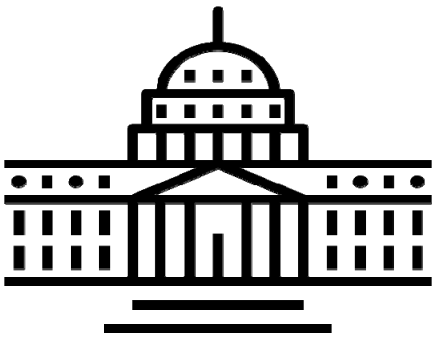
IBM z/OS Connect (OpenAPI 2.0)

Developing RESTful APIs for a CICS Channel program



IBM Washington Systems Center

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Table of Contents

Important: There is a folder on the Windows desktop named *CopyPaste Files.* This folder contains file with the commands and other text used in this workshop. Locate the file identified in the General Exercise Information and Guidelines section of this exercise and copy it to the desktop. Open the file and use the copy-and-paste function (**Ctrl-C** and **Ctrl-V**) to enter commands or text. It will save time and help avoid typo errors. As a reminder text that appears in this file will be highlighted in yellow.

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Overview

Important – You do not need any skills with CICS to perform this exercise. Even if CICS is not relevant to your current plans performing this exercise will give additional experience using the Toolkit to develop services and APIs.

The objective of these exercises is to gain experience with working with z/OS Connect and the API Toolkit. These two products allow the exposure of z/OS resources to JSON clients. For information about scheduling this workshop in your area contact your IBM representative.

If you have completed another the developing APIs exercise for this workshop you can start with section *z/OS Connect APIs and a CICS program* on page 7.

General Exercise Information and Guidelines

- ✓ This exercise requires using z/OS user identity *USER1*. The RACF password for this user is *user1* (lower case sensitive).
- ✓ Any time you have any questions about the use of IBM z/OS Explorer, 3270 screens, features or tools do not hesitate to ask the instructor for assistance.
- ✓ Text in **bold** and highlighted in **yellow** in this document should be available for copying and pasting in a file named *OpenAPI2 developing APIs CopyPaste* file.
- ✓ 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 information regarding the use of the Personal Communication 3270 emulator, see the *Personal Communications Tips* PDF in the exercise folder.

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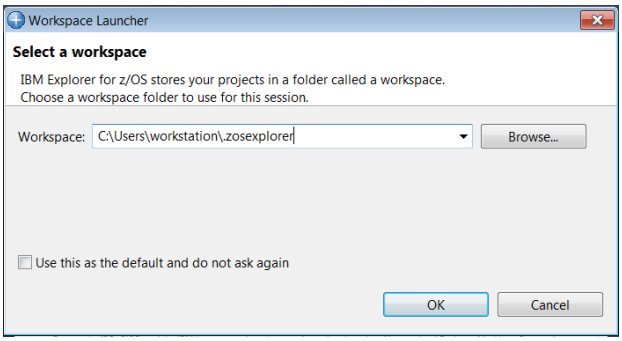
Connect the IBM z/OS Explorer to the z/OS Connect Server

Begin by establishing a connection to your z/OS Connect server from IBM z/OS Explorer. If you have performed one of the other exercises in this series of exercises this step may not be required.

Tech-Tip: Windows desktop tools can be opened either by double clicking the icon or by selecting the icon and clicking on the right mouse button and then selecting the *Open* option.

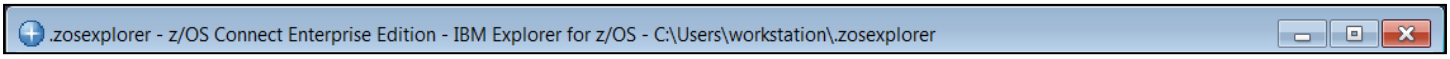
___1. On the workstation desktop, locate the *z/OS Explorer* icon and double click on it to open the Explorer.

___2. You will be prompted for a workspace:



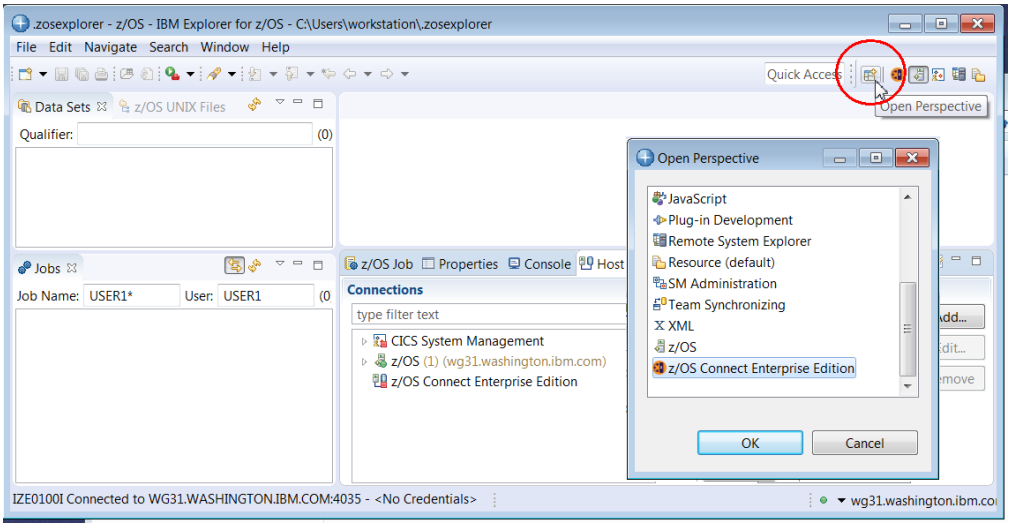
Take the default value by clicking **OK**.

___3. The Explorer should open in the *z/OS Connect Enterprise Edition* perspective. Verify this by looking in the upper left corner. You should see:



N.B. If a *Welcome* screen is displayed then click the white X beside *Welcome* to close this view.

___4. If the current perspective is not *z/OS Connect Enterprise Edition*, select the *Open Perspective* icon on the top right side to display the list of available perspectives, see below. Select **z/OS Connect Enterprise Edition** and click the **OK** button to switch to this perspective.



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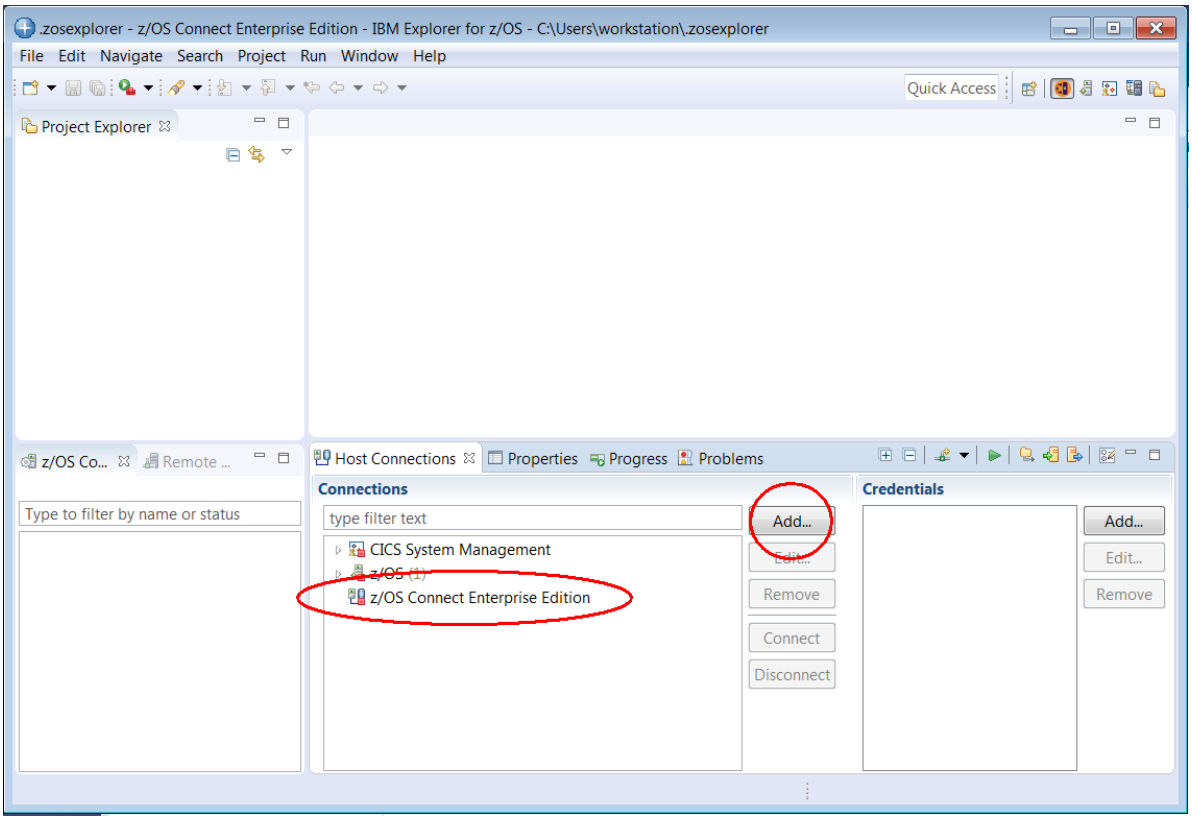
___5. To add a connection to the z/OS Connect Server select *z/OS Connect Enterprise Edition* connection in the *Host connection*s tab in the lower view and then click the **Add** button.



Tech-Tip: Eclipse based development tools like z/OS Explorer provide a graphical interface consisting of multiple views within a single window.

A view is an area in the window dedicated to providing a specific tool or function. For example, in the window above, *Host Connections* and *Project Explorer* are views that use different areas of the window for displaying information. At bottom on the right there is a single area for displaying the contents of four views stacked together (commonly called a *stacked views*), *z/OS Host Connections, Properties, Progress* and *Problems*. In a stacked view, the contents of each view can be displayed by clicking on the view tab (the name of the view).

At any time, a specific view can be enlarged to fill the entire window by double clicking in the view's title bar. Double clicking in the view's title bar will be restored the original arrangement. If a z/OS Explorer view is closed or otherwise disappears, the original arrangement can be restored by selecting Windows → Reset Perspective in the window's tool bar.

Eclipse based tools also can display multiple views based on the current role of the user. In this context, a window is known as a perspective. The contents (or views) of a perspective are based on the role the user, i.e., developer or administrator.

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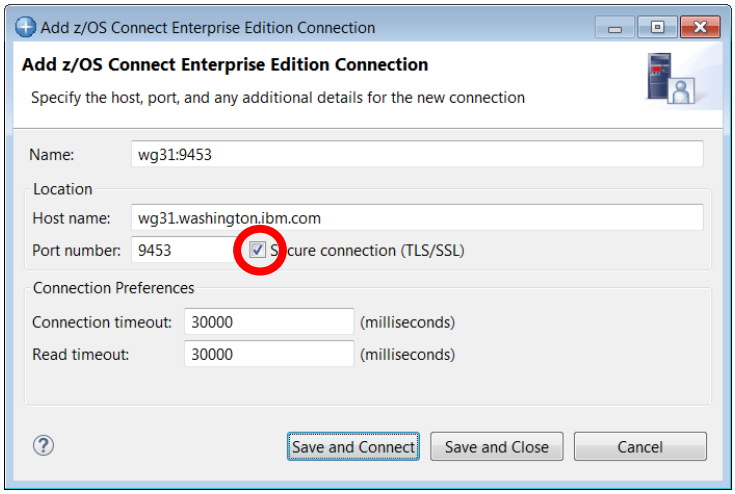
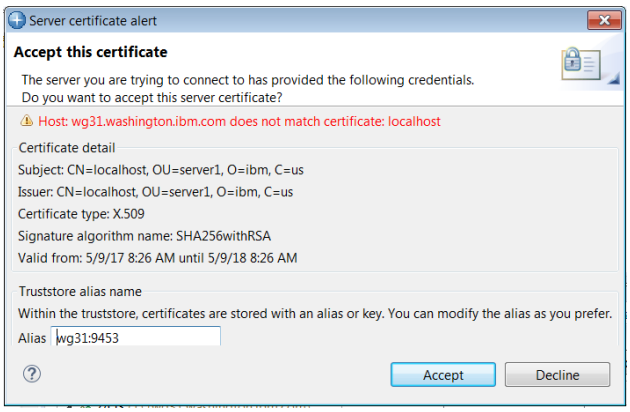
___6. In the pop-up list displayed select *z/OS Connect Enterprise Edition* and on the *Add z/OS Connect Enterprise Edition Connection* screen enter ***wg31.washington.ibm.com*** for the *Host name*, ***9453*** for the *Port Number*, check the box for *Secure connection (TLS/SSL)* and then click the **Save and Connect** button.



___7. On the *z/OS Connect Enterprise Edition – User ID* required screen create new credentials for a *User ID* of ***USER1*** and a *Password or Passphrase* of ***user1*** (case matters). Click **OK** to continue.

___8. Click the **Accept** button on the *Server certificate alert – Accept this certificate* screen. You may be presented with another prompt for a userid and password, enter ***Fred*** and ***fredpwd*** again.



___9. The status icon beside *wg31:9453* should now be a green circle with a lock. This shows that a secure connection has been established between the z/OS Explorer and the z/OS Connect server. A red box indicates that no connection exists.

~~A connection to the remote z/OS system was previously added. In the *Host Connection* view expand *z/OS Remote System* under *z/OS* and select *wg31.washington.ibm.com*. If the connection is not active the **Connect** button will be enabled. Click the **Connect** button and this will establish a session to the z/OS system. This step is required when submitting job for execution and viewing the output of these jobs later in this exercise~~

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z/OS Connect APIs and a CICS program

This exercise provides an opportunity to compose and deploy an API that invokes a CICS program. This program happens to interact using CICS Channels and Containers, but the process is fundamentally the same for CICS programs that interact using COMMAREAs.

The target CICS program, *CSCVINC,* is a simple CICS program that receives a container in a channel. The program accesses a VSAM file based on an *action* field in the container. If the *action* field contains an **I**, the program inserts a new record into the VSAM file. If the *action* field contains a **D**, the record identified by the key field is deleted. If the *action* field contains a **U** the program updates an existing record with new data from the container. Finally, ff the *action* field contains an S, the program selects or retrieves a record based on the key field in the container. The name of the request container is reused for the name of the response container. This allows accessing the program without any dependency on a specific container name.

The 4 functions of the CSCVINC program (insert, delete, update and select) will be exposed as 4 services that correspond to the HTTP methods POST, DELETE, PUT and GET respectively.

These 4 services will then be integrated into a RESTful API. Note that the response messages for the *POST*, *DELETE*, and *PUT* methods of this API will return to the client only the HTTP response code.

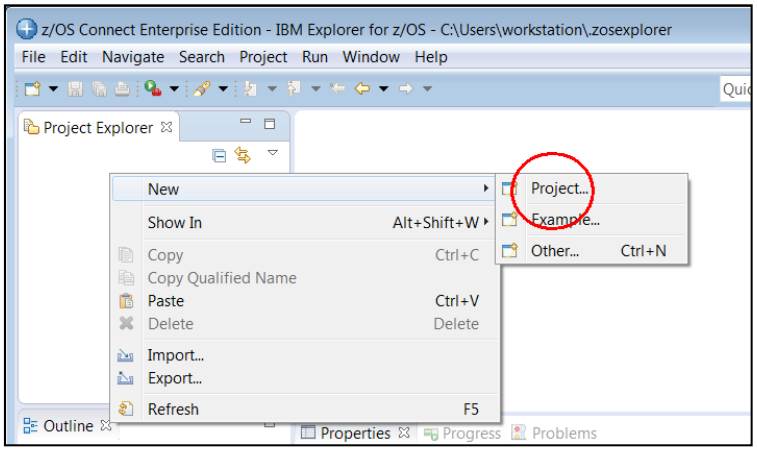
Create the services

The first step is to create the 4 services which describe the interaction with the CICS program CSCVINC. Each service will correspond to the insert, delete, update, or select functions described above.

Switch to the *z/OS Connect Enterprise Edition* perspective. Let's start with the *insert* or *POST* service.

Create the "Insert" service

___1. In the upper left, position your mouse anywhere in the *Project Explorer* view and right-mouse button click, then select *New* →*Project*:



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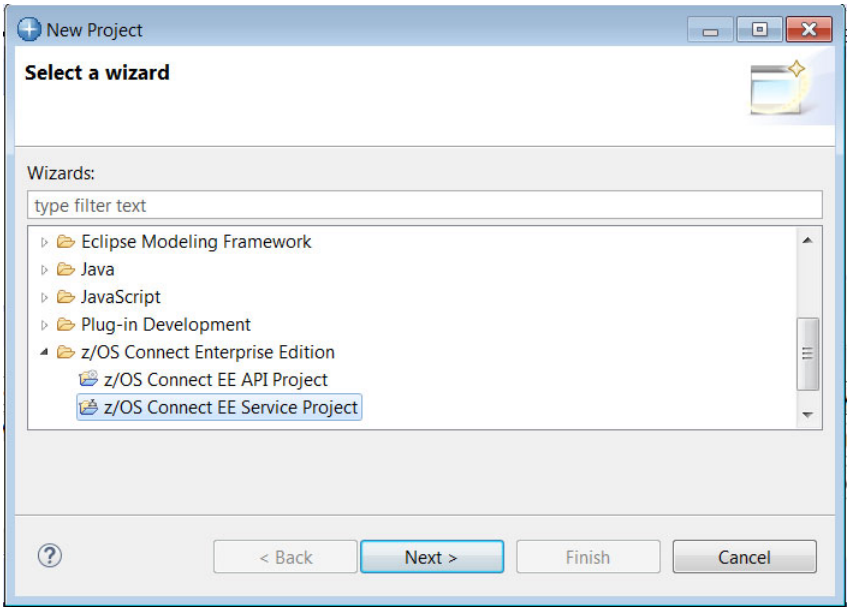
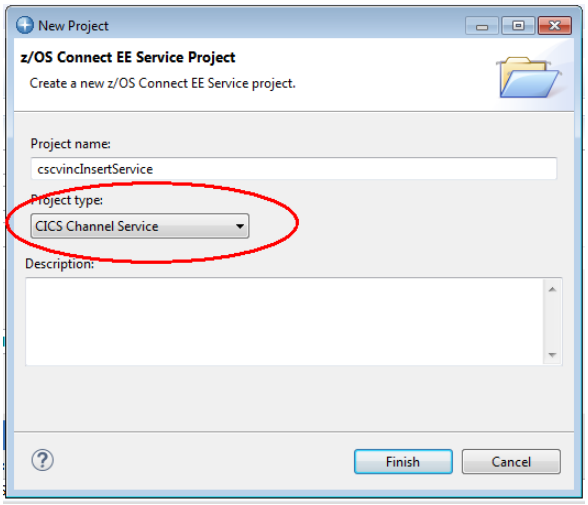
___2. In the *New Project* window, scroll down and open the *z/OS Connect Enterprise Edition* folder and select *z/OS Connect Service Project* and then click the **Next** button.



___3. In the new *New Project* window enter ***cscvincInsertService*** the *Project name* and use the pull-down arrow to select *CICS Channel Service* as the *Project type*. Click **Finish** to continue.



Tech-Tip: This is really the only difference between creating a service that accesses a CONTAINER enabled CICS program versus creating a service that accesses a COMMAREA enabled CICS program.

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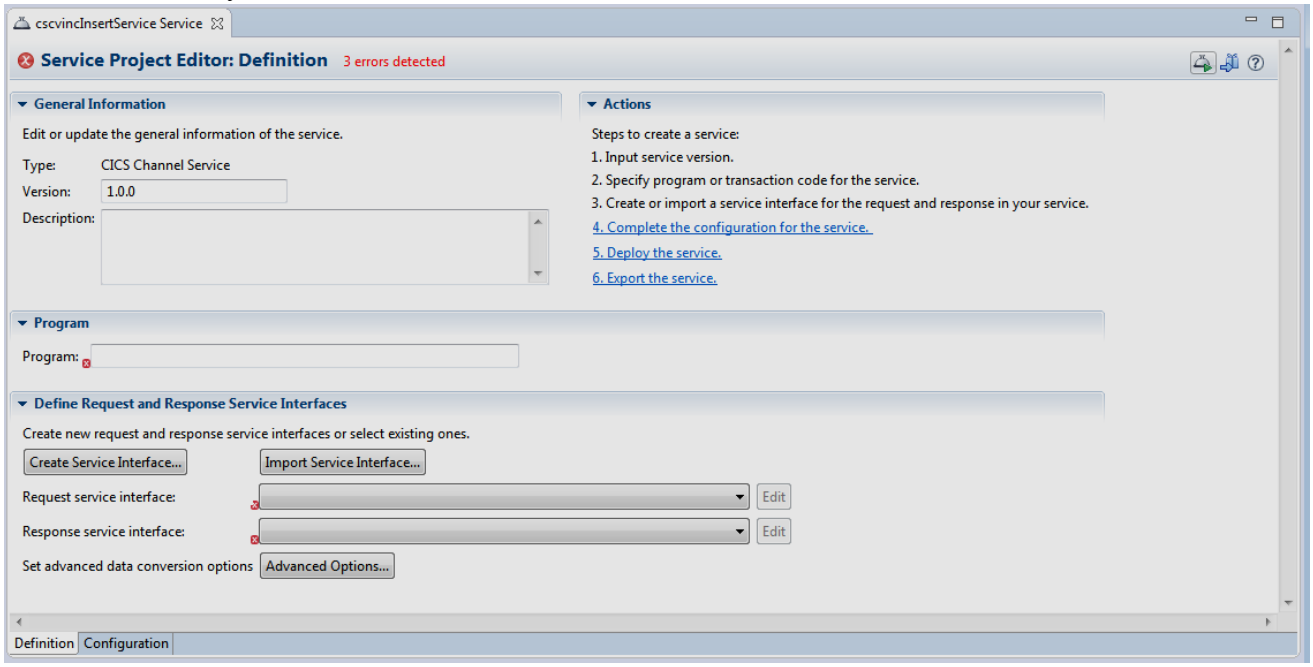
___4. This will open the *Overview* window for the *cscvincInsertService*. For now, disregard the message about the 3 errors addressed shortly.



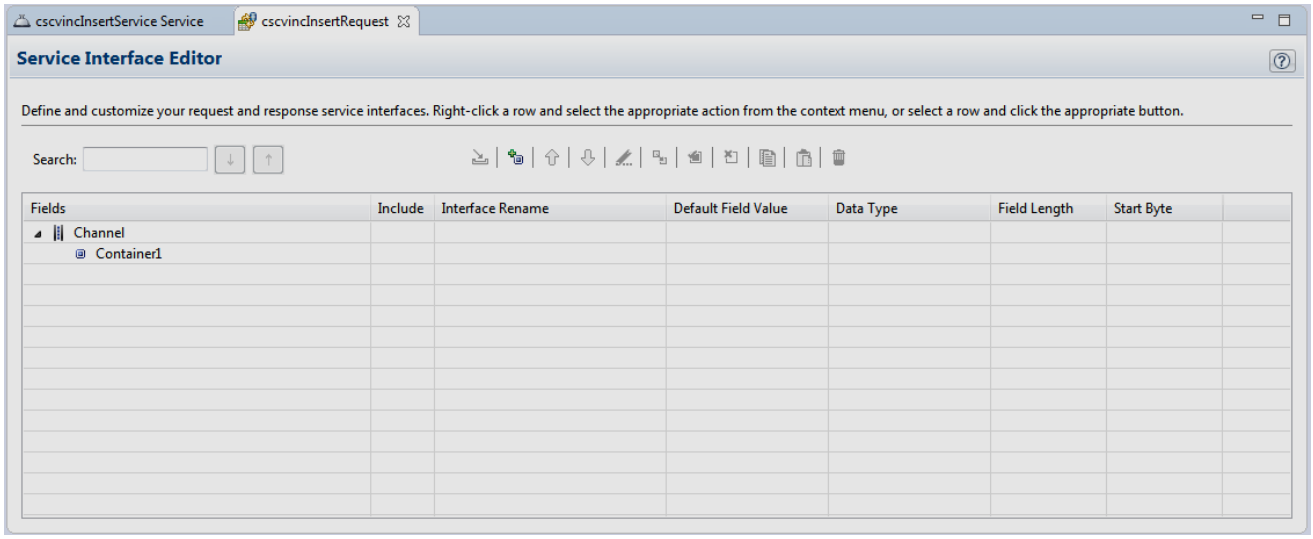
Tech-Tip: If this view is closed it can be reopened by double clicking the *service.properties* file in the service project.

