Spring Boot Microservices Communication Example using RestTemplate

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MICROSERVICES SPRING BOOT

In this tutorial, we will learn how to create multiple Spring boot microservices and how to use RestTemplate class to make Synchronous communication between multiple microservices.

There are two styles of Microservices Communications:

1. Synchronous Communication
2. Asynchronous Communication

Synchronous Communication

In the case of Synchronous Communication, the client sends a request and waits for a response from the service. The important point here is that the protocol (HTTP/HTTPS) is synchronous and the client code can only continue its task when it receives the HTTP server response.

For example, **Microservice1 acts as a client that sends a request and waits for a response from Microservice2.**

We can use RestTemplate or WebClient or Spring Cloud Open Feign library to make a Synchronous Communication multiple microservices.

Asynchronous Communication

In the case of Asynchronous Communication, The client sends a request and does not wait for a response from the service. The client will continue executing its task - It doesn't wait for the response from the service.

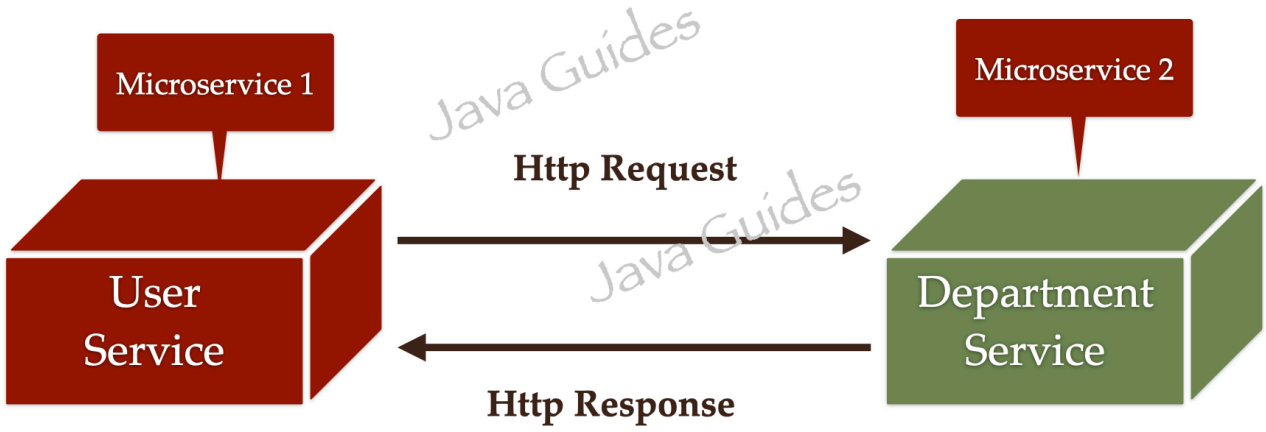
For example, **Microservice1 acts as a client that sends a request and doesn't wait for a response from Microservice2.**

We can use Message brokers such as RabbitMQ and Apache Kafka to make Asynchronous Communication between multiple microservices.

What we will Build?

Well, we will create two microservices such as `department-service` and `user-service` and we will make a REST API call from `user-service` to `department-service` to fetch a particular user department.

Microservices Communication using RestTemplate



We will create a separate MySQL database for each microservice.

We will create and set up two Spring boot projects as two microservices in IntelliJ IDEA.

