Spring Cloud

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Spring Cloud provides tools for developers to quickly build some of the common patterns in distributed systems (e.g. configuration management, service discovery, circuit breakers, intelligent routing, micro-proxy, control bus). Coordination of distributed systems leads to boiler plate patterns, and using Spring Cloud developers can quickly stand up services and applications that implement those patterns. They will work well in any distributed environment, including the developer's own laptop, bare metal data centres, and managed platforms such as Cloud Foundry.

Release Train Version: **2020.0.0-M4**

Supported Boot Version: **2.4.0-M3**

1. Features

Spring Cloud focuses on providing good out of box experience for typical use cases and extensibility mechanism to cover others.

- Distributed/versioned configuration
- Service registration and discovery
- Routing
- Service-to-service calls
- Load balancing
- Circuit Breakers
- Distributed messaging

2. Release Train Versions

Table 1. Release Train Project Versions

Project Name	Project Version
spring-boot	2.4.0-M3
spring-cloud-build	3.0.0-M4
spring-cloud-bus	3.0.0-M4
spring-cloud-circuitbreaker	2.0.0-M4
spring-cloud-cli	3.0.0-M4
spring-cloud-cloudfoundry	3.0.0-M4
spring-cloud-commons	3.0.0-M4
spring-cloud-config	3.0.0-M4
spring-cloud-consul	3.0.0-M4

Project Name	Project Version
spring-cloud-contract	3.0.0-M4
spring-cloud-function	3.1.0-M4
spring-cloud-gateway	3.0.0-M4
spring-cloud-kubernetes	2.0.0-M4
spring-cloud-netflix	3.0.0-M4
spring-cloud-openfeign	3.0.0-M4
spring-cloud-security	3.0.0-M4
spring-cloud-sleuth	3.0.0-M4
spring-cloud-stream	3.1.0-M3
spring-cloud-task	2.3.0-M3
spring-cloud-vault	3.0.0-M4
spring-cloud-zookeeper	3.0.0-M4

Spring Cloud Build

[spring cloud build]

Spring Cloud Build is a common utility project for Spring Cloud to use for plugin and dependency management.

1. Building and Deploying

To install locally:

```
$ mvn install -s .settings.xml
```

and to deploy snapshots to repo.spring.io:

```
$ mvn deploy
-DaltSnapshotDeploymentRepository=repo.spring.io::default::https://repo.spring.io/snap
shot
```

for a RELEASE build use

```
$ mvn deploy
-DaltReleaseDeploymentRepository=repo.spring.io::default::https://repo.spring.io/relea
se
```

and for jcenter use

```
$ mvn deploy
-DaltReleaseDeploymentRepository=bintray::default::https://api.bintray.com/maven/sprin
g/jars/org.springframework.cloud:build
```

and for Maven Central use

```
$ mvn deploy -P central -DaltReleaseDeploymentRepository=sonatype-nexus
-staging::default::https://oss.sonatype.org/service/local/staging/deploy/maven2
```

(the "central" profile is available for all projects in Spring Cloud and it sets up the gpg jar signing, and the repository has to be specified separately for this project because it is a parent of the starter parent which users in turn have as their own parent).

2. Contributing

Spring Cloud is released under the non-restrictive Apache 2.0 license, and follows a very standard Github development process, using Github tracker for issues and merging pull requests into master. If you want to contribute even something trivial please do not hesitate, but follow the guidelines below.

2.1. Sign the Contributor License Agreement

Before we accept a non-trivial patch or pull request we will need you to sign the Contributor License Agreement. Signing the contributor's agreement does not grant anyone commit rights to the main repository, but it does mean that we can accept your contributions, and you will get an author credit if we do. Active contributors might be asked to join the core team, and given the ability to merge pull requests.

2.2. Code of Conduct

This project adheres to the Contributor Covenant code of conduct. By participating, you are expected to uphold this code. Please report unacceptable behavior to spring-code-of-conduct@pivotal.io.

2.3. Code Conventions and Housekeeping

None of these is essential for a pull request, but they will all help. They can also be added after the original pull request but before a merge.

- Use the Spring Framework code format conventions. If you use Eclipse you can import formatter settings using the `eclipse-code-formatter.xml` file from the Spring Cloud Build project. If using IntelliJ, you can use the Eclipse Code Formatter Plugin to import the same file.

- Make sure all new `.java` files to have a simple Javadoc class comment with at least an `@author` tag identifying you, and preferably at least a paragraph on what the class is for.
- Add the ASF license header comment to all new `.java` files (copy from existing files in the project)
- Add yourself as an `@author` to the .java files that you modify substantially (more than cosmetic changes).
- Add some Javadocs and, if you change the namespace, some XSD doc elements.
- A few unit tests would help a lot as well — someone has to do it.
- If no-one else is using your branch, please rebase it against the current master (or other target branch in the main project).
- When writing a commit message please follow these conventions, if you are fixing an existing issue please add `Fixes gh-XXXX` at the end of the commit message (where XXXX is the issue number).

2.4. Checkstyle

Spring Cloud Build comes with a set of checkstyle rules. You can find them in the `spring-cloud-build-tools` module. The most notable files under the module are:

spring-cloud-build-tools/

```
└─── src
    ├─── checkstyle
    │    └─── checkstyle-suppressions.xml ③
    └─── main
        └─── resources
            ├─── checkstyle-header.txt ②
            └─── checkstyle.xml ①
```

① Default Checkstyle rules

② File header setup

③ Default suppression rules

2.4.1. Checkstyle configuration

Checkstyle rules are **disabled by default**. To add checkstyle to your project just define the following properties and plugins.

pom.xml

```
<properties>
<maven-checkstyle-plugin.failsOnError>true</maven-checkstyle-plugin.failsOnError> ①
        <maven-checkstyle-plugin.failsOnViolation>true
        </maven-checkstyle-plugin.failsOnViolation> ②
        <maven-checkstyle-plugin.includeTestSourceDirectory>true
        </maven-checkstyle-plugin.includeTestSourceDirectory> ③
</properties>

<build>
        <plugins>
            <plugin> ④
                <groupId>io.spring.javaformat</groupId>
                <artifactId>spring-javaformat-maven-plugin</artifactId>
            </plugin>
            <plugin> ⑤
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-checkstyle-plugin</artifactId>
            </plugin>
        </plugins>

    <reporting>
        <plugins>
            <plugin> ⑤
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-checkstyle-plugin</artifactId>
            </plugin>
        </plugins>
    </reporting>
</build>
```

① Fails the build upon Checkstyle errors

② Fails the build upon Checkstyle violations

③ Checkstyle analyzes also the test sources

④ Add the Spring Java Format plugin that will reformat your code to pass most of the Checkstyle formatting rules

⑤ Add checkstyle plugin to your build and reporting phases

If you need to suppress some rules (e.g. line length needs to be longer), then it's enough for you to define a file under `${project.root}/src/checkstyle/checkstyle-suppressions.xml` with your suppressions. Example:

projectRoot/src/checkstyle/checkstyle-suppresions.xml

```
<?xml version="1.0"?>
<!DOCTYPE suppressions PUBLIC
        "-//Puppy Crawl//DTD Suppressions 1.1//EN"
        "https://www.puppycrawl.com/dtds/suppressions_1_1.dtd">
<suppressions>
    <suppress files=".*ConfigServerApplication\.java"
checks="HideUtilityClassConstructor"/>
    <suppress files=".*ConfigClientWatch\.java" checks="LineLengthCheck"/>
</suppressions>
```

It's advisable to copy the `${spring-cloud-build.rootFolder}/.editorconfig` and `${spring-cloud-build.rootFolder}/.springformat` to your project. That way, some default formatting rules will be applied. You can do so by running this script:

```
$ curl https://raw.githubusercontent.com/spring-cloud/spring-cloud-
build/master/.editorconfig -o .editorconfig
$ touch .springformat
```

2.5. IDE setup

2.5.1. Intellij IDEA

In order to setup Intellij you should import our coding conventions, inspection profiles and set up the checkstyle plugin. The following files can be found in the Spring Cloud Build project.

spring-cloud-build-tools/

```
└── src
    ├── checkstyle
    │   └── checkstyle-suppressions.xml ③
    └── main
        └── resources
            ├── checkstyle-header.txt ②
            ├── checkstyle.xml ①
            └── intellij
                ├── Intellij_Project_Defaults.xml ④
                └── Intellij_Spring_Boot_Java_Conventions.xml ⑤
```

① Default Checkstyle rules

② File header setup

③ Default suppression rules

④ Project defaults for Intellij that apply most of Checkstyle rules

⑤ Project style conventions for Intellij that apply most of Checkstyle rules

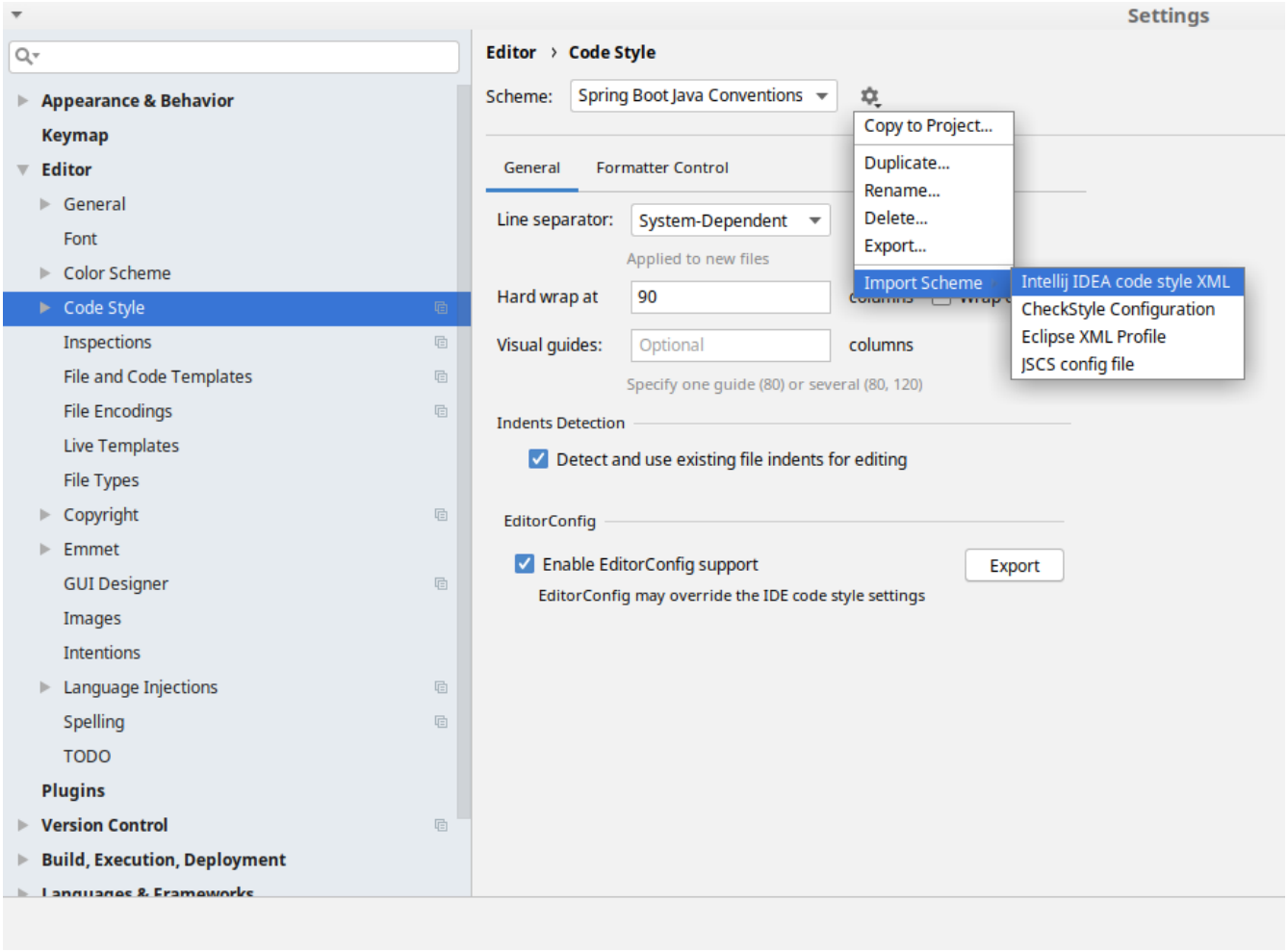


Figure 1. Code style

Go to `File → Settings → Editor → Code style`. There click on the icon next to the `Scheme` section. There, click on the `Import Scheme` value and pick the `Intellij IDEA code style XML` option. Import the `spring-cloud-build-tools/src/main/resources/intellij/Intellij_Spring_Boot_Java_Conventions.xml` file.

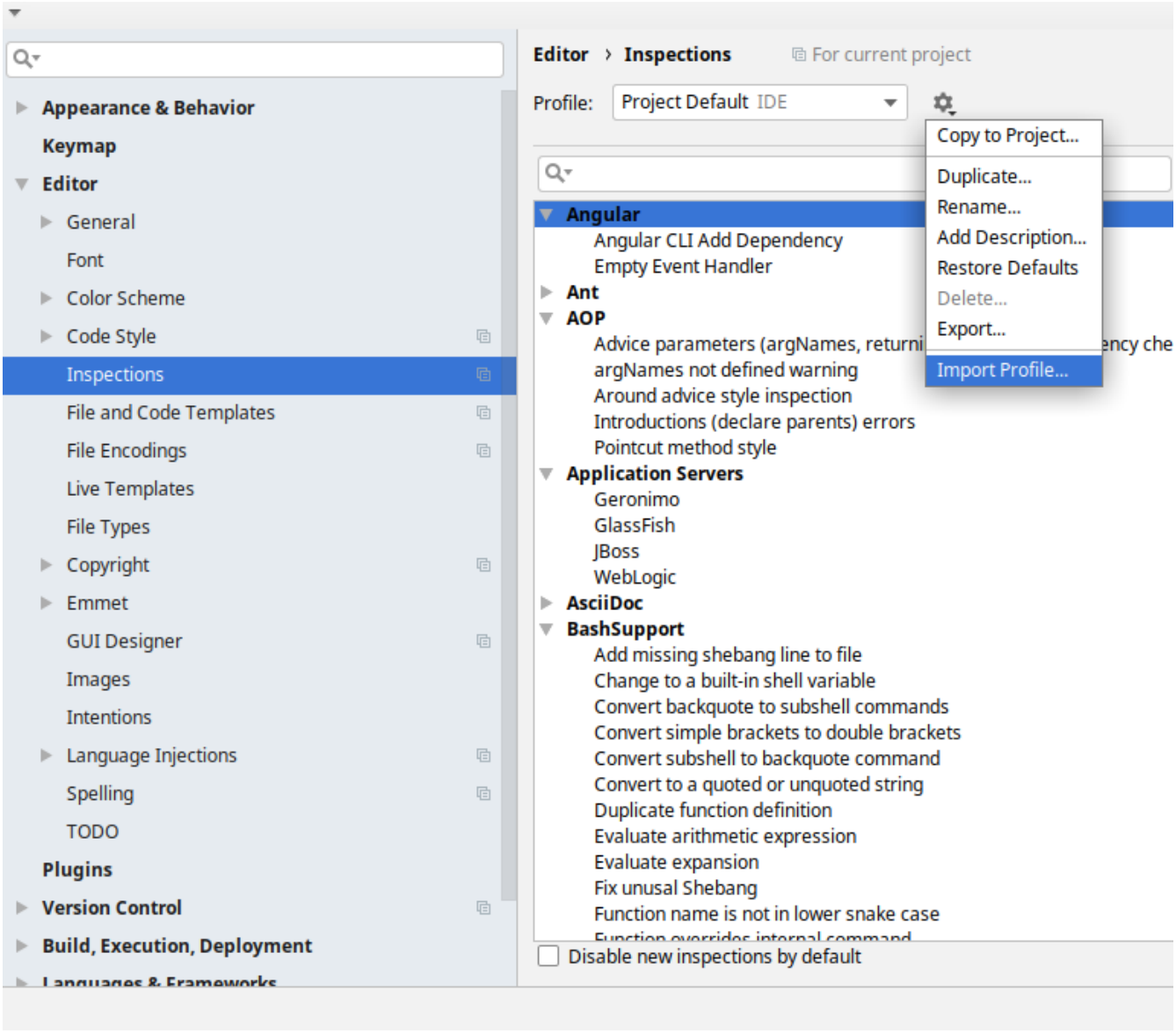
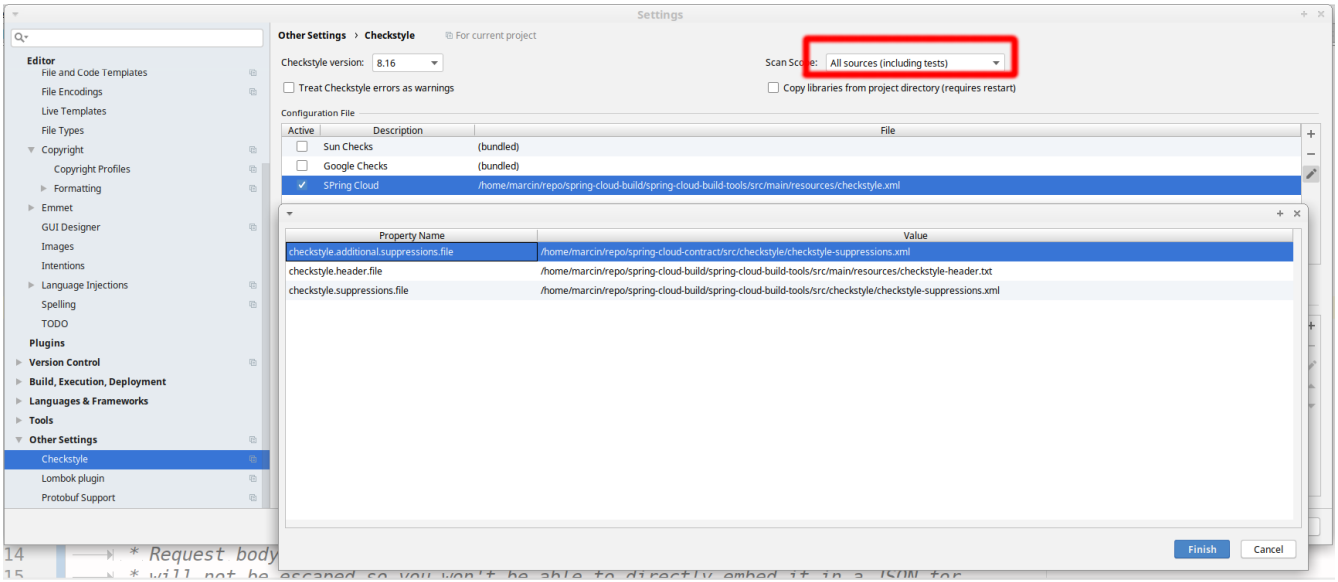


Figure 2. Inspection profiles

Go to `File` → `Settings` → `Editor` → `Inspections`. There click on the icon next to the `Profile` section. There, click on the `Import Profile` and import the `spring-cloud-build-tools/src/main/resources/intellij/Intellij_Project_Defaults.xml` file.

Checkstyle

To have Intellij work with Checkstyle, you have to install the `Checkstyle` plugin. It's advisable to also install the `Assertions2Assertj` to automatically convert the JUnit assertions



Go to `File → Settings → Other settings → Checkstyle`. There click on the `+` icon in the `Configuration file` section. There, you'll have to define where the checkstyle rules should be picked from. In the image above, we've picked the rules from the cloned Spring Cloud Build repository. However, you can point to the Spring Cloud Build's GitHub repository (e.g. for the `checkstyle.xml` : `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/main/resources/checkstyle.xml`). We need to provide the following variables:

- `checkstyle.header.file` - please point it to the Spring Cloud Build's, `spring-cloud-build-tools/src/main/resources/checkstyle-header.txt` file either in your cloned repo or via the `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/main/resources/checkstyle-header.txt` URL.
- `checkstyle.suppressions.file` - default suppressions. Please point it to the Spring Cloud Build's, `spring-cloud-build-tools/src/checkstyle/checkstyle-suppressions.xml` file either in your cloned repo or via the `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/checkstyle/checkstyle-suppressions.xml` URL.
- `checkstyle.additional.suppressions.file` - this variable corresponds to suppressions in your local project. E.g. you're working on `spring-cloud-contract`. Then point to the `project-root/src/checkstyle/checkstyle-suppressions.xml` folder. Example for `spring-cloud-contract` would be: `/home/username/spring-cloud-contract/src/checkstyle/checkstyle-suppressions.xml`.

Remember to set the `Scan Scope` to `All sources` since we apply checkstyle rules for production and test sources.

3. Flattening the POMs

To avoid propagating build setup that is required to build a Spring Cloud project, we're using the maven flatten plugin. It has the advantage of letting you use whatever features you need while publishing "clean" pom to the repository.

In order to add it, add the `org.codehaus.mojo:flatten-maven-plugin` to your `pom.xml`.

```
<build>
    <plugins>
        <plugin>
            <groupId>org.codehaus.mojo</groupId>
            <artifactId>flatten-maven-plugin</artifactId>
        </plugin>
    </plugins>
</build>
```

4. Reusing the documentation

Spring Cloud Build publishes its `spring-cloud-build-docs` module that contains helpful scripts (e.g. README generation ruby script) and css, xslt and images for the Spring Cloud documentation. If you want to follow the same convention approach of generating documentation just add these plugins to your `docs` module

```
<properties>
    <upload-docs-zip.phase>deploy</upload-docs-zip.phase> ⑧
</properties>
<profiles>
    <profile>
        <id>docs</id>
        <build>
            <plugins>
                <plugin>
                    <groupId>pl.project13.maven</groupId>
                    <artifactId>git-commit-id-plugin</artifactId> ①
                </plugin>
                <plugin>
                    <groupId>org.apache.maven.plugins</groupId>
                    <artifactId>maven-dependency-plugin</artifactId> ②
                </plugin>
                <plugin>
                    <groupId>org.apache.maven.plugins</groupId>
                    <artifactId>maven-resources-plugin</artifactId> ③
                </plugin>
                <plugin>
                    <groupId>org.codehaus.mojo</groupId>
                    <artifactId>exec-maven-plugin</artifactId> ④
                </plugin>
                <plugin>
                    <groupId>org.asciidoctor</groupId>
                    <artifactId>asciidoctor-maven-plugin</artifactId> ⑤
                </plugin>
                <plugin>
                    <groupId>org.apache.maven.plugins</groupId>
                    <artifactId>maven-antrun-plugin</artifactId> ⑥
                </plugin>
                <plugin>
                    <artifactId>maven-deploy-plugin</artifactId> ⑦
                </plugin>
            </plugins>
        </build>
    </profile>
</profiles>
```

① This plugin downloads sets up all the git information of the project

② This plugin downloads the resources of the `spring-cloud-build-docs` module

③ This plugin unpacks the resources of the `spring-cloud-build-docs` module

④ This plugin generates an `adoc` file with all the configuration properties from the classpath

⑤ This plugin is required to parse the Asciidoctor documentation

⑥ This plugin is required to copy resources into proper final destinations and to generate main README.adoc and to assert that no files use unresolved links

⑦ This plugin ensures that the generated zip docs will get published

⑧ This property turns on the "deploy" phase for <7>

The order of plugin declaration is important!

In order for the build to generate the `adoc` file with all your configuration properties, your `docs` module should contain all the dependencies on the classpath, that you would want to scan for configuration properties. The file will be output to `${docsModule}/src/main/asciidoc/_configprops.adoc` file (configurable via the `configprops.path` property).

If you want to modify which of the configuration properties are put in the table, you can tweak the `configprops.inclusionPattern` pattern to include only a subset of the properties (e.g. `<configprops.inclusionPattern>spring.sleuth.*</configprops.inclusionPattern>`).

Spring Cloud Build Docs comes with a set of attributes for asciidoctor that you can reuse.

```
<attributes>
    <docinfo>shared</docinfo>
    <allow-uri-read>true</allow-uri-read>
    <nofooter/>
    <toc>left</toc>
    <toc-levels>4</toc-levels>
    <sectlinks>true</sectlinks>
    <sources-root>${project.basedir}/src@</sources-root>
    <asciidoc-sources-root>${project.basedir}/src/main/asciidoc@</asciidoc-sources-
root>
    <generated-resources-root>${project.basedir}/target/generated-resources@
    </generated-resources-root>
    <!-- Use this attribute the reference code from another module -->
    <!-- Note the @ at the end, lowering the precedence of the attribute -->
    <project-root>${maven.multiModuleProjectDirectory}@</project-root>
    <!-- It's mandatory for you to pass the docs.main property -->
    <github-repo>${docs.main}@</github-repo>
    <github-project>https://github.com/spring-cloud/${docs.main}@</github-project>
    <github-raw>
        https://raw.githubusercontent.com/spring-cloud/${docs.main}/${github-tag}@
    </github-raw>
    <github-code>https://github.com/spring-cloud/${docs.main}/tree/${github-tag}@
    </github-code>
    <github-issues>https://github.com/spring-cloud/${docs.main}/issues/@</github-
issues>
    <github-wiki>https://github.com/spring-cloud/${docs.main}/wiki@</github-wiki>
    <github-master-code>https://github.com/spring-cloud/${docs.main}/tree/master@
    </github-master-code>
    <index-link>${index-link}@</index-link>

    <!-- Spring Cloud specific -->
    <!-- for backward compatibility -->
    <spring-cloud-version>${project.version}@</spring-cloud-version>
    <project-version>${project.version}@</project-version>
    <github-tag>${github-tag}@</github-tag>
    <version-type>${version-type}@</version-type>
    <docs-url>https://docs.spring.io/${docs.main}/docs/${project.version}@</docs-url>
    <raw-docs-url>${github-raw}@</raw-docs-url>
    <project-version>${project.version}@</project-version>
    <project-name>${docs.main}@</project-name>
</attributes>
```

5. Updating the guides

We assume that your project contains guides under the `guides` folder.

```
.
└── guides
    ├── gs-guide1
    ├── gs-guide2
    └── gs-guide3
```

This means that the project contains 3 guides that would correspond to the following guides in Spring Guides org.

- github.com/spring-guides/gs-guide1
- github.com/spring-guides/gs-guide2
- github.com/spring-guides/gs-guide3

If you deploy your project with the `-Pguides` profile like this

```
$ ./mvnw clean deploy -Pguides
```

what will happen is that for GA project versions, we will clone `gs-guide1`, `gs-guide2` and `gs-guide3` and update their contents with the ones being under your `guides` project.

You can skip this by either not adding the `guides` profile, or passing the `-DskipGuides` system property when the profile is turned on.

You can configure the project version passed to guides via the `guides-project.version` (defaults to `${project.version}`). The phase at which guides get updated can be configured by `guides-update.phase` (defaults to `deploy`).

Spring Cloud Bus

Spring Cloud Bus links the nodes of a distributed system with a lightweight message broker. This broker can then be used to broadcast state changes (such as 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. However, it can also be used as a communication channel between apps. This project provides starters for either an AMQP broker or Kafka as the transport.

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.

1. Quick Start

Spring Cloud Bus works by adding Spring Boot autconfiguration if it detects itself on the classpath. To enable the bus, add `spring-cloud-starter-bus-amqp` or `spring-cloud-starter-bus-kafka` to your dependency management. Spring Cloud takes care of the rest. Make sure the broker (RabbitMQ or

Kafka) is available and configured. When running on localhost, you need not do anything. If you run remotely, use Spring Cloud Connectors or Spring Boot conventions to define the broker credentials, as shown in the following example 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). The `/bus/*` actuator namespace has some HTTP endpoints. Currently, two are implemented. The first, `/bus/env`, sends key/value pairs to update each node's Spring Environment. The second, `/bus/refresh`, reloads each application's configuration, as though they had all been pinged on their `/refresh` endpoint.

The Spring Cloud Bus starters cover Rabbit and Kafka, because those are the two most common implementations. However, Spring Cloud Stream is quite flexible, and the binder works with `spring-cloud-bus`.

2. Bus Endpoints

Spring Cloud Bus provides two endpoints, `/actuator/busrefresh` and `/actuator/busenv` that correspond to individual actuator endpoints in Spring Cloud Commons, `/actuator/refresh` and `/actuator/env` respectively.

2.1. Bus Refresh Endpoint

The `/actuator/busrefresh` endpoint clears the `RefreshScope` cache and rebinds `@ConfigurationProperties`. See the Refresh Scope documentation for more information.

To expose the `/actuator/busrefresh` endpoint, you need to add following configuration to your application:

```
management.endpoints.web.exposure.include=busrefresh
```

2.2. Bus Env Endpoint

The `/actuator/busenv` endpoint updates each instances environment with the specified key/value pair across multiple instances.

To expose the `/actuator/busenv` endpoint, you need to add following configuration to your application:

```
management.endpoints.web.exposure.include=busenv
```

The `/actuator/busenv` endpoint accepts `POST` requests with the following shape:

```
{
    "name": "key1",
    "value": "value1"
}
```

3. Addressing an Instance

Each instance of the application has a service ID, whose value can be set with `spring.cloud.bus.id` and whose value is expected to be a colon-separated list of identifiers, in order from 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 of `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, `spring.application.index`, `local.server.port`, `server.port`, or `0` (in that order).
- `id` is the `vcap.application.instance_id`, if it exists, or a random value.

The HTTP endpoints accept a "destination" path parameter, such as `/busrefresh/customers:9000`, where `destination` is a service ID. If the ID is owned by an instance on the bus, it processes the message, and all other instances ignore it.

4. 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 processes the message. Using the example from earlier, `/busenv/customers:**` targets all instances of the "customers" service regardless of the rest of the service ID.

5. Service ID Must Be Unique

The bus tries twice to eliminate processing an event — once from the original `ApplicationEvent` and once from the queue. To do so, it checks the sending service ID against the current service ID. If multiple instances of a service have the same ID, events are not processed. When running on a local machine, each service is on a different port, and that port is 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.

6. Customizing the Message Broker

Spring Cloud Bus uses Spring Cloud Stream to broadcast the messages. So, to get messages to flow, you need only include the binder implementation of your choice in the classpath. There are convenient starters 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. 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.*` (for example, `spring.cloud.bus.destination` is the name of the topic to use as the external middleware). Normally, the defaults suffice.

To learn more about how to customize the message broker settings, consult the Spring Cloud Stream documentation.

7. Tracing Bus Events

Bus events (subclasses of `RemoteApplicationEvent`) can be traced by setting `spring.cloud.bus.trace.enabled=true`. If you do so, the Spring Boot `TraceRepository` (if it is present) shows each event sent and all the acks from each service instance. The following example comes 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": "*:**"
  }
}
```


The preceding trace shows that a `RefreshRemoteApplicationEvent` was sent from `customers:9000`, broadcast to all services, and 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). Alternatively, you could tap into the `TraceRepository` and mine the data from there.

Any Bus application can trace acks. However, sometimes, it is 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.

8. Broadcasting Your Own Events

The Bus can carry any event of type `RemoteApplicationEvent`. 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, you must put it 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.

Both the producer and the consumer need access to the class definition.

8.1. Registering events in custom packages

If you cannot or do not 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` by using the `@RemoteApplicationEventScan` annotation. Packages specified with `@RemoteApplicationEventScan` include subpackages.

For example, consider the following custom event, called `MyEvent`:

```
package com.acme;

public class MyEvent extends RemoteApplicationEvent {
    ...
}
```

You can register that 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 is registered. In this example, `com.acme` is registered by using the package of `BusConfiguration`.

You can also explicitly specify the packages to scan by using the `value`, `basePackages` or `basePackageClasses` properties on `@RemoteApplicationEventScan`, as shown in the following 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 of the preceding examples of `@RemoteApplicationEventScan` are equivalent, in that the `com.acme` package is registered by explicitly specifying the packages on `@RemoteApplicationEventScan`.

You can specify multiple base packages to scan.

9. Configuration properties

To see the list of all Bus related configuration properties please check the Appendix page.

Spring Cloud Circuit Breaker

2020.0.0-M4

.1. Configuring Resilience4J Circuit Breakers

.1.1. Starters

There are two starters for the Resilience4J implementations, one for reactive applications and one for non-reactive applications.

- `org.springframework.cloud:spring-cloud-starter-circuitbreaker-resilience4j` - non-reactive applications
- `org.springframework.cloud:spring-cloud-starter-circuitbreaker-reactor-resilience4j` - reactive applications

.1.2. Auto-Configuration

You can disable the Resilience4J auto-configuration by setting `spring.cloud.circuitbreaker.resilience4j.enabled` to `false`.

.1.3. Default Configuration

To provide a default configuration for all of your circuit breakers create a `Customize` bean that is passed a `Resilience4JCircuitBreakerFactory` or `ReactiveResilience4JCircuitBreakerFactory`. The `configureDefault` method can be used to provide a default configuration.

```
@Bean
public Customizer<Resilience4JCircuitBreakerFactory> defaultCustomizer() {
    return factory -> factory.configureDefault(id -> new
Resilience4JConfigBuilder(id)

.timeLimiterConfig(TimeLimiterConfig.custom().timeoutDuration(Duration.ofSeconds(4
)).build())
            .circuitBreakerConfig(CircuitBreakerConfig.ofDefaults())
            .build());
}
```

Reactive Example

```
@Bean
public Customizer<ReactiveResilience4JCircuitBreakerFactory> defaultCustomizer() {
    return factory -> factory.configureDefault(id -> new
Resilience4JConfigBuilder(id)
            .circuitBreakerConfig(CircuitBreakerConfig.ofDefaults())

.timeLimiterConfig(TimeLimiterConfig.custom().timeoutDuration(Duration.ofSeconds(4
)).build()).build());
}
```

.1.4. Specific Circuit Breaker Configuration

Similarly to providing a default configuration, you can create a `Customize` bean this is passed a `Resilience4JCircuitBreakerFactory` or `ReactiveResilience4JCircuitBreakerFactory`.

```
@Bean
public Customizer<Resilience4JCircuitBreakerFactory> slowCustomizer() {
    return factory -> factory.configure(builder ->
builder.circuitBreakerConfig(CircuitBreakerConfig.ofDefaults())

.timeLimiterConfig(TimeLimiterConfig.custom().timeoutDuration(Duration.ofSeconds(2
)).build()), "slow");
}
```

In addition to configuring the circuit breaker that is created you can also customize the circuit breaker after it has been created but before it is returned to the caller. To do this you can use the `addCircuitBreakerCustomizer` method. This can be useful for adding event handlers to Resilience4J circuit breakers.

```
@Bean
public Customizer<Resilience4JCircuitBreakerFactory> slowCustomizer() {
    return factory -> factory.addCircuitBreakerCustomizer(circuitBreaker ->
circuitBreaker.getEventPublisher()
    .onError(normalFluxErrorConsumer).onSuccess(normalFluxSuccessConsumer),
"normalflux");
}
```

Reactive Example

```
@Bean
public Customizer<ReactiveResilience4JCircuitBreakerFactory> slowCustomizer() {
    return factory -> {
        factory.configure(builder -> builder

.timeLimiterConfig(TimeLimiterConfig.custom().timeoutDuration(Duration.ofSeconds(2
)).build())
        .circuitBreakerConfig(CircuitBreakerConfig.ofDefaults()), "slow",
"slowflux");
        factory.addCircuitBreakerCustomizer(circuitBreaker ->
circuitBreaker.getEventPublisher()

.onError(normalFluxErrorConsumer).onSuccess(normalFluxSuccessConsumer),
"normalflux");
     };
}
```

.1.5. Collecting Metrics

Spring Cloud Circuit Breaker Resilience4j includes auto-configuration to setup metrics collection as long as the right dependencies are on the classpath. To enable metric collection you must include `org.springframework.boot:spring-boot-starter-actuator`, and `io.github.resilience4j:resilience4j-micrometer`. For more information on the metrics that get produced when these dependencies are present, see the Resilience4j documentation.

You don't have to include `micrometer-core` directly as it is brought in by `spring-boot-starter-actuator`

.2. Configuring Spring Retry Circuit Breakers

Spring Retry provides declarative retry support for Spring applications. A subset of the project includes the ability to implement circuit breaker functionality. Spring Retry provides a circuit breaker implementation via a combination of it's `CircuitBreakerRetryPolicy` and a stateful retry. All

circuit breakers created using Spring Retry will be created using the `CircuitBreakerRetryPolicy` and a `DefaultRetryState`. Both of these classes can be configured using `SpringRetryConfigBuilder`.

.2.1. Default Configuration

To provide a default configuration for all of your circuit breakers create a `Customize` bean that is passed a `SpringRetryCircuitBreakerFactory`. The `configureDefault` method can be used to provide a default configuration.

```
@Bean
public Customizer<SpringRetryCircuitBreakerFactory> defaultCustomizer() {
    return factory -> factory.configureDefault(id -> new
SpringRetryConfigBuilder(id)
        .retryPolicy(new TimeoutRetryPolicy()).build());
}
```

.2.2. Specific Circuit Breaker Configuration

Similarly to providing a default configuration, you can create a `Customize` bean this is passed a `SpringRetryCircuitBreakerFactory`.

```
@Bean
public Customizer<SpringRetryCircuitBreakerFactory> slowCustomizer() {
    return factory -> factory.configure(builder -> builder.retryPolicy(new
SimpleRetryPolicy(1)).build(), "slow");
}
```

In addition to configuring the circuit breaker that is created you can also customize the circuit breaker after it has been created but before it is returned to the caller. To do this you can use the `addRetryTemplateCustomizers` method. This can be useful for adding event handlers to the `RetryTemplate`.

```
@Bean
public Customizer<SpringRetryCircuitBreakerFactory> slowCustomizer() {
    return factory -> factory.addRetryTemplateCustomizers(retryTemplate ->
retryTemplate.registerListener(new RetryListener() {

        @Override
        public <T, E extends Throwable> boolean open(RetryContext context,
RetryCallback<T, E> callback) {
            return false;
        }

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

        }

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

        }
    }));
}
```

3. Building

3.1. Basic Compile and Test

To build the source you will need to install JDK 1.8.

Spring Cloud uses Maven for most build-related activities, and you should be able to get off the ground quite quickly by cloning the project you are interested in and typing

```
$ ./mvnw install
```

You can also install Maven (>=3.3.3) yourself and run the `mvn` command in place of `./mvnw` in the examples below. If you do that you also might need to add `-P spring` if your local Maven settings do not contain repository declarations for spring pre-release artifacts.

Be aware that you might need to increase the amount of memory available to Maven by setting a `MAVEN_OPTS` environment variable with a value like `-Xmx512m -XX:MaxPermSize=128m`. We try to cover this in the `.mvn` configuration, so if you find you have to do it to make a build succeed, please raise a ticket to get the settings added to source control.

For hints on how to build the project look in `.travis.yml` if there is one. There should be a "script" and maybe "install" command. Also look at the "services" section to see if any services need to be running locally (e.g. mongo or rabbit). Ignore the git-related bits that you might find in "before_install" since they're related to setting git credentials and you already have those.

The projects that require middleware generally include a `docker-compose.yml`, so consider using Docker Compose to run the middeware servers in Docker containers. See the README in the scripts demo repository for specific instructions about the common cases of mongo, rabbit and redis.

If all else fails, build with the command from `.travis.yml` (usually `./mvnw install`).

3.2. Documentation

The spring-cloud-build module has a "docs" profile, and if you switch that on it will try to build asciidoc sources from `src/main/asciidoc`. As part of that process it will look for a `README.adoc` and process it by loading all the includes, but not parsing or rendering it, just copying it to `${main.basedir}` (defaults to `$/home/marcin/repo/spring-cloud-release/train-docs/target/unpacked-docs`, i.e. the root of the project). If there are any changes in the README it will then show up after a Maven build as a modified file in the correct place. Just commit it and push the change.

3.3. Working with the code

If you don't have an IDE preference we would recommend that you use Spring Tools Suite or Eclipse when working with the code. We use the m2eclipse eclipse plugin for maven support. Other IDEs and tools should also work without issue as long as they use Maven 3.3.3 or better.

3.3.1. Activate the Spring Maven profile

Spring Cloud projects require the 'spring' Maven profile to be activated to resolve the spring milestone and snapshot repositories. Use your preferred IDE to set this profile to be active, or you may experience build errors.

3.3.2. Importing into eclipse with m2eclipse

We recommend the m2eclipse eclipse plugin when working with eclipse. If you don't already have m2eclipse installed it is available from the "eclipse marketplace".

Older versions of m2e do not support Maven 3.3, so once the projects are imported into Eclipse you will also need to tell m2eclipse to use the right profile for the projects. If you see many different errors related to the POMs in the projects, check that you have an up to date installation. If you can't upgrade m2e, add the "spring" profile to your `settings.xml`. Alternatively you can copy the repository settings from the "spring" profile of the parent pom into your `settings.xml`.

3.3.3. Importing into eclipse without m2eclipse

If you prefer not to use m2eclipse you can generate eclipse project metadata using the following command:

```
$ ./mvnw eclipse:eclipse
```

The generated eclipse projects can be imported by selecting `import existing projects` from the `file` menu.

4. Contributing

Spring Cloud is released under the non-restrictive Apache 2.0 license, and follows a very standard Github development process, using Github tracker for issues and merging pull requests into master. If you want to contribute even something trivial please do not hesitate, but follow the guidelines below.

4.1. Sign the Contributor License Agreement

Before we accept a non-trivial patch or pull request we will need you to sign the Contributor License Agreement. Signing the contributor's agreement does not grant anyone commit rights to the main repository, but it does mean that we can accept your contributions, and you will get an author credit if we do. Active contributors might be asked to join the core team, and given the ability to merge pull requests.

4.2. Code of Conduct

This project adheres to the Contributor Covenant code of conduct. By participating, you are expected to uphold this code. Please report unacceptable behavior to spring-code-of-conduct@pivotal.io.

4.3. Code Conventions and Housekeeping

None of these is essential for a pull request, but they will all help. They can also be added after the original pull request but before a merge.

- Use the Spring Framework code format conventions. If you use Eclipse you can import formatter settings using the `eclipse-code-formatter.xml` file from the Spring Cloud Build project.

If using IntelliJ, you can use the Eclipse Code Formatter Plugin to import the same file.

- Make sure all new `.java` files to have a simple Javadoc class comment with at least an `@author` tag identifying you, and preferably at least a paragraph on what the class is for.
- Add the ASF license header comment to all new `.java` files (copy from existing files in the project)
- Add yourself as an `@author` to the .java files that you modify substantially (more than cosmetic changes).
- Add some Javadocs and, if you change the namespace, some XSD doc elements.
- A few unit tests would help a lot as well — someone has to do it.
- If no-one else is using your branch, please rebase it against the current master (or other target branch in the main project).
- When writing a commit message please follow these conventions, if you are fixing an existing issue please add `Fixes gh-XXXX` at the end of the commit message (where XXXX is the issue number).

4.4. Checkstyle

Spring Cloud Build comes with a set of checkstyle rules. You can find them in the `spring-cloud-build-tools` module. The most notable files under the module are:

spring-cloud-build-tools/

```
└── src
    ├── checkstyle
    │   └── checkstyle-suppressions.xml ③
    └── main
        └── resources
            ├── checkstyle-header.txt ②
            └── checkstyle.xml ①
```

① Default Checkstyle rules

② File header setup

③ Default suppression rules

4.4.1. Checkstyle configuration

Checkstyle rules are **disabled by default**. To add checkstyle to your project just define the following properties and plugins.

pom.xml

```
<properties>
<maven-checkstyle-plugin.failsOnError>true</maven-checkstyle-plugin.failsOnError> ①
        <maven-checkstyle-plugin.failsOnViolation>true
        </maven-checkstyle-plugin.failsOnViolation> ②
        <maven-checkstyle-plugin.includeTestSourceDirectory>true
        </maven-checkstyle-plugin.includeTestSourceDirectory> ③
</properties>

<build>
        <plugins>
            <plugin> ④
                <groupId>io.spring.javaformat</groupId>
                <artifactId>spring-javaformat-maven-plugin</artifactId>
            </plugin>
            <plugin> ⑤
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-checkstyle-plugin</artifactId>
            </plugin>
        </plugins>

    <reporting>
        <plugins>
            <plugin> ⑤
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-checkstyle-plugin</artifactId>
            </plugin>
        </plugins>
    </reporting>
</build>
```

① Fails the build upon Checkstyle errors

② Fails the build upon Checkstyle violations

③ Checkstyle analyzes also the test sources

④ Add the Spring Java Format plugin that will reformat your code to pass most of the Checkstyle formatting rules

⑤ Add checkstyle plugin to your build and reporting phases

If you need to suppress some rules (e.g. line length needs to be longer), then it's enough for you to define a file under `${project.root}/src/checkstyle/checkstyle-suppressions.xml` with your suppressions. Example:

projectRoot/src/checkstyle/checkstyle-suppresions.xml

```
<?xml version="1.0"?>
<!DOCTYPE suppressions PUBLIC
        "-//Puppy Crawl//DTD Suppressions 1.1//EN"
        "https://www.puppycrawl.com/dtds/suppressions_1_1.dtd">
<suppressions>
    <suppress files=".*ConfigServerApplication\.java"
checks="HideUtilityClassConstructor"/>
    <suppress files=".*ConfigClientWatch\.java" checks="LineLengthCheck"/>
</suppressions>
```

It's advisable to copy the `${spring-cloud-build.rootFolder}/.editorconfig` and `${spring-cloud-build.rootFolder}/.springformat` to your project. That way, some default formatting rules will be applied. You can do so by running this script:

```
$ curl https://raw.githubusercontent.com/spring-cloud/spring-cloud-
build/master/.editorconfig -o .editorconfig
$ touch .springformat
```

4.5. IDE setup

4.5.1. Intellij IDEA

In order to setup Intellij you should import our coding conventions, inspection profiles and set up the checkstyle plugin. The following files can be found in the Spring Cloud Build project.

spring-cloud-build-tools/

```
└─── src
    ├─── checkstyle
    │    └─── checkstyle-suppressions.xml ③
    └─── main
        └─── resources
            ├─── checkstyle-header.txt ②
            ├─── checkstyle.xml ①
            └─── intellij
                ├─── Intellij_Project_Defaults.xml ④
                └─── Intellij_Spring_Boot_Java_Conventions.xml ⑤
```

① Default Checkstyle rules

② File header setup

③ Default suppression rules

④ Project defaults for Intellij that apply most of Checkstyle rules

⑤ Project style conventions for Intellij that apply most of Checkstyle rules

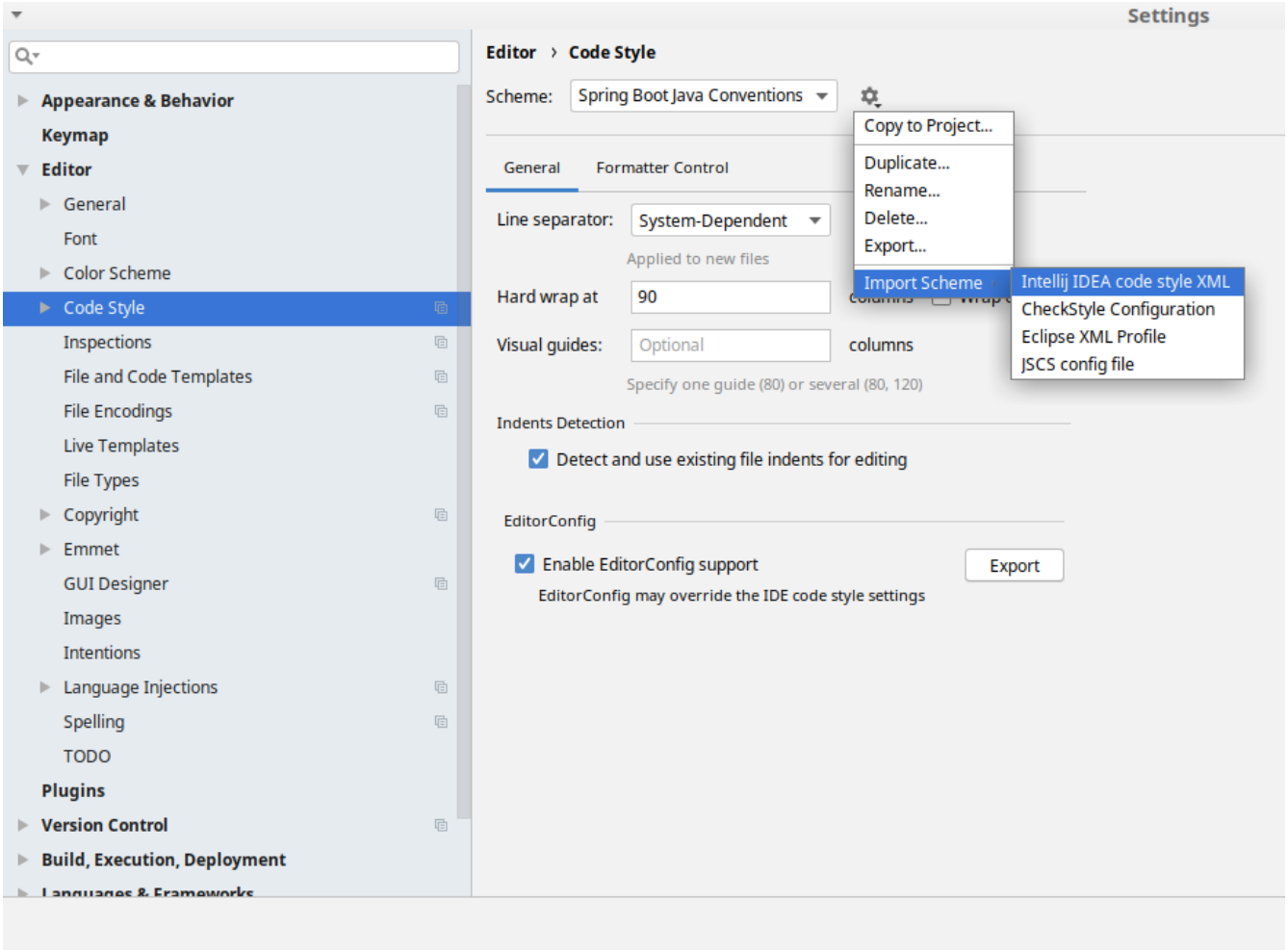


Figure 3. Code style

Go to `File → Settings → Editor → Code style`. There click on the icon next to the `Scheme` section. There, click on the `Import Scheme` value and pick the `Intellij IDEA code style XML` option. Import the `spring-cloud-build-tools/src/main/resources/intellij/Intellij_Spring_Boot_Java_Conventions.xml` file.

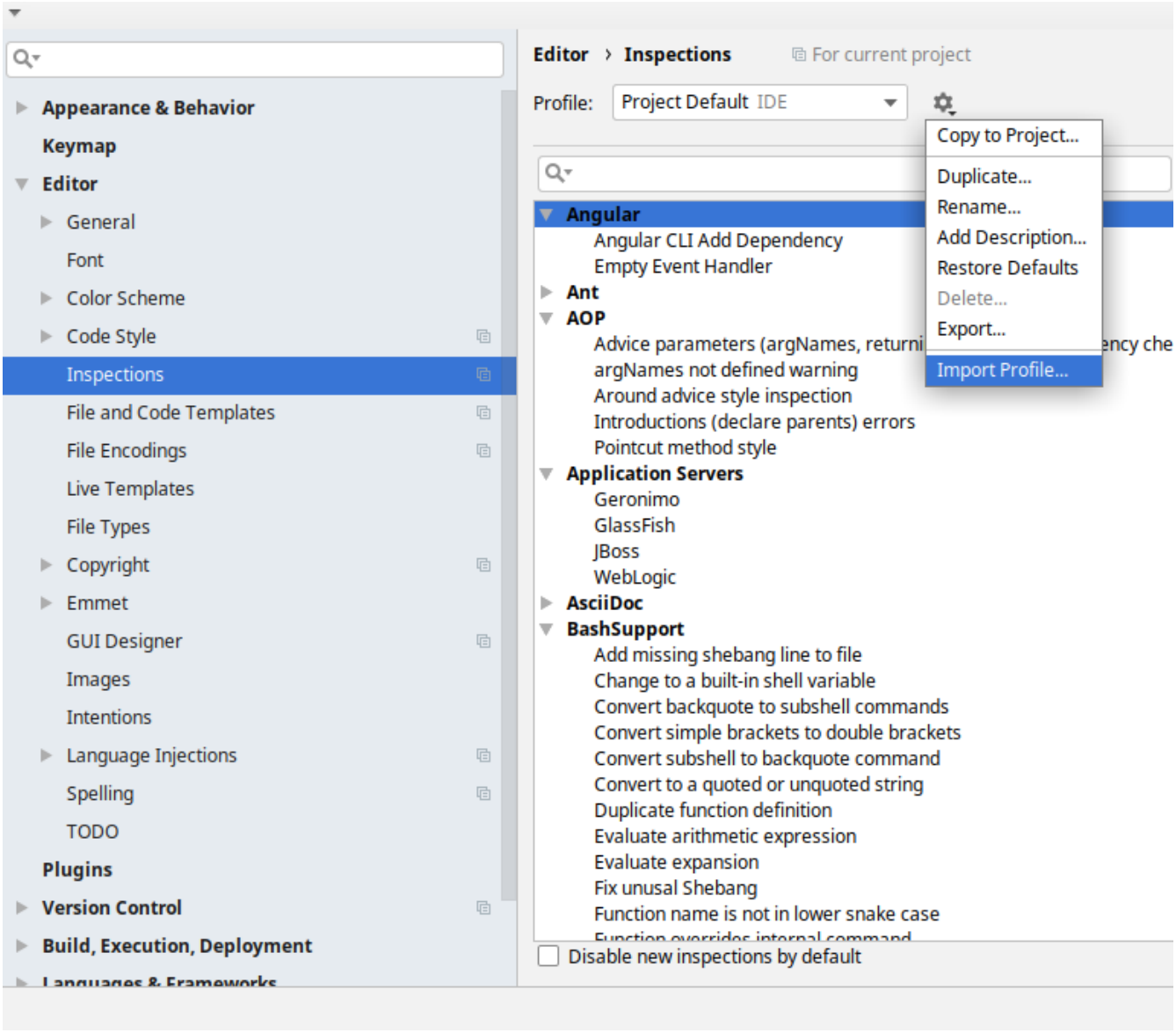
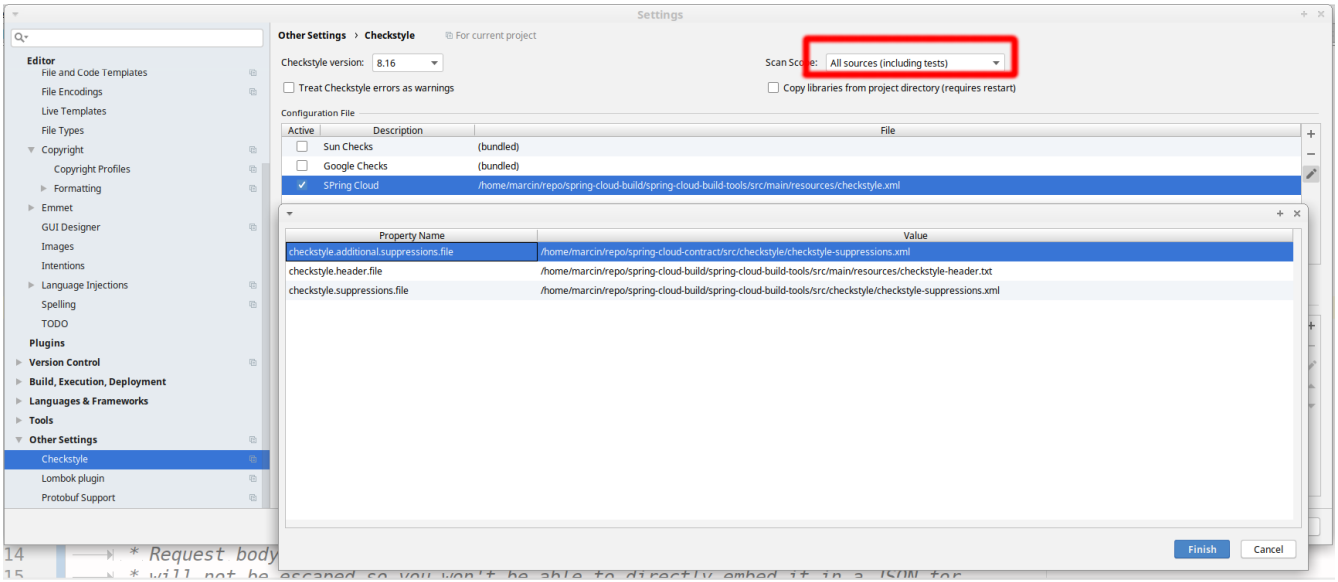


Figure 4. Inspection profiles

Go to `File` → `Settings` → `Editor` → `Inspections`. There click on the icon next to the `Profile` section. There, click on the `Import Profile` and import the `spring-cloud-build-tools/src/main/resources/intellij/Intellij_Project_Defaults.xml` file.

Checkstyle

To have Intellij work with Checkstyle, you have to install the `Checkstyle` plugin. It's advisable to also install the `Assertions2Assertj` to automatically convert the JUnit assertions



Go to `File` → `Settings` → `Other settings` → `Checkstyle`. There click on the `+` icon in the `Configuration file` section. There, you'll have to define where the checkstyle rules should be picked from. In the image above, we've picked the rules from the cloned Spring Cloud Build repository. However, you can point to the Spring Cloud Build's GitHub repository (e.g. for the `checkstyle.xml` : `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/main/resources/checkstyle.xml`). We need to provide the following variables:

- `checkstyle.header.file` - please point it to the Spring Cloud Build's, `spring-cloud-build-tools/src/main/resources/checkstyle-header.txt` file either in your cloned repo or via the `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/main/resources/checkstyle-header.txt` URL.
- `checkstyle.suppressions.file` - default suppressions. Please point it to the Spring Cloud Build's, `spring-cloud-build-tools/src/checkstyle/checkstyle-suppressions.xml` file either in your cloned repo or via the `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/checkstyle/checkstyle-suppressions.xml` URL.
- `checkstyle.additional.suppressions.file` - this variable corresponds to suppressions in your local project. E.g. you're working on `spring-cloud-contract`. Then point to the `project-root/src/checkstyle/checkstyle-suppressions.xml` folder. Example for `spring-cloud-contract` would be: `/home/username/spring-cloud-contract/src/checkstyle/checkstyle-suppressions.xml`.

Remember to set the `Scan Scope` to `All sources` since we apply checkstyle rules for production and test sources.

Spring Boot Cloud CLI

Spring Boot CLI provides Spring Boot command line features for Spring Cloud. You can write Groovy scripts to run Spring Cloud component applications (e.g. `@EnableEurekaServer`). You can also easily do things like encryption and decryption to support Spring Cloud Config clients with secret configuration values. With the Launcher CLI you can launch services like Eureka, Zipkin, Config Server conveniently all at once from the command line (very useful at development time).

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.

1. Installation

To install, make sure you have Spring Boot CLI (2.0.0 or better):

```
$ spring version
Spring CLI v2.2.0.BUILD-SNAPSHOT
```

E.g. for SDKMan users

```
$ sdk install springboot 2.2.0.BUILD-SNAPSHOT
$ sdk use springboot 2.2.0.BUILD-SNAPSHOT
```

and install the Spring Cloud plugin

```
$ mvn install
$ spring install org.springframework.cloud:spring-cloud-cli:2.2.0.BUILD-SNAPSHOT
```

Prerequisites: to use the encryption and decryption features you need the full-strength JCE installed in your JVM (it's not there by default). You can download the "Java Cryptography Extension (JCE) Unlimited Strength Jurisdiction Policy Files" from Oracle, and follow instructions for installation (essentially replace the 2 policy files in the JRE lib/security directory with the ones that you downloaded).

2. Running Spring Cloud Services in Development

The Launcher CLI can be used to run common services like Eureka, Config Server etc. from the command line. To list the available services you can do `spring cloud --list`, and to launch a default set of services just `spring cloud`. To choose the services to deploy, just list them on the command line, e.g.

```
$ spring cloud eureka configserver h2 kafka stubrunner zipkin
```

Summary of supported deployables:

Service	Name	Address	Description
eureka	Eureka Server	localhost:8761	Eureka server for service registration and discovery. All the other services show up in its catalog by default.
configserver	Config Server	localhost:8888	Spring Cloud Config Server running in the "native" profile and serving configuration from the local directory ./launcher
h2	H2 Database	localhost:9095 (console), jdbc:h2:tcp://localhost:9096/{data}	Relation database service. Use a file path for `{data}` (e.g. `./target/test`) when you connect. Remember that you can add `;MODE=MYSQL` or `;MODE=POSTGRESQL` to connect with compatibility to other server types.
kafka	Kafka Broker	localhost:9091 (actuator endpoints), localhost:9092	
dataflow	Dataflow Server	localhost:9393	Spring Cloud Dataflow server with UI at /admin-ui. Connect the Dataflow shell to target at root path.
zipkin	Zipkin Server	localhost:9411	Zipkin Server with UI for visualizing traces. Stores span data in memory and accepts them via HTTP POST of JSON data.

Service	Name	Address	Description
stubrunner	Stub Runner Boot	localhost:8750	Downloads WireMock stubs, starts WireMock and feeds the started servers with stored stubs. Pass `stubrunner.ids` to pass stub coordinates and then go to `localhost:8750/stubs`.

Each of these apps can be configured using a local YAML file with the same name (in the current working directory or a subdirectory called "config" or in `~/.spring-cloud`). E.g. in `configserver.yml` you might want to do something like this to locate a local git repository for the backend:

configserver.yml

```
spring:
  profiles:
    active: git
  cloud:
    config:
      server:
        git:
          uri: file://${user.home}/dev/demo/config-repo
```

E.g. in Stub Runner app you could fetch stubs from your local `.m2` in the following way.

stubrunner.yml

```
stubrunner:
  workOffline: true
  ids:
    - com.example:beer-api-producer:+:9876
```

2.1. Adding Additional Applications

Additional applications can be added to `./config/cloud.yml` (not `./config.yml` because that would replace the defaults), e.g. with

config/cloud.yml

```
spring:
  cloud:
    launcher:
      deployables:
        source:
          coordinates: maven://com.example:source:0.0.1-SNAPSHOT
          port: 7000
        sink:
          coordinates: maven://com.example:sink:0.0.1-SNAPSHOT
          port: 7001
```

when you list the apps:

```
$ spring cloud --list
source sink configserver dataflow eureka h2 kafka stubrunner zipkin
```

(notice the additional apps at the start of the list).

3. Writing Groovy Scripts and Running Applications

Spring Cloud CLI has support for most of the Spring Cloud declarative features, such as the `@Enable*` class of annotations. For example, here is a fully functional Eureka server

app.groovy

```
@EnableEurekaServer
class Eureka {}
```

which you can run from the command line like this

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

To include additional dependencies, often it suffices just to add the appropriate feature-enabling annotation, e.g. `@EnableConfigServer`, `@EnableOAuth2Sso` or `@EnableEurekaClient`. To manually include a dependency you can use a `@Grab` with the special "Spring Boot" short style artifact co-ordinates, i.e. with just the artifact ID (no need for group or version information), e.g. to set up a client app to listen on AMQP for management events from the Spring CLoud Bus:

app.groovy

```
@Grab('spring-cloud-starter-bus-amqp')
@RestController
class Service {
  @RequestMapping('/')
  def home() { [message: 'Hello'] }
}
```

4. Encryption and Decryption

The Spring Cloud CLI comes with an "encrypt" and a "decrypt" command. Both accept arguments in the same form with a key specified as a mandatory "--key", e.g.

```
$ spring encrypt mysecret --key foo
682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda
$ spring decrypt --key foo
682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda
mysecret
```

To use a key in a file (e.g. an RSA public key for encyption) prepend the key value with "@" and provide the file path, e.g.

```
$ spring encrypt mysecret --key @${HOME}/.ssh/id_rsa.pub
AQAjPgt3eFZQXwt8tsHAVv/QHiY5sI2dRcR+...
```

Spring Cloud for Cloud Foundry

Spring Cloud for Cloudfoundry makes it easy to run Spring Cloud apps in Cloud Foundry (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) 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.

1. 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.

2. Single Sign On

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.

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`.

3. Configuration

To see the list of all Spring Cloud Sloud Foundry related configuration properties please check the Appendix page.

Cloud Native Applications

Cloud Native is a style of application development that encourages easy adoption of best practices in the areas of continuous delivery and value-driven development. A related discipline is that of building 12-factor Applications, in which development practices are aligned with delivery and operations goals — for instance, by using declarative programming and management and monitoring. Spring Cloud facilitates these styles of development in a number of specific ways. The starting point is a set of features to which all components in a distributed system need easy access.

Many of those features are covered by Spring Boot, on which Spring Cloud builds. Some more features are delivered by Spring Cloud as two libraries: Spring Cloud Context and Spring Cloud Commons. Spring Cloud Context provides utilities and special services for the `ApplicationContext` of a Spring Cloud application (bootstrap context, encryption, refresh scope, and environment endpoints). Spring Cloud Commons is a set of abstractions and common classes used in different Spring Cloud implementations (such as Spring Cloud Netflix and Spring Cloud Consul).

If you get an exception due to "Illegal key size" and you use Sun's JDK, you need to install the Java Cryptography Extension (JCE) Unlimited Strength Jurisdiction Policy Files. See the following links for more information:

- Java 6 JCE
- Java 7 JCE
- Java 8 JCE

Extract the files into the JDK/jre/lib/security folder for whichever version of JRE/JDK x64/x86 you use.

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, you can find the source code and issue trackers for the project at github.

1. Spring Cloud Context: Application Context Services

Spring Boot has an opinionated view of how to build an application with Spring. For instance, it has conventional locations for common configuration files and has endpoints for common management and monitoring tasks. Spring Cloud builds on top of that and adds a few features that many components in a system would use or occasionally need.

1.1. The Bootstrap Application Context

A Spring Cloud application operates by creating a “bootstrap” context, which is a parent context for the main application. This context is responsible for loading configuration properties from the external sources and for decrypting properties in the local external configuration files. The two contexts share an `Environment`, which is the source of external properties for any Spring application. By default, bootstrap properties (not `bootstrap.properties` but properties that are loaded during the bootstrap phase) are added with high precedence, so they cannot be overridden by local configuration.

The bootstrap context uses a different convention for locating external configuration than the main application context. Instead of `application.yml` (or `.properties`), you can use `bootstrap.yml`, keeping the external configuration for bootstrap and main context nicely separate. The following listing shows an example:

Example 1. bootstrap.yml

```
spring:
  application:
    name: foo
  cloud:
    config:
      uri: ${SPRING_CONFIG_URI:http://localhost:8888}
```

If your application needs any application-specific configuration from the server, it is a good idea to set the `spring.application.name` (in `bootstrap.yml` or `application.yml`). For the property `spring.application.name` to be used as the application’s context ID, you must set it in `bootstrap.[properties | yml]`.

If you want to retrieve specific profile configuration, you should also set `spring.profiles.active` in `bootstrap.[properties | yml]`.

You can disable the bootstrap process completely by setting `spring.cloud.bootstrap.enabled=false` (for example, in system properties).

1.2. Application Context Hierarchies

If you build an application context from `SpringApplication` or `SpringApplicationBuilder`, the Bootstrap context is added as a parent to that context. It is a feature of Spring that child contexts inherit property sources and profiles from their parent, so the “main” application context contains additional property sources, compared to building the same context without Spring Cloud Config. The additional property sources are:

- “bootstrap”: If any `PropertySourceLocators` are found in the bootstrap context and if they have non-empty properties, an optional `CompositePropertySource` appears with high priority. An example would be properties from the Spring Cloud Config Server. See “Customizing the Bootstrap Property Sources” for how to customize the contents of this property source.

- “applicationConfig: [classpath:bootstrap.yml]” (and related files if Spring profiles are active): If you have a `bootstrap.yml` (or `.properties`), those properties are used to configure the bootstrap context. Then they get added to the child context when its parent is set. They have lower precedence than the `application.yml` (or `.properties`) and any other property sources that are added to the child as a normal part of the process of creating a Spring Boot application. See “Changing the Location of Bootstrap Properties” for how to customize the contents of these property sources.

Because of the ordering rules of property sources, the “bootstrap” entries take precedence. However, note that these do not contain any data from `bootstrap.yml`, which has very low precedence but can be used to set defaults.

You can extend the context hierarchy by setting the parent context of any `ApplicationContext` you create — for example, by using its own interface or with the `SpringApplicationBuilder` convenience methods (`parent()`, `child()` and `sibling()`). The bootstrap context is the parent of the most senior ancestor that you create yourself. Every context in the hierarchy has its own “bootstrap” (possibly empty) property source to avoid promoting values inadvertently from parents down to their descendants. If there is a config server, every context in the hierarchy can also (in principle) have a different `spring.application.name` and, hence, a different remote property source. Normal Spring application context behavior rules apply to property resolution: properties from a child context override those in the parent, by name and also by property source name. (If the child has a property source with the same name as the parent, the value from the parent is not included in the child).

Note that the `SpringApplicationBuilder` lets you share an `Environment` amongst the whole hierarchy, but that is not the default. Thus, sibling contexts (in particular) do not need to have the same profiles or property sources, even though they may share common values with their parent.

1.3. Changing the Location of Bootstrap Properties

The `bootstrap.yml` (or `.properties`) location can be specified by setting `spring.cloud.bootstrap.name` (default: `bootstrap`), `spring.cloud.bootstrap.location` (default: empty) or `spring.cloud.bootstrap.additional-location` (default: empty) — for example, in System properties.

Those properties behave like the `spring.config.*` variants with the same name. With `spring.cloud.bootstrap.location` the default locations are replaced and only the specified ones are used. To add locations to the list of default ones, `spring.cloud.bootstrap.additional-location` could be used. In fact, they are used to set up the bootstrap `ApplicationContext` by setting those properties in its `Environment`. If there is an active profile (from `spring.profiles.active` or through the `Environment` API in the context you are building), properties in that profile get loaded as well, the same as in a regular Spring Boot app — for example, from `bootstrap-development.properties` for a `development` profile.

1.4. Overriding the Values of Remote Properties

The property sources that are added to your application by the bootstrap context are often “remote” (from example, from Spring Cloud Config Server). By default, they cannot be overridden locally. If you want to let your applications override the remote properties with their own system

properties or config files, the remote property source has to grant it permission by setting `spring.cloud.config.allowOverride=true` (it does not work to set this locally). Once that flag is set, two finer-grained settings control the location of the remote properties in relation to system properties and the application's local configuration:

- `spring.cloud.config.overrideNone=true`: Override from any local property source.
- `spring.cloud.config.overrideSystemProperties=false`: Only system properties, command line arguments, and environment variables (but not the local config files) should override the remote settings.

1.5. Customizing the Bootstrap Configuration

The bootstrap context can be set to do anything you like by adding entries to `/META-INF/spring.factories` under a key named `org.springframework.cloud.bootstrap.BootstrapConfiguration`. This holds a comma-separated list of Spring `@Configuration` classes that are used to create the context. Any beans that you want to be available to the main application context for autowiring can be created here. There is a special contract for `@Beans` of type `ApplicationContextInitializer`. If you want to control the startup sequence, you can mark classes with the `@Order` annotation (the default order is `last`).

When adding custom `BootstrapConfiguration`, be careful that the classes you add are not `@ComponentScanned` by mistake into your "main" application context, where they might not be needed. Use a separate package name for boot configuration classes and make sure that name is not already covered by your `@ComponentScan` or `@SpringBootApplication` annotated configuration classes.

The bootstrap process ends by injecting initializers into the main `SpringApplication` instance (which is the normal Spring Boot startup sequence, whether it runs as a standalone application or is deployed in an application server). First, a bootstrap context is created from the classes found in `spring.factories`. Then, all `@Beans` of type `ApplicationContextInitializer` are added to the main `SpringApplication` before it is started.

1.6. Customizing the Bootstrap Property Sources

The default property source for external configuration added by the bootstrap process is the Spring Cloud Config Server, but you can add additional sources by adding beans of type `PropertySourceLocator` to the bootstrap context (through `spring.factories`). For instance, you can insert additional properties from a different server or from a database.

As an example, consider the following 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"));
    }

}
```

The `Environment` that is passed in is the one for the `ApplicationContext` about to be created — in other words, the one for which we supply additional property sources. It already has its normal Spring Boot-provided property sources, so you can use those to locate a property source specific to this `Environment` (for example, by keying it on `spring.application.name`, as is done in the default Spring Cloud Config Server property source locator).

If you create a jar with this class in it and then add a `META-INF/spring.factories` containing the following setting, the `customProperty PropertySource` appears in any application that includes that jar on its classpath:

```
org.springframework.cloud.bootstrap.BootstrapConfiguration=sample.custom.CustomPro
pertySourceLocator
```

1.7. Logging Configuration

If you use Spring Boot to configure log settings, you should place this configuration in `bootstrap.[yml | properties]` if you would like it to apply to all events.

For Spring Cloud to initialize logging configuration properly, you cannot use a custom prefix. For example, using `custom.loggin.logpath` is not recognized by Spring Cloud when initializing the logging system.

1.8. Environment Changes

The application listens for an `EnvironmentChangeEvent` and reacts to the change in a couple of standard ways (additional `ApplicationListeners` can be added as `@Beans` in the normal way). When an `EnvironmentChangeEvent` is observed, it has a list of key values that have changed, and the application uses those to:

- Re-bind any `@ConfigurationProperties` beans in the context.

- Set the logger levels for any properties in `logging.level.*`.

Note that the Spring Cloud Config Client does not, by default, poll for changes in the `Environment`. Generally, we would not recommend that approach for detecting changes (although you could set it up with a `@Scheduled` annotation). If you have a scaled-out client application, it is better to broadcast the `EnvironmentChangeEvent` to all the instances instead of having them polling for changes (for example, by using the Spring Cloud Bus).

The `EnvironmentChangeEvent` covers a large class of refresh use cases, as long as you can actually make a change to the `Environment` and publish the event. Note that those APIs are public and part of core Spring). You can verify that the changes are bound to `@ConfigurationProperties` beans by visiting the `/configprops` endpoint (a standard Spring Boot Actuator feature). For instance, a `DataSource` can have its `maxPoolSize` changed at runtime (the default `DataSource` created by Spring Boot is a `@ConfigurationProperties` bean) and grow capacity dynamically. Re-binding `@ConfigurationProperties` does not cover another large class of use cases, where you need more control over the refresh and where you need a change to be atomic over the whole `ApplicationContext`. To address those concerns, we have `@RefreshScope`.

1.9. Refresh Scope

When there is a configuration change, a Spring `@Bean` that is marked as `@RefreshScope` gets special treatment. This feature addresses the problem of stateful beans that get their configuration injected only when they are initialized. For instance, if a `DataSource` has open connections when the database URL is changed through the `Environment`, you probably want the holders of those connections to be able to complete what they are doing. Then, the next time something borrows a connection from the pool, it gets one with the new URL.

Sometimes, it might even be mandatory to apply the `@RefreshScope` annotation on some beans that can be only initialized once. If a bean is "immutable", you have to either annotate the bean with `@RefreshScope` or specify the classname under the property key: `spring.cloud.refresh.extra-refreshable`.

If you hava a `DataSource` bean that is a `HikariDataSource`, it can not be refreshed. It is the default value for `spring.cloud.refresh.never-refreshable`. Choose a different `DataSource` implementation if you need it to be refreshed.

Refresh scope beans are lazy proxies that initialize when they are used (that is, when a method is called), and the scope acts as a cache of initialized values. To force a bean to re-initialize on the next method call, you must invalidate its cache entry.

The `RefreshScope` is a bean in the context and has a public `refreshAll()` method to refresh all beans in the scope by clearing the target cache. The `/refresh` endpoint exposes this functionality (over HTTP or JMX). To refresh an individual bean by name, there is also a `refresh(String)` method.

To expose the `/refresh` endpoint, you need to add following configuration to your application:

```
management:
  endpoints:
    web:
      exposure:
        include: refresh
```

`@RefreshScope` works (technically) on a `@Configuration` class, but it might lead to surprising behavior. For example, it does not mean that all the `@Beans` defined in that class are themselves in `@RefreshScope`. Specifically, anything that depends on those beans cannot rely on them being updated when a refresh is initiated, unless it is itself in `@RefreshScope`. In that case, it is rebuilt on a refresh and its dependencies are re-injected. At that point, they are re-initialized from the refreshed `@Configuration`).

1.10. Encryption and Decryption

Spring Cloud has an `Environment` pre-processor for decrypting property values locally. It follows the same rules as the Spring Cloud Config Server and has the same external configuration through `encrypt.*`. Thus, you can use encrypted values in the form of `{cipher}*`, and, as long as there is a valid key, they are decrypted before the main application context gets the `Environment` settings. To use the encryption features in an application, you need to include Spring Security RSA in your classpath (Maven co-ordinates: `org.springframework.security:spring-security-rsa`), and you also need the full strength JCE extensions in your JVM.

If you get an exception due to "Illegal key size" and you use Sun's JDK, you need to install the Java Cryptography Extension (JCE) Unlimited Strength Jurisdiction Policy Files. See the following links for more information:

- Java 6 JCE
- Java 7 JCE
- Java 8 JCE

Extract the files into the JDK/jre/lib/security folder for whichever version of JRE/JDK x64/x86 you use.

1.11. Endpoints

For a Spring Boot Actuator application, some additional management endpoints are available. You can use:

- `POST` to `/actuator/env` to update the `Environment` and rebind `@ConfigurationProperties` and log levels.
- `/actuator/refresh` to re-load the boot strap context and refresh the `@RefreshScope` beans.
- `/actuator/restart` to close the `ApplicationContext` and restart it (disabled by default).

- `/actuator/pause` and `/actuator/resume` for calling the `Lifecycle` methods (`stop()` and `start()` on the `ApplicationContext`).

If you disable the `/actuator/restart` endpoint then the `/actuator/pause` and `/actuator/resume` endpoints will also be disabled since they are just a special case of `/actuator/restart`.

2. Spring Cloud Commons: Common Abstractions

Patterns such as service discovery, load balancing, and circuit breakers lend themselves to a common abstraction layer that can be consumed by all Spring Cloud clients, independent of the implementation (for example, discovery with Eureka or Consul).

2.1. The `@EnableDiscoveryClient` Annotation

Spring Cloud Commons provides the `@EnableDiscoveryClient` annotation. This looks for implementations of the `DiscoveryClient` and `ReactiveDiscoveryClient` interfaces with `META-INF/spring.factories`. Implementations of the discovery client add a configuration class to `spring.factories` under the `org.springframework.cloud.client.discovery.EnableDiscoveryClient` key. Examples of `DiscoveryClient` implementations include Spring Cloud Netflix Eureka, Spring Cloud Consul Discovery, and Spring Cloud Zookeeper Discovery.

Spring Cloud will provide both the blocking and reactive service discovery clients by default. You can disable the blocking and/or reactive clients easily by setting `spring.cloud.discovery.blocking.enabled=false` or `spring.cloud.discovery.reactive.enabled=false`. To completely disable service discovery you just need to set `spring.cloud.discovery.enabled=false`.

By default, implementations of `DiscoveryClient` auto-register the local Spring Boot server with the remote discovery server. This behavior can be disabled by setting `autoRegister=false` in `@EnableDiscoveryClient`.

`@EnableDiscoveryClient` is no longer required. You can put a `DiscoveryClient` implementation on the classpath to cause the Spring Boot application to register with the service discovery server.

