IBM z/OS Connect (OpenAPI 3.0)

Developing Native Server RESTful APIs for accessing Db2 REST Services

IBM Z
Wildfire Team –
Washington System Center

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Table of Contents

Important: On the desktop there is a file named *OpenAPI 3 development APIs CopyPaste.txt*. This file contains commands and other text used in this workshop. Locate that file and open it. Use the copy-and-paste function (**Ctrl-C** and **Ctrl-V**) to enter commands or text. It will save time and help avoid typo errors. As a reminder text that appears in this file will be highlighted in yellow.

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Overview

The objective of these exercises is to gain experience with developing and deploying API using the *z/OS Connect Designer*. This exercise is offered in conjunction with a Washington Systems Center Wildfire workshop for z/OS Connect. For information about scheduling this workshop in your area contact your IBM representative.

Important – You do not need any skills with Db2 to perform this exercise. Even if Db2 is not relevant to your current plans, performing the steps in this exercise will give additional experience using the *z/OS Connect Designer* to developing and administer APIs.

General Exercise Information and Guidelines

- ✓ This exercise requires using z/OS user identities *Fred, USER1* and *USER2*. The *Designer* passwords for these identities are *fredpwd, user1* and *user2* respectively and are case sensitive. The RACF password for these users are *FRED, USER1* and *USER2* respectively and are case insensitive.

- ✓ Any time you have any questions about the use of screens, features or tools do not hesitate to reach out for assistance.

- ✓ Text in **bold** and highlighted in **yellow** in this document should be available for copying and pasting in a file named *OpenAPI 3 development APIs CopyPaste* file on the desktop

- ✓ Please note that there may be minor differences between the screen shots in this exercise versus what you see when performing this exercise. These differences should not impact the completion of this exercise. For example, the text might reference host name *designer.ibm.com* when a screen shot shows the host as *designer.ibm.com* or even *localhost*. All these names resolve to the same IP address. Another example is that a section of a page has been expanded for display purposes. If a section or screen shot does not look exactly as what you are observing, consider maximizing or minimizing that section

Db2 REST services and z/OS Connect

Accessing a Db2 REST service from z/OS Connect differs from the ways in which z/OS Connect accesses the resources of other z/OS subsystems. Other subsystem's resources are accessed by using their normal subsystem interfaces (e.g., OTMA, IPIC, JMS, etc.).
A z/OS Connect Designer instance and server accesses Db2 not as a Db2 client using JDBC, but rather as a RESTful client accessing an existing Db2 REST service. This may raise the question as to what value-add does z/OS Connect provide if z/OS Connect can only access an existing Db2 REST service? The answer is that (1) the REST services support provided by Db2 only supports the POST method with only a few administrative services that support the GET method. There is no support for PUT or DELETE methods normally expected for a robust RESTful API service. Another reason (2) is that the API function of transforming JSON request or response messages, e.g., assigning values or removing fields from the interface is not available when using the Db2 native REST Services directly. And finally (3) z/OS Connect provides security mechanism (e.g., OAUTH and JWT tokens) not available with Db2. If a full function RESTful API with support for the major HTTP methods (POST, PUT, GET and DELETE), or transforming JSON payloads and/or additional authentication methods are required, then z/OS Connect is the solution

Db2 REST Services

Db2 REST services are defined either using a Db2 provided RESTful administrative service (DB2ServiceManager) or by using the Db2 BIND command using an update provided in Db2 PTF UI51748 and APAR PI98649 (PTF UI584231 or UI58425). The Db2 REST services used in this exercise were created using the Db2 BIND command as shown in this section.

- Db2 REST service *selectEmployee* was defined using the BIND JCL below.

```
//BIND EXEC PGM=IKJEFT01,DYNAMNBR=20
//STEPLIB  DD DSN=DSN1210.DB2.SDSNEXIT,DISP=SHR
//         DD DSN=DSN1210.DB2.SDSNLOAD,DISP=SHR
//SYSTSPRT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//DSNSTMT  DD *
  SELECT EMPNO AS "employeeNumber", FIRSTNME AS "firstName",
        MIDINIT AS "middleInitial", LASTNAME as "lastName",
        WORKDEPT AS "department", PHONENO AS "phoneNumber",
        JOB AS "job"
  FROM USER1.EMPLOYEE WHERE EMPNO = :employeeNumber
//SYSTSIN  DD *
 DSN SYSTEM(DSN2)
 BIND SERVICE("zCEEService") -
  NAME("selectEmployee") -
  SQLENCODING(1047) -
  DESCRIPTION('Select an employee from table USER1.EMPLOYEE')
/*
```


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This defines a Db2 native REST Services that select a single row from table USER1.EMPLOYEE based on the employee number (column EMPNO).

Important: The DBA creating this native Db2 REST service is excluding other table columns, e.g., SEX, SALARY, BONUS, COMMISION, etc. from the selection by omitting these columns from the SELECT statement. The DBA's use of the *AS* cause will also ensure the assigning of meaningful JSON property names rather than the original Db2 column names to the JSON request and response messages.

Tech-Tip: The input to DD DSNSTMT can be a CALL, DELETE, INSERT, SELECT, TRUNCATE, UPDATE, or WITH SQL statement.

To delete a service created by using the Db2 BIND command use the Db2 FREE command, e.g., FREE SERVICE("zCEEService"."selectEmployee")

Tech-Tip: A minimum of EXECUTE authority on package zCEEService.selectEmployee would be required to have the ability to execute this service.

- Db2 REST service *deleteEmployee* was defined using the BIND command below.

```
//BIND EXEC PGM=IKJEFT01,DYNAMNBR=20
//STEPLIB  DD DSN=DSN1210.DB2.SDSNEXIT,DISP=SHR
//         DD DSN=DSN1210.DB2.SDSNLOAD,DISP=SHR
//SYSTSPRT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//DSNSTMT  DD *
DELETE FROM USER1.EMPLOYEE WHERE EMPNO = :employeeNumber
//SYSTSIN  DD *
 DSN SYSTEM(DSN2)

 BIND SERVICE("zCEEService") -
  NAME("deleteEmployee") -
  SQLENCODING(1047) -
  DESCRIPTION('Delete an employee from table USER1.EMPLOYEE')
/*
```

The Db2 native REST Service named *deleteEmployee* deletes a row from table USER1.EMPLOYEE using a JSON request message like the one below.

```
{
      "employeeNumber": "000340"
}
```


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You should see this result in the response area.

```
{
    "Update Count": 1,
    "StatusCode": 200,
    "StatusDescription": "Execution Successful"
}
```

Tech-Tip: The update count, status code and description fields in a Db2 REST service response message will play an important part in determining if a request changed a Db2 resource.

- Db2 REST service *selectByRole* was defined using the BIND command below.

```
//BIND EXEC PGM=IKJEFT01,DYNAMNBR=20
//STEPLIB  DD  DSN=DSN1210.DB2.SDSNEXIT,DISP=SHR
//         DD  DSN=DSN1210.DB2.SDSNLOAD,DISP=SHR
//SYSTSPRT DD  SYSOUT=*
//SYSPRINT DD  SYSOUT=*
//SYSUDUMP DD  SYSOUT=*
//DSNSTMT  DD  *
   SELECT EMPNO AS "employeeNumber", FIRSTNME AS "firstName",
         MIDINIT AS "middleInitial", LASTNAME as "lastName",
         WORKDEPT AS "department", PHONENO AS "phoneNumber",
         JOB AS "job"
   FROM USER1.EMPLOYEE WHERE JOB = :job AND WORKDEPT = :department
//SYSTSIN  DD  *
 DSN SYSTEM(DSN2)

 BIND SERVICE("zCEEService") -
  NAME("selectByRole") -
  SQLENCODING(1047) -
  DESCRIPTION('Select an employee based on job and department')
/*
```

This service selects rows from table USER1.EMPLOYEE based on the contents of the WORKDEPT and JOB columns.

Important: The DBA creating this native Db2 REST service is excluding other table columns, e.g., SEX, SALARY, BONUS, COMMISION, etc. from the selection by omitting these columns from the SELECT statement. The DBA's use of the *AS* cause will also ensure the assigning of meaningful JSON property names rather than the original Db2 column names to the JSON request and response messages.

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- Db2 REST service insertEmployee was defined using the BIND command below

```
//BIND EXEC PGM=IKJEFT01,DYNAMNBR=20
//STEPLIB  DD DSN=DSN1210.DB2.SDSNEXIT,DISP=SHR
//         DD DSN=DSN1210.DB2.SDSNLOAD,DISP=SHR
//SYSTSPRT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//DSNSTMT  DD *
  INSERT INTO USER1.EMPLOYEE
         (EMPNO,FIRSTNME,MIDINIT,LASTNAME,WORKDEPT,PHONENO,
          HIREDATE,JOB,EDLEVEL,SEX,BIRTHDATE,SALARY,BONUS,COMM)
     VALUES (:employeeNumber, :firstName, :middleINit, :lastname,
             :department, :phoneNumber, :hireDate, :job,
             :educationLevel, :sex, :birthDate,
             :salary, :bonus, :commission)
//SYSTSIN  DD *
DSN SYSTEM(DSN2)
BIND SERVICE("zCEEService") -
NAME("insertEmployee") -
SQLENCODING(1047) -
DESCRIPTION('Insert an employee into table USER1.EMPLOYEE')
/*
```

This service inserts a new row into table USER1.EMPLOYEE.

Tech-Tip: The host variables specified in the VALUES clause will determine the JSON request and response message property names.

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• Db2 native REST service *updateEmployee* updates the SALARY, BONUS and COMM columns in the Db2 table. Db2 native REST service *displayEmployee* will display all the columns of the table (remember Db2 native REST service *selectEmployee* only returns a subset of the columns). These were defined be the BIND commands below.

```
//BIND EXEC PGM=IKJEFT01,DYNAMNBR=20
//SYSTSPRT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//DSNSTMT  DD *
  UPDATE USER1.EMPLOYEE
         SET SALARY = :salary, BONUS  = :bonus, COMM   = :commission
    WHERE EMPNO = :employeeNumber
//SYSTSIN  DD *
DSN SYSTEM(DSN2)
BIND SERVICE("zCEEService") -
NAME("updateEmployee") SQLENCODING(1047) -
DESCRIPTION('Insert an employee row into table USER1.EMPLOYEE')
//BIND EXEC PGM=IKJEFT01,DYNAMNBR=20
//SYSTSPRT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//DSNSTMT  DD *
  SELECT * FROM USER1.EMPLOYEE WHERE EMPNO = :employeeNumber
//SYSTSIN  DD *
DSN SYSTEM(DSN2)
BIND SERVICE("zCEEService") -
NAME("displayEmployee") SQLENCODING(1047) -
DESCRIPTION('Display an employee row in table USER1.EMPLOYEE')
('Select an employee from table USER1.EMPLOYEE')
```

There is a pattern in the response messages from the Db2 REST services. When a Db2 resources is added, updated, or deleted, the response message included an *Update Count* field. The field contains the number of Db2 resources affected by this invoking this service. In the same token, when Db2 resources were retrieved, the Db2 resources were returned in a list or array (e.g., *Resultset Output*) containing one or more list elements. These fields will be used in the *z/OS Connect Designer* to know if a specific REST method was successful or not.

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The z/OS Connect Designer Container environment

Before developing an API, it is useful to understand the configuration required for the z/OS Connect Designer the development environment.

The container configuration file

Regardless of whether *Docker Engine, Docker Desktop*, *Podman* or some other container runtime product is being used, the container's environment required configuration.

First, the container requires that Db2 related environment variable be provided. These variables are used to customize the Db2 related server XML configuration elements. For this exercise, the container was configured with these environment variables set in the *docker-compose.yaml* file (in ***bold***).

```
version: "3.2"
services:
    zosConnect:
        image: icr.io/zosconnect/ibm-zcon-designer:3.0.57
        user: root
        environment:
            - BASE_PATH=roster
            - CICS_USER=USER1
            - CICS_PASSWORD=USER1
            - CICS_HOST=wg31.washington.ibm.com
            - CICS_PORT=1491
            - DB2_USERNAME=USER1
            - DB2_PASSWORD=USER1
            - DB2_HOST=wg31.washington.ibm.com
            - DB2_PORT=2446
            - HTTP_PORT=9080
        ports:
            - "9449:9443"
            - "9086:9080"
        volumes:
            - ./project:/workspace/project
            - ./logs/:/logs/
            - ./certs:/output/resources/security/
```

Connecting to a Db2 subsystem requires the addition of a *zosconnect_db2Connection* configuration element to the container's Liberty configuration. And since this API has role-based security elements configured, additional configuration elements for a basic registry and authorization roles are also required. These Liberty configuration elements are described next.

Tech-Tip: The contents of this docker-compose.yaml file were based on the example found in the z/OS Connect product documentation at URL
https://www.ibm.com/docs/en/zos-connect/zos-connect/3.0?topic=tutorials-creating-db2-zos-connect-api

Considerations when deploying multiple APIs in a native server

Deploying multiple APIs into a single native server requires that each API have a unique context root, otherwise there may be collisions with the URI paths of other APIs. The optimal time to ensure this context root is unique and/or to provide a unique context root is before the YAML document is imported into the z/OS Connect Designer.

Review the YAML document (*c:\z\openapi3\yaml\employees.yaml*) and locate the ***Servers*** section (see an example below). Each element in the *server* attribute will have an *url* attribute where a base path could be provided. The default base path is simply a slash (/). Again, if multiple APIs are to be deployed into a single native server, a unique value needs to be provided for each API. In this exercise, the base path has already been set in the YAML file to ***/roster*** (as shown below).

```
servers:
  - url: /roster
```

Making this change in the z/OS Connect Designer requires the addition of a *webApplication* configuration element. This element will explicitly associate the WAR file developed for the API in this exercise with the value of **/roster** as the context root (see below).

To avoid hard coding a value for the context root, an additional environment variables **BASE_PATH** was added to the *docker-compose.yaml* file and set a value of ***roster***. The environment variable *${BASE_PATH}* will be used to provide values for the *name* and *contextRoot* attributes in the *webApplication* configuration element, see below.

```
<?xml version="1.0" encoding="UTF-8"?>
<server>

<webApplication id="myApi" name="${BASE_PATH}" contextRoot="/${BASE_PATH}"
 location="${server.config.dir}dropins/api.war" />

</server>
```

Connecting to Db2 and the required server XML configuration

The *zosconnect_db2Connection* element used to connect to a Db2 subsystem in this exercise looks like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="Db2 zosconnect_db2Connection ">
    <featureManager>
        <feature>zosconnect:db2-1.0</feature>
    </featureManager>

<zosconnect_db2Connection id="db2Conn"
   host="${DB2_HOST}"
   port="${DB2_PORT}"
   credentialRef="commonCredentials" />

<zosconnect_credential id="commonCredentials"
   user="${DB2_USERNAME}"
   password="${DB2_PASSWORD}" />

</server>
```

Notice the environment variables *${DB2_HOST}, ${DB2_PORT},${DB2_USERNAME}* and *${DB2_PASSWORD}* are set to the values provided in the *docker-compose.yaml* file.

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Basic security and the required server XML configuration

The *basicRegistry* and *authorization-roles* elements used in this exercise looks like this:

```
<server description="basic security">

    <!-- Enable features -->
    <featureManager>
     <feature>appSecurity-2.0</feature>
     <feature>restConnector-2.0</feature>
    </featureManager>

    <webAppSecurity allowFailOverToBasicAuth="true" />

    <basicRegistry id="basic" realm="zosConnect">
        <user name="Fred" password="fredpwd" />
        <user name="user1" password="user1" />
        <user name="user2" password="user2" />
     <group name="Manager">
        <member name="Fred"/>
     </group>
     <group name="Staff">
        <member name="Fred"/>
        <member name="user1"/>
     </group>
    </basicRegistry>

   <administrator-role>
    <group>Manager</group>
   </administrator-role>

   <authorization-roles id="zCEERoles">
    <security-role name="Manager"> <group name="Manager"/> </security-role>
    <security-role name="Staff"> <group name="Staff"/> </security-role>
   </authorization-roles>
</server>
```

In the above configuration, identity *Fred* is a member of the *Manager* and *Staff* group. Identities *USER1* and is a member of the *Staff* group. Identity *USER2* is not a member of any role-based groups.

The role names *Manager* and *Staff* correspond to the values that appear in the API's specification document . In this example, a default role of *Manager* is defined in the root of the OpenAPI definition. Each of the GET operations defines a role of *Staff*. So only users in or with access to the *Staff* role all allowed to perform the GET methods. And only users in or with access to the *Manager* role all allowed to perform the POST, PUT and DELETE methods. A user with only *Staff* access with receive an HTTP 403 (Forbidden) response if they try to invoke one of these privileged methods.

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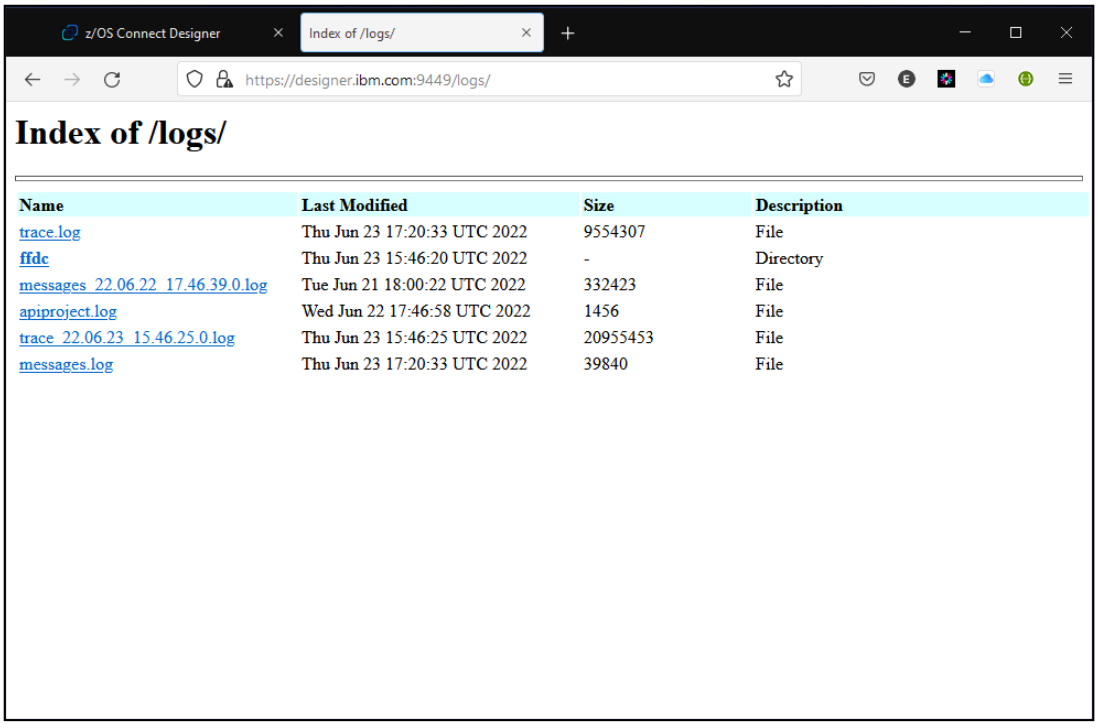
```
openapi: 3.0.0
x-ibm-zcon-roles-allowed:
- Manager
security:
- BasicAuth: []
- BearerAuth: []
paths:
  "/roles/{job}":
    get:
-----------------------------
      x-ibm-zcon-roles-allowed:
        - Staff
-----------------------------
  /employees:
    post:
-----------------------------
  /employees/details/{employee}:
    get:
-----------------------------
      x-ibm-zcon-roles-allowed:
        - Staff
-----------------------------
  "/employees/{employee}":
    get:
-----------------------------
      x-ibm-zcon-roles-allowed:
        - Staff
-----------------------------
    delete:
-----------------------------
    put:
-----------------------------
```

Accessing the z/OS Connect Designer log and trace files

The Liberty server in which the z/OS Connect Designer has been further customized with the addition of the server XML configuration elements below. These XML configuration elements enables the Liberty server to become a file server.

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="Default server">
<webApplication id="resources-dropins" name="dropins"
   location="/opt/ibm/wlp/usr/servers/defaultServer/dropins">
    <web-ext context-root="dropins"
      enable-file-serving="true" enable-directory-browsing="true">
      <file-servering-attribute name="extendDocumentRoot"
       value="/opt/ibm/wlp/usr/servers/defaultServer/dropins" />
    </web-ext>
</webApplication> >
<webApplication id="resources-logs" name="logs"
   location="/logs">
    <web-ext context-root="logs"
      enable-file-serving="true" enable-directory-browsing="true">
      <file-servering-attribute name="extendDocumentRoot"
       value="/logs" />
    </web-ext>
</webApplication> >
</server>
```

This is very useful because this allows the viewing of the server's log and trace file from a browser. This means an API developer using *z/OS Connect Designer* in one tab of browser will be able to monitor the messages and/or traces in other browser tabs as they are developing or testing their API. To access the server's logs directory, start with the same host and port as the *Designer* but with the URI path to */logs*. Double clicking on a file such as *trace.log* or *messages.log* allows the real time monitoring of trace messages or server messages by clicking the browser's refresh button.



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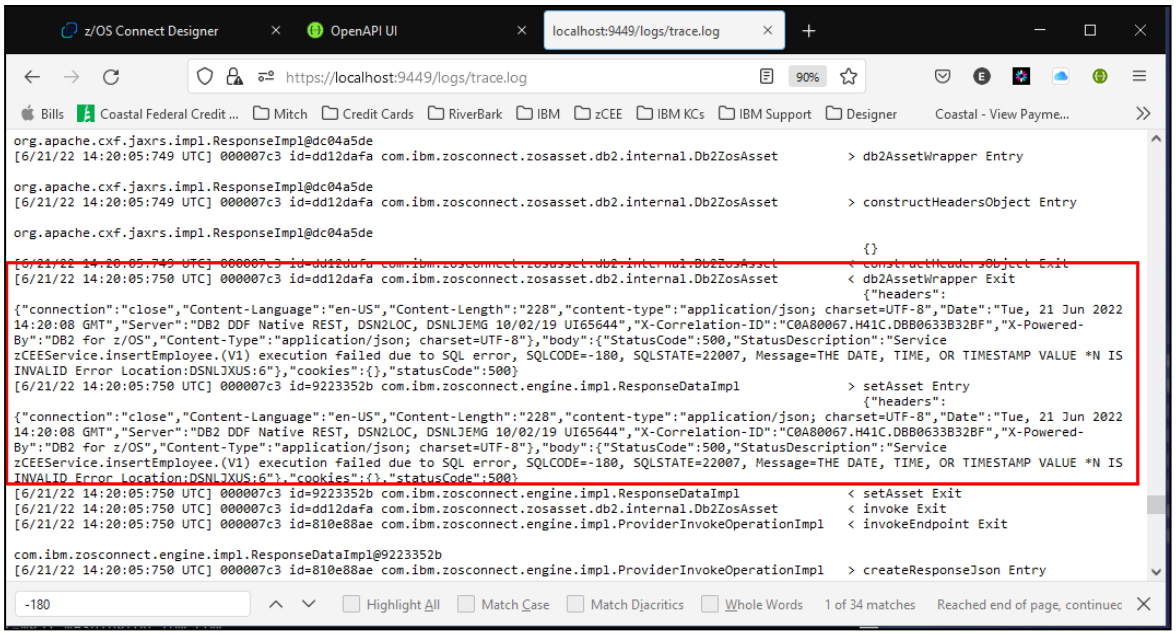
For example, using this technique the details of a SQL request and any SQL errors will appear in a *trace.log*. In this case this is information not returned in the response message but written to the trace by the service provider. This is very useful when the expected results are not returned.



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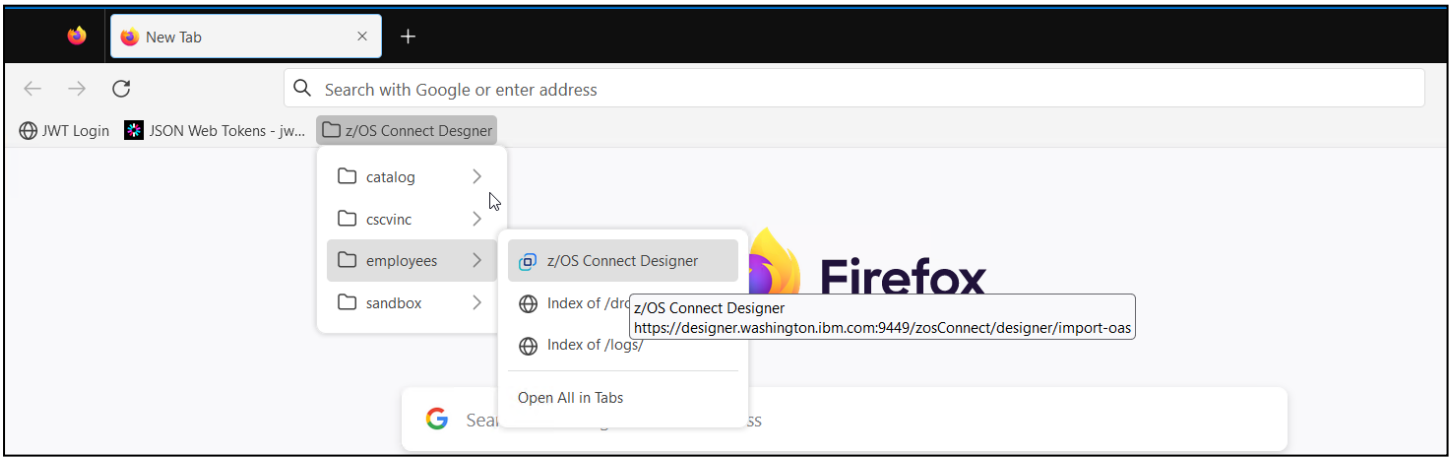
Developing a z/OS Connect APIs that accesses Db2

This section of the exercise provides an opportunity to compose and test an API that accesses Db2.

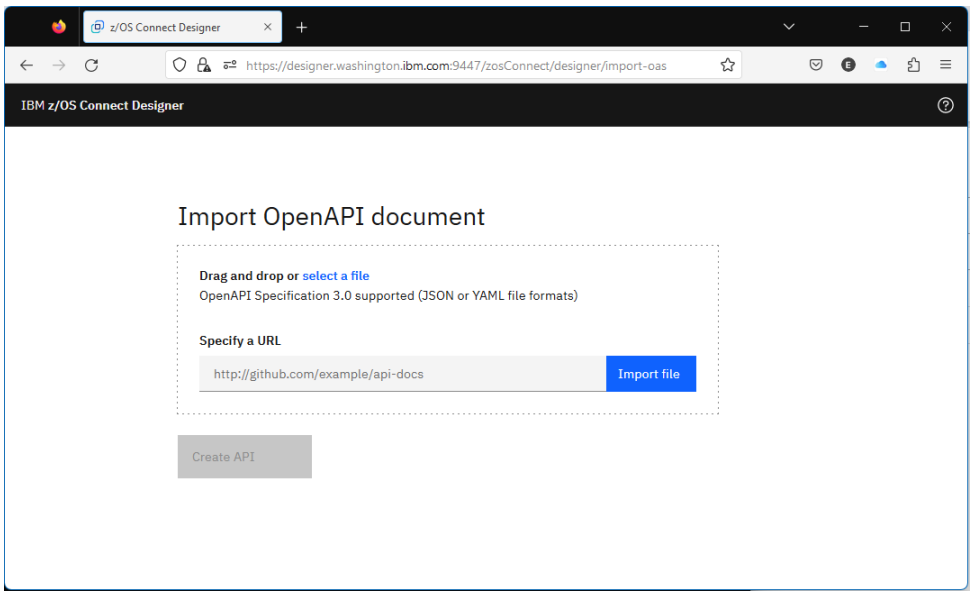
___1. Start by opening the Firefox browser and going to URL ***https://designer.washington.ibm.com:9449/zosConnect/designer/***

As an alternative, you could use the provided bookmark (see below) to access the Designer.



Tech-Tip: Be patient. It may take a while for the first page to fully load. Numerous background activities are being performed to fully initialized the application.

___2. The first window you will see in a 'fresh' *Designer* environment gives you the opportunity to import an OpenAPI document. On the *Import OpenAPI document* window, click on ***select a file*** and traverse in the *File Upload* window to the directory where the specification document files are stored, e.g., *C:/z/openApi3/yaml*. Select file *employee.yaml* and click the **Open** button to continue.



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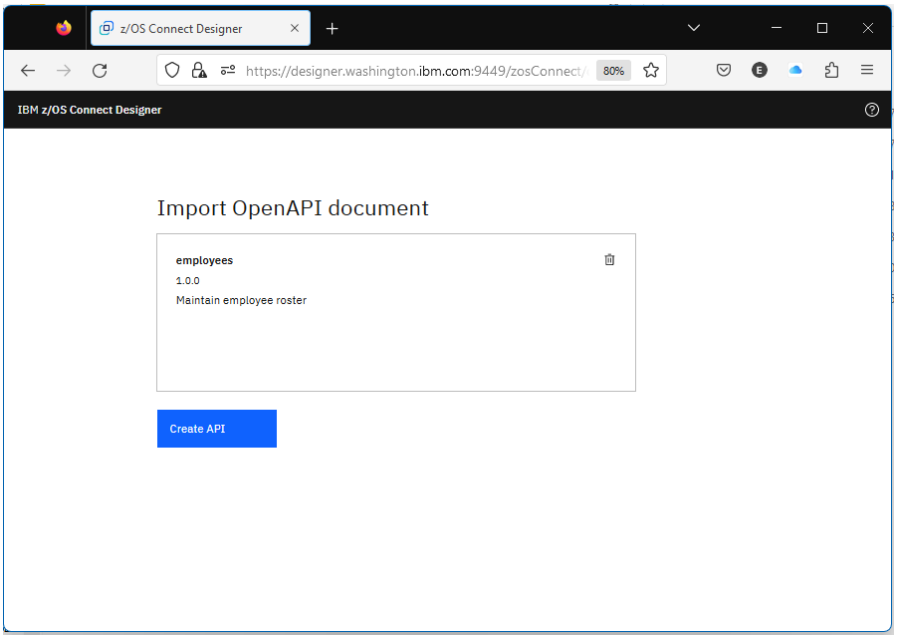
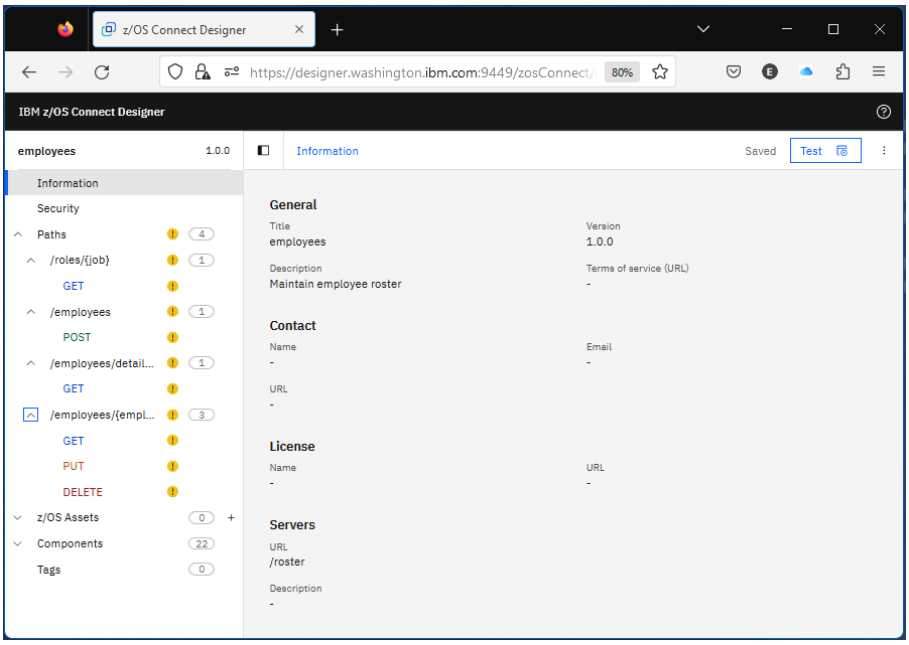
___3. On the next *Import OpenAPI document* window, click the **Create API** button to complete the importation of the specification document file into the *Designer.*



___4. The next *Designer* page to be displayed will be the details of the API provided by the specification document. Expand the **Paths** on the left-hand side and you will see the URI paths of the API. Expand the URI paths will display the individual methods of each path. For example, expanding URI paths */employees* and */employees/{employee}* will display the *POST, GET, PUT* and *DELETE* methods associated with these URI paths (see below).



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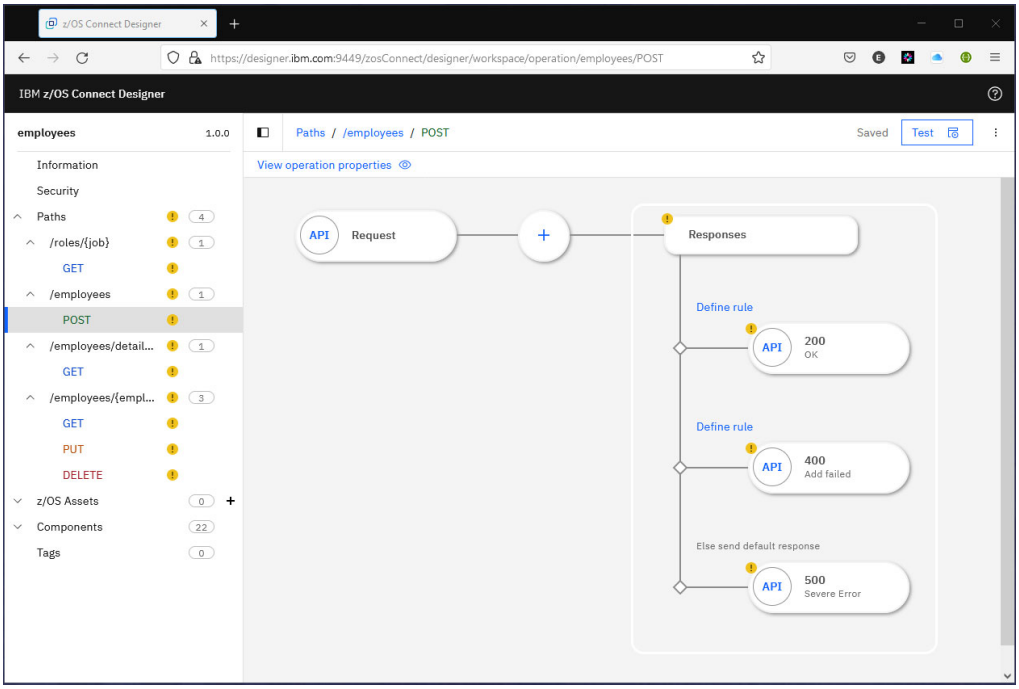
*Important: When using this tool, monitor the upper right-hand corner of the page. You will see either status of either **Saved** or **Saving**. It is suggested that you wait until changes are saved before continuing using the Designer.*

> **Tech-Tip:** The yellow exclamation marks simply indicate the underling configuration for this element is incomplete. As the exercise progresses, the exclamation marks will disappear.

