**Spring Cloud**

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[How to Write a Route Filter](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#zuul-developer-guide-sample-route-filter)

[How to Write a Post Filter](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#zuul-developer-guide-sample-post-filter)

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[**96.2. 1.1.x → 1.2.x**](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__migrations.html#cloud-verifier-1.1-1.2)

[96.2.1. Custom HttpServerStub](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__migrations.html#_custom_literal_httpserverstub_literal)

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# 1. Features

Spring Cloud专注于为典型用例和可扩展性机制提供良好的即时体验，以覆盖其他人。

* 分布式/版本化配置
* 服务注册和发现
* 路由
* Service-to-service calls
* 负载均衡
* Circuit Breakers(断路由)
* Distributed messaging(分布式消息)

**Part I. Cloud Native Applications(原生云应用)**

[Cloud Native](https://pivotal.io/platform-as-a-service/migrating-to-cloud-native-application-architectures-ebook)是一种应用程序开发风格，鼓励在持续交付和价值驱动开发领域轻松采用最佳实践。 一个相关的学科是构建 [12-factor Applications](http://12factor.net/)，其中开发实践与交付和操作目标相一致 - 例如，通过使用声明式编程和管理以及监控。 Spring Cloud以许多特定的方式促进了这些开发风格。 起点是分布式系统中的所有组件都需要轻松访问的一组功能。

Spring Boot构建[Spring Boot](https://projects.spring.io/spring-boot)所涵盖的许多功能。 Spring Cloud还提供了两个库：Spring Cloud Context和Spring Cloud Commons。 Spring Cloud Context为Spring云应用程序的ApplicationContext (bootstrap context, encryption, refresh scope, and environment endpoints)提供实用程序和特殊服务。 Spring Cloud Commons是一组用于不同Spring Cloud实现（例如Spring Cloud Netflix和Spring Cloud Consul）的抽象和通用类。

如果由于"Illegal key size"而导致的异常，并且您使用Sun的JDK，则需要安装Java Cryptography Extension（JCE）无限制强制管辖权策略文件。 有关更多信息，请参阅以下链接：

* [Java 6 JCE](http://www.oracle.com/technetwork/java/javase/downloads/jce-6-download-429243.html)
* [Java 7 JCE](http://www.oracle.com/technetwork/java/javase/downloads/jce-7-download-432124.html)
* [Java 8 JCE](http://www.oracle.com/technetwork/java/javase/downloads/jce8-download-2133166.html)

将文件解压缩到您使用的JRE / JDK x64 / x86版本的JDK / jre / lib / security目录中。

|  |
| --- |
| [Note] |
| Spring Cloud是在非限制性的Apache 2.0许可下发布的。 如果您想对本文档的这一部分做出贡献，或者如果发现错误，可以在[github](https://github.com/spring-cloud/spring-cloud-commons/tree/master/docs/src/main/asciidoc)上找到该项目的源代码和问题跟踪器。 |

## 2. Spring Cloud Context: Application Context Services

Spring Boot对如何使用Spring构建应用程序有自己的见解。 例如，它具有常规配置文件的常规位置，并具有用于常见管理和监视任务的端点。 Spring Cloud建立在此基础之上，并添加了一些可能系统中所有组件都会使用或偶尔需要的功能。

## 2.1 The Bootstrap Application Context

Spring Cloud应用程序通过创建“bootstrap” context来运行，该context是主应用程序的parent context。 它负责从外部源加载配置属性，并负责解密本地外部配置文件中的属性。 这两个context共享一个Environment，它是任何Spring应用程序的外部属性的来源。 默认情况下，bootstrap属性以高优先级添加，因此它们不能被本地配置覆盖。

bootstrap context使用不同的约定来定位外部配置，而不是main application context。 您可以使用bootstrap.yml，而不是使用application.yml（或.properties），以保持bootstrap的外部配置和主环境很好地分离。 以下列表显示了一个示例：

**bootstrap.yml.**

spring:

application:

name: foo

cloud:

config:

uri: ${SPRING\_CONFIG\_URI:http://localhost:8888}

如果您的应用程序需要来自服务器的任何特定于应用程序的配置，那么设置 spring.application.name (in bootstrap.yml or application.yml)是一个不错的主意。

您可以通过设置spring.cloud.bootstrap.enabled=false（例如，在系统属性中）完全禁用引导过程。

## 2.2 Application Context Hierarchies(层次结构)

如果您从SpringApplication or SpringApplicationBuilder构建应用程序上下文，那么Bootstrap上下文将作为该上下文的父项添加。 Spring的一个特性是子级上下文继承了父级的属性来源和配置文件，因此与不使用Spring Cloud Config构建相同上下文相比，“main”应用程序上下文包含其他属性源。 额外的property来源是：

* “bootstrap”: 如果Bootstrap上下文中找到任何 PropertySourceLocators ，并且他们具有非空属性，则可选CompositePropertySource 将以高优先级出现。一个例子是Spring Cloud Config Server的属性。请参阅“[Section 2.6, “Customizing the Bootstrap Property Sources”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_context_application_context_services.html#customizing-bootstrap-property-sources) 自定义Bootstrap属相源，以获取有关如何自定义属性源内容的说明。
* “applicationConfig: [classpath:bootstrap.yml]” (以及相关文件，如果Spring配置文件处于活动状态):如果你有 bootstrap.yml I (or .properties),则使用这些属性来配置Bootstrap上下文。当然，当他们的父级设置时，他们会被添加到子级上下文中。他们的优先级低于application.yml(or .properties) 以及作为创建Spring Boot应用程序过程的常规部分添加到子项的任何其他属性源。请参阅“[Section 2.3, “Changing the Location of Bootstrap Properties”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_context_application_context_services.html#customizing-bootstrap-properties)” 以获取有关如何自定义这些属性源内容的说明.

由于属性来源的排序规则，“bootstrap”条目优先。 但是，请注意，这些数据不包含bootstrap.yml中的任何数据，它们的优先级非常低，但可用于设置默认值。

您可以通过设置您创建的任何ApplicationContext的父上下文来扩展上下文层次结构 - 例如，使用自己的接口或SpringApplicationBuilder 便捷方法(parent(), child() and sibling())。 引导程序上下文是您自己创建的最高级祖先的父级。 层次结构中的每个环境都有自己的“bootstrap”（可能是空的）属性来源，以避免无意中将价值从父级推到他们的后代。 如果有配置服务器，则层次结构中的每个上下文也可以（原则上）具有不同的spring.application.name，并因此具有不同的远程属性源。 普通的Spring应用上下文行为规则适用于属性解析：来自子上下文的属性覆盖父类中的属性，按名称和属性源名称。 （如果孩子的姓名与父母姓名相同，则父母的值不包含在孩子中）。

请注意，SpringApplicationBuilder允许您在整个层次结构中共享一个Environment，但这不是默认设置。 因此，兄弟情境尤其不需要具有相同的profiles或property sources，即使它们可能与其父母分享共同的价值。

## 2.3 Changing the Location of Bootstrap Properties

可以通过设置spring.cloud.bootstrap.name（默认值：bootstrap）或spring.cloud.bootstrap.location（默认值：空）来指定bootstrap.yml（或.properties）位置，例如，在系统属性中。 这些属性的行为与具有相同名称的spring.config.\*变体类似。 实际上，它们用于通过在其环境中设置这些属性来设置引导程序ApplicationContext。 如果有活动配置文件（来自spring.profiles.active或通过您正在构建的上下文中的环境API），那么该配置文件中的属性也会加载，这与常规Spring Boot应用程序中的属性相同 - 例如，从bootstrap-development.properties development配置文件。

## 2.4 Overriding the Values of Remote Properties

通过引导上下文添加到应用程序的属性源通常是“remote”（例如，来自Spring Cloud Config Server的示例）。 默认情况下，除了在命令行上，它们不能在本地覆盖。 如果您想让应用程序使用自己的系统属性或配置文件覆盖远程属性，则远程属性源必须通过设置spring.cloud.config.allowOverride=true来授予其权限（无法在本地进行设置）。 一旦设置了该标志，两个更细粒度的设置将控制远程属性相对于系统属性和应用程序的本地配置的位置：

* spring.cloud.config.overrideNone=true: 覆盖任何本地属性源
* spring.cloud.config.overrideSystemProperties=false: 只有系统属性和环境变量(而不是本地配置文件)应该覆盖远程设置

## 2.5 Customizing the Bootstrap Configuration

通过在名为org.springframework.cloud.bootstrap.BootstrapConfiguration的键下添加条目到/META-INF/spring.factories，引导程序上下文可以设置为执行任何你喜欢的操作。 这包含用于创建上下文的Spring @Configuration类的逗号分隔列表。 您可以在此处创建任何要用于自动装配的主应用程序上下文的bean。 ApplicationContextInitializer类型的@Beans有一个特殊的约定。 如果要控制启动顺序，可以使用@Order注释标记类（默认顺序是last）。

|  |
| --- |
| [Warning] |
| 添加自定义BootstrapConfiguration时，请注意，您添加的类不是错误地@ComponentScanned扫描到您的“main”应用程序上下文中，可能不需要它们。 为引导配置类使用单独的软件包名称，并确保该名称尚未被@ComponentScan or @SpringBootApplication注释的配置类所覆盖。 |

bootstrap process通过向主SpringApplication实例注入初始化器（这是普通的Spring Boot启动序列，无论它是作为独立应用程序运行还是部署在应用程序服务器中）结束。 首先，通过spring.factories中的类创建引导程序上下文。 然后，在启动之前，ApplicationContextInitializer类型的所有@Beans被添加到主SpringApplication中。

## 2.6 Customizing the Bootstrap Property Sources

引导过程添加的外部配置的默认属性源是Spring Cloud Config Server，但是您可以通过将类型PropertySourceLocator的Bean添加到引导上下文（通过spring.factorie）来添加其他源。 例如，您可以从其他服务器或数据库插入其他属性。

作为一个例子，考虑下面的custom locator:

*@Configuration*

**public** **class** CustomPropertySourceLocator **implements** PropertySourceLocator {

*@Override*

**public** PropertySource<?> locate(Environment environment) {

**return** **new** MapPropertySource("customProperty",

Collections.<String, Object>singletonMap("property.from.sample.custom.source", "worked as intended"));

}

}

即将创建的ApplicationContext - 换句话说，我们为其提供额外的property sources。 它已经有了普通的Spring Boot提供的属性源，所以你可以使用它们来定位这个Environment特有的属性源（例如，通过在spring.application.name上键入它，就像在默认的Spring Cloud Config Server中完成的那样） 资源来源定位器）。

如果您创建了一个包含此类的jar，然后添加包含以下内容的META-INF/spring.factories，那么customProperty PropertySource将出现在包含该jar的类路径中的任何应用程序中：

org.springframework.cloud.bootstrap.BootstrapConfiguration=sample.custom.CustomPropertySourceLocator

## 2.7 Environment Changes

应用程序监听一个EnvironmentChangeEvent，并以一些标准方式响应更改（其他ApplicationListeners可以通过普通方式添加为@Beans）。 当观察到EnvironmentChangeEvent时，它具有已更改的键值列表，并且应用程序使用它们来：

* Re-bind任何 @ConfigurationProperties beans
* 为logging.level.\*中的任何属性设置logger

请注意，默认情况下，Config Client不会轮询Environment中的更改。 一般来说，我们不会推荐用于检测更改的方法（尽管您可以使用@Scheduled annotation进行设置）。 如果您有扩展的客户端应用程序，则最好将EnvironmentChangeEvent广播到所有实例，而不是让他们轮询更改（例如，通过使用 [Spring Cloud Bus](https://github.com/spring-cloud/spring-cloud-bus)）。

EnvironmentChangeEvent涵盖了一大类刷新用例，只要您可以实际更改Environment并发布该事件。 请注意，这些API是公开的，并且是核心Spring的一部分）。 您可以通过访问/ configpropsendpoint（普通的Spring Boot执行器功能）来验证更改是否绑定到@ConfigurationProperties bean。 例如，DataSource可以在运行时更改其maxPoolSize（Spring Boot创建的默认DataSource是一个@ConfigurationProperties bean）并动态增加容量。 重新绑定@ConfigurationProperties不包含另一大类的用例，您需要对刷新进行更多控制，并且需要对整个ApplicationContext进行原子级更改。 为了解决这些问题，我们有@RefreshScope。

## 2.8 Refresh Scope

当有配置更改时，标记为@RefreshScope的Spring @Bean会得到特殊待遇。 该功能解决了初始化时仅注入配置的有状态Bean的问题。 例如，如果一个DataSource在通过环境更改数据库URL时已打开连接，那么您可能希望这些连接的持有者能够完成他们正在做的事情。 然后，下一次从池中借用一个连接时，它将获得一个新的URL。

Refresh scope beans是使用它们进行初始化的惰性代理（即，调用方法时），范围充当初始化值的缓存。 要强制一个bean在下一次方法调用时重新初始化，必须使其缓存项无效。

RefreshScope是上下文中的一个bean，它有一个公共的refreshAll()方法，通过清除目标缓存来刷新作用域中的所有bean。 /refresh端点公开了这个功能（通过HTTP或JMX）。 要按名称刷新单个bean，还有一个refresh(String)方法。

|  |
| --- |
| [Note] |
| @RefreshScope在技术上适用于@Configuration类，但它可能会导致令人惊讶的行为。 例如，这并不意味着该类中定义的所有@Beans本身都位于@RefreshScope中。 具体来说，除非它本身位于@RefreshScope中，否则依赖于这些bean的任何内容都不能依赖于在启动刷新时更新它们。 在这种情况下，它将在刷新时重建，并且它的依赖关系会被重新注入。 此时，它们将从刷新的@Configuration重新初始化）。 |

## 2.9 Encryption and Decryption(加/解密)

Spring Cloud有一个Environment pre-processor用于本地解密属性值。 它遵循与Config Server相同的规则，并通过encrypt.\*具有相同的外部配置。 因此，您可以使用{cipher}\*格式的加密值，只要有一个有效的密钥，它们在主应用程序上下文获得环境设置之前就被解密。 要在应用程序中使用加密功能，您需要在您的类路径中包含Spring Security RSA（Maven协调：“org.springframework.security:spring-security-rsa”），并且您还需要完整强度的JCE扩展 你的JVM。

如果由于"Illegal key size"而导致异常，并且您使用Sun的JDK，则需要安装Java Cryptography Extension（JCE）无限制强制管辖权策略文件。 有关更多信息，请参阅以下链接：

* [Java 6 JCE](http://www.oracle.com/technetwork/java/javase/downloads/jce-6-download-429243.html)
* [Java 7 JCE](http://www.oracle.com/technetwork/java/javase/downloads/jce-7-download-432124.html)
* [Java 8 JCE](http://www.oracle.com/technetwork/java/javase/downloads/jce8-download-2133166.html)

将文件解压缩到您使用的JRE / JDK x64 / x86版本的JDK / jre / lib / security文件夹中。

## 2.10 Endpoints

对于Spring Boot Actuator应用程序，可以使用其他一些管理端点。 您可以使用：

* POST to /actuator/env 以更新 Environment 并重新绑定 @ConfigurationProperties 和log levels.
* /actuator/refresh 以 re-load 引导程序上下文并刷新 @RefreshScope beans.
* /actuator/restart 以关闭 ApplicationContext 并restart 它 (默认情况下禁用).
* /actuator/pause and /actuator/resume 调用 Lifecycle 方法 (stop() and start() on the ApplicationContext).

## 3. Spring Cloud Commons: Common Abstractions

诸如服务发现，负载均衡和断路器等模式适合于所有Spring Cloud客户端都可以使用的通用抽象层，而与实现无关（例如，使用Eureka或Consul进行发现）。

## 3.1 @EnableDiscoveryClient

Spring Cloud Commons提供了@EnableDiscoveryClient注解。 这将使用META-INF/spring.factories查找DiscoveryClient接口的实现。 Discovery Client的实现向org.springframework.cloud.client.discovery.EnableDiscoveryClient项下的spring.factories添加配置类。 DiscoveryClient实现的例子包括[Spring Cloud Netflix Eureka](https://cloud.spring.io/spring-cloud-netflix/), [Spring Cloud Consul Discovery](https://cloud.spring.io/spring-cloud-consul/), and [Spring Cloud Zookeeper Discovery](https://cloud.spring.io/spring-cloud-zookeeper/)。

默认情况下，DiscoveryClient的实现自动向远程发现服务器注册本地Spring Boot服务器。 此行为可以通过在@EnableDiscoveryClient中设置autoRegister=false来禁用。

|  |
| --- |
| [Note] |
| @EnableDiscoveryClient 不再需要。 您可以在类路径上放置一个DiscoveryClient实现，以使Spring Boot应用程序向服务发现服务器注册。 |

### 3.1.1 Health Indicator

Commons通过实施DiscoveryHealthIndicator创建一个Spring Boot HealthIndicator，DiscoveryClient实现可以参与。 要禁用复合HealthIndicator，请设置spring.cloud.discovery.client.composite-indicator.enabled=false。 基于DiscoveryClient的通用HealthIndicator是自动配置的（DiscoveryClientHealthIndicator）。 要禁用它，请设置spring.cloud.discovery.client.health-indicator.enabled=false。 要禁用DiscoveryClientHealthIndicator的描述字段，请设置spring.cloud.discovery.client.health-indicator.include-description=false。 否则，它可能会像卷起的HealthIndicator的description一样冒泡。

## 3.2 ServiceRegistry

Commons现在提供了一个ServiceRegistry接口，该接口提供了诸如register(Registration)和deregister(Registration)等方法，可以让您提供自定义的注册服务。 Registration是一个标记interface。

以下示例显示正在使用的ServiceRegistry：

*@Configuration*

*@EnableDiscoveryClient(autoRegister=false)*

**public** **class** MyConfiguration {

**private** ServiceRegistry registry;

**public** MyConfiguration(ServiceRegistry registry) {

**this**.registry = registry;

}

*// called through some external process, such as an event or a custom actuator endpoint*

**public** **void** register() {

Registration registration = constructRegistration();

**this**.registry.register(registration);

}

}

每个ServiceRegistry实现都有其自己的Registry implementation。

### 3.2.1 ServiceRegistry Auto-Registration

默认情况下，ServiceRegistry实现会自动注册正在运行的服务。 要禁用该行为，您可以设置：\* @EnableDiscoveryClient(autoRegister=false)）以永久禁用自动注册。 \* spring.cloud.service-registry.auto-registration.enabled=false通过配置禁用行为。

### 3.2.2 Service Registry Actuator Endpoint

Spring Cloud Commons提供了一个/service-registry执行器端点。 该端点依赖于Spring应用程序上下文中的Registration bean。 使用GET调用/service-registry返回注册的状态。 将POST用于具有JSON主体的相同端点会将当前注册的状态更改为新值。 JSON正文必须包含首选值的状态字段。 在更新状态和返回状态值时，请参阅用于允许值的ServiceRegistry实现的文档。 例如，Eureka支持的状态是UP, DOWN, OUT\_OF\_SERVICE, and UNKNOWN.

## 3.3 Spring RestTemplate as a Load Balancer Client

RestTemplate可以自动配置为使用功能区。 要创建一个负载平衡的RestTemplate，请创建一个RestTemplate @Bean并使用@LoadBalanced限定符，如下例所示：

*@Configuration*

**public** **class** MyConfiguration {

*@LoadBalanced*

*@Bean*

RestTemplate restTemplate() {

**return** **new** RestTemplate();

}

}

**public** **class** MyClass {

*@Autowired*

**private** RestTemplate restTemplate;

**public** String doOtherStuff() {

String results = restTemplate.getForObject("http://stores/stores", String.**class**);

**return** results;

}

}

|  |  |
| --- | --- |
| [Caution] | **Caution(警告)** |
| RestTemplate bean不再通过自动配置创建。 个人应用程序必须创建它。 |

该URI需要使用virtual host name（即服务名称，而不是主机名称）。 功能区客户端用于创建完整的物理地址。 有关如何设置RestTemplate的详细信息，请参阅 [RibbonAutoConfiguration](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/spring-cloud-netflix-core/src/main/java/org/springframework/cloud/netflix/ribbon/RibbonAutoConfiguration.java)。

## 3.4 Spring WebClient as a Load Balancer Client

WebClient可以自动配置为使用LoadBalancerClient。 要创建负载平衡的WebClient，请创建WebClient.Builder @Bean并使用@LoadBalanced限定符，如以下示例所示：

*@Configuration*

**public** **class** MyConfiguration {

*@Bean*

*@LoadBalanced*

**public** WebClient.Builder loadBalancedWebClientBuilder() {

**return** WebClient.builder();

}

}

**public** **class** MyClass {

*@Autowired*

**private** WebClient.Builder webClientBuilder;

**public** Mono<String> doOtherStuff() {

**return** webClientBuilder.build().get().uri("http://stores/stores")

.retrieve().bodyToMono(String.**class**);

}

}

该URI需要使用virtual host name（即服务名称，而不是主机名称）。 功能区客户端用于创建完整的物理地址。

### 3.4.1 Retrying Failed Requests

负载平衡的RestTemplate可以配置为重试失败的请求。 默认情况下，该逻辑被禁用。 您可以通过将 [Spring Retry](https://github.com/spring-projects/spring-retry)添加到应用程序的类路径来启用它。 负载平衡的RestTemplate支持一些与重试失败请求相关的功能区配置值。 您可以使用client.ribbon.MaxAutoRetries, client.ribbon.MaxAutoRetriesNextServer和client.ribbon.OkToRetryOnAllOperations属性。 如果您希望在类路径中使用Spring Retry禁用重试逻辑，则可以设置spring.cloud.loadbalancer.retry.enabled=false。 请参阅[Ribbon documentation](https://github.com/Netflix/ribbon/wiki/Getting-Started#the-properties-file-sample-clientproperties)以了解这些属性的功能。

如果您想在重试中实现BackOffPolicy，则需要创建一个LoadBalancedBackOffPolicyFactory类型的bean，并返回您希望用于给定服务的BackOffPolicy，如以下示例所示：

*@Configuration*

**public** **class** MyConfiguration {

*@Bean*

LoadBalancedBackOffPolicyFactory backOffPolciyFactory() {

**return** **new** LoadBalancedBackOffPolicyFactory() {

*@Override*

**public** BackOffPolicy createBackOffPolicy(String service) {

**return** **new** ExponentialBackOffPolicy();

}

};

}

}

|  |
| --- |
| [Note] |
| 前面的示例中的lient应替换为您的Ribbon客户端的名称。 |

如果要将一个或多个RetryListener实现添加到重试功能中，则需要创建LoadBalancedRetryListenerFactory类型的bean，并返回要用于给定服务的RetryListener数组，如以下示例所示：

*@Configuration*

**public** **class** MyConfiguration {

*@Bean*

LoadBalancedRetryListenerFactory retryListenerFactory() {

**return** **new** LoadBalancedRetryListenerFactory() {

*@Override*

**public** RetryListener[] createRetryListeners(String service) {

**return** **new** RetryListener[]{**new** RetryListener() {

*@Override*

**public** <T, E **extends** Throwable> **boolean** open(RetryContext context, RetryCallback<T, E> callback) {

*//TODO Do you business...*

**return** true;

}

*@Override*

**public** <T, E **extends** Throwable> **void** close(RetryContext context, RetryCallback<T, E> callback, Throwable throwable) {

*//TODO Do you business...*

}

*@Override*

**public** <T, E **extends** Throwable> **void** onError(RetryContext context, RetryCallback<T, E> callback, Throwable throwable) {

*//TODO Do you business...*

}

}};

}

};

}

}

## 3.5 Multiple RestTemplate objects

如果你想要一个没有负载平衡的RestTemplate，创建一个RestTemplate bean并注入它。 要访问负载平衡的RestTemplate，请在创建@Bean时使用@LoadBalanced限定符，如以下示例所示：\

*@Configuration*

**public** **class** MyConfiguration {

*@LoadBalanced*

*@Bean*

RestTemplate loadBalanced() {

**return** **new** RestTemplate();

}

*@Primary*

*@Bean*

RestTemplate restTemplate() {

**return** **new** RestTemplate();

}

}

**public** **class** MyClass {

*@Autowired*

**private** RestTemplate restTemplate;

*@Autowired*

*@LoadBalanced*

**private** RestTemplate loadBalanced;

**public** String doOtherStuff() {

**return** loadBalanced.getForObject("http://stores/stores", String.**class**);

}

**public** String doStuff() {

**return** restTemplate.getForObject("http://example.com", String.**class**);

}

}

|  |  |
| --- | --- |
| [Important] | **Important** |
| 请注意，在前面的示例中使用@Primary注解在简单的RestTemplate声明中可以消除不合格的@Autowired注入。 |
| [Tip] |
| 如果您看到类似java.lang.IllegalArgumentException的错误：无法将org.springframework.web.client.RestTemplate字段com.my.app.Foo.restTemplate设置为com.sun.proxy.$Proxy89，请尝试注入RestOperations或设置spring.aop.proxyTargetClass=true。 | |

## 3.6 Spring WebFlux WebClient as a Load Balancer Client

WebClient可以配置为使用LoadBalancerClient。 如果spring-webflux位于类路径中，则LoadBalancerExchangeFilterFunction会自动配置。 以下示例显示如何配置WebClient以使用负载均衡器：

**public** **class** MyClass {

*@Autowired*

**private** LoadBalancerExchangeFilterFunction lbFunction;

**public** Mono<String> doOtherStuff() {

**return** WebClient.builder().baseUrl("http://stores")

.filter(lbFunction)

.build()

.get()

.uri("/stores")

.retrieve()

.bodyToMono(String.**class**);

}

}

该URI需要使用virtual host name（即服务名称，而不是主机名称）。 LoadBalancerClient用于创建完整的物理地址。

## 3.7 Ignore Network Interfaces

有时候，忽略某些命名的网络接口是有用的，这样可以将它们从服务发现注册中排除（例如，在Docker容器中运行时）。 正则表达式列表可以设置为使所需的网络接口被忽略。 以下配置忽略docker0 interface和以veth开头的所有接口：

**application.yml.**

spring:

cloud:

inetutils:

ignoredInterfaces:

- docker0

- veth.\*

您还可以使用正则表达式列表强制仅使用指定的网络地址，如下例所示：

**application.yml.**

spring:

cloud:

inetutils:

preferredNetworks:

- 192.168

- 10.0

您还可以强制使用站点本地地址，如以下示例所示：.application.yml

spring:

cloud:

inetutils:

useOnlySiteLocalInterfaces: true

有关构成站点本地地址的详细信息，请参阅[Inet4Address.html.isSiteLocalAddress()](https://docs.oracle.com/javase/8/docs/api/java/net/Inet4Address.html#isSiteLocalAddress--) 。

## 3.8 HTTP Client Factories

Spring Cloud Commons提供了用于创建Apache HTTP客户端（ApacheHttpClientFactory）和OK HTTP客户端（OkHttpClientFactory）的bean。 OkHttpClientFactory bean仅在OK HTTP jar位于类路径中时创建。 另外，Spring Cloud Commons提供了用于创建两个客户端使用的连接管理器的bean：用于Apache HTTP客户端的 ApacheHttpClientConnectionManagerFactory和用于OK HTTP客户端的OkHttpClientConnectionPoolFactory。 如果您想定制在下游项目中如何创建HTTP客户端，则可以提供您自己的这些bean的实现。 另外，如果你提供了一个类型为HttpClientBuilder or OkHttpClient.Builder的bean，默认工厂使用这些构建器作为构建器返回到下游项目的基础。 您还可以通过将spring.cloud.httpclientfactories.apache.enabled or spring.cloud.httpclientfactories.ok.enabled 设置为 false来禁用这些bean的创建。

## 3.9 Enabled Features

Spring Cloud Commons提供了一个/features执行器端点。 此端点返回类路径上可用的功能以及它们是否已启用。 返回的信息包括功能类型，名称，版本和供应商。

### 3.9.1 Feature types

有两种类型的'features'：abstract and named。

Abstract features是定义接口或抽象类以及创建的实现（如DiscoveryClient, LoadBalancerClient, or LockService）的功能。 抽象类或接口用于在上下文中查找该类型的bean。 显示的版本是bean.getClass().getPackage().getImplementationVersion()。

Named features是没有实现特定类的功能，例如"Circuit Breaker"，"API Gateway", "Spring Cloud Bus"等。 这些功能需要一个名称和一个bean类型。

### 3.9.2 Declaring features

任何模块都可以声明任意数量的HasFeature beans，如以下示例所示：

*@Bean*

**public** HasFeatures commonsFeatures() {

**return** HasFeatures.abstractFeatures(DiscoveryClient.**class**, LoadBalancerClient.**class**);

}

*@Bean*

**public** HasFeatures consulFeatures() {

**return** HasFeatures.namedFeatures(

**new** NamedFeature("Spring Cloud Bus", ConsulBusAutoConfiguration.**class**),

**new** NamedFeature("Circuit Breaker", HystrixCommandAspect.**class**));

}

*@Bean*

HasFeatures localFeatures() {

**return** HasFeatures.builder()

.abstractFeature(Foo.**class**)

.namedFeature(**new** NamedFeature("Bar Feature", Bar.**class**))

.abstractFeature(Baz.**class**)

.build();

}

这些bean中的每一个都应该进入一个适当的保护@Configuration。

# Part II. Spring Cloud Config

**Finchley.M9**

Spring Cloud Config为分布式系统中的外部配置提供服务器端和客户端支持。使用Config Server，您可以在所有环境中管理应用程序的外部属性。客户端和服务器上的概念与Environment and PropertySource abstractions一致，所以它们非常适合Spring应用程序，但可以与任何运行在任何语言的应用程序一起使用。随着应用程序从开发到测试转移到生产环境中，您可以管理这些环境之间的配置，并确保应用程序拥有迁移时所需的所有内容。服务器存储后端的默认实现使用git，因此它很容易支持配置环境的标签版本，并可用于管理内容的各种工具。使用Spring配置很容易添加替代实现并将其插入。

## 4. Quick Start

quick start介绍了如何使用Spring Cloud Config Server的服务器和客户端。

首先，启动服务器，如下所示：

$ cd spring-cloud-config-server

$ ../mvnw spring-boot:run

该server是一个Spring Boot应用程序，因此如果您愿意，可以从IDE运行它（主类为ConfigServerApplication）。

接下来尝试一个客户端，如下所示：

$ curl localhost:8888/foo/development

{"name":"foo","label":"master","propertySources":[

{"name":"https://github.com/scratches/config-repo/foo-development.properties","source":{"bar":"spam"}},

{"name":"https://github.com/scratches/config-repo/foo.properties","source":{"foo":"bar"}}

]}

查找属性源的默认策略是克隆git存储库（在spring.cloud.config.server.git.uri）并使用它来初始化一个小型SpringApplication。 迷你应用程序的Environment用于枚举属性源并将它们发布到JSON端点。

HTTP服务具有以下形式的资源：

/{application}/{profile}[/{label}]

/{application}-{profile}.yml

/{label}/{application}-{profile}.yml

/{application}-{profile}.properties

/{label}/{application}-{profile}.properties

其中application是SpringApplication中的spring.config.name（通常是Spring Boot应用程序中的应用程序）注入的，profile是活动配置文件（或逗号分隔的属性列表），label是可选的git标签（ 默认为master。）

Spring Cloud Config Server从git仓库（必须提供）中为远程客户端提取配置，如以下示例所示：

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

## 4.1 Client Side Usage

要在应用程序中使用这些功能，可以将其构建为依赖于spring-cloud-config-client的Spring Boot应用程序（例如，请参阅config-client或示例应用程序的测试用例）。 添加依赖项最方便的方法是使用Spring Boot启动器org.springframework.cloud:spring-cloud-starter-config。 对于Maven用户还有一个父pom和BOM(spring-cloud-starter-parent)，以及Gradle和Spring CLI用户的Spring IO版本管理属性文件。 以下示例显示了一个典型的Maven配置：

**pom.xml.**

<parent>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-parent</artifactId>

<version>{spring-boot-docs-version}</version>

<relativePath /> *<!-- lookup parent from repository -->*

</parent>

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>{spring-cloud-version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-config</artifactId>

</dependency>

<dependency>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-test</artifactId>

<scope>test</scope>

</dependency>

</dependencies>

<build>

<plugins>

<plugin>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-maven-plugin</artifactId>

</plugin>

</plugins>

</build>

*<!-- repositories also needed for snapshots and milestones -->*

现在您可以创建一个标准的Spring Boot应用程序，例如以下HTTP server：

@SpringBootApplication

@RestController

public class Application {

@RequestMapping("/")

public String home() {

return "Hello World!";

}

public static void main(String[] args) {

SpringApplication.run(Application.class, args);

}

}

当此HTTP server运行时，它会从端口8888上的默认本地配置服务器（如果它正在运行）中获取外部配置。要修改启动行为，您可以使用bootstrap.properties（类似）更改配置服务器的位置 到application.properties，但是应用程序上下文的引导阶段），如以下示例所示：

spring.cloud.config.uri: http://myconfigserver.com

bootstrap properties在/env端点中显示为高优先级属性源，如以下示例所示。

$ curl localhost:8080/env

{

"profiles":[],

"configService:https://github.com/spring-cloud-samples/config-repo/bar.properties":{"foo":"bar"},

"servletContextInitParams":{},

"systemProperties":{...},

...

}

一个名为``configService:<URL of remote repository>/<file name>包含foo属性，其值为bar并且是最高优先级。

|  |
| --- |
| [Note] |
| 属性源名称中的URL是git存储库，而不是配置服务器URL。 |

## 5. Spring Cloud Config Server

Spring Cloud Config Server为外部配置（name-value对或同等YAML内容）提供基于HTTP资源的API。 通过使用@EnableConfigServer注解，服务器可嵌入到Spring Boot应用程序中。 因此，以下应用程序是一个config server：

**ConfigServer.java.**

*@SpringBootApplication*

*@EnableConfigServer*

**public** **class** ConfigServer {

**public** **static** **void** main(String[] args) {

SpringApplication.run(ConfigServer.**class**, args);

}

}

像所有的Spring Boot应用程序一样，默认情况下它在端口8080上运行，但您可以通过各种方式将其切换到更传统的端口8888。 最简单的方法是设置默认的配置库，方法是使用spring.config.name=configserver启动它（在Config Server jar中有一个configserver.yml）。 另一个是使用自己的application.properties，如以下示例所示：

server.port: 8888

spring.cloud.config.server.git.uri: file://${user.home}/config-repo

其中${user.home}/config-repo是一个包含YAML和属性文件的git存储库。

|  |
| --- |
| [Note] |
| 在Windows上，如果文件URL是绝对驱动器前缀（例如，file:///${user.home}/config-repo），则需要在文件URL中添加一个额外的“/”。 |
| [Tip] |
| 以下列表显示了在上例中创建git存储库的配方：  $ cd $HOME  $ mkdir config-repo  $ cd config-repo  $ git init .  $ echo info.foo: bar > application.properties  $ git add -A .  $ git commit -m "Add application.properties" | |

|  |
| --- |
| [Warning] |
| 为您的git存储库使用本地文件系统仅用于测试。 您应该使用服务器来托管生产中的配置存储库。 |
| [Warning] |
| 如果只保留文本文件，配置库的初始克隆可以快速有效。 如果您存储二进制文件，尤其是大型文件，则可能会在首次配置请求时遇到延迟，或者遇到服务器内存不足错误。 | |

## 5.1 Environment Repository

你应该在哪里存储配置服务器的配置数据？ 控制这种行为的策略是为环境对象提供服务的EnvironmentRepository。 这个Environment是SpringEnvironment中域的浅层副本（包括propertySources作为主要特性）。 Environment resources由三个变量进行参数化：

* {application}, 它映射到客户端的 spring.application.name .
* {profile}, 它映射到客户端的 spring.profiles.active(comma-separated list).
* {label}, 它是标记”versioned”配置文件集的server端功能.

版本库实现通常表现得像Spring Boot应用程序，从spring.config.name加载配置文件等于{application}参数，spring.profiles.active等于{profiles}参数。 配置文件的优先级规则也与普通的Spring Boot应用程序相同：活动配置文件优先于默认配置文件，并且，如果有多个配置文件，最后一个配置文件将获胜（类似于向Map添加条目）。

以下示例客户端应用程序具有此引导程序配置：

**bootstrap.yml.**

spring:

application:

name: foo

profiles:

active: dev,mysql

（像通常的Spring Boot应用程序一样，这些属性也可以通过环境变量或命令行参数来设置）。

如果存储库是基于文件的，则服务器将从application.yml（所有客户端共享）和foo.yml（优先foo.yml）创建一个Environment。 如果YAML文件内部有文档指向Spring配置文件，那么这些文件将以更高的优先级应用（按列出的配置文件的顺序）。 如果存在特定于配置文件的YAML（或属性）文件，则这些文件的优先级高于默认值。 更高的优先级转换为Environment中早先列出的PropertySource。 （这些相同的规则适用于独立的Spring Boot应用程序。）

### 5.1.1 Git Backend

EnvironmentRepository的默认实现使用Git后端，这对于管理升级和物理环境以及审核更改非常方便。要更改存储库的位置，可以在Config Server中设置spring.cloud.config.server.git.uri配置属性（例如，在application.yml中）。如果您使用file:前缀进行设置，它应该从本地存储库运行，这样您就可以在没有服务器的情况下快速轻松地启动。但是，在这种情况下，服务器直接在本地存储库上运行而不克隆它（因为配置服务器永远不会更改"remote"存储库，所以它不是裸露的，这并不重要）。要扩展配置服务器并使其具有高可用性，您需要将服务器的所有实例指向同一个存储库，因此只有共享文件系统才能工作。即使在这种情况下，最好对共享文件系统存储库使用ssh: protocol，以便服务器可以克隆它并使用本地工作副本作为缓存。

该存储库实现将HTTP资源的{label}参数映射到git标签（提交标识，分支名称或标记）。 如果git分支或标签名称包含一个斜杠(/)，则HTTP URL中的标签应该用特殊字符串$$\_$$指定（以避免与其他URL路径混淆）。 例如，如果标签是foo/bar，则替换斜杠将生成以下标签：foo($$\_$$)bar。 包含特殊字符串($$\_$$)也可以应用于{application}参数。 如果您使用诸如curl的命令行客户端，请小心URL中的括号 - 您应该使用单引号（''）将它们从shell中转义出来。

#### Placeholders(占位符) in Git URI

如果您需要，Spring Cloud Config Server支持带有{application} and {profile}（和{label}）占位符的git存储库URL，但请记住该标签作为git标签应用。 因此，您可以通过使用类似于以下内容的结构来支持“每个应用程序一个存储库”策略：

spring:

cloud:

config:

server:

git:

uri: https://github.com/myorg/{application**}**

您还可以使用类似的模式，但使用{profile}来支持“每个配置文件一个存储库”策略。

此外，在{application}参数中使用特殊字符串"($$\_$$)"可以支持多个organizations，如以下示例所示：

spring:

cloud:

config:

server:

git:

uri: https://github.com/{application**}**

在请求时按以下格式提供{application}：organization($$\_$$)application。

#### Pattern Matching and Multiple Repositories

Spring Cloud Config还支持更复杂的需求，并在应用程序和配置文件名称上进行模式匹配。 模式格式是带有通配符的{application}/{profile}名称的逗号分隔列表（请注意，可能需要引用以通配符开头的模式），如以下示例所示：

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

repos:

simple: https://github.com/simple/config-repo

special:

pattern: special\*/dev\*,\*special\*/dev\*

uri: https://github.com/special/config-repo

local:

pattern: local\*

uri: file:/home/configsvc/config-repo

如果{application}/{profile}与任何模式都不匹配，它将使用spring.cloud.config.server.git.uri下定义的默认URI。 在上面的示例中，对于“simple”存储库，该模式是simple/\*（它只匹配所有配置文件中名为simple的一个应用程序）。 “local”存储库匹配所有配置文件中以local开头的所有应用程序名称（/\*后缀自动添加到任何没有配置文件匹配器的模式）。

|  |
| --- |
| [Note] |
| “simple”示例中使用的“one-liner”快捷方式只能在要设置的唯一属性是URI的情况下使用。 如果您需要设置其他任何内容（credentials, pattern等），则需要使用full form。 |

repo中的pattern属性实际上是一个数组，因此您可以在属性文件中使用YAML数组（或[0], [1]等后缀）绑定到多个模式。 如果您要使用多个配置文件运行应用程序，则可能需要这样做，如下例所示：

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

repos:

development:

pattern:

- '\*/development'

- '\*/staging'

uri: https://github.com/development/config-repo

staging:

pattern:

- '\*/qa'

- '\*/production'

uri: https://github.com/staging/config-repo

|  |
| --- |
| [Note] |
| Spring Cloud猜测包含不以 \* 结尾的配置文件的模式意味着您实际上想匹配以此模式开始的配置文件列表（因此\*/staging是["\*/staging", "\*/staging,\*"]， 等等）。 例如，您需要在本地“development”配置文件中运行应用程序，而在远程运行“cloud”配置文件时，这也很常见。 |

每个存储库还可以选择将配置文件存储在子目录中，并且可以将搜索这些目录的模式指定为searchPaths。 以下示例显示了顶层的配置文件：

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

searchPaths: foo,bar\*

在前面的示例中，服务器搜索顶层和foo/子目录中的配置文件以及名称以bar开头的任何子目录。

默认情况下，服务器首次请求配置时克隆远程存储库。 可以将服务器配置为在启动时克隆存储库，如以下top-level示例所示：

spring:

cloud:

config:

server:

git:

uri: https://git/common/config-repo.git

repos:

team-a:

pattern: team-a-\*

cloneOnStart: **true**

uri: http://git/team-a/config-repo.git

team-b:

pattern: team-b-\*

cloneOnStart: **false**

uri: http://git/team-b/config-repo.git

team-c:

pattern: team-c-\*

uri: http://git/team-a/config-repo.git

在前面的示例中，服务器在启动时克隆team-a的config-repo，然后接受任何请求。 除非请求存储库中的配置，否则所有其他存储库都不会被克隆。

|  |
| --- |
| [Note] |
| 在配置服务器启动时设置要克隆的存储库可以帮助在配置服务器启动时快速识别配置错误的配置源（例如无效的存储库URI）。 使用cloneOnStart未启用配置源时，配置服务器可能会以错误配置或无效的配置源成功启动，并且在应用程序从该配置源请求配置之前检测不到错误。 |

#### Authentication(认证)

要在远程存储库上使用HTTP基本身份验证，请单独添加username和password属性（不在URL中），如以下示例所示：

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

username: trolley

password: strongpassword

If you do not use HTTPS and user credentials, SSH should also work out of the box when you store keys in the default directories (~/.ssh) and the URI points to an SSH location, such as git@github.com:configuration/cloud-configuration. It is important that an entry for the Git server be present in the ~/.ssh/known\_hosts file and that it is in ssh-rsa format. Other formats (such as ecdsa-sha2-nistp256) are not supported. To avoid surprises, you should ensure that only one entry is present in the known\_hosts file for the Git server and that it matches the URL you provided to the config server. If you use a hostname in the URL, you want to have exactly that (not the IP) in the known\_hosts file. The repository is accessed by using JGit, so any documentation you find on that should be applicable. HTTPS proxy settings can be set in ~/.git/config or (in the same way as for any other JVM process) with system properties (-Dhttps.proxyHost and -Dhttps.proxyPort).

|  |
| --- |
| [Tip] |
| If you do not know where your ~/.git directory is, use git config --global to manipulate the settings (for example, git config --global http.sslVerify false). |

#### Authentication with AWS CodeCommit

Spring Cloud Config Server also supports [AWS CodeCommit](https://docs.aws.amazon.com/codecommit/latest/userguide/welcome.html) authentication. AWS CodeCommit uses an authentication helper when using Git from the command line. This helper is not used with the JGit library, so a JGit CredentialProvider for AWS CodeCommit is created if the Git URI matches the AWS CodeCommit pattern. AWS CodeCommit URIs follow this pattern://git-codecommit.${AWS\_REGION}.amazonaws.com/${repopath}.

If you provide a username and password with an AWS CodeCommit URI, they must be the [AWS accessKeyId and secretAccessKey](https://docs.aws.amazon.com/AWSSimpleQueueService/latest/SQSGettingStartedGuide/AWSCredentials.html) that provide access to the repository. If you do not specify a username and password, the accessKeyId and secretAccessKey are retrieved by using the [AWS Default Credential Provider Chain](https://docs.aws.amazon.com/sdk-for-java/v1/developer-guide/credentials.html).

If your Git URI matches the CodeCommit URI pattern (shown earlier), you must provide valid AWS credentials in the username and password or in one of the locations supported by the default credential provider chain. AWS EC2 instances may use [IAM Roles for EC2 Instances](https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/iam-roles-for-amazon-ec2.html).

|  |
| --- |
| [Note] |
| The aws-java-sdk-core jar is an optional dependency. If the aws-java-sdk-core jar is not on your classpath, the AWS Code Commit credential provider is not created, regardless of the git server URI. |

#### Git SSH configuration using properties

By default, the JGit library used by Spring Cloud Config Server uses SSH configuration files such as ~/.ssh/known\_hosts and /etc/ssh/ssh\_config when connecting to Git repositories by using an SSH URI. In cloud environments such as Cloud Foundry, the local filesystem may be ephemeral or not easily accessible. For those cases, SSH configuration can be set by using Java properties. In order to activate property-based SSH configuration, the spring.cloud.config.server.git.ignoreLocalSshSettings property must be set to true, as shown in the following example:

spring:

cloud:

config:

server:

git:

uri: git*@gitserver.com:team/repo1.git*

ignoreLocalSshSettings: **true**

hostKey: someHostKey

hostKeyAlgorithm: ssh-rsa

privateKey: |

-----BEGIN RSA PRIVATE KEY-----

MIIEpgIBAAKCAQEAx4UbaDzY5xjW6hc9jwN0mX33XpTDVW9WqHp5AKaRbtAC3DqX

IXFMPgw3K45jxRb93f8tv9vL3rD9CUG1Gv4FM+o7ds7FRES5RTjv2RT/JVNJCoqF

ol8+ngLqRZCyBtQN7zYByWMRirPGoDUqdPYrj2yq+ObBBNhg5N+hOwKjjpzdj2Ud

1l7R+wxIqmJo1IYyy16xS8WsjyQuyC0lL456qkd5BDZ0Ag8j2X9H9D5220Ln7s9i

oezTipXipS7p7Jekf3Ywx6abJwOmB0rX79dV4qiNcGgzATnG1PkXxqt76VhcGa0W

DDVHEEYGbSQ6hIGSh0I7BQun0aLRZojfE3gqHQIDAQABAoIBAQCZmGrk8BK6tXCd

fY6yTiKxFzwb38IQP0ojIUWNrq0+9Xt+NsypviLHkXfXXCKKU4zUHeIGVRq5MN9b

BO56/RrcQHHOoJdUWuOV2qMqJvPUtC0CpGkD+valhfD75MxoXU7s3FK7yjxy3rsG

EmfA6tHV8/4a5umo5TqSd2YTm5B19AhRqiuUVI1wTB41DjULUGiMYrnYrhzQlVvj

5MjnKTlYu3V8PoYDfv1GmxPPh6vlpafXEeEYN8VB97e5x3DGHjZ5UrurAmTLTdO8

+AahyoKsIY612TkkQthJlt7FJAwnCGMgY6podzzvzICLFmmTXYiZ/28I4BX/mOSe

pZVnfRixAoGBAO6Uiwt40/PKs53mCEWngslSCsh9oGAaLTf/XdvMns5VmuyyAyKG

ti8Ol5wqBMi4GIUzjbgUvSUt+IowIrG3f5tN85wpjQ1UGVcpTnl5Qo9xaS1PFScQ

xrtWZ9eNj2TsIAMp/svJsyGG3OibxfnuAIpSXNQiJPwRlW3irzpGgVx/AoGBANYW

dnhshUcEHMJi3aXwR12OTDnaLoanVGLwLnkqLSYUZA7ZegpKq90UAuBdcEfgdpyi

PhKpeaeIiAaNnFo8m9aoTKr+7I6/uMTlwrVnfrsVTZv3orxjwQV20YIBCVRKD1uX

VhE0ozPZxwwKSPAFocpyWpGHGreGF1AIYBE9UBtjAoGBAI8bfPgJpyFyMiGBjO6z

FwlJc/xlFqDusrcHL7abW5qq0L4v3R+FrJw3ZYufzLTVcKfdj6GelwJJO+8wBm+R

gTKYJItEhT48duLIfTDyIpHGVm9+I1MGhh5zKuCqIhxIYr9jHloBB7kRm0rPvYY4

VAykcNgyDvtAVODP+4m6JvhjAoGBALbtTqErKN47V0+JJpapLnF0KxGrqeGIjIRV

cYA6V4WYGr7NeIfesecfOC356PyhgPfpcVyEztwlvwTKb3RzIT1TZN8fH4YBr6Ee

KTbTjefRFhVUjQqnucAvfGi29f+9oE3Ei9f7wA+H35ocF6JvTYUsHNMIO/3gZ38N

CPjyCMa9AoGBAMhsITNe3QcbsXAbdUR00dDsIFVROzyFJ2m40i4KCRM35bC/BIBs

q0TY3we+ERB40U8Z2BvU61QuwaunJ2+uGadHo58VSVdggqAo0BSkH58innKKt96J

69pcVH/4rmLbXdcmNYGm6iu+MlPQk4BUZknHSmVHIFdJ0EPupVaQ8RHT

-----END RSA PRIVATE KEY-----

The following table describes the SSH configuration properties.

**Table 5.1. SSH Configuration Properties**

| **Property Name** | **Remarks** |
| --- | --- |
| **ignoreLocalSshSettings** | If true, use property-based instead of file-based SSH config. Must be set at as spring.cloud.config.server.git.ignoreLocalSshSettings, **not** inside a repository definition. |
| **privateKey** | Valid SSH private key. Must be set if ignoreLocalSshSettings is true and Git URI is SSH format. |
| **hostKey** | Valid SSH host key. Must be set if hostKeyAlgorithm is also set. |
| **hostKeyAlgorithm** | One of ssh-dss, ssh-rsa, ecdsa-sha2-nistp256, ecdsa-sha2-nistp384, or ecdsa-sha2-nistp521. Must be set if hostKey is also set. |
| **strictHostKeyChecking** | true or false. If false, ignore errors with host key. |
| **knownHostsFile** | Location of custom .known\_hosts file. |
| **preferredAuthentications** | Override server authentication method order. This should allow for evading login prompts if server has keyboard-interactive authentication before the publickey method. |

#### Placeholders in Git Search Paths

Spring Cloud Config Server also supports a search path with placeholders for the {application} and {profile} (and {label} if you need it), as shown in the following example:

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

searchPaths: '{application}'

The preceding listing causes a search of the repository for files in the same name as the directory (as well as the top level). Wildcards are also valid in a search path with placeholders (any matching directory is included in the search).

#### Force pull in Git Repositories

As mentioned earlier, Spring Cloud Config Server makes a clone of the remote git repository in case the local copy gets dirty (for example, folder content changes by an OS process) such that Spring Cloud Config Server cannot update the local copy from remote repository.

To solve this issue, there is a force-pull property that makes Spring Cloud Config Server force pull from the remote repository if the local copy is dirty, as shown in the following example:

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

force-pull: **true**

If you have a multiple-repositories configuration, you can configure the force-pull property per repository, as shown in the following example:

spring:

cloud:

config:

server:

git:

uri: https://git/common/config-repo.git

force-pull: **true**

repos:

team-a:

pattern: team-a-\*

uri: http://git/team-a/config-repo.git

force-pull: **true**

team-b:

pattern: team-b-\*

uri: http://git/team-b/config-repo.git

force-pull: **true**

team-c:

pattern: team-c-\*

uri: http://git/team-a/config-repo.git

|  |
| --- |
| [Note] |
| The default value for force-pull property is false. |

#### Deleting untracked branches in Git Repositories

As Spring Cloud Config Server has a clone of the remote git repository after check-outing branch to local repo (e.g fetching properties by label) it will keep this branch forever or till the next server restart (which creates new local repo). So there could be a case when remote branch is deleted but local copy of it is still available for fetching. And if Spring Cloud Config Server client service starts with --spring.cloud.config.label=deletedRemoteBranch,master it will fetch properties from deletedRemoteBranch local branch, but not from master.

In order to keep local repository branches clean and up to remote - deleteUntrackedBranches property could be set. It will make Spring Cloud Config Server **force**delete untracked branches from local repository. Example:

spring:

cloud:

config:

server:

git:

uri: https://github.com/spring-cloud-samples/config-repo

deleteUntrackedBranches: **true**

|  |
| --- |
| [Note] |
| The default value for deleteUntrackedBranches property is false. |

### 5.1.2 Version Control Backend Filesystem Use

|  |
| --- |
| [Warning] |
| With VCS-based backends (git, svn), files are checked out or cloned to the local filesystem. By default, they are put in the system temporary directory with a prefix of config-repo-. On linux, for example, it could be /tmp/config-repo-<randomid>. Some operating systems [routinely clean out](https://serverfault.com/questions/377348/when-does-tmp-get-cleared/377349#377349) temporary directories. This can lead to unexpected behavior, such as missing properties. To avoid this problem, change the directory that Config Server uses by setting spring.cloud.config.server.git.basedir or spring.cloud.config.server.svn.basedir to a directory that does not reside in the system temp structure. |

### 5.1.3 File System Backend

There is also a “native” profile in the Config Server that does not use Git but loads the config files from the local classpath or file system (any static URL you want to point to with spring.cloud.config.server.native.searchLocations). To use the native profile, launch the Config Server with spring.profiles.active=native.

|  |
| --- |
| [Note] |
| Remember to use the file: prefix for file resources (the default without a prefix is usually the classpath). As with any Spring Boot configuration, you can embed ${}-style environment placeholders, but remember that absolute paths in Windows require an extra / (for example, file:///${user.home}/config-repo). |
| [Warning] |
| The default value of the searchLocations is identical to a local Spring Boot application (that is, [classpath:/, classpath:/config, file:./, file:./config]). This does not expose the application.properties from the server to all clients, because any property sources present in the server are removed before being sent to the client. | |

|  |
| --- |
| [Tip] |
| A filesystem backend is great for getting started quickly and for testing. To use it in production, you need to be sure that the file system is reliable and shared across all instances of the Config Server. |

The search locations can contain placeholders for {application}, {profile}, and {label}. In this way, you can segregate the directories in the path and choose a strategy that makes sense for you (such as subdirectory per application or subdirectory per profile).

If you do not use placeholders in the search locations, this repository also appends the {label} parameter of the HTTP resource to a suffix on the search path, so properties files are loaded from each search location **and** a subdirectory with the same name as the label (the labelled properties take precedence in the Spring Environment). Thus, the default behaviour with no placeholders is the same as adding a search location ending with /{label}/. For example, file:/tmp/config is the same as file:/tmp/config,file:/tmp/config/{label}. This behavior can be disabled by setting spring.cloud.config.server.native.addLabelLocations=false.

### 5.1.4 Vault Backend

Spring Cloud Config Server also supports [Vault](https://www.vaultproject.io/) as a backend.

Vault is a tool for securely accessing secrets. A secret is anything that to which you want to tightly control access, such as API keys, passwords, certificates, and other sensitive information. Vault provides a unified interface to any secret while providing tight access control and recording a detailed audit log.

For more information on Vault, see the [Vault quick start guide](https://www.vaultproject.io/intro/index.html).

To enable the config server to use a Vault backend, you can run your config server with the vault profile. For example, in your config server’s application.properties, you can add spring.profiles.active=vault.

By default, the config server assumes that your Vault server runs at [http://127.0.0.1:8200](http://127.0.0.1:8200/). It also assumes that the name of backend is secret and the key is application. All of these defaults can be configured in your config server’s application.properties. The following table describes configurable Vault properties:

| **Name** | | **Default Value** |
| --- | --- | --- |
| host | | 127.0.0.1 |
| port | | 8200 |
| scheme | | http |
| backend | | secret |
| defaultKey | | application |
| profileSeparator | | , |
| [Important] | **Important** |
| All of the properties in the preceding table must be prefixed with spring.cloud.config.server.vault. |

All configurable properties can be found in org.springframework.cloud.config.server.environment.VaultEnvironmentRepository.

With your config server running, you can make HTTP requests to the server to retrieve values from the Vault backend. To do so, you need a token for your Vault server.

First, place some data in you Vault, as shown in the following example:

$ vault write secret/application foo=bar baz=bam

$ vault write secret/myapp foo=myappsbar

Second, make an HTTP request to your config server to retrieve the values, as shown in the following example:

$ curl -X "GET" "http://localhost:8888/myapp/default" -H "X-Config-Token: yourtoken"

You should see a response similar to the following:

**{**

"name":"myapp"**,**

"profiles":**[**

"default"

]**,**

"label":null**,**

"version":null**,**

"state":null**,**

"propertySources":**[**

**{**

"name":"vault:myapp"**,**

"source":**{**

"foo":"myappsbar"

**}**

**},**

**{**

"name":"vault:application"**,**

"source":**{**

"baz":"bam"**,**

"foo":"bar"

**}**

**}**

**]**

**}**

#### Multiple Properties Sources

When using Vault, you can provide your applications with multiple properties sources. For example, assume you have written data to the following paths in Vault:

secret/myApp,dev

secret/myApp

secret/application,dev

secret/application

Properties written to secret/application are available to [all applications using the Config Server](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_config_server.html). An application with the name, myApp, would have any properties written to secret/myApp and secret/application available to it. When myApp has the dev profile enabled, properties written to all of the above paths would be available to it, with properties in the first path in the list taking priority over the others.

### 5.1.5 Sharing Configuration With All Applications

Sharing configuration between all applications varies according to which approach you take, as described in the following topics:

* [the section called “File Based Repositories”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_config_server.html#spring-cloud-config-server-file-based-repositories)
* [the section called “Vault Server”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_config_server.html#spring-cloud-config-server-vault-server)

#### File Based Repositories

With file-based (git, svn, and native) repositories, resources with file names in application\* (application.properties, application.yml, application-\*.properties, and so on) are shared between all client applications. You can use resources with these file names to configure global defaults and have them be overridden by application-specific files as necessary.

The #\_property\_overrides[property overrides] feature can also be used for setting global defaults, with placeholders applications allowed to override them locally.

|  |
| --- |
| [Tip] |
| With the “native” profile (a local file system backend) , you should use an explicit search location that is not part of the server’s own configuration. Otherwise, the application\* resources in the default search locations get removed because they are part of the server. |

#### Vault Server

When using Vault as a backend, you can share configuration with all applications by placing configuration in secret/application. For example, if you run the following Vault command, all applications using the config server will have the properties foo and baz available to them:

$ vault write secret/application foo=bar baz=bam

### 5.1.6 JDBC Backend

Spring Cloud Config Server supports JDBC (relational database) as a backend for configuration properties. You can enable this feature by adding spring-jdbc to the classpath and using the jdbc profile or by adding a bean of type JdbcEnvironmentRepository. If you include the right dependencies on the classpath (see the user guide for more details on that), Spring Boot configures a data source.

The database needs to have a table called PROPERTIES with columns called APPLICATION, PROFILE, and LABEL (with the usual Environment meaning), plus KEYand VALUE for the key and value pairs in Properties style. All fields are of type String in Java, so you can make them VARCHAR of whatever length you need. Property values behave in the same way as they would if they came from Spring Boot properties files named {application}-{profile}.properties, including all the encryption and decryption, which will be applied as post-processing steps (that is, not in the repository implementation directly).

### 5.1.7 Composite Environment Repositories

In some scenarios, you may wish to pull configuration data from multiple environment repositories. To do so, you can enable multiple profiles in your config server’s application properties or YAML file. If, for example, you want to pull configuration data from a Git repository as well as an SVN repository, you can set the following properties for your configuration server:

spring:

profiles:

active: git**,** svn

cloud:

config:

server:

svn:

uri: file:///path/to/svn/repo

order: 2

git:

uri: file:///path/to/git/repo

order: 1

In addition to each repository specifying a URI, you can also specify an order property. The order property lets you specify the priority order for all your repositories. The lower the numerical value of the order property, the higher priority it has. The priority order of a repository helps resolve any potential conflicts between repositories that contain values for the same properties.

|  |
| --- |
| [Note] |
| Any type of failure when retrieving values from an environment repository results in a failure for the entire composite environment. |
| [Note] |
| When using a composite environment, it is important that all repositories contain the same labels. If you have an environment similar to the one in the preceding example and you request configuration data with the master label but the SVN repository does not contain a branch called master, the entire request fails. | |

#### Custom Composite Environment Repositories

In addition to using one of the environment repositories from Spring Cloud, you can also provide your own EnvironmentRepository bean to be included as part of a composite environment. To do so, your bean must implement the EnvironmentRepository interface. If you want to control the priority of your custom EnvironmentRepository within the composite environment, you should also implement the Ordered interface and override the getOrdered method. If you do not implement the Ordered interface, your EnvironmentRepository is given the lowest priority.

### 5.1.8 Property Overrides

The Config Server has an “overrides” feature that lets the operator provide configuration properties to all applications. The overridden properties cannot be accidentally changed by the application with the normal Spring Boot hooks. To declare overrides, add a map of name-value pairs to spring.cloud.config.server.overrides, as shown in the following example:

spring:

cloud:

config:

server:

overrides:

foo: bar

The preceding examples causes all applications that are config clients to read foo=bar, independent of their own configuration.

|  |
| --- |
| [Note] |
| A configuration system cannot force an application to use configuration data in any particular way. Consequently, overrides are not enforceable. However, they do provide useful default behavior for Spring Cloud Config clients. |
| [Tip] |
| Normally, Spring environment placeholders with ${} can be escaped (and resolved on the client) by using backslash (\) to escape the $ or the {. For example, \${app.foo:bar} resolves to bar, unless the app provides its own app.foo. | |

|  |
| --- |
| [Note] |
| In YAML, you do not need to escape the backslash itself. However, in properties files, you do need to escape the backslash, when you configure the overrides on the server. |

You can change the priority of all overrides in the client to be more like default values, letting applications supply their own values in environment variables or System properties, by setting the spring.cloud.config.overrideNone=true flag (the default is false) in the remote repository.

## 5.2 Health Indicator

Config Server comes with a Health Indicator that checks whether the configured EnvironmentRepository is working. By default, it asks the EnvironmentRepositoryfor an application named app, the default profile, and the default label provided by the EnvironmentRepository implementation.

You can configure the Health Indicator to check more applications along with custom profiles and custom labels, as shown in the following example:

spring:

cloud:

config:

server:

health:

repositories:

myservice:

label: mylabel

myservice-dev:

name: myservice

profiles: development

You can disable the Health Indicator by setting spring.cloud.config.server.health.enabled=false.

## 5.3 Security

You can secure your Config Server in any way that makes sense to you (from physical network security to OAuth2 bearer tokens), because Spring Security and Spring Boot offer support for many security arrangements.

To use the default Spring Boot-configured HTTP Basic security, include Spring Security on the classpath (for example, through spring-boot-starter-security). The default is a username of user and a randomly generated password. A random password is not useful in practice, so we recommend you configure the password (by setting spring.security.user.password) and encrypt it (see below for instructions on how to do that).

## 5.4 Encryption and Decryption

|  |  |
| --- | --- |
| [Important] | **Important** |
| To use the encryption and decryption features you need the full-strength JCE installed in your JVM (it is not included by default). You can download the “Java Cryptography Extension (JCE) Unlimited Strength Jurisdiction Policy Files” from Oracle and follow the installation instructions (essentially, you need to replace the two policy files in the JRE lib/security directory with the ones that you downloaded). |

If the remote property sources contain encrypted content (values starting with {cipher}), they are decrypted before sending to clients over HTTP. The main advantage of this setup is that the property values need not be in plain text when they are “at rest” (for example, in a git repository). If a value cannot be decrypted, it is removed from the property source and an additional property is added with the same key but prefixed with invalid and a value that means “not applicable” (usually <n/a>). This is largely to prevent cipher text being used as a password and accidentally leaking.

If you set up a remote config repository for config client applications, it might contain an application.yml similar to the following:

**application.yml.**

spring:

datasource:

username: dbuser

password: '{cipher}FKSAJDFGYOS8F7GLHAKERGFHLSAJ'

Encrypted values in a .properties file must not be wrapped in quotes. Otherwise, the value is not decrypted. The following example shows values that would work:

**application.properties.**

spring.datasource.username: dbuser

spring.datasource.password: {cipher}FKSAJDFGYOS8F7GLHAKERGFHLSAJ

You can safely push this plain text to a shared git repository, and the secret password remains protected.

The server also exposes /encrypt and /decrypt endpoints (on the assumption that these are secured and only accessed by authorized agents). If you edit a remote config file, you can use the Config Server to encrypt values by POSTing to the /encrypt endpoint, as shown in the following example:

$ curl localhost:8888/encrypt -d mysecret

682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda

|  |
| --- |
| [Note] |
| If the value you encrypt has characters in it that need to be URL encoded, you should use the --data-urlencode option to curl to make sure they are encoded properly. |
| [Tip] |
| Be sure not to include any of the curl command statistics in the encrypted value. Outputting the value to a file can help avoid this problem. | |

The inverse operation is also available through /decrypt (provided the server is configured with a symmetric key or a full key pair), as shown in the following example:

$ curl localhost:8888/decrypt -d 682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda

mysecret

|  |
| --- |
| [Tip] |
| If you testing with curl, then use --data-urlencode (instead of -d) or set an explicit Content-Type: text/plain to make sure curl encodes the data correctly when there are special characters ('+' is particularly tricky). |

Take the encrypted value and add the {cipher} prefix before you put it in the YAML or properties file and before you commit and push it to a remote (potentially insecure) store.

The /encrypt and /decrypt endpoints also both accept paths in the form of /\*/{name}/{profiles}, which can be used to control cryptography on a per-application (name) and per-profile basis when clients call into the main environment resource.

|  |
| --- |
| [Note] |
| To control the cryptography in this granular way, you must also provide a @Bean of type TextEncryptorLocator that creates a different encryptor per name and profiles. The one that is provided by default does not do so (all encryptions use the same key). |

The spring command line client (with Spring Cloud CLI extensions installed) can also be used to encrypt and decrypt, as shown in the following example:

$ spring encrypt mysecret --key foo

682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda

$ spring decrypt --key foo 682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda

mysecret

To use a key in a file (such as an RSA public key for encryption), prepend the key value with "@" and provide the file path, as shown in the following example:

$ spring encrypt mysecret --key @${HOME}/.ssh/id\_rsa.pub

AQAjPgt3eFZQXwt8tsHAVv/QHiY5sI2dRcR+...

|  |
| --- |
| [Note] |
| The --key argument is mandatory (despite having a -- prefix). |

## 5.5 Key Management

The Config Server can use a symmetric (shared) key or an asymmetric one (RSA key pair). The asymmetric choice is superior in terms of security, but it is often more convenient to use a symmetric key since it is a single property value to configure in the bootstrap.properties.

To configure a symmetric key, you need to set encrypt.key to a secret String (or use the ENCRYPT\_KEY environment variable to keep it out of plain-text configuration files).

To configure an asymmetric key, you can either set the key as a PEM-encoded text value (in encrypt.key) or use a keystore (such as the keystore created by the keytool utility that comes with the JDK). The following table describes the keystore properties:

| **Property** | **Description** |
| --- | --- |
| encrypt.keyStore.location | Contains a Resource location |
| encrypt.keyStore.password | Holds the password that unlocks the keystore |
| encrypt.keyStore.alias | Identifies which key in the store to use |

The encryption is done with the public key, and a private key is needed for decryption. Thus, in principle, you can configure only the public key in the server if you want to only encrypt (and are prepared to decrypt the values yourself locally with the private key). In practice, you might not want to do decrypt locally, because it spreads the key management process around all the clients, instead of concentrating it in the server. On the other hand, it can be a useful option if your config server is relatively insecure and only a handful of clients need the encrypted properties.

## 5.6 Creating a Key Store for Testing

To create a keystore for testing, you can use a command resembling the following:

$ keytool -genkeypair -alias mytestkey -keyalg RSA \

-dname "CN=Web Server,OU=Unit,O=Organization,L=City,S=State,C=US" \

-keypass changeme -keystore server.jks -storepass letmein

Put the server.jks file in the classpath (for instance) and then, in your bootstrap.yml, for the Config Server, create the following settings:

encrypt:

keyStore:

location: classpath:/server.jks

password: letmein

alias: mytestkey

secret: changeme

## 5.7 Using Multiple Keys and Key Rotation

In addition to the {cipher} prefix in encrypted property values, the Config Server looks for zero or more {name:value} prefixes before the start of the (Base64 encoded) cipher text. The keys are passed to a TextEncryptorLocator, which can do whatever logic it needs to locate a TextEncryptor for the cipher. If you have configured a keystore (encrypt.keystore.location), the default locator looks for keys with aliases supplied by the key prefix, with a cipher text like resembling the following:

foo:

bar: `{cipher}{key:testkey}...`

The locator looks for a key named "testkey". A secret can also be supplied by using a {secret:…​} value in the prefix. However, if it is not supplied, the default is to use the keystore password (which is what you get when you build a keytore and do not specify a secret). If you do supply a secret, you should also encrypt the secret using a custom SecretLocator.

When the keys are being used only to encrypt a few bytes of configuration data (that is, they are not being used elsewhere), key rotation is hardly ever necessary on cryptographic grounds. However, you might occasionally need to change the keys (for example, in the event of a security breach). In that case, all the clients would need to change their source config files (for example, in git) and use a new {key:…​} prefix in all the ciphers. Note that the clients need to first check that the key alias is available in the Config Server keystore.

|  |
| --- |
| [Tip] |
| If you want to let the Config Server handle all encryption as well as decryption, the {name:value} prefixes can also be added as plain text posted to the /encrypt endpoint, . |

## 5.8 Serving Encrypted Properties

Sometimes you want the clients to decrypt the configuration locally, instead of doing it in the server. In that case, if you provide the encrypt.\* configuration to locate a key, you can still have /encrypt and /decrypt endpoints, but you need to explicitly switch off the decryption of outgoing properties by setting spring.cloud.config.server.encrypt.enabled=false. If you do not care about the endpoints, it should work if you do not configure either the key or the enabled flag.

## 6. Serving Alternative Formats

The default JSON format from the environment endpoints is perfect for consumption by Spring applications, because it maps directly onto the Environment abstraction. If you prefer, you can consume the same data as YAML or Java properties by adding a suffix (".yml", ".yaml" or ".properties") to the resource path. This can be useful for consumption by applications that do not care about the structure of the JSON endpoints or the extra metadata they provide (for example, an application that is not using Spring might benefit from the simplicity of this approach).

The YAML and properties representations have an additional flag (provided as a boolean query parameter called resolvePlaceholders) to signal that placeholders in the source documents (in the standard Spring ${…​} form) should be resolved in the output before rendering, where possible. This is a useful feature for consumers that do not know about the Spring placeholder conventions.

|  |
| --- |
| [Note] |
| There are limitations in using the YAML or properties formats, mainly in relation to the loss of metadata. For example, the JSON is structured as an ordered list of property sources, with names that correlate with the source. The YAML and properties forms are coalesced into a single map, even if the origin of the values has multiple sources, and the names of the original source files are lost. Also, the YAML representation is not necessarily a faithful representation of the YAML source in a backing repository either. It is constructed from a list of flat property sources, and assumptions have to be made about the form of the keys. |

## 7. Serving Plain Text

Instead of using the Environment abstraction (or one of the alternative representations of it in YAML or properties format), your applications might need generic plain-text configuration files that are tailored to their environment. The Config Server provides these through an additional endpoint at /{name}/{profile}/{label}/{path}, where name, profile, and label have the same meaning as the regular environment endpoint, but path is a file name (such as log.xml). The source files for this endpoint are located in the same way as for the environment endpoints. The same search path is used for properties and YAML files. However, instead of aggregating all matching resources, only the first one to match is returned.

After a resource is located, placeholders in the normal format (${…​}) are resolved by using the effective Environment for the supplied application name, profile, and label. In this way, the resource endpoint is tightly integrated with the environment endpoints. Consider the following example for a GIT or SVN repository:

application.yml

nginx.conf

where nginx.conf looks like this:

server {

listen 80;

server\_name ${nginx.server.name};

}

and application.yml like this:

nginx:

server:

name: example.com

*---*

spring:

profiles: development

nginx:

server:

name: develop.com

The /foo/default/master/nginx.conf resource might be as follows:

server {

listen 80;

server\_name example.com;

}

and /foo/development/master/nginx.conf like this:

server {

listen 80;

server\_name develop.com;

}

|  |
| --- |
| [Note] |
| As with the source files for environment configuration, the profile is used to resolve the file name. So, if you want a profile-specific file, /\*/development/\*/logback.xml can be resolved by a file called logback-development.xml (in preference to logback.xml). |
| [Note] |
| If you do not want to supply the label and let the server use the default label, you can supply a useDefaultLabel request parameter. So, the preceding example for the default profile could be /foo/default/nginx.conf?useDefaultLabel. | |

## 8. Embedding the Config Server

The Config Server runs best as a standalone application. However, if need be, you can embed it in another application. To do so, use the @EnableConfigServerannotation. An optional property named spring.cloud.config.server.bootstrap can be useful in this case is. It is a flag to indicate whether the server should configure itself from its own remote repository. By default, the flag is off, because it can delay startup. However, when embedded in another application, it makes sense to initialize the same way as any other application.

|  |
| --- |
| [Note] |
| If you use the bootstrap flag, the config server needs to have its name and repository URI configured in bootstrap.yml. |

To change the location of the server endpoints, you can (optionally) set spring.cloud.config.server.prefix (for example, /config), to serve the resources under a prefix. The prefix should start but not end with a /. It is applied to the @RequestMappings in the Config Server (that is, underneath the Spring Boot server.servletPath and server.contextPath prefixes).

If you want to read the configuration for an application directly from the backend repository (instead of from the config server), you basically wat an embedded config server with no endpoints. You can switch off the endpoints entirely by not using the @EnableConfigServer annotation (set spring.cloud.config.server.bootstrap=true).

## 9. Push Notifications and Spring Cloud Bus

Many source code repository providers (such as Github, Gitlab, Gitee, or Bitbucket) notify you of changes in a repository through a webhook. You can configure the webhook through the provider’s user interface as a URL and a set of events in which you are interested. For instance, [Github](https://developer.github.com/v3/activity/events/types/#pushevent) uses a POST to the webhook with a JSON body containing a list of commits and a header (X-Github-Event) set to push. If you add a dependency on the spring-cloud-config-monitor library and activate the Spring Cloud Bus in your Config Server, then a /monitor endpoint is enabled.

When the webhook is activated, the Config Server sends a RefreshRemoteApplicationEvent targeted at the applications it thinks might have changed. The change detection can be strategized. However, by default, it looks for changes in files that match the application name (for example, foo.properties is targeted at the fooapplication, while application.properties is targeted at all applications). The strategy to use when you want to override the behavior is PropertyPathNotificationExtractor, which accepts the request headers and body as parameters and returns a list of file paths that changed.

The default configuration works out of the box with Github, Gitlab, Gitee, or Bitbucket. In addition to the JSON notifications from Github, Gitlab, Gitee, or Bitbucket, you can trigger a change notification by POSTing to /monitor with form-encoded body parameters in the pattern of path={name}. Doing so broadcasts to applications matching the {name} pattern (which can contain wildcards).

|  |
| --- |
| [Note] |
| The RefreshRemoteApplicationEvent is transmitted only if the spring-cloud-bus is activated in both the Config Server and in the client application. |
| [Note] |
| The default configuration also detects filesystem changes in local git repositories. In that case, the webhook is not used. However, as soon as you edit a config file, a refresh is broadcast. | |

## 10. Spring Cloud Config Client

A Spring Boot application can take immediate advantage of the Spring Config Server (or other external property sources provided by the application developer). It also picks up some additional useful features related to Environment change events.

## 10.1 Config First Bootstrap

The default behavior for any application that has the Spring Cloud Config Client on the classpath is as follows: When a config client starts, it binds to the Config Server (through the spring.cloud.config.uri bootstrap configuration property) and initializes Spring Environment with remote property sources.

The net result of this behavior is that all client applciations that want to consume the Config Server need a bootstrap.yml (or an environment variable) with the server address set in spring.cloud.config.uri (it defaults to "http://localhost:8888").

## 10.2 Discovery First Bootstrap

If you use a `DiscoveryClient implementation, such as Spring Cloud Netflix and Eureka Service Discovery or Spring Cloud Consul, you can have the Config Server register with the Discovery Service. However, in the default “Config First” mode, clients cannot take advantage of the registration.

If you prefer to use DiscoveryClient to locate the Config Server, you can do so by setting spring.cloud.config.discovery.enabled=true (the default is false). The net result of doing so is that client applications all need a bootstrap.yml (or an environment variable) with the appropriate discovery configuration. For example, with Spring Cloud Netflix, you need to define the Eureka server address (for example, in eureka.client.serviceUrl.defaultZone). The price for using this option is an extra network round trip on startup, to locate the service registration. The benefit is that, as long as the Discovery Service is a fixed point, the Config Server can change its coordinates. The default service ID is configserver, but you can change that on the client by setting spring.cloud.config.discovery.serviceId(and on the server, in the usual way for a service, such as by setting spring.application.name).

The discovery client implementations all support some kind of metadata map (for example, we have eureka.instance.metadataMap for Eureka). Some additional properties of the Config Server may need to be configured in its service registration metadata so that clients can connect correctly. If the Config Server is secured with HTTP Basic, you can configure the credentials as username and password. Also, if the Config Server has a context path, you can set configPath. For example, the following YAML file is for a Config Server that is a Eureka client:

**bootstrap.yml.**

eureka:

instance:

...

metadataMap:

user: osufhalskjrtl

password: lviuhlszvaorhvlo5847

configPath: /config

## 10.3 Config Client Fail Fast

In some cases, you may want to fail startup of a service if it cannot connect to the Config Server. If this is the desired behavior, set the bootstrap configuration property spring.cloud.config.fail-fast=true to make the client halt with an Exception.

## 10.4 Config Client Retry

If you expect that the config server may occasionally be unavailable when your application starts, you can make it keep trying after a failure. First, you need to set spring.cloud.config.fail-fast=true. Then you need to add spring-retry and spring-boot-starter-aop to your classpath. The default behavior is to retry six times with an initial backoff interval of 1000ms and an exponential multiplier of 1.1 for subsequent backoffs. You can configure these properties (and others) by setting the spring.cloud.config.retry.\* configuration properties.

|  |
| --- |
| [Tip] |
| To take full control of the retry behavior, add a @Bean of type RetryOperationsInterceptor with an ID of configServerRetryInterceptor. Spring Retry has a RetryInterceptorBuilder that supports creating one. |

## 10.5 Locating Remote Configuration Resources

The Config Service serves property sources from /{name}/{profile}/{label}, where the default bindings in the client app are as follows:

* "name" = ${spring.application.name}
* "profile" = ${spring.profiles.active} (actually Environment.getActiveProfiles())
* "label" = "master"

You can override all of them by setting spring.cloud.config.\* (where \* is name, profile or label). The label is useful for rolling back to previous versions of configuration. With the default Config Server implementation, it can be a git label, branch name, or commit ID. Label can also be provided as a comma-separated list. In that case, the items in the list are tried one by one until one succeeds. This behavior can be useful when working on a feature branch. For instance, you might want to align the config label with your branch but make it optional (in that case, use spring.cloud.config.label=myfeature,develop).

## 10.6 Security

If you use HTTP Basic security on the server, clients need to know the password (and username if it is not the default). You can specify the username and password through the config server URI or via separate username and password properties, as shown in the following example:

**bootstrap.yml.**

spring:

cloud:

config:

uri: https://user:secret@myconfig.mycompany.com

The following example shows an alternate way to pass the same information:

**bootstrap.yml.**

spring:

cloud:

config:

uri: https://myconfig.mycompany.com

username: user

password: secret

The spring.cloud.config.password and spring.cloud.config.username values override anything that is provided in the URI.

If you deploy your apps on Cloud Foundry, the best way to provide the password is through service credentials (such as in the URI, since it does not need to be in a config file). The following example works locally and for a user-provided service on Cloud Foundry named configserver:

**bootstrap.yml.**

spring:

cloud:

config:

uri: ${vcap.services.configserver.credentials.uri:http://user:password@localhost:8888**}**

If you use another form of security, you might need to [provide a RestTemplate](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_config_client.html#custom-rest-template) to the ConfigServicePropertySourceLocator (for example, by grabbing it in the bootstrap context and injecting it).

### 10.6.1 Health Indicator

The Config Client supplies a Spring Boot Health Indicator that attempts to load configuration from the Config Server. The health indicator can be disabled by setting health.config.enabled=false. The response is also cached for performance reasons. The default cache time to live is 5 minutes. To change that value, set the health.config.time-to-live property (in milliseconds).

### 10.6.2 Providing A Custom RestTemplate

In some cases, you might need to customize the requests made to the config server from the client. Typically, doing so involves passing special Authorizationheaders to authenticate requests to the server. To provide a custom RestTemplate:

1. Create a new configuration bean with an implementation of PropertySourceLocator, as shown in the following example:

**CustomConfigServiceBootstrapConfiguration.java.**

*@Configuration*

**public** **class** CustomConfigServiceBootstrapConfiguration {

*@Bean*

**public** ConfigServicePropertySourceLocator configServicePropertySourceLocator() {

ConfigClientProperties clientProperties = configClientProperties();

ConfigServicePropertySourceLocator configServicePropertySourceLocator = **new** ConfigServicePropertySourceLocator(clientProperties);

configServicePropertySourceLocator.setRestTemplate(customRestTemplate(clientProperties));

**return** configServicePropertySourceLocator;

}

}

1. In resources/META-INF, create a file called spring.factories and specify your custom configuration, as shown in the following example:

**spring.factories.**

org.springframework.cloud.bootstrap.BootstrapConfiguration = com.my.config.client.CustomConfigServiceBootstrapConfiguration

### 10.6.3 Vault

When using Vault as a backend to your config server, the client needs to supply a token for the server to retrieve values from Vault. This token can be provided within the client by setting spring.cloud.config.token in bootstrap.yml, as shown in the following example:

**bootstrap.yml.**

spring:

cloud:

config:

token: YourVaultToken

## 10.7 Nested Keys In Vault

Vault supports the ability to nest keys in a value stored in Vault, as shown in the following example:

echo -n '{"appA": {"secret": "appAsecret"}, "bar": "baz"}' | vault write secret/myapp -

This command writes a JSON object to your Vault. To access these values in Spring, you would use the traditional dot(.) annotation, as shown in the following example

*@Value("${appA.secret}")*

String name = "World";

The preceding code would sets the value of the name variable to appAsecret.

# Part III. Spring Cloud Netflix

**Finchley.M9**

This project provides Netflix OSS integrations for Spring Boot apps through autoconfiguration and binding to the Spring Environment and other Spring programming model idioms. With a few simple annotations you can quickly enable and configure the common patterns inside your application and build large distributed systems with battle-tested Netflix components. The patterns provided include Service Discovery (Eureka), Circuit Breaker (Hystrix), Intelligent Routing (Zuul) and Client Side Load Balancing (Ribbon).

## 11. Service Discovery: Eureka Clients

Service Discovery is one of the key tenets of a microservice-based architecture. Trying to hand-configure each client or some form of convention can be difficult to do and can be brittle. Eureka is the Netflix Service Discovery Server and Client. The server can be configured and deployed to be highly available, with each server replicating state about the registered services to the others.

## 11.1 How to Include Eureka Client

To include the Eureka Client in your project, use the starter with a group ID of org.springframework.cloud and an artifact ID of spring-cloud-starter-netflix-eureka-client. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

## 11.2 Registering with Eureka

When a client registers with Eureka, it provides meta-data about itself — such as host, port, health indicator URL, home page, and other details. Eureka receives heartbeat messages from each instance belonging to a service. If the heartbeat fails over a configurable timetable, the instance is normally removed from the registry.

The following example shows a minimal Eureka client application:

*@SpringBootApplication*

*@RestController*

**public** **class** Application {

*@RequestMapping("/")*

**public** String home() {

**return** "Hello world";

}

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(Application.**class**).web(true).run(args);

}

}

Note that the preceding example shows a normal [Spring Boot](https://projects.spring.io/spring-boot/) application. By having spring-cloud-starter-netflix-eureka-client on the classpath, your application automatically registers with the Eureka Server. Configuration is required to locate the Eureka server, as shown in the following example:

**application.yml.**

eureka:

client:

serviceUrl:

defaultZone: http://localhost:8761/eureka/

In the preceding example, "defaultZone" is a magic string fallback value that provides the service URL for any client that does not express a preference (in other words, it is a useful default).

The default application name (that is, the service ID), virtual host, and non-secure port (taken from the Environment) are ${spring.application.name}, ${spring.application.name} and ${server.port}, respectively.

Having spring-cloud-starter-netflix-eureka-client on the classpath makes the app into both a Eureka “instance” (that is, it registers itself) and a “client” (it can query the registry to locate other services). The instance behaviour is driven by eureka.instance.\* configuration keys, but the defaults are fine if you ensure that your application has a value for spring.application.name (this is the default for the Eureka service ID or VIP).

See [EurekaInstanceConfigBean](https://github.com/spring-cloud/spring-cloud-netflix/tree/master/spring-cloud-netflix-eureka-client/src/main/java/org/springframework/cloud/netflix/eureka/EurekaInstanceConfigBean.java) and [EurekaClientConfigBean](https://github.com/spring-cloud/spring-cloud-netflix/tree/master/spring-cloud-netflix-eureka-client/src/main/java/org/springframework/cloud/netflix/eureka/EurekaClientConfigBean.java) for more details on the configurable options.

To disable the Eureka Discovery Client, you can set eureka.client.enabled to false.

## 11.3 Authenticating with the Eureka Server

HTTP basic authentication is automatically added to your eureka client if one of the eureka.client.serviceUrl.defaultZone URLs has credentials embedded in it (curl style, as follows: <http://user:password@localhost:8761/eureka>). For more complex needs, you can create a @Bean of type DiscoveryClientOptionalArgs and inject ClientFilter instances into it, all of which is applied to the calls from the client to the server.

|  |
| --- |
| [Note] |
| Because of a limitation in Eureka, it is not possible to support per-server basic auth credentials, so only the first set that are found is used. |

## 11.4 Status Page and Health Indicator

The status page and health indicators for a Eureka instance default to /info and /health respectively, which are the default locations of useful endpoints in a Spring Boot Actuator application. You need to change these, even for an Actuator application if you use a non-default context path or servlet path (such as server.servletPath=/custom) or management endpoint path (such as management.contextPath=/admin). The following example shows the default values for the two settings:

**application.yml.**

eureka:

instance:

statusPageUrlPath: ${management.context-path}/info

healthCheckUrlPath: ${management.context-path}/health

These links show up in the metadata that is consumed by clients and are used in some scenarios to decide whether to send requests to your application, so it is helpful if they are accurate.

## 11.5 Registering a Secure Application

If your app wants to be contacted over HTTPS, you can set two flags in the EurekaInstanceConfig:

* eureka.instance.[nonSecurePortEnabled]=[false]
* eureka.instance.[securePortEnabled]=[true]

Doing so makes Eureka publish instance information that shows an explicit preference for secure communication. The Spring Cloud DiscoveryClient always returns a URI starting with https for a service configured this way. Similarly, when a service is configured this way, the Eureka (native) instance information has a secure health check URL.

Because of the way Eureka works internally, it still publishes a non-secure URL for the status and home pages unless you also override those explicitly. You can use placeholders to configure the eureka instance URLs, as shown in the following example:

**application.yml.**

eureka:

instance:

statusPageUrl: https://${eureka.hostname}/info

healthCheckUrl: https://${eureka.hostname}/health

homePageUrl: https://${eureka.hostname}/

(Note that ${eureka.hostname} is a native placeholder only available in later versions of Eureka. You could achieve the same thing with Spring placeholders as well — for example, by using ${eureka.instance.hostName}.)

|  |
| --- |
| [Note] |
| If your application runs behind a proxy, and the SSL termination is in the proxy (for example, if you run in Cloud Foundry or other platforms as a service), then you need to ensure that the proxy “forwarded” headers are intercepted and handled by the application. If the Tomcat container embedded in a Spring Boot application has explicit configuration for the 'X-Forwarded-\\*` headers, this happens automatically. The links rendered by your app to itself being wrong (the wrong host, port, or protocol) is a sign that you got this configuration wrong. |

## 11.6 Eureka’s Health Checks

By default, Eureka uses the client heartbeat to determine if a client is up. Unless specified otherwise, the Discovery Client does not propagate the current health check status of the application, per the Spring Boot Actuator. Consequently, after successful registration, Eureka always announces that the application is in 'UP' state. This behavior can be altered by enabling Eureka health checks, which results in propagating application status to Eureka. As a consequence, every other application does not send traffic to applications in states other then 'UP'. The following example shows how to enable health checks for the client:

**application.yml.**

eureka:

client:

healthcheck:

enabled: true

|  |
| --- |
| [Warning] |
| eureka.client.healthcheck.enabled=true should only be set in application.yml. Setting the value in bootstrap.yml causes undesirable side effects, such as registering in Eureka with an UNKNOWN status. |

If you require more control over the health checks, consider implementing your own com.netflix.appinfo.HealthCheckHandler.

## 11.7 Eureka Metadata for Instances and Clients

It is worth spending a bit of time understanding how the Eureka metadata works, so you can use it in a way that makes sense in your platform. There is standard metadata for information such as hostname, IP address, port numbers, the status page, and health check. These are published in the service registry and used by clients to contact the services in a straightforward way. Additional metadata can be added to the instance registration in the eureka.instance.metadataMap, and this metadata is accessible in the remote clients. In general, additional metadata does not change the behavior of the client, unless the client is made aware of the meaning of the metadata. There are a couple of special cases, described later in this document, where Spring Cloud already assigns meaning to the metadata map.

### 11.7.1 Using Eureka on Cloudfoundry

Cloudfoundry has a global router so that all instances of the same app have the same hostname (other PaaS solutions with a similar architecture have the same arrangement). This is not necessarily a barrier to using Eureka. However, if you use the router (recommended or even mandatory, depending on the way your platform was set up), you need to explicitly set the hostname and port numbers (secure or non-secure) so that they use the router. You might also want to use instance metadata so that you can distinguish between the instances on the client (for example, in a custom load balancer). By default, the eureka.instance.instanceId is vcap.application.instance\_id, as shown in the following example:

**application.yml.**

eureka:

instance:

hostname: ${vcap.application.uris[0]}

nonSecurePort: 80

Depending on the way the security rules are set up in your Cloudfoundry instance, you might be able to register and use the IP address of the host VM for direct service-to-service calls. This feature is not yet available on Pivotal Web Services ([PWS](https://run.pivotal.io/)).

### 11.7.2 Using Eureka on AWS

If the application is planned to be deployed to an AWS cloud, the Eureka instance must be configured to be AWS-aware. You can do so by customizing the [EurekaInstanceConfigBean](https://github.com/spring-cloud/spring-cloud-netflix/tree/master/spring-cloud-netflix-eureka-client/src/main/java/org/springframework/cloud/netflix/eureka/EurekaInstanceConfigBean.java) as follows:

*@Bean*

*@Profile("!default")*

**public** EurekaInstanceConfigBean eurekaInstanceConfig(InetUtils inetUtils) {

EurekaInstanceConfigBean b = **new** EurekaInstanceConfigBean(inetUtils);

AmazonInfo info = AmazonInfo.Builder.newBuilder().autoBuild("eureka");

b.setDataCenterInfo(info);

**return** b;

}

### 11.7.3 Changing the Eureka Instance ID

A vanilla Netflix Eureka instance is registered with an ID that is equal to its host name (that is, there is only one service per host). Spring Cloud Eureka provides a sensible default, which is defined as follows:

${spring.cloud.client.hostname}:${spring.application.name}:${spring.application.instance\_id:${server.port}}}

An example is myhost:myappname:8080.

By using Spring Cloud, you can override this value by providing a unique identifier in eureka.instance.instanceId, as shown in the following example:

**application.yml.**

eureka:

instance:

instanceId: ${spring.application.name}:${vcap.application.instance\_id:${spring.application.instance\_id:${random.value}}}

With the metadata shown in the preceding example and multiple service instances deployed on localhost, the random value is inserted there to make the instance unique. In Cloudfoundry, the vcap.application.instance\_id is populated automatically in a Spring Boot application, so the random value is not needed.

## 11.8 Using the EurekaClient

Once you have an application that is a discovery client, you can use it to discover service instances from the [Eureka Server](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-eureka-server.html). One way to do so is to use the native com.netflix.discovery.EurekaClient (as opposed to the Spring Cloud DiscoveryClient), as shown in the following example:

@Autowired

private EurekaClient discoveryClient;

public String serviceUrl() {

InstanceInfo instance = discoveryClient.getNextServerFromEureka("STORES", false);

return instance.getHomePageUrl();

}

|  |
| --- |
| [Tip] |
| Do not use the EurekaClient in a @PostConstruct method or in a @Scheduled method (or anywhere where the ApplicationContext might not be started yet). It is initialized in a SmartLifecycle (with phase=0), so the earliest you can rely on it being available is in another SmartLifecycle with a higher phase. |

### 11.8.1 EurekaClient without Jersey

By default, EurekaClient uses Jersey for HTTP communication. If you wish to avoid dependencies from Jersey, you can exclude it from your dependencies. Spring Cloud auto-configures a transport client based on Spring RestTemplate. The following example shows Jersey being excluded:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-netflix-eureka-client</artifactId>

<exclusions>

<exclusion>

<groupId>com.sun.jersey</groupId>

<artifactId>jersey-client</artifactId>

</exclusion>

<exclusion>

<groupId>com.sun.jersey</groupId>

<artifactId>jersey-core</artifactId>

</exclusion>

<exclusion>

<groupId>com.sun.jersey.contribs</groupId>

<artifactId>jersey-apache-client4</artifactId>

</exclusion>

</exclusions>

</dependency>

## 11.9 Alternatives to the Native Netflix EurekaClient

You need not use the raw Netflix EurekaClient. Also, it is usually more convenient to use it behind a wrapper of some sort. Spring Cloud has support for [Feign](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-feign.html) (a REST client builder) and [Spring RestTemplate](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-ribbon.html) through the logical Eureka service identifiers (VIPs) instead of physical URLs. To configure Ribbon with a fixed list of physical servers, you can set <client>.ribbon.listOfServers to a comma-separated list of physical addresses (or hostnames), where <client> is the ID of the client.

You can also use the org.springframework.cloud.client.discovery.DiscoveryClient, which provides a simple API (not specific to Netflix) for discovery clients, as shown in the following example:

@Autowired

private DiscoveryClient discoveryClient;

public String serviceUrl() {

List<ServiceInstance> list = discoveryClient.getInstances("STORES");

if (list != null && list.size() > 0 ) {

return list.get(0).getUri();

}

return null;

}

## 11.10 Why Is It so Slow to Register a Service?

Being an instance also involves a periodic heartbeat to the registry (through the client’s serviceUrl) with a default duration of 30 seconds. A service is not available for discovery by clients until the instance, the server, and the client all have the same metadata in their local cache (so it could take 3 heartbeats). You can change the period by setting eureka.instance.leaseRenewalIntervalInSeconds. Setting it to a value of less than 30 speeds up the process of getting clients connected to other services. In production, it is probably better to stick with the default, because of internal computations in the server that make assumptions about the lease renewal period.

## 11.11 Zones

If you have deployed Eureka clients to multiple zones, you may prefer that those clients use services within the same zone before trying services in another zone. To set that up, you need to configure your Eureka clients correctly.

First, you need to make sure you have Eureka servers deployed to each zone and that they are peers of each other. See the section on [zones and regions](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-eureka-server.html#spring-cloud-eureka-server-zones-and-regions) for more information.

Next, you need to tell Eureka which zone your service is in. You can do so by using the metadataMap property. For example, if service 1 is deployed to both zone 1and zone 2, you need to set the following Eureka properties in service 1:

**Service 1 in Zone 1**

eureka.instance.metadataMap.zone = zone1

eureka.client.preferSameZoneEureka = true

**Service 1 in Zone 2**

eureka.instance.metadataMap.zone = zone2

eureka.client.preferSameZoneEureka = true

## 12. Service Discovery: Eureka Server

This section describes how to set up a Eureka server.

## 12.1 How to Include Eureka Server

To include Eureka Server in your project, use the starter with a group ID of org.springframework.cloud and an artifact ID of spring-cloud-starter-netflix-eureka-server. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

## 12.2 How to Run a Eureka Server

The following example shows a minimal Eureka server:

*@SpringBootApplication*

*@EnableEurekaServer*

**public** **class** Application {

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(Application.**class**).web(true).run(args);

}

}

The server has a home page with a UI and HTTP API endpoints for the normal Eureka functionality under /eureka/\*.

The following links have some Eureka background reading: [flux capacitor](https://github.com/cfregly/fluxcapacitor/wiki/NetflixOSS-FAQ#eureka-service-discovery-load-balancer) and [google group discussion](https://groups.google.com/forum/?fromgroups#!topic/eureka_netflix/g3p2r7gHnN0).

|  |
| --- |
| [Tip] |
| Due to Gradle’s dependency resolution rules and the lack of a parent bom feature, depending on spring-cloud-starter-netflix-eureka-server can cause failures on application startup. To remedy this issue, add the Spring Boot Gradle plugin and import the Spring cloud starter parent bom as follows:  **build.gradle.**  buildscript {  dependencies {  classpath("org.springframework.boot:spring-boot-gradle-plugin:{spring-boot-docs-version}")  }  }  apply plugin: "spring-boot"  dependencyManagement {  imports {  mavenBom "org.springframework.cloud:spring-cloud-dependencies:{spring-cloud-version}"  }  } |

## 12.3 High Availability, Zones and Regions

The Eureka server does not have a backend store, but the service instances in the registry all have to send heartbeats to keep their registrations up to date (so this can be done in memory). Clients also have an in-memory cache of Eureka registrations (so they do not have to go to the registry for every request to a service).

By default, every Eureka server is also a Eureka client and requires (at least one) service URL to locate a peer. If you do not provide it, the service runs and works, but it fills your logs with a lot of noise about not being able to register with the peer.

See also [below for details of Ribbon support](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-ribbon.html) on the client side for Zones and Regions.

## 12.4 Standalone Mode

The combination of the two caches (client and server) and the heartbeats make a standalone Eureka server fairly resilient to failure, as long as there is some sort of monitor or elastic runtime (such as Cloud Foundry) keeping it alive. In standalone mode, you might prefer to switch off the client side behavior so that it does not keep trying and failing to reach its peers. The following example shows how to switch off the client-side behavior:

**application.yml (Standalone Eureka Server).**

server:

port: 8761

eureka:

instance:

hostname: localhost

client:

registerWithEureka: false

fetchRegistry: false

serviceUrl:

defaultZone: http://${eureka.instance.hostname}:${server.port}/eureka/

Notice that the serviceUrl is pointing to the same host as the local instance.

## 12.5 Peer Awareness

Eureka can be made even more resilient and available by running multiple instances and asking them to register with each other. In fact, this is the default behavior, so all you need to do to make it work is add a valid serviceUrl to a peer, as shown in the following example:

**application.yml (Two Peer Aware Eureka Servers).**

---

spring:

profiles: peer1

eureka:

instance:

hostname: peer1

client:

serviceUrl:

defaultZone: http://peer2/eureka/

---

spring:

profiles: peer2

eureka:

instance:

hostname: peer2

client:

serviceUrl:

defaultZone: http://peer1/eureka/

In the preceding example, we have a YAML file that can be used to run the same server on two hosts (peer1 and peer2) by running it in different Spring profiles. You could use this configuration to test the peer awareness on a single host (there is not much value in doing that in production) by manipulating /etc/hosts to resolve the host names. In fact, the eureka.instance.hostname is not needed if you are running on a machine that knows its own hostname (by default, it is looked up by using java.net.InetAddress).

You can add multiple peers to a system, and, as long as they are all connected to each other by at least one edge, they synchronize the registrations amongst themselves. If the peers are physically separated (inside a data center or between multiple data centers), then the system can, in principle, survive “split-brain” type failures.

## 12.6 When to Prefer IP Address

In some cases, it is preferable for Eureka to advertise the IP addresses of services rather than the hostname. Set eureka.instance.preferIpAddress to true and, when the application registers with eureka, it uses its IP address rather than its hostname.

|  |
| --- |
| [Tip] |
| If the hostname cannot be determined by Java, then the IP address is sent to Eureka. Only explict way of setting the hostname is by setting eureka.instance.hostname property. You can set your hostname at the run-time by using an environment variable — for example, eureka.instance.hostname=${HOST\_NAME}. |

## 13. Circuit Breaker: Hystrix Clients

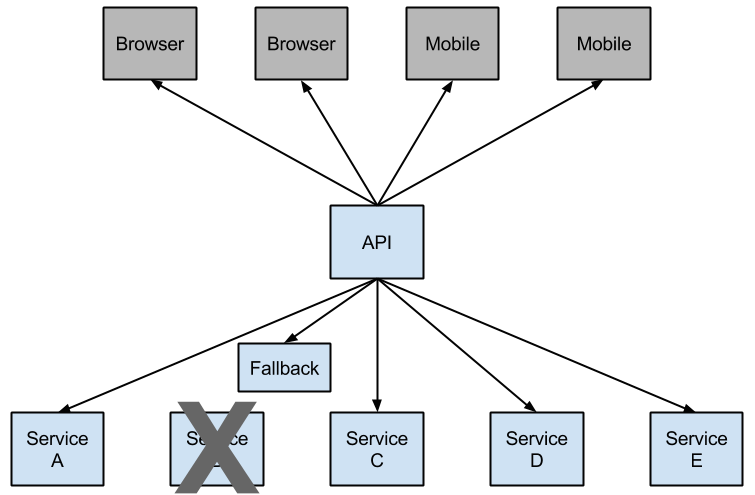
Netflix has created a library called [Hystrix](https://github.com/Netflix/Hystrix) that implements the [circuit breaker pattern](http://martinfowler.com/bliki/CircuitBreaker.html). In a microservice architecture, it is common to have multiple layers of service calls, as shown in the following example:

**Figure 13.1. Microservice Graph**



A service failure in the lower level of services can cause cascading failure all the way up to the user. When calls to a particular service exceed circuitBreaker.requestVolumeThreshold (default: 20 requests) and the failure percentage is greater than circuitBreaker.errorThresholdPercentage(default: >50%) in a rolling window defined by metrics.rollingStats.timeInMilliseconds (default: 10 seconds), the circuit opens and the call is not made. In cases of error and an open circuit, a fallback can be provided by the developer.

**Figure 13.2. Hystrix fallback prevents cascading failures**



Having an open circuit stops cascading failures and allows overwhelmed or failing services time to recover. The fallback can be another Hystrix protected call, static data, or a sensible empty value. Fallbacks may be chained so that the first fallback makes some other business call, which in turn falls back to static data.

## 13.1 How to Include Hystrix

To include Hystrix in your project, use the starter with a group ID of org.springframework.cloud and a artifact ID of spring-cloud-starter-netflix-hystrix. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

The following example shows a minimal Eureka server with a Hystrix circuit breaker:

@SpringBootApplication

@EnableCircuitBreaker

public class Application {

public static void main(String[] args) {

new SpringApplicationBuilder(Application.class).web(true).run(args);

}

}

@Component

public class StoreIntegration {

@HystrixCommand(fallbackMethod = "defaultStores")

public Object getStores(Map<String, Object> parameters) {

//do stuff that might fail

}

public Object defaultStores(Map<String, Object> parameters) {

return /\* something useful \*/;

}

}

The @HystrixCommand is provided by a Netflix contrib library called [“javanica”](https://github.com/Netflix/Hystrix/tree/master/hystrix-contrib/hystrix-javanica). Spring Cloud automatically wraps Spring beans with that annotation in a proxy that is connected to the Hystrix circuit breaker. The circuit breaker calculates when to open and close the circuit and what to do in case of a failure.

To configure the @HystrixCommand you can use the commandProperties attribute with a list of @HystrixProperty annotations. See [here](https://github.com/Netflix/Hystrix/tree/master/hystrix-contrib/hystrix-javanica#configuration) for more details. See the [Hystrix wiki](https://github.com/Netflix/Hystrix/wiki/Configuration) for details on the properties available.

## 13.2 Propagating the Security Context or Using Spring Scopes

If you want some thread local context to propagate into a @HystrixCommand, the default declaration does not work, because it executes the command in a thread pool (in case of timeouts). You can switch Hystrix to use the same thread as the caller through configuration or directly in the annotation, by asking it to use a different “Isolation Strategy”. The following example demonstrates setting the thread in the annotation:

*@HystrixCommand(fallbackMethod = "stubMyService",*

*commandProperties = {*

*@HystrixProperty(name="execution.isolation.strategy", value="SEMAPHORE")*

*}*

*)*

...

The same thing applies if you are using @SessionScope or @RequestScope. If you encounter a runtime exception that says it cannot find the scoped context, you need to use the same thread.

You also have the option to set the hystrix.shareSecurityContext property to true. Doing so auto-configures a Hystrix concurrency strategy plugin hook to transfer the SecurityContext from your main thread to the one used by the Hystrix command. Hystrix does not let multiple Hystrix concurrency strategy be registered so an extension mechanism is available by declaring your own HystrixConcurrencyStrategy as a Spring bean. Spring Cloud looks for your implementation within the Spring context and wrap it inside its own plugin.

## 13.3 Health Indicator

The state of the connected circuit breakers are also exposed in the /health endpoint of the calling application, as shown in the following example:

**{**

"hystrix": **{**

"openCircuitBreakers": **[**

"StoreIntegration::getStoresByLocationLink"

]**,**

"status": "CIRCUIT\_OPEN"

**},**

"status": "UP"

**}**

## 13.4 Hystrix Metrics Stream

To enable the Hystrix metrics stream, include a dependency on spring-boot-starter-actuator. Doing so exposes the /hystrix.stream as a management endpoint, as shown in the following example:

<dependency>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-actuator</artifactId>

</dependency>

## 14. Circuit Breaker: Hystrix Dashboard

One of the main benefits of Hystrix is the set of metrics it gathers about each HystrixCommand. The Hystrix Dashboard displays the health of each circuit breaker in an efficient manner.

**Figure 14.1. Hystrix Dashboard**



## 15. Hystrix Timeouts And Ribbon Clients

When using Hystrix commands that wrap Ribbon clients you want to make sure your Hystrix timeout is configured to be longer than the configured Ribbon timeout, including any potential retries that might be made. For example, if your Ribbon connection timeout is one second and the Ribbon client might retry the request three times, than your Hystrix timeout should be slightly more than three seconds.

## 15.1 How to Include the Hystrix Dashboard

To include the Hystrix Dashboard in your project, use the starter with a group ID of org.springframework.cloud and an artifact ID of spring-cloud-starter-netflix-hystrix-dashboard. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

To run the Hystrix Dashboard, annotate your Spring Boot main class with @EnableHystrixDashboard. Then visit /hystrix and point the dashboard to an individual instance’s /hystrix.stream endpoint in a Hystrix client application.

|  |
| --- |
| [Note] |
| When connecting to a /hystrix.stream endpoint that uses HTTPS, the certificate used by the server must be trusted by the JVM. If the certificate is not trusted, you must import the certificate into the JVM in order for the Hystrix Dashboard to make a successful connection to the stream endpoint. |

## 15.2 Turbine

Looking at an individual instance’s Hystrix data is not very useful in terms of the overall health of the system. [Turbine](https://github.com/Netflix/Turbine) is an application that aggregates all of the relevant /hystrix.stream endpoints into a combined /turbine.stream for use in the Hystrix Dashboard. Individual instances are located through Eureka. Running Turbine requires annotating your main class with the @EnableTurbine annotation (for example, by using spring-cloud-starter-netflix-turbine to set up the classpath). All of the documented configuration properties from [the Turbine 1 wiki](https://github.com/Netflix/Turbine/wiki/Configuration-(1.x)) apply. The only difference is that the turbine.instanceUrlSuffix does not need the port prepended, as this is handled automatically unless turbine.instanceInsertPort=false.

|  |
| --- |
| [Note] |
| By default, Turbine looks for the /hystrix.stream endpoint on a registered instance by looking up its hostName and port entries in Eureka and then appending /hystrix.stream to it. If the instance’s metadata contains management.port, it is used instead of the port value for the /hystrix.stream endpoint. By default, the metadata entry called management.port is equal to the management.port configuration property. It can be overridden though with following configuration: |

eureka:

instance:

metadata-map:

management.port: ${management.port:8081}

The turbine.appConfig configuration key is a list of Eureka serviceIds that turbine uses to lookup instances. The turbine stream is then used in the Hystrix dashboard with a URL similar to the following:

<http://my.turbine.server:8080/turbine.stream?cluster=CLUSTERNAME>

The cluster parameter can be omitted if the name is default. The cluster parameter must match an entry in turbine.aggregator.clusterConfig. Values returned from Eureka are upper-case. Consequently, the following example works if there is an application called customers registered with Eureka:

turbine:

aggregator:

clusterConfig: CUSTOMERS

appConfig: customers

If you need to customize which cluster names should be used by Turbine (because you do not want to store cluster names in turbine.aggregator.clusterConfigconfiguration), provide a bean of type TurbineClustersProvider.

The clusterName can be customized by a SPEL expression in turbine.clusterNameExpression with root as an instance of InstanceInfo. The default value is appName, which means that the Eureka serviceId becomes the cluster key (that is, the InstanceInfo for customers has an appName of CUSTOMERS). A different example is turbine.clusterNameExpression=aSGName, which gets the cluster name from the AWS ASG name. The following listing shows another example:

turbine:

aggregator:

clusterConfig: SYSTEM,USER

appConfig: customers,stores,ui,admin

clusterNameExpression: metadata['cluster']

In the preceding example, the cluster name from four services is pulled from their metadata map and is expected to have values that include SYSTEM and USER.

To use the “default” cluster for all apps, you need a string literal expression (with single quotes and escaped with double quotes if it is in YAML as well):

turbine:

appConfig: customers,stores

clusterNameExpression: "'default'"

Spring Cloud provides a spring-cloud-starter-netflix-turbine that has all the dependencies you need to get a Turbine server running. To ad Turnbine, create a Spring Boot application and annotate it with @EnableTurbine.

|  |
| --- |
| [Note] |
| By default, Spring Cloud lets Turbine use the host and port to allow multiple processes per host, per cluster. If you want the native Netflix behavior built into Turbine to not allow multiple processes per host, per cluster (the key to the instance ID is the hostname), set turbine.combineHostPort=false. |

## 15.3 Turbine Stream

In some environments (such as in a PaaS setting), the classic Turbine model of pulling metrics from all the distributed Hystrix commands does not work. In that case, you might want to have your Hystrix commands push metrics to Turbine. Spring Cloud enables that with messaging. To do so on the client, add a dependency to spring-cloud-netflix-hystrix-stream and the spring-cloud-starter-stream-\* of your choice. See the [Spring Cloud Stream documentation](https://docs.spring.io/spring-cloud-stream/docs/Ditmars.SR2/reference/htmlsingle/) for details on the brokers and how to configure the client credentials. It should work out of the box for a local broker.

