IBM z/OS Connect (OpenAPI 2.0)

Developing MVS Batch API Requesters Applications

IBM Washington Systems Center

Lab Version Date: August 8, 2023

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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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General Exercise Information and Guidelines

- ✓ The Windows artifacts for this exercise are in directory *c:\z\apiRequester*. Open a DOS command prompt Window and go to this directory using a change directory command, e.g.***, cd \z\apiRequester***
- ✓ Viewing or changing the contents of a file can easily be done by opening the Windows Explorer and going to directory *c:\z\apiRequester*. One this folder is display you can select a file and right mouse button click and select the *Edit* option to open a file.
- ✓ This exercise requires using TSO user *USER1* and the RACF password for this user is USER1.
- ✓ This exercise primarily uses data sets *USER1.ZCEE.CNTL* and *USER.ZCEE.SOURCE.*
- ✓ 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.
- ✓ Text in **bold** and highlighted in **yellow** in this document should be available for copying and pasting in a file named *OpenAPI2 developing API Requesters CopyPaste* file.
- ✓ 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.
- ✓ For information regarding the use of the Personal Communication 3270 emulator, see the *Personal Communications Tips* PDF in the exercise folder.

Important: The REST API provider applications used in this exercise access a CICS applications and MQ. These APIs were developed using the instructions provided in other exercises in this workshop. The REST API providers could have just as easily have been anywhere in the cloud on any remote system as long as the Swagger document for the REST API was available.

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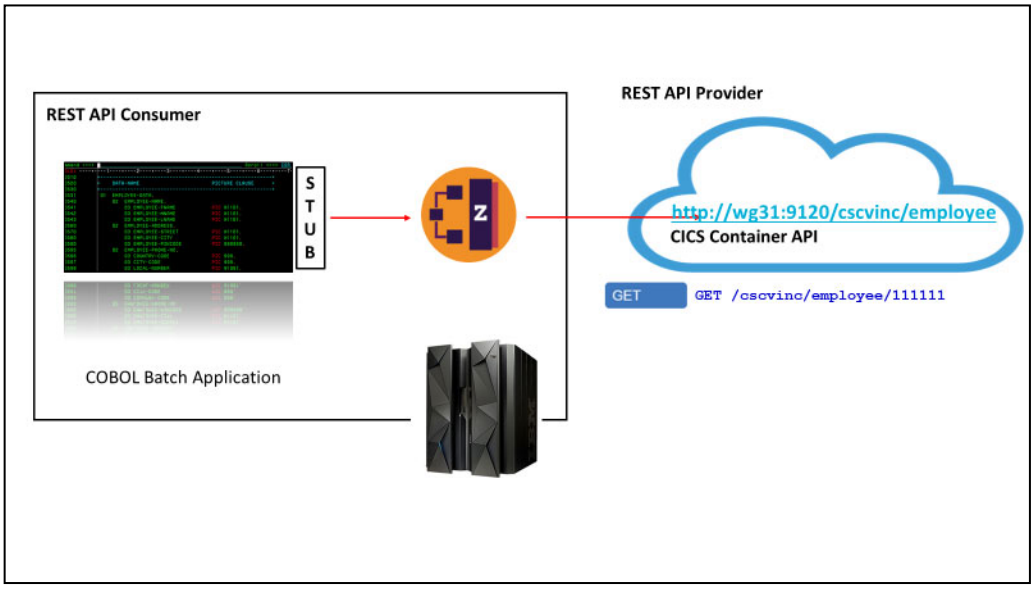
Overview

These exercises demonstrate the steps required to enable COBOL programs to invoke RESTful APIs. There are two samples provided to do this. One sample uses RESTful APIs to access a CICS program and the other uses RESTful APIs to interact with an MQ queue. Note that even though these APIs are hosted in z/OS Connect server these same steps could be followed to access APIs hosted anywhere in the cloud.

The process starts with the Swagger document that describes the API which the COBOL program will invoke. The Swagger document is used by the z/OS Connect build toolkit to (1) generate the COBOL copy books included in the COBOL program to invoke the API (2) as well as an API requester archive file (ARA) which is deployed to a z/OS Connect server.

The diagram shows this process at a high level. The copy books generated by the z/OS Connect build toolkit will be integrated into a COBOL program to provide (1) the COBOL representation of the request and response messages and to identity (2) the HTTP method to be used in the RESTful request. The API requester archive file will be deployed to a z/OS Connect server and used to convert (1) the COBOL request and response messages to JSON messages and to invoke (2) the outbound RESTful request and wait for the response.



In this exercise the COBOL program will be compiled and executed in a batch environment. The only differences between batch and CICS and IMS is the configuration required for connecting to the z/OS Connect server. Consult the z/OS Connect Knowledge Center for information how this is done for CICS and IMS.

If you have completed either the developing APIs exercise for MVS Batch, DB2 or MQ you can start with section *MVS Batch RESTful API Requester* on page 5.

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MVS Batch RESTful API Requester to a VSAM API Provider

In this section an API requester will be developed and tested where the target API accesses a VSAM data set. The batch programs will invoke the API to insert records (POST), retrieve records (GET), update record (PUT) and delete records (DELETE) in a VSAM data set.

Generate the API requester artifacts from a Swagger document

The first step is to use the API's Swagger document to generate the artifacts required for the COBOL API client application and the API requester archive file. The Swagger document was obtained from the server where the API is hosted. All the files mention in this section are in directory *c:/z/apiRequester/cscvinc* on your workstation.

The z/OS Connect build toolkit (ZCONBT) is a Java application shipped with z/OS Connect as a zip file and can be installed on a workstation or in OMVS. Anywhere a Java runtime is available. In this exercise the build toolkit will on Windows.

___1. Begin by reviewing the API's Swagger document for the VSAM API provider. This document identifies the types of HTTP methods supported as well as the path of each HTTP method. It also the contents each method's request JSON message and the response JSON message field contents and field types. This is the blueprint for invoking the API.

```
{

    "swagger": "2.0",
    "info": {
        "description": "",
        "version": "1.0.0",
        "title": "cscvinc"
    },
    "basePath": "/cscvinc",
    "schemes": [
        "https",
        "http"
    ],
    "consumes": [
        "application/json"
    ],
    "produces": [
        "application/json"
    ],
    "paths": {
        "/employee": {
            "post": {
                "operationId": "postCscvincService",
                "parameters": [
                    {
                        "in": "body",
                        "name": "postCscvincService_request",
                        "description": "request body",
                        "required": true,
                        "schema": {
                            "$ref": "#/definitions/postCscvincService_request"
                        }
```

Tech-Tip: Instructions for installing the z/OS Connect build toolkit can be found at URL
https://www.ibm.com/support/knowledgecenter/en/SS4SVW_3.0.0/com.ibm.zosconnect.doc/installing/bt_install.html

___2. Next review the input parameters that will be passed to the z/OS Connect build toolkit in a properties file. This file is *cscvinc.properties* see its below:

```
apiDescriptionFile=./swagger.json [1]
dataStructuresLocation=./syslib [2]
apiInfoFileLocation=./syslib [3]
logFileDirectory=./logs [4]
language=COBOL [5]
connectionRef=cscvincAPI [6]
requesterPrefix=csc [7]
```

1. Identifies the Swagger document that describes the API
2. Provides the directory where the generated COBOL copybooks representing the request and response messages will be written.
3. Provides the directory where the generated COBOL copybook with invocation details of the API will be written.
4. Provides the directory where a log file will be written.
5. Identifies the target language.
6. Identifies the corresponding *zosconnect_endpointConnection* element define in the z/OS Connect server's server.xml file.
7. Provides a 3-character prefix to be used for all generated copybooks

___3. View file *cscvinc.bat* which contains this one line.

```
c:\z\zconbt\bin\zconbt.bat -p=./cscvinc.properties -f=./cscvinc.ara
```

This is batch command file that when executed invokes the z/OS Connect build toolkit *(zconbt*). The -p switch identifies the input properties file and the -f switch identifies the name of the generate API requester archive file. The API requester archive (ARA) file will be deployed and made available to the z/OS Connect server in directory *.../resources/zosconnect/apiRequsters.*

___4. On the workstation desktop, locate the *Command Prompt* icon and double click on it to open a DOS session that will allow commands to be entered.