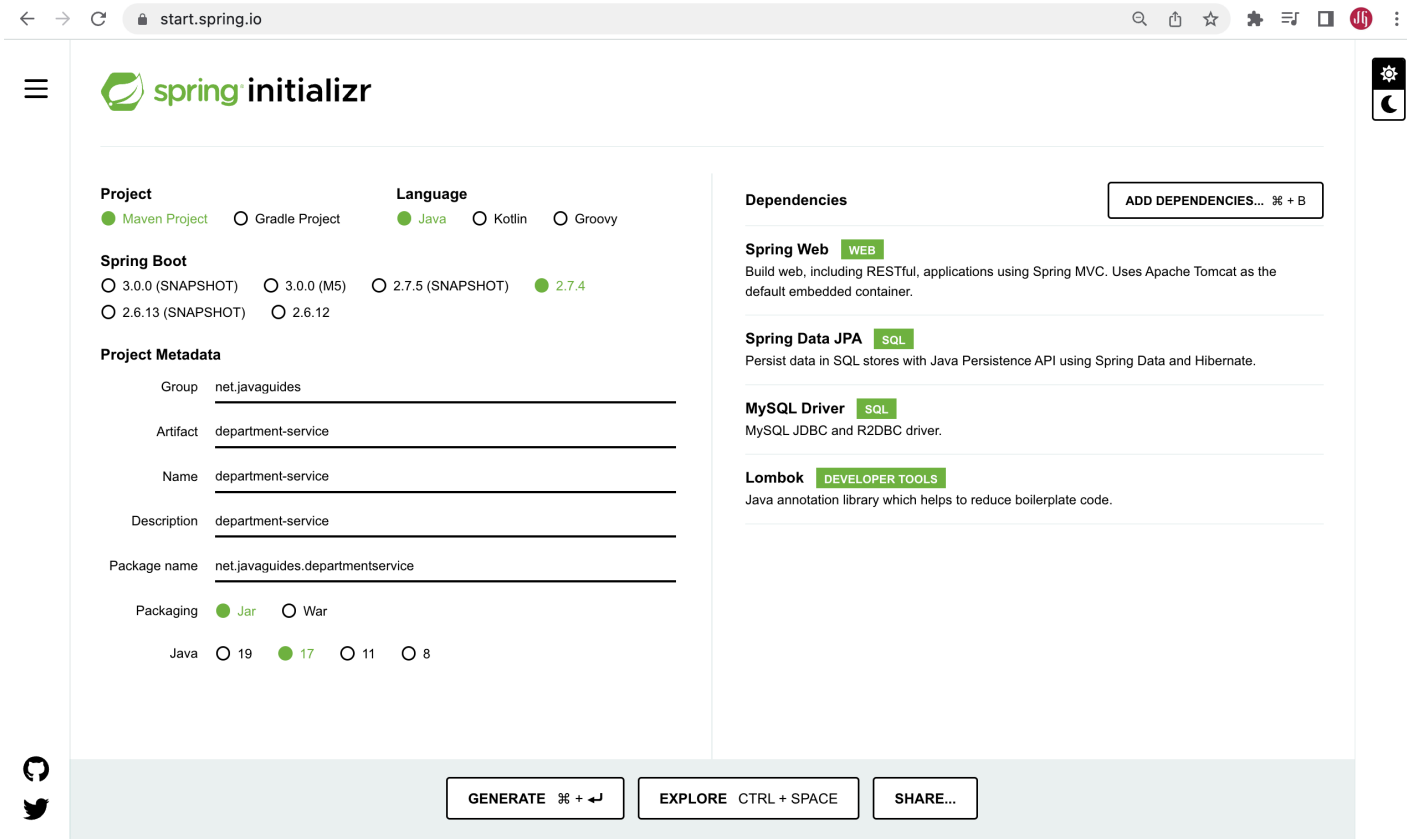
Creating DepartmentService Microservice

Let's first create and setup the `department-service` Spring boot project in IntelliJ IDEA

1. Create and setup spring boot project (department-service) in IntelliJ IDEA

Let's create a Spring boot project using the **spring initializr**.

Refer to the below screenshot to enter details while creating the spring boot application using the **spring initializr**:



Click on Generate button to download the Spring boot project as a zip file. Unzip the zip file and import the Spring boot project in IntelliJ IDEA.

Here is the `pom.xml` file for your reference:

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 https://maven.apache.org/xsd/maven-4.0.0.xsd">
        <modelVersion>4.0.0</modelVersion>
        <parent>
                <groupId>org.springframework.boot</groupId>
                <artifactId>spring-boot-starter-parent</artifactId>
                <version>2.7.4</version>
                <relativePath/> <!-- lookup parent from repository -->
        </parent>
        <groupId>net.javaguides</groupId>
        <artifactId>department-service</artifactId>
        <version>0.0.1-SNAPSHOT</version>
        <name>department-service</name>
        <description>department-service</description>
        <properties>
                <java.version>17</java.version>
        </properties>
        <dependencies>
                <dependency>
                        <groupId>org.springframework.boot</groupId>
                        <artifactId>spring-boot-starter-data-jpa</artifactId>
                </dependency>
                <dependency>
                        <groupId>org.springframework.boot</groupId>
                        <artifactId>spring-boot-starter-web</artifactId>
                </dependency>

                <dependency>
                        <groupId>mysql</groupId>
                        <artifactId>mysql-connector-java</artifactId>
                        <scope>runtime</scope>
                </dependency>
                <dependency>
                        <groupId>org.projectlombok</groupId>
                        <artifactId>lombok</artifactId>
```

```
                        <optional>true</optional>
                </dependency>
                <dependency>
                        <groupId>org.springframework.boot</groupId>
                        <artifactId>spring-boot-starter-test</artifactId>
                        <scope>test</scope>
                </dependency>
        </dependencies>

        <build>
                <plugins>
                        <plugin>
                                <groupId>org.springframework.boot</groupId>
                                <artifactId>spring-boot-maven-plugin</artifactId>
                                <configuration>
                                        <excludes>
                                                <exclude>
                                                        <groupId>org.projectlombok</groupId>
                                                        <artifactId>lombok</artifactId>
                                                </exclude>
                                        </excludes>
                                </configuration>
                        </plugin>
                </plugins>
        </build>

</project>
```

DepartmentService - Configure MySQL Database

Since we're using MySQL as our database, we need to configure the URL, username, and password so that our Spring boot can establish a connection with the database on startup.

Open the `src/main/resources/application.properties` file and add the following properties to it:

```
spring.datasource.url=jdbc:mysql://localhost:3306/department_db
spring.datasource.username=root
spring.datasource.password=Mysql@123

spring.jpa.properties.hibernate.dialect=org.hibernate.dialect.MySQLDialect
spring.jpa.hibernate.ddl-auto=update
```

Don't forget to change the `spring.datasource.username` and `spring.datasource.password` as per your MySQL installation. Also, create a database named **department_db** in MySQL before proceeding to the next section.

You don't need to create any tables. The tables will automatically be created by Hibernate from the `Department` entity that we will define in the next step. This is made possible by the property `spring.jpa.hibernate.ddl-auto = update.`

DepartmentService - Create Department JPA Entity