Tech-Tip: The CICS program name must be entered in upper case unless the program has been defined in CICS in lower case.

___5. Next enter the target CICS program name ***CSCVINC*** in the area beside *Program*.

___6. Click the **Create Service Interface** button to create the first service interface required by this API and enter a *Service interface name* of ***cscvincInsertRequest***. Click **OK** to continue.

___7. This will open a *Service Interface Definition* window.



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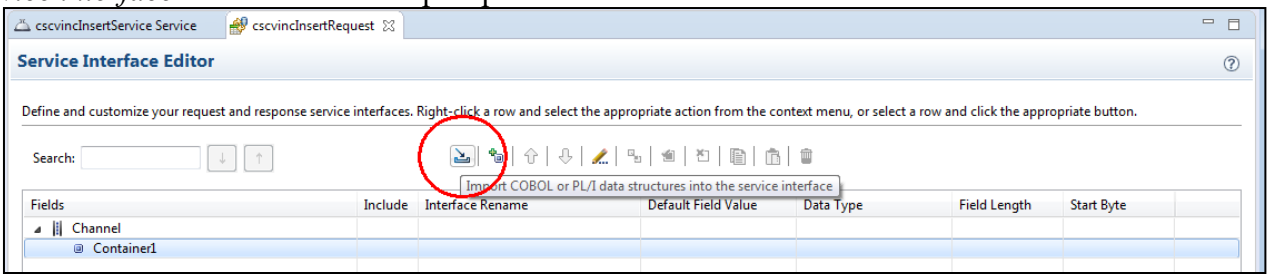
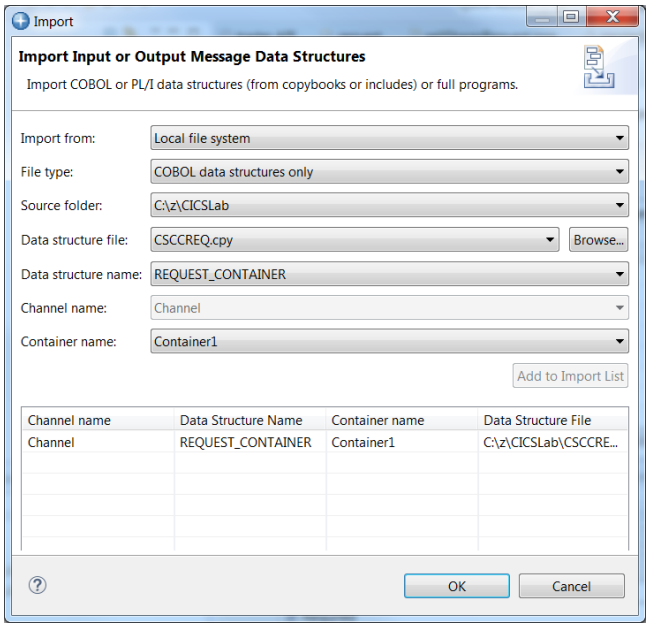
___8. The first step is to import the COBOL copy book (see below) that represents the inbound or request CONTAINER.

```
       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).
```

___9. On the *Service Interface Definition* window, there is a tool bar near the top. If you hover over an icon its function will be display as below. Select *Container1* and click the *Import COBOL or PL/I data structure into the service interface* icon to start the import process.



___10. This will open the *Import* window. On this window select *Local file system* as source of the import and *COBOL data structure only* as the *File type*. Press the **Browse** button and **Open** directory *C:\z\CICSLAB* and then select file *CSCCREQ*.cpy and click **Open** to import this file into this project. Click the **Add to Import List** button to continue.



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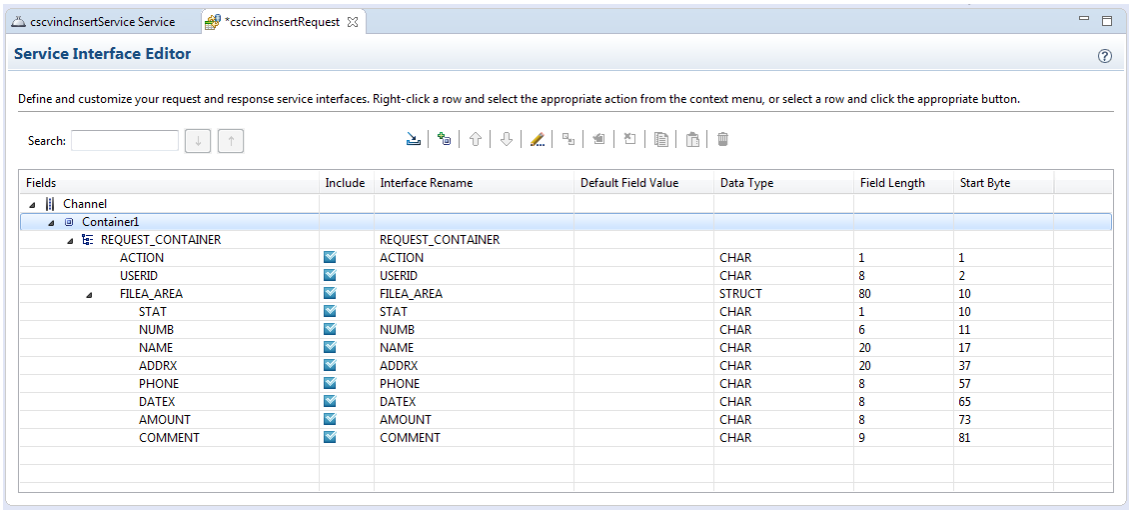
___11. Click **OK** and when you expand *Container1, REQUEST_CONTAINER* and *FILEA_AREA* you will see the COBOL 'variables' that have been imported into the service project.



Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
Container1						
REQUEST_CONTAINER		REQUEST_CONTAINER				
ACTION	☑	ACTION		CHAR	1	1
USERID	☑	USERID		CHAR	8	2
FILEA_AREA	☑	FILEA_AREA		STRUCT	80	10
STAT	☑	STAT		CHAR	1	10
NUMB	☑	NUMB		CHAR	6	11
NAME	☑	NAME		CHAR	20	17
ADDRX	☑	ADDRX		CHAR	20	37
PHONE	☑	PHONE		CHAR	8	57
DATEX	☑	DATEX		CHAR	8	65
AMOUNT	☑	AMOUNT		CHAR	8	73
COMMENT	☑	COMMENT		CHAR	9	81

N.B. by default all the variables/fields are automatically selected to be include in the interface and their default interface names are derived from the COBOL source shown earlier.

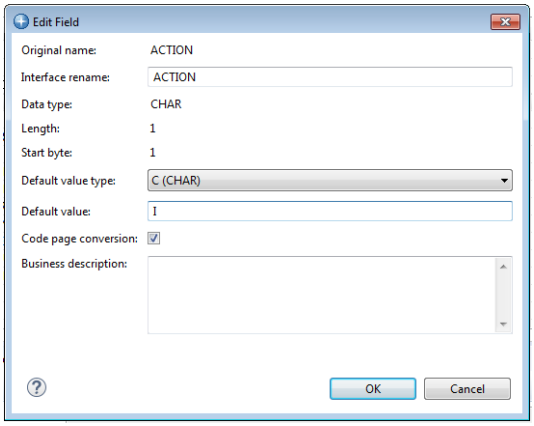
___12. In this window, you can edit and change the property name (e.g. *Interface name*) or exclude specific fields entirely from the interface. Either can be done by selecting a field and right mouse button clicking or by selecting a field and using the desired tool icon in the Service Interface toolbar. Let's try both techniques to remove the STAT and COMMENT fields.

___13. Select field *STAT* and right mouse button click and select the *Exclude field from interface* option on the list of options.

___14. Next select field *COMMENT* and use the *Exclude selected fields(s) from the interface* tool icon.

___15. Notice that the check boxes besides these two fields are now unchecked. (You could have simply unchecked the box to accomplish the same results.)

___16. Next select field *ACTION* and set its default value to ***I*** by using the right mouse button technique or the *Edit selected field* icon (the pencil) in the tool bar.



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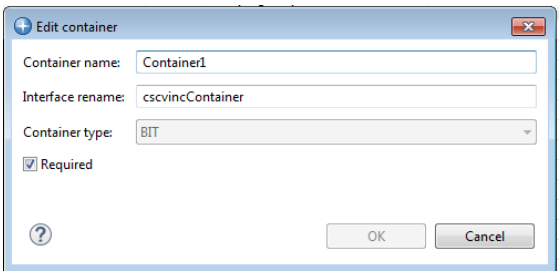
___17. Next remove all the fields from the service interface by unchecking all the boxes in the *Include* column.

___18. Select the *Container1* field and use the *Edit selected data structure* button to rename the interface name for the container to ***cscvincContainer*** (see below).



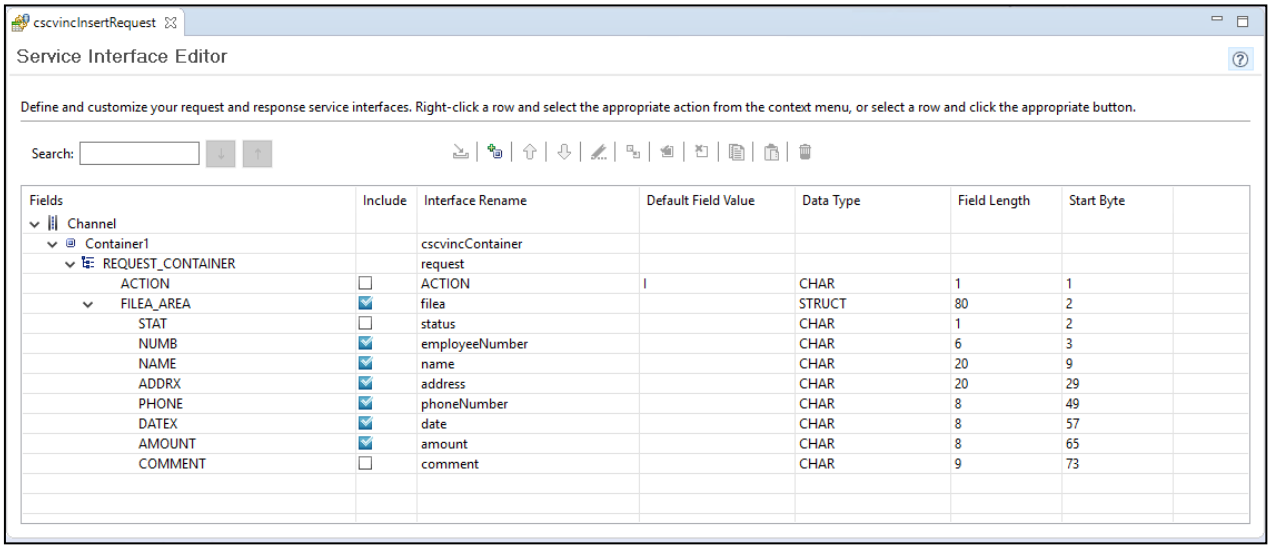
___19. Check the box beside the *NUMB, NAME, ADDRX, PHONE, DATEX* and *AMOUNT* fields so they will be included in the interface. Note the higher structure (*FILEA_AREA*) will be automatically selected also.

___20. Rename the other interface names for the other interface names as shown below:

- *REQUEST_CONTAINER* to ***request***
- *FILEA_AREA* to ***filea***
- *NUMB* to ***employeeNumber***
- *NAME* to ***name***
- *ADDRX* to ***address***
- *PHONE* to ***phoneNumber***
- *DATEX* to ***date***
- *AMOUNT* to ***amount***

N.B. if the interface names are not renamed, the original interface names will appear in subsequent screen shots.

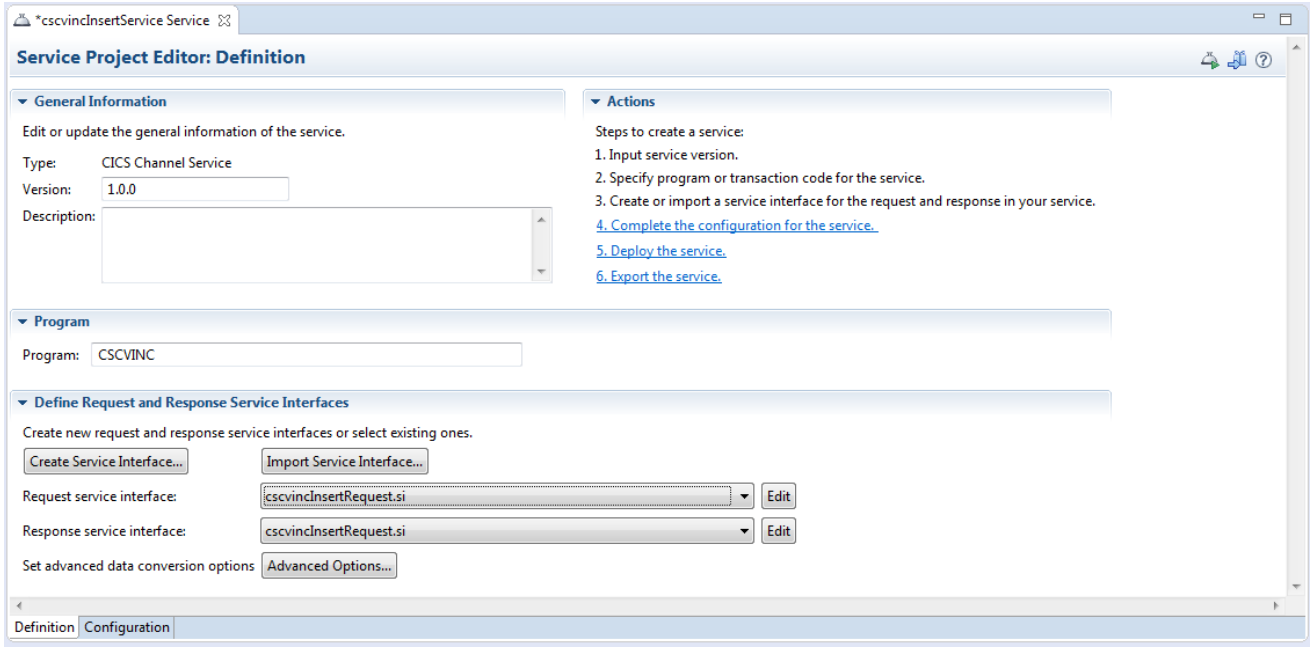
When finished your service definition interface should look like this.



Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
Container1		cscvincContainer				
REQUEST_CONTAINER		request				
ACTION	☐	ACTION	I	CHAR	1	1
FILEA_AREA	☑	filea		STRUCT	80	2
STAT	☐	status		CHAR	1	2
NUMB	☑	employeeNumber		CHAR	6	3
NAME	☑	name		CHAR	20	9
ADDRX	☑	address		CHAR	20	29
PHONE	☑	phoneNumber		CHAR	8	49
DATEX	☑	date		CHAR	8	57
AMOUNT	☑	amount		CHAR	8	65
COMMENT	☐	comment		CHAR	9	73

___21. Close the Service Interface Definition window by clicking on the white X in the tab being sure to save the changes. Note now that the *Request service interface* and the *Response service interface* areas have now been populated with *cscvincSelectServiceRequest.si*. Also note that you can use their respective **Edit** buttons to return to the *Service Interface Definition* window for each interface.

___22. The response container from program CSCVINC has a different layout from the request container so the Response service interface needs to be created.



___23. Click the **Create Service Interface** button to create the response service interface required by this API and enter a *Service interface name* of ***cscvincResponse***. Click **OK** to continue.

___24. This will open a *Service Interface Editor* window.

___25. The first step is to import the COBOL copy book (see below) that represents the outbound or response CONTAINER.

```
       01 Response-Container.
           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).
```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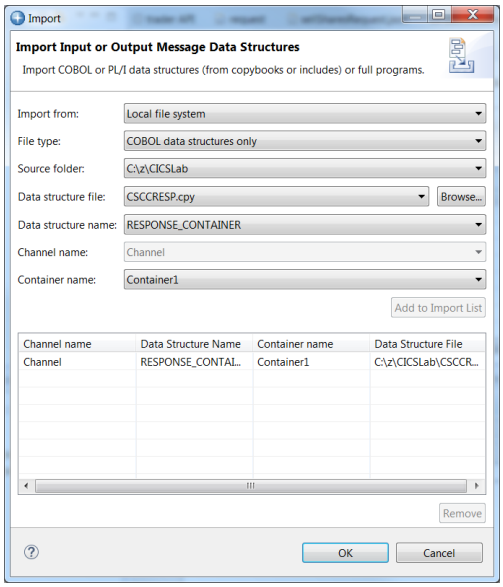
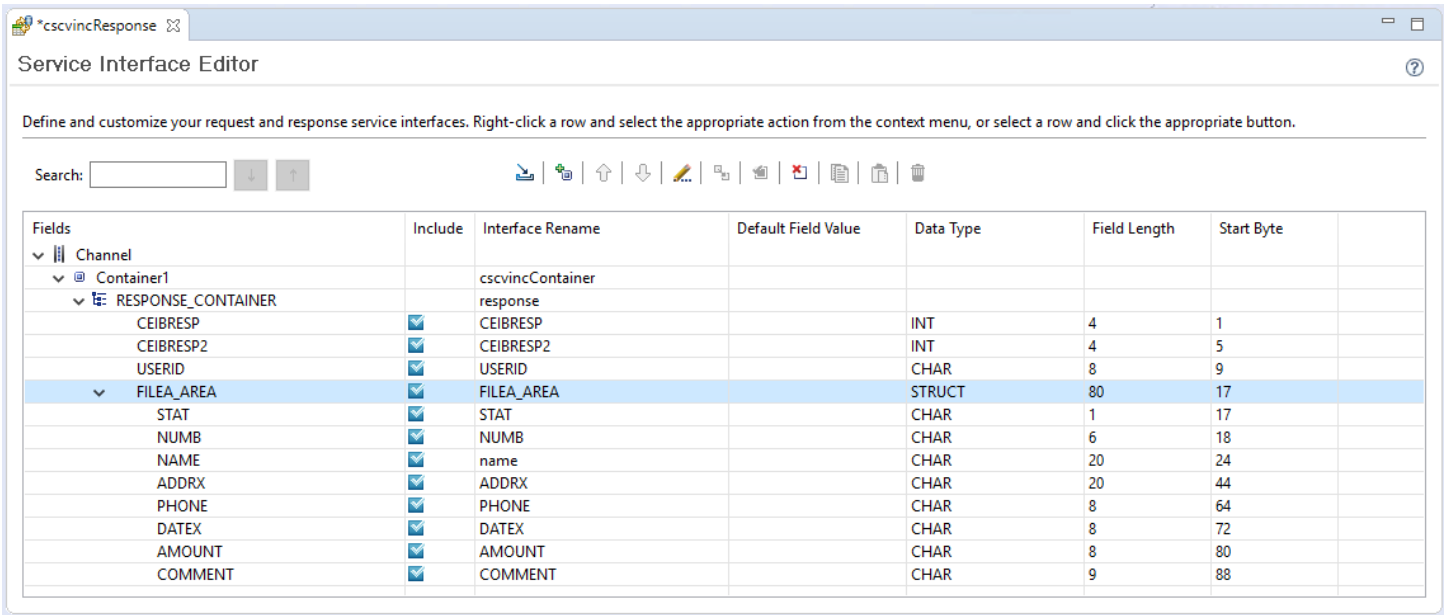
___26. On the *Service Interface Definition* window select *CONTAINER1* and click the *Import COBOL or PL/I data structure into the service interface* icon to start the import process.

___27. This will open the *Import* window. On this window select *Local file system* as source of the import and *COBOL data structure only* as the *File type*. Press the **Browse** button and **Open** directory *C:\z\CICSLAB* and then select file *CSCCRESP*.cpy and click **Open** to import this file into this project. Click the **Add to Import List** button to continue.



___28. Click **OK** and when you expand *Container1, RESPONSE_CONTAINER* and *FILEA_AREA* you will see the COBOL 'variables' that have been imported into the service project.



Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
Container1		cscvincContainer				
RESPONSE_CONTAINER		response				
CEIBRESP	☑	CEIBRESP		INT	4	1
CEIBRESP2	☑	CEIBRESP2		INT	4	5
USERID	☑	USERID		CHAR	8	9
FILEA_AREA	☑	FILEA_AREA		STRUCT	80	17
STAT	☑	STAT		CHAR	1	17
NUMB	☑	NUMB		CHAR	6	18
NAME	☑	name		CHAR	20	24
ADDRX	☑	ADDRX		CHAR	20	44
PHONE	☑	PHONE		CHAR	8	64
DATEX	☑	DATEX		CHAR	8	72
AMOUNT	☑	AMOUNT		CHAR	8	80
COMMENT	☑	COMMENT		CHAR	9	88

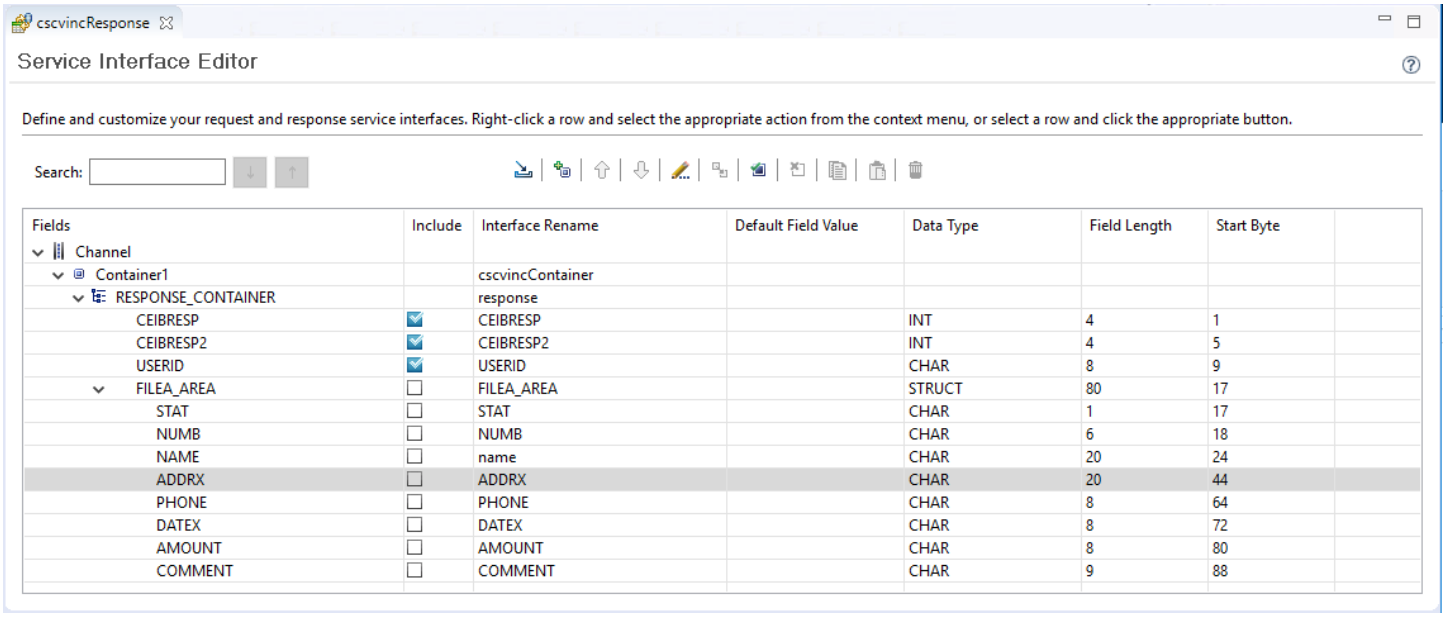
N.B. the interface names were derived from the COBOL source shown earlier

___29. Again, in this view we could exclude fields from the interface or rename fields. Exclude all of the fields from the interface except for *CEIBRESP, CEIBRESP2* and *USERID*. These fields will be referenced later.