___5. Use the change directory command (cd) to change to directory C:\z*api**Requester**cscvinc*, e.g.

cd c:\z\apiRequester\cscvinc

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___6. Enter command ***cscvinc*** in the DOS command prompt window and you should see output like the below:

```
BAQB0000I: z/OS Connect Enterprise Edition Build Toolkit Version 1.2 (20200408-1120).
BAQB0008I: Creating API requester archive from configuration file ./cscvinc.properties.
BAQB0040I: The generated API requester is automatically named cscvincapi_1.0.0 based on the title
cscvincapi and version 1.0.0 of the API to be called.
BAQB0015I: Start processing operation (operationId: getCscvincSelectService, relativePath:
/employee/{employee}, method: GET).
DFHPI9586W A reserved word "address" has been detected in the input document, it has been changed
to "Xaddress".
DFHPI9586W A reserved word "date" has been detected in the input document, it has been changed to
"Xdate".
BAQB0016I: Successfully processed operation (operationId: getCscvincSelectService, relativePath:
/employee/{employee}, method: GET).
BAQB0015I: Start processing operation (operationId: putCscvincUpdateService, relativePath:
/employee/{employee}, method: PUT).
DFHPI9586W A reserved word "address" has been detected in the input document, it has been changed
to "Xaddress".
DFHPI9586W A reserved word "date" has been detected in the input document, it has been changed to
"Xdate".
BAQB0016I: Successfully processed operation (operationId: putCscvincUpdateService, relativePath:
/employee/{employee}, method: PUT).
BAQB0015I: Start processing operation (operationId: postCscvincInsertService, relativePath:
/employee/{employee}, method: POST).
DFHPI9586W A reserved word "address" has been detected in the input document, it has been changed
to "Xaddress".
BAQB0016I: Successfully processed operation (operationId: postCscvincInsertService, relativePath:
/employee/{employee}, method: POST).
BAQB0015I: Start processing operation (operationId: deleteCscvincDeleteService, relativePath:
/employee/{employee}, method: DELETE).
BAQB0016I: Successfully processed operation (operationId: deleteCscvincDeleteService, relativePath:
/employee/{employee}, method: DELETE).

Total 4 operation(s) (success: 4, ignored: 0) defined in api description file: ./swagger.json
------ Successfully processed operation(s) ------
operationId: postCscvincInsertService, basePath: /cscvinc, relativePath: /employee, method: POST
- request data structure  : CSC00Q01
- response data structure : CSC00P01
- api info file           : CSC00I01

operationId: getCscvincSelectService, basePath: /cscvinc, relativePath: /employee/{employee},
method: GET
- request data structure  : CSC01Q01
- response data structure : CSC01P01
- api info file           : CSC01I01

operationId: putCscvincUpdateService, basePath: /cscvinc, relativePath: /employee/{employee},
method: PUT
- request data structure  : CSC02Q01
- response data structure : CSC02P01
- api info file           : CSC02I01

operationId: deleteCscvincDeleteService, basePath: /cscvinc, relativePath: /employee/{employee},
method: DELETE
- request data structure  : CSC03Q01
- response data structure : CSC03P01
- api info file           : CSC03I01
```

Note that each HTTP method defined in the Swagger document will cause the generation of up to three copy books. One for the request message(Q01), one for the response message(P01) and one for the API details(I01). The copy book names are based on the *requesterPrefix* property (e.g. *csc*) and use an ascending sequence number sequence to differentiate between methods. Also note that there may be fewer than three copy books generated. For example, if there is no response message or no request message for a specific method a copy book may not be generated.

Important Note: The COBOL programs used in this exercise include these generated copy books with the names as generated above, e.g. the GET COBOL program includes CSC01 prefixed copy books. Occasionally (probably after applying service) the sequence of the methods will change causing the corresponding sequence number of the copy book to also change. Review the sequence of the processing of the methods and change the COBOL applications so they include the correct copy book. Otherwise the compilation of the COBOL program may fail or unexpected results may be observed.

___7. Now explore a sample snippet of the copy book for the request message of a PUT method. Use *Notepad* to open file c:\z\apiRequester\cscvinc\syslib\CSC02Q01. Scroll down until you see something like the code below.

```
06 ReqPathParameters.
  09 employee-length                    PIC S9999 COMP-5 SYNC.
  09 employee                           PIC X(6).
06 ReqBody.
   09 cscvincUpdateServiceOp-num        PIC S9(9) COMP-5 SYNC.
   09 cscvincUpdateServiceOperatio.
    12 cscvincContainer.
       15 request2-num                  PIC S9(9) COMP-5   SYNC.
       15 request.
         18 filea2-num                  PIC S9(9) COMP-5 SYNC.
         18 filea.
           21 name-num                  PIC S9(9) COMP-5 SYNC.
           21 name.
            24 name2-length            PIC S9999 COMP-5 SYNC.
            24 name2                   PIC X(20).
           21 Xaddress-num              PIC S9(9) COMP-5 SYNC.
           21 Xaddress.
            24 Xaddress2-length        PIC S9999 COMP-5 SYNC.
            24 Xaddress2               PIC X(20).
           21 phoneNumber-num           PIC S9(9)  COMP-5 SYNC.
           21 phoneNumber.
            24 phoneNumber2-length     PIC S9999 COMP-5 SYNC.
            24 phoneNumber2            PIC X(8).
           21 Xdate-num                 PIC S9(9) COMP-5 SYNC.
           21 Xdate.
            24 Xdate2-length           PIC S9999 COMP-5 SYNC.
            24 Xdate2                  PIC X(8).
           21 amount-num                PIC S9(9) COMP-5 SYNC.
           21 amount.
            24 amount2-length          PIC S9999 COMP-5 SYNC.
            24 amount2                 PIC X(8)
```


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Note that each variable has an associated length (e.g. *name2-length).* The length of a variable is required since there is no delimiter between the variables in storage. The runtime needs to know the size of a variable at execution time so the request and response messages can be properly converted to and from JSON name/value pairs.

For this API, the Swagger document included an additional variable for the number of occurrences of a variable, (e.g. *name-num*). In this exercise we will set the number of each variable to one.

> **Tech-Tip:** This additional variable was included for this API because the target program is a CICS container enabled program and a CICS channel can have multiple occurrences of the same container. The z/OS Connect API requester support needs to know number of each variable is being sent (and returned). This behavior is not unique to CICS.

The corresponding response message (*c:\z\apiRequester\cscvinc\syslib\CSC02P01*) will have a similar layout.

___8. The corresponding API information copy book (*c:\z\apiRequester\cscvinc\syslib\CSC02I01*) has contents providing the API name and the path to be used for the method:

```
           03 BAQ-APINAME                 PIC X(255)
              VALUE 'cscvinc_1.0.0'.
           03 BAQ-APINAME-LEN             PIC S9(9) COMP-5 SYNC
              VALUE 13.
           03 BAQ-APIPATH                 PIC X(255)
              VALUE '%2Fcscvinc%2Femployee%2F%7Bemployee%7D'.
           03 BAQ-APIPATH-LEN             PIC S9(9) COMP-5 SYNC
              VALUE 38.
           03 BAQ-APIMETHOD               PIC X(255)
              VALUE 'PUT'.
           03 BAQ-APIMETHOD-LEN           PIC S9(9) COMP-5 SYNC
              VALUE 3.
```

Deploy the API Requester Archive file to the z/OS Connect server

Next make the API requester archive file available to the z/OS Connect server.

The API requester archive (ARA) file needs to be deployed to the API requester directory. In this case the target directory is */var/ats/zosconnect/servers/zceeapir/resources/zosconnect/apiRequesters*.

___1. Open a DOS command session and change to directory c:\z\apiRequester\cscvinc, e.g
cd c:\z\apiRequester\cscvinc

___2. Use the z/OS Connect RESTful administrative interface to deploy the ARA files by using the cURL command embedded in command file ***deploy*.** Invoke this command file to deploy the cscvinc API archive file.

```
c:\z\apiRequester\cscvinc>curl -X POST --user Fred:fredpwd --data-binary @cscvin
c.ara  --header "Content-Type: application/zip" --insecure https://wg31.washingt
on.ibm.com:9483/zosConnect/apiRequesters
{"name":"cscvinc_1.0.0","version":"1.0.0","description":"","status":"Started","api
RequesterUrl":"https:\/\/wg31.washington.ibm.com:9483\/zosConnect\/apiRequeste
rs\/cscvinc_1.0.0","connection":"cscvincAPI"}
```


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Tech-Tip: If a REST client tool like cURL or Postman was not available then ARA file could have been deployed using FTP to upload the file in binary mode to the *apiRequesters* directory.