2.1.1. Health Indicator

Commons creates a Spring Boot `HealthIndicator` that `DiscoveryClient` implementations can participate in by implementing `DiscoveryHealthIndicator`. To disable the composite `HealthIndicator`, set `spring.cloud.discovery.client.composite-indicator.enabled=false`. A generic `HealthIndicator` based on `DiscoveryClient` is auto-configured (`DiscoveryClientHealthIndicator`). To disable it, set `spring.cloud.discovery.client.health-indicator.enabled=false`. To disable the description field of the `DiscoveryClientHealthIndicator`, set `spring.cloud.discovery.client.health-indicator.include-description=false`. Otherwise, it can bubble up as the `description` of the rolled up `HealthIndicator`.

2.1.2. Ordering `DiscoveryClient` instances

`DiscoveryClient` interface extends `Ordered`. This is useful when using multiple discovery clients, as it allows you to define the order of the returned discovery clients, similar to how you can order the beans loaded by a Spring application. By default, the order of any `DiscoveryClient` is set to `0`. If you want to set a different order for your custom `DiscoveryClient` implementations, you just need to override the `getOrder()` method so that it returns the value that is suitable for your setup. Apart from this, you can use properties to set the order of the `DiscoveryClient` implementations provided by Spring Cloud, among others `ConsulDiscoveryClient`, `EurekaDiscoveryClient` and `ZookeeperDiscoveryClient`. In order to do it, you just need to set the `spring.cloud.{clientIdentifier}.discovery.order` (or `eureka.client.order` for Eureka) property to the desired value.

2.1.3. SimpleDiscoveryClient

If there is no Service-Registry-backed `DiscoveryClient` in the classpath, `SimpleDiscoveryClient` instance, that uses properties to get information on service and instances, will be used.

The information about the available instances should be passed to via properties in the following format: `spring.cloud.discovery.client.simple.instances.service1[0].uri=http://s11:8080`, where `spring.cloud.discovery.client.simple.instances` is the common prefix, then `service1` stands for the ID of the service in question, while `[0]` indicates the index number of the instance (as visible in the example, indexes start with `0`), and then the value of `uri` is the actual URI under which the instance is available.

2.2. ServiceRegistry

Commons now provides a `ServiceRegistry` interface that provides methods such as `register(Registration)` and `deregister(Registration)`, which let you provide custom registered services. `Registration` is a marker interface.

The following example shows the `ServiceRegistry` in use:

```
@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);
    }
}
```

Each `ServiceRegistry` implementation has its own `Registry` implementation.

- `ZookeeperRegistration` used with `ZookeeperServiceRegistry`
- `EurekaRegistration` used with `EurekaServiceRegistry`
- `ConsulRegistration` used with `ConsulServiceRegistry`

If you are using the `ServiceRegistry` interface, you are going to need to pass the correct `Registry` implementation for the `ServiceRegistry` implementation you are using.

2.2.1. ServiceRegistry Auto-Registration

By default, the `ServiceRegistry` implementation auto-registers the running service. To disable that behavior, you can set: * `@EnableDiscoveryClient(autoRegister=false)` to permanently disable auto-registration. * `spring.cloud.service-registry.auto-registration.enabled=false` to disable the behavior through configuration.

ServiceRegistry Auto-Registration Events

There are two events that will be fired when a service auto-registers. The first event, called `InstancePreRegisteredEvent`, is fired before the service is registered. The second event, called `InstanceRegisteredEvent`, is fired after the service is registered. You can register an `ApplicationListener`(s) to listen to and react to these events.

These events will not be fired if the `spring.cloud.service-registry.auto-registration.enabled` property is set to `false`.

2.2.2. Service Registry Actuator Endpoint

Spring Cloud Commons provides a `/service-registry` actuator endpoint. This endpoint relies on a

`Registration` bean in the Spring Application Context. Calling `/service-registry` with GET returns the status of the `Registration`. Using POST to the same endpoint with a JSON body changes the status of the current `Registration` to the new value. The JSON body has to include the `status` field with the preferred value. Please see the documentation of the `ServiceRegistry` implementation you use for the allowed values when updating the status and the values returned for the status. For instance, Eureka's supported statuses are `UP`, `DOWN`, `OUT_OF_SERVICE`, and `UNKNOWN`.

2.3. Spring RestTemplate as a Load Balancer Client

You can configure a `RestTemplate` to use a Load-balancer client. To create a load-balanced `RestTemplate`, create a `RestTemplate @Bean` and use the `@LoadBalanced` qualifier, as the following example shows:

```
@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;
    }
}
```

A `RestTemplate` bean is no longer created through auto-configuration. Individual applications must create it.

The URI needs to use a virtual host name (that is, a service name, not a host name). The BlockingLoadBalancerClient is used to create a full physical address.

To use a load-balanced `RestTemplate`, you need to have a load-balancer implementation in your classpath. Add Spring Cloud LoadBalancer starter to your project in order to use it.

2.4. Spring WebClient as a Load Balancer Client

You can configure `WebClient` to automatically use a load-balancer client. To create a load-balanced `WebClient`, create a `WebClient.Builder` `@Bean` and use the `@LoadBalanced` qualifier, as follows:

```
@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);
    }
}
```

The URI needs to use a virtual host name (that is, a service name, not a host name). The Spring Cloud LoadBalancer is used to create a full physical address.

If you want to use a `@LoadBalanced WebClient.Builder`, you need to have a load balancer implementation in the classpath. We recommend that you add the Spring Cloud LoadBalancer starter to your project. Then, `ReactiveLoadBalancer` is used underneath.

2.4.1. Retrying Failed Requests

A load-balanced `RestTemplate` can be configured to retry failed requests. By default, this logic is disabled. You can enable it by adding Spring Retry to your application's classpath.

If you would like to disable the retry logic with Spring Retry on the classpath, you can set `spring.cloud.loadbalancer.retry.enabled=false`.

If you would like to implement a `BackOffPolicy` in your retries, you need to create a bean of type `LoadBalancedRetryFactory` and override the `createBackOffPolicy()` method.

You can set:

- `spring.cloud.loadbalancer.retry.maxRetriesOnSameServiceInstance` - indicates how many times a

request should be retried on the same `ServiceInstance` (counted separately for every selected instance)

- `spring.cloud.loadbalancer.retry.maxRetriesOnNextServiceInstance` - indicates how many times a request should be retried a newly selected `ServiceInstance`
- `spring.cloud.loadbalancer.retry.retryableStatusCodes` - the status codes on which to always retry a failed request.

For load-balanced retries, by default, we wrap the `ServiceInstanceListSupplier` bean with `RetryAwareServiceInstanceListSupplier` to select a different instance from the one previously chosen, if available. You can disable this behavior by setting the value of `spring.cloud.loadbalancer.retry.avoidPreviousInstance` to `false`.

```
@Configuration
public class MyConfiguration {
    @Bean
    LoadBalancedRetryFactory retryFactory() {
        return new LoadBalancedRetryFactory() {
            @Override
            public BackOffPolicy createBackOffPolicy(String service) {
                return new ExponentialBackOffPolicy();
            }
        };
    }
}
```

If you want to add one or more `RetryListener` implementations to your retry functionality, you need to create a bean of type `LoadBalancedRetryListenerFactory` and return the `RetryListener` array you would like to use for a given service, as the following example shows:

```
@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...
                    }
                }};
            }
        };
    }
}
```

2.5. Multiple `RestTemplate` Objects

If you want a `RestTemplate` that is not load-balanced, create a `RestTemplate` bean and inject it. To access the load-balanced `RestTemplate`, use the `@LoadBalanced` qualifier when you create your `@Bean`, as the following example shows:

```
@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);
    }
}
```

Notice the use of the `@Primary` annotation on the plain `RestTemplate` declaration in the preceding example to disambiguate the unqualified `@Autowired` injection.

If you see errors such as `java.lang.IllegalArgumentException: Can not set org.springframework.web.client.RestTemplate field com.my.app.Foo.restTemplate to com.sun.proxy.$Proxy89`, try injecting `RestOperations` or setting `spring.aop.proxyTargetClass=true`.

2.6. Multiple WebClient Objects

If you want a `WebClient` that is not load-balanced, create a `WebClient` bean and inject it. To access the load-balanced `WebClient`, use the `@LoadBalanced` qualifier when you create your `@Bean`, as the following example shows:

```
@Configuration
public class MyConfiguration {

    @LoadBalanced
    @Bean
    WebClient.Builder loadBalanced() {
        return WebClient.builder();
    }

    @Primary
    @Bean
    WebClient.Builder webClient() {
        return WebClient.builder();
    }
}

public class MyClass {
    @Autowired
    private WebClient.Builder webClientBuilder;

    @Autowired
    @LoadBalanced
    private WebClient.Builder loadBalanced;

    public Mono<String> doOtherStuff() {
        return loadBalanced.build().get().uri("http://stores/stores")
                        .retrieve().bodyToMono(String.class);
    }

    public Mono<String> doStuff() {
        return webClientBuilder.build().get().uri("http://example.com")
                        .retrieve().bodyToMono(String.class);
    }
}
```

2.7. Spring WebFlux `WebClient` as a Load Balancer Client

The Spring WebFlux can work with both reactive and non-reactive `WebClient` configurations, as the topics describe:

- Spring WebFlux `WebClient` with `ReactorLoadBalancerExchangeFilterFunction`
- [load-balancer-exchange-filter-functionload-balancer-exchange-filter-function]

2.7.1. Spring WebFlux `WebClient` with `ReactorLoadBalancerExchangeFilterFunction`

You can configure `WebClient` to use the `ReactiveLoadBalancer`. If you add Spring Cloud LoadBalancer starter to your project and if `spring-webflux` is on the classpath, `ReactorLoadBalancerExchangeFilterFunction` is auto-configured. The following example shows how to configure a `WebClient` to use reactive load-balancer:

```
public class MyClass {
    @Autowired
    private ReactorLoadBalancerExchangeFilterFunction lbFunction;

    public Mono<String> doOtherStuff() {
        return WebClient.builder().baseUrl("http://stores")
            .filter(lbFunction)
            .build()
            .get()
            .uri("/stores")
            .retrieve()
            .bodyToMono(String.class);
    }
}
```

The URI needs to use a virtual host name (that is, a service name, not a host name). The `ReactorLoadBalancer` is used to create a full physical address.

2.7.2. Spring WebFlux `WebClient` with a Non-reactive Load Balancer Client

If `spring-webflux` is on the classpath, `LoadBalancerExchangeFilterFunction` is auto-configured. Note, however, that this uses a non-reactive client under the hood. The following example shows how to configure a `WebClient` to use load-balancer:

```
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);
    }
}
```

The URI needs to use a virtual host name (that is, a service name, not a host name). The `LoadBalancerClient` is used to create a full physical address.

WARN: This approach is now deprecated. We suggest that you use WebFlux with reactive Load-Balancer instead.

2.8. Ignore Network Interfaces

Sometimes, it is useful to ignore certain named network interfaces so that they can be excluded from Service Discovery registration (for example, when running in a Docker container). A list of regular expressions can be set to cause the desired network interfaces to be ignored. The following configuration ignores the `docker0` interface and all interfaces that start with `veth`:

Example 2. application.yml

```
spring:
  cloud:
    inetutils:
      ignoredInterfaces:
        - docker0
        - veth.*
```

You can also force the use of only specified network addresses by using a list of regular expressions, as the following example shows:

Example 3. bootstrap.yml

```
spring:
  cloud:
    inetutils:
      preferredNetworks:
        - 192.168
        - 10.0
```

You can also force the use of only site-local addresses, as the following example shows:

Example 4. application.yml

```
spring:
  cloud:
    inetutils:
      useOnlySiteLocalInterfaces: true
```

See Inet4Address.html.isSiteLocalAddress() for more details about what constitutes a site-local address.

2.9. HTTP Client Factories

Spring Cloud Commons provides beans for creating both Apache HTTP clients (`ApacheHttpClientFactory`) and OK HTTP clients (`OkHttpClientFactory`). The `OkHttpClientFactory` bean is created only if the OK HTTP jar is on the classpath. In addition, Spring Cloud Commons provides beans for creating the connection managers used by both clients: `ApacheHttpClientConnectionManagerFactory` for the Apache HTTP client and `OkHttpClientConnectionPoolFactory` for the OK HTTP client. If you would like to customize how the HTTP clients are created in downstream projects, you can provide your own implementation of these beans. In addition, if you provide a bean of type `HttpClientBuilder` or `OkHttpClient.Builder`, the default factories use these builders as the basis for the builders returned to downstream projects. You can also disable the creation of these beans by setting `spring.cloud.httpclientfactories.apache.enabled` or `spring.cloud.httpclientfactories.ok.enabled` to `false`.

2.10. Enabled Features

Spring Cloud Commons provides a `/features` actuator endpoint. This endpoint returns features available on the classpath and whether they are enabled. The information returned includes the feature type, name, version, and vendor.

2.10.1. Feature types

There are two types of 'features': abstract and named.

Abstract features are features where an interface or abstract class is defined and that an implementation the creates, such as `DiscoveryClient`, `LoadBalancerClient`, or `LockService`. The abstract class or interface is used to find a bean of that type in the context. The version displayed is `bean.getClass().getPackage().getImplementationVersion()`.

Named features are features that do not have a particular class they implement. These features include “Circuit Breaker”, “API Gateway”, “Spring Cloud Bus”, and others. These features require a name and a bean type.

2.10.2. Declaring features

Any module can declare any number of `HasFeature` beans, as the following examples show:

```
@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(Something.class)
      .namedFeature(new NamedFeature("Some Other Feature", Someother.class))
      .abstractFeature(Somethingelse.class)
      .build();
}
```

Each of these beans should go in an appropriately guarded `@Configuration`.

2.11. Spring Cloud Compatibility Verification

Due to the fact that some users have problem with setting up Spring Cloud application, we’ve decided to add a compatibility verification mechanism. It will break if your current setup is not compatible with Spring Cloud requirements, together with a report, showing what exactly went wrong.

At the moment we verify which version of Spring Boot is added to your classpath.

Example of a report

```
***************************
APPLICATION FAILED TO START
***************************

Description:

Your project setup is incompatible with our requirements due to following reasons:

- Spring Boot [2.1.0.RELEASE] is not compatible with this Spring Cloud release
train


Action:

Consider applying the following actions:

- Change Spring Boot version to one of the following versions [1.2.x, 1.3.x] .
You can find the latest Spring Boot versions here
[https://spring.io/projects/spring-boot#learn].
If you want to learn more about the Spring Cloud Release train compatibility, you
can visit this page [https://spring.io/projects/spring-cloud#overview] and check
the [Release Trains] section.
```

In order to disable this feature, set `spring.cloud.compatibility-verifier.enabled` to `false`. If you want to override the compatible Spring Boot versions, just set the `spring.cloud.compatibility-verifier.compatible-boot-versions` property with a comma separated list of compatible Spring Boot versions.

3. Spring Cloud LoadBalancer

Spring Cloud provides its own client-side load-balancer abstraction and implementation. For the load-balancing mechanism, `ReactiveLoadBalancer` interface has been added and a Round-Robin-based implementation has been provided for it. In order to get instances to select from reactive `ServiceInstanceListSupplier` is used. Currently we support a service-discovery-based implementation of `ServiceInstanceListSupplier` that retrieves available instances from Service Discovery using a Discovery Client available in the classpath.

3.1. Spring Cloud LoadBalancer integrations

In order to make it easy to use Spring Cloud LoadBalancer, we provide `ReactorLoadBalancerExchangeFilterFunction` that can be used with `WebClient` and `BlockingLoadBalancerClient` that works with `RestTemplate`. You can see more information and

examples of usage in the following sections:

- Spring RestTemplate as a Load Balancer Client
- Spring WebClient as a Load Balancer Client
- Spring WebFlux WebClient with `ReactorLoadBalancerExchangeFilterFunction`

3.2. Spring Cloud LoadBalancer Caching

Apart from the basic `ServiceInstanceListSupplier` implementation that retrieves instances via `DiscoveryClient` each time it has to choose an instance, we provide two caching implementations.

3.2.1. Caffeine-backed LoadBalancer Cache Implementation

If you have `com.github.ben-manes.caffeine:caffeine` in the classpath, Caffeine-based implementation will be used. See the LoadBalancerCacheConfiguration section for information on how to configure it.

If you are using Caffeine, you can also override the default Caffeine Cache setup for the LoadBalancer by passing your own Caffeine Specification in the `spring.cloud.loadbalancer.cache.caffeine.spec` property.

WARN: Passing your own Caffeine specification will override any other LoadBalancerCache settings, including General LoadBalancer Cache Configuration fields, such as `ttl` and `capacity`.

3.2.2. Default LoadBalancer Cache Implementation

If you do not have Caffeine in the classpath, the `DefaultLoadBalancerCache`, which comes automatically with `spring-cloud-starter-loadbalancer`, will be used. See the LoadBalancerCacheConfiguration section for information on how to configure it.

To use Caffeine instead of the default cache, add the `com.github.ben-manes.caffeine:caffeine` dependency to classpath.

3.2.3. LoadBalancer Cache Configuration

You can set your own `ttl` value (the time after write after which entries should be expired), expressed as `Duration`, by passing a `String` compliant with the Spring Boot `String` to `Duration` converter syntax. as the value of the `spring.cloud.loadbalancer.cache.ttl` property. You can also set your own LoadBalancer cache initial capacity by setting the value of the `spring.cloud.loadbalancer.cache.capacity` property.

The default setup includes `ttl` set to 35 seconds and the default `initialCapacity` is `256`.

You can also altogether disable loadBalancer caching by setting the value of `spring.cloud.loadbalancer.cache.enabled` to `false`.

Although the basic, non-cached, implementation is useful for prototyping and testing, it's much less efficient than the cached versions, so we recommend always using the cached version in production.

3.3. Zone-Based Load-Balancing

To enable zone-based load-balancing, we provide the `ZonePreferenceServiceInstanceListSupplier`. We use `DiscoveryClient`-specific `zone` configuration (for example, `eureka.instance.metadata-map.zone`) to pick the zone that the client tries to filter available service instances for.

You can also override `DiscoveryClient`-specific zone setup by setting the value of `spring.cloud.loadbalancer.zone` property.

For the time being, only Eureka Discovery Client is instrumented to set the LoadBalancer zone. For other discovery client, set the `spring.cloud.loadbalancer.zone` property. More instrumentations coming shortly.

To determine the zone of a retrieved `ServiceInstance`, we check the value under the `"zone"` key in its metadata map.

The `ZonePreferenceServiceInstanceListSupplier` filters retrieved instances and only returns the ones within the same zone. If the zone is `null` or there are no instances within the same zone, it returns all the retrieved instances.

In order to use the zone-based load-balancing approach, you will have to instantiate a `ZonePreferenceServiceInstanceListSupplier` bean in a custom configuration.

We use delegates to work with `ServiceInstanceListSupplier` beans. We suggest passing a `DiscoveryClientServiceInstanceListSupplier` delegate in the constructor of `ZonePreferenceServiceInstanceListSupplier` and, in turn, wrapping the latter with a `CachingServiceInstanceListSupplier` to leverage LoadBalancer caching mechanism.

You could use this sample configuration to set it up:

```
public class CustomLoadBalancerConfiguration {

    @Bean
    public ServiceInstanceListSupplier discoveryClientServiceInstanceListSupplier(
            ConfigurableApplicationContext context) {
        return ServiceInstanceListSuppliers.builder()
                    .withDiscoveryClient()
                    .withZonePreference()
                    .withCaching()
                    .build(context);
    }
}
```

3.4. Instance Health-Check for LoadBalancer

It is possible to enable a scheduled HealthCheck for the LoadBalancer. The `HealthCheckServiceInstanceListSupplier` is provided for that. It regularly verifies if the instances provided by a delegate `ServiceInstanceListSupplier` are still alive and only returns the healthy instances, unless there are none - then it returns all the retrieved instances.

This mechanism is particularly helpful while using the `SimpleDiscoveryClient`. For the clients backed by an actual Service Registry, it's not necessary to use, as we already get healthy instances after querying the external ServiceDiscovery.

TIP

This supplier is also recommended for setups with a small number of instances per service in order to avoid retrying calls on a failing instance.

`HealthCheckServiceInstanceListSupplier` uses properties prefixed with `spring.cloud.loadbalancer.health-check`. You can set the `initialDelay` and `interval` for the scheduler. You can set the default path for the healthcheck URL by setting the value of the `spring.cloud.loadbalancer.health-check.path.default` property. You can also set a specific value for any given service by setting the value of the `spring.cloud.loadbalancer.health-check.path.[SERVICE_ID]` property, substituting `[SERVICE_ID]` with the correct ID of your service. If the path is not set, `/actuator/health` is used by default.

TIP

If you rely on the default path (`/actuator/health`), make sure you add `spring-boot-starter-actuator` to your collaborator's dependencies, unless you are planning to add such an endpoint on your own.

In order to use the health-check scheduler approach, you will have to instantiate a `HealthCheckServiceInstanceListSupplier` bean in a custom configuration.

We use delegates to work with `ServiceInstanceListSupplier` beans. We suggest passing a `DiscoveryClientServiceInstanceListSupplier` delegate in the constructor of `HealthCheckServiceInstanceListSupplier`.

You could use this sample configuration to set it up:

```
public class CustomLoadBalancerConfiguration {

    @Bean
    public ServiceInstanceListSupplier discoveryClientServiceInstanceListSupplier(
            ConfigurableApplicationContext context) {
        return ServiceInstanceListSupplier.builder()
                    .withDiscoveryClient()
                    .withHealthChecks()
                    .build(context);
        }
    }
```

NOTE

`HealthCheckServiceInstanceListSupplier` has its own caching mechanism based on Reactor Flux `replay()`, therefore, if it's being used, you may want to skip wrapping that supplier with `CachingServiceInstanceListSupplier`.

3.5. Spring Cloud LoadBalancer Hints

Spring Cloud LoadBalancer lets you set `String` hints that are passed to the LoadBalancer within the `Request` object and that can later be used in `ReactiveLoadBalancer` implementations that can handle them.

You can set a default hint for all services by setting the value of the `spring.cloud.loadbalancer.hint.default` property. You can also set a specific value for any given service by setting the value of the `spring.cloud.loadbalancer.hint.[SERVICE_ID]` property, substituting `[SERVICE_ID]` with the correct ID of your service. If the hint is not set by the user, `default` is used.

3.6. Spring Cloud LoadBalancer Starter

We also provide a starter that allows you to easily add Spring Cloud LoadBalancer in a Spring Boot app. In order to use it, just add `org.springframework.cloud:spring-cloud-starter-loadbalancer` to your Spring Cloud dependencies in your build file.

Spring Cloud LoadBalancer starter includes Spring Boot Caching and Evictor.

3.7. Passing Your Own Spring Cloud LoadBalancer Configuration

You can also use the `@LoadBalancerClient` annotation to pass your own load-balancer client configuration, passing the name of the load-balancer client and the configuration class, as follows:

```
@Configuration
@LoadBalancerClient(value = "stores", configuration =
CustomLoadBalancerConfiguration.class)
public class MyConfiguration {

    @Bean
    @LoadBalanced
    public WebClient.Builder loadBalancedWebClientBuilder() {
        return WebClient.builder();
    }
}
```

TIP

In order to make working on your own LoadBalancer configuration easier, we have added a `builder()` method to the `ServiceInstanceListSupplier` class.

TIP

You can also use our alternative predefined configurations in place of the default ones by setting the value of `spring.cloud.loadbalancer.configurations` property to `zone-preference` to use `ZonePreferenceServiceInstanceListSupplier` with caching or to `health-check` to use `HealthCheckServiceInstanceListSupplier` with caching.

You can use this feature to instantiate different implementations of `ServiceInstanceListSupplier` or `ReactorLoadBalancer`, either written by you, or provided by us as alternatives (for example `ZonePreferenceServiceInstanceListSupplier`) to override the default setup.

You can see an example of a custom configuration here.

The annotation `value` arguments (`stores` in the example above) specifies the service id of the service that we should send the requests to with the given custom configuration.

You can also pass multiple configurations (for more than one load-balancer client) through the `@LoadBalancerClients` annotation, as the following example shows:

```
@Configuration
@LoadBalancerClients({@LoadBalancerClient(value = "stores", configuration =
StoresLoadBalancerClientConfiguration.class), @LoadBalancerClient(value =
"customers", configuration = CustomersLoadBalancerClientConfiguration.class)})
public class MyConfiguration {

    @Bean
    @LoadBalanced
    public WebClient.Builder loadBalancedWebClientBuilder() {
        return WebClient.builder();
    }
}
```

3.8. Spring Cloud LoadBalancer Lifecycle

One type of bean that it may be useful to register using Custom LoadBalancer configuration is `LoadBalancerLifecycle`.

The LoadBalancerLifecycle beans provide callback methods, named `onStart(Request<RC> request)` and `onComplete(CompletionContext<RES, T> completionContext)`, that you should implement to specify what actions should take place before and after load-balancing.

`onStart(Request<RC> request)` takes a `Request` object as a parameter. It contains data that is used to select an appropriate instance, including the downstream client request and hint. On the other hand, a `CompletionContext` object is provided to the `onComplete(CompletionContext<RES, T> completionContext)` method. It contains the LoadBalancer `Response`, including the selected service instance, the `Status` of the request executed against that service instance and (if available) the response returned to the downstream client, and (if an exception has occurred) the corresponding `Throwable`.

The `supports(Class requestContextClass, Class responseClass, Class serverTypeClass)` method can be used to determine whether the processor in question handles objects of provided types. If not overridden by the user, it returns `true`.

In the preceding method calls, `RC` means `RequestContext` type, `RES` means client response type, and `T` means returned server type.

4. Spring Cloud Circuit Breaker

4.1. Introduction

Spring Cloud Circuit breaker provides an abstraction across different circuit breaker implementations. It provides a consistent API to use in your applications, letting you, the developer, choose the circuit breaker implementation that best fits your needs for your application.

4.1.1. Supported Implementations

Spring Cloud supports the following circuit-breaker implementations:

- Resilience4J
- Sentinel
- Spring Retry

4.2. Core Concepts

To create a circuit breaker in your code, you can use the `CircuitBreakerFactory` API. When you include a Spring Cloud Circuit Breaker starter on your classpath, a bean that implements this API is automatically created for you. The following example shows a simple example of how to use this API:

```
@Service
public static class DemoControllerService {
    private RestTemplate rest;
    private CircuitBreakerFactory cbFactory;

    public DemoControllerService(RestTemplate rest, CircuitBreakerFactory
cbFactory) {
        this.rest = rest;
        this.cbFactory = cbFactory;
    }

    public String slow() {
        return cbFactory.create("slow").run(() -> rest.getForObject("/slow",
String.class), throwable -> "fallback");
    }

}
```

The `CircuitBreakerFactory.create` API creates an instance of a class called `CircuitBreaker`. The `run` method takes a `Supplier` and a `Function`. The `Supplier` is the code that you are going to wrap in a circuit breaker. The `Function` is the fallback that is run if the circuit breaker is tripped. The function is passed the `Throwable` that caused the fallback to be triggered. You can optionally exclude the fallback if you do not want to provide one.

4.2.1. Circuit Breakers In Reactive Code

If Project Reactor is on the class path, you can also use `ReactiveCircuitBreakerFactory` for your reactive code. The following example shows how to do so:

```
@Service
public static class DemoControllerService {
    private ReactiveCircuitBreakerFactory cbFactory;
    private WebClient webClient;


    public DemoControllerService(WebClient webClient,
ReactiveCircuitBreakerFactory cbFactory) {
        this.webClient = webClient;
        this.cbFactory = cbFactory;
    }

    public Mono<String> slow() {
        return
webClient.get().uri("/slow").retrieve().bodyToMono(String.class).transform(
        it -> cbFactory.create("slow").run(it, throwable -> return
Mono.just("fallback")));
    }
}
```

The `ReactiveCircuitBreakerFactory.create` API creates an instance of a class called `ReactiveCircuitBreaker`. The `run` method takes a `Mono` or a `Flux` and wraps it in a circuit breaker. You can optionally profile a fallback `Function`, which will be called if the circuit breaker is tripped and is passed the `Throwable` that caused the failure.

4.3. Configuration

You can configure your circuit breakers by creating beans of type `Customizer`. The `Customizer` interface has a single method (called `customize`) that takes the `Object` to customize.

For detailed information on how to customize a given implementation see the following documentation:

- Resilience4J
- Sentinal
- Spring Retry

Some `CircuitBreaker` implementations such as `Resilience4JCircuitBreaker` call `customize` method every time `CircuitBreaker#run` is called. It can be inefficient. In that case, you can use `CircuitBreaker#once` method. It is useful where calling `customize` many times doesn't make sense, for example, in case of consuming Resilience4j's events.

The following example shows the way for each `io.github.resilience4j.circuitbreaker.CircuitBreaker` to consume events.

```
Customizer.once(circuitBreaker -> {
  circuitBreaker.getEventPublisher()
    .onStateTransition(event -> log.info("{}: {}", event.getCircuitBreakerName(),
event.getStateTransition()));
}, CircuitBreaker::getName)
```

5. CachedRandomPropertySource

Spring Cloud Context provides a `PropertySource` that caches random values based on a key. Outside of the caching functionality it works the same as Spring Boot's `RandomValuePropertySource`. This random value might be useful in the case where you want a random value that is consistent even after the Spring Application context restarts. The property value takes the form of `cachedrandom.[yourkey].[type]` where `yourkey` is the key in the cache. The `type` value can be any type supported by Spring Boot's `RandomValuePropertySource`.

```
myrandom=${cachedrandom.appname.value}
```

6. Configuration Properties

To see the list of all Spring Cloud Commons related configuration properties please check the Appendix page.

Spring Cloud Config

2020.0.0-M4

Spring Cloud Config provides server-side and client-side support for externalized configuration in a distributed system. With the Config Server, you have a central place to manage external properties for applications across all environments. The concepts on both client and server map identically to the Spring `Environment` and `PropertySource` abstractions, so they fit very well with Spring applications but can be used with any application running in any language. As an application moves through the deployment pipeline from dev to test and into production, you can manage the configuration between those environments and be certain that applications have everything they need to run when they migrate. The default implementation of the server storage backend uses git, so it easily supports labelled versions of configuration environments as well as being accessible to a wide range of tooling for managing the content. It is easy to add alternative implementations and plug them in with Spring configuration.

1. Quick Start

This quick start walks through using both the server and the client of Spring Cloud Config Server.

First, start the server, as follows:

```
$ cd spring-cloud-config-server
$ ../mvnw spring-boot:run
```

The server is a Spring Boot application, so you can run it from your IDE if you prefer to do so (the main class is `ConfigServerApplication`).

Next try out a client, as follows:

```
$ 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"}}
]}
```

The default strategy for locating property sources is to clone a git repository (at `spring.cloud.config.server.git.uri`) and use it to initialize a mini `SpringApplication`. The mini-application's `Environment` is used to enumerate property sources and publish them at a JSON endpoint.

The HTTP service has resources in the following form:

```
/{application}/{profile}[/{label}]
/{application}-{profile}.yml
/{label}/{application}-{profile}.yml
/{application}-{profile}.properties
/{label}/{application}-{profile}.properties
```

where `application` is injected as the `spring.config.name` in the `SpringApplication` (what is normally `application` in a regular Spring Boot app), `profile` is an active profile (or comma-separated list of properties), and `label` is an optional git label (defaults to `master`.)

Spring Cloud Config Server pulls configuration for remote clients from various sources. The following example gets configuration from a git repository (which must be provided), as shown in the following example:

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

Other sources are any JDBC compatible database, Subversion, Hashicorp Vault, Credhub and local filesystems.

1.1. Client Side Usage

To use these features in an application, you can build it as a Spring Boot application that depends on spring-cloud-config-client (for an example, see the test cases for the config-client or the sample application). The most convenient way to add the dependency is with a Spring Boot starter `org.springframework.cloud:spring-cloud-starter-config`. There is also a parent pom and BOM (`spring-cloud-starter-parent`) for Maven users and a Spring IO version management properties file for Gradle and Spring CLI users. The following example shows a typical Maven configuration:

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 -->
```

Now you can create a standard Spring Boot application, such as the following 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 this HTTP server runs, it picks up the external configuration from the default local config server (if it is running) on port 8888. To modify the startup behavior, you can change the location of the config server by using `bootstrap.properties` (similar to `application.properties` but for the bootstrap phase of an application context), as shown in the following example:

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

By default, if no application name is set, `application` will be used. To modify the name, the following property can be added to the `bootstrap.properties` file:

```
spring.application.name: myapp
```

When setting the property `${spring.application.name}` do not prefix your app name with the reserved word `application-` to prevent issues resolving the correct property source.

The bootstrap properties show up in the `/env` endpoint as a high-priority property source, as shown in the following example.

```
$ curl localhost:8080/env
{
  "profiles":[],
  "configService:https://github.com/spring-cloud-samples/config-
repo/bar.properties":{"foo":"bar"},
  "servletContextInitParams":{},
  "systemProperties":{...},
  ...
}
```

A property source called `configService:<URL of remote repository>/<file name>` contains the `foo`

property with a value of `bar` and is the highest priority.

The URL in the property source name is the git repository, not the config server URL.

2. Spring Cloud Config Server

Spring Cloud Config Server provides an HTTP resource-based API for external configuration (name-value pairs or equivalent YAML content). The server is embeddable in a Spring Boot application, by using the `@EnableConfigServer` annotation. Consequently, the following application is a config server:

ConfigServer.java

```
@SpringBootApplication
@EnableConfigServer
public class ConfigServer {
  public static void main(String[] args) {
    SpringApplication.run(ConfigServer.class, args);
  }
}
```

Like all Spring Boot applications, it runs on port 8080 by default, but you can switch it to the more conventional port 8888 in various ways. The easiest, which also sets a default configuration repository, is by launching it with `spring.config.name=configserver` (there is a `configserver.yml` in the Config Server jar). Another is to use your own `application.properties`, as shown in the following example:

application.properties

```
server.port: 8888
spring.cloud.config.server.git.uri: file://${user.home}/config-repo
```

where `${user.home}/config-repo` is a git repository containing YAML and properties files.

On Windows, you need an extra "/" in the file URL if it is absolute with a drive prefix (for example,`/${user.home}/config-repo`).

The following listing shows a recipe for creating the git repository in the preceding example:

```
$ 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"
```

Using the local filesystem for your git repository is intended for testing only. You should use a server to host your configuration repositories in production.

The initial clone of your configuration repository can be quick and efficient if you keep only text files in it. If you store binary files, especially large ones, you may experience delays on the first request for configuration or encounter out of memory errors in the server.

2.1. Environment Repository

Where should you store the configuration data for the Config Server? The strategy that governs this behaviour is the `EnvironmentRepository`, serving `Environment` objects. This `Environment` is a shallow copy of the domain from the Spring `Environment` (including `propertySources` as the main feature). The `Environment` resources are parametrized by three variables:

- `{application}`, which maps to `spring.application.name` on the client side.
- `{profile}`, which maps to `spring.profiles.active` on the client (comma-separated list).
- `{label}`, which is a server side feature labelling a "versioned" set of config files.

Repository implementations generally behave like a Spring Boot application, loading configuration files from a `spring.config.name` equal to the `{application}` parameter, and `spring.profiles.active` equal to the `{profiles}` parameter. Precedence rules for profiles are also the same as in a regular Spring Boot application: Active profiles take precedence over defaults, and, if there are multiple profiles, the last one wins (similar to adding entries to a `Map`).

The following sample client application has this bootstrap configuration:

bootstrap.yml

```
spring:
  application:
    name: foo
  profiles:
    active: dev,mysql
```

(As usual with a Spring Boot application, these properties could also be set by environment variables or command line arguments).

If the repository is file-based, the server creates an `Environment` from `application.yml` (shared between all clients) and `foo.yml` (with `foo.yml` taking precedence). If the YAML files have documents inside them that point to Spring profiles, those are applied with higher precedence (in order of the profiles listed). If there are profile-specific YAML (or properties) files, these are also applied with higher precedence than the defaults. Higher precedence translates to a `PropertySource` listed earlier in the `Environment`. (These same rules apply in a standalone Spring Boot application.)

You can set spring.cloud.config.server.accept-empty to false so that Server would return a HTTP 404 status, if the application is not found.By default, this flag is set to true.

2.1.1. Git Backend

The default implementation of `EnvironmentRepository` uses a Git backend, which is very convenient for managing upgrades and physical environments and for auditing changes. To change the location of the repository, you can set the `spring.cloud.config.server.git.uri` configuration property in the Config Server (for example in `application.yml`). If you set it with a `file:` prefix, it should work from a local repository so that you can get started quickly and easily without a server. However, in that case, the server operates directly on the local repository without cloning it (it does not matter if it is not bare because the Config Server never makes changes to the "remote" repository). To scale the Config Server up and make it highly available, you need to have all instances of the server pointing to the same repository, so only a shared file system would work. Even in that case, it is better to use the `ssh:` protocol for a shared filesystem repository, so that the server can clone it and use a local working copy as a cache.

This repository implementation maps the `{label}` parameter of the HTTP resource to a git label (commit id, branch name, or tag). If the git branch or tag name contains a slash (`/`), then the label in the HTTP URL should instead be specified with the special string `(_)` (to avoid ambiguity with other URL paths). For example, if the label is `foo/bar`, replacing the slash would result in the following label: `foo(_)bar`. The inclusion of the special string `(_)` can also be applied to the `{application}` parameter. If you use a command-line client such as curl, be careful with the brackets in the URL — you should escape them from the shell with single quotes (').

Skipping SSL Certificate Validation

The configuration server's validation of the Git server's SSL certificate can be disabled by setting the `git.skipSslValidation` property to `true` (default is `false`).

```
spring:
  cloud:
    config:
      server:
        git:
          uri: https://example.com/my/repo
          skipSslValidation: true
```

Setting HTTP Connection Timeout

You can configure the time, in seconds, that the configuration server will wait to acquire an HTTP connection. Use the `git.timeout` property.

```
spring:
  cloud:
    config:
      server:
        git:
          uri: https://example.com/my/repo
          timeout: 4
```

Placeholders in Git URI

Spring Cloud Config Server supports a git repository URL with placeholders for the `{application}` and `{profile}` (and `{label}` if you need it, but remember that the label is applied as a git label anyway). So you can support a “one repository per application” policy by using a structure similar to the following:

```
spring:
  cloud:
    config:
      server:
        git:
          uri: https://github.com/myorg/{application}
```

You can also support a “one repository per profile” policy by using a similar pattern but with `{profile}`.

Additionally, using the special string "(_)" within your `{application}` parameters can enable support for multiple organizations, as shown in the following example:

```
spring:
  cloud:
    config:
      server:
        git:
          uri: https://github.com/{application}
```

where `{application}` is provided at request time in the following format: `organization(_)application`.

Pattern Matching and Multiple Repositories

Spring Cloud Config also includes support for more complex requirements with pattern matching on the application and profile name. The pattern format is a comma-separated list of

`{application}/{profile}` names with wildcards (note that a pattern beginning with a wildcard may need to be quoted), as shown in the following example:

```
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
```

If `{application}/{profile}` does not match any of the patterns, it uses the default URI defined under `spring.cloud.config.server.git.uri`. In the above example, for the "simple" repository, the pattern is `simple/*` (it only matches one application named `simple` in all profiles). The "local" repository matches all application names beginning with `local` in all profiles (the `/*` suffix is added automatically to any pattern that does not have a profile matcher).

The "one-liner" short cut used in the "simple" example can be used only if the only property to be set is the URI. If you need to set anything else (credentials, pattern, and so on) you need to use the full form.

The `pattern` property in the repo is actually an array, so you can use a YAML array (or `[0]`, `[1]`, etc. suffixes in properties files) to bind to multiple patterns. You may need to do so if you are going to run apps with multiple profiles, as shown in the following example:

```
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
```

Spring Cloud guesses that a pattern containing a profile that does not end in `*` implies that you actually want to match a list of profiles starting with this pattern (so `*/staging` is a shortcut for `["*/staging", "*/staging,*"]`, and so on). This is common where, for instance, you need to run applications in the "development" profile locally but also the "cloud" profile remotely.

Every repository can also optionally store config files in sub-directories, and patterns to search for those directories can be specified as `searchPaths`. The following example shows a config file at the top level:

```
spring:
  cloud:
    config:
      server:
        git:
          uri: https://github.com/spring-cloud-samples/config-repo
          searchPaths: foo,bar*
```

In the preceding example, the server searches for config files in the top level and in the `foo/` sub-directory and also any sub-directory whose name begins with `bar`.

By default, the server clones remote repositories when configuration is first requested. The server can be configured to clone the repositories at startup, as shown in the following top-level example:

```
spring:
  cloud:
    config:
      server:
        git:
          uri: https://git/common/config-repo.git
          repos:
            team-a:
                pattern: team-a-*
                cloneOnStart: true
                uri: https://git/team-a/config-repo.git
            team-b:
                pattern: team-b-*
                cloneOnStart: false
                uri: https://git/team-b/config-repo.git
            team-c:
                pattern: team-c-*
                uri: https://git/team-a/config-repo.git
```

In the preceding example, the server clones team-a's config-repo on startup, before it accepts any requests. All other repositories are not cloned until configuration from the repository is requested.

Setting a repository to be cloned when the Config Server starts up can help to identify a misconfigured configuration source (such as an invalid repository URI) quickly, while the Config Server is starting up. With `cloneOnStart` not enabled for a configuration source, the Config Server may start successfully with a misconfigured or invalid configuration source and not detect an error until an application requests configuration from that configuration source.

Authentication

To use HTTP basic authentication on the remote repository, add the `username` and `password` properties separately (not in the URL), as shown in the following example:

```
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).

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).

JGit requires RSA keys in PEM format. Below is an example ssh-keygen (from openssh) command that will generate a key in the corect format:

```
ssh-keygen -m PEM -t rsa -b 4096 -f ~/config_server_deploy_key.rsa
```

Warning: When working with SSH keys, the expected ssh private-key must begin with -----BEGIN RSA PRIVATE KEY-----. If the key starts with -----BEGIN OPENSSH PRIVATE KEY----- then the RSA key will not load when spring-cloud-config server is started. The error looks like:

```
- Error in object 'spring.cloud.config.server.git': codes
[PrivateKeyIsValid.spring.cloud.config.server.git,PrivateKeyIsValid]; arguments
[org.springframework.context.support.DefaultMessageSourceResolvable: codes
[spring.cloud.config.server.git.,]; arguments []; default message []]; default message
[Property 'spring.cloud.config.server.git.privateKey' is not a valid private key]
```

To correct the above error the RSA key must be converted to PEM format. An example using openssh is provided above for generating a new key in the appropriate format.

Authentication with AWS CodeCommit

Spring Cloud Config Server also supports AWS CodeCommit 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 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.

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.

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.

Authentication with Google Cloud Source

Spring Cloud Config Server also supports authenticating against Google Cloud Source repositories.

If your Git URI uses the http or https protocol and the domain name is source.developers.google.com, the Google Cloud Source credentials provider will be used. A Google Cloud Source repository URI has the format source.developers.google.com/p/${GCP_PROJECT}/r/${REPO}. To obtain the URI for your repository, click on "Clone" in the Google Cloud Source UI, and select "Manually generated credentials". Do not generate any credentials, simply copy the displayed URI.

The Google Cloud Source credentials provider will use Google Cloud Platform application default credentials. See Google Cloud SDK documentation on how to create application default credentials for a system. This approach will work for user accounts in dev environments and for service accounts in production environments.

com.google.auth:google-auth-library-oauth2-http is an optional dependency. If the google-auth-library-oauth2-http jar is not on your classpath, the Google Cloud Source 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 2. 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: https://git/team-a/config-repo.git
                force-pull: true
            team-b:
                pattern: team-b-*
                uri: https://git/team-b/config-repo.git
                force-pull: true
            team-c:
                pattern: team-c-*
                uri: https://git/team-a/config-repo.git
```

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
```

The default value for `deleteUntrackedBranches` property is `false`.

Git Refresh Rate

You can control how often the config server will fetch updated configuration data from your Git backend by using `spring.cloud.config.server.git.refreshRate`. The value of this property is specified in seconds. By default the value is 0, meaning the config server will fetch updated configuration from the Git repo every time it is requested.

2.1.2. Version Control Backend Filesystem Use

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 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.

2.1.3. 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`.

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 `${}`-style environment placeholders, but remember that absolute paths in Windows require an extra `/` (for example, `/${user.home}/config-repo`).

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.

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`.

2.1.4. Vault Backend

Spring Cloud Config Server also supports Vault 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.

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 `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	,
kvVersion	1

Name	Default Value
skipSslValidation	false
timeout	5
namespace	null

All of the properties in the preceding table must be prefixed with `spring.cloud.config.server.vault` or placed in the correct Vault section of a composite configuration.

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

Vault 0.10.0 introduced a versioned key-value backend (k/v backend version 2) that exposes a different API than earlier versions, it now requires a `data/` between the mount path and the actual context path and wraps secrets in a `data` object. Setting `spring.cloud.config.server.vault.kv-version=2` will take this into account.

Optionally, there is support for the Vault Enterprise `X-Vault-Namespace` header. To have it sent to Vault set the `namespace` property.

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 kv put secret/application foo=bar baz=bam
$ vault kv put 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"
         }
      }
   ]
}
```

The default way for a client to provide the necessary authentication to let Config Server talk to Vault is to set the X-Config-Token header. However, you can instead omit the header and configure the authentication in the server, by setting the same configuration properties as Spring Cloud Vault. The property to set is `spring.cloud.config.server.vault.authentication`. It should be set to one of the supported authentication methods. You may also need to set other properties specific to the authentication method you use, by using the same property names as documented for `spring.cloud.vault` but instead using the `spring.cloud.config.server.vault` prefix. See the Spring Cloud Vault Reference Guide for more detail.

If you omit the X-Config-Token header and use a server property to set the authentication, the Config Server application needs an additional dependency on Spring Vault to enable the additional authentication options. See the Spring Vault Reference Guide for how to add that dependency.

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. 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.

2.1.5. Accessing Backends Through a Proxy

The configuration server can access a Git or Vault backend through an HTTP or HTTPS proxy. This behavior is controlled for either Git or Vault by settings under `proxy.http` and `proxy.https`. These settings are per repository, so if you are using a composite environment repository you must configure proxy settings for each backend in the composite individually. If using a network which requires separate proxy servers for HTTP and HTTPS URLs, you can configure both the HTTP and the HTTPS proxy settings for a single backend.

The following table describes the proxy configuration properties for both HTTP and HTTPS proxies. All of these properties must be prefixed by `proxy.http` or `proxy.https`.

Table 3. Proxy Configuration Properties

Property Name	Remarks
host	The host of the proxy.
port	The port with which to access the proxy.
nonProxyHosts	Any hosts which the configuration server should access outside the proxy. If values are provided for both `proxy.http.nonProxyHosts` and `proxy.https.nonProxyHosts`, the `proxy.http` value will be used.
username	The username with which to authenticate to the proxy. If values are provided for both `proxy.http.username` and `proxy.https.username`, the `proxy.http` value will be used.
password	The password with which to authenticate to the proxy. If values are provided for both `proxy.http.password` and `proxy.https.password`, the `proxy.http` value will be used.

The following configuration uses an HTTPS proxy to access a Git repository.

```
spring:
  profiles:
    active: git
  cloud:
    config:
      server:
        git:
          uri: https://github.com/spring-cloud-samples/config-repo
          proxy:
            https:
              host: my-proxy.host.io
              password: myproxypassword
              port: '3128'
              username: myproxyusername
              nonProxyHosts: example.com
```

2.1.6. Sharing Configuration With All Applications

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

- File Based Repositories
- 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 feature can also be used for setting global defaults, with placeholders applications allowed to override them locally.

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
```

CredHub Server

When using CredHub as a backend, you can share configuration with all applications by placing configuration in `/application/` or by placing it in the `default` profile for the application. For example, if you run the following CredHub command, all applications using the config server will have the properties `shared.color1` and `shared.color2` available to them:

```
credhub set --name "/application/profile/master/shared" --type=json
value: {"shared.color1": "blue", "shared.color": "red"}
```

```
credhub set --name "/my-app/default/master/more-shared" --type=json
value: {"shared.word1": "hello", "shared.word2": "world"}
```

2.1.7. 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.

You can disable autoconfiguration for `JdbcEnvironmentRepository` by setting the `spring.cloud.config.server.jdbc.enabled` property to `false`.

The database needs to have a table called `PROPERTIES` with columns called `APPLICATION`, `PROFILE`, and `LABEL` (with the usual `Environment` meaning), plus `KEY` and `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).

2.1.8. Redis Backend

Spring Cloud Config Server supports Redis as a backend for configuration properties. You can enable this feature by adding a dependency to Spring Data Redis.

pom.xml

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

The following configuration uses Spring Data `RedisTemplate` to access a Redis. We can use `spring.redis.*` properties to override default connection settings.

```
spring:
  profiles:
    active: redis
  redis:
    host: redis
    port: 16379
```

The properties should be stored as fields in a hash. The name of hash should be the same as `spring.application.name` property or conjunction of `spring.application.name` and `spring.profiles.active[n]`.

```
HMSET sample-app server.port "8100" sample.topic.name "test" test.property1
"property1"
```

After running the command visible above a hash should contain the following keys with values:

```
HGETALL sample-app
{
  "server.port": "8100",
  "sample.topic.name": "test",
  "test.property1": "property1"
}
```

When no profile is specified `default` will be used.

2.1.9. AWS S3 Backend

Spring Cloud Config Server supports AWS S3 as a backend for configuration properties. You can enable this feature by adding a dependency to the AWS Java SDK For Amazon S3.

pom.xml

```
<dependencies>
    <dependency>
        <groupId>com.amazonaws</groupId>
        <artifactId>aws-java-sdk-s3</artifactId>
    </dependency>
</dependencies>
```

The following configuration uses the AWS S3 client to access configuration files. We can use `spring.awss3.*` properties to select the bucket where your configuration is stored.

```
spring:
  profiles:
    active: awss3
  cloud:
    config:
      server:
        awss3:
          region: us-east-1
          bucket: bucket1
```

It is also possible to specify an AWS URL to override the standard endpoint of your S3 service with `spring.awss3.endpoint`. This allows support for beta regions of S3, and other S3 compatible storage APIs.

Credentials are found using the Default AWS Credential Provider Chain. Versioned and encrypted buckets are supported without further configuration.

Configuration files are stored in your bucket as `{application}-{profile}.properties`, `{application}-{profile}.yml` or `{application}-{profile}.json`. An optional label can be provided to specify a directory path to the file.

When no profile is specified `default` will be used.

2.1.10. CredHub Backend

Spring Cloud Config Server supports CredHub as a backend for configuration properties. You can enable this feature by adding a dependency to Spring CredHub.

pom.xml

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

The following configuration uses mutual TLS to access a CredHub:

```
spring:
  profiles:
    active: credhub
  cloud:
    config:
      server:
        credhub:
          url: https://credhub:8844
```

The properties should be stored as JSON, such as:

```
credhub set --name "/demo-app/default/master/toggles" --type=json
value: {"toggle.button": "blue", "toggle.link": "red"}
```

```
credhub set --name "/demo-app/default/master/abs" --type=json
value: {"marketing.enabled": true, "external.enabled": false}
```

All client applications with the name `spring.cloud.config.name=demo-app` will have the following properties available to them:

```
{
    toggle.button: "blue",
    toggle.link: "red",
    marketing.enabled: true,
    external.enabled: false
}
```

When no profile is specified `default` will be used and when no label is specified `master` will be used as a default value. NOTE: Values added to `application` will be shared by all the applications.

OAuth 2.0

You can authenticate with OAuth 2.0 using UAA as a provider.

pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.security</groupId>
        <artifactId>spring-security-config</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.security</groupId>
        <artifactId>spring-security-oauth2-client</artifactId>
    </dependency>
</dependencies>
```

The following configuration uses OAuth 2.0 and UAA to access a CredHub:

```
spring:
  profiles:
    active: credhub
  cloud:
    config:
      server:
        credhub:
          url: https://credhub:8844
          oauth2:
            registration-id: credhub-client
  security:
    oauth2:
      client:
        registration:
          credhub-client:
            provider: uaa
            client-id: credhub_config_server
            client-secret: asecret
            authorization-grant-type: client_credentials
        provider:
          uaa:
            token-uri: https://uaa:8443/oauth/token
```

The used UAA client-id should have `credhub.read` as scope.

2.1.11. Composite Environment Repositories

In some scenarios, you may wish to pull configuration data from multiple environment repositories. To do so, you can enable the `composite` profile in your configuration server's application properties or YAML file. If, for example, you want to pull configuration data from a Subversion repository as well as two Git repositories, you can set the following properties for your configuration server:

```
spring:
  profiles:
    active: composite
  cloud:
    config:
      server:
        composite:
        -
          type: svn
          uri: file:///path/to/svn/repo
        -
          type: git
          uri: file:///path/to/rex/git/repo
        -
          type: git
          uri: file:///path/to/walter/git/repo
```

Using this configuration, precedence is determined by the order in which repositories are listed under the `composite` key. In the above example, the Subversion repository is listed first, so a value found in the Subversion repository will override values found for the same property in one of the Git repositories. A value found in the `rex` Git repository will be used before a value found for the same property in the `walter` Git repository.

If you want to pull configuration data only from repositories that are each of distinct types, you can enable the corresponding profiles, rather than the `composite` profile, in your configuration server's application properties or YAML file. If, for example, you want to pull configuration data from a single Git repository and a single HashiCorp Vault server, you can set the following properties for your configuration server:

```
spring:
  profiles:
    active: git, vault
  cloud:
    config:
      server:
        git:
          uri: file:///path/to/git/repo
          order: 2
        vault:
          host: 127.0.0.1
          port: 8200
          order: 1
```

Using this configuration, precedence can be determined by an `order` property. You can use the `order` property to 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.

If your composite environment includes a Vault server as in the previous example, you must include a Vault token in every request made to the configuration server. See Vault Backend.

Any type of failure when retrieving values from an environment repository results in a failure for the entire composite environment.

When using a composite environment, it is important that all repositories contain the same labels. If you have an environment similar to those in the preceding examples and you request configuration data with the `master` label but the Subversion 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.

2.1.12. 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.

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.

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`.

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.

2.2. Health Indicator

Config Server comes with a Health Indicator that checks whether the configured `EnvironmentRepository` is working. By default, it asks the `EnvironmentRepository` for 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 `management.health.config.enabled=false`.

2.3. 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).

2.4. Encryption and Decryption

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 -s -d mysecret
682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda
```

If you are testing with curl, then use `--data-urlencode` (instead of `-d`) and prefix the value to encrypt with `=` (curl requires this) or set an explicit `Content-Type: text/plain` to make sure curl encodes the data correctly when there are special characters ('+' is particularly tricky).

Be sure not to include any of the curl command statistics in the encrypted value, this is why the examples use the `-s` option to silence them. 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 -s -d
682bc583f4641835fa2db009355293665d2647dade3375c0ee201de2a49f7bda
mysecret
```

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 `/*/{application}/{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.

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+...
```

The `--key` argument is mandatory (despite having a `--` prefix).

2.5. 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).

You cannot configure an asymmetric key using `encrypt.key`.

To configure an asymmetric key use a keystore (e.g. as created by the `keytool` utility that comes with the JDK). The keystore properties are `encrypt.keyStore.*` with `*` equal to

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
`encrypt.keyStore.type`	The type of KeyStore to create. Defaults to `jks`.

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.

2.6. 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
```

When using JDK 11 or above you may get the following warning when using the command above. In this case you probably want to make sure the `keypass` and `storepass` values match.

```
Warning:  Different store and key passwords not supported for PKCS12 KeyStores.
Ignoring user-specified -keypass value.
```

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
```

2.7. 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 keystore 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.

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, .

2.8. 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 placing `spring.cloud.config.server.encrypt.enabled=false` in `bootstrap.[yml|properties]`. If you do not care about the endpoints, it should work if you do not configure either the key or the enabled flag.

3. 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.

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.

4. 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 `/{application}/{profile}/{label}/{path}`, where `application`, `profile`, and `label` have the same meaning as the regular environment endpoint, but `path` is a path to 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.

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`).

If you do not want to supply the `label` and let the server use the default label, you can supply a `useDefaultLabel` request parameter. Consequently, the preceding example for the `default` profile could be `/sample/default/nginx.conf?useDefaultLabel`.

At present, Spring Cloud Config can serve plaintext for git, SVN, native backends, and AWS S3. The support for git, SVN, and native backends is identical. AWS S3 works a bit differently. The following sections show how each one works:

- Git, SVN, and Native Backends
- AWS S3

4.1. Git, SVN, and Native Backends

Consider the following example for a GIT or SVN repository or a native backend:

```
application.yml
nginx.conf
```

The `nginx.conf` might resemble the following listing:

```
server {
    listen              80;
    server_name         ${nginx.server.name};
}
```

`application.yml` might resemble the following listing:

```
nginx:
  server:
    name: example.com
---
spring:
  profiles: development
nginx:
  server:
    name: develop.com
```

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

```
server {
    listen              80;
    server_name         example.com;
}
```

`/sample/development/master/nginx.conf` might be as follows:

```
server {
    listen              80;
    server_name         develop.com;
}
```

4.2. AWS S3

To enable serving plain text for AWS s3, the Config Server application needs to include a dependency on Spring Cloud AWS. For details on how to set up that dependency, see the Spring Cloud AWS Reference Guide. Then you need to configure Spring Cloud AWS, as described in the Spring Cloud AWS Reference Guide.

4.3. Decrypting Plain Text

By default, encrypted values in plain text files are not decrypted. In order to enable decryption for plain text files, set `spring.cloud.config.server.encrypt.enabled=true` and `spring.cloud.config.server.encrypt.plainTextEncrypt=true` in `bootstrap.[yml|properties]`

Decrypting plain text files is only supported for YAML, JSON, and properties file extensions.

If this feature is enabled, and an unsupported file extention is requested, any encrypted values in the file will not be decrypted.

5. 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 `@EnableConfigServer` annotation. An optional property named `spring.cloud.config.server.bootstrap` can be useful in this case. 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. When setting `spring.cloud.config.server.bootstrap` to `true` you must also use a composite environment repository configuration. For example

```
spring:
  application:
    name: configserver
  profiles:
    active: composite
  cloud:
    config:
      server:
        composite:
          - type: native
            search-locations: ${HOME}/Desktop/config
        bootstrap: true
```

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 want 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`).

6. Push Notifications and Spring Cloud Bus

Many source code repository providers (such as Github, Gitlab, Gitea, Gitee, Gogs, 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 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 `foo` application, 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, Gitea, Gitee, Gogs 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={application}`. Doing so broadcasts to applications matching the `{application}` pattern (which

can contain wildcards).

The `RefreshRemoteApplicationEvent` is transmitted only if the `spring-cloud-bus` is activated in both the Config Server and in the client application.

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.

7. 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.

7.1. 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 applications 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").

7.2. 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 `user` 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
```

7.3. 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.

7.4. 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.

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.

7.5. Locating Remote Configuration Resources

The Config Service serves property sources from `/{application}/{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"

When setting the property `${spring.application.name}` do not prefix your app name with the reserved word `application-` to prevent issues resolving the correct property source.

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`).

7.6. Specifying Multiple Urls for the Config Server

To ensure high availability when you have multiple instances of Config Server deployed and expect one or more instances to be unavailable from time to time, you can either specify multiple URLs (as a comma-separated list under the `spring.cloud.config.uri` property) or have all your instances register in a Service Registry like Eureka (if using Discovery-First Bootstrap mode). Note that doing so ensures high availability only when the Config Server is not running (that is, when the application has exited) or when a connection timeout has occurred. For example, if the Config Server returns a 500 (Internal Server Error) response or the Config Client receives a 401 from the Config Server (due to bad credentials or other causes), the Config Client does not try to fetch properties from other URLs. An error of that kind indicates a user issue rather than an availability problem.

If you use HTTP basic security on your Config Server, it is currently possible to support per-Config Server auth credentials only if you embed the credentials in each URL you specify under the `spring.cloud.config.uri` property. If you use any other kind of security mechanism, you cannot (currently) support per-Config Server authentication and authorization.

7.7. Configuring Timeouts

If you want to configure timeout thresholds:

- Read timeouts can be configured by using the property `spring.cloud.config.request-read-timeout`.
- Connection timeouts can be configured by using the property `spring.cloud.config.request-connect-timeout`.

7.8. 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 config server requires client side TLS certificate, you can configure client side TLS certificate and trust store via properties, as shown in following example:

bootstrap.yml

```
spring:
  cloud:
    config:
      uri: https://myconfig.myconfig.com
      tls:
        enabled: true
        key-store: <path-of-key-store>
        key-store-type: PKCS12
        key-store-password: <key-store-password>
        key-password: <key-password>
        trust-store: <path-of-trust-store>
        trust-store-type: PKCS12
        trust-store-password: <trust-store-password>
```

The `spring.cloud.config.tls.enabled` needs to be true to enable config client side TLS. When `spring.cloud.config.tls.trust-store` is omitted, a JVM default trust store is used. The default value for `spring.cloud.config.tls.key-store-type` and `spring.cloud.config.tls.trust-store-type` is PKCS12. When password properties are omitted, empty password is assumed.

If you use another form of security, you might need to provide a `RestTemplate` to the `ConfigServicePropertySourceLocator` (for example, by grabbing it in the bootstrap context and injecting it).

7.8.1. 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).

7.8.2. 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 `Authorization` headers 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;
    }
}
```

For a simplified approach to adding `Authorization` headers, the `spring.cloud.config.headers.*` property can be used instead.

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
```

7.8.3. 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
```

7.9. 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`.

Spring Cloud Consul

2020.0.0-M4

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.

1. Install Consul

Please see the installation documentation for instructions on how to install Consul.

2. 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 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 localhost:8500

3. 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 and DNS. 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 that communicates via a gossip protocol and uses the Raft consensus protocol.

3.1. 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 for details on setting up your build system with the current Spring Cloud Release Train.

3.2. 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 is created by default that Consul hits the `/actuator/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
```

If you use Spring Cloud Consul Config, 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`. Consul Discovery Client will also be disabled when `spring.cloud.discovery.enabled` is set to `false`.

To disable the service registration you can set `spring.cloud.consul.discovery.register` to `false`.

3.2.1. Registering Management as a Separate Service

When management server port is set to something different than the application port, by setting `management.server.port` property, management service will be registered as a separate service than the application service. For example:

application.yml

```
spring:
  application:
    name: myApp
management:
  server:
    port: 4452
```

Above configuration will register following 2 services:

- Application Service:

```
ID: myApp
Name: myApp
```

- Management Service:

```
ID: myApp-management
Name: myApp-management
```

Management service will inherit its `instanceId` and `serviceName` from the application service. For example:

application.yml

```
spring:
  application:
    name: myApp
management:
  server:
    port: 4452
spring:
  cloud:
    consul:
      discovery:
        instance-id: custom-service-id
        serviceName: myprefix-${spring.application.name}
```

Above configuration will register following 2 services:

- Application Service:

```
ID: custom-service-id
Name: myprefix-myApp
```

- Management Service:

```
ID: custom-service-id-management
Name: myprefix-myApp-management
```

Further customization is possible via following properties:

```
/** Port to register the management service under (defaults to management port) */
spring.cloud.consul.discovery.management-port

/** Suffix to use when registering management service (defaults to "management" */
spring.cloud.consul.discovery.management-suffix

/** Tags to use when registering management service (defaults to "management" */
spring.cloud.consul.discovery.management-tags
```

3.2.2. HTTP Health Check

The health check for a Consul instance defaults to "/actuator/health", which is the default location of the health endpoint in a Spring Boot Actuator application. You need to change this, 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.server.servlet.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.

This example illustrates the above (see the `spring.cloud.consul.discovery.health-check-*` properties in the appendix page for more options).

application.yml

```
spring:
  cloud:
    consul:
      discovery:
        healthCheckPath: ${management.server.servlet.context-path}/actuator/health
        healthCheckInterval: 15s
```

You can disable the HTTP health check entirely by setting `spring.cloud.consul.discovery.register-health-check=false`.

Applying Headers

Headers can be applied to health check requests. For example, if you're trying to register a Spring Cloud Config server that uses Vault Backend:

application.yml

```
spring:
  cloud:
    consul:
      discovery:
        health-check-headers:
          X-Config-Token: 6442e58b-d1ea-182e-cfa5-cf9cddef0722
```

According to the HTTP standard, each header can have more than one values, in which case, an array can be supplied:

application.yml

```
spring:
  cloud:
    consul:
      discovery:
        health-check-headers:
          X-Config-Token:
            - "6442e58b-d1ea-182e-cfa5-cf9cddef0722"
            - "Some other value"
```

3.2.3. Actuator Health Indicator(s)

If the service instance is a Spring Boot Actuator application, it may be provided the following Actuator health indicators.

DiscoveryClientHealthIndicator

When Consul Service Discovery is active, a DiscoverClientHealthIndicator is configured and made available to the Actuator health endpoint. See here for configuration options.

ConsulHealthIndicator

An indicator is configured that verifies the health of the `ConsulClient`.

By default, it retrieves the Consul leader node status and all registered services. In deployments that have many registered services it may be costly to retrieve all services on every health check. To skip the service retrieval and only check the leader node status set `spring.cloud.consul.health-indicator.include-services-query=false`.

To disable the indicator set `management.health.consul.enabled=false`.

When the application runs in bootstrap context mode (the default), this indicator is loaded into the bootstrap context and is not made available to the Actuator health endpoint.

3.2.4. Metadata

Consul supports metadata on services. Spring Cloud's `ServiceInstance` has a `Map<String, String> metadata` field which is populated from a services `meta` field. To populate the `meta` field set values on `spring.cloud.consul.discovery.metadata` or `spring.cloud.consul.discovery.management-metadata` properties.

application.yml

```
spring:
  cloud:
    consul:
      discovery:
        metadata:
          myfield: myvalue
          anotherfield: anothervalue
```

The above configuration will result in a service who's meta field contains `myfield→myvalue` and `anotherfield→anothervalue`.

Generated Metadata

The Consul Auto Registration will generate a few entries automatically.

Table 4. Auto Generated Metadata

Key	Value
'group'	Property `spring.cloud.consul.discovery.instance-group`. This values is only generated if `instance-group` is not empty.'
'secure'	True if property `spring.cloud.consul.discovery.scheme` equals 'https', otherwise false.
Property `spring.cloud.consul.discovery.default-zone-metadata-name`, defaults to 'zone'	Property `spring.cloud.consul.discovery.instance-zone`. This values is only generated if `instance-zone` is not empty.'

Older versions of Spring Cloud Consul populated the `ServiceInstance.getMetadata()` method from Spring Cloud Commons by parsing the `spring.cloud.consul.discovery.tags` property. This is no longer supported, please migrate to using the `spring.cloud.consul.discovery.metadata` map.

3.2.5. 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:${spring.application.instanc
e_id:${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.

3.3. Looking up services

3.3.1. Using Load-balancer

Spring Cloud has support for Feign (a REST client builder) and also Spring `RestTemplate` for looking up services using the logical service names/ids instead of physical URLs. Both Feign and the discovery-aware RestTemplate utilize Ribbon for client-side load balancing.

If you want to access service STORES using the RestTemplate simply declare:

```
@LoadBalanced
@Bean
public RestTemplate loadbalancedRestTemplate() {
     return 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.

Spring Cloud now also offers support for Spring Cloud LoadBalancer.

As Spring Cloud Ribbon is now under maintenance, we suggest you set `spring.cloud.loadbalancer.ribbon.enabled` to `false`, so that `BlockingLoadBalancerClient` is used instead of `RibbonLoadBalancerClient`.

3.3.2. 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;
}
```

3.4. Consul Catalog Watch

The Consul Catalog Watch takes advantage of the ability of consul to watch services. The Catalog Watch makes a blocking Consul HTTP API call to determine if any services have changed. If there is new service data a Heartbeat Event is published.

To change the frequency of when the Config Watch is called change `spring.cloud.consul.config.discovery.catalog-services-watch-delay`. The default value is 1000, which is in milliseconds. The delay is the amount of time after the end of the previous invocation and the start of the next.

To disable the Catalog Watch set `spring.cloud.consul.discovery.catalogServicesWatch.enabled=false`.

The watch uses a Spring `TaskScheduler` to schedule the call to consul. By default it is a `ThreadPoolTaskScheduler` with a `poolSize` of 1. To change the `TaskScheduler`, create a bean of type `TaskScheduler` named with the `ConsulDiscoveryClientConfiguration.CATALOG_WATCH_TASK_SCHEDULER_NAME` constant.

4. Distributed Configuration with Consul

Consul provides a Key/Value Store for storing configuration and other metadata. Spring Cloud

Consul Config is an alternative to the Config Server and Client. 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. Config Watch will also automatically detect changes and reload the application context.

4.1. 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 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.

4.2. 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

4.3. Config Watch

The Consul Config Watch takes advantage of the ability of consul to watch a key prefix. 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. The delay is the amount of time after the end of the previous invocation and the start of the next.

To disable the Config Watch set `spring.cloud.consul.config.watch.enabled=false`.

The watch uses a Spring `TaskScheduler` to schedule the call to consul. By default it is a `ThreadPoolTaskScheduler` with a `poolSize` of 1. To change the `TaskScheduler`, create a bean of type `TaskScheduler` named with the `ConsulConfigAutoConfiguration.CONFIG_WATCH_TASK_SCHEDULER_NAME` constant.

4.4. 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`.

4.5. 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.

4.6. 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.

5. 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-retry` and `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.

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.

6. Spring Cloud Bus with Consul

6.1. 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 for details on setting up your build system with the current Spring Cloud Release Train.

See the Spring Cloud Bus documentation for the available actuator endpoints and howto send custom messages.

7. 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 for more details.

8. 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);
    }
}
```

9. Configuration Properties

To see the list of all Consul related configuration properties please check the Appendix page.

index.htmladoc

Spring Cloud Function

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3.1.0-M4

1. Introduction

Spring Cloud Function is a project with the following high-level goals:

- Promote the implementation of business logic via functions.
- Decouple the development lifecycle of business logic from any specific runtime target so that the same code can run as a web endpoint, a stream processor, or a task.
- Support a uniform programming model across serverless providers, as well as the ability to run standalone (locally or in a PaaS).
- Enable Spring Boot features (auto-configuration, dependency injection, metrics) on serverless providers.

It abstracts away all of the transport details and infrastructure, allowing the developer to keep all the familiar tools and processes, and focus firmly on business logic.

Here's a complete, executable, testable Spring Boot application (implementing a simple string manipulation):

```
@SpringBootApplication
public class Application {

  @Bean
  public Function<Flux<String>, Flux<String>> uppercase() {
    return flux -> flux.map(value -> value.toUpperCase());
  }

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

It's just a Spring Boot application, so it can be built, run and tested, locally and in a CI build, the same way as any other Spring Boot application. The `Function` is from `java.util` and `Flux` is a Reactive Streams `Publisher` from Project Reactor. The function can be accessed over HTTP or messaging.

Spring Cloud Function has 4 main features:

In the nutshell Spring Cloud Function provides the following features: 1. Wrappers for `@Beans` of type `Function`, `Consumer` and `Supplier`, exposing them to the outside world as either HTTP endpoints and/or message stream listeners/publishers with RabbitMQ, Kafka etc.

- *Choice of programming styles - reactive, imperative or hybrid.*
- *Function composition and adaptation (e.g., composing imperative functions with reactive).*
- *Support for reactive function with multiple inputs and outputs allowing merging, joining and other complex streaming operation to be handled by functions.*

- *Transparent type conversion of inputs and outputs.*
- *Packaging functions for deployments, specific to the target platform (e.g., Project Riff, AWS Lambda and more)*
- *Adapters to expose function to the outside world as HTTP endpoints etc.*
- *Deploying a JAR file containing such an application context with an isolated classloader, so that you can pack them together in a single JVM.*
- *Compiling strings which are Java function bodies into bytecode, and then turning them into* `@Beans` *that can be wrapped as above.*
- *Adapters for AWS Lambda, Azure, Google Cloud Functions, Apache OpenWhisk and possibly other "serverless" service providers.*

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.

2. Getting Started

Build from the command line (and "install" the samples):

```
$ ./mvnw clean install
```

(If you like to YOLO add `-DskipTests`.)

Run one of the samples, e.g.

```
$ java -jar spring-cloud-function-samples/function-sample/target/*.jar
```

This runs the app and exposes its functions over HTTP, so you can convert a string to uppercase, like this:

```
$ curl -H "Content-Type: text/plain" localhost:8080/uppercase -d Hello
HELLO
```

You can convert multiple strings (a `Flux<String>`) by separating them with new lines

```
$ curl -H "Content-Type: text/plain" localhost:8080/uppercase -d 'Hello
> World'
HELLOWORLD
```

(You can use `^J` in a terminal to insert a new line in a literal string like that.)

3. Programming model

3.1. Function Catalog and Flexible Function Signatures

One of the main features of Spring Cloud Function is to adapt and support a range of type signatures for user-defined functions, while providing a consistent execution model. That's why all user defined functions are transformed into a canonical representation by `FunctionCatalog`.

While users don't normally have to care about the `FunctionCatalog` at all, it is useful to know what kind of functions are supported in user code.

It is also important to understand that Spring Cloud Function provides first class support for reactive API provided by Project Reactor allowing reactive primitives such as `Mono` and `Flux` to be used as types in user defined functions providing greater flexibility when choosing programming model for your function implementation. Reactive programming model also enables functional support for features that would be otherwise difficult to impossible to implement using imperative programming style. For more on this please read Function Arity section.

3.2. Java 8 function support

Spring Cloud Function embraces and builds on top of the 3 core functional interfaces defined by Java and available to us since Java 8.

- Supplier<O>
- Function<I, O>
- Consumer<I>

3.2.1. Supplier

Supplier can be *reactive* - `Supplier<Flux<T>>` or *imperative* - `Supplier<T>`. From the invocation standpoint this should make no difference to the implementor of such Supplier. However, when used within frameworks (e.g., Spring Cloud Stream), Suppliers, especially reactive, often used to represent the source of the stream, therefore they are invoked once to get the stream (e.g., Flux) to which consumers can subscribe to. In other words such suppliers represent an equivalent of an *infinite stream*. However, the same reactive suppliers can also represent *finite* stream(s) (e.g., result set on the polled JDBC data). In those cases such reactive suppliers must be hooked up to some polling mechanism of the underlying framework.

To assist with that Spring Cloud Function provides a marker annotation `org.springframework.cloud.function.context.PollableSupplier` to signal that such supplier produces a finite stream and may need to be polled again. That said, it is important to understand that Spring Cloud Function itself provides no behavior for this annotation.

In addition `PollableSupplier` annotation exposes a *splittable* attribute to signal that produced stream needs to be split (see Splitter EIP)

Here is the example:

```
@PollableSupplier(splittable = true)
public Supplier<Flux<String>> someSupplier() {
    return () -> {
        String v1 = String.valueOf(System.nanoTime());
        String v2 = String.valueOf(System.nanoTime());
        String v3 = String.valueOf(System.nanoTime());
        return Flux.just(v1, v2, v3);
    };
}
```

3.2.2. Function

Function can also be written in imperative or reactive way, yet unlike Supplier and Consumer there are no special considerations for the implementor other then understanding that when used within frameworks such as Spring Cloud Stream and others, reactive function is invoked only once to pass a reference to the stream (Flux or Mono) and imperative is invoked once per event.

3.2.3. Consumer

Consumer is a little bit special because it has a `void` return type, which implies blocking, at least potentially. Most likely you will not need to write `Consumer<Flux<?>>`, but if you do need to do that, remember to subscribe to the input flux.

3.3. Function Composition

Function Composition is a feature that allows one to compose several functions into one. The core support is based on function composition feature available with Function.andThen(..) support available since Java 8. However on top of it, we provide few additional features.

3.3.1. Declarative Function Composition

This feature allows you to provide composition instruction in a declarative way using `|` (pipe) or `,` (comma) delimiter when providing `spring.cloud.function.definition` property.

For example

```
--spring.cloud.function.definition=uppercase|reverse
```

Here we effectively provided a definition of a single function which itself is a composition of function `uppercase` and function `reverse`. In fact that is one of the reasons why the property name is *definition* and not *name*, since the definition of a function can be a composition of several named functions. And as mentioned you can use `,` instead of pipe (such as `... definition=uppercase,reverse`).

3.3.2. Composing non-Functions

Spring Cloud Function also supports composing Supplier with `Consumer` or `Function` as well as `Function` with `Consumer`. What's important here is to understand the end product of such definitions. Composing Supplier with Function still results in Supplier while composing Supplier with Consumer will effectively render Runnable. Following the same logic composing Function with Consumer will result in Consumer.

And of course you can't compose uncomposable such as Consumer and Function, Consumer and Supplier etc.

3.4. Function Routing

Since version 2.2 Spring Cloud Function provides routing feature allowing you to invoke a single function which acts as a router to an actual function you wish to invoke This feature is very useful in certain FAAS environments where maintaining configurations for several functions could be cumbersome or exposing more then one function is not possible.

The `RoutingFunction` is registered in *FunctionCatalog* under the name `functionRouter`. For simplicity and consistency you can also refer to `RoutingFunction.FUNCTION_NAME` constant.

This function has the following signature:

```
public class RoutingFunction implements Function<Object, Object> {
. . .
}
```

The routing instructions could be communicated in several ways;

Message Headers

If the input argument is of type `Message<?>`, you can communicate routing instruction by setting one of `spring.cloud.function.definition` or `spring.cloud.function.routing-expression` Message headers. For more static cases you can use `spring.cloud.function.definition` header which allows you to provide the name of a single function (e.g., `…definition=foo`) or a composition instruction (e.g., `…definition=foo|bar|baz`). For more dynamic cases you can use `spring.cloud.function.routing-expression` header which allows you to use Spring Expression Language (SpEL) and provide SpEL expression that should resolve into definition of a function (as described above).

SpEL evaluation context's root object is the actual input argument, so in he case of `Message<?>` you can construct expression that has access to both `payload` and `headers` (e.g., `spring.cloud.function.routing-expression=headers.function_name`).

In specific execution environments/models the adapters are responsible to translate and communicate `spring.cloud.function.definition` and/or `spring.cloud.function.routing-expression` via Message header. For example, when using *spring-cloud-function-web* you can provide `spring.cloud.function.definition` as an HTTP header and the framework will propagate it as well as other HTTP headers as Message headers.

Application Properties

Routing instruction can also be communicated via `spring.cloud.function.definition` or `spring.cloud.function.routing-expression` as application properties. The rules described in the previous section apply here as well. The only difference is you provide these instructions as application properties (e.g., `--spring.cloud.function.definition=foo`).

When dealing with reactive inputs (e.g., Publisher), routing instructions must only be provided via Function properties. This is due to the nature of the reactive functions which are invoked only once to pass a Publisher and the rest is handled by the reactor, hence we can not access and/or rely on the routing instructions communicated via individual values (e.g., Message).

3.5. Function Arity

There are times when a stream of data needs to be categorized and organized. For example, consider a classic big-data use case of dealing with unorganized data containing, let's say, 'orders' and 'invoices', and you want each to go into a separate data store. This is where function arity (functions with multiple inputs and outputs) support comes to play.

Let's look at an example of such a function (full implementation details are available here),

```
@Bean
public Function<Flux<Integer>, Tuple2<Flux<String>, Flux<String>>> organise() {
    return flux -> ...;
}
```

Given that Project Reactor is a core dependency of SCF, we are using its Tuple library. Tuples give us a unique advantage by communicating to us both *cardinality* and *type* information. Both are extremely important in the context of SCSt. Cardinality lets us know how many input and output bindings need to be created and bound to the corresponding inputs and outputs of a function. Awareness of the type information ensures proper type conversion.

Also, this is where the 'index' part of the naming convention for binding names comes into play, since, in this function, the two output binding names are `organise-out-0` and `organise-out-1`.

IMPORTANT: At the moment, function arity is **only** supported for reactive functions (`Function<TupleN<Flux<?>···>, TupleN<Flux<?>···>>`) centered on Complex event processing where evaluation and computation on confluence of events typically requires view into a stream of events rather than single event.

3.6. Type conversion (Content-Type negotiation)

Content-Type negotiation is one of the core features of Spring Cloud Function as it allows to not only transform the incoming data to the types declared by the function signature, but to do the same transformation during function composition making otherwise un-composable (by type)

functions composable.

To better understand the mechanics and the necessity behind content-type negotiation, we take a look at a very simple use case by using the following function as an example:

```
@Bean
public Function<Person, String> personFunction {..}
```

The function shown in the preceding example expects a `Person` object as an argument and produces a String type as an output. If such function is invoked with the type `Person`, than all works fine. But typically function plays a role of a handler for the incoming data which most often comes in the raw format such as `byte[]`, `JSON String` etc. In order for the framework to succeed in passing the incoming data as an argument to this function, it has to somehow transform the incoming data to a `Person` type.

Spring Cloud Function relies on two native to Spring mechanisms to accomplish that.

1. *MessageConverter* - to convert from incoming Message data to a type declared by the function.
2. *ConversionService* - to convert from incoming non-Message data to a type declared by the function.

This means that depending on the type of the raw data (Message or non-Message) Spring Cloud Function will apply one or the other mechanisms.

For most cases when dealing with functions that are invoked as part of some other request (e.g., HTTP, Messaging etc) the framework relies on `MessageConverters`, since such requests already converted to Spring `Message`. In other words, the framework locates and applies 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 function itself (Person type). Consequently, in theory, that should be (and, in some cases, is) enough. However, for the majority of use cases, in order to select the appropriate `MessageConverter`, the framework needs an additional piece of information. That missing piece is `contentType` header.

Such header usually comes as part of the Message where it is injected by the corresponding adapter that created such Message in the first place. For example, HTTP POST request will have its content-type HTTP header copied to `contentType` header of the Message.

For cases when such header does not exist framework relies on the default content type as `application/json`.

3.6.1. Content Type versus Argument Type

As mentioned earlier, 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 which trigger right before the invocation of the user-defined function (which is when the actual argument type is known to the framework). If the 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.

The combination of `contentType` and argument type is the mechanism by which framework determines if message can be converted to a target type by locating the appropriate `MessageConverter`. If no appropriate `MessageConverter` is found, an exception is thrown, which you can handle by adding a custom `MessageConverter` (see `User-defined Message Converters`).

Do not expect `Message` to be converted into some other type based only on the `contentType`. Remember that the `contentType` is complementary to the target type. It is a hint, which `MessageConverter` may or may not take into consideration.

3.6.2. 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 an incoming `Message` to an argument type. The payload of the `Message` could be any type, and it is up to the actual implementation of the `MessageConverter` to support multiple types.

3.6.3. Provided MessageConverters

As mentioned earlier, the framework already provides a stack of `MessageConverters` to handle most common use cases. The following list describes the provided `MessageConverters`, in order of precedence (the first `MessageConverter` that works is used):

1. `JsonMessageConverter`: Supports conversion of the payload of the `Message` to/from POJO for cases when `contentType` is `application/json` using Jackson or Gson libraries (DEFAULT).
2. `ByteArrayMessageConverter`: Supports conversion of the payload of the `Message` from `byte[]` to `byte[]` for cases when `contentType` is `application/octet-stream`. It is essentially a pass through and exists primarily for backward compatibility.
3. `StringMessageConverter`: Supports conversion of any type to a `String` when `contentType` is `text/plain`.

When no appropriate converter is found, the framework throws an exception. When that happens, you should check your code and configuration and ensure you did not miss anything (that is, ensure that you provided a `contentType` by using a binding or a header). However, most likely, you found some uncommon case (such as a custom `contentType` perhaps) and the current stack of provided `MessageConverters` does not know how to convert. If that is the case, you can add custom `MessageConverter`. See User-defined Message Converters.

3.6.4. User-defined Message Converters

Spring Cloud Function exposes a mechanism to define and register additional `MessageConverters`. To use it, implement `org.springframework.messaging.converter.MessageConverter`, configure it as a `@Bean`. It is then appended to the existing stack of `MessageConverter`s.

It is important to understand that custom `MessageConverter` implementations are added to the head of the existing stack. Consequently, custom `MessageConverter` implementations take precedence over the existing ones, which lets you override as well as add to the existing converters.

The following example shows how to create a message converter bean to support a new content type called `application/bar`:

```
@SpringBootApplication
public static class SinkApplication {

    ...

