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Hystrix Circuit Breaker Pattern – Spring Cloud

By Sajal Chakraborty | Filed Under: Spring Cloud

Learn to leverage the one of the Spring cloud Netflix stack component called `Hystrix` to implement **circuit breaker** while invoking underlying microservice. It is generally required to enable fault tolerance in the application where some underlying service is down/throwing error permanently, we need to fall back to different path of program execution automatically. This is related to distributed computing style of Eco system using lots of underlying Microservices. This is where circuit breaker pattern helps and `Hystrix` is an tool to build this circuit breaker.

Hystrix Example for real impatient

Hystrix configuration is done in four major steps.

1. Add Hystrix starter and dashboard dependencies.

```
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-hystrix</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-hystrix-
dashboard</artifactId>
</dependency>
```

2. Add `@EnableCircuitBreaker` annotation
3. Add `@EnableHystrixDashboard` annotation
4. Add annotation `@HystrixCommand(fallbackMethod = "myFallbackMethod")`

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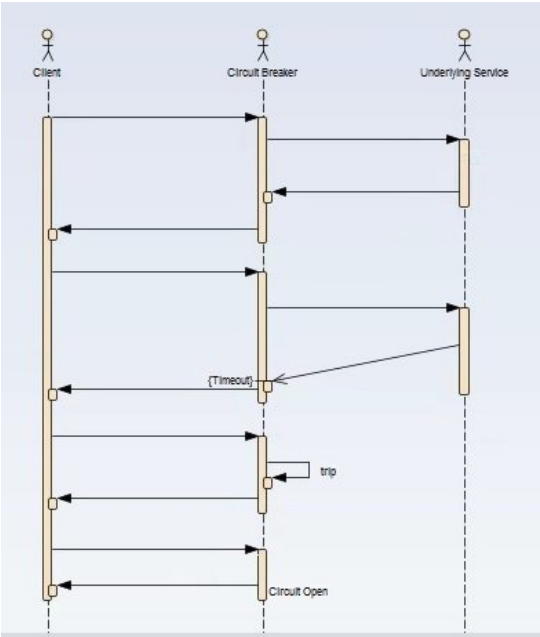
Whay is Circuit Breaker Pattern?

If we design our systems on microservice based architecture, we will generally develop many Microservices and those will interact with each other heavily in achieving certain business goals. Now, all of us can assume that this will give expected result if all the services are up and running and response time of each service is satisfactory.

Now what will happen if any service, of the current Eco system, has some issue and stopped servicing the requests. It will result in timeouts/exception and the whole Eco system will get unstable due to this single point of failure.

Here circuit breaker pattern comes handy and it redirects traffic to a fall back path once it sees any such scenario. Also it monitors the defective service closely and restore the traffic once the service came back to normalcy.

So circuit breaker is a kind of a wrapper of the method which is doing the service call and it monitors the service health and once it gets some issue, the circuit breaker trips and all further calls goto the circuit breaker fall back and finally restores automatically once the service came back !! That's cool right?



Circuit Breaker Sequence of Invocation

Hystrix Circuit Breaker Example

To demo circuit breaker, we will create following two microservices where first is dependent on another.

- **Student Microservice** – Which will give some basic functionality on `Student` entity. It will be a REST based service. We will call this service from `School` Service to understand Circuit Breaker. It will run on port `8098` in localhost.
- **School Microservice** – Again a simple REST based microservice where we will implement circuit breaker using `Hystrix`. `Student` Service will be invoked from here and we will test the fall back path once student service will be unavailable. It will run on port 9098 in localhost.

Tech Stack and Demo Runtime

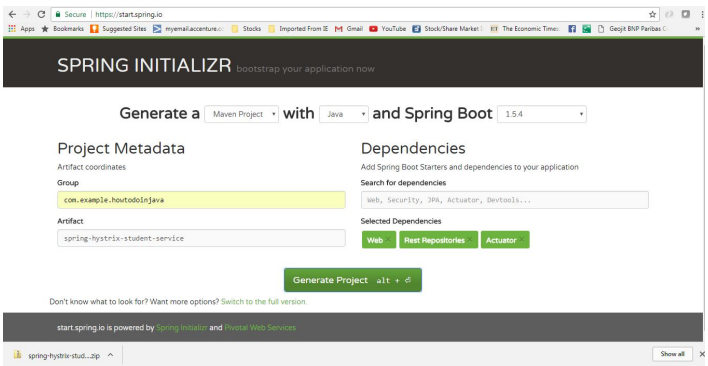
- Java 1.8
- Eclipse as IDE
- Maven as build tool
- Spring cloud Hystrix as circuit breaker framework
- Spring boot
- Spring Rest

Create Student Service

Follow these steps to create and run Student Service – a simple REST service providing some basic functionality of Student entity.