Tech-Tip: If an ARA needs to be redeployed, the cURL command with a PUT method can be used to stop the API requester
curl -X PUT --user Fred:fredpwd --insecure https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters/cscvinc_1.0.0?status=stopped
And the cURL command with a DELETE method can be used to delete the API requester.
curl -X DELETE --user Fred:fredpwd --insecure https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters/cscvinc_1.0.0
otherwise the redeployment of the ARA file will fail.

___3. The z/OS Connect server has the configuration below already included.

```
<server description="API Requester">
   <!-- Enable features -->
   <featureManager>
       <feature>zosconnect:apiRequester-1.0</feature>
   </featureManager>

 <zosconnect_endpointConnection id="cscvincAPI"        1
        host="http://wg31.washington.ibm.com"
        port="9120"
        basicAuthRef="myBasicAuth"
        connectionTimeout="10s"
        receiveTimeout="20s" />

 <zosconnect_authData id="myBasicAuth"       2
        user="Fred"
        password="fredpwd" />

</server>
```

1. Identifies the system which hosts the target API as well as any security information and time out parameters. Note that the ID of this element matches the value *connectionRef* property used when the ARA was generated by the z/OS Connect build toolkit.
2. The target server uses basic authentication, so we are simply provided a user identity and password. The password can be encrypted in the server.xml file or TLS used for security.

Tech-Tip: The *endpointConnection* element specifies the host and port of the target API provider. This z/OS Connect server performs the conversion of the COBOL data structure to JSON and then acts as a JSON REST client to the target API provider. Which for this example, is the same z/OS Connect server. The REST client loops back to itself when invoking the API. This would rarely happen in a real-world environment. This is why this host and port is also used by the API requester client in its environment variables.

Move the COBOL copy books to an MVS data set

Next make the generated COBOL copy books available for including into the COBOL program.

The generated COBOL copy books need in an MVS data set which is included in the compiler's SYSLIB. concatenation sequence, e.g., data set *USER1.ZCEE. SOURCE*. But first, the generated copybooks need to be moved to MVS. There are various methods for moving the files to MVS. In this case, we are using the cURL command.

___1. Open a DOS command prompt and use the change directory command to go to directory C:\z\apiRequester\cscvinc\syslib, e.g., ***cd \z\apiRequester\cscvinc\syslib***

___2. Start a file transfer session for the CSC00I01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC00I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___3. Start a file transfer session for the CSC00Q01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC00Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___4. Start a file transfer session for the CSC00P01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC00P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___5. Start a file transfer session for the CSC01I01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC01I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___6. Start a file transfer session for the CSC01Q01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC01Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___7. Start a file transfer session for the CSC01P01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC01P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___8. Start a file transfer session for the CSC02I01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC02I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___9. Start a file transfer session for the CSC02Q01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC02Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___10. Start a file transfer session for the CSC02P01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC02P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___11. Start a file transfer session for the CSC03I01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC03I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___12. Start a file transfer session for the CSC03Q01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC03Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___13. Start a file transfer session for the CSC03P01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T CSC03P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

The command window should something like what is shown below:

```
C:\z\apiRequester\cscvinc\syslib>curl -T CSC00I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   538    0     0  100   538      0   1013 --:--:-- --:--:-- --:--:--  1013

C:\z\apiRequester\cscvinc\syslib>curl -T CSC00Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 10819    0     0  100 10819      0  20027 --:--:-- --:--:-- --:--:-- 20035

C:\z\apiRequester\cscvinc\syslib>curl -T CSC00P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  5358    0     0  100  5358      0  11242 --:--:-- --:--:-- --:--:-- 11280

C:\z\apiRequester\cscvinc\syslib>curl -T CSC01I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   554    0     0  100   554      0   1072 --:--:-- --:--:-- --:--:--  1073
. . . .
```

___14. The 12 MVS data sets created by the invoking the curl command need to be copied or moved into the partitioned data set *USER1.ZCEE. SOURCE* with member names that match the original data set names.

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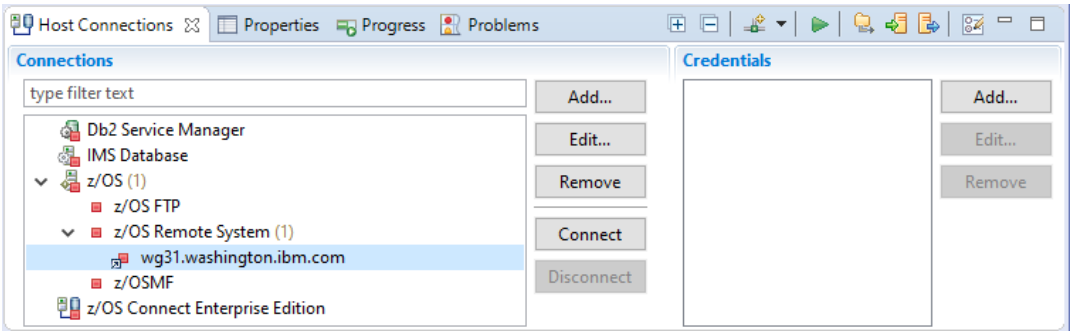
Review the application programs

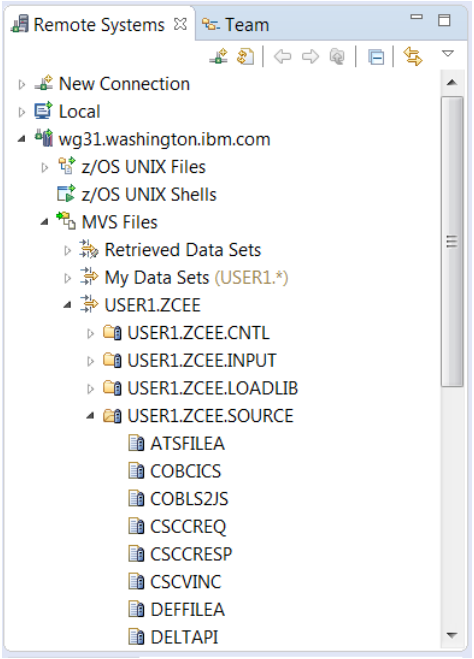
Now that the copy books have been generated and are available in a data set the next step is compile and link edit the application programs. The source for the application programs is in USER1.ZCEE.SOURCE. Member DELTAPI invokes the DELETE method, member GETAPI invokes the GET method, POSTAPI invokes the POST method and PUTAPI invokes the PUT method.

> **Tech-Tip:** Data set USER1.ZCEE.SOURCE can be accessed either by using the IBM z/OS Explorer or by using the Personal Communication icon on the desktop and logging on to TSO and use ISPF option 3.4 to access this data set. If you have any questions about either method, ask the instructor.

___1. Back in the IBM z/OS Explorer session switch to the *Remote System Explorer* perspective and select *wg31.washington.ibm.com* under *z/OS Remote System* and use the **Connect** button to connect to the remote system explorer daemon running on z/OS.



___2. Expand the USER1.ZCEE filter and select data set *USER1.ZCEE.SOURCE* in the *Remote System view* and double click to display a list of its members.



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Tech-Tip: Data set USER1.ZCEE.SOURCE can be accessed either by using the IBM z/OS Explorer or by using the Personal Communication icon on the desktop and logging on to TSO and use ISPF option 3.4 to access this data set. If you have any questions about either method, ask the instructor.

___3. Begin by reviewing the application programs GETAPI. Open member *GETAPI* in *USER1.ZCEE. SOURCE* and review its contents by selecting the member and right- mouse button clicking and selecting the *Open* option. Scroll down until you see these lines of code.

These lines of code copy into the source the required z/OS Connect copy book (BAQRINFO) and the copy books generated by the z/OS Connect build tool kit. If when you generated the copy book earlier in the exercise and the sequence number used for the GET method was not 00, e.g. the CSC**00** prefix, then you need to change the COBOL source to match sequence generated when you invoke the ZCONBT tool.

```
      * Copy API Requester required copybook
       COPY BAQRINFO.

      * Request and Response
       01 GET-REQUEST.
           COPY CSC01Q01.
       01 GET-RESPONSE.
           COPY CSC01P01.
      * Structure with the API information
       01 GET-INFO-OPER1.
           COPY CSC01I01.
```

___4. Scroll down further until you find this code which provides the contents of the request message.

```
      *-------------------------------------------------------------*
      * Set up the data for the API Requester call                  *
      *------------------- ----------------------------------------*
           MOVE employee of PARM-DATA TO employee IN GET-REQUEST.
           MOVE LENGTH of employee in GET-REQUEST to
               employee-length IN GET-REQUEST.

      *-------------------------------------------------------------*
      * Initialize API Requester PTRs & LENs                        *
      *-------------------------------------------------------------*
      * Use pointer and length to specify the location of
      *  request and response segment.
      * This procedure is general and necessary.
           SET BAQ-REQUEST-PTR TO ADDRESS OF GET-REQUEST.
           MOVE LENGTH OF GET-REQUEST TO BAQ-REQUEST-LEN.
           SET BAQ-RESPONSE-PTR TO ADDRESS OF GET-RESPONSE.
           MOVE LENGTH OF PUT-RESPONSE TO BAQ-RESPONSE-LEN.
```

The *GET* method only requires one variable and it is provided as a path parameter, e.g. /cscvinc/employee/{numb}.