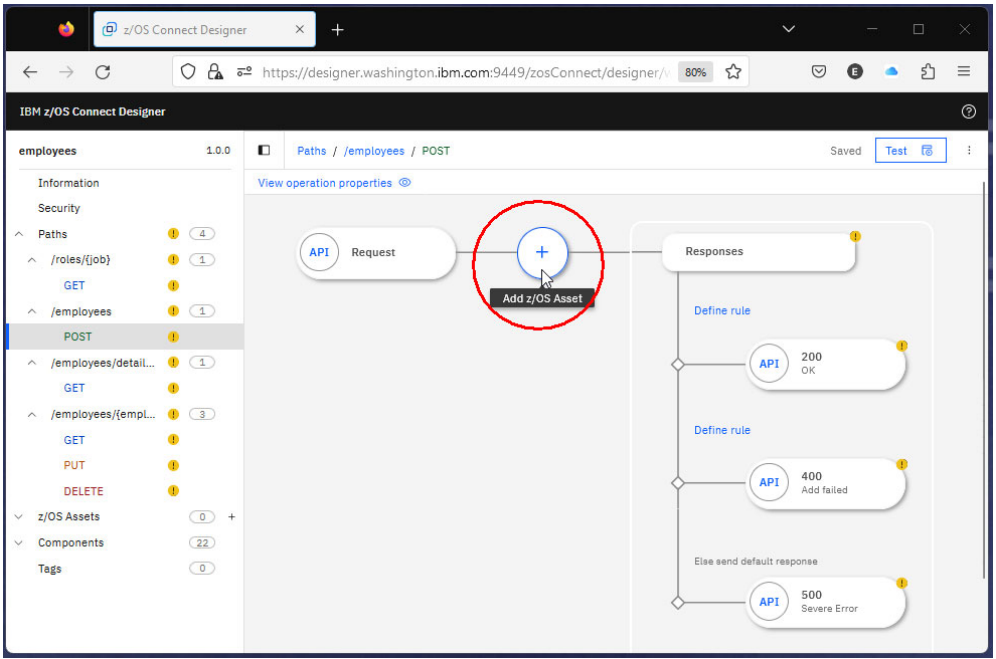
Configure the POST method for URI path /employees

___1. Selecting a method will display the operation properties of the method. Start with the *POST* method under */employees* and by selecting it, the view like the one below will appear.



In the example above, we see that the specification document defined 3 responses for this method. One is a 200-status code which indicate the invocation of the method (an insert) was successful. A 400-status code which indicates, in this case, that the request to insert an employee record failed. And finally, a 500-status code which indicates a severe error has occurred while processing the request.

___2. The first step in configuring this method for this URI path is to associate it with a z/OS asset or resource. Click the plus sign on the page to start the association of a z/OS asset with this URI path.



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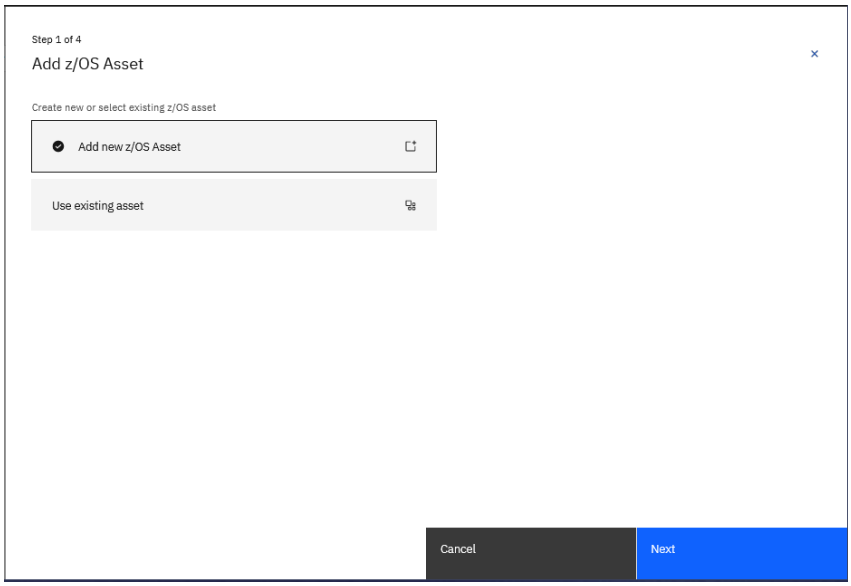
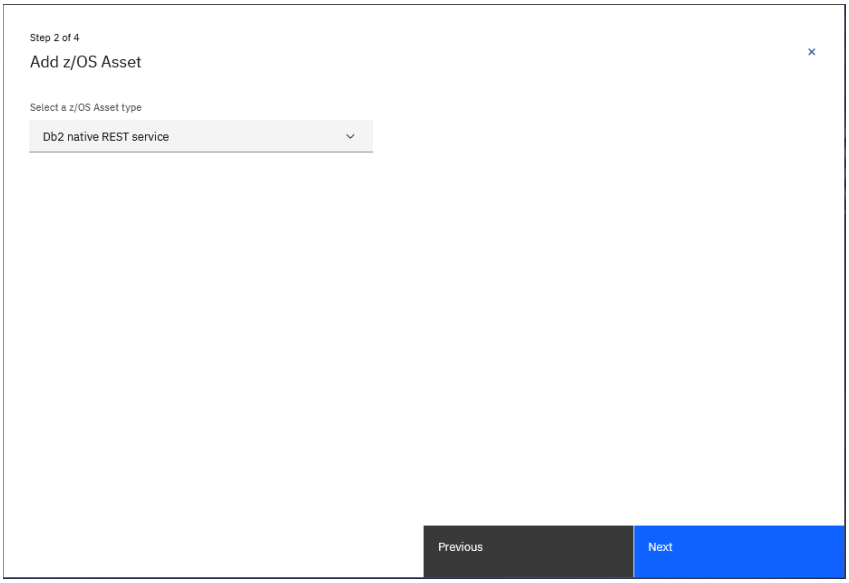
___3. On the *Add z/OS Asset (Step 1 of 4)* page, select the *Add new z/OS Asset* and press **Next** to continue.



___4. On the *Add z/OS Asset (Step 2 of 4)* page, use the pull-down arrow and select *Db2 native REST service* and press **Next** to continue.



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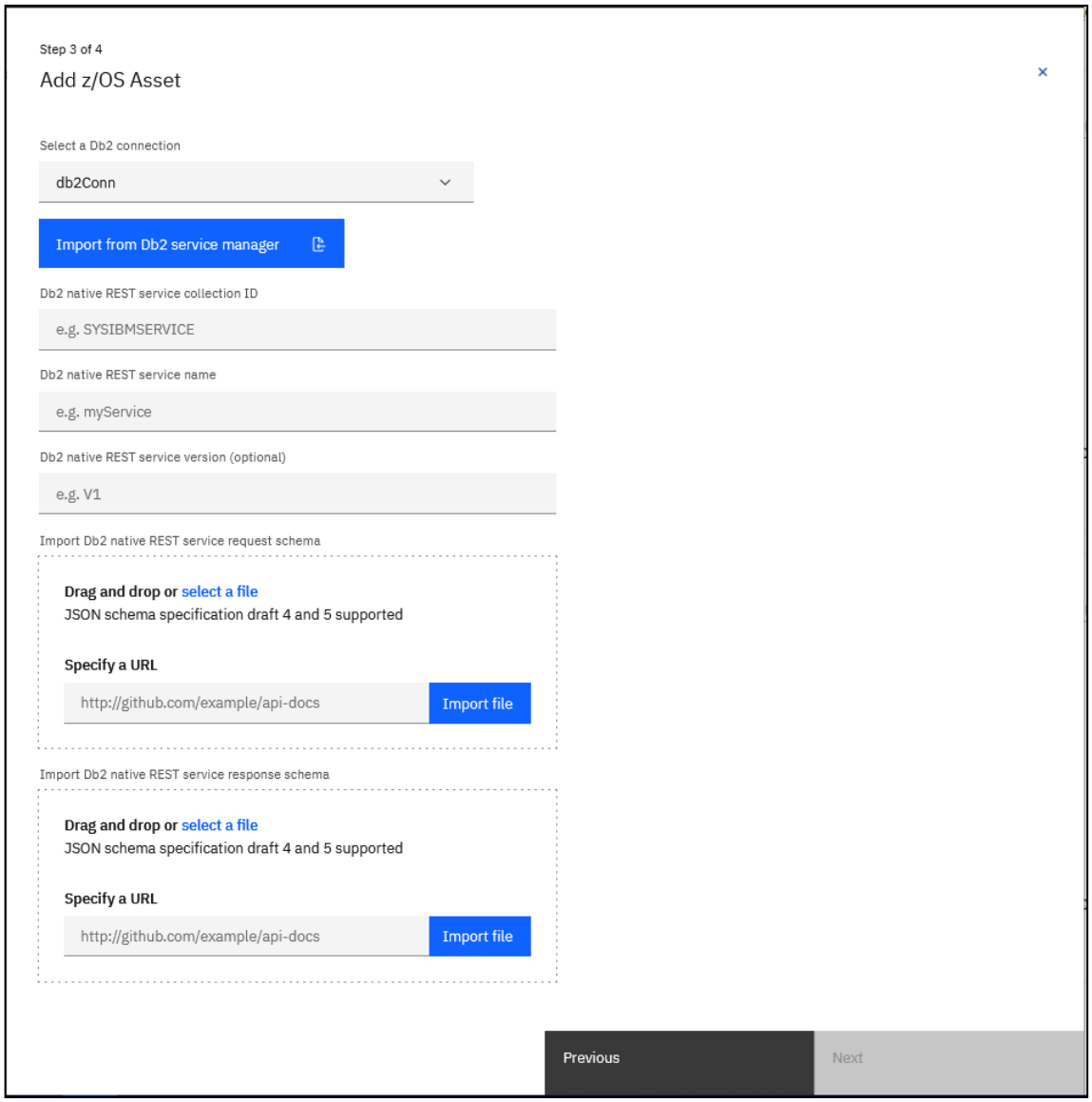
___5. On the *Add z/OS Asset (Step 3 of 4)* page, use the pull-down arrow and select the *db2conn* Db2 connection. This action will cause the full page to be displayed. Press **Import from Db2 service manager** to access Db2 and to list the available Db2 REST services. Note that the *collection ID*, *service name* and *version* can be used to filter the list.



Tech-Tip: The name ***db2conn*** is the name of the *zosconnect_db2Connection* configuration element described earlier in this exercise.

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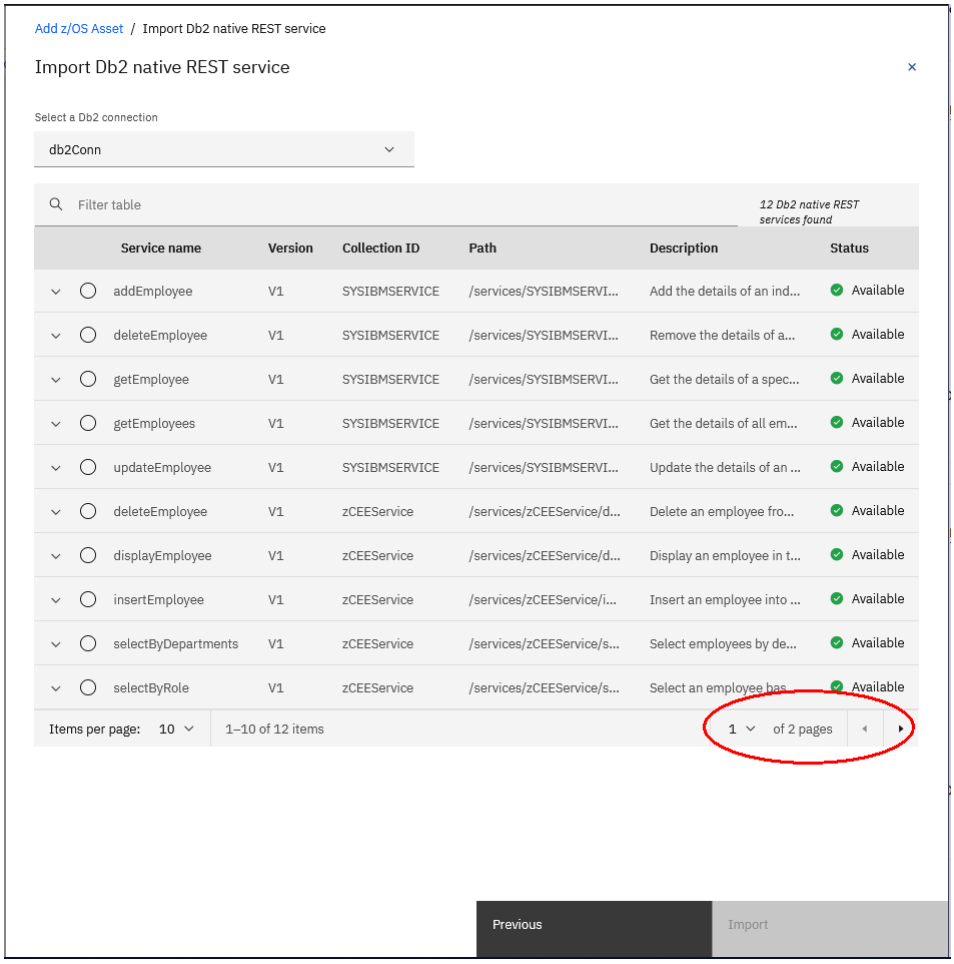
___6. A list of the available Db2 REST services will be displayed. In this case we want to associate the method with the Db2 REST service *insertEmployee* in the *zCEEService* collection. In this screen shot below, this service is on the first page. If it had not been, there would have been a need to use the page forward arrow at the bottom to go to page 2 of the list to display other pages of the list.



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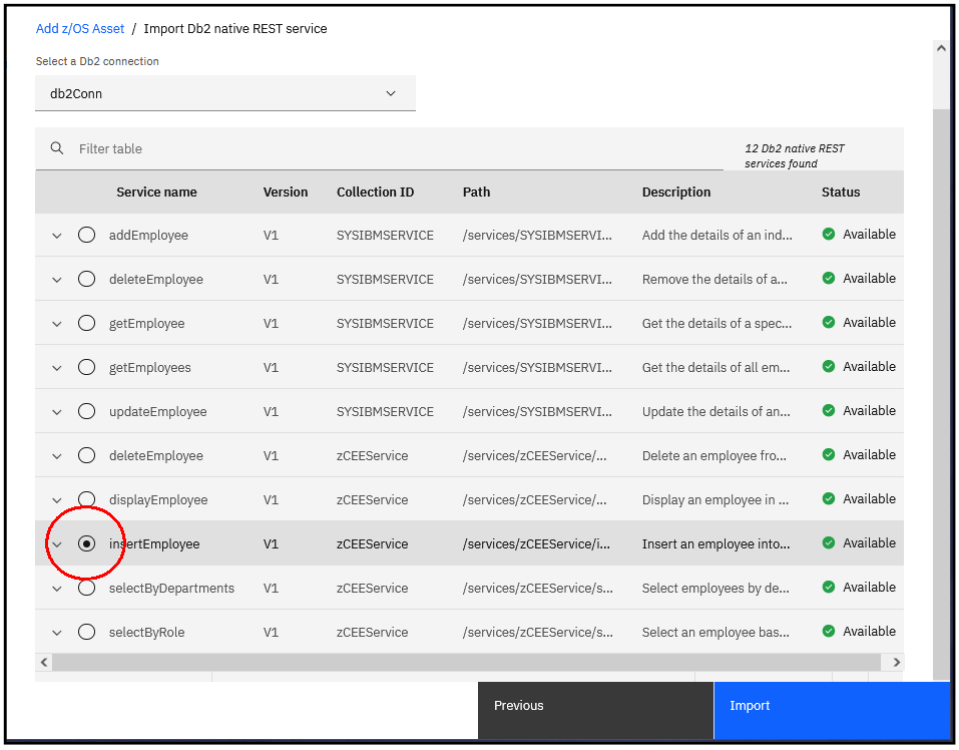
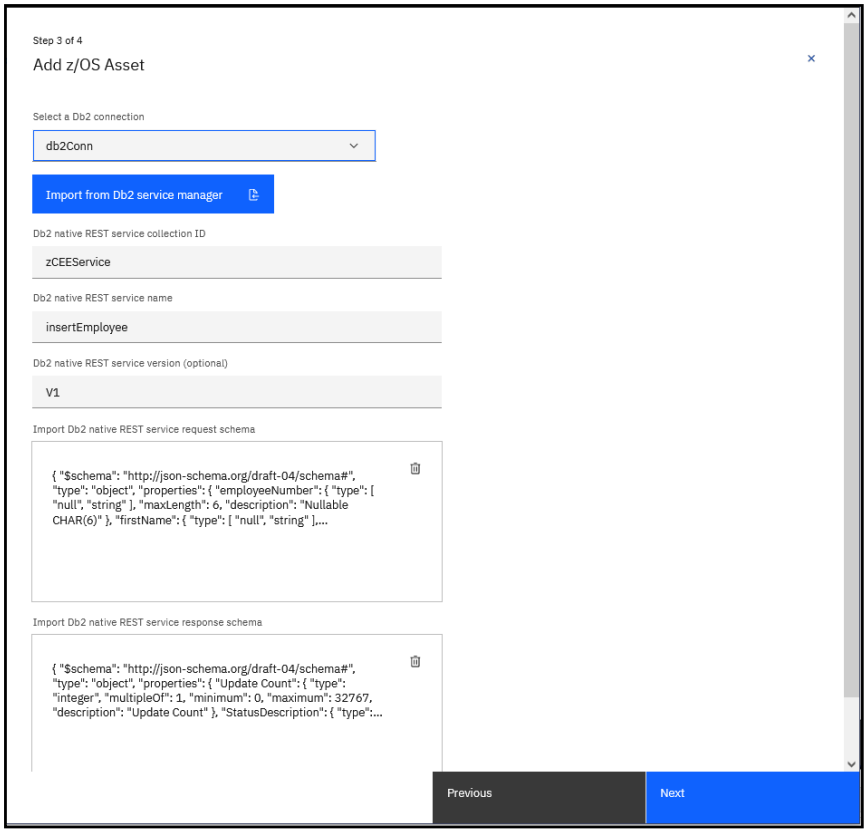
___7. Select the radio button beside the *insertEmployee* service under *Service Name* and in collection *zCEEService* see below. Press the **Import** button to have the Db2 native REST service information retrieved from Db2.



___8. This will return you back to the *Add z/OS Asset (Step 3 of 4)* page with the details (request and response schema, etc.) populated from the Db2 service repository. Click **Next** to continue.



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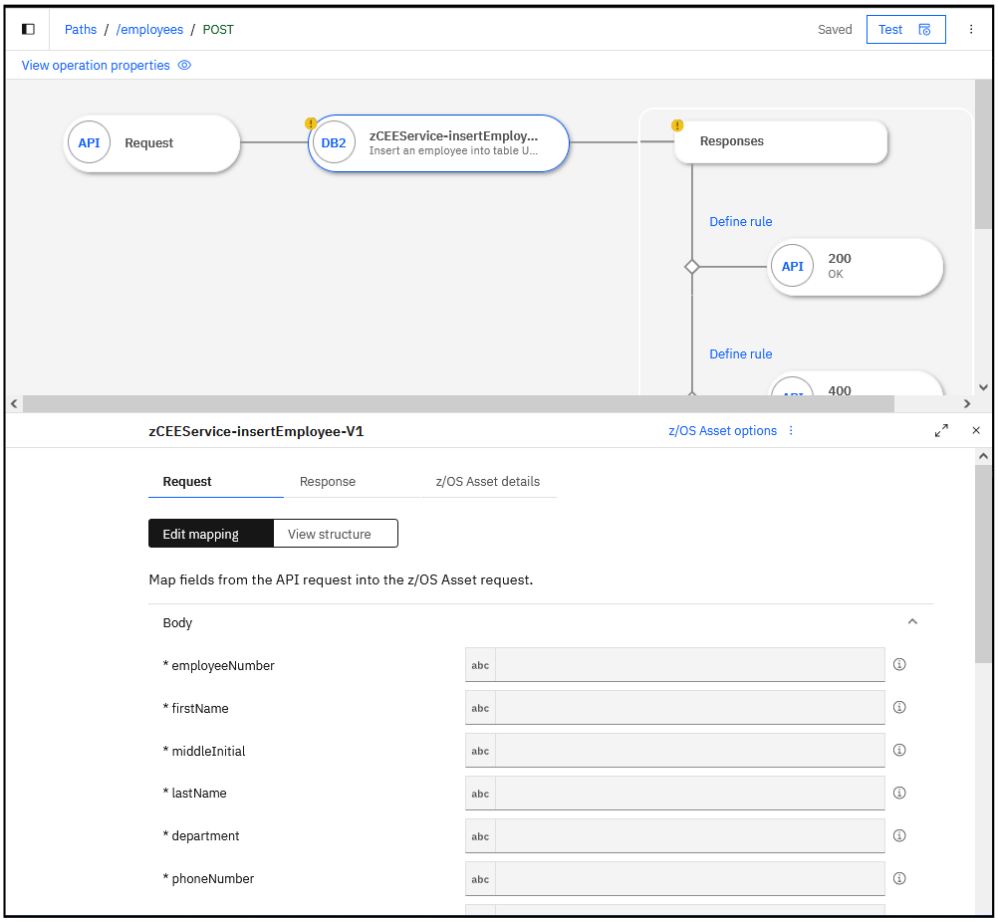
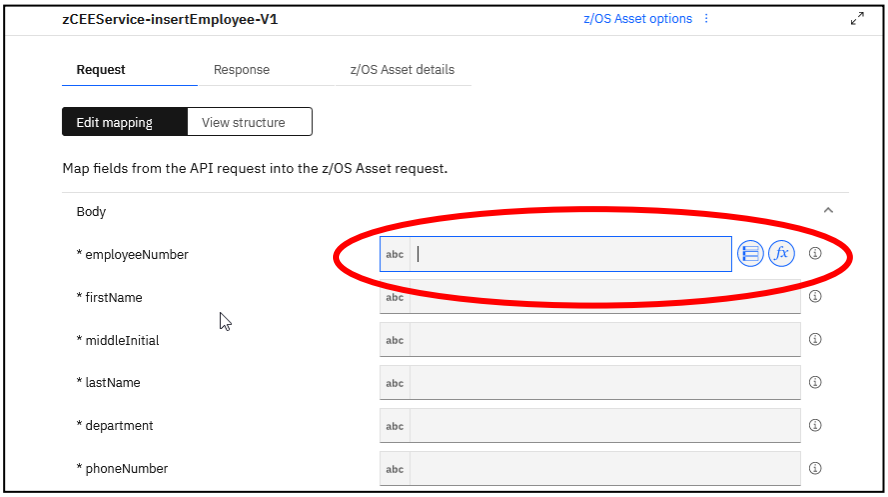
___9. On the *Add z/OS Asset (Step 4 of 4)* page, we are given an opportunity to rename or update the description of the z/OS asset. In this exercise, simply press **Add z/OS Asset** to continue. Eventually you see a brief message that the asset has been added successfully and the operation properties page will reflect the z/OS asset request mapping details (see below). On this page we are seeing the request properties from the Db2 request schema. What needs to be done is to map these fields to the request schema properties of the API as defined in the specification document that described the entire API.



Note: It is very important that when working with mapping fields that the field has been properly selected. A properly selection field will be displayed in a blue box as shown below.



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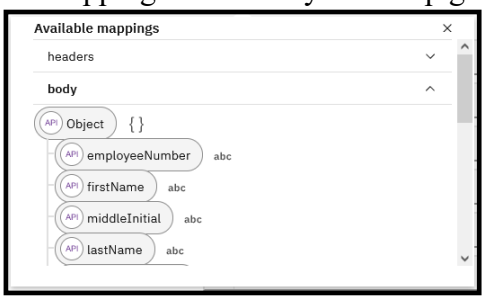
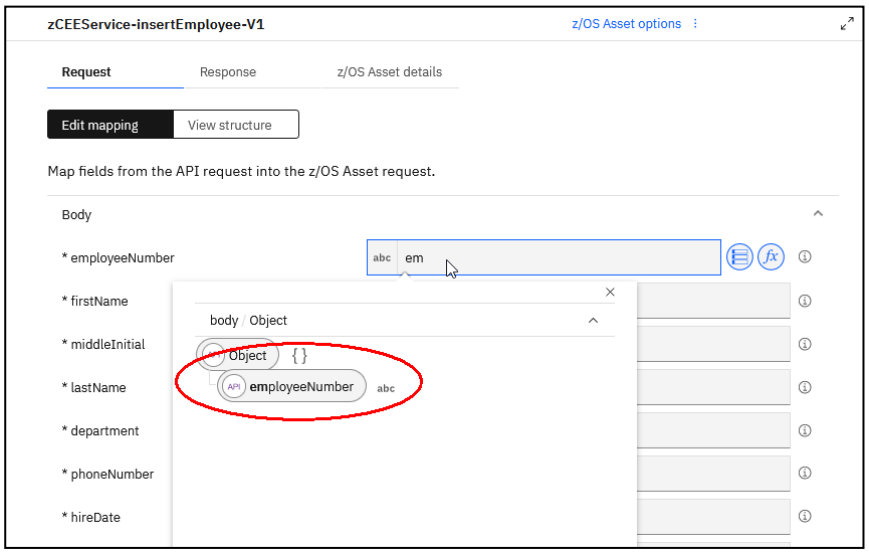
___10. Now map the Db2 request message fields with the corresponding API request message fields. But first become familiar with the fields in the API request message for this method. To display the API's request message fields, select any container field, and then select the *Insert a mapping* tool (see below).

___11. This will display the header and body mappings available for this method of the API. Become familiar with the mappings available in the body of the request message (you will have to use the scroll bar to see all the available mappings). Knowledge of the mappings in the body will help greatly in the next few steps.



There are two ways to map the Db2 request schema with the corresponding specification document API request fields. Both will be demonstrated in this section of the exercise. Use which ever method you prefer when mapping fields later in this exercise.

___12. Start by selecting an empty Db2 request message field and start typing the corresponding API request message field name. For example, entering the string ***em*** in the area beside *employeeNumber* will eventually match a field in the API request message whose name includes the same characters, and that schema field will be displayed in the drop-down list (see below).



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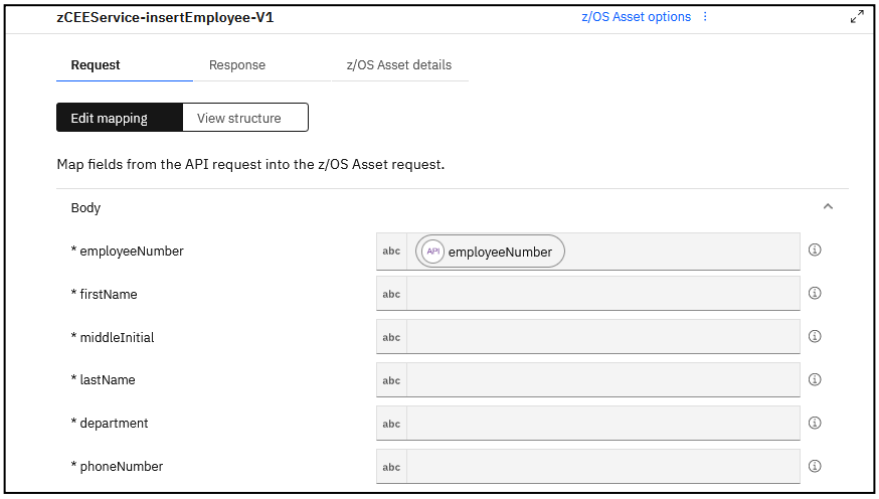
___13. Select the field and the area beside the Db2 request schema property name this will cause the API's request message field name to populate the area and complete the mapping.



Tech-Tip: The icon ⤢ can be used to maximize or reset this area of the page.

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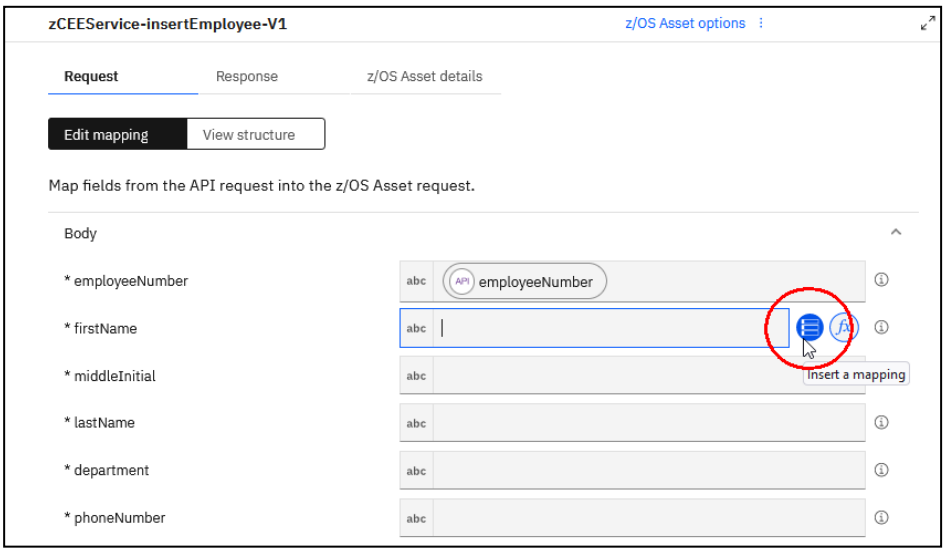
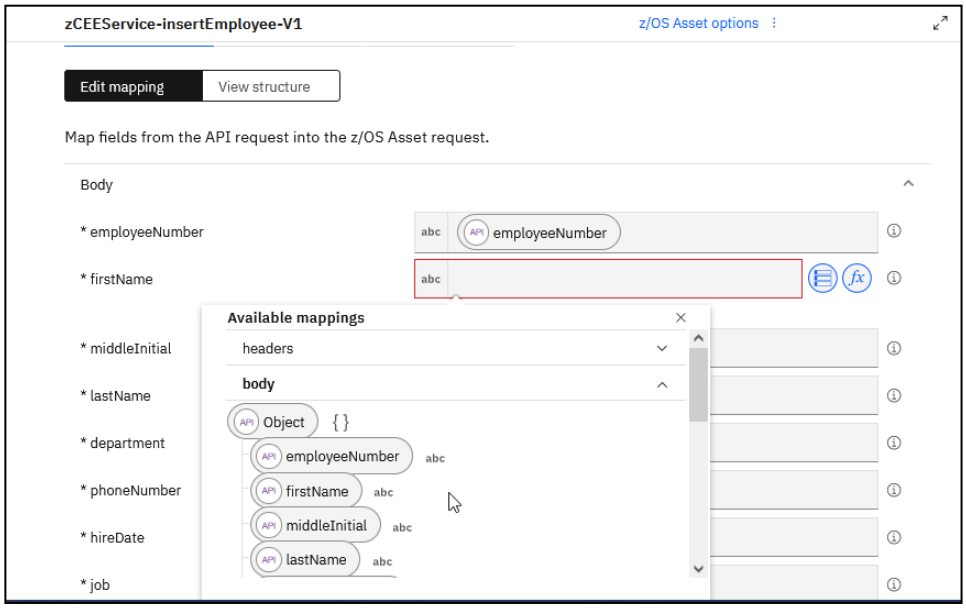
___14. The alternate mapping method is to select the *Insert a mapping* tool (see below).



___15. This will display a list of available mapping fields. Since this is a request message and the fields are in the request *body*. Scroll up or down and choose appropriate field from the fields from the *body*, not a query parameter, nor a path parameter. In this case, the field to select is the *firstName* field.



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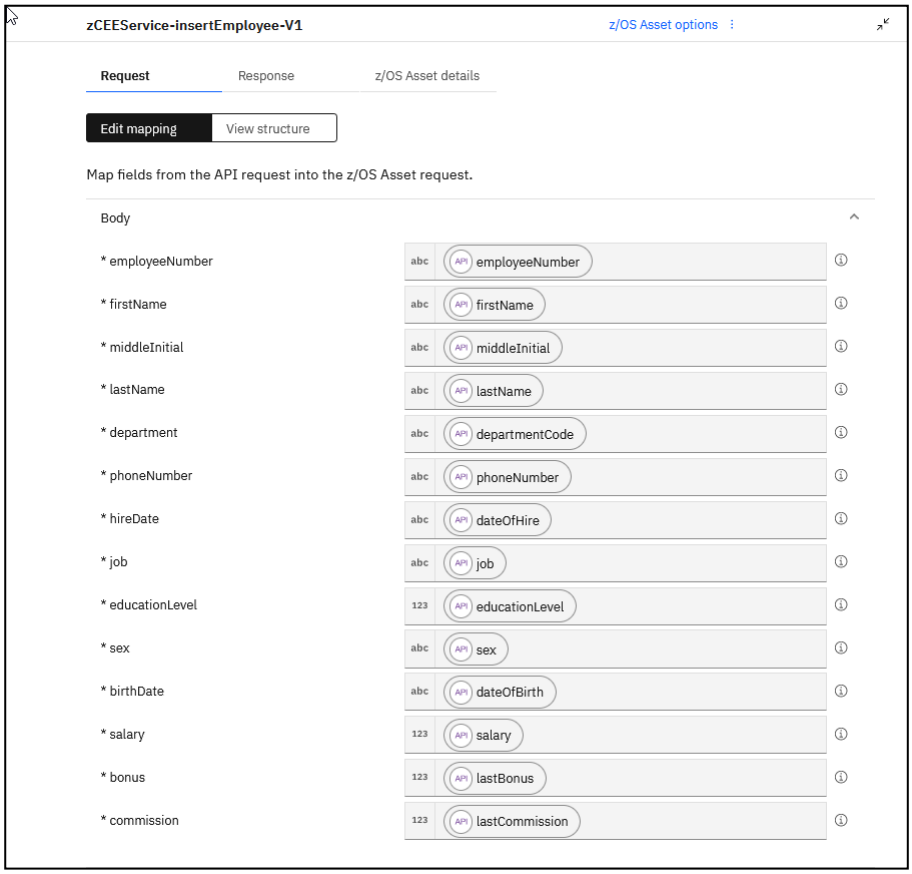
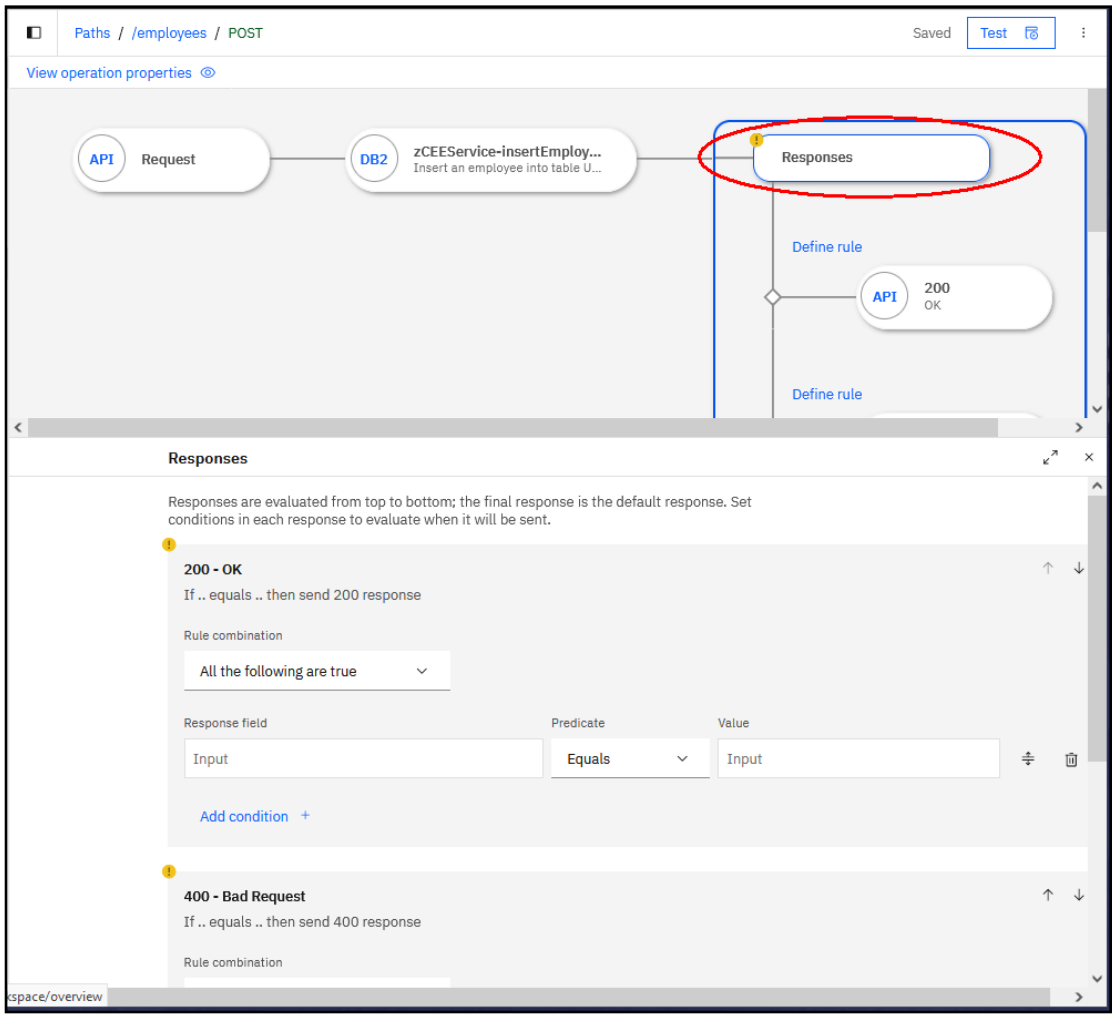
___16. Use either technique to complete the mappings. When completed, the results should look something like this the page below.



