Architecture of Enterprise Applications 10
Microservices & Serverless

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Contents and Objectives

- Contents
  - Microservice
  - Routing and Filtering
  - Severless
  - Function Service

- Objectives
  - 能够根据业务需求，抽象出系统中的微服务，并能够基于 Spring 框架开发对应的微服务

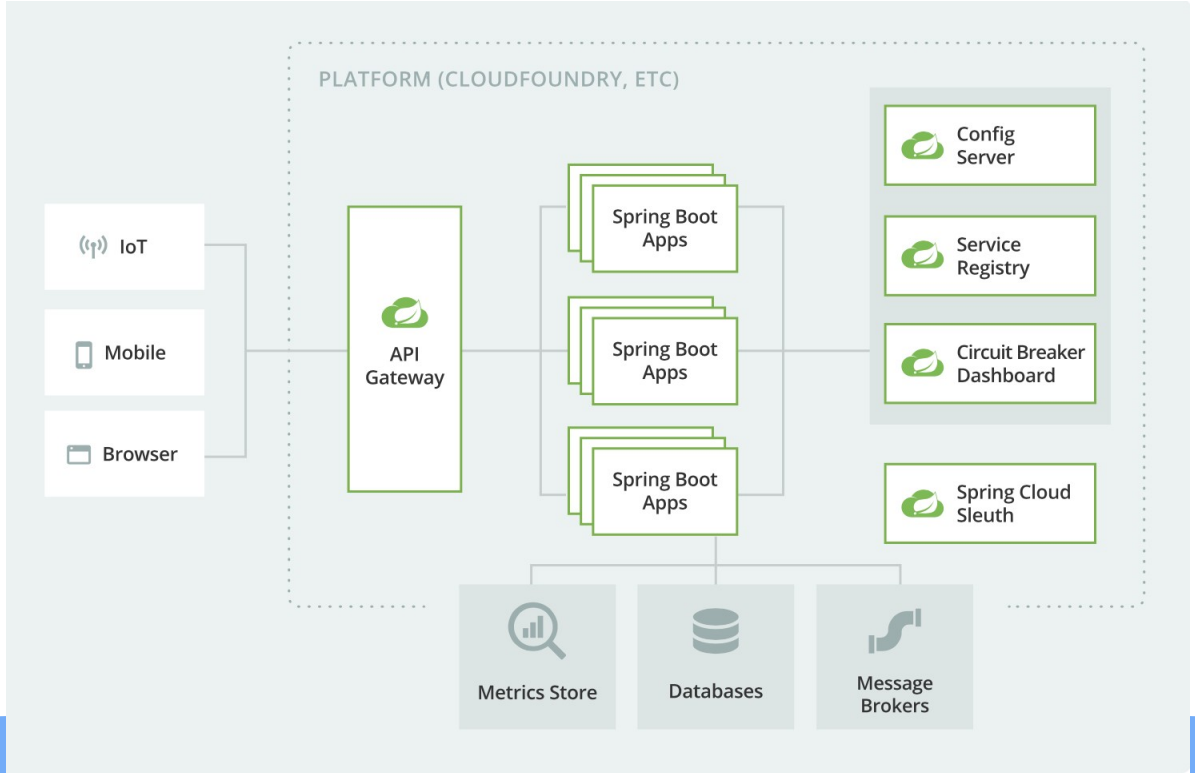
Microservices

- Microservice architectures are the ‘new normal’.
  - Building small, self-contained, ready to run applications can bring great flexibility and added resilience to your code.
  - Spring Boot’s many purpose-built features make it easy to build and run your microservices in production at scale.
  - And don’t forget, no microservice architecture is complete without Spring Cloud – easing administration and boosting your fault-tolerance.

- What are microservices?
  - Microservices are a modern approach to software whereby application code is delivered in small, manageable pieces, independent of others.
- Why build microservices?
  - Their small scale and relative isolation can lead to many additional benefits, such as easier maintenance, improved productivity, greater fault tolerance, better business alignment, and more.

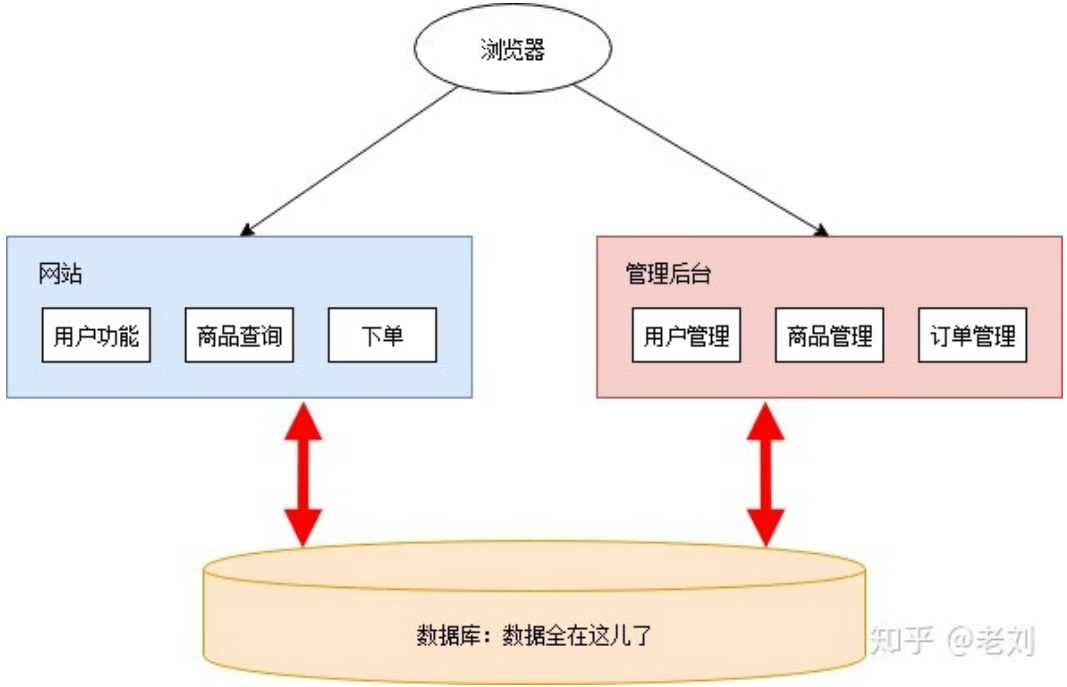
Microservice resilience with Spring Cloud

- The distributed nature of microservices brings challenges.
  - service discovery, load-balancing, circuit-breaking, distributed tracing, and monitoring



Microservice – a sample

- 在线商店



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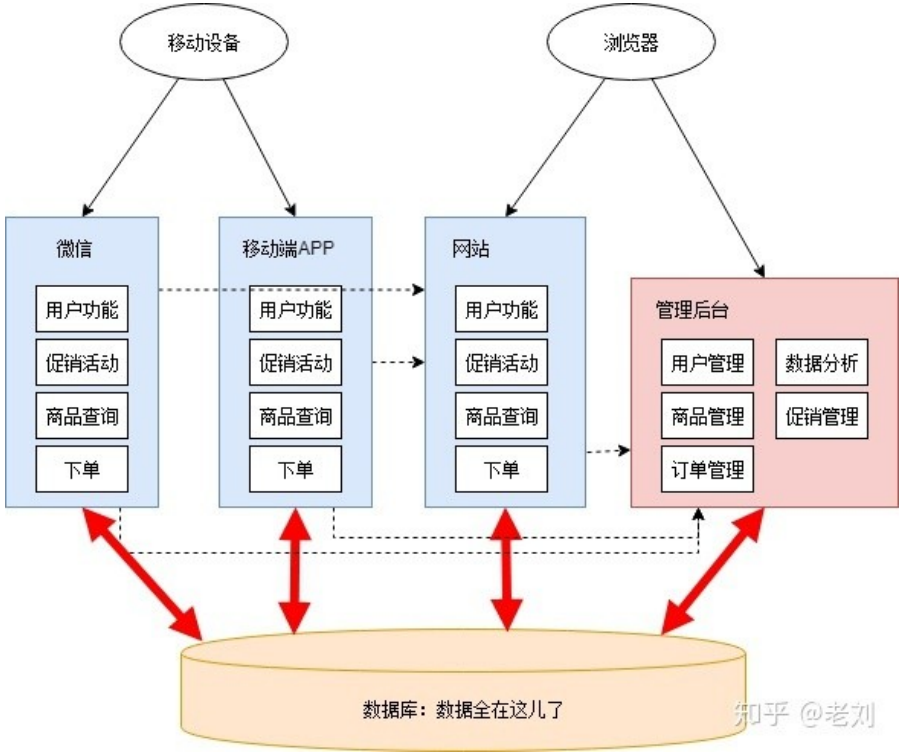
Microservice – a sample

- 移动端



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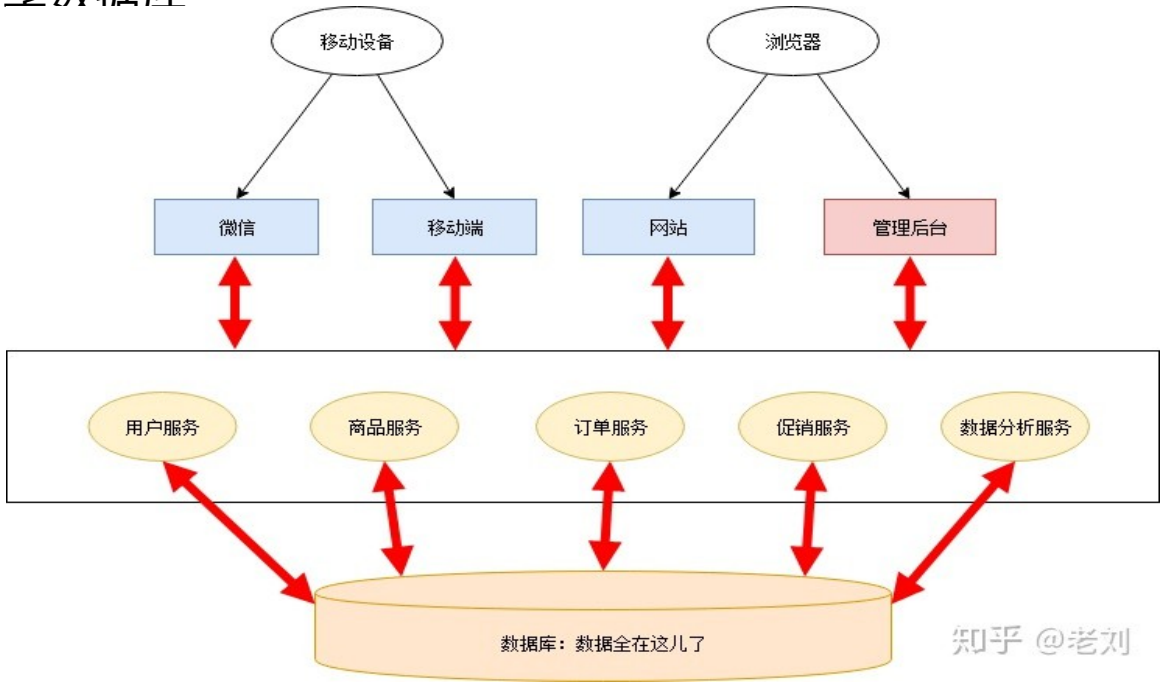
Microservice – a sample