___5. Scroll down further and you will the call to the z/OS Connect API requester stub module.

```
       *---------------------------------------------------------------*
       * Call the communication stub                                   *
       *---------------------------------------------------------------*
       * Call the subsystem-supplied stub code to send
       * API request to zCEE
            CALL COMM-STUB-PGM-NAME USING
                 BY REFERENCE   GET-INFO-OPER1
                 BY REFERENCE   BAQ-REQUEST-INFO
                 BY REFERENCE   BAQ-REQUEST-PTR
                 BY REFERENCE   BAQ-REQUEST-LEN
                 BY REFERENCE   BAQ-RESPONSE-INFO
                 BY REFERENCE   BAQ-RESPONSE-PTR
                 BY REFERENCE   BAQ-RESPONSE-LEN.
       * The BAQ-RETURN-CODE field in 'BAQRINFO' indicates whether this
       * API call is successful.
```

Note that the parameters are being passed by reference. This means that the z/OS Connect API requester stub will have direct access to the program storage for both accessing data and making changes (i.e. the response message).

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___6. Scroll down further and you will see the code where the application displays the results in the response message.

```
           IF BAQ-SUCCESS THEN
              DISPLAY "EmployeeNumber: " employeeNumber2 of GET-RESPONSE
              DISPLAY "EmployeeName:   " employeeName2 of GET-RESPONSE
              DISPLAY "Address:        " Xaddress2 of GET-RESPONSE
              DISPLAY "Phone:          " phoneNumber2 of GET-RESPONSE
              DISPLAY "Date:           " Xdate2  of GET-RESPONSE
              DISPLAY "Amount:         " amount2 of GET-RESPONSE
              MOVE CEIBRESP of GET-RESPONSE to EIBRESP
              MOVE CEIBRESP2 of GET-RESPONSE to EIBRESP2
              DISPLAY "EIBRESP:        " EIBRESP
              DISPLAY "EIBRESP2:       " EIBRESP2
              DISPLAY "USERID:         " USERID2
```

Close member *GETAPI* and open member *POSTAPI*. The code for this program is very similar to the code for *GETAPI* with the exception that all variables are provided in a JSON request message. Scroll down and find the code below.

```
      *-------------------------------------------------------------*
      * Set up the data for the API Requester call                  *
      *-------------------------------------------------------------*
           MOVE 1 to cscvincInsertServiceOp-num in POST-REQUEST
                     REQUEST2-num in POST-REQUEST
                     filea2-num in POST-REQUEST
                     employeeNumber-num in POST-REQUEST
                     employeeName-num in POST-REQUEST
                     Xaddress-num in POST-REQUEST
                     phoneNumber-num in POST-REQUEST
                     startDate-num in POST-REQUEST
                     amount-num in POST-REQUEST.

           MOVE employeeNumber of PARM-DATA TO employeeNumber2
                                IN POST-REQUEST.
           MOVE LENGTH of employeeNumber2 in POST-REQUEST to
               employeeNumber2-length IN POST-REQUEST.

           MOVE "John" TO employeeName2 IN POST-REQUEST.
           MOVE LENGTH of employeeName2 in POST-REQUEST to
               employeeName2-length IN POST-REQUEST.
```

In this case the number of occurrences of a property must be provided and the property value moved to the request copy book.

___7. Explore members *DELTAPI* and *PUTAPI* and their corresponding copy books to see the code which is common (variable housekeeping, calls to the z/OS Connect stub, etc.) regardless of the method being invoked.

Compile and link-edit the application programs

The applications programs now are ready to be compiled and link edited.

___1. Submit the job in member **CSCVINC** in data set *USER1.ZCEE.CNTL*.

```
//COMPILE EXEC IGYWCL,LNGPRFX=SYS1.ECOBOL,PARM.COBOL='NODYNAM
//COBOL.SYSIN  DD DISP=SHR,DSN=USER1.ZCEE.SOURCE(POSTAPI)
//COBOL.SYSLIB DD DISP=SHR,DSN=USER1.ZCEE.SOURCE
//             DD DISP=SHR,DSN=ZCEE30.SBAQCOB
//LKED.SYSLMOD DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB(POSTAPI)
//COMPILE EXEC IGYWCL,LNGPRFX=SYS1.ECOBOL,PARM.COBOL='NODYNAM
//COBOL.SYSIN  DD DISP=SHR,DSN=USER1.ZCEE.SOURCE(GETAPI)
//COBOL.SYSLIB DD DISP=SHR,DSN=USER1.ZCEE.SOURCE
//             DD DISP=SHR,DSN=ZCEE30.SBAQCOB
//LKED.SYSLMOD DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB(GETAPI)
//COMPILE EXEC IGYWCL,LNGPRFX=SYS1.ECOBOL,PARM.COBOL='NODYNAM'
//COBOL.SYSIN  DD DISP=SHR,DSN=USER1.ZCEE.SOURCE(PUTAPI)
//COBOL.SYSLIB DD DISP=SHR,DSN=USER1.ZCEE.SOURCE
//             DD DISP=SHR,DSN=ZCEE30.SBAQCOB
//LKED.SYSLMOD DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB(PUTAPI)
//COMPILE EXEC IGYWCL,LNGPRFX=SYS1.ECOBOL,PARM.COBOL='NODYNAM'
//COBOL.SYSIN  DD DISP=SHR,DSN=USER1.ZCEE.SOURCE(DELTAPI)
//COBOL.SYSLIB DD DISP=SHR,DSN=USER1.ZCEE.SOURCE
//             DD DISP=SHR,DSN=ZCEE30.SBAQCOB
//LKED.SYSLMOD DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB(DELTAPI)
```

Note that the CALL statement in each of this program uses a variable for the program name z/OS Connect stub program (BAQCSTUB). This means that this program will by dynamically linked at execution. The load module library containing BAQSCTUB (ZCEE30.SBAQLIB) must be available in the STEPLIB concatenation sequence when the program is executed.

This job should complete with a zero-return code.

Tech Tip: To submit a job when using the IBM z/OS Explorer select the member and right mouse button click and select the *Submit* option. Or if the member is currently opened simply right mouse button click and select the *Submit* option. Click the **Locate Job** button on the *Job Confirmation* pop-up. This will display the job output in the *Retrieved Job* section under *JES* in the *Remote Systems* view. The job's output can be viewed right mouse button clicking and selecting the *Open* option.

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Test the API requester application programs

The JCL to execute these programs can be found in USER1.ZCEE.CNTL, the member names in this data set match the program names. The members are DELTAPI, GETAPI, POSTAPI and PUTAPI.

___1. Submit the job in member **GETAPI** in *USER1.ZCEE.CNTL*.

```
//GETAPI EXEC PGM=GETAPI,PARM='111111'
//STEPLIB  DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB
//         DD DISP=SHR,DSN=ZCEE30.SBAQLIB
//SYSPRINT DD SYSOUT=*
//CEEOPTS  DD *
 POSIX(ON),
 ENVAR("BAQURI=wg31.washington.ibm.com",
 "BAQPORT=9120")
```

___2. The job should complete with a condition code of 200 and have the following output for SYSPRINT.

```
EmployeeNumber: 111111
EmployeeName:   C. BAKER
Address:        OTTAWA, ONTARIO
Phone:          51212003
Date:           26 11 81
Amount:         $0011.00
EIBRESP:        00000000
EIBRESP2:       00000000
USERID:         CICSUSER
HTTP CODE:      0000000200
```

___3.

Tech-Tip: An HTTP code of 200 indicates success. For an explanation of HTTP codes see URL https://en.wikipedia.org/wiki/List_of_HTTP_status_codes

___3. Change the PARM=’111111’ to PARM=’000000’ and resubmit. This time should receive a return code of 404 and the output should look like this:

```
Error code: 0000000404
Error
msg:{"cscvincSelectServiceOperationResponse":{"Container1":{"RESPONSE_CONTAINER":{"CEI
BRESP2":80,"fileArea":{"date
":"","employeeName":"","amount":"","address":"","phone":"","employeeNumber":"000000"},
"userIdentity":"CICSUSER","CEIBRESP":13}}}}
```

The EIBRESP and EIBRESP2 values are from a CICS program and the response codes received when an EXEC CICS READ fails with a *Not Found* condition.

