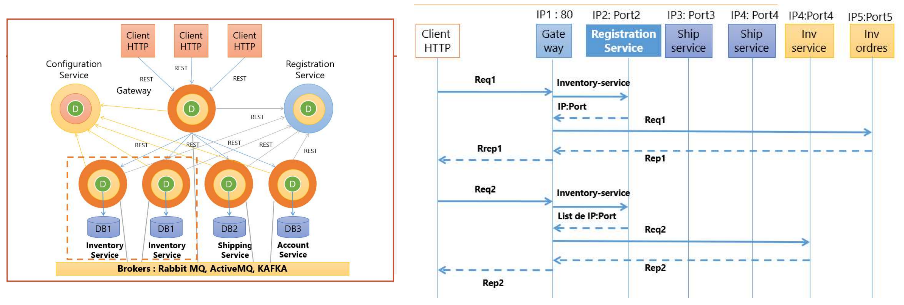
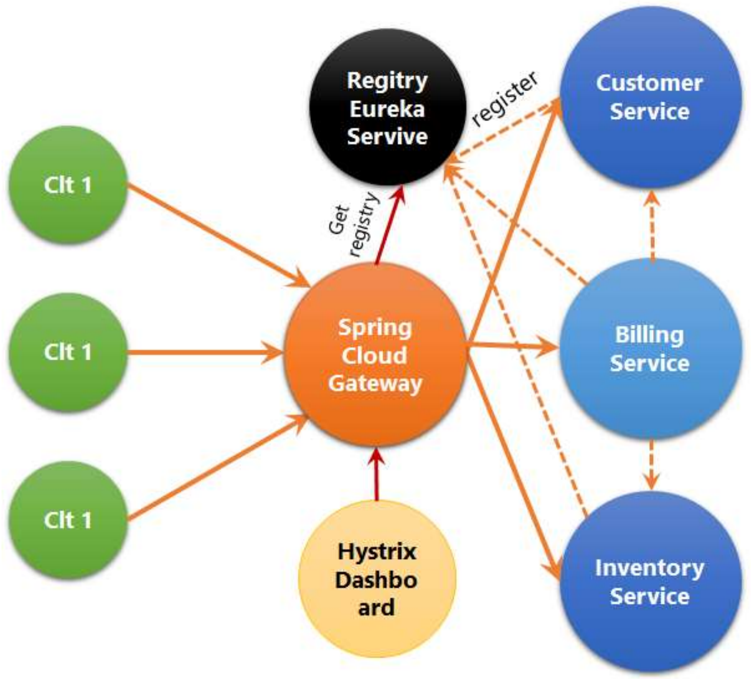
Micro Services avec Spring Cloud

- Spring Cloud Gateway
- Eureka Discovery
- Open Feign Rest Client
- Hystrix DashBoard





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ENSET, Université Hassan II Casablanca, Maroc
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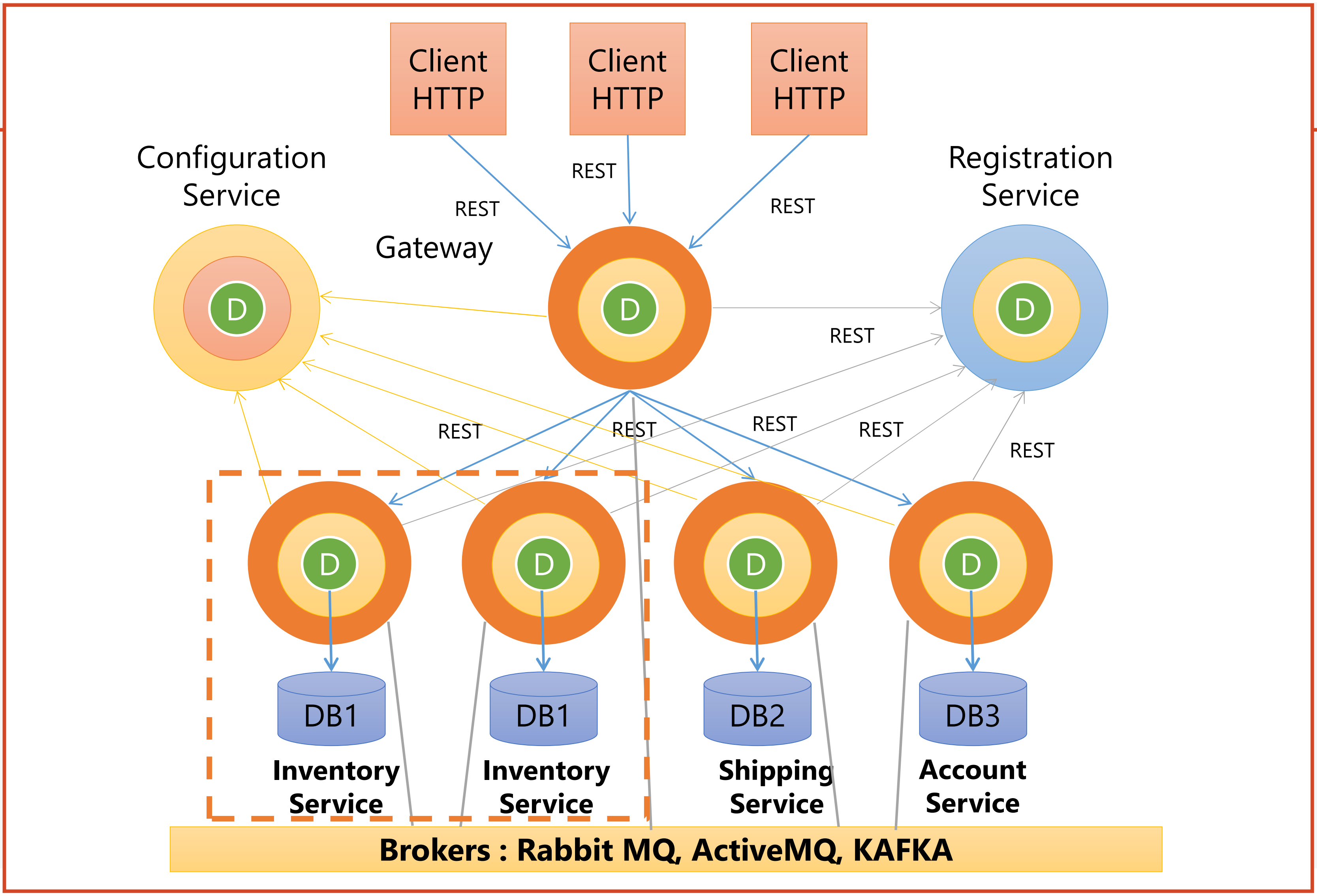
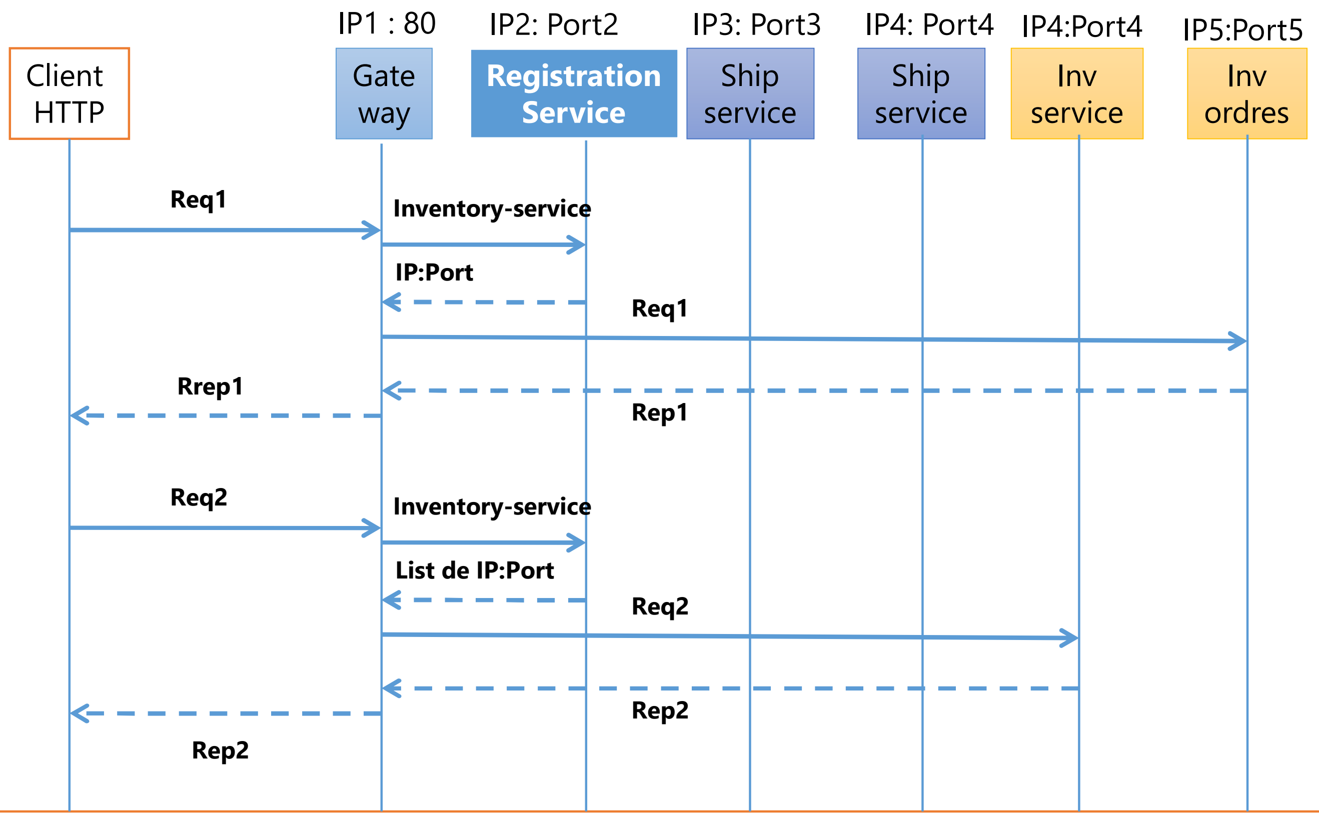
Supports de cours : http://fr.slideshare.net/mohamedyoussfi9
Chaîne vidéo : http://youtube.com/mohamedYoussfi
Recherche : http://www.researchgate.net/profile/Youssfi_Mohamed/publications


Client HTTP
Client HTTP
Client HTTP
REST
REST
REST
Configuration Service
Gateway
Registration Service
D
D
D
REST
REST
REST
REST
REST
REST
D
D
D
D
DB1
DB1
DB2
DB3
Inventory Service
Inventory Service
Shipping Service
Account Service
Brokers : Rabbit MQ, ActiveMQ, KAFKA

Consulter les services via le service proxy

Req 1 : GET http://gateway/inventory-service/products

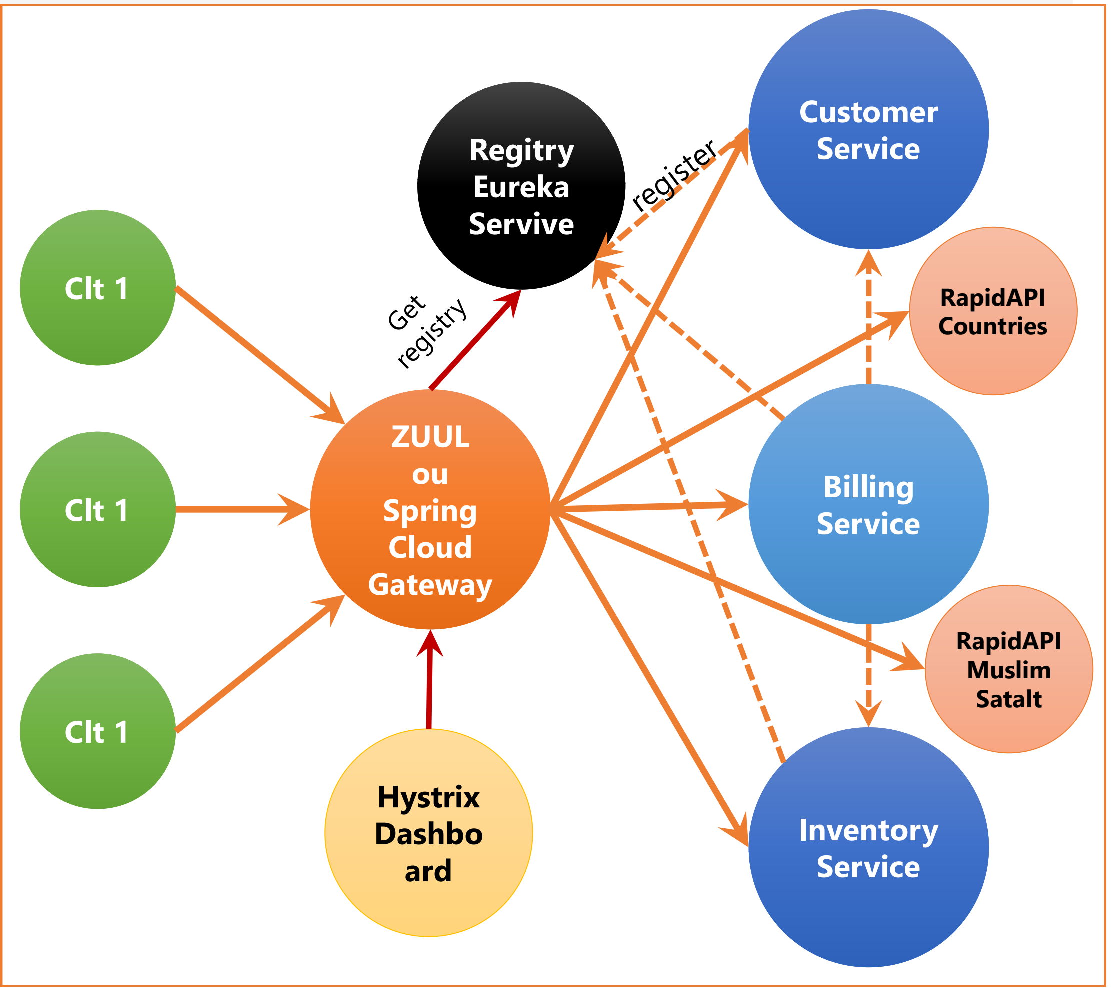
Req 2 : GET http://gateway/inventory-service/products



Spring Cloud Gateway

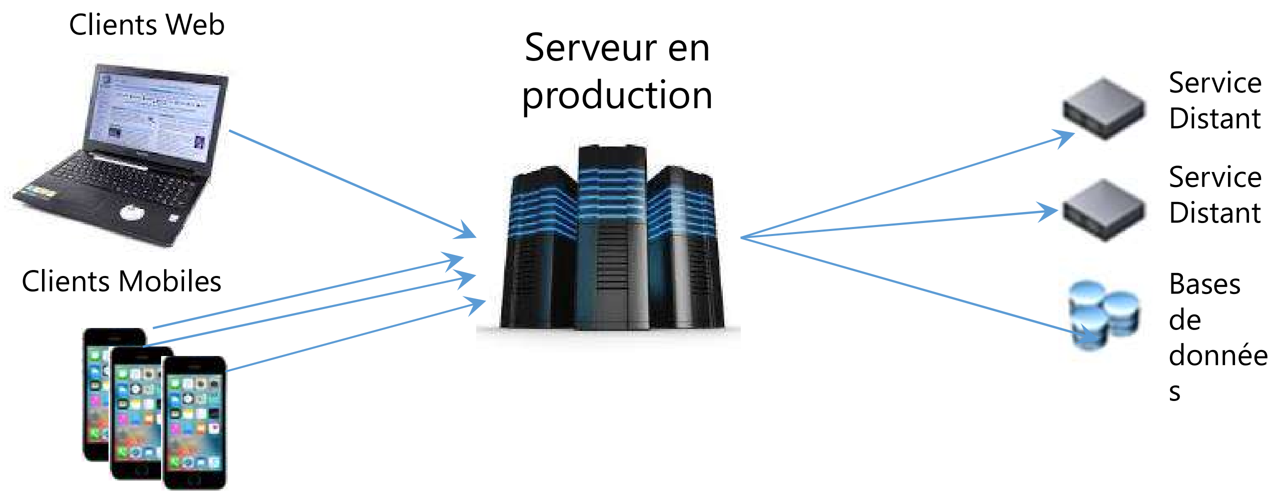
- Gateway API est un reverse proxy amélioré avec des fonctionnalités plus avancées, y compris l'**orchestration** et la **sécurité** et le **monitoring**.
- Quelques implémentations de API Gateway :

  Netflix Zuul Proxy, Amazon Gateway API, et Spring Cloud Gateway
- **Zuul** est un proxy utilisant une API qui utilise des entrées sorties bloquantes.
  - Une api de passerelle bloquante utilise autant de threads que le nombre de requêtes entrantes.
  - Si aucun thread n'est disponible pour traiter la requête entrante, celle-ci doit attendre dans la file d'attente.
- **Spring Cloud Gateway** est un proxy utilisant une API non bloquante.
  - Un thread est toujours disponible pour traiter requête entrante.
  - Ces requêtes sont ensuite traitées de manière asynchrone en arrière-plan et une fois complétées, la réponse est renvoyée.
  - Ainsi, aucune requête entrante n'est jamais bloquée lors de l'utilisation de Spring Cloud Gateway sauf si les ressources CPU et mémoires sont saturées.



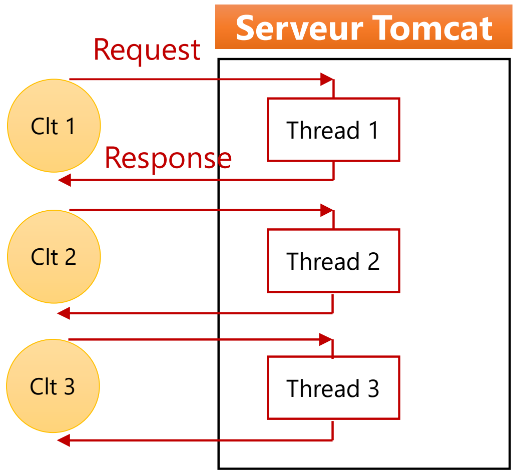
Blocking IO Model : Latency Problem

- Les applications qui tournent en production
- Une variété de clients et une variété de services distants qui peuvent être (Bases de données, d'autres services web)
- Problème et contraintes :
  - Des clients qui ont des connexions lentes (Long lived) et qui monopolisent des ressources sur notre serveur
  - Une API distante avec un problème de latence.
- Ce qui peut ralentir notre service.
- Voir le rendre complètement indisponible



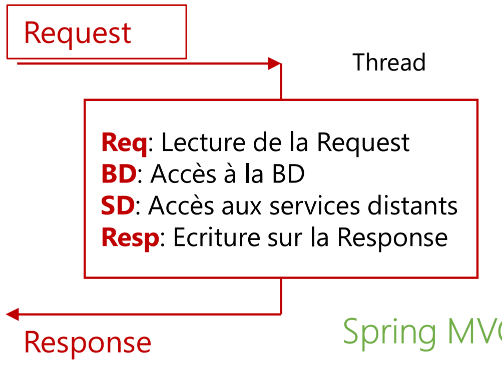
Modèles : Multi Threads avec IO Bloquantes Vs Single Thread avec IO Non Bloquantes

Multi Threads avec IO Bloquantes



Package java.io

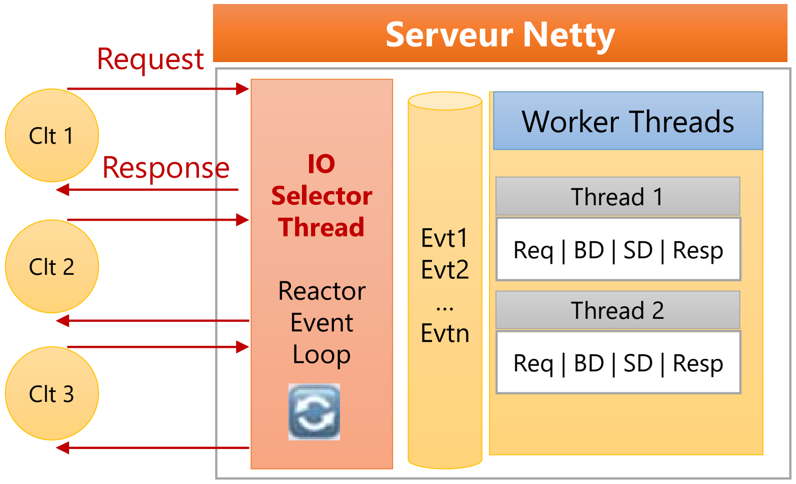
- InputStream
- OutputStream
- Reader
- Writer



Req: Lecture de la Request
BD: Accès à la BD
SD: Accès aux services distants
Resp: Ecriture sur la Response

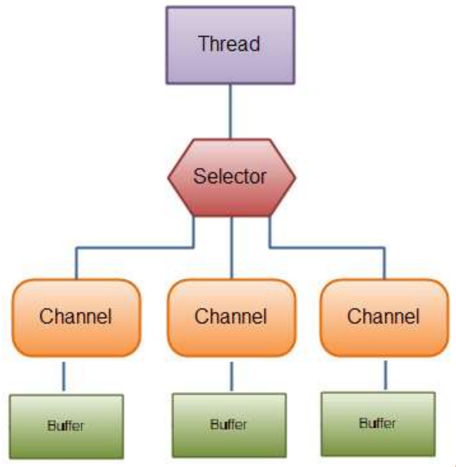
Spring MVC avec Tomcat

Single Thread avec IO Non Bloquantes



Package java.nio

- Channels:
  - SocketChannel,
  - DataGramChannel
- Buffers
- Selector



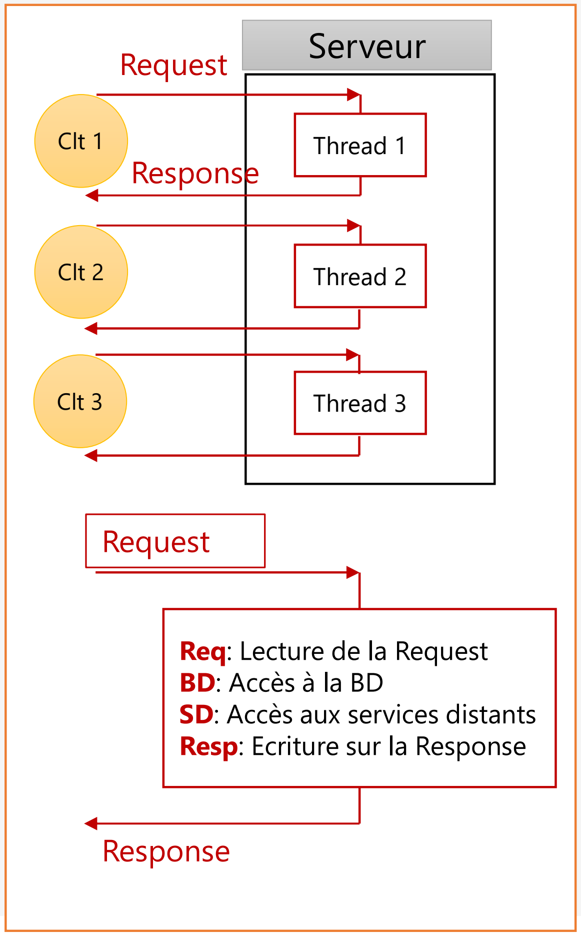
Réactive Spring ou Spring Web Flux avec Netty

Modèle Multi Threads Bloquant

Le modèle classique Bloquant basé sur une Pool de Threads.

