IBM z/OS Connect (OpenAPI 3.0)

Developing and Administering RESTful APIs for CICS REST Services

IBM Z
Wildfire Team –
Washington System Center

Date: July 27, 2022

Table of Contents

Mitch Johnson (mitchj@us.ibm.com)

Important: On the desktop there is a file named *OpenAPI 3 Development for CICS 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.

Overview

The objective of these exercises is to gain experience with working with *z/OS Connect* and 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 CICS to perform this exercise. Even if CICS 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.

- ✓ The IP address of the image where the *z/OS Connect Designer* containers are running has been configured in the *../etc/hosts* file as *designer.washington.ibm.com.* This was done so the host name that appears in this exercise would be consistent regardless of whether the containers were running in a local Windows Subsystem for Linux image using a loop back adapter or a remote server image.

- ✓ 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.washington.ibm.com* when a screen shot shows the host as *designer.ibm.com* or even *localhost*. All of 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.

The CSCVINC CICS application

In this exercise we are developing an API to access a CICS application program named CSCVINC. This application is a COBOL application that uses a channel/container interface. This application, when invoked, accesses the channel provided by CICS and looks for the container in that channel. The name of the container is not hard coded in the application, so the application will accept a container with any name.

The container has a field named ACTION. The contents of this field determines what function the application will perform. Based on the value of ACTION, the application will access the CICS sample FILEA VSAM data set and either insert a new record (I), retrieve an existing record (G), update an existing record (U) or delete an existing record (D).

The application returns the results of the request including the values of the CICS EIBRESP and EIBRESP3 response code from the EXEC CICS WRITE, EXEC CICS READ, EXE CICS REWRITE or EXEC CICS DELETE API performed by the program. Also returned is the identity under which the CICS transaction executed. The response container name will have the same name as the request container.

The COBOL copy book for the request container is shown here.

```
       01 Request-Container.
           03  ACTION           PIC X(1).
           03  USERID           PIC X(8).
           03  FILEA-AREA.
               05  STAT         PIC X.
               05  NUMB         PIC X(6).
               05  NAME         PIC X(20).
               05  ADDRX        PIC X(20).
               05  PHONE        PIC X(8).
               05  DATEX        PIC X(8).
               05  AMOUNT       PIC X(8).
               05  COMMENT      PIC X(9).
```

The COBOL copy book for the response container is shown here.

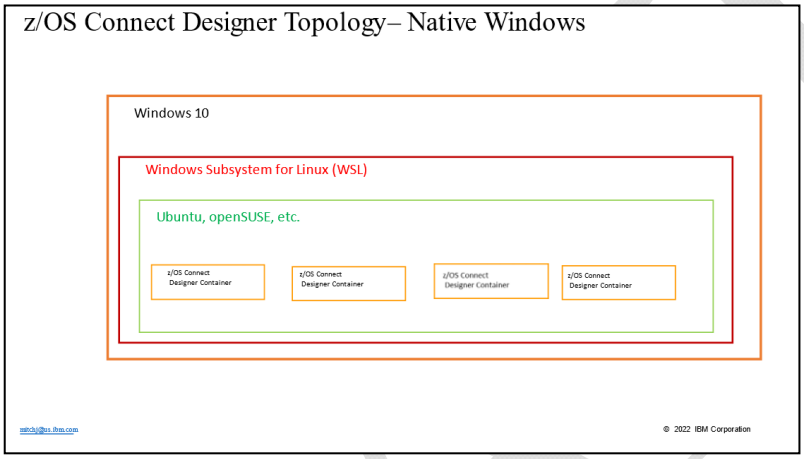
```
       01 Response-Container.
           03  ACTION           PIC X(1).
           03  CEIBRESP         PIC S9(8) COMP.
           03  CEIBRESP2        PIC S9(8) COMP.
           03  USERID           PIC X(8).
           03  FILEA-AREA.
               05  STAT         PIC X.
               05  NUMB         PIC X(6).
               05  NAME         PIC X(20).
               05  ADDRX        PIC X(20).
               05  PHONE        PIC X(8).
               05  DATEX        PIC X(8).
               05  AMOUNT       PIC X(8).
               05  COMMENT      PIC X(9).
```


Mitch Johnson (mitchj@us.ibm.com)

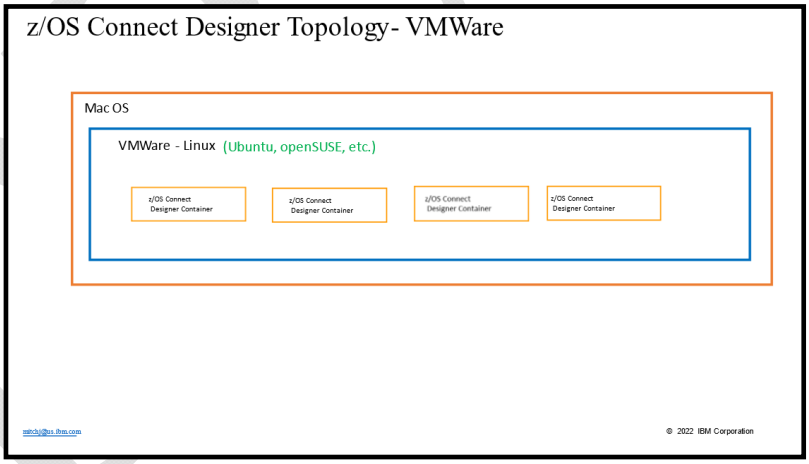
The z/OS Connect Designer Container environment

APIs for accessing CICS resources are developed using the *z/OS Connect Designer* which is an application that runs in a Liberty server environment. Each Liberty server with a *z/OS Connect Designer* (*Designer*) installed can only support the development of a single API. This should not be an issue since these Liberty servers are running in containers and multiple containers can run concurrently on a single image. Currently these containers must be running in a host Linux environment. And again, limiting containers to a Linux host is not a major issue because even if a native Linux environment is not available, current versions of Windows and Mac OS can host Linux host images using either *Windows Subsystems for Linux (WSL)* or virtual images.

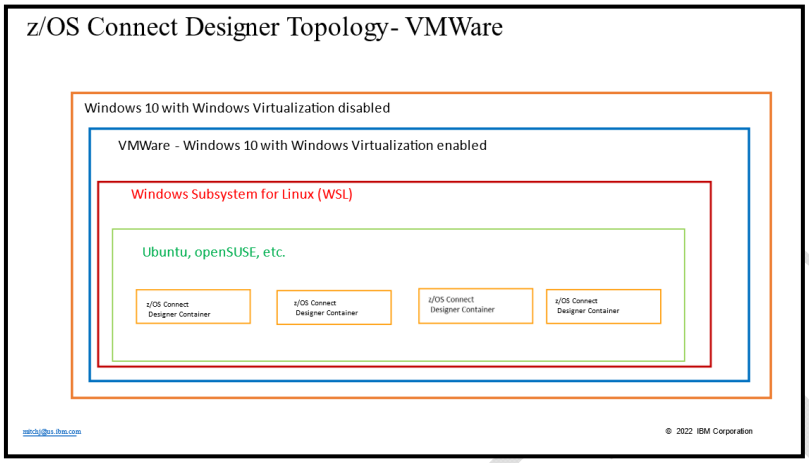
For example, consider the diagram below. This diagram is showing a Windows image with *WSL* enabled. The *WSL* environment allows the installation of a Linux distribution (*Ubuntu* in our case), and this *Ubuntu* host image can support multiple container each running the *z/OS Connect Designer* application in a Liberty server.



This diagram shows another scenario for a Mac OS image where VMWare Fusion© or Parallels© can be used to run a virtual Linux image in which where the Liberty *Designer* containers can run.

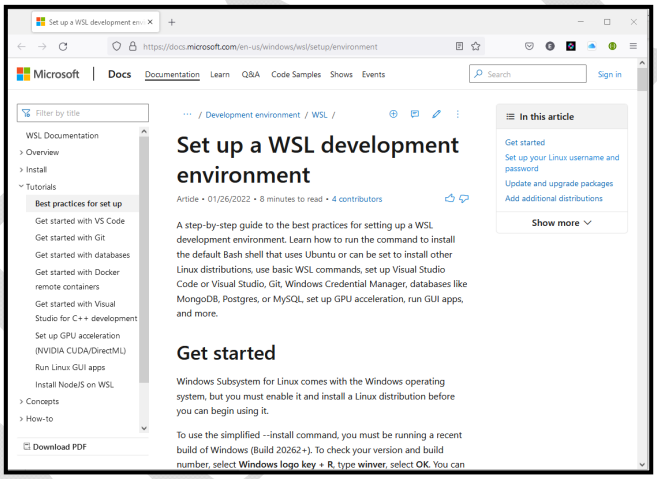


Another example is shown here where a Windows VMWare© can be used to host a Windows image which has WSL configure in which a host Linux image is running with multiple Liberty *Designer* containers running.

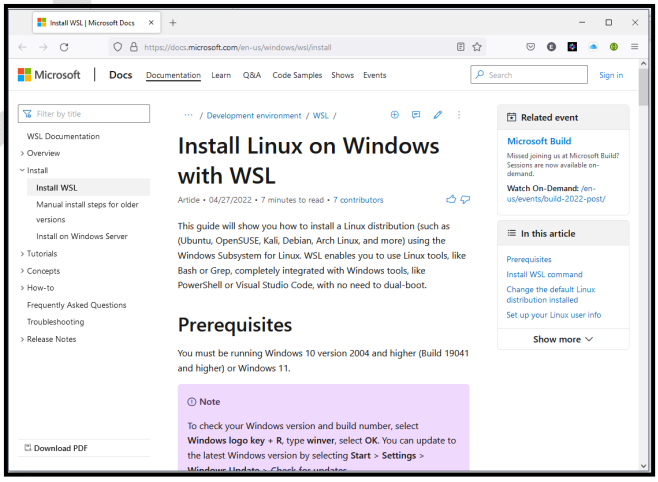


Setup required Windows Subsystems for Linux support

When running on Windows, the environment for the *Designer* containers required the enablement of *Windows Subsystem for Linux (WSL)*. WSL was configured using the instructions at URL https://docs.microsoft.com/en-us/windows/wsl/setup/enviroment were followed.



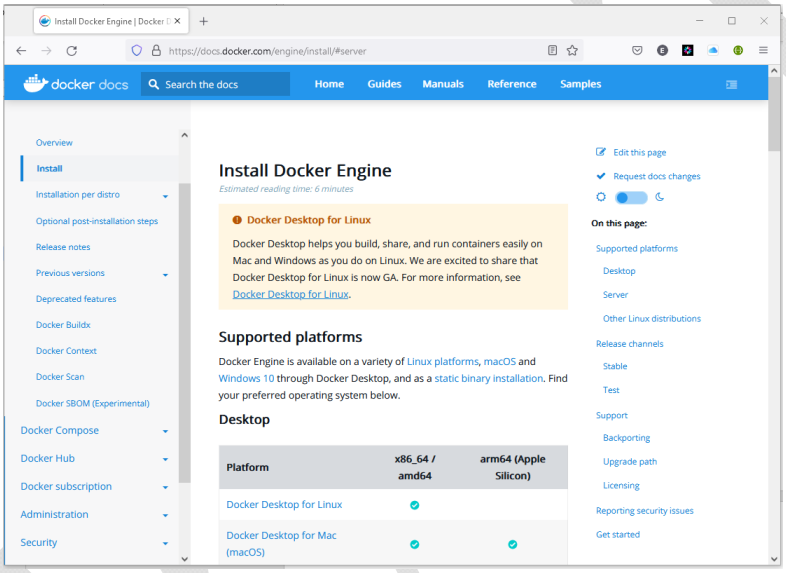
A Linux distribution can be installed following the instructions at URL https://docs.microsoft.com/en-us/windows/wsl/install



Once the host Linux distribution is installed, a container runtime product is required. The z/OS Connect product documentation refers to using *Docker Desktop* and other products. Know that the *Docker Desktop* is a licensed product with yearly cost per license. If the license cost are not issue then by all means, follow the product documentation, and use *Docker Desktop*. But for our purposes, *Docker Desktop* was not an option and z/OS *Connect Designer* containers for this exercise run in containers support by products that do not require licenses, *Docker Engine* and *Podman.*

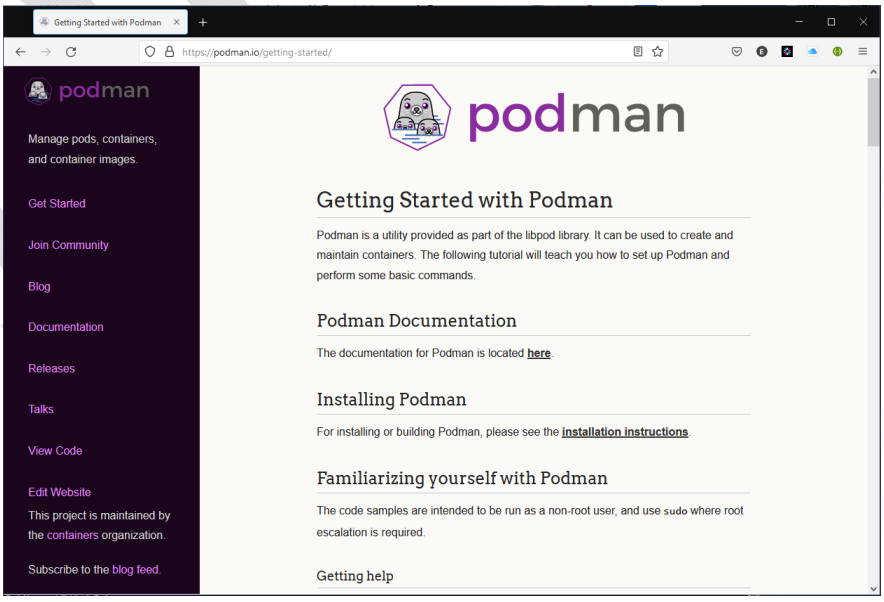
Docker Engine

As stated earlier, Docker Engine was used for this exercise since it does not require a license. Docker Engine was installed the host Linux image using the information at URL https://docs.docker.com/engine/install/#server



Podman

An alternative to using *Docker Engine* is to use *Podman* which also not require a license. *Podman* was installed in the host Linux image using the information at URL https://docs.docker.com/engine/install/#server



Mitch Johnson (mitchj@us.ibm.com)

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 CICS related environment variable be provided. These variables are used to customize the CICS 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:
            - 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
            - CICS_PORT=2446
            - HTTP_PORT=9080
        ports:
            - "9447:9443"
            - "9084:9080"
        volumes:
            - ./project:/workspace/project
            - ./logs/:/logs/
            - ./certs:/output/resources/security/
```

Connecting to a CICS region requires the addition of a zosconnect_cicsIpicConnection 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.

Connecting to a CICS region and the required server XML configuration

The *zosconnect_cicsIpicConnection* element used to connect to a CICS region in this exercise looks like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="IPIC connection to CICS">
    <featureManager>
        <feature>zosconnect:cics-1.0</feature>
    </featureManager>

    <zosconnect_cicsIpicConnection id="cicsConn"
        host="${CICS_HOST}"
        port="${CICS_PORT}"
        authDataRef="cicsCredentials" />

    <zosconnect_authData id="cicsCredentials"
        user="${CICS_USER}"
        password="${CICS_PASSWORD}" />

</server>
```

Notice the environment variables *${CICS_HOST}, ${CICS_PORT},${CICS_USER}* and *${CICS_PASSWORD}* are set to the values provided in the *docker-compose.yaml* file.

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.

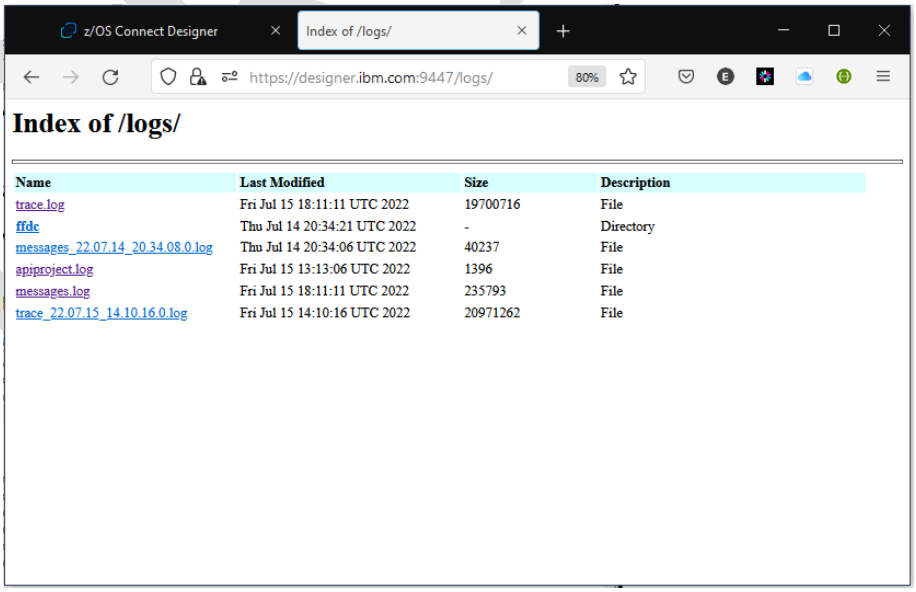
```
openapi: 3.0.0
info:
  description: "CICS Employee Sample VSAM Application"
  version: 1.0.0
  title: Employee
x-ibm-zcon-roles-allowed:
- Manager
paths:
  /employee:
    post:
-------------------------------------
  "/employee/{employee}":
    get:
      tags:
        - Employee
      operationId: getEmployeeSelectService
      x-ibm-zcon-roles-allowed:
        - Staff
-------------------------------------
    put:
      tags:
        - Employee
      operationId: putEmployeeUpdateService
      x-ibm-zcon-roles-allowed:
        - Staff
-------------------------------------
    delete:
      tags:
        - Employee
      operationId: putEmployeeUpdateService
      x-ibm-zcon-roles-allowed:
        - Staff

-------------------------------------
```

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.

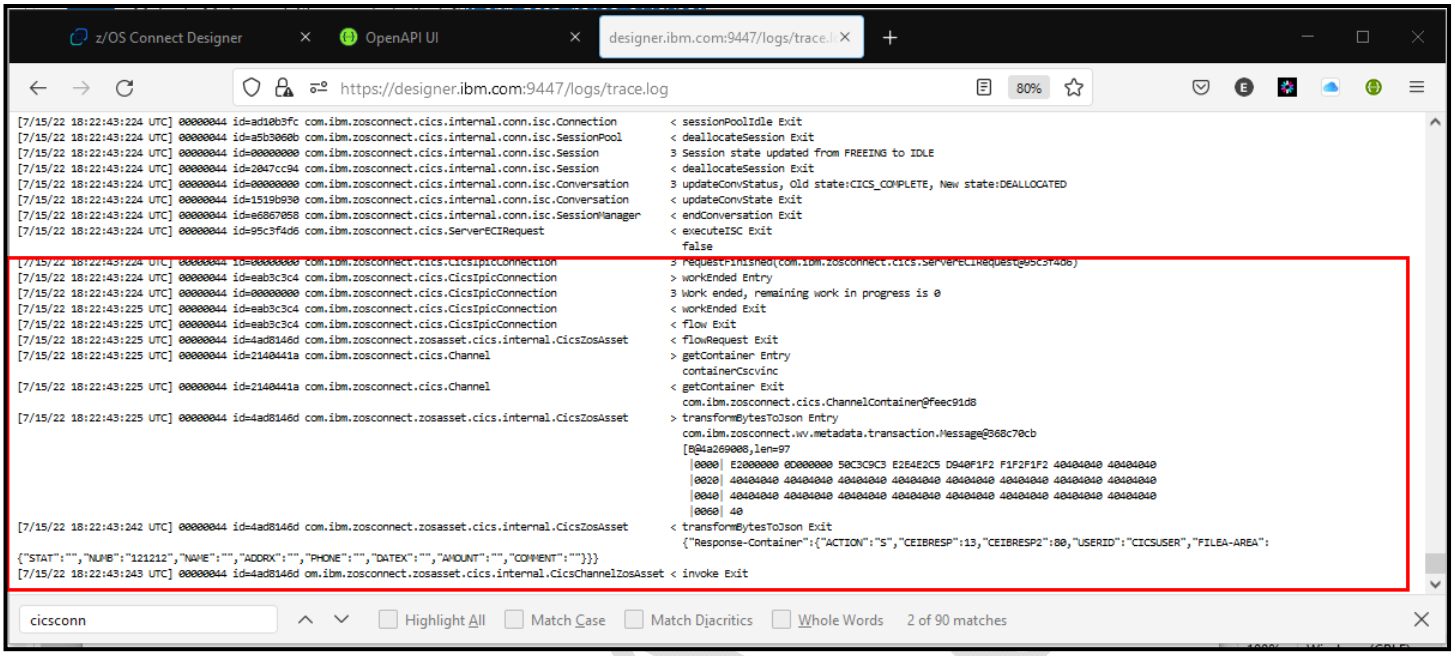
```
<?xml version="1.0" encoding="UTF-8"?>
<server description="Default server">
<webApplication id="resources-dropins" name="dropins"
   location="/opt/ibm/wlp/usr/servers/defaultServer/dropins">
    <web-ext context-root="dropins"
      enable-file-serving="true" enable-directory-browsing="true">
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



Mitch Johnson (mitchj@us.ibm.com)

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.



Mitch Johnson (mitchj@us.ibm.com)

Managing the z/OS Connect Designer container

Using Podman commands

The section explores the use of Podman and other commands when creating and administering *Designer* containers. They are provided more reference purposes since their execution is not required to complete the remainder of the exercise. That said, there is one set commands described here that can be used to 'refresh' a container or start over if you want to restart the API development process. These commands have been combined in a script file named *refreshPodmanContainer.* If anytime you wish to restart, open an Ubuntu terminal shell, and enter command ***refreshPodmanContainer employee.*** To open an Ubuntu terminal shell, click on the Ubuntu icon (see below) in the Windows task bar.

Creating a new container

___1. Access an *Ubuntu* terminal shell.

___2. Make new Linux directory for the container

mkdir /home/workstation/podman/sandbox

___3. Change location to the new directory

cd /home/workstation/podman/sandbox

___4. Make a configuration path

mkdir -p project/src/main/liberty/config

___5. Copy server XML configuration file from the Linux to the container's config directory

cp /mnt/c/z/openApi3/xml/* project/src/main/liberty/config

___6. Make the certs and logs subdirectories

mkdir certs

mkdir logs

___7. Copy the base docker-compose.yaml file into current directory

cp /mnt/c/z/openApi3/yaml/docker-compose.yaml .

___8. Edit docker-compose.yaml file and make the ports unique

sed -i "s/9080:9080/9084:9080/" docker-compose.yaml

sed -i "s/9443:9443/9447:9443/" docker-compose.yaml

___9. Start the container

podman-compose up -d

___10. Copy server XML override files from Linux into a container's configuration directory

podman cp /mnt/c/z/openApi3/xml/. sandbox_zosConnect_1:/config/configDropins/overrides

Tech-Tip: The above commands can be placed in a script, e.g., *createPodmanContainer,* see below. Since this script has been placed in directory /home/workstation/bin and this directory has been added to the PATH environment variable, the script can be invoked in any directory by simply entering ***createPodmanContainer containerName httpPort httpsPort*** (where *containerName* is the name of the container without the *_zosConnect_1 suffix* and *httpPort* and *httpsPort* are the ports to be configured for HTTP and HTTPS connections to the container).

```
echo on
[ -z "$2" ] && HTTP_port=9080 || HTTP_port=$2
[ -z "$3" ] && HTTPS_port=9443 || HTTPS_port=$3
echo creating container "$1"_zosConnect_1 with HTTP_port="$HTTP_port" and
HTTPS_port="$HTTPS_port"
mkdir $containerHome/podman/"$1"
cd $containerHome/podman/"$1"
mkdir certs
mkdir logs
mkdir -p project/src/main/liberty/config
cp /mnt/c/z/openApi3/xml/* project/src/main/liberty/config
cp /mnt/c/z/openApi3/yaml/docker-compose.yaml .
sed -i "s/9080:9080/$HTTP_port:9080/" docker-compose.yaml
sed -i "s/9443:9443/$HTTPS_port:9443/" docker-compose.yaml
podman-compose up -d
podman cp /mnt/c/z/openApi3/xml/. "$1"_zosConnect_1:/config/configDropins/overrides
```

___11. Display the status of the active containers

podman ps

```
root:/home/workstation:> podman ps
CONTAINER ID   IMAGE                                        COMMAND                  CREATED             STATUS             PORTS
NAMES
0a53e5d3a7af   icr.io/zosconnect/ibm-zcon-designer:3.0.57   "/opt/ibm/helpers/ru…"   About an hour ago   Up About an hour   0.0.0.0:9086->9080/tcp,
:::9086->9080/tcp, 0.0.0.0:9449->9443/tcp, :::9449->9443/tcp
 cscvinc_zosConnect_1
```

Refresh an existing container

These set of commands can be used to restart the development of API.

____1. Stop the container

podman stop sandbox_zosConnect_1

____2. Remove the container

podman container rm sandbox_zosConnect_1

____3. Change to the host Linux directory of the container

cd /home/workstation/podman/sandbox

____4. Remove the existing *project* directory and all subdirectories (this is required to delete the previous API artifacts.

rm -r project/*

____5. Make a new *project* directory and *config* subdirectory

mkdir -p project/src/main/liberty/config

____6. Copy XML configuration files into the *config* subdirectory.

cp /mnt/c/z/openApi3/xml/* project/src/main/liberty/config

____7. Remove the container

podman rm sandbox_zosConnect_1

____8. Start the container

podman-compose up -d

____9. Copy the XML configuration files into the container's configuration *override*s directory

podman cp /mnt/c/z/openApi3/xml/. Sandbox_zosConnect_1:/config/configDropins/overrides

Tech-Tip: The above commands can be placed in a script, e.g., *refreshPodmanContainer,* see below. Since this script has been placed in directory /home/workstation/bin and this directory has been added to the PATH environment variable, the script can be invoked in any directory by simply entering ***refreshPodmanContainer containerName***
(Where *containerName* is the name of the container without the *_zosConnect_1 suffix*).

```
echo refreshing container "$1"_zosConnect_1
podman stop "$1"_zosConnect_1
podman container rm "$1"_zosConnect_1
cd $containerHome/podman/"$1"
rm -r project/*
mkdir -p project/src/main/liberty/config
cp /mnt/c/z/openApi3/xml/* project/src/main/liberty/config
podman rm "$1"_zosConnect_1
podman-compose up -d
podman cp /mnt/c/z/openApi3/xml/.
"$1"_zosConnect_1:/config/configDropins/overrides
```

Using Docker commands

Note, *Docker* commands are the same as *Podman* commands. Just replace the *podman* command with *docker*.

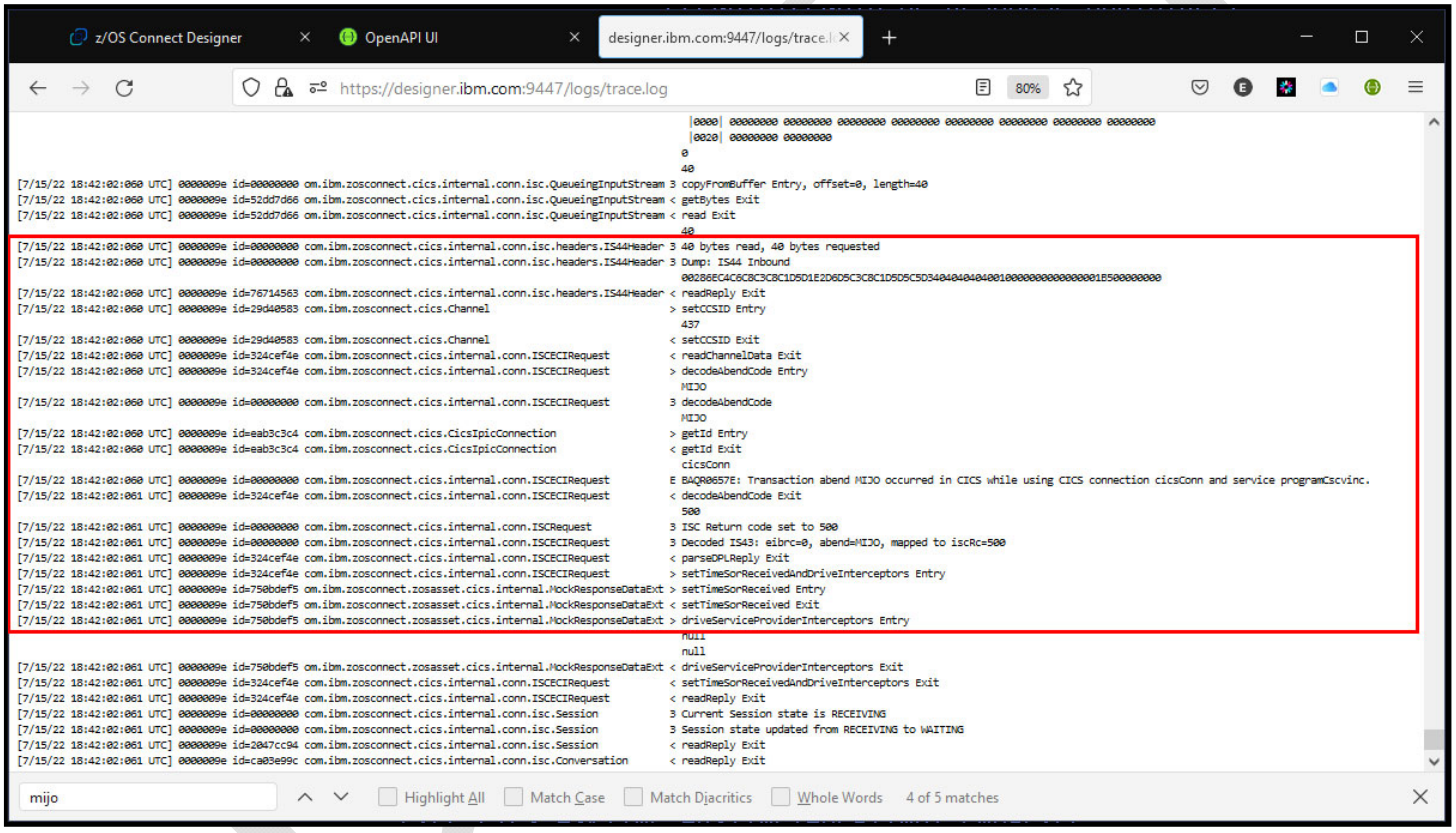
Mitch Johnson (mitchj@us.ibm.com)

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 500 with no EIB response code or identity. A review of the trace shows that the CICS transaction abended with an abend code of MIJO.

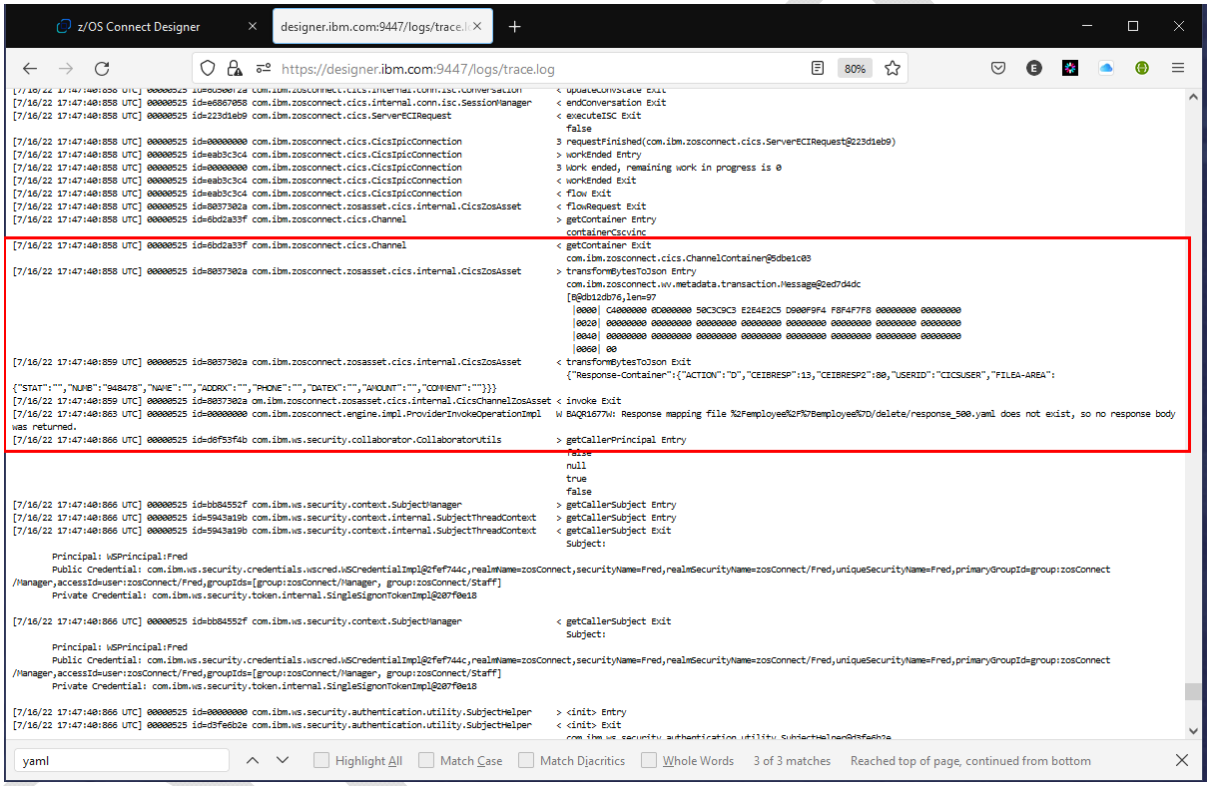


____2. Invoking a method returned an HTTP 500 with no other information, for example using the curl as shown below.

```
c:\z\openApi3>curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type:
application/json" --insecure --user Fred:fredpwd
https://designer.washington.ibm.com:9447/employee/948478
 - HTTP CODE 500
```

d

The trace showed a response came back from CICS with non-zero EIB response codes. But the mapping for this situation was not present, i.e., the *response_500.yaml* did not exist.



The point of this section is to use the *trace.log* and *messages.out* file when developing an API identify issues with the API and the interactions with the CICS region.

Developing a z/OS Connect APIs that accesses a CICS program

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

But before actually staring the exercise, let's do some container housekeeping.

a) *Open an Ubuntu terminal shell by clicking on the Ubuntu icon (see below) in the Windows task bar.*

b) *Switch to root authority by entering command **sudo su** and replying to the password prompt with root's password of **passw0rd**.*

c) *This exercise uses the cscvinc_zosConnect_1 container. Enter command **podman ps** to see a list of the active containers.*

d) *If this container does not appear in list, enter command **podman start cscvinc_zosConnect_1** to start this container.*

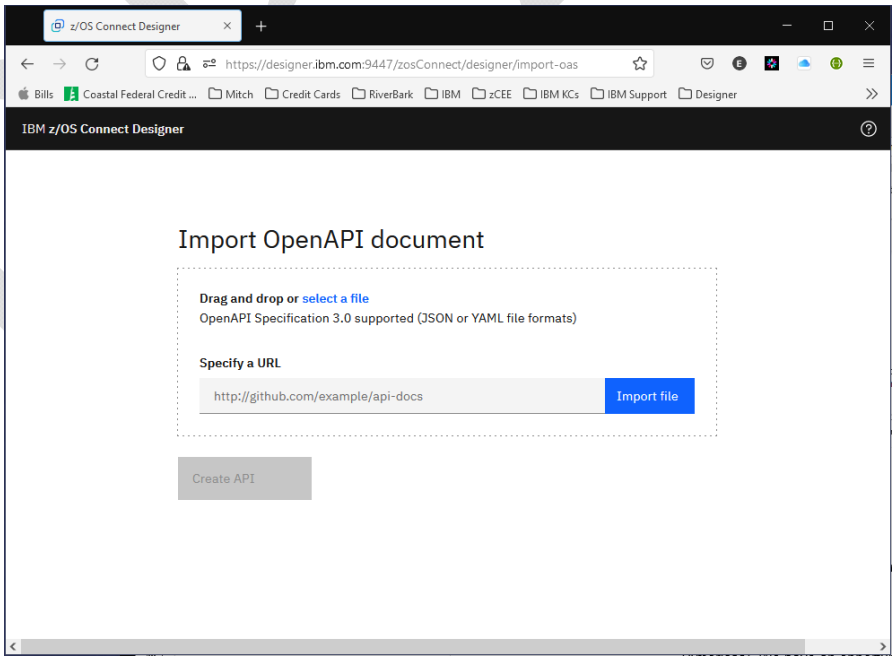
e) *Repeat the **podman ps** command and verify this command now appears in the list of active containers.*

