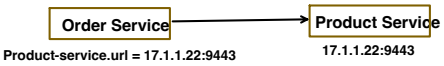
Service Discovery

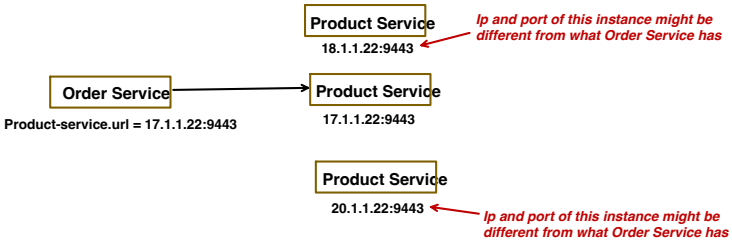
Wednesday, 11 June 2025 12:38 PM

- In Microservices, services or component instances are created and deleted dynamically.
- We can not hardcode the URL of a particular instance, its not scalable and feasible.

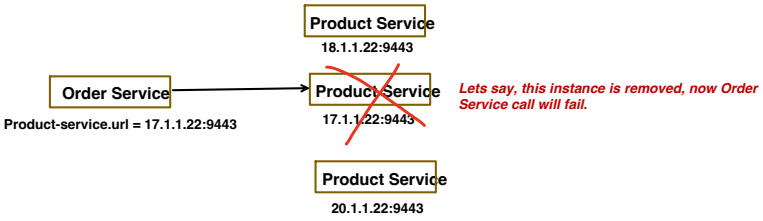


In above example:
- Order service has hardcoded the URL of the Product service and its ok till we have only 1 instance of Product service.

- But in case, when we have multiple Product service instances then….



Also, possible that, particular instance is removed



Now in above example, where multiple instances of Product service is present and Order Service has hardcoded the URL of the Product service, the problem it might face is:

- <u>Single point of failure</u>:
If hardcoded instance of Product Service goes down, Order service will not be able to communicate with any other instance.

- <u>No Load Balancing</u>:
Only one instance of Product Service get overburdened while other instances remain idle.

- <u>Tight Coupling</u>:
Because of hardcoded URL in Order Service, there is tight coupling between Product and Order Service, as without updating the Order Service its not possible to change or move Product Service.

- <u>Difficulty in testing</u>:
Different environment (say production, QA, dev) might uses different URL, which require frequent changes in config and not only cause difficulty in testing but prone to error too.

Solution for above problem is:

SERVICE DISCOVERY (like Eureka)

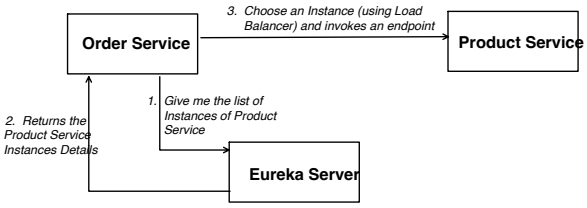
Eureka Server

- Act like a phonebook.
- Has all the instances info of all the registered clients like:
  - Service name
  - Instance id
  - IP
  - Port number
  - Health status

  etc.

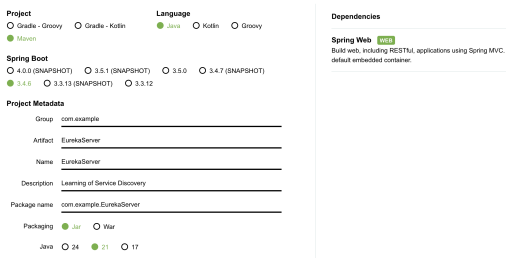
Eureka Client

- Register itself with the Server.
- Discovers an instance of other service via Eureka Server



Lets first set up Eureka Server Application:

Go to Spring Initializer (start.spring.io)



1. pom.xml

```
<dependency>
<groupId>org.springframework.cloud</groupId>
<artifactId>spring-cloud-starter-netflix-eureka-server</artifactId>
</dependency>
```

Version for *"spring-cloud-starter-netflix-eureka-server"* will be automatically resolved by below dependency management.

```
<dependencyManagement>
<dependencies>
<dependency>
<groupId>org.springframework.cloud</groupId>
<artifactId>spring-cloud-dependencies</artifactId>
<version>2023.0.1</version>
<type>pom</type>
<scope>import</scope>
</dependency>
</dependencies>
</dependencyManagement>
```

