



# IBM z/OS Connect Enterprise Edition

## Introduction and Overview

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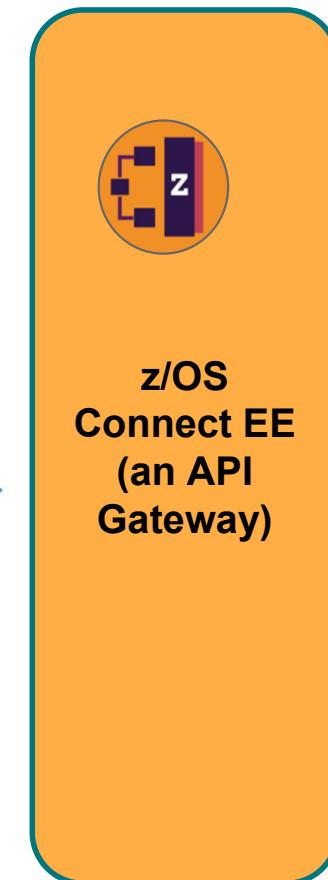


# Agenda

- An Introduction and Overview of using REST API
- Enabling RESTful API to various z/OS resources, e.g.
  - CICS
  - Db2
  - IMS/TM
  - IMS/DB
  - MQ
  - MVS Batch
  - Outbound REST APIs
  - IBM DVM
  - Host Access Transformation Services (3270 screen-based applications)
  - IBM File Manager
- Accessing RESTful API from z/OS COBOL Applications
- A brief overview of z/OS Connect Security\*

\*For more on security, contact your local IBM rep regarding the schedule of workshop *zOSSEC1 IBM z/OS Connect Administration/Security Wildfire Workshop*  
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# **z/OS Connect EE exposes z/OS resources to the “cloud” via RESTful APIs**



**z/OS Connect EE**

CICS

IMS/TM

IMS/DB

Db2

MQ

IBM File Manager<sup>+</sup>

HATS(3270)

IBM DVM<sup>+</sup>

MVS

WAS

Custom\*

+ HCL and Rocket Software

\*Other Vendors or your own implementation

# **/but\_first, what\_is\_REST?**

What makes an API “RESTful”?

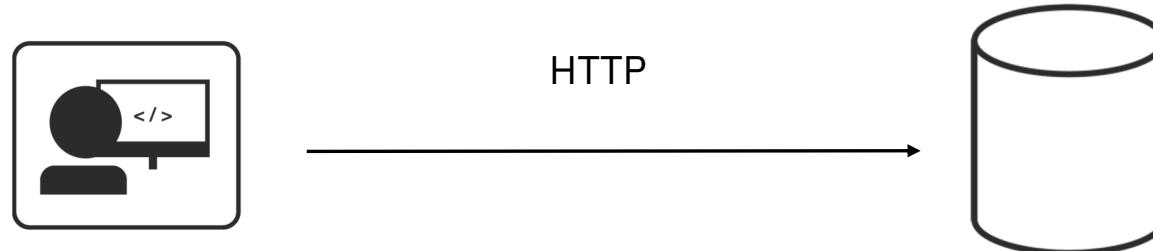
# REST is architectural programming style

**REST** stands for **R**epresentational **S**tate **T**ransfer.

An architectural programming style for **accessing** and **updating** data over the internet.

Typically using HTTP... but not all HTTP interfaces are “RESTful”.

Simple and intuitive for the end consumer (**the developer**).



Roy Fielding defined REST in his 2000 PhD dissertation "Architectural Styles and the Design of Network-based Software Architectures" at UC Irvine. He developed the REST architectural style in parallel with HTTP 1.1 of 1996-1999, based on the existing design of HTTP 1.0 of 1996.

# Key Principles of REST

Use HTTP verbs for Create, Read, Update, Delete (CRUD) operations

POST  
GET  
PUT  
DELETE

`http://<host>:<port>/path/parameter?name=value&name=value`

Use Path and Query parameters to refine the request

URI path identifies a resource (or lists of resources)

URL identifies the protocol, host and port and includes the URI Path

Request/Response Body is used to represent the data object

```
GET http://www.acme.com/customers/12345?personalDetails=true
RESPONSE: HTTP 200 OK
BODY { "id" : 12345
      "name" : "Joe Bloggs",
      "address" : "10 Old Street",
      "tel" : "01234 123456",
      "dateOfBirth" : "01/01/1980",
      "maritalStatus" : "married",
      "partner" : "http://www.acme.com/customers/12346" }
```



# REST vs RESTful

REST is an architectural style of development having these principles plus..

- It should be stateless (transaction management should be managed by the client)
- It should access and/or identify all server resources using only a single URI
- For performing CRUD operations, it should use HTTP verbs such as get, post, put and delete
- It should return the result only in the form of consistent and simple JSON

When an API follows these basic principles, it is considered a RESTful API, whereas a REST API only follows some but not all the above principles

- Remember - Not all REST APIs are RESTful APIs
- The key is consistency, RESTful APIs are consistent with these basic principles, REST APIs are not

# RESTful Examples



z/OS Connect EE

**POST** /account/ +  (*a JSON request message with Fred's information*)

**GET** /account?number=1234

**PUT** /account/1234 +  (*a JSON request message with dollar amount of deposit*)

HTTP Verb conveys the method against the resources; i.e., POST is for create, GET is for balance, etc.

URI conveys the resource to be acted upon; i.e., Fred's account with number 1234

The JSON body carries the specific data for the action (verb) against the resource (URI)

REST APIs are increasingly popular as an integration pattern because it is stateless, relatively lightweight, is relatively easy to program

<https://martinfowler.com/articles/richardsonMaturityModel.html>

# Not every REST API is a RESTful API

(How to know if an API is not RESTful)

## 1. Different URIs with the same method for operations on the same object

POST http://www.acme.com/customers/**GetCustomerDetails**/12345

POST http://www.acme.com/customers/**UpdateCustomerAddress**/12345?**address=**

## 2. Different representations of the same objects between request and response messages

POST http://www.acme.com/customers  
BODY { "firstName": "Joe",  
 "lastName" : "Bloggs",  
 "addr" : "10 Old Street",  
 "phoneNo" : "01234 0123456" }



RESPONSE HTTP 201 CREATED  
BODY { "id" : "12345",  
 "name" : "Joe Bloggs",  
 "address" : "10 New Street"  
 "tel" : "01234 0123456" }

## 3. Operational data (update, etc.) embedded in the request body

POST http://www.acme.com/customers/12345  
BODY { "updateField": "address",  
 "newValue" : "10 New Street" }



RESPONSE HTTP 200 OK  
BODY { "id" : "12345",  
 "name" : "Joe Bloggs",  
 "address" : "10 New Street"  
 "tel" : "01234 123456" }

# Why is REST popular?

<b>Ubiquitous Foundation</b>	It's based on HTTP, which operates on TCP/IP, which is a ubiquitous networking topology.
<b>Relatively Lightweight</b>	Compared to other technologies (for example, SOAP/WSDL), the REST/JSON pattern is relatively light protocol and data model, which maps well to resource-limited devices.
<b>Relatively Easy Development</b>	Since the REST interface is so simple, developing the client involves very few things: an understanding of the URI requirements (path, parameters) and any JSON data schema.
<b>Increasingly Common</b>	REST/JSON is becoming more and more a de facto "standard" for exposing APIs and Microservices. As more adopt the integration pattern, the more others become interested.
<b>Stateless</b>	REST is by definition a stateless protocol, which implies greater simplicity in topology design. There's no need to maintain, replicate or route based on state.

# **How do we describe a REST API?**



## **/swagger/open\_api**

The industry standard framework for describing RESTful APIs is by a  
Swagger document

# Why use Swagger?

It is more than just an API framework



There are a number of tools available to aid consumption:

## Consume Swagger\*

**Swagger Codegen** create stub code to consume APIs from various languages



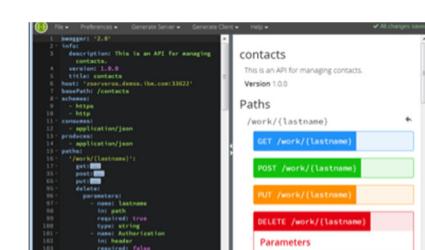
## Read Swagger<sup>+</sup>

**Swagger UI** allows API consumers to easily browse and try APIs based on Swagger Doc.



## Write Swagger

**Swagger Editor** allows API developers to design their swagger documents.



\* z/OS Connect API Requester

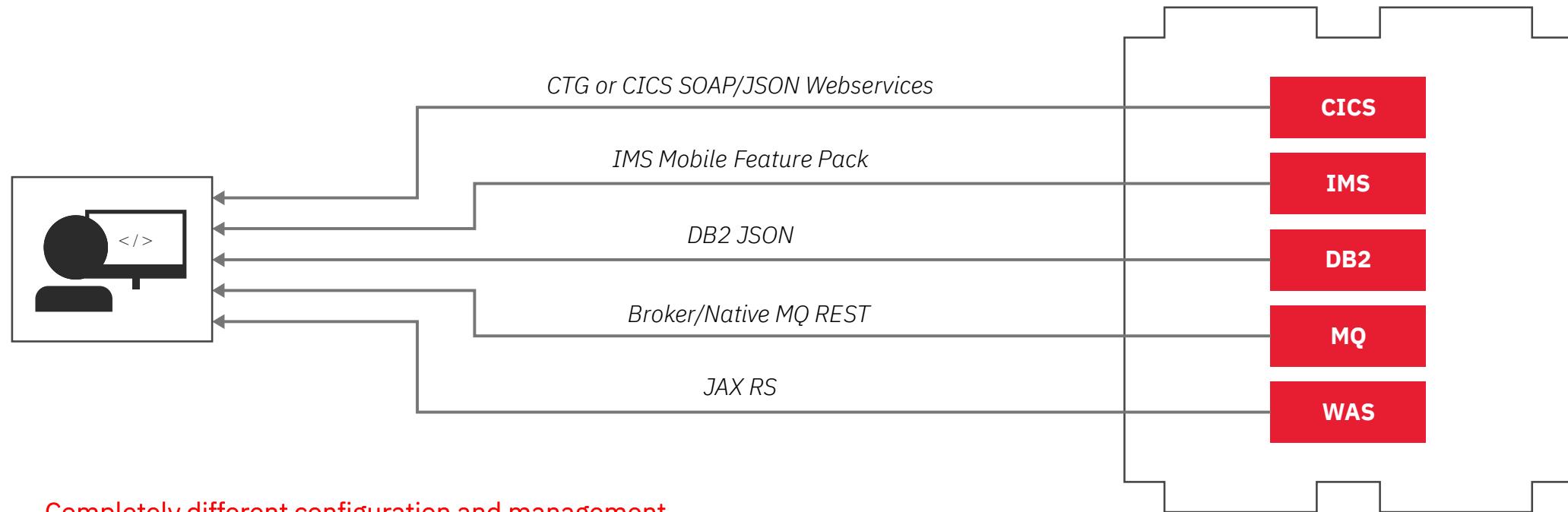
+z/OS Connect, MQ REST support, Zowe



## Why **/zos\_connect\_ee?**

Truly RESTful APIs to and from your mainframe.

# There was support for REST before z/OS Connect but..



Completely different configuration and management.

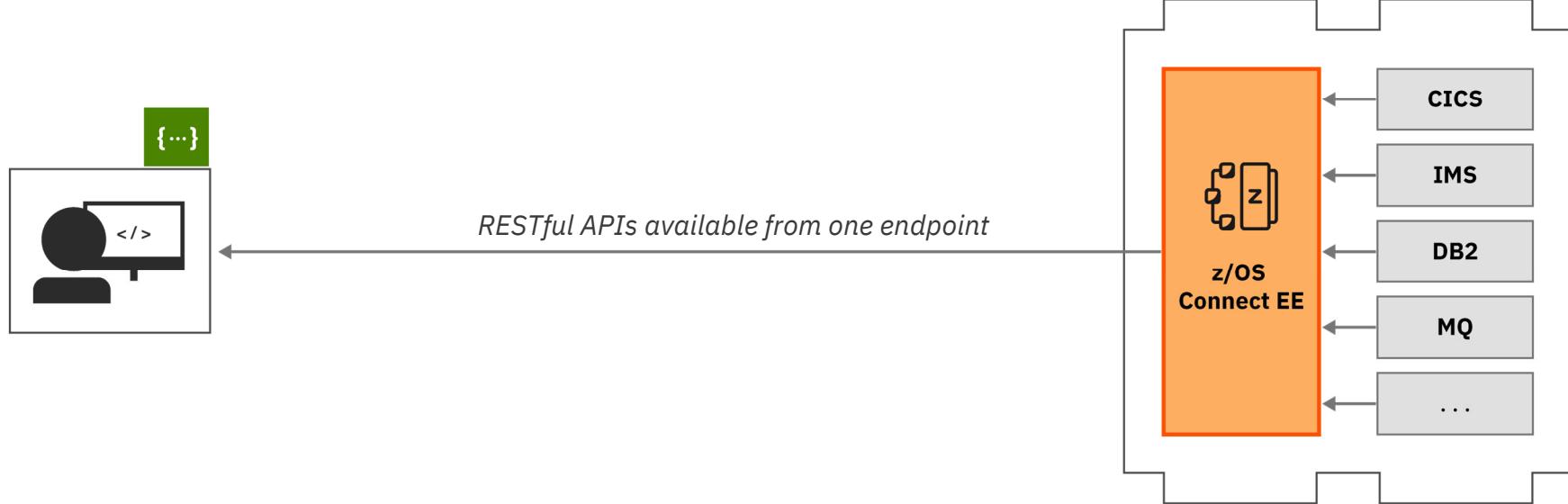
Multiple endpoints for developers to call/maintain access to.