```
CONTAINER ID   IMAGE                                          COMMAND                  CREATED       STATUS         PORTS
NAMES
27dcfdbc8760   icr.io/zosconnect/ibm-zcon-designer:3.0.58   "/opt/ibm/helpers/ru…"   11 days ago   Up 2 seconds   0.0.0.0:9086-
>9080/tcp, :::9086->9080/tcp, 0.0.0.0:9449->9443/tcp, :::9449->9443/tcp   employees_zosConnect_1
```

Container housekeeping is now complete.

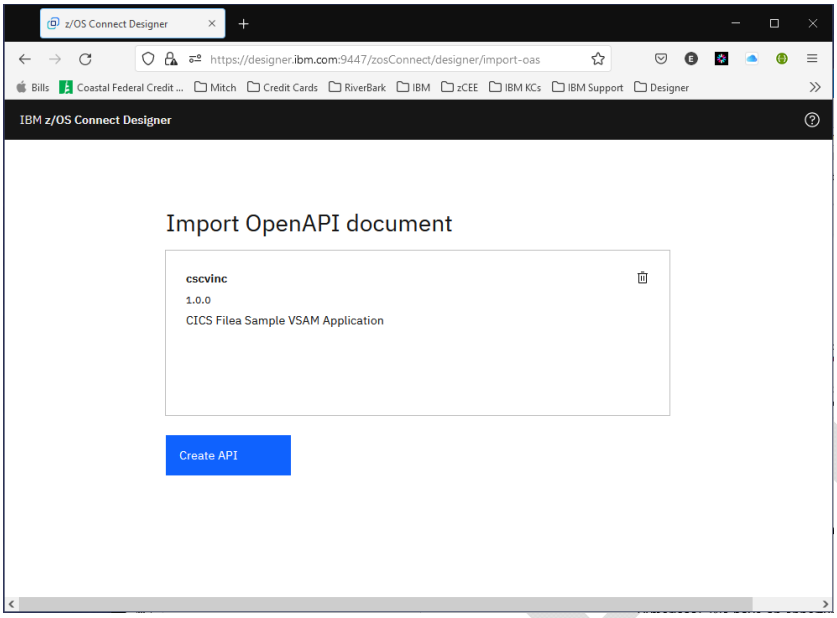
___1. Open the Firefox browser and go to URL ***https://designer.washington.ibm.com:9447/zosConnect/designer/***

___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 *cscvinc.yaml* and click the **Open** button to continue.

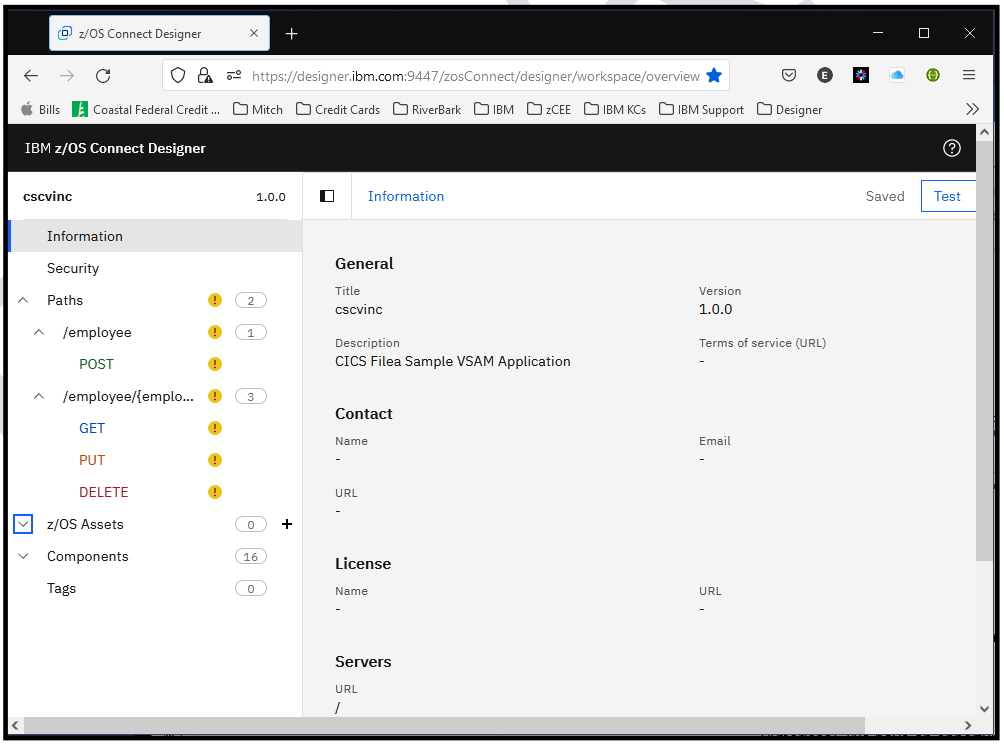


Mitch Johnson (mitchj@us.ibm.com)

___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 */employee* and */employee/{employee}* will display the *POST, GET, PUT* and *DELETE* methods associated with these URI paths (see below).

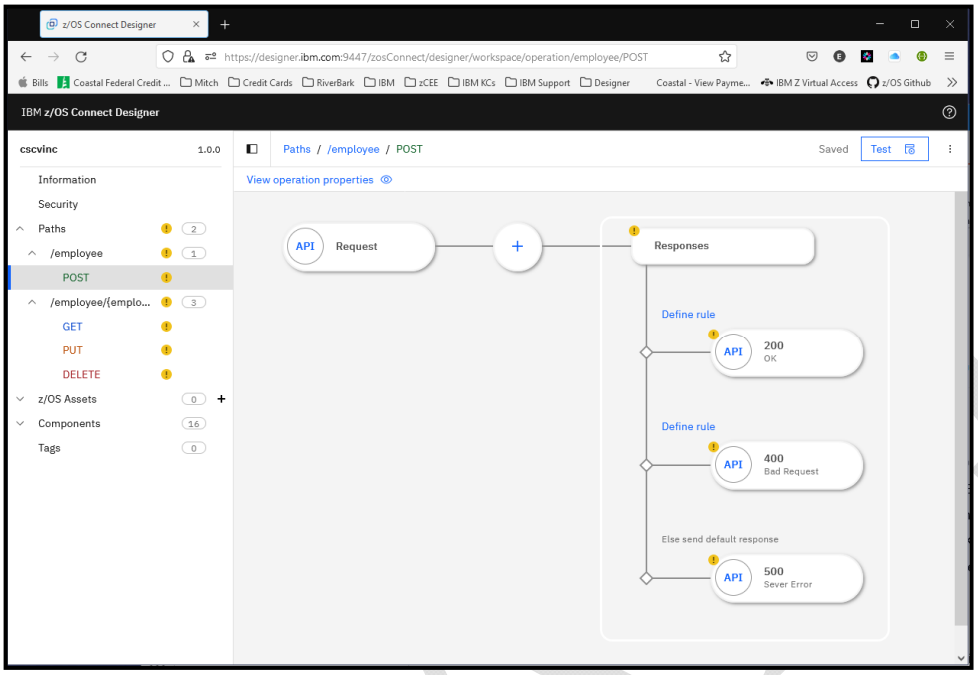


*Important: When using this tool, monitor the upper right-hand corner of the page. You will see either status of either **Saved** or **Saving**. It is suggested that you wait until changes are saved before continuing using the Designer.*

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.

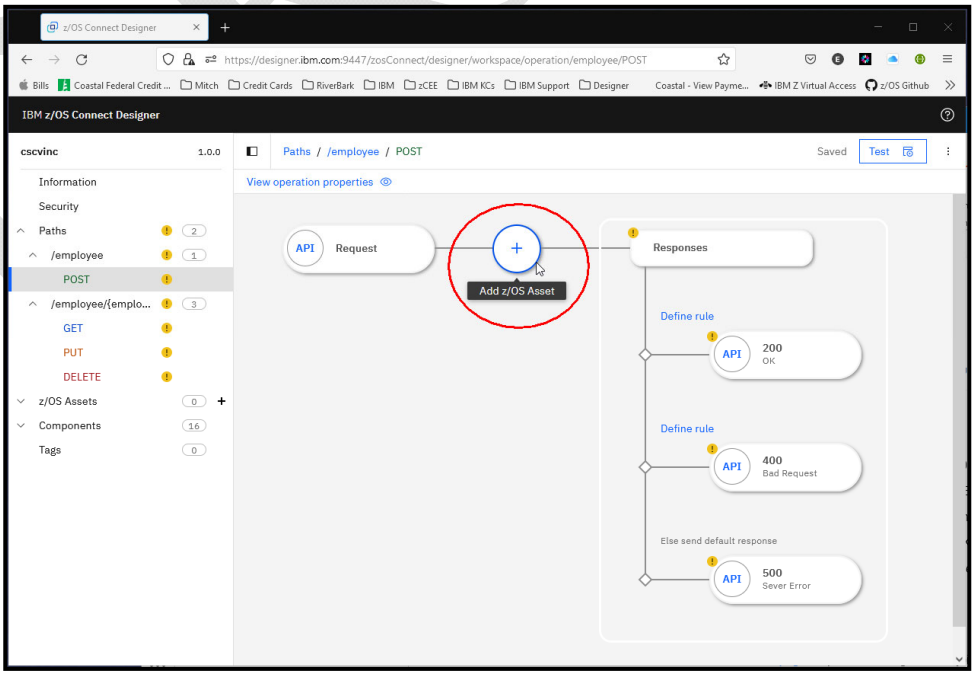
Configure the POST method for URI path /employee

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



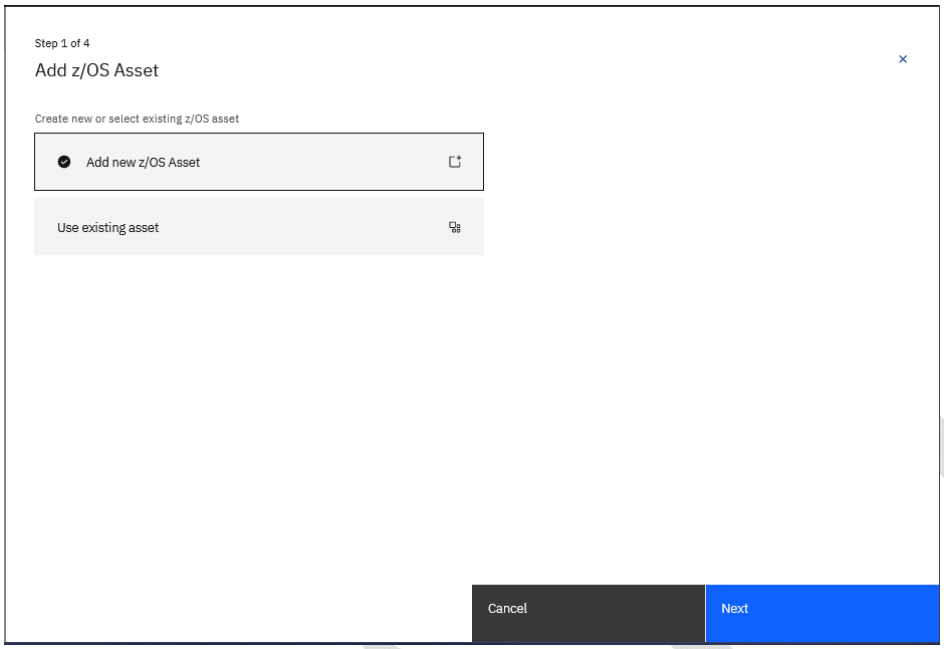
In the example above, we see that the specification document defined 3 responses for this method. One is a 200-status code which indicate the invocation of the method (an insert) was successful. A 400-status code which indicates, in this case, that the insert of the record failed. And finally, a 500-status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

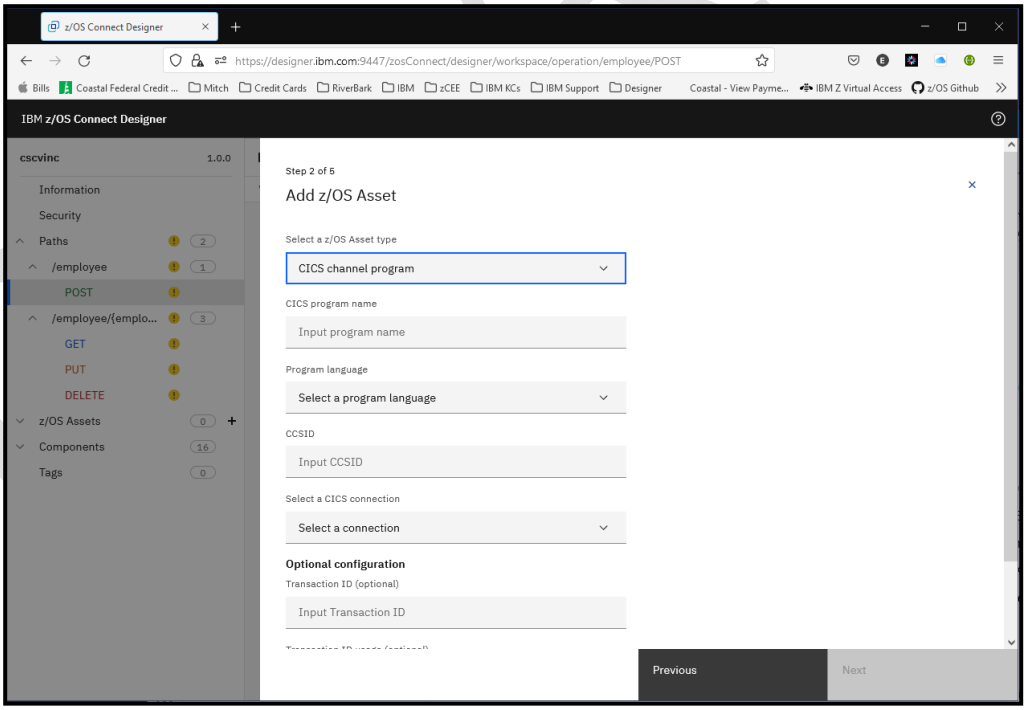


Mitch Johnson (mitchj@us.ibm.com)

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

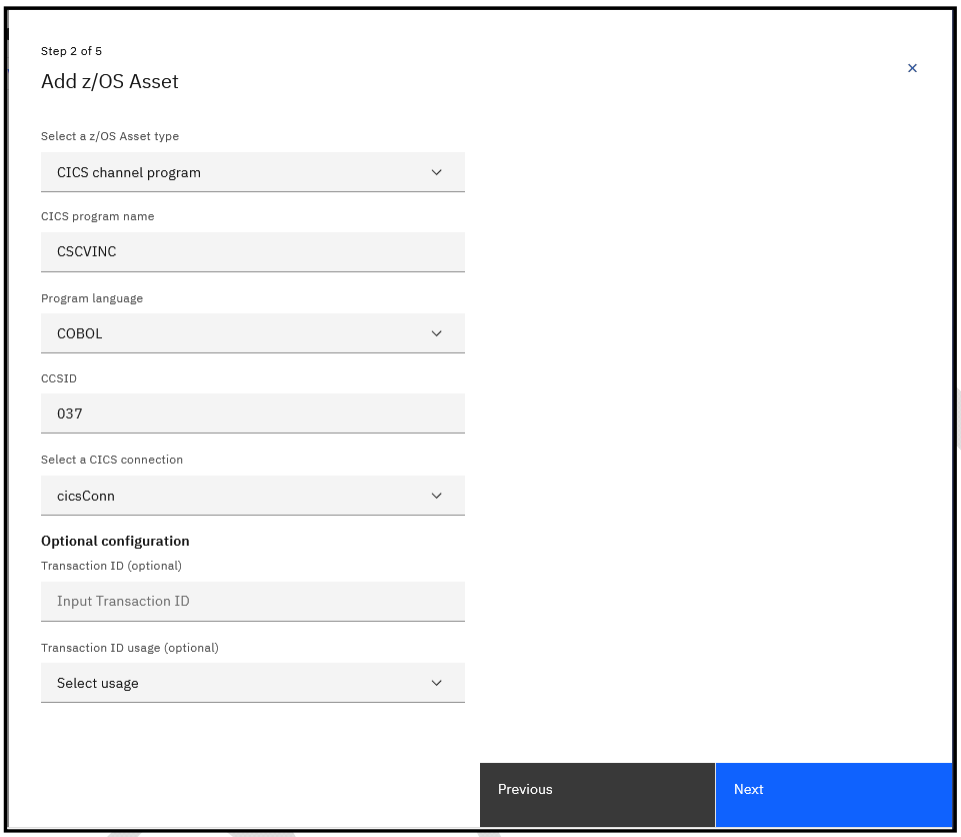


___4. On the *Add z/OS Asset (Step 2 of 4)* page, use the pull-down arrow and select *CICS channel program.* This action will display additional items on the page.



Mitch Johnson (mitchj@us.ibm.com)

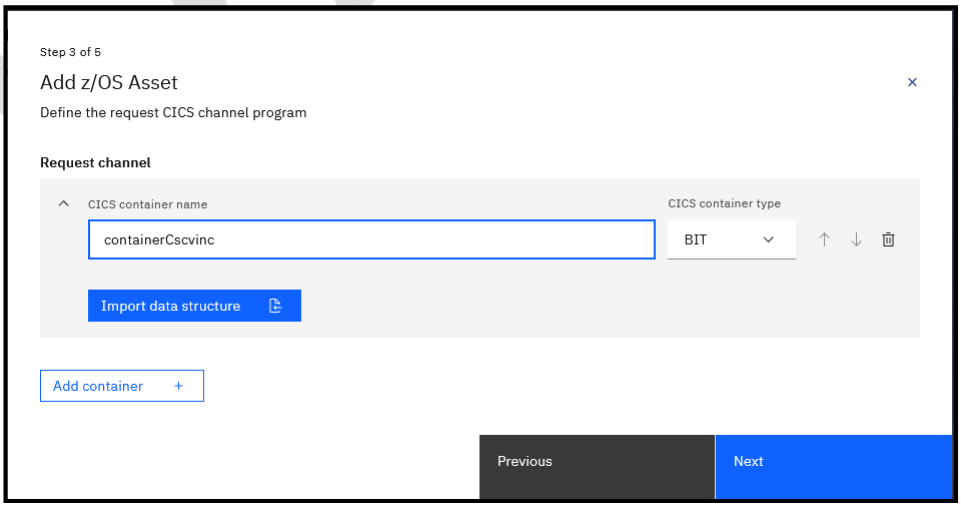
___5. On the *Add z/OS Asset (Step 2 of 5)* page, enter a *CICS program name* of ***CSCVINC***, use the pull-down arrow and select the ***COBOL*** as the *program language*. Enter ***037*** as the CCSID and use the pull-down arrow and select the ***cicsConn*** as the *CICS connection.* This enables the **Next** button. Press **Next** to continue.



Tech-Tip: The name ***cicsConn*** is the name of the *zosconnect cicsIpicConnection* configuration element described earlier in this exercise.

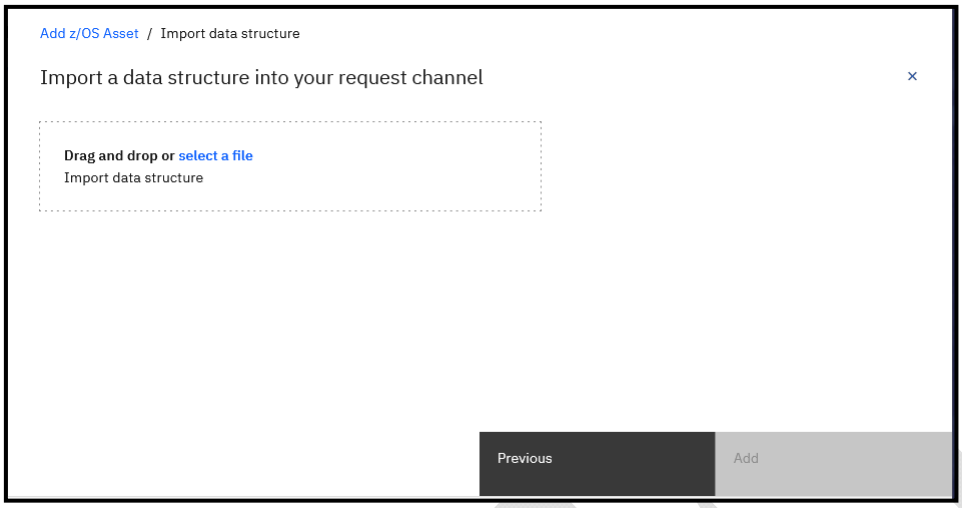
___6. On the *Add z/OS Asset (Step 3 of 5)* page, details of the request container will be provided. Press the **Add Container** button and enter a name of ***containerCscvinc*** for the *CICS container* name.

___7. Next press the **Import Data structure** to start the definition of the layout of this container.

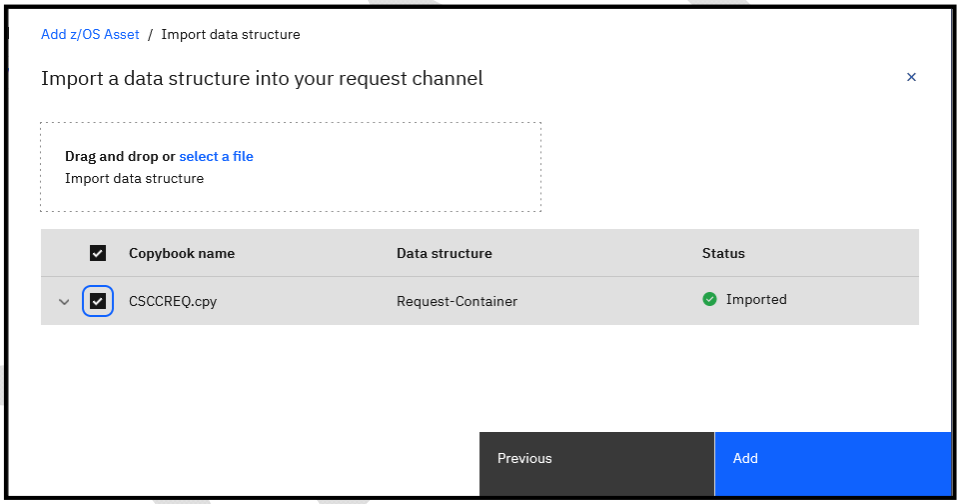


Mitch Johnson (mitchj@us.ibm.com)

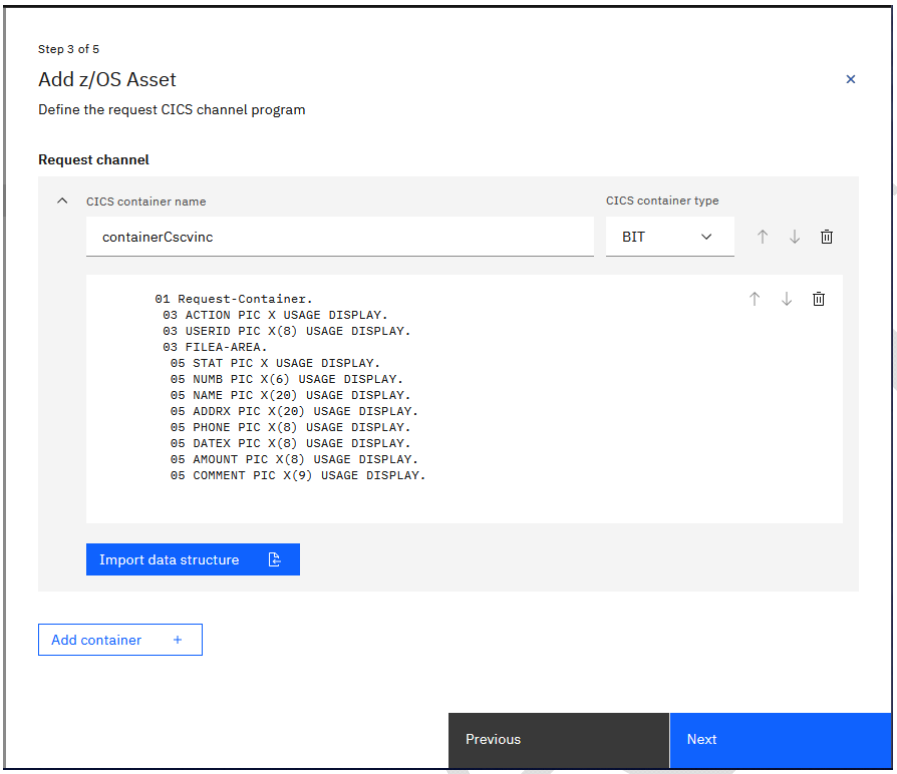
___8. On the *Add z/OS Asset / Import data structure* page, press the *select a file* area to start the import of the COBOL structure that represent the request container.



___9. Traverse to directory *c:/z/cicslab* and select file *CSCCREQ.cpy*. This file contains the COBOL source of the request container. Click the **Open** button to import the COBOL source into the *Designer*. Check the box beside *CSCCREQ.cpy* and click the **Add** button to continue.

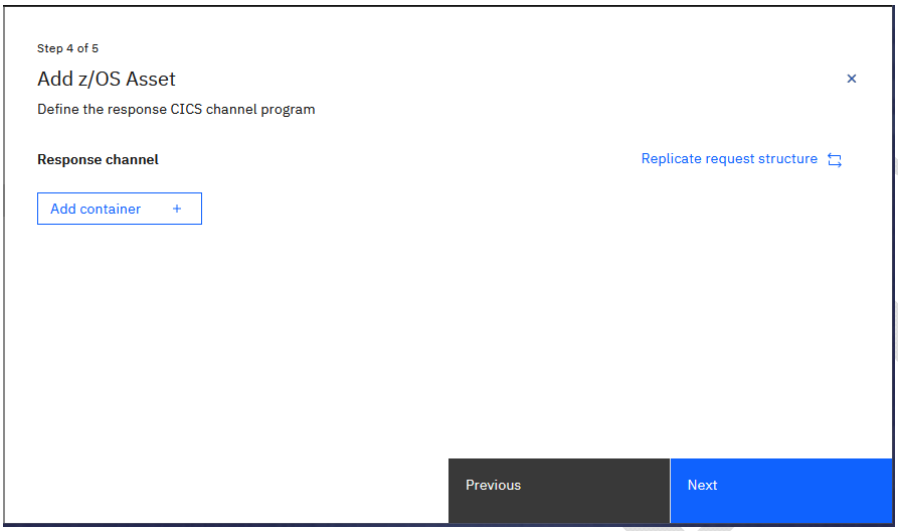


___10. On the *Add z/OS Asset (Step 3 of 6)* page, the COBOL structure of this container will be displayed (see below). Additional input or request containers be added by clicking the **Add container** button and repeating this process. Since this application expects only one input or request container, click the **Next** button to continue.

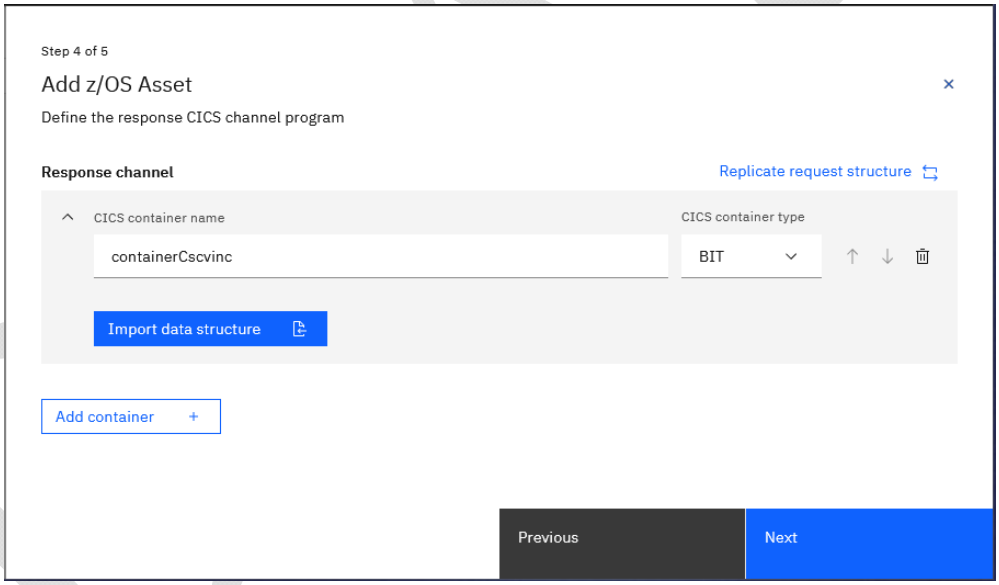


Mitch Johnson (mitchj@us.ibm.com)

___11. The response container is configured on the *Add z/OS Asset (Step 4 of 5)* page. If the response container that exactly matches the request container, then clicking the *Replicate request structure* will create a response container with the same details as the request container. In this case, the response contains does not match the request container, so click the **Add container** button to add the details of the response container.

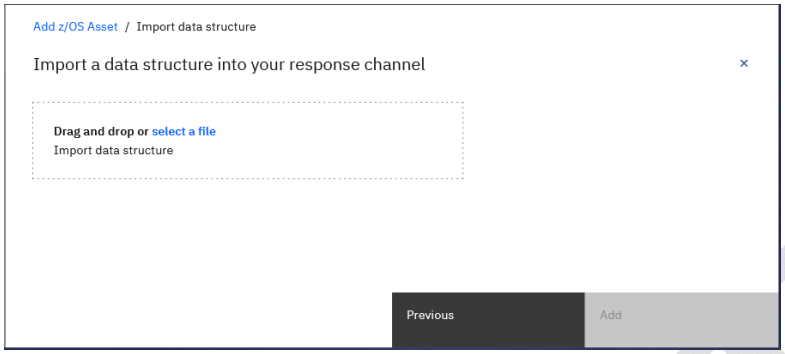


___12. This action will cause the **Import data structure** to appear. Enter ***containerCscvinc*** as the *CICS container name* (remember the application returns a response container using the same name are the request container). Click on the **Import data structure** button to import the layout of the response container.

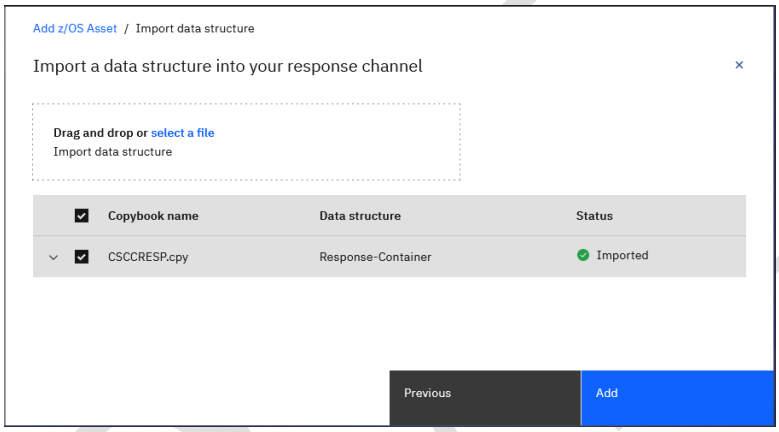


Mitch Johnson (mitchj@us.ibm.com)

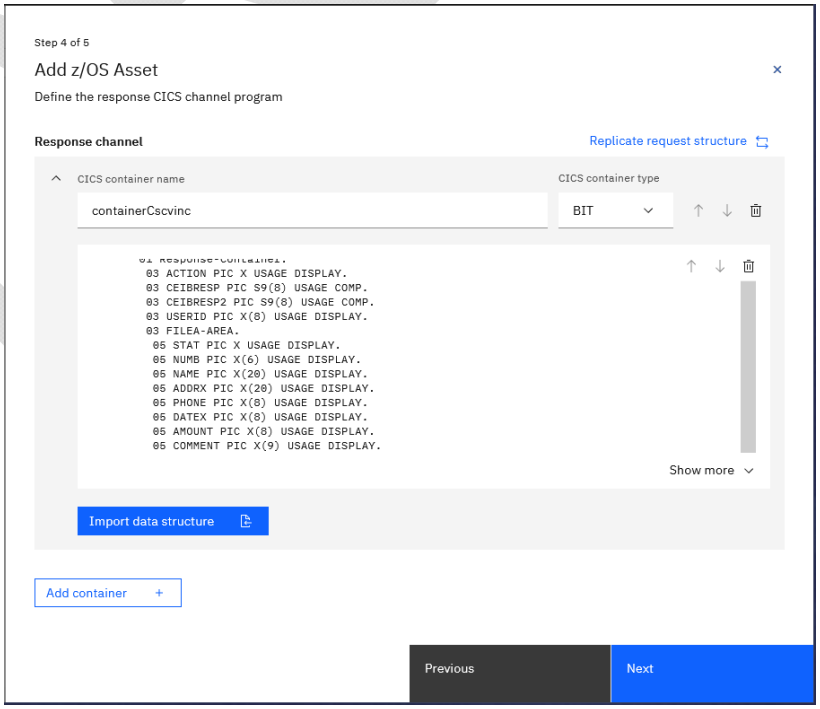
___13. On the *Add z/OS Assert/Import data structure* page. Click on the *select a file* area to continue.



___14. Traverse to directory *c:/z/cicslab* and select file *CSCCRESP.cpy* which contains the COBOL source of the response container. Click the **Open** button to import the COBOL source into the *Designer.* Check the box beside *CSCCRESP.cpy* and click the **Add** button to continue.

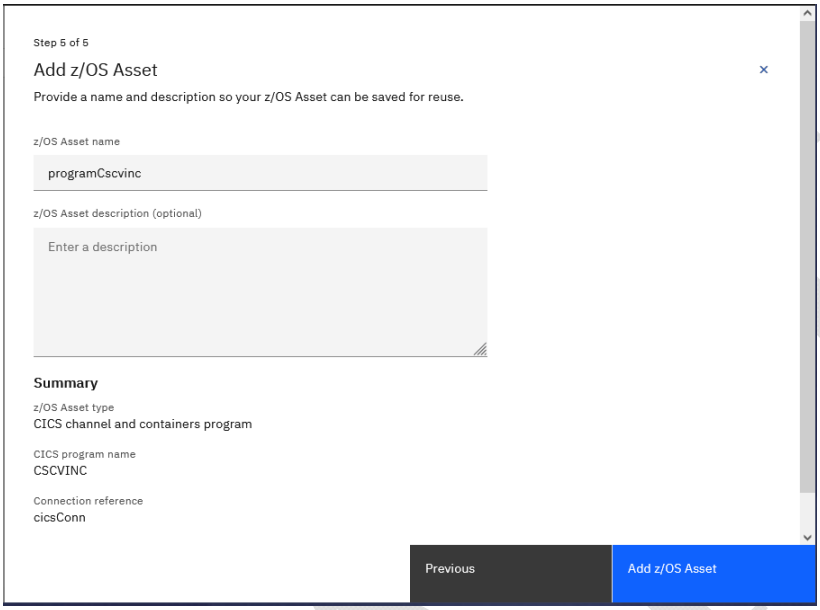


___15. On the *Add z/OS Asset (Step 4 of 5)* page, the COBOL structure of this container will be displayed (see below). Additional input or request containers be added by clicking the **Add container** button and repeating this process. This application only produces one response container, so click the **Next** button to continue.

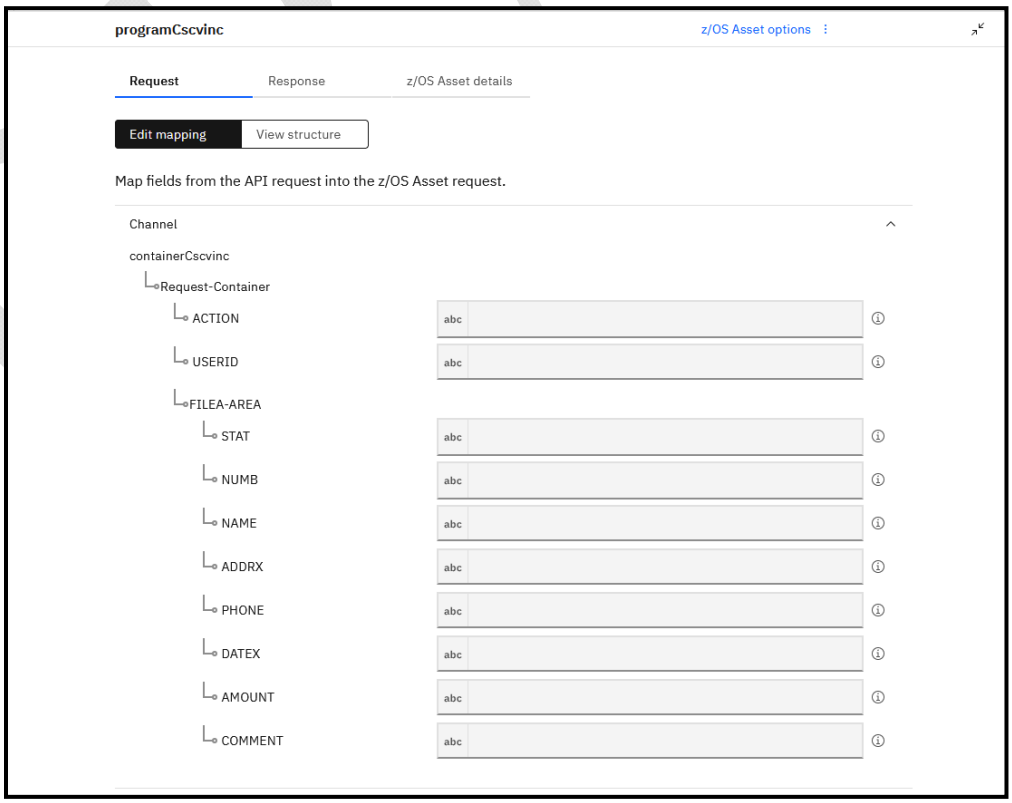


Mitch Johnson (mitchj@us.ibm.com)

___16. On the *Add z/OS Asset (Step 5 of 5)* page, we are required to provide a name and/or optionally provide a description of the z/OS asset. In this exercise, enter a value of ***programCscvinc*** as the name of the z/OS asset (a CICS application) and click the **Add z/OS Asset** button to complete the definition of this program as an asset and to continue.

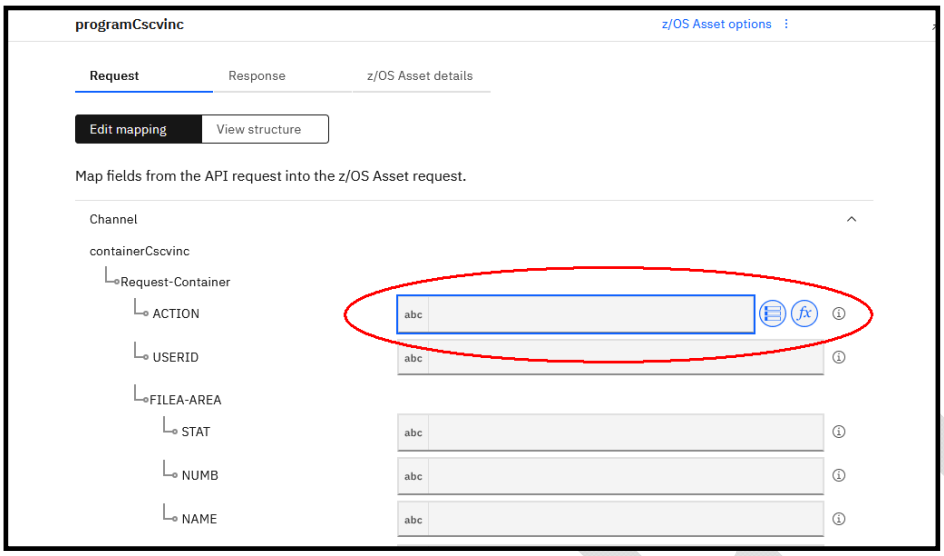


___17. Eventually you see a brief message that the asset has been added successfully and the operation properties page will reflect the z/OS asset request mapping details (see below). On this page we are seeing the field names of the CICS request container. These fields to the request schema properties of the API as defined in the specification document that defined the API.

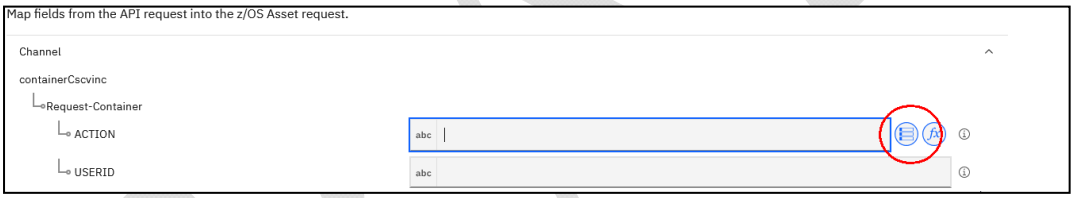


Mitch Johnson (mitchj@us.ibm.com)

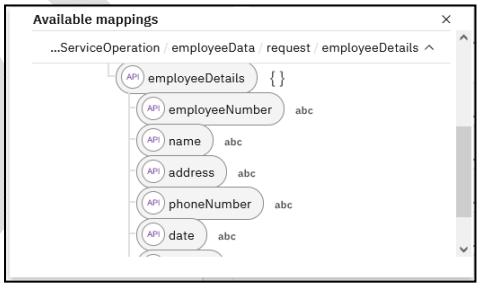
Note: It is very important that when working with mapping fields that the field has been properly selected. A properly selection field will be displayed in a blue box as shown below.



___18. Now map the CICS container 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).



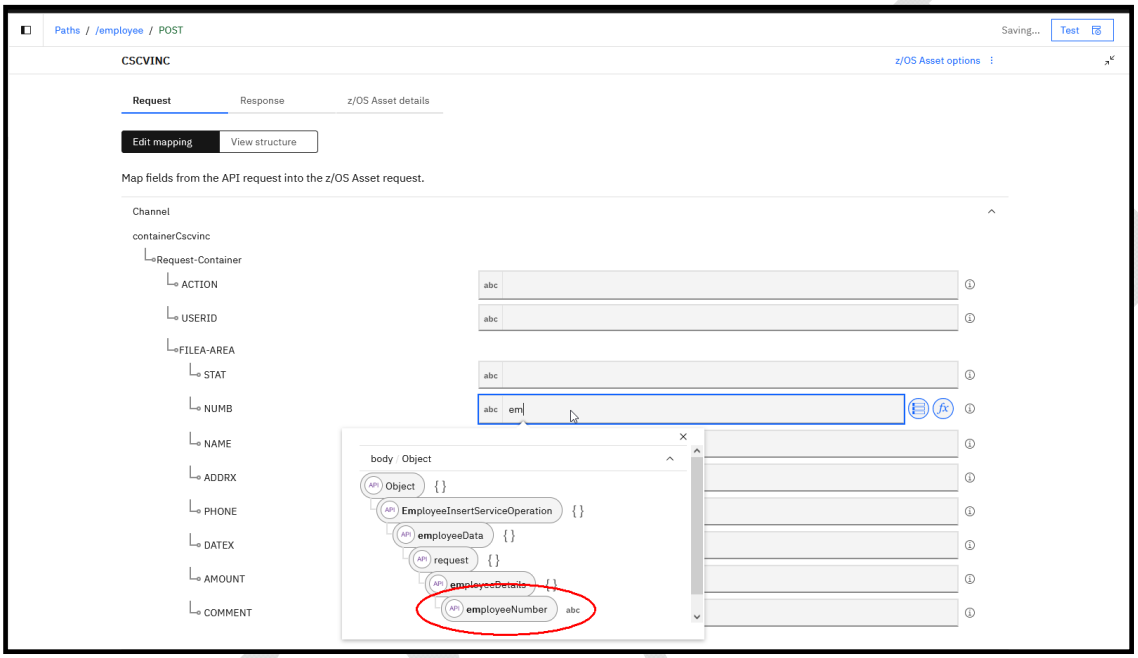
___19. This will display the header and body mappings available for this method of the API. Become familiar with the mappings available in the body of the request message (you will have to use the scroll bar to see all the available mappings). Knowledge of the mappings in the body will help greatly in the next few steps.



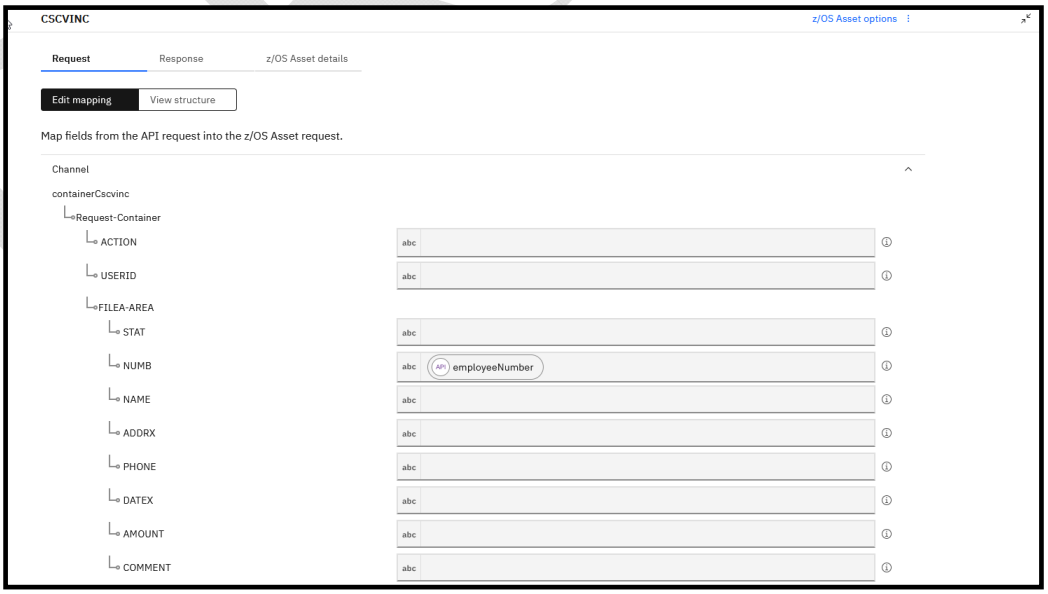
Mitch Johnson (mitchj@us.ibm.com)

There are two ways to map the CICS request container fields to 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.

___20. Select an empty CICS request container field and start typing the corresponding API request message field name. For example, entering the string ***em*** in the area beside NUMB 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).

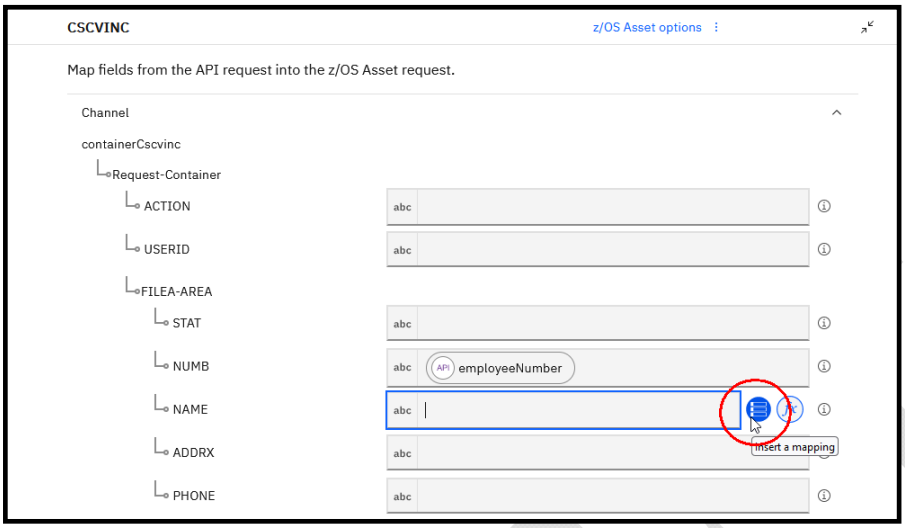


___21. Select the field and this will cause the API's request message field name to populate the area beside field name in the container area and complete the mapping.

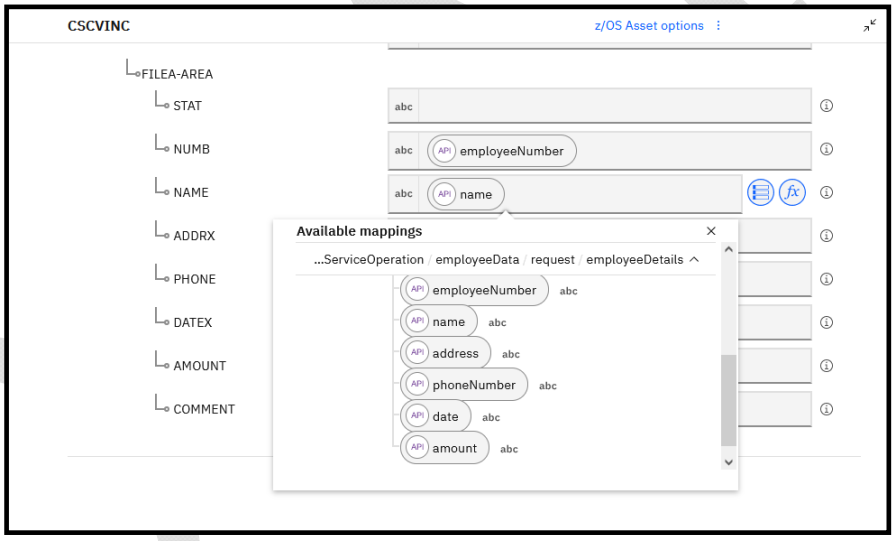


Tech-Tip: The icon ⤢ can be used to maximize or reset this area of the page.

___22. The alternate mapping method is to select the *Insert a mapping* tool (see below).

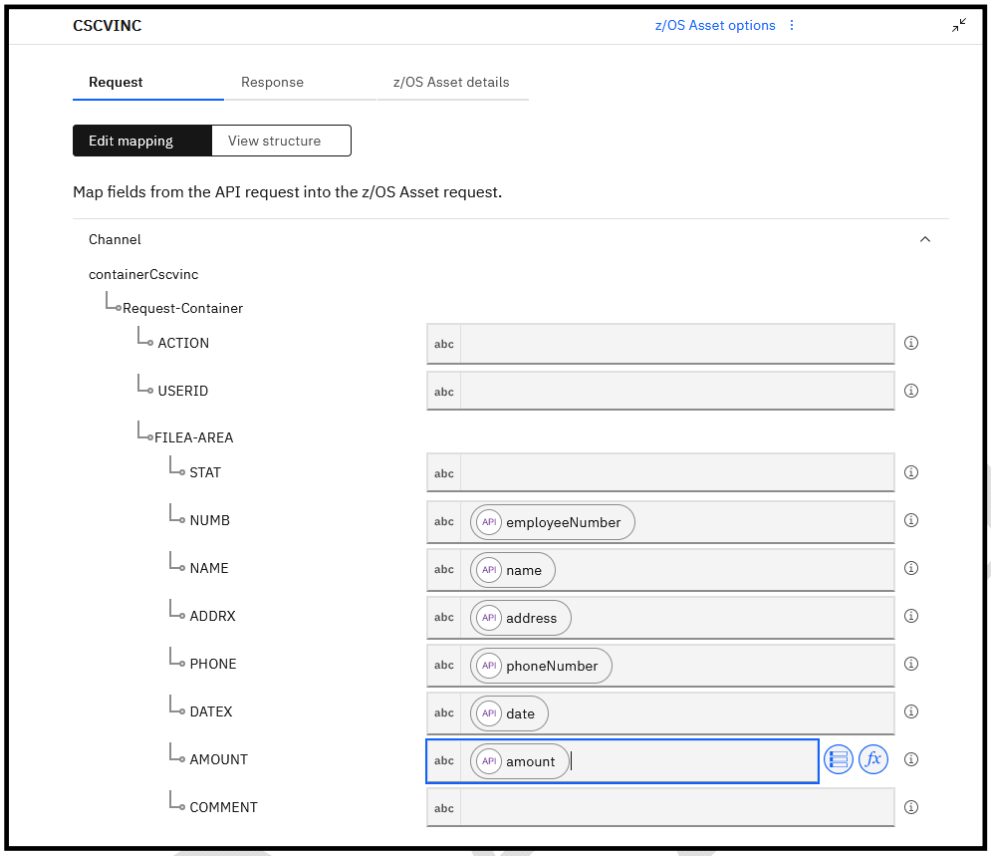


___23. This will display a list of available mapping fields. Since this is a request message and the fields are in the request *body*. Scroll up or down and choose appropriate field from the fields from the *body*, not a query parameter, nor a path parameter. In this case, the field to select is the request body *name* field.

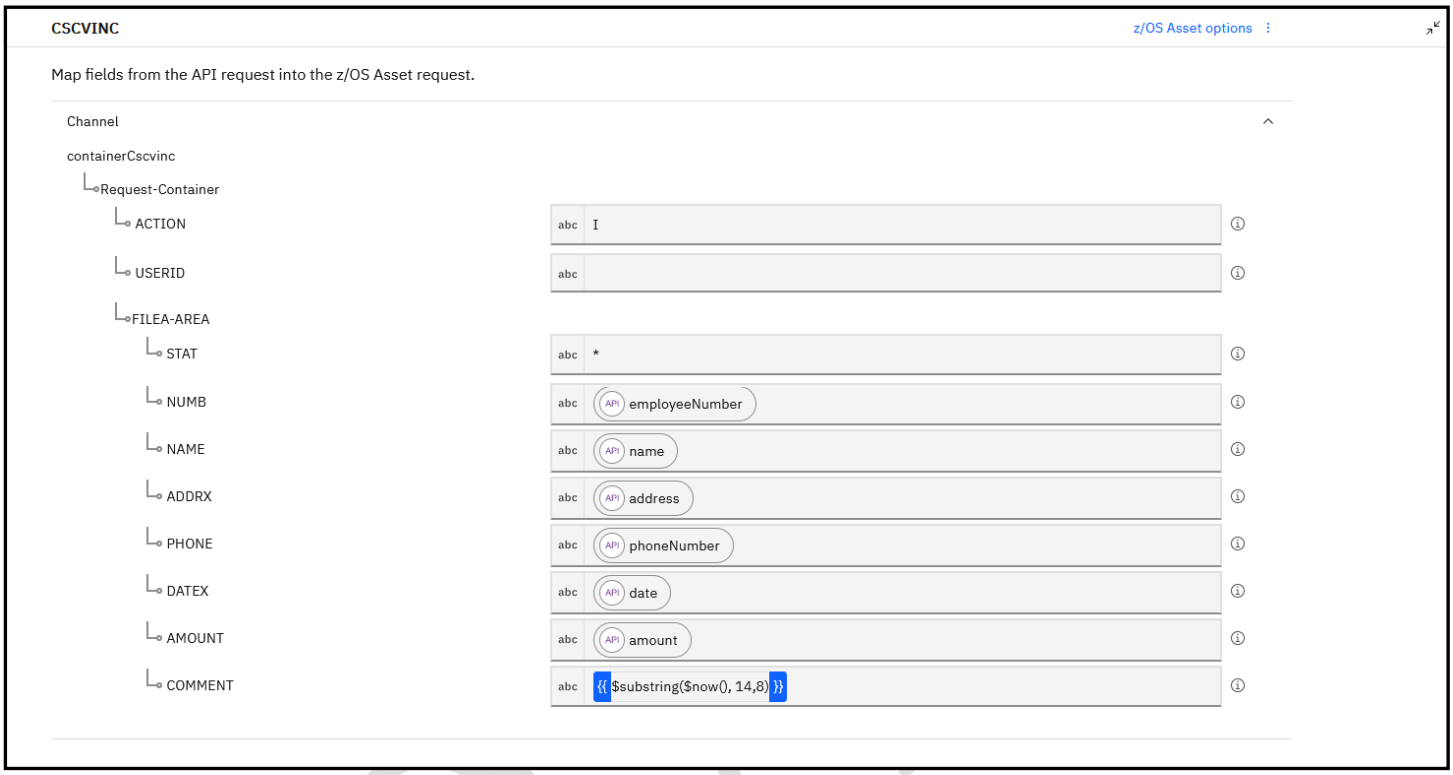


Mitch Johnson (mitchj@us.ibm.com)

___24. Use either technique to complete the mappings of the container fields to the API request body fields. When completed, the results should look something like this the page below.

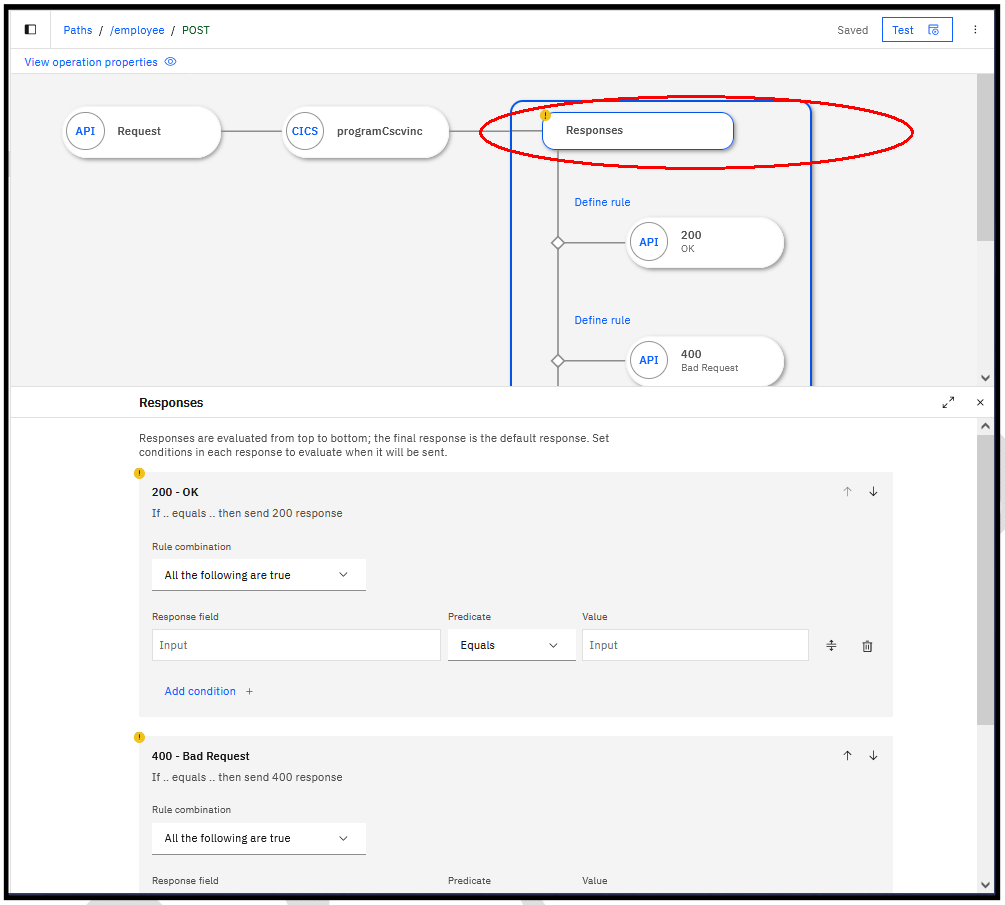


25. Note that not all of the container fields have been mapped from the API request message but by providing request message field names. For the *ACTION* field, the application requires that this field have a value of ***I*** in order for a record to be inserted in the VSAM data sets. The *USERID* is used by another client application and has no meaning for us, so leave this field blank. Set the value of the *STAT* field to an asterisk ***** and set the value of the *COMMENT* field to ***{{$substring($now(), 2,8)}}*** (the current date).



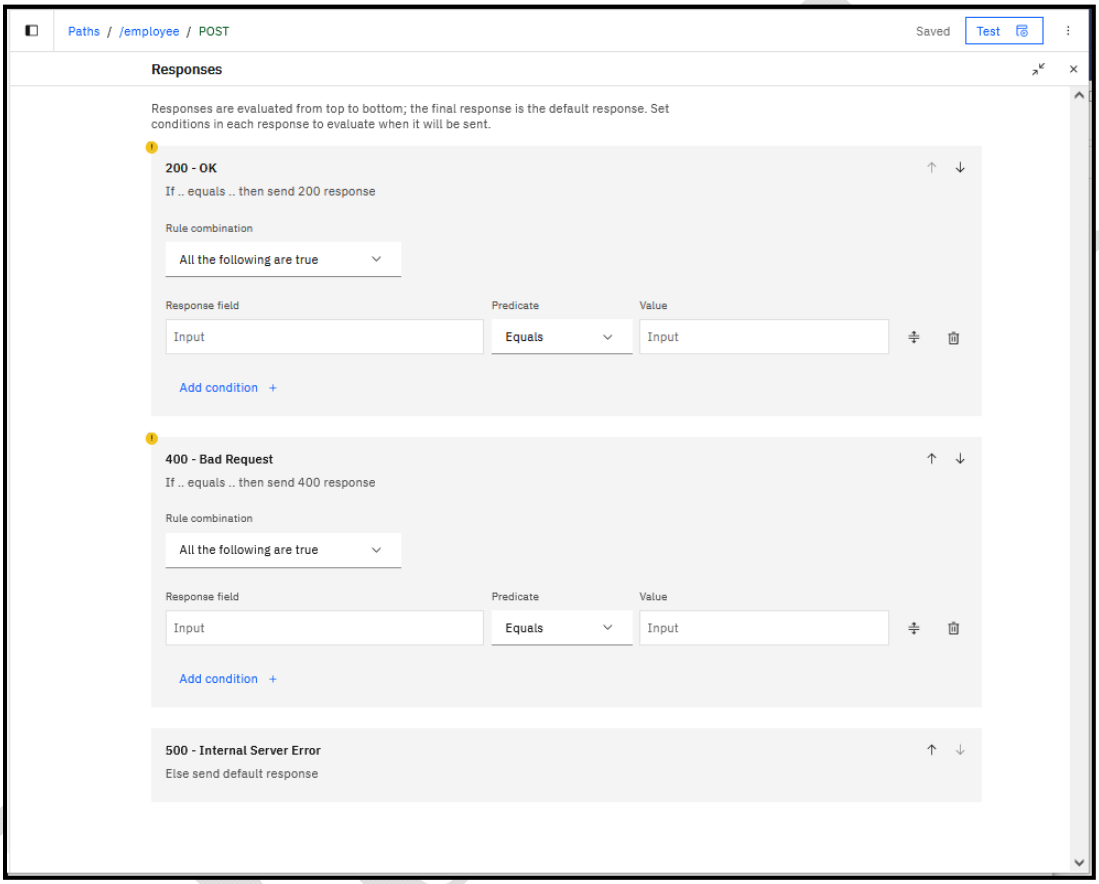
Mitch Johnson (mitchj@us.ibm.com)

___26. The next step is to evaluate the responses that come back in the CICS program response container. Select the *Responses* box in the *View operation properties* page.



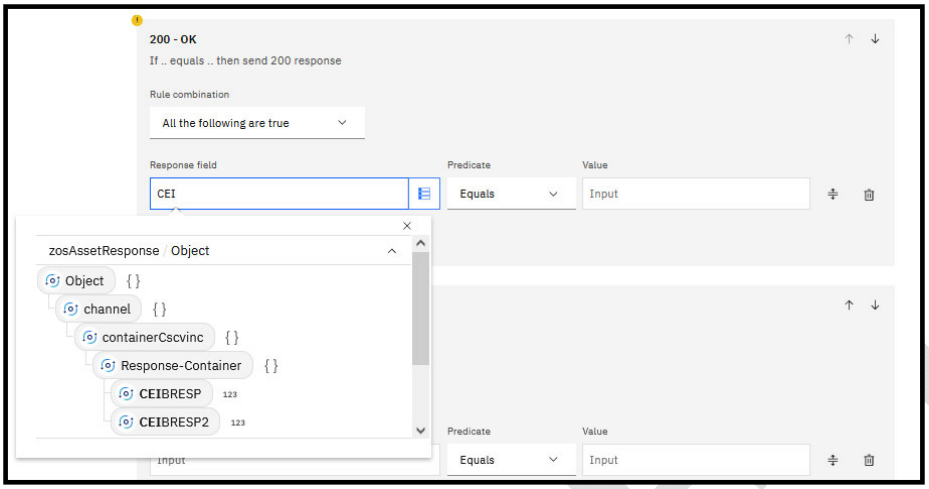
___27. Maximize the *Responses* area of the browser's page (see below).

The contents of the CEIBRESP and CEIBRESP2 fields in the CICS response container from the CICS application determine whether the request was successful or not. The first check is to see if the record was inserted as intended. The application will set the CEIBRESP and CEIBRESP2 fields to zero if a record was successfully insert into the VSAM data set. Otherwise, the insert failed. We are going to check and provide a message if a duplicate record condition (CEIBRESP = 14 and CEIBRESP2=150) was raised. Otherwise a message indicating a severe error has occurred along with the values of CEIBRESP and CEIBRESP2 fields.

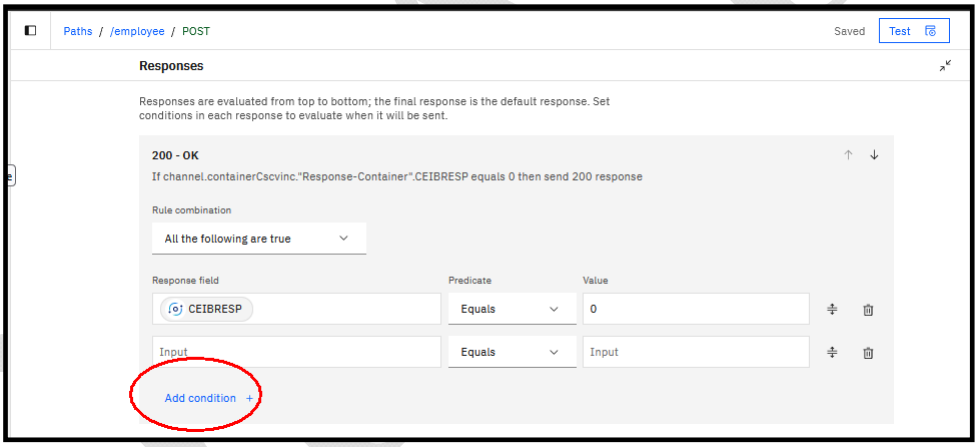


Mitch Johnson (mitchj@us.ibm.com)

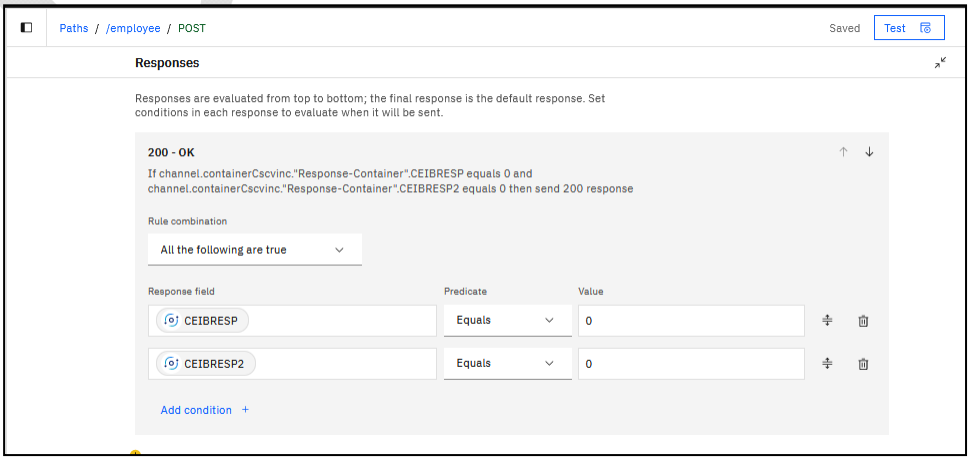
___28. Under the *200 – OK* response, Enter the string ***CEI*** in the *Input* area under *Response field*. This will display all the fields in the CICS response container which match this string (position of the string in the field name does not matter. If the string matches any portion of the field name, that field will be displayed. In this case, map or select the ***CEIBRESP*** field in the CICS response container. Leave the *Predicate* as *Equals* and enter ***0*** in the *Input* field for *Value*.



___29. Next add a condition check for the value of response container filed ***CEIBRESP2*** by clicking on *Add condition* in the *200 – OK* evaluation.



___30. Use the same technique described above to add a check for response container field ***CEIBRESP2***. Leave the *Predicate* as *Equals* and set the value to ***0*** as shown below:

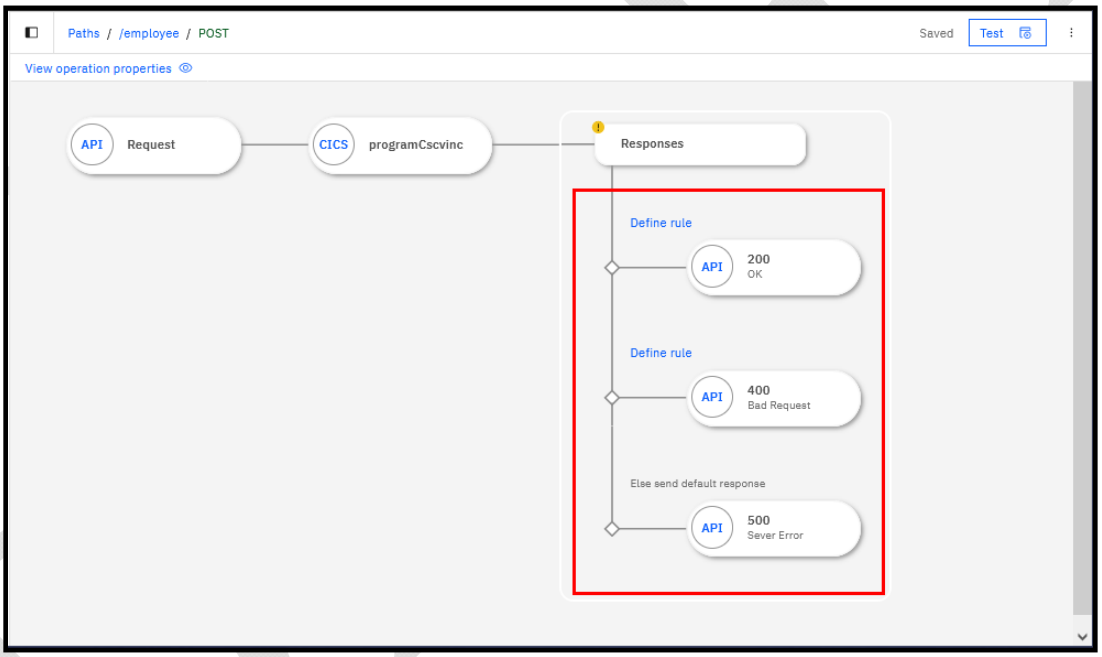


Mitch Johnson (mitchj@us.ibm.com)

___31. For the *400 – Bad Request* check, add a check for container field ***CEIBRESP*** equaling ***14*** and response container ***CEIBRESP2*** equaling ***150.***

___32. If neither of these connections are met, simply return with a HTTP 500 status code.

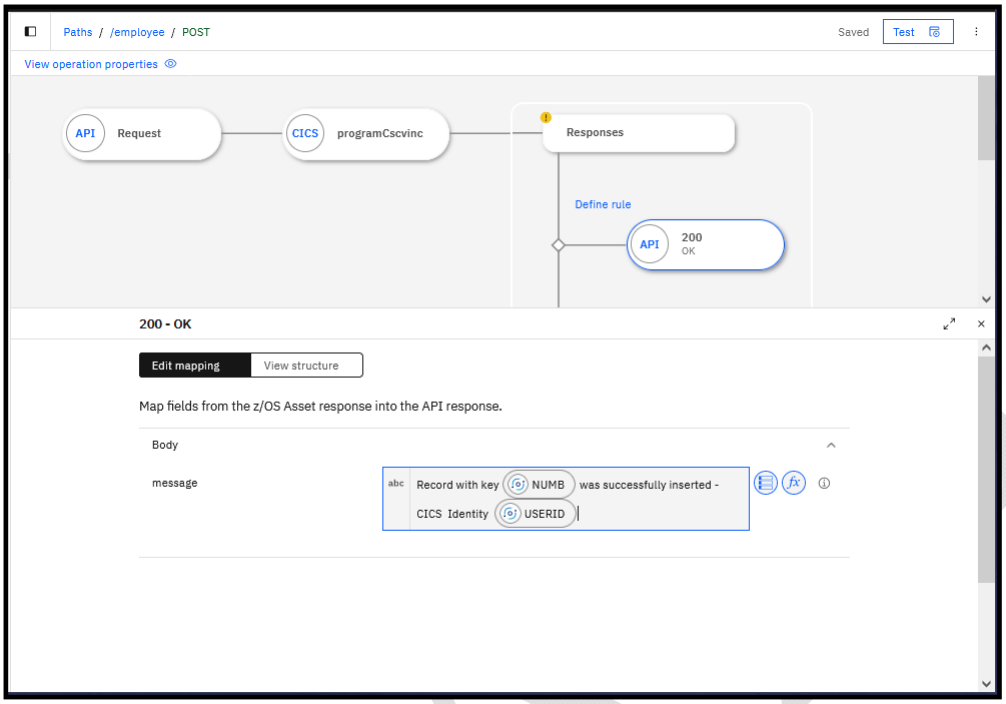
___33. Next the API response messages need to be configured for each of these potential status codes.



Mitch Johnson (mitchj@us.ibm.com)

___34. Select the response for *200 OK* paste the text below in the *message* area.

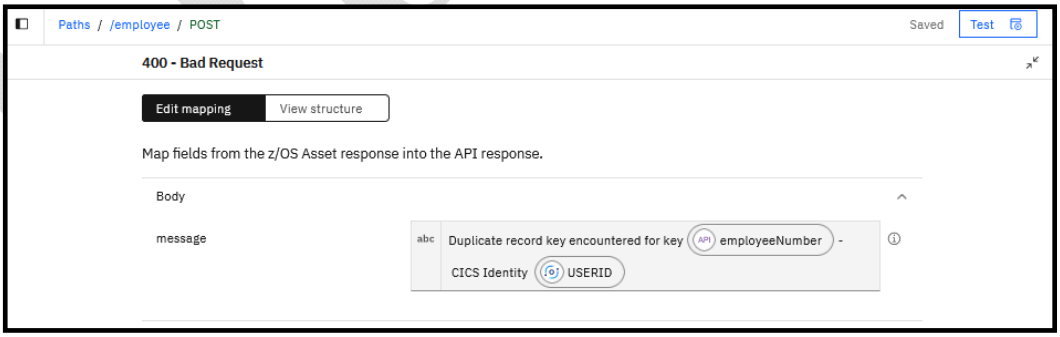
Record with key {{$zosAssetResponse.channel.containerCscvinc."Response-Container"."FILEA-AREA".NUMB}} was successfully inserted - CICS Identity {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}



The same techniques used to map API response with the CICS request container can be used to insert CICS response container fields 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 CICS response container

___35. Select the response for *400 Add failed* response mapping and paste the text below in the *message* area.

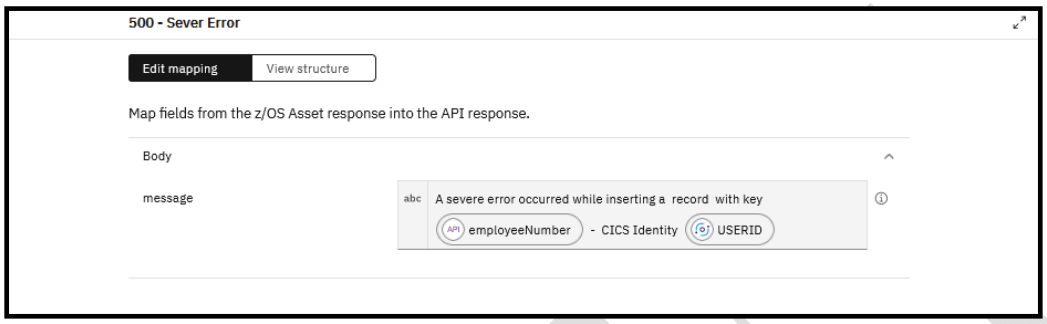
Duplicate record key encountered for key {{$apiRequest.body.EmployeeInsertServiceOperation.employeeData.request.employeeDetails.employeeNumber}} - CICS Identity {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}



Mitch Johnson (mitchj@us.ibm.com)

___36. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

A severe error occurred while inserting a record with key {{$zosAssetResponse.channel.containerCscvinc."Response-Container"."FILEA-AREA".NUMB}} - CICS Identity {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}} {{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP}}: {{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP2}}

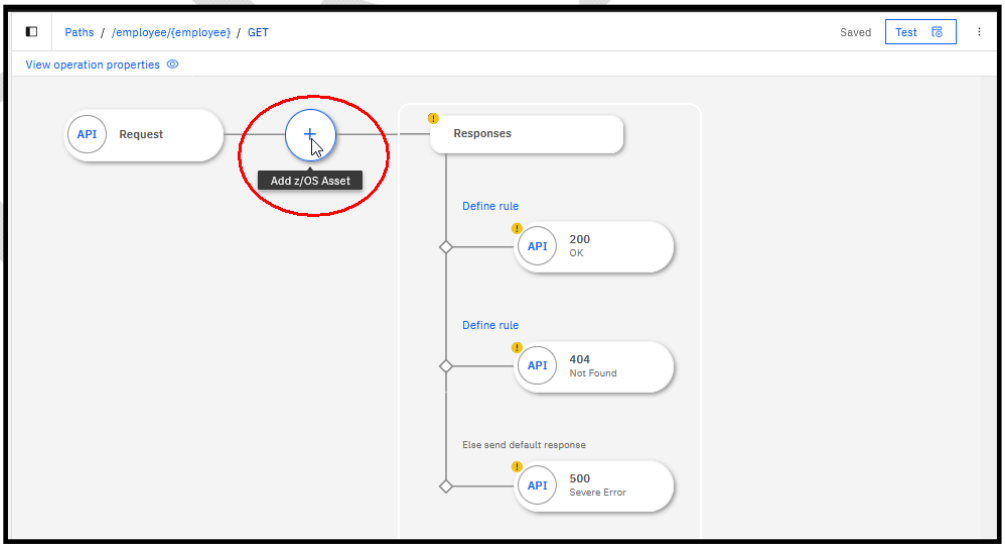


The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

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

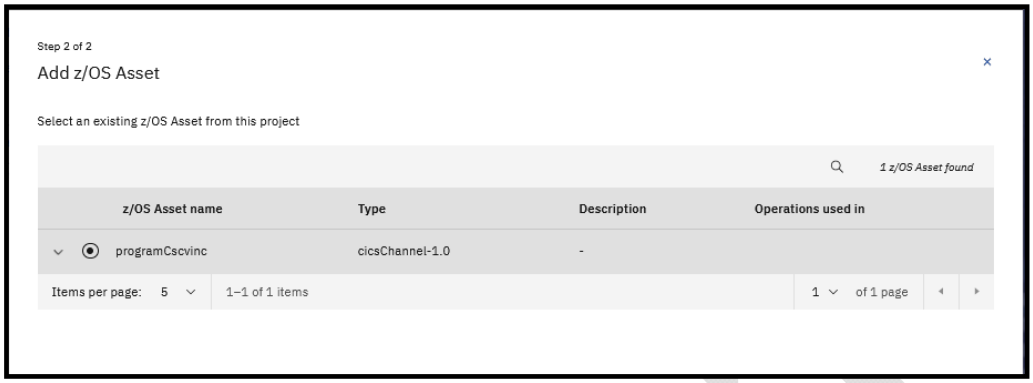
Now let's repeat the process and complete the configuration for the *GET* method of URI Path */employee/{employee}*

___1. Start by adding an existing z/OS Asset for CICS program *CSCVINC* to the GET method by using the same steps as performed before.

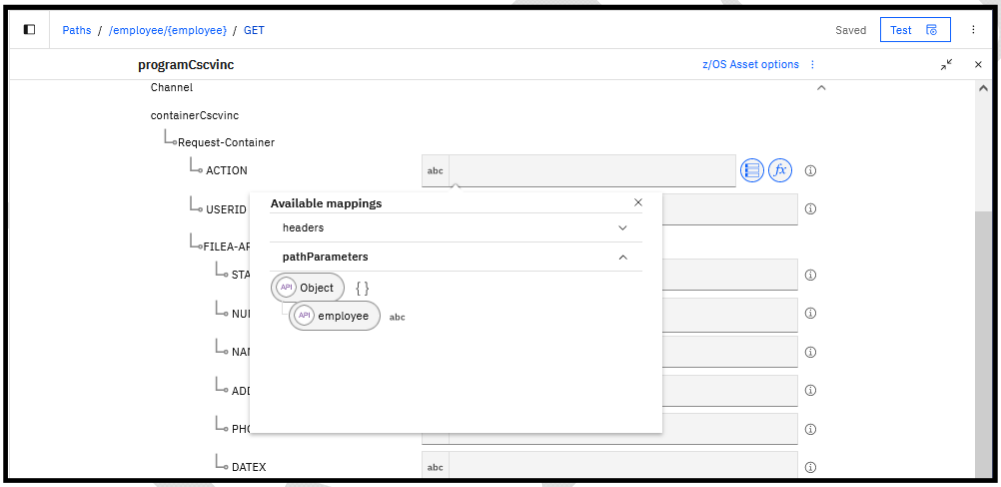


___2. On the *Step 1 of 2* page, select *Use existing asset* and click **Next**.

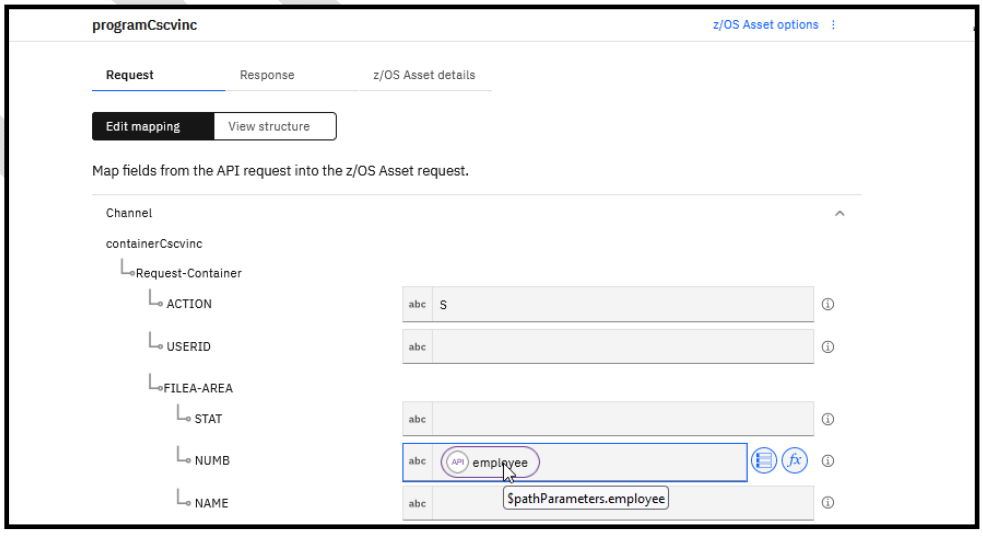
___3. On the *Step 2 of 2* page, select the radio button beside *programCSCVINC* and click the **Add z/OS Asset** button.



___4. Use the *Insert a mapping tool* to display the API request mapping for this method. Notice that there is no Body mapping. There is only mappings for headers properties and path parameters.



___5. So, the only mapping from the API request for this method is to map the path parameter *employee* to the container field *NUMB*. Use your preferred technique to do this mapping and set the value of *ACTION* to ***S***.

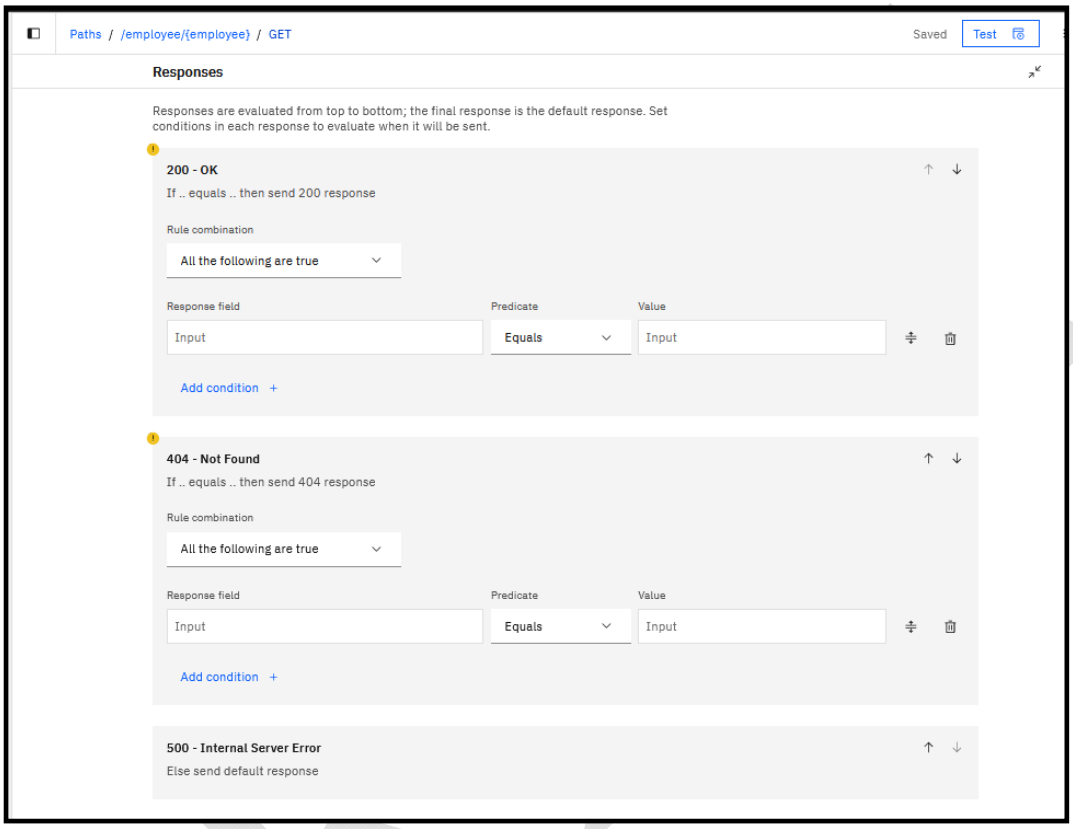


Mitch Johnson (mitchj@us.ibm.com)

___6. Maximize the *Responses* area of the browser's page (see below).

The contents of the *CEIBRESP* and *CEIBRESP2* fields in the CICS response container from the CICS application determine whether the request was successful or not. The first check is to see if the record was returned as intended. The application returns the values of the EIBRESP and EIBRESP2 from the EXECI CICS API in the container *CEIBRESP* and *CEIBRESP2* fields. Their values will be zero if a record was successfully read from the VSAM data set. Otherwise, the record did not exist, e.g., CEIBRESP=13 and CEIBRESP2=80 or some other error occurred will be returned.

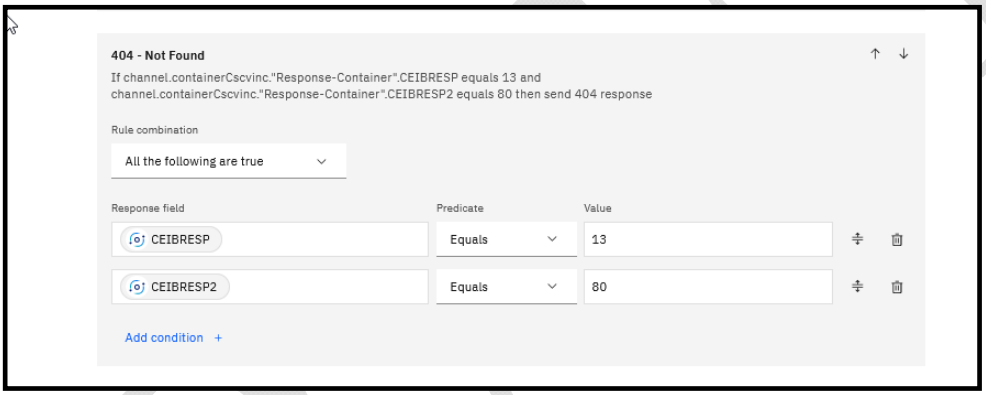
.



Mitch Johnson (mitchj@us.ibm.com)

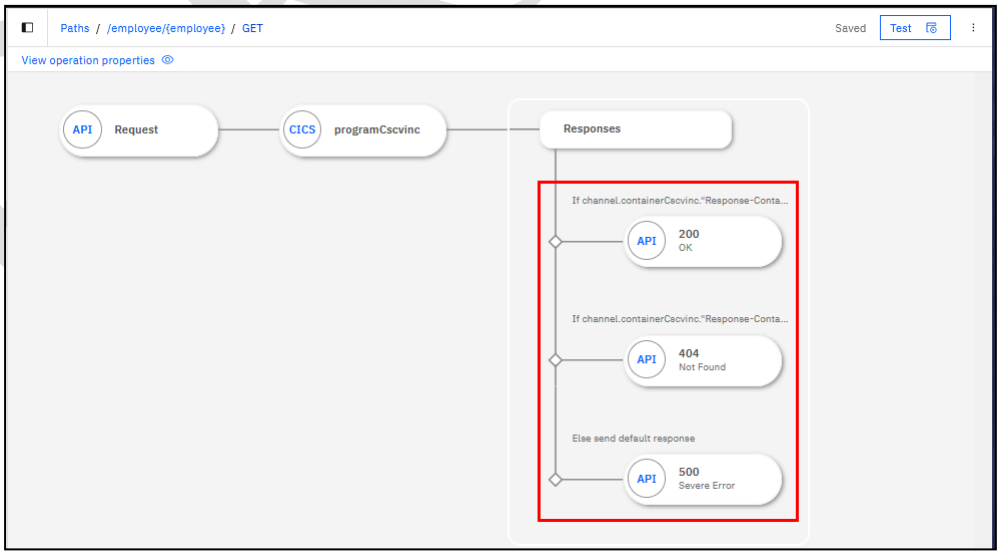
___7. Under the *200 – OK* response, use your preferred mapping technique to check the ***CEIBRESP*** and ***CEIBRESP2*** response fields are equal to ***0.***

___8. For the *404 – Not Found* check, use your preferred mapping technique to check the ***CEIBRESP*** container response field is equal to a value of ***13*** and the ***CEIBRESP2*** container response field is equal to a value of ***80***.



___9. If note of these connections are met, simply return with a HTTP 500 status code.

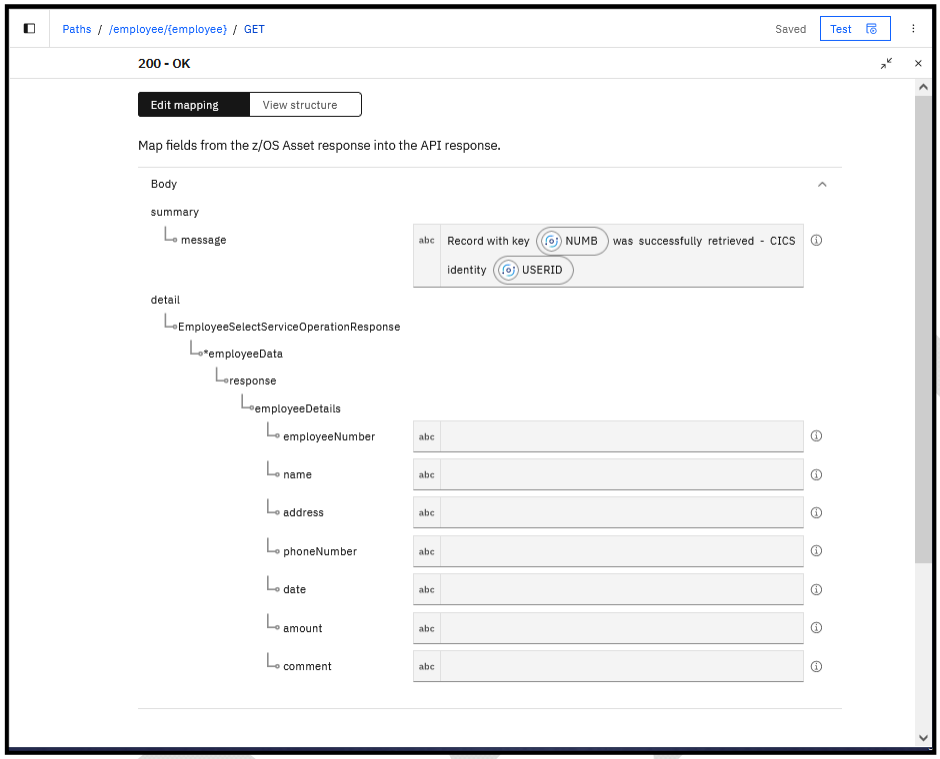
___10. Next the API response messages need to be configured for each of these potential status codes.



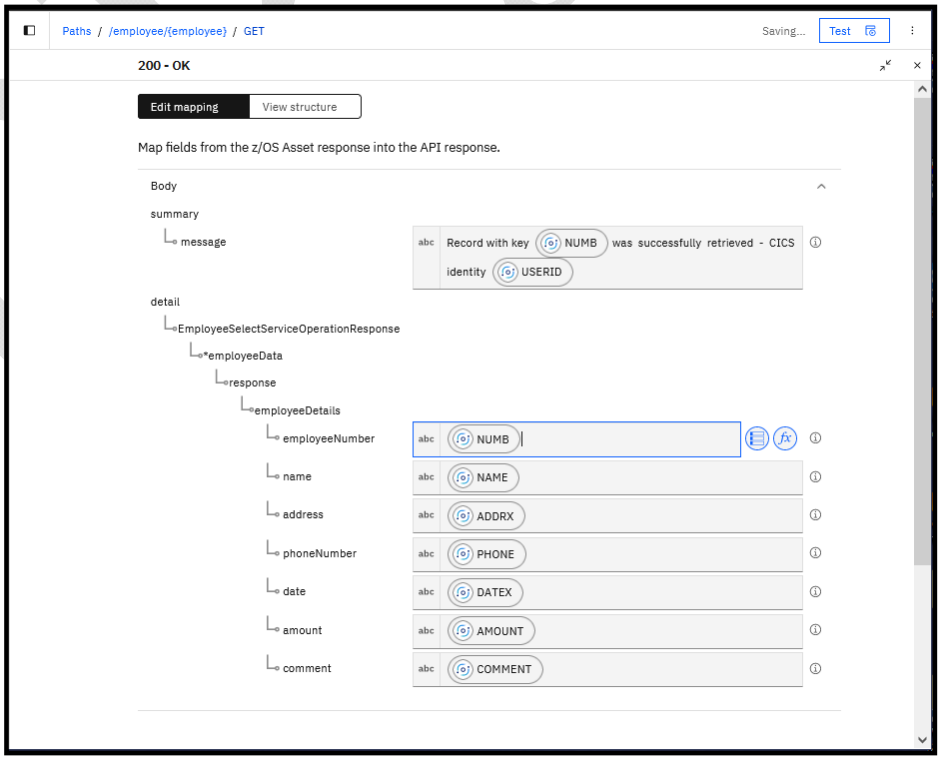
Mitch Johnson (mitchj@us.ibm.com)

___11. Select the response for *200 OK* and map the fields from the CICS response container. Start by mapping the message API response field the message below:

Record with key {{$zosAssetResponse.channel.containerCscvinc."Response-Container"."FILEA-AREA".NUMB}} was successfully retrieved - CICS identity {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}



___12. Complete the mapping for the other container fields to the corresponding API response message fields.



Mitch Johnson (mitchj@us.ibm.com)

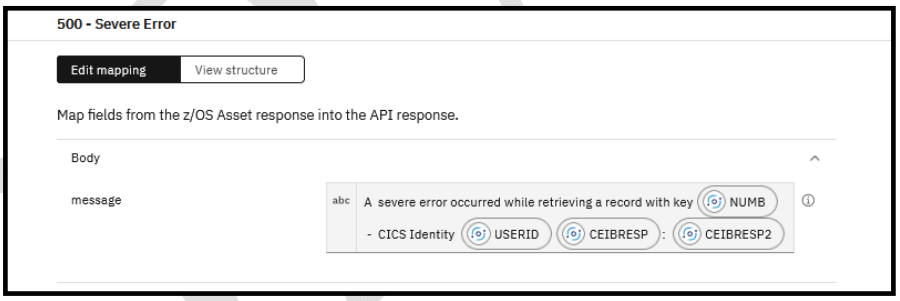
___13. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

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 response container field. Since the record was not found, the response container field for NUMB is empty.

___14. Finally in the 500 – Severe Error response mapping paste the following in the area for the message property

A severe error occurred while retrieving a record with key {{$zosAssetResponse.channel.containerCscvinc."Response-Container"."FILEA-AREA".NUMB}} - CICS Identity {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}} {{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP}}: {{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP2}}



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 *programCscvinc* on the operation page.

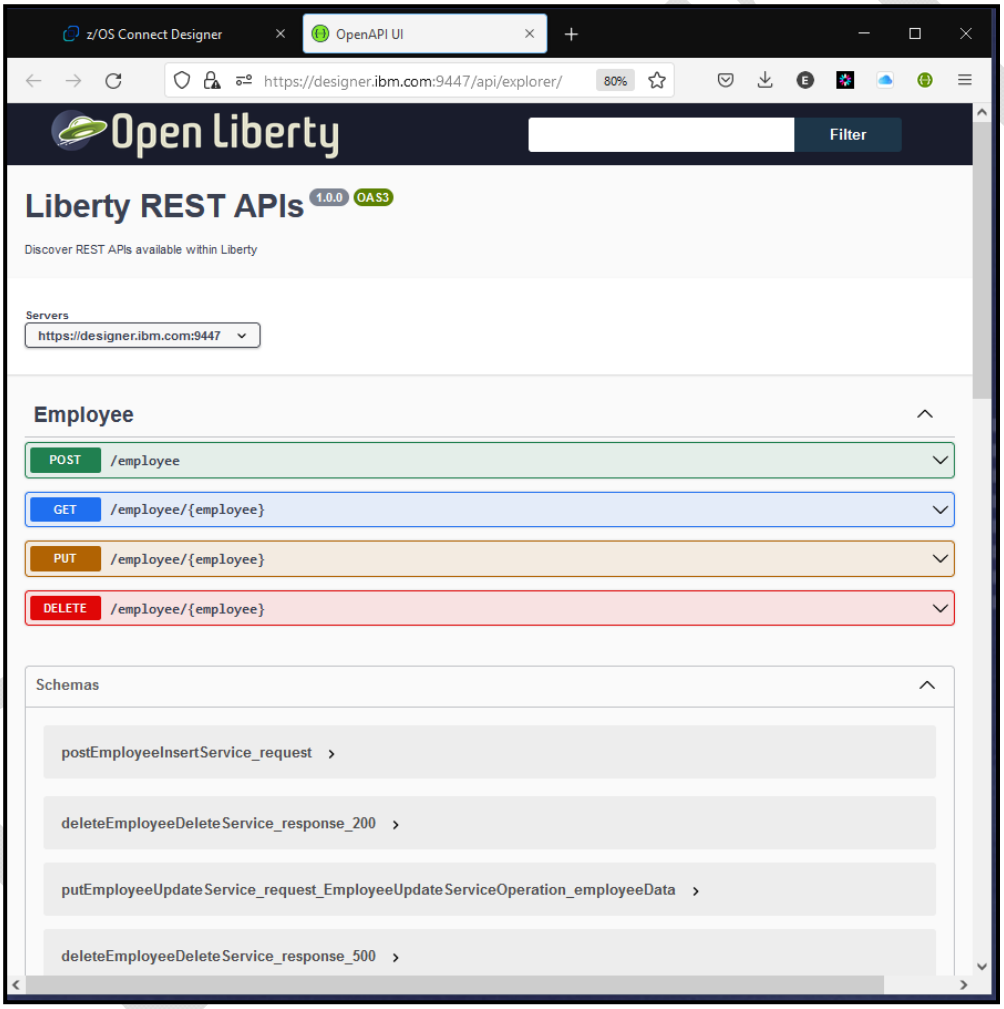
Mitch Johnson (mitchj@us.ibm.com)

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 */employee* and the *GET* for */employee/{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.

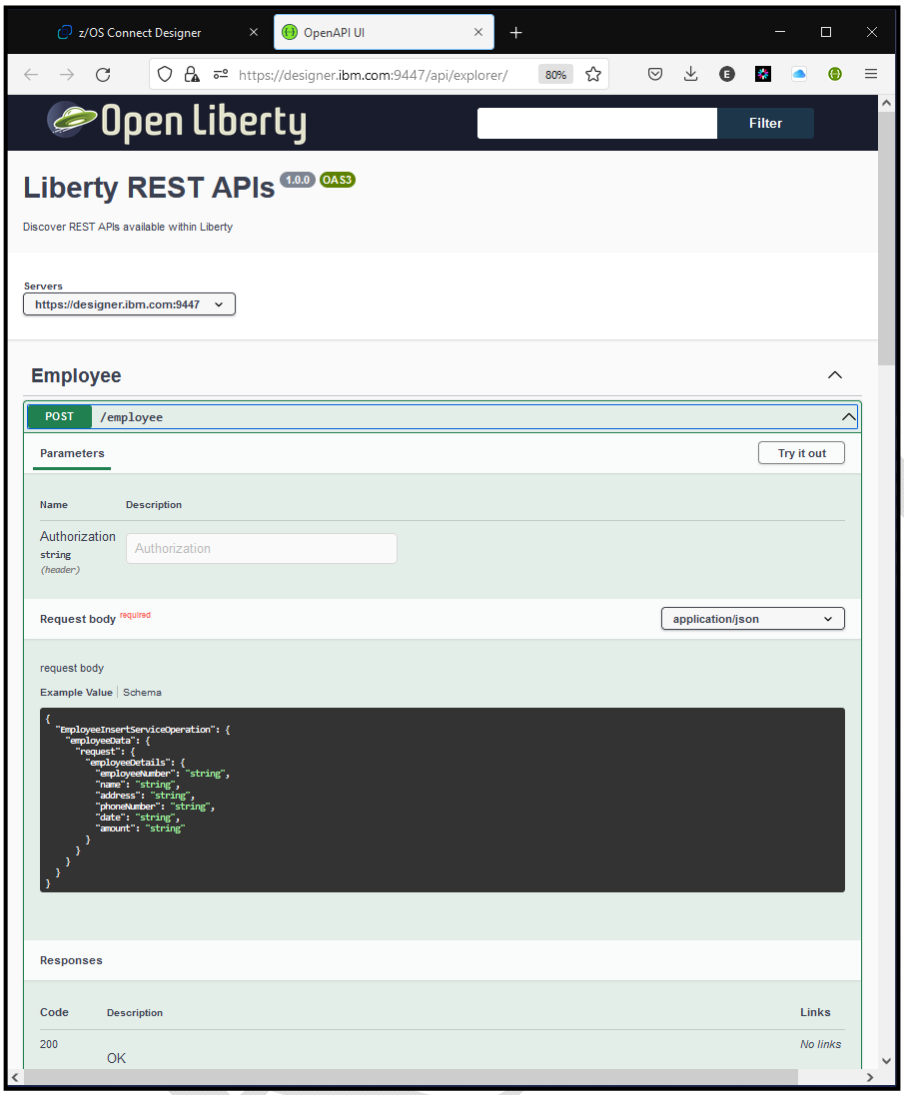
Let's test what has been developed so far.

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

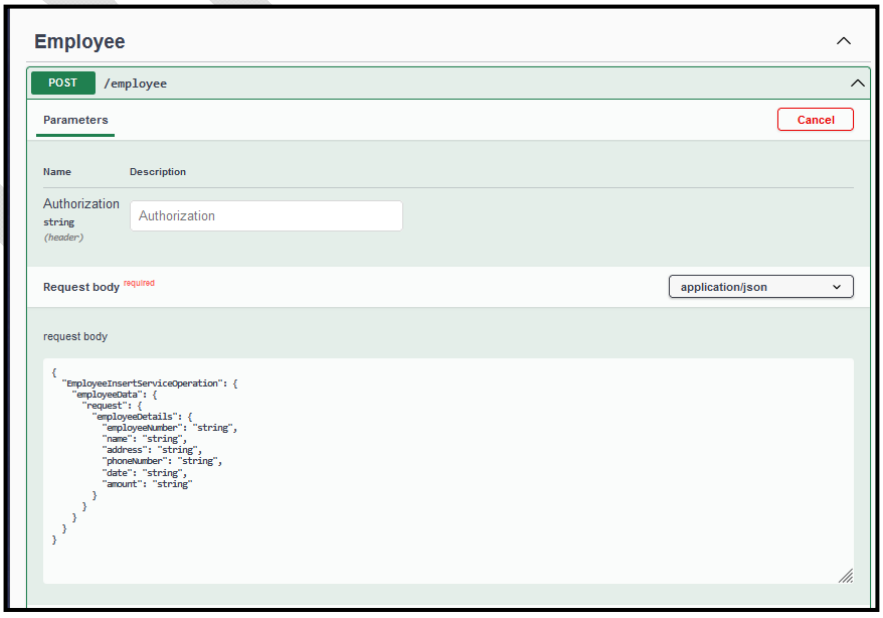


Tech Tip: You may be challenged by browser because the digital certificate used by the *Designer* is self-signed Click the **Advanced** button to continue. Scroll down and then click on the **Accept the Risk and Continue** button. Next you may see a prompt you for a userid and password. If you do see 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. Click on *Post /employee* URI path to display the request body view of the URI path.



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

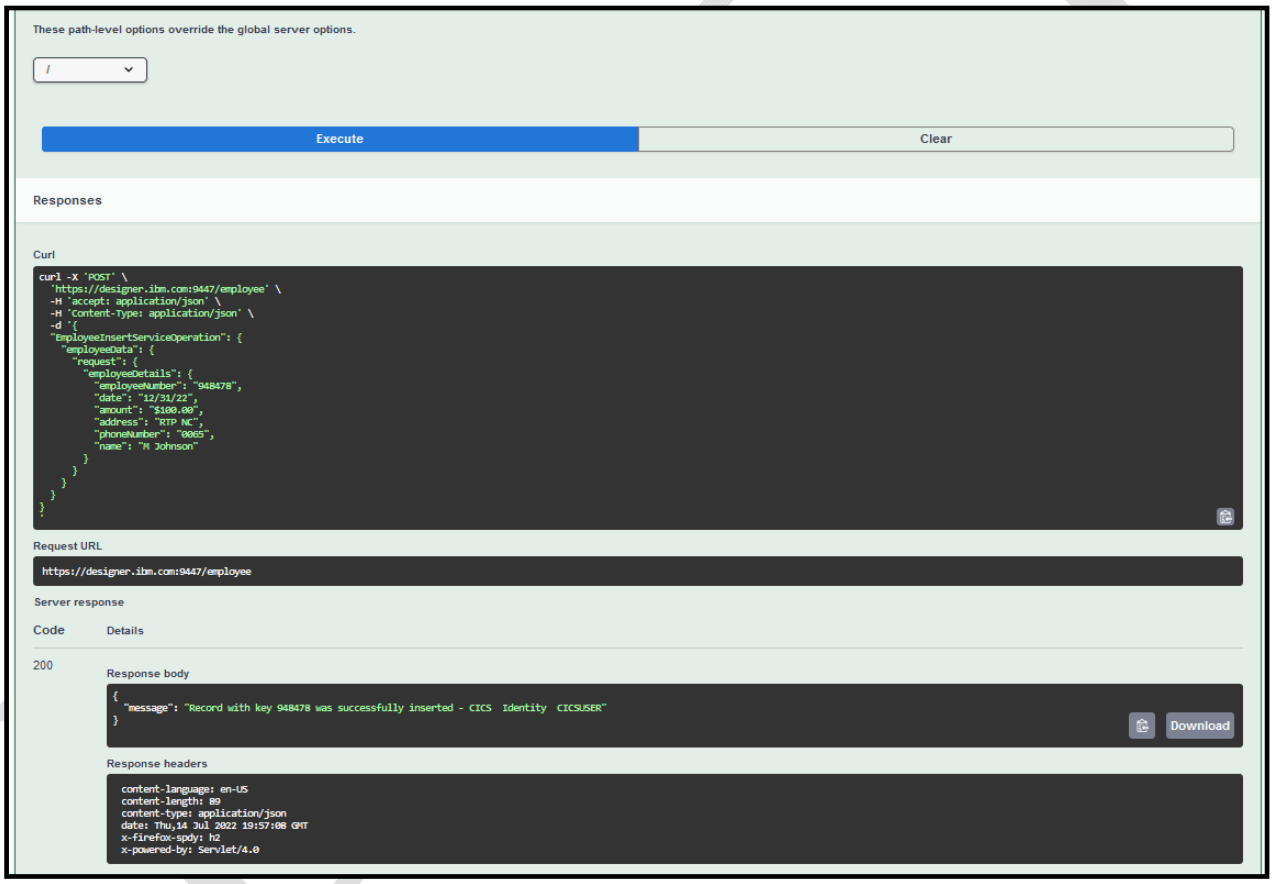


___4. Enter the JSON request message below in the *Request body* section and press the **Execute** button.

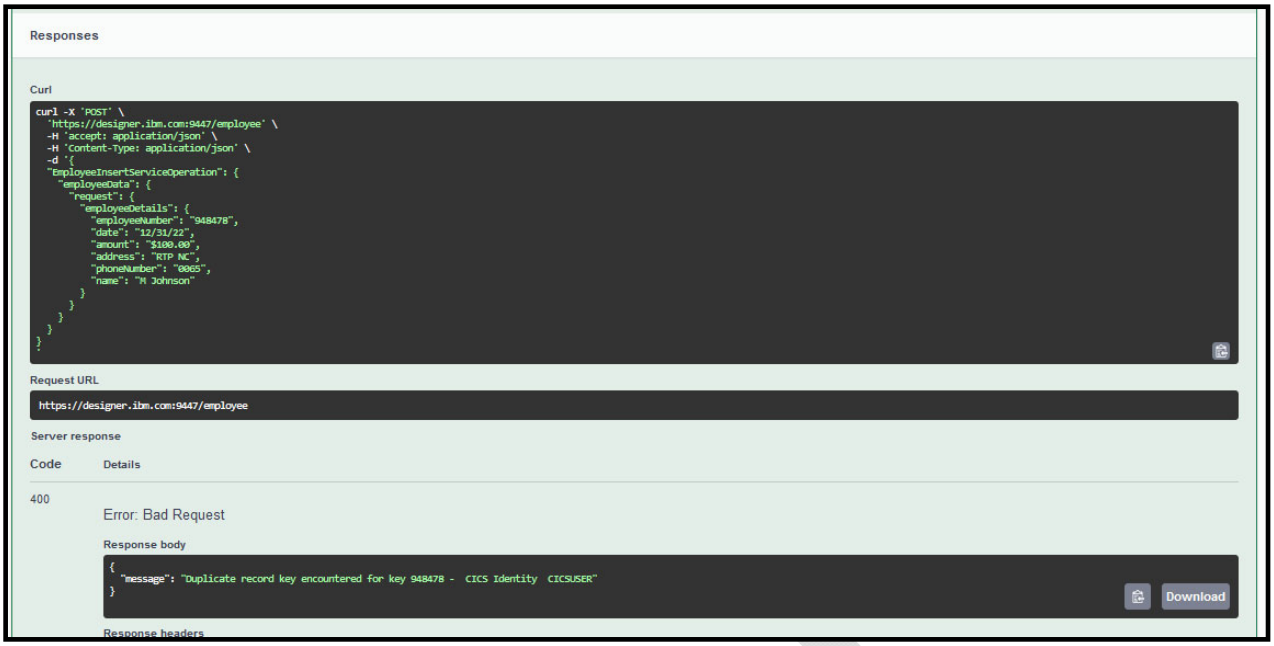
```
{
  "EmployeeInsertServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "employeeNumber": "948478",
          "date": "12/31/22",
          "amount": "$100.00",
          "address": "RTP NC",
          "phoneNumber": "0065",
          "name": "M Johnson"
        }    }   }   } }
```

___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.

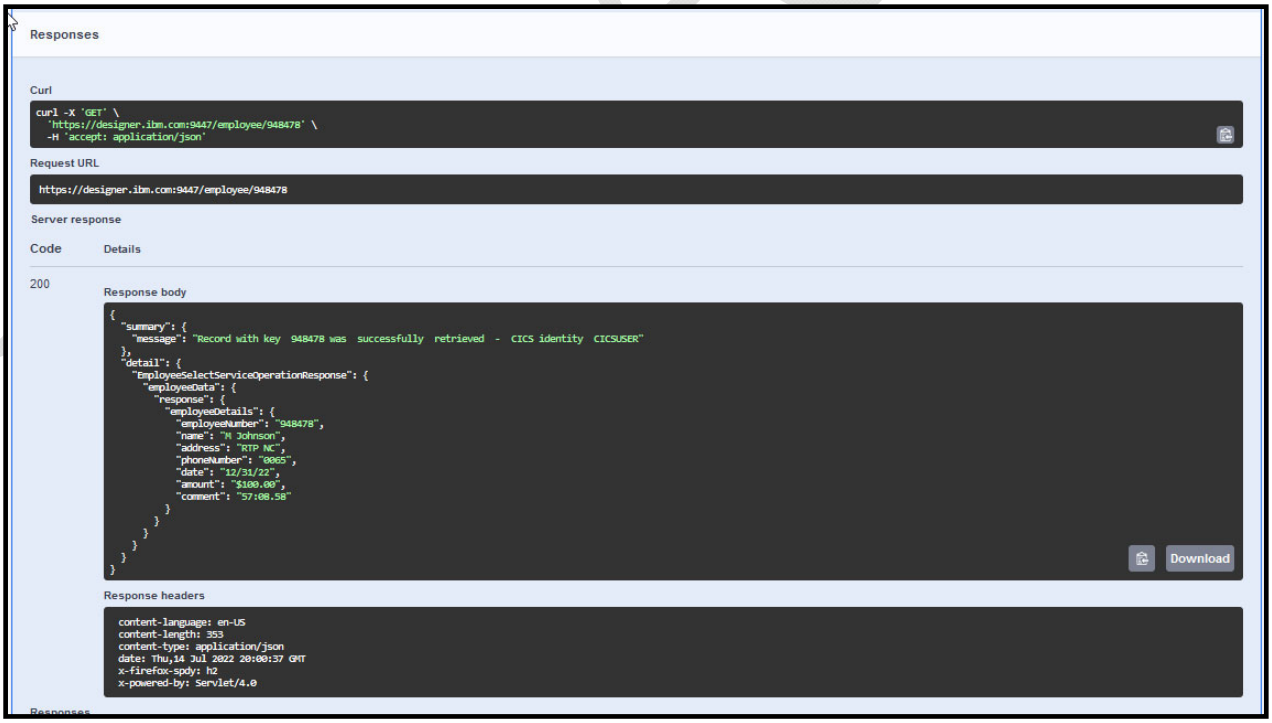
___6. Scroll down the view and you should see the *Response body* with the expected HTTP 200 - success message.



___7. Press the **Execute** button again and observe the results. A row for this employee number already existed in the in the VSAM data set so the request failed with an HTTP 400 – bad request.



___8. Scroll down and click on *GET /employee/{employee}* 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.



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

The table below list the contents of the VSAM data set.

stat	numb	name	addrx	Phone	datex	amount	comment
Y	000100	S. D. BORMAN	SURREY, ENGLAND	32156778	26 11 81	$0100.11	*********
Y	000102	J. T. CZAYKOWSI	WARWICK, ENGLAND	98356183	26 11 81	$1111.11	*********
Y	000104	M. B. DOMBEY	LONDON,ENGLAND	12846293	26 11 81	$0999.99	*********
Y	000106	A. I. HICKSON	CROYDON, ENGLAND	19485673	26 11 81	$0087.71	*********
Y	000111	ALAN TULIP	SARATOGA,CALIFORNIA	46120753	01 02 74	$0111.11	*********
Y	000762	SUSAN MALAIKA	SAN JOSE,CALIFORNIA	22312121	01 06 74	$0000.00	*********
Y	000983	J. S. TILLING	WASHINGTON, DC	34512120	21 04 75	$9999.99	*********
Y	001222	D.J.VOWLES	BOBLINGEN, GERMANY	70315551	10 04 73	$3349.99	*********
Y	001781	TINA J YOUNG	SINDELFINGEN,GERMANY	70319990	21 06 77	$0009.99	*********
Y	003210	B.A. WALKER	NICE, FRANCE	12345670	26 11 81	$3349.99	*********
N	003214	PHIL CONWAY	SUNNYVALE, CAL.	34112120	00 06 73	$0009.99	*********
N	003890	BRIAN HARDER	NICE FRANCE	00000000	28 05 74	$0009.99	*********
N	004004	JANET FOUCHE	DUBLIN, IRELAND	71112121	02 11 73	$1259.99	*********
N	004445	DR. P. JOHNSON	SOUTH BEND, S.DAK.	61212120	26 11 81	$0009.99	*********
N	004878	ADRIAN JONES	SUNNYVALE, CALIF.	32212120	10 06 73	$5399.99	*********
N	005005	A. E. DALTON	SAN FRANCISCO, CA.	00000001	01 08 73	$0009.99	*********
N	005444	ROS READER	SARATOGA, CALIF.	67712120	20 10 74	$0809.99	*********
N	005581	PETE ROBBINS	BOSTON, MASS.	41312120	11 04 74	$0259.99	*********
Y	006016	SIR MICHAEL ROBERTS	NEW DELHI, INDIA	70331211	21 05 74	$0009.88	*********
N	006670	IAN HALL	NEW YORK, N.Y.	21212120	31 01 75	$3509.88	*********
Y	006968	J.A.L. STAINFORTH	WARWICK, ENGLAND	56713821	26 11 81	$0009.88	*********
N	007007	ANDREW WHARMBY	STUTTGART, GERMANY	70311000	10 10 75	$5009.88	*********
N	007248	M. J. AYRES	REDWOOD CITY, CALF.	33312121	11 10 75	$0009.88	*********
Y	007779	MRS. A. STEWART	SAN JOSE, CALIF.	41512120	03 01 75	$0009.88	*********
Y	009000	P. E. HAVERCAN	WATERLOO, ONTARIO	09876543	21 01 75	$9000.00	*********
Y	100000	M. ADAMS	TORONTO, ONTARIO	03415121	26 11 81	$0010.00	*********
Y	111111	C. BAKER	OTTAWA, ONTARIO	51212003	26 11 81	$0011.00	*********
Y	200000	S. P. RUSSELL	GLASGOW, SCOTLAND	63738290	26 11 81	$0020.00	*********
Y	222222	DR E. GRIFFITHS	FRANKFURT, GERMANY	20034151	26 11 81	$0022.00	*********
Y	300000	V. J. HARRIS	NEW YORK, U.S.	64739801	26 11 81	$0030.00	*********
Y	333333	J.D. HENRY	CARDIFF, WALES	78493020	26 11 81	$0033.00	*********
Y	400000	C. HUNT	MILAN, ITALY	25363738	26 11 81	$0040.00	*********
Y	444444	D. JACOBS	CALGARY, ALBERTA	77889820	26 11 81	$0044.00	*********
Y	500000	P. KINGSLEY	MADRID, SPAIN	44454640	26 11 81	$0000.00	*********
Y	555555	S.J. LAZENBY	KINGSTON, N.Y.	39944420	26 11 81	$0005.00	*********
Y	600000	M.F. MASON	DUBLIN, IRELAND	12398780	26 11 81	$0010.00	*********
Y	666666	R. F. WALLER	LA HULPE, BRUSSELS	42983840	26 11 81	$0016.00	*********
Y	700000	M. BRANDON	DALLAS, TEXAS	57984320	26 11 81	$0002.00	*********
Y	777777	L.A. FARMER	WILLIAMSBURG, VIRG.	91876131	26 11 81	$0027.00	*********
Y	800000	P. LUPTON	WESTEND, LONDON	24233389	26 11 81	$0030.00	*********
Y	888888	P. MUNDY	NORTHAMPTON, ENG.	23691639	26 11 81	$0038.00	*********
Y	900000	D.S. RENSHAW	TAMPA, FLA.	35668120	26 11 81	$0040.00	*********
Y	999999	ANJI STEVENS	RALEIGH, N.Y.	84591639	26 11 81	$0049.00	*********

Compete the configuration of the API (Optional)

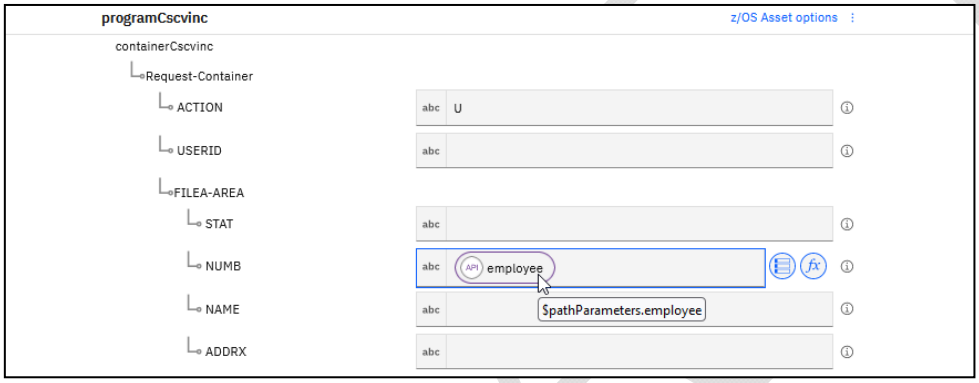
To be able to fully test all the URI paths and methods the other methods need to be configured. Otherwise, you may advance to the section *Deploying and Installing APIs in a z/OS Connect Native Server*.

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

___1. Start by adding the existing z/OS Asset for *programCscvinc* to this method.

___2. Now map the API path parameter field *employee* to the CICS container field *Numb* as shown below. Next set the ACTION container field to ***U***.

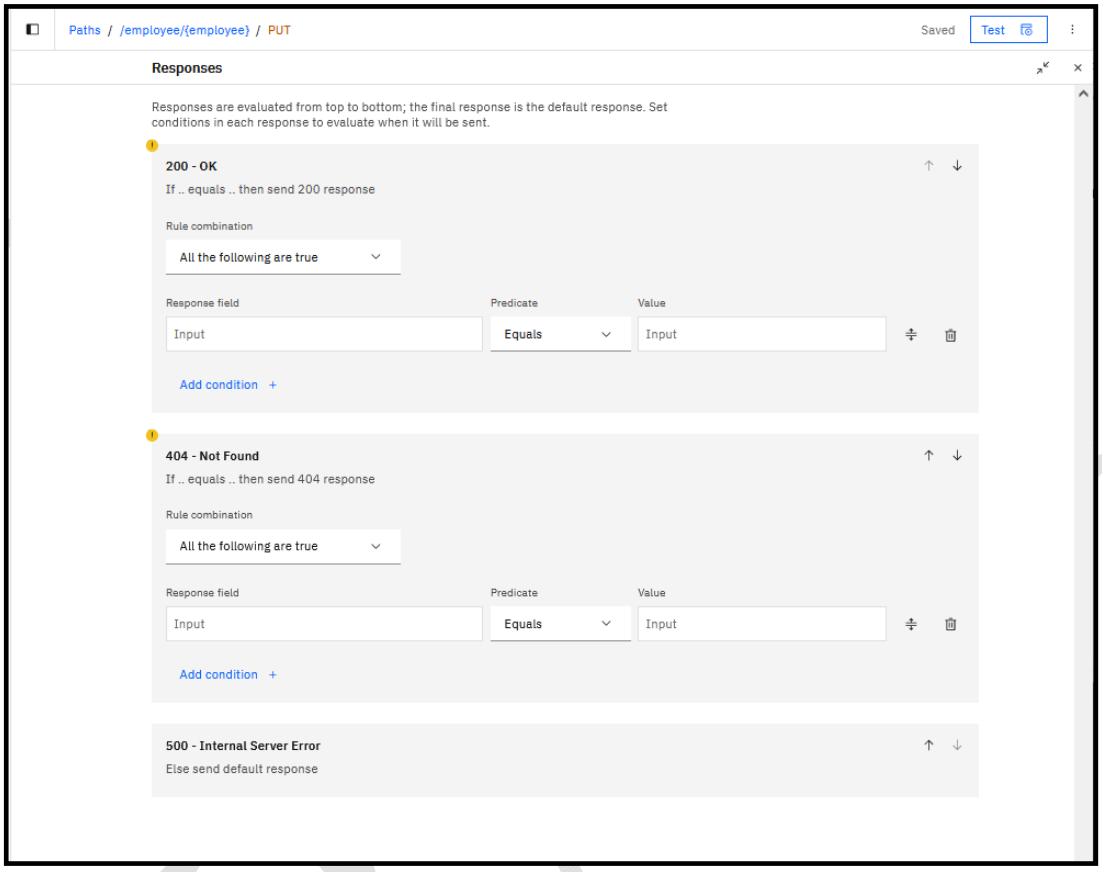


___3. Map the API request message body fields *status, name, address, phoneNumber, date, amount,* and *COMMENT* to the CICS container fields *STAT, NAME, ADDRX, PHONE, DATEX, AMOUNT* and *COMMENT* as shown below.

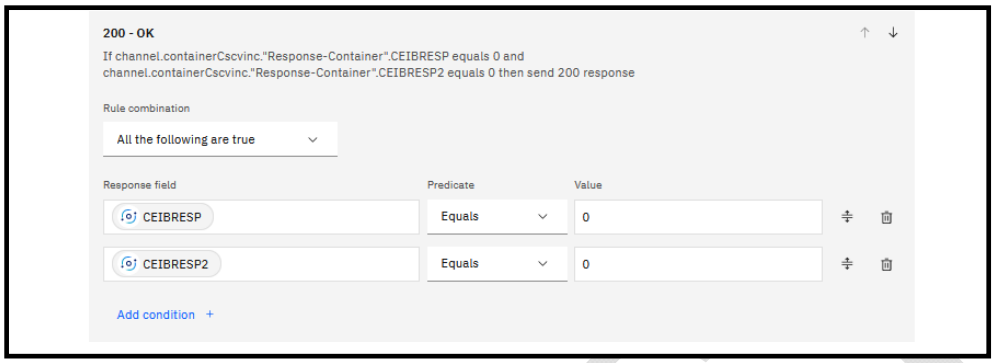
___4. Maximize the *Responses* area of the browser's page (see below).

The contents of the *CEIBRESP* and *CEIBRESP2* fields in the CICS response container from the CICS application determine whether the request was successful or not. The first check is to see if the record was

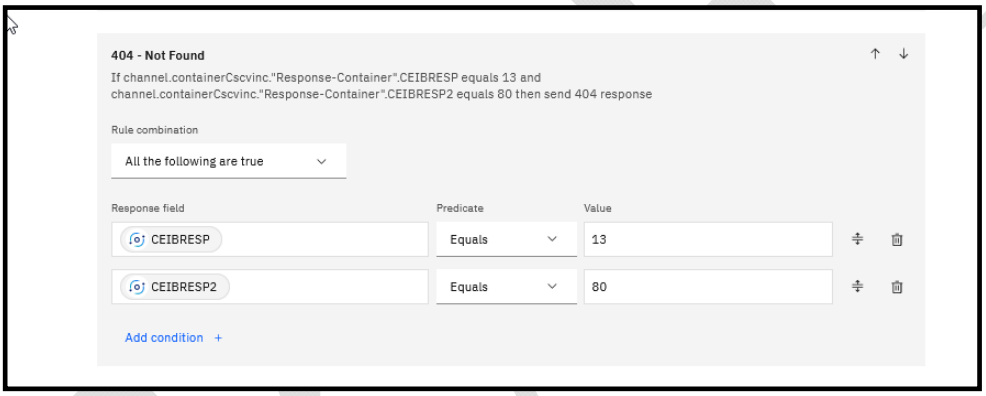
updated as intended. The application returns the values of the EIBRESP and EIBRESP2 from the EXECI CICS API in the container *CEIBRESP* and *CEIBRESP2* fields. Their values will be zero if a record was successfully updated in the VSAM data set. Otherwise, the record did not exist, e.g., CEIBRESP=13 and CEIBRESP2=80 or some other error occurred will be returned.



___5. Under the *200 – OK* response, use your preferred mapping technique to check the ***CEIBRESP*** and ***CEIBRESP2*** response fields are equal to ***0.***

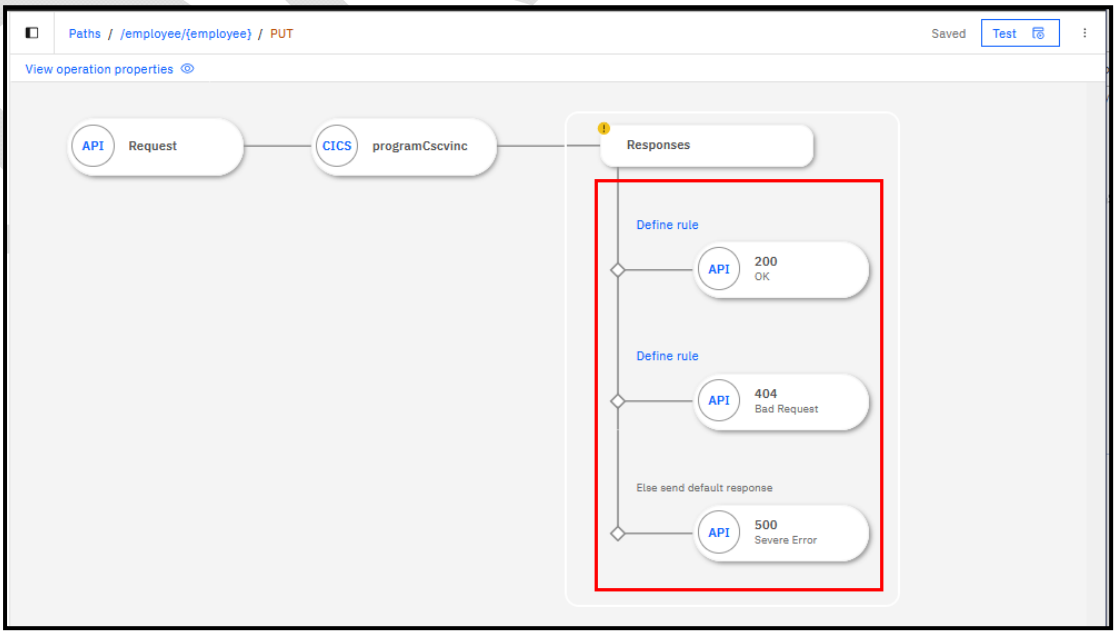


___6. For the *404 – Not Found* check, use your preferred mapping technique to check the ***CEIBRESP*** container response field is equal to a value of ***13*** and the ***CEIBRESP2*** container response field is equal to a value of ***80***.



___7. If note of these connections are met, simply return with a HTTP 500 status code.

___8. Next the API response messages need to be configured for each of these potential status codes.



___9. Select the response for *200 OK* paste the text below in the *message* area.