2. Enable Eureka Server functionality

Tells Spring boot to create necessary beans, which is required for Eureka Server like:
- *EurekaController*
- *Dashboard etc..*

```java
@SpringBootApplication
@EnableEurekaServer
public class EurekaServerApplication {

    public static void main(String[] args) {

        SpringApplication.run(EurekaServerApplication.class, args);
    }
}
```

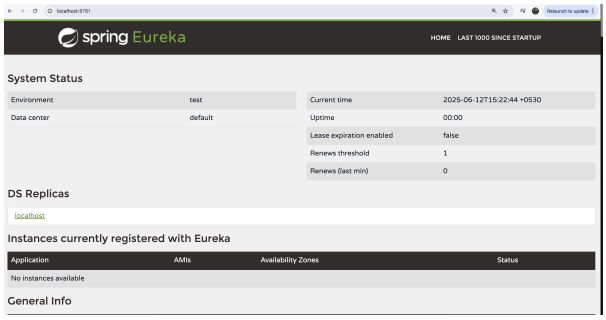
3. application.properties

```
spring.application.name=eureka-server
server.port=8761

# Since it's a server, we don't want it to register and
# also don't want to fetch the instances details
eureka.client.register-with-eureka=false
eureka.client.fetch-registry=false
```

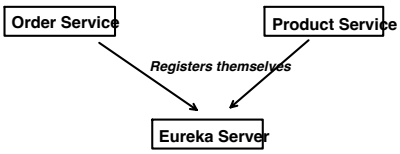
Lets start the Server and see the dashboard:

```
2025-06-12T15:22:06.258+05:30  INFO 43767 --- [eureka-server] [           main] o.s.b.a.e.web.EndpointLinksResolver      : Exposing 1 endpoint(s) beneath base path '/actua
2025-06-12T15:22:06.270+05:30  INFO 43767 --- [eureka-server] [           main] o.s.c.n.e.s.EurekaServiceRegistry        : Registering application EUREKA-SERVER with eurek
2025-06-12T15:22:06.274+05:30  INFO 43767 --- [eureka-server] [      Thread-9] o.s.c.n.e.server.EurekaServerBootstrap  : isAws returned false
2025-06-12T15:22:06.274+05:30  INFO 43767 --- [eureka-server] [      Thread-9] o.s.c.n.e.server.EurekaServerBootstrap  : Initialized server context
2025-06-12T15:22:06.274+05:30  INFO 43767 --- [eureka-server] [      Thread-9] c.n.e.r.PeerAwareInstanceRegistryImpl   : Got 1 instances from neighboring DS node
2025-06-12T15:22:06.274+05:30  INFO 43767 --- [eureka-server] [      Thread-9] c.n.e.r.PeerAwareInstanceRegistryImpl   : Renew threshold is: 1
2025-06-12T15:22:06.274+05:30  INFO 43767 --- [eureka-server] [      Thread-9] c.n.e.r.PeerAwareInstanceRegistryImpl   : Changing status to UP
2025-06-12T15:22:06.276+05:30  INFO 43767 --- [eureka-server] [           main] o.s.b.w.embedded.tomcat.TomcatWebServer  : Tomcat started on port 8761 (http) with context
2025-06-12T15:22:06.276+05:30  INFO 43767 --- [eureka-server] [           main] .s.c.n.e.s.EurekaAutoServiceRegistration : Updating port to 8761
2025-06-12T15:22:06.278+05:30  INFO 43767 --- [eureka-server] [      Thread-9] o.s.EurekaServerInitializerConfiguration : Started Eureka Server
2025-06-12T15:22:06.291+05:30  INFO 43767 --- [eureka-server] [           main] c.e.E.EurekaServerApplication            : Started EurekaServerApplication in 1.513 seconds
```

http://localhost:8761



Now lets set up Eureka Client Application:



Product Service

1. pom.xml

```
<dependency>
<groupId>org.springframework.cloud</groupId>
<artifactId>spring-cloud-starter-netflix-eureka-client</artifactId>
</dependency>
```