___30. Rename the interfaces for the other interface field names as shown below from:

- *Container1* to ***cscvincContainer***
- *RESPONSE_CONTAINER* to ***response***

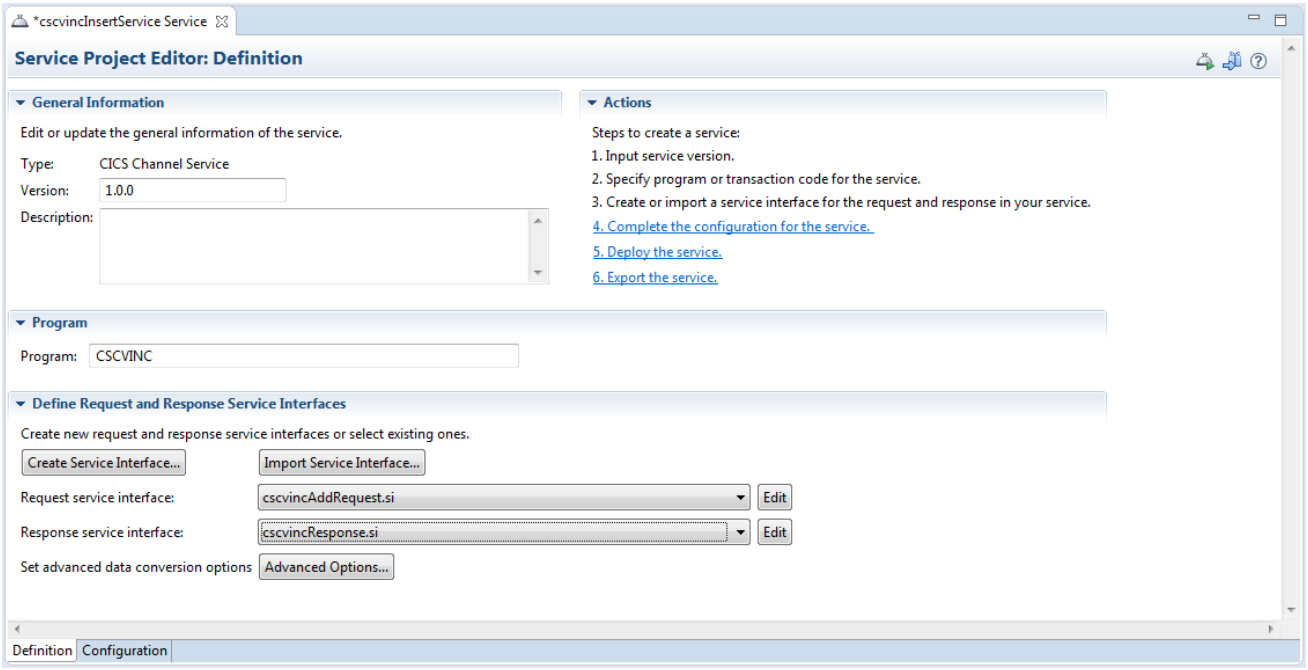
___31. When finished your service interface should look like this:



Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
Container1		cscvincContainer				
RESPONSE_CONTAINER		response				
CEIBRESP	☑	CEIBRESP		INT	4	1
CEIBRESP2	☑	CEIBRESP2		INT	4	5
USERID	☑	USERID		CHAR	8	9
FILEA_AREA	☐	FILEA_AREA		STRUCT	80	17
STAT	☐	STAT		CHAR	1	17
NUMB	☐	NUMB		CHAR	6	18
NAME	☐	name		CHAR	20	24
ADDRX	☐	ADDRX		CHAR	20	44
PHONE	☐	PHONE		CHAR	8	64
DATEX	☐	DATEX		CHAR	8	72
AMOUNT	☐	AMOUNT		CHAR	8	80
COMMENT	☐	COMMENT		CHAR	9	88

Close the *cscvincResponse* view by clicking on the white X.

___32. Use the pull-down arrow beside *Response service interface* to select *cscvincResponse.si*.



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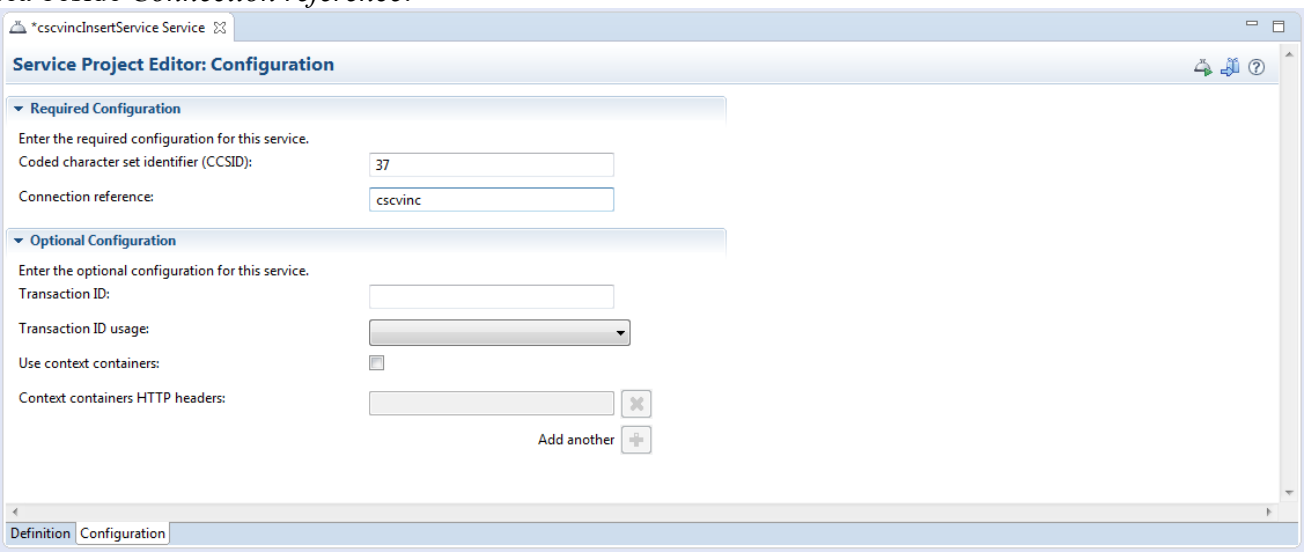
___33. Next, we need to identify a connection reference for which CICS region will be used. Click on the Configuration tab at the bottom of the *Overview* window to display the *Configuration* window. Enter ***cscvinc*** in the area beside *Connection reference*.



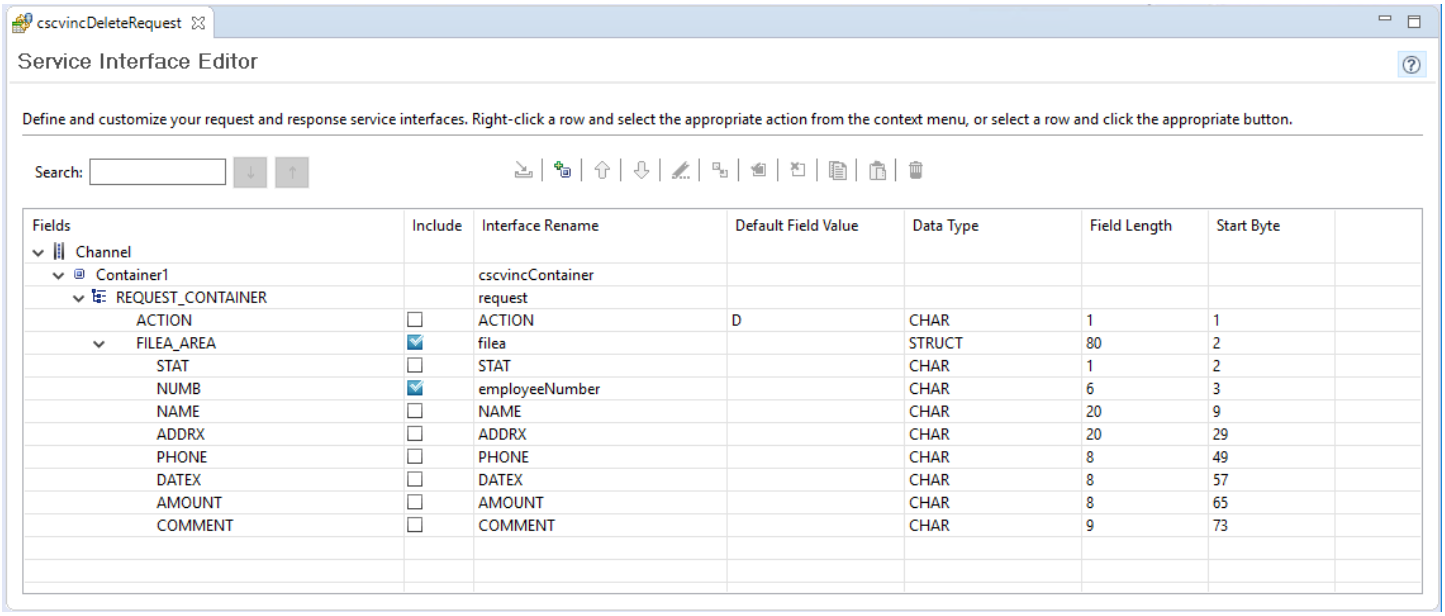
Tech-Tip: The *Connection reference* identifies the *cicsIpicConnection* element or *cicsLocalConnection* element to be used to access a CICS region in the z/OS Connect configuration, see ipic.xml on page 38. The case of the value of the *Connection reference* must match the case of the ID of the *cicsIpicConnection* element.

___35. Save the *cscvincInsertService* service either by closing the tab or using the **Ctrl-S** key sequence.

Create the "Delete" service

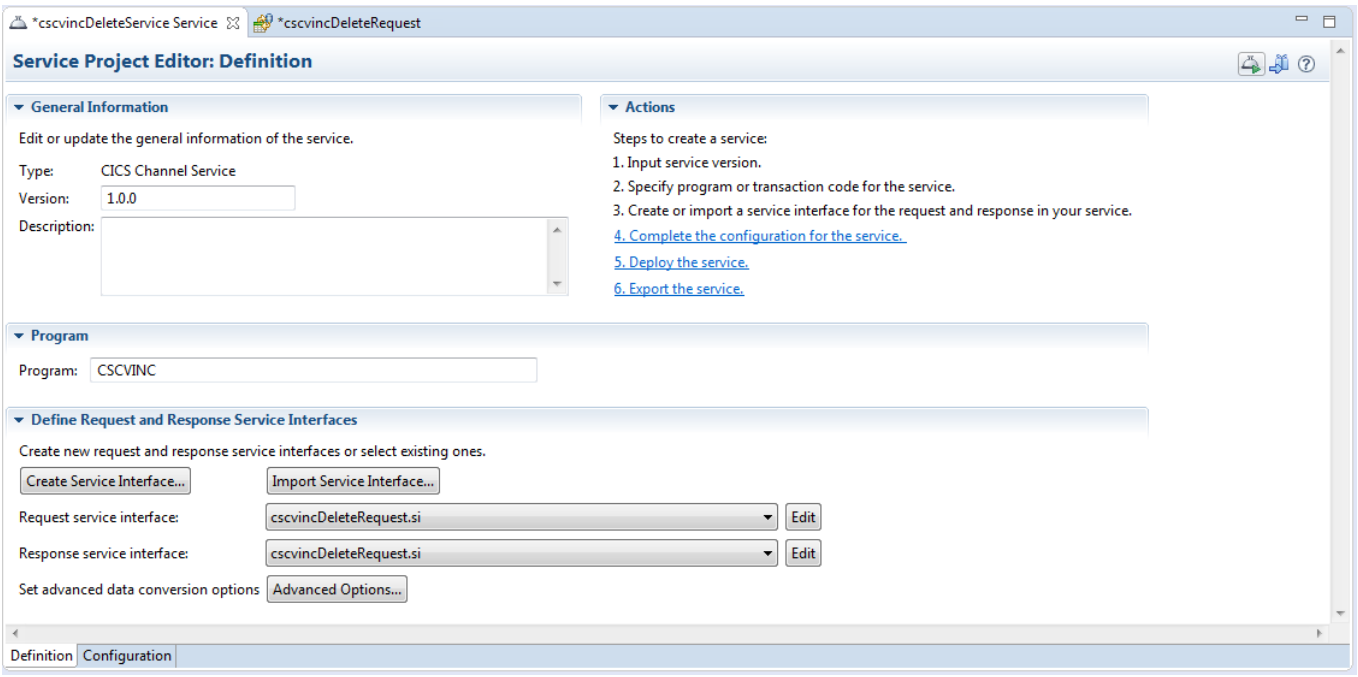
___1. Use Steps 1 through 19 in the Create Insert Service section to create service *cscvincDeleteService.* In this case the NUMB field is the only field exposed in the request message as ***employeeNumber***. The action is set to a ***D*** with this field omitted from the interface. Finally, change the interface names of *Container1* to ***cscvincContainer***, field *REQUST_CONTAINER* to ***request*** and *FILEA_AREA* to ***filea***.

- When finished the *cscvincDeleteRequest* service interface should look like:



Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
Container1		cscvincContainer				
REQUEST_CONTAINER		request				
ACTION	☐	ACTION	D	CHAR	1	1
FILEA_AREA	☑	filea		STRUCT	80	2
STAT	☐	STAT		CHAR	1	2
NUMB	☑	employeeNumber		CHAR	6	3
NAME	☐	NAME		CHAR	20	9
ADDRX	☐	ADDRX		CHAR	20	29
PHONE	☐	PHONE		CHAR	8	49
DATEX	☐	DATEX		CHAR	8	57
AMOUNT	☐	AMOUNT		CHAR	8	65
COMMENT	☐	COMMENT		CHAR	9	73

- And the service definition for the *cscvincDeleteService* should look like:



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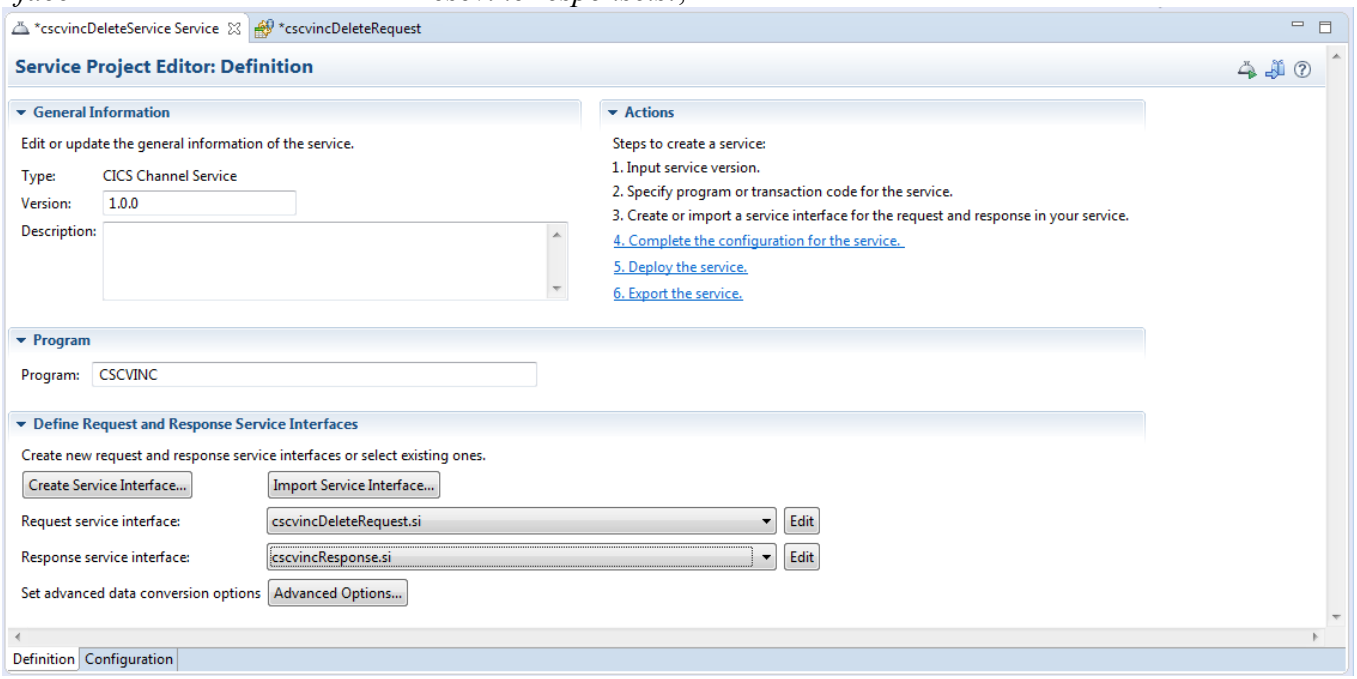
___2. On the *Service Project Editor: Definition* view, click the **Import Service Interface** button. Click the **Workspace** button on the *Import a service interface* screen. On the *Import Service Interface – Import Service Interface* window, expand the *cscvincInsertService* project and then expand *service-interfaces* and then select *cscvincResponse.si*. Click **OK** to import this service interface into this service project.

___3. On the *Service Project Editor: Definition* view use the pull-down arrow beside the area for *Response service interface* and select service interface *cscvincResponse.si*, see below:



Tech-Tip: This has just reused the response service interface from the *cscvincInsertService* service.

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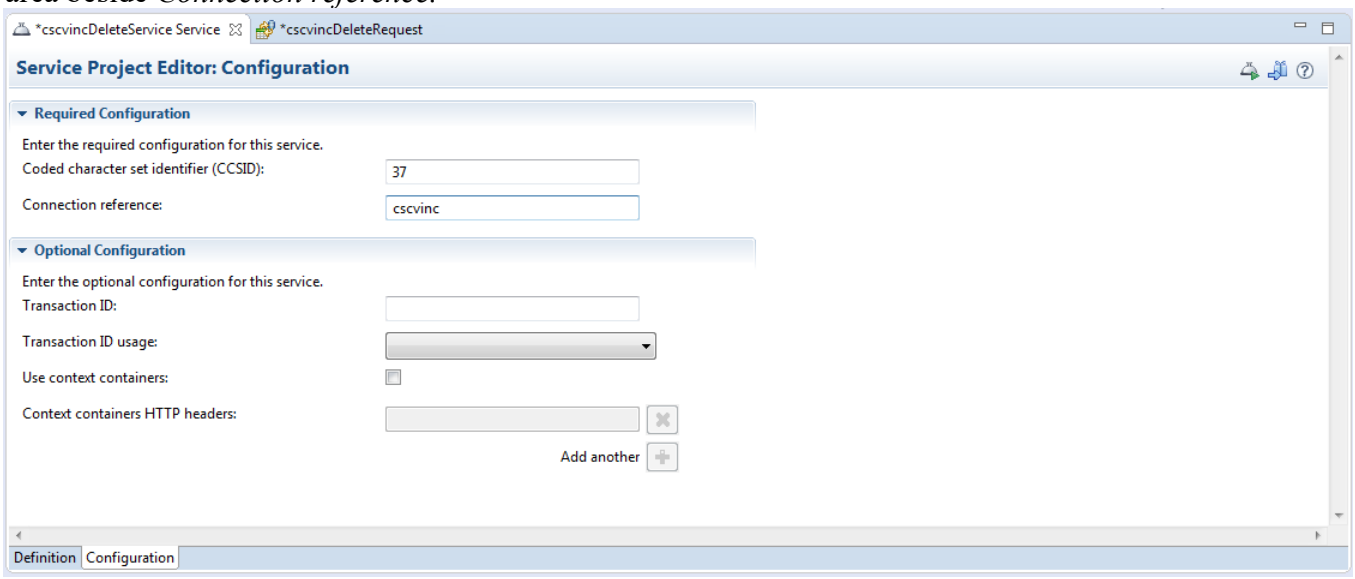
___4. Next, we need to identify a connection profile and interaction properties profile that will be used. Click on the Configuration tab at the bottom of the *Overview* window to display the *Configuration* window. Enter ***cscvinc*** in the area beside *Connection reference.*



___5. Save the *cscvincDeleteService* service either by closing the tab or using the **Ctrl-S** key sequence.

Create the "Update" Service

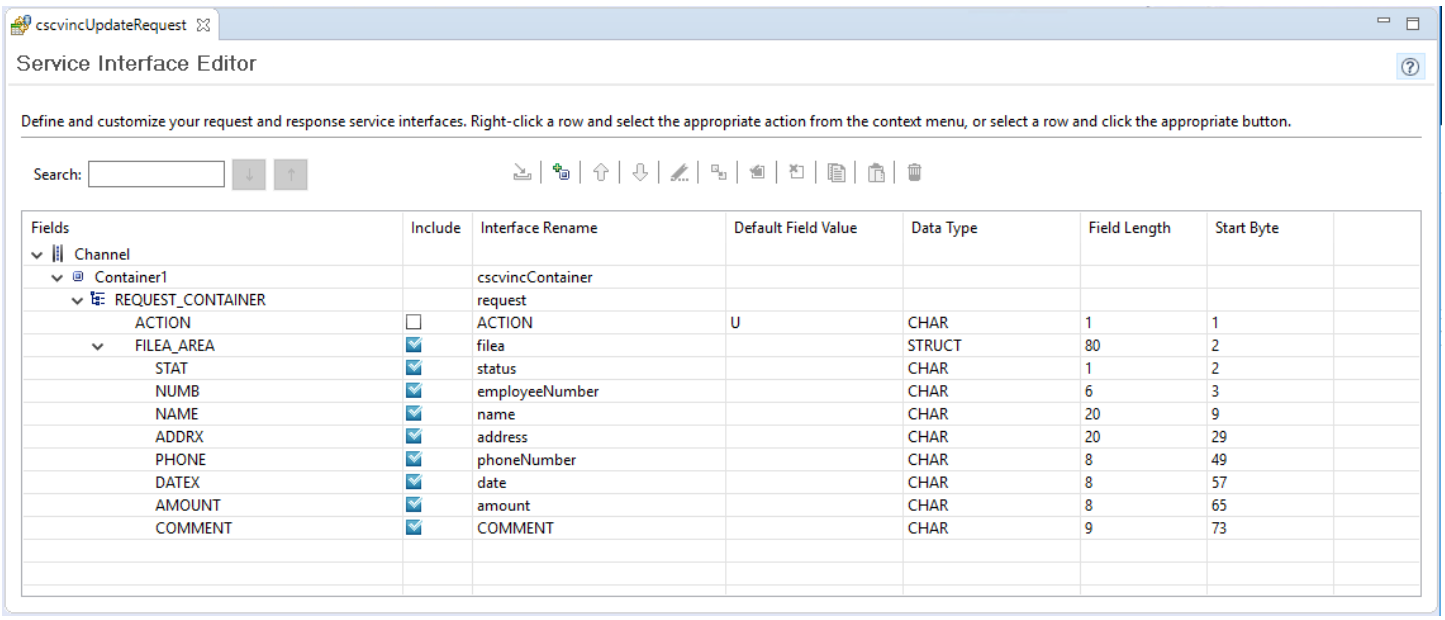
___1. Use Steps 1 through 19 in the create insert service section to create service *cscvincUpdateService.* The action field is set to ***U*** and this field is omitted from the interface. Change the interface names of *Container1* to ***cscvincContainer*** and *REQUST_CONTAINER* to ***request***.