```
Record with key  {{$zosAssetResponse.channel.containerCscvinc."Response-
Container"."FILEA-AREA".NUMB}} was  successfully  updated  -  CICS identity
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}
```

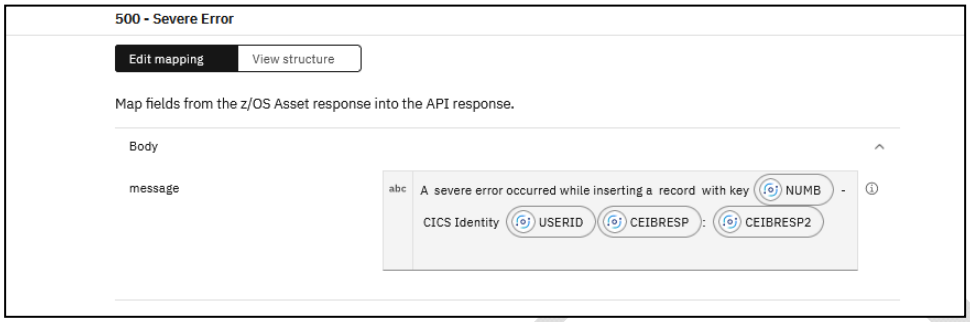
___10. Select the response for *404 Not found* response mapping and paste the text below in the *message* area.