- 服务独立 + 共享数据库



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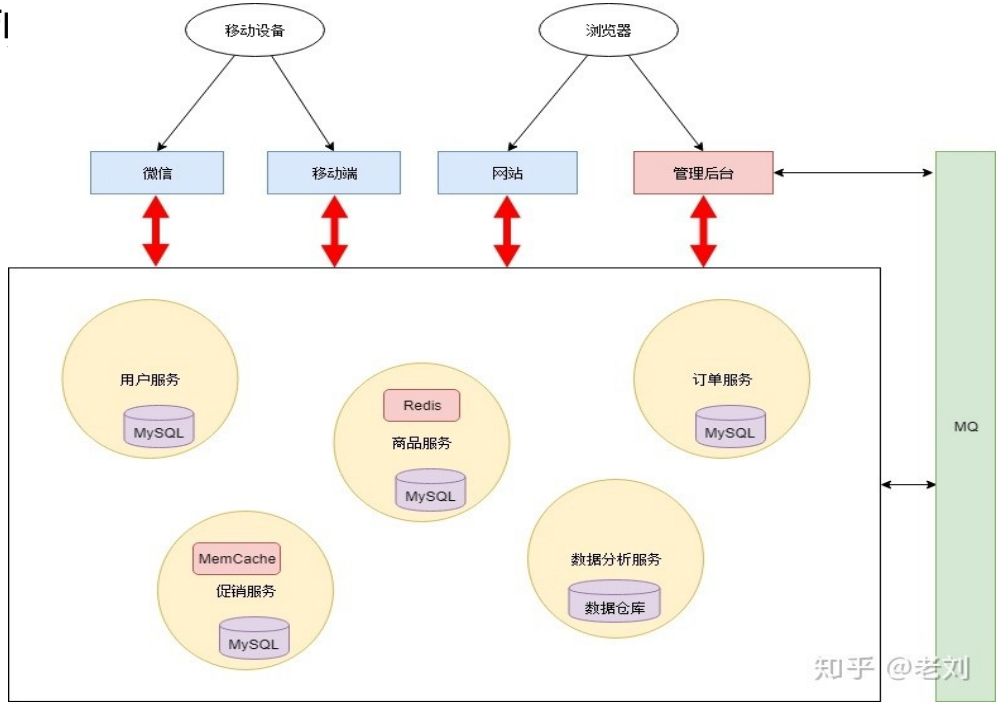
Microservice – a sample

- 独立数据库 + 消息队列



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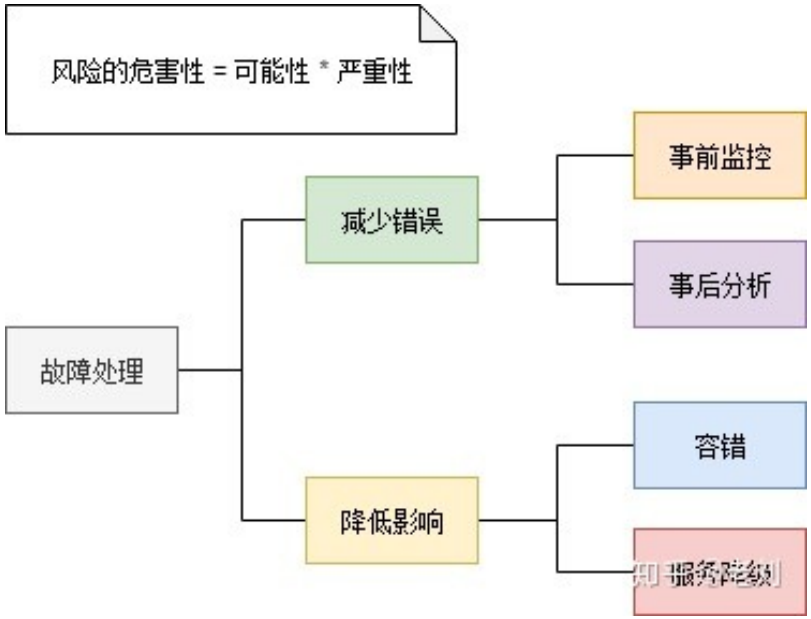
Microservice – a sample

- 故障处理



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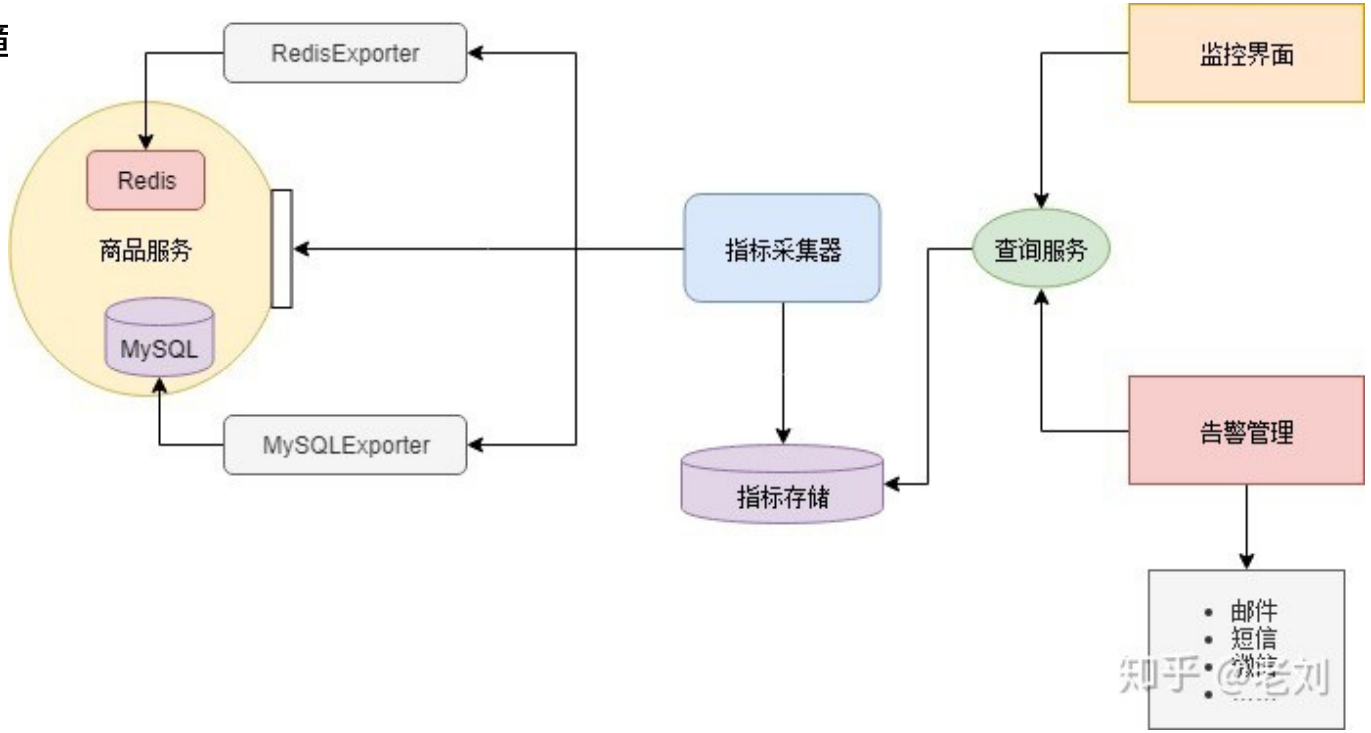
Microservice – a sample

- 监控 - 发现故障



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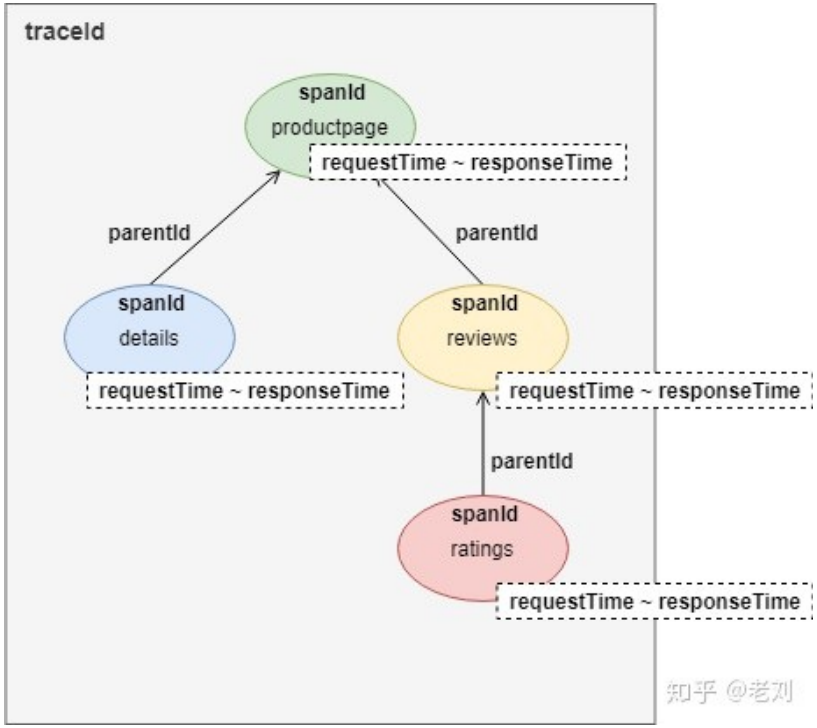
Microservice – a sample

- 定位问题 - 链路跟踪



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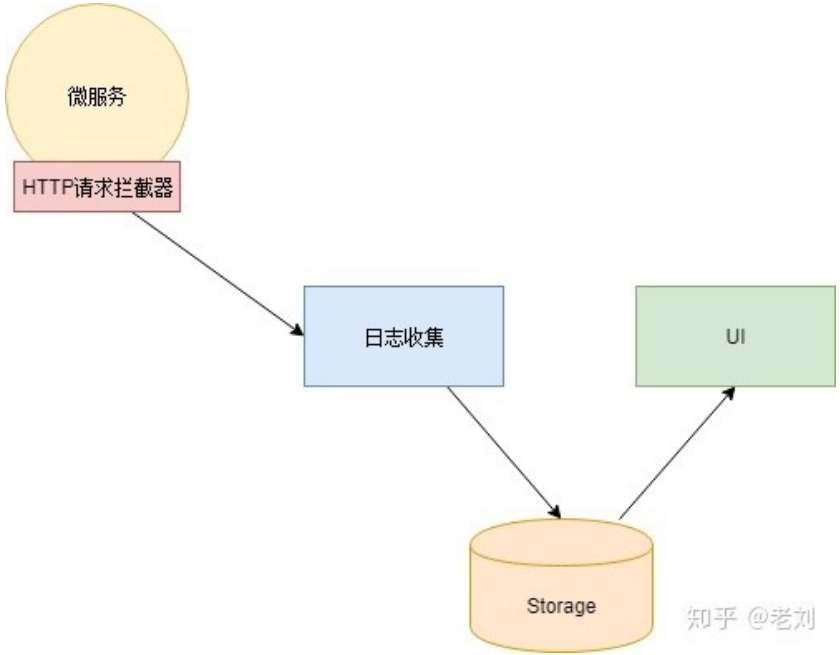
Microservice – a sample

- 日志收集



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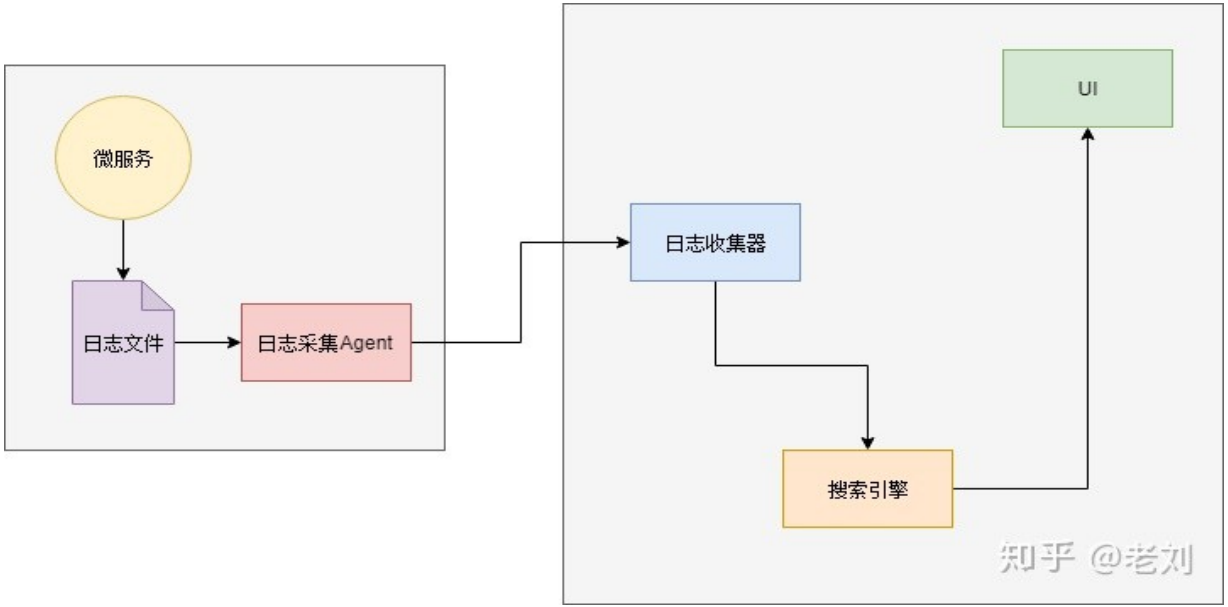
Microservice – a sample