- Marche très bien pour de nombreux cas
- A chaque requête, on affecte un Thread tiré du pool de centaines de threads.
- Le rôle de ce thread étant de gérer le traitement de la requête en question

- Pendant ce traitement on peut avoir :
  1. Lecture des données de la requête
  2. Accéder à une base de données
  3. Accéder à des services distants
  4. Ecriture sur la response
- Toutes ces Entrées Sorties sont bloquantes
- Le thread attend la lecture et l'écriture sur les IO
- Dans le cas d'une connexion lente, le thread est mobilisé pour longtemps coté serveur qui empêche d'exploiter les capacités des ressources du serveur.

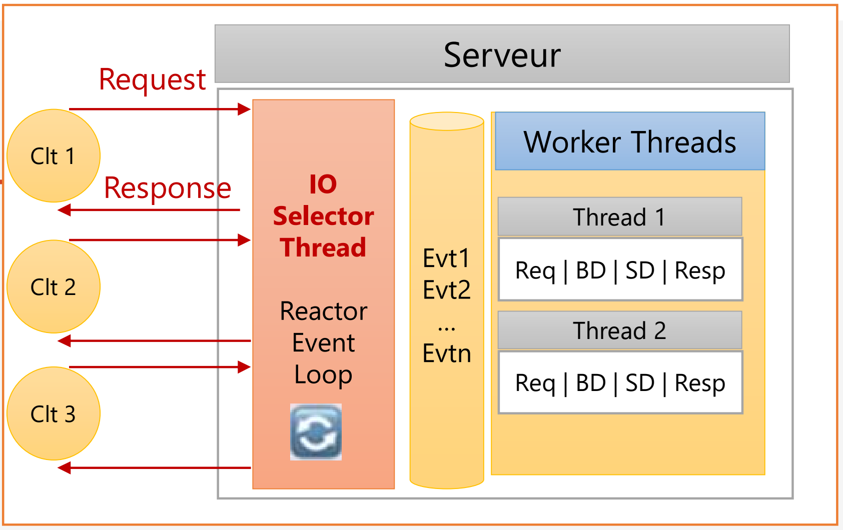


Req: Lecture de la Request
BD: Accès à la BD
SD: Accès aux services distants
Resp: Ecriture sur la Response

Modèle Single Thread Non Bloquant

On peut utiliser un autre modèle de Runtime qui permet de mieux gérer les ressources du serveur :

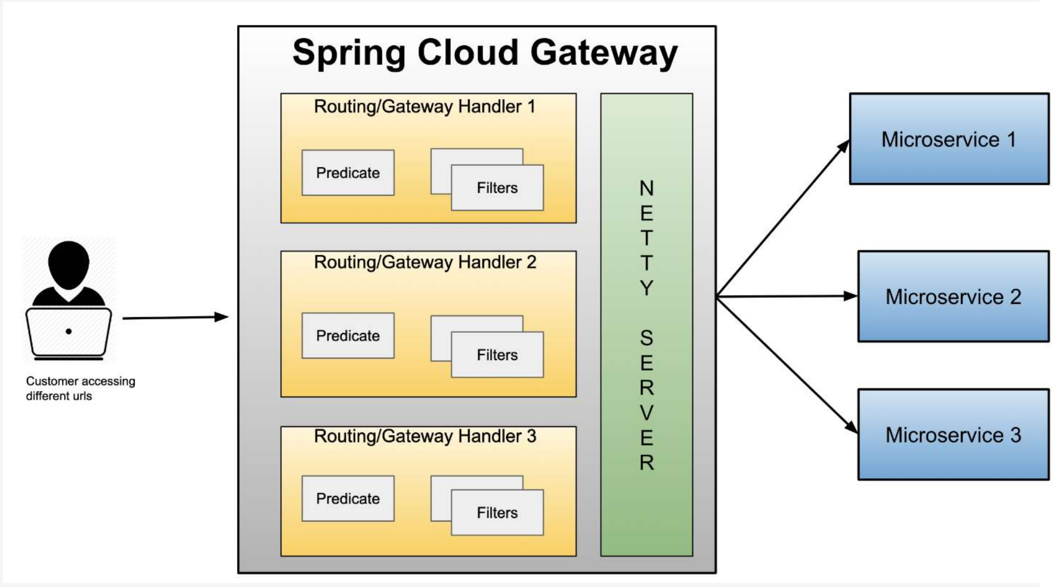
- Dans ce modèle on n'aura pas besoin d'un Thread par requête / response



- On a un modèle qui utilise un nombre beaucoup plus réduit de threads
  - Un IO Selector Thread dont le rôle est d'orchestrer les entrée sorties Non bloquantes.
  - Cette fois ci tous les IO doivent être faites d'une manière non bloquantes. Ce qui fait qu'on va jamais attendre
  - Cet IO thread va gérer les lectures et les écritures comme des évènements qu'il va empiler et dépiler dans une Queue d'une manière non bloquante.
  - Un nombre réduit de Worker Threads (en fonction du nombre de CPU du serveur)
  - Ces Workers Threads vont s'occuper de traiter les requêtes de manière non bloquantes. Il ne vont jamais attendre. Ils seront toujours entrain de travailler et exploiter aux maximum les ressources du serveur
  - Ce modèle assure la scalabilité verticale : les performances augmente avec la capacité du serveur (CPUs, Mémoire, Stockage, etc…)
  - La latence des IO ne va pas impacter les performances du serveur.

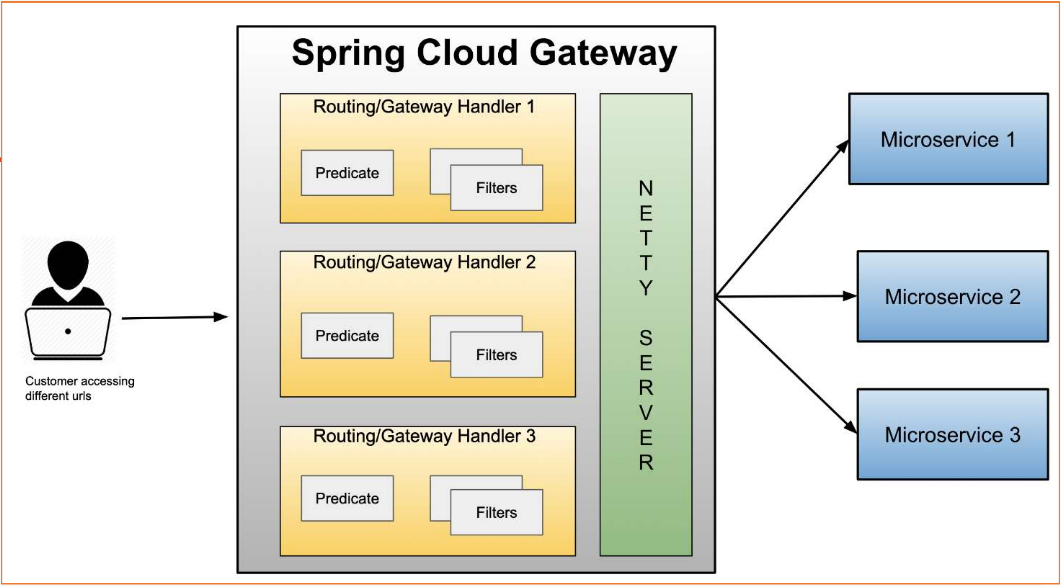
Spring Cloud Gateway

- Spring Cloud Gateway a été introduite dans Spring Cloud 2.x, au-dessus de l'écosystème Reactive Spring.
- Il fournit un moyen simple et efficace d'acheminer les requêtes entrantes vers la destination appropriée à l'aide du du Gateway Handler Mapping.
- Et Spring Cloud Gateway utilise le serveur Netty pour fournir un traitement asynchrone non bloquant des requêtes.



Spring Cloud Gateway

- Route: Destination vers laquelle nous voulons qu'une requête particulière soit acheminée. Une route comprend :
  - l'URI de destination,
  - Predicate : Une condition qui doit satisfaire
  - Filters : Un ou plusieurs filtres qui peuvent intervenir pour apporter des traitement et des modifications des requêtes et des réponses HTTP

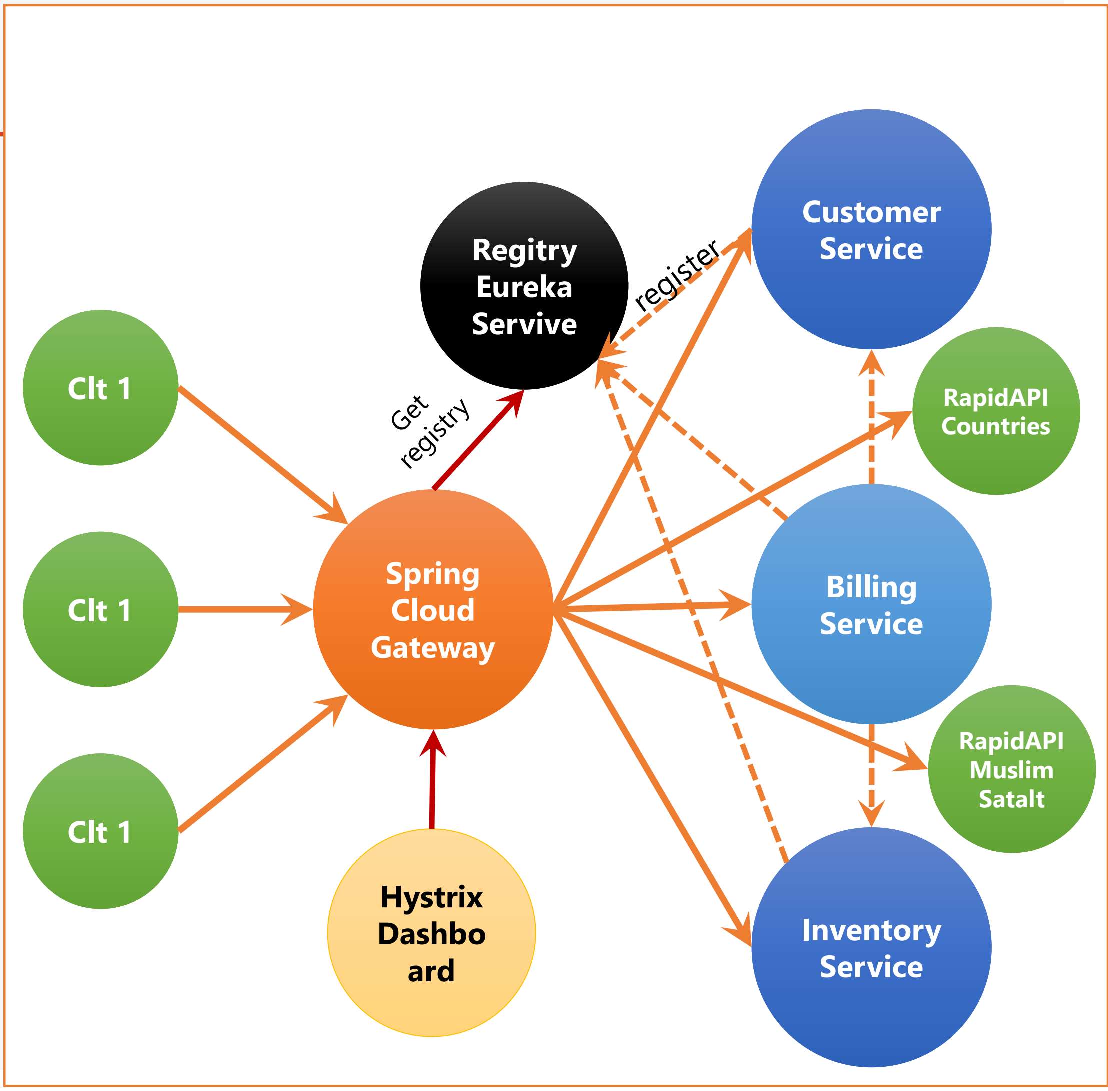


Predicates :
- Host, Path, Method
- After, Before, Between
- Cookie, Header, Query
- RmoteAddr
- Etc …

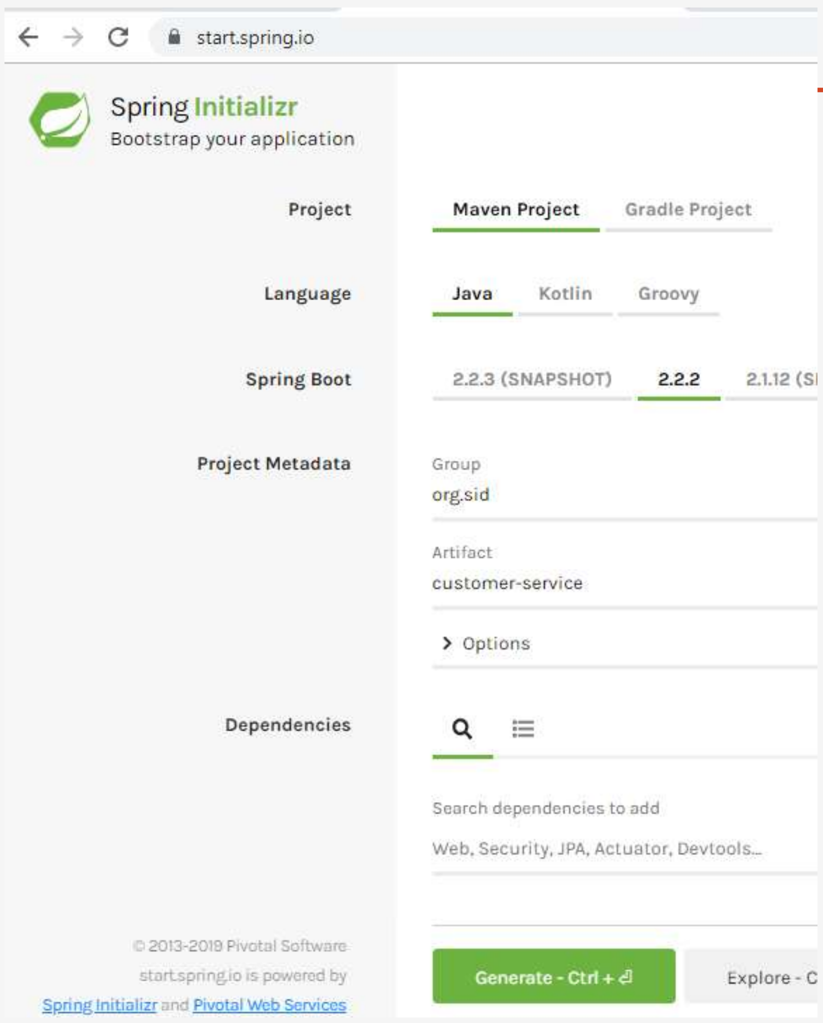
Filters :
- AddRequestHeader
- AddRequestParameter
- AddResponseHeader
- DedupeResponseHeader
- Hystrix
- CircuitBreaker
- RewritePath
- Etc …

Application

- Créer une application basée sur deux services métiers:
  - Service des clients
  - Service d'inventaire
  - Service Facturation
  - Services Externes : RapidAPI
- L'orchestration des services se fait via les services techniques de Spring Cloud :
  - Spring Cloud Gateway Service comme service proxy
  - Registry Eureka Service comme annuaire d'enregistrement et de découverte des services de l'architecture
  - Hystrix Circuit Breaker
  - Hystrix DashBoard



Customer-service



start.spring.io

Spring Initializr
Bootstrap your application

Project: Maven Project [✓] | Gradle Project

Language: Java [✓] | Kotlin | Groovy

Spring Boot: 2.2.3 (SNAPSHOT) | 2.2.2 [✓] | 2.1.12 (SI

Project Metadata

Group
org.sid

Artifact
customer-service

Options

Dependencies

Search dependencies to add

Web, Security, JPA, Actuator, Devtools...

Generate - Ctrl + ⏎ | Explore - C

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Spring Initializr and Pivotal Web Services

Selected dependencies

- **Spring Web** : Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.
- **Spring Data JPA** : Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.
- **H2 Database** : Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2mb) footprint. Supports embedded and server modes as well as a browser-based console application.
- **Rest Repositories** : Exposing Spring Data repositories over REST via Spring Data REST.
- **Lombok** : Java annotation library which helps to reduce boilerplate code.
- **Spring Boot DevTools** : Provides fast application restarts, LiveReload, and configurations for enhanced development experience.
- **Eureka Discovery Client** : a REST based service for locating services for the purpose of load balancing and failover of middle-tier servers.
- **Spring Boot Actuator :** Supports built in (or custom) endpoints that let you monitor and manage your application - such as application health, metrics, sessions, etc.

Customer-service : CustomerServiceApplication.java

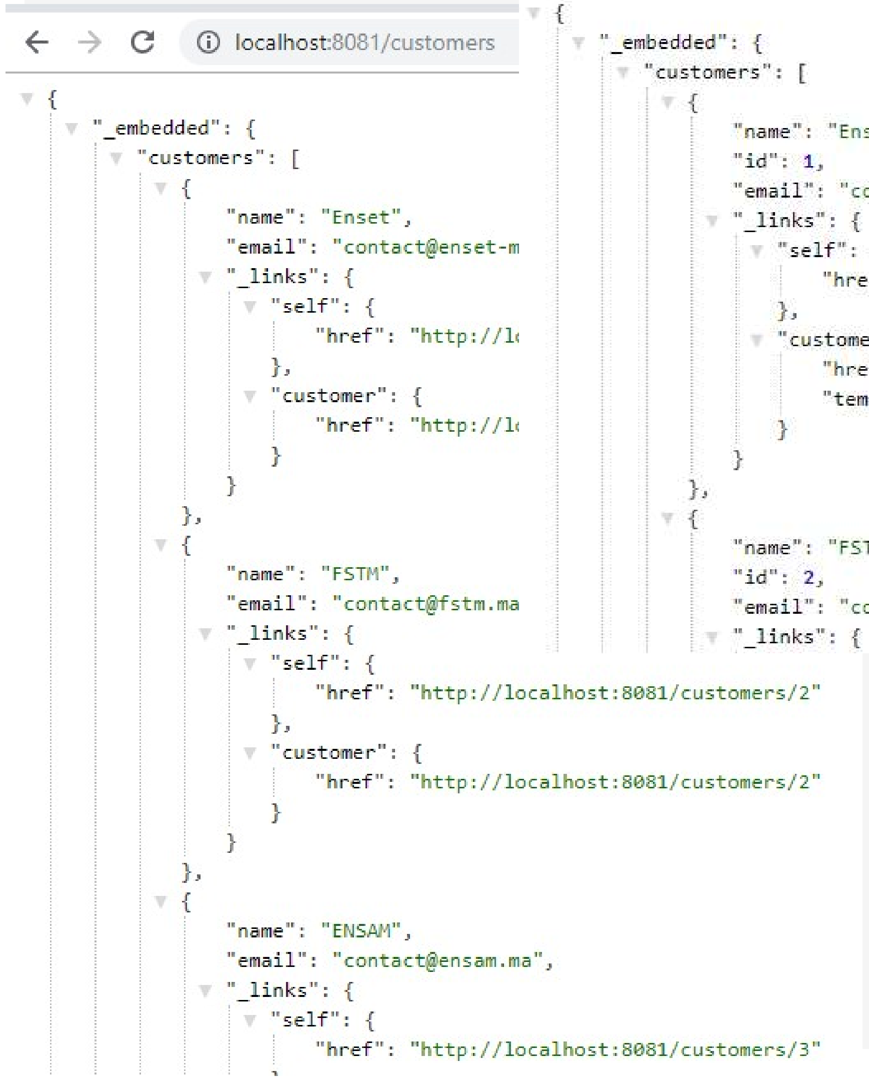
```java
package org.id.customerservice;
import lombok.AllArgsConstructor; import lombok.Data; import lombok.NoArgsConstructor;import lombok.ToString; import org.springframework.boot.CommandLineRunner;

import org.springframework.boot.SpringApplication;import org.springframework.boot.autoconfigure.SpringBootApplication;import org.springframework.context.annotation.Bean;
import org.springframework.data.jpa.repository.JpaRepository;import org.springframework.data.rest.core.annotation.RepositoryRestResource; import javax.persistence.Entity;
import javax.persistence.GeneratedValue;import javax.persistence.GenerationType; import javax.persistence.Id;

@Entity @Data @NoArgsConstructor @AllArgsConstructor @ToString

class Customer{
        @Id @GeneratedValue(strategy = GenerationType.IDENTITY)
        private Long id;   private String name; private String email;
}
@RepositoryRestResource
interface CustomerRepository extends JpaRepository<Customer,Long> { }


@SpringBootApplication
public class CustomerServiceApplication {

public static void main(String[] args) { pringApplication.run(CustomerServiceApplication.class, args);        }
        @Bean
        CommandLineRunner start(CustomerRepository customerRepository){
                return args -> {
                        customerRepository.save(new Customer(null,"Enset","contact@enset-media.ma"));
                        customerRepository.save(new Customer(null,"FSTM","contact@fstm.ma"));
                        customerRepository.save(new Customer(null,"ENSAM","contact@ensam.ma"));
                        customerRepository.findAll().forEach(System.out::println);
                };
        }
}
```

application.properties

```
spring.cloud.discovery.enabled=false
server.port=8081
spring.application.name=customer-service
#management.endpoints.web.exposure.include=*
```

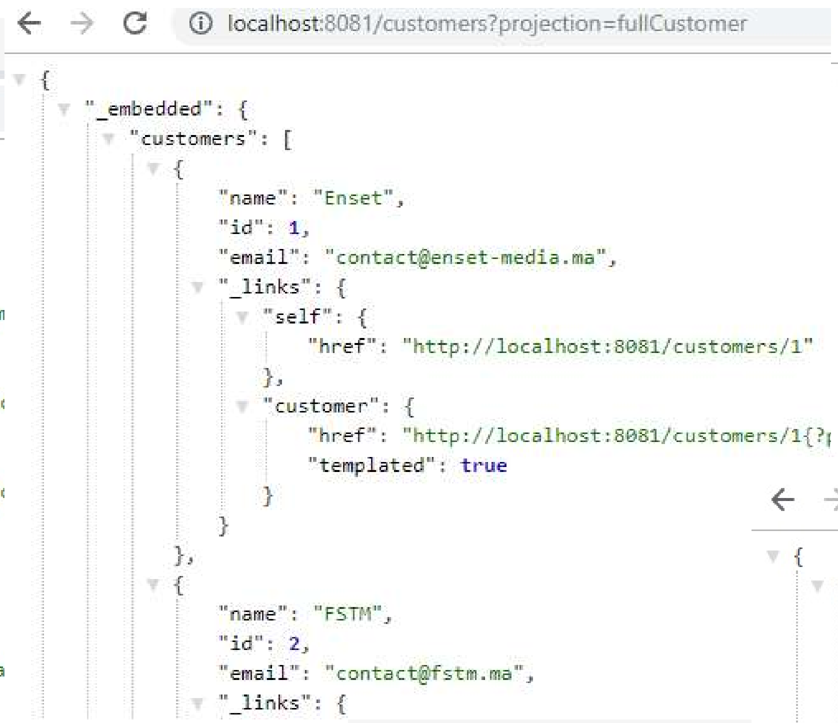
```java
@Projection(name = "fullCustomer",types =
Customer.class)
interface CustomerProjection extends Projection{
        public Long getId();
        public String getName();
        public String getEmail();
}
```