    @Bean
    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));
    }
}
```

3.7. Kotlin Lambda support

We also provide support for Kotlin lambdas (since v2.0). Consider the following:

```
@Bean
open fun kotlinSupplier(): () -> String {
    return  { "Hello from Kotlin" }
}

@Bean
open fun kotlinFunction(): (String) -> String {
    return  { it.toUpperCase() }
}

@Bean
open fun kotlinConsumer(): (String) -> Unit {
    return  { println(it) }
}
```

The above represents Kotlin lambdas configured as Spring beans. The signature of each maps to a Java equivalent of `Supplier`, `Function` and `Consumer`, and thus supported/recognized signatures by the framework. While mechanics of Kotlin-to-Java mapping are outside of the scope of this documentation, it is important to understand that the same rules for signature transformation outlined in "Java 8 function support" section are applied here as well.

To enable Kotlin support all you need is to add `spring-cloud-function-kotlin` module to your classpath which contains the appropriate autoconfiguration and supporting classes.

3.8. Function Component Scan

Spring Cloud Function will scan for implementations of `Function`, `Consumer` and `Supplier` in a package called `functions` if it exists. Using this feature you can write functions that have no dependencies on Spring - not even the `@Component` annotation is needed. If you want to use a different package, you can set `spring.cloud.function.scan.packages`. You can also use `spring.cloud.function.scan.enabled=false` to switch off the scan completely.

4. Standalone Web Applications

Functions could be automatically exported as HTTP endpoints.

The `spring-cloud-function-web` module has autoconfiguration that activates when it is included in a Spring Boot web application (with MVC support). There is also a `spring-cloud-starter-function-web` to collect all the optional dependencies in case you just want a simple getting started experience.

With the web configurations activated your app will have an MVC endpoint (on "/" by default, but configurable with `spring.cloud.function.web.path`) that can be used to access the functions in the application context where function name becomes part of the URL path. The supported content types are plain text and JSON.

Method	Path	Request	Response	Status
GET	/{supplier}	-	Items from the named supplier	200 OK
POST	/{consumer}	JSON object or text	Mirrors input and pushes request body into consumer	202 Accepted
POST	/{consumer}	JSON array or text with new lines	Mirrors input and pushes body into consumer one by one	202 Accepted
POST	/{function}	JSON object or text	The result of applying the named function	200 OK
POST	/{function}	JSON array or text with new lines	The result of applying the named function	200 OK
GET	/{function}/{item}	-	Convert the item into an object and return the result of applying the function	200 OK

As the table above shows the behaviour of the endpoint depends on the method and also the type of incoming request data. When the incoming data is single valued, and the target function is declared as obviously single valued (i.e. not returning a collection or `Flux`), then the response will also contain a single value. For multi-valued responses the client can ask for a server-sent event stream by sending `Accept: text/event-stream".

Functions and consumers that are declared with input and output in `Message<?>` will see the request headers on the input messages, and the output message headers will be converted to HTTP headers.

When POSTing text the response format might be different with Spring Boot 2.0 and older versions, depending on the content negotiation (provide content type and accept headers for the best results).

See Testing Functional Applications to see the details and example on how to test such application.

4.1. Function Mapping rules

If there is only a single function (consumer etc.) in the catalog, the name in the path is optional. In other words, providing you only have `uppercase` function in catalog `curl -H "Content-Type: text/plain" localhost:8080/uppercase -d hello` and `curl -H "Content-Type: text/plain" localhost:8080/ -d hello` calls are identical.

Composite functions can be addressed using pipes or commas to separate function names (pipes

are legal in URL paths, but a bit awkward to type on the command line). For example, `curl -H "Content-Type: text/plain" localhost:8080/uppercase,reverse -d hello`.

For cases where there is more then a single function in catalog, each function will be exported and mapped with function name being part of the path (e.g., `localhost:8080/uppercase`). In this scenario you can still map specific function or function composition to the root path by providing `spring.cloud.function.definition` property

For example,

```
--spring.cloud.function.definition=foo|bar
```

The above property will compose 'foo' and 'bar' function and map the composed function to the "/" path.

4.2. Function Filtering rules

In situations where there are more then one function in catalog there may be a need to only export certain functions or function compositions. In that case you can use the same `spring.cloud.function.definition` property listing functions you intend to export delimited by `;`. Note that in this case nothing will be mapped to the root path and functions that are not listed (including compositions) are not going to be exported

For example,

```
--spring.cloud.function.definition=foo;bar
```

This will only export function `foo` and function `bar` regardless how many functions are available in catalog (e.g., `localhost:8080/foo`).

```
--spring.cloud.function.definition=foo|bar;baz
```

This will only export function composition `foo|bar` and function `baz` regardless how many functions are available in catalog (e.g., `localhost:8080/foo,bar`).

5. Standalone Streaming Applications

To send or receive messages from a broker (such as RabbitMQ or Kafka) you can leverage `spring-cloud-stream` project and it's integration with Spring Cloud Function. Please refer to Spring Cloud Function section of the Spring Cloud Stream reference manual for more details and examples.

6. Deploying a Packaged Function

Spring Cloud Function provides a "deployer" library that allows you to launch a jar file (or exploded

archive, or set of jar files) with an isolated class loader and expose the functions defined in it. This is quite a powerful tool that would allow you to, for instance, adapt a function to a range of different input-output adapters without changing the target jar file. Serverless platforms often have this kind of feature built in, so you could see it as a building block for a function invoker in such a platform (indeed the Riff Java function invoker uses this library).

The standard entry point is to add `spring-cloud-function-deployer` to the classpath, the deployer kicks in and looks for some configuration to tell it where to find the function jar.

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-function-deployer</artifactId>
    <version>${spring.cloud.function.version}</version>
</dependency>
```

At a minimum the user has to provide a `spring.cloud.function.location` which is a URL or resource location for the archive containing the functions. It can optionally use a `maven:` prefix to locate the artifact via a dependency lookup (see `FunctionProperties` for complete details). A Spring Boot application is bootstrapped from the jar file, using the `MANIFEST.MF` to locate a start class, so that a standard Spring Boot fat jar works well, for example. If the target jar can be launched successfully then the result is a function registered in the main application's `FunctionCatalog`. The registered function can be applied by code in the main application, even though it was created in an isolated class loader (by deault).

Here is the example of deploying a JAR which contains an 'uppercase' function and invoking it .

```
@SpringBootApplication
public class DeployFunctionDemo {

    public static void main(String[] args) {
        ApplicationContext context = SpringApplication.run(DeployFunctionDemo.class,
                "--spring.cloud.function.location=.../target/uppercase-0.0.1-
SNAPSHOT.jar",
                "--spring.cloud.function.definition=uppercase");

        FunctionCatalog catalog = context.getBean(FunctionCatalog.class);
        Function<String, String> function = catalog.lookup("uppercase");
        System.out.println(function.apply("hello"));
    }
}
```

And here is the example using Maven URI (taken from one of the tests in `FunctionDeployerTests`):

```
@SpringBootApplication
public class DeployFunctionDemo {

    public static void main(String[] args) {
        String[] args = new String[] {
                "--spring.cloud.function.location=maven://oz.demo:demo-
uppercase:0.0.1-SNAPSHOT",
                "--spring.cloud.function.function-class=oz.demo.uppercase.MyFunction"
};

        ApplicationContext context = SpringApplication.run(DeployerApplication.class,
args);
        FunctionCatalog catalog = context.getBean(FunctionCatalog.class);
        Function<String, String> function = catalog.lookup("myFunction");

        assertThat(function.apply("bob")).isEqualTo("BOB");
    }
}
```

Keep in mind that Maven resource such as local and remote repositories, user, password and more are resolved using default MavenProperties which effectively use local defaults and will work for majority of cases. However if you need to customize you can simply provide a bean of type `MavenProperties` where you can set additional properties (see example below).

```
@Bean
public MavenProperties mavenProperties() {
    MavenProperties properties = new MavenProperties();
    properties.setLocalRepository("target/it/");
    return properties;
}
```

6.1. Supported Packaging Scenarios

Currently Spring Cloud Function supports several packaging scenarios to give you the most flexibility when it comes to deploying functions.

6.1.1. Simple JAR

This packaging option implies no dependency on anything related to Spring. For example; Consider that such JAR contains the following class:

```
package function.example;
. . .
public class UpperCaseFunction implements Function<String, String> {
    @Override
    public String apply(String value) {
        return value.toUpperCase();
    }
}
```

All you need to do is specify `location` and `function-class` properties when deploying such package:

```
--spring.cloud.function.location=target/it/simplestjar/target/simplestjar
-1.0.0.RELEASE.jar
--spring.cloud.function.function-class=function.example.UpperCaseFunction
```

It's conceivable in some cases that you might want to package multiple functions together. For such scenarios you can use `spring.cloud.function.function-class` property to list several classes delimiting them by `;`.

For example,

```
--spring.cloud.function.function
-class=function.example.UpperCaseFunction;function.example.ReverseFunction
```

Here we are identifying two functions to deploy, which we can now access in function catalog by name (e.g., `catalog.lookup("reverseFunction");`).

For more details please reference the complete sample available here. You can also find a corresponding test in FunctionDeployerTests.

6.1.2. Spring Boot JAR

This packaging option implies there is a dependency on Spring Boot and that the JAR was generated as Spring Boot JAR. That said, given that the deployed JAR runs in the isolated class loader, there will not be any version conflict with the Spring Boot version used by the actual deployer. For example; Consider that such JAR contains the following class (which could have some additional Spring dependencies providing Spring/Spring Boot is on the classpath):

```
package function.example;
. . .
public class UpperCaseFunction implements Function<String, String> {
    @Override
    public String apply(String value) {
        return value.toUpperCase();
    }
}
```

As before all you need to do is specify `location` and `function-class` properties when deploying such package:

```
--spring.cloud.function.location=target/it/simplestjar/target/simplestjar
-1.0.0.RELEASE.jar
--spring.cloud.function.function-class=function.example.UpperCaseFunction
```

For more details please reference the complete sample available here. You can also find a corresponding test in FunctionDeployerTests.

6.1.3. Spring Boot Application

This packaging option implies your JAR is complete stand alone Spring Boot application with functions as managed Spring beans. As before there is an obvious assumption that there is a dependency on Spring Boot and that the JAR was generated as Spring Boot JAR. That said, given that the deployed JAR runs in the isolated class loader, there will not be any version conflict with the Spring Boot version used by the actual deployer. For example; Consider that such JAR contains the following class:

```
package function.example;
. . .
@SpringBootApplication
public class SimpleFunctionAppApplication {

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

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }
}
```

Given that we're effectively dealing with another Spring Application context and that functions are spring managed beans, in addition to the `location` property we also specify `definition` property instead of `function-class`.

```
--spring.cloud.function.location=target/it/bootapp/target/bootapp-1.0.0.RELEASE
-exec.jar
--spring.cloud.function.definition=uppercase
```

For more details please reference the complete sample available here. You can also find a corresponding test in FunctionDeployerTests.

This particular deployment option may or may not have Spring Cloud Function on it's classpath. From the deployer perspective this doesn't matter.

7. Functional Bean Definitions

Spring Cloud Function supports a "functional" style of bean declarations for small apps where you need fast startup. The functional style of bean declaration was a feature of Spring Framework 5.0 with significant enhancements in 5.1.

7.1. Comparing Functional with Traditional Bean Definitions

Here's a vanilla Spring Cloud Function application from with the familiar `@Configuration` and `@Bean` declaration style:

```
@SpringBootApplication
public class DemoApplication {

  @Bean
  public Function<String, String> uppercase() {
    return value -> value.toUpperCase();
  }

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

}
```

Now for the functional beans: the user application code can be recast into "functional" form, like this:

```
@SpringBootConfiguration
public class DemoApplication implements
ApplicationContextInitializer<GenericApplicationContext> {

  public static void main(String[] args) {
    FunctionalSpringApplication.run(DemoApplication.class, args);
  }

  public Function<String, String> uppercase() {
    return value -> value.toUpperCase();
  }

  @Override
  public void initialize(GenericApplicationContext context) {
    context.registerBean("demo", FunctionRegistration.class,
        () -> new FunctionRegistration<>(uppercase())
            .type(FunctionType.from(String.class).to(String.class)));
  }

}
```

The main differences are:

- The main class is an `ApplicationContextInitializer`.
- The `@Bean` methods have been converted to calls to `context.registerBean()`
- The `@SpringBootApplication` has been replaced with `@SpringBootConfiguration` to signify that we are not enabling Spring Boot autoconfiguration, and yet still marking the class as an "entry point".
- The `SpringApplication` from Spring Boot has been replaced with a `FunctionalSpringApplication` from Spring Cloud Function (it's a subclass).

The business logic beans that you register in a Spring Cloud Function app are of type `FunctionRegistration`. This is a wrapper that contains both the function and information about the input and output types. In the `@Bean` form of the application that information can be derived reflectively, but in a functional bean registration some of it is lost unless we use a `FunctionRegistration`.

An alternative to using an `ApplicationContextInitializer` and `FunctionRegistration` is to make the application itself implement `Function` (or `Consumer` or `Supplier`). Example (equivalent to the above):

```
@SpringBootConfiguration
public class DemoApplication implements Function<String, String> {

  public static void main(String[] args) {
    FunctionalSpringApplication.run(DemoApplication.class, args);
  }

  @Override
  public String apply(String value) {
    return value.toUpperCase();
  }

}
```

It would also work if you add a separate, standalone class of type `Function` and register it with the `SpringApplication` using an alternative form of the `run()` method. The main thing is that the generic type information is available at runtime through the class declaration.

Suppose you have

```
@Component
public class CustomFunction implements Function<Flux<Foo>, Flux<Bar>> {
    @Override
    public Flux<Bar> apply(Flux<Foo> flux) {
        return flux.map(foo -> new Bar("This is a Bar object from Foo value: " +
foo.getValue()));
    }

}
```

You register it as such:

```
@Override
public void initialize(GenericApplicationContext context) {
        context.registerBean("function", FunctionRegistration.class,
                () -> new FunctionRegistration<>(new
CustomFunction()).type(CustomFunction.class));
}
```

7.2. Limitations of Functional Bean Declaration

Most Spring Cloud Function apps have a relatively small scope compared to the whole of Spring Boot, so we are able to adapt it to these functional bean definitions easily. If you step outside that limited scope, you can extend your Spring Cloud Function app by switching back to `@Bean` style configuration, or by using a hybrid approach. If you want to take advantage of Spring Boot autoconfiguration for integrations with external datastores, for example, you will need to use

`@EnableAutoConfiguration`. Your functions can still be defined using the functional declarations if you want (i.e. the "hybrid" style), but in that case you will need to explicitly switch off the "full functional mode" using `spring.functional.enabled=false` so that Spring Boot can take back control.

8. Testing Functional Applications

Spring Cloud Function also has some utilities for integration testing that will be very familiar to Spring Boot users.

Suppose this is your application:

```
@SpringBootApplication
public class SampleFunctionApplication {

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

    @Bean
    public Function<String, String> uppercase() {
        return v -> v.toUpperCase();
    }
}
```

Here is an integration test for the HTTP server wrapping this application:

```
@SpringBootTest(classes = SampleFunctionApplication.class,
            webEnvironment = WebEnvironment.RANDOM_PORT)
public class WebFunctionTests {

    @Autowired
    private TestRestTemplate rest;

    @Test
    public void test() throws Exception {
        ResponseEntity<String> result = this.rest.exchange(
            RequestEntity.post(new URI("/uppercase")).body("hello"), String.class);
        System.out.println(result.getBody());
    }
}
```

or when function bean definition style is used:

```
@FunctionalSpringBootTest
public class WebFunctionTests {

    @Autowired
    private TestRestTemplate rest;

    @Test
    public void test() throws Exception {
        ResponseEntity<String> result = this.rest.exchange(
            RequestEntity.post(new URI("/uppercase")).body("hello"), String.class);
        System.out.println(result.getBody());
    }
}
```

This test is almost identical to the one you would write for the `@Bean` version of the same app - the only difference is the `@FunctionalSpringBootTest` annotation, instead of the regular `@SpringBootTest`. All the other pieces, like the `@Autowired TestRestTemplate`, are standard Spring Boot features.

And to help with correct dependencies here is the excerpt from POM

```
    <parent>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-parent</artifactId>
        <version>2.2.2.RELEASE</version>
        <relativePath/> <!-- lookup parent from repository -->
    </parent>
    . . . .
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-function-web</artifactId>
        <version>3.0.1.BUILD-SNAPSHOT</version>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
        <scope>test</scope>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-test</artifactId>
        <scope>test</scope>
        <exclusions>
            <exclusion>
                <groupId>org.junit.vintage</groupId>
                <artifactId>junit-vintage-engine</artifactId>
            </exclusion>
        </exclusions>
    </dependency>
```

Or you could write a test for a non-HTTP app using just the `FunctionCatalog`. For example:

```
@RunWith(SpringRunner.class)
@FunctionalSpringBootTest
public class FunctionalTests {

    @Autowired
    private FunctionCatalog catalog;

    @Test
    public void words() throws Exception {
        Function<String, String> function = catalog.lookup(Function.class,
                "uppercase");
        assertThat(function.apply("hello")).isEqualTo("HELLO");
    }

}
```

9. Dynamic Compilation

There is a sample app that uses the function compiler to create a function from a configuration property. The vanilla "function-sample" also has that feature. And there are some scripts that you can run to see the compilation happening at run time. To run these examples, change into the `scripts` directory:

```
cd scripts
```

Also, start a RabbitMQ server locally (e.g. execute `rabbitmq-server`).

Start the Function Registry Service:

```
./function-registry.sh
```

Register a Function:

```
./registerFunction.sh -n uppercase -f "f->f.map(s->s.toString().toUpperCase())"
```

Run a REST Microservice using that Function:

```
./web.sh -f uppercase -p 9000
curl -H "Content-Type: text/plain" -H "Accept: text/plain" localhost:9000/uppercase -d
foo
```

Register a Supplier:

```
./registerSupplier.sh -n words -f "()->Flux.just(\"foo\",\"bar\")"
```

Run a REST Microservice using that Supplier:

```
./web.sh -s words -p 9001
curl -H "Accept: application/json" localhost:9001/words
```

Register a Consumer:

```
./registerConsumer.sh -n print -t String -f "System.out::println"
```

Run a REST Microservice using that Consumer:

```
./web.sh -c print -p 9002
curl -X POST -H "Content-Type: text/plain" -d foo localhost:9002/print
```

Run Stream Processing Microservices:

First register a streaming words supplier:

```
./registerSupplier.sh -n wordstream -f "()-
>Flux.interval(Duration.ofMillis(1000)).map(i->\"message-\"+i)"
```

Then start the source (supplier), processor (function), and sink (consumer) apps (in reverse order):

```
./stream.sh -p 9103 -i uppercaseWords -c print
./stream.sh -p 9102 -i words -f uppercase -o uppercaseWords
./stream.sh -p 9101 -s wordstream -o words
```

The output will appear in the console of the sink app (one message per second, converted to uppercase):

```
MESSAGE-0
MESSAGE-1
MESSAGE-2
MESSAGE-3
MESSAGE-4
MESSAGE-5
MESSAGE-6
MESSAGE-7
MESSAGE-8
MESSAGE-9
...
```

10. Serverless Platform Adapters

As well as being able to run as a standalone process, a Spring Cloud Function application can be adapted to run one of the existing serverless platforms. In the project there are adapters for AWS Lambda, Azure, and Apache OpenWhisk. The Oracle Fn platform has its own Spring Cloud Function adapter. And Riff supports Java functions and its Java Function Invoker acts natively is an adapter for Spring Cloud Function jars.

10.1. AWS Lambda

The AWS adapter takes a Spring Cloud Function app and converts it to a form that can run in AWS Lambda.

The details of how to get stared with AWS Lambda is out of scope of this document, so the expectation is that user has some familiarity with AWS and AWS Lambda and wants to learn what additional value spring provides.

10.1.1. Getting Started

One of the goals of Spring Cloud Function framework is to provide necessary infrastructure elements to enable a *simple function application* to interact in a certain way in a particular environment. A simple function application (in context or Spring) is an application that contains beans of type Supplier, Function or Consumer. So, with AWS it means that a simple function bean should somehow be recognised and executed in AWS Lambda environment.

Let’s look at the example:

```
@SpringBootApplication
public class FunctionConfiguration {

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

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }
}
```

It shows a complete Spring Boot application with a function bean defined in it. What's interesting is that on the surface this is just another boot app, but in the context of AWS Adapter it is also a perfectly valid AWS Lambda application. No other code or configuration is required. All you need to do is package it and deploy it, so let's look how we can do that.

To make things simpler we've provided a sample project ready to be built and deployed and you can access it here.

You simply execute `./mvnw clean package` to generate JAR file. All the necessary maven plugins have already been setup to generate appropriate AWS deployable JAR file. (You can read more details about JAR layout in Notes on JAR Layout).

Then you have to upload the JAR file (via AWS dashboard or AWS CLI) to AWS.

When ask about *handler* you specify `org.springframework.cloud.function.adapter.aws.FunctionInvoker::handleRequest` which is a generic request handler.

[AWS deploy] | *https://raw.githubusercontent.com/spring-cloud/spring-*

cloud/c943d3ebefa65353b08298162ba5d23676edc91c/docs/src/main/asciidoc/images/AWS-deploy.png

That is all. Save and execute the function with some sample data which for this function is expected to be a String which function will uppercase and return back.

While `org.springframework.cloud.function.adapter.aws.FunctionInvoker` is a general purpose AWS's `RequestHandler` implementation aimed at completely isolating you from the specifics of AWS Lambda API, for some cases you may want to specify which specific AWS's `RequestHandler` you want to use. The next section will explain you how you can accomplish just that.

10.1.2. AWS Request Handlers

The adapter has a couple of generic request handlers that you can use. The most generic is (and the one we used in the Getting Started section) is `org.springframework.cloud.function.adapter.aws.FunctionInvoker` which is the implementation of AWS's `RequestStreamHandler`. User doesn't need to do anything other then specify it as 'handler' on AWS dashborad when deploying function. It will handle most of the case including Kinesis, streaming etc. .

If your app has more than one `@Bean` of type `Function` etc. then you can choose the one to use by configuring `spring.cloud.function.definition` property or environment variable. The functions are extracted from the Spring Cloud `FunctionCatalog`. In the event you don't specify `spring.cloud.function.definition` the framework will attempt to find a default following the search order where it searches first for `Function` then `Consumer` and finally `Supplier`).

10.1.3. Notes on JAR Layout

You don't need the Spring Cloud Function Web or Stream adapter at runtime in Lambda, so you might need to exclude those before you create the JAR you send to AWS. A Lambda application has to be shaded, but a Spring Boot standalone application does not, so you can run the same app using 2 separate jars (as per the sample). The sample app creates 2 jar files, one with an `aws` classifier for deploying in Lambda, and one executable (thin) jar that includes `spring-cloud-function-web` at runtime. Spring Cloud Function will try and locate a "main class" for you from the JAR file manifest, using the `Start-Class` attribute (which will be added for you by the Spring Boot tooling if you use the starter parent). If there is no `Start-Class` in your manifest you can use an environment variable or system property `MAIN_CLASS` when you deploy the function to AWS.

If you are not using the functional bean definitions but relying on Spring Boot's auto-configuration, then additional transformers must be configured as part of the maven-shade-plugin execution.

```
<plugin>
    <groupId>org.apache.maven.plugins</groupId>
    <artifactId>maven-shade-plugin</artifactId>
    <dependencies>
        <dependency>
            <groupId>org.springframework.boot</groupId>
            <artifactId>spring-boot-maven-plugin</artifactId>
        </dependency>
    </dependencies>
    <configuration>
        <createDependencyReducedPom>false</createDependencyReducedPom>
        <shadedArtifactAttached>true</shadedArtifactAttached>
        <shadedClassifierName>aws</shadedClassifierName>
        <transformers>
            <transformer
implementation="org.apache.maven.plugins.shade.resource.AppendingTransformer">
                <resource>META-INF/spring.handlers</resource>
            </transformer>
            <transformer
implementation="org.springframework.boot.maven.PropertiesMergingResourceTransformer">
                <resource>META-INF/spring.factories</resource>
            </transformer>
            <transformer
implementation="org.apache.maven.plugins.shade.resource.AppendingTransformer">
                <resource>META-INF/spring.schemas</resource>
            </transformer>
        </transformers>
    </configuration>
</plugin>
```

10.1.4. Build file setup

In order to run Spring Cloud Function applications on AWS Lambda, you can leverage Maven or Gradle plugins offered by the cloud platform provider.

Maven

In order to use the adapter plugin for Maven, add the plugin dependency to your `pom.xml` file:

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-function-adapter-aws</artifactId>
    </dependency>
</dependencies>
```

As pointed out in the Notes on JAR Layout, you will need a shaded jar in order to upload it to AWS Lambda. You can use the Maven Shade Plugin for that. The example of the setup can be found

above.

You can use theSpring Boot Maven Plugin to generate the thin jar.

```
<plugin>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-maven-plugin</artifactId>
    <dependencies>
        <dependency>
            <groupId>org.springframework.boot.experimental</groupId>
            <artifactId>spring-boot-thin-layout</artifactId>
            <version>${wrapper.version}</version>
        </dependency>
    </dependencies>
</plugin>
```

You can find the entire sample `pom.xml` file for deploying Spring Cloud Function applications to AWS Lambda with Maven here.

Gradle

In order to use the adapter plugin for Gradle, add the dependency to your `build.gradle` file:

```
dependencies {
    compile("org.springframework.cloud:spring-cloud-function-adapter-aws:${version}")
}
```

As pointed out in Notes on JAR Layout, you will need a shaded jar in order to upload it to AWS Lambda. You can use the Gradle Shadow Plugin for that:

```
buildscript {
    dependencies {
        classpath "com.github.jengelman.gradle.plugins:shadow:${shadowPluginVersion}"
    }
}
apply plugin: 'com.github.johnrengelman.shadow'

assemble.dependsOn = [shadowJar]

import com.github.jengelman.gradle.plugins.shadow.transformers.*

shadowJar {
    classifier = 'aws'
    dependencies {
        exclude(
            dependency("org.springframework.cloud:spring-cloud-function-
web:${springCloudFunctionVersion}"))
    }
    // Required for Spring
    mergeServiceFiles()
    append 'META-INF/spring.handlers'
    append 'META-INF/spring.schemas'
    append 'META-INF/spring.tooling'
    transform(PropertiesFileTransformer) {
        paths = ['META-INF/spring.factories']
        mergeStrategy = "append"
    }
}
```

You can use the Spring Boot Gradle Plugin and Spring Boot Thin Gradle Plugin to generate the thin jar.

```
buildscript {
    dependencies {
        classpath("org.springframework.boot.experimental:spring-boot-thin-gradle-
plugin:${wrapperVersion}")
        classpath("org.springframework.boot:spring-boot-gradle-
plugin:${springBootVersion}")
    }
}
apply plugin: 'org.springframework.boot'
apply plugin: 'org.springframework.boot.experimental.thin-launcher'
assemble.dependsOn = [thinJar]
```

You can find the entire sample `build.gradle` file for deploying Spring Cloud Function applications to AWS Lambda with Gradle here.

10.1.5. Upload

Build the sample under `spring-cloud-function-samples/function-sample-aws` and upload the `-aws` jar file to Lambda. The handler can be `example.Handler` or `org.springframework.cloud.function.adapter.aws.SpringBootStreamHandler` (FQN of the class, *not* a method reference, although Lambda does accept method references).

```
./mvnw -U clean package
```

Using the AWS command line tools it looks like this:

```
aws lambda create-function --function-name Uppercase --role
arn:aws:iam::[USERID]:role/service-role/[ROLE] --zip-file fileb://function-sample-
aws/target/function-sample-aws-2.0.0.BUILD-SNAPSHOT-aws.jar --handler
org.springframework.cloud.function.adapter.aws.SpringBootStreamHandler --description
"Spring Cloud Function Adapter Example" --runtime java8 --region us-east-1 --timeout
30 --memory-size 1024 --publish
```

The input type for the function in the AWS sample is a Foo with a single property called "value". So you would need this to test it:

```
{
  "value": "test"
}
```

The AWS sample app is written in the "functional" style (as an `ApplicationContextInitializer`). This is much faster on startup in Lambda than the traditional `@Bean` style, so if you don't need `@Beans` (or `@EnableAutoConfiguration`) it's a good choice. Warm starts are not affected.

10.1.6. Type Conversion

Spring Cloud Function will attempt to transparently handle type conversion between the raw input stream and types declared by your function.

For example, if your function signature is as such `Function<Foo, Bar>` we will attempt to convert incoming stream event to an instance of `Foo`.

In the event type is not known or can not be determined (e.g., `Function<?, ?>`) we will attempt to convert an incoming stream event to a generic `Map`.

Raw Input

There are times when you may want to have access to a raw input. In this case all you need is to declare your function signature to accept `InputStream`. For example, `Function<InputStream, ?>`. In this case we will not attempt any conversion and will pass the raw input directly to a function.

10.2. Microsoft Azure

The Azure adapter bootstraps a Spring Cloud Function context and channels function calls from the Azure framework into the user functions, using Spring Boot configuration where necessary. Azure Functions has quite a unique, but invasive programming model, involving annotations in user code that are specific to the platform. The easiest way to use it with Spring Cloud is to extend a base class and write a method in it with the `@FunctionName` annotation which delegates to a base class method.

This project provides an adapter layer for a Spring Cloud Function application onto Azure. You can write an app with a single `@Bean` of type `Function` and it will be deployable in Azure if you get the JAR file laid out right.

There is an `AzureSpringBootRequestHandler` which you must extend, and provide the input and output types as annotated method parameters (enabling Azure to inspect the class and create JSON bindings). The base class has two useful methods (`handleRequest` and `handleOutput`) to which you can delegate the actual function call, so mostly the function will only ever have one line.

Example:

```
public class FooHandler extends AzureSpringBootRequestHandler<Foo, Bar> {
    @FunctionName("uppercase")
    public Bar execute(@HttpTrigger(name = "req", methods = {HttpMethod.GET,
            HttpMethod.POST}, authLevel = AuthorizationLevel.ANONYMOUS)
HttpRequestMessage<Optional<Foo>> request,
        ExecutionContext context) {
        return handleRequest(request.getBody().get(), context);
    }
}
```

This Azure handler will delegate to a `Function<Foo,Bar>` bean (or a `Function<Publisher<Foo>,Publisher<Bar>>`). Some Azure triggers (e.g. `@CosmosDBTrigger`) result in a input type of `List` and in that case you can bind to `List` in the Azure handler, or `String` (the raw JSON). The `List` input delegates to a `Function` with input type `Map<String,Object>`, or `Publisher` or `List` of the same type. The output of the `Function` can be a `List` (one-for-one) or a single value (aggregation), and the output binding in the Azure declaration should match.

If your app has more than one `@Bean` of type `Function` etc. then you can choose the one to use by configuring `function.name`. Or if you make the `@FunctionName` in the Azure handler method match the function name it should work that way (also for function apps with multiple functions). The functions are extracted from the Spring Cloud `FunctionCatalog` so the default function names are the same as the bean names.

10.2.1. Accessing Azure ExecutionContext

Some time there is a need to access the target execution context provided by Azure runtime in the form of `com.microsoft.azure.functions.ExecutionContext`. For example one of such needs is logging, so it can appear in the Azure console.

For that purpose Spring Cloud Function will register `ExecutionContext` as bean in the Application context, so it could be injected into your function. For example

```
@Bean
public Function<Foo, Bar> uppercase(ExecutionContext targetContext) {
    return foo -> {
        targetContext.getLogger().info("Invoking 'uppercase' on " + foo.getValue());
        return new Bar(foo.getValue().toUpperCase());
    };
}
```

Normally type-based injection should suffice, however if need to you can also utilise the bean name under which it is registered which is `targetExecutionContext`.

10.2.2. Notes on JAR Layout

You don't need the Spring Cloud Function Web at runtime in Azure, so you can exclude this before you create the JAR you deploy to Azure, but it won't be used if you include it, so it doesn't hurt to leave it in. A function application on Azure is an archive generated by the Maven plugin. The function lives in the JAR file generated by this project. The sample creates it as an executable jar, using the thin layout, so that Azure can find the handler classes. If you prefer you can just use a regular flat JAR file. The dependencies should **not** be included.

10.2.3. Build file setup

In order to run Spring Cloud Function applications on Microsoft Azure, you can leverage the Maven plugin offered by the cloud platform provider.

In order to use the adapter plugin for Maven, add the plugin dependency to your `pom.xml` file:

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-function-adapter-azure</artifactId>
    </dependency>
</dependencies>
```

Then, configure the plugin. You will need to provide Azure-specific configuration for your application, specifying the `resourceGroup`, `appName` and other optional properties, and add the `package` goal execution so that the `function.json` file required by Azure is generated for you. Full plugin documentation can be found in the plugin repository.

```
<plugin>
    <groupId>com.microsoft.azure</groupId>
    <artifactId>azure-functions-maven-plugin</artifactId>
    <configuration>
        <resourceGroup>${functionResourceGroup}</resourceGroup>
        <appName>${functionAppName}</appName>
    </configuration>
    <executions>
        <execution>
            <id>package-functions</id>
            <goals>
                <goal>package</goal>
            </goals>
        </execution>
    </executions>
</plugin>
```

You will also have to ensure that the files to be scanned by the plugin can be found in the Azure functions staging directory (see the plugin repository for more details on the staging directory and it's default location).

You can find the entire sample `pom.xml` file for deploying Spring Cloud Function applications to Microsoft Azure with Maven here.

As of yet, only Maven plugin is available. Gradle plugin has not been created by the cloud platform provider.

10.2.4. Build

```
./mvnw -U clean package
```

10.2.5. Running the sample

You can run the sample locally, just like the other Spring Cloud Function samples:

---

and `curl -H "Content-Type: text/plain" localhost:8080/api/uppercase -d '{"value": "hello foobar"}'`.

You will need the `az` CLI app (see docs.microsoft.com/en-us/azure/azure-functions/functions-create-first-java-maven for more detail). To deploy the function on Azure runtime:

```
$ az login
$ mvn azure-functions:deploy
```

On another terminal try this: `curl <azure-function-url-from-the-log>/api/uppercase -d '{"value": "hello foobar!"}'`. Please ensure that you use the right URL for the function above. Alternatively you can test the function in the Azure Dashboard UI (click on the function name, go to the right hand side and click "Test" and to the bottom right, "Run").

The input type for the function in the Azure sample is a Foo with a single property called "value". So you need this to test it with something like below:

```
{
  "value": "foobar"
}
```

The Azure sample app is written in the "non-functional" style (using `@Bean`). The functional style (with just `Function` or `ApplicationContextInitializer`) is much faster on startup in Azure than the traditional `@Bean` style, so if you don't need `@Beans` (or `@EnableAutoConfiguration`) it's a good choice. Warm starts are not affected. :branch: master

10.3. Google Cloud Functions (Alpha)

The Google Cloud Functions adapter enables Spring Cloud Function apps to run on the Google Cloud Functions serverless platform. You can either run the function locally using the open source Google Functions Framework for Java or on GCP.

10.3.1. Project Dependencies

Start by adding the `spring-cloud-function-adapter-gcp` dependency to your project.

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-function-adapter-gcp</artifactId>
    </dependency>

    ...
</dependencies>
```

In addition, add the `spring-boot-maven-plugin` which will build the JAR of the function to deploy.

Notice that we also reference `spring-cloud-function-adapter-gcp` as a dependency of the `spring-boot-maven-plugin`. This is necessary because it modifies the plugin to package your function in the correct JAR format for deployment on Google Cloud Functions.

```
<plugin>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-maven-plugin</artifactId>
    <configuration>
        <outputDirectory>target/deploy</outputDirectory>
    </configuration>
    <dependencies>
        <dependency>
            <groupId>org.springframework.cloud</groupId>
            <artifactId>spring-cloud-function-adapter-gcp</artifactId>
        </dependency>
    </dependencies>
</plugin>
```

Finally, add the Maven plugin provided as part of the Google Functions Framework for Java. This allows you to test your functions locally via `mvn function:run`.

The function target should always be set to `org.springframework.cloud.function.adapter.gcp.GcfJarLauncher`; this is an adapter class which acts as the entry point to your Spring Cloud Function from the Google Cloud Functions platform.

```
<plugin>
    <groupId>com.google.cloud.functions</groupId>
    <artifactId>function-maven-plugin</artifactId>
    <version>0.9.1</version>
    <configuration>

<functionTarget>org.springframework.cloud.function.adapter.gcp.GcfJarLauncher</functio
nTarget>
        <port>8080</port>
    </configuration>
</plugin>
```

A full example of a working `pom.xml` can be found in the Spring Cloud Functions GCP sample.

10.3.2. HTTP Functions

Google Cloud Functions supports deploying HTTP Functions, which are functions that are invoked by HTTP request. The sections below describe instructions for deploying a Spring Cloud Function as an HTTP Function.

Getting Started

Let's start with a simple Spring Cloud Function example:

```
@SpringBootApplication
public class CloudFunctionMain {

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

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }
}
```

Specify your configuration main class in `resources/META-INF/MANIFEST.MF`.

```
Main-Class: com.example.CloudFunctionMain
```

Then run the function locally. This is provided by the Google Cloud Functions `function-maven-plugin` described in the project dependencies section.

```
mvn function:run
```

Invoke the HTTP function:

```
curl http://localhost:8080/ -d "hello"
```

Deploy to GCP

As of March 2020, Google Cloud Functions for Java is in Alpha. You can get on the whitelist to try it out.

Start by packaging your application.

```
mvn package
```

If you added the custom `spring-boot-maven-plugin` plugin defined above, you should see the resulting JAR in `target/deploy` directory. This JAR is correctly formatted for deployment to Google Cloud Functions.

Next, make sure that you have the Cloud SDK CLI installed.

From the project base directory run the following command to deploy.

```
gcloud alpha functions deploy function-sample-gcp-http \
--entry-point org.springframework.cloud.function.adapter.gcp.GcfJarLauncher \
--runtime java11 \
--trigger-http \
--source target/deploy \
--memory 512MB
```

Invoke the HTTP function:

```
curl https://REGION-PROJECT_ID.cloudfunctions.net/function-sample-gcp-http -d "hello"
```

10.3.3. Background Functions

Google Cloud Functions also supports deploying Background Functions which are invoked indirectly in response to an event, such as a message on a Cloud Pub/Sub topic, a change in a Cloud Storage bucket, or a Firebase event.

The `spring-cloud-function-adapter-gcp` allows for functions to be deployed as background functions as well.

The sections below describe the process for writing a Cloud Pub/Sub topic background function. However, there are a number of different event types that can trigger a background function to execute which are not discussed here; these are described in the Background Function triggers documentation.

Getting Started

Let's start with a simple Spring Cloud Function which will run as a GCF background function:

```
@SpringBootApplication
public class BackgroundFunctionMain {

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

    @Bean
    public Consumer<PubSubMessage> pubSubFunction() {
        return message -> System.out.println("The Pub/Sub message data: " +
message.getData());
    }
}
```

In addition, create `PubSubMessage` class in the project with the below definition. This class represents the Pub/Sub event structure which gets passed to your function on a Pub/Sub topic event.

```
public class PubSubMessage {

    private String data;

    private Map<String, String> attributes;

    private String messageId;

    private String publishTime;

    public String getData() {
        return data;
    }

    public void setData(String data) {
        this.data = data;
    }

    public Map<String, String> getAttributes() {
        return attributes;
    }

    public void setAttributes(Map<String, String> attributes) {
        this.attributes = attributes;
    }

    public String getMessageId() {
        return messageId;
    }

    public void setMessageId(String messageId) {
        this.messageId = messageId;
    }

    public String getPublishTime() {
        return publishTime;
    }

    public void setPublishTime(String publishTime) {
        this.publishTime = publishTime;
    }

}
```

Specify your configuration main class in `resources/META-INF/MANIFEST.MF`.

```
Main-Class: com.example.BackgroundFunctionMain
```

Then run the function locally. This is provided by the Google Cloud Functions `function-maven-plugin` described in the project dependencies section.

```
mvn function:run
```

Invoke the HTTP function:

```
curl localhost:8080 -H "Content-Type: application/json" -d '{"data":"hello"}'
```

Verify that the function was invoked by viewing the logs.

Deploy to GCP

In order to deploy your background function to GCP, first package your application.

```
mvn package
```

If you added the custom `spring-boot-maven-plugin` plugin defined above, you should see the resulting JAR in `target/deploy` directory. This JAR is correctly formatted for deployment to Google Cloud Functions.

Next, make sure that you have the Cloud SDK CLI installed.

From the project base directory run the following command to deploy.

```
gcloud alpha functions deploy function-sample-gcp-background \
--entry-point org.springframework.cloud.function.adapter.gcp.GcfJarLauncher \
--runtime java11 \
--trigger-topic my-functions-topic \
--source target/deploy \
--memory 512MB
```

Google Cloud Function will now invoke the function every time a message is published to the topic specified by `--trigger-topic`.

For a walkthrough on testing and verifying your background function, see the instructions for running the GCF Background Function sample.

10.3.4. Sample Functions

The project provides the following sample functions as reference:

- The function-sample-gcp-http is an HTTP Function which you can test locally and try deploying.
- The function-sample-gcp-background shows an example of a background function that is triggered by a message being published to a specified Pub/Sub topic.

Spring Cloud Gateway

2020.0.0-M4

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.

1. How to Include Spring Cloud Gateway

To include Spring Cloud Gateway in your project, use the starter with a group ID of `org.springframework.cloud` and an artifact ID of `spring-cloud-starter-gateway`. See the Spring Cloud Project page for details on setting up your build system with the current Spring Cloud Release Train.

If you include the starter, but you do not want the gateway to be enabled, set `spring.cloud.gateway.enabled=false`.

Spring Cloud Gateway is built on Spring Boot 2.x, Spring WebFlux, and Project Reactor. As a consequence, many of the familiar synchronous libraries (Spring Data and Spring Security, for example) and patterns you know may not apply when you use Spring Cloud Gateway. If you are unfamiliar with these projects, we suggest you begin by reading their documentation to familiarize yourself with some of the new concepts before working with Spring Cloud Gateway.

Spring Cloud Gateway requires the Netty runtime provided by Spring Boot and Spring Webflux. It does not work in a traditional Servlet Container or when built as a WAR.

2. Glossary

- **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 the aggregate predicate is true.
- **Predicate**: This is a Java 8 Function Predicate. The input type is a Spring Framework `ServerWebExchange`. This lets you match on anything from the HTTP request, such as headers or parameters.
- **Filter**: These are instances of Spring Framework `GatewayFilter` that have been constructed with a specific factory. Here, you can modify requests and responses before or after sending the downstream request.

3. How It Works

The following diagram provides a high-level overview of how Spring Cloud Gateway works:

[Spring Cloud Gateway Diagram] | *spring_cloud_gateway_diagram.png*

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 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 can run logic both before and after the proxy request is sent. All “pre” filter logic is executed. Then the proxy request is made. After the proxy request is made, the “post” filter logic is run.

URIs defined in routes without a port get default port values of 80 and 443 for the HTTP and HTTPS URIs, respectively.

4. Configuring Route Predicate Factories and Gateway Filter Factories

There are two ways to configure predicates and filters: shortcuts and fully expanded arguments. Most examples below use the shortcut way.

The name and argument names will be listed as `code` in the first sentance or two of the each section. The arguments are typically listed in the order that would be needed for the shortcut configuration.

4.1. Shortcut Configuration

Shortcut configuration is recognized by the filter name, followed by an equals sign (`=`), followed by argument values separated by commas (`,`).

application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: after_route
        uri: https://example.org
        predicates:
        - Cookie=mycookie,mycookievalue
```

The previous sample defines the `Cookie` Route Predicate Factory with two arguments, the cookie name, `mycookie` and the value to match `mycookievalue`.

4.2. Fully Expanded Arguments

Fully expanded arguments appear more like standard yaml configuration with name/value pairs. Typically, there will be a `name` key and an `args` key. The `args` key is a map of key value pairs to configure the predicate or filter.

application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: after_route
        uri: https://example.org
        predicates:
        - name: Cookie
          args:
            name: mycookie
            regexp: mycookievalue
```

This is the full configuration of the shortcut configuration of the `Cookie` predicate shown above.

5. 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. You can combine multiple route predicate factories with logical `and` statements.

5.1. The After Route Predicate Factory

The `After` route predicate factory takes one parameter, a `datetime` (which is a java `ZonedDateTime`). This predicate matches requests that happen after the specified datetime. The following example configures an after route predicate:

Example 5. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: after_route
        uri: https://example.org
        predicates:
        - After=2017-01-20T17:42:47.789-07:00[America/Denver]
```

This route matches any request made after Jan 20, 2017 17:42 Mountain Time (Denver).

5.2. The Before Route Predicate Factory

The `Before` route predicate factory takes one parameter, a `datetime` (which is a java `ZonedDateTime`). This predicate matches requests that happen before the specified `datetime`. The following example configures a before route predicate:

Example 6. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: before_route
        uri: https://example.org
        predicates:
        - Before=2017-01-20T17:42:47.789-07:00[America/Denver]
```

This route matches any request made before Jan 20, 2017 17:42 Mountain Time (Denver).

5.3. The Between Route Predicate Factory

The `Between` route predicate factory takes two parameters, `datetime1` and `datetime2` which are java `ZonedDateTime` objects. This predicate matches requests that happen after `datetime1` and before `datetime2`. The `datetime2` parameter must be after `datetime1`. The following example configures a between route predicate:

Example 7. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: between_route
        uri: https://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 made 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.

5.4. The Cookie Route Predicate Factory

The `Cookie` route predicate factory takes two parameters, the cookie `name` and a `regexp` (which is a Java regular expression). This predicate matches cookies that have the given name and whose values match the regular expression. The following example configures a cookie route predicate factory:

Example 8. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: cookie_route
        uri: https://example.org
        predicates:
        - Cookie=chocolate, ch.p
```

This route matches requests that have a cookie named `chocolate` whose value matches the `ch.p` regular expression.

5.5. The Header Route Predicate Factory

The `Header` route predicate factory takes two parameters, the header `name` and a `regexp` (which is a Java regular expression). This predicate matches with a header that has the given name whose value matches the regular expression. The following example configures a header route predicate:

Example 9. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: header_route
        uri: https://example.org
        predicates:
        - Header=X-Request-Id, \d+
```

This route matches if the request has a header named `X-Request-Id` whose value matches the `\d+` regular expression (that is, it has a value of one or more digits).

5.6. The Host Route Predicate Factory

The `Host` route predicate factory takes one parameter: a list of host name `patterns`. The pattern is an

Ant-style pattern with `.` as the separator. This predicates matches the `Host` header that matches the pattern. The following example configures a host route predicate:

Example 10. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: host_route
        uri: https://example.org
        predicates:
        - Host=**.somehost.org,**.anotherhost.org
```

URI template variables (such as `{sub}.myhost.org`) are supported as well.

This route matches if the request has a `Host` header with a value of `www.somehost.org` or `beta.somehost.org` or `www.anotherhost.org`.

This predicate extracts the URI template variables (such as `sub`, defined in the preceding example) as a map of names and values and places it in the `ServerWebExchange.getAttributes()` with a key defined in `ServerWebExchangeUtils.URI_TEMPLATE_VARIABLES_ATTRIBUTE`. Those values are then available for use by `GatewayFilter` factories

5.7. The Method Route Predicate Factory

The `Method` Route Predicate Factory takes a `methods` argument which is one or more parameters: the HTTP methods to match. The following example configures a method route predicate:

Example 11. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: method_route
        uri: https://example.org
        predicates:
        - Method=GET,POST
```

This route matches if the request method was a `GET` or a `POST`.

5.8. The Path Route Predicate Factory

The `Path` Route Predicate Factory takes two parameters: a list of Spring `PathMatcher patterns` and an

optional flag called `matchTrailingSlash` (defaults to `true`). The following example configures a path route predicate:

Example 12. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: path_route
        uri: https://example.org
        predicates:
        - Path=/red/{segment},/blue/{segment}
```

This route matches if the request path was, for example: `/red/1` or `/red/1/` or `/red/blue` or `/blue/green`.

If `matchTrailingSlash` is set to `false`, then request path `/red/1/` will not be matched.

This predicate extracts the URI template variables (such as `segment`, defined in the preceding example) as a map of names and values and places it in the `ServerWebExchange.getAttributes()` with a key defined in `ServerWebExchangeUtils.URI_TEMPLATE_VARIABLES_ATTRIBUTE`. Those values are then available for use by `GatewayFilter` factories

A utility method (called `get`) is available to make access to these variables easier. The following example shows how to use the `get` method:

```
Map<String, String> uriVariables =
ServerWebExchangeUtils.getPathPredicateVariables(exchange);

String segment = uriVariables.get("segment");
```

5.9. The Query Route Predicate Factory

The `Query` route predicate factory takes two parameters: a required `param` and an optional `regexp` (which is a Java regular expression). The following example configures a query route predicate:

Example 13. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: query_route
        uri: https://example.org
        predicates:
        - Query=green
```

The preceding route matches if the request contained a `green` query parameter.

application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: query_route
        uri: https://example.org
        predicates:
        - Query=red, gree.
```

The preceding route matches if the request contained a `red` query parameter whose value matched the `gree.` regexp, so `green` and `greet` would match.

5.10. The RemoteAddr Route Predicate Factory

The `RemoteAddr` route predicate factory takes a list (min size 1) of `sources`, which are CIDR-notation (IPv4 or IPv6) strings, such as `192.168.0.1/16` (where `192.168.0.1` is an IP address and `16` is a subnet mask). The following example configures a RemoteAddr route predicate:

Example 14. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: remoteaddr_route
        uri: https://example.org
        predicates:
        - RemoteAddr=192.168.1.1/24
```

This route matches if the remote address of the request was, for example, `192.168.1.10`.

5.11. The Weight Route Predicate Factory

The `Weight` route predicate factory takes two arguments: `group` and `weight` (an int). The weights are calculated per group. The following example configures a weight route predicate:

Example 15. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: weight_high
        uri: https://weighthigh.org
        predicates:
        - Weight=group1, 8
      - id: weight_low
        uri: https://weightlow.org
        predicates:
        - Weight=group1, 2
```

This route would forward ~80% of traffic to weighthigh.org and ~20% of traffic to weighlow.org

5.11.1. Modifying the Way Remote Addresses Are Resolved

By default, the RemoteAddr route predicate factory uses the remote address from the incoming request. This may not match the actual client IP address if Spring Cloud Gateway sits behind a proxy layer.

You can customize the way that the remote address is resolved by setting a custom `RemoteAddressResolver`. Spring Cloud Gateway comes with one non-default remote address resolver that is based off of the X-Forwarded-For header, `XForwardedRemoteAddressResolver`.

`XForwardedRemoteAddressResolver` has two static constructor methods, which take different approaches to security:

- `XForwardedRemoteAddressResolver::trustAll` returns a `RemoteAddressResolver` that always takes the first IP address found in the `X-Forwarded-For` header. This approach is vulnerable to spoofing, as a malicious client could set an initial value for the `X-Forwarded-For`, which would be accepted by the resolver.
- `XForwardedRemoteAddressResolver::maxTrustedIndex` takes an index that correlates to the number of trusted infrastructure running in front of Spring Cloud Gateway. If Spring Cloud Gateway is, for example only accessible through HAProxy, then a value of 1 should be used. If two hops of trusted infrastructure are required before Spring Cloud Gateway is accessible, then a value of 2 should be used.

Consider the following header value:

```
X-Forwarded-For: 0.0.0.1, 0.0.0.2, 0.0.0.3
```

The following `maxTrustedIndex` values yield the following remote addresses:

`maxTrustedIndex`	**result**
[`Integer.MIN_VALUE`,0]	(invalid, `IllegalArgumentException` during initialization)
1	0.0.0.3
2	0.0.0.2
3	0.0.0.1
[4, `Integer.MAX_VALUE`]	0.0.0.1

The following example shows how to achieve the same configuration with Java:

Example 16. GatewayConfig.java

```
RemoteAddressResolver resolver = XForwardedRemoteAddressResolver
    .maxTrustedIndex(1);

...

.route("direct-route",
    r -> r.remoteAddr("10.1.1.1", "10.10.1.1/24")
        .uri("https://downstream1")
.route("proxied-route",
    r -> r.remoteAddr(resolver, "10.10.1.1", "10.10.1.1/24")
        .uri("https://downstream2")
)
```

6. `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.

For more detailed examples of how to use any of the following filters, take a look at the unit tests.

6.1. The `AddRequestHeader GatewayFilter` Factory

The `AddRequestHeader GatewayFilter` factory takes a `name` and `value` parameter. The following example configures an `AddRequestHeader GatewayFilter`:

Example 17. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: add_request_header_route
        uri: https://example.org
        filters:
        - AddRequestHeader=X-Request-red, blue
```

This listing adds `X-Request-red:blue` header to the downstream request's headers for all matching requests.

`AddRequestHeader` is aware of the URI variables used to match a path or host. URI variables may be used in the value and are expanded at runtime. The following example configures an `AddRequestHeader GatewayFilter` that uses a variable:

Example 18. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: add_request_header_route
        uri: https://example.org
        predicates:
        - Path=/red/{segment}
        filters:
        - AddRequestHeader=X-Request-Red, Blue-{segment}
```

6.2. The `AddRequestParameter GatewayFilter` Factory

The `AddRequestParameter GatewayFilter` Factory takes a `name` and `value` parameter. The following example configures an `AddRequestParameter GatewayFilter`:

Example 19. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: add_request_parameter_route
        uri: https://example.org
        filters:
        - AddRequestParameter=red, blue
```

This will add `red=blue` to the downstream request's query string for all matching requests.

`AddRequestParameter` is aware of the URI variables used to match a path or host. URI variables may be used in the value and are expanded at runtime. The following example configures an `AddRequestParameter GatewayFilter` that uses a variable:

Example 20. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: add_request_parameter_route
        uri: https://example.org
        predicates:
        - Host: {segment}.myhost.org
        filters:
        - AddRequestParameter=foo, bar-{segment}
```

6.3. The `AddResponseHeader GatewayFilter` Factory

The `AddResponseHeader GatewayFilter` Factory takes a `name` and `value` parameter. The following example configures an `AddResponseHeader GatewayFilter`:

Example 21. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: add_response_header_route
        uri: https://example.org
        filters:
        - AddResponseHeader=X-Response-Red, Blue
```

This adds `X-Response-Foo:Bar` header to the downstream response's headers for all matching requests.

`AddResponseHeader` is aware of URI variables used to match a path or host. URI variables may be used in the value and are expanded at runtime. The following example configures an `AddResponseHeader GatewayFilter` that uses a variable:

Example 22. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: add_response_header_route
        uri: https://example.org
        predicates:
        - Host: {segment}.myhost.org
        filters:
        - AddResponseHeader=foo, bar-{segment}
```

6.4. The `DedupeResponseHeader GatewayFilter` Factory

The DedupeResponseHeader GatewayFilter factory takes a `name` parameter and an optional `strategy` parameter. `name` can contain a space-separated list of header names. The following example configures a `DedupeResponseHeader GatewayFilter`:

Example 23. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: dedupe_response_header_route
        uri: https://example.org
        filters:
        - DedupeResponseHeader=Access-Control-Allow-Credentials Access-Control-
Allow-Origin
```

This removes duplicate values of `Access-Control-Allow-Credentials` and `Access-Control-Allow-Origin` response headers in cases when both the gateway CORS logic and the downstream logic add them.

The `DedupeResponseHeader` filter also accepts an optional `strategy` parameter. The accepted values are `RETAIN_FIRST` (default), `RETAIN_LAST`, and `RETAIN_UNIQUE`.

6.5. Spring Cloud CircuitBreaker GatewayFilter Factory

The Spring Cloud CircuitBreaker GatewayFilter factory uses the Spring Cloud CircuitBreaker APIs to wrap Gateway routes in a circuit breaker. Spring Cloud CircuitBreaker supports multiple libraries that can be used with Spring Cloud Gateway. Spring Cloud supports Resilience4J out of the box.

To enable the Spring Cloud CircuitBreaker filter, you need to place `spring-cloud-starter-circuitbreaker-reactor-resilience4j` on the classpath. The following example configures a Spring Cloud CircuitBreaker `GatewayFilter`:

Example 24. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: circuitbreaker_route
        uri: https://example.org
        filters:
        - CircuitBreaker=myCircuitBreaker
```

To configure the circuit breaker, see the configuration for the underlying circuit breaker implementation you are using.

- Resilience4J Documentation

The Spring Cloud CircuitBreaker filter can also accept an optional `fallbackUri` parameter. Currently, only `forward:` schemed URIs are supported. If the fallback is called, the request is forwarded to the controller matched by the URI. The following example configures such a fallback:

Example 25. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: circuitbreaker_route
        uri: lb://backing-service:8088
        predicates:
        - Path=/consumingServiceEndpoint
        filters:
        - name: CircuitBreaker
          args:
            name: myCircuitBreaker
            fallbackUri: forward:/inCaseOfFailureUseThis
        - RewritePath=/consumingServiceEndpoint, /backingServiceEndpoint
```

The following listing does the same thing in Java:

Example 26. Application.java

```
@Bean
public RouteLocator routes(RouteLocatorBuilder builder) {
    return builder.routes()
        .route("circuitbreaker_route", r -> r.path("/consumingServiceEndpoint")
            .filters(f -> f.circuitBreaker(c ->
c.name("myCircuitBreaker").fallbackUri("forward:/inCaseOfFailureUseThis"))
                .rewritePath("/consumingServiceEndpoint",
"/backingServiceEndpoint")).uri("lb://backing-service:8088")
        .build();
}
```

This example forwards to the `/inCaseofFailureUseThis` URI when the circuit breaker fallback is called. Note that this example also demonstrates the (optional) Spring Cloud Netflix Ribbon load-balancing (defined by the `lb` prefix on the destination URI).

The primary scenario is to use the `fallbackUri` to define an internal controller or handler within the gateway application. However, you can also reroute the request to a controller or handler in an external application, as follows:

Example 27. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: ingredients
        uri: lb://ingredients
        predicates:
        - Path=//ingredients/**
        filters:
        - name: CircuitBreaker
          args:
            name: fetchIngredients
            fallbackUri: forward:/fallback
      - id: ingredients-fallback
        uri: http://localhost:9994
        predicates:
        - Path=/fallback
```

In this example, there is no `fallback` endpoint or handler in the gateway application. However, there is one in another application, registered under `localhost:9994`.

In case of the request being forwarded to fallback, the Spring Cloud CircuitBreaker Gateway filter also provides the `Throwable` that has caused it. It is added to the `ServerWebExchange` as the `ServerWebExchangeUtils.CIRCUITBREAKER_EXECUTION_EXCEPTION_ATTR` attribute that can be used when handling the fallback within the gateway application.

For the external controller/handler scenario, headers can be added with exception details. You can find more information on doing so in the FallbackHeaders GatewayFilter Factory section.

6.5.1. Tripping The Circuit Breaker On Status Codes

In some cases you might want to trip a circuit breaker based on the status code returned from the route it wraps. The circuit breaker config object takes a list of status codes that if returned will cause the the circuit breaker to be tripped. When setting the status codes you want to trip the circuit breaker you can either use a integer with the status code value or the String representation of the `HttpStatus` enumeration.

Example 28. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: circuitbreaker_route
        uri: lb://backing-service:8088
        predicates:
        - Path=/consumingServiceEndpoint
        filters:
        - name: CircuitBreaker
          args:
            name: myCircuitBreaker
            fallbackUri: forward:/inCaseOfFailureUseThis
            statusCodes:
              - 500
              - "NOT_FOUND"
```

Example 29. Application.java

```
@Bean
public RouteLocator routes(RouteLocatorBuilder builder) {
    return builder.routes()
        .route("circuitbreaker_route", r -> r.path("/consumingServiceEndpoint")
            .filters(f -> f.circuitBreaker(c ->
c.name("myCircuitBreaker").fallbackUri("forward:/inCaseOfFailureUseThis").addStatu
sCode("INTERNAL_SERVER_ERROR"))
                .rewritePath("/consumingServiceEndpoint",
"/backingServiceEndpoint")).uri("lb://backing-service:8088")
        .build();
}
```

6.6. The `FallbackHeaders` `GatewayFilter` Factory

The `FallbackHeaders` factory lets you add Spring Cloud CircuitBreaker execution exception details in the headers of a request forwarded to a `fallbackUri` in an external application, as in the following scenario:

Example 30. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: ingredients
        uri: lb://ingredients
        predicates:
        - Path=//ingredients/**
        filters:
        - name: CircuitBreaker
          args:
            name: fetchIngredients
            fallbackUri: forward:/fallback
      - id: ingredients-fallback
        uri: http://localhost:9994
        predicates:
        - Path=/fallback
        filters:
        - name: FallbackHeaders
          args:
            executionExceptionTypeHeaderName: Test-Header
```

In this example, after an execution exception occurs while running the circuit breaker, the request is forwarded to the `fallback` endpoint or handler in an application running on `localhost:9994`. The headers with the exception type, message and (if available) root cause exception type and message are added to that request by the `FallbackHeaders` filter.

You can overwrite the names of the headers in the configuration by setting the values of the following arguments (shown with their default values):

- `executionExceptionTypeHeaderName` (`"Execution-Exception-Type"`)
- `executionExceptionMessageHeaderName` (`"Execution-Exception-Message"`)
- `rootCauseExceptionTypeHeaderName` (`"Root-Cause-Exception-Type"`)
- `rootCauseExceptionMessageHeaderName` (`"Root-Cause-Exception-Message"`)

For more information on circuit breakers and the gateway see the Spring Cloud CircuitBreaker Factory section.

6.7. The `MapRequestHeader GatewayFilter` Factory

The `MapRequestHeader GatewayFilter` factory takes `fromHeader` and `toHeader` parameters. It creates a new named header (`toHeader`), and the value is extracted out of an existing named header (`fromHeader`) from the incoming http request. If the input header does not exist, the filter has no impact. If the new named header already exists, its values are augmented with the new values. The

following example configures a `MapRequestHeader`:

Example 31. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: map_request_header_route
        uri: https://example.org
        filters:
        - MapRequestHeader=Blue, X-Request-Red
```

This adds `X-Request-Red:<values>` header to the downstream request with updated values from the incoming HTTP request's `Blue` header.

6.8. The `PrefixPath GatewayFilter` Factory

The `PrefixPath GatewayFilter` factory takes a single `prefix` parameter. The following example configures a `PrefixPath GatewayFilter`:

Example 32. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: prefixpath_route
        uri: https://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`.

6.9. The `PreserveHostHeader GatewayFilter` Factory

The `PreserveHostHeader GatewayFilter` factory has no parameters. This filter sets a request attribute that the routing filter inspects to determine if the original host header should be sent, rather than the host header determined by the HTTP client. The following example configures a `PreserveHostHeader GatewayFilter`:

Example 33. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: preserve_host_route
        uri: https://example.org
        filters:
        - PreserveHostHeader
```

6.10. The `RequestRateLimiter` `GatewayFilter` Factory

The `RequestRateLimiter` `GatewayFilter` factory uses a `RateLimiter` implementation to determine if the current request is allowed to proceed. If it is not, a status of `HTTP 429 - Too Many Requests` (by default) is returned.

This filter takes an optional `keyResolver` parameter and parameters specific to the rate limiter (described later in this section).

`keyResolver` is a bean that implements the `KeyResolver` interface. In configuration, reference the bean by name using SpEL. `#{@myKeyResolver}` is a SpEL expression that references a bean named `myKeyResolver`. The following listing shows the `KeyResolver` interface:

Example 34. KeyResolver.java

```
public interface KeyResolver {
    Mono<String> resolve(ServerWebExchange exchange);
}
```

The `KeyResolver` interface lets pluggable strategies derive the key for limiting requests. In future milestone releases, there will be some `KeyResolver` implementations.

The default implementation of `KeyResolver` is the `PrincipalNameKeyResolver`, which retrieves the `Principal` from the `ServerWebExchange` and calls `Principal.getName()`.

By default, if the `KeyResolver` does not find a key, requests are denied. You can adjust this behavior by setting the `spring.cloud.gateway.filter.request-rate-limiter.deny-empty-key` (`true` or `false`) and `spring.cloud.gateway.filter.request-rate-limiter.empty-key-status-code` properties.

The `RequestRateLimiter` is not configurable with the "shortcut" notation. The following example below is *invalid*:

Example 35. application.properties

```
# INVALID SHORTCUT CONFIGURATION
spring.cloud.gateway.routes[0].filters[0]=RequestRateLimiter=2, 2,
#{@userkeyresolver}
```

6.10.1. The Redis `RateLimiter`

The Redis implementation is based off of work done at Stripe. It requires the use of the `spring-boot-starter-data-redis-reactive` Spring Boot starter.

The algorithm used is the Token Bucket Algorithm.

The `redis-rate-limiter.replenishRate` property is how many requests per second you want a user to be allowed to do, without any dropped requests. This is the rate at which the token bucket is filled.

The `redis-rate-limiter.burstCapacity` property is the maximum number of requests a user is allowed to do in a single second. This is the number of tokens the token bucket can hold. Setting this value to zero blocks all requests.

The `redis-rate-limiter.requestedTokens` property is how many tokens a request costs. This is the number of tokens taken from the bucket for each request and defaults to `1`.

A steady rate is accomplished by setting the same value in `replenishRate` and `burstCapacity`. Temporary bursts can be allowed by setting `burstCapacity` higher than `replenishRate`. In this case, the rate limiter needs to be allowed some time between bursts (according to `replenishRate`), as two consecutive bursts will result in dropped requests (`HTTP 429 - Too Many Requests`). The following listing configures a `redis-rate-limiter`:

Rate limits bellow `1 request/s` are accomplished by setting `replenishRate` to the wanted number of requests, `requestedTokens` to the timespan in seconds and `burstCapacity` to the product of `replenishRate` and `requestedTokens`, e.g. setting `replenishRate=1`, `requestedTokens=60` and `burstCapacity=60` will result in a limit of `1 request/min`.

Example 36. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: requestratelimiter_route
        uri: https://example.org
        filters:
        - name: RequestRateLimiter
          args:
            redis-rate-limiter.replenishRate: 10
            redis-rate-limiter.burstCapacity: 20
            redis-rate-limiter.requestedTokens: 1
```

The following example configures a KeyResolver in Java:

Example 37. Config.java

```
@Bean
KeyResolver userKeyResolver() {
    return exchange ->
Mono.just(exchange.getRequest().getQueryParams().getFirst("user"));
}
```

This defines a request rate limit of 10 per user. A burst of 20 is allowed, but, in the next second, only 10 requests are available. The `KeyResolver` is a simple one that gets the `user` request parameter (note that this is not recommended for production).

You can also define a rate limiter as a bean that implements the `RateLimiter` interface. In configuration, you can reference the bean by name using SpEL. `#{@myRateLimiter}` is a SpEL expression that references a bean with named `myRateLimiter`. The following listing defines a rate limiter that uses the `KeyResolver` defined in the previous listing:

Example 38. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: requestratelimiter_route
        uri: https://example.org
        filters:
        - name: RequestRateLimiter
          args:
            rate-limiter: "#{@myRateLimiter}"
            key-resolver: "#{@userKeyResolver}"
```

6.11. The `RedirectTo GatewayFilter` Factory

The `RedirectTo GatewayFilter` factory takes two parameters, `status` and `url`. The `status` parameter should be a 300 series redirect HTTP code, such as 301. The `url` parameter should be a valid URL. This is the value of the `Location` header. For relative redirects, you should use `uri: no://op` as the uri of your route definition. The following listing configures a `RedirectTo GatewayFilter`:

Example 39. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: prefixpath_route
        uri: https://example.org
        filters:
        - RedirectTo=302, https://acme.org
```

This will send a status 302 with a `Location:https://acme.org` header to perform a redirect.

6.12. The `RemoveRequestHeader` GatewayFilter Factory

The `RemoveRequestHeader GatewayFilter` factory takes a `name` parameter. It is the name of the header to be removed. The following listing configures a `RemoveRequestHeader GatewayFilter`:

Example 40. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: removerequestheader_route
        uri: https://example.org
        filters:
        - RemoveRequestHeader=X-Request-Foo
```

This removes the `X-Request-Foo` header before it is sent downstream.

6.13. `RemoveResponseHeader GatewayFilter` Factory

The `RemoveResponseHeader GatewayFilter` factory takes a `name` parameter. It is the name of the header to be removed. The following listing configures a `RemoveResponseHeader GatewayFilter`:

Example 41. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: removeresponseheader_route
        uri: https://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.

To remove any kind of sensitive header, you should configure this filter for any routes for which you may want to do so. In addition, you can configure this filter once by using `spring.cloud.gateway.default-filters` and have it applied to all routes.

6.14. The `RemoveRequestParameter GatewayFilter` Factory

The `RemoveRequestParameter GatewayFilter` factory takes a `name` parameter. It is the name of the query parameter to be removed. The following example configures a `RemoveRequestParameter GatewayFilter`:

Example 42. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: removerequestparameter_route
        uri: https://example.org
        filters:
        - RemoveRequestParameter=red
```

This will remove the `red` parameter before it is sent downstream.

6.15. The `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. The following listing configures a `RewritePath GatewayFilter`:

Example 43. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: rewritepath_route
        uri: https://example.org
        predicates:
        - Path=/red/**
        filters:
        - RewritePath=/red(?<segment>/?.*), $\{segment}
```

For a request path of `/red/blue`, this sets the path to `/blue` before making the downstream request. Note that the `$` should be replaced with `$\` because of the YAML specification.

6.16. `RewriteLocationResponseHeader GatewayFilter` Factory

The `RewriteLocationResponseHeader GatewayFilter` factory modifies the value of the `Location` response header, usually to get rid of backend-specific details. It takes `stripVersionMode`, `locationHeaderName`, `hostValue`, and `protocolsRegex` parameters. The following listing configures a `RewriteLocationResponseHeader GatewayFilter`:

Example 44. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: rewritelocationresponseheader_route
        uri: http://example.org
        filters:
        - RewriteLocationResponseHeader=AS_IN_REQUEST, Location, ,
```

For example, for a request of `POST api.example.com/some/object/name`, the `Location` response header value of `object-service.prod.example.net/v2/some/object/id` is rewritten as `api.example.com/some/object/id`.

The `stripVersionMode` parameter has the following possible values: `NEVER_STRIP`, `AS_IN_REQUEST` (default), and `ALWAYS_STRIP`.

- `NEVER_STRIP`: The version is not stripped, even if the original request path contains no version.
- `AS_IN_REQUEST` The version is stripped only if the original request path contains no version.
- `ALWAYS_STRIP` The version is always stripped, even if the original request path contains version.

The `hostValue` parameter, if provided, is used to replace the `host:port` portion of the response `Location` header. If it is not provided, the value of the `Host` request header is used.

The `protocolsRegex` parameter must be a valid regex `String`, against which the protocol name is matched. If it is not matched, the filter does nothing. The default is `http|https|ftp|ftps`.

6.17. The `RewriteResponseHeader GatewayFilter` Factory

The `RewriteResponseHeader GatewayFilter` factory takes `name`, `regexp`, and `replacement` parameters. It uses Java regular expressions for a flexible way to rewrite the response header value. The following example configures a `RewriteResponseHeader GatewayFilter`:

Example 45. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: rewriteresponseheader_route
        uri: https://example.org
        filters:
        - RewriteResponseHeader=X-Response-Red, , password=[^&]+, password=***
```

For a header value of `/42?user=ford&password=omg!what&flag=true`, it is set to `/42?user=ford&password=***&flag=true` after making the downstream request. You must use `$\` to mean `$` because of the YAML specification.

6.18. The `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 with a lazy data store and you need to ensure the session state has been saved before making the forwarded call. The following example configures a `SaveSession GatewayFilter`:

Example 46. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: save_session
        uri: https://example.org
        predicates:
        - Path=/foo/**
        filters:
        - SaveSession
```

If you integrate Spring Security with Spring Session and want to ensure security details have been forwarded to the remote process, this is critical.

6.19. The `SecureHeaders GatewayFilter` Factory

The `SecureHeaders GatewayFilter` factory adds a number of headers to the response, per the recommendation made in this blog post.

The following headers (shown with their default values) are added:

- `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. The following properties are available:

- `xss-protection-header`
- `strict-transport-security`
- `x-frame-options`
- `x-content-type-options`
- `referrer-policy`
- `content-security-policy`
- `x-download-options`
- `x-permitted-cross-domain-policies`

To disable the default values set the `spring.cloud.gateway.filter.secure-headers.disable` property with comma-separated values. The following example shows how to do so:

```
spring.cloud.gateway.filter.secure-headers.disable=x-frame-options,strict-
transport-security
```

The lowercase full name of the secure header needs to be used to disable it..

6.20. The `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. The following example configures a `SetPath GatewayFilter`:

Example 47. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setpath_route
        uri: https://example.org
        predicates:
        - Path=/red/{segment}
        filters:
        - SetPath=/{segment}
```

For a request path of `/red/blue`, this sets the path to `/blue` before making the downstream request.

6.21. The `SetRequestHeader GatewayFilter` Factory

The `SetRequestHeader GatewayFilter` factory takes `name` and `value` parameters. The following listing configures a `SetRequestHeader GatewayFilter`:

Example 48. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setrequestheader_route
        uri: https://example.org
        filters:
        - SetRequestHeader=X-Request-Red, Blue
```

This `GatewayFilter` replaces (rather than adding) all headers with the given name. So, if the downstream server responded with a `X-Request-Red:1234`, this would be replaced with `X-Request-Red:Blue`, which is what the downstream service would receive.

`SetRequestHeader` is aware of URI variables used to match a path or host. URI variables may be used in the value and are expanded at runtime. The following example configures an `SetRequestHeader GatewayFilter` that uses a variable:

Example 49. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setrequestheader_route
        uri: https://example.org
        predicates:
        - Host: {segment}.myhost.org
        filters:
        - SetRequestHeader=foo, bar-{segment}
```

6.22. The `SetResponseHeader GatewayFilter` Factory

The `SetResponseHeader GatewayFilter` factory takes `name` and `value` parameters. The following listing configures a `SetResponseHeader GatewayFilter`:

Example 50. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setresponseheader_route
        uri: https://example.org
        filters:
        - SetResponseHeader=X-Response-Red, Blue
```

This GatewayFilter replaces (rather than adding) all headers with the given name. So, if the downstream server responded with a `X-Response-Red:1234`, this is replaced with `X-Response-Red:Blue`, which is what the gateway client would receive.

`SetResponseHeader` is aware of URI variables used to match a path or host. URI variables may be used in the value and will be expanded at runtime. The following example configures an `SetResponseHeader GatewayFilter` that uses a variable:

Example 51. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setresponseheader_route
        uri: https://example.org
        predicates:
        - Host: {segment}.myhost.org
        filters:
        - SetResponseHeader=foo, bar-{segment}
```

6.23. The `SetStatus GatewayFilter` Factory

The `SetStatus GatewayFilter` factory takes a single parameter, `status`. It must be a valid Spring `HttpStatus`. It may be the integer value `404` or the string representation of the enumeration: `NOT_FOUND`. The following listing configures a `SetStatus GatewayFilter`:

Example 52. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setstatusstring_route
        uri: https://example.org
        filters:
        - SetStatus=BAD_REQUEST
      - id: setstatusint_route
        uri: https://example.org
        filters:
        - SetStatus=401
```

In either case, the HTTP status of the response is set to 401.

You can configure the `SetStatus GatewayFilter` to return the original HTTP status code from the proxied request in a header in the response. The header is added to the response if configured with the following property:

Example 53. application.yml

```
spring:
  cloud:
    gateway:
      set-status:
        original-status-header-name: original-http-status
```

6.24. The `StripPrefix GatewayFilter` Factory

The `StripPrefix GatewayFilter` factory takes one parameter, `parts`. The `parts` parameter indicates the number of parts in the path to strip from the request before sending it downstream. The following listing configures a `StripPrefix GatewayFilter`:

Example 54. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: nameRoot
        uri: https://nameservice
        predicates:
        - Path=/name/**
        filters:
        - StripPrefix=2
```

When a request is made through the gateway to `/name/blue/red`, the request made to `nameservice` looks like `nameservice/red`.