These are typically not RESTful!



# z/OS Connect provides a single-entry point

To expose z/OS resources without writing any code.



## z/OS Connect EE provides

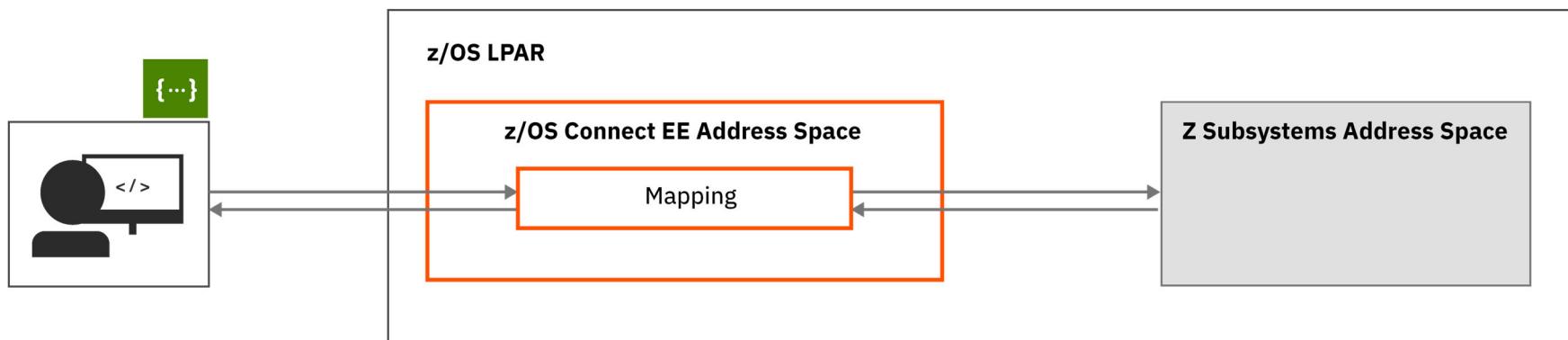
- Single Configuration Administration
- Single Security Administration
- With sophisticated mapping of truly RESTful APIs to existing mainframe and services data without writing any code.



**Other than a RESTful interface,  
what else does z/OS Connect provide?**

# Let's Start with Data mapping

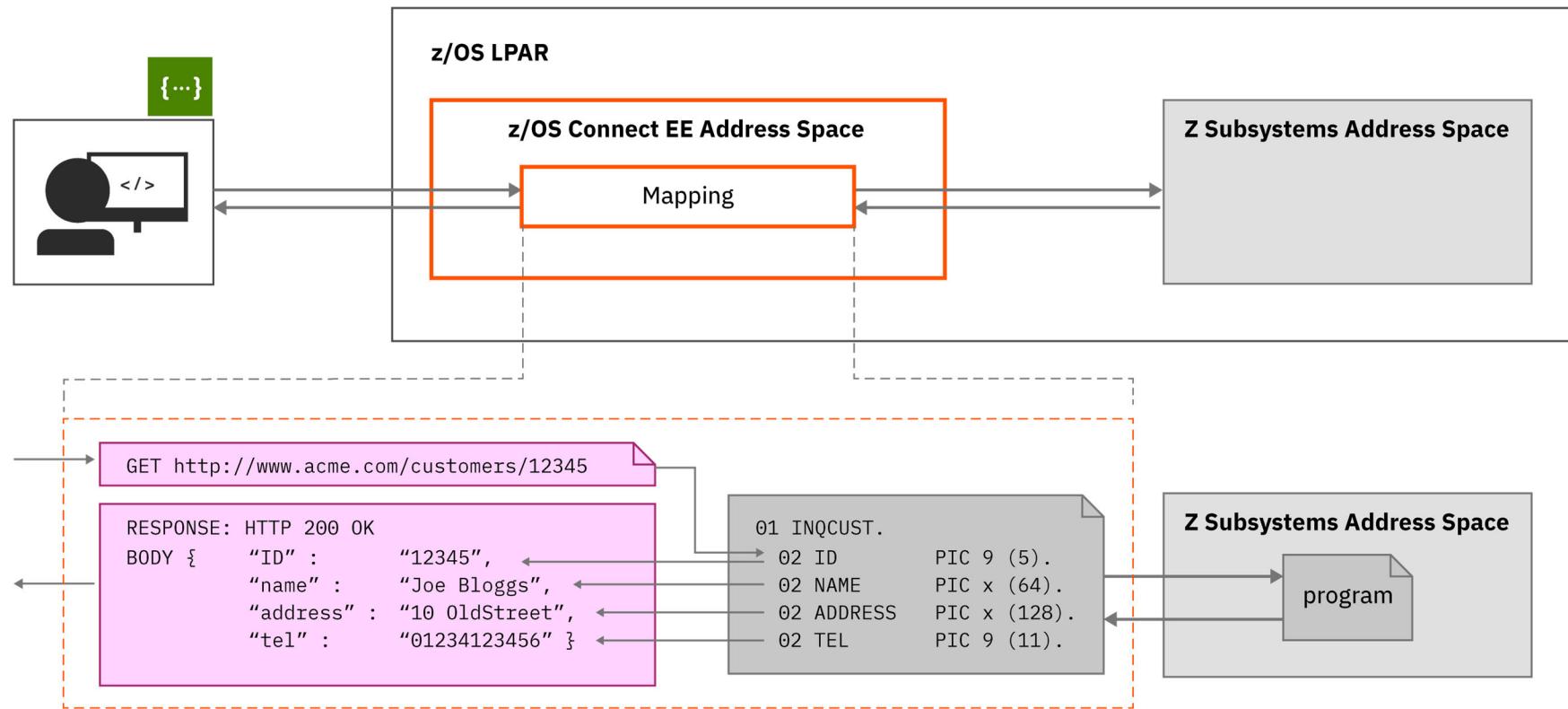
Converting the JSON message to the format the target's subsystem expects\*.



\* Most z/OS subsystems depend on information in a serial data format and do not normally work with JSON request/response messages. Examples of non-JSON formats are CICS COMMAREAAs and CONTAINERS, IMS or MQ messages, or records stored in sequential or VSAM data sets. Data mapping and transformation refers to the process of converting JSON messages to a serialized layout (e.g., sequentially arranged in storage).

# Data mapping Example

A closer look



# Tech-Tip: Behind the curtains, COBOL to JSON schema example



```
01 MINILOAN-COMMAREA.  
 10 name pic X(20).  
 10 creditScore pic 9(16)v99.  
 10 yearlyIncome pic 9(16)v99.  
 10 age pic 9(10).  
 10 amount pic 9999999v99.  
 10 approved pic X.  
     88 BoolValue value 'T'.  
 10 effectDate pic X(8).  
 10 yearlyInterestRate pic S9(5).  
 10 yearlyRepayment pic 9(18).  
 10 messages-Num pic 9(9).  
 10 messages pic X(60) occurs 1 to 10 times  
      depending on messages-Num.
```

```
"MINILOAN_COMMAREA" : {  
    "type" : "object",  
    "properties" : {  
        "NAME" : {  
            "maxLength" : 20,  
            "type" : "string"  
        },  
        "CREDITSCORE" : {  
            "multipleOf" : 0.01,  
            "minimum" : 0,  
            "maximum" : 99999999999999.99,  
            "type" : "number",  
            "format" : "decimal"  
        },  
    }  
},
```