___17. The next step is to provide the configuration to evaluate the responses that come back in the Db2 REST service response message. Select the *Responses* box in the *view operation properties* page.



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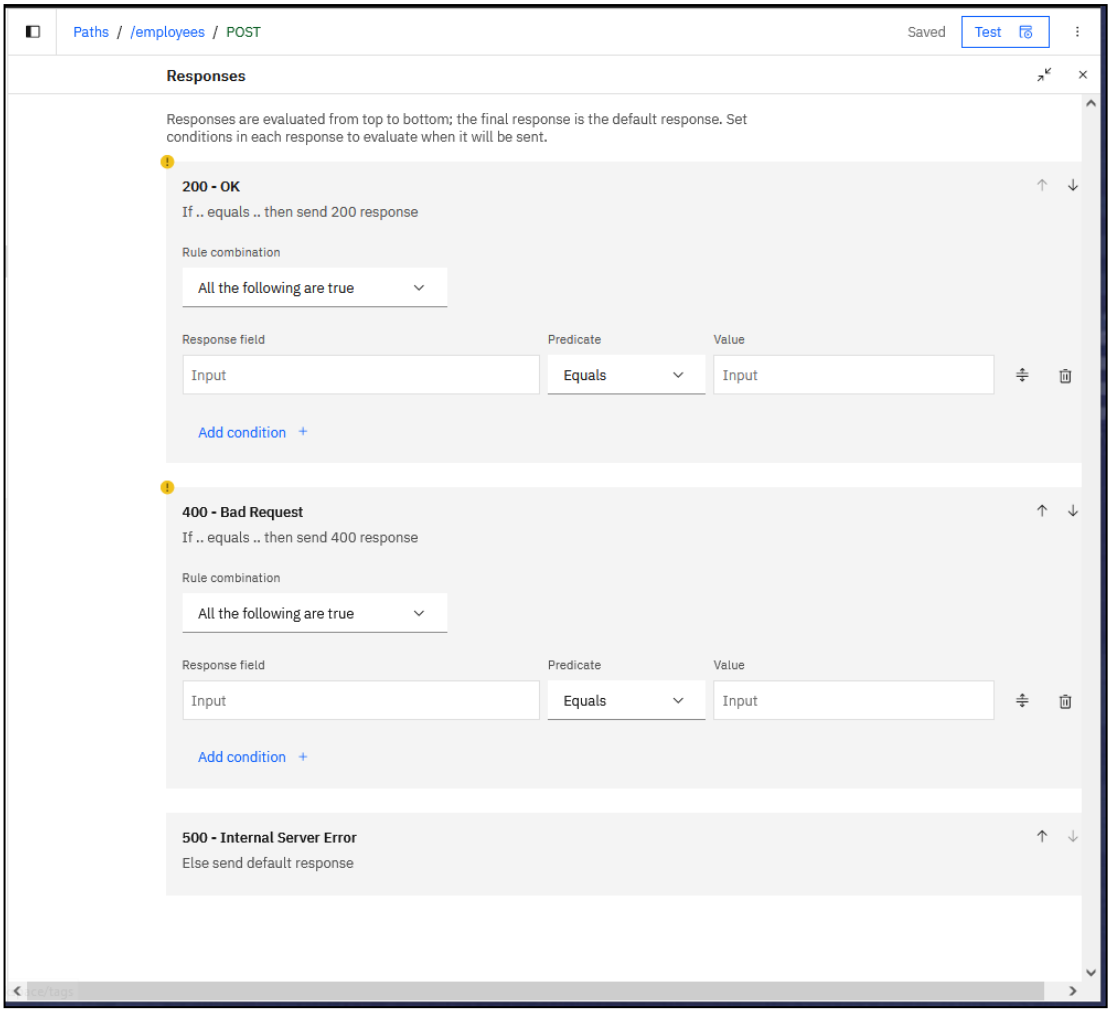
___18. Maximize the *Responses* area of the browser's page (see below).

Responses from the Db2 REST service are evaluated in the order shown in the sequence shown. The first check is to see if the record was inserted successfully. Db2 REST services will return an HTTP status code of 200 if the Db2 REST service was able to complete regardless of whether a row was inserted or not. So, we need another way to determine whether a row was really inserted. Fortunately, a Db2 REST service returns another response field, *Update Count,* which we can check the value to see how many rows were affected by this request.

So, we are going to check the response fields to (1) confirm the HTTP status code from Db2 is 200 and (2) the value of *Update Count* is set to either 1 or zero.



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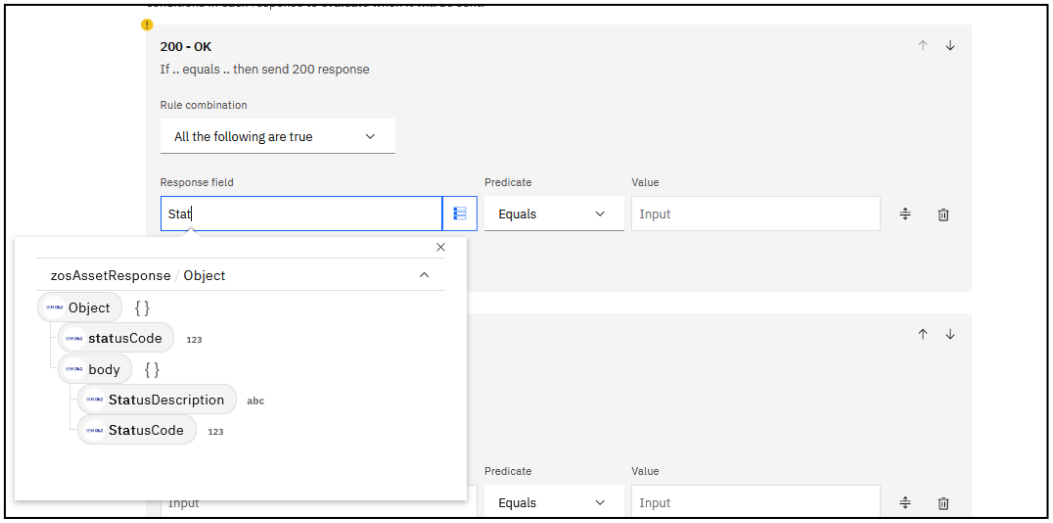
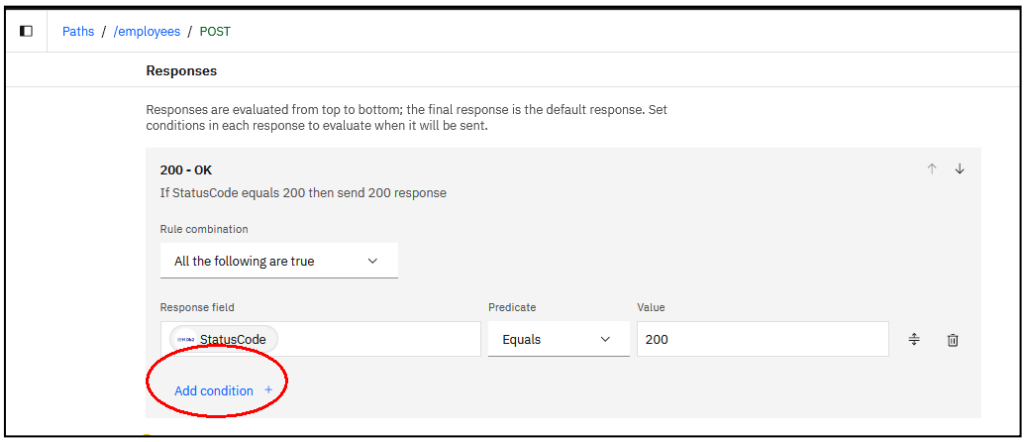
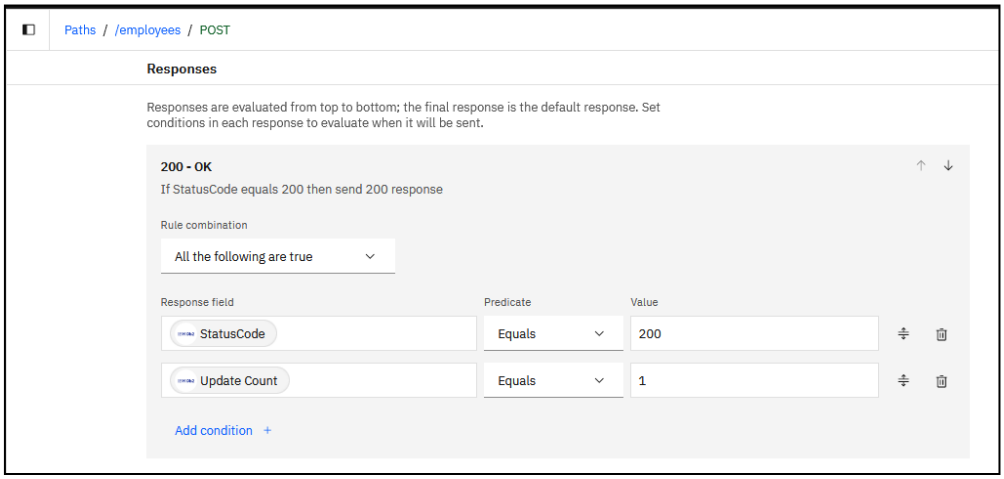
19. Under the *200 – OK* response, Enter the string ***Stat*** in the *Input* area under *Response field*. This will display all the fields in the Db2 REST response which match this string (position of the string in the field name does not matter, if the entered string matches any portion of the field name, that field will be displayed). In this case, select the *StatusCode* field. Leave the *Predicate* as *Equals* and enter ***200*** in the *Input* field for *Value*.



20. Next add a condition check for the value of *Update Count* by clicking on *Add condition* in the *200 – OK* evaluation.



21. Use the same technique described above to add a check for response field Update Count. Leave the *Predicate* as *Equals* and set the value to ***1*** as shown below:



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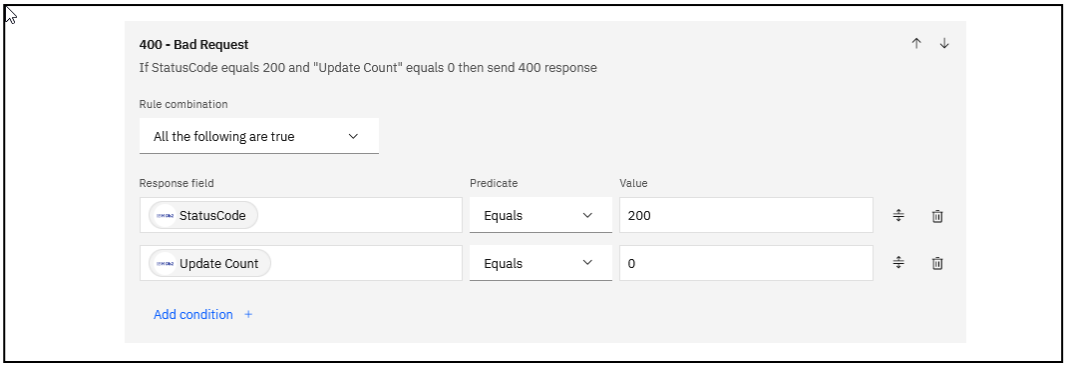
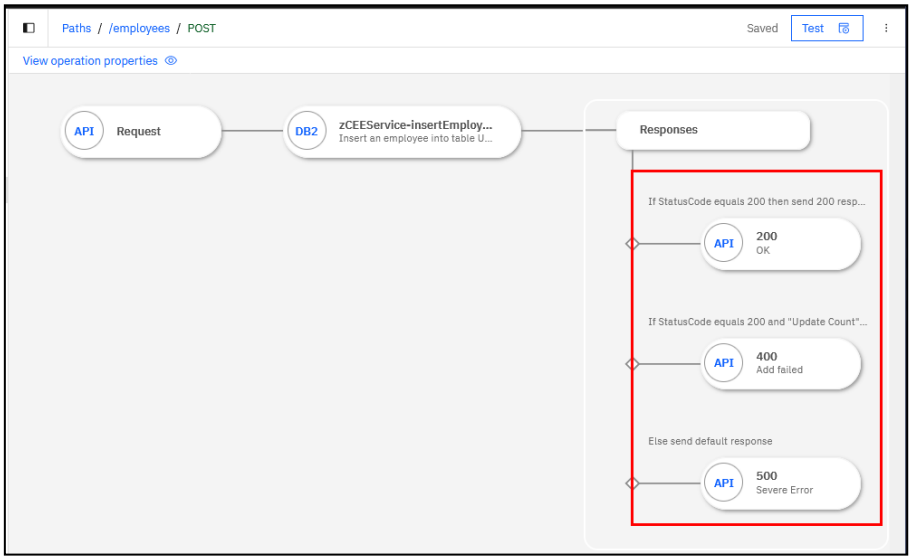
___22. For the *400 – Bad Request* check, add a check for ***StatusCod***e equaling ***200*** and a check for Update Count equaling ***0***



___23. If neither of these connections are met, simply return with a HTTP 500 status code.

___24. Next the API response messages need to be configured for each of these potential status codes.



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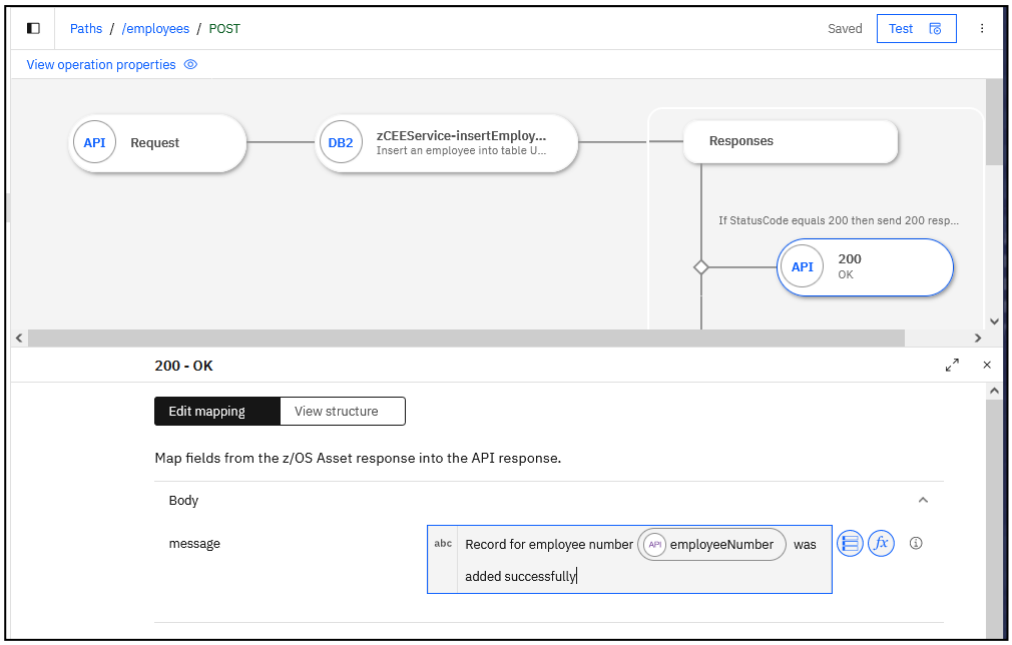
___25. Select the response for *200 OK* paste the text below in the *message* area.

Record for employee number {{$apiRequest.body.employeeNumber}} was added successfully



The same techniques used to map API response with the Db2 REST request message can be used to insert Db2 REST response files into text like this message which is then subsequently mapped to a field in the API response message. There is flexibility is building complex text strings based on the fields in the Db2 REST response message.

___26. Select the response for *400 Add failed* response mapping and paste the text below in the *message* area.

Record for employee number {{$apiRequest.body.employeeNumber}} was not added - {{$zosAssetResponse.body.StatusDescription}}

Tech-Tip: Db2 REST response property field *StatusDescription* provides more information regarding the issue that caused the insert to fail.

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___27. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

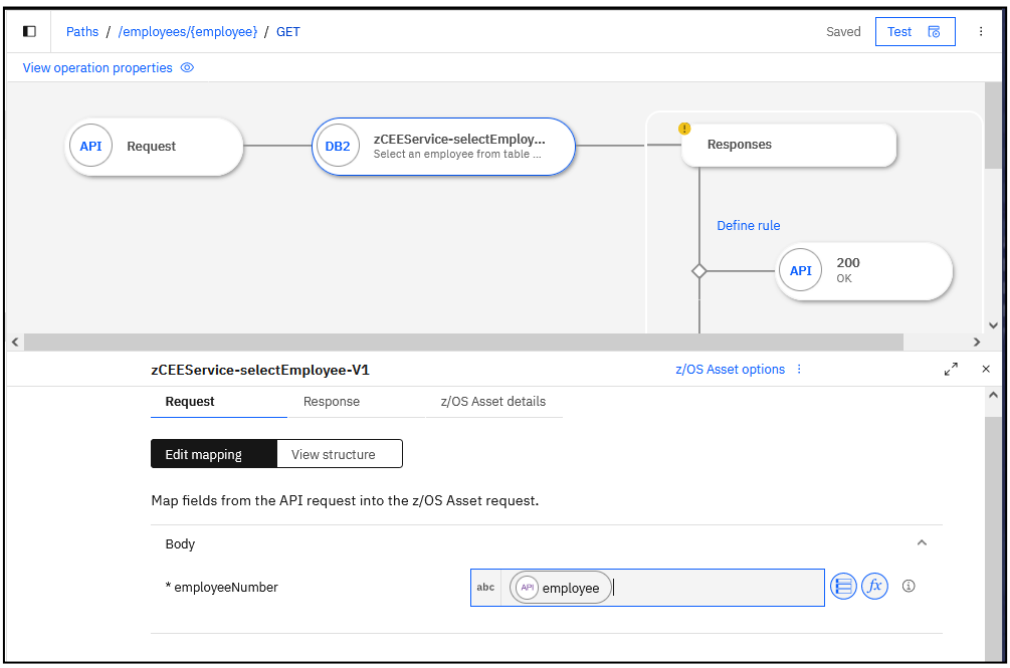
A severe error has occurred - {{$zosAssetResponse.body.StatusDescription}}

The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Configure the GET method for URI path /employees/{employee}

Now let's repeat the process and complete the configuration for the *GET* method of URI Path */employees/{employee}*

___1. Start by adding a new z/OS Asset for Db2 REST service *zCEEService-selectEmployee* to this method by using the same steps as performed before. Map the path parameter *employee* to the Db2 REST service request message field *employeeNumber* as shown below.



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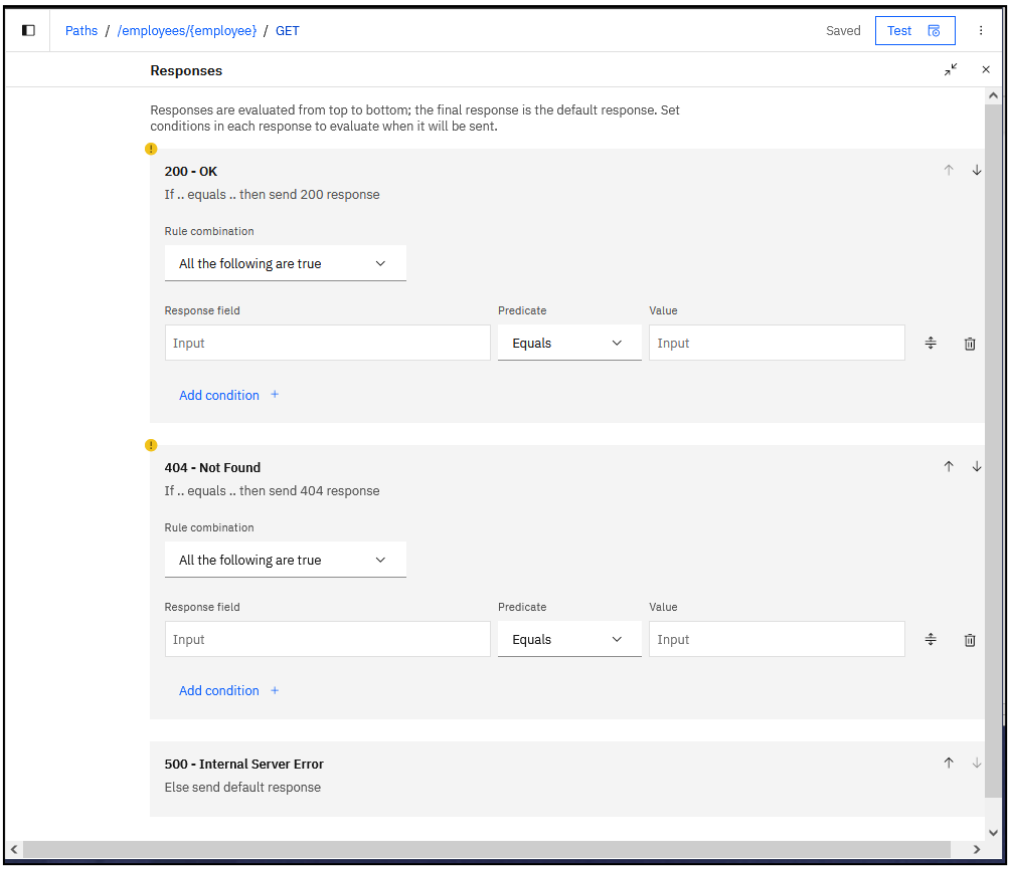
___2. Maximize the *Responses* area of the browser's page (see below).

Again, responses from the Db2 REST service are evaluated in the order shown in the sequence shown. The first check is to see if the record a row or rows were returned as intended. Db2 REST services will return an HTTP status code of 200 if the Db2 REST service was able to complete regardless of whether a row was selected or not. So, we need another way to determine whether a row was really selected. In this case a Db2 REST service will return the rows selected in a list or array. We are going to take advantage of function that will return the number of elements in the list or array, e.g., $count. If the result of invoking the function against a list returns a non-zero values, the list or array contains elements. If the result is zero, no elements are in the list and therefore no rows were selected.

So, we are going to check the response fields to (1) confirm the HTTP status code from Db2 is 200 and (2) and the value of invoking the $count function against the list of returned rows.



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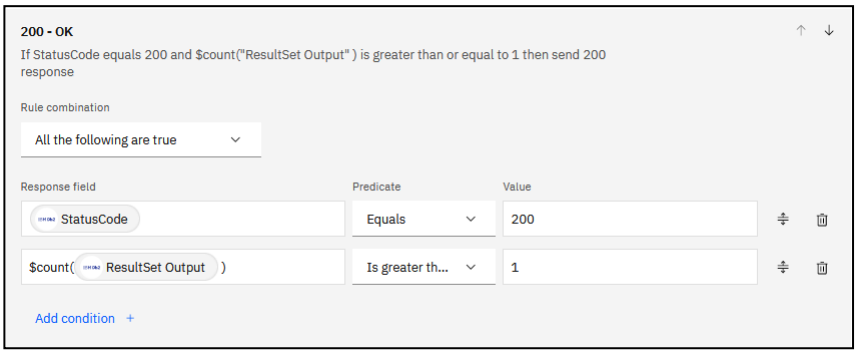
Under the *200 – OK* response, Enter the string ***Stat*** in the *Input* area under *Response field*. This will display all the fields in the Db2 REST response which match this string (position of the string in the field name does not matter, if the entered string matches any portion of the field name, that field will be displayed). In this case, select the *StatusCode* field. Leave the *Predicate* as *Equals* and enter ***200*** in the *Input* field for *Value*.

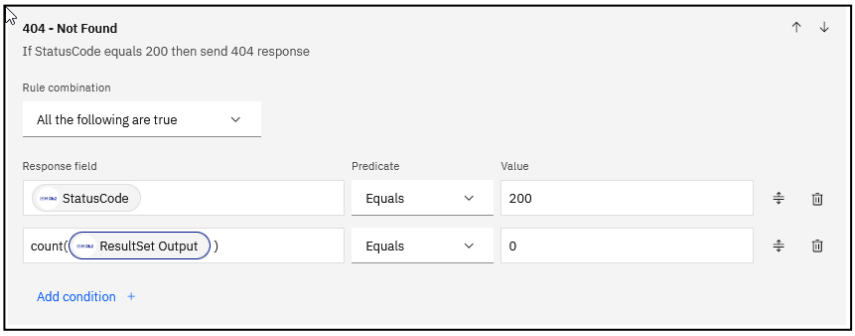
Next add a condition check for the value of invoking the function $count against the array of rows returned by the Db2 REST service *Count* by clicking on Add condition in the *200 – OK* evaluation and entering the string below in the area for the new check of a Response field.

$count($zosAssetResponse.body."ResultSet Output")

And set the *Predicate* to *Is greater than or equal to* a *Value* of ***1***.

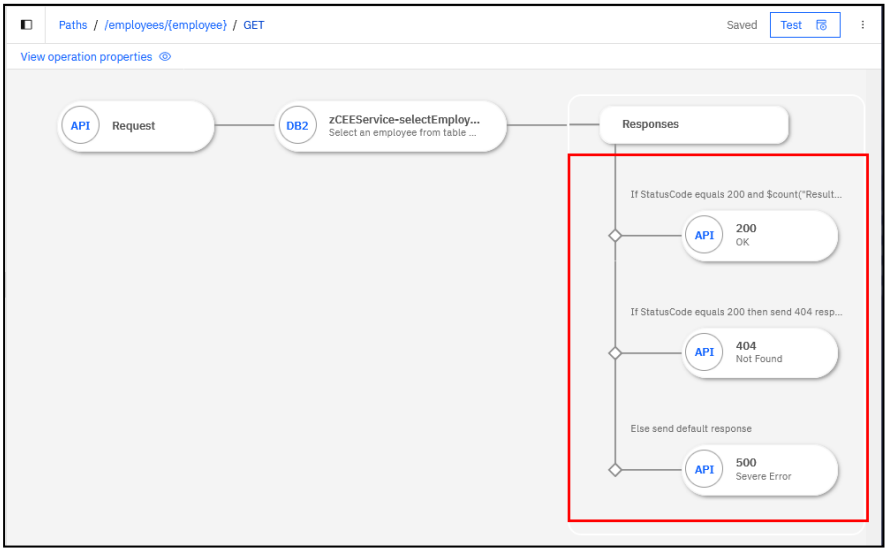


___3. For the *404 – Not Found* check, add a check for ***StatusCod***e equaling ***200*** and a check for the count equaling zero.



___4. If neither of these connections are met, simply return with a HTTP 500 status code.

___5. Next the API response messages need to be configured for each of these potential status codes.



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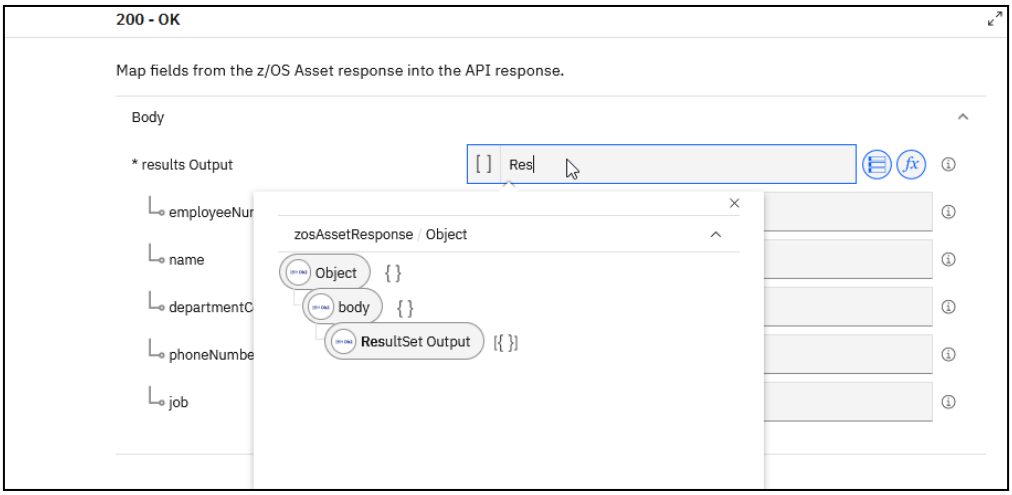
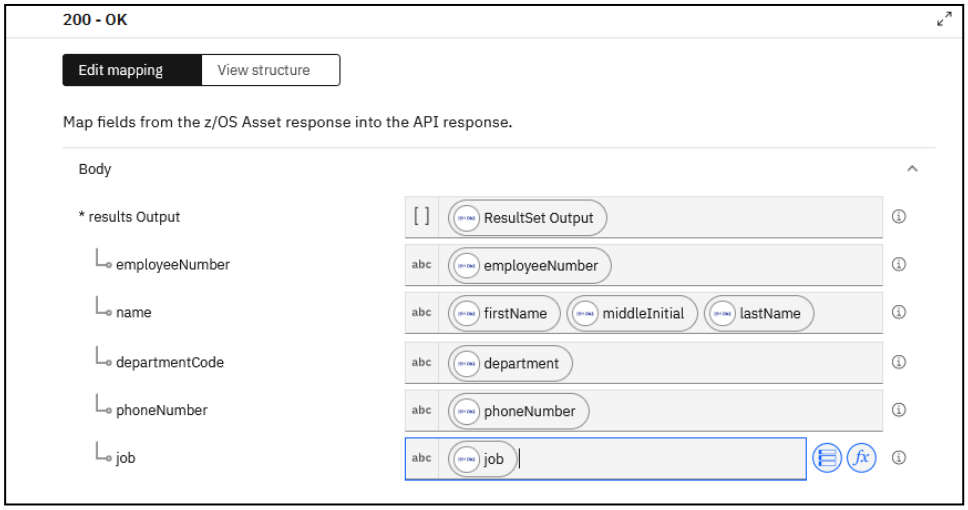
___6. Select the response for *200 OK* and map the fields from the Db2 REST response message. Start by mapping the *ResultSet Output* field from the Db2 REST response message to the API response field *results Output*. This must be done first to be able to access the elements in the array.



___7. Be careful at this point to ensure you are selecting fields in the *ResultSet output* array in the *body* of the *zosAssetResponse*. The same property name may appear in another one of the available mappings, e.g., *apiRequest, ResultSet Row item,* etc. and if a property is selected from one these mappings, the results will be unpredictable.

___8. Complete the mapping for the other properties. Notice the mapping of the Db2 REST response properties *firstName, middleInitial* and *lastName* into the single API response property *name*.



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___9. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

Record for employee number {{$apiRequest.pathParameters.employee}} was not found

Notice that the mapping for the property in the message was from the API request message and not the Db2 REST response message.

___10. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

A severe error has occurred - {{$zosAssetResponse.body.StatusDescription}}

The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Tech-Tip: Note that the exclamation mark has disappeared from *zCEEService-insertEmployee* on the operation page.

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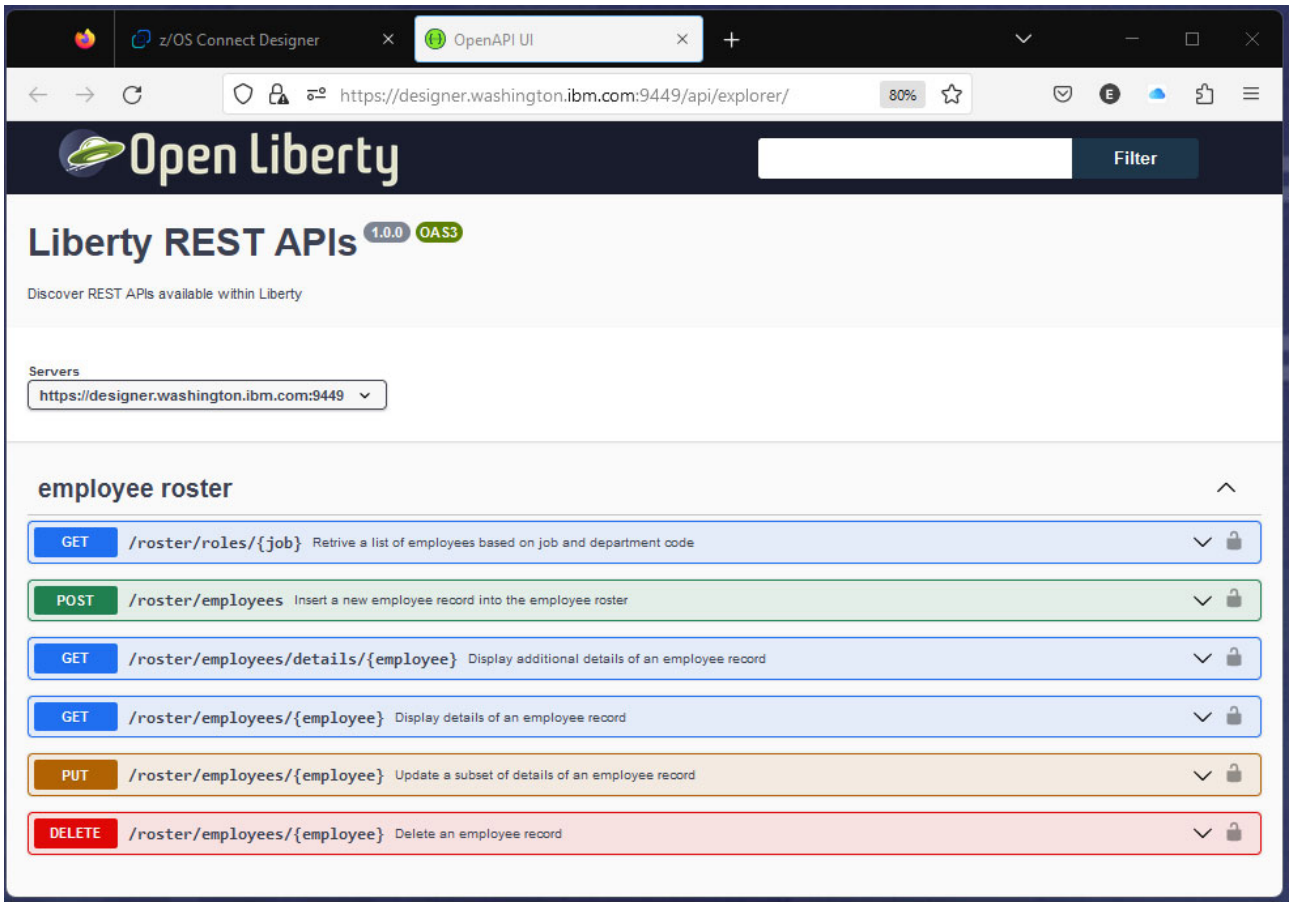
Testing the API's POST and GET methods

As the API was being developed, the changes have been saved and a Web Archive (WAR) file was generated with each change. If the upper right-hand corner of the browser page there will be a **Test** button.
Clicking this button will open an API Explorer page. All the URI paths and methods in the original OpenAPI 3 specification document will be displayed, but only the *POST* for */employees* and the *GET* for */employees/{employee}* have been created. Executing one of the other methods will return an HTTP 404 because the components required to execute these methods cannot be found in the WAR.

