from the pool.
spring.jta.bitronix.connectionfactory.two-pc-ordering-position=1 # The position that this
resource should take during two-phase commit (always first is Integer.MIN_VALUE, always last is
Integer MAX VALUE).
spring.jta.bitronix.connectionfactory.unique-name=jmsConnectionFactory # The unique name used to
identify the resource during recovery.
spring.jta.bitronix.connectionfactory.use-tm-join=true # Whether TMJOIN should be used when starting
XAResources
spring.jta.bitronix.connectionfactory.user= # The user to use to connect to the JMS provider.
spring.jta.bitronix.datasource.acquire-increment=1 # Number of connections to create when growing the
spring.jta.bitronix.datasource.acquisition-interval=1 # Time, in seconds, to wait before trying to
acquire a connection again after an invalid connection was acquired.
spring.jta.bitronix.datasource.acquisition-timeout=30 # Timeout, in seconds, for acquiring connections
 from the pool.
spring.jta.bitronix.datasource.allow-local-transactions=true # Whether the transaction manager should
allow mixing XA and non-XA transactions.
spring.jta.bitronix.datasource.apply-transaction-timeout=false # Whether the transaction timeout should
be set on the XAResource when it is enlisted.
spring.jta.bitronix.datasource.automatic-enlisting-enabled=true # Whether resources should be enlisted
and delisted automatically.
spring.jta.bitronix.datasource.class-name= # Underlying implementation class name of the XA resource.
spring.ita.bitronix.datasource.cursor-holdability= # The default cursor holdability for connections.
spring.jta.bitronix.datasource.defer-connection-release=true # Whether the database can run many
transactions on the same connection and supports transaction interleaving.
spring.jta.bitronix.datasource.disabled= # Whether this resource is disabled, meaning it's temporarily
forbidden to acquire a connection from its pool.
spring.jta.bitronix.datasource.driver-properties= # Properties that should be set on the underlying
implementation.
spring.jta.bitronix.datasource.enable-jdbc4-connection-test= # Whether Connection.isValid() is called
when acquiring a connection from the pool.
spring.jta.bitronix.datasource.failed= # Mark this resource producer as failed.
spring.jta.bitronix.datasource.ignore-recovery-failures=false # Whether recovery failures should be
spring.ita.bitronix.datasource.isolation-level= # The default isolation level for connections.
spring.jta.bitronix.datasource.local-auto-commit= # The default auto-commit mode for local transactions.
spring.jta.bitronix.datasource.login-timeout= # Timeout, in seconds, for establishing a database
spring.ita.bitronix.datasource.max-idle-time=60 # The time, in seconds, after which connections are
cleaned up from the pool.
spring.jta.bitronix.datasource.max-pool-size=10 # The maximum size of the pool. 0 denotes no limit.
spring.jta.bitronix.datasource.min-pool-size=0 # The minimum size of the pool.
spring.jta.bitronix.datasource.prepared-statement-cache-size=0 # The target size of the prepared
statement cache. O disables the cache.
spring.jta.bitronix.datasource.share-transaction-connections=false # Whether connections in the
 ACCESSIBLE state can be shared within the context of a transaction.
spring.jta.bitronix.datasource.test-query= # SQL query or statement used to validate a connection before
spring.jta.bitronix.datasource.two-pc-ordering-position=1 # The position that this resource should take
during two-phase commit (always first is Integer.MIN_VALUE), and always last is Integer.MAX_VALUE).
spring.ita.bitronix.datasource.unique-name=dataSource # The unique name used to identify the resource
spring.ita.bitronix.datasource.use-tm-join=true # Whether TMJOIN should be used when starting
```

```
spring.jta.bitronix.properties.allow-multiple-lrc=false # Whether to allow multiple LRC resources to be
enlisted into the same transaction.
spring.jta.bitronix.properties.asynchronous2-pc=false # Whether to enable asynchronously execution of
two phase commit.
spring.jta.bitronix.properties.background-recovery-interval-seconds=60 # Interval in seconds at which to
run the recovery process in the background.
spring.jta.bitronix.properties.current-node-only-recovery=true # Whether to recover only the current
spring.jta.bitronix.properties.debug-zero-resource-transaction=false # Whether to log the creation and
commit call stacks of transactions executed without a single enlisted resource.
spring.jta.bitronix.properties.default-transaction-timeout=60 # Default transaction timeout, in seconds.
spring.jta.bitronix.properties.disable-jmx=false # Whether to enable JMX support.
spring.jta.bitronix.properties.exception-analyzer= # Set the fully qualified name of the exception
analyzer implementation to use
spring.jta.bitronix.properties.filter-log-status=false # Whether to enable filtering of logs so that
only mandatory logs are written
spring.jta.bitronix.properties.force-batching-enabled=true # Whether disk forces are batched.
spring.jta.bitronix.properties.forced-write-enabled=true # Whether logs are forced to disk.
spring.jta.bitronix.properties.graceful-shutdown-interval=60 # Maximum amount of seconds the TM waits
for transactions to get done before aborting them at shutdown time.
spring.jta.bitronix.properties.jndi-transaction-synchronization-registry-name= # JNDI name of the
TransactionSynchronizationRegistry.
spring.jta.bitronix.properties.jndi-user-transaction-name= # JNDI name of the UserTransaction.
spring.jta.bitronix.properties.journal=disk # Name of the journal. Can be 'disk', 'null', or a class
spring.jta.bitronix.properties.log-part1-filename=btm1.tlog # Name of the first fragment of the journal.
spring.jta.bitronix.properties.log-part2-filename=btm2.tlog # Name of the second fragment of the
iournal.
spring.jta.bitronix.properties.max-log-size-in-mb=2 # Maximum size in megabytes of the journal
spring.jta.bitronix.properties.resource-configuration-filename= # ResourceLoader configuration file
spring.jta.bitronix.properties.server-id= # ASCII ID that must uniquely identify this TM instance.
Defaults to the machine's IP address.
spring.jta.bitronix.properties.skip-corrupted-logs=false # Skip corrupted transactions log entries.
spring.jta.bitronix.properties.warn-about-zero-resource-transaction=true # Whether to log a warning for
transactions executed without a single enlisted resource.
# EMBEDDED MONGODB (EmbeddedMongoProperties)
spring.mongodb.embedded.features=sync_delay # Comma-separated list of features to enable.
spring.mongodb.embedded.storage.database-dir= # Directory used for data storage.
spring.mongodb.embedded.storage.oplog-size= # Maximum size of the oplog.
spring.mongodb.embedded.storage.repl-set-name= # Name of the replica set.
spring.mongodb.embedded.version=3.5.5 # Version of Mongo to use.
# REDIS (RedisProperties)
spring.redis.cluster.max-redirects= # Maximum number of redirects to follow when executing commands
across the cluster.
spring.redis.cluster.nodes= # Comma-separated list of "host:port" pairs to bootstrap from.
spring.redis.database=0 # Database index used by the connection factory.
spring.redis.url= # Connection URL. Overrides host, port, and password. User is ignored. Example:
redis://user:password@example.com:6379
spring.redis.host=localhost # Redis server host.
spring.redis.jedis.pool.max-active=8 # Maximum number of connections that can be allocated by the pool
at a given time. Use a negative value for no limit.
spring.redis.jedis.pool.max-idle=8 # Maximum number of "idle" connections in the pool. Use a negative
value to indicate an unlimited number of idle connections.
spring.redis.jedis.pool.max-wait=-1ms # Maximum amount of time a connection allocation should block
before throwing an exception when the pool is exhausted. Use a negative value to block indefinitely.
spring.redis.jedis.pool.min-idle=0 # Target for the minimum number of idle connections to maintain in
the pool. This setting only has an effect if it is positive.
spring.redis.lettuce.pool.max-active=8 # Maximum number of connections that can be allocated by the pool
at a given time. Use a negative value for no limit.
spring.redis.lettuce.pool.max-idle=8 # Maximum number of "idle" connections in the pool. Use a negative
value to indicate an unlimited number of idle connections.
spring.redis.lettuce.pool.max-wait=-lms # Maximum amount of time a connection allocation should block
before throwing an exception when the pool is exhausted. Use a negative value to block indefinitely.
spring.redis.lettuce.pool.min-idle=0 # Target for the minimum number of idle connections to maintain in
the pool. This setting only has an effect if it is positive.
spring.redis.lettuce.shutdown-timeout=100ms # Shutdown timeout.
spring.redis.password= # Login password of the redis server.
```

```
spring.redis.port=6379 # Redis server port.
spring.redis.sentinel.master= # Name of the Redis server.
spring.redis.sentinel.nodes= # Comma-separated list of "host:port" pairs.
spring.redis.ssl=false # Whether to enable SSL support.
spring.redis.timeout= # Connection timeout.
# TRANSACTION (TransactionProperties)
spring.transaction.default-timeout= # Default transaction timeout. If a duration suffix is not
specified, seconds will be used.
spring.transaction.rollback-on-commit-failure= # Whether to roll back on commit failures.
# INTEGRATION PROPERTIES
# ACTIVEMO (ActiveMOProperties)
spring.activemq.broker-url= # URL of the ActiveMQ broker. Auto-generated by default.
spring.activemq.close-timeout=15s # Time to wait before considering a close complete.
spring.activemq.in-memory=true # Whether the default broker URL should be in memory. Ignored if an
explicit broker has been specified.
spring.activemq.non-blocking-redelivery=false # Whether to stop message delivery before re-delivering
messages from a rolled back transaction. This implies that message order is not preserved when this is
enabled.
spring.activemq.password= # Login password of the broker.
spring.activemq.send-timeout=0ms # Time to wait on message sends for a response. Set it to 0 to wait
forever.
spring.activemq.user= # Login user of the broker.
spring.activemq.packages.trust-all= # Whether to trust all packages.
spring.activemq.packages.trusted= # Comma-separated list of specific packages to trust (when not
trusting all packages)
spring.activemq.pool.block-if-full=true # Whether to block when a connection is requested and the pool
is full. Set it to false to throw a "JMSException" instead.
spring.activemq.pool.block-if-full-timeout=-1ms # Blocking period before throwing an exception if the
pool is still full.
spring.activemq.pool.enabled=false # Whether a JmsPoolConnectionFactory should be created, instead of a
regular ConnectionFactory.
spring.activemg.pool.idle-timeout=30s # Connection idle timeout.
spring.activemg.pool.max-connections=1 # Maximum number of pooled connections.
spring.activemq.pool.max-sessions-per-connection=500 # Maximum number of pooled sessions per connection
in the pool.
spring.activemq.pool.time-between-expiration-check=-1ms # Time to sleep between runs of the idle
connection eviction thread. When negative, no idle connection eviction thread runs.
spring.activemq.pool.use-anonymous-producers=true # Whether to use only one anonymous "MessageProducer"
instance. Set it to false to create one "MessageProducer" every time one is required.
# ARTEMIS (ArtemisProperties)
spring.artemis.embedded.cluster-password= # Cluster password. Randomly generated on startup by default.
spring.artemis.embedded.data-directory= # Journal file directory. Not necessary if persistence is turned
off.
spring.artemis.embedded.enabled=true # Whether to enable embedded mode if the Artemis server APIs are
available.
spring.artemis.embedded.persistent=false # Whether to enable persistent store.
spring.artemis.embedded.queues= # Comma-separated list of queues to create on startup.
spring.artemis.embedded.server-id= # Server ID. By default, an auto-incremented counter is used.
spring.artemis.embedded.topics= # Comma-separated list of topics to create on startup.
spring.artemis.host=localhost # Artemis broker host.
spring.artemis.mode= # Artemis deployment mode, auto-detected by default.
spring.artemis.password= # Login password of the broker.
spring.artemis.pool.block-if-full=true # Whether to block when a connection is requested and the pool is
 full. Set it to false to throw a "JMSException" instead.
spring.artemis.pool.block-if-full-timeout=-1ms # Blocking period before throwing an exception if the
pool is still full.
spring.artemis.pool.enabled=false # Whether a JmsPoolConnectionFactory should be created, instead of a
regular ConnectionFactory.
spring.artemis.pool.idle-timeout=30s # Connection idle timeout.
spring.artemis.pool.max-connections=1 # Maximum number of pooled connections.
spring.artemis.pool.max-sessions-per-connection=500 # Maximum number of pooled sessions per connection
in the pool.
```

```
spring.artemis.pool.time-between-expiration-check=-1ms # Time to sleep between runs of the idle
connection eviction thread. When negative, no idle connection eviction thread runs.
spring.artemis.pool.use-anonymous-producers=true # Whether to use only one anonymous "MessageProducer"
instance. Set it to false to create one "MessageProducer" every time one is required.
spring.artemis.port=61616 # Artemis broker port.
spring.artemis.user= # Login user of the broker.
# SPRING BATCH (BatchProperties)
spring.batch.initialize-schema=embedded # Database schema initialization mode.
spring.batch.job.enabled=true # Execute all Spring Batch jobs in the context on startup.
spring.batch.job.names= # Comma-separated list of job names to execute on startup (for instance,
 'job1, job2'). By default, all Jobs found in the context are executed.
spring.batch.schema=classpath:org/springframework/batch/core/schema-@eplatform@e.sql # Path to the SQL
file to use to initialize the database schema.
spring.batch.table-prefix= # Table prefix for all the batch meta-data tables.
# SPRING INTEGRATION (IntegrationProperties)
spring.integration.jdbc.initialize-schema=embedded # Database schema initialization mode.
spring.integration.jdbc.schema=classpath:org/springframework/integration/jdbc/schema-@@platform@@.sql #
Path to the SQL file to use to initialize the database schema.
# JMS (JmsProperties)
spring.jms.cache.consumers=false # Whether to cache message consumers.
spring.jms.cache.enabled=true # Whether to cache sessions.
spring.jms.cache.producers=true # Whether to cache message producers.
spring.jms.cache.session-cache-size=1 # Size of the session cache (per JMS Session type).
spring.jms.jndi-name= # Connection factory JNDI name. When set, takes precedence to others connection
factory auto-configurations.
spring.jms.listener.acknowledge-mode= # Acknowledge mode of the container. By default, the listener is
transacted with automatic acknowledgment.
spring.jms.listener.auto-startup=true # Start the container automatically on startup.
spring.jms.listener.concurrency= # Minimum number of concurrent consumers.
spring.jms.listener.max-concurrency= # Maximum number of concurrent consumers.
spring.jms.pub-sub-domain=false # Whether the default destination type is topic.
spring.jms.template.default-destination= # Default destination to use on send and receive operations
that do not have a destination parameter.
spring.jms.template.delivery-delay= # Delivery delay to use for send calls.
spring.jms.template.delivery-mode= # Delivery mode. Enables QoS (Quality of Service) when set.
spring.jms.template.priority= # Priority of a message when sending. Enables QoS (Quality of Service)
when set
spring.jms.template.qos-enabled= # Whether to enable explicit QoS (Quality of Service) when sending a
spring.jms.template.receive-timeout= # Timeout to use for receive calls.
spring.jms.template.time-to-live= # Time-to-live of a message when sending. Enables QoS (Quality of
Service) when set.
# APACHE KAFKA (KafkaProperties)
spring.kafka.admin.client-id= # ID to pass to the server when making requests. Used for server-side
logaina
spring.kafka.admin.fail-fast=false # Whether to fail fast if the broker is not available on startup.
spring.kafka.admin.properties. *= # Additional admin-specific properties used to configure the client.
spring.kafka.admin.ssl.key-password= # Password of the private key in the key store file.
spring.kafka.admin.ssl.key-store-location= # Location of the key store file.
spring.kafka.admin.ssl.key-store-password= # Store password for the key store file.
spring.kafka.admin.ssl.key-store-type= # Type of the key store.
spring.kafka.admin.ssl.protocol= # SSL protocol to use.
spring.kafka.admin.ssl.trust-store-location= # Location of the trust store file.
spring.kafka.admin.ssl.trust-store-password= # Store password for the trust store file.
spring.kafka.admin.ssl.trust-store-type= # Type of the trust store.
spring.kafka.bootstrap-servers= # Comma-delimited list of host:port pairs to use for establishing the
initial connections to the Kafka cluster. Applies to all components unless overridden.
spring.kafka.client-id= # ID to pass to the server when making requests. Used for server-side logging.
spring.kafka.consumer.auto-commit-interval= # Frequency with which the consumer offsets are auto-
committed to Kafka if 'enable.auto.commit' is set to true.
spring.kafka.consumer.auto-offset-reset= # What to do when there is no initial offset in Kafka or if the
current offset no longer exists on the server.
spring.kafka.consumer.bootstrap-servers= # Comma-delimited list of host:port pairs to use for
establishing the initial connections to the Kafka cluster. Overrides the global property, for
spring.kafka.consumer.client-id= # ID to pass to the server when making requests. Used for server-side
logging.
```

```
spring.kafka.consumer.enable-auto-commit= # Whether the consumer's offset is periodically committed in
the background.
spring.kafka.consumer.fetch-max-wait= # Maximum amount of time the server blocks before answering the
fetch request if there isn't sufficient data to immediately satisfy the requirement given by "fetch-
spring.kafka.consumer.fetch-min-size= # Minimum amount of data the server should return for a fetch
spring.kafka.consumer.group-id= # Unique string that identifies the consumer group to which this
consumer belongs.
spring.kafka.consumer.heartbeat-interval = # Expected time between heartbeats to the consumer
spring.kafka.consumer.key-deserializer= # Deserializer class for keys.
spring.kafka.consumer.max-poll-records= # Maximum number of records returned in a single call to poll().
spring.kafka.consumer.properties.*= # Additional consumer-specific properties used to configure the
spring.kafka.consumer.ssl.key-password= # Password of the private key in the key store file.
spring.kafka.consumer.ssl.key-store-location= # Location of the key store file.
spring.kafka.consumer.ssl.key-store-password= # Store password for the key store file.
spring.kafka.consumer.ssl.key-store-type= # Type of the key store.
spring.kafka.consumer.ssl.protocol= # SSL protocol to use.
spring.kafka.consumer.ssl.trust-store-location= # Location of the trust store file.
spring.kafka.consumer.ssl.trust-store-password= # Store password for the trust store file.
spring.kafka.consumer.ssl.trust-store-type= # Type of the trust store
spring.kafka.consumer.value-deserializer= # Deserializer class for values.
spring.kafka.jaas.control-flag=required # Control flag for login configuration.
spring.kafka.jaas.enabled=false # Whether to enable JAAS configuration.
spring.kafka.jaas.login-module=com.sun.security.auth.module.Krb5LoginModule # Login module.
spring.kafka.jaas.options= # Additional JAAS options.
spring.kafka.listener.ack-count= # Number of records between offset commits when ackMode is "COUNT" or
 "COUNT TIME
spring.kafka.listener.ack-mode= # Listener AckMode. See the spring-kafka documentation.
spring.kafka.listener.ack-time= # Time between offset commits when ackMode is "TIME" or "COUNT_TIME".
spring.kafka.listener.client-id= # Prefix for the listener's consumer client.id property.
spring.kafka.listener.concurrency= # Number of threads to run in the listener containers.
spring.kafka.listener.idle-event-interval= # Time between publishing idle consumer events (no data
received).
spring.kafka.listener.log-container-config= # Whether to log the container configuration during
initialization (INFO level).
spring.kafka.listener.monitor-interval= # Time between checks for non-responsive consumers. If a
duration suffix is not specified, seconds will be used.
spring.kafka.listener.no-poll-threshold= # Multiplier applied to "pollTimeout" to determine if a
consumer is non-responsive.
spring.kafka.listener.poll-timeout= # Timeout to use when polling the consumer.
spring.kafka.listener.type=single # Listener type.
spring.kafka.producer.acks= # Number of acknowledgments the producer requires the leader to have
received before considering a request complete.
spring.kafka.producer.batch-size= # Default batch size.
spring.kafka.producer.bootstrap-servers= # Comma-delimited list of host:port pairs to use for
establishing the initial connections to the Kafka cluster. Overrides the global property, for
spring.kafka.producer.buffer-memory= # Total memory size the producer can use to buffer records waiting
to be sent to the server.
spring.kafka.producer.client-id= # ID to pass to the server when making requests. Used for server-side
spring.kafka.producer.compression-type= # Compression type for all data generated by the producer.
spring.kafka.producer.key-serializer= # Serializer class for keys.
spring.kafka.producer.properties.*= # Additional producer-specific properties used to configure the
client
spring.kafka.producer.retries= # When greater than zero, enables retrying of failed sends.
spring.kafka.producer.ssl.key-password= # Password of the private key in the key store file.
spring.kafka.producer.ssl.key-store-location= # Location of the key store file.
spring.kafka.producer.ssl.key-store-password= # Store password for the key store file.
spring.kafka.producer.ssl.key-store-type= # Type of the key store.
spring.kafka.producer.ssl.protocol= # SSL protocol to use.
spring.kafka.producer.ssl.trust-store-location= # Location of the trust store file.
spring.kafka.producer.ssl.trust-store-password= # Store password for the trust store file.
spring.kafka.producer.ssl.trust-store-type= # Type of the trust store.
spring.kafka.producer.transaction-id-prefix= # When non empty, enables transaction support for producer.
spring.kafka.producer.value-serializer= # Serializer class for values.
spring.kafka.properties.*= # Additional properties, common to producers and consumers, used to configure
the client.
```