6.25. The Retry `GatewayFilter` Factory

The `Retry GatewayFilter` factory supports the following parameters:

- `retries`: The number of retries that should be attempted.
- `statuses`: The HTTP status codes that should be retried, represented by using `org.springframework.http.HttpStatus`.
- `methods`: The HTTP methods that should be retried, represented by using `org.springframework.http.HttpMethod`.
- `series`: The series of status codes to be retried, represented by using `org.springframework.http.HttpStatus.Series`.
- `exceptions`: A list of thrown exceptions that should be retried.
- `backoff`: The configured exponential backoff for the retries. Retries are performed after a backoff interval of `firstBackoff * (factor ^ n)`, where `n` is the iteration. If `maxBackoff` is configured, the maximum backoff applied is limited to `maxBackoff`. If `basedOnPreviousValue` is true, the backoff is calculated byusing `prevBackoff * factor`.

The following defaults are configured for `Retry` filter, if enabled:

- `retries`: Three times
- `series`: 5XX series
- `methods`: GET method
- `exceptions`: `IOException` and `TimeoutException`
- `backoff`: disabled

The following listing configures a Retry `GatewayFilter`:

Example 55. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: retry_test
        uri: http://localhost:8080/flakey
        predicates:
        - Host=*.retry.com
        filters:
        - name: Retry
          args:
            retries: 3
            statuses: BAD_GATEWAY
            methods: GET,POST
            backoff:
              firstBackoff: 10ms
              maxBackoff: 50ms
              factor: 2
              basedOnPreviousValue: false
```

When using the retry filter with a `forward:` prefixed URL, the target endpoint should be written carefully so that, in case of an error, it does not do anything that could result in a response being sent to the client and committed. For example, if the target endpoint is an annotated controller, the target controller method should not return `ResponseEntity` with an error status code. Instead, it should throw an `Exception` or signal an error (for example, through a `Mono.error(ex)` return value), which the retry filter can be configured to handle by retrying.

When using the retry filter with any HTTP method with a body, the body will be cached and the gateway will become memory constrained. The body is cached in a request attribute defined by `ServerWebExchangeUtils.CACHED_REQUEST_BODY_ATTR`. The type of the object is a `org.springframework.core.io.buffer.DataBuffer`.

6.26. The `RequestSize GatewayFilter` Factory

When the request size is greater than the permissible limit, the `RequestSize GatewayFilter` factory can restrict a request from reaching the downstream service. The filter takes a `maxSize` parameter. The `maxSize is a `DataSize` type, so values can be defined as a number followed by an optional `DataUnit` suffix such as 'KB' or 'MB'. The default is 'B' for bytes. It is the permissible size limit of the request defined in bytes. The following listing configures a `RequestSize GatewayFilter`:

Example 56. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: request_size_route
        uri: http://localhost:8080/upload
        predicates:
        - Path=/upload
        filters:
        - name: RequestSize
          args:
            maxSize: 5000000
```

The `RequestSize GatewayFilter` factory sets the response status as `413 Payload Too Large` with an additional header `errorMessage` when the request is rejected due to size. The following example shows such an `errorMessage`:

```
errorMessage` : `Request size is larger than permissible limit. Request size is
6.0 MB where permissible limit is 5.0 MB
```

The default request size is set to five MB if not provided as a filter argument in the route definition.

6.27. The `SetRequestHost GatewayFilter` Factory

There are certain situation when the host header may need to be overridden. In this situation, the `SetRequestHost GatewayFilter` factory can replace the existing host header with a specified vaue. The filter takes a `host` parameter. The following listing configures a `SetRequestHost GatewayFilter`:

Example 57. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: set_request_host_header_route
        uri: http://localhost:8080/headers
        predicates:
        - Path=/headers
        filters:
        - name: SetRequestHost
          args:
            host: example.org
```

The `SetRequestHost` `GatewayFilter` factory replaces the value of the host header with `example.org`.

6.28. Modify a Request Body `GatewayFilter` Factory

You can use the `ModifyRequestBody` filter filter to modify the request body before it is sent downstream by the gateway.

This filter can be configured only by using the Java DSL.

The following listing shows how to modify a request body `GatewayFilter`:

```
@Bean
public RouteLocator routes(RouteLocatorBuilder builder) {
    return builder.routes()
        .route("rewrite_request_obj", r -> r.host("*.rewriterequestobj.org")
            .filters(f -> f.prefixPath("/httpbin")
                .modifyRequestBody(String.class, Hello.class,
MediaType.APPLICATION_JSON_VALUE,
                    (exchange, s) -> return Mono.just(new
Hello(s.toUpperCase())))).uri(uri))
        .build();
}

static class Hello {
    String message;

    public Hello() { }

    public Hello(String message) {
        this.message = message;
    }

    public String getMessage() {
        return message;
    }

    public void setMessage(String message) {
        this.message = message;
    }
}
```

6.29. Modify a Response Body `GatewayFilter` Factory

You can use the `ModifyResponseBody` filter to modify the response body before it is sent back to the client.

This filter can be configured only by using the Java DSL.

The following listing shows how to modify a response body `GatewayFilter`:

```
@Bean
public RouteLocator routes(RouteLocatorBuilder builder) {
    return builder.routes()
        .route("rewrite_response_upper", r -> r.host("*.rewriteresponseupper.org")
            .filters(f -> f.prefixPath("/httpbin")
                .modifyResponseBody(String.class, String.class,
                    (exchange, s) -> Mono.just(s.toUpperCase()))).uri(uri))
        .build();
}
```

6.30. Default Filters

To add a filter and apply it to all routes, you can use `spring.cloud.gateway.default-filters`. This property takes a list of filters. The following listing defines a set of default filters:

Example 58. application.yml

```
spring:
  cloud:
    gateway:
      default-filters:
      - AddResponseHeader=X-Response-Default-Red, Default-Blue
      - PrefixPath=/httpbin
```

7. 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 its usage are subject to change in future milestone releases.

7.1. Combined Global Filter and `GatewayFilter` Ordering

When a request matches a route, the filtering web handler adds all instances of `GlobalFilter` and all route-specific instances of `GatewayFilter` to a filter chain. This combined filter chain is sorted by the `org.springframework.core.Ordered` interface, which you can set by implementing the `getOrder()` method.

As Spring Cloud Gateway distinguishes between “pre” and “post” phases for filter logic execution (see How it Works), the filter with the highest precedence is the first in the “pre”-phase and the last in the “post”-phase.

The following listing configures a filter chain:

Example 59. ExampleConfiguration.java

```
@Bean
public GlobalFilter customFilter() {
    return new CustomGlobalFilter();
}

public class CustomGlobalFilter implements GlobalFilter, Ordered {

    @Override
    public Mono<Void> filter(ServerWebExchange exchange, GatewayFilterChain chain)
{
        log.info("custom global filter");
        return chain.filter(exchange);
    }

    @Override
    public int getOrder() {
        return -1;
    }
}
```

7.2. 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 (such as `forward:///localendpoint`), it uses the Spring `DispatcherHandler` to handle the request. The path part of the request URL is overridden with the path in the forward URL. The unmodified original URL is appended to the list in the `ServerWebExchangeUtils.GATEWAY_ORIGINAL_REQUEST_URL_ATTR` attribute.

7.3. The `LoadBalancerClient` Filter

The `LoadBalancerClientFilter` looks for a URI in the exchange attribute named `ServerWebExchangeUtils.GATEWAY_REQUEST_URL_ATTR`. If the URL has a scheme of `lb` (such as `lb://myservice`), it uses the Spring Cloud `LoadBalancerClient` to resolve the name (`myservice` in this case) to an actual host and port and replaces 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 also looks in the `ServerWebExchangeUtils.GATEWAY_SCHEME_PREFIX_ATTR` attribute to see if it equals `lb`. If so, the same rules apply. The following listing configures a `LoadBalancerClientFilter`:

Example 60. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: myRoute
        uri: lb://service
        predicates:
        - Path=/service/**
```

By default, when a service instance cannot be found in the `LoadBalancer`, a `503` is returned. You can configure the Gateway to return a `404` by setting `spring.cloud.gateway.loadbalancer.use404=true`.

The `isSecure` value of the `ServiceInstance` returned from the `LoadBalancer` overrides the scheme specified in the request made to the Gateway. For example, if the request comes into the Gateway over `HTTPS` but the `ServiceInstance` indicates it is not secure, the downstream request is made over `HTTP`. The opposite situation can also apply. However, if `GATEWAY_SCHEME_PREFIX_ATTR` is specified for the route in the Gateway configuration, the prefix is stripped and the resulting scheme from the route URL overrides the `ServiceInstance` configuration.

`LoadBalancerClientFilter` uses a blocking ribbon `LoadBalancerClient` under the hood. We suggest you use `ReactiveLoadBalancerClientFilter` instead. You can switch to it by setting the value of the `spring.cloud.loadbalancer.ribbon.enabled` to `false`.

7.4. The `ReactiveLoadBalancerClientFilter`

The `ReactiveLoadBalancerClientFilter` looks for a URI in the exchange attribute named `ServerWebExchangeUtils.GATEWAY_REQUEST_URL_ATTR`. If the URL has a `lb` scheme (such as `lb://myservice`), it uses the Spring Cloud `ReactorLoadBalancer` to resolve the name (`myservice` in this example) to an actual host and port and replaces 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 also looks in the `ServerWebExchangeUtils.GATEWAY_SCHEME_PREFIX_ATTR` attribute to see if it equals `lb`. If so, the same rules apply. The following listing configures a `ReactiveLoadBalancerClientFilter`:

Example 61. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: myRoute
        uri: lb://service
        predicates:
        - Path=/service/**
```

By default, when a service instance cannot be found by the `ReactorLoadBalancer`, a `503` is returned. You can configure the gateway to return a `404` by setting `spring.cloud.gateway.loadbalancer.use404=true`.

The `isSecure` value of the `ServiceInstance` returned from the `ReactiveLoadBalancerClientFilter` overrides the scheme specified in the request made to the Gateway. For example, if the request comes into the Gateway over `HTTPS` but the `ServiceInstance` indicates it is not secure, the downstream request is made over `HTTP`. The opposite situation can also apply. However, if `GATEWAY_SCHEME_PREFIX_ATTR` is specified for the route in the Gateway configuration, the prefix is stripped and the resulting scheme from the route URL overrides the `ServiceInstance` configuration.

7.5. The 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 also an experimental `WebClientHttpRoutingFilter` that performs the same function but does not require Netty.)

7.6. The Netty Write Response Filter

The `NettyWriteResponseFilter` runs if there is a Netty `HttpClientResponse` in the `ServerWebExchangeUtils.CLIENT_RESPONSE_ATTR` exchange attribute. It runs after all other filters have completed and writes the proxy response back to the gateway client response. (There is also an experimental `WebClientWriteResponseFilter` that performs the same function but does not require Netty.)

7.7. The `RouteToRequestUrl` Filter

If there is a `Route` object in the `ServerWebExchangeUtils.GATEWAY_ROUTE_ATTR` exchange attribute, the `RouteToRequestUrlFilter` runs. 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.

7.8. The Websocket Routing Filter

If the URL located in the `ServerWebExchangeUtils.GATEWAY_REQUEST_URL_ATTR` exchange attribute has a `ws` or `wss` scheme, the websocket routing filter runs. It uses the Spring WebSocket infrastructure to forward the websocket request downstream.

You can load-balance websockets by prefixing the URI with `lb`, such as `lb:ws://serviceid`.

If you use SockJS as a fallback over normal HTTP, you should configure a normal HTTP route as well as the websocket Route.

The following listing configures a websocket routing filter:

Example 62. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      # SockJS route
      - id: websocket_sockjs_route
        uri: http://localhost:3001
        predicates:
        - Path=/websocket/info/**
      # Normal Websocket route
      - id: websocket_route
        uri: ws://localhost:3001
        predicates:
        - Path=/websocket/**
```

7.9. The Gateway Metrics Filter

To enable gateway metrics, add spring-boot-starter-actuator as a project dependency. Then, by default, the gateway metrics filter runs as long as the property `spring.cloud.gateway.metrics.enabled` is not set to `false`. This filter adds a timer metric named `gateway.requests` with the following tags:

- `routeId`: The route ID.
- `routeUri`: The URI to which the API is routed.

- `outcome`: The outcome, as classified by HttpStatus.Series.
- `status`: The HTTP status of the request returned to the client.
- `httpStatusCode`: The HTTP Status of the request returned to the client.
- `httpMethod`: The HTTP method used for the request.

These metrics are then available to be scraped from `/actuator/metrics/gateway.requests` and can be easily integrated with Prometheus to create a Grafana dashboard.

To enable the prometheus endpoint, add `micrometer-registry-prometheus` as a project dependency.

7.10. Marking An Exchange As Routed

After the gateway has routed a `ServerWebExchange`, it marks that exchange as "routed" by adding `gatewayAlreadyRouted` to the exchange attributes. Once a request has been marked as routed, other routing filters will not route the request again, essentially skipping the filter. There are convenience methods that you can use to mark an exchange as routed or check if an exchange has already been routed.

- `ServerWebExchangeUtils.isAlreadyRouted` takes a `ServerWebExchange` object and checks if it has been "routed".
- `ServerWebExchangeUtils.setAlreadyRouted` takes a `ServerWebExchange` object and marks it as "routed".

8. HttpHeadersFilters

HttpHeadersFilters are applied to requests before sending them downstream, such as in the `NettyRoutingFilter`.

8.1. Forwarded Headers Filter

The `Forwarded` Headers Filter creates a `Forwarded` header to send to the downstream service. It adds the `Host` header, scheme and port of the current request to any existing `Forwarded` header.

8.2. RemoveHopByHop Headers Filter

The `RemoveHopByHop` Headers Filter removes headers from forwarded requests. The default list of headers that is removed comes from the IETF.

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-hop-by-hop.headers` property to the list of header names to remove.

8.3. XForwarded Headers Filter

The `XForwarded` Headers Filter creates various a `X-Forwarded-*` headers to send to the downstream service. It users the `Host` header, scheme, port and path of the current request to create the various headers.

Creating of individual headers can be controlled by the following boolean properties (defaults to true):

- `spring.cloud.gateway.x-forwarded.for-enabled`
- `spring.cloud.gateway.x-forwarded.host-enabled`
- `spring.cloud.gateway.x-forwarded.port-enabled`
- `spring.cloud.gateway.x-forwarded.proto-enabled`
- `spring.cloud.gateway.x-forwarded.prefix-enabled`

Appending multiple headers can be controlled by the following boolean properties (defaults to true):

- `spring.cloud.gateway.x-forwarded.for-append`
- `spring.cloud.gateway.x-forwarded.host-append`
- `spring.cloud.gateway.x-forwarded.port-append`
- `spring.cloud.gateway.x-forwarded.proto-append`
- `spring.cloud.gateway.x-forwarded.prefix-append`

9. TLS and SSL

The gateway can listen for requests on HTTPS by following the usual Spring server configuration. The following example shows how to do so:

Example 63. application.yml

```
server:
  ssl:
    enabled: true
    key-alias: scg
    key-store-password: scg1234
    key-store: classpath:scg-keystore.p12
    key-store-type: PKCS12
```

You can route gateway routes to both HTTP and HTTPS backends. If you are routing to an HTTPS backend, you can configure the gateway to trust all downstream certificates with the following configuration:

Example 64. application.yml

```
spring:
  cloud:
    gateway:
      httpclient:
        ssl:
          useInsecureTrustManager: true
```

Using an insecure trust manager is not suitable for production. For a production deployment, you can configure the gateway with a set of known certificates that it can trust with the following configuration:

Example 65. application.yml

```
spring:
  cloud:
    gateway:
      httpclient:
        ssl:
          trustedX509Certificates:
          - cert1.pem
          - cert2.pem
```

If the Spring Cloud Gateway is not provisioned with trusted certificates, the default trust store is used (which you can override by setting the `javax.net.ssl.trustStore` system property).

9.1. TLS Handshake

The gateway maintains a client pool that it uses to route to backends. When communicating over HTTPS, the client initiates a TLS handshake. A number of timeouts are associated with this handshake. You can configure these timeouts can be configured (defaults shown) as follows:

Example 66. application.yml

```
spring:
  cloud:
    gateway:
      httpclient:
        ssl:
          handshake-timeout-millis: 10000
          close-notify-flush-timeout-millis: 3000
          close-notify-read-timeout-millis: 0
```

10. Configuration

Configuration for Spring Cloud Gateway is driven by a collection of `RouteDefinitionLocator` instances. The following listing shows the definition of the `RouteDefinitionLocator` interface:

Example 67. RouteDefinitionLocator.java

```
public interface RouteDefinitionLocator {
    Flux<RouteDefinition> getRouteDefinitions();
}
```

By default, a `PropertiesRouteDefinitionLocator` loads properties by using Spring Boot's `@ConfigurationProperties` mechanism.

The earlier configuration examples all use a shortcut notation that uses positional arguments rather than named ones. The following two examples are equivalent:

Example 68. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: setstatus_route
        uri: https://example.org
        filters:
        - name: SetStatus
          args:
            status: 401
      - id: setstatusshortcut_route
        uri: https://example.org
        filters:
        - SetStatus=401
```

For some usages of the gateway, properties are adequate, but some production use cases 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.

11. Route Metadata Configuration

You can configure additional parameters for each route by using metadata, as follows:

Example 69. application.yml

```
spring:
  cloud:
    gateway:
      routes:
      - id: route_with_metadata
        uri: https://example.org
        metadata:
          optionName: "OptionValue"
          compositeObject:
            name: "value"
          iAmNumber: 1
```

You could acquire all metadata properties from an exchange, as follows:

```
Route route = exchange.getAttribute(GATEWAY_ROUTE_ATTR);
// get all metadata properties
route.getMetadata();
// get a single metadata property
route.getMetadata(someKey);
```

12. Http timeouts configuration

Http timeouts (response and connect) can be configured for all routes and overridden for each specific route.

12.1. Global timeouts

To configure Global http timeouts:
`connect-timeout` must be specified in milliseconds.
`response-timeout` must be specified as a java.time.Duration

global http timeouts example

```
spring:
  cloud:
    gateway:
      httpclient:
        connect-timeout: 1000
        response-timeout: 5s
```

12.2. Per-route timeouts

To configure per-route timeouts:
`connect-timeout` must be specified in milliseconds.
`response-timeout` must be specified in milliseconds.

per-route http timeouts configuration via configuration

```
      - id: per_route_timeouts
        uri: https://example.org
        predicates:
          - name: Path
            args:
              pattern: /delay/{timeout}
        metadata:
          response-timeout: 200
          connect-timeout: 200
```

per-route timeouts configuration using Java DSL

```
import static
org.springframework.cloud.gateway.support.RouteMetadataUtils.CONNECT_TIMEOUT_ATTR;
import static
org.springframework.cloud.gateway.support.RouteMetadataUtils.RESPONSE_TIMEOUT_ATTR;

      @Bean
      public RouteLocator customRouteLocator(RouteLocatorBuilder routeBuilder){
         return routeBuilder.routes()
               .route("test1", r -> {
                  return r.host("*.somehost.org").and().path("/somepath")
                        .filters(f -> f.addRequestHeader("header1", "header-value-1"))
                        .uri("http://someuri")
                        .metadata(RESPONSE_TIMEOUT_ATTR, 200)
                        .metadata(CONNECT_TIMEOUT_ATTR, 200);
               })
               .build();
      }
```

12.3. Fluent Java Routes API

To allow for simple configuration in Java, the `RouteLocatorBuilder` bean includes a fluent API. The following listing shows how it works:

Example 70. 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")
                .metadata("key", "value")
            )
            .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")
                .metadata("key", "value")
            )
            .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.

12.4. The `DiscoveryClient` Route Definition Locator

You can configure the gateway 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 (such as Netflix Eureka, Consul, or Zookeeper) is on the classpath and enabled.

12.4.1. Configuring Predicates and Filters For `DiscoveryClient` Routes

By default, the gateway defines a single predicate and filter for routes created with a `DiscoveryClient`.

The default predicate is a path predicate defined with the pattern `/serviceId/**`, where `serviceId` is the ID of the service from the `DiscoveryClient`.

The default filter is a rewrite path filter with the regex `/serviceId/(?<remaining>.*)` and the replacement `/${remaining}`. This strips the service ID from the path before the request is sent downstream.

If you want to customize the predicates or filters used by the `DiscoveryClient` routes, set `spring.cloud.gateway.discovery.locator.predicates[x]` and `spring.cloud.gateway.discovery.locator.filters[y]`. When doing so, you need to make sure to include the default predicate and filter shown earlier, if you want to retain that functionality. The following example shows what this looks like:

Example 71. application.properties

```
spring.cloud.gateway.discovery.locator.predicates[0].name: Path
spring.cloud.gateway.discovery.locator.predicates[0].args[pattern]:
"'/'+serviceId+'/**'"
spring.cloud.gateway.discovery.locator.predicates[1].name: Host
spring.cloud.gateway.discovery.locator.predicates[1].args[pattern]: "'**.foo.com'"
spring.cloud.gateway.discovery.locator.filters[0].name: CircuitBreaker
spring.cloud.gateway.discovery.locator.filters[0].args[name]: serviceId
spring.cloud.gateway.discovery.locator.filters[1].name: RewritePath
spring.cloud.gateway.discovery.locator.filters[1].args[regexp]: "'/' + serviceId +
'/(?<remaining>.*)'"
spring.cloud.gateway.discovery.locator.filters[1].args[replacement]:
"'/${remaining}'"
```

13. Reactor Netty Access Logs

To enable Reactor Netty access logs, set `-Dreactor.netty.http.server.accessLogEnabled=true`.

It must be a Java System Property, not a Spring Boot property.

You can configure the logging system to have a separate access log file. The following example creates a Logback configuration:

Example 72. logback.xml

```
    <appender name="accessLog" class="ch.qos.logback.core.FileAppender">
        <file>access_log.log</file>
        <encoder>
            <pattern>%msg%n</pattern>
        </encoder>
    </appender>
    <appender name="async" class="ch.qos.logback.classic.AsyncAppender">
        <appender-ref ref="accessLog" />
    </appender>

    <logger name="reactor.netty.http.server.AccessLog" level="INFO"
additivity="false">
        <appender-ref ref="async"/>
    </logger>
```

14. CORS Configuration

You can configure the gateway to control CORS behavior. The "global" CORS configuration is a map of URL patterns to Spring Framework `CorsConfiguration`. The following example configures CORS:

Example 73. application.yml

```
spring:
  cloud:
    gateway:
      globalcors:
        cors-configurations:
          '[/**]':
            allowedOrigins: "https://docs.spring.io"
            allowedMethods:
            - GET
```

In the preceding example, CORS requests are allowed from requests that originate from `docs.spring.io` for all GET requested paths.

To provide the same CORS configuration to requests that are not handled by some gateway route predicate, set the `spring.cloud.gateway.globalcors.add-to-simple-url-handler-mapping` property to `true`. This is useful when you try to support CORS preflight requests and your route predicate does not evalute to `true` because the HTTP method is `options`.

15. Actuator API

The `/gateway` actuator endpoint lets you monitor and interact with a Spring Cloud Gateway application. To be remotely accessible, the endpoint has to be enabled and exposed over HTTP or JMX in the application properties. The following listing shows how to do so:

Example 74. application.properties

```
management.endpoint.gateway.enabled=true # default value
management.endpoints.web.exposure.include=gateway
```

15.1. Verbose Actuator Format

A new, more verbose format has been added to Spring Cloud Gateway. It adds more detail to each route, letting you view the predicates and filters associated with each route along with any configuration that is available. The following example configures `/actuator/gateway/routes`:

```
[
  {
    "predicate": "(Hosts: [**.addrequestheader.org] && Paths: [/headers], match
trailing slash: true)",
    "route_id": "add_request_header_test",
    "filters": [
      "[[AddResponseHeader X-Response-Default-Foo = 'Default-Bar'], order = 1]",
      "[[AddRequestHeader X-Request-Foo = 'Bar'], order = 1]",
      "[[PrefixPath prefix = '/httpbin'], order = 2]"
    ],
    "uri": "lb://testservice",
    "order": 0
  }
]
```

This feature is enabled by default. To disable it, set the following property:

Example 75. application.properties

```
spring.cloud.gateway.actuator.verbose.enabled=false
```

This will default to `true` in a future release.

15.2. Retrieving Route Filters

This section details how to retrieve route filters, including:

- Global Filters
- [gateway-route-filters]

15.2.1. Global Filters

To retrieve the global filters applied to all routes, make a `GET` request to `/actuator/gateway/globalfilters`. The resulting response is similar to the following:

```
{
  "org.springframework.cloud.gateway.filter.LoadBalancerClientFilter@77856cc5":
10100,
  "org.springframework.cloud.gateway.filter.RouteToRequestUrlFilter@4f6fd101":
10000,
  "org.springframework.cloud.gateway.filter.NettyWriteResponseFilter@32d22650":
-1,
  "org.springframework.cloud.gateway.filter.ForwardRoutingFilter@106459d9":
2147483647,
  "org.springframework.cloud.gateway.filter.NettyRoutingFilter@1fbd5e0":
2147483647,
  "org.springframework.cloud.gateway.filter.ForwardPathFilter@33a71d23": 0,
  "org.springframework.cloud.gateway.filter.AdaptCachedBodyGlobalFilter@135064ea":
2147483637,
  "org.springframework.cloud.gateway.filter.WebsocketRoutingFilter@23c05889":
2147483646
}
```

The response contains the details of the global filters that are in place. For each global filter, there is a string representation of the filter object (for example, `org.springframework.cloud.gateway.filter.LoadBalancerClientFilter@77856cc5`) and the corresponding order in the filter chain.}

15.2.2. Route Filters

To retrieve the `GatewayFilter` factories applied to routes, make a `GET` request to `/actuator/gateway/routefilters`. The resulting response is similar to the following:

```
{
  "[AddRequestHeaderGatewayFilterFactory@570ed9c configClass =
AbstractNameValueGatewayFilterFactory.NameValueConfig]": null,
  "[SecureHeadersGatewayFilterFactory@fceab5d configClass = Object]": null,
  "[SaveSessionGatewayFilterFactory@4449b273 configClass = Object]": null
}
```

The response contains the details of the `GatewayFilter` factories applied to any particular route. For each factory there is a string representation of the corresponding object (for example, `[SecureHeadersGatewayFilterFactory@fceab5d configClass = Object]`). Note that the `null` value is due to an incomplete implementation of the endpoint controller, because it tries to set the order of the object in the filter chain, which does not apply to a `GatewayFilter` factory object.

15.3. Refreshing the Route Cache

To clear the routes cache, make a `POST` request to `/actuator/gateway/refresh`. The request returns a 200 without a response body.

15.4. Retrieving the Routes Defined in the Gateway

To retrieve the routes defined in the gateway, make a `GET` request to `/actuator/gateway/routes`. The resulting response is similar to the following:

```
[{
  "route_id": "first_route",
  "route_object": {
    "predicate":
"org.springframework.cloud.gateway.handler.predicate.PathRoutePredicateFactory$$La
mbda$432/1736826640@1e9d7e7d",
    "filters": [

"OrderedGatewayFilter{delegate=org.springframework.cloud.gateway.filter.factory.Pr
eserveHostHeaderGatewayFilterFactory$$Lambda$436/674480275@6631ef72, order=0}"
    ]
  },
  "order": 0
},
{
  "route_id": "second_route",
  "route_object": {
    "predicate":
"org.springframework.cloud.gateway.handler.predicate.PathRoutePredicateFactory$$La
mbda$432/1736826640@cd8d298",
    "filters": []
  },
  "order": 0
}]
```

The response contains the details of all the routes defined in the gateway. The following table describes the structure of each element (each is a route) of the response:

Path	Type	Description
`route_id`	String	The route ID.
`route_object.predicate`	Object	The route predicate.
`route_object.filters`	Array	The `GatewayFilter` factories applied to the route.
`order`	Number	The route order.

15.5. Retrieving Information about a Particular Route

To retrieve information about a single route, make a `GET` request to `/actuator/gateway/routes/{id}` (for example, `/actuator/gateway/routes/first_route`). The resulting response is similar to the following:

```
{
  "id": "first_route",
  "predicates": [{
    "name": "Path",
    "args": {"_genkey_0":"/first"}
  }],
  "filters": [],
  "uri": "https://www.uri-destination.org",
  "order": 0
}]
```

The following table describes the structure of the response:

Path	Type	Description
`id`	String	The route ID.
`predicates`	Array	The collection of route predicates. Each item defines the name and the arguments of a given predicate.
`filters`	Array	The collection of filters applied to the route.
`uri`	String	The destination URI of the route.
`order`	Number	The route order.

15.6. Creating and Deleting a Particular Route

To create a route, make a `POST` request to `/gateway/routes/{id_route_to_create}` with a JSON body that specifies the fields of the route (see Retrieving Information about a Particular Route).

To delete a route, make a `DELETE` request to `/gateway/routes/{id_route_to_delete}`.

15.7. Recap: The List of All endpoints

The folloiwng table below summarizes the Spring Cloud Gateway actuator endpoints (note that each endpoint has `/actuator/gateway` as the base-path):

ID	HTTP Method	Description
`globalfilters`	GET	Displays the list of global filters applied to the routes.
`routefilters`	GET	Displays the list of `GatewayFilter` factories applied to a particular route.
`refresh`	POST	Clears the routes cache.
`routes`	GET	Displays the list of routes defined in the gateway.

ID	HTTP Method	Description
routes/{id}	GET	Displays information about a particular route.
routes/{id}	POST	Adds a new route to the gateway.
routes/{id}	DELETE	Removes an existing route from the gateway.

16. Troubleshooting

This section covers common problems that may arise when you use Spring Cloud Gateway.

16.1. Log Levels

The following loggers may contain valuable troubleshooting information at the DEBUG and TRACE levels:

- org.springframework.cloud.gateway
- org.springframework.http.server.reactive
- org.springframework.web.reactive
- org.springframework.boot.autoconfigure.web
- reactor.netty
- redisratelimiter

16.2. Wiretap

The Reactor Netty HttpClient and HttpServer can have wiretap enabled. When combined with setting the reactor.netty log level to DEBUG or TRACE, it enables the logging of information, such as headers and bodies sent and received across the wire. To enable wiretap, set spring.cloud.gateway.httpserver.wiretap=true or spring.cloud.gateway.httpclient.wiretap=true for the HttpServer and HttpClient, respectively.

17. Developer Guide

These are basic guides to writing some custom components of the gateway.

17.1. Writing Custom Route Predicate Factories

In order to write a Route Predicate you will need to implement RoutePredicateFactory. There is an abstract class called AbstractRoutePredicateFactory which you can extend.

MyRoutePredicateFactory.java

```
public class MyRoutePredicateFactory extends
AbstractRoutePredicateFactory<HeaderRoutePredicateFactory.Config> {

    public MyRoutePredicateFactory() {
        super(Config.class);
    }

    @Override
    public Predicate<ServerWebExchange> apply(Config config) {
        // grab configuration from Config object
        return exchange -> {
            //grab the request
            ServerHttpRequest request = exchange.getRequest();
            //take information from the request to see if it
            //matches configuration.
            return matches(config, request);
        };
    }

    public static class Config {
        //Put the configuration properties for your filter here
    }

}
```

17.2. Writing Custom GatewayFilter Factories

To write a `GatewayFilter`, you must implement `GatewayFilterFactory`. You can extend an abstract class called `AbstractGatewayFilterFactory`. The following examples show how to do so:

Example 76. PreGatewayFilterFactory.java

```
public class PreGatewayFilterFactory extends
AbstractGatewayFilterFactory<PreGatewayFilterFactory.Config> {

    public PreGatewayFilterFactory() {
        super(Config.class);
    }

    @Override
    public GatewayFilter apply(Config config) {
        // grab configuration from Config object
        return (exchange, chain) -> {
            //If you want to build a "pre" filter you need to manipulate the
            //request before calling chain.filter
            ServerHttpRequest.Builder builder = exchange.getRequest().mutate();
            //use builder to manipulate the request
            return
chain.filter(exchange.mutate().request(builder.build()).build());
        };
    }

    public static class Config {
        //Put the configuration properties for your filter here
    }

}
```

PostGatewayFilterFactory.java

```
public class PostGatewayFilterFactory extends
AbstractGatewayFilterFactory<PostGatewayFilterFactory.Config> {

    public PostGatewayFilterFactory() {
        super(Config.class);
    }

    @Override
    public GatewayFilter apply(Config config) {
        // grab configuration from Config object
        return (exchange, chain) -> {
            return chain.filter(exchange).then(Mono.fromRunnable(() -> {
                ServerHttpResponse response = exchange.getResponse();
                //Manipulate the response in some way
            }));
        };
    }

    public static class Config {
        //Put the configuration properties for your filter here
    }

}
```

17.2.1. Naming Custom Filters And References In Configuration

Custom filters class names should end in `GatewayFilterFactory`.

For example, to reference a filter named `Something` in configuration files, the filter must be in a class named `SomethingGatewayFilterFactory`.

It is possible to create a gateway filter named without the `GatewayFilterFactory` suffix, such as `class AnotherThing`. This filter could be referenced as `AnotherThing` in configuration files. This is **not** a supported naming convention and this syntax may be removed in future releases. Please update the filter name to be compliant.

17.3. Writing Custom Global Filters

To write a custom global filter, you must implement `GlobalFilter` interface. This applies the filter to all requests.

The following examples show how to set up global pre and post filters, respectively:

```
@Bean
public GlobalFilter customGlobalFilter() {
    return (exchange, chain) -> exchange.getPrincipal()
        .map(Principal::getName)
        .defaultIfEmpty("Default User")
        .map(userName -> {
          //adds header to proxied request
          exchange.getRequest().mutate().header("CUSTOM-REQUEST-HEADER",
userName).build();
          return exchange;
        })
        .flatMap(chain::filter);
}

@Bean
public GlobalFilter customGlobalPostFilter() {
    return (exchange, chain) -> chain.filter(exchange)
        .then(Mono.just(exchange))
        .map(serverWebExchange -> {
          //adds header to response
          serverWebExchange.getResponse().getHeaders().set("CUSTOM-RESPONSE-
HEADER",

HttpStatus.OK.equals(serverWebExchange.getResponse().getStatusCode()) ? "It
worked": "It did not work");
          return serverWebExchange;
        })
        .then();
}
```

18. Building a Simple Gateway by Using Spring MVC or Webflux

The following describes an alternative style gateway. None of the prior documentation applies to what follows.

Spring Cloud Gateway provides a utility object called `ProxyExchange`. You can use it inside a regular Spring web handler as a method parameter. It supports basic downstream HTTP exchanges through methods that mirror the HTTP verbs. With MVC, it also supports forwarding to a local handler through the `forward()` method. To use the `ProxyExchange`, include the right module in your classpath (either `spring-cloud-gateway-mvc` or `spring-cloud-gateway-webflux`).

The following MVC example proxies 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<byte[]> proxy) throws Exception {
        return proxy.uri(home.toString() + "/image/png").get();
    }

}
```

The following example does the same thing with Webflux:

```
@RestController
@SpringBootApplication
public class GatewaySampleApplication {

    @Value("${remote.home}")
    private URI home;

    @GetMapping("/test")
    public Mono<ResponseEntity<?>> proxy(ProxyExchange<byte[]> proxy) throws
Exception {
        return proxy.uri(home.toString() + "/image/png").get();
    }

}
```

Convenience methods on the `ProxyExchange` 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<byte[]> proxy) throws Exception {
  String path = proxy.path("/proxy/path/");
  return proxy.uri(home.toString() + "/foos/" + path).get();
}
```

All the features of Spring MVC and Webflux are available to gateway handler methods. As a result,

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.

You can add headers to the downstream response by 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()` method (and other methods). 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 (by default, `cookie` and `authorization`), which are not passed downstream, and for "proxy" (`x-forwarded-*`) headers.

19. Configuration properties

To see the list of all Spring Cloud Gateway related configuration properties, see the appendix.

Spring Cloud Kubernetes

This reference guide covers how to use Spring Cloud Kubernetes.

1. Why do you need Spring Cloud Kubernetes?

Spring Cloud Kubernetes provides implementations of well known Spring Cloud interfaces allowing developers to build and run Spring Cloud applications on Kubernetes. While this project may be useful to you when building a cloud native application, it is also not a requirement in order to deploy a Spring Boot app on Kubernetes. If you are just getting started in your journey to running your Spring Boot app on Kubernetes you can accomplish a lot with nothing more than a basic Spring Boot app and Kubernetes itself. To learn more, you can get started by reading the Spring Boot reference documentation for deploying to Kubernetes and also working through the workshop material Spring and Kubernetes.

2. Starters

Starters are convenient dependency descriptors you can include in your application. Include a starter to get the dependencies and Spring Boot auto-configuration for a feature set.

Starter	Features
<dependency> <groupId>org.springframework.cloud</groupId> <artifactId>spring-cloud-starter-kubernetes</artifactId> </dependency>	Discovery Client implementation that resolves service names to Kubernetes Services.
<dependency> <groupId>org.springframework.cloud</groupId> <artifactId>spring-cloud-starter-kubernetes-config</artifactId> </dependency>	Load application properties from Kubernetes ConfigMaps and Secrets. Reload application properties when a ConfigMap or Secret changes.
<dependency> <groupId>org.springframework.cloud</groupId> <artifactId>spring-cloud-starter-kubernetes-all</artifactId> </dependency>	All Spring Cloud Kubernetes features.

3. DiscoveryClient for Kubernetes

This project provides an implementation of Discovery Client for Kubernetes. This client lets you query Kubernetes endpoints (see services) by name. A service is typically exposed by the Kubernetes API server as a collection of endpoints that represent `http` and `https` addresses and that a client can access from a Spring Boot application running as a pod.

This is something that you get for free by adding the following dependency inside your project:

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-kubernetes</artifactId>
</dependency>
```

To enable loading of the `DiscoveryClient`, add `@EnableDiscoveryClient` to the according configuration

or application class, as the following example shows:

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

Then you can inject the client in your code simply by autowiring it, as the following example shows:

```
@Autowired
private DiscoveryClient discoveryClient;
```

You can choose to enable `DiscoveryClient` from all namespaces by setting the following property in `application.properties`:

```
spring.cloud.kubernetes.discovery.all-namespaces=true
```

If, for any reason, you need to disable the `DiscoveryClient`, you can set the following property in `application.properties`:

```
spring.cloud.kubernetes.discovery.enabled=false
```

Some Spring Cloud components use the `DiscoveryClient` in order to obtain information about the local service instance. For this to work, you need to align the Kubernetes service name with the `spring.application.name` property.

`spring.application.name` has no effect as far as the name registered for the application within Kubernetes

Spring Cloud Kubernetes can also watch the Kubernetes service catalog for changes and update the `DiscoveryClient` implementation accordingly. In order to enable this functionality you need to add `@EnableScheduling` on a configuration class in your application.

4. Kubernetes native service discovery

Kubernetes itself is capable of (server side) service discovery (see: kubernetes.io/docs/concepts/services-networking/service/#discovering-services). Using native kubernetes service discovery ensures compatibility with additional tooling, such as Istio (istio.io), a service mesh that is capable of load balancing, circuit breaker, failover, and much more.

The caller service then need only refer to names resolvable in a particular Kubernetes cluster. A simple implementation might use a spring `RestTemplate` that refers to a fully qualified domain name (FQDN), such as `{service-name}.{namespace}.svc.{cluster}.local:{service-port}`.

Additionally, you can use Hystrix for:

- Circuit breaker implementation on the caller side, by annotating the spring boot application class with `@EnableCircuitBreaker`
- Fallback functionality, by annotating the respective method with `@HystrixCommand(fallbackMethod=`

5. Kubernetes PropertySource implementations

The most common approach to configuring your Spring Boot application is to create an `application.properties` or `application.yaml` or an `application-profile.properties` or `application-profile.yaml` file that contains key-value pairs that provide customization values to your application or Spring Boot starters. You can override these properties by specifying system properties or environment variables.

5.1. Using a `ConfigMap PropertySource`

Kubernetes provides a resource named `ConfigMap` to externalize the parameters to pass to your application in the form of key-value pairs or embedded `application.properties` or `application.yaml` files. The Spring Cloud Kubernetes Config project makes Kubernetes `ConfigMap` instances available during application bootstrapping and triggers hot reloading of beans or Spring context when changes are detected on observed `ConfigMap` instances.

The default behavior is to create a `ConfigMapPropertySource` based on a Kubernetes `ConfigMap` that has a `metadata.name` value of either the name of your Spring application (as defined by its `spring.application.name` property) or a custom name defined within the `bootstrap.properties` file under the following key: `spring.cloud.kubernetes.config.name`.

However, more advanced configuration is possible where you can use multiple `ConfigMap` instances. The `spring.cloud.kubernetes.config.sources` list makes this possible. For example, you could define the following `ConfigMap` instances:

```
spring:
  application:
    name: cloud-k8s-app
  cloud:
    kubernetes:
      config:
        name: default-name
        namespace: default-namespace
        sources:
         # Spring Cloud Kubernetes looks up a ConfigMap named c1 in namespace
default-namespace
         - name: c1
         # Spring Cloud Kubernetes looks up a ConfigMap named default-name in
whatever namespace n2
         - namespace: n2
         # Spring Cloud Kubernetes looks up a ConfigMap named c3 in namespace n3
         - namespace: n3
           name: c3
```

In the preceding example, if `spring.cloud.kubernetes.config.namespace` had not been set, the `ConfigMap` named `c1` would be looked up in the namespace that the application runs.

Any matching `ConfigMap` that is found is processed as follows:

- Apply individual configuration properties.
- Apply as `yaml` the content of any property named `application.yaml`.
- Apply as a properties file the content of any property named `application.properties`.

The single exception to the aforementioned flow is when the `ConfigMap` contains a **single** key that indicates the file is a YAML or properties file. In that case, the name of the key does NOT have to be `application.yaml` or `application.properties` (it can be anything) and the value of the property is treated correctly. This features facilitates the use case where the `ConfigMap` was created by using something like the following:

```
kubectl create configmap game-config --from-file=/path/to/app-config.yaml
```

Assume that we have a Spring Boot application named `demo` that uses the following properties to read its thread pool configuration.

- `pool.size.core`
- `pool.size.maximum`

This can be externalized to config map in `yaml` format as follows:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo
data:
  pool.size.core: 1
  pool.size.max: 16
```

Individual properties work fine for most cases. However, sometimes, embedded `yaml` is more convenient. In this case, we use a single property named `application.yaml` to embed our `yaml`, as follows:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo
data:
  application.yaml: |-
    pool:
      size:
        core: 1
        max:16
```

The following example also works:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo
data:
  custom-name.yaml: |-
    pool:
      size:
        core: 1
        max:16
```

You can also configure Spring Boot applications differently depending on active profiles that are merged together when the `ConfigMap` is read. You can provide different property values for different profiles by using an `application.properties` or `application.yaml` property, specifying profile-specific values, each in their own document (indicated by the `---` sequence), as follows:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo
data:
  application.yml: |-
    greeting:
      message: Say Hello to the World
    farewell:
      message: Say Goodbye
    ---
    spring:
      profiles: development
    greeting:
      message: Say Hello to the Developers
    farewell:
      message: Say Goodbye to the Developers
    ---
    spring:
      profiles: production
    greeting:
      message: Say Hello to the Ops
```

In the preceding case, the configuration loaded into your Spring Application with the `development` profile is as follows:

```
  greeting:
    message: Say Hello to the Developers
  farewell:
    message: Say Goodbye to the Developers
```

However, if the `production` profile is active, the configuration becomes:

```
  greeting:
    message: Say Hello to the Ops
  farewell:
    message: Say Goodbye
```

If both profiles are active, the property that appears last within the `ConfigMap` overwrites any preceding values.

Another option is to create a different config map per profile and spring boot will automatically

fetch it based on active profiles

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo
data:
  application.yml: |-
    greeting:
      message: Say Hello to the World
    farewell:
      message: Say Goodbye
```

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo-development
data:
  application.yml: |-
    spring:
      profiles: development
    greeting:
      message: Say Hello to the Developers
    farewell:
      message: Say Goodbye to the Developers
```

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: demo-production
data:
  application.yml: |-
    spring:
      profiles: production
    greeting:
      message: Say Hello to the Ops
    farewell:
      message: Say Goodbye
```

To tell Spring Boot which `profile` should be enabled at bootstrap, you can pass `SPRING_PROFILES_ACTIVE` environment variable. To do so, you can launch your Spring Boot application with an environment variable that you can define it in the PodSpec at the container

specification. Deployment resource file, as follows:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: deployment-name
  labels:
    app: deployment-name
spec:
  replicas: 1
  selector:
    matchLabels:
      app: deployment-name
  template:
    metadata:
      labels:
        app: deployment-name
    spec:
        containers:
        - name: container-name
          image: your-image
          env:
          - name: SPRING_PROFILES_ACTIVE
            value: "development"
```

You should check the security configuration section. To access config maps from inside a pod you need to have the correct Kubernetes service accounts, roles and role bindings.

Another option for using `ConfigMap` instances is to mount them into the Pod by running the Spring Cloud Kubernetes application and having Spring Cloud Kubernetes read them from the file system. This behavior is controlled by the `spring.cloud.kubernetes.config.paths` property. You can use it in addition to or instead of the mechanism described earlier. You can specify multiple (exact) file paths in `spring.cloud.kubernetes.config.paths` by using the `,` delimiter.

You have to provide the full exact path to each property file, because directories are not being recursively parsed.

If you use `spring.cloud.kubernetes.config.paths` or `spring.cloud.kubernetes.secrets.path` the automatic reload functionality will not work. You will need to make a `POST` request to the `/actuator/refresh` endpoint or restart/redeploy the application.

Table 5. Properties:

Name	Type	Default	Description
spring.cloud.kubernetes.config.enabled	Boolean	true	Enable ConfigMaps PropertySource
spring.cloud.kubernetes.config.name	String	${spring.application.name}	Sets the name of ConfigMap to look up
spring.cloud.kubernetes.config.namespace	String	Client namespace	Sets the Kubernetes namespace where to lookup
spring.cloud.kubernetes.config.paths	List	null	Sets the paths where ConfigMap instances are mounted
spring.cloud.kubernetes.config.enableApi	Boolean	true	Enable or disable consuming ConfigMap instances through APIs

5.2. Secrets PropertySource

Kubernetes has the notion of Secrets for storing sensitive data such as passwords, OAuth tokens, and so on. This project provides integration with Secrets to make secrets accessible by Spring Boot applications. You can explicitly enable or disable This feature by setting the spring.cloud.kubernetes.secrets.enabled property.

When enabled, the SecretsPropertySource looks up Kubernetes for Secrets from the following sources:

1. Reading recursively from secrets mounts
2. Named after the application (as defined by spring.application.name)
3. Matching some labels

Note:

By default, consuming Secrets through the API (points 2 and 3 above) **is not enabled** for security reasons. The permission 'list' on secrets allows clients to inspect secrets values in the specified namespace. Further, we recommend that containers share secrets through mounted volumes.

If you enable consuming Secrets through the API, we recommend that you limit access to Secrets by using an authorization policy, such as RBAC. For more information about risks and best practices when consuming Secrets through the API refer to this doc.

If the secrets are found, their data is made available to the application.

Assume that we have a spring boot application named demo that uses properties to read its database configuration. We can create a Kubernetes secret by using the following command:

```
kubectl create secret generic db-secret --from-literal=username=user --from
-literal=password=p455w0rd
```

The preceding command would create the following secret (which you can see by using `kubectl get secrets db-secret -o yaml`):

```
apiVersion: v1
data:
  password: cDQ1NXcwcmQ=
  username: dXNlcg==
kind: Secret
metadata:
  creationTimestamp: 2017-07-04T09:15:57Z
  name: db-secret
  namespace: default
  resourceVersion: "357496"
  selfLink: /api/v1/namespaces/default/secrets/db-secret
  uid: 63c89263-6099-11e7-b3da-76d6186905a8
type: Opaque
```

Note that the data contains Base64-encoded versions of the literal provided by the `create` command.

Your application can then use this secret — for example, by exporting the secret's value as environment variables:

```
apiVersion: v1
kind: Deployment
metadata:
  name: ${project.artifactId}
spec:
   template:
     spec:
       containers:
         - env:
            - name: DB_USERNAME
              valueFrom:
                 secretKeyRef:
                   name: db-secret
                   key: username
            - name: DB_PASSWORD
              valueFrom:
                 secretKeyRef:
                   name: db-secret
                   key: password
```

You can select the Secrets to consume in a number of ways:

1. By listing the directories where secrets are mapped:

   ```
   -Dspring.cloud.kubernetes.secrets.paths=/etc/secrets/db
   -secret,etc/secrets/postgresql
   ```

   If you have all the secrets mapped to a common root, you can set them like:

   ```
   -Dspring.cloud.kubernetes.secrets.paths=/etc/secrets
   ```

2. By setting a named secret:

   ```
   -Dspring.cloud.kubernetes.secrets.name=db-secret
   ```

3. By defining a list of labels:

```
-Dspring.cloud.kubernetes.secrets.labels.broker=activemq
-Dspring.cloud.kubernetes.secrets.labels.db=postgresql
```

As the case with `ConfigMap`, more advanced configuration is also possible where you can use multiple `Secret` instances. The `spring.cloud.kubernetes.secrets.sources` list makes this possible. For example, you could define the following `Secret` instances:

```
spring:
  application:
    name: cloud-k8s-app
  cloud:
    kubernetes:
      secrets:
        name: default-name
        namespace: default-namespace
        sources:
         # Spring Cloud Kubernetes looks up a Secret named s1 in namespace
default-namespace
         - name: s1
         # Spring Cloud Kubernetes looks up a Secret named default-name in
whatever namespace n2
         - namespace: n2
         # Spring Cloud Kubernetes looks up a Secret named s3 in namespace n3
         - namespace: n3
           name: s3
```

In the preceding example, if `spring.cloud.kubernetes.secrets.namespace` had not been set, the `Secret` named `s1` would be looked up in the namespace that the application runs.

Table 6. Properties:

Name	Type	Default	Description
`spring.cloud.kubernetes.secrets.enabled`	`Boolean`	`true`	Enable Secrets `PropertySource`
`spring.cloud.kubernetes.secrets.name`	`String`	`${spring.application.name}`	Sets the name of the secret to look up
`spring.cloud.kubernetes.secrets.namespace`	`String`	Client namespace	Sets the Kubernetes namespace where to look up
`spring.cloud.kubernetes.secrets.labels`	`Map`	`null`	Sets the labels used to lookup secrets

Name	Type	Default	Description
spring.cloud.kubernetes.secrets.paths	List	null	Sets the paths where secrets are mounted (example 1)
spring.cloud.kubernetes.secrets.enableApi	Boolean	false	Enables or disables consuming secrets through APIs (examples 2 and 3)

Notes:

- The `spring.cloud.kubernetes.secrets.labels` property behaves as defined by Map-based binding.
- The `spring.cloud.kubernetes.secrets.paths` property behaves as defined by Collection-based binding.
- Access to secrets through the API may be restricted for security reasons. The preferred way is to mount secrets to the Pod.

You can find an example of an application that uses secrets (though it has not been updated to use the new `spring-cloud-kubernetes` project) at spring-boot-camel-config

5.3. `PropertySource` Reload

This functionality has been deprecated in the 2020.0 release. Please see the Spring Cloud Kubernetes Configuration Watcher controller for an alternative way to achieve the same functionality.

Some applications may need to detect changes on external property sources and update their internal status to reflect the new configuration. The reload feature of Spring Cloud Kubernetes is able to trigger an application reload when a related `ConfigMap` or `Secret` changes.

By default, this feature is disabled. You can enable it by using the `spring.cloud.kubernetes.reload.enabled=true` configuration property (for example, in the `application.properties` file).

The following levels of reload are supported (by setting the `spring.cloud.kubernetes.reload.strategy` property):

- `refresh` (default): Only configuration beans annotated with `@ConfigurationProperties` or `@RefreshScope` are reloaded. This reload level leverages the refresh feature of Spring Cloud Context.
- `restart_context`: the whole Spring `ApplicationContext` is gracefully restarted. Beans are recreated with the new configuration. In order for the restart context functionality to work properly you must enable and expose the restart actuator endpoint

```
management:
  endpoint:
    restart:
      enabled: true
  endpoints:
    web:
      exposure:
        include: restart
```

- `shutdown`: the Spring `ApplicationContext` is shut down to activate a restart of the container. When you use this level, make sure that the lifecycle of all non-daemon threads is bound to the `ApplicationContext` and that a replication controller or replica set is configured to restart the pod.

Assuming that the reload feature is enabled with default settings (`refresh` mode), the following bean is refreshed when the config map changes:

```
@Configuration
@ConfigurationProperties(prefix = "bean")
public class MyConfig {

    private String message = "a message that can be changed live";

    // getter and setters

}
```

To see that changes effectively happen, you can create another bean that prints the message periodically, as follows

```
@Component
public class MyBean {

    @Autowired
    private MyConfig config;

    @Scheduled(fixedDelay = 5000)
    public void hello() {
        System.out.println("The message is: " + config.getMessage());
    }
}
```

You can change the message printed by the application by using a `ConfigMap`, as follows:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: reload-example
data:
  application.properties: |-
    bean.message=Hello World!
```

Any change to the property named `bean.message` in the `ConfigMap` associated with the pod is reflected in the output. More generally speaking, changes associated to properties prefixed with the value defined by the `prefix` field of the `@ConfigurationProperties` annotation are detected and reflected in the application. Associating a `ConfigMap` with a pod is explained earlier in this chapter.

The full example is available in `spring-cloud-kubernetes-reload-example`.

The reload feature supports two operating modes: * Event (default): Watches for changes in config maps or secrets by using the Kubernetes API (web socket). Any event produces a re-check on the configuration and, in case of changes, a reload. The `view` role on the service account is required in order to listen for config map changes. A higher level role (such as `edit`) is required for secrets (by default, secrets are not monitored). * Polling: Periodically re-creates the configuration from config maps and secrets to see if it has changed. You can configure the polling period by using the `spring.cloud.kubernetes.reload.period` property and defaults to 15 seconds. It requires the same role as the monitored property source. This means, for example, that using polling on file-mounted secret sources does not require particular privileges.

Table 7. Properties:

Name	Type	Default	Description
`spring.cloud.kubernetes.reload.enabled`	`Boolean`	`false`	Enables monitoring of property sources and configuration reload
`spring.cloud.kubernetes.reload.monitoring-config-maps`	`Boolean`	`true`	Allow monitoring changes in config maps
`spring.cloud.kubernetes.reload.monitoring-secrets`	`Boolean`	`false`	Allow monitoring changes in secrets
`spring.cloud.kubernetes.reload.strategy`	`Enum`	`refresh`	The strategy to use when firing a reload (`refresh`, `restart_context`, or `shutdown`)

Name	Type	Default	Description
spring.cloud.kubernetes.reload.mode	Enum	event	Specifies how to listen for changes in property sources (event or polling)
spring.cloud.kubernetes.reload.period	Duration	15s	The period for verifying changes when using the polling strategy

Notes: * You should not use properties under spring.cloud.kubernetes.reload in config maps or secrets. Changing such properties at runtime may lead to unexpected results. * Deleting a property or the whole config map does not restore the original state of the beans when you use the refresh level.

6. Kubernetes Ecosystem Awareness

All of the features described earlier in this guide work equally well, regardless of whether your application is running inside Kubernetes. This is really helpful for development and troubleshooting. From a development point of view, this lets you start your Spring Boot application and debug one of the modules that is part of this project. You need not deploy it in Kubernetes, as the code of the project relies on the Fabric8 Kubernetes Java client, which is a fluent DSL that can communicate by using http protocol to the REST API of the Kubernetes Server.

To disable the integration with Kubernetes you can set spring.cloud.kubernetes.enabled to false. Please be aware that when spring-cloud-kubernetes-config is on the classpath, spring.cloud.kubernetes.enabled should be set in bootstrap.{properties|yml} (or the profile specific one) otherwise it should be in application.{properties|yml} (or the profile specific one). Also note that these properties: spring.cloud.kubernetes.config.enabled and spring.cloud.kubernetes.secrets.enabled only take effect when set in bootstrap.{properties|yml}

6.1. Kubernetes Profile Autoconfiguration

When the application runs as a pod inside Kubernetes, a Spring profile named kubernetes automatically gets activated. This lets you customize the configuration, to define beans that are applied when the Spring Boot application is deployed within the Kubernetes platform (for example, different development and production configuration).

6.2. Istio Awareness

When you include the spring-cloud-kubernetes-istio module in the application classpath, a new profile is added to the application, provided the application is running inside a Kubernetes Cluster with Istio installed. You can then use spring @Profile("istio") annotations in your Beans and @Configuration classes.

The Istio awareness module uses me.snowdrop:istio-client to interact with Istio APIs, letting us

discover traffic rules, circuit breakers, and so on, making it easy for our Spring Boot applications to consume this data to dynamically configure themselves according to the environment.

7. Pod Health Indicator

Spring Boot uses `HealthIndicator` to expose info about the health of an application. That makes it really useful for exposing health-related information to the user and makes it a good fit for use as readiness probes.

The Kubernetes health indicator (which is part of the core module) exposes the following info:

- Pod name, IP address, namespace, service account, node name, and its IP address
- A flag that indicates whether the Spring Boot application is internal or external to Kubernetes

8. Leader Election

<TBD>

9. LoadBalancer for Kubernetes

This project includes Spring Cloud Load Balancer for load balancing based on Kubernetes Endpoints and provides implementation of load balancer based on Kubernetes Service. To include it to your project add the following dependency.

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-kubernetes-loadbalancer</artifactId>
</dependency>
```

To enable load balancing based on Kubernetes Service name use the following property. Then load balancer would try to call application using address, for example `service-a.default.svc.cluster.local`

```
spring.cloud.kubernetes.loadbalancer.mode=SERVICE
```

To enabled load balancing across all namespaces use the following property. Property from `spring-cloud-kubernetes-discovery` module is respected.

```
spring.cloud.kubernetes.discovery.all-namespaces=true
```

10. Security Configurations Inside Kubernetes

10.1. Namespace

Most of the components provided in this project need to know the namespace. For Kubernetes (1.3+), the namespace is made available to the pod as part of the service account secret and is automatically detected by the client. For earlier versions, it needs to be specified as an environment variable to the pod. A quick way to do this is as follows:

```
env:
- name: "KUBERNETES_NAMESPACE"
  valueFrom:
    fieldRef:
      fieldPath: "metadata.namespace"
```

10.2. Service Account

For distributions of Kubernetes that support more fine-grained role-based access within the cluster, you need to make sure a pod that runs with `spring-cloud-kubernetes` has access to the Kubernetes API. For any service accounts you assign to a deployment or pod, you need to make sure they have the correct roles.

Depending on the requirements, you'll need `get`, `list` and `watch` permission on the following resources:

Table 8. Kubernetes Resource Permissions

Dependency	Resources
spring-cloud-starter-kubernetes	pods, services, endpoints
spring-cloud-starter-kubernetes-config	configmaps, secrets

For development purposes, you can add `cluster-reader` permissions to your `default` service account. On a production system you'll likely want to provide more granular permissions.

The following Role and RoleBinding are an example for namespaced permissions for the `default` account:

```
kind: Role
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  namespace: YOUR-NAME-SPACE
  name: namespace-reader
rules:
  - apiGroups: ["", "extensions", "apps"]
    resources: ["configmaps", "pods", "services", "endpoints", "secrets"]
    verbs: ["get", "list", "watch"]

---

kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: namespace-reader-binding
  namespace: YOUR-NAME-SPACE
subjects:
- kind: ServiceAccount
  name: default
  apiGroup: ""
roleRef:
  kind: Role
  name: namespace-reader
  apiGroup: ""
```

11. Service Registry Implementation

In Kubernetes service registration is controlled by the platform, the application itself does not control registration as it may do in other platforms. For this reason using `spring.cloud.service-registry.auto-registration.enabled` or setting `@EnableDiscoveryClient(autoRegister=false)` will have no effect in Spring Cloud Kubernetes.

12. Spring Cloud Kubernetes Configuration Watcher

Kubernetes provides the ability to mount a ConfigMap or Secret as a volume in the container of your application. When the contents of the ConfigMap or Secret changes, the mounted volume will be updated with those changes.

However, Spring Boot will not automatically update those changes unless you restart the application. Spring Cloud provides the ability refresh the application context without restarting the application by either hitting the actuator endpoint `/refresh` or via publishing a `RefreshRemoteApplicationEvent` using Spring Cloud Bus.

To achieve this configuration refresh of a Spring Cloud app running on Kubernetes, you can deploy the Spring Cloud Kubernetes Configuration Watcher controller into your Kubernetes cluster.

The application is published as a container and is available on Docker Hub.

Spring Cloud Kubernetes Configuration Watcher can send refresh notifications to applications in two ways.

1. Over HTTP in which case the application being notified must of the `/refresh` actuator endpoint exposed and accessible from within the cluster
2. Using Spring Cloud Bus, in which case you will need a message broker deployed to your custer for the application to use.

12.1. Deployment YAML

Below is a sample deployment YAML you can use to deploy the Kubernetes Configuration Watcher to Kubernetes.

```
---
apiVersion: v1
kind: List
items:
  - apiVersion: v1
    kind: Service
    metadata:
      labels:
        app: spring-cloud-kubernetes-configuration-watcher
      name: spring-cloud-kubernetes-configuration-watcher
    spec:
      ports:
        - name: http
          port: 8888
          targetPort: 8888
      selector:
        app: spring-cloud-kubernetes-configuration-watcher
      type: ClusterIP
  - apiVersion: v1
    kind: ServiceAccount
    metadata:
      labels:
        app: spring-cloud-kubernetes-configuration-watcher
      name: spring-cloud-kubernetes-configuration-watcher
  - apiVersion: rbac.authorization.k8s.io/v1
    kind: RoleBinding
    metadata:
      labels:
        app: spring-cloud-kubernetes-configuration-watcher
      name: spring-cloud-kubernetes-configuration-watcher:view
    roleRef:
```

```
      kind: Role
      apiGroup: rbac.authorization.k8s.io
      name: namespace-reader
    subjects:
      - kind: ServiceAccount
        name: spring-cloud-kubernetes-configuration-watcher
  - apiVersion: rbac.authorization.k8s.io/v1
    kind: Role
    metadata:
      namespace: default
      name: namespace-reader
    rules:
      - apiGroups: ["", "extensions", "apps"]
        resources: ["configmaps", "pods", "services", "endpoints", "secrets"]
        verbs: ["get", "list", "watch"]
  - apiVersion: apps/v1
    kind: Deployment
    metadata:
      name: spring-cloud-kubernetes-configuration-watcher-deployment
    spec:
      selector:
        matchLabels:
          app: spring-cloud-kubernetes-configuration-watcher
      template:
        metadata:
          labels:
            app: spring-cloud-kubernetes-configuration-watcher
        spec:
          serviceAccount: spring-cloud-kubernetes-configuration-watcher
          containers:
          - name: spring-cloud-kubernetes-configuration-watcher
            image: springcloud/spring-cloud-kubernetes-configuration-
watcher:2.0.0-SNAPSHOT
            imagePullPolicy: IfNotPresent
            readinessProbe:
              httpGet:
                port: 8888
                path: /actuator/health/readiness
            livenessProbe:
              httpGet:
                port: 8888
                path: /actuator/health/liveness
            ports:
            - containerPort: 8888
```

The Service Account and associated Role Binding is important for Spring Cloud Kubernetes Configuration to work properly. The controller needs access to read data about ConfigMaps, Pods, Services, Endpoints and Secrets in the Kubernetes cluster.

12.2. Monitoring ConfigMaps and Secrets

Spring Cloud Kubernetes Configuration Watcher will react to changes in ConfigMaps with a label of `spring.cloud.kubernetes.config` with the value `true` or any Secret with a label of `spring.cloud.kubernetes.secret` with the value `true`. If the ConfigMap or Secret does not have either of those labels or the values of those labels is not `true` then any changes will be ignored.

The labels Spring Cloud Kubernetes Configuration Watcher looks for on ConfigMaps and Secrets can be changed by setting `spring.cloud.kubernetes.configuration.watcher.configLabel` and `spring.cloud.kubernetes.configuration.watcher.secretLabel` respectively.

If a change is made to a ConfigMap or Secret with valid labels then Spring Cloud Kubernetes Configuration Watcher will take the name of the ConfigMap or Secret and send a notification to the application with that name.

12.3. HTTP Implementation

The HTTP implementation is what is used by default. When this implementation is used Spring Cloud Kubernetes Configuration Watcher and a change to a ConfigMap or Secret occurs then the HTTP implementation will use the Spring Cloud Kubernetes Discovery Client to fetch all instances of the application which match the name of the ConfigMap or Secret and send an HTTP POST request to the application's actuator `/refresh` endpoint. By default it will send the post request to `/actuator/refresh` using the port registered in the discovery client.

12.3.1. Non-Default Management Port and Actuator Path

If the application is using a non-default actuator path and/or using a different port for the management endpoints, the Kubernetes service for the application can add an annotation called `boot.spring.io/actuator` and set its value to the path and port used by the application. For example

```
apiVersion: v1
kind: Service
metadata:
  labels:
    app: config-map-demo
  name: config-map-demo
  annotations:
    boot.spring.io/actuator: http://:9090/myactuator/home
spec:
  ports:
    - name: http
      port: 8080
      targetPort: 8080
  selector:
    app: config-map-demo
```

Another way you can choose to configure the actuator path and/or management port is by setting `spring.cloud.kubernetes.configuration.watcher.actuatorPath` and `spring.cloud.kubernetes.configuration.watcher.actuatorPort`.

12.4. Messaging Implementation

The messaging implementation can be enabled by setting the profile `bus` when the Spring Cloud Kubernetes Configuration Watcher application is deployed to Kubernetes.

Currently the only supported message broker is RabbitMQ

12.5. Configuring RabbitMQ

When the `bus` profile is enabled you will need to configure Spring RabbitMQ to point it to the location of the RabbitMQ instance you would like to use as well as any credentials necessary to authenticate. This can be done by setting the standard Spring RabbitMQ properties, for example

```
spring:
  rabbitmq:
    username: user
    password: password
    host: rabbitmq
```

13. Examples

Spring Cloud Kubernetes tries to make it transparent for your applications to consume Kubernetes Native Services by following the Spring Cloud interfaces.

In your applications, you need to add the `spring-cloud-kubernetes-discovery` dependency to your classpath and remove any other dependency that contains a `DiscoveryClient` implementation (that is, a Eureka discovery client). The same applies for `PropertySourceLocator`, where you need to add to the classpath the `spring-cloud-kubernetes-config` and remove any other dependency that contains a `PropertySourceLocator` implementation (that is, a configuration server client).

The following projects highlight the usage of these dependencies and demonstrate how you can use these libraries from any Spring Boot application:

- Spring Cloud Kubernetes Examples: the ones located inside this repository.
- Spring Cloud Kubernetes Full Example: Minions and Boss
  - Minion
  - Boss
- Spring Cloud Kubernetes Full Example: SpringOne Platform Tickets Service
- Spring Cloud Gateway with Spring Cloud Kubernetes Discovery and Config

- Spring Boot Admin with Spring Cloud Kubernetes Discovery and Config

14. Other Resources

This section lists other resources, such as presentations (slides) and videos about Spring Cloud Kubernetes.

- S1P Spring Cloud on PKS
- Spring Cloud, Docker, Kubernetes → London Java Community July 2018

Please feel free to submit other resources through pull requests to this repository.

15. Configuration properties

To see the list of all Sleuth related configuration properties please check the Appendix page.

16. Building

16.1. Basic Compile and Test

To build the source you will need to install JDK 1.7.

Spring Cloud uses Maven for most build-related activities, and you should be able to get off the ground quite quickly by cloning the project you are interested in and typing

```
$ ./mvnw install
```

You can also install Maven (>=3.3.3) yourself and run the `mvn` command in place of `./mvnw` in the examples below. If you do that you also might need to add `-P spring` if your local Maven settings do not contain repository declarations for spring pre-release artifacts.

Be aware that you might need to increase the amount of memory available to Maven by setting a `MAVEN_OPTS` environment variable with a value like `-Xmx512m -XX:MaxPermSize=128m`. We try to cover this in the `.mvn` configuration, so if you find you have to do it to make a build succeed, please raise a ticket to get the settings added to source control.

For hints on how to build the project look in `.travis.yml` if there is one. There should be a "script" and maybe "install" command. Also look at the "services" section to see if any services need to be running locally (e.g. mongo or rabbit). Ignore the git-related bits that you might find in "before_install" since they're related to setting git credentials and you already have those.

The projects that require middleware generally include a `docker-compose.yml`, so consider using

Docker Compose to run the middeware servers in Docker containers. See the README in the scripts demo repository for specific instructions about the common cases of mongo, rabbit and redis.

If all else fails, build with the command from `.travis.yml` (usually `./mvnw install`).

16.2. Documentation

The spring-cloud-build module has a "docs" profile, and if you switch that on it will try to build asciidoc sources from `src/main/asciidoc`. As part of that process it will look for a `README.adoc` and process it by loading all the includes, but not parsing or rendering it, just copying it to `${main.basedir}` (defaults to `$/home/marcin/repo/spring-cloud-release/train-docs/target/unpacked-docs`, i.e. the root of the project). If there are any changes in the README it will then show up after a Maven build as a modified file in the correct place. Just commit it and push the change.

16.3. Working with the code

If you don't have an IDE preference we would recommend that you use Spring Tools Suite or Eclipse when working with the code. We use the m2eclipse eclipse plugin for maven support. Other IDEs and tools should also work without issue as long as they use Maven 3.3.3 or better.

16.3.1. Activate the Spring Maven profile

Spring Cloud projects require the 'spring' Maven profile to be activated to resolve the spring milestone and snapshot repositories. Use your preferred IDE to set this profile to be active, or you may experience build errors.

16.3.2. Importing into eclipse with m2eclipse

We recommend the m2eclipse eclipse plugin when working with eclipse. If you don't already have m2eclipse installed it is available from the "eclipse marketplace".

Older versions of m2e do not support Maven 3.3, so once the projects are imported into Eclipse you will also need to tell m2eclipse to use the right profile for the projects. If you see many different errors related to the POMs in the projects, check that you have an up to date installation. If you can't upgrade m2e, add the "spring" profile to your `settings.xml`. Alternatively you can copy the repository settings from the "spring" profile of the parent pom into your `settings.xml`.

16.3.3. Importing into eclipse without m2eclipse

If you prefer not to use m2eclipse you can generate eclipse project metadata using the following command:

```
$ ./mvnw eclipse:eclipse
```

The generated eclipse projects can be imported by selecting `import existing projects` from the `file`

menu.

17. Contributing

Spring Cloud is released under the non-restrictive Apache 2.0 license, and follows a very standard Github development process, using Github tracker for issues and merging pull requests into master. If you want to contribute even something trivial please do not hesitate, but follow the guidelines below.

17.1. Sign the Contributor License Agreement

Before we accept a non-trivial patch or pull request we will need you to sign the Contributor License Agreement. Signing the contributor's agreement does not grant anyone commit rights to the main repository, but it does mean that we can accept your contributions, and you will get an author credit if we do. Active contributors might be asked to join the core team, and given the ability to merge pull requests.

17.2. Code of Conduct

This project adheres to the Contributor Covenant code of conduct. By participating, you are expected to uphold this code. Please report unacceptable behavior to spring-code-of-conduct@pivotal.io.

17.3. Code Conventions and Housekeeping

None of these is essential for a pull request, but they will all help. They can also be added after the original pull request but before a merge.

- Use the Spring Framework code format conventions. If you use Eclipse you can import formatter settings using the `eclipse-code-formatter.xml` file from the Spring Cloud Build project. If using IntelliJ, you can use the Eclipse Code Formatter Plugin to import the same file.
- Make sure all new `.java` files to have a simple Javadoc class comment with at least an `@author` tag identifying you, and preferably at least a paragraph on what the class is for.
- Add the ASF license header comment to all new `.java` files (copy from existing files in the project)
- Add yourself as an `@author` to the .java files that you modify substantially (more than cosmetic changes).
- Add some Javadocs and, if you change the namespace, some XSD doc elements.
- A few unit tests would help a lot as well — someone has to do it.
- If no-one else is using your branch, please rebase it against the current master (or other target branch in the main project).
- When writing a commit message please follow these conventions, if you are fixing an existing issue please add `Fixes gh-XXXX` at the end of the commit message (where XXXX is the issue number).

17.4. Checkstyle

Spring Cloud Build comes with a set of checkstyle rules. You can find them in the `spring-cloud-build-tools` module. The most notable files under the module are:

spring-cloud-build-tools/

```
└─── src
    ├─── checkstyle
    │    └─── checkstyle-suppressions.xml ③
    └─── main
        └─── resources
            ├─── checkstyle-header.txt ②
            └─── checkstyle.xml ①
```

① Default Checkstyle rules

② File header setup

③ Default suppression rules

17.4.1. Checkstyle configuration

Checkstyle rules are **disabled by default**. To add checkstyle to your project just define the following properties and plugins.

pom.xml

```
<properties>
<maven-checkstyle-plugin.failsOnError>true</maven-checkstyle-plugin.failsOnError> ①
        <maven-checkstyle-plugin.failsOnViolation>true
        </maven-checkstyle-plugin.failsOnViolation> ②
        <maven-checkstyle-plugin.includeTestSourceDirectory>true
        </maven-checkstyle-plugin.includeTestSourceDirectory> ③
</properties>

<build>
        <plugins>
            <plugin> ④
                <groupId>io.spring.javaformat</groupId>
                <artifactId>spring-javaformat-maven-plugin</artifactId>
            </plugin>
            <plugin> ⑤
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-checkstyle-plugin</artifactId>
            </plugin>
        </plugins>

    <reporting>
        <plugins>
            <plugin> ⑤
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-checkstyle-plugin</artifactId>
            </plugin>
        </plugins>
    </reporting>
</build>
```

① Fails the build upon Checkstyle errors

② Fails the build upon Checkstyle violations

③ Checkstyle analyzes also the test sources

④ Add the Spring Java Format plugin that will reformat your code to pass most of the Checkstyle formatting rules

⑤ Add checkstyle plugin to your build and reporting phases

If you need to suppress some rules (e.g. line length needs to be longer), then it's enough for you to define a file under `${project.root}/src/checkstyle/checkstyle-suppressions.xml` with your suppressions. Example:

projectRoot/src/checkstyle/checkstyle-suppresions.xml

```
<?xml version="1.0"?>
<!DOCTYPE suppressions PUBLIC
        "-//Puppy Crawl//DTD Suppressions 1.1//EN"
        "https://www.puppycrawl.com/dtds/suppressions_1_1.dtd">
<suppressions>
    <suppress files=".*ConfigServerApplication\.java"
checks="HideUtilityClassConstructor"/>
    <suppress files=".*ConfigClientWatch\.java" checks="LineLengthCheck"/>
</suppressions>
```

It's advisable to copy the `${spring-cloud-build.rootFolder}/.editorconfig` and `${spring-cloud-build.rootFolder}/.springformat` to your project. That way, some default formatting rules will be applied. You can do so by running this script:

```
$ curl https://raw.githubusercontent.com/spring-cloud/spring-cloud-
build/master/.editorconfig -o .editorconfig
$ touch .springformat
```

17.5. IDE setup

17.5.1. Intellij IDEA

In order to setup Intellij you should import our coding conventions, inspection profiles and set up the checkstyle plugin. The following files can be found in the Spring Cloud Build project.

spring-cloud-build-tools/

```
└─── src
    ├─── checkstyle
    │    └─── checkstyle-suppressions.xml ③
    └─── main
        └─── resources
            ├─── checkstyle-header.txt ②
            ├─── checkstyle.xml ①
            └─── intellij
                ├─── Intellij_Project_Defaults.xml ④
                └─── Intellij_Spring_Boot_Java_Conventions.xml ⑤
```

① Default Checkstyle rules

② File header setup

③ Default suppression rules

④ Project defaults for Intellij that apply most of Checkstyle rules

⑤ Project style conventions for Intellij that apply most of Checkstyle rules

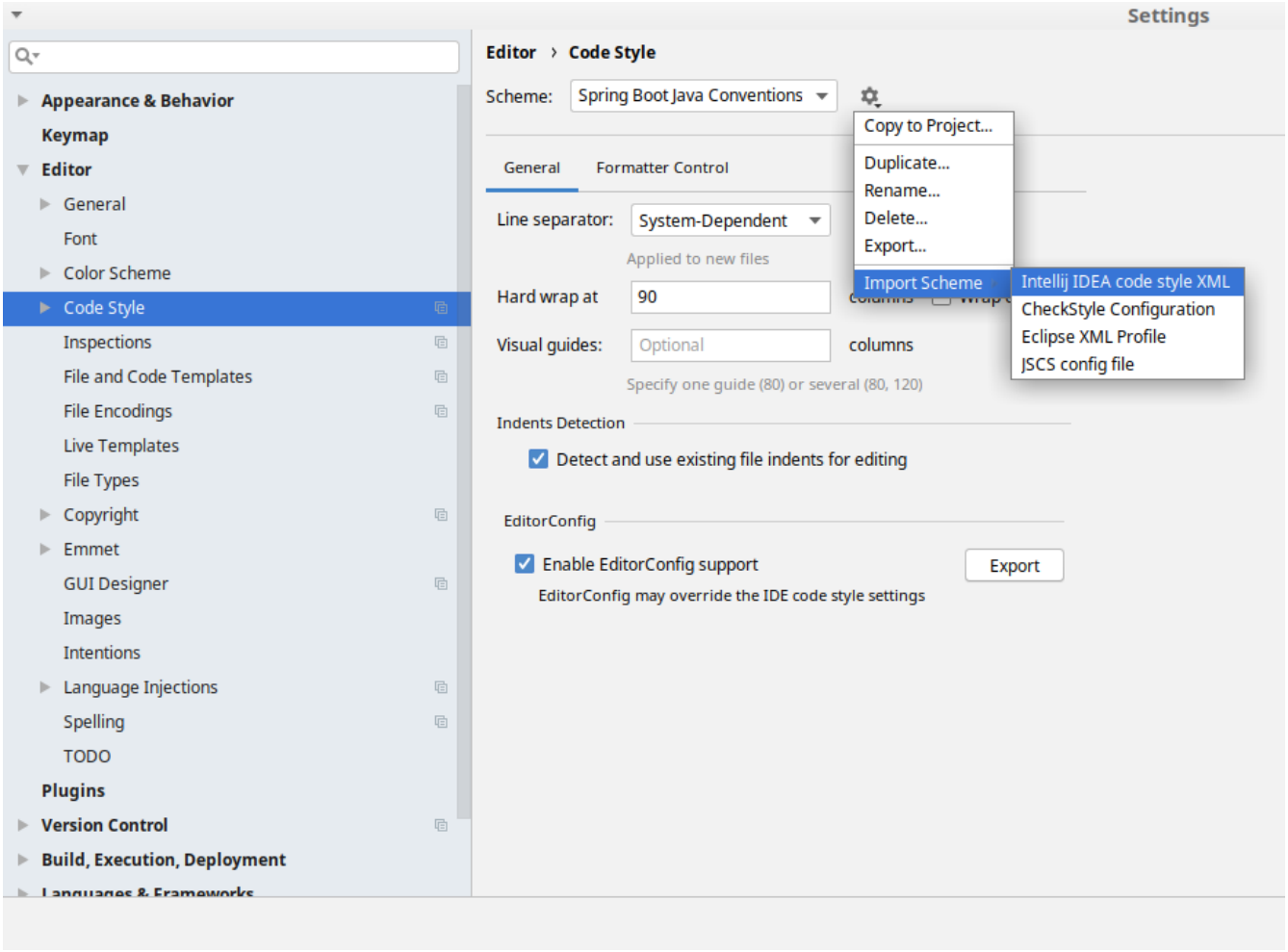


Figure 5. Code style

Go to `File → Settings → Editor → Code style`. There click on the icon next to the `Scheme` section. There, click on the `Import Scheme` value and pick the `Intellij IDEA code style XML` option. Import the `spring-cloud-build-tools/src/main/resources/intellij/Intellij_Spring_Boot_Java_Conventions.xml` file.