Let's test what has been developed so far.

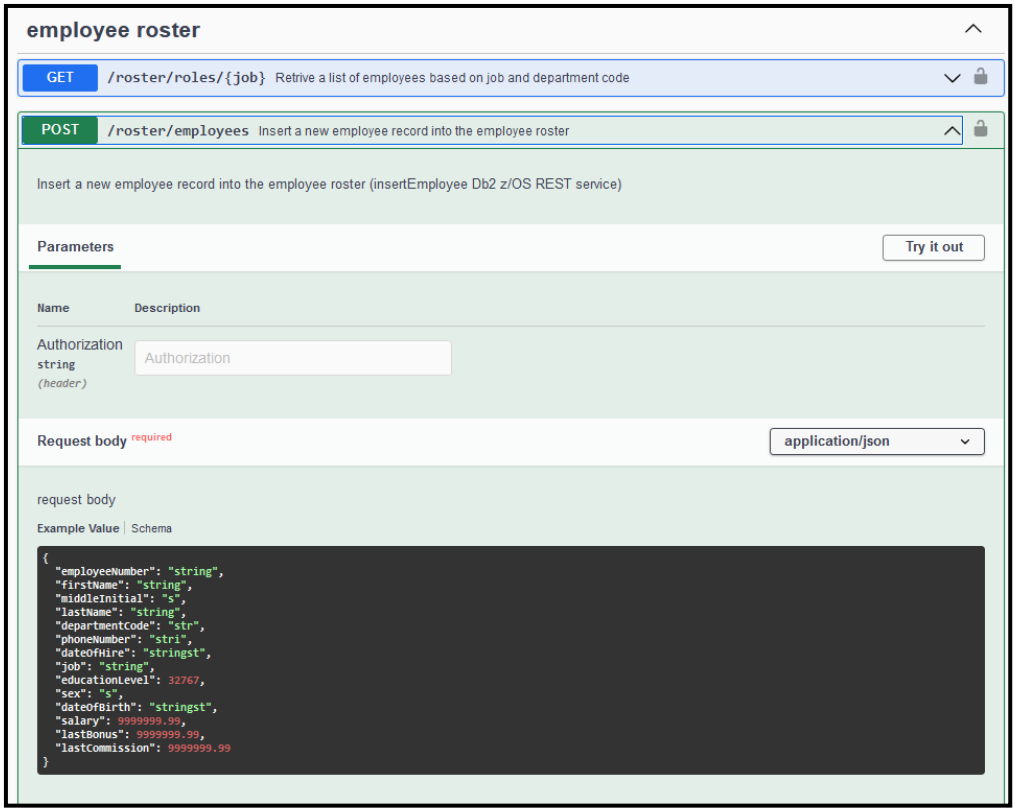
___1. Click the **Test** button to open the API Explorer.



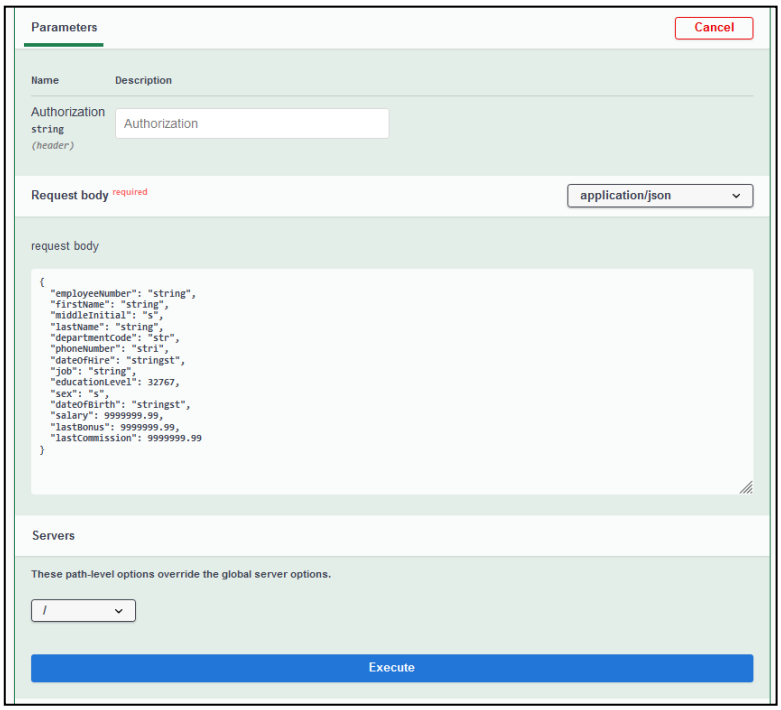
Tech Tip: You may be challenged by browser because the digital certificate used by the *Designer* is self-signed Click the **Advanced** button to continue. Scroll down and then click on the **Accept the Risk and Continue** button. Next you may see a prompt you for a userid and password. If you do see the prompt, enter the username ***Fred*** and password **fredpwd** (case matters) and click **OK**. Remember we are using basic security, and this is the user identity and password defined in the server.xml file.

___2. Use the pull-down arrow in the *Servers* box at the top of the page and select **https://designer.washington.ibm.com:9449**

___3. Click on *Post /roster/employees* URI path to display the request body view of the URI path.



___4. Next press the ***Try it out*** button to enable the entry of an authorization string and a request message body



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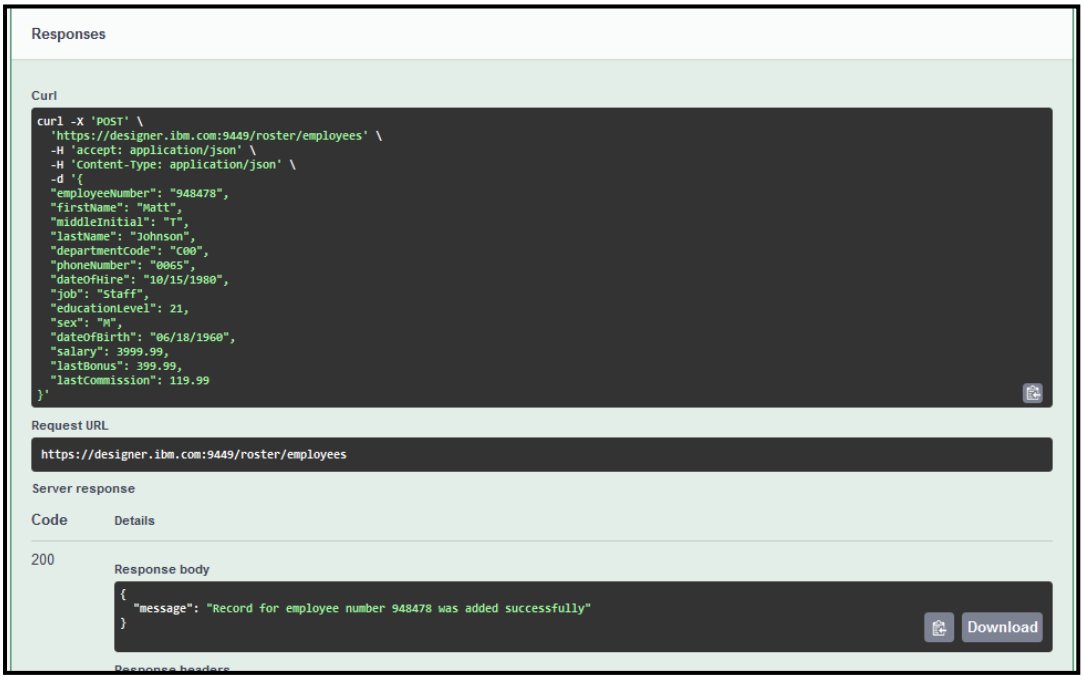
___5. Enter the JSON request message below in the *Request body* section and press the **Execute** button.

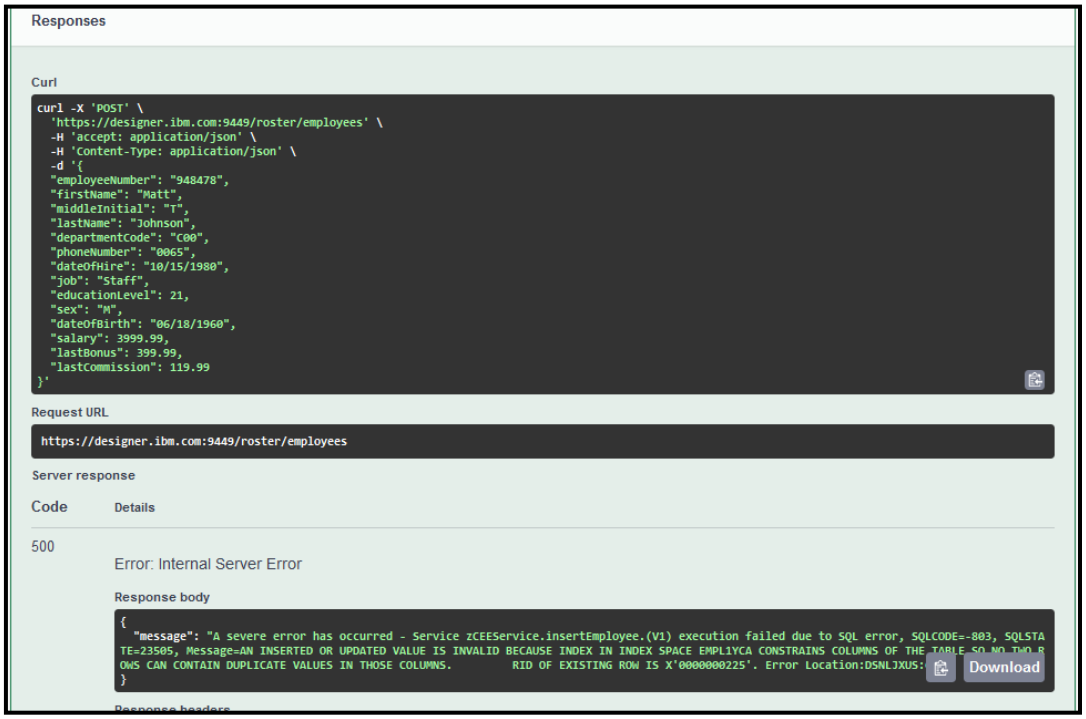
```
{
  "employeeNumber": "948478",
  "firstName": "Matt",
  "middleInitial": "T",
  "lastName": "Johnson",
  "departmentCode": "C00",
  "phoneNumber": "0065",
  "dateOfHire": "10/15/1980",
  "job": "Staff",
  "educationLevel": 21,
  "sex": "M",
  "dateOfBirth": "06/18/1960",
  "salary": 3999.99,
  "lastBonus": 399.99,
  "lastCommission": 119.99
}
```

___6. Security was enabled in the original specification document, so you will be required to sign in with one of the identities defined in the basicSecurity.xml file explored earlier. Use ***Fred*** for the *Username* and ***fredpwd*** for the *Password*. Please note that this identity can be changed unless all browser sessions are stopped.

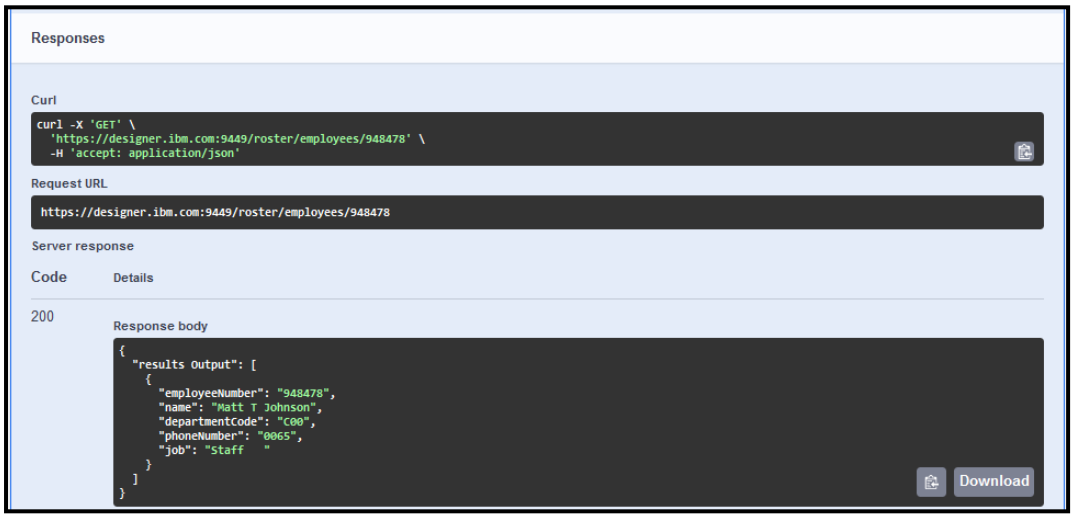
___7. Scroll down the view and you should see the *Response body* with the expected successful message.



___8. Press the **Execute** button again and observe the results. A row for this employee number already existed in the employee roster (a Db2 tables) so the request failed with an HTTP 500.



___9. Scroll down and click on *GET /roster/employees/{employees}* URI path to display the request body view of the URI path for this method. Next click on the ***Try it out*** button to enable the entry of data for this method. Enter ***948478*** as the employee identity and press the **Execute** button to retrieve a subset of data for this employee.



___10. Try this again using number ***121212*** and observe the results. You see the message that the employee was not found.

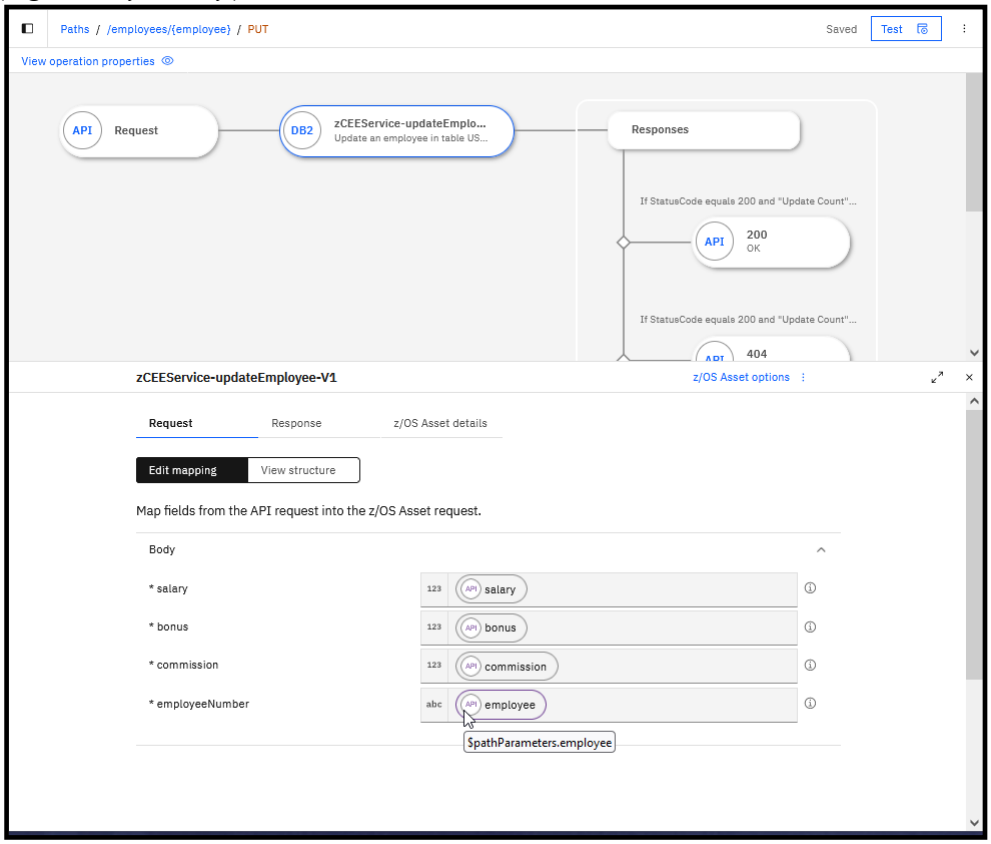
Compete the configuration of the API (Optional)

To be able to fully test all the URI paths and methods the other methods need to be configured. Otherwise, you may advance to the section *Deploying and Installing APIs in a z/OS Connect Native Server*.

Configure the PUT method for URI path /employees/{employee}

Now add support for updated a subset of the details of an employee record by completing the configuration for the *PUT* method of URI Path */employees/{employee}*

___1. Start by adding a new z/OS Asset for Db2 REST service *zCEEService-updatetEmployee* to this method. Map the API request path parameter field *employee (*$*pathParameters.employee*) to the DB2 REST request message field *employeeNumber* as shown below. Map *salary, bonus,* and *commission* fields from the body of the API request message (e.g., *$body.salary*)



Tech Tip: Hover each of the properties and you see that all the properties except *employee* are mapped to the Db2 REST service from the *body* of the API request message. Property *employee* is mapped to the Db2 REST service from the path parameter.

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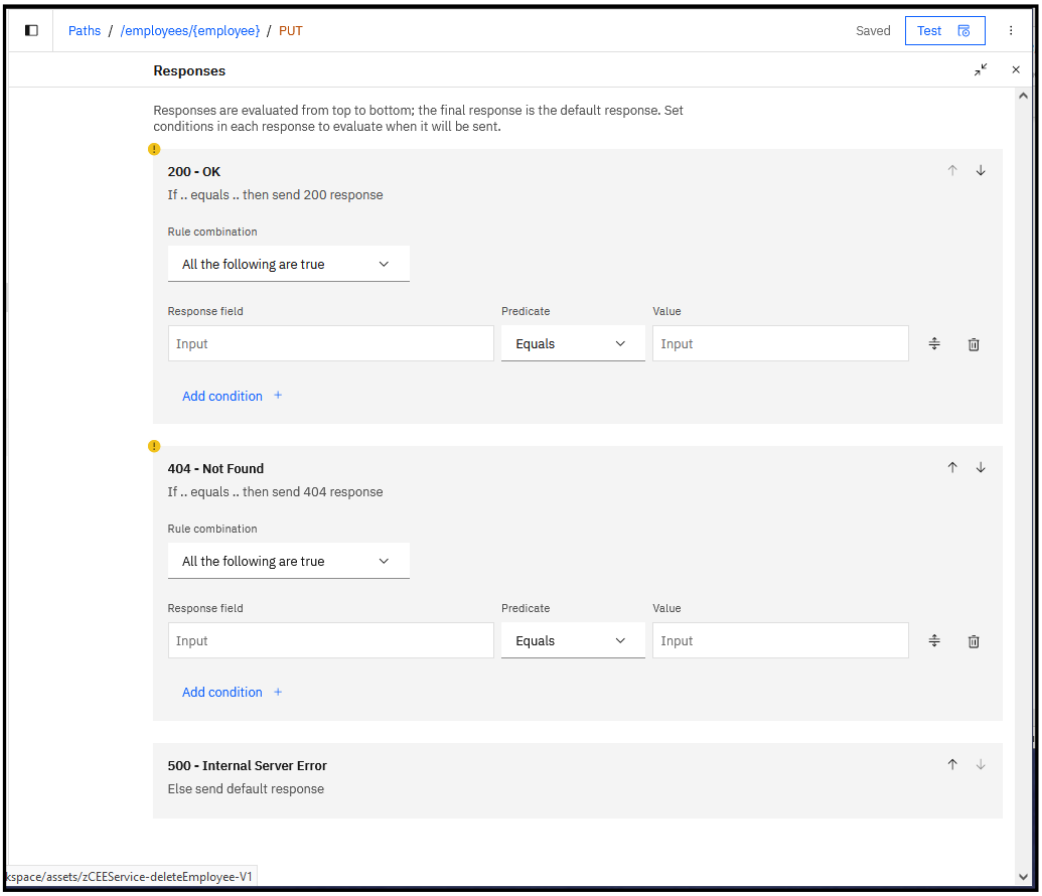
___2. Maximize the *Responses* area of the browser's page (see below).

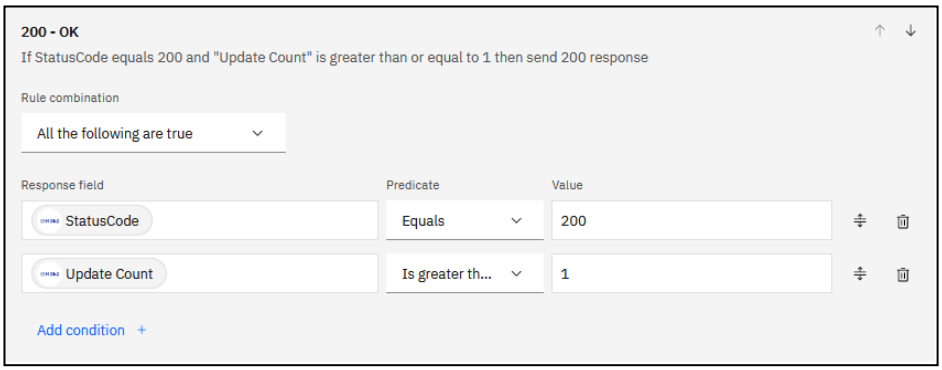
Responses from the Db2 REST service are evaluated in the order shown in the sequence shown. The first check is to see if the record was updated as intended. Db2 REST services will return an HTTP status code of 200 if the Db2 REST service was able to complete regardless of whether a row was updated or not. So, we need another way to determine whether a row was really updated. Again, we will use the *Update Count* response field to check the value to see how many rows were affected by this request.

So, we are going to check the response fields to (1) confirm the HTTP status code from Db2 is 200 and (2) and for the value of *Update Count*.

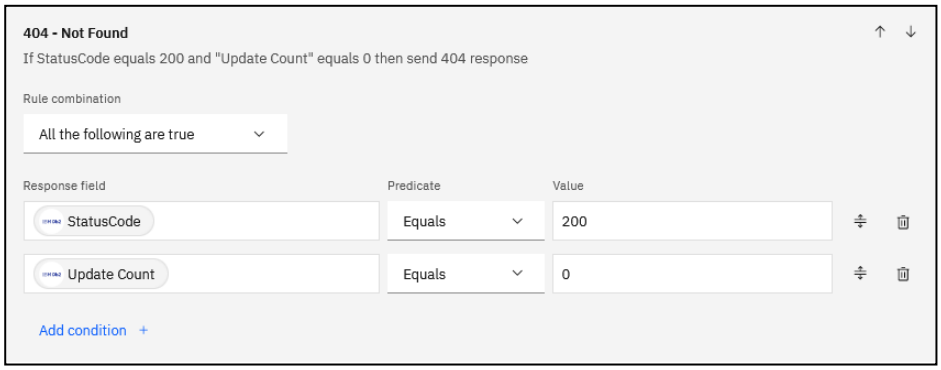


___3. Under the *200 – OK* response, Enter the string ***Stat*** in the *Input* area under *Response field*. This will display all the fields in the Db2 REST response which match this string (position of the string in the field name does not matter, as long as the string entered matches any portion of the field name, that field will be displayed). In this case, select the *StatusCode* field. Leave the *Predicate* as *Equals* and enter ***200*** in the *Input* field for *Value*.

Next add a condition check for the value of the *Update Count* Db2 REST response property by clicking on the *Add condition* in the *200 – OK* evaluation and entering the string below in the area for the new check of a Response field. Enter property ***Update Count*** for the Response field name. Set the *Predicate* to *Is greater than or equal to* and a value of ***1***.

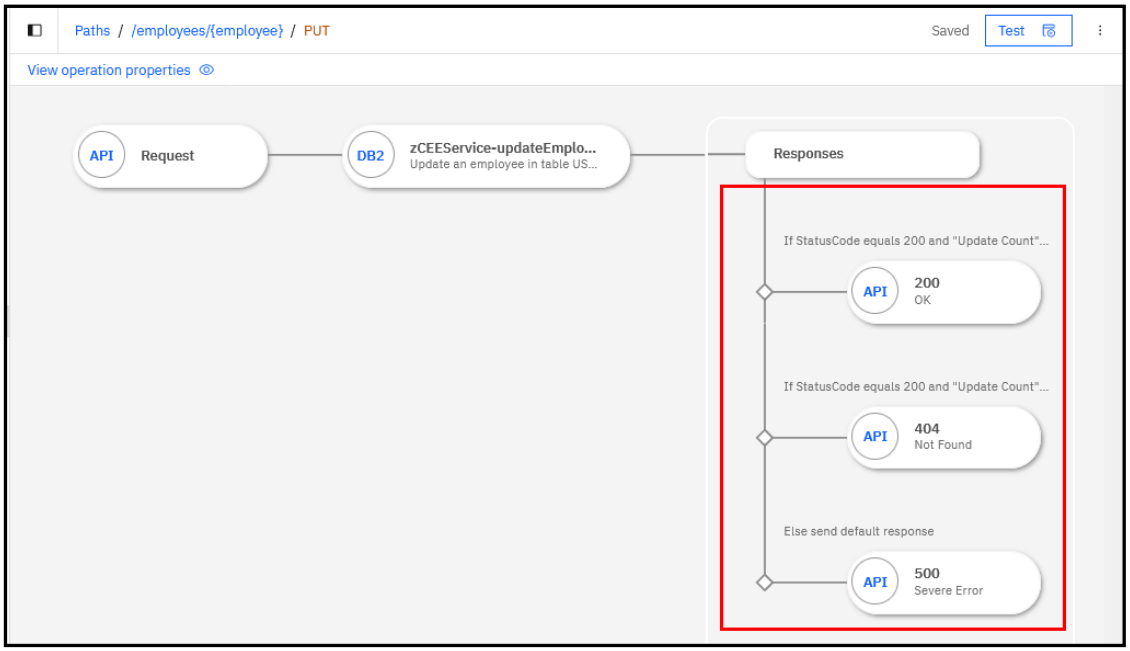


___4. For the *404 – Not Found* check, add a check for ***StatusCod***e equaling ***200*** and a check for *Update Count* equaling zero.



___5. If neither of these connections are met, simply return with a HTTP 500 status code.

___6. Next the API response messages need to be configured for each of these potential status codes.



___7. Select the response for *200 OK* paste the text below in the *message* area.

Record for employee {{$apiRequest.pathParameters.employee}} successfully updated

___8. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

Record for employee number {{$apiRequest.pathParameters.employee}} was not found

Notice that the mapping for the property in the message was from the API request message and not the Db2 REST response message.

___9. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

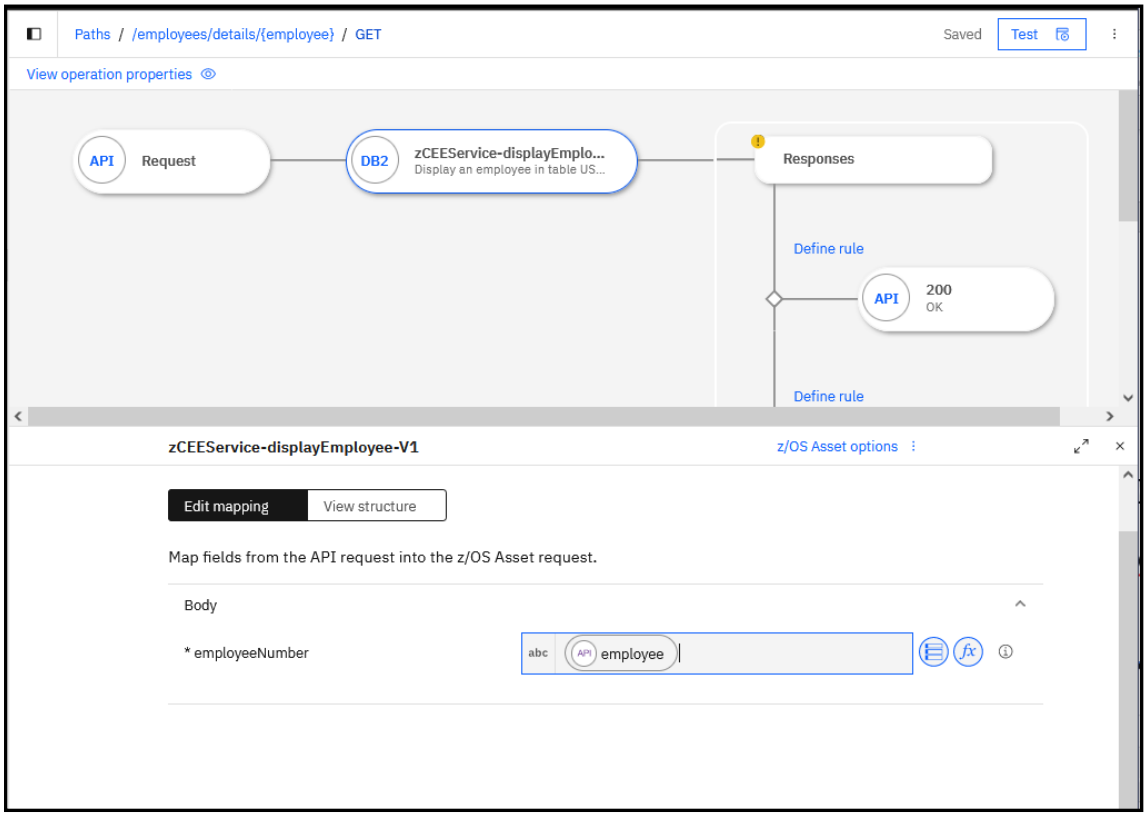
A severe error has occurred - {{$zosAssetResponse.body.StatusDescription}}

The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Configure the GET method for URI path /employees/details/{employee}

Now let's repeat the process and complete the configuration for the *GET* method of URI Path */employees/details/{employee}*

___1. Start by adding a new z/OS Asset for Db2 REST service *zCEEService-displayEmployee* to this method. Map the API request field *employee* to the DB2 REST request message field *employeeNumber* as shown below.



___2. Maximize the *Responses* area of the browser's page (see below).

Again, responses from the Db2 REST service are evaluated in the order shown in the sequence shown. The first check is to see if the record a row or rows were returned as intended. Db2 REST services will return an HTTP status code of 200 if the Db2 REST service was able to complete regardless of whether a row was selected or not. So, we need another way to determine whether a row was really selected. A Db2 REST service will return the rows selected in a list or array. We are going to take advantage of function that will return the number of elements in the list or array, e.g., $count. If the result of invoking the function returns a non-zero values, the list or array contains elements. If the result is zero, no rows were selected.

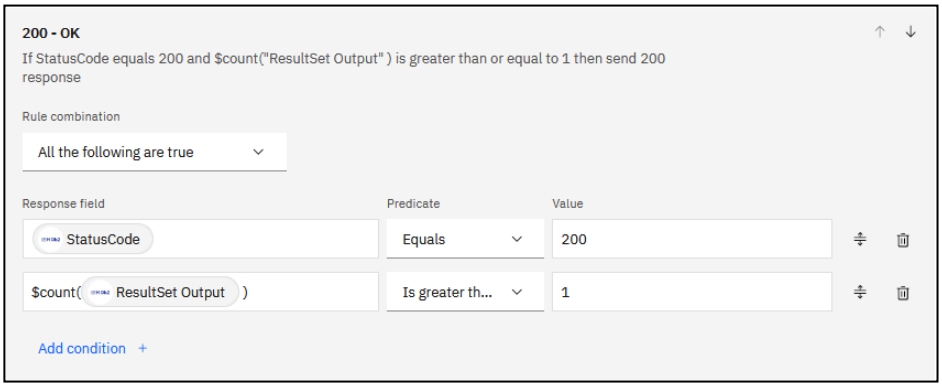
So, we are going to check the response fields to (1) confirm the HTTP status code from Db2 is 200 and (2) and for the value of invoking the $count function against the array of returned rows.

___3. Under the *200 – OK* response, Enter the string ***Stat*** in the *Input* area under *Response field*. This will display all the fields in the Db2 REST response which match this string (position of the string in the field name does not matter, if the entered string matches any portion of the field name, that field will be displayed). In this case, select the *StatusCode* field. Leave the *Predicate* as *Equals* and enter ***200*** in the *Input* field for *Value*.

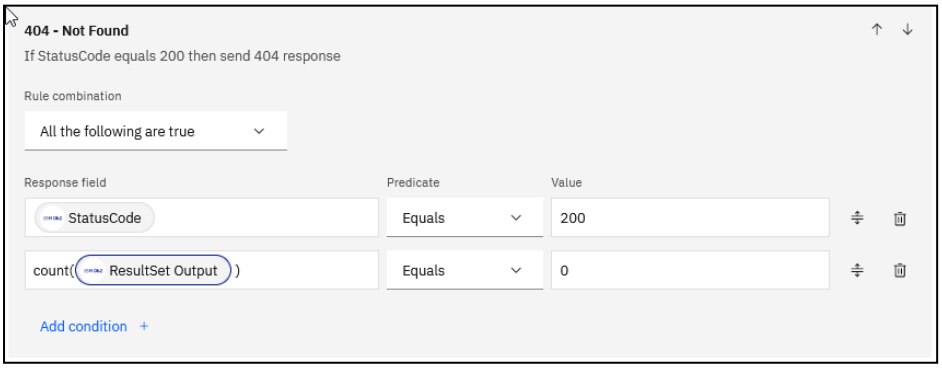
Next add a condition check for the value of invoking the function $count against the array of rows returned by the Db2 REST service *Count* by clicking on Add condition in the *200 – OK* evaluation and entering the string below in the area for the new check of a Response field.

$count($zosAssetResponse.body."ResultSet Output")

And set the *Predicate* to *Is greater than or equal to* a *Value* of ***1***.