___2. Rename the other interface names for the other interface names as shown below:

- *FILEA_AREA* to ***filea***
- *NUMB* to ***employeeNumber***
- *Name* to ***name***
- *ADDRX* to ***address***
- *PHONE* to ***phoneNumber***
- *DATEX* to ***date***
- *AMOUNT* to ***amount***

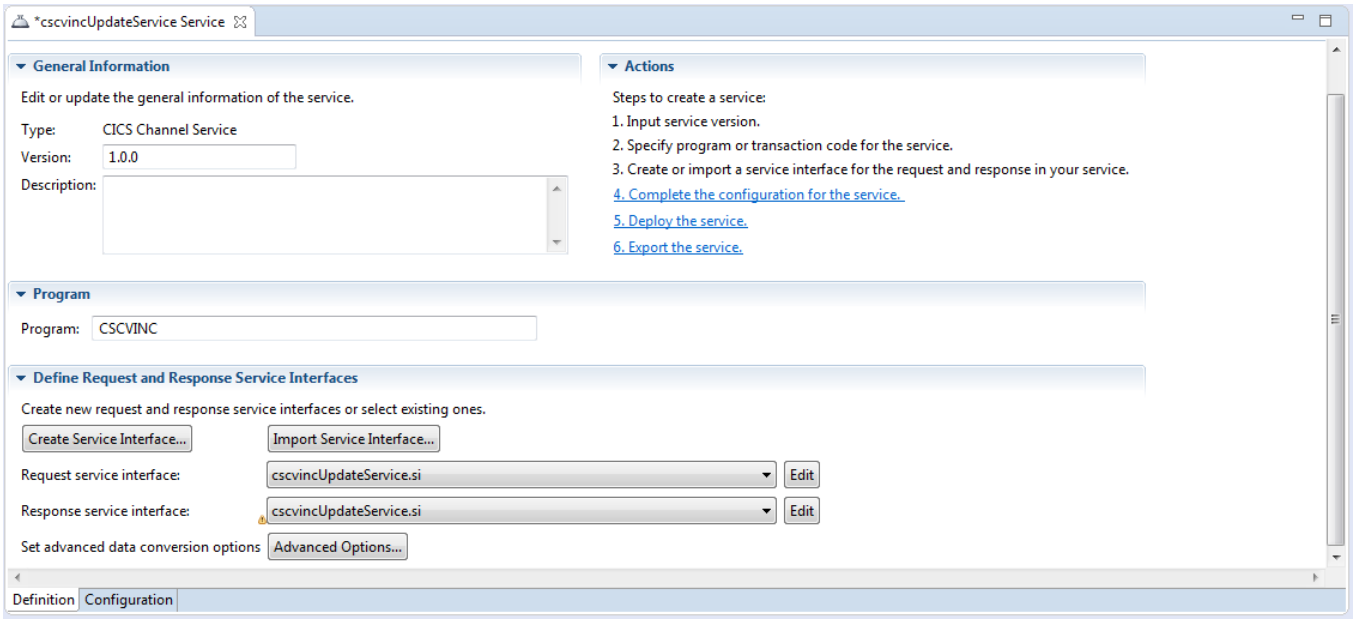
N.B. if the interface names are not renamed, the original interface names will appear in subsequent screen shots.

When finished your service definition interface should look like this.



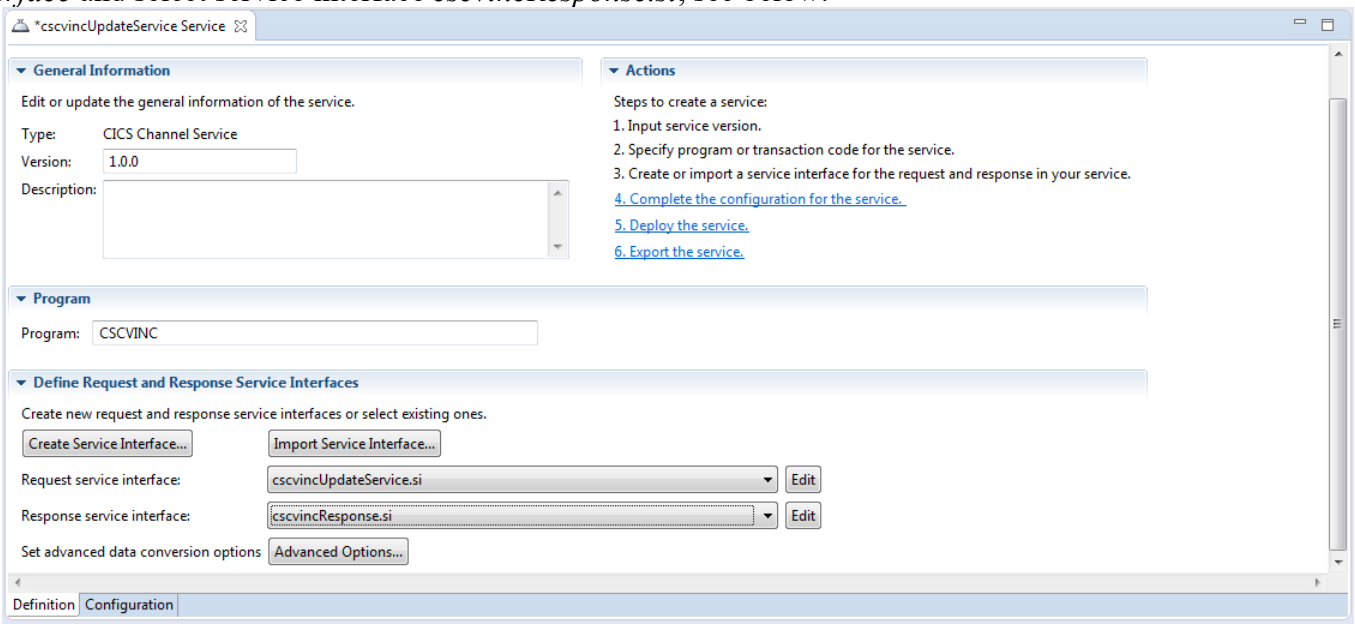
Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
Container1		cscvincContainer				
REQUEST_CONTAINER		request				
ACTION	☐	ACTION	U	CHAR	1	1
FILEA_AREA	☑	filea		STRUCT	80	2
STAT	☑	status		CHAR	1	2
NUMB	☑	employeeNumber		CHAR	6	3
NAME	☑	name		CHAR	20	9
ADDRX	☑	address		CHAR	20	29
PHONE	☑	phoneNumber		CHAR	8	49
DATEX	☑	date		CHAR	8	57
AMOUNT	☑	amount		CHAR	8	65
COMMENT	☑	COMMENT		CHAR	9	73

- When finished the service definition for the *cscvincUpdateService* should look like this:

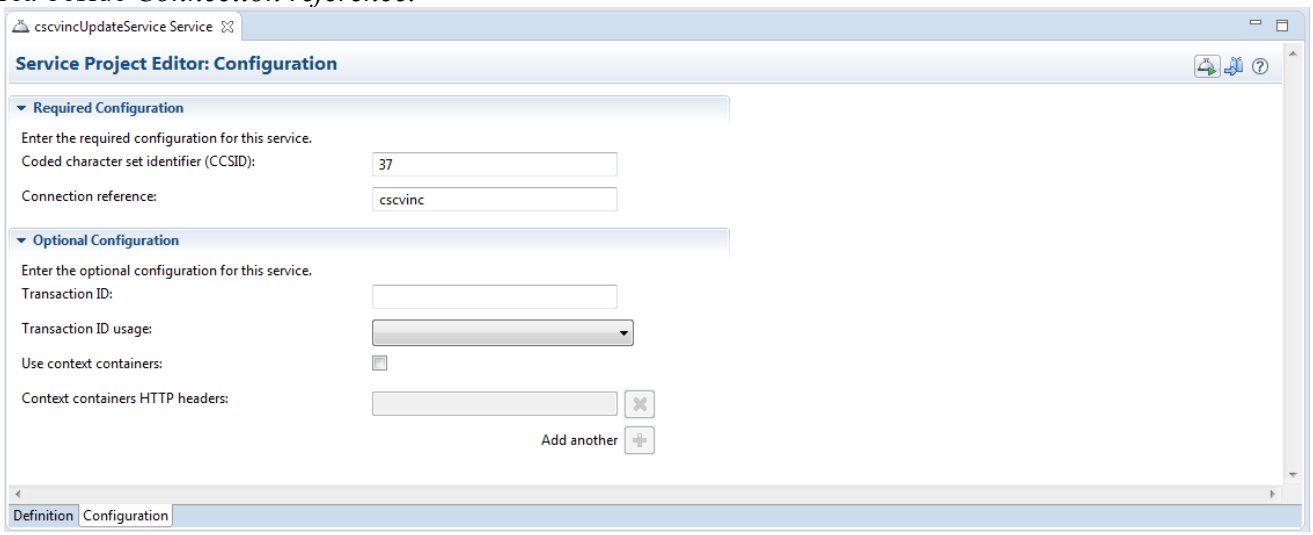


___3. On the *Service Project Editor: Definition* view, click the **Import Service Interface** button. Click the **Workspace** button on the *Import a service interface* screen. On the *Import Service Interface – Import Service Interface* window, expand the *cscvincInsertService* project and then expand *service-interfaces* and then select *cscvincResponse.si*. Click **OK** to import this service interface into this service project.

___4. On the *Service Project Editor: Definition* view, use the pull-down arrow beside the area for *Response service interface* and select service interface *cscvincResponse.si*, see below:



___5. Next, we need to identify a connection profile and interaction properties profile that will be used. Click on the Configuration tab at the bottom of the *Overview* window to display the *Configuration* window. Enter ***cscvinc*** in the area beside *Connection reference.*

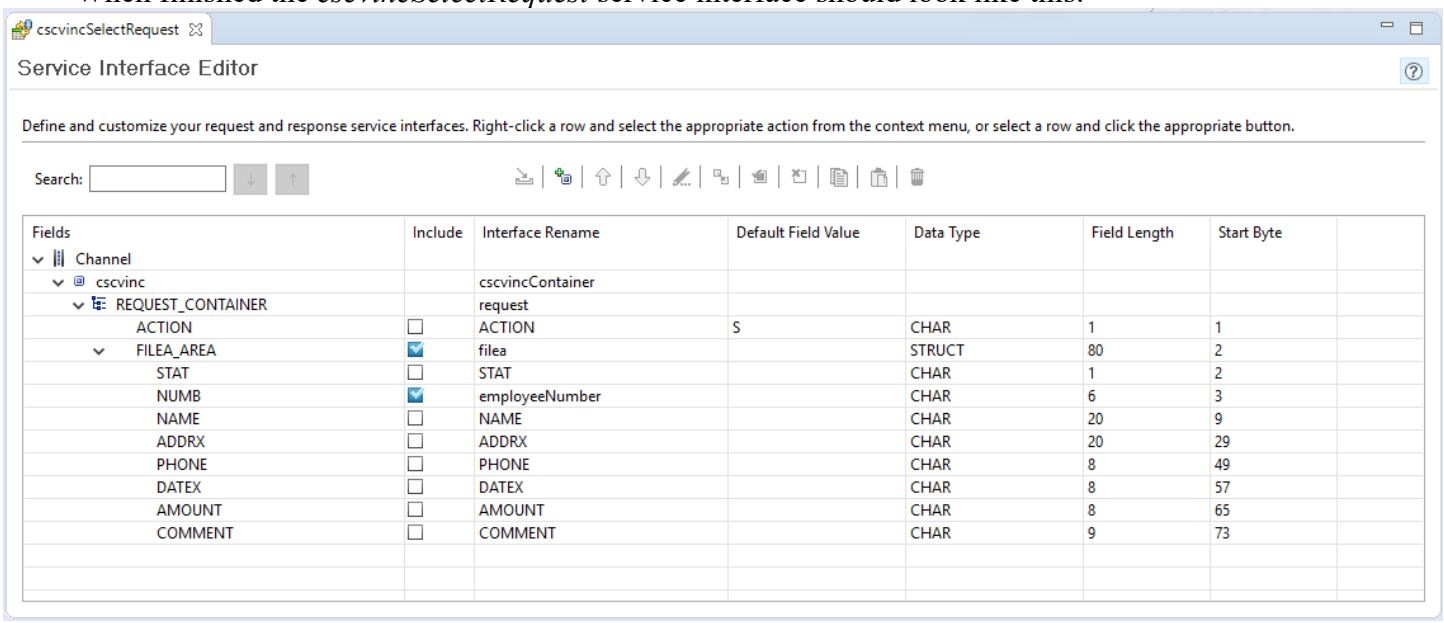


___6. Save the *cscvincUpdateService* service either by closing the tab or using the **Ctrl-S** key sequence.

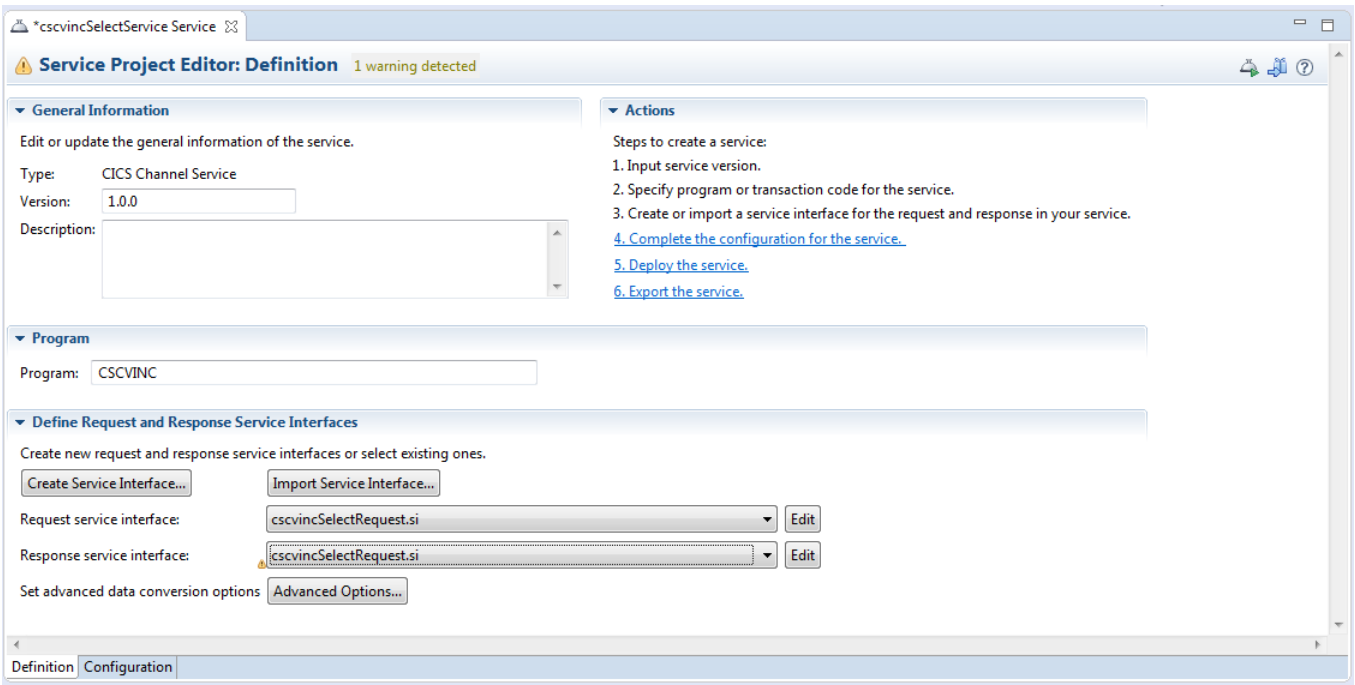
Create the "Select" Service

___7. Use Steps 1 through 19 to create the service *cscvincSelectService.* In this case NUMB will be the only field exposed in the request message. The action is set to ***S*** with this field omitted from the interface. Finally change the interface name of *Container1* to ***cscvincContainer***, *REQUEST_CONTAINER* to ***request***, ***FILEA_AREA*** to ***filea*** and *NUMB* to ***employeeNumber***.

- When finished the *cscvincSelectRequest* service interface should look like this:



- When finished the service definition for the *cscvincSelectService* should look like this:



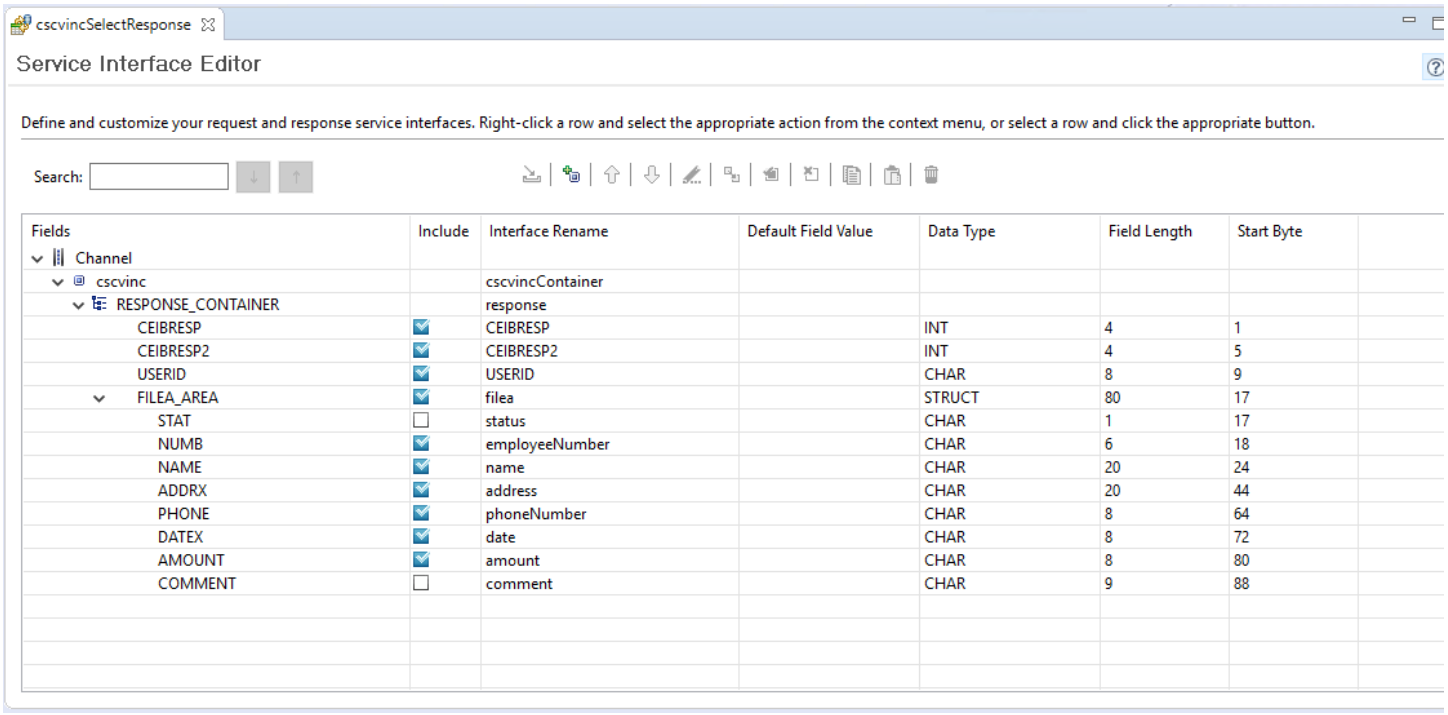
___8. Again, the default response service interface is not what we want so we need to create another service interface named *cscvincSelectResponse* that will include the contact information in the response message. Use the *Create Service Interface* button and create a new service interface named ***cscvincSelectResponse***.

___9. Change the interface names of *Container1* to ***cscvincContainer*** and field *REQUEST_CONTAINER* to ***request***.

___10. Rename the other interface names for the other interface names as shown below:

- *FILEA_AREA* to ***filea***
- *NAME to* ***name***
- *NUMB* to ***employeeNumber***
- *ADDRX* to ***address***
- *PHONE* to ***phoneNumber***
- *DATEX* to ***date***
- *AMOUNT* to ***amount***

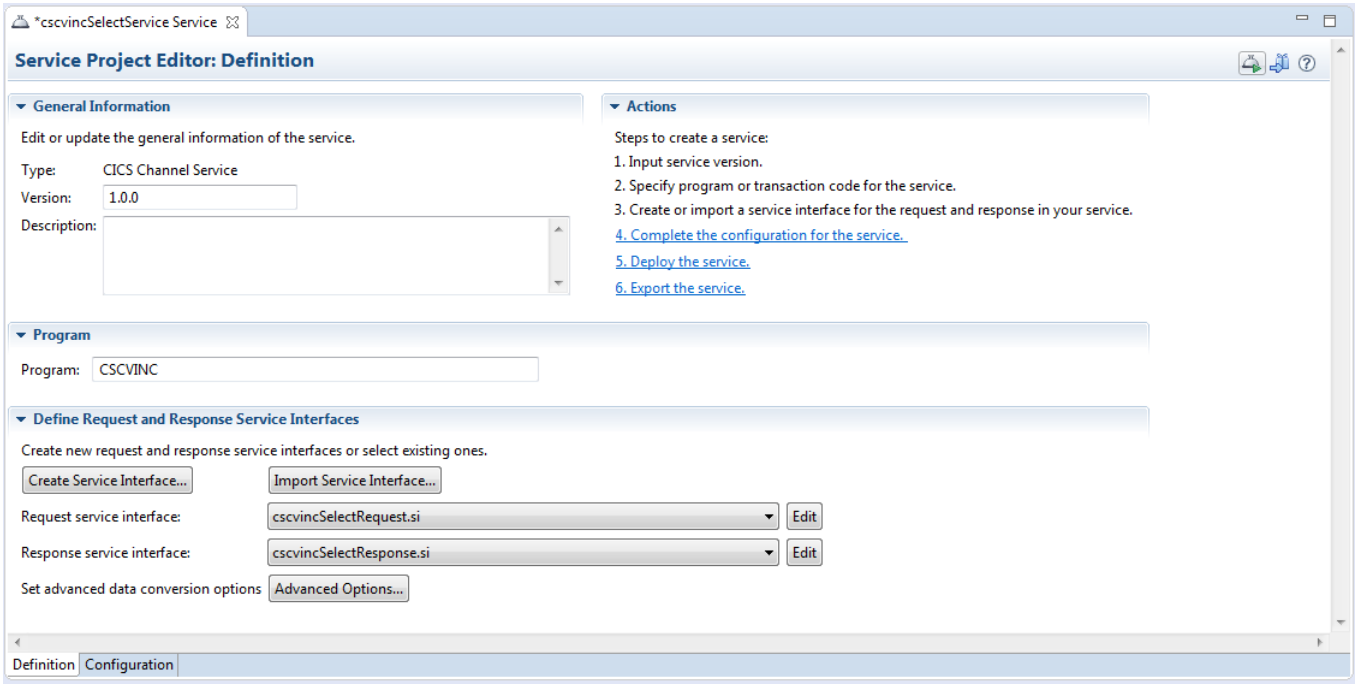
N.B. if the interface names are not renamed, the original interface names will appear in subsequent screen shots.