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>  
<ns2:message xmlns:ns2="http://www.ibm.com/ims/Transaction" transactionCode="" messageName="miniloanRequest" direction="0" serviceType="0">  
    <message id="1" name="miniloanRequest">  
        <segment id="1" name="COMMAREA" originalName="COMMAREA" included="Y" path="MINILOAN_COMMAREA">  
            <field name="NAME" originalName="NAME" included="Y" path="MINILOAN_COMMAREA.NAME">  
                <startPos>1</startPos>  
                <bytes>736</bytes>  
                <maxBytes>0</maxBytes>  
                <applicationDatatype datatype="STRUCT"/>  
                <field name="NAME" originalName="NAME" included="Y" path="MINILOAN_COMMAREA.NAME">  
                    <startPos></startPos>  
                    <bytes>20</bytes>  
                    <maxBytes>20</maxBytes>  
                    <applicationDatatype datatype="CHAR"/>  
                </field>  
            <field name="CREDITSCORE" originalName="CREDITSCORE" included="Y" path="MINILOAN_COMMAREA.CREDITSCORE">  
                <startPos>21</startPos>  
                <bytes>18</bytes>  
                <maxBytes>18</maxBytes>  
                <marshaller isSigned="N" isSignLeading="N" isSignSeparate="N" isWCHAROnly="N">  
                    <typeConverter>ZONEDDECIMAL</typeConverter>  
                </marshaller>  
                <applicationDatatype datatype="DECIMAL" precision="18" scale="2"/>  
            </field>
```

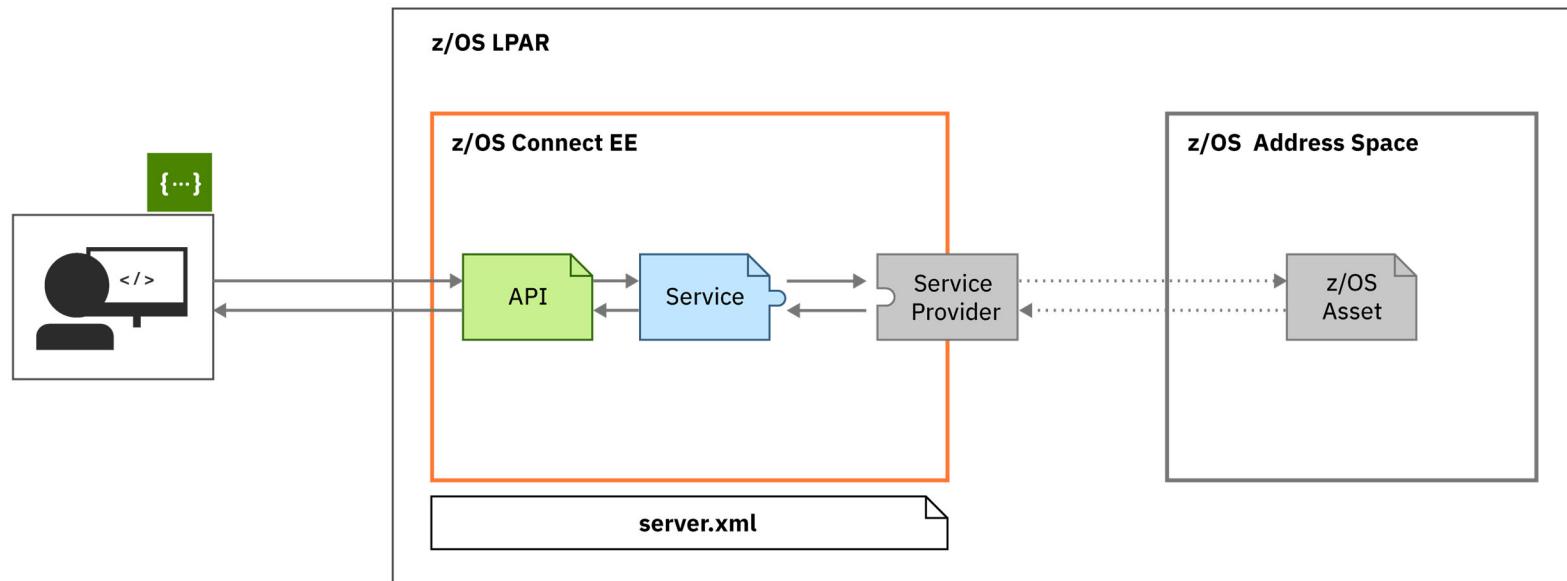
“name”：“Mitch Johnson”,  
“creditScore”：“72000”

All data is sent as character strings,  
removing the big v. little endian and +/-  
issue

[https://www.ibm.com/support/knowledgecenter/en/SSEPEK\\_10.0.0/char/src/tpc/db2z\\_endianness.html](https://www.ibm.com/support/knowledgecenter/en/SSEPEK_10.0.0/char/src/tpc/db2z_endianness.html)

# Steps to expose a z/OS application

z/OS Connect does not use a single monolithic interface – but rather separate plug-and-play components



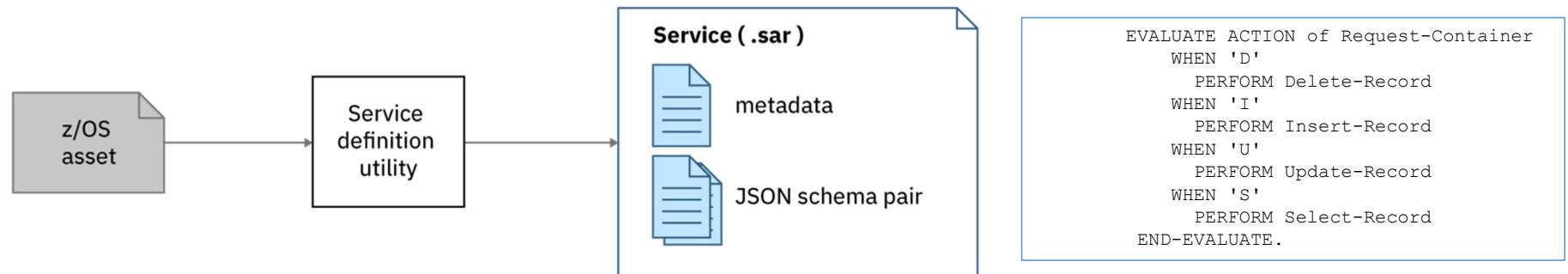
- The API provides the RESTful interface is ready to be consumed by a client and it requires no knowledge that a z/OS resource is being accessed
- The Service provides meta data specific to the z/OS Asset (e.g., CICS program, MQ queue manager, etc.)
- The Service Provider is tightly coupled to a specific instance of a resource (e.g., host and port)

# Steps to expose a z/OS application

## 1. Start by creating a service to represent an interaction with the resource

To start mapping an API, z/OS Connect EE needs a representation of the underlying z/OS application: in a **Service Archive file (.sar)**.

The metadata consists of data mapping XML and provider specific configuration information

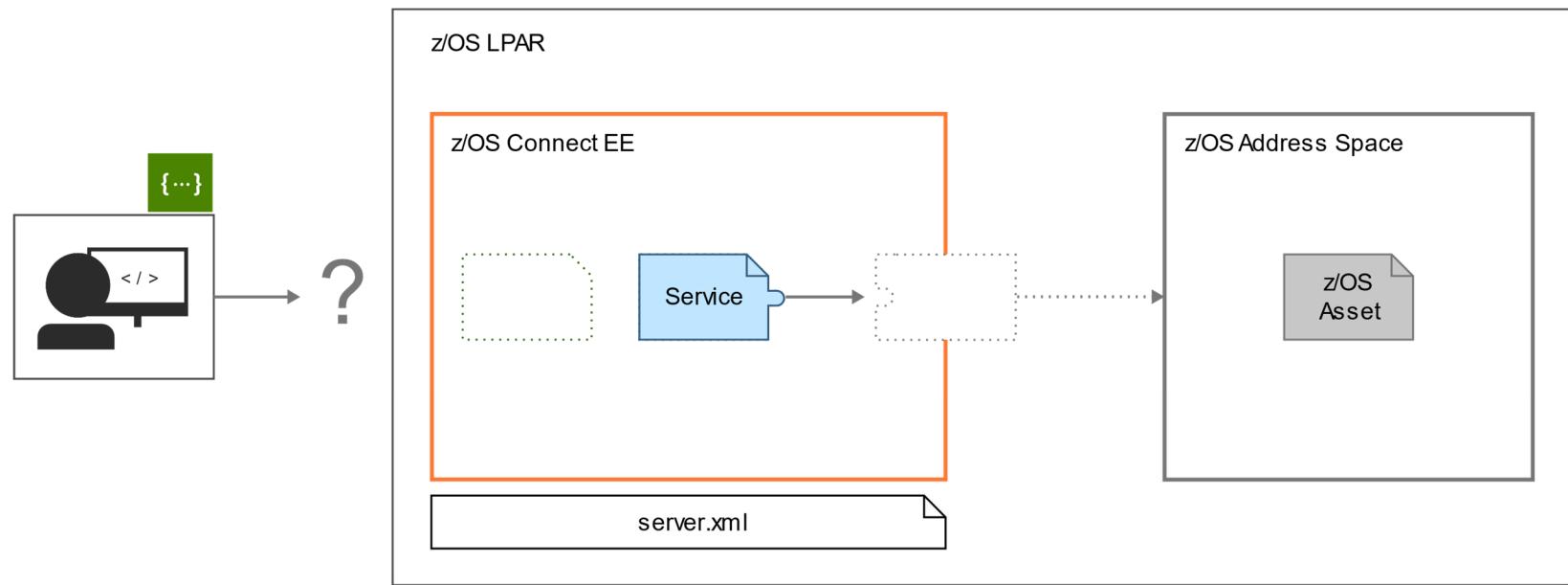


Use a system-appropriate utility to generate a service archive file for the z/OS application

- Eclipse based - API Toolkit (CICS, IMS TM, IMS DB, Db2 and MQ)
- Command line - z/OS Connect EE Build Toolkit (MVS Batch, IBM File Manager and HATS)
- Eclipse based - DVM Toolkit

# Steps to expose a z/OS application

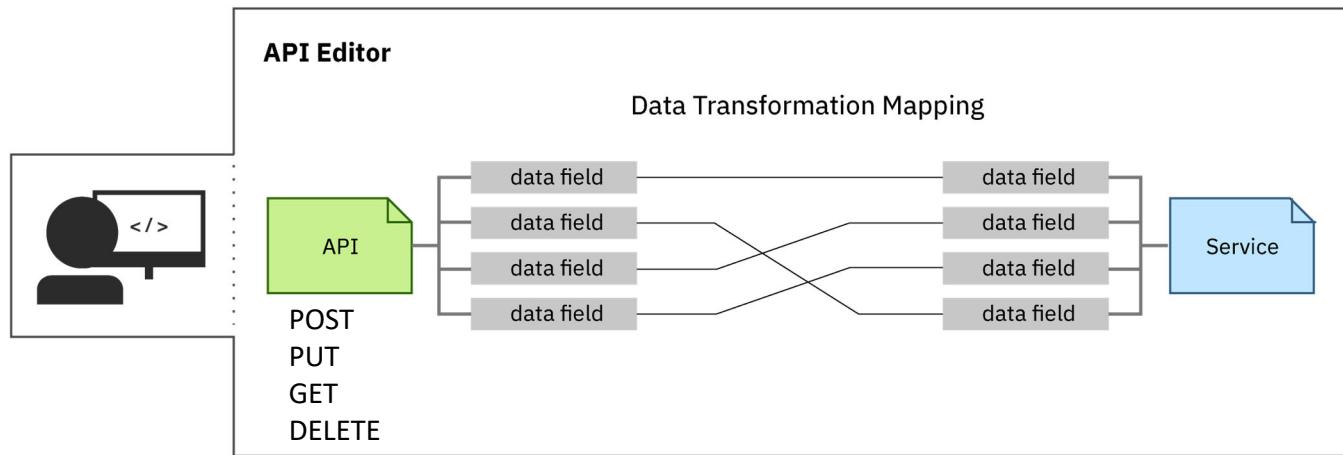
## 2. Deploy and export the service



Deploy the service archive file generated in **Step 1** using the right-click deploy in **the API toolkit**.

# Steps to expose a z/OS application

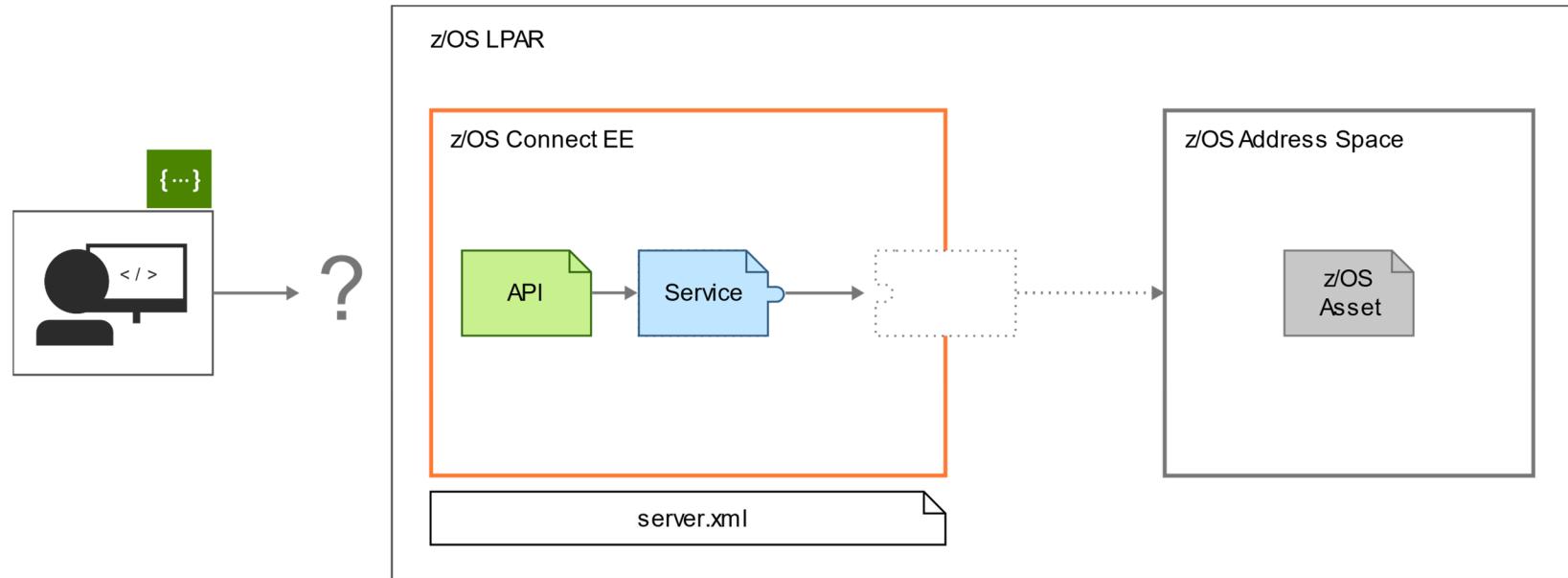
3. Export the service and then import it to create an API that consumes the service



- Import the service archive file into the **API toolkit** and start designing the RESTful API.
- Provides additional data mapping
- Use the editor to describe the API and how it maps to underlying services.

# Steps to expose a z/OS application

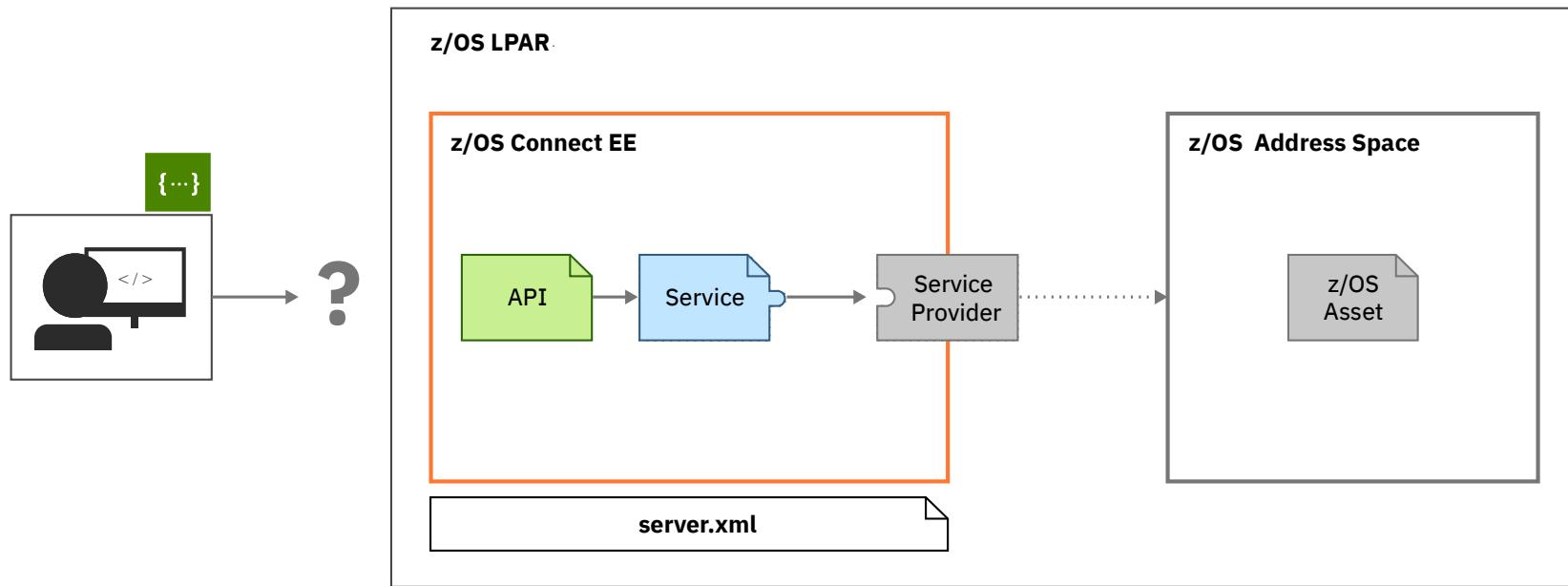
## 4. Deploy the API



Deploy your API using the right-click deploy in **the API toolkit**

# Steps to expose a z/OS application

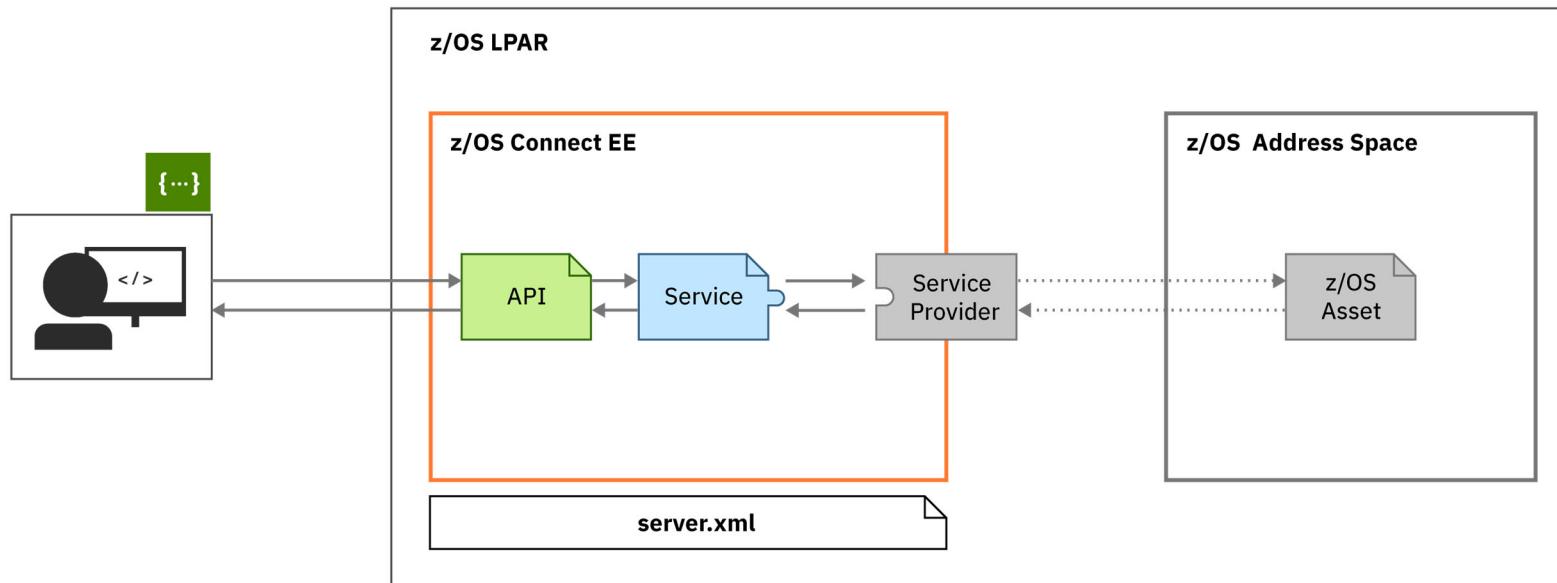
## 5. Configure the service provider



Configure the system-appropriate service provider to connect to your backend system in your `server.xml`.

# Steps to expose a z/OS application

## 6. Done



- The API is ready to be consumed and requires no knowledge that a z/OS resource is being accessed
- The Service provides meta data specific to the z/OS Asset (e.g., CICS program, MQ queue manager, etc.)
- The Service Provider is tightly coupled to a specific instance of a resource (e.g., host and port, security)

# Results: the client code is totally unaware of the z/OS infrastructure



z/OS Connect EE

**CICS**