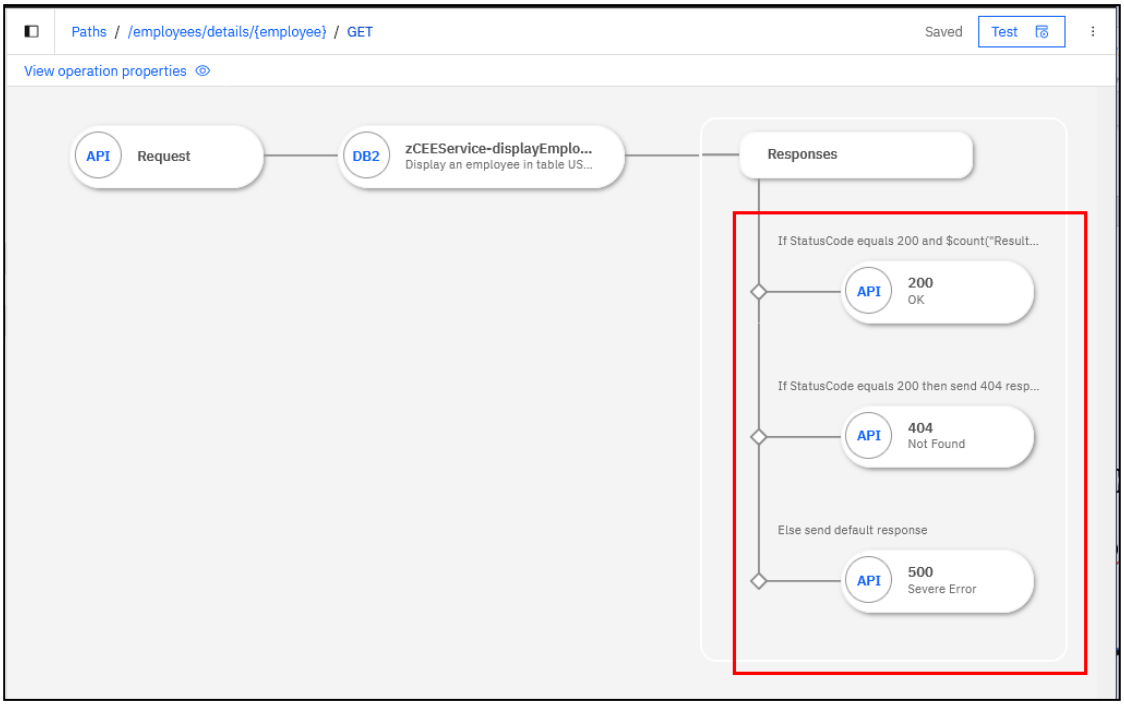


___4. For the *404 – Not Found* check, add a check for ***StatusCod***e equaling ***200*** and a check for the count equaling zero.

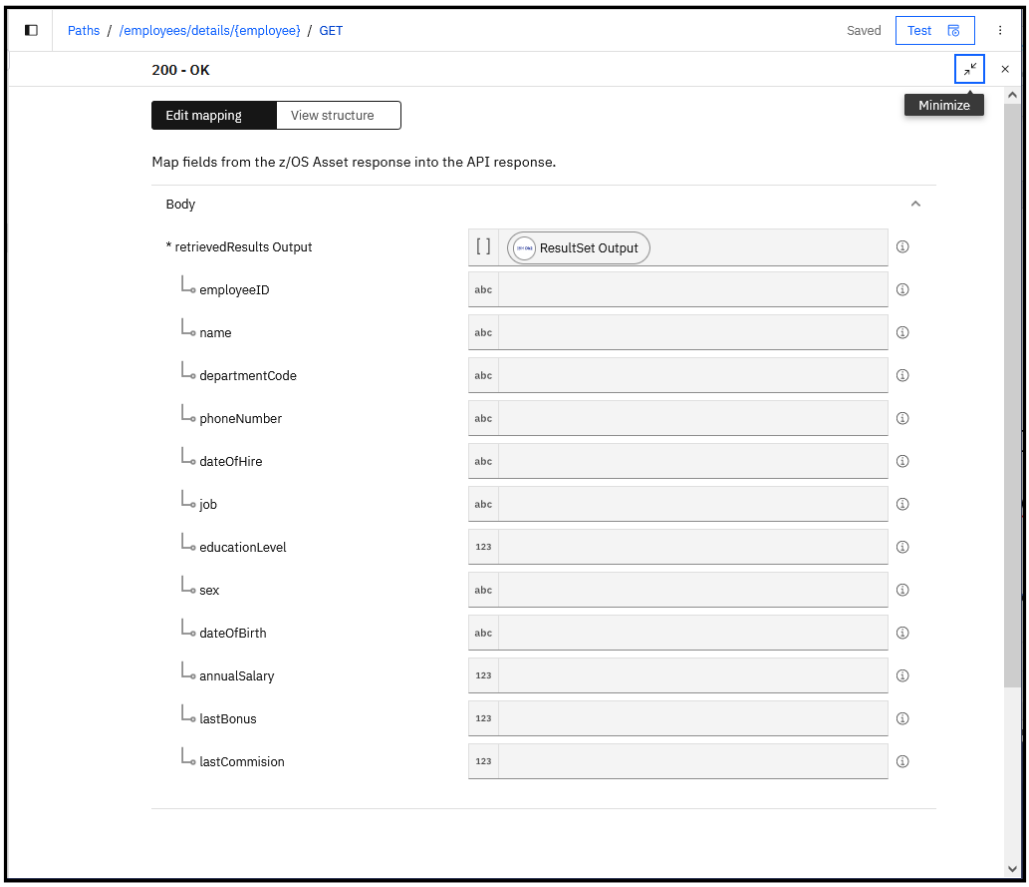


___5. If neither of these connections are met, simply return with a HTTP 500 status code.

___6. Next the API response messages need to be configured for each of these potential status codes.

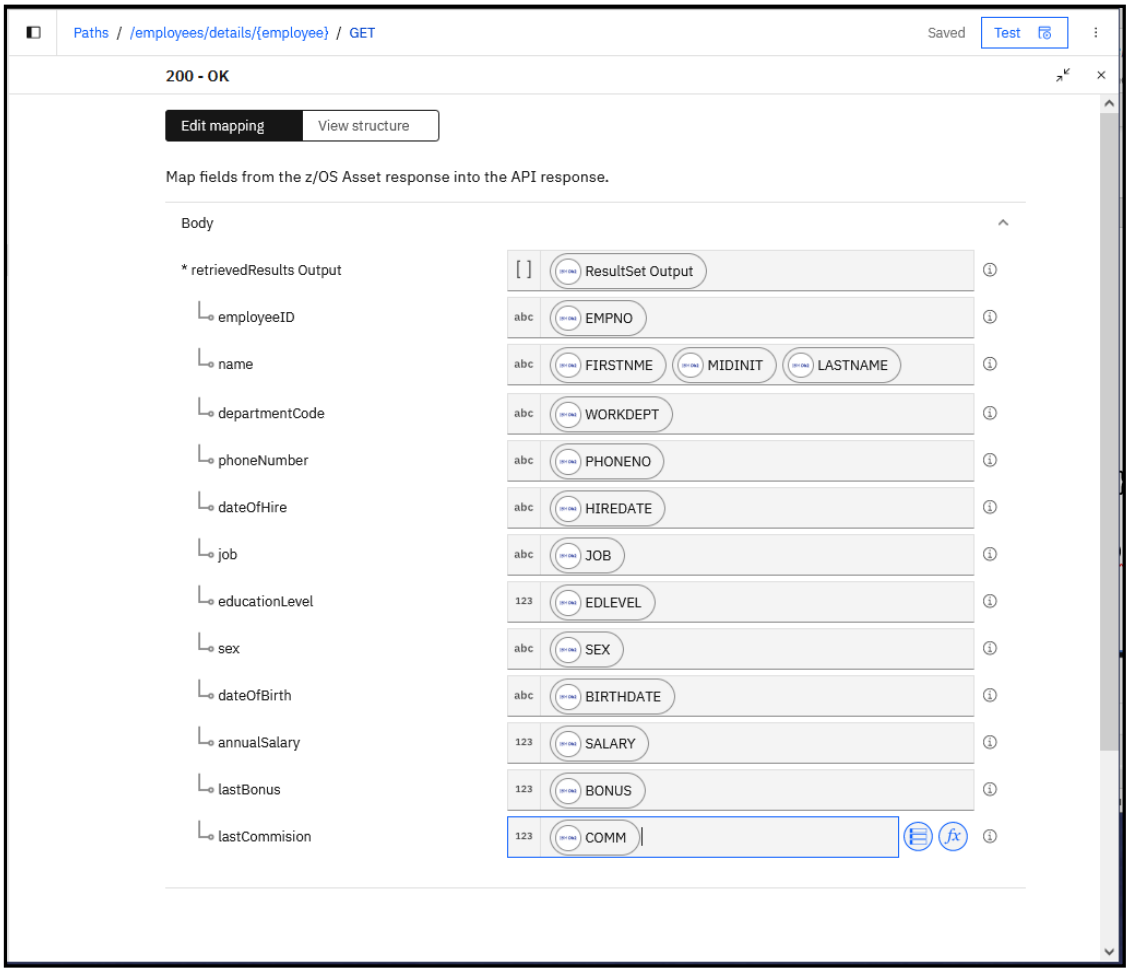


___7. Select the response for *200 OK* and map the fields from the Db2 REST response message. Start by mapping the *ResultSet Output* field from the Db2 REST response message to the API response field *results Output*. This must be done first to access the elements in the array.



___8. Be careful at this point to ensure you are selecting fields in the *ResultSet output* array in the *body* of the *zosAssetResponse*. The same property name may appear in another one of the available mappings, e.g., *apiRequest, ResultSet Row item,* etc. and if a property is selected from one these mappings, the results will be invalid.

___9. Complete the mapping for the other properties. Notice the mapping of the Db2 REST response properties *firstName, middleInitial* and *lastName* into the API response property *name*.



___10. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

Record for employee number {{$apiRequest.pathParameters.employee}} was not found

Notice that the mapping for the property in the message was from the API request message and not the Db2 REST service response message.

___11. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

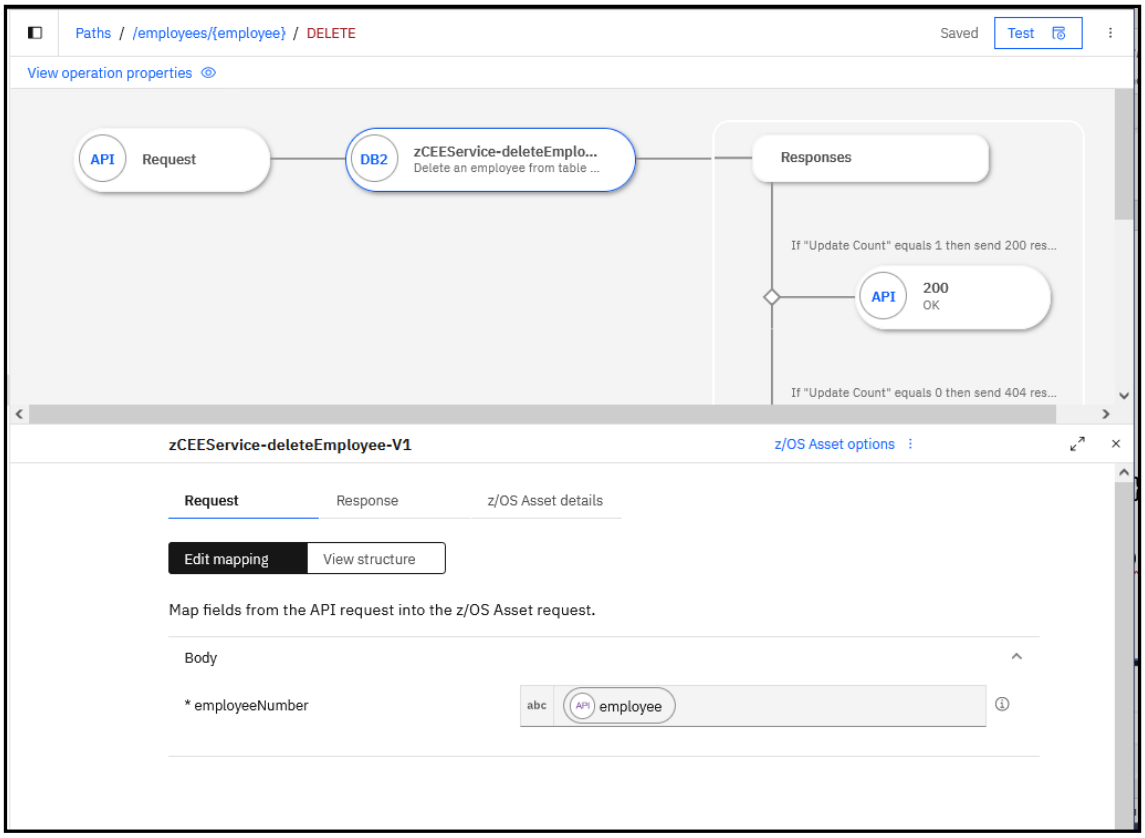
A severe error has occurred - {{$zosAssetResponse.body.StatusDescription}}

The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Configure the DELETE method for URI path /employees/{employee}

Now let's repeat the process and complete the configuration for the *DELETE* method of URI Path */employees/{employee}*

___1. Start by adding a new z/OS Asset for Db2 REST service *zCEEService-deleteEmployee* to this method. Map the API request field *employee* to the DB2 REST request message field *employeeNumber* as shown below.



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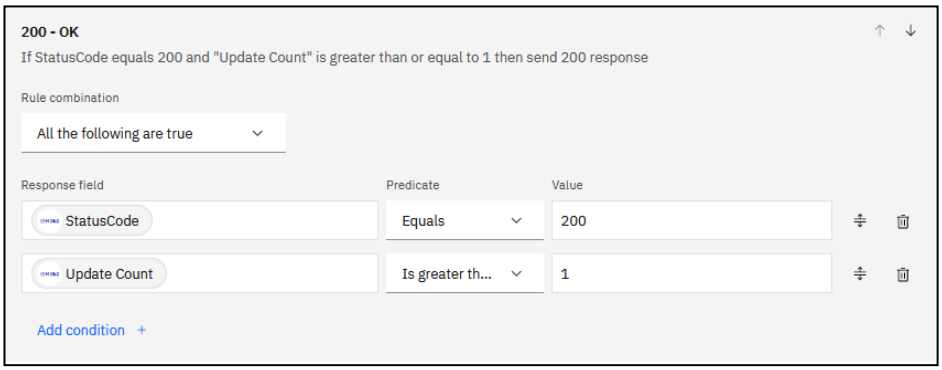
___2. Maximize the *Responses* area of the browser's page (see below).

Responses from the Db2 REST service are evaluated in the order shown in the sequence shown. The first check is to see if the record was updated as intended. Db2 REST services will return an HTTP status code of 200 if the Db2 REST service was able to complete regardless of whether a row was updated or not. So, we need another indication whether a row was really updated. Again, we will use the *Update Count* response field to check the value to see how many rows were affected by this request.

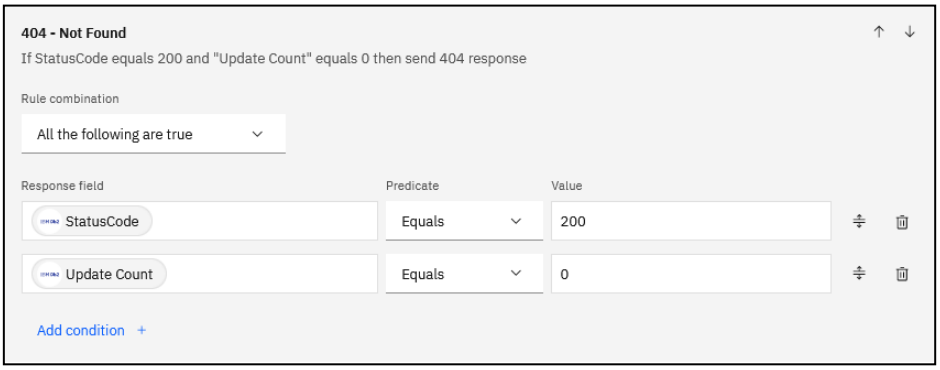
So, we are going to check the response fields to (1) confirm the HTTP status code from Db2 is 200 and (2) and for the value of *Update Count*.

___3. Under the *200 – OK* response, Enter the string ***Stat*** in the *Input* area under *Response field*. This will display all the fields in the Db2 REST response which match this string (position of the string in the field name does not matter, if the entered string matches any portion of the field name, that field will be displayed). In this case, select the *StatusCode* field. Leave the *Predicate* as *Equals* and enter ***200*** in the *Input* field for *Value*.

Next add a condition check for the value of the *Update Count* Db2 REST response property by clicking on the *Add condition* in the *200 – OK* evaluation and entering the string below in the area for the new check of a Response field. Enter property ***Update Count*** for the Response field name. Set the *Predicate* to *Is greater than or equal to* and a value of ***1***.

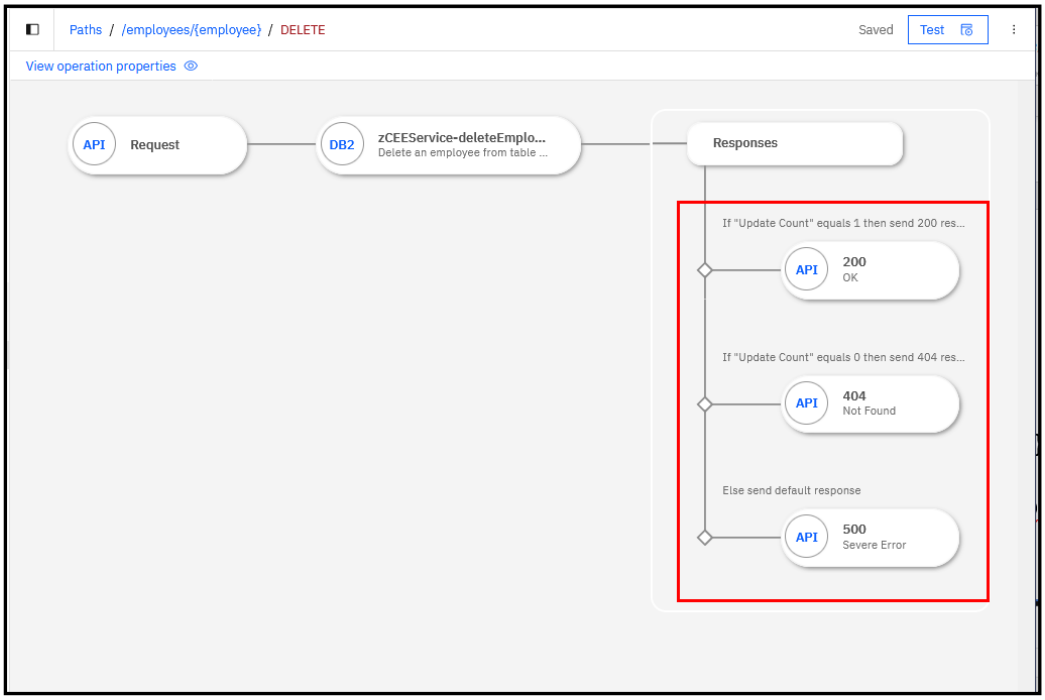


___4. For the *404 – Not Found* check, add a check for ***StatusCod***e equaling ***200*** and a check for an update count equaling zero.



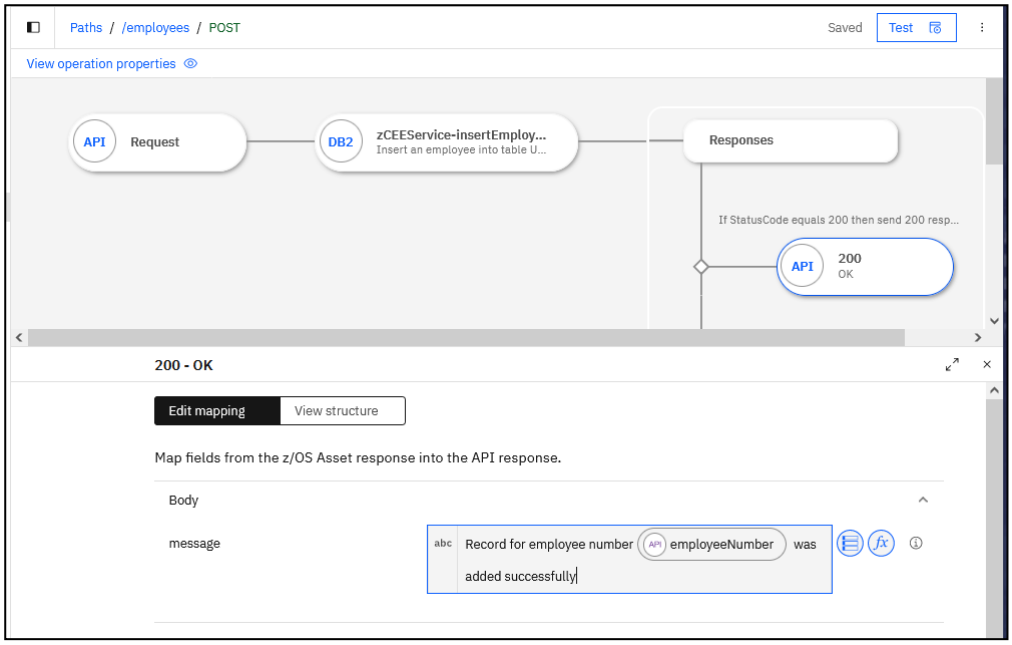
___5. If neither of these connections are met, simply return with a HTTP 500 status code.

___6. Next the API response messages need to be configured for each of these potential status codes.



___28. Select the response for *200 OK* paste the text below in the *message* area.

Record for employee number {{$apiRequest.body.employeeNumber}} was deleted successfully



___12. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

Record for employee number {{$apiRequest.pathParameters.employee}} was not found

Notice that the mapping for the property in the message was from the API request message and not the Db2 REST response message.

___13. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

A severe error has occurred - {{$zosAssetResponse.body.StatusDescription}}

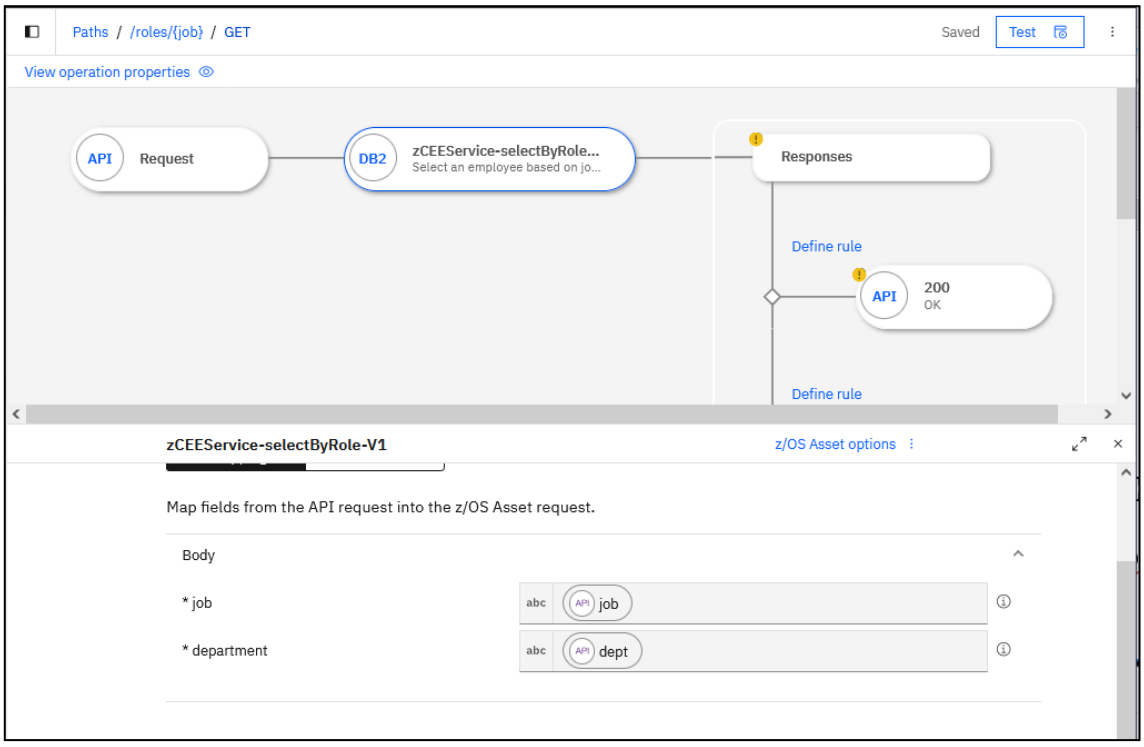
Tech-Tip: Db2 REST response property field *StatusDescription* provides more information regarding the issue that caused the insert to fail.

The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Configure the GET method for URI path /roles/{job}

Now complete the configuration for the *GET* method of URI Path */roles/{job}*. This method includes both a path parameter and a query parameter.

___1. Start by adding a new z/OS Asset for Db2 REST service *zCEEService-selectByRole* to this method. Map the API request path parameter *job* to the DB2 REST server request message field *job* and the API query parameter *department* to the Db2 REST service request message field *dept*.



___2. Maximize the *Responses* area of the browser's page (see below).

Again, responses from the Db2 REST service are evaluated in the order shown in the sequence shown. The first check is to see if the record a row or rows were returned as intended. Db2 REST services will return an HTTP status code of 200 if the Db2 REST service was able to complete regardless of whether a row was selected or not. So, we need another indication whether a row was really selected. A Db2 REST service will return the rows selected in a list or array. We are going to take advantage of function that will return the number of elements in the list or array, e.g., $count. If the result of invoking the function returns a non-zero values, the list or array contains elements. If the result is zero, no rows were selected.

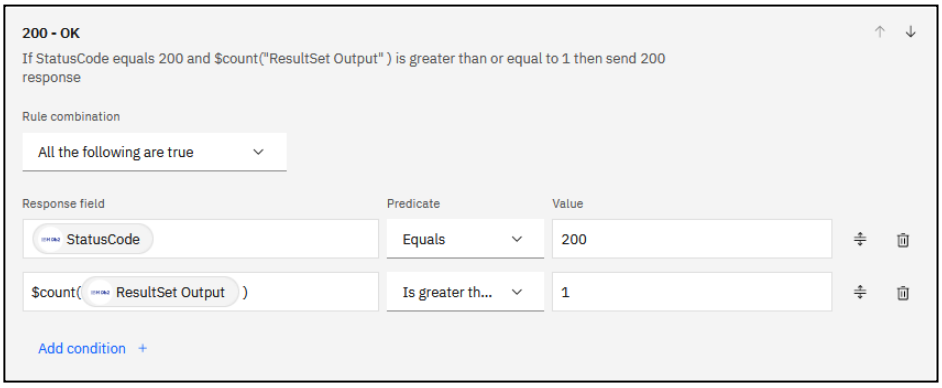
So, we are going to check the response fields to (1) confirm the HTTP status code from Db2 is 200 and (2) and for the value of invoking the $count function against the array of returned rows.

___3. Under the *200 – OK* response, Enter the string ***Stat*** in the *Input* area under *Response field*. This will display all the fields in the Db2 REST response which match this string (position of the string in the field name does not matter, if the entered string matches any portion of the field name, that field will be displayed). In this case, select the *StatusCode* field. Leave the *Predicate* as *Equals* and enter ***200*** in the *Input* field for *Value*.

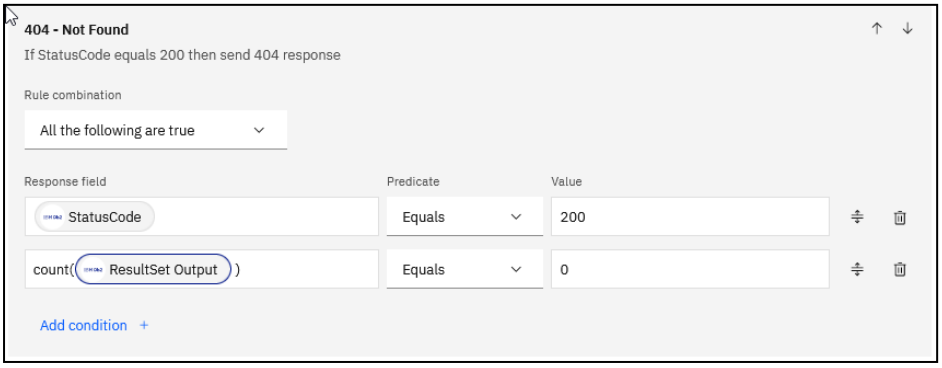
Next add a condition check for the value of invoking the function $count against the array of rows returned by the Db2 REST service *Count* by clicking on Add condition in the *200 – OK* evaluation and entering the string below in the area for the new check of a Response field.

$count($zosAssetResponse.body."ResultSet Output")

And set the *Predicate* to *Is greater than or equal to* a *Value* of ***1***.

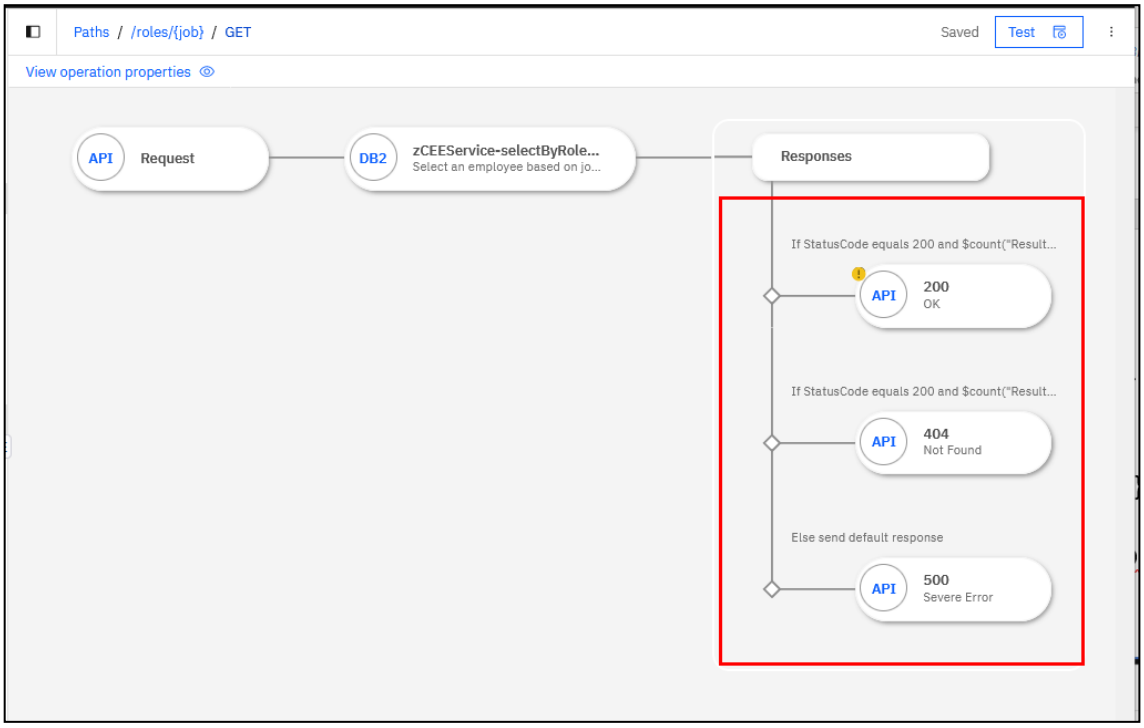


___4. For the *404 – Not Found* check, add a check for ***StatusCod***e equaling ***200*** and a check for count equaling zero.

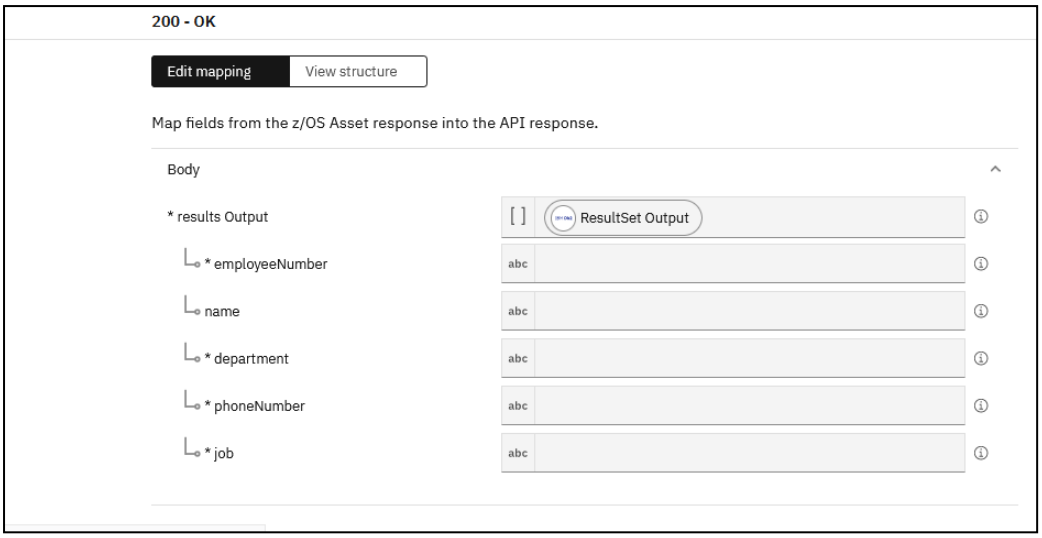


___5. If neither of these connections are met, simply return with a HTTP 500 status code.

___6. Next the API response messages need to be configured for each of these potential status codes.



___7. Select the response for *200 OK* and map the fields from the Db2 REST response message. Start by mapping the *ResultSet Output* field from the Db2 REST response message to the API response field *results Output*. This must be done first to be able to access the elements in the array.



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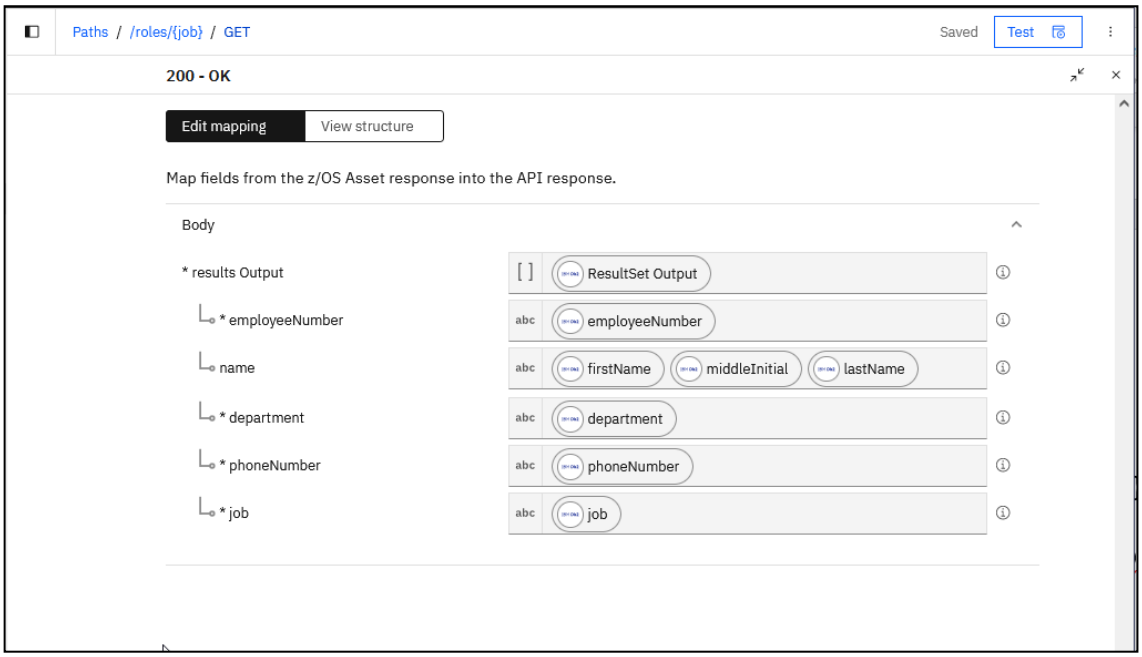
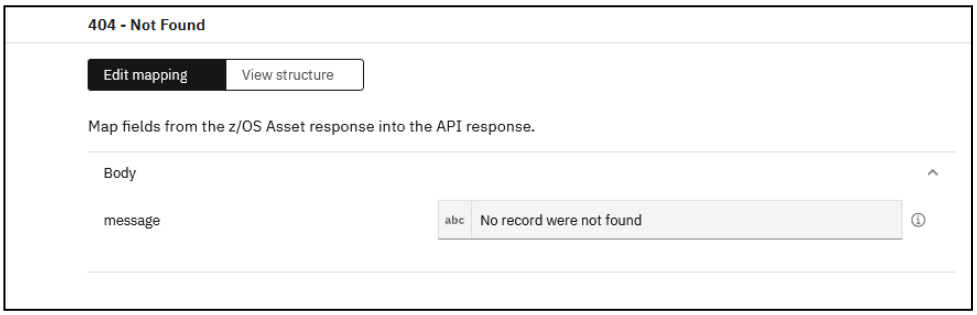
___8. Be careful at this point to ensure you are selecting fields in the *ResultSet output* array in the *body* of the *zosAssetResponse*. The same property name may appear in another one of the available mappings, e.g., *apiRequest, ResultSet Row item,* etc. and if a property is selected from one these mappings, the results will be invalid.