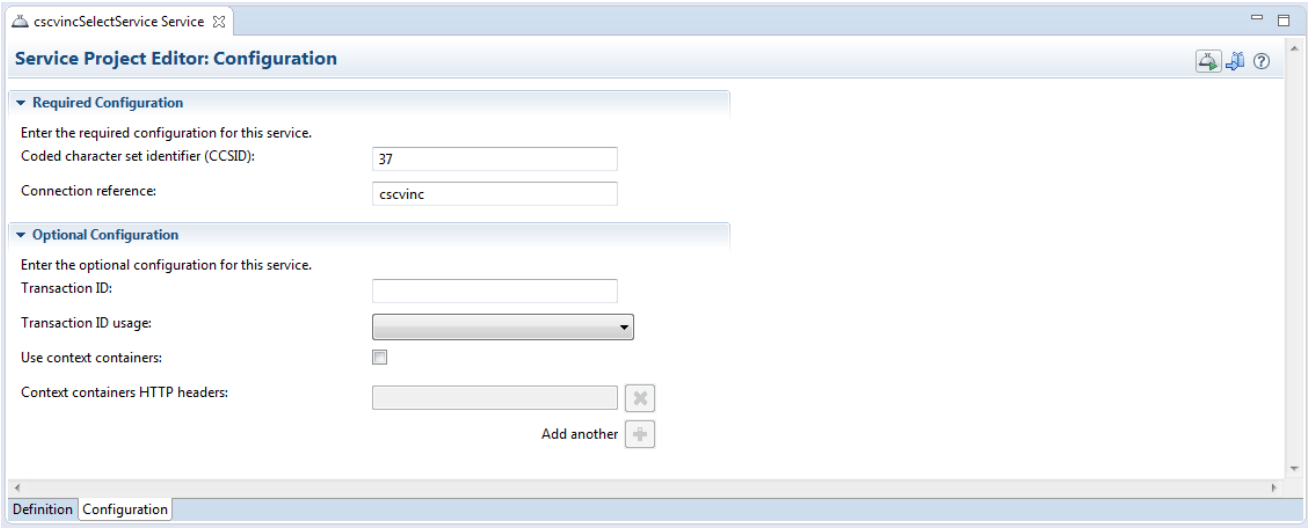
Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length	Start Byte
Channel						
cscvinc		cscvincContainer				
RESPONSE_CONTAINER		response				
CEIBRESP	☑	CEIBRESP		INT	4	1
CEIBRESP2	☑	CEIBRESP2		INT	4	5
USERID	☑	USERID		CHAR	8	9
FILEA_AREA	☑	filea		STRUCT	80	17
STAT	☐	status		CHAR	1	17
NUMB	☑	employeeNumber		CHAR	6	18
NAME	☑	name		CHAR	20	24
ADDRX	☑	address		CHAR	20	44
PHONE	☑	phoneNumber		CHAR	8	64
DATEX	☑	date		CHAR	8	72
AMOUNT	☑	amount		CHAR	8	80
COMMENT	☐	comment		CHAR	9	88

___11. Close the *Service Interface Definition* window.

___12. Set the *Response service interface* to *cscvincSelectResponse.si* as shown below.



___13. Next, we need to identify a connection profile and interaction properties profile that will be used. Click on the Configuration tab at the bottom of the *Overview* window to display the *Configuration* window. Enter ***cscvinc*** in the area beside *Connection reference.*



___14. Save the *cscvincSelectService* service either by closing the tab or using the **Ctrl-S** key sequence.

This services now need to be made available for developing the API and for deployment to the z/OS Connect server.

The service now needs to be made available for developing the API and for deployment to the z/OS Connect server.

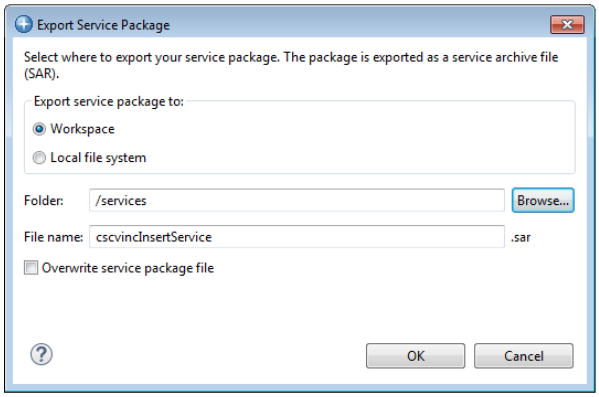
Export and deploy the Service Archive files

Before a service interface can be used it must be exported to create Service Archive (SAR) file and deployed as a SAR file to the server. The exported SAR is used in developing an API in the z/OS Connect Toolkit. This section describes the process for exporting and deploying SAR files.

___1. First, export' the service interface as a SAR into another project in the z/OS Connect Toolkit. Select ***File*** on the tool bar and then on the pop up select **New → Project**. Expand the *General* folder and select *Project* to create a target project for exporting the Service Archive (SAR) files. Click **Next** to continue.

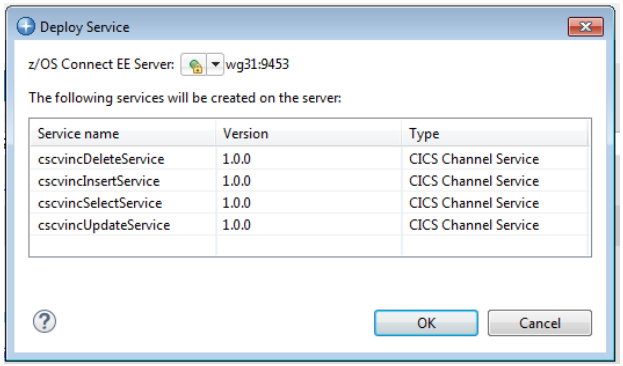
___2. On the *New Project* window enter ***Services*** as the *Project name*. Click **Finish** to continue. This action will add a new project in the *Project Explorer* named *Services*. If this project already exists continue with Step 3.

___3. Select the *cscvincInsertService* service project and click the right mouse button. On the pop-up selection select **z/OS Connect → Export z/OS Connect Service Archive**. On the *Export Services Package* window select the radio button beside *Workspace* and use the **Browse** button to select the *Services* folder. Click **OK** to continue.



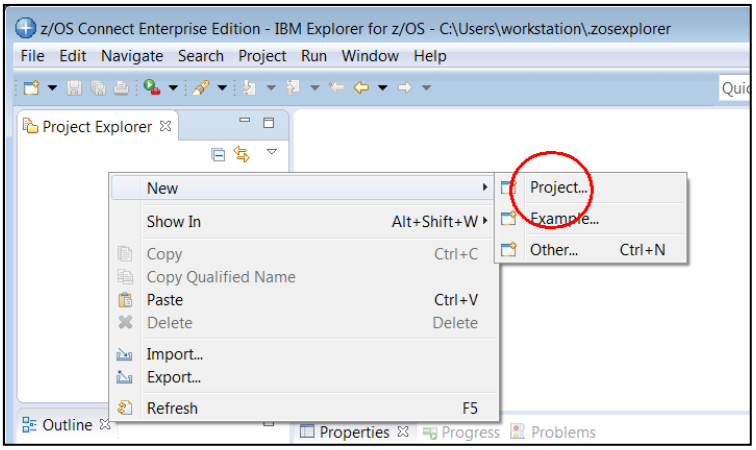
___4. Repeat this step for the other 3 services.

___5. Select all 4 service projects and right mouse button click again and on the pop-up selection select **z/OS Connect → Deploy Service to z/OS Connect Server**. On the *Deploy Service* window select the target server (*wg31:9453*) and click **OK** twice to continue.

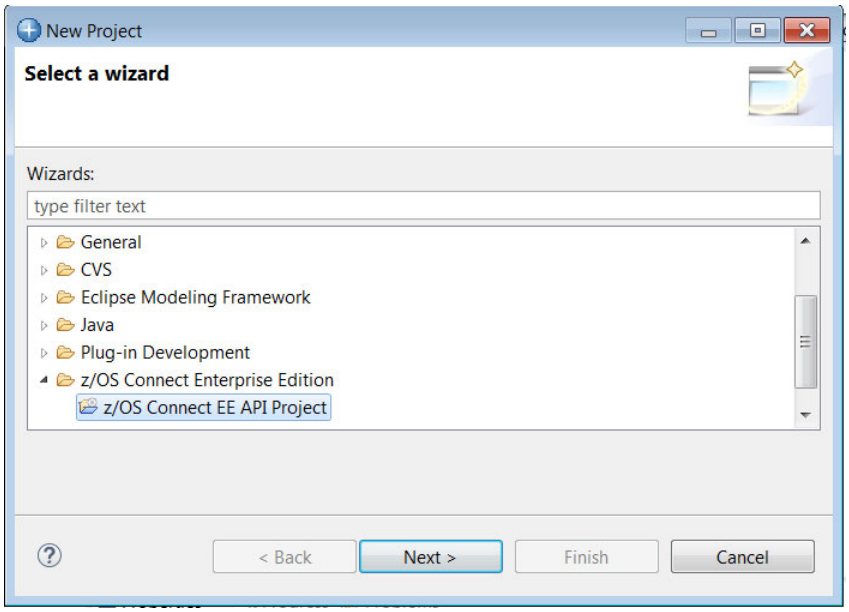


Create the CscvincAPI API project

___1. In the *z/OS Connect Enterprise Edition* perspective of the z/OS Explorer, create a new API project by clicking the right mouse button and selecting New →*Project*:



___2. In the *New Project* screen, scroll down and open the *z/OS Connect Enterprise Edition* folder and select *z/OS Connect API Project* and then click the **Next** button.



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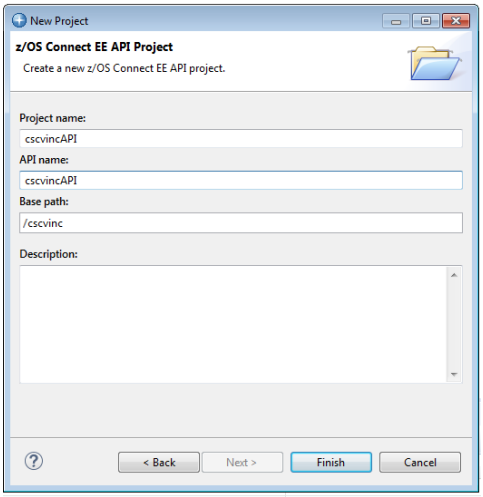
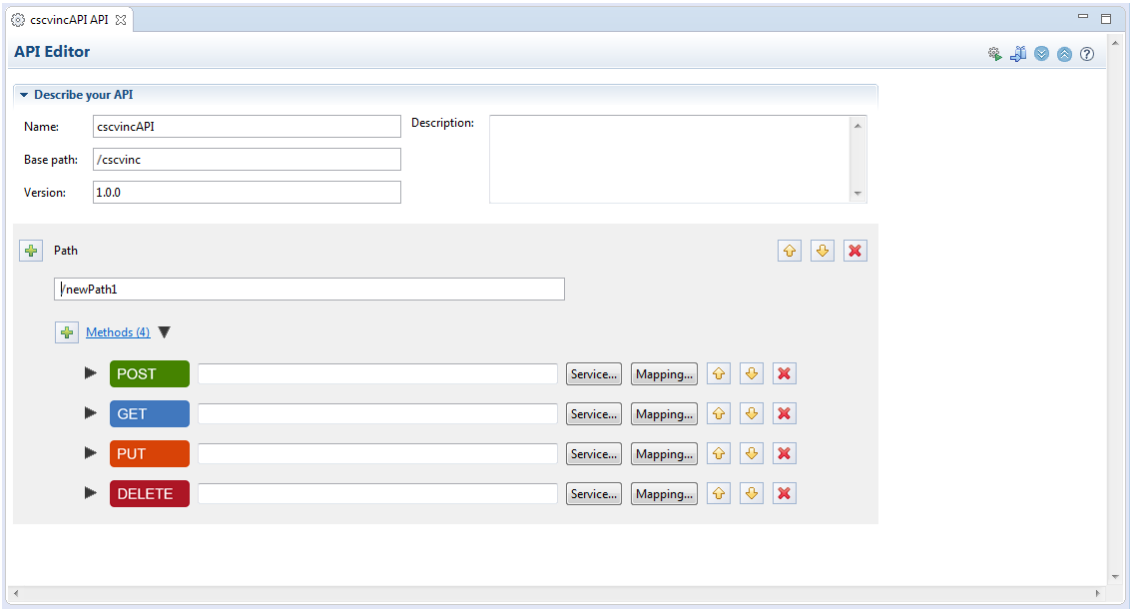
___3. Enter ***cscvincAPI*** for the *Project name.* Be sure the *API name* is set to ***cscvincAPI*** and the *Base path is* set to ***/cscvinc.*** Click **Finish** to continue.



Important: The values are somewhat arbitrary, but they do relate to later tasks. If you use the values and cases as supplied, then the subsequent commands and the use of subsequent URLs will work seamlessly.

___4. You should now see something like the view below. The view may need to be adjusted by dragging the view boundary lines.



Tech-Tip: If the API Editor view is closed, it can be reopened by double clicking the *package.xml* file in the API project.

Summary

This created the basic framework for the API project in the API editor.

Compose the API for the CICS Channel Application

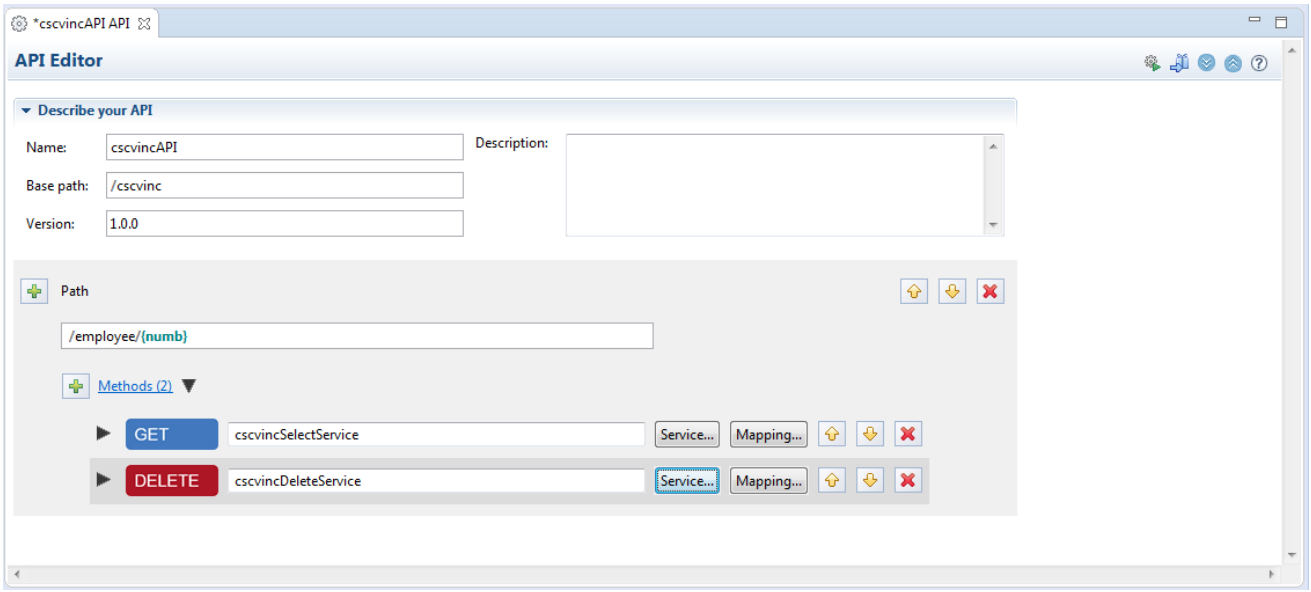
The API for the CICS container application will have two paths. One path which includes a path parameter which identifies the key of the record to be retrieved or deleted and another path with no path parameter for inserting and/or updating a record. In this case the key is one of the fields in the request message.

___1. Start by entering a *Path* of ***/employee/{numb}*** in the *z/OS Connect API Editor* view. Remove the *POST* and *PUT* methods by the red X's next to each.

___2. Click the **Service** button beside the *GET* method and on the *Select a z/OS Connect Service* window click the ***Workspace*** *button*. On the *Import z/OS Connect Services* window expand the *services* folder and select *cscvincDeleteService.sar, cscvincInsertService.sar, cscvincSelectService and cscvincUpdateService.sar service archive files*. Click OK three times to import these SAR files into this project.

___3. Click the Service button beside the *GET* method and on the *Select a z/OS Connect Service* window select *cscvincSelectService.sar* and click **OK**.

___4. Click the **Service** button beside the *Delete* method and on the *Select a z/OS Connect Service* window select *cscvincDeleteService.sar* and click **OK**.



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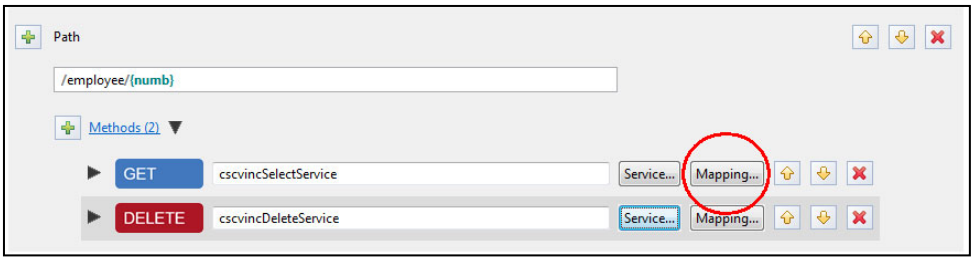
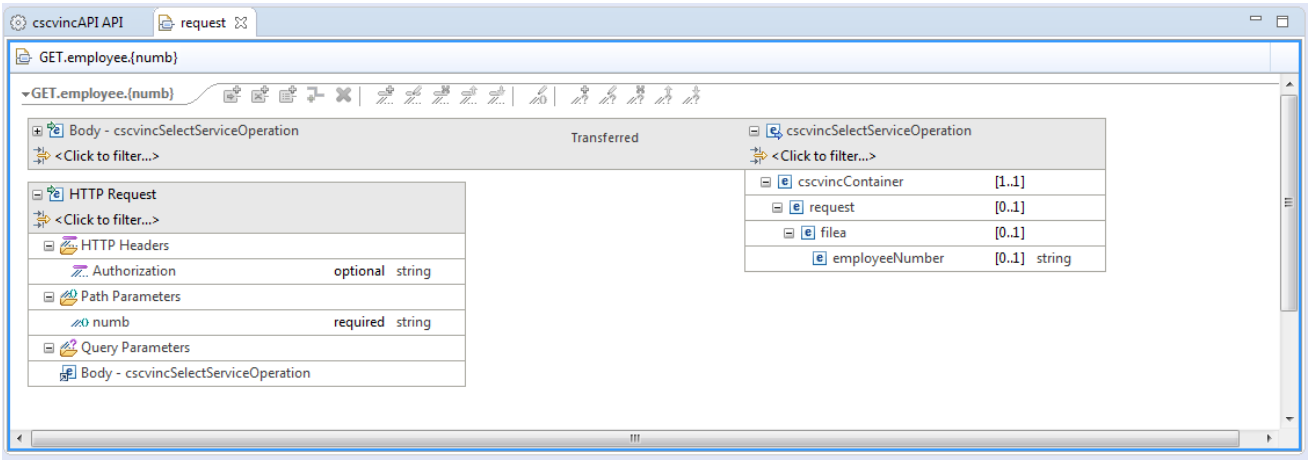
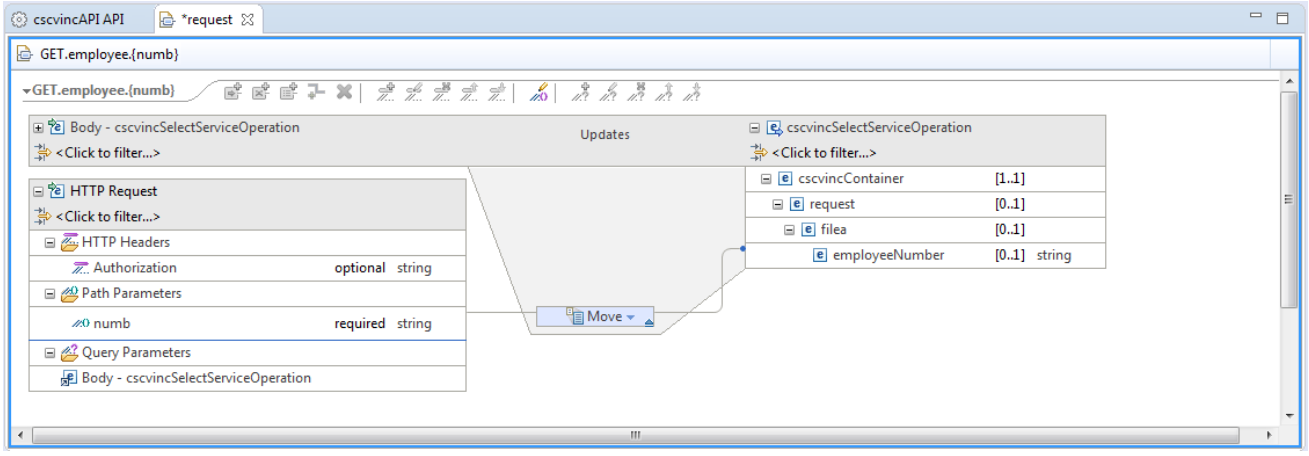
___5. Next, click on the **Mapping** button beside the **GET** method and then select *Open Request Mapping*:



___6. In the mapping view that opens, go to the right side of the mapping (which represents interface fields included in the service by the service developer), and click the little + signs to expand *cscvincContainer, request* and *filea.* You should see only the *employeeNumber* field.