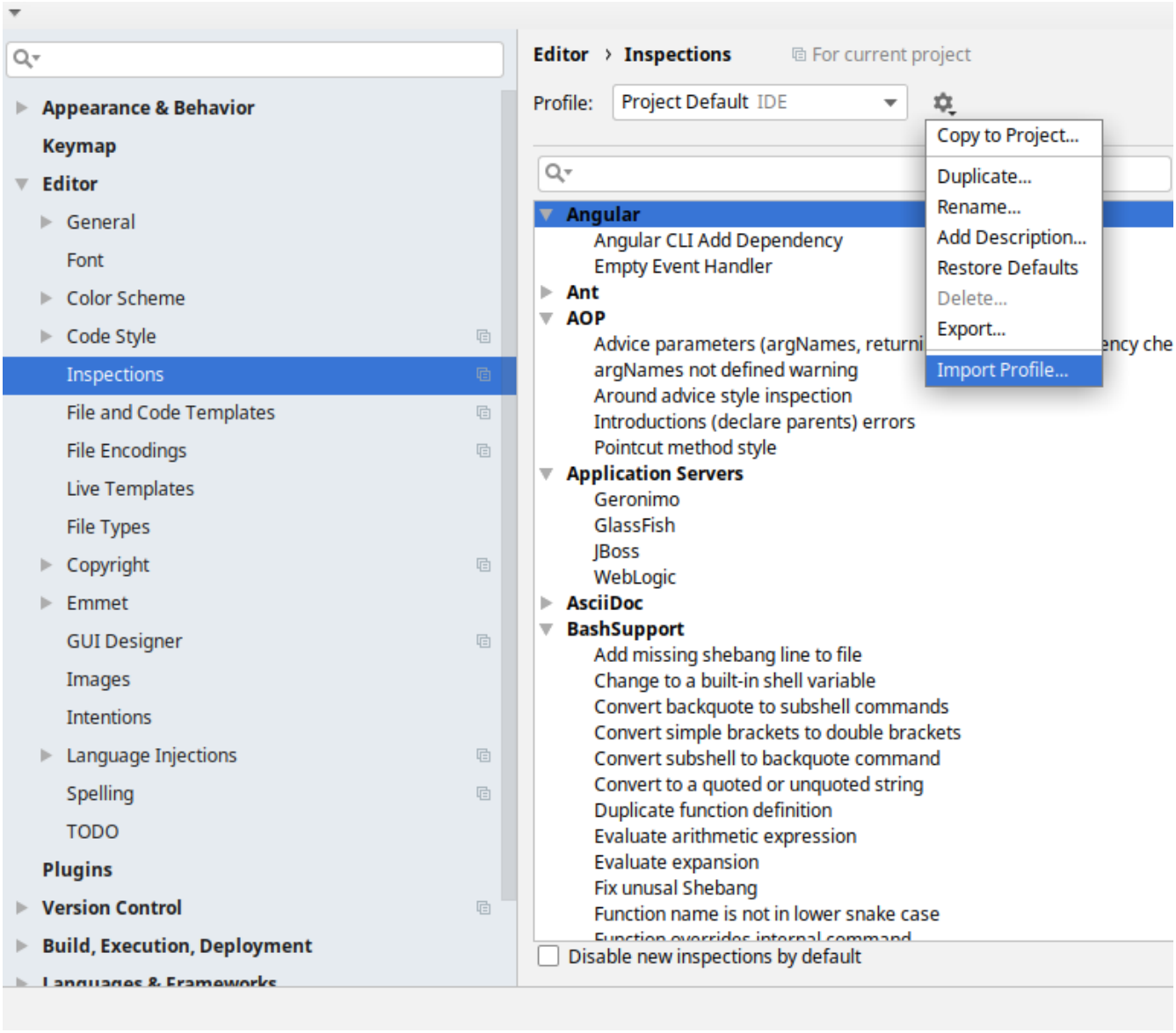
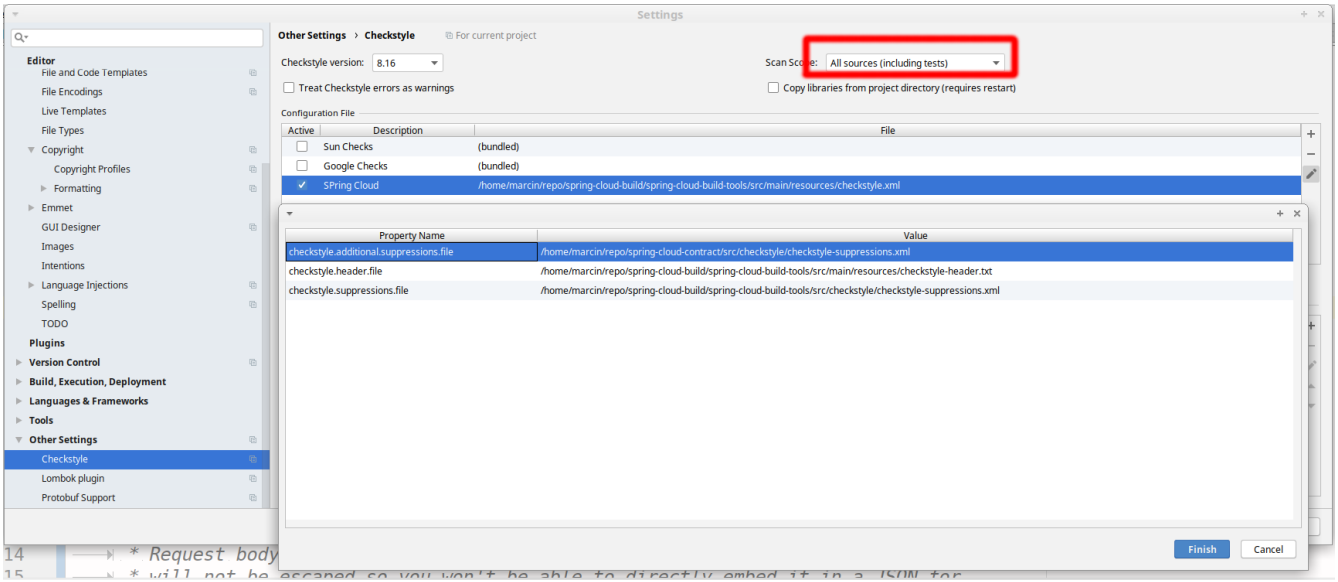


Figure 6. Inspection profiles

Go to `File` → `Settings` → `Editor` → `Inspections`. There click on the icon next to the `Profile` section. There, click on the `Import Profile` and import the `spring-cloud-build-tools/src/main/resources/intellij/Intellij_Project_Defaults.xml` file.

Checkstyle

To have Intellij work with Checkstyle, you have to install the `Checkstyle` plugin. It's advisable to also install the `Assertions2Assertj` to automatically convert the JUnit assertions



Go to `File → Settings → Other settings → Checkstyle`. There click on the `+` icon in the `Configuration file` section. There, you'll have to define where the checkstyle rules should be picked from. In the image above, we've picked the rules from the cloned Spring Cloud Build repository. However, you can point to the Spring Cloud Build's GitHub repository (e.g. for the `checkstyle.xml` : `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/main/resources/checkstyle.xml`). We need to provide the following variables:

- `checkstyle.header.file` - please point it to the Spring Cloud Build's, `spring-cloud-build-tools/src/main/resources/checkstyle-header.txt` file either in your cloned repo or via the `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/main/resources/checkstyle-header.txt` URL.
- `checkstyle.suppressions.file` - default suppressions. Please point it to the Spring Cloud Build's, `spring-cloud-build-tools/src/checkstyle/checkstyle-suppressions.xml` file either in your cloned repo or via the `raw.githubusercontent.com/spring-cloud/spring-cloud-build/master/spring-cloud-build-tools/src/checkstyle/checkstyle-suppressions.xml` URL.
- `checkstyle.additional.suppressions.file` - this variable corresponds to suppressions in your local project. E.g. you're working on `spring-cloud-contract`. Then point to the `project-root/src/checkstyle/checkstyle-suppressions.xml` folder. Example for `spring-cloud-contract` would be: `/home/username/spring-cloud-contract/src/checkstyle/checkstyle-suppressions.xml`.

Remember to set the `Scan Scope` to `All sources` since we apply checkstyle rules for production and test sources.

Spring Cloud Netflix

2020.0.0-M4

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).

1. 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.

1.1. 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 for details on setting up your build system with the current Spring Cloud Release Train.

1.2. 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 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 `defaultZone` property is case sensitive and requires camel case because the `serviceUrl` property is a `Map<String, String>`. Therefore, the `defaultZone` property does not follow the normal Spring Boot snake-case convention of `default-zone`.

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 and EurekaClientConfigBean for more details on the configurable options.

To disable the Eureka Discovery Client, you can set `eureka.client.enabled` to `false`. Eureka Discovery Client will also be disabled when `spring.cloud.discovery.enabled` is set to `false`.

1.3. 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: `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.

When Eureka server requires client side certificate for authentication, the client side certificate and trust store can be configured via properties, as shown in following example:

application.yml

```
eureka:
  client:
    tls:
      enabled: true
      key-store: <path-of-key-store>
      key-store-type: PKCS12
      key-store-password: <key-store-password>
      key-password: <key-password>
      trust-store: <path-of-trust-store>
      trust-store-type: PKCS12
      trust-store-password: <trust-store-password>
```

The `eureka.client.tls.enabled` needs to be true to enable Eureka client side TLS. When `eureka.client.tls.trust-store` is omitted, a JVM default trust store is used. The default value for `eureka.client.tls.key-store-type` and `eureka.client.tls.trust-store-type` is PKCS12. When password properties are omitted, empty password is assumed.

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.

1.4. 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`). The following example shows the default values for the two settings:

application.yml

```
eureka:
  instance:
    statusPageUrlPath: ${server.servletPath}/info
    healthCheckUrlPath: ${server.servletPath}/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.

In Dalston it was also required to set the status and health check URLs when changing that management context path. This requirement was removed beginning in Edgware.

1.5. 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}`.)

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.

1.6. 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
```

`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`.

1.7. 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.

1.7.1. Using Eureka on Cloud Foundry

Cloud Foundry 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 Cloud Foundry 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).

1.7.2. 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 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;
}
```

1.7.3. 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 Cloud Foundry, the `vcap.application.instance_id` is populated automatically in a Spring Boot application, so the random value is not needed.

1.8. 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. 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();
}
```

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.

1.8.1. 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>
```

1.9. 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 (a REST client builder) and Spring `RestTemplate` 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;
}
```

1.10. 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.

1.11. 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 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 1` and `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
```

1.12. Refreshing Eureka Clients

By default, the `EurekaClient` bean is refreshable, meaning the Eureka client properties can be changed and refreshed. When a refresh occurs clients will be unregistered from the Eureka server and there might be a brief moment of time where all instance of a given service are not available. One way to eliminate this from happening is to disable the ability to refresh Eureka clients. To do this set `eureka.client.refresh.enable=false`.

1.13. Using Eureka with Spring Cloud LoadBalancer

We offer support for the Spring Cloud LoadBalancer `ZonePreferenceServiceInstanceListSupplier`. The `zone` value from the Eureka instance metadata (`eureka.instance.metadataMap.zone`) is used for setting the value of `spring-clod-loadbalancer-zone` property that is used to filter service instances by zone.

If that is missing and if the `spring.cloud.loadbalancer.eureka.approximateZoneFromHostname` flag is set to `true`, it can use the domain name from the server hostname as a proxy for the zone.

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).

2. Service Discovery: Eureka Server

This section describes how to set up a Eureka server.

2.1. 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 for details on setting up your build system with the current Spring Cloud Release Train.

If your project already uses Thymeleaf as its template engine, the Freemarker templates of the Eureka server may not be loaded correctly. In this case it is necessary to configure the template loader manually:

application.yml

```
spring:
  freemarker:
    template-loader-path: classpath:/templates/
    prefer-file-system-access: false
```

2.2. 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 and google group discussion.

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}"
  }
}
```

2.3. High Availability, Zones and Regions

The Eureka server does not have a back end 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 on the client side for Zones and Regions.

2.4. 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.

2.5. 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: https://peer2/eureka/

---
spring:
  profiles: peer2
eureka:
  instance:
    hostname: peer2
  client:
    serviceUrl:
      defaultZone: https://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. You can add multiple peers to a system, and as long as they are all directly connected to each other, they will synchronize the registrations amongst themselves.

application.yml (Three Peer Aware Eureka Servers)

```
eureka:
  client:
    serviceUrl:
      defaultZone: https://peer1/eureka/,http://peer2/eureka/,http://peer3/eureka/

---
spring:
  profiles: peer1
eureka:
  instance:
    hostname: peer1

---
spring:
  profiles: peer2
eureka:
  instance:
    hostname: peer2

---
spring:
  profiles: peer3
eureka:
  instance:
    hostname: peer3
```

2.6. 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.

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}`.

2.7. Securing The Eureka Server

You can secure your Eureka server simply by adding Spring Security to your server's classpath via `spring-boot-starter-security`. By default when Spring Security is on the classpath it will require that a valid CSRF token be sent with every request to the app. Eureka clients will not generally possess a valid cross site request forgery (CSRF) token you will need to disable this requirement for the `/eureka/**` endpoints. For example:

```
@EnableWebSecurity
class WebSecurityConfig extends WebSecurityConfigurerAdapter {

    @Override
    protected void configure(HttpSecurity http) throws Exception {
        http.csrf().ignoringAntMatchers("/eureka/**");
        super.configure(http);
    }
}
```

For more information on CSRF see the Spring Security documentation.

A demo Eureka Server can be found in the Spring Cloud Samples repo.

2.8. JDK 11 Support

The JAXB modules which the Eureka server depends upon were removed in JDK 11. If you intend to use JDK 11 when running a Eureka server you must include these dependencies in your POM or Gradle file.

```
<dependency>
    <groupId>org.glassfish.jaxb</groupId>
    <artifactId>jaxb-runtime</artifactId>
</dependency>
```

3. Configuration properties

To see the list of all Spring Cloud Netflix related configuration properties please check the Appendix page.

Spring Cloud OpenFeign

2020.0.0-M4

This project provides OpenFeign integrations for Spring Boot apps through autoconfiguration and binding to the Spring Environment and other Spring programming model idioms.

1. Declarative REST Client: Feign

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 Eureka, as well as Spring Cloud LoadBalancer to provide a load-balanced http client when using Feign.

1.1. 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 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.GET, value = "/stores")
    Page<Store> getStores(Pageable pageable);

    @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 Spring Cloud LoadBalancer client. 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 load-balancer 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 using `SimpleDiscoveryClient`.

1.2. 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`. It is possible to override the name of that ensemble by using the `contextId` attribute of the `@FeignClient` annotation.

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).

`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`.

The `serviceId` attribute is now deprecated in favor of the `name` attribute.

Using `contextId` attribute of the `@FeignClient` annotation in addition to changing the name of the `ApplicationContext` ensemble, it will override the alias of the client name and it will be used as part of the name of the configuration bean created for that client.

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 OpenFeign 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 Spring Cloud LoadBalancer is in the classpath, `FeignBlockingLoadBalancerClient` is used. If none of them is in the classpath, the default feign client is used.

`spring-cloud-starter-openfeign` supports `spring-cloud-starter-loadbalancer`. However, as is an optional dependency, you need to make sure it been added to your project if you want to use it.

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 `org.apache.http.impl.client.CloseableHttpClient` when using Apache or `okhttp3.OkHttpClient` when using OK HTTP.

Spring Cloud OpenFeign *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`
- `QueryMapEncoder`

A bean of `Retryer.NEVER_RETRY` with the type `Retryer` is created by default, which will disable retrying. Notice this retrying behavior is different from the Feign default one, where it will automatically retry IOExceptions, treating them as transient network related exceptions, and any RetryableException thrown from an ErrorDecoder.

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`.

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
```

If we want to create multiple feign clients with the same name or url so that they would point to the same server but each with a different custom configuration then we have to use `contextId` attribute of the `@FeignClient` in order to avoid name collision of these configuration beans.

```
@FeignClient(contextId = "fooClient", name = "stores", configuration =
FooConfiguration.class)
public interface FooClient {
    //..
}
```

```
@FeignClient(contextId = "barClient", name = "stores", configuration =
BarConfiguration.class)
public interface BarClient {
    //..
}
```

It is also possible to configure FeignClient not to inherit beans from the parent context. You can do this by overriding the `inheritParentConfiguration()` in a `FeignClientConfigurer` bean to return `false`:

```
@Configuration
public class CustomConfiguration{

@Bean
public FeignClientConfigurer feignClientConfigurer() {
            return new FeignClientConfigurer() {

                @Override
                public boolean inheritParentConfiguration() {
                    return false;
                }
            };

        }
}
```

1.3. 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. 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, "https://PROD-SVC");

        this.adminClient = Feign.builder().client(client)
                .encoder(encoder)
                .decoder(decoder)
                .contract(contract)
                .requestInterceptor(new BasicAuthRequestInterceptor("admin", "admin"))
                .target(FooClient.class, "https://PROD-SVC");
    }
}
```

In the above example `FeignClientsConfiguration.class` is the default configuration provided by Spring Cloud OpenFeign.

`PROD-SVC` is the name of the service the Clients will be making requests to.

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.

You can also use the `Builder`to configure FeignClient not to inherit beans from the parent context. You can do this by overriding calling `inheritParentContext(false)` on the `Builder`.

1.4. 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();
    }
}
```

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.

1.5. 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 `@FeignClient` set 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());
            }
        };
    }
}
```

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`.

1.6. 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 OpenFeign 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
}
```

1.7. 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 {

}
```

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).

1.8. 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.

For http clients except OkHttpClient, default gzip decoder can be enabled to decode gzip response in UTF-8 encoding:

```
feign.compression.response.enabled=true
feign.compression.response.useGzipDecoder=true
```

1.9. 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;
    }
}
```

1.10. Feign @QueryMap support

The OpenFeign `@QueryMap` annotation provides support for POJOs to be used as GET parameter maps. Unfortunately, the default OpenFeign QueryMap annotation is incompatible with Spring because it lacks a `value` property.

Spring Cloud OpenFeign provides an equivalent `@SpringQueryMap` annotation, which is used to annotate a POJO or Map parameter as a query parameter map.

For example, the `Params` class defines parameters `param1` and `param2`:

```
// Params.java
public class Params {
    private String param1;
    private String param2;

    // [Getters and setters omitted for brevity]
}
```

The following feign client uses the `Params` class by using the `@SpringQueryMap` annotation:

```
@FeignClient("demo")
public interface DemoTemplate {

    @GetMapping(path = "/demo")
    String demoEndpoint(@SpringQueryMap Params params);
}
```

If you need more control over the generated query parameter map, you can implement a custom `QueryMapEncoder` bean.

1.11. HATEOAS support

Spring provides some APIs to create REST representations that follow the HATEOAS principle, Spring Hateoas and Spring Data REST.

If your project use the `org.springframework.boot:spring-boot-starter-hateoas` starter or the `org.springframework.boot:spring-boot-starter-data-rest` starter, Feign HATEOAS support is enabled by default.

When HATEOAS support is enabled, Feign clients are allowed to serialize and deserialize HATEOAS representation models: EntityModel, CollectionModel and PagedModel.

```
@FeignClient("demo")
public interface DemoTemplate {

    @GetMapping(path = "/stores")
    CollectionModel<Store> getStores();
}
```

1.12. Spring @MatrixVariable Support

Spring Cloud OpenFeign provides support for the Spring `@MatrixVariable` annotation.

If a map is passed as the method argument, the `@MatrixVariable` path segment is created by joining key-value pairs from the map with a `=`.

If a different object is passed, either the `name` provided in the `@MatrixVariable` annotation (if defined) or the annotated variable name is joined with the provided method argument using `=`.

IMPORTANT

Even though, on the server side, Spring does not require the users to name the path segment placeholder same as the matrix variable name, since it would be too ambiguous on the client side, Spring Cloud OpenFeign requires that you add a path segment placeholder with a name matching either the `name` provided in the `@MatrixVariable` annotation (if defined) or the annotated variable name.

For example:

```
@GetMapping("/objects/links/{matrixVars}")
Map<String, List<String>> getObjects(@MatrixVariable Map<String, List<String>>
matrixVars);
```

Note that both variable name and the path segment placeholder are called `matrixVars`.

```
@FeignClient("demo")
public interface DemoTemplate {

    @GetMapping(path = "/stores")
    CollectionModel<Store> getStores();
}
```

1.13. Feign `CollectionFormat` support

We support `feign.CollectionFormat` by providing the `@CollectionFormat` annotation. You can annotate a Feign client method with it by passing the desired `feign.CollectionFormat` as annotation value.

In the following example, the `CSV` format is used instead of the default `EXPLODED` to process the method.

```
@FeignClient(name = "demo")
    protected interface PageableFeignClient {

        @CollectionFormat(feign.CollectionFormat.CSV)
        @GetMapping(path = "/page")
        ResponseEntity performRequest(Pageable page);

    }
```

Set the `CSV` format while sending `Pageable` as a query parameter in order for it to be encoded correctly.

1.14. Reactive Support

As the OpenFeign project does not currently support reactive clients, such as Spring WebClient, neither does Spring Cloud OpenFeign. We will add support for it here as soon as it becomes available in the core project.

Until that is done, we recommend using feign-reactive for Spring WebClient support.

1.14.1. Early Initialization Errors

Depending on how you are using your Feign clients you may see initialization errors when starting your application. To work around this problem you can use an `ObjectProvider` when autowiring your client.

```
@Autowired
ObjectProvider<TestFeginClient> testFeginClient;
```

2. Configuration properties

To see the list of all Sleuth related configuration properties please check the Appendix page.

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.

In a future major release, the functionality contained in this project will move to the respective projects.

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.

1. Quickstart

1.1. 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.

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).

1.2. 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
```

2. More Detail

2.1. Single Sign On

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.

2.2. 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.

2.2.1. Client Token Relay in Spring Cloud Gateway

If your app also has a Spring Cloud Gateway embedded reverse proxy 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.java

```
@Autowired
private TokenRelayGatewayFilterFactory filterFactory;

@Bean
public RouteLocator customRouteLocator(RouteLocatorBuilder builder) {
    return builder.routes()
            .route("resource", r -> r.path("/resource")
                    .filters(f -> f.filter(filterFactory.apply()))
                    .uri("http://localhost:9000"))
            .build();
}
```

or this

application.yaml

```
spring:
  cloud:
    gateway:
      routes:
      - id: resource
        uri: http://localhost:9000
        predicates:
        - Path=/resource
        filters:
        - TokenRelay=
```

and it will (in addition to logging the user in and grabbing a token) pass the authentication token downstream to the services (in this case `/resource`).

To enable this for Spring Cloud Gateway add the following dependencies

- `org.springframework.boot:spring-boot-starter-oauth2-client`
- `org.springframework.cloud:spring-cloud-starter-security`

How does it work? The filter extracts an access token from the currently authenticated user, and puts it in a request header for the downstream requests.

For a full working sample see this project.

The default implementation of `ReactiveOAuth2AuthorizedClientService` used by `TokenRelayGatewayFilterFactory` uses an in-memory data store. You will need to provide your own implementation `ReactiveOAuth2AuthorizedClientService` if you need a more robust solution.

2.2.2. 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.)

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")`.

2.2.3. Client Token Relay in Zuul Proxy

If your app also has a Spring Cloud Zuul 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 just extracts an access token from the currently authenticated user, and puts it in a request header for the downstream requests.

Spring Boot does not create an `OAuth2RestOperations` automatically which is needed for `refresh_token`. In that case you need to create your own `OAuth2RestOperations` so `OAuth2TokenRelayFilter` can refresh the token if needed.

2.2.4. 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 `AccessTokenContextRelay` to 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.

3. 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 for full details.

Spring Cloud Sleuth

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1. Overview

Spring Cloud Sleuth provides Spring Boot auto-configuration for distributed tracing. Underneath, Spring Cloud Sleuth is a layer over a Tracer library named Brave.

Sleuth configures everything you need to get started. This includes where trace data (spans) are reported to, how many traces to keep (sampling), if remote fields (baggage) are sent, and which libraries are traced.

We maintain an example app where two Spring Boot services collaborate on an HTTP request. Sleuth configures these apps, so that timing of these requests are recorded into Zipkin, a distributed tracing system. Tracing UIs visualize latency, such as time in one service vs waiting for other services.

Here's an example of what it looks like:

[Zipkin Trace] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/src/main/asciidoc/images/zipkin-trace-screenshot.png

The source repository of this example includes demonstrations of many things, including WebFlux and messaging. Most features require only a property or dependency change to work. These snippets showcase the value of Spring Cloud Sleuth: Through auto-configuration, Sleuth make getting started with distributed tracing easy!

To keep things simple, the same example is used throughout documentation using basic HTTP communication.

2. Features

Sleuth sets up instrumentation not only to track timing, but also to catch errors so that they can be analyzed or correlated with logs. This works the same way regardless of if the error came from a common instrumented library, such as `RestTemplate`, or your own code annotated with `@NewSpan` or similar.

Below, we'll use the word Zipkin to describe the tracing system, and include Zipkin screenshots. However, most services accepting Zipkin format have similar base features. Sleuth can also be configured to send data in other formats, something detailed later.

2.1. Contextualizing errors

Without distributed tracing, it can be difficult to understand the impact of a an exception. For example, it can be hard to know if a specific request caused the caller to fail or not.

Zipkin reduces time in triage by contextualizing errors and delays.

Requests colored red in the search screen failed:

[Error Traces] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/src/main/asciidoc/images/zipkin-error-traces.png

If you then click on one of the traces, you can understand if the failure happened before the request hit another service or not:

[Error Traces Info propagation] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/src/main/asciidoc/images/zipkin-error-trace-screenshot.png

For example, the above error happened in the "backend" service, and caused the "frontend" service to fail.

2.2. Log correlation

Sleuth configures the logging context with variables including the service name (`%{spring.zipkin.service.name}`) and the trace ID (`%{traceId}`). These help you connect logs with distributed traces and allow you choice in what tools you use to troubleshoot your services.

Once you find any log with an error, you can look for the trace ID in the message. Paste that into Zipkin to visualize the entire trace, regardless of how many services the first request ended up hitting.

```
backend.log:  2020-04-09 17:45:40.516 ERROR
[backend,5e8eeec48b08e26882aba313eb08f0a4,dcc1df555b5777b3,true] 97203 --- [nio-9000-
exec-1] o.s.c.s.i.web.ExceptionLoggingFilter     : Uncaught exception thrown
frontend.log:2020-04-09 17:45:40.574 ERROR
[frontend,5e8eeec48b08e26882aba313eb08f0a4,82aba313eb08f0a4,true] 97192 --- [nio-8081-
exec-2] o.s.c.s.i.web.ExceptionLoggingFilter     : Uncaught exception thrown
```

Above, you'll notice the trace ID is `5e8eeec48b08e26882aba313eb08f0a4`, for example. This log configuration was automatically setup by Sleuth.

2.3. Service Dependency Graph

When you consider distributed tracing tracks requests, it makes sense that trace data can paint a picture of your architecture.

Zipkin includes a tool to build service dependency diagrams from traces, including the count of calls and how many errors exist.

The example application will make a simple diagram like this, but your real environment diagram may be more complex.

[Zipkin Dependencies] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/zipkin-dependencies.png

Note: Production environments will generate a lot of data. You will likely need to run a separate service to aggregate the dependency graph. You can learn more here.

2.4. Request scoped properties (Baggage)

Distributed tracing works by propagating fields inside and across services that connect the trace together: traceId and spanId notably. The context that holds these fields can optionally push other fields that need to be consistent regardless of many services are touched. The simple name for these extra fields is "Baggage".

Sleuth allows you to define which baggage are permitted to exist in the trace context, including what header names are used.

The following example shows setting baggage values:

```
Span initialSpan = this.tracer.nextSpan().name("span").start();
BUSINESS_PROCESS.updateValue(initialSpan.context(), "ALM");
COUNTRY_CODE.updateValue(initialSpan.context(), "FO");
```

There is currently no limitation of the count or size of baggage items. 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.

2.4.1. Baggage versus Tags

Like trace IDs, Baggage is attached to messages or requests, usually as headers. Tags are key value pairs sent in a Span to Zipkin. Baggage values are not added spans by default, which means you can't search based on Baggage unless you opt-in.

To make baggage also tags, use the property `spring.sleuth.baggage.tag-fields` like so:

```
spring:
  sleuth:
    baggage:
      foo: bar
      remoteFields:
        - country-code
        - x-vcap-request-id
      tagFields:
        - country-code
```

3. Adding Sleuth to your Project

This section addresses how to add Sleuth to your project with either Maven or Gradle.

To ensure that your application name is properly displayed in Zipkin, set the `spring.application.name` property in `bootstrap.yml`.

3.1. 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> ①
      <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> ②
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-zipkin</artifactId>
</dependency>
```

① We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself.

② Add the dependency to `spring-cloud-starter-zipkin`.

The following example shows how to do so for Gradle:

Gradle

```
dependencyManagement { ①
    imports {
        mavenBom "org.springframework.cloud:spring-cloud-
dependencies:${releaseTrainVersion}"
    }
}

dependencies { ②
    compile "org.springframework.cloud:spring-cloud-starter-zipkin"
}
```

① We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself.

② Add the dependency to `spring-cloud-starter-zipkin`.

3.2. 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`.

If using Kafka, you must set the property `spring.zipkin.sender.type` property accordingly:

```
spring.zipkin.sender.type: kafka
```

`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> ①
      <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> ②
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-zipkin</artifactId>
</dependency>
<dependency> ③
    <groupId>org.springframework.amqp</groupId>
    <artifactId>spring-rabbit</artifactId>
</dependency>
```

① We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself.

② Add the dependency to `spring-cloud-starter-zipkin`. That way, all nested dependencies get downloaded.

③ To automatically configure RabbitMQ, add the `spring-rabbit` dependency.

Gradle

```
dependencyManagement { ①
    imports {
        mavenBom "org.springframework.cloud:spring-cloud-
dependencies:${releaseTrainVersion}"
    }
}

dependencies {
    compile "org.springframework.cloud:spring-cloud-starter-zipkin" ②
    compile "org.springframework.amqp:spring-rabbit" ③
}
```

① We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself.

② Add the dependency to `spring-cloud-starter-zipkin`. That way, all nested dependencies get downloaded.

③ To automatically configure RabbitMQ, add the `spring-rabbit` dependency.

3.3. Overriding the auto-configuration of Zipkin

Spring Cloud Sleuth supports sending traces to multiple tracing systems as of version 2.1.0. In order to get this to work, every tracing system needs to have a `Reporter<Span>` and `Sender`. If you want to override the provided beans you need to give them a specific name. To do this you can use respectively `ZipkinAutoConfiguration.REPORTER_BEAN_NAME` and `ZipkinAutoConfiguration.SENDER_BEAN_NAME`.

```
@Configuration
protected static class MyConfig {

    @Bean(ZipkinAutoConfiguration.REPORTER_BEAN_NAME)
    Reporter<zipkin2.Span> myReporter() {
        return AsyncReporter.create(mySender());
    }

    @Bean(ZipkinAutoConfiguration.SENDER_BEAN_NAME)
    MySender mySender() {
        return new MySender();
    }

    static class MySender extends Sender {

        private boolean spanSent = false;

        boolean isSpanSent() {
            return this.spanSent;
        }

        @Override
        public Encoding encoding() {
            return Encoding.JSON;
        }

        @Override
        public int messageMaxBytes() {
            return Integer.MAX_VALUE;
        }

        @Override
        public int messageSizeInBytes(List<byte[]> encodedSpans) {
            return encoding().listSizeInBytes(encodedSpans);
        }

        @Override
        public Call<Void> sendSpans(List<byte[]> encodedSpans) {
            this.spanSent = true;
            return Call.create(null);
        }

    }

}
```

3.4. 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> ①
      <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> ②
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-sleuth</artifactId>
</dependency>
```

① We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself.

② Add the dependency to `spring-cloud-starter-sleuth`.

The following example shows how to add Sleuth with Gradle:

Gradle

```
dependencyManagement { ①
    imports {
        mavenBom "org.springframework.cloud:spring-cloud-
dependencies:${releaseTrainVersion}"
    }
}

dependencies { ②
    compile "org.springframework.cloud:spring-cloud-starter-sleuth"
}
```

① We recommend that you add the dependency management through the Spring BOM so that you need not manage versions yourself.

② Add the dependency to `spring-cloud-starter-sleuth`.

4. How Sleuth works

Spring Cloud Sleuth is a layer over Brave.

Brave is a distributed tracing instrumentation library. Brave typically intercepts production requests to gather timing data, correlate and propagate trace contexts.

Trace data, also called spans, are typically reported to Zipkin. Zipkin is an Open Source tracing system, which includes a UI and various collectors, such as HTTP and messaging.

Many Open Source and commercial products accept Zipkin format. Some options are documented here, but many are not. If you cannot use Zipkin and your product isn't listed, clarify with your support representative and have them update that page. In many cases, products already support Zipkin format, they just don't document it.

Traces connect from service to service using header propagation. The default format is B3. Similar to data formats, you can configure alternate header formats also, provided trace and span IDs are compatible with B3. Most notably, this means the trace ID and span IDs are lower-case hex, not UUIDs. Besides trace identifiers, other properties (Baggage) can also be passed along with the request. Remote Baggage must be predefined, but is flexible otherwise.

Sleuth configures everything you need to get started with tracing. Sleuth configures where trace data (spans) are reported to, how many traces to keep (sampling), if remote fields (baggage) are sent, and which libraries are traced. Sleuth also adds annotation based tracing features and some instrumentation not available otherwise, such as Reactor. If cannot find the configuration you are looking for in the documentation, ask Gitter before assuming something cannot be done.

4.1. Brave Basics

Most instrumentation work is done for you by default. Sleuth provides beans to allow you to change what's traced, and it even provides annotations to avoid using tracing libraries! All of this is explained later in this document.

That said, you might want to know more about how things work underneath. Here are some pointers.

Here are the most core types you might use:

- `SpanCustomizer` - to change the span currently in progress
- `Tracer` - to get a start new spans ad-hoc

Here are the most relevant links from the OpenZipkin Brave project:

- Brave's core library
- Baggage (propagated fields)
- HTTP tracing

5. Sampling

Sampling only applies to tracing backends, such as Zipkin. Trace IDs appear in logs regardless of sample rate. Sampling is a way to prevent overloading the system, by consistently tracing some, but not all requests.

The default rate of 10 traces per second is controlled by the `spring.sleuth.sampler.rate` property and applies when we know Sleuth is used for reasons besides logging. Use a rate above 100 traces per second with extreme caution as it can overload your tracing system.

The sampler can be set by Java Config also, as shown in the following example:

```
@Bean
public Sampler defaultSampler() {
    return Sampler.ALWAYS_SAMPLE;
}
```

You can set the HTTP header `b3` to `1`, or, when doing messaging, you can set the `spanFlags` header to `1`. Doing so forces the current request to be sampled regardless of configuration.

By default samplers will work with the refresh scope mechanism. That means that you can change the sampling properties at runtime, refresh the application and the changes will be reflected. However, sometimes the fact of creating a proxy around samplers and calling it from too early (from `@PostConstruct` annotated method) may lead to dead locks. In such a case either create a sampler bean explicitly, or set the property `spring.sleuth.sampler.refresh.enabled` to `false` to disable the refresh scope support.

6. Baggage

Baggage are fields that are propagated with the trace, optionally out of process. You can use properties to define fields that have no special configuration such as name mapping:

- `spring.sleuth.baggage.remote-fields` is a list of header names to accept and propagate to remote services.
- `spring.sleuth.baggage.local-fields` is a list of names to propagate locally

No prefixing applies with these keys. What you set is literally what is used.

A name set in either of these properties will result in a `BaggageField` of the same name.

In order to automatically set the baggage values to Slf4j's MDC, you have to set the `spring.sleuth.baggage.correlation-fields` property with a list of allowed local or remote keys. E.g. `spring.sleuth.baggage.correlation-fields=country-code` will set the value of the `country-code` baggage into MDC.

Remember that adding entries to MDC can drastically decrease the performance of your application!

If you want to add the baggage entries as tags, to make it possible to search for spans via the baggage entries, you can set the value of `spring.sleuth.baggage.tag-fields` with a list of allowed baggage keys. To disable the feature you have to pass the `spring.sleuth.propagation.tag.enabled=false` property.

6.1. Java configuration

If you need to do anything more advanced than above, do not define properties and instead use a `@Bean` config for the baggage fields you use.

- `BaggagePropagationCustomizer` sets up baggage fields
- Add a `SingleBaggageField` to control header names for a `BaggageField`.
- `CorrelationScopeCustomizer` sets up MDC fields
- Add a `SingleCorrelationField` to change the MDC name of a `BaggageField` or if updates flush.

7. 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).

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).

8. Span lifecycle

You can do the following operations on the Span by means of `brave.Tracer`:

- start: When you start a span, its name is assigned and the start timestamp is recorded.
- close: 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: A new instance of span is created. It is a copy of the one that it continues.
- detach: The span does not get stopped or closed. It only gets removed from the current thread.
- create with explicit parent: You can create a new span and set an explicit parent for it.

Spring Cloud Sleuth creates an instance of `Tracer` for you. In order to use it, you can autowire it.

8.1. 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.

Always clean after you create a span. Also, always finish any span that you want to send to Zipkin.

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.

8.2. 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.

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.toSpan(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();
}
```

8.3. 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();
    }
}
```

After creating such a span, you must finish it. Otherwise it is not reported (for example, to Zipkin).

9. 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 `controllerMethodName`
- `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.

9.1. `@SpanName` Annotation

You can name the span explicitly by using the `@SpanName` annotation, as shown in the following 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(this.tracing, spanNamer, new
TaxCountingRunnable());
Future<?> future = executorService.submit(runnable);
// ... some additional logic ...
future.get();
```

9.2. `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(this.tracing, spanNamer, new Runnable() {
    @Override
    public void run() {
        // perform logic
    }

    @Override
    public String toString() {
        return "calculateTax";
    }
});
Future<?> future = executorService.submit(runnable);
// ... some additional logic ...
future.get();
```

10. Managing Spans with Annotations

You can manage spans with a variety of annotations.

10.1. 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.

10.2. 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 `@NewSpan` annotation, the most concrete one wins (in this case `customNameOnTestMethod3` is set).

10.3. 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.

10.4. 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. **IMPORTANT** You can only reference properties from the SPEL expression. Method execution is not allowed due to security constraints.
3. If we do not find any expression to evaluate, return the `toString()` value of the parameter.

10.4.1. 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`.

10.4.2. Resolving Expressions for a Value

Consider the following annotated method:

```
@NewSpan
public void getAnnotationForTagValueExpression(
        @SpanTag(key = "test", expression = "'hello' + ' 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.

10.4.3. 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"`.

11. Customizations

The `Tracer` object is fully managed by sleuth, so you rarely need to affect it. That said, Sleuth supports a number of `Customizer` types, that allow you to configure anything not already done by Sleuth with auto-configuration or properties.

If you define one of the following as a `Bean`, Sleuth will invoke it to customize behaviour:

- `RpcTracingCustomizer` - for RPC tagging and sampling policy
- `HttpTracingCustomizer` - for HTTP tagging and sampling policy
- `MessagingTracingCustomizer` - for messaging tagging and sampling policy
- `CurrentTraceContextCustomizer` - to integrate decorators such as correlation.
- `BaggagePropagationCustomize`r - for propagating baggage fields in process and over headers
- `CorrelationScopeDecoratorCustomizer` - for scope decorations such as MDC (logging) field correlation

11.1. HTTP

11.1.1. Data Policy

The default span data policy for HTTP requests is described in Brave: github.com/openzipkin/brave/tree/master/instrumentation/http#span-data-policy

To add different data to the span, you need to register a bean of type `brave.http.HttpRequestParser` or `brave.http.HttpResponseParser` based on when the data is collected.

The bean names correspond to the request or response side, and whether it is a client or server. For example, `sleuthHttpClientRequestParser` changes what is collected before a client request is sent to the server.

For your convenience `@HttpClientRequestParser`, `@HttpClientResponseParser` and corresponding server annotations can be used to inject the proper beans or to reference the bean names via their static String `NAME` fields.

Here's an example adding the HTTP url in addition to defaults:

```
@Configuration
class Config {
  @Bean(name = { HttpClientRequestParser.NAME, HttpServerRequestParser.NAME })
  HttpRequestParser sleuthHttpServerRequestParser() {
      return (req, context, span) -> {
          HttpRequestParser.DEFAULT.parse(req, context, span);
          String url = req.url();
          if (url != null) {
              span.tag("http.url", url);
          }
      };
  }
}
```

11.1.2. Sampling

If client /server sampling is required, just register a bean of type `brave.sampler.SamplerFunction<HttpRequest>` and name the bean `sleuthHttpClientSampler` for client sampler and `sleuthHttpServerSampler` for server sampler.

For your convenience the `@HttpClientSampler` and `@HttpServerSampler` annotations 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 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, `Sampler<HttpRequest>`.

```
@Configuration
class Config {
  @Bean(name = HttpServerSampler.NAME)
  SamplerFunction<HttpRequest> myHttpSampler(SkipPatternProvider provider) {
      Pattern pattern = provider.skipPattern();
      return request -> {
          String url = request.path();
          boolean shouldSkip = pattern.matcher(url).matches();
          if (shouldSkip) {
              return false;
          }
          return null;
      };
  }
}
```

11.2. `TracingFilter`

You can also modify the behavior of the `TracingFilter`, 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 `TracingFilter` bean.

In the following example, we register the `TracingFilter` 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) {
            chain.doFilter(request, response);
            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);
    }

}
```

11.3. Messaging

Sleuth automatically configures the `MessagingTracing` bean which serves as a foundation for Messaging instrumentation such as Kafka or JMS.

If a customization of producer / consumer sampling of messaging traces is required, just register a bean of type `brave.sampler.SamplerFunction<MessagingRequest>` and name the bean `sleuthProducerSampler` for producer sampler and `sleuthConsumerSampler` for consumer sampler.

For your convenience the `@ProducerSampler` and `@ConsumerSampler` annotations can be used to inject the proper beans or to reference the bean names via their static String `NAME` fields.

Ex. Here's a sampler that traces 100 consumer requests per second, except for the "alerts" channel. Other requests will use a global rate provided by the `Tracing` component.

```
@Configuration
class Config {
}
```

For more, see github.com/openzipkin/brave/tree/master/instrumentation/messaging#sampling-policy

11.4. RPC

Sleuth automatically configures the `RpcTracing` bean which serves as a foundation for RPC instrumentation such as gRPC or Dubbo.

If a customization of client / server sampling of the RPC traces is required, just register a bean of type `brave.sampler.SamplerFunction<RpcRequest>` and name the bean `sleuthRpcClientSampler` for client sampler and `sleuthRpcServerSampler` for server sampler.

For your convenience the `@RpcClientSampler` and `@RpcServerSampler` annotations can be used to inject the proper beans or to reference the bean names via their static String `NAME` fields.

Ex. Here's a sampler that traces 100 "GetUserToken" server requests per second. This doesn't start new traces for requests to the health check service. Other requests will use the global sampling configuration.

```
@Configuration
class Config {
  @Bean(name = RpcServerSampler.NAME)
  SamplerFunction<RpcRequest> myRpcSampler() {
      Matcher<RpcRequest> userAuth = and(serviceEquals("users.UserService"),
methodEquals("GetUserToken"));
      return
RpcRuleSampler.newBuilder().putRule(serviceEquals("grpc.health.v1.Health"),
Sampler.NEVER_SAMPLE)
              .putRule(userAuth, RateLimitingSampler.create(100)).build();
  }
}
```

For more, see github.com/openzipkin/brave/tree/master/instrumentation/rpc#sampling-policy

11.5. 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.name` property. 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
```

11.6. 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 implementing a `SpanHandler`.

In Sleuth, we generate spans with a fixed name. Some users want to modify the name depending on values of tags. You can implement the `SpanHandler` interface to alter that name.

The following example shows how to register two beans that implement `SpanHandler`:

```
@Bean
SpanHandler handlerOne() {
    return new SpanHandler() {
        @Override
        public boolean end(TraceContext traceContext, MutableSpan span, Cause cause) {
            span.name("foo");
            return true; // keep this span
        }
    };
}

@Bean
SpanHandler handlerTwo() {
    return new SpanHandler() {
        @Override
        public boolean end(TraceContext traceContext, MutableSpan span, Cause cause) {
            span.name(span.name() + " bar");
            return true; // keep this span
        }
    };
}
```

The preceding example results in changing the name of the reported span to `foo bar`, just before it gets reported (for example, to Zipkin).

Sleuth registers a `SpanHandler` bean that can automatically skip reporting spans of given name patterns. The property `spring.sleuth.span-handler.span-name-patterns-to-skip` contains the default skip patterns for span names. The property `spring.sleuth.span-handler.additional-span-name-patterns-to-skip` will append the provided span name patterns to the existing ones. In order to disable this functionality just set `spring.sleuth.span-handler.enabled` to `false`.

11.7. Host Locator

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
```

12. 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: https://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: https://zipkinserver/
```

To disable this feature just set `spring.zipkin.discoveryClientEnabled` to `false.

When the Discovery Client feature is enabled, Sleuth uses `LoadBalancerClient` to find the URL of the Zipkin Server. It means that you can set up the load balancing configuration e.g. via Ribbon.

```
zipkinserver:
  ribbon:
    ListOfServers: host1,host2
```

If you have web, rabbit, activemq 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`, `activemq` or `kafka` to the `spring.zipkin.sender.type` property. The following example shows setting the sender type for `web`:

```
spring.zipkin.sender.type: web
```

To customize the `RestTemplate` that sends spans to Zipkin via HTTP, you can register the `ZipkinRestTemplateCustomizer` bean.

```
@Configuration
class MyConfig {
    @Bean ZipkinRestTemplateCustomizer myCustomizer() {
        return new ZipkinRestTemplateCustomizer() {
            @Override
            void customize(RestTemplate restTemplate) {
                // customize the RestTemplate
            }
        };
    }
}
```

If, however, you would like to control the full process of creating the `RestTemplate` object, you will have to create a bean of `zipkin2.reporter.Sender` type.

```
    @Bean Sender myRestTemplateSender(ZipkinProperties zipkin,
            ZipkinRestTemplateCustomizer zipkinRestTemplateCustomizer) {
        RestTemplate restTemplate = mySuperCustomRestTemplate();
        zipkinRestTemplateCustomizer.customize(restTemplate);
        return myCustomSender(zipkin, restTemplate);
    }
```

13. Integrations

13.1. OpenTracing

Spring Cloud Sleuth is compatible with OpenTracing. 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`

13.2. 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(this.tracing, spanNamer, runnable,
"calculateTax");
// Wrapping `Runnable` with `Tracing`. That way the current span will be available
// in the thread of `Runnable`
Runnable traceRunnableFromTracer = this.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<>(this.tracing, spanNamer,
callable, "calculateTax");
// Wrapping `Callable` with `Tracing`. That way the current span will be available
// in the thread of `Callable`
Callable<String> traceCallableFromTracer =
this.tracing.currentTraceContext().wrap(callable);
```

That way, you ensure that a new span is created and closed for each execution.

13.3. Spring Cloud CircuitBreaker

If you have Spring Cloud CircuitBreaker on the classpath, we will wrap the passed command `Supplier` and the fallback `Function` in its trace representations. In order to disable this instrumentation set `spring.sleuth.circuitbreaker.enabled` to `false`.

13.4. RxJava

We registering a custom `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.

The suggest approach to reactive programming and Sleuth is to use the Reactor support.

13.5. HTTP integration

Features from this section can be disabled by setting the `spring.sleuth.web.enabled` property with value equal to `false`.

13.5.1. HTTP Filter

Through the `TracingFilter`, 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` 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`.

By default, all the spring boot actuator endpoints are automatically added to the skip pattern. If you want to disable this behaviour set `spring.sleuth.web.ignore-auto-configured-skip-patterns` to `true`.

To change the order of tracing filter registration, please set the `spring.sleuth.web.filter-order` property.

To disable the filter that logs uncaught exceptions you can disable the `spring.sleuth.web.exception-throwing-filter-enabled` property.

13.5.2. 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 `TracingFilter` does 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.

13.5.3. 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.

13.5.4. 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`.

In order to achieve best results in terms of performance and context propagation we suggest that you switch the `spring.sleuth.reactor.instrumentation-type` to `MANUAL`. In order to execute code with the span in scope you can call `WebFluxSleuthOperators.withSpanInScope`.

To change the order of tracing filter registration, please set the `spring.sleuth.web.filter-order` property.

13.5.5. Dubbo RPC support

Via the integration with Brave, Spring Cloud Sleuth supports Dubbo. It's enough to add the `brave-instrumentation-dubbo` dependency:

```
<dependency>
    <groupId>io.zipkin.brave</groupId>
    <artifactId>brave-instrumentation-dubbo</artifactId>
</dependency>
```

You need to also set a `dubbo.properties` file with the following contents:

```
dubbo.provider.filter=tracing
dubbo.consumer.filter=tracing
```

You can read more about Brave - Dubbo integration here. An example of Spring Cloud Sleuth and Dubbo can be found here.

13.6. HTTP Client Integration

13.6.1. 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`.

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.

13.6.2. Asynchronous Rest Template

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;
    }

}
```

13.6.3. `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`.

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.

13.6.4. Traverson

If you use the 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("https://some/address"),
    MediaType.APPLICATION_JSON,
MediaType.APPLICATION_JSON_UTF8).setRestOperations(restTemplate);
// use Traverson
```

13.6.5. 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`.

13.6.6. Netty `HttpClient`

We instrument the Netty's `HttpClient`.

To block this feature, set `spring.sleuth.web.client.enabled` to `false`.

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.

13.6.7. `UserInfoRestTemplateCustomizer`

We instrument the Spring Security's `UserInfoRestTemplateCustomizer`.

To block this feature, set `spring.sleuth.web.client.enabled` to `false`.

13.7. 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.

13.8. gRPC

Spring Cloud Sleuth provides instrumentation for gRPC through `TraceGrpcAutoConfiguration`. You can disable it entirely by setting `spring.sleuth.grpc.enabled` to `false`.

13.8.1. Variant 1

Dependencies

The gRPC integration relies on two external libraries to instrument clients and servers and both of those libraries must be on the class path to enable the instrumentation.

Maven:

```
<dependency>
    <groupId>io.github.lognet</groupId>
    <artifactId>grpc-spring-boot-starter</artifactId>
</dependency>
<dependency>
    <groupId>io.zipkin.brave</groupId>
    <artifactId>brave-instrumentation-grpc</artifactId>
</dependency>
```

Gradle:

```
compile("io.github.lognet:grpc-spring-boot-starter")
compile("io.zipkin.brave:brave-instrumentation-grpc")
```

Server Instrumentation

Spring Cloud Sleuth leverages grpc-spring-boot-starter to register Brave's gRPC server interceptor with all services annotated with `@GRpcService`.

Client Instrumentation

gRPC clients leverage a `ManagedChannelBuilder` to construct a `ManagedChannel` used to communicate to the gRPC server. The native `ManagedChannelBuilder` provides static methods as entry points for construction of `ManagedChannel` instances, however, this mechanism is outside the influence of the

Spring application context.

Spring Cloud Sleuth provides a `SpringAwareManagedChannelBuilder` that can be customized through the Spring application context and injected by gRPC clients. **This builder must be used when creating `ManagedChannel` instances.**

Sleuth creates a `TracingManagedChannelBuilderCustomizer` which inject Brave's client interceptor into the `SpringAwareManagedChannelBuilder`.

13.8.2. Variant 2

Grpc Spring Boot Starter automatically detects the presence of Spring Cloud Sleuth and brave's instrumentation for gRPC and registers the necessary client and/or server tooling.

13.9. Asynchronous Communication

13.9.1. `@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.

13.9.2. `@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.

13.9.3. 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"));
```

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.

If there are beans that implement the `Executor` interface that you would like to exclude from span creation, you can use the `spring.sleuth.async.ignored-beans` property where you can provide a list of bean names.

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
// add the infrastructure role to ensure that the bean gets auto-proxied
@Role(BeanDefinition.ROLE_INFRASTRUCTURE)
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);
    }

}
```

To ensure that your configuration gets post processed, remember to add the `@Role(BeanDefinition.ROLE_INFRASTRUCTURE)` on your `@Configuration` class

13.10. Messaging

Features from this section can be disabled by setting the `spring.sleuth.messaging.enabled` property with value equal to `false`.

13.10.1. Spring Integration

Spring Cloud Sleuth integrates with 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 but `hystrixStreamOutput` channel are included.

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.

If you want to customize the way tracing context is read from and written to message headers, it's enough for you to register beans of types:

- `Propagation.Setter<MessageHeaderAccessor, String>` - for writing headers to the message
- `Propagation.Getter<MessageHeaderAccessor, String>` - for reading headers from the message

13.10.2. Spring Cloud Function and Spring Cloud Stream

Spring Cloud Sleuth can instrument Spring Cloud Function. The way to achieve it is to provide a `Function` or `Consumer` or `Supplier` that takes in a `Message` as a parameter e.g. `Function<Message<String>, Message<Integer>>`. If the type is not `Message` then instrumentation will not take place. Out of the box instrumentation will not take place when dealing with Reactor based streams - e.g. `Function<Flux<Message<String>>, Flux<Message<Integer>>>`.

Since Spring Cloud Stream reuses Spring Cloud Function, you'll get the instrumentation out of the box.

You can disable this behavior by setting the value of `spring.sleuth.function.enabled` to `false`.

In order to work with reactive Stream functions you can leverage the `MessagingSleuthOperators` utility class that allows you to manipulate the input and output messages in order to continue the tracing context and to execute custom code within the tracing context.

```
class SimpleReactiveManualFunction implements Function<Flux<Message<String>>,
Flux<Message<String>>> {

    private static final Logger log =
LoggerFactory.getLogger(SimpleReactiveFunction.class);

    private final Tracing tracing;

    SimpleReactiveManualFunction(Tracing tracing) {
        this.tracing = tracing;
    }

    @Override
    public Flux<Message<String>> apply(Flux<Message<String>> input) {
        return input.map(message -> (MessagingSleuthOperators.asFunction(this.tracing,
message))
                .andThen(msg -> MessagingSleuthOperators.withSpanInScope(this.tracing,
msg, stringMessage -> {
                    log.info("Hello from simple manual [{}]",
stringMessage.getPayload());
                    return stringMessage;
                })).andThen(msg ->
MessagingSleuthOperators.afterMessageHandled(this.tracing, msg, null))
                .andThen(msg ->
MessageBuilder.createMessage(msg.getPayload().toUpperCase(), msg.getHeaders()))
                .andThen(msg ->
MessagingSleuthOperators.handleOutputMessage(this.tracing, msg)).apply(message));
    }

}
```

13.10.3. 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`.

13.10.4. 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`.

13.10.5. Spring Kafka Streams

We instrument the `KafkaStreams KafkaClientSupplier` so that tracing headers get injected into the `Producer` and `Consumer`s. A `KafkaStreamsTracing` bean allows for further instrumentation through additional `TransformerSupplier` and `ProcessorSupplier` methods.

To block this feature, set `spring.sleuth.messaging.kafka.streams.enabled` to `false`.

13.10.6. Spring JMS

We instrument the `JmsTemplate` so that tracing headers get injected into the message. We also support `@JmsListener` annotated methods on the consumer side.

To block this feature, set `spring.sleuth.messaging.jms.enabled` to `false`.

We don't support baggage propagation for JMS

13.10.7. Spring Cloud AWS Messaging SQS

We instrument `@SqsListener` which is provided by `org.springframework.cloud:spring-cloud-aws-messaging` so that tracing headers get extracted from the message and a trace gets put into the context.

To block this feature, set `spring.sleuth.messaging.sqs.enabled` to `false`.

13.11. Redis

We set `tracing` property to Lettcue `ClientResources` instance to enable Brave tracing built in Lettuce . To disable Redis support, set the `spring.sleuth.redis.enabled` property to `false`.

13.12. Quartz

We instrument quartz jobs by adding Job/Trigger listeners to the Quartz Scheduler.

To turn off this feature, set the `spring.sleuth.quartz.enabled` property to `false`.

13.13. Project Reactor

We have three modes of instrumenting reactor based applications that can be set via `spring.sleuth.reactor.instrumentation-type` property:

- `ON_EACH` - wraps every Reactor operator in a trace representation. Passes the tracing context in most cases. This mode might lead to drastic performance degradation.
- `ON_LAST` - wraps last Reactor operator in a trace representation. Passes the tracing context in some cases thus accessing MDC context might not work. This mode might lead to medium performance degradation.
- `MANUAL` - wraps every Reactor in the least invasive way without passing of tracing context. It's up to the user to do it.

Current default is `ON_EACH` for backward compatibility reasons, however we encourage the users to migrate to the `MANUAL` instrumentation and profit from `WebFluxSleuthOperators` and `MessagingSleuthOperators`. The performance improvement can be substantial. Example:

```
@GetMapping("/simpleManual")
public Mono<String> simpleManual() {
    return Mono.just("hello").map(String::toUpperCase).doOnEach(WebFluxSleuthOperators
            .withSpanInScope(SignalType.ON_NEXT, signal -> log.info("Hello from simple
[{}]", signal.get())));
}
```

14. Log integration

Sleuth configures the logging context with variables including the service name (`%{spring.zipkin.service.name}`) and the trace ID (`%{traceId}`). These help you connect logs with distributed traces and allow you choice in what tools you use to troubleshoot your services.

If you use a log aggregating tool (such as Kibana, Splunk, and others), you can order the events that took place. An example from Kibana would resemble the following image:

[Log correlation with Kibana] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/src/main/asciidoc/images/kibana.png

If you want to use Logstash, the following listing shows the Grok pattern for Logstash:

```
filter {
  # pattern matching logback pattern
  grok {
    match => { "message" =>
"%{TIMESTAMP_ISO8601:timestamp}\s+%{LOGLEVEL:severity}\s+\[%{DATA:service},%{DATA:trac
e},%{DATA:span}\]\s+%{DATA:pid}\s+---
\s+\[%{DATA:thread}\]\s+%{DATA:class}\s+:\s+%{GREEDYDATA:rest}" }
  }
  date {
    match => ["timestamp", "ISO8601"]
  }
  mutate {
    remove_field => ["timestamp"]
  }
}
```

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+\[%{DATA:service},%
{DATA:trace},%{DATA:span}\]\s+%{DATA:pid}\s+---
\s+\[%{DATA:thread}\]\s+%{DATA:class}\s+:\s+%{GREEDYDATA:rest}" }
  }
  date {
    match => ["timestamp", "ISO8601"]
  }
  mutate {
    remove_field => ["timestamp"]
  }
}
```

14.1. 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 (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>${LOG_FILE}.json.%d{yyyy-MM-dd}.gz</fileNamePattern>
            <maxHistory>7</maxHistory>
        </rollingPolicy>
        <encoder
class="net.logstash.logback.encoder.LoggingEventCompositeJsonEncoder">
            <providers>
                <timestamp>
                    <timeZone>UTC</timeZone>
                </timestamp>
                <pattern>
                    <pattern>
                        {
                        "timestamp": "@timestamp",
                        "severity": "%level",
                        "service": "${springAppName:-}",
                        "trace": "%X{traceId:-}",
                        "span": "%X{spanId:-}",
                        "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.

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.

15. Configuration properties

To see the list of all Sleuth related configuration properties please check the Appendix page.

3.1.0-M3

16. Preface

16.1. A Brief History of Spring's Data Integration Journey

Spring's journey on Data Integration started with Spring Integration. With its programming model, it provided a consistent developer experience to build applications that can embrace Enterprise Integration Patterns to connect with external systems such as, databases, message brokers, and among others.

Fast forward to the cloud-era, where microservices have become prominent in the enterprise setting. Spring Boot transformed the way how developers built Applications. With Spring's programming model and the runtime responsibilities handled by Spring Boot, it became seamless to develop stand-alone, production-grade Spring-based microservices.

To extend this to Data Integration workloads, Spring Integration and Spring Boot were put together into a new project. Spring Cloud Stream was born.

With Spring Cloud Stream, developers can:

- Build, test and deploy data-centric applications in isolation.
- Apply modern microservices architecture patterns, including composition through messaging.
- Decouple application responsibilities with event-centric thinking. An event can represent something that has happened in time, to which the downstream consumer applications can react without knowing where it originated or the producer's identity.
- Port the business logic onto message brokers (such as RabbitMQ, Apache Kafka, Amazon Kinesis).
- Rely on the framework's automatic content-type support for common use-cases. Extending to different data conversion types is possible.
- and many more. . .

16.2. Quick Start

You can try Spring Cloud Stream in less then 5 min even before you jump into any details by following this three-step guide.

We show you how to create a Spring Cloud Stream application that receives messages coming from the messaging middleware of your choice (more on this later) and logs received messages to the

console. We call it `LoggingConsumer`. While not very practical, it provides a good introduction to some of the main concepts and abstractions, making it easier to digest the rest of this user guide.

The three steps are as follows:

1. Creating a Sample Application by Using Spring Initializr
2. Importing the Project into Your IDE
3. Adding a Message Handler, Building, and Running

16.2.1. Creating a Sample Application by Using Spring Initializr

To get started, visit the Spring Initializr. From there, you can generate our `LoggingConsumer` application. To do so:

1. In the **Dependencies** section, start typing `stream`. When the "Cloud Stream" option should appears, select it.
2. Start typing either 'kafka' or 'rabbit'.
3. Select "Kafka" or "RabbitMQ".

   Basically, you choose the messaging middleware to which your application binds. We recommend using the one you have already installed or feel more comfortable with installing and running. Also, as you can see from the Initilaizer screen, there are a few other options you can choose. For example, you can choose Gradle as your build tool instead of Maven (the default).

4. In the **Artifact** field, type 'logging-consumer'.

   The value of the **Artifact** field becomes the application name. If you chose RabbitMQ for the middleware, your Spring Initializr should now be as follows:

[spring initializr] | */docs/src/main/asciidoc/images/spring-initializr.png*

1. Click the **Generate Project** button.

   Doing so downloads the zipped version of the generated project to your hard drive.

2. Unzip the file into the folder you want to use as your project directory.

We encourage you to explore the many possibilities available in the Spring Initializr. It lets you create many different kinds of Spring applications.

16.2.2. Importing the Project into Your IDE

Now you can import the project into your IDE. Keep in mind that, depending on the IDE, you may need to follow a specific import procedure. For example, depending on how the project was generated (Maven or Gradle), you may need to follow specific import procedure (for example, in Eclipse or STS, you need to use File → Import → Maven → Existing Maven Project).

Once imported, the project must have no errors of any kind. Also, `src/main/java` should contain `com.example.loggingconsumer.LoggingConsumerApplication`.

Technically, at this point, you can run the application's main class. It is already a valid Spring Boot application. However, it does not do anything, so we want to add some code.

16.2.3. Adding a Message Handler, Building, and Running

Modify the `com.example.loggingconsumer.LoggingConsumerApplication` class to look as follows:

```
@SpringBootApplication
public class LoggingConsumerApplication {

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

    @Bean
    public Consumer<Person> log() {
        return 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 preceding listing:

- We are using functional programming model (see Spring Cloud Function support) to define a single message handler as `Consumer`.
- We are relying on framework conventions to bind such handler to the input destination binding exposed by the binder.

Doing so also lets you see one of the core features of the framework: It tries to automatically convert incoming message payloads to type `Person`.

You now have a fully functional Spring Cloud Stream application that does listens for messages.

From here, for simplicity, we assume you selected RabbitMQ in step one. Assuming you have RabbitMQ installed and running, you can start the application by running its `main` method in your IDE.

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 the RabbitMQ management console or any other RabbitMQ client and send a message to `input.anonymous.CbMIwdkJSBO1ZoPDOtHtCg`. The `anonymous.CbMIwdkJSBO1ZoPDOtHtCg` part represents the group name and is generated, so it is bound to be different in your environment. For something more predictable, you can use an explicit group name by setting `spring.cloud.stream.bindings.input.group=hello` (or whatever name you like).

The contents of the message should be a JSON representation of the `Person` class, as follows:

```
{"name":"Sam Spade"}
```

Then, in your console, you should see:

```
Received: Sam Spade
```

You can also build and package your application into a boot jar (by using `./mvnw clean install`) and run the built JAR by using the `java -jar` command.

Now you have a working (albeit very basic) Spring Cloud Stream application.

17. What's New in 3.0?

17.1. New Features and Enhancements

- **Routing Function** - see [Routing with functions] for more details.
- **Multiple bindings with functions** (multiple message handlers) - see Multiple functions in a single application for more details.
- **Functions with multiple inputs/outputs** (single function that can subscribe or target multiple

destinations) - see Functions with multiple input and output arguments for more details.

- **Native support for reactive programming** - since v3.0.0 we no longer distribute spring-cloud-stream-reactive modules and instead relying on native reactive support provided by spring cloud function. For backward compatibility you can still bring `spring-cloud-stream-reactive` from previous versions.

17.2. Notable Deprecations

- *Reactive module* (`spring-cloud-stream-reactive`) is discontinued and no longer distributed in favor of native support via spring-cloud-function. For backward compatibility you can still bring `spring-cloud-stream-reactive` from previous versions.
- *Test support binder* `spring-cloud-stream-test-support` with MessageCollector in favor of a new test binder. See Testing for more details.
- *@StreamMessageConverter* - deprecated as it is no longer required.
- The `original-content-type` header references have been removed after it's been deprecated in v2.0.
- The `BinderAwareChannelResolver` is deprecated in favor if providing `spring.cloud.stream.sendto.destination` property. This is primarily for function-based programming model. For StreamListener it would still be required and thus will stay until we deprecate and eventually discontinue StreamListener and annotation-based programming model.

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.

18. 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.

By adding `spring-cloud-stream` dependencies to the classpath of your application, you get immediate connectivity to a message broker exposed by the provided `spring-cloud-stream` binder (more on that later), and you can implement your functional requirement, which is run (based on the incoming message) by a `java.util.function.Function`.

The following listing shows a quick example:

```
@SpringBootApplication
public class SampleApplication {

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

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }
}
```

The following listing shows the corresponding test:

```
@SpringBootTest(classes =  SampleApplication.class)
@Import({TestChannelBinderConfiguration.class})
class BootTestStreamApplicationTests {

    @Autowired
    private InputDestination input;

    @Autowired
    private OutputDestination output;

    @Test
    void contextLoads() {
        input.send(new GenericMessage<byte[]>("hello".getBytes()));
        assertThat(output.receive().getPayload()).isEqualTo("HELLO".getBytes());
    }
}
```

19. 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 SPI

19.1. Application Model

A Spring Cloud Stream application consists of a middleware-neutral core. The application communicates with the outside world by establishing *bindings* between destinations exposed by the external brokers and input/output arguments in your code. Broker specific details necessary to establish bindings are handled by middleware-specific *Binder* implementations.

[SCSt with binder] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/SCSt-with-binder.png

Figure 7. Spring Cloud Stream Application

19.1.1. Fat JAR

Spring Cloud Stream applications can be run in stand-alone 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. See the Spring Boot Reference Guide for more details.

19.2. The Binder Abstraction

Spring Cloud Stream provides Binder implementations for Kafka and Rabbit MQ. The framework also includes a test binder for integration testing of your applications as spring-cloud-stream application. See Testing section for more details.

Binder abstraction is also one of the extension points of the framework, which means you can implement your own binder on top of Spring Cloud Stream. In the How to create a Spring Cloud Stream Binder from scratch post a community member documents in details, with an example, a set of steps necessary to implement a custom binder. The steps are also highlighted in the `Implementing Custom Binders` section.

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 mapping between the external destinations (such as the Kafka topics or RabbitMQ exchanges) and inputs and outputs of the message handler (such as input parameter of the function and its return argument). 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 Introducing Spring Cloud Stream section, setting the `spring.cloud.stream.bindings.input.destination` application property to `raw-sensor-data` causes 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 use different types of middleware with the same code. To do so, 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 bindings) at runtime.

19.3. 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.

[SCSt sensors] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/SCSt-sensors.png

Figure 8. 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 (Hadoop Distributed File System). 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 lets new applications 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.

19.4. 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 so, 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.<bindingName>.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.<bindingName>.group=hdfsWrite` or `spring.cloud.stream.bindings.<bindingName>.group=average`.

[SCSt groups] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/SCSt-groups.png

Figure 9. Spring Cloud Stream Consumer Groups

All groups that 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.

19.5. 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. A message is delivered as soon as it is available and a thread is available to process it.

When you wish to control the rate at which messages are processed, you might want to use a synchronous consumer.

19.5.1. 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 that, once at least one subscription for a group has been created, the group receives messages, even if they are sent while all applications in the group are stopped.

Anonymous subscriptions are non-durable by nature. For some binder implementations (such as 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. Doing so prevents the application's instances from receiving duplicate messages (unless that behavior is desired, which is unusual).

19.6. 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 (such as 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 (for example, Kafka) or not (for example, RabbitMQ).

[SCSt partitioning] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/SCSt-partitioning.png

Figure 10. 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.

To set up a partitioned processing scenario, you must configure both the data-producing and the data-consuming ends.

20. Programming Model

To understand the programming model, you should be familiar with the following core concepts:

- **Destination Binders:** Components responsible to provide integration with the external messaging systems.
- **Bindings:** Bridge between the external messaging systems and application provided *Producers* and *Consumers* of messages (created by the Destination Binders).
- **Message:** The canonical data structure used by producers and consumers to communicate with Destination Binders (and thus other applications via external messaging systems).

[SCSt overview] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/SCSt-overview.png

20.1. Destination Binders

Destination Binders are extension components of Spring Cloud Stream responsible for providing the necessary configuration and implementation to facilitate integration with external messaging systems. This integration is responsible for connectivity, delegation, and routing of messages to and from producers and consumers, data type conversion, invocation of the user code, and more.

Binders handle a lot of the boiler plate responsibilities that would otherwise fall on your shoulders. However, to accomplish that, the binder still needs some help in the form of minimalistic yet required set of instructions from the user, which typically come in the form of some type of *binding* configuration.

While it is out of scope of this section to discuss all of the available binder and binding configuration options (the rest of the manual covers them extensively), *Binding* as a concept, does require special attention. The next section discusses it in detail.

20.2. Bindings

As stated earlier, *Bindings* provide a bridge between the external messaging system (e.g., queue, topic etc.) and application-provided *Producers* and *Consumers*.

The following example shows a fully configured and functioning Spring Cloud Stream application that receives the payload of the message as a `String` type (see Content Type Negotiation section), logs it to the console and sends it down stream after converting it to upper case.

```
@SpringBootApplication
public class SampleApplication {

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

    @Bean
    public Function<String, String> uppercase() {
        return value -> {
            System.out.println("Received: " + value);
            return value.toUpperCase()
        };
    }
}
```

Unlike previous versions of spring-cloud-stream which relied on `@EnableBinding` and `@StreamListener` annotations, the above example looks no different then any vanilla spring-boot application. It defines a single bean of type `Function` and that it is. So, how does it became spring-cloud-stream application? It becomes spring-cloud-stream application simply based on the presence of spring-cloud-stream and binder dependencies and auto-configuration classes on the

classpath effectively setting the context for your boot application as spring-cloud-stream application. And in this context beans of type `Supplier`, `Function` or `Consumer` are treated as defacto message handlers triggering binding of to destinations exposed by the provided binder following certain naming conventions and rules to avoid extra configuration.

20.2.1. Binding and Binding names

Binding is an abstraction that represents a bridge between sources and targets exposed by the binder and user code, This abstraction has a name and while we try to do our best to limit configuration required to run spring-cloud-stream applications, being aware of such name(s) is necessary for cases where additional per-binding configuration is required.

Throughout this manual you will see examples of configuration properties such as `spring.cloud.stream.bindings.input.destination=myQueue`. The `input` segment in this property name is what we refer to as *binding name* and it could derive via several mechanisms. The following sub-sections will describe the naming conventions and configuration elements used by spring-cloud-stream to control binding names.

Functional binding names

Unlike the explicit naming required by annotation-based support (legacy) used in the previous versions of spring-cloud-stream, the functional programming model defaults to a simple convention when it comes to binding names, thus greatly simplifying application configuration. Let's look at the first example:

```
@SpringBootApplication
public class SampleApplication {

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }
}
```

In the preceding example we have an application with a single function which acts as message handler. As a `Function` it has an input and output. The naming convention used to name input and output bindings is as follows:

- input - `<functionName> + -in- + <index>`
- output - `<functionName> + -out- + <index>`

The `in` and `out` corresponds to the type of binding (such as *input* or *output*). The `index` is the index of the input or output binding. It is always 0 for typical single input/output function, so it's only relevant for Functions with multiple input and output arguments.

So if for example you would want to map the input of this function to a remote destination (e.g., topic, queue etc) called "my-topic" you would do so with the following property:

```
--spring.cloud.stream.bindings.uppercase-in-0.destination=my-topic
```

Note how `uppercase-in-0` is used as a segment in property name. The same goes for `uppercase-out-0`.

Descriptive Binding Names

Some times to improve readability you may want to give your binding a more descriptive name (such as 'account', 'orders` etc). Another way of looking at it is you can map an *implicit binding name* to an *explicit binding name*. And you can do it with `spring.cloud.stream.function.bindings.<binding-name>` property. This property also provides a migration path for existing applications that rely on custom interface-based bindings that require explicit names.

For example,

```
--spring.cloud.stream.function.bindings.uppercase-in-0=input`
```

In the preceding example you mapped and effectively renamed `uppercase-in-0` binding name to `input`. Now all configuration properties can refer to `input` binding name instead (e.g., `--spring.cloud.stream.bindings.input.destination=my-topic`).

While descriptive binding names may enhance the readability aspect of the configuration, they also create another level of misdirection by mapping an implicit binding name to an explicit binding name. And since all subsequent configuration properties will use the explicit binding name you must always refer to this 'bindings' property to correlate which function it actually corresponds to. We believe that for most cases (with the exception of Functional Composition) it may be an overkill, so, it is our recommendation to avoid using it altogether, especially since not using it provides a clear path between binder destination and binding name, such as `spring.cloud.stream.bindings.uppercase-in-0.destination=sample-topic`, where you are clearly correlating the input of `uppercase` function to `sample-topic` destination.

For more on properties and other configuration options please see Configuration Options section.

Annotation-based binding names (legacy)

In previous versions of spring-cloud-stream *binding* names and in fact implementations, derived from the `@EnableBinding` annotation which typically would take one or more interface classes as parameters. The parameters are referred to as *bindings*, and they contain methods representing *bindable components*.

For compliance with legacy style applications we still support this annotation-based programming model and you can get more information about it in Annotation-based support (legacy) section (sub-section of the Programming Model section).

Spring Cloud Stream already provides *binding* interfaces for typical message exchange contracts,

which include:

- **Sink:** Identifies the contract for the message consumer by providing the destination from which the message is consumed.
- **Source:** Identifies the contract for the message producer by providing the destination to which the produced message is sent.
- **Processor:** Encapsulates both the sink and the source contracts by exposing two destinations that allow consumption and production of messages.

```
public interface Sink {

  String INPUT = "input";

  @Input(Sink.INPUT)
  SubscribableChannel input();
}
```

```
public interface Source {

  String OUTPUT = "output";

  @Output(Source.OUTPUT)
  MessageChannel output();
}
```

```
public interface Processor extends Source, Sink {}
```

And you can define your own interfaces as well

```
public interface MyBinding {

  String FOO = "foo";

  @Output(MyBinding.FOO)
  MessageChannel foo();
}
```

The reason why `@EnableBinding` and binding interfaces are not required with functional programming model is because they could be derived from the type of functional interface itself. For example, *Processor* = *Function*, *Source* = *Supplier* and so on.

Pollable Destination Binding

While the previously described bindings support event-based message consumption, sometimes you need more control, such as rate of consumption.

Starting with version 2.0, you can now bind a pollable consumer:

The following example shows how to bind a pollable consumer:

```
public interface PolledBarista {

    @Input
    PollableMessageSource orders();
    . . .
}
```

In this case, an implementation of `PollableMessageSource` is bound to the `orders` "channel". See Using Polled Consumers for more details.

20.3. Producing and Consuming Messages

You can write a Spring Cloud Stream application by simply writing functions and exposing them as `@Bean`s. You can also use Spring Integration annotations based configuration or Spring Cloud Stream annotation based configuration, although starting with spring-cloud-stream 3.x we recommend using functional implementations.

20.3.1. Spring Cloud Function support

Overview

Since Spring Cloud Stream v2.1, another alternative for defining *stream handlers* and *sources* is to use build-in support for Spring Cloud Function where they can be expressed as beans of type `java.util.function.[Supplier/Function/Consumer]`.

To specify which functional bean to bind to the external destination(s) exposed by the bindings, you must provide `spring.cloud.function.definition` property.

In the event you only have single bean of type `java.util.function.[Supplier/Function/Consumer]`, you can skip the `spring.cloud.function.definition` property, since such functional bean will be auto-discovered. However, it is considered best practice to use such property to avoid any confusion.

Here is the example of the application exposing message handler as `java.util.function.Function` effectively supporting *pass-thru* semantics by acting as consumer and producer of data.