```

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    // Invoke the REST API using a GET method
    URL url = new URL("https://wg31.washington.ibm.com:9453/cscvinc/employee/" + args[1]);
    System.out.println("URL: " + url);
    HttpsURLConnection conn = (HttpsURLConnection) url.openConnection();
    conn.setRequestMethod("GET");
    conn.setRequestProperty("Content-Type", "application/json");
    byte[] bytesEncoded = Base64.encodeBase64(args[0].getBytes());
    conn.addRequestProperty("Authorization", "Basic " + new String(bytesEncoded));
    try {
        if (conn.getResponseCode() != 200) {
            throw new RuntimeException("Failed : HTTP error code : " + conn.getResponseCode());
        }
        BufferedReader bufferReader = new BufferedReader(new InputStreamReader((conn.getInputStream())));
        while ((output = bufferReader.readLine()) != null) {
            System.out.println(output);
        }
    } catch (Exception e) {
        e.printStackTrace();
    }
}

```

Problems @ Javadoc Declaration Console Coverage

<terminated> ZceeCICSGet [Java Application] C:\Program Files\IBM\Java80\jre\bin\javaw.exe (May 7, 2021, 2:54:24 PM)

URL: https://wg31.washington.ibm.com:9453/cscvinc/employee/22222

USERID: CICSUMER  
CEIBRESP0: 0  
CEIBRESP2: 0  
name: DR E. GRIFFITHS  
employeeNumber: 22222  
amount: \$0022.00  
address: FRANKFURT, GERMANY  
phoneNumber: 20034151  
date: 26 11 81  
Response Message: {"cscvincSelectServiceOperationResponse": {"cscvincContainer": {"response": {"CEIBRESP0": "0", "USERID": "CICSUMER", "CEIBRESP2": "0", "name": "DR E. GRIFFITHS", "employeeNumber": "22222", "amount": "\$0022.00", "address": "FRANKFURT, GERMANY", "phoneNumber": "20034151", "date": "26 11 81"}}}

**Db2**

```

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    // Invoke the REST API using a GET method
    URL url = new URL("https://wg31.washington.ibm.com:9453/db2/employee/" + args[1]);
    System.out.println("URL: " + url);
    HttpsURLConnection conn = (HttpsURLConnection) url.openConnection();
    conn.setRequestMethod("GET");
    conn.setRequestProperty("Content-Type", "application/json");
    byte[] bytesEncoded = Base64.encodeBase64(args[0].getBytes());
    conn.addRequestProperty("Authorization", "Basic " + new String(bytesEncoded));
    try {
        if (conn.getResponseCode() != 200) {
            throw new RuntimeException("Failed : HTTP error code : " + conn.getResponseCode());
        }
        BufferedReader bufferReader = new BufferedReader(new InputStreamReader((conn.getInputStream())));
        while ((output = bufferReader.readLine()) != null) {
            System.out.println(output);
        }
    } catch (Exception e) {
        e.printStackTrace();
    }
}

```

Problems @ Javadoc Declaration Console Coverage

<terminated> ZceeDb2Get [Java Application] C:\Program Files\IBM\Java80\jre\bin\javaw.exe (May 7, 2021, 2:56:06 PM)

URL: https://wg31.washington.ibm.com:9453/db2/employee/000010

Employee Number: 000010  
First Name : CHRISTINE  
Last Name: HAAS  
Middle Initial: I  
Phone Number: 3200

**IMS**