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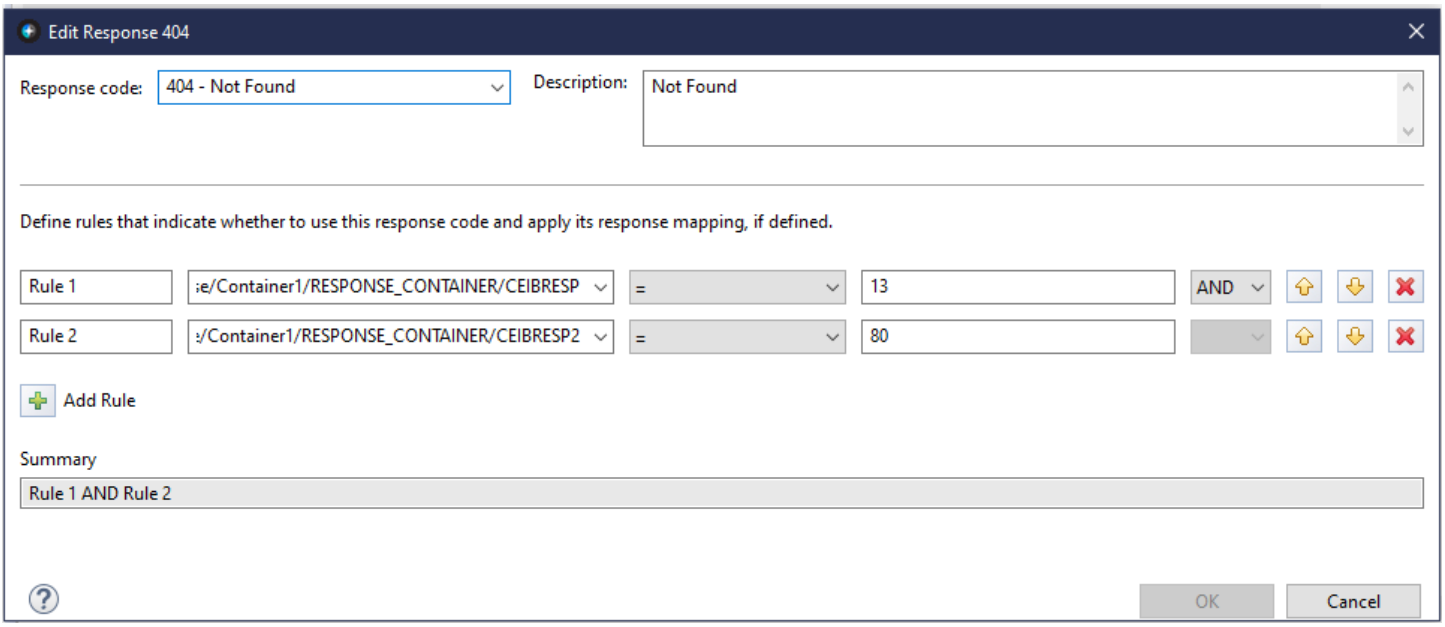
The target API was developed using z/OS Connect and had a response code mapping that checked the values of EIBRESP and EIBRESP2 and if this error occurred, the API was to return an HTTP 404 return code.



___4. Submit the job in member **POSTAPI** in *USER1.ZCEE.CNTL*.

___5. The job should complete with a condition code of 200 and have the following output for SYSPRINT.

```
EIBRESP:    00000000
EIBRESP2:   00000000
USERID:     CICSUSER
HTTP CODE:  0000000200
```

This job added a record for employee 323232.

___6. Edit member **GETAPI** and change the *PARM* value to ***323232*** and submit the job.

```
EmployeeNumber: 323232
EmployeeName:   John
Address:        Apex
Phone:          0065
Date:           11 22 65
Amount:         $1000.65
EIBRESP:        00000000
EIBRESP2:       00000000
USERID:         CICSUSER
HTTP CODE:      0000000200
```

___7. Member **DELTAPI** in *USER.ZCEE.CNTL* will delete a record and **PUTAPI** will update an existing record. Submit these jobs and observe the results. Or if you want to modify the request messages in POSTAPI and PUTAPI and recompile and relink these programs and observe the results when different values are provided.

The available records are listed below:

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

Summary

You have use the z/OS Connect build toolkit to generate an API requester archive file and the COBOL copy books that must be included in the COBOL application program when accessing the API requester archive file in a z/OS Connect server. The COBOL applications have been compiled and link-edited and the target API has been tested using various RESTful methods

MVS Batch RESTful API Requester to a MQ API provider

In this section an API requester will be developed and tested where the target API accesses a MQ queue. The batch programs will be put messages (POST) to the queue, do non-destructive gets (GET) and destructive gets (DELETE) of messages from the same queue.

Generate the API requester artifacts from a Swagger document

The first step is to use to use the API's Swagger document to generate the artifacts required for the COBOL API client application and the API requester archive file. The Swagger document was obtained from the server where the API is hosted. All the files mention in this section are in directory *c:/z/apiRequester/mqapi* on your workstation.

The z/OS Connect build toolkit (ZCONBT) is a Java application shipped with z/OS Connect as a zip file and can be installed on a workstation or in OMVS. Anywhere a Java runtime is available. In this exercise the build toolkit will on Windows.

> **Tech-Tip:** Instructions for installing the z/OS Connect build toolkit can be found at URL https://www.ibm.com/support/knowledgecenter/en/SS4SVW_3.0.0/com.ibm.zosconnect.doc/installing/bt_install.html

___1. Begin by reviewing the API's Swagger document for the API. This document identifies the types of HTTP methods supported as well as the path of each HTTP method. It also the contents each method's request JSON message and the response JSON message field contents and field types. This is the blue print for invoking the API.

```
{

    "swagger": "2.0",
    "info": {
        "description": "",
        "version": "1.0.0",
        "title": "mqapi"
    },
    "basePath": "/mqapi",
    "schemes": [
        "https",
        "http"
    ],
    "consumes": [
        "application/json"
    ],
    "produces": [
        "application/json"
    ],
    "paths": {
        "/queue": {
            "get": {
                "tags": [
                    "mqapi"
                ],
                "operationId": "getMqGet",
                "parameters": [
```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___2. Next review the input parameters that will be passed to the z/OS Connect build toolkit in a properties file. This file is *mqapi.properties* see its below:

```
apiDescriptionFile=./mqapi.json [1]
dataStructuresLocation=./syslib [2]
apiInfoFileLocation=./syslib [3]
logFileDirectory=./logs [4]
language=COBOL [5]
connectionRef=mqapi [6]
requesterPrefix=mq [7]
```

1. Identifies the Swagger document that describes the API
2. Provides the directory where the generated COBOL copybooks representing the request and response messages will be written.
3. Provides the directory where the generated COBOL copybook with invocation details of the API will be written.
4. Provides the directory where a log file will be written.
5. Identifies the target language.
6. Identifies the corresponding *zosconnect_endpointConnection* element define in the z/OS Connect server's server.xml file.
7. Provides a 3-character prefix to be used for all generated copybooks

___3. View file *mqapi.bat* which contains this one line.

```
c:\z\zconbt\bin\zconbt.bat -p=./mqapi.properties -f=./mqapi.ara
```

This is batch command file that when executed invokes the z/OS Connect build toolkit *(zconbt*). The -p switch identifies the input properties file and the -f switch identifies the name of the generate API requester archive file. The API requester archive (ARA) file will be uploaded and make available to the z/OS Connect server in directory *.../resources/zosconnect/apiRequsters.*

___4. On the workstation desktop, locate the *Command Prompt* icon and double click on it to open a DOS session that will allow commands to be entered.