- 分析问题 - 日志分析



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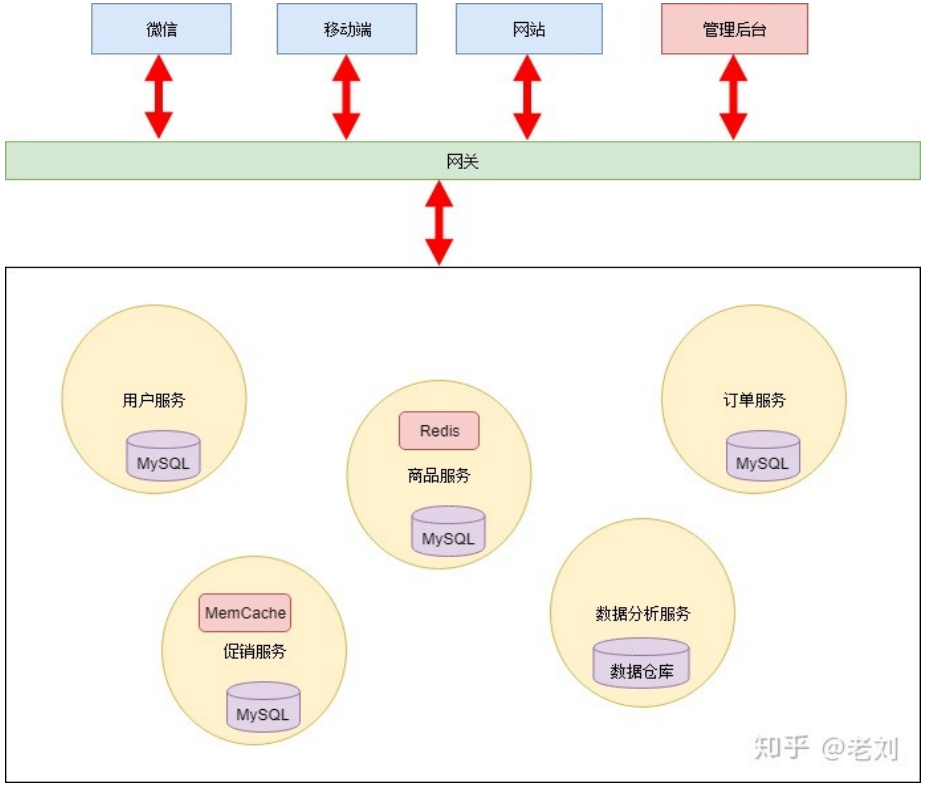
Microservice – a sample

- 网关



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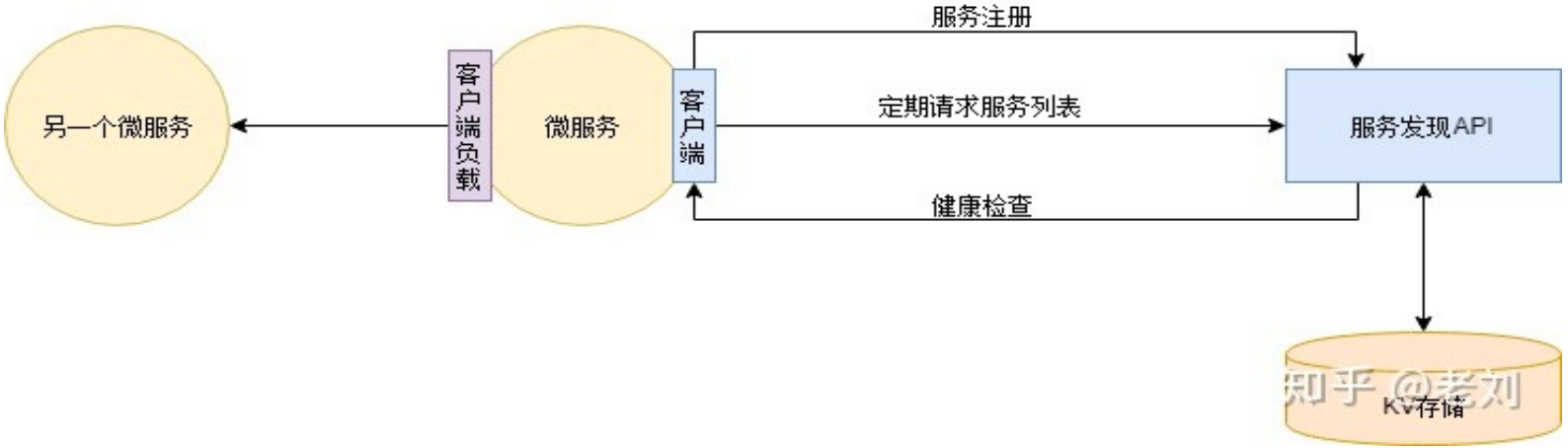
Microservice – a sample

- 服务注册于发现 - 动态扩容



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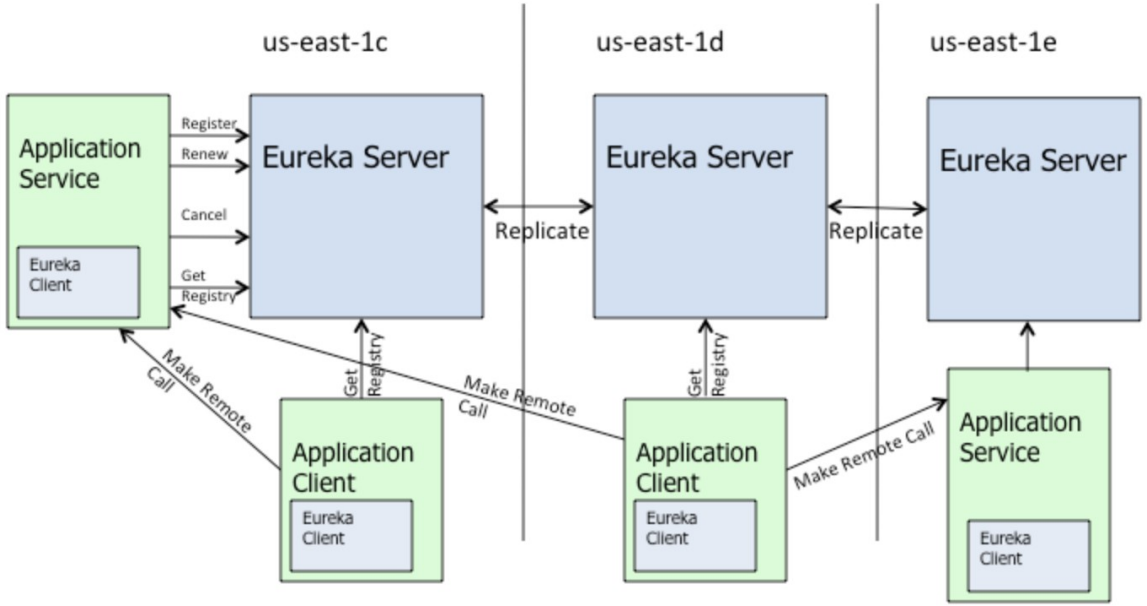
Service Registration & Discovery

- In the cloud,
  - applications can’t always know the exact location of other services.
  - A service registry, such as Netflix Eureka, or a sidecar solution, such as HashiCorp Consul, can help.
  - Spring Cloud provides DiscoveryClient implementations for popular registries such as Eureka, Consul, Zookeeper, and even Kubernetes' built-in system.
  - There’s also a Spring Cloud Load Balancer to help you distribute the load carefully among your service instances.

Eureka

- Eureka is
  - a REST (Representational State Transfer) based service that is primarily used in the AWS cloud for locating services for the purpose of load balancing and failover of middle-tier servers.
  - We call this service, the **Eureka Server**.
  - Eureka also comes with a Java-based client component, the **Eureka Client**, which makes interactions with the service much easier.
  - The client also has a built-in load balancer that does basic round-robin load balancing.
  - At Netflix, a much more sophisticated load balancer wraps Eureka to provide weighted load balancing based on several factors like traffic, resource usage, error conditions etc. to provide superior resiliency.

- High-Level Architecture
  - There is **one** eureka cluster per **region** which knows only about instances in its region. There is at the least **one** eureka server per **zone** to handle zone failures.



Service Application

- pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-starter-netflix-eureka-server</artifactId>
    </dependency>
</dependencies>
<dependencyManagement>
    <dependencies>
        <dependency>
            <groupId>org.springframework.cloud</groupId>
            <artifactId>spring-cloud-dependencies</artifactId>
            <version>${spring-cloud.version}</version>
            <type>pom</type>
            <scope>import</scope>
        </dependency>
    </dependencies>
</dependencyManagement>
```

Service Application

- Main java class

```
@EnableEurekaServer
@SpringBootApplication
public class ServiceRegistrationAndDiscoveryServiceApplication {

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

Service Application

- resources/application.properties

```
server.port=8761

eureka.client.register-with-eureka=false
eureka.client.fetch-registry=false

logging.level.com.netflix.eureka=OFF
logging.level.com.netflix.discovery=OFF
```

Client Application

- pom.xml

```
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-starter-netflix-eureka-client</artifactId>
    </dependency>
</dependencies>
<dependencyManagement>
    <dependencies>
        <dependency>
            <groupId>org.springframework.cloud</groupId>
            <artifactId>spring-cloud-dependencies</artifactId>
            <version>${spring-cloud.version}</version>
            <type>pom</type>
            <scope>import</scope>
        </dependency>
    </dependencies>
</dependencyManagement>
```

Client Application

- Main java class

```
@SpringBootApplication
public class ServiceRegistrationAndDiscoveryClientApplication {

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

@RestController
class ServiceInstanceRestController {

  @Autowired
  private DiscoveryClient discoveryClient;

  @RequestMapping("/service-instances/{applicationName}")
  public List<ServiceInstance> serviceInstancesByApplicationName(
      @PathVariable String applicationName) {
    return this.discoveryClient.getInstances(applicationName);
  }
}
```

Client Application

- resources/application.properties

```
spring.application.name=a-bootiful-client
```

Test the Application

- http://localhost:8080/service-instances/a-bootiful-client


```
[{"instanceId":"172.20.10.6:a-bootiful-client","serviceId":"A-BOOTIFUL-
CLIENT","uri":"http://172.20.10.6:8080","instanceInfo":
{"instanceId":"172.20.10.6:a-bootiful-client","app":"A-BOOTIFUL-
CLIENT","appGroupName":null,"ipAddr":"172.20.10.6","sid":"na","homePageUrl":"htt
p://172.20.10.6:8080/","statusPageUrl":"http://172.20.10.6:8080/actuator/info","
healthCheckUrl":"http://172.20.10.6:8080/actuator/health","secureHealthCheckUrl"
:null,"vipAddress":"a-bootiful-client","secureVipAddress":"a-bootiful-
client","countryId":1,"dataCenterInfo":
{"@class":"com.netflix.appinfo.InstanceInfo$DefaultDataCenterInfo","name":"MyOwn
"},"hostName":"172.20.10.6","status":"UP","overriddenStatus":"UNKNOWN","leaseInf
o":
{"renewalIntervalInSecs":30,"durationInSecs":90,"registrationTimestamp":16210586
04835,"lastRenewalTimestamp":1621058604835,"evictionTimestamp":0,"serviceUpTimes
tamp":1621058604235},"isCoordinatingDiscoveryServer":false,"metadata":
{"management.port":"8080"},"lastUpdatedTimestamp":1621058604835,"lastDirtyTimest
amp":1621058604180,"actionType":"ADDED","asgName":null},"scheme":"http","host":"
172.20.10.6","port":8080,"metadata":{"management.port":"8080"},"secure":false}]
```