```

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    URL url = new URL("https://wg31.washington.ibm.com:9453/phonebook/contacts/" + args[1]);
    System.out.println("URL: " + url);
    HttpURLConnection conn = (HttpURLConnection) url.openConnection();
    conn.setRequestMethod("GET");
    conn.setRequestProperty("Content-Type", "application/json");
    byte[] bytesEncoded = Base64.encodeBase64(args[0].getBytes());
    conn.addRequestProperty("Authorization", "Basic " + new String(bytesEncoded));
    try {
        if (conn.getResponseCode() != 200) {
            throw new RuntimeException("Failed : HTTP error code : " + conn.getResponseCode());
        }
        BufferedReader bufferReader = new BufferedReader(new InputStreamReader((conn.getInputStream())));
        while ((output = bufferReader.readLine()) != null) {
            System.out.println(output);
        }
    } catch (Exception e) {
        e.printStackTrace();
    }
}

```

Problems @ Javadoc Declaration Console Coverage

<terminated> ZceeIMSGet [Java Application] C:\Program Files\IBM\Java80\jre\bin\javaw.exe (May 7, 2021, 8:48:25 AM)

URL: https://wg31.washington.ibm.com:9453/phonebook/contacts/LAST1

lastName: LAST1  
firstName: FIRST1  
zipCode: D01/R01  
extension: 8-111-1111  
message: ENTRY WAS DISPLAYED  
HTTP code: 200



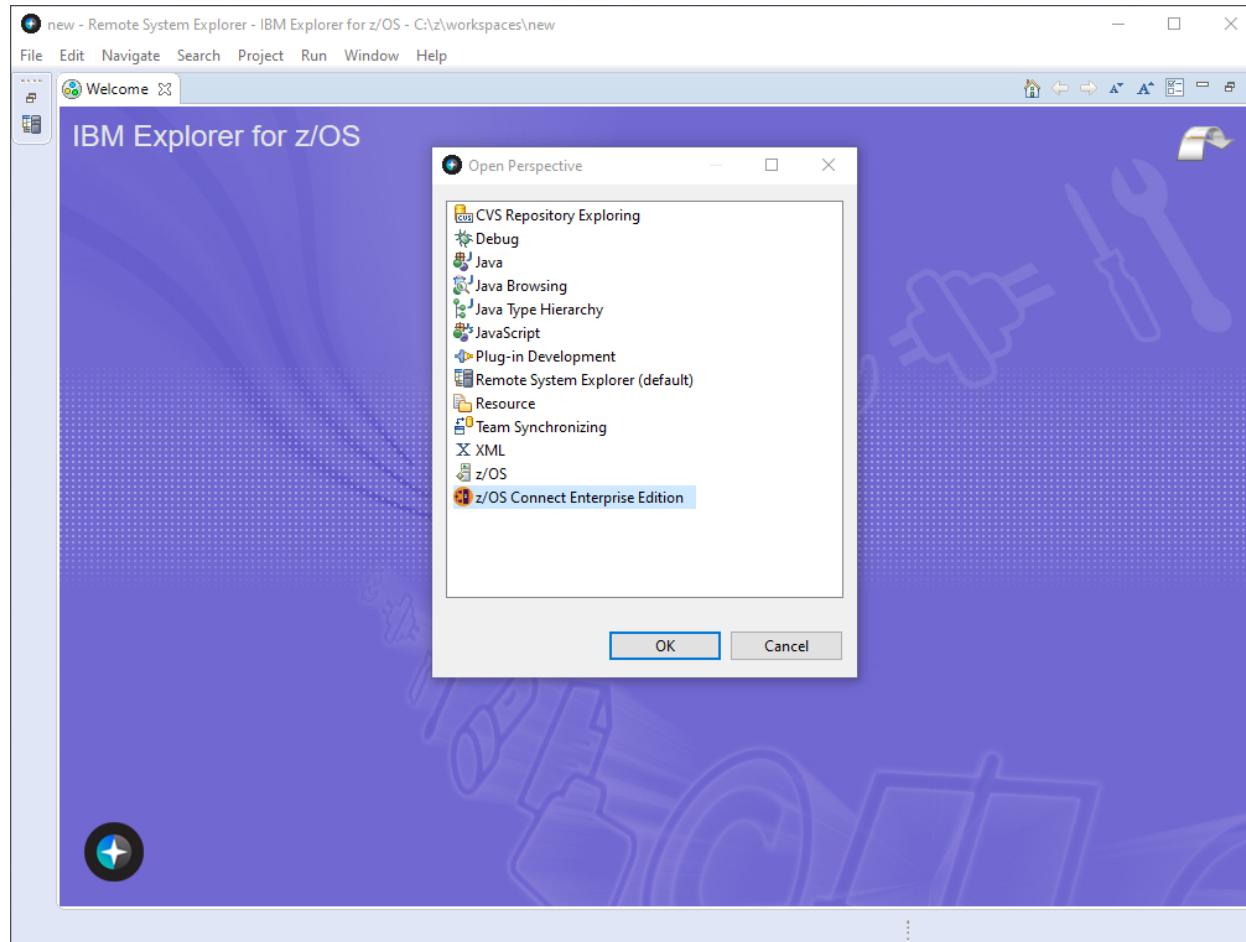
# /api\_toolkit/services

Simple **service creation.**

# Eclipse API toolkit – Creating Services for CICS, IMS TM, IMS DB, Db2 and MQ



z/OS Connect EE



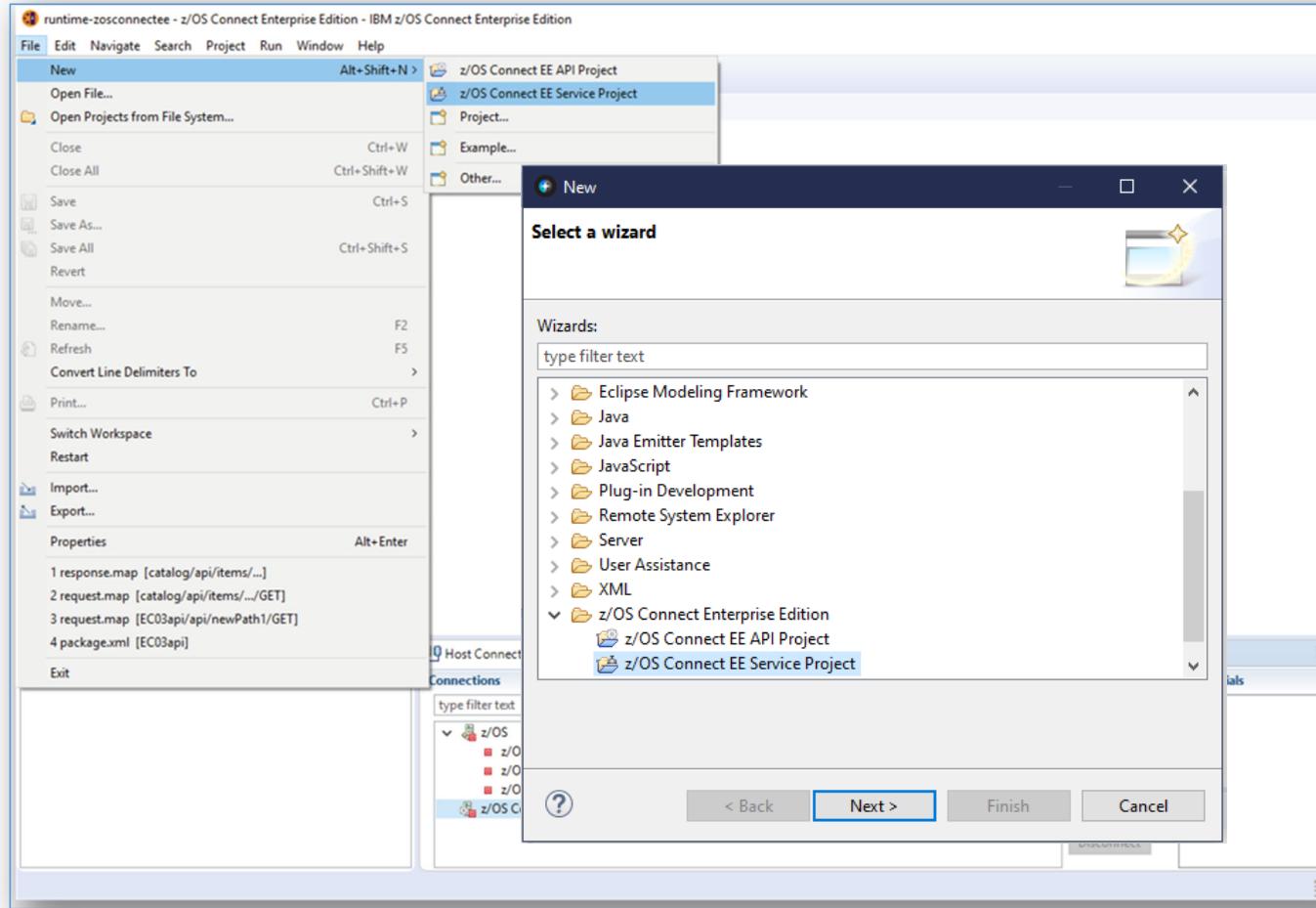
Use the **API toolkit** to create services through Eclipse-based tooling.

The API toolkit is available in the z/OS Connect Enterprise Edition Perspective in an Eclipse environment.

# API toolkit – Creating Services for CICS, IMS TM, IMS DB, Db2 and MQ



z/OS Connect EE

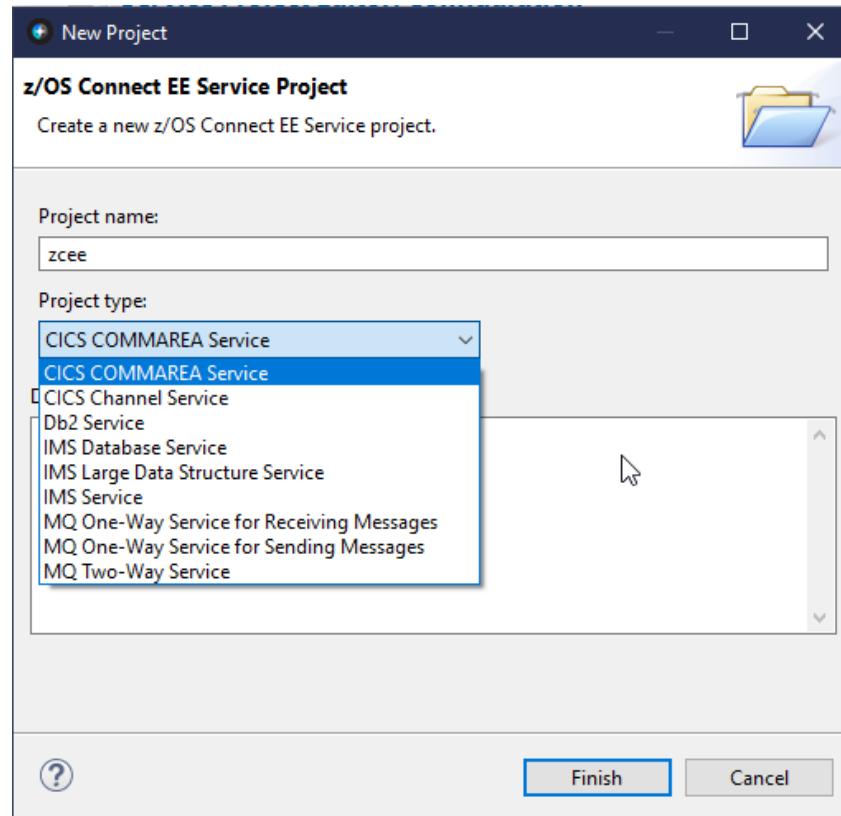


Use the **API toolkit** to create services through Eclipse-based tooling.

Services are described as Eclipse **Projects**, so they can be easily managed in source control.

# API toolkit – Creating Services for CICS, IMS TM, IMS DB, Db2 and MQ

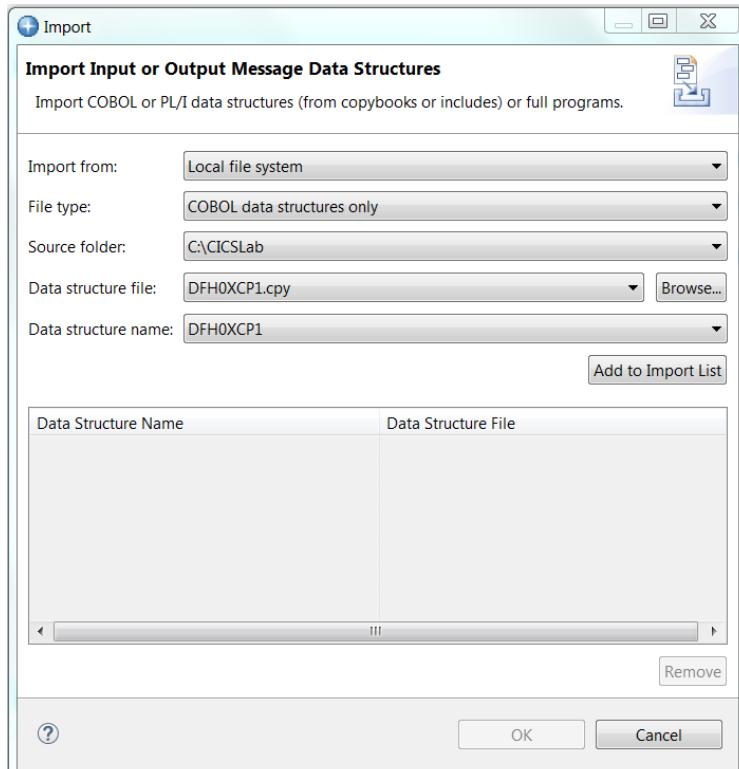
## Service creation – a common interface



A common interface for service creation, irrespective of back-end subsystem.

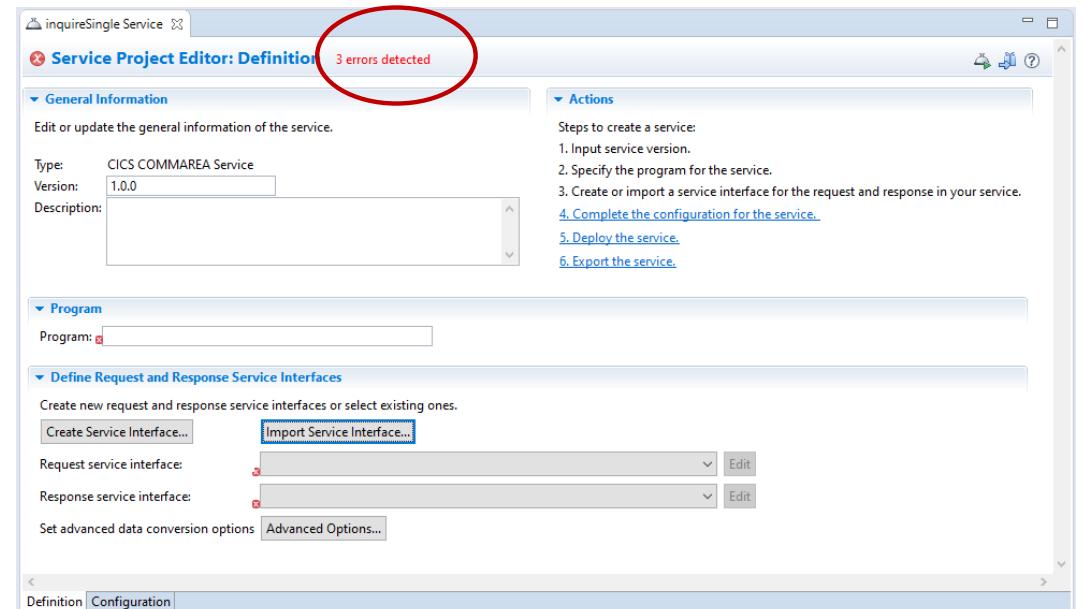
# API toolkit – Creating Services for CICS, IMS TM and MQ

## Creating a service project from source for a COMMAREA, Container or Message



Start by importing data structures into the service interface from the local file system or the workspace to create the request and response service interfaces.

The service interface supports complex data structures, including OCCURS DEPENDING ON and REDEFINES clauses.

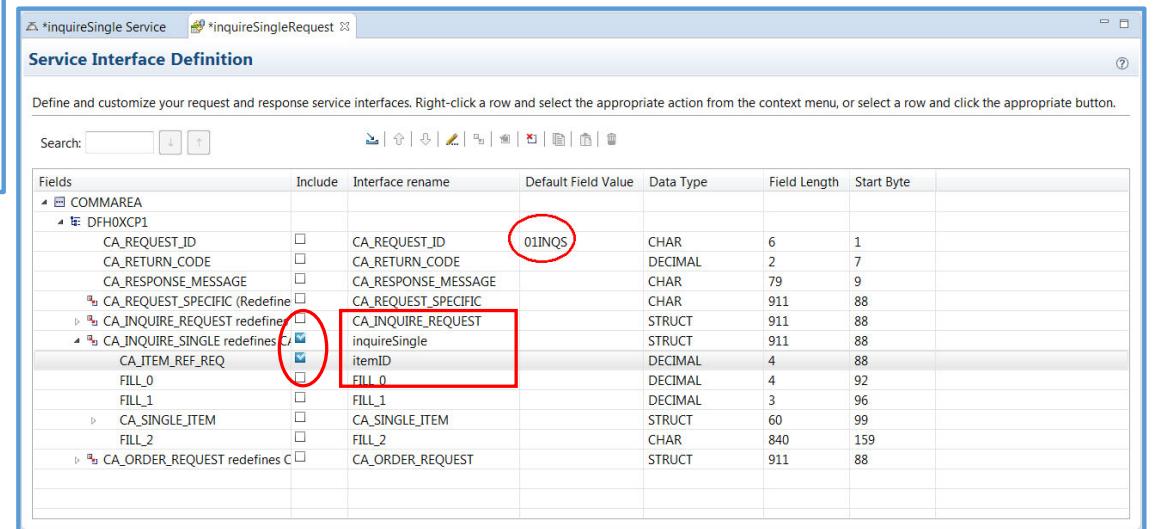


# API toolkit – Creating Services for CICS, IMS TM and MQ

Allows editing a request service interface definition