```
package net.javaguides.departmentservice.entity;

import javax.persistence.*;
import lombok.AllArgsConstructor;
import lombok.Getter;
import lombok.NoArgsConstructor;
import lombok.Setter;

@Entity
@Table(name = "departments")
@NoArgsConstructor
@AllArgsConstructor
@Setter
```

```
@Getter
public class Department {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;
    private String departmentName;
    private String departmentAddress;
    private String departmentCode;
}
```

DepartmentService - Create Spring Data JPA Repository

```
package net.javaguides.departmentservice.repository;

import net.javaguides.departmentservice.entity.Department;
import org.springframework.data.jpa.repository.JpaRepository;

public interface DepartmentRepository extends JpaRepository<Department, Long> {
}
```

DepartmentService - Create Service Layer

DepartmentService Interface

```
package net.javaguides.departmentservice.service;

import net.javaguides.departmentservice.entity.Department;

public interface DepartmentService {
    Department saveDepartment(Department department);

    Department getDepartmentById(Long departmentId);
}
```

DepartmentServiceImpl class

```
package net.javaguides.departmentservice.service.impl;

import lombok.AllArgsConstructor;
import lombok.extern.slf4j.Slf4j;
import net.javaguides.departmentservice.entity.Department;
import net.javaguides.departmentservice.repository.DepartmentRepository;
import net.javaguides.departmentservice.service.DepartmentService;
import org.springframework.stereotype.Service;

@Service
@AllArgsConstructor
@Slf4j
public class DepartmentServiceImpl implements DepartmentService {

    private DepartmentRepository departmentRepository;

    @Override
    public Department saveDepartment(Department department) {
        return departmentRepository.save(department);
    }

    @Override
    public Department getDepartmentById(Long departmentId) {
        return departmentRepository.findById(departmentId).get();
    }
}
```

DepartmentService - Create Controller Layer: DepartmentController

```
package net.javaguides.departmentservice.controller;

import lombok.AllArgsConstructor;
import net.javaguides.departmentservice.entity.Department;
import net.javaguides.departmentservice.service.DepartmentService;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.*;

@RestController
@RequestMapping("api/departments")
@AllArgsConstructor
public class DepartmentController {

    private DepartmentService departmentService;

    @PostMapping
    public ResponseEntity<Department> saveDepartment(@RequestBody Department department){
        Department savedDepartment = departmentService.saveDepartment(department);
        return new ResponseEntity<>(savedDepartment, HttpStatus.CREATED);
    }

    @GetMapping("{id}")
    public ResponseEntity<Department> getDepartmentById(@PathVariable("id") Long departmentId){
        Department department = departmentService.getDepartmentById(departmentId);
        return ResponseEntity.ok(department);
    }
}
```

DepartmentService - Start Spring Boot Application

Two ways we can start the standalone Spring boot application.

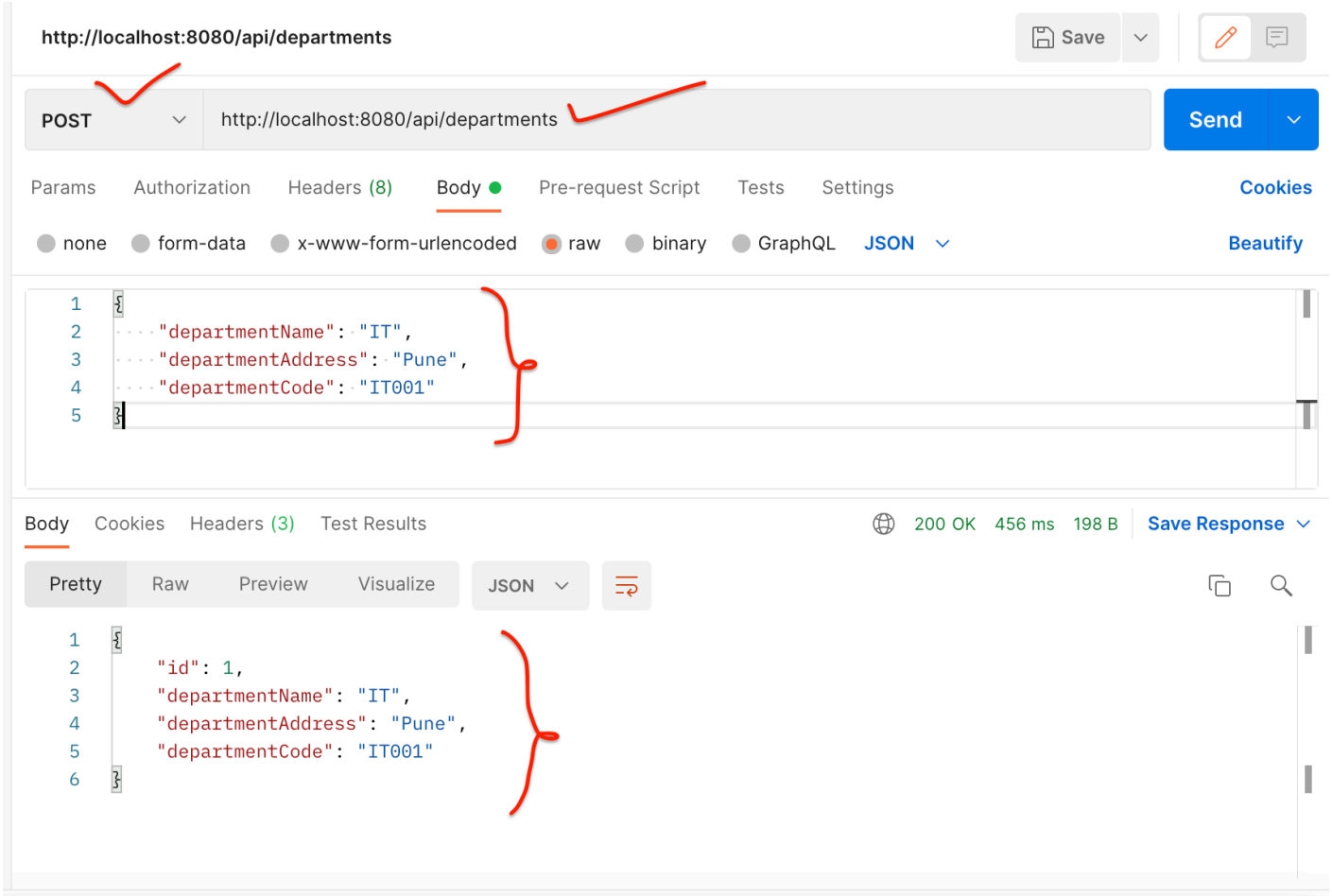
1. From the root directory of the application and type the following command to run it -