On the server side, create a Spring Boot application and annotate it with @EnableTurbineStream. By default, it starts on port 8989 (point your Hystrix dashboard to that port on any path). You can customize the port by setting either server.port or turbine.stream.port. If you have spring-boot-starter-web and spring-boot-starter-actuator on the classpath as well, you can expose the Actuator endpoints on a separate port (with Tomcat by default) by providing a management.port that differs from the Hystrix port.

You can then point the Hystrix Dashboard to the Turbine Stream Server instead of individual Hystrix streams. If Turbine Stream is running on port 8989 on myhost, then put [http://myhost:8989](http://myhost:8989/) in the stream input field in the Hystrix Dashboard. Circuits are prefixed by their respective serviceId, followed by a dot (.), and then the circuit name.

Spring Cloud provides a spring-cloud-starter-netflix-turbine-stream that has all the dependencies you need to get a Turbine Stream server running. You can then add the Stream binder of your choice — such as spring-cloud-starter-stream-rabbit. Because it is Netty-based, you need Java 8 to run the application.

## 16. Client Side Load Balancer: Ribbon

Ribbon is a client-side load balancer that gives you a lot of control over the behavior of HTTP and TCP clients. Feign already uses Ribbon, so, if you use @FeignClient, this section also applies.

A central concept in Ribbon is that of the named client. Each load balancer is part of an ensemble of components that work together to contact a remote server on demand, and the ensemble has a name that you give it as an application developer (for example, by using the @FeignClient annotation). On demand, Spring Cloud creates a new ensemble as an ApplicationContext for each named client by using RibbonClientConfiguration. This contains (amongst other things) an ILoadBalancer, a RestClient, and a ServerListFilter.

## 16.1 How to Include Ribbon

To include Ribbon in your project, use the starter with a group ID of org.springframework.cloud and an artifact ID of spring-cloud-starter-netflix-ribbon. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

## 16.2 Customizing the Ribbon Client

You can configure some bits of a Ribbon client by using external properties in <client>.ribbon.\*, which is similar to using the Netflix APIs natively, except that you can use Spring Boot configuration files. The native options can be inspected as static fields in [CommonClientConfigKey](https://github.com/Netflix/ribbon/blob/master/ribbon-core/src/main/java/com/netflix/client/config/CommonClientConfigKey.java) (part of ribbon-core).

Spring Cloud also lets you take full control of the client by declaring additional configuration (on top of the RibbonClientConfiguration) using @RibbonClient, as shown in the following example:

*@Configuration*

*@RibbonClient(name = "custom", configuration = CustomConfiguration.class)*

**public** **class** TestConfiguration {

}

In this case, the client is composed from the components already in RibbonClientConfiguration, together with any in CustomConfiguration (where the latter generally overrides the former).

|  |
| --- |
| [Warning] |
| The CuostomConfiguration clas must be a @Configuration class, but take care that it is not in a @ComponentScan for the main application context. Otherwise, it is shared by all the @RibbonClients. If you use @ComponentScan (or @SpringBootApplication), you need to take steps to avoid it being included (for instance, you can put it in a separate, non-overlapping package or specify the packages to scan explicitly in the @ComponentScan). |

The following table shows the beans that Spring Cloud Netflix provides by default for Ribbon:

| **Bean Type** | **Bean Name** | **Class Name** |
| --- | --- | --- |
| IClientConfig | ribbonClientConfig | DefaultClientConfigImpl |
| IRule | ribbonRule | ZoneAvoidanceRule |
| IPing | ribbonPing | DummyPing |
| ServerList<Server> | ribbonServerList | ConfigurationBasedServerList |
| ServerListFilter<Server> | ribbonServerListFilter | ZonePreferenceServerListFilter |
| ILoadBalancer | ribbonLoadBalancer | ZoneAwareLoadBalancer |
| ServerListUpdater | ribbonServerListUpdater | PollingServerListUpdater |

Creating a bean of one of those type and placing it in a @RibbonClient configuration (such as FooConfiguration above) lets you override each one of the beans described, as shown in the following example:

*@Configuration*

**protected** **static** **class** FooConfiguration {

*@Bean*

**public** ZonePreferenceServerListFilter serverListFilter() {

ZonePreferenceServerListFilter filter = **new** ZonePreferenceServerListFilter();

filter.setZone("myTestZone");

**return** filter;

}

*@Bean*

**public** IPing ribbonPing() {

**return** **new** PingUrl();

}

}

The include statement in the preceding example replaces NoOpPing with PingUrl and provides a custom serverListFilter.

## 16.3 Customizing the Default for All Ribbon Clients

A default configuration can be provided for all Ribbon Clients by using the @RibbonClients annotation and registering a default configuration, as shown in the following example:

*@RibbonClients(defaultConfiguration = DefaultRibbonConfig.class)*

**public** **class** RibbonClientDefaultConfigurationTestsConfig {

**public** **static** **class** BazServiceList **extends** ConfigurationBasedServerList {

**public** BazServiceList(IClientConfig config) {

**super**.initWithNiwsConfig(config);

}

}

}

*@Configuration*

**class** DefaultRibbonConfig {

*@Bean*

**public** IRule ribbonRule() {

**return** **new** BestAvailableRule();

}

*@Bean*

**public** IPing ribbonPing() {

**return** **new** PingUrl();

}

*@Bean*

**public** ServerList<Server> ribbonServerList(IClientConfig config) {

**return** **new** RibbonClientDefaultConfigurationTestsConfig.BazServiceList(config);

}

*@Bean*

**public** ServerListSubsetFilter serverListFilter() {

ServerListSubsetFilter filter = **new** ServerListSubsetFilter();

**return** filter;

}

}

## 16.4 Customizing the Ribbon Client by Setting Properties

Starting with version 1.2.0, Spring Cloud Netflix now supports customizing Ribbon clients by setting properties to be compatible with the [Ribbon documentation](https://github.com/Netflix/ribbon/wiki/Working-with-load-balancers#components-of-load-balancer).

This lets you change behavior at start up time in different environments.

The following list shows the supported properties>:

* <clientName>.ribbon.NFLoadBalancerClassName: Should implement ILoadBalancer
* <clientName>.ribbon.NFLoadBalancerRuleClassName: Should implement IRule
* <clientName>.ribbon.NFLoadBalancerPingClassName: Should implement IPing
* <clientName>.ribbon.NIWSServerListClassName: Should implement ServerList
* <clientName>.ribbon.NIWSServerListFilterClassName: Should implement ServerListFilter

|  |
| --- |
| [Note] |
| Classes defined in these properties have precedence over beans defined by using @RibbonClient(configuration=MyRibbonConfig.class) and the defaults provided by Spring Cloud Netflix. |

To set the IRule for a service name called users, you could set the following properties:

**application.yml.**

users:

ribbon:

NIWSServerListClassName: com.netflix.loadbalancer.ConfigurationBasedServerList

NFLoadBalancerRuleClassName: com.netflix.loadbalancer.WeightedResponseTimeRule

See the [Ribbon documentation](https://github.com/Netflix/ribbon/wiki/Working-with-load-balancers) for implementations provided by Ribbon.

## 16.5 Using Ribbon with Eureka

When Eureka is used in conjunction with Ribbon (that is, both are on the classpath), the ribbonServerList is overridden with an extension of DiscoveryEnabledNIWSServerList, which populates the list of servers from Eureka. It also replaces the IPing interface with NIWSDiscoveryPing, which delegates to Eureka to determine if a server is up. The ServerList that is installed by default is a DomainExtractingServerList. Its purpose is to make metadata available to the load balancer without using AWS AMI metadata (which is what Netflix relies on). By default, the server list is constructed with “zone” information, as provided in the instance metadata (so, on the remote clients, set eureka.instance.metadataMap.zone). If that is missing and if the approximateZoneFromHostname flag is set, it can use the domain name from the server hostname as a proxy for the zone. Once the zone information is available, it can be used in a ServerListFilter. By default, it is used to locate a server in the same zone as the client, because the default is a ZonePreferenceServerListFilter. By default, the zone of the client is determined in the same way as the remote instances (that is, through eureka.instance.metadataMap.zone).

|  |
| --- |
| [Note] |
| The orthodox “archaius” way to set the client zone is through a configuration property called "@zone". If it is available, Spring Cloud uses that in preference to all other settings (note that the key must be quoted in YAML configuration). |
| [Note] |
| If there is no other source of zone data, then a guess is made, based on the client configuration (as opposed to the instance configuration). We take eureka.client.availabilityZones, which is a map from region name to a list of zones, and pull out the first zone for the instance’s own region (that is, the eureka.client.region, which defaults to "us-east-1", for compatibility with native Netflix). | |

## 16.6 Example: How to Use Ribbon Without Eureka

Eureka is a convenient way to abstract the discovery of remote servers so that you do not have to hard code their URLs in clients. However, if you prefer not to use Eureka, Ribbon and Feign also work. Suppose you have declared a @RibbonClient for "stores", and Eureka is not in use (and not even on the classpath). The Ribbon client defaults to a configured server list. You can supply the configuration as follows:

**application.yml.**

stores:

ribbon:

listOfServers: example.com,google.com

## 16.7 Example: Disable Eureka Use in Ribbon

Setting the ribbon.eureka.enabled property to false explicitly disables the use of Eureka in Ribbon, as shown in the following example:

**application.yml.**

ribbon:

eureka:

enabled: false

## 16.8 Using the Ribbon API Directly

You can also use the LoadBalancerClient directly, as shown in the following example:

**public** **class** MyClass {

*@Autowired*

**private** LoadBalancerClient loadBalancer;

**public** **void** doStuff() {

ServiceInstance instance = loadBalancer.choose("stores");

URI storesUri = URI.create(String.format("http://%s:%s", instance.getHost(), instance.getPort()));

*// ... do something with the URI*

}

}

## 16.9 Caching of Ribbon Configuration

Each Ribbon named client has a corresponding child application Context that Spring Cloud maintains. This application context is lazily loaded on the first request to the named client. This lazy loading behavior can be changed to instead eagerly load these child application contexts at startup, by specifying the names of the Ribbon clients, as shown in the following example:

**application.yml.**

ribbon:

eager-load:

enabled: true

clients: client1, client2, client3

## 16.10 How to Configure Hystrix Thread Pools

If you change zuul.ribbonIsolationStrategy to THREAD, the thread isolation strategy for Hystrix is used for all routes. In that case, the HystrixThreadPoolKey is set to RibbonCommand as the default. It means that HystrixCommands for all routes are executed in the same Hystrix thread pool. This behavior can be changed with the following configuration:

**application.yml.**

zuul:

threadPool:

useSeparateThreadPools: true

The preceding example results in HystrixCommands being executed in the Hystrix thread pool for each route.

In this case, the default HystrixThreadPoolKey is the same as the service ID for each route. To add a prefix to HystrixThreadPoolKey, set zuul.threadPool.threadPoolKeyPrefix to the value that you want to add, as shown in the following example:

**application.yml.**

zuul:

threadPool:

useSeparateThreadPools: true

threadPoolKeyPrefix: zuulgw

## 16.11 How to Provide a Key to Ribbon’s IRule

If you need to provide your own IRule implementation to handle a special routing requirement like a “canary” test, pass some information to the choose method of IRule.

**com.netflix.loadbalancer.IRule.java.**

public interface IRule{

public Server choose(Object key);

:

You can provide some information that is used by your IRule implementation to choose a target server, as shown in the following example:

RequestContext.getCurrentContext()

.set(FilterConstants.LOAD\_BALANCER\_KEY, "canary-test");

If you put any object into the RequestContext with a key of FilterConstants.LOAD\_BALANCER\_KEY, it is passed to the choose method of the IRuleimplementation. The code shown in the preceding example must be executed before RibbonRoutingFilter is executed. Zuul’s pre filter is the best place to do that. You can access HTTP headers and query parameters through the RequestContext in pre filter, so it can be used to determine the LOAD\_BALANCER\_KEY that is passed to Ribbon. If you do not put any value with LOAD\_BALANCER\_KEY in RequestContext, null is passed as a parameter of the choose method.

## 17. External Configuration: Archaius

[Archaius](https://github.com/Netflix/archaius) is the Netflix client-side configuration library. It is the library used by all of the Netflix OSS components for configuration. Archaius is an extension of the [Apache Commons Configuration](https://commons.apache.org/proper/commons-configuration) project. It allows updates to configuration by either polling a source for changes or by letting a source push changes to the client. Archaius uses Dynamic<Type>Property classes as handles to properties, as shown in the following example:

**Archaius Example.**

**class** ArchaiusTest {

DynamicStringProperty myprop = DynamicPropertyFactory

.getInstance()

.getStringProperty("my.prop");

**void** doSomething() {

OtherClass.someMethod(myprop.get());

}

}

Archaius has its own set of configuration files and loading priorities. Spring applications should generally not use Archaius directly, but the need to configure the Netflix tools natively remains. Spring Cloud has a Spring Environment Bridge so that Archaius can read properties from the Spring Environment. This brisge allows Spring Boot projects to use the normal configuration toolchain while letting them configure the Netflix tools as documented (for the most part).

## 18. Router and Filter: Zuul

Routing is an integral part of a microservice architecture. For example, / may be mapped to your web application, /api/users is mapped to the user service and /api/shop is mapped to the shop service. [Zuul](https://github.com/Netflix/zuul) is a JVM-based router and server-side load balancer from Netflix.

[Netflix uses Zuul](http://www.slideshare.net/MikeyCohen1/edge-architecture-ieee-international-conference-on-cloud-engineering-32240146/27) for the following:

* Authentication
* Insights
* Stress Testing
* Canary Testing
* Dynamic Routing
* Service Migration
* Load Shedding
* Security
* Static Response handling
* Active/Active traffic management

Zuul’s rule engine lets rules and filters be written in essentially any JVM language, with built-in support for Java and Groovy.

|  |
| --- |
| [Note] |
| The configuration property zuul.max.host.connections has been replaced by two new properties, zuul.host.maxTotalConnections and zuul.host.maxPerRouteConnections, which default to 200 and 20 respectively. | |
| [Note] | |
| The default Hystrix isolation pattern (ExecutionIsolationStrategy) for all routes is SEMAPHORE. zuul.ribbonIsolationStrategy can be changed to THREAD if that isolation pattern is preferred. | |

## 18.1 How to Include Zuul

To include Zuul in your project, use the starter with a group ID of org.springframework.cloud and a artifact ID of spring-cloud-starter-netflix-zuul. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

## 18.2 Embedded Zuul Reverse Proxy

Spring Cloud has created an embedded Zuul proxy to ease the development of a common use case where a UI application wants to make proxy calls to one or more back end services. This feature is useful for a user interface to proxy to the backend services it requires, avoiding the need to manage CORS and authentication concerns independently for all the backends.

To enable it, annotate a Spring Boot main class with @EnableZuulProxy. Doing so causes local calls to be forwarded to the appropriate service. By convention, a service with an ID of users receives requests from the proxy located at /users (with the prefix stripped). The proxy uses Ribbon to locate an instance to which to forward through discovery. All requests are executed in a [hystrix command](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#hystrix-fallbacks-for-routes), so failures appear in Hystrix metrics. Once the circuit is open, the proxy does not try to contact the service.

|  |
| --- |
| [Note] |
| the Zuul starter does not include a discovery client, so, for routes based on service IDs, you need to provide one of those on the classpath as well (Eureka is one choice). |

To skip having a service automatically added, set zuul.ignored-services to a list of service ID patterns. If a service matches a pattern that is ignored but is also included in the explicitly configured routes map, it is unignored, as shown in the following example:

**application.yml.**

zuul:

ignoredServices: '\*'

routes:

users: /myusers/\*\*

In the preceding example, all services are ignored, **except** for users.

To augment or change the proxy routes, you can add external configuration, as follows:

**application.yml.**

zuul:

routes:

users: /myusers/\*\*

The preceding example means that HTTP calls to /myusers get forwarded to the users service (for example /myusers/101 is forwarded to /101).

To get more fine-grained control over a route, you can specify the path and the serviceId independently, as follows:

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

serviceId: users\_service

The preceding example means that HTTP calls to /myusers get forwarded to the users\_service service. The route must have a path that can be specified as an ant-style pattern, so /myusers/\* only matches one level, but /myusers/\*\* matches hierarchically.

The location of the backend can be specified as either a serviceId (for a service from discovery) or a url (for a physical location), as shown in the following example:

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

url: http://example.com/users\_service

These simple url-routes do not get executed as a HystrixCommand, nor do they load-balance multiple URLs with Ribbon. To achieve those goals, you can specify a serviceId with a static list of servers, as follows:

**application.yml.**

zuul:

routes:

echo:

path: /myusers/\*\*

serviceId: myusers-service

stripPrefix: **true**

hystrix:

command:

myusers-service:

execution:

isolation:

thread:

timeoutInMilliseconds: ...

myusers-service:

ribbon:

NIWSServerListClassName: com.netflix.loadbalancer.ConfigurationBasedServerList

ListOfServers: http://example1.com,http://example2.com

ConnectTimeout: 1000

ReadTimeout: 3000

MaxTotalHttpConnections: 500

MaxConnectionsPerHost: 100

Another method is specifiying a service-route and configuring a Ribbon client for the serviceId (doing so requires disabling Eureka support in Ribbon — see [above for more information](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-ribbon.html#spring-cloud-ribbon-without-eureka)), as shown in the following example:

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

serviceId: users

ribbon:

eureka:

enabled: **false**

users:

ribbon:

listOfServers: example.com,google.com

You can provide a convention between serviceId and routes by using regexmapper. It uses regular-expression named groups to extract variables from serviceIdand inject them into a route pattern, as shown in the following example:

**ApplicationConfiguration.java.**

*@Bean*

**public** PatternServiceRouteMapper serviceRouteMapper() {

**return** **new** PatternServiceRouteMapper(

"(?<name>^.+)-(?<version>v.+$)",

"${version}/${name}");

}

The preceding example means that a serviceId of myusers-v1 is mapped to route /v1/myusers/\*\*. Any regular expression is accepted, but all named groups must be present in both servicePattern and routePattern. If servicePattern does not match a serviceId, the default behavior is used. In the preceding example, a serviceId of myusers is mapped to the "/myusers/\*\*" route (with no version detected). This feature is disabled by default and only applies to discovered services.

To add a prefix to all mappings, set zuul.prefix to a value, such as /api. By default, the proxy prefix is stripped from the request before the request is forwarded by (you can switch this behavior off with zuul.stripPrefix=false). You can also switch off the stripping of the service-specific prefix from individual routes, as shown in the following example:

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

stripPrefix: **false**

|  |
| --- |
| [Note] |
| zuul.stripPrefix only applies to the prefix set in zuul.prefix. It does not have any effect on prefixes defined within a given route’s path. |

In the preceding example, requests to /myusers/101 are forwarded to /myusers/101 on the users service.

The zuul.routes entries actually bind to an object of type ZuulProperties. If you look at the properties of that object, you can see that it also has a retryable flag. Set that flag to true to have the Ribbon client automatically retry failed requests. You can also set that flag to true when you need to modify the parameters of the retry operations that use the Ribbon client configuration.

By default, the X-Forwarded-Host header is added to the forwarded requests. To turn it off, set zuul.addProxyHeaders = false. By default, the prefix path is stripped, and the request to the backend picks up a X-Forwarded-Prefix header (/myusers in the examples shown earlier).

If you set a default route (/), an application with @EnableZuulProxy could act as a standalone server. For example, zuul.route.home: / would route all traffic ("/\*\*") to the "home" service.

If more fine-grained ignoring is needed, you can specify specific patterns to ignore. These patterns are evaluated at the start of the route location process, which means prefixes should be included in the pattern to warrant a match. Ignored patterns span all services and supersede any other route specification. The following example shows how to create ignored patterns:

**application.yml.**

zuul:

ignoredPatterns: /\*\*/admin/\*\*

routes:

users: /myusers/\*\*

The preceding example means that all calls (such as /myusers/101) are forwarded to /101 on the users service. However, calls including /admin/ do not resolve.

|  |
| --- |
| [Warning] |
| If you need your routes to have their order preserved, you need to use a YAML file, as the ordering is lost when using a properties file. The following example shows such a YAML file: |

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

legacy:

path: /\*\*

If you were to use a properties file, the legacy path might end up in front of the users path, rendering the users path unreachable.

## 18.3 Zuul Http Client

The default HTTP client used by Zuul is now backed by the Apache HTTP Client instead of the deprecated Ribbon RestClient. To use RestClient or okhttp3.OkHttpClient, set ribbon.restclient.enabled=true or ribbon.okhttp.enabled=true, respectively. If you would like to customize the Apache HTTP client or the OK HTTP client, provide a bean of type ClosableHttpClient or OkHttpClient.

## 18.4 Cookies and Sensitive Headers

You can share headers between services in the same system, but you probably do not want sensitive headers leaking downstream into external servers. You can specify a list of ignored headers as part of the route configuration. Cookies play a special role, because they have well defined semantics in browsers, and they are always to be treated as sensitive. If the consumer of your proxy is a browser, then cookies for downstream services also cause problems for the user, because they all get jumbled up together (all downstream services look like they come from the same place).

If you are careful with the design of your services, (for example, if only one of the downstream services sets cookies), you might be able to let them flow from the backend all the way up to the caller. Also, if your proxy sets cookies and all your back-end services are part of the same system, it can be natural to simply share them (and, for instance, use Spring Session to link them up to some shared state). Other than that, any cookies that get set by downstream services are likely to be not useful to the caller, so it is recommended that you make (at least) Set-Cookie and Cookie into sensitive headers for routes that are not part of your domain. Even for routes that are part of your domain, try to think carefully about what it means before letting cookies flow between them and the proxy.

The sensitive headers can be configured as a comma-separated list per route, as shown in the following example:

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

sensitiveHeaders: Cookie,Set-Cookie,Authorization

url: https://downstream

|  |
| --- |
| [Note] |
| This is the default value for sensitiveHeaders, so you need not set it unless you want it to be different. This is new in Spring Cloud Netflix 1.1 (in 1.0, the user had no control over headers, and all cookies flowed in both directions). |

The sensitiveHeaders are a blacklist, and the default is not empty. Consequently, to make Zuul send all headers (except the ignored ones), you must explicitly set it to the empty list. Doing so is necessary if you want to pass cookie or authorization headers to your back end. The following example shows how to use sensitiveHeaders:

**application.yml.**

zuul:

routes:

users:

path: /myusers/\*\*

sensitiveHeaders:

url: https://downstream

You can also set sensitive headers, by setting zuul.sensitiveHeaders. If sensitiveHeaders is set on a route, it overrides the global sensitiveHeaders setting.

## 18.5 Ignored Headers

In addition to the route-sensitive headers, you can set a global value called zuul.ignoredHeaders for values (both request and response) that should be discarded during interactions with downstream services. By default, if Spring Security is not on the classpath, these are empty. Otherwise, they are initialized to a set of well known “security” headers (for example, involving caching) as specified by Spring Security. The assumption in this case is that the downstream services might add these headers, too, but we want the values from the proxy. To not discard these well known security headers when Spring Security is on the classpath, you can set zuul.ignoreSecurityHeaders to false. Doing so can be useful if you disabled the HTTP Security response headers in Spring Security and want the values provided by downstream services.

## 18.6 Management Endpoints

By default, if you use @EnableZuulProxy with the Spring Boot Actuator, you enable two additional endpoints:

* Routes
* Filters

### 18.6.1 Routes Endpoint

A GET to the routes endpoint at /routes returns a list of the mapped routes:

**GET /routes.**

**{**

/stores/\*\*: "http://localhost:8081"

**}**

Additional route details can be requested by adding the ?format=details query string to /routes. Doing so produces the following output:

**GET /routes/details.**

**{**

"/stores/\*\*": **{**

"id": "stores"**,**

"fullPath": "/stores/\*\*"**,**

"location": "http://localhost:8081"**,**

"path": "/\*\*"**,**

"prefix": "/stores"**,**

"retryable": **false,**

"customSensitiveHeaders": **false,**

"prefixStripped": **true**

**}**

**}**

A POST to /routes forces a refresh of the existing routes (for example, when there have been changes in the service catalog). You can disable this endpoint by setting endpoints.routes.enabled to false.

|  |
| --- |
| [Note] |
| the routes should respond automatically to changes in the service catalog, but the POST to /routes is a way to force the change to happen immediately. |

### 18.6.2 Filters Endpoint

A GET to the filters endpoint at /filters returns a map of Zuul filters by type. For each filter type in the map, you get a list of all the filters of that type, along with their details.

## 18.7 Strangulation Patterns and Local Forwards

A common pattern when migrating an existing application or API is to “strangle” old endpoints, slowly replacing them with different implementations. The Zuul proxy is a useful tool for this because you can use it to handle all traffic from the clients of the old endpoints but redirect some of the requests to new ones.

The following example shows the configuration details for a “strangle” scenario:

**application.yml.**

zuul:

routes:

first:

path: /first/\*\*

url: http://first.example.com

second:

path: /second/\*\*

url: forward:/second

third:

path: /third/\*\*

url: forward:/3rd

legacy:

path: /\*\*

url: http://legacy.example.com

In the preceding example, we are strangle the “legacy” application, which is mapped to all requests that do not match one of the other patterns. Paths in /first/\*\*have been extracted into a new service with an external URL. Paths in /second/\*\* are forwarded so that they can be handled locally (for example, with a normal Spring @RequestMapping). Paths in /third/\*\* are also forwarded but with a different prefix (/third/foo is forwarded to /3rd/foo).

|  |
| --- |
| [Note] |
| The ignored patterns aren’t completely ignored, they just are not handled by the proxy (so they are also effectively forwarded locally). |

## 18.8 Uploading Files through Zuul

If you use @EnableZuulProxy, you can use the proxy paths to upload files and it should work, so long as the files are small. For large files there is an alternative path that bypasses the Spring DispatcherServlet (to avoid multipart processing) in "/zuul/\*". In other words, if you have zuul.routes.customers=/customers/\*\*, then you can POST large files to /zuul/customers/\*. The servlet path is externalized via zuul.servletPath. If the proxy route takes you through a Ribbon load balancer, extremely large files also require elevated timeout settings, as shown in the following example:

**application.yml.**

hystrix.command.default.execution.isolation.thread.timeoutInMilliseconds: 60000

ribbon:

ConnectTimeout: 3000

ReadTimeout: 60000

Note that, for streaming to work with large files, you need to use chunked encoding in the request (which some browsers do not do by default), as shown in the following example:

$ curl -v -H "Transfer-Encoding: chunked" \

-F "file=@mylarge.iso" localhost:9999/zuul/simple/file

## 18.9 Query String Encoding

When processing the incoming request, query params are decoded so that they can be available for possible modifications in Zuul filters. They are then re-encoded the backend request is rebuilt in the route filters. The result can be different than the original input if (for example) it was encoded with Javascript’s encodeURIComponent()method. While this causes no issues in most cases, some web servers can be picky with the encoding of complex query string.

To force the original encoding of the query string, it is possible to pass a special flag to ZuulProperties so that the query string is taken as is with the HttpServletRequest::getQueryString method, as shown in the following example:

**application.yml.**

zuul:

forceOriginalQueryStringEncoding: **true**

|  |
| --- |
| [Note] |
| This special flag works only with SimpleHostRoutingFilter. Also, you loose the ability to easily override query parameters with RequestContext.getCurrentContext().setRequestQueryParams(someOverriddenParameters), because the query string is now fetched directly on the original HttpServletRequest. |

## 18.10 Plain Embedded Zuul

If you use @EnableZuulServer (instead of @EnableZuulProxy), you can also run a Zuul server without proxying or selectively switch on parts of the proxying platform. Any beans that you add to the application of type ZuulFilter are installed automatically (as they are with @EnableZuulProxy) but without any of the proxy filters being added automatically.

In that case, the routes into the Zuul server are still specified by configuring "zuul.routes.\*", but there is no service discovery and no proxying. Consequently, the "serviceId" and "url" settings are ignored. The following example maps all paths in "/api/\*\*" to the Zuul filter chain:

**application.yml.**

zuul:

routes:

api: /api/\*\*

## 18.11 Disable Zuul Filters

Zuul for Spring Cloud comes with a number of ZuulFilter beans enabled by default in both proxy and server mode. See [the Zuul filters package](https://github.com/spring-cloud/spring-cloud-netflix/tree/master/spring-cloud-netflix-zuul/src/main/java/org/springframework/cloud/netflix/zuul/filters) for the list of filters that you can enable. If you want to disable one, set zuul.<SimpleClassName>.<filterType>.disable=true. By convention, the package after filters is the Zuul filter type. For example to disable org.springframework.cloud.netflix.zuul.filters.post.SendResponseFilter, set zuul.SendResponseFilter.post.disable=true.

## 18.12 Providing Hystrix Fallbacks For Routes

When a circuit for a given route in Zuul is tripped, you can provide a fallback response by creating a bean of type FallbackProvider. Within this bean, you need to specify the route ID the fallback is for and provide a ClientHttpResponse to return as a fallback. The following example shows a relatively simple FallbackProviderimplementation:

**class** MyFallbackProvider **implements** FallbackProvider {

*@Override*

**public** String getRoute() {

**return** "customers";

}

*@Override*

**public** ClientHttpResponse fallbackResponse(String route, **final** Throwable cause) {

**if** (cause **instanceof** HystrixTimeoutException) {

**return** response(HttpStatus.GATEWAY\_TIMEOUT);

} **else** {

**return** response(HttpStatus.INTERNAL\_SERVER\_ERROR);

}

}

**private** ClientHttpResponse response(**final** HttpStatus status) {

**return** **new** ClientHttpResponse() {

*@Override*

**public** HttpStatus getStatusCode() **throws** IOException {

**return** status;

}

*@Override*

**public** **int** getRawStatusCode() **throws** IOException {

**return** status.value();

}

*@Override*

**public** String getStatusText() **throws** IOException {

**return** status.getReasonPhrase();

}

*@Override*

**public** **void** close() {

}

*@Override*

**public** InputStream getBody() **throws** IOException {

**return** **new** ByteArrayInputStream("fallback".getBytes());

}

*@Override*

**public** HttpHeaders getHeaders() {

HttpHeaders headers = **new** HttpHeaders();

headers.setContentType(MediaType.APPLICATION\_JSON);

**return** headers;

}

};

}

}

The following example shows how the route configuration for the previous example might appear:

zuul:

routes:

customers: /customers/\*\*

If you would like to provide a default fallback for all routes, you can create a bean of type FallbackProvider and have the getRoute method return \* or null, as shown in the following example:

**class** MyFallbackProvider **implements** FallbackProvider {

*@Override*

**public** String getRoute() {

**return** "\*";

}

*@Override*

**public** ClientHttpResponse fallbackResponse(String route, Throwable throwable) {

**return** **new** ClientHttpResponse() {

*@Override*

**public** HttpStatus getStatusCode() **throws** IOException {

**return** HttpStatus.OK;

}

*@Override*

**public** **int** getRawStatusCode() **throws** IOException {

**return** 200;

}

*@Override*

**public** String getStatusText() **throws** IOException {

**return** "OK";

}

*@Override*

**public** **void** close() {

}

*@Override*

**public** InputStream getBody() **throws** IOException {

**return** **new** ByteArrayInputStream("fallback".getBytes());

}

*@Override*

**public** HttpHeaders getHeaders() {

HttpHeaders headers = **new** HttpHeaders();

headers.setContentType(MediaType.APPLICATION\_JSON);

**return** headers;

}

};

}

}

## 18.13 Zuul Timeouts

If you want to configure the socket timeouts and read timeouts for requests proxied through Zuul, you have two options, based on your configuration:

* If Zuul uses service discovery, you need to configure these timeouts with the ribbon.ReadTimeout and ribbon.SocketTimeout Ribbon properties.

If you have configured Zuul routes by specifying URLs, you need to use zuul.host.connect-timeout-millis and zuul.host.socket-timeout-millis.

## 18.14 Rewriting the Location header

If Zuul is fronting a web application, you may need to re-write the Location header when the web application redirects through a HTTP status code of 3XX. Otherwise, the browser redirects to the web application’s URL instead of the Zuul URL. You can configure a LocationRewriteFilter Zuul filter to re-write the Location header to the Zuul’s URL. It also adds back the stripped global and route-specific prefixes. The following example adds a filter by using a Spring Configuration file:

**import** org.springframework.cloud.netflix.zuul.filters.post.LocationRewriteFilter;

...

*@Configuration*

*@EnableZuulProxy*

**public** **class** ZuulConfig {

*@Bean*

**public** LocationRewriteFilter locationRewriteFilter() {

**return** **new** LocationRewriteFilter();

}

}

|  |  |
| --- | --- |
| [Caution] | **Caution** |
| Use this filter carefully. The filter acts on the Location header of ALL 3XX response codes, which may not be appropriate in all scenarios, such as when redirecting the user to an external URL. |

## 18.15 Zuul Developer Guide

For a general overview of how Zuul works, see [the Zuul Wiki](https://github.com/Netflix/zuul/wiki/How-it-Works).

### 18.15.1 The Zuul Servlet

Zuul is implemented as a Servlet. For the general cases, Zuul is embedded into the Spring Dispatch mechanism. This lets Spring MVC be in control of the routing. In this case, Zuul buffers requests. If there is a need to go through Zuul without buffering requests (for example, for large file uploads), the Servlet is also installed outside of the Spring Dispatcher. By default, the servlet has an address of /zuul. This path can be changed with the zuul.servlet-path property.

### 18.15.2 Zuul RequestContext

To pass information between filters, Zuul uses a [RequestContext](https://github.com/Netflix/zuul/blob/1.x/zuul-core/src/main/java/com/netflix/zuul/context/RequestContext.java). Its data is held in a ThreadLocal specific to each request. Information about where to route requests, errors, and the actual HttpServletRequest and HttpServletResponse are stored there. The RequestContext extends ConcurrentHashMap, so anything can be stored in the context. [FilterConstants](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/spring-cloud-netflix-core/src/main/java/org/springframework/cloud/netflix/zuul/filters/support/FilterConstants.java) contains the keys used by the filters installed by Spring Cloud Netflix (more on these [later](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#zuul-developer-guide-enable-filters)).

### 18.15.3 @EnableZuulProxy vs. @EnableZuulServer

Spring Cloud Netflix installs a number of filters, depending on which annotation was used to enable Zuul. @EnableZuulProxy is a superset of @EnableZuulServer. In other words, @EnableZuulProxy contains all the filters installed by @EnableZuulServer. The additional filters in the “proxy” enable routing functionality. If you want a “blank” Zuul, you should use @EnableZuulServer.

### 18.15.4 @EnableZuulServer Filters

@EnableZuulServer creates a SimpleRouteLocator that loads route definitions from Spring Boot configuration files.

The following filters are installed (as normal Spring Beans):

* Pre filters:
  + ServletDetectionFilter: Detects whether the request is through the Spring Dispatcher. Sets a boolean with a key of FilterConstants.IS\_DISPATCHER\_SERVLET\_REQUEST\_KEY.
  + FormBodyWrapperFilter: Parses form data and re-encodes it for downstream requests.
  + DebugFilter: If the debug request parameter is set, sets RequestContext.setDebugRouting() and RequestContext.setDebugRequest() to true. \*Route filters:
  + SendForwardFilter: Forwards requests by using the Servlet RequestDispatcher. The forwarding location is stored in the RequestContext attribute, FilterConstants.FORWARD\_TO\_KEY. This is useful for forwarding to endpoints in the current application.
* Post filters:
  + SendResponseFilter: Writes responses from proxied requests to the current response.
* Error filters:
  + SendErrorFilter: Forwards to /error (by default) if RequestContext.getThrowable() is not null. You can change the default forwarding path (/error) by setting the error.path property.

### 18.15.5 @EnableZuulProxy Filters

Creates a DiscoveryClientRouteLocator that loads route definitions from a DiscoveryClient (such as Eureka) as well as from properties. A route is created for each serviceId from the DiscoveryClient. As new services are added, the routes are refreshed.

In addition to the filters described earlier, the following filters are installed (as normal Spring Beans):

* Pre filters:
  + PreDecorationFilter: Determines where and how to route, depending on the supplied RouteLocator. It also sets various proxy-related headers for downstream requests.
* Route filters:
  + RibbonRoutingFilter: Uses Ribbon, Hystrix, and pluggable HTTP clients to send requests. Service IDs are found in the RequestContext attribute, FilterConstants.SERVICE\_ID\_KEY. This filter can use different HTTP clients:
    - Apache HttpClient: The default client.
    - Squareup OkHttpClient v3: Enabled by having the com.squareup.okhttp3:okhttp library on the classpath and setting ribbon.okhttp.enabled=true.
    - Netflix Ribbon HTTP client: Enabled by setting ribbon.restclient.enabled=true. This client has limitations, including that it does not support the PATCH method, but it also has built-in retry.
  + SimpleHostRoutingFilter: Sends requests to predetermined URLs through an Apache HttpClient. URLs are found in RequestContext.getRouteHost().

### 18.15.6 Custom Zuul Filter Examples

Most of the following "How to Write" examples below are included [Sample Zuul Filters](https://github.com/spring-cloud-samples/sample-zuul-filters) project. There are also examples of manipulating the request or response body in that repository.

This section includes the following examples:

* [the section called “How to Write a Pre Filter”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#zuul-developer-guide-sample-pre-filter)
* [the section called “How to Write a Route Filter”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#zuul-developer-guide-sample-route-filter)
* [the section called “How to Write a Post Filter”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__router_and_filter_zuul.html#zuul-developer-guide-sample-post-filter)

#### How to Write a Pre Filter

Pre filters set up data in the RequestContext for use in filters downstream. The main use case is to set information required for route filters. The following example shows a Zuul pre filter:

**public** **class** QueryParamPreFilter **extends** ZuulFilter {

*@Override*

**public** **int** filterOrder() {

**return** PRE\_DECORATION\_FILTER\_ORDER - 1; *// run before PreDecoration*

}

*@Override*

**public** String filterType() {

**return** PRE\_TYPE;

}

*@Override*

**public** **boolean** shouldFilter() {

RequestContext ctx = RequestContext.getCurrentContext();

**return** !ctx.containsKey(FORWARD\_TO\_KEY) *// a filter has already forwarded*

&& !ctx.containsKey(SERVICE\_ID\_KEY); *// a filter has already determined serviceId*

}

*@Override*

**public** Object run() {

RequestContext ctx = RequestContext.getCurrentContext();

HttpServletRequest request = ctx.getRequest();

**if** (request.getParameter("sample") != null) {

*// put the serviceId in `RequestContext`*

ctx.put(SERVICE\_ID\_KEY, request.getParameter("foo"));

}

**return** null;

}

}

The preceding filter populates SERVICE\_ID\_KEY from the sample request parameter. In practice, you should not do that kind of direct mapping. Instead, the service ID should be looked up from the value of sample instead.

Now that SERVICE\_ID\_KEY is populated, PreDecorationFilter does not run and RibbonRoutingFilter runs.

|  |
| --- |
| [Tip] |
| If you want to route to a full URL, call ctx.setRouteHost(url) instead. |

To modify the path to which routing filters forward, set the REQUEST\_URI\_KEY.

#### How to Write a Route Filter

Route filters run after pre filters and make requests to other services. Much of the work here is to translate request and response data to and from the model required by the client. The following example shows a Zuul route filter:

**public** **class** OkHttpRoutingFilter **extends** ZuulFilter {

*@Autowired*

**private** ProxyRequestHelper helper;

*@Override*

**public** String filterType() {

**return** ROUTE\_TYPE;

}

*@Override*

**public** **int** filterOrder() {

**return** SIMPLE\_HOST\_ROUTING\_FILTER\_ORDER - 1;

}

*@Override*

**public** **boolean** shouldFilter() {

**return** RequestContext.getCurrentContext().getRouteHost() != null

&& RequestContext.getCurrentContext().sendZuulResponse();

}

*@Override*

**public** Object run() {

OkHttpClient httpClient = **new** OkHttpClient.Builder()

*// customize*

.build();

RequestContext context = RequestContext.getCurrentContext();

HttpServletRequest request = context.getRequest();

String method = request.getMethod();

String uri = **this**.helper.buildZuulRequestURI(request);

Headers.Builder headers = **new** Headers.Builder();

Enumeration<String> headerNames = request.getHeaderNames();

**while** (headerNames.hasMoreElements()) {

String name = headerNames.nextElement();

Enumeration<String> values = request.getHeaders(name);

**while** (values.hasMoreElements()) {

String value = values.nextElement();

headers.add(name, value);

}

}

InputStream inputStream = request.getInputStream();

RequestBody requestBody = null;

**if** (inputStream != null && HttpMethod.permitsRequestBody(method)) {

MediaType mediaType = null;

**if** (headers.get("Content-Type") != null) {

mediaType = MediaType.parse(headers.get("Content-Type"));

}

requestBody = RequestBody.create(mediaType, StreamUtils.copyToByteArray(inputStream));

}

Request.Builder builder = **new** Request.Builder()

.headers(headers.build())

.url(uri)

.method(method, requestBody);

Response response = httpClient.newCall(builder.build()).execute();

LinkedMultiValueMap<String, String> responseHeaders = **new** LinkedMultiValueMap<>();

**for** (Map.Entry<String, List<String>> entry : response.headers().toMultimap().entrySet()) {

responseHeaders.put(entry.getKey(), entry.getValue());

}

**this**.helper.setResponse(response.code(), response.body().byteStream(),

responseHeaders);

context.setRouteHost(null); *// prevent SimpleHostRoutingFilter from running*

**return** null;

}

}

The preceding filter translates Servlet request information into OkHttp3 request information, executes an HTTP request, and translates OkHttp3 response information to the Servlet response.

#### How to Write a Post Filter

Post filters typically manipulate the response. The following filter adds a random UUID as the X-Sample header:

**public** **class** AddResponseHeaderFilter **extends** ZuulFilter {

*@Override*

**public** String filterType() {

**return** POST\_TYPE;

}

*@Override*

**public** **int** filterOrder() {

**return** SEND\_RESPONSE\_FILTER\_ORDER - 1;

}

*@Override*

**public** **boolean** shouldFilter() {

**return** true;

}

*@Override*

**public** Object run() {

RequestContext context = RequestContext.getCurrentContext();

HttpServletResponse servletResponse = context.getResponse();

servletResponse.addHeader("X-Sample", UUID.randomUUID().toString());

**return** null;

}

}

|  |
| --- |
| [Note] |
| Other manipulations, such as transforming the response body, are much more complex and computationally intensive. |

### 18.15.7 How Zuul Errors Work

If an exception is thrown during any portion of the Zuul filter lifecycle, the error filters are executed. The SendErrorFilter is only run if RequestContext.getThrowable() is not null. It then sets specific javax.servlet.error.\* attributes in the request and forwards the request to the Spring Boot error page.

### 18.15.8 Zuul Eager Application Context Loading

Zuul internally uses Ribbon for calling the remote URLs. By default, Ribbon clients are lazily loaded by Spring Cloud on first call. This behavior can be changed for Zuul by using the following configuration, which results eager loading of the child Ribbon related Application contexts at application startup time. The following example shows how to enable eager loading:

**application.yml.**

zuul:

ribbon:

eager-load:

enabled: true

## 19. Polyglot support with Sidecar

Do you have non-JVM languages with which you want to take advantage of Eureka, Ribbon, and Config Server? The Spring Cloud Netflix Sidecar was inspired by [Netflix Prana](https://github.com/Netflix/Prana). It includes an HTTP API to get all of the instances (by host and port) for a given service. You can also proxy service calls through an embedded Zuul proxy that gets its route entries from Eureka. The Spring Cloud Config Server can be accessed directly through host lookup or through the Zuul Proxy. The non-JVM application should implement a health check so the Sidecar can report to Eureka whether the app is up or down.

To include Sidecar in your project, use the dependency with a group ID of org.springframework.cloud and artifact ID or spring-cloud-netflix-sidecar.

To enable the Sidecar, create a Spring Boot application with @EnableSidecar. This annotation includes @EnableCircuitBreaker, @EnableDiscoveryClient, and @EnableZuulProxy. Run the resulting application on the same host as the non-JVM application.

To configure the side car, add sidecar.port and sidecar.health-uri to application.yml. The sidecar.port property is the port on which the non-JVM application listens. This is so the Sidecar can properly register the application with Eureka. The sidecar.health-uri is a URI accessible on the non-JVM application that mimics a Spring Boot health indicator. It should return a JSON document that resembles the following:

**health-uri-document.**

**{**

"status":"UP"

**}**

HThe following application.yml example shows sample configuration for a Sidecar application:

**application.yml.**

server:

port: 5678

spring:

application:

name: sidecar

sidecar:

port: 8000

health-uri: http://localhost:8000/health.json

The API for the DiscoveryClient.getInstances() method is /hosts/{serviceId}. The following example response for /hosts/customers returns two instances on different hosts:

**/hosts/customers.**

**[**

**{**

"host": "myhost"**,**

"port": 9000**,**

"uri": "http://myhost:9000"**,**

"serviceId": "CUSTOMERS"**,**

"secure": **false**

**},**

**{**

"host": "myhost2"**,**

"port": 9000**,**

"uri": "http://myhost2:9000"**,**

"serviceId": "CUSTOMERS"**,**

"secure": **false**

**}**

**]**

This API is accessible to the non-JVM application (if the sidecar is on port 5678) at [http://localhost:5678/hosts/{serviceId}](http://localhost:5678/hosts/%7BserviceId%7D).

The Zuul proxy automatically adds routes for each service known in Eureka to /<serviceId>, so the customers service is available at /customers. The non-JVM application can access the customer service at <http://localhost:5678/customers> (assuming the sidecar is listening on port 5678).

If the Config Server is registered with Eureka, the non-JVM application can access it through the Zuul proxy. If the serviceId of the ConfigServer is configserverand the Sidecar is on port 5678, then it can be accessed at <http://localhost:5678/configserver>.

Non-JVM applications can take advantage of the Config Server’s ability to return YAML documents. For example, a call to <http://sidecar.local.spring.io:5678/configserver/default-master.yml> might result in a YAML document resembling the following:

eureka:

client:

serviceUrl:

defaultZone: http://localhost:8761/eureka/

password: password

info:

description: Spring Cloud Samples

url: https://github.com/spring-cloud-samples

## 20. Metrics: Spectator, Servo, and Atlas

When used together, Spectator (or Servo) and Atlas provide a near real-time operational insight platform. Spectator and Servo are Netflix’s metrics collection libraries. Atlas is a Netflix metrics backend that manages dimensional time-series data.

Servo served Netflix for several years and is still usable but is gradually being phased out in favor of Spectator, which is designed to work only with Java 8. Spring Cloud Netflix provides support for both, but Java 8-based applications are encouraged to use Spectator.

## 20.1 Dimensional Versus Hierarchical Metrics

Spring Boot Actuator metrics are hierarchical, and the metrics are separated only by name. These names often follow a naming convention that embeds key/value attribute pairs (dimensions) into the name (separated by periods). Consider the following metrics for two endpoints, root and star-star:

**{**

"counter.status.200.root": 20**,**

"counter.status.400.root": 3**,**

"counter.status.200.star-star": 5**,**

**}**

The first metric gives us a normalized count of successful requests against the root endpoint per unit of time. But what if the system has 20 endpoints and you want to get a count of successful requests against all the endpoints? Some hierarchical metrics backends would let you specify a wildcard, such as counter.status.200.\*, that would read all 20 metrics and aggregate the results. Alternatively, you could provide a HandlerInterceptorAdapter that intercepts and records a metric such as counter.status.200.all for all successful requests irrespective of the endpoint, but now you must write 20+1 different metrics. Similarly, if you want to know the total number of successful requests for all endpoints in the service, you could specify a wildcard such as counter.status.2\*.\*.

Even in the presence of wildcarding support on a hierarchical metrics backend, naming consistency can be difficult. Specifically, the position of these tags in the name string can slip with time, breaking queries. For example, suppose we add an additional dimension to the earlier hierarchical metrics for an HTTP method. Then counter.status.200.root becomes counter.status.200.method.get.root (or post and so on). Suddenly, Our counter.status.200.\* no longer has the same semantic meaning. Furthermore, if the new dimension is not applied uniformly across the codebase, certain queries may become impossible. This can quickly get out of hand.

Netflix metrics are tagged (in other words, they are dimensional). Each metric has a name, but this single named metric can contain multiple statistics and 'tag' key/value pairs, which allows more querying flexibility. In fact, the statistics themselves are recorded in a special tag.

When recorded with Netflix Servo or Spectator, a timer for the root endpoint described earlier contains four statistics for each status code, where the count statistic is identical to Spring Boot Actuator’s counter. When we have encountered an HTTP 200 and 400 with the preceding examples, there are eight available data points, as shown in the following example:

**{**

"root(status=200,stastic=count)": 20**,**

"root(status=200,stastic=max)": 0.7265630630000001**,**

"root(status=200,stastic=totalOfSquares)": 0.04759702862580789**,**

"root(status=200,stastic=totalTime)": 0.2093076914666667**,**

"root(status=400,stastic=count)": 1**,**

"root(status=400,stastic=max)": 0**,**

"root(status=400,stastic=totalOfSquares)": 0**,**

"root(status=400,stastic=totalTime)": 0**,**

**}**

## 20.2 Default Metrics Collection

Without any additional dependencies or configuration, a Spring Cloud based service autoconfigures a Servo MonitorRegistry and begins collecting metrics on every Spring MVC request. By default, a Servo timer with a name of rest is recorded for each MVC request, which is tagged with the following information:

* HTTP method (GET, POST, and so on).
* HTTP status (200, 400, 500, and so on).
* URI (or root if the URI is empty), sanitized for Atlas.
* The exception class name, if the request handler threw an exception.
* The caller, if a request header with a key matching netflix.metrics.rest.callerHeader is set on the request. There is no default key for netflix.metrics.rest.callerHeader. You must add it to your application properties if you wish to collect caller information.

Set the netflix.metrics.rest.metricName property to change the name of the metric from rest to the name you provide.

If Spring AOP is enabled and org.aspectj:aspectjweaver is present on your runtime classpath, Spring Cloud also collects metrics on every client call made with RestTemplate. A Servo timer with a name of restclient is recorded for each MVC request, which is tagged with the following information:

* HTTP method ('GET', 'POST', and so on).
* HTTP status (200, 400, 500, and so on) and possibly CLIENT\_ERROR if the response returned null or IO\_ERROR if an IOException occurred during the execution of the RestTemplate method.
* URI, sanitized for Atlas.
* Client name.

|  |
| --- |
| [Warning] |
| Avoid using hard-coded URL parameters within RestTemplate. When targeting dynamic endpoints, use URL variables. Doing so avoids potential “GC Overhead Limit Reached” issues where ServoMonitorCache treats each URL as a unique key. The following example shows both the recommended and the problematic ways to set URL parameters: |

*// recommended*

String orderid = "1";

restTemplate.getForObject("http://testeurekabrixtonclient/orders/{orderid}", String.**class**, orderid)

*// avoid*

restTemplate.getForObject("http://testeurekabrixtonclient/orders/1", String.**class**)

## 20.3 Metrics Collection: Spectator

To enable Spectator metrics, include a dependency on spring-boot-starter-spectator, as follows:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-netflix-spectator</artifactId>

</dependency>

In Spectator parlance, a meter is a named, typed, and tagged configuration, while a metric represents the value of a given meter at a point in time. Spectator meters are created and controlled by a registry, which currently has several different implementations. Spectator provides four meter types: counter, timer, gauge, and distribution summary.

Spring Cloud Spectator integration configures an injectable com.netflix.spectator.api.Registry instance for you. Specifically, it configures a ServoRegistryinstance in order to unify the collection of REST metrics and the exporting of metrics to the Atlas backend under a single Servo API. Practically, this means that your code may use a mixture of Servo monitors and Spectator meters. Spring Boot scoops up both Actuator MetricReader instances and ships them to the Atlas backend.

### 20.3.1 Spectator Counter

A counter measures the rate at which some event is occurring, as shown in the following example:

*// create a counter with a name and a set of tags*

Counter counter = registry.counter("counterName", "tagKey1", "tagValue1", ...);

counter.increment(); *// increment when an event occurs*

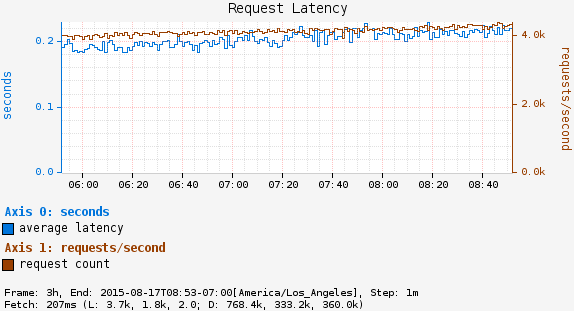
counter.increment(10); *// increment by a discrete amount*

The counter records a single time-normalized statistic.

### 20.3.2 Spectator Timer

A timer measures how long some event takes. Spring Cloud automatically records timers for Spring MVC requests and, conditionally, RestTemplate requests, which can later be used to create dashboards for request related metrics like latency, as shown in the following example:

**Figure 20.1. Request Latency**



*// create a timer with a name and a set of tags*

Timer timer = registry.timer("timerName", "tagKey1", "tagValue1", ...);

*// execute an operation and time it at the same time*

T result = timer.record(() -> fooReturnsT());

*// alternatively, if you must manually record the time*

Long start = System.nanoTime();

T result = fooReturnsT();

timer.record(System.nanoTime() - start, TimeUnit.NANOSECONDS);

The timer simultaneously records four statistics: count, max, totalOfSquares, and totalTime. The count statistic always matches the single normalized value provided by a counter as though you had called increment() once on the counter for each time you recorded a timing, so it is rarely necessary to count and time separately for a single operation.

For [long-running operations](https://github.com/Netflix/spectator/wiki/Timer-Usage#longtasktimer), Spectator provides a special LongTaskTimer.

### 20.3.3 Spectator Gauge

Gauges show some current value, such as the size of a queue or number of threads in a running state. Since gauges are sampled, they provide no information about how these values fluctuate between samples.

The normal use of a gauge involves registering the gauge once on initialization with an ID, a reference to the object to be sampled, and a function to get or compute a numeric value based on the object. The reference to the object is passed in separately, and the Spectator registry keeps a weak reference to the object. If the object is garbage collected, Spectator automatically drops the registration. See [the note](https://github.com/Netflix/spectator/wiki/Gauge-Usage#using-lambda) in Spectator’s documentation about potential memory leaks if this API is misused. The following listing shows how to automatically and manually sample a gauge:

*// the registry automatically samples this gauge periodically*

registry.gauge("gaugeName", pool, Pool::numberOfRunningThreads);

*// manually sample a value in code at periodic intervals -- last resort!*

registry.gauge("gaugeName", Arrays.asList("tagKey1", "tagValue1", ...), 1000);

### 20.3.4 Spectator Distribution Summaries

A distribution summary tracks the distribution of events. It is similar to a timer but more general in that the size does not have to be a period of time. For example, a distribution summary could be used to measure the payload sizes of requests hitting a server. The following example defines a distribution summary:

*// the registry automatically samples this gauge periodically*

DistributionSummary ds = registry.distributionSummary("dsName", "tagKey1", "tagValue1", ...);

ds.record(request.sizeInBytes());

## 20.4 Metrics Collection: Servo

|  |
| --- |
| [Note] |
| If your code is compiled on Java 8, use Spectator instead of Servo, as Spectator is destined to replace Servo entirely. |

In Servo parlance, a monitor is a named, typed, and tagged configuration, and a metric represents the value of a given monitor at a point in time. Servo monitors are logically equivalent to Spectator meters. Servo monitors are created and controlled by a MonitorRegistry. While it is still available, Servo has a [wider array](https://github.com/Netflix/servo/wiki/Getting-Started) of monitor options than Spectator has meters.

Spring Cloud integration configures an injectable com.netflix.servo.MonitorRegistry instance for you. Once you have created the appropriate Monitor type in Servo, the process of recording data is similar to that of Spectator.

### 20.4.1 Creating Servo Monitors

If you use the Servo MonitorRegistry instance provided by Spring Cloud (specifically, an instance of DefaultMonitorRegistry), Servo provides convenience classes for retrieving [counters](https://github.com/Netflix/spectator/wiki/Servo-Comparison#dynamiccounter) and [timers](https://github.com/Netflix/spectator/wiki/Servo-Comparison#dynamictimer). These convenience classes ensure that only one Monitor is registered for each unique combination of name and tags.

To manually create a Monitor type in Servo, especially for the more exotic monitor types for which convenience methods are not provided, instantiate the appropriate type by providing a MonitorConfig instance, as shown in the following example:

MonitorConfig config = MonitorConfig.builder("timerName").withTag("tagKey1", "tagValue1").build();

*// somewhere we should cache this Monitor by MonitorConfig*

Timer timer = **new** BasicTimer(config);

monitorRegistry.register(timer);

## 21. Metrics Backend: Atlas

Atlas was developed by Netflix to manage dimensional time-series data for near real-time operational insight. Atlas features in-memory data storage, letting it gather and report large numbers of metrics quickly.

Atlas captures operational intelligence. Whereas business intelligence is data gathered for analyzing trends over time, operational intelligence provides a picture of what is currently happening within a system.

Spring Cloud provides a spring-cloud-starter-netflix-atlas that has all the dependencies you need. Then you can annotate your Spring Boot application with @EnableAtlas and provide a location for your running Atlas server by setting the netflix.atlas.uri property.

## 21.1 Global Tags

Spring Cloud lets you add tags to every metric sent to the Atlas backend. Global tags can be used to separate metrics by application name, environment, region, and so on.

Each bean implementing AtlasTagProvider contributes to the global tag list, as shown in the following example:

*@Bean*

AtlasTagProvider atlasCommonTags(

*@Value("${spring.application.name}")* String appName) {

**return** () -> Collections.singletonMap("app", appName);

}

### 21.1.1 Using Atlas

To bootstrap an in-memory standalone Atlas instance, use the following commands:

$ curl -LO https://github.com/Netflix/atlas/releases/download/v1.4.2/atlas-1.4.2-standalone.jar

$ java -jar atlas-1.4.2-standalone.jar

|  |
| --- |
| [Tip] |
| An Atlas standalone node running on an r3.2xlarge (61GB RAM) can handle roughly 2 million metrics per minute for a given six-hour window. |

Once the application is running and you have collected a handful of metrics, you can verify that your setup is correct by listing tags on the Atlas server, as shown in the following example:

$ curl http://ATLAS/api/v1/tags

|  |
| --- |
| [Tip] |
| After running several requests against your service, you can gather some basic information on the request latency of every request by pasting the following URL in your browser: [http://ATLAS/api/v1/graph?q=name,rest,:eq,:avg](http://atlas/api/v1/graph?q=name,rest,:eq,:avg) |

The Atlas wiki contains a [compilation of sample queries](https://github.com/Netflix/atlas/wiki/Single-Line) for various scenarios.

See the [alerting philosophy](https://github.com/Netflix/atlas/wiki/Alerting-Philosophy) and docs on using [double exponential smoothing](https://github.com/Netflix/atlas/wiki/DES) to generate dynamic alert thresholds.

## 22. Retrying Failed Requests

Spring Cloud Netflix offers a variety of ways to make HTTP requests. You can use a load balanced RestTemplate, Ribbon, or Feign. No matter how you choose to create your HTTP requests, there is always a chance that a request may fail. When a request fails, you may want to have the request be retried automatically. To do so when using Sping Cloud Netflix, you need to include [Spring Retry](https://github.com/spring-projects/spring-retry) on your application’s classpath. When Spring Retry is present, load-balanced RestTemplates, Feign, and Zuul automatically retry any failed requests (assuming your configuration allows doing so).

## 22.1 BackOff Policies

By default, no backoff policy is used when retrying requests. If you would like to configure a backoff policy, you need to create a bean of type LoadBalancedBackOffPolicyFactory, which is used to create a BackOffPolicy for a given service, as shown in the following example:

*@Configuration*

**public** **class** MyConfiguration {

*@Bean*

LoadBalancedBackOffPolicyFactory backOffPolicyFactory() {

**return** **new** LoadBalancedBackOffPolicyFactory() {

*@Override*

**public** BackOffPolicy createBackOffPolicy(String service) {

**return** **new** ExponentialBackOffPolicy();

}

};

}

}

## 22.2 Configuration

When you use Ribbon with Spring Retry, you can control the retry functionality by configuring certain Ribbon properties. To do so, set the client.ribbon.MaxAutoRetries, client.ribbon.MaxAutoRetriesNextServer, and client.ribbon.OkToRetryOnAllOperations properties. See the [Ribbon documentation](https://github.com/Netflix/ribbon/wiki/Getting-Started#the-properties-file-sample-clientproperties) for a description of what these properties do.

|  |
| --- |
| [Warning] |
| Enabling client.ribbon.OkToRetryOnAllOperations includes retrying POST requests, which can have an impact on the server’s resources, due to the buffering of the request body. |

In addition, you may want to retry requests when certain status codes are returned in the response. You can list the response codes you would like the Ribbon client to retry by setting the clientName.ribbon.retryableStatusCodes property, as shown in the following example:

clientName:

ribbon:

retryableStatusCodes: 404,502

You can also create a bean of type LoadBalancedRetryPolicy and implement the retryableStatusCode method to retry a request given the status code.

### 22.2.1 Zuul

You can turn off Zuul’s retry functionality by setting zuul.retryable to false. You can also disable retry functionality on a route-by-route basis by setting zuul.routes.routename.retryable to false.

## 23. HTTP Clients

Spring Cloud Netflix automatically creates the HTTP client used by Ribbon, Feign, and Zuul for you. However, you can also provide your own HTTP clients customized as you need them to be. To do so, you can create a bean of type ClosableHttpClient if you are using the Apache Http Cient or OkHttpClient if you are using OK HTTP.

|  |
| --- |
| [Note] |
| When you create your own HTTP client, you are also responsible for implementing the correct connection management strategies for these clients. Doing so improperly can result in resource management issues. |

# Part IV. Spring Cloud OpenFeign

**Finchley.M9**

This project provides OpenFeign integrations for Spring Boot apps through autoconfiguration and binding to the Spring Environment and other Spring programming model idioms.

## 24. Declarative REST Client: Feign

[Feign](https://github.com/Netflix/feign) is a declarative web service client. It makes writing web service clients easier. To use Feign create an interface and annotate it. It has pluggable annotation support including Feign annotations and JAX-RS annotations. Feign also supports pluggable encoders and decoders. Spring Cloud adds support for Spring MVC annotations and for using the same HttpMessageConverters used by default in Spring Web. Spring Cloud integrates Ribbon and Eureka to provide a load balanced http client when using Feign.

## 24.1 How to Include Feign

To include Feign in your project use the starter with group org.springframework.cloud and artifact id spring-cloud-starter-openfeign. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

Example spring boot app

*@SpringBootApplication*

*@EnableFeignClients*

**public** **class** Application {

**public** **static** **void** main(String[] args) {

SpringApplication.run(Application.**class**, args);

}

}

**StoreClient.java.**

*@FeignClient("stores")*

**public** **interface** StoreClient {

*@RequestMapping(method = RequestMethod.GET, value = "/stores")*

List<Store> getStores();

*@RequestMapping(method = RequestMethod.POST, value = "/stores/{storeId}", consumes = "application/json")*

Store update(*@PathVariable("storeId")* Long storeId, Store store);

}

In the @FeignClient annotation the String value ("stores" above) is an arbitrary client name, which is used to create a Ribbon load balancer (see [below for details of Ribbon support](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-ribbon.html)). You can also specify a URL using the url attribute (absolute value or just a hostname). The name of the bean in the application context is the fully qualified name of the interface. To specify your own alias value you can use the qualifier value of the @FeignClient annotation.

The Ribbon client above will want to discover the physical addresses for the "stores" service. If your application is a Eureka client then it will resolve the service in the Eureka service registry. If you don’t want to use Eureka, you can simply configure a list of servers in your external configuration (see [above for example](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-ribbon.html#spring-cloud-ribbon-without-eureka)).

## 24.2 Overriding Feign Defaults

A central concept in Spring Cloud’s Feign support is that of the named client. Each feign client is part of an ensemble of components that work together to contact a remote server on demand, and the ensemble has a name that you give it as an application developer using the @FeignClient annotation. Spring Cloud creates a new ensemble as an ApplicationContext on demand for each named client using FeignClientsConfiguration. This contains (amongst other things) an feign.Decoder, a feign.Encoder, and a feign.Contract.

Spring Cloud lets you take full control of the feign client by declaring additional configuration (on top of the FeignClientsConfiguration) using @FeignClient. Example:

*@FeignClient(name = "stores", configuration = FooConfiguration.class)*

**public** **interface** StoreClient {

*//..*

}

In this case the client is composed from the components already in FeignClientsConfiguration together with any in FooConfiguration (where the latter will override the former).

|  |
| --- |
| [Note] |
| FooConfiguration does not need to be annotated with @Configuration. However, if it is, then take care to exclude it from any @ComponentScan that would otherwise include this configuration as it will become the default source for feign.Decoder, feign.Encoder, feign.Contract, etc., when specified. This can be avoided by putting it in a separate, non-overlapping package from any @ComponentScan or @SpringBootApplication, or it can be explicitly excluded in @ComponentScan. | |
| [Note] | |
| The serviceId attribute is now deprecated in favor of the name attribute. | |

|  |
| --- |
| [Warning] |
| Previously, using the url attribute, did not require the name attribute. Using name is now required. |

Placeholders are supported in the name and url attributes.

*@FeignClient(name = "${feign.name}", url = "${feign.url}")*

**public** **interface** StoreClient {

*//..*

}

Spring Cloud Netflix provides the following beans by default for feign (BeanType beanName: ClassName):

* Decoder feignDecoder: ResponseEntityDecoder (which wraps a SpringDecoder)
* Encoder feignEncoder: SpringEncoder
* Logger feignLogger: Slf4jLogger
* Contract feignContract: SpringMvcContract
* Feign.Builder feignBuilder: HystrixFeign.Builder
* Client feignClient: if Ribbon is enabled it is a LoadBalancerFeignClient, otherwise the default feign client is used.

The OkHttpClient and ApacheHttpClient feign clients can be used by setting feign.okhttp.enabled or feign.httpclient.enabled to true, respectively, and having them on the classpath. You can customize the HTTP client used by providing a bean of either ClosableHttpClient when using Apache or OkHttpClient whe using OK HTTP.

Spring Cloud Netflix does not provide the following beans by default for feign, but still looks up beans of these types from the application context to create the feign client:

* Logger.Level
* Retryer
* ErrorDecoder
* Request.Options
* Collection<RequestInterceptor>
* SetterFactory

Creating a bean of one of those type and placing it in a @FeignClient configuration (such as FooConfiguration above) allows you to override each one of the beans described. Example:

*@Configuration*

**public** **class** FooConfiguration {

*@Bean*

**public** Contract feignContract() {

**return** **new** feign.Contract.Default();

}

*@Bean*

**public** BasicAuthRequestInterceptor basicAuthRequestInterceptor() {

**return** **new** BasicAuthRequestInterceptor("user", "password");

}

}

This replaces the SpringMvcContract with feign.Contract.Default and adds a RequestInterceptor to the collection of RequestInterceptor.

@FeignClient also can be configured using configuration properties.

application.yml

feign:

client:

config:

feignName:

connectTimeout: 5000

readTimeout: 5000

loggerLevel: full

errorDecoder: com.example.SimpleErrorDecoder

retryer: com.example.SimpleRetryer

requestInterceptors:

- com.example.FooRequestInterceptor

- com.example.BarRequestInterceptor

decode404: **false**

encoder: com.example.SimpleEncoder

decoder: com.example.SimpleDecoder

contract: com.example.SimpleContract

Default configurations can be specified in the @EnableFeignClients attribute defaultConfiguration in a similar manner as described above. The difference is that this configuration will apply to all feign clients.

If you prefer using configuration properties to configured all @FeignClient, you can create configuration properties with default feign name.

application.yml

feign:

client:

config:

default:

connectTimeout: 5000

readTimeout: 5000

loggerLevel: basic

If we create both @Configuration bean and configuration properties, configuration properties will win. It will override @Configuration values. But if you want to change the priority to @Configuration, you can change feign.client.default-to-properties to false.

|  |
| --- |
| [Note] |
| If you need to use ThreadLocal bound variables in your RequestInterceptor`s you will need to either set the thread isolation strategy for Hystrix to `SEMAPHORE or disable Hystrix in Feign. |

application.yml

*# To disable Hystrix in Feign*

feign:

hystrix:

enabled: **false**

*# To set thread isolation to SEMAPHORE*

hystrix:

command:

default:

execution:

isolation:

strategy: SEMAPHORE

## 24.3 Creating Feign Clients Manually

In some cases it might be necessary to customize your Feign Clients in a way that is not possible using the methods above. In this case you can create Clients using the[Feign Builder API](https://github.com/OpenFeign/feign/#basics). Below is an example which creates two Feign Clients with the same interface but configures each one with a separate request interceptor.

*@Import(FeignClientsConfiguration.class)*

**class** FooController {

**private** FooClient fooClient;

**private** FooClient adminClient;

*@Autowired*

**public** FooController(

Decoder decoder, Encoder encoder, Client client, Contract contract) {

**this**.fooClient = Feign.builder().client(client)

.encoder(encoder)

.decoder(decoder)

.contract(contract)

.requestInterceptor(**new** BasicAuthRequestInterceptor("user", "user"))

.target(FooClient.**class**, "http://PROD-SVC");

**this**.adminClient = Feign.builder().client(client)

.encoder(encoder)

.decoder(decoder)

.contract(contract)

.requestInterceptor(**new** BasicAuthRequestInterceptor("admin", "admin"))

.target(FooClient.**class**, "http://PROD-SVC");

}

}

|  |
| --- |
| [Note] |
| In the above example FeignClientsConfiguration.class is the default configuration provided by Spring Cloud Netflix. |
| [Note] |
| PROD-SVC is the name of the service the Clients will be making requests to. | |

|  |
| --- |
| [Note] |
| The Feign Contract object defines what annotations and values are valid on interfaces. The autowired Contract bean provides supports for SpringMVC annotations, instead of the default Feign native annotations. |

## 24.4 Feign Hystrix Support

If Hystrix is on the classpath and feign.hystrix.enabled=true, Feign will wrap all methods with a circuit breaker. Returning a com.netflix.hystrix.HystrixCommand is also available. This lets you use reactive patterns (with a call to .toObservable() or .observe() or asynchronous use (with a call to .queue()).

To disable Hystrix support on a per-client basis create a vanilla Feign.Builder with the "prototype" scope, e.g.:

*@Configuration*

**public** **class** FooConfiguration {

*@Bean*

*@Scope("prototype")*

**public** Feign.Builder feignBuilder() {

**return** Feign.builder();

}

}

|  |
| --- |
| [Warning] |
| Prior to the Spring Cloud Dalston release, if Hystrix was on the classpath Feign would have wrapped all methods in a circuit breaker by default. This default behavior was changed in Spring Cloud Dalston in favor for an opt-in approach. |

## 24.5 Feign Hystrix Fallbacks

Hystrix supports the notion of a fallback: a default code path that is executed when they circuit is open or there is an error. To enable fallbacks for a given @FeignClientset the fallback attribute to the class name that implements the fallback. You also need to declare your implementation as a Spring bean.

*@FeignClient(name = "hello", fallback = HystrixClientFallback.class)*

**protected** **interface** HystrixClient {

*@RequestMapping(method = RequestMethod.GET, value = "/hello")*

Hello iFailSometimes();

}

**static** **class** HystrixClientFallback **implements** HystrixClient {

*@Override*

**public** Hello iFailSometimes() {

**return** **new** Hello("fallback");

}

}

If one needs access to the cause that made the fallback trigger, one can use the fallbackFactory attribute inside @FeignClient.

*@FeignClient(name = "hello", fallbackFactory = HystrixClientFallbackFactory.class)*

**protected** **interface** HystrixClient {

*@RequestMapping(method = RequestMethod.GET, value = "/hello")*

Hello iFailSometimes();

}

*@Component*

**static** **class** HystrixClientFallbackFactory **implements** FallbackFactory<HystrixClient> {

*@Override*

**public** HystrixClient create(Throwable cause) {

**return** **new** HystrixClient() {

*@Override*

**public** Hello iFailSometimes() {

**return** **new** Hello("fallback; reason was: " + cause.getMessage());

}

};

}

}

|  |
| --- |
| [Warning] |
| There is a limitation with the implementation of fallbacks in Feign and how Hystrix fallbacks work. Fallbacks are currently not supported for methods that return com.netflix.hystrix.HystrixCommand and rx.Observable. |

## 24.6 Feign and @Primary

When using Feign with Hystrix fallbacks, there are multiple beans in the ApplicationContext of the same type. This will cause @Autowired to not work because there isn’t exactly one bean, or one marked as primary. To work around this, Spring Cloud Netflix marks all Feign instances as @Primary, so Spring Framework will know which bean to inject. In some cases, this may not be desirable. To turn off this behavior set the primary attribute of @FeignClient to false.

*@FeignClient(name = "hello", primary = false)*

**public** **interface** HelloClient {

*// methods here*

}

## 24.7 Feign Inheritance Support

Feign supports boilerplate apis via single-inheritance interfaces. This allows grouping common operations into convenient base interfaces.

**UserService.java.**

**public** **interface** UserService {

*@RequestMapping(method = RequestMethod.GET, value ="/users/{id}")*

User getUser(*@PathVariable("id")* **long** id);

}

**UserResource.java.**

*@RestController*

**public** **class** UserResource **implements** UserService {

}

**UserClient.java.**

**package** project.user;

*@FeignClient("users")*

**public** **interface** UserClient **extends** UserService {

}

|  |
| --- |
| [Note] |
| It is generally not advisable to share an interface between a server and a client. It introduces tight coupling, and also actually doesn’t work with Spring MVC in its current form (method parameter mapping is not inherited). |

## 24.8 Feign request/response compression

You may consider enabling the request or response GZIP compression for your Feign requests. You can do this by enabling one of the properties:

feign.compression.request.enabled=true

feign.compression.response.enabled=true

Feign request compression gives you settings similar to what you may set for your web server:

feign.compression.request.enabled=true

feign.compression.request.mime-types=text/xml,application/xml,application/json

feign.compression.request.min-request-size=2048

These properties allow you to be selective about the compressed media types and minimum request threshold length.

## 24.9 Feign logging

A logger is created for each Feign client created. By default the name of the logger is the full class name of the interface used to create the Feign client. Feign logging only responds to the DEBUG level.

**application.yml.**

logging.level.project.user.UserClient: DEBUG

The Logger.Level object that you may configure per client, tells Feign how much to log. Choices are:

* NONE, No logging (**DEFAULT**).
* BASIC, Log only the request method and URL and the response status code and execution time.
* HEADERS, Log the basic information along with request and response headers.
* FULL, Log the headers, body, and metadata for both requests and responses.

For example, the following would set the Logger.Level to FULL:

*@Configuration*

**public** **class** FooConfiguration {

*@Bean*

Logger.Level feignLoggerLevel() {

**return** Logger.Level.FULL;

}

}

OtherClass.someMethod(myprop.get());

}

}

stripped). The proxy uses Ribbon to locate an instance to forward to

via discovery, and all requests are executed in a

<<hystrix-fallbacks-for-routes, hystrix command>>, so

failures will show up in Hystrix metrics, and once the circuit is open

the proxy will not try to contact the service.

# Part V. Spring Cloud Stream

## 25. Quick Start

You can try Spring Cloud Stream in less then 5 min even before you jump into any details and the following three-step guide will help.

We’ll create a simple Spring Cloud Stream application which receives messages coming from the messaging middleware of your choice (more on this later) and logs received messages to the console. We’ll call it LoggingConsumer. While not very practical it will certainly provide a good introduction to some of the main concepts and abstractions, making it easier to digest the rest of this user guide.

So let’s get started. . .

## 25.1 Step One - Create sample Application using Spring Initilaizer

Visit the [Spring Initializr](https://start.spring.io/). This is where we’ll generate our LoggingConsumer application.

In the Dependencies start typing 'stream' and Cloud Stream option should pop up. Select it. Now start typing either 'kafka' or 'rabbit'. Basically this is where you are choosing what messaging midleware this application will be bound to. Choose the one you have already installed and/or feel more comfortable with installing/running. Also, as you can see from the Initilaizer screen there are few other options you can choose. For example, you can choose Gradle as your build tool instead of the default Maven. With the Dependencies selected the only other thing you have to identify is the application name - logging-consumer. Your configuration screeen should now contain the following:

Dependencies: Cloud Stream, RabbitMQ (or Kafka)

Group: com.example - default

Artifact: logging-consumer

Spring Boot Version: 2.0.0 (or above) - default

Click on Generate Project button. This will donwload the zipped version of the generated project to your hard drive. Unzip it and you’re ready for Step Two.

## 25.2 Step Two - Import project into the IDE

Here you simply import the project into your IDE of choice. Please keep in mind that dependening on the IDE you may need to follow a specific import procedures. For example depending on how the project was generated (Maven or Gradle) you may need to follow specific import procedure (e.g., in Eclipse/STS: File → Import → Maven → Existing Maven Project).

Ones imported the project must have no errors of any kind and src/main/java should also contain com.example.loggingconsumer.LoggingConsumerApplication.

Technically at this point you can just run the application’s main class since it’s already a valid Spring Boot application, but it does not do anything, so let’s add some code.

## 25.3 Step Three - Add message handler, build and run

Modify the com.example.loggingconsumer.LoggingConsumerApplication to look as follows:

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** LoggingConsumerApplication {

**public** **static** **void** main(String[] args) {

SpringApplication.run(LoggingConsumerApplication.**class**, args);

}

*@StreamListener(Sink.INPUT)*

**public** **void** handle(Person person) {

System.out.println("Received: " + person);

}

**public** **static** **class** Person {

**private** String name;

**public** String getName() {

**return** name;

}

**public** **void** setName(String name) {

**this**.name = name;

}

**public** String toString() {

**return** **this**.name;

}

}

}

As you can see from the above:

* We’ve enabled Sink binding (input-no-output) via @EnableBinding(Sink.class). This will signal to the framework to initiate binding to the messaging middleware where it will auto-create the destination (i.e., queue, topic) which will be bound to Sink.INPUT channel.
* We’ve added handler method to receive incoming Message as type Person. What this means is that here youcan already observe one of the core features of the framework where it will attempt to automatically convert incoming message’s payload to type Person.

This is it, we now have a fully functional Spring Cloud Stream application that does something. From here for simplicity we’ll assume RabbitMQ was selected in step one. Assuming you have RabbitMQ installed and running, start the application by simply running its main method.

You should see following output:

--- [ main] c.s.b.r.p.RabbitExchangeQueueProvisioner : declaring queue for inbound: input.anonymous.CbMIwdkJSBO1ZoPDOtHtCg, bound to: input

--- [ main] o.s.a.r.c.CachingConnectionFactory : Attempting to connect to: [localhost:5672]

--- [ main] o.s.a.r.c.CachingConnectionFactory : Created new connection: rabbitConnectionFactory#2a3a299:0/SimpleConnection@66c83fc8. . .

. . .

--- [ main] o.s.i.a.i.AmqpInboundChannelAdapter : started inbound.input.anonymous.CbMIwdkJSBO1ZoPDOtHtCg

. . .

--- [ main] c.e.l.LoggingConsumerApplication : Started LoggingConsumerApplication in 2.531 seconds (JVM running for 2.897)

Go to RabbitMQ management console or any other RabbitMQ client and simply send message to input.anonymous.CbMIwdkJSBO1ZoPDOtHtCg (NOTE: the anonymous.CbMIwdkJSBO1ZoPDOtHtCg part represents the group name and is generated and will be different in your environment. For something more predictable you can use explicit group name via spring.cloud.stream.bindings.input.group=hello).

The contents of the message should be JSON representation of Person class, so let’s send this:

{"name":"Turd Ferguson"}

And in your console you should see:

Received: Turd Ferguson

You can also build/package your application into a boot jar (i.e., ./mvnw clean install) and run the built JAR using java -jar command.

That is all!

## 26. What’s New in 2.0?

Spring Cloud Stream introduces quite a number of new features, enhancements and changes. The following sections outline most notable ones.

## 26.1 New Features and Components

### 26.1.1 Polling Consumer

Introduction of polled consumers, where the application can control message processing rates. Please refer to the appropriate section for more details. You can also read this blog for more details <https://spring.io/blog/2018/02/27/spring-cloud-stream-2-0-polled-consumers>

### 26.1.2 Micrometer support

Metrics has been switched to use [Micrometer](https://micrometer.io/). MeterRegistry is also provided as a bean so custom application can autowire it to capture custom metrics. Please refer to the appropriate section for more details

### 26.1.3 New Actuator Binding controls

There are now new new Actuator binding controls to both visualize as well as control Bindings lifecycle. For more details please visit [Section 30.6, “Binding visualization and control”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__binders.html#_binding_visualization_and_control)

### 26.1.4 Configurable RetryTemplate

Aside from providing properties to configure RetryTemplate we now allow you to provide your own effectively overriding the one provided by the framework. Simply configure it as a @Bean in your application.

## 26.2 Notable changes and enhancements

### 26.2.1 Both Actuator and Web dependencies are now optional

This helps to slim down the footprint of the deployed application in the event neither of the functionality is required. It also allows one to swicth between the reactive and conventional web paradigms by adding one of the following dependencies manually:

<dependency>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-web</artifactId>

</dependency>

or

<dependency>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-webflux</artifactId>

</dependency>

Actuator dependency can be added as follows:

<dependency>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-actuator</artifactId>

</dependency>

### 26.2.2 Content-type negotiation improvenents

One of the core themes for 2.0 is improvements (both consistency and performance) around content-type negotiation and message conversion. The following summary outlines notable changes and improvements. Please refer to the appropriate section for more details as well as this blog <https://spring.io/blog/2018/02/26/spring-cloud-stream-2-0-content-type-negotiation-and-transformation>.

* All message conversion is now handled **only** by MessageConverters.
* Introduction of @StreamMessageConverter annotation to provide custom MessageConverters.
* Introduction of the default Content Type as application/json which needs to be taken into consideration when migrating 1.3 application and/or operating in the mixed mode (i.e., 1.3 producer → 2.0 consumer).
* Messages with textual payloads and contentType text/…​ or …​/json are no longer converted to Message<String> for cases where argument type of the provided MessageHandler can not be determnied (i.e., public void handle(Message<?> message) or public void handle(Object payload)). Further more, a strong argument type may not be enough to properly convert messages, so contentType header is may be used as supplement by some MessageConverters.

## 26.3 Notable Deprecations

### 26.3.1 Java serialization (Java native and Kryo)

* JavaSerializationMessageConverter and KryoMessageConverter. While these two converters remain for now, they will be moved out of the core packages and support in the future. The main reason for this deprecation is to signal the issue type-based language-specific serialization couuld cause in the distributed environments, where Producers and Consumers may not only depend on different JVM versions or have different versions of supporting libraries (i.e., Kryo), but to also draw the attention to the fact that Consumers and Producers may and in a lot of cases are non-Java based.

### 26.3.2 Deprecated classes and methods

Following is a quick summary of notable deprecations. See corresponding javadocs fort more details.

* SharedChannelRegistry in favor of SharedBindingTargetRegistry.
* Bindings - beans qualified by it are already uniquely identified by their type. For example, provided Source, Processor or custom bindings:

public interface Foo {

String OUTPUT = "fooOutput";

@Output(Foo.OUTPUT)

MessageChannel output();

}

* HeaderMode.raw. Use none, headers or embeddedHeaders
* ProducerProperties.partitionKeyExtractorClass in favor of partitionKeyExtractorName and ProducerProperties.partitionSelectorClass in favor of partitionSelectorName. This is to ensure that both components are Spring configured/managed and referenced in Spring-friendly way.
* BinderAwareRouterBeanPostProcessor - while the component exists it is no longer a Bean Post Processor and will be renamed in the future.
* BinderProperties.setEnvironment(Properties environment) in favor of BinderProperties.setEnvironment(Map<String, Object> environment).

This section goes into more detail about how you can work with Spring Cloud Stream. It covers topics such as creating and running stream applications.

## 27. Introducing Spring Cloud Stream

Spring Cloud Stream is a framework for building message-driven microservice applications. Spring Cloud Stream builds upon Spring Boot to create standalone, production-grade Spring applications, and uses Spring Integration to provide connectivity to message brokers. It provides opinionated configuration of middleware from several vendors, introducing the concepts of persistent publish-subscribe semantics, consumer groups, and partitions.

You can add the @EnableBinding annotation to your application to get immediate connectivity to a message broker, and you can add @StreamListener to a method to cause it to receive events for stream processing. The following is a simple sink application which receives external messages.

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** VoteRecordingSinkApplication {

**public** **static** **void** main(String[] args) {

SpringApplication.run(VoteRecordingSinkApplication.**class**, args);

}

*@StreamListener(Sink.INPUT)*

**public** **void** processVote(Vote vote) {

votingService.recordVote(vote);

}

}

The @EnableBinding annotation takes one or more interfaces as parameters (in this case, the parameter is a single Sink interface). An interface declares input and/or output channels. Spring Cloud Stream provides the interfaces Source, Sink, and Processor; you can also define your own interfaces.

The following is the definition of the Sink interface:

**public** **interface** Sink {

String INPUT = "input";

*@Input(Sink.INPUT)*

SubscribableChannel input();

}

The @Input annotation identifies an input channel, through which received messages enter the application; the @Output annotation identifies an output channel, through which published messages leave the application. The @Input and @Output annotations can take a channel name as a parameter; if a name is not provided, the name of the annotated method will be used.

Spring Cloud Stream will create an implementation of the interface for you. You can use this in the application by autowiring it, as in the following example of a test case.

*@RunWith(SpringJUnit4ClassRunner.class)*

*@SpringApplicationConfiguration(classes = VoteRecordingSinkApplication.class)*

*@WebAppConfiguration*

*@DirtiesContext*

**public** **class** StreamApplicationTests {

*@Autowired*

**private** Sink sink;

*@Test*

**public** **void** contextLoads() {

assertNotNull(**this**.sink.input());

}

}

## 28. Main Concepts

Spring Cloud Stream provides a number of abstractions and primitives that simplify the writing of message-driven microservice applications. This section gives an overview of the following:

* Spring Cloud Stream’s application model
* The Binder abstraction
* Persistent publish-subscribe support
* Consumer group support
* Partitioning support
* A pluggable Binder API

## 28.1 Application Model

A Spring Cloud Stream application consists of a middleware-neutral core. The application communicates with the outside world through input and output channelsinjected into it by Spring Cloud Stream. Channels are connected to external brokers through middleware-specific Binder implementations.

**Figure 28.1. Spring Cloud Stream Application**

### 28.1.1 Fat JAR

Spring Cloud Stream applications can be run in standalone mode from your IDE for testing. To run a Spring Cloud Stream application in production, you can create an executable (or "fat") JAR by using the standard Spring Boot tooling provided for Maven or Gradle.

## 28.2 The Binder Abstraction

Spring Cloud Stream provides Binder implementations for [Kafka](https://github.com/spring-cloud/spring-cloud-stream/tree/master/spring-cloud-stream-binders/spring-cloud-stream-binder-kafka) and [Rabbit MQ](https://github.com/spring-cloud/spring-cloud-stream/tree/master/spring-cloud-stream-binders/spring-cloud-stream-binder-rabbit). Spring Cloud Stream also includes a [TestSupportBinder](https://github.com/spring-cloud/spring-cloud-stream/blob/master/spring-cloud-stream-test-support/src/main/java/org/springframework/cloud/stream/test/binder/TestSupportBinder.java), which leaves a channel unmodified so that tests can interact with channels directly and reliably assert on what is received. You can use the extensible API to write your own Binder.

Spring Cloud Stream uses Spring Boot for configuration, and the Binder abstraction makes it possible for a Spring Cloud Stream application to be flexible in how it connects to middleware. For example, deployers can dynamically choose, at runtime, the destinations (e.g., the Kafka topics or RabbitMQ exchanges) to which channels connect. Such configuration can be provided through external configuration properties and in any form supported by Spring Boot (including application arguments, environment variables, and application.yml or application.properties files). In the sink example from the [Chapter 27, *Introducing Spring Cloud Stream*](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__introducing_spring_cloud_stream.html) section, setting the application property spring.cloud.stream.bindings.input.destination to raw-sensor-data will cause it to read from the raw-sensor-data Kafka topic, or from a queue bound to the raw-sensor-data RabbitMQ exchange.

Spring Cloud Stream automatically detects and uses a binder found on the classpath. You can easily use different types of middleware with the same code: just include a different binder at build time. For more complex use cases, you can also package multiple binders with your application and have it choose the binder, and even whether to use different binders for different channels, at runtime.

## 28.3 Persistent Publish-Subscribe Support

Communication between applications follows a publish-subscribe model, where data is broadcast through shared topics. This can be seen in the following figure, which shows a typical deployment for a set of interacting Spring Cloud Stream applications.

**Figure 28.2. Spring Cloud Stream Publish-Subscribe**

Data reported by sensors to an HTTP endpoint is sent to a common destination named raw-sensor-data. From the destination, it is independently processed by a microservice application that computes time-windowed averages and by another microservice application that ingests the raw data into HDFS. In order to process the data, both applications declare the topic as their input at runtime.

The publish-subscribe communication model reduces the complexity of both the producer and the consumer, and allows new applications to be added to the topology without disruption of the existing flow. For example, downstream from the average-calculating application, you can add an application that calculates the highest temperature values for display and monitoring. You can then add another application that interprets the same flow of averages for fault detection. Doing all communication through shared topics rather than point-to-point queues reduces coupling between microservices.

While the concept of publish-subscribe messaging is not new, Spring Cloud Stream takes the extra step of making it an opinionated choice for its application model. By using native middleware support, Spring Cloud Stream also simplifies use of the publish-subscribe model across different platforms.

## 28.4 Consumer Groups

While the publish-subscribe model makes it easy to connect applications through shared topics, the ability to scale up by creating multiple instances of a given application is equally important. When doing this, different instances of an application are placed in a competing consumer relationship, where only one of the instances is expected to handle a given message.

Spring Cloud Stream models this behavior through the concept of a consumer group. (Spring Cloud Stream consumer groups are similar to and inspired by Kafka consumer groups.) Each consumer binding can use the spring.cloud.stream.bindings.<channelName>.group property to specify a group name. For the consumers shown in the following figure, this property would be set as spring.cloud.stream.bindings.<channelName>.group=hdfsWrite or spring.cloud.stream.bindings.<channelName>.group=average.

**Figure 28.3. Spring Cloud Stream Consumer Groups**

All groups which subscribe to a given destination receive a copy of published data, but only one member of each group receives a given message from that destination. By default, when a group is not specified, Spring Cloud Stream assigns the application to an anonymous and independent single-member consumer group that is in a publish-subscribe relationship with all other consumer groups.

## 28.5 Consumer Types

Two types of consumer are supported:

* Message-driven (sometimes referred to as Asynchronous)
* Polled (sometimes referred to as Synchronous)

Prior to version 2.0, only asynchronous consumers were supported, where a message is delivered as soon as it is available (and there is a thread available to process it).

You might want to use a synchronous consumer when you wish to control the rate at which messages are processed.

### 28.5.1 Durability

Consistent with the opinionated application model of Spring Cloud Stream, consumer group subscriptions are durable. That is, a binder implementation ensures that group subscriptions are persistent, and ones at least one subscription for a group has been created, the group will receive messages, even if they are sent while all applications in the group are stopped.

|  |
| --- |
| [Note] |
| Anonymous subscriptions are non-durable by nature. For some binder implementations (e.g., RabbitMQ), it is possible to have non-durable group subscriptions. |

In general, it is preferable to always specify a consumer group when binding an application to a given destination. When scaling up a Spring Cloud Stream application, you must specify a consumer group for each of its input bindings. This prevents the application’s instances from receiving duplicate messages (unless that behavior is desired, which is unusual).

## 28.6 Partitioning Support

Spring Cloud Stream provides support for partitioning data between multiple instances of a given application. In a partitioned scenario, the physical communication medium (e.g., the broker topic) is viewed as being structured into multiple partitions. One or more producer application instances send data to multiple consumer application instances and ensure that data identified by common characteristics are processed by the same consumer instance.

Spring Cloud Stream provides a common abstraction for implementing partitioned processing use cases in a uniform fashion. Partitioning can thus be used whether the broker itself is naturally partitioned (e.g., Kafka) or not (e.g., RabbitMQ).

**Figure 28.4. Spring Cloud Stream Partitioning**

Partitioning is a critical concept in stateful processing, where it is critical, for either performance or consistency reasons, to ensure that all related data is processed together. For example, in the time-windowed average calculation example, it is important that all measurements from any given sensor are processed by the same application instance.

|  |
| --- |
| [Note] |
| To set up a partitioned processing scenario, you must configure both the data-producing and the data-consuming ends. |

## 29. Programming Model

This section describes Spring Cloud Stream’s programming model. Spring Cloud Stream provides a number of predefined annotations for declaring bound input and output channels as well as how to listen to channels.

## 29.1 Declaring and Binding Producers and Consumers

### 29.1.1 Triggering Binding Via @EnableBinding

You can turn a Spring application into a Spring Cloud Stream application by applying the @EnableBinding annotation to one of the application’s configuration classes. The @EnableBinding annotation itself is meta-annotated with @Configuration and triggers the configuration of Spring Cloud Stream infrastructure:

...

*@Import(...)*

*@Configuration*

*@EnableIntegration*

**public** *@interface* EnableBinding {

...

Class<?>[] value() **default** {};

}

The @EnableBinding annotation can take as parameters one or more interface classes that contain methods which represent bindable components (typically message channels).

|  |
| --- |
| [Note] |
| The @EnableBinding annotation is only required on your Configuration classes, you can provide as many binding interfaces as you need, for instance: @EnableBinding(value={Orders.class, Payment.class}. Where both Order and Payment interfaces would declare @Input and @Outputchannels. |

### 29.1.2 @Input and @Output

A Spring Cloud Stream application can have an arbitrary number of input and output channels defined in an interface as @Input and @Output methods:

**public** **interface** Barista {

*@Input*

SubscribableChannel orders();

*@Output*

MessageChannel hotDrinks();

*@Output*

MessageChannel coldDrinks();

}

Using this interface as a parameter to @EnableBinding will trigger the creation of three bound channels named orders, hotDrinks, and coldDrinks, respectively.

*@EnableBinding(Barista.class)*

**public** **class** CafeConfiguration {

...

}

|  |
| --- |
| [Note] |
| In Spring Cloud Stream, the bindable MessageChannel components are the Spring Messaging MessageChannel (for outbound) and its extension SubscribableChannel (for inbound). Using the same mechanism, other bindable components can be supported. KStream support in Spring Cloud Stream Kafka binder is one such example where KStream is used as inbound/outbound bindable components. Also, as discussed below, a PollableMessageSource can be bound to an inbound destination. In this documentation, we will continue to refer to MessageChannels as the bindablecomponents. |

Starting with version 2.0, you can now bind a pollable consumer as follows:

**public** **interface** PolledBarista {

*@Input*

PollableMessageSource orders();

*@Output*

MessageChannel hotDrinks();

*@Output*

MessageChannel coldDrinks();

}

In this case, an implementation of PollableMessageSource is bound to the orders "channel".

#### Customizing Channel Names

Using the @Input and @Output annotations, you can specify a customized channel name for the channel, as shown in the following example:

**public** **interface** Barista {

...

*@Input("inboundOrders")*

SubscribableChannel orders();

}

In this example, the created bound channel will be named inboundOrders.

#### Source, Sink, and Processor

For easy addressing of the most common use cases, which involve either an input channel, an output channel, or both, Spring Cloud Stream provides three predefined interfaces out of the box.

Source can be used for an application which has a single outbound channel.

**public** **interface** Source {

String OUTPUT = "output";

*@Output(Source.OUTPUT)*

MessageChannel output();

}

Sink can be used for an application which has a single inbound channel.

**public** **interface** Sink {

String INPUT = "input";

*@Input(Sink.INPUT)*

SubscribableChannel input();

}

Processor can be used for an application which has both an inbound channel and an outbound channel.

**public** **interface** Processor **extends** Source, Sink {

}

Spring Cloud Stream provides no special handling for any of these interfaces; they are only provided out of the box.

### 29.1.3 Accessing Bound Channels

#### Injecting the Bound Interfaces

For each bound interface, Spring Cloud Stream will generate a bean that implements the interface. Invoking a @Input-annotated or @Output-annotated method of one of these beans will return the relevant bound channel.

The bean in the following example sends a message on the output channel when its hello method is invoked. It invokes output() on the injected Source bean to retrieve the target channel.

*@Component*

**public** **class** SendingBean {

**private** Source source;

*@Autowired*

**public** SendingBean(Source source) {

**this**.source = source;

}

**public** **void** sayHello(String name) {

source.output().send(MessageBuilder.withPayload(name).build());

}

}

#### Injecting Channels Directly

Bound channels can be also injected directly:

*@Component*

**public** **class** SendingBean {

**private** MessageChannel output;

*@Autowired*

**public** SendingBean(MessageChannel output) {

**this**.output = output;

}

**public** **void** sayHello(String name) {

output.send(MessageBuilder.withPayload(name).build());

}

}

If the name of the channel is customized on the declaring annotation, that name should be used instead of the method name. Given the following declaration:

**public** **interface** CustomSource {

...

*@Output("customOutput")*

MessageChannel output();

}

The channel will be injected as shown in the following example:

*@Component*

**public** **class** SendingBean {

**private** MessageChannel output;

*@Autowired*

**public** SendingBean(*@Qualifier("customOutput")* MessageChannel output) {

**this**.output = output;

}

**public** **void** sayHello(String name) {

**this**.output.send(MessageBuilder.withPayload(name).build());

}

}

### 29.1.4 Producing and Consuming Messages

You can write a Spring Cloud Stream application using either Spring Integration annotations or Spring Cloud Stream’s @StreamListener annotation. The @StreamListener annotation is modeled after other Spring Messaging annotations (such as @MessageMapping, @JmsListener, @RabbitListener, etc.) but adds content type management and type coercion features.

#### Native Spring Integration Support

Because Spring Cloud Stream is based on Spring Integration, Stream completely inherits Integration’s foundation and infrastructure as well as the component itself. For example, you can attach the output channel of a Source to a MessageSource:

*@EnableBinding(Source.class)*

**public** **class** TimerSource {

*@Value("${format}")*

**private** String format;

*@Bean*

*@InboundChannelAdapter(value = Source.OUTPUT, poller = @Poller(fixedDelay = "${fixedDelay}", maxMessagesPerPoll = "1"))*

**public** MessageSource<String> timerMessageSource() {

**return** () -> **new** GenericMessage<>(**new** SimpleDateFormat(format).format(**new** Date()));

}

}

Or you can use a processor’s channels in a transformer:

*@EnableBinding(Processor.class)*

**public** **class** TransformProcessor {

*@Transformer(inputChannel = Processor.INPUT, outputChannel = Processor.OUTPUT)*

**public** Object transform(String message) {

**return** message.toUpperCase();

}

}

|  |
| --- |
| [Note] |
| It’s important to understant that when you consume from the same binding using @StreamListener a pubsub model is used, where each method annotated with @StreamListener receives it’s own copy of the message, each one has its own consumer group. However, if you share a bindable channel as an input for @Aggregator, @Transformer or @ServiceActivator, those will consume in a competing model, no individual consumer group is created for each subscription. |

#### Spring Integration Error Channel Support

Spring Cloud Stream supports publishing error messages received by the Spring Integration global error channel. Error messages sent to the errorChannel can be published to a specific destination at the broker by configuring a binding for the outbound target named error. For example, to publish error messages to a broker destination named "myErrors", provide the following property: spring.cloud.stream.bindings.error.destination=myErrors.

#### Message Channel Binders and Error Channels

Starting with version 1.3, some MessageChannel - based binders publish errors to a discrete error channel for each destination. In addition, these error channels are bridged to the global Spring Integration errorChannel mentioned above. You can therefore consume errors for specific destinations and/or for all destinations, using a standard Spring Integration flow (IntegrationFlow, @ServiceActivator, etc.).

On the consumer side, the listener thread catches any exceptions and forwards an ErrorMessage to the destination’s error channel. The payload of the message is a MessagingException with the normal failedMessage and cause properties. Usually, the raw data received from the broker is included in a header. For binders that support (and are configured with) a dead letter destination; a MessagePublishingErrorHandler is subscribed to the channel, and the raw data is forwarded to the dead letter destination.

On the producer side; for binders that support some kind of async result after publishing messages (e.g. RabbitMQ, Kafka), you can enable an error channel by setting the …​producer.errorChannelEnabled to true. The payload of the ErrorMessage depends on the binder implementation but will be a MessagingException with the normal failedMessage property, as well as additional properties about the failure. Refer to the binder documentation for complete details.

#### Using @StreamListener for Automatic Content Type Handling

Complementary to its Spring Integration support, Spring Cloud Stream provides its own @StreamListener annotation, modeled after other Spring Messaging annotations (e.g. @MessageMapping, @JmsListener, @RabbitListener, etc.). The @StreamListener annotation provides a simpler model for handling inbound messages, especially when dealing with use cases that involve content type management and type coercion.

Spring Cloud Stream provides an extensible MessageConverter mechanism for handling data conversion by bound channels and for, in this case, dispatching to methods annotated with @StreamListener. The following is an example of an application which processes external Vote events:

*@EnableBinding(Sink.class)*

**public** **class** VoteHandler {

*@Autowired*

VotingService votingService;

*@StreamListener(Sink.INPUT)*

**public** **void** handle(Vote vote) {

votingService.record(vote);

}

}

The distinction between @StreamListener and a Spring Integration @ServiceActivator is seen when considering an inbound Message that has a String payload and a contentType header of application/json. In the case of @StreamListener, the MessageConverter mechanism will use the contentType header to parse the String payload into a Vote object.

As with other Spring Messaging methods, method arguments can be annotated with @Payload, @Headers and @Header.

|  |
| --- |
| [Note] |
| For methods which return data, you must use the @SendTo annotation to specify the output binding destination for data returned by the method:  *@EnableBinding(Processor.class)*  **public** **class** TransformProcessor {  *@Autowired*  VotingService votingService;  *@StreamListener(Processor.INPUT)*  *@SendTo(Processor.OUTPUT)*  **public** VoteResult handle(Vote vote) {  **return** votingService.record(vote);  }  } |

#### Using @StreamListener for dispatching messages to multiple methods

Since version 1.2, Spring Cloud Stream supports dispatching messages to multiple @StreamListener methods registered on an input channel, based on a condition.

In order to be eligible to support conditional dispatching, a method must satisfy the follow conditions:

* it must not return a value
* it must be an individual message handling method (reactive API methods are not supported)

The condition is specified via a SpEL expression in the condition attribute of the annotation and is evaluated for each message. All the handlers that match the condition will be invoked in the same thread and no assumption must be made about the order in which the invocations take place.

An example of using @StreamListener with dispatching conditions can be seen below. In this example, all the messages bearing a header type with the value foowill be dispatched to the receiveFoo method, and all the messages bearing a header type with the value bar will be dispatched to the receiveBar method.

*@EnableBinding(Sink.class)*

*@EnableAutoConfiguration*

**public** **static** **class** TestPojoWithAnnotatedArguments {

*@StreamListener(target = Sink.INPUT, condition = "headers['type']=='foo'")*

**public** **void** receiveFoo(*@Payload* FooPojo fooPojo) {

*// handle the message*

}

*@StreamListener(target = Sink.INPUT, condition = "headers['type']=='bar'")*

**public** **void** receiveBar(*@Payload* BarPojo barPojo) {

*// handle the message*

}

}

|  |
| --- |
| [Note] |
| Dispatching via @StreamListener conditions is only supported for handlers of individual messages, and not for reactive programming support (described below). |

#### Using Polled Consumers

When using polled consumers, you poll the PollableMessageSource on demand. For example, given…​

**public** **interface** PolledConsumer {

*@Input*

PollableMessageSource destIn();

*@Output*

MessageChannel destOut();

}

…​you might use that consumer as follows:

*@Bean*

**public** ApplicationRunner poller(PollableMessageSource destIn, MessageChannel destOut) {

**return** args -> {

**while** (someCondition()) {

**try** {

**if** (!destIn.poll(m -> {

String newPayload = ((String) m.getPayload()).toUpperCase();

destOut.send(**new** GenericMessage<>(newPayload));

})) {

Thread.sleep(1000);

}

}

**catch** (Exception e) {

*// handle failure (throw an exception to reject the message);*

}

}

};

}

The PollableMessageSource.poll() method takes a MessageHandler argument (often a lambda expression as shown here). It returns true if the message was received and successfully processed.

As with message-driven consumers, if the MessageHandler throws an exception, messages are published to error channels as discussed in [the section called “Message Channel Binders and Error Channels”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__programming_model.html#binder-error-channels).

Normally, the poll() method will acknowledge the message when the MessageHandler exits. If the method exits abnormally, the message is rejected (not requeued). You can override that behavior, by taking responsibility for the acknowledgment, as follows:

*@Bean*

**public** ApplicationRunner poller(PollableMessageSource dest1In, MessageChannel dest2Out) {

**return** args -> {

**while** (someCondition()) {

**if** (!dest1In.poll(m -> {

StaticMessageHeaderAccessor.getAcknowledgmentCallback(m).noAutoAck();

*// e.g. hand off to another thread which can perform the ack*

*// or acknowledge(Status.REQUEUE)*

})) {

Thread.sleep(1000);

}

}

};

}

|  |  |  |
| --- | --- | --- |
| [Important] | | **Important** |
| You must ack (or nack) the message at some point, to avoid resource leaks. |
| [Important] | **Important** | | |
| Some messaging systems (such as Apache Kafka) maintain a simple offset in a log, if a delivery fails and is requeued with StaticMessageHeaderAccessor.getAcknowledgmentCallback(m).acknowledge(Status.REQUEUE);, any later successfully ack’d messages will be redelivered. | | |

There is also an overloaded poll method:

poll(MessageHandler handler, ParameterizedTypeReference<?> type)

The type is a conversion hint allowing the incoming message payload to be converted:

**boolean** result = pollableSource.poll(received -> {

Map<String, Foo> payload = (Map<String, Foo>) received.getPayload();

...

}, **new** ParameterizedTypeReference<Map<String, Foo>>() {});

### 29.1.5 Reactive Programming Support

Spring Cloud Stream also supports the use of reactive APIs where incoming and outgoing data is handled as continuous data flows. Support for reactive APIs is available via the spring-cloud-stream-reactive, which needs to be added explicitly to your project.

The programming model with reactive APIs is declarative, where instead of specifying how each individual message should be handled, you can use operators that describe functional transformations from inbound to outbound data flows.

Spring Cloud Stream supports the following reactive APIs:

* Reactor

In the future, it is intended to support a more generic model based on Reactive Streams.

The reactive programming model is also using the @StreamListener annotation for setting up reactive handlers. The differences are that:

* the @StreamListener annotation must not specify an input or output, as they are provided as arguments and return values from the method;
* the arguments of the method must be annotated with @Input and @Output indicating which input or output will the incoming and respectively outgoing data flows connect to;
* the return value of the method, if any, will be annotated with @Output, indicating the input where data shall be sent.

|  |
| --- |
| [Note] |
| Reactive programming support requires Java 1.8. |
| [Note] |
| As of Spring Cloud Stream 1.1.1 and later (starting with release train Brooklyn.SR2), reactive programming support requires the use of Reactor 3.0.4.RELEASE and higher. Earlier Reactor versions (including 3.0.1.RELEASE, 3.0.2.RELEASE and 3.0.3.RELEASE) are not supported.spring-cloud-stream-reactive will transitively retrieve the proper version, but it is possible for the project structure to manage the version of the io.projectreactor:reactor-core to an earlier release, especially when using Maven. This is the case for projects generated via Spring Initializr with Spring Boot 1.x, which will override the Reactor version to 2.0.8.RELEASE. In such cases you must ensure that the proper version of the artifact is released. This can be simply achieved by adding a direct dependency on io.projectreactor:reactor-core with a version of 3.0.4.RELEASE or later to your project. | |

|  |
| --- |
| [Note] |
| The use of term reactive is currently referring to the reactive APIs being used and not to the execution model being reactive (i.e. the bound endpoints are still using a 'push' rather than 'pull' model). While some backpressure support is provided by the use of Reactor, we do intend on the long run to support entirely reactive pipelines by the use of native reactive clients for the connected middleware. |

#### Reactor-based handlers

A Reactor based handler can have the following argument types:

* For arguments annotated with @Input, it supports the Reactor type Flux. The parameterization of the inbound Flux follows the same rules as in the case of individual message handling: it can be the entire Message, a POJO which can be the Message payload, or a POJO which is the result of a transformation based on the Message content-type header. Multiple inputs are provided;
* For arguments annotated with Output, it supports the type FluxSender which connects a Flux produced by the method with an output. Generally speaking, specifying outputs as arguments is only recommended when the method can have multiple outputs;

A Reactor based handler supports a return type of Flux, case in which it must be annotated with @Output. We recommend using the return value of the method when a single output flux is available.

Here is an example of a simple Reactor-based Processor.

*@EnableBinding(Processor.class)*

*@EnableAutoConfiguration*

**public** **static** **class** UppercaseTransformer {

*@StreamListener*

*@Output(Processor.OUTPUT)*

**public** Flux<String> receive(*@Input(Processor.INPUT)* Flux<String> input) {

**return** input.map(s -> s.toUpperCase());

}

}

The same processor using output arguments looks like this:

*@EnableBinding(Processor.class)*

*@EnableAutoConfiguration*

**public** **static** **class** UppercaseTransformer {

*@StreamListener*

**public** **void** receive(*@Input(Processor.INPUT)* Flux<String> input,

*@Output(Processor.OUTPUT)* FluxSender output) {

output.send(input.map(s -> s.toUpperCase()));

}

}

#### Reactive Sources

Spring Cloud Stream reactive support also provides the ability for creating reactive sources through the StreamEmitter annotation. Using StreamEmitter annotation, a regular source may be converted to a reactive one. StreamEmitter is a method level annotation that marks a method to be an emitter to outputs declared via EnableBinding. It is not allowed to use the Input annotation along with StreamEmitter, as the methods marked with this annotation are not listening from any input, rather generating to an output. Following the same programming model used in StreamListener, StreamEmitter also allows flexible ways of using the Output annotation depending on whether the method has any arguments, return type etc.