```
-----*
* Check which operation is being requested
*-----*
* Uppercase the value passed in the Request Id field
  MOVE FUNCTION UPPER-CASE(CA-REQUEST-ID) TO CA-REQUEST-ID
  EVALUATE CA-REQUEST-ID
    WHEN '01INQC'
      Call routine to perform for inquire
      PERFORM CATALOG-INQUIRE
    WHEN '01INQS'
      Call routine to perform for inquire for single item
      PERFORM CATALOG-INQUIRE-SINGLE
    WHEN '01ORDR'
      Call routine to place order
      PERFORM PLACE-ORDER
    WHEN OTHER
      Request is not recognised or supported
      PERFORM REQUEST-NOT-RECOGNISED
  END-EVALUATE
```

See the imported data structure and then can **redact fields, rename fields, and add default values to fields** to make the service more consumable for an API developer.



The screenshot shows a 'Service Interface Definition' window with two tabs: '\*inquireSingle Service' and '\*inquireSingleRequest'. The table below lists fields with various actions available for each row.

Fields	Include	Interface rename	Default Field Value	Data Type	Field Length	Start Byte
COMMAREA						
DFHXCPI						
CA_REQUEST_ID	<input type="checkbox"/>	CA_REQUEST_ID	01INQS	CHAR	6	1
CA_RETURN_CODE	<input type="checkbox"/>	CA_RETURN_CODE		DECIMAL	2	7
CA_RESPONSE_MESSAGE	<input type="checkbox"/>	CA_RESPONSE_MESSAGE		CHAR	79	9
CA_REQUEST_SPECIFIC (Redefine)	<input type="checkbox"/>	CA_REQUEST_SPECIFIC		CHAR	911	88
CA_INQUIRE_REQUEST redefine	<input type="checkbox"/>	CA_INQUIRE_REQUEST		STRUCT	911	88
CA_INQUIRE_SINGLE redefines CA_INQUIRE_REQUEST	<input checked="" type="checkbox"/>	inquireSingle		STRUCT	911	88
CA_ITEM_REF_REQ	<input type="checkbox"/>	itemID		DECIMAL	4	88
FILL_0	<input type="checkbox"/>	FILL_0		DECIMAL	4	92
FILL_1	<input type="checkbox"/>	FILL_1		DECIMAL	3	96
CA_SINGLE_ITEM	<input type="checkbox"/>	CA_SINGLE_ITEM		STRUCT	60	99
FILL_2	<input type="checkbox"/>	FILL_2		CHAR	840	159
CA_ORDER_REQUEST redefines CA_INQUIRE_REQUEST	<input type="checkbox"/>	CA_ORDER_REQUEST		STRUCT	911	88

# API toolkit – Creating Services for CICS, IMS TM, IMS DB and MQ

## And editing a response message service interface definition

\*inquireSingleResponse

**Service Interface Definition**

Define and customize your request and response service interfaces. Right-click a row and select the appropriate action from the context menu, or select a row and click the appropriate button.

Fields	Include	Interface rename	Default Field Value	Data Type	Field Length	Start Byte
COMMAREA	<input type="checkbox"/>					
DFH0XCP1	<input type="checkbox"/>					
CA_REQUEST_ID	<input checked="" type="checkbox"/>	CA_REQUEST_ID		CHAR	6	1
CA_RETURN_CODE	<input checked="" type="checkbox"/>	returnCode		DECIMAL	2	7
CA_RESPONSE_MESSAGE	<input checked="" type="checkbox"/>	responseMessage		CHAR	79	9
CA_REQUEST_SPECIFIC (Redefines CA_INQUIRE_REQUEST)	<input type="checkbox"/>	CA_REQUEST_SPECIFIC		CHAR	911	88
CA_INQUIRE_REQUEST redefines CA_INQUIRE_SINGLE	<input type="checkbox"/>	CA_INQUIRE_REQUEST		STRUCT	911	88
CA_INQUIRE_SINGLE redefines CA_ITEM_REF_REQ	<input checked="" type="checkbox"/>	inquireSingle		STRUCT	911	88
CA_ITEM_REF_REQ	<input type="checkbox"/>	CA_ITEM_REF_REQ		DECIMAL	4	88
FILL_0	<input type="checkbox"/>	FILL_0		DECIMAL	4	92
FILL_1	<input type="checkbox"/>	FILL_1		DECIMAL	3	96
CA_SINGLE_ITEM	<input checked="" type="checkbox"/>	singleItem		STRUCT	60	99
CA_SNGL_ITEM_REF	<input checked="" type="checkbox"/>	itemReference		DECIMAL	4	99
CA_SNGL_DESCRIPTION	<input checked="" type="checkbox"/>	description		CHAR	40	103
CA_SNGL_DEPARTMENT	<input checked="" type="checkbox"/>	department		DECIMAL	3	143
CA_SNGL_COST	<input checked="" type="checkbox"/>	cost		CHAR	6	146
IN_SNGL_STOCK	<input checked="" type="checkbox"/>	inStock		DECIMAL	4	152
ON_SNGL_ORDER	<input checked="" type="checkbox"/>	onOrder		DECIMAL	3	156
FILL_2	<input type="checkbox"/>	FILL_2		CHAR	840	159
CA_ORDER_REQUEST redefines CA_USERID	<input type="checkbox"/>	CA_ORDER_REQUEST		STRUCT	911	88
CA_USERID	<input type="checkbox"/>	CA_USERID		CHAR	8	88
CA_CHARGE_DEPT	<input type="checkbox"/>	CA_CHARGE_DEPT		CHAR	8	96
CA_ITEM_REF_NUMBER	<input type="checkbox"/>	CA_ITEM_REF_NUMBER		DECIMAL	4	104
CA_QUANTITY_REQ	<input type="checkbox"/>	CA_QUANTITY_REQ		DECIMAL	3	108
FILL_3	<input type="checkbox"/>	FILL_3		CHAR	888	111

See the imported data structure and can **redact fields** and **rename fields**



# API toolkit – Creating Services for CICS

Creating multiple services definitions to the same resource

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
Channel		CSCCINCContainer			
@ Container1		REQUEST_CONTAINER	S	CHAR	1
ACTION	<input type="checkbox"/>	ACTION		CHAR	8
USERID	<input type="checkbox"/>	USERID		STRUCT	80
FILEA_AREA	<input checked="" type="checkbox"/>	FILEA_AREA		CHAR	1
STAT	<input type="checkbox"/>	STAT		CHAR	8
NUMB	<input checked="" type="checkbox"/>	NUMB		CHAR	6
NAME	<input type="checkbox"/>	NAME		CHAR	20
ADDRX	<input type="checkbox"/>	ADDRX		CHAR	20
PHONE	<input type="checkbox"/>	PHONE		CHAR	8
DATEX	<input type="checkbox"/>	DATEX		CHAR	8
AMOUNT	<input type="checkbox"/>	AMOUNT		CHAR	8
COMMENT	<input type="checkbox"/>	COMMENT		CHAR	9

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
Channel		cscvincInsertContainer			
@ Container1		REQUEST_CONTAINER	I	CHAR	1
ACTION	<input type="checkbox"/>	ACTION		CHAR	8
USERID	<input type="checkbox"/>	USERID		STRUCT	80
FILEA_AREA	<input checked="" type="checkbox"/>	FILEA_AREA		CHAR	1
STAT	<input checked="" type="checkbox"/>	status		CHAR	6
NUMB	<input checked="" type="checkbox"/>	employeeNumber		CHAR	20
NAME	<input checked="" type="checkbox"/>	employeeName		CHAR	20
ADDRX	<input checked="" type="checkbox"/>	address		CHAR	8
PHONE	<input checked="" type="checkbox"/>	phoneNumber		CHAR	8
DATEX	<input checked="" type="checkbox"/>	startDate		CHAR	8
AMOUNT	<input checked="" type="checkbox"/>	amount		CHAR	8
COMMENT	<input checked="" type="checkbox"/>	comment		CHAR	9

```
EVALUATE ACTION of Request-Container
WHEN 'D'
  PERFORM Delete-Record
WHEN 'I'
  PERFORM Insert-Record
WHEN 'U'
  PERFORM Update-Record
WHEN 'S'
  PERFORM Select-Record
END-EVALUATE.
```

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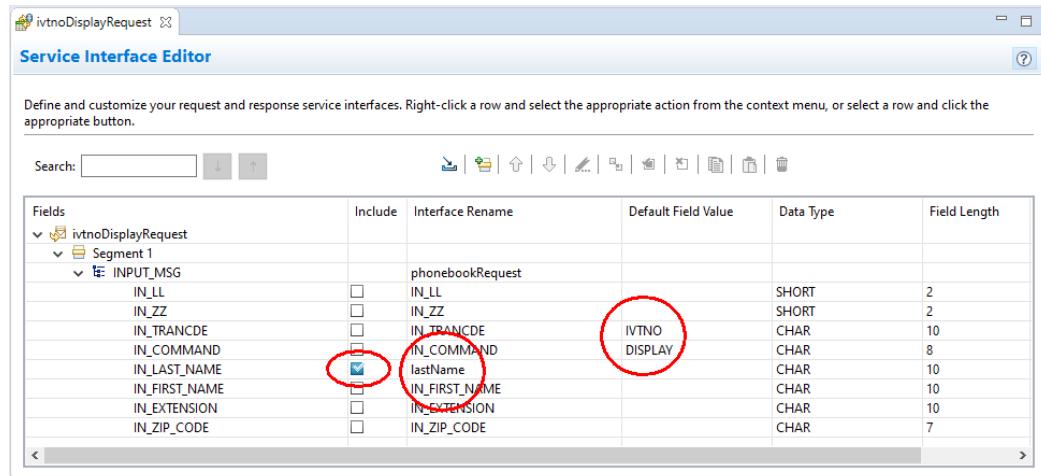
The service developer creates distinct services for each function by setting the ACTION field to S for select, I for insert, U for update or D for delete

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# API toolkit – Creating Services for IMS

## Creating a “GET” service interface request definition