Create spring boot project

Create a Spring boot project from Spring Boot initializer portal with three dependencies i.e. `Web`, `Rest Repositories` and `Actuator`. Give other maven GAV coordinates and download the project.



Student Service Generation

Unzip and import the project into Eclipse as existing maven project. In this step, all necessary dependencies will be downloaded from maven repository.

Server Port Settings

Open `application.properties` and add port information.

```
server.port = 8098
```

This will enable this application run on default port 8098. We can easily override this by supplying `-Dserver.port = XXXX` argument at the time of starting the server.

Create REST APIs

Now add one REST controller class called `StudentServiceController` and expose one rest endpoint for getting all the student details for a particular school. Here we are exposing `/getStudentDetailsForSchool/{schoolname}` endpoint to serve the business purpose. For simplicity, we are hard coding the student details.

StudentServiceController.java

```
package
com.example.howtodoinjava.springhystrixstudentservice.controller;

import java.util.ArrayList;
import java.util.HashMap;
import java.util.List;
import java.util.Map;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestMethod;
import org.springframework.web.bind.annotation.RestController;
import
com.example.howtodoinjava.springhystrixstudentservice.domain.Stud
ent;

@RestController
public class StudentServiceController {

    private static Map<String, List<Student>> schooDB = new
HashMap<String, List<Student>>();

    static {
        schooDB = new HashMap<String, List<Student>>();

        List<Student> lst = new ArrayList<Student>();
        Student std = new Student("Sajal", "Class IV");
        lst.add(std);
        std = new Student("Lokesh", "Class V");
        lst.add(std);

        schooDB.put("abcschool", lst);

        lst = new ArrayList<Student>();
        std = new Student("Kajal", "Class III");
        lst.add(std);
        std = new Student("Sukesh", "Class VI");
        lst.add(std);

        schooDB.put("xyzschool", lst);

    }

    @RequestMapping(value =
"/getStudentDetailsForSchool/{schoolname}", method =
RequestMethod.GET)
    public List<Student> getStudents(@PathVariable String
schoolname) {
        System.out.println("Getting Student details for " +
schoolname);

        List<Student> studentList = schooDB.get(schoolname);
        if (studentList == null) {
            studentList = new ArrayList<Student>();
            Student std = new Student("Not Found", "N/A");
            studentList.add(std);
        }
        return studentList;
    }
}
```

Student.java

```
package
com.example.howtodoinjava.springhystrixstudentservice.domain;

public class Student {

    private String name;
    private String className;

    public Student(String name, String className) {
```

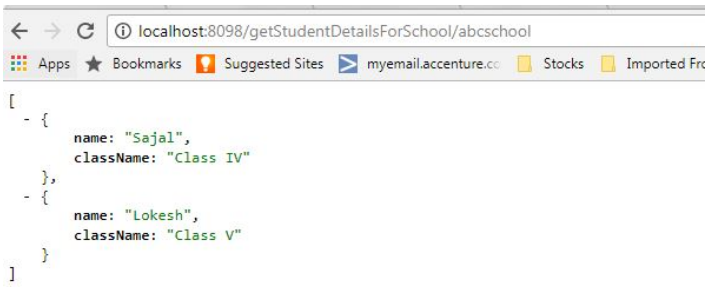
```
        super();
        this.name = name;
        this.className = className;
    }

    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public String getClassName() {
        return className;
    }

    public void setClassName(String className) {
        this.className = className;
    }
}
```

Build and Test Student Service

Now do a final build using `mvn clean install` and run the server using command `java -jar target\spring-hystrix-student-service-0.0.1-SNAPSHOT.jar`. This will start the student service in default port `8098`.