```
spring.kafka.ssl.key-password= # Password of the private key in the key store file.
spring.kafka.ssl.key-store-location= # Location of the key store file.
spring.kafka.ssl.key-store-password= # Store password for the key store file.
spring.kafka.ssl.key-store-type= # Type of the key store.
spring.kafka.ssl.protocol= # SSL protocol to use.
spring.kafka.ssl.trust-store-location= # Location of the trust store file.
spring.kafka.ssl.trust-store-password= # Store password for the trust store file.
spring.kafka.ssl.trust-store-type= # Type of the trust store.
spring.kafka.streams.application-id= # Kafka streams application.id property; default
spring.application.name.
spring.kafka.streams.auto-startup=true # Whether or not to auto-start the streams factory bean.
spring.kafka.streams.bootstrap-servers= # Comma-delimited list of host:port pairs to use for
establishing the initial connections to the Kafka cluster. Overrides the global property, for streams.
spring.kafka.streams.cache-max-size-buffering= # Maximum memory size to be used for buffering across all
spring.kafka.streams.client-id= # ID to pass to the server when making requests. Used for server-side
logging
spring.kafka.streams.properties.*= # Additional Kafka properties used to configure the streams.
spring.kafka.streams.replication-factor= # The replication factor for change log topics and repartition
topics created by the stream processing application.
spring.kafka.streams.ssl.key-password= # Password of the private key in the key store file.
spring.kafka.streams.ssl.key-store-location= # Location of the key store file.
spring.kafka.streams.ssl.key-store-password= # Store password for the key store file.
spring.kafka.streams.ssl.key-store-type= # Type of the key store.
spring.kafka.streams.ssl.protocol= # SSL protocol to use.
spring.kafka.streams.ssl.trust-store-location= # Location of the trust store file.
spring.kafka.streams.ssl.trust-store-password= # Store password for the trust store file.
spring.kafka.streams.ssl.trust-store-type= # Type of the trust store.
spring.kafka.streams.state-dir= # Directory location for the state store.
spring.kafka.template.default-topic # Default topic to which messages are sent.
# RABBIT (RabbitProperties)
spring.rabbitmq.addresses= # Comma-separated list of addresses to which the client should connect.
spring.rabbitmq.cache.channel.checkout-timeout= # Duration to wait to obtain a channel if the cache size
has been reached.
spring.rabbitmq.cache.channel.size= # Number of channels to retain in the cache.
spring.rabbitmq.cache.connection.mode=channel # Connection factory cache mode.
spring.rabbitmq.cache.connection.size= # Number of connections to cache.
spring.rabbitmg.connection-timeout= # Connection timeout. Set it to zero to wait forever.
spring.rabbitmg.dynamic=true # Whether to create an AmopAdmin bean.
spring.rabbitmq.host=localhost # RabbitMQ host.
spring.rabbitmq.listener.direct.acknowledge-mode= # Acknowledge mode of container.
spring.rabbitmq.listener.direct.auto-startup=true # Whether to start the container automatically on
spring.rabbitmq.listener.direct.consumers-per-queue= # Number of consumers per queue.
spring.rabbitmq.listener.direct.default-requeue-rejected= # Whether rejected deliveries are re-queued by
spring.rabbitmg.listener.direct.idle-event-interval= # How often idle container events should be
published.
spring.rabbitmq.listener.direct.missing-queues-fatal=false # Whether to fail if the queues declared by
the container are not available on the broker.
spring.rabbitmq.listener.direct.prefetch= # Maximum number of unacknowledged messages that can be
outstanding at each consumer.
spring.rabbitmq.listener.direct.retry.enabled=false # Whether publishing retries are enabled.
spring.rabbitmq.listener.direct.retry.initial-interval=1000ms # Duration between the first and second
attempt to deliver a message.
spring.rabbitmg.listener.direct.retry.max-attempts=3 # Maximum number of attempts to deliver a message.
spring.rabbitmq.listener.direct.retry.max-interval=10000ms # Maximum duration between attempts.
spring.rabbitmq.listener.direct.retry.multiplier=1 # Multiplier to apply to the previous retry interval.
spring.rabbitmq.listener.direct.retry.stateless=true # Whether retries are stateless or stateful.
spring.rabbitmq.listener.simple.acknowledge-mode= # Acknowledge mode of container.
spring.rabbitmq.listener.simple.auto-startup=true # Whether to start the container automatically on
startup
spring.rabbitmq.listener.simple.concurrency= # Minimum number of listener invoker threads.
spring.rabbitmq.listener.simple.default-requeue-rejected= # Whether rejected deliveries are re-queued by
default
spring.rabbitmg.listener.simple.idle-event-interval= # How often idle container events should be
published.
spring.rabbitmg.listener.simple.max-concurrency= # Maximum number of listener invoker threads.
```

```
spring.rabbitmq.listener.simple.missing-queues-fatal=true # Whether to fail if the queues declared
by the container are not available on the broker and/or whether to stop the container if one or more
queues are deleted at runtime.
spring.rabbitmq.listener.simple.prefetch= # Maximum number of unacknowledged messages that can be
outstanding at each consumer.
spring.rabbitmg.listener.simple.retry.enabled=false # Whether publishing retries are enabled.
spring.rabbitmq.listener.simple.retry.initial-interval=1000ms # Duration between the first and second
attempt to deliver a message.
spring.rabbitmq.listener.simple.retry.max-attempts=3 # Maximum number of attempts to deliver a message.
spring.rabbitmg.listener.simple.retry.max-interval=10000ms # Maximum duration between attempts.
spring.rabbitmq.listener.simple.retry.multiplier=1 # Multiplier to apply to the previous retry interval.
spring.rabbitmq.listener.simple.retry.stateless=true # Whether retries are stateless or stateful.
spring.rabbitmq.listener.simple.transaction-size= # Number of messages to be processed between acks when
 the acknowledge mode is AUTO. If larger than prefetch, prefetch will be increased to this value.
spring.rabbitmq.listener.type=simple # Listener container type.
spring.rabbitmq.password=guest # Login to authenticate against the broker.
spring.rabbitmq.port=5672 # RabbitMQ port.
spring.rabbitmq.publisher-confirms=false # Whether to enable publisher confirms.
spring.rabbitmq.publisher-returns=false # Whether to enable publisher returns.
spring.rabbitmq.requested-heartbeat= # Requested heartbeat timeout; zero for none. If a duration suffix
is not specified, seconds will be used.
spring.rabbitmq.ssl.algorithm= # SSL algorithm to use. By default, configured by the Rabbit client
spring.rabbitmq.ssl.enabled=false # Whether to enable SSL support.
spring.rabbitmq.ssl.key-store= # Path to the key store that holds the SSL certificate.
spring.rabbitmq.ssl.key-store-password= # Password used to access the key store.
spring.rabbitmq.ssl.key-store-type=PKCS12 # Key store type.
spring.rabbitmq.ssl.trust-store= # Trust store that holds SSL certificates.
spring.rabbitmq.ssl.trust-store-password= # Password used to access the trust store.
spring.rabbitmq.ssl.trust-store-type=JKS # Trust store type.
spring.rabbitmq.ssl.validate-server-certificate=true # Whether to enable server side certificate
spring.rabbitmq.ssl.verify-hostname=true # Whether to enable hostname verification.
spring.rabbitmq.template.exchange= # Name of the default exchange to use for send operations.
spring.rabbitmq.template.mandatory= # Whether to enable mandatory messages.
spring.rabbitmq.template.queue= # Name of the default queue to receive messages from when none is
specified explicitly
spring.rabbitmq.template.receive-timeout  # Timeout for `receive()` operations.
spring.rabbitmq.template.reply-timeout= # Timeout for `sendAndReceive()` operations.
spring.rabbitmq.template.retry.enabled=false # Whether publishing retries are enabled.
spring.rabbitmq.template.retry.initial-interval=1000ms # Duration between the first and second attempt
to deliver a message.
spring.rabbitmq.template.retry.max-attempts=3 # Maximum number of attempts to deliver a message.
spring.rabbitmq.template.retry.max-interval=10000ms # Maximum duration between attempts.
spring.rabbitmq.template.retry.multiplier=1 # Multiplier to apply to the previous retry interval.
spring.rabbitmq.template.routing-key= # Value of a default routing key to use for send operations.
spring.rabbitmq.username=quest # Login user to authenticate to the broker.
spring.rabbitmg.virtual-host= # Virtual host to use when connecting to the broker.
# ACTUATOR PROPERTIES
# MANAGEMENT HTTP SERVER (ManagementServerProperties)
management.server.add-application-context-header=false # Add the "X-Application-Context" HTTP header in
each response.
management.server.address= # Network address to which the management endpoints should bind. Requires a
custom management.server.port.
management.server.port= # Management endpoint HTTP port (uses the same port as the application by
default). Configure a different port to use management-specific SSL.
{f management.server.servlet.context-path}= # Management endpoint context-path (for instance, {f `}/
management`). Requires a custom management.server.port.
management.server.ssl.ciphers= # Supported SSL ciphers.
management.server.ssl.client-auth= # Whether client authentication is wanted ("want") or needed
 ("need"). Requires a trust store.
management.server.ssl.enabled=true # Whether to enable SSL support.
management.server.ssl.enabled-protocols= # Enabled SSL protocols.
management.server.ssl.key-alias= # Alias that identifies the key in the key store.
management.server.ssl.key-password= # Password used to access the key in the key store.
```

```
management.server.ssl.key-store= # Path to the key store that holds the SSL certificate (typically a jks
 file)
management.server.ssl.key-store-password= # Password used to access the key store.
management.server.ssl.key-store-provider= # Provider for the key store.
management.server.ssl.key-store-type= # Type of the key store.
management.server.ssl.protocol=TLS # SSL protocol to use.
management.server.ssl.trust-store= # Trust store that holds SSL certificates.
management.server.ssl.trust-store-password= # Password used to access the trust store.
management.server.ssl.trust-store-provider= # Provider for the trust store.
management.server.ssl.trust-store-type= # Type of the trust store.
# CLOUDFOUNDRY
management.cloudfoundry.enabled=true # Whether to enable extended Cloud Foundry actuator endpoints.
management.cloudfoundry.skip-ssl-validation=false # Whether to skip SSL verification for Cloud Foundry
 actuator endpoint security calls.
# ENDPOINTS GENERAL CONFIGURATION
management.endpoints.enabled-by-default= # Whether to enable or disable all endpoints by default.
# ENDPOINTS JMX CONFIGURATION (JmxEndpointProperties)
management.endpoints.jmx.domain=org.springframework.boot # Endpoints JMX domain name. Fallback to
 'spring.jmx.default-domain' if set.
management.endpoints.jmx.exposure.include=* # Endpoint IDs that should be included or '*' for all.
management.endpoints.jmx.exposure.exclude= # Endpoint IDs that should be excluded or '*' for all.
management.endpoints.jmx.static-names= # Additional static properties to append to all ObjectNames of
MBeans representing Endpoints.
# ENDPOINTS WEB CONFIGURATION (WebEndpointProperties)
management.endpoints.web.exposure.include=health,info # Endpoint IDs that should be included or '*' for
a11.
management.endpoints.web.exposure.exclude= # Endpoint IDs that should be excluded or '*' for all.
management.endpoints.web.base-path=/actuator # Base path for Web endpoints. Relative to
server.servlet.context-path or management.server.servlet.context-path if management.server.port is
management.endpoints.web.path-mapping= # Mapping between endpoint IDs and the path that should expose
# ENDPOINTS CORS CONFIGURATION (CorsEndpointProperties)
management.endpoints.web.cors.allow-credentials= # Whether credentials are supported. When not set,
credentials are not supported.
management.endpoints.web.cors.allowed-headers= # Comma-separated list of headers to allow in a request.
 '*' allows all headers.
management.endpoints.web.cors.allowed-methods= # Comma-separated list of methods to allow. '*' allows
all methods. When not set, defaults to GET
management.endpoints.web.cors.allowed-origins= # Comma-separated list of origins to allow. '*' allows
 all origins. When not set, CORS support is disabled.
management.endpoints.web.cors.exposed-headers= # Comma-separated list of headers to include in a
management.endpoints.web.cors.max-age=1800s # How long the response from a pre-flight request can be
cached by clients. If a duration suffix is not specified, seconds will be used.
# AUDIT EVENTS ENDPOINT (AuditEventsEndpoint)
management.endpoint.auditevents.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.auditevents.enabled=true # Whether to enable the auditevents endpoint.
# BEANS ENDPOINT (BeansEndpoint)
management.endpoint.beans.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.beans.enabled=true # Whether to enable the beans endpoint.
# CACHES ENDPOINT (CachesEndpoint)
management.endpoint.caches.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.caches.enabled=true # Whether to enable the caches endpoint.
# CONDITIONS REPORT ENDPOINT (ConditionsReportEndpoint)
management.endpoint.conditions.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.conditions.enabled=true # Whether to enable the conditions endpoint.
# CONFIGURATION PROPERTIES REPORT ENDPOINT
 (\underline{ConfigurationPropertiesReportEndpoint}, \underline{ConfigurationPropertiesReportEndpointProperties})
management.endpoint.configprops.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.configprops.enabled=true # Whether to enable the configprops endpoint.
```

```
management.endpoint.configprops.keys-to-
sanitize=password, secret, key, token, .*credentials.*, vcap_services, sun. java.command # Keys that should be
 sanitized. Keys can be simple strings that the property ends with or regular expressions.
# ENVIRONMENT ENDPOINT (EnvironmentEndpoint, EnvironmentEndpointProperties)
management.endpoint.env.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.env.enabled=true # Whether to enable the env endpoint.
management.endpoint.env.kevs-to-
sanitize=password, secret, key, token, .*credentials.*, vcap_services, sun. java.command # Keys that should be
sanitized. Keys can be simple strings that the property ends with or regular expressions.
# FLYWAY ENDPOINT (FlywayEndpoint)
management.endpoint.flyway.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.flyway.enabled=true # Whether to enable the flyway endpoint.
# HEALTH ENDPOINT (HealthEndpoint, HealthEndpointProperties)
management.endpoint.health.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.health.enabled=true # Whether to enable the health endpoint.
management.endpoint.health.roles= # Roles used to determine whether or not a user is authorized to be
shown details. When empty, all authenticated users are authorized.
management.endpoint.health.show-details=never # When to show full health details.
# HEAP DUMP ENDPOINT (HeapDumpWebEndpoint)
management.endpoint.heapdump.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.heapdump.enabled=true # Whether to enable the heapdump endpoint.
# HTTP TRACE ENDPOINT (HttpTraceEndpoint)
management.endpoint.httptrace.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.httptrace.enabled=true # Whether to enable the httptrace endpoint.
# INFO ENDPOINT (InfoEndpoint)
info= # Arbitrary properties to add to the info endpoint.
management.endpoint.info.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.info.enabled=true # Whether to enable the info endpoint.
# INTEGRATION GRAPH ENDPOINT (IntegrationGraphEndpoint)
management.endpoint.integrationgraph.cache.time-to-live=0ms # Maximum time that a response can be
management.endpoint.integrationgraph.enabled=true # Whether to enable the integrationgraph endpoint.
# JOLOKIA ENDPOINT (JolokiaProperties)
management.endpoint.jolokia.config.*= # Jolokia settings. Refer to the documentation of Jolokia for more
details.
management.endpoint.jolokia.enabled=true # Whether to enable the jolokia endpoint.
# LIQUIBASE ENDPOINT (LiquibaseEndpoint)
management.endpoint.liquibase.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.liquibase.enabled=true # Whether to enable the liquibase endpoint.
# LOG FILE ENDPOINT (LogFileWebEndpoint, LogFileWebEndpointProperties)
management.endpoint.logfile.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.logfile.enabled=true # Whether to enable the logfile endpoint.
management.endpoint.logfile.external-file= # External Logfile to be accessed. Can be used if the logfile
 is written by output redirect and not by the logging system itself.
# LOGGERS ENDPOINT (LoggersEndpoint)
management.endpoint.loggers.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.loggers.enabled=true # Whether to enable the loggers endpoint.
# REQUEST MAPPING ENDPOINT (MappingsEndpoint)
management.endpoint.mappings.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.mappings.enabled=true # Whether to enable the mappings endpoint.
# METRICS ENDPOINT (MetricsEndpoint)
management.endpoint.metrics.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.metrics.enabled=true # Whether to enable the metrics endpoint.
# PROMETHEUS ENDPOINT (PrometheusScrapeEndpoint)
management.endpoint.prometheus.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.prometheus.enabled=true # Whether to enable the prometheus endpoint.
```

```
# SCHEDULED TASKS ENDPOINT (ScheduledTasksEndpoint)
management.endpoint.scheduledtasks.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.scheduledtasks.enabled=true # Whether to enable the scheduledtasks endpoint.
# SESSIONS ENDPOINT (SessionsEndpoint)
management.endpoint.sessions.enabled=true # Whether to enable the sessions endpoint.
# SHUTDOWN ENDPOINT (ShutdownEndpoint)
management.endpoint.shutdown.enabled=false # Whether to enable the shutdown endpoint.
# THREAD DUMP ENDPOINT (ThreadDumpEndpoint)
management.endpoint.threaddump.cache.time-to-live=0ms # Maximum time that a response can be cached.
management.endpoint.threaddump.enabled=true # Whether to enable the threaddump endpoint.
# HEALTH INDICATORS
management.health.db.enabled=true # Whether to enable database health check.
management.health.cassandra.enabled=true # Whether to enable Cassandra health check.
management.health.couchbase.enabled=true # Whether to enable Couchbase health check.
management.health.defaults.enabled=true # Whether to enable default health indicators.
management.health.diskspace.enabled=true # Whether to enable disk space health check.
management.health.diskspace.path= # Path used to compute the available disk space.
management.health.diskspace.threshold=10MB  # Minimum disk space that should be available.
management.health.elasticsearch.enabled=true # Whether to enable Elasticsearch health check.
management.health.elasticsearch.indices= # Comma-separated index names.
management.health.elasticsearch.response-timeout=100ms # Time to wait for a response from the cluster.
management.health.influxdb.enabled=true # Whether to enable InfluxDB health check.
management.health.ims.enabled=true # Whether to enable JMS health check.
management.health.ldap.enabled=true # Whether to enable LDAP health check.
management.health.mail.enabled=true # Whether to enable Mail health check.
management.health.mongo.enabled=true # Whether to enable MongoDB health check.
management.health.neo4j.enabled=true # Whether to enable Neo4j health check.
management.health.rabbit.enabled=true # Whether to enable RabbitMQ health check.
management.health.redis.enabled=true # Whether to enable Redis health check.
management.health.solr.enabled=true # Whether to enable Solr health check.
management.health.status.http-mapping= # Mapping of health statuses to HTTP status codes. By default,
registered health statuses map to sensible defaults (for example, UP maps to 200).
management.health.status.order=DOWN,OUT_OF_SERVICE,UP,UNKNOWN # Comma-separated list of health statuses
# HTTP TRACING (HttpTraceProperties)
management.trace.http.enabled=true # Whether to enable HTTP request-response tracing.
management.trace.http.include=request-headers,response-headers,cookies,errors # Items to be included in
# INFO CONTRIBUTORS (InfoContributorProperties)
management.info.build.enabled=true # Whether to enable build info.
management.info.defaults.enabled=true # Whether to enable default info contributors.
management.info.env.enabled=true # Whether to enable environment info.
management.info.git.enabled=true # Whether to enable git info.
management.info.git.mode=simple # Mode to use to expose git information.
# METRICS
management.metrics.distribution.maximum-expected-value.*= # Maximum value that meter IDs starting-with
 the specified name are expected to observe
management.metrics.distribution.minimum-expected-value.*= # Minimum value that meter IDs starting-with
the specified name are expected to observe
management.metrics.distribution.percentiles.*= # Specific computed non-aggregable percentiles to ship to
 the backend for meter IDs starting-with the specified name.
management.metrics.distribution.percentiles-histogram.*= # Whether meter IDs starting with the specified
name should publish percentile histograms.
management.metrics.distribution.sla.*= # Specific SLA boundaries for meter IDs starting-with the
 specified name. The longest match wins.
management.metrics.enable.*= # Whether meter IDs starting-with the specified name should be enabled. The
 longest match wins, the key `all` can also be used to configure all meters.
management.metrics.export.appoptics.api-token= # AppOptics API token.
management.metrics.export.appoptics.batch-size=500 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.appoptics.connect-timeout=5s # Connection timeout for requests to this
management.metrics.export.appoptics.enabled=true # Whether exporting of metrics to this backend is
enabled.
```