```
Record with key
{{$apiRequest.body.EmployeeUpdateServiceOperation.employeeData.request.employeeDetails.em
ployeeNumber}} was not found -  CICS Identity
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}
```

Notice that the mapping for the employeeNumber in the message was from the API request message and not the CICS response container.

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

```
A severe error occurred while inserting a record with key
{{$zosAssetResponse.channel.containerCscvinc."Response-Container"."FILEA-AREA".NUMB}}  -
CICS Identity  {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP}}:
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP2}}
```

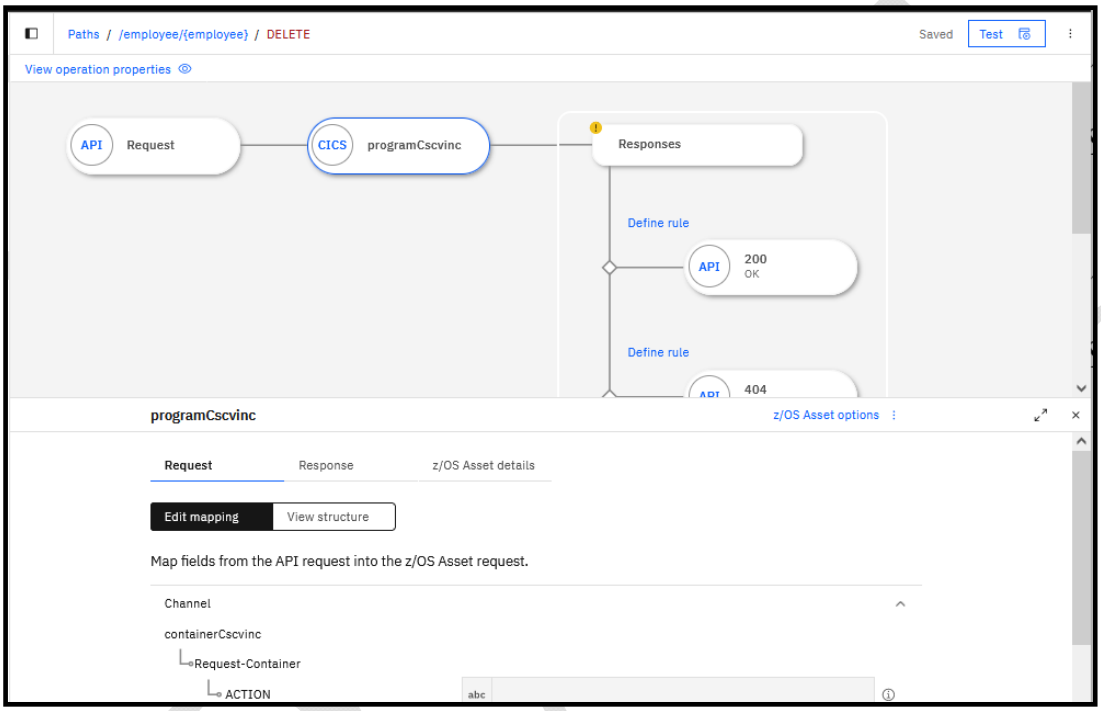


The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

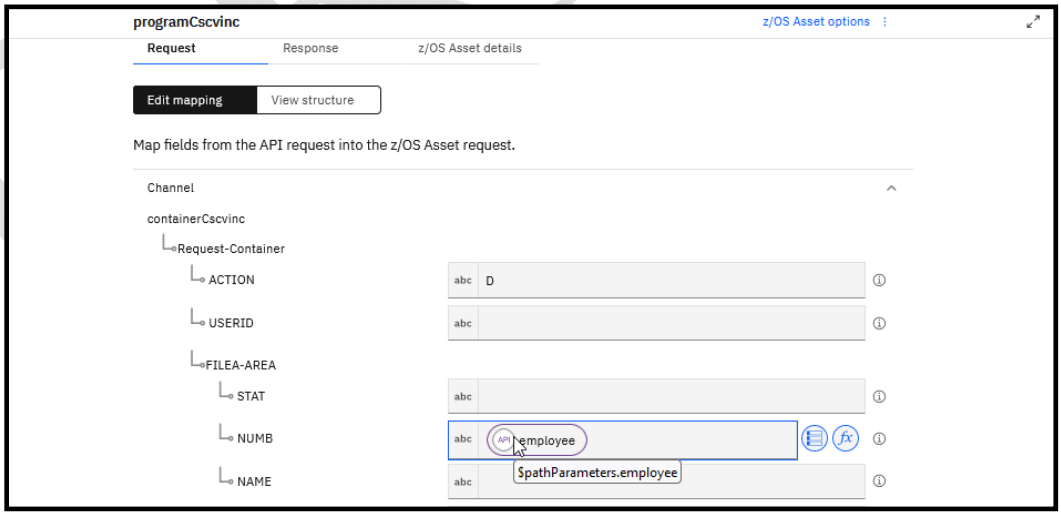
Configure the DELETE method for URI path /employee/{employee}

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

___1. Start by adding the existing *programCscvinc* z/OS Asset to this method.

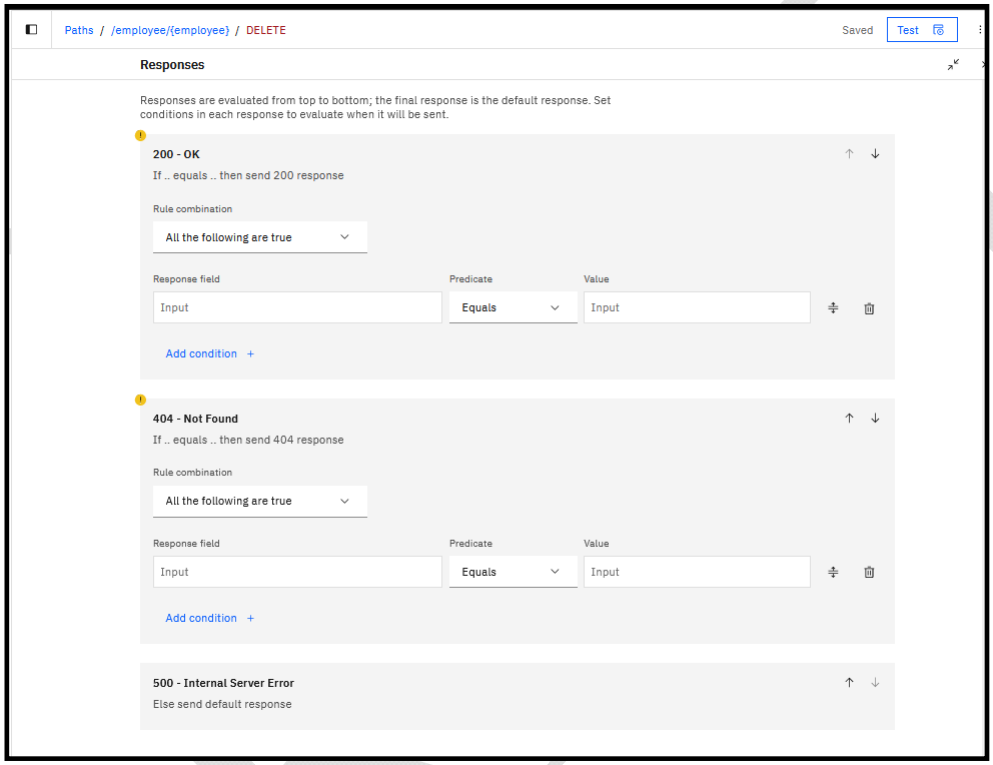


___2. Now map the API path parameter field *employee* to the CICS container field *Numb* as shown below and enter a ***D*** in the *ACTION* field of the request container.



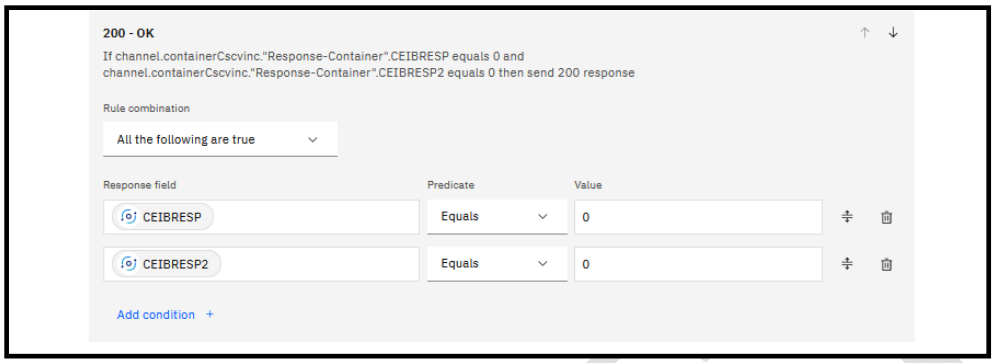
___3. Maximize the *Responses* area of the browser's page (see below).

The contents of the *CEIBRESP* and *CEIBRESP2* fields in the CICS response container from the CICS application determine whether the request was successful or not. The first check is to see if the record was deleted as intended. The application returns the values of the EIBRESP and EIBRESP2 from the EXECI CICS API in the container *CEIBRESP* and *CEIBRESP2* fields. Their values will be zero if a record was successfully deleted from the VSAM data set. Otherwise, the record did not exist, e.g., CEIBRESP=13 and CEIBRESP2=80 or some other error occurred will be returned.

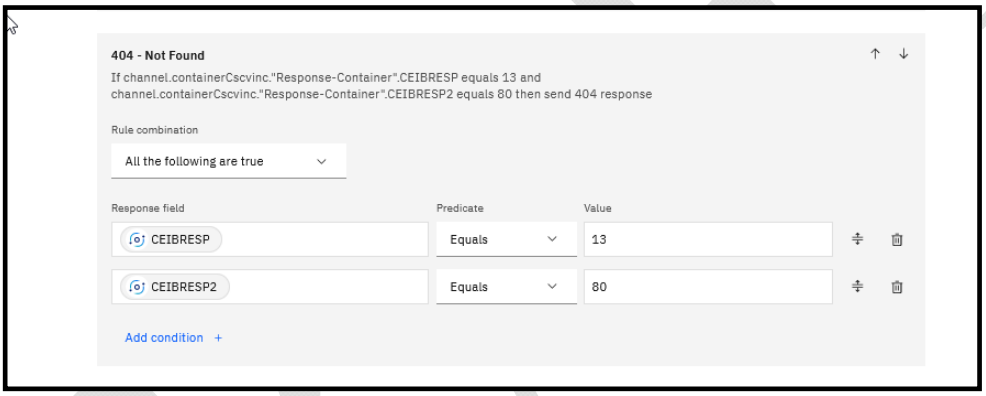


Mitch Johnson (mitchj@us.ibm.com)

___4. Under the *200 – OK* response, use your preferred mapping technique to check the ***CEIBRESP*** and ***CEIBRESP2*** response fields are equal to ***0.***

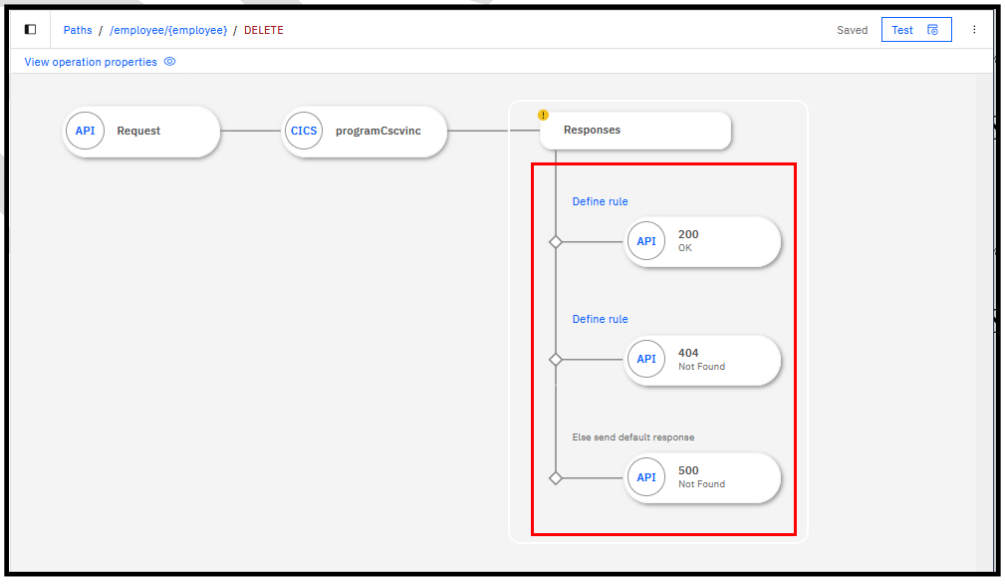


___5. For the *404 – Not Found* check, use your preferred mapping technique to check the ***CEIBRESP*** container response field is equal to a value of ***13*** and the ***CEIBRESP2*** container response field is equal to a value of ***80***.



___6. If note of these connections are met, simply return with a HTTP 500 status code.

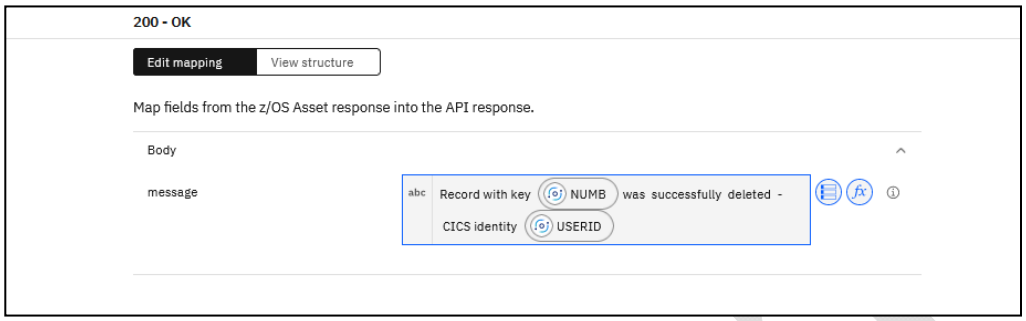
___7. Next the API response messages need to be configured for each of these potential status codes.



Mitch Johnson (mitchj@us.ibm.com)

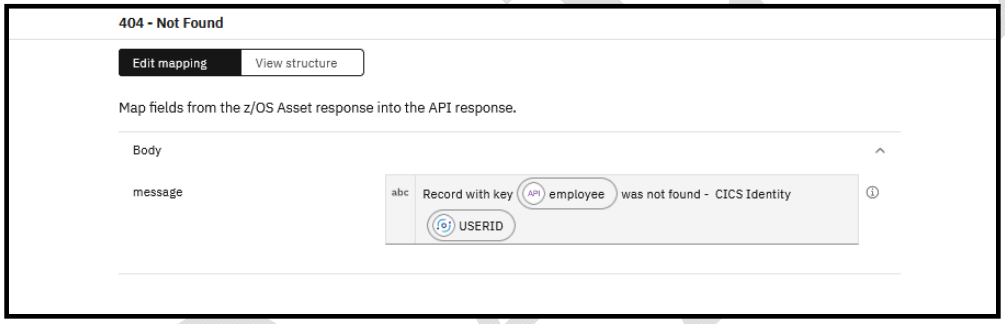
___8. Select the response for *200 OK* paste the text below in the *message* area.