Here are some examples of using StreamEmitter in various styles.

The following example will emit the "Hello World" message every millisecond and publish to a Flux. In this case, the resulting messages in Flux will be sent to the output channel of the Source.

*@EnableBinding(Source.class)*

*@EnableAutoConfiguration*

**public** **static** **class** HelloWorldEmitter {

*@StreamEmitter*

*@Output(Source.OUTPUT)*

**public** Flux<String> emit() {

**return** Flux.intervalMillis(1)

.map(l -> "Hello World");

}

}

Following is another flavor of the same sample as above. Instead of returning a Flux, this method uses a FluxSender to programmatically send Flux from a source.

*@EnableBinding(Source.class)*

*@EnableAutoConfiguration*

**public** **static** **class** HelloWorldEmitter {

*@StreamEmitter*

*@Output(Source.OUTPUT)*

**public** **void** emit(FluxSender output) {

output.send(Flux.intervalMillis(1)

.map(l -> "Hello World"));

}

}

Following is exactly same as the above snippet in functionality and style. However, instead of using an explicit Output annotation at the method level, it is used as the method parameter level.

*@EnableBinding(Source.class)*

*@EnableAutoConfiguration*

**public** **static** **class** HelloWorldEmitter {

*@StreamEmitter*

**public** **void** emit(*@Output(Source.OUTPUT)* FluxSender output) {

output.send(Flux.intervalMillis(1)

.map(l -> "Hello World"));

}

}

Here is yet another flavor of writing reacting sources using the Reactive Streams Publisher API and the support for it in the [Spring Integration Java DSL](https://github.com/spring-projects/spring-integration-java-dsl/wiki/Spring-Integration-Java-DSL-Reference). The Publisher is still using Reactor Flux under the hood, but from an application perspective, that is transparent to the user and only needs Reactive Streams and Java DSL for Spring Integration.

*@EnableBinding(Source.class)*

*@EnableAutoConfiguration*

**public** **static** **class** HelloWorldEmitter {

*@StreamEmitter*

*@Output(Source.OUTPUT)*

*@Bean*

**public** Publisher<Message<String>> emit() {

**return** IntegrationFlows.from(() ->

**new** GenericMessage<>("Hello World"),

e -> e.poller(p -> p.fixedDelay(1)))

.toReactivePublisher();

}

}

### 29.1.6 Aggregation

Spring Cloud Stream provides support for aggregating multiple applications together, connecting their input and output channels directly and avoiding the additional cost of exchanging messages via a broker. As of version 1.0 of Spring Cloud Stream, aggregation is supported only for the following types of applications:

* sources - applications with a single output channel named output, typically having a single binding of the type org.springframework.cloud.stream.messaging.Source
* sinks - applications with a single input channel named input, typically having a single binding of the type org.springframework.cloud.stream.messaging.Sink
* processors - applications with a single input channel named input and a single output channel named output, typically having a single binding of the type org.springframework.cloud.stream.messaging.Processor.

They can be aggregated together by creating a sequence of interconnected applications, in which the output channel of an element in the sequence is connected to the input channel of the next element, if it exists. A sequence can start with either a source or a processor, it can contain an arbitrary number of processors and must end with either a processor or a sink.

Depending on the nature of the starting and ending element, the sequence may have one or more bindable channels, as follows:

* if the sequence starts with a source and ends with a sink, all communication between the applications is direct and no channels will be bound
* if the sequence starts with a processor, then its input channel will become the input channel of the aggregate and will be bound accordingly
* if the sequence ends with a processor, then its output channel will become the output channel of the aggregate and will be bound accordingly

Aggregation is performed using the AggregateApplicationBuilder utility class, as in the following example. Let’s consider a project in which we have source, processor and a sink, which may be defined in the project, or may be contained in one of the project’s dependencies.

|  |
| --- |
| [Note] |
| Each component (source, sink or processor) in an aggregate application must be provided in a separate package if the configuration classes use @SpringBootApplication. This is required to avoid cross-talk between applications, due to the classpath scanning performed by @SpringBootApplication on the configuration classes inside the same package. In the example below, it can be seen that the Source, Processor and Sink application classes are grouped in separate packages. A possible alternative is to provide the source, sink or processor configuration in a separate @Configuration class, avoid the use of @SpringBootApplication/@ComponentScan and use those for aggregation. |

**package** com.app.mysink;

*// Imports omitted*

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** SinkApplication {

**private** **static** Logger logger = LoggerFactory.getLogger(SinkApplication.**class**);

*@ServiceActivator(inputChannel=Sink.INPUT)*

**public** **void** loggerSink(Object payload) {

logger.info("Received: " + payload);

}

}

**package** com.app.myprocessor;

*// Imports omitted*

*@SpringBootApplication*

*@EnableBinding(Processor.class)*

**public** **class** ProcessorApplication {

*@Transformer(inputChannel = Processor.INPUT, outputChannel = Processor.OUTPUT)*

**public** String loggerSink(String payload) {

**return** payload.toUpperCase();

}

}

**package** com.app.mysource;

*// Imports omitted*

*@SpringBootApplication*

*@EnableBinding(Source.class)*

**public** **class** SourceApplication {

*@InboundChannelAdapter(value = Source.OUTPUT)*

**public** String timerMessageSource() {

**return** **new** SimpleDateFormat().format(**new** Date());

}

}

Each configuration can be used for running a separate component, but in this case they can be aggregated together as follows:

**package** com.app;

*// Imports omitted*

*@SpringBootApplication*

**public** **class** SampleAggregateApplication {

**public** **static** **void** main(String[] args) {

**new** AggregateApplicationBuilder()

.from(SourceApplication.**class**).args("--fixedDelay=5000")

.via(ProcessorApplication.**class**)

.to(SinkApplication.**class**).args("--debug=true").run(args);

}

}

The starting component of the sequence is provided as argument to the from() method. The ending component of the sequence is provided as argument to the to()method. Intermediate processors are provided as argument to the via() method. Multiple processors of the same type can be chained together (e.g. for pipelining transformations with different configurations). For each component, the builder can provide runtime arguments for Spring Boot configuration.

#### Configuring aggregate application

Spring Cloud Stream supports passing properties for the individual applications inside the aggregate application using 'namespace' as prefix.

The namespace can be set for applications as follows:

*@SpringBootApplication*

**public** **class** SampleAggregateApplication {

**public** **static** **void** main(String[] args) {

**new** AggregateApplicationBuilder()

.from(SourceApplication.**class**).namespace("source").args("--fixedDelay=5000")

.via(ProcessorApplication.**class**).namespace("processor1")

.to(SinkApplication.**class**).namespace("sink").args("--debug=true").run(args);

}

}

Ones the 'namespace' is set for the individual applications, the application properties with the namespace as prefix can be passed to the aggregate application using any supported property source (commandline, environment properties etc.).

For instance, to override the default fixedDelay and debug properties of 'source' and 'sink' applications:

java -jar target/MyAggregateApplication-0.0.1-SNAPSHOT.jar --source.fixedDelay=10000 --sink.debug=false

#### Configuring binding service properties for non self contained aggregate application

The non self-contained aggregate application is bound to external broker via either or both the inbound/outbound components (typically, message channels) of the aggregate application while the applications inside the aggregate application are directly bound. For example: a source application’s output and a processor application’s input are directly bound while the processor’s output channel is bound to an external destination at the broker. When passing the binding service properties for non-self contained aggregate application, it is required to pass the binding service properties to the aggregate application instead of setting them as 'args' to individual child application. For instance,

*@SpringBootApplication*

**public** **class** SampleAggregateApplication {

**public** **static** **void** main(String[] args) {

**new** AggregateApplicationBuilder()

.from(SourceApplication.**class**).namespace("source").args("--fixedDelay=5000")

.via(ProcessorApplication.**class**).namespace("processor1").args("--debug=true").run(args);

}

}

The binding properties like --spring.cloud.stream.bindings.output.destination=processor-output need to be specified as one of the external configuration properties (cmdline arg etc.).

## 30. Binders

Spring Cloud Stream provides a Binder abstraction for use in connecting to physical destinations at the external middleware. This section provides information about the main concepts behind the Binder SPI, its main components, and implementation-specific details.

## 30.1 Producers and Consumers

**Figure 30.1. Producers and Consumers**

A producer is any component that sends messages to a channel. The channel can be bound to an external message broker via a Binder implementation for that broker. When invoking the bindProducer() method, the first parameter is the name of the destination within the broker, the second parameter is the local channel instance to which the producer will send messages, and the third parameter contains properties (such as a partition key expression) to be used within the adapter that is created for that channel.

A consumer is any component that receives messages from a channel. As with a producer, the consumer’s channel can be bound to an external message broker. When invoking the bindConsumer() method, the first parameter is the destination name, and a second parameter provides the name of a logical group of consumers. Each group that is represented by consumer bindings for a given destination receives a copy of each message that a producer sends to that destination (i.e., publish-subscribe semantics). If there are multiple consumer instances bound using the same group name, then messages will be load-balanced across those consumer instances so that each message sent by a producer is consumed by only a single consumer instance within each group (i.e., queueing semantics).

## 30.2 Binder SPI

The Binder SPI consists of a number of interfaces, out-of-the box utility classes and discovery strategies that provide a pluggable mechanism for connecting to external middleware.

The key point of the SPI is the Binder interface which is a strategy for connecting inputs and outputs to external middleware.

**public** **interface** Binder<T, C **extends** ConsumerProperties, P **extends** ProducerProperties> {

Binding<T> bindConsumer(String name, String group, T inboundBindTarget, C consumerProperties);

Binding<T> bindProducer(String name, T outboundBindTarget, P producerProperties);

}

The interface is parameterized, offering a number of extension points:

* input and output bind targets - as of version 1.0, only MessageChannel is supported, but this is intended to be used as an extension point in the future;
* extended consumer and producer properties - allowing specific Binder implementations to add supplemental properties which can be supported in a type-safe manner.

A typical binder implementation consists of the following

* a class that implements the Binder interface;
* a Spring @Configuration class that creates a bean of the type above along with the middleware connection infrastructure;
* a META-INF/spring.binders file found on the classpath containing one or more binder definitions, e.g.

kafka:\

org.springframework.cloud.stream.binder.kafka.config.KafkaBinderConfiguration

## 30.3 Binder Detection

Spring Cloud Stream relies on implementations of the Binder SPI to perform the task of connecting channels to message brokers. Each Binder implementation typically connects to one type of messaging system.

### 30.3.1 Classpath Detection

By default, Spring Cloud Stream relies on Spring Boot’s auto-configuration to configure the binding process. If a single Binder implementation is found on the classpath, Spring Cloud Stream will use it automatically. For example, a Spring Cloud Stream project that aims to bind only to RabbitMQ can simply add the following dependency:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-binder-rabbit</artifactId>

</dependency>

For the specific maven coordinates of other binder dependencies, please refer to the documentation of that binder implementation.

## 30.4 Multiple Binders on the Classpath

When multiple binders are present on the classpath, the application must indicate which binder is to be used for each channel binding. Each binder configuration contains a META-INF/spring.binders, which is a simple properties file:

rabbit:\

org.springframework.cloud.stream.binder.rabbit.config.RabbitServiceAutoConfiguration

Similar files exist for the other provided binder implementations (e.g., Kafka), and custom binder implementations are expected to provide them, as well. The key represents an identifying name for the binder implementation, whereas the value is a comma-separated list of configuration classes that each contain one and only one bean definition of type org.springframework.cloud.stream.binder.Binder.

Binder selection can either be performed globally, using the spring.cloud.stream.defaultBinder property (e.g., spring.cloud.stream.defaultBinder=rabbit) or individually, by configuring the binder on each channel binding. For instance, a processor application (that has channels with the names input and output for read/write respectively) which reads from Kafka and writes to RabbitMQ can specify the following configuration:

spring.cloud.stream.bindings.input.binder=kafka

spring.cloud.stream.bindings.output.binder=rabbit

## 30.5 Connecting to Multiple Systems

By default, binders share the application’s Spring Boot auto-configuration, so that one instance of each binder found on the classpath will be created. If your application should connect to more than one broker of the same type, you can specify multiple binder configurations, each with different environment settings.

|  |
| --- |
| [Note] |
| Turning on explicit binder configuration will disable the default binder configuration process altogether. If you do this, all in use must be included in the configuration. Frameworks that intend to use Spring Cloud Stream transparently may create binder configurations that can be referenced by name, but will not affect the default binder configuration. In order to do so, a binder configuration may have its defaultCandidate flag set to false, e.g. spring.cloud.stream.binders.<configurationName>.defaultCandidate=false. This denotes a configuration that will exist independently of the default binder configuration process. |

For example, this is the typical configuration for a processor application which connects to two RabbitMQ broker instances:

spring:

cloud:

stream:

bindings:

input:

destination: foo

binder: rabbit1

output:

destination: bar

binder: rabbit2

binders:

rabbit1:

type: rabbit

environment:

spring:

rabbitmq:

host: <host1>

rabbit2:

type: rabbit

environment:

spring:

rabbitmq:

host: <host2>

## 30.6 Binding visualization and control

Since version 2.0 Spring Cloud Stream supports visualization and control of the Bindings via Actuator endpoints.

|  |
| --- |
| [Note] |
| Given that starting with version 2.0 actuator and web are optional, one must first add one of the web dependencies as well as the actuator dependency manually.  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-web</artifactId>  </dependency>  or  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-webflux</artifactId>  </dependency>  Actuator dependency can be added as follows:  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-actuator</artifactId>  </dependency>  You must also enable bindings actuator endpoints with the following property --management.endpoints.web.exposure.include=bindings. |

Once the above prerequisites are satisfied you should see the following in the logs when application is started:

: Mapped "{[/actuator/bindings/{name}],methods=[POST]. . .

: Mapped "{[/actuator/bindings],methods=[GET]. . .

: Mapped "{[/actuator/bindings/{name}],methods=[GET]. . .

To visualize current bindings simply access the following URL:

http://<host>:<port>/actuator/bindings

or

http://<host>:<port>/actuator/bindings/myBindingName

…​if you want to visualize a single binding named 'myBindingName'

You can also stop, start, pause and resume individual binding by posting to the same URL while providing state argument as JSON.

For example,

curl -d '{"state":"STOPPED"}' -H "Content-Type: application/json" -X POST http://<host>:<port>/actuator/bindings/myBindingName

curl -d '{"state":"STARTED"}' -H "Content-Type: application/json" -X POST http://<host>:<port>/actuator/bindings/myBindingName

curl -d '{"state":"PAUSED"}' -H "Content-Type: application/json" -X POST http://<host>:<port>/actuator/bindings/myBindingName

curl -d '{"state":"RESUMED"}' -H "Content-Type: application/json" -X POST http://<host>:<port>/actuator/bindings/myBindingName

|  |
| --- |
| [Note] |
| PAUSED and RESUMED are only effective if corresponding binder and its underlyig technology supports it, otherwise you’ll see the warning message in the logs. Currently only Kafka binder supports PAUSED and RESUMED state. |

## 30.7 Binder configuration properties

The following properties are available when creating custom binder configurations. They must be prefixed with spring.cloud.stream.binders.<configurationName>.

type

The binder type. It typically references one of the binders found on the classpath, in particular a key in a META-INF/spring.binders file.

By default, it has the same value as the configuration name.

inheritEnvironment

Whether the configuration will inherit the environment of the application itself.

Default true.

environment

Root for a set of properties that can be used to customize the environment of the binder. When this is configured, the context in which the binder is being created is not a child of the application context. This allows for complete separation between the binder components and the application components.

Default empty.

defaultCandidate

Whether the binder configuration is a candidate for being considered a default binder, or can be used only when explicitly referenced. This allows adding binder configurations without interfering with the default processing.

Default true.

## 31. Configuration Options

Spring Cloud Stream supports general configuration options as well as configuration for bindings and binders. Some binders allow additional binding properties to support middleware-specific features.

Configuration options can be provided to Spring Cloud Stream applications via any mechanism supported by Spring Boot. This includes application arguments, environment variables, and YAML or .properties files.

## 31.1 Spring Cloud Stream Properties

spring.cloud.stream.instanceCount

The number of deployed instances of an application. Must be set for partitioning on the producer side, and on the consumer side if using RabbitMQ and with Kafka if autoRebalanceEnabled=false.

Default: 1.

spring.cloud.stream.instanceIndex

The instance index of the application: a number from 0 to instanceCount-1. Used for partitioning with RabbitMQ and with Kafka if autoRebalanceEnabled=false. Automatically set in Cloud Foundry to match the application’s instance index.

spring.cloud.stream.dynamicDestinations

A list of destinations that can be bound dynamically (for example, in a dynamic routing scenario). If set, only listed destinations can be bound.

Default: empty (allowing any destination to be bound).

spring.cloud.stream.defaultBinder

The default binder to use, if multiple binders are configured. See [Multiple Binders on the Classpath](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__binders.html#multiple-binders).

Default: empty.

spring.cloud.stream.overrideCloudConnectors

This property is only applicable when the cloud profile is active and Spring Cloud Connectors are provided with the application. If the property is false (the default), the binder will detect a suitable bound service (e.g. a RabbitMQ service bound in Cloud Foundry for the RabbitMQ binder) and will use it for creating connections (usually via Spring Cloud Connectors). When set to true, this property instructs binders to completely ignore the bound services and rely on Spring Boot properties (e.g. relying on the spring.rabbitmq.\* properties provided in the environment for the RabbitMQ binder). The typical usage of this property is to be nested in a customized environment [when connecting to multiple systems](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__binders.html#multiple-systems).

Default: false.

spring.cloud.stream.bindingRetryInterval

The interval (seconds) between retrying binding creation when, for example, the binder doesn’t support late binding and the broker is down (e.g. Apache Kafka). Set to zero to treat such conditions as fatal, preventing the application from starting.

Default: 30

## 31.2 Binding Properties

Binding properties are supplied using the format spring.cloud.stream.bindings.<channelName>.<property>=<value>. The <channelName> represents the name of the channel being configured (e.g., output for a Source).

To avoid repetition, Spring Cloud Stream supports setting values for all channels, in the format spring.cloud.stream.default.<property>=<value>.

In what follows, we indicate where we have omitted the spring.cloud.stream.bindings.<channelName>. prefix and focus just on the property name, with the understanding that the prefix will be included at runtime.

### 31.2.1 Properties for Use of Spring Cloud Stream

The following binding properties are available for both input and output bindings and must be prefixed with spring.cloud.stream.bindings.<channelName>., e.g. spring.cloud.stream.bindings.input.destination=ticktock.

Default values can be set by using the prefix spring.cloud.stream.default, e.g. spring.cloud.stream.default.contentType=application/json.

destination

The target destination of a channel on the bound middleware (e.g., the RabbitMQ exchange or Kafka topic). If the channel is bound as a consumer, it could be bound to multiple destinations and the destination names can be specified as comma separated String values. If not set, the channel name is used instead. The default value of this property cannot be overridden.

group

The consumer group of the channel. Applies only to inbound bindings. See [Consumer Groups](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__main_concepts.html#consumer-groups).

Default: null (indicating an anonymous consumer).

contentType

The content type of the channel.

Default: null (so that no type coercion is performed).

binder

The binder used by this binding. See [Section 30.4, “Multiple Binders on the Classpath”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__binders.html#multiple-binders) for details.

Default: null (the default binder will be used, if one exists).

### 31.2.2 Consumer properties

The following binding properties are available for input bindings only and must be prefixed with spring.cloud.stream.bindings.<channelName>.consumer., e.g. spring.cloud.stream.bindings.input.consumer.concurrency=3.

Default values can be set by using the prefix spring.cloud.stream.default.consumer, e.g. spring.cloud.stream.default.consumer.headerMode=none.

concurrency

The concurrency of the inbound consumer.

Default: 1.

partitioned

Whether the consumer receives data from a partitioned producer.

Default: false.

headerMode

When set to none, disables header parsing on input. Effective only for messaging middleware that does not support message headers natively and requires header embedding. This option is useful when consuming data from non-Spring Cloud Stream applications when native headers are not supported. When set to headers, uses the middleware’s native header mechanism. When set to embeddedHeaders, embeds headers into the message payload.

Default: depends on binder implementation.

maxAttempts

If processing fails, the number of attempts to process the message (including the first). Set to 1 to disable retry.

Default: 3.

backOffInitialInterval

The backoff initial interval on retry.

Default: 1000.

backOffMaxInterval

The maximum backoff interval.

Default: 10000.

backOffMultiplier

The backoff multiplier.

Default: 2.0.

instanceIndex

When set to a value greater than equal to zero, allows customizing the instance index of this consumer (if different from spring.cloud.stream.instanceIndex). When set to a negative value, it will default to spring.cloud.stream.instanceIndex. See that property for more information.

Default: -1.

instanceCount

When set to a value greater than equal to zero, allows customizing the instance count of this consumer (if different from spring.cloud.stream.instanceCount). When set to a negative value, it will default to spring.cloud.stream.instanceCount. See that property for more information.

Default: -1.

### 31.2.3 Producer Properties

The following binding properties are available for output bindings only and must be prefixed with spring.cloud.stream.bindings.<channelName>.producer., e.g. spring.cloud.stream.bindings.input.producer.partitionKeyExpression=payload.id.

Default values can be set by using the prefix spring.cloud.stream.default.producer, e.g. spring.cloud.stream.default.producer.partitionKeyExpression=payload.id.

partitionKeyExpression

A SpEL expression that determines how to partition outbound data. If set, or if partitionKeyExtractorClass is set, outbound data on this channel will be partitioned, and partitionCount must be set to a value greater than 1 to be effective. The two options are mutually exclusive. See [Section 28.6, “Partitioning Support”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__main_concepts.html#partitioning).

Default: null.

partitionKeyExtractorClass

A PartitionKeyExtractorStrategy implementation. If set, or if partitionKeyExpression is set, outbound data on this channel will be partitioned, and partitionCount must be set to a value greater than 1 to be effective. The two options are mutually exclusive. See [Section 28.6, “Partitioning Support”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__main_concepts.html#partitioning).

Default: null.

partitionSelectorClass

A PartitionSelectorStrategy implementation. Mutually exclusive with partitionSelectorExpression. If neither is set, the partition will be selected as the hashCode(key) % partitionCount, where key is computed via either partitionKeyExpression or partitionKeyExtractorClass.

Default: null.

partitionSelectorExpression

A SpEL expression for customizing partition selection. Mutually exclusive with partitionSelectorClass. If neither is set, the partition will be selected as the hashCode(key) % partitionCount, where key is computed via either partitionKeyExpression or partitionKeyExtractorClass.

Default: null.

partitionCount

The number of target partitions for the data, if partitioning is enabled. Must be set to a value greater than 1 if the producer is partitioned. On Kafka, interpreted as a hint; the larger of this and the partition count of the target topic is used instead.

Default: 1.

requiredGroups

A comma-separated list of groups to which the producer must ensure message delivery even if they start after it has been created (e.g., by pre-creating durable queues in RabbitMQ).

headerMode

When set to none, disables header embedding on output. Effective only for messaging middleware that does not support message headers natively and requires header embedding. This option is useful when producing data for non-Spring Cloud Stream applications when native headers are not supported. When set to headers, uses the middleware’s native header mechanism. When set to embeddedHeaders, embeds headers into the message payload.

Default: Depends on binder implementation.

useNativeEncoding

When set to true, the outbound message is serialized directly by client library, which must be configured correspondingly (e.g. setting an appropriate Kafka producer value serializer). When this configuration is being used, the outbound message marshalling is not based on the contentType of the binding. When native encoding is used, it is the responsibility of the consumer to use appropriate decoder (ex: Kafka consumer value de-serializer) to deserialize the inbound message. Also, when native encoding/decoding is used the headerMode=embeddedHeaders property is ignored and headers will not be embedded into the message.

Default: false.

errorChannelEnabled

When set to true, if the binder supports async send results; send failures will be sent to an error channel for the destination. See [the section called “Message Channel Binders and Error Channels”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__programming_model.html#binder-error-channels) for more information.

Default: false.

## 31.3 Using dynamically bound destinations

Besides the channels defined via @EnableBinding, Spring Cloud Stream allows applications to send messages to dynamically bound destinations. This is useful, for example, when the target destination needs to be determined at runtime. Applications can do so by using the BinderAwareChannelResolver bean, registered automatically by the @EnableBinding annotation.

The property 'spring.cloud.stream.dynamicDestinations' can be used for restricting the dynamic destination names to a set known beforehand (whitelisting). If the property is not set, any destination can be bound dynamically.

The BinderAwareChannelResolver can be used directly as in the following example, in which a REST controller uses a path variable to decide the target channel.

*@EnableBinding*

*@Controller*

**public** **class** SourceWithDynamicDestination {

*@Autowired*

**private** BinderAwareChannelResolver resolver;

*@RequestMapping(path = "/{target}", method = POST, consumes = "\*/\*")*

*@ResponseStatus(HttpStatus.ACCEPTED)*

**public** **void** handleRequest(*@RequestBody* String body, *@PathVariable("target")* target,

*@RequestHeader(HttpHeaders.CONTENT\_TYPE)* Object contentType) {

sendMessage(body, target, contentType);

}

**private** **void** sendMessage(String body, String target, Object contentType) {

resolver.resolveDestination(target).send(MessageBuilder.createMessage(body,

**new** MessageHeaders(Collections.singletonMap(MessageHeaders.CONTENT\_TYPE, contentType))));

}

}

After starting the application on the default port 8080, when sending the following data:

curl -H "Content-Type: application/json" -X POST -d "customer-1" http://localhost:8080/customers

curl -H "Content-Type: application/json" -X POST -d "order-1" http://localhost:8080/orders

The destinations 'customers' and 'orders' are created in the broker (for example: exchange in case of Rabbit or topic in case of Kafka) with the names 'customers' and 'orders', and the data is published to the appropriate destinations.

The BinderAwareChannelResolver is a general purpose Spring Integration DestinationResolver and can be injected in other components. For example, in a router using a SpEL expression based on the target field of an incoming JSON message.

*@EnableBinding*

*@Controller*

**public** **class** SourceWithDynamicDestination {

*@Autowired*

**private** BinderAwareChannelResolver resolver;

*@RequestMapping(path = "/", method = POST, consumes = "application/json")*

*@ResponseStatus(HttpStatus.ACCEPTED)*

**public** **void** handleRequest(*@RequestBody* String body, *@RequestHeader(HttpHeaders.CONTENT\_TYPE)* Object contentType) {

sendMessage(body, contentType);

}

**private** **void** sendMessage(Object body, Object contentType) {

routerChannel().send(MessageBuilder.createMessage(body,

**new** MessageHeaders(Collections.singletonMap(MessageHeaders.CONTENT\_TYPE, contentType))));

}

*@Bean(name = "routerChannel")*

**public** MessageChannel routerChannel() {

**return** **new** DirectChannel();

}

*@Bean*

*@ServiceActivator(inputChannel = "routerChannel")*

**public** ExpressionEvaluatingRouter router() {

ExpressionEvaluatingRouter router =

**new** ExpressionEvaluatingRouter(**new** SpelExpressionParser().parseExpression("payload.target"));

router.setDefaultOutputChannelName("default-output");

router.setChannelResolver(resolver);

**return** router;

}

}

The [Router Sink Application](https://github.com/spring-cloud-stream-app-starters/router) uses this technique to create the destinations on-demand.

If the channel names are known in advance, you can configure the producer properties as with any other destination. Alternatively, if you register a NewBindingCallback<> bean, it will be invoked just before the binding is created. The callback takes the generic type of the extended producer properties used by the binder; it has one method:

**void** configure(String channelName, MessageChannel channel, ProducerProperties producerProperties,

T extendedProducerProperties);

The following is an example using the RabbitMQ binder:

*@Bean*

**public** NewBindingCallback<RabbitProducerProperties> dynamicConfigurer() {

**return** (name, channel, props, extended) -> {

props.setRequiredGroups("bindThisQueue");

extended.setQueueNameGroupOnly(true);

extended.setAutoBindDlq(true);

extended.setDeadLetterQueueName("myDLQ");

};

}

|  |
| --- |
| [Note] |
| If you need to support dynamic destinations with multiple binder types, use Object for the generic type and cast the extended argument as needed. |

## 32. Content Type negotiation

## 32.1 Introduction

Data transformation is one of the core features of any message-driven microservice architecture. Given that in Spring Cloud Stream, such data is represented as a Spring Message, such message may have to be transformed to a desired shape/size before reaching its destination. This is required for two reasons:

1. To convert the contents of the incoming message to match the signature of the application-provided handler.

2. To convert the contents of the outgoing message to the wire format.

The wire format is typically byte[] (i.e., Kafka and Rabbit binders), but is governed by the binder implementation.

In Spring Cloud Stream, message transformation is accomplished with a org.springframework.messaging.converter.MessageConverter.

|  |
| --- |
| [Note] |
| As a supplement to the details to follow you may also want to read the following [blog](https://spring.io/blog/2018/02/26/spring-cloud-stream-2-0-content-type-negotiation-and-transformation) |

## 32.2 Mechanics

To better understand the mechanics and the necessity behind content-type negotiation let’s look at the very simple use case using the following message handler as an example. Also let’s assume that this is the only handler in the application (no internal pipeline) for simplicity.

*@StreamListener(Processor.INPUT)*

*@SendTo(Processor.OUTPUT)*

**public** String handle(Person person) {..}

The above handler expects Person type as an argument and will produce String type as an output. In order for the framework to succeed in passing the incomingMessage as an argument to this handler it has to somehow transform the payload of the Message from the wire format to Person type. In other words the framework must locate and apply the appropriate MessageConverter. To accomplish that the framework needs some instructions from the user. One of these instructions is already provided by the signature of the handler method itself (Person type), so in theory, that should and in some cases is enough, but for the majority of the use cases in order to select the appropriate MessageConverter the framework needs an additional piece of information. That missing piece is contentType.

Spring Cloud Stream provides three simple mechanisms to define contentType and they all come with precedence order:

1. ***HEADER*** - the *contentType* can be communicated through the Message itself. By simply providing *contentType* header you are declaring the content type to use to locate and apply the appropriate MessageConverter.

2. ***BINDING*** - the *contentType* can be set per destination binding via *spring.cloud.stream.bindings.input.content-type* property. NOTE: the segment *input*in the property name corresponds to the actual name of the destination which is “input” in our case. This approach allows one to declare per-binding the content type to use to locate and apply the appropriate MessageConverter.

3. ***DEFAULT*** - in the event *contentType* is not present in the Message header and/or binding, the default *application/json* content type will be used to locate and apply the appropriate MessageConverter.

As mentioned, the above also demonstrates the order of precedence in the event there is a tie. For example, header provided content type takes precedence over any other content type. The same applies for content type set per binding which essentially allows one to override the default content type. But it also provides a sensible default which was determined from the community feedback.

Another reason for making application/json the default stems from the interoperability requirements driven by distributed microservices architectures where producer and consumer not only run in different JVMs, but can also run on different non-JVM platforms.

Once the non-void handler method returns and unless the return value is already a Message, the new Message is constructed with return vlaue as the payload while inheriting headers from the input Message less the ones defined/filtered by SpringIntegrationProperties.messageHandlerNotPropagatedHeaders. By default, there is only one header set there - contentType. This means that the new Message will not have contentType header set, thus ensuring that the contentType can evolve. You can always opt out to returning a Message from the handler method where you can inject any header you wish.

If there is an internal pipeline the Message is sent to the next handler going through the same process of conversion, or if there is no internal pipeline or you’ve reached the end of it the Message is sent back to the output destination.

### 32.2.1 Content type vs. argument type

As it was mentioned, for the framework to select the appropriate MessageConverter it requires argument type and optionally content type information. The logic for selecting the appropriate MessageConverter resides with the argument resolvers (HandlerMethodArgumentResolvers), right before the invocation of the user defined handler method (that is when the actual argument type is known to the framework). If argument type does NOT match the type of the current payload the framework delegates to the stack of the pre-configured MessageConverters to see if any one of them can convert the payload. As you can see the Object fromMessage(Message<?> message, Class<?> targetClass); operation of the MessageConverter takes targetClass as one of its arguments. The framework also ensures that the provided Message always contains contentType header in the event one was not there already (injects the default one or the one set per binding). That is the mechanism by which framework determines if message can be converted to a target type - contentType and argumenyt type. If no appropriate MessageConverter is found the exception is thrown at which time you can add custom MessageConverter (more on this later).

But what if the payload type matches the target type declared by the handler method? In this cases there is obviously nothing to convert and the payload will be passed unmodified. While this sounds pretty straight forward and logical, keep in mind handler methods that take Message<?> and/or Object as an argument. By doing so you are essentially forfeiting the conversion process by declaring the target type to be Object which is an instanceof everything in Java.

In other words:

|  |
| --- |
| [Note] |
| Do NOT expect Message to be converted into some type based on the contentType only. Remember that the contentType is complimentary to the target type. A hint if you wish which MessageConverter may or may not take into consideration. |

### 32.2.2 Message Converters

MessageConverters define two methods:

Object fromMessage(Message<?> message, Class<?> targetClass);

Message<?> toMessage(Object payload, *@Nullable* MessageHeaders headers);

It is important to understand the contract of these methods and their usage specifically in the context of Spring Cloud Stream.

The fromMessage method converts incoming Message to an argument type. The payload of the Message could be any type and it’s up to the actual implementation of the MessageConverter to support multiple types. For example, some JSON converter may support the payload type as byte[] and String etc. This is important when application contains an internal pipeline (i.e., input → handler1 → handler2 →. . . → output) and the output of the upstream handler results in a Message which may not be in the initial wire format.

However. . .

The toMessage method has a more strict contract and must always convert Message to the wire format - byte[].

So for all intents and purposes (and especially when implementing your own converter) you might as well look at them as:

Object fromMessage(Message<?> message, Class<?> targetClass);

Message<**byte**[]> toMessage(Object payload, *@Nullable* MessageHeaders headers);

## 32.3 Provided MessageConverters

As it was mentioned earlier the framework already provides a stack of MessageConverters to handle most common use cases. Below is the ordered list of provided MessageConverters.

|  |
| --- |
| [Note] |
| It is important to understand the importance of the order since the mechanism by which the framework locates the appropriate MessageConverter is by iterating through each and asking if it can convert using the first one that can convert. |

1. ApplicationJsonMessageMarshallingConverter - variation of the *org.springframework.messaging.converter.MappingJackson2MessageConverter*. Supports conversion of the payload of the *Message* from *String* or *byte[]*.
2. TupleJsonMessageConverter - ***[DEPRECATED]*** Supports conversion of the payload of the *Message* from *org.springframework.tuple.Tuple*.
3. ByteArrayMessageConverter - Supports conversion of the payload of the *Message* from *byte[]* to *byte[]* for cases when *contentType* is set to *application/octet-stream*. Essentially a pass through and exists primarily for backward compatibility.
4. ObjectStringMessageConverter - Supports conversion of any type to a *String*, when contentType is *text/plain*. Invokes Object’s *toString()* method or if payload is *byte[]* then new *String(byte[])*.
5. JavaSerializationMessageConverter - ***[DEPRECATED]*** Supports conversion based on java serialization when *contentType* is *application/x-java-serialized-object*.
6. KryoMessageConverter - ***[DEPRECATED]*** Supports conversion based on kryo serialization when *contentType* is *application/x-java-object*.
7. JsonUnmarshallingConverter - Similar to the *ApplicationJsonMessageMarshallingConverter*. Supports conversion of any type when *contentType* is *application/x-java-object*. Expects the actual type information to be embedded in the *contentType* as an attribute (e.g., *application/x-java-object;type=foo.bar.Baz*).

In the event no appropriate converter is found the framework will throw an exception at which point you should check your code and configfuration and ensure you didn’t miss anything (i.e., provide contentType via binding or header). However, most likely you are dealing with some uncommon case (custom contentType perhaps) and the current stack of provided MessageConverters doesn’t know how to convert. And if that’s the case you can add custom MessageConverter.

## 32.4 User defined Message Converters

Spring Cloud Stream exposes a mechanism to define and register additional MessageConverters. All you need to do is implement org.springframework.messaging.converter.MessageConverter, confiure it as @Bean and annotate it with @StreamMessageConverter and it will be added to the existing stack of MessageConverters. The @StreamMessageConverter qualifier annotation is to avoid picking up other converters that may be present on the Application Context.

|  |
| --- |
| [Note] |
| It is important to undetrstand that custom MessageConverters are added to the head of the existing stack. This allows custom MessageConverters to take precedence over the existing ones, thus supporting not only addition, but the override of the existing ones. |

Here is an example of creating a message converter bean to support new content type application/bar:

*@EnableBinding(Sink.class)*

*@SpringBootApplication*

**public** **static** **class** SinkApplication {

...

*@Bean*

*@StreamConverter*

**public** MessageConverter customMessageConverter() {

**return** **new** MyCustomMessageConverter();

}

}

**public** **class** MyCustomMessageConverter **extends** AbstractMessageConverter {

**public** MyCustomMessageConverter() {

**super**(**new** MimeType("application", "bar"));

}

*@Override*

**protected** **boolean** supports(Class<?> clazz) {

**return** (Bar.**class**.equals(clazz));

}

*@Override*

**protected** Object convertFromInternal(Message<?> message, Class<?> targetClass, Object conversionHint) {

Object payload = message.getPayload();

**return** (payload **instanceof** Bar ? payload : **new** Bar((**byte**[]) payload));

}

}

Spring Cloud Stream also provides support for Avro-based converters and schema evolution. See [the specific section](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_schema-evolution.html) for details.

## 33. Schema evolution support

Spring Cloud Stream provides support for schema-based message converters through its spring-cloud-stream-schema module. Currently, the only serialization format supported out of the box for schema-based message converters is Apache Avro, with more formats to be added in future versions.

## 33.1 Apache Avro Message Converters

The spring-cloud-stream-schema module contains two types of message converters that can be used for Apache Avro serialization:

* converters using the class information of the serialized/deserialized objects, or a schema with a location known at startup;
* converters using a schema registry - they locate the schemas at runtime, as well as dynamically registering new schemas as domain objects evolve.

## 33.2 Converters with schema support

The AvroSchemaMessageConverter supports serializing and deserializing messages either using a predefined schema or by using the schema information available in the class (either reflectively, or contained in the SpecificRecord). If the target type of the conversion is a GenericRecord, then a schema must be set.

For using it, you can simply add it to the application context, optionally specifying one ore more MimeTypes to associate it with. The default MimeType is application/avro.

Here is an example of configuring it in a sink application registering the Apache Avro MessageConverter, without a predefined schema:

*@EnableBinding(Sink.class)*

*@SpringBootApplication*

**public** **static** **class** SinkApplication {

...

*@Bean*

**public** MessageConverter userMessageConverter() {

**return** **new** AvroSchemaMessageConverter(MimeType.valueOf("avro/bytes"));

}

}

Conversely, here is an application that registers a converter with a predefined schema, to be found on the classpath:

*@EnableBinding(Sink.class)*

*@SpringBootApplication*

**public** **static** **class** SinkApplication {

...

*@Bean*

**public** MessageConverter userMessageConverter() {

AvroSchemaMessageConverter converter = **new** AvroSchemaMessageConverter(MimeType.valueOf("avro/bytes"));

converter.setSchemaLocation(**new** ClassPathResource("schemas/User.avro"));

**return** converter;

}

}

In order to understand the schema registry client converter, we will describe the schema registry support first.

## 33.3 Schema Registry Support

Most serialization models, especially the ones that aim for portability across different platforms and languages, rely on a schema that describes how the data is serialized in the binary payload. In order to serialize the data and then to interpret it, both the sending and receiving sides must have access to a schema that describes the binary format. In certain cases, the schema can be inferred from the payload type on serialization, or from the target type on deserialization, but in a lot of cases applications benefit from having access to an explicit schema that describes the binary data format. A schema registry allows you to store schema information in a textual format (typically JSON) and makes that information accessible to various applications that need it to receive and send data in binary format. A schema is referenceable as a tuple consisting of:

* a subject that is the logical name of the schema;
* the schema version;
* the schema format which describes the binary format of the data.

## 33.4 Schema Registry Server

Spring Cloud Stream provides a schema registry server implementation. In order to use it, you can simply add the spring-cloud-stream-schema-server artifact to your project and use the @EnableSchemaRegistryServer annotation, adding the schema registry server REST controller to your application. This annotation is intended to be used with Spring Boot web applications, and the listening port of the server is controlled by the server.port setting. The spring.cloud.stream.schema.server.path setting can be used to control the root path of the schema server (especially when it is embedded in other applications). The spring.cloud.stream.schema.server.allowSchemaDeletion boolean setting enables the deletion of schema. By default this is disabled.

The schema registry server uses a relational database to store the schemas. By default, it uses an embedded database. You can customize the schema storage using the [Spring Boot SQL database and JDBC configuration options](https://docs.spring.io/spring-boot/docs/current-SNAPSHOT/reference/htmlsingle/#boot-features-sql).

A Spring Boot application enabling the schema registry looks as follows:

*@SpringBootApplication*

*@EnableSchemaRegistryServer*

**public** **class** SchemaRegistryServerApplication {

**public** **static** **void** main(String[] args) {

SpringApplication.run(SchemaRegistryServerApplication.**class**, args);

}

}

### 33.4.1 Schema Registry Server API

The Schema Registry Server API consists of the following operations:

POST /

Register a new schema.

Accepts JSON payload with the following fields:

* subject the schema subject;
* format the schema format;
* definition the schema definition.

Response is a schema object in JSON format, with the following fields:

* id the schema id;
* subject the schema subject;
* format the schema format;
* version the schema version;
* definition the schema definition.

GET /{subject}/{format}/{version}

Retrieve an existing schema by its subject, format and version.

Response is a schema object in JSON format, with the following fields:

* id the schema id;
* subject the schema subject;
* format the schema format;
* version the schema version;
* definition the schema definition.

GET /{subject}/{format}

Retrieve a list of existing schema by its subject and format.

Response is a list of schemas with each schema object in JSON format, with the following fields:

* id the schema id;
* subject the schema subject;
* format the schema format;
* version the schema version;
* definition the schema definition.

GET /schemas/{id}

Retrieve an existing schema by its id.

Response is a schema object in JSON format, with the following fields:

* id the schema id;
* subject the schema subject;
* format the schema format;
* version the schema version;
* definition the schema definition.

DELETE /{subject}/{format}/{version}

Delete an existing schema by its subject, format and version.

DELETE /schemas/{id}

Delete an existing schema by its id.

DELETE /{subject}

Delete existing schemas by their subject.

|  |
| --- |
| [Note] |
| This note applies to users of Spring Cloud Stream 1.1.0.RELEASE only. Spring Cloud Stream 1.1.0.RELEASE used the table name schema for storing Schema objects, which is a keyword in a number of database implementations. To avoid any conflicts in the future, starting with 1.1.1.RELEASE we have opted for the name SCHEMA\_REPOSITORY for the storage table. Any Spring Cloud Stream 1.1.0.RELEASE users that are upgrading are advised to migrate their existing schemas to the new table before upgrading. |

## 33.5 Schema Registry Client

The client-side abstraction for interacting with schema registry servers is the SchemaRegistryClient interface, with the following structure:

**public** **interface** SchemaRegistryClient {

SchemaRegistrationResponse register(String subject, String format, String schema);

String fetch(SchemaReference schemaReference);

String fetch(Integer id);

}

Spring Cloud Stream provides out of the box implementations for interacting with its own schema server, as well as for interacting with the Confluent Schema Registry.

A client for the Spring Cloud Stream schema registry can be configured using the @EnableSchemaRegistryClient as follows:

*@EnableBinding(Sink.class)*

*@SpringBootApplication*

*@EnableSchemaRegistryClient*

**public** **static** **class** AvroSinkApplication {

...

}

|  |
| --- |
| [Note] |
| The default converter is optimized to cache not only the schemas from the remote server but also the parse() and toString() methods that are quite expensive. Because of this, it uses a DefaultSchemaRegistryClient that does not caches responses. If you intend to use the client directly on your code, you can request a bean that also caches responses to be created. To do that, just add the property spring.cloud.stream.schemaRegistryClient.cached=true to your application properties. |

### 33.5.1 Using Confluent’s Schema Registry

The default configuration will create a DefaultSchemaRegistryClient bean. If you want to use the Confluent schema registry, you need to create a bean of type ConfluentSchemaRegistryClient, which will supersede the one configured by default by the framework.

*@Bean*

**public** SchemaRegistryClient schemaRegistryClient(*@Value("${spring.cloud.stream.schemaRegistryClient.endpoint}")* String endpoint){

ConfluentSchemaRegistryClient client = **new** ConfluentSchemaRegistryClient();

client.setEndpoint(endpoint);

**return** client;

}

|  |
| --- |
| [Note] |
| The ConfluentSchemaRegistryClient is tested against Confluent platform version 3.2.2. |

### 33.5.2 Schema Registry Client properties

The Schema Registry Client supports the following properties:

spring.cloud.stream.schemaRegistryClient.endpoint

The location of the schema-server. Use a full URL when setting this, including protocol (http or https) , port and context path.

Default

<http://localhost:8990/>

spring.cloud.stream.schemaRegistryClient.cached

Whether the client should cache schema server responses. Normally set to false, as the caching happens in the message converter. Clients using the schema registry client should set this to true.

Default

true

## 33.6 Avro Schema Registry Client Message Converters

For Spring Boot applications that have a SchemaRegistryClient bean registered with the application context, Spring Cloud Stream will auto-configure an Apache Avro message converter that uses the schema registry client for schema management. This eases schema evolution, as applications that receive messages can get easy access to a writer schema that can be reconciled with their own reader schema.

For outbound messages, the MessageConverter will be activated if the content type of the channel is set to application/\*+avro, e.g.:

spring.cloud.stream.bindings.output.contentType=application/\*+avro

During the outbound conversion, the message converter will try to infer the schemas of the outbound messages based on their type and register them to a subject based on the payload type using the SchemaRegistryClient. If an identical schema is already found, then a reference to it will be retrieved. If not, the schema will be registered and a new version number will be provided. The message will be sent with a contentType header using the scheme application/[prefix].[subject].v[version]+avro, where prefix is configurable and subject is deduced from the payload type.

For example, a message of the type User may be sent as a binary payload with a content type of application/vnd.user.v2+avro, where user is the subject and 2 is the version number.

When receiving messages, the converter will infer the schema reference from the header of the incoming message and will try to retrieve it. The schema will be used as the writer schema in the deserialization process.

### 33.6.1 Avro Schema Registry Message Converter properties

If you have enabled Avro based schema registry client by setting spring.cloud.stream.bindings.output.contentType=application/\*+avro you can customize the behavior of the registration with the following properties.

spring.cloud.stream.schema.avro.dynamicSchemaGenerationEnabled

Enable if you want the converter to use reflection to infer a Schema from a POJO.

Default

false

spring.cloud.stream.schema.avro.readerSchema

Avro compares schema versions by looking at a writer schema (origin payload) and a reader schema (your application payload), check [Avro](https://avro.apache.org/docs/1.7.6/spec.html) documentation for more information. If set, this overrides any lookups at the schema server and uses the local schema as the reader schema.

Default

null

spring.cloud.stream.schema.avro.schemaLocations

Register any .avsc files listed in this property with the Schema Server.

Default

empty

spring.cloud.stream.schema.avro.prefix

The prefix to be used on the Content-Type header.

Default

vnd

## 33.7 Schema Registration and Resolution

To better understand how Spring Cloud Stream registers and resolves new schemas, as well as its use of Avro schema comparison features, we will provide two separate subsections below: one for the registration, and one for the resolution of schemas.

### 33.7.1 Schema Registration Process (Serialization)

The first part of the registration process is extracting a schema from the payload that is being sent over a channel. Avro types such as SpecificRecord or GenericRecord already contain a schema, which can be retrieved immediately from the instance. In the case of POJOs a schema will be inferred if the property spring.cloud.stream.schema.avro.dynamicSchemaGenerationEnabled is set to true (the default).

**Figure 33.1. Schema Writer Resolution Process**

Ones a schema is obtained, the converter will then load its metadata (version) from the remote server. First it queries a local cache, and if not found it then submits the data to the server that will reply with versioning information. The converter will always cache the results to avoid the overhead of querying the Schema Server for every new message that needs to be serialized.

**Figure 33.2. Schema Registration Process**

With the schema version information, the converter sets the contentType header of the message to carry the version information such as application/vnd.user.v1+avro

### 33.7.2 Schema Resolution Process (Deserialization)

When reading messages that contain version information (i.e. a contentType header with a scheme like above), the converter will query the Schema server to fetch the **writer** schema of the message. Ones it has found the correct schema of the incoming message, it then retrieves the reader schema and using Avro’s schema resolution support reads it into the reader definition (setting defaults and missing properties).

**Figure 33.3. Schema Reading Resolution Process**

|  |
| --- |
| [Note] |
| It’s important to understand the difference between a writer schema (the application that wrote the message) and a reader schema (the receiving application). Please take a moment to read [the Avro terminology](https://avro.apache.org/docs/1.7.6/spec.html) and understand the process. Spring Cloud Stream will always fetch the writer schema to determine how to read a message. If you want to get Avro’s schema evolution support working you need to make sure that a readerSchema was properly set for your application. |

## 34. Inter-Application Communication

## 34.1 Connecting Multiple Application Instances

While Spring Cloud Stream makes it easy for individual Spring Boot applications to connect to messaging systems, the typical scenario for Spring Cloud Stream is the creation of multi-application pipelines, where microservice applications send data to each other. You can achieve this scenario by correlating the input and output destinations of adjacent applications.

Supposing that a design calls for the Time Source application to send data to the Log Sink application, you can use a common destination named ticktock for bindings within both applications.

Time Source (that has the channel name output) will set the following property:

spring.cloud.stream.bindings.output.destination=ticktock

Log Sink (that has the channel name input) will set the following property:

spring.cloud.stream.bindings.input.destination=ticktock

## 34.2 Instance Index and Instance Count

When scaling up Spring Cloud Stream applications, each instance can receive information about how many other instances of the same application exist and what its own instance index is. Spring Cloud Stream does this through the spring.cloud.stream.instanceCount and spring.cloud.stream.instanceIndex properties. For example, if there are three instances of a HDFS sink application, all three instances will have spring.cloud.stream.instanceCount set to 3, and the individual applications will have spring.cloud.stream.instanceIndex set to 0, 1, and 2, respectively.

When Spring Cloud Stream applications are deployed via Spring Cloud Data Flow, these properties are configured automatically; when Spring Cloud Stream applications are launched independently, these properties must be set correctly. By default, spring.cloud.stream.instanceCount is 1, and spring.cloud.stream.instanceIndex is 0.

In a scaled-up scenario, correct configuration of these two properties is important for addressing partitioning behavior (see below) in general, and the two properties are always required by certain binders (e.g., the Kafka binder) in order to ensure that data are split correctly across multiple consumer instances.

## 34.3 Partitioning

### 34.3.1 Configuring Output Bindings for Partitioning

An output binding is configured to send partitioned data by setting one and only one of its partitionKeyExpression or partitionKeyExtractorName (see next paragraph) properties, as well as its partitionCount property.

For example, the following is a valid and typical configuration:

spring.cloud.stream.bindings.output.producer.partitionKeyExpression=payload.id

spring.cloud.stream.bindings.output.producer.partitionCount=5

Based on the above example configuration, data will be sent to the target partition using the following logic.

A partition key’s value is calculated for each message sent to a partitioned output channel based on the partitionKeyExpression. The partitionKeyExpression is a SpEL expression which is evaluated against the outbound message for extracting the partitioning key.

If a SpEL expression is not sufficient for your needs, you can instead calculate the partition key value by providing implementation of org.springframework.cloud.stream.binder.PartitionKeyExtractorStrategy and configuring it as a bean (i.e., @Bean). In the event you have more then one bean of type org.springframework.cloud.stream.binder.PartitionKeyExtractorStrategy available in the Application Context you can further filter it by specifying its name via partitionKeyExtractorName property:

--spring.cloud.stream.bindings.output.producer.partitionKeyExtractorName=customPartitionKeyExtractor

--spring.cloud.stream.bindings.output.producer.partitionCount=5

. . .

@Bean

public CustomPartitionKeyExtractorClass customPartitionKeyExtractor() {

return new CustomPartitionKeyExtractorClass();

}

|  |
| --- |
| [Note] |
| In previous versions of Spring Cloud Stream you could specify the implementation of org.springframework.cloud.stream.binder.PartitionKeyExtractorStrategy as spring.cloud.stream.bindings.output.producer.partitionKeyExtractorClass property. Since version 2.0 this property is deprecated and support for it will be removed in a future version. |

Ones the message key is calculated, the partition selection process will determine the target partition as a value between 0 and partitionCount - 1. The default calculation, applicable in most scenarios, is based on the formula key.hashCode() % partitionCount. This can be customized on the binding, either by setting a SpEL expression to be evaluated against the 'key' (via the partitionSelectorExpression property) or by configuring an implementation of org.springframework.cloud.stream.binder.PartitionSelectorStrategy as a bean (i.e., @Bean). And similarly to the PartitionKeyExtractorStrategy you can further filter it using spring.cloud.stream.bindings.output.producer.partitionSelectorName property in the event there are more then one bean of this type is available in the Application Context.

--spring.cloud.stream.bindings.output.producer.partitionSelectorName=customPartitionSelector

. . .

@Bean

public CustomPartitionSelectorClass customPartitionSelector() {

return new CustomPartitionSelectorClass();

}

|  |
| --- |
| [Note] |
| In previous versions of Spring Cloud Stream you could specify the implementation of org.springframework.cloud.stream.binder.PartitionSelectorStrategy as spring.cloud.stream.bindings.output.producer.partitionSelectorClass property. Since version 2.0 this property is deprecated and support for it will be removed in a future version. |

#### Configuring Input Bindings for Partitioning

An input binding (with the channel name input) is configured to receive partitioned data by setting its partitioned property, as well as the instanceIndex and instanceCount properties on the application itself, as in the following example:

spring.cloud.stream.bindings.input.consumer.partitioned=true

spring.cloud.stream.instanceIndex=3

spring.cloud.stream.instanceCount=5

The instanceCount value represents the total number of application instances between which the data need to be partitioned, and the instanceIndex must be a unique value across the multiple instances, between 0 and instanceCount - 1. The instance index helps each application instance to identify the unique partition(s) from which it receives data. It is required by binders using technology that doesn’t support partitioning natively, for example, with RabbitMQ, there is a queue for each partition, with the queue name containing the instance index. With Kafka, if autoRebalanceEnabled is true (default), Kafka will take care of distributing partitions across instances and these properties are not required. If autoRebalanceEnabled is set to false, the instanceCount and instanceIndex are used by the binder to determine which partition(s) the instance will subscribe to (you must have at least as many partitions as there are instances). The binder will allocate the partitions instead of Kafka. This might be useful if you want messages for a particular partition to always go to the same instance. When a binder configuration that requires them, it is important to set both values correctly in order to ensure that all of the data is consumed and that the application instances receive mutually exclusive datasets.

While a scenario which using multiple instances for partitioned data processing may be complex to set up in a standalone case, Spring Cloud Dataflow can simplify the process significantly by populating both the input and output values correctly as well as relying on the runtime infrastructure to provide information about the instance index and instance count.

## 35. Testing

Spring Cloud Stream provides support for testing your microservice applications without connecting to a messaging system. You can do that by using the TestSupportBinder provided by the spring-cloud-stream-test-support library, which can be added as a test dependency to the application:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-test-support</artifactId>

<scope>test</scope>

</dependency>

|  |
| --- |
| [Note] |
| The TestSupportBinder uses the Spring Boot autoconfiguration mechanism to supersede the other binders found on the classpath. Therefore, when adding a binder as a dependency, make sure that the test scope is being used. |

The TestSupportBinder allows users to interact with the bound channels and inspect what messages are sent and received by the application

For outbound message channels, the TestSupportBinder registers a single subscriber and retains the messages emitted by the application in a MessageCollector. They can be retrieved during tests and have assertions made against them.

The user can also send messages to inbound message channels, so that the consumer application can consume the messages. The following example shows how to test both input and output channels on a processor.

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment= SpringBootTest.WebEnvironment.RANDOM\_PORT)*

**public** **class** ExampleTest {

*@Autowired*

**private** Processor processor;

*@Autowired*

**private** MessageCollector messageCollector;

*@Test*

*@SuppressWarnings("unchecked")*

**public** **void** testWiring() {

Message<String> message = **new** GenericMessage<>("hello");

processor.input().send(message);

Message<String> received = (Message<String>) messageCollector.forChannel(processor.output()).poll();

assertThat(received.getPayload(), equalTo("hello world"));

}

*@SpringBootApplication*

*@EnableBinding(Processor.class)*

**public** **static** **class** MyProcessor {

*@Autowired*

**private** Processor channels;

*@Transformer(inputChannel = Processor.INPUT, outputChannel = Processor.OUTPUT)*

**public** String transform(String in) {

**return** in + " world";

}

}

}

In the example above, we are creating an application that has an input and an output channel, bound through the Processor interface. The bound interface is injected into the test so we can have access to both channels. We are sending a message on the input channel and we are using the MessageCollector provided by Spring Cloud Stream’s test support to capture the message has been sent to the output channel as a result. Ones we have received the message, we can validate that the component functions correctly.

## 35.1 Disabling the test binder autoconfiguration

The intent behind the test binder superseding all the other binders on the classpath is to make it easy to test your applications without making changes to your production dependencies. In some cases (e.g. integration tests) it is useful to use the actual production binders instead, and that requires disabling the test binder autoconfiguration. In order to do so, you can exclude the org.springframework.cloud.stream.test.binder.TestSupportBinderAutoConfiguration class using one of the Spring Boot autoconfiguration exclusion mechanisms, as in the following example.

*@SpringBootApplication(exclude = TestSupportBinderAutoConfiguration.class)*

*@EnableBinding(Processor.class)*

**public** **static** **class** MyProcessor {

*@Transformer(inputChannel = Processor.INPUT, outputChannel = Processor.OUTPUT)*

**public** String transform(String in) {

**return** in + " world";

}

}

When autoconfiguration is disabled, the test binder is available on the classpath, and its defaultCandidate property is set to false, so that it does not interfere with the regular user configuration. It can be referenced under the name test e.g.:

spring.cloud.stream.defaultBinder=test

## 36. Health Indicator

Spring Cloud Stream provides a health indicator for binders. It is registered under the name of binders and can be enabled or disabled by setting the management.health.binders.enabled property.

## 37. Metrics Emitter

Spring Cloud Stream provides a module called spring-cloud-stream-metrics that can be used to emit any available metric from [Spring Boot metrics endpoint](https://docs.spring.io/spring-boot/docs/current/reference/html/production-ready-metrics.html) to a named channel. This module allow operators to collect metrics from stream applications without relying on polling their endpoints.

The module is activated when you set the destination name for metrics binding, e.g. spring.cloud.stream.bindings.applicationMetrics.destination=<DESTINATION\_NAME>. applicationMetrics can be configured in a similar fashion to any other producer binding. The default contentType setting of applicationMetrics is application/json.

The following properties can be used for customizing the emission of metrics:

spring.cloud.stream.metrics.key

The name of the metric being emitted. Should be an unique value per application.

Default

${spring.application.name:${vcap.application.name:${spring.config.name:application}}}

spring.cloud.stream.metrics.prefix

Prefix string to be prepended to the metrics key.

Default: ``

spring.cloud.stream.metrics.properties

Just like the includes option, it allows white listing application properties that will be added to the metrics payload

Default: null.

A detailed overview of the metrics export process can be found in the [Spring Boot reference documentation](https://docs.spring.io/spring-boot/docs/current/reference/html/production-ready-metrics.html#production-ready-metric-writers). Spring Cloud Stream provides a metric exporter named application that can be configured via regular [Spring Boot metrics configuration properties](https://github.com/spring-projects/spring-boot/blob/1.5.x/spring-boot-actuator/src/main/java/org/springframework/boot/actuate/metrics/export/TriggerProperties.java).

The exporter can be configured either by using the global Spring Boot configuration settings for exporters, or by using exporter-specific properties. For using the global configuration settings, the properties should be prefixed by spring.metric.export (e.g. spring.metric.export.includes=integration\*\*). These configuration options will apply to all exporters (unless they have been configured differently). Alternatively, if it is intended to use configuration settings that are different from the other exporters (e.g. for restricting the number of metrics published), the Spring Cloud Stream provided metrics exporter can be configured using the prefix spring.metrics.export.triggers.application (e.g. spring.metrics.export.triggers.application.includes=integration\*\*).

|  |
| --- |
| [Note] |
| Due to Spring Boot’s [relaxed binding](https://docs.spring.io/spring-boot/docs/current/reference/html/boot-features-external-config.html#boot-features-external-config-relaxed-binding) the value of a property being included can be slightly different than the original value.  As a rule of thumb, the metric exporter will attempt to normalize all the properties in a consistent format using the dot notation (e.g. JAVA\_HOME becomes java.home).  The goal of normalization is to make downstream consumers of those metrics capable of receiving property names consistently, regardless of how they are set on the monitored application (--spring.application.name or SPRING\_APPLICATION\_NAME would always yield spring.application.name). |

Below is a sample of the data published to the channel in JSON format by the following command:

java -jar time-source.jar \

--spring.cloud.stream.bindings.applicationMetrics.destination=someMetrics \

--spring.cloud.stream.metrics.properties=spring.application\*\* \

--spring.metrics.export.includes=integration.channel.input\*\*,integration.channel.output\*\*

The resulting JSON is:

{

"name":"time-source",

"metrics":[

{

"name":"integration.channel.output.errorRate.mean",

"value":0.0,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.errorRate.max",

"value":0.0,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.errorRate.min",

"value":0.0,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.errorRate.stdev",

"value":0.0,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.errorRate.count",

"value":0.0,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.sendCount",

"value":6.0,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.sendRate.mean",

"value":0.994885872292989,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.sendRate.max",

"value":1.006247080013156,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.sendRate.min",

"value":1.0012035220116378,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.sendRate.stdev",

"value":6.505181111084848E-4,

"timestamp":"2017-04-11T16:56:35.790Z"

},

{

"name":"integration.channel.output.sendRate.count",

"value":6.0,

"timestamp":"2017-04-11T16:56:35.790Z"

}

],

"createdTime":"2017-04-11T20:56:35.790Z",

"properties":{

"spring.application.name":"time-source",

"spring.application.index":"0"

}

}

## 38. Samples

For Spring Cloud Stream samples, please refer to the [spring-cloud-stream-samples](https://github.com/spring-cloud/spring-cloud-stream-samples) repository on GitHub.

## 38.1 Deploying Stream applications on CloudFoundry

On CloudFoundry services are usually exposed via a special environment variable called [VCAP\_SERVICES](https://docs.cloudfoundry.org/devguide/deploy-apps/environment-variable.html#VCAP-SERVICES).

When configuring your binder connections, you can use the values from an environment variable as explained on the [dataflow cloudfoundry server](https://docs.spring.io/spring-cloud-dataflow-server-cloudfoundry/docs/current-SNAPSHOT/reference/htmlsingle/#getting-started-ups) docs.

# Part VI. Binder Implementations

## 39. Apache Kafka Binder

## 39.1 Usage

To use Apache Kafka binder all you need is to add spring-cloud-stream-binder-kafka as a dependency to your Spring Cloud Stream application. Below is a Maven example:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-binder-kafka</artifactId>

</dependency>

Alternatively, you can also use the Spring Cloud Stream Kafka Starter.

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-stream-kafka</artifactId>

</dependency>

## 39.2 Apache Kafka Binder Overview

A simplified diagram of how the Apache Kafka binder operates can be seen below.

**Figure 39.1. Kafka Binder**

The Apache Kafka Binder implementation maps each destination to an Apache Kafka topic. The consumer group maps directly to the same Apache Kafka concept. Partitioning also maps directly to Apache Kafka partitions as well.

The binder currently uses the Apache Kafka kafka-clients 1.0.0 jar and is designed to be used with a broker at least that version. This client can communicate with older brokers (refer to the Kafka documentation), but certain features may not be available. For example, with versions earlier than 0.11.x.x, native headers are not supported. Also, 0.11.x.x does not support the autoAddPartitions property.

## 39.3 Configuration Options

This section contains the configuration options used by the Apache Kafka binder.

For common configuration options and properties pertaining to binder, refer to the [core documentation](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__configuration_options.html#binding-properties).

### 39.3.1 Kafka Binder Properties

spring.cloud.stream.kafka.binder.brokers

A list of brokers to which the Kafka binder will connect.

Default: localhost.

spring.cloud.stream.kafka.binder.defaultBrokerPort

brokers allows hosts specified with or without port information (e.g., host1,host2:port2). This sets the default port when no port is configured in the broker list.

Default: 9092.

spring.cloud.stream.kafka.binder.configuration

Key/Value map of client properties (both producers and consumer) passed to all clients created by the binder. Due to the fact that these properties will be used by both producers and consumers, usage should be restricted to common properties, for example, security settings.

Default: Empty map.

spring.cloud.stream.kafka.binder.headers

The list of custom headers that will be transported by the binder. Only required when communicating with older applications (⇐ 1.3.x) with a kafka-clientsversion < 0.11.0.0; newer versions support headers natively.

Default: empty.

spring.cloud.stream.kafka.binder.healthTimeout

The time to wait to get partition information in seconds; default 60. Health will report as down if this timer expires.

Default: 10.

spring.cloud.stream.kafka.binder.requiredAcks

The number of required acks on the broker. See the Kafka documentation for the producer acks property.

Default: 1.

spring.cloud.stream.kafka.binder.minPartitionCount

Effective only if autoCreateTopics or autoAddPartitions is set. The global minimum number of partitions that the binder will configure on topics on which it produces/consumes data. It can be superseded by the partitionCount setting of the producer or by the value of instanceCount \* concurrency settings of the producer (if either is larger).

Default: 1.

spring.cloud.stream.kafka.binder.replicationFactor

The replication factor of auto-created topics if autoCreateTopics is active. Can be overriden on each binding.

Default: 1.

spring.cloud.stream.kafka.binder.autoCreateTopics

If set to true, the binder will create new topics automatically. If set to false, the binder will rely on the topics being already configured. In the latter case, if the topics do not exist, the binder will fail to start. Of note, this setting is independent of the auto.topic.create.enable setting of the broker and it does not influence it: if the server is set to auto-create topics, they may be created as part of the metadata retrieval request, with default broker settings.

Default: true.

spring.cloud.stream.kafka.binder.autoAddPartitions

If set to true, the binder will create add new partitions if required. If set to false, the binder will rely on the partition size of the topic being already configured. If the partition count of the target topic is smaller than the expected value, the binder will fail to start.

Default: false.

spring.cloud.stream.kafka.binder.transaction.transactionIdPrefix

Enable transactions in the binder; see transaction.id in the Kafka documentation and [Transactions](https://docs.spring.io/spring-kafka/reference/html/_reference.html#transactions) in the spring-kafka documentation. When transactions are enabled, individual producer properties are ignored and all producers use the spring.cloud.stream.kafka.binder.transaction.producer.\*properties.

Default null (no transactions)

spring.cloud.stream.kafka.binder.transaction.producer.\*

Global producer properties for producers in a transactional binder. See spring.cloud.stream.kafka.binder.transaction.transactionIdPrefix and [Section 39.3.3, “Kafka Producer Properties”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__apache_kafka_binder.html#kafka-producer-properties) and the general producer properties supported by all binders.

Default: See individual producer properties.

spring.cloud.stream.kafka.binder.headerMapperBeanName

The bean name of a KafkaHeaderMapper used for mapping spring-messaging headers to/from Kafka headers. Use this, for example, if you wish to customize the trusted packages in a DefaultKafkaHeaderMapper, which uses JSON deserialization for the headers.

Default: none.

### 39.3.2 Kafka Consumer Properties

The following properties are available for Kafka consumers only and must be prefixed with spring.cloud.stream.kafka.bindings.<channelName>.consumer..

admin.configuration

A Map of Kafka topic properties used when provisioning topics. e.g. spring.cloud.stream.kafka.bindings.input.consumer.admin.configuration.message.format.version=0.9.0.0

Default: none.

admin.replicas-assignment

A Map<Integer, List<Integer>> of replica assignments, with the key being the partition and value the assignments. Used when provisioning new topics. See NewTopic javadocs in the kafka-clients jar.

Default: none.

admin.replication-factor

The replication factor to use when provisioning topics; overrides the binder-wide setting. Ignored if replicas-assignments is present.

Default: none (the binder-wide default of 1 is used).

autoRebalanceEnabled

When true, topic partitions will be automatically rebalanced between the members of a consumer group. When false, each consumer will be assigned a fixed set of partitions based on spring.cloud.stream.instanceCount and spring.cloud.stream.instanceIndex. This requires both spring.cloud.stream.instanceCount and spring.cloud.stream.instanceIndex properties to be set appropriately on each launched instance. The property spring.cloud.stream.instanceCount must typically be greater than 1 in this case.

Default: true.

ackEachRecord

When autoCommitOffset is true, whether to commit the offset after each record is processed. By default, offsets are committed after all records in the batch of records returned by consumer.poll() have been processed. The number of records returned by a poll can be controlled with the max.poll.recods Kafka property, set via the consumer configuration property. Setting this to true may cause a degradation in performance, but reduces the likelihood of redelivered records when a failure occurs. Also see the binder requiredAcks property, which also affects the performance of committing offsets.

Default: false.

autoCommitOffset

Whether to autocommit offsets when a message has been processed. If set to false, a header with the key kafka\_acknowledgment of the type org.springframework.kafka.support.Acknowledgment header will be present in the inbound message. Applications may use this header for acknowledging messages. See the examples section for details. When this property is set to false, Kafka binder will set the ack mode to org.springframework.kafka.listener.AbstractMessageListenerContainer.AckMode.MANUAL and the application is responsible for acknowledging records. Also see ackEachRecord.

Default: true.

autoCommitOnError

Effective only if autoCommitOffset is set to true. If set to false it suppresses auto-commits for messages that result in errors, and will commit only for successful messages, allows a stream to automatically replay from the last successfully processed message, in case of persistent failures. If set to true, it will always auto-commit (if auto-commit is enabled). If not set (default), it effectively has the same value as enableDlq, auto-committing erroneous messages if they are sent to a DLQ, and not committing them otherwise.

Default: not set.

resetOffsets

Whether to reset offsets on the consumer to the value provided by startOffset.

Default: false.

startOffset

The starting offset for new groups. Allowed values: earliest, latest. If the consumer group is set explicitly for the consumer 'binding' (via spring.cloud.stream.bindings.<channelName>.group), then 'startOffset' is set to earliest; otherwise it is set to latest for the anonymous consumer group. Also see resetOffsets.

Default: null (equivalent to earliest).

enableDlq

When set to true, it will send enable DLQ behavior for the consumer. By default, messages that result in errors will be forwarded to a topic named error.<destination>.<group>. The DLQ topic name can be configurable via the property dlqName. This provides an alternative option to the more common Kafka replay scenario for the case when the number of errors is relatively small and replaying the entire original topic may be too cumbersome. See [Section 39.6, “Dead-Letter Topic Processing”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__apache_kafka_binder.html#kafka-dlq-processing) processing for more information. Starting with version 2.0, messages sent to the DLQ topic are enhanced with the following headers: x-original-topic, x-exception-message and x-exception-stacktrace as byte[].

Default: false.

configuration

Map with a key/value pair containing generic Kafka consumer properties.

Default: Empty map.

dlqName

The name of the DLQ topic to receive the error messages.

Default: null (If not specified, messages that result in errors will be forwarded to a topic named error.<destination>.<group>).

dlqProducerProperties

Using this, dlq specific producer properties can be set. All the properties available through kafka producer properties can be set through this property.

Default: Default Kafka producer properties.

standardHeaders

Indicates which standard headers are populated by the inbound channel adapter. none, id, timestamp or both. Useful if using native deserialization and the first component to receive a message needs an id (such as an aggregator that is configured to use a JDBC message store).

Default: none

converterBeanName

The name of a bean that implements RecordMessageConverter; used in the inbound channel adapter to replace the default MessagingMessageConverter.

Default: null

idleEventInterval

The interval, in milliseconds between events indicating that no messages have recently been received. Use an ApplicationListener<ListenerContainerIdleEvent> to receive these events. See [the section called “Example: Pausing and Resuming the Consumer”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__apache_kafka_binder.html#pause-resume) for a usage example.

Default: 30000

### 39.3.3 Kafka Producer Properties

The following properties are available for Kafka producers only and must be prefixed with spring.cloud.stream.kafka.bindings.<channelName>.producer..

admin.configuration

A Map of Kafka topic properties used when provisioning new topics. e.g. spring.cloud.stream.kafka.bindings.input.consumer.admin.configuration.message.format.version=0.9.0.0

Default: none.

admin.replicas-assignment

A Map<Integer, List<Integer>> of replica assignments, with the key being the partition and value the assignments. Used when provisioning new topics. See NewTopic javadocs in the kafka-clients jar.

Default: none.

admin.replication-factor

The replication factor to use when provisioning new topics; overrides the binder-wide setting. Ignored if replicas-assignments is present.

Default: none (the binder-wide default of 1 is used).

bufferSize

Upper limit, in bytes, of how much data the Kafka producer will attempt to batch before sending.

Default: 16384.

sync

Whether the producer is synchronous.

Default: false.

batchTimeout

How long the producer will wait before sending in order to allow more messages to accumulate in the same batch. (Normally the producer does not wait at all, and simply sends all the messages that accumulated while the previous send was in progress.) A non-zero value may increase throughput at the expense of latency.

Default: 0.

messageKeyExpression

A SpEL expression evaluated against the outgoing message used to populate the key of the produced Kafka message. For example headers['myKey']; the payload cannot be used because by the time this expression is evaluated, the payload is already in the form of a byte[].

Default: none.

headerPatterns

A comma-delimited list of simple patterns to match spring-messaging headers to be mapped to the kafka Headers in the ProducerRecord. Patterns can begin or end with the wildcard character (asterisk). Patterns can be negated by prefixing with !; matching stops after the first match (positive or negative). For example !foo,fo\* will pass fox but not foo. id and timestamp are never mapped.

Default: \* (all headers - except the id and timestamp)

configuration

Map with a key/value pair containing generic Kafka producer properties.

Default: Empty map.

|  |
| --- |
| [Note] |
| The Kafka binder will use the partitionCount setting of the producer as a hint to create a topic with the given partition count (in conjunction with the minPartitionCount, the maximum of the two being the value being used). Exercise caution when configuring both minPartitionCount for a binder and partitionCount for an application, as the larger value will be used. If a topic already exists with a smaller partition count and autoAddPartitionsis disabled (the default), then the binder will fail to start. If a topic already exists with a smaller partition count and autoAddPartitions is enabled, new partitions will be added. If a topic already exists with a larger number of partitions than the maximum of (minPartitionCount and partitionCount), the existing partition count will be used. |

### 39.3.4 Usage examples

In this section, we illustrate the use of the above properties for specific scenarios.

#### Example: Setting autoCommitOffset false and relying on manual acking.

This example illustrates how one may manually acknowledge offsets in a consumer application.

This example requires that spring.cloud.stream.kafka.bindings.input.consumer.autoCommitOffset is set to false. Use the corresponding input channel name for your example.

@SpringBootApplication

@EnableBinding(Sink.class)

public class ManuallyAcknowdledgingConsumer {

public static void main(String[] args) {

SpringApplication.run(ManuallyAcknowdledgingConsumer.class, args);

}

@StreamListener(Sink.INPUT)

public void process(Message<?> message) {

Acknowledgment acknowledgment = message.getHeaders().get(KafkaHeaders.ACKNOWLEDGMENT, Acknowledgment.class);

if (acknowledgment != null) {

System.out.println("Acknowledgment provided");

acknowledgment.acknowledge();

}

}

}

#### Example: security configuration

Apache Kafka 0.9 supports secure connections between client and brokers. To take advantage of this feature, follow the guidelines in the [Apache Kafka Documentation](https://kafka.apache.org/090/documentation.html#security_configclients)as well as the Kafka 0.9 [security guidelines from the Confluent documentation](http://docs.confluent.io/2.0.0/kafka/security.html). Use the spring.cloud.stream.kafka.binder.configuration option to set security properties for all clients created by the binder.

For example, for setting security.protocol to SASL\_SSL, set:

spring.cloud.stream.kafka.binder.configuration.security.protocol=SASL\_SSL

All the other security properties can be set in a similar manner.

When using Kerberos, follow the instructions in the [reference documentation](https://kafka.apache.org/090/documentation.html#security_sasl_clientconfig) for creating and referencing the JAAS configuration.

Spring Cloud Stream supports passing JAAS configuration information to the application using a JAAS configuration file and using Spring Boot properties.

##### Using JAAS configuration files

The JAAS, and (optionally) krb5 file locations can be set for Spring Cloud Stream applications by using system properties. Here is an example of launching a Spring Cloud Stream application with SASL and Kerberos using a JAAS configuration file:

java -Djava.security.auth.login.config=/path.to/kafka\_client\_jaas.conf -jar log.jar \

--spring.cloud.stream.kafka.binder.brokers=secure.server:9092 \

--spring.cloud.stream.bindings.input.destination=stream.ticktock \

--spring.cloud.stream.kafka.binder.configuration.security.protocol=SASL\_PLAINTEXT

##### Using Spring Boot properties

As an alternative to having a JAAS configuration file, Spring Cloud Stream provides a mechanism for setting up the JAAS configuration for Spring Cloud Stream applications using Spring Boot properties.

The following properties can be used for configuring the login context of the Kafka client.

spring.cloud.stream.kafka.binder.jaas.loginModule

The login module name. Not necessary to be set in normal cases.

Default: com.sun.security.auth.module.Krb5LoginModule.

spring.cloud.stream.kafka.binder.jaas.controlFlag

The control flag of the login module.

Default: required.

spring.cloud.stream.kafka.binder.jaas.options

Map with a key/value pair containing the login module options.

Default: Empty map.

Here is an example of launching a Spring Cloud Stream application with SASL and Kerberos using Spring Boot configuration properties:

java --spring.cloud.stream.kafka.binder.brokers=secure.server:9092 \

--spring.cloud.stream.bindings.input.destination=stream.ticktock \

--spring.cloud.stream.kafka.binder.autoCreateTopics=false \

--spring.cloud.stream.kafka.binder.configuration.security.protocol=SASL\_PLAINTEXT \

--spring.cloud.stream.kafka.binder.jaas.options.useKeyTab=true \

--spring.cloud.stream.kafka.binder.jaas.options.storeKey=true \

--spring.cloud.stream.kafka.binder.jaas.options.keyTab=/etc/security/keytabs/kafka\_client.keytab \

--spring.cloud.stream.kafka.binder.jaas.options.principal=kafka-client-1@EXAMPLE.COM

This represents the equivalent of the following JAAS file:

KafkaClient {

com.sun.security.auth.module.Krb5LoginModule required

useKeyTab=true

storeKey=true

keyTab="/etc/security/keytabs/kafka\_client.keytab"

principal="kafka-client-1@EXAMPLE.COM";

};

If the topics required already exist on the broker, or will be created by an administrator, autocreation can be turned off and only client JAAS properties need to be sent.

|  |
| --- |
| [Note] |
| Do not mix JAAS configuration files and Spring Boot properties in the same application. If the -Djava.security.auth.login.config system property is already present, Spring Cloud Stream will ignore the Spring Boot properties. |
| [Note] |
| Exercise caution when using the autoCreateTopics and autoAddPartitions if using Kerberos. Usually applications may use principals that do not have administrative rights in Kafka and Zookeeper, and relying on Spring Cloud Stream to create/modify topics may fail. In secure environments, we strongly recommend creating topics and managing ACLs administratively using Kafka tooling. | |

#### Example: Pausing and Resuming the Consumer

If you wish to suspend consumption, but not cause a partition rebalance, you can pause and resume the consumer. This is facilitated by adding the Consumer as a parameter to your @StreamListener. To resume, you need an ApplicationListener for ListenerContainerIdleEvent s; the frequency at which events are published is controlled by the idleEventInterval property. Since the consumer is not thread-safe, you must call these methods on the calling thread.

The following simple application shows how to pause and resume.

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** Application {

**public** **static** **void** main(String[] args) {

SpringApplication.run(Application.**class**, args);

}

*@StreamListener(Sink.INPUT)*

**public** **void** in(String in, *@Header(KafkaHeaders.CONSUMER)* Consumer<?, ?> consumer) {

System.out.println(in);

consumer.pause(Collections.singleton(**new** TopicPartition("myTopic", 0)));

}

*@Bean*

**public** ApplicationListener<ListenerContainerIdleEvent> idleListener() {

**return** event -> {

System.out.println(event);

**if** (event.getConsumer().paused().size() > 0) {

event.getConsumer().resume(event.getConsumer().paused());

}

};

}

}

## 39.4 Error Channels

Starting with version 1.3, the binder unconditionally sends exceptions to an error channel for each consumer destination, and can be configured to send async producer send failures to an error channel too. See [the section called “Message Channel Binders and Error Channels”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__programming_model.html#binder-error-channels) for more information.

The payload of the ErrorMessage for a send failure is a KafkaSendFailureException with properties:

* failedMessage - the spring-messaging Message<?> that failed to be sent.
* record - the raw ProducerRecord that was created from the failedMessage

There is no automatic handling of producer exceptions (such as sending to a [Dead-Letter queue](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__apache_kafka_binder.html#kafka-dlq-processing)); you can consume these exceptions with your own Spring Integration flow.

## 39.5 Kafka Metrics

Kafka binder module exposes the following metrics:

spring.cloud.stream.binder.kafka.someGroup.someTopic.lag - this metric indicates how many messages have not been yet consumed from given binder’s topic by given consumer group. For example if the value of the metric spring.cloud.stream.binder.kafka.myGroup.myTopic.lag is 1000, then consumer group myGroup has 1000 messages to waiting to be consumed from topic myTopic. This metric is particularly useful to provide auto-scaling feedback to PaaS platform of your choice.

## 39.6 Dead-Letter Topic Processing

Because it can’t be anticipated how users would want to dispose of dead-lettered messages, the framework does not provide any standard mechanism to handle them. If the reason for the dead-lettering is transient, you may wish to route the messages back to the original topic. However, if the problem is a permanent issue, that could cause an infinite loop. The following spring-boot application is an example of how to route those messages back to the original topic, but moves them to a third "parking lot" topic after three attempts. The application is simply another spring-cloud-stream application that reads from the dead-letter topic. It terminates when no messages are received for 5 seconds.

The examples assume the original destination is so8400out and the consumer group is so8400.

There are several considerations.

* Consider only running the rerouting when the main application is not running. Otherwise, the retries for transient errors will be used up very quickly.
* Alternatively, use a two-stage approach - use this application to route to a third topic, and another to route from there back to the main topic.
* Since this technique uses a message header to keep track of retries, it won’t work with headerMode=raw. In that case, consider adding some data to the payload (that can be ignored by the main application).
* x-retries has to be added to the headers property spring.cloud.stream.kafka.binder.headers=x-retries on both this, and the main application so that the header is transported between the applications.
* Since kafka is publish/subscribe, replayed messages will be sent to each consumer group, even those that successfully processed a message the first time around.

**application.properties.**

spring.cloud.stream.bindings.input.group=so8400replay

spring.cloud.stream.bindings.input.destination=error.so8400out.so8400

spring.cloud.stream.bindings.output.destination=so8400out

spring.cloud.stream.bindings.output.producer.partitioned=true

spring.cloud.stream.bindings.parkingLot.destination=so8400in.parkingLot

spring.cloud.stream.bindings.parkingLot.producer.partitioned=true

spring.cloud.stream.kafka.binder.configuration.auto.offset.reset=earliest

spring.cloud.stream.kafka.binder.headers=x-retries

**Application.**

*@SpringBootApplication*

*@EnableBinding(TwoOutputProcessor.class)*

**public** **class** ReRouteDlqKApplication **implements** CommandLineRunner {

**private** **static** **final** String X\_RETRIES\_HEADER = "x-retries";

**public** **static** **void** main(String[] args) {

SpringApplication.run(ReRouteDlqKApplication.**class**, args).close();

}

**private** **final** AtomicInteger processed = **new** AtomicInteger();

*@Autowired*

**private** MessageChannel parkingLot;

*@StreamListener(Processor.INPUT)*

*@SendTo(Processor.OUTPUT)*

**public** Message<?> reRoute(Message<?> failed) {

processed.incrementAndGet();

Integer retries = failed.getHeaders().get(X\_RETRIES\_HEADER, Integer.**class**);

**if** (retries == null) {

System.out.println("First retry for " + failed);

**return** MessageBuilder.fromMessage(failed)

.setHeader(X\_RETRIES\_HEADER, **new** Integer(1))

.setHeader(BinderHeaders.PARTITION\_OVERRIDE,

failed.getHeaders().get(KafkaHeaders.RECEIVED\_PARTITION\_ID))

.build();

}

**else** **if** (retries.intValue() < 3) {

System.out.println("Another retry for " + failed);

**return** MessageBuilder.fromMessage(failed)

.setHeader(X\_RETRIES\_HEADER, **new** Integer(retries.intValue() + 1))

.setHeader(BinderHeaders.PARTITION\_OVERRIDE,

failed.getHeaders().get(KafkaHeaders.RECEIVED\_PARTITION\_ID))

.build();

}

**else** {

System.out.println("Retries exhausted for " + failed);

parkingLot.send(MessageBuilder.fromMessage(failed)

.setHeader(BinderHeaders.PARTITION\_OVERRIDE,

failed.getHeaders().get(KafkaHeaders.RECEIVED\_PARTITION\_ID))

.build());

}

**return** null;

}

*@Override*

**public** **void** run(String... args) **throws** Exception {

**while** (true) {

**int** count = **this**.processed.get();

Thread.sleep(5000);

**if** (count == **this**.processed.get()) {

System.out.println("Idle, terminating");

**return**;

}

}

}

**public** **interface** TwoOutputProcessor **extends** Processor {

*@Output("parkingLot")*

MessageChannel parkingLot();

}

}

## 39.7 Partitioning with the Kafka Binder

Apache Kafka supports topic partitioning natively.

Sometimes it is advantageous to send data to specific partitions, for example when you want to strictly order message processing - all messages for a particular customer should go to the same partition.

The following illustrates how to configure the producer and consumer side:

*@SpringBootApplication*

*@EnableBinding(Source.class)*

**public** **class** KafkaPartitionProducerApplication {

**private** **static** **final** Random RANDOM = **new** Random(System.currentTimeMillis());

**private** **static** **final** String[] data = **new** String[] {

"foo1", "bar1", "qux1",

"foo2", "bar2", "qux2",

"foo3", "bar3", "qux3",

"foo4", "bar4", "qux4",

};

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(KafkaPartitionProducerApplication.**class**)

.web(false)

.run(args);

}

*@InboundChannelAdapter(channel = Source.OUTPUT, poller = @Poller(fixedRate = "5000"))*

**public** Message<?> generate() {

String value = data[RANDOM.nextInt(data.length)];

System.out.println("Sending: " + value);

**return** MessageBuilder.withPayload(value)

.setHeader("partitionKey", value)

.build();

}

}

**application.yml.**

spring:

cloud:

stream:

bindings:

output:

destination: partitioned.topic

producer:

partitioned: **true**

partition-key-expression: headers['partitionKey'**]**

partition-count: 12

|  |  |  |
| --- | --- | --- |
| [Important] | | **Important** |
| The topic must be provisioned to have enough partitions to achieve the desired concurrency for all consumer groups. The above configuration will support up to 12 consumer instances (or 6 if their concurrency is 2, etc.). It is generally best to "over provision" the partitions to allow for future increases in consumers and/or concurrency. |
| [Note] |
| The above configuration uses the default partitioning (key.hashCode() % partitionCount). This may or may not provide a suitably balanced algorithm, depending on the key values; you can override this default by using the partitionSelectorExpression or partitionSelectorClass properties. | | |

Since partitions are natively handled by Kafka, no special configuration is needed on the consumer side. Kafka will allocate partitions across the instances.

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** KafkaPartitionConsumerApplication {

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(KafkaPartitionConsumerApplication.**class**)

.web(false)

.run(args);

}

*@StreamListener(Sink.INPUT)*

**public** **void** listen(*@Payload* String in, *@Header(KafkaHeaders.RECEIVED\_PARTITION\_ID)* **int** partition) {

System.out.println(in + " received from partition " + partition);

}

}

**application.yml.**

spring:

cloud:

stream:

bindings:

input:

destination: partitioned.topic

group: myGroup

You can add instances as needed; Kafka will rebalance the partition allocations. If the instance count (or instance count \* concurrency) exceeds the number of partitions, some consumers will be idle.

## 40. Apache Kafka Streams Binder

## 40.1 Usage

For using the Kafka Streams binder, you just need to add it to your Spring Cloud Stream application, using the following Maven coordinates:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-binder-kafka-streams</artifactId>

</dependency>

## 40.2 Kafka Streams Binder Overview

Spring Cloud Stream’s Apache Kafka support also includes a binder implementation designed explicitly for Apache Kafka Streams binding. With this native integration, a Spring Cloud Stream "processor" application can directly use the [Apache Kafka Streams](https://kafka.apache.org/documentation/streams/developer-guide) APIs in the core business logic.

Kafka Streams binder implementation builds on the foundation provided by the [Kafka Streams in Spring Kafka](https://docs.spring.io/spring-kafka/reference/html/_reference.html#kafka-streams) project.

As part of this native integration, the high-level [Streams DSL](https://docs.confluent.io/current/streams/developer-guide/dsl-api.html) provided by the Kafka Streams API is available for use in the business logic, too.

An early version of the [Processor API](https://docs.confluent.io/current/streams/developer-guide/processor-api.html) support is available as well.

As noted early-on, Kafka Streams support in Spring Cloud Stream strictly only available for use in the Processor model. A model in which the messages read from an inbound topic, business processing can be applied, and the transformed messages can be written to an outbound topic. It can also be used in Processor applications with a no-outbound destination.

### 40.2.1 Streams DSL

This application consumes data from a Kafka topic (e.g., words), computes word count for each unique word in a 5 seconds time window, and the computed results are sent to a downstream topic (e.g., counts) for further processing.

@SpringBootApplication

@EnableBinding(KStreamProcessor.class)

public class WordCountProcessorApplication {

@StreamListener("input")

@SendTo("output")

public KStream<?, WordCount> process(KStream<?, String> input) {

return input

.flatMapValues(value -> Arrays.asList(value.toLowerCase().split("\\W+")))

.groupBy((key, value) -> value)

.windowedBy(TimeWindows.of(5000))

.count(Materialized.as("WordCounts-multi"))

.toStream()

.map((key, value) -> new KeyValue<>(null, new WordCount(key.key(), value, new Date(key.window().start()), new Date(key.window().end()))));

}

public static void main(String[] args) {

SpringApplication.run(WordCountProcessorApplication.class, args);

}

Once built as a uber-jar (e.g., wordcount-processor.jar), you can run the above example like the following.

java -jar wordcount-processor.jar --spring.cloud.stream.bindings.input.destination=words --spring.cloud.stream.bindings.output.destination=counts

This application will consume messages from the Kafka topic words and the computed results are published to an output topic counts.

Spring Cloud Stream will ensure that the messages from both the incoming and outgoing topics are automatically bound as KStream objects. As a developer, you can exclusively focus on the business aspects of the code, i.e. writing the logic required in the processor. Setting up the Streams DSL specific configuration required by the Kafka Streams infrastructure is automatically handled by the framework.

## 40.3 Configuration Options

This section contains the configuration options used by the Kafka Streams binder.

For common configuration options and properties pertaining to binder, refer to the [core documentation](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__configuration_options.html#binding-properties).

### 40.3.1 Kafka Streams Properties

The following properties are available at the binder level and must be prefixed with spring.cloud.stream.kafka.binder. literal.

configuration

Map with a key/value pair containing properties pertaining to Apache Kafka Streams API. This property must be prefixed with spring.cloud.stream.kafka.streams.binder.. Following are some examples of using this property.

spring.cloud.stream.kafka.streams.binder.configuration.default.key.serde=org.apache.kafka.common.serialization.Serdes$StringSerde

spring.cloud.stream.kafka.streams.binder.configuration.default.value.serde=org.apache.kafka.common.serialization.Serdes$StringSerde

spring.cloud.stream.kafka.streams.binder.configuration.commit.interval.ms=1000

For more information about all the properties that may go into streams configuration, see StreamsConfig JavaDocs in Apache Kafka Streams docs.

brokers

Broker URL

Default: localhost

zkNodes

Zookeeper URL

Default: localhost

serdeError

Deserialization error handler type. Possible values are - logAndContinue, logAndFail or sendToDlq

Default: logAndFail

applicationId

Application ID for all the stream configurations in the current application context. You can override the application id for an individual StreamListener method using the group property on the binding. You have to ensure that you are using the same group name for all input bindings in the case of multiple inputs on the same methods.

Default: default

The following properties are only available for Kafka Streams producers and must be prefixed with spring.cloud.stream.kafka.streams.bindings.<binding name>.producer. literal.

keySerde

key serde to use

Default: none.

valueSerde

value serde to use

Default: none.

useNativeEncoding

flag to enable native encoding

Default: false.

The following properties are only available for Kafka Streams consumers and must be prefixed with spring.cloud.stream.kafka.streams.bindings.<binding name>.consumer. literal.

keySerde

key serde to use

Default: none.

valueSerde

value serde to use

Default: none.

materializedAs

state store to materialize when using incoming KTable types

Default: none.

useNativeDecoding

flag to enable native decoding

Default: false.

dlqName

DLQ topic name.

Default: none.

### 40.3.2 TimeWindow properties:

Windowing is an important concept in stream processing applications. Following properties are available to configure time-window computations.

spring.cloud.stream.kafka.streams.timeWindow.length

When this property is given, you can autowire a TimeWindows bean into the application. The value is expressed in milliseconds.

Default: none.

spring.cloud.stream.kstream.timeWindow.advanceBy

Value is given in milliseconds.

Default: none.

## 40.4 Multiple Input Bindings

For use cases that requires multiple incoming KStream objects or a combination of KStream and KTable objects, the Kafka Streams binder provides multiple bindings support.

Let’s see it in action.

### 40.4.1 Multiple Input Bindings as a Sink

@EnableBinding(KStreamKTableBinding.class)

.....

.....

@StreamListener

public void process(@Input("inputStream") KStream<String, PlayEvent> playEvents,

@Input("inputTable") KTable<Long, Song> songTable) {

....

....

}

interface KStreamKTableBinding {

@Input("inputStream")

KStream<?, ?> inputStream();

@Input("inputTable")

KTable<?, ?> inputTable();

}

In the above example, the application is written as a sink, i.e. there are no output bindings and the application has to decide concerning downstream processing. When you write applications in this style, you might want to send the information downstream or store them in a state store (See below for Queryable State Stores).

In the case of incoming KTable, if you want to materialize the computations to a state store, you have to express it through the following property.

spring.cloud.stream.kafka.streams.bindings.inputTable.consumer.materializedAs: all-songs

### 40.4.2 Multiple Input Bindings as a Processor

@EnableBinding(KStreamKTableBinding.class)

....

....

@StreamListener

@SendTo("output")

public KStream<String, Long> process(@Input("input") KStream<String, Long> userClicksStream,

@Input("inputTable") KTable<String, String> userRegionsTable) {

....

....

}

interface KStreamKTableBinding extends KafkaStreamsProcessor {

@Input("inputX")

KTable<?, ?> inputTable();

}

## 40.5 Multiple Output Bindings (aka Branching)

Kafka Streams allow outbound data to be split into multiple topics based on some predicates. The Kafka Streams binder provides support for this feature without compromising the programming model exposed through StreamListener in the end user application.

You can write the application in the usual way as demonstrated above in the word count example. However, when using the branching feature, you are required to do a few things. First, you need to make sure that your return type is KStream[] instead of a regular KStream. Second, you need to use the SendTo annotation containing the output bindings in the order (see example below). For each of these output bindings, you need to configure destination, content-type etc., complying with the standard Spring Cloud Stream expectations.

Here is an example:

@EnableBinding(KStreamProcessorWithBranches.class)

@EnableAutoConfiguration

public static class WordCountProcessorApplication {

@Autowired

private TimeWindows timeWindows;

@StreamListener("input")

@SendTo({"output1","output2","output3})

public KStream<?, WordCount>[] process(KStream<Object, String> input) {

Predicate<Object, WordCount> isEnglish = (k, v) -> v.word.equals("english");

Predicate<Object, WordCount> isFrench = (k, v) -> v.word.equals("french");

Predicate<Object, WordCount> isSpanish = (k, v) -> v.word.equals("spanish");

return input

.flatMapValues(value -> Arrays.asList(value.toLowerCase().split("\\W+")))

.groupBy((key, value) -> value)

.windowedBy(timeWindows)

.count(Materialized.as("WordCounts-1"))

.toStream()

.map((key, value) -> new KeyValue<>(null, new WordCount(key.key(), value, new Date(key.window().start()), new Date(key.window().end()))))

.branch(isEnglish, isFrench, isSpanish);

}

interface KStreamProcessorWithBranches {

@Input("input")

KStream<?, ?> input();

@Output("output1")

KStream<?, ?> output1();

@Output("output2")

KStream<?, ?> output2();

@Output("output3")

KStream<?, ?> output3();

}

}

Properties:

spring.cloud.stream.bindings.output1.contentType: application/json

spring.cloud.stream.bindings.output2.contentType: application/json

spring.cloud.stream.bindings.output3.contentType: application/json

spring.cloud.stream.kafka.streams.binder.configuration.commit.interval.ms: 1000

spring.cloud.stream.kafka.streams.binder.configuration:

default.key.serde: org.apache.kafka.common.serialization.Serdes$StringSerde

default.value.serde: org.apache.kafka.common.serialization.Serdes$StringSerde

spring.cloud.stream.bindings.output1:

destination: foo

producer:

headerMode: raw

spring.cloud.stream.bindings.output2:

destination: bar

producer:

headerMode: raw

spring.cloud.stream.bindings.output3:

destination: fox

producer:

headerMode: raw

spring.cloud.stream.bindings.input:

destination: words

consumer:

headerMode: raw

## 40.6 Message Conversion

Similar to message-channel based binder applications, the Kafka Streams binder adapts to the out-of-the-box content-type conversions without any compromise.

It is typical for Kafka Streams operations to know the type of SerDe’s used to transform the key and value correctly. Therefore, it may be more natural to rely on the SerDe facilities provided by the Apache Kafka Streams library itself at the inbound and outbound conversions rather than using the content-type conversions offered by the framework. On the other hand, you might be already familiar with the content-type conversion patterns provided by the framework, and that, you’d like to continue using for inbound and outbound conversions.

Both the options are supported in the Kafka Streams binder implementation.

### 40.6.1 Outbound serialization

If native encoding is disabled (which is the default), then the framework will convert the message using the contentType set by the user (otherwise, the default application/json will be applied). It will ignore any SerDe set on the outbound in this case for outbound serialization.

Here is the property to set the contentType on the outbound.

spring.cloud.stream.bindings.output.contentType: application/json

Here is the property to enable native encoding.

spring.cloud.stream.bindings.output.nativeEncoding: true

If native encoding is enabled on the output binding (user has to enable it as above explicitly), then the framework will skip any form of automatic message conversion on the outbound. In that case, it will switch to the Serde set by the user. The valueSerde property set on the actual output binding will be used. Here is an example.

spring.cloud.stream.kafka.streams.bindings.output.producer.valueSerde: org.apache.kafka.common.serialization.Serdes$StringSerde

If this property is not set, then it will use the "default" SerDe: spring.cloud.stream.kafka.streams.binder.configuration.default.value.serde.

It is worth to mention that Kafka Streams binder does not serialize the keys on outbound - it simply relies on Kafka itself. Therefore, you either have to specify the keySerde property on the binding or it will default to the application-wide common keySerde.

Binding level key serde:

spring.cloud.stream.kafka.streams.bindings.output.producer.keySerde

Common Key serde:

spring.cloud.stream.kafka.streams.binder.configuration.default.key.serde

If branching is used, then you need to use multiple output bindings. For example,

interface KStreamProcessorWithBranches {

@Input("input")

KStream<?, ?> input();

@Output("output1")

KStream<?, ?> output1();

@Output("output2")

KStream<?, ?> output2();

@Output("output3")

KStream<?, ?> output3();

}

If nativeEncoding is set, then you can set different SerDe’s on individual output bindings as below.

spring.cloud.stream.kstream.bindings.output1.producer.valueSerde=IntegerSerde

spring.cloud.stream.kstream.bindings.output2.producer.valueSerde=StringSerde

spring.cloud.stream.kstream.bindings.output3.producer.valueSerde=JsonSerde

Then if you have SendTo like this, @SendTo({"output1", "output2", "output3"}), the KStream[] from the branches are applied with proper SerDe objects as defined above. If you are not enabling nativeEncoding, you can then set different contentType values on the output bindings as below. In that case, the framework will use the appropriate message converter to convert the messages before sending to Kafka.

spring.cloud.stream.bindings.output1.contentType: application/json

spring.cloud.stream.bindings.output2.contentType: application/java-serialzied-object

spring.cloud.stream.bindings.output3.contentType: application/octet-stream

### 40.6.2 Inbound Deserialization

Similar rules apply to data deserialization on the inbound.

If native decoding is disabled (which is the default), then the framework will convert the message using the contentType set by the user (otherwise, the default application/json will be applied). It will ignore any SerDe set on the inbound in this case for inbound deserialization.

Here is the property to set the contentType on the inbound.

spring.cloud.stream.bindings.input.contentType: application/json

Here is the property to enable native decoding.

spring.cloud.stream.bindings.input.nativeDecoding: true

If native decoding is enabled on the input binding (user has to enable it as above explicitly), then the framework will skip doing any message conversion on the inbound. In that case, it will switch to the SerDe set by the user. The valueSerde property set on the actual output binding will be used. Here is an example.

spring.cloud.stream.kafka.streams.bindings.input.consumer.valueSerde: org.apache.kafka.common.serialization.Serdes$StringSerde

If this property is not set, it will use the default SerDe: spring.cloud.stream.kafka.streams.binder.configuration.default.value.serde.

It is worth to mention that Kafka Streams binder does not deserialize the keys on inbound - it simply relies on Kafka itself. Therefore, you either have to specify the keySerde property on the binding or it will default to the application-wide common keySerde.

Binding level key serde:

spring.cloud.stream.kafka.streams.bindings.input.consumer.keySerde

Common Key serde:

spring.cloud.stream.kafka.streams.binder.configuration.default.key.serde

As in the case of KStream branching on the outbound, the benefit of setting value SerDe per binding is that if you have multiple input bindings (multiple KStreams object) and they all require separate value SerDe’s, then you can configure them individually. If you use the common configuration approach, then this feature won’t be applicable.

## 40.7 Error Handling

Apache Kafka Streams provide the capability for natively handling exceptions from deserialization errors. For details on this support, please see [this](https://cwiki.apache.org/confluence/display/KAFKA/KIP-161%3A+streams+deserialization+exception+handlers) Out of the box, Apache Kafka Streams provide two kinds of deserialization exception handlers - logAndContinue and logAndFail. As the name indicates, the former will log the error and continue processing the next records and the latter will log the error and fail. LogAndFail is the default deserialization exception handler.

### 40.7.1 Handling Deserialization Exceptions

Kafka Streams binder supports a selection of exception handlers through the following properties.

spring.cloud.stream.kafka.streams.binder.serdeError: logAndContinue

In addition to the above two deserialization exception handlers, the binder also provides a third one for sending the erroneous records (poison pills) to a DLQ topic. Here is how you enable this DLQ exception handler.

spring.cloud.stream.kafka.streams.binder.serdeError: sendToDlq

When the above property is set, all the deserialization error records are automatically sent to the DLQ topic.

spring.cloud.stream.kafka.streams.bindings.input.consumer.dlqName: foo-dlq

If this is set, then the error records are sent to the topic foo-dlq. If this is not set, then it will create a DLQ topic with the name error.<input-topic-name>.<group-name>.

A couple of things to keep in mind when using the exception handling feature in Kafka Streams binder.

* The property spring.cloud.stream.kafka.streams.binder.serdeError is applicable for the entire application. This implies that if there are multiple StreamListener methods in the same application, this property is applied to all of them.
* The exception handling for deserialization works consistently with native deserialization and framework provided message conversion.

### 40.7.2 Handling Non-Deserialization Exceptions

For general error handling in Kafka Streams binder, it is up to the end user applications to handle application level errors. As a side effect of providing a DLQ for deserialization exception handlers, Kafka Streams binder provides a way to get access to the DLQ sending bean directly from your application. Once you get access to that bean, you can programmatically send any exception records from your application to the DLQ.

It continues to remain hard to robust error handling using the high-level DSL; Kafka Streams doesn’t natively support error handling yet.

However, when you use the low-level Processor API in your application, there are options to control this behavior. See below.

@Autowired

private SendToDlqAndContinue dlqHandler;

@StreamListener("input")

@SendTo("output")

public KStream<?, WordCount> process(KStream<Object, String> input) {

input.process(() -> new Processor() {

ProcessorContext context;

@Override

public void init(ProcessorContext context) {

this.context = context;

}

@Override

public void process(Object o, Object o2) {

try {

.....

.....

}

catch(Exception e) {

//explicitly provide the kafka topic corresponding to the input binding as the first argument.

//DLQ handler will correctly map to the dlq topic from the actual incoming destination.

dlqHandler.sendToDlq("topic-name", (byte[]) o1, (byte[]) o2, context.partition());

}

}

.....

.....

});

}

## 40.8 Interactive Queries

As part of the public Kafka Streams binder API, we expose a class called QueryableStoreRegistry. You can access this as a Spring bean in your application. An easy way to get access to this bean from your application is to "autowire" the bean in your application.

@Autowired

private QueryableStoreRegistry queryableStoreRegistry;

Once you gain access to this bean, then you can query for the particular state-store that you are interested. See below.

ReadOnlyKeyValueStore<Object, Object> keyValueStore =

queryableStoreRegistry.getQueryableStoreType("my-store", QueryableStoreTypes.keyValueStore());

## 41. RabbitMQ Binder

## 41.1 Usage

For using the RabbitMQ binder, you just need to add it to your Spring Cloud Stream application, using the following Maven coordinates:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-binder-rabbit</artifactId>

</dependency>

Alternatively, you can also use the Spring Cloud Stream RabbitMQ Starter.

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-stream-rabbit</artifactId>

</dependency>

## 41.2 RabbitMQ Binder Overview

A simplified diagram of how the RabbitMQ binder operates can be seen below.

**Figure 41.1. RabbitMQ Binder**

The RabbitMQ Binder implementation maps each destination to a TopicExchange (by default). For each consumer group, a Queue will be bound to that TopicExchange. Each consumer instance have a corresponding RabbitMQ Consumer instance for its group’s Queue. For partitioned producers/consumers the queues are suffixed with the partition index and use the partition index as routing key. For anonymous consumers (no group property) an auto-delete queue is used, with a randomized unique name.

Using the optional autoBindDlq option, you can configure the binder to create and configure dead-letter queues (DLQs) (and a dead-letter exchange DLX as well as routing infrastructure). By default, the dead letter queue has the name of the destination, appended with .dlq. If retry is enabled (maxAttempts > 1) failed messages will be delivered to the DLQ after retries are exhausted. If retry is disabled (maxAttempts = 1), you should set requeueRejected to false (default) so that a failed message will be routed to the DLQ, instead of being requeued. In addition, republishToDlq causes the binder to publish a failed message to the DLQ (instead of rejecting it); this enables additional information to be added to the message in headers, such as the stack trace in the x-exception-stacktrace header. This option does not need retry enabled; you can republish a failed message after just one attempt. Starting with version 1.2, you can configure the delivery mode of republished messages; see property republishDeliveryMode.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Setting requeueRejected to true (with republishToDlq=false ) will cause the message to be requeued and redelivered continually, which is likely not what you want unless the reason for the failure is transient. In general, it’s better to enable retry within the binder by setting maxAttempts to greater than one, or set republishToDlq to true. |

See [Section 41.3.1, “RabbitMQ Binder Properties”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__rabbitmq_binder.html#rabbit-binder-properties) for more information about these properties.

The framework does not provide any standard mechanism to consume dead-letter messages (or to re-route them back to the primary queue). Some options are described in [Section 41.6, “Dead-Letter Queue Processing”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__rabbitmq_binder.html#rabbit-dlq-processing).

|  |
| --- |
| [Note] |
| When **multiple** RabbitMQ binders are used in a Spring Cloud Stream application, it is important to disable 'RabbitAutoConfiguration' to avoid the same configuration from RabbitAutoConfiguration being applied to the two binders. Exclude the class using the @SpringBootApplication annotation. |

Starting with version 2.0, the RabbitMessageChannelBinder sets the RabbitTemplate.userPublisherConnection property to true so that the non-transactional producers will avoid dead locks on consumers which can happen if cached connections are blocked because of [Memory Alarm](https://www.rabbitmq.com/memory.html) on Broker.

## 41.3 Configuration Options

This section contains settings specific to the RabbitMQ Binder and bound channels.

For general binding configuration options and properties, please refer to the [Spring Cloud Stream core documentation](https://github.com/spring-cloud/spring-cloud-stream/blob/master/spring-cloud-stream-core-docs/src/main/asciidoc/spring-cloud-stream-overview.adoc#configuration-options).

### 41.3.1 RabbitMQ Binder Properties

By default, the RabbitMQ binder uses Spring Boot’s ConnectionFactory, and it therefore supports all Spring Boot configuration options for RabbitMQ. (For reference, consult the [Spring Boot documentation](https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#common-application-properties)). RabbitMQ configuration options use the spring.rabbitmq prefix.

In addition to Spring Boot options, the RabbitMQ binder supports the following properties:

spring.cloud.stream.rabbit.binder.adminAddresses

A comma-separated list of RabbitMQ management plugin URLs. Only used when nodes contains more than one entry. Each entry in this list must have a corresponding entry in spring.rabbitmq.addresses. **Only needed if you are using a RabbitMQ cluster and wish to consume from the node that hosts the queue.** **See**[**Queue Affinity and the LocalizedQueueConnectionFactory**](https://docs.spring.io/spring-amqp/reference/html/_reference.html#queue-affinity)**for more information.**

Default: empty.

spring.cloud.stream.rabbit.binder.nodes

A comma-separated list of RabbitMQ node names. When more than one entry, used to locate the server address where a queue is located. Each entry in this list must have a corresponding entry in spring.rabbitmq.addresses. **Only needed if you are using a RabbitMQ cluster and wish to consume from the node that hosts the queue.** **See**[**Queue Affinity and the LocalizedQueueConnectionFactory**](https://docs.spring.io/spring-amqp/reference/html/_reference.html#queue-affinity)**for more information.**

Default: empty.

spring.cloud.stream.rabbit.binder.compressionLevel

Compression level for compressed bindings. See java.util.zip.Deflater.