___9. Complete the mapping for the other properties. Notice the mapping of the Db2 REST response properties *firstName, middleInitial* and *lastName* into the API response property *name*.



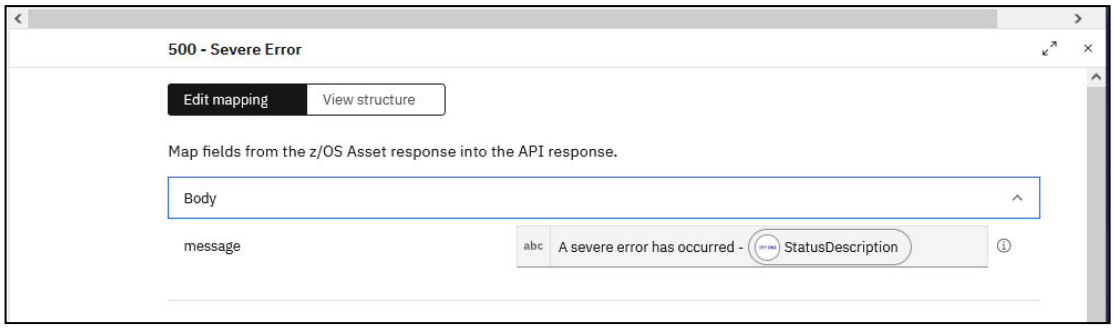
___10. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

No records were found



___11. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

A severe error has occurred - {{$zosAssetResponse.body.StatusDescription}}



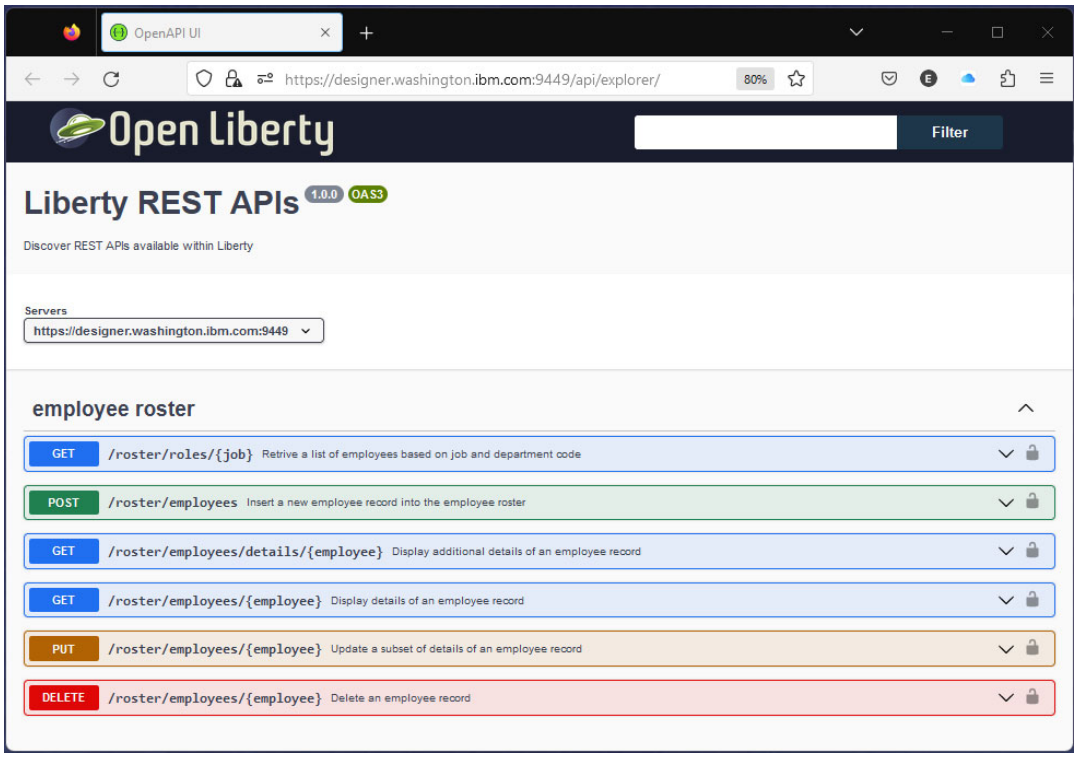
The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Testing APIs deployed in a z/OS Connect Designer container

The deployed APIs are accessible when the *Designer* container is active, even when the *Designer* is not opened in a browser. In fact, there are advantages in this behavior when testing security roles outside of the *Designer* since security tokens are cached by the browser.

This section will demonstrate using common HTTP clients to test APIs specifically for when security enabled.

We know the URI paths of the API from the initial page of the *API Explorer* displayed when testing in the *Designer*. From this page the first part of the URL can be determined, e.g., *https://designer.washington.ibm.com:9449*. This along with the URI path of each methods provides the URL we need to use to invoke a method. For example, to invoke the GET to display the additional details of an employee record in any client, the URL will be *https://designer.washington.ibm.com:9449/employee/{employee}*



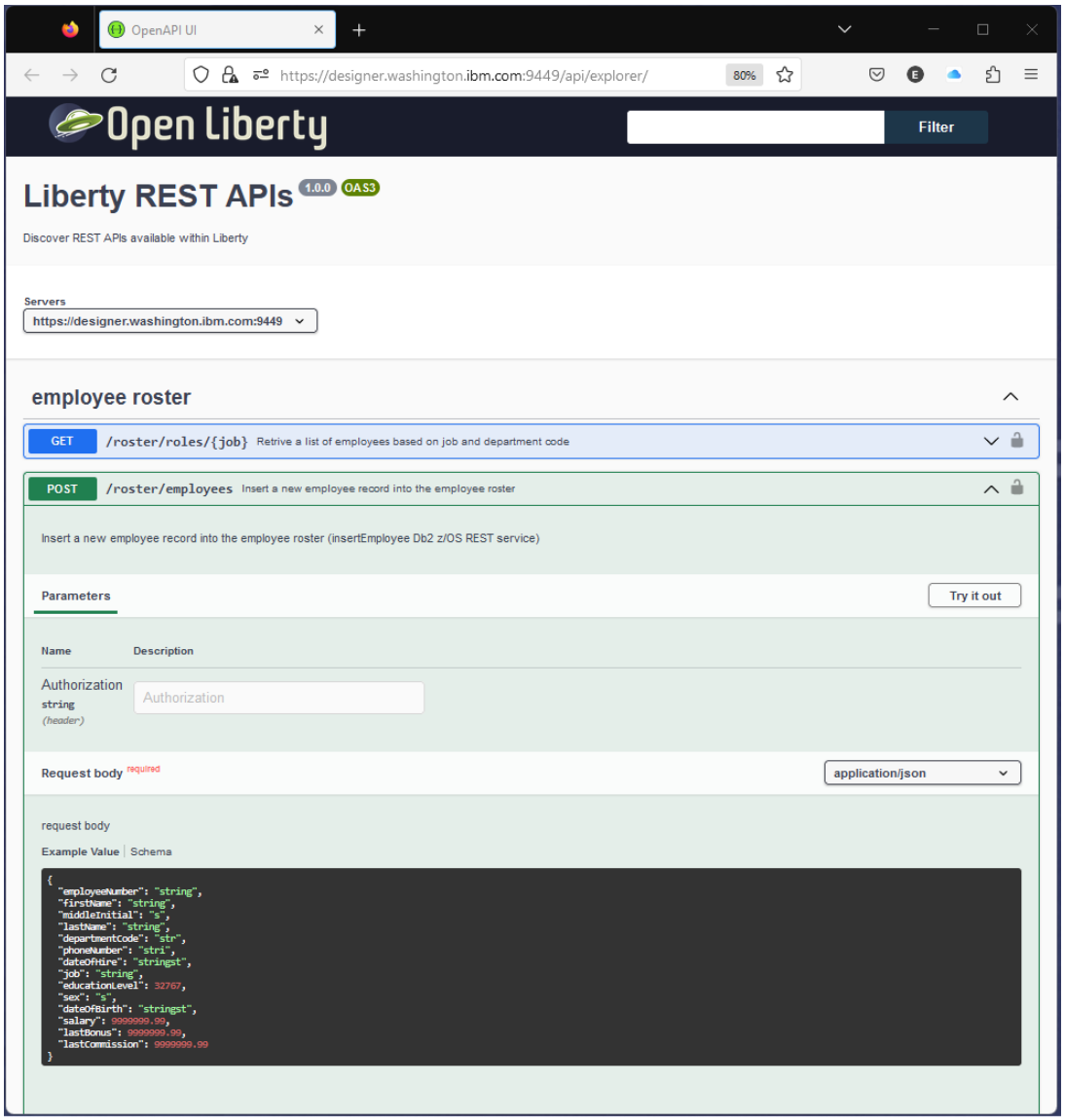
From this display, the methods and URLs required to access the API deployed in this container are:

- GET https://designer.washington.ibm.com:9449/roster/roles/{job}
- POST https://designer.washington.ibm.com:9449/roster/employees
- GET https://designer.washington.ibm.com:9449/roster/employees/details/{employee}
- GET https://designer.washington.ibm.com:9449/roster/employees/{employee}
- PUT https://designer.washington.ibm.com:9449/roster/employees/{employee}
- DELETE https://designer.washington.ibm.com:9449/roster/employees/{employee}

This section primarily covers the testing of the optional *DELETE, PUT, and GET details* methods. The tests for the POST and GET methods have already been covered in section *Testing the API's POST and GET methods* on page 38 and can be repeated using the *API Explorer* as described in this section.

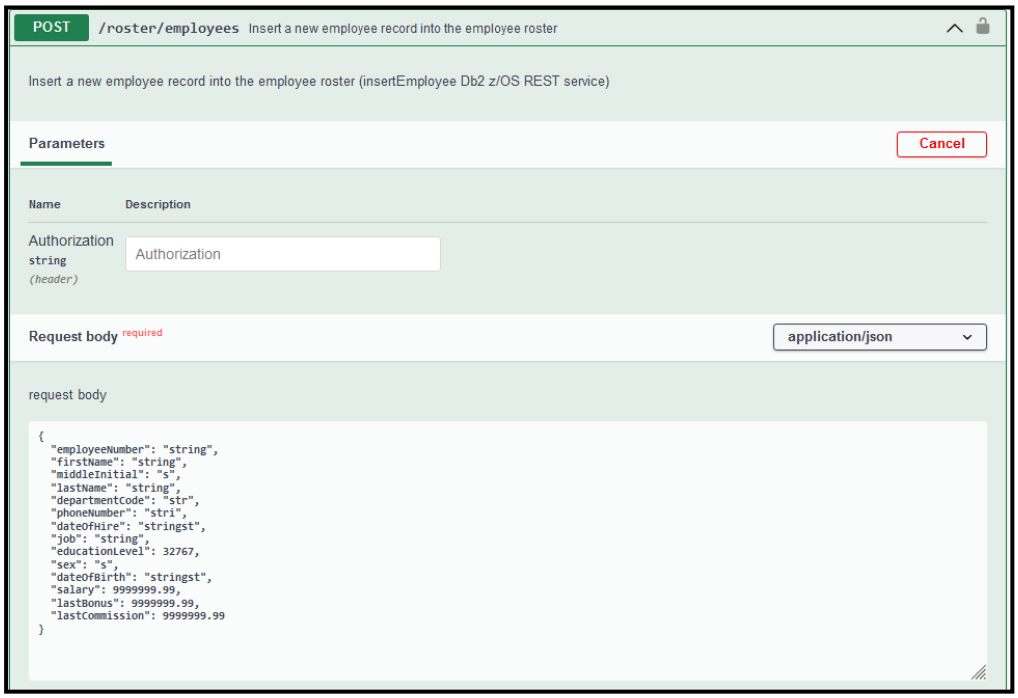
____1. Using the Firefox browser, go to URL ***https://designer.washington.ibm.com:9449/api/explorer*** to start the API Explorer.

____2. Click on *Post /roster/employees* URI path to display the request body view of the URI path.



Tech Tip: You may be challenged by browser because the digital certificate used by the *Designer* is self-signed Click the **Advanced** button to continue. Scroll down and then click on the **Accept the Risk and Continue** button. Next you may see a prompt you for a userid and password. If you do see the prompt, enter the username ***Fred*** and password **fredpwd** (case matters) and click **OK**. Remember we are using basic security, and this is the user identity and password defined in the server.xml file.

___2. Next press the ***Try it out*** button to enable the entry of a request message body

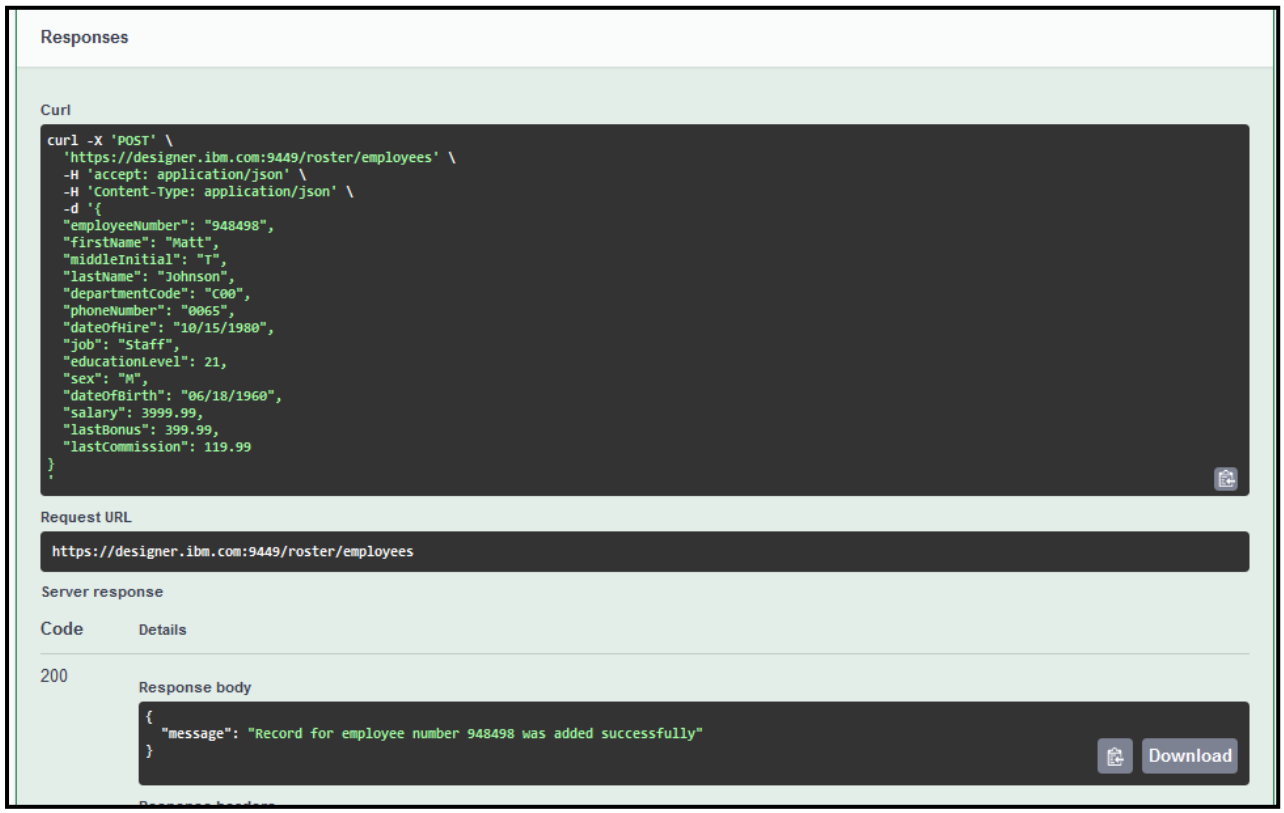


___3. Enter the JSON request message below in the *Request body* section and press the **Execute** button.

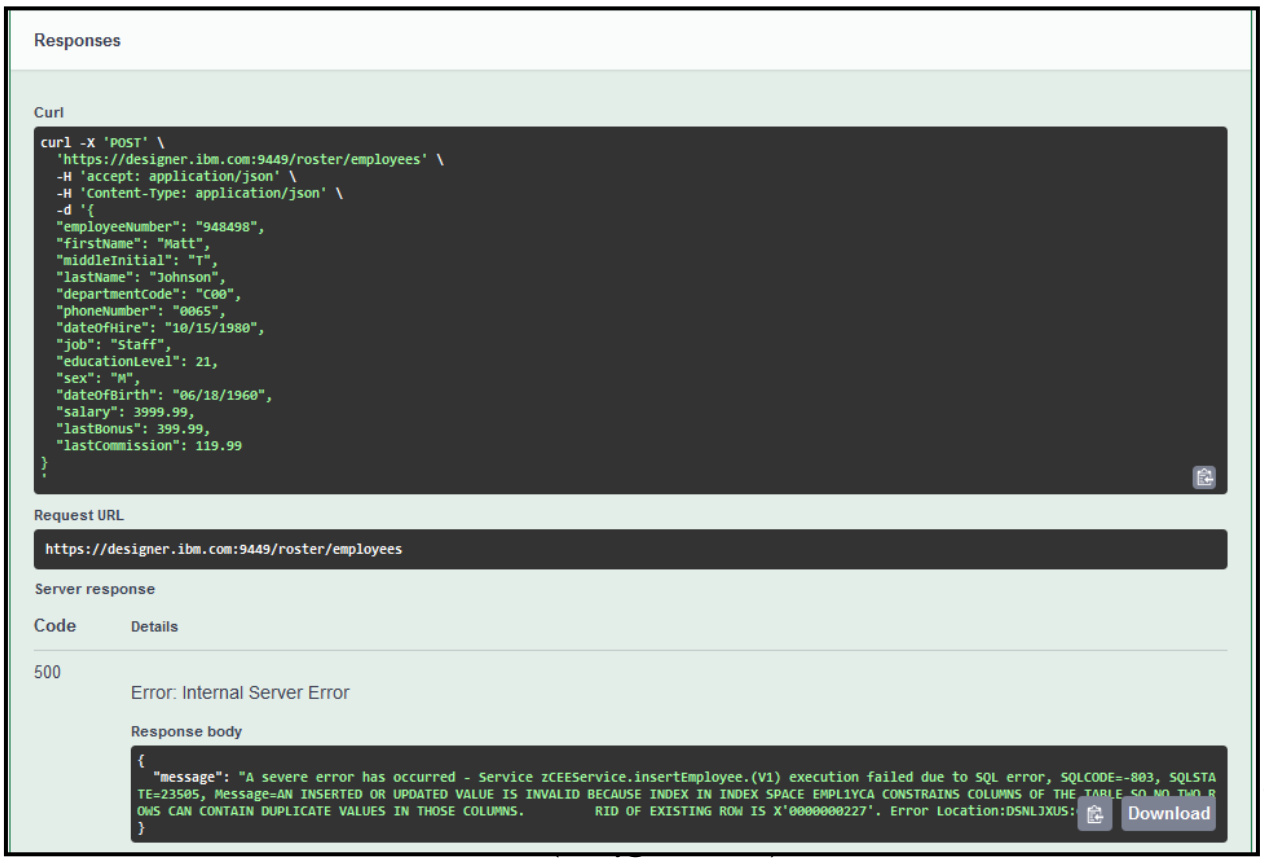
```
{
  "employeeNumber": "948498",
  "firstName": "Matt",
  "middleInitial": "T",
  "lastName": "Johnson",
  "departmentCode": "C00",
  "phoneNumber": "0065",
  "dateOfHire": "10/15/1980",
  "job": "Staff",
  "educationLevel": 21,
  "sex": "M",
  "dateOfBirth": "06/18/1960",
  "salary": 3999.99,
  "lastBonus": 399.99,
  "lastCommission": 119.99
}
```

___4. Security was enabled in the original specification document, so you will be required to sign in with one of the identities defined in the basicSecurity.xml file explored earlier. Use ***Fred*** for the *Username* and ***fredpwd*** for the *Password*. Please note that this identity can be changed unless all browser sessions are stopped.

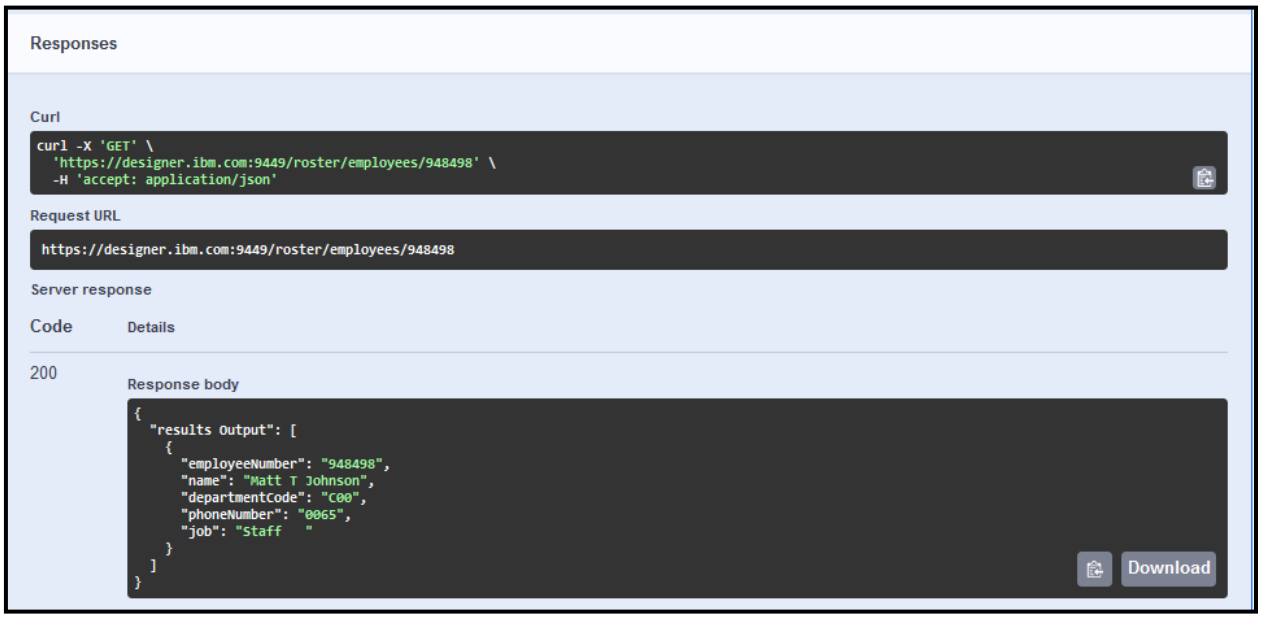
___5. Scroll down the view and you should see the *Response body* with the expected successful message.



___6. Press the **Execute** button again and observe the results. A row for this employee number already existed in the employee roster (a Db2 tables) so the request failed with an HTTP 500.



___7. Scroll down and click on *GET /roster/employees//{employees}* URI path to display the request body view of the URI path for this method. Next click on the ***Try it out*** button to enable the entry of data for this method. Enter ***948498*** as the employee identity and press the **Execute** button to retrieve a subset of data for this employee.



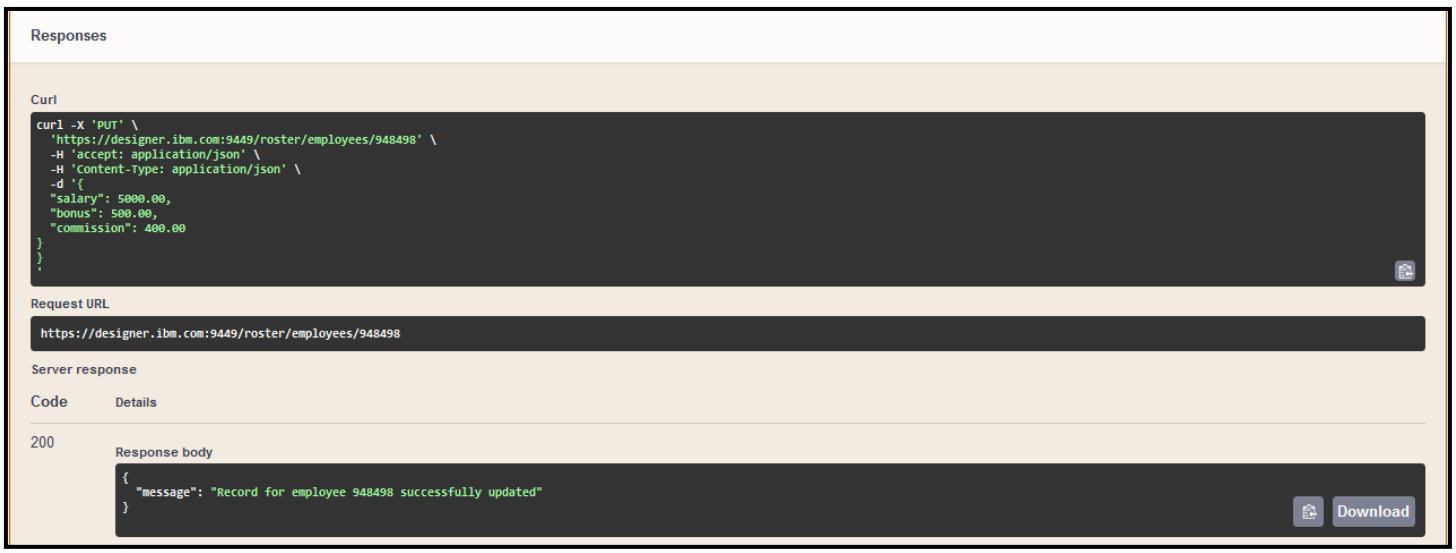
___8. Try this again using number ***121212*** and observe the results. You see the message that the employee was not found.

___9. Expand the *PUT* method and enter press the **Try it out** button.

___10. Enter ***948498*** in the *employee* field and paste the JSON below in the request body area.

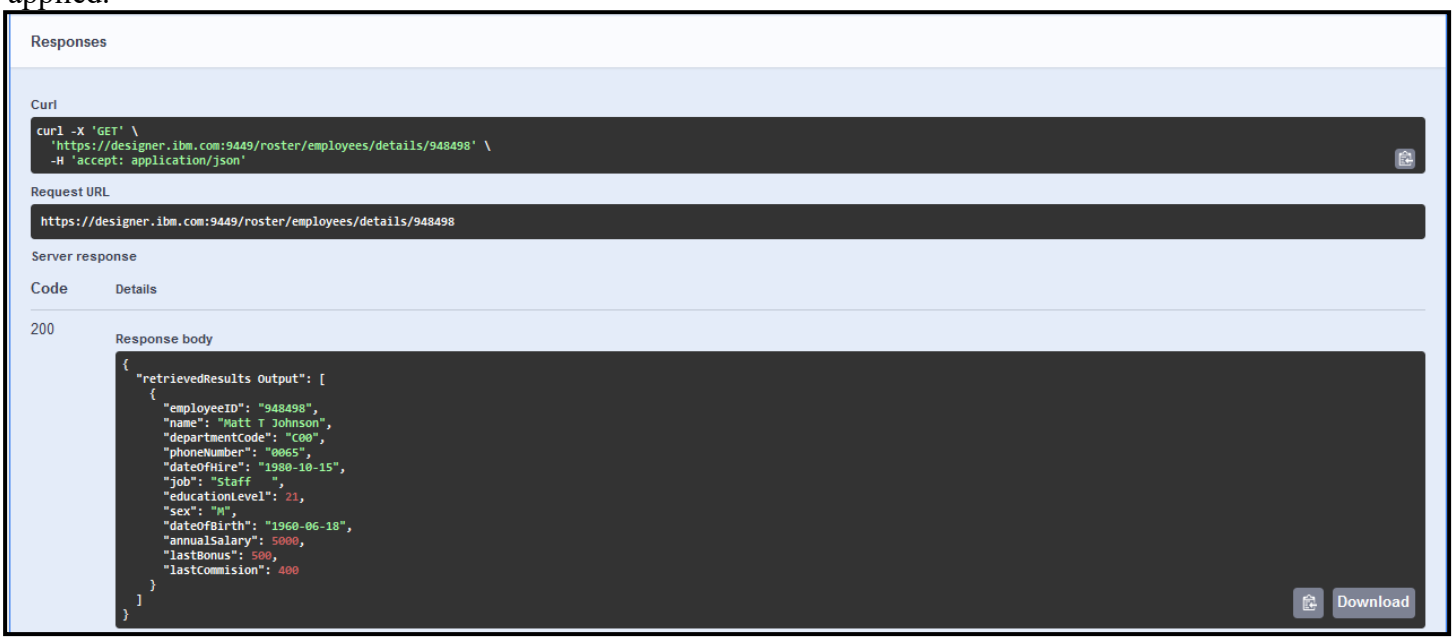
```
{
  "salary": 5000.00,
  "bonus": 500.00,
  "commission": 400.00
}
```

___11. Press the **Execute** button.



___12. Expand the *GET* method for URI path */roster/employees/details/{employee}* and enter press the **Try it out** button.

___13. Enter ***948498*** in the *employee* field and press the **Execute** button. Observe that the updates values have been applied.



___14. Expand the *DELETE* method for URI path */roster/employees/{employee}* and enter 948498 as the employee number press the **Try it out** button. Observe the record has been deleted.

___15. Repeat either of the two *GET* method request for employee ***948498*** and you see a message that the record could not be found.

___16. Try other methods using other rows in the table. The initial contents of the Db2 table are shown below. See the table on page 83 for the contents of the Db2 table.

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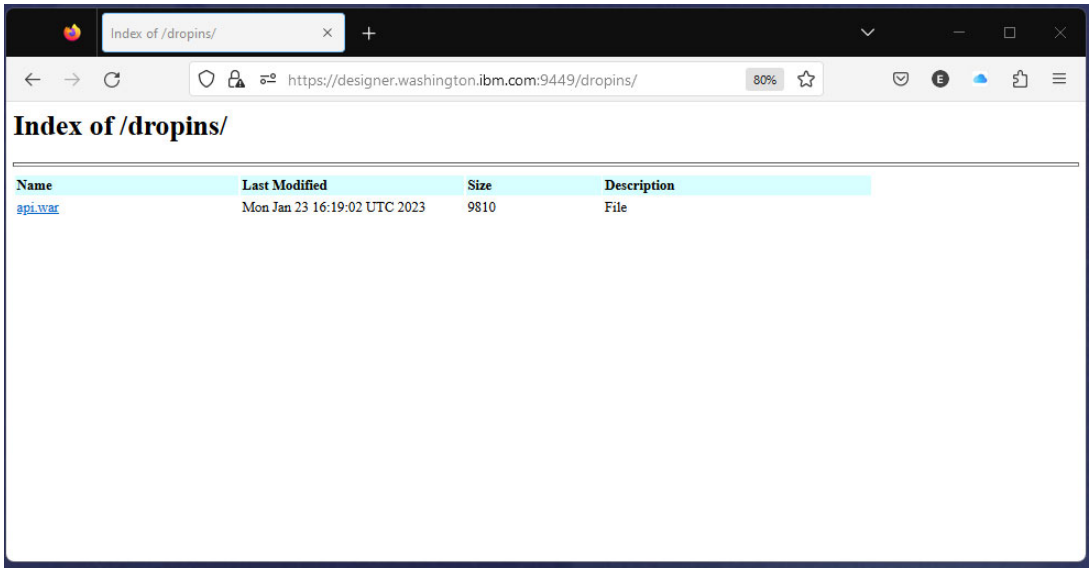
Deploying and installing APIs in a z/OS Connect Native Server

As the *z/OS Connect Designer* is being used to develop the API from specification file, a Web Archive (WAR) file is being constantly regenerated and being automatically deployed to the z/OS Connect server embedded in the *Designer.* This section of the exercises provides details on how this WAR file can be extracted from the *Designer* container, moved to a zOS OMVS directory, and then added to a native z/OS Connect server.

Moving the API Web Archive file from the container to a z/OS OMVS directory

___1. The first step is to use the file serving capability added the Liberty server's configuration. Use a web browser to access URL https://designer.washington.ibm.com:9449/dropins.



Double click the *api.war* file and use the save as option to save the file in local directory, e.g., *c:\z\openApi3\wars*. Specify a *File* name of ***employees.war***.

___2. Open a DOS command prompt and use the change directory command to go to directory C:\z\openApi3\wars, e.g., ***cd C:\z\openApi3\wars***

___3. Start a file transfer session with the WG31 host using the *ftp* command, e.g., **ftp wg31**

___4. Logon as USER1 and then use the *cd* command to change to directory to data set */var/zcee/openApi3/apps, e.g.* ***cd /var/zcee/openApi3/apps***

___5. Toggle prompting off by entering command **prompt**

___6. Enter binary mode transmission but entering command **bin**

___7. Perform multiple put requests by using the multiple put command, **mput employees.war**

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___8. When the last transfer has completed enter the **quit** command.

```
c:\z\openApi3> cd wars
c:\z\openApi3\wars>ftp wg31.washington.ibm.com
Connected to wg31.washington.ibm.com.
220-FTP 16:26:23 on 2018-02-15.
220 Connection will close if idle for more than 200 minutes.
User (wg31.washington.ibm.com:(none)): user1
331 Send password please. user1
Password:
230 USER1 is logged on.  Working directory is "USER1.".
ftp> cd /var/zcee/openApi3
250 HFS directory /var/zcee/openApi3/apps is the current working directory
ftp> prompt
Interactive mode Off .
ftp> bin
200 Representation type is Image
ftp> mput employees.war
200 Port request OK.
125 Storing data set /var/zcee/openApi3/apps/employees.war
250 Transfer completed successfully.
ftp: 35491 bytes sent in 0.39Seconds 90.77Kbytes/sec.
ftp> quit
```

These steps have moved the WAR file from the Designer container to the OMVS directory accessible by the z/OS Connect native server.

Updating the server xml

The next step is to add a *webApplication* server XML configuraton element for the API to the OpenAPI 3 server's configuration.