```
@SpringBootApplication
public class MyFunctionBootApp {

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

    @Bean
    public Function<String, String> toUpperCase() {
        return s -> s.toUpperCase();
    }
}
```

In the preceding example, we define a bean of type `java.util.function.Function` called *toUpperCase* to be acting as message handler whose 'input' and 'output' must be bound to the external destinations exposed by the provided destination binder. By default the 'input' and 'output' binding names will be `toUpperCase-in-0` and `toUpperCase-out-0`. Please see Functional binding names section for details on naming convention used to establish binding names.

Below are the examples of simple functional applications to support other semantics:

Here is the example of a *source* semantics exposed as `java.util.function.Supplier`

```
@SpringBootApplication
public static class SourceFromSupplier {

    @Bean
    public Supplier<Date> date() {
        return () -> new Date(12345L);
    }
}
```

Here is the example of a *sink semantics* exposed as `java.util.function.Consumer`

```
@SpringBootApplication
public static class SinkFromConsumer {

    @Bean
    public Consumer<String> sink() {
        return System.out::println;
    }
}
```

Suppliers (Sources)

`Function` and `Consumer` are pretty straightforward when it comes to how their invocation is triggered. They are triggered based on data (events) sent to the destination they are bound to. In

other words, they are classic event-driven components.

However, `Supplier` is in its own category when it comes to triggering. Since it is, by definition, the source (the origin) of the data, it does not subscribe to any in-bound destination and, therefore, has to be triggered by some other mechanism(s). There is also a question of `Supplier` implementation, which could be *imperative* or *reactive* and which directly relates to the triggering of such suppliers.

Consider the following sample:

```
@SpringBootApplication
public static class SupplierConfiguration {

    @Bean
    public Supplier<String> stringSupplier() {
        return () -> "Hello from Supplier";
    }
}
```

The preceding `Supplier` bean produces a string whenever its `get()` method is invoked. However, who invokes this method and how often? The framework provides a default polling mechanism (answering the question of "Who?") that will trigger the invocation of the supplier and by default it will do so every second (answering the question of "How often?"). In other words, the above configuration produces a single message every second and each message is sent to an `output` destination that is exposed by the binder. To learn how to customize the polling mechanism, see Polling Configuration Properties section.

Consider a different example:

```
@SpringBootApplication
public static class SupplierConfiguration {

    @Bean
    public Supplier<Flux<String>> stringSupplier() {
        return () -> Flux.fromStream(Stream.generate(new Supplier<String>() {
            @Override
            public String get() {
                try {
                    Thread.sleep(1000);
                    return "Hello from Supplier";
                } catch (Exception e) {
                    // ignore
                }
            }
        })).subscribeOn(Schedulers.elastic()).share();
    }
}
```

The preceding `Supplier` bean adopts the reactive programming style. Typically, and unlike the

imperative supplier, it should be triggered only once, given that the invocation of its `get()` method produces (supplies) the continuous stream of messages and not an individual message.

The framework recognizes the difference in the programming style and guarantees that such a supplier is triggered only once.

However, imagine the use case where you want to poll some data source and return a finite stream of data representing the result set. The reactive programming style is a perfect mechanism for such a Supplier. However, given the finite nature of the produced stream, such Supplier still needs to be invoked periodically.

Consider the following sample, which emulates such use case by producing a finite stream of data:

```
@SpringBootApplication
public static class SupplierConfiguration {

    @PollableBean
    public Supplier<Flux<String>> stringSupplier() {
        return () -> Flux.just("hello", "bye");
    }
}
```

The bean itself is annotated with `PollableBean` annotation (sub-set of `@Bean`), thus signaling to the framework that although the implementation of such a supplier is reactive, it still needs to be polled.

There is a `splittable` attribute defined in `PollableBean` which signals to the post processors of this annotation that the result produced by the annotated component has to be split and is set to `true` by default. It means that the framework will split the returning sending out each item as an individual message. If this is not he desired behavior you can set it to `false` at which point such supplier will simply return the produced Flux without splitting it.

Consumer (Reactive)

Reactive `Consumer` is a little bit special because it has a void return type, leaving framework with no reference to subscribe to. Most likely you will not need to write `Consumer<Flux<?>>`, and instead write it as a `Function<Flux<?>, Mono<Void>>` invoking `then` operator as the last operator on your stream.

For example:

```
public Function<Flux<?>, Mono<Void>>`consumer() {
    return flux -> flux.map(..).filter(..).then();
}
```

But if you do need to write an explicit `Consumer<Flux<?>>`, remember to subscribe to the incoming Flux.

Polling Configuration Properties

The following properties are exposed by `org.springframework.cloud.stream.config.DefaultPollerProperties` and are prefixed with `spring.cloud.stream.poller`:

fixedDelay

Fixed delay for default poller in milliseconds.

Default: 1000L.

maxMessagesPerPoll

Maximum messages for each polling event of the default poller.

Default: 1L.

For example `--spring.cloud.stream.poller.fixed-delay=2000` sets the poller interval to poll every two seconds.

Sending arbitrary data to an output (e.g. Foreign event-driven sources)

There are cases where the actual source of data may be coming from the external (foreign) system that is not a binder. For example, the source of the data may be a classic REST endpoint. How do we bridge such source with the functional mechanism used by spring-cloud-stream?

Spring Cloud Stream provides two mechanisms, so let's look at them in more details

Here, for both samples we'll use a standard MVC endpoint method called `delegateToSupplier` bound to the root web context, delegating incoming requests to stream via two different mechanisms - imperative (via StreamBridge) and reactive (via EmitterProcessor).

Using StreamBridge

```
@SpringBootApplication
@Controller
public class WebSourceApplication {

    public static void main(String[] args) {
        SpringApplication.run(WebSourceApplication.class, "--
spring.cloud.stream.source=toStream");
    }

    @Autowired
    private StreamBridge streamBridge;

    @RequestMapping
    @ResponseStatus(HttpStatus.ACCEPTED)
    public void delegateToSupplier(@RequestBody String body) {
        System.out.println("Sending " + body);
        streamBridge.send("toStream-out-0", body);
    }
}
```

Here we autowire a `StreamBridge` bean which allows us to send data to an output binding effectively bridging non-stream application with spring-cloud-stream. Note that preceding example does not have any source functions defined (e.g., Supplier bean) leaving the framework with no trigger to create source bindings, which would be typical for cases where configuration contains function beans. So to trigger the creation of source binding we use `spring.cloud.stream.source` property where you can declare the name of your sources. The provided name will be used as a trigger to create a source binding. So in the preceding example the name of the output binding will be `toStream-out-0` which is consistent with the binding naming convention used by functions (see Binding and Binding names). You can use `;` to signify multiple sources (e.g., `--spring.cloud.stream.source=foo;bar`)

Also, note that `streamBridge.send(..)` method takes an `Object` for data. This means you can send POJO or `Message` to it and it will go through the same routine when sending output as if it was from any Function or Supplier providing the same level of consistency as with functions. This means the output type conversion, partitioning etc are honored as if it was from the output produced by functions.

StreamBridge and Dynamic Destinations

`StreamBridge` can also be used for cases when output destination(s) are not known ahead of time similar to the use cases described in Routing FROM Consumer section.

Let's look at the example

```
@SpringBootApplication
@Controller
public class WebSourceApplication {

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

    @Autowired
    private StreamBridge streamBridge;

    @RequestMapping
    @ResponseStatus(HttpStatus.ACCEPTED)
    public void delegateToSupplier(@RequestBody String body) {
        System.out.println("Sending " + body);
        streamBridge.send("myDestination", body);
    }
}
```

As you can see the preceding example is very similar to the previous one with the exception of explicit binding instruction provided via `spring.cloud.stream.source` property (which is not provided). Here we're sending data to `myDestination` name which does not exist as a binding. Therefore such name will be treated as dynamic destination as described in Routing FROM Consumer section.

Using reactor API

Another approach that can be used to send arbitrary data to the output is using Reactor API.

All we need to do is declare a `Supplier<Flux<whatever>>` which returns EmitterProcessor from the reactor API (see Reactive Functions support for more details) to effectively provide a bridge between the actual event source (*foreign source*) and spring-cloud-stream. All you need to do now is feed the `EmitterProcessor` with data via `EmitterProcessor#onNext(data)` operation.

For example,

```
public class SampleApplication {

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

    EmitterProcessor<String> processor = EmitterProcessor.create();

    @Bean
    public ApplicationRunner runner() {
        Message<String> msg1 = MessageBuilder.withPayload("foo")
                .setHeader("*.events", "test1.events.billing")
                .build();
        Message<String> msg2 = MessageBuilder.withPayload("bar")
                .setHeader("*.events", "test2.events.messages")
                .build();
        return args -> {
            this.processor.onNext(msg1);
            this.processor.onNext(msg2);
        };
    }

    @Bean
    public Supplier<Flux<String>> supplier() {
              return () -> this.processor;
    }
}
```

In the preceding example, we are using `ApplicationRunner` as a *foreign source* to feed the stream.

A more practical example, where the foreign source is REST endpoint.

```
@SpringBootApplication
@Controller
public class WebSourceApplication {

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

    EmitterProcessor<String> processor = EmitterProcessor.create();

    @RequestMapping
    @ResponseStatus(HttpStatus.ACCEPTED)
    public void delegateToSupplier(@RequestBody String body) {
        processor.onNext(body);
    }

    @Bean
    public Supplier<Flux<String>> supplier() {
        return () -> this.processor;
    }
}
```

Same as before we declare a `Supplier` bean which returns `Flux<String>`. But given that this is a REST endpoint we send messages by simply posting to this REST endpoint.

```
curl -H "Content-Type: text/plain" -X POST -d "hello from the other side"
http://localhost:8080/
```

By showing two example we want to emphasize the approach will work with any type of foreign sources.

Reactive Functions support

Since *Spring Cloud Function* is build on top of Project Reactor there isn't much you need to do to benefit from reactive programming model while implementing `Supplier`, `Function` or `Consumer`.

For example:

```
@SpringBootApplication
public static class SinkFromConsumer {

    @Bean
    public Function<Flux<String>, Flux<String>> reactiveUpperCase() {
        return flux -> flux.map(val -> val.toUpperCase());
    }
}
```

Functional Composition

Using functional programming model you can also benefit from functional composition where you can dynamically compose complex handlers from a set of simple functions. As an example let's add the following function bean to the application defined above

```
@Bean
public Function<String, String> wrapInQuotes() {
    return s -> "\"" + s + "\"";
}
```

and modify the `spring.cloud.function.definition` property to reflect your intention to compose a new function from both 'toUpperCase' and 'wrapInQuotes'. To do so Spring Cloud Function relies on `|` (pipe) symbol. So, to finish our example our property will now look like this:

```
--spring.cloud.function.definition=toUpperCase|wrapInQuotes
```

One of the great benefits of functional composition support provided by *Spring Cloud Function* is the fact that you can compose *reactive* and *imperative* functions.

The result of a composition is a single function which, as you may guess, could have a very long and rather cryptic name (e.g., `foo|bar|baz|xyz. . .`) presenting a great deal of inconvenience when it comes to other configuration properties. This is where *descriptive binding names* feature described in Functional binding names section can help.

For example, if we want to give our `toUpperCase|wrapInQuotes` a more descriptive name we can do so with the following property `spring.cloud.stream.function.bindings.toUpperCase|wrapInQuotes=quotedUpperCase` allowing other configuration properties to refer to that binding name (e.g., `spring.cloud.stream.bindings.quotedUpperCase.destination=myDestination`).

Functions with multiple input and output arguments

Starting with version 3.0 spring-cloud-stream provides support for functions that have multiple inputs and/or multiple outputs (return values). What does this actually mean and what type of use cases it is targeting?

- *Big Data: Imagine the source of data you're dealing with is highly un-organized and contains various types of data elements (e.g., orders, transactions etc) and you effectively need to sort it out.*
- *Data aggregation: Another use case may require you to merge data elements from 2+ incoming _streams.*

The above describes just a few use cases where you may need to use a single function to accept and/or produce multiple *streams* of data. And that is the type of use cases we are targeting here.

Also, note a slightly different emphasis on the concept of *streams* here. The assumption is that such functions are only valuable if they are given access to the actual streams of data (not the individual

elements). So for that we are relying on abstractions provided by Project Reactor (i.e., `Flux` and `Mono`) which is already available on the classpath as part of the dependencies brought in by spring-cloud-functions.

Another important aspect is representation of multiple input and outputs. While java provides variety of different abstractions to represent *multiple of something* those abstractions are *a) unbounded, b) lack arity* and *c) lack type information* which are all important in this context. As an example, let's look at `Collection` or an array which only allows us to describe *multiple* of a single type or up-cast everything to an `Object`, affecting the transparent type conversion feature of spring-cloud-stream and so on.

So to accommodate all these requirements the initial support is relying on the signature which utilizes another abstraction provided by *Project Reactor* - Tuples. However, we are working on allowing a more flexible signatures.

Please refer to Binding and Binding names section to understand the naming convention used to establish *binding names* used by such application.

Let's look at the few samples:

```
@SpringBootApplication
public class SampleApplication {

    @Bean
    public Function<Tuple2<Flux<String>, Flux<Integer>>, Flux<String>> gather() {
        return tuple -> {
            Flux<String> stringStream = tuple.getT1();
            Flux<String> intStream = tuple.getT2().map(i -> String.valueOf(i));
            return Flux.merge(stringStream, intStream);
        };
    }
}
```

The above example demonstrates function which takes two inputs (first of type `String` and second of type `Integer`) and produces a single output of type `String`.

So, for the above example the two input bindings will be `gather-in-0` and `gather-in-1` and for consistency the output binding also follows the same convention and is named `gather-out-0`.

Knowing that will allow you to set binding specific properties the same way you did with `@StreamListener`. For example, the following will override content-type for `gather-in-0` binding:

```
--spring.cloud.stream.bindings.gather-in-0.content-type=text/plain
```

```
@SpringBootApplication
public class SampleApplication {

    @Bean
    public static Function<Flux<Integer>, Tuple2<Flux<String>, Flux<String>>>
scatter() {
        return flux -> {
            Flux<Integer> connectedFlux = flux.publish().autoConnect(2);
            UnicastProcessor even = UnicastProcessor.create();
            UnicastProcessor odd = UnicastProcessor.create();
            Flux<Integer> evenFlux = connectedFlux.filter(number -> number % 2 ==
0).doOnNext(number -> even.onNext("EVEN: " + number));
            Flux<Integer> oddFlux = connectedFlux.filter(number -> number % 2 !=
0).doOnNext(number -> odd.onNext("ODD: " + number));

            return Tuples.of(Flux.from(even).doOnSubscribe(x -> evenFlux.subscribe()),
Flux.from(odd).doOnSubscribe(x -> oddFlux.subscribe()));
        };
    }
}
```

The above example is somewhat of a the opposite from the previous sample and demonstrates function which takes single input of type `Integer` and produces two outputs (both of type `String`).

So, for the above example the input binding is `scatter-in-0` and the output bindings are `scatter-out-0` and `scatter-out-1`.

And you test it with the following code:

```
@Test
public void testSingleInputMultiOutput() {
    try (ConfigurableApplicationContext context = new SpringApplicationBuilder(
            TestChannelBinderConfiguration.getCompleteConfiguration(
                    SampleApplication.class))
                            .run("--spring.cloud.function.definition=scatter")) {

        InputDestination inputDestination = context.getBean(InputDestination.class);
        OutputDestination outputDestination =
context.getBean(OutputDestination.class);

        for (int i = 0; i < 10; i++) {

inputDestination.send(MessageBuilder.withPayload(String.valueOf(i).getBytes()).build()
);
        }

        int counter = 0;
        for (int i = 0; i < 5; i++) {
            Message<byte[]> even = outputDestination.receive(0, 0);
            assertThat(even.getPayload()).isEqualTo(("EVEN: " +
String.valueOf(counter++)).getBytes());
            Message<byte[]> odd = outputDestination.receive(0, 1);
            assertThat(odd.getPayload()).isEqualTo(("ODD: " +
String.valueOf(counter++)).getBytes());
        }
    }
}
```

Multiple functions in a single application

There may also be a need for grouping several message handlers in a single application. You would do so by defining several functions.

```
@SpringBootApplication
public class SampleApplication {

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }

    @Bean
    public Function<String, String> reverse() {
        return value -> new StringBuilder(value).reverse().toString();
    }
}
```

In the above example we have configuration which defines two functions `uppercase` and `reverse`. So first, as mentioned before, we need to notice that there is a a conflict (more then one function) and therefore we need to resolve it by providing `spring.cloud.function.definition` property pointing to the actual function we want to bind. Except here we will use `;` delimiter to point to both functions (see test case below).

As with functions with multiple inputs/outputs, please refer to Binding and Binding names section to understand the naming convention used to establish *binding names* used by such application.

And you test it with the following code:

```
@Test
public void testMultipleFunctions() {
    try (ConfigurableApplicationContext context = new SpringApplicationBuilder(
            TestChannelBinderConfiguration.getCompleteConfiguration(
                    ReactiveFunctionConfiguration.class))
                            .run("--
spring.cloud.function.definition=uppercase;reverse")) {

        InputDestination inputDestination = context.getBean(InputDestination.class);
        OutputDestination outputDestination =
context.getBean(OutputDestination.class);

        Message<byte[]> inputMessage =
MessageBuilder.withPayload("Hello".getBytes()).build();
        inputDestination.send(inputMessage, "uppercase-in-0");
        inputDestination.send(inputMessage, "reverse-in-0");

        Message<byte[]> outputMessage = outputDestination.receive(0, "uppercase-out-
0");
        assertThat(outputMessage.getPayload()).isEqualTo("HELLO".getBytes());

        outputMessage = outputDestination.receive(0, "uppercase-out-1");
        assertThat(outputMessage.getPayload()).isEqualTo("olleH".getBytes());
    }
}
```

Batch Consumers

When using a `MessageChannelBinder` that supports batch listeners, and the feature is enabled for the consumer binding, you can set `spring.cloud.stream.bindings.<binding-name>.consumer.batch-mode` to `true` to enable the entire batch of messages to be passed to the function in a `List`.

```
@Bean
public Function<List<Person>, Person> findFirstPerson() {
    return persons -> persons.get(0);
}
```

Spring Integration flow as functions

When you implement a function, you may have complex requirements that fit the category of Enterprise Integration Patterns (EIP). These are best handled by using a framework such as Spring Integration (SI), which is a reference implementation of EIP.

Thankfully SI already provides support for exposing integration flows as functions via Integration flow as gateway Consider the following sample:

```
@SpringBootApplication
public class FunctionSampleSpringIntegrationApplication {

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

    @Bean
    public IntegrationFlow uppercaseFlow() {
        return IntegrationFlows.from(MessageFunction.class, "uppercase")
                .<String, String>transform(String::toUpperCase)
                .logAndReply(LoggingHandler.Level.WARN);
    }

    public interface MessageFunction extends Function<Message<String>,
Message<String>> {

    }
}
```

For those who are familiar with SI you can see we define a bean of type `IntegrationFlow` where we declare an integration flow that we want to expose as a `Function<String, String>` (using SI DSL) called `uppercase`. The `MessageFunction` interface lets us explicitly declare the type of the inputs and outputs for proper type conversion. See Content Type Negotiation section for more on type conversion.

To receive raw input you can use `from(Function.class, …)`.

The resulting function is bound to the input and output destinations exposed by the target binder.

Please refer to Binding and Binding names section to understand the naming convention used to establish *binding names* used by such application.

For more details on interoperability of Spring Integration and Spring Cloud Stream specifically

around functional programming model you may find this post very interesting, as it dives a bit deeper into various patterns you can apply by merging the best of Spring Integration and Spring Cloud Stream/Functions.

20.3.2. Annotation-based support (legacy)

As mentioned earlier you can also use Spring Integration annotations based configuration or Spring Cloud Stream annotation based configuration.

Spring Integration Support

Spring Cloud Stream is built on the concepts and patterns defined by Enterprise Integration Patterns and relies in its internal implementation on an already established and popular implementation of Enterprise Integration Patterns within the Spring portfolio of projects: Spring Integration framework.

So its only natural for it to support the foundation, semantics, and configuration options that are already established by Spring Integration

For example, you can attach the output channel of a `Source` to a `MessageSource` and use the familiar `@InboundChannelAdapter` annotation, as follows:

```
@EnableBinding(Source.class)
public class TimerSource {

  @Bean
  @InboundChannelAdapter(value = Source.OUTPUT, poller = @Poller(fixedDelay = "10",
maxMessagesPerPoll = "1"))
  public MessageSource<String> timerMessageSource() {
    return () -> new GenericMessage<>("Hello Spring Cloud Stream");
  }
}
```

Similarly, you can use @Transformer or @ServiceActivator while providing an implementation of a message handler method for a *Processor* binding contract, as shown in the following example:

```
@EnableBinding(Processor.class)
public class TransformProcessor {
  @Transformer(inputChannel = Processor.INPUT, outputChannel = Processor.OUTPUT)
  public Object transform(String message) {
    return message.toUpperCase();
  }
}
```

While this may be skipping ahead a bit, it is important to understand that, when you consume from the same binding using `@StreamListener` annotation, a pub-sub model is used. Each method annotated with `@StreamListener` receives its own copy of a message, and each one has its own consumer group. However, if you consume from the same binding by using one of the Spring Integration annotation (such as `@Aggregator`, `@Transformer`, or `@ServiceActivator`), those consume in a competing model. No individual consumer group is created for each subscription.

Using @StreamListener Annotation

Complementary to its Spring Integration support, Spring Cloud Stream provides its own `@StreamListener` annotation, modeled after other Spring Messaging annotations (`@MessageMapping`, `@JmsListener`, `@RabbitListener`, and others) and provides conveniences such as content-based routing and others.

```
@EnableBinding(Sink.class)
public class VoteHandler {

  @Autowired
  VotingService votingService;

  @StreamListener(Sink.INPUT)
  public void handle(Vote vote) {
    votingService.record(vote);
  }
}
```

As with other Spring Messaging methods, method arguments can be annotated with `@Payload`, `@Headers`, and `@Header`.

For methods that return data, you must use the `@SendTo` annotation to specify the output binding destination for data returned by the method, as shown in the following example:

```
@EnableBinding(Processor.class)
public class TransformProcessor {

  @Autowired
  VotingService votingService;

  @StreamListener(Processor.INPUT)
  @SendTo(Processor.OUTPUT)
  public VoteResult handle(Vote vote) {
    return votingService.record(vote);
  }
}
```

Similar to Spring MVC you can also benefit from JSR-303/309 compliant validation by annotating

your arguments with `@Valid`.

```
@StreamListener(Processor.INPUT)
  @SendTo(Processor.OUTPUT)
  public VoteResult handle(@Valid Vote vote) {
    return votingService.record(vote);
  }
```

In the above example the `Vote` object and its individual fields will be validated according to the rules set by you (e.g., `@NotBlank`, `@Min`/`@Max` etc.).

Spring Cloud Stream does NOT provide a default `org.springframework.validation.Validator` to avoid potential conflicts with validators provided by other frameworks that may be part of your application (e.g., MVC), therefore you may need to provide your own validator by configuring a bean of type `org.springframework.validation.Validator`.

Using @StreamListener for Content-based routing

Spring Cloud Stream supports dispatching messages to multiple handler methods annotated with `@StreamListener` based on conditions.

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 by a SpEL expression in the `condition` argument of the annotation and is evaluated for each message. All the handlers that match the condition are invoked in the same thread, and no assumption must be made about the order in which the invocations take place.

In the following example of a `@StreamListener` with dispatching conditions, all the messages bearing a header `type` with the value `bogey` are dispatched to the `receiveBogey` method, and all the messages bearing a header `type` with the value `bacall` are dispatched to the `receiveBacall` method.

```
@EnableBinding(Sink.class)
@EnableAutoConfiguration
public static class TestPojoWithAnnotatedArguments {

    @StreamListener(target = Sink.INPUT, condition = "headers['type']=='bogey'")
    public void receiveBogey(@Payload BogeyPojo bogeyPojo) {
       // handle the message
    }

    @StreamListener(target = Sink.INPUT, condition = "headers['type']=='bacall'")
    public void receiveBacall(@Payload BacallPojo bacallPojo) {
       // handle the message
    }
}
```

Content Type Negotiation in the Context of `condition`

It is important to understand some of the mechanics behind content-based routing using the `condition` argument of `@StreamListener`, especially in the context of the type of the message as a whole. It may also help if you familiarize yourself with the Content Type Negotiation before you proceed.

Consider the following scenario:

```
@EnableBinding(Sink.class)
@EnableAutoConfiguration
public static class CatsAndDogs {

    @StreamListener(target = Sink.INPUT, condition =
"payload.class.simpleName=='Dog'")
    public void bark(Dog dog) {
       // handle the message
    }

    @StreamListener(target = Sink.INPUT, condition =
"payload.class.simpleName=='Cat'")
    public void purr(Cat cat) {
       // handle the message
    }
}
```

The preceding code is perfectly valid. It compiles and deploys without any issues, yet it never produces the result you expect.

That is because you are testing something that does not yet exist in a state you expect. That is because the payload of the message is not yet converted from the wire format (`byte[]`) to the desired type. In other words, it has not yet gone through the type conversion process described in the Content Type Negotiation.

So, unless you use a SPeL expression that evaluates raw data (for example, the value of the first byte in the byte array), use message header-based expressions (such as `condition = "headers['type']=='dog'"`).

At the moment, dispatching through `@StreamListener` conditions is supported only for channel-based binders (not for reactive programming) support.

20.3.3. Using Polled Consumers

Overview

When using polled consumers, you poll the `PollableMessageSource` on demand. To define binding for polled consumer you need to provide `spring.cloud.stream.pollable-source` property.

Consider the following example of a polled consumer binding:

```
--spring.cloud.stream.pollable-source=myDestination
```

The pollable-source name `myDestination` in the preceding example will result in `myDestination-in-0` binding name to stay consistent with functional programming model.

Given the polled consumer in the preceding example, you might use it 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
            }
        }
    };
}
```

A less manual and more Spring-like alternative would be to configure a scheduled task bean. For example,

```
@Scheduled(fixedDelay = 5_000)
public void poll() {
    System.out.println("Polling...");
    this.source.poll(m -> {
        System.out.println(m.getPayload());

    }, new ParameterizedTypeReference<Foo>() { });
}
```

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 `Error Handling`.

Normally, the `poll()` method acknowledges the message when the `MessageHandler` exits. If the method exits abnormally, the message is rejected (not re-queued), but see Handling Errors. You can override that behavior by taking responsibility for the acknowledgment, as shown in the following example:

```
@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);
            }
        }
    };
}
```

You must `ack` (or `nack`) the message at some point, to avoid resource leaks.

Some messaging systems (such as Apache Kafka) maintain a simple offset in a log. If a delivery fails and is re-queued with `StaticMessageHeaderAccessor.getAcknowledgmentCallback(m).acknowledge(Status.REQUEUE);`, any later successfully ack'd messages are redelivered.

There is also an overloaded `poll` method, for which the definition is as follows:

```
poll(MessageHandler handler, ParameterizedTypeReference<?> type)
```

The `type` is a conversion hint that allows the incoming message payload to be converted, as shown in the following example:

```
boolean result = pollableSource.poll(received -> {
            Map<String, Foo> payload = (Map<String, Foo>) received.getPayload();
            ...

        }, new ParameterizedTypeReference<Map<String, Foo>>() {});
```

Handling Errors

By default, an error channel is configured for the pollable source; if the callback throws an exception, an `ErrorMessage` is sent to the error channel (`<destination>.<group>.errors`); this error channel is also bridged to the global Spring Integration `errorChannel`.

You can subscribe to either error channel with a `@ServiceActivator` to handle errors; without a subscription, the error will simply be logged and the message will be acknowledged as successful. If the error channel service activator throws an exception, the message will be rejected (by default) and won't be redelivered. If the service activator throws a `RequeueCurrentMessageException`, the message will be requeued at the broker and will be again retrieved on a subsequent poll.

If the listener throws a `RequeueCurrentMessageException` directly, the message will be requeued, as discussed above, and will not be sent to the error channels.

20.4. Event Routing

Event Routing, in the context of Spring Cloud Stream, is the ability to either *a) route events to a particular event subscriber* or *b) route events produced by an event subscriber to a particular destination*. Here we'll refer to it as route 'TO' and route 'FROM'.

20.4.1. Routing TO Consumer

Routing can be achieved by relying on `RoutingFunction` available in Spring Cloud Function 3.0. All you need to do is enable it via `--spring.cloud.stream.function.routing.enabled=true` application property or provide `spring.cloud.function.routing-expression` property. Once enabled `RoutingFunction` will be bound to input destination receiving all the messages and route them to other functions based on the provided instruction.

For the purposes of binding the name of the routing destination is `functionRouter-in-0` (see RoutingFunction.FUNCTION_NAME and binding naming convention Functional binding names).

Instruction could be provided with individual messages as well as application properties.

Here are couple of samples:

Using message headers

```
@SpringBootApplication
public class SampleApplication {

    public static void main(String[] args) {
        SpringApplication.run(SampleApplication.class,
                        "--spring.cloud.stream.function.routing.enabled=true");
    }

    @Bean
    public Consumer<String> even() {
        return value -> {
            System.out.println("EVEN: " + value);
        };
    }

    @Bean
    public Consumer<String> odd() {
        return value -> {
            System.out.println("ODD: " + value);
        };
    }
}
```

By sending a message to the `functionRouter-in-0` destination exposed by the binder (i.e., rabbit, kafka), such message will be routed to the appropriate (‘even’ or ‘odd’) Consumer.

By default `RoutingFunction` will look for a `spring.cloud.function.definition` or `spring.cloud.function.routing-expression` (for more dynamic scenarios with SpEL) header and if it is found, its value will be treated as the routing instruction.

For example, setting `spring.cloud.function.routing-expression` header to value `T(java.lang.System).currentTimeMillis() % 2 == 0 ? 'even' : 'odd'` will end up semi-randomly routing request to either `odd` or `even` functions. Also, for SpEL, the *root object* of the evaluation context is `Message` so you can do evaluation on individual headers (or message) as well `…routing-expression=headers['type']`

Using application properties

The `spring.cloud.function.routing-expression` and/or `spring.cloud.function.definition` can be passed as application properties (e.g., `spring.cloud.function.routing-expression=headers['type']`.

```
@SpringBootApplication
public class RoutingStreamApplication {

  public static void main(String[] args) {
      SpringApplication.run(RoutingStreamApplication.class,
      "--spring.cloud.function.routing-expression="
      + "T(java.lang.System).nanoTime() % 2 == 0 ? 'even' : 'odd'");
  }
  @Bean
  public Consumer<Integer> even() {
    return value -> System.out.println("EVEN: " + value);
  }

  @Bean
  public Consumer<Integer> odd() {
    return value -> System.out.println("ODD: " + value);
  }
}
```

Passing instructions via application properties is especially important for reactive functions given that a reactive function is only invoked once to pass the Publisher, so access to the individual items is limited.

20.4.2. Routing FROM Consumer

Aside from static destinations, Spring Cloud Stream lets applications 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 in one of two ways.

BinderAwareChannelResolver

The `BinderAwareChannelResolver` is a special bean registered automatically by the framework. You can autowire this bean into your application and use it to resolve output destination at runtime

The 'spring.cloud.stream.dynamicDestinations' property can be used for restricting the dynamic destination names to a known set (that is, intentionally allowed values). If this property is not set, any destination can be bound dynamically.

The following example demonstrates one of the common scenarios where REST controller uses a path variable to determine target destination:

```
@SpringBootApplication
@Controller
public class SourceWithDynamicDestination {

    @Autowired
    private BinderAwareChannelResolver resolver;

    @RequestMapping(value="/{target}")
    @ResponseStatus(HttpStatus.ACCEPTED)
    public void send(@RequestBody String body, @PathVariable("target") String target){
        resolver.resolveDestination(target).send(new GenericMessage<String>(body));
    }
}
```

Now consider what happens when we start the application on the default port (8080) and make the following requests with CURL:

```
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 (in the exchange for Rabbit or in the topic for Kafka) with names of 'customers' and 'orders', and the data is published to the appropriate destinations.

spring.cloud.stream.sendto.destination

You can also delegate to the framework to dynamically resolve the output destination by specifying `spring.cloud.stream.sendto.destination` header set to the name of the destination to be resolved.

Consider the following example:

```
@SpringBootApplication
@Controller
public class SourceWithDynamicDestination {

    @Bean
    public Function<String, Message<String>> destinationAsPayload() {
        return value -> {
            return MessageBuilder.withPayload(value)
                .setHeader("spring.cloud.stream.sendto.destination", value).build();};
    }
}
```

Albeit trivial you can clearly see in this example, our output is a Message with

`spring.cloud.stream.sendto.destination` header set to the value of he input argument. The framework will consult this header and will attempt to create or discover a destination with that name and send output to it.

If destination names are known in advance, you can configure the producer properties as with any other destination. Alternatively, if you register a `NewDestinationBindingCallback<>` bean, it is 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 destinationName, MessageChannel channel, ProducerProperties
producerProperties,
        T extendedProducerProperties);
```

The following example shows how to use the RabbitMQ binder:

```
@Bean
public NewDestinationBindingCallback<RabbitProducerProperties> dynamicConfigurer() {
    return (name, channel, props, extended) -> {
        props.setRequiredGroups("bindThisQueue");
        extended.setQueueNameGroupOnly(true);
        extended.setAutoBindDlq(true);
        extended.setDeadLetterQueueName("myDLQ");
    };
}
```

If you need to support dynamic destinations with multiple binder types, use `Object` for the generic type and cast the `extended` argument as needed.

Also, please see Using StreamBridge section to see how yet another option (StreamBridge) can be utilized for similar cases.

20.5. Error Handling

In this section we'll explain the general idea behind error handling mechanisms provided by the framework. We'll be using Rabbit binder as an example, since individual binders define different set of properties for certain supported mechanisms specific to underlying broker capabilities (such as Kafka binder).

Errors happen, and Spring Cloud Stream provides several flexible mechanisms to deal with them. Note that the techniques are dependent on binder implementation and the capability of the underlying messaging middleware.

Whenever there is an exception during message processing, the framework will make several attempts at re-trying the same message (3 by default). For that, the framework uses Spring Retry library (for imperative functions and standard message handlers) and `retryBackoff` capabilities of the reactive API (for reactive functions).

Whenever a handler (function) throws an exception, it is propagated back to the binder, and the binder subsequently propagates the error back to the messaging system. Depending on the capabilities of the messaging system such system may *drop* the message, *re-queue* the message for re-processing or *send the failed message to DLQ*. Both Rabbit and Kafka support these concepts. However, other binders may not, so refer to your individual binder's documentation for details on supported error-handling options.

20.5.1. Drop Failed Messages

By default, if no additional system-level configuration is provided, the messaging system drops the failed message. While acceptable in some cases, for most cases, it is not, and we need some recovery mechanism to avoid message loss.

20.5.2. DLQ - Dead Letter Queue

Perhaps the most common mechanism, DLQ allows failed messages to be sent to a special destination: the *Dead Letter Queue*.

When configured, failed messages are sent to this destination for subsequent re-processing or auditing and reconciliation.

Consider the following example:

```
@SpringBootApplication
public class SimpleStreamApplication {

    public static void main(String[] args) throws Exception {
        SpringApplication.run(SimpleStreamApplication.class,
          "--spring.cloud.function.definition=uppercase",
          "--spring.cloud.stream.bindings.uppercase-in-0.destination=uppercase",
          "--spring.cloud.stream.bindings.uppercase-in-0.group=myGroup",
          "--spring.cloud.stream.rabbit.bindings.uppercase-in-0.consumer.auto-bind-
dlq=true"
        );
    }

    @Bean
    public Function<Person, Person> uppercase() {
        return personIn -> {
           throw new RuntimeException("intentional");
          });
        };
    }
}
```

As a reminder, in this example `uppercase-in-0` segment of the property corresponds to the name of the input destination binding. The `consumer` segment indicates that it is a consumer property.

When using DLQ, at least the `group` property must be provided for proper naming of the DLQ destination. However `group` is often used together with `destination` property, as in our example.

Aside from some standard properties we also set the `auto-bind-dlq` to instruct the binder to create and configure DLQ destination for `uppercase-in-0` binding which corresponds to `uppercase` destination (see corresponding property), which results in an additional Rabbit queue named `uppercase.myGroup.dlq` (see Kafka documentation for Kafka specific DLQ properties).

Once configured, all failed messages are routed to this destination preserving the original message for further actions.

And you can see that the error message contains more information relevant to the original error, as follows:

```
. . . .
x-exception-stacktrace: org.springframework.messaging.MessageHandlingException: nested
exception is
      org.springframework.messaging.MessagingException: has an error,
failedMessage=GenericMessage [payload=byte[15],
      headers={amqp_receivedDeliveryMode=NON_PERSISTENT,
amqp_receivedRoutingKey=input.hello, amqp_deliveryTag=1,
      deliveryAttempt=3, amqp_consumerQueue=input.hello, amqp_redelivered=false,
id=a15231e6-3f80-677b-5ad7-d4b1e61e486e,
      amqp_consumerTag=amq.ctag-skBFapilvtZhDsn0k3ZmQg, contentType=application/json,
timestamp=1522327846136}]
      at
org.spring...integ...han...MethodInvokingMessageProcessor.processMessage(MethodInvokin
gMessageProcessor.java:107)
      at. . . . .
Payload: blah
```

You can also facilitate immediate dispatch to DLQ (without re-tries) by setting `max-attempts` to '1'. For example,

```
--spring.cloud.stream.bindings.uppercase-in-0.consumer.max-attempts=1
```

20.5.3. Retry Template and retryBackoff

In this section we cover configuration properties relevant to configuration of retry capabilities. Given that we use two different mechanisms for imperative and reactive handlers (RetryTemplate and retryBackoff), properties that correspond to both will be identified as such.

The `RetryTemplate` is part of the Spring Retry library. While it is out of scope of this document to cover all of the capabilities of the `RetryTemplate`, we will mention the following consumer properties that are specifically related to the `RetryTemplate`:

maxAttempts

The number of attempts to process the message.

Default: 3. - Applies to 'retryBackoff'

backOffInitialInterval

The backoff initial interval on retry.

Default 1000 milliseconds. - Applies to 'retryBackoff'

backOffMaxInterval

The maximum backoff interval.

Default 10000 milliseconds. - Applies to 'retryBackoff'

backOffMultiplier

The backoff multiplier.

Default 2.0.

defaultRetryable

Whether exceptions thrown by the listener that are not listed in the `retryableExceptions` are retryable.

Default: `true`.

retryableExceptions

A map of Throwable class names in the key and a boolean in the value. Specify those exceptions (and subclasses) that will or won't be retried. Also see `defaultRetriable`. Example: `spring.cloud.stream.bindings.input.consumer.retryable-exceptions.java.lang.IllegalStateException=false`.

Default: empty.

While the preceding settings are sufficient for the majority of the customization requirements, they may not satisfy certain complex requirements, at which point you may want to provide your own instance of the `RetryTemplate`. To do so configure it as a bean in your application configuration. The application provided instance will override the one provided by the framework. Also, to avoid conflicts you must qualify the instance of the `RetryTemplate` you want to be used by the binder as `@StreamRetryTemplate`. For example,

```
@StreamRetryTemplate
public RetryTemplate myRetryTemplate() {
    return new RetryTemplate();
}
```

As you can see from the above example you don't need to annotate it with `@Bean` since `@StreamRetryTemplate` is a qualified `@Bean`.

If you need to be more precise with your `RetryTemplate`, you can specify the bean by name in your `ConsumerProperties` to associate the specific retry bean per binding.

```
spring.cloud.stream.bindings.<foo>.consumer.retry-template-name=<your-retry-template-
bean-name>
```

21. 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.

21.1. Producers and Consumers

The following image shows the general relationship of producers and consumers:

[producers consumers] | *https://raw.github.com/spring-cloud/spring-cloud-*

netflix/master/docs/src/main/asciidoc/images/producers-consumers.png

Figure 11. Producers and Consumers

A producer is any component that sends messages to a binding destination. The binding destination can be bound to an external message broker with 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 instance if local destination to which the producer sends messages, and the third parameter contains properties (such as a partition key expression) to be used within the adapter that is created for that binding destination.

A consumer is any component that receives messages from the binding destination. As with a producer, the consumer 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 (that is, it follows normal publish-subscribe semantics). If there are multiple consumer instances bound with the same group name, then messages are 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 (that is, it follows normal queueing semantics).

21.2. 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. The following listing shows the definition of the `Binder` interface:

```
public interface Binder<T, C extends ConsumerProperties, P extends ProducerProperties>
{
    Binding<T> bindConsumer(String bindingName, String group, T inboundBindTarget, C
consumerProperties);

    Binding<T> bindProducer(String bindingName, T outboundBindTarget, P
producerProperties);
}
```

The interface is parameterized, offering a number of extension points:

- Input and output bind targets.
- Extended consumer and producer properties, allowing specific Binder implementations to add supplemental properties that 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 type `Binder` along with the middleware

connection infrastructure.

- A `META-INF/spring.binders` file found on the classpath containing one or more binder definitions, as shown in the following example:

```
kafka:\
org.springframework.cloud.stream.binder.kafka.config.KafkaBinderConfiguration
```

As it was mentioned earlier Binder abstraction is also one of the extension points of the framework. So if you can't find a suitable binder in the preceding list you can implement your own binder on top of Spring Cloud Stream. In the How to create a Spring Cloud Stream Binder from scratch post a community member documents in details, with an example, a set of steps necessary to implement a custom binder. The steps are also highlighted in the `Implementing Custom Binders` section.

21.3. Binder Detection

Spring Cloud Stream relies on implementations of the Binder SPI to perform the task of connecting (binding) user code to message brokers. Each Binder implementation typically connects to one type of messaging system.

21.3.1. 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 automatically uses it. For example, a Spring Cloud Stream project that aims to bind only to RabbitMQ can 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, see the documentation of that binder implementation.

21.4. 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 destination binding. Each binder configuration contains a `META-INF/spring.binders` file, which is a simple properties file, as shown in the following example:

```
rabbit:\
org.springframework.cloud.stream.binder.rabbit.config.RabbitServiceAutoConfiguration
```

Similar files exist for the other provided binder implementations (such as 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 (for example, `spring.cloud.stream.defaultBinder=rabbit`) or individually, by configuring the binder on each binding. For instance, a processor application (that has bindings named `input` and `output` for read and write respectively) that 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
```

21.5. 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 is 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.

Turning on explicit binder configuration disables the default binder configuration process altogether. If you do so, all binders 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 they do not affect the default binder configuration. In order to do so, a binder configuration may have its `defaultCandidate` flag set to false (for example, `spring.cloud.stream.binders.<configurationName>.defaultCandidate=false`). This denotes a configuration that exists independently of the default binder configuration process.

The following example shows a typical configuration for a processor application that connects to two RabbitMQ broker instances:

```
spring:
  cloud:
    stream:
      bindings:
        input:
          destination: thing1
          binder: rabbit1
        output:
          destination: thing2
          binder: rabbit2
      binders:
        rabbit1:
          type: rabbit
          environment:
            spring:
              rabbitmq:
                host: <host1>
        rabbit2:
          type: rabbit
          environment:
            spring:
              rabbitmq:
                host: <host2>
```

The `environment` property of the particular binder can also be used for any Spring Boot property, including this `spring.main.sources` which can be useful for adding additional configurations for the particular binders, e.g. overriding auto-configured beans.

For example;

```
environment:
    spring:
        main:
           sources: com.acme.config.MyCustomBinderConfiguration
```

To activate a specific profile for the particular binder environment, you should use a `spring.profiles.active` property:

```
environment:
    spring:
        profiles:
           active: myBinderProfile
```

21.6. Binding visualization and control

Since version 2.0, Spring Cloud Stream supports visualization and control of the Bindings through Actuator endpoints.

Starting with version 2.0 actuator and web are optional, you must first add one of the web dependencies as well as add the actuator dependency manually. The following example shows how to add the dependency for the Web framework:

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

The following example shows how to add the dependency for the WebFlux framework:

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

You can add the Actuator dependency as follows:

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

To run Spring Cloud Stream 2.0 apps in Cloud Foundry, you must add `spring-boot-starter-web` and `spring-boot-starter-actuator` to the classpath. Otherwise, the application will not start due to health check failures.

You must also enable the `bindings` actuator endpoints by setting the following property: `--management.endpoints.web.exposure.include=bindings`.

Once those prerequisites are satisfied. you should see the following in the logs when application start:

```
: Mapped "{[/actuator/bindings/{name}],methods=[POST]. . .
: Mapped "{[/actuator/bindings],methods=[GET]. . .
: Mapped "{[/actuator/bindings/{name}],methods=[GET]. . .
```

To visualize the current bindings, access the following URL: `<host>:<port>/actuator/bindings`

Alternative, to see a single binding, access one of the URLs similar to the following: <code><a

href="http://<host>:<port>/actuator/bindings/<bindingName>" class="bare"><host>:<port>/actuator/bindings/<bindingName>;</code>

You can also stop, start, pause, and resume individual bindings by posting to the same URL while providing a `state` argument as JSON, as shown in the following examples:

```
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
```

`PAUSED` and `RESUMED` work only when the corresponding binder and its underlying technology supports it. Otherwise, you see the warning message in the logs. Currently, only Kafka binder supports the `PAUSED` and `RESUMED` states.

21.7. Binder Configuration Properties

The following properties are available when customizing binder configurations. These properties exposed via `org.springframework.cloud.stream.config.BinderProperties`

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 inherits 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 property is set, the context in which the binder is being created is not a child of the application context. This setting 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 setting allows adding binder configurations without

interfering with the default processing.

Default: `true`.

21.8. Implementing Custom Binders

In order to implement a custom `Binder`, all you need is to:

- Add the required dependencies
- Provide a ProvisioningProvider implementation
- Provide a MessageProducer implementation
- Provide a MessageHandler implementation
- Provide a Binder implementation
- Create a Binder Configuration
- Define your binder in META-INF/spring.binders

Add the required dependencies

Add the `spring-cloud-stream` dependency to your project *(eg. for Maven)*:

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-stream</artifactId>
    <version>${spring.cloud.stream.version}</version>
</dependency>
```

Provide a ProvisioningProvider implementation

The `ProvisioningProvider` is responsible for the provisioning of consumer and producer destinations, and is required to convert the logical destinations included in the application.yml or application.properties file in physical destination references.

Below an example of ProvisioningProvider implementation that simply trims the destinations provided via input/output bindings configuration:

```
public class FileMessageBinderProvisioner implements
ProvisioningProvider<ConsumerProperties, ProducerProperties> {

    @Override
    public ProducerDestination provisionProducerDestination(
            final String name,
            final ProducerProperties properties) {

        return new FileMessageDestination(name);
    }

    @Override
    public ConsumerDestination provisionConsumerDestination(
            final String name,
            final String group,
            final ConsumerProperties properties) {

        return new FileMessageDestination(name);
    }

    private class FileMessageDestination implements ProducerDestination,
ConsumerDestination {

        private final String destination;

        private FileMessageDestination(final String destination) {
            this.destination = destination;
        }

        @Override
        public String getName() {
            return destination.trim();
        }

        @Override
        public String getNameForPartition(int partition) {
            throw new UnsupportedOperationException("Partitioning is not implemented
for file messaging.");
        }

    }

}
```

Provide a MessageProducer implementation

The `MessageProducer` is responsible for consuming events and handling them as messages to the client application that is configured to consume such events.

Here is an example of MessageProducer implementation that extends the `MessageProducerSupport`

abstraction in order to poll on a file that matches the trimmed destination name and is located in the project path, while also archiving read messages and discarding consequent identical messages:

```
public class FileMessageProducer extends MessageProducerSupport {

    public static final String ARCHIVE = "archive.txt";
    private final ConsumerDestination destination;
    private String previousPayload;

    public FileMessageProducer(ConsumerDestination destination) {
        this.destination = destination;
    }

    @Override
    public void doStart() {
        receive();
    }

    private void receive() {
        ScheduledExecutorService executorService =
Executors.newScheduledThreadPool(1);

        executorService.scheduleWithFixedDelay(() -> {
            String payload = getPayload();

            if(payload != null) {
                Message<String> receivedMessage =
MessageBuilder.withPayload(payload).build();
                archiveMessage(payload);
                sendMessage(receivedMessage);
            }

        }, 0, 50, MILLISECONDS);
    }

    private String getPayload() {
        try {
            List<String> allLines =
Files.readAllLines(Paths.get(destination.getName()));
            String currentPayload = allLines.get(allLines.size() - 1);

            if(!currentPayload.equals(previousPayload)) {
                previousPayload = currentPayload;
                return currentPayload;
            }
        } catch (IOException e) {
            throw new RuntimeException(e);
        }

        return null;
```

```
    }

    private void archiveMessage(String payload) {
        try {
            Files.write(Paths.get(ARCHIVE), (payload + "\n").getBytes(), CREATE,
APPEND);
        } catch (IOException e) {
            throw new RuntimeException(e);
        }
    }

}
```

When implementing a custom binder, this step is not strictly mandatory as you could always resort to using an already existing MessageProducer implementation!

Provide a MessageHandler implementation

The `MessageHandler` provides the logic required to produce an event.

Here is an example of MessageHandler implementation:

```
public class FileMessageHandler implements MessageHandler{

    @Override
    public void handleMessage(Message<?> message) throws MessagingException {
        //write message to file
    }

}
```

When implementing a custom binder, this step is not strictly mandatory as you could always resort to using an already existing MessageHandler implementation!

Provide a Binder implementation

You are now able to provide your own implementation of the `Binder` abstraction. This can be easily done by:

- extending the `AbstractMessageChannelBinder` class
- specifying your ProvisioningProvider as a generic argument of the AbstractMessageChannelBinder
- overriding the `createProducerMessageHandler` and `createConsumerEndpoint` methods

eg.:

```
public class FileMessageBinder extends
AbstractMessageChannelBinder<ConsumerProperties, ProducerProperties,
FileMessageBinderProvisioner> {

    public FileMessageBinder(
            String[] headersToEmbed,
            FileMessageBinderProvisioner provisioningProvider) {

        super(headersToEmbed, provisioningProvider);
    }

    @Override
    protected MessageHandler createProducerMessageHandler(
            final ProducerDestination destination,
            final ProducerProperties producerProperties,
            final MessageChannel errorChannel) throws Exception {

        return message -> {
            String fileName = destination.getName();
            String payload = new String((byte[])message.getPayload()) + "\n";

            try {
                Files.write(Paths.get(fileName), payload.getBytes(), CREATE, APPEND);
            } catch (IOException e) {
                throw new RuntimeException(e);
            }
        };
    }

    @Override
    protected MessageProducer createConsumerEndpoint(
            final ConsumerDestination destination,
            final String group,
            final ConsumerProperties properties) throws Exception {

        return new FileMessageProducer(destination);
    }

}
```

Create a Binder Configuration

It is strictly required that you create a Spring Configuration to initialize the bean for your binder implementation *(and all other beans that you might need)*:

```
@Configuration
public class FileMessageBinderConfiguration {

    @Bean
    @ConditionalOnMissingBean
    public FileMessageBinderProvisioner fileMessageBinderProvisioner() {
        return new FileMessageBinderProvisioner();
    }

    @Bean
    @ConditionalOnMissingBean
    public FileMessageBinder fileMessageBinder(FileMessageBinderProvisioner
fileMessageBinderProvisioner) {
        return new FileMessageBinder(null, fileMessageBinderProvisioner);
    }

}
```

Define your binder in META-INF/spring.binders

Finally, you must define your binder in a `META-INF/spring.binders` file on the classpath, specifying both the name of the binder and the full qualified name of your Binder Configuration class:

```
myFileBinder:\
com.example.springcloudstreamcustombinder.config.FileMessageBinderConfiguration
```

22. Configuration Options

Spring Cloud Stream supports general configuration options as well as configuration for bindings and binders. Some binders let additional binding properties support middleware-specific features.

Configuration options can be provided to Spring Cloud Stream applications through any mechanism supported by Spring Boot. This includes application arguments, environment variables, and YAML or .properties files.

22.1. Binding Service Properties

These properties are exposed via `org.springframework.cloud.stream.config.BindingServiceProperties`

spring.cloud.stream.instanceCount

The number of deployed instances of an application. Must be set for partitioning on the producer side. Must be set on the consumer side when 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 (letting any destination be bound).

spring.cloud.stream.defaultBinder

The default binder to use, if multiple binders are configured. See Multiple Binders on the Classpath.

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 detects a suitable bound service (for example, a RabbitMQ service bound in Cloud Foundry for the RabbitMQ binder) and uses it for creating connections (usually through Spring Cloud Connectors). When set to `true`, this property instructs binders to completely ignore the bound services and rely on Spring Boot properties (for example, 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.

Default: `false`.

spring.cloud.stream.bindingRetryInterval

The interval (in seconds) between retrying binding creation when, for example, the binder does not support late binding and the broker (for example, Apache Kafka) is down. Set it to zero to treat such conditions as fatal, preventing the application from starting.

Default: `30`

22.2. Binding Properties

Binding properties are supplied by using the format of `spring.cloud.stream.bindings.<bindingName>.<property>=<value>`. The `<bindingName>` represents the name of the binding being configured.

For example, for the following function

```
@Bean
public Function<String, String> uppercase() {
    return v -> v.toUpperCase();
}
```

there are two bindings named `uppercase-in-0` for input and `uppercase-out-0` for output. See Binding and Binding names for more details.

To avoid repetition, Spring Cloud Stream supports setting values for all bindings, in the format of `spring.cloud.stream.default.<property>=<value>` and `spring.cloud.stream.default.<producer|consumer>.<property>=<value>` for common binding properties.

When it comes to avoiding repetitions for extended binding properties, this format should be used - `spring.cloud.stream.<binder-type>.default.<producer|consumer>.<property>=<value>`.

22.2.1. Common Binding Properties

These properties are exposed via `org.springframework.cloud.stream.config.BindingProperties`

The following binding properties are available for both input and output bindings and must be prefixed with `spring.cloud.stream.bindings.<bindingName>.` (for example, `spring.cloud.stream.bindings.uppercase-in-0.destination=ticktock`).

Default values can be set by using the `spring.cloud.stream.default` prefix (for example `spring.cloud.stream.default.contentType=application/json`).

destination

The target destination of a binding on the bound middleware (for example, the RabbitMQ exchange or Kafka topic). If binding represents a consumer binding (input), it could be bound to multiple destinations, and the destination names can be specified as comma-separated `String` values. If not, the actual binding name is used instead. The default value of this property cannot be overridden.

group

The consumer group of the binding. Applies only to inbound bindings. See Consumer Groups.

Default: `null` (indicating an anonymous consumer).

contentType

The content type of this binding. See `Content Type Negotiation`.

Default: `application/json`.

binder

The binder used by this binding. See `Multiple Binders on the Classpath` for details.

Default: `null` (the default binder is used, if it exists).

22.2.2. Consumer Properties

These properties are exposed via `org.springframework.cloud.stream.binder.ConsumerProperties`

The following binding properties are available for input bindings only and must be prefixed with `spring.cloud.stream.bindings.<bindingName>.consumer.` (for example,

`spring.cloud.stream.bindings.input.consumer.concurrency=3`).

Default values can be set by using the `spring.cloud.stream.default.consumer` prefix (for example, `spring.cloud.stream.default.consumer.headerMode=none`).

autoStartup

Signals if this consumer needs to be started automatically

Default: `true`.

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`, it uses the middleware's native header mechanism. When set to `embeddedHeaders`, it embeds headers into the message payload.

Default: depends on the 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`.

defaultRetryable

Whether exceptions thrown by the listener that are not listed in the `retryableExceptions` are retryable.

Default: `true`.

instanceCount

When set to a value greater than equal to zero, it allows customizing the instance count of this consumer (if different from `spring.cloud.stream.instanceCount`). When set to a negative value, it defaults to `spring.cloud.stream.instanceCount`. See `Instance Index and Instance Count` for more information.

Default: `-1`.

instanceIndex

When set to a value greater than equal to zero, it allows customizing the instance index of this consumer (if different from `spring.cloud.stream.instanceIndex`). When set to a negative value, it defaults to `spring.cloud.stream.instanceIndex`. Ignored if `instanceIndexList` is provided. See `Instance Index and Instance Count` for more information.

Default: `-1`.

instanceIndexList

Used with binders that do not support native partitioning (such as RabbitMQ); allows an application instance to consume from more than one partition.

Default: empty.

retryableExceptions

A map of Throwable class names in the key and a boolean in the value. Specify those exceptions (and subclasses) that will or won't be retried. Also see `defaultRetriable`. Example: `spring.cloud.stream.bindings.input.consumer.retryable-exceptions.java.lang.IllegalStateException=false`.

Default: empty.

useNativeDecoding

When set to `true`, the inbound message is deserialized directly by the client library, which must be configured correspondingly (for example, setting an appropriate Kafka producer value deserializer). When this configuration is being used, the inbound message unmarshalling is not based on the `contentType` of the binding. When native decoding is used, it is the responsibility of the producer to use an appropriate encoder (for example, the Kafka producer value serializer) to serialize the outbound message. Also, when native encoding and decoding is used, the `headerMode=embeddedHeaders` property is ignored and headers are not embedded in the message. See the producer property `useNativeEncoding`.

Default: `false`.

multiplex

When set to true, the underlying binder will natively multiplex destinations on the same input binding.

Default: `false`.

22.2.3. Advanced Consumer Configuration

For advanced configuration of the underlying message listener container for message-driven consumers, add a single `ListenerContainerCustomizer` bean to the application context. It will be invoked after the above properties have been applied and can be used to set additional properties. Similarly, for polled consumers, add a `MessageSourceCustomizer` bean.

The following is an example for the RabbitMQ binder:

```
@Bean
public ListenerContainerCustomizer<AbstractMessageListenerContainer>
containerCustomizer() {
    return (container, dest, group) -> container.setAdviceChain(advice1, advice2);
}

@Bean
public MessageSourceCustomizer<AmqpMessageSource> sourceCustomizer() {
    return (source, dest, group) ->
source.setPropertiesConverter(customPropertiesConverter);
}
```

22.2.4. Producer Properties

These properties are exposed via `org.springframework.cloud.stream.binder.ProducerProperties`

The following binding properties are available for output bindings only and must be prefixed with `spring.cloud.stream.bindings.<bindingName>.producer.` (for example, `spring.cloud.stream.bindings.func-out-0.producer.partitionKeyExpression=payload.id`).

Default values can be set by using the prefix `spring.cloud.stream.default.producer` (for example, `spring.cloud.stream.default.producer.partitionKeyExpression=payload.id`).

autoStartup

Signals if this consumer needs to be started automatically

Default: `true`.

partitionKeyExpression

A SpEL expression that determines how to partition outbound data. If set, outbound data on this binding is partitioned. `partitionCount` must be set to a value greater than 1 to be effective. See Partitioning Support.

Default: null.

partitionKeyExtractorName

The name of the bean that implements `PartitionKeyExtractorStrategy`. Used to extract a key used to compute the partition id (see 'partitionSelector*'). Mutually exclusive with 'partitionKeyExpression'.

Default: null.

partitionSelectorName

The name of the bean that implements `PartitionSelectorStrategy`. Used to determine partition id based on partition key (see 'partitionKeyExtractor*'). Mutually exclusive with 'partitionSelectorExpression'.

Default: null.

partitionSelectorExpression

A SpEL expression for customizing partition selection. If neither is set, the partition is selected as the `hashCode(key) % partitionCount`, where `key` is computed through either `partitionKeyExpression`.

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, it is 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 (for example, by pre-creating durable queues in RabbitMQ).

headerMode

When set to `none`, it disables header embedding on output. It is 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`, it uses the middleware's native header mechanism. When set to `embeddedHeaders`, it embeds headers into the message payload.

Default: Depends on the binder implementation.

useNativeEncoding

When set to `true`, the outbound message is serialized directly by the client library, which must be configured correspondingly (for example, 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 an appropriate decoder (for example, the Kafka consumer value de-

serializer) to deserialize the inbound message. Also, when native encoding and decoding is used, the `headerMode=embeddedHeaders` property is ignored and headers are not embedded in the message. See the consumer property `useNativeDecoding`.

Default: `false`.

errorChannelEnabled

When set to true, if the binder supports asynchroous send results, send failures are sent to an error channel for the destination. See Error Handling for more information.

Default: false.

23. Content Type Negotiation

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`, a message may have to be transformed to a desired shape or 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[]` (that is true for the Kafka and Rabbit binders), but it is governed by the binder implementation.

In Spring Cloud Stream, message transformation is accomplished with an `org.springframework.messaging.converter.MessageConverter`.

As a supplement to the details to follow, you may also want to read the following blog post.

23.1. Mechanics

To better understand the mechanics and the necessity behind content-type negotiation, we take a look at a very simple use case by using the following message handler as an example:

```
public Function<Person, Person> personFunction {..}
```

For simplicity, we assume that this is the only handler function in the application (we assume there is no internal pipeline).

The handler shown in the preceding example expects a `Person` object as an argument and produces a `String` type as an output. In order for the framework to succeed in passing the incoming `Message` as an argument to this handler, it has to somehow transform the payload of the `Message` type from the wire format to a `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). Consequently, in theory, that should be (and, in some cases, is) enough. However, for the majority of 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 mechanisms to define `contentType` (in order of precedence):

1. **HEADER**: The `contentType` can be communicated through the Message itself. By providing a `contentType` header, you declare the content type to use to locate and apply the appropriate `MessageConverter`.
2. **BINDING**: The `contentType` can be set per destination binding by setting the `spring.cloud.stream.bindings.input.content-type` property.

The `input` segment in the property name corresponds to the actual name of the destination (which is "input" in our case). This approach lets you declare, on a per-binding basis, the content type to use to locate and apply the appropriate `MessageConverter`.

3. **DEFAULT**: If `contentType` is not present in the `Message` header or the binding, the default `application/json` content type is used to locate and apply the appropriate `MessageConverter`.

As mentioned earlier, the preceding list also demonstrates the order of precedence in case of a tie. For example, a header-provided content type takes precedence over any other content type. The same applies for a content type set on a per-binding basis, which essentially lets you override the default content type. However, it also provides a sensible default (which was determined from 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.

When the non-void handler method returns, if the return value is already a `Message`, that `Message` becomes the payload. However, when the return value is not a `Message`, the new `Message` is constructed with the return value as the payload while inheriting headers from the input `Message` minus the headers defined or filtered by `SpringIntegrationProperties.messageHandlerNotPropagatedHeaders`. By default, there is only one header set there: `contentType`. This means that the new `Message` does not have `contentType` header set, thus ensuring that the `contentType` can evolve. You can always opt out of 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 by going through the same process of conversion. However, if there is no internal pipeline or you have reached the end of it, the `Message` is sent back to the output destination.

23.1.1. Content Type versus Argument Type

As mentioned earlier, 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`), which trigger right before the invocation of the user-defined handler method (which is when the actual argument type is known to the framework). If the 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 a `contentType` header. When no contentType header was already present, it injects either the per-binding `contentType` header or the default `contentType` header. The combination of `contentType` argument type is the mechanism by which framework determines if message can be converted to a target type. If no appropriate `MessageConverter` is found, an exception is thrown, which you can handle by adding a custom `MessageConverter` (see `User-defined Message Converters`).

But what if the payload type matches the target type declared by the handler method? In this case, there is nothing to convert, and the payload is passed unmodified. While this sounds pretty straightforward and logical, keep in mind handler methods that take a `Message<?>` or `Object` as an argument. By declaring the target type to be `Object` (which is an `instanceof` everything in Java), you essentially forfeit the conversion process.

Do not expect `Message` to be converted into some other type based only on the `contentType`. Remember that the `contentType` is complementary to the target type. If you wish, you can provide a hint, which `MessageConverter` may or may not take into consideration.

23.1.2. 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 an incoming `Message` to an argument type. The payload of the `Message` could be any type, and it is up to the actual implementation of the `MessageConverter` to support multiple types. For example, some JSON converter may support the payload type as `byte[]`, `String`, and others. This is important when the application contains an internal pipeline (that is, 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 regard the two methods as having the following signatures:

```
Object fromMessage(Message<?> message, Class<?> targetClass);

Message<byte[]> toMessage(Object payload, @Nullable MessageHeaders headers);
```

23.2. Provided MessageConverters

As mentioned earlier, the framework already provides a stack of `MessageConverters` to handle most common use cases. The following list describes the provided `MessageConverters`, in order of precedence (the first `MessageConverter` that works is used):

1. `ApplicationJsonMessageMarshallingConverter`: Variation of the `org.springframework.messaging.converter.MappingJackson2MessageConverter`. Supports conversion of the payload of the `Message` to/from POJO for cases when `contentType` is `application/json` (DEFAULT).
2. `ByteArrayMessageConverter`: Supports conversion of the payload of the `Message` from `byte[]` to `byte[]` for cases when `contentType` is `application/octet-stream`. It is essentially a pass through and exists primarily for backward compatibility.
3. `ObjectStringMessageConverter`: Supports conversion of any type to a `String` when `contentType` is `text/plain`. It invokes Object's `toString()` method or, if the payload is `byte[]`, a new `String(byte[])`.
4. `JsonUnmarshallingConverter`: Similar to the `ApplicationJsonMessageMarshallingConverter`. It supports conversion of any type when `contentType` is `application/x-java-object`. It expects the actual type information to be embedded in the `contentType` as an attribute (for example, `application/x-java-object;type=foo.bar.Cat`).

When no appropriate converter is found, the framework throws an exception. When that happens, you should check your code and configuration and ensure you did not miss anything (that is, ensure that you provided a `contentType` by using a binding or a header). However, most likely, you found some uncommon case (such as a custom `contentType` perhaps) and the current stack of provided `MessageConverters` does not know how to convert. If that is the case, you can add custom `MessageConverter`. See User-defined Message Converters.

23.3. User-defined Message Converters

Spring Cloud Stream exposes a mechanism to define and register additional `MessageConverters`. To use it, implement `org.springframework.messaging.converter.MessageConverter`, configure it as a `@Bean`. It is then appended to the existing stack of `MessageConverter`s.

It is important to understand that custom `MessageConverter` implementations are added to the head of the existing stack. Consequently, custom `MessageConverter` implementations take precedence over the existing ones, which lets you override as well as add to the existing converters.

The following example shows how to create a message converter bean to support a new content type called `application/bar`:

```
@SpringBootApplication
public static class SinkApplication {

    ...

    @Bean
    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 [schema-evolution] for details.

[== Inter-Application Communication

Spring Cloud Stream enables communication between applications. Inter-application communication is a complex issue spanning several concerns, as described in the following topics:

- Connecting Multiple Application Instances
- Instance Index and Instance Count
- Partitioning

23.4. 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.

Suppose a design calls for the Time Source application to send data to the Log Sink application. You could use a common destination named `ticktock` for bindings within both applications.

Time Source (that has the binding named `output`) would set the following property:

```
spring.cloud.stream.bindings.output.destination=ticktock
```

Log Sink (that has the binding named `input`) would set the following property:

```
spring.cloud.stream.bindings.input.destination=ticktock
```

23.5. 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 have `spring.cloud.stream.instanceCount` set to `3`, and the individual applications have `spring.cloud.stream.instanceIndex` set to `0`, `1`, and `2`, respectively.

When Spring Cloud Stream applications are deployed through 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 (for example, the Kafka binder) in order to ensure that data are split correctly across multiple consumer instances.

23.6. Partitioning

Partitioning in Spring Cloud Stream consists of two tasks:

- Configuring Output Bindings for Partitioning
- Configuring Input Bindings for Partitioning

23.6.1. Configuring Output Bindings for Partitioning

You can configure an output binding to send partitioned data by setting one and only one of its `partitionKeyExpression` or `partitionKeyExtractorName` properties, as well as its `partitionCount` property.

For example, the following is a valid and typical configuration:

```
spring.cloud.stream.bindings.func-out-0.producer.partitionKeyExpression=payload.id
spring.cloud.stream.bindings.func-out-0.producer.partitionCount=5
```

Based on that example configuration, data is sent to the target partition by using the following logic.

A partition key's value is calculated for each message sent to a partitioned output binding based on the `partitionKeyExpression`. The `partitionKeyExpression` is a SpEL expression that 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 an implementation of `org.springframework.cloud.stream.binder.PartitionKeyExtractorStrategy` and configuring it as a bean (by using the `@Bean` annotation). If 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 with the `partitionKeyExtractorName` property, as shown in the following example:

```
--spring.cloud.stream.bindings.func-out
-0.producer.partitionKeyExtractorName=customPartitionKeyExtractor
--spring.cloud.stream.bindings.func-out-0.producer.partitionCount=5
. . .
@Bean
public CustomPartitionKeyExtractorClass customPartitionKeyExtractor() {
    return new CustomPartitionKeyExtractorClass();
}
```

In previous versions of Spring Cloud Stream, you could specify the implementation of `org.springframework.cloud.stream.binder.PartitionKeyExtractorStrategy` by setting the `spring.cloud.stream.bindings.output.producer.partitionKeyExtractorClass` property. Since version 3.0, this property is removed.

Once the message key is calculated, the partition selection process determines the target partition as a value between `0` and `partitionCount - 1`. The default calculation, applicable in most scenarios, is based on the following formula: `key.hashCode() % partitionCount`. This can be customized on the binding, either by setting a SpEL expression to be evaluated against the 'key' (through the `partitionSelectorExpression` property) or by configuring an implementation of `org.springframework.cloud.stream.binder.PartitionSelectorStrategy` as a bean (by using the @Bean annotation). Similar to the `PartitionKeyExtractorStrategy`, you can further filter it by using the `spring.cloud.stream.bindings.output.producer.partitionSelectorName` property when more than one bean of this type is available in the Application Context, as shown in the following example:

```
--spring.cloud.stream.bindings.func-out
-0.producer.partitionSelectorName=customPartitionSelector
. . .
@Bean
public CustomPartitionSelectorClass customPartitionSelector() {
    return new CustomPartitionSelectorClass();
}
```

In previous versions of Spring Cloud Stream you could specify the implementation of `org.springframework.cloud.stream.binder.PartitionSelectorStrategy` by setting the `spring.cloud.stream.bindings.output.producer.partitionSelectorClass` property. Since version 3.0, this property is removed.

23.6.2. Configuring Input Bindings for Partitioning

An input binding (with the binding name `uppercase-in-0`) is configured to receive partitioned data by setting its `partitioned` property, as well as the `instanceIndex` and `instanceCount` properties on the application itself, as shown in the following example:

```
spring.cloud.stream.bindings.uppercase-in-0.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 should be partitioned. The `instanceIndex` must be a unique value across the multiple instances, with a value 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 does not 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 takes 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 subscribes to (you must have at least as many partitions as there are instances). The binder allocates 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 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 in 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 and by letting you rely on the runtime infrastructure to provide information about the instance index and instance count.

24. Testing

Spring Cloud Stream provides support for testing your microservice applications without connecting to a messaging system.

24.1. Spring Integration Test Binder

The old test binder defined in `spring-cloud-stream-test-support` module was specifically designed to facilitate *unit testing* of the actual messaging components and thus bypasses some of the core functionality of the binder API.

While such light-weight approach is sufficient for a lot of cases, it usually requires additional *integration testing* with real binders (e.g., Rabbit, Kafka etc). So we are effectively deprecating it.

To begin bridging the gap between *unit* and *integration* testing we've developed a new test binder which uses Spring Integration framework as an in-JVM Message Broker essentially giving you the best of both worlds - a real binder without the networking.

24.1.1. Test Binder configuration

To enable Spring Integration Test Binder all you need is:

- Add required dependencies
- Remove the dependency for `spring-cloud-stream-test-support`

Add required dependencies

Below is the example of the required Maven POM entries which could be easily retrofitted into Gradle.

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-stream</artifactId>
    <version>${spring.cloud.stream.version}</version>
    <type>test-jar</type>
    <scope>test</scope>
    <classifier>test-binder</classifier>
</dependency>
```

Remove the dependency for `spring-cloud-stream-test-support`

To avoid conflicts with the existing test binder you must remove the following entry

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-stream-test-support</artifactId>
    <scope>test</scope>
</dependency>
```

24.1.2. Test Binder usage

Now you can test your microservice as a simple unit test

```
@SpringBootTest
@RunWith(SpringRunner.class)
public class SampleStreamTests {

    @Autowired
    private InputDestination input;

    @Autowired
    private OutputDestination output;

    @Test
    public void testEmptyConfiguration() {
        this.input.send(new GenericMessage<byte[]>("hello".getBytes()));
        assertThat(output.receive().getPayload()).isEqualTo("HELLO".getBytes());
    }

    @SpringBootApplication
    @Import(TestChannelBinderConfiguration.class)
    public static class SampleConfiguration {
        @Bean
        public Function<String, String> uppercase() {
            return v -> v.toUpperCase();
        }
    }
}
```

And if you need more control or want to test several configurations in the same test suite you can also do the following:

```
@EnableAutoConfiguration
public static class MyTestConfiguration {
    @Bean
    public Function<String, String> uppercase() {
            return v -> v.toUpperCase();
    }
}

. . .

@Test
public void sampleTest() {
    try (ConfigurableApplicationContext context = new SpringApplicationBuilder(
                TestChannelBinderConfiguration.getCompleteConfiguration(
                        MyTestConfiguration.class))
                .run("--spring.cloud.function.definition=uppercase")) {
        InputDestination source = context.getBean(InputDestination.class);
        OutputDestination target = context.getBean(OutputDestination.class);
        source.send(new GenericMessage<byte[]>("hello".getBytes()));
        assertThat(target.receive().getPayload()).isEqualTo("HELLO".getBytes());
    }
}
```

For cases where you have multiple bindings and/or multiple inputs and outputs, or simply want to be explicit about names of the destination you are sending to or receiving from, the `send()` and `receive()` methods of `InputDestination` and `OutputDestination` are overridden to allow you to provide the name of the input and output destination.

Consider the following sample:

```
@EnableAutoConfiguration
public static class SampleFunctionConfiguration {

    @Bean
    public Function<String, String> uppercase() {
        return value -> value.toUpperCase();
    }

    @Bean
    public Function<String, String> reverse() {
        return value -> new StringBuilder(value).reverse().toString();
    }
}
```

and the actual test

```
@Test
public void testMultipleFunctions() {
    try (ConfigurableApplicationContext context = new SpringApplicationBuilder(
            TestChannelBinderConfiguration.getCompleteConfiguration(
                    SampleFunctionConfiguration.class))
                            .run("--
spring.cloud.function.definition=uppercase;reverse")) {

        InputDestination inputDestination = context.getBean(InputDestination.class);
        OutputDestination outputDestination =
context.getBean(OutputDestination.class);

        Message<byte[]> inputMessage =
MessageBuilder.withPayload("Hello".getBytes()).build();
        inputDestination.send(inputMessage, "uppercase-in-0");
        inputDestination.send(inputMessage, "uppercase-in-0");

        Message<byte[]> outputMessage = outputDestination.receive(0, "uppercase-out-
0");
        assertThat(outputMessage.getPayload()).isEqualTo("HELLO".getBytes());

        outputMessage = outputDestination.receive(0, "uppercase-out-0");
        assertThat(outputMessage.getPayload()).isEqualTo("olleH".getBytes());
    }
}
```

For cases where you have additional mapping properties such as `destination` you should use those names. For example, consider a different version of the preceding test where we explicitly map inputs and outputs of the `uppercase` function to `myInput` and `myOutput` binding names:

```
@Test
public void testMultipleFunctions() {
    try (ConfigurableApplicationContext context = new SpringApplicationBuilder(
            TestChannelBinderConfiguration.getCompleteConfiguration(
                    SampleFunctionConfiguration.class))
                            .run(
                            "--spring.cloud.function.definition=uppercase;reverse",
                            "--spring.cloud.stream.bindings.uppercase-in-
0.destination=myInput",
                            "--spring.cloud.stream.bindings.uppercase-out-
0.destination=myOutput",
                            )) {

        InputDestination inputDestination = context.getBean(InputDestination.class);
        OutputDestination outputDestination =
context.getBean(OutputDestination.class);

        Message<byte[]> inputMessage =
MessageBuilder.withPayload("Hello".getBytes()).build();
        inputDestination.send(inputMessage, "myInput");
        inputDestination.send(inputMessage, "myInput");

        Message<byte[]> outputMessage = outputDestination.receive(0, "myOutput");
        assertThat(outputMessage.getPayload()).isEqualTo("HELLO".getBytes());

        outputMessage = outputDestination.receive(0, "myOutput");
        assertThat(outputMessage.getPayload()).isEqualTo("olleH".getBytes());
    }
}
```

You can also use this binder with legacy annotation-based configuration:

```
@SpringBootApplication
@EnableBinding(Processor.class)
public class LegacyStreamApplication {

    @StreamListener(Processor.INPUT)
    @SendTo(Processor.OUTPUT)
    public String echo(String value) {
        return value;
    }
}

. . .

@Test
public void sampleTest() {
    try (ConfigurableApplicationContext context = new SpringApplicationBuilder(
                TestChannelBinderConfiguration.getCompleteConfiguration(
                        LegacyStreamApplication.class)).run()) {
        InputDestination source = context.getBean(InputDestination.class);
        OutputDestination target = context.getBean(OutputDestination.class);
        source.send(new GenericMessage<byte[]>("hello".getBytes()));
        assertThat(target.receive().getPayload()).isEqualTo("hello".getBytes());
    }
}
```

In the above you simply create an ApplicationContext with your configuration (your application) while additionally supplying `TestChannelBinderConfiguration` provided by the framework. Then you access `InputDestination` and `OutputDestination` beans to send/receive messages. In the context of this binder `InputDestination` and `OutputDestination` emulate remote destinations such as Rabbit *exchange/queue* or Kafka *topic*.

In the future we plan to simplify the API.

In its current state Spring Integration Test Binder only supports the three bindings provided by the framework (Source, Processor, Sink) specifically to promote light-weight microservices architectures rather then general purpose messaging applications.

24.1.3. Test Binder and PollableMessageSource

Spring Integration Test Binder also allows you to write tests when working with `PollableMessageSource` (see Using Polled Consumers for more details).

The important thing that needs to be understood though is that polling is not event-driven, and that `PollableMessageSource` is a strategy which exposes operation to produce (poll for) a Message (singular). How often you poll or how many threads you use or where you're polling from (message queue or file system) is entirely up to you; In other words it is your responsibility to configure Poller or Threads or the actual source of Message. Luckily Spring has plenty of abstractions to

configure exactly that.

Let’s look at the example:

```
@Test
public void samplePollingTest() {
    ApplicationContext context = new
SpringApplicationBuilder(SamplePolledConfiguration.class)
                .web(WebApplicationType.NONE)
                .run("--spring.jmx.enabled=false");
    OutputDestination destination = context.getBean(OutputDestination.class);
    System.out.println("Message 1: " + new
String(destination.receive().getPayload()));
    System.out.println("Message 2: " + new
String(destination.receive().getPayload()));
    System.out.println("Message 3: " + new
String(destination.receive().getPayload()));
}

@EnableBinding(SamplePolledConfiguration.PolledConsumer.class)
@Import(TestChannelBinderConfiguration.class)
@EnableAutoConfiguration
public static class SamplePolledConfiguration {
    @Bean
    public ApplicationRunner poller(PollableMessageSource polledMessageSource,
MessageChannel output, TaskExecutor taskScheduler) {
        return args -> {
            taskScheduler.execute(() -> {
                for (int i = 0; i < 3; i++) {
                    try {
                        if (!polledMessageSource.poll(m -> {
                            String newPayload = ((String)
m.getPayload()).toUpperCase();
                            output.send(new GenericMessage<>(newPayload));
                        })) {
                            Thread.sleep(2000);
                        }
                    }
                    catch (Exception e) {
                        // handle failure
                    }
                }
            });
        };
    }

    public static interface PolledConsumer extends Source {
        @Input
        PollableMessageSource pollableSource();
    }
}
```

The above (very rudimentary) example will produce 3 messages in 2 second intervals sending them to the output destination of `Source` which this binder sends to `OutputDestination` where we retrieve

them (for any assertions). Currently it prints the following:

```
Message 1: POLLED DATA
Message 2: POLLED DATA
Message 3: POLLED DATA
```

As you can see the data is the same. That is because this binder defines a default implementation of the actual `MessageSource` - the source from which the Messages are polled using `poll()` operation. While sufficient for most testing scenarios, there are cases where you may want to define your own `MessageSource`. To do so simply configure a bean of type `MessageSource` in your test configuration providing your own implementation of Message sourcing.