```
management.metrics.export.appoptics.host-tag=instance # Tag that will be mapped to "@host" when shipping
metrics to AppOptics.
management.metrics.export.appoptics.num-threads=2 # Number of threads to use with the metrics publishing
scheduler
management.metrics.export.appoptics.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.appoptics.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.appoptics.uri=https://api.appoptics.com/v1/measurements # URI to ship metrics
management.metrics.export.atlas.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.atlas.config-refresh-frequency=10s # Frequency for refreshing config settings
from the LWC service.
management.metrics.export.atlas.config-time-to-live=150s # Time to live for subscriptions from the LWC
management.metrics.export.atlas.config-uri=http://localhost:7101/lwc/api/v1/expressions/local-dev # URI
for the Atlas LWC endpoint to retrieve current subscriptions.
management.metrics.export.atlas.connect-timeout=1s # Connection timeout for requests to this backend.
management.metrics.export.atlas.enabled=true # Whether exporting of metrics to this backend is enabled.
management.metrics.export.atlas.eval-uri=http://localhost:7101/lwc/api/v1/evaluate # URI for the Atlas
LWC endpoint to evaluate the data for a subscription.
management.metrics.export.atlas.lwc-enabled=false # Whether to enable streaming to Atlas LWC.
management.metrics.export.atlas.meter-time-to-live=15m # Time to live for meters that do not have any
activity. After this period the meter will be considered expired and will not get reported.
management.metrics.export.atlas.num-threads=2 # Number of threads to use with the metrics publishing
scheduler.
management.metrics.export.atlas.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.atlas.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.atlas.uri=http://localhost:7101/api/v1/publish # URI of the Atlas server.
management.metrics.export.datadog.api-key= # Datadog API key.
management.metrics.export.datadog.application-key= # Datadog application key. Not strictly required, but
 improves the Datadog experience by sending meter descriptions, types, and base units to Datadog.
management.metrics.export.datadog.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.datadog.connect-timeout=1s # Connection timeout for requests to this backend.
management.metrics.export.datadog.descriptions=true # Whether to publish descriptions metadata to
Datadog. Turn this off to minimize the amount of metadata sent.
management.metrics.export.datadog.enabled=true # Whether exporting of metrics to this backend is
management.metrics.export.datadog.host-tag=instance # Tag that will be mapped to "host" when shipping
metrics to Datadog.
management.metrics.export.datadog.num-threads=2 # Number of threads to use with the metrics publishing
management.metrics.export.datadog.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.datadog.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.datadog.uri=https://app.datadoghq.com # URI to ship metrics to. If you need to
publish metrics to an internal proxy en-route to Datadog, you can define the location of the proxy with
this.
management.metrics.export.dynatrace.api-token= # Dynatrace authentication token.
management.metrics.export.dynatrace.batch-size=10000 # Number of measurements per request to use for
this backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.dynatrace.connect-timeout=1s # Connection timeout for requests to this
management.metrics.export.dynatrace.device-id= # ID of the custom device that is exporting metrics to
management.metrics.export.dynatrace.enabled=true # Whether exporting of metrics to this backend is
management.metrics.export.dynatrace.num-threads=2 # Number of threads to use with the metrics publishing
management.metrics.export.dvnatrace.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.dynatrace.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.dynatrace.technology-type=java # Technology type for exported metrics. Used to
group metrics under a logical technology name in the Dynatrace UI
management.metrics.export.dynatrace.uri= # URI to ship metrics to. Should be used for SaaS, self managed
instances or to en-route through an internal proxy.
management.metrics.export.elastic.auto-create-index=true # Whether to create the index automatically if
management.metrics.export.elastic.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.elastic.connect-timeout=1s # Connection timeout for requests to this backend.
management.metrics.export.elastic.enabled=true # Whether exporting of metrics to this backend is
enabled.
```

```
management.metrics.export.elastic.host=http://localhost:9200 # Host to export metrics to.
management.metrics.export.elastic.index=metrics # Index to export metrics to.
management.metrics.export.elastic.index-date-format=yyyy-MM # Index date format used for rolling
indices. Appended to the index name, preceded by a '-'
management.metrics.export.elastic.num-threads=2 # Number of threads to use with the metrics publishing
scheduler.
management.metrics.export.elastic.password= # Login password of the Elastic server.
management.metrics.export.elastic.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.elastic.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.elastic.timestamp-field-name=@timestamp # Name of the timestamp field.
management.metrics.export.elastic.user-name= # Login user of the Elastic server.
management.metrics.export.ganglia.addressing-mode=multicast # UDP addressing mode, either unicast or
multicast.
management.metrics.export.ganglia.duration-units=milliseconds # Base time unit used to report durations.
management.metrics.export.ganglia.enabled=true # Whether exporting of metrics to Ganglia is enabled.
management.metrics.export.ganglia.host=localhost # Host of the Ganglia server to receive exported
metrics.
management.metrics.export.ganglia.port=8649 # Port of the Ganglia server to receive exported metrics.
management.metrics.export.ganglia.protocol-version=3.1 # Ganglia protocol version. Must be either 3.1 or
3.0.
management.metrics.export.ganglia.rate-units=seconds # Base time unit used to report rates.
management.metrics.export.ganglia.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.ganglia.time-to-live=1 # Time to live for metrics on Ganglia. Set the multi-
cast Time-To-Live to be one greater than the number of hops (routers) between the hosts.
management.metrics.export.graphite.duration-units=milliseconds # Base time unit used to report
management.metrics.export.graphite.enabled=true # Whether exporting of metrics to Graphite is enabled.
management.metrics.export.graphite.host=localhost # Host of the Graphite server to receive exported
management.metrics.export.graphite.port=2004 # Port of the Graphite server to receive exported metrics.
management.metrics.export.graphite.protocol=pickled # Protocol to use while shipping data to Graphite.
management.metrics.export.graphite.rate-units=seconds # Base time unit used to report rates.
management.metrics.export.graphite.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.graphite.tags-as-prefix= # For the default naming convention, turn the
specified tag keys into part of the metric prefix.
management.metrics.export.humio.api-token= # Humio API token.
management.metrics.export.humio.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.humio.connect-timeout=5s # Connection timeout for requests to this backend.
management.metrics.export.humio.enabled=true # Whether exporting of metrics to this backend is enabled.
management.metrics.export.humio.num-threads=2 # Number of threads to use with the metrics publishing
scheduler
management.metrics.export.humio.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.humio.repository=sandbox # Name of the repository to publish metrics to.
management.metrics.export.humio.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.humio.tags.*= # Humio tags describing the data source in which metrics will be
stored. Humio tags are a distinct concept from Micrometer's tags. Micrometer's tags are used to divide
metrics along dimensional boundaries.
management.metrics.export.humio.uri=https://cloud.humio.com # URI to ship metrics to. If you need to
publish metrics to an internal proxy en-route to Humio, you can define the location of the proxy with
this.
management.metrics.export.influx.auto-create-db=true # Whether to create the Influx database if it does
not exist before attempting to publish metrics to it.
management.metrics.export.influx.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.influx.compressed=true # Whether to enable GZIP compression of metrics batches
published to Influx.
management.metrics.export.influx.connect-timeout=1s # Connection timeout for requests to this backend.
management.metrics.export.influx.consistency=one # Write consistency for each point.
management.metrics.export.influx.db=mydb # Tag that will be mapped to "host" when shipping metrics to
Influx.
management.metrics.export.influx.enabled=true # Whether exporting of metrics to this backend is enabled.
management.metrics.export.influx.num-threads=2 # Number of threads to use with the metrics publishing
management.metrics.export.influx.password= # Login password of the Influx server.
management.metrics.export.influx.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.influx.retention-duration= # Time period for which Influx should retain data
in the current database
management.metrics.export.influx.retention-shard-duration= # Time range covered by a shard group.
management.metrics.export.influx.retention-policy= # Retention policy to use (Influx writes to the
DEFAULT retention policy if one is not specified).
```

```
management.metrics.export.influx.retention-replication-factor= # How many copies of the data are stored
 in the cluster
management.metrics.export.influx.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.influx.uri=http://localhost:8086 # URI of the Influx server.
management.metrics.export.influx.user-name= # Login user of the Influx server.
management.metrics.export.jmx.domain=metrics # Metrics JMX domain name.
management.metrics.export.jmx.enabled=true # Whether exporting of metrics to JMX is enabled.
management.metrics.export.jmx.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.kairos.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.kairos.connect-timeout=1s # Connection timeout for requests to this backend.
management.metrics.export.kairos.enabled=true # Whether exporting of metrics to this backend is enabled.
management.metrics.export.kairos.num-threads=2 # Number of threads to use with the metrics publishing
management.metrics.export.kairos.password= # Login password of the KairosDB server.
management.metrics.export.kairos.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.kairos.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.kairos.uri = localhost:8080/api/v1/datapoints # URI of the KairosDB server.
management.metrics.export.kairos.user-name= # Login user of the KairosDB server.
management.metrics.export.newrelic.account-id= # New Relic account ID.
management.metrics.export.newrelic.api-key= # New Relic API key.
management.metrics.export.newrelic.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.newrelic.connect-timeout=1s # Connection timeout for requests to this backend.
\textbf{management.metrics.export.newrelic.enabled} = \texttt{true} \ \# \ \textit{Whether exporting of metrics to this backend is}
management.metrics.export.newrelic.num-threads=2 # Number of threads to use with the metrics publishing
management.metrics.export.newrelic.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.newrelic.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.newrelic.uri=https://insights-collector.newrelic.com # URI to ship metrics to.
management.metrics.export.prometheus.descriptions=true # Whether to enable publishing descriptions as
part of the scrape payload to Prometheus. Turn this off to minimize the amount of data sent on each
scrape.
management.metrics.export.prometheus.enabled=true # Whether exporting of metrics to Prometheus is
management.metrics.export.prometheus.step=1m # Step size (i.e. reporting frequency) to use.
management.metrics.export.prometheus.pushgateway.base-url=localhost:9091  # Base URL for the Pushgateway.
management.metrics.export.prometheus.pushgateway.enabled=false # Enable publishing via a Prometheus
management.metrics.export.prometheus.pushgateway.grouping-key= # Grouping key for the pushed metrics.
management.metrics.export.prometheus.pushgateway.job= # Job identifier for this application instance.
management.metrics.export.prometheus.pushgateway.push-rate=1m # Frequency with which to push metrics.
management.metrics.export.prometheus.pushgateway.shutdown-operation= # Operation that should be
performed on shutdown.
management.metrics.export.signalfx.access-token= # SignalfX access token.
management.metrics.export.signalfx.batch-size=10000 # Number of measurements per request to use for this
backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.signalfx.connect-timeout=1s # Connection timeout for requests to this backend.
management.metrics.export.signalfx.enabled=true # Whether exporting of metrics to this backend is
enabled.
management.metrics.export.signalfx.num-threads=2 # Number of threads to use with the metrics publishing
scheduler
management.metrics.export.signalfx.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.signalfx.source= # Uniquely identifies the app instance that is publishing
metrics to SignalFx. Defaults to the local host name.
management.metrics.export.signalfx.step=10s # Step size (i.e. reporting frequency) to use.
management.metrics.export.signalfx.uri=https://ingest.signalfx.com # URI to ship metrics to
management.metrics.export.simple.enabled=true # Whether, in the absence of any other exporter, exporting
of metrics to an in-memory backend is enabled.
management.metrics.export.simple.mode=cumulative # Counting mode.
management.metrics.export.simple.step=lm # Step size (i.e. reporting frequency) to use.
management.metrics.export.statsd.enabled=true # Whether exporting of metrics to StatsD is enabled.
management.metrics.export.statsd.flavor=datadog # StatsD line protocol to use.
management.metrics.export.statsd.host=localhost # Host of the StatsD server to receive exported metrics.
management.metrics.export.statsd.max-packet-length=1400 # Total length of a single payload should be
kept within your network's MTU.
management.metrics.export.statsd.polling-frequency=10s # How often gauges will be polled. When a gauge
 is polled, its value is recalculated and if the value has changed (or publishUnchangedMeters is true),
 it is sent to the StatsD server.
management.metrics.export.statsd.port=8125 # Port of the StatsD server to receive exported metrics.
```

```
management.metrics.export.statsd.publish-unchanged-meters=true # Whether to send unchanged meters to the
StatsD server.
management.metrics.export.wavefront.api-token= # API token used when publishing metrics directly to the
Wavefront API host.
management.metrics.export.wavefront.batch-size=10000 # Number of measurements per request to use for
this backend. If more measurements are found, then multiple requests will be made.
management.metrics.export.wavefront.connect-timeout=1s # Connection timeout for requests to this
backend
management.metrics.export.wavefront.enabled=true # Whether exporting of metrics to this backend is
enabled.
management.metrics.export.wavefront.global-prefix= # Global prefix to separate metrics originating from
this app's white box instrumentation from those originating from other Wavefront integrations when
viewed in the Wavefront UI.
management.metrics.export.wavefront.num-threads=2 # Number of threads to use with the metrics publishing
management.metrics.export.wavefront.read-timeout=10s # Read timeout for requests to this backend.
management.metrics.export.wavefront.source= # Unique identifier for the app instance that is the source
of metrics being published to Wavefront. Defaults to the local host name.
management.metrics.export.wavefront.step=10s # Step size (i.e. reporting frequency) to use.
management.metrics.export.wavefront.uri=https://longboard.wavefront.com # URI to ship metrics to.
management.metrics.use-global-registry=true # Whether auto-configured MeterRegistry implementations
should be bound to the global static registry on Metrics.
management.metrics.tags.*= # Common tags that are applied to every meter.
management.metrics.web.client.max-uri-tags=100 # Maximum number of unique URI tag values allowed. After
the max number of tag values is reached, metrics with additional tag values are denied by filter.
management.metrics.web.client.requests-metric-name=http.client.requests # Name of the metric for sent
requests
or Jersey should be automatically timed.
management.metrics.web.server.max-uri-tags=100 # Maximum number of unique URI tag values allowed. After
the max number of tag values is reached, metrics with additional tag values are denied by filter.
management.metrics.web.server.requests-metric-name=http.server.requests # Name of the metric for
received requests.
# DEVTOOLS PROPERTIES
# DEVTOOLS (DevToolsProperties)
spring.devtools.add-properties=true # Whether to enable development property defaults.
spring.devtools.livereload.enabled=true # Whether to enable a livereload.com-compatible server.
spring.devtools.livereload.port=35729 # Server port.
spring.devtools.restart.additional-exclude= # Additional patterns that should be excluded from
triggering a full restart
spring.devtools.restart.additional-paths= # Additional paths to watch for changes.
spring.devtools.restart.enabled=true # Whether to enable automatic restart.
spring.devtools.restart.exclude=META-INF/maven/**,META-INF/resources/**,resources/**,static/**,public/
**,templates/**,**/*Test.class,**/*Tests.class,git.properties,META-INF/build-info.properties # Patterns
that should be excluded from triggering a full restart.
spring.devtools.restart.log-condition-evaluation-delta=true # Whether to log the condition evaluation
delta upon restart.
spring.devtools.restart.poll-interval=1s # Amount of time to wait between polling for classpath changes.
spring.devtools.restart.quiet-period=400ms # Amount of quiet time required without any classpath changes
before a restart is triggered.
spring.devtools.restart.trigger-file= # Name of a specific file that, when changed, triggers the restart
check. If not specified, any classpath file change triggers the restart.
# REMOTE DEVTOOLS (RemoteDevToolsProperties)
spring.devtools.remote.context-path=/.~~spring-boot!~ # Context path used to handle the remote
connection.
spring.devtools.remote.proxy.host= # The host of the proxy to use to connect to the remote application.
spring.devtools.remote.proxy.port= # The port of the proxy to use to connect to the remote application.
spring.devtools.remote.restart.enabled=true # Whether to enable remote restart.
spring.devtools.remote.secret= # A shared secret required to establish a connection (required to enable
spring.devtools.remote.secret-header-name=X-AUTH-TOKEN # HTTP header used to transfer the shared secret.
# TESTING PROPERTIES
```

# **Appendix B. Configuration Metadata**

Spring Boot jars include metadata files that provide details of all supported configuration properties. The files are designed to let IDE developers offer contextual help and "code completion" as users are working with application.properties or application.yml files.

The majority of the metadata file is generated automatically at compile time by processing all items annotated with <code>@ConfigurationProperties</code>. However, it is possible to <u>write part of the metadata manually</u> for corner cases or more advanced use cases.

#### **B.1 Metadata Format**

Configuration metadata files are located inside jars under META-INF/spring-configuration-metadata.json They use a simple JSON format with items categorized under either "groups" or "properties" and additional values hints categorized under "hints", as shown in the following example:

```
{"groups": [
 "type": "org.springframework.boot.autoconfigure.web.ServerProperties",
 "sourceType" "org.springframework.boot.autoconfigure.web.ServerProperties"
 "name": "spring.jpa.hibernate",
 "type": "org.springframework.boot.autoconfigure.orm.jpa.JpaProperties$Hibernate",
 "sourceType": "org.springframework.boot.autoconfigure.orm.jpa.JpaProperties",
 "sourceMethod": "getHibernate()"
],"properties": [
 "name": "server.port",
 "type": "java.lang.Integer",
 "sourceType": "org.springframework.boot.autoconfigure.web.ServerProperties"
 "name": "server.address".
 "type": "java.net.InetAddress",
 "sourceType": "org.springframework.boot.autoconfigure.web.ServerProperties"
},
   "name": "spring.jpa.hibernate.ddl-auto",
   "type": "java.lang.String",
   "description": "DDL mode. This is actually a shortcut for the \"hibernate.hbm2ddl.auto\" property.",
   "sourceType": "org.springframework.boot.autoconfigure.orm.jpa.JpaProperties$Hibernate"
],"hints": [
 "name": "spring.jpa.hibernate.ddl-auto",
 "values": [
   "value": "none",
   "description": "Disable DDL handling."
   "value": "validate",
   "description": "Validate the schema, make no changes to the database."
   "value": "update".
   "description" "Update the schema if necessary."
```