Customer-service



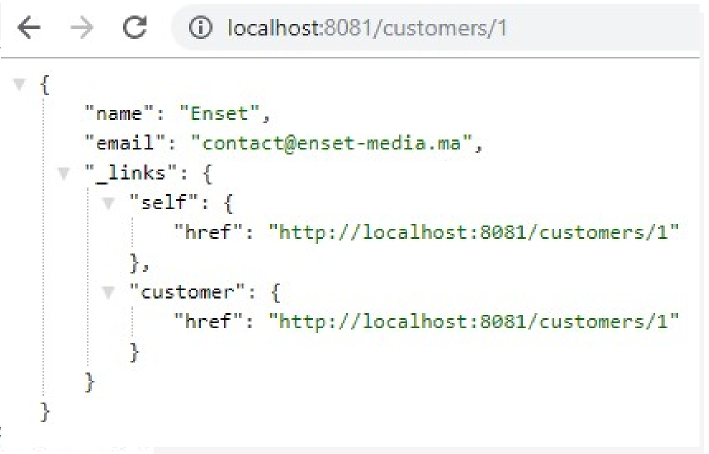
localhost:8081/customers

```
{
  "_embedded": {
    "customers": [
      {
        "name": "Enset",
        "email": "contact@enset-m
        "_links": {
          "self": {
            "href": "http://l
          },
          "customer": {
            "href": "http://l
          }
        }
      },
      {
        "name": "FSTM",
        "email": "contact@fstm.ma
        "_links": {
          "self": {
            "href": "http://localhost:8081/customers/2"
          },
          "customer": {
            "href": "http://localhost:8081/customers/2"
          }
        }
      },
      {
        "name": "ENSAM",
        "email": "contact@ensam.ma",
        "_links": {
          "self": {
            "href": "http://localhost:8081/customers/3"
```



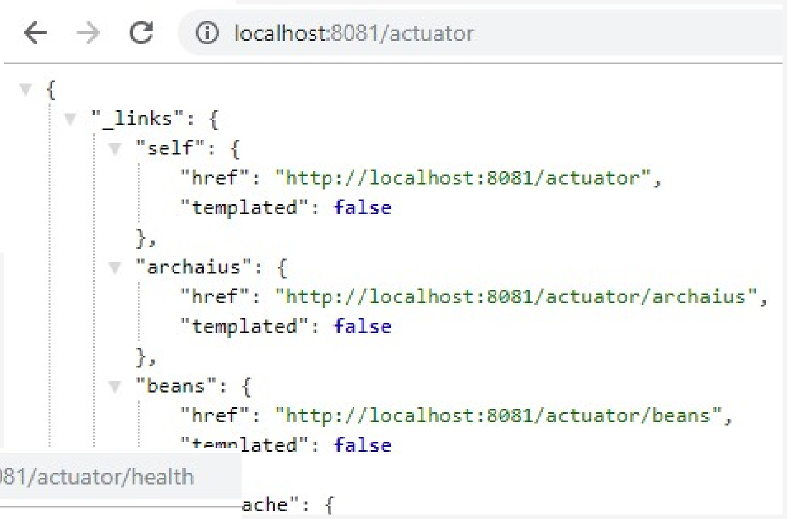
localhost:8081/customers?projection=fullCustomer

```
{
  "_embedded": {
    "customers": [
      {
        "name": "Enset",
        "id": 1,
        "email": "contact@enset-media.ma",
        "_links": {
          "self": {
            "href": "http://localhost:8081/customers/1"
          },
          "customer": {
            "href": "http://localhost:8081/customers/1{?
            "templated": true
          }
        }
      },
      {
        "name": "FSTM",
        "id": 2,
        "email": "contact@fstm.ma",
        "_links": {
```



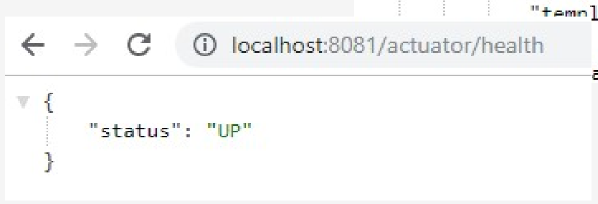
localhost:8081/customers/1

```
{
  "name": "Enset",
  "email": "contact@enset-media.ma",
  "_links": {
    "self": {
      "href": "http://localhost:8081/customers/1"
    },
    "customer": {
      "href": "http://localhost:8081/customers/1"
    }
  }
}
```



localhost:8081/actuator

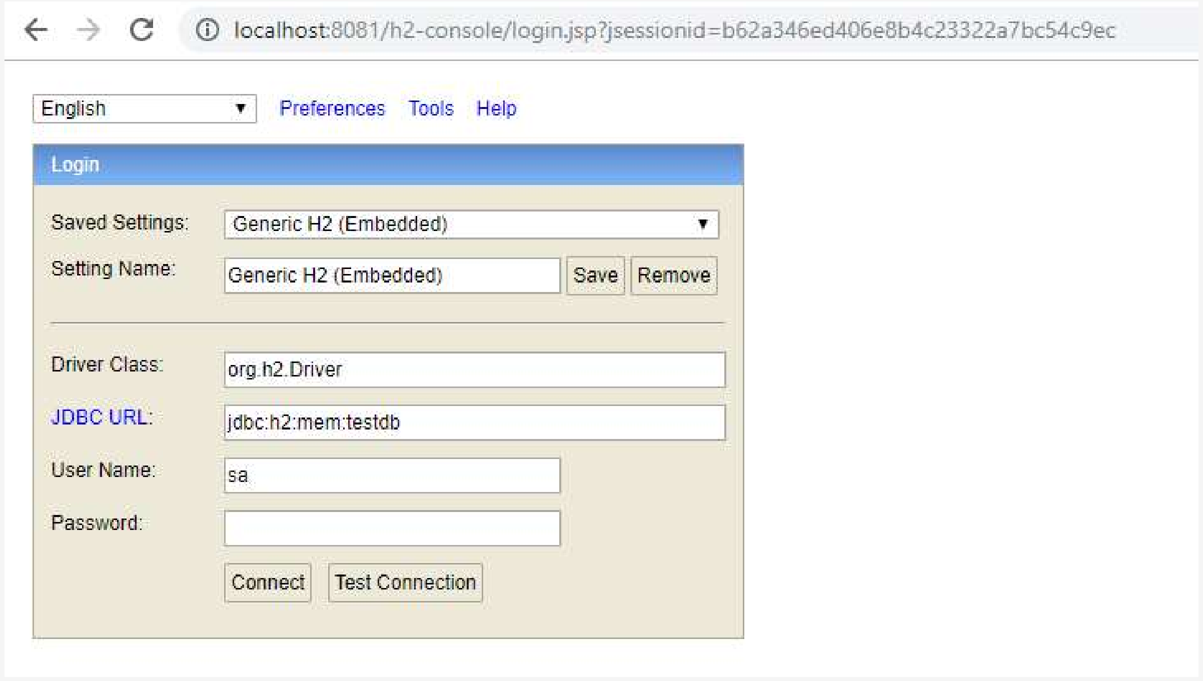
```
{
  "_links": {
    "self": {
      "href": "http://localhost:8081/actuator",
      "templated": false
    },
    "archaius": {
      "href": "http://localhost:8081/actuator/archaius",
      "templated": false
    },
    "beans": {
      "href": "http://localhost:8081/actuator/beans",
      "templated": false

ache": {
```



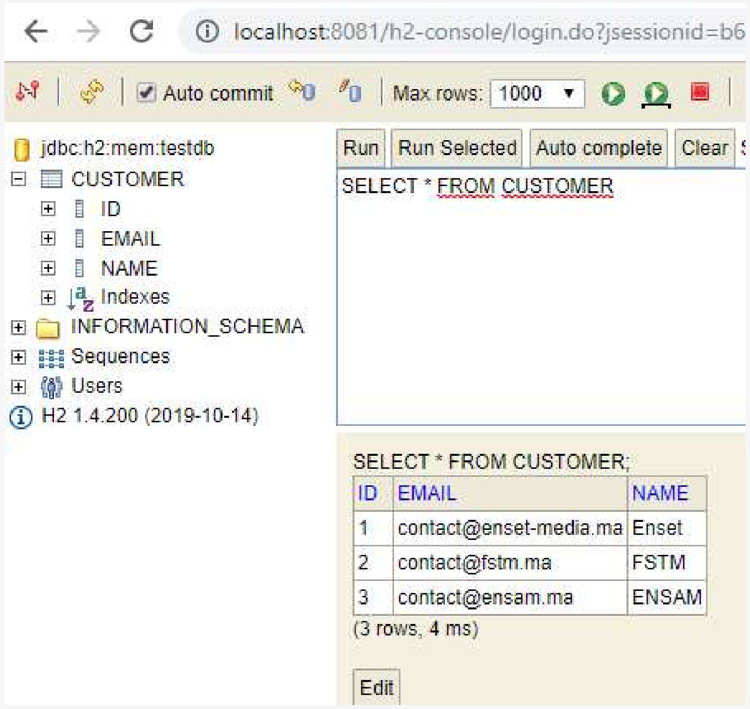
localhost:8081/actuator/health

```
{
  "status": "UP"
}
```

Customer-service : Base de données H2 (http://localhost:8081/h2-console)


localhost:8081/h2-console/login.jsp?jsessionid=b62a346ed406e8b4c23322a7bc54c9ec

Saved Settings:	Generic H2 (Embedded)
Setting Name:	Generic H2 (Embedded)
Driver Class:	org.h2.Driver
JDBC URL:	jdbc:h2:mem:testdb
User Name:	sa
Password:	


localhost:8081/h2-console/login.do?jsessionid=b6

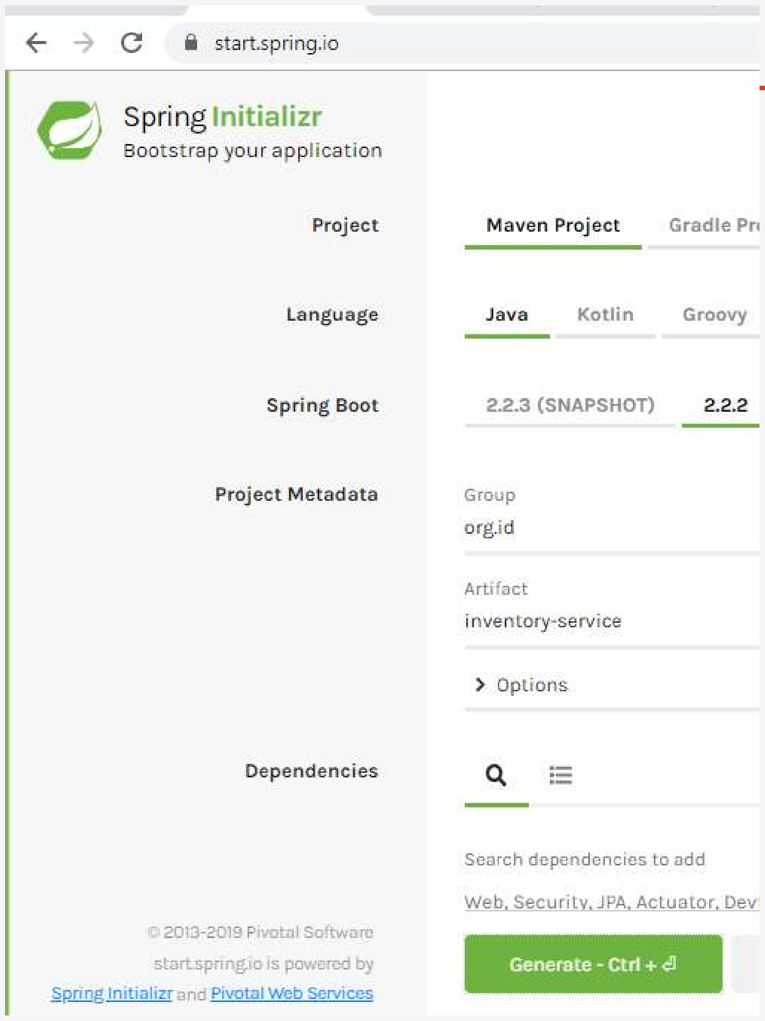
```
SELECT * FROM CUSTOMER
```

SELECT * FROM CUSTOMER;

ID	EMAIL	NAME
1	contact@enset-media.ma	Enset
2	contact@fstm.ma	FSTM
3	contact@ensam.ma	ENSAM

(3 rows, 4 ms)

Inventory-service



start.spring.io

Spring Initializr
Bootstrap your application

Project: Maven Project | Gradle Pr

Language: Java | Kotlin | Groovy

Spring Boot: 2.2.3 (SNAPSHOT) | 2.2.2

Project Metadata
Group: org.id
Artifact: inventory-service

Selected dependencies

- **Spring Web** : Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.
- **Spring Data JPA** : Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.
- **H2 Database** : Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2mb) footprint. Supports embedded and server modes as well as a browser based console application.
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- **Spring Boot Actuator :** Supports built in (or custom) endpoints that let you monitor and manage your application - such as application health, metrics, sessions, etc.

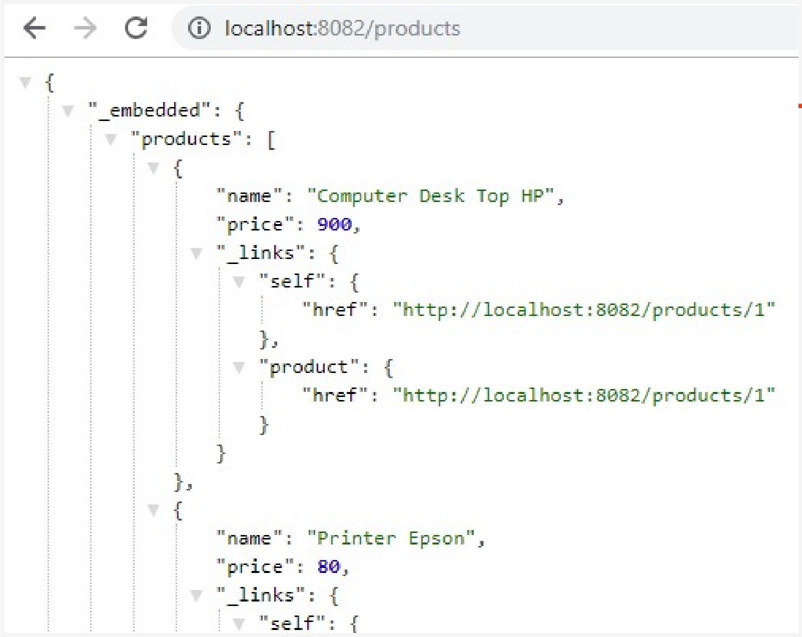
Inventory-service : InventoryServiceApplication.java

```java
package org.id.inventoryservice;

import ...

@Entity @Data @NoArgsConstructor @AllArgsConstructor @ToString
class Product{
         @Id @GeneratedValue(strategy = GenerationType.IDENTITY)
         private Long id; private String name;private double price;
}
@RepositoryRestResource
interface ProductRepository extends JpaRepository<Product,Long> { }

@SpringBootApplication
public class InventoryServiceApplication {
         public static void main(String[] args) { pringApplication.run(InventoryServiceApplication.class, args);}

         @Bean
         CommandLineRunner start(ProductRepository productRepository){
                  return args -> {
                           productRepository.save(new Product(null,"Computer Desk Top HP",900));
                           productRepository.save(new Product(null,"Printer Epson",80));
                           productRepository.save(new Product(null,"MacBook Pro Lap Top",1800));
                           productRepository.findAll().forEach(System.out::println);
                  };
         }
}
```

application.properties

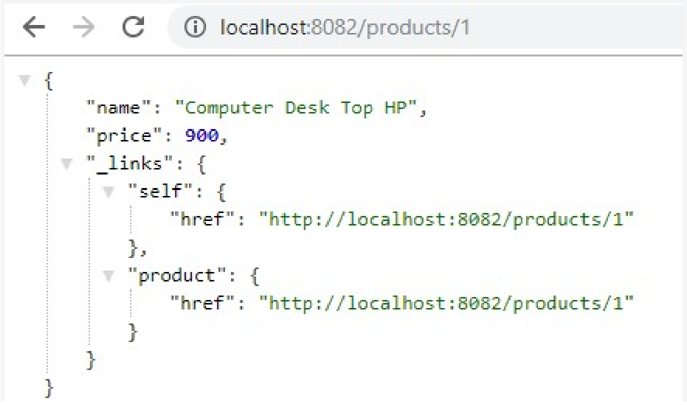
```
spring.application.name=inventory-service
spring.cloud.discovery.enabled=false
server.port=8082
```

Inventory-service



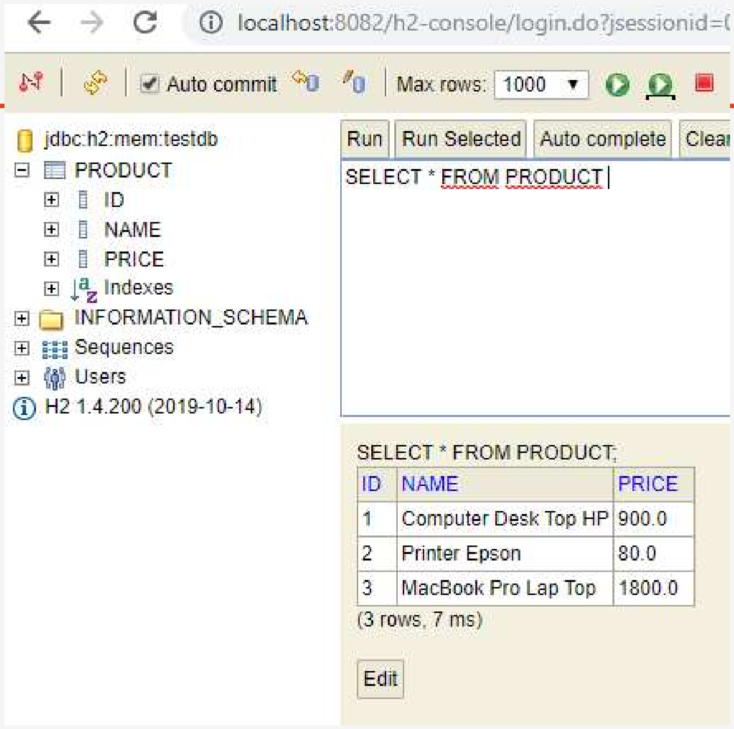
localhost:8082/products

```
{
  "_embedded": {
    "products": [
      {
        "name": "Computer Desk Top HP",
        "price": 900,
        "_links": {
          "self": {
            "href": "http://localhost:8082/products/1"
          },
          "product": {
            "href": "http://localhost:8082/products/1"
          }
        }
      },
      {
        "name": "Printer Epson",
        "price": 80,
        "_links": {
          "self": {
```



localhost:8082/products/1

```
{
  "name": "Computer Desk Top HP",
  "price": 900,
  "_links": {
    "self": {
      "href": "http://localhost:8082/products/1"
    },
    "product": {
      "href": "http://localhost:8082/products/1"
    }
  }
}
```



localhost:8082/h2-console/login.do?jsessionid=(

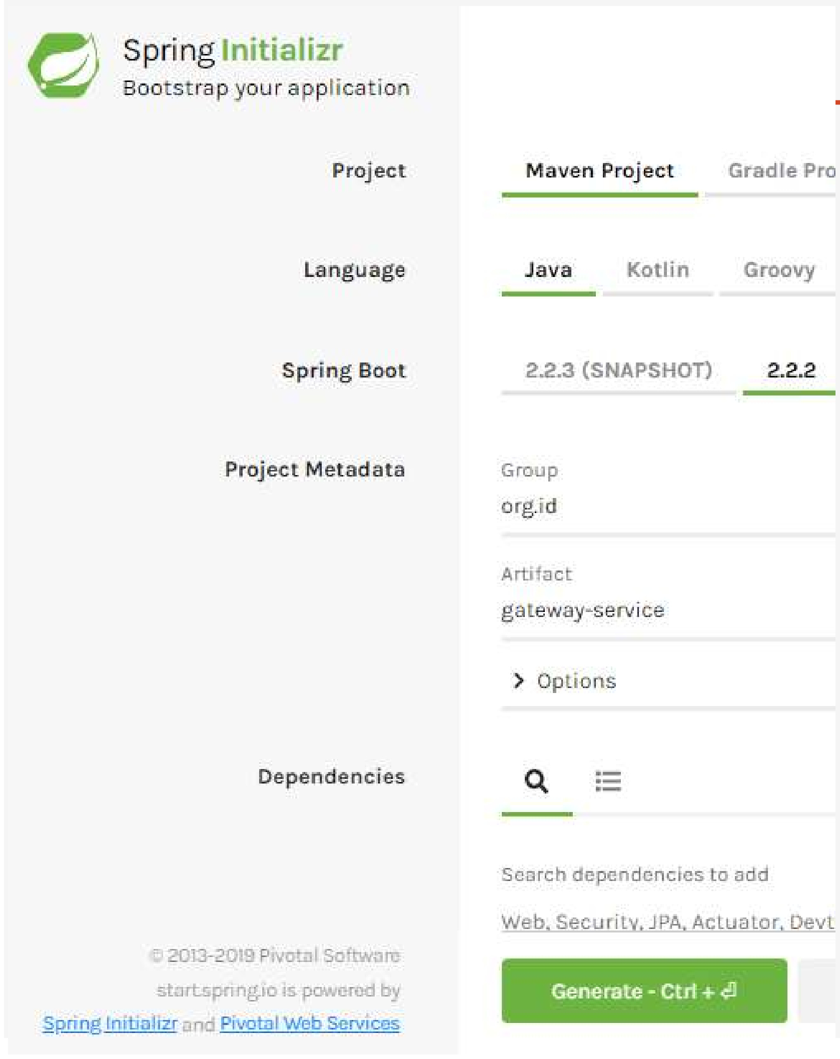
```
SELECT * FROM PRODUCT
```

SELECT * FROM PRODUCT;

ID	NAME	PRICE
1	Computer Desk Top HP	900.0
2	Printer Epson	80.0
3	MacBook Pro Lap Top	1800.0

(3 rows, 7 ms)

Gateway-service


Spring Initializr
Bootstrap your application

Project: Maven Project | Gradle Pro
Language: Java | Kotlin | Groovy
Spring Boot: 2.2.3 (SNAPSHOT) | 2.2.2
Project Metadata
Group: org.id
Artifact: gateway-service
Options
Dependencies
Search dependencies to add
Web, Security, JPA, Actuator, Devt
Generate - Ctrl + ⏎

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Spring Initializr and Pivotal Web Services

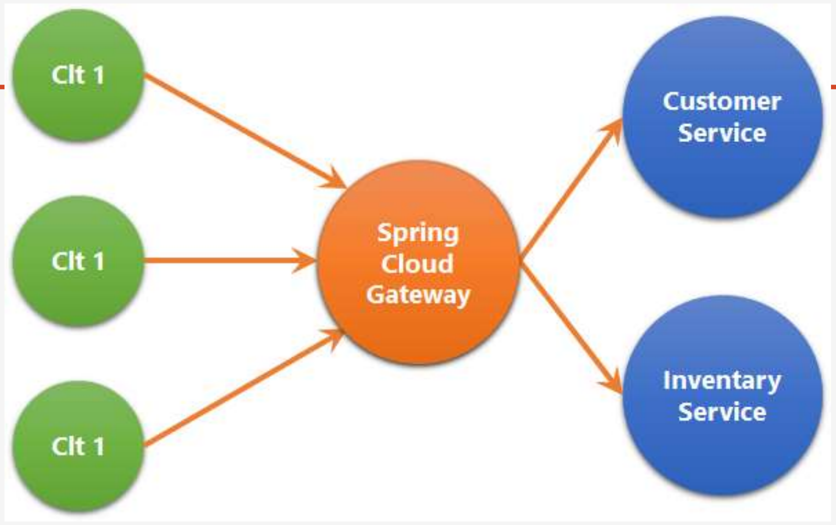
Selected dependencies

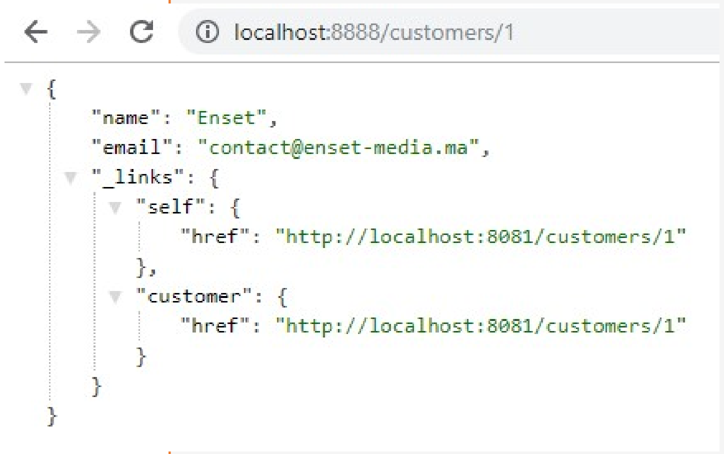
- **Gateway** : Provides a simple, yet effective way to route to APIs and provide cross cutting concerns to them such as security, monitoring/metrics, and resiliency.
- **Spring Boot Actuator** : Supports built in (or custom) endpoints that let you monitor and manage your application - such as application health, metrics, sessions, etc.
- **Hystrix** : Circuit breaker with Spring Cloud Netflix Hystrix.
- **Eureka Discovery Client** : a REST based service for locating services for the purpose of load balancing and failover of middle-tier servers.