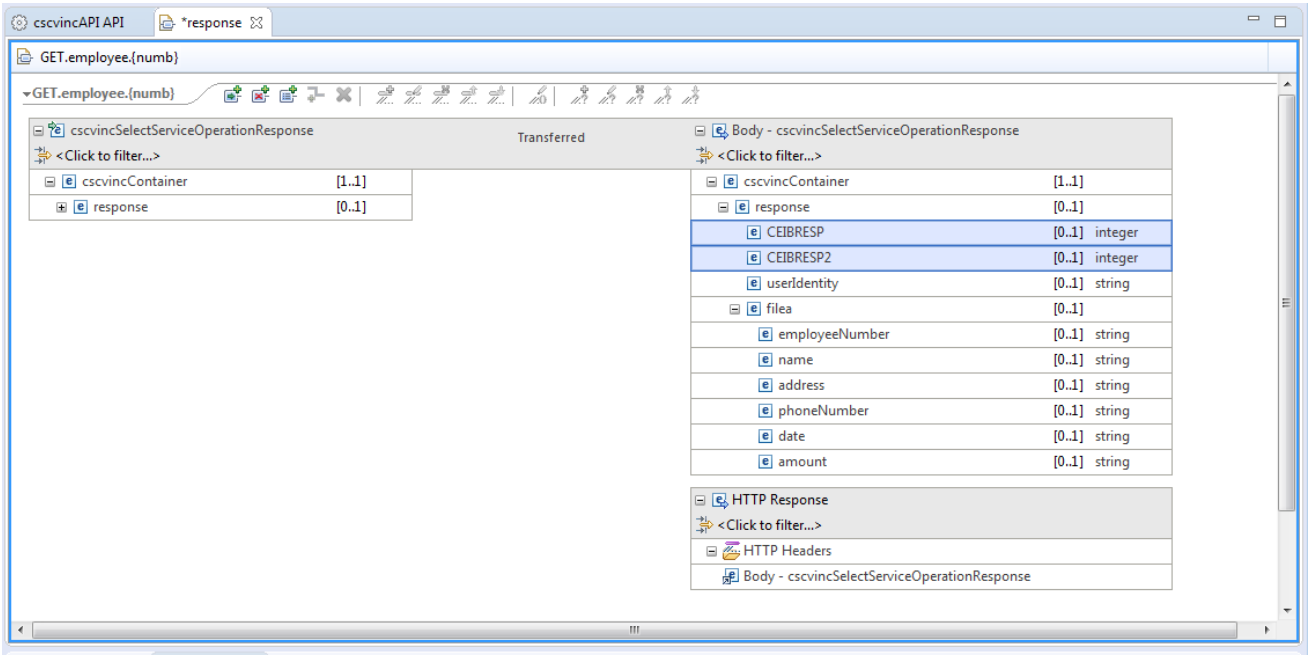
___7. The contents of the *employeeNumber* field should be provided by the *numb* path parameter from the URL. On the left-hand side of the view select the *numb* path parameter with the left mouse button and drag it without releasing the mouse button) to the *employeeNumber* field on the right-hand side to create a "move" connection from the *numb* path parameter to the *employeeNumber* field in the *cscvincContainer* structure.



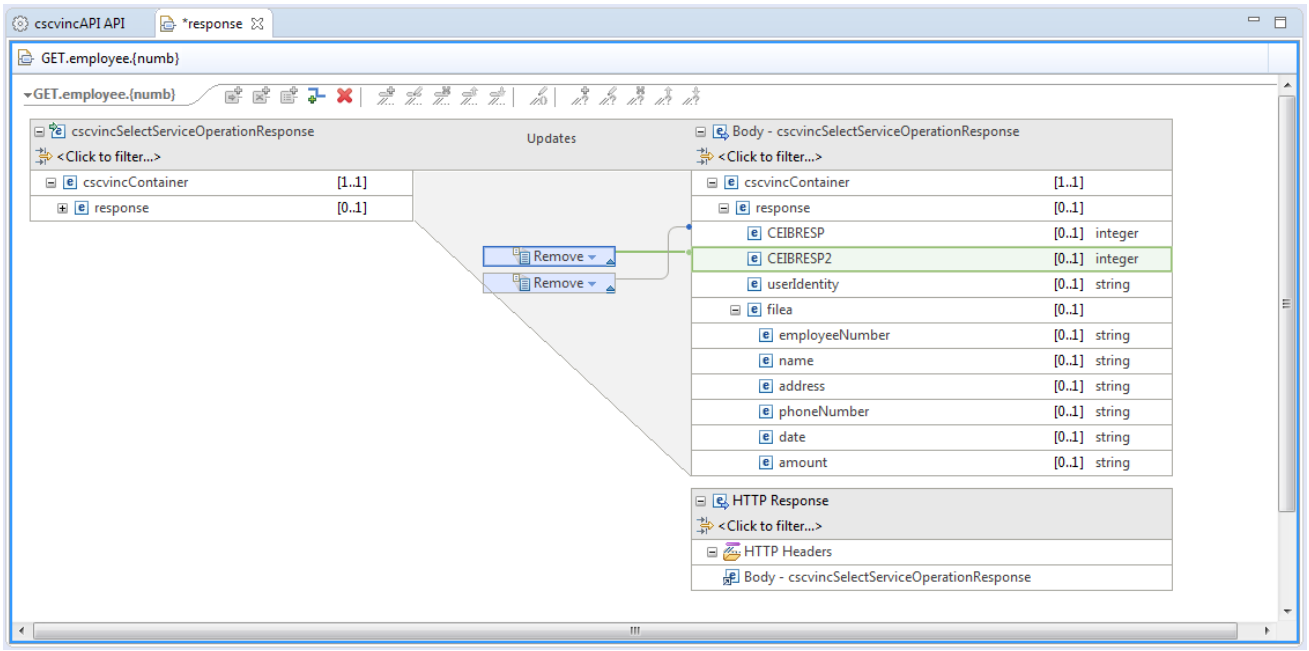
___8. Use the ***Ctrl-S*** key sequence to save all changes and close the *GET.employee.{numb}* view.

___9. For **GET** the method we want the default response mapping to return all fields except *CEIBRESP* and *CEIBRESP*2. To change/review the fields that will be returned click the **Mapping** button beside the **GET** method and select the *Open Default Response Mapping* option.

___10. Fully expand *cscvincContainer* and use the slider bar to fully expose the *cscvincContainer* structure. Use the left mouse button and draw a dotted line box that fully includes the *CEIBRESP and CEIBRESP2* fields. When you release the button, these fields should be selected (the background should be blue).



___11. Right mouse button click on any of the selected fields and select the *Add Remove transform* from the list of options



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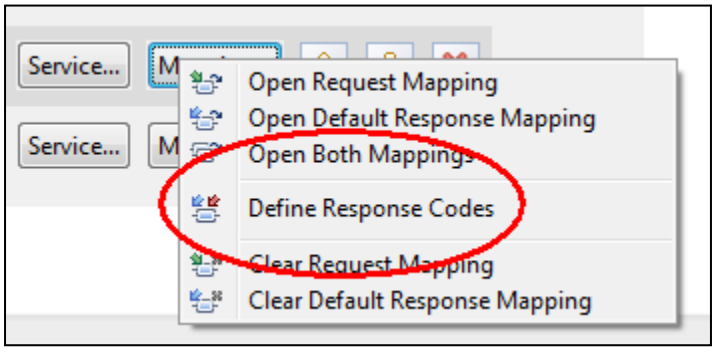
___12. This action generates multiple “remove” requests (see above) for the selected fields. These fields will not be exposed to the REST clients using this method.

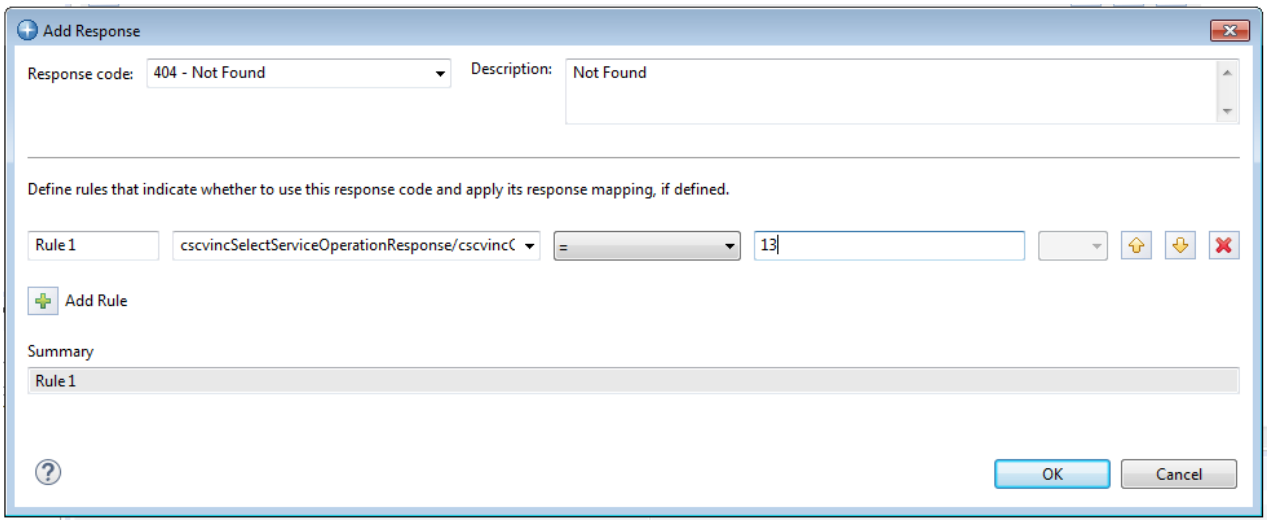
___13. Use the ***Ctrl-S*** key sequence to save all changes and close the *GET.employee.{numb}* view

___14. Click the **Mapping** button again but this time select *Define Response Codes*.



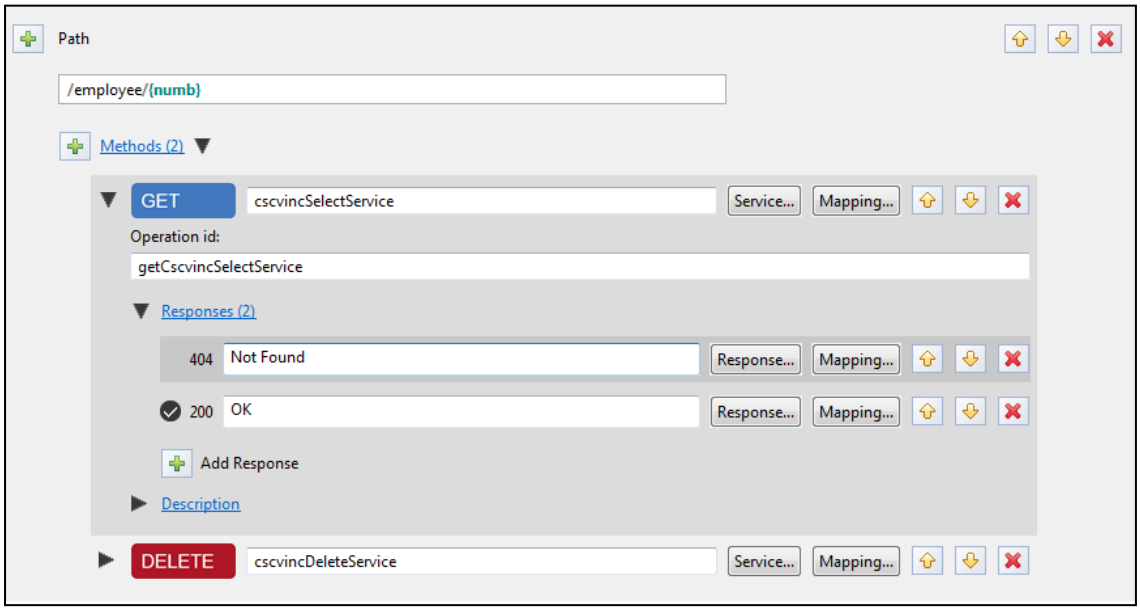
This will allow the setting of the HTTP response code based on the contents of the response message.

___15. Click the plus sign beside *Add Response* and use the pull-down arrows to select a *Response code* of *404 – Not Found*, use the pull-down to select field *cscvincSelectServiceOperationResponse/cscvincContainer/response/CEIBRESP* for the first operand, an equal sign for the operation and enter ***13*** (NOTFND) for the second operand.

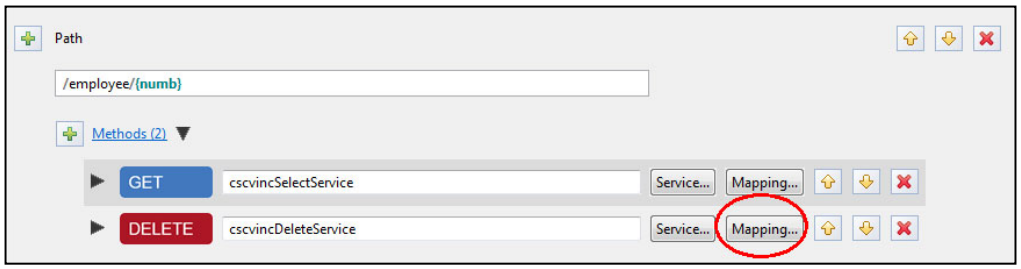


Important: The CICS program returns in the response container the EIBRESP and EIBRESP2 values from the EXEC CICS commands in the program. For other possible EIB values see the *CICS Knowledge Center* at URL https://www.ibm.com/support/knowledgecenter/en/SSGMCP_5.5.0/reference/commands-api/dfhp4_eibfields.html

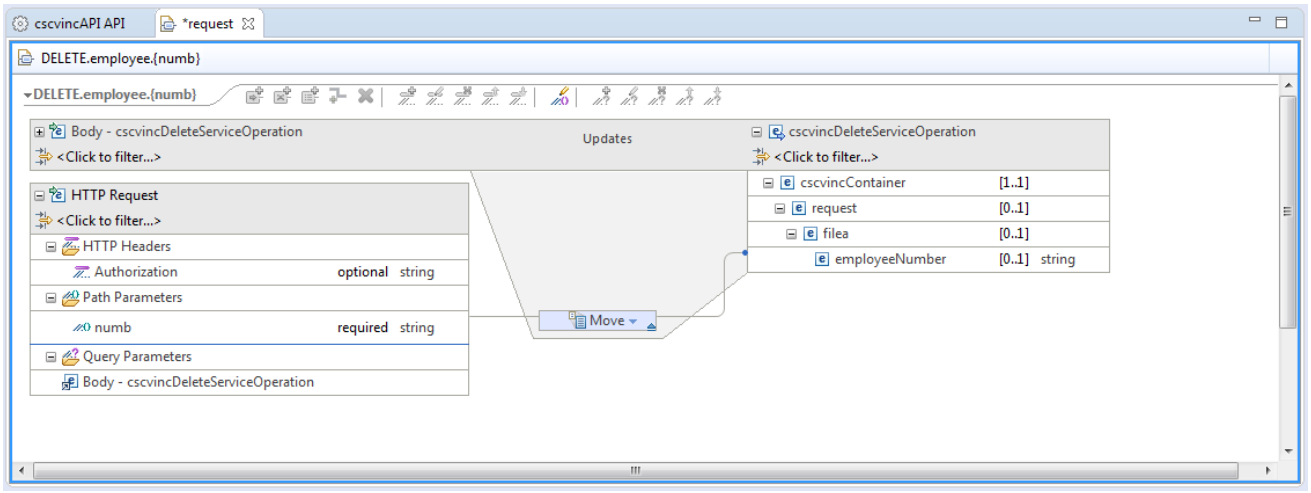
___16. Click **OK** and now you should see



___17. Next, click on the **Mapping** button beside the **DELETE** method and then select *Open Request Mapping*:



___18. Use the drag and drop as before and move the contents of the part parameter *numb* to the *employeeNumber* field in the request.

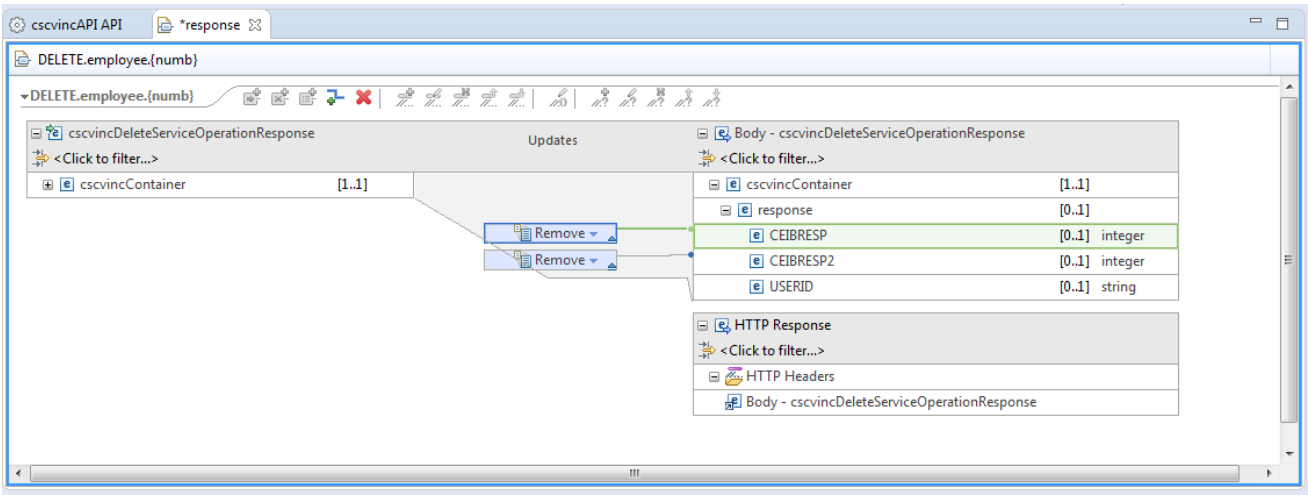


___19. Use the ***Ctrl-S*** key sequence to save all changes and close the *DELETE.employee.{numb}* view.

___20. For the **DELETE** we want the default response mapping to return only the USERID field to the client. To change/review the fields that will be returned click the **Mapping** button beside the **DELETE** method and select the *Open Default Response Mapping* option.

___21. Fully expand *cscvincContainer* and use the slider bar to fully expose the *cscvincContainer* structure. Use the left mouse button and draw a dotted line box that fully includes the *CEIBRESP and CEIBRESP2* fields. When you release the button, these fields should be selected (the background should be blue).

___22. Right mouse button click on any of the selected fields and select the *Add Remove transform* from the list of options



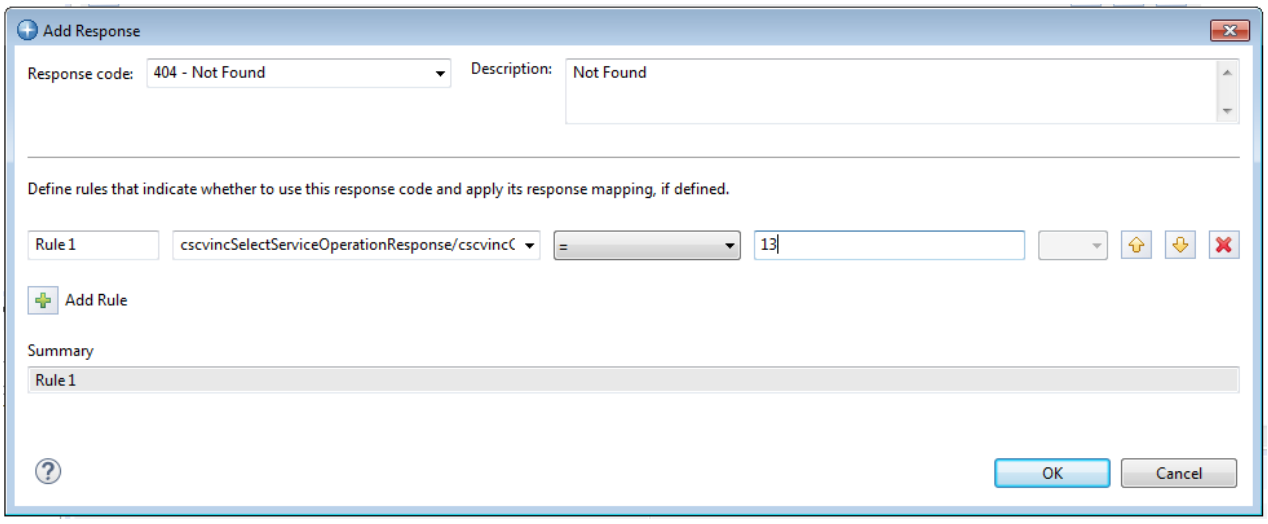
___23. This action generates multiple "remove" requests (see above) for the selected fields. These fields will not be exposed to the REST clients using this method.

___24. Use the ***Ctrl-S*** key sequence to save all changes and close the *DELETE.employee.{numb}* view.

___25. Click the **Mapping** button again but this time select *Define Response Codes*.

This will allow the setting of the HTTP response code based on the contents of the response message.

___26. Click the plus sign beside *Add Response* and use the pull-down arrows to select a *Response code* of *404 – Not Found*, use the pull-down to select field *cscvincSelectServiceOperationResponse/cscvincContainer/response/CEIBRESP* for the first operand, an equal sign for the operation and enter ***13*** (NOTFND) for the second operand.



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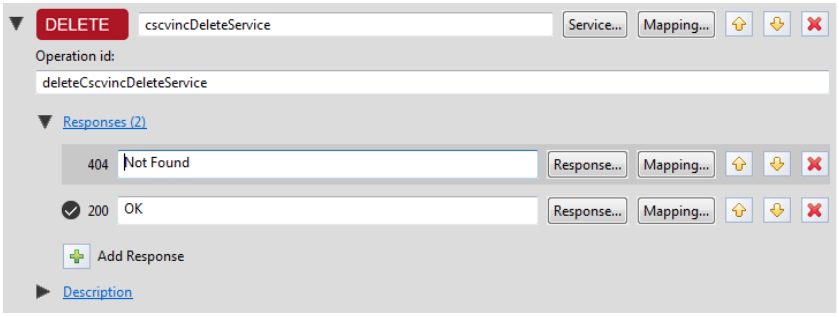
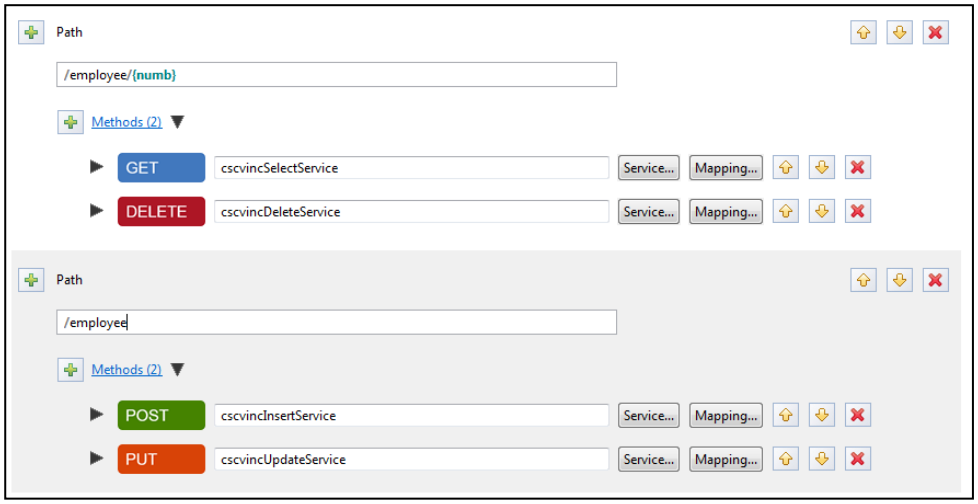
___27. Click **OK** and now you should see



___28. Next, we want to add a new *Path* for the **POST** and **PUT** methods. Click the plus sign beside PATH and enter a *Path* of ***/employee*** in the *z/OS Connect API Editor* view. Remove the *DELETE* and *GET* methods by the red X's next to each.