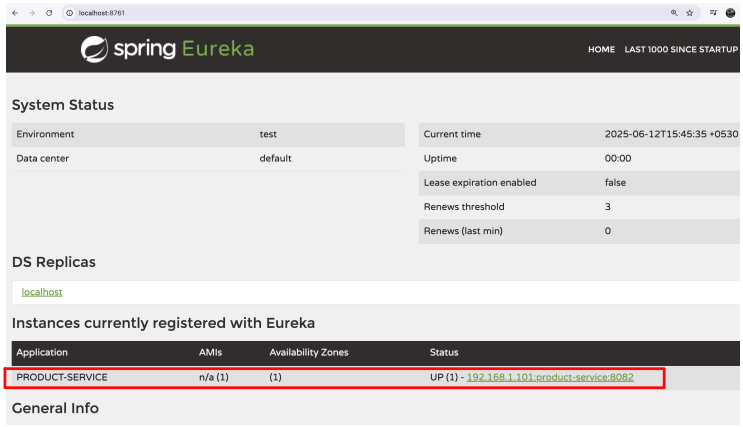
Version for *"spring-cloud-starter-netflix-eureka-client"* will be automatically resolved by below dependency management.

```
<dependencyManagement>
<dependencies>
<dependency>
<groupId>org.springframework.cloud</groupId>
<artifactId>spring-cloud-dependencies</artifactId>
<version>2023.0.1</version>
<type>pom</type>
<scope>import</scope>
</dependency>
</dependencies>
</dependencyManagement>
```

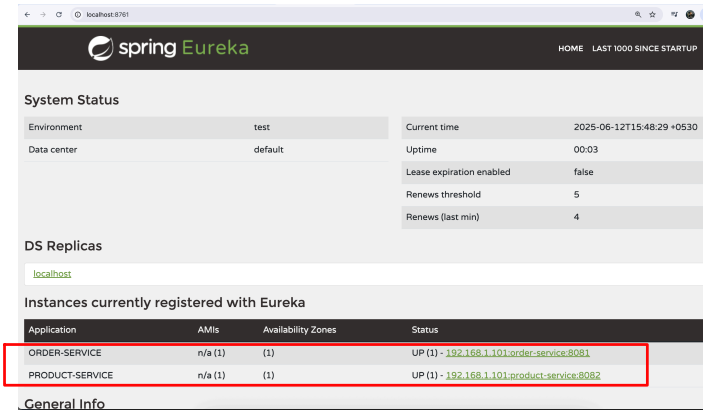
2. application.properties

```
server.port=8082
spring.application.name=product-service

#path of the Eureka Server
eureka.client.service-url.defaultZone=http://localhost:8761/eureka

#by-default values are true only, so we can even skip below configs
eureka.client.register-with-eureka=true
eureka.client.fetch-registry=true
```

Lets start the Product Service Server and see the dashboard again:



Similarly for Order Service, we can register it with Eureka Server



Now lets see, how Order Service can invoke Product Service:

Using RestTemplate

Without Service Discovery

```
public void callProductAPI(String id) {
    RestTemplate restTemplate = new RestTemplate();
    String response = restTemplate.getForObject( url: "http://localhost:8082/products/"+id, String.class);
    System.out.println("Response from Product api call is: " + response);
}
```

Specifically mentioning the URL

With Service Discovery

```
Import org.springframework.cloud.client.ServiceInstance;
Import org.springframework.cloud.client.discovery.DiscoveryClient;
```

```
@Autowired
DiscoveryClient discoveryClient;

public void callProductAPI(String id) {

    RestTemplate restTemplate = new RestTemplate();
    List<ServiceInstance> instances = discoveryClient.getInstances( serviceId: "product-service");
    URI uri = instances.get(0).getUri();

    String response = restTemplate.getForObject( url: uri + "/products/" + id, String.class);

    System.out.println("Response from Product api call is: " + response);
}
```

1. Fetching the instances of "product-service"
2. load balancer logic to choose a particular instance

So with RestTemplate, load balancing (choosing an instance for the product service) logic need to be handled.

Using FeignClient

So with FeignClient, load balancing is handled automatically and by the framework.

So we need to provide the Load Balancer dependency too, apart from *"spring-cloud-starter-netflix-eureka-client"*

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

Earlier without Service Discovery:

```
@FeignClient(name = "product-service",
        url = "${feign.client.product-service.url}")
public interface ProductClient {

    @GetMapping(value = "/products/{id}")
    String getProductById(@PathVariable("id") String id);
}
```

We need to provide the URL

With Service Discovery:

```
@FeignClient(name = "product-service")
public interface ProductClient {

    @GetMapping(value = "/products/{id}")
    String getProductById(@PathVariable("id") String id);
}
```

No need of the URL, only the registered name of the product service is required.
and
Load Balancing will also be handled internally by the framework.