```
$ mvn spring-boot:run
```

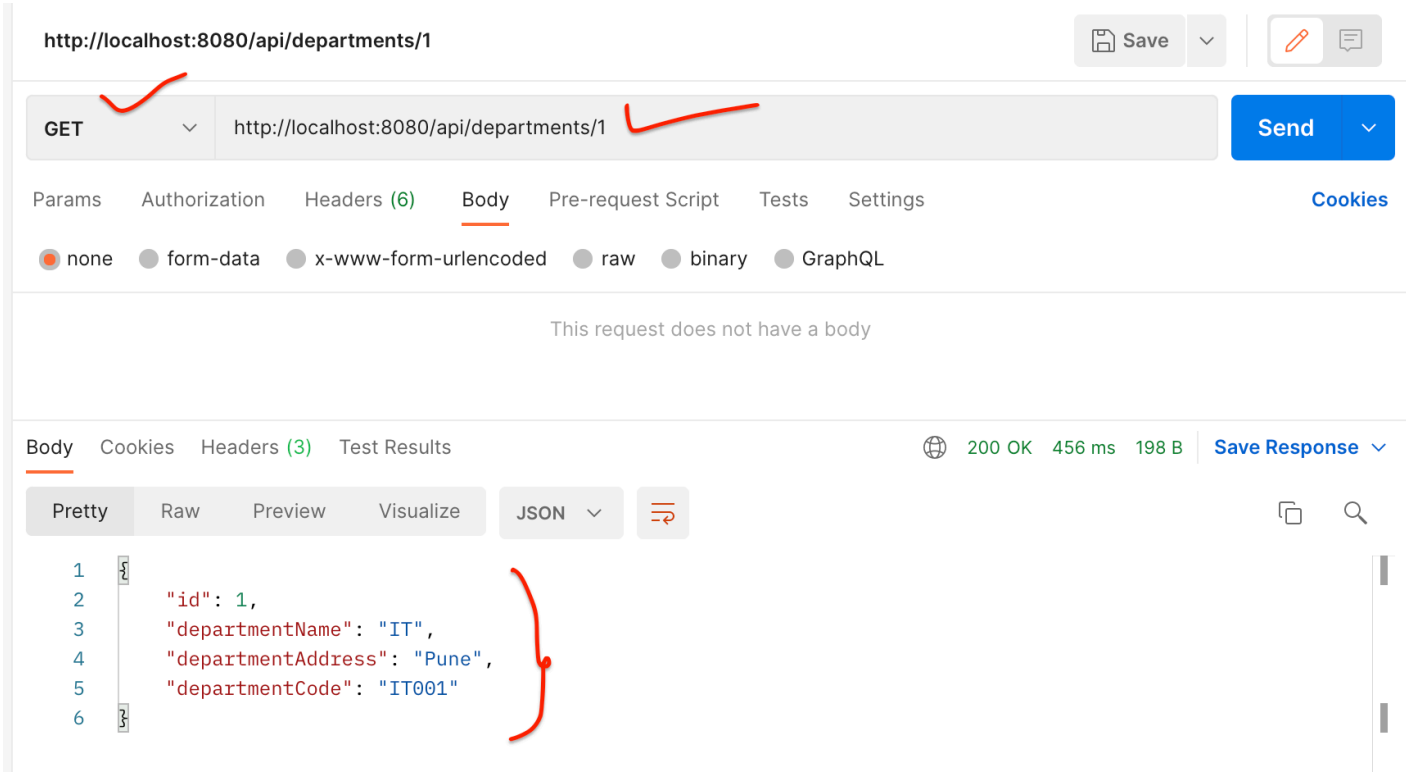
2. From your IDE, run the `DepartmentServiceApplication.main()` method as a standalone Java class that will start the embedded Tomcat server on port 8080 and point the browser to **http://localhost:8080/**.

DepartmentService - Test REST APIs using Postman Client

Save Department REST API:



Get Single Department REST API:



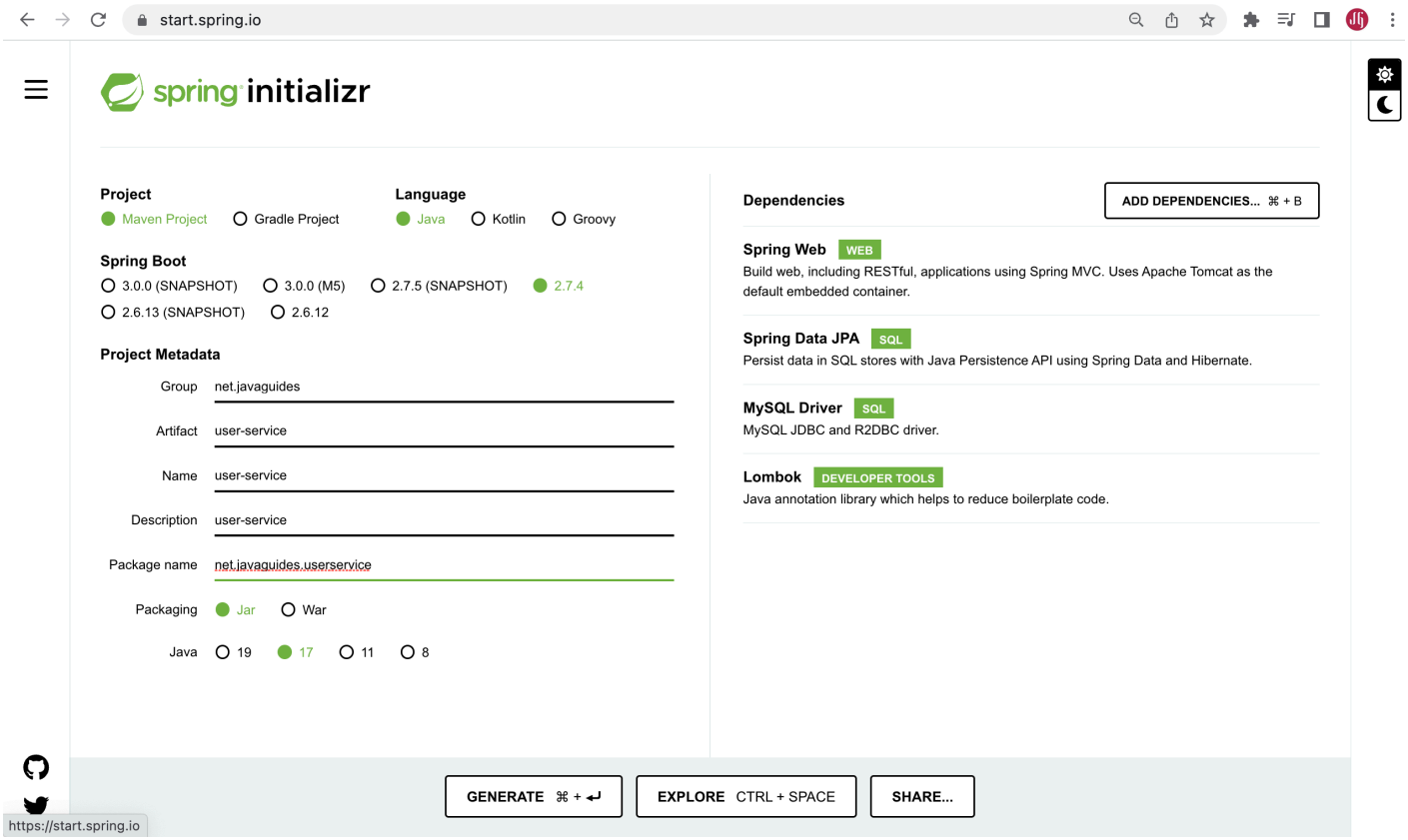
2. Creating UserService Microservice

Let's first create and setup the `user-service` Spring boot project in IntelliJ IDEA

1. Create and setup spring boot project (user-service) in IntelliJ IDEA

Let's create a Spring boot project using the **spring initializr**.

Refer to the below screenshot to enter details while creating the spring boot application using the **spring initializr**:



Click on Generate button to download the Spring boot project as a zip file. Unzip the zip file and import the Spring boot project in IntelliJ IDEA.

Here is the `pom.xml` file for your reference:

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 https://maven.apache.org/xsd/maven-4.0.0.xsd">
        <modelVersion>4.0.0</modelVersion>
        <parent>
                <groupId>org.springframework.boot</groupId>
                <artifactId>spring-boot-starter-parent</artifactId>
                <version>2.7.4</version>
                <relativePath/> <!-- lookup parent from repository -->
        </parent>
        <groupId>net.javaguides</groupId>
        <artifactId>user-service</artifactId>
        <version>0.0.1-SNAPSHOT</version>
        <name>user-service</name>
        <description>user-service</description>
        <properties>
                <java.version>17</java.version>
        </properties>
        <dependencies>
                <dependency>
                        <groupId>org.springframework.boot</groupId>
                        <artifactId>spring-boot-starter-data-jpa</artifactId>
                </dependency>
                <dependency>
                        <groupId>org.springframework.boot</groupId>
```

```
                        <artifactId>spring-boot-starter-web</artifactId>
                </dependency>

                <dependency>
                        <groupId>mysql</groupId>
                        <artifactId>mysql-connector-java</artifactId>
                        <scope>runtime</scope>
                </dependency>
                <dependency>
                        <groupId>org.projectlombok</groupId>
                        <artifactId>lombok</artifactId>
                        <optional>true</optional>
                </dependency>
                <dependency>
                        <groupId>org.springframework.boot</groupId>
                        <artifactId>spring-boot-starter-test</artifactId>
                        <scope>test</scope>
                </dependency>
        </dependencies>

        <build>
                <plugins>
                        <plugin>
                                <groupId>org.springframework.boot</groupId>
                                <artifactId>spring-boot-maven-plugin</artifactId>
                                <configuration>
                                        <excludes>
                                                <exclude>
                                                        <groupId>org.projectlombok</groupId>
                                                        <artifactId>lombok</artifactId>
                                                </exclude>
                                        </excludes>
                                </configuration>
                        </plugin>
                </plugins>
        </build>

</project>
```