```
"value": "create",
  "description": "Create the schema and destroy previous data."
},
{
  "value": "create-drop",
  "description": "Create and then destroy the schema at the end of the session."
}
]
}
```

Each "property" is a configuration item that the user specifies with a given value. For example, server.port and server.address might be specified in application.properties, as follows:

```
server.port=9090
server.address=127.0.0.1
```

The "groups" are higher level items that do not themselves specify a value but instead provide a contextual grouping for properties. For example, the server.port and server.address properties are part of the server group.

#### Note

It is not required that every "property" has a "group". Some properties might exist in their own right.

Finally, "hints" are additional information used to assist the user in configuring a given property. For example, when a developer is configuring the <code>spring.jpa.hibernate.ddl-auto</code> property, a tool can use the hints to offer some auto-completion help for the <code>none</code>, <code>validate</code>, <code>update</code>, <code>create</code>, and <code>create-drop</code> values.

#### **Group Attributes**

The JSON object contained in the groups array can contain the attributes shown in the following table:

Name	Туре	Purpose	
name	String	The full name of the group. This attribute is mandatory.	
type	String	The class name of the data type of the group. For example, if the group were based on a class annotated with <code>@ConfigurationProperties</code> , the attribute would contain the fully qualified name of that class. If it were based on a <code>@Bean</code> method, it would be the return type of that method. If the type is not known, the attribute may be omitted.	
description	String	A short description of the group that can be displayed to users. not description is available, it may be omitted. It is recommende that descriptions be short paragraphs, with the first line providing a concise summary. The last line in the description should end with a period (.).	
sourceType	String	The class name of the source that contributed this group. For example, if the group were based on a <code>@Bean</code> method annotated with <code>@ConfigurationProperties</code> , this attribute would contain the fully qualified name of the <code>@Configuration</code> class that	

Name	Туре	Purpose	
		contains the method. If the source type is not known, the attribute may be omitted.	
sourceMethod	String	The full name of the method (include parenthesis and argument types) that contributed this group (for example, the name of a @ConfigurationProperties annotated @Bean method). If the source method is not known, it may be omitted.	

# **Property Attributes**

The JSON object contained in the properties array can contain the attributes described in the following table:

Name	Туре	Purpose	
name	String	The full name of the property. Names are in lower-case period- separated form (for example, server.address). This attribute is mandatory.	
type	String	The full signature of the data type of the property (for example, java.lang.String) but also a full generic type (such as java.util.Map <java.util.string,acme.myenum>). You can use this attribute to guide the user as to the types of values that they can enter. For consistency, the type of a primitive is specified by using its wrapper counterpart (for example, boolean becomes java.lang.Boolean). Note that this class may be a complex type that gets converted from a String as values are bound. If the type is not known, it may be omitted.</java.util.string,acme.myenum>	
description	String	A short description of the group that can be displayed to users. If no description is available, it may be omitted. It is recommended that descriptions be short paragraphs, with the first line providing a concise summary. The last line in the description should end with a period (.).	
sourceType	String	The class name of the source that contributed this property. For example, if the property were from a class annotated with <code>@ConfigurationProperties</code> , this attribute would contain the fully qualified name of that class. If the source type is unknown, it may be omitted.	
defaultValue	Object	The default value, which is used if the property is not specified. If the type of the property is an array, it can be an array of value(s). If the default value is unknown, it may be omitted.	
deprecation	Deprecation	Specify whether the property is deprecated. If the field is not deprecated or if that information is not known, it may be omitted. The next table offers more detail about the deprecation attribute.	

The JSON object contained in the deprecation attribute of each properties element can contain the following attributes:

Name	Туре	Purpose	
level	String	The level of deprecation, which can be either warning (the default) or error. When a property has a warning deprecation level, it should still be bound in the environment. However, when it has an error deprecation level, the property is no longer managed and is not bound.	
reason	String	A short description of the reason why the property was deprecated. If no reason is available, it may be omitted. It is recommended that descriptions be short paragraphs, with the first line providing a concise summary. The last line in the description should end with a period (.).	
replacement	String	The full name of the property that <i>replaces</i> this deprecated property. If there is no replacement for this property, it may be omitted.	

#### Note

Prior to Spring Boot 1.3, a single deprecated boolean attribute can be used instead of the deprecation element. This is still supported in a deprecated fashion and should no longer be used. If no reason and replacement are available, an empty deprecation object should be set.

Deprecation can also be specified declaratively in code by adding the <code>@DeprecatedConfigurationProperty</code> annotation to the getter exposing the deprecated property. For instance, assume that the <code>app.acme.target</code> property was confusing and was renamed to <code>app.acme.name</code>. The following example shows how to handle that situation:

```
@ConfigurationProperties("app.acme")
public class AcmeProperties {

private String name;

public String getName() { ... }

public void setName(String name) { ... }

@DeprecatedConfigurationProperty(replacement = "app.acme.name")
@Deprecated
public String getTarget() {
   return getName();
}

@Deprecated
public void setTarget(String target) {
   setName(target);
}
```

#### Note

There is no way to set a level. warning is always assumed, since code is still handling the property.

The preceding code makes sure that the deprecated property still works (delegating to the name property behind the scenes). Once the getTarget and setTarget methods can be removed from your public

API, the automatic deprecation hint in the metadata goes away as well. If you want to keep a hint, adding manual metadata with an error deprecation level ensures that users are still informed about that property. Doing so is particularly useful when a replacement is provided.

#### **Hint Attributes**

The JSON object contained in the hints array can contain the attributes shown in the following table:

Name	Туре	Purpose	
name	String	The full name of the property to which this hint refers.  Names are in lower-case period-separated form (such as spring.mvc.servlet.path). If the property refers to a map (such as system.contexts), the hint either applies to the keys of the map (system.context.keys) or the values (system.context.values) of the map. This attribute is mandatory.	
values	ValueHint[]	A list of valid values as defined by the ValueHint object (described in the next table). Each entry defines the value and may have a description.	
providers	ValueProvider[]	A list of providers as defined by the ValueProvider object (described later in this document). Each entry defines the name of the provider and its parameters, if any.	

The JSON object contained in the values attribute of each hint element can contain the attributes described in the following table:

Name	Туре	Purpose	
value	Object	A valid value for the element to which the hint refers. If the typ the property is an array, it can also be an array of value(s). Th attribute is mandatory.	
description	String	A short description of the value that can be displayed to users. If no description is available, it may be omitted. It is recommended that descriptions be short paragraphs, with the first line providing a concise summary. The last line in the description should end with a period (.).	

The JSON object contained in the providers attribute of each hint element can contain the attributes described in the following table:

Name	Туре	Purpose
name	String	The name of the provider to use to offer additional content assistance for the element to which the hint refers.
parameters	JSON object	Any additional parameter that the provider supports (check the documentation of the provider for more details).

#### **Repeated Metadata Items**

Objects with the same "property" and "group" name can appear multiple times within a metadata file. For example, you could bind two separate classes to the same prefix, with each having potentially overlapping property names. While the same names appearing in the metadata multiple times should not be common, consumers of metadata should take care to ensure that they support it.

### **B.2 Providing Manual Hints**

To improve the user experience and further assist the user in configuring a given property, you can provide additional metadata that:

- Describes the list of potential values for a property.
- Associates a provider, to attach a well defined semantic to a property, so that a tool can discover the list of potential values based on the project's context.

#### **Value Hint**

The name attribute of each hint refers to the name of a property. In the <u>initial example shown earlier</u>, we provide five values for the spring.jpa.hibernate.ddl-auto property: none, validate, update, create, and create-drop. Each value may have a description as well.

If your property is of type Map, you can provide hints for both the keys and the values (but not for the map itself). The special .keys and .values suffixes must refer to the keys and the values, respectively.

Assume a sample.contexts maps magic String values to an integer, as shown in the following example:

```
@ConfigurationProperties("sample")
public class SampleProperties {

   private Map<String,Integer> contexts;
   // getters and setters
}
```

The magic values are (in this example) are sample1 and sample2. In order to offer additional content assistance for the keys, you could add the following JSON to the manual metadata of the module:

#### Tip

We recommend that you use an Enum for those two values instead. If your IDE supports it, this is by far the most effective approach to auto-completion.

#### **Value Providers**

Providers are a powerful way to attach semantics to a property. In this section, we define the official providers that you can use for your own hints. However, your favorite IDE may implement some of these or none of them. Also, it could eventually provide its own.

#### Note

As this is a new feature, IDE vendors must catch up with how it works. Adoption times naturally vary.

The following table summarizes the list of supported providers:

Name	Description
any	Permits any additional value to be provided.
class-reference	Auto-completes the classes available in the project. Usually constrained by a base class that is specified by the target parameter.
handle-as	Handles the property as if it were defined by the type defined by the mandatory target parameter.
logger-name	Auto-completes valid logger names and logger groups. Typically, package and class names available in the current project can be auto-completed as well as defined groups.
spring-bean-reference	Auto-completes the available bean names in the current project. Usually constrained by a base class that is specified by the target parameter.
spring-profile-name	Auto-completes the available Spring profile names in the project.

#### Tip

Only one provider can be active for a given property, but you can specify several providers if they can all manage the property *in some way*. Make sure to place the most powerful provider first, as the IDE must use the first one in the JSON section that it can handle. If no provider for a given property is supported, no special content assistance is provided, either.

#### Any

The special **any** provider value permits any additional values to be provided. Regular value validation based on the property type should be applied if this is supported.

This provider is typically used if you have a list of values and any extra values should still be considered as valid.

The following example offers on and off as auto-completion values for system.state:

```
"value": "on"
},
{
    "value": "off"
}
],
    "providers": [
    {
        "name": "any"
    }
]
}
```

Note that, in the preceding example, any other value is also allowed.

#### **Class Reference**

The **class-reference** provider auto-completes classes available in the project. This provider supports the following parameters:

Parameter	Туре	Default value	Description
target	String (Class)	none	The fully qualified name of the class that should be assignable to the chosen value. Typically used to filter out-non candidate classes. Note that this information can be provided by the type itself by exposing a class with the appropriate upper bound.
concrete	boolean	true	Specify whether only concrete classes are to be considered as valid candidates.

The following metadata snippet corresponds to the standard server.servlet.jsp.class-name property that defines the JspServlet class name to use:

#### **Handle As**

The **handle-as** provider lets you substitute the type of the property to a more high-level type. This typically happens when the property has a <code>java.lang.String</code> type, because you do not want your configuration classes to rely on classes that may not be on the classpath. This provider supports the following parameters:

Parameter	Туре	Default value	Description
target	String (Class)	none	The fully qualified name of the type to consider for the property. This parameter is mandatory.

The following types can be used:

- Any java.lang.Enum: Lists the possible values for the property. (We recommend defining the
  property with the Enum type, as no further hint should be required for the IDE to auto-complete the
  values.)
- java.nio.charset.Charset: Supports auto-completion of charset/encoding values (such as UTF-8)
- java.util.Locale: auto-completion of locales (such as en\_US)
- org.springframework.util.MimeType: Supports auto-completion of content type values (such as text/plain)
- org.springframework.core.io.Resource: Supports auto-completion of Spring's Resource
  abstraction to refer to a file on the filesystem or on the classpath. (such as classpath:/
  sample.properties)

#### Tip

If multiple values can be provided, use a Collection or Array type to teach the IDE about it.

The following metadata snippet corresponds to the standard <code>spring.liquibase.change-log</code> property that defines the path to the changelog to use. It is actually used internally as a <code>org.springframework.core.io.Resource</code> but cannot be exposed as such, because we need to keep the original String value to pass it to the Liquibase API.

#### **Logger Name**

The **logger-name** provider auto-completes valid logger names and <u>logger groups</u>. Typically, package and class names available in the current project can be auto-completed. If groups are enabled (default) and if a custom logger group is identified in the configuration, auto-completion for it should be provided. Specific frameworks may have extra magic logger names that can be supported as well.

This provider supports the following parameters:

Parameter	Туре	Default value	Description
group	boolean	true	Specify whether known groups should be considered.

Since a logger name can be any arbitrary name, this provider should allow any value but could highlight valid package and class names that are not available in the project's classpath.

The following metadata snippet corresponds to the standard <code>logging.level</code> property. Keys are *logger names*, and values correspond to the standard log levels or any custom level. As Spring Boot defines a few logger groups out-of-the-box, dedicated value hints have been added for those.

```
{"hints": [
  "name": "logging.level.keys",
  "values": [
    "value": "root",
   "description": "Root logger used to assign the default logging level."
    "value": "sql",
   "description": "SQL logging group including Hibernate SQL logger."
    "value": "web",
   "description": "Web logging group including codecs."
  "providers": [
  {
    "name": "logger-name"
},
  "name": "logging.level.values",
  "values": [
    "value": "trace"
    "value": "debug"
    "value": "info"
  },
    "value": "warn"
    "value": "error"
  },
    "value": "fatal"
    "value": "off"
  "providers": [
    "name": "any"
```

#### **Spring Bean Reference**

The **spring-bean-reference** provider auto-completes the beans that are defined in the configuration of the current project. This provider supports the following parameters:

Parameter	Туре	Default value	Description
target	String (Class)	none	The fully qualified name of the bean class that should be assignable to the candidate. Typically used to filter out non-candidate beans.

The following metadata snippet corresponds to the standard spring.jmx.server property that defines the name of the MBeanServer bean to use:

#### Note

The binder is not aware of the metadata. If you provide that hint, you still need to transform the bean name into an actual Bean reference using by the ApplicationContext.

#### **Spring Profile Name**

The **spring-profile-name** provider auto-completes the Spring profiles that are defined in the configuration of the current project.

The following metadata snippet corresponds to the standard spring.profiles.active property that defines the name of the Spring profile(s) to enable:

```
{"hints": [
    {
        "name": "spring.profiles.active",
        "providers": [
        {
            "name": "spring-profile-name"
        }
        ]
    }
}
```

# B.3 Generating Your Own Metadata by Using the Annotation Processor

You can easily generate your own configuration metadata file from items annotated with @ConfigurationProperties by using the spring-boot-configuration-processor jar. The jar includes a Java annotation processor which is invoked as your project is compiled. To use the processor, include a dependency on spring-boot-configuration-processor.

With Maven the dependency should be declared as optional, as shown in the following example:

```
<dependency>
```

```
<groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-configuration-processor</artifactId>
  <optional>true</optional>
  </dependency>
```

With Gradle 4.5 and earlier, the dependency should be declared in the compileOnly configuration, as shown in the following example:

```
dependencies {
  compileOnly "org.springframework.boot:spring-boot-configuration-processor"
}
```

With Gradle 4.6 and later, the dependency should be declared in the annotationProcessor configuration, as shown in the following example:

```
dependencies {
  annotationProcessor "org.springframework.boot:spring-boot-configuration-processor"
}
```

If you are using an additional-spring-configuration-metadata.json file, the compileJava task should be configured to depend on the processResources task, as shown in the following example:

```
compileJava.dependsOn(processResources)
```

This dependency ensures that the additional metadata is available when the annotation processor runs during compilation.

The processor picks up both classes and methods that are annotated with <code>@ConfigurationProperties</code>. The Javadoc for field values within configuration classes is used to populate the <code>description</code> attribute.

#### Note

You should only use simple text with @ConfigurationProperties field Javadoc, since they are not processed before being added to the JSON.

Properties are discovered through the presence of standard getters and setters with special handling for collection types (that is detected even if only a getter is present). The annotation processor also supports the use of the <code>@Data</code>, <code>@Getter</code>, and <code>@Setter</code> lombok annotations.

#### Note

If you are using AspectJ in your project, you need to make sure that the annotation processor runs only once. There are several ways to do this. With Maven, you can configure the maven-apt-plugin explicitly and add the dependency to the annotation processor only there. You could also let the AspectJ plugin run all the processing and disable annotation processing in the maven-compiler-plugin configuration, as follows:

```
<plugin>
<groupId>org.apache.maven.plugins</groupId>
<artifactId>maven-compiler-plugin</artifactId>
<configuration>

/configuration>
</plugin>
```

#### **Nested Properties**

The annotation processor automatically considers inner classes as nested properties. Consider the following class:

```
@ConfigurationProperties(prefix="server")
public class ServerProperties {

private String name;

private Host host;

// ... getter and setters

public static class Host {

private String ip;

private int port;