Open browser and type `http://localhost:8098/getStudentDetailsForSchool/abcschool`.

It should show the below output in browser –



Student Service Response

Create School Service – Hystrix Enabled

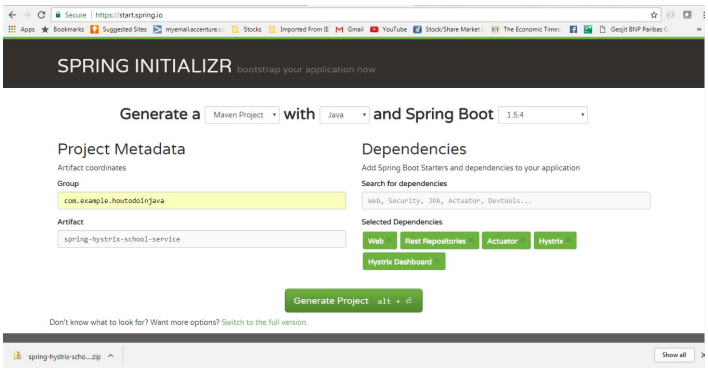
Similar to Student service, create another microservice for School. It will internally invoke already developed Student Service.

Generate spring boot project

Create a Spring boot project from Spring Boot initializer portal with those dependencies mainly.

- **Web** – REST Endpoints
- **Actuator** – providing basic management URL
- **Hystrix** – Enable Circuit Breaker
- **Hystrix Dashboard** – Enable one Dashboard screen related to the Circuit Breaker monitoring

Give other maven GAV coordinates and download the project.



School Service Project

Unzip and import the project into Eclipse as *existing maven project*. In this step, all necessary dependencies will be downloaded from maven repository.

Server Port Settings

Open `application.properties` and add port information.

```
server.port = 9098
```

This will enable this application run on default port 9098. We can easily override this by supplying `-Dserver.port = XXXX` argument at the time of starting the server.

Enable Hystrix Settings

Open `SpringHystrixSchoolServiceApplication` i.e the generated class with `@SpringBootApplication` and add `@EnableHystrixDashboard` and `@EnableCircuitBreaker` annotations.

This will **enable Hystrix circuit breaker** in the application and also will add one useful dashboard running on localhost provided by Hystrix.

```
package com.example.howtodoinjava.springhystrixschoolservice;

import org.springframework.boot.SpringApplication;
import
org.springframework.boot.autoconfigure.SpringBootApplication;
import
org.springframework.cloud.client.circuitbreaker.EnableCircuitBrea
ker;
import
org.springframework.cloud.netflix.hystrix.dashboard.EnableHystrix
Dashboard;

@SpringBootApplication
@EnableHystrixDashboard
@EnableCircuitBreaker
public class SpringHystrixSchoolServiceApplication {

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

Add REST controller

Add `SchoolServiceController` Rest Controller where we will expose `/getSchoolDetails/{schoolname}` endpoint which will simply return school details along with its student details. For Student Details it will call the already developed Student service endpoint. We will create a Delegate layer

`StudentServiceDelegate.java` to call the Student Service. This simple Code will look like

SchoolServiceController.java

```
package
com.example.howtodoinjava.springhystrixschoolservice.controller;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestMethod;
import org.springframework.web.bind.annotation.RestController;
import
com.example.howtodoinjava.springhystrixschoolservice.delegate.Stu
dentServiceDelegate;

@RestController
public class SchoolServiceController {

    @Autowired
    StudentServiceDelegate studentServiceDelegate;

    @RequestMapping(value = "/getSchoolDetails/{schoolname}",
method = RequestMethod.GET)
    public String getStudents(@PathVariable String schoolname) {
        System.out.println("Going to call student service to get
data!");
        return
studentServiceDelegate.callStudentServiceAndGetData(schoolname);
    }
}
```

StudentServiceDelegate

We will do the following things here to enable Hystrix circuit breaker.

- Invoke Student Service through spring framework provided `RestTemplate`
- Add Hystrix Command to enable fallback method – `@HystrixCommand(fallbackMethod = "callStudentServiceAndGetData_Fallback")` – this means that we will have to add another method `callStudentServiceAndGetData_Fallback` with same signature, which will be invoked when actual Student service will be down.
- Add fallback method – `callStudentServiceAndGetData_Fallback` which will simply return some default value.

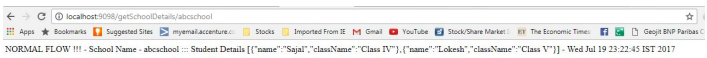
```
package
com.example.howtodoinjava.springhystrixschoolservice.delegate;