UserService - Configure MySQL Database

Open the `src/main/resources/application.properties` file and add the following properties to it:

```
spring.datasource.url=jdbc:mysql://localhost:3306/employee_db
spring.datasource.username=root
spring.datasource.password=Mysql@123

spring.jpa.properties.hibernate.dialect=org.hibernate.dialect.MySQLDialect
spring.jpa.hibernate.ddl-auto=update
```

Don't forget to change the `spring.datasource.username` and `spring.datasource.password` as per your MySQL installation. Also, create a database named **employee_db** in MySQL before proceeding to the next section.

You don't need to create any tables. The tables will automatically be created by Hibernate from the `User` entity that we will define in the next step. This is made possible by the property `spring.jpa.hibernate.ddl-auto = update.`

UserService - Change the Server Port

Note that the department service Spring boot project is running on the default tomcat server port 8080.

For user service, we need to change the embedded tomcat server port to 8081 using the below property:

```
server.port = 8081
```

UserService - Create User JPA Entity

```
package net.javaguides.userservice.entity;

import javax.persistence.*;
import lombok.AllArgsConstructor;
import lombok.Getter;
import lombok.NoArgsConstructor;
import lombok.Setter;

@Entity
@Table(name = "users")
@Setter
@Getter
@NoArgsConstructor
@AllArgsConstructor
public class User {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;
    private String firstName;
    private String lastName;
    @Column(nullable = false, unique = true)
    private String email;
    private String departmentId;
}
```

UserService - Create Spring Data JPA Repository

```
package net.javaguides.userservice.repository;

import net.javaguides.userservice.entity.User;
import org.springframework.data.jpa.repository.JpaRepository;

public interface UserRepository extends JpaRepository<User, Long> {

}
```

UserService - Create DTO Classes

DepartmentDto

```
package net.javaguides.userservice.dto;

import lombok.AllArgsConstructor;
import lombok.Getter;
import lombok.NoArgsConstructor;
import lombok.Setter;

@Setter
@Getter
@AllArgsConstructor
@NoArgsConstructor
public class DepartmentDto {
    private Long id;
    private String departmentName;
    private String departmentAddress;
    private String departmentCode;
}
```

UserDto

```
package net.javaguides.userservice.dto;

import lombok.AllArgsConstructor;
```

```
import lombok.Getter;
import lombok.NoArgsConstructor;
import lombok.Setter;

@Setter
@Getter
@NoArgsConstructor
@AllArgsConstructor
public class UserDto {
    private Long id;
    private String firstName;
    private String lastName;
    private String email;
}
```

ResponseDto

```
package net.javaguides.userservice.dto;

import lombok.AllArgsConstructor;
import lombok.Getter;
import lombok.NoArgsConstructor;
import lombok.Setter;

@Setter
@Getter
@NoArgsConstructor
@AllArgsConstructor
public class ResponseDto {
    private DepartmentDto department;
    private UserDto user;
}
```

UserService - Configure RestTemplate as Spring Bean

Let's configure RestTemplate class as Spring bean so that we can inject and use it.

```
package net.javaguides.userservice;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.context.annotation.Bean;
import org.springframework.web.client.RestTemplate;

@SpringBootApplication
public class UserServiceApplication {

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

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

UserService - Create Service Layer

UserService Interface

```
package net.javaguides.userservice.service;

import net.javaguides.userservice.dto.ResponseDto;
import net.javaguides.userservice.entity.User;
```

```
public interface UserService {
    User saveUser(User user);

    ResponseDto getUser(Long userId);
}
```

UserServiceImpl class

```
package net.javaguides.userservice.service.impl;

import lombok.AllArgsConstructor;
import net.javaguides.userservice.dto.DepartmentDto;
import net.javaguides.userservice.dto.ResponseDto;
import net.javaguides.userservice.dto.UserDto;
import net.javaguides.userservice.entity.User;
import net.javaguides.userservice.repository.UserRepository;
import net.javaguides.userservice.service.UserService;
import org.springframework.http.ResponseEntity;
import org.springframework.stereotype.Service;
import org.springframework.web.client.RestTemplate;

@Service
@AllArgsConstructor
public class UserServiceImpl implements UserService {

    private UserRepository userRepository;
    private RestTemplate restTemplate;

    @Override
    public User saveUser(User user) {
        return userRepository.save(user);
    }