Test the Application

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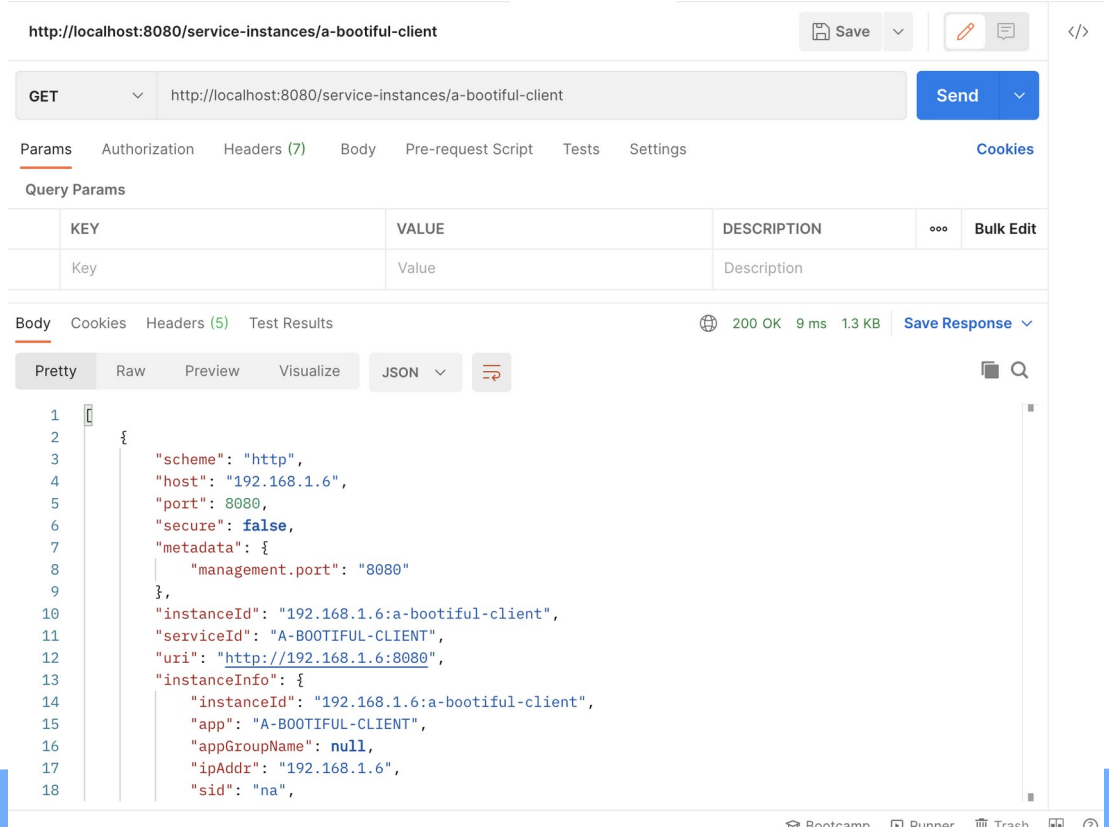
- http://localhost:8080/service-instances/a-bootiful-client



Spring Cloud Gateway

- pom.xml

```
<dependencies>
  <dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-gateway</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-circuitbreaker-reactor-resilience4j</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-starter-contract-stub-runner</artifactId>
    <exclusions>
      <exclusion>
        <artifactId>spring-boot-starter-web</artifactId>
        <groupId>org.springframework.boot</groupId>
      </exclusion>
    </exclusions>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
  </dependency>
</dependencies>
```

```
<!-- https://mvnrepository.com/artifact/io.netty/netty-resolver-dns-native-macos
-->
<dependency>
    <groupId>io.netty</groupId>
    <artifactId>netty-resolver-dns-native-macos</artifactId>
    <version>4.1.97.Final</version>
    <classifier>osx-aarch_64</classifier>
</dependency>
```

Spring Cloud Gateway

- Main Java Class

```
@SpringBootApplication
@EnableConfigurationProperties(UriConfiguration.class)
@RestController
public class Se335310GatewayApplication {

    public static void main(String[] args) {
        SpringApplication.run(Se335310GatewayApplication.class, args);
    }

    @Bean
    public RouteLocator myRoutes(RouteLocatorBuilder builder, UriConfiguration
uriConfiguration) {
        String httpUri = uriConfiguration.getHttpbin();
        return builder.routes()
                .route(p -> p
                        .path("/get")
                        .filters(f -> f.addRequestHeader("Hello", "World"))
                        .uri(httpUri))
                .route(p -> p
                        .host("*.circuitbreaker.com")
                        .filters(f -> f
                                .circuitBreaker(config -> config
                                        .setName("mycmd")
                                        .setFallbackUri("forward:/fallback")))
                        .uri(httpUri))
                .build();
    }

    @RequestMapping("/fallback")
    public Mono<String> fallback() {
        return Mono.just("fallback");
    }
}
```

- Main Java Class

```
@ConfigurationProperties
class UriConfiguration {

    private String httpbin = "http://httpbin.org:80";

    public String getHttpbin() {
        return httpbin;
    }

    public void setHttpbin(String httpbin) {
        this.httpbin = httpbin;
    }
}
```

Test the Gateway

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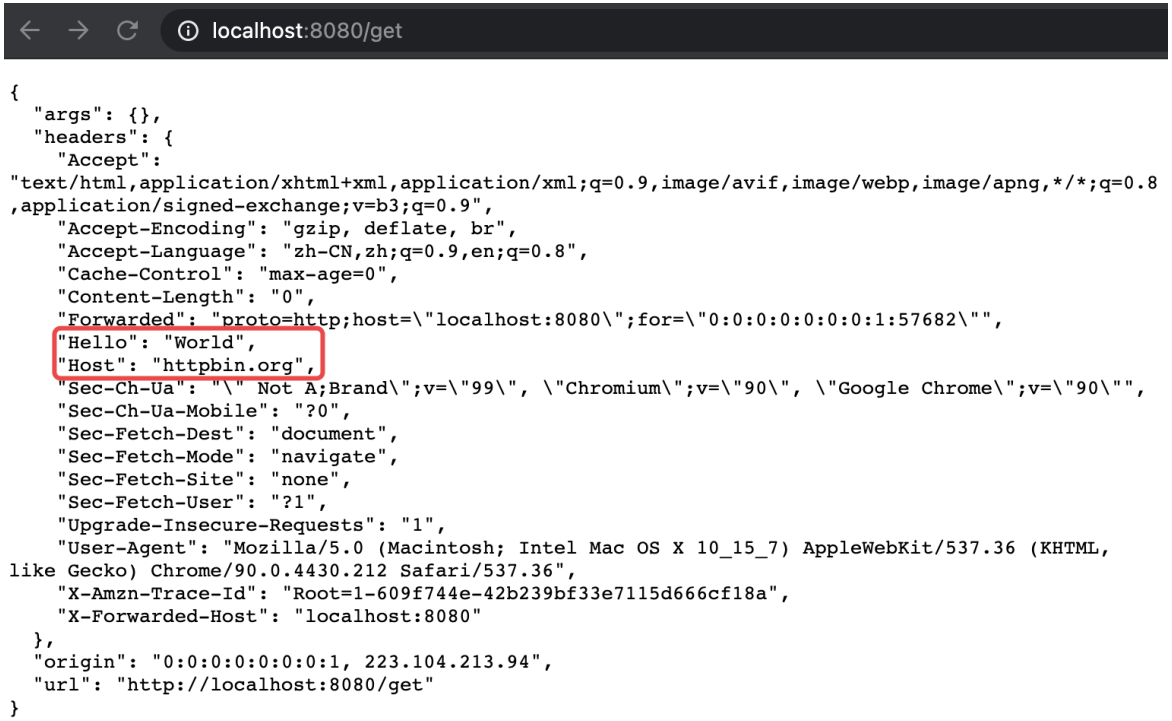
- http://localhost:8080/get



Routing and Filtering – Book App

- Main Java Class

```
@RestController
@RequestMapping("/books")
@SpringBootApplication
public class RoutingAndFilteringBookApplication {

  @RequestMapping(value = "/available")
  public String available() {
    return "Spring in Action";
  }

  @RequestMapping(value = "/checked-out")
  public String checkedOut() {
    return "Spring Boot in Action";
  }

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

Routing and Filtering – Book App

- application.properties

```
spring.application.name=book

server.port=8090
```

Routing and Filtering – Edge Service

- Main Java Class

```
@SpringBootApplication
public class GatewayApplication {

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

    @Bean
    public RouteLocator myRoutes(RouteLocatorBuilder builder) {
        return builder.routes()
                .route(p -> p
                        .path("/books/**")
                        .filters(f->f.rewritePath("/books",""))
                        .uri("http://localhost:8090/"))
                .build();
    }

}
```

Routing and Filtering – Edge Service

- application.properties

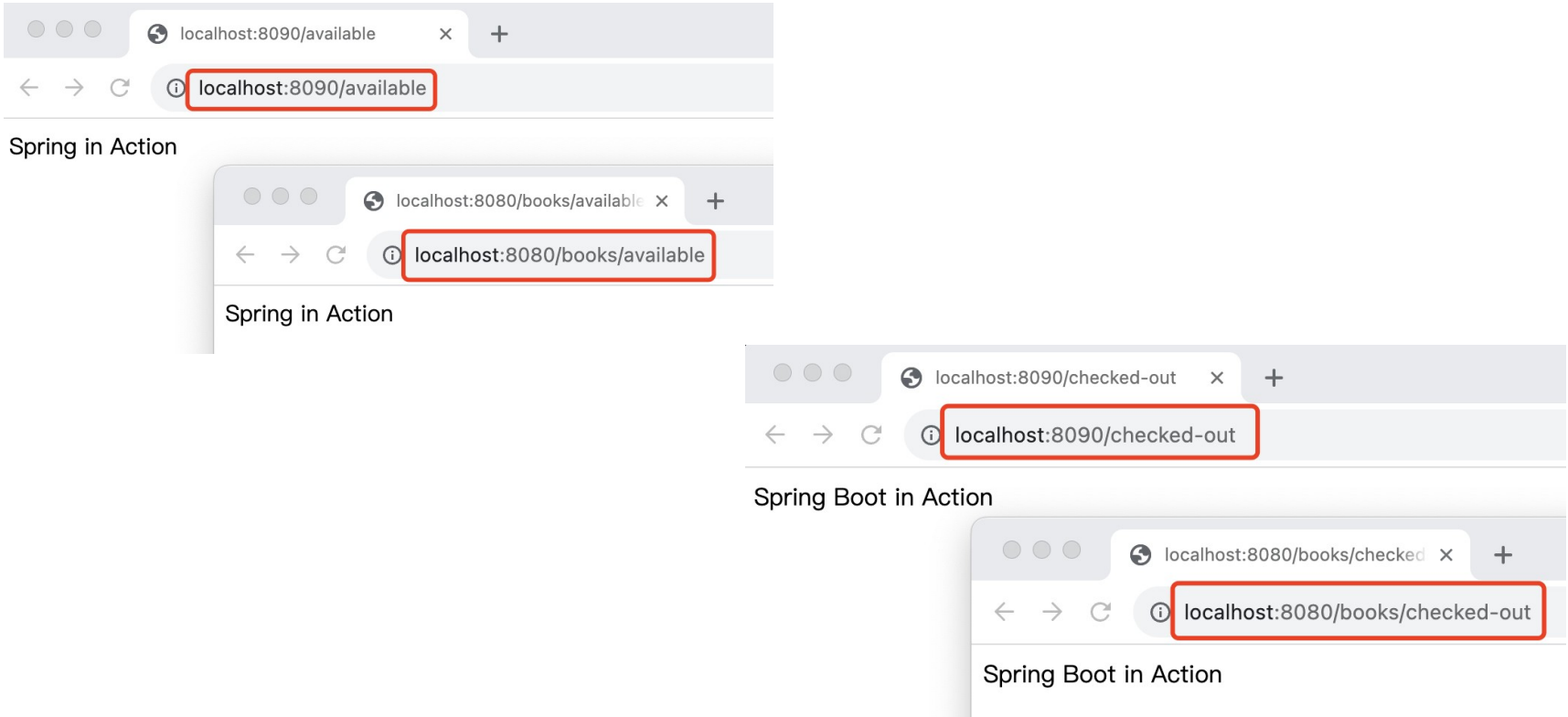
```
server.port=8080
```

Test Gateway

- You can access the book application
  - directly at localhost:8090/available and
  - through the Gateway service at localhost:8080/books/available.

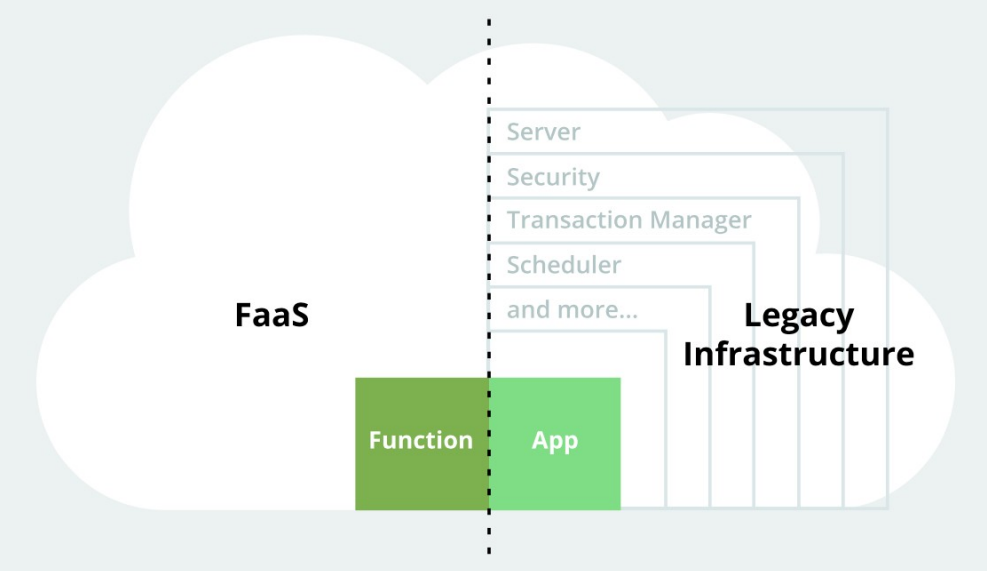
- Visit one of the Book service endpoints
  - (localhost:8080/books/available or localhost:8080/books/checked-out)

Test Netflix Zuul Gateway



Serverless

- Serverless applications
  - take advantage of modern cloud computing capabilities and abstractions to let you focus on logic rather than on infrastructure.
  - In a serverless environment, you can concentrate on writing application code while the underlying platform takes care of scaling, runtimes, resource allocation, security, and other “server” specifics.



Serverless

- What is serverless?
  - Serverless workloads are “event-driven workloads that aren’t concerned with aspects normally handled by server infrastructure.”
  - Concerns like “how many instances to run” and “what operating system to use” are all managed by a Function as a Service platform (or FaaS), leaving developers free to focus on business logic.

- Serverless characteristics?
  - Serverless applications have a number of specific characteristics, including:
    - Event-driven code execution with triggers
    - Platform handles all the starting, stopping, and scaling chores
    - Scales to zero, with low to no cost when idle
    - Stateless

Spring Cloud Function

- Spring Cloud Function
  - provides capabilities that lets Spring developers take advantage of serverless or FaaS platforms.
- Spring Cloud Function
  - provides adaptors so that you can run your functions on the most common FaaS services including :
  - Amazon Lambda, Apache OpenWhisk, Microsoft Azure, and Project Riff.

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

Function Sample

- Main Java Class