```
Record with key  {{$zosAssetResponse.channel.containerCscvinc."Response-
Container"."FILEA-AREA".NUMB}} was  successfully  deleted  -  CICS identity
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}
```



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

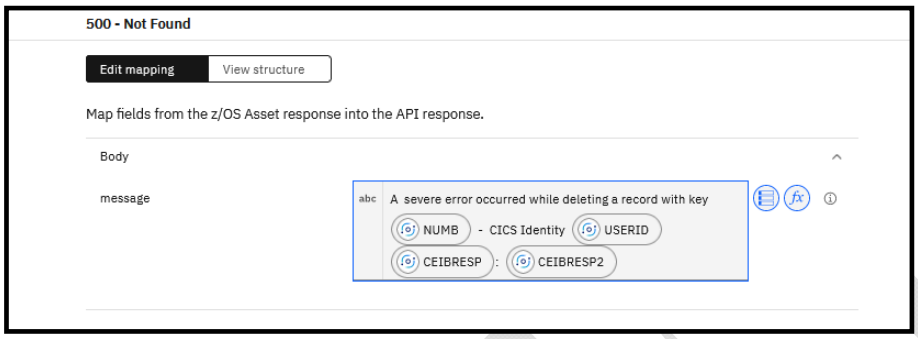
```
Record with key {{$apiRequest.pathParameters.employee}} was not found -  CICS Identity
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}
```



Notice that the mapping for the employeeNumber in the message was from the API request message and not the CICS response container.

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

```
A severe error occurred while deleting a record with key
{{$zosAssetResponse.channel.containerCscvinc."Response-Container"."FILEA-AREA".NUMB}}  -
CICS Identity  {{$zosAssetResponse.channel.containerCscvinc."Response-Container".USERID}}
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP}}:
{{$zosAssetResponse.channel.containerCscvinc."Response-Container".CEIBRESP2}}
```

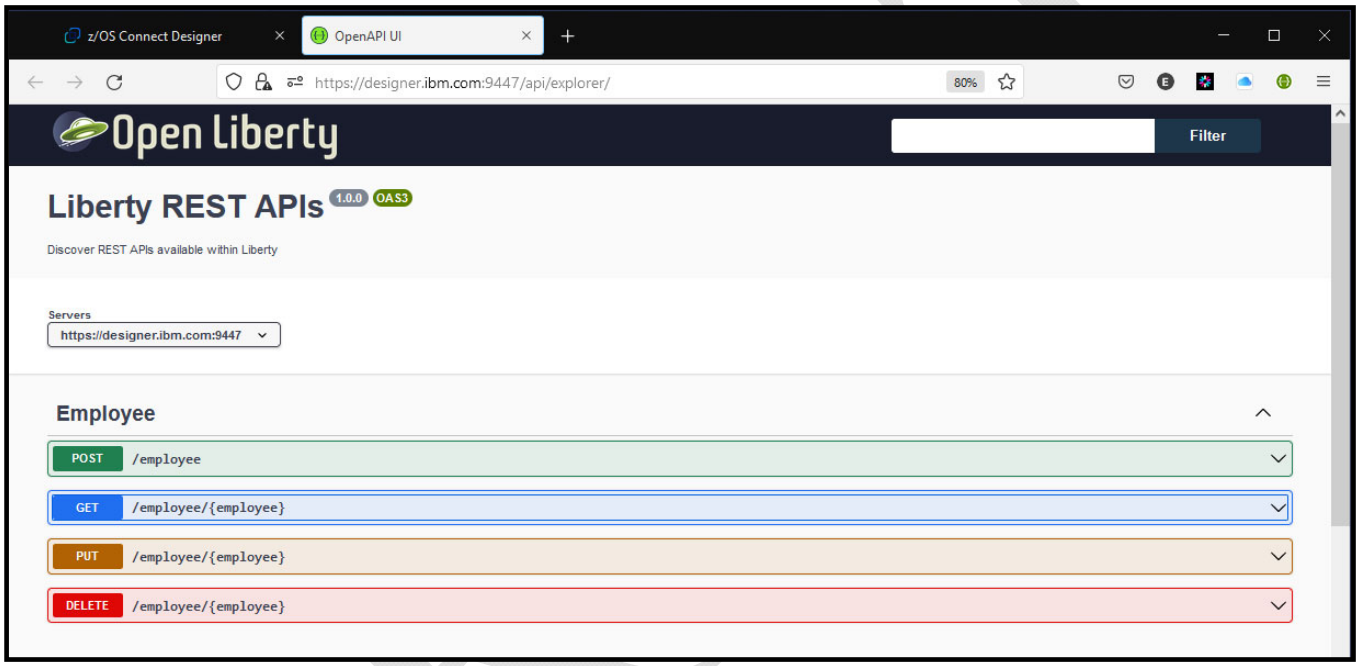


The completes the configuration of this method of this URI path of the API. All the exclamation marks for this method should now have disappeared. If not investigate which subcomponent still has an exclamation mark and resolve the issue.

Testing APIs deployed in a z/OS Connect Designer container

The deployed APIs are accessible as long as 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. This section will demonstrate using common HTTP clients to test APIs specifically with 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:9447*. 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:9447/employee/{employee}*



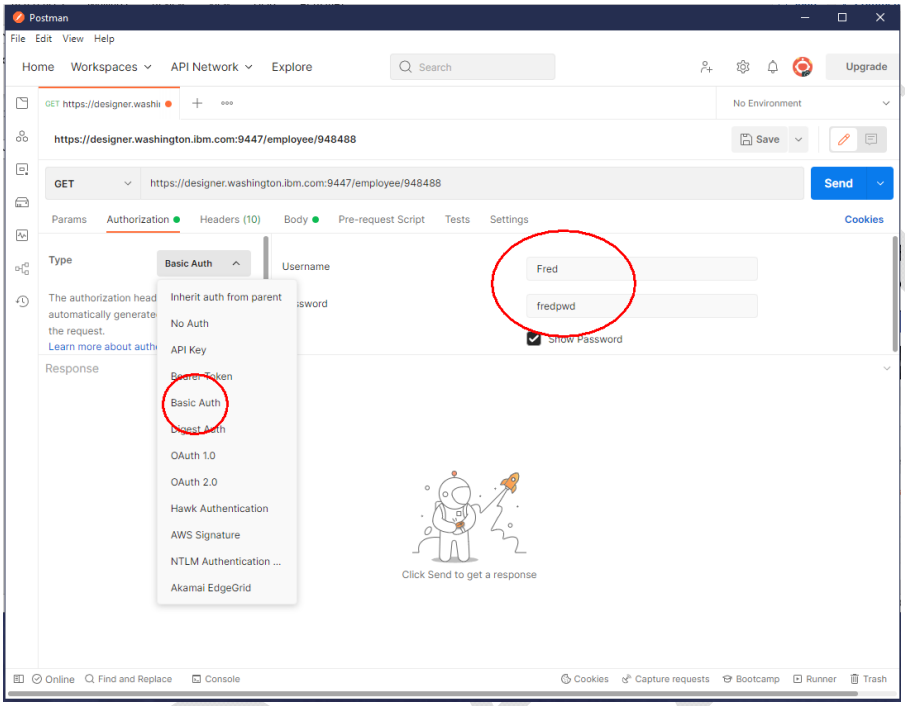
From this display, the methods and URLs required to access the API deployed in this container are:

- POST https://designer.washington.ibm.com:9447/employee
- GET https://designer.washington.ibm.com:9447/employee/{employee}
- PUT https://designer.washington.ibm.com:9447/employee/{employee}
- DELETE https://designer.washington.ibm.com:9447/employee/{employee}

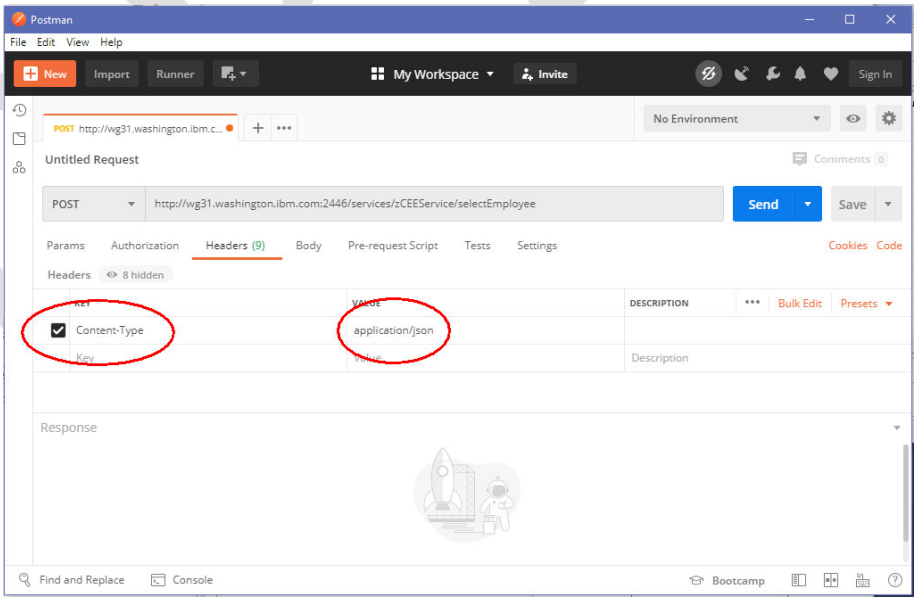
Using Postman

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. 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 ***fredpwd*** as the *Password.*



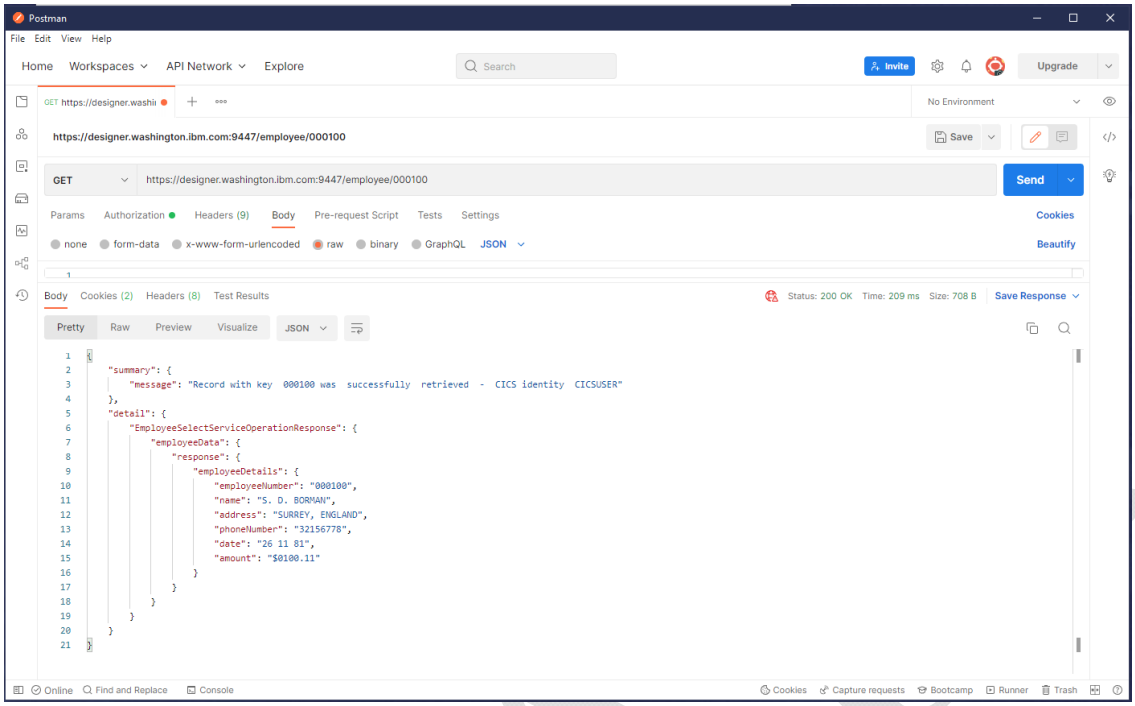
____2. Next select the *Headers* tab and under *KEY* use the code assist feature to enter ***Content-Type*** and under *VALUE* use the code assist feature to enter ***application/json***.



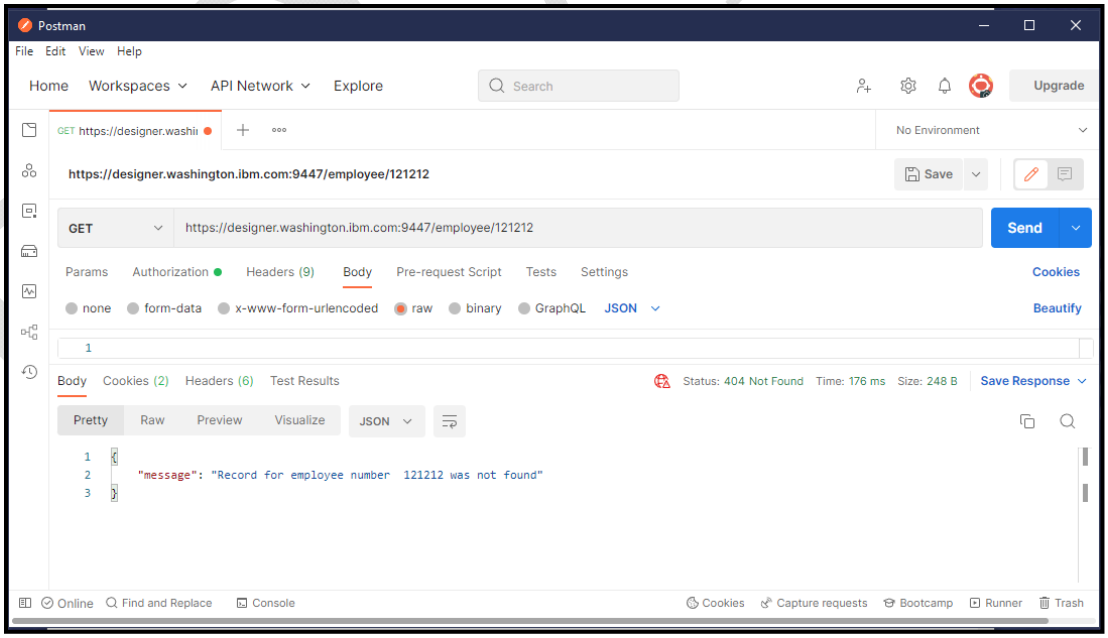
Tech-Tip: Code assist simply means that when text is entered in field, all the valid values for that field that match the typed text will be displayed. You can select the desired value for the field from the list displayed and that value will populate that field.

Mitch Johnson (mitchj@us.ibm.com)

____3. Then go to the *Body* tab and use the down arrow to select **GET** and enter ***https://designer.washington.ibm.com:9447/employee/000100*** in the URL area (see below) and press **Send**. You should see results like below in the response *Body* area.



____4. Next enter an invalid employee number such as 121212, ***https://designer.washington.ibm.com:/employees/121212*** in the URL area (see below) and press **Send**. You should see results like below in the response Body area.

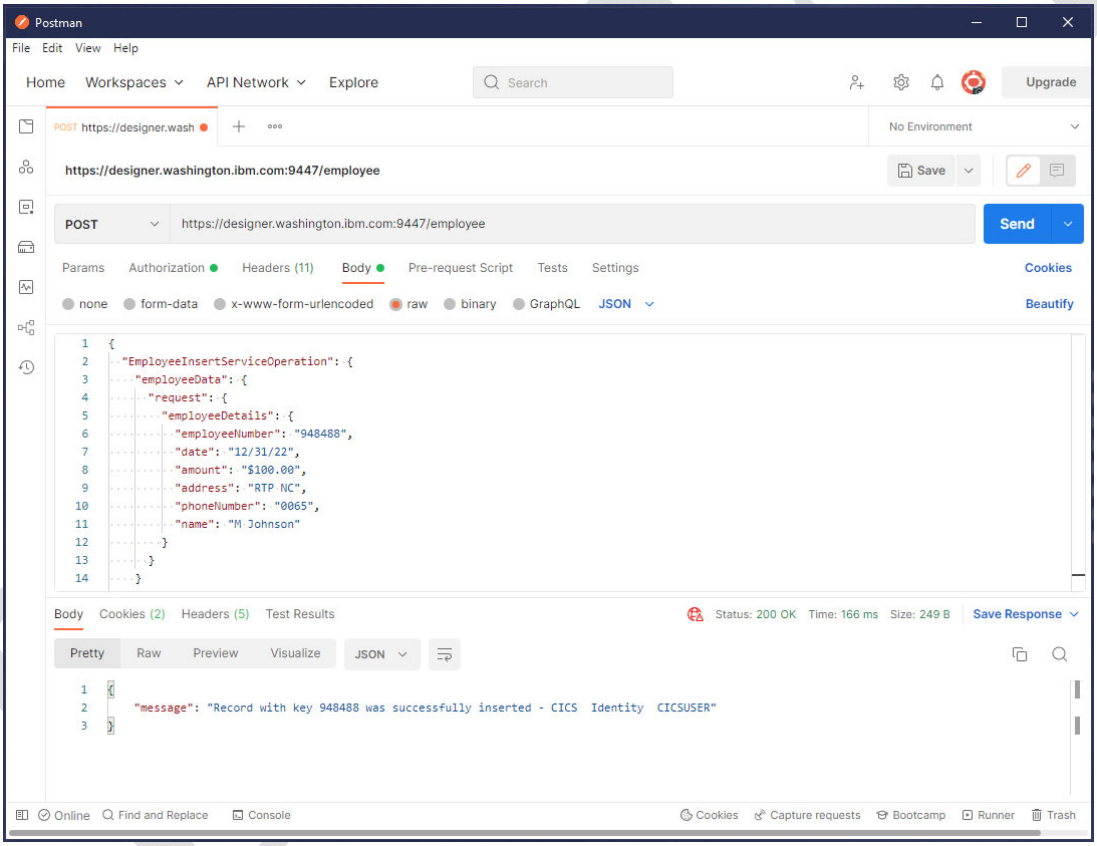


Mitch Johnson (mitchj@us.ibm.com)

____5. Next use *Postman* to invoke other methods of the API. For example, if you want to invoke a *POST* method with URL ***https://designer.washington.ibm.com:9447/employee*** and the JSON below for the request message.

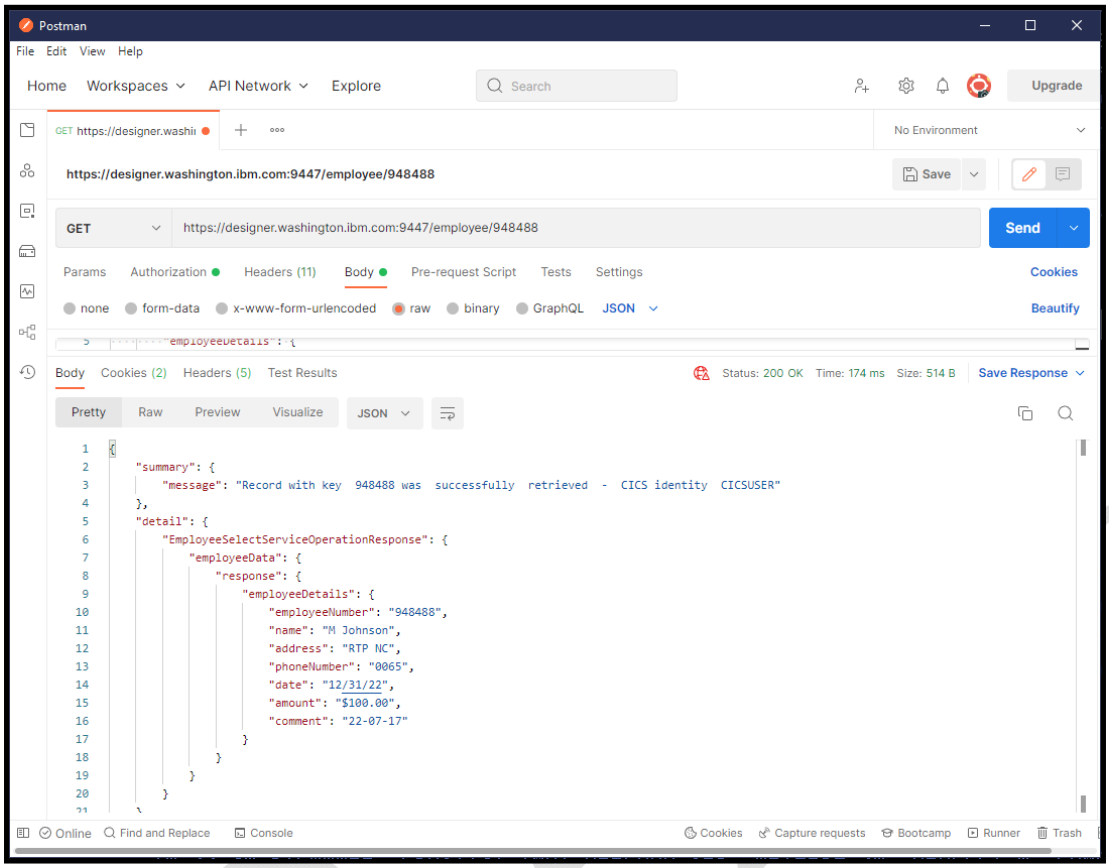
```
{
  "EmployeeInsertServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "employeeNumber": "948488",
          "date": "12/31/22",
          "amount": "$100.00",
          "address": "RTP NC",
          "phoneNumber": "0065",
          "name": "M Johnson"
        }   }   }   }   }
```

Pressing the **Send** button invokes the POST method of URI path */employee*.



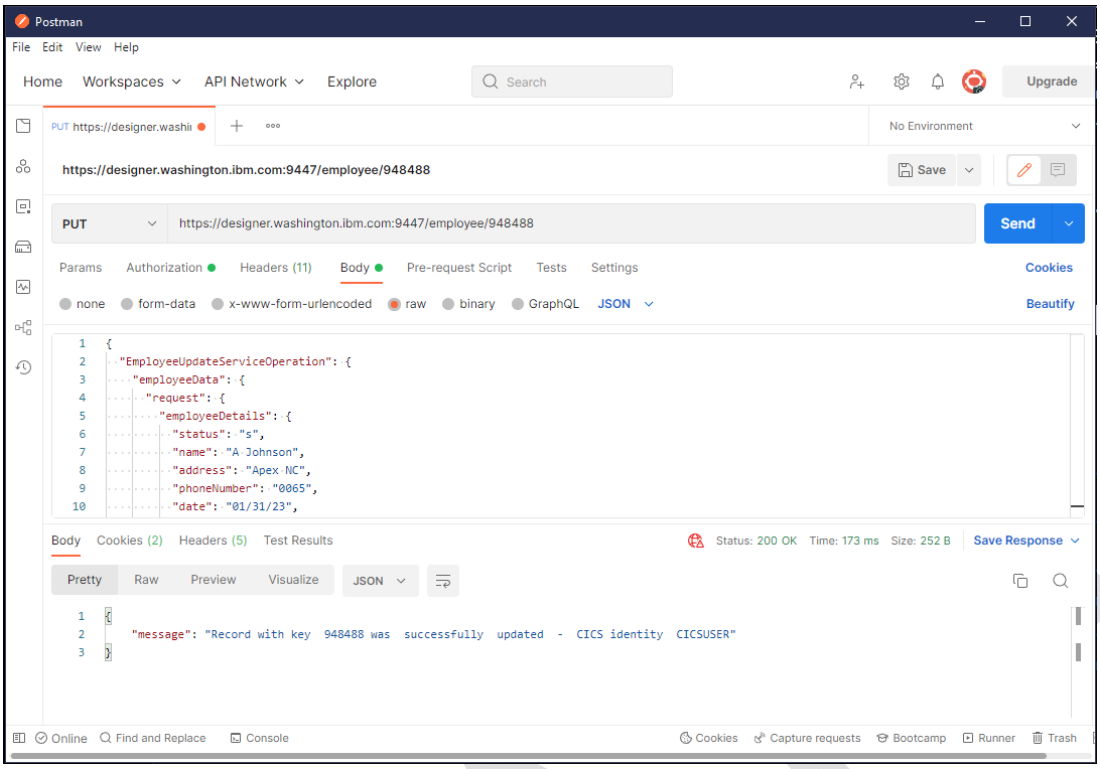
Mitch Johnson (mitchj@us.ibm.com)

____6. Invoke the *GET* method with URL ***https://designer.washington.ibm.com:9447/employee/948488*** to display the record just inserted.

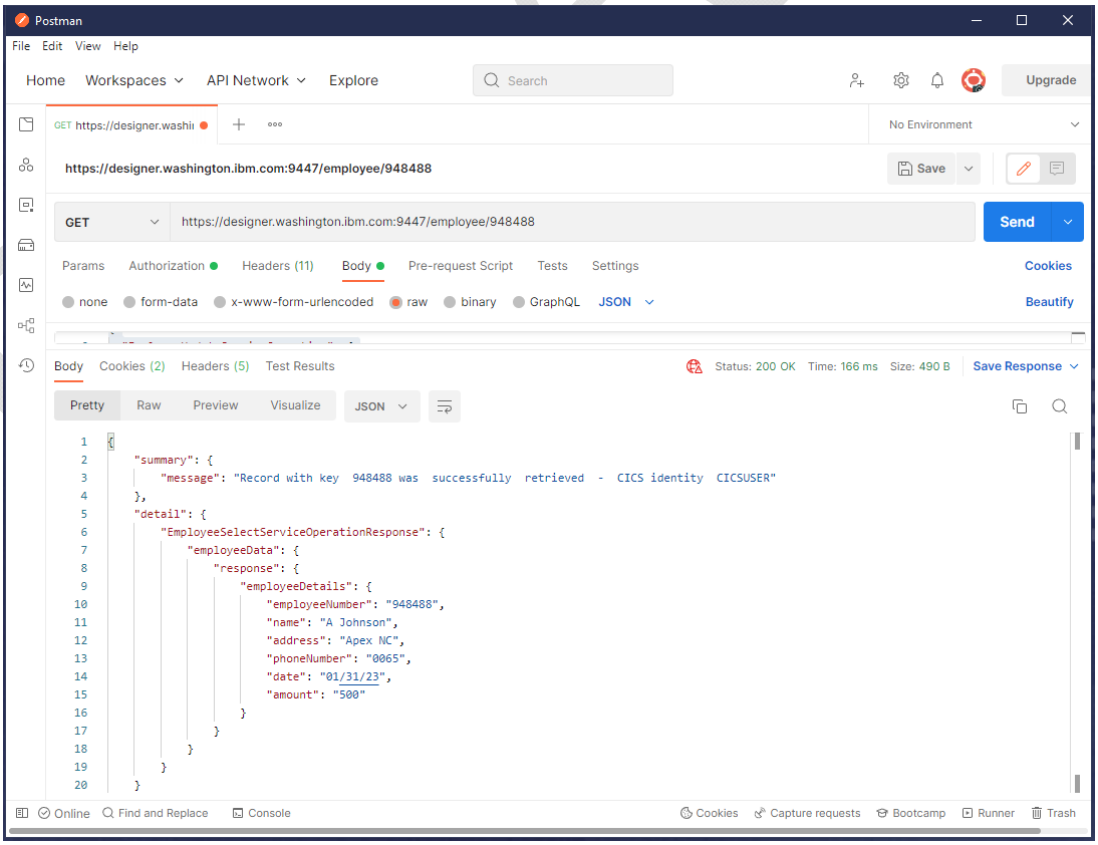


____7. Invoke a *PUT* method with URL ***https://designer.washington.ibm.com:9447/employee/948488*** and the JSON below for the request message to update the *salary, bonus, and commission* columns of this row.

```
{
  "EmployeeUpdateServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "status": "s",
          "name": "A Johnson",
          "address": "Apex NC",
          "phoneNumber": "0065",
          "date": "01/31/23",
          "amount": "500",
          "COMMENT": "updated"
        } } } } }
```

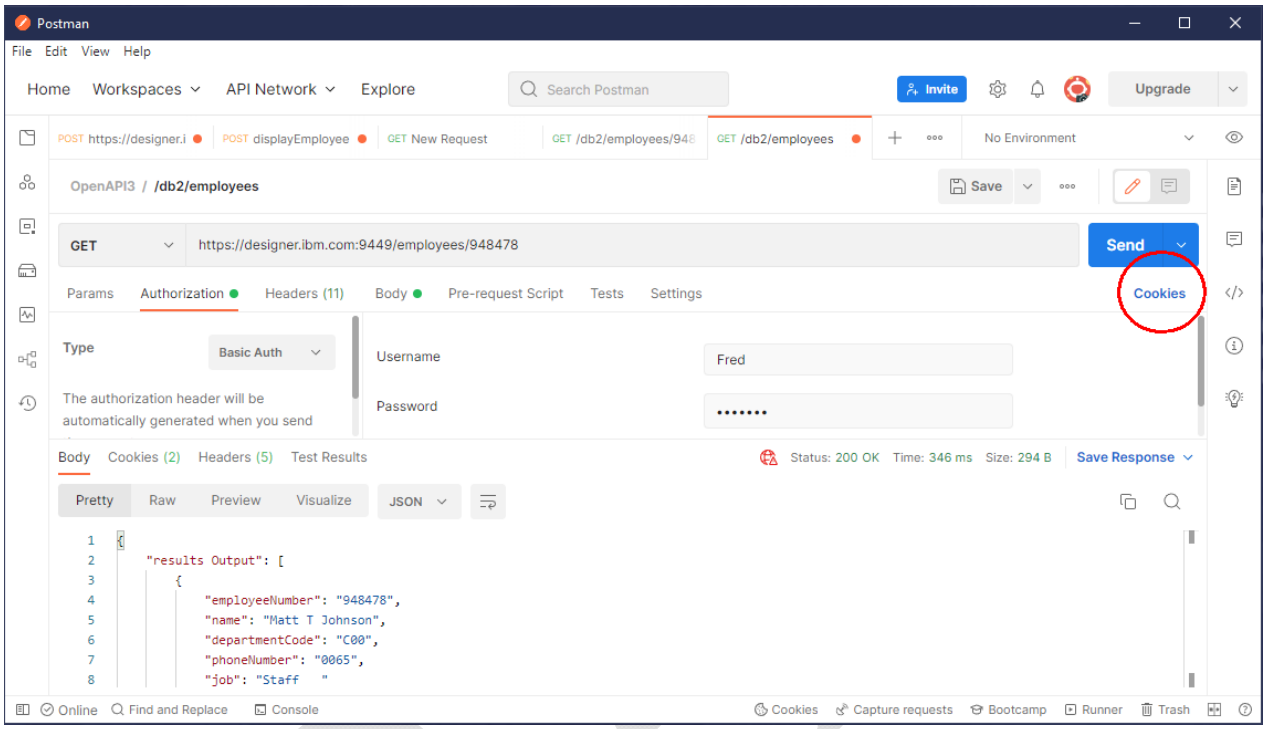


____8. Display the updated record by using a *GET* method with URL
https://designer.washington.ibm.com:9447/employee/948488

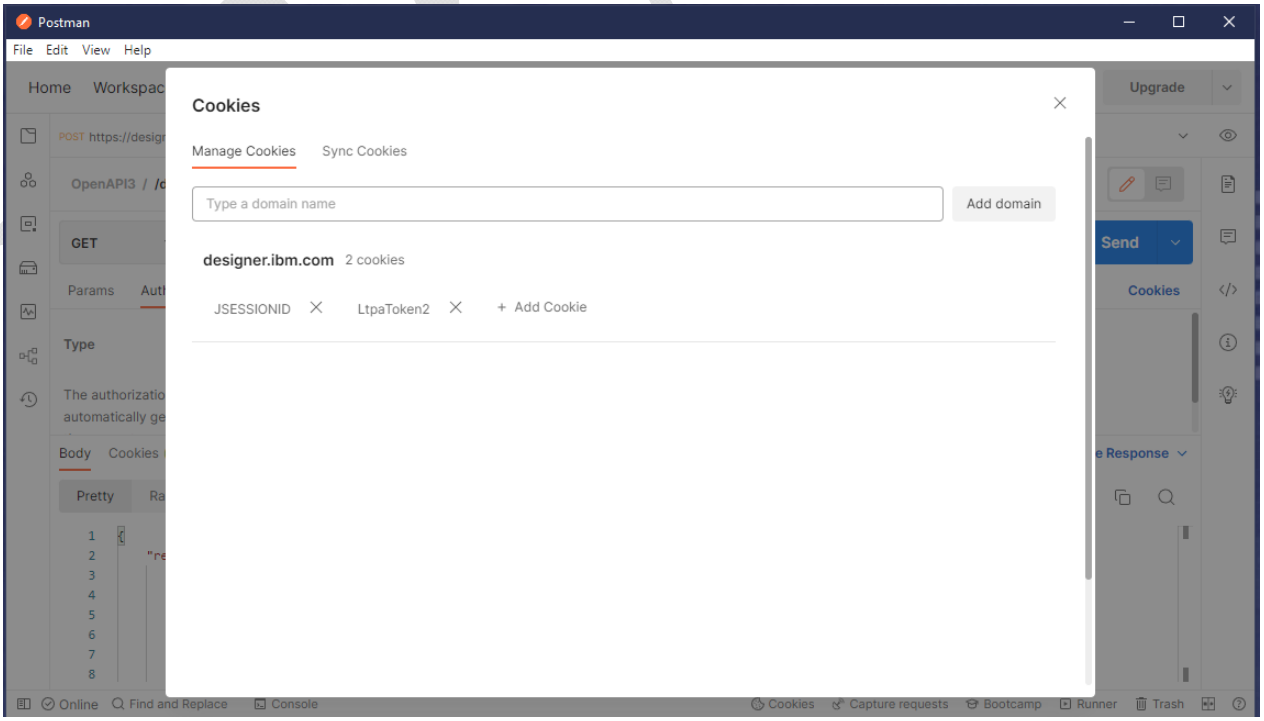


____9. Up until this point you have been using the role assigned to user *Fred*. Now experiment using user *user1* and/or *user2*. Before we can use other credentails we have to clear the credentails that cached by *Postman*. Unless this is done, *Postman* will continue to use the credentails for *Fred* regardless of what is provided in the authorization header.

____10. To clear the *Postman* cachced security tokens, click on the *Cookies* section of the *Postman* window and

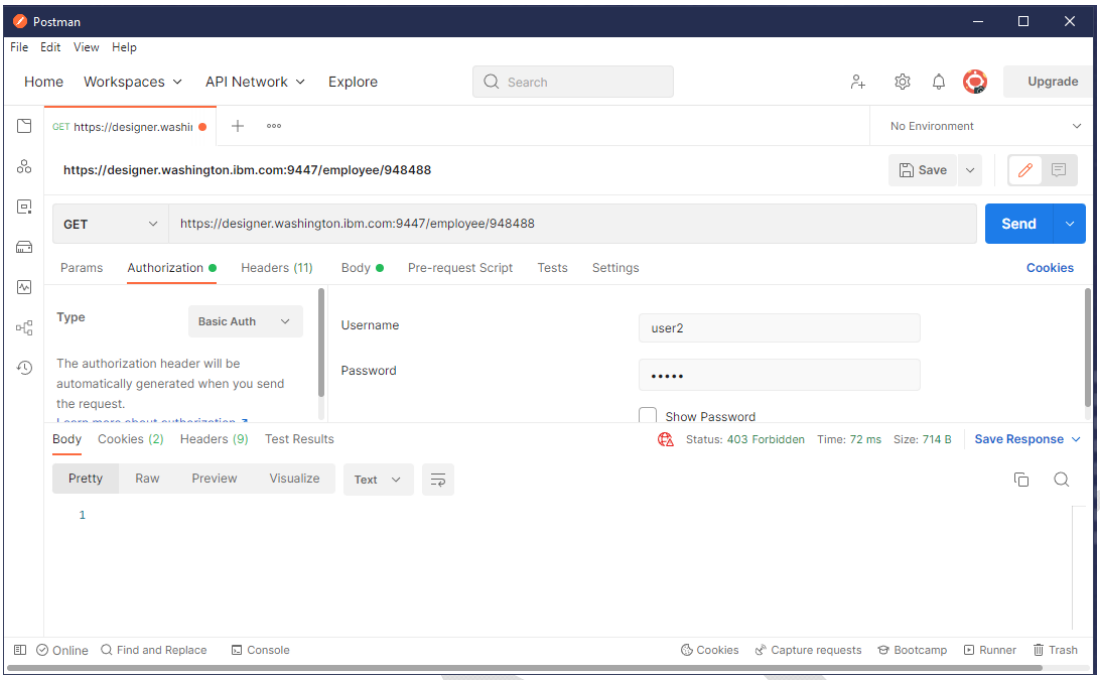


And delete any *JSESSIONID* and *LtpaToken2* cookies displayed.

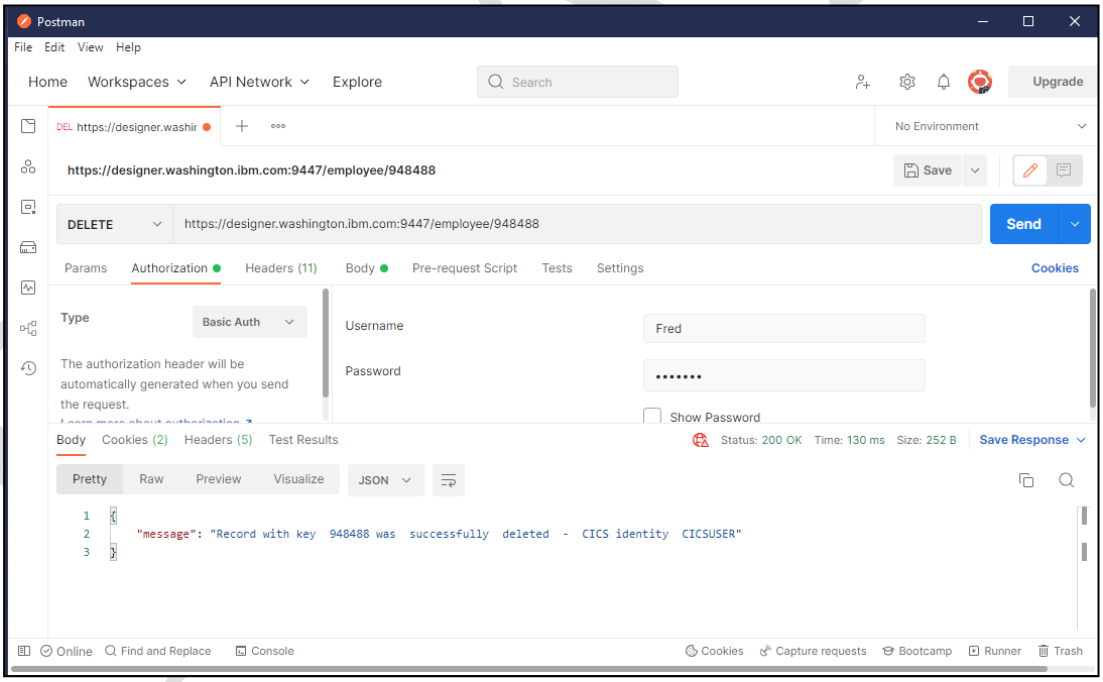


Mitch Johnson (mitchj@us.ibm.com)

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. For example, if you try to delete a record as *user1*, you should see an HTTP Status code of 403 (Forbidden).



While a delete request by Fred is successful.



Mitch Johnson (mitchj@us.ibm.com)

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:fredpwd --header "Content-Type:
application/json" --insecure  https://designer.washington.ibm.com:9447/employee/000100
```

```
c:\z\openApi3>curl -X GET  -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type:
application/json" --insecure  https://designer.washington.ibm.com:9447/employee/000100
{"summary":{"message":"Record with key  000100 was  successfully  retrieved  -  CICS identity
CICSUSER"},"detail":{"EmployeeSelectServiceOperationResponse":{"employeeData":{"response":{"employeeDetai
ls":{"employeeNumber":"000100","name":"S. D. BORMAN","address":"SURREY,
ENGLAND","phoneNumber":"32156778","date":"26 11 81","amount":"$0100.11"}}}}}} - HTTP CODE 200
```

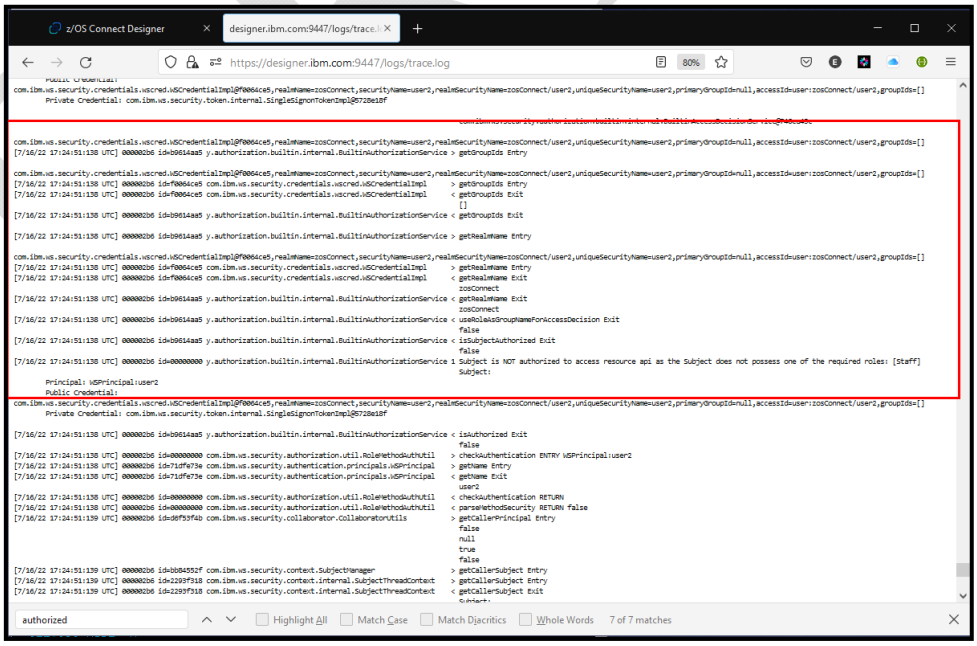
Fred is a member of the *Staff* group and has *Staff* access to the **Staff** role. Any identity with **Staff** access can invoke one of the GET methods.

___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://designer.washington.ibm.com:9447/employee/000100
```

```
c:\z\openApi3>curl -X GET  -w " - HTTP CODE %{http_code}" --user user2:user2 --header "Content-Type:
application/json" --insecure  https://designer.washington.ibm.com:9447/employee/000100
 - HTTP CODE 403
```

A review of the *trace.log* file will show the HTTP 403 (Forbidden) occurred because the identity *user2* is not a member of the *Staff* group.



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.*

Mitch Johnson (mitchj@us.ibm.com)

___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:fredpwd --data @insertCscvinc.json https://designer.washington.ibm.com:9447/employee/

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

```
{
  "EmployeeInsertServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "employeeNumber": "948499",
          "date": "12/31/22",
          "amount": "$100.00",
          "address": "RTP NC",
          "phoneNumber": "0065",
          "name": "M Johnson"
        } } } } }
```

```
c:\z\openApi3>curl -X POST -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fredpwd --data @insertCscvinc.json https://designer.washington.ibm.com:9447/employee/
{"message":"Record with key 948499 was successfully inserted - CICS  Identity  CICSUSER"} - HTTP CODE 200{"message":"Record for employee number 948489  was added successfully"} - HTTP CODE 200
```

___5. Enter the *curl* command below to invoke the *GET* method with URI path */employee/{employee}*

curl -X GET -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fredpwd https://designer.washington.ibm.com:9447/employee/948499

```
c:\z\openApi3>curl -X GET -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fredpwd  https://designer.washington.ibm.com:9447/employee/948478
{"summary":{"message":"Record with key  948478 was  successfully  retrieved  -  CICS identity
CICSUSER"},"detail":{"EmployeeSelectServiceOperationResponse":{"employeeData":{"response":{"employeeDetails":{"
employeeNumber":"948478","name":"name","address":"RTP
NC","phoneNumber":"0065","date":"12/31/22","amount":"$100.00"}}}}} - HTTP CODE 200
```

Now try using user2's credentials and see that it fails with an HTTP 403.

curl -X GET -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user user2:user2 https://designer.washington.ibm.com:9447/employee/948499

___6. Enter the *curl* command below to invoke the *PUT* method with URI path */employee/{employee}*

```
curl -X PUT -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --
insecure --user Fred:fredpwd  --data @updateCscvinc.json
https://designer.washington.ibm.com:9447/employee/948499
```

```
c:\z\openApi3>curl -X PUT -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure
--user Fred:fredpwd  --data @updateCscvinc.json https://designer.washington.ibm.com:9447/employee/948499
{"message":"Record with key  948478 was  successfully  updated  -  CICS identity  CICSUSER"} - HTTP CODE 200
```

The file *updateCscvinc.json* contains the contents below:

```
{
  "EmployeeUpdateServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "status": "s",
          "name": "A Johnson",
          "address": "Apex NC",
          "phoneNumber": "0065",
          "date": "01/31/23",
          "amount": "500",
          "COMMENT": "updated"
        }  }  }  } }
```

___7. Confirm the updates were made by using a *GET* method to retrieve this record.

___8. Enter the *curl* command below to invoke the *DELETE* method with URI path */employee/{employee}*.