As a curious engineer, few questions comes to our mind:

Service Registration doubts:
---
1. **How does Eureka Server know whether a client is UP or DOWN?**
2. **Where and how the data is stored?**
3. **What if Eureka Server itself goes down? Is it a single point of failure?**

Discovery Doubts:
---
1. **It can cause latency issue, as each call now required 2 hops, first it has to invoke Eureka Server and then the actual call.**
2. **What if the local cache is stale? Can this lead to calling a dead instance?**

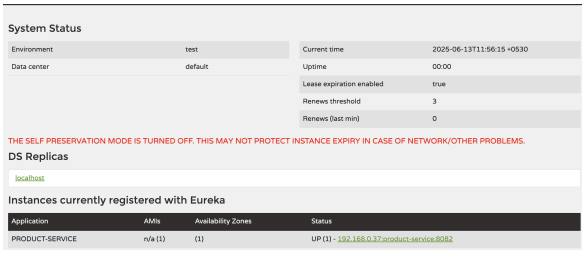
Lets try to find an answer one by one:

1. **How does Eureka Server know whether a client is UP or DOWN?**

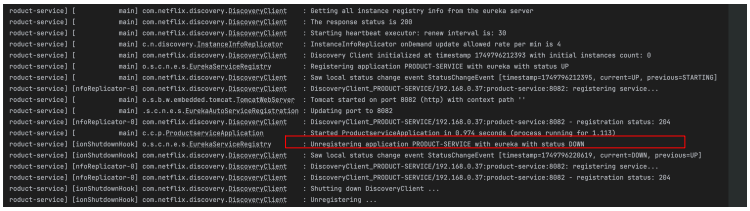
Through Client de-registration request

Through Client Heart Beat

When client application is gracefully shut down, then eureka client sends the de-registration request to Eureka Server, it mark client status as DOWN.



Client(product-service) application logs :



Eureka Client periodically sends Heart Beat to the Eureka Server.

Lets say, if client shut down without sending any de-registration request (bcoz of Network issue).

then Eureka server wait for the heart beat from Client for a particular interval (decided at the time of registration) and if no Heart Beat received within that time interval, it remove the client instance itself.

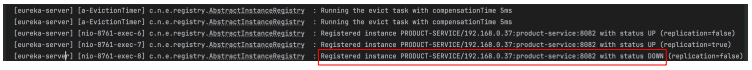
Client(product-service) ***application.properties:***

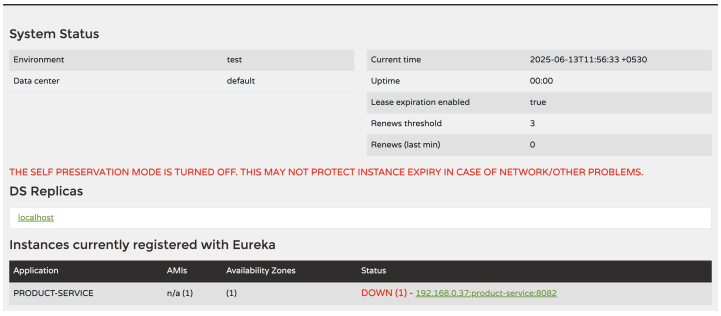
```
server.port=8082
spring.application.name=product-service

#path of the Eureka Server
eureka.client.service-url.defaultZone=http://localhost:8761/eureka

#by-default values are true only, so we can even skip below configs
eureka.client.register-with-eureka=true
eureka.client.fetch-registry=true

#every 60seconds client will send the heart beat to server
eureka.instance.lease-renewal-interval-in-seconds=60

#telling server to wait this much time, if no heart beat received in this time, then remove me.
#for testing, kept it less than lease-renewal-interval
eureka.instance.lease-expiration-duration-in-seconds=5
```

After this much seconds, client will send the new heart beat to server. Default time is 30sec

Telling server to wait only this much time for the heart beat. After that, you can remove it from the list. Default time is 90sec

Server (Eureka-server) application logs :