```
@SpringBootApplication
public class FunctionsampleApplication {

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

    @Bean
    public Function<Flux<Integer>, Flux<Integer>> name() { return e -> e.map(value -> value * 2) ;  }

    @Bean
    public Function<Flux<Integer>, Flux<Integer>> square() { return e -> e.map(value -> value * value) ;  }

    @Bean
    public Function<Flux<Integer>, Flux<Integer>> compose() { return e -> name().compose(square()).apply(e); }

    @Bean
    public Function<Flux<Integer>, Flux<Integer>> andThen() { return e -> name().andThen(square()).apply(e); }

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

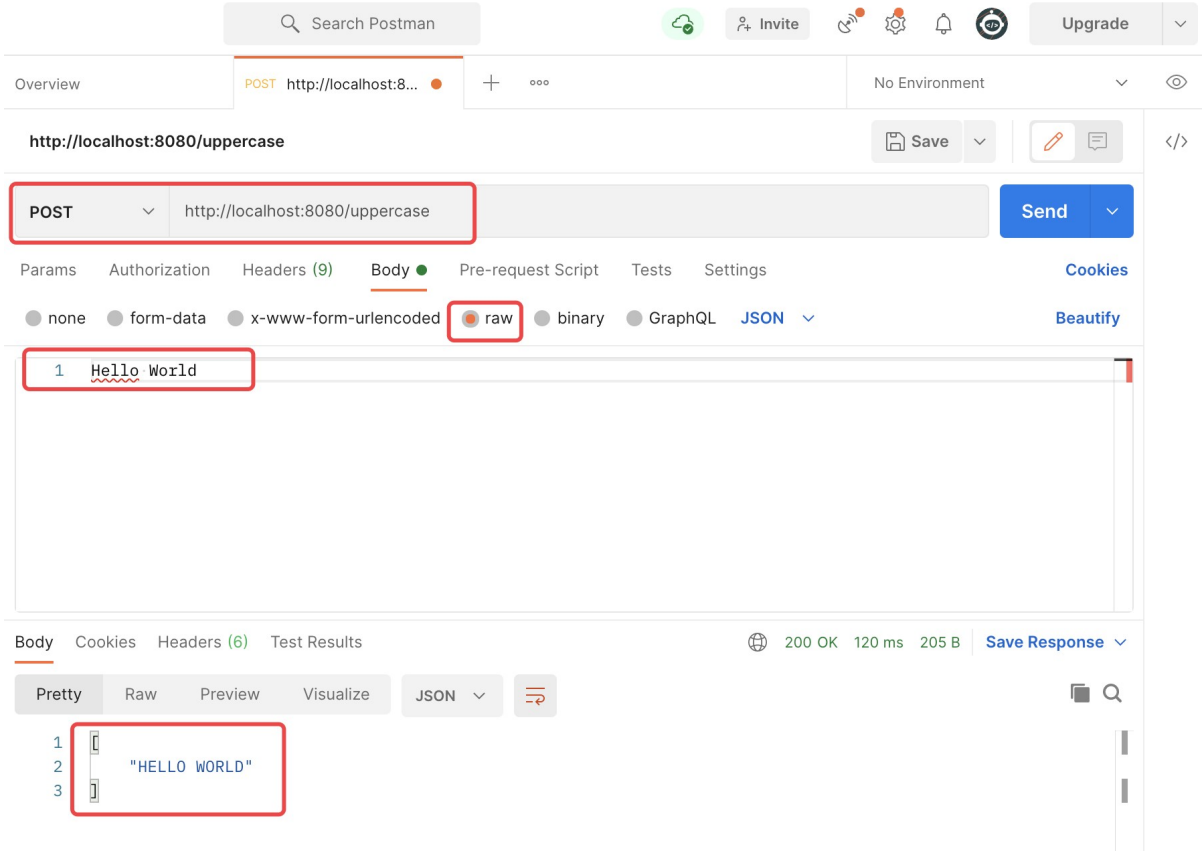
Function Sample

- pom.xml

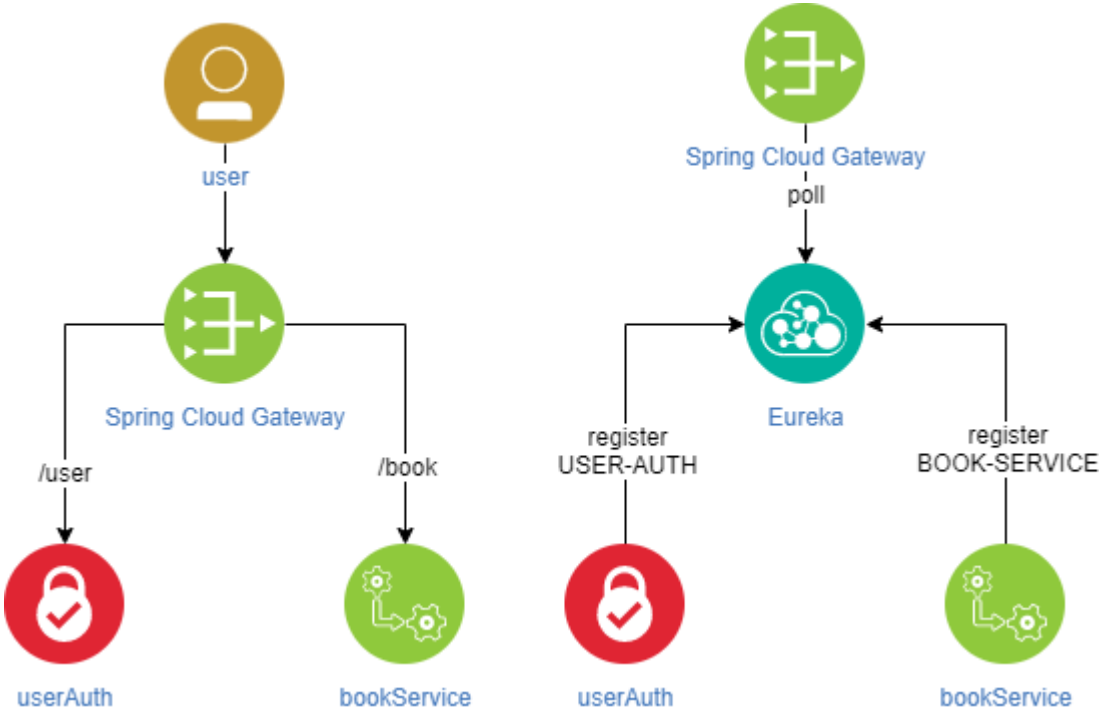
```
 <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.cloud</groupId>
    <artifactId>spring-cloud-function-web</artifactId>
</dependency>
```

```
<dependencyManagement>
    <dependencies>
      <dependency>

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

<artifactId>spring-cloud-dependencies</artifactId>
        <version>${spring-cloud.version}</version>
        <type>pom</type>
        <scope>import</scope>
      </dependency>
    </dependencies>
</dependencyManagement>
```

Function Sample



Microservice Demo



Microservice Demo Eureka

- application.yaml

```yaml
server:
  port:
    8040
spring:
  application:
    name: Eureka
eureka:
  instance:
    prefer-ip-address: true
  client:
    fetch-registry: false
    register-with-eureka: false
    serviceUrl:
      defaultZone: http://localhost:8040/eureka
```