// ... getter and setters
}
```

The preceding example produces metadata information for server.name, server.host.ip, and server.host.port properties. You can use the @NestedConfigurationProperty annotation on a field to indicate that a regular (non-inner) class should be treated as if it were nested.

#### Tip

This has no effect on collections and maps, as those types are automatically identified, and a single metadata property is generated for each of them.

#### **Adding Additional Metadata**

Spring Boot's configuration file handling is quite flexible, and it is often the case that properties may exist that are not bound to a <code>@ConfigurationProperties</code> bean. You may also need to tune some attributes of an existing key. To support such cases and let you provide custom "hints", the annotation processor automatically merges items from <code>META-INF/additional-spring-configuration-metadata.json</code> into the main metadata file.

If you refer to a property that has been detected automatically, the description, default value, and deprecation information are overridden, if specified. If the manual property declaration is not identified in the current module, it is added as a new property.

The format of the additional-spring-configuration-metadata.json file is exactly the same as the regular spring-configuration-metadata.json. The additional properties file is optional. If you do not have any additional properties, do not add the file.

# Appendix C. Auto-configuration classes

Here is a list of all auto-configuration classes provided by Spring Boot, with links to documentation and source code. Remember to also look at the conditions report in your application for more details of which features are switched on. (To do so, start the app with --debug or -Ddebug or, in an Actuator application, use the conditions endpoint).

# C.1 From the "spring-boot-autoconfigure" module

The following auto-configuration classes are from the spring-boot-autoconfigure module:

Configuration Class	Links
<u>ActiveMQAutoConfiguration</u>	<u>javadoc</u>
<u>AopAutoConfiguration</u>	<u>javadoc</u>
ArtemisAutoConfiguration	<u>javadoc</u>
BatchAutoConfiguration	<u>javadoc</u>
CacheAutoConfiguration	javadoc
CassandraAutoConfiguration	javadoc
CassandraDataAutoConfiguration	<u>javadoc</u>
CassandraReactiveDataAutoConfiguration	javadoc
CassandraReactiveRepositoriesAutoConfiguration	javadoc
<u>CassandraRepositoriesAutoConfiguration</u>	<u>javadoc</u>
ClientHttpConnectorAutoConfiguration	javadoc
CloudServiceConnectorsAutoConfiguration	javadoc
CodecsAutoConfiguration	javadoc
ConfigurationPropertiesAutoConfiguration	<u>javadoc</u>
CouchbaseAutoConfiguration	<u>javadoc</u>
CouchbaseDataAutoConfiguration	<u>javadoc</u>
CouchbaseReactiveDataAutoConfiguration	<u>javadoc</u>
CouchbaseReactiveRepositoriesAutoConfiguration	javadoc
<u>CouchbaseRepositoriesAutoConfiguration</u>	<u>javadoc</u>
<u>DataSourceAutoConfiguration</u>	<u>javadoc</u>
<u>DataSourceTransactionManagerAutoConfiguration</u>	<u>javadoc</u>
DispatcherServletAutoConfiguration	<u>javadoc</u>

Configuration Class	Links
ElasticsearchAutoConfiguration	javadoc
ElasticsearchDataAutoConfiguration	javadoc
ElasticsearchRepositoriesAutoConfiguration	javadoc
<u>EmbeddedLdapAutoConfiguration</u>	javadoc
<u>EmbeddedMongoAutoConfiguration</u>	<u>javadoc</u>
<u>EmbeddedWebServerFactoryCustomizerAutoConfiguration</u>	javadoc
<u>ErrorMvcAutoConfiguration</u>	<u>javadoc</u>
<u>ErrorWebFluxAutoConfiguration</u>	<u>javadoc</u>
FlywayAutoConfiguration	javadoc
<u>FreeMarkerAutoConfiguration</u>	<u>javadoc</u>
<u>GroovyTemplateAutoConfiguration</u>	javadoc
GsonAutoConfiguration	javadoc
H2ConsoleAutoConfiguration	javadoc
<u>HazelcastAutoConfiguration</u>	javadoc
<u>HazelcastJpaDependencyAutoConfiguration</u>	javadoc
<u>HibernateJpaAutoConfiguration</u>	javadoc
HttpEncodingAutoConfiguration	javadoc
HttpHandlerAutoConfiguration	javadoc
<u>HttpMessageConvertersAutoConfiguration</u>	javadoc
<u>HypermediaAutoConfiguration</u>	<u>javadoc</u>
InfluxDbAutoConfiguration	javadoc
IntegrationAutoConfiguration	javadoc
<u>JacksonAutoConfiguration</u>	<u>javadoc</u>
<u>JdbcRepositoriesAutoConfiguration</u>	<u>javadoc</u>
<u>JdbcTemplateAutoConfiguration</u>	<u>javadoc</u>
<u>JerseyAutoConfiguration</u>	<u>javadoc</u>
<u>JestAutoConfiguration</u>	<u>javadoc</u>
<u>JmsAutoConfiguration</u>	<u>javadoc</u>
<u>JmxAutoConfiguration</u>	<u>javadoc</u>
<u>JndiConnectionFactoryAutoConfiguration</u>	<u>javadoc</u>

Configuration Class	Links
<u>JndiDataSourceAutoConfiguration</u>	javadoc
<u>JooqAutoConfiguration</u>	javadoc
<u>JpaRepositoriesAutoConfiguration</u>	javadoc
<u>JsonbAutoConfiguration</u>	javadoc
<u>JtaAutoConfiguration</u>	javadoc
<u>KafkaAutoConfiguration</u>	javadoc
<u>LdapAutoConfiguration</u>	javadoc
<u>LdapRepositoriesAutoConfiguration</u>	javadoc
<u>LiquibaseAutoConfiguration</u>	javadoc
MailSenderAutoConfiguration	<u>javadoc</u>
MailSenderValidatorAutoConfiguration	javadoc
<u>MessageSourceAutoConfiguration</u>	javadoc
MongoAutoConfiguration	javadoc
<u>MongoDataAutoConfiguration</u>	javadoc
MongoReactiveAutoConfiguration	javadoc
MongoReactiveDataAutoConfiguration	javadoc
MongoReactiveRepositoriesAutoConfiguration	<u>javadoc</u>
MongoRepositoriesAutoConfiguration	<u>javadoc</u>
<u>MultipartAutoConfiguration</u>	javadoc
<u>MustacheAutoConfiguration</u>	javadoc
Neo4jDataAutoConfiguration	javadoc
Neo4jRepositoriesAutoConfiguration	javadoc
OAuth2ClientAutoConfiguration	javadoc
OAuth2ResourceServerAutoConfiguration	<u>javadoc</u>
PersistenceExceptionTranslationAutoConfiguration	<u>javadoc</u>
<u>ProjectInfoAutoConfiguration</u>	<u>javadoc</u>
PropertyPlaceholderAutoConfiguration	<u>javadoc</u>
QuartzAutoConfiguration	<u>javadoc</u>
RabbitAutoConfiguration	<u>javadoc</u>
ReactiveOAuth2ClientAutoConfiguration	<u>javadoc</u>

Configuration Class	Links
ReactiveOAuth2ResourceServerAutoConfiguration	javadoc
<u>ReactiveSecurityAutoConfiguration</u>	javadoc
ReactiveUserDetailsServiceAutoConfiguration	javadoc
ReactiveWebServerFactoryAutoConfiguration	javadoc
ReactorCoreAutoConfiguration	<u>javadoc</u>
RedisAutoConfiguration	javadoc
RedisReactiveAutoConfiguration	javadoc
RedisRepositoriesAutoConfiguration	javadoc
RepositoryRestMvcAutoConfiguration	javadoc
<u>RestClientAutoConfiguration</u>	<u>javadoc</u>
RestTemplateAutoConfiguration	javadoc
<u>SecurityAutoConfiguration</u>	javadoc
<u>SecurityFilterAutoConfiguration</u>	javadoc
<u>SecurityRequestMatcherProviderAutoConfiguration</u>	javadoc
<u>SendGridAutoConfiguration</u>	javadoc
ServletWebServerFactoryAutoConfiguration	javadoc
SessionAutoConfiguration	javadoc
SolrAutoConfiguration	javadoc
SolrRepositoriesAutoConfiguration	javadoc
SpringApplicationAdminJmxAutoConfiguration	javadoc
<u>SpringDataWebAutoConfiguration</u>	javadoc
TaskExecutionAutoConfiguration	javadoc
<u>TaskSchedulingAutoConfiguration</u>	<u>javadoc</u>
<u>ThymeleafAutoConfiguration</u>	<u>javadoc</u>
TransactionAutoConfiguration	<u>javadoc</u>
<u>UserDetailsServiceAutoConfiguration</u>	<u>javadoc</u>
ValidationAutoConfiguration	<u>javadoc</u>
WebClientAutoConfiguration	<u>javadoc</u>
WebFluxAutoConfiguration	<u>javadoc</u>
WebMvcAutoConfiguration	<u>javadoc</u>

Configuration Class	Links
WebServiceTemplateAutoConfiguration	<u>javadoc</u>
WebServicesAutoConfiguration	<u>javadoc</u>
WebSocketMessagingAutoConfiguration	<u>javadoc</u>
WebSocketReactiveAutoConfiguration	<u>javadoc</u>
WebSocketServletAutoConfiguration	<u>javadoc</u>
XADataSourceAutoConfiguration	<u>javadoc</u>

# C.2 From the "spring-boot-actuator-autoconfigure" module

The following auto-configuration classes are from the spring-boot-actuator-autoconfigure module:

Configuration Class	Links
<u>AppOpticsMetricsExportAutoConfiguration</u>	<u>javadoc</u>
AtlasMetricsExportAutoConfiguration	<u>javadoc</u>
AuditAutoConfiguration	<u>javadoc</u>
AuditEventsEndpointAutoConfiguration	<u>javadoc</u>
BeansEndpointAutoConfiguration	<u>javadoc</u>
CacheMetricsAutoConfiguration	<u>javadoc</u>
CachesEndpointAutoConfiguration	<u>javadoc</u>
CassandraHealthIndicatorAutoConfiguration	javadoc
CassandraReactiveHealthIndicatorAutoConfiguration	<u>javadoc</u>
CloudFoundryActuatorAutoConfiguration	<u>javadoc</u>
CompositeMeterRegistryAutoConfiguration	<u>javadoc</u>
ConditionsReportEndpointAutoConfiguration	javadoc
ConfigurationPropertiesReportEndpointAutoConfiguration	<u>javadoc</u>
CouchbaseHealthIndicatorAutoConfiguration	<u>javadoc</u>
<u>CouchbaseReactiveHealthIndicatorAutoConfiguration</u>	<u>javadoc</u>
DataSourceHealthIndicatorAutoConfiguration	javadoc
<u>DataSourcePoolMetricsAutoConfiguration</u>	javadoc
DatadogMetricsExportAutoConfiguration	javadoc
DiskSpaceHealthIndicatorAutoConfiguration	javadoc
DynatraceMetricsExportAutoConfiguration	javadoc

Configuration Class	Links
<u>ElasticMetricsExportAutoConfiguration</u>	javadoc
<u>ElasticSearchClientHealthIndicatorAutoConfiguration</u>	javadoc
ElasticSearchJestHealthIndicatorAutoConfiguration	javadoc
<u>EndpointAutoConfiguration</u>	javadoc
<u>EnvironmentEndpointAutoConfiguration</u>	javadoc
FlywayEndpointAutoConfiguration	javadoc
<u>GangliaMetricsExportAutoConfiguration</u>	<u>javadoc</u>
<u>GraphiteMetricsExportAutoConfiguration</u>	javadoc
<u>HealthEndpointAutoConfiguration</u>	javadoc
<u>HealthIndicatorAutoConfiguration</u>	<u>javadoc</u>
<u>HeapDumpWebEndpointAutoConfiguration</u>	<u>javadoc</u>
HibernateMetricsAutoConfiguration	javadoc
HttpClientMetricsAutoConfiguration	javadoc
HttpTraceAutoConfiguration	javadoc
HttpTraceEndpointAutoConfiguration	javadoc
<u>HumioMetricsExportAutoConfiguration</u>	javadoc
InfluxDbHealthIndicatorAutoConfiguration	javadoc
InfluxMetricsExportAutoConfiguration	javadoc
InfoContributorAutoConfiguration	javadoc
InfoEndpointAutoConfiguration	javadoc
IntegrationGraphEndpointAutoConfiguration	javadoc
<u>JerseyServerMetricsAutoConfiguration</u>	javadoc
<u>JettyMetricsAutoConfiguration</u>	javadoc
JmsHealthIndicatorAutoConfiguration	javadoc
<u>JmxEndpointAutoConfiguration</u>	<u>javadoc</u>
JmxMetricsExportAutoConfiguration	javadoc
<u>JolokiaEndpointAutoConfiguration</u>	<u>javadoc</u>
<u>JvmMetricsAutoConfiguration</u>	<u>javadoc</u>
<u>KafkaMetricsAutoConfiguration</u>	<u>javadoc</u>
<u>KairosMetricsExportAutoConfiguration</u>	<u>javadoc</u>

Configuration Class	Links
<u>LdapHealthIndicatorAutoConfiguration</u>	javadoc
LiquibaseEndpointAutoConfiguration	javadoc
Log4J2MetricsAutoConfiguration	javadoc
<u>LogFileWebEndpointAutoConfiguration</u>	javadoc
<u>LogbackMetricsAutoConfiguration</u>	javadoc
LoggersEndpointAutoConfiguration	javadoc
MailHealthIndicatorAutoConfiguration	<u>javadoc</u>
<u>ManagementContextAutoConfiguration</u>	javadoc
<u>ManagementWebSecurityAutoConfiguration</u>	javadoc
<u>MappingsEndpointAutoConfiguration</u>	<u>javadoc</u>
MetricsAutoConfiguration	<u>javadoc</u>
MetricsEndpointAutoConfiguration	javadoc
MongoHealthIndicatorAutoConfiguration	javadoc
MongoReactiveHealthIndicatorAutoConfiguration	javadoc
Neo4jHealthIndicatorAutoConfiguration	javadoc
NewRelicMetricsExportAutoConfiguration	javadoc
PrometheusMetricsExportAutoConfiguration	javadoc
RabbitHealthIndicatorAutoConfiguration	javadoc
RabbitMetricsAutoConfiguration	javadoc
ReactiveCloudFoundryActuatorAutoConfiguration	javadoc
ReactiveManagementContextAutoConfiguration	javadoc
ReactiveManagementWebSecurityAutoConfiguration	javadoc
RedisHealthIndicatorAutoConfiguration	javadoc
RedisReactiveHealthIndicatorAutoConfiguration	javadoc
<u>ScheduledTasksEndpointAutoConfiguration</u>	javadoc
<u>ServletManagementContextAutoConfiguration</u>	javadoc
<u>SessionsEndpointAutoConfiguration</u>	<u>javadoc</u>
<u>ShutdownEndpointAutoConfiguration</u>	<u>javadoc</u>
<u>SignalFxMetricsExportAutoConfiguration</u>	javadoc
SimpleMetricsExportAutoConfiguration	<u>javadoc</u>

Configuration Class	Links
<u>SolrHealthIndicatorAutoConfiguration</u>	javadoc
<u>StatsdMetricsExportAutoConfiguration</u>	javadoc
<u>SystemMetricsAutoConfiguration</u>	<u>javadoc</u>
<u>ThreadDumpEndpointAutoConfiguration</u>	javadoc
<u>TomcatMetricsAutoConfiguration</u>	javadoc
<u>WavefrontMetricsExportAutoConfiguration</u>	javadoc
WebEndpointAutoConfiguration	javadoc
WebFluxMetricsAutoConfiguration	javadoc
WebMvcMetricsAutoConfiguration	<u>javadoc</u>

# Appendix D. Test auto-configuration annotations

The following table lists the various @...Test annotations that can be used to test slices of your application and the auto-configuration that they import by default:

Test slice	Imported auto-configuration
@DataJdbcTest	org.springframework.boot.autoconfigure.cache.Cacorg.springframework.boot.autoconfigure.data.jdboorg.springframework.boot.autoconfigure.flyway.Florg.springframework.boot.autoconfigure.jdbc.Dataorg.springframework.boot.autoconfigure.jdbc.Dataorg.springframework.boot.autoconfigure.jdbc.Jdboorg.springframework.boot.autoconfigure.liquibaseorg.springframework.boot.autoconfigure.transactiorg.springframework.boot.autoconfigure.transactiorg.springframework.boot.test.autoconfigure.jdbo
@DataJpaTest	org.springframework.boot.autoconfigure.cache.Cacorg.springframework.boot.autoconfigure.data.jpa.org.springframework.boot.autoconfigure.flyway.Florg.springframework.boot.autoconfigure.jdbc.Dataorg.springframework.boot.autoconfigure.jdbc.Dataorg.springframework.boot.autoconfigure.jdbc.Jdbcorg.springframework.boot.autoconfigure.liquibaseorg.springframework.boot.autoconfigure.orm.jpa.Horg.springframework.boot.autoconfigure.transactiorg.springframework.boot.autoconfigure.transactiorg.springframework.boot.test.autoconfigure.jdbcorg.springframework.boot.test.autoconfigure.orm.
@DataLdapTest	org.springframework.boot.autoconfigure.cache.Cac org.springframework.boot.autoconfigure.data.ldag org.springframework.boot.autoconfigure.ldap.Ldag org.springframework.boot.autoconfigure.ldap.embe
@DataMongoTest	org.springframework.boot.autoconfigure.cache.Cac org.springframework.boot.autoconfigure.data.mong org.springframework.boot.autoconfigure.data.mong org.springframework.boot.autoconfigure.data.mong org.springframework.boot.autoconfigure.data.mong org.springframework.boot.autoconfigure.mongo.Mon org.springframework.boot.autoconfigure.mongo.Mon org.springframework.boot.autoconfigure.mongo.emk
@DataNeo4jTest	org.springframework.boot.autoconfigure.cache.Cac org.springframework.boot.autoconfigure.data.neo4 org.springframework.boot.autoconfigure.data.neo4

Test slice	Imported auto-configuration
@DataRedisTest	org.springframework.boot.autoconfigure.cache.Cachorg.springframework.boot.autoconfigure.data.redisorg.springframework.data.redisorg.springframework.boot.autoconfigure.data.redisorg.springframework.data.data.data.data.data.data.data.dat
@JdbcTest	org.springframework.boot.autoconfigure.cache.Cachorg.springframework.boot.autoconfigure.flyway.Flyorg.springframework.boot.autoconfigure.jdbc.DataSorg.springframework.boot.autoconfigure.jdbc.DataSorg.springframework.boot.autoconfigure.jdbc.JdbcTorg.springframework.boot.autoconfigure.liquibase.org.springframework.boot.autoconfigure.transacticorg.springframework.boot.autoconfigure.transacticorg.springframework.boot.test.autoconfigure.jdbc.
@JooqTest	org.springframework.boot.autoconfigure.flyway.Flyorg.springframework.boot.autoconfigure.jdbc.DataSorg.springframework.boot.autoconfigure.jdbc.DataSorg.springframework.boot.autoconfigure.jooq.JooqForg.springframework.boot.autoconfigure.liquibase.org.springframework.boot.autoconfigure.transactions
@JsonTest	org.springframework.boot.autoconfigure.cache.Cachorg.springframework.boot.autoconfigure.gson.GsonForg.springframework.boot.autoconfigure.jackson.Jacorg.springframework.boot.autoconfigure.jsonb.Jsororg.springframework.boot.test.autoconfigure.json.
@RestClientTest	org.springframework.boot.autoconfigure.cache.Cache.org.springframework.boot.autoconfigure.gson.Gson.org.springframework.boot.autoconfigure.http.Http.Morg.springframework.boot.autoconfigure.http.code.org.springframework.boot.autoconfigure.jackson.Jacorg.springframework.boot.autoconfigure.jsonb.Json.org.springframework.boot.autoconfigure.web.client.org.springframework.boot.autoconfigure.web.reactiong.springframework.boot.test.autoconfigure.web.corg.springframework.boot.test.a
@WebFluxTest	org.springframework.boot.autoconfigure.cache.Cach org.springframework.boot.autoconfigure.context.Me org.springframework.boot.autoconfigure.security.r org.springframework.boot.autoconfigure.security.r org.springframework.boot.autoconfigure.validation org.springframework.boot.autoconfigure.web.reactions.springframework.boot.test.autoconfigure.web.reactions.
@WebMvcTest	org.springframework.boot.autoconfigure.cache.Cache.org.springframework.boot.autoconfigure.context.Meorg.springframework.boot.autoconfigure.data.web.Sorg.springframework.boot.autoconfigure.freemarkerorg.springframework.boot.autoconfigure.groovy.tem

Test slice	Imported auto-configuration
	org.springframework.boot.autoconfigure.gson.GsonA
	org.springframework.boot.autoconfigure.hateoas.Hy
	org.springframework.boot.autoconfigure.http.HttpM
	org.springframework.boot.autoconfigure.jackson.Ja
	org.springframework.boot.autoconfigure.jsonb.Json
	org.springframework.boot.autoconfigure.mustache.M
	org.springframework.boot.autoconfigure.task.TaskE
	org.springframework.boot.autoconfigure.thymeleaf.
	org.springframework.boot.autoconfigure.validation
	org.springframework.boot.autoconfigure.web.servle
	org.springframework.boot.autoconfigure.web.servle
	org.springframework.boot.test.autoconfigure.web.s
	org.springframework.boot.test.autoconfigure.web.s
	org.springframework.boot.test.autoconfigure.web.s
	org.springframework.boot.test.autoconfigure.web.s

# Appendix E. The Executable Jar Format

The spring-boot-loader modules lets Spring Boot support executable jar and war files. If you use the Maven plugin or the Gradle plugin, executable jars are automatically generated, and you generally do not need to know the details of how they work.

If you need to create executable jars from a different build system or if you are just curious about the underlying technology, this section provides some background.

#### **E.1 Nested JARs**

Java does not provide any standard way to load nested jar files (that is, jar files that are themselves contained within a jar). This can be problematic if you need to distribute a self-contained application that can be run from the command line without unpacking.

To solve this problem, many developers use "shaded" jars. A shaded jar packages all classes, from all jars, into a single "uber jar". The problem with shaded jars is that it becomes hard to see which libraries are actually in your application. It can also be problematic if the same filename is used (but with different content) in multiple jars. Spring Boot takes a different approach and lets you actually nest jars directly.

#### The Executable Jar File Structure

Spring Boot Loader-compatible jar files should be structured in the following way:

```
example.jar
|
+-META-INF
| +-MANIFEST.MF
+-org
| +-springframework
| +-boot
| +-loader
| +-(spring boot loader classes)
+-BOOT-INF
+-classes
| +-mycompany
| +-project
| +-YourClasses.class
+-lib
+-dependency1.jar
+-dependency2.jar
```

Application classes should be placed in a nested BOOT-INF/classes directory. Dependencies should be placed in a nested BOOT-INF/lib directory.

#### The Executable War File Structure

Spring Boot Loader-compatible war files should be structured in the following way:

```
example.war

|
+-META-INF
| +-MANIFEST.MF
+-org
| +-springframework
```

```
| +-boot
| +-loader
| +-<spring boot loader classes>
+-WEB-INF
+-classes
| +-com
| +-mycompany
| +-project
| +-YourClasses.class
+-lib
| +-dependency1.jar
| +-dependency2.jar
+-lib-provided
+-servlet-api.jar
+-dependency3.jar
```

Dependencies should be placed in a nested WEB-INF/lib directory. Any dependencies that are required when running embedded but are not required when deploying to a traditional web container should be placed in WEB-INF/lib-provided.

### E.2 Spring Boot's "JarFile" Class

The core class used to support loading nested jars is org.springframework.boot.loader.jar.JarFile. It lets you load jar content from a standard jar file or from nested child jar data. When first loaded, the location of each JarEntry is mapped to a physical file offset of the outer jar, as shown in the following example:

The preceding example shows how A.class can be found in /BOOT-INF/classes in myapp.jar at position 0063. B.class from the nested jar can actually be found in myapp.jar at position 3452, and C.class is at position 3980.

Armed with this information, we can load specific nested entries by seeking to the appropriate part of the outer jar. We do not need to unpack the archive, and we do not need to read all entry data into memory.

#### Compatibility with the Standard Java "JarFile"

Spring Boot Loader strives to remain compatible with existing code and libraries. org.springframework.boot.loader.jar.JarFile extends from java.util.jar.JarFile and should work as a drop-in replacement. The getURL() method returns a URL that opens a connection compatible with java.net.JarURLConnection and can be used with Java's URLClassLoader.

## **E.3 Launching Executable Jars**

The org.springframework.boot.loader.Launcher class is a special bootstrap class that is used as an executable jar's main entry point. It is the actual Main-Class in your jar file, and it is used to setup an appropriate URLClassLoader and ultimately call your main() method.

Their purpose is to load resources (.class files and so on.) from nested jar files or war files in directories (as opposed to those explicitly on the classpath). In the case of JarLauncher and WarLauncher, the nested paths are fixed. JarLauncher looks in BOOT-INF/lib/, and WarLauncher looks in WEB-INF/lib/ and WEB-INF/lib-provided/. You can add extra jars in those locations if you want more. The PropertiesLauncher looks in BOOT-INF/lib/ in your application archive by default, but you can add additional locations by setting an environment variable called LOADER\_PATH or loader.path in loader.properties (which is a comma-separated list of directories, archives, or directories within archives).

#### **Launcher Manifest**

You need to specify an appropriate Launcher as the Main-Class attribute of META-INF/MANIFEST.MF. The actual class that you want to launch (that is, the class that contains a main method) should be specified in the Start-Class attribute.

The following example shows a typical MANIFEST.MF for an executable jar file:

```
Main-Class: org.springframework.boot.loader.JarLauncher
Start-Class: com.mycompany.project.MyApplication
```

For a war file, it would be as follows:

```
Main-Class: org.springframework.boot.loader.WarLauncher
Start-Class: com.mycompany.project.MyApplication
```

#### Note

You need not specify Class-Path entries in your manifest file. The classpath is deduced from the nested jars.

#### **Exploded Archives**

Certain PaaS implementations may choose to unpack archives before they run. For example, Cloud Foundry operates this way. You can run an unpacked archive by starting the appropriate launcher, as follows:

```
$ unzip -q myapp.jar
$ java org.springframework.boot.loader.JarLauncher
```

### E.4 PropertiesLauncher Features

PropertiesLauncher has a few special features that can be enabled with external properties (System properties, environment variables, manifest entries, or loader.properties). The following table describes these properties:

Key	Purpose
loader.path	Comma-separated Classpath, such as lib, \$\{\text{HOME}\}/\app/lib. Earlier entries take precedence, like a regular -classpath on the javac command line.

Key	Purpose
loader.home	Used to resolve relative paths in loader.path. For example, given loader.path=lib, then \${loader.home}/lib is a classpath location (along with all jar files in that directory). This property is also used to locate a loader.properties file, as in the following example /opt/app It defaults to \${user.dir}.
loader.args	Default arguments for the main method (space separated).
loader.main	Name of main class to launch (for example, com.app.Application).
loader.config.name	Name of properties file (for example, launcher) It defaults to loader.
loader.config.location	Path to properties file (for example, classpath:loader.properties). It defaults to loader.properties.
loader.system	Boolean flag to indicate that all properties should be added to System properties It defaults to false.

When specified as environment variables or manifest entries, the following names should be used:

Key	Manifest entry	Environment variable
loader.path	Loader-Path	LOADER_PATH
loader.home	Loader-Home	LOADER_HOME
loader.args	Loader-Args	LOADER_ARGS
loader.main	Start-Class	LOADER_MAIN
loader.config.location	Loader-Config-Location	LOADER_CONFIG_LOCATION
loader.system	Loader-System	LOADER_SYSTEM

#### Tip

Build plugins automatically move the Main-Class attribute to Start-Class when the fat jar is built. If you use that, specify the name of the class to launch by using the Main-Class attribute and leaving out Start-Class.

The following rules apply to working with PropertiesLauncher:

- loader.properties is searched for in loader.home, then in the root of the classpath, and then in classpath:/BOOT-INF/classes. The first location where a file with that name exists is used.
- loader.home is the directory location of an additional properties file (overriding the default) only when loader.config.location is not specified.

- loader.path can contain directories (which are scanned recursively for jar and zip files), archive paths, a directory within an archive that is scanned for jar files (for example, dependencies.jar!/lib), or wildcard patterns (for the default JVM behavior). Archive paths can be relative to loader.home or anywhere in the file system with a jar:file: prefix.
- loader.path (if empty) defaults to BOOT-INF/lib (meaning a local directory or a nested one if running from an archive). Because of this, PropertiesLauncher behaves the same as JarLauncher when no additional configuration is provided.
- loader.path can not be used to configure the location of loader.properties (the classpath used to search for the latter is the JVM classpath when PropertiesLauncher is launched).
- Placeholder replacement is done from System and environment variables plus the properties file itself on all values before use.
- The search order for properties (where it makes sense to look in more than one place) is environment variables, system properties, loader.properties, the exploded archive manifest, and the archive manifest.

#### E.5 Executable Jar Restrictions

You need to consider the following restrictions when working with a Spring Boot Loader packaged application:

- Zip entry compression: The ZipEntry for a nested jar must be saved by using the ZipEntry. STORED method. This is required so that we can seek directly to individual content within the nested jar. The content of the nested jar file itself can still be compressed, as can any other entries in the outer jar.
- System classLoader: Launched applications should use Thread.getContextClassLoader() when loading classes (most libraries and frameworks do so by default). Trying to load nested jar classes with ClassLoader.getSystemClassLoader() fails.java.util.Logging always uses the system classloader. For this reason, you should consider a different logging implementation.

## **E.6 Alternative Single Jar Solutions**

If the preceding restrictions mean that you cannot use Spring Boot Loader, consider the following alternatives:

- Maven Shade Plugin
- JarClassLoader
- OneJar

# **Appendix F. Dependency versions**

The following table provides details of all of the dependency versions that are provided by Spring Boot in its CLI (Command Line Interface), Maven dependency management, and Gradle plugin. When you declare a dependency on one of these artifacts without declaring a version, the version listed in the table is used.

Group ID	Artifact ID	Version
antlr	antlr	2.7.7
ch.qos.logback	logback-access	1.2.3
ch.qos.logback	logback-classic	1.2.3
ch.qos.logback	logback-core	1.2.3
com.atomikos	transactions-jdbc	4.0.6
com.atomikos	transactions-jms	4.0.6
com.atomikos	transactions-jta	4.0.6
com.couchbase.client	couchbase-spring-cache	2.1.0
com.couchbase.client	java-client	2.7.0
com.datastax.cassandra	cassandra-driver-core	3.6.0
com.datastax.cassandra	cassandra-driver- mapping	3.6.0
com.fasterxml	classmate	1.4.0
com.fasterxml.jackson.com	rġackson-annotations	2.9.0
com.fasterxml.jackson.com	rġackson-core	2.9.7
com.fasterxml.jackson.com	rġackson-databind	2.9.7
com.fasterxml.jackson.da	t <b>jāokman</b> -dataformat-avro	2.9.7
com.fasterxml.jackson.da	t <b>jāckmə</b> h-dataformat-cbor	2.9.7
com.fasterxml.jackson.da	t <b>jāckmə</b> h-dataformat-csv	2.9.7
com.fasterxml.jackson.da	t <b>jāckmah</b> -dataformat-ion	2.9.7
com.fasterxml.jackson.da	t <b>jāckman</b> -dataformat- properties	2.9.7
com.fasterxml.jackson.da	t <b>jáckmen</b> -dataformat- protobuf	2.9.7
com.fasterxml.jackson.da	t <b>jáckmen</b> -dataformat- smile	2.9.7
com.fasterxml.jackson.da	t <b>jáckmen</b> -dataformat-xml	2.9.7

Group ID	Artifact ID	Version
com.fasterxml.jackson.da	t <b>jāokmə</b> h-dataformat-yaml	2.9.7
com.fasterxml.jackson.da	t <b>jayke</b> on-datatype-guava	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype- hibernate3	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype- hibernate4	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype- hibernate5	2.9.7
com.fasterxml.jackson.da	t <b>jayke</b> on-datatype-hppc	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype-jaxrs	2.9.7
com.fasterxml.jackson.da	t <b>jayke</b> on-datatype-jdk8	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype-joda	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype-json- org	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype-jsr310	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype-jsr353	2.9.7
com.fasterxml.jackson.da	t <b>jayks</b> on-datatype- pcollections	2.9.7
com.fasterxml.jackson.ja	хijackson-jaxrs-base	2.9.7
com.fasterxml.jackson.ja	x <b>ja</b> ckson-jaxrs-cbor- provider	2.9.7
com.fasterxml.jackson.ja	x <b>ja</b> ckson-jaxrs-json- provider	2.9.7
com.fasterxml.jackson.ja	x <b>ja</b> ckson-jaxrs-smile- provider	2.9.7
com.fasterxml.jackson.ja	x <b>ja</b> ckson-jaxrs-xml- provider	2.9.7
com.fasterxml.jackson.ja	x <b>ja</b> ckson-jaxrs-yaml- provider	2.9.7
com.fasterxml.jackson.jr	jackson-jr-all	2.9.7
com.fasterxml.jackson.jr	jackson-jr-objects	2.9.7
com.fasterxml.jackson.jr	jackson-jr-retrofit2	2.9.7
com.fasterxml.jackson.jr	jackson-jr-stree	2.9.7

Group ID	Artifact ID	Version
com.fasterxml.jackson.mod	d <b>jåe</b> kson-module- afterburner	2.9.7
com.fasterxml.jackson.mod	dg <b>ae</b> kson-module-guice	2.9.7
com.fasterxml.jackson.mod	dj <b>ae</b> kson-module-jaxb- annotations	2.9.7
com.fasterxml.jackson.mod	d <b>jàe</b> kson-module- jsonSchema	2.9.7
com.fasterxml.jackson.mod	dg <b>ae</b> kson-module-kotlin	2.9.7
com.fasterxml.jackson.mod	dg <b>àe</b> kson-module-mrbean	2.9.7
com.fasterxml.jackson.mod	d <b>jāe</b> kson-module-osgi	2.9.7
com.fasterxml.jackson.mod	dy <b>àe</b> kson-module- parameter-names	2.9.7
com.fasterxml.jackson.mod	d <b>jåe</b> kson-module- paranamer	2.9.7
com.fasterxml.jackson.mod	d <b>jåe</b> kson-module- scala_2.10	2.9.7
com.fasterxml.jackson.mod	lij <b>àe</b> kson-module- scala_2.11	2.9.7
com.fasterxml.jackson.mod	lij <b>àe</b> kson-module- scala_2.12	2.9.7
com.github.ben- manes.caffeine	caffeine	2.6.2
com.github.ben- manes.caffeine	guava	2.6.2
com.github.ben- manes.caffeine	jcache	2.6.2
com.github.ben- manes.caffeine	simulator	2.6.2
com.github.mxab.thymelean	f <b>thymels</b> af-extras-data- attribute	2.0.1
com.google.appengine	appengine-api-1.0-sdk	1.9.67
com.google.code.gson	gson	2.8.5
com.h2database	h2	1.4.197
com.hazelcast	hazelcast	3.11
com.hazelcast	hazelcast-client	3.11

Group ID	Artifact ID	Version
com.hazelcast	hazelcast-hibernate52	1.2.3
com.hazelcast	hazelcast-spring	3.11
com.jayway.jsonpath	json-path	2.4.0
com.jayway.jsonpath	json-path-assert	2.4.0
com.microsoft.sqlserver	mssql-jdbc	6.4.0.jre8
com.querydsl	querydsl-apt	4.2.1
com.querydsl	querydsl-collections	4.2.1
com.querydsl	querydsl-core	4.2.1
com.querydsl	querydsl-jpa	4.2.1
com.querydsl	querydsl-mongodb	4.2.1
com.rabbitmq	amqp-client	5.4.3
com.samskivert	jmustache	1.14
com.sendgrid	sendgrid-java	4.3.0
com.sun.mail	javax.mail	1.6.2
com.sun.xml.messaging.sa	a <b>ş</b> aaj-impl	1.5.0
com.timgroup	java-statsd-client	3.1.0
com.unboundid	unboundid-ldapsdk	4.0.8
com.zaxxer	HikariCP	3.2.0
commons-codec	commons-codec	1.11
commons-pool	commons-pool	1.6
de.flapdoodle.embed	de.flapdoodle.embed.mong	o2.1.1
dom4j	dom4j	1.6.1
io.dropwizard.metrics	metrics-annotation	4.0.3
io.dropwizard.metrics	metrics-core	4.0.3
io.dropwizard.metrics	metrics-ehcache	4.0.3
io.dropwizard.metrics	metrics-graphite	4.0.3
io.dropwizard.metrics	metrics-healthchecks	4.0.3
io.dropwizard.metrics	metrics-httpasyncclient	4.0.3
io.dropwizard.metrics	metrics-jdbi	4.0.3
io.dropwizard.metrics	metrics-jersey	4.0.3

Group ID	Artifact ID	Version
io.dropwizard.metrics	metrics-jersey2	4.0.3
io.dropwizard.metrics	metrics-jetty8	4.0.3
io.dropwizard.metrics	metrics-jetty9	4.0.3
io.dropwizard.metrics	metrics-jetty9-legacy	4.0.3
io.dropwizard.metrics	metrics-jmx	4.0.3
io.dropwizard.metrics	metrics-json	4.0.3
io.dropwizard.metrics	metrics-jvm	4.0.3
io.dropwizard.metrics	metrics-log4j	4.0.3
io.dropwizard.metrics	metrics-log4j2	4.0.3
io.dropwizard.metrics	metrics-logback	4.0.3
io.dropwizard.metrics	metrics-servlet	4.0.3
io.dropwizard.metrics	metrics-servlets	4.0.3
io.lettuce	lettuce-core	5.1.2.RELEASE
io.micrometer	micrometer-core	1.1.0
io.micrometer	micrometer-jersey2	1.1.0
io.micrometer	micrometer-registry- appoptics	1.1.0
io.micrometer	micrometer-registry- atlas	1.1.0
io.micrometer	micrometer-registry- azure-monitor	1.1.0
io.micrometer	micrometer-registry- cloudwatch	1.1.0
io.micrometer	micrometer-registry-datadog	1.1.0
io.micrometer	micrometer-registry- dynatrace	1.1.0
io.micrometer	micrometer-registry- elastic	1.1.0
io.micrometer	micrometer-registry- ganglia	1.1.0
io.micrometer	micrometer-registry- graphite	1.1.0

Group ID	Artifact ID	Version
io.micrometer	micrometer-registry- humio	1.1.0
io.micrometer	micrometer-registry- influx	1.1.0
io.micrometer	micrometer-registry-jmx	1.1.0
io.micrometer	micrometer-registry- kairos	1.1.0
io.micrometer	micrometer-registry- new-relic	1.1.0
io.micrometer	micrometer-registry- prometheus	1.1.0
io.micrometer	micrometer-registry- signalfx	1.1.0
io.micrometer	micrometer-registry- statsd	1.1.0
io.micrometer	micrometer-registry- wavefront	1.1.0
io.micrometer	micrometer-test	1.1.0
io.netty	netty-all	4.1.29.Final
io.netty	netty-buffer	4.1.29.Final
io.netty	netty-codec	4.1.29.Final
io.netty	netty-codec-dns	4.1.29.Final
io.netty	netty-codec-haproxy	4.1.29.Final
io.netty	netty-codec-http	4.1.29.Final
io.netty	netty-codec-http2	4.1.29.Final
io.netty	netty-codec-memcache	4.1.29.Final
io.netty	netty-codec-mqtt	4.1.29.Final
io.netty	netty-codec-redis	4.1.29.Final
io.netty	netty-codec-smtp	4.1.29.Final
io.netty	netty-codec-socks	4.1.29.Final
io.netty	netty-codec-stomp	4.1.29.Final
io.netty	netty-codec-xml	4.1.29.Final
io.netty	netty-common	4.1.29.Final

Group ID	Artifact ID	Version
io.netty	netty-dev-tools	4.1.29.Final
io.netty	netty-example	4.1.29.Final
io.netty	netty-handler	4.1.29.Final
io.netty	netty-handler-proxy	4.1.29.Final
io.netty	netty-resolver	4.1.29.Final
io.netty	netty-resolver-dns	4.1.29.Final
io.netty	netty-tcnative- boringssl-static	2.0.17.Final
io.netty	netty-transport	4.1.29.Final
io.netty	netty-transport-native- epoll	4.1.29.Final
io.netty	netty-transport-native- kqueue	4.1.29.Final
io.netty	netty-transport-native- unix-common	4.1.29.Final
io.netty	netty-transport-rxtx	4.1.29.Final
io.netty	netty-transport-sctp	4.1.29.Final
io.netty	netty-transport-udt	4.1.29.Final
io.projectreactor	reactor-core	3.2.2.RELEASE
io.projectreactor	reactor-test	3.2.2.RELEASE
io.projectreactor.addons	reactor-adapter	3.2.0.RELEASE
io.projectreactor.addons	reactor-extra	3.2.0.RELEASE
io.projectreactor.addons	reactor-logback	3.2.0.RELEASE
io.projectreactor.kafka	reactor-kafka	1.1.0.RELEASE
io.projectreactor.netty	reactor-netty	0.8.2.RELEASE
io.prometheus	simpleclient_pushgateway	0.5.0
io.reactivex	rxjava	1.3.8
io.reactivex	rxjava-reactive-streams	1.2.1
io.reactivex.rxjava2	rxjava	2.2.3
io.rest-assured	json-path	3.1.1
io.rest-assured	json-schema-validator	3.1.1
io.rest-assured	rest-assured	3.1.1

Group ID	Artifact ID	Version
io.rest-assured	scala-support	3.1.1
io.rest-assured	spring-mock-mvc	3.1.1
io.rest-assured	xml-path	3.1.1
io.searchbox	jest	6.3.1
io.undertow	undertow-core	2.0.14.Final
io.undertow	undertow-servlet	2.0.14.Final
io.undertow	undertow-websockets-jsr	2.0.14.Final
javax.activation	javax.activation-api	1.2.0
javax.annotation	javax.annotation-api	1.3.2
javax.cache	cache-api	1.1.0
javax.jms	javax.jms-api	2.0.1
javax.json	javax.json-api	1.1.3
javax.json.bind	javax.json.bind-api	1.0
javax.mail	javax.mail-api	1.6.2
javax.money	money-api	1.0.3
javax.persistence	javax.persistence-api	2.2
javax.servlet	javax.servlet-api	4.0.1
javax.servlet	jstl	1.2
javax.transaction	javax.transaction-api	1.3
javax.validation	validation-api	2.0.1.Final
javax.websocket	javax.websocket-api	1.1
javax.xml.bind	jaxb-api	2.3.1
javax.xml.ws	jaxws-api	2.3.1
jaxen	jaxen	1.1.6
joda-time	joda-time	2.10.1
junit	junit	4.12
mysql	mysql-connector-java	8.0.13
net.bytebuddy	byte-buddy	1.9.3
net.bytebuddy	byte-buddy-agent	1.9.3
net.java.dev.jna	jna	4.5.2

Group ID	Artifact ID	Version
net.java.dev.jna	jna-platform	4.5.2
net.sf.ehcache	ehcache	2.10.6
net.sourceforge.htmlunit	htmlunit	2.33
net.sourceforge.jtds	jtds	1.3.1
net.sourceforge.nekohtml	nekohtml	1.9.22
nz.net.ultraq.thymeleaf	thymeleaf-layout- dialect	2.3.0
org.apache.activemq	activemq-amqp	5.15.7
org.apache.activemq	activemq-blueprint	5.15.7
org.apache.activemq	activemq-broker	5.15.7
org.apache.activemq	activemq-camel	5.15.7
org.apache.activemq	activemq-client	5.15.7
org.apache.activemq	activemq-console	5.15.7
org.apache.activemq	activemq-http	5.15.7
org.apache.activemq	activemq-jaas	5.15.7
org.apache.activemq	activemq-jdbc-store	5.15.7
org.apache.activemq	activemq-jms-pool	5.15.7
org.apache.activemq	activemq-kahadb-store	5.15.7
org.apache.activemq	activemq-karaf	5.15.7
org.apache.activemq	activemq-leveldb-store	5.15.7
org.apache.activemq	activemq-log4j-appender	5.15.7
org.apache.activemq	activemq-mqtt	5.15.7
org.apache.activemq	activemq-openwire- generator	5.15.7
org.apache.activemq	activemq-openwire- legacy	5.15.7
org.apache.activemq	activemq-osgi	5.15.7
org.apache.activemq	activemq-partition	5.15.7
org.apache.activemq	activemq-pool	5.15.7
org.apache.activemq	activemq-ra	5.15.7
org.apache.activemq	activemq-run	5.15.7

Group ID	Artifact ID	Version
org.apache.activemq	activemq-runtime-config	5.15.7
org.apache.activemq	activemq-shiro	5.15.7
org.apache.activemq	activemq-spring	5.15.7
org.apache.activemq	activemq-stomp	5.15.7
org.apache.activemq	activemq-web	5.15.7
org.apache.activemq	artemis-amqp-protocol	2.6.3
org.apache.activemq	artemis-commons	2.6.3
org.apache.activemq	artemis-core-client	2.6.3
org.apache.activemq	artemis-jms-client	2.6.3
org.apache.activemq	artemis-jms-server	2.6.3
org.apache.activemq	artemis-journal	2.6.3
org.apache.activemq	artemis-native	2.6.3
org.apache.activemq	artemis-selector	2.6.3
org.apache.activemq	artemis-server	2.6.3
org.apache.activemq	artemis-service- extensions	2.6.3
org.apache.commons	commons-dbcp2	2.5.0
org.apache.commons	commons-lang3	3.8.1
org.apache.commons	commons-pool2	2.6.0
org.apache.derby	derby	10.14.2.0
org.apache.httpcomponent	sfluent-hc	4.5.6
org.apache.httpcomponent	shttpasyncclient	4.1.4
org.apache.httpcomponent	shttpclient	4.5.6
org.apache.httpcomponent	shttpclient-cache	4.5.6
org.apache.httpcomponent	shttpclient-osgi	4.5.6
org.apache.httpcomponent	shttpclient-win	4.5.6
org.apache.httpcomponent	shttpcore	4.4.10
org.apache.httpcomponent	shttpcore-nio	4.4.10
org.apache.httpcomponent	shttpmime	4.5.6
org.apache.johnzon	johnzon-core	1.1.10
org.apache.johnzon	johnzon-jaxrs	1.1.10

Group ID	Artifact ID	Version
org.apache.johnzon	johnzon-jsonb	1.1.10
org.apache.johnzon	johnzon-jsonb-extras	1.1.10
org.apache.johnzon	johnzon-jsonschema	1.1.10
org.apache.johnzon	johnzon-mapper	1.1.10
org.apache.johnzon	johnzon-websocket	1.1.10
org.apache.kafka	connect-api	2.0.0
org.apache.kafka	connect-file	2.0.0
org.apache.kafka	connect-json	2.0.0
org.apache.kafka	connect-runtime	2.0.0
org.apache.kafka	connect-transforms	2.0.0
org.apache.kafka	kafka_2.11	2.0.0
org.apache.kafka	kafka_2.12	2.0.0
org.apache.kafka	kafka-clients	2.0.0
org.apache.kafka	kafka-log4j-appender	2.0.0
org.apache.kafka	kafka-streams	2.0.0
org.apache.kafka	kafka-tools	2.0.0
org.apache.logging.log4j	log4j-1.2-api	2.11.1
org.apache.logging.log4j	log4j-api	2.11.1
org.apache.logging.log4j	log4j-cassandra	2.11.1
org.apache.logging.log4j	log4j-core	2.11.1
org.apache.logging.log4j	log4j-couchdb	2.11.1
org.apache.logging.log4j	log4j-flume-ng	2.11.1
org.apache.logging.log4j	log4j-iostreams	2.11.1
org.apache.logging.log4j	log4j-jcl	2.11.1
org.apache.logging.log4j	log4j-jmx-gui	2.11.1
org.apache.logging.log4j	log4j-jpa	2.11.1
org.apache.logging.log4j	log4j-jul	2.11.1
org.apache.logging.log4j	log4j-liquibase	2.11.1
org.apache.logging.log4j	log4j-mongodb2	2.11.1
org.apache.logging.log4j	log4j-mongodb3	2.11.1

Group ID	Artifact ID	Version
org.apache.logging.log4j	log4j-slf4j-impl	2.11.1
org.apache.logging.log4j	log4j-taglib	2.11.1
org.apache.logging.log4j	log4j-to-slf4j	2.11.1
org.apache.logging.log4j	log4j-web	2.11.1
org.apache.solr	solr-analysis-extras	7.4.0
org.apache.solr	solr-analytics	7.4.0
org.apache.solr	solr-cell	7.4.0
org.apache.solr	solr-clustering	7.4.0
org.apache.solr	solr-core	7.4.0
org.apache.solr	solr-dataimporthandler	7.4.0
org.apache.solr	solr-dataimporthandler-extras	7.4.0
org.apache.solr	solr-langid	7.4.0
org.apache.solr	solr-ltr	7.4.0
org.apache.solr	solr-solrj	7.4.0
org.apache.solr	solr-test-framework	7.4.0
org.apache.solr	solr-uima	7.4.0
org.apache.solr	solr-velocity	7.4.0
org.apache.tomcat	tomcat-annotations-api	9.0.12
org.apache.tomcat	tomcat-catalina-jmx-remote	9.0.12
org.apache.tomcat	tomcat-jdbc	9.0.12
org.apache.tomcat	tomcat-jsp-api	9.0.12
org.apache.tomcat.embed	tomcat-embed-core	9.0.12
org.apache.tomcat.embed	tomcat-embed-el	9.0.12
org.apache.tomcat.embed	tomcat-embed-jasper	9.0.12
org.apache.tomcat.embed	tomcat-embed-websocket	9.0.12
org.aspectj	aspectjrt	1.9.2
org.aspectj	aspectjtools	1.9.2
org.aspectj	aspectjweaver	1.9.2
org.assertj	assertj-core	3.11.1

Group ID	Artifact ID	Version
org.codehaus.btm	btm	2.1.4
org.codehaus.groovy	groovy	2.5.3
org.codehaus.groovy	groovy-ant	2.5.3
org.codehaus.groovy	groovy-bsf	2.5.3
org.codehaus.groovy	groovy-console	2.5.3
org.codehaus.groovy	groovy-docgenerator	2.5.3
org.codehaus.groovy	groovy-groovydoc	2.5.3
org.codehaus.groovy	groovy-groovysh	2.5.3
org.codehaus.groovy	groovy-jmx	2.5.3
org.codehaus.groovy	groovy-json	2.5.3
org.codehaus.groovy	groovy-jsr223	2.5.3
org.codehaus.groovy	groovy-nio	2.5.3
org.codehaus.groovy	groovy-servlet	2.5.3
org.codehaus.groovy	groovy-sql	2.5.3
org.codehaus.groovy	groovy-swing	2.5.3
org.codehaus.groovy	groovy-templates	2.5.3
org.codehaus.groovy	groovy-test	2.5.3
org.codehaus.groovy	groovy-testng	2.5.3
org.codehaus.groovy	groovy-xml	2.5.3
org.codehaus.janino	janino	3.0.10
org.eclipse.jetty	apache-jsp	9.4.12.v20180830
org.eclipse.jetty	apache-jstl	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-client	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-conscrypt- client	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-conscrypt- server	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-java-client	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-java-server	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-openjdk8- client	9.4.12.v20180830

Group ID	Artifact ID	Version
org.eclipse.jetty	jetty-alpn-openjdk8- server	9.4.12.v20180830
org.eclipse.jetty	jetty-alpn-server	9.4.12.v20180830
org.eclipse.jetty	jetty-annotations	9.4.12.v20180830
org.eclipse.jetty	jetty-ant	9.4.12.v20180830
org.eclipse.jetty	jetty-client	9.4.12.v20180830
org.eclipse.jetty	jetty-continuation	9.4.12.v20180830
org.eclipse.jetty	jetty-deploy	9.4.12.v20180830
org.eclipse.jetty	jetty-distribution	9.4.12.v20180830
org.eclipse.jetty	jetty-hazelcast	9.4.12.v20180830
org.eclipse.jetty	jetty-home	9.4.12.v20180830
org.eclipse.jetty	jetty-http	9.4.12.v20180830
org.eclipse.jetty	jetty-http-spi	9.4.12.v20180830
org.eclipse.jetty	jetty-infinispan	9.4.12.v20180830
org.eclipse.jetty	jetty-io	9.4.12.v20180830
org.eclipse.jetty	jetty-jaas	9.4.12.v20180830
org.eclipse.jetty	jetty-jaspi	9.4.12.v20180830
org.eclipse.jetty	jetty-jmx	9.4.12.v20180830
org.eclipse.jetty	jetty-jndi	9.4.12.v20180830
org.eclipse.jetty	jetty-nosql	9.4.12.v20180830
org.eclipse.jetty	jetty-plus	9.4.12.v20180830
org.eclipse.jetty	jetty-proxy	9.4.12.v20180830
org.eclipse.jetty	jetty-quickstart	9.4.12.v20180830
org.eclipse.jetty	jetty-reactive- httpclient	1.0.1
org.eclipse.jetty	jetty-rewrite	9.4.12.v20180830
org.eclipse.jetty	jetty-security	9.4.12.v20180830
org.eclipse.jetty	jetty-server	9.4.12.v20180830
org.eclipse.jetty	jetty-servlet	9.4.12.v20180830
org.eclipse.jetty	jetty-servlets	9.4.12.v20180830
org.eclipse.jetty	jetty-spring	9.4.12.v20180830

Group ID	Artifact ID	Version
org.eclipse.jetty	jetty-unixsocket	9.4.12.v20180830
org.eclipse.jetty	jetty-util	9.4.12.v20180830
org.eclipse.jetty	jetty-util-ajax	9.4.12.v20180830
org.eclipse.jetty	jetty-webapp	9.4.12.v20180830
org.eclipse.jetty	jetty-xml	9.4.12.v20180830
org.eclipse.jetty.cdi	cdi-core	9.4.12.v20180830
org.eclipse.jetty.cdi	cdi-servlet	9.4.12.v20180830
org.eclipse.jetty.fcgi	fcgi-client	9.4.12.v20180830
org.eclipse.jetty.fcgi	fcgi-server	9.4.12.v20180830
org.eclipse.jetty.gcloud	jetty-gcloud-session- manager	9.4.12.v20180830
org.eclipse.jetty.http2	http2-client	9.4.12.v20180830
org.eclipse.jetty.http2	http2-common	9.4.12.v20180830
org.eclipse.jetty.http2	http2-hpack	9.4.12.v20180830
org.eclipse.jetty.http2	http2-http-client- transport	9.4.12.v20180830
org.eclipse.jetty.http2	http2-server	9.4.12.v20180830
org.eclipse.jetty.memcacl	n <b>ġē</b> tty-memcached- sessions	9.4.12.v20180830
org.eclipse.jetty.orbit	javax.servlet.jsp	2.2.0.v201112011158
org.eclipse.jetty.osgi	jetty-httpservice	9.4.12.v20180830
org.eclipse.jetty.osgi	jetty-osgi-boot	9.4.12.v20180830
org.eclipse.jetty.osgi	jetty-osgi-boot-jsp	9.4.12.v20180830
org.eclipse.jetty.osgi	jetty-osgi-boot-warurl	9.4.12.v20180830
org.eclipse.jetty.websocl	kġāvax-websocket-client- impl	9.4.12.v20180830
org.eclipse.jetty.websock	kgʻavax-websocket-server- impl	9.4.12.v20180830
org.eclipse.jetty.websocl	kwebsocket-api	9.4.12.v20180830
org.eclipse.jetty.websocl	k <b>we</b> bsocket-client	9.4.12.v20180830
org.eclipse.jetty.websocl	kwebsocket-common	9.4.12.v20180830
org.eclipse.jetty.websocl	k <b>we</b> bsocket-server	9.4.12.v20180830

Group ID	Artifact ID	Version