Default: 1 (BEST\_LEVEL).

spring.cloud.stream.binder.connection-name-prefix

A connection name prefix used to name the connection(s) created by this binder. The name will be this prefix followed by #n, where n increments each time a new connection is opened.

Default: none (Spring AMQP default).

### 41.3.2 RabbitMQ Consumer Properties

The following properties are available for Rabbit consumers only and must be prefixed with spring.cloud.stream.rabbit.bindings.<channelName>.consumer..

acknowledgeMode

The acknowledge mode.

Default: AUTO.

autoBindDlq

Whether to automatically declare the DLQ and bind it to the binder DLX.

Default: false.

bindingRoutingKey

The routing key with which to bind the queue to the exchange (if bindQueue is true). for partitioned destinations -<instanceIndex> will be appended.

Default: #.

bindQueue

Whether to bind the queue to the destination exchange; set to false if you have set up your own infrastructure and have previously created/bound the queue.

Default: true.

deadLetterQueueName

name of the DLQ

Default: prefix+destination.dlq

deadLetterExchange

a DLX to assign to the queue; if autoBindDlq is true

Default: 'prefix+DLX'

deadLetterRoutingKey

a dead letter routing key to assign to the queue; if autoBindDlq is true

Default: destination

declareExchange

Whether to declare the exchange for the destination.

Default: true.

delayedExchange

Whether to declare the exchange as a Delayed Message Exchange - requires the delayed message exchange plugin on the broker. The x-delayed-typeargument is set to the exchangeType.

Default: false.

dlqDeadLetterExchange

if a DLQ is declared, a DLX to assign to that queue

Default: none

dlqDeadLetterRoutingKey

if a DLQ is declared, a dead letter routing key to assign to that queue; default none

Default: none

dlqExpires

how long before an unused dead letter queue is deleted (ms)

Default: no expiration

dlqLazy

Declare the dead letter queue with the x-queue-mode=lazy argument. See [Lazy Queues](https://www.rabbitmq.com/lazy-queues.html). Consider using a policy instead of this setting because using a policy allows changing the setting without deleting the queue.

Default: false.

dlqMaxLength

maximum number of messages in the dead letter queue

Default: no limit

dlqMaxLengthBytes

maximum number of total bytes in the dead letter queue from all messages

Default: no limit

dlqMaxPriority

maximum priority of messages in the dead letter queue (0-255)

Default: none

dlqTtl

default time to live to apply to the dead letter queue when declared (ms)

Default: no limit

durableSubscription

Whether subscription should be durable. Only effective if group is also set.

Default: true.

exchangeAutoDelete

If declareExchange is true, whether the exchange should be auto-delete (removed after the last queue is removed).

Default: true.

exchangeDurable

If declareExchange is true, whether the exchange should be durable (survives broker restart).

Default: true.

exchangeType

The exchange type; direct, fanout or topic for non-partitioned destinations; direct or topic for partitioned destinations.

Default: topic.

exclusive

Create an exclusive consumer; concurrency should be 1 when this is true; often used when strict ordering is required but enabling a hot standby instance to take over after a failure. See recoveryInterval, which controls how often a standby instance will attempt to consume.

Default: false.

expires

how long before an unused queue is deleted (ms)

Default: no expiration

failedDeclarationRetryInterval

The interval (ms) between attempts to consume from a queue if it is missing.

Default: 5000

headerPatterns

Patterns for headers to be mapped from inbound messages.

Default: ['\*'] (all headers).

lazy

Declare the queue with the x-queue-mode=lazy argument. See [Lazy Queues](https://www.rabbitmq.com/lazy-queues.html). Consider using a policy instead of this setting because using a policy allows changing the setting without deleting the queue.

Default: false.

maxConcurrency

the maximum number of consumers

Default: 1.

maxLength

maximum number of messages in the queue

Default: no limit

maxLengthBytes

maximum number of total bytes in the queue from all messages

Default: no limit

maxPriority

maximum priority of messages in the queue (0-255)

Default: none

missingQueuesFatal

If the queue cannot be found, treat the condition as fatal and stop the listener container. Defaults to false so that the container keeps trying to consume from the queue, for example when using a cluster and the node hosting a non HA queue is down.

Default: false

prefetch

Prefetch count.

Default: 1.

prefix

A prefix to be added to the name of the destination and queues.

Default: "".

queueDeclarationRetries

The number of times to retry consuming from a queue if it is missing. Only relevant if missingQueuesFatal is true; otherwise the container keeps retrying indefinitely.

Default: 3

queueNameGroupOnly

When true, consume from a queue with a name equal to the group; otherwise the queue name is destination.group. This is useful, for example, when using Spring Cloud Stream to consume from an existing RabbitMQ queue.

Default: false.

recoveryInterval

The interval between connection recovery attempts, in milliseconds.

Default: 5000.

requeueRejected

Whether delivery failures should be requeued when retry is disabled or republishToDlq is false.

Default: false.

republishDeliveryMode

When republishToDlq is true, specify the delivery mode of the republished message.

Default: DeliveryMode.PERSISTENT

republishToDlq

By default, messages which fail after retries are exhausted are rejected. If a dead-letter queue (DLQ) is configured, RabbitMQ will route the failed message (unchanged) to the DLQ. If set to true, the binder will republish failed messages to the DLQ with additional headers, including the exception message and stack trace from the cause of the final failure.

Default: false

transacted

Whether to use transacted channels.

Default: false.

ttl

default time to live to apply to the queue when declared (ms)

Default: no limit

txSize

The number of deliveries between acks.

Default: 1.

### 41.3.3 Rabbit Producer Properties

The following properties are available for Rabbit producers only and must be prefixed with spring.cloud.stream.rabbit.bindings.<channelName>.producer..

autoBindDlq

Whether to automatically declare the DLQ and bind it to the binder DLX.

Default: false.

batchingEnabled

Whether to enable message batching by producers. Messages are batched into one message according to the following properties. Refer to [Batching](https://docs.spring.io/spring-amqp/reference/html/_reference.html#template-batching) for more information.

Default: false.

batchSize

The number of messages to buffer when batching is enabled.

Default: 100.

batchBufferLimit

The maximum buffer size when batching is enabled.

Default: `10000`.

batchTimeout

The batch timeout when batching is enabled.

Default: `5000`.

bindingRoutingKey

The routing key with which to bind the queue to the exchange (if bindQueue is true). Only applies to non-partitioned destinations. Only applies if requiredGroups are provided and then only to those groups.

Default: #.

bindQueue

Whether to bind the queue to the destination exchange; set to false if you have set up your own infrastructure and have previously created/bound the queue. Only applies if requiredGroups are provided and then only to those groups.

Default: true.

compress

Whether data should be compressed when sent.

Default: false.

deadLetterQueueName

name of the DLQ Only applies if requiredGroups are provided and then only to those groups.

Default: prefix+destination.dlq

deadLetterExchange

a DLX to assign to the queue; if autoBindDlq is true Only applies if requiredGroups are provided and then only to those groups.

Default: 'prefix+DLX'

deadLetterRoutingKey

a dead letter routing key to assign to the queue; if autoBindDlq is true Only applies if requiredGroups are provided and then only to those groups.

Default: destination

declareExchange

Whether to declare the exchange for the destination.

Default: true.

delayExpression

A SpEL expression to evaluate the delay to apply to the message (x-delay header) - has no effect if the exchange is not a delayed message exchange.

Default: No x-delay header is set.

delayedExchange

Whether to declare the exchange as a Delayed Message Exchange - requires the delayed message exchange plugin on the broker. The x-delayed-typeargument is set to the exchangeType.

Default: false.

deliveryMode

Delivery mode.

Default: PERSISTENT.

dlqDeadLetterExchange

if a DLQ is declared, a DLX to assign to that queue Only applies if requiredGroups are provided and then only to those groups.

Default: none

dlqDeadLetterRoutingKey

if a DLQ is declared, a dead letter routing key to assign to that queue; default none Only applies if requiredGroups are provided and then only to those groups.

Default: none

dlqExpires

how long before an unused dead letter queue is deleted (ms) Only applies if requiredGroups are provided and then only to those groups.

Default: no expiration

dlqLazy

Declare the dead letter queue with the x-queue-mode=lazy argument. See [Lazy Queues](https://www.rabbitmq.com/lazy-queues.html). Consider using a policy instead of this setting because using a policy allows changing the setting without deleting the queue. Only applies if requiredGroups are provided and then only to those groups.

dlqMaxLength

maximum number of messages in the dead letter queue Only applies if requiredGroups are provided and then only to those groups.

Default: no limit

dlqMaxLengthBytes

maximum number of total bytes in the dead letter queue from all messages Only applies if requiredGroups are provided and then only to those groups.

Default: no limit

dlqMaxPriority

maximum priority of messages in the dead letter queue (0-255) Only applies if requiredGroups are provided and then only to those groups.

Default: none

dlqTtl

default time to live to apply to the dead letter queue when declared (ms) Only applies if requiredGroups are provided and then only to those groups.

Default: no limit

exchangeAutoDelete

If declareExchange is true, whether the exchange should be auto-delete (removed after the last queue is removed).

Default: true.

exchangeDurable

If declareExchange is true, whether the exchange should be durable (survives broker restart).

Default: true.

exchangeType

The exchange type; direct, fanout or topic for non-partitioned destinations; direct or topic for partitioned destinations.

Default: topic.

expires

how long before an unused queue is deleted (ms) Only applies if requiredGroups are provided and then only to those groups.

Default: no expiration

headerPatterns

Patterns for headers to be mapped to outbound messages.

Default: ['\*'] (all headers).

lazy

Declare the queue with the x-queue-mode=lazy argument. See [Lazy Queues](https://www.rabbitmq.com/lazy-queues.html). Consider using a policy instead of this setting because using a policy allows changing the setting without deleting the queue. Only applies if requiredGroups are provided and then only to those groups.

Default: false.

maxLength

maximum number of messages in the queue Only applies if requiredGroups are provided and then only to those groups.

Default: no limit

maxLengthBytes

maximum number of total bytes in the queue from all messages Only applies if requiredGroups are provided and then only to those groups.

Default: no limit

maxPriority

maximum priority of messages in the queue (0-255) Only applies if requiredGroups are provided and then only to those groups.

Default: none

prefix

A prefix to be added to the name of the destination exchange.

Default: "".

queueNameGroupOnly

When true, consume from a queue with a name equal to the group; otherwise the queue name is destination.group. This is useful, for example, when using Spring Cloud Stream to consume from an existing RabbitMQ queue. Only applies if requiredGroups are provided and then only to those groups.

Default: false.

routingKeyExpression

A SpEL expression to determine the routing key to use when publishing messages. For a fixed routing key, use a literal expression, e.g. routingKeyExpression='my.routingKey' in a properties file, or routingKeyExpression: '''my.routingKey''' in a YAML file.

Default: destination or destination-<partition> for partitioned destinations.

transacted

Whether to use transacted channels.

Default: false.

ttl

default time to live to apply to the queue when declared (ms) Only applies if requiredGroups are provided and then only to those groups.

Default: no limit

|  |
| --- |
| [Note] |
| In the case of RabbitMQ, content type headers can be set by external applications. Spring Cloud Stream supports them as part of an extended internal protocol used for any type of transport (including transports, such as Kafka (prior to 0.11), that do not natively support headers). |

## 41.4 Retry With the RabbitMQ Binder

### 41.4.1 Overview

When retry is enabled within the binder, the listener container thread is suspended for any back off periods that are configured. This might be important when strict ordering is required with a single consumer but for other use cases it prevents other messages from being processed on that thread. An alternative to using binder retry is to set up dead lettering with time to live on the dead-letter queue (DLQ), as well as dead-letter configuration on the DLQ itself. See [Section 41.3.1, “RabbitMQ Binder Properties”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__rabbitmq_binder.html#rabbit-binder-properties) for more information about the properties discussed here. Example configuration to enable this feature:

* Set autoBindDlq to true - the binder will create a DLQ; you can optionally specify a name in deadLetterQueueName
* Set dlqTtl to the back off time you want to wait between redeliveries
* Set the dlqDeadLetterExchange to the default exchange - expired messages from the DLQ will be routed to the original queue since the default deadLetterRoutingKey is the queue name (destination.group) - setting to the default exchange is achieved by setting the property with no value, as is shown in the example below

To force a message to be dead-lettered, either throw an AmqpRejectAndDontRequeueException, or set requeueRejected to true (default) and throw any exception.

The loop will continue without end, which is fine for transient problems but you may want to give up after some number of attempts. Fortunately, RabbitMQ provides the x-death header which allows you to determine how many cycles have occurred.

To acknowledge a message after giving up, throw an ImmediateAcknowledgeAmqpException.

### 41.4.2 Putting it All Together

---

spring.cloud.stream.bindings.input.destination=myDestination

spring.cloud.stream.bindings.input.group=consumerGroup

#disable binder retries

spring.cloud.stream.bindings.input.consumer.max-attempts=1

#dlx/dlq setup

spring.cloud.stream.rabbit.bindings.input.consumer.auto-bind-dlq=true

spring.cloud.stream.rabbit.bindings.input.consumer.dlq-ttl=5000

spring.cloud.stream.rabbit.bindings.input.consumer.dlq-dead-letter-exchange=

---

This configuration creates an exchange myDestination with queue myDestination.consumerGroup bound to a topic exchange with a wildcard routing key #. It creates a DLQ bound to a direct exchange DLX with routing key myDestination.consumerGroup. When messages are rejected, they are routed to the DLQ. After 5 seconds, the message expires and is routed to the original queue using the queue name as the routing key.

**Spring Boot application.**

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** XDeathApplication {

**public** **static** **void** main(String[] args) {

SpringApplication.run(XDeathApplication.**class**, args);

}

*@StreamListener(Sink.INPUT)*

**public** **void** listen(String in, *@Header(name = "x-death", required = false)* Map<?,?> death) {

**if** (death != null && death.get("count").equals(3L)) {

*// giving up - don't send to DLX*

**throw** **new** ImmediateAcknowledgeAmqpException("Failed after 4 attempts");

}

**throw** **new** AmqpRejectAndDontRequeueException("failed");

}

}

Notice that the count property in the x-death header is a Long.

## 41.5 Error Channels

Starting with version 1.3, the binder unconditionally sends exceptions to an error channel for each consumer destination, and can be configured to send async producer send failures to an error channel too. See [the section called “Message Channel Binders and Error Channels”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__programming_model.html#binder-error-channels) for more information.

With rabbitmq, there are two types of send failures:

* returned messages
* negatively acknowledged [Publisher Confirms](https://www.rabbitmq.com/confirms.html)

The latter is rare; quoting the RabbitMQ documentation "[A nack] will only be delivered if an internal error occurs in the Erlang process responsible for a queue.".

As well as enabling producer error channels as described in [the section called “Message Channel Binders and Error Channels”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__programming_model.html#binder-error-channels), the RabbitMQ binder will only send messages to the channels if the connection factory is appropriately configured:

* ccf.setPublisherConfirms(true);
* ccf.setPublisherReturns(true);

When using spring boot configuration for the connection factory, set properties:

* spring.rabbitmq.publisher-confirms
* spring.rabbitmq.publisher-returns

The payload of the ErrorMessage for a returned message is a ReturnedAmqpMessageException with properties:

* failedMessage - the spring-messaging Message<?> that failed to be sent.
* amqpMessage - the raw spring-amqp Message
* replyCode - an integer value indicating the reason for the failure (e.g. 312 - No route)
* replyText - a text value indicating the reason for the failure e.g. NO\_ROUTE.
* exchange - the exchange to which the message was published.
* routingKey - the routing key used when the message was published.

For negatively acknowledged confirms, the payload is a NackedAmqpMessageException with properties:

* failedMessage - the spring-messaging Message<?> that failed to be sent.
* nackReason - a reason (if available; you may need to examine the broker logs for more information).

There is no automatic handling of these exceptions (such as sending to a [Dead-Letter queue](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__rabbitmq_binder.html#rabbit-dlq-processing)); you can consume these exceptions with your own Spring Integration flow.

## 41.6 Dead-Letter Queue Processing

Because it can’t be anticipated how users would want to dispose of dead-lettered messages, the framework does not provide any standard mechanism to handle them. If the reason for the dead-lettering is transient, you may wish to route the messages back to the original queue. However, if the problem is a permanent issue, that could cause an infinite loop. The following spring-boot application is an example of how to route those messages back to the original queue, but moves them to a third "parking lot" queue after three attempts. The second example utilizes the [RabbitMQ Delayed Message Exchange](https://www.rabbitmq.com/blog/2015/04/16/scheduling-messages-with-rabbitmq/) to introduce a delay to the requeued message. In this example, the delay increases for each attempt. These examples use a @RabbitListener to receive messages from the DLQ, you could also use RabbitTemplate.receive() in a batch process.

The examples assume the original destination is so8400in and the consumer group is so8400.

### 41.6.1 Non-Partitioned Destinations

The first two examples are when the destination is **not** partitioned.

*@SpringBootApplication*

**public** **class** ReRouteDlqApplication {

**private** **static** **final** String ORIGINAL\_QUEUE = "so8400in.so8400";

**private** **static** **final** String DLQ = ORIGINAL\_QUEUE + ".dlq";

**private** **static** **final** String PARKING\_LOT = ORIGINAL\_QUEUE + ".parkingLot";

**private** **static** **final** String X\_RETRIES\_HEADER = "x-retries";

**public** **static** **void** main(String[] args) **throws** Exception {

ConfigurableApplicationContext context = SpringApplication.run(ReRouteDlqApplication.**class**, args);

System.out.println("Hit enter to terminate");

System.in.read();

context.close();

}

*@Autowired*

**private** RabbitTemplate rabbitTemplate;

*@RabbitListener(queues = DLQ)*

**public** **void** rePublish(Message failedMessage) {

Integer retriesHeader = (Integer) failedMessage.getMessageProperties().getHeaders().get(X\_RETRIES\_HEADER);

**if** (retriesHeader == null) {

retriesHeader = Integer.valueOf(0);

}

**if** (retriesHeader < 3) {

failedMessage.getMessageProperties().getHeaders().put(X\_RETRIES\_HEADER, retriesHeader + 1);

**this**.rabbitTemplate.send(ORIGINAL\_QUEUE, failedMessage);

}

**else** {

**this**.rabbitTemplate.send(PARKING\_LOT, failedMessage);

}

}

*@Bean*

**public** Queue parkingLot() {

**return** **new** Queue(PARKING\_LOT);

}

}

*@SpringBootApplication*

**public** **class** ReRouteDlqApplication {

**private** **static** **final** String ORIGINAL\_QUEUE = "so8400in.so8400";

**private** **static** **final** String DLQ = ORIGINAL\_QUEUE + ".dlq";

**private** **static** **final** String PARKING\_LOT = ORIGINAL\_QUEUE + ".parkingLot";

**private** **static** **final** String X\_RETRIES\_HEADER = "x-retries";

**private** **static** **final** String DELAY\_EXCHANGE = "dlqReRouter";

**public** **static** **void** main(String[] args) **throws** Exception {

ConfigurableApplicationContext context = SpringApplication.run(ReRouteDlqApplication.**class**, args);

System.out.println("Hit enter to terminate");

System.in.read();

context.close();

}

*@Autowired*

**private** RabbitTemplate rabbitTemplate;

*@RabbitListener(queues = DLQ)*

**public** **void** rePublish(Message failedMessage) {

Map<String, Object> headers = failedMessage.getMessageProperties().getHeaders();

Integer retriesHeader = (Integer) headers.get(X\_RETRIES\_HEADER);

**if** (retriesHeader == null) {

retriesHeader = Integer.valueOf(0);

}

**if** (retriesHeader < 3) {

headers.put(X\_RETRIES\_HEADER, retriesHeader + 1);

headers.put("x-delay", 5000 \* retriesHeader);

**this**.rabbitTemplate.send(DELAY\_EXCHANGE, ORIGINAL\_QUEUE, failedMessage);

}

**else** {

**this**.rabbitTemplate.send(PARKING\_LOT, failedMessage);

}

}

*@Bean*

**public** DirectExchange delayExchange() {

DirectExchange exchange = **new** DirectExchange(DELAY\_EXCHANGE);

exchange.setDelayed(true);

**return** exchange;

}

*@Bean*

**public** Binding bindOriginalToDelay() {

**return** BindingBuilder.bind(**new** Queue(ORIGINAL\_QUEUE)).to(delayExchange()).with(ORIGINAL\_QUEUE);

}

*@Bean*

**public** Queue parkingLot() {

**return** **new** Queue(PARKING\_LOT);

}

}

### 41.6.2 Partitioned Destinations

With partitioned destinations, there is one DLQ for all partitions and we determine the original queue from the headers.

#### republishToDlq=false

When republishToDlq is false, RabbitMQ publishes the message to the DLX/DLQ with an x-death header containing information about the original destination.

*@SpringBootApplication*

**public** **class** ReRouteDlqApplication {

**private** **static** **final** String ORIGINAL\_QUEUE = "so8400in.so8400";

**private** **static** **final** String DLQ = ORIGINAL\_QUEUE + ".dlq";

**private** **static** **final** String PARKING\_LOT = ORIGINAL\_QUEUE + ".parkingLot";

**private** **static** **final** String X\_DEATH\_HEADER = "x-death";

**private** **static** **final** String X\_RETRIES\_HEADER = "x-retries";

**public** **static** **void** main(String[] args) **throws** Exception {

ConfigurableApplicationContext context = SpringApplication.run(ReRouteDlqApplication.**class**, args);

System.out.println("Hit enter to terminate");

System.in.read();

context.close();

}

*@Autowired*

**private** RabbitTemplate rabbitTemplate;

*@SuppressWarnings("unchecked")*

*@RabbitListener(queues = DLQ)*

**public** **void** rePublish(Message failedMessage) {

Map<String, Object> headers = failedMessage.getMessageProperties().getHeaders();

Integer retriesHeader = (Integer) headers.get(X\_RETRIES\_HEADER);

**if** (retriesHeader == null) {

retriesHeader = Integer.valueOf(0);

}

**if** (retriesHeader < 3) {

headers.put(X\_RETRIES\_HEADER, retriesHeader + 1);

List<Map<String, ?>> xDeath = (List<Map<String, ?>>) headers.get(X\_DEATH\_HEADER);

String exchange = (String) xDeath.get(0).get("exchange");

List<String> routingKeys = (List<String>) xDeath.get(0).get("routing-keys");

**this**.rabbitTemplate.send(exchange, routingKeys.get(0), failedMessage);

}

**else** {

**this**.rabbitTemplate.send(PARKING\_LOT, failedMessage);

}

}

*@Bean*

**public** Queue parkingLot() {

**return** **new** Queue(PARKING\_LOT);

}

}

#### republishToDlq=true

When republishToDlq is true, the republishing recoverer adds the original exchange and routing key to headers.

*@SpringBootApplication*

**public** **class** ReRouteDlqApplication {

**private** **static** **final** String ORIGINAL\_QUEUE = "so8400in.so8400";

**private** **static** **final** String DLQ = ORIGINAL\_QUEUE + ".dlq";

**private** **static** **final** String PARKING\_LOT = ORIGINAL\_QUEUE + ".parkingLot";

**private** **static** **final** String X\_RETRIES\_HEADER = "x-retries";

**private** **static** **final** String X\_ORIGINAL\_EXCHANGE\_HEADER = RepublishMessageRecoverer.X\_ORIGINAL\_EXCHANGE;

**private** **static** **final** String X\_ORIGINAL\_ROUTING\_KEY\_HEADER = RepublishMessageRecoverer.X\_ORIGINAL\_ROUTING\_KEY;

**public** **static** **void** main(String[] args) **throws** Exception {

ConfigurableApplicationContext context = SpringApplication.run(ReRouteDlqApplication.**class**, args);

System.out.println("Hit enter to terminate");

System.in.read();

context.close();

}

*@Autowired*

**private** RabbitTemplate rabbitTemplate;

*@RabbitListener(queues = DLQ)*

**public** **void** rePublish(Message failedMessage) {

Map<String, Object> headers = failedMessage.getMessageProperties().getHeaders();

Integer retriesHeader = (Integer) headers.get(X\_RETRIES\_HEADER);

**if** (retriesHeader == null) {

retriesHeader = Integer.valueOf(0);

}

**if** (retriesHeader < 3) {

headers.put(X\_RETRIES\_HEADER, retriesHeader + 1);

String exchange = (String) headers.get(X\_ORIGINAL\_EXCHANGE\_HEADER);

String originalRoutingKey = (String) headers.get(X\_ORIGINAL\_ROUTING\_KEY\_HEADER);

**this**.rabbitTemplate.send(exchange, originalRoutingKey, failedMessage);

}

**else** {

**this**.rabbitTemplate.send(PARKING\_LOT, failedMessage);

}

}

*@Bean*

**public** Queue parkingLot() {

**return** **new** Queue(PARKING\_LOT);

}

}

## 41.7 Partitioning with the RabbitMQ Binder

RabbitMQ does not support partitioning natively.

Sometimes it is advantageous to send data to specific partitions, for example when you want to strictly order message processing - all messages for a particular customer should go to the same partition.

The RabbitMessageChannelBinder provides partitioning by binding a queue for each partition to the destination exchange.

The following illustrates how to configure the producer and consumer side:

**Producer.**

*@SpringBootApplication*

*@EnableBinding(Source.class)*

**public** **class** RabbitPartitionProducerApplication {

**private** **static** **final** Random RANDOM = **new** Random(System.currentTimeMillis());

**private** **static** **final** String[] data = **new** String[] {

"foo1", "bar1", "qux1",

"foo2", "bar2", "qux2",

"foo3", "bar3", "qux3",

"foo4", "bar4", "qux4",

};

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(RabbitPartitionProducerApplication.**class**)

.web(false)

.run(args);

}

*@InboundChannelAdapter(channel = Source.OUTPUT, poller = @Poller(fixedRate = "5000"))*

**public** Message<?> generate() {

String value = data[RANDOM.nextInt(data.length)];

System.out.println("Sending: " + value);

**return** MessageBuilder.withPayload(value)

.setHeader("partitionKey", value)

.build();

}

}

**application.yml.**

spring:

cloud:

stream:

bindings:

output:

destination: partitioned.destination

producer:

partitioned: **true**

partition-key-expression: headers['partitionKey'**]**

partition-count: 2

required-groups:

- myGroup

|  |
| --- |
| [Note] |
| The above configuration uses the default partitioning (key.hashCode() % partitionCount). This may or may not provide a suitably balanced algorithm, depending on the key values; you can override this default by using the partitionSelectorExpression or partitionSelectorClass properties.  The required-groups property is only required if you need the consumer queues to be provisioned when the producer is deployed. Otherwise, any messages sent to a partition will be lost until the corresponding consumer is deployed. |

This configuration provisions a topic exchange:

and these queues bound to that exchange:

with these bindings:

**Consumer.**

*@SpringBootApplication*

*@EnableBinding(Sink.class)*

**public** **class** RabbitPartitionConsumerApplication {

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(RabbitPartitionConsumerApplication.**class**)

.web(false)

.run(args);

}

*@StreamListener(Sink.INPUT)*

**public** **void** listen(*@Payload* String in, *@Header(AmqpHeaders.CONSUMER\_QUEUE)* String queue) {

System.out.println(in + " received from queue " + queue);

}

}

**application.yml.**

spring:

cloud:

stream:

bindings:

input:

destination: partitioned.destination

group: myGroup

consumer:

partitioned: **true**

instance-index: 0

|  |  |
| --- | --- |
| [Important] | **Important** |
| The RabbitMessageChannelBinder does not support dynamic scaling; there must be at least one consumer per partition. The consumer’s instanceIndex is used to indicate which partition will be consumed. On platforms such as Cloud Foundry there can only be one instance with an instanceIndex. |

# Part VII. Spring Cloud Bus

Spring Cloud Bus links nodes of a distributed system with a lightweight message broker. This can then be used to broadcast state changes (e.g. configuration changes) or other management instructions. A key idea is that the Bus is like a distributed Actuator for a Spring Boot application that is scaled out, but it can also be used as a communication channel between apps. Starters are provided for an AMQP broker as the transport or for Kafka, but the same basic feature set (and some more depending on the transport) is on the roadmap for other transports.

|  |
| --- |
| [Note] |
| Spring Cloud is released under the non-restrictive Apache 2.0 license. If you would like to contribute to this section of the documentation or if you find an error, please find the source code and issue trackers in the project at [github](https://github.com/spring-cloud/spring-cloud-config/tree/master/docs/src/main/asciidoc). |

## 42. Quick Start

Spring Cloud Bus works by adding Spring Boot autconfiguration if it detects itself on the classpath. All you need to do to enable the bus is to add spring-cloud-starter-bus-amqp or spring-cloud-starter-bus-kafka to your dependency management and Spring Cloud takes care of the rest. Make sure the broker (RabbitMQ or Kafka) is available and configured: running on localhost you shouldn’t have to do anything, but if you are running remotely use Spring Cloud Connectors, or Spring Boot conventions to define the broker credentials, e.g. for Rabbit

**application.yml.**

spring:

rabbitmq:

host: mybroker.com

port: 5672

username: user

password: secret

The bus currently supports sending messages to all nodes listening or all nodes for a particular service (as defined by Eureka). More selector criteria may be added in the future (ie. only service X nodes in data center Y, etc…​). There are also some http endpoints under the /bus/\* actuator namespace. There are currently two implemented. The first, /bus/env, sends key/value pairs to update each node’s Spring Environment. The second, /bus/refresh, will reload each application’s configuration, just as if they had all been pinged on their /refresh endpoint.

|  |
| --- |
| [Note] |
| The Bus starters cover Rabbit and Kafka, because those are the two most common implementations, but Spring Cloud Stream is quite flexible and binder will work combined with spring-cloud-bus. |

## 43. Addressing an Instance

Each instance of the application has a service ID, whose value can be set using spring.cloud.bus.id, and whose value is expected to be a colon-separated list of identifiers, in order of least specific to most specific. The default value is constructed from the environment as a combination of the spring.application.name and server.port (or spring.application.index if set). The default value of the ID is constructed in the form app:index:id where:

* app is the vcap.application.name if it exists, or spring.application.name
* index is the vcap.application.instance\_index if it exists, or else spring.application.index, or else local.server.port (or server.port or 0).
* id is the vcap.application.instance\_id if it exists, or else a random value.

The HTTP endpoints accept a "destination" parameter, e.g. "/bus/refresh?destination=customers:9000", where the destination is a service ID. If the ID is owned by an instance on the Bus then it will process the message and all other instances will ignore it.

## 44. Addressing all instances of a service

The "destination" parameter is used in a Spring PathMatcher (with the path separator as a colon :) to determine if an instance will process the message. Using the example from above, "/bus/refresh?destination=customers:\*\*" will target all instances of the "customers" service regardless of the rest of the service ID.

## 45. Service ID must be unique

The bus tries to eliminate processing an event twice, once from the original ApplicationEvent and once from the queue. To do this, it checks the sending service ID againts the current service ID. If multiple instances of a service have the same ID, events will not be processed. Running on a local machine, each service will be on a different port and that will be part of the ID. Cloud Foundry supplies an index to differentiate. To ensure that the ID is unique outside Cloud Foundry, set spring.application.index to something unique for each instance of a service.

## 46. Customizing the Message Broker

Spring Cloud Bus uses [Spring Cloud Stream](https://cloud.spring.io/spring-cloud-stream) to broadcast the messages so to get messages to flow you only need to include the binder implementation of your choice in the classpath. There are convenient starters specifically for the bus with AMQP (RabbitMQ) and Kafka (spring-cloud-starter-bus-[amqp,kafka]). Generally speaking Spring Cloud Stream relies on Spring Boot autoconfiguration conventions for configuring middleware, so for instance the AMQP broker address can be changed with spring.rabbitmq.\* configuration properties. Spring Cloud Bus has a handful of native configuration properties in spring.cloud.bus.\* (e.g. spring.cloud.bus.destination is the name of the topic to use the the externall middleware). Normally the defaults will suffice.

To lean more about how to customize the message broker settings consult the Spring Cloud Stream documentation.

## 47. Tracing Bus Events

Bus events (subclasses of RemoteApplicationEvent) can be traced by setting spring.cloud.bus.trace.enabled=true. If you do this then the Spring Boot TraceRepository (if it is present) will show each event sent and all the acks from each service instance. Example (from the /trace endpoint):

**{**

"timestamp": "2015-11-26T10:24:44.411+0000"**,**

"info": **{**

"signal": "spring.cloud.bus.ack"**,**

"type": "RefreshRemoteApplicationEvent"**,**

"id": "c4d374b7-58ea-4928-a312-31984def293b"**,**

"origin": "stores:8081"**,**

"destination": "\*:\*\*"

**}**

**},**

**{**

"timestamp": "2015-11-26T10:24:41.864+0000"**,**

"info": **{**

"signal": "spring.cloud.bus.sent"**,**

"type": "RefreshRemoteApplicationEvent"**,**

"id": "c4d374b7-58ea-4928-a312-31984def293b"**,**

"origin": "customers:9000"**,**

"destination": "\*:\*\*"

**}**

**},**

**{**

"timestamp": "2015-11-26T10:24:41.862+0000"**,**

"info": **{**

"signal": "spring.cloud.bus.ack"**,**

"type": "RefreshRemoteApplicationEvent"**,**

"id": "c4d374b7-58ea-4928-a312-31984def293b"**,**

"origin": "customers:9000"**,**

"destination": "\*:\*\*"

**}**

**}**

This trace shows that a RefreshRemoteApplicationEvent was sent from customers:9000, broadcast to all services, and it was received (acked) by customers:9000 and stores:8081.

To handle the ack signals yourself you could add an @EventListener for the AckRemoteApplicationEvent and SentApplicationEvent types to your app (and enable tracing). Or you could tap into the TraceRepository and mine the data from there.

|  |
| --- |
| [Note] |
| Any Bus application can trace acks, but sometimes it will be useful to do this in a central service that can do more complex queries on the data. Or forward it to a specialized tracing service. |

## 48. Broadcasting Your Own Events

The Bus can carry any event of type RemoteApplicationEvent, but the default transport is JSON and the deserializer needs to know which types are going to be used ahead of time. To register a new type it needs to be in a subpackage of org.springframework.cloud.bus.event.

To customise the event name you can use @JsonTypeName on your custom class or rely on the default strategy which is to use the simple name of the class. Note that both the producer and the consumer will need access to the class definition.

## 48.1 Registering events in custom packages

If you cannot or don’t want to use a subpackage of org.springframework.cloud.bus.event for your custom events, you must specify which packages to scan for events of type RemoteApplicationEvent using @RemoteApplicationEventScan. Packages specified with @RemoteApplicationEventScan include subpackages.

For example, if you have a custom event called FooEvent:

**package** com.acme;

**public** **class** FooEvent **extends** RemoteApplicationEvent {

...

}

you can register this event with the deserializer in the following way:

**package** com.acme;

*@Configuration*

*@RemoteApplicationEventScan*

**public** **class** BusConfiguration {

...

}

Without specifying a value, the package of the class where @RemoteApplicationEventScan is used will be registered. In this example com.acme will be registered using the package of BusConfiguration.

You can also explicitly specify the packages to scan using the value, basePackages or basePackageClasses properties on @RemoteApplicationEventScan. For example:

**package** com.acme;

*@Configuration*

*//@RemoteApplicationEventScan({"com.acme", "foo.bar"})*

*//@RemoteApplicationEventScan(basePackages = {"com.acme", "foo.bar", "fizz.buzz"})*

*@RemoteApplicationEventScan(basePackageClasses = BusConfiguration.class)*

**public** **class** BusConfiguration {

...

}

All examples of @RemoteApplicationEventScan above are equivalent, in that the com.acme package will be registered by explicitly specifying the packages on @RemoteApplicationEventScan. Note, you can specify multiple base packages to scan.

# Part VIII. Spring Cloud Sleuth

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**Finchley.M9**

## 49. Introduction

Spring Cloud Sleuth implements a distributed tracing solution for [Spring Cloud](https://cloud.spring.io/).

## 49.1 Terminology

Spring Cloud Sleuth borrows [Dapper’s](http://research.google.com/pubs/pub36356.html) terminology.

**Span**: The basic unit of work. For example, sending an RPC is a new span, as is sending a response to an RPC. Spans are identified by a unique 64-bit ID for the span and another 64-bit ID for the trace the span is a part of. Spans also have other data, such as descriptions, timestamped events, key-value annotations (tags), the ID of the span that caused them, and process IDs (normally IP addresses).

Spans can be started and stopped, and they keep track of their timing information. Once you create a span, you must stop it at some point in the future.

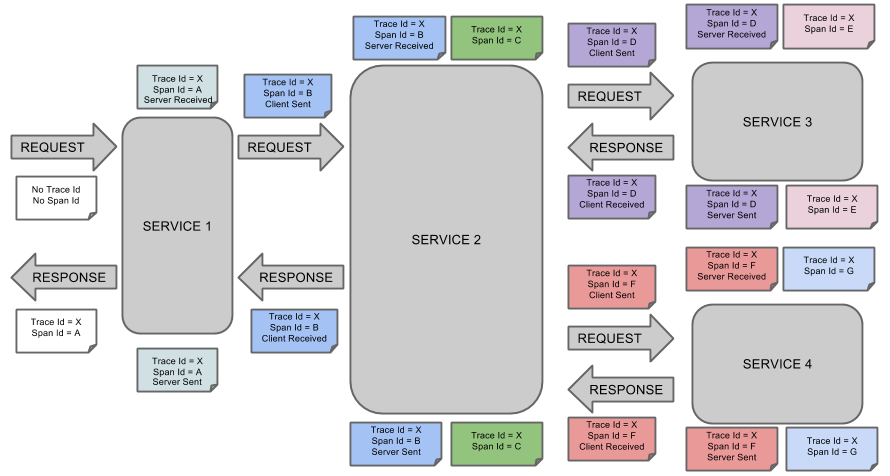
|  |
| --- |
| [Tip] |
| The initial span that starts a trace is called a root span. The value of the ID of that span is equal to the trace ID. |

**Trace:** A set of spans forming a tree-like structure. For example, if you run a distributed big-data store, a trace might be formed by a PUT request.

**Annotation:** Used to record the existence of an event in time. With [Brave](https://github.com/openzipkin/brave) instrumentation, we no longer need to set special events for [Zipkin](https://zipkin.io/) to understand who the client and server are, where the request started, and where it ended. For learning purposes, however, we mark these events to highlight what kind of an action took place.

* **cs**: Client Sent. The client has made a request. This annotation indicates the start of the span.
* **sr**: Server Received: The server side got the request and started processing it. Subtracting the cs timestamp from this timestamp reveals the network latency.
* **ss**: Server Sent. Annotated upon completion of request processing (when the response got sent back to the client). Subtracting the sr timestamp from this timestamp reveals the time needed by the server side to process the request.
* **cr**> Client Received. Signifies the end of the span. The client has successfully received the response from the server side. Subtracting the cs timestamp from this timestamp reveals the whole time needed by the client to receive the response from the server.

The following image shows how **Span** and **Trace** look in a system, together with the Zipkin annotations:



Each color of a note signifies a span (there are seven spans - from **A** to **G**). Consider the following note:

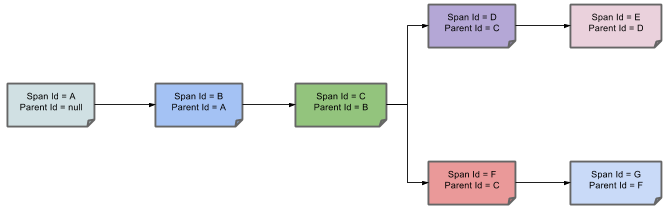
Trace Id = X

Span Id = D

Client Sent

This note indicats thatthe current span has **Trace Id** set to **X** and **Span Id** set to **D**. Also, the Client Sent event took place.

The following image shows how parent-child relationships of spans look:

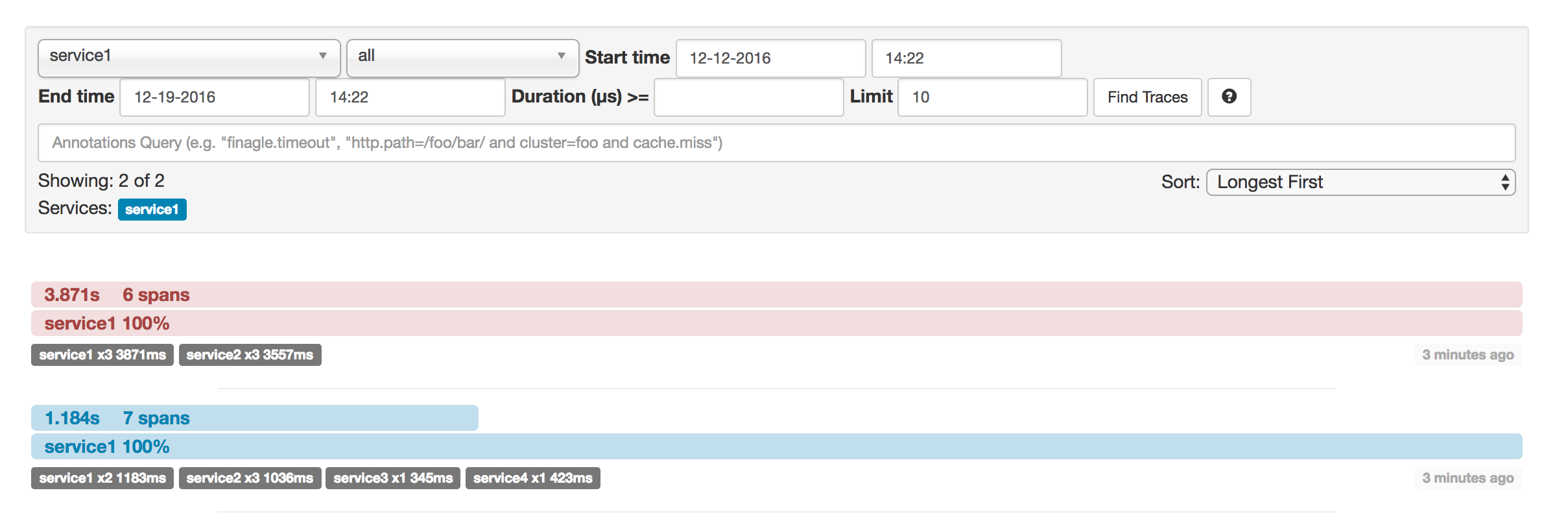


## 49.2 Purpose

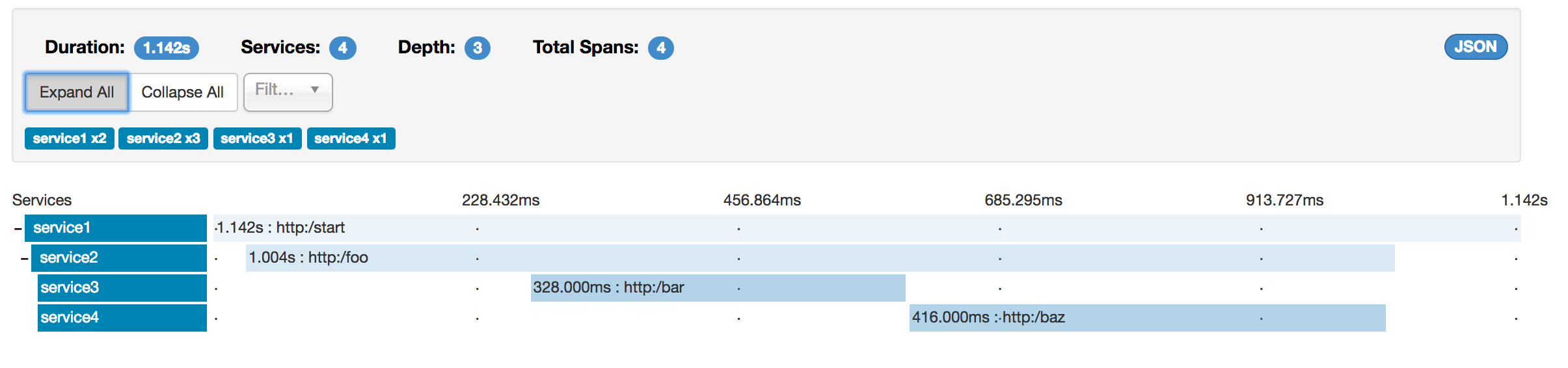
The following sections refer to the example shown in the preceding image.

### 49.2.1 Distributed Tracing with Zipkin

This example has seven spans. If you go to traces in Zipkin, you can see this number in the second trace, as shown in the following image:



However, if you pick a particular trace, you can see four spans, as shown in the following image:



|  |
| --- |
| [Note] |
| When you pick a particular trace, you see merged spans. That means that, if there were two spans sent to Zipkin with Server Received and Server Sent or Client Received and Client Sent annotations, they are presented as a single span. |

Why is there a difference between the seven and four spans in this case?

* Two spans come from the http:/start span. It has the Server Received (sr) and Server Sent (ss) annotations.
* Two spans come from the RPC call from service1 to service2 to the http:/foo endpoint. The Client Sent (cs) and Client Received (cr) events took place on the service1 side. Server Received (sr) and Server Sent (ss) events took place on the service2 side. These two spans form one logical span related to an RPC call.
* Two spans come from the RPC call from service2 to service3 to the http:/bar endpoint. The Client Sent (cs) and Client Received (cr) events took place on the service2 side. The Server Received (sr) and Server Sent (ss) events took place on the service3 side. These two spans form one logical span related to an RPC call.
* Two spans come from the RPC call from service2 to service4 to the http:/baz endpoint. The Client Sent (cs) and Client Received (cr) events took place on the service2 side. Server Received (sr) and Server Sent (ss) events took place on the service4 side. These two spans form one logical span related to an RPC call.

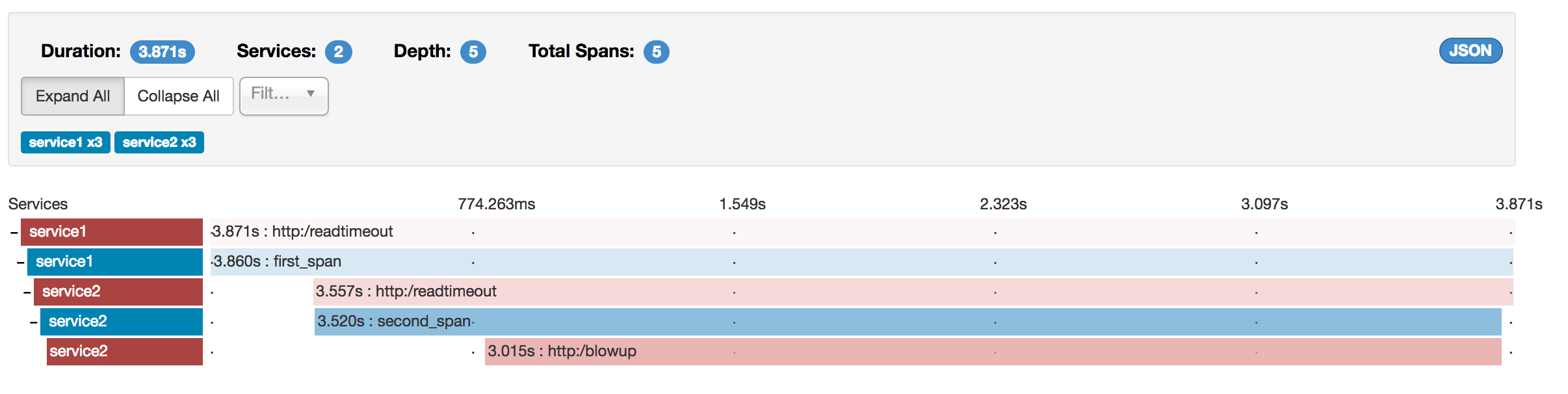
So, if we count the physical spans, we have one from http:/start, two from service1 calling service2, two from service2 calling service3, and two from service2 calling service4. In sum, we have a total of seven spans.

Logically, we see the information of four total Spans because we have one span related to the incoming request to service1 and three spans related to RPC calls.

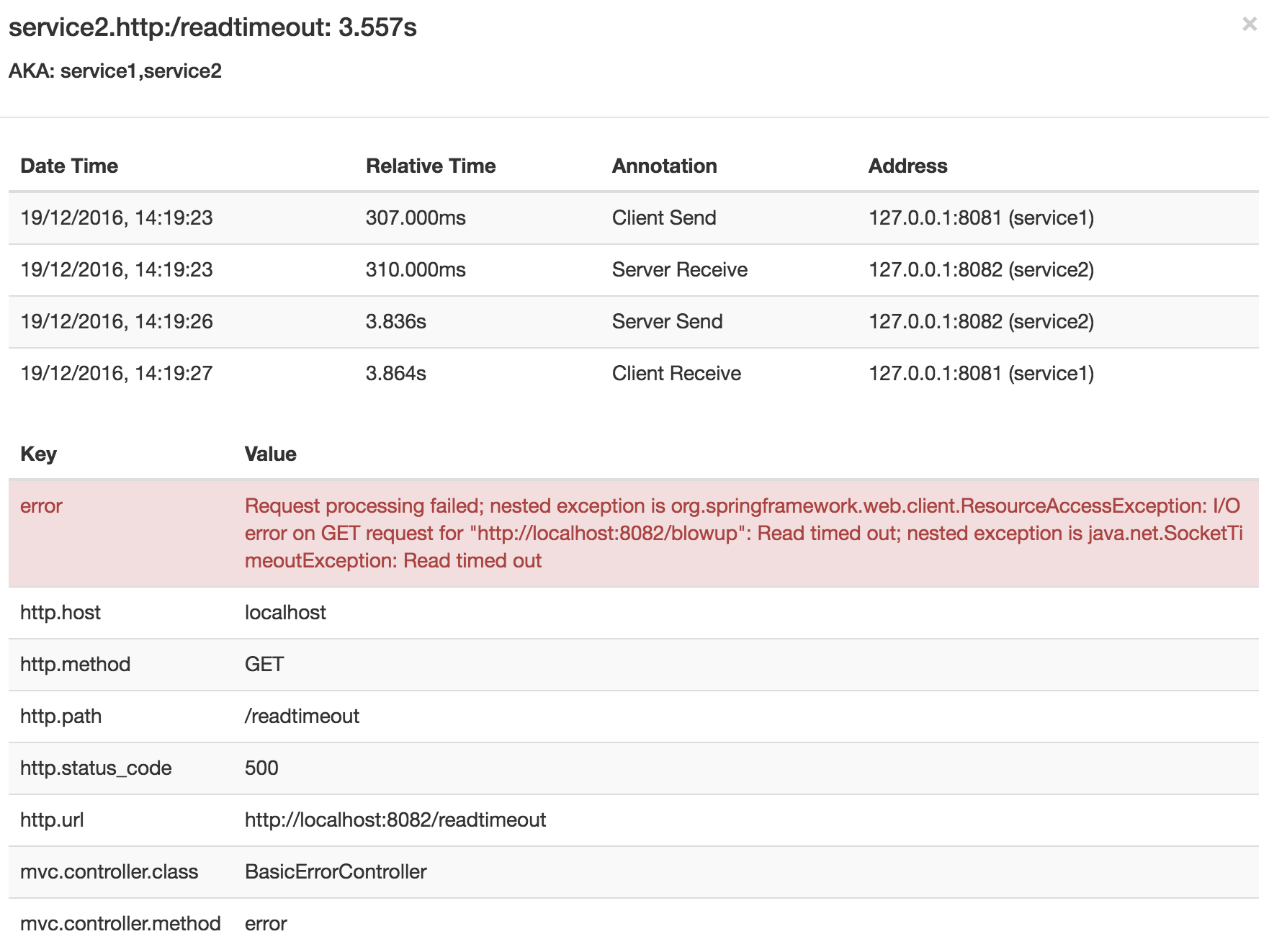
### 49.2.2 Visualizing errors

Zipkin lets you visualize errors in your trace. When an exception was thrown and was not caught, we set proper tags on the span, which Zipkin can then properly colorize. You could see in the list of traces one trace that is red. That appears because an exception was thrown.

If you click that trace, you see a similar picture, as follows:



If you then click on one of the spans, you see the following



The span shows the reason for the error and the whole stack trace related to it.

### 49.2.3 Distributed Tracing with Brave

Starting with version 2.0.0, Spring Cloud Sleuth uses [Brave](https://github.com/openzipkin/brave) as the tracing library. Consequently, Sleuth no longer takes care of storing the context but delegates that work to Brave.

Due to the fact that Sleuth had different naming and tagging conventions than Brave, we decided to follow Brave’s conventions from now on. However, if you want to use the legacy Sleuth approaches, you can set the spring.sleuth.http.legacy.enabled property to true.

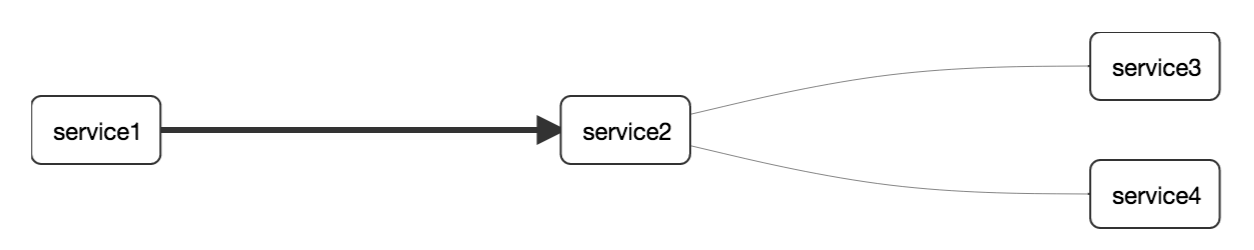
### 49.2.4 Live examples

**Figure 49.1. Click the Pivotal Web Services icon to see it live!**



[Click here to see it live!](https://docssleuth-zipkin-server.cfapps.io/)

The dependency graph in Zipkin should resemble the following image:



**Figure 49.2. Click the Pivotal Web Services icon to see it live!**



[Click here to see it live!](https://docssleuth-zipkin-server.cfapps.io/dependency)

### 49.2.5 Log correlation

When using grep to read the logs of those four applications by scanning for a trace ID equal to (for example) 2485ec27856c56f4, you get output resembling the following:

service1.log:2016-02-26 11:15:47.561 INFO [service1,2485ec27856c56f4,2485ec27856c56f4,true] 68058 --- [nio-8081-exec-1] i.s.c.sleuth.docs.service1.Application : Hello from service1. Calling service2

service2.log:2016-02-26 11:15:47.710 INFO [service2,2485ec27856c56f4,9aa10ee6fbde75fa,true] 68059 --- [nio-8082-exec-1] i.s.c.sleuth.docs.service2.Application : Hello from service2. Calling service3 and then service4

service3.log:2016-02-26 11:15:47.895 INFO [service3,2485ec27856c56f4,1210be13194bfe5,true] 68060 --- [nio-8083-exec-1] i.s.c.sleuth.docs.service3.Application : Hello from service3

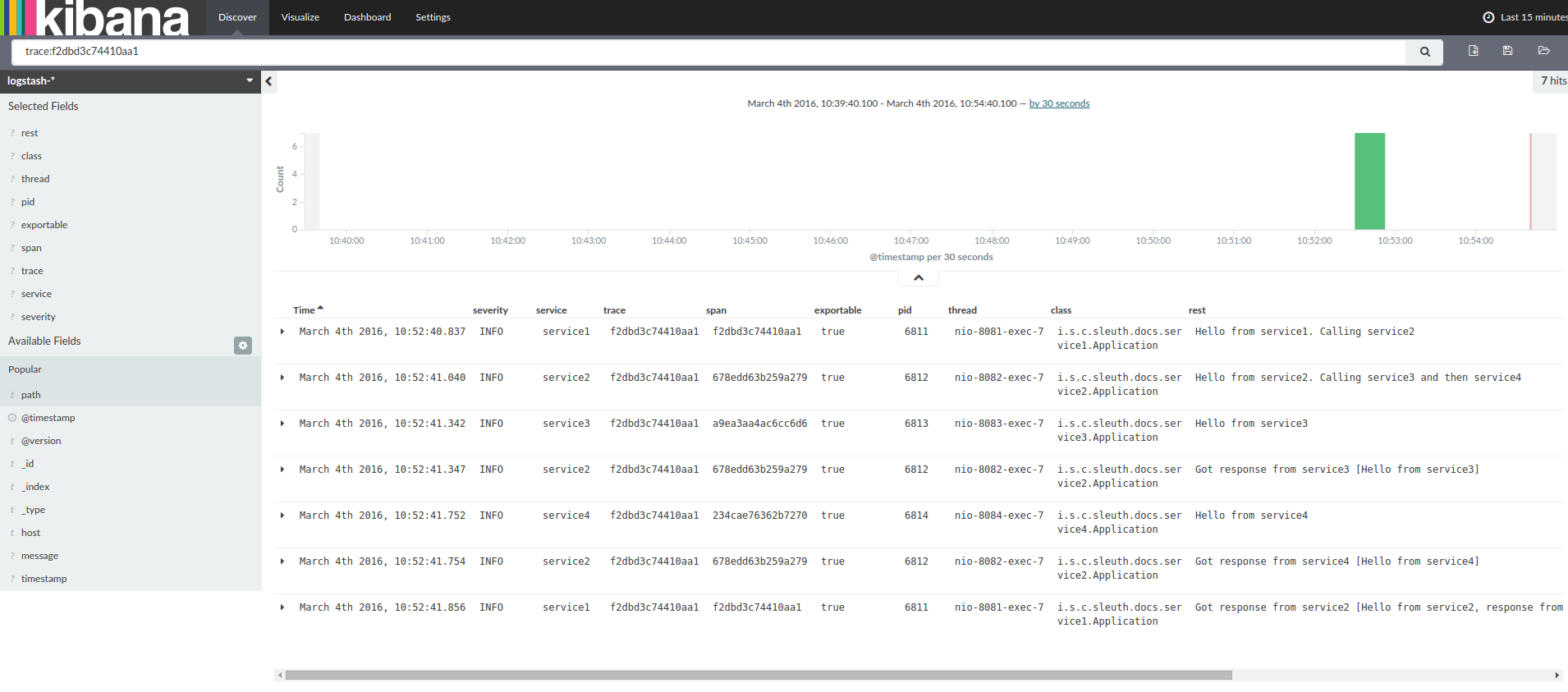
service2.log:2016-02-26 11:15:47.924 INFO [service2,2485ec27856c56f4,9aa10ee6fbde75fa,true] 68059 --- [nio-8082-exec-1] i.s.c.sleuth.docs.service2.Application : Got response from service3 [Hello from service3]

service4.log:2016-02-26 11:15:48.134 INFO [service4,2485ec27856c56f4,1b1845262ffba49d,true] 68061 --- [nio-8084-exec-1] i.s.c.sleuth.docs.service4.Application : Hello from service4

service2.log:2016-02-26 11:15:48.156 INFO [service2,2485ec27856c56f4,9aa10ee6fbde75fa,true] 68059 --- [nio-8082-exec-1] i.s.c.sleuth.docs.service2.Application : Got response from service4 [Hello from service4]

service1.log:2016-02-26 11:15:48.182 INFO [service1,2485ec27856c56f4,2485ec27856c56f4,true] 68058 --- [nio-8081-exec-1] i.s.c.sleuth.docs.service1.Application : Got response from service2 [Hello from service2, response from service3 [Hello from service3] and from service4 [Hello from service4]]

If you use a log aggregating tool (such as [Kibana](https://www.elastic.co/products/kibana), [Splunk](http://www.splunk.com/), and others), you can order the events that took place. An example from Kibana would resemble the following image:



If you want to use [Logstash](https://www.elastic.co/guide/en/logstash/current/index.html), the following listing shows the Grok pattern for Logstash:

filter {

# pattern matching logback pattern

grok {

match => { "message" => "%{TIMESTAMP\_ISO8601:timestamp}\s+%{LOGLEVEL:severity}\s+\[%{DATA:service},%{DATA:trace},%{DATA:span},%{DATA:exportable}\]\s+%{DATA:pid}\s+---\s+\[%{DATA:thread}\]\s+%{DATA:class}\s+:\s+%{GREEDYDATA:rest}" }

}

}

|  |
| --- |
| [Note] |
| If you want to use Grok together with the logs from Cloud Foundry, you have to use the following pattern: |

filter {

# pattern matching logback pattern

grok {

match => { "message" => "(?m)OUT\s+%{TIMESTAMP\_ISO8601:timestamp}\s+%{LOGLEVEL:severity}\s+\[%{DATA:service},%{DATA:trace},%{DATA:span},%{DATA:exportable}\]\s+%{DATA:pid}\s+---\s+\[%{DATA:thread}\]\s+%{DATA:class}\s+:\s+%{GREEDYDATA:rest}" }

}

}

#### JSON Logback with Logstash

Often, you do not want to store your logs in a text file but in a JSON file that Logstash can immediately pick. To do so, you have to do the following (for readability, we pass the dependencies in the groupId:artifactId:version notation).

**Dependencies Setup**

1. Ensure that Logback is on the classpath (ch.qos.logback:logback-core).
2. Add Logstash Logback encode. For example, to use version 4.6, add net.logstash.logback:logstash-logback-encoder:4.6.

**Logback Setup**

Consider the following example of a Logback configuration file (named [logback-spring.xml](https://github.com/spring-cloud-samples/sleuth-documentation-apps/blob/master/service1/src/main/resources/logback-spring.xml)).

<?xml version="1.0" encoding="UTF-8"?>

<configuration>

<include resource="org/springframework/boot/logging/logback/defaults.xml"/>

​

<springProperty scope="context" name="springAppName" source="spring.application.name"/>

*<!-- Example for logging into the build folder of your project -->*

<property name="LOG\_FILE" value="${BUILD\_FOLDER:-build}/${springAppName}"/>​

*<!-- You can override this to have a custom pattern -->*

<property name="CONSOLE\_LOG\_PATTERN"

value="%clr(%d{yyyy-MM-dd HH:mm:ss.SSS}){faint} %clr(${LOG\_LEVEL\_PATTERN:-%5p}) %clr(${PID:- }){magenta} %clr(---){faint} %clr([%15.15t]){faint} %clr(%-40.40logger{39}){cyan} %clr(:){faint} %m%n${LOG\_EXCEPTION\_CONVERSION\_WORD:-%wEx}"/>

*<!-- Appender to log to console -->*

<appender name="console" class="ch.qos.logback.core.ConsoleAppender">

<filter class="ch.qos.logback.classic.filter.ThresholdFilter">

*<!-- Minimum logging level to be presented in the console logs-->*

<level>DEBUG</level>

</filter>

<encoder>

<pattern>${CONSOLE\_LOG\_PATTERN}</pattern>

<charset>utf8</charset>

</encoder>

</appender>

*<!-- Appender to log to file -->*​

<appender name="flatfile" class="ch.qos.logback.core.rolling.RollingFileAppender">

<file>${LOG\_FILE}</file>

<rollingPolicy class="ch.qos.logback.core.rolling.TimeBasedRollingPolicy">

<fileNamePattern>${LOG\_FILE}.%d{yyyy-MM-dd}.gz</fileNamePattern>

<maxHistory>7</maxHistory>

</rollingPolicy>

<encoder>

<pattern>${CONSOLE\_LOG\_PATTERN}</pattern>

<charset>utf8</charset>

</encoder>

</appender>

​

*<!-- Appender to log to file in a JSON format -->*

<appender name="logstash" class="ch.qos.logback.core.rolling.RollingFileAppender">

<file>${LOG\_FILE}.json</file>

<rollingPolicy class="ch.qos.logback.core.rolling.TimeBasedRollingPolicy">

<fileNamePattern>${LOG\_FILE}.json.%d{yyyy-MM-dd}.gz</fileNamePattern>

<maxHistory>7</maxHistory>

</rollingPolicy>

<encoder class="net.logstash.logback.encoder.LoggingEventCompositeJsonEncoder">

<providers>

<timestamp>

<timeZone>UTC</timeZone>

</timestamp>

<pattern>

<pattern>

{

"severity": "%level",

"service": "${springAppName:-}",

"trace": "%X{X-B3-TraceId:-}",

"span": "%X{X-B3-SpanId:-}",

"parent": "%X{X-B3-ParentSpanId:-}",

"exportable": "%X{X-Span-Export:-}",

"pid": "${PID:-}",

"thread": "%thread",

"class": "%logger{40}",

"rest": "%message"

}

</pattern>

</pattern>

</providers>

</encoder>

</appender>

​

<root level="INFO">

<appender-ref ref="console"/>

*<!-- uncomment this to have also JSON logs -->*

*<!--<appender-ref ref="logstash"/>-->*

*<!--<appender-ref ref="flatfile"/>-->*

</root>

</configuration>

That Logback configuration file:

* Logs information from the application in a JSON format to a build/${spring.application.name}.json file.
* Has commented out two additional appenders: console and standard log file.
* Has the same logging pattern as the one presented in the previous section.

|  |
| --- |
| [Note] |
| If you use a custom logback-spring.xml, you must pass the spring.application.name in the bootstrap rather than the application property file. Otherwise, your custom logback file does not properly read the property. |

### 49.2.6 Propagating Span Context

The span context is the state that must get propagated to any child spans across process boundaries. Part of the Span Context is the Baggage. The trace and span IDs are a required part of the span context. Baggage is an optional part.

Baggage is a set of key:value pairs stored in the span context. Baggage travels together with the trace and is attached to every span. Spring Cloud Sleuth understands that a header is baggage-related if the HTTP header is prefixed with baggage- and, for messaging, it starts with baggage\_.

|  |  |
| --- | --- |
| [Important] | **Important** |
| There is currently no limitation of the count or size of baggage items. However, keep in mind that too many can decrease system throughput or increase RPC latency. In extreme cases, too much baggage can crash the application, due to exceeding transport-level message or header capacity. |

The following example shows setting baggage on a span:

Span initialSpan = **this**.tracer.nextSpan().name("span").start();

**try** (Tracer.SpanInScope ws = **this**.tracer.withSpanInScope(initialSpan)) {

ExtraFieldPropagation.set("foo", "bar");

ExtraFieldPropagation.set("UPPER\_CASE", "someValue");

}

#### Baggage versus Span Tags

Baggage travels with the trace (every child span contains the baggage of its parent). Zipkin has no knowledge of baggage and does not receive that information.

Tags are attached to a specific span. In other words, they are presented only for that particular span. However, you can search by tag to find the trace, assuming a span having the searched tag value exists.

If you want to be able to lookup a span based on baggage, you should add a corresponding entry as a tag in the root span.

|  |  |
| --- | --- |
| [Important] | **Important** |
| The span must be in scope. |

The following listing shows integration tests that use baggage:

initialSpan.tag("foo",

ExtraFieldPropagation.get(initialSpan.context(), "foo"));

initialSpan.tag("UPPER\_CASE",

ExtraFieldPropagation.get(initialSpan.context(), "UPPER\_CASE"));

## 49.3 Adding Sleuth to the Project

This section addresses how to add Sleuth to your project with either Maven or Gradle.

|  |  |
| --- | --- |
| [Important] | **Important** |
| To ensure that your application name is properly displayed in Zipkin, set the spring.application.name property in bootstrap.yml. |

### 49.3.1 Only Sleuth (log correlation)

If you want to use only Spring Cloud Sleuth without the Zipkin integration, add the spring-cloud-starter-sleuth module to your project.

The following example shows how to add Sleuth with Maven:

**Maven.**

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${release.train.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-sleuth</artifactId>

</dependency>

|  |  |
| --- | --- |
|  | We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself. |
|  | Add the dependency to spring-cloud-starter-sleuth. |

The following example shows how to add Sleuth with Gradle:

**Gradle.**

dependencyManagement {

imports {

mavenBom "org.springframework.cloud:spring-cloud-dependencies:${releaseTrainVersion}"

}

}

dependencies {

compile "org.springframework.cloud:spring-cloud-starter-sleuth"

}

|  |  |
| --- | --- |
|  | We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself. |
|  | Add the dependency to spring-cloud-starter-sleuth. |

### 49.3.2 Sleuth with Zipkin via HTTP

If you want both Sleuth and Zipkin, add the spring-cloud-starter-zipkin dependency.

The following example shows how to do so for Maven:

**Maven.**

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${release.train.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-zipkin</artifactId>

</dependency>

|  |  |
| --- | --- |
|  | We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself. |
|  | Add the dependency to spring-cloud-starter-zipkin. |

The following example shows how to do so for Gradle:

**Gradle.**

dependencyManagement {

imports {

mavenBom "org.springframework.cloud:spring-cloud-dependencies:${releaseTrainVersion}"

}

}

dependencies {

compile "org.springframework.cloud:spring-cloud-starter-zipkin"

}

|  |  |
| --- | --- |
|  | We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself. |
|  | Add the dependency to spring-cloud-starter-zipkin. |

### 49.3.3 Sleuth with Zipkin over RabbitMQ or Kafka

If you want to use RabbitMQ or Kafka instead of HTTP, add the spring-rabbit or spring-kafka dependency. The default destination name is zipkin.

|  |  |
| --- | --- |
| [Caution] | **Caution** |
| spring-cloud-sleuth-stream is deprecated and incompatible with these destinations. |

If you want Sleuth over RabbitMQ, add the spring-cloud-starter-zipkin and spring-rabbit dependencies.

The following example shows how to do so for Gradle:

**Maven.**

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${release.train.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-zipkin</artifactId>

</dependency>

<dependency>

<groupId>org.springframework.amqp</groupId>

<artifactId>spring-rabbit</artifactId>

</dependency>

|  |  |
| --- | --- |
|  | We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself. |
|  | Add the dependency to spring-cloud-starter-zipkin. That way, all nested dependencies get downloaded. |
|  | To automatically configure RabbitMQ, add the spring-rabbit dependency. |

**Gradle.**

dependencyManagement {

imports {

mavenBom "org.springframework.cloud:spring-cloud-dependencies:${releaseTrainVersion}"

}

}

dependencies {

compile "org.springframework.cloud:spring-cloud-starter-zipkin"

compile "org.springframework.amqp:spring-rabbit"

}

|  |  |
| --- | --- |
|  | We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself. |
|  | Add the dependency to spring-cloud-starter-zipkin. That way, all nested dependencies get downloaded. |
|  | To automatically configure RabbitMQ, add the spring-rabbit dependency. |

## 50. Additional Resources

You can watch a video of Marcin Grzejszczak talking about Spring Cloud Sleuth and Zipkin:

[click here to see the video](https://www.youtube.com/watch?v=eQV71Mw1u1c)

## 51. Features

* Adds trace and span IDs to the Slf4J MDC, so you can extract all the logs from a given trace or span in a log aggregator, as shown in the following example logs:
* 2016-02-02 15:30:57.902 INFO [bar,6bfd228dc00d216b,6bfd228dc00d216b,false] 23030 --- [nio-8081-exec-3] ...
* 2016-02-02 15:30:58.372 ERROR [bar,6bfd228dc00d216b,6bfd228dc00d216b,false] 23030 --- [nio-8081-exec-3] ...

2016-02-02 15:31:01.936 INFO [bar,46ab0d418373cbc9,46ab0d418373cbc9,false] 23030 --- [nio-8081-exec-4] ...

Notice the [appname,traceId,spanId,exportable] entries from the MDC:

* + **spanId**: The ID of a specific operation that took place.
  + **appname**: The name of the application that logged the span.
  + **traceId**: The ID of the latency graph that contains the span.
  + **exportable**: Whether the log should be exported to Zipkin. When would you like the span not to be exportable? When you want to wrap some operation in a Span and have it written to the logs only.
* Provides an abstraction over common distributed tracing data models: traces, spans (forming a DAG), annotations, and key-value annotations. Spring Cloud Slwuth is loosely based on HTrace but is compatible with Zipkin (Dapper).
* Sleuth records timing information to aid in latency analysis. By using sleuth, you can pinpoint causes of latency in your applications.
* Sleuth is written to not log too much and to not cause your production application to crash. To that end, Sleuth:
  + Propagates structural data about your call graph in-band and the rest out-of-band.
  + Includes opinionated instrumentation of layers such as HTTP.
  + Includes a sampling policy to manage volume.
  + Can report to a Zipkin system for query and visualization.
* Instruments common ingress and egress points from Spring applications (servlet filter, async endpoints, rest template, scheduled actions, message channels, Zuul filters, and Feign client).
* Sleuth includes default logic to join a trace across HTTP or messaging boundaries. For example, HTTP propagation works over Zipkin-compatible request headers. This propagation logic is defined and customized through SpanInjector and SpanExtractor implementations.
* Sleuth can propagate context (also known as baggage) between processes. Consequently, if you set a baggage element on a Span, it is sent downstream to other processes over either HTTP or messaging.
* Provides a way to create or continue spans and add tags and logs through annotations.
* If spring-cloud-sleuth-zipkin is on the classpath, the app generates and collects Zipkin-compatible traces. By default, it sends them over HTTP to a Zipkin server on localhost (port 9411). You can configure the location of the service by setting spring.zipkin.baseUrl.
  + If you depend on spring-rabbit or spring-kafka, your app sends traces to a broker instead of HTTP. \*\*

|  |  |
| --- | --- |
| [Caution] | **Caution** |
| spring-cloud-sleuth-stream is deprecated and should no longer be used. |

* Spring Cloud Sleuth is [OpenTracing](http://opentracing.io/) compatible.

|  |  |  |
| --- | --- | --- |
| [Important] | | **Important** |
| If you use Zipkin, configure the probability of spans exported by setting spring.sleuth.sampler.probability (default: 0.1, which is 10 percent). Otherwise, you might think that Sleuth is not working be cause it omits some spans. |
| [Note] |
| The SLF4J MDC is always set and logback users immediately see the trace and span IDs in logs per the example shown earlier. Other logging systems have to configure their own formatter to get the same result. The default is as follows: logging.pattern.level set to %5p [${spring.zipkin.service.name:${spring.application.name:-}},%X{X-B3-TraceId:-},%X{X-B3-SpanId:-},%X{X-Span-Export:-}](this is a Spring Boot feature for logback users). If you do not use SLF4J, this pattern is NOT automatically applied. | | |

## 51.1 Introduction to Brave

|  |  |
| --- | --- |
| [Important] | **Important** |
| Starting with version 2.0.0, Spring Cloud Sleuth uses [Brave](https://github.com/openzipkin/brave) as the tracing library. For your convenience, we embed part of the Brave’s docs here. |

Brave is a library used to capture and report latency information about distributed operations to Zipkin. Most users do not use Brave directly. They use libraries or frameworks rather than employ Brave on their behalf.

This module includes a tracer that creates and joins spans that model the latency of potentially distributed work. It also includes libraries to propagate the trace context over network boundaries (for example, with HTTP headers).

### 51.1.1 Tracing

Most importantly, you need a brave.Tracer, configured to [report to Zipkin](https://github.com/openzipkin/zipkin-reporter-java).

The following example setup sends trace data (spans) to Zipkin over HTTP (as opposed to Kafka):

**class** MyClass {

**private** **final** Tracer tracer;

*// Tracer will be autowired*

MyClass(Tracer tracer) {

**this**.tracer = tracer;

}

**void** doSth() {

Span span = tracer.newTrace().name("encode").start();

*// ...*

}

}

|  |  |
| --- | --- |
| [Important] | **Important** |
| If your span contains a name longer than 50 chars, then that name is truncated to 50 chars. Your names have to be explicit and concrete. Big names lead to latency issues and sometimes even thrown exceptions. |

The tracer creates and joins spans that model the latency of potentially distributed work. It can employ sampling to reduce overhead during the process, to reduce the amount of data sent to Zipkin, or both.

Spans returned by a tracer report data to Zipkin when finished or do nothing if unsampled. After starting a span, you can annotate events of interest or add tags containing details or lookup keys.

Spans have a context that includes trace identifiers that place the span at the correct spot in the tree representing the distributed operation.

### 51.1.2 Local Tracing

When tracing local code, you can run it inside a span, as shown in the following example:

Span span = tracer.newTrace().name("encode").start();

**try** {

doSomethingExpensive();

} **finally** {

span.finish();

}

In the preceding example, the span is the root of the trace. In many cases, the span is part of an existing trace. When this is the case, call newChild instead of newTrace, as shown in the following example:

Span span = tracer.newChild(root.context()).name("encode").start();

**try** {

doSomethingExpensive();

} **finally** {

span.finish();

}

### 51.1.3 Customizing Spans

Once you have a span, you can add tags to it. The tags can be used as lookup keys or details. For example, you might add a tag with your runtime version, as shown in the following example:

span.tag("clnt/finagle.version", "6.36.0");

When exposing the ability to customize spans to third parties, prefer brave.SpanCustomizer as opposed to brave.Span. The former is simpler to understand and test and does not tempt users with span lifecycle hooks.

**interface** MyTraceCallback {

**void** request(Request request, SpanCustomizer customizer);

}

Since brave.Span implements brave.SpanCustomizer, you can pass it to users, as shown in the following example:

**for** (MyTraceCallback callback : userCallbacks) {

callback.request(request, span);

}

### 51.1.4 Implicitly Looking up the Current Span

Sometimes, you do not know if a trace is in progress or not, and you do not want users to do null checks. brave.CurrentSpanCustomizer handles this problem by adding data to any span that’s in progress or drops, as shown in the following example:

Ex.

*// The user code can then inject this without a chance of it being null.*

*@Autowire* SpanCustomizer span;

**void** userCode() {

span.annotate("tx.started");

...

}

### 51.1.5 RPC tracing

|  |
| --- |
| [Tip] |
| Check for [instrumentation written here](https://github.com/openzipkin/sleuth/tree/master/instrumentation) and [Zipkin’s list](http://zipkin.io/pages/existing_instrumentations.html) before rolling your own RPC instrumentation. |

RPC tracing is often done automatically by interceptors. Behind the scenes, they add tags and events that relate to their role in an RPC operation.

The following example shows how to add a client span:

*// before you send a request, add metadata that describes the operation*

span = tracer.newTrace().name("get").type(CLIENT);

span.tag("clnt/finagle.version", "6.36.0");

span.tag(TraceKeys.HTTP\_PATH, "/api");

span.remoteEndpoint(Endpoint.builder()

.serviceName("backend")

.ipv4(127 << 24 | 1)

.port(8080).build());

*// when the request is scheduled, start the span*

span.start();

*// if you have callbacks for when data is on the wire, note those events*

span.annotate(Constants.WIRE\_SEND);

span.annotate(Constants.WIRE\_RECV);

*// when the response is complete, finish the span*

span.finish();

#### One-Way tracing

Sometimes, you need to model an asynchronous operation where there is a request but no response. In normal RPC tracing, you use span.finish() to indicate that the response was received. In one-way tracing, you use span.flush() instead, as you do not expect a response.

The following example shows how a client might model a one-way operation:

*// start a new span representing a client request*

oneWaySend = tracer.newSpan(parent).kind(Span.Kind.CLIENT);

*// Add the trace context to the request, so it can be propagated in-band*

tracing.propagation().injector(Request::addHeader)

.inject(oneWaySend.context(), request);

*// fire off the request asynchronously, totally dropping any response*

request.execute();

*// start the client side and flush instead of finish*

oneWaySend.start().flush();

The following example shows how a server might handle a one-way operation:

*// pull the context out of the incoming request*

extractor = tracing.propagation().extractor(Request::getHeader);

*// convert that context to a span which you can name and add tags to*

oneWayReceive = nextSpan(tracer, extractor.extract(request))

.name("process-request")

.kind(SERVER)

... add tags etc.

*// start the server side and flush instead of finish*

oneWayReceive.start().flush();

*// you should not modify this span anymore as it is complete. However,*

*// you can create children to represent follow-up work.*

next = tracer.newSpan(oneWayReceive.context()).name("step2").start();

|  |
| --- |
| [Note] |
| The propagation logic shown in the preceding example is a simplified version of our [http handlers](<https://github.com/openzipkin/sleuth/tree/master/instrumentation/http#http-server>). |

You can find a working example of a one-way span [here](src/test/java/sleuth/features/async/OneWaySpanTest.java).

## 52. Sampling

Sampling may be employed to reduce the data collected and reported out of process. When a span is not sampled, it adds no overhead (a noop).

Sampling is an up-front decision, meaning that the decision to report data is made at the first operation in a trace and that decision is propagated downstream.

By default, a global sampler applies a single rate to all traced operations. Tracer.Builder.sampler controls this setting, and it defaults to tracing every request.

## 52.1 Declarative sampling

Some applications need to sample based on the type or annotations of a java method.

Most users use a framework interceptor to automate this sort of policy. The following example shows how that might work internally:

*// derives a sample rate from an annotation on a java method*

DeclarativeSampler<Traced> sampler = DeclarativeSampler.create(Traced::sampleRate);

*@Around("@annotation(traced)")*

**public** Object traceThing(ProceedingJoinPoint pjp, Traced traced) **throws** Throwable {

Span span = tracing.tracer().newTrace(sampler.sample(traced))...

**try** {

**return** pjp.proceed();

} **finally** {

span.finish();

}

}

## 52.2 Custom sampling

Depending on what the operation is, you may want to apply different policies. For example, you might not want to trace requests to static resources such as images, or you might want to trace all requests to a new api.

Most users use a framework interceptor to automate this sort of policy. The following example shows how that might work internally:

Span newTrace(Request input) {

SamplingFlags flags = SamplingFlags.NONE;

**if** (input.url().startsWith("/experimental")) {

flags = SamplingFlags.SAMPLED;

} **else** **if** (input.url().startsWith("/static")) {

flags = SamplingFlags.NOT\_SAMPLED;

}

**return** tracer.newTrace(flags);

}

|  |
| --- |
| [Note] |
| The preceding example forms the basis for the built-in [http sampler](https://github.com/openzipkin/sleuth/tree/master/instrumentation/http). |

## 52.3 Sampling in Spring Cloud Sleuth

By default Spring Cloud Sleuth sets all spans to non-exportable. That means that traces appear in logs but not in any remote store. For testing the default is often enough, and it probably is all you need if you use only the logs (for example, with an ELK aggregator). If you export span data to Zipkin, there is also an Sampler.ALWAYS\_SAMPLE setting that exports everything and a ProbabilityBasedSampler setting that samples a fixed fraction of spans.

|  |
| --- |
| [Note] |
| The ProbabilityBasedSampler is the default if you use spring-cloud-sleuth-zipkin. You can configure the exports by setting spring.sleuth.sampler.probability. The passed value needs to be a double from 0.0 to 1.0. |

A sampler can be installed by creating a bean definition, as shown in the following example:

*@Bean*

**public** Sampler defaultSampler() {

**return** Sampler.ALWAYS\_SAMPLE;

}

|  |
| --- |
| [Tip] |
| You can set the HTTP header X-B3-Flags to 1, or, when doing messaging, you can set the spanFlags header to 1. Doing so forces the current span to be exportable regardless of the sampling decision. |

## 53. Propagation

Propagation is needed to ensure activities originating from the same root are collected together in the same trace. The most common propagation approach is to copy a trace context from a client by sending an RPC request to a server receiving it.

For example, when a downstream HTTP call is made, its trace context is encoded as request headers and sent along with it, as shown in the following image:

Client Span Server Span

┌──────────────────┐ ┌──────────────────┐

│ │ │ │

│ TraceContext │ Http Request Headers │ TraceContext │

│ ┌──────────────┐ │ ┌───────────────────┐ │ ┌──────────────┐ │

│ │ TraceId │ │ │ X─B3─TraceId │ │ │ TraceId │ │

│ │ │ │ │ │ │ │ │ │

│ │ ParentSpanId │ │ Extract │ X─B3─ParentSpanId │ Inject │ │ ParentSpanId │ │

│ │ ├─┼─────────>│ ├────────┼>│ │ │

│ │ SpanId │ │ │ X─B3─SpanId │ │ │ SpanId │ │

│ │ │ │ │ │ │ │ │ │

│ │ Sampled │ │ │ X─B3─Sampled │ │ │ Sampled │ │

│ └──────────────┘ │ └───────────────────┘ │ └──────────────┘ │

│ │ │ │

└──────────────────┘ └──────────────────┘

The names above are from [B3 Propagation](https://github.com/openzipkin/b3-propagation), which is built-in to Brave and has implementations in many languages and frameworks.

Most users use a framework interceptor to automate propagation. The next two examples show how that might work for a client and a server.

The following example shows how client-side propagation might work:

*// configure a function that injects a trace context into a request*

injector = tracing.propagation().injector(Request.Builder::addHeader);

*// before a request is sent, add the current span's context to it*

injector.inject(span.context(), request);

The following example shows how server-side propagation might work:

*// configure a function that extracts the trace context from a request*

extracted = tracing.propagation().extractor(Request::getHeader);

*// when a server receives a request, it joins or starts a new trace*

span = tracer.nextSpan(extracted, request);

## 53.1 Propagating extra fields

Sometimes you need to propagate extra fields, such as a request ID or an alternate trace context. For example, if you are in a Cloud Foundry environment, you might want to pass the request ID, as shown in the following example:

*// when you initialize the builder, define the extra field you want to propagate*

tracingBuilder.propagationFactory(

ExtraFieldPropagation.newFactory(B3Propagation.FACTORY, "x-vcap-request-id")

);

*// later, you can tag that request ID or use it in log correlation*

requestId = ExtraFieldPropagation.get("x-vcap-request-id");

You may also need to propagate a trace context that you are not using. For example, you may be in an Amazon Web Services environment but not be reporting data to X-Ray. To ensure X-Ray can co-exist correctly, pass-through its tracing header, as shown in the following example:

tracingBuilder.propagationFactory(

ExtraFieldPropagation.newFactory(B3Propagation.FACTORY, "x-amzn-trace-id")

);

### 53.1.1 Prefixed fields

If they follow a common pattern, you can also prefix fields. The following example shows how to propagate x-vcap-request-id the field as-is but send the country-code and user-id fields on the wire as x-baggage-country-code and x-baggage-user-id, respectively:

tracingBuilder.propagationFactory(

ExtraFieldPropagation.newFactoryBuilder(B3Propagation.FACTORY)

.addField("x-vcap-request-id")

.addPrefixedFields("baggage-", Arrays.asList("country-code", "user-id"))

.build()

);

Later, you can call the following code to affect the country code of the current trace context:

ExtraFieldPropagation.set("country-code", "FO");

String countryCode = ExtraFieldPropagation.get("country-code");

Alternatively, if you have a reference to a trace context, you can use it explicitly, as shown in the following example:

ExtraFieldPropagation.set(span.context(), "country-code", "FO");

String countryCode = ExtraFieldPropagation.get(span.context(), "country-code");

|  |  |
| --- | --- |
| [Important] | **Important** |
| A difference from previous versions of Sleuth is that, with Brave, you must pass the list of baggage keys. There are two properties to achieve this. With the spring.sleuth.baggage-keys, you set keys that get prefixed with baggage- for HTTP calls and baggage\_ for messaging. You can also use the spring.sleuth.propagation-keys property to pass a list of prefixed keys that are whitelisted without any prefix. |

### 53.1.2 Extracting a Propagated Context

The TraceContext.Extractor<C> reads trace identifiers and sampling status from an incoming request or message. The carrier is usually a request object or headers.

This utility is used in standard instrumentation (such as [HttpServerHandler](../instrumentation/http/src/main/java/sleuth/http/HttpServerHandler.java)) but can also be used for custom RPC or messaging code.

TraceContextOrSamplingFlags is usually used only with Tracer.nextSpan(extracted), unless you are sharing span IDs between a client and a server.

### 53.1.3 Sharing span IDs between Client and Server

A normal instrumentation pattern is to create a span representing the server side of an RPC. Extractor.extract might return a complete trace context when applied to an incoming client request. Tracer.joinSpan attempts to continue this trace, using the same span ID if supported or creating a child span if not. When the span ID is shared, the reported data includes a flag saying so.

The following image shows an example of B3 propagation:

┌───────────────────┐ ┌───────────────────┐

Incoming Headers │ TraceContext │ │ TraceContext │

┌───────────────────┐(extract)│ ┌───────────────┐ │(join)│ ┌───────────────┐ │

│ X─B3-TraceId │─────────┼─┼> TraceId │ │──────┼─┼> TraceId │ │

│ │ │ │ │ │ │ │ │ │

│ X─B3-ParentSpanId │─────────┼─┼> ParentSpanId │ │──────┼─┼> ParentSpanId │ │

│ │ │ │ │ │ │ │ │ │

│ X─B3-SpanId │─────────┼─┼> SpanId │ │──────┼─┼> SpanId │ │

└───────────────────┘ │ │ │ │ │ │ │ │

│ │ │ │ │ │ Shared: true │ │

│ └───────────────┘ │ │ └───────────────┘ │

└───────────────────┘ └───────────────────┘

Some propagation systems forward only the parent span ID, detected when Propagation.Factory.supportsJoin() == false. In this case, a new span ID is always provisioned, and the incoming context determines the parent ID.

The following image shows an example of AWS propagation:

┌───────────────────┐ ┌───────────────────┐

x-amzn-trace-id │ TraceContext │ │ TraceContext │

┌───────────────────┐(extract)│ ┌───────────────┐ │(join)│ ┌───────────────┐ │

│ Root │─────────┼─┼> TraceId │ │──────┼─┼> TraceId │ │

│ │ │ │ │ │ │ │ │ │

│ Parent │─────────┼─┼> SpanId │ │──────┼─┼> ParentSpanId │ │

└───────────────────┘ │ └───────────────┘ │ │ │ │ │

└───────────────────┘ │ │ SpanId: New │ │

│ └───────────────┘ │

└───────────────────┘

Note: Some span reporters do not support sharing span IDs. For example, if you set Tracing.Builder.spanReporter(amazonXrayOrGoogleStackdrive), you should disable join by setting Tracing.Builder.supportsJoin(false). Doing so forces a new child span on Tracer.joinSpan().

### 53.1.4 Implementing Propagation

TraceContext.Extractor<C> is implemented by a Propagation.Factory plugin. Internally, this code creates the union type, TraceContextOrSamplingFlags, with one of the following: \* TraceContext if trace and span IDs were present. \* TraceIdContext if a trace ID was present but span IDs were not present. \* SamplingFlags if no identifiers were present.

Some Propagation implementations carry extra data from the point of extraction (for example, reading incoming headers) to injection (for example, writing outgoing headers). For example, it might carry a request ID. When implementations have extra data, they handle it as follows: \* If a TraceContext were extracted, add the extra data as TraceContext.extra(). \* Otherwise, add it as TraceContextOrSamplingFlags.extra(), which Tracer.nextSpan handles.

## 54. Current Tracing Component

Brave supports a “current tracing component” concept, which should only be used when you have no other way to get a reference. This was made for JDBC connections, as they often initialize prior to the tracing component.

The most recent tracing component instantiated is available through Tracing.current(). You can also use Tracing.currentTracer() to get only the tracer. If you use either of these methods, do not cache the result. Instead, look them up each time you need them.

## 55. Current Span

Brave supports a “current span” concept which represents the in-flight operation. You can use Tracer.currentSpan() to add custom tags to a span and Tracer.nextSpan() to create a child of whatever is in-flight.

## 55.1 Setting a span in scope manually

When writing new instrumentation, it is important to place a span you created in scope as the current span. Not only does doing so let users access it with Tracer.currentSpan(), but it also allows customizations such as SLF4J MDC to see the current trace IDs.

Tracer.withSpanInScope(Span) facilitates this and is most conveniently employed by using the try-with-resources idiom. Whenever external code might be invoked (such as proceeding an interceptor or otherwise), place the span in scope, as shown in the following example:

**try** (SpanInScope ws = tracer.withSpanInScope(span)) {

**return** inboundRequest.invoke();

} **finally** { *// note the scope is independent of the span*

span.finish();

}

In edge cases, you may need to clear the current span temporarily (for example, launching a task that should not be associated with the current request). To do tso, pass null to withSpanInScope, as shown in the following example:

**try** (SpanInScope cleared = tracer.withSpanInScope(null)) {

startBackgroundThread();

}

## 56. Instrumentation

Spring Cloud Sleuth automatically instruments all your Spring applications, so you should not have to do anything to activate it. The instrumentation is added by using a variety of technologies according to the stack that is available. For example, for a servlet web application, we use a Filter, and, for Spring Integration, we use ChannelInterceptors.

You can customize the keys used in span tags. To limit the volume of span data, an HTTP request is, by default, tagged only with a handful of metadata, such as the status code, the host, and the URL. You can add request headers by configuring spring.sleuth.keys.http.headers (a list of header names).

|  |
| --- |
| [Note] |
| Tags are collected and exported only if there is a Sampler that allows it. By default, there is no such Sampler, to ensure that there is no danger of accidentally collecting too much data without configuring something). |

## 57. Span lifecycle

You can do the following operations on the Span by means of brave.Tracer:

* [start](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__span_lifecycle.html#creating-and-finishing-spans): When you start a span, its name is assigned and the start timestamp is recorded.
* [close](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__span_lifecycle.html#creating-and-finishing-spans): The span gets finished (the end time of the span is recorded) and, if the span is sampled, it is eligible for collection (for example, to Zipkin).
* [continue](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__span_lifecycle.html#continuing-spans): A new instance of span is created. It is a copy of the one that it continues.
* [detach](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__span_lifecycle.html#continuing-spans): The span does not get stopped or closed. It only gets removed from the current thread.
* [create with explicit parent](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__span_lifecycle.html#creating-spans-with-explicit-parent): You can create a new span and set an explicit parent for it.

|  |
| --- |
| [Tip] |
| Spring Cloud Sleuth creates an instance of Tracer for you. In order to use it, you can autowire it. |

## 57.1 Creating and finishing spans

You can manually create spans by using the Tracer, as shown in the following example:

*// Start a span. If there was a span present in this thread it will become*

*// the `newSpan`'s parent.*

Span newSpan = **this**.tracer.nextSpan().name("calculateTax");

**try** (Tracer.SpanInScope ws = **this**.tracer.withSpanInScope(newSpan.start())) {

*// ...*

*// You can tag a span*

newSpan.tag("taxValue", taxValue);

*// ...*

*// You can log an event on a span*

newSpan.annotate("taxCalculated");

} **finally** {

*// Once done remember to finish the span. This will allow collecting*

*// the span to send it to Zipkin*

newSpan.finish();

}

In the preceding example, we could see how to create a new instance of the span. If there is already a span in this thread, it becomes the parent of the new span.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Always clean after you create a span. Also, always finish any span that you want to send to Zipkin. |
| [Important] | **Important** | |
| If your span contains a name greater than 50 chars, that name is truncated to 50 chars. Your names have to be explicit and concrete. Big names lead to latency issues and sometimes even exceptions. | |

## 57.2 Continuing Spans

Sometimes, you do not want to create a new span but you want to continue one. An example of such a situation might be as follows:

* **AOP**: If there was already a span created before an aspect was reached, you might not want to create a new span.
* **Hystrix**: Executing a Hystrix command is most likely a logical part of the current processing. It is in fact merely a technical implementation detail that you would not necessarily want to reflect in tracing as a separate being.

To continue a span, you can use brave.Tracer, as shown in the following example:

*// let's assume that we're in a thread Y and we've received*

*// the `initialSpan` from thread X*

Span continuedSpan = **this**.tracer.joinSpan(newSpan.context());

**try** {

*// ...*

*// You can tag a span*

continuedSpan.tag("taxValue", taxValue);

*// ...*

*// You can log an event on a span*

continuedSpan.annotate("taxCalculated");

} **finally** {

*// Once done remember to flush the span. That means that*

*// it will get reported but the span itself is not yet finished*

continuedSpan.flush();

}

## 57.3 Creating a Span with an explicit Parent

You might want to start a new span and provide an explicit parent of that span. Assume that the parent of a span is in one thread and you want to start a new span in another thread. In Brave, whenever you call nextSpan(), it creates a span in reference to the span that is currently in scope. You can put the span in scope and then call nextSpan(), as shown in the following example:

*// let's assume that we're in a thread Y and we've received*

*// the `initialSpan` from thread X. `initialSpan` will be the parent*

*// of the `newSpan`*

Span newSpan = null;

**try** (Tracer.SpanInScope ws = **this**.tracer.withSpanInScope(initialSpan)) {

newSpan = **this**.tracer.nextSpan().name("calculateCommission");

*// ...*

*// You can tag a span*

newSpan.tag("commissionValue", commissionValue);

*// ...*

*// You can log an event on a span*

newSpan.annotate("commissionCalculated");

} **finally** {

*// Once done remember to finish the span. This will allow collecting*

*// the span to send it to Zipkin. The tags and events set on the*

*// newSpan will not be present on the parent*

**if** (newSpan != null) {

newSpan.finish();

}

}

|  |  |
| --- | --- |
| [Important] | **Important** |
| After creating such a span, you must finish it. Otherwise it is not reported (for example, to Zipkin). |

## 58. Naming spans

Picking a span name is not a trivial task. A span name should depict an operation name. The name should be low cardinality, so it should not include identifiers.

Since there is a lot of instrumentation going on, some span names are artificial:

* controller-method-name when received by a Controller with a method name of conrollerMethodName
* async for asynchronous operations done with wrapped Callable and Runnable interfaces.
* Methods annotated with @Scheduled return the simple name of the class.

Fortunately, for asynchronous processing, you can provide explicit naming.

## 58.1 @SpanName Annotation

You can name the span explicitly by using the @SpanName annotation, as shown in the followwng example:

*@SpanName("calculateTax")*

**class** TaxCountingRunnable **implements** Runnable {

*@Override* **public** **void** run() {

*// perform logic*

}

}

In this case, when processed in the following manner, the span is named calculateTax:

Runnable runnable = **new** TraceRunnable(tracer, spanNamer, errorParser,

**new** TaxCountingRunnable());

Future<?> future = executorService.submit(runnable);

*// ... some additional logic ...*

future.get();

## 58.2 toString() method

It is pretty rare to create separate classes for Runnable or Callable. Typically, one creates an anonymous instance of those classes. You cannot annotate such classes. To overcome that limitation, if there is no @SpanName annotation present, we check whether the class has a custom implementation of the toString()method.

Running such code leads to creating a span named calculateTax, as shown in the following example:

Runnable runnable = **new** TraceRunnable(tracer, spanNamer, errorParser, **new** Runnable() {

*@Override* **public** **void** run() {

*// perform logic*

}

*@Override* **public** String toString() {

**return** "calculateTax";

}

});

Future<?> future = executorService.submit(runnable);

*// ... some additional logic ...*

future.get();

## 59. Managing Spans with Annotations

You can manage spans with a variety of annotations.

## 59.1 Rationale

There are a number of good reasons to manage spans with annotations, including:

* API-agnostic means to collaborate with a span. Use of annotations lets users add to a span with no library dependency on a span api. Doing so lets Sleuth change its core API to create less impact to user code.
* Reduced surface area for basic span operations. Without this feature, you must use the span api, which has lifecycle commands that could be used incorrectly. By only exposing scope, tag, and log functionality, you can collaborate without accidentally breaking span lifecycle.
* Collaboration with runtime generated code. With libraries such as Spring Data and Feign, the implementations of interfaces are generated at runtime. Consequently, span wrapping of objects was tedious. Now you can provide annotations over interfaces and the arguments of those interfaces.

## 59.2 Creating New Spans

If you do not want to create local spans manually, you can use the @NewSpan annotation. Also, we provide the @SpanTag annotation to add tags in an automated fashion.

Now we can consider some examples of usage.

*@NewSpan*

**void** testMethod();

Annotating the method without any parameter leads to creating a new span whose name equals the annotated method name.

*@NewSpan("customNameOnTestMethod4")*

**void** testMethod4();

If you provide the value in the annotation (either directly or by setting the name parameter), the created span has the provided value as the name.

*// method declaration*

*@NewSpan(name = "customNameOnTestMethod5")*

**void** testMethod5(*@SpanTag("testTag")* String param);

*// and method execution*

**this**.testBean.testMethod5("test");

You can combine both the name and a tag. Let’s focus on the latter. In this case, the value of the annotated method’s parameter runtime value becomes the value of the tag. In our sample, the tag key is testTag, and the tag value is test.

*@NewSpan(name = "customNameOnTestMethod3")*

*@Override*

**public** **void** testMethod3() {

}

You can place the @NewSpan annotation on both the class and an interface. If you override the interface’s method and provide a different value for the @NewSpanannotation, the most concrete one wins (in this case customNameOnTestMethod3 is set).

## 59.3 Continuing Spans

If you want to add tags and annotations to an existing span, you can use the @ContinueSpan annotation, as shown in the following example:

*// method declaration*

*@ContinueSpan(log = "testMethod11")*

**void** testMethod11(*@SpanTag("testTag11")* String param);

*// method execution*

**this**.testBean.testMethod11("test");

**this**.testBean.testMethod13();

(Note that, in contrast with the @NewSpan annotation ,you can also add logs with the log parameter.)

That way, the span gets continued and:

* Log entries named testMethod11.before and testMethod11.after are created.
* If an exception is thrown, a log entry named testMethod11.afterFailure is also created.
* A tag with a key of testTag11 and a value of test is created.

## 59.4 Advanced Tag Setting

There are 3 different ways to add tags to a span. All of them are controlled by the SpanTag annotation. The precedence is as follows:

1. Try with a bean of TagValueResolver type and a provided name.
2. If the bean name has not been provided, try to evaluate an expression. We search for a TagValueExpressionResolver bean. The default implementation uses SPEL expression resolution.
3. If we do not find any expression to evaluate, return the toString() value of the parameter.

### 59.4.1 Custom extractor

The value of the tag for the following method is computed by an implementation of TagValueResolver interface. Its class name has to be passed as the value of the resolver attribute.

Consider the following annotated method:

*@NewSpan*

**public** **void** getAnnotationForTagValueResolver(*@SpanTag(key = "test", resolver = TagValueResolver.class)* String test) {

}

Now further consider the following TagValueResolver bean implementation:

*@Bean(name = "myCustomTagValueResolver")*

**public** TagValueResolver tagValueResolver() {

**return** parameter -> "Value from myCustomTagValueResolver";

}

The two preceding examples lead to setting a tag value equal to Value from myCustomTagValueResolver.

### 59.4.2 Resolving Expressions for a Value

Consider the following annotated method:

*@NewSpan*

**public** **void** getAnnotationForTagValueExpression(*@SpanTag(key = "test", expression = "length() + ' characters'")* String test) {

}

No custom implementation of a TagValueExpressionResolver leads to evaluation of the SPEL expression, and a tag with a value of 4 characters is set on the span. If you want to use some other expression resolution mechanism, you can create your own implementation of the bean.

### 59.4.3 Using the toString() method

Consider the following annotated method:

*@NewSpan*

**public** **void** getAnnotationForArgumentToString(*@SpanTag("test")* Long param) {

}

Running the preceding method with a value of 15 leads to setting a tag with a String value of "15".

## 60. Customizations

## 60.1 HTTP

If a customization of client / server parsing of the HTTP related spans is required, just register a bean of type brave.http.HttpClientParser orbrave.http.HttpServerParser. If client /server sampling is required, just register a bean of type brave.http.HttpSampler and name the beansleuthClientSampler for client sampler and sleuthServerSampler for server sampler. For your convenience the @ClientSampler and @ServerSamplerannotations can be used to inject the proper beans or to reference the bean names via their static String NAME fields.

Check out Brave’s code to see an example of how to make a path-based sampler <https://github.com/openzipkin/brave/tree/master/instrumentation/http#sampling-policy>

If you want to completely rewrite the HttpTracing bean you can use the SkipPatternProvider interface to retrieve the URL Pattern for spans that should be not sampled. Below you can see an example of usage of SkipPatternProvider inside a server side, HttpSampler.

*@Configuration*

**class** Config {

*@Bean(name = ServerSampler.NAME)*

HttpSampler myHttpSampler(SkipPatternProvider provider) {

Pattern pattern = provider.skipPattern();

**return** **new** HttpSampler() {

*@Override* **public** <Req> Boolean trySample(HttpAdapter<Req, ?> adapter, Req request) {

String url = adapter.path(request);

**boolean** shouldSkip = pattern.matcher(url).matches();

**if** (shouldSkip) {

**return** false;

}

**return** null;

}

};

}

}

## 60.2 TraceFilter

You can also modify the behavior of the TraceFilter, which is the component that is responsible for processing the input HTTP request and adding tags basing on the HTTP response. You can customize the tags or modify the response headers by registering your own instance of the TraceFilter bean.

In the following example, we register the TraceFilter bean, add the ZIPKIN-TRACE-ID response header containing the current Span’s trace id, and add a tag with key custom and a value tag to the span.

*@Component*

*@Order(TraceWebServletAutoConfiguration.TRACING\_FILTER\_ORDER + 1)*

**class** MyFilter **extends** GenericFilterBean {

**private** **final** Tracer tracer;

MyFilter(Tracer tracer) {

**this**.tracer = tracer;

}

*@Override* **public** **void** doFilter(ServletRequest request, ServletResponse response,

FilterChain chain) **throws** IOException, ServletException {

Span currentSpan = **this**.tracer.currentSpan();

**if** (currentSpan == null) {

**return**;

}

*// for readability we're returning trace id in a hex form*

((HttpServletResponse) response)

.addHeader("ZIPKIN-TRACE-ID",

currentSpan.context().traceIdString());

*// we can also add some custom tags*

currentSpan.tag("custom", "tag");

chain.doFilter(request, response);

}

}

## 60.3 Custom service name

By default, Sleuth assumes that, when you send a span to Zipkin, you want the span’s service name to be equal to the value of the spring.application.nameproperty. That is not always the case, though. There are situations in which you want to explicitly provide a different service name for all spans coming from your application. To achieve that, you can pass the following property to your application to override that value (the example is for a service named myService):

spring.zipkin.service.name: myService

## 60.4 Customization of Reported Spans

Before reporting spans (for example, to Zipkin) you may want to modify that span in some way. You can do so by using the SpanAdjuster interface.

In Sleuth, we generat spans with a fixed name. Some users want to modify the name depending on values of tags. You can implement the SpanAdjuster interface to alter that name.

The following example shows how to register two beans that implement SpanAdjuster:

*@Bean* SpanAdjuster adjusterOne() {

**return** span -> span.toBuilder().name("foo").build();

}

*@Bean* SpanAdjuster adjusterTwo() {

**return** span -> span.toBuilder().name(span.name() + " bar").build();

}

The preceding example results in changing the name of the reported span to foo bar, just before it gets reported (for example, to Zipkin).

## 60.5 Host Locator

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is about defining **host** from service discovery. It is **NOT** about finding Zipkin through service discovery. |

To define the host that corresponds to a particular span, we need to resolve the host name and port. The default approach is to take these values from server properties. If those are not set, we try to retrieve the host name from the network interfaces.

If you have the discovery client enabled and prefer to retrieve the host address from the registered instance in a service registry, you have to set the spring.zipkin.locator.discovery.enabled property (it is applicable for both HTTP-based and Stream-based span reporting), as follows:

spring.zipkin.locator.discovery.enabled: **true**

## 61. Sending Spans to Zipkin

By default, if you add spring-cloud-starter-zipkin as a dependency to your project, when the span is closed, it is sent to Zipkin over HTTP. The communication is asynchronous. You can configure the URL by setting the spring.zipkin.baseUrl property, as follows:

spring.zipkin.baseUrl: http://192.168.99.100:9411/

If you want to find Zipkin through service discovery, you can pass the Zipkin’s service ID inside the URL, as shown in the following example for zipkinserver service ID:

spring.zipkin.baseUrl: http://zipkinserver/

If you have web, rabbit, or kafka together on the classpath, you might need to pick the means by which you would like to send spans to zipkin. To do so, set web, rabbit, or kafka to the spring.zipkin.sender.type property. The following example shows setting the sender type for web:

spring.zipkin.sender.type: web

## 62. Zipkin Stream Span Consumer

|  |  |
| --- | --- |
| [Important] | **Important** |
| We recommend using Zipkin’s native support for message-based span sending. Starting from the Edgware release, the Zipkin Stream server is deprecated. In the Finchley release, it got removed. |

See the [Dalston Documentaion](https://cloud.spring.io/spring-cloud-static/Dalston.SR4/multi/multi__span_data_as_messages.html#_zipkin_consumer) for how to create a Stream Zipkin server.

## 63. Integrations

## 63.1 OpenTracing

Spring Cloud Sleuth is compatible with [OpenTracing](http://opentracing.io/). If you have OpenTracing on the classpath, we automatically register the OpenTracing Tracer bean. If you wish to disable this, set spring.sleuth.opentracing.enabled to false

## 63.2 Runnable and Callable

If you wrap your logic in Runnable or Callable, you can wrap those classes in their Sleuth representative, as shown in the following example for Runnable:

Runnable runnable = **new** Runnable() {

*@Override*

**public** **void** run() {

*// do some work*

}

*@Override*

**public** String toString() {

**return** "spanNameFromToStringMethod";

}

};

*// Manual `TraceRunnable` creation with explicit "calculateTax" Span name*

Runnable traceRunnable = **new** TraceRunnable(tracer, spanNamer, errorParser,

runnable, "calculateTax");

*// Wrapping `Runnable` with `Tracing`. That way the current span will be available*

*// in the thread of `Runnable`*

Runnable traceRunnableFromTracer = tracing.currentTraceContext().wrap(runnable);

The following example shows how to do so for Callable:

Callable<String> callable = **new** Callable<String>() {

*@Override*

**public** String call() **throws** Exception {

**return** someLogic();

}

*@Override*

**public** String toString() {

**return** "spanNameFromToStringMethod";

}

};

*// Manual `TraceCallable` creation with explicit "calculateTax" Span name*

Callable<String> traceCallable = **new** TraceCallable<>(tracer, spanNamer, errorParser,

callable, "calculateTax");

*// Wrapping `Callable` with `Tracing`. That way the current span will be available*

*// in the thread of `Callable`*

Callable<String> traceCallableFromTracer = tracing.currentTraceContext().wrap(callable);

That way, you ensure that a new span is created and closed for each execution.

## 63.3 Hystrix

### 63.3.1 Custom Concurrency Strategy

We register a custom [HystrixConcurrencyStrategy](https://github.com/Netflix/Hystrix/wiki/Plugins#concurrencystrategy) called TraceCallable that wraps all Callable instances in their Sleuth representative. The strategy either starts or continues a span, depending on whether tracing was already going on before the Hystrix command was called. To disable the custom Hystrix Concurrency Strategy, set the spring.sleuth.hystrix.strategy.enabled to false.

### 63.3.2 Manual Command setting

Assume that you have the following HystrixCommand:

HystrixCommand<String> hystrixCommand = **new** HystrixCommand<String>(setter) {

*@Override*

**protected** String run() **throws** Exception {

**return** someLogic();

}

};

To pass the tracing information, you have to wrap the same logic in the Sleuth version of the HystrixCommand, which is called TraceCommand, as shown in the following example:

TraceCommand<String> traceCommand = **new** TraceCommand<String>(tracer, traceKeys, setter) {

*@Override*

**public** String doRun() **throws** Exception {

**return** someLogic();

}

};

## 63.4 RxJava

We registering a custom [RxJavaSchedulersHook](https://github.com/ReactiveX/RxJava/wiki/Plugins#rxjavaschedulershook) that wraps all Action0 instances in their Sleuth representative, which is called TraceAction. The hook either starts or continues a span, depending on whether tracing was already going on before the Action was scheduled. To disable the custom RxJavaSchedulersHook, set the spring.sleuth.rxjava.schedulers.hook.enabled to false.