Microservice Demo Eureka

- EurekaApplication

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

Microservice Demo Eureka

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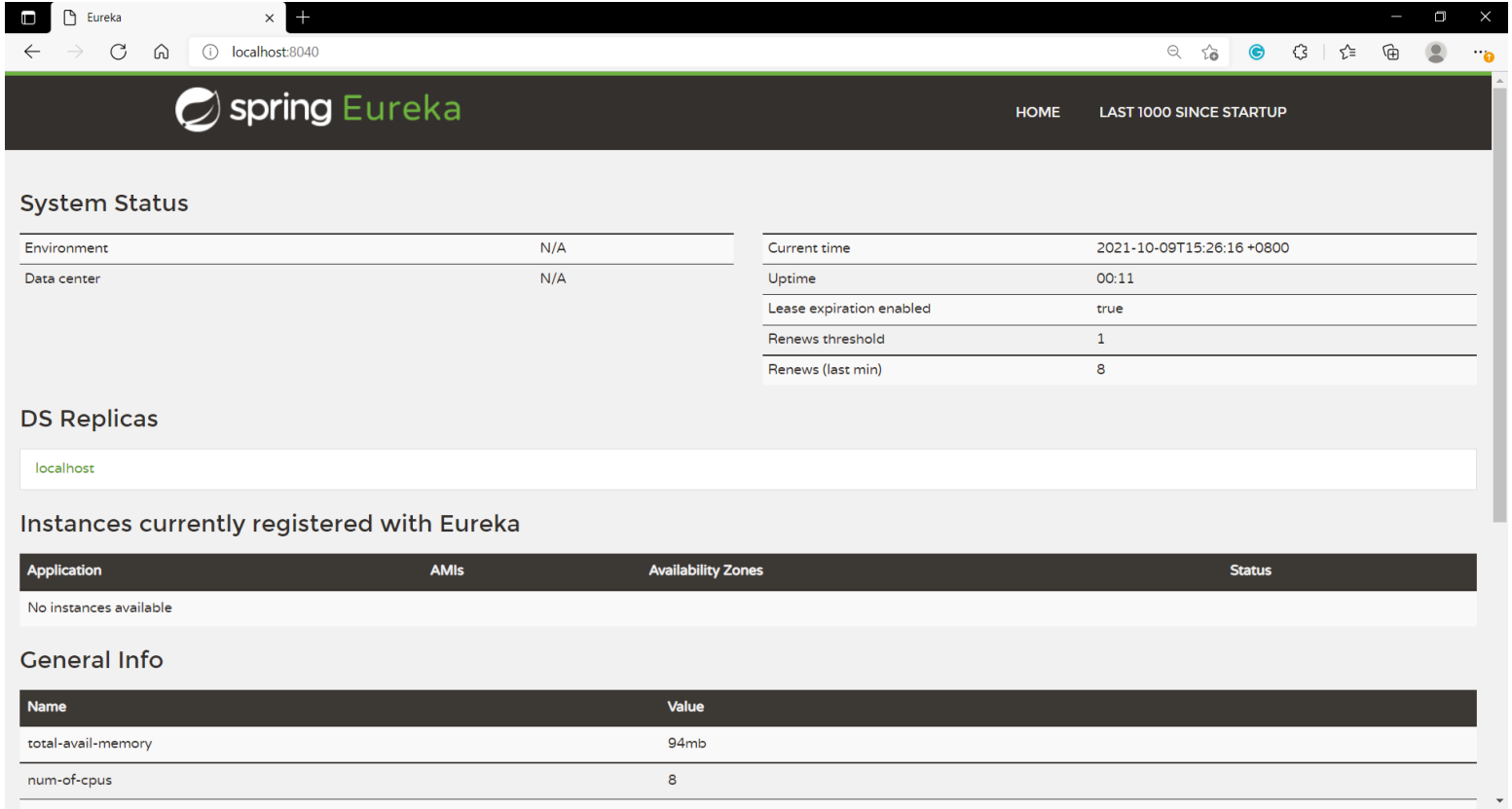

Microservice Demo Book Service

- application.yaml

```yaml
spring:
  application:
    name: book-service

eureka:
  instance:
    prefer-ip-address: true
    ip-address: localhost
  client:
    registerWithEureka: true
    fetchRegistry: true
    serviceUrl:
      defaultZone: http://localhost:8040/eureka

server:
  port: 11130
```

Microservice Demo Book Service

- BookController

```
@Slf4j
@RestController
public class BookController {
    @RequestMapping("/buyBook")
    public ResultDTO checkAuth(@RequestHeader("userName") String userName,
                               @RequestParam("bookName") String bookName){
        log.info("userName: {}, bookName: {}", userName, bookName);
        return ResultDTO.success(String.format("userName: %s, bookName: %s", userName, bookName));
    }
}
```

Microservice Demo Book Service

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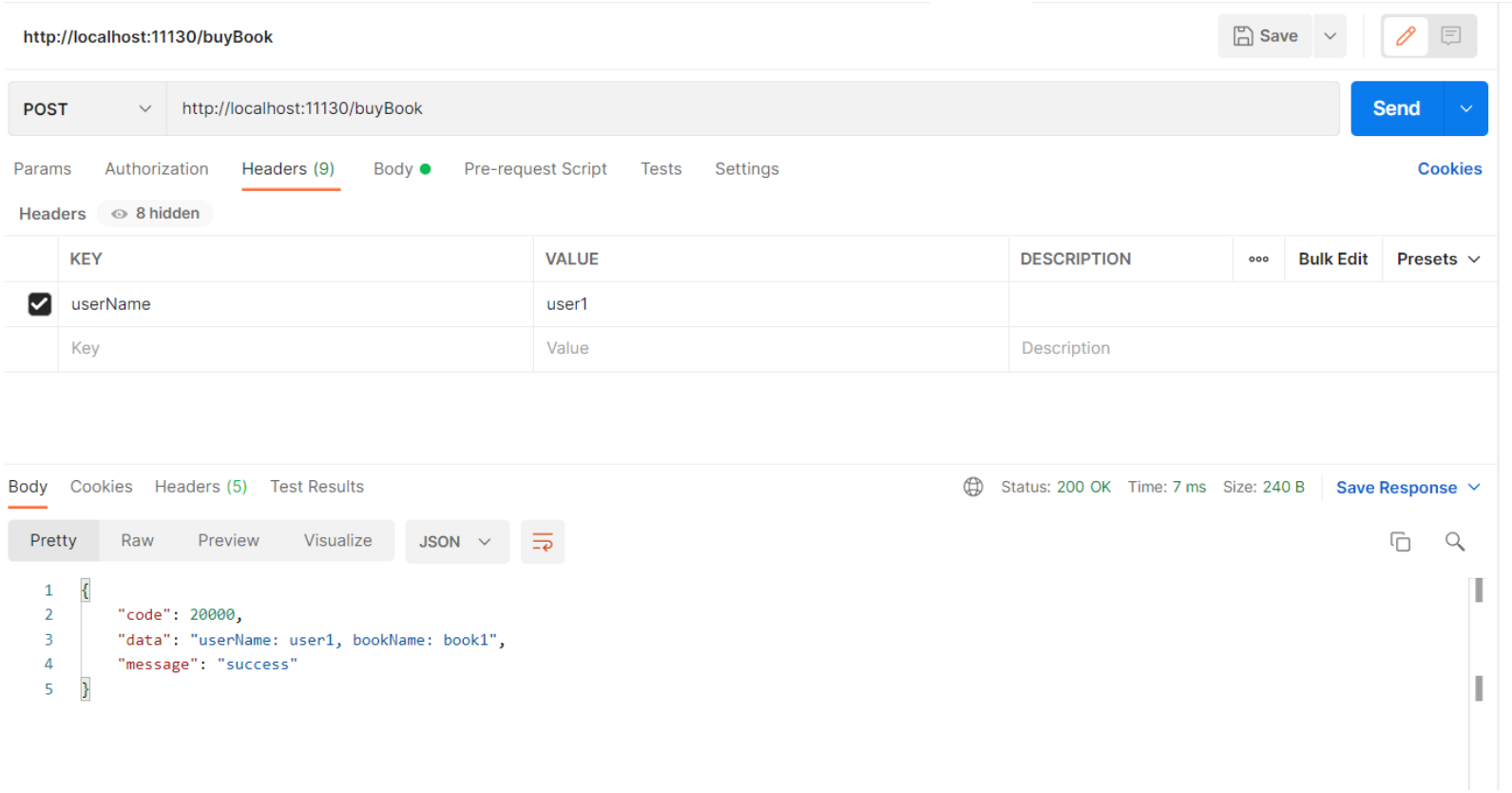

Microservice Demo Book Service

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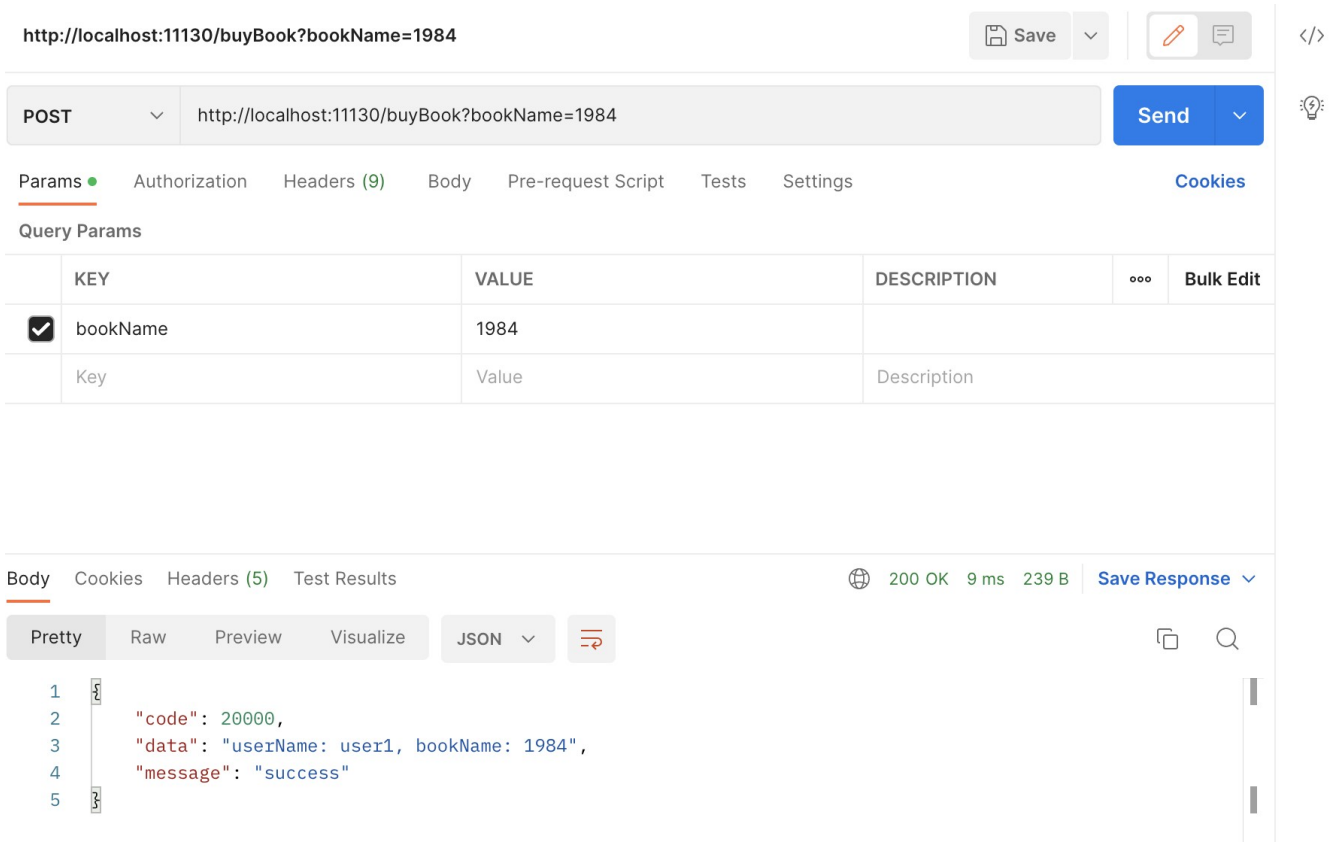

Microservice Demo User Authorize

- application.yaml

```yaml
spring:
  application:
    name: user-auth

eureka:
  instance:
    prefer-ip-address: true
    ip-address: localhost
  client:
    registerWithEureka: true
    fetchRegistry: true
    serviceUrl:
      defaultZone: http://localhost:8040/eureka

server:
  port: 11230
```

Microservice Demo User Authorize

- UserinfoController

```
@ResponseBody
@PostMapping("/Login")
public Response login(Userinfo userinfo){
    return  userinfoService.verify(userinfo);
}
```

Microservice Demo User Authorize

- UserinfoService

```
public Response verify(Userinfo userinfo) {
    Response response = new Response();
    QueryWrapper<Userinfo> queryWrapper = new QueryWrapper<>();
    queryWrapper.eq("username", userinfo.getUsername());

    if(usernameExist(userinfo.getUsername())){
        Userinfo _userinfo = userinfoMapper.selectOne(queryWrapper);
        if(Objects.equals(userinfo.getPassword(), _userinfo.getPassword())) {
            response.setCode(200);
            response.setMessage("success");
            response.setData(createTokenPair(_userinfo));
        }  else …
    }  else …
    return  response;
}
```