import java.util.Date;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.annotation.Bean;
import org.springframework.core.ParameterizedTypeReference;
import org.springframework.http.HttpMethod;
import org.springframework.stereotype.Service;
import org.springframework.web.client.RestTemplate;
import
com.netflix.hystrix.contrib.javanica.annotation.HystrixCommand;

@Service
public class StudentServiceDelegate {

    @Autowired
    RestTemplate restTemplate;

    @HystrixCommand(fallbackMethod =
"callStudentServiceAndGetData_Fallback")
    public String callStudentServiceAndGetData(String schoolname)
{

        System.out.println("Getting School details for " +
schoolname);
```

```
        String response = restTemplate
                .exchange("http://localhost:8098/getStudentDetail
sForSchool/{schoolname}"
                , HttpMethod.GET
                , null
                , new ParameterizedTypeReference<String>() {
            }, schoolname).getBody();

        System.out.println("Response Received as " + response + "
-  " + new Date());

        return "NORMAL FLOW !!! - School Name -  " + schoolname +
" :::  " +
                    " Student Details " + response + " -  " + new
Date();
    }

    @SuppressWarnings("unused")
    private String callStudentServiceAndGetData_Fallback(String
schoolname) {

        System.out.println("Student Service is down!!! fallback
route enabled...");

        return "CIRCUIT BREAKER ENABLED!!! No Response From
Student Service at this moment. " +
                    " Service will be back shortly - " + new
Date();
    }