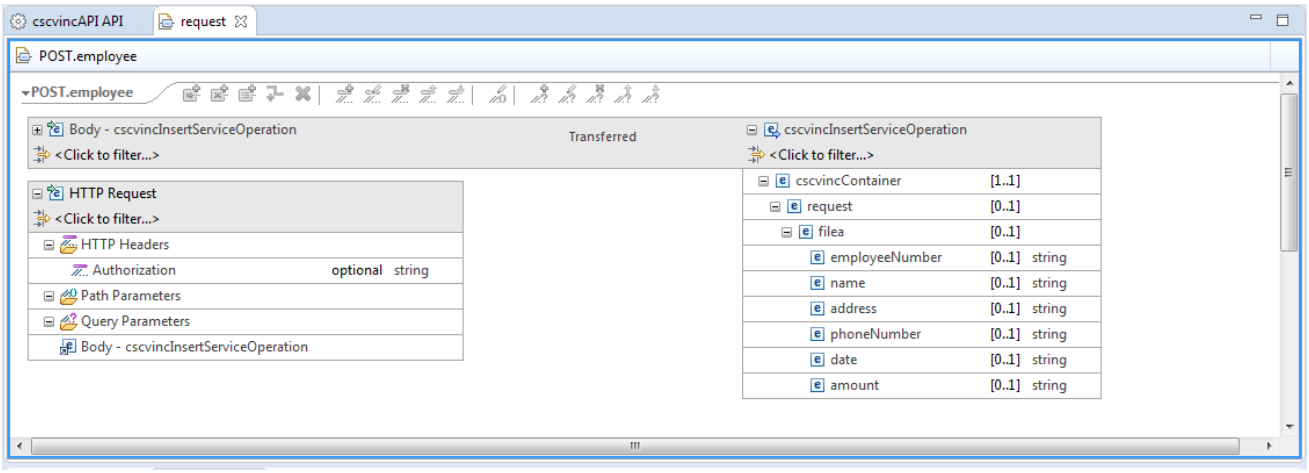
___29. Click the **Service** button beside the *POST* method and on the *Select a z/OS Connect Service* window select *cscvincInsertService* and click **OK**

___30. Click the **Service** button beside the *PUT* method and on the *Select a z/OS Connect Service* window select *cscvincUpdateService* and click **OK**.



___31. Next, click on the **Mapping** button beside the **POST** method and then select *Open Request Mapping*:

___32. In the mapping view that opens, go to the right side of the mapping (which represents the fields included in the interface by the services developer), and click the little + signs to expand *cscvincContainer*.

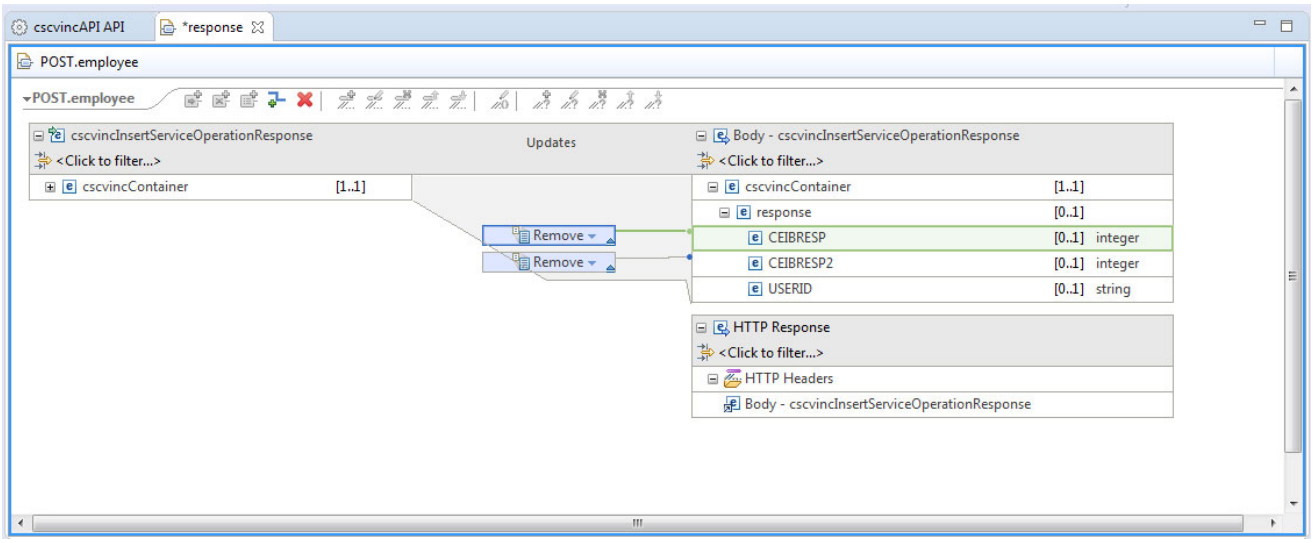


___33. Use the ***Ctrl-S*** key sequence to save all changes and close the *POST.employee* view.

___34. For the **POST** method we want the default response mapping to return only the *USERID* field to the client. To change/review the fields that will be returned click the **Mapping** button beside the **POST** method and select the *Open Default Response Mapping* option.

___35. Fully expand *cscvincContainer* and use the slider bar to fully expose the *cscvincContainer* structure. Use the left mouse button and draw a dotted line box that fully includes the *CEIBRESP and CEIBRESP2* fields. When you release the button, these fields should be selected (the background should be blue).

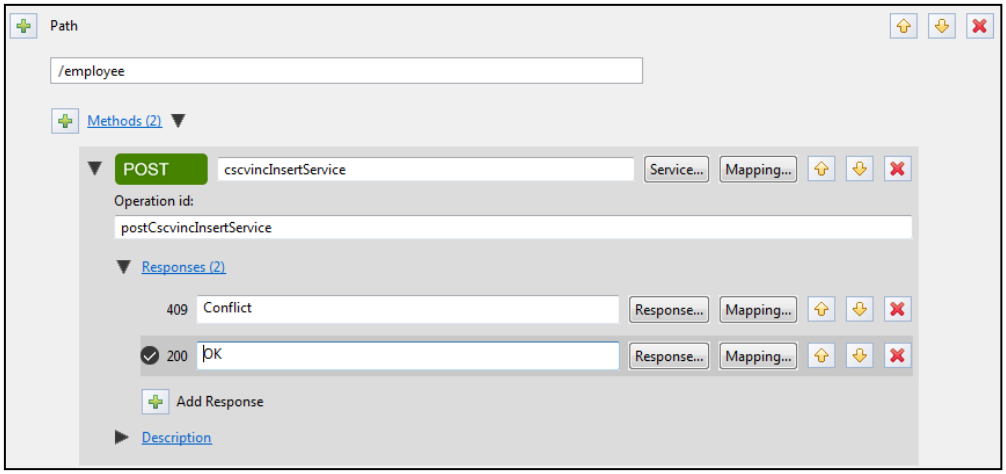
___36. Right mouse button click on any of the selected fields and select the *Add Remove transform* from the list of options



___37. Use the ***Ctrl-S*** key sequence to save all changes and close the *POST.employee* view.

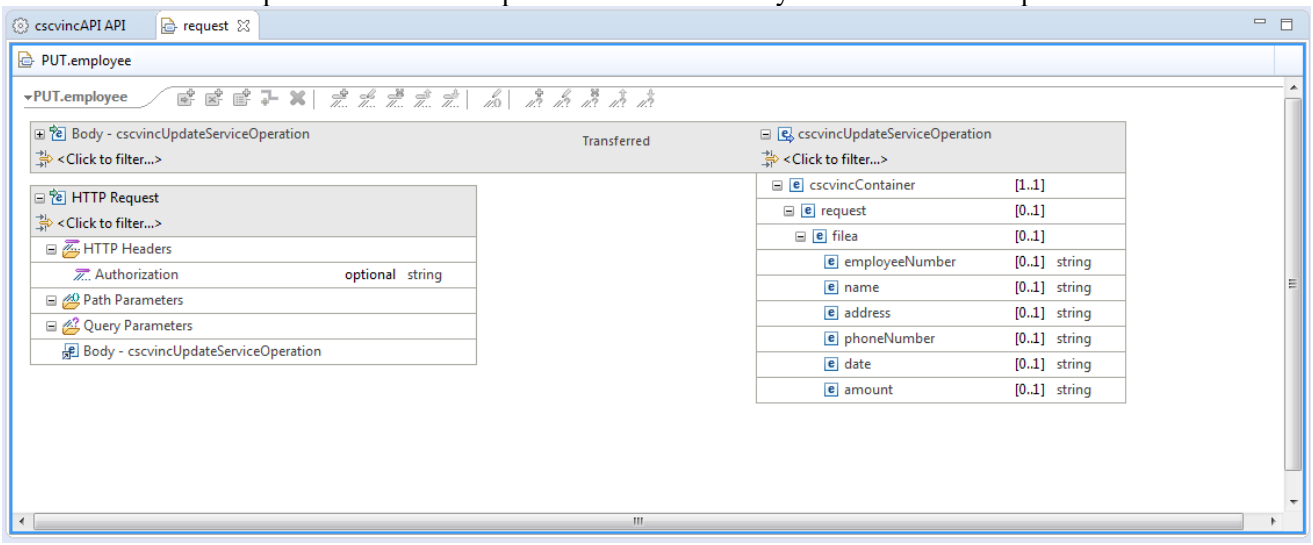
___38. Click the **Mapping** button again but this time select *Define Response Codes*.

___39. Click the plus sign beside *Add Response* and use the pull-down arrows to select a *Response code* of *409 – Conflict*, use the pull-down to select field *cscvincSelectServiceOperationResponse/cscvincContainer/response/CEIBRESP* for the first operand, an equal sign for the operation and enter ***14*** (DUPKEY) for the second operand.



___40. Next, click on the **Mapping** button beside the **PUT** method and then select *Open Request Mapping*:

___41. In the mapping view that opens, go to the right side of the mapping and fully expand *cscvincContainer*. You should see fields that correspond to the fields exposed in the interface by the services developer.

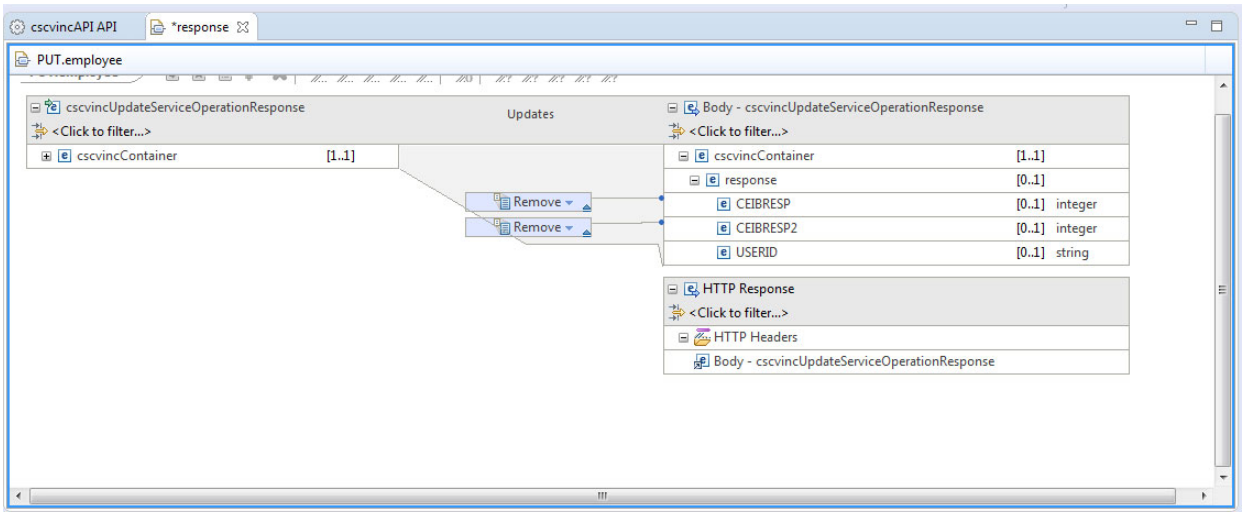


___42. Use the ***Ctrl-S*** key sequence to save all changes and close the *PUT.employee.{numb}* view.

___43. For the **PUT** method we want the default response mapping to return only the *USERID* field to the client. To change/review the fields that will be returned click the **Mapping** button beside the **PUT** method and select the *Open Default Response Mapping* option.

___44. Fully expand *cscvincContainer* and use the slider bar to fully expose the *cscvincContainer* structure. Use the left mouse button and draw a dotted line box that fully includes the *CEIBRESP and CEIBRESP2* fields. When you release the button, these fields should be selected (the background should be blue).

___45. Right mouse button click on any of the selected fields and select the *Add Remove transform* from the list of options



___46. Use the ***Ctrl-S*** key sequence to save all changes and close the *PUT.employee.{numb}* view.

___47. Click the **Mapping** button again but this time select *Define Response Codes*.

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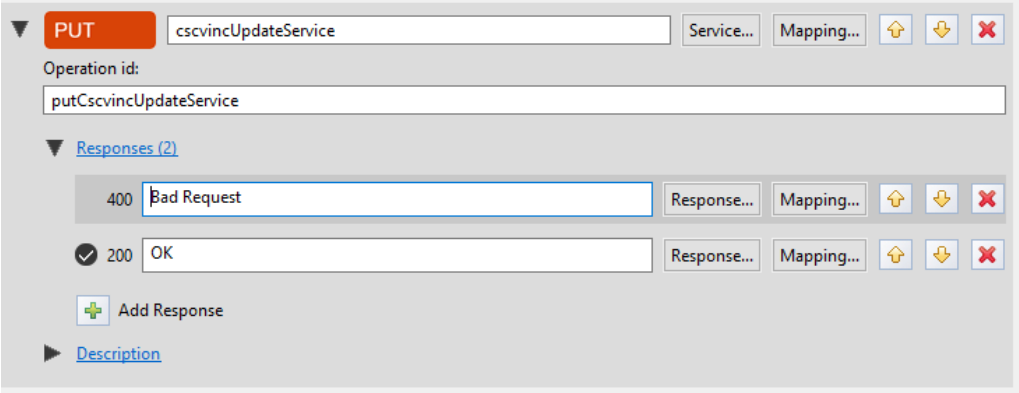
___48. Click the plus sign beside *Add Response* and use the pull-down arrows to select a *Response code* of *400 – Bad Request*, use the pull-down to select field *cscvincSelectServiceOperationResponse/cscvincContainer/response/CEIBRESP* for the first operand, an equal sign for the operation and enter ***16*** (INVREQ) for the second operand.



Summary

You created the API, which consists of two paths and the HTTP methods and request and response mapping associated with each. That API will now be deployed into z/OS Connect. Note in this scenario there was one service and the API developer used this one service to support a RESTful API with PUT, POST, GET and DELETE HTTP methods.

Deploy the API to a z/OS Connect Server

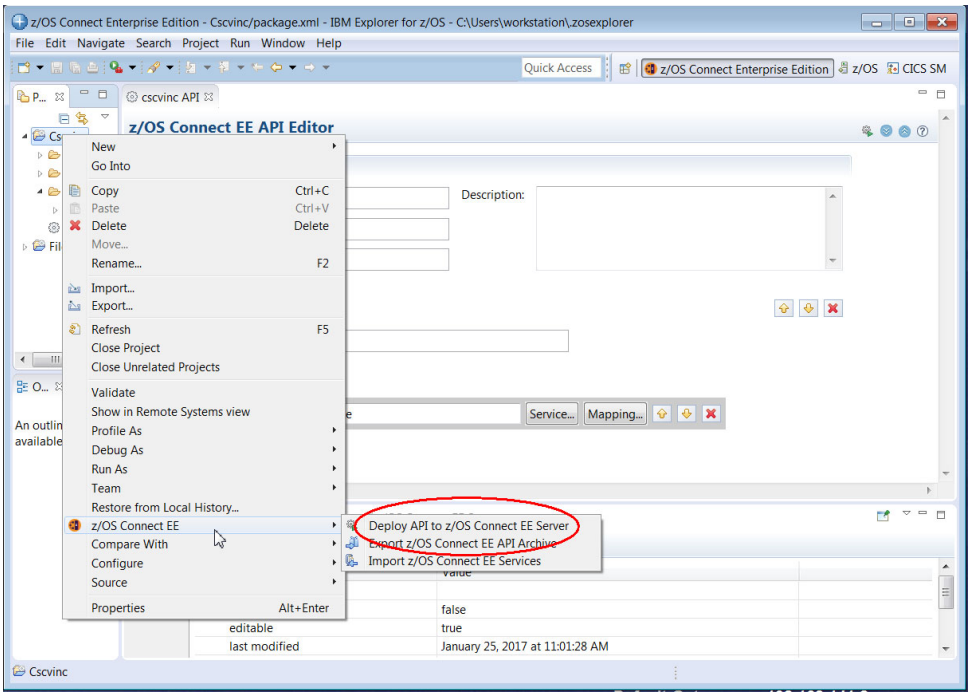
___1. The ***cscvinc*** API *and* ***cscvincService*** service were defined by the inclusion of the *ipic.xml* file in the *server.xml*.

```
<server description="CICS IPIC">

     <featureManager>
       <feature>zosconnect:cicsService-1.0</feature>
     </featureManager>

     <zosconnect_cicsIpicConnection id="cscvinc"
       host="wg31.washington.ibm.com"
       port="1491"/>

</server>                                                    "
```

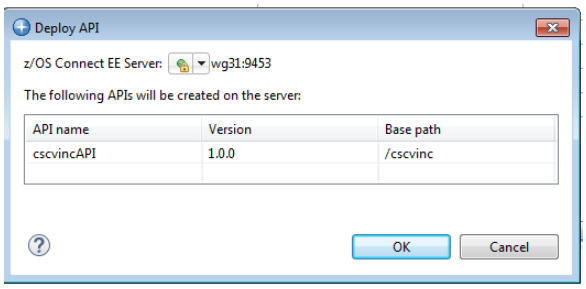
Figure 1 - ipic.xml

The *zosconnect_cicsIpicConnection* element provides the CICS IPIC information that will be used for communications with the CICS region.

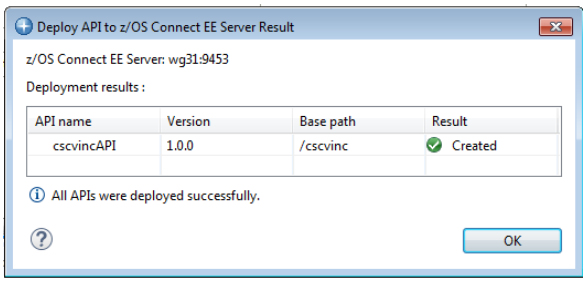
___2. In the *Project Explorer* view (upper left), right-mouse click on the *CscvincAPI* folder, then select *z/OS Connect→ Deploy API to z/OS Connect Server*.



___3. Since z/OS Explorer is connected to only one z/OS Connect server there is only one choice (*wg31:9453*). If z/OS Explorer had multiple host connections to z/OS Connect servers then the pull down arrow would allow a selection to which server to deploy. Click **OK** on this screen to continue.



___4. The API artifacts will be transferred to z/OS and copied into the */var/ats/zosconnect/servers/zceesrv1/resources/zosconnect/apis* directory.



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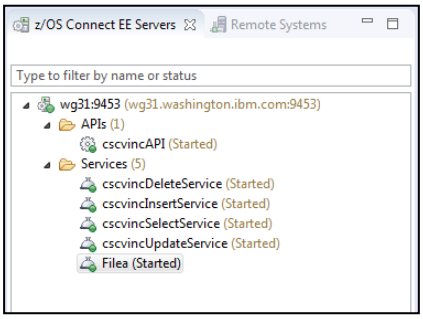
Test the APIs with a CICS Channel Application

The CICS application used to test the API accesses the same VSAM file used in the previous section. It supports 4 RESTful APIs by provide a *request* field in the request, adding a record (**I** for **POST**), updating a record (**U** for **PUT**), retrieving a record (**S** for **GET**) and deleting a record (**D** for **DELETE**). To test the z/OS Connect API with this CICS application we will use the same browser plugin used earlier to test the API to the batch application.

Tech Tip: You may be challenged by Firefox because the digital certificate used by the Liberty on z/OS server is self-signed If you receive a warning about a potential security risk, click the **Advanced** button to continue. Scroll down and then click on the **Accept the Risk and Continue** button.

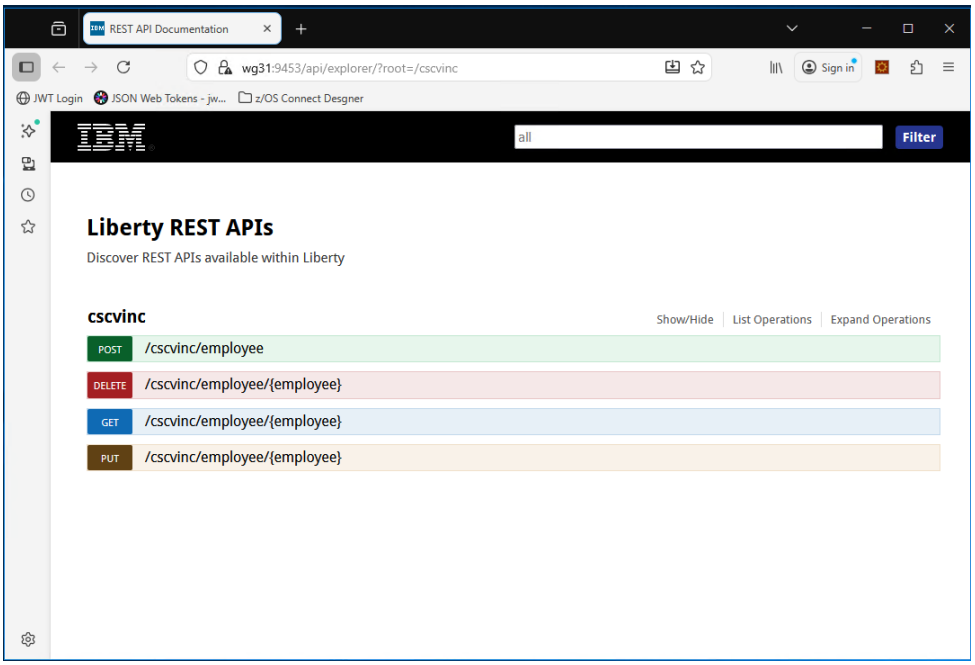
___1. In the lower left-hand side of the *z/OS Connect Explorer* perspective there is view entitled *z/OS Connect Servers*. Expand *wg31:9453* and the expand the *APIs* folder. You should see a list of the APIs installed in the server.