```
curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" -
-insecure --user Fred:fredpwd  https://designer.washington.ibm.com:9447/employee/948499
```

```
c:\z\openApi3>curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --
insecure --user Fred:fredpwd  https://designer.washington.ibm.com:9447/employee/948478
{"message":"Record with key  948499 was  successfully  deleted  -  CICS identity  CICSUSER"} - HTTP CODE
200
```

Repeat the command again and observe the results

```
c:\z\openApi3>curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --
insecure --user Fred:fredpwd  https://designer.washington.ibm.com:9447/employee/948478
{"message":"Record with key 948499 was not found -  CICS Identity  CICSUSER"} - HTTP CODE 404
```

___9. Enter the *curl* command below to invoke the *DELETE* method again with URI path */employee/{employee}*.

```
Curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" -
-insecure --user user1:user1  https://designer.washington.ibm.com:9447/employee/948499
```

```
c:\z\openApi3>curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --
insecure --user user1:user1  https://designer.washington.ibm.com:9447/employee/948499
 - HTTP CODE 403
```

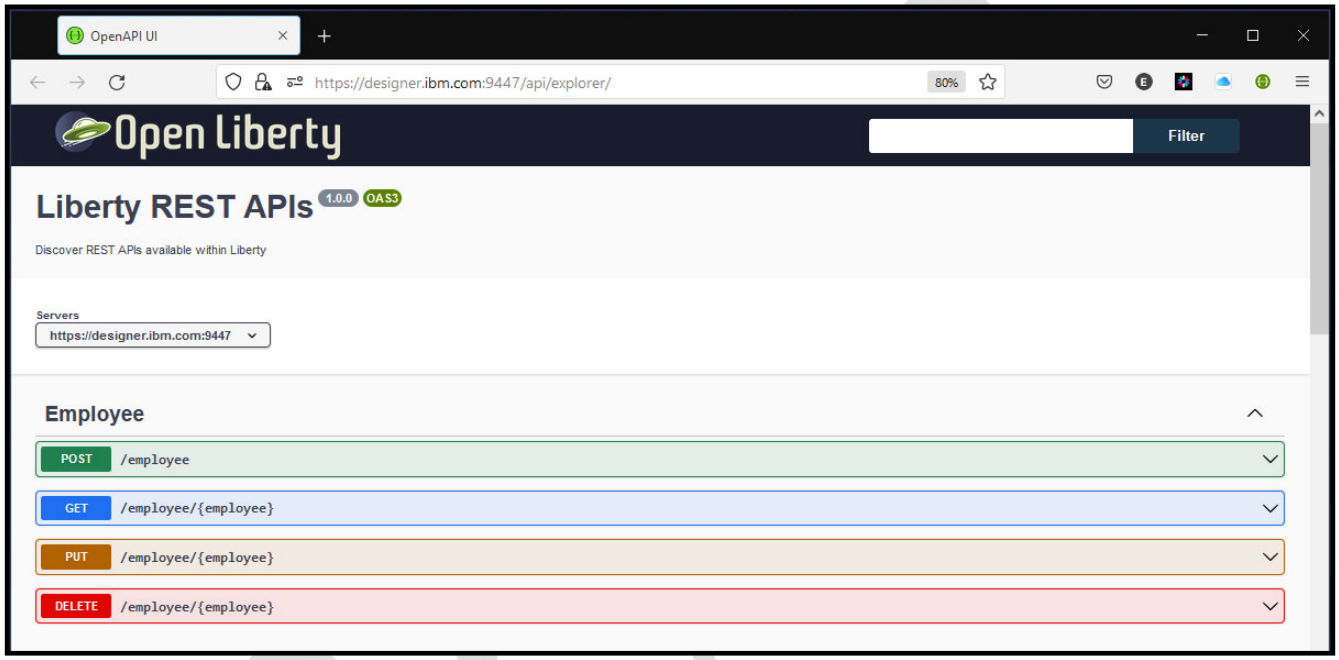
The HTTP 403 is cause by user1 not having DELETE authority.

Invoke other curl commands varying the credentials , methods, etc. until you feel comfortable the API is working as intended.

Using the API Explorer

The API Explorer was used in the Designer to test the APIs as they were being developed. The API Explorer All the URI paths and methods in the original OpenAPI 3 specification document will be displayed, but only the *POST* for */employee* and the *GET* for */employee/{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.

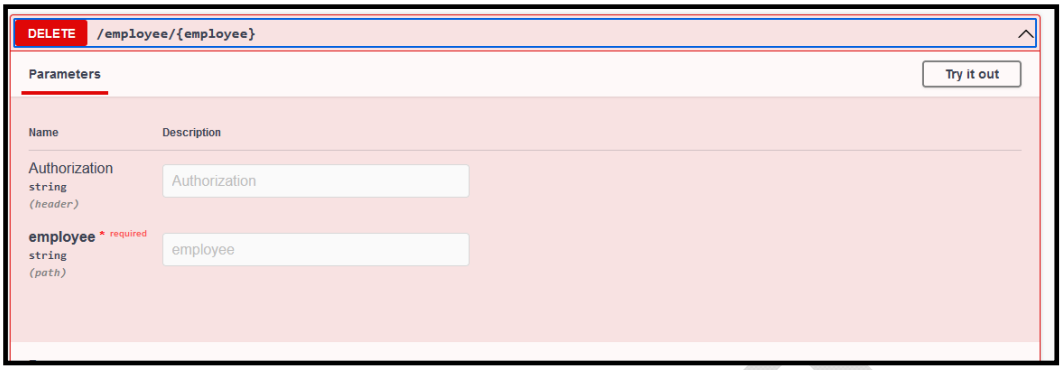
___1. Using the Firefox browser, go to URL ***https://designer.washington.ibm.com:9447/api/explorer*** to start the API Explorer.



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.

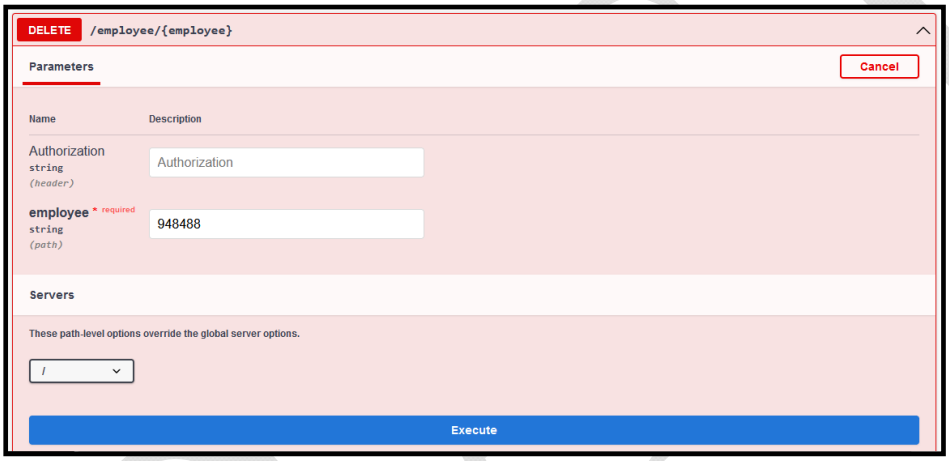
Mitch Johnson (mitchj@us.ibm.com)

___2. Click on *DELETE /employee/{employee}* URI path to display the request parameters.



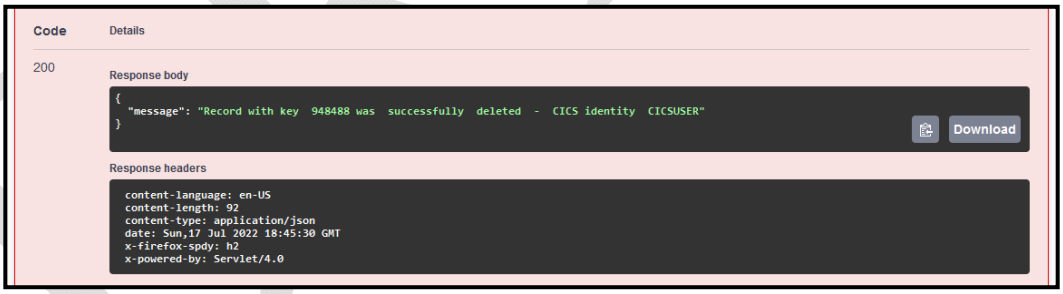
___3. Press the **Try it out button**.

___4. Enter a value of ***948488*** and press the **Execute** button.



___5. Enter a value of ***948488*** and press the **Execute** button .

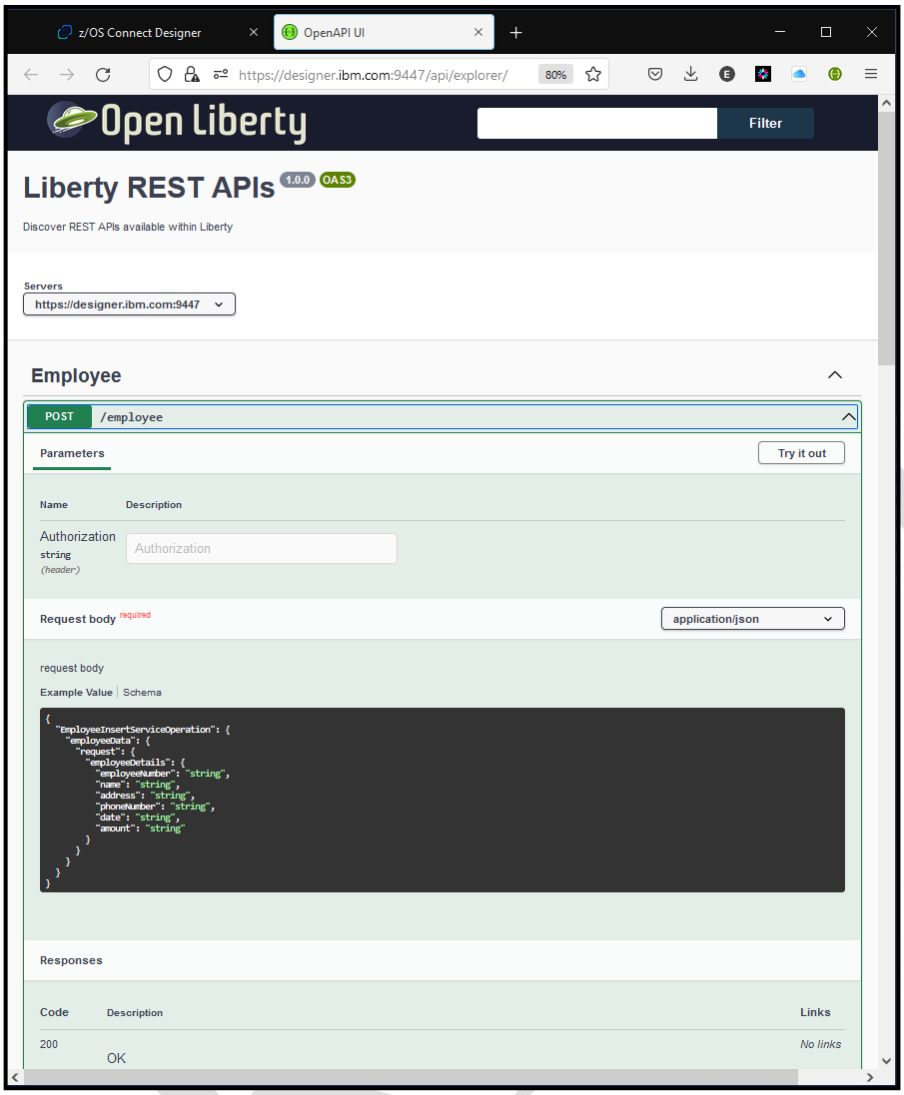
___6. If the record exist, a message like the one below will appear.



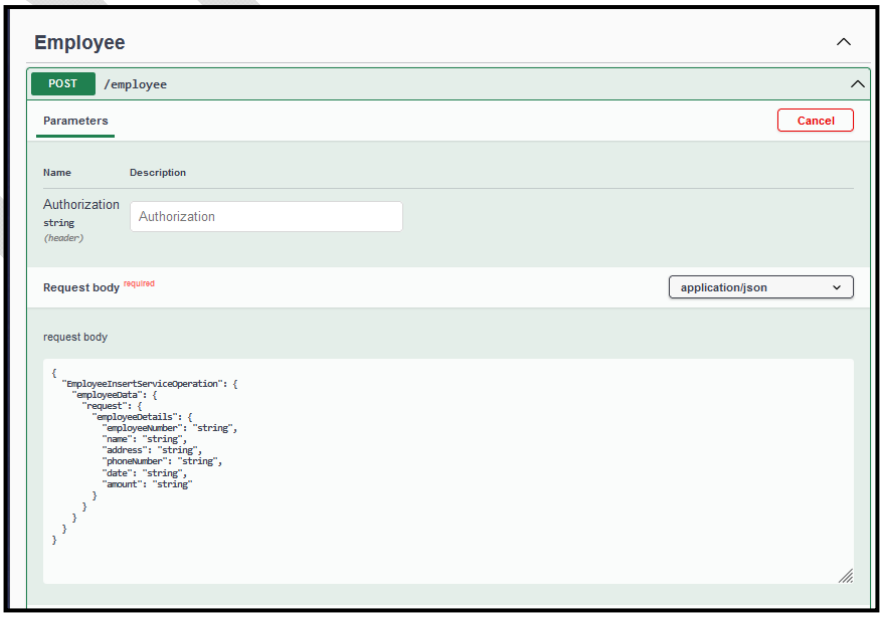
___7. Otherwise, a message that the record was not found will appear.

Mitch Johnson (mitchj@us.ibm.com)

___8. Click on *POST /employee* URI path to display the request body view of the URI path.



___9. Next press the ***Try it out*** button to enable the entry of a request message body

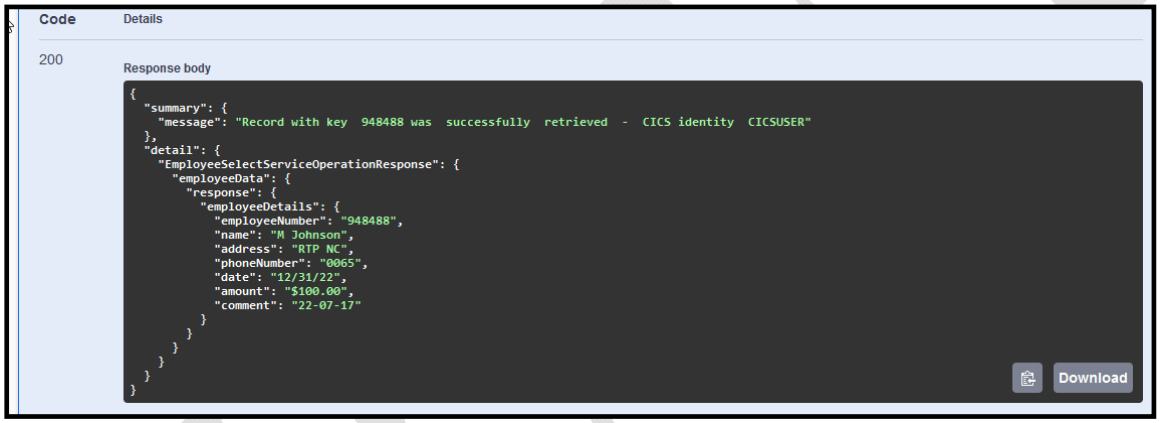


Mitch Johnson (mitchj@us.ibm.com)

___10. Enter the JSON request message below in the *Request body* section and press the **Execute** button.

```
{
  "EmployeeInsertServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "employeeNumber": "948488",
          "date": "12/31/22",
          "amount": "$100.00",
          "address": "RTP NC",
          "phoneNumber": "0065",
          "name": "M Johnson"
        } } } } }
```

___11. Use a Click on *GET* for URI path */employee/{employee}* to display the GET method parameters. Press the **Try it out button** Enter ***948488*** for the employee and press the **Execute** button to display this record.



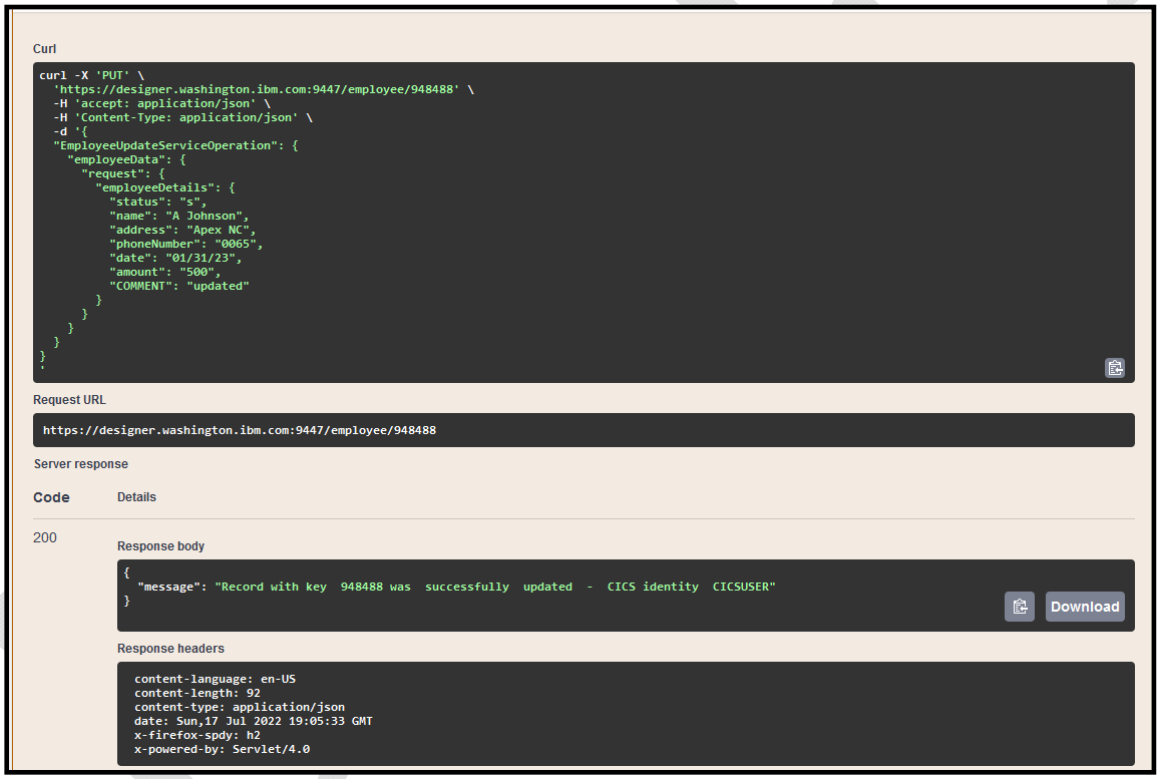
Security was enabled in the original specification document, so you will be required to sign in with a RACF identity. Use ***Fred*** for the *Username* and ***fred*** for the *Password*. Please note that this identity can be changed unless all browser sessions are stopped.

___12. Try this again using number ***121212*** and observe the results. You see the message that the employee was not found.

___13. Expand the *PUT* method and press the **Try it out** button.

___14. Enter ***948488*** in the area beside *employee* and enter the JSON below in the request body area and press the **Execute** button.

```
{
  "EmployeeUpdateServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "status": "s",
          "name": "A Johnson",
          "address": "Apex NC",
          "phoneNumber": "0065",
          "date": "01/31/23",
          "amount": "500",
          "COMMENT": "updated"
        } } } } }
```



___15. Use the *GET* method to confirm the updates have taken place.

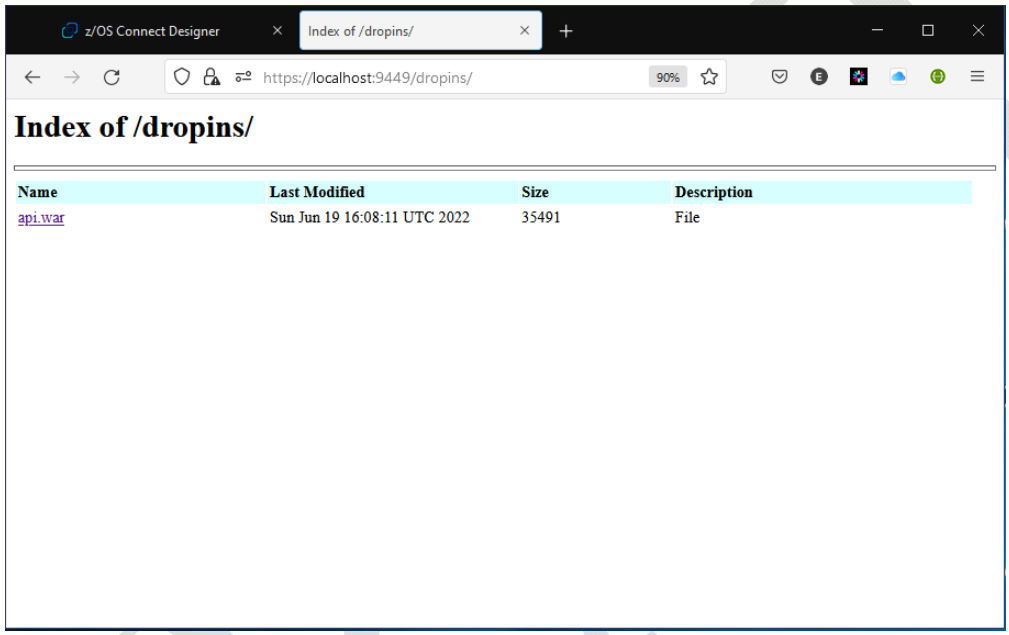
___16. Use the *DELETE* method to delete employee ***948488*** and confirm the record has been deleted.

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:9447/dropins.



Double click the *api.war* file and save the file in local directory, e.g., *c:/z/openApi3/wars*. Specify a *File* name of ***cscvinc.war***.

___2. Open a DOS command prompt and use the change directory command to go to directory C:\z\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**

___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 cscvinc.war
200 Port request OK.
125 Storing data set /var/zcee/openApi3/apps/employee.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.

Mitch Johnson (mitchj@us.ibm.com)

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="cics" contextRoot="/cics"  name="cicsAPI"
location="${server.config.dir}apps/cscvinc.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 */cics* 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.

Mitch Johnson (mitchj@us.ibm.com)

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 **cicsApi**. The final source is the role name provided in the specification document, **Manager** or **Staff**. So, two EJBRoles need to be defined, **ATSZDFLT.cicsApi.Manager** and **ATSZDFLT.cicsApi.Staff**.

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

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

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

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

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

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

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

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

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

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

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

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

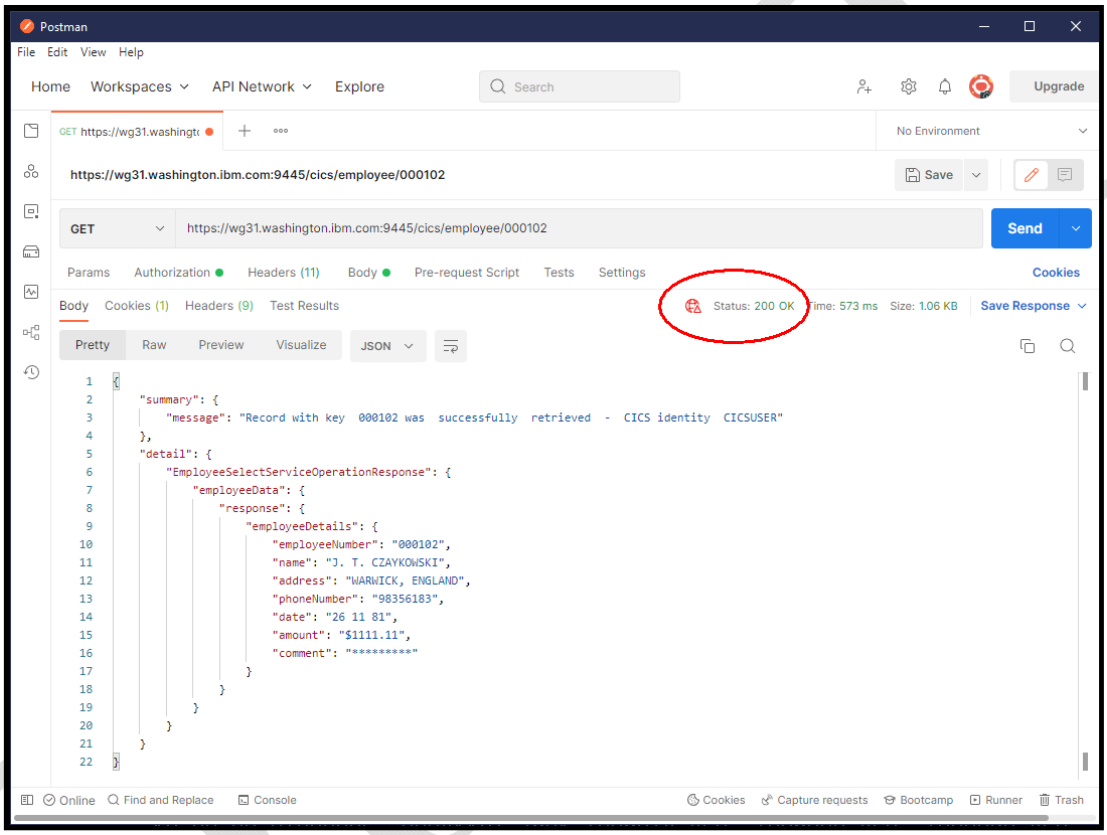
Now we are ready to test the invoking of the methods of this API.

Testing APIs deployed in a native z/OS server

Using Postman

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

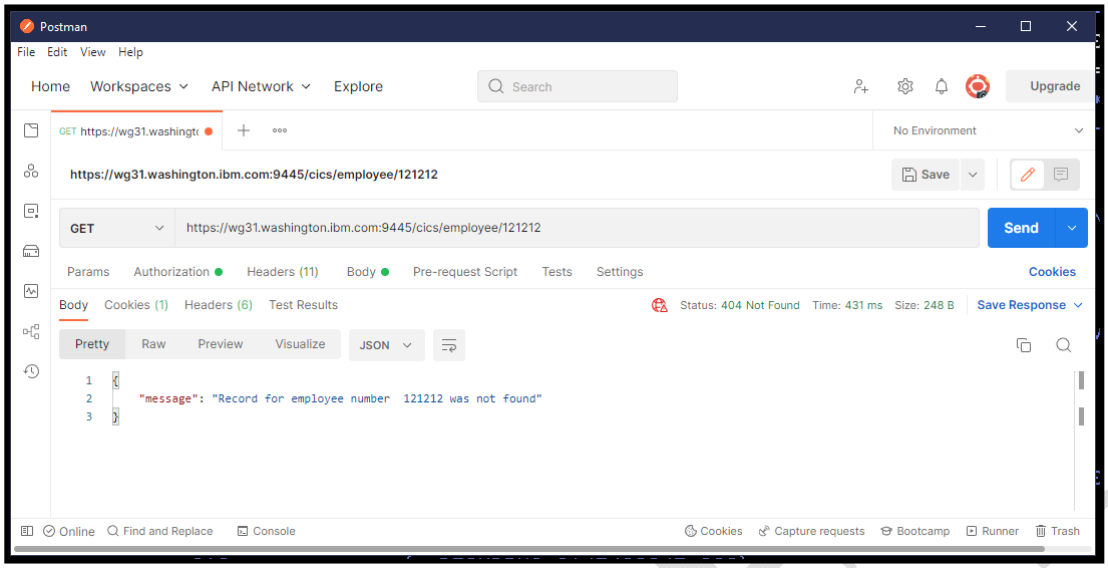
____1. Open the *Postman* tool icon on the desktop and if necessary reply to any prompts and close any welcome messages. Set *Authorization* type to to basic and use ***fred*** as the *Username* and ***fred*** as the *Password* and add a header property of ***Content-Type*** with a value of ***application/json***. Then use the down arrow in the *Body* tab to select **GET** and enter ***https://wg31.washington.ibm.com:9445/cics/employee/000102*** 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. The other major differences was of the context root of */cics* in the URI path. This was the value of the *contextRoot* attribute in the *webApplication* configuration element that defined this application in the z/OS Connect server.

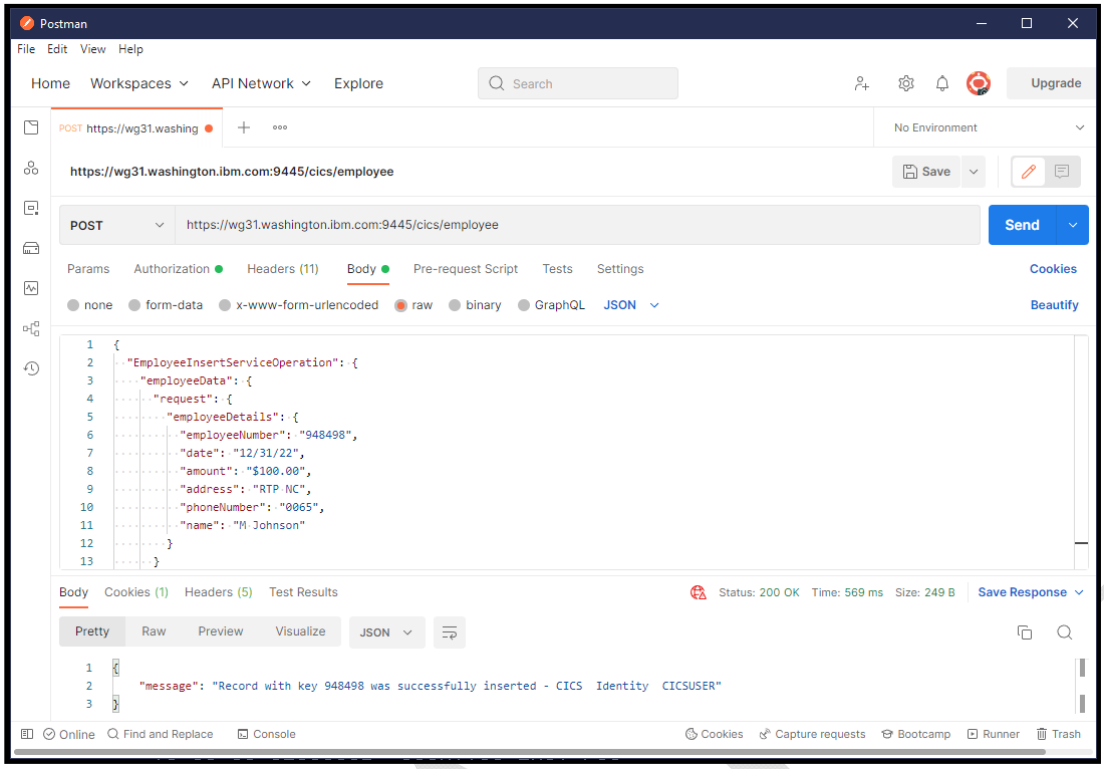
Mitch Johnson (mitchj@us.ibm.com)

____2. Next enter an invalid employee number such as 121212, ***https://wg31.washington.ibm.com:9445/cics/employee/121212*** in the URL area (see below) and press **Send**. You should see results like below in the response *Body* area.



____3. Invoke a *POST* with URI path */employee,* use the JSON below for the request message.

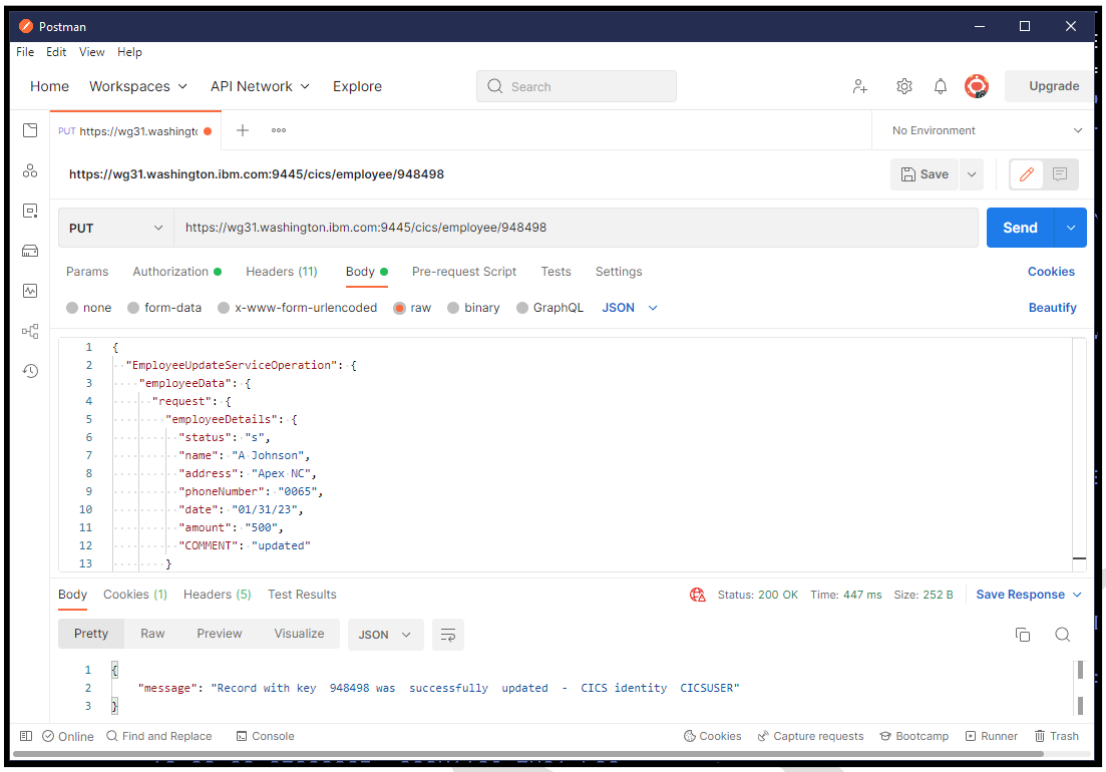
```
{
  "EmployeeInsertServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "employeeNumber": "948498",
          "date": "12/31/22",
          "amount": "$100.00",
          "address": "RTP NC",
          "phoneNumber": "0065",
          "name": "M Johnson"
        } } } } }
```



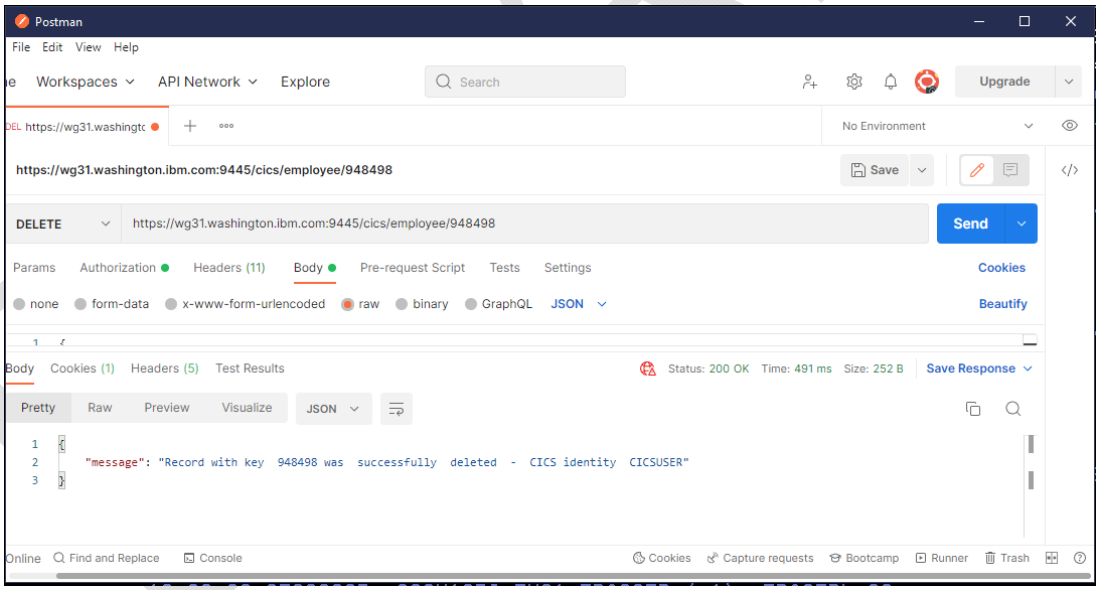
____4. Perform a *PUT* with URI path /cics/employee/{employee} use this JSON request message.

https://wg31.washington.ibm.com:9445/cics/employee/948498

```
{
  "EmployeeUpdateServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "status": "s",
          "name": "A Johnson",
          "address": "Apex NC",
          "phoneNumber": "0065",
          "date": "01/31/23",
          "amount": "500",
          "COMMENT": "updated"
        } } } } }
```

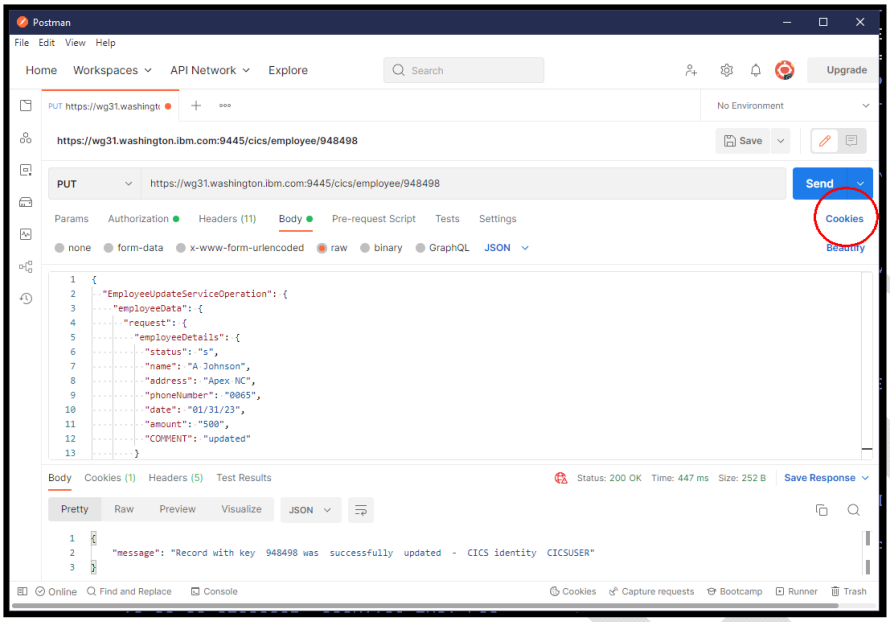


____5. Perform a *DELETE* with URI path */cics/employee/948498*.

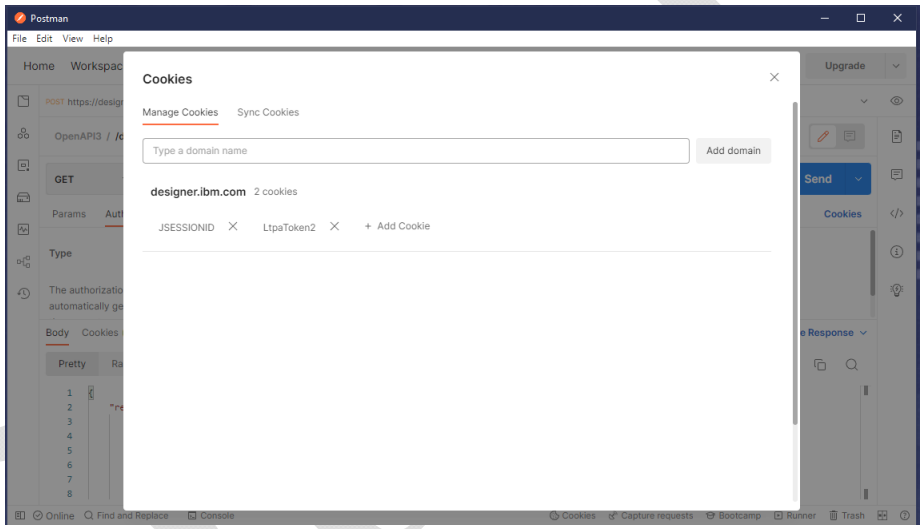


____6. Up until this point you have been using the role assigned to user *Fred*. Now experiment using user *user1* and/or *user2*. Before we can use other credentails we have to clear the credentails that cached by *Postman*. Unless this is done, *Postman* will continue to use the credentails for *Fred* regardless of what is provided in the authorization header.

____7. To clear the *Postman* cachced tokens, click on the *Cookies* section of the *Postman* window.



____8. 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.

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*.

___10. Start a DOS command prompt session and go to directory *c:\z\openapi3, e.g.,* ***cd \z\openap3***.

___11. 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/cics/employee/222222
```

```
c:\z\openApi3>curl -X GET  -w " - HTTP CODE %{http_code}" --user Fred:fred --header "Content-
Type: application/json" --insecure  https://wg31.washington.ibm.com:9445/cics/employee/222222
{"summary":{"message":"Record with key  222222 was  successfully  retrieved  -  CICS identity
CICSUSER"},"detail":{"EmployeeSelectServiceOperationResponse":{"employeeData":{"response":{"e
mployeeDetails":{"employeeNumber":"222222","name":"DR E.
GRIFFITHS","address":"FRANKFURT, GERMANY","phoneNumber":"20034151","date":"26 11
81","amount":"$0022.00","comment":"*********"}}}}}} - 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.

___12. 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/cics/employee/222222
```

```
c:\z\openApi3>curl -X GET  -w " - HTTP CODE %{http_code}" --user user2:user2 --header "Content-
Type: application/json" --insecure  https://wg31.washington.ibm.com:9445/cics/employee/222222
 - HTTP CODE 403
```

A review of the SYSLOG will show that RACF access to the EJBRole protecting this method prevented USER2 from accessing this method.

```
ICH408I USER(USER2   ) GROUP(SYS1    ) NAME(WORKSHOP USER2      )
  ATSZDFLT.cicsAPI.Staff CL(EJBROLE )
  INSUFFICIENT ACCESS AUTHORITY
  ACCESS INTENT(READ   )  ACCESS ALLOWED(NONE   )
```


Mitch Johnson (mitchj@us.ibm.com)

___13. 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 @insertCscvinc.json https://wg31.washington.ibm.com:9445/cics/employee/
```

```
{
 "EmployeeInsertServiceOperation": {
  "employeeData": {
   "request": {
    "employeeDetails": {
     "employeeNumber": "948478",
     "date": "12/31/22",
     "amount": "$100.00",
     "address": "RTP NC",
     "phoneNumber": "0065",
     "name": "M Johnson"
    }
   }
  }
 }
}
```

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

```
c:\z\openApi3>curl -X POST -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred --data @insertCscvinc.json https://wg31.washington.ibm.com:9445/cics/employee/
{"message":"Record with key 948478 was successfully inserted - CICS  Identity CICSUSER"} - HTTP CODE 200
```

___14. Enter the curl command below to invoke the *PUT* method with URI /employee/{employee} to update a record.

```
curl -X PUT -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred --data @updateCscvinc.json https://wg31.washington.ibm.com:9445/cics/employee/948478
```

```
c:\z\openApi3>curl -X PUT -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred --data @updateCscvinc.json https://wg31.washington.ibm.com:9445/cics/employee/948478
{"message":"Record with key  948478 was  successfully  updated  -  CICS identity  CICSUSER"} - HTTP CODE 200
```


Mitch Johnson (mitchj@us.ibm.com)

In the above command, file *updateCscvinc.json* contains this content.

```
{
  "EmployeeUpdateServiceOperation": {
    "employeeData": {
      "request": {
        "employeeDetails": {
          "status": "s",
          "name": "A Johnson",
          "address": "Apex NC",
          "phoneNumber": "0065",
          "date": "01/31/23",
          "amount": "500",
          "COMMENT": "updated"
        } } } } }
```

___15. Repeat the GET request to observe that the updates have been applied.

___16. Enter the curl command below to invoke the *DELETE* method with URI path */employee/{employee}*.