___5. Use the change directory command (cd) to change to directory *apiRequester*/*mqapi*, e.g.

cd c:\z\apiRequester\mqapi

___6. Enter command ***mqapi*** in the DOS command prompt window and you should see output like the below:

```
c:\z\apiRequester\mqapi>c:\z\software\zconbt\bin\zconbt.bat -p=./mqapi.properties -
f=./mqapi.ara
BAQB0000I: z/OS Connect Enterprise Edition Build Toolkit Version 1.2 (20200408-1120).
BAQB0008I: Creating API requester archive from configuration file ./mqapi.properties.
BAQB0040I: The generated API requester is automatically named mqapi_1.0.0 based on the title
mqapi and version 1.0.0 of the API to be called.
BAQB0015I: Start processing operation (operationId: getMqGetService, relativePath: /queue,
method: GET).
BAQB0016I: Successfully processed operation (operationId: getMqGetService, relativePath:
/queue, method: GET).
BAQB0015I: Start processing operation (operationId: postMqPutService, relativePath: /queue,
method: POST).
BAQB0016I: Successfully processed operation (operationId: postMqPutService, relativePath:
/queue, method: POST).

Total 2 operation(s) (success: 2, ignored: 0) defined in api description file: ./mqapi.json
------ Successfully processed operation(s) ------
operationId: getMqGetService, basePath: /mqapi, relativePath: /queue, method: GET
- request data structure  : No data structure needs to be generated.
- response data structure : MQ000P01
- api info file           : MQ000I01

operationId: postMqPutService, basePath: /mqapi, relativePath: /queue, method: POST
- request data structure  : MQ001Q01
- response data structure : No data structure needs to be generated.
- api info file           : MQ001I01


BAQB0009I: Successfully created API requester archive file ./mqapi.ara.
```

Note that each HTTP method defined in the Swagger document will normally cause the generation of up to three copy books. One for the request message(Q01), one for the response message(P01) and one for the API details(I01). For this API only two copy books were generated for the messages. One for either the request message or one for the response message. In this case the API did not require both types for any method. Also note that the copy book names are based on the *requesterPrefix* property (e.g. *mq*) and use an ascending sequence number sequence to differentiate between methods.

Important Note: The COBOL programs used in this exercise include these generated copy books with the names as generated above, e.g. the GET COBOL program includes CSC01 prefixed copy books. Occasionally (probably after applying service) the sequence of the methods will change causing the corresponding sequence number of the copy book to also change. Review the sequence of the processing of the methods and change the COBOL applications so they include the correct copy book. Otherwise the compilation of the COBOL program may fail, or unexpected results may be observed.

___7. Now explore a sample snippet of the copy book for the request message of a PUT method. Use *Notepad* to open file c:\z\apiRequester\mqapi\syslib\MQ001Q01. Scroll down until you see something like the code below.

```
           06 ReqBody.
             09 MQMESSAGE2-num               PIC S9(9) COMP-5 SYNC.
             09 MQMESSAGE.
               12 STAT-num                     PIC S9(9) COMP-5 SYNC.
               12 STAT.
                 15 STAT2-length                 PIC S9999 COMP-5 SYNC.
                 15 STAT2                        PIC X(1).
               12 NUMB-num                     PIC S9(9) COMP-5 SYNC.
               12 NUMB.
                 15 NUMB2-length                 PIC S9999 COMP-5 SYNC.
                 15 NUMB2                        PIC X(6).
               12 NAME-num                     PIC S9(9) COMP-5 SYNC.
               12 NAME.
                 15 NAME2-length                 PIC S9999 COMP-5 SYNC.
```

Note that each variable has an associated length (e.g. *STAT2-length).* The length of a variable is required since there is no delimiter between the variables in storage. The runtime needs to know the size of a variable at execution time so the request and response messages can be properly converted to and from JSON name/value pairs.

A response message (*c:\z\apiRequester\mqapi\syslib\MQ000P01*) will have a similar layout.

___8. An API information copy book (*c:\z\apiRequester\mqapi\syslib\MQ001I01*) has contents providing the API name and the path to be used for the method:

```
           03 BAQ-APINAME                 PIC X(255)
              VALUE 'mqapi_1.0.0'.
           03 BAQ-APINAME-LEN             PIC S9(9) COMP-5 SYNC
              VALUE 11.
           03 BAQ-APIPATH                 PIC X(255)
              VALUE '%2Fmqapi%2Fqueue'.
           03 BAQ-APIPATH-LEN             PIC S9(9) COMP-5 SYNC
              VALUE 16.
           03 BAQ-APIMETHOD               PIC X(255)
              VALUE 'GET'.
           03 BAQ-APIMETHOD-LEN           PIC S9(9) COMP-5 SYNC
              VALUE 3.
```

Deploy the API Requester Archive file to the z/OS Connect server

Next make the API requester archive file available to the z/OS Connect server.

The API requester archive (ARA) file needs to be deployed to the API requester directory. In this case the target directory is */var/ats/zosconnect/servers/zceeapir/resources/zosconnect/apiRequesters*.

___1. Open a DOS command session and change to directory C:\z\apiRequester\mqapi, e.g
cd \z\apiRequester\mqapi

___2. Use the z/OS Connect RESTful administrative interface to deploy the ARA files by using the cURL command embedded in command file ***deploy***. Invoke this command file to deploy the MQ API archive file.

```
c:\z\apiRequester\mqapi>curl -X POST --user Fred:fredpwd --data-binary @mqapi.ara
--header "Content-Type: application/zip" --insecure
https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters
{"name":"mqapi_1.0.0","version":"1.0.0","description":"","status":"Started"
,"apiRequesterUrl":"https:\/\/wg31.washington.ibm.com:9483\/zosConnect\/apiReque
sters\/mqapi_1.0.0","connection":"mqapi"}
```

Tech-Tip: If a REST client tool like cURL or Postman was not available then ARA file could have been deployed using FTP to upload the file in binary mode to the *apiRequesters* directory.

Tech-Tip: If an ARA needs to be redeployed, the cURL command with a PUT method can be used to stop the API requester
curl -X PUT --user Fred:fredpwd --insecure
https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters/mqapi_1.0.0?status=stopped
And the cURL command with a DELETE method can be used to delete the API requester.
curl -X DELETE --user Fred:fredpwd --insecure
https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters/mqapi_1.0.0
otherwise the redeployment of the ARA file will fail.

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___3. The z/OS Connect server where the API requester will be installed has the configuration below in its server.xml file.

```
<server description="API Requester">
   <!-- Enable features -->
   <featureManager>
       <feature>zosconnect:apiRequester-1.0</feature>
   </featureManager>

 <zosconnect_endpointConnection id="mqapi"          1
        host="http://wg31.washington.ibm.com"
        port="9120"
        basicAuthRef="myBasicAuth"
        connectionTimeout="10s"
        receiveTimeout="20s" />

 <zosconnect_authData id="myBasicAuth"          2
        user="Fred"
        password="fredpwd" />

</server>
```

1. Identifies the system which hosts the target API as well as any security information and time out parameters. Note that the ID of this element matches the value *connectionRef* property used when the ARA was generated by the z/OS Connect build toolkit.
2. The target server uses basic authentication, so we are simply provided a user identity and password. The password can be encrypted and/or TLS can be used for security.

Tech-Tip: The host and port in the *endpointConnection* element specifies the host and port of the target API provider. Normally the z/OS Connect server performs the conversion of the COBOL data structure to JSON and then acts as a JSON REST client to the target API provider. In this exercise the target API provider is the same z/OS Connect server. This is why this host and port is also used by the batch API requester client in its environment variables.

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Move the COBOL copy books to a MVS data set

Next make the generated COBOL copy books available for including into the COBOL program.

The generated COBOL copy books need in an MVS data set which is included in the compiler's SYSLIB. concatenation sequence, e.g., data set *USER1.ZCEE. SOURCE*. But first, the generated copybooks need to be moved to MVS. There are various methods for moving the files to MVS. In this case, we are using the cURL command.

___1. Open a DOS command prompt and use the change directory command to go to directory C:\z\apiRequester\fileaqueue\syslib, e.g., ***cd \z\apiRequester\mqapi\syslib***

___2. Start a file transfer session for the MQ000I01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T MQ000I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___3. Start a file transfer session for the MQ000P01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T MQ000P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

___4. Start a file transfer session for the MQ001I01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T MQ001I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

Start a file transfer session for the MQ001Q01 copybook with the WG31 host using the *curl* command, e.g.,

curl -T MQ001Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii

The command window should something like what is shown below:

```
C:\z\apiRequester\mqapi\syslib>curl -T MQ000I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   530    0     0  100   530      0   1018 --:--:-- --:--:-- --:--:--  1019

C:\z\apiRequester\mqapi\syslib>curl -T MQ000P01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 10762    0     0  100 10762      0  22593 --:--:-- --:--:-- --:--:-- 22656

C:\z\apiRequester\mqapi\syslib>curl -T MQ001I01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   531    0     0  100   531      0   1014 --:--:-- --:--:-- --:--:--  1015.
C:\z\apiRequester\mqapi\syslib>curl -T MQ001Q01 ftp://wg31.washington.ibm.com --user user1:user1 --use-ascii
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 10738    0     0  100 10738      0  19182 --:--:-- --:--:-- --:--:-- 19209
```

___15. The 4 MVS data sets created by the invoking the curl command need to be copied or moved into the partitioned data set *USER1.ZCEE. SOURCE* with member names that match the original data set names.