Static routes configuration: application.yml

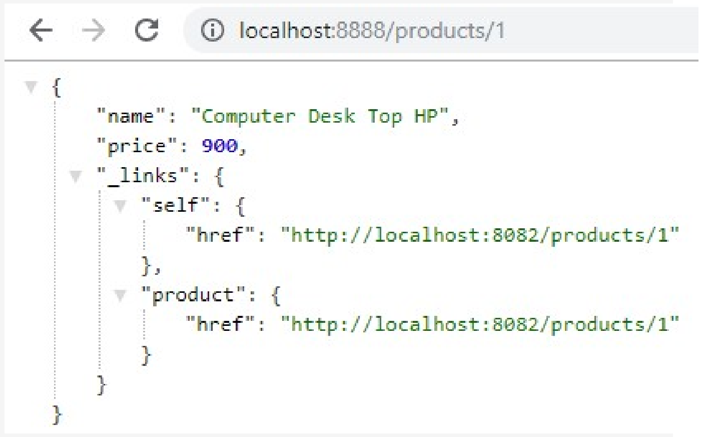
application.yml

```yaml
spring:
  cloud:
    gateway:
      routes:
        - id : r1
          uri : http://localhost:8081/
          predicates :
            - Path= /customers/**
        - id : r2
          uri : http://localhost:8082/
          predicates :
            - Path= /products/**
    discovery:
      enabled: false
server:
  port: 8888
```




localhost:8888/customers/1

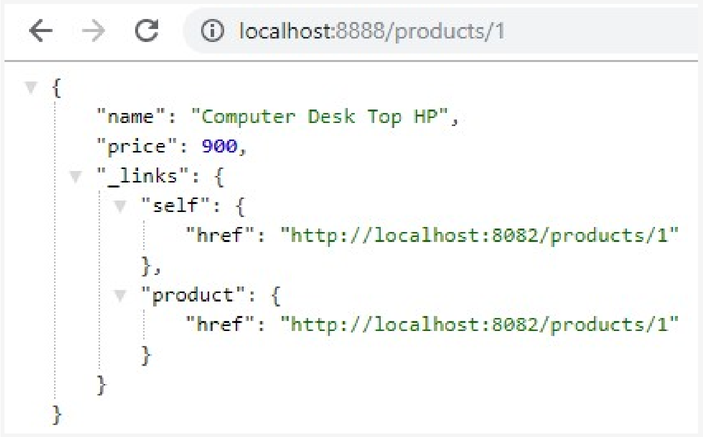
```
{
    "name": "Enset",
    "email": "contact@enset-media.ma",
    "_links": {
        "self": {
            "href": "http://localhost:8081/customers/1"
        },
        "customer": {
            "href": "http://localhost:8081/customers/1"
        }
    }
}
```


localhost:8888/products/1

```
{
    "name": "Computer Desk Top HP",
    "price": 900,
    "_links": {
        "self": {
            "href": "http://localhost:8082/products/1"
        },
        "product": {
            "href": "http://localhost:8082/products/1"
        }
    }
}
```

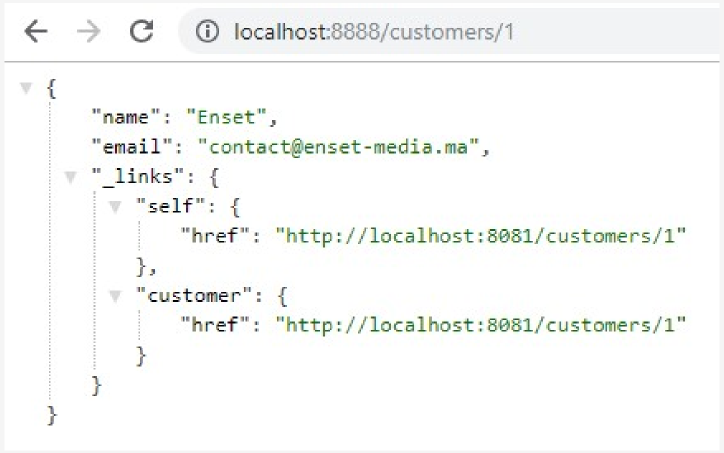
Static routes configuration: Java Config Class

```java
@Bean
RouteLocator gatewayRoutes(RouteLocatorBuilder builder){
        return builder.routes()
                        .route(r->r.path("/customers/**").uri("http://localhost:8081/").id("r1"))
                        .route(r->r.path("/products/**").uri("http://localhost:8082/").id("r2"))
                        .build();
}
```



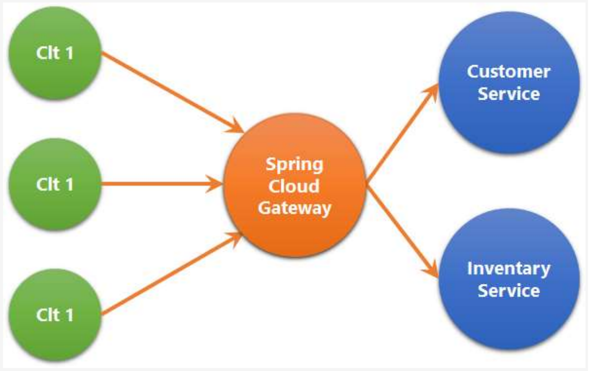
localhost:8888/products/1

```
{
    "name": "Computer Desk Top HP",
    "price": 900,
    "_links": {
        "self": {
            "href": "http://localhost:8082/products/1"
        },
        "product": {
            "href": "http://localhost:8082/products/1"
        }
    }
}
```

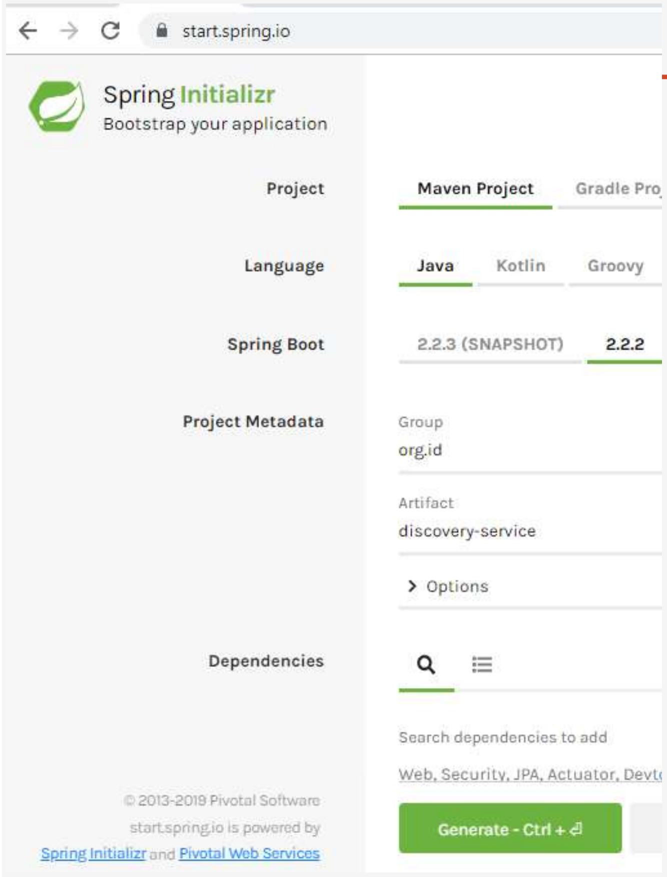


localhost:8888/customers/1

```
{
    "name": "Enset",
    "email": "contact@enset-media.ma",
    "_links": {
        "self": {
            "href": "http://localhost:8081/customers/1"
        },
        "customer": {
            "href": "http://localhost:8081/customers/1"
        }
    }
}
```



Eureka Discovery Service : Dynamic Routing



start.spring.io

Spring Initializr
Bootstrap your application

Project: Maven Project | Gradle Pro

Language: Java | Kotlin | Groovy

Spring Boot: 2.2.3 (SNAPSHOT) | 2.2.2

Project Metadata
Group: org.id
Artifact: discovery-service

Options

Dependencies

Search dependencies to add
Web, Security, JPA, Actuator, Devt

Generate - Ctrl + ⏎

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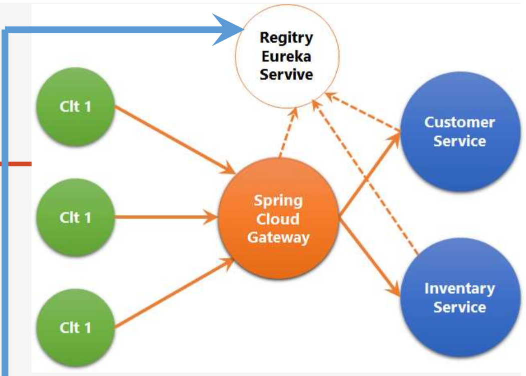
start.spring.io is powered by
Spring Initializr and Pivotal Web Services

Selected dependencies

- **Eureka Server** : spring-cloud-netflix Eureka Server.

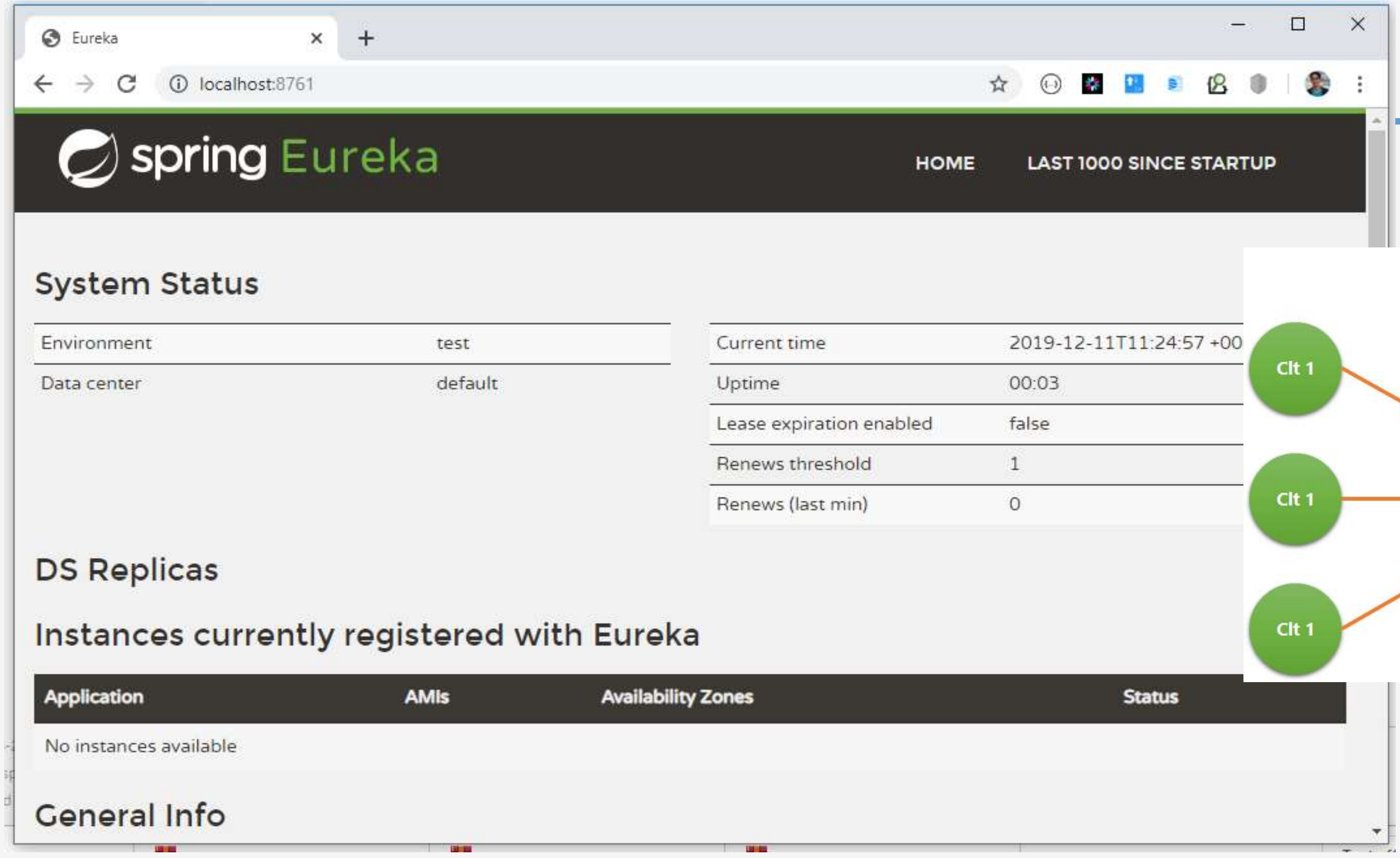


```java
package org.id.discoveryservice; import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.cloud.netflix.eureka.server.EnableEurekaServer;
@SpringBootApplication
@EnableEurekaServer
public class DiscoveryServiceApplication {
 public static void main(String[] args) {
  SpringApplication.run(DiscoveryServiceApplication.class, args);
 }
}
```

application.properties

```properties
server.port=8761
# dont register server itself as a client.
eureka.client.fetch-registry=false
# Does not register itself in the service registry.
eureka.client.register-with-eureka=false
```

Eureka Discovery Service : Dynamic Routing



System Status

Environment	test
Data center	default

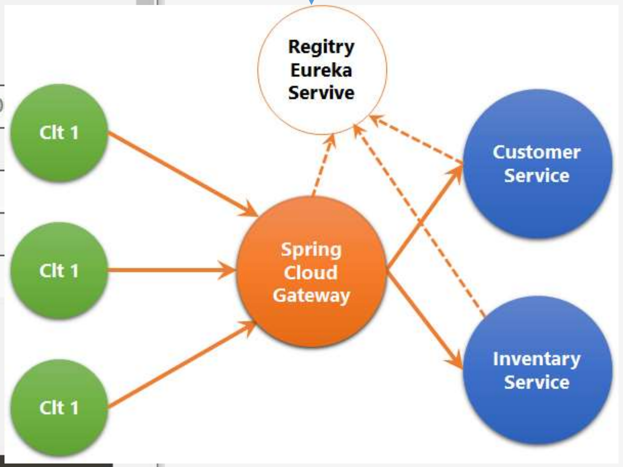
Current time	2019-12-11T11:24:57 +00
Uptime	00:03
Lease expiration enabled	false
Renews threshold	1
Renews (last min)	0

DS Replicas

Instances currently registered with Eureka

Application	AMIs	Availability Zones	Status
No instances available			

General Info



Permettre à Customer-service et Invotory-service de s'enregistrer chez Eureka server

Customer-service

application.properties

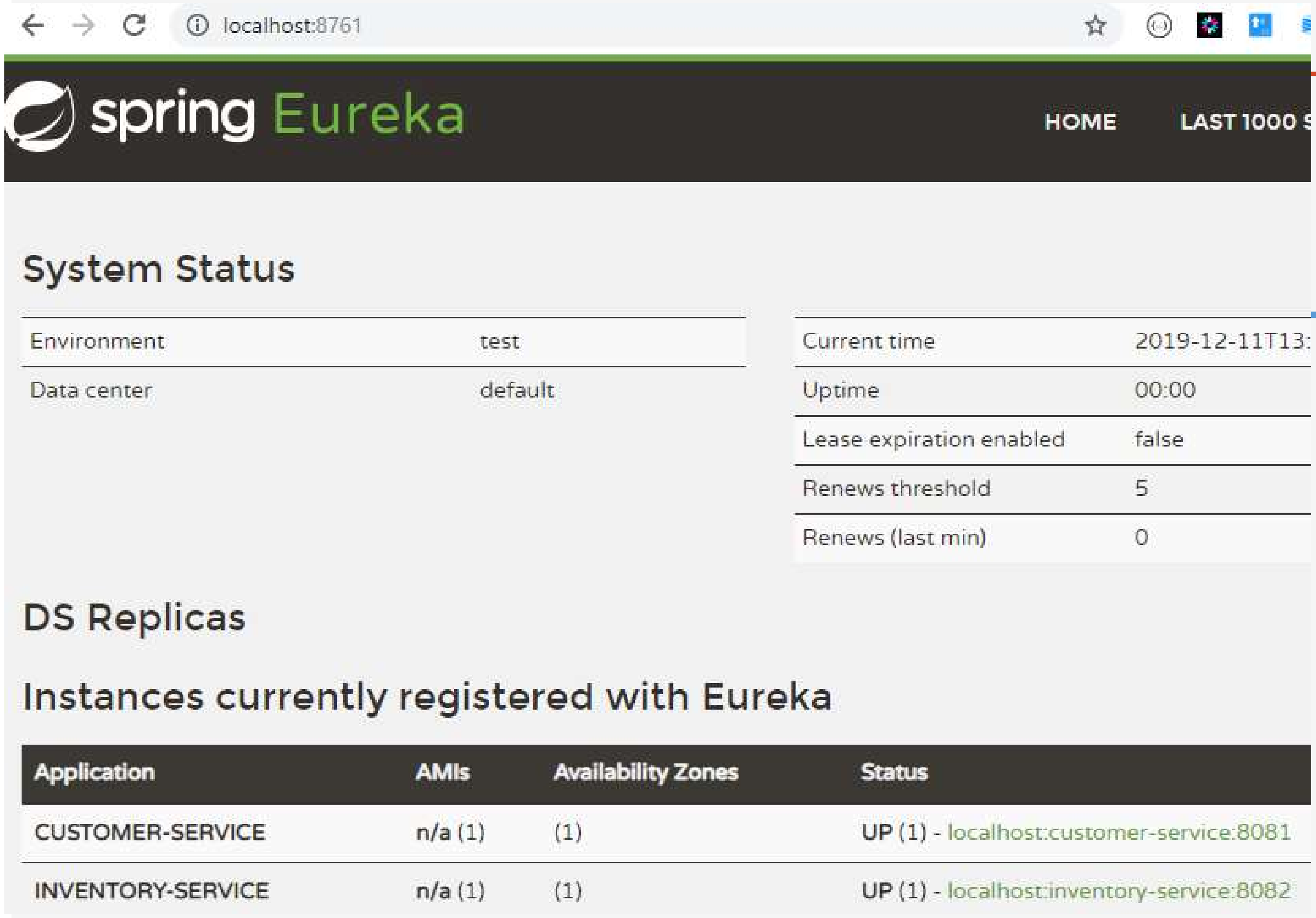
```
spring.cloud.discovery.enabled=true
server.port=8081
spring.application.name=customer-service
management.endpoints.web.exposure.include=*
eureka.client.service-url.defaultZone=http://localhost:8761/eureka
```

Inventory-service

application.properties

```
spring.cloud.discovery.enabled=true
server.port=8082
spring.application.name=inventory-service
eureka.client.service-url.defaultZone=http://localhost:8761/eureka
```

Eureka Discovery Service : Dynamic Routing



System Status

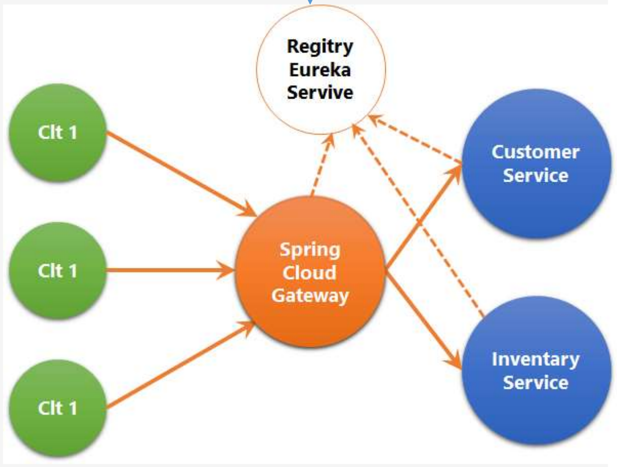
Environment	test
Data center	default

Current time	2019-12-11T13:
Uptime	00:00
Lease expiration enabled	false
Renews threshold	5
Renews (last min)	0

DS Replicas

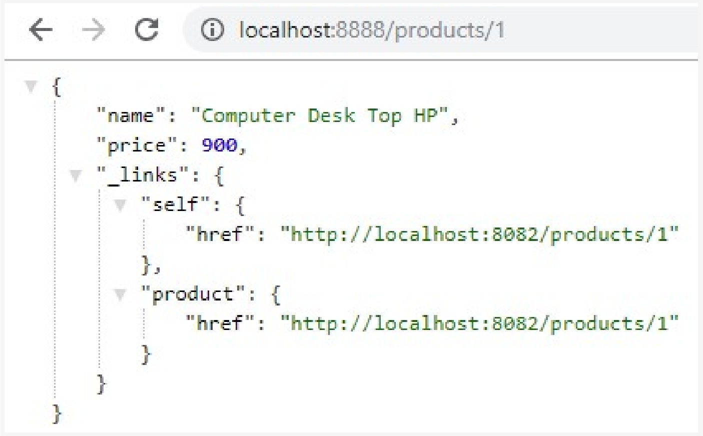
Instances currently registered with Eureka