org.eclipse.jetty.websocl	k <b>we</b> bsocket-servlet	9.4.12.v20180830
org.ehcache	ehcache	3.6.1
org.ehcache	ehcache-clustered	3.6.1
org.ehcache	ehcache-transactions	3.6.1
org.elasticsearch	elasticsearch	6.4.2
org.elasticsearch.client	elasticsearch-rest- client	6.4.2
org.elasticsearch.client	elasticsearch-rest- high-level-client	6.4.2
org.elasticsearch.client	transport	6.4.2
org.elasticsearch.distrib	o <b>eflásní čseag</b> eh	6.4.2
org.elasticsearch.plugin	transport-netty4-client	6.4.2
org.firebirdsql.jdbc	jaybird-jdk17	3.0.5
org.firebirdsql.jdbc	jaybird-jdk18	3.0.5
org.flywaydb	flyway-core	5.2.1
org.freemarker	freemarker	2.3.28
org.glassfish	javax.el	3.0.0
org.glassfish.jaxb	jaxb-runtime	2.3.1
org.glassfish.jersey.bund	d <b>jex</b> rs-ri	2.27
org.glassfish.jersey.com	n <b>gersry</b> -apache-connector	2.27
org.glassfish.jersey.com	n <b>ėersry</b> -grizzly- connector	2.27
org.glassfish.jersey.com	n <b>ġerszy</b> -jdk-connector	2.27
org.glassfish.jersey.com	ngersey-jetty-connector	2.27
org.glassfish.jersey.com	ngersey-netty-connector	2.27
org.glassfish.jersey.com	t <b>jėmsry</b> -container- grizzly2-http	2.27
org.glassfish.jersey.com	t <b>jėmsry</b> -container- grizzly2-servlet	2.27
org.glassfish.jersey.com	t <b>jėmsey</b> -container-jdk- http	2.27

Group ID	Artifact ID	Version
org.glassfish.jersey.com	t <b>jėmsey</b> -container-jetty- http	2.27
org.glassfish.jersey.com	t <b>jėmsey</b> -container-jetty- servlet	2.27
org.glassfish.jersey.com	t <b>jėmery</b> -container-netty- http	2.27
org.glassfish.jersey.com	t <b>jėmsey</b> -container- servlet	2.27
org.glassfish.jersey.com	t <b>jėmsry</b> -container- servlet-core	2.27
org.glassfish.jersey.com	t <b>jėmsry</b> -container- simple-http	2.27
org.glassfish.jersey.com	t <b>jėmsey-g</b> Iaejbish	2.27
org.glassfish.jersey.core	ejersey-client	2.27
org.glassfish.jersey.core	ejersey-common	2.27
org.glassfish.jersey.core	ejersey-server	2.27
org.glassfish.jersey.ext	jersey-bean-validation	2.27
org.glassfish.jersey.ext	jersey-declarative- linking	2.27
org.glassfish.jersey.ext	jersey-entity-filtering	2.27
org.glassfish.jersey.ext	jersey-metainf-services	2.27
org.glassfish.jersey.ext	jersey-mvc	2.27
org.glassfish.jersey.ext	jersey-mvc-bean- validation	2.27
org.glassfish.jersey.ext	jersey-mvc-freemarker	2.27
org.glassfish.jersey.ext	jersey-mvc-jsp	2.27
org.glassfish.jersey.ext	jersey-mvc-mustache	2.27
org.glassfish.jersey.ext	jersey-proxy-client	2.27
org.glassfish.jersey.ext	jersey-servlet- portability	2.27
org.glassfish.jersey.ext	jersey-spring4	2.27
org.glassfish.jersey.ext	jersey-wadl-doclet	2.27
org.glassfish.jersey.ext	.ġ <b>ē</b> rsey-cdilx	2.27

Group ID	Artifact ID	Version
org.glassfish.jersey.ext	.g <b>ė</b> rsey-cdi1x-ban- custom-hk2-binding	2.27
org.glassfish.jersey.ext	.ġ <b>ė</b> rsey-cdilx-servlet	2.27
org.glassfish.jersey.ext	.g <b>ė</b> rsey-cdilx- transaction	2.27
org.glassfish.jersey.ext	.ġ <b>d</b> rsey-cdilx-validation	2.27
org.glassfish.jersey.ext	.ġ <b>d</b> rsey-weld2-se	2.27
org.glassfish.jersey.ext	.ர்ærsey-rx-client-guava	2.27
org.glassfish.jersey.ext	.ர் <b>ಜ</b> rsey-rx-client-rxjava	2.27
org.glassfish.jersey.ext	.jærsey-rx-client- rxjava2	2.27
org.glassfish.jersey.inj	egersey-cdi2-se	2.27
org.glassfish.jersey.inj	eġŧrsey-hk2	2.27
org.glassfish.jersey.med	iġersey-media-jaxb	2.27
org.glassfish.jersey.med	igersey-media-json- binding	2.27
org.glassfish.jersey.med	igersey-media-json- jackson	2.27
org.glassfish.jersey.med	igersey-media-json- jackson1	2.27
org.glassfish.jersey.med	igersey-media-json- jettison	2.27
org.glassfish.jersey.med	igersey-media-json- processing	2.27
org.glassfish.jersey.med	iġersey-media-kryo	2.27
org.glassfish.jersey.med	iġersey-media-moxy	2.27
org.glassfish.jersey.med	iġersey-media-multipart	2.27
org.glassfish.jersey.med	iġersey-media-sse	2.27
org.glassfish.jersey.sec	u <b>rāt</b> †h1-client	2.27
org.glassfish.jersey.sec	upātţh1-server	2.27
org.glassfish.jersey.sec	u <b>pāt</b> †h1-signature	2.27
org.glassfish.jersey.sec	u <b>vāt</b> †h2-client	2.27

Group ID	Artifact ID	Version
org.glassfish.jersey.tes	tjersey-test-framework- core	2.27
org.glassfish.jersey.tes	tjersey-test-framework- util	2.27
org.glassfish.jersey.tes framework.providers	tjersey-test-framework- provider-bundle	2.27
org.glassfish.jersey.tes	tjersey-test-framework- provider-external	2.27
org.glassfish.jersey.tes	tjersey-test-framework- provider-grizzly2	2.27
org.glassfish.jersey.tes	tjersey-test-framework- provider-inmemory	2.27
org.glassfish.jersey.tes	tjersey-test-framework- provider-jdk-http	2.27
org.glassfish.jersey.tes	tjersey-test-framework- provider-jetty	2.27
org.glassfish.jersey.tes	tjersey-test-framework- provider-simple	2.27
org.hamcrest	hamcrest-core	1.3
org.hamcrest	hamcrest-library	1.3
org.hibernate	hibernate-c3p0	5.3.7.Final
org.hibernate	hibernate-core	5.3.7.Final
org.hibernate	hibernate-ehcache	5.3.7.Final
org.hibernate	hibernate-entitymanager	5.3.7.Final
org.hibernate	hibernate-envers	5.3.7.Final
org.hibernate	hibernate-hikaricp	5.3.7.Final
org.hibernate	hibernate-java8	5.3.7.Final
org.hibernate	hibernate-jcache	5.3.7.Final
org.hibernate	hibernate-jpamodelgen	5.3.7.Final
org.hibernate	hibernate-proxool	5.3.7.Final
org.hibernate	hibernate-spatial	5.3.7.Final
org.hibernate	hibernate-testing	5.3.7.Final
org.hibernate.validator	hibernate-validator	6.0.13.Final

Group ID	Artifact ID	Version
org.hibernate.validator	hibernate-validator- annotation-processor	6.0.13.Final
org.hsqldb	hsqldb	2.4.1
org.infinispan	infinispan-cachestore- jdbc	9.4.0.Final
org.infinispan	infinispan-cachestore- jpa	9.4.0.Final
org.infinispan	infinispan-cachestore- leveldb	9.4.0.Final
org.infinispan	infinispan-cachestore- remote	9.4.0.Final
org.infinispan	infinispan-cachestore- rest	9.4.0.Final
org.infinispan	infinispan-cachestore- rocksdb	9.4.0.Final
org.infinispan	infinispan-cdi-common	9.4.0.Final
org.infinispan	infinispan-cdi-embedded	9.4.0.Final
org.infinispan	infinispan-cdi-remote	9.4.0.Final
org.infinispan	infinispan-client- hotrod	9.4.0.Final
org.infinispan	infinispan-cloud	9.4.0.Final
org.infinispan	infinispan-clustered- counter	9.4.0.Final
org.infinispan	infinispan-clustered- lock	9.4.0.Final
org.infinispan	infinispan-commons	9.4.0.Final
org.infinispan	infinispan-core	9.4.0.Final
org.infinispan	infinispan-directory- provider	9.4.0.Final
org.infinispan	infinispan-hibernate- cache-v53	9.4.0.Final
org.infinispan	infinispan-jcache	9.4.0.Final
org.infinispan	infinispan-jcache- commons	9.4.0.Final

Group ID	Artifact ID	Version
org.infinispan	infinispan-jcache- remote	9.4.0.Final
org.infinispan	infinispan-lucene- directory	9.4.0.Final
org.infinispan	infinispan-management- console	9.4.0.Final
org.infinispan	infinispan-objectfilter	9.4.0.Final
org.infinispan	infinispan-osgi	9.4.0.Final
org.infinispan	infinispan-persistence- cli	9.4.0.Final
org.infinispan	infinispan-persistence- soft-index	9.4.0.Final
org.infinispan	infinispan-query	9.4.0.Final
org.infinispan	infinispan-query-dsl	9.4.0.Final
org.infinispan	infinispan-remote- query-client	9.4.0.Final
org.infinispan	infinispan-remote- query-server	9.4.0.Final
org.infinispan	infinispan-scripting	9.4.0.Final
org.infinispan	infinispan-server-core	9.4.0.Final
org.infinispan	infinispan-server- hotrod	9.4.0.Final
org.infinispan	infinispan-server- memcached	9.4.0.Final
org.infinispan	infinispan-server- router	9.4.0.Final
org.infinispan	infinispan-spring4- common	9.4.0.Final
org.infinispan	infinispan-spring4- embedded	9.4.0.Final
org.infinispan	infinispan-spring4- remote	9.4.0.Final
org.infinispan	infinispan-tasks	9.4.0.Final
org.infinispan	infinispan-tasks-api	9.4.0.Final
org.infinispan	infinispan-tools	9.4.0.Final

Group ID	Artifact ID	Version
org.infinispan	infinispan-tree	9.4.0.Final
org.influxdb	influxdb-java	2.14
org.jboss	jboss-transaction-spi	7.6.0.Final
org.jboss.logging	jboss-logging	3.3.2.Final
org.jdom	jdom2	2.0.6
org.jetbrains.kotlin	kotlin-reflect	1.2.71
org.jetbrains.kotlin	kotlin-runtime	1.2.71
org.jetbrains.kotlin	kotlin-stdlib	1.2.71
org.jetbrains.kotlin	kotlin-stdlib-jdk7	1.2.71
org.jetbrains.kotlin	kotlin-stdlib-jdk8	1.2.71
org.jetbrains.kotlin	kotlin-stdlib-jre7	1.2.71
org.jetbrains.kotlin	kotlin-stdlib-jre8	1.2.71
org.jolokia	jolokia-core	1.6.0
org.jooq	jooq	3.11.5
org.jooq	jooq-codegen	3.11.5
org.jooq	jooq-meta	3.11.5
org.junit.jupiter	junit-jupiter-api	5.3.1
org.junit.jupiter	junit-jupiter-engine	5.3.1
org.junit.jupiter	junit-jupiter- migrationsupport	5.3.1
org.junit.jupiter	junit-jupiter-params	5.3.1
org.junit.platform	junit-platform-commons	1.3.1
org.junit.platform	junit-platform-console	1.3.1
org.junit.platform	junit-platform-engine	1.3.1
org.junit.platform	junit-platform-launcher	1.3.1
org.junit.platform	junit-platform-runner	1.3.1
org.junit.platform	junit-platform-suite- api	1.3.1
org.junit.platform	junit-platform- surefire-provider	1.3.1
org.junit.vintage	junit-vintage-engine	5.3.1

Group ID	Artifact ID	Version
org.jvnet.mimepull	mimepull	1.9.10
org.liquibase	liquibase-core	3.6.2
org.mariadb.jdbc	mariadb-java-client	2.3.0
org.messaginghub	pooled-jms	1.0.3
org.mockito	mockito-core	2.23.0
org.mockito	mockito-inline	2.23.0
org.mockito	mockito-junit-jupiter	2.23.0
org.mongodb	bson	3.8.2
org.mongodb	mongodb-driver	3.8.2
org.mongodb	mongodb-driver-async	3.8.2
org.mongodb	mongodb-driver-core	3.8.2
org.mongodb	mongodb-driver- reactivestreams	1.9.2
org.mongodb	mongo-java-driver	3.8.2
org.mortbay.jasper	apache-el	8.5.33
org.neo4j	neo4j-ogm-api	3.1.4
org.neo4j	neo4j-ogm-bolt-driver	3.1.4
org.neo4j	neo4j-ogm-core	3.1.4
org.neo4j	neo4j-ogm-embedded- driver	3.1.4
org.neo4j	neo4j-ogm-http-driver	3.1.4
org.postgresql	postgresql	42.2.5
org.projectlombok	lombok	1.18.2
org.quartz-scheduler	quartz	2.3.0
org.quartz-scheduler	quartz-jobs	2.3.0
org.reactivestreams	reactive-streams	1.0.2
org.seleniumhq.selenium	htmlunit-driver	2.33.0
org.seleniumhq.selenium	selenium-api	3.14.0
org.seleniumhq.selenium	selenium-chrome-driver	3.14.0
org.seleniumhq.selenium	selenium-edge-driver	3.14.0
org.seleniumhq.selenium	selenium-firefox-driver	3.14.0

Group ID	Artifact ID	Version
org.seleniumhq.selenium	selenium-ie-driver	3.14.0
org.seleniumhq.selenium	selenium-java	3.14.0
org.seleniumhq.selenium	selenium-opera-driver	3.14.0
org.seleniumhq.selenium	selenium-remote-driver	3.14.0
org.seleniumhq.selenium	selenium-safari-driver	3.14.0
org.seleniumhq.selenium	selenium-support	3.14.0
org.skyscreamer	jsonassert	1.5.0
org.slf4j	jcl-over-slf4j	1.7.25
org.slf4j	jul-to-slf4j	1.7.25
org.slf4j	log4j-over-slf4j	1.7.25
org.slf4j	slf4j-api	1.7.25
org.slf4j	slf4j-ext	1.7.25
org.slf4j	slf4j-jcl	1.7.25
org.slf4j	slf4j-jdk14	1.7.25
org.slf4j	slf4j-log4j12	1.7.25
org.slf4j	slf4j-nop	1.7.25
org.slf4j	slf4j-simple	1.7.25
org.springframework	spring-aop	5.1.2.RELEASE
org.springframework	spring-aspects	5.1.2.RELEASE
org.springframework	spring-beans	5.1.2.RELEASE
org.springframework	spring-context	5.1.2.RELEASE
org.springframework	spring-context-indexer	5.1.2.RELEASE
org.springframework	spring-context-support	5.1.2.RELEASE
org.springframework	spring-core	5.1.2.RELEASE
org.springframework	spring-expression	5.1.2.RELEASE
org.springframework	spring-instrument	5.1.2.RELEASE
org.springframework	spring-jcl	5.1.2.RELEASE
org.springframework	spring-jdbc	5.1.2.RELEASE
org.springframework	spring-jms	5.1.2.RELEASE
org.springframework	spring-messaging	5.1.2.RELEASE

Group ID	Artifact ID	Version
org.springframework	spring-orm	5.1.2.RELEASE
org.springframework	spring-oxm	5.1.2.RELEASE
org.springframework	spring-test	5.1.2.RELEASE
org.springframework	spring-tx	5.1.2.RELEASE
org.springframework	spring-web	5.1.2.RELEASE
org.springframework	spring-webflux	5.1.2.RELEASE
org.springframework	spring-webmvc	5.1.2.RELEASE
org.springframework	spring-websocket	5.1.2.RELEASE
org.springframework.amqp	spring-amqp	2.1.0.RELEASE
org.springframework.amqp	spring-rabbit	2.1.0.RELEASE
org.springframework.amqp	spring-rabbit-junit	2.1.0.RELEASE
org.springframework.amqp	spring-rabbit-test	2.1.0.RELEASE
org.springframework.batch	nspring-batch-core	4.1.0.RELEASE
org.springframework.batch	nspring-batch- infrastructure	4.1.0.RELEASE
org.springframework.batch	nspring-batch- integration	4.1.0.RELEASE
org.springframework.batcl	nspring-batch-test	4.1.0.RELEASE
org.springframework.boot	spring-boot	2.1.0.RELEASE
org.springframework.boot	spring-boot-actuator	2.1.0.RELEASE
org.springframework.boot	spring-boot-actuator- autoconfigure	2.1.0.RELEASE
org.springframework.boot	spring-boot- autoconfigure	2.1.0.RELEASE
org.springframework.boot	spring-boot- autoconfigure-processor	2.1.0.RELEASE
org.springframework.boot	spring-boot- configuration-metadata	2.1.0.RELEASE
org.springframework.boot	spring-boot- configuration-processor	2.1.0.RELEASE
org.springframework.boot	spring-boot-devtools	2.1.0.RELEASE
org.springframework.boot	spring-boot-loader	2.1.0.RELEASE

Group ID	Artifact ID	Version
org.springframework.boot	spring-boot-loader- tools	2.1.0.RELEASE
org.springframework.boot	spring-boot-properties- migrator	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- activemq	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- actuator	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- amqp	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-aop	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- artemis	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- batch	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-cache	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- cloud-connectors	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-cassandra	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-cassandra-reactive	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-couchbase	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-couchbase-reactive	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-data-elasticsearch	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-jdbc	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-jpa	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-ldap	2.1.0.RELEASE

Group ID	Artifact ID	Version
org.springframework.boot	spring-boot-starter-data-mongodb	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-data-mongodb-reactive	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-data-neo4j	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-redis	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-data-redis-reactive	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- data-rest	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-data-solr	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- freemarker	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- groovy-templates	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- hateoas	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- integration	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- jdbc	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- jersey	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- jetty	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- jooq	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- json	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- jta-atomikos	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- jta-bitronix	2.1.0.RELEASE

Group ID	Artifact ID	Version
org.springframework.boot	spring-boot-starter-log4j2	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- logging	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- mail	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- mustache	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- oauth2-client	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- oauth2-resource-server	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- quartz	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- reactor-netty	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- security	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- test	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- thymeleaf	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- tomcat	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- undertow	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- validation	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter-web	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- webflux	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- web-services	2.1.0.RELEASE
org.springframework.boot	spring-boot-starter- websocket	2.1.0.RELEASE
org.springframework.boot	spring-boot-test	2.1.0.RELEASE

Group ID	Artifact ID	Version
org.springframework.boot	spring-boot-test- autoconfigure	2.1.0.RELEASE
org.springframework.cloud	dspring-cloud- cloudfoundry-connector	2.0.3.RELEASE
org.springframework.cloud	dspring-cloud- connectors-core	2.0.3.RELEASE
org.springframework.cloud	dspring-cloud-heroku- connector	2.0.3.RELEASE
org.springframework.cloud	dspring-cloud- localconfig-connector	2.0.3.RELEASE
org.springframework.cloud	dspring-cloud-spring- service-connector	2.0.3.RELEASE
org.springframework.data	spring-data-cassandra	2.1.2.RELEASE
org.springframework.data	spring-data-commons	2.1.2.RELEASE
org.springframework.data	spring-data-couchbase	3.1.2.RELEASE
org.springframework.data	spring-data- elasticsearch	3.1.2.RELEASE
org.springframework.data	spring-data-envers	2.1.2.RELEASE
org.springframework.data	spring-data-gemfire	2.1.2.RELEASE
org.springframework.data	spring-data-geode	2.1.2.RELEASE
org.springframework.data	spring-data-jdbc	1.0.2.RELEASE
org.springframework.data	spring-data-jpa	2.1.2.RELEASE
org.springframework.data	spring-data-keyvalue	2.1.2.RELEASE
org.springframework.data	spring-data-ldap	2.1.2.RELEASE
org.springframework.data	spring-data-mongodb	2.1.2.RELEASE
org.springframework.data	spring-data-mongodb- cross-store	2.1.2.RELEASE
org.springframework.data	spring-data-neo4j	5.1.2.RELEASE
org.springframework.data	spring-data-redis	2.1.2.RELEASE
org.springframework.data	spring-data-rest-core	3.1.2.RELEASE
org.springframework.data	spring-data-rest-hal- browser	3.1.2.RELEASE
org.springframework.data	spring-data-rest-webmvc	3.1.2.RELEASE

Group ID	Artifact ID	Version
org.springframework.data	spring-data-solr	4.0.2.RELEASE
org.springframework.hated	o <b>sp</b> ring-hateoas	0.25.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-amqp	5.1.0.RELEASE
org.springframework.integ	g <b>saring</b> -integration-core	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- event	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-feed	5.1.0.RELEASE
org.springframework.integ	g <b>saring</b> -integration-file	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-ftp	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- gemfire	5.1.0.RELEASE
org.springframework.integ	g <b>sating</b> -integration- groovy	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-http	5.1.0.RELEASE
org.springframework.integ	g <b>saring</b> -integration-ip	5.1.0.RELEASE
org.springframework.integ	g <b>saring</b> -integration-jdbc	5.1.0.RELEASE
org.springframework.integ	g <b>saring</b> -integration-jms	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-jmx	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-jpa	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-mail	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- mongodb	5.1.0.RELEASE
org.springframework.integ	g <b>saring</b> -integration-mqtt	5.1.0.RELEASE
org.springframework.integ	g <b>spting</b> -integration- redis	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-rmi	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- scripting	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- security	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-sftp	5.1.0.RELEASE
org.springframework.integ	g <b>spting</b> -integration- stomp	5.1.0.RELEASE

Group ID	Artifact ID	Version
org.springframework.integ	g <b>saring</b> -integration- stream	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- syslog	5.1.0.RELEASE
org.springframework.integ	g <b>sating</b> -integration-test	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- test-support	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- webflux	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- websocket	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-ws	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-xml	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration-xmpp	5.1.0.RELEASE
org.springframework.integ	g <b>spring</b> -integration- zookeeper	5.1.0.RELEASE
org.springframework.kafka	aspring-kafka	2.2.0.RELEASE
org.springframework.kafka	aspring-kafka-test	2.2.0.RELEASE
org.springframework.ldap	spring-ldap-core	2.3.2.RELEASE
org.springframework.ldap	spring-ldap-core-tiger	2.3.2.RELEASE
org.springframework.ldap	spring-ldap-ldif-batch	2.3.2.RELEASE
org.springframework.ldap	spring-ldap-ldif-core	2.3.2.RELEASE
org.springframework.ldap	spring-ldap-odm	2.3.2.RELEASE
org.springframework.ldap	spring-ldap-test	2.3.2.RELEASE
org.springframework.plug	i <b>s</b> pring-plugin-core	1.2.0.RELEASE
org.springframework.plug	i <b>s</b> pring-plugin-metadata	1.2.0.RELEASE
org.springframework.resto	d <b>sps</b> ing-restdocs- asciidoctor	2.0.2.RELEASE
org.springframework.resto	d <b>sp</b> :sing-restdocs-core	2.0.2.RELEASE
org.springframework.resto	d <b>sp</b> :sing-restdocs-mockmvc	2.0.2.RELEASE
org.springframework.resto	d <b>sps</b> ing-restdocs- restassured	2.0.2.RELEASE

Group ID	Artifact ID	Version
org.springframework.resto	d <b>sps</b> ing-restdocs- webtestclient	2.0.2.RELEASE
org.springframework.retr	yspring-retry	1.2.2.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-acl	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-aspects	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-cas	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-config	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-core	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-crypto	5.1.1.RELEASE
org.springframework.secu	r <b>sp</b> ying-security-data	5.1.1.RELEASE
org.springframework.secu	r <b>sp</b> ying-security-ldap	5.1.1.RELEASE
org.springframework.secu	rspying-security- messaging	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-oauth2- client	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-oauth2- core	5.1.1.RELEASE
org.springframework.secu	rspying-security-oauth2- jose	5.1.1.RELEASE
org.springframework.secu	rspying-security-oauth2- resource-server	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-openid	5.1.1.RELEASE
org.springframework.secu	rspying-security- remoting	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-taglibs	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-test	5.1.1.RELEASE
org.springframework.secu	r <b>spy</b> ing-security-web	5.1.1.RELEASE
org.springframework.sess	i <b>sp</b> ring-session-core	2.1.1.RELEASE
org.springframework.sess	i <b>sp</b> ring-session-data- gemfire	2.1.0.RELEASE
org.springframework.sess	i <b>sp</b> ring-session-data- geode	2.1.0.RELEASE
org.springframework.sess	i <b>sp</b> ring-session-data- mongodb	2.1.0.RELEASE

Group ID	Artifact ID	Version
org.springframework.sess	i <b>sp</b> ring-session-data- redis	2.1.1.RELEASE
org.springframework.sess	i <b>sp</b> ring-session- hazelcast	2.1.1.RELEASE
org.springframework.sess	i <b>sp</b> ring-session-jdbc	2.1.1.RELEASE
org.springframework.ws	spring-ws-core	3.0.4.RELEASE
org.springframework.ws	spring-ws-security	3.0.4.RELEASE
org.springframework.ws	spring-ws-support	3.0.4.RELEASE
org.springframework.ws	spring-ws-test	3.0.4.RELEASE
org.springframework.ws	spring-xml	3.0.4.RELEASE
org.synchronoss.cloud	nio-multipart-parser	1.1.0
org.thymeleaf	thymeleaf	3.0.11.RELEASE
org.thymeleaf	thymeleaf-spring5	3.0.11.RELEASE
org.thymeleaf.extras	thymeleaf-extras- java8time	3.0.1.RELEASE
org.thymeleaf.extras	thymeleaf-extras- springsecurity5	3.0.4.RELEASE
org.webjars	hal-browser	3325375
org.webjars	webjars-locator-core	0.35
org.xerial	sqlite-jdbc	3.25.2
org.xmlunit	xmlunit-core	2.6.2
org.xmlunit	xmlunit-legacy	2.6.2
org.xmlunit	xmlunit-matchers	2.6.2
org.yaml	snakeyaml	1.23
redis.clients	jedis	2.9.0
wsdl4j	wsd14j	1.6.3
xml-apis	xml-apis	1.4.01