You can define a list of regular expressions for thread names for which you do not want spans to be created. To do so, provide a comma-separated list of regular expressions in the spring.sleuth.rxjava.schedulers.ignoredthreads property.

|  |  |
| --- | --- |
| [Important] | **Important** |
| The suggest approach to reactive programming and Sleuth is to use the Reactor support. |

## 63.5 HTTP integration

Features from this section can be disabled by setting the spring.sleuth.web.enabled property with value equal to false.

### 63.5.1 HTTP Filter

Through the TraceFilter, all sampled incoming requests result in creation of a Span. That Span’s name is http: + the path to which the request was sent. For example, if the request was sent to /this/this then the name will be http:/this/that. You can configure which URIs you would like to skip by setting the spring.sleuth.web.skipPattern property. If you have ManagementServerProperties on classpath, its value of contextPath gets appended to the provided skip pattern. If you want to reuse the Sleuth’s default skip patterns and just append your own, pass those patterns by using the spring.sleuth.web.additionalSkipPattern.

### 63.5.2 HandlerInterceptor

Since we want the span names to be precise, we use a TraceHandlerInterceptor that either wraps an existing HandlerInterceptor or is added directly to the list of existing HandlerInterceptors. The TraceHandlerInterceptor adds a special request attribute to the given HttpServletRequest. If the the TraceFilterdoes not see this attribute, it creates a “fallback” span, which is an additional span created on the server side so that the trace is presented properly in the UI. If that happens, there is probably missing instrumentation. In that case, please file an issue in Spring Cloud Sleuth.

### 63.5.3 Async Servlet support

If your controller returns a Callable or a WebAsyncTask, Spring Cloud Sleuth continues the existing span instead of creating a new one.

### 63.5.4 WebFlux support

Through TraceWebFilter, all sampled incoming requests result in creation of a Span. That Span’s name is http: + the path to which the request was sent. For example, if the request was sent to /this/that, the name is http:/this/that. You can configure which URIs you would like to skip by using the spring.sleuth.web.skipPattern property. If you have ManagementServerProperties on the classpath, its value of contextPath gets appended to the provided skip pattern. If you want to reuse Sleuth’s default skip patterns and append your own, pass those patterns by using the spring.sleuth.web.additionalSkipPattern.

## 63.6 HTTP Client Integration

### 63.6.1 Synchronous Rest Template

We inject a RestTemplate interceptor to ensure that all the tracing information is passed to the requests. Each time a call is made, a new Span is created. It gets closed upon receiving the response. To block the synchronous RestTemplate features, set spring.sleuth.web.client.enabled to false.

|  |  |
| --- | --- |
| [Important] | **Important** |
| You have to register RestTemplate as a bean so that the interceptors get injected. If you create a RestTemplate instance with a new keyword, the instrumentation does NOT work. |

### 63.6.2 Asynchronous Rest Template

|  |  |
| --- | --- |
| [Important] | **Important** |
| Starting with Sleuth 2.0.0, we no longer register a bean of AsyncRestTemplate type. It is up to you to create such a bean. Then we instrument it. |

To block the AsyncRestTemplate features, set spring.sleuth.web.async.client.enabled to false. To disable creation of the default TraceAsyncClientHttpRequestFactoryWrapper, set spring.sleuth.web.async.client.factory.enabled to false. If you do not want to create AsyncRestClient at all, set spring.sleuth.web.async.client.template.enabled to false.

#### Multiple Asynchronous Rest Templates

Sometimes you need to use multiple implementations of the Asynchronous Rest Template. In the following snippet, you can see an example of how to set up such a custom AsyncRestTemplate:

*@Configuration*

*@EnableAutoConfiguration*

**static** **class** Config {

*@Bean(name = "customAsyncRestTemplate")*

**public** AsyncRestTemplate traceAsyncRestTemplate() {

**return** **new** AsyncRestTemplate(asyncClientFactory(), clientHttpRequestFactory());

}

**private** ClientHttpRequestFactory clientHttpRequestFactory() {

ClientHttpRequestFactory clientHttpRequestFactory = **new** CustomClientHttpRequestFactory();

*//CUSTOMIZE HERE*

**return** clientHttpRequestFactory;

}

**private** AsyncClientHttpRequestFactory asyncClientFactory() {

AsyncClientHttpRequestFactory factory = **new** CustomAsyncClientHttpRequestFactory();

*//CUSTOMIZE HERE*

**return** factory;

}

}

### 63.6.3 WebClient

We inject a ExchangeFilterFunction implementation that creates a span and, through on-success and on-error callbacks, takes care of closing client-side spans.

To block this feature, set spring.sleuth.web.client.enabled to false.

|  |  |
| --- | --- |
| [Important] | **Important** |
| You have to register WebClient as a bean so that the tracing instrumentation gets applied. If you create a WebClient instance with a new keyword, the instrumentation does NOT work. |

### 63.6.4 Traverson

If you use the [Traverson](https://docs.spring.io/spring-hateoas/docs/current/reference/html/#client.traverson) library, you can inject a RestTemplate as a bean into your Traverson object. Since RestTemplate is already intercepted, you get full support for tracing in your client. The following pseudo code shows how to do that:

*@Autowired* RestTemplate restTemplate;

Traverson traverson = **new** Traverson(URI.create("http://some/address"),

MediaType.APPLICATION\_JSON, MediaType.APPLICATION\_JSON\_UTF8).setRestOperations(restTemplate);

*// use Traverson*

### 63.6.5 Apache HttpClientBuilder and HttpAsyncClientBuilder

We instrument the HttpClientBuilder and HttpAsyncClientBuilder so that tracing context gets injected to the sent requests.

To block these features, set spring.sleuth.web.client.enabled to false.

### 63.6.6 Netty HttpClient

We instrument the Netty’s HttpClient.

To block this feature, set spring.sleuth.web.client.enabled to false.

|  |  |
| --- | --- |
| [Important] | **Important** |
| You have to register HttpClient as a bean so that the instrumentation happens. If you create a HttpClient instance with a new keyword, the instrumentation does NOT work. |

### 63.6.7 UserInfoRestTemplateCustomizer

We instrument the Spring Security’s UserInfoRestTemplateCustomizer.

To block this feature, set spring.sleuth.web.client.enabled to false.

## 63.7 Feign

By default, Spring Cloud Sleuth provides integration with Feign through TraceFeignClientAutoConfiguration. You can disable it entirely by setting spring.sleuth.feign.enabled to false. If you do so, no Feign-related instrumentation take place.

Part of Feign instrumentation is done through a FeignBeanPostProcessor. You can disable it by setting spring.sleuth.feign.processor.enabled to false. If you set it to false, Spring Cloud Sleuth does not instrument any of your custom Feign components. However, all the default instrumentation is still there.

## 63.8 Asynchronous Communication

### 63.8.1 @Async Annotated methods

In Spring Cloud Sleuth, we instrument async-related components so that the tracing information is passed between threads. You can disable this behavior by setting the value of spring.sleuth.async.enabled to false.

If you annotate your method with @Async, we automatically create a new Span with the following characteristics:

* If the method is annotated with @SpanName, the value of the annotation is the Span’s name.
* If the method is not annotated with @SpanName, the Span name is the annotated method name.
* The span is tagged with the method’s class name and method name.

### 63.8.2 @Scheduled Annotated Methods

In Spring Cloud Sleuth, we instrument scheduled method execution so that the tracing information is passed between threads. You can disable this behavior by setting the value of spring.sleuth.scheduled.enabled to false.

If you annotate your method with @Scheduled, we automatically create a new span with the following characteristics:

* The span name is the annotated method name.
* The span is tagged with the method’s class name and method name.

If you want to skip span creation for some @Scheduled annotated classes, you can set the spring.sleuth.scheduled.skipPattern with a regular expression that matches the fully qualified name of the @Scheduled annotated class.

|  |
| --- |
| [Tip] |
| If you use spring-cloud-sleuth-stream and spring-cloud-netflix-hystrix-stream together, a span is created for each Hystrix metrics and sent to Zipkin. This behavior may be annoying. You can prevent it by setting spring.sleuth.scheduled.skipPattern=org.springframework.cloud.netflix.hystrix.stream.HystrixStreamTask. |

### 63.8.3 Executor, ExecutorService, and ScheduledExecutorService

We provide LazyTraceExecutor, TraceableExecutorService, and TraceableScheduledExecutorService. Those implementations create spans each time a new task is submitted, invoked, or scheduled.

The following example shows how to pass tracing information with TraceableExecutorService when working with CompletableFuture:

CompletableFuture<Long> completableFuture = CompletableFuture.supplyAsync(() -> {

*// perform some logic*

**return** 1\_000\_000L;

}, **new** TraceableExecutorService(beanFactory, executorService,

*// 'calculateTax' explicitly names the span - this param is optional*

"calculateTax"));

|  |  |
| --- | --- |
| [Important] | **Important** |
| Sleuth does not work with parallelStream() out of the box. If you want to have the tracing information propagated through the stream, you have to use the approach with supplyAsync(…​), as shown earlier. |

#### Customization of Executors

Sometimes, you need to set up a custom instance of the AsyncExecutor. The following example shows how to set up such a custom Executor:

*@Configuration*

*@EnableAutoConfiguration*

*@EnableAsync*

**static** **class** CustomExecutorConfig **extends** AsyncConfigurerSupport {

*@Autowired* BeanFactory beanFactory;

*@Override* **public** Executor getAsyncExecutor() {

ThreadPoolTaskExecutor executor = **new** ThreadPoolTaskExecutor();

*// CUSTOMIZE HERE*

executor.setCorePoolSize(7);

executor.setMaxPoolSize(42);

executor.setQueueCapacity(11);

executor.setThreadNamePrefix("MyExecutor-");

*// DON'T FORGET TO INITIALIZE*

executor.initialize();

**return** **new** LazyTraceExecutor(**this**.beanFactory, executor);

}

}

## 63.9 Messaging

Features from this section can be disabled by setting the spring.sleuth.messaging.enabled property with value equal to false.

### 63.9.1 Spring Integration and Spring Cloud Stream

Spring Cloud Sleuth integrates with [Spring Integration](https://projects.spring.io/spring-integration/). It creates spans for publish and subscribe events. To disable Spring Integration instrumentation, set spring.sleuth.integration.enabled to false.

You can provide the spring.sleuth.integration.patterns pattern to explicitly provide the names of channels that you want to include for tracing. By default, all channels are included.

|  |  |
| --- | --- |
| [Important] | **Important** |
| When using the Executor to build a Spring Integration IntegrationFlow, you must use the untraced version of the Executor. Decorating the Spring Integration Executor Channel with TraceableExecutorService causes the spans to be improperly closed. |

### 63.9.2 Spring RabbitMq

We instrument the RabbitTemplate so that tracing headers get injected into the message.

To block this feature, set spring.sleuth.messaging.rabbit.enabled to false.

### 63.9.3 Spring Kafka

We instrument the Spring Kafka’s ProducerFactory and ConsumerFactory so that tracing headers get injected into the created Spring Kafka’s Producer and Consumer.

To block this feature, set spring.sleuth.messaging.kafka.enabled to false.

## 63.10 Zuul

We instrument the Zuul Ribbon integration by enriching the Ribbon requests with tracing information. To disable Zuul support, set the spring.sleuth.zuul.enabledproperty to false.

## 64. Running examples

You can see the running examples deployed in the [Pivotal Web Services](https://run.pivotal.io/). Check them out at the following links:

* [Zipkin for apps presented in the samples to the top](https://docssleuth-zipkin-server.cfapps.io/)
* [Zipkin for Brewery on PWS](https://docsbrewing-zipkin-server.cfapps.io/), its [Github Code](https://github.com/spring-cloud-samples/brewery)

# Part IX. Spring Cloud Consul

**Finchley.M9**

This project provides Consul integrations for Spring Boot apps through autoconfiguration and binding to the Spring Environment and other Spring programming model idioms. With a few simple annotations you can quickly enable and configure the common patterns inside your application and build large distributed systems with Consul based components. The patterns provided include Service Discovery, Control Bus and Configuration. Intelligent Routing (Zuul) and Client Side Load Balancing (Ribbon), Circuit Breaker (Hystrix) are provided by integration with Spring Cloud Netflix.

## 65. Install Consul

Please see the [installation documentation](https://www.consul.io/intro/getting-started/install.html) for instructions on how to install Consul.

## 66. Consul Agent

A Consul Agent client must be available to all Spring Cloud Consul applications. By default, the Agent client is expected to be at localhost:8500. See the [Agent documentation](https://consul.io/docs/agent/basics.html) for specifics on how to start an Agent client and how to connect to a cluster of Consul Agent Servers. For development, after you have installed consul, you may start a Consul Agent using the following command:

./src/main/bash/local\_run\_consul.sh

This will start an agent in server mode on port 8500, with the ui available at [http://localhost:8500](http://localhost:8500/)

## 67. Service Discovery with Consul

Service Discovery is one of the key tenets of a microservice based architecture. Trying to hand configure each client or some form of convention can be very difficult to do and can be very brittle. Consul provides Service Discovery services via an [HTTP API](https://www.consul.io/docs/agent/http.html) and [DNS](https://www.consul.io/docs/agent/dns.html). Spring Cloud Consul leverages the HTTP API for service registration and discovery. This does not prevent non-Spring Cloud applications from leveraging the DNS interface. Consul Agents servers are run in a [cluster](https://www.consul.io/docs/internals/architecture.html) that communicates via a [gossip protocol](https://www.consul.io/docs/internals/gossip.html) and uses the [Raft consensus protocol](https://www.consul.io/docs/internals/consensus.html).

## 67.1 How to activate

To activate Consul Service Discovery use the starter with group org.springframework.cloud and artifact id spring-cloud-starter-consul-discovery. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

## 67.2 Registering with Consul

When a client registers with Consul, it provides meta-data about itself such as host and port, id, name and tags. An HTTP [Check](https://www.consul.io/docs/agent/checks.html) is created by default that Consul hits the /health endpoint every 10 seconds. If the health check fails, the service instance is marked as critical.

Example Consul client:

*@SpringBootApplication*

*@RestController*

**public** **class** Application {

*@RequestMapping("/")*

**public** String home() {

**return** "Hello world";

}

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(Application.**class**).web(true).run(args);

}

}

(i.e. utterly normal Spring Boot app). If the Consul client is located somewhere other than localhost:8500, the configuration is required to locate the client. Example:

**application.yml.**

spring:

cloud:

consul:

host: localhost

port: 8500

|  |  |
| --- | --- |
| [Caution] | **Caution** |
| If you use [Spring Cloud Consul Config](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-consul-config.html), the above values will need to be placed in bootstrap.yml instead of application.yml. |

The default service name, instance id and port, taken from the Environment, are ${spring.application.name}, the Spring Context ID and ${server.port}respectively.

To disable the Consul Discovery Client you can set spring.cloud.consul.discovery.enabled to false.

To disable the service registration you can set spring.cloud.consul.discovery.register to false.

## 67.3 HTTP Health Check

The health check for a Consul instance defaults to "/health", which is the default locations of a useful endpoint in a Spring Boot Actuator application. You need to change these, even for an Actuator application if you use a non-default context path or servlet path (e.g. server.servletPath=/foo) or management endpoint path (e.g. management.context-path=/admin). The interval that Consul uses to check the health endpoint may also be configured. "10s" and "1m" represent 10 seconds and 1 minute respectively. Example:

**application.yml.**

spring:

cloud:

consul:

discovery:

healthCheckPath: ${management.context-path}/health

healthCheckInterval: 15s

### 67.3.1 Metadata and Consul tags

Consul does not yet support metadata on services. Spring Cloud’s ServiceInstance has a Map<String, String> metadata field. Spring Cloud Consul uses Consul tags to approximate metadata until Consul officially supports metadata. Tags with the form key=value will be split and used as a Map key and value respectively. Tags without the equal = sign, will be used as both the key and value.

**application.yml.**

spring:

cloud:

consul:

discovery:

tags: foo=bar, baz

The above configuration will result in a map with foo→bar and baz→baz.

### 67.3.2 Making the Consul Instance ID Unique

By default a consul instance is registered with an ID that is equal to its Spring Application Context ID. By default, the Spring Application Context ID is ${spring.application.name}:comma,separated,profiles:${server.port}. For most cases, this will allow multiple instances of one service to run on one machine. If further uniqueness is required, Using Spring Cloud you can override this by providing a unique identifier in spring.cloud.consul.discovery.instanceId. For example:

**application.yml.**

spring:

cloud:

consul:

discovery:

instanceId: ${spring.application.name}:${vcap.application.instance\_id:${spring.application.instance\_id:${random.value}}}

With this metadata, and multiple service instances deployed on localhost, the random value will kick in there to make the instance unique. In Cloudfoundry the vcap.application.instance\_id will be populated automatically in a Spring Boot application, so the random value will not be needed.

## 67.4 Looking up services

### 67.4.1 Using Ribbon

Spring Cloud has support for [Feign](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/docs/src/main/asciidoc/spring-cloud-netflix.adoc#spring-cloud-feign) (a REST client builder) and also [Spring RestTemplate](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/docs/src/main/asciidoc/spring-cloud-netflix.adoc#spring-cloud-ribbon) for looking up services using the logical service names/ids instead of physical URLs. Both Feign and the discovery-aware RestTemplate utilize [Ribbon](https://cloud.spring.io/spring-cloud-netflix/single/spring-cloud-netflix.html#spring-cloud-ribbon) for client-side load balancing.

If you want to access service STORES using the RestTemplate simply declare:

@LoadBalanced

@Bean

public RestTemplate loadbalancedRestTemplate() {

new RestTemplate();

}

and use it like this (notice how we use the STORES service name/id from Consul instead of a fully qualified domainname):

@Autowired

RestTemplate restTemplate;

public String getFirstProduct() {

return this.restTemplate.getForObject("https://STORES/products/1", String.class);

}

If you have Consul clusters in multiple datacenters and you want to access a service in another datacenter a service name/id alone is not enough. In that case you use property spring.cloud.consul.discovery.datacenters.STORES=dc-west where STORES is the service name/id and dc-west is the datacenter where the STORES service lives.

### 67.4.2 Using the DiscoveryClient

You can also use the org.springframework.cloud.client.discovery.DiscoveryClient which provides a simple API for discovery clients that is not specific to Netflix, e.g.

@Autowired

private DiscoveryClient discoveryClient;

public String serviceUrl() {

List<ServiceInstance> list = discoveryClient.getInstances("STORES");

if (list != null && list.size() > 0 ) {

return list.get(0).getUri();

}

return null;

}

## 68. Distributed Configuration with Consul

Consul provides a [Key/Value Store](https://consul.io/docs/agent/http/kv.html) for storing configuration and other metadata. Spring Cloud Consul Config is an alternative to the [Config Server and Client](https://github.com/spring-cloud/spring-cloud-config). Configuration is loaded into the Spring Environment during the special "bootstrap" phase. Configuration is stored in the /config folder by default. Multiple PropertySource instances are created based on the application’s name and the active profiles that mimicks the Spring Cloud Config order of resolving properties. For example, an application with the name "testApp" and with the "dev" profile will have the following property sources created:

config/testApp,dev/

config/testApp/

config/application,dev/

config/application/

The most specific property source is at the top, with the least specific at the bottom. Properties in the config/application folder are applicable to all applications using consul for configuration. Properties in the config/testApp folder are only available to the instances of the service named "testApp".

Configuration is currently read on startup of the application. Sending a HTTP POST to /refresh will cause the configuration to be reloaded. [Section 68.3, “Config Watch”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-consul-config.html#spring-cloud-consul-config-watch) will also automatically detect changes and reload the application context.

## 68.1 How to activate

To get started with Consul Configuration use the starter with group org.springframework.cloud and artifact id spring-cloud-starter-consul-config. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

This will enable auto-configuration that will setup Spring Cloud Consul Config.

## 68.2 Customizing

Consul Config may be customized using the following properties:

**bootstrap.yml.**

spring:

cloud:

consul:

config:

enabled: true

prefix: configuration

defaultContext: apps

profileSeparator: '::'

* enabled setting this value to "false" disables Consul Config
* prefix sets the base folder for configuration values
* defaultContext sets the folder name used by all applications
* profileSeparator sets the value of the separator used to separate the profile name in property sources with profiles

## 68.3 Config Watch

The Consul Config Watch takes advantage of the ability of consul to [watch a key prefix](https://www.consul.io/docs/agent/watches.html#keyprefix). The Config Watch makes a blocking Consul HTTP API call to determine if any relevant configuration data has changed for the current application. If there is new configuration data a Refresh Event is published. This is equivalent to calling the /refresh actuator endpoint.

To change the frequency of when the Config Watch is called change spring.cloud.consul.config.watch.delay. The default value is 1000, which is in milliseconds.

To disable the Config Watch set spring.cloud.consul.config.watch.enabled=false.

## 68.4 YAML or Properties with Config

It may be more convenient to store a blob of properties in YAML or Properties format as opposed to individual key/value pairs. Set the spring.cloud.consul.config.format property to YAML or PROPERTIES. For example to use YAML:

**bootstrap.yml.**

spring:

cloud:

consul:

config:

format: YAML

YAML must be set in the appropriate data key in consul. Using the defaults above the keys would look like:

config/testApp,dev/data

config/testApp/data

config/application,dev/data

config/application/data

You could store a YAML document in any of the keys listed above.

You can change the data key using spring.cloud.consul.config.data-key.

## 68.5 git2consul with Config

git2consul is a Consul community project that loads files from a git repository to individual keys into Consul. By default the names of the keys are names of the files. YAML and Properties files are supported with file extensions of .yml and .properties respectively. Set the spring.cloud.consul.config.format property to FILES. For example:

**bootstrap.yml.**

spring:

cloud:

consul:

config:

format: FILES

Given the following keys in /config, the development profile and an application name of foo:

.gitignore

application.yml

bar.properties

foo-development.properties

foo-production.yml

foo.properties

master.ref

the following property sources would be created:

config/foo-development.properties

config/foo.properties

config/application.yml

The value of each key needs to be a properly formatted YAML or Properties file.

## 68.6 Fail Fast

It may be convenient in certain circumstances (like local development or certain test scenarios) to not fail if consul isn’t available for configuration. Setting spring.cloud.consul.config.failFast=false in bootstrap.yml will cause the configuration module to log a warning rather than throw an exception. This will allow the application to continue startup normally.

## 69. Consul Retry

If you expect that the consul agent may occasionally be unavailable when your app starts, you can ask it to keep trying after a failure. You need to add spring-retryand spring-boot-starter-aop to your classpath. The default behaviour is to retry 6 times with an initial backoff interval of 1000ms and an exponential multiplier of 1.1 for subsequent backoffs. You can configure these properties (and others) using spring.cloud.consul.retry.\* configuration properties. This works with both Spring Cloud Consul Config and Discovery registration.

|  |
| --- |
| [Tip] |
| To take full control of the retry add a @Bean of type RetryOperationsInterceptor with id "consulRetryInterceptor". Spring Retry has a RetryInterceptorBuilder that makes it easy to create one. |

## 70. Spring Cloud Bus with Consul

## 70.1 How to activate

To get started with the Consul Bus use the starter with group org.springframework.cloud and artifact id spring-cloud-starter-consul-bus. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

See the [Spring Cloud Bus](https://cloud.spring.io/spring-cloud-bus/) documentation for the available actuator endpoints and howto send custom messages.

## 71. Circuit Breaker with Hystrix

Applications can use the Hystrix Circuit Breaker provided by the Spring Cloud Netflix project by including this starter in the projects pom.xml: spring-cloud-starter-hystrix. Hystrix doesn’t depend on the Netflix Discovery Client. The @EnableHystrix annotation should be placed on a configuration class (usually the main class). Then methods can be annotated with @HystrixCommand to be protected by a circuit breaker. See [the documentation](https://projects.spring.io/spring-cloud/spring-cloud.html#_circuit_breaker_hystrix_clients) for more details.

## 72. Hystrix metrics aggregation with Turbine and Consul

Turbine (provided by the Spring Cloud Netflix project), aggregates multiple instances Hystrix metrics streams, so the dashboard can display an aggregate view. Turbine uses the DiscoveryClient interface to lookup relevant instances. To use Turbine with Spring Cloud Consul, configure the Turbine application in a manner similar to the following examples:

**pom.xml.**

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-netflix-turbine</artifactId>

</dependency>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-consul-discovery</artifactId>

</dependency>

Notice that the Turbine dependency is not a starter. The turbine starter includes support for Netflix Eureka.

**application.yml.**

spring.application.name: turbine

applications: consulhystrixclient

turbine:

aggregator:

clusterConfig: ${applications}

appConfig: ${applications}

The clusterConfig and appConfig sections must match, so it’s useful to put the comma-separated list of service ID’s into a separate configuration property.

**Turbine.java.**

@EnableTurbine

@SpringBootApplication

public class Turbine {

public static void main(String[] args) {

SpringApplication.run(DemoturbinecommonsApplication.class, args);

}

}

# Part X. Spring Cloud Zookeeper

This project provides Zookeeper integrations for Spring Boot applications through autoconfiguration and binding to the Spring Environment and other Spring programming model idioms. With a few annotations, you can quickly enable and configure the common patterns inside your application and build large distributed systems with Zookeeper based components. The provided patterns include Service Discovery and Configuration. Integration with Spring Cloud Netflix provides Intelligent Routing (Zuul), Client Side Load Balancing (Ribbon), and Circuit Breaker (Hystrix).

## 73. Install Zookeeper

See the [installation documentation](https://zookeeper.apache.org/doc/current/zookeeperStarted.html) for instructions on how to install Zookeeper.

## 74. Service Discovery with Zookeeper

Service Discovery is one of the key tenets of a microservice based architecture. Trying to hand-configure each client or some form of convention can be difficult to do and can be brittle. [Curator](https://curator.apache.org/)(A Java library for Zookeeper) provides Service Discovery through a [Service Discovery Extension](https://curator.apache.org/curator-x-discovery/). Spring Cloud Zookeeper uses this extension for service registration and discovery.

## 74.1 Activating

Including a dependency on org.springframework.cloud:spring-cloud-starter-zookeeper-discovery enables autoconfiguration that sets up Spring Cloud Zookeeper Discovery.

|  |
| --- |
| [Note] |
| For web functionality, you still need to include org.springframework.boot:spring-boot-starter-web. |

## 74.2 Registering with Zookeeper

When a client registers with Zookeeper, it provides metadata (such as host and port, ID, and name) about itself.

The following example shows a Zookeeper client:

*@SpringBootApplication*

*@RestController*

**public** **class** Application {

*@RequestMapping("/")*

**public** String home() {

**return** "Hello world";

}

**public** **static** **void** main(String[] args) {

**new** SpringApplicationBuilder(Application.**class**).web(true).run(args);

}

}

|  |
| --- |
| [Note] |
| The preceding example is a normal Spring Boot application. |

If Zookeeper is located somewhere other than localhost:2181, the configuration must provide the location of the server, as shown in the following example:

**application.yml.**

spring:

cloud:

zookeeper:

connect-string: localhost:2181

|  |  |
| --- | --- |
| [Caution] | **Caution** |
| If you use [Spring Cloud Zookeeper Config](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-config.html), the values shown in the preceding example need to be in bootstrap.yml instead ofapplication.yml. |

The default service name, instance ID, and port (taken from the Environment) are ${spring.application.name}, the Spring Context ID, and ${server.port}, respectively.

Having spring-cloud-starter-zookeeper-discovery on the classpath makes the app into both a Zookeeper “service” (that is, it registers itself) and a “client” (that is, it can query Zookeeper to locate other services).

If you would like to disable the Zookeeper Discovery Client, you can set spring.cloud.zookeeper.discovery.enabled to false.

## 74.3 Using the DiscoveryClient

Spring Cloud has support for [Feign](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/docs/src/main/asciidoc/spring-cloud-netflix.adoc#spring-cloud-feign) (a REST client builder) and [Spring RestTemplate](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/docs/src/main/asciidoc/spring-cloud-netflix.adoc#spring-cloud-ribbon), using logical service names instead of physical URLs.

You can also use the org.springframework.cloud.client.discovery.DiscoveryClient, which provides a simple API for discovery clients that is not specific to Netflix, as shown in the following example:

*@Autowired*

**private** DiscoveryClient discoveryClient;

**public** String serviceUrl() {

List<ServiceInstance> list = discoveryClient.getInstances("STORES");

**if** (list != null && list.size() > 0 ) {

**return** list.get(0).getUri().toString();

}

**return** null;

}

## 75. Using Spring Cloud Zookeeper with Spring Cloud Netflix Components

Spring Cloud Netflix supplies useful tools that work regardless of which DiscoveryClient implementation you use. Feign, Turbine, Ribbon, and Zuul all work with Spring Cloud Zookeeper.

## 75.1 Ribbon with Zookeeper

Spring Cloud Zookeeper provides an implementation of Ribbon’s ServerList. When you use the spring-cloud-starter-zookeeper-discovery, Ribbon is autoconfigured to use the ZookeeperServerList by default.

## 76. Spring Cloud Zookeeper and Service Registry

Spring Cloud Zookeeper implements the ServiceRegistry interface, letting developers register arbitrary services in a programmatic way.

The ServiceInstanceRegistration class offers a builder() method to create a Registration object that can be used by the ServiceRegistry, as shown in the following example:

*@Autowired*

**private** ZookeeperServiceRegistry serviceRegistry;

**public** **void** registerThings() {

ZookeeperRegistration registration = ServiceInstanceRegistration.builder()

.defaultUriSpec()

.address("anyUrl")

.port(10)

.name("/a/b/c/d/anotherservice")

.build();

**this**.serviceRegistry.register(registration);

}

## 76.1 Instance Status

Netflix Eureka supports having instances that are OUT\_OF\_SERVICE registered with the server. These instances are not returned as active service instances. This is useful for behaviors such as blue/green deployments. (Note that the Curator Service Discovery recipe does not support this behavior.) Taking advantage of the flexible payload has let Spring Cloud Zookeeper implement OUT\_OF\_SERVICE by updating some specific metadata and then filtering on that metadata in the Ribbon ZookeeperServerList. The ZookeeperServerList filters out all non-null instance statuses that do not equal UP. If the instance status field is empty, it is considered to be UP for backwards compatibility. To change the status of an instance, make a POST with OUT\_OF\_SERVICE to the ServiceRegistry instance status actuator endpoint, as shown in the following example:

$ http POST http://localhost:8081/service-registry status=OUT\_OF\_SERVICE

|  |
| --- |
| [Note] |
| The preceding example uses the http command from [https://httpie.org](https://httpie.org/). |

## 77. Zookeeper Dependencies

The following topics cover how to work with Spring Cloud Zookeeper dependencies:

* [Section 77.1, “Using the Zookeeper Dependencies”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-dependencies.html#spring-cloud-zookeeper-dependencies-using)
* [Section 77.2, “Activating Zookeeper Dependencies”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-dependencies.html#spring-cloud-zookeeper-dependencies-activating)
* [Section 77.3, “Setting up Zookeeper Dependencies”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-dependencies.html#spring-cloud-zookeeper-dependencies-setting-up)
* [Section 77.4, “Configuring Spring Cloud Zookeeper Dependencies”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-dependencies.html#spring-cloud-zookeeper-dependencies-configuring)

## 77.1 Using the Zookeeper Dependencies

Spring Cloud Zookeeper gives you a possibility to provide dependencies of your application as properties. As dependencies, you can understand other applications that are registered in Zookeeper and which you would like to call through [Feign](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/docs/src/main/asciidoc/spring-cloud-netflix.adoc#spring-cloud-feign) (a REST client builder) and [Spring RestTemplate](https://github.com/spring-cloud/spring-cloud-netflix/blob/master/docs/src/main/asciidoc/spring-cloud-netflix.adoc#spring-cloud-ribbon).

You can also use the Zookeeper Dependency Watchers functionality to control and monitor the state of your dependencies.

## 77.2 Activating Zookeeper Dependencies

Including a dependency on org.springframework.cloud:spring-cloud-starter-zookeeper-discovery enables autoconfiguration that sets up Spring Cloud Zookeeper Dependencies. Even if you provide the dependencies in your properties, you can turn off the dependencies. To do so, set thespring.cloud.zookeeper.dependency.enabled property to false (it defaults to true).

## 77.3 Setting up Zookeeper Dependencies

Consider the following example of dependency representation:

**application.yml.**

spring.application.name: yourServiceName

spring.cloud.zookeeper:

dependencies:

newsletter:

path: /path/where/newsletter/has/registered/in/zookeeper

loadBalancerType: ROUND\_ROBIN

contentTypeTemplate: application/vnd.newsletter.$version+json

version: v1

headers:

header1:

- value1

header2:

- value2

required: false

stubs: org.springframework:foo:stubs

mailing:

path: /path/where/mailing/has/registered/in/zookeeper

loadBalancerType: ROUND\_ROBIN

contentTypeTemplate: application/vnd.mailing.$version+json

version: v1

required: true

The next few sections go through each part of the dependency one by one. The root property name is spring.cloud.zookeeper.dependencies.

### 77.3.1 Aliases

Below the root property you have to represent each dependency as an alias. This is due to the constraints of Ribbon, which requires that the application ID be placed in the URL. Consequently, you cannot pass any complex path, suchas /myApp/myRoute/name). The alias is the name you use instead of the serviceId for DiscoveryClient, Feign, or RestTemplate.

In the previous examples, the aliases are newsletter and mailing. The following example shows Feign usage with a newsletter alias:

*@FeignClient("newsletter")*

**public** **interface** NewsletterService {

*@RequestMapping(method = RequestMethod.GET, value = "/newsletter")*

String getNewsletters();

}

### 77.3.2 Path

The path is represented by the path YAML property and is the path under which the dependency is registered under Zookeeper. As described in the [previous section](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-dependencies.html#spring-cloud-zookeeper-dependencies-setting-up-aliases), Ribbon operates on URLs. As a result, this path is not compliant with its requirement. That is why Spring Cloud Zookeeper maps the alias to the proper path.

### 77.3.3 Load Balancer Type

The load balancer type is represented by loadBalancerType YAML property.

If you know what kind of load-balancing strategy has to be applied when calling this particular dependency, you can provide it in the YAML file, and it is automatically applied. You can choose one of the following load balancing strategies:

* STICKY: Once chosen, the instance is always called.
* RANDOM: Picks an instance randomly.
* ROUND\_ROBIN: Iterates over instances over and over again.

### 77.3.4 Content-Type Template and Version

The Content-Type template and version are represented by the contentTypeTemplate and version YAML properties.

If you version your API in the Content-Type header, you do not want to add this header to each of your requests. Also, if you want to call a new version of the API, you do not want to roam around your code to bump up the API version. That is why you can provide a contentTypeTemplate with a special $version placeholder. That placeholder will be filled by the value of the version YAML property. Consider the following example of a contentTypeTemplate:

application/vnd.newsletter.$version+json

Further consider the following version:

v1

The combination of contentTypeTemplate and version results in the creation of a Content-Type header for each request, as follows:

application/vnd.newsletter.v1+json

### 77.3.5 Default Headers

Default headers are represented by the headers map in YAML.

Sometimes, each call to a dependency requires setting up of some default headers. To not do that in code, you can set them up in the YAML file, as shown in the following example headers section:

headers:

Accept:

- text/html

- application/xhtml+xml

Cache-Control:

- no-cache

That headers section results in adding the Accept and Cache-Control headers with appropriate list of values in your HTTP request.

### 77.3.6 Required Dependencies

Required dependencies are represented by required property in YAML.

If one of your dependencies is required to be up when your application boots, you can set the required: true property in the YAML file.

If your application cannot localize the required dependency during boot time, it throws an exception, and the Spring Context fails to set up. In other words, your application cannot start if the required dependency is not registered in Zookeeper.

You can read more about Spring Cloud Zookeeper Presence Checker [later in this document](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_spring-cloud-zookeeper-dependency-watcher.html#spring-cloud-zookeeper-dependency-watcher-presence-checker).

### 77.3.7 Stubs

You can provide a colon-separated path to the JAR containing stubs of the dependency, as shown in the following example:

stubs: org.springframework:myApp:stubs

where:

* org.springframework is the groupId.
* myApp is the artifactId.
* stubs is the classifier. (Note that stubs is the default value.)

Because stubs is the default classifier, the preceding example is equal to the following example:

stubs: org.springframework:myApp

## 77.4 Configuring Spring Cloud Zookeeper Dependencies

You can set the following properties to enable or disable parts of Zookeeper Dependencies functionalities:

* spring.cloud.zookeeper.dependencies: If you do not set this property, you cannot use Zookeeper Dependencies.
* spring.cloud.zookeeper.dependency.ribbon.enabled (enabled by default): Ribbon requires either explicit global configuration or a particular one for a dependency. By turning on this property, runtime load balancing strategy resolution is possible, and you can use the loadBalancerType section of the Zookeeper Dependencies. The configuration that needs this property has an implementation of LoadBalancerClient that delegates to the ILoadBalancer presented in the next bullet.
* spring.cloud.zookeeper.dependency.ribbon.loadbalancer (enabled by default): Thanks to this property, the custom ILoadBalancer knows that the part of the URI passed to Ribbon might actually be the alias that has to be resolved to a proper path in Zookeeper. Without this property, you cannot register applications under nested paths.
* spring.cloud.zookeeper.dependency.headers.enabled (enabled by default): This property registers a RibbonClient that automatically appends appropriate headers and content types with their versions, as presented in the Dependency configuration. Without this setting, those two parameters do not work.
* spring.cloud.zookeeper.dependency.resttemplate.enabled (enabled by default): When enabled, this property modifies the request headers of a @LoadBalanced-annotated RestTemplate such that it passes headers and content type with the version set in dependency configuration. Without this setting, those two parameters do not work.

## 78. Spring Cloud Zookeeper Dependency Watcher

The Dependency Watcher mechanism lets you register listeners to your dependencies. The functionality is, in fact, an implementation of the Observator pattern. When a dependency changes, its state (to either UP or DOWN), some custom logic can be applied.

## 78.1 Activating

Spring Cloud Zookeeper Dependencies functionality needs to be enabled for you to use the Dependency Watcher mechanism.

## 78.2 Registering a Listener

To register a listener, you must implement an interface called org.springframework.cloud.zookeeper.discovery.watcher.DependencyWatcherListener and register it as a bean. The interface gives you one method:

**void** stateChanged(String dependencyName, DependencyState newState);

If you want to register a listener for a particular dependency, the dependencyName would be the discriminator for your concrete implementation. newState provides you with information about whether your dependency has changed to CONNECTED or DISCONNECTED.

## 78.3 Using the Presence Checker

Bound with the Dependency Watcher is the functionality called Presence Checker. It lets you provide custom behavior when your application boots, to react according to the state of your dependencies.

The default implementation of the abstract org.springframework.cloud.zookeeper.discovery.watcher.presence.DependencyPresenceOnStartupVerifierclass is the org.springframework.cloud.zookeeper.discovery.watcher.presence.DefaultDependencyPresenceOnStartupVerifier, which works in the following way.

1. If the dependency is marked us required and is not in Zookeeper, when your application boots, it throws an exception and shuts down.
2. If the dependency is not required, the org.springframework.cloud.zookeeper.discovery.watcher.presence.LogMissingDependencyChecker logs that the dependency is missing at the WARN level.

Because the DefaultDependencyPresenceOnStartupVerifier is registered only when there is no bean of type DependencyPresenceOnStartupVerifier, this functionality can be overridden.

## 79. Distributed Configuration with Zookeeper

Zookeeper provides a [hierarchical namespace](https://zookeeper.apache.org/doc/current/zookeeperOver.html#sc_dataModelNameSpace) that lets clients store arbitrary data, such as configuration data. Spring Cloud Zookeeper Config is an alternative to the[Config Server and Client](https://github.com/spring-cloud/spring-cloud-config). Configuration is loaded into the Spring Environment during the special “bootstrap” phase. Configuration is stored in the /config namespace by default. Multiple PropertySource instances are created, based on the application’s name and the active profiles, to mimic the Spring Cloud Config order of resolving properties. For example, an application with a name of testApp and with the dev profile has the following property sources created for it:

* config/testApp,dev
* config/testApp
* config/application,dev
* config/application

The most specific property source is at the top, with the least specific at the bottom. Properties in the config/application namespace apply to all applications that use zookeeper for configuration. Properties in the config/testApp namespace are available only to the instances of the service named testApp.

Configuration is currently read on startup of the application. Sending a HTTP POST request to /refresh causes the configuration to be reloaded. Watching the configuration namespace (which Zookeeper supports) is not currently implemented.

## 79.1 Activating

Including a dependency on org.springframework.cloud:spring-cloud-starter-zookeeper-config enables autoconfiguration that sets up Spring Cloud Zookeeper Config.

## 79.2 Customizing

Zookeeper Config may be customized by setting the following properties:

**bootstrap.yml.**

spring:

cloud:

zookeeper:

config:

enabled: true

root: configuration

defaultContext: apps

profileSeparator: '::'

* enabled: Setting this value to false disables Zookeeper Config.
* root: Sets the base namespace for configuration values.
* defaultContext: Sets the name used by all applications.
* profileSeparator: Sets the value of the separator used to separate the profile name in property sources with profiles.

## 79.3 Access Control Lists (ACLs)

You can add authentication information for Zookeeper ACLs by calling the addAuthInfo method of a CuratorFramework bean. One way to accomplish this is to provide your own CuratorFramework bean, as shown in the following example:

*@BoostrapConfiguration*

**public** **class** CustomCuratorFrameworkConfig {

*@Bean*

**public** CuratorFramework curatorFramework() {

CuratorFramework curator = **new** CuratorFramework();

curator.addAuthInfo("digest", "user:password".getBytes());

**return** curator;

}

}

Consult [the ZookeeperAutoConfiguration class](https://github.com/spring-cloud/spring-cloud-zookeeper/blob/master/spring-cloud-zookeeper-core/src/main/java/org/springframework/cloud/zookeeper/ZookeeperAutoConfiguration.java) to see how the CuratorFramework bean’s default configuration.

Alternatively, you can add your credentials from a class that depends on the existing CuratorFramework bean, as shown in the following example:

*@BoostrapConfiguration*

**public** **class** DefaultCuratorFrameworkConfig {

**public** ZookeeperConfig(CuratorFramework curator) {

curator.addAuthInfo("digest", "user:password".getBytes());

}

}

The creation of this bean must occur during the boostrapping phase. You can register configuration classes to run during this phase by annotating them with@BootstrapConfiguration and including them in a comma-separated list that you set as the value of the org.springframework.cloud.bootstrap.BootstrapConfiguration property in the resources/META-INF/spring.factories file, as shown in the following example:

**resources/META-INF/spring.factories.**

org.springframework.cloud.bootstrap.BootstrapConfiguration=\

my.project.CustomCuratorFrameworkConfig,\

my.project.DefaultCuratorFrameworkConfig

Unresolved directive in spring-cloud.adoc - include::../../../../cli/docs/src/main/asciidoc/spring-cloud-cli.adoc[]

# Part XI. Spring Cloud Security

Spring Cloud Security offers a set of primitives for building secure applications and services with minimum fuss. A declarative model which can be heavily configured externally (or centrally) lends itself to the implementation of large systems of co-operating, remote components, usually with a central indentity management service. It is also extremely easy to use in a service platform like Cloud Foundry. Building on Spring Boot and Spring Security OAuth2 we can quickly create systems that implement common patterns like single sign on, token relay and token exchange.

|  |
| --- |
| [Note] |
| Spring Cloud is released under the non-restrictive Apache 2.0 license. If you would like to contribute to this section of the documentation or if you find an error, please find the source code and issue trackers in the project at [github](https://github.com/spring-cloud/spring-cloud-security/tree/master/src/main/asciidoc). |

## 80. Quickstart

## 80.1 OAuth2 Single Sign On

Here’s a Spring Cloud "Hello World" app with HTTP Basic authentication and a single user account:

**app.groovy.**

*@Grab('spring-boot-starter-security')*

*@Controller*

**class** Application {

*@RequestMapping('/')*

String home() {

'Hello World'

}

}

You can run it with spring run app.groovy and watch the logs for the password (username is "user"). So far this is just the default for a Spring Boot app.

Here’s a Spring Cloud app with OAuth2 SSO:

**app.groovy.**

*@Controller*

*@EnableOAuth2Sso*

**class** Application {

*@RequestMapping('/')*

String home() {

'Hello World'

}

}

Spot the difference? This app will actually behave exactly the same as the previous one, because it doesn’t know it’s OAuth2 credentals yet.

You can register an app in github quite easily, so try that if you want a production app on your own domain. If you are happy to test on localhost:8080, then set up these properties in your application configuration:

**application.yml.**

security:

oauth2:

client:

clientId: bd1c0a783ccdd1c9b9e4

clientSecret: 1a9030fbca47a5b2c28e92f19050bb77824b5ad1

accessTokenUri: https://github.com/login/oauth/access\_token

userAuthorizationUri: https://github.com/login/oauth/authorize

clientAuthenticationScheme: form

resource:

userInfoUri: https://api.github.com/user

preferTokenInfo: **false**

run the app above and it will redirect to github for authorization. If you are already signed into github you won’t even notice that it has authenticated. These credentials will only work if your app is running on port 8080.

To limit the scope that the client asks for when it obtains an access token you can set security.oauth2.client.scope (comma separated or an array in YAML). By default the scope is empty and it is up to to Authorization Server to decide what the defaults should be, usually depending on the settings in the client registration that it holds.

|  |
| --- |
| [Note] |
| The examples above are all Groovy scripts. If you want to write the same code in Java (or Groovy) you need to add Spring Security OAuth2 to the classpath (e.g. see the [sample here](https://github.com/spring-cloud-samples/sso)). |

## 80.2 OAuth2 Protected Resource

You want to protect an API resource with an OAuth2 token? Here’s a simple example (paired with the client above):

**app.groovy.**

*@Grab('spring-cloud-starter-security')*

*@RestController*

*@EnableResourceServer*

**class** Application {

*@RequestMapping('/')*

def home() {

[message: 'Hello World']

}

}

and

**application.yml.**

security:

oauth2:

resource:

userInfoUri: https://api.github.com/user

preferTokenInfo: **false**

## 81. More Detail

## 81.1 Single Sign On

|  |
| --- |
| [Note] |
| All of the OAuth2 SSO and resource server features moved to Spring Boot in version 1.3. You can find documentation in the [Spring Boot user guide](https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/). |

## 81.2 Token Relay

A Token Relay is where an OAuth2 consumer acts as a Client and forwards the incoming token to outgoing resource requests. The consumer can be a pure Client (like an SSO application) or a Resource Server.

### 81.2.1 Client Token Relay

If your app is a user facing OAuth2 client (i.e. has declared @EnableOAuth2Sso or @EnableOAuth2Client) then it has an OAuth2ClientContext in request scope from Spring Boot. You can create your own OAuth2RestTemplate from this context and an autowired OAuth2ProtectedResourceDetails, and then the context will always forward the access token downstream, also refreshing the access token automatically if it expires. (These are features of Spring Security and Spring Boot.)

|  |
| --- |
| [Note] |
| Spring Boot (1.4.1) does not create an OAuth2ProtectedResourceDetails automatically if you are using client\_credentials tokens. In that case you need to create your own ClientCredentialsResourceDetails and configure it with @ConfigurationProperties("security.oauth2.client"). |

### 81.2.2 Client Token Relay in Zuul Proxy

If your app also has a [Spring Cloud Zuul](https://cloud.spring.io/spring-cloud.html#netflix-zuul-reverse-proxy) embedded reverse proxy (using @EnableZuulProxy) then you can ask it to forward OAuth2 access tokens downstream to the services it is proxying. Thus the SSO app above can be enhanced simply like this:

**app.groovy.**

*@Controller*

*@EnableOAuth2Sso*

*@EnableZuulProxy*

**class** Application {

}

and it will (in addition to logging the user in and grabbing a token) pass the authentication token downstream to the /proxy/\* services. If those services are implemented with @EnableResourceServer then they will get a valid token in the correct header.

How does it work? The @EnableOAuth2Sso annotation pulls in spring-cloud-starter-security (which you could do manually in a traditional app), and that in turn triggers some autoconfiguration for a ZuulFilter, which itself is activated because Zuul is on the classpath (via @EnableZuulProxy). The [filter](https://github.com/spring-cloud/spring-cloud-security/tree/master/src/main/java/org/springframework/cloud/security/oauth2/proxy/OAuth2TokenRelayFilter.java) just extracts an access token from the currently authenticated user, and puts it in a request header for the downstream requests.

### 81.2.3 Resource Server Token Relay

If your app has @EnableResourceServer you might want to relay the incoming token downstream to other services. If you use a RestTemplate to contact the downstream services then this is just a matter of how to create the template with the right context.

If your service uses UserInfoTokenServices to authenticate incoming tokens (i.e. it is using the security.oauth2.user-info-uri configuration), then you can simply create an OAuth2RestTemplate using an autowired OAuth2ClientContext (it will be populated by the authentication process before it hits the backend code). Equivalently (with Spring Boot 1.4), you could inject a UserInfoRestTemplateFactory and grab its OAuth2RestTemplate in your configuration. For example:

**MyConfiguration.java.**

*@Bean*

**public** OAuth2RestTemplate restTemplate(UserInfoRestTemplateFactory factory) {

**return** factory.getUserInfoRestTemplate();

}

This rest template will then have the same OAuth2ClientContext (request-scoped) that is used by the authentication filter, so you can use it to send requests with the same access token.

If your app is not using UserInfoTokenServices but is still a client (i.e. it declares @EnableOAuth2Client or @EnableOAuth2Sso), then with Spring Security Cloud any OAuth2RestOperations that the user creates from an @Autowired @OAuth2Context will also forward tokens. This feature is implemented by default as an MVC handler interceptor, so it only works in Spring MVC. If you are not using MVC you could use a custom filter or AOP interceptor wrapping an AccessTokenContextRelayto provide the same feature.

Here’s a basic example showing the use of an autowired rest template created elsewhere ("foo.com" is a Resource Server accepting the same tokens as the surrounding app):

**MyController.java.**

*@Autowired*

**private** OAuth2RestOperations restTemplate;

*@RequestMapping("/relay")*

**public** String relay() {

ResponseEntity<String> response =

restTemplate.getForEntity("https://foo.com/bar", String.**class**);

**return** "Success! (" + response.getBody() + ")";

}

If you don’t want to forward tokens (and that is a valid choice, since you might want to act as yourself, rather than the client that sent you the token), then you only need to create your own OAuth2Context instead of autowiring the default one.

Feign clients will also pick up an interceptor that uses the OAuth2ClientContext if it is available, so they should also do a token relay anywhere where a RestTemplate would.

## 82. Configuring Authentication Downstream of a Zuul Proxy

You can control the authorization behaviour downstream of an @EnableZuulProxy through the proxy.auth.\* settings. Example:

**application.yml.**

proxy:

auth:

routes:

customers: oauth2

stores: passthru

recommendations: none

In this example the "customers" service gets an OAuth2 token relay, the "stores" service gets a passthrough (the authorization header is just passed downstream), and the "recommendations" service has its authorization header removed. The default behaviour is to do a token relay if there is a token available, and passthru otherwise.

See [ProxyAuthenticationProperties](https://github.com/spring-cloud/spring-cloud-security/tree/master/src/main/java/org/springframework/cloud/security/oauth2/proxy/ProxyAuthenticationProperties) for full details.

# Part XII. Spring Cloud for Cloud Foundry

Spring Cloud for Cloudfoundry makes it easy to run [Spring Cloud](https://github.com/spring-cloud) apps in [Cloud Foundry](https://github.com/cloudfoundry) (the Platform as a Service). Cloud Foundry has the notion of a "service", which is middlware that you "bind" to an app, essentially providing it with an environment variable containing credentials (e.g. the location and username to use for the service).

The spring-cloud-cloudfoundry-commons module configures the Reactor-based Cloud Foundry Java client, v 3.0, and can be used standalone.

The spring-cloud-cloudfoundry-web project provides basic support for some enhanced features of webapps in Cloud Foundry: binding automatically to single-sign-on services and optionally enabling sticky routing for discovery.

The spring-cloud-cloudfoundry-discovery project provides an implementation of Spring Cloud Commons DiscoveryClient so you can@EnableDiscoveryClient and provide your credentials as spring.cloud.cloudfoundry.discovery.[username,password] (also \*.url if you are not connecting to [Pivotal Web Services](https://run.pivotal.io/)) and then you can use the DiscoveryClient directly or via a LoadBalancerClient.

The first time you use it the discovery client might be slow owing to the fact that it has to get an access token from Cloud Foundry.

## 83. Discovery

Here’s a Spring Cloud app with Cloud Foundry discovery:

**app.groovy.**

*@Grab('org.springframework.cloud:spring-cloud-cloudfoundry')*

*@RestController*

*@EnableDiscoveryClient*

**class** Application {

*@Autowired*

DiscoveryClient client

*@RequestMapping('/')*

String home() {

'Hello from ' + client.getLocalServiceInstance()

}

}

If you run it without any service bindings:

$ spring jar app.jar app.groovy

$ cf push -p app.jar

It will show its app name in the home page.

The DiscoveryClient can lists all the apps in a space, according to the credentials it is authenticated with, where the space defaults to the one the client is running in (if any). If neither org nor space are configured, they default per the user’s profile in Cloud Foundry.

## 84. Single Sign On

|  |
| --- |
| [Note] |
| All of the OAuth2 SSO and resource server features moved to Spring Boot in version 1.3. You can find documentation in the [Spring Boot user guide](https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/). |

This project provides automatic binding from CloudFoundry service credentials to the Spring Boot features. If you have a CloudFoundry service called "sso", for instance, with credentials containing "client\_id", "client\_secret" and "auth\_domain", it will bind automatically to the Spring OAuth2 client that you enable with @EnableOAuth2Sso(from Spring Boot). The name of the service can be parameterized using spring.oauth2.sso.serviceId.

# Part XIII. Spring Cloud Contract

\_Documentation Authors: Adam Dudczak, Mathias Düsterhöft, Marcin Grzejszczak, Dennis Kieselhorst, Jakub Kubryński, Karol Lassak, Olga Maciaszek-Sharma, Mariusz Smykuła, Dave Syer, Jay Bryant

Finchley.M9

## 85. Spring Cloud Contract

You need confidence when pushing new features to a new application or service in a distributed system. This project provides support for Consumer Driven Contracts and service schemas in Spring applications (for both HTTP and message-based interactions), covering a range of options for writing tests, publishing them as assets, and asserting that a contract is kept by producers and consumers.

## 86. Spring Cloud Contract Verifier Introduction

|  |
| --- |
| [Tip] |
| The Accurest project was initially started by Marcin Grzejszczak and Jakub Kubrynski ([codearte.io](http://codearte.io/)) |

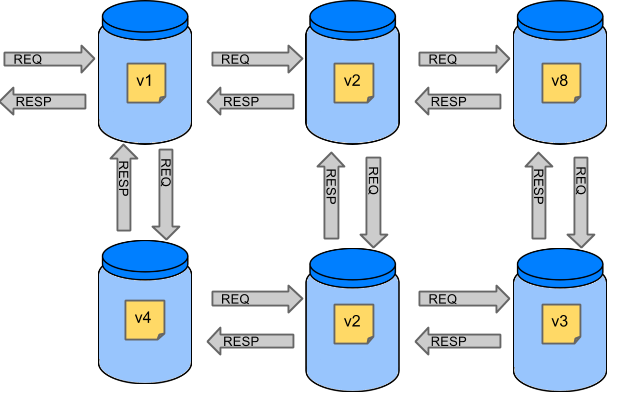
Spring Cloud Contract Verifier enables Consumer Driven Contract (CDC) development of JVM-based applications. It moves TDD to the level of software architecture.

Spring Cloud Contract Verifier ships with Contract Definition Language (CDL). Contract definitions are used to produce the following resources:

* JSON stub definitions to be used by WireMock when doing integration testing on the client code (client tests). Test code must still be written by hand, and test data is produced by Spring Cloud Contract Verifier.
* Messaging routes, if you’re using a messaging service. We integrate with Spring Integration, Spring Cloud Stream, Spring AMQP, and Apache Camel. You can also set your own integrations.
* Acceptance tests (in JUnit or Spock) are used to verify if server-side implementation of the API is compliant with the contract (server tests). A full test is generated by Spring Cloud Contract Verifier.

## 86.1 Why a Contract Verifier?

Assume that we have a system consisting of multiple microservices:



### 86.1.1 Testing issues

If we wanted to test the application in top left corner to determine whether it can communicate with other services, we could do one of two things:

* Deploy all microservices and perform end-to-end tests.
* Mock other microservices in unit/integration tests.

Both have their advantages but also a lot of disadvantages.

**Deploy all microservices and perform end to end tests**

Advantages:

* Simulates production.
* Tests real communication between services.

Disadvantages:

* To test one microservice, we have to deploy 6 microservices, a couple of databases, etc.
* The environment where the tests run is locked for a single suite of tests (nobody else would be able to run the tests in the meantime).
* They take a long time to run.
* The feedback comes very late in the process.
* They are extremely hard to debug.

**Mock other microservices in unit/integration tests**

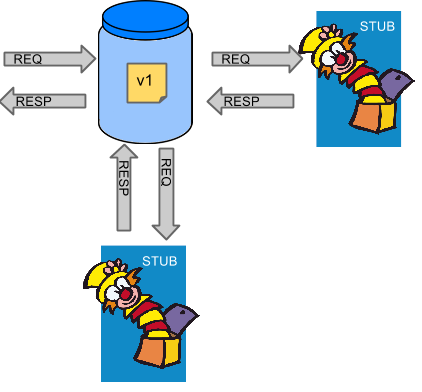
Advantages:

* They provide very fast feedback.
* They have no infrastructure requirements.

Disadvantages:

* The implementor of the service creates stubs that might have nothing to do with reality.
* You can go to production with passing tests and failing production.

To solve the aforementioned issues, Spring Cloud Contract Verifier with Stub Runner was created. The main idea is to give you very fast feedback, without the need to set up the whole world of microservices. If you work on stubs, then the only applications you need are those that your application directly uses.



Spring Cloud Contract Verifier gives you the certainty that the stubs that you use were created by the service that you’re calling. Also, if you can use them, it means that they were tested against the producer’s side. In short, you can trust those stubs.

## 86.2 Purposes

The main purposes of Spring Cloud Contract Verifier with Stub Runner are:

* To ensure that WireMock/Messaging stubs (used when developing the client) do exactly what the actual server-side implementation does.
* To promote ATDD method and Microservices architectural style.
* To provide a way to publish changes in contracts that are immediately visible on both sides.
* To generate boilerplate test code to be used on the server side.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Spring Cloud Contract Verifier’s purpose is NOT to start writing business features in the contracts. Assume that we have a business use case of fraud check. If a user can be a fraud for 100 different reasons, we would assume that you would create 2 contracts, one for the positive case and one for the negative case. Contract tests are used to test contracts between applications and not to simulate full behavior. |

## 86.3 How It Works

This section explores how Spring Cloud Contract Verifier with Stub Runner works.

### 86.3.1 A Three-second Tour

This very brief tour walks through using Spring Cloud Contract:

* [the section called “On the Producer Side”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_introduction.html#spring-cloud-contract-verifier-intro-three-second-tour-producer)
* [the section called “On the Consumer Side”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_introduction.html#spring-cloud-contract-verifier-intro-three-second-tour-consumer)

You can find a somewhat longer tour [here](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_introduction.html#spring-cloud-contract-verifier-intro-three-minute-tour).

#### On the Producer Side

To start working with Spring Cloud Contract, add files with REST/ messaging contracts expressed in either Groovy DSL or YAML to the contracts directory, which is set by the contractsDslDir property. By default, it is $rootDir/src/test/resources/contracts.

Then add the Spring Cloud Contract Verifier dependency and plugin to your build file, as shown in the following example:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-verifier</artifactId>

<scope>test</scope>

</dependency>

The following listing shows how to add the plugin, which should go in the build/plugins portion of the file:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

</plugin>

Running ./mvnw clean install automatically generates tests that verify the application compliance with the added contracts. By default, the tests get generated under org.springframework.cloud.contract.verifier.tests..

As the implementation of the functionalities described by the contracts is not yet present, the tests fail.

To make them pass, you must add the correct implementation of either handling HTTP requests or messages. Also, you must add a correct base test class for auto-generated tests to the project. This class is extended by all the auto-generated tests, and it should contain all the setup necessary to run them (for example RestAssuredMockMvc controller setup or messaging test setup).

Once the implementation and the test base class are in place, the tests pass, and both the application and the stub artifacts are built and installed in the local Maven repository. The changes can now be merged, and both the application and the stub artifacts may be published in an online repository.

#### On the Consumer Side

Spring Cloud Contract Stub Runner can be used in the integration tests to get a running WireMock instance or messaging route that simulates the actual service.

To do so, add the dependency to Spring Cloud Contract Stub Runner, as shown in the following example:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-stub-runner</artifactId>

<scope>test</scope>

</dependency>

You can get the Producer-side stubs installed in your Maven repository in either of two ways:

* By checking out the Producer side repository and adding contracts and generating the stubs by running the following commands:
* $ **cd** local-http-server-repo

$ ./mvnw clean install -DskipTests

|  |
| --- |
| [Tip] |
| The tests are being skipped because the Producer-side contract implementation is not in place yet, so the automatically-generated contract tests fail. |

* By getting already-existing producer service stubs from a remote repository. To do so, pass the stub artifact IDs and artifact repository URL as Spring Cloud Contract Stub Runner properties, as shown in the following example:
* stubrunner:
* ids: 'com.example:http-server-dsl:+:stubs:8080'

repositoryRoot: http://repo.spring.io/libs-snapshot

Now you can annotate your test class with @AutoConfigureStubRunner. In the annotation, provide the group-id and artifact-id values for Spring Cloud Contract Stub Runner to run the collaborators' stubs for you, as shown in the following example:

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment=WebEnvironment.NONE)*

*@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:stubs:6565"},*

*stubsMode = StubRunnerProperties.StubsMode.LOCAL)*

*@DirtiesContext*

**public** **class** LoanApplicationServiceTests {

|  |
| --- |
| [Tip] |
| Use the REMOTE stubsMode when downloading stubs from an online repository and LOCAL for offline work. |

Now, in your integration test, you can receive stubbed versions of HTTP responses or messages that are expected to be emitted by the collaborator service.

### 86.3.2 A Three-minute Tour

This brief tour walks through using Spring Cloud Contract:

* [the section called “On the Producer Side”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_introduction.html#spring-cloud-contract-verifier-intro-three-minute-tour-producer)
* [the section called “On the Consumer Side”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_introduction.html#spring-cloud-contract-verifier-intro-three-minute-tour-consumer)

You can find an even more brief tour [here](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_introduction.html#spring-cloud-contract-verifier-intro-three-second-tour).

#### On the Producer Side

To start working with Spring Cloud Contract, add files with REST/ messaging contracts expressed in either Groovy DSL or YAML to the contracts directory, which is set by the contractsDslDir property. By default, it is $rootDir/src/test/resources/contracts.

For the HTTP stubs, a contract defines what kind of response should be returned for a given request (taking into account the HTTP methods, URLs, headers, status codes, and so on). The following example shows how an HTTP stub contract in Groovy DSL:

**package** contracts

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'PUT'

url '/fraudcheck'

body([

"client.id": $(regex('[0-9]{10}')),

loanAmount: 99999

])

headers {

contentType('application/json')

}

}

response {

status OK()

body([

fraudCheckStatus: "FRAUD",

"rejection.reason": "Amount too high"

])

headers {

contentType('application/json')

}

}

}

The same contract expressed in YAML would look like the following example:

request:

method: PUT

url: /fraudcheck

body:

"client.id": 1234567890

loanAmount: 99999

headers:

Content-Type: application/json

matchers:

body:

- path: $.['client.id'**]**

type: by\_regex

value: "[0-9]{10}"

response:

status: 200

body:

fraudCheckStatus: "FRAUD"

"rejection.reason": "Amount too high"

headers:

Content-Type: application/json;charset=UTF-8

In the case of messaging, you can define:

* The input and the output messages can be defined (taking into account from and where it was sent, the message body, and the header).
* The methods that should be called after the message is received.
* The methods that, when called, should trigger a message.

The following example shows a Camel messaging contract expressed in Groovy DSL:

def contractDsl = Contract.make {

label 'some\_label'

input {

messageFrom('jms:delete')

messageBody([

bookName: 'foo'

])

messageHeaders {

header('sample', 'header')

}

assertThat('bookWasDeleted()')

}

}

The following example shows the same contract expressed in YAML:

label: some\_label

input:

messageFrom: jms:delete

messageBody:

bookName: 'foo'

messageHeaders:

sample: header

assertThat: bookWasDeleted()

Then you can add Spring Cloud Contract Verifier dependency and plugin to your build file, as shown in the following example:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-verifier</artifactId>

<scope>test</scope>

</dependency>

The following listing shows how to add the plugin, which should go in the build/plugins portion of the file:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

</plugin>

Running ./mvnw clean install automatically generates tests that verify the application compliance with the added contracts. By default, the generated tests are under org.springframework.cloud.contract.verifier.tests..

The following example shows a sample auto-generated test for an HTTP contract:

*@Test*

**public** **void** validate\_shouldMarkClientAsFraud() **throws** Exception {

*// given:*

MockMvcRequestSpecification request = given()

.header("Content-Type", "application/vnd.fraud.v1+json")

.body("{\"client.id\":\"1234567890\",\"loanAmount\":99999}");

*// when:*

ResponseOptions response = given().spec(request)

.put("/fraudcheck");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

assertThat(response.header("Content-Type")).matches("application/vnd.fraud.v1.json.\*");

*// and:*

DocumentContext parsedJson = JsonPath.parse(response.getBody().asString());

assertThatJson(parsedJson).field("['fraudCheckStatus']").matches("[A-Z]{5}");

assertThatJson(parsedJson).field("['rejection.reason']").isEqualTo("Amount too high");

}

The preceding example uses Spring’s MockMvc to run the tests. This is the default test mode for HTTP contracts. However, JAX-RX client and explicit HTTP invocations can also be used. (To do so, change the testMode property of the plugin to JAX-RS or EXPLICIT, respectively.)

Apart from the default JUnit, you can instead use Spock tests, by setting the plugin testFramework property to Spock.

|  |
| --- |
| [Tip] |
| You can now also generate WireMock scenarios based on the contracts, by including an order number followed by an underscore at the beginning of the contract file names. |

The following example shows an auto-generated test in Spock for a messaging stub contract:

[source,groovy,indent=0]

given:

ContractVerifierMessage inputMessage = contractVerifierMessaging.create(

\'\'\'{"bookName":"foo"}\'\'\',

['sample': 'header']

)

when:

contractVerifierMessaging.send(inputMessage, 'jms:delete')

then:

noExceptionThrown()

bookWasDeleted()

As the implementation of the functionalities described by the contracts is not yet present, the tests fail.

To make them pass, you must add the correct implementation of handling either HTTP requests or messages. Also, you must add a correct base test class for auto-generated tests to the project. This class is extended by all the auto-generated tests and should contain all the setup necessary to run them (for example, RestAssuredMockMvc controller setup or messaging test setup).

Once the implementation and the test base class are in place, the tests pass, and both the application and the stub artifacts are built and installed in the local Maven repository. Information about installing the stubs jar to the local repository appears in the logs, as shown in the following example:

[INFO] --- spring-cloud-contract-maven-plugin:1.0.0.BUILD-SNAPSHOT:generateStubs (default-generateStubs) @ http-server ---

[INFO] Building jar: /some/path/http-server/target/http-server-0.0.1-SNAPSHOT-stubs.jar

[INFO]

[INFO] --- maven-jar-plugin:2.6:jar (default-jar) @ http-server ---

[INFO] Building jar: /some/path/http-server/target/http-server-0.0.1-SNAPSHOT.jar

[INFO]

[INFO] --- spring-boot-maven-plugin:1.5.5.BUILD-SNAPSHOT:repackage (default) @ http-server ---

[INFO]

[INFO] --- maven-install-plugin:2.5.2:install (default-install) @ http-server ---

[INFO] Installing /some/path/http-server/target/http-server-0.0.1-SNAPSHOT.jar to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT.jar

[INFO] Installing /some/path/http-server/pom.xml to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT.pom

[INFO] Installing /some/path/http-server/target/http-server-0.0.1-SNAPSHOT-stubs.jar to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar

You can now merge the changes and publish both the application and the stub artifacts in an online repository.

**Docker Project**

In order to enable working with contracts while creating applications in non-JVM technologies, the springcloud/spring-cloud-contract Docker image has been created. It contains a project that automatically generates tests for HTTP contracts and executes them in EXPLICIT test mode. Then, if the tests pass, it generates Wiremock stubs and, optionally, publishes them to an artifact manager. In order to use the image, you can mount the contracts into the /contracts directory and set a few environment variables.

#### On the Consumer Side

Spring Cloud Contract Stub Runner can be used in the integration tests to get a running WireMock instance or messaging route that simulates the actual service.

To get started, add the dependency to Spring Cloud Contract Stub Runner:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-stub-runner</artifactId>

<scope>test</scope>

</dependency>

You can get the Producer-side stubs installed in your Maven repository in either of two ways:

* By checking out the Producer side repository and adding contracts and generating the stubs by running the following commands:
* $ **cd** local-http-server-repo

$ ./mvnw clean install -DskipTests

|  |
| --- |
| [Note] |
| The tests are skipped because the Producer-side contract implementation is not yet in place, so the automatically-generated contract tests fail. |

* Getting already existing producer service stubs from a remote repository. To do so, pass the stub artifact IDs and artifact repository URl as Spring Cloud Contract Stub Runner properties, as shown in the following example:
* stubrunner:
* ids: 'com.example:http-server-dsl:+:stubs:8080'

repositoryRoot: http://repo.spring.io/libs-snapshot

Now you can annotate your test class with @AutoConfigureStubRunner. In the annotation, provide the group-id and artifact-id for Spring Cloud Contract Stub Runner to run the collaborators' stubs for you, as shown in the following example:

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment=WebEnvironment.NONE)*

*@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:stubs:6565"},*

*stubsMode = StubRunnerProperties.StubsMode.LOCAL)*

*@DirtiesContext*

**public** **class** LoanApplicationServiceTests {

|  |
| --- |
| [Tip] |
| Use the REMOTE stubsMode when downloading stubs from an online repository and LOCAL for offline work. |

In your integration test, you can receive stubbed versions of HTTP responses or messages that are expected to be emitted by the collaborator service. You can see entries similar to the following in the build logs:

2016-07-19 14:22:25.403 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Desired version is + - will try to resolve the latest version

2016-07-19 14:22:25.438 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Resolved version is 0.0.1-SNAPSHOT

2016-07-19 14:22:25.439 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Resolving artifact com.example:http-server:jar:stubs:0.0.1-SNAPSHOT using remote repositories []

2016-07-19 14:22:25.451 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Resolved artifact com.example:http-server:jar:stubs:0.0.1-SNAPSHOT to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar

2016-07-19 14:22:25.465 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Unpacking stub from JAR [URI: file:/path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar]

2016-07-19 14:22:25.475 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Unpacked file to [/var/folders/0p/xwq47sq106x1\_g3dtv6qfm940000gq/T/contracts100276532569594265]

2016-07-19 14:22:27.737 INFO 41050 --- [ main] o.s.c.c.stubrunner.StubRunnerExecutor : All stubs are now running RunningStubs [namesAndPorts={com.example:http-server:0.0.1-SNAPSHOT:stubs=8080}]

### 86.3.3 Defining the Contract

As consumers of services, we need to define what exactly we want to achieve. We need to formulate our expectations. That is why we write contracts.

Assume that you want to send a request containing the ID of a client company and the amount it wants to borrow from us. You also want to send it to the /fraudcheck url via the PUT method.

**Groovy DSL.**

**package** contracts

org.springframework.cloud.contract.spec.Contract.make {

request { *// (1)*

method 'PUT' *// (2)*

url '/fraudcheck' *// (3)*

body([ *// (4)*

"client.id": $(regex('[0-9]{10}')),

loanAmount: 99999

])

headers { *// (5)*

contentType('application/json')

}

}

response { *// (6)*

status OK() *// (7)*

body([ *// (8)*

fraudCheckStatus: "FRAUD",

"rejection.reason": "Amount too high"

])

headers { *// (9)*

contentType('application/json')

}

}

}

*/\**

*From the Consumer perspective, when shooting a request in the integration test:*

*(1) - If the consumer sends a request*

*(2) - With the "PUT" method*

*(3) - to the URL "/fraudcheck"*

*(4) - with the JSON body that*

*\* has a field `client.id` that matches a regular expression `[0-9]{10}`*

*\* has a field `loanAmount` that is equal to `99999`*

*(5) - with header `Content-Type` equal to `application/json`*

*(6) - then the response will be sent with*

*(7) - status equal `200`*

*(8) - and JSON body equal to*

*{ "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }*

*(9) - with header `Content-Type` equal to `application/json`*

*From the Producer perspective, in the autogenerated producer-side test:*

*(1) - A request will be sent to the producer*

*(2) - With the "PUT" method*

*(3) - to the URL "/fraudcheck"*

*(4) - with the JSON body that*

*\* has a field `client.id` that will have a generated value that matches a regular expression `[0-9]{10}`*

*\* has a field `loanAmount` that is equal to `99999`*

*(5) - with header `Content-Type` equal to `application/json`*

*(6) - then the test will assert if the response has been sent with*

*(7) - status equal `200`*

*(8) - and JSON body equal to*

*{ "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }*

*(9) - with header `Content-Type` matching `application/json.\*`*

*\*/*

**YAML.**

request: # (1)

method: PUT # (2)

url: /fraudcheck # (3)

body: # (4)

"client.id": 1234567890

loanAmount: 99999

headers: # (5)

Content-Type: application/json

matchers:

body:

- path: $.['client.id'] # (6)

type: by\_regex

value: "[0-9]{10}"

response: # (7)

status: 200 # (8)

body: # (9)

fraudCheckStatus: "FRAUD"

"rejection.reason": "Amount too high"

headers: # (10)

Content-Type: application/json;charset=UTF-8

#From the Consumer perspective, when shooting a request in the integration test:

#

#(1) - If the consumer sends a request

#(2) - With the "PUT" method

#(3) - to the URL "/fraudcheck"

#(4) - with the JSON body that

# \* has a field `client.id`

# \* has a field `loanAmount` that is equal to `99999`

#(5) - with header `Content-Type` equal to `application/json`

#(6) - and a `client.id` json entry matches the regular expression `[0-9]{10}`

#(7) - then the response will be sent with

#(8) - status equal `200`

#(9) - and JSON body equal to

# { "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }

#(10) - with header `Content-Type` equal to `application/json`

#

#From the Producer perspective, in the autogenerated producer-side test:

#

#(1) - A request will be sent to the producer

#(2) - With the "PUT" method

#(3) - to the URL "/fraudcheck"

#(4) - with the JSON body that

# \* has a field `client.id` `1234567890`

# \* has a field `loanAmount` that is equal to `99999`

#(5) - with header `Content-Type` equal to `application/json`

#(7) - then the test will assert if the response has been sent with

#(8) - status equal `200`

#(9) - and JSON body equal to

# { "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }

#(10) - with header `Content-Type` equal to `application/json;charset=UTF-8`

### 86.3.4 Client Side

Spring Cloud Contract generates stubs, which you can use during client-side testing. You get a running WireMock instance/Messaging route that simulates the service. You would like to feed that instance with a proper stub definition.

At some point in time, you need to send a request to the Fraud Detection service.

ResponseEntity<FraudServiceResponse> response =

restTemplate.exchange("http://localhost:" + port + "/fraudcheck", HttpMethod.PUT,

**new** HttpEntity<>(request, httpHeaders),

FraudServiceResponse.**class**);

Annotate your test class with @AutoConfigureStubRunner. In the annotation provide the group id and artifact id for the Stub Runner to download stubs of your collaborators.

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment=WebEnvironment.NONE)*

*@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:stubs:6565"},*

*stubsMode = StubRunnerProperties.StubsMode.LOCAL)*

*@DirtiesContext*

**public** **class** LoanApplicationServiceTests {

After that, during the tests, Spring Cloud Contract automatically finds the stubs (simulating the real service) in the Maven repository and exposes them on a configured (or random) port.

### 86.3.5 Server Side

Since you are developing your stub, you need to be sure that it actually resembles your concrete implementation. You cannot have a situation where your stub acts in one way and your application behaves in a different way, especially in production.

To ensure that your application behaves the way you define in your stub, tests are generated from the stub you provide.

The autogenerated test looks, more or less, like this:

*@Test*

**public** **void** validate\_shouldMarkClientAsFraud() **throws** Exception {

*// given:*

MockMvcRequestSpecification request = given()

.header("Content-Type", "application/vnd.fraud.v1+json")

.body("{\"client.id\":\"1234567890\",\"loanAmount\":99999}");

*// when:*

ResponseOptions response = given().spec(request)

.put("/fraudcheck");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

assertThat(response.header("Content-Type")).matches("application/vnd.fraud.v1.json.\*");

*// and:*

DocumentContext parsedJson = JsonPath.parse(response.getBody().asString());

assertThatJson(parsedJson).field("['fraudCheckStatus']").matches("[A-Z]{5}");

assertThatJson(parsedJson).field("['rejection.reason']").isEqualTo("Amount too high");

}

## 86.4 Step-by-step Guide to Consumer Driven Contracts (CDC)

Consider an example of Fraud Detection and the Loan Issuance process. The business scenario is such that we want to issue loans to people but do not want them to steal from us. The current implementation of our system grants loans to everybody.

Assume that Loan Issuance is a client to the Fraud Detection server. In the current sprint, we must develop a new feature: if a client wants to borrow too much money, then we mark the client as a fraud.

Technical remark - Fraud Detection has an artifact-id of http-server, while Loan Issuance has an artifact-id of http-client, and both have a group-id of com.example.

Social remark - both client and server development teams need to communicate directly and discuss changes while going through the process. CDC is all about communication.

The [server side code is available here](https://github.com/spring-cloud/spring-cloud-contract/tree/1.2.x/samples/standalone/dsl/http-server) and [the client code here](https://github.com/spring-cloud/spring-cloud-contract/tree/1.2.x/samples/standalone/dsl/http-client).

|  |
| --- |
| [Tip] |
| In this case, the producer owns the contracts. Physically, all the contract are in the producer’s repository. |

### 86.4.1 Technical note

If using the **SNAPSHOT** / **Milestone** / **Release Candidate** versions please add the following section to your build:

**Maven.**

<repositories>

<repository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</repository>

<repository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

<repository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

</repositories>

<pluginRepositories>

<pluginRepository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

</pluginRepositories>

**Gradle.**

repositories {

mavenCentral()

mavenLocal()

maven { url "http://repo.spring.io/snapshot" }

maven { url "http://repo.spring.io/milestone" }

maven { url "http://repo.spring.io/release" }

}

### 86.4.2 Consumer side (Loan Issuance)

As a developer of the Loan Issuance service (a consumer of the Fraud Detection server), you might do the following steps:

1. Start doing TDD by writing a test for your feature.
2. Write the missing implementation.
3. Clone the Fraud Detection service repository locally.
4. Define the contract locally in the repo of Fraud Detection service.
5. Add the Spring Cloud Contract Verifier plugin.
6. Run the integration tests.
7. File a pull request.
8. Create an initial implementation.
9. Take over the pull request.
10. Write the missing implementation.
11. Deploy your app.
12. Work online.

**Start doing TDD by writing a test for your feature.**

*@Test*

**public** **void** shouldBeRejectedDueToAbnormalLoanAmount() {

*// given:*

LoanApplication application = **new** LoanApplication(**new** Client("1234567890"),

99999);

*// when:*

LoanApplicationResult loanApplication = service.loanApplication(application);

*// then:*

assertThat(loanApplication.getLoanApplicationStatus())

.isEqualTo(LoanApplicationStatus.LOAN\_APPLICATION\_REJECTED);

assertThat(loanApplication.getRejectionReason()).isEqualTo("Amount too high");

}

Assume that you have written a test of your new feature. If a loan application for a big amount is received, the system should reject that loan application with some description.

**Write the missing implementation.**

At some point in time, you need to send a request to the Fraud Detection service. Assume that you need to send the request containing the ID of the client and the amount the client wants to borrow. You want to send it to the /fraudcheck url via the PUT method.

ResponseEntity<FraudServiceResponse> response =

restTemplate.exchange("http://localhost:" + port + "/fraudcheck", HttpMethod.PUT,

**new** HttpEntity<>(request, httpHeaders),

FraudServiceResponse.**class**);

For simplicity, the port of the Fraud Detection service is set to 8080, and the application runs on 8090.

If you start the test at this point, it breaks, because no service currently runs on port 8080.

**Clone the Fraud Detection service repository locally.**

You can start by playing around with the server side contract. To do so, you must first clone it.

$ git clone https://your-git-server.com/server-side.git local-http-server-repo

**Define the contract locally in the repo of Fraud Detection service.**

As a consumer, you need to define what exactly you want to achieve. You need to formulate your expectations. To do so, write the following contract:

|  |  |
| --- | --- |
| [Important] | **Important** |
| Place the contract under src/test/resources/contracts/fraud folder. The fraud folder is important because the producer’s test base class name references that folder. |

**Groovy DSL.**

**package** contracts

org.springframework.cloud.contract.spec.Contract.make {

request { *// (1)*

method 'PUT' *// (2)*

url '/fraudcheck' *// (3)*

body([ *// (4)*

"client.id": $(regex('[0-9]{10}')),

loanAmount: 99999

])

headers { *// (5)*

contentType('application/json')

}

}

response { *// (6)*

status OK() *// (7)*

body([ *// (8)*

fraudCheckStatus: "FRAUD",

"rejection.reason": "Amount too high"

])

headers { *// (9)*

contentType('application/json')

}

}

}

*/\**

*From the Consumer perspective, when shooting a request in the integration test:*

*(1) - If the consumer sends a request*

*(2) - With the "PUT" method*

*(3) - to the URL "/fraudcheck"*

*(4) - with the JSON body that*

*\* has a field `client.id` that matches a regular expression `[0-9]{10}`*

*\* has a field `loanAmount` that is equal to `99999`*

*(5) - with header `Content-Type` equal to `application/json`*

*(6) - then the response will be sent with*

*(7) - status equal `200`*

*(8) - and JSON body equal to*

*{ "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }*

*(9) - with header `Content-Type` equal to `application/json`*

*From the Producer perspective, in the autogenerated producer-side test:*

*(1) - A request will be sent to the producer*

*(2) - With the "PUT" method*

*(3) - to the URL "/fraudcheck"*

*(4) - with the JSON body that*

*\* has a field `client.id` that will have a generated value that matches a regular expression `[0-9]{10}`*

*\* has a field `loanAmount` that is equal to `99999`*

*(5) - with header `Content-Type` equal to `application/json`*

*(6) - then the test will assert if the response has been sent with*

*(7) - status equal `200`*

*(8) - and JSON body equal to*

*{ "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }*

*(9) - with header `Content-Type` matching `application/json.\*`*

*\*/*

**YAML.**

request: # (1)

method: PUT # (2)

url: /fraudcheck # (3)

body: # (4)

"client.id": 1234567890

loanAmount: 99999

headers: # (5)

Content-Type: application/json

matchers:

body:

- path: $.['client.id'] # (6)

type: by\_regex

value: "[0-9]{10}"

response: # (7)

status: 200 # (8)

body: # (9)

fraudCheckStatus: "FRAUD"

"rejection.reason": "Amount too high"

headers: # (10)

Content-Type: application/json;charset=UTF-8

#From the Consumer perspective, when shooting a request in the integration test:

#

#(1) - If the consumer sends a request

#(2) - With the "PUT" method

#(3) - to the URL "/fraudcheck"

#(4) - with the JSON body that

# \* has a field `client.id`

# \* has a field `loanAmount` that is equal to `99999`

#(5) - with header `Content-Type` equal to `application/json`

#(6) - and a `client.id` json entry matches the regular expression `[0-9]{10}`

#(7) - then the response will be sent with

#(8) - status equal `200`

#(9) - and JSON body equal to

# { "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }

#(10) - with header `Content-Type` equal to `application/json`

#

#From the Producer perspective, in the autogenerated producer-side test:

#

#(1) - A request will be sent to the producer

#(2) - With the "PUT" method

#(3) - to the URL "/fraudcheck"

#(4) - with the JSON body that

# \* has a field `client.id` `1234567890`

# \* has a field `loanAmount` that is equal to `99999`

#(5) - with header `Content-Type` equal to `application/json`

#(7) - then the test will assert if the response has been sent with

#(8) - status equal `200`

#(9) - and JSON body equal to

# { "fraudCheckStatus": "FRAUD", "rejectionReason": "Amount too high" }

#(10) - with header `Content-Type` equal to `application/json;charset=UTF-8`

The YML contract is quite straight-forward. However when you take a look at the Contract written using a statically typed Groovy DSL - you might wonder what thevalue(client(…​), server(…​)) parts are. By using this notation, Spring Cloud Contract lets you define parts of a JSON block, a URL, etc., which are dynamic. In case of an identifier or a timestamp, you need not hardcode a value. You want to allow some different ranges of values. To enable ranges of values, you can set regular expressions matching those values for the consumer side. You can provide the body by means of either a map notation or String with interpolations. [Consult the docs for more information.](https://cloud.spring.io/spring-cloud-contract/single/spring-cloud-contract.html#_contract_dsl) We highly recommend using the map notation!

|  |
| --- |
| [Tip] |
| You must understand the map notation in order to set up contracts. Please read the [Groovy docs regarding JSON](http://groovy-lang.org/json.html). |

The previously shown contract is an agreement between two sides that:

* if an HTTP request is sent with all of
  + a PUT method on the /fraudcheck endpoint,
  + a JSON body with a client.id that matches the regular expression [0-9]{10} and loanAmount equal to 99999,
  + and a Content-Type header with a value of application/vnd.fraud.v1+json,
* then an HTTP response is sent to the consumer that
  + has status 200,
  + contains a JSON body with the fraudCheckStatus field containing a value FRAUD and the rejectionReason field having value Amount too high,
  + and a Content-Type header with a value of application/vnd.fraud.v1+json.

Once you are ready to check the API in practice in the integration tests, you need to install the stubs locally.

**Add the Spring Cloud Contract Verifier plugin.**

We can add either a Maven or a Gradle plugin. In this example, you see how to add Maven. First, add the Spring Cloud Contract BOM.

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${spring-cloud-dependencies.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

Next, add the Spring Cloud Contract Verifier Maven plugin

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example.fraud</packageWithBaseClasses>

</configuration>

</plugin>

Since the plugin was added, you get the Spring Cloud Contract Verifier features which, from the provided contracts:

* generate and run tests
* produce and install stubs

You do not want to generate tests since you, as the consumer, want only to play with the stubs. You need to skip the test generation and execution. When you execute:

$ **cd** local-http-server-repo

$ ./mvnw clean install -DskipTests

In the logs, you see something like this:

[INFO] --- spring-cloud-contract-maven-plugin:1.0.0.BUILD-SNAPSHOT:generateStubs (default-generateStubs) @ http-server ---

[INFO] Building jar: /some/path/http-server/target/http-server-0.0.1-SNAPSHOT-stubs.jar

[INFO]

[INFO] --- maven-jar-plugin:2.6:jar (default-jar) @ http-server ---

[INFO] Building jar: /some/path/http-server/target/http-server-0.0.1-SNAPSHOT.jar

[INFO]

[INFO] --- spring-boot-maven-plugin:1.5.5.BUILD-SNAPSHOT:repackage (default) @ http-server ---

[INFO]

[INFO] --- maven-install-plugin:2.5.2:install (default-install) @ http-server ---

[INFO] Installing /some/path/http-server/target/http-server-0.0.1-SNAPSHOT.jar to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT.jar

[INFO] Installing /some/path/http-server/pom.xml to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT.pom

[INFO] Installing /some/path/http-server/target/http-server-0.0.1-SNAPSHOT-stubs.jar to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar

The following line is extremely important:

[INFO] Installing /some/path/http-server/target/http-server-0.0.1-SNAPSHOT-stubs.jar to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar

It confirms that the stubs of the http-server have been installed in the local repository.

**Run the integration tests.**

In order to profit from the Spring Cloud Contract Stub Runner functionality of automatic stub downloading, you must do the following in your consumer side project (Loan Application service):

Add the Spring Cloud Contract BOM:

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${spring-cloud-dependencies.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

Add the dependency to Spring Cloud Contract Stub Runner:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-stub-runner</artifactId>

<scope>test</scope>

</dependency>

Annotate your test class with @AutoConfigureStubRunner. In the annotation, provide the group-id and artifact-id for the Stub Runner to download the stubs of your collaborators. (Optional step) Because you’re playing with the collaborators offline, you can also provide the offline work switch (StubRunnerProperties.StubsMode.LOCAL).

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment=WebEnvironment.NONE)*

*@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:stubs:6565"},*

*stubsMode = StubRunnerProperties.StubsMode.LOCAL)*

*@DirtiesContext*

**public** **class** LoanApplicationServiceTests {

Now, when you run your tests, you see something like this:

2016-07-19 14:22:25.403 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Desired version is + - will try to resolve the latest version

2016-07-19 14:22:25.438 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Resolved version is 0.0.1-SNAPSHOT

2016-07-19 14:22:25.439 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Resolving artifact com.example:http-server:jar:stubs:0.0.1-SNAPSHOT using remote repositories []

2016-07-19 14:22:25.451 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Resolved artifact com.example:http-server:jar:stubs:0.0.1-SNAPSHOT to /path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar

2016-07-19 14:22:25.465 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Unpacking stub from JAR [URI: file:/path/to/your/.m2/repository/com/example/http-server/0.0.1-SNAPSHOT/http-server-0.0.1-SNAPSHOT-stubs.jar]

2016-07-19 14:22:25.475 INFO 41050 --- [ main] o.s.c.c.stubrunner.AetherStubDownloader : Unpacked file to [/var/folders/0p/xwq47sq106x1\_g3dtv6qfm940000gq/T/contracts100276532569594265]

2016-07-19 14:22:27.737 INFO 41050 --- [ main] o.s.c.c.stubrunner.StubRunnerExecutor : All stubs are now running RunningStubs [namesAndPorts={com.example:http-server:0.0.1-SNAPSHOT:stubs=8080}]

This output means that Stub Runner has found your stubs and started a server for your app with group id com.example, artifact id http-server with version 0.0.1-SNAPSHOT of the stubs and with stubs classifier on port 8080.

**File a pull request.**

What you have done until now is an iterative process. You can play around with the contract, install it locally, and work on the consumer side until the contract works as you wish.

Once you are satisfied with the results and the test passes, publish a pull request to the server side. Currently, the consumer side work is done.

### 86.4.3 Producer side (Fraud Detection server)

As a developer of the Fraud Detection server (a server to the Loan Issuance service):

**Create an initial implementation.**

As a reminder, you can see the initial implementation here:

*@RequestMapping(value = "/fraudcheck", method = PUT)*

**public** FraudCheckResult fraudCheck(*@RequestBody* FraudCheck fraudCheck) {

**return** **new** FraudCheckResult(FraudCheckStatus.OK, NO\_REASON);

}

**Take over the pull request.**

$ git checkout -b contract-change-pr master

$ git pull https://your-git-server.com/server-side-fork.git contract-change-pr

You must add the dependencies needed by the autogenerated tests:

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-verifier</artifactId>

<scope>test</scope>

</dependency>

In the configuration of the Maven plugin, pass the packageWithBaseClasses property

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example.fraud</packageWithBaseClasses>

</configuration>

</plugin>

|  |  |
| --- | --- |
| [Important] | **Important** |
| This example uses "convention based" naming by setting the packageWithBaseClasses property. Doing so means that the two last packages combine to make the name of the base test class. In our case, the contracts were placed under src/test/resources/contracts/fraud. Since you do not have two packages starting from the contracts folder, pick only one, which should be fraud. Add the Base suffix and capitalize fraud. That gives you the FraudBase test class name. |

All the generated tests extend that class. Over there, you can set up your Spring Context or whatever is necessary. In this case, use [Rest Assured MVC](http://rest-assured.io/) to start the server side FraudDetectionController.

**package** com.example.fraud;

**import** org.junit.Before;

**import** io.restassured.module.mockmvc.RestAssuredMockMvc;

**public** **class** FraudBase {

*@Before*

**public** **void** setup() {

RestAssuredMockMvc.standaloneSetup(**new** FraudDetectionController(),

**new** FraudStatsController(stubbedStatsProvider()));

}

**private** StatsProvider stubbedStatsProvider() {

**return** fraudType -> {

**switch** (fraudType) {

**case** DRUNKS:

**return** 100;

**case** ALL:

**return** 200;

}

**return** 0;

};

}

**public** **void** assertThatRejectionReasonIsNull(Object rejectionReason) {

assert rejectionReason == null;

}

}

Now, if you run the ./mvnw clean install, you get something like this:

Results :

Tests in error:

ContractVerifierTest.validate\_shouldMarkClientAsFraud:32 » IllegalState Parsed...

This error occurs because you have a new contract from which a test was generated and it failed since you have not implemented the feature. The auto-generated test would look like this:

*@Test*

**public** **void** validate\_shouldMarkClientAsFraud() **throws** Exception {

*// given:*

MockMvcRequestSpecification request = given()

.header("Content-Type", "application/vnd.fraud.v1+json")

.body("{\"client.id\":\"1234567890\",\"loanAmount\":99999}");

*// when:*

ResponseOptions response = given().spec(request)

.put("/fraudcheck");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

assertThat(response.header("Content-Type")).matches("application/vnd.fraud.v1.json.\*");

*// and:*

DocumentContext parsedJson = JsonPath.parse(response.getBody().asString());

assertThatJson(parsedJson).field("['fraudCheckStatus']").matches("[A-Z]{5}");

assertThatJson(parsedJson).field("['rejection.reason']").isEqualTo("Amount too high");

}

If you used the Groovy DSL, you can see, all the producer() parts of the Contract that were present in the value(consumer(…​), producer(…​)) blocks got injected into the test. In case of using YAML, the same applied for the matchers sections of the response.

Note that, on the producer side, you are also doing TDD. The expectations are expressed in the form of a test. This test sends a request to our own application with the URL, headers, and body defined in the contract. It also is expecting precisely defined values in the response. In other words, you have the red part of red, green, andrefactor. It is time to convert the red into the green.

**Write the missing implementation.**

Because you know the expected input and expected output, you can write the missing implementation:

*@RequestMapping(value = "/fraudcheck", method = PUT)*

**public** FraudCheckResult fraudCheck(*@RequestBody* FraudCheck fraudCheck) {

**if** (amountGreaterThanThreshold(fraudCheck)) {

**return** **new** FraudCheckResult(FraudCheckStatus.FRAUD, AMOUNT\_TOO\_HIGH);

}

**return** **new** FraudCheckResult(FraudCheckStatus.OK, NO\_REASON);

}

When you execute ./mvnw clean install again, the tests pass. Since the Spring Cloud Contract Verifier plugin adds the tests to the generated-test-sources, you can actually run those tests from your IDE.

**Deploy your app.**

Once you finish your work, you can deploy your change. First, merge the branch:

$ git checkout master

$ git merge --no-ff contract-change-pr

$ git push origin master

Your CI might run something like ./mvnw clean deploy, which would publish both the application and the stub artifacts.

### 86.4.4 Consumer Side (Loan Issuance) Final Step

As a developer of the Loan Issuance service (a consumer of the Fraud Detection server):

**Merge branch to master.**

$ git checkout master

$ git merge --no-ff contract-change-pr

**Work online.**

Now you can disable the offline work for Spring Cloud Contract Stub Runner and indicate where the repository with your stubs is located. At this moment the stubs of the server side are automatically downloaded from Nexus/Artifactory. You can set the value of stubsMode to REMOTE. The following code shows an example of achieving the same thing by changing the properties.

stubrunner:

ids: 'com.example:http-server-dsl:+:stubs:8080'

repositoryRoot: http://repo.spring.io/libs-snapshot

That’s it!

## 86.5 Dependencies

The best way to add dependencies is to use the proper starter dependency.

For stub-runner, use spring-cloud-starter-stub-runner. When you use a plugin, add spring-cloud-starter-contract-verifier.

## 86.6 Additional Links

Here are some resources related to Spring Cloud Contract Verifier and Stub Runner. Note that some may be outdated, because the Spring Cloud Contract Verifier project is under constant development.

### 86.6.1 Spring Cloud Contract video

You can check out the video from the Warsaw JUG about Spring Cloud Contract:

### 86.6.2 Readings

* [Slides from Marcin Grzejszczak’s talk about Accurest](http://www.slideshare.net/MarcinGrzejszczak/stick-to-the-rules-consumer-driven-contracts-201507-confitura)
* [Accurest related articles from Marcin Grzejszczak’s blog](http://toomuchcoding.com/blog/categories/accurest/)
* [Spring Cloud Contract related articles from Marcin Grzejszczak’s blog](http://toomuchcoding.com/blog/categories/spring-cloud-contract/)
* [Groovy docs regarding JSON](http://groovy-lang.org/json.html)

## 86.7 Samples

You can find some samples at [samples](https://github.com/spring-cloud-samples/spring-cloud-contract-samples).

## 87. Spring Cloud Contract FAQ

## 87.1 Why use Spring Cloud Contract Verifier and not X ?

For the time being Spring Cloud Contract Verifier is a JVM based tool. So it could be your first pick when you’re already creating software for the JVM. This project has a lot of really interesting features but especially quite a few of them definitely make Spring Cloud Contract Verifier stand out on the "market" of Consumer Driven Contract (CDC) tooling. Out of many the most interesting are:

* Possibility to do CDC with messaging
* Clear and easy to use, statically typed DSL
* Possibility to copy paste your current JSON file to the contract and only edit its elements
* Automatic generation of tests from the defined Contract
* Stub Runner functionality - the stubs are automatically downloaded at runtime from Nexus / Artifactory
* Spring Cloud integration - no discovery service is needed for integration tests

## 87.2 I don’t want to write a contract in Groovy!

No problem. You can write a contract in YAML!

## 87.3 What is this value(consumer(), producer()) ?

One of the biggest challenges related to stubs is their reusability. Only if they can be vastly used, will they serve their purpose. What typically makes that difficult are the hard-coded values of request / response elements. For example dates or ids. Imagine the following JSON request

**{**

"time" : "2016-10-10 20:10:15"**,**

"id" : "9febab1c-6f36-4a0b-88d6-3b6a6d81cd4a"**,**

"body" : "foo"

**}**

and JSON response

**{**

"time" : "2016-10-10 21:10:15"**,**

"id" : "c4231e1f-3ca9-48d3-b7e7-567d55f0d051"**,**

"body" : "bar"

**}**

Imagine the pain required to set proper value of the time field (let’s assume that this content is generated by the database) by changing the clock in the system or providing stub implementations of data providers. The same is related to the field called id. Will you create a stubbed implementation of UUID generator? Makes little sense…​

So as a consumer you would like to send a request that matches any form of a time or any UUID. That way your system will work as usual - will generate data and you won’t have to stub anything out. Let’s assume that in case of the aforementioned JSON the most important part is the body field. You can focus on that and provide matching for other fields. In other words you would like the stub to work like this:

**{**

"time" : "SOMETHING THAT MATCHES TIME"**,**

"id" : "SOMETHING THAT MATCHES UUID"**,**

"body" : "foo"

**}**

As far as the response goes as a consumer you need a concrete value that you can operate on. So such a JSON is valid

**{**

"time" : "2016-10-10 21:10:15"**,**

"id" : "c4231e1f-3ca9-48d3-b7e7-567d55f0d051"**,**

"body" : "bar"

**}**

As you could see in the previous sections we generate tests from contracts. So from the producer’s side the situation looks much different. We’re parsing the provided contract and in the test we want to send a real request to your endpoints. So for the case of a producer for the request we can’t have any sort of matching. We need concrete values that the producer’s backend can work on. Such a JSON would be a valid one:

**{**

"time" : "2016-10-10 20:10:15"**,**

"id" : "9febab1c-6f36-4a0b-88d6-3b6a6d81cd4a"**,**

"body" : "foo"

**}**

On the other hand from the point of view of the validity of the contract the response doesn’t necessarily have to contain concrete values of time or id. Let’s say that you generate those on the producer side - again, you’d have to do a lot of stubbing to ensure that you always return the same values. That’s why from the producer’s side what you might want is the following response:

**{**

"time" : "SOMETHING THAT MATCHES TIME"**,**

"id" : "SOMETHING THAT MATCHES UUID"**,**

"body" : "bar"

**}**

How can you then provide one time a matcher for the consumer and a concrete value for the producer and vice versa? In Spring Cloud Contract we’re allowing you to provide a **dynamic value**. That means that it can differ for both sides of the communication. You can pass the values:

Either via the value method

value(consumer(...), producer(...))

value(stub(...), test(...))

value(client(...), server(...))

or using the $() method

$(consumer(...), producer(...))

$(stub(...), test(...))

$(client(...), server(...))

You can read more about this in the [Contract DSL section](https://cloud.spring.io/spring-cloud-contract/single/spring-cloud-contract.html#_contract_dsl).

Calling value() or $() tells Spring Cloud Contract that you will be passing a dynamic value. Inside the consumer() method you pass the value that should be used on the consumer side (in the generated stub). Inside the producer() method you pass the value that should be used on the producer side (in the generated test).

|  |
| --- |
| [Tip] |
| If on one side you have passed the regular expression and you haven’t passed the other, then the other side will get auto-generated. |

Most often you will use that method together with the regex helper method. E.g. consumer(regex('[0-9]{10}')).

To sum it up the contract for the aforementioned scenario would look more or less like this (the regular expression for time and UUID are simplified and most likely invalid but we want to keep things very simple in this example):

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'GET'

url '/someUrl'

body([

time : value(consumer(regex('[0-9]{4}-[0-9]{2}-[0-9]{2} [0-2][0-9]-[0-5][0-9]-[0-5][0-9]')),

id: value(consumer(regex('[0-9a-zA-z]{8}-[0-9a-zA-z]{4}-[0-9a-zA-z]{4}-[0-9a-zA-z]{12}'))

body: "foo"

])

}

response {

status OK()

body([

time : value(producer(regex('[0-9]{4}-[0-9]{2}-[0-9]{2} [0-2][0-9]-[0-5][0-9]-[0-5][0-9]')),

id: value([producer(regex('[0-9a-zA-z]{8}-[0-9a-zA-z]{4}-[0-9a-zA-z]{4}-[0-9a-zA-z]{12}'))

body: "bar"

])

}

}

|  |  |
| --- | --- |
| [Important] | **Important** |
| Please read the [Groovy docs related to JSON](http://groovy-lang.org/json.html) to understand how to properly structure the request / response bodies. |

## 87.4 How to do Stubs versioning?

### 87.4.1 API Versioning

Let’s try to answer a question what versioning really means. If you’re referring to the API version then there are different approaches.

* use Hypermedia, links and do not version your API by any means
* pass versions through headers / urls

I will not try to answer a question which approach is better. Whatever suit your needs and allows you to generate business value should be picked.

Let’s assume that you do version your API. In that case you should provide as many contracts as many versions you support. You can create a subfolder for every version or append it to th contract name - whatever suits you more.

### 87.4.2 JAR versioning

If by versioning you mean the version of the JAR that contains the stubs then there are essentially two main approaches.

Let’s assume that you’re doing Continuous Delivery / Deployment which means that you’re generating a new version of the jar each time you go through the pipeline and that jar can go to production at any time. For example your jar version looks like this (it got built on the 20.10.2016 at 20:15:21) :

1.0.0.20161020-201521-RELEASE

In that case your generated stub jar will look like this.

1.0.0.20161020-201521-RELEASE-stubs.jar

In this case you should inside your application.yml or @AutoConfigureStubRunner when referencing stubs provide the latest version of the stubs. You can do that by passing the + sign. Example

@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:stubs:8080"})

If the versioning however is fixed (e.g. 1.0.4.RELEASE or 2.1.1) then you have to set the concrete value of the jar version. Example for 2.1.1.

@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:2.1.1:stubs:8080"})

### 87.4.3 Dev or prod stubs

You can manipulate the classifier to run the tests against current development version of the stubs of other services or the ones that were deployed to production. If you alter your build to deploy the stubs with the prod-stubs classifier once you reach production deployment then you can run tests in one case with dev stubs and one with prod stubs.

Example of tests using development version of stubs

@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:stubs:8080"})

Example of tests using production version of stubs

@AutoConfigureStubRunner(ids = {"com.example:http-server-dsl:+:prod-stubs:8080"})

You can pass those values also via properties from your deployment pipeline.

## 87.5 Common repo with contracts

Another way of storing contracts other than having them with the producer is keeping them in a common place. It can be related to security issues where the consumers can’t clone the producer’s code. Also if you keep contracts in a single place then you, as a producer, will know how many consumers you have and which consumer will you break with your local changes.

### 87.5.1 Repo structure

Let’s assume that we have a producer with coordinates com.example:server and 3 consumers: client1, client2, client3. Then in the repository with common contracts you would have the following setup (which you can checkout [here](https://github.com/spring-cloud/spring-cloud-contract/tree/1.0.x/samples/standalone/contracts):

├── com

│   └── example

│   └── server

│   ├── client1

│   │   └── expectation.groovy

│   ├── client2

│   │   └── expectation.groovy

│   ├── client3

│   │   └── expectation.groovy

│   └── pom.xml

├── mvnw

├── mvnw.cmd

├── pom.xml

└── src

└── assembly

└── contracts.xml

As you can see the under the slash-delimited groupid / artifact id folder (com/example/server) you have expectations of the 3 consumers (client1, client2 and client3). Expectations are the standard Groovy DSL contract files as described throughout this documentation. This repository has to produce a JAR file that maps one to one to the contents of the repo.

Example of a pom.xml inside the server folder.

<?xml version="1.0" encoding="UTF-8"?>

<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

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>

<groupId>com.example</groupId>

<artifactId>server</artifactId>

<version>0.0.1-SNAPSHOT</version>

<name>Server Stubs</name>

<description>POM used to install locally stubs for consumer side</description>

<parent>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-parent</artifactId>

<version>1.5.10.RELEASE</version>

<relativePath />

</parent>

<properties>

<project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>

<java.version>1.8</java.version>

<spring-cloud-contract.version>1.2.4.BUILD-SNAPSHOT</spring-cloud-contract.version>

<spring-cloud-dependencies.version>Edgware.BUILD-SNAPSHOT</spring-cloud-dependencies.version>

<excludeBuildFolders>true</excludeBuildFolders>

</properties>

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${spring-cloud-dependencies.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

<build>

<plugins>

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

*<!-- By default it would search under src/test/resources/ -->*

<contractsDirectory>${project.basedir}</contractsDirectory>

</configuration>

</plugin>

</plugins>

</build>

<repositories>

<repository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</repository>

<repository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

<repository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

</repositories>

<pluginRepositories>

<pluginRepository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

</pluginRepositories>

</project>

As you can see there are no dependencies other than the Spring Cloud Contract Maven Plugin. Those poms are necessary for the consumer side to run mvn clean install -DskipTests to locally install stubs of the producer project.

The pom.xml in the root folder can look like this:

<?xml version="1.0" encoding="UTF-8"?>

<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

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>

<groupId>com.example.standalone</groupId>

<artifactId>contracts</artifactId>

<version>0.0.1-SNAPSHOT</version>

<name>Contracts</name>

<description>Contains all the Spring Cloud Contracts, well, contracts. JAR used by the producers to generate tests and stubs</description>

<properties>

<project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>

</properties>

<build>

<plugins>

<plugin>

<groupId>org.apache.maven.plugins</groupId>

<artifactId>maven-assembly-plugin</artifactId>

<executions>

<execution>

<id>contracts</id>

<phase>prepare-package</phase>

<goals>

<goal>single</goal>

</goals>

<configuration>

<attach>true</attach>

<descriptor>${basedir}/src/assembly/contracts.xml</descriptor>

*<!-- If you want an explicit classifier remove the following line -->*

<appendAssemblyId>false</appendAssemblyId>

</configuration>

</execution>

</executions>

</plugin>

</plugins>

</build>

</project>

It’s using the assembly plugin in order to build the JAR with all the contracts. Example of such setup is here:

<assembly xmlns="http://maven.apache.org/plugins/maven-assembly-plugin/assembly/1.1.3"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://maven.apache.org/plugins/maven-assembly-plugin/assembly/1.1.3 http://maven.apache.org/xsd/assembly-1.1.3.xsd">

<id>project</id>

<formats>

<format>jar</format>

</formats>

<includeBaseDirectory>false</includeBaseDirectory>

<fileSets>

<fileSet>

<directory>${project.basedir}</directory>

<outputDirectory>/</outputDirectory>

<useDefaultExcludes>true</useDefaultExcludes>

<excludes>

<exclude>\*\*/${project.build.directory}/\*\*</exclude>

<exclude>mvnw</exclude>

<exclude>mvnw.cmd</exclude>

<exclude>.mvn/\*\*</exclude>

<exclude>src/\*\*</exclude>

</excludes>

</fileSet>

</fileSets>

</assembly>

### 87.5.2 Workflow

The workflow would look similar to the one presented in the Step by step guide to CDC. The only difference is that the producer doesn’t own the contracts anymore. So the consumer and the producer have to work on common contracts in a common repository.

### 87.5.3 Consumer

When the **consumer** wants to work on the contracts offline, instead of cloning the producer code, the consumer team clones the common repository, goes to the required producer’s folder (e.g. com/example/server) and runs mvn clean install -DskipTests to install locally the stubs converted from the contracts.

|  |
| --- |
| [Tip] |
| You need to have [Maven installed locally](https://maven.apache.org/download.cgi) |

### 87.5.4 Producer

As a **producer** it’s enough to alter the Spring Cloud Contract Verifier to provide the URL and the dependency of the JAR containing the contracts:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<configuration>

<contractsRepositoryUrl>http://link/to/your/nexus/or/artifactory/or/sth</contractsRepositoryUrl>

<contractDependency>

<groupId>com.example.standalone</groupId>

<artifactId>contracts</artifactId>

</contractDependency>

</configuration>

</plugin>

With this setup the JAR with groupid com.example.standalone and artifactid contracts will be downloaded from <http://link/to/your/nexus/or/artifactory/or/sth>. It will be then unpacked in a local temporary folder and contracts present under the com/example/serverwill be picked as the ones used to generate the tests and the stubs. Due to this convention the producer team will know which consumer teams will be broken when some incompatible changes are done.