```
*-----*
*      ROUTE TO REQUEST HANDLER
*-----*
SPACE 1
CLC KADD,IOCMD    IF COMMAND ADD ENTERED ?
BE TOADD     ...THEN, GOTO INSERT ENTRY
CLC KUPD,IOCMD    IF COMMAND UPDATE ENTERED ?
BE TOUPD     ...THEN, GOTO UPDATE ENTRY
CLC KDEL,IOCMD    IF COMMAND DEL ENTERED ?
BE TODEL     ...THEN, GOTO DELETE ENTRY
CLC KDIS,IOCMD    IF COMMAND DIS ENTERED ?
BE TODIS     ...THEN, GOTO DISPLAY ENTRY
CLC KTAD,IOCMD    IF TEST ADD WITH REPLY ?
BE TOTAD     ...THEN,
B  INVREQ1   INVALID REQUEST
```

 ivtnoDisplayRequest Service Interface Editor

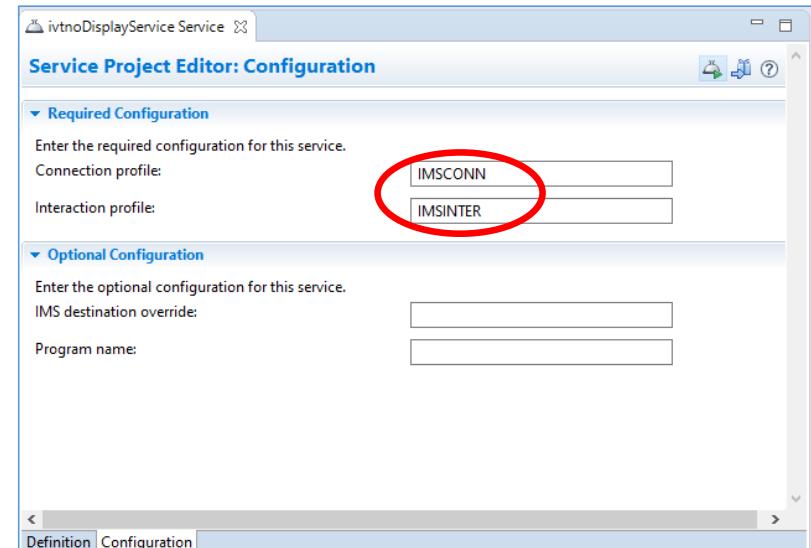
Define and customize your request and response service interfaces. Right-click a row and select the appropriate action from the context menu, or select a row and click the appropriate button.

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
ivtnoDisplayRequest					
Segment 1					
INPUT_MSG		phonebookRequest			
IN_LL	<input type="checkbox"/>	IN_LL		SHORT	2
IN_ZZ	<input type="checkbox"/>	IN_ZZ		SHORT	2
IN_TRANCODE	<input type="checkbox"/>	IN_TRANCODE		CHAR	10
IN_COMMAND	<input checked="" type="checkbox"/>	IN_COMMAND	IVTNO DISPLAY	CHAR	8
IN_LAST_NAME	<input type="checkbox"/>	lastName		CHAR	10
IN_FIRST_NAME	<input type="checkbox"/>	IN_FIRST_NAME		CHAR	10
IN_EXTENSION	<input type="checkbox"/>	IN_EXTENSION		CHAR	10
IN_ZIP_CODE	<input type="checkbox"/>	IN_ZIP_CODE		CHAR	7

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The service developer creates distinct services for each function.

DISPLAY (GET)  
DELETE (DELETE)  
ADD (POST)  
UPDATE (PUT)

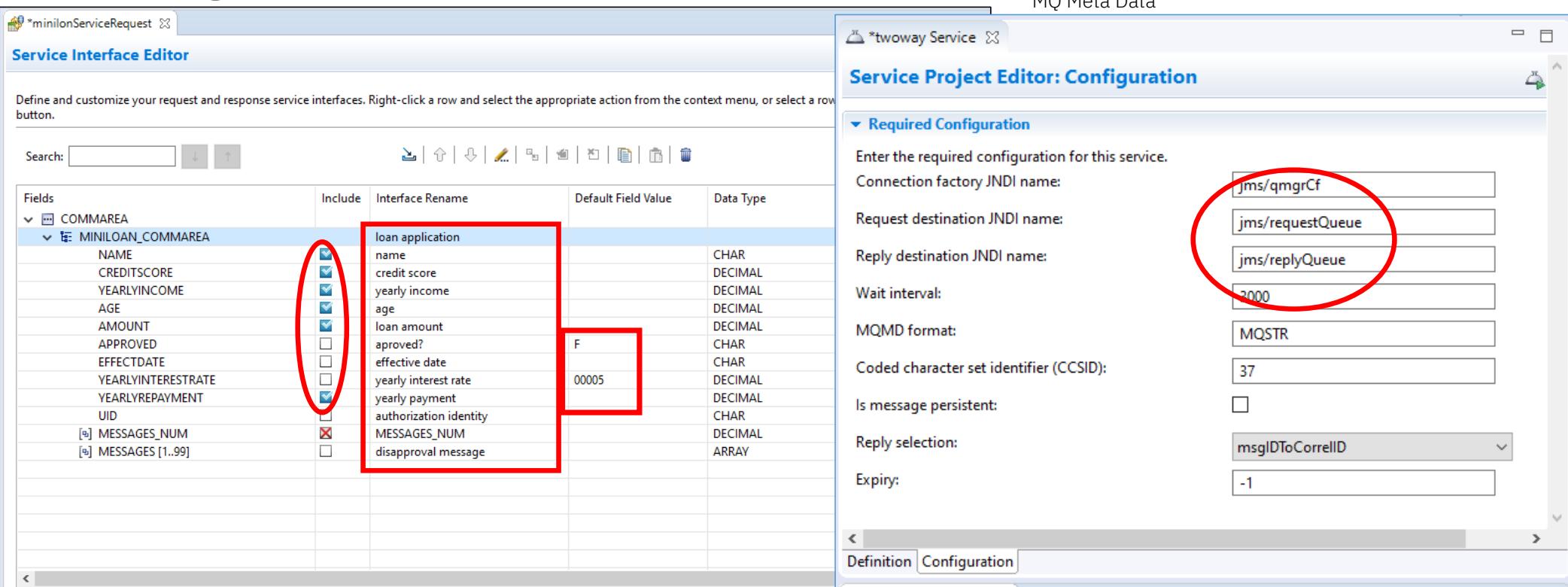


IMS/TM Meta Data

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# API toolkit – Creating Services for MQ

## Creating a “POST” service interface definition



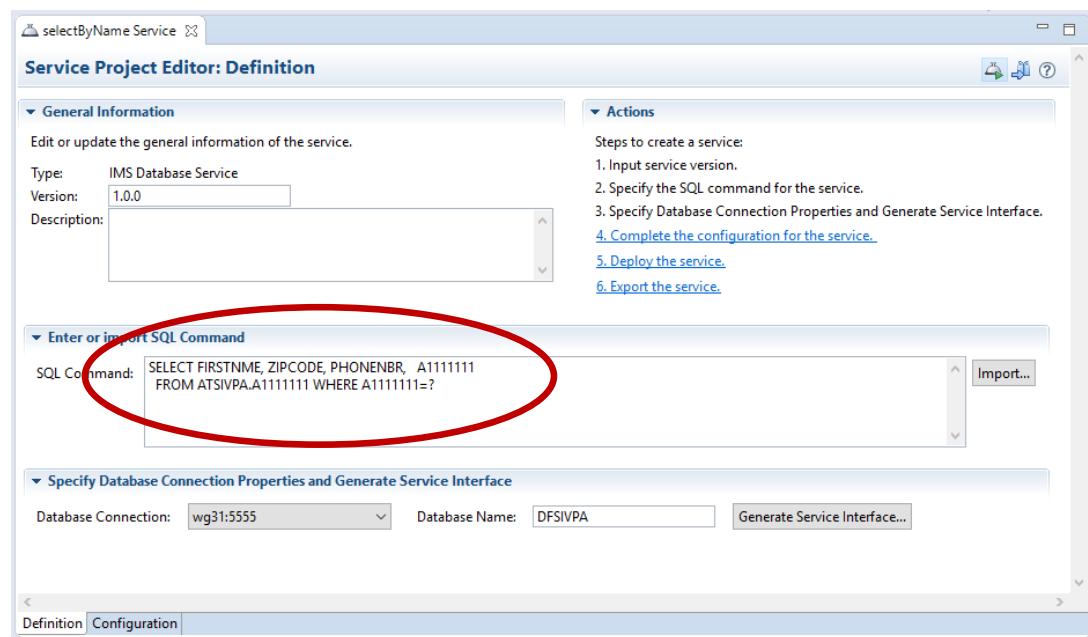
The screenshot shows two windows side-by-side:

- Service Interface Editor:** This window displays a table of fields for a service interface named "minilnServiceRequest". The columns are "Fields", "Include", "Interface Rename", "Default Field Value", and "Data Type". A red box highlights the "Interface Rename" column for the "loan application" row, which contains the values "name", "credit score", "yearly income", "age", "loan amount", "aprov?", "effective date", "yearly interest rate", "yearly payment", "authorization identity", "MESSAGES\_NUM", and "disapproval message". A red circle highlights the "Include" checkbox for the "loan application" row.
- Service Project Editor: Configuration:** This window shows configuration settings for a service named "twoway Service". The "Required Configuration" section includes fields for "Connection factory JNDI name" (jms/qmgrCf), "Request destination JNDI name" (jms/requestQueue), "Reply destination JNDI name" (jms/replyQueue), "Wait interval" (3000), "MQMD format" (MQSTR), "Coded character set identifier (CCSID)" (37), "Is message persistent" (unchecked), "Reply selection" (msgIDToCorrelID), and "Expiry" (-1). A red circle highlights the "Request destination JNDI name" field.

Again the service developer can then see the imported data structure and can **redact fields**, **rename fields**, and **add default values to fields** to make the service more consumable for an API developer.

# API toolkit – Creating Services for IMS DB

## Creating a service project from the IMS Catalog

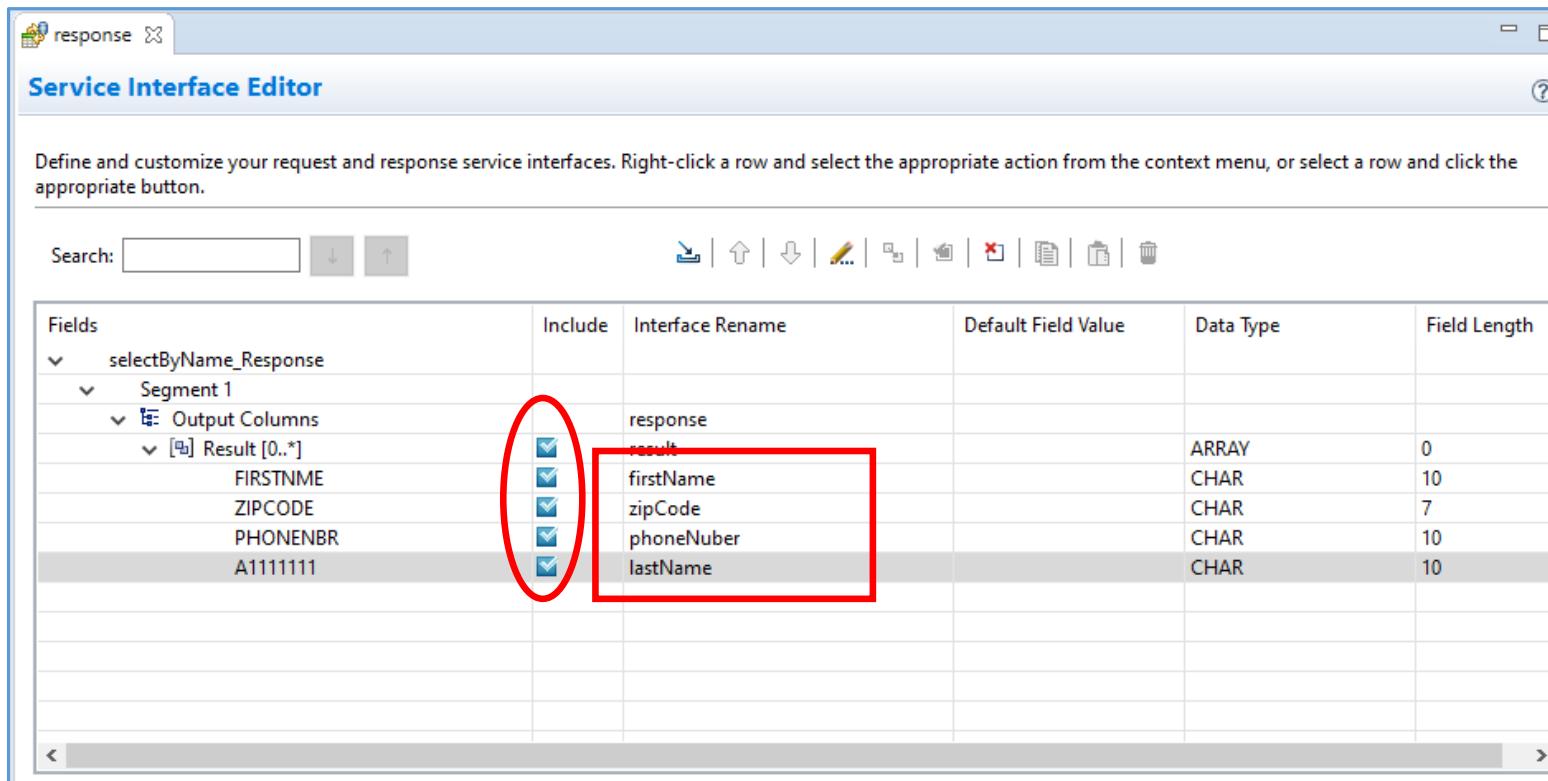


Use the IMS Catalog to assist with developing and testing SQL SELECT commands used for accessing IMS databases.