```
curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred  https://wg31.washington.ibm.com:9445/cics/employee/948478
```

```
c:\z\openApi3>curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user Fred:fred  https://wg31.washington.ibm.com:9445/cics/employee/948478
{"message":"Record with key  948478 was  successfully  deleted  -  CICS identity  CICSUSER"} - HTTP CODE 200
```

___17. Enter the curl command below to invoke the *DELETE* method with URI path */employee/{employee}*.

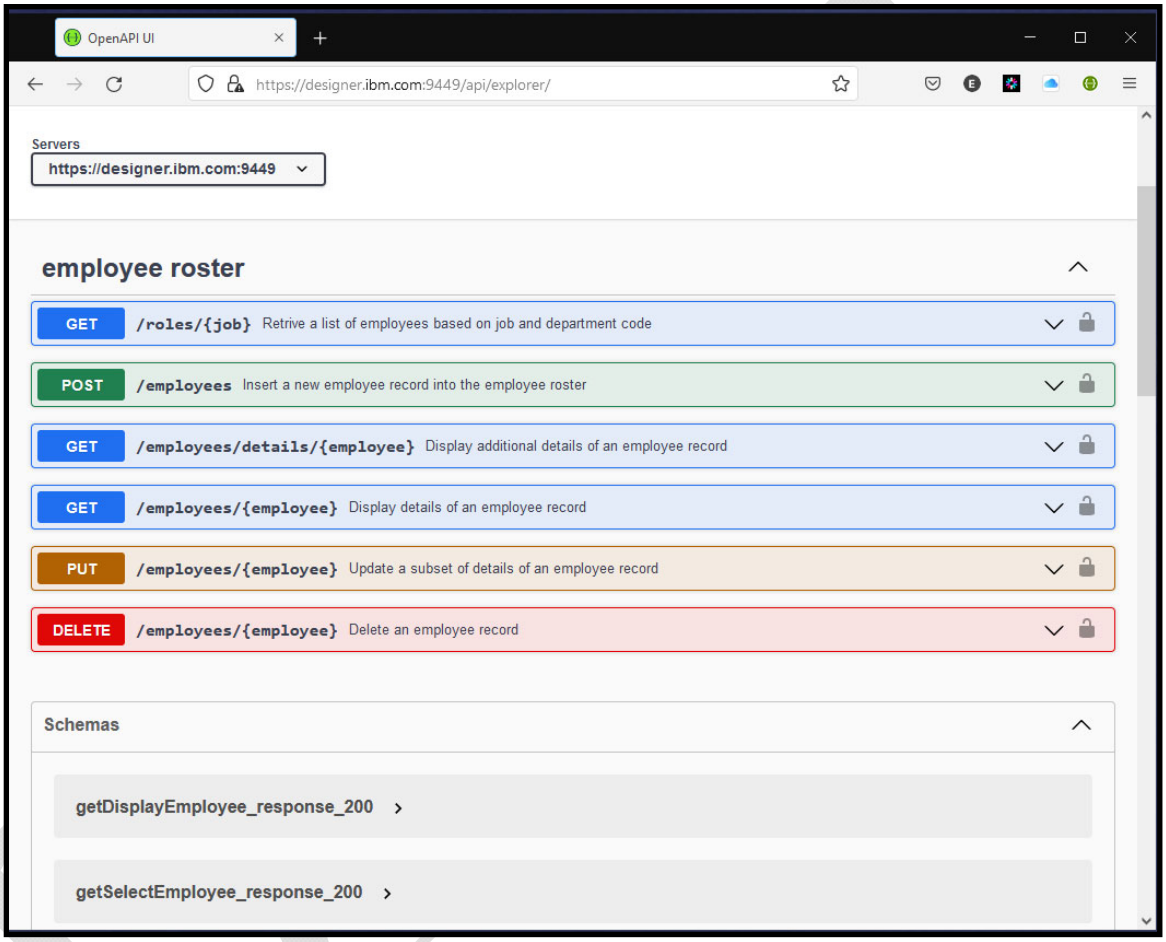
```
curl -X DELETE -w " - HTTP CODE %{http_code}" --header "Content-Type: application/json" --insecure --user user1:user1  https://wg31.washington.ibm.com:9445/cics/employee/948478
```

What HTTP status code occurred and why did it occur?

Using the API Explorer

The API Explorer was used in the Designer to test the APIs as they were being developed. The API Explorer All the URI paths and methods in the original OpenAPI 3 specification document will be displayed, but only the *POST* for */employee* and the *GET* for */employee/{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.

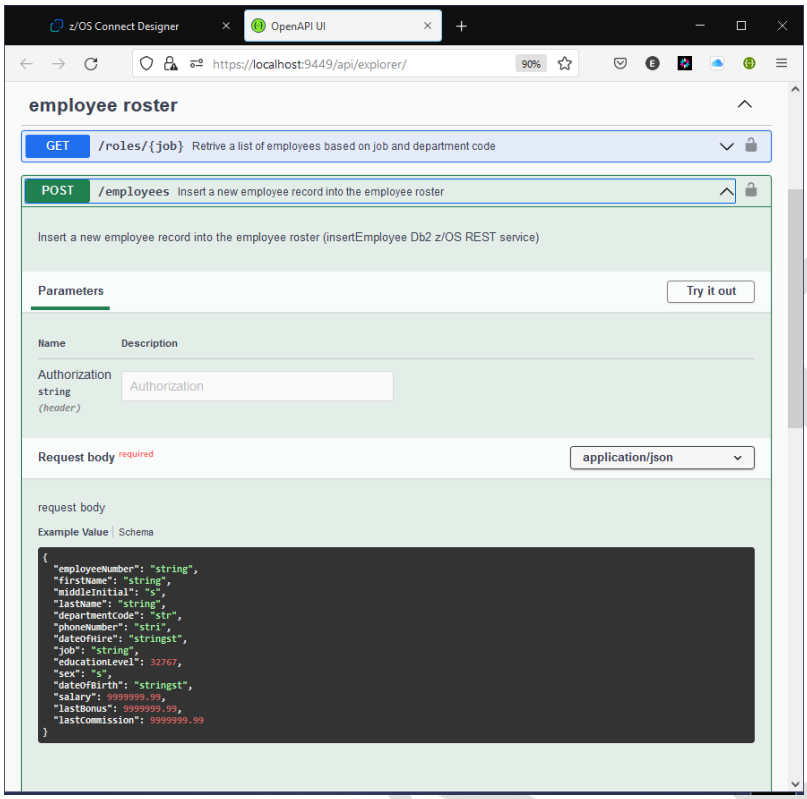
___17. Using the Firefox browser, go to URL ***https://wg31.washington.ibm.com:9445/api/explorer*** to start the API Explorer.



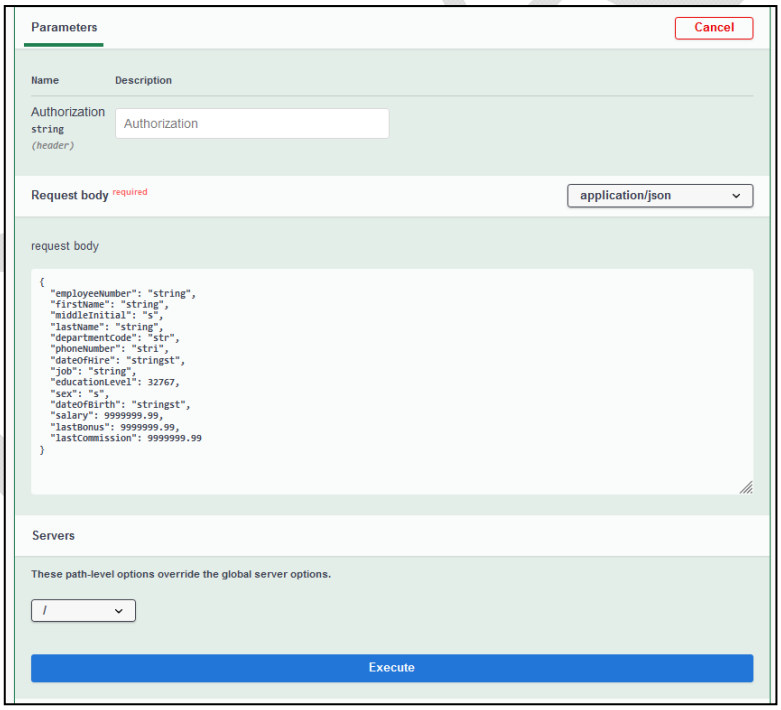
Tech Tip: You may be challenged by browser because the digital certificate used by the *Designer* is self-signed Click the **Advanced** button to continue. Scroll down and then click on the **Accept the Risk and Continue** button. Next you may see a prompt you for a userid and password. If you do see 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.

Mitch Johnson (mitchj@us.ibm.com)

Click on *Post /employee* URI path to display the request body view of the URI path.



___18. Next press the ***Try it out*** button to enable the entry of an authorization string and a request message body



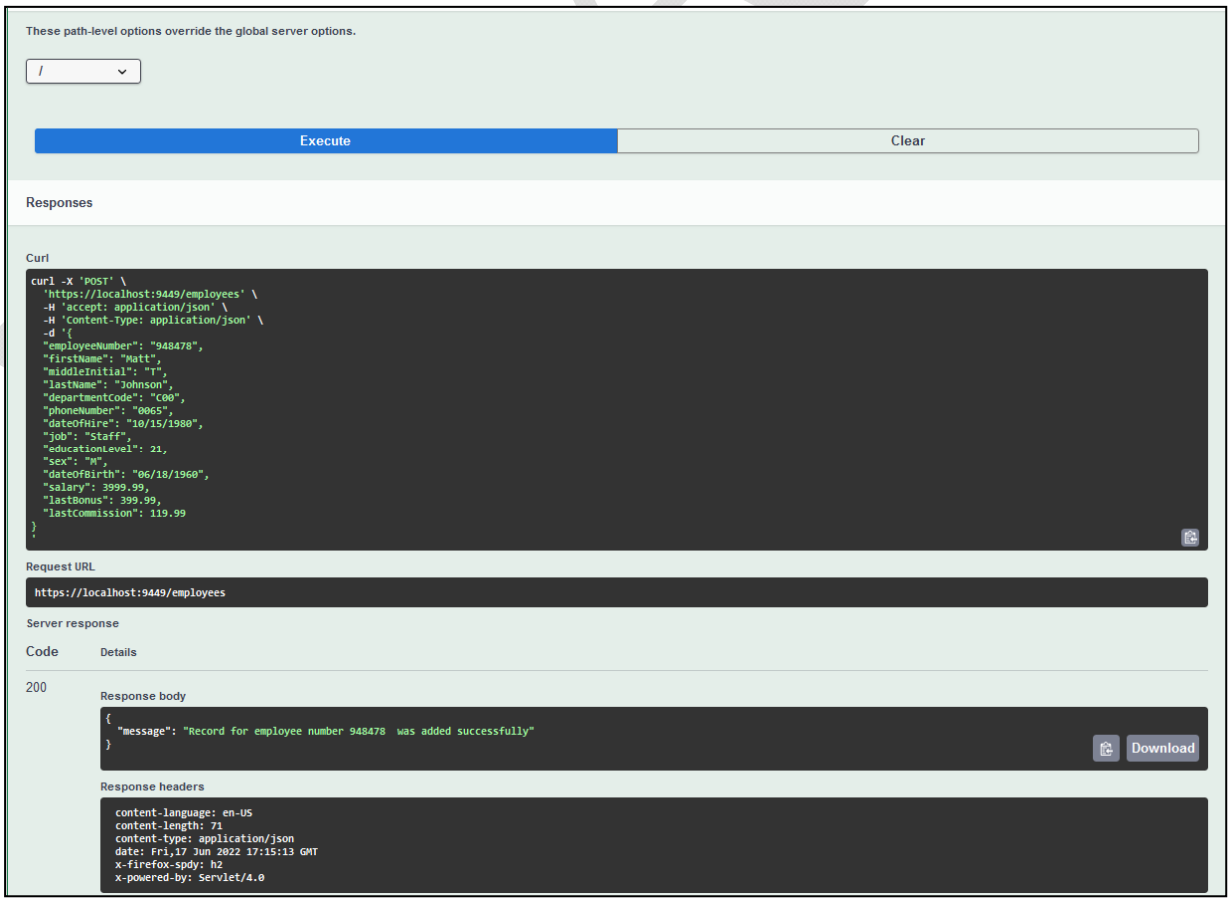
Mitch Johnson (mitchj@us.ibm.com)

___19. 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
}
```

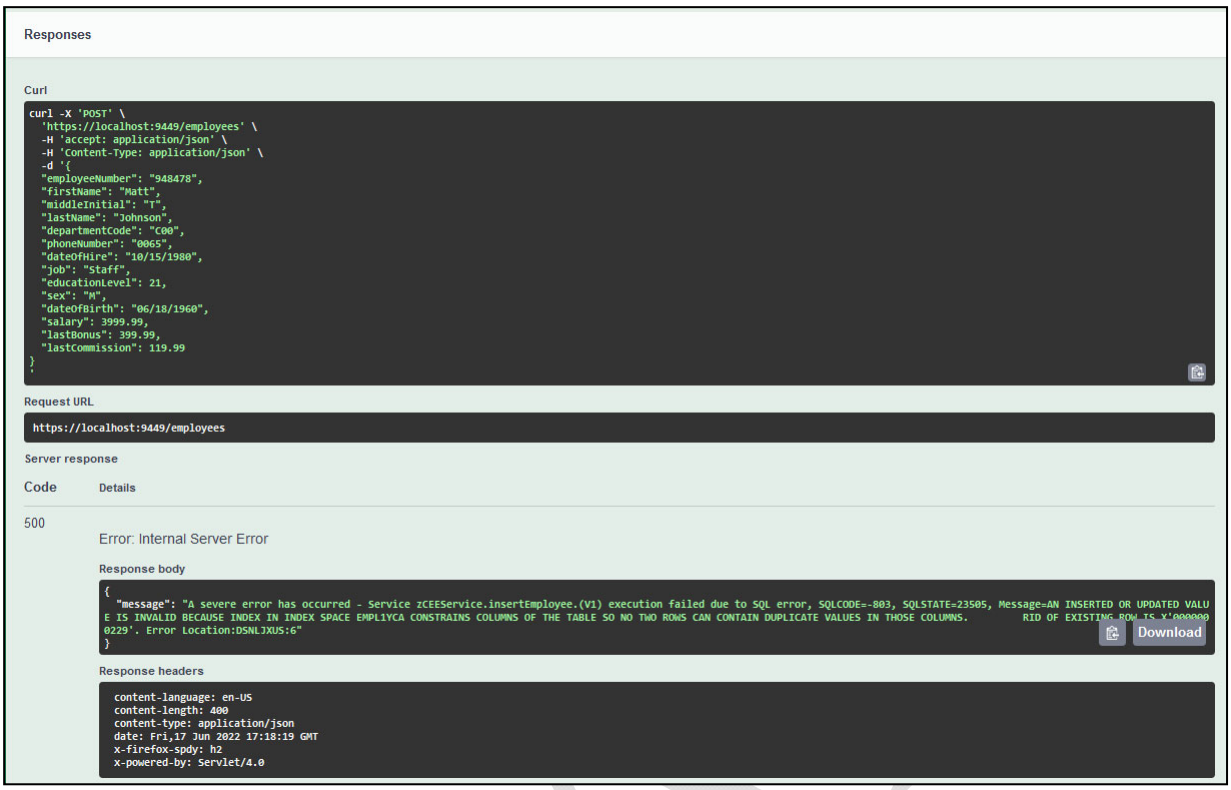
___20. Security was enabled in the original specification document, so you will be required to sign in with one of the identities defined in the basicSecurity.xml file explored earlier. Use ***Fred*** for the *Username* and ***fredpwd*** for the *Password*. Please note that this identity can be changed unless all browser sessions are stopped.

___21. Scroll down the view and you should see the *Response body* with the expected successful message.

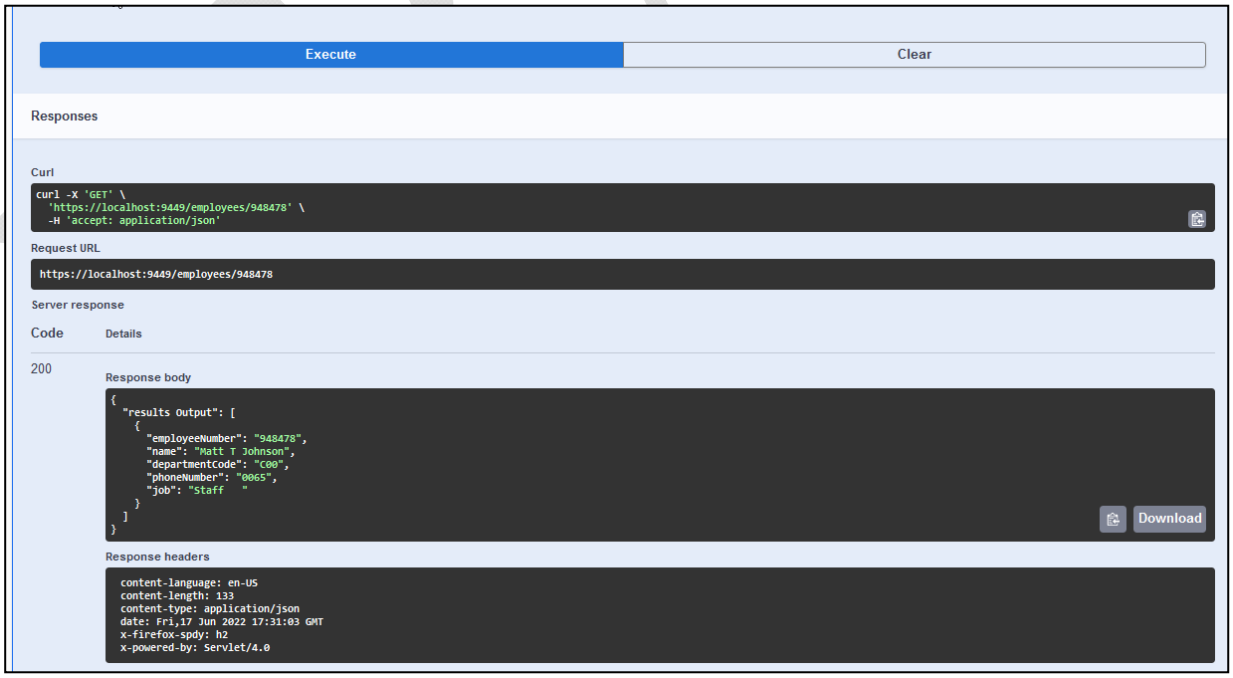


Mitch Johnson (mitchj@us.ibm.com)

22. 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.



23. Scroll down and click on *GET /employee/{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.



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

The table below list the contents of the VSAM data set.

stat	numb	name	addrx	Phone	datex	amount	comment
Y	000100	S. D. BORMAN	SURREY, ENGLAND	32156778	26 11 81	$0100.11	*********
Y	000102	J. T. CZAYKOWSI	WARWICK, ENGLAND	98356183	26 11 81	$1111.11	*********
Y	000104	M. B. DOMBEY	LONDON,ENGLAND	12846293	26 11 81	$0999.99	*********
Y	000106	A. I. HICKSON	CROYDON, ENGLAND	19485673	26 11 81	$0087.71	*********
Y	000111	ALAN TULIP	SARATOGA,CALIFORNIA	46120753	01 02 74	$0111.11	*********
Y	000762	SUSAN MALAIKA	SAN JOSE,CALIFORNIA	22312121	01 06 74	$0000.00	*********
Y	000983	J. S. TILLING	WASHINGTON, DC	34512120	21 04 75	$9999.99	*********
Y	001222	D.J.VOWLES	BOBLINGEN, GERMANY	70315551	10 04 73	$3349.99	*********
Y	001781	TINA J YOUNG	SINDELFINGEN,GERMANY	70319990	21 06 77	$0009.99	*********
Y	003210	B.A. WALKER	NICE, FRANCE	12345670	26 11 81	$3349.99	*********
N	003214	PHIL CONWAY	SUNNYVALE, CAL.	34112120	00 06 73	$0009.99	*********
N	003890	BRIAN HARDER	NICE FRANCE	00000000	28 05 74	$0009.99	*********
N	004004	JANET FOUCHE	DUBLIN, IRELAND	71112121	02 11 73	$1259.99	*********
N	004445	DR. P. JOHNSON	SOUTH BEND, S.DAK.	61212120	26 11 81	$0009.99	*********
N	004878	ADRIAN JONES	SUNNYVALE, CALIF.	32212120	10 06 73	$5399.99	*********
N	005005	A. E. DALTON	SAN FRANCISCO, CA.	00000001	01 08 73	$0009.99	*********
N	005444	ROS READER	SARATOGA, CALIF.	67712120	20 10 74	$0809.99	*********
N	005581	PETE ROBBINS	BOSTON, MASS.	41312120	11 04 74	$0259.99	*********
Y	006016	SIR MICHAEL ROBERTS	NEW DELHI, INDIA	70331211	21 05 74	$0009.88	*********
N	006670	IAN HALL	NEW YORK, N.Y.	21212120	31 01 75	$3509.88	*********
Y	006968	J.A.L. STAINFORTH	WARWICK, ENGLAND	56713821	26 11 81	$0009.88	*********
N	007007	ANDREW WHARMBY	STUTTGART, GERMANY	70311000	10 10 75	$5009.88	*********
N	007248	M. J. AYRES	REDWOOD CITY, CALF.	33312121	11 10 75	$0009.88	*********
Y	007779	MRS. A. STEWART	SAN JOSE, CALIF.	41512120	03 01 75	$0009.88	*********
Y	009000	P. E. HAVERCAN	WATERLOO, ONTARIO	09876543	21 01 75	$9000.00	*********
Y	100000	M. ADAMS	TORONTO, ONTARIO	03415121	26 11 81	$0010.00	*********
Y	111111	C. BAKER	OTTAWA, ONTARIO	51212003	26 11 81	$0011.00	*********
Y	200000	S. P. RUSSELL	GLASGOW, SCOTLAND	63738290	26 11 81	$0020.00	*********
Y	222222	DR E. GRIFFITHS	FRANKFURT, GERMANY	20034151	26 11 81	$0022.00	*********
Y	300000	V. J. HARRIS	NEW YORK, U.S.	64739801	26 11 81	$0030.00	*********
Y	333333	J.D. HENRY	CARDIFF, WALES	78493020	26 11 81	$0033.00	*********
Y	400000	C. HUNT	MILAN, ITALY	25363738	26 11 81	$0040.00	*********
Y	444444	D. JACOBS	CALGARY, ALBERTA	77889820	26 11 81	$0044.00	*********
Y	500000	P. KINGSLEY	MADRID, SPAIN	44454640	26 11 81	$0000.00	*********
Y	555555	S.J. LAZENBY	KINGSTON, N.Y.	39944420	26 11 81	$0005.00	*********
Y	600000	M.F. MASON	DUBLIN, IRELAND	12398780	26 11 81	$0010.00	*********
Y	666666	R. F. WALLER	LA HULPE, BRUSSELS	42983840	26 11 81	$0016.00	*********
Y	700000	M. BRANDON	DALLAS, TEXAS	57984320	26 11 81	$0002.00	*********
Y	777777	L.A. FARMER	WILLIAMSBURG, VIRG.	91876131	26 11 81	$0027.00	*********
Y	800000	P. LUPTON	WESTEND, LONDON	24233389	26 11 81	$0030.00	*********
Y	888888	P. MUNDY	NORTHAMPTON, ENG.	23691639	26 11 81	$0038.00	*********
Y	900000	D.S. RENSHAW	TAMPA, FLA.	35668120	26 11 81	$0040.00	*********
Y	999999	ANJI STEVENS	RALEIGH, N.Y.	84591639	26 11 81	$0049.00	*********

Mitch Johnson (mitchj@us.ibm.com)

Using TLS to access CICS

Creating the RACF resources

In this section, the certificates and key ring required for using TLS to protect connections to CICS will be imported into and/or defined to RACF.

The certificate authority public certificate, labeled as *CICS CA*, be imported into RACF as a CERTAUTH certificate. There are also a personal certificate signed by the same certificate authority that will be used as CICS's server certificate (labeled *CICS Server Cert*) and another personal certificate that will used as a client certificate (labeled *USER1 CICS Cert*) for use when mutual authentication is enabled. The personal certificates are provided by the certificate authority in encrypted files since they contain private keys. This means that the certificate authority has also provide a password or pass phrase that can be used to decrypt the contents of these files when they are being imported in to RACF.

The certificate authority (CERTAUTH) certificate and the personal certificate labeled *CICS Server Cert* will be connected to the RACF key ring used by CICS as the server endpoint.

The CERTAUTH certificate will also be provided to CICS clients in order for them to verify the server certificate provided by CICS during the handshake. Only clients with the public key of the certificate authority that signed the CICS's server certificate in their trust stores will be able perform TLS handshakes with CICS.

Private keys in a personal certificate are by both server and client endpoints to encrypt a message during the TLS handshake. The other endpoint uses the public key of the sending endpoint to decrypt the message encrypted with the private key. Being able to successfully decrypt a message encrypted with a private key, verifies the identity of the sending endpoint (asymmetric encryption) since only the holder of a private key should the owner of the certificate.

> **Tech-Tip:** In this exercise we are using RACF as our certificate authority. This is unusual and you probably will be using a non-RACF certificate authority, either internal your organization or one of the well-known certificate authorities like Verisign or Entrust. More than likely you will only be using the RACDCERT command to create keyrings and connect certificates to these key rings.

___1. Browse data set *USER1.ZCEE30.CNTL*. You should see the members in that data set.

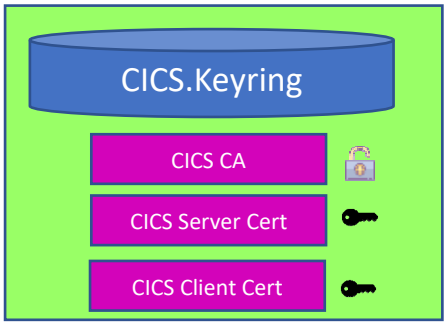
___2. Browse member **CICSTLS3**. The job contains the RACF RACDCERT commands below. Submit the job for execution.

```
/* Add CERTAUTH and personal certificates to RACF */
racdcert CERTAUTH withlabel('CICS CA') -
   add('USER1.CICSCA.PEM')

racdcert id(CICSSTC) Withlabel('CICS Client Cert') -
   add('USER1.CICSCLT.P12') password('secret')

racdcert id(CICSSTC) Withlabel('CICS Server Cert') -
   add('USER1.CICSSRV.P12') password('secret')

racdcert id(USER1) withlabel('USER1 CICS Cert') -
   add('USER1.CICSUSR1.P12') password('secret')

racdcert id(USER2) withlabel('USER2 CICS Cert') -
   add('USER1.CICSUSR2.P12') password('secret')

setropts raclist(digtcert,digtnmap) refresh

  /* Create CICS key ring and connect CA and personal certificates */
racdcert id(cicsstc) addring(CICS.KeyRing)

racdcert id(cicsstc) connect(ring(CICS.KeyRing) +
          label('CICS CA') certauth usage(certauth))

racdcert id(cicsstc) connect(ring(CICS.KeyRing) +
          label('CICS CA') certauth usage(certauth))

 /* Connect default personal certificiate */
racdcert id(cicsstc) connect(ring(CICS.KeyRing) +
          label('CICS Client Cert') default

 /* Connect default personal certificiate */
racdcert id(cicsstc) connect(ring(CICS.KeyRing) +
          label('CICS Server Cert')

setropts raclist(digtring,digtnmap) refresh

permit irr.digtcert.listring +
  class(facility) id(cicsstc) access(read)

permit irr.digtcert.list +
  class(facility) id(cicsstc) access(read)
```

The commands in this job:

- Imports (adds) the certificate authority and personal certificates to RACF. The personal certificates are added because if they are to be used in TLS handshakes, they have to associated with valid RACF identities
- Define a key ring to be used for TLS handshakes.
- Connect the CICS server personal certificate to this key ring.
- Connect the CA public certificate used to sign the CICS server's certificate to this key ring.
- The in-storage profile for digital certificates resources are refreshed.

When finished, the CICS key ring looks something like this:



Tech-Tip: Both server certificates and client certificates are personal certificates. The differences is the role of the certificate during the handshake. The endpoint that initiates the connection is the client and its personal certificate is referred to as a client certificate. The endpoint that receives the connection request is the server and its personal certificate is referred to as a server certificate. A personal certificate can be used as either a client or a server certificate at any time as long as the certificate contains a private key that can be used to encrypt handshake messages.

Enabling CICS TLS support

The next step is to update the CICS's regions initialization parameters to add support for TLS. This involves adding system initialization table (SIT) parameters.

___1. Edit member *CICSZ* in data set *CICSTS.CICSZ.SYSIN.*

___2. Add the following system initialization overrides anywhere before the .END line.

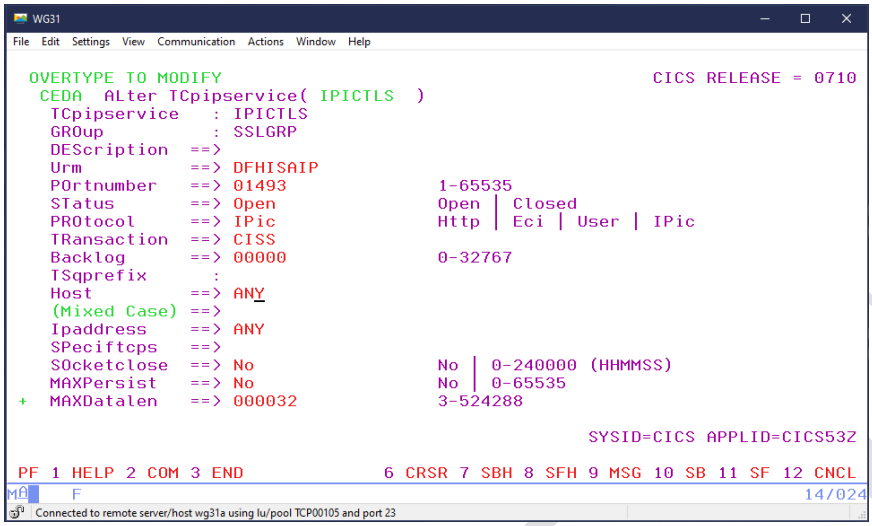
```
KEYRING=CICS.KeyRing,
ENCRYPTION=STRONG,
MAXSSLTCBS=8,
SSLDELAY=600,
```

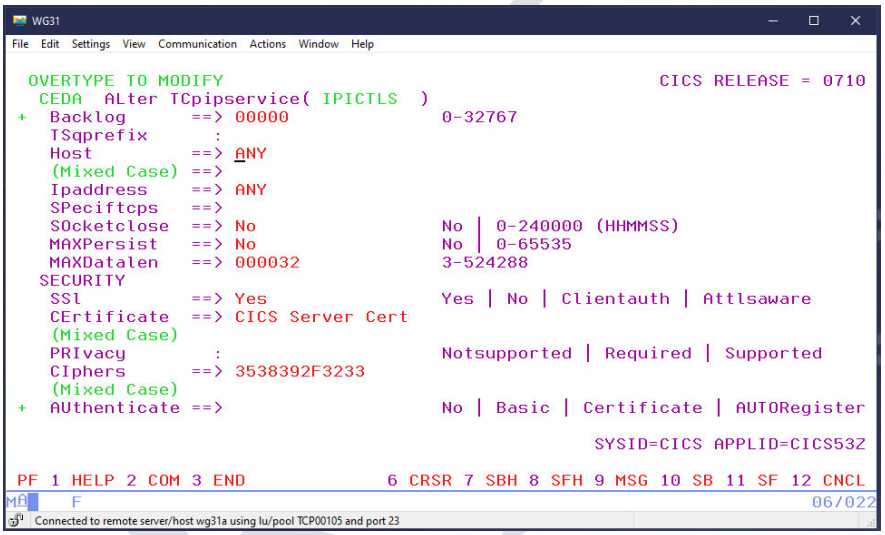
___3. Use the CEDA transaction to change the *SCheme* and *POrt* of the *BAQURIMP* Urimap resource from *HTTP* to ***HTTPS*** and from *9120* to ***9443***, see below.

CEDA COPY TCPIPS(IPICTLS) G(IPICTLS) TO(SYSPGRP)

Mitch Johnson (mitchj@us.ibm.com)

Below is the definition of this TCPIPService.





Shutdown CICS with a ***CEMT PE SHUTDOWN*** command, using either an MVS modify command or in a CICS terminal session.

___4. When CICS is no longer active, restart the region with MVS command ***S CICSZ.***

Mitch Johnson (mitchj@us.ibm.com)

Test the TLS connection from the z/OS Connect Designer to a CICS subsystem

In the following steps you will download the CICS CERTAUTH public key certificate exported from RACF in a previous section and add it to a *Designer* trust key store that will be used to perform a TLS handshake with CICS from the *Designer*.

___1. On the Windows desktop, open DOS command prompt by clicking on the DOS icon.

___2. Enter the command: ***cd c:\z\openApi3\certs***

___3. Enter the command: ***ftp wg31.washington.ibm.com***

___4. Logon with *USER1* and the password for that ID

___5. Enter the command: ***prompt off***

___6. Enter the command: ***mget CICSCA.PE<***

___7. Enter the command: ***bin***

___8. Enter the command: ***mget CICSUSR1.p12***

___9. Enter the command***: quit***

```
Microsoft Windows [Version 10.0.19044.1766]
(c) Microsoft Corporation. All rights reserved.

c:\z>cd c:\z\openApi3

c:\z\openapi3>ftp wg31.washington.ibm.com
Connected to wg31.washington.ibm.com.
220-FTP 13:34:13 on 2022-07-05.
220 Connection will close if idle for more than 200 minutes.
501 command OPTS aborted -- no options supported for UTF8
User (wg31.washington.ibm.com:(none)): user1
331 Send password please.
Password:
230 USER1 is logged on.  Working directory is "USER1.".
ftp> prompt
Interactive mode Off .
ftp> mget CICSCA.PEM
200 Representation type is Ascii NonPrint
200 Port request OK.
125 Sending data set USER1.CICSCA.PEM
250 Transfer completed successfully.
ftp: 1244 bytes received in 0.00Seconds 414.67Kbytes/sec.
ftp> bin
200 Representation type is Image
ftp> mget CICSUSR1.p12
200 Representation type is Image
200 Port request OK.
125 Sending data set USER1.CICSUSR1.P12
250 Transfer completed successfully.
ftp: 3416 bytes received in 0.11Seconds 31.05Kbytes/sec.
ftp> quit
221 Quit command received. Goodbye.
```

> **Tech-Tip:** The significance of the P12 file extensions of the certificate is that this extension usually indicates the file contains a private key and will require a password or pass phrase to be able to access this certificate.

___10. On the Windows desktop, open an Ubuntu terminal shell by clicking on the *Ubuntu* icon in the task bar.

___11. In the Ubuntu session, switch to *root* access by entering the command: ***sudo su***

___12. Enter root's password of ***passw0rd***.

Using a JSSE key store from the Designer

In this section a JSSE trust store will be create for use in TLS handshakes with CICS. Note that JSSE supports the use of the same or different key store files for both the personal and CERTAUTH repositories.

First, create a CICS trust store and import the CICS CA public key file into the JSSE trust store.

___1. In an Ubuntu session, copy the CERTAUTH public key certificate file (*CICSCA.PEM*) from Windows into the Linux directory mapped to a container's directory (see the docker-compose.yaml) file.

cp /mnt/c/z/openApi3/certs/CICSCA.PEM /home/workstation/podman/cscvinc/certs

> **Tech-Tip:** The directory */home/workstation/podman/cscvinc/certs* has been mapped to container directory */output/resources/security* in the docker-compose.yaml used to create the cscvinc container.

___2. In the same Ubuntu session, import the CERTAUTH public key into the container's CICS key store (this will create the JSSE keystore file).

podman exec -it cscvinc_zosConnect_1 keytool -keystore /output/resources/security/cicsTrustStore.jks -storetype PKCS12 -storepass changeit -importcert -file /output/resources/security/CICSCA.PEM -alias CICSCA

> **Tech-Tip:** The command, *podman exec -it cscvinc_zosConnect_1* provides a command interface for invoking command in the container. In this case, the *podman exec* command is being used to invoke the *keytool* command in the container.

Note that there will be a prompt as to whether the certificate is to be trusted or not, reply ***yes***.

```
root:/home/mitchj/podman/cscvinc/certs:> podman exec -it cscvinc_zosConnect_1 keytool -keystore
/output/resources/security/cicsTrustStore.jks -storetype PKCS12 -storepass changeit -importcert -file
/output/resources/security/CICSCA.PEM  -alias CICSCA
Error: can only create exec sessions on running containers: container state improper
root:/home/mitchj/podman/cscvinc/certs:> podman start cscvinc_zosConnect_1
cscvinc_zosConnect_1
root:/home/mitchj/podman/cscvinc/certs:> podman exec -it cscvinc_zosConnect_1 keytool -keystore
/output/resources/security/cicsTrustStore.jks -storetype PKCS12 -storepass changeit -importcert -file
/output/resources/security/CICSCA.PEM  -alias CICSCA
Owner: CN=CICS CA, OU=ATS, O=IBM
Issuer: CN=CICS CA, OU=ATS, O=IBM
Serial number: 0
Valid from: 7/20/22 5:00 AM until: 1/1/24 4:59 AM
Certificate fingerprints:
         MD5:  1E:E3:84:FB:72:B7:6E:62:44:CC:78:7E:D9:8C:F2:30
         SHA1: 4D:CF:C3:BE:7D:B9:DE:C2:F4:6B:86:E3:14:B9:5B:25:9B:F8:02:CB
         SHA256: 75:9C:9B:D7:6D:8D:D2:09:9A:4D:B0:82:9A:CB:3A:09:49:60:CB:84:60:DE:ED:6F:7F:36:15:01:95:85:71:50
         Signature algorithm name: SHA256withRSA
         Version: 3

Extensions:

#1: ObjectId: 2.16.840.1.113730.1.13 Criticality=false
0000: 16 30 47 65 6e 65 72 61  74 65 64 20 62 79 20 74  .0Generated.by.t
0010: 68 65 20 53 65 63 75 72  69 74 79 20 53 65 72 76  he.Security.Serv
0020: 65 72 20 66 6f 72 20 7a  2f 4f 53 20 28 52 41 43  er.for.z.OS..RAC
0030: 46 29                                             F.


#2: ObjectId: 2.5.29.15 Criticality=true
KeyUsage [
  Key_CertSign
  Crl_Sign
]

#3: ObjectId: 2.5.29.14 Criticality=false
SubjectKeyIdentifier [
KeyIdentifier [
0000: 0b b8 de 32 a7 84 bc 71  4e 42 d4 77 09 57 2e 4e  ...2...qNB.w.W.N
0010: 59 98 fc c5                                       Y...
]
]

#4: ObjectId: 2.5.29.19 Criticality=true
BasicConstraints:[
CA:true
PathLen:2147483647
]

Trust this certificate? [no]:  yes
Certificate was added to keystore
```

Tech-Tip: All Podman commands(*podman*) need to be entered in Ubuntu sessions.

___3. To view the contents of this key store using this command

podman exec -it cscvinc_zosConnect_1 keytool -keystore /output/resources/security/cicsTrustStore.jks -storetype PKCS12 --storepass changeit -list

```
root:/home/mitchj/podman/cscvinc/certs:> podman exec -it cscvinc_zosConnect_1 keytool -keystore
/output/resources/security/cicsTrustStore.jks -storetype PKCS12 --storepass changeit -list

Keystore type: PKCS12
Keystore provider: IBMJCE

Your keystore contains 1 entry

cicsca, Jul 23, 2022, trustedCertEntry,
Certificate fingerprint (SHA1): 4D:CF:C3:BE:7D:B9:DE:C2:F4:6B:86:E3:14:B9:5B:25:9B:F8:02:CB
```

This JSSE keystore contains one trustedCertEntry(CERTAUTH) certificate (labeled *cicsca*)

___4. Now list the contents of the details of the *cicsca* certificate using this command

podman exec -it cscvinc_zosConnect_1 keytool -keystore /output/resources/security/cicsTrustStore.jks -storetype PKCS12 --storepass changeit -list -alias cicsca -v

```
root:/home/mitchj/podman/cscvinc/certs:> podman exec -it cscvinc_zosConnect_1 keytool -keystore
/output/resources/security/cicsTrustStore.jks -storetype PKCS12 --storepass changeit -list  -alias cicsca -v
Alias name: cicsca
Creation date: Jul 23, 2022
Entry type: trustedCertEntry

Owner: CN=CICS CA, OU=ATS, O=IBM
Issuer: CN=CICS CA, OU=ATS, O=IBM
Serial number: 0
Valid from: 7/20/22 5:00 AM until: 1/1/24 4:59 AM
Certificate fingerprints:
         MD5:  1E:E3:84:FB:72:B7:6E:62:44:CC:78:7E:D9:8C:F2:30
         SHA1: 4D:CF:C3:BE:7D:B9:DE:C2:F4:6B:86:E3:14:B9:5B:25:9B:F8:02:CB
         SHA256: 75:9C:9B:D7:6D:8D:D2:09:9A:4D:B0:82:9A:CB:3A:09:49:60:CB:84:60:DE:ED:6F:7F:36:15:01:95:85:71:50
         Signature algorithm name: SHA256withRSA
         Version: 3

Extensions:

#1: ObjectId: 2.16.840.1.113730.1.13 Criticality=false
0000: 16 30 47 65 6e 65 72 61  74 65 64 20 62 79 20 74  .0Generated.by.t
0010: 68 65 20 53 65 63 75 72  69 74 79 20 53 65 72 76  he.Security.Serv
0020: 65 72 20 66 6f 72 20 7a  2f 4f 53 20 28 52 41 43  er.for.z.OS..RAC
0030: 46 29                                              F.


#2: ObjectId: 2.5.29.15 Criticality=true
KeyUsage [
  Key_CertSign
  Crl_Sign
]

#3: ObjectId: 2.5.29.14 Criticality=false
SubjectKeyIdentifier [
KeyIdentifier [
0000: 0b b8 de 32 a7 84 bc 71  4e 42 d4 77 09 57 2e 4e  ...2...qNB.w.W.N
0010: 59 98 fc c5                                        Y...
]
]

#4: ObjectId: 2.5.29.19 Criticality=true
BasicConstraints:[
CA:true
PathLen:2147483647
]
```

In this output we are seeing that even though it is a self-signed certificate also (refer to the distinguished names) we imported this certificate as a trustedCertEntry (e.g., CERTAUTH) certificate. Also note that this certificate has *Key_CertSign* as a *KeyUsage* attribute. This means that it can be used to validate personal certificates signed by the *Issuer*, *CN=CICS CA, OU=ATS, O=IBM*

This diagram shows what we just created.

This is the minimum required to enable sever authentication TLS support between a *Designer* container and CICS.

Server certificate authentication

The container in which the *Designer* is running needs to be updated with new environment variables. Adding environment variables to a container requires updating the *docker-compose.yaml* file with the new variables and the stopping and then restarting the container with a *docker-compose* or *podman-compose* commands technique.

Update the *docker-compose.yaml* file to add three new environment variables, *CICSSSL_PORT*, *CICSTRUSTSTORE_PASSWOED and CICSKEYSTORE_PASSWORD* with values as shown below:

```
version: "3.2"
services:
    zosConnect:
        image: icr.io/zosconnect/ibm-zcon-designer:3.0.57
        user: root
        environment:
            - CICS_USER=USER1
            - CICS_PASSWORD=USER1
            - CICS_HOST=wg31.washington.ibm.com
            - CICS_PORT=1491
            - CICSTRUSTSTORE_PASSWORD=changeit
            - CICSKEYSTORE_PASSWORD=secret
            - CICSSSL_PORT=1493
            - DB2_USERNAME=USER1
            - DB2_PASSWORD=USER1
            - DB2_HOST=wg31.washington.ibm.com
            - DB2_PORT=2446
            - HTTP_PORT=9080
        ports:
            - "9447:9443"
            - "9084:9080"
        volumes:
            - ./project:/workspace/project
            - ./logs/:/logs/
            - ./certs:/output/resources/security/
```

Tech Tip: The value for the trust store password (*changeit*) is the value of *-STORPASS* used in the keytool command when the trust store was initially created. The value for the key store password is *secret* (the encryption password provided by the certificate authority and used in the earlier *RACDDERT ADD* commands). The *CICSKEYSTORE* environment variable will be used in a later section of the exercise.

____1. If you are comfortable with the vi editor, the *docker-compose.yaml* file in the container's base Linux directory can be updated directly and then proceed to Step 4. Otherwise, using an Ubuntu session, copy the container's *docker-compose.yaml* file to a Windows directory using command:

cp /home/workstation/podman/cscvinc/docker-compose.yaml /mnt/c/openapi3/

____2. Update the *docker-compose.yaml* file as described above using your favorite Windows editor.

____3. In an Ubuntu session, copy the update YAML file back to the Linux directory for this container.

cp /mnt/c/openapi3/docker-compose.yaml /home/workstation/podman/cscvinc

____4. The container needs to be stopped and restarted in order for the new environment variables to be recognized. Stop the container with command:

podman stop cscvinc_zosConnect_1

____5. Remove the container with this command. This remove the container but leaves contents of the project directory as is. This means the contents of this directory structure (the API definition) will be remapped when the container is restarted with the *podmon-compose* command.

podman rm cscvinc_zosConnect_1

____6. Restart the container with this command (*invoke this command while in directory /home/workstation/podman/employee*).

podman-compose up -d

Now the *zosconnect.cicsIpicConnection* entry for the CICS connection needs to have additional attributes added for TLS.

____7. Copy the Windows file *cicstlsServer.xml* to the container configuration directory as file *cics.xml.*

cp /mnt/c/z/openapi3/tls/cicsTlsServer.xml /home/workstation/podman/cscvinc/project/src/main/liberty/config/cics.xml

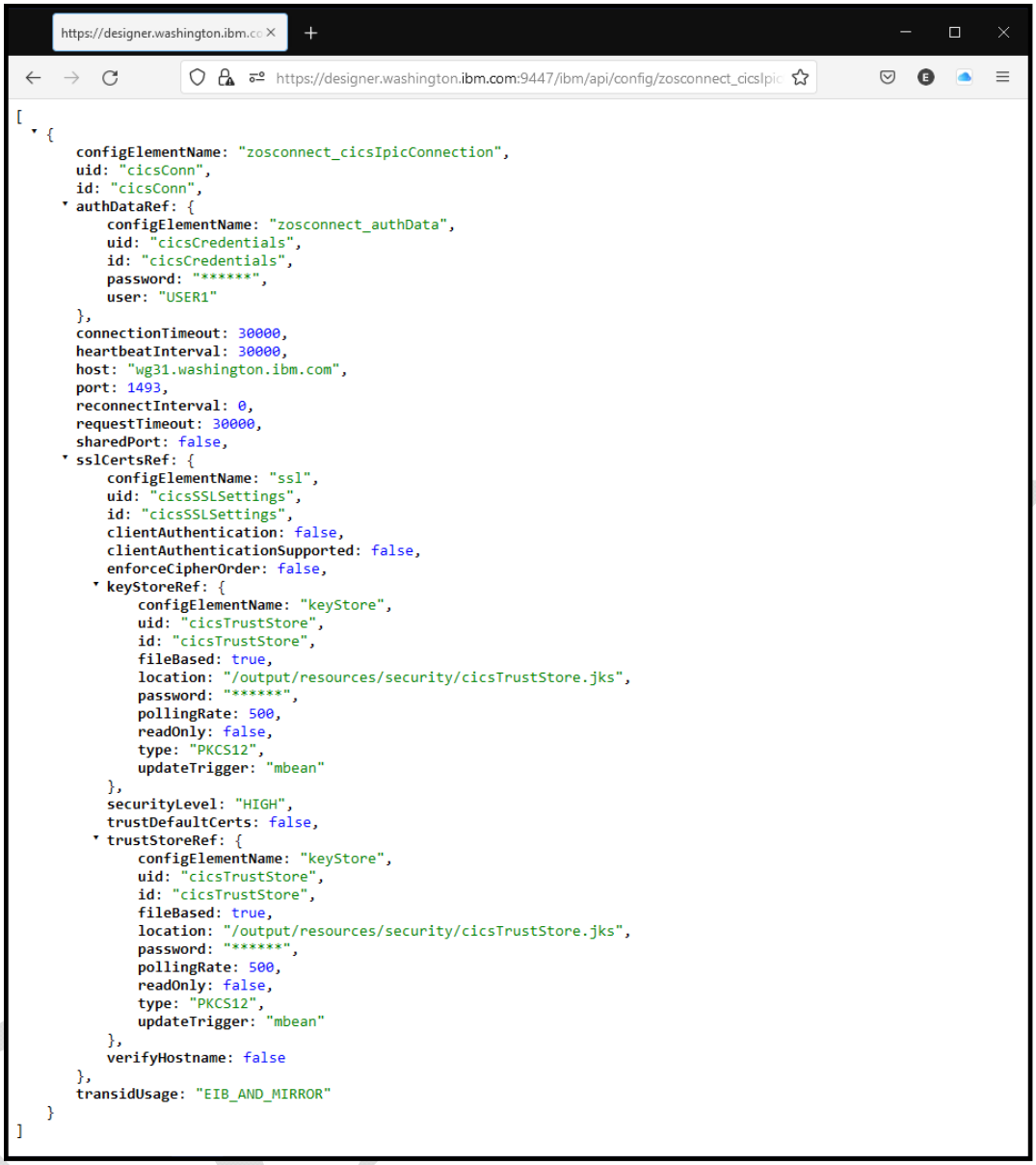
Below are the contents of *cicsTlsServer.xml*. The boldfaced lines are the additions made to the original contents of cics.xml for adding TLS support between the *Designer* and CICS.