The rest of the flow looks the same.

### 87.5.5 How can I define messaging contracts per topic not per producer?

To avoid messaging contracts duplication in the common repo, when few producers writing messages to one topic, we could create the structure when the rest contracts would be placed in a folder per producer and messaging contracts in the folder per topic.

#### For Maven Project

To make it possible to work on the producer side we could do the following things (all via Maven plugins):

* Add common repo dependency to your classpath:

<dependency>

<groupId>com.example</groupId>

<artifactId>common-repo</artifactId>

<version>${common-repo.version}</version>

</dependency>

* Download the JAR with the contracts and unpack the JAR to target:

<plugin>

<groupId>org.apache.maven.plugins</groupId>

<artifactId>maven-dependency-plugin</artifactId>

<version>3.0.0</version>

<executions>

<execution>

<id>unpack-dependencies</id>

<phase>process-resources</phase>

<goals>

<goal>unpack</goal>

</goals>

<configuration>

<artifactItems>

<artifactItem>

<groupId>com.example</groupId>

<artifactId>common-repo</artifactId>

<type>jar</type>

<overWrite>false</overWrite>

<outputDirectory>${project.build.directory}/contracts</outputDirectory>

</artifactItem>

</artifactItems>

</configuration>

</execution>

</executions>

</plugin>

* Rip out all the folders we’re not interested in:

<plugin>

<groupId>org.apache.maven.plugins</groupId>

<artifactId>maven-antrun-plugin</artifactId>

<version>1.8</version>

<executions>

<execution>

<phase>process-resources</phase>

<goals>

<goal>run</goal>

</goals>

<configuration>

<tasks>

<delete includeemptydirs="true">

<fileset dir="${project.build.directory}/contracts">

<include name="\*\*/\*" />

*<!--Producer artifactId-->*

<exclude name="\*\*/${project.artifactId}/\*\*" />

*<!--List of the supported topics-->*

<exclude name="\*\*/${first-topic}/\*\*" />

<exclude name="\*\*/${second-topic}/\*\*" />

</fileset>

</delete>

</tasks>

</configuration>

</execution>

</executions>

</plugin>

* Run the contract plugin by pointing to the contracts to the folder under target:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example</packageWithBaseClasses>

<baseClassMappings>

<baseClassMapping>

<contractPackageRegex>.\*intoxication.\*</contractPackageRegex>

<baseClassFQN>com.example.intoxication.BeerIntoxicationBase</baseClassFQN>

</baseClassMapping>

</baseClassMappings>

<contractsDirectory>${project.build.directory}/contracts</contractsDirectory>

</configuration>

</plugin>

#### For Gradle Project

* Add a custom configuration for the common-repo dependency:

ext {

conractsGroupId = "com.example"

contractsArtifactId = "common-repo"

contractsVersion = "1.2.3"

}

configurations {

contracts {

transitive = false

}

}

* Add the common-repo dependency to your classpath:

dependencies {

contracts "${conractsGroupId}:${contractsArtifactId}:${contractsVersion}"

testCompile "${conractsGroupId}:${contractsArtifactId}:${contractsVersion}"

}

* Download the dependency to an appropriate folder:

task getContracts(type: Copy) {

from configurations.contracts

into **new** File(project.buildDir, "downloadedContracts")

}

* Unzip JAR:

task unzipContracts(type: Copy) {

def zipFile = **new** File(project.buildDir, "downloadedContracts/${contractsArtifactId}-${contractsVersion}.jar")

def outputDir = file("${buildDir}/unpackedContracts")

from zipTree(zipFile)

into outputDir

}

* Cleanup unused contracts:

task deleteUnwantedContracts(type: Delete) {

delete fileTree(dir: "${buildDir}/unpackedContracts",

include: "\*\*/\*",

excludes: [

"\*\*/${project.name}/\*\*"",

\*\*/${first-topic}**/\*\*",**

**\*\*/**${second-topic}**/\*\*])**

**}**

* Create task dependencies:

unzipContracts.dependsOn("getContracts")

deleteUnwantedContracts.dependsOn("unzipContracts")

build.dependsOn("deleteUnwantedContracts")

* Configure plugin by specifying the directory containing contracts using contractsDslDir property

contracts {

contractsDslDir = **new** File("${buildDir}/unpackedContracts")

}

## 87.6 Can I have multiple base classes for tests?

Yes! Check out the [Different base classes for contracts](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html#_different_base_classes_for_contracts) sections of either Gradle or Maven plugins.

## 87.7 How can I debug the request/response being sent by the generated tests client?

The generated tests all boil down to RestAssured in some form or fashion which relies on [Apache HttpClient](https://hc.apache.org/httpcomponents-client-ga/). HttpClient has a facility called [wire logging](https://hc.apache.org/httpcomponents-client-ga/logging.html#Wire_Logging) which logs the entire request and response to HttpClient. Spring Boot has a logging [common application property](https://docs.spring.io/spring-boot/docs/current/reference/html/common-application-properties.html) for doing this sort of thing, just add this to your application properties

logging.level.org.apache.http.wire=DEBUG

### 87.7.1 How can I debug the mapping/request/response being sent by WireMock?

Starting from version 1.2.0 we turn on WireMock logging to info and the WireMock notifier to being verbose. Now you will exactly know what request was received by WireMock server and which matching response definition was picked.

To turn off this feature just bump WireMock logging to ERROR

logging.level.com.github.tomakehurst.wiremock=ERROR

### 87.7.2 How can I see what got registered in the HTTP server stub?

You can use the mappingsOutputFolder property on @AutoConfigureStubRunner or StubRunnerRule to dump all mappings per artifact id. Also the port at which the given stub server was started will be attached.

### 87.7.3 Can I reference the request from the response?

Yes! With version 1.1.0 we’ve added such a possibility. On the HTTP stub server side we’re providing support for this for WireMock. In case of other HTTP server stubs you’ll have to implement the approach yourself.

### 87.7.4 Can I reference text from file?

Yes! With version 1.2.0 we’ve added such a possibility. It’s enough to call file(…​) method in the DSL and provide a path relative to where the contract lays. If you’re using YAML just use the bodyFromFile property.

## 88. Spring Cloud Contract Verifier Setup

You can set up Spring Cloud Contract Verifier in the following ways:

* [As a Gradle project](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-project)
* [As a Maven project](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-project)
* [As a Docker project](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#docker-project)

## 88.1 Gradle Project

To learn how to set up the Gradle project for Spring Cloud Contract Verifier, read the following sections:

* [Section 88.1.1, “Prerequisites”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-prerequisites)
* [Section 88.1.2, “Add Gradle Plugin with Dependencies”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-add-gradle-plugin)
* [Section 88.1.3, “Gradle and Rest Assured 2.0”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-and-rest-assured)
* [Section 88.1.4, “Snapshot Versions for Gradle”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-snapshot-versions)
* [Section 88.1.5, “Add stubs”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-add-stubs)
* [Section 88.1.7, “Default Setup”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-default-setup)
* [Section 88.1.8, “Configure Plugin”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-configure-plugin)
* [Section 88.1.9, “Configuration Options”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-configuration-options)
* [Section 88.1.10, “Single Base Class for All Tests”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-single-base-class)
* [Section 88.1.11, “Different Base Classes for Contracts”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-different-base-classes)
* [Section 88.1.12, “Invoking Generated Tests”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-invoking-generated-tests)
* [Section 88.1.13, “Spring Cloud Contract Verifier on the Consumer Side”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#gradle-consumer)

### 88.1.1 Prerequisites

In order to use Spring Cloud Contract Verifier with WireMock, you muse use either a Gradle or a Maven plugin.

|  |
| --- |
| [Warning] |
| If you want to use Spock in your projects, you must add separately the spock-core and spock-spring modules. Check [Spock docs for more information](https://spockframework.github.io/) |

### 88.1.2 Add Gradle Plugin with Dependencies

To add a Gradle plugin with dependencies, use code similar to this:

buildscript {

repositories {

mavenCentral()

}

dependencies {

classpath "org.springframework.boot:spring-boot-gradle-plugin:${springboot\_version}"

classpath "org.springframework.cloud:spring-cloud-contract-gradle-plugin:${verifier\_version}"

}

}

apply plugin: 'groovy'

apply plugin: 'spring-cloud-contract'

dependencyManagement {

imports {

mavenBom "org.springframework.cloud:spring-cloud-contract-dependencies:${verifier\_version}"

}

}

dependencies {

testCompile 'org.codehaus.groovy:groovy-all:2.4.6'

*// example with adding Spock core and Spock Spring*

testCompile 'org.spockframework:spock-core:1.0-groovy-2.4'

testCompile 'org.spockframework:spock-spring:1.0-groovy-2.4'

testCompile 'org.springframework.cloud:spring-cloud-starter-contract-verifier'

}

### 88.1.3 Gradle and Rest Assured 2.0

By default, Rest Assured 3.x is added to the classpath. However, to use Rest Assured 2.x you can add it to the plugins classpath, as shown here:

buildscript {

repositories {

mavenCentral()

}

dependencies {

classpath "org.springframework.boot:spring-boot-gradle-plugin:${springboot\_version}"

classpath "org.springframework.cloud:spring-cloud-contract-gradle-plugin:${verifier\_version}"

classpath "com.jayway.restassured:rest-assured:2.5.0"

classpath "com.jayway.restassured:spring-mock-mvc:2.5.0"

}

}

depenendencies {

*// all dependencies*

*// you can exclude rest-assured from spring-cloud-contract-verifier*

testCompile "com.jayway.restassured:rest-assured:2.5.0"

testCompile "com.jayway.restassured:spring-mock-mvc:2.5.0"

}

That way, the plugin automatically sees that Rest Assured 2.x is present on the classpath and modifies the imports accordingly.

### 88.1.4 Snapshot Versions for Gradle

Add the additional snapshot repository to your build.gradle to use snapshot versions, which are automatically uploaded after every successful build, as shown here:

buildscript {

repositories {

mavenCentral()

mavenLocal()

maven { url "http://repo.spring.io/snapshot" }

maven { url "http://repo.spring.io/milestone" }

maven { url "http://repo.spring.io/release" }

}

}

### 88.1.5 Add stubs

By default, Spring Cloud Contract Verifier is looking for stubs in the src/test/resources/contracts directory.

The directory containing stub definitions is treated as a class name, and each stub definition is treated as a single test. Spring Cloud Contract Verifier assumes that it contains at least one level of directories that are to be used as the test class name. If more than one level of nested directories is present, all except the last one is used as the package name. For example, with following structure:

src/test/resources/contracts/myservice/shouldCreateUser.groovy

src/test/resources/contracts/myservice/shouldReturnUser.groovy

Spring Cloud Contract Verifier creates a test class named defaultBasePackage.MyService with two methods:

* shouldCreateUser()
* shouldReturnUser()

### 88.1.6 Run the Plugin

The plugin registers itself to be invoked before a check task. If you want it to be part of your build process, you need to do nothing more. If you just want to generate tests, invoke the generateContractTests task.

### 88.1.7 Default Setup

The default Gradle Plugin setup creates the following Gradle part of the build (in pseudocode):

contracts {

targetFramework = 'JUNIT'

testMode = 'MockMvc'

generatedTestSourcesDir = project.file("${project.buildDir}/generated-test-sources/contracts")

contractsDslDir = "${project.rootDir}/src/test/resources/contracts"

basePackageForTests = 'org.springframework.cloud.verifier.tests'

stubsOutputDir = project.file("${project.buildDir}/stubs")

*// the following properties are used when you want to provide where the JAR with contract lays*

contractDependency {

stringNotation = ''

}

contractsPath = ''

contractsWorkOffline = false

contractRepository {

cacheDownloadedContracts(true)

}

}

tasks.create(type: Jar, name: 'verifierStubsJar', dependsOn: 'generateClientStubs') {

baseName = project.name

classifier = contracts.stubsSuffix

from contractVerifier.stubsOutputDir

}

project.artifacts {

archives task

}

tasks.create(type: Copy, name: 'copyContracts') {

from contracts.contractsDslDir

into contracts.stubsOutputDir

}

verifierStubsJar.dependsOn 'copyContracts'

publishing {

publications {

stubs(MavenPublication) {

artifactId project.name

artifact verifierStubsJar

}

}

}

### 88.1.8 Configure Plugin

To change the default configuration, add a contracts snippet to your Gradle config, as shown here:

contracts {

testMode = 'MockMvc'

baseClassForTests = 'org.mycompany.tests'

generatedTestSourcesDir = project.file('src/generatedContract')

}

### 88.1.9 Configuration Options

* **testMode**: Defines the mode for acceptance tests. By default, the mode is MockMvc, which is based on Spring’s MockMvc. It can also be changed to **JaxRsClient** or to **Explicit** for real HTTP calls.
* **imports**: Creates an array with imports that should be included in generated tests (for example ['org.myorg.Matchers']). By default, it creates an empty array.
* **staticImports**: Creates an array with static imports that should be included in generated tests(for example ['org.myorg.Matchers.\*']). By default, it creates an empty array.
* **basePackageForTests**: Specifies the base package for all generated tests. If not set, the value is picked from baseClassForTests’s package and from `packageWithBaseClasses. If neither of these values are set, then the value is set toorg.springframework.cloud.contract.verifier.tests.
* **baseClassForTests**: Creates a base class for all generated tests. By default, if you use Spock classes, the class is spock.lang.Specification.
* **packageWithBaseClasses**: Defines a package where all the base classes reside. This setting takes precedence over **baseClassForTests**.
* **baseClassMappings**: Explicitly maps a contract package to a FQN of a base class. This setting takes precedence over **packageWithBaseClasses** and **baseClassForTests**.
* **ruleClassForTests**: Specifies a rule that should be added to the generated test classes.
* **ignoredFiles**: Uses an Antmatcher to allow defining stub files for which processing should be skipped. By default, it is an empty array.
* **contractsDslDir**: Specifies the directory containing contracts written using the GroovyDSL. By default, its value is $rootDir/src/test/resources/contracts.
* **generatedTestSourcesDir**: Specifies the test source directory where tests generated from the Groovy DSL should be placed. By default its value is$buildDir/generated-test-sources/contractVerifier.
* **stubsOutputDir**: Specifies the directory where the generated WireMock stubs from the Groovy DSL should be placed.
* **targetFramework**: Specifies the target test framework to be used. Currently, Spock and JUnit are supported with JUnit being the default framework.

The following properties are used when you want to specify the location of the JAR containing the contracts: \* **contractDependency**: Specifies the Dependency that provides groupid:artifactid:version:classifier coordinates. You can use the contractDependency closure to set it up. \* **contractsPath**: Specifies the path to the jar. If contract dependencies are downloaded, the path defaults to groupid/artifactid where groupid is slash separated. Otherwise, it scans contracts under the provided directory. \* **contractsMode**: Specifies the mode of downloading contracts (whether the JAR is available offline, remotely etc.) \* **contractsSnapshotCheckSkip**: If set to true will not assert whether the downloaded stubs / contract JAR was downloaded from a remote location or a local one \* **deleteStubsAfterTest**: If set to false will not remove any downloaded contracts from temporary directories

### 88.1.10 Single Base Class for All Tests

When using Spring Cloud Contract Verifier in default MockMvc, you need to create a base specification for all generated acceptance tests. In this class, you need to point to an endpoint, which should be verified.

**abstract** **class** BaseMockMvcSpec **extends** Specification {

def setup() {

RestAssuredMockMvc.standaloneSetup(**new** PairIdController())

}

**void** isProperCorrelationId(Integer correlationId) {

assert correlationId == 123456

}

**void** isEmpty(String value) {

assert value == null

}

}

If you use Explicit mode, you can use a base class to initialize the whole tested app as you might see in regular integration tests. If you use the JAXRSCLIENT mode, this base class should also contain a protected WebTarget webTarget field. Right now, the only option to test the JAX-RS API is to start a web server.

### 88.1.11 Different Base Classes for Contracts

If your base classes differ between contracts, you can tell the Spring Cloud Contract plugin which class should get extended by the autogenerated tests. You have two options:

* Follow a convention by providing the packageWithBaseClasses
* Provide explicit mapping via baseClassMappings

**By Convention**

The convention is such that if you have a contract under (for example) src/test/resources/contract/foo/bar/baz/ and set the value of thepackageWithBaseClasses property to com.example.base, then Spring Cloud Contract Verifier assumes that there is a BarBazBase class under the com.example.base package. In other words, the system takes the last two parts of the package, if they exist, and forms a class with a Base suffix. This rule takes precedence over **baseClassForTests**. Here is an example of how it works in the contracts closure:

packageWithBaseClasses = 'com.example.base'

**By Mapping**

You can manually map a regular expression of the contract’s package to fully qualified name of the base class for the matched contract. You have to provide a list calledbaseClassMappings that consists baseClassMapping objects that takes a contractPackageRegex to baseClassFQN mapping. Consider the following example:

baseClassForTests = "com.example.FooBase"

baseClassMappings {

baseClassMapping('.\*/com/.\*', 'com.example.ComBase')

baseClassMapping('.\*/bar/.\*':'com.example.BarBase')

}

Let’s assume that you have contracts under - src/test/resources/contract/com/ - src/test/resources/contract/foo/

By providing the baseClassForTests, we have a fallback in case mapping did not succeed. (You could also provide the packageWithBaseClasses as a fallback.) That way, the tests generated from src/test/resources/contract/com/ contracts extend the com.example.ComBase, whereas the rest of the tests extend com.example.FooBase.

### 88.1.12 Invoking Generated Tests

To ensure that the provider side is compliant with defined contracts, you need to invoke:

./gradlew generateContractTests **test**

### 88.1.13 Spring Cloud Contract Verifier on the Consumer Side

In a consuming service, you need to configure the Spring Cloud Contract Verifier plugin in exactly the same way as in case of provider. If you do not want to use Stub Runner then you need to copy contracts stored in src/test/resources/contracts and generate WireMock JSON stubs using:

./gradlew generateClientStubs

|  |
| --- |
| [Note] |
| The stubsOutputDir option has to be set for stub generation to work. |

When present, JSON stubs can be used in automated tests of consuming a service.

*@ContextConfiguration(loader == SpringApplicationContextLoader, classes == Application)*

**class** LoanApplicationServiceSpec **extends** Specification {

*@ClassRule*

*@Shared*

WireMockClassRule wireMockRule == **new** WireMockClassRule()

*@Autowired*

LoanApplicationService sut

def 'should successfully apply for loan'() {

given:

LoanApplication application =

**new** LoanApplication(client: **new** Client(clientPesel: '12345678901'), amount: 123.123)

when:

LoanApplicationResult loanApplication == sut.loanApplication(application)

then:

loanApplication.loanApplicationStatus == LoanApplicationStatus.LOAN\_APPLIED

loanApplication.rejectionReason == null

}

}

LoanApplication makes a call to FraudDetection service. This request is handled by a WireMock server configured with stubs generated by Spring Cloud Contract Verifier.

## 88.2 Maven Project

To learn how to set up the Maven project for Spring Cloud Contract Verifier, read the following sections:

* [Section 88.2.1, “Add maven plugin”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-add-plugin)
* [Section 88.2.2, “Maven and Rest Assured 2.0”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-rest-assured)
* [Section 88.2.3, “Snapshot versions for Maven”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-snapshot-versions)
* [Section 88.2.4, “Add stubs”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-add-stubs)
* [Section 88.2.5, “Run plugin”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-run-plugin)
* [Section 88.2.6, “Configure plugin”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-configure-plugin)
* [Section 88.2.7, “Configuration Options”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-configuration-options)
* [Section 88.2.8, “Single Base Class for All Tests”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-single-base)
* [Section 88.2.9, “Different base classes for contracts”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-different-base)
* [Section 88.2.10, “Invoking generated tests”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-invoking-generated-tests)
* [Section 88.2.11, “Maven Plugin and STS”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#maven-sts)

### 88.2.1 Add maven plugin

Add the Spring Cloud Contract BOM in a fashion similar to this:

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>${spring-cloud-dependencies.version}</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

Next, add the Spring Cloud Contract Verifier Maven plugin:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example.fraud</packageWithBaseClasses>

</configuration>

</plugin>

You can read more in the [Spring Cloud Contract Maven Plugin Documentation](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract-maven-plugin/).

### 88.2.2 Maven and Rest Assured 2.0

By default, Rest Assured 3.x is added to the classpath. However, you can use Rest Assured 2.x by adding it to the plugins classpath, as shown here:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example</packageWithBaseClasses>

</configuration>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-verifier</artifactId>

<version>${spring-cloud-contract.version}</version>

</dependency>

<dependency>

<groupId>com.jayway.restassured</groupId>

<artifactId>rest-assured</artifactId>

<version>2.5.0</version>

<scope>compile</scope>

</dependency>

<dependency>

<groupId>com.jayway.restassured</groupId>

<artifactId>spring-mock-mvc</artifactId>

<version>2.5.0</version>

<scope>compile</scope>

</dependency>

</dependencies>

</plugin>

<dependencies>

<!-- all dependencies -->

<!-- you can exclude rest-assured from spring-cloud-contract-verifier -->

<dependency>

<groupId>com.jayway.restassured</groupId>

<artifactId>rest-assured</artifactId>

<version>2.5.0</version>

<scope>test</scope>

</dependency>

<dependency>

<groupId>com.jayway.restassured</groupId>

<artifactId>spring-mock-mvc</artifactId>

<version>2.5.0</version>

<scope>test</scope>

</dependency>

</dependencies>

That way, the plugin automatically sees that Rest Assured 3.x is present on the classpath and modifies the imports accordingly.

### 88.2.3 Snapshot versions for Maven

For Snapshot and Milestone versions, you have to add the following section to your pom.xml, as shown here:

<repositories>

<repository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</repository>

<repository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

<repository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

</repositories>

<pluginRepositories>

<pluginRepository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

</pluginRepositories>

### 88.2.4 Add stubs

By default, Spring Cloud Contract Verifier is looking for stubs in the src/test/resources/contracts directory. The directory containing stub definitions is treated as a class name, and each stub definition is treated as a single test. We assume that it contains at least one directory to be used as test class name. If there is more than one level of nested directories, all except the last one is used as package name. For example, with following structure:

src/test/resources/contracts/myservice/shouldCreateUser.groovy

src/test/resources/contracts/myservice/shouldReturnUser.groovy

Spring Cloud Contract Verifier creates a test class named defaultBasePackage.MyService with two methods

* shouldCreateUser()
* shouldReturnUser()

### 88.2.5 Run plugin

The plugin goal generateTests is assigned to be invoked in the phase called generate-test-sources. If you want it to be part of your build process, you need not do anything. If you just want to generate tests, invoke the generateTests goal.

### 88.2.6 Configure plugin

To change the default configuration, just add a configuration section to the plugin definition or the execution definition, as shown here:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<executions>

<execution>

<goals>

<goal>convert</goal>

<goal>generateStubs</goal>

<goal>generateTests</goal>

</goals>

</execution>

</executions>

<configuration>

<basePackageForTests>org.springframework.cloud.verifier.twitter.place</basePackageForTests>

<baseClassForTests>org.springframework.cloud.verifier.twitter.place.BaseMockMvcSpec</baseClassForTests>

</configuration>

</plugin>

### 88.2.7 Configuration Options

* **testMode**: Defines the mode for acceptance tests. By default, the mode is MockMvc, which is based on Spring’s MockMvc. It can also be changed to **JaxRsClient** or to **Explicit** for real HTTP calls.
* **basePackageForTests**: Specifies the base package for all generated tests. If not set, the value is picked from baseClassForTests’s package and from `packageWithBaseClasses. If neither of these values are set, then the value is set toorg.springframework.cloud.contract.verifier.tests.
* **ruleClassForTests**: Specifies a rule that should be added to the generated test classes.
* **baseClassForTests**: Creates a base class for all generated tests. By default, if you use Spock classes, the class is spock.lang.Specification.
* **contractsDirectory**: Specifies a directory containing contracts written with the GroovyDSL. The default directory is /src/test/resources/contracts.
* **testFramework**: Specifies the target test framework to be used. Currently, Spock and JUnit are supported with JUnit being the default framework
* **packageWithBaseClasses**: Defines a package where all the base classes reside. This setting takes precedence over **baseClassForTests**. The convention is such that, if you have a contract under (for example) src/test/resources/contract/foo/bar/baz/ and set the value of the packageWithBaseClasses property to com.example.base, then Spring Cloud Contract Verifier assumes that there is a BarBazBase class under the com.example.base package. In other words, the system takes the last two parts of the package, if they exist, and forms a class with a Base suffix.
* **baseClassMappings**: Specifies a list of base class mappings that provide contractPackageRegex, which is checked against the package where the contract is located, and baseClassFQN, which maps to the fully qualified name of the base class for the matched contract. For example, if you have a contract undersrc/test/resources/contract/foo/bar/baz/ and map the property .\* → com.example.base.BaseClass, then the test class generated from these contracts extends com.example.base.BaseClass. This setting takes precedence over **packageWithBaseClasses** and **baseClassForTests**.

If you want to download your contract definitions from a Maven repository, you can use the following options:

* **contractDependency**: The contract dependency that contains all the packaged contracts.
* **contractsPath**: The path to the concrete contracts in the JAR with packaged contracts. Defaults to groupid/artifactid where gropuid is slash separated.
* **contractsMode**: Picks the mode in which stubs will be found and registered
* **contractsSnapshotCheckSkip**: If true then will not assert whether a stub / contract JAR was downloaded from local or remote location
* **deleteStubsAfterTest**: If set to false will not remove any downloaded contracts from temporary directories
* **contractsRepositoryUrl**: URL to a repo with the artifacts that have contracts. If it is not provided, use the current Maven ones.
* **contractsRepositoryUsername**: The user name to be used to connect to the repo with contracts.
* **contractsRepositoryPassword**: The password to be used to connect to the repo with contracts.
* **contractsRepositoryProxyHost**: The proxy host to be used to connect to the repo with contracts.
* **contractsRepositoryProxyPort**: The proxy port to be used to connect to the repo with contracts.

We cache only non-snapshot, explicitly provided versions (for example + or 1.0.0.BUILD-SNAPSHOT won’t get cached). By default, this feature is turned on.

### 88.2.8 Single Base Class for All Tests

When using Spring Cloud Contract Verifier in default MockMvc, you need to create a base specification for all generated acceptance tests. In this class, you need to point to an endpoint, which should be verified.

**package** org.mycompany.tests

**import** org.mycompany.ExampleSpringController

**import** com.jayway.restassured.module.mockmvc.RestAssuredMockMvc

**import** spock.lang.Specification

**class** MvcSpec **extends** Specification {

def setup() {

RestAssuredMockMvc.standaloneSetup(**new** ExampleSpringController())

}

}

You can also setup the whole context if necessary.

**import** io.restassured.module.mockmvc.RestAssuredMockMvc;

**import** org.junit.Before;

**import** org.junit.runner.RunWith;

**import** org.springframework.beans.factory.annotation.Autowired;

**import** org.springframework.boot.test.context.SpringBootTest;

**import** org.springframework.test.context.junit4.SpringRunner;

**import** org.springframework.web.context.WebApplicationContext;

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment = WebEnvironment.RANDOM\_PORT, classes = SomeConfig.class, properties="some=property")*

**public** **abstract** **class** BaseTestClass {

*@Autowired*

WebApplicationContext context;

*@Before*

**public** **void** setup() {

RestAssuredMockMvc.webAppContextSetup(**this**.context);

}

}

If you use EXPLICIT mode, you can use a base class to initialize the whole tested app similarly, as you might find in regular integration tests.

**import** io.restassured.RestAssured;

**import** org.junit.Before;

**import** org.junit.runner.RunWith;

**import** org.springframework.beans.factory.annotation.Autowired;

**import** org.springframework.boot.test.context.SpringBootTest;

**import** org.springframework.boot.web.server.LocalServerPort

**import** org.springframework.test.context.junit4.SpringRunner;

**import** org.springframework.web.context.WebApplicationContext;

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment = WebEnvironment.RANDOM\_PORT, classes = SomeConfig.class, properties="some=property")*

**public** **abstract** **class** BaseTestClass {

*@LocalServerPort*

**int** port;

*@Before*

**public** **void** setup() {

RestAssured.baseURI = "http://localhost:" + **this**.port;

}

}

If you use the JAXRSCLIENT mode, this base class should also contain a protected WebTarget webTarget field. Right now, the only option to test the JAX-RS API is to start a web server.

### 88.2.9 Different base classes for contracts

If your base classes differ between contracts, you can tell the Spring Cloud Contract plugin which class should get extended by the autogenerated tests. You have two options:

* Follow a convention by providing the packageWithBaseClasses
* provide explicit mapping via baseClassMappings

**By Convention**

The convention is such that if you have a contract under (for example) src/test/resources/contract/foo/bar/baz/ and set the value of thepackageWithBaseClasses property to com.example.base, then Spring Cloud Contract Verifier assumes that there is a BarBazBase class under the com.example.base package. In other words, the system takes the last two parts of the package, if they exist, and forms a class with a Base suffix. This rule takes precedence over **baseClassForTests**. Here is an example of how it works in the contracts closure:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<configuration>

<packageWithBaseClasses>hello</packageWithBaseClasses>

</configuration>

</plugin>

**By Mapping**

You can manually map a regular expression of the contract’s package to fully qualified name of the base class for the matched contract. You have to provide a list calledbaseClassMappings that consists baseClassMapping objects that takes a contractPackageRegex to baseClassFQN mapping. Consider the following example:

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<configuration>

<baseClassForTests>com.example.FooBase</baseClassForTests>

<baseClassMappings>

<baseClassMapping>

<contractPackageRegex>.\*com.\*</contractPackageRegex>

<baseClassFQN>com.example.TestBase</baseClassFQN>

</baseClassMapping>

</baseClassMappings>

</configuration>

</plugin>

Assume that you have contracts under these two locations: \* src/test/resources/contract/com/ \* src/test/resources/contract/foo/

By providing the baseClassForTests, we have a fallback in case mapping did not succeed. (You can also provide the packageWithBaseClasses as a fallback.) That way, the tests generated from src/test/resources/contract/com/ contracts extend the com.example.ComBase, whereas the rest of the tests extend com.example.FooBase.

### 88.2.10 Invoking generated tests

The Spring Cloud Contract Maven Plugin generates verification code in a directory called /generated-test-sources/contractVerifier and attaches this directory to testCompile goal.

For Groovy Spock code, use the following:

<plugin>

<groupId>org.codehaus.gmavenplus</groupId>

<artifactId>gmavenplus-plugin</artifactId>

<version>1.5</version>

<executions>

<execution>

<goals>

<goal>testCompile</goal>

</goals>

</execution>

</executions>

<configuration>

<testSources>

<testSource>

<directory>${project.basedir}/src/test/groovy</directory>

<includes>

<include>\*\*/\*.groovy</include>

</includes>

</testSource>

<testSource>

<directory>${project.build.directory}/generated-test-sources/contractVerifier</directory>

<includes>

<include>\*\*/\*.groovy</include>

</includes>

</testSource>

</testSources>

</configuration>

</plugin>

To ensure that provider side is compliant with defined contracts, you need to invoke mvn generateTest test.

### 88.2.11 Maven Plugin and STS

If you see the following exception while using STS:

When you click on the error marker you should see something like this:

plugin:1.1.0.M1:convert:default-convert:process-**test**-resources) org.apache.maven.plugin.PluginExecutionException: Execution default-convert of goal org.springframework.cloud:spring-

cloud-contract-maven-plugin:1.1.0.M1:convert failed. at org.apache.maven.plugin.DefaultBuildPluginManager.executeMojo(DefaultBuildPluginManager.java:145) at

org.eclipse.m2e.core.internal.embedder.MavenImpl.execute(MavenImpl.java:331) at org.eclipse.m2e.core.internal.embedder.MavenImpl$11.call(MavenImpl.java:1362) at

...

org.eclipse.core.internal.jobs.Worker.run(Worker.java:55) Caused by: java.lang.NullPointerException at

org.eclipse.m2e.core.internal.builder.plexusbuildapi.EclipseIncrementalBuildContext.hasDelta(EclipseIncrementalBuildContext.java:53) at

org.sonatype.plexus.build.incremental.ThreadBuildContext.hasDelta(ThreadBuildContext.java:59) at

In order to fix this issue, provide the following section in your pom.xml:

<build>

<pluginManagement>

<plugins>

*<!--This plugin's configuration is used to store Eclipse m2e settings*

*only. It has no influence on the Maven build itself. -->*

<plugin>

<groupId>org.eclipse.m2e</groupId>

<artifactId>lifecycle-mapping</artifactId>

<version>1.0.0</version>

<configuration>

<lifecycleMappingMetadata>

<pluginExecutions>

<pluginExecution>

<pluginExecutionFilter>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<versionRange>[1.0,)</versionRange>

<goals>

<goal>convert</goal>

</goals>

</pluginExecutionFilter>

<action>

<execute />

</action>

</pluginExecution>

</pluginExecutions>

</lifecycleMappingMetadata>

</configuration>

</plugin>

</plugins>

</pluginManagement>

</build>

## 88.3 Stubs and Transitive Dependencies

The Maven and Gradle plugin that add the tasks that create the stubs jar for you. One problem that arises is that, when reusing the stubs, you can mistakenly import all of that stub’s dependencies. When building a Maven artifact, even though you have a couple of different jars, all of them share one pom:

├── github-webhook-0.0.1.BUILD-20160903.075506-1-stubs.jar

├── github-webhook-0.0.1.BUILD-20160903.075506-1-stubs.jar.sha1

├── github-webhook-0.0.1.BUILD-20160903.075655-2-stubs.jar

├── github-webhook-0.0.1.BUILD-20160903.075655-2-stubs.jar.sha1

├── github-webhook-0.0.1.BUILD-SNAPSHOT.jar

├── github-webhook-0.0.1.BUILD-SNAPSHOT.pom

├── github-webhook-0.0.1.BUILD-SNAPSHOT-stubs.jar

├── ...

└── ...

There are three possibilities of working with those dependencies so as not to have any issues with transitive dependencies:

* Mark all application dependencies as optional
* Create a separate artifactid for the stubs
* Exclude dependencies on the consumer side

**Mark all application dependencies as optional**

If, in the github-webhook application, you mark all of your dependencies as optional, when you include the github-webhook stubs in another application (or when that dependency gets downloaded by Stub Runner) then, since all of the dependencies are optional, they will not get downloaded.

**Create a separate artifactid for the stubs**

If you create a separate artifactid, then you can set it up in whatever way you wish. For example, you might decide to have no dependencies at all.

**Exclude dependencies on the consumer side**

As a consumer, if you add the stub dependency to your classpath, you can explicitly exclude the unwanted dependencies.

## 88.4 CI Server setup

When fetching stubs / contracts in a CI, shared environment, what might happen is that both the producer and the consumer reuse the same local Maven repository. Due to this, the framework, responsible for downloading a stub JAR from remote location, can’t decide which JAR should be picked, local or remote one. That caused the "The artifact was found in the local repository but you have explicitly stated that it should be downloaded from a remote one" exception and failed the build.

For such cases we’re introducing the property and plugin setup mechanism:

* via stubrunner.snapshot-check-skip system property
* via STUBRUNNER\_SNAPSHOT\_CHECK\_SKIP environment variable

if either of these values is set to true, then the stub downloader will not verify the origin of the downloaded JAR.

For the plugins you need to set the contractsSnapshotSkipCheck property to true.

## 88.5 Scenarios

You can handle scenarios with Spring Cloud Contract Verifier. All you need to do is to stick to the proper naming convention while creating your contracts. The convention requires including an order number followed by an underscore. This will work regardles of whether you’re working with YAML or Groovy. Example:

my\_contracts\_dir\

scenario1\

1\_login.groovy

2\_showCart.groovy

3\_logout.groovy

Such a tree causes Spring Cloud Contract Verifier to generate WireMock’s scenario with a name of scenario1 and the three following steps:

1. login marked as Started pointing to…​
2. showCart marked as Step1 pointing to…​
3. logout marked as Step2 which will close the scenario.

More details about WireMock scenarios can be found at <http://wiremock.org/stateful-behaviour.html>

Spring Cloud Contract Verifier also generates tests with a guaranteed order of execution.

## 88.6 Docker Project

We’re publishing a springcloud/spring-cloud-contract Docker image that contains a project that will generate tests and execute them in EXPLICIT mode against a running application.

|  |
| --- |
| [Tip] |
| The EXPLICIT mode means that the tests generated from contracts will send real requests and not the mocked ones. |

### 88.6.1 Short intro to Maven, JARs and Binary storage

Since the Docker image can be used by non JVM projects, it’s good to explain the basic terms behind Spring Cloud Contract packaging defaults.

Part of the following definitions were taken from the [Maven Glossary](https://maven.apache.org/glossary.html)

* Project: Maven thinks in terms of projects. Everything that you will build are projects. Those projects follow a well defined “Project Object Model”. Projects can depend on other projects, in which case the latter are called “dependencies”. A project may consistent of several subprojects, however these subprojects are still treated equally as projects.
* Artifact: An artifact is something that is either produced or used by a project. Examples of artifacts produced by Maven for a project include: JARs, source and binary distributions. Each artifact is uniquely identified by a group id and an artifact ID which is unique within a group.
* JAR: JAR stands for Java ARchive. It’s a format based on the ZIP file format. Spring Cloud Contract packages the contracts and generated stubs in a JAR file.
* GroupId: A group ID is a universally unique identifier for a project. While this is often just the project name (eg. commons-collections), it is helpful to use a fully-qualified package name to distinguish it from other projects with a similar name (eg. org.apache.maven). Typically, when published to the Artifact Manager, the GroupId will get slash separated and form part of the URL. E.g. for group id com.example and artifact id application would be /com/example/application/.
* Classifier: The Maven dependency notation looks as follows: groupId:artifactId:version:classifier. The classifier is additional suffix passed to the dependency. E.g. stubs, sources. The same dependency e.g. com.example:application can produce multiple artifacts that differ from each other with the classifier.
* Artifact manager: When you generate binaries / sources / packages, you would like them to be available for others to download / reference or reuse. In case of the JVM world those artifacts would be JARs, for Ruby these are gems and for Docker those would be Docker images. You can store those artifacts in a manager. Examples of such managers can be [Artifactory](https://jfrog.com/artifactory/) or [Nexus](http://www.sonatype.org/nexus/).

### 88.6.2 How it works

The image searches for contracts under the /contracts folder. The output from running the tests will be available under /spring-cloud-contract/build folder (it’s useful for debugging purposes).

It’s enough for you to mount your contracts, pass the environment variables and the image will:

* generate the contract tests
* execute the tests against the provided URL
* generate the [WireMock](http://wiremock.org/) stubs
* (optional - turned on by default) publish the stubs to a Artifact Manager

#### Environment Variables

The Docker image requires some environment variables to point to your running application, to the Artifact manager instance etc.

* PROJECT\_GROUP - your project’s group id. Defaults to com.example
* PROJECT\_VERSION - your project’s version. Defaults to 0.0.1-SNAPSHOT
* PROJECT\_NAME - artifact id. Defaults to example
* REPO\_WITH\_BINARIES\_URL - URL of your Artifact Manager. Defaults to <http://localhost:8081/artifactory/libs-release-local> which is the default URL of [Artifactory](https://jfrog.com/artifactory/) running locally
* REPO\_WITH\_BINARIES\_USERNAME - (optional) username when the Artifact Manager is secured
* REPO\_WITH\_BINARIES\_PASSWORD - (optional) password when the Artifact Manager is secured
* PUBLISH\_ARTIFACTS - if set to true then will publish artifact to binary storage. Defaults to true.

These environment variables are used when contracts lay in an external repository. To enable this feature you must set the EXTERNAL\_CONTRACTS\_ARTIFACT\_IDenvironment variable.

* EXTERNAL\_CONTRACTS\_GROUP\_ID - group id of the project with contracts. Defaults to com.example
* EXTERNAL\_CONTRACTS\_ARTIFACT\_ID- artifact id of the project with contracts.
* EXTERNAL\_CONTRACTS\_CLASSIFIER- classifier of the project with contracts. Empty by default
* EXTERNAL\_CONTRACTS\_VERSION - version of the project with contracts. Defaults to +, equivalent to picking the latest
* EXTERNAL\_CONTRACTS\_REPO\_WITH\_BINARIES\_URL - URL of your Artifact Manager. Defaults to value of REPO\_WITH\_BINARIES\_URL env var. If that’s not set, defaults to <http://localhost:8081/artifactory/libs-release-local> which is the default URL of [Artifactory](https://jfrog.com/artifactory/) running locally
* EXTERNAL\_CONTRACTS\_PATH - path to contracts for the given project, inside the project with contracts. Defaults to slash separated EXTERNAL\_CONTRACTS\_GROUP\_ID concatenated with / and EXTERNAL\_CONTRACTS\_ARTIFACT\_ID. E.g. for group id foo.bar and artifact id baz, would result in foo/bar/baz contracts path.
* EXTERNAL\_CONTRACTS\_WORK\_OFFLINE - if set to true then will retrieve artifact with contracts from the container’s .m2. Mount your local .m2 as a volume available at the container’s /root/.m2 path. You must not set both EXTERNAL\_CONTRACTS\_WORK\_OFFLINE and EXTERNAL\_CONTRACTS\_REPO\_WITH\_BINARIES\_URL.

These environment variables are used when tests are executed:

* APPLICATION\_BASE\_URL - url against which tests should be executed. Remember that it has to be accessible from the Docker container (e.g. localhost will not work)
* APPLICATION\_USERNAME - (optional) username for basic authentication to your application
* APPLICATION\_PASSWORD - (optional) password for basic authentication to your application

### 88.6.3 Example of usage

Let’s take a look at a simple MVC application

$ git clone https://github.com/spring-cloud-samples/spring-cloud-contract-nodejs

$ **cd** bookstore

The contracts are available under /contracts folder.

### 88.6.4 Server side (nodejs)

Since we want to run tests, we could just execute:

$ npm **test**

however, for learning purposes, let’s split it into pieces:

*# Stop docker infra (nodejs, artifactory)*

$ ./stop\_infra.sh

*# Start docker infra (nodejs, artifactory)*

$ ./setup\_infra.sh

*# Kill & Run app*

$ pkill -f "node app"

$ nohup node app &

*# Prepare environment variables*

$ SC\_CONTRACT\_DOCKER\_VERSION="..."

$ APP\_IP="192.168.0.100"

$ APP\_PORT="3000"

$ ARTIFACTORY\_PORT="8081"

$ APPLICATION\_BASE\_URL="http://${APP\_IP}:${APP\_PORT}"

$ ARTIFACTORY\_URL="http://${APP\_IP}:${ARTIFACTORY\_PORT}/artifactory/libs-release-local"

$ CURRENT\_DIR="$( pwd )"

$ CURRENT\_FOLDER\_NAME=${PWD*##\*/}*

$ PROJECT\_VERSION="0.0.1.RELEASE"

*# Execute contract tests*

$ docker run --rm -e "APPLICATION\_BASE\_URL=${APPLICATION\_BASE\_URL}" -e "PUBLISH\_ARTIFACTS=true" -e "PROJECT\_NAME=${CURRENT\_FOLDER\_NAME}" -e "REPO\_WITH\_BINARIES\_URL=${ARTIFACTORY\_URL}" -e "PROJECT\_VERSION=${PROJECT\_VERSION}" -v "${CURRENT\_DIR}/contracts/:/contracts:ro" -v "${CURRENT\_DIR}/node\_modules/spring-cloud-contract/output:/spring-cloud-contract-output/" springcloud/spring-cloud-contract:"${SC\_CONTRACT\_DOCKER\_VERSION}"

*# Kill app*

$ pkill -f "node app"

What will happen is that via bash scripts:

* infrastructure will be set up (MongoDb, Artifactory). In real life scenario you would just run the NodeJS application with mocked database. In this example we want to show how we can benefit from Spring Cloud Contract in no time.
* due to those constraints the contracts also represent the stateful situation
  + first request is a POST that causes data to get inserted to the database
  + second request is a GET that returns a list of data with 1 previously inserted element
* the NodeJS application will be started (on port 3000)
* contract tests will be generated via Docker and tests will be executed against the running application
  + the contracts will be taken from /contracts folder.
  + the output of the test execution is available under node\_modules/spring-cloud-contract/output.
* the stubs will be uploaded to Artifactory. You can check them out under <http://localhost:8081/artifactory/libs-release-local/com/example/bookstore/0.0.1.RELEASE/> . The stubs will be here <http://localhost:8081/artifactory/libs-release-local/com/example/bookstore/0.0.1.RELEASE/bookstore-0.0.1.RELEASE-stubs.jar>.

To see how the client side looks like check out the [Section 90.9, “Stub Runner Docker”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_stub_runner.html#stubrunner-docker) section.

## 89. Spring Cloud Contract Verifier Messaging

Spring Cloud Contract Verifier lets you verify applications that use messaging as a means of communication. All of the integrations shown in this document work with Spring, but you can also create one of your own and use that.

## 89.1 Integrations

You can use one of the following four integration configurations:

* Apache Camel
* Spring Integration
* Spring Cloud Stream
* Spring AMQP

Since we use Spring Boot, if you have added one of these libraries to the classpath, all the messaging configuration is automatically set up.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Remember to put @AutoConfigureMessageVerifier on the base class of your generated tests. Otherwise, messaging part of Spring Cloud Contract Verifier does not work. |
| [Important] | **Important** | |
| If you want to use Spring Cloud Stream, remember to add a dependency on org.springframework.cloud:spring-cloud-stream-test-support, as shown here: | |

**Maven.**

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-test-support</artifactId>

<scope>test</scope>

</dependency>

**Gradle.**

testCompile "org.springframework.cloud:spring-cloud-stream-test-support"

## 89.2 Manual Integration Testing

The main interface used by the tests is org.springframework.cloud.contract.verifier.messaging.MessageVerifier. It defines how to send and receive messages. You can create your own implementation to achieve the same goal.

In a test, you can inject a ContractVerifierMessageExchange to send and receive messages that follow the contract. Then add @AutoConfigureMessageVerifierto your test. Here’s an example:

*@RunWith(SpringTestRunner.class)*

*@SpringBootTest*

*@AutoConfigureMessageVerifier*

**public** **static** **class** MessagingContractTests {

*@Autowired*

**private** MessageVerifier verifier;

...

}

|  |
| --- |
| [Note] |
| If your tests require stubs as well, then @AutoConfigureStubRunner includes the messaging configuration, so you only need the one annotation. |

## 89.3 Publisher-Side Test Generation

Having the input or outputMessage sections in your DSL results in creation of tests on the publisher’s side. By default, JUnit tests are created. However, there is also a possibility to create Spock tests.

There are 3 main scenarios that we should take into consideration:

* Scenario 1: There is no input message that produces an output message. The output message is triggered by a component inside the application (for example, scheduler).
* Scenario 2: The input message triggers an output message.
* Scenario 3: The input message is consumed and there is no output message.

|  |  |
| --- | --- |
| [Important] | **Important** |
| The destination passed to messageFrom or sentTo can have different meanings for different messaging implementations. For **Stream** and **Integration** it is first resolved as a destination of a channel. Then, if there is no such destination it is resolved as a channel name. For **Camel**, that’s a certain component (for example, jms). |

### 89.3.1 Scenario 1: No Input Message

Here is an example for Camel. For the given contract:

**Groovy DSL.**

def contractDsl = Contract.make {

label 'some\_label'

input {

triggeredBy('bookReturnedTriggered()')

}

outputMessage {

sentTo('activemq:output')

body('''{ "bookName" : "foo" }''')

headers {

header('BOOK-NAME', 'foo')

messagingContentType(applicationJson())

}

}

}

**YAML.**

label: some\_label

input:

triggeredBy: bookReturnedTriggered

outputMessage:

sentTo: activemq:output

body:

bookName: foo

headers:

BOOK-NAME: foo

contentType: application/json

The following JUnit test is created:

'''

*// when:*

bookReturnedTriggered();

*// then:*

ContractVerifierMessage response = contractVerifierMessaging.receive("activemq:output");

assertThat(response).isNotNull();

assertThat(response.getHeader("BOOK-NAME")).isNotNull();

assertThat(response.getHeader("BOOK-NAME").toString()).isEqualTo("foo");

assertThat(response.getHeader("contentType")).isNotNull();

assertThat(response.getHeader("contentType").toString()).isEqualTo("application/json");

*// and:*

DocumentContext parsedJson = JsonPath.parse(contractVerifierObjectMapper.writeValueAsString(response.getPayload()));

assertThatJson(parsedJson).field("bookName").isEqualTo("foo");

'''

And the following Spock test would be created:

'''

when:

bookReturnedTriggered()

then:

ContractVerifierMessage response = contractVerifierMessaging.receive('activemq:output')

assert response != null

response.getHeader('BOOK-NAME')?.toString() == 'foo'

response.getHeader('contentType')?.toString() == 'application/json'

and:

DocumentContext parsedJson = JsonPath.parse(contractVerifierObjectMapper.writeValueAsString(response.payload))

assertThatJson(parsedJson).field("bookName").isEqualTo("foo")

'''

### 89.3.2 Scenario 2: Output Triggered by Input

Here is an example for Camel. For the given contract:

**Groovy DSL.**

def contractDsl = Contract.make {

label 'some\_label'

input {

messageFrom('jms:input')

messageBody([

bookName: 'foo'

])

messageHeaders {

header('sample', 'header')

}

}

outputMessage {

sentTo('jms:output')

body([

bookName: 'foo'

])

headers {

header('BOOK-NAME', 'foo')

}

}

}

**YAML.**

label: some\_label

input:

messageFrom: jms:input

messageBody:

bookName: 'foo'

messageHeaders:

sample: header

outputMessage:

sentTo: jms:output

body:

bookName: foo

headers:

BOOK-NAME: foo

The following JUnit test is created:

'''

*// given:*

ContractVerifierMessage inputMessage = contractVerifierMessaging.create(

"{\\"bookName\\":\\"foo\\"}"

, headers()

.header("sample", "header"));

*// when:*

contractVerifierMessaging.send(inputMessage, "jms:input");

*// then:*

ContractVerifierMessage response = contractVerifierMessaging.receive("jms:output");

assertThat(response).isNotNull();

assertThat(response.getHeader("BOOK-NAME")).isNotNull();

assertThat(response.getHeader("BOOK-NAME").toString()).isEqualTo("foo");

*// and:*

DocumentContext parsedJson = JsonPath.parse(contractVerifierObjectMapper.writeValueAsString(response.getPayload()));

assertThatJson(parsedJson).field("bookName").isEqualTo("foo");

'''

And the following Spock test would be created:

"""\

given:

ContractVerifierMessage inputMessage = contractVerifierMessaging.create(

'''{"bookName":"foo"}''',

['sample': 'header']

)

when:

contractVerifierMessaging.send(inputMessage, 'jms:input')

then:

ContractVerifierMessage response = contractVerifierMessaging.receive('jms:output')

assert response !- null

response.getHeader('BOOK-NAME')?.toString() == 'foo'

and:

DocumentContext parsedJson = JsonPath.parse(contractVerifierObjectMapper.writeValueAsString(response.payload))

assertThatJson(parsedJson).field("bookName").isEqualTo("foo")

"""

### 89.3.3 Scenario 3: No Output Message

Here is an example for Camel. For the given contract:

**Groovy DSL.**

def contractDsl = Contract.make {

label 'some\_label'

input {

messageFrom('jms:delete')

messageBody([

bookName: 'foo'

])

messageHeaders {

header('sample', 'header')

}

assertThat('bookWasDeleted()')

}

}

**YAML.**

label: some\_label

input:

messageFrom: jms:delete

messageBody:

bookName: 'foo'

messageHeaders:

sample: header

assertThat: bookWasDeleted()

The following JUnit test is created:

'''

*// given:*

ContractVerifierMessage inputMessage = contractVerifierMessaging.create(

"{\\"bookName\\":\\"foo\\"}"

, headers()

.header("sample", "header"));

*// when:*

contractVerifierMessaging.send(inputMessage, "jms:delete");

*// then:*

bookWasDeleted();

'''

And the following Spock test would be created:

'''

given:

ContractVerifierMessage inputMessage = contractVerifierMessaging.create(

\'\'\'{"bookName":"foo"}\'\'\',

['sample': 'header']

)

when:

contractVerifierMessaging.send(inputMessage, 'jms:delete')

then:

noExceptionThrown()

bookWasDeleted()

'''

## 89.4 Consumer Stub Generation

Unlike the HTTP part, in messaging, we need to publish the Groovy DSL inside the JAR with a stub. Then it is parsed on the consumer side and proper stubbed routes are created.

For more information, see [the Stub Runner Messaging sections](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html/#stub-runner-for-messaging).

**Maven.**

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-stream-rabbit</artifactId>

</dependency>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-contract-stub-runner</artifactId>

<scope>test</scope>

</dependency>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-test-support</artifactId>

<scope>test</scope>

</dependency>

</dependencies>

<dependencyManagement>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-dependencies</artifactId>

<version>Finchley.BUILD-SNAPSHOT</version>

<type>pom</type>

<scope>import</scope>

</dependency>

</dependencies>

</dependencyManagement>

**Gradle.**

ext {

contractsDir = file("mappings")

stubsOutputDirRoot = file("${project.buildDir}/production/${project.name}-stubs/")

}

*// Automatically added by plugin:*

*// copyContracts - copies contracts to the output folder from which JAR will be created*

*// verifierStubsJar - JAR with a provided stub suffix*

*// the presented publication is also added by the plugin but you can modify it as you wish*

publishing {

publications {

stubs(MavenPublication) {

artifactId "${project.name}-stubs"

artifact verifierStubsJar

}

}

}

## 90. Spring Cloud Contract Stub Runner

One of the issues that you might encounter while using Spring Cloud Contract Verifier is passing the generated WireMock JSON stubs from the server side to the client side (or to various clients). The same takes place in terms of client-side generation for messaging.

Copying the JSON files and setting the client side for messaging manually is out of the question. That is why we introduced Spring Cloud Contract Stub Runner. It can automatically download and run the stubs for you.

## 90.1 Snapshot versions

Add the additional snapshot repository to your build.gradle file to use snapshot versions, which are automatically uploaded after every successful build:

**Maven.**

<repositories>

<repository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</repository>

<repository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

<repository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</repository>

</repositories>

<pluginRepositories>

<pluginRepository>

<id>spring-snapshots</id>

<name>Spring Snapshots</name>

<url>https://repo.spring.io/snapshot</url>

<snapshots>

<enabled>true</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-milestones</id>

<name>Spring Milestones</name>

<url>https://repo.spring.io/milestone</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

<pluginRepository>

<id>spring-releases</id>

<name>Spring Releases</name>

<url>https://repo.spring.io/release</url>

<snapshots>

<enabled>false</enabled>

</snapshots>

</pluginRepository>

</pluginRepositories>

**Gradle.**

buildscript {

repositories {

mavenCentral()

mavenLocal()

maven { url "http://repo.spring.io/snapshot" }

maven { url "http://repo.spring.io/milestone" }

maven { url "http://repo.spring.io/release" }

}

## 90.2 Publishing Stubs as JARs

The easiest approach would be to centralize the way stubs are kept. For example, you can keep them as jars in a Maven repository.

|  |
| --- |
| [Tip] |
| For both Maven and Gradle, the setup comes ready to work. However, you can customize it if you want to. |

**Maven.**

*<!-- First disable the default jar setup in the properties section -->*

*<!-- we don't want the verifier to do a jar for us -->*

<spring.cloud.contract.verifier.skip>true</spring.cloud.contract.verifier.skip>

*<!-- Next add the assembly plugin to your build -->*

*<!-- we want the assembly plugin to generate the JAR -->*

<plugin>

<groupId>org.apache.maven.plugins</groupId>

<artifactId>maven-assembly-plugin</artifactId>

<executions>

<execution>

<id>stub</id>

<phase>prepare-package</phase>

<goals>

<goal>single</goal>

</goals>

<inherited>false</inherited>

<configuration>

<attach>true</attach>

<descriptor>$../../../../src/assembly/stub.xml</descriptor>

</configuration>

</execution>

</executions>

</plugin>

*<!-- Finally setup your assembly. Below you can find the contents of src/main/assembly/stub.xml -->*

<assembly

xmlns="http://maven.apache.org/plugins/maven-assembly-plugin/assembly/1.1.3"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://maven.apache.org/plugins/maven-assembly-plugin/assembly/1.1.3 http://maven.apache.org/xsd/assembly-1.1.3.xsd">

<id>stubs</id>

<formats>

<format>jar</format>

</formats>

<includeBaseDirectory>false</includeBaseDirectory>

<fileSets>

<fileSet>

<directory>src/main/java</directory>

<outputDirectory>/</outputDirectory>

<includes>

<include>\*\*com/example/model/\*.\*</include>

</includes>

</fileSet>

<fileSet>

<directory>${project.build.directory}/classes</directory>

<outputDirectory>/</outputDirectory>

<includes>

<include>\*\*com/example/model/\*.\*</include>

</includes>

</fileSet>

<fileSet>

<directory>${project.build.directory}/snippets/stubs</directory>

<outputDirectory>META-INF/${project.groupId}/${project.artifactId}/${project.version}/mappings</outputDirectory>

<includes>

<include>\*\*/\*</include>

</includes>

</fileSet>

<fileSet>

<directory>$../../../../src/test/resources/contracts</directory>

<outputDirectory>META-INF/${project.groupId}/${project.artifactId}/${project.version}/contracts</outputDirectory>

<includes>

<include>\*\*/\*.groovy</include>

</includes>

</fileSet>

</fileSets>

</assembly>

**Gradle.**

ext {

contractsDir = file("mappings")

stubsOutputDirRoot = file("${project.buildDir}/production/${project.name}-stubs/")

}

*// Automatically added by plugin:*

*// copyContracts - copies contracts to the output folder from which JAR will be created*

*// verifierStubsJar - JAR with a provided stub suffix*

*// the presented publication is also added by the plugin but you can modify it as you wish*

publishing {

publications {

stubs(MavenPublication) {

artifactId "${project.name}-stubs"

artifact verifierStubsJar

}

}

}

## 90.3 Stub Runner Core

Runs stubs for service collaborators. Treating stubs as contracts of services allows to use stub-runner as an implementation of [Consumer Driven Contracts](http://martinfowler.com/articles/consumerDrivenContracts.html).

Stub Runner allows you to automatically download the stubs of the provided dependencies (or pick those from the classpath), start WireMock servers for them and feed them with proper stub definitions. For messaging, special stub routes are defined.

### 90.3.1 Retrieving stubs

You can pick the following options of acquiring stubs

* Aether based solution that downloads JARs with stubs from Artifactory / Nexus
* Classpath scanning solution that searches classpath via pattern to retrieve stubs
* Write your own implementation of the org.springframework.cloud.contract.stubrunner.StubDownloaderBuilder for full customization

The latter example is described in the [Custom Stub Runner](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_stub_runner.html) section.

#### Stub downloading

You can control the stub downloading via the stubsMode switch. It picks value from the StubRunnerProperties.StubsMode enum. You can use the following options

* StubRunnerProperties.StubsMode.CLASSPATH (default value) - will pick stubs from the classpath
* StubRunnerProperties.StubsMode.LOCAL - will pick stubs from a local storage (e.g. .m2)
* StubRunnerProperties.StubsMode.REMOTE - will pick stubs from a remote location

Example:

@AutoConfigureStubRunner(repositoryRoot="http://foo.bar", ids = "com.example:beer-api-producer:+:stubs:8095", stubsMode = StubRunnerProperties.StubsMode.LOCAL)

#### Classpath scanning

If you set the stubsMode property to StubRunnerProperties.StubsMode.CLASSPATH (or set nothing since CLASSPATH is the default value) then classpath will get scanned. Let’s look at the following example:

@AutoConfigureStubRunner(ids = {

"com.example:beer-api-producer:+:stubs:8095",

"com.example.foo:bar:1.0.0:superstubs:8096"

})

If you’ve added the dependencies to your classpath

**Maven.**

<dependency>

<groupId>com.example</groupId>

<artifactId>beer-api-producer-restdocs</artifactId>

<classifier>stubs</classifier>

<version>0.0.1-SNAPSHOT</version>

<scope>test</scope>

<exclusions>

<exclusion>

<groupId>\*</groupId>

<artifactId>\*</artifactId>

</exclusion>

</exclusions>

</dependency>

<dependency>

<groupId>com.example.foo</groupId>

<artifactId>bar</artifactId>

<classifier>superstubs</classifier>

<version>1.0.0</version>

<scope>test</scope>

<exclusions>

<exclusion>

<groupId>\*</groupId>

<artifactId>\*</artifactId>

</exclusion>

</exclusions>

</dependency>

**Gradle.**

testCompile("com.example:beer-api-producer-restdocs:0.0.1-SNAPSHOT:stubs") {

transitive = false

}

testCompile("com.example.foo:bar:1.0.0:superstubs") {

transitive = false

}

Then the following locations on your classpath will get scanned. For com.example:beer-api-producer-restdocs

* /META-INF/com.example/beer-api-producer-restdocs/**\*/**.\*
* /contracts/com.example/beer-api-producer-restdocs/**\*/**.\*
* /mappings/com.example/beer-api-producer-restdocs/**\*/**.\*

and com.example.foo:bar

* /META-INF/com.example.foo/bar/**\*/**.\*
* /contracts/com.example.foo/bar/**\*/**.\*
* /mappings/com.example.foo/bar/**\*/**.\*

|  |
| --- |
| [Tip] |
| As you can see you have to explicitly provide the group and artifact ids when packaging the producer stubs. |

The producer would setup the contracts like this:

└── src

└── **test**

└── resources

└── contracts

   └── com.example

      └── beer-api-producer-restdocs

      └── nested

      └── contract3.groovy

To achieve proper stub packaging.

Or using the [Maven assembly plugin](https://github.com/spring-cloud-samples/spring-cloud-contract-samples/blob/2.0.x/producer_with_restdocs/pom.xml) or [Gradle Jar](https://github.com/spring-cloud-samples/spring-cloud-contract-samples/blob/2.0.x/producer_with_restdocs/build.gradle) task you have to create the following structure in your stubs jar.

└── META-INF

└── com.example

└── beer-api-producer-restdocs

└── 2.0.0

├── contracts

│   └── nested

   │ └── contract2.groovy

   └── mappings

   └── mapping.json

By maintaining this structure classpath gets scanned and you can profit from the messaging / HTTP stubs without the need to download artifacts.

### 90.3.2 Running stubs

#### Limitations

|  |  |
| --- | --- |
| [Important] | **Important** |
| There might be a problem with StubRunner shutting down ports between tests. You might have a situation in which you get port conflicts. As long as you use the same context across tests everything works fine. But when the context are different (e.g. different stubs or different profiles) then you have to either use @DirtiesContext to shut down the stub servers, or else run them on different ports per test. |

#### Running using main app

You can set the following options to the main class:

-c, --classifier Suffix **for** the jar containing stubs (e.

g. 'stubs' **if** the stub jar would

have a 'stubs' classifier **for** stubs:

foobar-stubs ). Defaults to 'stubs'

(**default**: stubs)

--maxPort, --maxp <Integer> Maximum port value to be assigned to

the WireMock instance. Defaults to

15000 (**default**: 15000)

--minPort, --minp <Integer> Minimum port value to be assigned to

the WireMock instance. Defaults to

10000 (**default**: 10000)

-p, --password Password to user when connecting to

repository

--phost, --proxyHost Proxy host to use **for** repository

requests

--pport, --proxyPort [Integer] Proxy port to use **for** repository

requests

-r, --root Location of a Jar containing server

where you keep your stubs (e.g. http:

*//nexus.*

net/content/repositories/repository)

-s, --stubs Comma separated list of Ivy

representation of jars with stubs.

Eg. groupid:artifactid1,groupid2:

artifactid2:classifier

--sm, --stubsMode Stubs mode to be used. Acceptable values

[CLASSPATH, LOCAL, REMOTE]

-u, --username Username to user when connecting to

repository

#### HTTP Stubs

Stubs are defined in JSON documents, whose syntax is defined in [WireMock documentation](http://wiremock.org/stubbing.html)

Example:

{

"request": {

"method": "GET",

"url": "/ping"

},

"response": {

"status": 200,

"body": "pong",

"headers": {

"Content-Type": "text/plain"

}

}

}

#### Viewing registered mappings

Every stubbed collaborator exposes list of defined mappings under \_\_/admin/ endpoint.

You can also use the mappingsOutputFolder property to dump the mappings to files. For annotation based approach it would look like this

@AutoConfigureStubRunner(ids="a.b.c:loanIssuance,a.b.c:fraudDetectionServer",

mappingsOutputFolder = "target/outputmappings/")

and for the JUnit approach like this:

*@ClassRule* *@Shared* StubRunnerRule rule = **new** StubRunnerRule()

.repoRoot("http://some\_url")

.downloadStub("a.b.c", "loanIssuance")

.downloadStub("a.b.c:fraudDetectionServer")

.withMappingsOutputFolder("target/outputmappings")

Then if you check out the folder target/outputmappings you would see the following structure

.

├── fraudDetectionServer\_13705

└── loanIssuance\_12255

That means that there were two stubs registered. fraudDetectionServer was registered at port 13705 and loanIssuance at port 12255. If we take a look at one of the files we would see (for WireMock) mappings available for the given server:

[**{**

"id" : "f9152eb9-bf77-4c38-8289-90be7d10d0d7"**,**

"request" : **{**

"url" : "/name"**,**

"method" : "GET"

**},**

"response" : **{**

"status" : 200**,**

"body" : "fraudDetectionServer"

**},**

"uuid" : "f9152eb9-bf77-4c38-8289-90be7d10d0d7"

**},**

...

**]**

#### Messaging Stubs

Depending on the provided Stub Runner dependency and the DSL the messaging routes are automatically set up.

## 90.4 Stub Runner JUnit Rule

Stub Runner comes with a JUnit rule thanks to which you can very easily download and run stubs for given group and artifact id:

*@ClassRule* **public** **static** StubRunnerRule rule = **new** StubRunnerRule()

.repoRoot(repoRoot())

.downloadStub("org.springframework.cloud.contract.verifier.stubs", "loanIssuance")

.downloadStub("org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer");

After that rule gets executed Stub Runner connects to your Maven repository and for the given list of dependencies tries to:

* download them
* cache them locally
* unzip them to a temporary folder
* start a WireMock server for each Maven dependency on a random port from the provided range of ports / provided port
* feed the WireMock server with all JSON files that are valid WireMock definitions
* can also send messages (remember to pass an implementation of MessageVerifier interface)

Stub Runner uses [Eclipse Aether](https://wiki.eclipse.org/Aether) mechanism to download the Maven dependencies. Check their [docs](https://wiki.eclipse.org/Aether) for more information.

Since the StubRunnerRule implements the StubFinder it allows you to find the started stubs:

**package** org.springframework.cloud.contract.stubrunner;

**import** java.net.URL;

**import** java.util.Collection;

**import** java.util.Map;

**import** org.springframework.cloud.contract.spec.Contract;

**public** **interface** StubFinder **extends** StubTrigger {

**/\*\***

**\* For the given groupId and artifactId tries to find the matching**

**\* URL of the running stub.**

**\***

**\* @param groupId - might be null. In that case a search only via artifactId takes place**

**\* @return URL of a running stub or throws exception if not found**

**\*/**

URL findStubUrl(String groupId, String artifactId) **throws** StubNotFoundException;

**/\*\***

**\* For the given Ivy notation {@code [groupId]:artifactId:[version]:[classifier]} tries to**

**\* find the matching URL of the running stub. You can also pass only {@code artifactId}.**

**\***

**\* @param ivyNotation - Ivy representation of the Maven artifact**

**\* @return URL of a running stub or throws exception if not found**

**\*/**

URL findStubUrl(String ivyNotation) **throws** StubNotFoundException;

**/\*\***

**\* Returns all running stubs**

**\*/**

RunningStubs findAllRunningStubs();

**/\*\***

**\* Returns the list of Contracts**

**\*/**

Map<StubConfiguration, Collection<Contract>> getContracts();

}

Example of usage in Spock tests:

*@ClassRule* *@Shared* StubRunnerRule rule = **new** StubRunnerRule()

.stubsMode(StubRunnerProperties.StubsMode.REMOTE)

.repoRoot(StubRunnerRuleSpec.getResource("/m2repo/repository").toURI().toString())

.downloadStub("org.springframework.cloud.contract.verifier.stubs", "loanIssuance")

.downloadStub("org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer")

.withMappingsOutputFolder("target/outputmappingsforrule")

def 'should start WireMock servers'() {

expect: 'WireMocks are running'

rule.findStubUrl('org.springframework.cloud.contract.verifier.stubs', 'loanIssuance') != null

rule.findStubUrl('loanIssuance') != null

rule.findStubUrl('loanIssuance') == rule.findStubUrl('org.springframework.cloud.contract.verifier.stubs', 'loanIssuance')

rule.findStubUrl('org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer') != null

and:

rule.findAllRunningStubs().isPresent('loanIssuance')

rule.findAllRunningStubs().isPresent('org.springframework.cloud.contract.verifier.stubs', 'fraudDetectionServer')

rule.findAllRunningStubs().isPresent('org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer')

and: 'Stubs were registered'

"${rule.findStubUrl('loanIssuance').toString()}/name".toURL().text == 'loanIssuance'

"${rule.findStubUrl('fraudDetectionServer').toString()}/name".toURL().text == 'fraudDetectionServer'

}

def 'should output mappings to output folder'() {

when:

def url = rule.findStubUrl('fraudDetectionServer')

then:

**new** File("target/outputmappingsforrule", "fraudDetectionServer\_${url.port}").exists()

}

Example of usage in JUnit tests:

*@Test*

**public** **void** should\_start\_wiremock\_servers() **throws** Exception {

*// expect: 'WireMocks are running'*

then(rule.findStubUrl("org.springframework.cloud.contract.verifier.stubs", "loanIssuance")).isNotNull();

then(rule.findStubUrl("loanIssuance")).isNotNull();

then(rule.findStubUrl("loanIssuance")).isEqualTo(rule.findStubUrl("org.springframework.cloud.contract.verifier.stubs", "loanIssuance"));

then(rule.findStubUrl("org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer")).isNotNull();

*// and:*

then(rule.findAllRunningStubs().isPresent("loanIssuance")).isTrue();

then(rule.findAllRunningStubs().isPresent("org.springframework.cloud.contract.verifier.stubs", "fraudDetectionServer")).isTrue();

then(rule.findAllRunningStubs().isPresent("org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer")).isTrue();

*// and: 'Stubs were registered'*

then(httpGet(rule.findStubUrl("loanIssuance").toString() + "/name")).isEqualTo("loanIssuance");

then(httpGet(rule.findStubUrl("fraudDetectionServer").toString() + "/name")).isEqualTo("fraudDetectionServer");

}

Check the **Common properties for JUnit and Spring** for more information on how to apply global configuration of Stub Runner.

|  |  |
| --- | --- |
| [Important] | **Important** |
| To use the JUnit rule together with messaging you have to provide an implementation of the MessageVerifier interface to the rule builder (e.g. rule.messageVerifier(new MyMessageVerifier())). If you don’t do this then whenever you try to send a message an exception will be thrown. |

### 90.4.1 Maven settings

The stub downloader honors Maven settings for a different local repository folder. Authentication details for repositories and profiles are currently not taken into account, so you need to specify it using the properties mentioned above.

### 90.4.2 Providing fixed ports

You can also run your stubs on fixed ports. You can do it in two different ways. One is to pass it in the properties, and the other via fluent API of JUnit rule.

### 90.4.3 Fluent API

When using the StubRunnerRule you can add a stub to download and then pass the port for the last downloaded stub.

*@ClassRule* **public** **static** StubRunnerRule rule = **new** StubRunnerRule()

.repoRoot(repoRoot())

.downloadStub("org.springframework.cloud.contract.verifier.stubs", "loanIssuance")

.withPort(12345)

.downloadStub("org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer:12346");

You can see that for this example the following test is valid:

then(rule.findStubUrl("loanIssuance")).isEqualTo(URI.create("http://localhost:12345").toURL());

then(rule.findStubUrl("fraudDetectionServer")).isEqualTo(URI.create("http://localhost:12346").toURL());

### 90.4.4 Stub Runner with Spring

Sets up Spring configuration of the Stub Runner project.

By providing a list of stubs inside your configuration file the Stub Runner automatically downloads and registers in WireMock the selected stubs.

If you want to find the URL of your stubbed dependency you can autowire the StubFinder interface and use its methods as presented below:

*@ContextConfiguration(classes = Config, loader = SpringBootContextLoader)*

*@SpringBootTest(properties = [" stubrunner.cloud.enabled=false",*

*'foo=${stubrunner.runningstubs.fraudDetectionServer.port}',*

*'fooWithGroup=${stubrunner.runningstubs.org.springframework.cloud.contract.verifier.stubs.fraudDetectionServer.port}'])*

*@AutoConfigureStubRunner(mappingsOutputFolder = "target/outputmappings/")*

*@DirtiesContext*

*@ActiveProfiles("test")*

**class** StubRunnerConfigurationSpec **extends** Specification {

*@Autowired* StubFinder stubFinder

*@Autowired* Environment environment

*@StubRunnerPort("fraudDetectionServer")* **int** fraudDetectionServerPort

*@StubRunnerPort("org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer")* **int** fraudDetectionServerPortWithGroupId

*@Value('${foo}')* Integer foo

*@BeforeClass*

*@AfterClass*

**void** setupProps() {

System.clearProperty("stubrunner.repository.root")

System.clearProperty("stubrunner.classifier")

}

def 'should start WireMock servers'() {

expect: 'WireMocks are running'

stubFinder.findStubUrl('org.springframework.cloud.contract.verifier.stubs', 'loanIssuance') != null

stubFinder.findStubUrl('loanIssuance') != null

stubFinder.findStubUrl('loanIssuance') == stubFinder.findStubUrl('org.springframework.cloud.contract.verifier.stubs', 'loanIssuance')

stubFinder.findStubUrl('loanIssuance') == stubFinder.findStubUrl('org.springframework.cloud.contract.verifier.stubs:loanIssuance')

stubFinder.findStubUrl('org.springframework.cloud.contract.verifier.stubs:loanIssuance:0.0.1-SNAPSHOT') == stubFinder.findStubUrl('org.springframework.cloud.contract.verifier.stubs:loanIssuance:0.0.1-SNAPSHOT:stubs')

stubFinder.findStubUrl('org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer') != null

and:

stubFinder.findAllRunningStubs().isPresent('loanIssuance')

stubFinder.findAllRunningStubs().isPresent('org.springframework.cloud.contract.verifier.stubs', 'fraudDetectionServer')

stubFinder.findAllRunningStubs().isPresent('org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer')

and: 'Stubs were registered'

"${stubFinder.findStubUrl('loanIssuance').toString()}/name".toURL().text == 'loanIssuance'

"${stubFinder.findStubUrl('fraudDetectionServer').toString()}/name".toURL().text == 'fraudDetectionServer'

}

def 'should throw an exception when stub is not found'() {

when:

stubFinder.findStubUrl('nonExistingService')

then:

thrown(StubNotFoundException)

when:

stubFinder.findStubUrl('nonExistingGroupId', 'nonExistingArtifactId')

then:

thrown(StubNotFoundException)

}

def 'should register started servers as environment variables'() {

expect:

environment.getProperty("stubrunner.runningstubs.loanIssuance.port") != null

stubFinder.findAllRunningStubs().getPort("loanIssuance") == (environment.getProperty("stubrunner.runningstubs.loanIssuance.port") as Integer)

and:

environment.getProperty("stubrunner.runningstubs.fraudDetectionServer.port") != null

stubFinder.findAllRunningStubs().getPort("fraudDetectionServer") == (environment.getProperty("stubrunner.runningstubs.fraudDetectionServer.port") as Integer)

and:

environment.getProperty("stubrunner.runningstubs.fraudDetectionServer.port") != null

stubFinder.findAllRunningStubs().getPort("fraudDetectionServer") == (environment.getProperty("stubrunner.runningstubs.org.springframework.cloud.contract.verifier.stubs.fraudDetectionServer.port") as Integer)

}

def 'should be able to interpolate a running stub in the passed test property'() {

given:

**int** fraudPort = stubFinder.findAllRunningStubs().getPort("fraudDetectionServer")

expect:

fraudPort > 0

environment.getProperty("foo", Integer) == fraudPort

environment.getProperty("fooWithGroup", Integer) == fraudPort

foo == fraudPort

}

*@Issue("#573")*

def 'should be able to retrieve the port of a running stub via an annotation'() {

given:

**int** fraudPort = stubFinder.findAllRunningStubs().getPort("fraudDetectionServer")

expect:

fraudPort > 0

fraudDetectionServerPort == fraudPort

fraudDetectionServerPortWithGroupId == fraudPort

}

def 'should dump all mappings to a file'() {

when:

def url = stubFinder.findStubUrl("fraudDetectionServer")

then:

**new** File("target/outputmappings/", "fraudDetectionServer\_${url.port}").exists()

}

*@Configuration*

*@EnableAutoConfiguration*

**static** **class** Config {}

}

for the following configuration file:

stubrunner:

repositoryRoot: classpath:m2repo/repository/

ids:

- org.springframework.cloud.contract.verifier.stubs:loanIssuance

- org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer

- org.springframework.cloud.contract.verifier.stubs:bootService

stubs-mode: remote

Instead of using the properties you can also use the properties inside the @AutoConfigureStubRunner. Below you can find an example of achieving the same result by setting values on the annotation.

@AutoConfigureStubRunner(

ids = ["org.springframework.cloud.contract.verifier.stubs:loanIssuance",

"org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer",

"org.springframework.cloud.contract.verifier.stubs:bootService"],

stubsMode = StubRunnerProperties.StubsMode.REMOTE,

repositoryRoot = "classpath:m2repo/repository/")

Stub Runner Spring registers environment variables in the following manner for every registered WireMock server. Example for Stub Runner ids com.example:foo, com.example:bar.

* stubrunner.runningstubs.foo.port
* stubrunner.runningstubs.com.example.foo.port
* stubrunner.runningstubs.bar.port
* stubrunner.runningstubs.com.example.bar.port

Which you can reference in your code.

You can also use the @StubRunnerPort annotation to inject the port of a running stub. Value of the annotation can be the groupid:artifactid or just the artifactid. Example for Stub Runner ids com.example:foo, com.example:bar.

*@StubRunnerPort("foo")*

**int** fooPort;

*@StubRunnerPort("com.example:bar")*

**int** barPort;

## 90.5 Stub Runner Spring Cloud

Stub Runner can integrate with Spring Cloud.

For real life examples you can check the

* [producer app sample](https://github.com/spring-cloud-samples/spring-cloud-contract-samples/tree/2.0.x/producer)
* [consumer app sample](https://github.com/spring-cloud-samples/spring-cloud-contract-samples/tree/2.0.x/consumer_with_discovery)

### 90.5.1 Stubbing Service Discovery

The most important feature of Stub Runner Spring Cloud is the fact that it’s stubbing

* DiscoveryClient
* Ribbon ServerList

that means that regardless of the fact whether you’re using Zookeeper, Consul, Eureka or anything else, you don’t need that in your tests. We’re starting WireMock instances of your dependencies and we’re telling your application whenever you’re using Feign, load balanced RestTemplate or DiscoveryClient directly, to call those stubbed servers instead of calling the real Service Discovery tool.

For example this test will pass

def 'should make service discovery work'() {

expect: 'WireMocks are running'

"${stubFinder.findStubUrl('loanIssuance').toString()}/name".toURL().text == 'loanIssuance'

"${stubFinder.findStubUrl('fraudDetectionServer').toString()}/name".toURL().text == 'fraudDetectionServer'

and: 'Stubs can be reached via load service discovery'

restTemplate.getForObject('http://loanIssuance/name', String) == 'loanIssuance'

restTemplate.getForObject('http://someNameThatShouldMapFraudDetectionServer/name', String) == 'fraudDetectionServer'

}

for the following configuration file

stubrunner:

idsToServiceIds:

ivyNotation: someValueInsideYourCode

fraudDetectionServer: someNameThatShouldMapFraudDetectionServer

#### Test profiles and service discovery

In your integration tests you typically don’t want to call neither a discovery service (e.g. Eureka) or Config Server. That’s why you create an additional test configuration in which you want to disable these features.

Due to certain limitations of [spring-cloud-commons](https://github.com/spring-cloud/spring-cloud-commons/issues/156) to achieve this you have disable these properties via a static block like presented below (example for Eureka)

*//Hack to work around https://github.com/spring-cloud/spring-cloud-commons/issues/156*

**static** {

System.setProperty("eureka.client.enabled", "false");

System.setProperty("spring.cloud.config.failFast", "false");

}

### 90.5.2 Additional Configuration

You can match the artifactId of the stub with the name of your app by using the stubrunner.idsToServiceIds: map. You can disable Stub Runner Ribbon support by providing: stubrunner.cloud.ribbon.enabled equal to false You can disable Stub Runner support by providing: stubrunner.cloud.enabled equal to false

|  |
| --- |
| [Tip] |
| By default all service discovery will be stubbed. That means that regardless of the fact if you have an existing DiscoveryClient its results will be ignored. However, if you want to reuse it, just set stubrunner.cloud.delegate.enabled to true and then your existing DiscoveryClient results will be merged with the stubbed ones. |

The default Maven configuration used by Stub Runner can be tweaked either via the following system properties or environment variables

* maven.repo.local - path to the custom maven local repository location
* org.apache.maven.user-settings - path to custom maven user settings location
* org.apache.maven.global-settings - path to maven global settings location

## 90.6 Stub Runner Boot Application

Spring Cloud Contract Stub Runner Boot is a Spring Boot application that exposes REST endpoints to trigger the messaging labels and to access started WireMock servers.

One of the use-cases is to run some smoke (end to end) tests on a deployed application. You can check out the [Spring Cloud Pipelines](https://github.com/spring-cloud/spring-cloud-pipelines) project for more information.

### 90.6.1 How to use it?

#### Stub Runner Server

Just add the

compile "org.springframework.cloud:spring-cloud-starter-stub-runner"

Annotate a class with @EnableStubRunnerServer, build a fat-jar and you’re ready to go!

For the properties check the **Stub Runner Spring** section.

#### Stub Runner Server Fat Jar

You can download a standalone JAR from Maven (for example, for version 1.2.3.RELEASE), as follows:

$ wget -O stub-runner.jar 'https://search.maven.org/remote\_content?g=org.springframework.cloud&a=spring-cloud-contract-stub-runner-boot&v=1.2.3.RELEASE'

$ java -jar stub-runner.jar --stubrunner.ids=... --stubrunner.repositoryRoot=...

#### Spring Cloud CLI

Starting from 1.4.0.RELEASE version of the [Spring Cloud CLI](https://cloud.spring.io/spring-cloud-cli) project you can start Stub Runner Boot by executing spring cloud stubrunner.

In order to pass the configuration just create a stubrunner.yml file in the current working directory or a subdirectory called config or in ~/.spring-cloud. The file could look like this (example for running stubs installed locally)

**stubrunner.yml.**

stubrunner:

stubsMode: LOCAL

ids:

- com.example:beer-api-producer:+:9876

and then just call spring cloud stubrunner from your terminal window to start the Stub Runner server. It will be available at port 8750.

### 90.6.2 Endpoints

#### HTTP

* GET /stubs - returns a list of all running stubs in ivy:integer notation
* GET /stubs/{ivy} - returns a port for the given ivy notation (when calling the endpoint ivy can also be artifactId only)

#### Messaging

For Messaging

* GET /triggers - returns a list of all running labels in ivy : [ label1, label2 …​] notation
* POST /triggers/{label} - executes a trigger with label
* POST /triggers/{ivy}/{label} - executes a trigger with label for the given ivy notation (when calling the endpoint ivy can also be artifactId only)

### 90.6.3 Example

*@ContextConfiguration(classes = StubRunnerBoot, loader = SpringBootContextLoader)*

*@SpringBootTest(properties = "spring.cloud.zookeeper.enabled=false")*

*@ActiveProfiles("test")*

**class** StubRunnerBootSpec **extends** Specification {

*@Autowired* StubRunning stubRunning

def setup() {

RestAssuredMockMvc.standaloneSetup(**new** HttpStubsController(stubRunning),

**new** TriggerController(stubRunning))

}

def 'should return a list of running stub servers in "full ivy:port" notation'() {

when:

String response = RestAssuredMockMvc.get('/stubs').body.asString()

then:

def root = **new** JsonSlurper().parseText(response)

root.'org.springframework.cloud.contract.verifier.stubs:bootService:0.0.1-SNAPSHOT:stubs' **instanceof** Integer

}

def 'should return a port on which a [#stubId] stub is running'() {

when:

def response = RestAssuredMockMvc.get("/stubs/${stubId}")

then:

response.statusCode == 200

Integer.valueOf(response.body.asString()) > 0

where:

stubId << ['org.springframework.cloud.contract.verifier.stubs:bootService:+:stubs',

'org.springframework.cloud.contract.verifier.stubs:bootService:0.0.1-SNAPSHOT:stubs',

'org.springframework.cloud.contract.verifier.stubs:bootService:+',

'org.springframework.cloud.contract.verifier.stubs:bootService',

'bootService']

}

def 'should return 404 when missing stub was called'() {

when:

def response = RestAssuredMockMvc.get("/stubs/a:b:c:d")

then:

response.statusCode == 404

}

def 'should return a list of messaging labels that can be triggered when version and classifier are passed'() {

when:

String response = RestAssuredMockMvc.get('/triggers').body.asString()

then:

def root = **new** JsonSlurper().parseText(response)

root.'org.springframework.cloud.contract.verifier.stubs:bootService:0.0.1-SNAPSHOT:stubs'?.containsAll(["delete\_book","return\_book\_1","return\_book\_2"])

}

def 'should trigger a messaging label'() {

given:

StubRunning stubRunning = Mock()

RestAssuredMockMvc.standaloneSetup(**new** HttpStubsController(stubRunning), **new** TriggerController(stubRunning))

when:

def response = RestAssuredMockMvc.post("/triggers/delete\_book")

then:

response.statusCode == 200

and:

1 \* stubRunning.trigger('delete\_book')

}

def 'should trigger a messaging label for a stub with [#stubId] ivy notation'() {

given:

StubRunning stubRunning = Mock()

RestAssuredMockMvc.standaloneSetup(**new** HttpStubsController(stubRunning), **new** TriggerController(stubRunning))

when:

def response = RestAssuredMockMvc.post("/triggers/$stubId/delete\_book")

then:

response.statusCode == 200

and:

1 \* stubRunning.trigger(stubId, 'delete\_book')

where:

stubId << ['org.springframework.cloud.contract.verifier.stubs:bootService:stubs', 'org.springframework.cloud.contract.verifier.stubs:bootService', 'bootService']

}

def 'should throw exception when trigger is missing'() {

when:

RestAssuredMockMvc.post("/triggers/missing\_label")

then:

Exception e = thrown(Exception)

e.message.contains("Exception occurred while trying to return [missing\_label] label.")

e.message.contains("Available labels are")

e.message.contains("org.springframework.cloud.contract.verifier.stubs:loanIssuance:0.0.1-SNAPSHOT:stubs=[]")

e.message.contains("org.springframework.cloud.contract.verifier.stubs:bootService:0.0.1-SNAPSHOT:stubs=")

}

}

### 90.6.4 Stub Runner Boot with Service Discovery

One of the possibilities of using Stub Runner Boot is to use it as a feed of stubs for "smoke-tests". What does it mean? Let’s assume that you don’t want to deploy 50 microservice to a test environment in order to check if your application is working fine. You’ve already executed a suite of tests during the build process but you would also like to ensure that the packaging of your application is fine. What you can do is to deploy your application to an environment, start it and run a couple of tests on it to see if it’s working fine. We can call those tests smoke-tests since their idea is to check only a handful of testing scenarios.

The problem with this approach is such that if you’re doing microservices most likely you’re using a service discovery tool. Stub Runner Boot allows you to solve this issue by starting the required stubs and register them in a service discovery tool. Let’s take a look at an example of such a setup with Eureka. Let’s assume that Eureka was already running.

*@SpringBootApplication*

*@EnableStubRunnerServer*

*@EnableEurekaClient*

*@AutoConfigureStubRunner*

**public** **class** StubRunnerBootEurekaExample {

**public** **static** **void** main(String[] args) {

SpringApplication.run(StubRunnerBootEurekaExample.**class**, args);

}

}

As you can see we want to start a Stub Runner Boot server @EnableStubRunnerServer, enable Eureka client @EnableEurekaClient and we want to have the stub runner feature turned on @AutoConfigureStubRunner.

Now let’s assume that we want to start this application so that the stubs get automatically registered. We can do it by running the app java -jar ${SYSTEM\_PROPS} stub-runner-boot-eureka-example.jar where ${SYSTEM\_PROPS} would contain the following list of properties

-Dstubrunner.repositoryRoot=http://repo.spring.io/snapshots (1)

-Dstubrunner.cloud.stubbed.discovery.enabled=false (2)

-Dstubrunner.ids=org.springframework.cloud.contract.verifier.stubs:loanIssuance,org.springframework.cloud.contract.verifier.stubs:fraudDetectionServer,org.springframework.cloud.contract.verifier.stubs:bootService (3)

-Dstubrunner.idsToServiceIds.fraudDetectionServer=someNameThatShouldMapFraudDetectionServer (4)

(1) - we tell Stub Runner where all the stubs reside

(2) - we don't want the default behaviour where the discovery service is stubbed. That's why the stub registration will be picked

(3) - we provide a list of stubs to download

(4) - we provide a list of artifactId to serviceId mapping

That way your deployed application can send requests to started WireMock servers via the service discovery. Most likely points 1-3 could be set by default in application.yml cause they are not likely to change. That way you can provide only the list of stubs to download whenever you start the Stub Runner Boot.

## 90.7 Stubs Per Consumer

There are cases in which 2 consumers of the same endpoint want to have 2 different responses.

|  |
| --- |
| [Tip] |
| This approach also allows you to immediately know which consumer is using which part of your API. You can remove part of a response that your API produces and you can see which of your autogenerated tests fails. If none fails then you can safely delete that part of the response cause nobody is using it. |

Let’s look at the following example for contract defined for the producer called producer. There are 2 consumers: foo-consumer and bar-consumer.

**Consumer foo-service**

request {

url '/foo'

method GET()

}

response {

status OK()

body(

foo: "foo"

}

}

**Consumer bar-service**

request {

url '/foo'

method GET()

}

response {

status OK()

body(

bar: "bar"

}

}

You can’t produce for the same request 2 different responses. That’s why you can properly package the contracts and then profit from the stubsPerConsumer feature.

On the producer side the consumers can have a folder that contains contracts related only to them. By setting the stubrunner.stubs-per-consumer flag to true we no longer register all stubs but only those that correspond to the consumer application’s name. In other words we’ll scan the path of every stub and if it contains the subfolder with name of the consumer in the path only then will it get registered.

On the foo producer side the contracts would look like this

.

└── contracts

├── bar-consumer

│   ├── bookReturnedForBar.groovy

│   └── shouldCallBar.groovy

└── foo-consumer

├── bookReturnedForFoo.groovy

└── shouldCallFoo.groovy

Being the bar-consumer consumer you can either set the spring.application.name or the stubrunner.consumer-name to bar-consumer Or set the test as follows:

*@ContextConfiguration(classes = Config, loader = SpringBootContextLoader)*

*@SpringBootTest(properties = ["spring.application.name=bar-consumer"])*

*@AutoConfigureStubRunner(ids = "org.springframework.cloud.contract.verifier.stubs:producerWithMultipleConsumers",*

*repositoryRoot = "classpath:m2repo/repository/",*

*stubsMode = StubRunnerProperties.StubsMode.REMOTE,*

*stubsPerConsumer = true)*

*@DirtiesContext*

**class** StubRunnerStubsPerConsumerSpec **extends** Specification {

...

}

Then only the stubs registered under a path that contains the bar-consumer in its name (i.e. those from thesrc/test/resources/contracts/bar-consumer/some/contracts/…​ folder) will be allowed to be referenced.

Or set the consumer name explicitly

*@ContextConfiguration(classes = Config, loader = SpringBootContextLoader)*

*@SpringBootTest*

*@AutoConfigureStubRunner(ids = "org.springframework.cloud.contract.verifier.stubs:producerWithMultipleConsumers",*

*repositoryRoot = "classpath:m2repo/repository/",*

*consumerName = "foo-consumer",*

*stubsMode = StubRunnerProperties.StubsMode.REMOTE,*

*stubsPerConsumer = true)*

*@DirtiesContext*

**class** StubRunnerStubsPerConsumerWithConsumerNameSpec **extends** Specification {

...

}

Then only the stubs registered under a path that contains the foo-consumer in its name (i.e. those from thesrc/test/resources/contracts/foo-consumer/some/contracts/…​ folder) will be allowed to be referenced.

You can check out [issue 224](https://github.com/spring-cloud/spring-cloud-contract/issues/224) for more information about the reasons behind this change.

## 90.8 Common

This section briefly describes common properties, including:

* [Section 90.8.1, “Common Properties for JUnit and Spring”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_stub_runner.html#common-properties-junit-spring)
* [Section 90.8.2, “Stub Runner Stubs IDs”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_stub_runner.html#stub-runner-stub-ids)

### 90.8.1 Common Properties for JUnit and Spring

You can set repetitive properties by using system properties or Spring configuration properties. Here are their names with their default values:

| **Property name** | **Default value** | **Description** |
| --- | --- | --- |
| stubrunner.minPort | 10000 | Minimum value of a port for a started WireMock with stubs. |
| stubrunner.maxPort | 15000 | Maximum value of a port for a started WireMock with stubs. |
| stubrunner.repositoryRoot |  | Maven repo URL. If blank, then call the local maven repo. |
| stubrunner.classifier | stubs | Default classifier for the stub artifacts. |
| stubrunner.stubsMode | CLASSPATH | The way you want to fetch and register the stubs |
| stubrunner.ids |  | Array of Ivy notation stubs to download. |
| stubrunner.username |  | Optional username to access the tool that stores the JARs with stubs. |
| stubrunner.password |  | Optional password to access the tool that stores the JARs with stubs. |
| stubrunner.stubsPerConsumer | false | Set to true if you want to use different stubs for each consumer instead of registering all stubs for every consumer. |
| stubrunner.consumerName |  | If you want to use a stub for each consumer and want to override the consumer name just change this value. |

### 90.8.2 Stub Runner Stubs IDs

You can provide the stubs to download via the stubrunner.ids system property. They follow this pattern:

groupId:artifactId:version:classifier:port

Note that version, classifier and port are optional.

* If you do not provide the port, a random one will be picked.
* If you do not provide the classifier, the default is used. (Note that you can pass an empty classifier this way: groupId:artifactId:version:).
* If you do not provide the version, then the + will be passed and the latest one is downloaded.

port means the port of the WireMock server.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Starting with version 1.0.4, you can provide a range of versions that you would like the Stub Runner to take into consideration. You can read more about the[Aether versioning ranges here](https://wiki.eclipse.org/Aether/New_and_Noteworthy#Version_Ranges). |

## 90.9 Stub Runner Docker

We’re publishing a spring-cloud/spring-cloud-contract-stub-runner Docker image that will start the standalone version of Stub Runner.

If you want to learn more about the basics of Maven, artifact ids, group ids, classifiers and Artifact Managers, just click here [Section 88.6, “Docker Project”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#docker-project).

### 90.9.1 How to use it

Just execute the docker image. You can pass any of the [Section 90.8.1, “Common Properties for JUnit and Spring”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_stub_runner.html#common-properties-junit-spring) as environment variables. The convention is that all the letters should be upper case. The camel case notation should and the dot (.) should be separated via underscore (\_). E.g. the stubrunner.repositoryRootproperty should be represented as a STUBRUNNER\_REPOSITORY\_ROOT environment variable.

### 90.9.2 Example of client side usage in a non JVM project

We’d like to use the stubs created in this [Section 88.6.4, “Server side (nodejs)”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__spring_cloud_contract_verifier_setup.html#docker-server-side) step. Let’s assume that we want to run the stubs on port 9876. The NodeJS code is available here:

$ git clone https://github.com/spring-cloud-samples/spring-cloud-contract-nodejs

$ **cd** bookstore

Let’s run the Stub Runner Boot application with the stubs.

*# Provide the Spring Cloud Contract Docker version*

$ SC\_CONTRACT\_DOCKER\_VERSION="..."

*# The IP at which the app is running and Docker container can reach it*

$ APP\_IP="192.168.0.100"

*# Spring Cloud Contract Stub Runner properties*

$ STUBRUNNER\_PORT="8083"

*# Stub coordinates 'groupId:artifactId:version:classifier:port'*

$ STUBRUNNER\_IDS="com.example:bookstore:0.0.1.RELEASE:stubs:9876"

$ STUBRUNNER\_REPOSITORY\_ROOT="http://${APP\_IP}:8081/artifactory/libs-release-local"

*# Run the docker with Stub Runner Boot*

$ docker run --rm -e "STUBRUNNER\_IDS=${STUBRUNNER\_IDS}" -e "STUBRUNNER\_REPOSITORY\_ROOT=${STUBRUNNER\_REPOSITORY\_ROOT}" -p "${STUBRUNNER\_PORT}:${STUBRUNNER\_PORT}" -p "9876:9876" springcloud/spring-cloud-contract-stub-runner:"${SC\_CONTRACT\_DOCKER\_VERSION}"

What’s happening is that

* a standalone Stub Runner application got started
* it downloaded the stub with coordinates com.example:bookstore:0.0.1.RELEASE:stubs on port 9876
* it got downloaded from Artifactory running at <http://192.168.0.100:8081/artifactory/libs-release-local>
* after a while Stub Runner will be running on port 8083
* and the stubs will be running at port 9876

On the server side we built a stateful stub. Let’s use curl to assert that the stubs are setup properly.

*# let's execute the first request (no response is returned)*

$ curl -H "Content-Type:application/json" -X POST --data '{ "title" : "Title", "genre" : "Genre", "description" : "Description", "author" : "Author", "publisher" : "Publisher", "pages" : 100, "image\_url" : "https://d213dhlpdb53mu.cloudfront.net/assets/pivotal-square-logo-41418bd391196c3022f3cd9f3959b3f6d7764c47873d858583384e759c7db435.svg", "buy\_url" : "https://pivotal.io" }' http://localhost:9876/api/books

*# Now time for the second request*

$ curl -X GET http://localhost:9876/api/books

*# You will receive contents of the JSON*

## 91. Stub Runner for Messaging

Stub Runner can run the published stubs in memory. It can integrate with the following frameworks:

* Spring Integration
* Spring Cloud Stream
* Spring AMQP

It also provides entry points to integrate with any other solution on the market.

|  |  |
| --- | --- |
| [Important] | **Important** |
| If you have multiple frameworks on the classpath Stub Runner will need to define which one should be used. Let’s assume that you have both AMQP, Spring Cloud Stream and Spring Integration on the classpath. Then you need to set stubrunner.stream.enabled=false and stubrunner.integration.enabled=false. That way the only remaining framework is Spring AMQP. |

## 91.1 Stub triggering

To trigger a message, use the StubTrigger interface:

**package** org.springframework.cloud.contract.stubrunner;

**import** java.util.Collection;

**import** java.util.Map;

**public** **interface** StubTrigger {

**/\*\***

**\* Triggers an event by a given label for a given {@code groupid:artifactid} notation. You can use only {@code artifactId} too.**

**\***

**\* Feature related to messaging.**

**\***

**\* @return true - if managed to run a trigger**

**\*/**

**boolean** trigger(String ivyNotation, String labelName);

**/\*\***

**\* Triggers an event by a given label.**

**\***

**\* Feature related to messaging.**

**\***

**\* @return true - if managed to run a trigger**

**\*/**

**boolean** trigger(String labelName);

**/\*\***

**\* Triggers all possible events.**

**\***

**\* Feature related to messaging.**

**\***

**\* @return true - if managed to run a trigger**

**\*/**

**boolean** trigger();

**/\*\***

**\* Returns a mapping of ivy notation of a dependency to all the labels it has.**

**\***

**\* Feature related to messaging.**

**\*/**

Map<String, Collection<String>> labels();

}

For convenience, the StubFinder interface extends StubTrigger, so you only need one or the other in your tests.

StubTrigger gives you the following options to trigger a message:

* [Section 91.1.1, “Trigger by Label”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#trigger-label)
* [Section 91.1.2, “Trigger by Group and Artifact Ids”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#trigger-group-artifact-ids)
* [Section 91.1.3, “Trigger by Artifact Ids”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#trigger-artifact-ids)
* [Section 91.1.4, “Trigger All Messages”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#trigger-all-messages)

### 91.1.1 Trigger by Label

stubFinder.trigger('return\_book\_1')

### 91.1.2 Trigger by Group and Artifact Ids

stubFinder.trigger('org.springframework.cloud.contract.verifier.stubs:streamService', 'return\_book\_1')

### 91.1.3 Trigger by Artifact Ids

stubFinder.trigger('streamService', 'return\_book\_1')

### 91.1.4 Trigger All Messages

stubFinder.trigger()

## 91.2 Stub Runner Integration

Spring Cloud Contract Verifier Stub Runner’s messaging module gives you an easy way to integrate with Spring Integration. For the provided artifacts, it automatically downloads the stubs and registers the required routes.

### 91.2.1 Adding the Runner to the Project

You can have both Spring Integration and Spring Cloud Contract Stub Runner on the classpath. Remember to annotate your test class with @AutoConfigureStubRunner.

### 91.2.2 Disabling the functionality

If you need to disable this functionality, set the stubrunner.integration.enabled=false property.

Assume that you have the following Maven repository with deployed stubs for the integrationService application:

└── .m2

└── repository

└── io

└── codearte

└── accurest

└── stubs

└── integrationService

├── 0.0.1-SNAPSHOT

│   ├── integrationService-0.0.1-SNAPSHOT.pom

│   ├── integrationService-0.0.1-SNAPSHOT-stubs.jar

│   └── maven-metadata-local.xml

└── maven-metadata-local.xml

Further assume the stubs contain the following structure:

├── META-INF

│   └── MANIFEST.MF

└── repository

├── accurest

│   ├── bookDeleted.groovy

│   ├── bookReturned1.groovy

│   └── bookReturned2.groovy

└── mappings

Consider the following contracts (numbered **1**):

Contract.make {

label 'return\_book\_1'

input {

triggeredBy('bookReturnedTriggered()')

}

outputMessage {

sentTo('output')

body('''{ "bookName" : "foo" }''')

headers {

header('BOOK-NAME', 'foo')

}

}

}

Now consider **2**:

Contract.make {

label 'return\_book\_2'

input {

messageFrom('input')

messageBody([

bookName: 'foo'

])

messageHeaders {

header('sample', 'header')

}

}

outputMessage {

sentTo('output')

body([

bookName: 'foo'

])

headers {

header('BOOK-NAME', 'foo')

}

}

}

and the following Spring Integration Route:

<?xml version="1.0" encoding="UTF-8"?>

<beans:beans xmlns="http://www.springframework.org/schema/integration"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xmlns:beans="http://www.springframework.org/schema/beans"

xsi:schemaLocation="http://www.springframework.org/schema/beans

http://www.springframework.org/schema/beans/spring-beans.xsd

http://www.springframework.org/schema/integration

http://www.springframework.org/schema/integration/spring-integration.xsd">

*<!-- REQUIRED FOR TESTING -->*

<bridge input-channel="output"

output-channel="outputTest"/>

<channel id="outputTest">

<queue/>

</channel>

</beans:beans>

These examples lend themselves to three scenarios:

* [the section called “Scenario 1 (no input message)”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#integration-scenario-1)
* [???](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html)
* [the section called “Scenario 3 (input with no output)”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#integration-scenario-3)

#### Scenario 1 (no input message)

To trigger a message via the return\_book\_1 label, use the StubTigger interface, as follows:

stubFinder.trigger('return\_book\_1')

To listen to the output of the message sent to output:

Message<?> receivedMessage = messaging.receive('outputTest')

The received message would pass the following assertions:

receivedMessage != null

assertJsons(receivedMessage.payload)

receivedMessage.headers.get('BOOK-NAME') == 'foo'

#### Scenario 2 (output triggered by input)

Since the route is set for you, you can send a message to the output destination:

messaging.send(**new** BookReturned('foo'), [sample: 'header'], 'input')

To listen to the output of the message sent to output:

Message<?> receivedMessage = messaging.receive('outputTest')

The received message passes the following assertions:

receivedMessage != null

assertJsons(receivedMessage.payload)

receivedMessage.headers.get('BOOK-NAME') == 'foo'

#### Scenario 3 (input with no output)

Since the route is set for you, you can send a message to the input destination:

messaging.send(**new** BookReturned('foo'), [sample: 'header'], 'delete')

## 91.3 Stub Runner Stream

Spring Cloud Contract Verifier Stub Runner’s messaging module gives you an easy way to integrate with Spring Stream. For the provided artifacts, it automatically downloads the stubs and registers the required routes.

|  |
| --- |
| [Warning] |
| If Stub Runner’s integration with Stream the messageFrom or sentTo Strings are resolved first as a destination of a channel and no such destination exists, the destination is resolved as a channel name. |
| [Important] | **Important** | |
| If you want to use Spring Cloud Stream remember, to add a dependency on org.springframework.cloud:spring-cloud-stream-test-support. | |

**Maven.**

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-stream-test-support</artifactId>

<scope>test</scope>

</dependency>

**Gradle.**

testCompile "org.springframework.cloud:spring-cloud-stream-test-support"

### 91.3.1 Adding the Runner to the Project

You can have both Spring Cloud Stream and Spring Cloud Contract Stub Runner on the classpath. Remember to annotate your test class with @AutoConfigureStubRunner.

### 91.3.2 Disabling the functionality

If you need to disable this functionality, set the stubrunner.stream.enabled=false property.

Assume that you have the following Maven repository with a deployed stubs for the streamService application:

└── .m2

└── repository

└── io

└── codearte

└── accurest

└── stubs

└── streamService

├── 0.0.1-SNAPSHOT

│   ├── streamService-0.0.1-SNAPSHOT.pom

│   ├── streamService-0.0.1-SNAPSHOT-stubs.jar

│   └── maven-metadata-local.xml

└── maven-metadata-local.xml

Further assume the stubs contain the following structure:

├── META-INF

│   └── MANIFEST.MF

└── repository

├── accurest

│   ├── bookDeleted.groovy

│   ├── bookReturned1.groovy

│   └── bookReturned2.groovy

└── mappings

Consider the following contracts (numbered **1**):

Contract.make {

label 'return\_book\_1'

input { triggeredBy('bookReturnedTriggered()') }

outputMessage {

sentTo('returnBook')

body('''{ "bookName" : "foo" }''')

headers { header('BOOK-NAME', 'foo') }

}

}

Now consider **2**:

Contract.make {

label 'return\_book\_2'

input {

messageFrom('bookStorage')

messageBody([

bookName: 'foo'

])

messageHeaders { header('sample', 'header') }

}

outputMessage {

sentTo('returnBook')

body([

bookName: 'foo'

])

headers { header('BOOK-NAME', 'foo') }

}

}

Now consider the following Spring configuration:

stubrunner.repositoryRoot: classpath:m2repo/repository/

stubrunner.ids: org.springframework.cloud.contract.verifier.stubs:streamService:0.0.1-SNAPSHOT:stubs

stubrunner.stubs-mode: remote

spring:

cloud:

stream:

bindings:

output:

destination: returnBook

input:

destination: bookStorage

server:

port: 0

debug: **true**

These examples lend themselves to three scenarios:

* [the section called “Scenario 1 (no input message)”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#stream-scenario-1)
* [the section called “Scenario 2 (output triggered by input)”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#stream-scenario-2)
* [the section called “Scenario 3 (input with no output)”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__stub_runner_for_messaging.html#stream-scenario-3)

#### Scenario 1 (no input message)

To trigger a message via the return\_book\_1 label, use the StubTrigger interface as follows:

stubFinder.trigger('return\_book\_1')

To listen to the output of the message sent to a channel whose destination is returnBook:

Message<?> receivedMessage = messaging.receive('returnBook')

The received message passes the following assertions:

receivedMessage != null

assertJsons(receivedMessage.payload)

receivedMessage.headers.get('BOOK-NAME') == 'foo'

#### Scenario 2 (output triggered by input)

Since the route is set for you, you can send a message to the bookStorage destination:

messaging.send(**new** BookReturned('foo'), [sample: 'header'], 'bookStorage')

To listen to the output of the message sent to returnBook:

Message<?> receivedMessage = messaging.receive('returnBook')

The received message passes the following assertions:

receivedMessage != null

assertJsons(receivedMessage.payload)

receivedMessage.headers.get('BOOK-NAME') == 'foo'

#### Scenario 3 (input with no output)

Since the route is set for you, you can send a message to the output destination:

messaging.send(**new** BookReturned('foo'), [sample: 'header'], 'delete')

## 91.4 Stub Runner Spring AMQP

Spring Cloud Contract Verifier Stub Runner’s messaging module provides an easy way to integrate with Spring AMQP’s Rabbit Template. For the provided artifacts, it automatically downloads the stubs and registers the required routes.

The integration tries to work standalone (that is, without interaction with a running RabbitMQ message broker). It expects a RabbitTemplate on the application context and uses it as a spring boot test named @SpyBean. As a result, it can use the mockito spy functionality to verify and inspect messages sent by the application.

On the message consumer side, the stub runner considers all @RabbitListener annotated endpoints and all SimpleMessageListenerContainer objects on the application context.

As messages are usually sent to exchanges in AMQP, the message contract contains the exchange name as the destination. Message listeners on the other side are bound to queues. Bindings connect an exchange to a queue. If message contracts are triggered, the Spring AMQP stub runner integration looks for bindings on the application context that match this exchange. Then it collects the queues from the Spring exchanges and tries to find message listeners bound to these queues. The message is triggered for all matching message listeners.

### 91.4.1 Adding the Runner to the Project

You can have both Spring AMQP and Spring Cloud Contract Stub Runner on the classpath and set the property stubrunner.amqp.enabled=true. Remember to annotate your test class with @AutoConfigureStubRunner.

|  |  |
| --- | --- |
| [Important] | **Important** |
| If you already have Stream and Integration on the classpath, you need to disable them explicitly by setting the stubrunner.stream.enabled=false andstubrunner.integration.enabled=false properties. |

Assume that you have the following Maven repository with a deployed stubs for the spring-cloud-contract-amqp-test application.