Application	AMIs	Availability Zones	Status
CUSTOMER-SERVICE	n/a (1)	(1)	UP (1) - localhost:customer-service:8081
INVENTORY-SERVICE	n/a (1)	(1)	UP (1) - localhost:inventory-service:8082



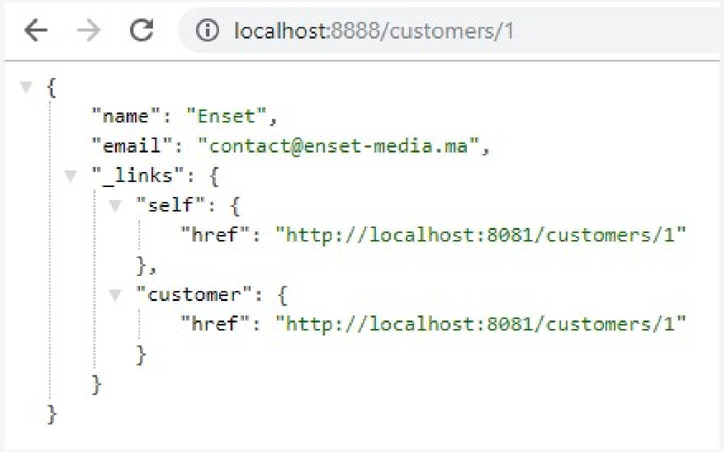
Static routes configuration with Discovery Service

```
@Bean
RouteLocator gatewayRoutes(RouteLocatorBuilder builder){
         return builder.routes()
                          .route(r->r.path("/customers/**") uri("lb://CUSTOMER-SERVICE")  .id("r1"))
                           .route(r->r.path("/products/**") uri("lb://INVENTORY-SERVICE") .id("r2"))
                          .build();
}
```



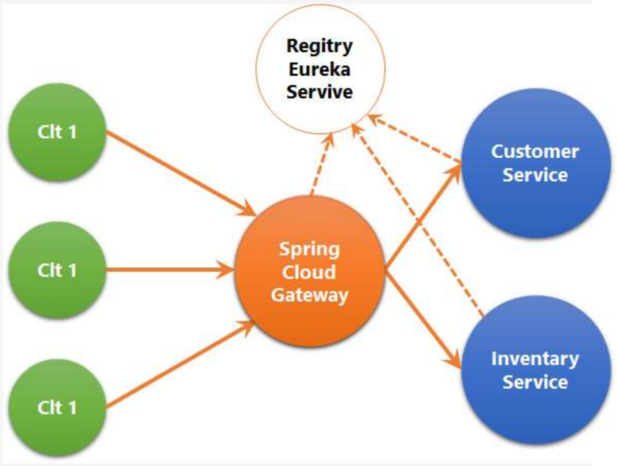
localhost:8888/products/1

```
{
    "name": "Computer Desk Top HP",
    "price": 900,
    "_links": {
        "self": {
            "href": "http://localhost:8082/products/1"
        },
        "product": {
            "href": "http://localhost:8082/products/1"
        }
    }
}
```



localhost:8888/customers/1

```
{
    "name": "Enset",
    "email": "contact@enset-media.ma",
    "_links": {
        "self": {
            "href": "http://localhost:8081/customers/1"
        },
        "customer": {
            "href": "http://localhost:8081/customers/1"
        }
    }
}
```

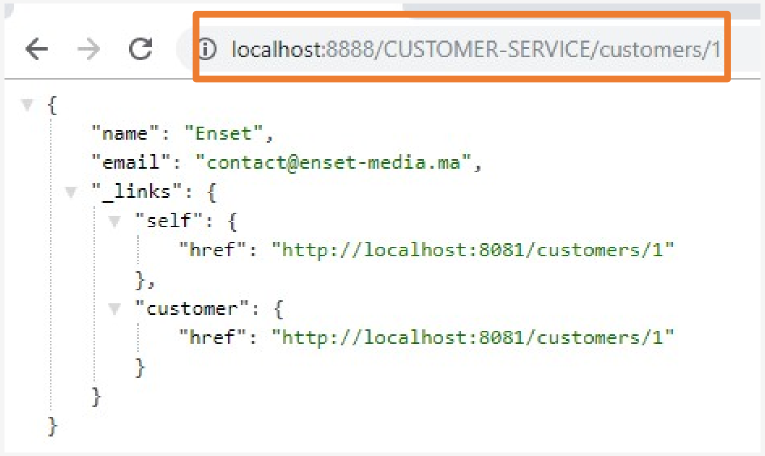


Dynamic routes configuration with Discovery Service

application.properties

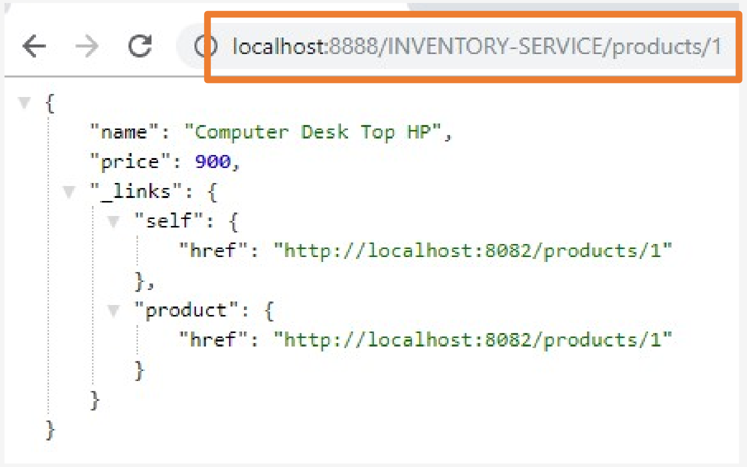
```
spring.application.name=gateway-service
spring.cloud.discovery.enabled=true
server.port=8888
```

```
@Bean
DiscoveryClientRouteDefinitionLocator dynamicRoutes(ReactiveDiscoveryClient rdc,
DiscoveryLocatorProperties dlp){
        return new DiscoveryClientRouteDefinitionLocator(rdc,dlp);
}
```



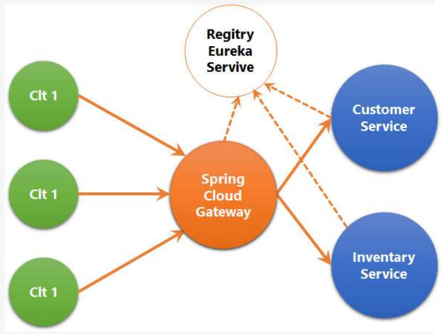
localhost:8888/CUSTOMER-SERVICE/customers/1

```
{
    "name": "Enset",
    "email": "contact@enset-media.ma",
    "_links": {
        "self": {
            "href": "http://localhost:8081/customers/1"
        },
        "customer": {
            "href": "http://localhost:8081/customers/1"
        }
    }
}
```



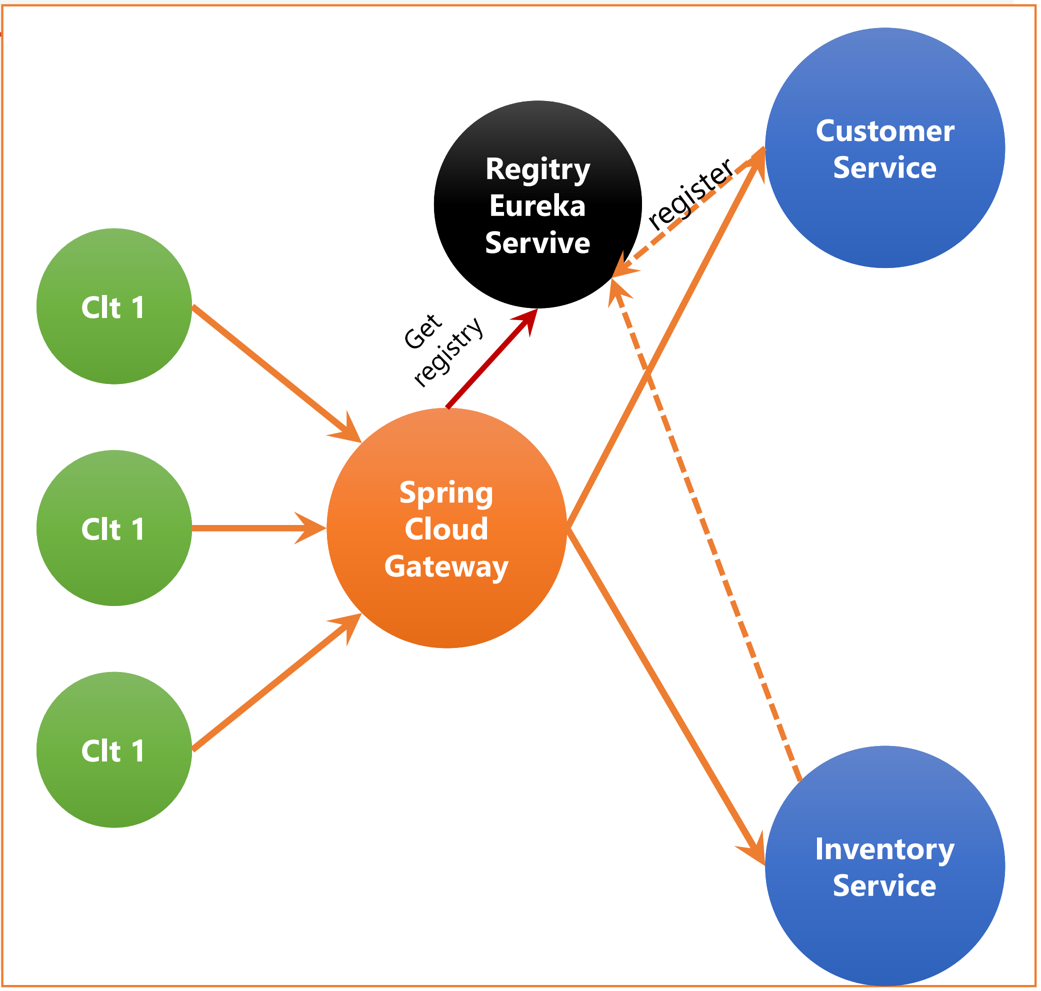
localhost:8888/INVENTORY-SERVICE/products/1

```
{
    "name": "Computer Desk Top HP",
    "price": 900,
    "_links": {
        "self": {
            "href": "http://localhost:8082/products/1"
        },
        "product": {
            "href": "http://localhost:8082/products/1"
        }
    }
}
```



Activité Pratique 1 : Travail à faire

1. Créer le micro service Customer-service
   - Créer l'entité Customer
   - Créer l'interface CustomerRepository basée sur Spring Data
   - Déployer l'API Restful du micro-service en utilisant Spring Data Rest
   - Tester le Micro service
2. Créer le micro service Inventory-service
   - Créer l'entité Product
   - Créer l'interface ProductRepository basée sur Spring Data
   - Déployer l'API Restful du micro-service en utilisant Spring Data Rest
   - Tester le Micro service
3. Créer la Gateway service en utilisant Spring Cloud Gateway
   1. Tester la Service proxy en utilisant une configuration Statique basée sur le fichier application.yml
   2. Tester la Service proxy en utilisant une configuration Statique basée une configuration Java
4. Créer l'annuaire Registry Service basé sur NetFlix Eureka Server
5. Tester le proxy en utilisant une configuration dynamique de Gestion des routes vers les micro services enregistrés dans l'annuaire Eureka Server



Activité Pratique : Travail à faire

1. Créer le micro service Customer-service
   - Créer l'entité Customer
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   - Déployer l'API Restful du micro-service en utilisant Spring Data Rest
   - Tester le Micro service
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   - Créer l'entité Product
   - Créer l'interface ProductRepository basée sur Spring Data
   - Déployer l'API Restful du micro-service en utilisant Spring Data Rest
   - Tester le Micro service
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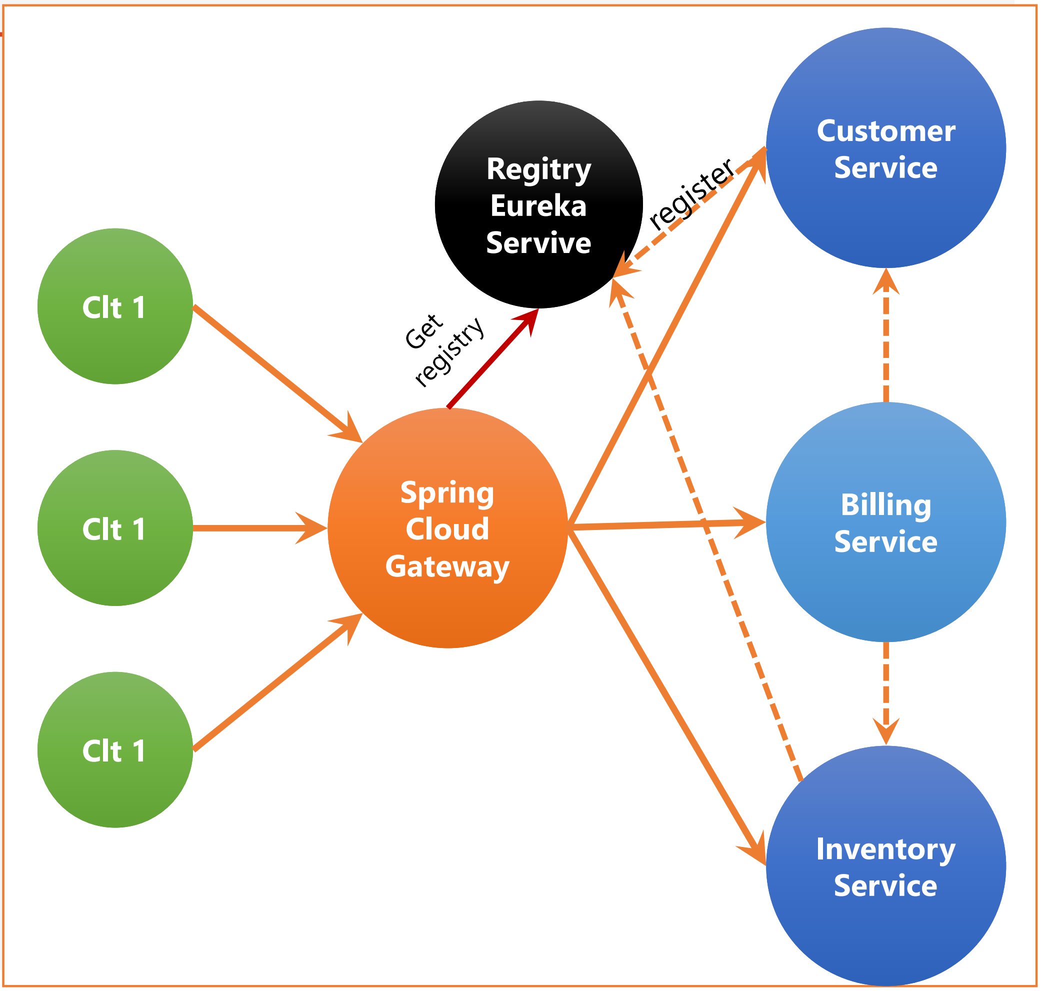
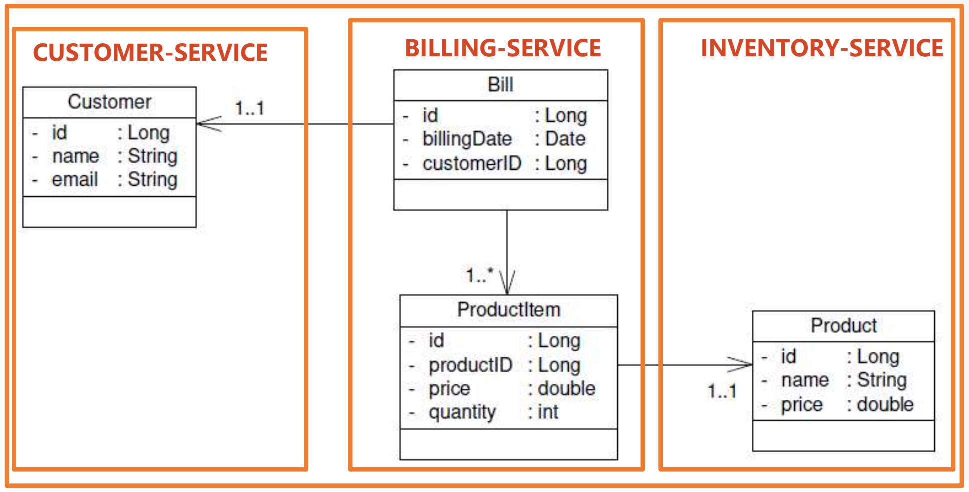
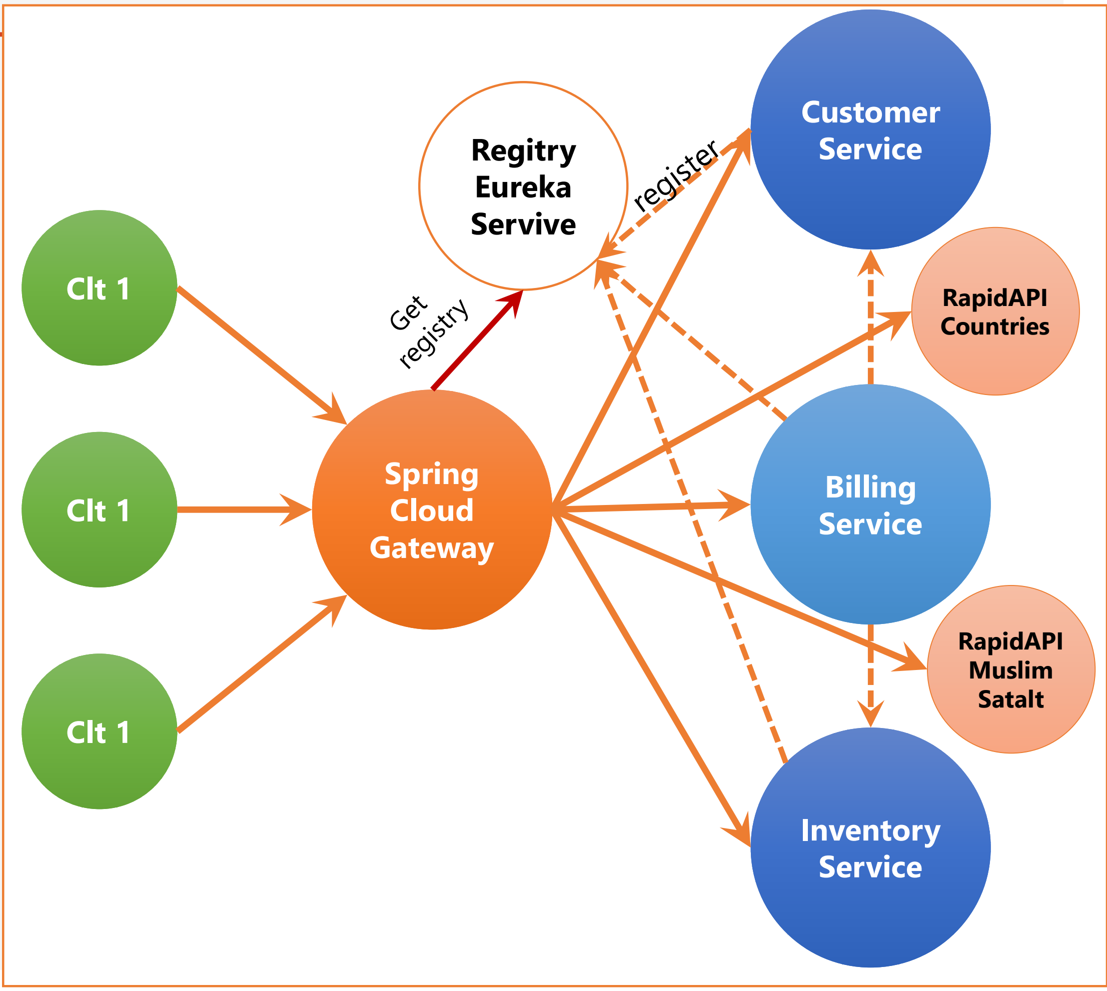
   1. Tester la Service proxy en utilisant une configuration Statique basée sur le fichier application.yml
   2. Tester la Service proxy en utilisant une configuration Statique basée une configuration Java
4. Créer l'annuaire Registry Service basé sur NetFlix Eureka Server
5. Tester le proxy en utilisant une configuration dynamique de Gestion des routes vers les micro services enregistrés dans l'annuaire Eureka Server
6. Créer Le service Billing-Service en utilisant Open Feign pour communiquer avec les services Customer-service et Inventory-service
7. Créer un client Angular qui permet d'afficher une facture



Autres services à ajouter

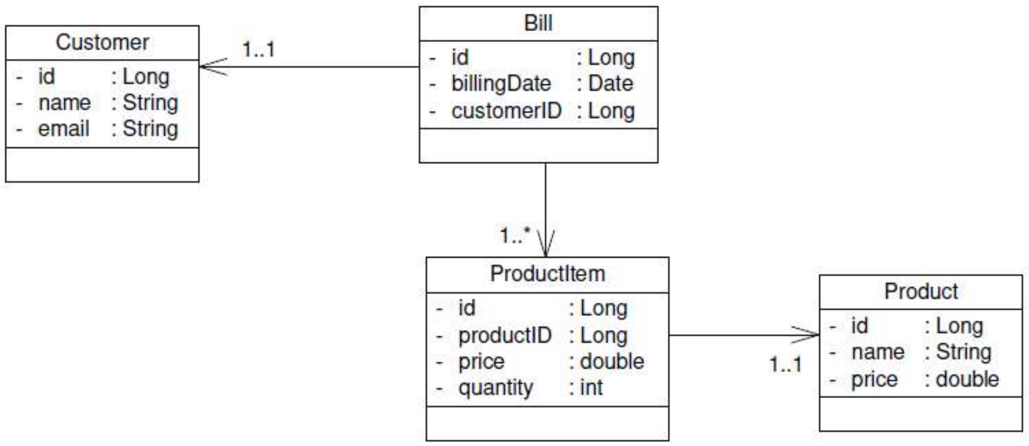
1. Accès aux services externes en utilisant des filtres au niveau du gateway service :
   - RapidAPI Countries
   - Rapid API Mulsim Salat
2. Utilisation de Circuit Breaker avec Hystrix
3. Utilisation de Hystrix Dashboard pour surveiller l'état du trafic au niveau du service Gateway
4. Ajouter un service de facturation (Billing Service), qui communique avec les services Clients et Inventaire en utilisant Spring cloud OpenFeign Rest Client





Billing-service

```java
@Entity @Data @NoArgsConstructor @AllArgsConstructor
class Bill{
 @Id  @GeneratedValue(strategy = GenerationType.IDENTITY)
 private Long id; private Date billingDate;
 @OneToMany(mappedBy = "bill")
 private Collection<ProductItem> productItems;
 private long customerID;

 @Transient private Customer customer;
}
@RepositoryRestResource
interface BillRepository extends JpaRepository<Bill,Long>{}
```