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="IPIC connection to CICS">
    <featureManager>
        <feature>zosconnect:cics-1.0</feature>
    </featureManager>

    <zosconnect_cicsIpicConnection id="cicsConn"
        host="${CICS_HOST}"
        port="${CICSSSL_PORT}"
        sslCertsRef="cicsSSLSettings"
        authDataRef="cicsCredentials" />

   <ssl id="cicsSSLSettings"
     keyStoreRef= "cicsTrustStore"
     trustStoreRef= "cicsTrustStore" />
   <keyStore id= "cicsTrustStore"
     location="/output/resources/security/cicsTrustStore.jks"
     password="${CICSTRUSTSTORE_PASSWORD}" type="PKCS12" />

    <zosconnect_authData id="cicsCredentials"
        user="${CICS_USER}"
        password="${CICS_PASSWORD}" />

</server>
```

The above configuration defines a TLS repertoire (*cicsSSLSettings*) for use when connection to a CICS. Note the *sslRef* in the *zosconnect_cicsIpicConnection* configuration elements references *cicsSSLSettings.* The TLS repertoire has attributes *keyStoreRef* and *trustStoreRef* referencing the same *keystore* element. This is where we could have made a distinction between personal certificates and CERTAUTH key store files. The *keystore* element, *cicsTrustStore*, identifies the key store we created in the previous section. This key store contains the CICS *CERTAUTH* certificate.

____8. Enter the URL below in a browser to verify the updated *zosconnect_cicsIpicConnection* configuraton

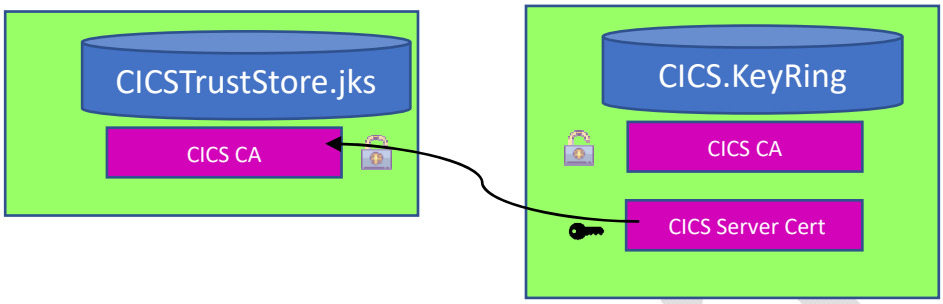
https://designer.washington.ibm.com:9447/ibm/api/config/zosconnect_cicsIpicConnection



If a logon is required, use ***Fred*** as the *Username* and ***fredpwd*** as the *Password.*

Tech-Tip: Installing the *restConnector-2.0* feature and providing an *administrator-role* configuration element, (see the *basicSecurity.xml file*), enabled the displaying of configuration elements in a web browser. This is good method for reviewing for syntax or other configuration errors in the installed server XML configuration element names particularly when other configuration elements are referenced.

This diagram shows the TLS handshake flow as it currently configured. When a client requests a connection, CICS will send its server certificate to the client where it will be validated with a local CERTAUTH certificate. The client will validate the server certificate and an encrypted connection will be established (this is not mutual authentication).

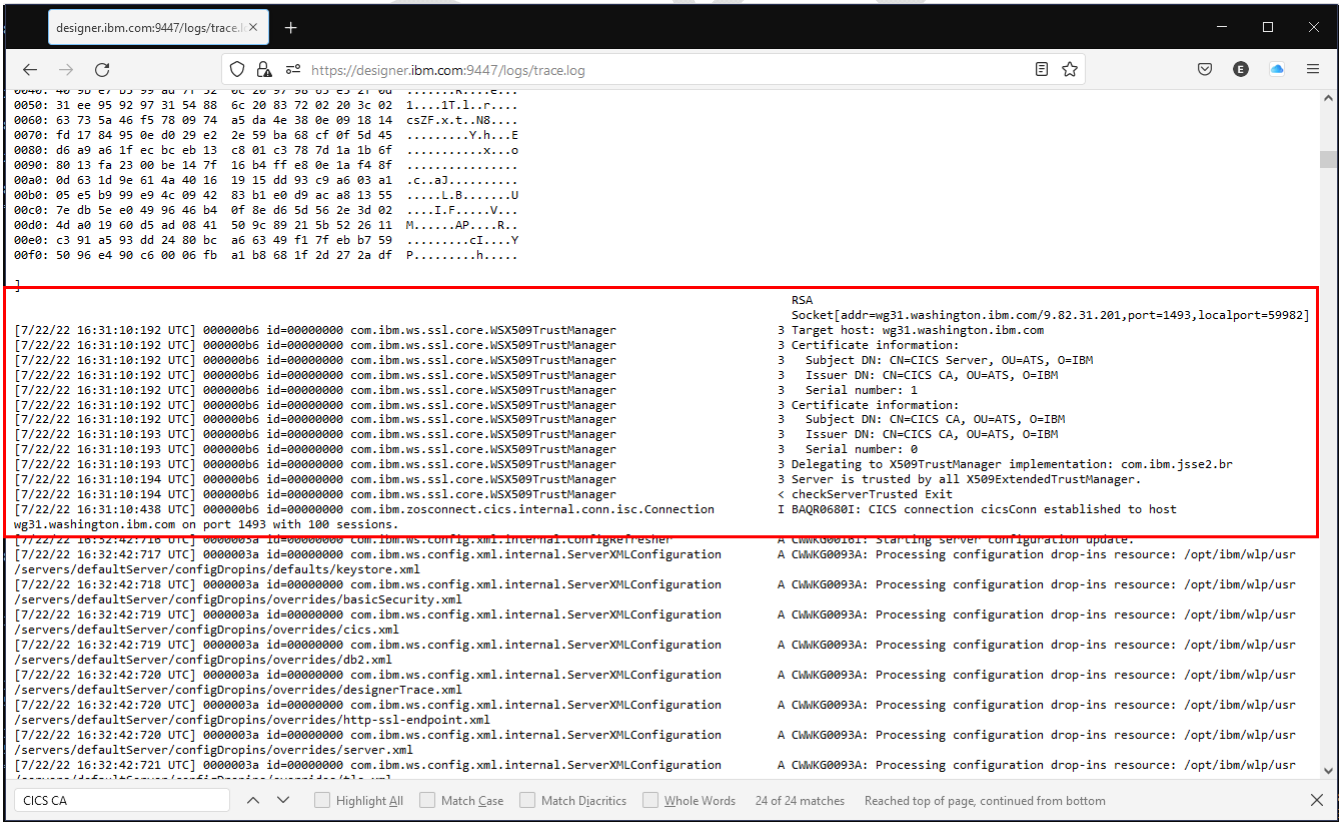


Test the TLS connection between the *Designer* and CICS using a curl command.

```
curl -X GET  -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type: application/json" --insecure https://designer.washington.ibm.com:9447/employee/000100
```

```
c:\z\openapi3>curl -X GET  -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type: application/json" --insecure  https://designer.washington.ibm.com:9449/employee/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
```

And a review of the Liberty traces shows the handshake flow.



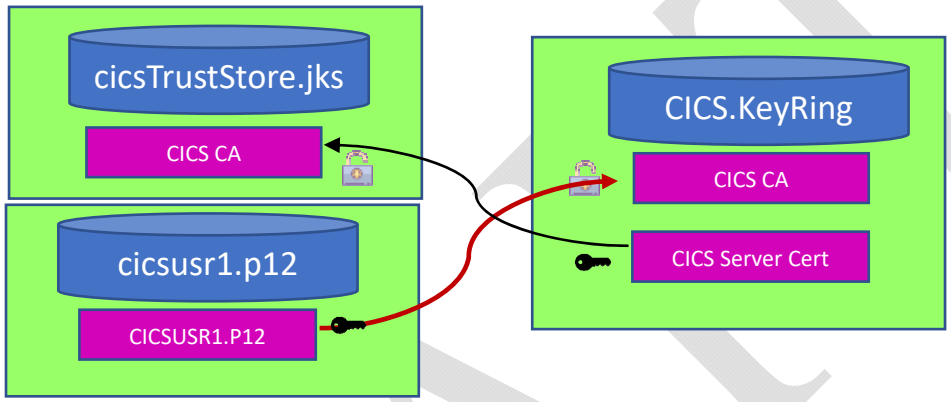
This completes the basic configuraton of just a server handshake,

Mitch Johnson (mitchj@us.ibm.com)

Client certificate (mutual) authentication

Now let's look at implementing mutual authentication. Mutual authentication occurs when the server endpoint requires the client to provide a proof of its identity by using a digital certificate. When mutual authentication is enabled, the client's personal certificate must have a private key.

Initially the client will send the public portion of its personal certificate (including a public key) to the server where the public contents of certificate will be validated with a local CERTAUTH certificate. Verification of the client is ensured because the client will then create a message digest (hash) of all the messages exchanged with the server. This digest is then encrypted with the client private key and sent to the server. The server uses the client public key to decrypt the digest. If the decrypted digest matches the server's digest derived from its record of the messages exchanged, then the client has proven its identity.



____1. In an Ubuntu session, copy the user's private key certificate file (CICSUSR1.*PEM*) from Windows into the Linux directory mapped to a container's directory (see the docker-compose.yaml) file.

cp /mnt/c/z/openApi3/certs/CICSUSR1.P12 /home/workstation/podman/cscvinc/certs

____2. In an Ubuntu session, copy the Windows file *cicsTlsMutual.xml* to the container configuration directory as file *cics.xml.*

cp /mnt/c/z/openapi3/tls/cicsTlsMutual.xml
/home/workstation/podman/cscvinc/project/src/main/liberty/config/cics.xml

Mitch Johnson (mitchj@us.ibm.com)

The *zosconnect_cicsIpicConnection* element need values to match the IPCONN resource for *zosConnectNetworkid* and *zosConnectApplid.* The *authDataRef* attribute is no longer needed.

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="IPIC connection to CICS">
    <featureManager>
        <feature>zosconnect:cics-1.0</feature>
    </featureManager>

    <zosconnect_cicsIpicConnection id="cicsConn"
        host="${CICS_HOST}"
        port="${CICSSSL_PORT}"
        zosConnectNetworkid="DESIGNER"
        zosConnectApplid="DESIGNER"
        sslCertsRef="cicsSSLSettings"/>

   <ssl id="cicsSSLSettings"
     keyStoreRef= "cicsKeyStore"
     trustStoreRef= "cicsTrustStore" />
   <keyStore id= "cicsTrustStore"
     location="/output/resources/security/cicsTrustStore.jks"
     password="${CICSTRUSTSTORE_PASSWORD}" type="PKCS12" />
   <keyStore id= "cicsKeyStore"
     location="/output/resources/security/CICSUSR1.P12"
     password="${CICSKEYSTORE_PASSWORD}" type="PKCS12" />

</server>
```

The above configuration defines a TLS repertoire (*cicsSSLSettings*) for use when connection to a CICS. Note the *sslRef* in the *zosconnect_cicsIpicConnection* configuration elements references *cicsSSLSettings.* The TLS repertoire has attributes *keyStoreRef* and *trustStoreRef* referencing different *keystore* elements. The *keystore* element, **cicsTrustStore**, identifies the key store we used for server authentication in the previous section. This key store contains CICS *CERTAUTH* certificate. The keystore element, **cicsKeyStore**, identifies the key store that contains this client's personal certificate, in this case, the P12 file can be a key store.

____3. In an Ubuntu session, stop the container using this command:

podman stop cscvinc_zosConnect_1

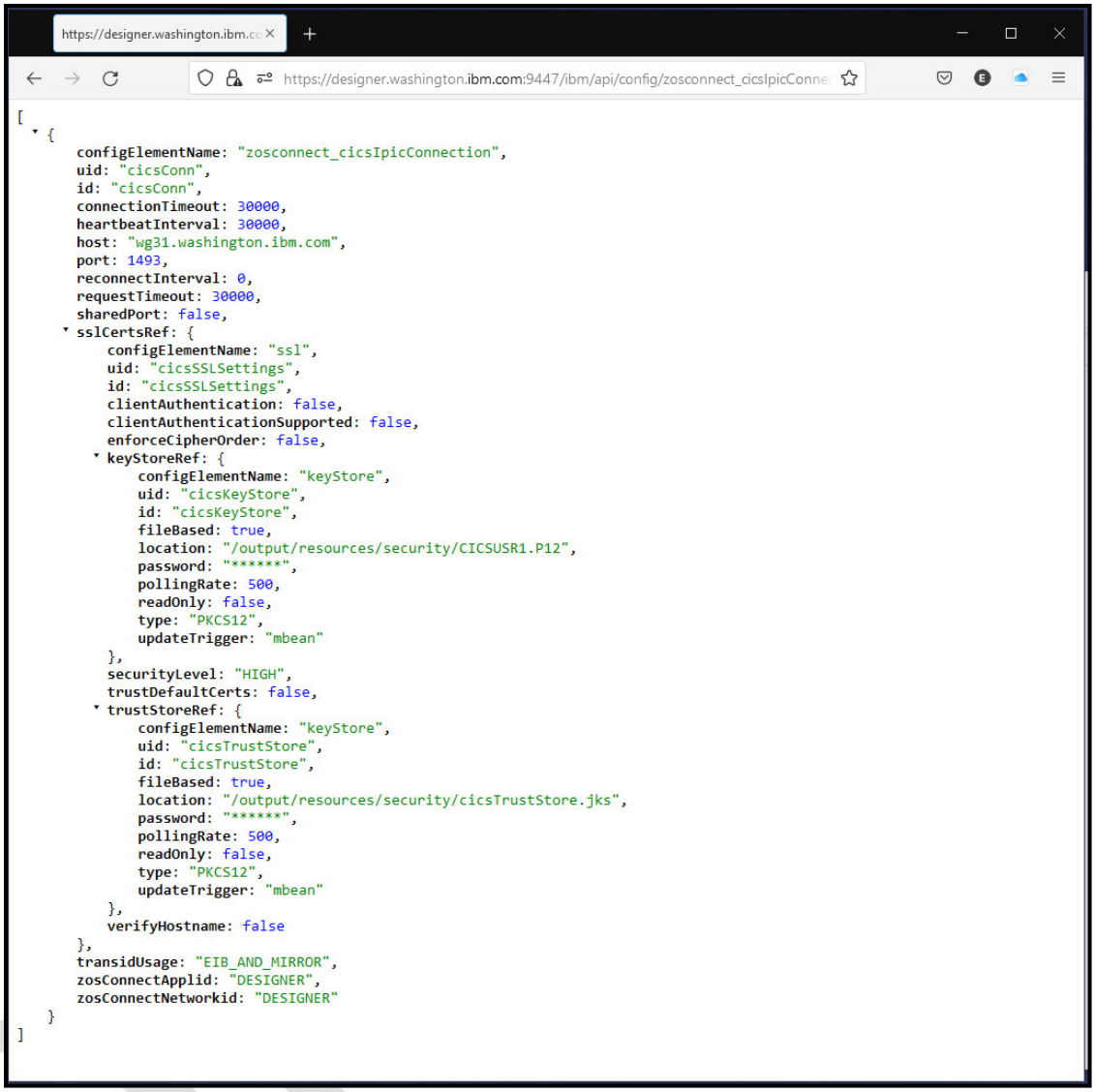
____4. In an Ubuntu session, restart the container using this command:

podman start cscvinc_zosConnect_1

Mitch Johnson (mitchj@us.ibm.com)

____5. Enter the URL below in a browser to verify the updated *zosconnect_cicsIpicConnection* configuraton

https://designer.washington.ibm.com:9447/ibm/api/config/zosconnect_cicsIpicConnection

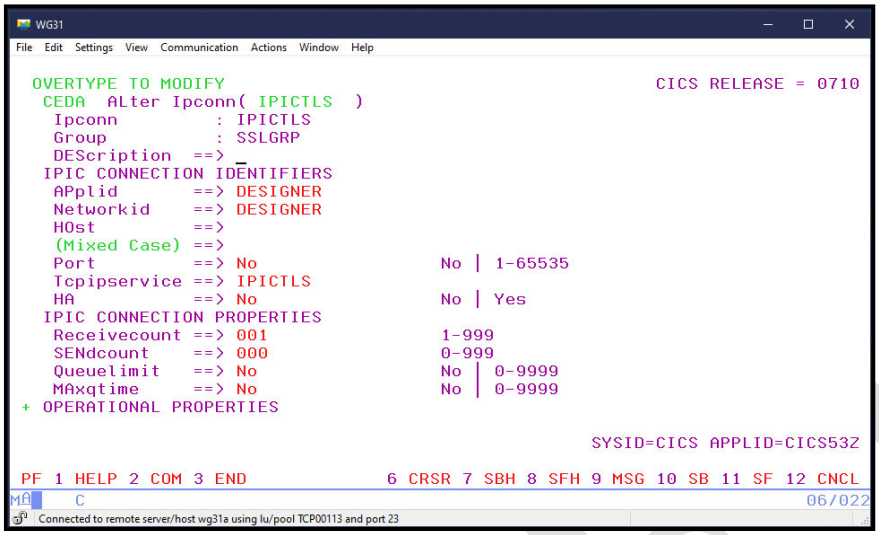


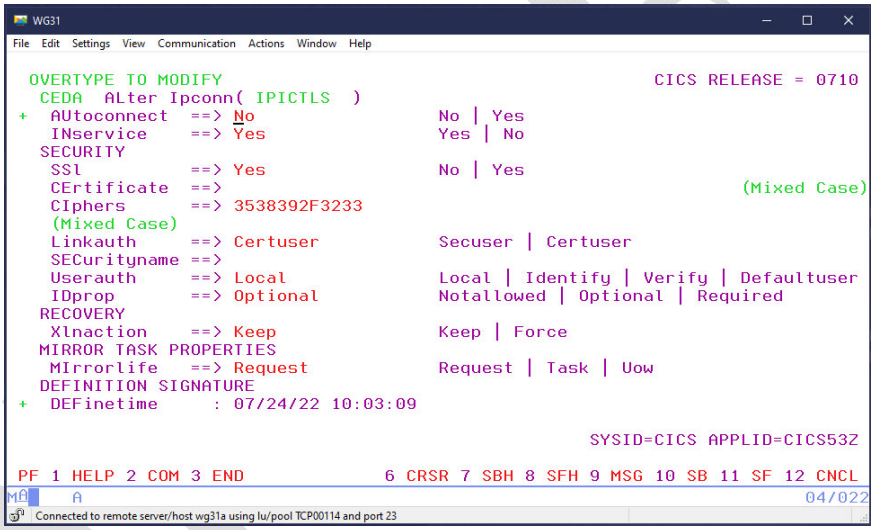
If a logon is required, use ***Fred*** as the *Username* and ***fredpwd*** as the *Password*

Tech-Tip: Installing the *restConnector-2.0* feature and providing an *administrator-role* configuration element, (see the *basicSecurity.xml file*), enabled the displaying of configuration elements in a web browser. This is good method for reviewing for syntax or other configuration errors in the installed server XML configuration element names particularly when other configuration elements are referenced.

____6. The CICS IPCONN and TCPIPServices need to be updated.

The IPCONN resources needs to have values for *Applid* and *Networkid* that will match the zosconnect_cicsIpicConnection element as a value of ***Certuser*** for *Linkauth*.



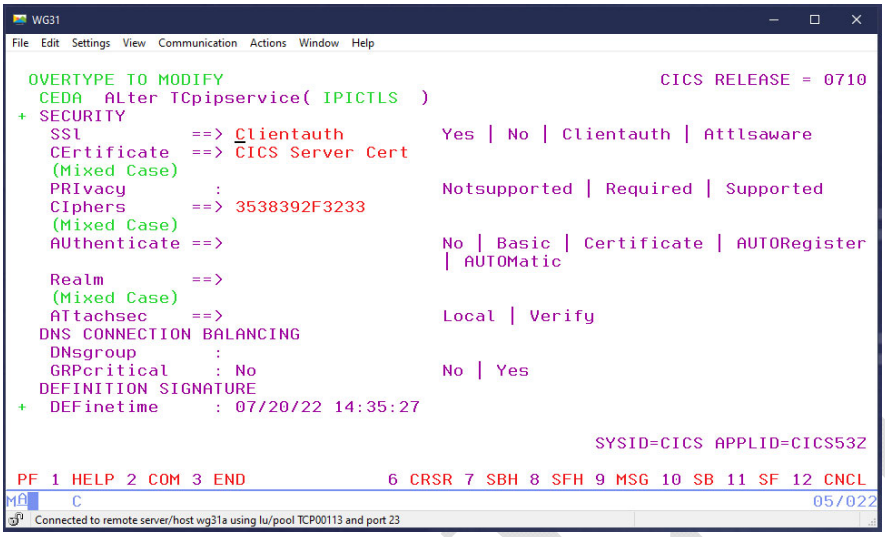


The value for *Userauth* is important. When *Userauth* is set to a value of ***Local*** as above, the CICS transaction will run under the identity associate with the client certificate sent from the *Designer* container. If *Userauth* is set to a value of ***Identity***, the identity authenticated by Designer will be propagated to CICS and this distributed identity will need to be map to a valid RACF identity because the CICS transaction will be started using the mapped identity, using RACMAP commands like the ones below:

```
RACMAP ID(FRED)  MAP USERDIDFILTER(NAME('Fred')) REGISTRY(NAME('*')) WITHLABEL('zCEE FRED')
RACMAP ID(USER1) MAP USERDIDFILTER(NAME('user1')) REGISTRY(NAME('*')) WITHLABEL('zCEE user1')
```


Mitch Johnson (mitchj@us.ibm.com)

The TCPIPService will need to specify a value of ***ClientAuth*** for the *SSL* attribute.



____7. Test the TLS connection between the *Designer* and CICS using a curl command.

curl -X GET -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type: application/json" --insecure https://designer.washington.ibm.com:9447/employee/000100

Results when the IPCONN *Userauth* attribute set to ***Local***, the identity mapped to the identity is used,

```
c:\z>curl -X GET  -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type: application/json" --
insecure  https://designer.washington.ibm.com:9447/employee/000100
{"summary":{"message":"Record with key  000100 was  successfully  retrieved  -  CICS identity
USER1"},"detail":{"EmployeeSelectServiceOperationResponse":{"employeeData":{"response":{"employeeDetails":{"
employeeNumber":"000100","name":"S. D. BORMAN","address":"SURREY,
ENGLAND","phoneNumber":"32156778","date":"26 11 81","amount":"$0100.11","comment":"*********"}}}}}} -
HTTP CODE 200
```

Results when the IPCONN *Userauth* attribute set to ***Identify***, the identity asserted from the Designer is used.

```
c:\z>curl -X GET  -w " - HTTP CODE %{http_code}" --user Fred:fredpwd --header "Content-Type: application/json" --
insecure  https://designer.washington.ibm.com:9447/employee/000100
{"summary":{"message":"Record with key  000100 was  successfully  retrieved  -  CICS identity
FRED"},"detail":{"EmployeeSelectServiceOperationResponse":{"employeeData":{"response":{"employeeDetails":{"e
mployeeNumber":"000100","name":"S. D. BORMAN","address":"SURREY,
ENGLAND","phoneNumber":"32156778","date":"26 11 81","amount":"$0100.11","comment":"*********"}}}}}} -
HTTP CODE 200
```

And a review of the Liberty traces show the completion of the mutual authentication handshake flow.

```
3 Certificate information:
[7/23/22 23:33:01:979 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3   Subject DN: CN=CICS Server, OU=ATS, O=IBM
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3   Issuer DN: CN=CICS CA, OU=ATS, O=IBM
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3   Serial number: 1
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3 Certificate information:
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3   Subject DN: CN=CICS CA, OU=ATS, O=IBM
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3   Issuer DN: CN=CICS CA, OU=ATS, O=IBM
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3   Serial number: 0
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3 Delegating to X509TrustManager implementation: com.ibm.jsse2.br
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
3 Server is trusted by all X509ExtendedTrustManager.
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509TrustManager
< checkServerTrusted Exit
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
> chooseClientAlias Entry
RSA
CN=CICS CA, OU=ATS, O=IBM
CN=CICS Client, OU=ATS, O=IBM
CN=CICS Server, OU=ATS, O=IBM
Socket[addr=wg31.washington.ibm.com/9.82.31.201,port=1493,localport=44896]
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
< chooseClientAlias Exit
[7/23/22 23:33:01:980 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
> chooseClientAlias Entry
RSA
CN=CICS CA, OU=ATS, O=IB
CN=CICS Client, OU=ATS, O=IBM
CN=CICS Server, OU=ATS, O=IBM
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.websphere.ssl.JSSEHelper
> getOutboundConnectionInfo Entry
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.config.ThreadContext
3 getOutboundConnectionInfo
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.websphere.ssl.JSSEHelper
< getOutboundConnectionInfo Exit
null
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
< chooseClientAlias (from JSSE) Exit
user1 cics cert
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
> getPrivateKey Entry
user1 cics cert
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
3 getX509KeyManager -> com.ibm.jsse2.bn
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
< getPrivateKey -> true Exit
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
> getCertificateChain: user1 cics cert Entry
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
3 getX509KeyManager -> com.ibm.jsse2.bn
[7/23/22 23:33:01:981 UTC] 00000098 id=00000000 com.ibm.ws.ssl.core.WSX509KeyManager
< getCertificateChain Exit

[
[
  Version: V3
  Subject: CN=USER1 Client Cert, OU=ATS, O=IBM
  Signature Algorithm: SHA256withRSA, OID = 1.2.840.113549.1.1.11

  Key:  IBMJCE RSA Public Key:
```

This completes the basic configuraton of just a mutual authentication handshake.

Mitch Johnson (mitchj@us.ibm.com)

Using RACF key rings from the native z/OS server

To enable TLS connections between a z/OS Connect native server a RACF key ring will have to be created and the CERTAUTH certificate and a personal for the native server's RACF identity (if mutual authentication is required) connected to this key ring.

____1. Invoke these are the commands to add the certificates provide by the certificate authority to a new key ring. These commands to not include the commands to connect a personal certificate to the key ring.

racdcert id(atsserv) addring(CICSClient.KeyRing)

racdcert id(atsserv) connect(ring(CICSClient.KeyRing) label('CICS CA') certauth usage(certauth))

setropts raclist(digtring,digtnmap) refresh

____2. Update the current contents */var/zcee/openapi3/includes/cicsApi3.xml* with the contents in bold below:

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="CICS SSL">
    <featureManager>
        <feature>zosconnect:cics-1.0</feature>
    </featureManager>
    <zosconnect_credential id="commonCredentials"
      user="${CICS_USER}" password="${CICS_PASSWORD}" />
    <zosconnect_cicsIpicConnection id="cicsIpicConn"
      host="${CICS_HOST}" port="${CICS_PORT}"
      sslRef="cicsSSLSettings" />
     <ssl id="cicsSSLSettings"
      keyStoreRef="cicsKeyRing"
      trustStoreRef="cicsKeyRing" />
    <keyStore id="cicsKeyRing"
     location="safkeyring:///CICSClient.KeyRing"
     password="password" type="JCERACFKS"
    fileBased="false" readOnly="true" />
 </server>
```

____3. Change the value of the *CICS_PORT* variable */var/zcee/openapi3/includes/openApi3.xml* from 1491 to ***1493***.

```
<variable name="CICS_HOST" value="wg31.washington.ibm.com"/>
<variable name="CICS_PORT" value="1493/>
```

____4. Update the server's configuration using a MVS modify command:

F ZCEEAPI3,REFRESH,CONFIG

____5. Repeat some of the tests perform in section *Testing APIs deployed in a native z/OS server*, see page 79

Congratulations, you have completed this exercise.

Mitch Johnson (mitchj@us.ibm.com)

Additional information and samples

This section contains samples of using command to generate self-signed certificates and having them signed and then imported into a JSSE keystore. And the contents of the original YAML file used to develop the Open API 3 API.

Client Certificate Requests

___1. Create a self-signed certificate (and indirectly create a local keystore)

podman exec -it cscvinc_zosConnect_1 keytool -keystore /output/resources/security/cicsKeyStore.jks -storetype PKCS12 -storepass changeit -genkey -keysize 2048 -alias cicsusr -dname "CN=user1, O=IBM, C=US" -keyalg RSA -validity 365

___2. Now list the contents of the details of the *designer* certificate store using this command

podman exec -it cscvinc_zosConnect_1 keytool -keystore /output/resources/security/cicsKeyStore.jks -storetype PKCS12 --storepass changeit -list -alias designer -v

```
root:/home/workstation/podman/employee:> podman exec -it cscvinc_zosConnect_1 keytool -keystore
/output/resources/security/cicsKeyStore.jks -storetype PKCS12 --storepass changeit -list  -alias designer -v
Alias name: designer
Creation date: Jul 1, 2022
Entry type: keyEntry
Certificate chain length: 1
Certificate[1]:
Owner: CN=user1, O=IBM, C=US
Issuer: CN=user1, O=IBM, C=US
Serial number: 5bc5192c
Valid from: 7/1/22 1:52 PM until: 7/1/23 1:52 PM
Certificate fingerprints:
         MD5:  BC:26:9F:73:A6:31:54:DD:17:BC:F8:BA:1B:28:46:63
         SHA1: D4:62:23:4F:59:AB:E7:1C:59:74:2E:15:77:19:1D:4A:C7:F4:D1:6F
         SHA256: 6B:49:8A:4B:62:B9:11:EC:EA:29:8B:CD:56:6E:3C:B4:80:50:2E:43:1F:64:BE:D5:93:A1:02:9B:76:B0:E3:20
         Signature algorithm name: SHA256withRSA
         Version: 3

Extensions:

#1: ObjectId: 2.5.29.14 Criticality=false
SubjectKeyIdentifier [
KeyIdentifier [
0000: 76 40 fc 00 ad fc 2b c5  b1 ab cc 9e 4a 34 fc 9b  v.....+.....J4..
0010: 93 b8 e8 c4                                        ....
]
]
```

Note in the above output that the *Issuer* and *Owner* have the same distinguished name, the very definition of a self-signed certificate.

___3. Create a certificate request from the self-signed certificate

podman exec -it cscvinc_zosConnect_1 keytool -keystore /output/resources/security/cicsKeyStore.jks -storetype PKCS12 -certreq -alias cicsusr -file /output/resources/security/user1.arm

Send the certificate request file to the certificate authority for signing.

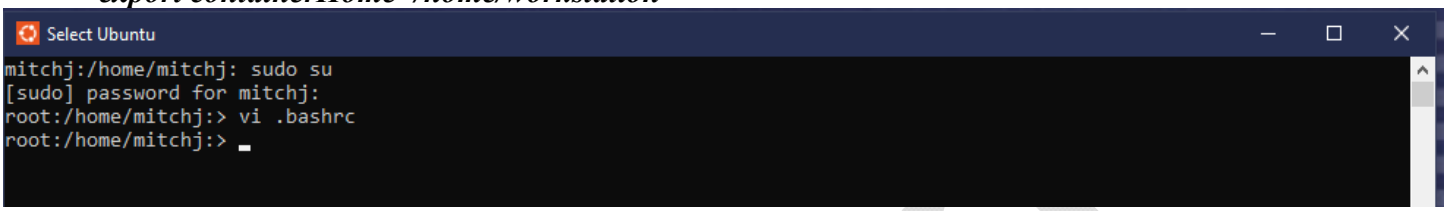
___4. Import the signed personal certificate into the local keystore

podman exec -it cscvinc_zosConnect_1 keytool -importcert -file /output/resources/security/user1.PEM -alias cicsusr -storetype PKCS12 --noprompt -keystore /output/resources/security/cicsKeyStore.jks

Suggestions for customizing the Linux shell environment

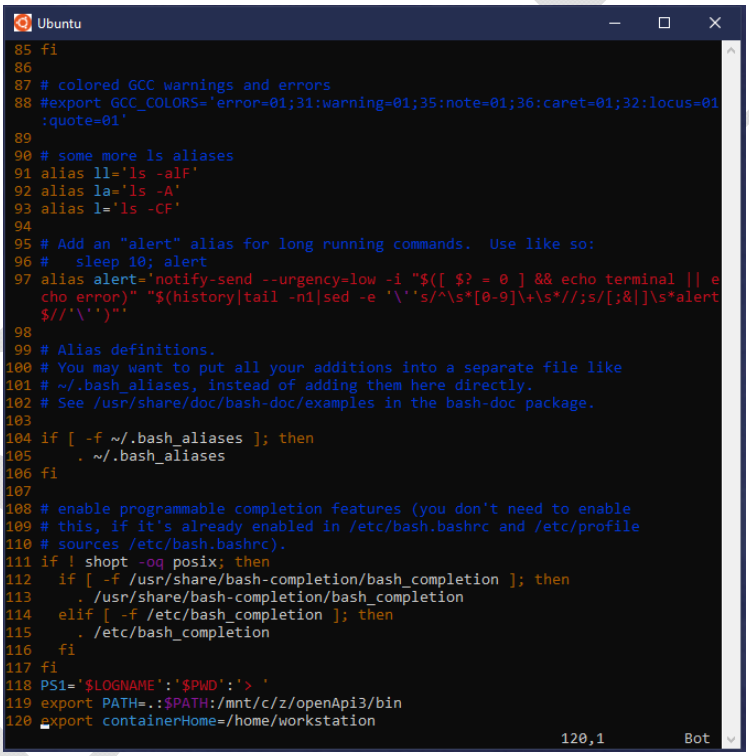
- Adding these lines to file ***.bashrc*** in your Linux home directory add path details to the Linux command prompt

  PS1='$LOGNAME':'$PWD':> '
  export PATH=.:$PATH:/mnt/c/z/openApi3/bin
  export containerHome=/home/workstation



- Creating a file named ***.exrc*** in your Linux home directory improves the *vi* editor experience

  set showmode
  set redraw
  set wrapmargin=3
  set nu



Useful commands for managing containers

- Start a new container or update an existing container using a *docker-compose-yaml* file

  podman-compose -f /home/mitchj/podman/sandbox/docker-compose.yaml up -d

- Start a new container using *docker-compose-yaml* while in directory /home/mitchj/podman/sandbox

  podman-compose up –d

- Stop the container using podman-compose command while in directory /home/mitchj/podman/sandbox

  podman-compose down

- Start the sandbox container regardless of current directory

  podman start sandbox-zosConnect-1

- Stop the sandbox container regardless of current directory

  podman stop sandbox-zosConnect-1

- Copy server XML override files from Linux into a container directory*

  podman cp /home/mitchj/xml/. sandbox_zosConnect_1:/config/configDropins/overrides

- List the active containers

  podman ps

```
CONTAINER ID   IMAGE                                          COMMAND                  CREATED          STATUS
PORTS                                                                                   NAMES
97756ede6692   icr.io/zosconnect/ibm-zcon-designer:3.0.55   "/opt/ibm/helpers/ru…"   26 hours ago     Up 26 hours
0.0.0.0:9088->9080/tcp, :::9088->9080/tcp, 0.0.0.0:9429->9443/tcp, :::9429->9443/tcp   cscvinc_zosConnect_1
642f17a4063a   icr.io/zosconnect/ibm-zcon-designer:3.0.55   "/opt/ibm/helpers/ru…"   47 hours ago     Up 20 hours
0.0.0.0:9082->9080/tcp, :::9082->9080/tcp, 0.0.0.0:9445->9443/tcp, :::9445->9443/tcp   sandbox_zosConnect_1
```

- List all active and stopped containers

  podman ps -a

- Remove a container by name or container ID

  podman rm sandbox_zosconnect_1

  or

  podman rm 642f17a4063a

- Start a bash shell in the container

  podman exec -it sandbox_zosConnect_1 bash

- List the installed images

  podman images

```
REPOSITORY                                TAG       IMAGE ID       CREATED         SIZE
icr.io/zosconnect/ibm-zcon-designer       3.0.57    386f4ac8cbd0   25 hours ago    1.16GB
icr.io/zosconnect/ibm-zcon-designer       3.0.56    cf167f4230b5   6 weeks ago     1.57GB
icr.io/zosconnect/ibm-zcon-designer       3.0.55    be9c9101f533   2 months ago    1.52GB
hello-world                               latest    feb5d9fea6a5   8 months ago    13.3kB
```

- Remove an installed image

  podman rmi icr.io/zosconnect/ibm-zcon-designer:3.0.56

- Install the Podman *podman-compose* command

  pip install podman-compose

- Display the details of a container

  podman container inspect sandbox-zosConnect-1

- Create a copy of a container

  podman commit sandbox_zosConnect_1 sandbox_zosconnect_1_Next

- Copy the configuration XML override file from Linux into the container

  podman cp /home/mitchj/xml/. sandbox_zosConnect_1:/config/configDropins/overrides/

- Copy the war files and from the container

  podman cp sandbox_zosConnect_1:/workspace/project/build/libs/api.war /home/mitchj/wars/cscvinc.war

- Copy the configuration XML files from the container into Linux

  podman cp /home/mitchj/xml/. sandbox_zosConnect_1:/config/configDropins/overrides

- Pull in a new (download) a z/OS Connect Designer image

  podman pull icr.io/zosconnect/ibm-zcon-designer:3.0.57

- Save the z/OS Connect Podman image to a file

  podman save icr.io/zosconnect/ibm-zcon-designer:3.0.57 | gzip > 3.0.57.tar.gz

- Copy the z/OS Connect Podman image file to a Windows directory location

  cp *.tar.gz /mnt/c/z/ftp

- Use FTP to move the image file from the original image to the target Linux image
- Load the z/OS Connect Podman image on the Linux image

  podman load < 3.0.57.tar.gz

The contents of the cscvinc.yaml file

```
openapi: 3.0.0
info:
  description: "CICS Employee Sample VSAM Application"
  version: 1.0.0
  title: Employee
x-ibm-zcon-roles-allowed:
- Manager
paths:
  /employee:
    post:
      tags:
        - Employee
      operationId: postEmployeeInsertService
      parameters:
        - name: Authorization
          in: header
          required: false
          schema:
            type: string
      requestBody:
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/postEmployeeInsertService_request"
        description: request body
        required: true
      responses:
        "200":
          description: OK
          content:
            application/json:
              schema:
                $ref: "#/components/schemas/postEmployeeInsertService_response_200"
        "400":
          description: Bad Request
          content:
            application/json:
              schema:
                $ref: "#/components/schemas/postEmployeeInsertService_response_400"
        "500":
          description: Sever Error
          content:
            application/json:
              schema:
                $ref: "#/components/schemas/postEmployeeInsertService_response_500"
```

```
"/employee/{employee}":
  get:
    tags:
      - Employee
    operationId: getEmployeeSelectService
    x-ibm-zcon-roles-allowed:
      - Staff
    parameters:
      - name: Authorization
        in: header
        required: false
        schema:
          type: string
      - name: employee
        in: path
        required: true
        schema:
          type: string
          maxLength: 6
    responses:
      "200":
        description: OK
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/getEmployeeSelectService_response_200"
      "404":
        description: Not Found
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/getEmployeeSelectService_response_404"
      "500":
        description: Severe Error
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/getEmployeeSelectService_response_500"
  put:
    tags:
      - Employee
    operationId: putEmployeeUpdateService
    x-ibm-zcon-roles-allowed:
      - Staff
    parameters:
      - name: Authorization
        in: header
        required: false
        schema:
          type: string
```

```
    - name: employee
      in: path
      required: true
      schema:
        type: string
  requestBody:
    content:
      application/json:
        schema:
          $ref: "#/components/schemas/putEmployeeUpdateService_request"
    description: request body
    required: true
  responses:
    "200":
      description: OK
      content:
        application/json:
          schema:
            $ref: "#/components/schemas/putEmployeeUpdateService_response_200"
    "404":
      description: Bad Request
      content:
        application/json:
          schema:
            $ref: "#/components/schemas/putEmployeeUpdateService_response_404"
    "500":
      description: Severe Error
      content:
        application/json:
          schema:
            $ref: "#/components/schemas/putEmployeeUpdateService_response_500"
delete:
  tags:
    - Employee
  operationId: deleteEmployeeDeleteService
  x-ibm-zcon-roles-allowed:
    - Manager
  parameters:
    - name: Authorization
      in: header
      required: false
      schema:
        type: string
    - name: employee
      in: path
      required: true
      schema:
        type: string
        maxLength: 6
  responses:
```

```
      "200":
        description: OK
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/deleteEmployeeDeleteService_response_200"
      "404":
        description: Not Found
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/deleteEmployeeDeleteService_response_404"
      "500":
        description: Not Found
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/deleteEmployeeDeleteService_response_500"
servers:
  - url: /
components:
  schemas:
    getEmployeeSelectService_response_404:
      type: object
      properties:
        message:
          type: string
      example:
        message: Record could not be found
    getEmployeeSelectService_response_200:
      type: object
      properties:
        summary:
          $ref: '#/components/schemas/getEmployeeSelectService_response_200_message'
        detail:
          $ref: '#/components/schemas/getEmployeeSelectService_response_200_detail'
    getEmployeeSelectService_response_200_message:
      type: object
      properties:
        message:
          type: string
      example:
        message: record retrieved
    getEmployeeSelectService_response_200_detail:
      type: object
      properties:
        EmployeeSelectServiceOperationResponse:
          type: object
          properties:
            employeeData:
```

```
        type: object
        properties:
          response:
            type: object
            properties:
              employeeDetails:
                type: object
                properties:
                  employeeNumber:
                    type: string
                    maxLength: 6
                  name:
                    type: string
                    maxLength: 20
                  address:
                    type: string
                    maxLength: 20
                  phoneNumber:
                    type: string
                    maxLength: 8
                  date:
                    type: string
                    maxLength: 8
                  amount:
                    type: string
                    maxLength: 8
                  comment:
                    type: string
                    maxLength: 9
      required:
        - employeeData
getEmployeeSelectService_response_500:
  type: object
  properties:
    message:
      type: string
  example:
    message: A severe error has occurred
deleteEmployeeDeleteService_response_404:
  type: object
  properties:
    message:
      type: string
  example:
    message: Record could not be found to be deleted
deleteEmployeeDeleteService_response_500:
  type: object
  properties:
    message:
      type: string
```

```
  example:
    message: A severe error has occurred
deleteEmployeeDeleteService_response_200:
  type: object
  properties:
    message:
      type: string
  example:
    message: Record deleted
putEmployeeUpdateService_request:
  type: object
  properties:
    EmployeeUpdateServiceOperation:
      type: object
      properties:
        employeeData:
          type: object
          properties:
            request:
              type: object
              properties:
                employeeDetails:
                  type: object
                  properties:
                    status:
                      type: string
                      maxLength: 1
                    employeeNumber:
                      type: string
                      maxLength: 6
                    name:
                      type: string
                      maxLength: 20
                    address:
                      type: string
                      maxLength: 20
                    phoneNumber:
                      type: string
                      maxLength: 8
                    date:
                      type: string
                      maxLength: 8
                    amount:
                      type: string
                      maxLength: 8
                    COMMENT:
                      type: string
                      maxLength: 9
      required:
        - employeeData
```

```
putEmployeeUpdateService_response_404:
  type: object
  properties:
    message:
      type: string
  example:
    message: Record update failed
putEmployeeUpdateService_response_500:
  type: object
  properties:
    message:
      type: string
  example:
    message: A severe has occurred
putEmployeeUpdateService_response_200:
  type: object
  properties:
    message:
      type: string
  example:
    message: Record updated
postEmployeeInsertService_request:
  type: object
  properties:
    EmployeeInsertServiceOperation:
      type: object
      properties:
        employeeData:
          type: object
          properties:
            request:
              type: object
              properties:
                employeeDetails:
                  type: object
                  properties:
                    employeeNumber:
                      type: string
                      maxLength: 6
                    name:
                      type: string
                      maxLength: 20
                    address:
                      type: string
                      maxLength: 20
                    phoneNumber:
                      type: string
                      maxLength: 8
                    date:
                      type: string
```

```
            maxLength: 8
          amount:
            type: string
            maxLength: 8
    required:
     - employeeData
postEmployeeInsertService_response_400:
  type: object
  properties:
    message:
      type: string
  example:
    message: Employee insert failed
postEmployeeInsertService_response_500:
  type: object
  properties:
    message:
      type: string
  example:
    message: Severe Error Occurred
postEmployeeInsertService_response_200:
  type: object
  properties:
    message:
      type: string
  example:
    message: Record successfully inserted
```


Mitch Johnson (mitchj@us.ibm.com)