└── .m2

└── repository

└── com

└── example

└── spring-cloud-contract-amqp-**test**

├── 0.4.0-SNAPSHOT

│   ├── spring-cloud-contract-amqp-**test**-0.4.0-SNAPSHOT.pom

│   ├── spring-cloud-contract-amqp-**test**-0.4.0-SNAPSHOT-stubs.jar

│   └── maven-metadata-local.xml

└── maven-metadata-local.xml

Further assume that the stubs contain the following structure:

├── META-INF

│   └── MANIFEST.MF

└── contracts

└── shouldProduceValidPersonData.groovy

Consider the following contract:

Contract.make {

*// Human readable description*

description 'Should produce valid person data'

*// Label by means of which the output message can be triggered*

label 'contract-test.person.created.event'

*// input to the contract*

input {

*// the contract will be triggered by a method*

triggeredBy('createPerson()')

}

*// output message of the contract*

outputMessage {

*// destination to which the output message will be sent*

sentTo 'contract-test.exchange'

headers {

header('contentType': 'application/json')

header('\_\_TypeId\_\_': 'org.springframework.cloud.contract.stubrunner.messaging.amqp.Person')

}

*// the body of the output message*

body ([

id: $(consumer(9), producer(regex("[0-9]+"))),

name: "me"

])

}

}

Now consider the following Spring configuration:

stubrunner:

repositoryRoot: classpath:m2repo/repository/

ids: org.springframework.cloud.contract.verifier.stubs.amqp:spring-cloud-contract-amqp-test:0.4.0-SNAPSHOT:stubs

stubs-mode: remote

amqp:

enabled: **true**

server:

port: 0

#### Triggering the message

To trigger a message using the contract above, use the StubTrigger interface as follows:

stubTrigger.trigger("contract-test.person.created.event")

The message has a destination of contract-test.exchange, so the Spring AMQP stub runner integration looks for bindings related to this exchange.

*@Bean*

**public** Binding binding() {

**return** BindingBuilder.bind(**new** Queue("test.queue")).to(**new** DirectExchange("contract-test.exchange")).with("#");

}

The binding definition binds the queue test.queue. As a result, the following listener definition is matched and invoked with the contract message.

*@Bean*

**public** SimpleMessageListenerContainer simpleMessageListenerContainer(ConnectionFactory connectionFactory,

MessageListenerAdapter listenerAdapter) {

SimpleMessageListenerContainer container = **new** SimpleMessageListenerContainer();

container.setConnectionFactory(connectionFactory);

container.setQueueNames("test.queue");

container.setMessageListener(listenerAdapter);

**return** container;

}

Also, the following annotated listener matches and is invoked:

*@RabbitListener(bindings = @QueueBinding(*

*value = @Queue(value = "test.queue"),*

*exchange = @Exchange(value = "contract-test.exchange", ignoreDeclarationExceptions = "true")))*

**public** **void** handlePerson(Person person) {

**this**.person = person;

}

|  |
| --- |
| [Note] |
| The message is directly handed over to the onMessage method of the MessageListener associated with the matching SimpleMessageListenerContainer. |

#### Spring AMQP Test Configuration

In order to avoid Spring AMQP trying to connect to a running broker during our tests configure a mock ConnectionFactory.

To disable the mocked ConnectionFactory, set the following property: stubrunner.amqp.mockConnection=false

stubrunner:

amqp:

mockConnection: **false**

## 92. Contract DSL

Spring Cloud Contract supports out of the box 2 types of DSL. One written in Groovy and one written in YAML.

If you decide to write the contract in Groovy, do not be alarmed if you have not used Groovy before. Knowledge of the language is not really needed, as the Contract DSL uses only a tiny subset of it (only literals, method calls and closures). Also, the DSL is statically typed, to make it programmer-readable without any knowledge of the DSL itself.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Remember that, inside the Groovy contract file, you have to provide the fully qualified name to the Contract class and make static imports, such asorg.springframework.cloud.spec.Contract.make { …​ }. You can also provide an import to the Contract class: import org.springframework.cloud.spec.Contract and then call Contract.make { …​ }. |
| [Tip] |
| Spring Cloud Contract supports defining multiple contracts in a single file. | |

The following is a complete example of a Groovy contract definition:

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'PUT'

url '/api/12'

headers {

header 'Content-Type': 'application/vnd.org.springframework.cloud.contract.verifier.twitter-places-analyzer.v1+json'

}

body '''\

[{

"created\_at": "Sat Jul 26 09:38:57 +0000 2014",

"id": 492967299297845248,

"id\_str": "492967299297845248",

"text": "Gonna see you at Warsaw",

"place":

{

"attributes":{},

"bounding\_box":

{

"coordinates":

[[

[-77.119759,38.791645],

[-76.909393,38.791645],

[-76.909393,38.995548],

[-77.119759,38.995548]

]],

"type":"Polygon"

},

"country":"United States",

"country\_code":"US",

"full\_name":"Washington, DC",

"id":"01fbe706f872cb32",

"name":"Washington",

"place\_type":"city",

"url": "http://api.twitter.com/1/geo/id/01fbe706f872cb32.json"

}

}]

'''

}

response {

status OK()

}

}

The following is a complete example of a YAML contract definition:

description: Some description

name: some name

priority: 8

ignored: true

request:

url: /foo

queryParameters:

a: b

b: c

method: PUT

headers:

foo: bar

fooReq: baz

body:

foo: bar

matchers:

body:

- path: $.foo

type: by\_regex

value: bar

headers:

- key: foo

regex: bar

response:

status: 200

headers:

foo2: bar

foo3: foo33

fooRes: baz

body:

foo2: bar

foo3: baz

matchers:

body:

- path: $.foo2

type: by\_regex

value: bar

- path: $.foo3

type: by\_command

value: executeMe($it)

headers:

- key: foo2

regex: bar

- key: foo3

command: andMeToo($it)

|  |
| --- |
| [Tip] |
| You can compile contracts to stubs mapping using standalone maven command:mvn org.springframework.cloud:spring-cloud-contract-maven-plugin:convert |

## 92.1 Limitations

|  |
| --- |
| [Warning] |
| Spring Cloud Contract Verifier does not properly support XML. Please use JSON or help us implement this feature. |
| [Warning] |
| The support for verifying the size of JSON arrays is experimental. If you want to turn it on, please set the value of the following system property to true:spring.cloud.contract.verifier.assert.size. By default, this feature is set to false. You can also provide the assertJsonSize property in the plugin configuration. | |

|  |
| --- |
| [Warning] |
| Because JSON structure can have any form, it can be impossible to parse it properly when using the Groovy DSL and the value(consumer(…​), producer(…​)) notation in GString. That is why you should use the Groovy Map notation. |

## 92.2 Common Top-Level elements

The following sections describe the most common top-level elements:

* [Section 92.2.1, “Description”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-description)
* [Section 92.2.2, “Name”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-name)
* [Section 92.2.3, “Ignoring Contracts”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-ignoring-contracts)
* [Section 92.2.4, “Passing Values from Files”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-passing-values-from-files)
* [Section 92.2.5, “HTTP Top-Level Elements”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-http-top-level-elements)

### 92.2.1 Description

You can add a description to your contract. The description is arbitrary text. The following code shows an example:

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

description('''

given:

An input

when:

Sth happens

then:

Output

''')

}

**YAML.**

description: Some description

name: some name

priority: 8

ignored: true

request:

url: /foo

queryParameters:

a: b

b: c

method: PUT

headers:

foo: bar

fooReq: baz

body:

foo: bar

matchers:

body:

- path: $.foo

type: by\_regex

value: bar

headers:

- key: foo

regex: bar

response:

status: 200

headers:

foo2: bar

foo3: foo33

fooRes: baz

body:

foo2: bar

foo3: baz

matchers:

body:

- path: $.foo2

type: by\_regex

value: bar

- path: $.foo3

type: by\_command

value: executeMe($it)

headers:

- key: foo2

regex: bar

- key: foo3

command: andMeToo($it)

### 92.2.2 Name

You can provide a name for your contract. Assume that you provided the following name: should register a user. If you do so, the name of the autogenerated test isvalidate\_should\_register\_a\_user. Also, the name of the stub in a WireMock stub is should\_register\_a\_user.json.

|  |  |
| --- | --- |
| [Important] | **Important** |
| You must ensure that the name does not contain any characters that make the generated test not compile. Also, remember that, if you provide the same name for multiple contracts, your autogenerated tests fail to compile and your generated stubs override each other. |

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

name("some\_special\_name")

}

**YAML.**

name: some name

### 92.2.3 Ignoring Contracts

If you want to ignore a contract, you can either set a value of ignored contracts in the plugin configuration or set the ignored property on the contract itself:

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

ignored()

}

**YAML.**

ignored: true

### 92.2.4 Passing Values from Files

Starting with version 1.2.0, you can pass values from files. Assume that you have the following resources in our project.

└── src

    └── **test**

       └── resources

          └── contracts

    ├── readFromFile.groovy

    ├── request.json

    └── response.json

Further assume that your contract is as follows:

**Groovy DSL.**

**import** org.springframework.cloud.contract.spec.Contract

Contract.make {

request {

method('PUT')

headers {

contentType(applicationJson())

}

body(file("request.json"))

url("/1")

}

response {

status OK()

body(file("response.json"))

headers {

contentType(textPlain())

}

}

}

**YAML.**

request:

method: GET

url: /foo

bodyFromFile: request.json

response:

status: 200

bodyFromFile: response.json

Further assume that the JSON files is as follows:

**request.json**

**{** "status" : "REQUEST" **}**

**response.json**

**{** "status" : "RESPONSE" **}**

When test or stub generation takes place, the contents of the file is passed to the body of a request or a response. The name of the file needs to be a file with location relative to the folder in which the contract lays.

### 92.2.5 HTTP Top-Level Elements

The following methods can be called in the top-level closure of a contract definition. request and response are mandatory. priority is optional.

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

*// Definition of HTTP request part of the contract*

*// (this can be a valid request or invalid depending*

*// on type of contract being specified).*

request {

*//...*

}

*// Definition of HTTP response part of the contract*

*// (a service implementing this contract should respond*

*// with following response after receiving request*

*// specified in "request" part above).*

response {

*//...*

}

*// Contract priority, which can be used for overriding*

*// contracts (1 is highest). Priority is optional.*

priority 1

}

**YAML.**

priority: 8

request:

...

response:

...

|  |  |
| --- | --- |
| [Important] | **Important** |
| If you want to make your contract have a **higher** value of priority you need to pass a **lower** number to the priority tag / method. E.g. priority with value 5 has **higher** priority than priority with value 10. |

## 92.3 Request

The HTTP protocol requires only **method and url** to be specified in a request. The same information is mandatory in request definition of the Contract.

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

*// HTTP request method (GET/POST/PUT/DELETE).*

method 'GET'

*// Path component of request URL is specified as follows.*

urlPath('/users')

}

response {

*//...*

}

}

**YAML.**

method: PUT

url: /foo

It is possible to specify an absolute rather than relative url, but using urlPath is the recommended way, as doing so makes the tests **host-independent**.

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'GET'

*// Specifying `url` and `urlPath` in one contract is illegal.*

url('http://localhost:8888/users')

}

response {

*//...*

}

}

**YAML.**

request:

method: PUT

urlPath: /foo

request may contain **query parameters**.

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

*//...*

urlPath('/users') {

*// Each parameter is specified in form*

*// `'paramName' : paramValue` where parameter value*

*// may be a simple literal or one of matcher functions,*

*// all of which are used in this example.*

queryParameters {

*// If a simple literal is used as value*

*// default matcher function is used (equalTo)*

parameter 'limit': 100

*// `equalTo` function simply compares passed value*

*// using identity operator (==).*

parameter 'filter': equalTo("email")

*// `containing` function matches strings*

*// that contains passed substring.*

parameter 'gender': value(consumer(containing("[mf]")), producer('mf'))

*// `matching` function tests parameter*

*// against passed regular expression.*

parameter 'offset': value(consumer(matching("[0-9]+")), producer(123))

*// `notMatching` functions tests if parameter*

*// does not match passed regular expression.*

parameter 'loginStartsWith': value(consumer(notMatching(".{0,2}")), producer(3))

}

}

*//...*

}

response {

*//...*

}

}

**YAML.**

request:

...

queryParameters:

a: b

b: c

headers:

foo: bar

fooReq: baz

body:

foo: bar

matchers:

body:

- path: $.foo

type: by\_regex

value: bar

headers:

- key: foo

regex: bar

response:

status: 200

headers:

foo2: bar

foo3: foo33

fooRes: baz

body:

foo2: bar

foo3: baz

matchers:

body:

- path: $.foo2

type: by\_regex

value: bar

- path: $.foo3

type: by\_command

value: executeMe($it)

headers:

- key: foo2

regex: bar

- key: foo3

command: andMeToo($it)

request may contain additional **request headers**, as shown in the following example:

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

*//...*

*// Each header is added in form `'Header-Name' : 'Header-Value'`.*

*// there are also some helper methods*

headers {

header 'key': 'value'

contentType(applicationJson())

}

*//...*

}

response {

*//...*

}

}

**YAML.**

request:

...

headers:

foo: bar

fooReq: baz

request may contain a **request body**:

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

*//...*

*// Currently only JSON format of request body is supported.*

*// Format will be determined from a header or body's content.*

body '''{ "login" : "john", "name": "John The Contract" }'''

}

response {

*//...*

}

}

**YAML.**

request:

...

body:

foo: bar

request may contain **multipart** elements. To include multipart elements, use the multipart method/section, as shown in the following examples

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract contractDsl = org.springframework.cloud.contract.spec.Contract.make {

request {

method "PUT"

url "/multipart"

headers {

contentType('multipart/form-data;boundary=AaB03x')

}

multipart(

*// key (parameter name), value (parameter value) pair*

formParameter: $(c(regex('".+"')), p('"formParameterValue"')),

someBooleanParameter: $(c(regex(anyBoolean())), p('true')),

*// a named parameter (e.g. with `file` name) that represents file with*

*// `name` and `content`. You can also call `named("fileName", "fileContent")`*

file: named(

*// name of the file*

name: $(c(regex(nonEmpty())), p('filename.csv')),

*// content of the file*

content: $(c(regex(nonEmpty())), p('file content')))

)

}

response {

status OK()

}

}

org.springframework.cloud.contract.spec.Contract contractDsl = org.springframework.cloud.contract.spec.Contract.make {

request {

method "PUT"

url "/multipart"

headers {

contentType('multipart/form-data;boundary=AaB03x')

}

multipart(

file: named(

name: value(stub(regex('.+')), test('file')),

content: value(stub(regex('.+')), test([100, 117, 100, 97] as **byte**[]))

)

)

}

response {

status 200

}

}

**YAML.**

request:

method: PUT

url: /multipart

headers:

Content-Type: multipart/form-data;boundary=AaB03x

multipart:

params:

# key (parameter name), value (parameter value) pair

formParameter: '"formParameterValue"'

someBooleanParameter: true

named:

- paramName: file

fileName: filename.csv

fileContent: file content

matchers:

multipart:

params:

- key: formParameter

regex: ".+"

- key: someBooleanParameter

predefined: any\_boolean

named:

- paramName: file

fileName:

predefined: non\_empty

fileContent:

predefined: non\_empty

response:

status: 200

In the preceding example, we define parameters in either of two ways:

**Groovy DSL**

* Directly, by using the map notation, where the value can be a dynamic property (such as formParameter: $(consumer(…​), producer(…​))).
* By using the named(…​) method that lets you set a named parameter. A named parameter can set a name and content. You can call it either via a method with two arguments, such as named("fileName", "fileContent"), or via a map notation, such as named(name: "fileName", content: "fileContent").

**YAML**

* The multipart parameters are set via multipart.params section
* The named parameters (the fileName and fileContent for a given parameter name) can be set via the multipart.named section. That section contains the paramName (name of the parameter), fileName (name of the file), fileContent (content of the file) fields
* The dynamic bits can be set via the matchers.multipart section
  + for parameters use the params section that can accept regex or a predefined regular expression
  + for named params use the named section where first you define the parameter name via paramName and then you can pass the parametrization of either fileName or fileContent via regex or a predefined regular expression

From this contract, the generated test is as follows:

*// given:*

MockMvcRequestSpecification request = given()

.header("Content-Type", "multipart/form-data;boundary=AaB03x")

.param("formParameter", "\"formParameterValue\"")

.param("someBooleanParameter", "true")

.multiPart("file", "filename.csv", "file content".getBytes());

*// when:*

ResponseOptions response = given().spec(request)

.put("/multipart");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

The WireMock stub is as follows:

'''

**{**

"request" : **{**

"url" : "/multipart"**,**

"method" : "PUT"**,**

"headers" : **{**

"Content-Type" : **{**

"matches" : "multipart/form-data;boundary=AaB03x.\*"

**}**

**},**

"bodyPatterns" : **[** **{**

"matches" : ".\*--(.\*)\\r\\nContent-Disposition: form-data; name=\\"formParameter\\"\\r\\n(Content-Type: .\*\\r\\n)?(Content-Transfer-Encoding: .\*\\r\\n)?(Content-Length: \\\\d+\\r\\n)?\\r\\n\\".+\\"\\r\\n--\\\\1.\*"

**},** **{**

"matches" : ".\*--(.\*)\\r\\nContent-Disposition: form-data; name=\\"someBooleanParameter\\"\\r\\n(Content-Type: .\*\\r\\n)?(Content-Transfer-Encoding: .\*\\r\\n)?(Content-Length: \\\\d+\\r\\n)?\\r\\n(true|false)\\r\\n--\\\\1.\*"

**},** **{**

"matches" : ".\*--(.\*)\\r\\nContent-Disposition: form-data; name=\\"file\\"; filename=\\"[\\\\S\\\\s]+\\"\\r\\n(Content-Type: .\*\\r\\n)?(Content-Transfer-Encoding: .\*\\r\\n)?(Content-Length: \\\\d+\\r\\n)?\\r\\n[\\\\S\\\\s]+\\r\\n--\\\\1.\*"

**}** **]**

**},**

"response" : **{**

"status" : 200**,**

"transformers" : **[** "response-template"**,** "foo-transformer" **]**

**}**

**}**

'''

## 92.4 Response

The response must contain an **HTTP status code** and may contain other information. The following code shows an example:

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

*//...*

}

response {

*// Status code sent by the server*

*// in response to request specified above.*

status OK()

}

}

**YAML.**

response:

...

status: 200

Besides status, the response may contain **headers** and a **body**, both of which are specified the same way as in the request (see the previous paragraph).

|  |
| --- |
| [Tip] |
| Via the Groovy DSL you can reference the org.springframework.cloud.contract.spec.internal.HttpStatus methods to provide a meaningful status instead of a digit. E.g. you can call OK() for a status 200 or BAD\_REQUEST() for 400. |

## 92.5 Dynamic properties

The contract can contain some dynamic properties: timestamps, IDs, and so on. You do not want to force the consumers to stub their clocks to always return the same value of time so that it gets matched by the stub.

For Groovy DSL you can provide the dynamic parts in your contracts in two ways: pass them directly in the body or set them in separate sections called testMatchersand stubMatchers.

For YAML you can only use the matchers section.

### 92.5.1 Dynamic properties inside the body

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is valid only for Groovy DSL. Check out the [Section 92.5.7, “Dynamic Properties in the Matchers Sections”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-matchers) section for YAML examples of a similar feature. |

You can set the properties inside the body either with the value method or, if you use the Groovy map notation, with $(). The following example shows how to set dynamic properties with the value method:

value(consumer(...), producer(...))

value(c(...), p(...))

value(stub(...), test(...))

value(client(...), server(...))

The following example shows how to set dynamic properties with $():

$(consumer(...), producer(...))

$(c(...), p(...))

$(stub(...), test(...))

$(client(...), server(...))

Both approaches work equally well. stub and client methods are aliases over the consumer method. Subsequent sections take a closer look at what you can do with those values.

### 92.5.2 Regular expressions

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is valid only for Groovy DSL. Check out the [Section 92.5.7, “Dynamic Properties in the Matchers Sections”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-matchers) section for YAML examples of a similar feature. |

You can use regular expressions to write your requests in Contract DSL. Doing so is particularly useful when you want to indicate that a given response should be provided for requests that follow a given pattern. Also, you can use regular expressions when you need to use patterns and not exact values both for your test and your server side tests.

The following example shows how to use regular expressions to write a request:

org.springframework.cloud.contract.spec.Contract.make {

request {

method('GET')

url $(consumer(~/\/[0-9]{2}/), producer('/12'))

}

response {

status OK()

body(

id: $(anyNumber()),

surname: $(

consumer('Kowalsky'),

producer(regex('[a-zA-Z]+'))

),

name: 'Jan',

created: $(consumer('2014-02-02 12:23:43'), producer(execute('currentDate(it)'))),

correlationId: value(consumer('5d1f9fef-e0dc-4f3d-a7e4-72d2220dd827'),

producer(regex('[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{12}'))

)

)

headers {

header 'Content-Type': 'text/plain'

}

}

}

You can also provide only one side of the communication with a regular expression. If you do so, then the contract engine automatically provides the generated string that matches the provided regular expression. The following code shows an example:

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'PUT'

url value(consumer(regex('/foo/[0-9]{5}')))

body([

requestElement: $(consumer(regex('[0-9]{5}')))

])

headers {

header('header', $(consumer(regex('application\\/vnd\\.fraud\\.v1\\+json;.\*'))))

}

}

response {

status OK()

body([

responseElement: $(producer(regex('[0-9]{7}')))

])

headers {

contentType("application/vnd.fraud.v1+json")

}

}

}

In the preceding example, the opposite side of the communication has the respective data generated for request and response.

Spring Cloud Contract comes with a series of predefined regular expressions that you can use in your contracts, as shown in the following example:

**protected** **static** **final** Pattern TRUE\_OR\_FALSE = Pattern.compile(/(true|false)/)

**protected** **static** **final** Pattern ONLY\_ALPHA\_UNICODE = Pattern.compile(/[\p{L}]\*/)

**protected** **static** **final** Pattern NUMBER = Pattern.compile('-?(\\d\*\\.\\d+|\\d+)')

**protected** **static** **final** Pattern DOUBLE = Pattern.compile('-?(\\d\*\\.\\d+)')

**protected** **static** **final** Pattern IP\_ADDRESS = Pattern.compile('([01]?\\d\\d?|2[0-4]\\d|25[0-5])\\.([01]?\\d\\d?|2[0-4]\\d|25[0-5])\\.([01]?\\d\\d?|2[0-4]\\d|25[0-5])\\.([01]?\\d\\d?|2[0-4]\\d|25[0-5])')

**protected** **static** **final** Pattern HOSTNAME\_PATTERN = Pattern.compile('((http[s]?|ftp):/)/?([^:/\\s]+)(:[0-9]{1,5})?')

**protected** **static** **final** Pattern EMAIL = Pattern.compile('[a-zA-Z0-9.\_%+-]+@[a-zA-Z0-9.-]+\\.[a-zA-Z]{2,6}')

**protected** **static** **final** Pattern URL = UrlHelper.URL

**protected** **static** **final** Pattern UUID = Pattern.compile('[a-f0-9]{8}-[a-f0-9]{4}-[a-f0-9]{4}-[a-f0-9]{4}-[a-f0-9]{12}')

**protected** **static** **final** Pattern ANY\_DATE = Pattern.compile('(\\d\\d\\d\\d)-(0[1-9]|1[012])-(0[1-9]|[12][0-9]|3[01])')

**protected** **static** **final** Pattern ANY\_DATE\_TIME = Pattern.compile('([0-9]{4})-(1[0-2]|0[1-9])-(3[01]|0[1-9]|[12][0-9])T(2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9])')

**protected** **static** **final** Pattern ANY\_TIME = Pattern.compile('(2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9])')

**protected** **static** **final** Pattern NON\_EMPTY = Pattern.compile(/[\S\s]+/)

**protected** **static** **final** Pattern NON\_BLANK = Pattern.compile(/^\s\*\S[\S\s]\*/)

**protected** **static** **final** Pattern ISO8601\_WITH\_OFFSET = Pattern.compile(/([0-9]{4})-(1[0-2]|0[1-9])-(3[01]|0[1-9]|[12][0-9])T(2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9])(\.\d{3})?(Z|[+-][01]\d:[0-5]\d)/)

**protected** **static** Pattern anyOf(String... values){

**return** Pattern.compile(values.collect({"^$it\$"}).join("|"))

}

Pattern onlyAlphaUnicode() {

**return** ONLY\_ALPHA\_UNICODE

}

Pattern number() {

**return** NUMBER

}

Pattern anyBoolean() {

**return** TRUE\_OR\_FALSE

}

Pattern aDouble() {

**return** DOUBLE

}

Pattern ipAddress() {

**return** IP\_ADDRESS

}

Pattern hostname() {

**return** HOSTNAME\_PATTERN

}

Pattern email() {

**return** EMAIL

}

Pattern url() {

**return** URL

}

Pattern uuid(){

**return** UUID

}

Pattern isoDate() {

**return** ANY\_DATE

}

Pattern isoDateTime() {

**return** ANY\_DATE\_TIME

}

Pattern isoTime() {

**return** ANY\_TIME

}

Pattern iso8601WithOffset() {

**return** ISO8601\_WITH\_OFFSET

}

Pattern nonEmpty() {

**return** NON\_EMPTY

}

Pattern nonBlank() {

**return** NON\_BLANK

}

In your contract, you can use it as shown in the following example:

Contract dslWithOptionalsInString = Contract.make {

priority 1

request {

method POST()

url '/users/password'

headers {

contentType(applicationJson())

}

body(

email: $(consumer(optional(regex(email()))), producer('abc@abc.com')),

callback\_url: $(consumer(regex(hostname())), producer('http://partners.com'))

)

}

response {

status 404

headers {

contentType(applicationJson())

}

body(

code: value(consumer("123123"), producer(optional("123123"))),

message: "User not found by email = [${value(producer(regex(email())), consumer('not.existing@user.com'))}]"

)

}

}

### 92.5.3 Passing Optional Parameters

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is valid only for Groovy DSL. Check out the [Section 92.5.7, “Dynamic Properties in the Matchers Sections”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-matchers) section for YAML examples of a similar feature. |

It is possible to provide optional parameters in your contract. However, you can provide optional parameters only for the following:

* STUB side of the Request
* TEST side of the Response

The following example shows how to provide optional parameters:

org.springframework.cloud.contract.spec.Contract.make {

priority 1

request {

method 'POST'

url '/users/password'

headers {

contentType(applicationJson())

}

body(

email: $(consumer(optional(regex(email()))), producer('abc@abc.com')),

callback\_url: $(consumer(regex(hostname())), producer('http://partners.com'))

)

}

response {

status 404

headers {

header 'Content-Type': 'application/json'

}

body(

code: value(consumer("123123"), producer(optional("123123")))

)

}

}

By wrapping a part of the body with the optional() method, you create a regular expression that must be present 0 or more times.

If you use Spock for, the following test would be generated from the previous example:

"""

given:

def request = given()

.header("Content-Type", "application/json")

.body('''{"email":"abc@abc.com","callback\_url":"http://partners.com"}''')

when:

def response = given().spec(request)

.post("/users/password")

then:

response.statusCode == 404

response.header('Content-Type') == 'application/json'

and:

DocumentContext parsedJson = JsonPath.parse(response.body.asString())

assertThatJson(parsedJson).field("['code']").matches("(123123)?")

"""

The following stub would also be generated:

'''

{

"request" : {

"url" : "/users/password",

"method" : "POST",

"bodyPatterns" : [ {

"matchesJsonPath" : "$[?(@.['email'] =~ /([a-zA-Z0-9.\_%+-]+@[a-zA-Z0-9.-]+\\\\.[a-zA-Z]{2,6})?/)]"

}, {

"matchesJsonPath" : "$[?(@.['callback\_url'] =~ /((http[s]?|ftp):\\\\/)\\\\/?([^:\\\\/\\\\s]+)(:[0-9]{1,5})?/)]"

} ],

"headers" : {

"Content-Type" : {

"equalTo" : "application/json"

}

}

},

"response" : {

"status" : 404,

"body" : "{\\"code\\":\\"123123\\",\\"message\\":\\"User not found by email == [not.existing*@user.com]\\"}",*

"headers" : {

"Content-Type" : "application/json"

}

},

"priority" : 1

}

'''

### 92.5.4 Executing Custom Methods on the Server Side

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is valid only for Groovy DSL. Check out the [Section 92.5.7, “Dynamic Properties in the Matchers Sections”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-matchers) section for YAML examples of a similar feature. |

You can define a method call that executes on the server side during the test. Such a method can be added to the class defined as "baseClassForTests" in the configuration. The following code shows an example of the contract portion of the test case:

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'PUT'

url $(consumer(regex('^/api/[0-9]{2}$')), producer('/api/12'))

headers {

header 'Content-Type': 'application/json'

}

body '''\

[{

"text": "Gonna see you at Warsaw"

}]

'''

}

response {

body (

path: $(consumer('/api/12'), producer(regex('^/api/[0-9]{2}$'))),

correlationId: $(consumer('1223456'), producer(execute('isProperCorrelationId($it)')))

)

status OK()

}

}

The following code shows the base class portion of the test case:

**abstract** **class** BaseMockMvcSpec **extends** Specification {

def setup() {

RestAssuredMockMvc.standaloneSetup(**new** PairIdController())

}

**void** isProperCorrelationId(Integer correlationId) {

assert correlationId == 123456

}

**void** isEmpty(String value) {

assert value == null

}

}

|  |  |
| --- | --- |
| [Important] | **Important** |
| You cannot use both a String and execute to perform concatenation. For example, calling header('Authorization', 'Bearer ' + execute('authToken()')) leads to improper results. Instead, call header('Authorization', execute('authToken()')) and ensure that the authToken() method returns everything you need. |

The type of the object read from the JSON can be one of the following, depending on the JSON path:

* String: If you point to a String value in the JSON.
* JSONArray: If you point to a List in the JSON.
* Map: If you point to a Map in the JSON.
* Number: If you point to Integer, Double etc. in the JSON.
* Boolean: If you point to a Boolean in the JSON.

In the request part of the contract, you can specify that the body should be taken from a method.

|  |  |
| --- | --- |
| [Important] | **Important** |
| You must provide both the consumer and the producer side. The execute part is applied for the whole body - not for parts of it. |

The following example shows how to read an object from JSON:

Contract contractDsl = Contract.make {

request {

method 'GET'

url '/something'

body(

$(c("foo"), p(execute("hashCode()")))

)

}

response {

status OK()

}

}

The preceding example results in calling the hashCode() method in the request body. It should resemble the following code:

*// given:*

MockMvcRequestSpecification request = given()

.body(hashCode());

*// when:*

ResponseOptions response = given().spec(request)

.get("/something");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

### 92.5.5 Referencing the Request from the Response

The best situation is to provide fixed values, but sometimes you need to reference a request in your response.

If you’re writing contracts using Groovy DSL, you can use the fromRequest() method, which lets you reference a bunch of elements from the HTTP request. You can use the following options:

* fromRequest().url(): Returns the request URL and query parameters.
* fromRequest().query(String key): Returns the first query parameter with a given name.
* fromRequest().query(String key, int index): Returns the nth query parameter with a given name.
* fromRequest().path(): Returns the full path.
* fromRequest().path(int index): Returns the nth path element.
* fromRequest().header(String key): Returns the first header with a given name.
* fromRequest().header(String key, int index): Returns the nth header with a given name.
* fromRequest().body(): Returns the full request body.
* fromRequest().body(String jsonPath): Returns the element from the request that matches the JSON Path.

If you’re using the YAML contract definition you have to use the [Handlebars](http://handlebarsjs.com/) {{{ }}} notation with custom, Spring Cloud Contract functions to achieve this.

* {{{ request.url }}}: Returns the request URL and query parameters.
* {{{ request.query.key.[index] }}}: Returns the nth query parameter with a given name. E.g. for key foo, first entry {{{ request.query.foo.[0] }}}
* {{{ request.path }}}: Returns the full path.
* {{{ request.path.[index] }}}: Returns the nth path element. E.g. for first entry `{{{ request.path.[0] }}}
* {{{ request.headers.key }}}: Returns the first header with a given name.
* {{{ request.headers.key.[index] }}}: Returns the nth header with a given name.
* {{{ request.body }}}: Returns the full request body.
* {{{ jsonpath this 'your.json.path' }}}: Returns the element from the request that matches the JSON Path. E.g. for json path $.foo - {{{ jsonpath this '$.foo' }}}

Consider the following contract:

**Groovy DSL.**

Contract contractDsl = Contract.make {

request {

method 'GET'

url('/api/v1/xxxx') {

queryParameters {

parameter("foo", "bar")

parameter("foo", "bar2")

}

}

headers {

header(authorization(), "secret")

header(authorization(), "secret2")

}

body(foo: "bar", baz: 5)

}

response {

status OK()

headers {

header(authorization(), "foo ${fromRequest().header(authorization())} bar")

}

body(

url: fromRequest().url(),

path: fromRequest().path(),

pathIndex: fromRequest().path(1),

param: fromRequest().query("foo"),

paramIndex: fromRequest().query("foo", 1),

authorization: fromRequest().header("Authorization"),

authorization2: fromRequest().header("Authorization", 1),

fullBody: fromRequest().body(),

responseFoo: fromRequest().body('$.foo'),

responseBaz: fromRequest().body('$.baz'),

responseBaz2: "Bla bla ${fromRequest().body('$.foo')} bla bla"

)

}

}

**YAML.**

request:

method: GET

url: /api/v1/xxxx

queryParameters:

foo:

- bar

- bar2

headers:

Authorization:

- secret

- secret2

body:

foo: bar

baz: 5

response:

status: 200

headers:

Authorization: "foo {{{ request.headers.Authorization.0 }}} bar"

body:

url: "{{{ request.url }}}"

path: "{{{ request.path }}}"

pathIndex: "{{{ request.path.1 }}}"

param: "{{{ request.query.foo }}}"

paramIndex: "{{{ request.query.foo.1 }}}"

authorization: "{{{ request.headers.Authorization.0 }}}"

authorization2: "{{{ request.headers.Authorization.1 }}"

fullBody: "{{{ request.body }}}"

responseFoo: "{{{ jsonpath this '$.foo' }}}"

responseBaz: "{{{ jsonpath this '$.baz' }}}"

responseBaz2: "Bla bla {{{ jsonpath this '$.foo' }}} bla bla"

Running a JUnit test generation leads to a test that resembles the following example:

*// given:*

MockMvcRequestSpecification request = given()

.header("Authorization", "secret")

.header("Authorization", "secret2")

.body("{\"foo\":\"bar\",\"baz\":5}");

*// when:*

ResponseOptions response = given().spec(request)

.queryParam("foo","bar")

.queryParam("foo","bar2")

.get("/api/v1/xxxx");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

assertThat(response.header("Authorization")).isEqualTo("foo secret bar");

*// and:*

DocumentContext parsedJson = JsonPath.parse(response.getBody().asString());

assertThatJson(parsedJson).field("['fullBody']").isEqualTo("{\"foo\":\"bar\",\"baz\":5}");

assertThatJson(parsedJson).field("['authorization']").isEqualTo("secret");

assertThatJson(parsedJson).field("['authorization2']").isEqualTo("secret2");

assertThatJson(parsedJson).field("['path']").isEqualTo("/api/v1/xxxx");

assertThatJson(parsedJson).field("['param']").isEqualTo("bar");

assertThatJson(parsedJson).field("['paramIndex']").isEqualTo("bar2");

assertThatJson(parsedJson).field("['pathIndex']").isEqualTo("v1");

assertThatJson(parsedJson).field("['responseBaz']").isEqualTo(5);

assertThatJson(parsedJson).field("['responseFoo']").isEqualTo("bar");

assertThatJson(parsedJson).field("['url']").isEqualTo("/api/v1/xxxx?foo=bar&foo=bar2");

assertThatJson(parsedJson).field("['responseBaz2']").isEqualTo("Bla bla bar bla bla");

As you can see, elements from the request have been properly referenced in the response.

The generated WireMock stub should resemble the following example:

**{**

"request" : **{**

"urlPath" : "/api/v1/xxxx"**,**

"method" : "POST"**,**

"headers" : **{**

"Authorization" : **{**

"equalTo" : "secret2"

**}**

**},**

"queryParameters" : **{**

"foo" : **{**

"equalTo" : "bar2"

**}**

**},**

"bodyPatterns" : **[** **{**

"matchesJsonPath" : "$[?(@.['baz'] == 5)]"

**},** **{**

"matchesJsonPath" : "$[?(@.['foo'] == 'bar')]"

**}** **]**

**},**

"response" : **{**

"status" : 200**,**

"body" : "{\"authorization\":\"{{{request.headers.Authorization.[0]}}}\",\"path\":\"{{{request.path}}}\",\"responseBaz\":{{{jsonpath this '$.baz'}}} ,\"param\":\"{{{request.query.foo.[0]}}}\",\"pathIndex\":\"{{{request.path.[1]}}}\",\"responseBaz2\":\"Bla bla {{{jsonpath this '$.foo'}}} bla bla\",\"responseFoo\":\"{{{jsonpath this '$.foo'}}}\",\"authorization2\":\"{{{request.headers.Authorization.[1]}}}\",\"fullBody\":\"{{{escapejsonbody}}}\",\"url\":\"{{{request.url}}}\",\"paramIndex\":\"{{{request.query.foo.[1]}}}\"}"**,**

"headers" : **{**

"Authorization" : "{{{request.headers.Authorization.[0]}}};foo"

**},**

"transformers" : **[** "response-template" **]**

**}**

**}**

Sending a request such as the one presented in the request part of the contract results in sending the following response body:

**{**

"url" : "/api/v1/xxxx?foo=bar&foo=bar2"**,**

"path" : "/api/v1/xxxx"**,**

"pathIndex" : "v1"**,**

"param" : "bar"**,**

"paramIndex" : "bar2"**,**

"authorization" : "secret"**,**

"authorization2" : "secret2"**,**

"fullBody" : "{\"foo\":\"bar\",\"baz\":5}"**,**

"responseFoo" : "bar"**,**

"responseBaz" : 5**,**

"responseBaz2" : "Bla bla bar bla bla"

**}**

|  |  |
| --- | --- |
| [Important] | **Important** |
| This feature works only with WireMock having a version greater than or equal to 2.5.1. The Spring Cloud Contract Verifier uses WireMock’sresponse-template response transformer. It uses Handlebars to convert the Mustache {{{ }}} templates into proper values. Additionally, it registers two helper functions: |

* escapejsonbody: Escapes the request body in a format that can be embedded in a JSON.
* jsonpath: For a given parameter, find an object in the request body.

### 92.5.6 Registering Your Own WireMock Extension

WireMock lets you register custom extensions. By default, Spring Cloud Contract registers the transformer, which lets you reference a request from a response. If you want to provide your own extensions, you can register an implementation of theorg.springframework.cloud.contract.verifier.dsl.wiremock.WireMockExtensions interface. Since we use the spring.factories extension approach, you can create an entry in META-INF/spring.factories file similar to the following:

org.springframework.cloud.contract.verifier.dsl.wiremock.WireMockExtensions=\

org.springframework.cloud.contract.stubrunner.provider.wiremock.TestWireMockExtensions

The following is an example of a custom extension:

**TestWireMockExtensions.groovy.**

**package** org.springframework.cloud.contract.verifier.dsl.wiremock

**import** com.github.tomakehurst.wiremock.extension.Extension

**/\*\***

**\* Extension that registers the default transformer and the custom one**

**\*/**

**class** TestWireMockExtensions **implements** WireMockExtensions {

*@Override*

List<Extension> extensions() {

**return** [

**new** DefaultResponseTransformer(),

**new** CustomExtension()

]

}

}

**class** CustomExtension **implements** Extension {

*@Override*

String getName() {

**return** "foo-transformer"

}

}

|  |  |
| --- | --- |
| [Important] | **Important** |
| Remember to override the applyGlobally() method and set it to false if you want the transformation to be applied only for a mapping that explicitly requires it. |

### 92.5.7 Dynamic Properties in the Matchers Sections

If you work with [Pact](https://docs.pact.io/), the following discussion may seem familiar. Quite a few users are used to having a separation between the body and setting the dynamic parts of a contract.

You can use two separate sections:

* stubMatchers, which lets you define the dynamic values that should end up in a stub. You can set it in the request or inputMessage part of your contract.
* testMatchers, which is present in the response or outputMessage side of the contract.

Currently, Spring Cloud Contract Verifier supports only JSON Path-based matchers with the following matching possibilities:

**Groovy DSL**

* For stubMatchers:
  + byEquality(): The value taken from the response via the provided JSON Path must be equal to the value provided in the contract.
  + byRegex(…​): The value taken from the response via the provided JSON Path must match the regex.
  + byDate(): The value taken from the response via the provided JSON Path must match the regex for an ISO Date value.
  + byTimestamp(): The value taken from the response via the provided JSON Path must match the regex for an ISO DateTime value.
  + byTime(): The value taken from the response via the provided JSON Path must match the regex for an ISO Time value.
* For testMatchers:
  + byEquality(): The value taken from the response via the provided JSON Path must be equal to the provided value in the contract.
  + byRegex(…​): The value taken from the response via the provided JSON Path must match the regex.
  + byDate(): The value taken from the response via the provided JSON Path must match the regex for an ISO Date value.
  + byTimestamp(): The value taken from the response via the provided JSON Path must match the regex for an ISO DateTime value.
  + byTime(): The value taken from the response via the provided JSON Path must match the regex for an ISO Time value.
  + byType(): The value taken from the response via the provided JSON Path needs to be of the same type as the type defined in the body of the response in the contract. byType can take a closure, in which you can set minOccurrence and maxOccurrence. That way, you can assert the size of the flattened collection. To check the size of an unflattened collection, use a custom method with the byCommand(…​) testMatcher.
  + byCommand(…​): The value taken from the response via the provided JSON Path is passed as an input to the custom method that you provide. For example,byCommand('foo($it)') results in calling a foo method to which the value matching the JSON Path gets passed. The type of the object read from the JSON can be one of the following, depending on the JSON path:
    - String: If you point to a String value.
    - JSONArray: If you point to a List.
    - Map: If you point to a Map.
    - Number: If you point to Integer, Double, or other kind of number.
    - Boolean: If you point to a Boolean.

**YAML.**Please read the Groovy section for detailed explanation of what the types mean

For YAML the structure of a matcher looks like this

- path: $.foo

type: by\_regex

value: bar

Or if you want to use one of the predefined regular expressions[only\_alpha\_unicode, number, any\_boolean, ip\_address, hostname, email, url, uuid, iso\_date, iso\_date\_time, iso\_time, iso\_8601\_with\_offset, non\_empty, non\_blank]:

- path: $.foo

type: by\_regex

predefined: only\_alpha\_unicode

Below you can find the allowed list of `type`s.

* For stubMatchers:
  + by\_equality
  + by\_regex
  + by\_date
  + by\_timestamp
  + by\_time
* For testMatchers:
  + by\_equality
  + by\_regex
  + by\_date
  + by\_timestamp
  + by\_time
  + by\_type
    - there are 2 additional fields accepted: minOccurrence and maxOccurrence.
  + by\_command

Consider the following example:

**Groovy DSL.**

Contract contractDsl = Contract.make {

request {

method 'GET'

urlPath '/get'

body([

duck: 123,

alpha: "abc",

number: 123,

aBoolean: true,

date: "2017-01-01",

dateTime: "2017-01-01T01:23:45",

time: "01:02:34",

valueWithoutAMatcher: "foo",

valueWithTypeMatch: "string",

key: [

'complex.key' : 'foo'

]

])

stubMatchers {

jsonPath('$.duck', byRegex("[0-9]{3}"))

jsonPath('$.duck', byEquality())

jsonPath('$.alpha', byRegex(onlyAlphaUnicode()))

jsonPath('$.alpha', byEquality())

jsonPath('$.number', byRegex(number()))

jsonPath('$.aBoolean', byRegex(anyBoolean()))

jsonPath('$.date', byDate())

jsonPath('$.dateTime', byTimestamp())

jsonPath('$.time', byTime())

jsonPath("\$.['key'].['complex.key']", byEquality())

}

headers {

contentType(applicationJson())

}

}

response {

status OK()

body([

duck: 123,

alpha: "abc",

number: 123,

aBoolean: true,

date: "2017-01-01",

dateTime: "2017-01-01T01:23:45",

time: "01:02:34",

valueWithoutAMatcher: "foo",

valueWithTypeMatch: "string",

valueWithMin: [

1,2,3

],

valueWithMax: [

1,2,3

],

valueWithMinMax: [

1,2,3

],

valueWithMinEmpty: [],

valueWithMaxEmpty: [],

key: [

'complex.key' : 'foo'

]

])

testMatchers {

*// asserts the jsonpath value against manual regex*

jsonPath('$.duck', byRegex("[0-9]{3}"))

*// asserts the jsonpath value against the provided value*

jsonPath('$.duck', byEquality())

*// asserts the jsonpath value against some default regex*

jsonPath('$.alpha', byRegex(onlyAlphaUnicode()))

jsonPath('$.alpha', byEquality())

jsonPath('$.number', byRegex(number()))

jsonPath('$.aBoolean', byRegex(anyBoolean()))

*// asserts vs inbuilt time related regex*

jsonPath('$.date', byDate())

jsonPath('$.dateTime', byTimestamp())

jsonPath('$.time', byTime())

*// asserts that the resulting type is the same as in response body*

jsonPath('$.valueWithTypeMatch', byType())

jsonPath('$.valueWithMin', byType {

*// results in verification of size of array (min 1)*

minOccurrence(1)

})

jsonPath('$.valueWithMax', byType {

*// results in verification of size of array (max 3)*

maxOccurrence(3)

})

jsonPath('$.valueWithMinMax', byType {

*// results in verification of size of array (min 1 & max 3)*

minOccurrence(1)

maxOccurrence(3)

})

jsonPath('$.valueWithMinEmpty', byType {

*// results in verification of size of array (min 0)*

minOccurrence(0)

})

jsonPath('$.valueWithMaxEmpty', byType {

*// results in verification of size of array (max 0)*

maxOccurrence(0)

})

*// will execute a method `assertThatValueIsANumber`*

jsonPath('$.duck', byCommand('assertThatValueIsANumber($it)'))

jsonPath("\$.['key'].['complex.key']", byEquality())

}

headers {

contentType(applicationJson())

}

}

}

**YAML.**

request:

method: GET

urlPath: /get

body:

duck: 123

alpha: "abc"

number: 123

aBoolean: true

date: "2017-01-01"

dateTime: "2017-01-01T01:23:45"

time: "01:02:34"

valueWithoutAMatcher: "foo"

valueWithTypeMatch: "string"

key:

"complex.key": 'foo'

matchers:

headers:

- key: Content-Type

regex: "application/json.\*"

body:

- path: $.duck

type: by\_regex

value: "[0-9]{3}"

- path: $.duck

type: by\_equality

- path: $.alpha

type: by\_regex

predefined: only\_alpha\_unicode

- path: $.alpha

type: by\_equality

- path: $.number

type: by\_regex

predefined: number

- path: $.aBoolean

type: by\_regex

predefined: any\_boolean

- path: $.date

type: by\_date

- path: $.dateTime

type: by\_timestamp

- path: $.time

type: by\_time

- path: "$.['key'].['complex.key']"

type: by\_equality

headers:

Content-Type: application/json

response:

status: 200

body:

duck: 123

alpha: "abc"

number: 123

aBoolean: true

date: "2017-01-01"

dateTime: "2017-01-01T01:23:45"

time: "01:02:34"

valueWithoutAMatcher: "foo"

valueWithTypeMatch: "string"

valueWithMin:

- 1

- 2

- 3

valueWithMax:

- 1

- 2

- 3

valueWithMinMax:

- 1

- 2

- 3

valueWithMinEmpty: []

valueWithMaxEmpty: []

key:

'complex.key' : 'foo'

matchers:

headers:

- key: Content-Type

regex: "application/json.\*"

body:

- path: $.duck

type: by\_regex

value: "[0-9]{3}"

- path: $.duck

type: by\_equality

- path: $.alpha

type: by\_regex

predefined: only\_alpha\_unicode

- path: $.alpha

type: by\_equality

- path: $.number

type: by\_regex

predefined: number

- path: $.aBoolean

type: by\_regex

predefined: any\_boolean

- path: $.date

type: by\_date

- path: $.dateTime

type: by\_timestamp

- path: $.time

type: by\_time

- path: $.valueWithTypeMatch

type: by\_type

- path: $.valueWithMin

type: by\_type

minOccurrence: 1

- path: $.valueWithMax

type: by\_type

maxOccurrence: 3

- path: $.valueWithMinMax

type: by\_type

minOccurrence: 1

maxOccurrence: 3

- path: $.valueWithMinEmpty

type: by\_type

minOccurrence: 0

- path: $.valueWithMaxEmpty

type: by\_type

maxOccurrence: 0

- path: $.duck

type: by\_command

value: assertThatValueIsANumber($it)

headers:

Content-Type: application/json

In the preceding example, you can see the dynamic portions of the contract in the matchers sections. For the request part, you can see that, for all fields butvalueWithoutAMatcher, the values of the regular expressions that the stub should contain are explicitly set. For the valueWithoutAMatcher, the verification takes place in the same way as without the use of matchers. In that case, the test performs an equality check.

For the response side in the testMatchers section, we define the dynamic parts in a similar manner. The only difference is that the byType matchers are also present. The verifier engine checks four fields to verify whether the response from the test has a value for which the JSON path matches the given field, is of the same type as the one defined in the response body, and passes the following check (based on the method being called):

* For $.valueWithTypeMatch, the engine checks whether the type is the same.
* For $.valueWithMin, the engine check the type and asserts whether the size is greater than or equal to the minimum occurrence.
* For $.valueWithMax, the engine checks the type and asserts whether the size is smaller than or equal to the maximum occurrence.
* For $.valueWithMinMax, the engine checks the type and asserts whether the size is between the min and maximum occurrence.

The resulting test would resemble the following example (note that an and section separates the autogenerated assertions and the assertion from matchers):

*// given:*

MockMvcRequestSpecification request = given()

.header("Content-Type", "application/json")

.body("{\"duck\":123,\"alpha\":\"abc\",\"number\":123,\"aBoolean\":true,\"date\":\"2017-01-01\",\"dateTime\":\"2017-01-01T01:23:45\",\"time\":\"01:02:34\",\"valueWithoutAMatcher\":\"foo\",\"valueWithTypeMatch\":\"string\"}");

*// when:*

ResponseOptions response = given().spec(request)

.get("/get");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

assertThat(response.header("Content-Type")).matches("application/json.\*");

*// and:*

DocumentContext parsedJson = JsonPath.parse(response.getBody().asString());

assertThatJson(parsedJson).field("valueWithoutAMatcher").isEqualTo("foo");

*// and:*

assertThat(parsedJson.read("$.duck", String.**class**)).matches("[0-9]{3}");

assertThat(parsedJson.read("$.duck", Integer.**class**)).isEqualTo(123);

assertThat(parsedJson.read("$.alpha", String.**class**)).matches("[\\p{L}]\*");

assertThat(parsedJson.read("$.alpha", String.**class**)).isEqualTo("abc");

assertThat(parsedJson.read("$.number", String.**class**)).matches("-?\\d\*(\\.\\d+)?");

assertThat(parsedJson.read("$.aBoolean", String.**class**)).matches("(true|false)");

assertThat(parsedJson.read("$.date", String.**class**)).matches("(\\d\\d\\d\\d)-(0[1-9]|1[012])-(0[1-9]|[12][0-9]|3[01])");

assertThat(parsedJson.read("$.dateTime", String.**class**)).matches("([0-9]{4})-(1[0-2]|0[1-9])-(3[01]|0[1-9]|[12][0-9])T(2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9])");

assertThat(parsedJson.read("$.time", String.**class**)).matches("(2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9])");

assertThat((Object) parsedJson.read("$.valueWithTypeMatch")).isInstanceOf(java.lang.String.**class**);

assertThat((Object) parsedJson.read("$.valueWithMin")).isInstanceOf(java.util.List.**class**);

assertThat((java.lang.Iterable) parsedJson.read("$.valueWithMin", java.util.Collection.**class**)).hasSizeGreaterThanOrEqualTo(1);

assertThat((Object) parsedJson.read("$.valueWithMax")).isInstanceOf(java.util.List.**class**);

assertThat((java.lang.Iterable) parsedJson.read("$.valueWithMax", java.util.Collection.**class**)).hasSizeLessThanOrEqualTo(3);

assertThat((Object) parsedJson.read("$.valueWithMinMax")).isInstanceOf(java.util.List.**class**);

assertThat((java.lang.Iterable) parsedJson.read("$.valueWithMinMax", java.util.Collection.**class**)).hasSizeBetween(1, 3);

assertThat((Object) parsedJson.read("$.valueWithMinEmpty")).isInstanceOf(java.util.List.**class**);

assertThat((java.lang.Iterable) parsedJson.read("$.valueWithMinEmpty", java.util.Collection.**class**)).hasSizeGreaterThanOrEqualTo(0);

assertThat((Object) parsedJson.read("$.valueWithMaxEmpty")).isInstanceOf(java.util.List.**class**);

assertThat((java.lang.Iterable) parsedJson.read("$.valueWithMaxEmpty", java.util.Collection.**class**)).hasSizeLessThanOrEqualTo(0);

assertThatValueIsANumber(parsedJson.read("$.duck"));

|  |  |
| --- | --- |
| [Important] | **Important** |
| Notice that, for the byCommand method, the example calls the assertThatValueIsANumber. This method must be defined in the test base class or be statically imported to your tests. Notice that the byCommand call was converted to assertThatValueIsANumber(parsedJson.read("$.duck"));. That means that the engine took the method name and passed the proper JSON path as a parameter to it. |

The resulting WireMock stub is in the following example:

'''

**{**

"request" : **{**

"urlPath" : "/get"**,**

"method" : "POST"**,**

"headers" : **{**

"Content-Type" : **{**

"matches" : "application/json.\*"

**}**

**},**

"bodyPatterns" : **[** **{**

"matchesJsonPath" : "$[?(@.['valueWithoutAMatcher'] == 'foo')]"

**},** **{**

"matchesJsonPath" : "$[?(@.['valueWithTypeMatch'] == 'string')]"

**},** **{**

"matchesJsonPath" : "$.['list'].['some'].['nested'][?(@.['anothervalue'] == 4)]"

**},** **{**

"matchesJsonPath" : "$.['list'].['someother'].['nested'][?(@.['anothervalue'] == 4)]"

**},** **{**

"matchesJsonPath" : "$.['list'].['someother'].['nested'][?(@.['json'] == 'with value')]"

**},** **{**

"matchesJsonPath" : "$[?(@.duck =~ /([0-9]{3})/)]"

**},** **{**

"matchesJsonPath" : "$[?(@.duck == 123)]"

**},** **{**

"matchesJsonPath" : "$[?(@.alpha =~ /([\\\\p{L}]\*)/)]"

**},** **{**

"matchesJsonPath" : "$[?(@.alpha == 'abc')]"

**},** **{**

"matchesJsonPath" : "$[?(@.number =~ /(-?(\\\\d\*\\\\.\\\\d+|\\\\d+))/)]"

**},** **{**

"matchesJsonPath" : "$[?(@.aBoolean =~ /((true|false))/)]"

**},** **{**

"matchesJsonPath" : "$[?(@.date =~ /((\\\\d\\\\d\\\\d\\\\d)-(0[1-9]|1[012])-(0[1-9]|[12][0-9]|3[01]))/)]"

**},** **{**

"matchesJsonPath" : "$[?(@.dateTime =~ /(([0-9]{4})-(1[0-2]|0[1-9])-(3[01]|0[1-9]|[12][0-9])T(2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9]))/)]"

**},** **{**

"matchesJsonPath" : "$[?(@.time =~ /((2[0-3]|[01][0-9]):([0-5][0-9]):([0-5][0-9]))/)]"

**},** **{**

"matchesJsonPath" : "$.list.some.nested[?(@.json =~ /(.\*)/)]"

**}** **]**

**},**

"response" : **{**

"status" : 200**,**

"body" : "{\\"date\\":\\"2017-01-01\\",\\"dateTime\\":\\"2017-01-01T01:23:45\\",\\"number\\":123,\\"aBoolean\\":true,\\"duck\\":123,\\"alpha\\":\\"abc\\",\\"valueWithMin\\":[1,2,3],\\"time\\":\\"01:02:34\\",\\"valueWithTypeMatch\\":\\"string\\",\\"valueWithMax\\":[1,2,3],\\"valueWithMinMax\\":[1,2,3],\\"valueWithoutAMatcher\\":\\"foo\\"}"**,**

"headers" : **{**

"Content-Type" : "application/json"

**}**

**}**

**}**

'''

|  |  |
| --- | --- |
| [Important] | **Important** |
| If you use a matcher, then the part of the request aned response that the matcher addresses with the JSON Path gets removed from the assertion. In the case of verifying a collection, you must create matchers for **all** the elements of the collection. |

Consider the following example:

Contract.make {

request {

method 'GET'

url("/foo")

}

response {

status OK()

body(events: [[

operation : 'EXPORT',

eventId : '16f1ed75-0bcc-4f0d-a04d-3121798faf99',

status : 'OK'

], [

operation : 'INPUT\_PROCESSING',

eventId : '3bb4ac82-6652-462f-b6d1-75e424a0024a',

status : 'OK'

]

]

)

testMatchers {

jsonPath('$.events[0].operation', byRegex('.+'))

jsonPath('$.events[0].eventId', byRegex('^([a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{12})$'))

jsonPath('$.events[0].status', byRegex('.+'))

}

}

}

The preceding code leads to creating the following test (the code block shows only the assertion section):

and:

DocumentContext parsedJson = JsonPath.parse(response.body.asString())

assertThatJson(parsedJson).array("['events']").contains("['eventId']").isEqualTo("16f1ed75-0bcc-4f0d-a04d-3121798faf99")

assertThatJson(parsedJson).array("['events']").contains("['operation']").isEqualTo("EXPORT")

assertThatJson(parsedJson).array("['events']").contains("['operation']").isEqualTo("INPUT\_PROCESSING")

assertThatJson(parsedJson).array("['events']").contains("['eventId']").isEqualTo("3bb4ac82-6652-462f-b6d1-75e424a0024a")

assertThatJson(parsedJson).array("['events']").contains("['status']").isEqualTo("OK")

and:

assertThat(parsedJson.read("\$.events[0].operation", String.**class**)).matches(".+")

assertThat(parsedJson.read("\$.events[0].eventId", String.**class**)).matches("^([a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{12})\$")

assertThat(parsedJson.read("\$.events[0].status", String.**class**)).matches(".+")

As you can see, the assertion is malformed. Only the first element of the array got asserted. In order to fix this, you should apply the assertion to the whole $.eventscollection and assert it with the byCommand(…​) method.

## 92.6 JAX-RS Support

The Spring Cloud Contract Verifier supports the JAX-RS 2 Client API. The base class needs to define protected WebTarget webTarget and server initialization. The only option for testing JAX-RS API is to start a web server. Also, a request with a body needs to have a content type set. Otherwise, the default of application/octet-stream gets used.

In order to use JAX-RS mode, use the following settings:

testMode == 'JAXRSCLIENT'

The following example shows a generated test API:

'''

*// when:*

Response response = webTarget

.path("/users")

.queryParam("limit", "10")

.queryParam("offset", "20")

.queryParam("filter", "email")

.queryParam("sort", "name")

.queryParam("search", "55")

.queryParam("age", "99")

.queryParam("name", "Denis.Stepanov")

.queryParam("email", "bob@email.com")

.request()

.method("GET");

String responseAsString = response.readEntity(String.**class**);

*// then:*

assertThat(response.getStatus()).isEqualTo(200);

*// and:*

DocumentContext parsedJson = JsonPath.parse(responseAsString);

assertThatJson(parsedJson).field("['property1']").isEqualTo("a");

'''

## 92.7 Async Support

If you’re using asynchronous communication on the server side (your controllers are returning Callable, DeferredResult, and so on), then, inside your contract, you must provide a sync() method in the response section. The following code shows an example:

**Groovy DSL.**

org.springframework.cloud.contract.spec.Contract.make {

request {

method GET()

url '/get'

}

response {

status OK()

body 'Passed'

async()

}

}

**YAML.**

response:

async: true

## 92.8 Working with Context Paths

Spring Cloud Contract supports context paths.

|  |  |
| --- | --- |
| [Important] | **Important** |
| The only change needed to fully support context paths is the switch on the **PRODUCER** side. Also, the autogenerated tests must use **EXPLICIT** mode. The consumer side remains untouched. In order for the generated test to pass, you must use **EXPLICIT** mode. |

**Maven.**

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<testMode>EXPLICIT</testMode>

</configuration>

</plugin>

**Gradle.**

contracts {

testMode = 'EXPLICIT'

}

That way, you generate a test that **DOES NOT** use MockMvc. It means that you generate real requests and you need to setup your generated test’s base class to work on a real socket.

Consider the following contract:

org.springframework.cloud.contract.spec.Contract.make {

request {

method 'GET'

url '/my-context-path/url'

}

response {

status OK()

}

}

The following example shows how to set up a base class and Rest Assured:

**import** io.restassured.RestAssured;

**import** org.junit.Before;

**import** org.springframework.boot.web.server.LocalServerPort;

**import** org.springframework.boot.test.context.SpringBootTest;

*@SpringBootTest(classes = ContextPathTestingBaseClass.class, webEnvironment = SpringBootTest.WebEnvironment.RANDOM\_PORT)*

**class** ContextPathTestingBaseClass {

*@LocalServerPort* **int** port;

*@Before*

**public** **void** setup() {

RestAssured.baseURI = "http://localhost";

RestAssured.port = **this**.port;

}

}

If you do it this way:

* All of your requests in the autogenerated tests are sent to the real endpoint with your context path included (for example, /my-context-path/url).
* Your contracts reflect that you have a context path. Your generated stubs also have that information (for example, in the stubs, you have to call /my-context-path/url).

## 92.9 Messaging Top-Level Elements

The DSL for messaging looks a little bit different than the one that focuses on HTTP. The following sections explain the differences:

* [Section 92.9.1, “Output Triggered by a Method”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-output-triggered-method)
* [Section 92.9.2, “Output Triggered by a Message”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-output-triggered-message)
* [Section 92.9.3, “Consumer/Producer”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-consumer-producer)
* [Section 92.9.4, “Common”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__contract_dsl.html#contract-dsl-common)

### 92.9.1 Output Triggered by a Method

The output message can be triggered by calling a method (such as a Scheduler when a was started and a message was sent), as shown in the following example:

**Groovy DSL.**

def dsl = Contract.make {

*// Human readable description*

description 'Some description'

*// Label by means of which the output message can be triggered*

label 'some\_label'

*// input to the contract*

input {

*// the contract will be triggered by a method*

triggeredBy('bookReturnedTriggered()')

}

*// output message of the contract*

outputMessage {

*// destination to which the output message will be sent*

sentTo('output')

*// the body of the output message*

body('''{ "bookName" : "foo" }''')

*// the headers of the output message*

headers {

header('BOOK-NAME', 'foo')

}

}

}

**YAML.**

# Human readable description

description: Some description

# Label by means of which the output message can be triggered

label: some\_label

input:

# the contract will be triggered by a method

triggeredBy: bookReturnedTriggered()

# output message of the contract

outputMessage:

# destination to which the output message will be sent

sentTo: output

# the body of the output message

body:

bookName: foo

# the headers of the output message

headers:

BOOK-NAME: foo

In the previous example case, the output message is sent to output if a method called bookReturnedTriggered is executed. On the message **publisher’s** side, we generate a test that calls that method to trigger the message. On the **consumer** side, you can use the some\_label to trigger the message.

### 92.9.2 Output Triggered by a Message

The output message can be triggered by receiving a message, as shown in the following example:

**Groovy DSL.**

def dsl = Contract.make {

description 'Some Description'

label 'some\_label'

*// input is a message*

input {

*// the message was received from this destination*

messageFrom('input')

*// has the following body*

messageBody([

bookName: 'foo'

])

*// and the following headers*

messageHeaders {

header('sample', 'header')

}

}

outputMessage {

sentTo('output')

body([

bookName: 'foo'

])

headers {

header('BOOK-NAME', 'foo')

}

}

}

**YAML.**

# Human readable description

description: Some description

# Label by means of which the output message can be triggered

label: some\_label

# input is a message

input:

messageFrom: input

# has the following body

messageBody:

bookName: 'foo'

# and the following headers

messageHeaders:

sample: 'header'

# output message of the contract

outputMessage:

# destination to which the output message will be sent

sentTo: output

# the body of the output message

body:

bookName: foo

# the headers of the output message

headers:

BOOK-NAME: foo

In the preceding example, the output message is sent to output if a proper message is received on the input destination. On the message **publisher’s** side, the engine generates a test that sends the input message to the defined destination. On the **consumer** side, you can either send a message to the input destination or use a label (some\_label in the example) to trigger the message.

### 92.9.3 Consumer/Producer

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is valid only for Groovy DSL. |

In HTTP, you have a notion of client/stub and `server/test notation. You can also use those paradigms in messaging. In addition, Spring Cloud Contract Verifier also provides the consumer and producer methods, as presented in the following example (note that you can use either $ or value methods to provide consumerand producer parts):

Contract.make {

label 'some\_label'

input {

messageFrom value(consumer('jms:output'), producer('jms:input'))

messageBody([

bookName: 'foo'

])

messageHeaders {

header('sample', 'header')

}

}

outputMessage {

sentTo $(consumer('jms:input'), producer('jms:output'))

body([

bookName: 'foo'

])

}

}

### 92.9.4 Common

In the input or outputMessage section you can call assertThat with the name of a method (e.g. assertThatMessageIsOnTheQueue()) that you have defined in the base class or in a static import. Spring Cloud Contract will execute that method in the generated test.

## 92.10 Multiple Contracts in One File

You can define multiple contracts in one file. Such a contract might resemble the following example:

**Groovy DSL.**

**import** org.springframework.cloud.contract.spec.Contract

[

Contract.make {

name("should post a user")

request {

method 'POST'

url('/users/1')

}

response {

status OK()

}

},

Contract.make {

request {

method 'POST'

url('/users/2')

}

response {

status OK()

}

}

]

**YAML.**

---

name: should post a user

request:

method: POST

url: /users/1

response:

status: 200

---

request:

method: POST

url: /users/2

response:

status: 200

In the preceding example, one contract has the name field and the other does not. This leads to generation of two tests that look more or less like this:

**package** org.springframework.cloud.contract.verifier.tests.com.hello;

**import** com.example.TestBase;

**import** com.jayway.jsonpath.DocumentContext;

**import** com.jayway.jsonpath.JsonPath;

**import** com.jayway.restassured.module.mockmvc.specification.MockMvcRequestSpecification;

**import** com.jayway.restassured.response.ResponseOptions;

**import** org.junit.Test;

**import** **static** com.jayway.restassured.module.mockmvc.RestAssuredMockMvc.\*;

**import** **static** com.toomuchcoding.jsonassert.JsonAssertion.assertThatJson;

**import** **static** org.assertj.core.api.Assertions.assertThat;

**public** **class** V1Test **extends** TestBase {

*@Test*

**public** **void** validate\_should\_post\_a\_user() **throws** Exception {

*// given:*

MockMvcRequestSpecification request = given();

*// when:*

ResponseOptions response = given().spec(request)

.post("/users/1");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

}

*@Test*

**public** **void** validate\_withList\_1() **throws** Exception {

*// given:*

MockMvcRequestSpecification request = given();

*// when:*

ResponseOptions response = given().spec(request)

.post("/users/2");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

}

}

Notice that, for the contract that has the name field, the generated test method is named validate\_should\_post\_a\_user. For the one that does not have the name, it is called validate\_withList\_1. It corresponds to the name of the file WithList.groovy and the index of the contract in the list.

The generated stubs is shown in the following example:

should post a user.json

1\_WithList.json

As you can see, the first file got the name parameter from the contract. The second got the name of the contract file (WithList.groovy) prefixed with the index (in this case, the contract had an index of 1 in the list of contracts in the file).

|  |
| --- |
| [Tip] |
| As you can see, it iss much better if you name your contracts because doing so makes your tests far more meaningful. |

## 93. Customization

|  |  |
| --- | --- |
| [Important] | **Important** |
| This section is valid only for Groovy DSL |

You can customize the Spring Cloud Contract Verifier by extending the DSL, as shown in the remainder of this section.

## 93.1 Extending the DSL

You can provide your own functions to the DSL. The key requirement for this feature is to maintain the static compatibility. Later in this document, you can see examples of:

* Creating a JAR with reusable classes.
* Referencing of these classes in the DSLs.

You can find the full example [here](https://github.com/spring-cloud-samples/spring-cloud-contract-samples).

### 93.1.1 Common JAR

The following examples show three classes that can be reused in the DSLs.

**PatternUtils** contains functions used by both the **consumer** and the **producer**.

**package** com.example;

**import** java.util.regex.Pattern;

**/\*\***

**\* If you want to use {@link Pattern} directly in your tests**

**\* then you can create a class resembling this one. It can**

**\* contain all the {@link Pattern} you want to use in the DSL.**

**\***

**\* <pre>**

**\* {@code**

**\* request {**

**\* body(**

**\* [ age: $(c(PatternUtils.oldEnough()))]**

**\* )**

**\* }**

**\* </pre>**

**\***

**\* Notice that we're using both {@code $()} for dynamic values**

**\* and {@code c()} for the consumer side.**

**\***

**\* @author Marcin Grzejszczak**

**\*/**

*//tag::impl[]*

**public** **class** PatternUtils {

**public** **static** String tooYoung() {

*//remove::start[]*

**return** "[0-1][0-9]";

*//remove::end[return]*

}

**public** **static** Pattern oldEnough() {

*//remove::start[]*

**return** Pattern.compile("[2-9][0-9]");

*//remove::end[return]*

}

**/\*\***

**\* Makes little sense but it's just an example ;)**

**\*/**

**public** **static** Pattern ok() {

*//remove::start[]*

**return** Pattern.compile("OK");

*//remove::end[return]*

}

}

*//end::impl[]*

**ConsumerUtils** contains functions used by the **consumer**.

**package** com.example;

**import** org.springframework.cloud.contract.spec.internal.ClientDslProperty;

**/\*\***

**\* DSL Properties passed to the DSL from the consumer's perspective.**

**\* That means that on the input side {@code Request} for HTTP**

**\* or {@code Input} for messaging you can have a regular expression.**

**\* On the {@code Response} for HTTP or {@code Output} for messaging**

**\* you have to have a concrete value.**

**\***

**\* @author Marcin Grzejszczak**

**\*/**

*//tag::impl[]*

**public** **class** ConsumerUtils {

**/\*\***

**\* Consumer side property. By using the {@link ClientDslProperty}**

**\* you can omit most of boilerplate code from the perspective**

**\* of dynamic values. Example**

**\***

**\* <pre>**

**\* {@code**

**\* request {**

**\* body(**

**\* [ age: $(ConsumerUtils.oldEnough())]**

**\* )**

**\* }**

**\* </pre>**

**\***

**\* That way it's in the implementation that we decide what value we will pass to the consumer**

**\* and which one to the producer.**

**\***

**\* @author Marcin Grzejszczak**

**\*/**

**public** **static** ClientDslProperty oldEnough() {

*//remove::start[]*

*// this example is not the best one and*

*// theoretically you could just pass the regex instead of `ServerDslProperty` but*

*// it's just to show some new tricks :)*

**return** **new** ClientDslProperty(PatternUtils.oldEnough(), 40);

*//remove::end[return]*

}

}

*//end::impl[]*

**ProducerUtils** contains functions used by the **producer**.

**package** com.example;

**import** org.springframework.cloud.contract.spec.internal.ServerDslProperty;

**/\*\***

**\* DSL Properties passed to the DSL from the producer's perspective.**

**\* That means that on the input side {@code Request} for HTTP**

**\* or {@code Input} for messaging you have to have a concrete value.**

**\* On the {@code Response} for HTTP or {@code Output} for messaging**

**\* you can have a regular expression.**

**\***

**\* @author Marcin Grzejszczak**

**\*/**

*//tag::impl[]*

**public** **class** ProducerUtils {

**/\*\***

**\* Producer side property. By using the {@link ProducerUtils}**

**\* you can omit most of boilerplate code from the perspective**

**\* of dynamic values. Example**

**\***

**\* <pre>**

**\* {@code**

**\* response {**

**\* body(**

**\* [ status: $(ProducerUtils.ok())]**

**\* )**

**\* }**

**\* </pre>**

**\***

**\* That way it's in the implementation that we decide what value we will pass to the consumer**

**\* and which one to the producer.**

**\*/**

**public** **static** ServerDslProperty ok() {

*// this example is not the best one and*

*// theoretically you could just pass the regex instead of `ServerDslProperty` but*

*// it's just to show some new tricks :)*

**return** **new** ServerDslProperty( PatternUtils.ok(), "OK");

}

}

*//end::impl[]*

### 93.1.2 Adding the Dependency to the Project

In order for the plugins and IDE to be able to reference the common JAR classes, you need to pass the dependency to your project.

### 93.1.3 Test the Dependency in the Project’s Dependencies

First, add the common jar dependency as a test dependency. Because your contracts files are available on the test resources path, the common jar classes automatically become visible in your Groovy files. The following examples show how to test the dependency:

**Maven.**

<dependency>

<groupId>com.example</groupId>

<artifactId>beer-common</artifactId>

<version>${project.version}</version>

<scope>test</scope>

</dependency>

**Gradle.**

testCompile("com.example:beer-common:0.0.1-SNAPSHOT")

### 93.1.4 Test a Dependency in the Plugin’s Dependencies

Now, you must add the dependency for the plugin to reuse at runtime, as shown in the following example:

**Maven.**

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example</packageWithBaseClasses>

<baseClassMappings>

<baseClassMapping>

<contractPackageRegex>.\*intoxication.\*</contractPackageRegex>

<baseClassFQN>com.example.intoxication.BeerIntoxicationBase</baseClassFQN>

</baseClassMapping>

</baseClassMappings>

</configuration>

<dependencies>

<dependency>

<groupId>com.example</groupId>

<artifactId>beer-common</artifactId>

<version>${project.version}</version>

<scope>compile</scope>

</dependency>

</dependencies>

</plugin>

**Gradle.**

classpath "com.example:beer-common:0.0.1-SNAPSHOT"

### 93.1.5 Referencing classes in DSLs

You can now reference your classes in your DSL, as shown in the following example:

**package** contracts.beer.rest

**import** com.example.ConsumerUtils

**import** com.example.ProducerUtils

**import** org.springframework.cloud.contract.spec.Contract

Contract.make {

description("""

Represents a successful scenario of getting a beer

```

given:

client is old enough

when:

he applies **for** a beer

then:

we'll grant him the beer

```

""")

request {

method 'POST'

url '/check'

body(

age: $(ConsumerUtils.oldEnough())

)

headers {

contentType(applicationJson())

}

}

response {

status 200

body("""

{

"status": "${value(ProducerUtils.ok())}"

}

""")

headers {

contentType(applicationJson())

}

}

}

## 94. Using the Pluggable Architecture

You may encounter cases where you have your contracts have been defined in other formats, such as YAML, RAML or PACT. In those cases, you still want to benefit from the automatic generation of tests and stubs. You can add your own implementation for generating both tests and stubs. Also, you can customize the way tests are generated (for example, you can generate tests for other languages) and the way stubs are generated (for example, you can generate stubs for other HTTP server implementations).

## 94.1 Custom Contract Converter

The ContractConverter interface lets you register your own implementation of a contract structure converter. The following code listing shows the ContractConverter interface:

**package** org.springframework.cloud.contract.spec

**/\*\***

**\* Converter to be used to convert FROM {@link File} TO {@link Contract}**

**\* and from {@link Contract} to {@code T}**

**\***

**\* @param <T> - type to which we want to convert the contract**

**\***

**\* @author Marcin Grzejszczak**

**\* @since 1.1.0**

**\*/**

**interface** ContractConverter<T> {

**/\*\***

**\* Should this file be accepted by the converter. Can use the file extension**

**\* to check if the conversion is possible.**

**\***

**\* @param file - file to be considered for conversion**

**\* @return - {@code true} if the given implementation can convert the file**

**\*/**

**boolean** isAccepted(File file)

**/\*\***

**\* Converts the given {@link File} to its {@link Contract} representation**

**\***

**\* @param file - file to convert**

**\* @return - {@link Contract} representation of the file**

**\*/**

Collection<Contract> convertFrom(File file)

**/\*\***

**\* Converts the given {@link Contract} to a {@link T} representation**

**\***

**\* @param contract - the parsed contract**

**\* @return - {@link T} the type to which we do the conversion**

**\*/**

T convertTo(Collection<Contract> contract)

}

Your implementation must define the condition on which it should start the conversion. Also, you must define how to perform that conversion in both directions.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Once you create your implementation, you must create a /META-INF/spring.factories file in which you provide the fully qualified name of your implementation. |

The following example shows a typical spring.factories file:

org.springframework.cloud.contract.spec.ContractConverter=\

org.springframework.cloud.contract.verifier.converter.YamlContractConverter

### 94.1.1 Pact Converter

Spring Cloud Contract includes support for [Pact](https://docs.pact.io/) representation of contracts. Instead of using the Groovy DSL, you can use Pact files. In this section, we present how to add Pact support for your project.

### 94.1.2 Pact Contract

Consider following example of a Pact contract, which is a file under the src/test/resources/contracts folder.

{

"provider": {

"name": "Provider"

},

"consumer": {

"name": "Consumer"

},

"interactions": [

{

"description": "",

"request": {

"method": "PUT",

"path": "/fraudcheck",

"headers": {

"Content-Type": "application/vnd.fraud.v1+json"

},

"body": {

"clientId": "1234567890",

"loanAmount": 99999

},

"matchingRules": {

"$.body.clientId": {

"match": "regex",

"regex": "[0-9]{10}"

}

}

},

"response": {

"status": 200,

"headers": {

"Content-Type": "application/vnd.fraud.v1+json;charset=UTF-8"

},

"body": {

"fraudCheckStatus": "FRAUD",

"rejectionReason": "Amount too high"

},

"matchingRules": {

"$.body.fraudCheckStatus": {

"match": "regex",

"regex": "FRAUD"

}

}

}

}

],

"metadata": {

"pact-specification": {

"version": "2.0.0"

},

"pact-jvm": {

"version": "2.4.18"

}

}

}

The remainder of this section about using Pact refers to the preceding file.

### 94.1.3 Pact for Producers

On the producer side, you mustadd two additional dependencies to your plugin configuration. One is the Spring Cloud Contract Pact support, and the other represents the current Pact version that you use.

**Maven.**

<plugin>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-maven-plugin</artifactId>

<version>${spring-cloud-contract.version}</version>

<extensions>true</extensions>

<configuration>

<packageWithBaseClasses>com.example.fraud</packageWithBaseClasses>

</configuration>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-spec-pact</artifactId>

<version>${spring-cloud-contract.version}</version>

</dependency>

<dependency>

<groupId>au.com.dius</groupId>

<artifactId>pact-jvm-model</artifactId>

<version>2.4.18</version>

</dependency>

</dependencies>

</plugin>

**Gradle.**

classpath "org.springframework.cloud:spring-cloud-contract-spec-pact:${findProperty('verifierVersion') ?: verifierVersion}"

classpath 'au.com.dius:pact-jvm-model:2.4.18'

When you execute the build of your application, a test will be generated. The generated test might be as follows:

*@Test*

**public** **void** validate\_shouldMarkClientAsFraud() **throws** Exception {

*// given:*

MockMvcRequestSpecification request = given()

.header("Content-Type", "application/vnd.fraud.v1+json")

.body("{\"clientId\":\"1234567890\",\"loanAmount\":99999}");

*// when:*

ResponseOptions response = given().spec(request)

.put("/fraudcheck");

*// then:*

assertThat(response.statusCode()).isEqualTo(200);

assertThat(response.header("Content-Type")).isEqualTo("application/vnd.fraud.v1+json;charset=UTF-8");

*// and:*

DocumentContext parsedJson = JsonPath.parse(response.getBody().asString());

assertThatJson(parsedJson).field("rejectionReason").isEqualTo("Amount too high");

*// and:*

assertThat(parsedJson.read("$.fraudCheckStatus", String.**class**)).matches("FRAUD");

}

The corresponding generated stub might be as follows:

{

"uuid" : "996ae5ae-6834-4db6-8fac-358ca187ab62",

"request" : {

"url" : "/fraudcheck",

"method" : "PUT",

"headers" : {

"Content-Type" : {

"equalTo" : "application/vnd.fraud.v1+json"

}

},

"bodyPatterns" : [ {

"matchesJsonPath" : "$[?(@.loanAmount == 99999)]"

}, {

"matchesJsonPath" : "$[?(@.clientId =~ /([0-9]{10})/)]"

} ]

},

"response" : {

"status" : 200,

"body" : "{\"fraudCheckStatus\":\"FRAUD\",\"rejectionReason\":\"Amount too high\"}",

"headers" : {

"Content-Type" : "application/vnd.fraud.v1+json;charset=UTF-8"

}

}

}

### 94.1.4 Pact for Consumers

On the producer side, you must add two additional dependencies to your project dependencies. One is the Spring Cloud Contract Pact support, and the other represents the current Pact version that you use.

**Maven.**

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-contract-spec-pact</artifactId>

<scope>test</scope>

</dependency>

<dependency>

<groupId>au.com.dius</groupId>

<artifactId>pact-jvm-model</artifactId>

<version>2.4.18</version>

<scope>test</scope>

</dependency>

**Gradle.**

testCompile "org.springframework.cloud:spring-cloud-contract-spec-pact"

testCompile 'au.com.dius:pact-jvm-model:2.4.18'

## 94.2 Using the Custom Test Generator

If you want to generate tests for languages other than Java or you are not happy with the way the verifier builds Java tests, you can register your own implementation.

The SingleTestGenerator interface lets you register your own implementation. The following code listing shows the SingleTestGenerator interface:

**package** org.springframework.cloud.contract.verifier.builder

**import** org.springframework.cloud.contract.verifier.config.ContractVerifierConfigProperties

**import** org.springframework.cloud.contract.verifier.file.ContractMetadata

**/\*\***

**\* Builds a single test.**

**\***

**\* @since 1.1.0**

**\*/**

**interface** SingleTestGenerator {

**/\*\***

**\* Creates contents of a single test class in which all test scenarios from**

**\* the contract metadata should be placed.**

**\***

**\* @param properties - properties passed to the plugin**

**\* @param listOfFiles - list of parsed contracts with additional metadata**

**\* @param className - the name of the generated test class**

**\* @param classPackage - the name of the package in which the test class should be stored**

**\* @param includedDirectoryRelativePath - relative path to the included directory**

**\* @return contents of a single test class**

**\*/**

String buildClass(ContractVerifierConfigProperties properties, Collection<ContractMetadata> listOfFiles,

String className, String classPackage, String includedDirectoryRelativePath)

**/\*\***

**\* Extension that should be appended to the generated test class. E.g. {@code .java} or {@code .php}**

**\***

**\* @param properties - properties passed to the plugin**

**\*/**

String fileExtension(ContractVerifierConfigProperties properties)

}

Again, you must provide a spring.factories file, such as the one shown in the following example:

org.springframework.cloud.contract.verifier.builder.SingleTestGenerator=/

com.example.MyGenerator

## 94.3 Using the Custom Stub Generator

If you want to generate stubs for stub servers other than WireMock, you can plug in your own implementation of the StubGenerator interface. The following code listing shows the StubGenerator interface:

**package** org.springframework.cloud.contract.verifier.converter

**import** groovy.transform.CompileStatic

**import** org.springframework.cloud.contract.spec.Contract

**import** org.springframework.cloud.contract.verifier.file.ContractMetadata

**/\*\***

**\* Converts contracts into their stub representation.**

**\***

**\* @since 1.1.0**

**\*/**

*@CompileStatic*

**interface** StubGenerator {

**/\*\***

**\* Returns {@code true} if the converter can handle the file to convert it into a stub.**

**\*/**

**boolean** canHandleFileName(String fileName)

**/\*\***

**\* Returns the collection of converted contracts into stubs. One contract can**

**\* result in multiple stubs.**

**\*/**

Map<Contract, String> convertContents(String rootName, ContractMetadata content)

**/\*\***

**\* Returns the name of the converted stub file. If you have multiple contracts**

**\* in a single file then a prefix will be added to the generated file. If you**

**\* provide the {@link Contract#name} field then that field will override the**

**\* generated file name.**

**\***

**\* Example: name of file with 2 contracts is {@code foo.groovy}, it will be**

**\* converted by the implementation to {@code foo.json}. The recursive file**

**\* converter will create two files {@code 0\_foo.json} and {@code 1\_foo.json}**

**\*/**

String generateOutputFileNameForInput(String inputFileName)

}

Again, you must provide a spring.factories file, such as the one shown in the following example:

# Stub converters

org.springframework.cloud.contract.verifier.converter.StubGenerator=\

org.springframework.cloud.contract.verifier.wiremock.DslToWireMockClientConverter

The default implementation is the WireMock stub generation.

|  |
| --- |
| [Tip] |
| You can provide multiple stub generator implementations. For example, from a single DSL, you can produce both WireMock stubs and Pact files. |

## 94.4 Using the Custom Stub Runner

If you decide to use a custom stub generation, you also need a custom way of running stubs with your different stub provider.

Assume that you use [Moco](https://github.com/dreamhead/moco) to build your stubs and that you have written a stub generator and placed your stubs in a JAR file.

In order for Stub Runner to know how to run your stubs, you have to define a custom HTTP Stub server implementation, which might resemble the following example:

**package** org.springframework.cloud.contract.stubrunner.provider.moco

**import** com.github.dreamhead.moco.bootstrap.arg.HttpArgs

**import** com.github.dreamhead.moco.runner.JsonRunner

**import** com.github.dreamhead.moco.runner.RunnerSetting

**import** groovy.util.logging.Slf4j

**import** org.springframework.cloud.contract.stubrunner.HttpServerStub

**import** org.springframework.util.SocketUtils

*@Slf4j*

**class** MocoHttpServerStub **implements** HttpServerStub {

**private** **boolean** started

**private** JsonRunner runner

**private** **int** port

*@Override*

**int** port() {

**if** (!isRunning()) {

**return** -1

}

**return** port

}

*@Override*

**boolean** isRunning() {

**return** started

}

*@Override*

HttpServerStub start() {

**return** start(SocketUtils.findAvailableTcpPort())

}

*@Override*

HttpServerStub start(**int** port) {

**this**.port = port

**return** **this**

}

*@Override*

HttpServerStub stop() {

**if** (!isRunning()) {

**return** **this**

}

**this**.runner.stop()

**return** **this**

}

*@Override*

HttpServerStub registerMappings(Collection<File> stubFiles) {

List<RunnerSetting> settings = stubFiles.findAll { it.name.endsWith("json") }

.collect {

log.info("Trying to parse [{}]", it.name)

**try** {

**return** RunnerSetting.aRunnerSetting().withStream(it.newInputStream()).build()

} **catch** (Exception e) {

log.warn("Exception occurred while trying to parse file [{}]", it.name, e)

**return** null

}

}.findAll { it }

**this**.runner = JsonRunner.newJsonRunnerWithSetting(settings,

HttpArgs.httpArgs().withPort(**this**.port).build())

**this**.runner.run()

**this**.started = true

**return** **this**

}

*@Override*

String registeredMappings() {

**return** ""

}

*@Override*

**boolean** isAccepted(File file) {

**return** file.name.endsWith(".json")

}

}

Then, you can register it in your spring.factories file, as shown in the following example:

org.springframework.cloud.contract.stubrunner.HttpServerStub=\

org.springframework.cloud.contract.stubrunner.provider.moco.MocoHttpServerStub

Now you can run stubs with Moco.

|  |  |
| --- | --- |
| [Important] | **Important** |
| If you do not provide any implementation, then the default (WireMock) implementation is used. If you provide more than one, the first one on the list is used. |

## 94.5 Using the Custom Stub Downloader

You can customize the way your stubs are downloaded by creating an implementation of the StubDownloaderBuilder interface, as shown in the following example:

**package** com.example;

**class** CustomStubDownloaderBuilder **implements** StubDownloaderBuilder {

*@Override*

**public** StubDownloader build(**final** StubRunnerOptions stubRunnerOptions) {

**return** **new** StubDownloader() {

*@Override*

**public** Map.Entry<StubConfiguration, File> downloadAndUnpackStubJar(

StubConfiguration config) {

File unpackedStubs = retrieveStubs();

**return** **new** AbstractMap.SimpleEntry<>(

**new** StubConfiguration(config.getGroupId(), config.getArtifactId(), version,

config.getClassifier()), unpackedStubs);

}

File retrieveStubs() {

*// here goes your custom logic to provide a folder where all the stubs reside*

}

}

Then you can register it in your spring.factories file, as shown in the following example:

# Example of a custom Stub Downloader Provider

org.springframework.cloud.contract.stubrunner.StubDownloaderBuilder=\

com.example.CustomStubDownloaderBuilder

Now you can pick a folder with the source of your stubs.

|  |  |
| --- | --- |
| [Important] | **Important** |
| If you do not provide any implementation, then the default is used (scan classpath). If you provide the stubsMode = StubRunnerProperties.StubsMode.LOCAL or , stubsMode = StubRunnerProperties.StubsMode.REMOTE then the Aether implementation will be used If you provide more than one, then the first one on the list is used. |

## 95. Spring Cloud Contract WireMock

The Spring Cloud Contract WireMock modules let you use [WireMock](http://wiremock.org/) in a Spring Boot application. Check out the [samples](https://github.com/spring-cloud/spring-cloud-contract/tree/master/samples) for more details.

If you have a Spring Boot application that uses Tomcat as an embedded server (which is the default with spring-boot-starter-web), you can addspring-cloud-starter-contract-stub-runner to your classpath and add @AutoConfigureWireMock in order to be able to use Wiremock in your tests. Wiremock runs as a stub server and you can register stub behavior using a Java API or via static JSON declarations as part of your test. The following code shows an example:

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment = WebEnvironment.RANDOM\_PORT)*

*@AutoConfigureWireMock(port = 0)*

**public** **class** WiremockForDocsTests {

*// A service that calls out over HTTP*

*@Autowired* **private** Service service;

*// Using the WireMock APIs in the normal way:*

*@Test*

**public** **void** contextLoads() **throws** Exception {

*// Stubbing WireMock*

stubFor(get(urlEqualTo("/resource"))

.willReturn(aResponse().withHeader("Content-Type", "text/plain").withBody("Hello World!")));

*// We're asserting if WireMock responded properly*

assertThat(**this**.service.go()).isEqualTo("Hello World!");

}

}

To start the stub server on a different port use (for example), @AutoConfigureWireMock(port=9999). For a random port, use a value of 0. The stub server port can be bound in the test application context with the "wiremock.server.port" property. Using @AutoConfigureWireMock adds a bean of type WiremockConfiguration to your test application context, where it will be cached in between methods and classes having the same context, the same as for Spring integration tests.

## 95.1 Registering Stubs Automatically

If you use @AutoConfigureWireMock, it registers WireMock JSON stubs from the file system or classpath (by default, from file:src/test/resources/mappings). You can customize the locations using the stubs attribute in the annotation, which can be an Ant-style resource pattern or a directory. In the case of a directory, **\*/**.json is appended. The following code shows an example:

@RunWith(SpringRunner.class)

@SpringBootTest

@AutoConfigureWireMock(stubs="classpath:/stubs")

public class WiremockImportApplicationTests {

@Autowired

private Service service;

@Test

public void contextLoads() throws Exception {

assertThat(this.service.go()).isEqualTo("Hello World!");

}

}

|  |
| --- |
| [Note] |
| Actually, WireMock always loads mappings from src/test/resources/mappings **as well as** the custom locations in the stubs attribute. To change this behavior, you can also specify a files root as described in the next section of this document. |

## 95.2 Using Files to Specify the Stub Bodies

WireMock can read response bodies from files on the classpath or the file system. In that case, you can see in the JSON DSL that the response has a bodyFileNameinstead of a (literal) body. The files are resolved relative to a root directory (by default, src/test/resources/\_\_files). To customize this location you can set the files attribute in the @AutoConfigureWireMock annotation to the location of the parent directory (in other words, \_\_files is a subdirectory). You can use Spring resource notation to refer to file:…​ or classpath:…​ locations. Generic URLs are not supported. A list of values can be given, in which case WireMock resolves the first file that exists when it needs to find a response body.

|  |
| --- |
| [Note] |
| When you configure the files root, it also affects the automatic loading of stubs, because they come from the root location in a subdirectory called "mappings". The value of files has no effect on the stubs loaded explicitly from the stubs attribute. |

## 95.3 Alternative: Using JUnit Rules

For a more conventional WireMock experience, you can use JUnit @Rules to start and stop the server. To do so, use the WireMockSpring convenience class to obtain an Options instance, as shown in the following example:

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment = WebEnvironment.RANDOM\_PORT)*

**public** **class** WiremockForDocsClassRuleTests {

*// Start WireMock on some dynamic port*

*// for some reason `dynamicPort()` is not working properly*

*@ClassRule*

**public** **static** WireMockClassRule wiremock = **new** WireMockClassRule(

WireMockSpring.options().dynamicPort());

*// A service that calls out over HTTP to localhost:${wiremock.port}*

*@Autowired*

**private** Service service;

*// Using the WireMock APIs in the normal way:*

*@Test*

**public** **void** contextLoads() **throws** Exception {

*// Stubbing WireMock*

wiremock.stubFor(get(urlEqualTo("/resource"))

.willReturn(aResponse().withHeader("Content-Type", "text/plain").withBody("Hello World!")));

*// We're asserting if WireMock responded properly*

assertThat(**this**.service.go()).isEqualTo("Hello World!");

}

}

The @ClassRule means that the server shuts down after all the methods in this class have been run.

## 95.4 Relaxed SSL Validation for Rest Template

WireMock lets you stub a "secure" server with an "https" URL protocol. If your application wants to contact that stub server in an integration test, it will find that the SSL certificates are not valid (the usual problem with self-installed certificates). The best option is often to re-configure the client to use "http". If that’s not an option, you can ask Spring to configure an HTTP client that ignores SSL validation errors (do so only for tests, of course).

To make this work with minimum fuss, you need to be using the Spring Boot RestTemplateBuilder in your app, as shown in the following example:

*@Bean*

**public** RestTemplate restTemplate(RestTemplateBuilder builder) {

**return** builder.build();

}

You need RestTemplateBuilder because the builder is passed through callbacks to initialize it, so the SSL validation can be set up in the client at that point. This happens automatically in your test if you are using the @AutoConfigureWireMock annotation or the stub runner. If you use the JUnit @Rule approach, you need to add the @AutoConfigureHttpClient annotation as well, as shown in the following example:

*@RunWith(SpringRunner.class)*

*@SpringBootTest("app.baseUrl=https://localhost:6443")*

*@AutoConfigureHttpClient*

**public** **class** WiremockHttpsServerApplicationTests {

*@ClassRule*

**public** **static** WireMockClassRule wiremock = **new** WireMockClassRule(

WireMockSpring.options().httpsPort(6443));

...

}

If you are using spring-boot-starter-test, you have the Apache HTTP client on the classpath and it is selected by the RestTemplateBuilder and configured to ignore SSL errors. If you use the default java.net client, you do not need the annotation (but it won’t do any harm). There is no support currently for other clients, but it may be added in future releases.

To disable the custom RestTemplateBuilder, set the wiremock.rest-template-ssl-enabled property to false.

## 95.5 WireMock and Spring MVC Mocks

Spring Cloud Contract provides a convenience class that can load JSON WireMock stubs into a Spring MockRestServiceServer. The following code shows an example:

*@RunWith(SpringRunner.class)*

*@SpringBootTest(webEnvironment = WebEnvironment.NONE)*

**public** **class** WiremockForDocsMockServerApplicationTests {

*@Autowired*

**private** RestTemplate restTemplate;

*@Autowired*

**private** Service service;

*@Test*

**public** **void** contextLoads() **throws** Exception {

*// will read stubs classpath*

MockRestServiceServer server = WireMockRestServiceServer.with(**this**.restTemplate)

.baseUrl("http://example.org").stubs("classpath:/stubs/resource.json")

.build();

*// We're asserting if WireMock responded properly*

assertThat(**this**.service.go()).isEqualTo("Hello World");

server.verify();

}

}

The baseUrl value is prepended to all mock calls, and the stubs() method takes a stub path resource pattern as an argument. In the preceding example, the stub defined at /stubs/resource.json is loaded into the mock server. If the RestTemplate is asked to visit <http://example.org/>, it gets the responses as being declared at that URL. More than one stub pattern can be specified, and each one can be a directory (for a recursive list of all ".json"), a fixed filename (as in the example above), or an Ant-style pattern. The JSON format is the normal WireMock format, which you can read about in the [WireMock website](http://wiremock.org/docs/stubbing/).

Currently, the Spring Cloud Contract Verifier supports Tomcat, Jetty, and Undertow as Spring Boot embedded servers, and Wiremock itself has "native" support for a particular version of Jetty (currently 9.2). To use the native Jetty, you need to add the native Wiremock dependencies and exclude the Spring Boot container (if there is one).

## 95.6 Customization of WireMock configuration

You can register a bean of org.springframework.cloud.contract.wiremock.WireMockConfigurationCustomizer type in order to customize the WireMock configuration (e.g. add custom transformers). Example:

*@Bean* WireMockConfigurationCustomizer optionsCustomizer() {

**return** **new** WireMockConfigurationCustomizer() {

*@Override* **public** **void** customize(WireMockConfiguration options) {

*// perform your customization here*

}

};

}

## 95.7 Generating Stubs using REST Docs

[Spring REST Docs](https://projects.spring.io/spring-restdocs) can be used to generate documentation (for example in Asciidoctor format) for an HTTP API with Spring MockMvc or WebTestClient or Rest Assured. At the same time that you generate documentation for your API, you can also generate WireMock stubs by using Spring Cloud Contract WireMock. To do so, write your normal REST Docs test cases and use @AutoConfigureRestDocs to have stubs be automatically generated in the REST Docs output directory. The following code shows an example using MockMvc:

*@RunWith(SpringRunner.class)*

*@SpringBootTest*

*@AutoConfigureRestDocs(outputDir = "target/snippets")*

*@AutoConfigureMockMvc*

**public** **class** ApplicationTests {

*@Autowired*

**private** MockMvc mockMvc;

*@Test*

**public** **void** contextLoads() **throws** Exception {

mockMvc.perform(get("/resource"))

.andExpect(content().string("Hello World"))

.andDo(document("resource"));

}

}

This test generates a WireMock stub at "target/snippets/stubs/resource.json". It matches all GET requests to the "/resource" path. The same example with WebTestClient (used for testing Spring WebFlux applications) would look like this:

*@RunWith(SpringRunner.class)*

*@SpringBootTest*

*@AutoConfigureRestDocs(outputDir = "target/snippets")*

*@AutoConfigureWebTestClient*

**public** **class** ApplicationTests {

*@Autowired*

**private** WebTestClient client;

*@Test*

**public** **void** contextLoads() **throws** Exception {

client.get().uri("/resource").exchange()

.expectBody(String.**class**).isEqualTo("Hello World")

.consumeWith(document("resource"));

}

}

Without any additional configuration, these tests create a stub with a request matcher for the HTTP method and all headers except "host" and "content-length". To match the request more precisely (for example, to match the body of a POST or PUT), we need to explicitly create a request matcher. Doing so has two effects:

* Creating a stub that matches only in the way you specify.
* Asserting that the request in the test case also matches the same conditions.

The main entry point for this feature is WireMockRestDocs.verify(), which can be used as a substitute for the document() convenience method, as shown in the following example:

**import** **static** org.springframework.cloud.contract.wiremock.restdocs.WireMockRestDocs.verify;

@RunWith(SpringRunner.class)

@SpringBootTest

@AutoConfigureRestDocs(outputDir = "target/snippets")

@AutoConfigureMockMvc

public class ApplicationTests {

@Autowired

private MockMvc mockMvc;

@Test

public void contextLoads() throws Exception {

mockMvc.perform(post("/resource")

.content("{\"id\":\"123456\",\"message\":\"Hello World\"}"))

.andExpect(status().isOk())

.andDo(verify().jsonPath("$.id")

.stub("resource"));

}

}

This contract specifies that any valid POST with an "id" field receives the response defined in this test. You can chain together calls to .jsonPath() to add additional matchers. If JSON Path is unfamiliar, The [JayWay documentation](https://github.com/jayway/JsonPath) can help you get up to speed. The WebTestClient version of this test has a similar verify() static helper that you insert in the same place.

Instead of the jsonPath and contentType convenience methods, you can also use the WireMock APIs to verify that the request matches the created stub, as shown in the following example:

*@Test*

**public** **void** contextLoads() **throws** Exception {

mockMvc.perform(post("/resource")

.content("{\"id\":\"123456\",\"message\":\"Hello World\"}"))

.andExpect(status().isOk())

.andDo(verify()

.wiremock(WireMock.post(

urlPathEquals("/resource"))

.withRequestBody(matchingJsonPath("$.id"))

.stub("post-resource"));

}

The WireMock API is rich. You can match headers, query parameters, and request body by regex as well as by JSON path. These features can be used to create stubs with a wider range of parameters. The above example generates a stub resembling the following example:

**post-resource.json.**

**{**

"request" : **{**

"url" : "/resource"**,**

"method" : "POST"**,**

"bodyPatterns" : **[** **{**

"matchesJsonPath" : "$.id"

**}]**

**},**

"response" : **{**

"status" : 200**,**

"body" : "Hello World"**,**

"headers" : **{**

"X-Application-Context" : "application:-1"**,**

"Content-Type" : "text/plain"

**}**

**}**

**}**

|  |
| --- |
| [Note] |
| You can use either the wiremock() method or the jsonPath() and contentType() methods to create request matchers, but you can’t use both approaches. |

On the consumer side, you can make the resource.json generated earlier in this section available on the classpath (by [publishing stubs as JARs](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html#_publishing_stubs_as_jars), for example). After that, you can create a stub using WireMock in a number of different ways, including by using @AutoConfigureWireMock(stubs="classpath:resource.json"), as described earlier in this document.

## 95.8 Generating Contracts by Using REST Docs

You can also generate Spring Cloud Contract DSL files and documentation with Spring REST Docs. If you do so in combination with Spring Cloud WireMock, you get both the contracts and the stubs.

Why would you want to use this feature? Some people in the community asked questions about a situation in which they would like to move to DSL-based contract definition, but they already have a lot of Spring MVC tests. Using this feature lets you generate the contract files that you can later modify and move to folders (defined in your configuration) so that the plugin finds them.

|  |
| --- |
| [Tip] |
| You might wonder why this functionality is in the WireMock module. The functionality is there because it makes sense to generate both the contracts and the stubs. |

Consider the following test:

**this**.mockMvc.perform(post("/foo")

.accept(MediaType.APPLICATION\_PDF)

.accept(MediaType.APPLICATION\_JSON)

.contentType(MediaType.APPLICATION\_JSON)

.content("{\"foo\": 23, \"bar\" : \"baz\" }"))

.andExpect(status().isOk())

.andExpect(content().string("bar"))

*// first WireMock*

.andDo(WireMockRestDocs.verify()

.jsonPath("$[?(@.foo >= 20)]")

.jsonPath("$[?(@.bar in ['baz','bazz','bazzz'])]")

.contentType(MediaType.valueOf("application/json"))

.stub("shouldGrantABeerIfOldEnough"))

*// then Contract DSL documentation*

.andDo(document("index", SpringCloudContractRestDocs.dslContract()));

The preceding test creates the stub presented in the previous section, generating both the contract and a documentation file.

The contract is called index.groovy and might look like the following example:

**import** org.springframework.cloud.contract.spec.Contract

Contract.make {

request {

method 'POST'

url '/foo'

body('''

{"foo": 23 }

''')

headers {

header('''Accept''', '''application/json''')

header('''Content-Type''', '''application/json''')

}

}

response {

status OK()

body('''

bar

''')

headers {

header('''Content-Type''', '''application/json;charset=UTF-8''')

header('''Content-Length''', '''3''')

}

testMatchers {

jsonPath('$[?(@.foo >= 20)]', byType())

}

}

}

The generated document (formatted in Asciidoc in this case) contains a formatted contract. The location of this file would be index/dsl-contract.adoc.

## 96. Migrations

This section covers migrating from one version of Spring Cloud Contract Verifier to the next version. It covers the following versions upgrade paths:

## 96.1 1.0.x → 1.1.x

This section covers upgrading from version 1.0 to version 1.1.

### 96.1.1 New structure of generated stubs

In 1.1.x we have introduced a change to the structure of generated stubs. If you have been using the @AutoConfigureWireMock notation to use the stubs from the classpath, it no longer works. The following example shows how the @AutoConfigureWireMock notation used to work:

@AutoConfigureWireMock(stubs = "classpath:/customer-stubs/mappings", port = 8084)

You must either change the location of the stubs to: classpath:…​/META-INF/groupId/artifactId/version/mappings or use the new classpath-based @AutoConfigureStubRunner, as shown in the following example:

@AutoConfigureWireMock(stubs = "classpath:customer-stubs/META-INF/travel.components/customer-contract/1.0.2-SNAPSHOT/mappings/", port = 8084)

If you do not want to use @AutoConfigureStubRunner and you want to remain with the old structure, set your plugin tasks accordingly. The following example would work for the structure presented in the previous snippet.

**Maven.**

*<!-- start of pom.xml -->*

<properties>

*<!-- we don't want the verifier to do a jar for us -->*

<spring.cloud.contract.verifier.skip>true</spring.cloud.contract.verifier.skip>

</properties>

*<!-- ... -->*

*<!-- You need to set up the assembly plugin -->*

<build>

<plugins>

<plugin>

<groupId>org.apache.maven.plugins</groupId>

<artifactId>maven-assembly-plugin</artifactId>

<executions>

<execution>

<id>stub</id>

<phase>prepare-package</phase>

<goals>

<goal>single</goal>

</goals>

<inherited>false</inherited>

<configuration>

<attach>true</attach>

<descriptor>$../../../../src/assembly/stub.xml</descriptor>

</configuration>

</execution>

</executions>

</plugin>

</plugins>

</build>

*<!-- end of pom.xml -->*

*<!-- start of stub.xml-->*

<assembly

xmlns="http://maven.apache.org/plugins/maven-assembly-plugin/assembly/1.1.3"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://maven.apache.org/plugins/maven-assembly-plugin/assembly/1.1.3 http://maven.apache.org/xsd/assembly-1.1.3.xsd">

<id>stubs</id>

<formats>

<format>jar</format>

</formats>

<includeBaseDirectory>false</includeBaseDirectory>

<fileSets>

<fileSet>

<directory>${project.build.directory}/snippets/stubs</directory>

<outputDirectory>customer-stubs/mappings</outputDirectory>

<includes>

<include>\*\*/\*</include>

</includes>

</fileSet>

<fileSet>

<directory>$../../../../src/test/resources/contracts</directory>

<outputDirectory>customer-stubs/contracts</outputDirectory>

<includes>

<include>\*\*/\*.groovy</include>

</includes>

</fileSet>

</fileSets>

</assembly>

*<!-- end of stub.xml-->*

**Gradle.**

task copyStubs(type: Copy, dependsOn: 'generateWireMockClientStubs') {

*// Preserve directory structure from 1.0.X of spring-cloud-contract*

from "${project.buildDir}/resources/main/customer-stubs/META-INF/${project.group}/${project.name}/${project.version}"

into "${project.buildDir}/resources/main/customer-stubs"

}

## 96.2 1.1.x → 1.2.x

This section covers upgrading from version 1.1 to version 1.2.

### 96.2.1 Custom HttpServerStub

HttpServerStub includes a method that was not in version 1.1. The method is String registeredMappings() If you have classes that implement HttpServerStub, you now have to implement the registeredMappings() method. It should return a String representing all mappings available in a single HttpServerStub.

See [issue 355](https://github.com/spring-cloud/spring-cloud-contract/issues/355) for more detail.

### 96.2.2 New packages for generated tests

The flow for setting the generated tests package name will look like this:

* Set basePackageForTests
* If basePackageForTests was not set, pick the package from baseClassForTests
* If baseClassForTests was not set, pick packageWithBaseClasses
* If nothing got set, pick the default value: org.springframework.cloud.contract.verifier.tests

See [issue 260](https://github.com/spring-cloud/spring-cloud-contract/issues/260) for more detail.

### 96.2.3 New Methods in TemplateProcessor

In order to add support for fromRequest.path, the following methods had to be added to the TemplateProcessor interface:

* path()
* path(int index)

See [issue 388](https://github.com/spring-cloud/spring-cloud-contract/issues/388) for more detail.

### 96.2.4 RestAssured 3.0

Rest Assured, used in the generated test classes, got bumped to 3.0. If you manually set versions of Spring Cloud Contract and the release train you might see the following exception:

Failed to execute goal org.apache.maven.plugins:maven-compiler-plugin:3.1:testCompile (default-testCompile) on project some-project: Compilation failure: Compilation failure:

[ERROR] /some/path/SomeClass.java:[4,39] package com.jayway.restassured.response does not exist

This exception will occur due to the fact that the tests got generated with an old version of plugin and at test execution time you have an incompatible version of the release train (and vice versa).

Done via [issue 267](https://github.com/spring-cloud/spring-cloud-contract/issues/267)

## 96.3 1.2.x → 2.0.x

### 96.3.1 No Camel support

We will add back Apache Camel support only after this [issue](https://issues.apache.org/jira/browse/CAMEL-11430) gets fixed

## 97. Links

The following links may be helpful when working with Spring Cloud Contract Verifier:

* [Spring Cloud Contract Github Repository](https://github.com/spring-cloud/spring-cloud-contract/)
* [Spring Cloud Contract Samples](https://github.com/spring-cloud-samples/spring-cloud-contract-samples/)
* [Spring Cloud Contract Documentation](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html)
* [Accurest Legacy Documentation](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html/deprecated)
* [Spring Cloud Contract Stub Runner Documentation](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html/#spring-cloud-contract-stub-runner)
* [Spring Cloud Contract Stub Runner Messaging Documentation](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract.html/#stub-runner-for-messaging)
* [Spring Cloud Contract Gitter](https://gitter.im/spring-cloud/spring-cloud-contract)
* [Spring Cloud Contract Maven Plugin](https://cloud.spring.io/spring-cloud-contract/spring-cloud-contract-maven-plugin/)
* [Spring Cloud Contract WJUG Presentation by Marcin Grzejszczak](https://www.youtube.com/watch?v=sAAklvxmPmk)

# Part XIV. Spring Cloud Vault

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|  |
| --- |
| [Note] |
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Spring Cloud Vault Config provides client-side support for externalized configuration in a distributed system. With [HashiCorp’s Vault](https://www.vaultproject.io/) you have a central place to manage external secret properties for applications across all environments. Vault can manage static and dynamic secrets such as username/password for remote applications/resources and provide credentials for external services such as MySQL, PostgreSQL, Apache Cassandra, MongoDB, Consul, AWS and more.