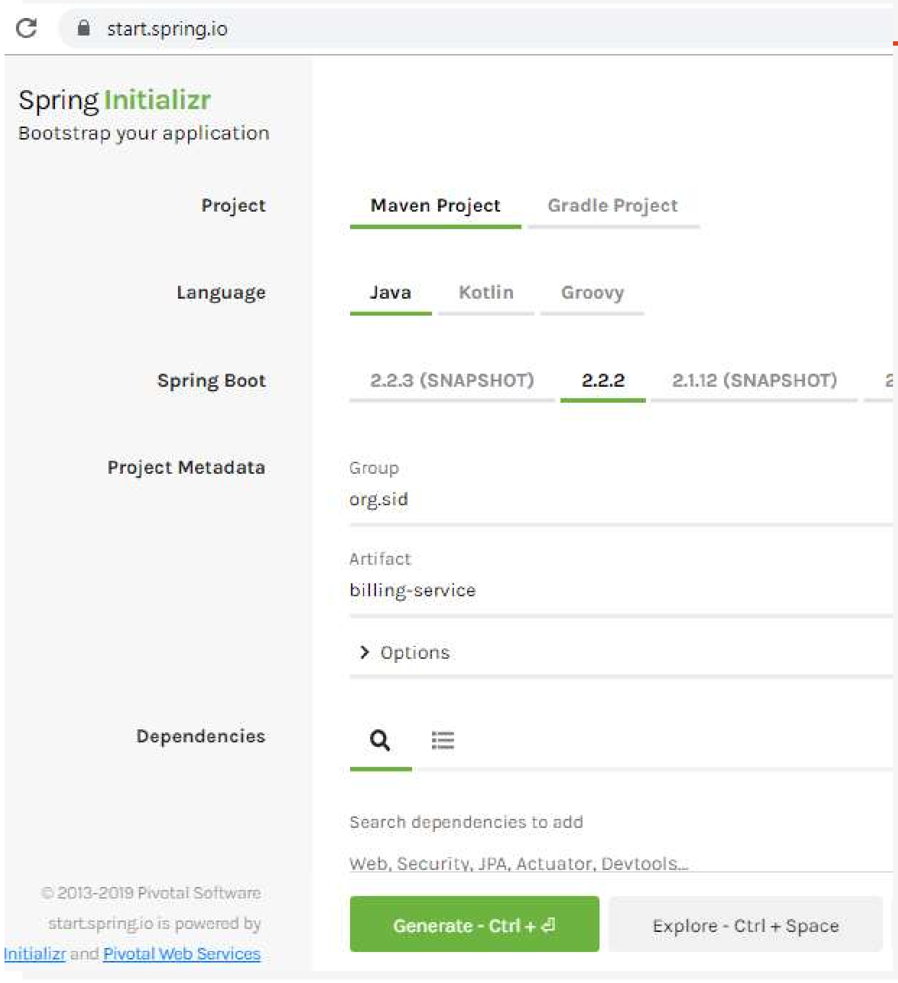
```java
@Entity @Data @NoArgsConstructor @AllArgsConstructor
class ProductItem{
 @Id @GeneratedValue(strategy = GenerationType.IDENTITY)
 private Long id;
 private long productID;
 private double price; private double quantity;
 @ManyToOne
 private Bill bill;

 @Transient private Product product;
}
@RepositoryRestResource
interface ProductItemRepository extends
JpaRepository<ProductItem,Long>{
         List<ProductItem> findByBillId(Long billID);
}
```

Billing-service

```java
@Data
class Product{
        private Long id;
        private String name;
        private double price;
}
@Data
class Customer{
        private Long id;
        private String name;
        private String email;
}
```

```java
@FeignClient(name="customer-service")
interface CustomerServiceClient{
    @GetMapping("/customers/{id}?projection=fullCustomer")
    Customer findCustomerById(@PathVariable("id") Long id);
}
@FeignClient(name="inventory-service")
interface InventoryServiceClient{
  @GetMapping("/products/{id}?projection=fullProduct")
  Product findProductById(@PathVariable("id") Long id);
  @GetMapping("/products?projection=fullProduct")
  PagedModel<Product> findAll();
}
```

Billing-service


start.spring.io

Spring Initializr
Bootstrap your application

Project: [✓ Maven Project] Gradle Project

Language: [✓ Java] Kotlin Groovy

Spring Boot: 2.2.3 (SNAPSHOT) [✓ 2.2.2] 2.1.12 (SNAPSHOT)

Project Metadata
Group: org.sid
Artifact: billing-service

> Options
Dependencies
Search dependencies to add
Web, Security, JPA, Actuator, Devtools...
Generate - Ctrl + ⏎
Explore - Ctrl + Space
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start.spring.io is powered by
Initializr and Pivotal Web Services

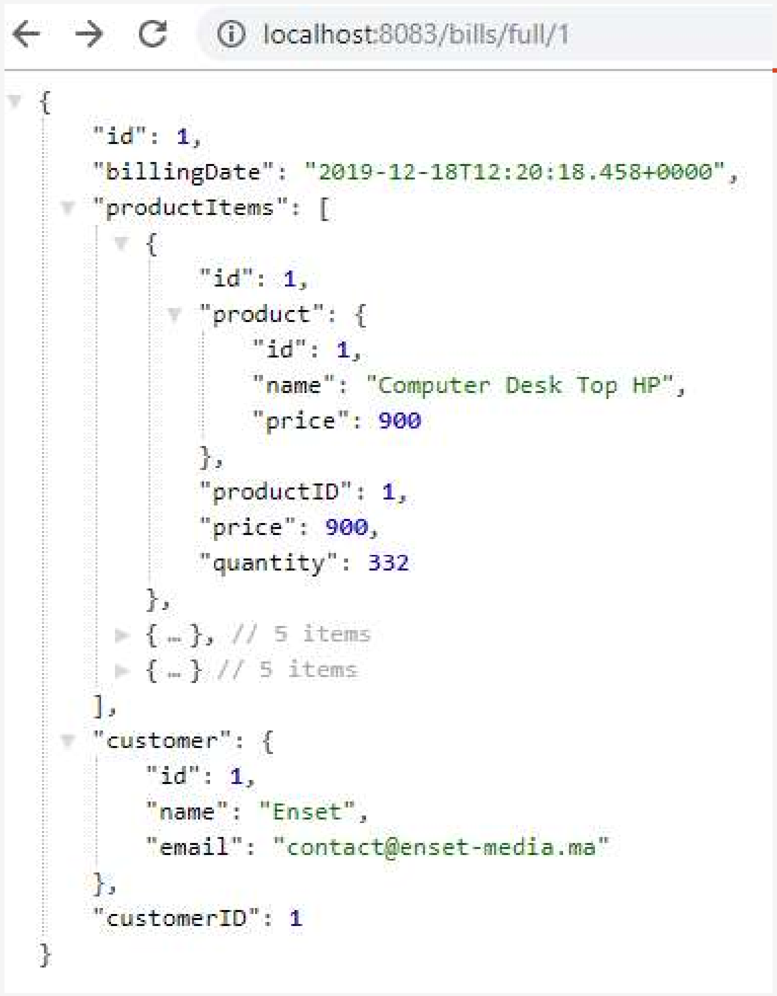
Selected dependencies

- **Spring Web** : Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.
- **Spring Data JPA** : Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.
- **H2 Database** : Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2mb) footprint. Supports embedded and server modes as well as a browser based console application.
- **Rest Repositories** : Exposing Spring Data repositories over REST via Spring Data REST.
- **Lombok** : Java annotation library which helps to reduce boilerplate code.
- **Spring Boot DevTools** : Provides fast application restarts, LiveReload, and configurations for enhanced development experience.
- **Eureka Discovery Client** : a REST based service for locating services for the purpose of load balancing and failover of middle-tier servers.
- **OpenFeign** : Declarative REST Client. OpenFeign creates a dynamic implementation of an interface decorated with JAX-RS or Spring MVC annotations.
- **Spring HATEOAS** : Eases the creation of RESTful APIs that follow the HATEOAS principle when working with Spring / Spring MVC.

Billing-service

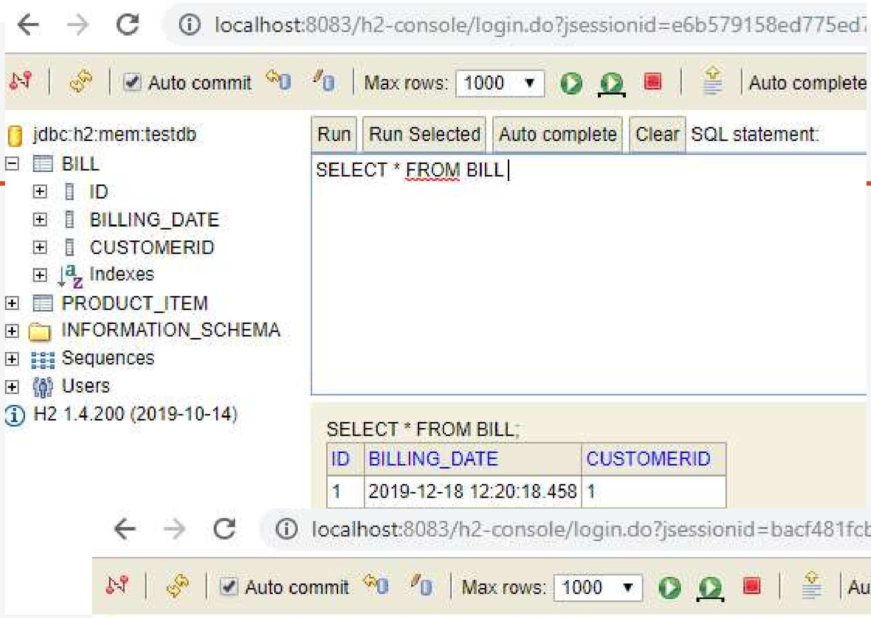
```
@RestController
class BillRestController{
        @Autowired private BillRepository billRepository;
        @Autowired private ProductItemRepository productItemRepository;
        @Autowired private CustomerServiceClient customerServiceClient;
        @Autowired private InventoryServiceClient inventoryServiceClient;
        @GetMapping("/bills/full/{id}")
        Bill getBill(@PathVariable(name="id") Long id){
            Bill bill=billRepository.findById(id).get();
            bill.setCustomer(customerServiceClient.findCustomerById(bill.getCustomerID()));
            bill.setProductItems(productItemRepository.findByBillId(id));
            bill.getProductItems().forEach(pi->{
                pi.setProduct(inventoryServiceClient.findProductById(pi.getProductID()));
                });
        return bill; }
}
```

Billing-service



localhost:8083/bills/full/1

```
{
  "id": 1,
  "billingDate": "2019-12-18T12:20:18.458+0000",
  "productItems": [
    {
      "id": 1,
      "product": {
        "id": 1,
        "name": "Computer Desk Top HP",
        "price": 900
      },
      "productID": 1,
      "price": 900,
      "quantity": 332
    },
    { … }, // 5 items
    { … } // 5 items
  ],
  "customer": {
    "id": 1,
    "name": "Enset",
    "email": "contact@enset-media.ma"
  },
  "customerID": 1
}
```

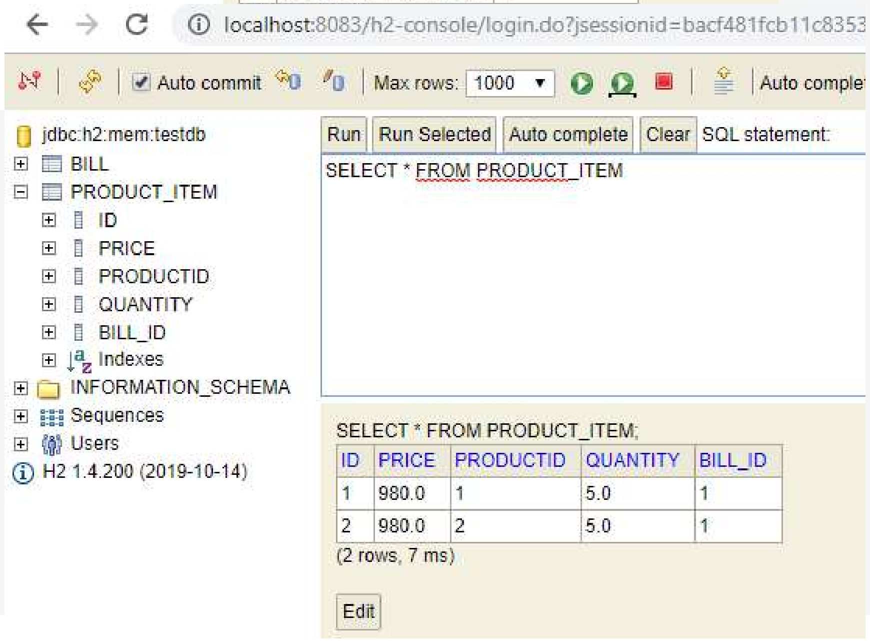


localhost:8083/h2-console/login.do?jsessionid=e6b579158ed775ed7

```
SELECT * FROM BILL
```

SELECT * FROM BILL;

ID	BILLING_DATE	CUSTOMERID
1	2019-12-18 12:20:18.458	1



localhost:8083/h2-console/login.do?jsessionid=bacf481fcb11c8353

```
SELECT * FROM PRODUCT_ITEM
```

SELECT * FROM PRODUCT_ITEM;

ID	PRICE	PRODUCTID	QUANTITY	BILL_ID
1	980.0	1	5.0	1
2	980.0	2	5.0	1

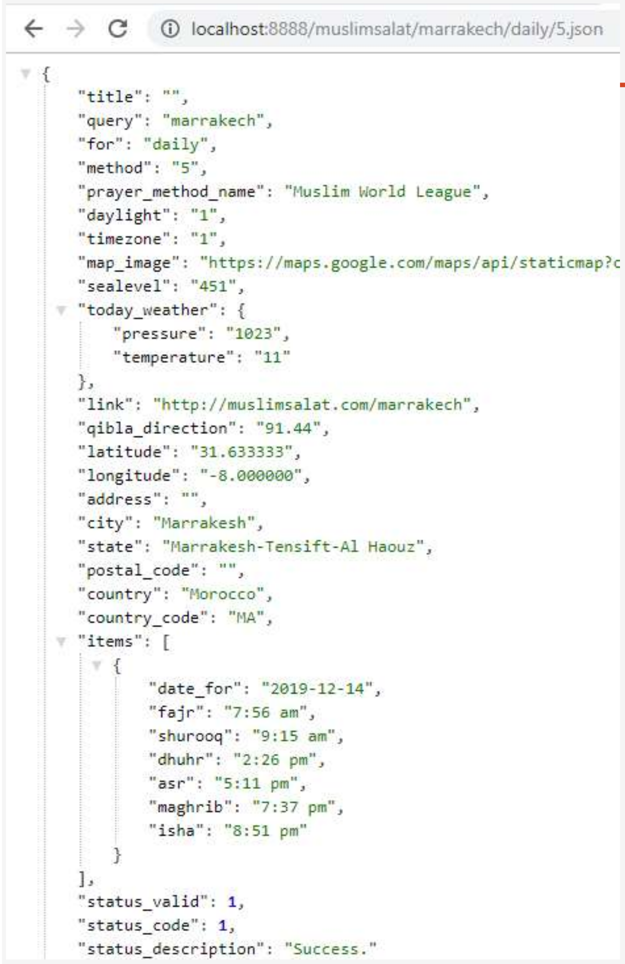
(2 rows, 7 ms)

Edit

Exemple de : Routes Filters

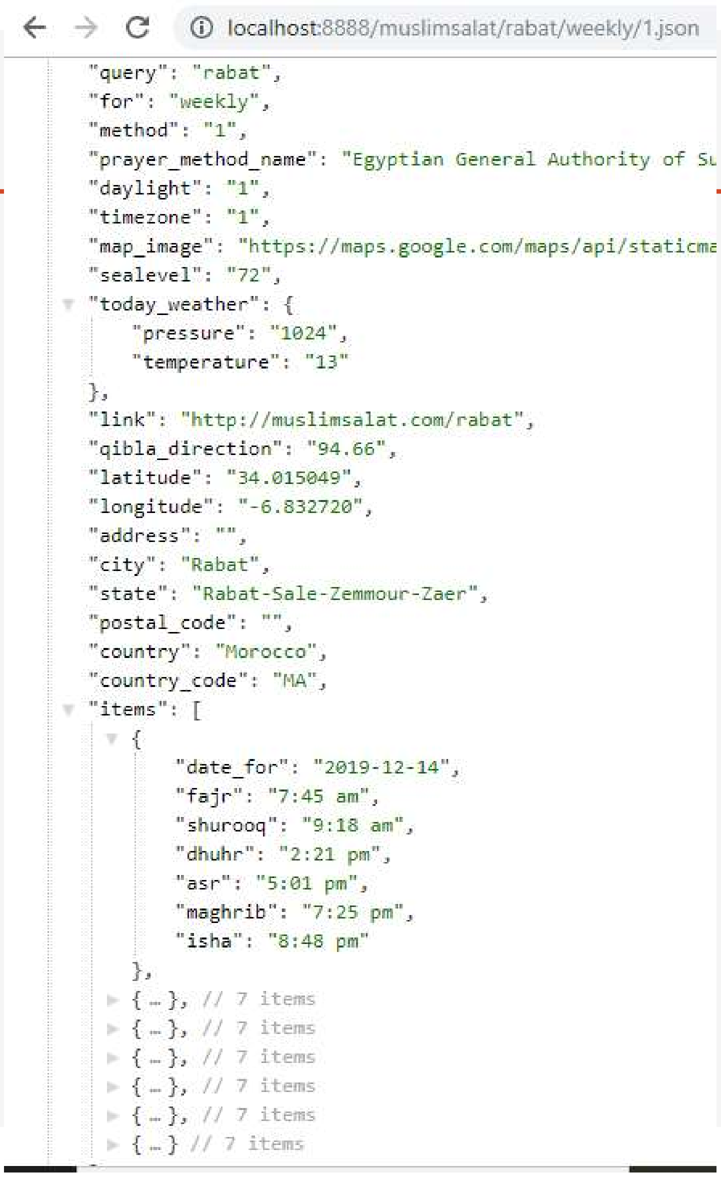
```
@Bean
RouteLocator gatewayRoutes(RouteLocatorBuilder builder){
         return builder.routes()
           .route(r->r.path("/restcountries/**")
            .filters(f->f
             .addRequestHeader("x-rapidapi-host","restcountries-v1.p.rapidapi.com")
             .addRequestHeader("x-rapidapi-key", "fe5e774996msh4eb6e863d457420p1d2ffbjsnee0617ac5078")
             .rewritePath("/restcountries/(?<segment>.*)","/${segment}")

           )
            .uri("https://restcountries-v1.p.rapidapi.com").id("countries")
          )
         .route(r->r.path("/muslimsalat/**")
           .filters(f->f
             .addRequestHeader("x-rapidapi-host","muslimsalat.p.rapidapi.com")
             .addRequestHeader("x-rapidapi-key", "fe5e774996msh4eb6e863d457420p1d2ffbjsnee0617ac5078")
             .rewritePath("/muslimsalat/(?<segment>.*)","/${segment}")
            )
           .uri("https://muslimsalat.p.rapidapi.com")
           .id("countries")
          )
         .build();
}
```

Static Routes with Filters



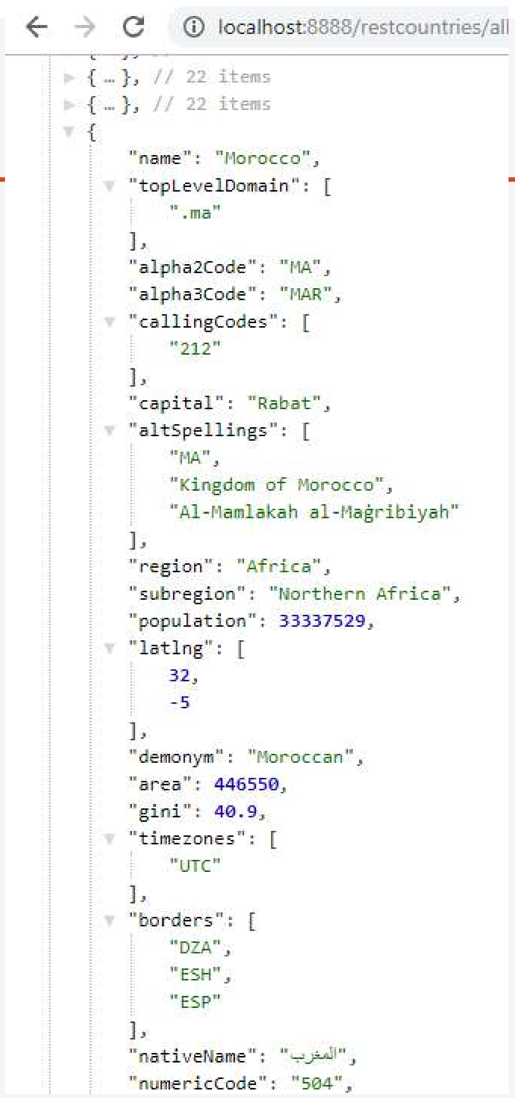
localhost:8888/muslimsalat/marrakech/daily/5.json

```
{
  "title": "",
  "query": "marrakech",
  "for": "daily",
  "method": "5",
  "prayer_method_name": "Muslim World League",
  "daylight": "1",
  "timezone": "1",
  "map_image": "https://maps.google.com/maps/api/staticmap?c
  "sealevel": "451",
  "today_weather": {
     "pressure": "1023",
     "temperature": "11"
  },
  "link": "http://muslimsalat.com/marrakech",
  "qibla_direction": "91.44",
  "latitude": "31.633333",
  "longitude": "-8.000000",
  "address": "",
  "city": "Marrakesh",
  "state": "Marrakesh-Tensift-Al Haouz",
  "postal_code": "",
  "country": "Morocco",
  "country_code": "MA",
  "items": [
     {
        "date_for": "2019-12-14",
        "fajr": "7:56 am",
        "shurooq": "9:15 am",
        "dhuhr": "2:26 pm",
        "asr": "5:11 pm",
        "maghrib": "7:37 pm",
        "isha": "8:51 pm"
     }
  ],
  "status_valid": 1,
  "status_code": 1,
  "status_description": "Success."
```