Here is the example:

```
@Bean
public MessageSource<?> source() {
    return () -> new GenericMessage<>("My Own Data " + UUID.randomUUID());
}
```

rendering the following output;

```
Message 1: MY OWN DATA 1C180A91-E79F-494F-ABF4-BA3F993710DA
Message 2: MY OWN DATA D8F3A477-5547-41B4-9434-E69DA7616FEE
Message 3: MY OWN DATA 20BF2E64-7FF4-4CB6-A823-4053D30B5C74
```

DO NOT name this bean `messageSource` as it is going to be in conflict with the bean of the same name (different type) provided by Spring Boot for unrelated reasons.

25. Health Indicator

Spring Cloud Stream provides a health indicator for binders. It is registered under the name `binders` and can be enabled or disabled by setting the `management.health.binders.enabled` property.

To enable health check you first need to enable both "web" and "actuator" by including its dependencies (see Binding visualization and control)

If `management.health.binders.enabled` is not set explicitly by the application, then `management.health.defaults.enabled` is matched as `true` and the binder health indicators are enabled. If you want to disable health indicator completely, then you have to set `management.health.binders.enabled` to `false`.

You can use Spring Boot actuator health endpoint to access the health indicator - `/actuator/health`. By default, you will only receive the top level application status when you hit the above endpoint. In order to receive the full details from the binder specific health indicators, you need to include the property `management.endpoint.health.show-details` with the value `ALWAYS` in your application.

Health indicators are binder-specific and certain binder implementations may not necessarily provide a health indicator.

If you want to completely disable all health indicators available out of the box and instead provide your own health indicators, you can do so by setting property `management.health.binders.enabled` to `false` and then provide your own `HealthIndicator` beans in your application. In this case, the health indicator infrastructure from Spring Boot will still pick up these custom beans. Even if you are not disabling the binder health indicators, you can still enhance the health checks by providing your own `HealthIndicator` beans in addition to the out of the box health checks.

When you have multiple binders in the same application, health indicators are enabled by default unless the application turns them off by setting `management.health.binders.enabled` to `false`. In this case, if the user wants to disable health check for a subset of the binders, then that should be done by setting `management.health.binders.enabled` to `false` in the multi binder configurations's environment. See Connecting to Multiple Systems for details on how environment specific properties can be provided.

If there are multiple binders present in the classpath but not all of them are used in the application, this may cause some issues in the context of health indicators. There may be implementation specific details as to how the health checks are performed. For example, a Kafka binder may decide the status as `DOWN` if there are no destinations registered by the binder. For this reason, if you include a binder in the classpath, it is advised to use that binder by providing at least one binding (for E.g. through `EnableBinding`). If you don't have any bindings to provide for this binder, then that is an indication that you don't need to include that binder in the classpath.

Lets take a concrete situation. Imagine you have both Kafka and Kafka Streams binders present in the classpath, but only use the Kafka Streams binder in the application code, i.e. only provide bindings using the Kafka Streams binder. Since Kafka binder is not used and it has specific checks to see if any destinations are registered, the binder health check will fail. The top level application health check status will be reported as `DOWN`. In this situation, you can simply remove the dependency for kafka binder from your application since you are not using it.

26. Samples

For Spring Cloud Stream samples, see the spring-cloud-stream-samples repository on GitHub.

26.1. Deploying Stream Applications on CloudFoundry

On CloudFoundry, services are usually exposed through a special environment variable called VCAP_SERVICES.

When configuring your binder connections, you can use the values from an environment variable as explained on the dataflow Cloud Foundry Server docs.

27. Binder Implementations

The following is the list of available binder implementations

- RabbitMQ
- Apache Kafka
- Amazon Kinesis
- Google PubSub *(partner maintained)*
- Solace PubSub+ *(partner maintained)*
- Azure Event Hubs *(partner maintained)*
- Apache RocketMQ *(partner maintained)*

As it was mentioned earlier Binder abstraction is also one of the extension points of the framework. So if you can't find a suitable binder in the preceding list you can implement your own binder on top of Spring Cloud Stream. In the How to create a Spring Cloud Stream Binder from scratch post a community member documents in details, with an example, a set of steps necessary to implement a custom binder. The steps are also highlighted in the `Implementing Custom Binders` section.

Spring Cloud Task Reference Guide

Michael Minella, Glenn Renfro, Jay Bryant :doctype: book :toc: :toclevels: 4 :source-highlighter: prettify :numbered: :icons: font :hide-uri-scheme: :spring-cloud-task-repo: snapshot :github-tag: master :spring-cloud-task-docs-version: current :spring-cloud-task-docs: docs.spring.io/spring-cloud-task/docs/{version}/reference :spring-cloud-task-docs-current: docs.spring.io/spring-cloud-task/docs/current-SNAPSHOT/reference/html/ :github-repo: spring-cloud/spring-cloud-task :github-raw: raw.github.com/spring-cloud/spring-cloud-netflix/master :github-code: github.com/spring-cloud/spring-cloud-netflix/tree/master :github-wiki: github.com/spring-cloud/spring-cloud-netflix/wiki :github-master-code: github.com/spring-cloud/spring-cloud-netflix/tree/master :sc-ext: java :sc-spring-boot: github.com/spring-cloud/spring-cloud-netflix/tree/master/spring-boot/src/main/java/org/springframework/boot :dc-ext: html :dc-root: docs.spring.io/spring-cloud-task/docs/{spring-cloud-dataflow-docs-version}/api :dc-spring-boot: {dc-root}/org/springframework/boot :dependency-management-plugin: github.com/spring-gradle-plugins/dependency-management-plugin :dependency-management-plugin-documentation: {dependency-management-plugin}/blob/master/README.md :spring-boot-maven-plugin-site: docs.spring.io/spring-boot/docs/{spring-boot-docs-version}/maven-plugin :spring-reference: docs.spring.io/spring/docs/{spring-docs-version}/spring-framework-reference/htmlsingle :spring-security-reference: docs.spring.io/spring-security/site/docs/{spring-security-docs-version}/reference/htmlsingle :spring-javadoc: docs.spring.io/spring/docs/{spring-docs-version}/javadoc-api/org/springframework :spring-amqp-javadoc: docs.spring.io/spring-amqp/docs/current/api/org/springframework/amqp :spring-data-javadoc: docs.spring.io/spring-data/jpa/docs/current/api/org/springframework/data/jpa :spring-data-commons-javadoc: docs.spring.io/spring-data/commons/docs/current/api/org/springframework/data :spring-data-mongo-javadoc: docs.spring.io/spring-data/mongodb/docs/current/api/org/springframework/data/mongodb :spring-data-rest-javadoc: docs.spring.io/spring-data/rest/docs/current/api/org/springframework/data/rest :gradle-userguide: www.gradle.org/docs/current/userguide :propdeps-plugin: github.com/spring-projects/gradle-plugins/tree/master/propdeps-plugin :ant-manual: ant.apache.org/manual :attributes: allow-uri-read

Preface

This section provides a brief overview of the Spring Cloud Task reference documentation. Think of it as a map for the rest of the document. You can read this reference guide in a linear fashion or you can skip sections if something does not interest you.

1. About the documentation

The Spring Cloud Task reference guide is available in {spring-cloud-task-docs}/html[html], {spring-cloud-task-docs}/pdf/spring-cloud-task-reference.pdf[pdf] and {spring-cloud-task-docs}/epub/spring-cloud-task-reference.epub[epub] formats. The latest copy is available at {spring-cloud-task-docs-current}.

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

2. Getting help

Having trouble with Spring Cloud Task? We would like to help!

- Ask a question. We monitor stackoverflow.com for questions tagged with `spring-cloud-task`.
- Report bugs with Spring Cloud Task at github.com/spring-cloud/spring-cloud-task/issues.

All of Spring Cloud Task is open source, including the documentation. If you find a problem with the docs or if you just want to improve them, please get involved.

3. First Steps

If you are just getting started with Spring Cloud Task or with 'Spring' in general, we suggesting reading the getting-started.pdf chapter.

To get started from scratch, read the following sections: * “getting-started.pdf” * “getting-started.pdf” To follow the tutorial, read “getting-started.pdf” To run your example, read “getting-started.pdf”

Getting started

If you are just getting started with Spring Cloud Task, you should read this section. Here, we answer the basic “what?”, “how?”, and “why?” questions. We start with a gentle introduction to Spring

Cloud Task. We then build a Spring Cloud Task application, discussing some core principles as we go.

1. Introducing Spring Cloud Task

Spring Cloud Task makes it easy to create short-lived microservices. It provides capabilities that let short lived JVM processes be executed on demand in a production environment.

2. System Requirements

You need to have Java installed (Java 8 or better). To build, you need to have Maven installed as well.

2.1. Database Requirements

Spring Cloud Task uses a relational database to store the results of an executed task. While you can begin developing a task without a database (the status of the task is logged as part of the task repository's updates), for production environments, you want to use a supported database. Spring Cloud Task currently supports the following databases:

- DB2
- H2
- HSQLDB
- MySql
- Oracle
- Postgres
- SqlServer

3. Developing Your First Spring Cloud Task Application

A good place to start is with a simple "Hello, World!" application, so we create the Spring Cloud Task equivalent to highlight the features of the framework. Most IDEs have good support for Apache Maven, so we use it as the build tool for this project.

The spring.io web site contains many "`Getting Started`" guides that use Spring Boot. If you need to solve a specific problem, check there first. You can shortcut the following steps by going to the Spring Initializr and creating a new project. Doing so automatically generates a new project structure so that you can start coding right away. We recommend experimenting with the Spring Initializr to become familiar with it.

3.1. Creating the Spring Task Project using Spring Initializr

Now we can create and test an application that prints `Hello, World!` to the console.

To do so:

1. Visit the Spring Initialzr site.
    a. Create a new Maven project with a **Group** name of `io.spring.demo` and an **Artifact** name of `helloworld`.
    b. In the Dependencies text box, type `task` and then select the `Cloud Task` dependency.
    c. In the Dependencies text box, type `jdbc` and then select the `JDBC` dependency.
    d. In the Dependencies text box, type `h2` and then select the `H2`. (or your favorite database)
    e. Click the **Generate Project** button
2. Unzip the helloworld.zip file and import the project into your favorite IDE.

3.2. Writing the Code

To finish our application, we need to update the generated `HelloworldApplication` with the following contents so that it launches a Task.

```
package io.spring.demo.helloworld;

import org.springframework.boot.CommandLineRunner;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.context.annotation.Bean;

@SpringBootApplication
@EnableTask
public class HelloworldApplication {

    @Bean
    public CommandLineRunner commandLineRunner() {
        return new HelloWorldCommandLineRunner();
    }

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

    public static class HelloWorldCommandLineRunner implements CommandLineRunner {

        @Override
        public void run(String... strings) throws Exception {
            System.out.println("Hello, World!");
        }
    }
}
```

While it may seem small, quite a bit is going on. For more about Spring Boot specifics, see the Spring Boot reference documentation.

Now we can open the `application.properties` file in `src/main/resources`. We need to configure two properties in `application.properties`:

- `application.name`: To set the application name (which is translated to the task name)
- `logging.level`: To set the logging for Spring Cloud Task to `DEBUG` in order to get a view of what is going on.

The following example shows how to do both:

```
logging.level.org.springframework.cloud.task=DEBUG
spring.application.name=helloWorld
```

3.2.1. Task Auto Configuration

When including Spring Cloud Task Starter dependency, Task auto configures all beans to bootstrap it's functionality. Part of this configuration registers the `TaskRepository` and the infrastructure for its

use.

In our demo, the `TaskRepository` uses an embedded H2 database to record the results of a task. This H2 embedded database is not a practical solution for a production environment, since the H2 DB goes away once the task ends. However, for a quick getting-started experience, we can use this in our example as well as echoing to the logs what is being updated in that repository. In the Configuration section (later in this documentation), we cover how to customize the configuration of the pieces provided by Spring Cloud Task.

When our sample application runs, Spring Boot launches our `HelloWorldCommandLineRunner` and outputs our "Hello, World!" message to standard out. The `TaskLifecycleListener` records the start of the task and the end of the task in the repository.

3.2.2. The main method

The main method serves as the entry point to any java application. Our main method delegates to Spring Boot's SpringApplication class.

3.2.3. The CommandLineRunner

Spring includes many ways to bootstrap an application's logic. Spring Boot provides a convenient method of doing so in an organized manner through its `*Runner` interfaces (`CommandLineRunner` or `ApplicationRunner`). A well behaved task can bootstrap any logic by using one of these two runners.

The lifecycle of a task is considered from before the `*Runner#run` methods are executed to once they are all complete. Spring Boot lets an application use multiple `*Runner` implementations, as does Spring Cloud Task.

Any processing bootstrapped from mechanisms other than a `CommandLineRunner` or `ApplicationRunner` (by using `InitializingBean#afterPropertiesSet` for example) is not recorded by Spring Cloud Task.

3.3. Running the Example

At this point, our application should work. Since this application is Spring Boot-based, we can run it from the command line by using `$ mvn spring-boot:run` from the root of our application, as shown (with its output) in the following example:

```
$ mvn clean spring-boot:run
....... . . .
....... . . . (Maven log output here)
....... . . .


  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
```

```
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::        (v2.0.3.RELEASE)

2018-07-23 17:44:34.426  INFO 1978 --- [           main]
i.s.d.helloworld.HelloworldApplication   : Starting HelloworldApplication on Glenns-
MBP-2.attlocal.net with PID 1978 (/Users/glennrenfro/project/helloworld/target/classes
started by glennrenfro in /Users/glennrenfro/project/helloworld)
2018-07-23 17:44:34.430  INFO 1978 --- [           main]
i.s.d.helloworld.HelloworldApplication   : No active profile set, falling back to
default profiles: default
2018-07-23 17:44:34.472  INFO 1978 --- [           main]
s.c.a.AnnotationConfigApplicationContext : Refreshing
org.springframework.context.annotation.AnnotationConfigApplicationContext@1d24f32d:
startup date [Mon Jul 23 17:44:34 EDT 2018]; root of context hierarchy
2018-07-23 17:44:35.280  INFO 1978 --- [           main]
com.zaxxer.hikari.HikariDataSource       : HikariPool-1 - Starting...
2018-07-23 17:44:35.410  INFO 1978 --- [           main]
com.zaxxer.hikari.HikariDataSource       : HikariPool-1 - Start completed.
2018-07-23 17:44:35.419 DEBUG 1978 --- [           main]
o.s.c.t.c.SimpleTaskConfiguration        : Using
org.springframework.cloud.task.configuration.DefaultTaskConfigurer TaskConfigurer
2018-07-23 17:44:35.420 DEBUG 1978 --- [           main]
o.s.c.t.c.DefaultTaskConfigurer          : No EntityManager was found, using
DataSourceTransactionManager
2018-07-23 17:44:35.522 DEBUG 1978 --- [           main]
o.s.c.t.r.s.TaskRepositoryInitializer    : Initializing task schema for h2 database
2018-07-23 17:44:35.525  INFO 1978 --- [           main]
o.s.jdbc.datasource.init.ScriptUtils     : Executing SQL script from class path
resource [org/springframework/cloud/task/schema-h2.sql]
2018-07-23 17:44:35.558  INFO 1978 --- [           main]
o.s.jdbc.datasource.init.ScriptUtils     : Executed SQL script from class path
resource [org/springframework/cloud/task/schema-h2.sql] in 33 ms.
2018-07-23 17:44:35.728  INFO 1978 --- [           main]
o.s.j.e.a.AnnotationMBeanExporter        : Registering beans for JMX exposure on
startup
2018-07-23 17:44:35.730  INFO 1978 --- [           main]
o.s.j.e.a.AnnotationMBeanExporter        : Bean with name 'dataSource' has been
autodetected for JMX exposure
2018-07-23 17:44:35.733  INFO 1978 --- [           main]
o.s.j.e.a.AnnotationMBeanExporter        : Located MBean 'dataSource': registering
with JMX server as MBean [com.zaxxer.hikari:name=dataSource,type=HikariDataSource]
2018-07-23 17:44:35.738  INFO 1978 --- [           main]
o.s.c.support.DefaultLifecycleProcessor  : Starting beans in phase 0
2018-07-23 17:44:35.762 DEBUG 1978 --- [           main]
o.s.c.t.r.support.SimpleTaskRepository   : Creating: TaskExecution{executionId=0,
parentExecutionId=null, exitCode=null, taskName='application', startTime=Mon Jul 23
17:44:35 EDT 2018, endTime=null, exitMessage='null', externalExecutionId='null',
errorMessage='null', arguments=[]}
2018-07-23 17:44:35.772  INFO 1978 --- [           main]
i.s.d.helloworld.HelloworldApplication   : Started HelloworldApplication in 1.625
seconds (JVM running for 4.764)
```

```
Hello, World!
2018-07-23 17:44:35.782 DEBUG 1978 --- [           main]
o.s.c.t.r.support.SimpleTaskRepository   : Updating: TaskExecution with executionId=1
with the following {exitCode=0, endTime=Mon Jul 23 17:44:35 EDT 2018,
exitMessage='null', errorMessage='null'}
```

The preceding output has three lines that of interest to us here:

- `SimpleTaskRepository` logged the creation of the entry in the `TaskRepository`.
- The execution of our `CommandLineRunner`, demonstrated by the "Hello, World!" output.
- `SimpleTaskRepository` logs the completion of the task in the `TaskRepository`.

A simple task application can be found in the samples module of the Spring Cloud Task Project here.

Features

This section goes into more detail about Spring Cloud Task, including how to use it, how to configure it, and the appropriate extension points.

1. The lifecycle of a Spring Cloud Task

In most cases, the modern cloud environment is designed around the execution of processes that are not expected to end. If they do end, they are typically restarted. While most platforms do have some way to run a process that is not restarted when it ends, the results of that run are typically not maintained in a consumable way. Spring Cloud Task offers the ability to execute short-lived processes in an environment and record the results. Doing so allows for a microservices architecture around short-lived processes as well as longer running services through the integration of tasks by messages.

While this functionality is useful in a cloud environment, the same issues can arise in a traditional deployment model as well. When running Spring Boot applications with a scheduler such as cron, it can be useful to be able to monitor the results of the application after its completion.

Spring Cloud Task takes the approach that a Spring Boot application can have a start and an end and still be successful. Batch applications are one example of how processes that are expected to end (and that are often short-lived) can be helpful.

Spring Cloud Task records the lifecycle events of a given task. Most long-running processes, typified by most web applications, do not save their lifecycle events. The tasks at the heart of Spring Cloud Task do.

The lifecycle consists of a single task execution. This is a physical execution of a Spring Boot application configured to be a task (that is, it has the Sprint Cloud Task dependencies).

At the beginning of a task, before any `CommandLineRunner` or `ApplicationRunner` implementations have

been run, an entry in the `TaskRepository` that records the start event is created. This event is triggered through `SmartLifecycle#start` being triggered by the Spring Framework. This indicates to the system that all beans are ready for use and comes before running any of the `CommandLineRunner` or `ApplicationRunner` implementations provided by Spring Boot.

The recording of a task only occurs upon the successful bootstrapping of an `ApplicationContext`. If the context fails to bootstrap at all, the task's run is not recorded.

Upon completion of all of the `*Runner#run` calls from Spring Boot or the failure of an `ApplicationContext` (indicated by an `ApplicationFailedEvent`), the task execution is updated in the repository with the results.

If the application requires the `ApplicationContext` to be closed at the completion of a task (all `*Runner#run` methods have been called and the task repository has been updated), set the property `spring.cloud.task.closecontextEnabled` to true.

1.1. The TaskExecution

The information stored in the `TaskRepository` is modeled in the `TaskExecution` class and consists of the following information:

Field	Description
`executionid`	The unique ID for the task's run.
`exitCode`	The exit code generated from an `ExitCodeExceptionMapper` implementation. If there is no exit code generated but an `ApplicationFailedEvent` is thrown, 1 is set. Otherwise, it is assumed to be 0.
`taskName`	The name for the task, as determined by the configured `TaskNameResolver`.
`startTime`	The time the task was started, as indicated by the `SmartLifecycle#start` call.
`endTime`	The time the task was completed, as indicated by the `ApplicationReadyEvent`.
`exitMessage`	Any information available at the time of exit. This can programmatically be set by a `TaskExecutionListener`.
`errorMessage`	If an exception is the cause of the end of the task (as indicated by an `ApplicationFailedEvent`), the stack trace for that exception is stored here.
`arguments`	A `List` of the string command line arguments as they were passed into the executable boot application.

1.2. Mapping Exit Codes

When a task completes, it tries to return an exit code to the OS. If we take a look at our original example, we can see that we are not controlling that aspect of our application. So, if an exception is thrown, the JVM returns a code that may or may not be of any use to you in debugging.

Consequently, Spring Boot provides an interface, `ExitCodeExceptionMapper`, that lets you map uncaught exceptions to exit codes. Doing so lets you indicate, at the level of exit codes, what went wrong. Also, by mapping exit codes in this manner, Spring Cloud Task records the returned exit code.

If the task terminates with a SIG-INT or a SIG-TERM, the exit code is zero unless otherwise specified within the code.

While the task is running, the exit code is stored as a null in the repository. Once the task completes, the appropriate exit code is stored based on the guidelines described earlier in this section.

2. Configuration

Spring Cloud Task provides a ready-to-use configuration, as defined in the `DefaultTaskConfigurer` and `SimpleTaskConfiguration` classes. This section walks through the defaults and how to customize Spring Cloud Task for your needs.

2.1. DataSource

Spring Cloud Task uses a datasource for storing the results of task executions. By default, we provide an in-memory instance of H2 to provide a simple method of bootstrapping development. However, in a production environment, you probably want to configure your own `DataSource`.

If your application uses only a single `DataSource` and that serves as both your business schema and the task repository, all you need to do is provide any `DataSource` (the easiest way to do so is through Spring Boot's configuration conventions). This `DataSource` is automatically used by Spring Cloud Task for the repository.

If your application uses more than one `DataSource`, you need to configure the task repository with the appropriate `DataSource`. This customization can be done through an implementation of `TaskConfigurer`.

2.2. Table Prefix

One modifiable property of `TaskRepository` is the table prefix for the task tables. By default, they are all prefaced with `TASK_`. `TASK_EXECUTION` and `TASK_EXECUTION_PARAMS` are two examples. However, there are potential reasons to modify this prefix. If the schema name needs to be prepended to the table names or if more than one set of task tables is needed within the same schema, you must change the table prefix. You can do so by setting the `spring.cloud.task.tablePrefix` to the prefix you need, as follows:

```
spring.cloud.task.tablePrefix=yourPrefix
```

By using the `spring.cloud.task.tablePrefix`, a user assumes the responsibility to create the task tables that meet both the criteria for the task table schema but with modifications that are required for a user's business needs. You can utilize the Spring Cloud Task Schema DDL as a guide when creating your own Task DDL as seen here.

2.3. Enable/Disable table initialization

In cases where you are creating the task tables and do not wish for Spring Cloud Task to create them at task startup, set the `spring.cloud.task.initialize-enabled` property to `false`, as follows:

```
spring.cloud.task.initialize-enabled=false
```

It defaults to `true`.

The property `spring.cloud.task.initialize.enable` has been deprecated.

2.4. Externally Generated Task ID

In some cases, you may want to allow for the time difference between when a task is requested and when the infrastructure actually launches it. Spring Cloud Task lets you create a `TaskExecution` when the task is requested. Then pass the execution ID of the generated `TaskExecution` to the task so that it can update the `TaskExecution` through the task's lifecycle.

A `TaskExecution` can be created by calling the `createTaskExecution` method on an implementation of the `TaskRepository` that references the datastore that holds the `TaskExecution` objects.

In order to configure your Task to use a generated `TaskExecutionId`, add the following property:

```
spring.cloud.task.executionid=yourtaskId
```

2.5. External Task Id

Spring Cloud Task lets you store an external task ID for each `TaskExecution`. An example of this would be a task ID provided by Cloud Foundry when a task is launched on the platform. In order to configure your Task to use a generated `TaskExecutionId`, add the following property:

```
spring.cloud.task.external-execution-id=<externalTaskId>
```

2.6. Parent Task Id

Spring Cloud Task lets you store a parent task ID for each `TaskExecution`. An example of this would be a task that executes another task or tasks and you want to record which task launched each of the child tasks. In order to configure your Task to set a parent `TaskExecutionId` add the following property on the child task:

```
spring.cloud.task.parent-execution-id=<parentExecutionTaskId>
```

2.7. TaskConfigurer

The `TaskConfigurer` is a strategy interface that lets you customize the way components of Spring Cloud Task are configured. By default, we provide the `DefaultTaskConfigurer` that provides logical defaults: `Map`-based in-memory components (useful for development if no `DataSource` is provided) and JDBC based components (useful if there is a `DataSource` available).

The `TaskConfigurer` lets you configure three main components:

Component	Description	Default (provided by `DefaultTaskConfigurer`)
`TaskRepository`	The implementation of the `TaskRepository` to be used.	`SimpleTaskRepository`
`TaskExplorer`	The implementation of the `TaskExplorer` (a component for read-only access to the task repository) to be used.	`SimpleTaskExplorer`
`PlatformTransactionManager`	A transaction manager to be used when running updates for tasks.	`DataSourceTransactionManager` if a `DataSource` is used. `ResourcelessTransactionManager` if it is not.

You can customize any of the components described in the preceding table by creating a custom implementation of the `TaskConfigurer` interface. Typically, extending the `DefaultTaskConfigurer` (which is provided if a `TaskConfigurer` is not found) and overriding the required getter is sufficient. However, implementing your own from scratch may be required.

Users should not directly use getter methods from a `TaskConfigurer` directly unless they are using it to supply implementations to be exposed as Spring Beans.

2.8. Task Name

In most cases, the name of the task is the application name as configured in Spring Boot. However, there are some cases where you may want to map the run of a task to a different name. Spring Cloud Data Flow is an example of this (because you probably want the task to be run with the name of the task definition). Because of this, we offer the ability to customize how the task is named, through the `TaskNameResolver` interface.

By default, Spring Cloud Task provides the `SimpleTaskNameResolver`, which uses the following options (in order of precedence):

1. A Spring Boot property (configured in any of the ways Spring Boot allows) called `spring.cloud.task.name`.
2. The application name as resolved using Spring Boot's rules (obtained through `ApplicationContext#getId`).

2.9. Task Execution Listener

`TaskExecutionListener` lets you register listeners for specific events that occur during the task lifecycle. To do so, create a class that implements the `TaskExecutionListener` interface. The class that implements the `TaskExecutionListener` interface is notified of the following events:

- `onTaskStartup`: Prior to storing the `TaskExecution` into the `TaskRepository`.
- `onTaskEnd`: Prior to updating the `TaskExecution` entry in the `TaskRepository` and marking the final state of the task.
- `onTaskFailed`: Prior to the `onTaskEnd` method being invoked when an unhandled exception is thrown by the task.

Spring Cloud Task also lets you add `TaskExecution` Listeners to methods within a bean by using the following method annotations:

- `@BeforeTask`: Prior to the storing the `TaskExecution` into the `TaskRepository`
- `@AfterTask`: Prior to the updating of the `TaskExecution` entry in the `TaskRepository` marking the final state of the task.
- `@FailedTask`: Prior to the `@AfterTask` method being invoked when an unhandled exception is thrown by the task.

The following example shows the three annotations in use:

```
public class MyBean {

   @BeforeTask
   public void methodA(TaskExecution taskExecution) {
   }

   @AfterTask
   public void methodB(TaskExecution taskExecution) {
   }

   @FailedTask
   public void methodC(TaskExecution taskExecution, Throwable throwable) {
   }
}
```

Inserting an `ApplicationListener` earlier in the chain than `TaskLifecycleListener` exists may cause unexpected effects.

2.9.1. Exceptions Thrown by Task Execution Listener

If an exception is thrown by a `TaskExecutionListener` event handler, all listener processing for that event handler stops. For example, if three `onTaskStartup` listeners have started and the first `onTaskStartup` event handler throws an exception, the other two `onTaskStartup` methods are not

called. However, the other event handlers (`onTaskEnd` and `onTaskFailed`) for the `TaskExecutionListeners` are called.

The exit code returned when a exception is thrown by a `TaskExecutionListener` event handler is the exit code that was reported by the ExitCodeEvent. If no `ExitCodeEvent` is emitted, the Exception thrown is evaluated to see if it is of type ExitCodeGenerator. If so, it returns the exit code from the `ExitCodeGenerator`. Otherwise, `1` is returned.

In the case that an exception is thrown in an `onTaskStartup` method, the exit code for the application will be `1`. If an exception is thrown in either a `onTaskEnd` or `onTaskFailed` method, the exit code for the application will be the one established using the rules enumerated above.

In the case of an exception being thrown in a `onTaskStartup`, `onTaskEnd`, or `onTaskFailed` you can not override the exit code for the application using `ExitCodeExceptionMapper`.

2.9.2. Exit Messages

You can set the exit message for a task programmatically by using a `TaskExecutionListener`. This is done by setting the `TaskExecution's exitMessage`, which then gets passed into the `TaskExecutionListener`. The following example shows a method that is annotated with the `@AfterTask ExecutionListener` :

```
@AfterTask
public void afterMe(TaskExecution taskExecution) {
    taskExecution.setExitMessage("AFTER EXIT MESSAGE");
}
```

An `ExitMessage` can be set at any of the listener events (`onTaskStartup`, `onTaskFailed`, and `onTaskEnd`). The order of precedence for the three listeners follows:

1. `onTaskEnd`
2. `onTaskFailed`
3. `onTaskStartup`

For example, if you set an `exitMessage` for the `onTaskStartup` and `onTaskFailed` listeners and the task ends without failing, the `exitMessage` from the `onTaskStartup` is stored in the repository. Otherwise, if a failure occurs, the `exitMessage` from the `onTaskFailed` is stored. Also if you set the `exitMessage` with an `onTaskEnd` listener, the `exitMessage` from the `onTaskEnd` supersedes the exit messages from both the `onTaskStartup` and `onTaskFailed`.

2.10. Restricting Spring Cloud Task Instances

Spring Cloud Task lets you establish that only one task with a given task name can be run at a time. To do so, you need to establish the task name and set `spring.cloud.task.single-instance-enabled=true` for each task execution. While the first task execution is running, any other time you try to run a task with the same task name and `spring.cloud.task.single-instance-enabled=true`, the

task fails with the following error message: `Task with name "application" is already running.` The default value for `spring.cloud.task.single-instance-enabled` is `false`. The following example shows how to set `spring.cloud.task.single-instance-enabled` to `true`:

```
spring.cloud.task.single-instance-enabled=true or false
```

To use this feature, you must add the following Spring Integration dependencies to your application:

```
<dependency>
    <groupId>org.springframework.integration</groupId>
    <artifactId>spring-integration-core</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.integration</groupId>
    <artifactId>spring-integration-jdbc</artifactId>
</dependency>
```

The exit code for the application will be 1 if the task fails because this feature is enabled and another task is running with the same task name.

2.11. Disabling Spring Cloud Task Auto Configuration

In cases where Spring Cloud Task should not be auto configured for an implementation, you can disable Task's auto configuration. This can be done either by adding the following annotation to your Task application:

```
@EnableAutoConfiguration(exclude={SimpleTaskAutoConfiguration.class})
```

You may also disable Task auto configuration by setting the `spring.cloud.task.autoconfiguration.enabled` property to `false`.

2.12. Closing the Context

If the application requires the `ApplicationContext` to be closed at the completion of a task (all `*Runner#run` methods have been called and the task repository has been updated), set the property `spring.cloud.task.closecontextEnabled` to `true`.

Another case to close the context is when the Task Execution completes however the application does not terminate. In these cases the context is held open because a thread has been allocated (for example: if you are using a TaskExecutor). In these cases set the `spring.cloud.task.closecontextEnabled` property to `true` when launching your task. This will close the application's context once the task is complete. Thus allowing the application to terminate.

Batch

This section goes into more detail about Spring Cloud Task's integration with Spring Batch. Tracking the association between a job execution and the task in which it was executed as well as remote partitioning through Spring Cloud Deployer are covered in this section.

1. Associating a Job Execution to the Task in which It Was Executed

Spring Boot provides facilities for the execution of batch jobs within an über-jar. Spring Boot's support of this functionality lets a developer execute multiple batch jobs within that execution. Spring Cloud Task provides the ability to associate the execution of a job (a job execution) with a task's execution so that one can be traced back to the other.

Spring Cloud Task achieves this functionality by using the `TaskBatchExecutionListener`. By default, this listener is auto configured in any context that has both a Spring Batch Job configured (by having a bean of type `Job` defined in the context) and the `spring-cloud-task-batch` jar on the classpath. The listener is injected into all jobs that meet those conditions.

1.1. Overriding the TaskBatchExecutionListener

To prevent the listener from being injected into any batch jobs within the current context, you can disable the autoconfiguration by using standard Spring Boot mechanisms.

To only have the listener injected into particular jobs within the context, override the `batchTaskExecutionListenerBeanPostProcessor` and provide a list of job bean IDs, as shown in the following example:

```
public TaskBatchExecutionListenerBeanPostProcessor
batchTaskExecutionListenerBeanPostProcessor() {
    TaskBatchExecutionListenerBeanPostProcessor postProcessor =
        new TaskBatchExecutionListenerBeanPostProcessor();

    postProcessor.setJobNames(Arrays.asList(new String[] {"job1", "job2"}));

    return postProcessor;
}
```

You can find a sample batch application in the samples module of the Spring Cloud Task Project, here.

2. Remote Partitioning

Spring Cloud Deployer provides facilities for launching Spring Boot-based applications on most

cloud infrastructures. The `DeployerPartitionHandler` and `DeployerStepExecutionHandler` delegate the launching of worker step executions to Spring Cloud Deployer.

To configure the `DeployerStepExecutionHandler`, you must provide a `Resource` representing the Spring Boot über-jar to be executed, a `TaskLauncher`, and a `JobExplorer`. You can configure any environment properties as well as the max number of workers to be executing at once, the interval to poll for the results (defaults to 10 seconds), and a timeout (defaults to -1 or no timeout). The following example shows how configuring this `PartitionHandler` might look:

```
@Bean
public PartitionHandler partitionHandler(TaskLauncher taskLauncher,
        JobExplorer jobExplorer) throws Exception {

    MavenProperties mavenProperties = new MavenProperties();
    mavenProperties.setRemoteRepositories(new
HashMap<>(Collections.singletonMap("springRepo",
        new MavenProperties.RemoteRepository(repository))));

    Resource resource =
        MavenResource.parse(String.format("%s:%s:%s",
                "io.spring.cloud",
                "partitioned-batch-job",
                "1.1.0.RELEASE"), mavenProperties);

    DeployerPartitionHandler partitionHandler =
        new DeployerPartitionHandler(taskLauncher, jobExplorer, resource,
"workerStep");

    List<String> commandLineArgs = new ArrayList<>(3);
    commandLineArgs.add("--spring.profiles.active=worker");
    commandLineArgs.add("--spring.cloud.task.initialize.enable=false");
    commandLineArgs.add("--spring.batch.initializer.enabled=false");

    partitionHandler.setCommandLineArgsProvider(
        new PassThroughCommandLineArgsProvider(commandLineArgs));
    partitionHandler.setEnvironmentVariablesProvider(new
NoOpEnvironmentVariablesProvider());
    partitionHandler.setMaxWorkers(2);
    partitionHandler.setApplicationName("PartitionedBatchJobTask");

    return partitionHandler;
}
```

When passing environment variables to partitions, each partition may be on a different machine with different environment settings. Consequently, you should pass only those environment variables that are required.

Notice in the example above that we have set the maximum number of workers to 2. Setting the maximum of workers establishes the maximum number of partitions that should be running at one

time.

The `Resource` to be executed is expected to be a Spring Boot über-jar with a `DeployerStepExecutionHandler` configured as a `CommandLineRunner` in the current context. The repository enumerated in the preceding example should be the remote repository in which the über-jar is located. Both the manager and worker are expected to have visibility into the same data store being used as the job repository and task repository. Once the underlying infrastructure has bootstrapped the Spring Boot jar and Spring Boot has launched the `DeployerStepExecutionHandler`, the step handler executes the requested `Step`. The following example shows how to configure the `DefaultStepExecutionHandler`:

```
@Bean
public DeployerStepExecutionHandler stepExecutionHandler(JobExplorer jobExplorer) {
    DeployerStepExecutionHandler handler =
        new DeployerStepExecutionHandler(this.context, jobExplorer,
this.jobRepository);

    return handler;
}
```

You can find a sample remote partition application in the samples module of the Spring Cloud Task project, here.

2.1. Notes on Developing a Batch-partitioned application for the Kubernetes Platform

- When deploying partitioned apps on the Kubernetes platform, you must use the following dependency for the Spring Cloud Kubernetes Deployer:

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-deployer-kubernetes</artifactId>
</dependency>
```

- The application name for the task application and its partitions need to follow the following regex pattern: `[a-z0-9]([-a-z0-9]*[a-z0-9])`. Otherwise, an exception is thrown.

2.2. Notes on Developing a Batch-partitioned Application for the Cloud Foundry Platform

- When deploying partitioned apps on the Cloud Foundry platform, you must use the following dependencies for the Spring Cloud Foundry Deployer:

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-deployer-cloudfoundry</artifactId>
</dependency>
<dependency>
    <groupId>io.projectreactor</groupId>
    <artifactId>reactor-core</artifactId>
    <version>3.1.5.RELEASE</version>
</dependency>
<dependency>
    <groupId>io.projectreactor.ipc</groupId>
    <artifactId>reactor-netty</artifactId>
    <version>0.7.5.RELEASE</version>
</dependency>
```

- When configuring the partition handler, Cloud Foundry Deployment environment variables need to be established so that the partition handler can start the partitions. The following list shows the required environment variables:
  - `spring_cloud_deployer_cloudfoundry_url`
  - `spring_cloud_deployer_cloudfoundry_org`
  - `spring_cloud_deployer_cloudfoundry_space`
  - `spring_cloud_deployer_cloudfoundry_domain`
  - `spring_cloud_deployer_cloudfoundry_username`
  - `spring_cloud_deployer_cloudfoundry_password`
  - `spring_cloud_deployer_cloudfoundry_services`
  - `spring_cloud_deployer_cloudfoundry_taskTimeout`

An example set of deployment environment variables for a partitioned task that uses a `mysql` database service might resemble the following:

```
spring_cloud_deployer_cloudfoundry_url=https://api.local.pcfdev.io
spring_cloud_deployer_cloudfoundry_org=pcfdev-org
spring_cloud_deployer_cloudfoundry_space=pcfdev-space
spring_cloud_deployer_cloudfoundry_domain=local.pcfdev.io
spring_cloud_deployer_cloudfoundry_username=admin
spring_cloud_deployer_cloudfoundry_password=admin
spring_cloud_deployer_cloudfoundry_services=mysql
spring_cloud_deployer_cloudfoundry_taskTimeout=300
```

When using PCF-Dev, the following environment variable is also required: `spring_cloud_deployer_cloudfoundry_skipSslValidation=true`

3. Batch Informational Messages

Spring Cloud Task provides the ability for batch jobs to emit informational messages. The

“stream.pdf” section covers this feature in detail.

4. Batch Job Exit Codes

As discussed earlier, Spring Cloud Task applications support the ability to record the exit code of a task execution. However, in cases where you run a Spring Batch Job within a task, regardless of how the Batch Job Execution completes, the result of the task is always zero when using the default Batch/Boot behavior. Keep in mind that a task is a boot application and that the exit code returned from the task is the same as a boot application. To override this behavior and allow the task to return an exit code other than zero when a batch job returns an BatchStatus of `FAILED`, set `spring.cloud.task.batch.fail-on-job-failure` to `true`. Then the exit code can be 1 (the default) or be based on the specified `ExitCodeGenerator`)

This functionality uses a new `CommandLineRunner` that replaces the one provided by Spring Boot. By default, it is configured with the same order. However, if you want to customize the order in which the `CommandLineRunner` is run, you can set its order by setting the `spring.cloud.task.batch.commandLineRunnerOrder` property. To have your task return the exit code based on the result of the batch job execution, you need to write your own `CommandLineRunner`.

Spring Cloud Stream Integration

A task by itself can be useful, but integration of a task into a larger ecosystem lets it be useful for more complex processing and orchestration. This section covers the integration options for Spring Cloud Task with Spring Cloud Stream.

1. Launching a Task from a Spring Cloud Stream

You can launch tasks from a stream. To do so, create a sink that listens for a message that contains a `TaskLaunchRequest` as its payload. The `TaskLaunchRequest` contains:

- `uri`: To the task artifact that is to be executed.
- `applicationName`: The name that is associated with the task. If no applicationName is set, the `TaskLaunchRequest` generates a task name comprised of the following: `Task-<UUID>`.
- `commandLineArguments`: A list containing the command line arguments for the task.
- `environmentProperties`: A map containing the environment variables to be used by the task.
- `deploymentProperties`: A map containing the properties that are used by the deployer to deploy the task.

If the payload is of a different type, the sink throws an exception.

For example, a stream can be created that has a processor that takes in data from an HTTP source and creates a `GenericMessage` that contains the `TaskLaunchRequest` and sends the message to its

output channel. The task sink would then receive the message from its input channnel and then launch the task.

To create a taskSink, you need only create a Spring Boot application that includes the `EnableTaskLauncher` annotation, as shown in the following example:

```
@SpringBootApplication
@EnableTaskLauncher
public class TaskSinkApplication {
    public static void main(String[] args) {
        SpringApplication.run(TaskSinkApplication.class, args);
    }
}
```

The samples module of the Spring Cloud Task project contains a sample Sink and Processor. To install these samples into your local maven repository, run a maven build from the `spring-cloud-task-samples` directory with the `skipInstall` property set to `false`, as shown in the following example:

```
mvn clean install
```

The `maven.remoteRepositories.springRepo.url` property must be set to the location of the remote repository in which the über-jar is located. If not set, there is no remote repository, so it relies upon the local repository only.

1.1. Spring Cloud Data Flow

To create a stream in Spring Cloud Data Flow, you must first register the Task Sink Application we created. In the following example, we are registering the Processor and Sink sample applications by using the Spring Cloud Data Flow shell:

```
app register --name taskSink --type sink --uri
maven://io.spring.cloud:tasksink:<version>
app register --name taskProcessor --type processor --uri
maven:io.spring.cloud:taskprocessor:<version>
```

The following example shows how to create a stream from the Spring Cloud Data Flow shell:

```
stream create foo --definition "http --server.port=9000|taskProcessor|taskSink"
--deploy
```

2. Spring Cloud Task Events

Spring Cloud Task provides the ability to emit events through a Spring Cloud Stream channel when the task is run through a Spring Cloud Stream channel. A task listener is used to publish the

`TaskExecution` on a message channel named `task-events`. This feature is autowired into any task that has `spring-cloud-stream`, `spring-cloud-stream-<binder>`, and a defined task on its classpath.

To disable the event emitting listener, set the `spring.cloud.task.events.enabled` property to `false`.

With the appropriate classpath defined, the following task emits the `TaskExecution` as an event on the `task-events` channel (at both the start and the end of the task):

```
@SpringBootApplication
public class TaskEventsApplication {

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

    @Configuration
    public static class TaskConfiguration {

        @Bean
        public CommandLineRunner commandLineRunner() {
            return new CommandLineRunner() {
                @Override
                public void run(String... args) throws Exception {
                    System.out.println("The CommandLineRunner was executed");
                }
            };
        }
    }
}
```

A binder implementation is also required to be on the classpath.

A sample task event application can be found in the samples module of the Spring Cloud Task Project, here.

2.1. Disabling Specific Task Events

To disable task events, you can set the `spring.cloud.task.events.enabled` property to `false`.

3. Spring Batch Events

When executing a Spring Batch job through a task, Spring Cloud Task can be configured to emit informational messages based on the Spring Batch listeners available in Spring Batch. Specifically, the following Spring Batch listeners are autoconfigured into each batch job and emit messages on the associated Spring Cloud Stream channels when run through Spring Cloud Task:

- `JobExecutionListener` listens for `job-execution-events`
- `StepExecutionListener` listens for `step-execution-events`
- `ChunkListener` listens for `chunk-events`
- `ItemReadListener` listens for `item-read-events`
- `ItemProcessListener` listens for `item-process-events`
- `ItemWriteListener` listens for `item-write-events`
- `SkipListener` listens for `skip-events`

These listeners are autoconfigured into any `AbstractJob` when the appropriate beans (a `Job` and a `TaskLifecycleListener`) exist in the context. Configuration to listen to these events is handled the same way binding to any other Spring Cloud Stream channel is done. Our task (the one running the batch job) serves as a `Source`, with the listening applications serving as either a `Processor` or a `Sink`.

An example could be to have an application listening to the `job-execution-events` channel for the start and stop of a job. To configure the listening application, you would configure the input to be `job-execution-events` as follows:

```
spring.cloud.stream.bindings.input.destination=job-execution-events
```

A binder implementation is also required to be on the classpath.

A sample batch event application can be found in the samples module of the Spring Cloud Task Project, here.

3.1. Sending Batch Events to Different Channels

One of the options that Spring Cloud Task offers for batch events is the ability to alter the channel to which a specific listener can emit its messages. To do so, use the following configuration: `spring.cloud.stream.bindings.<the channel>.destination=<new destination>`. For example, if `StepExecutionListener` needs to emit its messages to another channel called `my-step-execution-events` instead of the default `step-execution-events`, you can add the following configuration:

```
spring.cloud.stream.bindings.step-execution-events.destination=my-step-execution-events
```

3.2. Disabling Batch Events

To disable the listener functionality for all batch events, use the following configuration:

```
spring.cloud.task.batch.events.enabled=false
```

To disable a specific batch event, use the following configuration:

`spring.cloud.task.batch.events.<batch event listener>.enabled=false`:

The following listing shows individual listeners that you can disable:

```
spring.cloud.task.batch.events.job-execution.enabled=false
spring.cloud.task.batch.events.step-execution.enabled=false
spring.cloud.task.batch.events.chunk.enabled=false
spring.cloud.task.batch.events.item-read.enabled=false
spring.cloud.task.batch.events.item-process.enabled=false
spring.cloud.task.batch.events.item-write.enabled=false
spring.cloud.task.batch.events.skip.enabled=false
```

3.3. Emit Order for Batch Events

By default, batch events have `Ordered.LOWEST_PRECEDENCE`. To change this value (for example, to 5), use the following configuration:

```
spring.cloud.task.batch.events.job-execution-order=5
spring.cloud.task.batch.events.step-execution-order=5
spring.cloud.task.batch.events.chunk-order=5
spring.cloud.task.batch.events.item-read-order=5
spring.cloud.task.batch.events.item-process-order=5
spring.cloud.task.batch.events.item-write-order=5
spring.cloud.task.batch.events.skip-order=5
```

Appendices

1. Task Repository Schema

This appendix provides an ERD for the database schema used in the task repository.

[task schema] | *task_schema.png*

1.1. Table Information

TASK_EXECUTION

Stores the task execution information.

Column Name	Required	Type	Field Length	Notes
TASK_EXECUTION_ID	TRUE	BIGINT	X	Spring Cloud Task Framework at app startup establishes the next available id as obtained from the TASK_SEQ. Or if the record is created outside of task then the value must be populated at record creation time.
START_TIME	FALSE	DATETIME	X	Spring Cloud Task Framework at app startup establishes the value.
END_TIME	FALSE	DATETIME	X	Spring Cloud Task Framework at app exit establishes the value.
TASK_NAME	FALSE	VARCHAR	100	Spring Cloud Task Framework at app startup will set this to "Application" unless user establish the name using the spring.cloud.task.name as discussed here
EXIT_CODE	FALSE	INTEGER	X	Follows Spring Boot defaults unless overridden by the user as discussed here.
EXIT_MESSAGE	FALSE	VARCHAR	2500	User Defined as discussed here.
ERROR_MESSAGE	FALSE	VARCHAR	2500	Spring Cloud Task Framework at app exit establishes the value.
LAST_UPDATED	TRUE	DATETIME	X	Spring Cloud Task Framework at app startup establishes the value. Or if the record is created outside of task then the value must be populated at record creation time.

Column Name	Required	Type	Field Length	Notes
EXTERNAL_EXECUTION_ID	FALSE	VARCHAR	250	If the `spring.cloud.task.external-execution-id` property is set then Spring Cloud Task Framework at app startup will set this to the value specified. More information can be found here
PARENT_TASK_EXECUTION_ID	FALSE	BIGINT	X	If the `spring.cloud.task.parent-execution-id` property is set then Spring Cloud Task Framework at app startup will set this to the value specified. More information can be found here

TASK_EXECUTION_PARAMS

Stores the parameters used for a task execution

Column Name	Required	Type	Field Length
TASK_EXECUTION_ID	TRUE	BIGINT	X
	TASK_PARAM	FALSE	VARCHAR

TASK_TASK_BATCH

Used to link the task execution to the batch execution.

Column Name	Required	Type	Field Length
TASK_EXECUTION_ID	TRUE	BIGINT	X
	JOB_EXECUTION_ID	TRUE	BIGINT

TASK_LOCK

Used for the `single-instance-enabled` feature discussed here.

Column Name	Required	Type	Field Length	Notes
LOCK_KEY	TRUE	CHAR	36	UUID for the this lock
REGION	TRUE	VARCHAR	100	User can establish a group of locks using this field.
CLIENT_ID	TRUE	CHAR	36	The task execution id that contains the name of the app to lock.
CREATED_DATE	TRUE	DATETIME	X	The date that the entry was created

The DDL for setting up tables for each database type can be found here.

2. Building This Documentation

This project uses Maven to generate this documentation. To generate it for yourself, run the following command: `$ ./mvnw clean package -P full`.

3. Running a Task App on Cloud Foundry

The simplest way to launch a Spring Cloud Task application as a task on Cloud Foundry is to use Spring Cloud Data Flow. Via Spring Cloud Data Flow you can register your task application, create a definition for it and then launch it. You then can track the task execution(s) via a RESTful API, the Spring Cloud Data Flow Shell, or the UI. To learn out to get started installing Data Flow follow the instructions in the Getting Started section of the reference documentation. For info on how to register and launch tasks, see the Lifecycle of a Task documentation.

Spring Cloud Vault

Spring Cloud Vault Config provides client-side support for externalized configuration in a distributed system. With HashiCorp's Vault 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, Couchbase, MongoDB, Consul, AWS and more.

1. New & Noteworthy

This section briefly covers items that are new and noteworthy in the latest releases.

1.1. New in Spring Cloud Vault 3.0

- Migration of `PropertySource` initialization from Spring Cloud's Bootstrap Context to Spring Boot's ConfigData API.
- Support for the Couchbase Database backend.
- Configuration of keystore/truststore types through `spring.cloud.vault.ssl.key-store-type=…` /`spring.cloud.vault.ssl.trust-store-type=…` including PEM support.
- Support for `ReactiveDiscoveryClient` by configuring a `ReactiveVaultEndpointProvider`.

2. 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 8 and a properly configured `JAVA_HOME` environment variable

This guide explains Vault setup from a Spring Cloud Vault perspective for integration testing. You can find a getting started guide directly on the Vault project site: learn.hashicorp.com/vault

Install Vault

```
$ wget
https://releases.hashicorp.com/vault/${vault_version}/vault_${vault_version}_${platfor
m}.zip
$ unzip vault_${vault_version}_${platform}.zip
```

These steps can be achieved by downloading and running `install_vault.sh`.

Create SSL certificates for Vault

Next, you'r required to generate a set of certificates:

- Root CA
- Vault Certificate (decrypted key `work/ca/private/localhost.decrypted.key.pem` and certificate `work/ca/certs/localhost.cert.pem`)

Make sure to import the Root Certificate into a Java-compliant truststore.

The easiest way to achieve this is by using OpenSSL.

`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

Next create a config file along the lines of:

```
backend "inmem" {
}

listener "tcp" {
  address = "0.0.0.0:8200"
  tls_cert_file = "work/ca/certs/localhost.cert.pem"
  tls_key_file = "work/ca/private/localhost.decrypted.key.pem"
}

disable_mlock = true
```

You can find an example config file at `vault.conf`.

```
$ vault server -config=vault.conf
```

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.

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.

3. 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 77. pom.xml

```
<parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>2.4.0.RELEASE</version>
    <relativePath /> <!-- lookup parent from repository -->
</parent>

<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-starter-vault-config</artifactId>
        <version>3.0.0-M4</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 `application.properties`, for example

Example 78. application.yml

```
spring.cloud.vault:
    host: localhost
    port: 8200
    scheme: https
    uri: https://localhost:8200
    connection-timeout: 5000
    read-timeout: 15000
    config:
spring.config.import: vault://
```

- `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
- `spring.config.import` mounts Vault as `PropertySource` using all enabled secret backends (key-value enabled by default)

Enabling further integrations requires additional dependencies and configuration. Depending on how you have set up Vault you might need additional configuration like SSL and 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 `management.health.vault.enabled` (default to `true`).

With Spring Cloud Vault 3.0 and Spring Boot 2.4, the bootstrap context initialization (`bootstrap.yml`, `bootstrap.properties`) of property sources was deprecated. Instead, Spring Cloud Vault favors Spring Boot's Config Data API which allows importing configuration from Vault. You can enable the bootstrap context either by setting the configuration property `spring.cloud.bootstrap.enabled=true` or by including the dependency `org.springframework.cloud:spring-cloud-starter-bootstrap`.

3.1. Authentication

Vault requires an authentication mechanism to authorize client requests.

Spring Cloud Vault supports multiple authentication mechanisms to authenticate applications with Vault.

For a quickstart, use the root token printed by the Vault initialization.

Example 79. application.yml

```
spring.cloud.vault:
    token: 19aefa97-cccc-bbbb-aaaa-225940e63d76
spring.config.import: vault://
```

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.

4. ConfigData API

Spring Boot provides since version 2.4 a ConfigData API that allows the declaration of configuration sources and importing these as property sources.

Spring Cloud Vault uses as of version 3.0 the ConfigData API to mount Vault's secret backends as property sources. In previous versions, the Bootstrap context was used. The ConfigData API is much more flexible as it allows specifying which configuration systems to import and in which order.

You can enable the deprecated bootstrap context either by setting the configuration property `spring.cloud.bootstrap.enabled=true` or by including the dependency `org.springframework.cloud:spring-cloud-starter-bootstrap`.

4.1. ConfigData Locations

You can mount Vault configuration through one or more `PropertySource` that are materialized from Vault. Spring Cloud Vault supports two config locations:

- `vault://` (default location)
- `vault:///<context-path>` (contextual location)

Using the default location mounts property sources for all enabled Secret Backends. Without further configuration, Spring Cloud Vault mounts the key-value backend at `/secret/${spring.application.name}`. Each activated profile adds another context path following the form `/secret/${spring.application.name}/${profile}`. Adding further modules to the classpath, such as `spring-cloud-config-databases`, provides additional secret backend configuration options which get mounted as property sources if enabled.

If you want to control which context paths are mounted from Vault as `PropertySource`, you can either use a contextual location (`vault:///my/context/path`) or configure a `VaultConfigurer`.

Contextual locations are specified and mounted individually. Spring Cloud Vault mounts each location as a unique `PropertySource`. You can mix the default locations with contextual locations (or other config systems) to control the order of property sources. This approach is useful in particular if you want to disable the default key-value path computation and mount each key-value backend yourself instead.

Example 80. application.yml

```
spring.config.import: vault://first/context/path, vault://other/path, vault://
```

4.2. Infrastructure Customization

Spring Cloud Vault requires infrastructure classes to interact with Vault. When not using the ConfigData API (meaning that you haven't specified `spring.config.import=vault://` or a contextual Vault path), Spring Cloud Vault defines its beans through `VaultAutoConfiguration` and `VaultReactiveAutoConfiguration`. Spring Boot bootstraps the application before a Spring Context is available. Therefore `VaultConfigDataLoader` registers beans itself to propagate these later on into the application context.

You can customize the infrastructure used by Spring Cloud Vault by registering custom instances using the `Bootstrapper` API:

```
InstanceSupplier<RestTemplateBuilder> builderSupplier = ctx -> RestTemplateBuilder
      .builder()

.requestFactory(ctx.get(ClientFactoryWrapper.class).getClientHttpRequestFactory())
      .defaultHeader("X-Vault-Namespace", "my-namespace");

SpringApplication application = new SpringApplication(MyApplication.class);
application.addBootstrapper(registry ->
registry.register(RestTemplateBuilder.class, builderSupplier));
```

See also Customize which secret backends to expose as PropertySource and the source of `VaultConfigDataLoader` for customization hooks.

5. 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.

5.1. 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.

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 81. application.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

5.2. Vault Agent authentication

Vault ships a sidecar utility with Vault Agent since version 0.11.0. Vault Agent implements the

functionality of Spring Vault's `SessionManager` with its Auto-Auth feature. Applications can reuse cached session credentials by relying on Vault Agent running on `localhost`. Spring Vault can send requests without the `X-Vault-Token` header. Disable Spring Vault's authentication infrastructure to disable client authentication and session management.

Example 82. application.yml

```
spring.cloud.vault:
    authentication: NONE
```

- `authentication` setting this value to `NONE` disables `ClientAuthentication` and `SessionManager`.

See also: Vault Documentation: Agent

5.3. AppId authentication

Vault supports AppId 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 83. application.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
```

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 84. application.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
```

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.

5.3.1. 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 85. application.yml

```
spring.cloud.vault:
    authentication: APPID
    app-id:
        user-id: com.examlple.MyUserIdMechanism
```

Example 86. 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

5.4. AppRole authentication

AppRole is intended for machine authentication, like the deprecated (since Vault 0.6.1) AppId authentication. 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 87. application.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 9. 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 10. 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	

You can use still all combinations of push/pull/wrapped modes by providing a configured `AppRoleAuthentication` bean within the context. Spring Cloud Vault cannot derive all possible AppRole combinations from the configuration properties.

AppRole authentication is limited to simple pull mode using reactive infrastructure. Full pull mode is not yet supported. Using Spring Cloud Vault with the Spring WebFlux stack enables Vault's reactive auto-configuration which can be disabled by setting `spring.cloud.vault.reactive.enabled=false`.

Example 88. application.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

5.5. AWS-EC2 authentication

The aws-ec2 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 89. application.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.role` property.

Example 90. application.yml with configured role

```
spring.cloud.vault:
    authentication: AWS_EC2
    aws-ec2:
        role: application-server
```

Example 91. application.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

5.6. AWS-IAM authentication

The aws 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 92. application.yml with required AWS-IAM Authentication properties

```
spring.cloud.vault:
    authentication: AWS_IAM
```

Example 93. application.yml with all AWS-IAM Authentication properties

```
spring.cloud.vault:
    authentication: AWS_IAM
    aws-iam:
        role: my-dev-role
        aws-path: aws
        server-name: some.server.name
        endpoint-uri: https://sts.eu-central-1.amazonaws.com
```

- `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-name` sets the value to use for the `X-Vault-AWS-IAM-Server-ID` header preventing certain types of replay attacks.
- `endpoint-uri` sets the value to use for the AWS STS API used for the `iam_request_url` parameter.

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

5.7. Azure MSI authentication

The azure auth backend provides a secure introduction mechanism for Azure VM 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 Azure as a Trusted Third Party and uses the managed service identity and instance metadata information that can be bound to a VM instance.

Example 94. application.yml with required Azure Authentication properties

```
spring.cloud.vault:
    authentication: AZURE_MSI
    azure-msi:
        role: my-dev-role
```

Example 95. application.yml with all Azure Authentication properties

```
spring.cloud.vault:
    authentication: AZURE_MSI
    azure-msi:
        role: my-dev-role
        azure-path: azure
        metadata-service: http://169.254.169.254/metadata/instance…
        identity-token-service: http://169.254.169.254/metadata/identity…
```

- `role` sets the name of the role against which the login is being attempted.
- `azure-path` sets the path of the Azure mount to use
- `metadata-service` sets the URI at which to access the instance metadata service
- `identity-token-service` sets the URI at which to access the identity token service

Azure MSI authentication obtains environmental details about the virtual machine (subscription Id, resource group, VM name) from the instance metadata service. The Vault server has Resource Id defaults to `vault.hashicorp.com`. To change this, set `spring.cloud.vault.azure-msi.identity-token-service` accordingly.

See also:

- Vault Documentation: Using the azure auth backend
- Azure Documentation: Azure Instance Metadata Service

5.8. 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 Vault Client SSL configuration
2. Configure a Java `Keystore` that contains the client certificate and the private key
3. Set the `spring.cloud.vault.authentication` to `CERT`

Example 96. application.yml

```
spring.cloud.vault:
    authentication: CERT
    ssl:
        key-store: classpath:keystore.jks
        key-store-password: changeit
        key-store-type: JKS
        cert-auth-path: cert
```

See also: Vault Documentation: Using the Cert auth backend

5.9. 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

Response Wrapping for token creation requires Vault 0.6.0 or higher.

Example 97. 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 98. application.yml

```
spring.cloud.vault:
    authentication: CUBBYHOLE
    token: 397ccb93-ff6c-b17b-9389-380b01ca2645
```

See also:

- Vault Documentation: Tokens

- Vault Documentation: Cubbyhole Secret Backend
- Vault Documentation: Response Wrapping

5.10. GCP-GCE authentication

The gcp auth backend allows Vault login by using existing GCP (Google Cloud Platform) IAM and GCE credentials.

GCP GCE (Google Compute Engine) authentication creates a signature in the form of a JSON Web Token (JWT) for a service account. A JWT for a Compute Engine instance is obtained from the GCE metadata service using Instance identification. This API creates a JSON Web Token that can be used to confirm the instance identity.

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 GCP as a Trusted Third Party and uses the cryptographically signed dynamic metadata information that uniquely represents each GCP service account.

Example 99. application.yml with required GCP-GCE Authentication properties

```
spring.cloud.vault:
    authentication: GCP_GCE
    gcp-gce:
        role: my-dev-role
```

Example 100. application.yml with all GCP-GCE Authentication properties

```
spring.cloud.vault:
    authentication: GCP_GCE
    gcp-gce:
        gcp-path: gcp
        role: my-dev-role
        service-account: my-service@projectid.iam.gserviceaccount.com
```

- `role` sets the name of the role against which the login is being attempted.
- `gcp-path` sets the path of the GCP mount to use
- `service-account` allows overriding the service account Id to a specific value. Defaults to the `default` service account.

See also:

- Vault Documentation: Using the GCP auth backend
- GCP Documentation: Verifying the Identity of Instances

5.11. GCP-IAM authentication

The gcp auth backend allows Vault login by using existing GCP (Google Cloud Platform) IAM and GCE credentials.

GCP IAM authentication creates a signature in the form of a JSON Web Token (JWT) for a service account. A JWT for a service account is obtained by calling GCP IAM's `projects.serviceAccounts.signJwt` API. The caller authenticates against GCP IAM and proves thereby its identity. This Vault backend treats GCP as a Trusted Third Party.

IAM credentials can be obtained from either the runtime environment , specifically the `GOOGLE_APPLICATION_CREDENTIALS` environment variable, the Google Compute metadata service, or supplied externally as e.g. JSON or base64 encoded. JSON is the preferred form as it carries the project id and service account identifier required for calling `projects.serviceAccounts.signJwt`.

Example 101. application.yml with required GCP-IAM Authentication properties

```
spring.cloud.vault:
    authentication: GCP_IAM
    gcp-iam:
        role: my-dev-role
```

Example 102. application.yml with all GCP-IAM Authentication properties

```
spring.cloud.vault:
    authentication: GCP_IAM
    gcp-iam:
        credentials:
            location: classpath:credentials.json
            encoded-key: e+KApn0=
        gcp-path: gcp
        jwt-validity: 15m
        project-id: my-project-id
        role: my-dev-role
        service-account-id: my-service@projectid.iam.gserviceaccount.com
```

- `role` sets the name of the role against which the login is being attempted.
- `credentials.location` path to the credentials resource that contains Google credentials in JSON format.
- `credentials.encoded-key` the base64 encoded contents of an OAuth2 account private key in the JSON format.
- `gcp-path` sets the path of the GCP mount to use
- `jwt-validity` configures the JWT token validity. Defaults to 15 minutes.

- `project-id` allows overriding the project Id to a specific value. Defaults to the project Id from the obtained credential.
- `service-account` allows overriding the service account Id to a specific value. Defaults to the service account from the obtained credential.

GCP IAM authentication requires the Google Cloud Java SDK dependency (`com.google.apis:google-api-services-iam` and `com.google.auth:google-auth-library-oauth2-http`) as the authentication implementation uses Google APIs for credentials and JWT signing.

Google credentials require an OAuth 2 token maintaining the token lifecycle. All API is synchronous therefore, `GcpIamAuthentication` does not support `AuthenticationSteps` which is required for reactive usage.

See also:

- Vault Documentation: Using the GCP auth backend
- GCP Documentation: projects.serviceAccounts.signJwt

5.12. 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 103. application.yml with all Kubernetes authentication properties

```
spring.cloud.vault:
    authentication: KUBERNETES
    kubernetes:
        role: my-dev-role
        kubernetes-path: kubernetes
        service-account-token-file:
/var/run/secrets/kubernetes.io/serviceaccount/token
```

- `role` sets the Role.
- `kubernetes-path` sets the path of the Kubernetes mount to use.
- `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

- Kubernetes Documentation: Configure Service Accounts for Pods

5.13. Pivotal CloudFoundry authentication

The pcf auth backend provides a secure introduction mechanism for applications running within Pivotal's CloudFoundry 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.) as identity provisioning is handled by PCF itself. Instead, it treats PCF as a Trusted Third Party and uses the managed instance identity.

Example 104. application.yml with required PCF Authentication properties

```
spring.cloud.vault:
    authentication: PCF
    pcf:
        role: my-dev-role
```

Example 105. application.yml with all PCF Authentication properties

```
spring.cloud.vault:
    authentication: PCF
    pcf:
        role: my-dev-role
        pcf-path: path
        instance-certificate: /etc/cf-instance-credentials/instance.crt
        instance-key: /etc/cf-instance-credentials/instance.key
```

- `role` sets the name of the role against which the login is being attempted.
- `pcf-path` sets the path of the PCF mount to use.
- `instance-certificate` sets the path to the PCF instance identity certificate. Defaults to `${CF_INSTANCE_CERT}` env variable.
- `instance-key` sets the path to the PCF instance identity key. Defaults to `${CF_INSTANCE_KEY}` env variable.

PCF authentication requires BouncyCastle (bcpkix-jdk15on) to be on the classpath for RSA PSS signing.

See also: Vault Documentation: Using the pcf auth backend

6. Secret Backends

6.1. Key-Value Backend

Spring Cloud Vault supports both Key-Value secret backends, the versioned (v2) and unversioned (v1). The key-value 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 determines itself whether a secret is using versioning and maps the path to its appropriate URL. 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.kv.application-name`
- `spring.cloud.vault.application-name`
- `spring.application.name`

The profiles are determined by the properties:

- `spring.cloud.vault.kv.profiles`
- `spring.profiles.active`

Secrets can be obtained from other contexts within the key-value 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 adds the `data/` context between the mount path and the actual context path depending on whether the mount uses the versioned key-value backend.

```
spring.cloud.vault:
    kv:
        enabled: true
        backend: secret
        profile-separator: '/'
        default-context: application
        application-name: my-app
        profiles: local, cloud
```

- `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 key-value backend
- `profiles` overrides the active profiles for use in the key-value backend
- `profile-separator` separates the profile name from the context in property sources with profiles

The key-value secret backend can be operated in versioned (v2) and non-versioned (v1) modes.

See also:

- Vault Documentation: Using the KV Secrets Engine - Version 1 (generic secret backend)
- Vault Documentation: Using the KV Secrets Engine - Version 2 (versioned key-value backend)

6.2. Consul

Spring Cloud Vault can obtain credentials for HashiCorp Consul. The Consul integration requires the `spring-cloud-vault-config-consul` dependency.

Example 106. pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-vault-config-consul</artifactId>
        <version>3.0.0-M4</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

6.3. RabbitMQ

Spring Cloud Vault can obtain credentials for RabbitMQ.

The RabbitMQ integration requires the `spring-cloud-vault-config-rabbitmq` dependency.

Example 107. pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-vault-config-rabbitmq</artifactId>
        <version>3.0.0-M4</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` and `spring.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

6.4. AWS

Spring Cloud Vault can obtain credentials for AWS.

The AWS integration requires the `spring-cloud-vault-config-aws` dependency.

Example 108. pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-vault-config-aws</artifactId>
        <version>3.0.0-M4</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` and `spring.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

7. 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:

- Database
- Apache Cassandra
- Couchbase Database
- Elasticsearch
- MongoDB
- MySQL
- 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 109. pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-vault-config-databases</artifactId>
        <version>3.0.0-M4</version>
    </dependency>
</dependencies>
```

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.

7.1. Database

Spring Cloud Vault can obtain credentials for any database listed at www.vaultproject.io/api/secret/databases/index.html. The integration can be enabled by setting `spring.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 available from `spring.datasource.username` and `spring.datasource.password` properties 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` and `spring.cloud.vault.database.password-property`.

```
spring.cloud.vault:
    database:
        enabled: true
        role: readonly
        backend: database
        username-property: spring.datasource.username
        password-property: spring.datasource.password
```

- `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

Spring Cloud Vault does not support getting new credentials and configuring your `DataSource` with them when the maximum lease time has been reached. That is, if `max_ttl` of the Database role in Vault is set to `24h` that means that 24 hours after your application has started it can no longer authenticate with the database.

7.2. Apache Cassandra

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 available from `spring.data.cassandra.username` and `spring.data.cassandra.password` properties 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` and `spring.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.password
```

- `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

7.3. Couchbase Database

Spring Cloud Vault can obtain credentials for Couchbase. The integration can be enabled by setting `spring.cloud.vault.couchbase.enabled=true` (default `false`) and providing the role name with `spring.cloud.vault.couchbase.role=⋯`.

Username and password are available from `spring.couchbase.username` and `spring.couchbase.password` properties so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting `spring.cloud.vault.couchbase.username-property` and `spring.cloud.vault.couchbase.password-property`.

```
spring.cloud.vault:
    couchbase:
        enabled: true
        role: readonly
        backend: database
        username-property: spring.couchbase.username
        password-property: spring.couchbase.password
```

- `enabled` setting this value to `true` enables the Couchbase backend config usage
- `role` sets the role name of the Couchbase role definition
- `backend` sets the path of the Couchbase mount to use
- `username-property` sets the property name in which the Couchbase username is stored
- `password-property` sets the property name in which the Couchbase password is stored

See also: Couchbase Database Plugin Documentation

7.4. Elasticsearch

Spring Cloud Vault can obtain since version 3.0 credentials for Elasticsearch. The integration can be enabled by setting `spring.cloud.vault.elasticsearch.enabled=true` (default `false`) and providing the role name with `spring.cloud.vault.elasticsearch.role=⋯`.

Username and password are available from `spring.elasticsearch.rest.username` and `spring.elasticsearch.rest.password` properties so using Spring Boot will pick up the generated credentials without further configuration. You can configure the property names by setting `spring.cloud.vault.elasticsearch.username-property` and `spring.cloud.vault.elasticsearch.password-property`.

```
spring.cloud.vault:
    elasticsearch:
        enabled: true
        role: readonly
        backend: mongodb
        username-property: spring.elasticsearch.rest.username
        password-property: spring.elasticsearch.rest.password
```

- `enabled` setting this value to `true` enables the Elasticsearch database backend config usage
- `role` sets the role name of the Elasticsearch role definition
- `backend` sets the path of the Elasticsearch mount to use
- `username-property` sets the property name in which the Elasticsearch username is stored
- `password-property` sets the property name in which the Elasticsearch password is stored

See also: Vault Documentation: Setting up Elasticsearch with Vault

7.5. MongoDB

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` and `spring.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

7.6. MySQL

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 available from `spring.datasource.username` and `spring.datasource.password` properties 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` and `spring.cloud.vault.mysql.password-property`.

```
spring.cloud.vault:
    mysql:
        enabled: true
        role: readonly
        backend: mysql
        username-property: spring.datasource.username
        password-property: spring.datasource.password
```

- `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

7.7. PostgreSQL

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 available from `spring.datasource.username` and `spring.datasource.password` properties 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` and `spring.cloud.vault.postgresql.password-property`.

```
spring.cloud.vault:
    postgresql:
        enabled: true
        role: readonly
        backend: postgresql
        username-property: spring.datasource.username
        password-property: spring.datasource.password
```

- `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

8. Customize which secret backends to expose as PropertySource

Spring Cloud Vault uses property-based configuration to create `PropertySource`s for key-value 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 a `VaultConfigurer` for customization. Default key-value and discovered backend registration is disabled if you provide a `VaultConfigurer`. You can however enable default registration with `SecretBackendConfigurer.registerDefaultKeyValueSecretBackends()` and `SecretBackendConfigurer.registerDefaultDiscoveredSecretBackends()`.

```
public class CustomizationBean implements VaultConfigurer {

    @Override
    public void addSecretBackends(SecretBackendConfigurer configurer) {

        configurer.add("secret/my-application");

        configurer.registerDefaultKeyValueSecretBackends(false);
        configurer.registerDefaultDiscoveredSecretBackends(true);
    }
}
```

```
SpringApplication application = new SpringApplication(MyApplication.class);
application.addBootstrapper(VaultBootstrapper.fromConfigurer(new
CustomizationBean()));
```

9. Custom Secret Backend Implementations

Spring Cloud Vault ships with secret backend support for the most common backend integrations. You can integrate with any kind of backend by providing an implementation that describes how to obtain data from the backend you want to use and how to surface data provided by that backend by providing a `PropertyTransformer`.

Adding a custom implementation for a backend requires implementation of two interfaces:

- `org.springframework.cloud.vault.config.VaultSecretBackendDescriptor`
- `org.springframework.cloud.vault.config.SecretBackendMetadataFactory`

`VaultSecretBackendDescriptor` is typically an object that holds configuration data, such as `VaultDatabaseProperties`. Spring Cloud Vault requires that your type is annotated with `@ConfigurationProperties` to materialize the class from the configuration.

`SecretBackendMetadataFactory` accepts `VaultSecretBackendDescriptor` to create the actual `SecretBackendMetadata` object which holds the context path within your Vault server, any path variables required to resolve parametrized context paths and `PropertyTransformer`.

Both, `VaultSecretBackendDescriptor` and `SecretBackendMetadataFactory` types must be registered in `spring.factories` which is an extension mechanism provided by Spring, similar to Java's ServiceLoader.

10. 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 application.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 with `spring.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
```

11. 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
```

12. Vault Enterprise Namespace Support

Vault Enterprise allows using namespaces to isolate multiple Vaults on a single Vault server. Configuring a namespace by setting `spring.cloud.vault.namespace=⋯` enables the namespace header `X-Vault-Namespace` on every outgoing HTTP request when using the Vault `RestTemplate` or `WebClient`.

Please note that this feature is not supported by Vault Community edition and has no effect on Vault operations.

```
spring.cloud.vault:
    namespace: my-namespace
```

See also: Vault Enterprise: Namespaces

13. 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-type: JKS
```

- `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
- `trust-store-type` sets the trust-store type. Supported values are all supported `KeyStore` types including `PEM`.

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.

14. 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.

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
        min-renewal: 10s
        expiry-threshold: 1m
        lease-endpoints: Legacy
```

- `enabled` controls whether leases associated with secrets are considered to be renewed and expired secrets are rotated. Enabled by default.
- `min-renewal` sets the duration that is at least required before renewing a lease. This setting prevents renewals from happening too often.
- `expiry-threshold` sets the expiry threshold. A lease is renewed the configured period of time before it expires.
- `lease-endpoints` sets the endpoints for renew and revoke. Legacy for vault versions before 0.8 and SysLeases for later.

See also: Vault Documentation: Lease, Renew, and Revoke

15. Session token lifecycle management (renewal, re-login and revocation)

A Vault session token (also referred to as `LoginToken`) is quite similar to a lease as it has a TTL, max TTL, and may expire. Once a login token expires, it cannot be used anymore to interact with Vault. Therefore, Spring Vault ships with a `SessionManager` API for imperative and reactive use.

Spring Cloud Vault maintains the session token lifecycle by default. Session tokens are obtained lazily so the actual login is deferred until the first session-bound use of Vault. Once Spring Cloud Vault obtains a session token, it retains it until expiry. The next time a session-bound activity is used, Spring Cloud Vault re-logins into Vault and obtains a new session token. On application shut down, Spring Cloud Vault revokes the token if it was still active to terminate the session.

Session lifecycle is enabled by default and can be disabled by setting `spring.cloud.vault.session.lifecycle.enabled` to `false`. Disabling is not recommended as session tokens can expire and Spring Cloud Vault cannot longer access Vault.