## 98. Quick Start

**Prerequisites**

To get started with Vault and this guide you need a \*NIX-like operating systems that provides:

* wget, openssl and unzip
* at least Java 7 and a properly configured JAVA\_HOME environment variable

**Install Vault**

$ src/**test**/bash/install\_vault.sh

**Create SSL certificates for Vault**

$ src/**test**/bash/create\_certificates.sh

|  |
| --- |
| [Note] |
| create\_certificates.sh creates certificates in work/ca and a JKS truststore work/keystore.jks. If you want to run Spring Cloud Vault using this quickstart guide you need to configure the truststore the spring.cloud.vault.ssl.trust-store property to file:work/keystore.jks. |

**Start Vault server**

$ src/**test**/bash/local\_run\_vault.sh

Vault is started listening on 0.0.0.0:8200 using the inmem storage and https. Vault is sealed and not initialized when starting up.

|  |
| --- |
| [Note] |
| If you want to run tests, leave Vault uninitialized. The tests will initialize Vault and create a root token 00000000-0000-0000-0000-000000000000. |

If you want to use Vault for your application or give it a try then you need to initialize it first.

$ **export** VAULT\_ADDR="https://localhost:8200"

$ **export** VAULT\_SKIP\_VERIFY=true *# Don't do this for production*

$ vault init

You should see something like:

Key 1: 7149c6a2e16b8833f6eb1e76df03e47f6113a3288b3093faf5033d44f0e70fe701

Key 2: 901c534c7988c18c20435a85213c683bdcf0efcd82e38e2893779f152978c18c02

Key 3: 03ff3948575b1165a20c20ee7c3e6edf04f4cdbe0e82dbff5be49c63f98bc03a03

Key 4: 216ae5cc3ddaf93ceb8e1d15bb9fc3176653f5b738f5f3d1ee00cd7dccbe926e04

Key 5: b2898fc8130929d569c1677ee69dc5f3be57d7c4b494a6062693ce0b1c4d93d805

Initial Root Token: 19aefa97-cccc-bbbb-aaaa-225940e63d76

Vault initialized with 5 keys and a key threshold of 3. Please

securely distribute the above keys. When the Vault is re-sealed,

restarted, or stopped, you must provide at least 3 of these keys

to unseal it again.

Vault does not store the master key. Without at least 3 keys,

your Vault will remain permanently sealed.

Vault will initialize and return a set of unsealing keys and the root token. Pick 3 keys and unseal Vault. Store the Vault token in the VAULT\_TOKEN environment variable.

$ vault unseal (Key 1)

$ vault unseal (Key 2)

$ vault unseal (Key 3)

$ **export** VAULT\_TOKEN=(Root token)

*# Required to run Spring Cloud Vault tests after manual initialization*

$ vault token-create -id="00000000-0000-0000-0000-000000000000" -policy="root"

Spring Cloud Vault accesses different resources. By default, the secret backend is enabled which accesses secret config settings via JSON endpoints.

The HTTP service has resources in the form:

/secret/{application}/{profile}

/secret/{application}

/secret/{defaultContext}/{profile}

/secret/{defaultContext}

where the "application" is injected as the spring.application.name in the SpringApplication (i.e. what is normally "application" in a regular Spring Boot app), "profile" is an active profile (or comma-separated list of properties). Properties retrieved from Vault will be used "as-is" without further prefixing of the property names.

## 99. Client Side Usage

To use these features in an application, just build it as a Spring Boot application that depends on spring-cloud-vault-config (e.g. see the test cases). Example Maven configuration:

**Example 99.1. pom.xml**

<parent>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-parent</artifactId>

<version>1.5.4.RELEASE</version>

<relativePath /> *<!-- lookup parent from repository -->*

</parent>

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-starter-vault-config</artifactId>

<version>Finchley.M9</version>

</dependency>

<dependency>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-starter-test</artifactId>

<scope>test</scope>

</dependency>

</dependencies>

<build>

<plugins>

<plugin>

<groupId>org.springframework.boot</groupId>

<artifactId>spring-boot-maven-plugin</artifactId>

</plugin>

</plugins>

</build>

*<!-- repositories also needed for snapshots and milestones -->*

Then you can create a standard Spring Boot application, like this simple HTTP server:

*@SpringBootApplication*

*@RestController*

**public** **class** Application {

*@RequestMapping("/")*

**public** String home() {

**return** "Hello World!";

}

**public** **static** **void** main(String[] args) {

SpringApplication.run(Application.**class**, args);

}

}

When it runs it will pick up the external configuration from the default local Vault server on port 8200 if it is running. To modify the startup behavior you can change the location of the Vault server using bootstrap.properties (like application.properties but for the bootstrap phase of an application context), e.g.

**Example 99.2. bootstrap.yml**

spring.cloud.vault:

host: localhost

port: 8200

scheme: https

uri: https://localhost:8200

connection-timeout: 5000

read-timeout: 15000

config:

order: -10

* host sets the hostname of the Vault host. The host name will be used for SSL certificate validation
* port sets the Vault port
* scheme setting the scheme to http will use plain HTTP. Supported schemes are http and https.
* uri configure the Vault endpoint with an URI. Takes precedence over host/port/scheme configuration
* connection-timeout sets the connection timeout in milliseconds
* read-timeout sets the read timeout in milliseconds
* config.order sets the order for the property source

Enabling further integrations requires additional dependencies and configuration. Depending on how you have set up Vault you might need additional configuration like[SSL](https://cloud.spring.io/spring-cloud-vault/spring-cloud-vault.html#vault.config.ssl) and [authentication](https://cloud.spring.io/spring-cloud-vault/spring-cloud-vault.html#vault.config.authentication).

If the application imports the spring-boot-starter-actuator project, the status of the vault server will be available via the /health endpoint.

The vault health indicator can be enabled or disabled through the property health.vault.enabled (default true).

## 99.1 Authentication

Vault requires an [authentication mechanism](https://www.vaultproject.io/docs/concepts/auth.html) to [authorize client requests](https://www.vaultproject.io/docs/concepts/tokens.html).

Spring Cloud Vault supports multiple [authentication mechanisms](https://cloud.spring.io/spring-cloud-vault/spring-cloud-vault.html#vault.config.authentication) to authenticate applications with Vault.

For a quickstart, use the root token printed by the [Vault initialization](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi__quick_start_4.html#quickstart.vault.start).

**Example 99.3. bootstrap.yml**

spring.cloud.vault:

token: 19aefa97-cccc-bbbb-aaaa-225940e63d76

|  |
| --- |
| [Warning] |
| Consider carefully your security requirements. Static token authentication is fine if you want quickly get started with Vault, but a static token is not protected any further. Any disclosure to unintended parties allows Vault use with the associated token roles. |

## 100. Authentication methods

Different organizations have different requirements for security and authentication. Vault reflects that need by shipping multiple authentication methods. Spring Cloud Vault supports token and AppId authentication.

## 100.1 Token authentication

Tokens are the core method for authentication within Vault. Token authentication requires a static token to be provided using the [Bootstrap Application Context](https://github.com/spring-cloud/spring-cloud-commons/blob/master/docs/src/main/asciidoc/spring-cloud-commons.adoc#the-bootstrap-application-context).

|  |
| --- |
| [Note] |
| Token authentication is the default authentication method. If a token is disclosed an unintended party gains access to Vault and can access secrets for the intended client. |

**Example 100.1. bootstrap.yml**

spring.cloud.vault:

authentication: TOKEN

token: 00000000-0000-0000-0000-000000000000

* authentication setting this value to TOKEN selects the Token authentication method
* token sets the static token to use

See also: [Vault Documentation: Tokens](https://www.vaultproject.io/docs/concepts/tokens.html)

## 100.2 AppId authentication

Vault supports [AppId](https://www.vaultproject.io/docs/auth/app-id.html) authentication that consists of two hard to guess tokens. The AppId defaults to spring.application.name that is statically configured. The second token is the UserId which is a part determined by the application, usually related to the runtime environment. IP address, Mac address or a Docker container name are good examples. Spring Cloud Vault Config supports IP address, Mac address and static UserId’s (e.g. supplied via System properties). The IP and Mac address are represented as Hex-encoded SHA256 hash.

IP address-based UserId’s use the local host’s IP address.

**Example 100.2. bootstrap.yml using SHA256 IP-Address UserId’s**

spring.cloud.vault:

authentication: APPID

app-id:

user-id: IP\_ADDRESS

* authentication setting this value to APPID selects the AppId authentication method
* app-id-path sets the path of the AppId mount to use
* user-id sets the UserId method. Possible values are IP\_ADDRESS, MAC\_ADDRESS or a class name implementing a custom AppIdUserIdMechanism

The corresponding command to generate the IP address UserId from a command line is:

$ echo -n 192.168.99.1 | sha256sum

|  |
| --- |
| [Note] |
| Including the line break of echo leads to a different hash value so make sure to include the -n flag. |

Mac address-based UserId’s obtain their network device from the localhost-bound device. The configuration also allows specifying a network-interface hint to pick the right device. The value of network-interface is optional and can be either an interface name or interface index (0-based).

**Example 100.3. bootstrap.yml using SHA256 Mac-Address UserId’s**

spring.cloud.vault:

authentication: APPID

app-id:

user-id: MAC\_ADDRESS

network-interface: eth0

* network-interface sets network interface to obtain the physical address

The corresponding command to generate the IP address UserId from a command line is:

$ echo -n 0AFEDE1234AC | sha256sum

|  |
| --- |
| [Note] |
| The Mac address is specified uppercase and without colons. Including the line break of echo leads to a different hash value so make sure to include the -n flag. |

### 100.2.1 Custom UserId

The UserId generation is an open mechanism. You can set spring.cloud.vault.app-id.user-id to any string and the configured value will be used as static UserId.

A more advanced approach lets you set spring.cloud.vault.app-id.user-id to a classname. This class must be on your classpath and must implement the org.springframework.cloud.vault.AppIdUserIdMechanism interface and the createUserId method. Spring Cloud Vault will obtain the UserId by calling createUserId each time it authenticates using AppId to obtain a token.

**Example 100.4. bootstrap.yml**

spring.cloud.vault:

authentication: APPID

app-id:

user-id: com.examlple.MyUserIdMechanism

**Example 100.5. MyUserIdMechanism.java**

public class MyUserIdMechanism implements AppIdUserIdMechanism **{**

*@Override*

public String createUserId() **{**

String userId = ...

return userId;

**}**

**}**

See also: [Vault Documentation: Using the App ID auth backend](https://www.vaultproject.io/docs/auth/app-id.html)

## 100.3 AppRole authentication

[AppRole](https://www.vaultproject.io/docs/auth/app-id.html) is intended for machine authentication, like the deprecated (since Vault 0.6.1) [Section 100.2, “AppId authentication”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.authentication.html#vault.config.authentication.appid). AppRole authentication consists of two hard to guess (secret) tokens: RoleId and SecretId.

Spring Vault supports various AppRole scenarios (push/pull mode and wrapped).

RoleId and optionally SecretId must be provided by configuration, Spring Vault will not look up these or create a custom SecretId.

**Example 100.6. bootstrap.yml with AppRole authentication properties**

spring.cloud.vault:

authentication: APPROLE

app-role:

role-id: bde2076b-cccb-3cf0-d57e-bca7b1e83a52

The following scenarios are supported along the required configuration details:

**Table 100.1. Configuration**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Method** | **RoleId** | **SecretId** | **RoleName** | **Token** |
| Provided RoleId/SecretId | Provided | Provided |  |  |
| Provided RoleId without SecretId | Provided |  |  |  |
| Provided RoleId, Pull SecretId | Provided | Provided | Provided | Provided |
| Pull RoleId, provided SecretId |  | Provided | Provided | Provided |
| Full Pull Mode |  |  | Provided | Provided |
| Wrapped |  |  |  | Provided |
| Wrapped RoleId, provided SecretId | Provided |  |  | Provided |
| Provided RoleId, wrapped SecretId |  | Provided |  | Provided |

**Table 100.2. Pull/Push/Wrapped Matrix**

|  |  |  |
| --- | --- | --- |
| **RoleId** | **SecretId** | **Supported** |
| Provided | Provided | ✅ |
| Provided | Pull | ✅ |
| Provided | Wrapped | ✅ |
| Provided | Absent | ✅ |
| Pull | Provided | ✅ |
| Pull | Pull | ✅ |
| Pull | Wrapped | ❌ |
| Pull | Absent | ❌ |
| Wrapped | Provided | ✅ |
| Wrapped | Pull | ❌ |
| Wrapped | Wrapped | ✅ |
| Wrapped | Absent | ❌ |

|  |
| --- |
| [Note] |
| You can use still all combinations of push/pull/wrapped modes by providing a configured AppRoleAuthentication bean within the boostrap context. Spring Cloud Vault cannot derive all possible AppRole combinations from the configuration properties. |

**Example 100.7. bootstrap.yml with all AppRole authentication properties**

spring.cloud.vault:

authentication: APPROLE

app-role:

role-id: bde2076b-cccb-3cf0-d57e-bca7b1e83a52

secret-id: 1696536f-1976-73b1-b241-0b4213908d39

role: my-role

app-role-path: approle

* role-id sets the RoleId.
* secret-id sets the SecretId. SecretId can be omitted if AppRole is configured without requiring SecretId (See bind\_secret\_id).
* role: sets the AppRole name for pull mode.
* app-role-path sets the path of the approle authentication mount to use.

See also: [Vault Documentation: Using the AppRole auth backend](https://www.vaultproject.io/docs/auth/approle.html)

## 100.4 AWS-EC2 authentication

The [aws-ec2](https://www.vaultproject.io/docs/auth/aws-ec2.html) auth backend provides a secure introduction mechanism for AWS EC2 instances, allowing automated retrieval of a Vault token. Unlike most Vault authentication backends, this backend does not require first-deploying, or provisioning security-sensitive credentials (tokens, username/password, client certificates, etc.). Instead, it treats AWS as a Trusted Third Party and uses the cryptographically signed dynamic metadata information that uniquely represents each EC2 instance.

**Example 100.8. bootstrap.yml using AWS-EC2 Authentication**

spring.cloud.vault:

authentication: AWS\_EC2

AWS-EC2 authentication enables nonce by default to follow the Trust On First Use (TOFU) principle. Any unintended party that gains access to the PKCS#7 identity metadata can authenticate against Vault.

During the first login, Spring Cloud Vault generates a nonce that is stored in the auth backend aside the instance Id. Re-authentication requires the same nonce to be sent. Any other party does not have the nonce and can raise an alert in Vault for further investigation.

The nonce is kept in memory and is lost during application restart. You can configure a static nonce with spring.cloud.vault.aws-ec2.nonce.

AWS-EC2 authentication roles are optional and default to the AMI. You can configure the authentication role by setting the spring.cloud.vault.aws-ec2.roleproperty.

**Example 100.9. bootstrap.yml with configured role**

spring.cloud.vault:

authentication: AWS\_EC2

aws-ec2:

role: application-server

**Example 100.10. bootstrap.yml with all AWS EC2 authentication properties**

spring.cloud.vault:

authentication: AWS\_EC2

aws-ec2:

role: application-server

aws-ec2-path: aws-ec2

identity-document: http://...

nonce: my-static-nonce

* authentication setting this value to AWS\_EC2 selects the AWS EC2 authentication method
* role sets the name of the role against which the login is being attempted.
* aws-ec2-path sets the path of the AWS EC2 mount to use
* identity-document sets URL of the PKCS#7 AWS EC2 identity document
* nonce used for AWS-EC2 authentication. An empty nonce defaults to nonce generation

See also: [Vault Documentation: Using the aws auth backend](https://www.vaultproject.io/docs/auth/aws.html)

## 100.5 AWS-IAM authentication

The [aws](https://www.vaultproject.io/docs/auth/aws-ec2.html) backend provides a secure authentication mechanism for AWS IAM roles, allowing the automatic authentication with vault based on the current IAM role of the running application. Unlike most Vault authentication backends, this backend does not require first-deploying, or provisioning security-sensitive credentials (tokens, username/password, client certificates, etc.). Instead, it treats AWS as a Trusted Third Party and uses the 4 pieces of information signed by the caller with their IAM credentials to verify that the caller is indeed using that IAM role.

The current IAM role the application is running in is automatically calculated. If you are running your application on AWS ECS then the application will use the IAM role assigned to the ECS task of the running container. If you are running your application naked on top of an EC2 instance then the IAM role used will be the one assigned to the EC2 instance.

When using the AWS-IAM authentication you must create a role in Vault and assign it to your IAM role. An empty role defaults to the friendly name the current IAM role.

**Example 100.11. bootstrap.yml with required AWS-IAM Authentication properties**

spring.cloud.vault:

authentication: AWS\_IAM

**Example 100.12. bootstrap.yml with all AWS-IAM Authentication properties**

spring.cloud.vault:

authentication: AWS\_IAM

aws-iam:

role: my-dev-role

aws-path: aws

server-id: some.server.name

* role sets the name of the role against which the login is being attempted. This should be bound to your IAM role. If one is not supplied then the friendly name of the current IAM user will be used as the vault role.
* aws-path sets the path of the AWS mount to use
* server-id sets the value to use for the X-Vault-AWS-IAM-Server-ID header preventing certain types of replay attacks.

AWS-IAM requires the AWS Java SDK dependency (com.amazonaws:aws-java-sdk-core) as the authentication implementation uses AWS SDK types for credentials and request signing.

See also: [Vault Documentation: Using the aws auth backend](https://www.vaultproject.io/docs/auth/aws.html)

## 100.6 TLS certificate authentication

The cert auth backend allows authentication using SSL/TLS client certificates that are either signed by a CA or self-signed.

To enable cert authentication you need to:

1. Use SSL, see [Chapter 106, *Vault Client SSL configuration*](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.ssl.html)
2. Configure a Java Keystore that contains the client certificate and the private key
3. Set the spring.cloud.vault.authentication to CERT

**Example 100.13. bootstrap.yml**

spring.cloud.vault:

authentication: CERT

ssl:

key-store: classpath:keystore.jks

key-store-password: changeit

cert-auth-path: cert

See also: [Vault Documentation: Using the Cert auth backend](https://www.vaultproject.io/docs/auth/cert.html)

## 100.7 Cubbyhole authentication

Cubbyhole authentication uses Vault primitives to provide a secured authentication workflow. Cubbyhole authentication uses tokens as primary login method. An ephemeral token is used to obtain a second, login VaultToken from Vault’s Cubbyhole secret backend. The login token is usually longer-lived and used to interact with Vault. The login token will be retrieved from a wrapped response stored at /cubbyhole/response.

**Creating a wrapped token**

|  |
| --- |
| [Note] |
| Response Wrapping for token creation requires Vault 0.6.0 or higher. |

**Example 100.14. Creating and storing tokens**

$ vault token-create -wrap-ttl="10m"

Key Value

--- -----

wrapping\_token: 397ccb93-ff6c-b17b-9389-380b01ca2645

wrapping\_token\_ttl: 0h10m0s

wrapping\_token\_creation\_time: 2016-09-18 20:29:48.652957077 +0200 CEST

wrapped\_accessor: 46b6aebb-187f-932a-26d7-4f3d86a68319

**Example 100.15. bootstrap.yml**

spring.cloud.vault:

authentication: CUBBYHOLE

token: 397ccb93-ff6c-b17b-9389-380b01ca2645

See also:

* [Vault Documentation: Tokens](https://www.vaultproject.io/docs/concepts/tokens.html)
* [Vault Documentation: Cubbyhole Secret Backend](https://www.vaultproject.io/docs/secrets/cubbyhole/index.html)
* [Vault Documentation: Response Wrapping](https://www.vaultproject.io/docs/concepts/response-wrapping.html)

## 100.8 Kubernetes authentication

Kubernetes authentication mechanism (since Vault 0.8.3) allows to authenticate with Vault using a Kubernetes Service Account Token. The authentication is role based and the role is bound to a service account name and a namespace.

A file containing a JWT token for a pod’s service account is automatically mounted at /var/run/secrets/kubernetes.io/serviceaccount/token.

**Example 100.16. bootstrap.yml with all Kubernetes authentication properties**

spring.cloud.vault:

authentication: KUBERNETES

kubernetes:

role: my-dev-role

service-account-token-file: /var/run/secrets/kubernetes.io/serviceaccount/token

* role sets the Role.
* service-account-token-file sets the location of the file containing the Kubernetes Service Account Token. Defaults to /var/run/secrets/kubernetes.io/serviceaccount/token.

See also:

* [Vault Documentation: Kubernetes](https://www.vaultproject.io/docs/auth/kubernetes.html)
* [Kubernetes Documentation: Configure Service Accounts for Pods](https://kubernetes.io/docs/tasks/configure-pod-container/configure-service-account/)

## 101. Secret Backends

## 101.1 Generic Backend

Spring Cloud Vault supports at the basic level the generic secret backend. The generic secret backend allows storage of arbitrary values as key-value store. A single context can store one or many key-value tuples. Contexts can be organized hierarchically. Spring Cloud Vault allows using the Application name and a default context name (application) in combination with active profiles.

/secret/{application}/{profile}

/secret/{application}

/secret/{default-context}/{profile}

/secret/{default-context}

The application name is determined by the properties:

* spring.cloud.vault.generic.application-name
* spring.cloud.vault.application-name
* spring.application.name

Secrets can be obtained from other folders within the generic backend by adding their paths to the application name, separated by commas. For example, given the application name usefulapp,mysql1,projectx/aws, each of these folders will be used:

* /secret/usefulapp
* /secret/mysql1
* /secret/projectx/aws

Spring Cloud Vault adds all active profiles to the list of possible context paths. No active profiles will skip accessing contexts with a profile name.

Properties are exposed like they are stored (i.e. without additional prefixes).

spring.cloud.vault:

generic:

enabled: **true**

backend: secret

profile-separator: '/'

default-context: application

application-name: my-app

* enabled setting this value to false disables the secret backend config usage
* backend sets the path of the secret mount to use
* default-context sets the context name used by all applications
* application-name overrides the application name for use in the generic backend
* profile-separator separates the profile name from the context in property sources with profiles

See also: [Vault Documentation: Using the generic secret backend](https://www.vaultproject.io/docs/secrets/generic/index.html)

## 101.2 Consul

Spring Cloud Vault can obtain credentials for HashiCorp Consul. The Consul integration requires the spring-cloud-vault-config-consul dependency.

**Example 101.1. pom.xml**

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-vault-config-consul</artifactId>

<version>Finchley.M9</version>

</dependency>

</dependencies>

The integration can be enabled by setting spring.cloud.vault.consul.enabled=true (default false) and providing the role name with spring.cloud.vault.consul.role=….

The obtained token is stored in spring.cloud.consul.token so using Spring Cloud Consul can pick up the generated credentials without further configuration. You can configure the property name by setting spring.cloud.vault.consul.token-property.

spring.cloud.vault:

consul:

enabled: **true**

role: readonly

backend: consul

token-property: spring.cloud.consul.token

* enabled setting this value to true enables the Consul backend config usage
* role sets the role name of the Consul role definition
* backend sets the path of the Consul mount to use
* token-property sets the property name in which the Consul ACL token is stored

See also: [Vault Documentation: Setting up Consul with Vault](https://www.vaultproject.io/docs/secrets/consul/index.html)

## 101.3 RabbitMQ

Spring Cloud Vault can obtain credentials for RabbitMQ.

The RabbitMQ integration requires the spring-cloud-vault-config-rabbitmq dependency.

**Example 101.2. pom.xml**

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-vault-config-rabbitmq</artifactId>

<version>Finchley.M9</version>

</dependency>

</dependencies>

The integration can be enabled by setting spring.cloud.vault.rabbitmq.enabled=true (default false) and providing the role name with spring.cloud.vault.rabbitmq.role=….

Username and password are stored in spring.rabbitmq.username and spring.rabbitmq.password so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting spring.cloud.vault.rabbitmq.username-property andspring.cloud.vault.rabbitmq.password-property.

spring.cloud.vault:

rabbitmq:

enabled: **true**

role: readonly

backend: rabbitmq

username-property: spring.rabbitmq.username

password-property: spring.rabbitmq.password

* enabled setting this value to true enables the RabbitMQ backend config usage
* role sets the role name of the RabbitMQ role definition
* backend sets the path of the RabbitMQ mount to use
* username-property sets the property name in which the RabbitMQ username is stored
* password-property sets the property name in which the RabbitMQ password is stored

See also: [Vault Documentation: Setting up RabbitMQ with Vault](https://www.vaultproject.io/docs/secrets/rabbitmq/index.html)

## 101.4 AWS

Spring Cloud Vault can obtain credentials for AWS.

The AWS integration requires the spring-cloud-vault-config-aws dependency.

**Example 101.3. pom.xml**

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-vault-config-aws</artifactId>

<version>Finchley.M9</version>

</dependency>

</dependencies>

The integration can be enabled by setting spring.cloud.vault.aws=true (default false) and providing the role name with spring.cloud.vault.aws.role=….

The access key and secret key are stored in cloud.aws.credentials.accessKey and cloud.aws.credentials.secretKey so using Spring Cloud AWS will pick up the generated credentials without further configuration. You can configure the property names by setting spring.cloud.vault.aws.access-key-property andspring.cloud.vault.aws.secret-key-property.

spring.cloud.vault:

aws:

enabled: **true**

role: readonly

backend: aws

access-key-property: cloud.aws.credentials.accessKey

secret-key-property: cloud.aws.credentials.secretKey

* enabled setting this value to true enables the AWS backend config usage
* role sets the role name of the AWS role definition
* backend sets the path of the AWS mount to use
* access-key-property sets the property name in which the AWS access key is stored
* secret-key-property sets the property name in which the AWS secret key is stored

See also: [Vault Documentation: Setting up AWS with Vault](https://www.vaultproject.io/docs/secrets/aws/index.html)

## 102. Database backends

Vault supports several database secret backends to generate database credentials dynamically based on configured roles. This means services that need to access a database no longer need to configure credentials: they can request them from Vault, and use Vault’s leasing mechanism to more easily roll keys.

Spring Cloud Vault integrates with these backends:

* [Section 102.1, “Database”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.backends.database-backends.html#vault.config.backends.database)
* [Section 102.2, “Apache Cassandra”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.backends.database-backends.html#vault.config.backends.cassandra)
* [Section 102.3, “MongoDB”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.backends.database-backends.html#vault.config.backends.mongodb)
* [Section 102.4, “MySQL”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.backends.database-backends.html#vault.config.backends.mysql)
* [Section 102.5, “PostgreSQL”](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_vault.config.backends.database-backends.html#vault.config.backends.postgresql)

Using a database secret backend requires to enable the backend in the configuration and the spring-cloud-vault-config-databases dependency.

Vault ships since 0.7.1 with a dedicated database secret backend that allows database integration via plugins. You can use that specific backend by using the generic database backend. Make sure to specify the appropriate backend path, e.g. spring.cloud.vault.mysql.role.backend=database.

**Example 102.1. pom.xml**

<dependencies>

<dependency>

<groupId>org.springframework.cloud</groupId>

<artifactId>spring-cloud-vault-config-databases</artifactId>

<version>Finchley.M9</version>

</dependency>

</dependencies>

|  |
| --- |
| [Note] |
| Enabling multiple JDBC-compliant databases will generate credentials and store them by default in the same property keys hence property names for JDBC secrets need to be configured separately. |

## 102.1 Database

Spring Cloud Vault can obtain credentials for any database listed at <https://www.vaultproject.io/api/secret/databases/index.html>. The integration can be enabled by settingspring.cloud.vault.database.enabled=true (default false) and providing the role name with spring.cloud.vault.database.role=….

While the database backend is a generic one, spring.cloud.vault.database specifically targets JDBC databases. Username and password are stored in spring.datasource.username and spring.datasource.password so using Spring Boot will pick up the generated credentials for your DataSource without further configuration. You can configure the property names by setting spring.cloud.vault.database.username-property andspring.cloud.vault.database.password-property.

spring.cloud.vault:

database:

enabled: **true**

role: readonly

backend: database

username-property: spring.datasource.username

password-property: spring.datasource.username

* enabled setting this value to true enables the Database backend config usage
* role sets the role name of the Database role definition
* backend sets the path of the Database mount to use
* username-property sets the property name in which the Database username is stored
* password-property sets the property name in which the Database password is stored

See also: [Vault Documentation: Database Secrets backend](https://www.vaultproject.io/docs/secrets/databases/index.html)

## 102.2 Apache Cassandra

|  |
| --- |
| [Note] |
| The cassandra backend has been deprecated in Vault 0.7.1 and it is recommended to use the database backend and mount it as cassandra. |

Spring Cloud Vault can obtain credentials for Apache Cassandra. The integration can be enabled by setting spring.cloud.vault.cassandra.enabled=true (default false) and providing the role name with spring.cloud.vault.cassandra.role=….

Username and password are stored in spring.data.cassandra.username and spring.data.cassandra.password so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting spring.cloud.vault.cassandra.username-property andspring.cloud.vault.cassandra.password-property.

spring.cloud.vault:

cassandra:

enabled: **true**

role: readonly

backend: cassandra

username-property: spring.data.cassandra.username

password-property: spring.data.cassandra.username

* enabled setting this value to true enables the Cassandra backend config usage
* role sets the role name of the Cassandra role definition
* backend sets the path of the Cassandra mount to use
* username-property sets the property name in which the Cassandra username is stored
* password-property sets the property name in which the Cassandra password is stored

See also: [Vault Documentation: Setting up Apache Cassandra with Vault](https://www.vaultproject.io/docs/secrets/cassandra/index.html)

## 102.3 MongoDB

|  |
| --- |
| [Note] |
| The mongodb backend has been deprecated in Vault 0.7.1 and it is recommended to use the database backend and mount it as mongodb. |

Spring Cloud Vault can obtain credentials for MongoDB. The integration can be enabled by setting spring.cloud.vault.mongodb.enabled=true (default false) and providing the role name with spring.cloud.vault.mongodb.role=….

Username and password are stored in spring.data.mongodb.username and spring.data.mongodb.password so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting spring.cloud.vault.mongodb.username-property andspring.cloud.vault.mongodb.password-property.

spring.cloud.vault:

mongodb:

enabled: **true**

role: readonly

backend: mongodb

username-property: spring.data.mongodb.username

password-property: spring.data.mongodb.password

* enabled setting this value to true enables the MongodB backend config usage
* role sets the role name of the MongoDB role definition
* backend sets the path of the MongoDB mount to use
* username-property sets the property name in which the MongoDB username is stored
* password-property sets the property name in which the MongoDB password is stored

See also: [Vault Documentation: Setting up MongoDB with Vault](https://www.vaultproject.io/docs/secrets/mongodb/index.html)

## 102.4 MySQL

|  |
| --- |
| [Note] |
| The mysql backend has been deprecated in Vault 0.7.1 and it is recommended to use the database backend and mount it as mysql. Configuration for spring.cloud.vault.mysql will be removed in a future version. |

Spring Cloud Vault can obtain credentials for MySQL. The integration can be enabled by setting spring.cloud.vault.mysql.enabled=true (default false) and providing the role name with spring.cloud.vault.mysql.role=….

Username and password are stored in spring.datasource.username and spring.datasource.password so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting spring.cloud.vault.mysql.username-property andspring.cloud.vault.mysql.password-property.

spring.cloud.vault:

mysql:

enabled: **true**

role: readonly

backend: mysql

username-property: spring.datasource.username

password-property: spring.datasource.username

* enabled setting this value to true enables the MySQL backend config usage
* role sets the role name of the MySQL role definition
* backend sets the path of the MySQL mount to use
* username-property sets the property name in which the MySQL username is stored
* password-property sets the property name in which the MySQL password is stored

See also: [Vault Documentation: Setting up MySQL with Vault](https://www.vaultproject.io/docs/secrets/mysql/index.html)

## 102.5 PostgreSQL

|  |
| --- |
| [Note] |
| The postgresql backend has been deprecated in Vault 0.7.1 and it is recommended to use the database backend and mount it as postgresql. Configuration for spring.cloud.vault.postgresql will be removed in a future version. |

Spring Cloud Vault can obtain credentials for PostgreSQL. The integration can be enabled by setting spring.cloud.vault.postgresql.enabled=true (default false) and providing the role name with spring.cloud.vault.postgresql.role=….

Username and password are stored in spring.datasource.username and spring.datasource.password so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting spring.cloud.vault.postgresql.username-property andspring.cloud.vault.postgresql.password-property.

spring.cloud.vault:

postgresql:

enabled: **true**

role: readonly

backend: postgresql

username-property: spring.datasource.username

password-property: spring.datasource.username

* enabled setting this value to true enables the PostgreSQL backend config usage
* role sets the role name of the PostgreSQL role definition
* backend sets the path of the PostgreSQL mount to use
* username-property sets the property name in which the PostgreSQL username is stored
* password-property sets the property name in which the PostgreSQL password is stored

See also: [Vault Documentation: Setting up PostgreSQL with Vault](https://www.vaultproject.io/docs/secrets/postgresql/index.html)

## 103. Configure PropertySourceLocator behavior

Spring Cloud Vault uses property-based configuration to create PropertySources for generic and discovered secret backends.

Discovered backends provide VaultSecretBackendDescriptor beans to describe the configuration state to use secret backend as PropertySource. A SecretBackendMetadataFactory is required to create a SecretBackendMetadata object which contains path, name and property transformation configuration.

SecretBackendMetadata is used to back a particular PropertySource.

You can register an arbitrary number of beans implementing VaultConfigurer for customization. Default generic and discovered backend registration is disabled if Spring Cloud Vault discovers at least one VaultConfigurer bean. You can however enable default registration withSecretBackendConfigurer.registerDefaultGenericSecretBackends() and SecretBackendConfigurer.registerDefaultDiscoveredSecretBackends().

**public** **class** CustomizationBean **implements** VaultConfigurer {

*@Override*

**public** **void** addSecretBackends(SecretBackendConfigurer configurer) {

configurer.add("secret/my-application");

configurer.registerDefaultGenericSecretBackends(false);

configurer.registerDefaultDiscoveredSecretBackends(true);

}

}

|  |
| --- |
| [Note] |
| All customization is required to happen in the bootstrap context. Add your configuration classes to META-INF/spring.factories at org.springframework.cloud.bootstrap.BootstrapConfiguration in your application. |

## 104. Service Registry Configuration

You can use a DiscoveryClient (such as from Spring Cloud Consul) to locate a Vault server by setting spring.cloud.vault.discovery.enabled=true (default false). The net result of that is that your apps need a bootstrap.yml (or an environment variable) with the appropriate discovery configuration. The benefit is that the Vault can change its co-ordinates, as long as the discovery service is a fixed point. The default service id is vault but you can change that on the client withspring.cloud.vault.discovery.serviceId.

The discovery client implementations all support some kind of metadata map (e.g. for Eureka we have eureka.instance.metadataMap). Some additional properties of the service may need to be configured in its service registration metadata so that clients can connect correctly. Service registries that do not provide details about transport layer security need to provide a scheme metadata entry to be set either to https or http. If no scheme is configured and the service is not exposed as secure service, then configuration defaults to spring.cloud.vault.scheme which is https when it’s not set.

spring.cloud.vault.discovery:

enabled: **true**

service-id: my-vault-service

## 105. Vault Client Fail Fast

In some cases, it may be desirable to fail startup of a service if it cannot connect to the Vault Server. If this is the desired behavior, set the bootstrap configuration property spring.cloud.vault.fail-fast=true and the client will halt with an Exception.

spring.cloud.vault:

fail-fast: **true**

## 106. Vault Client SSL configuration

SSL can be configured declaratively by setting various properties. You can set either javax.net.ssl.trustStore to configure JVM-wide SSL settings or spring.cloud.vault.ssl.trust-store to set SSL settings only for Spring Cloud Vault Config.

spring.cloud.vault:

ssl:

trust-store: classpath:keystore.jks

trust-store-password: changeit

* trust-store sets the resource for the trust-store. SSL-secured Vault communication will validate the Vault SSL certificate with the specified trust-store.
* trust-store-password sets the trust-store password

Please note that configuring spring.cloud.vault.ssl.\* can be only applied when either Apache Http Components or the OkHttp client is on your class-path.

## 107. Lease lifecycle management (renewal and revocation)

With every secret, Vault creates a lease: metadata containing information such as a time duration, renewability, and more.

Vault promises that the data will be valid for the given duration, or Time To Live (TTL). Once the lease is expired, Vault can revoke the data, and the consumer of the secret can no longer be certain that it is valid.

Spring Cloud Vault maintains a lease lifecycle beyond the creation of login tokens and secrets. That said, login tokens and secrets associated with a lease are scheduled for renewal just before the lease expires until terminal expiry. Application shutdown revokes obtained login tokens and renewable leases.

Secret service and database backends (such as MongoDB or MySQL) usually generate a renewable lease so generated credentials will be disabled on application shutdown.

|  |
| --- |
| [Note] |
| Static tokens are not renewed or revoked. |

Lease renewal and revocation is enabled by default and can be disabled by setting spring.cloud.vault.config.lifecycle.enabled to false. This is not recommended as leases can expire and Spring Cloud Vault cannot longer access Vault or services using generated credentials and valid credentials remain active after application shutdown.

spring.cloud.vault:

config.lifecycle.enabled: **true**

See also: [Vault Documentation: Lease, Renew, and Revoke](https://www.vaultproject.io/docs/concepts/lease.html)

# Part XV. Spring Cloud Gateway

**Finchley.M9**

This project provides an API Gateway built on top of the Spring Ecosystem, including: Spring 5, Spring Boot 2 and Project Reactor. Spring Cloud Gateway aims to provide a simple, yet effective way to route to APIs and provide cross cutting concerns to them such as: security, monitoring/metrics, and resiliency.

## 108. How to Include Spring Cloud Gateway

To include Spring Cloud Gateway in your project use the starter with group org.springframework.cloud and artifact id spring-cloud-starter-gateway. See the [Spring Cloud Project page](https://projects.spring.io/spring-cloud/) for details on setting up your build system with the current Spring Cloud Release Train.

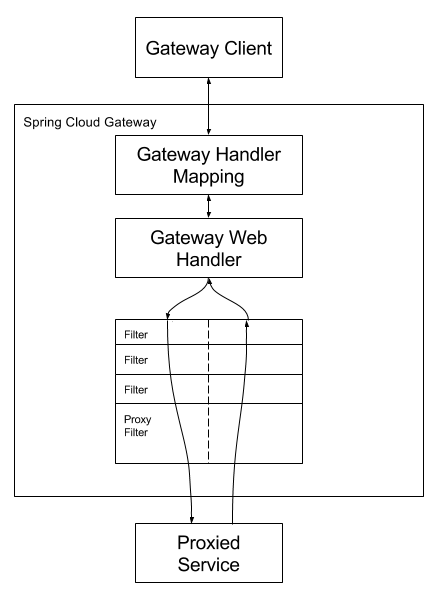
If you include the starter, but, for some reason, you do not want the gateway to be enabled, set spring.cloud.gateway.enabled=false.

|  |  |
| --- | --- |
| [Important] | **Important** |
| Spring Cloud Gateway requires the Netty runtime provided by Spring Boot and Spring Webflux. It does not work in a traditional Servlet Container or built as a WAR. |

## 109. Glossary

* **Route**: Route the basic building block of the gateway. It is defined by an ID, a destination URI, a collection of predicates and a collection of filters. A route is matched if aggregate predicate is true.
* **Predicate**: This is a [Java 8 Function Predicate](http://docs.oracle.com/javase/8/docs/api/java/util/function/Predicate.html). The input type is a [Spring Framework ServerWebExchange](https://docs.spring.io/spring/docs/5.0.x/javadoc-api/org/springframework/web/server/ServerWebExchange.html). This allows developers to match on anything from the HTTP request, such as headers or parameters.
* **Filter**: These are instances [Spring Framework GatewayFilter](https://docs.spring.io/spring/docs/5.0.x/javadoc-api/org/springframework/web/server/GatewayFilter.html) constructed in with a specific factory. Here, requests and responses can be modified before or after sending the downstream request.

## 110. How It Works



Clients make requests to Spring Cloud Gateway. If the Gateway Handler Mapping determines that a request matches a Route, it is sent to the Gateway Web Handler. This handler runs sends the request through a filter chain that is specific to the request. The reason the filters are divided by the dotted line, is that filters may execute logic before the proxy request is sent or after. All "pre" filter logic is executed, then the proxy request is made. After the proxy request is made, the "post" filter logic is executed.

|  |
| --- |
| [Note] |
| URIs defined in routes without a port will get a default port set to 80 and 443 for HTTP and HTTPS URIs respectively. |

## 111. Route Predicate Factories

Spring Cloud Gateway matches routes as part of the Spring WebFlux HandlerMapping infrastructure. Spring Cloud Gateway includes many built-in Route Predicate Factories. All of these predicates match on different attributes of the HTTP request. Multiple Route Predicate Factories can be combined and are combined via logical and.

## 111.1 After Route Predicate Factory

The After Route Predicate Factory takes one parameter, a datetime. This predicate matches requests that happen after the current datetime.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: after\_route

uri: http://example.org

predicates:

- After=2017-01-20T17:42:47.789-07:00[America/Denver**]**

This route matches any request after Jan 20, 2017 17:42 Mountain Time (Denver).

## 111.2 Before Route Predicate Factory

The Before Route Predicate Factory takes one parameter, a datetime. This predicate matches requests that happen before the current datetime.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: before\_route

uri: http://example.org

predicates:

- Before=2017-01-20T17:42:47.789-07:00[America/Denver**]**

This route matches any request before Jan 20, 2017 17:42 Mountain Time (Denver).

## 111.3 Between Route Predicate Factory

The Between Route Predicate Factory takes two parameters, datetime1 and datetime2. This predicate matches requests that happen after datetime1 and before datetime2. The datetime2 parameter must be after datetime1.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: between\_route

uri: http://example.org

predicates:

- Between=2017-01-20T17:42:47.789-07:00[America/Denver]**,** 2017-01-21T17:42:47.789-07:00[America/Denver**]**

This route matches any request after Jan 20, 2017 17:42 Mountain Time (Denver) and before Jan 21, 2017 17:42 Mountain Time (Denver). This could be useful for maintenance windows.

## 111.4 Cookie Route Predicate Factory

The Cookie Route Predicate Factory takes two parameters, the cookie name and a regular expression. This predicate matches cookies that have the given name and the value matches the regular expression.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: cookie\_route

uri: http://example.org

predicates:

- Cookie=chocolate**,** ch.p

This route matches the request has a cookie named chocolate who’s value matches the ch.p regular expression.

## 111.5 Header Route Predicate Factory

The Header Route Predicate Factory takes two parameters, the header name and a regular expression. This predicate matches with a header that has the given name and the value matches the regular expression.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: header\_route

uri: http://example.org

predicates:

- Header=X-Request-Id**,** \d+

This route matches if the request has a header named X-Request-Id whos value matches the \d+ regular expression (has a value of one or more digits).

## 111.6 Host Route Predicate Factory

The Host Route Predicate Factory takes one parameter: the host name pattern. The pattern is an Ant style pattern with . as the separator. This predicates matches the Host header that matches the pattern.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: host\_route

uri: http://example.org

predicates:

- Host=\*\*.somehost.org

This route would match if the request has a Host header has the value www.somehost.org or beta.somehost.org.

## 111.7 Method Route Predicate Factory

The Method Route Predicate Factory takes one parameter: the HTTP method to match.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: method\_route

uri: http://example.org

predicates:

- Method=GET

This route would match if the request method was a GET.

## 111.8 Path Route Predicate Factory

The Path Route Predicate Factory takes one parameter: a Spring PathMatcher pattern.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: host\_route

uri: http://example.org

predicates:

- Path=/foo/{segment**}**

This route would match if the request path was, for example: /foo/1 or /foo/bar.

This predicate extracts the URI template variables (like segment defined in the example above) as a map of names and values and places it in the ServerWebExchange.getAttributes() with a key defined in PathRoutePredicate.URL\_PREDICATE\_VARS\_ATTR. Those values are then available for use by [GatewayFilter Factories](http://cloud.spring.io/spring-cloud-static/Finchley.M9/multi/multi_gateway-route-filters.html)

## 111.9 Query Route Predicate Factory

The Query Route Predicate Factory takes two parameters: a required param and an optional regexp.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: query\_route

uri: http://example.org

predicates:

- Query=baz

This route would match if the request contained a baz query parameter.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: query\_route

uri: http://example.org

predicates:

- Query=foo**,** ba.

This route would match if the request contained a foo query parameter whose value matched the ba. regexp, so bar and baz would match.

## 111.10 RemoteAddr Route Predicate Factory

The RemoteAddr Route Predicate Factory takes a list (min size 1) of CIDR-notation (IPv4 or IPv6) strings, e.g. 192.168.0.1/16 (where 192.168.0.1 is an IP address and 16 is a subnet mask.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: remoteaddr\_route

uri: http://example.org

predicates:

- RemoteAddr=192.168.1.1/24

This route would match if the remote address of the request was, for example, 192.168.1.10.

## 112. GatewayFilter Factories

Route filters allow the modification of the incoming HTTP request or outgoing HTTP response in some manner. Route filters are scoped to a particular route. Spring Cloud Gateway includes many built-in GatewayFilter Factories.

## 112.1 AddRequestHeader GatewayFilter Factory

The AddRequestHeader GatewayFilter Factory takes a name and value parameter.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: add\_request\_header\_route

uri: http://example.org

filters:

- AddRequestHeader=X-Request-Foo**,** Bar

This will add X-Request-Foo:Bar header to the downstream request’s headers for all matching requests.

## 112.2 AddRequestParameter GatewayFilter Factory

The AddRequestParameter GatewayFilter Factory takes a name and value parameter.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: add\_request\_parameter\_route

uri: http://example.org

filters:

- AddRequestParameter=foo**,** bar

This will add foo=bar to the downstream request’s query string for all matching requests.

## 112.3 AddResponseHeader GatewayFilter Factory

The AddResponseHeader GatewayFilter Factory takes a name and value parameter.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: add\_request\_header\_route

uri: http://example.org

filters:

- AddResponseHeader=X-Response-Foo**,** Bar

This will add X-Response-Foo:Bar header to the downstream response’s headers for all matching requests.

## 112.4 Hystrix GatewayFilter Factory

The Hystrix GatewayFilter Factory requires a single name parameter, which is the name of the HystrixCommand.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: hystrix\_route

uri: http://example.org

filters:

- Hystrix=myCommandName

This wraps the remaining filters in a HystrixCommand with command name myCommandName.

The Hystrix filter can also accept an optional fallbackUri parameter. Currently, only forward: schemed URIs are supported. If the fallback is called, the request will be forwarded to the controller matched by the URI.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: hystrix\_route

uri: lb://backing-service:8088

predicates:

- Path=/consumingserviceendpoint

filters:

- name: Hystrix

args:

name: fallbackcmd

fallbackUri: forward:/incaseoffailureusethis

- RewritePath=/consumingserviceendpoint**,** /backingserviceendpoint

This will forward to the /incaseoffailureusethis URI when the Hystrix fallback is called. Note that this example also demonstrates (optional) Spring Cloud Netflix Ribbon load-balancing via the lb prefix on the destination URI.

## 112.5 PrefixPath GatewayFilter Factory

The PrefixPath GatewayFilter Factory takes a single prefix parameter.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: prefixpath\_route

uri: http://example.org

filters:

- PrefixPath=/mypath

This will prefix /mypath to the path of all matching requests. So a request to /hello, would be sent to /mypath/hello.

## 112.6 PreserveHostHeader GatewayFilter Factory

The PreserveHostHeader GatewayFilter Factory has not parameters. This filter, sets a request attribute that the routing filter will inspect to determine if the original host header should be sent, rather than the host header determined by the http client.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: preserve\_host\_route

uri: http://example.org

filters:

- PreserveHostHeader

This will prefix /mypath to the path of all matching requests. So a request to /hello, would be sent to /mypath/hello.

## 112.7 RequestRateLimiter GatewayFilter Factory

The RequestRateLimiter GatewayFilter Factory takes three parameters: replenishRate, burstCapacity & keyResolverName.

replenishRate is how many requests per second do you want a user to be allowed to do.

burstCapacity TODO: document burst capacity

keyResolver is a bean that implements the KeyResolver interface. In configuration, reference the bean by name using SpEL. #{@myKeyResolver} is a SpEL expression referencing a bean with the name myKeyResolver.

**KeyResolver.java.**

**public** **interface** KeyResolver {

Mono<String> resolve(ServerWebExchange exchange);

}

The KeyResolver interface allows pluggable strategies to derive the key for limiting requests. In future milestones, there will be some KeyResolver implementations.

The redis implementation is based off of work done at [Stripe](https://stripe.com/blog/rate-limiters). It requires the use of the spring-boot-starter-data-redis-reactive Spring Boot starter.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: requestratelimiter\_route

uri: http://example.org

filters:

- RequestRateLimiter=10**,** 20**,** *#{@userKeyResolver}*

**Config.java.**

*@Bean*

KeyResolver userKeyResolver() {

**return** exchange -> Mono.just(exchange.getRequest().getQueryParams().getFirst("user"));

}

This defines a request rate limit of 10 per user. The KeyResolver is a simple one that gets the user request parameter (note: this is not recommended for production).

## 112.8 RedirectTo GatewayFilter Factory

The RedirectTo GatewayFilter Factory takes a status and a url parameter. The status should be a 300 series redirect http code, such as 301. The url should be a valid url. This will be the value of the Location header.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: prefixpath\_route

uri: http://example.org

filters:

- RedirectTo=302**,** http://acme.org

This will send a status 302 with a Location:http://acme.org header to perform a redirect.

## 112.9 RemoveNonProxyHeaders GatewayFilter Factory

The RemoveNonProxyHeaders GatewayFilter Factory removes headers from forwarded requests. The default list of headers that is removed comes from the [IETF](https://tools.ietf.org/html/draft-ietf-httpbis-p1-messaging-14#section-7.1.3).

**The default removed headers are:**

* Connection
* Keep-Alive
* Proxy-Authenticate
* Proxy-Authorization
* TE
* Trailer
* Transfer-Encoding
* Upgrade

To change this, set the spring.cloud.gateway.filter.remove-non-proxy-headers.headers property to the list of header names to remove.

## 112.10 RemoveRequestHeader GatewayFilter Factory

The RemoveRequestHeader GatewayFilter Factory takes a name parameter. It is the name of the header to be removed.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: removerequestheader\_route

uri: http://example.org

filters:

- RemoveRequestHeader=X-Request-Foo

This will remove the X-Request-Foo header before it is sent downstream.

## 112.11 RemoveResponseHeader GatewayFilter Factory

The RemoveResponseHeader GatewayFilter Factory takes a name parameter. It is the name of the header to be removed.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: removeresponseheader\_route

uri: http://example.org

filters:

- RemoveResponseHeader=X-Response-Foo

This will remove the X-Response-Foo header from the response before it is returned to the gateway client.

## 112.12 RewritePath GatewayFilter Factory

The RewritePath GatewayFilter Factory takes a path regexp parameter and a replacement parameter. This uses Java regular expressions for a flexible way to rewrite the request path.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: rewritepath\_route

uri: http://example.org

predicates:

- Path=/foo/\*\*

filters:

- RewritePath=/foo/(?<segment>.\*)**,** /$\{segment**}**

For a request path of /foo/bar, this will set the path to /bar before making the downstream request. Notice the $\ which is replaced with $ because of the YAML spec.

## 112.13 SaveSession GatewayFilter Factory

The SaveSession GatewayFilter Factory forces a WebSession::save operation before forwarding the call downstream. This is of particular use when using something like [Spring Session](https://projects.spring.io/spring-session/) with a lazy data store and need to ensure the session state has been saved before making the forwarded call.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: save\_session

uri: http://example.org

predicates:

- Path=/foo/\*\*

filters:

- SaveSession

If you are integrating [Spring Security](https://projects.spring.io/spring-security/) with Spring Session, and want to ensure security details have been forwarded to the remote process, this is critical.

## 112.14 SecureHeaders GatewayFilter Factory

The SecureHeaders GatewayFilter Factory adds a number of headers to the response at the reccomendation from [this blog post](https://blog.appcanary.com/2017/http-security-headers.html).

**The following headers are added (allong with default values):**

* X-Xss-Protection:1; mode=block
* Strict-Transport-Security:max-age=631138519
* X-Frame-Options:DENY
* X-Content-Type-Options:nosniff
* Referrer-Policy:no-referrer
* Content-Security-Policy:default-src 'self' https:; font-src 'self' https: data:; img-src 'self' https: data:; object-src 'none'; script-src https:; style-src 'self' https: 'unsafe-inline'
* X-Download-Options:noopen
* X-Permitted-Cross-Domain-Policies:none

To change the default values set the appropriate property in the spring.cloud.gateway.filter.secure-headers namespace:

**Property to change:**

* xss-protection-header
* strict-transport-security
* frame-options
* content-type-options
* referrer-policy
* content-security-policy
* download-options
* permitted-cross-domain-policies

## 112.15 SetPath GatewayFilter Factory

The SetPath GatewayFilter Factory takes a path template parameter. It offers a simple way to manipulate the request path by allowing templated segments of the path. This uses the uri templates from Spring Framework. Multiple matching segments are allowed.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: setpath\_route

uri: http://example.org

predicates:

- Path=/foo/{segment**}**

filters:

- SetPath=/{segment**}**

For a request path of /foo/bar, this will set the path to /bar before making the downstream request.

## 112.16 SetResponseHeader GatewayFilter Factory

The SetResponseHeader GatewayFilter Factory takes name and value parameters.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: setresponseheader\_route

uri: http://example.org

filters:

- SetResponseHeader=X-Response-Foo**,** Bar

This GatewayFilter replaces all headers with the given name, rather than adding. So if the downstream server responded with a X-Response-Foo:1234, this would be replaced with X-Response-Foo:Bar, which is what the gateway client would receive.

## 112.17 SetStatus GatewayFilter Factory

The SetStatus GatewayFilter Factory takes a single status parameter. It must be a valid Spring HttpStatus. It may be the integer value 404 or the string representation of the enumeration NOT\_FOUND.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: setstatusstring\_route

uri: http://example.org

filters:

- SetStatus=BAD\_REQUEST

- id: setstatusint\_route

uri: http://example.org

filters:

- SetStatus=401

In either case, the HTTP status of the response will be set to 401.

## 112.18 StripPrefix GatewayFilter Factory

The StripPrefix GatewayFilter Factory takes one paramter, parts. The parts parameter indicated the number of parts in the path to strip from the request before sending it downstream.

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: nameRoot

uri: http://nameservice

predicates:

- Path=/name/\*\*

filters:

- StripPrefix=2

When a request is made through the gateway to /name/bar/foo the request made to nameservice will look like <http://nameservice/foo>.

## 113. Global Filters

The GlobalFilter interface has the same signature as GatewayFilter. These are special filters that are conditionally applied to all routes. (This interface and usage are subject to change in future milestones).

## 113.1 Combined Global Filter and GatewayFilter Ordering

TODO: document ordering

## 113.2 Forward Routing Filter

The ForwardRoutingFilter looks for a URI in the exchange attribute ServerWebExchangeUtils.GATEWAY\_REQUEST\_URL\_ATTR. If the url has a forward scheme (ie forward:///localendpoint), it will use the Spring DispatcherHandler to handler the request. The unmodified original url is appended to the list in the ServerWebExchangeUtils.GATEWAY\_ORIGINAL\_REQUEST\_URL\_ATTR attribute.

## 113.3 LoadBalancerClient Filter

The LoadBalancerClientFilter looks for a URI in the exchange attribute ServerWebExchangeUtils.GATEWAY\_REQUEST\_URL\_ATTR. If the url has a lb scheme (ie lb://myservice), it will use the Spring Cloud LoadBalancerClient to resolve the name (myservice in the previous example) to an actual host and port and replace the URI in the same attribute. The unmodified original url is appended to the list in the ServerWebExchangeUtils.GATEWAY\_ORIGINAL\_REQUEST\_URL\_ATTR attribute. The filter will also look in the ServerWebExchangeUtils.GATEWAY\_SCHEME\_PREFIX\_ATTR attribute to see if it equals lb and then the same rules apply.

## 113.4 Netty Routing Filter

The Netty Routing Filter runs if the url located in the ServerWebExchangeUtils.GATEWAY\_REQUEST\_URL\_ATTR exchange attribute has a http or https scheme. It uses the Netty HttpClient to make the downstream proxy request. The response is put in the ServerWebExchangeUtils.CLIENT\_RESPONSE\_ATTR exchange attribute for use in a later filter. (There is an experimental WebClientHttpRoutingFilter that performs the same function, but does not require netty)

## 113.5 Netty Write Response Filter

The NettyWriteResponseFilter runs if there is a Netty HttpClientResponse in the ServerWebExchangeUtils.CLIENT\_RESPONSE\_ATTR exchange attribute. It is run after all other filters have completed and writes the proxy response back to the gateway client response. (There is an experimental WebClientWriteResponseFilter that performs the same function, but does not require netty)

## 113.6 RouteToRequestUrl Filter

The RouteToRequestUrlFilter runs if there is a Route object in the ServerWebExchangeUtils.GATEWAY\_ROUTE\_ATTR exchange attribute. It creates a new URI, based off of the request URI, but updated with the URI attribute of the Route object. The new URI is placed in the ServerWebExchangeUtils.GATEWAY\_REQUEST\_URL\_ATTR exchange attribute`.

If the URI has a scheme prefix, such as lb:ws://serviceid, the lb scheme is stripped from the URI and placed in the ServerWebExchangeUtils.GATEWAY\_SCHEME\_PREFIX\_ATTR for use later in the filter chain.

## 113.7 Websocket Routing Filter

The Websocket Routing Filter runs if the url located in the ServerWebExchangeUtils.GATEWAY\_REQUEST\_URL\_ATTR exchange attribute has a ws or wss scheme. It uses the Spring Web Socket infrastructure to forward the Websocket request downstream.

Websockets may be load-balanced by prefixing the URI with lb, such as lb:ws://serviceid.

## 114. Configuration

Configuration for Spring Cloud Gateway is driven by a collection of `RouteDefinitionLocator`s.

**RouteDefinitionLocator.java.**

**public** **interface** RouteDefinitionLocator {

Flux<RouteDefinition> getRouteDefinitions();

}

By default, a PropertiesRouteDefinitionLocator loads properties using Spring Boot’s @ConfigurationProperties mechanism.

The configuration examples above all use a shortcut notation that uses positional arguments rather than named ones. The two examples below are equivalent:

**application.yml.**

spring:

cloud:

gateway:

routes:

- id: setstatus\_route

uri: http://example.org

filters:

- name: SetStatus

args:

status: 401

- id: setstatusshortcut\_route

uri: http://example.org

filters:

- SetStatus=401

For some usages of the gateway, properties will be adequate, but some production use cases will benefit from loading configuration from an external source, such as a database. Future milestone versions will have RouteDefinitionLocator implementations based off of Spring Data Repositories such as: Redis, MongoDB and Cassandra.

## 114.1 Fluent Java Routes API

To allow for simple configuration in Java, there is a fluent API defined in the RouteLocatorBuilder bean.

**GatewaySampleApplication.java.**

*// static imports from GatewayFilters and RoutePredicates*

*@Bean*

**public** RouteLocator customRouteLocator(RouteLocatorBuilder builder, ThrottleGatewayFilterFactory throttle) {

**return** builder.routes()

.route(r -> r.host("\*\*.abc.org").and().path("/image/png")

.filters(f ->

f.addResponseHeader("X-TestHeader", "foobar"))

.uri("http://httpbin.org:80")

)

.route(r -> r.path("/image/webp")

.filters(f ->

f.addResponseHeader("X-AnotherHeader", "baz"))

.uri("http://httpbin.org:80")

)

.route(r -> r.order(-1)

.host("\*\*.throttle.org").and().path("/get")

.filters(f -> f.filter(throttle.apply(1,

1,

10,

TimeUnit.SECONDS)))

.uri("http://httpbin.org:80")

)

.build();

}

This style also allows for more custom predicate assertions. The predicates defined by RouteDefinitionLocator beans are combined using logical and. By using the fluent Java API, you can use the and(), or() and negate() operators on the Predicate class.

## 114.2 DiscoveryClient Route Definition Locator

The Gateway can be configured to create routes based on services registered with a DiscoveryClient compatible service registry.

To enable this, set spring.cloud.gateway.discovery.locator.enabled=true and make sure a DiscoveryClient implementation is on the classpath and enabled (such as Netflix Eureka, Consul or Zookeeper).

## 115. Actuator API

TODO: document the /gateway actuator endpoint

## 116. Developer Guide

TODO: overview of writing custom integrations

## 116.1 Writing Custom Route Predicate Factories

TODO: document writing Custom Route Predicate Factories

## 116.2 Writing Custom GatewayFilter Factories

TODO: document writing Custom GatewayFilter Factories

## 116.3 Writing Custom Global Filters

TODO: document writing Custom Global Filters

## 116.4 Writing Custom Route Locators and Writers

TODO: document writing Custom Route Locators and Writers

## 117. Building a Simple Gateway Using Spring MVC

Spring Cloud Gateway provides a utility object called ProxyExchange which you can use inside a regular Spring MVC handler as a method parameter. It supports basic downstream HTTP exchanges via methods that mirror the HTTP verbs, or forwarding to a local handler via the forward() method.

Example (proxying a request to "/test" downstream to a remote server):

*@RestController*

*@SpringBootApplication*

**public** **class** GatewaySampleApplication {

*@Value("${remote.home}")*

**private** URI home;

*@GetMapping("/test")*

**public** ResponseEntity<?> proxy(ProxyExchange<Object> proxy) **throws** Exception {

**return** proxy.uri(home.toString() + "/image/png").get();

}

}

There are convenience methods on the ProxyExchange to enable the handler method to discover and enhance the URI path of the incoming request. For example you might want to extract the trailing elements of a path to pass them downstream:

*@GetMapping("/proxy/path/\*\*")*

**public** ResponseEntity<?> proxyPath(ProxyExchange<?> proxy) **throws** Exception {

String path = proxy.path("/proxy/path/");

**return** proxy.uri(home.toString() + "/foos/" + path).get();

}

All the features of Spring MVC are available to Gateway handler methods. So you can inject request headers and query parameters, for instance, and you can constrain the incoming requests with declarations in the mapping annotation. See the documentation for @RequestMapping in Spring MVC for more details of those features.

Headers can be added to the downstream response using the header() methods on ProxyExchange.

You can also manipulate response headers (and anything else you like in the response) by adding a mapper to the get() etc. method. The mapper is a Function that takes the incoming ResponseEntity and converts it to an outgoing one.

First class support is provided for "sensitive" headers ("cookie" and "authorization" by default) which are not passed downstream, and for "proxy" headers (x-forwarded-\*).

# Part XVI. Appendix: Compendium of Configuration Properties

| **Name** | **Default** | **Description** |
| --- | --- | --- |
| encrypt.fail-on-error | true | Flag to say that a process should fail if there is an encryption or decryption error. |
| encrypt.key |  | A symmetric key. As a stronger alternative consider using a keystore. |
| encrypt.key-store.alias |  | Alias for a key in the store. |
| encrypt.key-store.location |  | Location of the key store file, e.g. classpath:/keystore.jks. |
| encrypt.key-store.password |  | Password that locks the keystore. |
| encrypt.key-store.secret |  | Secret protecting the key (defaults to the same as the password). |
| encrypt.rsa.algorithm |  | The RSA algorithm to use (DEFAULT or OEAP). Once it is set do not change it (or existing ciphers will not a decryptable). |
| encrypt.rsa.salt | deadbeef | Salt for the random secret used to encrypt cipher text. Once it is set do not change it (or existing ciphers will not a decryptable). |
| encrypt.rsa.strong | false | Flag to indicate that "strong" AES encryption should be used internally. If true then the GCM algorithm is applied to the AES encrypted bytes. Default is false (in which case "standard" CBC is used instead). Once it is set do not change it (or existing ciphers will not a decryptable). |
| endpoints.bus.enabled |  |  |
| endpoints.bus.id |  |  |
| endpoints.bus.sensitive |  |  |
| endpoints.consul.enabled |  |  |
| endpoints.consul.id |  |  |
| endpoints.consul.sensitive |  |  |
| endpoints.env.post.enabled | true | Enable changing the Environment through a POST to /env. |
| endpoints.features.enabled |  |  |
| endpoints.features.id |  |  |
| endpoints.features.sensitive |  |  |
| endpoints.pause.enabled | true | Enable the /pause endpoint (to send Lifecycle.stop()). |
| endpoints.pause.id |  |  |
| endpoints.pause.sensitive |  |  |
| endpoints.refresh.enabled | true | Enable the /refresh endpoint to refresh configuration and re-initialize refresh scoped beans. |
| endpoints.refresh.id |  |  |
| endpoints.refresh.sensitive |  |  |
| endpoints.restart.enabled | true | Enable the /restart endpoint to restart the application context. |
| endpoints.restart.id |  |  |
| endpoints.restart.pause-endpoint.enabled |  |  |
| endpoints.restart.pause-endpoint.id |  |  |
| endpoints.restart.pause-endpoint.sensitive |  |  |
| endpoints.restart.resume-endpoint.enabled |  |  |
| endpoints.restart.resume-endpoint.id |  |  |
| endpoints.restart.resume-endpoint.sensitive |  |  |
| endpoints.restart.sensitive |  |  |
| endpoints.restart.timeout | 0 |  |
| endpoints.resume.enabled | true | Enable the /resume endpoint (to send Lifecycle.start()). |
| endpoints.resume.id |  |  |
| endpoints.resume.sensitive |  |  |
| endpoints.zookeeper.enabled | true | Enable the /zookeeper endpoint to inspect the state of zookeeper. |
| eureka.client.allow-redirects | false | Indicates whether server can redirect a client request to a backup server/cluster. If set to false, the server will handle the request directly, If set to true, it may send HTTP redirect to the client, with a new server location. |
| eureka.client.availability-zones |  | Gets the list of availability zones (used in AWS data centers) for the region in which this instance resides.  The changes are effective at runtime at the next registry fetch cycle as specified by registryFetchIntervalSeconds. |
| eureka.client.backup-registry-impl |  | Gets the name of the implementation which implements BackupRegistry to fetch the registry information as a fall back option for only the first time when the eureka client starts.  This may be needed for applications which needs additional resiliency for registry information without which it cannot operate. |
| eureka.client.cache-refresh-executor-exponential-back-off-bound | 10 | Cache refresh executor exponential back off related property. It is a maximum multiplier value for retry delay, in case where a sequence of timeouts occurred. |
| eureka.client.cache-refresh-executor-thread-pool-size | 2 | The thread pool size for the cacheRefreshExecutor to initialise with |
| eureka.client.client-data-accept |  | EurekaAccept name for client data accept |
| eureka.client.decoder-name |  | This is a transient config and once the latest codecs are stable, can be removed (as there will only be one) |
| eureka.client.disable-delta | false | Indicates whether the eureka client should disable fetching of delta and should rather resort to getting the full registry information.  Note that the delta fetches can reduce the traffic tremendously, because the rate of change with the eureka server is normally much lower than the rate of fetches.  The changes are effective at runtime at the next registry fetch cycle as specified by registryFetchIntervalSeconds |
| eureka.client.dollar-replacement | \_- | Get a replacement string for Dollar sign <code>$</code> during serializing/deserializing information in eureka server. |
| eureka.client.enabled | true | Flag to indicate that the Eureka client is enabled. |
| eureka.client.encoder-name |  | This is a transient config and once the latest codecs are stable, can be removed (as there will only be one) |
| eureka.client.escape-char-replacement | \_\_ | Get a replacement string for underscore sign <code>\_</code> during serializing/deserializing information in eureka server. |
| eureka.client.eureka-connection-idle-timeout-seconds | 30 | Indicates how much time (in seconds) that the HTTP connections to eureka server can stay idle before it can be closed.  In the AWS environment, it is recommended that the values is 30 seconds or less, since the firewall cleans up the connection information after a few mins leaving the connection hanging in limbo |
| eureka.client.eureka-server-connect-timeout-seconds | 5 | Indicates how long to wait (in seconds) before a connection to eureka server needs to timeout. Note that the connections in the client are pooled by org.apache.http.client.HttpClient and this setting affects the actual connection creation and also the wait time to get the connection from the pool. |
| eureka.client.eureka-server-d-n-s-name |  | Gets the DNS name to be queried to get the list of eureka servers.This information is not required if the contract returns the service urls by implementing serviceUrls.  The DNS mechanism is used when useDnsForFetchingServiceUrls is set to true and the eureka client expects the DNS to configured a certain way so that it can fetch changing eureka servers dynamically.  The changes are effective at runtime. |
| eureka.client.eureka-server-port |  | Gets the port to be used to construct the service url to contact eureka server when the list of eureka servers come from the DNS.This information is not required if the contract returns the service urls eurekaServerServiceUrls(String).  The DNS mechanism is used when useDnsForFetchingServiceUrls is set to true and the eureka client expects the DNS to configured a certain way so that it can fetch changing eureka servers dynamically.  The changes are effective at runtime. |
| eureka.client.eureka-server-read-timeout-seconds | 8 | Indicates how long to wait (in seconds) before a read from eureka server needs to timeout. |
| eureka.client.eureka-server-total-connections | 200 | Gets the total number of connections that is allowed from eureka client to all eureka servers. |
| eureka.client.eureka-server-total-connections-per-host | 50 | Gets the total number of connections that is allowed from eureka client to a eureka server host. |
| eureka.client.eureka-server-u-r-l-context |  | Gets the URL context to be used to construct the service url to contact eureka server when the list of eureka servers come from the DNS. This information is not required if the contract returns the service urls from eurekaServerServiceUrls.  The DNS mechanism is used when useDnsForFetchingServiceUrls is set to true and the eureka client expects the DNS to configured a certain way so that it can fetch changing eureka servers dynamically. The changes are effective at runtime. |
| eureka.client.eureka-service-url-poll-interval-seconds | 0 | Indicates how often(in seconds) to poll for changes to eureka server information. Eureka servers could be added or removed and this setting controls how soon the eureka clients should know about it. |
| eureka.client.fetch-registry | true | Indicates whether this client should fetch eureka registry information from eureka server. |
| eureka.client.fetch-remote-regions-registry |  | Comma separated list of regions for which the eureka registry information will be fetched. It is mandatory to define the availability zones for each of these regions as returned by availabilityZones. Failing to do so, will result in failure of discovery client startup. |
| eureka.client.filter-only-up-instances | true | Indicates whether to get the applications after filtering the applications for instances with only InstanceStatus UP states. |
| eureka.client.g-zip-content | true | Indicates whether the content fetched from eureka server has to be compressed whenever it is supported by the server. The registry information from the eureka server is compressed for optimum network traffic. |
| eureka.client.heartbeat-executor-exponential-back-off-bound | 10 | Heartbeat executor exponential back off related property. It is a maximum multiplier value for retry delay, in case where a sequence of timeouts occurred. |
| eureka.client.heartbeat-executor-thread-pool-size | 2 | The thread pool size for the heartbeatExecutor to initialise with |
| eureka.client.initial-instance-info-replication-interval-seconds | 40 | Indicates how long initially (in seconds) to replicate instance info to the eureka server |
| eureka.client.instance-info-replication-interval-seconds | 30 | Indicates how often(in seconds) to replicate instance changes to be replicated to the eureka server. |
| eureka.client.log-delta-diff | false | Indicates whether to log differences between the eureka server and the eureka client in terms of registry information.  Eureka client tries to retrieve only delta changes from eureka server to minimize network traffic. After receiving the deltas, eureka client reconciles the information from the server to verify it has not missed out some information. Reconciliation failures could happen when the client has had network issues communicating to server.If the reconciliation fails, eureka client gets the full registry information.  While getting the full registry information, the eureka client can log the differences between the client and the server and this setting controls that.  The changes are effective at runtime at the next registry fetch cycle as specified by registryFetchIntervalSecondsr |
| eureka.client.on-demand-update-status-change | true | If set to true, local status updates via ApplicationInfoManager will trigger on-demand (but rate limited) register/updates to remote eureka servers |
| eureka.client.prefer-same-zone-eureka | true | Indicates whether or not this instance should try to use the eureka server in the same zone for latency and/or other reason.  Ideally eureka clients are configured to talk to servers in the same zone  The changes are effective at runtime at the next registry fetch cycle as specified by registryFetchIntervalSeconds |
| eureka.client.property-resolver |  |  |
| eureka.client.proxy-host |  | Gets the proxy host to eureka server if any. |
| eureka.client.proxy-password |  | Gets the proxy password if any. |
| eureka.client.proxy-port |  | Gets the proxy port to eureka server if any. |
| eureka.client.proxy-user-name |  | Gets the proxy user name if any. |
| eureka.client.region | us-east-1 | Gets the region (used in AWS datacenters) where this instance resides. |
| eureka.client.register-with-eureka | true | Indicates whether or not this instance should register its information with eureka server for discovery by others.  In some cases, you do not want your instances to be discovered whereas you just want do discover other instances. |
| eureka.client.registry-fetch-interval-seconds | 30 | Indicates how often(in seconds) to fetch the registry information from the eureka server. |
| eureka.client.registry-refresh-single-vip-address |  | Indicates whether the client is only interested in the registry information for a single VIP. |
| eureka.client.service-url |  | Map of availability zone to list of fully qualified URLs to communicate with eureka server. Each value can be a single URL or a comma separated list of alternative locations.  Typically the eureka server URLs carry protocol,host,port,context and version information if any. Example: <http://ec2-256-156-243-129.compute-1.amazonaws.com:7001/eureka/>  The changes are effective at runtime at the next service url refresh cycle as specified by eurekaServiceUrlPollIntervalSeconds. |
| eureka.client.transport |  |  |
| eureka.client.use-dns-for-fetching-service-urls | false | Indicates whether the eureka client should use the DNS mechanism to fetch a list of eureka servers to talk to. When the DNS name is updated to have additional servers, that information is used immediately after the eureka client polls for that information as specified in eurekaServiceUrlPollIntervalSeconds.  Alternatively, the service urls can be returned serviceUrls, but the users should implement their own mechanism to return the updated list in case of changes.  The changes are effective at runtime. |
| eureka.dashboard.enabled | true | Flag to enable the Eureka dashboard. Default true. |
| eureka.dashboard.path | / | The path to the Eureka dashboard (relative to the servlet path). Defaults to "/". |
| eureka.instance.a-s-g-name |  | Gets the AWS autoscaling group name associated with this instance. This information is specifically used in an AWS environment to automatically put an instance out of service after the instance is launched and it has been disabled for traffic.. |
| eureka.instance.app-group-name |  | Get the name of the application group to be registered with eureka. |
| eureka.instance.appname | unknown | Get the name of the application to be registered with eureka. |
| eureka.instance.data-center-info |  | Returns the data center this instance is deployed. This information is used to get some AWS specific instance information if the instance is deployed in AWS. |
| eureka.instance.default-address-resolution-order | [] |  |
| eureka.instance.environment |  |  |
| eureka.instance.health-check-url |  | Gets the absolute health check page URL for this instance. The users can provide the healthCheckUrlPath if the health check page resides in the same instance talking to eureka, else in the cases where the instance is a proxy for some other server, users can provide the full URL. If the full URL is provided it takes precedence.  <p> It is normally used for making educated decisions based on the health of the instance - for example, it can be used to determine whether to proceed deployments to an entire farm or stop the deployments without causing further damage. The full URL should follow the format http://${eureka.hostname}:7001/ where the value ${eureka.hostname} is replaced at runtime. |
| eureka.instance.health-check-url-path | /health | Gets the relative health check URL path for this instance. The health check page URL is then constructed out of the hostname and the type of communication - secure or unsecure as specified in securePort and nonSecurePort.  It is normally used for making educated decisions based on the health of the instance - for example, it can be used to determine whether to proceed deployments to an entire farm or stop the deployments without causing further damage. |
| eureka.instance.home-page-url |  | Gets the absolute home page URL for this instance. The users can provide the homePageUrlPath if the home page resides in the same instance talking to eureka, else in the cases where the instance is a proxy for some other server, users can provide the full URL. If the full URL is provided it takes precedence.  It is normally used for informational purposes for other services to use it as a landing page. The full URL should follow the format http://${eureka.hostname}:7001/ where the value ${eureka.hostname} is replaced at runtime. |
| eureka.instance.home-page-url-path | / | Gets the relative home page URL Path for this instance. The home page URL is then constructed out of the hostName and the type of communication - secure or unsecure.  It is normally used for informational purposes for other services to use it as a landing page. |
| eureka.instance.host-info |  |  |
| eureka.instance.hostname |  | The hostname if it can be determined at configuration time (otherwise it will be guessed from OS primitives). |
| eureka.instance.inet-utils |  |  |
| eureka.instance.initial-status |  | Initial status to register with rmeote Eureka server. |
| eureka.instance.instance-enabled-onit | false | Indicates whether the instance should be enabled for taking traffic as soon as it is registered with eureka. Sometimes the application might need to do some pre-processing before it is ready to take traffic. |
| eureka.instance.instance-id |  | Get the unique Id (within the scope of the appName) of this instance to be registered with eureka. |
| eureka.instance.ip-address |  | Get the IPAdress of the instance. This information is for academic purposes only as the communication from other instances primarily happen using the information supplied in {@link #getHostName(boolean)}. |
| eureka.instance.lease-expiration-duration-in-seconds | 90 | Indicates the time in seconds that the eureka server waits since it received the last heartbeat before it can remove this instance from its view and there by disallowing traffic to this instance.  Setting this value too long could mean that the traffic could be routed to the instance even though the instance is not alive. Setting this value too small could mean, the instance may be taken out of traffic because of temporary network glitches.This value to be set to atleast higher than the value specified in leaseRenewalIntervalInSeconds. |
| eureka.instance.lease-renewal-interval-in-seconds | 30 | Indicates how often (in seconds) the eureka client needs to send heartbeats to eureka server to indicate that it is still alive. If the heartbeats are not received for the period specified in leaseExpirationDurationInSeconds, eureka server will remove the instance from its view, there by disallowing traffic to this instance.  Note that the instance could still not take traffic if it implements HealthCheckCallback and then decides to make itself unavailable. |
| eureka.instance.metadata-map |  | Gets the metadata name/value pairs associated with this instance. This information is sent to eureka server and can be used by other instances. |
| eureka.instance.namespace | eureka | Get the namespace used to find properties. Ignored in Spring Cloud. |
| eureka.instance.non-secure-port | 80 | Get the non-secure port on which the instance should receive traffic. |
| eureka.instance.non-secure-port-enabled | true | Indicates whether the non-secure port should be enabled for traffic or not. |
| eureka.instance.prefer-ip-address | false | Flag to say that, when guessing a hostname, the IP address of the server should be used in prference to the hostname reported by the OS. |
| eureka.instance.registry.default-open-for-traffic-count | 1 | Value used in determining when leases are cancelled, default to 1 for standalone. Should be set to 0 for peer replicated eurekas |
| eureka.instance.registry.expected-number-of-renews-per-min | 1 |  |
| eureka.instance.secure-health-check-url |  | Gets the absolute secure health check page URL for this instance. The users can provide the secureHealthCheckUrl if the health check page resides in the same instance talking to eureka, else in the cases where the instance is a proxy for some other server, users can provide the full URL. If the full URL is provided it takes precedence.  <p> It is normally used for making educated decisions based on the health of the instance - for example, it can be used to determine whether to proceed deployments to an entire farm or stop the deployments without causing further damage. The full URL should follow the format http://${eureka.hostname}:7001/ where the value ${eureka.hostname} is replaced at runtime. |
| eureka.instance.secure-port | 443 | Get the Secure port on which the instance should receive traffic. |
| eureka.instance.secure-port-enabled | false | Indicates whether the secure port should be enabled for traffic or not. |
| eureka.instance.secure-virtual-host-name | unknown | Gets the secure virtual host name defined for this instance.  This is typically the way other instance would find this instance by using the secure virtual host name.Think of this as similar to the fully qualified domain name, that the users of your services will need to find this instance. |
| eureka.instance.status-page-url |  | Gets the absolute status page URL path for this instance. The users can provide the statusPageUrlPath if the status page resides in the same instance talking to eureka, else in the cases where the instance is a proxy for some other server, users can provide the full URL. If the full URL is provided it takes precedence.  It is normally used for informational purposes for other services to find about the status of this instance. Users can provide a simple HTML indicating what is the current status of the instance. |
| eureka.instance.status-page-url-path | /info | Gets the relative status page URL path for this instance. The status page URL is then constructed out of the hostName and the type of communication - secure or unsecure as specified in securePort and nonSecurePort.  It is normally used for informational purposes for other services to find about the status of this instance. Users can provide a simple HTML indicating what is the current status of the instance. |
| eureka.instance.virtual-host-name | unknown | Gets the virtual host name defined for this instance.  This is typically the way other instance would find this instance by using the virtual host name.Think of this as similar to the fully qualified domain name, that the users of your services will need to find this instance. |
| eureka.server.a-s-g-cache-expiry-timeout-ms | 0 |  |
| eureka.server.a-s-g-query-timeout-ms | 300 |  |
| eureka.server.a-s-g-update-interval-ms | 0 |  |
| eureka.server.a-w-s-access-id |  |  |
| eureka.server.a-w-s-secret-key |  |  |
| eureka.server.batch-replication | false |  |
| eureka.server.binding-strategy |  |  |
| eureka.server.delta-retention-timer-interval-in-ms | 0 |  |
| eureka.server.disable-delta | false |  |
| eureka.server.disable-delta-for-remote-regions | false |  |
| eureka.server.disable-transparent-fallback-to-other-region | false |  |
| eureka.server.e-i-p-bind-rebind-retries | 3 |  |
| eureka.server.e-i-p-binding-retry-interval-ms | 0 |  |
| eureka.server.e-i-p-binding-retry-interval-ms-when-unbound | 0 |  |
| eureka.server.enable-replicated-request-compression | false |  |
| eureka.server.enable-self-preservation | true |  |
| eureka.server.eviction-interval-timer-in-ms | 0 |  |
| eureka.server.g-zip-content-from-remote-region | true |  |
| eureka.server.json-codec-name |  |  |
| eureka.server.list-auto-scaling-groups-role-name | ListAutoScalingGroups |  |
| eureka.server.log-identity-headers | true |  |
| eureka.server.max-elements-in-peer-replication-pool | 10000 |  |
| eureka.server.max-elements-in-status-replication-pool | 10000 |  |
| eureka.server.max-idle-thread-age-in-minutes-for-peer-replication | 15 |  |
| eureka.server.max-idle-thread-in-minutes-age-for-status-replication | 10 |  |
| eureka.server.max-threads-for-peer-replication | 20 |  |
| eureka.server.max-threads-for-status-replication | 1 |  |
| eureka.server.max-time-for-replication | 30000 |  |
| eureka.server.min-threads-for-peer-replication | 5 |  |
| eureka.server.min-threads-for-status-replication | 1 |  |
| eureka.server.number-of-replication-retries | 5 |  |
| eureka.server.peer-eureka-nodes-update-interval-ms | 0 |  |
| eureka.server.peer-eureka-status-refresh-time-interval-ms | 0 |  |
| eureka.server.peer-node-connect-timeout-ms | 200 |  |
| eureka.server.peer-node-connection-idle-timeout-seconds | 30 |  |
| eureka.server.peer-node-read-timeout-ms | 200 |  |
| eureka.server.peer-node-total-connections | 1000 |  |
| eureka.server.peer-node-total-connections-per-host | 500 |  |
| eureka.server.prime-aws-replica-connections | true |  |
| eureka.server.property-resolver |  |  |
| eureka.server.rate-limiter-burst-size | 10 |  |
| eureka.server.rate-limiter-enabled | false |  |
| eureka.server.rate-limiter-full-fetch-average-rate | 100 |  |
| eureka.server.rate-limiter-privileged-clients |  |  |
| eureka.server.rate-limiter-registry-fetch-average-rate | 500 |  |
| eureka.server.rate-limiter-throttle-standard-clients | false |  |
| eureka.server.registry-sync-retries | 0 |  |
| eureka.server.registry-sync-retry-wait-ms | 0 |  |
| eureka.server.remote-region-app-whitelist |  |  |
| eureka.server.remote-region-connect-timeout-ms | 1000 |  |
| eureka.server.remote-region-connection-idle-timeout-seconds | 30 |  |
| eureka.server.remote-region-fetch-thread-pool-size | 20 |  |
| eureka.server.remote-region-read-timeout-ms | 1000 |  |
| eureka.server.remote-region-registry-fetch-interval | 30 |  |
| eureka.server.remote-region-total-connections | 1000 |  |
| eureka.server.remote-region-total-connections-per-host | 500 |  |
| eureka.server.remote-region-trust-store |  |  |
| eureka.server.remote-region-trust-store-password | changeit |  |
| eureka.server.remote-region-urls |  |  |
| eureka.server.remote-region-urls-with-name |  |  |
| eureka.server.renewal-percent-threshold | 0.85 |  |
| eureka.server.renewal-threshold-update-interval-ms | 0 |  |
| eureka.server.response-cache-auto-expiration-in-seconds | 180 |  |
| eureka.server.response-cache-update-interval-ms | 0 |  |
| eureka.server.retention-time-in-m-s-in-delta-queue | 0 |  |
| eureka.server.route53-bind-rebind-retries | 3 |  |
| eureka.server.route53-binding-retry-interval-ms | 0 |  |
| eureka.server.route53-domain-t-t-l | 30 |  |
| eureka.server.sync-when-timestamp-differs | true |  |
| eureka.server.use-read-only-response-cache | true |  |
| eureka.server.wait-time-in-ms-when-sync-empty | 0 |  |
| eureka.server.xml-codec-name |  |  |
| feign.compression.request.mime-types | [text/xml, application/xml, application/json] | The list of supported mime types. |
| feign.compression.request.min-request-size | 2048 | The minimum threshold content size. |
| health.config.enabled | false | Flag to indicate that the config server health indicator should be installed. |
| health.config.time-to-live | 0 | Time to live for cached result, in milliseconds. Default 300000 (5 min). |
| hystrix.metrics.enabled | true | Enable Hystrix metrics polling. Defaults to true. |
| hystrix.metrics.polling-interval-ms | 2000 | Interval between subsequent polling of metrics. Defaults to 2000 ms. |
| management.health.refresh.enabled | true | Enable the health endpoint for the refresh scope. |
| management.health.zookeeper.enabled | true | Enable the health endpoint for zookeeper. |
| netflix.atlas.batch-size | 10000 |  |
| netflix.atlas.enabled | true |  |
| netflix.atlas.uri |  |  |
| netflix.metrics.servo.cache-warning-threshold | 1000 | When the ServoMonitorCache reaches this size, a warning is logged. This will be useful if you are using string concatenation in RestTemplate urls. |
| netflix.metrics.servo.registry-class | com.netflix.servo.BasicMonitorRegistry | Fully qualified class name for monitor registry used by Servo. |
| proxy.auth.load-balanced |  |  |
| proxy.auth.routes |  | Authentication strategy per route. |
| spring.cloud.bus.ack.destination-service |  | Service that wants to listen to acks. By default null (meaning all services). |
| spring.cloud.bus.ack.enabled | true | Flag to switch off acks (default on). |
| spring.cloud.bus.destination | springCloudBus | Name of Spring Cloud Stream destination for messages. |
| spring.cloud.bus.enabled | true | Flag to indicate that the bus is enabled. |
| spring.cloud.bus.env.enabled | true | Flag to switch off environment change events (default on). |
| spring.cloud.bus.refresh.enabled | true | Flag to switch off refresh events (default on). |
| spring.cloud.bus.trace.enabled | false | Flag to switch on tracing of acks (default off). |
| spring.cloud.cloudfoundry.discovery.enabled | true | Flag to indicate that discovery is enabled. |
| spring.cloud.cloudfoundry.discovery.heartbeat-frequency | 5000 | Frequency in milliseconds of poll for heart beat. The client will poll on this frequency and broadcast a list of service ids. |
| spring.cloud.cloudfoundry.discovery.org |  | Organization name to authenticate with (default to user’s default). |
| spring.cloud.cloudfoundry.discovery.password |  | Password for user to authenticate and obtain token. |
| spring.cloud.cloudfoundry.discovery.space |  | Space name to authenticate with (default to user’s default). |
| spring.cloud.cloudfoundry.discovery.url | [https://api.run.pivotal.io](https://api.run.pivotal.io/) | URL of Cloud Foundry API (Cloud Controller). |
| spring.cloud.cloudfoundry.discovery.username |  | Username to authenticate (usually an email address). |
| spring.cloud.config.allow-override | true | Flag to indicate that {@link #isSystemPropertiesOverride() systemPropertiesOverride} can be used. Set to false to prevent users from changing the default accidentally. Default true. |
| spring.cloud.config.authorization |  | Authorization token used by the client to connect to the server. |
| spring.cloud.config.discovery.enabled | false | Flag to indicate that config server discovery is enabled (config server URL will be looked up via discovery). |
| spring.cloud.config.discovery.service-id | configserver | Service id to locate config server. |
| spring.cloud.config.enabled | true | Flag to say that remote configuration is enabled. Default true; |
| spring.cloud.config.fail-fast | false | Flag to indicate that failure to connect to the server is fatal (default false). |
| spring.cloud.config.label |  | The label name to use to pull remote configuration properties. The default is set on the server (generally "master" for a git based server). |
| spring.cloud.config.name |  | Name of application used to fetch remote properties. |
| spring.cloud.config.override-none | false | Flag to indicate that when {@link #setAllowOverride(boolean) allowOverride} is true, external properties should take lowest priority, and not override any existing property sources (including local config files). Default false. |
| spring.cloud.config.override-system-properties | true | Flag to indicate that the external properties should override system properties. Default true. |
| spring.cloud.config.password |  | The password to use (HTTP Basic) when contacting the remote server. |
| spring.cloud.config.profile | default | The default profile to use when fetching remote configuration (comma-separated). Default is "default". |
| spring.cloud.config.retry.initial-interval | 1000 | Initial retry interval in milliseconds. |
| spring.cloud.config.retry.max-attempts | 6 | Maximum number of attempts. |
| spring.cloud.config.retry.max-interval | 2000 | Maximum interval for backoff. |
| spring.cloud.config.retry.multiplier | 1.1 | Multiplier for next interval. |
| spring.cloud.config.server.bootstrap | false | Flag indicating that the config server should initialize its own Environment with properties from the remote repository. Off by default because it delays startup but can be useful when embedding the server in another application. |
| spring.cloud.config.server.default-application-name | application | Default application name when incoming requests do not have a specific one. |
| spring.cloud.config.server.default-label |  | Default repository label when incoming requests do not have a specific label. |
| spring.cloud.config.server.default-profile | default | Default application profile when incoming requests do not have a specific one. |
| spring.cloud.config.server.encrypt.enabled | true | Enable decryption of environment properties before sending to client. |
| spring.cloud.config.server.git.basedir |  | Base directory for local working copy of repository. |
| spring.cloud.config.server.git.clone-on-start |  | Flag to indicate that the repository should be cloned on startup (not on demand). Generally leads to slower startup but faster first query. |
| spring.cloud.config.server.git.default-label |  |  |
| spring.cloud.config.server.git.environment |  |  |
| spring.cloud.config.server.git.force-pull |  | Flag to indicate that the repository should force pull. If true discard any local changes and take from remote repository. |
| spring.cloud.config.server.git.git-factory |  |  |
| spring.cloud.config.server.git.password |  | Password for authentication with remote repository. |
| spring.cloud.config.server.git.repos |  | Map of repository identifier to location and other properties. |
| spring.cloud.config.server.git.search-paths |  | Search paths to use within local working copy. By default searches only the root. |
| spring.cloud.config.server.git.timeout |  | Timeout (in seconds) for obtaining HTTP or SSH connection (if applicable). Default 5 seconds. |
| spring.cloud.config.server.git.uri |  | URI of remote repository. |
| spring.cloud.config.server.git.username |  | Username for authentication with remote repository. |
| spring.cloud.config.server.health.repositories |  |  |
| spring.cloud.config.server.native.fail-on-error | false | Flag to determine how to handle exceptions during decryption (default false). |
| spring.cloud.config.server.native.search-locations | [] | Locations to search for configuration files. Defaults to the same as a Spring Boot app so [classpath:/,classpath:/config/,file:./,file:./config/]. |
| spring.cloud.config.server.native.version |  | Version string to be reported for native repository |
| spring.cloud.config.server.overrides |  | Extra map for a property source to be sent to all clients unconditionally. |
| spring.cloud.config.server.prefix |  | Prefix for configuration resource paths (default is empty). Useful when embedding in another application when you don’t want to change the context path or servlet path. |
| spring.cloud.config.server.strip-document-from-yaml | true | Flag to indicate that YAML documents that are text or collections (not a map) should be returned in "native" form. |
| spring.cloud.config.server.svn.basedir |  | Base directory for local working copy of repository. |
| spring.cloud.config.server.svn.default-label | trunk | The default label for environment properties requests. |
| spring.cloud.config.server.svn.environment |  |  |
| spring.cloud.config.server.svn.password |  | Password for authentication with remote repository. |
| spring.cloud.config.server.svn.search-paths |  | Search paths to use within local working copy. By default searches only the root. |
| spring.cloud.config.server.svn.uri |  | URI of remote repository. |
| spring.cloud.config.server.svn.username |  | Username for authentication with remote repository. |
| spring.cloud.config.token |  | Security Token passed thru to underlying environment repository. |
| spring.cloud.config.uri | [http://localhost:8888](http://localhost:8888/) | The URI of the remote server (default [http://localhost:8888](http://localhost:8888/)). |
| spring.cloud.config.username |  | The username to use (HTTP Basic) when contacting the remote server. |
| spring.cloud.consul.config.acl-token |  |  |
| spring.cloud.consul.config.data-key | data | If format is Format.PROPERTIES or Format.YAML then the following field is used as key to look up consul for configuration. |
| spring.cloud.consul.config.default-context | application |  |
| spring.cloud.consul.config.enabled | true |  |
| spring.cloud.consul.config.fail-fast | true | Throw exceptions during config lookup if true, otherwise, log warnings. |
| spring.cloud.consul.config.format |  |  |
| spring.cloud.consul.config.prefix | config |  |
| spring.cloud.consul.config.profile-separator | , |  |
| spring.cloud.consul.config.watch.delay | 1000 | The value of the fixed delay for the watch in millis. Defaults to 1000. |
| spring.cloud.consul.config.watch.enabled | true | If the watch is enabled. Defaults to true. |
| spring.cloud.consul.config.watch.wait-time | 55 | The number of seconds to wait (or block) for watch query, defaults to 55. Needs to be less than default ConsulClient (defaults to 60). To increase ConsulClient timeout create a ConsulClient bean with a custom ConsulRawClient with a custom HttpClient. |
| spring.cloud.consul.discovery.acl-token |  |  |
| spring.cloud.consul.discovery.catalog-services-watch-delay | 10 |  |
| spring.cloud.consul.discovery.catalog-services-watch-timeout | 2 |  |
| spring.cloud.consul.discovery.default-query-tag |  | Tag to query for in service list if one is not listed in serverListQueryTags. |
| spring.cloud.consul.discovery.default-zone-metadata-name | zone | Service instance zone comes from metadata. This allows changing the metadata tag name. |
| spring.cloud.consul.discovery.enabled | true | Is service discovery enabled? |
| spring.cloud.consul.discovery.fail-fast | true | Throw exceptions during service registration if true, otherwise, log warnings (defaults to true). |
| spring.cloud.consul.discovery.health-check-interval | 10s | How often to perform the health check (e.g. 10s) |
| spring.cloud.consul.discovery.health-check-path | /health | Alternate server path to invoke for health checking |
| spring.cloud.consul.discovery.health-check-timeout |  | Timeout for health check (e.g. 10s) |
| spring.cloud.consul.discovery.health-check-url |  | Custom health check url to override default |
| spring.cloud.consul.discovery.heartbeat.enabled | false |  |
| spring.cloud.consul.discovery.heartbeat.heartbeat-interval |  |  |
| spring.cloud.consul.discovery.heartbeat.interval-ratio |  |  |
| spring.cloud.consul.discovery.heartbeat.ttl-unit | s |  |
| spring.cloud.consul.discovery.heartbeat.ttl-value | 30 |  |
| spring.cloud.consul.discovery.host-info |  |  |
| spring.cloud.consul.discovery.hostname |  | Hostname to use when accessing server |
| spring.cloud.consul.discovery.instance-id |  | Unique service instance id |
| spring.cloud.consul.discovery.instance-zone |  | Service instance zone |
| spring.cloud.consul.discovery.ip-address |  | IP address to use when accessing service (must also set preferIpAddress to use) |
| spring.cloud.consul.discovery.lifecycle.enabled | true |  |
| spring.cloud.consul.discovery.management-port |  | Port to register the management service under (defaults to management port) |
| spring.cloud.consul.discovery.management-suffix | management | Suffix to use when registering management service |
| spring.cloud.consul.discovery.management-tags |  | Tags to use when registering management service |
| spring.cloud.consul.discovery.port |  | Port to register the service under (defaults to listening port) |
| spring.cloud.consul.discovery.prefer-agent-address | false | Source of how we will determine the address to use |
| spring.cloud.consul.discovery.prefer-ip-address | false | Use ip address rather than hostname during registration |
| spring.cloud.consul.discovery.query-passing | false | Add the 'passing` parameter to /v1/health/service/serviceName. This pushes health check passing to the server. |
| spring.cloud.consul.discovery.register | true | Register as a service in consul. |
| spring.cloud.consul.discovery.register-health-check | true | Register health check in consul. Useful during development of a service. |
| spring.cloud.consul.discovery.scheme | http | Whether to register an http or https service |
| spring.cloud.consul.discovery.server-list-query-tags |  | Map of serviceId’s → tag to query for in server list. This allows filtering services by a single tag. |
| spring.cloud.consul.discovery.service-name |  | Service name |
| spring.cloud.consul.discovery.tags |  | Tags to use when registering service |
| spring.cloud.consul.enabled | true | Is spring cloud consul enabled |
| spring.cloud.consul.host | localhost | Consul agent hostname. Defaults to 'localhost'. |
| spring.cloud.consul.port | 8500 | Consul agent port. Defaults to '8500'. |
| spring.cloud.consul.retry.initial-interval | 1000 | Initial retry interval in milliseconds. |
| spring.cloud.consul.retry.max-attempts | 6 | Maximum number of attempts. |
| spring.cloud.consul.retry.max-interval | 2000 | Maximum interval for backoff. |
| spring.cloud.consul.retry.multiplier | 1.1 | Multiplier for next interval. |
| spring.cloud.hypermedia.refresh.fixed-delay | 5000 |  |
| spring.cloud.hypermedia.refresh.initial-delay | 10000 |  |
| spring.cloud.inetutils.default-hostname | localhost | The default hostname. Used in case of errors. |
| spring.cloud.inetutils.default-ip-address | 127.0.0.1 | The default ipaddress. Used in case of errors. |
| spring.cloud.inetutils.ignored-interfaces |  | List of Java regex expressions for network interfaces that will be ignored. |
| spring.cloud.inetutils.preferred-networks |  | List of Java regex expressions for network addresses that will be ignored. |
| spring.cloud.inetutils.timeout-seconds | 1 | Timeout in seconds for calculating hostname. |
| spring.cloud.inetutils.use-only-site-local-interfaces | false | Use only interfaces with site local addresses. See {@link InetAddress#isSiteLocalAddress()} for more details. |
| spring.cloud.loadbalancer.retry.enabled | false |  |
| spring.cloud.stream.binders |  |  |
| spring.cloud.stream.bindings |  |  |
| spring.cloud.stream.consul.binder.event-timeout | 5 |  |
| spring.cloud.stream.consumer-defaults |  |  |
| spring.cloud.stream.default-binder |  |  |
| spring.cloud.stream.dynamic-destinations | [] |  |
| spring.cloud.stream.ignore-unknown-properties | true |  |
| spring.cloud.stream.instance-count | 1 |  |
| spring.cloud.stream.instance-index | 0 |  |
| spring.cloud.stream.producer-defaults |  |  |
| spring.cloud.stream.rabbit.binder.admin-adresses | [] |  |
| spring.cloud.stream.rabbit.binder.compression-level | 0 |  |
| spring.cloud.stream.rabbit.binder.nodes | [] |  |
| spring.cloud.stream.rabbit.bindings |  |  |
| spring.cloud.zookeeper.base-sleep-time-ms | 50 | Initial amount of time to wait between retries |
| spring.cloud.zookeeper.block-until-connected-unit |  | The unit of time related to blocking on connection to Zookeeper |
| spring.cloud.zookeeper.block-until-connected-wait | 10 | Wait time to block on connection to Zookeeper |
| spring.cloud.zookeeper.connect-string | localhost:2181 | Connection string to the Zookeeper cluster |
| spring.cloud.zookeeper.default-health-endpoint |  | Default health endpoint that will be checked to verify that a dependency is alive |
| spring.cloud.zookeeper.dependencies |  | Mapping of alias to ZookeeperDependency. From Ribbon perspective the alias is actually serviceID since Ribbon can’t accept nested structures in serviceID |
| spring.cloud.zookeeper.dependency-configurations |  |  |
| spring.cloud.zookeeper.dependency-names |  |  |
| spring.cloud.zookeeper.discovery.enabled | true |  |
| spring.cloud.zookeeper.discovery.instance-host |  | Predefined host with which a service can register itself in Zookeeper. Corresponds to the {code address} from the URI spec. |
| spring.cloud.zookeeper.discovery.instance-port |  | Port to register the service under (defaults to listening port) |
| spring.cloud.zookeeper.discovery.metadata |  | Gets the metadata name/value pairs associated with this instance. This information is sent to zookeeper and can be used by other instances. |
| spring.cloud.zookeeper.discovery.register | true | Register as a service in zookeeper. |
| spring.cloud.zookeeper.discovery.root | /services | Root Zookeeper folder in which all instances are registered |
| spring.cloud.zookeeper.discovery.uri-spec | {scheme}://{address}:{port} | The URI specification to resolve during service registration in Zookeeper |
| spring.cloud.zookeeper.enabled | true | Is Zookeeper enabled |
| spring.cloud.zookeeper.max-retries | 10 | Max number of times to retry |
| spring.cloud.zookeeper.max-sleep-ms | 500 | Max time in ms to sleep on each retry |
| spring.cloud.zookeeper.prefix |  | Common prefix that will be applied to all Zookeeper dependencies' paths |
| spring.integration.poller.fixed-delay | 1000 | Fixed delay for default poller. |
| spring.integration.poller.max-messages-per-poll | 1 | Maximum messages per poll for the default poller. |
| spring.sleuth.integration.enabled | true | Enable Spring Integration sleuth instrumentation. |
| spring.sleuth.integration.patterns | \* | An array of simple patterns against which channel names will be matched. Default is \* (all channels). See org.springframework.util.PatternMatchUtils.simpleMatch(String, String). |
| spring.sleuth.keys.async.class-name-key | class | Simple name of the class with a method annotated with {@code @Async} from which the asynchronous process started  @see org.springframework.scheduling.annotation.Async |
| spring.sleuth.keys.async.method-name-key | method | Name of the method annotated with {@code @Async}  @see org.springframework.scheduling.annotation.Async |
| spring.sleuth.keys.async.prefix |  | Prefix for header names if they are added as tags. |
| spring.sleuth.keys.async.thread-name-key | thread | Name of the thread that executed the async method  @see org.springframework.scheduling.annotation.Async |
| spring.sleuth.keys.http.headers |  | Additional headers that should be added as tags if they exist. If the header value is multi-valued, the tag value will be a comma-separated, single-quoted list. |
| spring.sleuth.keys.http.host | http.host | The domain portion of the URL or host header. Example: "mybucket.s3.amazonaws.com". Used to filter by host as opposed to ip address. |
| spring.sleuth.keys.http.method | http.method | The HTTP method, or verb, such as "GET" or "POST". Used to filter against an http route. |
| spring.sleuth.keys.http.path | http.path | The absolute http path, without any query parameters. Example: "/objects/abcd-ff". Used to filter against an http route, portably with zipkin v1. In zipkin v1, only equals filters are supported. Dropping query parameters makes the number of distinct URIs less. For example, one can query for the same resource, regardless of signing parameters encoded in the query line. This does not reduce cardinality to a HTTP single route. For example, it is common to express a route as an http URI template like "/resource/{resource\_id}". In systems where only equals queries are available, searching for {@code http.uri=/resource} won’t match if the actual request was "/resource/abcd-ff". Historical note: This was commonly expressed as "http.uri" in zipkin, eventhough it was most often just a path. |
| spring.sleuth.keys.http.prefix | http. | Prefix for header names if they are added as tags. |
| spring.sleuth.keys.http.request-size | http.request.size | The size of the non-empty HTTP request body, in bytes. Ex. "16384"  <p>Large uploads can exceed limits or contribute directly to latency. |
| spring.sleuth.keys.http.response-size | http.response.size | The size of the non-empty HTTP response body, in bytes. Ex. "16384"  <p>Large downloads can exceed limits or contribute directly to latency. |
| spring.sleuth.keys.http.status-code | http.status\_code | The HTTP response code, when not in 2xx range. Ex. "503" Used to filter for error status. 2xx range are not logged as success codes are less interesting for latency troubleshooting. Omitting saves at least 20 bytes per span. |
| spring.sleuth.keys.http.url | http.url | The entire URL, including the scheme, host and query parameters if available. Ex. "https://mybucket.s3.amazonaws.com/objects/abcd-ff?X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Algorithm=AWS4-HMAC-SHA256…​" Combined with {@link #method}, you can understand the fully-qualified request line. This is optional as it may include private data or be of considerable length. |
| spring.sleuth.keys.hystrix.command-group | commandGroup | Name of the command group. Hystrix uses the command group key to group together commands such as for reporting, alerting, dashboards, or team/library ownership.  @see com.netflix.hystrix.HystrixCommandGroupKey |
| spring.sleuth.keys.hystrix.command-key | commandKey | Name of the command key. Describes the name for the given command. A key to represent a {@link com.netflix.hystrix.HystrixCommand} for monitoring, circuit-breakers, metrics publishing, caching and other such uses.  @see com.netflix.hystrix.HystrixCommandKey |
| spring.sleuth.keys.hystrix.prefix |  | Prefix for header names if they are added as tags. |
| spring.sleuth.keys.hystrix.thread-pool-key | threadPoolKey | Name of the thread pool key. The thread-pool key represents a {@link com.netflix.hystrix.HystrixThreadPool} for monitoring, metrics publishing, caching, and other such uses. A {@link com.netflix.hystrix.HystrixCommand} is associated with a single {@link com.netflix.hystrix.HystrixThreadPool} as retrieved by the {@link com.netflix.hystrix.HystrixThreadPoolKey} injected into it, or it defaults to one created using the {@link com.netflix.hystrix.HystrixCommandGroupKey} it is created with.  @see com.netflix.hystrix.HystrixThreadPoolKey |
| spring.sleuth.keys.message.headers |  | Additional headers that should be added as tags if they exist. If the header value is not a String it will be converted to a String using its toString() method. |
| spring.sleuth.keys.message.payload.size | message/payload-size | An estimate of the size of the payload if available. |
| spring.sleuth.keys.message.payload.type | message/payload-type | The type of the payload. |
| spring.sleuth.keys.message.prefix | message/ | Prefix for header names if they are added as tags. |
| spring.sleuth.keys.mvc.controller-class | mvc.controller.class | The lower case, hyphen delimited name of the class that processes the request. Ex. class named "BookController" will result in "book-controller" tag value. |
| spring.sleuth.keys.mvc.controller-method | mvc.controller.method | The lower case, hyphen delimited name of the class that processes the request. Ex. method named "listOfBooks" will result in "list-of-books" tag value. |
| spring.sleuth.metric.span.accepted-name | counter.span.accepted |  |
| spring.sleuth.metric.span.dropped-name | counter.span.dropped |  |
| spring.sleuth.sampler.percentage | 0.1 | Percentage of requests that should be sampled. E.g. 1.0 - 100% requests should be sampled. The precision is whole-numbers only (i.e. there’s no support for 0.1% of the traces). |
| spring.sleuth.trace-id128 | false | When true, generate 128-bit trace IDs instead of 64-bit ones. |
| zuul.add-host-header | false | Flag to determine whether the proxy forwards the Host header. |
| zuul.add-proxy-headers | true | Flag to determine whether the proxy adds X-Forwarded-\* headers. |
| zuul.host.max-per-route-connections | 20 | The maximum number of connections that can be used by a single route. |
| zuul.host.max-total-connections | 200 | The maximum number of total connections the proxy can hold open to backends. |
| zuul.ignore-local-service | true |  |
| zuul.ignore-security-headers | true | Flag to say that SECURITY\_HEADERS are added to ignored headers if spring security is on the classpath. By setting ignoreSecurityHeaders to false we can switch off this default behaviour. This should be used together with disabling the default spring security headers see <https://docs.spring.io/spring-security/site/docs/current/reference/html/headers.html#default-security-headers> |
| zuul.ignored-headers |  | Names of HTTP headers to ignore completely (i.e. leave them out of downstream requests and drop them from downstream responses). |
| zuul.ignored-patterns |  |  |
| zuul.ignored-services |  | Set of service names not to consider for proxying automatically. By default all services in the discovery client will be proxied. |
| zuul.prefix |  | A common prefix for all routes. |
| zuul.remove-semicolon-content | true | Flag to say that path elements past the first semicolon can be dropped. |
| zuul.retryable |  | Flag for whether retry is supported by default (assuming the routes themselves support it). |
| zuul.ribbon-isolation-strategy |  |  |
| zuul.routes |  | Map of route names to properties. |
| zuul.s-e-c-u-r-i-t-y-h-e-a-d-e-r-s |  | Headers that are generally expected to be added by Spring Security, and hence often duplicated if the proxy and the backend are secured with Spring. By default they are added to the ignored headers if Spring Security is present and ignoreSecurityHeaders = true. |
| zuul.semaphore.max-semaphores | 100 | The maximum number of total semaphores for Hystrix. |
| zuul.sensitive-headers |  | List of sensitive headers that are not passed to downstream requests. Defaults to a "safe" set of headers that commonly contain user credentials. It’s OK to remove those from the list if the downstream service is part of the same system as the proxy, so they are sharing authentication data. If using a physical URL outside your own domain, then generally it would be a bad idea to leak user credentials. |
| zuul.servlet-path | /zuul | Path to install Zuul as a servlet (not part of Spring MVC). The servlet is more memory efficient for requests with large bodies, e.g. file uploads. |
| zuul.ssl-hostname-validation-enabled | true | Flag to say whether the hostname for ssl connections should be verified or not. Default is true. This should only be used in test setups! |
| zuul.strip-prefix | true | Flag saying whether to strip the prefix from the path before forwarding. |
| zuul.trace-request-body | true | Flag to say that request bodies can be traced. |