Microservice Demo User Authorize

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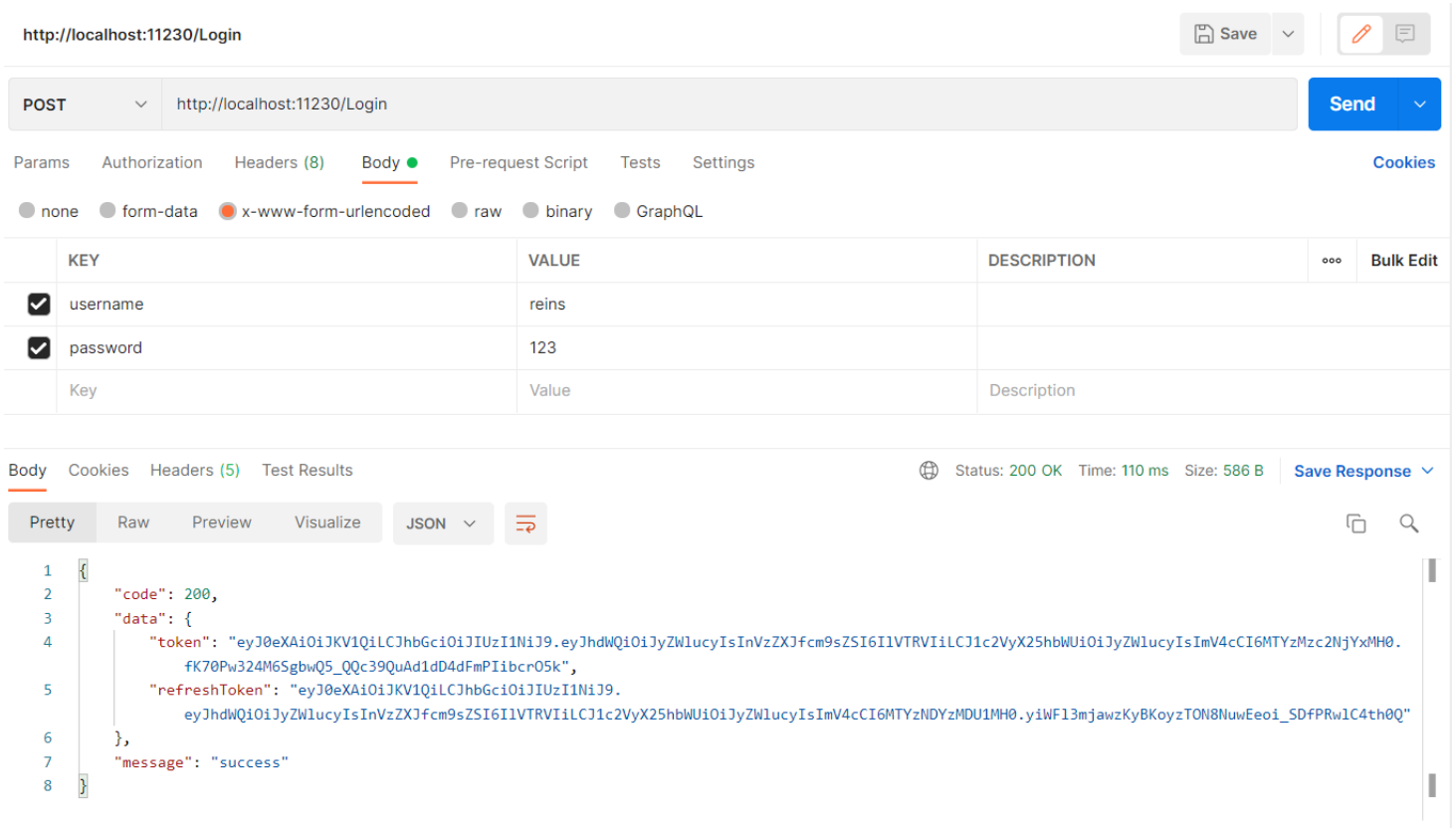


Microservice Demo Gateway

- application.yaml

```yaml
server:
  port: 8080
  error:
    include-message: always
spring:
  cloud:
    gateway:
      globalcors:
        cors-configurations:
          '[/**]':
            allowedOrigins: "*"
            allowedMethods:
              - GET
              - POST
  application:
    name: gateway
```

Microservice Demo Gateway

- application.yaml

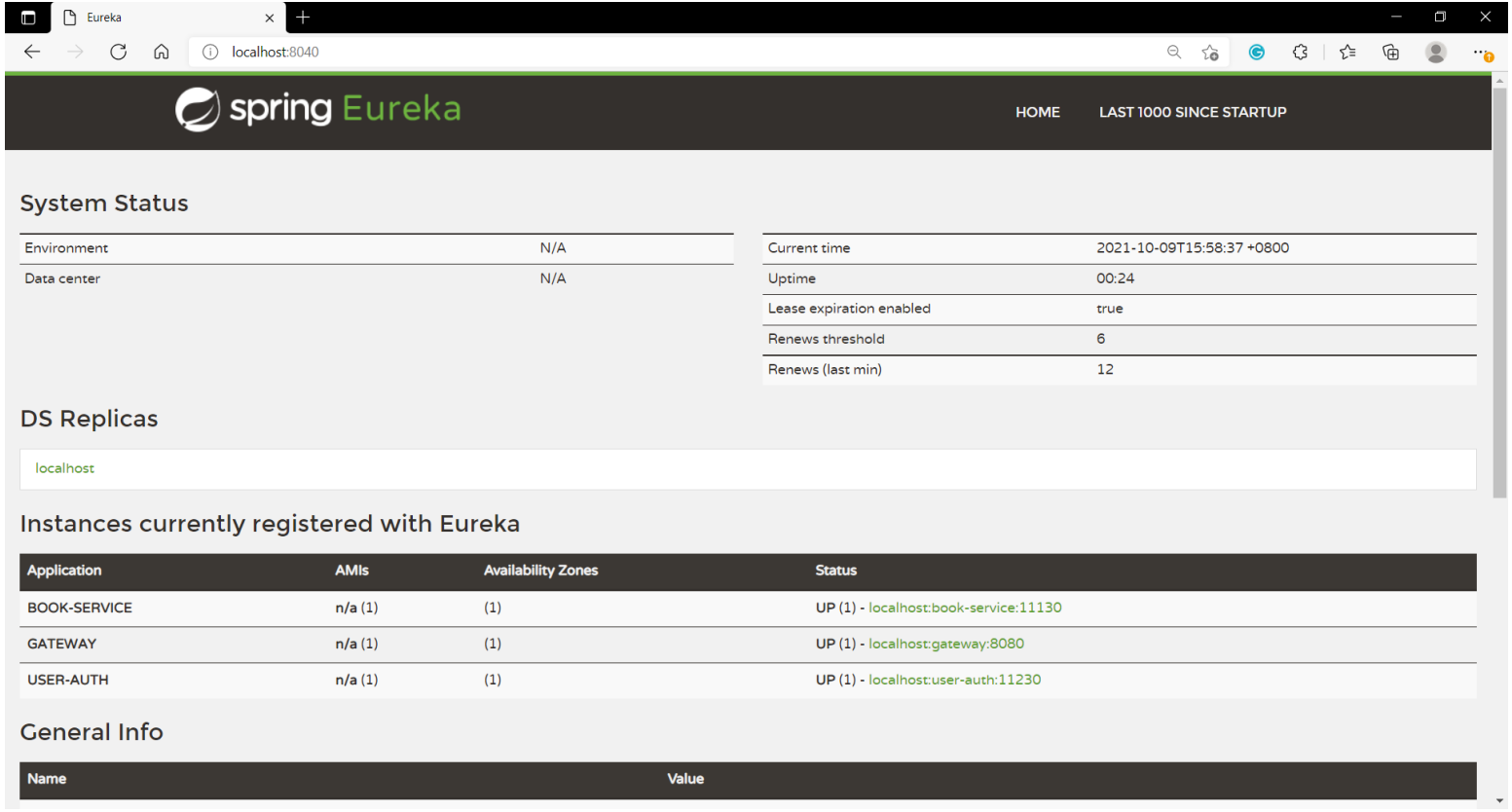
```
eureka:
  instance:
    prefer-ip-address: true
    ip-address: localhost
  client:
    registerWithEureka: true
    fetchRegistry: true
    serviceUrl:
      defaultZone: http://localhost:8040/eureka
    eureka-service-url-poll-interval-seconds: 10
```

Microservice Demo Gateway

- MainGateway

```
@SpringBootApplication
@EnableDiscoveryClient
@EnableEurekaClient
public class MainGateway {
    public static void main(String[] args) {
        SpringApplication.run(MainGateway.class, args);
    }
    @Autowired
    JwtCheckFilter jwtCheckFilter;
    @Bean
    public RouteLocator myRoutes(RouteLocatorBuilder builder) {
        return builder.routes()
                .route(r -> r.path("/book/**")
                        .filters(f -> f.rewritePath("/book","").filter(jwtCheckFilter))
                        .uri("lb://BOOK-SERVICE")
                ).route(r->r.path("/user/**")
                        .filters(f->f.rewritePath("/user",""))
                        .uri("lb://USER-AUTH")
                )
                .build();
    }
}
```