___1. Edit OMVS file **server.xml** in directory */var/zcee/openApi3* and add this configuration element.

```
<webApplication id="db2" contextRoot="/roster"  name="db2API"
location="${server.config.dir}apps/employees.war"/>
```

The addition of this configuration adds the web application found in the *employees.war* file to the server's configuration. The context root of */db2* is prepended is to the URI paths of each URI path found in the web application to ensure the uniqueness of this API's URI paths versus the URI paths of other APIs installed in the server.

___2. Use MVS modify command ***F ZCEEAPI3,REFRESH,CONFIG*** to have the server XML changes installed.

Tech-Tip: To refresh an application using the MVS modify command ***F ZCEEAPI3,REFRESH,APPS***

This completes the installation of the API's web application.

Defining the required RACF EJBRole resources

The API has been installed but the required RACF EJBRoles have not been defined and access permitted. This section describes the steps required to complete the RACF configuration required to execute the API.

Remember the specification file defined two roles for invoking the methods of this API, *Manager* and *Staff*. In the basicSecurity.xml configuration file we saw how we configured these roles and granted access to the roles in a Liberty internal registry. On z/OS we want to use RACF. The names of the required RACF EJBRoles are derived by combining information from 3 sources. The first is the *profilePrefix* attribute of the server XML *safCredentials* configuration element. In our case, the value of *profilePrefix* is **ATSZDFLT**. The next source is the name of the web application. The name of the web application is either derived from information in the specification or the *name* attribute provided on the webApplication configuration element. In our case, this value should be **db2API**. The final source is the role name provided in the specification document, **Manager** or **Staff**. So, two EJBRoles need to be defined, **ATSZDFLT.db2API.Manager** and **ATSZDFLT.db2API.Staff**.

___1. Use the RACF RDEFINE command to define EJBROLE **ATSZDFLT.db2API.Manager.**

```
rdefine ejbrole ATSZDFLT.db2API.Manager   uacc(none)
```

___2. Use the RACF RDEFINE command to define EJBROLE **ATSZDFLT.db2API.Staff.**

```
rdefine ejbrole ATSZDFLT.db2API.Staff  uacc(none)
```

___3. Use the RACF PERMIT command to permit identity FRED READ access to EJBROLE **ATSZDFLT.db2API.Manager.**

```
permit ATSZDFLT.db2API.Manager  class(ejbrole) id(fred) acc(read)
```

___4. Use the RACF PERMIT command to permit identity FRED READ access to EJBROLE **ATSZDFLT.Db2API.STAFF.**

```
permit ATSZDFLT.db2API.Staff  class(ejbrole) id(fred) acc(read)
```

___5. Use the RACF PERMIT command to permit identity USER1 READ access to EJBROLE **ATSZDFLT.Db2API.STAFF.**

```
permit ATSZDFLT.db2API.Staff  class(ejbrole) id(user1) acc(read)
```

___6. Use the RACF SETROPTS command to refresh the EJBRole instorage profiles.

```
setropts raclist(ejbrole) refresh
```

Now we are ready to test the invoking of the methods of this API.

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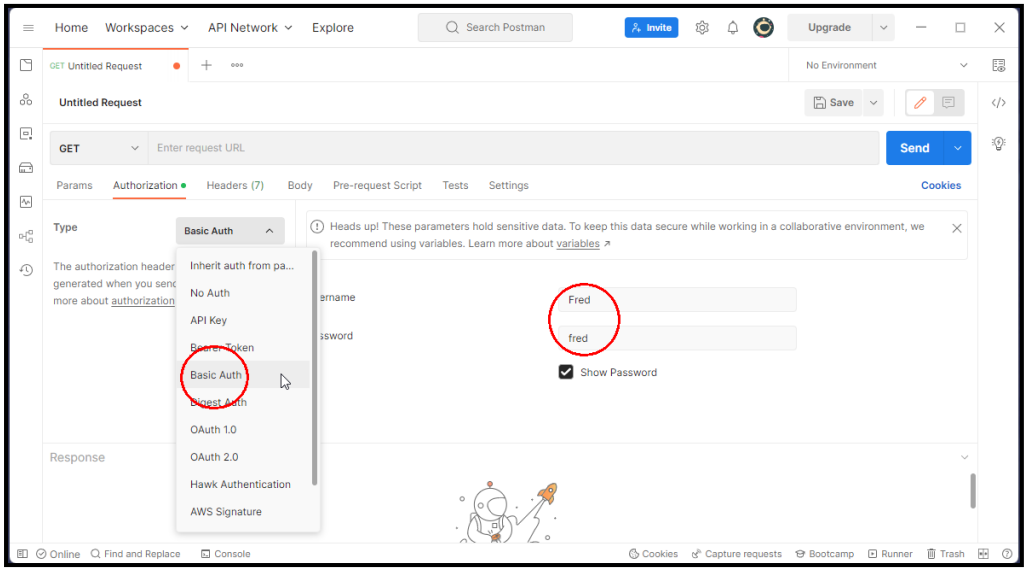
Testing APIs deployed in a native z/OS server

This section assumes the optional configuration steps in section *Compete the configuration of the API (Optional)* on page 42 have completed. If this section was skipped, then some of the test in this section cannot be performed.

Using Postman

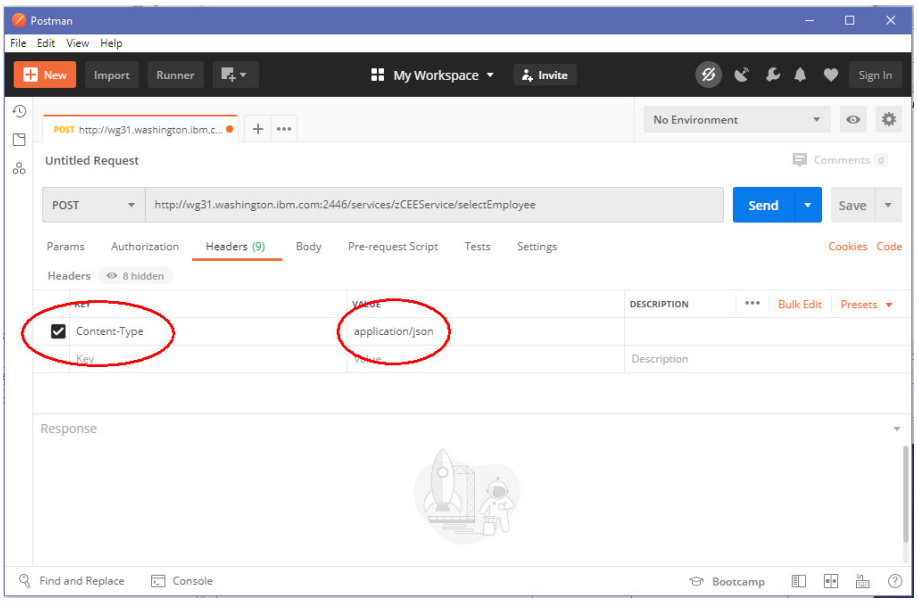
Start a Postman session using the Postman icon on the desktop.

____1. Open the *Postman* tool icon on the desktop and if necessary reply to any prompts and close any welcome messages and select the *Authorization* tab to enter an authorization identity and password. Use the pull down arrow to select *Basic Auth* and enter ***Fred*** as the *Username* and ***fred*** as the *Password*.



Tech-Tip: If the above Postman view is not displayed select *File* on the toolbar and then choose *New Tab* on the pull down. Alternatively, if the *Launchpad* view is displayed, click on the *Create a request* option.

- Next select the *Headers* tab and under *KEY* use the code assist feature to enter ***Content-Type*** and under *VALUE* use the code assist feature to enter ***application/json***.



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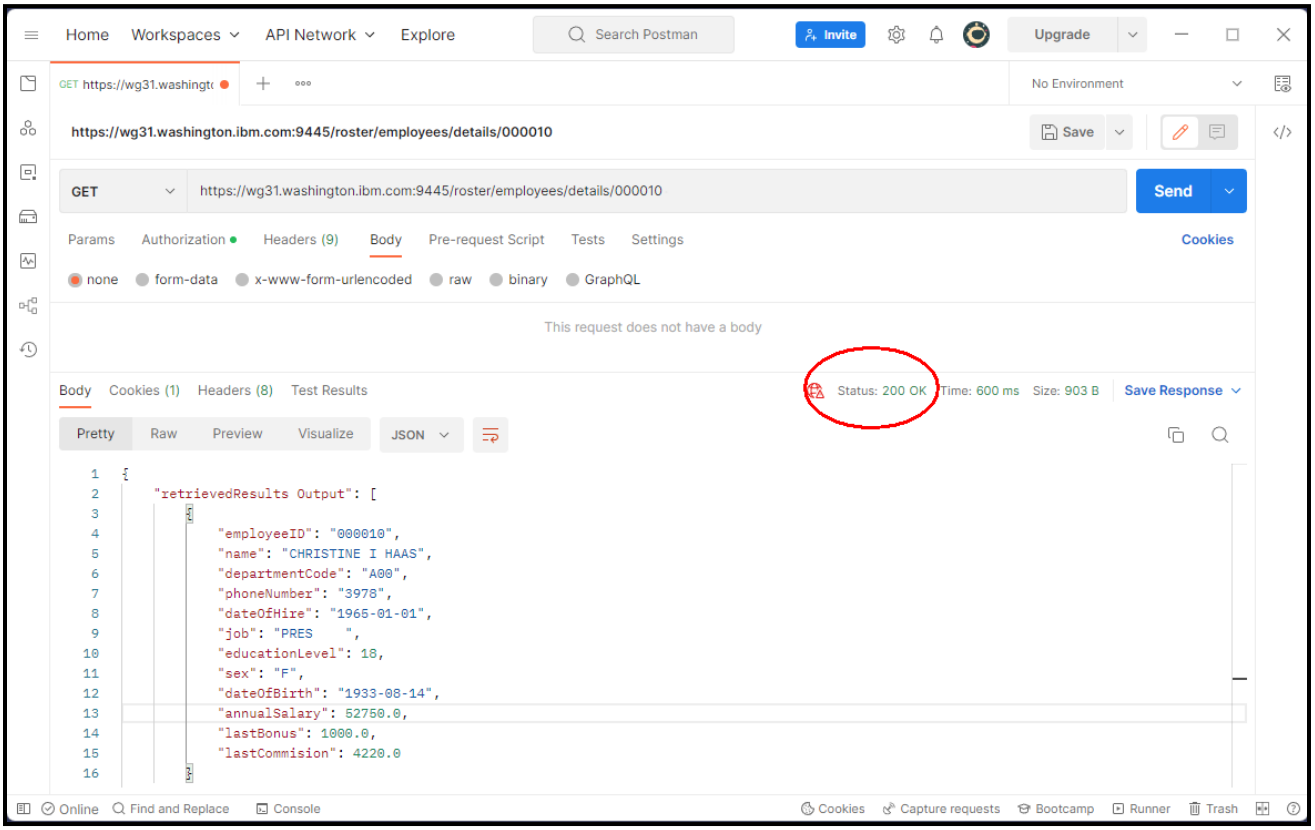
Tech-Tip: Code assist simply means that when text is entered in field, all the valid values for that field that match the typed text will be displayed. You can select the desired value for the field from the list displayed and that value will populate that field.

____2. Next select the *Body* tab and selct the *raw* radio button. Then use the down arrow in the *Body* tab to select **GET** and enter ***https://wg31.washington.ibm.com:9445/roster/employees/details/000010*** in the URL area (see below) and press **Send**. You should see results like below in the response *Body* area.



Notice what is different from the earlier testing when the API was deployed in the *Designer* container. First the credentials were for the RACF credentials (*fred*) with access to the RACF EJBRole.

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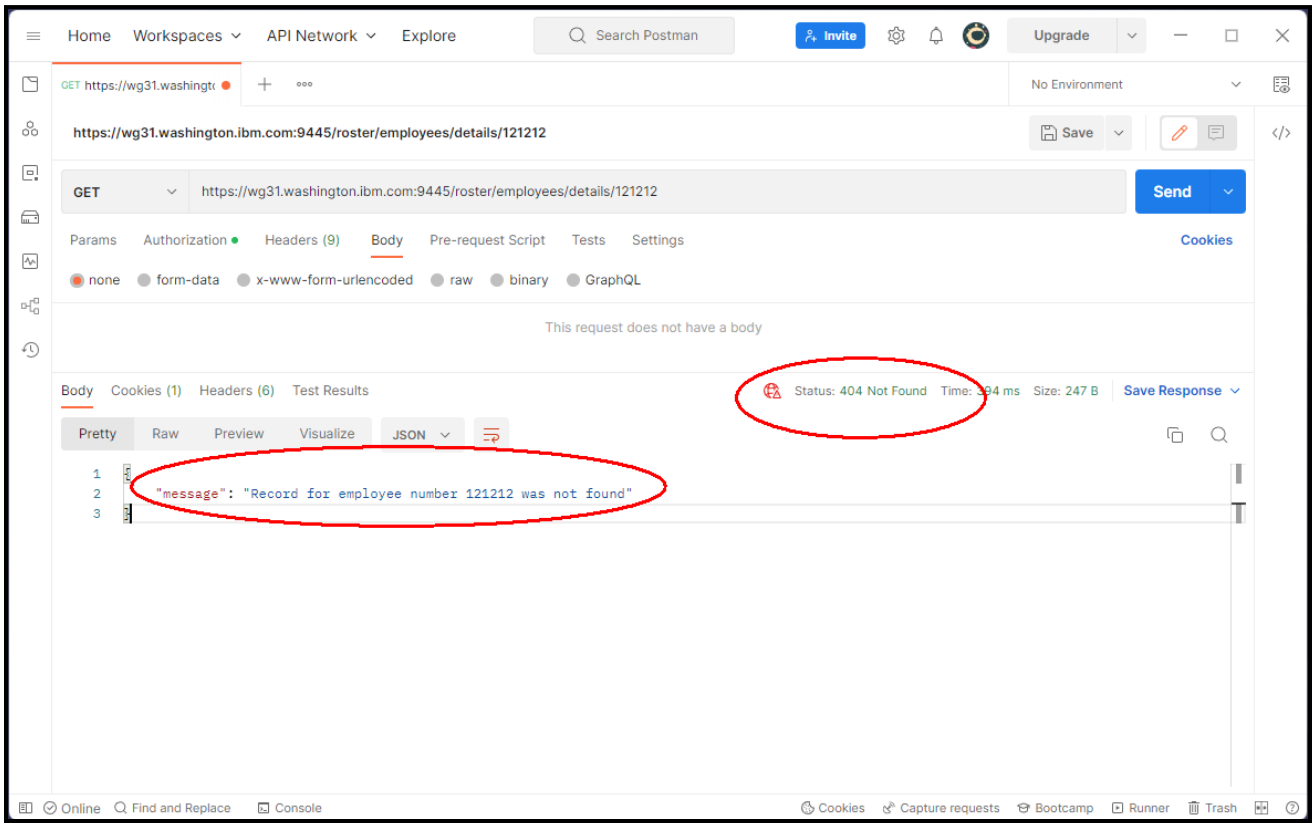
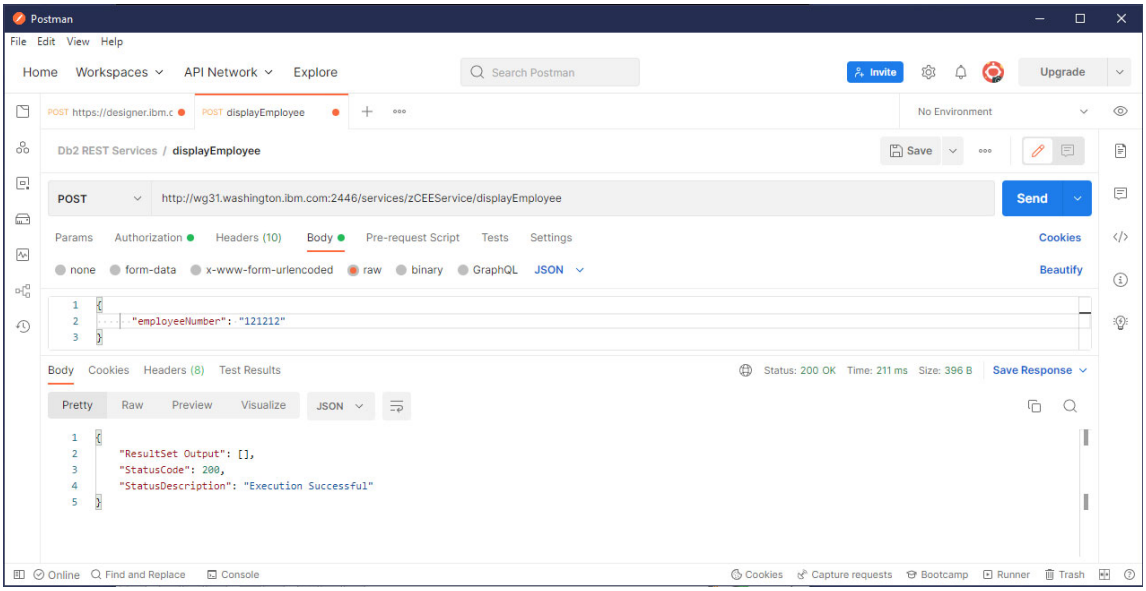
____3. Next enter an invalid employee number such as 121212, ***https://wg31.washington.ibm.com:9445/roster/employees/details/121212*** in the URL area (see below) and press **Send**. You should see results like below in the response *Body* area.



If you invoked the underlying Db2 REST service *(/services/zCEEService/displayEmployee*) you would receive an HTTP 200 with an empty *ResultSet Output* array.



The API created in the *Designer* essentially intercepted the response from the Db2 service and was to determine no results were found and returned an HTTP 404 (not found) to the client rather than an HTTP 200 (OK).

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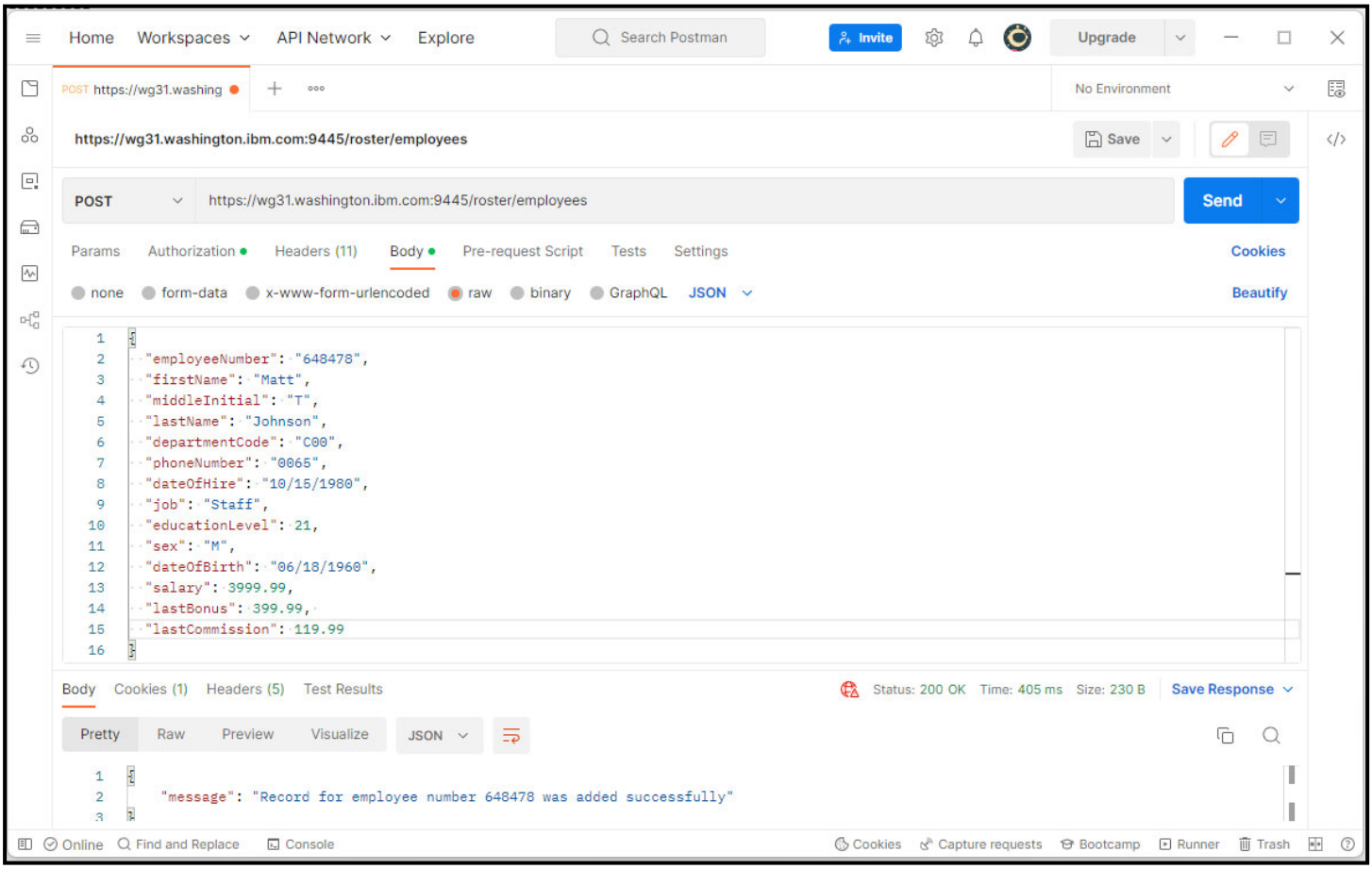
Optional, experiment using *Postman* to invoke other methods of the API. For example, if you want to invoke a *POST* with URI path */roster/employees,* use the JSON below for the request message.

```
{
  "employeeNumber": "648478",
  "firstName": "Matt",
  "middleInitial": "T",
  "lastName": "Johnson",
  "departmentCode": "C00",
  "phoneNumber": "0065",
  "dateOfHire": "10/15/1980",
  "job": "Staff",
  "educationLevel": 21,
  "sex": "M",
  "dateOfBirth": "06/18/1960",
  "salary": 3999.99,
  "lastBonus": 399.99,
  "lastCommission": 119.99
}
```



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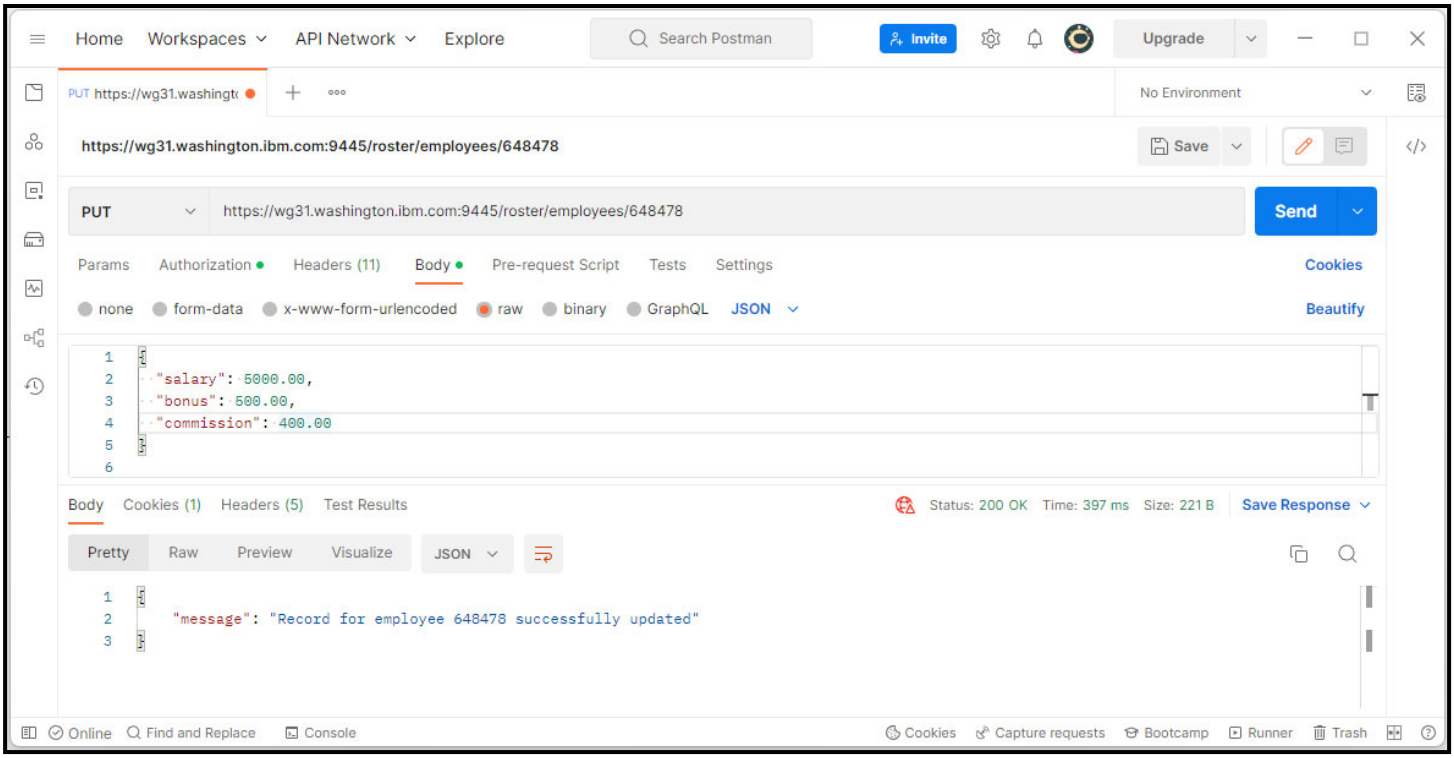
Or if you want to do a *PUT* with URI path /roster/employees/{employee} use this JSON request message.

https://wg31.washington.ibm.com:9445/roster/employees/648489

```
{
  "salary": 5000.00,
  "bonus": 500.00,
  "commission": 400.00
}
```



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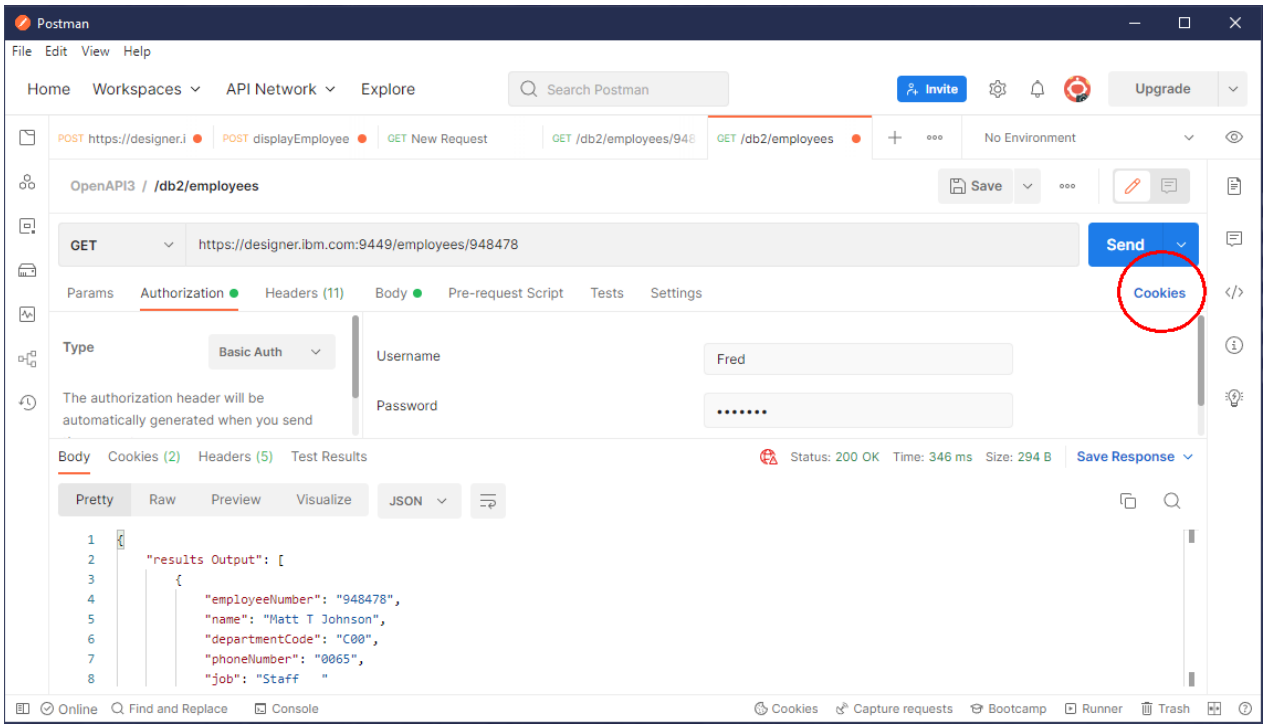
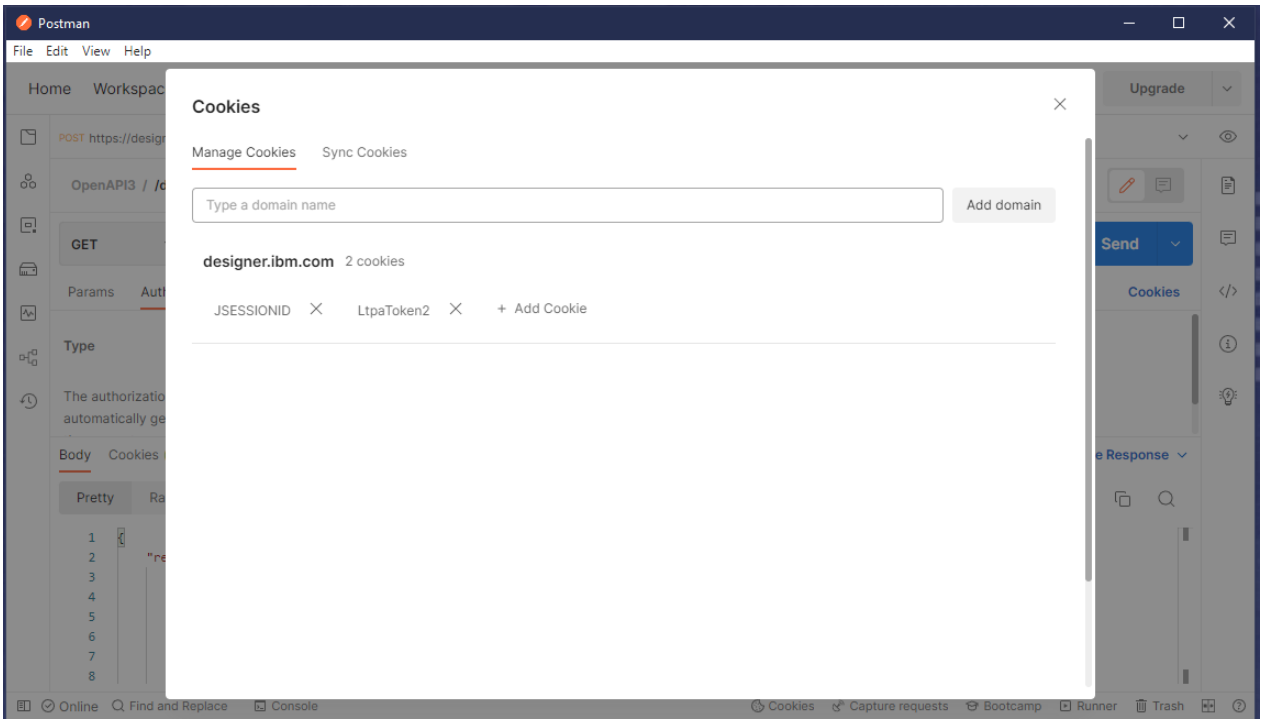
____4. Up until this point you have been using the role assigned to user *Fred*. Now experiment using user *user1* and/or *user2*. Before we can use other credentails we have to clear the credentails that cached by *Postman*. Unless this is done, *Postman* will continue to use the credentails for *Fred* regardless of what is provided in the authorization header

____5. To clear the *Postman* cachced tokens, click on the *Cookies* section of the *Postman* window and



And delete any *JSESSIONID* and *LtpaToken2* cookies displayed.



Test various methods using Username *user1* and *user2* and observe the results. Remember, *user1* can only invoke GET methods and *user2* can not invoke any method.

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Using cURL

Client for URL (*cURL*) is a common tool for driving REST client request to APIs. In this section, the *curl* command will be used to test the API's methods deployed into the *z/OS Connect Designer's* container and more importantly, demonstrate role-based security. *Postman* caches security credentials between tests and the cached credentials must be cleared if the identity being used is changed. *cURL* does not this caching of credentials and therefore it is easier to change security credentials between request with *cURL* than with *Postman*.

____1. Start a DOS command prompt session and go to directory *c:\z\openapi3, e.g.,* ***cd \z\openap3***.

____2. Enter the *curl* command below and observe the response.

curl -X GET -w " - HTTP CODE %{http_code}" --user Fred:fred --header "Content-Type: application/json" --insecure https://wg31.washington.ibm.com:9445/roster/employees/details/000010

c:\z\openapi3>***curl -X GET -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type: application/json" --insecure https://localhost:9449/roster/employees/details/000010***
{"retrievedResults Output":[{"employeeID":"000010","name":"CHRISTINE I HAAS",
"departmentCode":"A00","phoneNumber":"3978","dateOfHire":"1965-01-01","job":"PRES ",
"educationLevel":18,"sex":"F","dateOfBirth":"1933-08-14","annualSalary":52750.0,
"lastBonus":1000.0,"lastCommision":4220.0}]} - **HTTP CODE 200**

Fred is a member of the *Staff* group and has *Staff* access to the **Staff** role. Any identity with **Staff** access can invoke one of the GET methods.