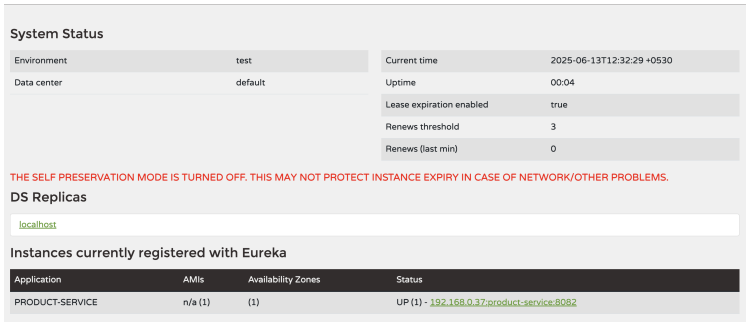


Eureka Server ***application.properties:***

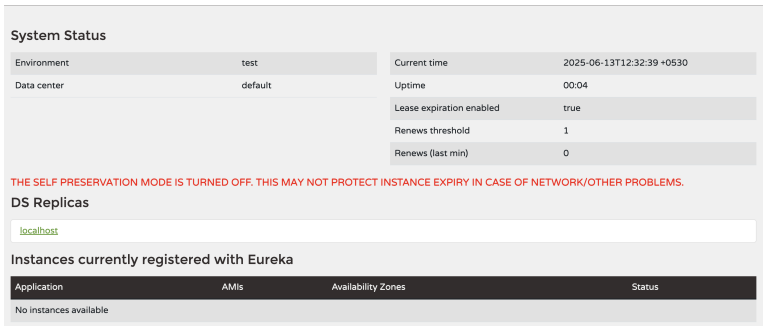
```
spring.application.name=eureka-server
server.port=8761

# Since it's a server, we don't want it to register and
# also don't want to fetch the instances details
eureka.client.register-with-eureka=false
eureka.client.fetch-registry=false

#by default Server do not remove the client, even heart beat is missed.
#so we need to turn this OFF. And allow the server to remove if client heart beat missed.
eureka.server.enable-self-preservation=false

#how frequently eviction task runs
eureka.server.eviction-interval-timer-in-ms=6000
```

Allowing server to remove the instance, if heart beat is not received.

How often, server check for dead instances



Because in above config:
- Client will send the heart beat after - 60seconds
- Server will wait for the heart beat only for - 5 seconds
So server, removed the client instance from the list, even Client application is running and up.



2. How does Eureka Server stores the data

Eureka Server only stores the data in-memory : Map<String, Lease<InstanceInfo>>

- **Key : *appName/instanceId***
  ex:
  PRODUCT-SERVICE/192.157.2.27:product-service:8082
- value: ***InstanceInfo object***
  - Instance ID
  - App name
  - IP address
  - Host name
  - Port
  - Status (UP, DOWN)
  - Last renewed timestamp
  - Lease duration
    Etc.

3. What if Eureka Server itself goes down? Is it a single point of failure?

- **Yes, a Single Eureka Server is a Single point of failure, if it goes down.**
- **Usually, 3 nodes cluster is used.**

Say, we have 3 Eureka Server on different machine or container:

- **eureka-1 at port 8761**
- **eureka-2 at port 8762**
- **eureka-3 at port 8763**

Now, each Server is a client too. As they have to register themselves, fetch the registry, replicate changes.

application.properties for eureka server 1:

```
spring.application.name=eureka-server
server.port=8761
eureka.instance.hostname=localhost

eureka.client.register-with-eureka=true
eureka.client.fetch-registry=true
eureka.client.service-url.defaultZone= http://localhost:8762/eureka/, http://localhost:8763/eureka/
```

application.properties for eureka server 2:

```
spring.application.name=eureka-server
server.port=8762
eureka.instance.hostname=localhost

eureka.client.register-with-eureka=true
eureka.client.fetch-registry=true
eureka.client.service-url.defaultZone= http://localhost:8761/eureka/, http://localhost:8763/eureka/
```

application.properties for eureka server 3:

```
spring.application.name=eureka-server
server.port=8763
eureka.instance.hostname=localhost

eureka.client.register-with-eureka=true
eureka.client.fetch-registry=true
eureka.client.service-url.defaultZone= http://localhost:8761/eureka/, http://localhost:8762/eureka/
```

And in Client application.properties:

eureka.client.service-url.defaultZone= http://eureka-1:8761/eureka, http://eureka-2:8762/eureka, http://eureka-3:8763/eureka

Now even if 1 server is down, it will not impact the client availability.

4. It can cause latency issue, as each call now required 2 hops, first it has to invoke Eureka Server and then the actual call.

- Eureka Server does not get called for every request.
- At startup, Client say (order-service) fetch the registry
  eureka.client.fetch-registry=true
- And Cache it locally, all future request, uses this local copy to find the instance.

we can control this with config like below, after every 30 seconds client will refresh its cache copy:

eureka.client.registry-fetch-interval-seconds=30

5. What if the local cache is stale? Can this lead to calling a dead instance?

It's a valid scenario and you can say it's a trade off.