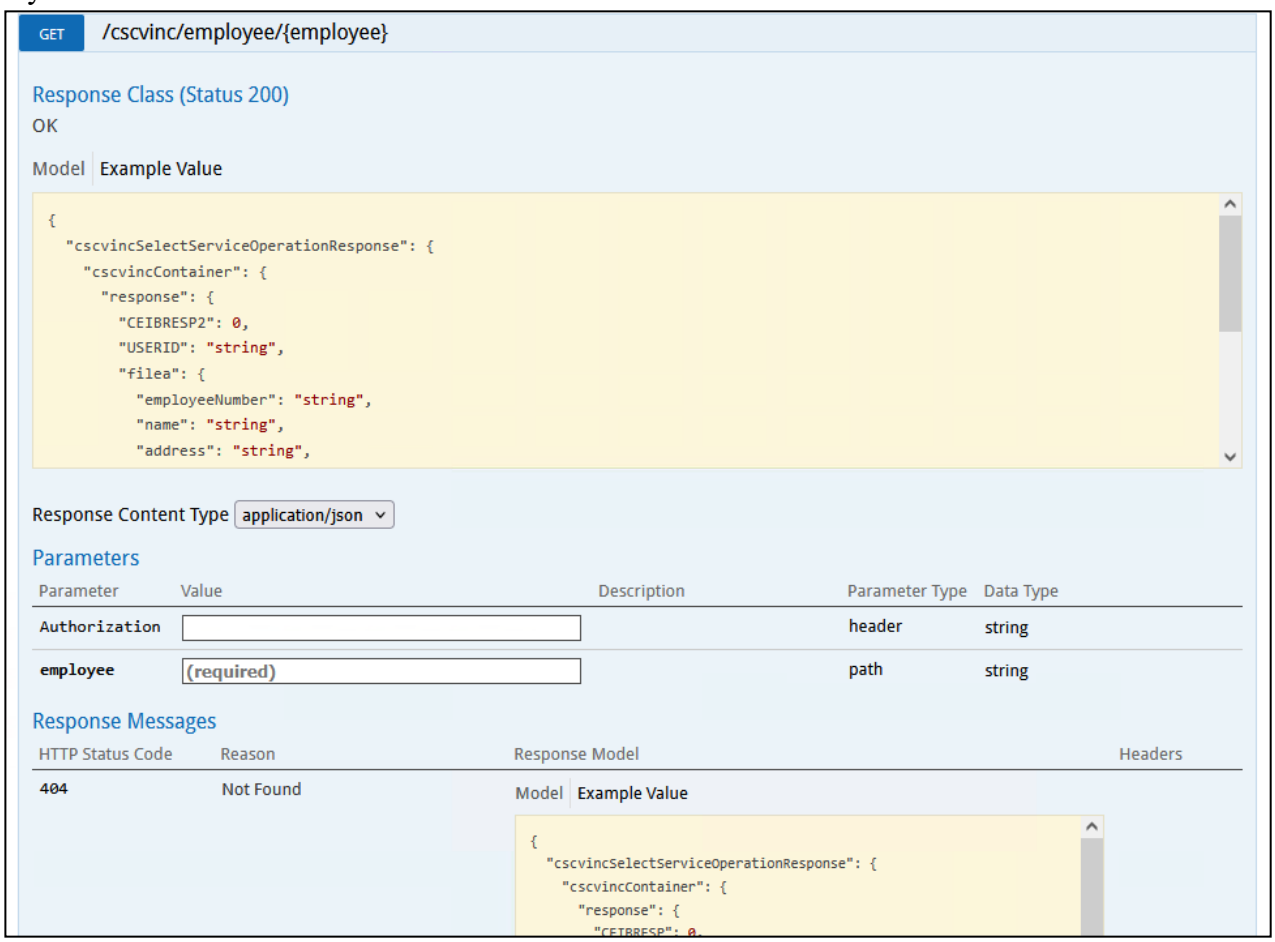
___2. Hover over *cscvincAPI* and click on the right mouse button and then select *Open in API Explorer.* Accept the server's self-signed certificate

Tech Tip: When using the Swagger UI to test an API it is very important to access the z/OS Connect server from a browser prior to any testing. Accessing a z/OS Connect URL from a browser starts an SSL handshake between the browser and the server. If this handshake has not performed prior to performing any test the test will fail with no message in the browser and no explanation.

___3. Click the *List Operations* and the browser should show a list of the available HTTP methods like this:



___4. Expand the *GET* operation by clicking on the *Get* box and scroll down until the method *Parameters* are displayed as shown below:



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___5. Enter ***000100*** in the area beside numb and scroll down click the **Try it Out!** button

___6. A pop-up window for a credentials may be displayed. Enter ***user1*** as the identity and ***user1*** as the password.

___7. Scroll down to see the **Response Body**. Note the *Response Code* of 200 (success) and details in the body.

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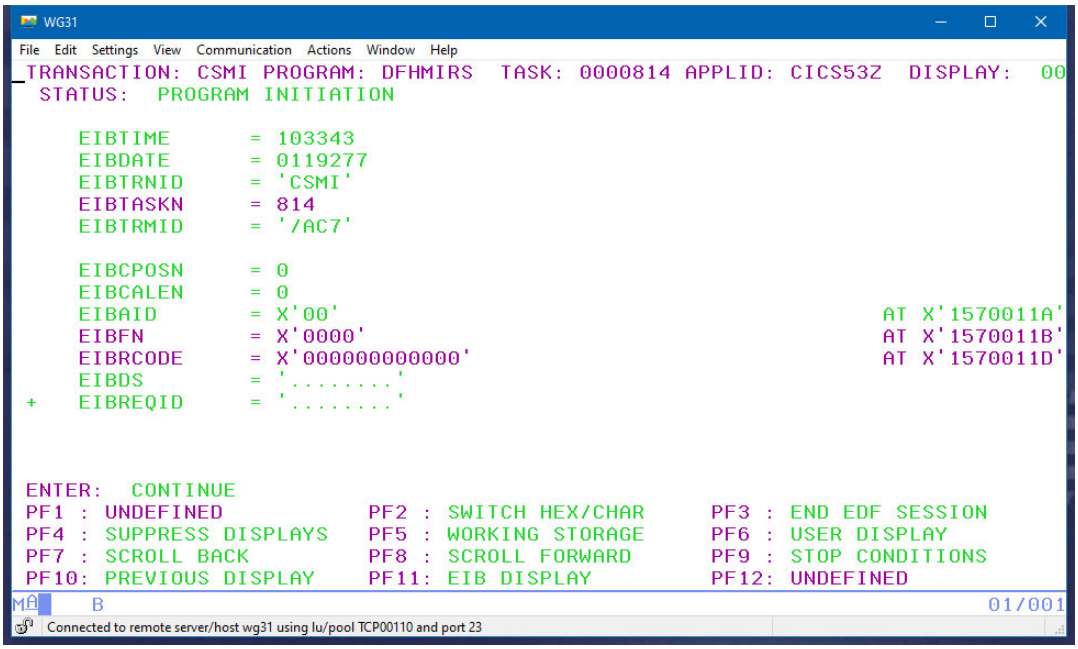
___8. Enter ***000101*** in the area beside numb and click the **Try it Out!** button. Scroll down and you see the response.

Tech Tip: The HTTP status code of 404 – Not Found was set in the API response message when then CEIBRESP return code was 13.

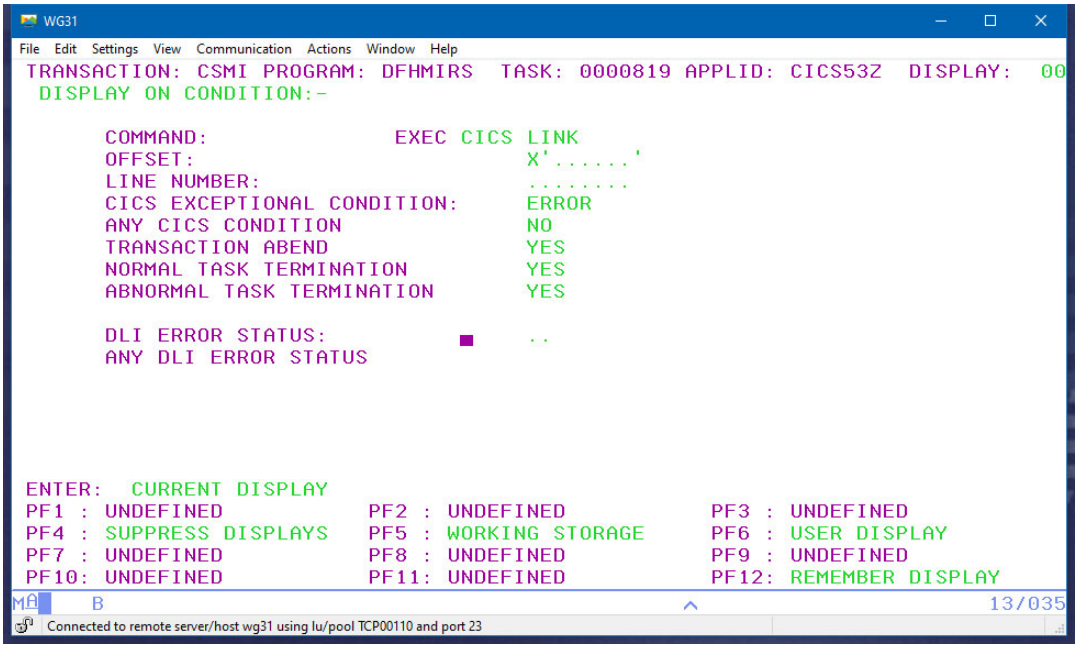
The record was not found.

___9. In a new or existing 3270 session start a session with CICS by entering ***CICS1***. Clear the screen and enter CICS transaction ***CEDX CSMI*** to start a CICS execution diagnostic facility (EDF) on transaction CSMI.

___10. Send another GET API request and you should see the EDF session start in the 3270 session.



___11. Use the **F9** key to set a stop condition. Set a stop on ***EXEC CICS LINK*** commands.



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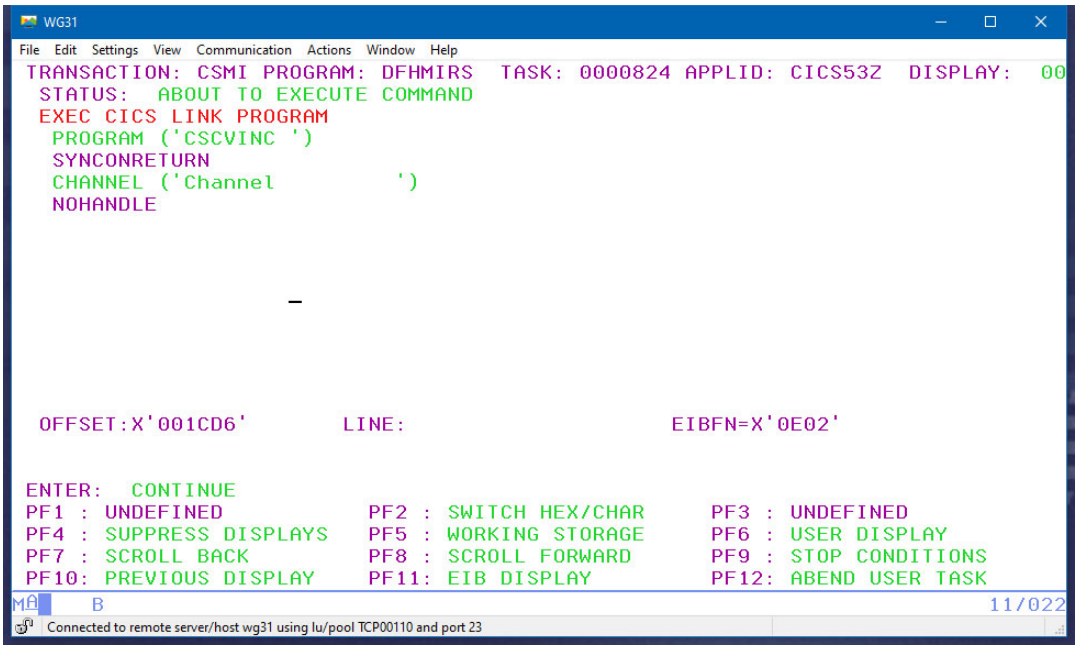
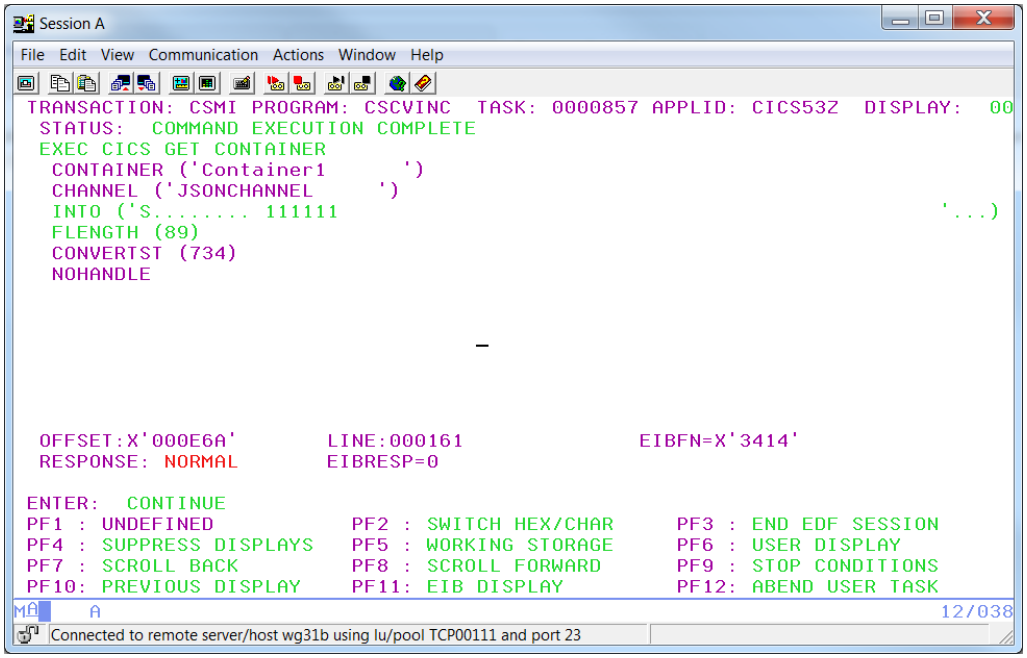
___12. Use the F4 key to suppress the intervening EDF displays. Eventually EDF will stop on an EXEC CICS LINK request.

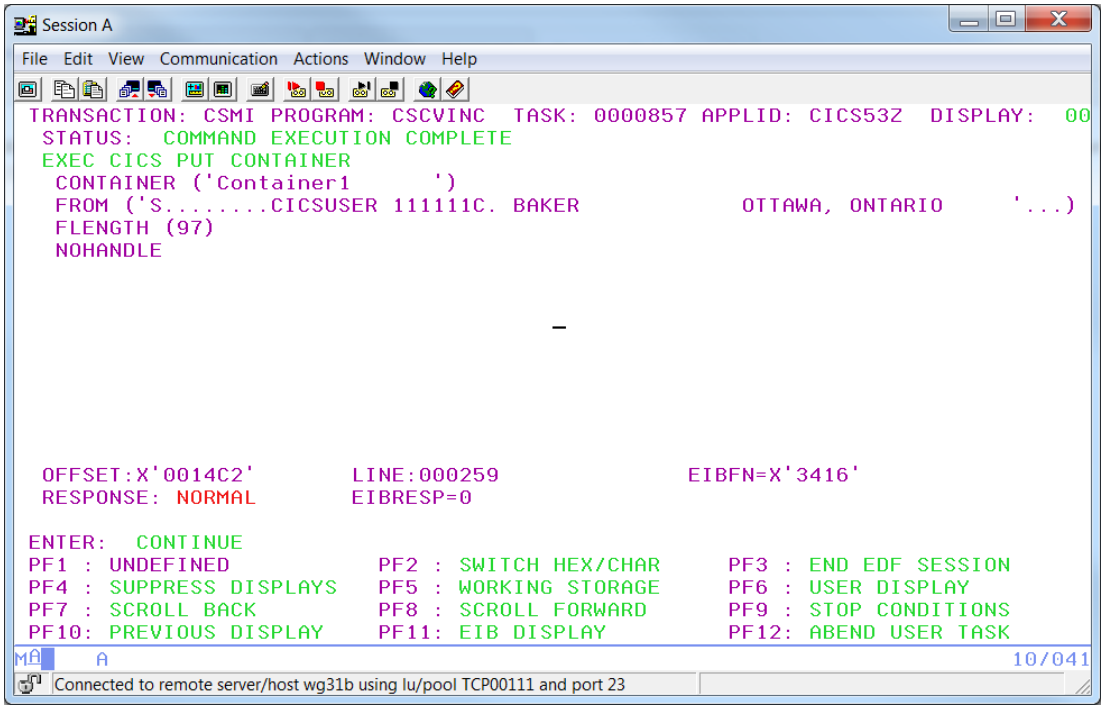


___13. Keep pressing **ENTER** and eventually you will see the target program receive a NORMAL response to an *EXEC CICS GET CONTAINER* request.



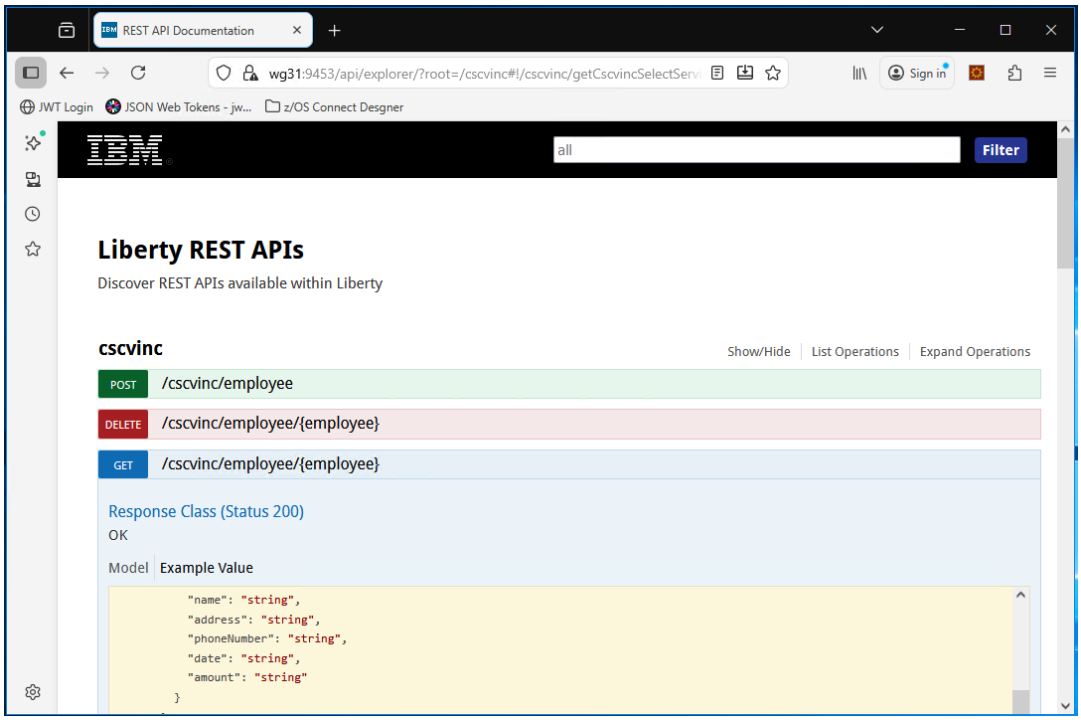
Tech Tip: You may experience timeouts in because the runtime has been configured to timeout if a response is not received within 30 seconds (connectionTimeout).

___14. Keep pressing ENTER and the EXEC CICS APIs in the target program will be traced in EDF. Eventually there will be EXEC CICS PUT CONTAINER execution which places the results container into the channel for return back to z/OS Connect for conversion to a JSON message.



___15. Use the **F3** key to terminate the EDF tracing.

___16. Back in the API Explorer browser session scroll up to the list of operations and select the *Delete* operation.



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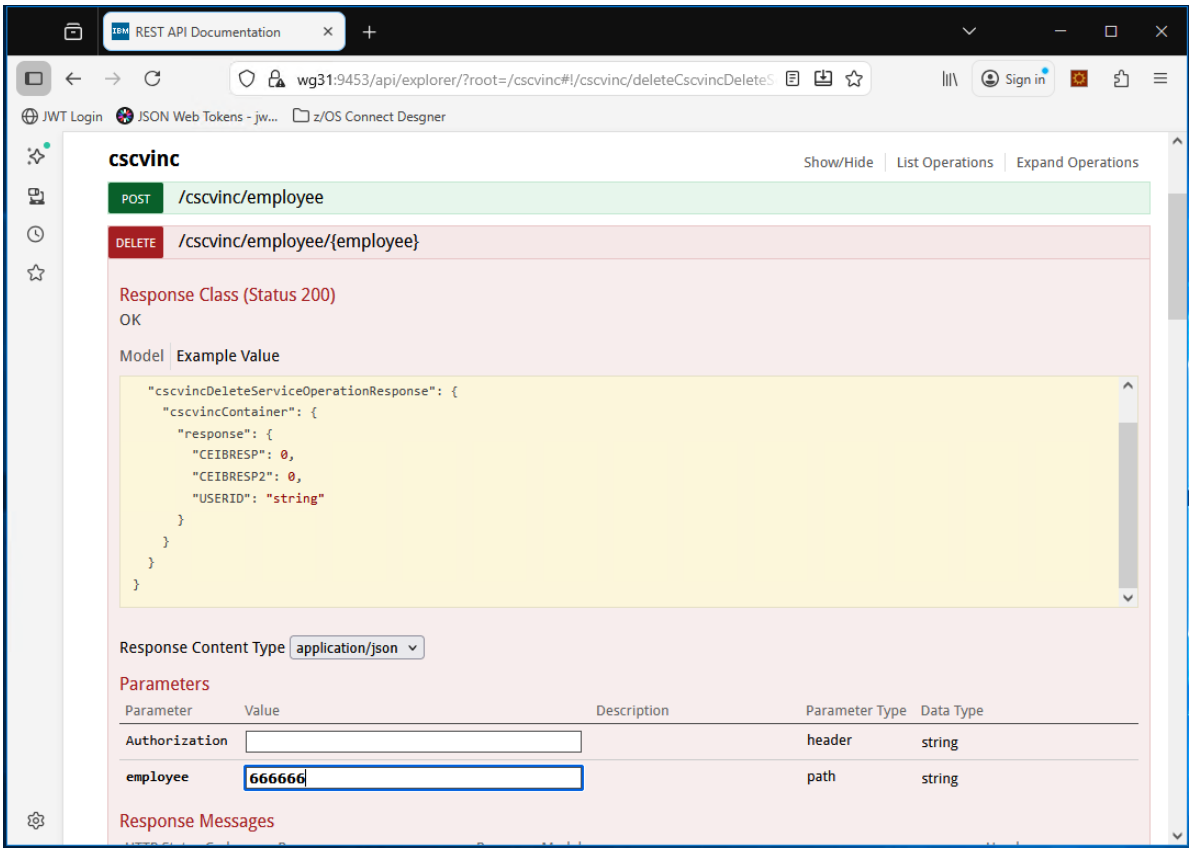
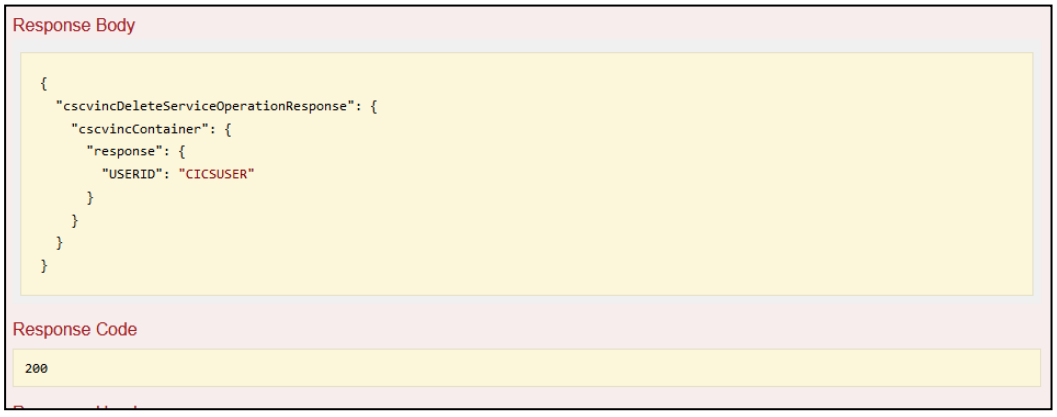
___17. Scroll down to display the details of the *DELETE* parameters. Enter ***666666*** in the area beside *numb*.



___18. Press the **Try it out!** button and you see the results in the response body. The response code of 200 indicted the record was successfully deleted.



___19. Press the **Try it out!** button again and you should see a response code of 404 (the record to be deleted was not found).

___20. Try using the Swagger-UI to test the other operations (PUT and POST) with the other records

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	*********

Summary

You have verified the API. The service layer is what does the data conversion and mapping and the IPIC connection to the backend program. The API layer provides a further level of abstraction and allows a more flexible use of HTTP verbs, and better mapping of data via the API editor function.

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