Spring Cloud Consul

3.0.0-SNAPSHOT

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 `/health` endpoint every 10 seconds. If the health check fails, the service instance is marked as critical.

Example Consul client:

JAVA

```java
@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
```

3.3. HTTP Health Check

The health check for a Consul instance defaults to "/health", which is the default locations of a useful endpoint in a Spring Boot Actuator application. You need to change these, even for an Actuator application if you use a non-default context path or servlet path (e.g. `server.servletPath=/foo`) or management endpoint path (e.g. `management.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. Example:

application.yml

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

You can disable the health check by setting `management.health.consul.enabled=false`.

3.3.1. 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 1. Auto Generated Metadata

Key	Value
'group'	Property `spring.cloud.consul.discovery.instance-group`. This values is only generated if `instance-group` is not empty.'

Key	Value
'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.

3.3.2. Making the Consul Instance ID Unique

By default a consul instance is registered with an ID that is equal to its Spring Application Context ID. By default, the Spring Application Context ID is `${spring.application.name}:comma,separated,profiles:${server.port}`. For most cases, this will allow multiple instances of one service to run on one machine. If further uniqueness is required, Using Spring Cloud you can override this by providing a unique identifier in `spring.cloud.consul.discovery.instanceId`. For example:

application.yml

```
spring:
  cloud:
    consul:
      discovery:
        instanceId: ${spring.application.name}:${vcap.application.instance_id:${spring.applicati
```

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.

3.3.3. Applying Headers to Health Check Requests

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"
```

3.4. Looking up services

3.4.1. 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`.

3.4.2. Using the DiscoveryClient

You can also use the `org.springframework.cloud.client.discovery.DiscoveryClient` which provides a simple API for discovery clients that is not specific to Netflix, e.g.

```
@Autowired
private DiscoveryClient discoveryClient;

public String serviceUrl() {
    List<ServiceInstance> list = discoveryClient.getInstances("STORES");
    if (list != null && list.size() > 0 ) {
        return list.get(0).getUri();
    }
    return null;
}
```

3.5. 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.

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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.

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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.

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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.