    @Override
    public ResponseDto getUser(Long userId) {

        ResponseDto responseDto = new ResponseDto();
        User user = userRepository.findById(userId).get();
        UserDto userDto = mapToUser(user);

        ResponseEntity<DepartmentDto> responseEntity = restTemplate
                .getForEntity("http://localhost:8080/api/departments/" + user.getDepartmentId(),
                DepartmentDto.class);

        DepartmentDto departmentDto = responseEntity.getBody();

        System.out.println(responseEntity.getStatusCode());

        responseDto.setUser(userDto);
        responseDto.setDepartment(departmentDto);

        return responseDto;
    }

    private UserDto mapToUser(User user){
        UserDto userDto = new UserDto();
        userDto.setId(user.getId());
        userDto.setFirstName(user.getFirstName());
        userDto.setLastName(user.getLastName());
        userDto.setEmail(user.getEmail());
        return userDto;
    }
}
```

Note that we are using `RestTemplate` to make a REST API call to department-service:

```
        ResponseEntity<DepartmentDto> responseEntity = restTemplate
                .getForEntity("http://localhost:8080/api/departments/" + user.getDepartmentId(),
```

```
                DepartmentDto.class);
```

UserService - Create Controller Layer: UserController

```
package net.javaguides.userservice.controller;

import lombok.AllArgsConstructor;
import net.javaguides.userservice.dto.ResponseDto;
import net.javaguides.userservice.entity.User;
import net.javaguides.userservice.service.UserService;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.*;

@RestController
@RequestMapping("api/users")
@AllArgsConstructor
public class UserController {

    private UserService userService;

    @PostMapping
    public ResponseEntity<User> saveUser(@RequestBody User user){
        User savedUser = userService.saveUser(user);
        return new ResponseEntity<>(savedUser, HttpStatus.CREATED);
    }

    @GetMapping("{id}")
    public ResponseEntity<ResponseDto> getUser(@PathVariable("id") Long userId){
        ResponseDto responseDto = userService.getUser(userId);
        return ResponseEntity.ok(responseDto);
    }
}
```

UserService - Start Spring Boot Application

Two ways we can start the standalone Spring boot application.

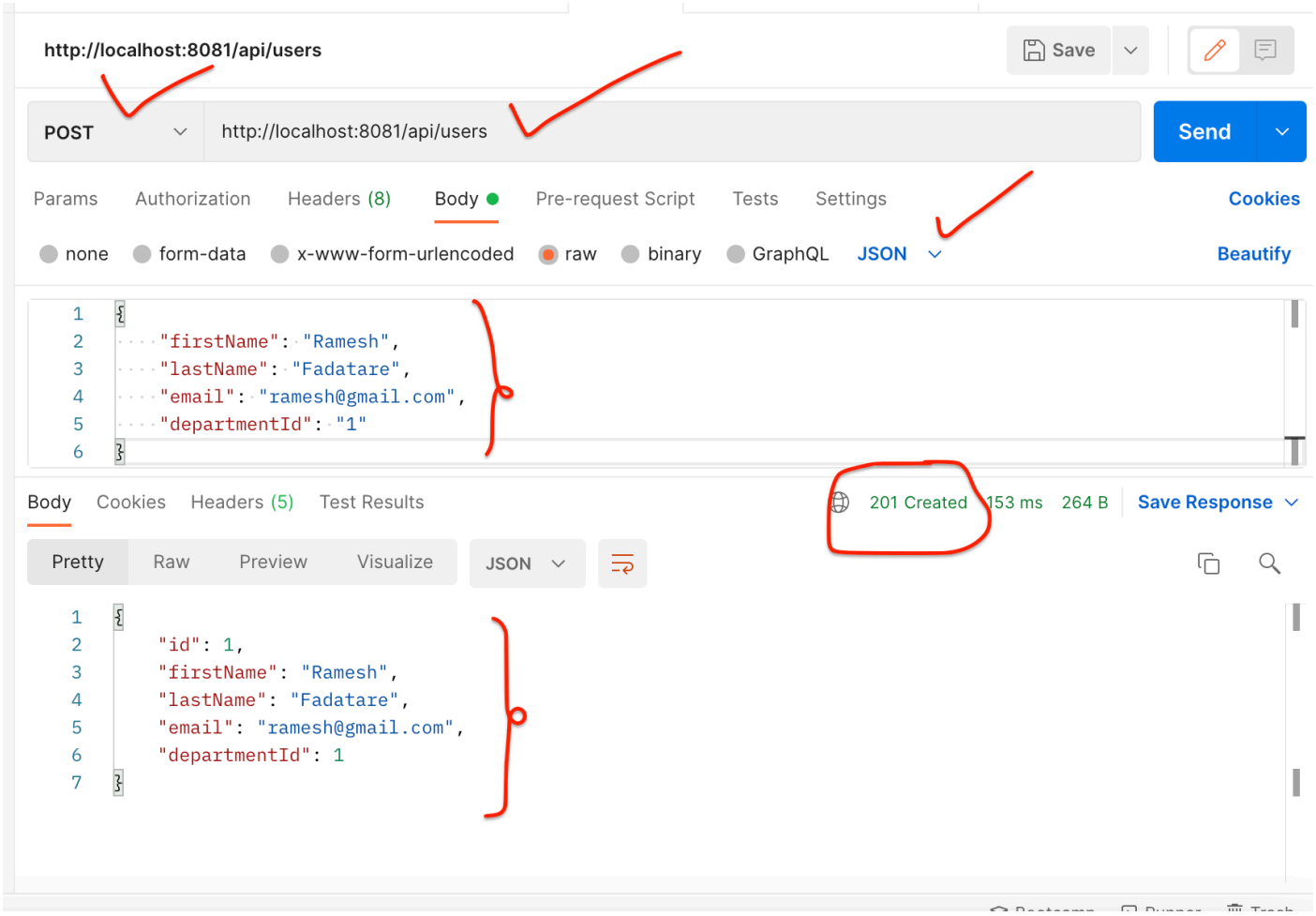
1. From the root directory of the application and type the following command to run it -