Microservice Demo Service Register



Microservice Demo Gateway

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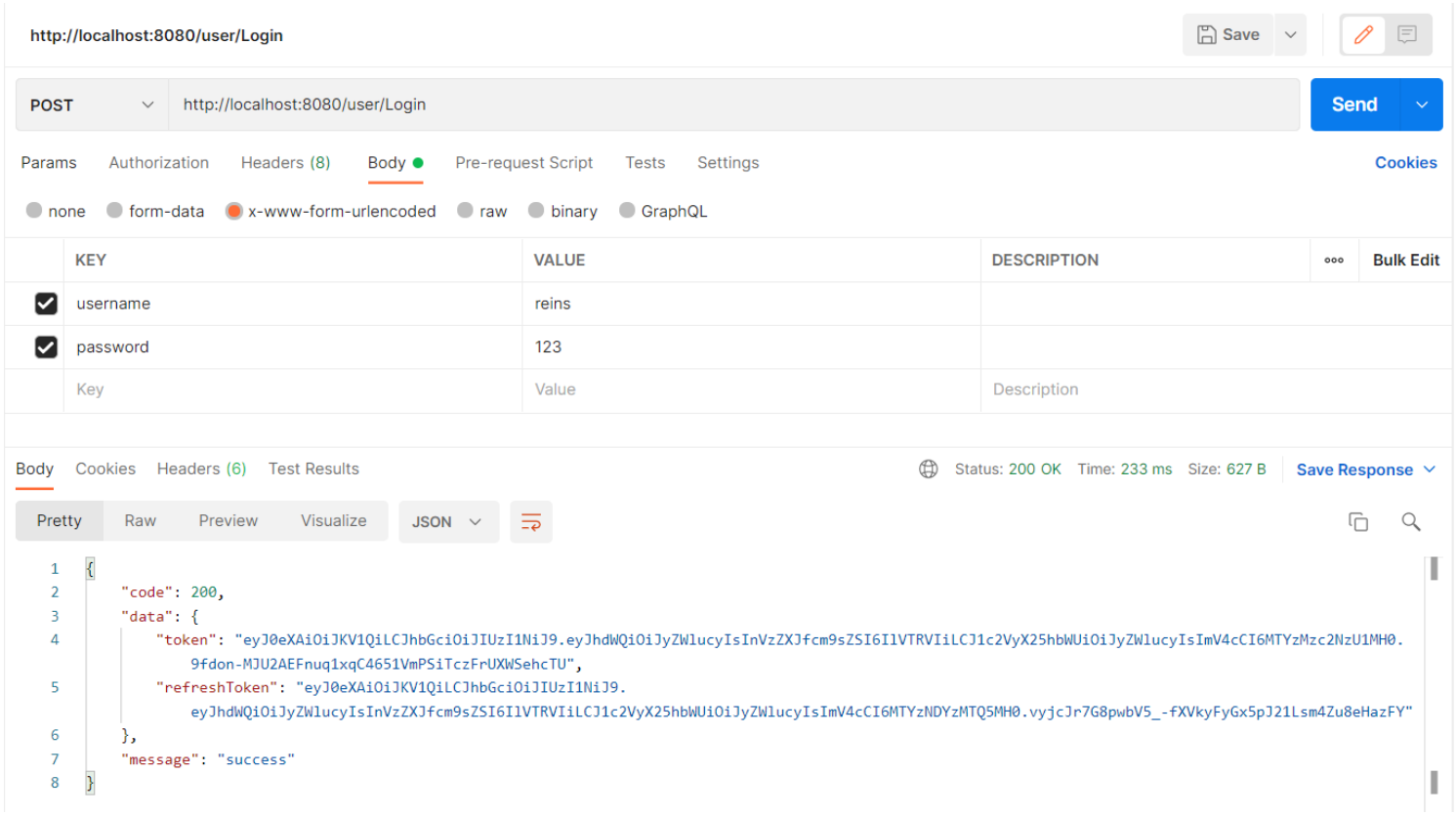
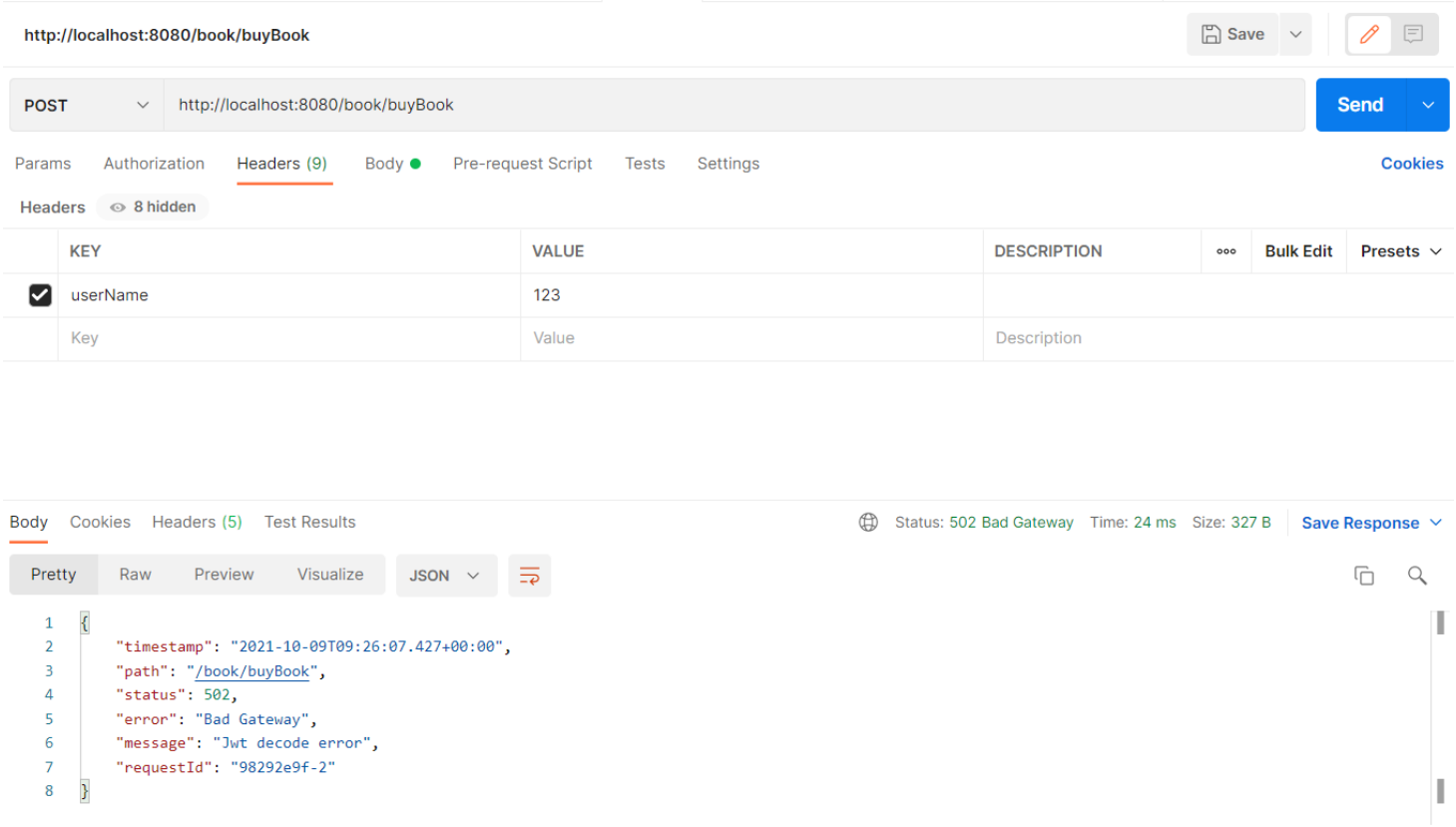


Microservice Demo Gateway



Microservice Demo Gateway

- JwtCheckFilter

```
public Mono<Void> filter(ServerWebExchange exchange, GatewayFilterChain chain) {
    String jwtToken = exchange.getRequest().getHeaders().getFirst("token");
    UserInfo userInfo = jwt.parseToken(jwtToken);
    System.out.println(userInfo);
    if(userInfo != null && userInfo.getUsername()!=null) {
        ServerHttpRequest request = exchange.getRequest().mutate()
                .header("userName", userInfo.getUsername())
                .build();
        return chain.filter(exchange.mutate().request(request).build());
    }
    throw new ResponseStatusException(HttpStatus.BAD_GATEWAY, "Jwt decode error");
}
```

Microservice Demo Gateway

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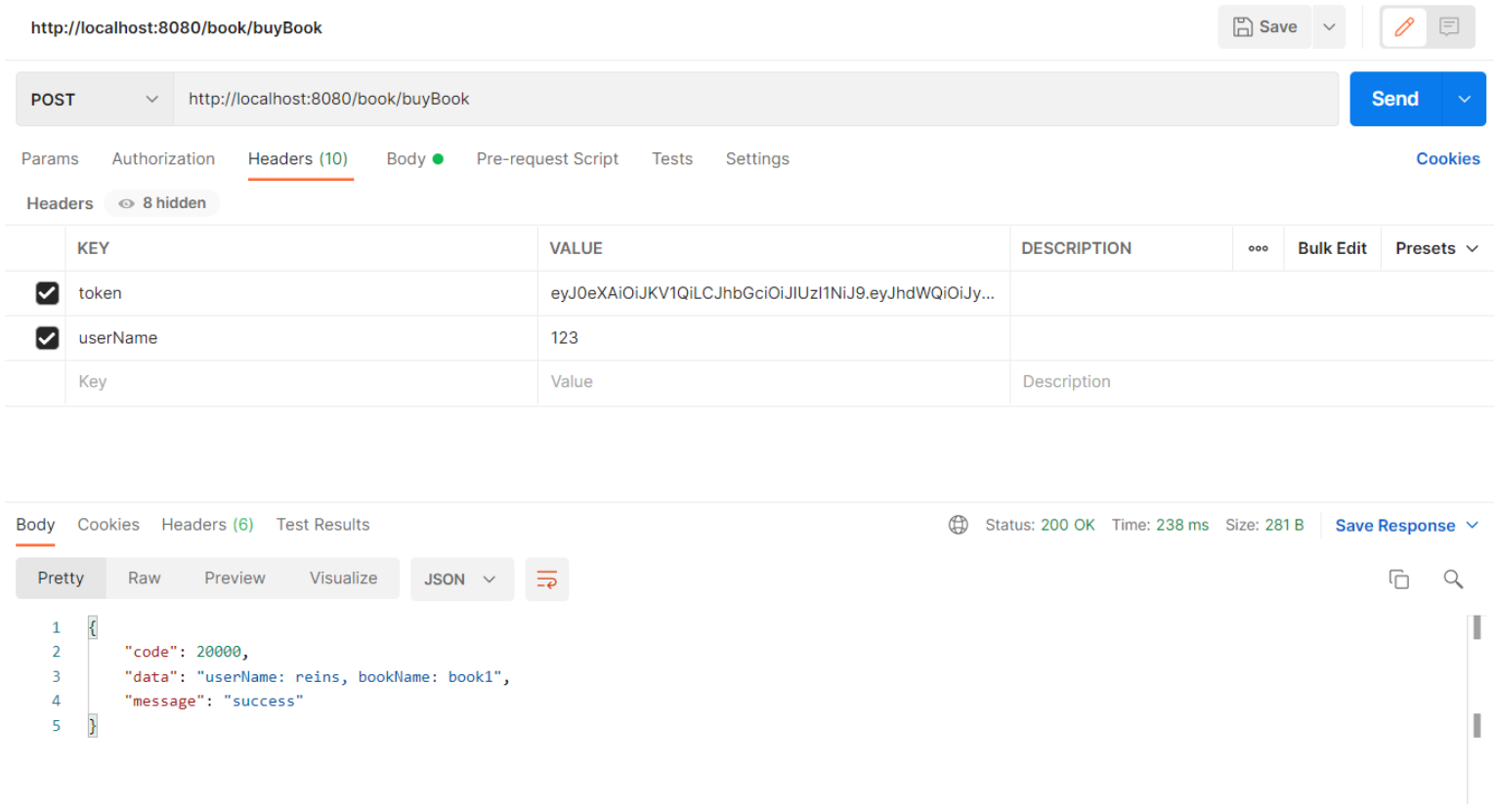

Microservice Demo Gateway

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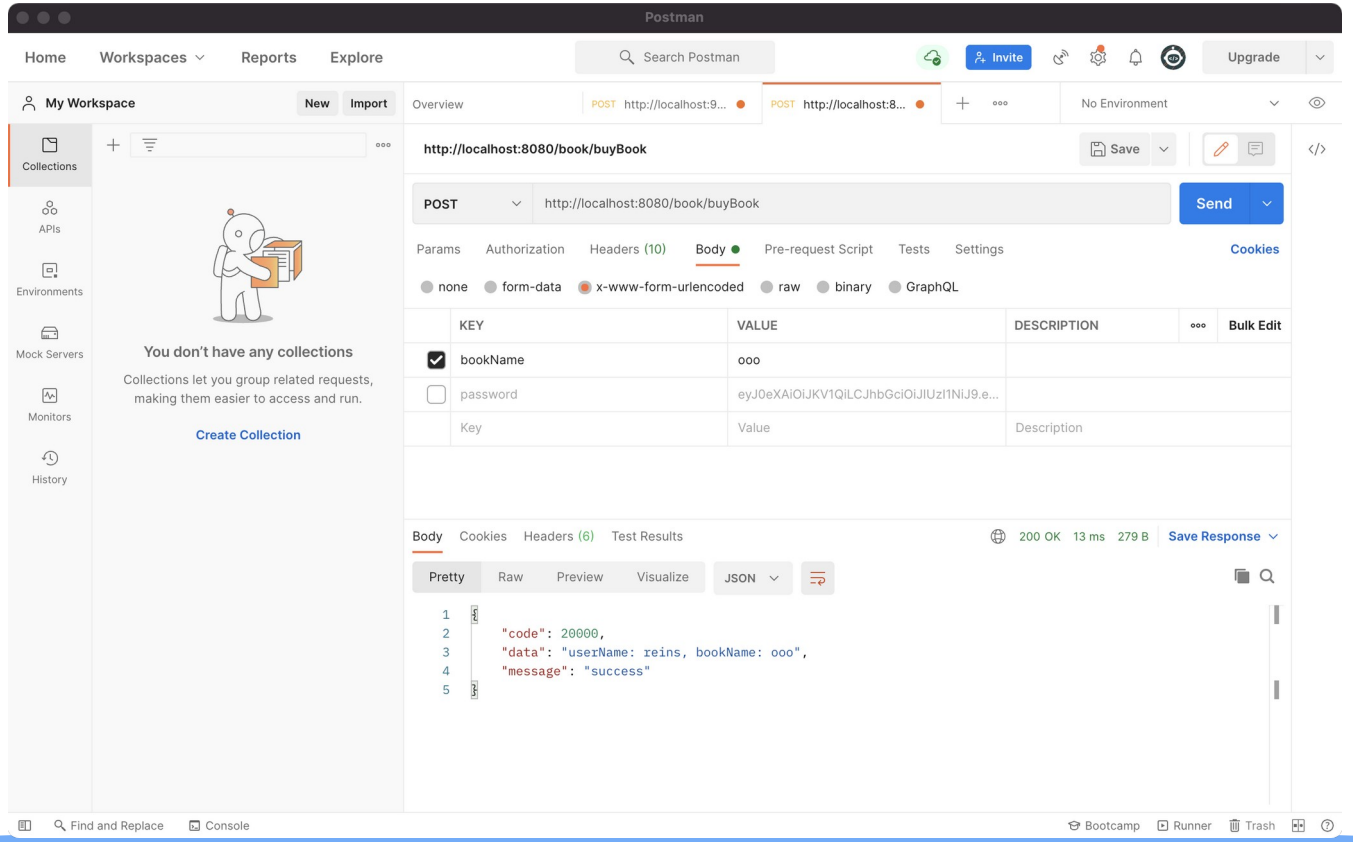

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Thank You!