____3. Enter the curl command below and observe the response.

curl -X GET -w " - HTTP CODE %{http_code}" --user user2:user2 --header "Content-Type: application/json" --insecure https://wg31.washington.ibm.com:9445/roster/employees/details/000010

c:\z\openapi3>***curl -X GET -w " - HTTP CODE %{http_code}" --user user2:user2 --header "Content-Type: application/json" --insecure https://localhost:9449roster//employees/details/000010***
- **HTTP CODE 403**

Tech-Tip: If you had provided an invalid password, e.g., *–user user2:userx, the request would have failed with an HTTP status of 401, Unauthorized.*

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____4. Enter the curl command below and observe the response.

curl -X POST -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred --data @insertEmployee.json https://wg31.washington.ibm.com:9445/roster/employees/

In the above command, the file insertEmployee.json has the contents below:

```
{
 "employeeNumber": "748478",
 "firstName": "Matt",
 "middleInitial": "T",
 "lastName": "Johnson",
 "departmentCode": "C00",
 "phoneNumber": "0065",
 "dateOfHire": "10/15/1980",
 "job": "Staff",
 "educationLevel": 21,
 "sex": "M",
 "dateOfBirth": "06/18/1960",
 "salary": 3999.99,
 "lastBonus": 399.99,
 "lastCommission": 119.99
}
```

```
c:\z\openapi3>curl -X POST -w " - HTTP CODE %{http_code}"  --header "Content-Type: application/json" --insecure --user Fred:fred --data @insertEmployee.json https://wg31.washington.ibm.com:9445/roster/employees/
```

____5. Enter the curl command below to invoke the *GET* method with URI path */roles/{job}*.

curl -X GET -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred https://wg31.washington.ibm.com:9445/roster/roles/PRES?dept=A00

____6. Enter the curl command below to invoke the *DELETE* method with URI path */employees/{employee}*.

curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred https://wg31.washington.ibm.com:9445/roster/employees/000012

____7. Enter the curl command below to invoke the *DELETE* method with URI path */employees/{employee}*.

curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user user1:user1 https://wg31.washington.ibm.com:9445/roster/employees/000012

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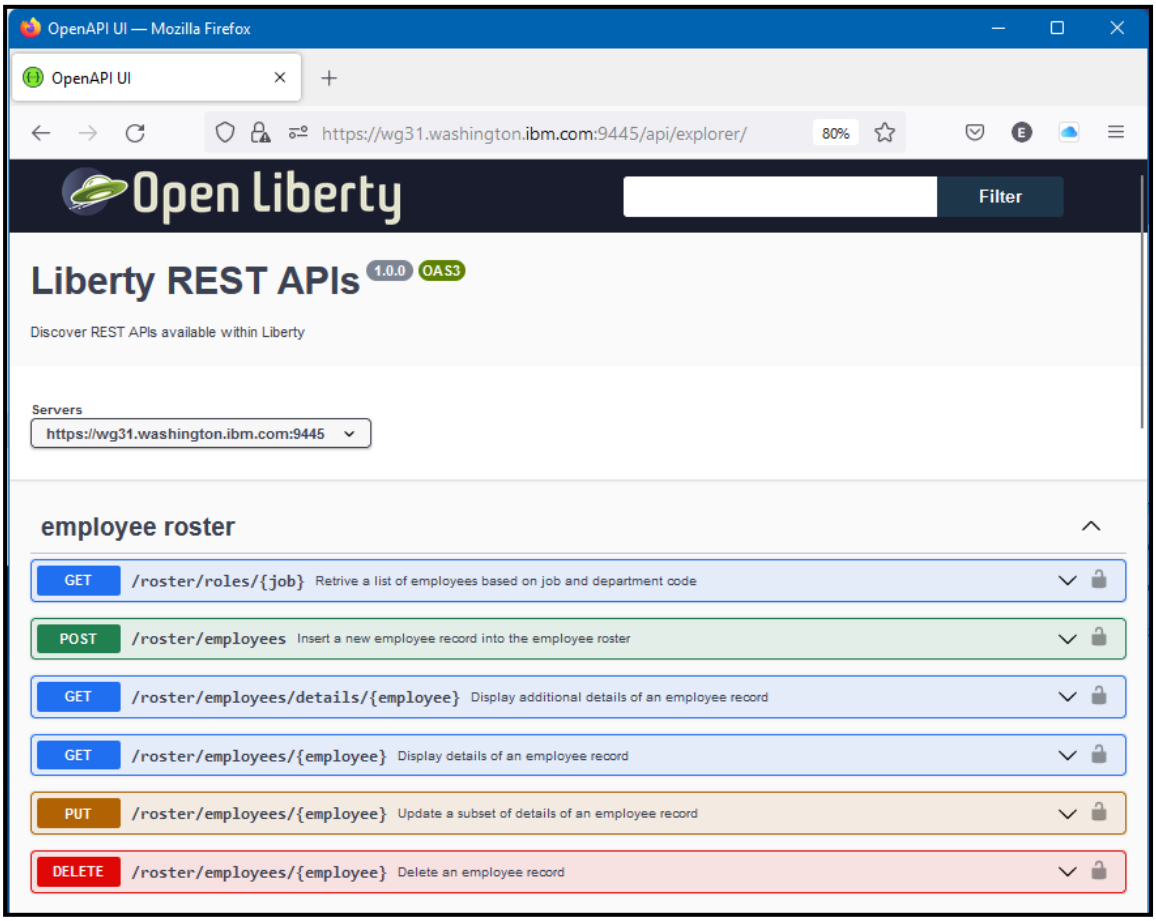
Using the API Explorer

The API Explorer used to test the APIs in the Designer can also be used to test API once they are deployed to a native server.

____1. Using the Firefox browser, go to URL ***https://wg31.washington..ibm.com:9445/api/explorer*** to start the API Explorer.



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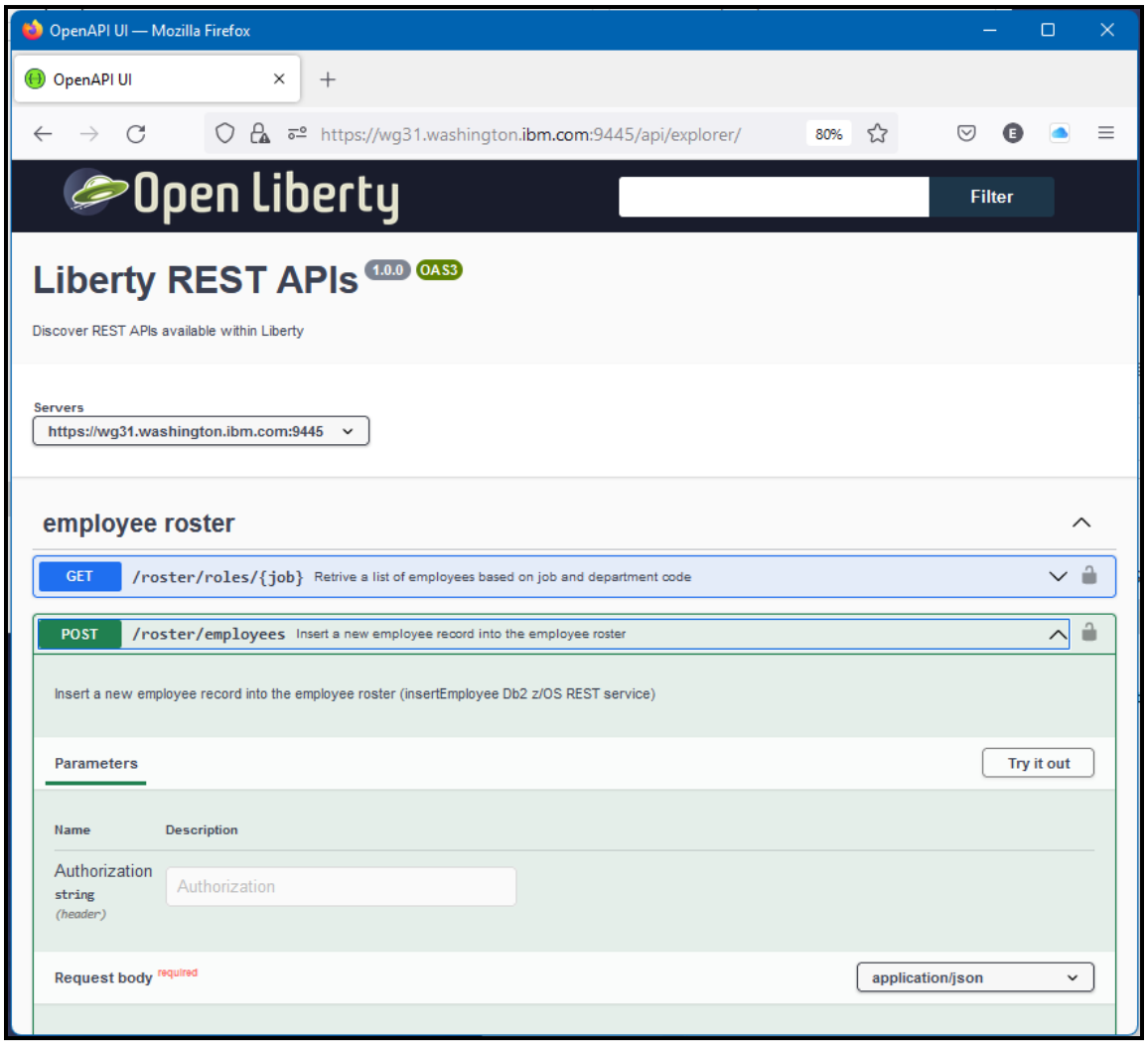
____2. Use the pull-down arrow in the *Servers* box at the top of the page and select **https://wg31.washington.ibm.com:9445**

____3. Click on *Post /roster/employees* URI path to display the request body view of the URI path.



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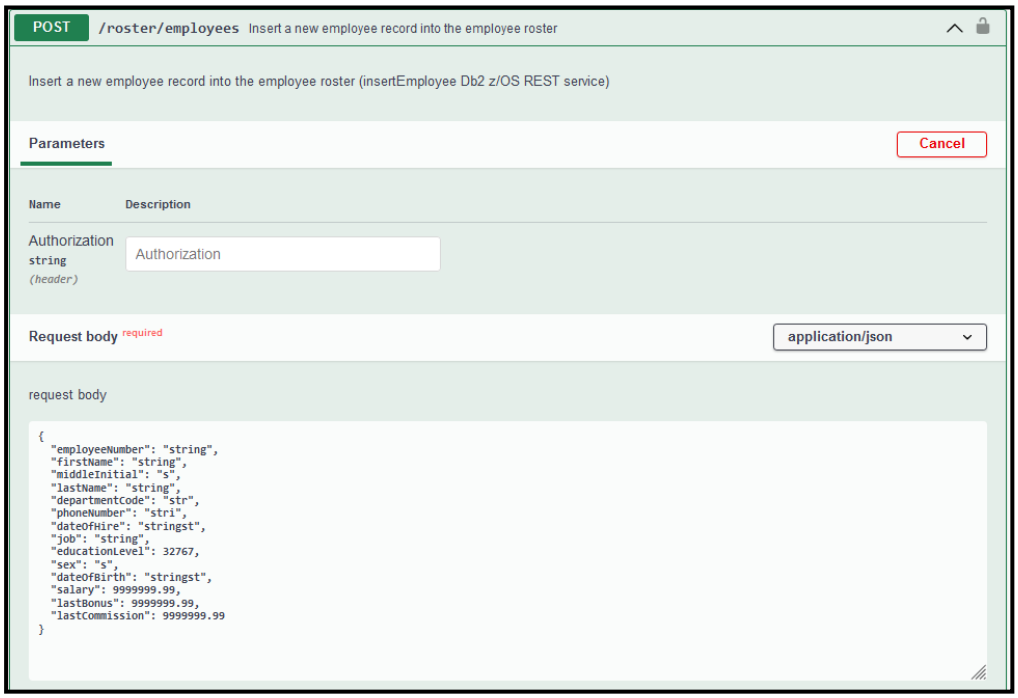
___3. Next press the ***Try it out*** button to enable the entry of a request message body



___4. Enter the JSON request message below in the *Request body* section and press the **Execute** button.

```
{
  "employeeNumber": "848478",
  "firstName": "Matt",
  "middleInitial": "T",
  "lastName": "Johnson",
  "departmentCode": "C00",
  "phoneNumber": "0065",
  "dateOfHire": "10/15/1980",
  "job": "Staff",
  "educationLevel": 21,
  "sex": "M",
  "dateOfBirth": "06/18/1960",
  "salary": 3999.99,
  "lastBonus": 399.99,
  "lastCommission": 119.99
}
```

___5. Security was enabled in the original specification document, so you will be required to sign in with one of the identities defined in the basicSecurity.xml file explored earlier. Use ***Fred*** for the *Username* and ***fredpwd*** for the *Password*. Please note that this identity can be changed unless all browser sessions are stopped.

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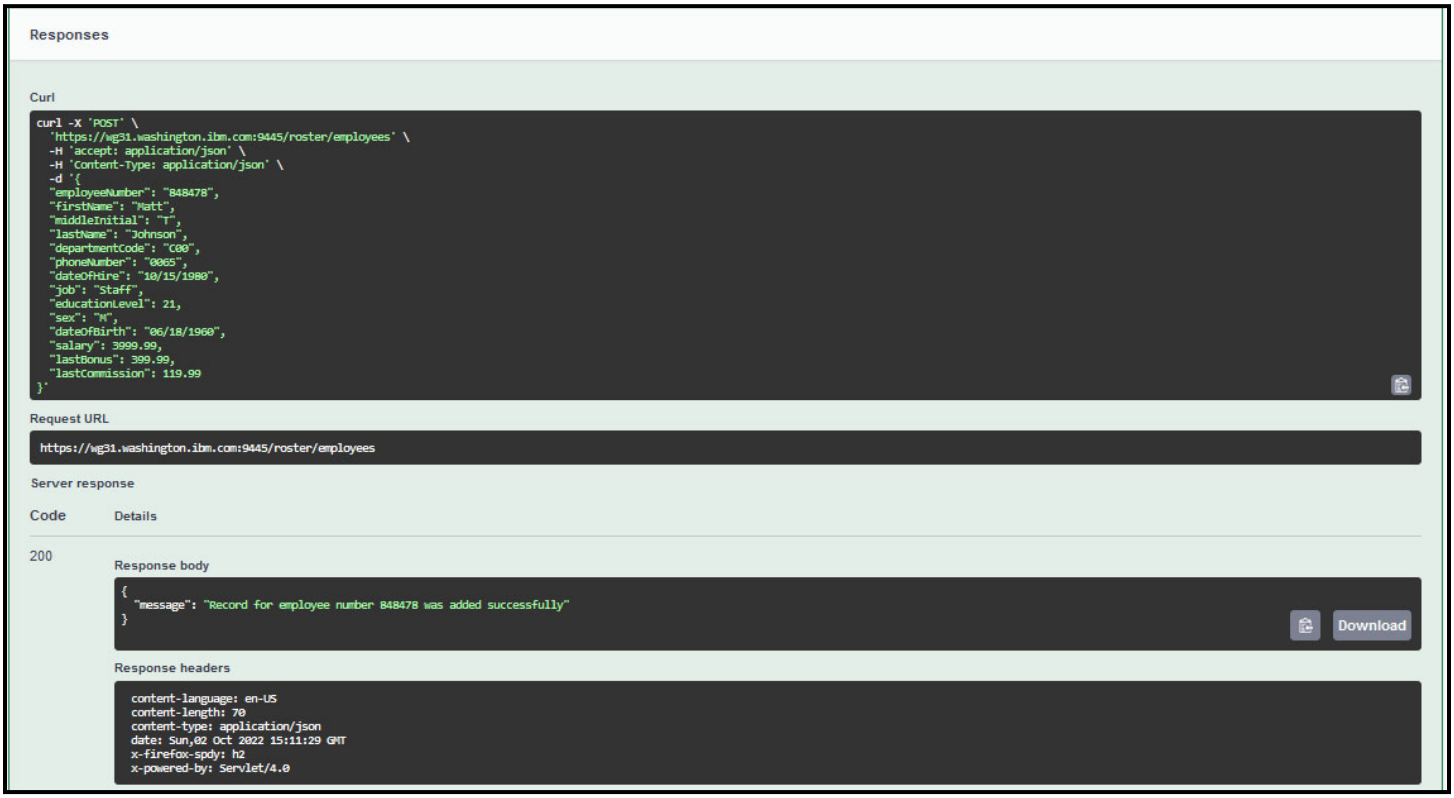
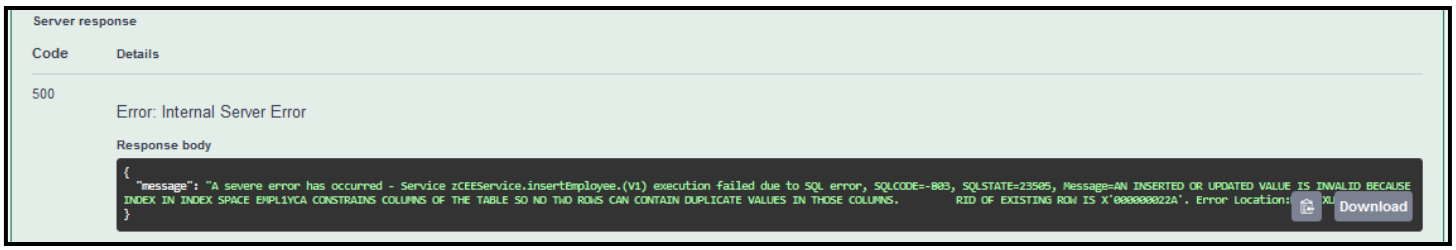
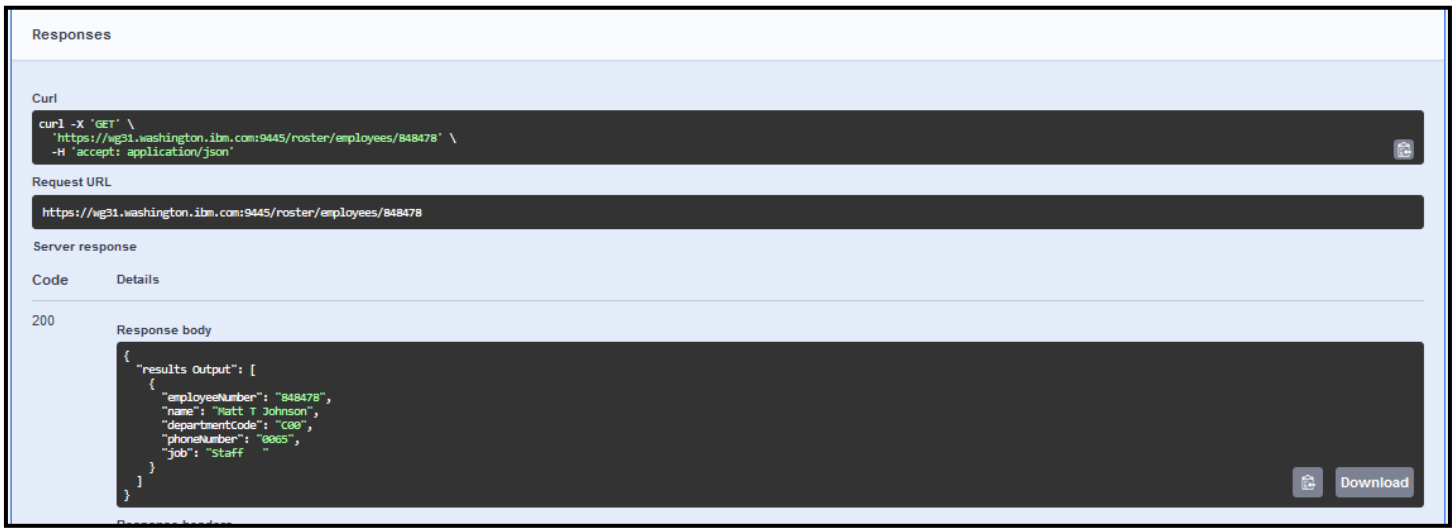
___6. Scroll down the view and you should see the *Response body* with the expected successful message.



___7. Press the **Execute** button again and observe the results. A row for this employee number already existed in the employee roster (a Db2 tables) so the request failed with an HTTP 500.



___8. Scroll down and click on *GET /roster/employees/{employees}* URI path to display the request body view of the URI path for this method. Next click on the ***Try it out*** button to enable the entry of data for this method. Enter ***848478*** as the employee identity and press the **Execute** button to retrieve a subset of data for this employee.



___9. Try this again using number ***121212*** and observe the results. You see the message that the employee was not found.

___10. Expand the *PUT /roster/employees/{employees}* method and enter press the **Try it out** button.

___11. Enter ***848478*** in the *employee* field and paste the JSON below in the request body area.

```
{
  "salary": 5000.00,
  "bonus": 500.00,
  "commission": 400.00
}
```

___12. Press the **Execute** button.

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___13. Expand the *GET* method for URI path */roster/employees/details/{employee}* and enter press the **Try it out** button.

___14. Enter ***848478*** in the *employee* field and press the **Execute** button. Observe that the updates values have been applied.

___15. Expand the *DELETE* method for URI path */employees/{employee}* and enter 848478 as the employee number press the **Try it out** button. Observe the record has been deleted.

___16. Repeat either of the two *GET* method request for employee ***948478*** and you see a message that the record could not be found.

Try other methods using other rows in the table. The initial contents of the Db2 table are shown below. See the table on page 83 for the contents of the Db2 table

Congratulations, you have completed this exercise.

Additional information and samples

This section provides the contents of the Db2 table used in this exercise as well as the JCL used to load the Db2 table. There is an introduction to performing problem determination while developing APIs as well as the contents of the original YAML file used to develop the Open API 3 API.

The initial contents of the Db2 table are shown below.

EMPNO	FIRSTNME	MIDINIT	LASTNAME	WORKDEPT	PHONENO	HIREDATE	JOB	EDLEVEL	SEX	Birthdate	Salary	Bonus	COMM
000011	CHRISTINE	I	HAAS	A00	A1A1	1965-01-01	PRES	18	F	1933-08-14	52750.00	1000.00	4220.00
000020	MICHAEL	L	THOMPSON	B01	3476	1973-10-10	MANAGER	18	M	1948-02-02	41250.00	800.00	3300.00
000030	SALLY	A	KWAN	C01	4738	1975-04-05	MANAGER	20	F	1941-05-11	38250.00	800.00	3060.00
000050	JOHN	B	GEYER	E01	6789	1949-08-17	MANAGER	16	M	1925-09-15	40175.00	800.00	3214.00
000060	IRVING	F	STERN	D11	6423	1973-09-14	MANAGER	16	M	1945-07-07	32250.00	600.00	2580.00
000070	EVA	D	PULASKI	D21	7831	1980-09-30	MANAGER	16	F	1953-05-26	36170.00	700.00	2893.00
000090	EILEEN	W	HENDERSON	E11	5498	1970-08-15	MANAGER	16	F	1941-05-15	29750.00	600.00	2380.00
000100	THEODORE	Q	SPENSER	E21	0972	1980-06-19	MANAGER	14	M	1956-12-18	26150.00	500.00	2092.00
000110	VINCENZO	G	LUCCHESI	A00	3490	1958-05-16	SALESREP	19	M	1929-11-05	46500.00	900.00	3720.00
000120	SEAN		O'CONNELL	A00	2167	1963-12-05	CLERK	14	M	1942-10-18	29250.00	600.00	2340.00
000130	DOLORES	M	QUINTANA	C01	4578	1971-07-28	ANALYST	16	F	1925-09-15	23800.00	500.00	1904.00
000140	HEATHER	A	NICHOLLS	C01	1793	1976-12-15	ANALYST	18	F	1946-01-19	28420.00	600.00	2274.00
000150	BRUCE		ADAMSON	D11	4510	1972-02-12	DESIGNER	16	M	1947-05-17	25280.00	500.00	2022.00
000160	ELIZABETH	R	PIANKA	D11	3782	1977-10-11	DESIGNER	17	F	1955-04-12	22250.00	400.00	1780.00
000170	MASATOSHI	J	YOSHIMURA	D11	2890	1978-09-15	DESIGNER	16	M	1951-01-05	24680.00	500.00	1974.00
000180	MARILYN	S	SCOUTTEN	D11	1682	1973-07-07	DESIGNER	17	F	1949-02-21	21340.00	500.00	1707.00
000190	JAMES	H	WALKER	D11	2986	1974-07-26	DESIGNER	16	M	1952-06-25	20450.00	400.00	1636.00
000200	DAVID		BROWN	D11	4501	1966-03-03	DESIGNER	16	M	1941-05-29	27740.00	600.00	2217.00
000210	WILLIAM	T	JONES	D11	0942	1979-04-11	DESIGNER	17	M	1953-02-23	18270.00	400.00	1462.00
000220	JENNIFER	K	LUTZ	D11	0672	1968-08-29	DESIGNER	18	F	1948-03-19	29840.00	600.00	2387.00
000230	JAMES	J	JEFFERSON	D21	2094	1966-11-21	CLERK	14	M	1935-05-30	22180.00	400.00	1774.00
000240	SALVATORE	M	MARINO	D21	3780	1979-12-05	CLERK	17	M	1954-03-31	28760.00	600.00	2301.00
000250	DANIEL	S	SMITH	D21	0961	1969-10-30	CLERK	15	M	1939-11-12	19180.00	400.00	1534.00
000260	SYBIL	V	JOHNSON	D21	8953	1975-09-11	CLERK	16	F	1936-10-05	17250.00	300.00	1380.00
000270	MARIA	L	PEREZ	D21	9001	1980-09-30	CLERK	15	F	1953-05-26	27380.00	500.00	2190.00
000280	ETHEL	R	SCHNEIDER	E11	8997	1967-03-24	OPERATOR	17	F	1936-03-28	26250.00	500.00	2100.00
000290	JOHN	R	PARKER	E11	4502	1980-05-30	OPERATOR	12	M	1946-07-09	15340.00	300.00	1227.00
000300	PHILIP	X	SMITH	E11	2095	1972-06-19	OPERATOR	14	M	1936-10-27	17750.00	400.00	1420.00
000310	MAUDE	F	SETRIGHT	E11	3332	1964-09-12	OPERATOR	12	F	1931-04-21	15900.00	300.00	1272.00
000320	RAMLAL	V	MEHTA	E21	9990	1965-07-07	FIELDREP	16	M	1932-08-11	19950.00	400.00	1596.00
000330	WING		LEE	E21	2103	1976-02-23	FIELDREP	14	M	1941-07-18	25370.00	500.00	2030.00
000340	JASON	R	GOUNOT	E21	5698	1947-05-05	FIELDREP	16	M	1926-05-17	23840.00	500.00	1907.00

JCL to define and load the Db2 table USER1.EMPLOYEE

Below is the JCL used to load the Db2 table accessed by this API. This table was based on the standard Db2 sample employee with some constraints removed.

```
//EMPLOYEE EXEC PGM=IKJEFT01,DYNAMNBR=20
//SYSTSPRT DD  SYSOUT=*
//SYSTSIN  DD  *
 DSN SYSTEM(DSN2)
 RUN  PROGRAM(DSNTIAD) PLAN(DSNTIA12) -
      LIB('DSN2.RUNLIB.LOAD')
//SYSPRINT DD  SYSOUT=*
//SYSUDUMP DD  SYSOUT=*
//SYSIN    DD  *
  DROP TABLE USER1.EMPLOYEE;
  COMMIT;

 CREATE TABLE USER1.EMPLOYEE
               (EMPNO     CHAR(6)        NOT NULL,
                FIRSTNME  VARCHAR(12)    NOT NULL,
                MIDINIT   CHAR(1)        NOT NULL,
                LASTNAME  VARCHAR(15)    NOT NULL,
                WORKDEPT  CHAR(3)                ,
                PHONENO   CHAR(4)                ,
                HIREDATE  DATE                   ,
                JOB       CHAR(8)                ,
                EDLEVEL   SMALLINT               ,
                SEX       CHAR(1)                ,
                BIRTHDATE DATE                   ,
                SALARY    DECIMAL(9, 2)          ,
                BONUS     DECIMAL(9, 2)          ,
                COMM      DECIMAL(9, 2)          ,
                PRIMARY KEY(EMPNO));

GRANT ALL PRIVILEGES ON TABLE USER1.EMPLOYEE TO USER1;

//LOAD    EXEC DSNUPROC,PARM='DSN2,DSNTEX',COND=(4,LT)
//SORTLIB  DD  DSN=SYS1.SORTLIB,DISP=SHR
//SORTOUT  DD  UNIT=SYSDA,SPACE=(4000,(20,20),,,ROUND)
//SORTWK01 DD  UNIT=SYSDA,SPACE=(4000,(20,20),,,ROUND)
//SORTWK02 DD  UNIT=SYSDA,SPACE=(4000,(20,20),,,ROUND)
//SORTWK03 DD  UNIT=SYSDA,SPACE=(4000,(20,20),,,ROUND)
//SORTWK04 DD  UNIT=SYSDA,SPACE=(4000,(20,20),,,ROUND)
//DSNTRACE DD  SYSOUT=*
//SYSRECEM DD  DSN=DSN1210.DB2.SDSNSAMP(DSN8LEM),
//             DISP=SHR
//SYSUT1   DD  UNIT=SYSDA,SPACE=(4000,(50,50),,,ROUND)
//SYSIN    DD  *

 LOAD DATA INDDN(SYSRECEM) CONTINUEIF(72:72)='X'
      INTO TABLE USER1.EMPLOYEE
           (EMPNO     POSITION( 1)  CHAR(6),
            FIRSTNME  POSITION( 8)  VARCHAR,
            MIDINIT   POSITION(21)  CHAR(1),
            LASTNAME  POSITION(23)  VARCHAR,
            WORKDEPT  POSITION(36)  CHAR(3),
            PHONENO   POSITION(40)  CHAR(4),
            HIREDATE  POSITION(45)  DATE EXTERNAL,
            JOB       POSITION(56)  CHAR(8),
            EDLEVEL   POSITION(65)  INTEGER EXTERNAL(2),
            SEX       POSITION(68)  CHAR(1),
            BIRTHDATE POSITION(80)  DATE EXTERNAL,
            SALARY    POSITION(91)  INTEGER EXTERNAL(5),
            BONUS     POSITION(97)  INTEGER EXTERNAL(5),
            COMM      POSITION(103) INTEGER EXTERNAL(5))
      ENFORCE NO
```


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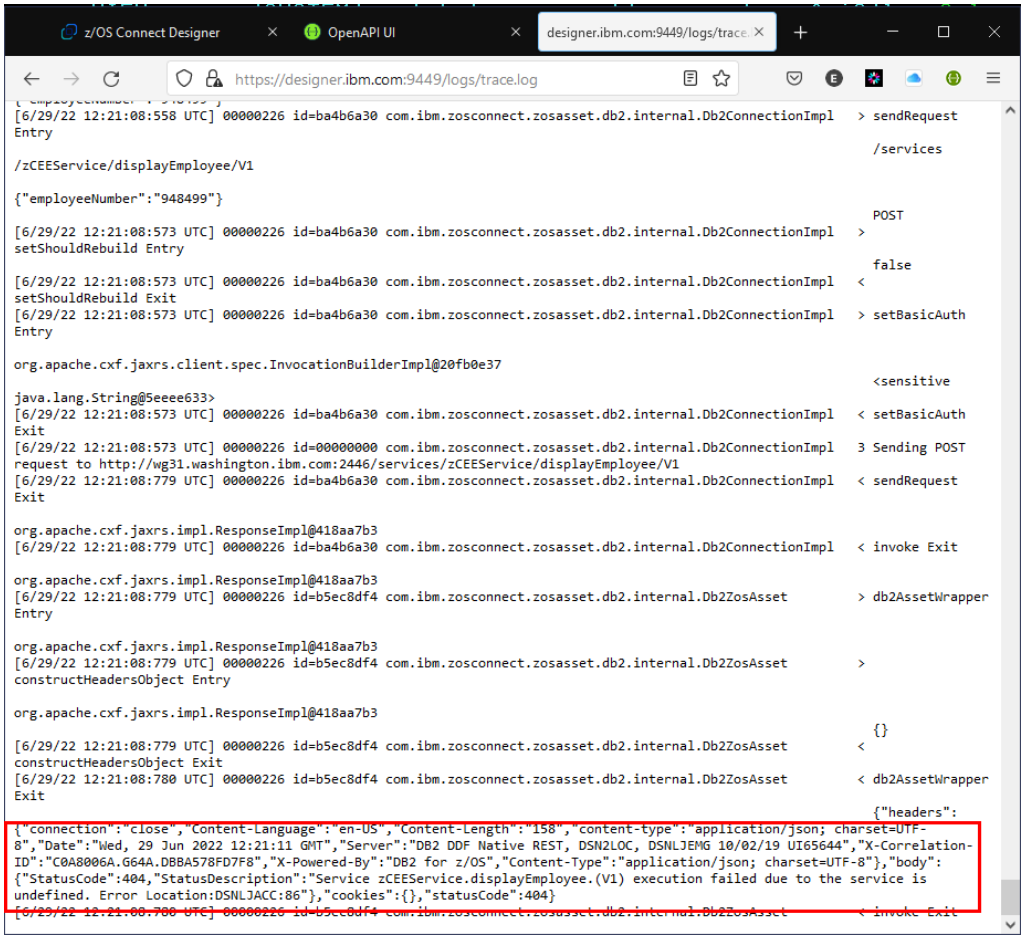
Designer problem determination

In this section, we will explore various scenarios using tracing to resolve API development issues, the trace output was created using this trace specification.

```
<logging traceSpecification="
        zosConnectCics=all:
        zosConnectDb2=all"
        />
```

____1. Invoking a method returned an HTTP 404 response and no other response. There should have been a message displayed to state that a record for this employee did not exist. A review of the trace showed the Db2 REST service did return an HTTP 404 status code and a status message. The status message indicated that the request Db2 REST service did not exist. The resource not found (HTTP 404) was the REST service, not the employee record.



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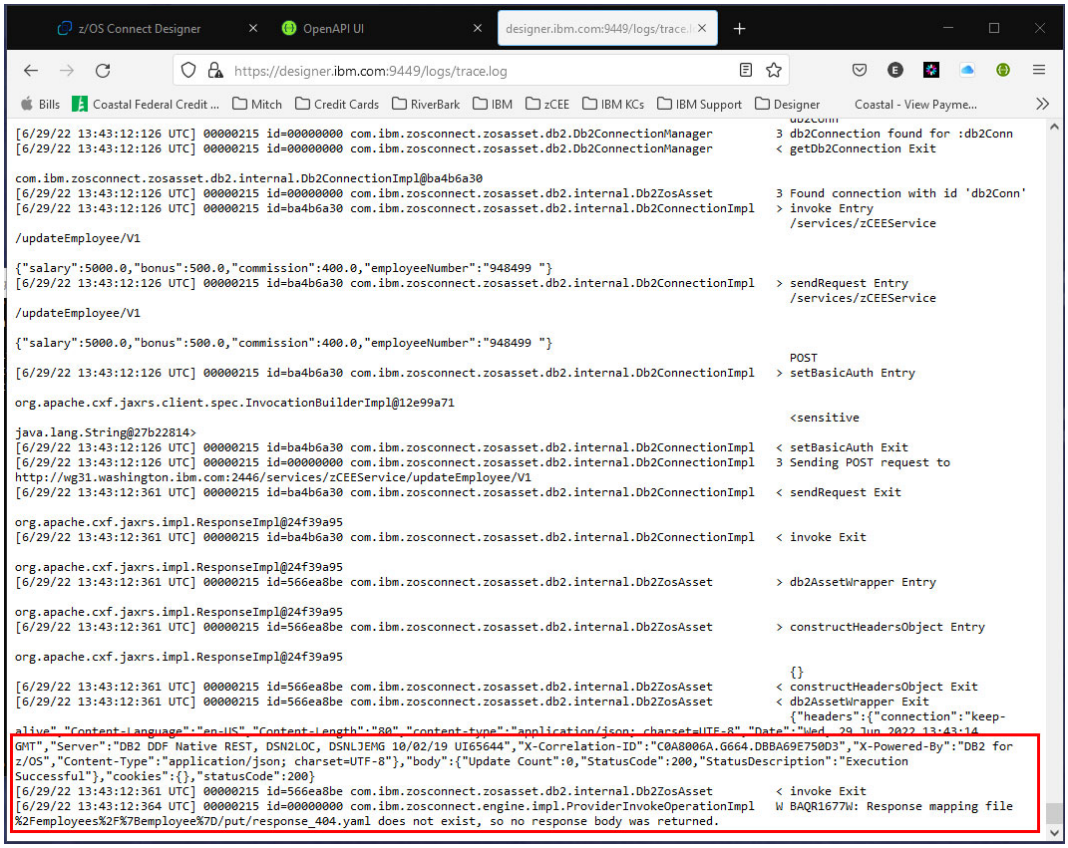
____2. Here is another situation. Invoking a method returned an HTTP 404 response and no other details. There should have been a message displayed to state that a record for this employee did not exist. A review of the trace showed the Db2 REST service did return an HTTP 200 code but not the results array. In this case a review of trace showed the issue was that the response mapping for this situation, *response_404.yaml,* did not exist in the API. It was this resource not being found which generated the HTTP 404 (not found) condition, not the employee record and not the Db2 REST service.



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