```
$ mvn spring-boot:run
```

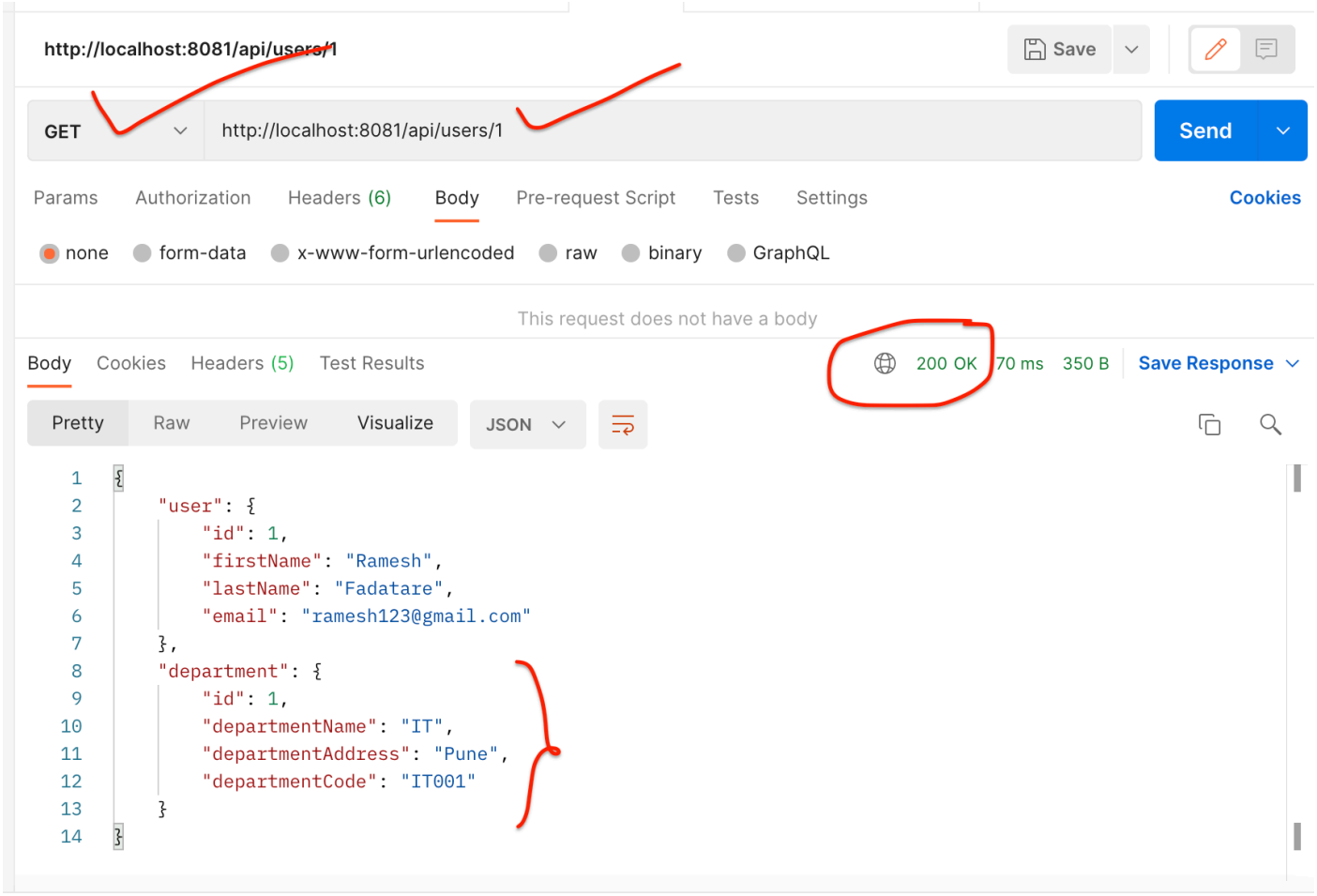
2. From your IDE, run the `UserServiceApplication.main()` method as a standalone Java class that will start the embedded Tomcat server on port 8080 and point the browser to **http://localhost:8081/**.

UserService - Test REST APIs using Postman Client

Save User REST API:



Get User REST API:



Note that the response contains a Department for a User. This demonstrates that we have successfully made a REST API call from UserService to DepartmentService.

Conclusion

In this tutorial, we learned how to create multiple Spring boot microservices and how to use `RestTemplate` class to make Synchronous communication between multiple microservices.

As of 5.0, the `RestTemplate` class is in maintenance mode and soon will be deprecated. So the Spring team recommended using `org.springframework.web.reactive.client.WebClient` has a modern API and supports sync, async, and streaming scenarios.