    @Bean
    public RestTemplate restTemplate() {
        return new RestTemplate();
    }
}
```

Build and Test of School Service

Now do a final build using `mvn clean install` and run the server using command `java -jar target\spring-hystrix-school-service-0.0.1-SNAPSHOT.jar`. This will start the school service in default port **9098**.

Start the student service as described above and then test school service by opening browser and type `http://localhost:9098/getSchoolDetails/abcschool`. It should show the below output in browser :

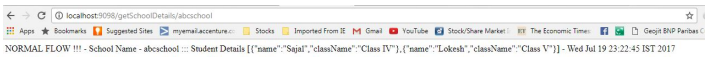


School Service Response

Test Hystrix Circuit Breaker – Demo

Opening browser and type `http://localhost:9098/getSchoolDetails/abcschool`.

It should show the below output in browser –



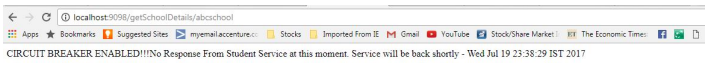
School Service Response

Now we already know that School service is calling student service internally, and it is getting student details from that service. So if both the services are running, school service is displaying the data returned by

student service as we have seen in the school service browser output above. This is **CIRCUIT CLOSED State**.

Now let us *stop the student service* by just pressing `CTRL + C` in the student service server console (stop the server) and test the school service again from browser. This time it will return the fall back method response. Here Hystrix comes into picture, it monitors Student service in frequent interval and as it is down, Hystrix component has opened the Circuit and fallback path enabled.

Here is the fall back output in the browser.



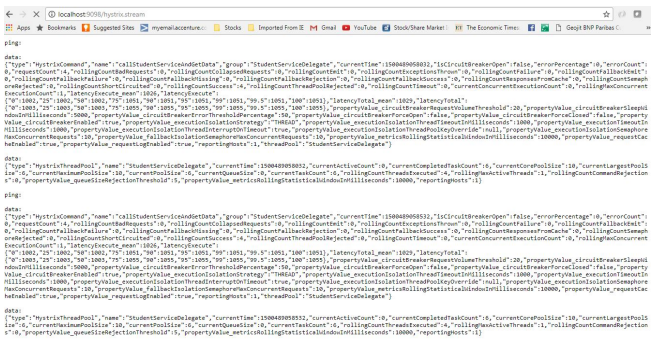
School Service Response Fallback path

Again start the Student service, wait for few moments and go back to school service and it will again start responding in normal flow.

Hystrix Dashboard

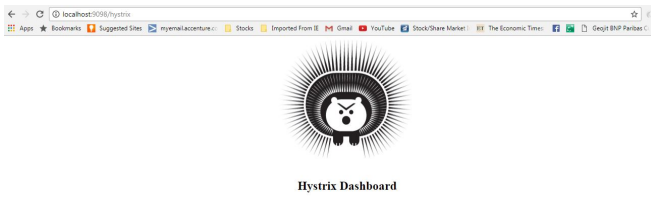
As we have added hystrix dashboard dependency, hystrix has provided one nice Dashboard and a Hystrix Stream in the bellow URLS:

- http://localhost:9098/hystrix.stream – It's a continuous stream that Hystrix generates. It is just a health check result along with all the service calls that are being monitored by Hystrix. Sample output will look like in browser –



Hystrix Stream output

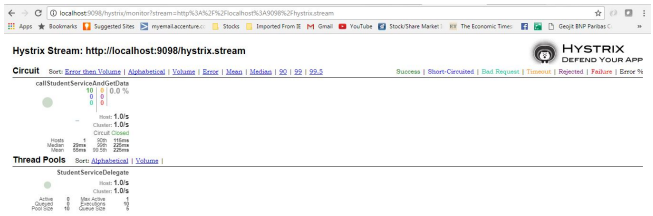
- http://localhost:9098/hystrix – This is visual dashboard initial state.



Hystrix Initial Dashboard

- Now add http://localhost:9098/hystrix.stream in dashboard to get a meaningful dynamic visual representation of the circuit being

monitored by the Hystrix component. Visual Dashboard after providing the Stream input in the home page –



Hystrix visual Dashboard

Summary

That's all about **creating spring could Hystrix Circuit Breaker**, we have tested both **circuit open path** and **circuit closed path**. Do the setup on your own and play with different combination service state to be more clear of whole concept.

Please add comments if you have any difficulty executing this article. We will be happy to look into the problem.

Download Source code

Happy Learning!!

Feedback, Discussion and Comments

cici

March 18, 2019

What if the service itself is up, but returns a valid error. How do you make the fallback only fire if the service is truly down?

Reply

jagadeesh

March 5, 2019

Hi ,

Same example i tried its working fine but when i configured sonfig-server,Discovery-server ,zuul-gate its working fine if student service running and when i am trying to down the student server school service with hystrix not working(means : sys printing but response not display in browser) ,please let me know need any changes

Reply

Deena

December 17, 2018

Even after all these steps, only some services are being seen in the dashboard, not all. Could there be any reason for that?

Reply

Savani

August 24, 2018

Hi Lokesh – Could you please update the dependency to work with Spring Boot Version 2.0.4.RELESE?

Reply

Abdul

August 10, 2018

hi Lokesh,

can you please create a tutorial for RabbitMQ and Spring Restful services security using OAuth and JWT.

It will be really good to learn these topics from your tutorials.

Thank you.

Reply

Lokesh Gupta

August 10, 2018

Thanks for the suggestions. I will work on it.

Reply

Himanshubhusan Rath

July 9, 2018

Very helpful and clear explanation.

Sir, Thank you a ton 🙂

Reply

maroua

February 25, 2018

Hello
I got this error when trying to acces to hystrix dashboard "Unable to connect to Command Metric Stream.
and in the console of the browser I found this error " EventSource's response has a MIME type ("text/plain") that is not "text/event-stream". Aborting the connection."

when I try other examples every thing gos well but my project doesn't
I am using zuul for proxying routes

Reply

Kedar Erande

March 28, 2018

http://localhost:{portno}/hystrix.stream is the URL
You must have hit hystrix/stream

Reply

Ask Questions & Share Feedback

Your email address will not be published. Required fields are marked *

Comment

*Want to Post Code Snippets or XML content? Please use [java] ... [/java] tags otherwise code may not appear partially or even fully. e.g.

```
[java]
public static void main (String[] args) {
...
}
[/java]
```

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