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Review the application programs

Now that the copy books have been generated and are available in a data set the next step is compile and link edit the application programs. The source for the application programs are in *USER1.ZCEE. SOURCE*. Member DELMQAPI invokes the DELETE method, member GETMQAPI invokes the GET method and PSTMQAPI invokes the POST method. No changes need to be made to these programs.

> **Tech-Tip:** Data set USER1.ZCEE.SOURCE can be accessed either by using the IBM z/OS Explorer filter or by using the Personal Communication icon on the desktop and logging on to TSO and use ISPF option 3.4 to access this data set. If you have any questions about either method ask the instructor.

___1. Begin by reviewing the application programs MQGET. Browse data set *USER1.ZCEE. SOURCE* and open member MQGET. Scroll down until you see these lines of code.

```
      * Copy API Requester required copybook
       COPY BAQRINFO.

      * Request and Response
       01 PUT-REQUEST.
           10 FILLER              PIC X(1).
       01 PUT-RESPONSE.
           COPY MQ000P01.
      * Structure with the API information
       01 PUT-INFO-OPER1.
           COPY MQ000I01.
```

These lines of code copy into the source the required z/OS Connect copy book (BAQRINFO) and the copy books generated by the z/OS Connect build tool kit. If when you generated the copy book earlier in the exercise and the sequence number used for the GET method was not 02 then you need to change the COBOL source to match sequence generated when you invoke the ZCONBT tool.

___2. Scroll down further and you will the call to the z/OS Connect API requester stub module.

```
      *---------------------------------------------------------------*
      * Call the communication stub                                   *
      *---------------------------------------------------------------*
      * Call the subsystem-supplied stub code to send
      * API request to zCEE
           CALL COMM-STUB-PGM-NAME USING
                BY REFERENCE   PUT-INFO-OPER1
                BY REFERENCE   BAQ-REQUEST-INFO
                BY REFERENCE   BAQ-REQUEST-PTR
                BY REFERENCE   BAQ-REQUEST-LEN
                BY REFERENCE   BAQ-RESPONSE-INFO
                BY REFERENCE   BAQ-RESPONSE-PTR
                BY REFERENCE   BAQ-RESPONSE-LEN.
      * The BAQ-RETURN-CODE field in 'BAQRINFO' indicates whether this
      * API call is successful.
```


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Note that the parameters are being passed by reference. This means that the z/OS Connect API requester stub will have direct access to the program storage for both accessing data and making changes (i.e. the response message).

___3. Scroll down further and you will see the code where the application displays the results in the response message.

```
           IF BAQ-SUCCESS THEN
              DISPLAY "NUMB:    " numb    of PUT-RESPONSE
              DISPLAY "NAME:    " name    of PUT-RESPONSE
              DISPLAY "ADDRX:   " addrx   of PUT-RESPONSE
              DISPLAY "PHONE:   " phone   of PUT-RESPONSE
              DISPLAY "DATEX:   " datex   of PUT-RESPONSE
              DISPLAY "AMOUNT: " amount  of PUT-RESPONSE
              DISPLAY "HTTP CODE: " BAQ-STATUS-CODE
```

___4. Exit member *MQGET* and open member *MQPUT*. The code for this program is very similar to the code for *MQGET* with the exception that all variables are provided in a JSON request message. Scroll down and find the code below.

```
      *-------------------------------------------------------------*
      * Set up the data for the API Requester call                  *
      *-------------------------------------------------------------*
           MOVE 1 to MQMESSAGE2-num.
           MOVE "837367" TO numb2 IN PUT-REQUEST.
           MOVE LENGTH of numb2 in PUT-REQUEST to
               numb2-length IN PUT-REQUEST.

           MOVE "John" TO name2 IN PUT-REQUEST.
           MOVE LENGTH of name2 in PUT-REQUEST to
               name2-length IN PUT-REQUEST.

           MOVE "Apex" TO addrx2 IN PUT-REQUEST.
           MOVE LENGTH of addrx2 in PUT-REQUEST to
               addrx2-length IN PUT-REQUEST.

           MOVE "0065" TO phone2 IN PUT-REQUEST.
           MOVE LENGTH of phone2 in PUT-REQUEST to
               phone2-length IN PUT-REQUEST.

           MOVE "11 22 65" TO datex2 IN PUT-REQUEST.
           MOVE LENGTH of datex2 in PUT-REQUEST to
               datex2-length IN PUT-REQUEST.

           MOVE "$1000.65" TO amount2 IN PUT-REQUEST.
           MOVE LENGTH of amount2 in PUT-REQUEST to
               amount2-length IN PUT-REQUEST.
```

In this case the length of the property value and finally the property value moved to the request copy book.

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Compile and link-edit the application programs

The applications programs now are ready to be compiled and link-edited.

___1. Submit the job in member **APIRMQ** in data set *USER1.ZCEE.CNTL*.

```
//USER1S JOB MSGCLASS=H,NOTIFY=&SYSUID
//* JCLLIB ORDER=SYS1.ECOBOL.SIGYPROC
//COMPILE EXEC IGYWCL,LNGPRFX=SYS1.ECOBOL,PARM.COBOL='NODYNAM'
//COBOL.SYSIN  DD DISP=SHR,DSN=USER1.ZCEE.SOURCE(MQGET)
//COBOL.SYSLIB DD DISP=SHR,DSN=USER1.ZCEE.SOURCE
//             DD DISP=SHR,DSN=ZCEE30.SBAQCOB
//LKED.SYSLMOD DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB(MQGET)
//COMPILE EXEC IGYWCL,LNGPRFX=SYS1.ECOBOL,PARM.COBOL='NODYNAM'
//COBOL.SYSIN  DD DISP=SHR,DSN=USER1.ZCEE.SOURCE(MQPUT)
//COBOL.SYSLIB DD DISP=SHR,DSN=USER1.ZCEE.SOURCE
//             DD DISP=SHR,DSN=ZCEE30.SBAQCOB
//LKED.SYSLMOD DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB(MQPUT)
```

Note that the CALL statement in each of this program uses a variable for the program name z/OS Connect stub program (BAQCSTUB). This means that this program will by dynamically linked at execution. The load module library containing BAQSCTUB (ZCEE30.SBAQLIB) must be available in the STEPLIB concatenation sequence when the program is executed.

The execution of this job should complete with at most a 4-return code.

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Test the API requester application programs

The JCL to execute these programs can be found in USER1.ZCEE.CNTL, the member names in this data set match the program names. The members are DLTMQAPI, GETMQAPI and PSTMQAPI.

___1. Submit the job in member **MQGET** in *USER1.ZCEE.CNTL*.

```
//GETAPI EXEC PGM=MQGET
//STEPLIB  DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB
//         DD DISP=SHR,DSN=ZCEE30.SBAQLIB
//SYSPRINT DD SYSOUT=*
//CEEOPTS  DD *
 POSIX(ON),
 ENVAR("BAQURI=wg31.washington.ibm.com",
 "BAQPORT=9120")
```

___2. The job should complete with a condition of 200 (HTTP success) and have the following output for SYSPRINT.

```
NUMB:   000100
NAME:   S. D. BORMAN
ADDRX:  SURREY, ENGLAND
PHONE:  32156778
DATEX:  26 11 81
AMOUNT: $0100.11
HTTP CODE: 0000000200
```

Tech-Tip: An HTTP code of 200 indicates success. For an explanation of HTTP codes see URL https://en.wikipedia.org/wiki/List_of_HTTP_status_codes

___3. Member **MQPUT** in *USER.ZCEE.CNTL* will invokes a POST HTTP method which will put a message on the queue. Submit this job for execution and observe the results. The POST method for this API does not return a response message.

```
HTTP CODE: 0000000204
```

Tech-Tip: An HTTP code of 204 indicates that the server processed the request and is not returning any content. For an explanation of HTTP codes see URL https://en.wikipedia.org/wiki/List_of_HTTP_status_codes