localhost:8888/muslimsalat/rabat/weekly/1.json

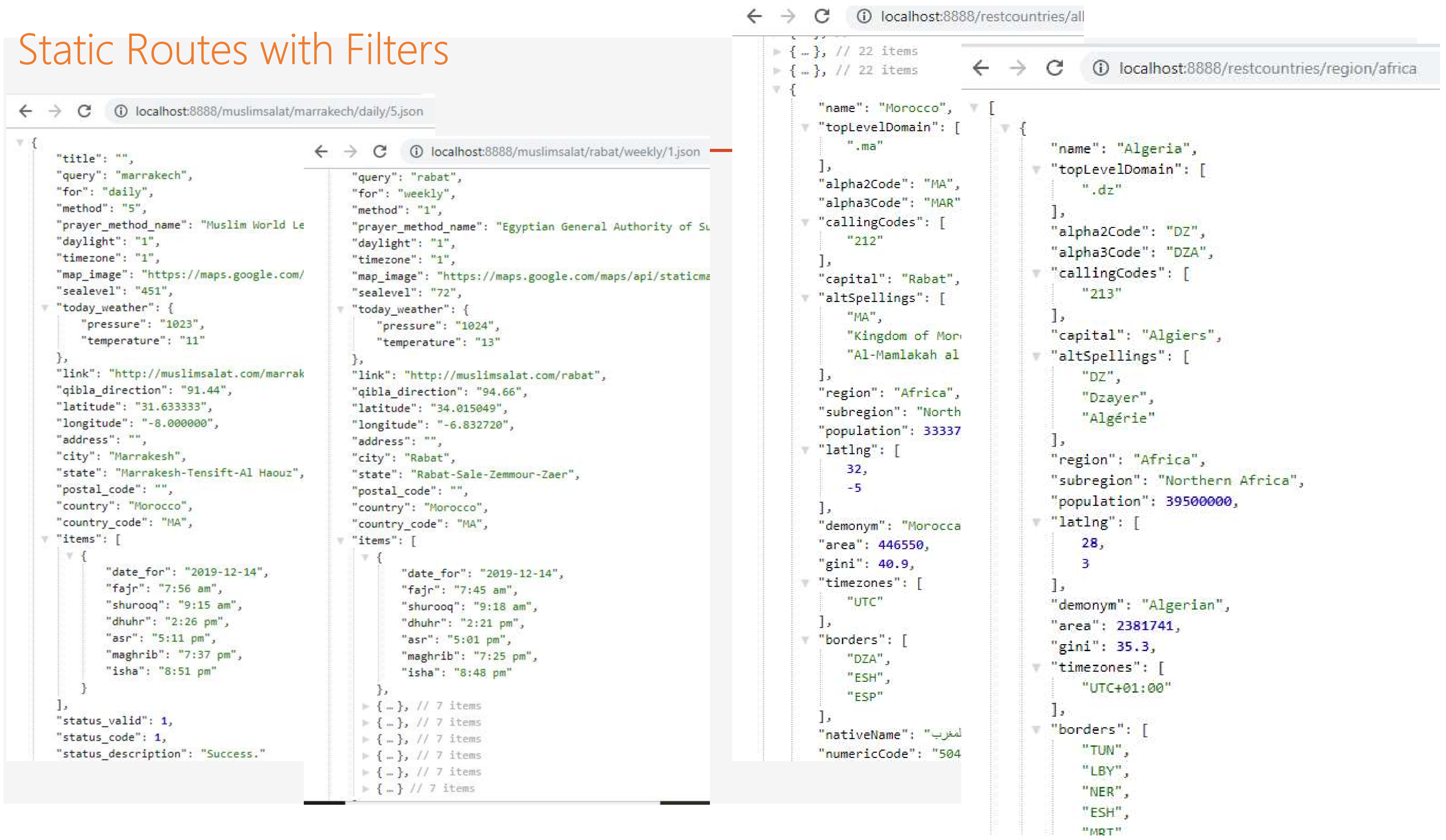
```
"query": "rabat",
"for": "weekly",
"method": "1",
"prayer_method_name": "Egyptian General Authority of Su
"daylight": "1",
"timezone": "1",
"map_image": "https://maps.google.com/maps/api/staticma
"sealevel": "72",
"today_weather": {
    "pressure": "1024",
    "temperature": "13"
},
"link": "http://muslimsalat.com/rabat",
"qibla_direction": "94.66",
"latitude": "34.015049",
"longitude": "-6.832720",
"address": "",
"city": "Rabat",
"state": "Rabat-Sale-Zemmour-Zaer",
"postal_code": "",
"country": "Morocco",
"country_code": "MA",
"items": [
   {
      "date_for": "2019-12-14",
      "fajr": "7:45 am",
      "shurooq": "9:18 am",
      "dhuhr": "2:21 pm",
      "asr": "5:01 pm",
      "maghrib": "7:25 pm",
      "isha": "8:48 pm"
   },
   { … }, // 7 items
   { … }, // 7 items
   { … }, // 7 items
   { … }, // 7 items
   { … }, // 7 items
   { … } // 7 items
```



localhost:8888/restcountries/all

```
{ … }, // 22 items
{ … }, // 22 items
{
   "name": "Morocco",
   "topLevelDomain": [
      ".ma"
   ],
   "alpha2Code": "MA",
   "alpha3Code": "MAR",
   "callingCodes": [
      "212"
   ],
   "capital": "Rabat",
   "altSpellings": [
      "MA",
      "Kingdom of Morocco",
      "Al-Mamlakah al-Maġribiyah"
   ],
   "region": "Africa",
   "subregion": "Northern Africa",
   "population": 33337529,
   "latlng": [
      32,
      -5
   ],
   "demonym": "Moroccan",
   "area": 446550,
   "gini": 40.9,
   "timezones": [
      "UTC"
   ],
   "borders": [
      "DZA",
      "ESH",
      "ESP"
   ],
   "nativeName": "المغرب",
   "numericCode": "504",
```

Static Routes with Filters



localhost:8888/muslimsalat/marrakech/daily/5.json

```
{
    "title": "",
    "query": "marrakech",
    "for": "daily",
    "method": "5",
    "prayer_method_name": "Muslim World Le
    "daylight": "1",
    "timezone": "1",
    "map_image": "https://maps.google.com/
    "sealevel": "451",
    "today_weather": {
        "pressure": "1023",
        "temperature": "11"
    },
    "link": "http://muslimsalat.com/marrak
    "qibla_direction": "91.44",
    "latitude": "31.633333",
    "longitude": "-8.000000",
    "address": "",
    "city": "Marrakesh",
    "state": "Marrakesh-Tensift-Al Haouz",
    "postal_code": "",
    "country": "Morocco",
    "country_code": "MA",
    "items": [
        {
            "date_for": "2019-12-14",
            "fajr": "7:56 am",
            "shurooq": "9:15 am",
            "dhuhr": "2:26 pm",
            "asr": "5:11 pm",
            "maghrib": "7:37 pm",
            "isha": "8:51 pm"
        }
    ],
    "status_valid": 1,
    "status_code": 1,
    "status_description": "Success."
```

localhost:8888/muslimsalat/rabat/weekly/1.json

```
    "query": "rabat",
    "for": "weekly",
    "method": "1",
    "prayer_method_name": "Egyptian General Authority of Su
    "daylight": "1",
    "timezone": "1",
    "map_image": "https://maps.google.com/maps/api/staticma
    "sealevel": "72",
    "today_weather": {
        "pressure": "1024",
        "temperature": "13"
    },
    "link": "http://muslimsalat.com/rabat",
    "qibla_direction": "94.66",
    "latitude": "34.015049",
    "longitude": "-6.832720",
    "address": "",
    "city": "Rabat",
    "state": "Rabat-Sale-Zemmour-Zaer",
    "postal_code": "",
    "country": "Morocco",
    "country_code": "MA",
    "items": [
        {
            "date_for": "2019-12-14",
            "fajr": "7:45 am",
            "shurooq": "9:18 am",
            "dhuhr": "2:21 pm",
            "asr": "5:01 pm",
            "maghrib": "7:25 pm",
            "isha": "8:48 pm"
        },
        {…}, // 7 items
        {…}, // 7 items
        {…}, // 7 items
        {…}, // 7 items
        {…}, // 7 items
        {…} // 7 items
```

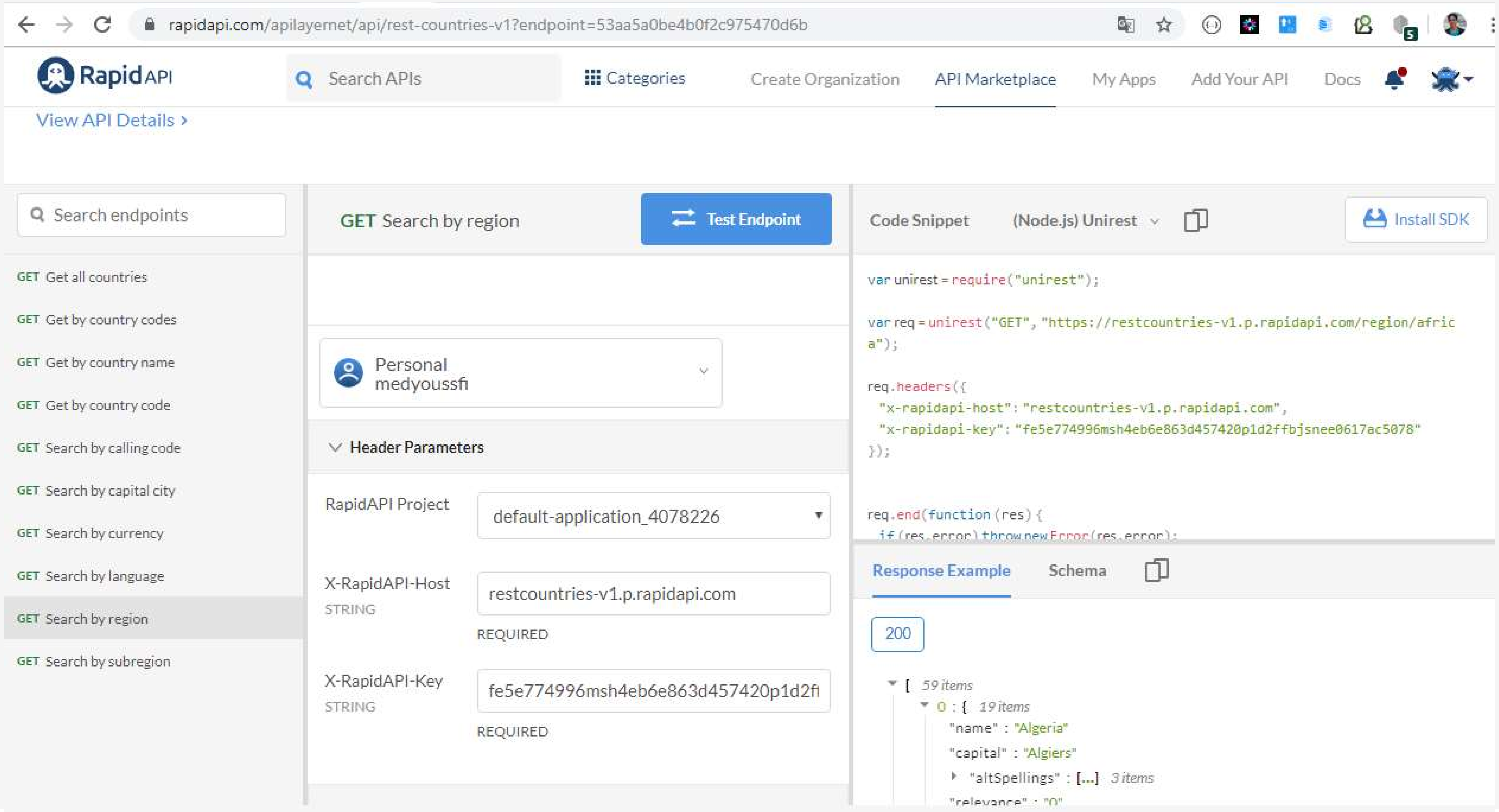
localhost:8888/restcountries/all

```
    {…}, // 22 items
    {…}, // 22 items
    {
        "name": "Morocco",
        "topLevelDomain": [
            ".ma"
        ],
        "alpha2Code": "MA",
        "alpha3Code": "MAR"
        "callingCodes": [
            "212"
        ],
        "capital": "Rabat",
        "altSpellings": [
            "MA",
            "Kingdom of Mor
            "Al-Mamlakah al
        ],
        "region": "Africa",
        "subregion": "North
        "population": 33337
        "latlng": [
            32,
            -5
        ],
        "demonym": "Morocca
        "area": 446550,
        "gini": 40.9,
        "timezones": [
            "UTC"
        ],
        "borders": [
            "DZA",
            "ESH",
            "ESP"
        ],
        "nativeName": "لمغرب
        "numericCode": "504
```

localhost:8888/restcountries/region/africa

```
[
    {
        "name": "Algeria",
        "topLevelDomain": [
            ".dz"
        ],
        "alpha2Code": "DZ",
        "alpha3Code": "DZA",
        "callingCodes": [
            "213"
        ],
        "capital": "Algiers",
        "altSpellings": [
            "DZ",
            "Dzayer",
            "Algérie"
        ],
        "region": "Africa",
        "subregion": "Northern Africa",
        "population": 39500000,
        "latlng": [
            28,
            3
        ],
        "demonym": "Algerian",
        "area": 2381741,
        "gini": 35.3,
        "timezones": [
            "UTC+01:00"
        ],
        "borders": [
            "TUN",
            "LBY",
            "NER",
            "ESH",
            "MRT"
```

Static Routes with Filters



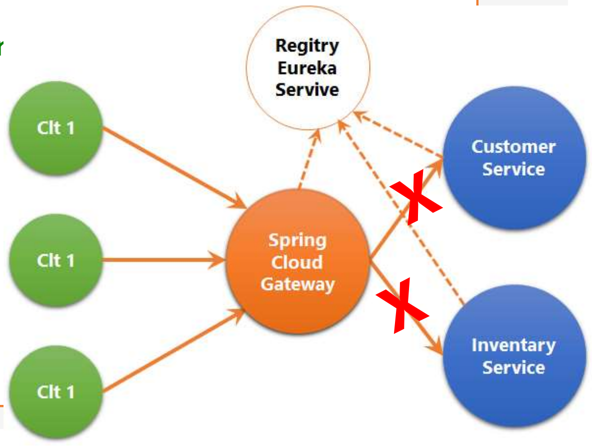
RapidAPI Project	default-application_4078226
X-RapidAPI-Host STRING	restcountries-v1.p.rapidapi.com REQUIRED
X-RapidAPI-Key STRING	fe5e774996msh4eb6e863d457420p1d2ff REQUIRED

```
var unirest = require("unirest");

var req = unirest("GET", "https://restcountries-v1.p.rapidapi.com/region/afric
a");

req.headers({
  "x-rapidapi-host": "restcountries-v1.p.rapidapi.com",
  "x-rapidapi-key": "fe5e774996msh4eb6e863d457420p1d2ffbjsnee0617ac5078"
});


req.end(function (res) {
  if (res.error) throw new Error(res.error);
```

```
▾ [ 59 items
  ▾ 0 : { 19 items
      "name" : "Algeria"
      "capital" : "Algiers"
    ▸ "altSpellings" : [...] 3 items
      "relevance" : "0"
```

Circuit Breaker avec Hystrix

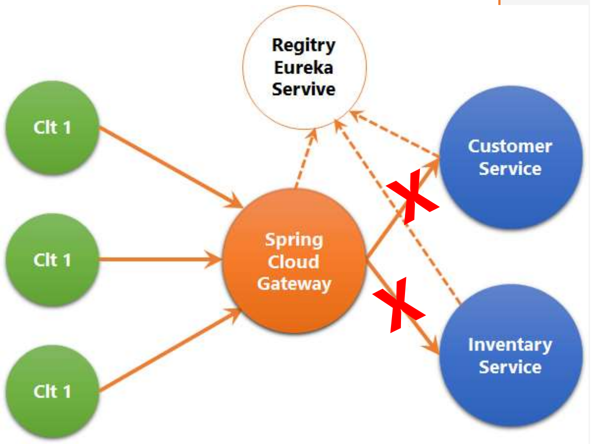
```
@Bean
RouteLocator gatewayRoutes(RouteLocatorBuilder builder){
          return builder.routes()
          .route(r->r.path("/restcountries/**")
            .filters(f->f
            .addRequestHeader("x-rapidapi-host","restcountries-v1.p.rapidapi.com")
            .addRequestHeader("x-rapidapi-key", "fe5e774996msh4eb6e863d457420p1d2ffbjsnee0617ac5078")
            .rewritePath("/restcountries/(?<segment>.*)","/${segment}")
            .hystrix(h->h.setName("rest-countries")
             .setFallbackUri("forward:/restCountriesFallback"))

          )
          .uri("https://restcountries-v1.p.rapidapi.com").id("countries")
          .route(r->r.path("/muslimsalat/**")
            .filters(f->f
              .addRequestHeader("x-rapidapi-host","muslimsalat.p.rapidapi.com")
              .addRequestHeader("x-rapidapi-key", "fe5e774996msh4eb6e863d457420p1d2ffbjsr
              .rewritePath("/muslimsalat/(?<segment>.*)","/${segment}")
              .hystrix(h->h.setName("muslimsalat")
                .setFallbackUri("forward:/muslimsalatFallback"))
          )
           .uri("https://muslimsalat.p.rapidapi.com").id("countries")
          )
      .build();
}
```



Circuit Breaker avec Hystrix

```java
@SpringBootApplication
@EnableHystrix
public class CloudGatewayApplication {
```

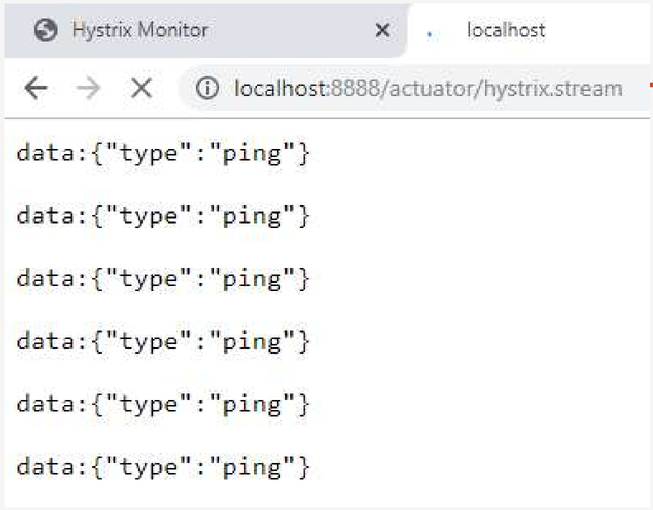
```java
@RestController
class FallBackRestController{
        @GetMapping("/restCountriesFallback")
        public Map<String,String> restCountriesFallback(){
                Map<String,String> map=new HashMap<>();
                map.put("message","Default Rest Countries Fallback service");
                map.put("countries","Algeria, Morocco");
                return map;
        }
        @GetMapping("/muslimsalatFallback")
        public Map<String,String> muslimsalatback(){
                Map<String,String> map=new HashMap<>();
                map.put("message","Default Muslim Fallback service");
                map.put("Fajr","07:00");
                map.put("DOHR","14:00");
                return map;
        }
}
```



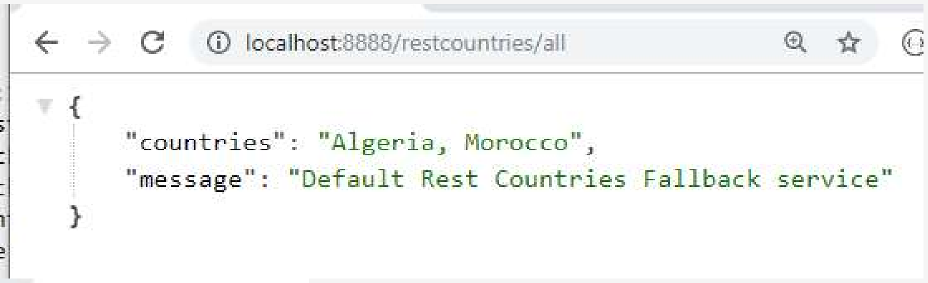
application.properties

```
management.endpoints.web.exposure.include=hystrix.stream
hystrix.command.default.execution.isolation.thread.timeoutInMilliseconds=1000
```

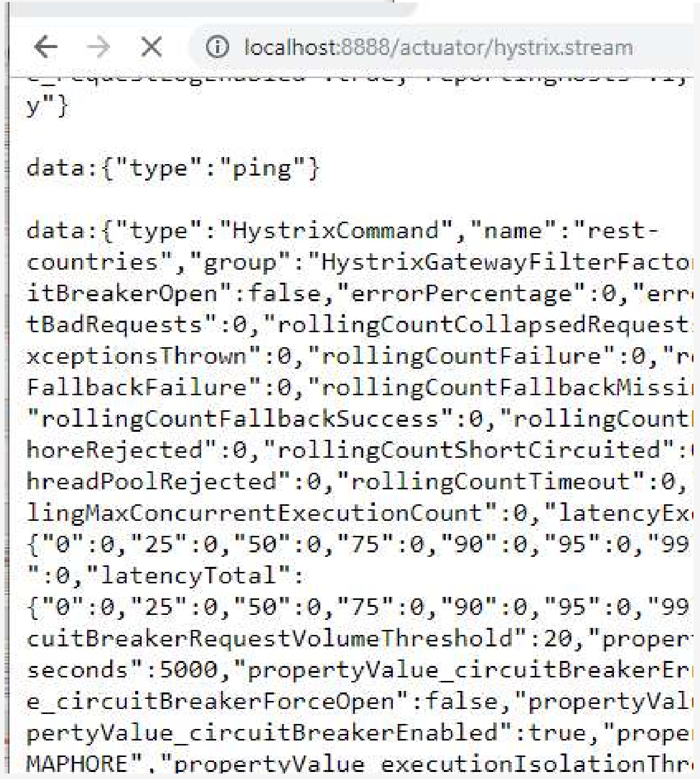
Circuit Breaker With Hystrix



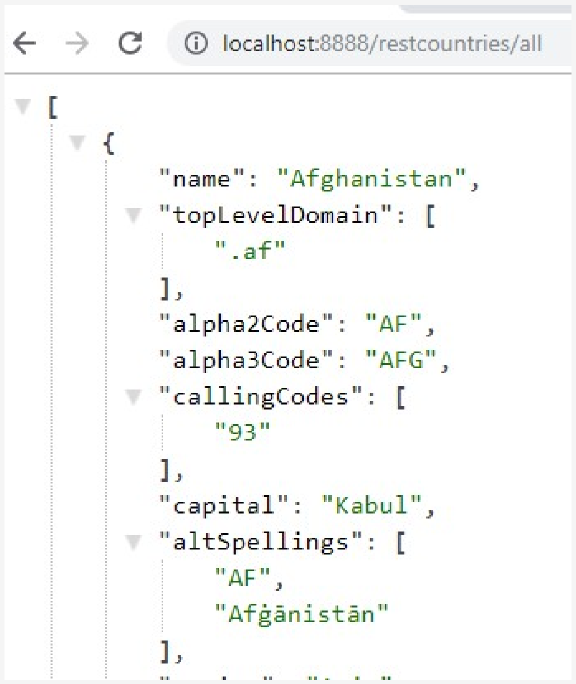
```
data:{"type":"ping"}

data:{"type":"ping"}

data:{"type":"ping"}

data:{"type":"ping"}

data:{"type":"ping"}

data:{"type":"ping"}
```



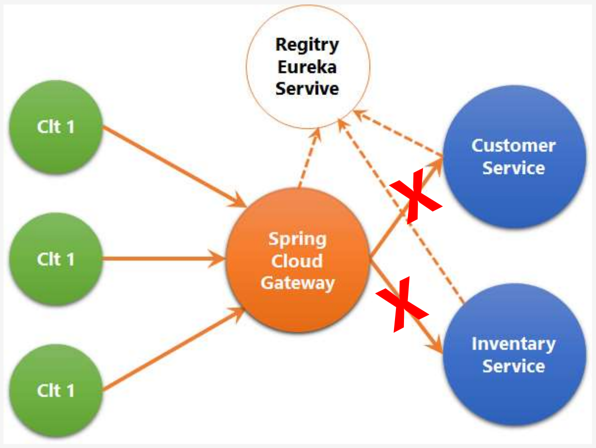
```
{
    "countries": "Algeria, Morocco",
    "message": "Default Rest Countries Fallback service"
}
```