```
spring.cloud.vault:
    session.lifecycle:
        enabled: true
        refresh-before-expiry: 10s
        expiry-threshold: 20s
```

- `enabled` controls whether session lifecycle management is enabled to renew session tokens. Enabled by default.
- `refresh-before-expiry` controls the point in time when the session token gets renewed. The refresh time is calculated by subtracting `refresh-before-expiry` from the token expiry time. Defaults to `5 seconds`.
- `expiry-threshold` sets the expiry threshold. The threshold represents a minimum TTL duration to consider a session token as valid. Tokens with a shorter TTL are considered expired and are not used anymore. Should be greater than `refresh-before-expiry` to prevent token expiry. Defaults to `7 seconds`.

See also: Vault Documentation: Token Renewal

Appendix A: Common application properties

Various properties can be specified inside your `application.properties` file, inside your `application.yml` file, or as command line switches. This appendix provides a list of common Spring Cloud Vault properties and references to the underlying classes that consume them.

Property contributions can come from additional jar files on your classpath, so you should not consider this an exhaustive list. Also, you can define your own properties.

Name	Default	Description
spring.cloud.vault.app-id.app-id-path	app-id	Mount path of the AppId authentication backend.
spring.cloud.vault.app-id.network-interface		Network interface hint for the "MAC_ADDRESS" UserId mechanism.
spring.cloud.vault.app-id.user-id	MAC_ADDRESS	UserId mechanism. Can be either "MAC_ADDRESS", "IP_ADDRESS", a string or a class name.
spring.cloud.vault.app-role.app-role-path	approle	Mount path of the AppRole authentication backend.
spring.cloud.vault.app-role.role		Name of the role, optional, used for pull-mode.

Name	Default	Description
spring.cloud.vault.app-role.role-id		The RoleId.
spring.cloud.vault.app-role.secret-id		The SecretId.
spring.cloud.vault.application-name	application	Application name for AppId authentication.
spring.cloud.vault.authentication		
spring.cloud.vault.aws-ec2.aws-ec2-path	aws-ec2	Mount path of the AWS-EC2 authentication backend.
spring.cloud.vault.aws-ec2.identity-document	169.254.169.254/latest/dynamic/instance-identity/pkcs7	URL of the AWS-EC2 PKCS7 identity document.
spring.cloud.vault.aws-ec2.nonce		Nonce used for AWS-EC2 authentication. An empty nonce defaults to nonce generation.
spring.cloud.vault.aws-ec2.role		Name of the role, optional.
spring.cloud.vault.aws-iam.aws-path	aws	Mount path of the AWS authentication backend.
spring.cloud.vault.aws-iam.endpoint-uri		STS server URI. @since 2.2
spring.cloud.vault.aws-iam.role		Name of the role, optional. Defaults to the friendly IAM name if not set.
spring.cloud.vault.aws-iam.server-name		Name of the server used to set {@code X-Vault-AWS-IAM-Server-ID} header in the headers of login requests.
spring.cloud.vault.aws.access-key-property	cloud.aws.credentials.accessKey	Target property for the obtained access key.
spring.cloud.vault.aws.backend	aws	aws backend path.
spring.cloud.vault.aws.enabled	false	Enable aws backend usage.
spring.cloud.vault.aws.role		Role name for credentials.
spring.cloud.vault.aws.secret-key-property	cloud.aws.credentials.secretKey	Target property for the obtained secret key.
spring.cloud.vault.azure-msi.azure-path	azure	Mount path of the Azure MSI authentication backend.
spring.cloud.vault.azure-msi.identity-token-service		Identity token service URI. @since 3.0

Name	Default	Description
spring.cloud.vault.azure-msi.metadata-service		Instance metadata service URI. @since 3.0
spring.cloud.vault.azure-msi.role		Name of the role.
spring.cloud.vault.cassandra.backend	cassandra	Cassandra backend path.
spring.cloud.vault.cassandra.enabled	false	Enable cassandra backend usage.
spring.cloud.vault.cassandra.password-property	spring.data.cassandra.password	Target property for the obtained password.
spring.cloud.vault.cassandra.role		Role name for credentials.
spring.cloud.vault.cassandra.static-role	false	Enable static role usage. @since 2.2
spring.cloud.vault.cassandra.username-property	spring.data.cassandra.username	Target property for the obtained username.
spring.cloud.vault.config.lifecycle.enabled	true	Enable lifecycle management.
spring.cloud.vault.config.lifecycle.expiry-threshold		The expiry threshold. {@link Lease} is renewed the given {@link Duration} before it expires. @since 2.2
spring.cloud.vault.config.lifecycle.lease-endpoints		Set the {@link LeaseEndpoints} to delegate renewal/revocation calls to. {@link LeaseEndpoints} encapsulates differences between Vault versions that affect the location of renewal/revocation endpoints. Can be {@link LeaseEndpoints#SysLeases} for version 0.8 or above of Vault or {@link LeaseEndpoints#Legacy} for older versions (the default). @since 2.2
spring.cloud.vault.config.lifecycle.min-renewal		The time period that is at least required before renewing a lease. @since 2.2

Name	Default	Description
spring.cloud.vault.config.order	0	Used to set a {@link org.springframework.core.env.PropertySource} priority. This is useful to use Vault as an override on other property sources. @see org.springframework.core.PriorityOrdered
spring.cloud.vault.connection-timeout	5000	Connection timeout.
spring.cloud.vault.consul.backend	consul	Consul backend path.
spring.cloud.vault.consul.enabled	false	Enable consul backend usage.
spring.cloud.vault.consul.role		Role name for credentials.
spring.cloud.vault.consul.token-property	spring.cloud.consul.token	Target property for the obtained token.
spring.cloud.vault.couchbase.backend	database	Couchbase backend path.
spring.cloud.vault.couchbase.enabled	false	Enable couchbase backend usage.
spring.cloud.vault.couchbase.password-property	spring.couchbase.password	Target property for the obtained password.
spring.cloud.vault.couchbase.role		Role name for credentials.
spring.cloud.vault.couchbase.static-role	false	Enable static role usage.
spring.cloud.vault.couchbase.username-property	spring.couchbase.username	Target property for the obtained username.
spring.cloud.vault.database.backend	database	Database backend path.
spring.cloud.vault.database.enabled	false	Enable database backend usage.
spring.cloud.vault.database.password-property	spring.datasource.password	Target property for the obtained password.
spring.cloud.vault.database.role		Role name for credentials.
spring.cloud.vault.database.static-role	false	Enable static role usage.

Name	Default	Description
spring.cloud.vault.database.username-property	spring.datasource.username	Target property for the obtained username.
spring.cloud.vault.discovery.enabled	false	Flag to indicate that Vault server discovery is enabled (vault server URL will be looked up via discovery).
spring.cloud.vault.discovery.service-id	vault	Service id to locate Vault.
spring.cloud.vault.elasticsearch.backend	database	Database backend path.
spring.cloud.vault.elasticsearch.enabled	false	Enable elasticsearch backend usage.
spring.cloud.vault.elasticsearch.password-property	spring.elasticsearch.rest.password	Target property for the obtained password.
spring.cloud.vault.elasticsearch.role		Role name for credentials.
spring.cloud.vault.elasticsearch.static-role	false	Enable static role usage.
spring.cloud.vault.elasticsearch.username-property	spring.elasticsearch.rest.username	Target property for the obtained username.
spring.cloud.vault.enabled	true	Enable Vault config server.
spring.cloud.vault.fail-fast	false	Fail fast if data cannot be obtained from Vault.
spring.cloud.vault.gcp-gce.gcp-path	gcp	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.gcp-gce.role		Name of the role against which the login is being attempted.
spring.cloud.vault.gcp-gce.service-account		Optional service account id. Using the default id if left unconfigured.
spring.cloud.vault.gcp-iam.credentials.encoded-key		The base64 encoded contents of an OAuth2 account private key in JSON format.
spring.cloud.vault.gcp-iam.credentials.location		Location of the OAuth2 credentials private key. <p> Since this is a Resource, the private key can be in a multitude of locations, such as a local file system, classpath, URL, etc.

Name	Default	Description
spring.cloud.vault.gcp-iam.gcp-path	gcp	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.gcp-iam.jwt-validity	15m	Validity of the JWT token.
spring.cloud.vault.gcp-iam.project-id		Overrides the GCP project Id.
spring.cloud.vault.gcp-iam.role		Name of the role against which the login is being attempted.
spring.cloud.vault.gcp-iam.service-account-id		Overrides the GCP service account Id.
spring.cloud.vault.host	localhost	Vault server host.
spring.cloud.vault.kubernetes.kubernetes-path	kubernetes	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.kubernetes.role		Name of the role against which the login is being attempted.
spring.cloud.vault.kubernetes.service-account-token-file	/var/run/secrets/kubernetes.io/serviceaccount/token	Path to the service account token file.
spring.cloud.vault.kv.application-name	application	Application name to be used for the context.
spring.cloud.vault.kv.backend	secret	Name of the default backend.
spring.cloud.vault.kv.backend-version	2	Key-Value backend version. Currently supported versions are: - Version 1 (unversioned key-value backend). - Version 2 (versioned key-value backend).
spring.cloud.vault.kv.default-context	application	Name of the default context.
spring.cloud.vault.kv.enabled	true	Enable the kev-value backend.
spring.cloud.vault.kv.profile-separator	/	Profile-separator to combine application name and profile.
spring.cloud.vault.kv.profiles		List of active profiles. @since 3.0
spring.cloud.vault.mongodb.backend	mongodb	MongoDB backend path.
spring.cloud.vault.mongodb.enabled	false	Enable mongodb backend usage.

Name	Default	Description
spring.cloud.vault.mongodb.password-property	spring.data.mongodb.password	Target property for the obtained password.
spring.cloud.vault.mongodb.role		Role name for credentials.
spring.cloud.vault.mongodb.static-role	false	Enable static role usage. @since 2.2
spring.cloud.vault.mongodb.username-property	spring.data.mongodb.username	Target property for the obtained username.
spring.cloud.vault.mysql.backend	mysql	mysql backend path.
spring.cloud.vault.mysql.enabled	false	Enable mysql backend usage.
spring.cloud.vault.mysql.password-property	spring.datasource.password	Target property for the obtained username.
spring.cloud.vault.mysql.role		Role name for credentials.
spring.cloud.vault.mysql.username-property	spring.datasource.username	Target property for the obtained username.
spring.cloud.vault.namespace		Vault namespace (requires Vault Enterprise).
spring.cloud.vault.pcf.instance-certificate		Path to the instance certificate (PEM). Defaults to {@code CF_INSTANCE_CERT} env variable.
spring.cloud.vault.pcf.instance-key		Path to the instance key (PEM). Defaults to {@code CF_INSTANCE_KEY} env variable.
spring.cloud.vault.pcf.pcf-path	pcf	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.pcf.role		Name of the role against which the login is being attempted.
spring.cloud.vault.port	8200	Vault server port.
spring.cloud.vault.postgresql.backend	postgresql	postgresql backend path.
spring.cloud.vault.postgresql.enabled	false	Enable postgresql backend usage.
spring.cloud.vault.postgresql.password-property	spring.datasource.password	Target property for the obtained username.

Name	Default	Description
spring.cloud.vault.postgresql.role		Role name for credentials.
spring.cloud.vault.postgresql.username-property	spring.datasource.username	Target property for the obtained username.
spring.cloud.vault.rabbitmq.backend	rabbitmq	rabbitmq backend path.
spring.cloud.vault.rabbitmq.enabled	false	Enable rabbitmq backend usage.
spring.cloud.vault.rabbitmq.password-property	spring.rabbitmq.password	Target property for the obtained password.
spring.cloud.vault.rabbitmq.role		Role name for credentials.
spring.cloud.vault.rabbitmq.username-property	spring.rabbitmq.username	Target property for the obtained username.
spring.cloud.vault.read-timeout	15000	Read timeout.
spring.cloud.vault.scheme	https	Protocol scheme. Can be either "http" or "https".
spring.cloud.vault.session.lifecycle.enabled	true	Enable session lifecycle management.
spring.cloud.vault.session.lifecycle.expiry-threshold	7s	The expiry threshold for a {@link LoginToken}. The threshold represents a minimum TTL duration to consider a login token as valid. Tokens with a shorter TTL are considered expired and are not used anymore. Should be greater than {@code refreshBeforeExpiry} to prevent token expiry.
spring.cloud.vault.session.lifecycle.refresh-before-expiry	5s	The time period that is at least required before renewing the {@link LoginToken}.
spring.cloud.vault.ssl.cert-auth-path	cert	Mount path of the TLS cert authentication backend.
spring.cloud.vault.ssl.key-store		Trust store that holds certificates and private keys.
spring.cloud.vault.ssl.key-store-password		Password used to access the key store.

Name	Default	Description
spring.cloud.vault.ssl.key-store-type		Type of the key store. @since 3.0
spring.cloud.vault.ssl.trust-store		Trust store that holds SSL certificates.
spring.cloud.vault.ssl.trust-store-password		Password used to access the trust store.
spring.cloud.vault.ssl.trust-store-type		Type of the trust store. @since 3.0
spring.cloud.vault.token		Static vault token. Required if {@link #authentication} is {@code TOKEN}.
spring.cloud.vault.uri		Vault URI. Can be set with scheme, host and port.

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. The project also provides client-side load-balancing via integration with Spring Cloud LoadBalancer.

1. Install Zookeeper

See the installation documentation for instructions on how to install Zookeeper.

Spring Cloud Zookeeper uses Apache Curator behind the scenes. While Zookeeper 3.5.x is still considered "beta" by the Zookeeper development team, the reality is that it is used in production by many users. However, Zookeeper 3.4.x is also used in production. Prior to Apache Curator 4.0, both versions of Zookeeper were supported via two versions of Apache Curator. Starting with Curator 4.0 both versions of Zookeeper are supported via the same Curator libraries.

In case you are integrating with version 3.4 you need to change the Zookeeper dependency that comes shipped with `curator`, and thus `spring-cloud-zookeeper`. To do so simply exclude that dependency and add the 3.4.x version like shown below.

maven

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-zookeeper-all</artifactId>
    <exclusions>
        <exclusion>
            <groupId>org.apache.zookeeper</groupId>
            <artifactId>zookeeper</artifactId>
        </exclusion>
    </exclusions>
</dependency>
<dependency>
    <groupId>org.apache.zookeeper</groupId>
    <artifactId>zookeeper</artifactId>
    <version>3.4.12</version>
    <exclusions>
        <exclusion>
            <groupId>org.slf4j</groupId>
            <artifactId>slf4j-log4j12</artifactId>
        </exclusion>
    </exclusions>
</dependency>
```

gradle

```
compile('org.springframework.cloud:spring-cloud-starter-zookeeper-all') {
  exclude group: 'org.apache.zookeeper', module: 'zookeeper'
}
compile('org.apache.zookeeper:zookeeper:3.4.12') {
  exclude group: 'org.slf4j', module: 'slf4j-log4j12'
}
```

2. 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(A Java library for Zookeeper) provides Service Discovery through a Service Discovery Extension. Spring Cloud Zookeeper uses this extension for service registration and discovery.

2.1. Activating

Including a dependency on `org.springframework.cloud:spring-cloud-starter-zookeeper-discovery` enables autoconfiguration that sets up Spring Cloud Zookeeper Discovery.

For web functionality, you still need to include `org.springframework.boot:spring-boot-starter-web`.

When working with version 3.4 of Zookeeper you need to change the way you include the dependency as described here.

2.2. 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);
    }

}
```

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
```

If you use Spring Cloud Zookeeper Config, the values shown in the preceding example need to be 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.

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`.

2.3. Using the DiscoveryClient

Spring Cloud has support for Feign (a REST client builder), Spring `RestTemplate` and Spring WebFlux, 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;
}
```

3. 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 and Spring Cloud LoadBalancer also work with Spring Cloud Zookeeper.

3.1. Spring Cloud LoadBalancer with Zookeeper

Spring Cloud Zookeeper provides an implementation of Spring Cloud LoadBalancer `ServiceInstanceListSupplier`. When you use the `spring-cloud-starter-zookeeper-discovery`, Spring Cloud LoadBalancer is autoconfigured to use the `ZookeeperServiceInstanceListSupplier` by default.

4. 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);
}
```

4.1. 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 Spring Cloud LoadBalancer `ZookeeperServiceInstanceListSupplier`. The `ZookeeperServiceInstanceListSupplier` 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
```

The preceding example uses the `http` command from httpie.org.

5. Zookeeper Dependencies

The following topics cover how to work with Spring Cloud Zookeeper dependencies:

- Using the Zookeeper Dependencies
- Activating Zookeeper Dependencies
- Setting up Zookeeper Dependencies
- Configuring Spring Cloud Zookeeper Dependencies

5.1. 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 (a REST client builder), Spring `RestTemplate` and Spring WebFlux.

You can also use the Zookeeper Dependency Watchers functionality to control and monitor the state of your dependencies.

5.2. 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 the `spring.cloud.zookeeper.dependency.enabled` property to false (it defaults to `true`).

5.3. 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`.

5.3.1. Aliases

Below the root property you have to represent each dependency as an alias. This is due to the constraints of Spring Cloud LoadBalancer, 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();
}
```

5.3.2. 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, Spring Cloud LoadBalancer 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.

5.3.3. 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.

5.3.4. `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
```

5.3.5. 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.

5.3.6. 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.

5.3.7. 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
```

5.4. 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.loadbalancer.enabled` (enabled by default): Turns on Zookeeper-specific custom load-balancing strategies, including `ZookeeperServiceInstanceListSupplier` and dependency-based load-balanced `RestTemplate` setup.
- `spring.cloud.zookeeper.dependency.headers.enabled` (enabled by default): This property registers a `FeignBlockingLoadBalancerClient` 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.

6. 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.

6.1. Activating

Spring Cloud Zookeeper Dependencies functionality needs to be enabled for you to use the Dependency Watcher mechanism.

6.2. 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`.

6.3. 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.DependencyPresenceOnStartupVerifier` class 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.

7. Distributed Configuration with Zookeeper

Zookeeper provides a hierarchical namespace that lets clients store arbitrary data, such as configuration data. Spring Cloud Zookeeper Config is an alternative to the Config Server and Client. 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.

7.1. Activating

Including a dependency on `org.springframework.cloud:spring-cloud-starter-zookeeper-config` enables autoconfiguration that sets up Spring Cloud Zookeeper Config.

When working with version 3.4 of Zookeeper you need to change the way you include the dependency as described here.

7.2. 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.

7.3. 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 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
```

Appendix: Compendium of Configuration Properties

Name	Default	Description
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.

Name	Default	Description
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.

Name	Default	Description
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.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.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.server.peer-eureka-nodes-update-interval-ms	0	

Name	Default	Description
eureka.server.peer-eureka-status-refresh-time-interval-ms	0	
feign.client.config		
feign.client.default-config	default	
feign.client.default-to-properties	true	
feign.compression.request.enabled	false	Enables the request sent by Feign to be compressed.
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.
feign.compression.response.enabled	false	Enables the response from Feign to be compressed.
feign.compression.response.useGzipDecoder	false	Enables the default gzip decoder to be used.
feign.httpclient.connection-timeout	2000	
feign.httpclient.connection-timer-repeat	3000	
feign.httpclient.disable-ssl-validation	false	
feign.httpclient.enabled	true	Enables the use of the Apache HTTP Client by Feign.
feign.httpclient.follow-redirects	true	
feign.httpclient.max-connections	200	
feign.httpclient.max-connections-per-route	50	
feign.httpclient.time-to-live	900	
feign.httpclient.time-to-live-unit		
feign.hystrix.enabled	false	If true, an OpenFeign client will be wrapped with a Hystrix circuit breaker.
feign.okhttp.enabled	false	Enables the use of the OK HTTP Client by Feign.
ribbon.eureka.enabled	true	Enables the use of Eureka with Ribbon.

Name	Default	Description
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.content-type		The bus mime-type.
spring.cloud.bus.destination		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.id	application	The identifier for this application instance.
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.default-server-port	80	Port to use when no port is defined by service discovery.
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.internal-domain	apps.internal	Default internal domain when configured to use Native DNS service discovery.
spring.cloud.cloudfoundry.discovery.order	0	Order of the discovery client used by `CompositeDiscoveryClient` for sorting available clients.
spring.cloud.cloudfoundry.discovery.use-container-ip	false	Whether to resolve hostname when BOSH DNS is used. In order to use this feature, spring.cloud.cloudfoundry.discovery.use-dns must be true.

Name	Default	Description
spring.cloud.cloudfoundry.discovery.use-dns	false	Whether to use BOSH DNS for the discovery. In order to use this feature, your Cloud Foundry installation must support Service Discovery.
spring.cloud.cloudfoundry.org		Organization name to initially target.
spring.cloud.cloudfoundry.password		Password for user to authenticate and obtain token.
spring.cloud.cloudfoundry.skip-ssl-validation	false	
spring.cloud.cloudfoundry.space		Space name to initially target.
spring.cloud.cloudfoundry.url		URL of Cloud Foundry API (Cloud Controller).
spring.cloud.cloudfoundry.username		Username to authenticate (usually an email address).
spring.cloud.compatibility-verifier.compatible-boot-versions		Default accepted versions for the Spring Boot dependency. You can set {@code x} for the patch version if you don't want to specify a concrete value. Example: {@code 3.4.x}
spring.cloud.compatibility-verifier.enabled	false	Enables creation of Spring Cloud compatibility verification.
spring.cloud.config.allow-override	true	Flag to indicate that {@link #isOverrideSystemProperties() systemPropertiesOverride} can be used. Set to false to prevent users from changing the default accidentally. Default true.
spring.cloud.config.allow-override	true	Flag to indicate that {@link #isOverrideSystemProperties() systemPropertiesOverride} can be used. Set to false to prevent users from changing the default accidentally. Default true.

Name	Default	Description
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.headers		Additional headers used to create the client request.
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 should not override any existing property sources (including local config files). Default false.
spring.cloud.config.override-none	false	Flag to indicate that when {@link #setAllowOverride(boolean) allowOverride} is true, external properties should take lowest priority and should not override any existing property sources (including local config files). Default false.

Name	Default	Description
spring.cloud.config.override-system-properties	true	Flag to indicate that the external properties should override system properties. Default true.
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.request-connect-timeout	0	timeout on waiting to connect to the Config Server.
spring.cloud.config.request-read-timeout	0	timeout on waiting to read data from the Config Server.
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.send-state	true	Flag to indicate whether to send state. Default true.
spring.cloud.config.tls		TLS properties.
spring.cloud.config.token		Security Token passed thru to underlying environment repository.
spring.cloud.config.uri	[localhost:8888]	The URI of the remote server (default localhost:8888).
spring.cloud.config.username		The username to use (HTTP Basic) when contacting the remote server.
spring.cloud.consul.config.acl-token		

Name	Default	Description
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.name		Alternative to spring.application.name to use in looking up values in consul KV.
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	1000	The delay between calls to watch consul catalog in millis, default is 1000.

Name	Default	Description
spring.cloud.consul.discovery.catalog-services-watch-timeout	2	The number of seconds to block while watching consul catalog, default is 2.
spring.cloud.consul.discovery.consistency-mode		Consistency mode for health service request.
spring.cloud.consul.discovery.datacenters		Map of serviceId's -> datacenter to query for in server list. This allows looking up services in another datacenters.
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.deregister	true	Disable automatic de-registration of service in consul.
spring.cloud.consul.discovery.enable-tag-override		Enable tag override for the registered service.
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-critical-timeout		Timeout to deregister services critical for longer than timeout (e.g. 30m). Requires consul version 7.x or higher.
spring.cloud.consul.discovery.health-check-headers		Headers to be applied to the Health Check calls.
spring.cloud.consul.discovery.health-check-interval	10s	How often to perform the health check (e.g. 10s), defaults to 10s.
spring.cloud.consul.discovery.health-check-path	/actuator/health	Alternate server path to invoke for health checking.
spring.cloud.consul.discovery.health-check-timeout		Timeout for health check (e.g. 10s).

Name	Default	Description
spring.cloud.consul.discovery.health-check-tls-skip-verify		Skips certificate verification during service checks if true, otherwise runs certificate verification.
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.interval-ratio		
spring.cloud.consul.discovery.heartbeat.ttl	30s	
spring.cloud.consul.discovery.hostname		Hostname to use when accessing server.
spring.cloud.consul.discovery.include-hostname-in-instance-id	false	Whether hostname is included into the default instance id when registering service.
spring.cloud.consul.discovery.instance-group		Service instance group.
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-enable-tag-override		Enable tag override for the registered management service.
spring.cloud.consul.discovery.management-metadata		Metadata to use when registering management service.
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.

Name	Default	Description
spring.cloud.consul.discovery.metadata		Metadata to use when registering service.
spring.cloud.consul.discovery.order	0	Order of the discovery client used by `CompositeDiscoveryClient` for sorting available clients.
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.enabled	true	If consul retry is enabled.

Name	Default	Description
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.consul.scheme		Consul agent scheme (HTTP/HTTPS). If there is no scheme in address - client will use HTTP.
spring.cloud.consul.service-registry.auto-registration.enabled	true	Enables Consul Service Registry Auto-registration.
spring.cloud.consul.service-registry.enabled	true	Enables Consul Service Registry functionality.
spring.cloud.consul.tls.certificate-password		Password to open the certificate.
spring.cloud.consul.tls.certificate-path		File path to the certificate.
spring.cloud.consul.tls.key-store-instance-type		Type of key framework to use.
spring.cloud.consul.tls.key-store-password		Password to an external keystore.
spring.cloud.consul.tls.key-store-path		Path to an external keystore.
spring.cloud.discovery.client.composite-indicator.enabled	true	Enables discovery client composite health indicator.
spring.cloud.discovery.client.health-indicator.enabled	true	
spring.cloud.discovery.client.health-indicator.include-description	false	
spring.cloud.discovery.client.simple.instances		
spring.cloud.discovery.client.simple.local.instance-id		The unique identifier or name for the service instance.

Name	Default	Description
spring.cloud.discovery.client.simple.local.metadata		Metadata for the service instance. Can be used by discovery clients to modify their behaviour per instance, e.g. when load balancing.
spring.cloud.discovery.client.simple.local.service-id		The identifier or name for the service. Multiple instances might share the same service ID.
spring.cloud.discovery.client.simple.local.uri		The URI of the service instance. Will be parsed to extract the scheme, host, and port.
spring.cloud.discovery.client.simple.order		
spring.cloud.discovery.enabled	true	Enables discovery client health indicators.
spring.cloud.features.enabled	true	Enables the features endpoint.
spring.cloud.gateway.default-filters		List of filter definitions that are applied to every route.
spring.cloud.gateway.discovery.locator.enabled	false	Flag that enables DiscoveryClient gateway integration.
spring.cloud.gateway.discovery.locator.filters		
spring.cloud.gateway.discovery.locator.include-expression	true	SpEL expression that will evaluate whether to include a service in gateway integration or not, defaults to: true.
spring.cloud.gateway.discovery.locator.lower-case-service-id	false	Option to lower case serviceId in predicates and filters, defaults to false. Useful with eureka when it automatically uppercases serviceId. so MYSERIVCE, would match /myservice/**
spring.cloud.gateway.discovery.locator.predicates		

Name	Default	Description
spring.cloud.gateway.discovery.locator.route-id-prefix		The prefix for the routeId, defaults to discoveryClient.getClass().getSimpleName() + "_". Service Id will be appended to create the routeId.
spring.cloud.gateway.discovery.locator.url-expression	'lb://'+serviceId	SpEL expression that create the uri for each route, defaults to: 'lb://'+serviceId.
spring.cloud.gateway.enabled	true	Enables gateway functionality.
spring.cloud.gateway.fail-on-route-definition-error	true	Option to fail on route definition errors, defaults to true. Otherwise, a warning is logged.
spring.cloud.gateway.filter.add-request-header.enabled	true	Enables the add-request-header filter.
spring.cloud.gateway.filter.add-request-parameter.enabled	true	Enables the add-request-parameter filter.
spring.cloud.gateway.filter.add-response-header.enabled	true	Enables the add-response-header filter.
spring.cloud.gateway.filter.circuit-breaker.enabled	true	Enables the circuit-breaker filter.
spring.cloud.gateway.filter.dedupe-response-header.enabled	true	Enables the dedupe-response-header filter.
spring.cloud.gateway.filter.fallback-headers.enabled	true	Enables the fallback-headers filter.
spring.cloud.gateway.filter.hystrix.enabled	true	Enables the hystrix filter.
spring.cloud.gateway.filter.map-request-header.enabled	true	Enables the map-request-header filter.
spring.cloud.gateway.filter.modify-request-body.enabled	true	Enables the modify-request-body filter.
spring.cloud.gateway.filter.modify-response-body.enabled	true	Enables the modify-response-body filter.
spring.cloud.gateway.filter.prefix-path.enabled	true	Enables the prefix-path filter.
spring.cloud.gateway.filter.preserve-host-header.enabled	true	Enables the preserve-host-header filter.
spring.cloud.gateway.filter.redirect-to.enabled	true	Enables the redirect-to filter.

Name	Default	Description
spring.cloud.gateway.filter.remove-hop-by-hop.headers		
spring.cloud.gateway.filter.remove-hop-by-hop.order		
spring.cloud.gateway.filter.remove-request-header.enabled	true	Enables the remove-request-header filter.
spring.cloud.gateway.filter.remove-request-parameter.enabled	true	Enables the remove-request-parameter filter.
spring.cloud.gateway.filter.remove-response-header.enabled	true	Enables the remove-response-header filter.
spring.cloud.gateway.filter.request-header-size.enabled	true	Enables the request-header-size filter.
spring.cloud.gateway.filter.request-header-to-request-uri.enabled	true	Enables the request-header-to-request-uri filter.
spring.cloud.gateway.filter.request-rate-limiter.deny-empty-key	true	Switch to deny requests if the Key Resolver returns an empty key, defaults to true.
spring.cloud.gateway.filter.request-rate-limiter.empty-key-status-code		HttpStatus to return when denyEmptyKey is true, defaults to FORBIDDEN.
spring.cloud.gateway.filter.request-rate-limiter.enabled	true	Enables the request-rate-limiter filter.
spring.cloud.gateway.filter.request-size.enabled	true	Enables the request-size filter.
spring.cloud.gateway.filter.retry.enabled	true	Enables the retry filter.
spring.cloud.gateway.filter.rewrite-location-response-header.enabled	true	Enables the rewrite-location-response-header filter.
spring.cloud.gateway.filter.rewrite-location.enabled	true	Enables the rewrite-location filter.
spring.cloud.gateway.filter.rewrite-path.enabled	true	Enables the rewrite-path filter.
spring.cloud.gateway.filter.rewrite-response-header.enabled	true	Enables the rewrite-response-header filter.
spring.cloud.gateway.filter.save-session.enabled	true	Enables the save-session filter.

Name	Default	Description
spring.cloud.gateway.filter.secure-headers.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'	
spring.cloud.gateway.filter.secure-headers.content-type-options	nosniff	
spring.cloud.gateway.filter.secure-headers.disable		
spring.cloud.gateway.filter.secure-headers.download-options	noopen	
spring.cloud.gateway.filter.secure-headers.enabled	true	Enables the secure-headers filter.
spring.cloud.gateway.filter.secure-headers.frame-options	DENY	
spring.cloud.gateway.filter.secure-headers.permitted-cross-domain-policies	none	
spring.cloud.gateway.filter.secure-headers.referrer-policy	no-referrer	
spring.cloud.gateway.filter.secure-headers.strict-transport-security	max-age=631138519	
spring.cloud.gateway.filter.secure-headers.xss-protection-header	1 ; mode=block	
spring.cloud.gateway.filter.set-path.enabled	true	Enables the set-path filter.
spring.cloud.gateway.filter.set-request-header.enabled	true	Enables the set-request-header filter.
spring.cloud.gateway.filter.set-request-host-header.enabled	true	Enables the set-request-host-header filter.
spring.cloud.gateway.filter.set-response-header.enabled	true	Enables the set-response-header filter.
spring.cloud.gateway.filter.set-status.enabled	true	Enables the set-status filter.
spring.cloud.gateway.filter.strip-prefix.enabled	true	Enables the strip-prefix filter.
spring.cloud.gateway.forwarded.enabled	true	Enables the ForwardedHeadersFilter.

Name	Default	Description
spring.cloud.gateway.global-filter.adapt-cached-body.enabled	true	Enables the adapt-cached-body global filter.
spring.cloud.gateway.global-filter.forward-path.enabled	true	Enables the forward-path global filter.
spring.cloud.gateway.global-filter.forward-routing.enabled	true	Enables the forward-routing global filter.
spring.cloud.gateway.global-filter.load-balancer-client.enabled	true	Enables the load-balancer-client global filter.
spring.cloud.gateway.global-filter.netty-routing.enabled	true	Enables the netty-routing global filter.
spring.cloud.gateway.global-filter.netty-write-response.enabled	true	Enables the netty-write-response global filter.
spring.cloud.gateway.global-filter.reactive-load-balancer-client.enabled	true	Enables the reactive-load-balancer-client global filter.
spring.cloud.gateway.global-filter.remove-cached-body.enabled	true	Enables the remove-cached-body global filter.
spring.cloud.gateway.global-filter.route-to-request-url.enabled	true	Enables the route-to-request-url global filter.
spring.cloud.gateway.global-filter.websocket-routing.enabled	true	Enables the websocket-routing global filter.
spring.cloud.gateway.globalcors.add-to-simple-url-handler-mapping	false	If global CORS config should be added to the URL handler.
spring.cloud.gateway.globalcors.cors-configurations		
spring.cloud.gateway.httpclient.connect-timeout		The connect timeout in millis, the default is 45s.
spring.cloud.gateway.httpclient.max-header-size		The max response header size.
spring.cloud.gateway.httpclient.max-initial-line-length		The max initial line length.

Name	Default	Description
spring.cloud.gateway.httpclient.pool.acquire-timeout		Only for type FIXED, the maximum time in millis to wait for aquiring.
spring.cloud.gateway.httpclient.pool.max-connections		Only for type FIXED, the maximum number of connections before starting pending acquisition on existing ones.
spring.cloud.gateway.httpclient.pool.max-idle-time		Time in millis after which the channel will be closed. If NULL, there is no max idle time.
spring.cloud.gateway.httpclient.pool.max-life-time		Duration after which the channel will be closed. If NULL, there is no max life time.
spring.cloud.gateway.httpclient.pool.name	proxy	The channel pool map name, defaults to proxy.
spring.cloud.gateway.httpclient.pool.type		Type of pool for HttpClient to use, defaults to ELASTIC.
spring.cloud.gateway.httpclient.proxy.host		Hostname for proxy configuration of Netty HttpClient.
spring.cloud.gateway.httpclient.proxy.non-proxy-hosts-pattern		Regular expression (Java) for a configured list of hosts. that should be reached directly, bypassing the proxy
spring.cloud.gateway.httpclient.proxy.password		Password for proxy configuration of Netty HttpClient.
spring.cloud.gateway.httpclient.proxy.port		Port for proxy configuration of Netty HttpClient.
spring.cloud.gateway.httpclient.proxy.username		Username for proxy configuration of Netty HttpClient.
spring.cloud.gateway.httpclient.response-timeout		The response timeout.
spring.cloud.gateway.httpclient.ssl.close-notify-flush-timeout	3000ms	SSL close_notify flush timeout. Default to 3000 ms.
spring.cloud.gateway.httpclient.ssl.close-notify-read-timeout	0	SSL close_notify read timeout. Default to 0 ms.

Name	Default	Description
spring.cloud.gateway.httpclient.ssl.default-configuration-type		The default ssl configuration type. Defaults to TCP.
spring.cloud.gateway.httpclient.ssl.handshake-timeout	10000ms	SSL handshake timeout. Default to 10000 ms
spring.cloud.gateway.httpclient.ssl.key-password		Key password, default is same as keyStorePassword.
spring.cloud.gateway.httpclient.ssl.key-store		Keystore path for Netty HttpClient.
spring.cloud.gateway.httpclient.ssl.key-store-password		Keystore password.
spring.cloud.gateway.httpclient.ssl.key-store-provider		Keystore provider for Netty HttpClient, optional field.
spring.cloud.gateway.httpclient.ssl.key-store-type	JKS	Keystore type for Netty HttpClient, default is JKS.
spring.cloud.gateway.httpclient.ssl.trusted-x509-certificates		Trusted certificates for verifying the remote endpoint's certificate.
spring.cloud.gateway.httpclient.ssl.use-insecure-trust-manager	false	Installs the netty InsecureTrustManagerFactory. This is insecure and not suitable for production.
spring.cloud.gateway.httpclient.websocket.max-frame-payload-length		Max frame payload length.
spring.cloud.gateway.httpclient.websocket.proxy-ping	true	Proxy ping frames to downstream services, defaults to true.
spring.cloud.gateway.httpclient.wiretap	false	Enables wiretap debugging for Netty HttpClient.
spring.cloud.gateway.httpserver.wiretap	false	Enables wiretap debugging for Netty HttpServer.
spring.cloud.gateway.loadbalancer.use404	false	
spring.cloud.gateway.metrics.enabled	true	Enables the collection of metrics data.
spring.cloud.gateway.metrics.tags		Tags map that added to metrics.
spring.cloud.gateway.predicate.after.enabled	true	Enables the after predicate.

Name	Default	Description
spring.cloud.gateway.predicate.before.enabled	true	Enables the before predicate.
spring.cloud.gateway.predicate.between.enabled	true	Enables the between predicate.
spring.cloud.gateway.predicate.cloud-foundry-route-service.enabled	true	Enables the cloud-foundry-route-service predicate.
spring.cloud.gateway.predicate.cookie.enabled	true	Enables the cookie predicate.
spring.cloud.gateway.predicate.header.enabled	true	Enables the header predicate.
spring.cloud.gateway.predicate.host.enabled	true	Enables the host predicate.
spring.cloud.gateway.predicate.method.enabled	true	Enables the method predicate.
spring.cloud.gateway.predicate.path.enabled	true	Enables the path predicate.
spring.cloud.gateway.predicate.query.enabled	true	Enables the query predicate.
spring.cloud.gateway.predicate.read-body.enabled	true	Enables the read-body predicate.
spring.cloud.gateway.predicate.remote-addr.enabled	true	Enables the remote-addr predicate.
spring.cloud.gateway.predicate.weight.enabled	true	Enables the weight predicate.
spring.cloud.gateway.redis-rate-limiter.burst-capacity-header	X-RateLimit-Burst-Capacity	The name of the header that returns the burst capacity configuration.
spring.cloud.gateway.redis-rate-limiter.config		
spring.cloud.gateway.redis-rate-limiter.include-headers	true	Whether or not to include headers containing rate limiter information, defaults to true.
spring.cloud.gateway.redis-rate-limiter.remaining-header	X-RateLimit-Remaining	The name of the header that returns number of remaining requests during the current second.
spring.cloud.gateway.redis-rate-limiter.replenish-rate-header	X-RateLimit-Replenish-Rate	The name of the header that returns the replenish rate configuration.

Name	Default	Description
spring.cloud.gateway.redis-rate-limiter.requested-tokens-header	X-RateLimit-Requested-Tokens	The name of the header that returns the requested tokens configuration.
spring.cloud.gateway.routes		List of Routes.
spring.cloud.gateway.set-status.original-status-header-name		The name of the header which contains http code of the proxied request.
spring.cloud.gateway.streaming-media-types		
spring.cloud.gateway.x-forwarded.enabled	true	If the XForwardedHeadersFilter is enabled.
spring.cloud.gateway.x-forwarded.for-append	true	If appending X-Forwarded-For as a list is enabled.
spring.cloud.gateway.x-forwarded.for-enabled	true	If X-Forwarded-For is enabled.
spring.cloud.gateway.x-forwarded.host-append	true	If appending X-Forwarded-Host as a list is enabled.
spring.cloud.gateway.x-forwarded.host-enabled	true	If X-Forwarded-Host is enabled.
spring.cloud.gateway.x-forwarded.order	0	The order of the XForwardedHeadersFilter.
spring.cloud.gateway.x-forwarded.port-append	true	If appending X-Forwarded-Port as a list is enabled.
spring.cloud.gateway.x-forwarded.port-enabled	true	If X-Forwarded-Port is enabled.
spring.cloud.gateway.x-forwarded.prefix-append	true	If appending X-Forwarded-Prefix as a list is enabled.
spring.cloud.gateway.x-forwarded.prefix-enabled	true	If X-Forwarded-Prefix is enabled.
spring.cloud.gateway.x-forwarded.proto-append	true	If appending X-Forwarded-Proto as a list is enabled.
spring.cloud.gateway.x-forwarded.proto-enabled	true	If X-Forwarded-Proto is enabled.
spring.cloud.httpclientfactories.apache.enabled	true	Enables creation of Apache Http Client factory beans.
spring.cloud.httpclientfactories.ok.enabled	true	Enables creation of OK Http Client factory beans.
spring.cloud.hypermedia.refresh.fixed-delay	5000	

Name	Default	Description
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 IP address. Used in case of errors.
spring.cloud.inetutils.ignored-interfaces		List of Java regular expressions for network interfaces that will be ignored.
spring.cloud.inetutils.preferred-networks		List of Java regular expressions for network addresses that will be preferred.
spring.cloud.inetutils.timeout-seconds	1	Timeout, in seconds, for calculating hostname.
spring.cloud.inetutils.use-only-site-local-interfaces	false	Whether to use only interfaces with site local addresses. See {@link InetAddress#isSiteLocalAddress()} for more details.
spring.cloud.kubernetes.client.api-version		
spring.cloud.kubernetes.client.apiVersion	v1	Kubernetes API Version
spring.cloud.kubernetes.client.ca-cert-data		
spring.cloud.kubernetes.client.ca-cert-file		
spring.cloud.kubernetes.client.caCertData		Kubernetes API CACertData
spring.cloud.kubernetes.client.caCertFile		Kubernetes API CACertFile
spring.cloud.kubernetes.client.client-cert-data		
spring.cloud.kubernetes.client.client-cert-file		
spring.cloud.kubernetes.client.client-key-algo		
spring.cloud.kubernetes.client.client-key-data		

Name	Default	Description
spring.cloud.kubernetes.client.client-key-file		
spring.cloud.kubernetes.client.client-key-passphrase		
spring.cloud.kubernetes.client.clientCertData		Kubernetes API ClientCertData
spring.cloud.kubernetes.client.clientCertFile		Kubernetes API ClientCertFile
spring.cloud.kubernetes.client.clientKeyAlgo	RSA	Kubernetes API ClientKeyAlgo
spring.cloud.kubernetes.client.clientKeyData		Kubernetes API ClientKeyData
spring.cloud.kubernetes.client.clientKeyFile		Kubernetes API ClientKeyFile
spring.cloud.kubernetes.client.clientKeyPassphrase	changeit	Kubernetes API ClientKeyPassphrase
spring.cloud.kubernetes.client.connection-timeout		
spring.cloud.kubernetes.client.connectionTimeout	10s	Connection timeout
spring.cloud.kubernetes.client.http-proxy		
spring.cloud.kubernetes.client.https-proxy		
spring.cloud.kubernetes.client.logging-interval		
spring.cloud.kubernetes.client.loggingInterval	20s	Logging interval
spring.cloud.kubernetes.client.master-url		
spring.cloud.kubernetes.client.masterUrl	kubernetes.default.svc	Kubernetes API Master Node URL
spring.cloud.kubernetes.client.namespace	true	Kubernetes Namespace
spring.cloud.kubernetes.client.no-proxy		
spring.cloud.kubernetes.client.password		Kubernetes API Password

Name	Default	Description
spring.cloud.kubernetes.client.proxy-password		
spring.cloud.kubernetes.client.proxy-username		
spring.cloud.kubernetes.client.request-timeout		
spring.cloud.kubernetes.client.requestTimeout	10s	Request timeout
spring.cloud.kubernetes.client.rolling-timeout		
spring.cloud.kubernetes.client.rollingTimeout	900s	Rolling timeout
spring.cloud.kubernetes.client.trust-certs		
spring.cloud.kubernetes.client.trustCerts	false	Kubernetes API Trust Certificates
spring.cloud.kubernetes.client.username		Kubernetes API Username
spring.cloud.kubernetes.client.watch-reconnect-interval		
spring.cloud.kubernetes.client.watch-reconnect-limit		
spring.cloud.kubernetes.client.watchReconnectInterval	1s	Reconnect Interval
spring.cloud.kubernetes.client.watchReconnectLimit	-1	Reconnect Interval limit retries
spring.cloud.kubernetes.config.enable-api	true	
spring.cloud.kubernetes.config.enabled	true	Enable the ConfigMap property source locator.
spring.cloud.kubernetes.config.name		
spring.cloud.kubernetes.config.namespace		
spring.cloud.kubernetes.config.paths		
spring.cloud.kubernetes.config.sources		

Name	Default	Description
spring.cloud.kubernetes.discovery.all-namespaces	false	If discovering all namespaces.
spring.cloud.kubernetes.discovery.enabled	true	If Kubernetes Discovery is enabled.
spring.cloud.kubernetes.discovery.filter		SpEL expression to filter services AFTER they have been retrieved from the Kubernetes API server.
spring.cloud.kubernetes.discovery.known-secure-ports		Set the port numbers that are considered secure and use HTTPS.
spring.cloud.kubernetes.discovery.metadata.add-annotations	true	When set, the Kubernetes annotations of the services will be included as metadata of the returned ServiceInstance.
spring.cloud.kubernetes.discovery.metadata.add-labels	true	When set, the Kubernetes labels of the services will be included as metadata of the returned ServiceInstance.
spring.cloud.kubernetes.discovery.metadata.add-ports	true	When set, any named Kubernetes service ports will be included as metadata of the returned ServiceInstance.
spring.cloud.kubernetes.discovery.metadata.annotations-prefix		When addAnnotations is set, then this will be used as a prefix to the key names in the metadata map.
spring.cloud.kubernetes.discovery.metadata.labels-prefix		When addLabels is set, then this will be used as a prefix to the key names in the metadata map.
spring.cloud.kubernetes.discovery.metadata.ports-prefix	port.	When addPorts is set, then this will be used as a prefix to the key names in the metadata map.
spring.cloud.kubernetes.discovery.order		
spring.cloud.kubernetes.discovery.primary-port-name		If set then the port with a given name is used as primary when multiple ports are defined for a service.

Name	Default	Description
spring.cloud.kubernetes.discovery.service-labels		If set, then only the services matching these labels will be fetched from the Kubernetes API server.
spring.cloud.kubernetes.discovery.service-name	unknown	The service name of the local instance.
spring.cloud.kubernetes.enabled	true	Whether to enable Kubernetes integration.
spring.cloud.kubernetes.loadbalancer.cluster-domain	cluster.local	cluster domain.
spring.cloud.kubernetes.loadbalancer.enabled	true	Load balancer enabled,default true.
spring.cloud.kubernetes.loadbalancer.mode		{@link KubernetesLoadBalancerMode} setting load balancer server list with ip of pod or service name. default value is POD.
spring.cloud.kubernetes.loadbalancer.port-name	http	service port name.
spring.cloud.kubernetes.reload.enabled	false	Enables the Kubernetes configuration reload on change.
spring.cloud.kubernetes.reload.max-wait-for-restart	2s	If Restart or Shutdown strategies are used, Spring Cloud Kubernetes waits a random amount of time before restarting. This is done in order to avoid having all instances of the same application restart at the same time. This property configures the maximum of amount of wait time from the moment the signal is received that a restart is needed until the moment the restart is actually triggered
spring.cloud.kubernetes.reload.mode		Sets the detection mode for Kubernetes configuration reload.
spring.cloud.kubernetes.reload.monitoring-config-maps	true	Enables monitoring on config maps to detect changes.

Name	Default	Description
spring.cloud.kubernetes.reload.monitoring-secrets	false	Enables monitoring on secrets to detect changes.
spring.cloud.kubernetes.reload.period	15000ms	Sets the polling period to use when the detection mode is POLLING.
spring.cloud.kubernetes.reload.strategy		Sets the reload strategy for Kubernetes configuration reload on change.
spring.cloud.kubernetes.secrets.enable-api	false	
spring.cloud.kubernetes.secrets.enabled	true	Enable the Secrets property source locator.
spring.cloud.kubernetes.secrets.labels		
spring.cloud.kubernetes.secrets.name		
spring.cloud.kubernetes.secrets.namespace		
spring.cloud.kubernetes.secrets.paths		
spring.cloud.kubernetes.secrets.sources		
spring.cloud.loadbalancer.cache.caffeine.spec		The spec to use to create caches. See CaffeineSpec for more details on the spec format.
spring.cloud.loadbalancer.cache.capacity	256	Initial cache capacity expressed as int.
spring.cloud.loadbalancer.cache.enabled	true	Enables Spring Cloud LoadBalancer caching mechanism.

Name	Default	Description
spring.cloud.loadbalancer.cache.ttl	35s	Time To Live - time counted from writing of the record, after which cache entries are expired, expressed as a {@link Duration}. The property {@link String} has to be in keeping with the appropriate syntax as specified in Spring Boot <code>StringToDurationConverter</code>. @see github.com/spring-projects/spring-boot/blob/master/spring-boot-project/spring-boot/src/main/java/org/springframework/boot/convert/StringToDurationConverter.java">StringToDurationConverter.java</a&gt;
spring.cloud.loadbalancer.eureka.approximate-zone-from-hostname	false	Used to determine whether we should try to get the `zone` value from host name.
spring.cloud.loadbalancer.health-check.initial-delay	0	Initial delay value for the HealthCheck scheduler.
spring.cloud.loadbalancer.health-check.interval	25s	Interval for rerunning the HealthCheck scheduler.
spring.cloud.loadbalancer.health-check.path		

Name	Default	Description
spring.cloud.loadbalancer.hint		Allows setting the value of <code>hint</code> that is passed on to the LoadBalancer request and can subsequently be used in {@link ReactiveLoadBalancer} implementations.
spring.cloud.loadbalancer.retry.avoid-previous-instance	true	Enables wrapping ServiceInstanceListSupplier beans with `RetryAwareServiceInstanceListSupplier` if Spring-Retry is in the classpath.
spring.cloud.loadbalancer.retry.enabled	true	
spring.cloud.loadbalancer.retry.max-retries-on-next-service-instance	1	Number of retries to be executed on the next <code>ServiceInstance</code>. A <code>ServiceInstance</code> is chosen before each retry call.
spring.cloud.loadbalancer.retry.max-retries-on-same-service-instance	0	Number of retries to be executed on the same <code>ServiceInstance</code>.
spring.cloud.loadbalancer.retry.retry-on-all-operations	false	Indicates retries should be attempted on operations other than {@link HttpMethod#GET}.
spring.cloud.loadbalancer.retry.retryable-status-codes		A {@link Set} of status codes that should trigger a retry.
spring.cloud.loadbalancer.ribbon.enabled	true	Causes `RibbonLoadBalancerClient` to be used by default.
spring.cloud.loadbalancer.service-discovery.timeout		String representation of Duration of the timeout for calls to service discovery.
spring.cloud.loadbalancer.zone		Spring Cloud LoadBalancer zone.
spring.cloud.refresh.enabled	true	Enables autoconfiguration for the refresh scope and associated features.

Name	Default	Description
spring.cloud.refresh.extra-refreshable	true	Additional class names for beans to post process into refresh scope.
spring.cloud.refresh.never-refreshable	true	Comma separated list of class names for beans to never be refreshed or rebound.
spring.cloud.service-registry.auto-registration.enabled	true	Whether service auto-registration is enabled. Defaults to true.
spring.cloud.service-registry.auto-registration.fail-fast	false	Whether startup fails if there is no AutoServiceRegistration. Defaults to false.
spring.cloud.service-registry.auto-registration.register-management	true	Whether to register the management as a service. Defaults to true.
spring.cloud.stream.binders		Additional per-binder properties (see {@link BinderProperties}) if more then one binder of the same type is used (i.e., connect to multiple instances of RabbitMq). Here you can specify multiple binder configurations, each with different environment settings. For example; spring.cloud.stream.binders.rabbit1.environment. . . , spring.cloud.stream.binders.rabbit2.environment. . .
spring.cloud.stream.binding-retry-interval	30	Retry interval (in seconds) used to schedule binding attempts. Default: 30 sec.
spring.cloud.stream.bindings		Additional binding properties (see {@link BinderProperties}) per binding name (e.g., 'input`). For example; This sets the content-type for the 'input' binding of a Sink application: 'spring.cloud.stream.bindings.input.contentType=text/plain'

Name	Default	Description
spring.cloud.stream.default-binder		The name of the binder to use by all bindings in the event multiple binders available (e.g., 'rabbit').
spring.cloud.stream.dynamic-destination-cache-size	10	The maximum size of Least Recently Used (LRU) cache of dynamic destinations. Once this size is reached, new destinations will trigger the removal of old destinations. Default: 10
spring.cloud.stream.dynamic-destinations	[]	A list of destinations that can be bound dynamically. If set, only listed destinations can be bound.
spring.cloud.stream.function.batch-mode	false	
spring.cloud.stream.function.bindings		
spring.cloud.stream.function.definition		Definition of functions to bind. If several functions need to be composed into one, use pipes (e.g., 'fooFunc\
spring.cloud.stream.instance-count	1	The number of deployed instances of an application. Default: 1. NOTE: Could also be managed per individual binding "spring.cloud.stream.bindings.foo.consumer.instance-count" where 'foo' is the name of the binding.
spring.cloud.stream.instance-index	0	The instance id of the application: a number from 0 to instanceCount-1. Used for partitioning and with Kafka. NOTE: Could also be managed per individual binding "spring.cloud.stream.bindings.foo.consumer.instance-index" where 'foo' is the name of the binding.

Name	Default	Description
spring.cloud.stream.instance-index-list		A list of instance id's from 0 to instanceCount-1. Used for partitioning and with Kafka. NOTE: Could also be managed per individual binding "spring.cloud.stream.bindings.foo.consumer.instance-index-list" where 'foo' is the name of the binding. This setting will override the one set in 'spring.cloud.stream.instance-index'
spring.cloud.stream.integration.message-handler-not-propagated-headers		Message header names that will NOT be copied from the inbound message.
spring.cloud.stream.metrics.export-properties		List of properties that are going to be appended to each message. This gets populate by onApplicationEvent, once the context refreshes to avoid overhead of doing per message basis.
spring.cloud.stream.metrics.key		The name of the metric being emitted. Should be an unique value per application. Defaults to: ${spring.application.name:${vcap.application.name:${spring.config.name:application}}}.
spring.cloud.stream.metrics.meter-filter		Pattern to control the 'meters' one wants to capture. By default all 'meters' will be captured. For example, 'spring.integration.*' will only capture metric information for meters whose name starts with 'spring.integration'.
spring.cloud.stream.metrics.properties		Application properties that should be added to the metrics payload For example: `spring.application**`.

Name	Default	Description
spring.cloud.stream.metrics.schedule-interval	60s	Interval expressed as Duration for scheduling metrics snapshots publishing. Defaults to 60 seconds
spring.cloud.stream.override-cloud-connectors	false	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 detects a suitable bound service (for example, a RabbitMQ service bound in Cloud Foundry for the RabbitMQ binder) and uses it for creating connections (usually through Spring Cloud Connectors). When set to true, this property instructs binders to completely ignore the bound services and rely on Spring Boot properties (for example, 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.
spring.cloud.stream.pollable-source	none	A semi-colon delimited list of binding names of pollable sources. Binding names follow the same naming convention as functions. For example, name '…pollable-source=foobar' will be accessible as 'foobar-iin-0'' binding
spring.cloud.stream.poller.cron		Cron expression value for the Cron Trigger.
spring.cloud.stream.poller.fixed-delay	1000	Fixed delay for default poller.
spring.cloud.stream.poller.initial-delay	0	Initial delay for periodic triggers.

Name	Default	Description
spring.cloud.stream.poller.max-messages-per-poll	1	Maximum messages per poll for the default poller.
spring.cloud.stream.sendto.destination	none	The name of the header used to determine the name of the output destination
spring.cloud.stream.source		A colon delimited string representing the names of the sources based on which source bindings will be created. This is primarily to support cases where source binding may be required without providing a corresponding Supplier. (e.g., for cases where the actual source of data is outside of scope of spring-cloud-stream - HTTP -> Stream)
spring.cloud.util.enabled	true	Enables creation of Spring Cloud utility beans.
spring.cloud.vault.app-id.app-id-path	app-id	Mount path of the AppId authentication backend.
spring.cloud.vault.app-id.network-interface		Network interface hint for the "MAC_ADDRESS" UserId mechanism.
spring.cloud.vault.app-id.user-id	MAC_ADDRESS	UserId mechanism. Can be either "MAC_ADDRESS", "IP_ADDRESS", a string or a class name.
spring.cloud.vault.app-role.app-role-path	approle	Mount path of the AppRole authentication backend.
spring.cloud.vault.app-role.role		Name of the role, optional, used for pull-mode.
spring.cloud.vault.app-role.role-id		The RoleId.
spring.cloud.vault.app-role.secret-id		The SecretId.
spring.cloud.vault.application-name	application	Application name for AppId authentication.
spring.cloud.vault.authentication		

Name	Default	Description
spring.cloud.vault.aws-ec2.aws-ec2-path	aws-ec2	Mount path of the AWS-EC2 authentication backend.
spring.cloud.vault.aws-ec2.identity-document	169.254.169.254/latest/dynamic/instance-identity/pkcs7	URL of the AWS-EC2 PKCS7 identity document.
spring.cloud.vault.aws-ec2.nonce		Nonce used for AWS-EC2 authentication. An empty nonce defaults to nonce generation.
spring.cloud.vault.aws-ec2.role		Name of the role, optional.
spring.cloud.vault.aws-iam.aws-path	aws	Mount path of the AWS authentication backend.
spring.cloud.vault.aws-iam.endpoint-uri		STS server URI. @since 2.2
spring.cloud.vault.aws-iam.role		Name of the role, optional. Defaults to the friendly IAM name if not set.
spring.cloud.vault.aws-iam.server-name		Name of the server used to set {@code X-Vault-AWS-IAM-Server-ID} header in the headers of login requests.
spring.cloud.vault.aws.access-key-property	cloud.aws.credentials.accessKey	Target property for the obtained access key.
spring.cloud.vault.aws.backend	aws	aws backend path.
spring.cloud.vault.aws.enabled	false	Enable aws backend usage.
spring.cloud.vault.aws.role		Role name for credentials.
spring.cloud.vault.aws.secret-key-property	cloud.aws.credentials.secretKey	Target property for the obtained secret key.
spring.cloud.vault.azure-msi.azure-path	azure	Mount path of the Azure MSI authentication backend.
spring.cloud.vault.azure-msi.identity-token-service		Identity token service URI. @since 3.0
spring.cloud.vault.azure-msi.metadata-service		Instance metadata service URI. @since 3.0
spring.cloud.vault.azure-msi.role		Name of the role.
spring.cloud.vault.cassandra.backend	cassandra	Cassandra backend path.
spring.cloud.vault.cassandra.enabled	false	Enable cassandra backend usage.

Name	Default	Description
spring.cloud.vault.cassandra.password-property	spring.data.cassandra.password	Target property for the obtained password.
spring.cloud.vault.cassandra.role		Role name for credentials.
spring.cloud.vault.cassandra.static-role	false	Enable static role usage. @since 2.2
spring.cloud.vault.cassandra.username-property	spring.data.cassandra.username	Target property for the obtained username.
spring.cloud.vault.config.lifecycle.enabled	true	Enable lifecycle management.
spring.cloud.vault.config.lifecycle.expiry-threshold		The expiry threshold. {@link Lease} is renewed the given {@link Duration} before it expires. @since 2.2
spring.cloud.vault.config.lifecycle.lease-endpoints		Set the {@link LeaseEndpoints} to delegate renewal/revocation calls to. {@link LeaseEndpoints} encapsulates differences between Vault versions that affect the location of renewal/revocation endpoints. Can be {@link LeaseEndpoints#SysLeases} for version 0.8 or above of Vault or {@link LeaseEndpoints#Legacy} for older versions (the default). @since 2.2
spring.cloud.vault.config.lifecycle.min-renewal		The time period that is at least required before renewing a lease. @since 2.2
spring.cloud.vault.config.order	0	Used to set a {@link org.springframework.core.env.PropertySource} priority. This is useful to use Vault as an override on other property sources. @see org.springframework.core.PriorityOrdered
spring.cloud.vault.connection-timeout	5000	Connection timeout.
spring.cloud.vault.consul.backend	consul	Consul backend path.

Name	Default	Description
spring.cloud.vault.consul.enabled	false	Enable consul backend usage.
spring.cloud.vault.consul.role		Role name for credentials.
spring.cloud.vault.consul.token-property	spring.cloud.consul.token	Target property for the obtained token.
spring.cloud.vault.couchbase.backend	database	Couchbase backend path.
spring.cloud.vault.couchbase.enabled	false	Enable couchbase backend usage.
spring.cloud.vault.couchbase.password-property	spring.couchbase.password	Target property for the obtained password.
spring.cloud.vault.couchbase.role		Role name for credentials.
spring.cloud.vault.couchbase.static-role	false	Enable static role usage.
spring.cloud.vault.couchbase.username-property	spring.couchbase.username	Target property for the obtained username.
spring.cloud.vault.database.backend	database	Database backend path.
spring.cloud.vault.database.enabled	false	Enable database backend usage.
spring.cloud.vault.database.password-property	spring.datasource.password	Target property for the obtained password.
spring.cloud.vault.database.role		Role name for credentials.
spring.cloud.vault.database.static-role	false	Enable static role usage.
spring.cloud.vault.database.username-property	spring.datasource.username	Target property for the obtained username.
spring.cloud.vault.discovery.enabled	false	Flag to indicate that Vault server discovery is enabled (vault server URL will be looked up via discovery).
spring.cloud.vault.discovery.service-id	vault	Service id to locate Vault.
spring.cloud.vault.elasticsearch.backend	database	Database backend path.
spring.cloud.vault.elasticsearch.enabled	false	Enable elasticsearch backend usage.

Name	Default	Description
spring.cloud.vault.elasticsearch.password-property	spring.elasticsearch.rest.password	Target property for the obtained password.
spring.cloud.vault.elasticsearch.role		Role name for credentials.
spring.cloud.vault.elasticsearch.static-role	false	Enable static role usage.
spring.cloud.vault.elasticsearch.username-property	spring.elasticsearch.rest.username	Target property for the obtained username.
spring.cloud.vault.enabled	true	Enable Vault config server.
spring.cloud.vault.fail-fast	false	Fail fast if data cannot be obtained from Vault.
spring.cloud.vault.gcp-gce.gcp-path	gcp	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.gcp-gce.role		Name of the role against which the login is being attempted.
spring.cloud.vault.gcp-gce.service-account		Optional service account id. Using the default id if left unconfigured.
spring.cloud.vault.gcp-iam.credentials.encoded-key		The base64 encoded contents of an OAuth2 account private key in JSON format.
spring.cloud.vault.gcp-iam.credentials.location		Location of the OAuth2 credentials private key. <p> Since this is a Resource, the private key can be in a multitude of locations, such as a local file system, classpath, URL, etc.
spring.cloud.vault.gcp-iam.gcp-path	gcp	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.gcp-iam.jwt-validity	15m	Validity of the JWT token.
spring.cloud.vault.gcp-iam.project-id		Overrides the GCP project Id.
spring.cloud.vault.gcp-iam.role		Name of the role against which the login is being attempted.
spring.cloud.vault.gcp-iam.service-account-id		Overrides the GCP service account Id.
spring.cloud.vault.host	localhost	Vault server host.

Name	Default	Description
spring.cloud.vault.kubernetes.kubernetes-path	kubernetes	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.kubernetes.role		Name of the role against which the login is being attempted.
spring.cloud.vault.kubernetes.service-account-token-file	/var/run/secrets/kubernetes.io/serviceaccount/token	Path to the service account token file.
spring.cloud.vault.kv.application-name	application	Application name to be used for the context.
spring.cloud.vault.kv.backend	secret	Name of the default backend.
spring.cloud.vault.kv.backend-version	2	Key-Value backend version. Currently supported versions are: - Version 1 (unversioned key-value backend). - Version 2 (versioned key-value backend).
spring.cloud.vault.kv.default-context	application	Name of the default context.
spring.cloud.vault.kv.enabled	true	Enable the kev-value backend.
spring.cloud.vault.kv.profile-separator	/	Profile-separator to combine application name and profile.
spring.cloud.vault.kv.profiles		List of active profiles. @since 3.0
spring.cloud.vault.mongodb.backend	mongodb	MongoDB backend path.
spring.cloud.vault.mongodb.enabled	false	Enable mongodb backend usage.
spring.cloud.vault.mongodb.password-property	spring.data.mongodb.password	Target property for the obtained password.
spring.cloud.vault.mongodb.role		Role name for credentials.
spring.cloud.vault.mongodb.static-role	false	Enable static role usage. @since 2.2
spring.cloud.vault.mongodb.username-property	spring.data.mongodb.username	Target property for the obtained username.
spring.cloud.vault.mysql.backend	mysql	mysql backend path.
spring.cloud.vault.mysql.enabled	false	Enable mysql backend usage.

Name	Default	Description
spring.cloud.vault.mysql.password-property	spring.datasource.password	Target property for the obtained username.
spring.cloud.vault.mysql.role		Role name for credentials.
spring.cloud.vault.mysql.username-property	spring.datasource.username	Target property for the obtained username.
spring.cloud.vault.namespace		Vault namespace (requires Vault Enterprise).
spring.cloud.vault.pcf.instance-certificate		Path to the instance certificate (PEM). Defaults to {@code CF_INSTANCE_CERT} env variable.
spring.cloud.vault.pcf.instance-key		Path to the instance key (PEM). Defaults to {@code CF_INSTANCE_KEY} env variable.
spring.cloud.vault.pcf.pcf-path	pcf	Mount path of the Kubernetes authentication backend.
spring.cloud.vault.pcf.role		Name of the role against which the login is being attempted.
spring.cloud.vault.port	8200	Vault server port.
spring.cloud.vault.postgresql.backend	postgresql	postgresql backend path.
spring.cloud.vault.postgresql.enabled	false	Enable postgresql backend usage.
spring.cloud.vault.postgresql.password-property	spring.datasource.password	Target property for the obtained username.
spring.cloud.vault.postgresql.role		Role name for credentials.
spring.cloud.vault.postgresql.username-property	spring.datasource.username	Target property for the obtained username.
spring.cloud.vault.rabbitmq.backend	rabbitmq	rabbitmq backend path.
spring.cloud.vault.rabbitmq.enabled	false	Enable rabbitmq backend usage.
spring.cloud.vault.rabbitmq.password-property	spring.rabbitmq.password	Target property for the obtained password.
spring.cloud.vault.rabbitmq.role		Role name for credentials.

Name	Default	Description
spring.cloud.vault.rabbitmq.username-property	spring.rabbitmq.username	Target property for the obtained username.
spring.cloud.vault.read-timeout	15000	Read timeout.
spring.cloud.vault.scheme	https	Protocol scheme. Can be either "http" or "https".
spring.cloud.vault.session.lifecycle.enabled	true	Enable session lifecycle management.
spring.cloud.vault.session.lifecycle.expiry-threshold	7s	The expiry threshold for a {@link LoginToken}. The threshold represents a minimum TTL duration to consider a login token as valid. Tokens with a shorter TTL are considered expired and are not used anymore. Should be greater than {@code refreshBeforeExpiry} to prevent token expiry.
spring.cloud.vault.session.lifecycle.refresh-before-expiry	5s	The time period that is at least required before renewing the {@link LoginToken}.
spring.cloud.vault.ssl.cert-auth-path	cert	Mount path of the TLS cert authentication backend.
spring.cloud.vault.ssl.key-store		Trust store that holds certificates and private keys.
spring.cloud.vault.ssl.key-store-password		Password used to access the key store.
spring.cloud.vault.ssl.key-store-type		Type of the key store. @since 3.0
spring.cloud.vault.ssl.trust-store		Trust store that holds SSL certificates.
spring.cloud.vault.ssl.trust-store-password		Password used to access the trust store.
spring.cloud.vault.ssl.trust-store-type		Type of the trust store. @since 3.0
spring.cloud.vault.token		Static vault token. Required if {@link #authentication} is {@code TOKEN}.
spring.cloud.vault.uri		Vault URI. Can be set with scheme, host and port.

Name	Default	Description
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.connection-timeout		The configured connection timeout in milliseconds.
spring.cloud.zookeeper.dependencies		Mapping of alias to ZookeeperDependency. From LoadBalancer perspective the alias is actually serviceID since SC LoadBalancer 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.initial-status		The initial status of this instance (defaults to {@link StatusConstants#STATUS_UP}).
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-id		Id used to register with zookeeper. Defaults to a random UUID.
spring.cloud.zookeeper.discovery.instance-port		Port to register the service under (defaults to listening port).
spring.cloud.zookeeper.discovery.instance-ssl-port		Ssl port of the registered service.

Name	Default	Description
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.order	0	Order of the discovery client used by `CompositeDiscoveryClient` for sorting available clients.
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.

Name	Default	Description
spring.cloud.zookeeper.session-timeout		The configured/negotiated session timeout in milliseconds. Please refer to cwiki.apache.org/confluence/display/CURATOR/TN14'>Curator's Tech Note 14 to understand how Curator implements connection sessions. @see cwiki.apache.org/confluence/display/CURATOR/TN14'>Curator's Tech Note 14
spring.sleuth.async.configurer.enabled	true	Enable default AsyncConfigurer.
spring.sleuth.async.enabled	true	Enable instrumenting async related components so that the tracing information is passed between threads.
spring.sleuth.async.ignored-beans		List of {@link java.util.concurrent.Executor} bean names that should be ignored and not wrapped in a trace representation.
spring.sleuth.baggage.correlation-enabled	true	Adds a {@link CorrelationScopeDecorator} to put baggage values into the correlation context.
spring.sleuth.baggage.correlation-fields		A list of {@link BaggageField#name() fields} to add to correlation (MDC) context. @see CorrelationScopeConfig.SingleCorrelationField#create(BaggageField)

Name	Default	Description
spring.sleuth.baggage.local-fields		Same as {@link #remoteFields} except that this field is not propagated to remote services. @see BaggagePropagationConfig.SingleBaggageField#local(BaggageField)
spring.sleuth.baggage.remote-fields		List of fields that are referenced the same in-process as it is on the wire. For example, the field "x-vcap-request-id" would be set as-is including the prefix. @see BaggagePropagationConfig.SingleBaggageField#remote(BaggageField) @see BaggagePropagationConfig.SingleBaggageField.Builder#addKeyName(String)
spring.sleuth.baggage.tag-fields		A list of {@link BaggageField#name() fields} to tag into the span. @see Tags#BAGGAGE_FIELD
spring.sleuth.circuitbreaker.enabled	true	Enable Spring Cloud CircuitBreaker instrumentation.
spring.sleuth.enabled	true	
spring.sleuth.feign.enabled	true	Enable span information propagation when using Feign.
spring.sleuth.feign.processor.enabled	true	Enable post processor that wraps Feign Context in its tracing representations.
spring.sleuth.grpc.enabled	true	Enable span information propagation when using GRPC.
spring.sleuth.http.enabled	true	
spring.sleuth.http.legacy.enabled	false	
spring.sleuth.integration.enabled	true	Enable Spring Integration sleuth instrumentation.

Name	Default	Description
spring.sleuth.integration.patterns	[!hystrixStreamOutput*, , **!channel**]	An array of patterns against which channel names will be matched. @see org.springframework.integration.config.GlobalChannelInterceptor#patterns() Defaults to any channel name not matching the Hystrix Stream and functional Stream channel names.
spring.sleuth.integration.websockets.enabled	true	Enable tracing for WebSockets.
spring.sleuth.messaging.enabled	false	Should messaging be turned on.
spring.sleuth.messaging.jms.enabled	true	Enable tracing of JMS.
spring.sleuth.messaging.jms.remote-service-name	jms	
spring.sleuth.messaging.kafka.enabled	true	Enable tracing of Kafka.
spring.sleuth.messaging.kafka.mapper.enabled	true	Enable DefaultKafkaHeaderMapper tracing for Kafka.
spring.sleuth.messaging.kafka.remote-service-name	kafka	
spring.sleuth.messaging.rabbit.enabled	true	Enable tracing of RabbitMQ.
spring.sleuth.messaging.rabbit.remote-service-name	rabbitmq	
spring.sleuth.mongodb.enabled	true	Enable tracing for MongoDb.
spring.sleuth.opentracing.enabled	true	
spring.sleuth.quartz.enabled	true	Enable tracing for Quartz.

Name	Default	Description
spring.sleuth.reactor.decorate-on-each	true	When true decorates on each operator, will be less performing, but logging will always contain the tracing entries in each operator. When false decorates on last operator, will be more performing, but logging might not always contain the tracing entries. @deprecated use explicit value via {@link SleuthReactorProperties#instrumentationType}
spring.sleuth.reactor.enabled	true	When true enables instrumentation for reactor.
spring.sleuth.reactor.instrumentation-type		
spring.sleuth.redis.enabled	true	Enable span information propagation when using Redis.
spring.sleuth.redis.remote-service-name	redis	Service name for the remote Redis endpoint.
spring.sleuth.rpc.enabled	true	Enable tracing of RPC.
spring.sleuth.rxjava.schedulers.hook.enabled	true	Enable support for RxJava via RxJavaSchedulersHook.
spring.sleuth.rxjava.schedulers.ignoredthreads	[HystrixMetricPoller, ^RxComputation.*$]	Thread names for which spans will not be sampled.
spring.sleuth.sampler.probability		Probability 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).

Name	Default	Description
spring.sleuth.sampler.rate	10	A rate per second can be a nice choice for low-traffic endpoints as it allows you surge protection. For example, you may never expect the endpoint to get more than 50 requests per second. If there was a sudden surge of traffic, to 5000 requests per second, you would still end up with 50 traces per second. Conversely, if you had a percentage, like 10%, the same surge would end up with 500 traces per second, possibly overloading your storage. Amazon X-Ray includes a rate-limited sampler (named Reservoir) for this purpose. Brave has taken the same approach via the {@link brave.sampler.RateLimitingSampler}.
spring.sleuth.sampler.refresh.enabled	true	Enable refresh scope for sampler.
spring.sleuth.scheduled.enabled	true	Enable tracing for {@link org.springframework.scheduling.annotation.Scheduled}.
spring.sleuth.scheduled.skip-pattern		Pattern for the fully qualified name of a class that should be skipped.
spring.sleuth.span-handler.additional-span-name-patterns-to-ignore		Additional list of span names to ignore. Will be appended to {@link #spanNamePatternsToSkip}.
spring.sleuth.span-handler.enabled	false	Will turn on the default Sleuth handler mechanism. Might ignore exporting of certain spans;
spring.sleuth.span-handler.span-name-patterns-to-skip	^catalogWatchTaskScheduler$	List of span names to ignore. They will not be sent to external systems.

Name	Default	Description
spring.sleuth.supports-join	true	True means the tracing system supports sharing a span ID between a client and server.
spring.sleuth.trace-id128	false	When true, generate 128-bit trace IDs instead of 64-bit ones.
spring.sleuth.web.additional-skip-pattern		Additional pattern for URLs that should be skipped in tracing. This will be appended to the {@link SleuthWebProperties#skipPattern}.
spring.sleuth.web.client.enabled	true	Enable interceptor injecting into {@link org.springframework.web.client.RestTemplate}.
spring.sleuth.web.client.skip-pattern		Pattern for URLs that should be skipped in client side tracing.
spring.sleuth.web.enabled	true	When true enables instrumentation for web applications.
spring.sleuth.web.filter-order		Order in which the tracing filters should be registered. Defaults to {@link TraceHttpAutoConfiguration#TRACING_FILTER_ORDER}.
spring.sleuth.web.ignore-auto-configured-skip-patterns	false	If set to true, auto-configured skip patterns will be ignored. @see SkipPatternConfiguration
spring.sleuth.web.skip-pattern	/api-docs.*\	/swagger.*\
spring.sleuth.web.webclient.enabled	true	Enable tracing instrumentation for WebClient.
spring.zipkin.activemq.message-max-bytes	100000	Maximum number of bytes for a given message with spans sent to Zipkin over ActiveMQ.
spring.zipkin.activemq.queue	zipkin	Name of the ActiveMQ queue where spans should be sent to Zipkin.

Name	Default	Description
spring.zipkin.base-url	localhost:9411/	URL of the zipkin query server instance. You can also provide the service id of the Zipkin server if Zipkin's registered in service discovery (e.g. zipkinserver/).
spring.zipkin.compression.enabled	false	
spring.zipkin.discovery-client-enabled		If set to {@code false}, will treat the {@link ZipkinProperties#baseUrl} as a URL always.
spring.zipkin.enabled	true	Enables sending spans to Zipkin.
spring.zipkin.encoder		Encoding type of spans sent to Zipkin. Set to {@link SpanBytesEncoder#JSON_V1} if your server is not recent.
spring.zipkin.kafka.topic	zipkin	Name of the Kafka topic where spans should be sent to Zipkin.
spring.zipkin.locator.discovery.enabled	false	Enabling of locating the host name via service discovery.
spring.zipkin.message-timeout	1	Timeout in seconds before pending spans will be sent in batches to Zipkin.
spring.zipkin.rabbitmq.addresses		Addresses of the RabbitMQ brokers used to send spans to Zipkin
spring.zipkin.rabbitmq.queue	zipkin	Name of the RabbitMQ queue where spans should be sent to Zipkin.
spring.zipkin.sender.type		Means of sending spans to Zipkin.
spring.zipkin.service.name		The name of the service, from which the Span was sent via HTTP, that should appear in Zipkin.
stubrunner.amqp.enabled	false	Whether to enable support for Stub Runner and AMQP.

Name	Default	Description
stubrunner.amqp.mockCOnnection	true	Whether to enable support for Stub Runner and AMQP mocked connection factory.
stubrunner.classifier	stubs	The classifier to use by default in ivy co-ordinates for a stub.
stubrunner.cloud.consul.enabled	true	Whether to enable stubs registration in Consul.
stubrunner.cloud.delegate.enabled	true	Whether to enable DiscoveryClient's Stub Runner implementation.
stubrunner.cloud.enabled	true	Whether to enable Spring Cloud support for Stub Runner.
stubrunner.cloud.eureka.enabled	true	Whether to enable stubs registration in Eureka.
stubrunner.cloud.loadbalancer.enabled	true	Whether to enable Stub Runner's Spring Cloud Load Balancer integration.
stubrunner.cloud.stubbed.discovery.enabled	true	Whether Service Discovery should be stubbed for Stub Runner. If set to false, stubs will get registered in real service discovery.
stubrunner.cloud.zookeeper.enabled	true	Whether to enable stubs registration in Zookeeper.
stubrunner.consumer-name		You can override the default {@code spring.application.name} of this field by setting a value to this parameter.
stubrunner.delete-stubs-after-test	true	If set to {@code false} will NOT delete stubs from a temporary folder after running tests.
stubrunner.fail-on-no-stubs	true	When enabled, this flag will tell stub runner to throw an exception when no stubs / contracts were found.

Name	Default	Description
stubrunner.generate-stubs	false	When enabled, this flag will tell stub runner to not load the generated stubs, but convert the found contracts at runtime to a stub format and run those stubs.
stubrunner.http-server-stub-configurer		Configuration for an HTTP server stub.
stubrunner.ids	[]	The ids of the stubs to run in "ivy" notation ([groupId]:artifactId:[version]:[classifier][:port]). {@code groupId}, {@code classifier}, {@code version} and {@code port} can be optional.
stubrunner.ids-to-service-ids		Mapping of Ivy notation based ids to serviceIds inside your application. Example "a:b" -> "myService" "artifactId" -> "myOtherService"
stubrunner.integration.enabled	true	Whether to enable Stub Runner integration with Spring Integration.
stubrunner.jms.enabled	true	Whether to enable Stub Runner integration with Spring JMS.
stubrunner.kafka.enabled	true	Whether to enable Stub Runner integration with Spring Kafka.
stubrunner.kafka.initializer.enabled	true	Whether to allow Stub Runner to take care of polling for messages instead of the KafkaStubMessages component. The latter should be used only on the producer side.
stubrunner.mappings-output-folder		Dumps the mappings of each HTTP server to the selected folder.
stubrunner.max-port	15000	Max value of a port for the automatically started WireMock server.
stubrunner.min-port	10000	Min value of a port for the automatically started WireMock server.

Name	Default	Description
stubrunner.password		Repository password.
stubrunner.properties		Map of properties that can be passed to custom {@link org.springframework.cloud.contract.stubrunner.StubDownloaderBuilder}.
stubrunner.proxy-host		Repository proxy host.
stubrunner.proxy-port		Repository proxy port.
stubrunner.server-id		
stubrunner.stream.enabled	true	Whether to enable Stub Runner integration with Spring Cloud Stream.
stubrunner.stubs-mode		Pick where the stubs should come from.
stubrunner.stubs-per-consumer	false	Should only stubs for this particular consumer get registered in HTTP server stub.
stubrunner.username		Repository username.
wiremock.placeholders.enabled	true	Flag to indicate that http URLs in generated wiremock stubs should be filtered to add or resolve a placeholder for a dynamic port.
wiremock.reset-mappings-after-each-test	false	
wiremock.rest-template-ssl-enabled	false	
wiremock.server.files	[]	
wiremock.server.https-port	-1	
wiremock.server.https-port-dynamic	false	
wiremock.server.port	8080	
wiremock.server.port-dynamic	false	
wiremock.server.stubs	[]	