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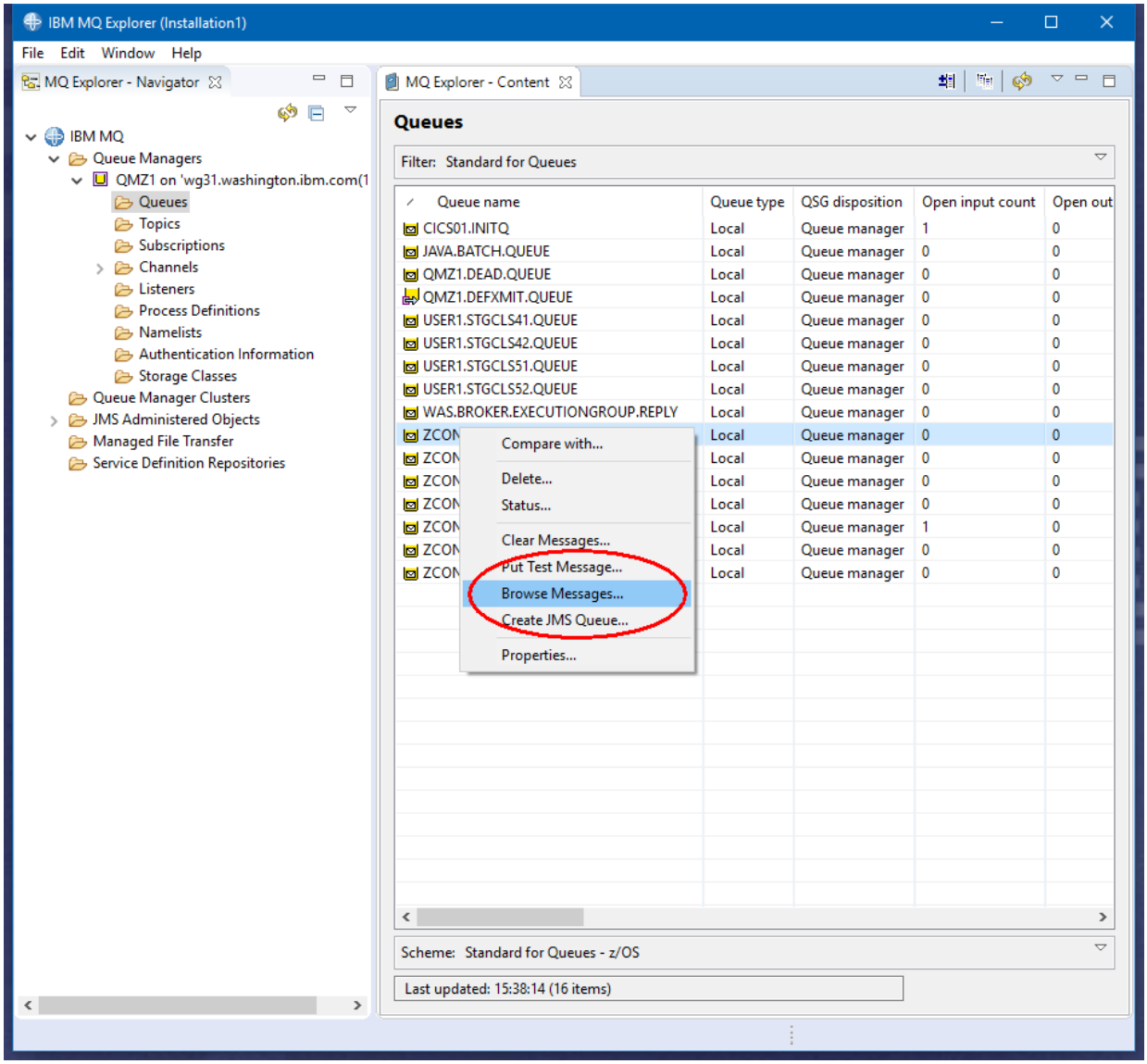
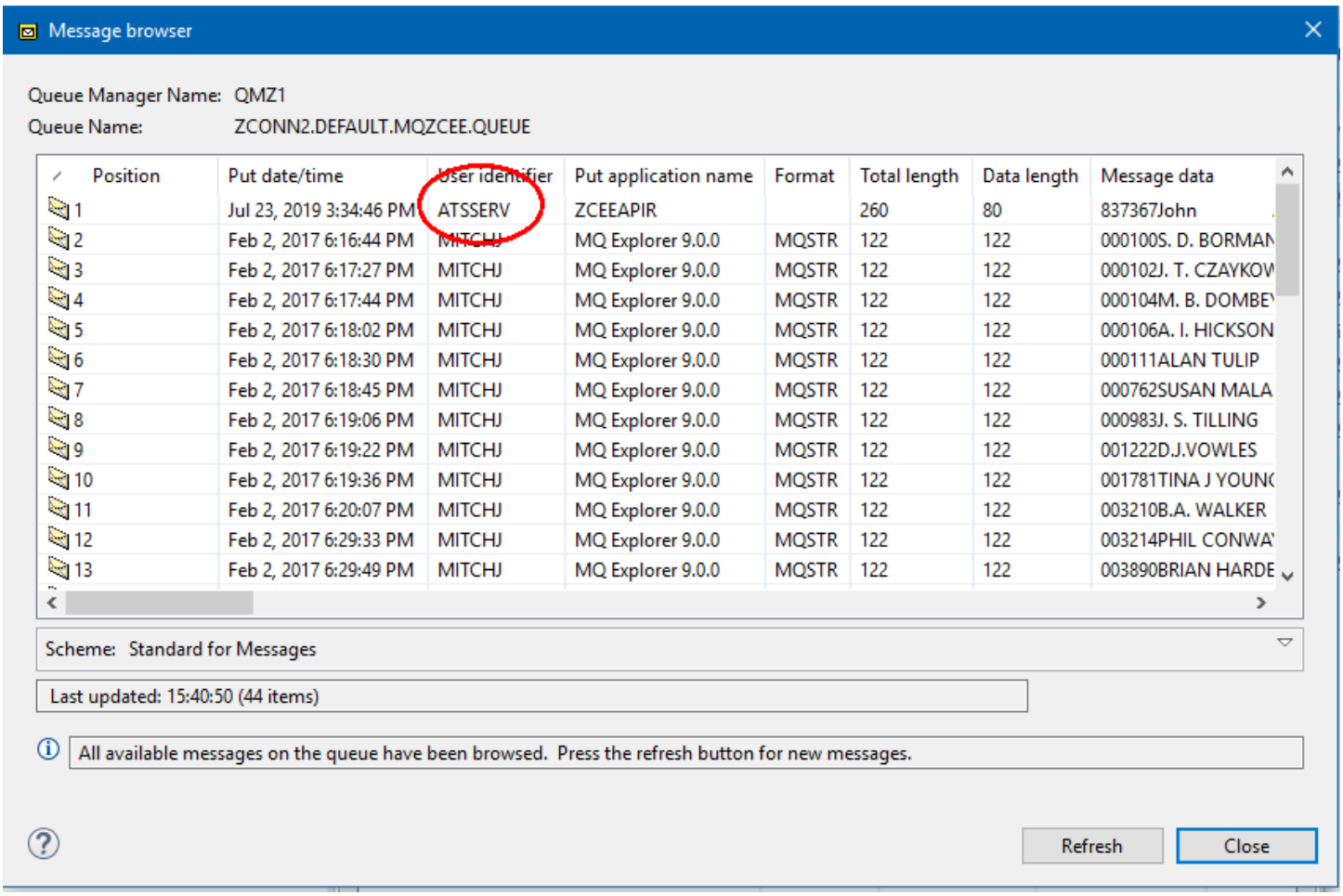
___4. Confirm by opening the *MQExplorer* icon on the desktop and browsing the messages in the *ZCONN2.DEFAULT.MQZCEE.QUEUE* queue.

- Select *QMZ1* under **Queue Managers** and right mouse button click
- Select the *Connect* option.
- Once connected, expand the *Queues* folder and select *ZCONN2.DEFAULT.MQZEE.QUEUE* and right mouse button click and select the *Browse Messages* option.



___5. Your see a list of the messages currently in the queue, something like the list below:



Summary

You have use the z/OS Connect build toolkit to generate an API requester archive file and the COBOL copy books that must be included in the COBOL application program when accessing the API requester archive file in a z/OS Connect server. The COBOL applications have been compiled and link edited, and the target API has been tested using various RESTful methods.

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