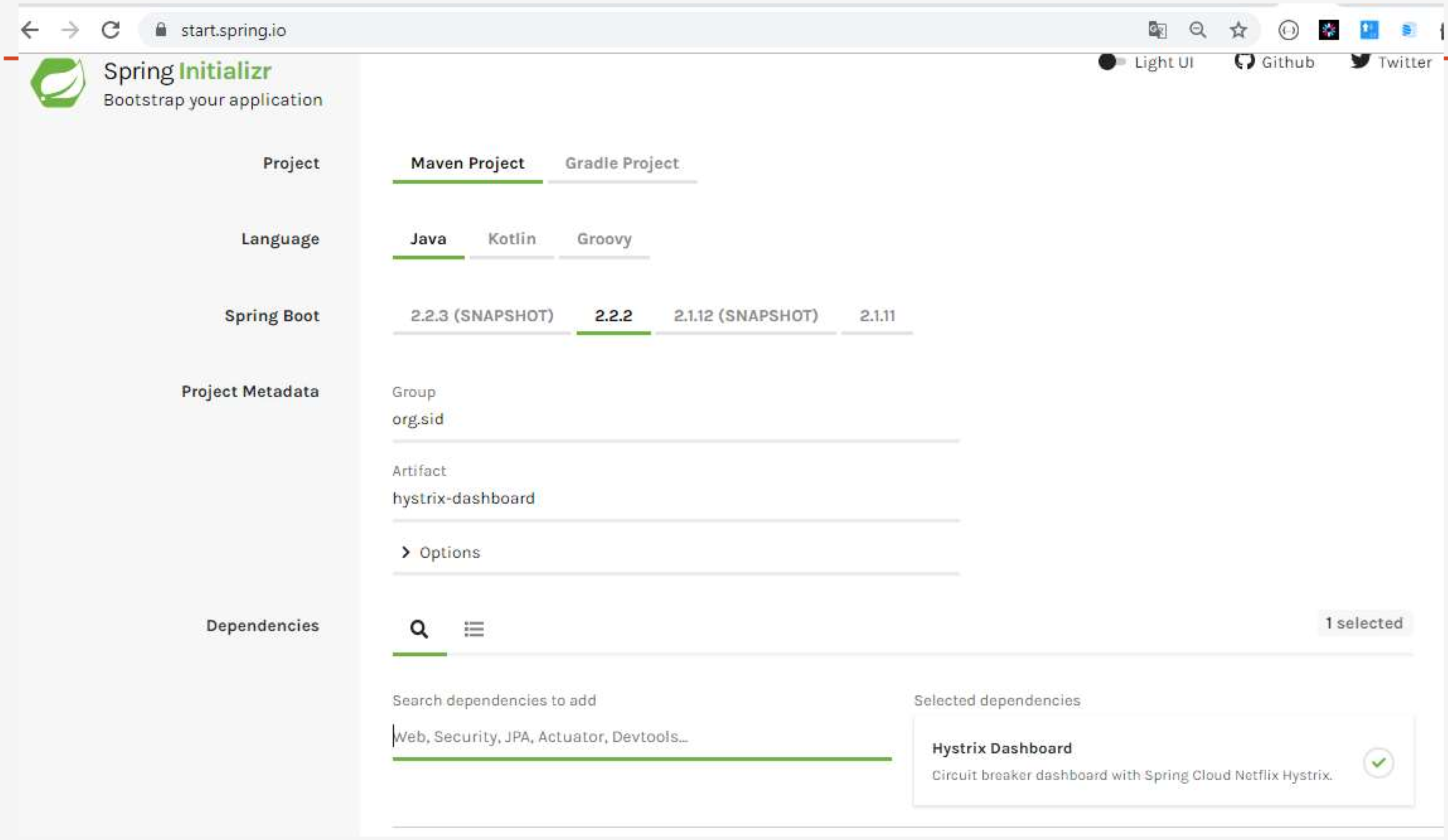
```
y"}

data:{"type":"ping"}

data:{"type":"HystrixCommand","name":"rest-
countries","group":"HystrixGatewayFilterFacto
itBreakerOpen":false,"errorPercentage":0,"err
tBadRequests":0,"rollingCountCollapsedRequest
xceptionsThrown":0,"rollingCountFailure":0,"r
FallbackFailure":0,"rollingCountFallbackMissi
"rollingCountFallbackSuccess":0,"rollingCount
horeRejected":0,"rollingCountShortCircuited":
hreadPoolRejected":0,"rollingCountTimeout":0,
lingMaxConcurrentExecutionCount":0,"latencyEx
{"0":0,"25":0,"50":0,"75":0,"90":0,"95":0,"99
":0,"latencyTotal":
{"0":0,"25":0,"50":0,"75":0,"90":0,"95":0,"99
cuitBreakerRequestVolumeThreshold":20,"proper
seconds":5000,"propertyValue_circuitBreakerEr
e_circuitBreakerForceOpen":false,"propertyVal
pertyValue_circuitBreakerEnabled":true,"prope
MAPHORE","propertyValue executionIsolationThr
```



```
[
    {
        "name": "Afghanistan",
        "topLevelDomain": [
            ".af"
        ],
        "alpha2Code": "AF",
        "alpha3Code": "AFG",
        "callingCodes": [
            "93"
        ],
        "capital": "Kabul",
        "altSpellings": [
            "AF",
            "Afġānistān"
        ],
```



Hystrix Dashboard



start.spring.io

Light UI Github Twitter

Spring Initializr
Bootstrap your application

Project: Maven Project [✓] | Gradle Project

Language: Java [✓] | Kotlin | Groovy

Spring Boot: 2.2.3 (SNAPSHOT) | 2.2.2 [✓] | 2.1.12 (SNAPSHOT) | 2.1.11

Project Metadata

Group
org.sid

Artifact
hystrix-dashboard

> Options

Dependencies

1 selected

Search dependencies to add
Web, Security, JPA, Actuator, Devtools...

Selected dependencies

Hystrix Dashboard
Circuit breaker dashboard with Spring Cloud Netflix Hystrix.

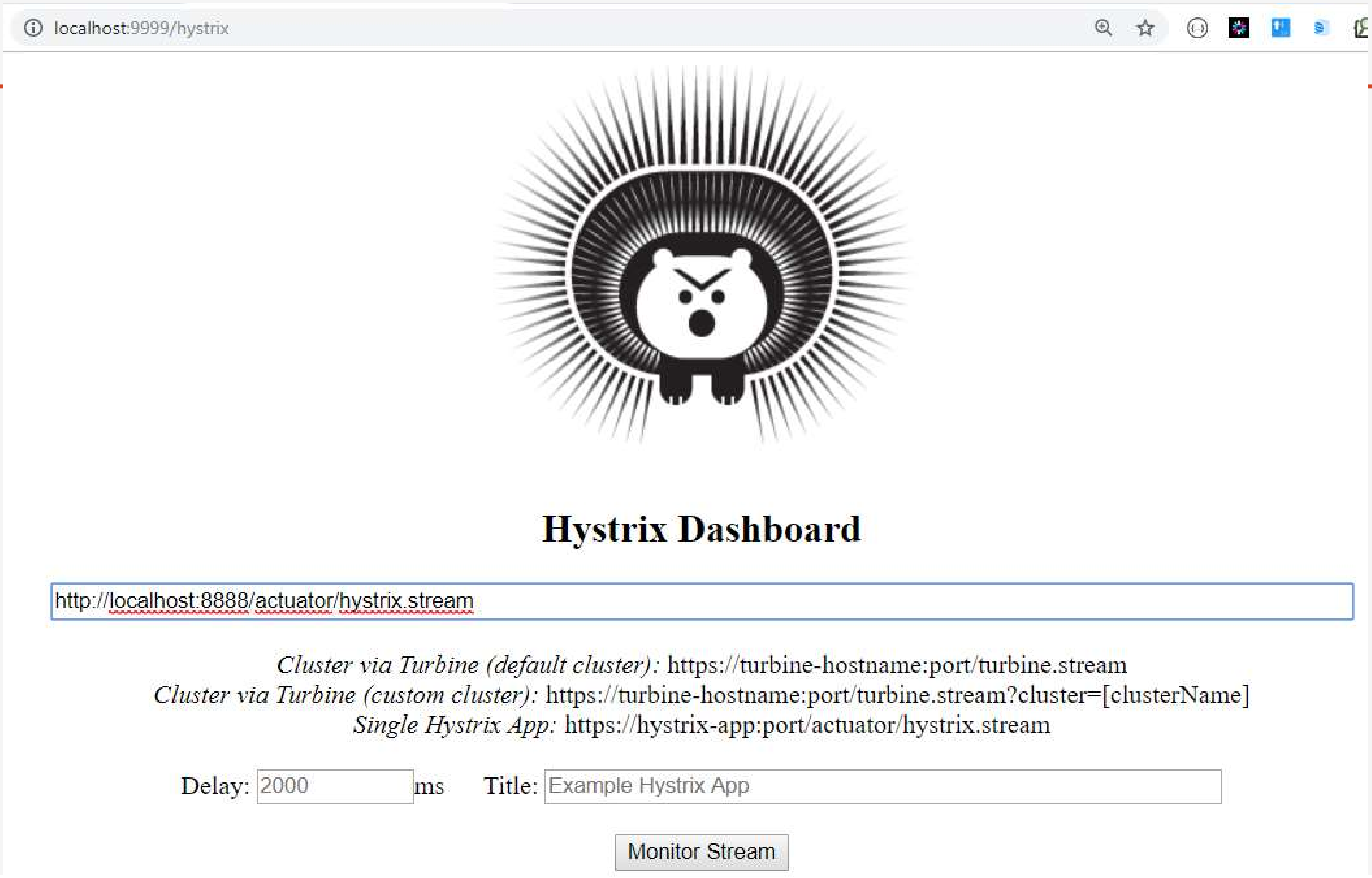
Circuit Breaker avec Hystrix

```java
package org.sid.hystrixdashboard;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.cloud.netflix.hystrix.dashboard.EnableHystrixDashboard;

@SpringBootApplication
@EnableHystrixDashboard
public class HystrixDashboardApplication {

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

}
```

application.properties

```
server.port=9999
```

Circuit Breaker avec Hystrix



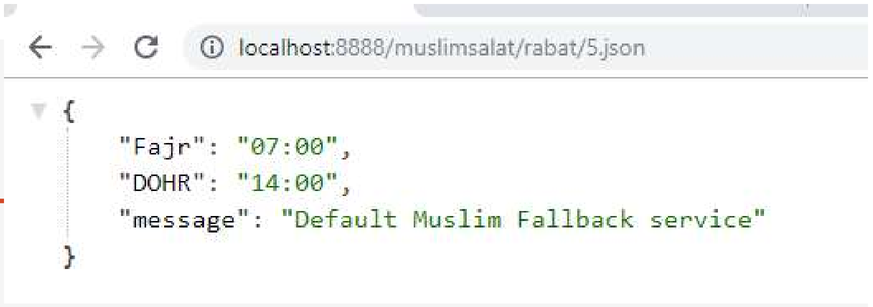
Hystrix Dashboard

http://localhost:8888/actuator/hystrix.stream

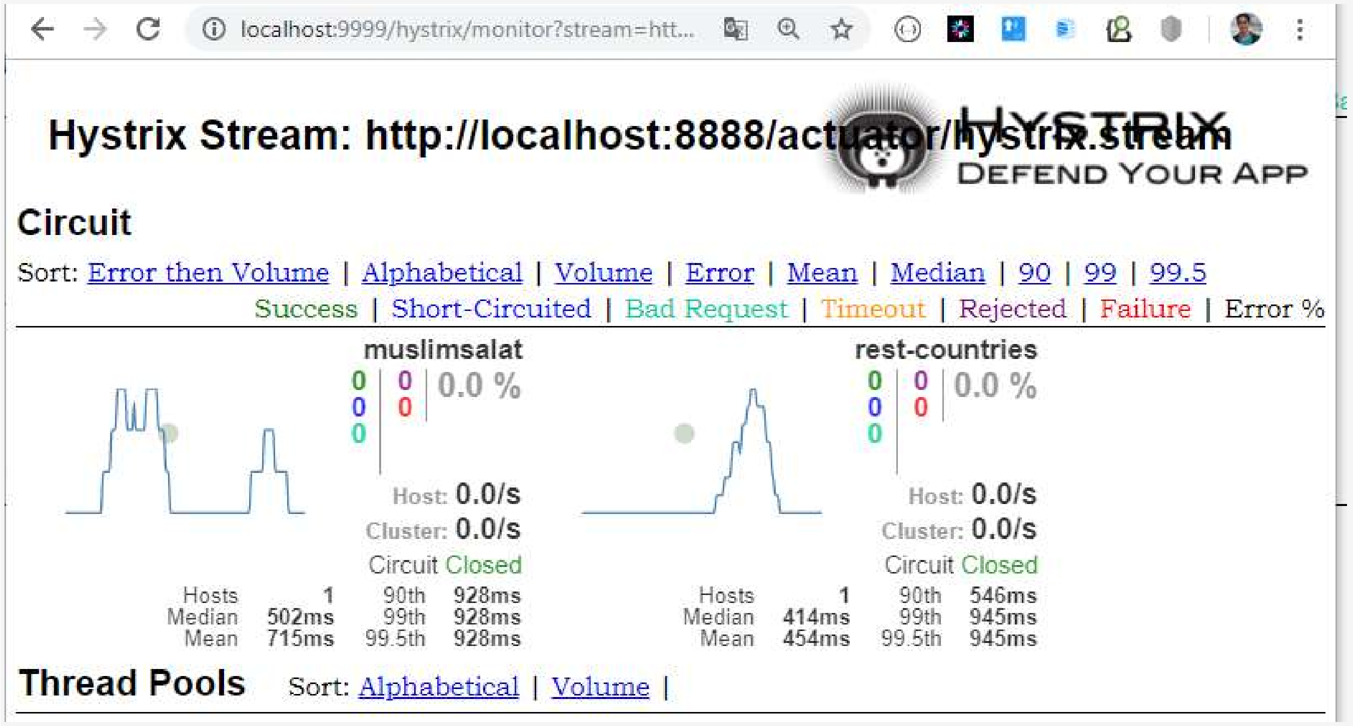
Cluster via Turbine (default cluster): https://turbine-hostname:port/turbine.stream
Cluster via Turbine (custom cluster): https://turbine-hostname:port/turbine.stream?cluster=[clusterName]
Single Hystrix App: https://hystrix-app:port/actuator/hystrix.stream

Delay: 2000 ms Title: Example Hystrix App

Circuit Breaker avec Hystrix


localhost:8888/muslimsalat/rabat/5.json

```
{
    "Fajr": "07:00",
    "DOHR": "14:00",
    "message": "Default Muslim Fallback service"
}
```


localhost:9999/hystrix/monitor?stream=htt...

Hystrix Stream: http://localhost:8888/actuator/hystrix.stream

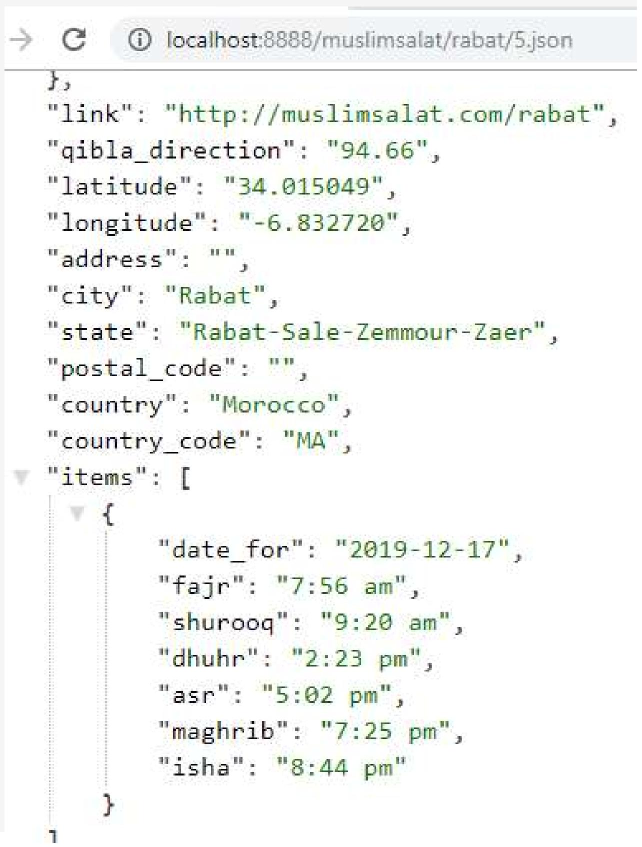
Circuit

Sort: Error then Volume | Alphabetical | Volume | Error | Mean | Median | 90 | 99 | 99.5

Success | Short-Circuited | Bad Request | Timeout | Rejected | Failure | Error %

```
muslimsalat                          rest-countries
0 | 0 | 0.0 %                        0 | 0 | 0.0 %
0 | 0                                0 | 0
0                                    0
Host: 0.0/s                          Host: 0.0/s
Cluster: 0.0/s                       Cluster: 0.0/s
Circuit Closed                       Circuit Closed
Hosts       1   90th   928ms         Hosts       1   90th   546ms
Median  502ms   99th   928ms         Median  414ms   99th   945ms
Mean    715ms   99.5th 928ms         Mean    454ms   99.5th 945ms
```

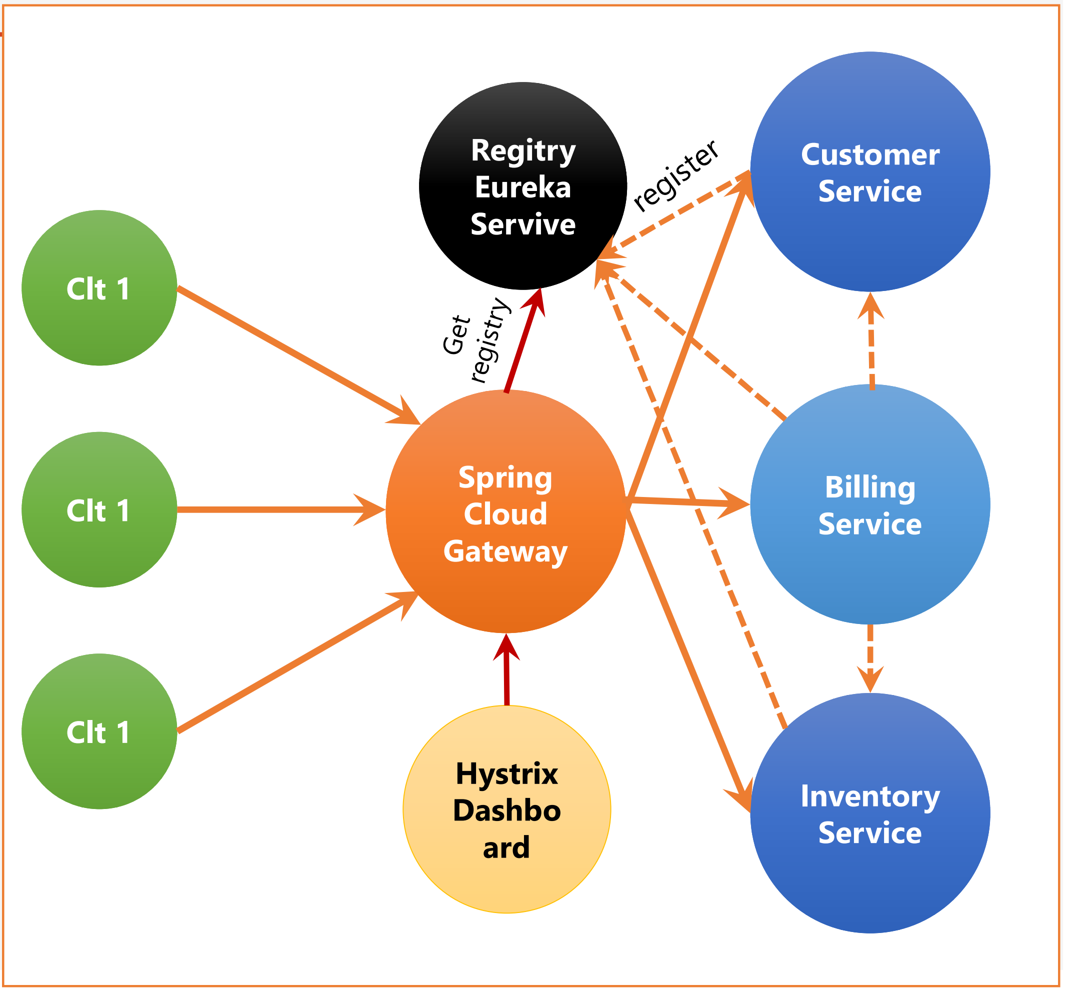
Thread Pools Sort: Alphabetical | Volume |


localhost:8888/muslimsalat/rabat/5.json

```
},
"link": "http://muslimsalat.com/rabat",
"qibla_direction": "94.66",
"latitude": "34.015049",
"longitude": "-6.832720",
"address": "",
"city": "Rabat",
"state": "Rabat-Sale-Zemmour-Zaer",
"postal_code": "",
"country": "Morocco",
"country_code": "MA",
"items": [
  {
      "date_for": "2019-12-17",
      "fajr": "7:56 am",
      "shurooq": "9:20 am",
      "dhuhr": "2:23 pm",
      "asr": "5:02 pm",
      "maghrib": "7:25 pm",
      "isha": "8:44 pm"
  }
]
```

Communication REST entre les micro-services : Declarative Rest Client avec Spring Cloud Feign

- Feign est un Framework, introduite dans Spring cloud, qui permet de créer facilement un Client REST d'une manière déclarative.
- Feign peut être utilisée à la place de RestTemplate pour intéragir avec d'autres services distants via des API Restful.
- Dans Notre cas, nous allons ajouter un autre service de facturation qui a besoin de communiquer avec els services d'inventaires et le service client pour récupérer les informations sur le client et les produits d'une facture



Billing-service

```java
@SpringBootApplication
@EnableFeignClients
public class BillingServiceApplication {
    public static void main(String[] args) {SpringApplication.run(BillingServiceApplication.class, args); }
         @Bean
         CommandLineRunner start(BillRepository billRepository, ProductItemRepository productItemRepository,
         InventoryServiceClient inventoryServiceClient, CustomerServiceClient customerServiceClient){
                  return args -> {
                           Bill bill=new Bill();
                           bill.setBillingDate(new Date());
                           Customer customer=customerServiceClient.findCustomerById(1L);
                           bill.setCustomerID(customer.getId());
                           billRepository.save(bill);
                           inventoryServiceClient.findAll().getContent().forEach(p->{
productItemRepository.save(new ProductItem(null,null,p.getId(),p.getPrice(),(int)(1+Math.random()*1000),bill));
                           });
                  };
         }}
```

Billing-service

```java
package org.sid.billingservice;
import com.fasterxml.jackson.annotation.JsonProperty;
import lombok.AllArgsConstructor;import lombok.Data; import lombok.NoArgsConstructor;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.CommandLineRunner;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.cloud.openfeign.EnableFeignClients;
import org.springframework.cloud.openfeign.FeignClient;
import org.springframework.context.annotation.Bean;
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.data.rest.core.annotation.RepositoryRestResource;
import org.springframework.hateoas.PagedModel;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RestController;
import javax.persistence.*;import java.util.Collection; import java.util.Date;import java.util.List;
```