```
*-----*
* SEGMENT DESCRIPTION *
* ROOT ONLY DATABASE *
*   BYTES 1-10 LAST NAME (CHARACTER) - KEY *
*   BYTES 11-20 FIRST NAME (CHARACTER) *
*   BYTES 21-30 INTERNAL PHONE NUMBER (NUMERIC) *
*   BYTES 31-37 INTERNAL ZIP (CHARACTER) *
*   BYTES 38-40 RESERVED *
*
-----*
DBD      NAME=IVPDB1,ACCESS=(HIDAM,OSAM)
DATASET  DD1=DFSVVD1,DEVICE=3380,SIZE=2048
SEGM    NAME=A1111111,PARENT=0,BYTES=40,RULES=(LLV,LAST),
        PTR=(TB,CTR)
FIELD   NAME=(A1111111,SEQ,U),BYTES=010,START=00001,TYPE=C
FIELD   NAME=FIRSTNME,BYTES=010,START=00011,TYPE=C
FIELD   NAME=PHONENBR,BYTES=010,START=00021,TYPE=C
FIELD   NAME=ZIPCODE,BYTES=7,START=00031,TYPE=C
LCHILD  NAME=(A1,IVPDB1I),POINTER=INDX,RULES=LAST
DBDGEN
FINISH
END
```

## API toolkit – Creating Services for IMS DB

The Toolkit allows editing a service interface definitions\*



The screenshot shows the Service Interface Editor window. The title bar says "Service Interface Editor". The main area has a heading "Define and customize your request and response service interfaces. Right-click a row and select the appropriate action from the context menu, or select a row and click the appropriate button." Below this is a search bar and a toolbar with icons for copy, paste, up, down, edit, etc. The main table has columns: Fields, Include, Interface Rename, Default Field Value, Data Type, and Field Length. The table data is as follows:

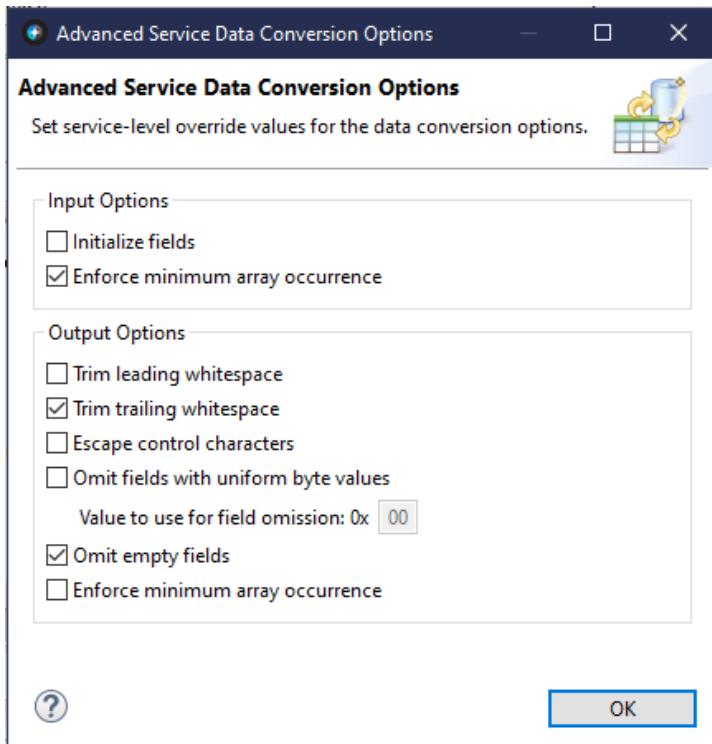
Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
selectByName_Response					
Segment 1					
Output Columns					
Result [0..*]	<input checked="" type="checkbox"/>	response			
FIRSTMNAME	<input checked="" type="checkbox"/>	result		ARRAY	0
ZIPCODE	<input checked="" type="checkbox"/>	firstName		CHAR	10
PHONENR	<input checked="" type="checkbox"/>	zipCode		CHAR	7
A1111111	<input checked="" type="checkbox"/>	phoneNuber		CHAR	10
	<input checked="" type="checkbox"/>	lastName		CHAR	10

\*Using a slightly different process

# API toolkit – Advanced Data Conversion Options



z/OS Connect EE



## Request Messages:

- Initialize fields
- Enforce minimum array occurrence

## Response Messages:

- Trim leading whitespace
- Trim trailing whitespace
- Escape control characters
- Omit fields with uniform byte values
- Omit empty fields
- Enforce minimum array occurrence

# API toolkit – Creating Services for Db2

## Creating a service project from Db2 REST service

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

 Import Db2 service from service manager

Db2 service manager connection:  wg31:2446

Type to search...

Service Name	Version	Collection ID	Description
selectEmployee		SYSIBMSERVICE	Select an employee from table USER1.EMPLOYEE
deleteEmployee		zCEEService	Delete an employee from table USER1.EMPLOYEE
displayEmployee		zCEEService	Display an employee in table USER1.EMPLOYEE
insertEmployee		zCEEService	Insert an employee into table USER1.EMPLOYEE
selectByDepartments		zCEEService	Select employees by departments
selectByRole		zCEEService	Select an employee based on job and department
selectEmployee	V1	zCEEService	Select an employee from table USER1.EMPLOYEE
selectEmployee	V2	zCEEService	Select an employee from table USER1.EMPLOYEE
updateEmployee		zCEEService	Update an employee in table USER1.EMPLOYEE

Definition Configuration

Import Cancel

 \*selectEmployee Service

**Service Project Editor: Definition**

**General Information**

Edit or update the general information of the service.

Type: Db2 Service  
Version: 1.0.0  
Description:

**Actions**

Steps to create a service:

1. Input service version.
2. Import JSON schemas from a Db2 service manager or your local machine.
3. Complete the configuration for the service.
4. Deploy the service.
5. Export the service.

**Define Db2 service**

Import a Db2 native REST service from a Db2 service manager. Alternatively, enter your Db2 service details and import the JSON schemas from your local machine.

[Import from Db2 service manager...](#)

Collection Id: SYSIBMSERVICE  
Db2 native REST service name: selectByRole  
Db2 native REST service version: V1  
Request JSON schema: request-schema.json [Import from local machine...](#)  
Response JSON schema: response-schema.json [Import from local machine...](#)

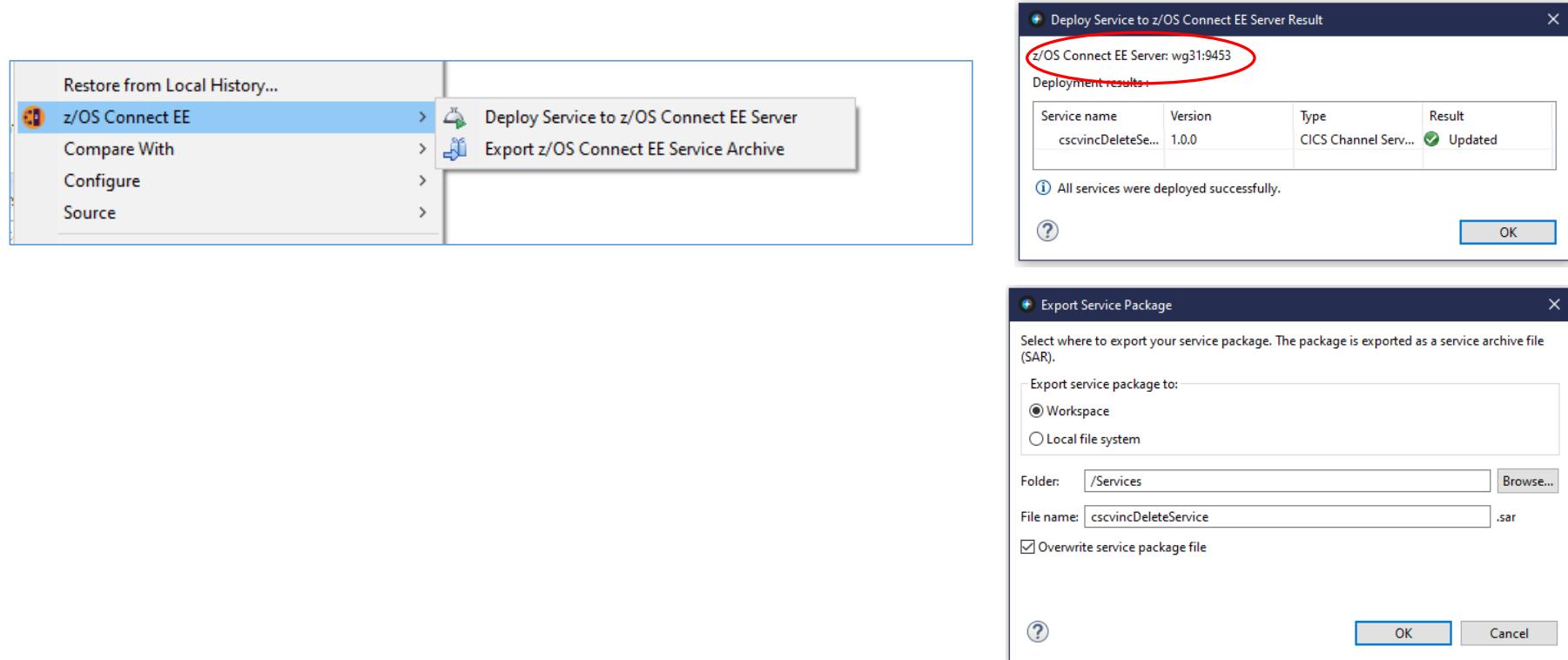
The service developer retrieves details about the Db2 REST services

Note there is no service interface editor available

# API toolkit – Services Editor

## Server connection and Services deployment

Manage z/OS Connect EE server connections in the **Host Connections** view:



The screenshot shows the API toolkit interface with the "z/OS Connect EE" server selected in the "Host Connections" view. A context menu is open, showing options: "Deploy Service to z/OS Connect EE Server" and "Export z/OS Connect EE Service Archive".

**Deploy Service to z/OS Connect EE Server Result**

z/OS Connect EE Server: wg31:9453

Deployment results:

Service name	Version	Type	Result
cscvincDeleteSe...	1.0.0	CICS Channel Serv...	Updated

All services were deployed successfully.

OK

**Export Service Package**

Select where to export your service package. The package is exported as a service archive file (SAR).

Export service package to:

Workspace

Local file system

Folder: /Services

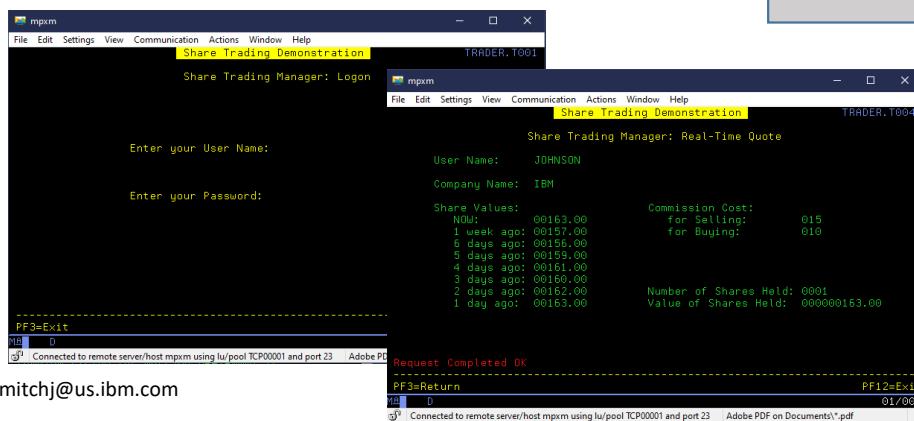
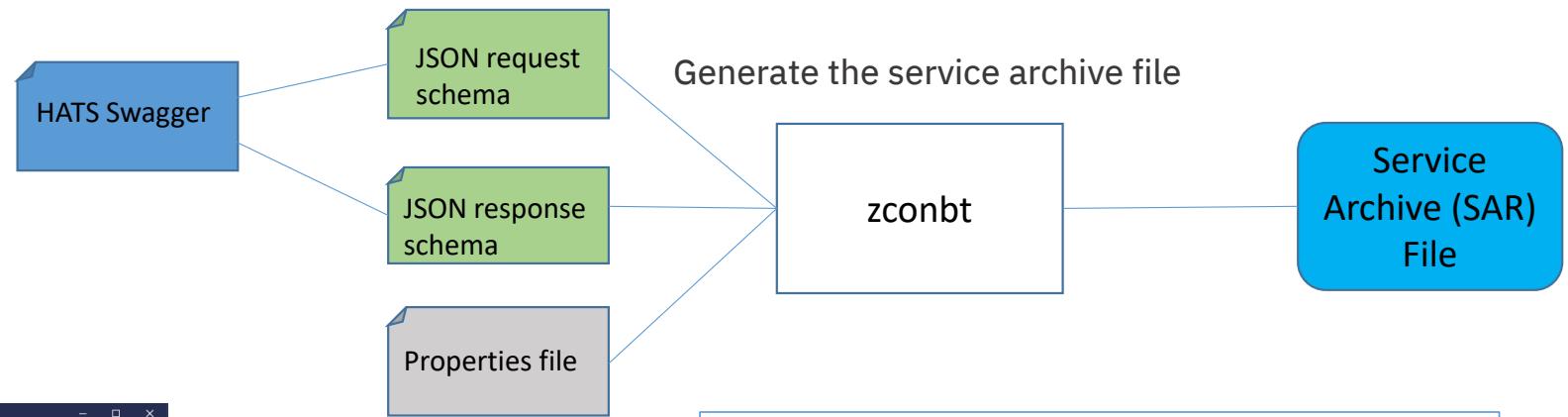
File name: cscvincDeleteService.sar

Overwrite service package file

OK Cancel

# Command line(zconbt) – REST Services

For HATS REST Services use the z/OS Connect Build toolkit (zconbt)



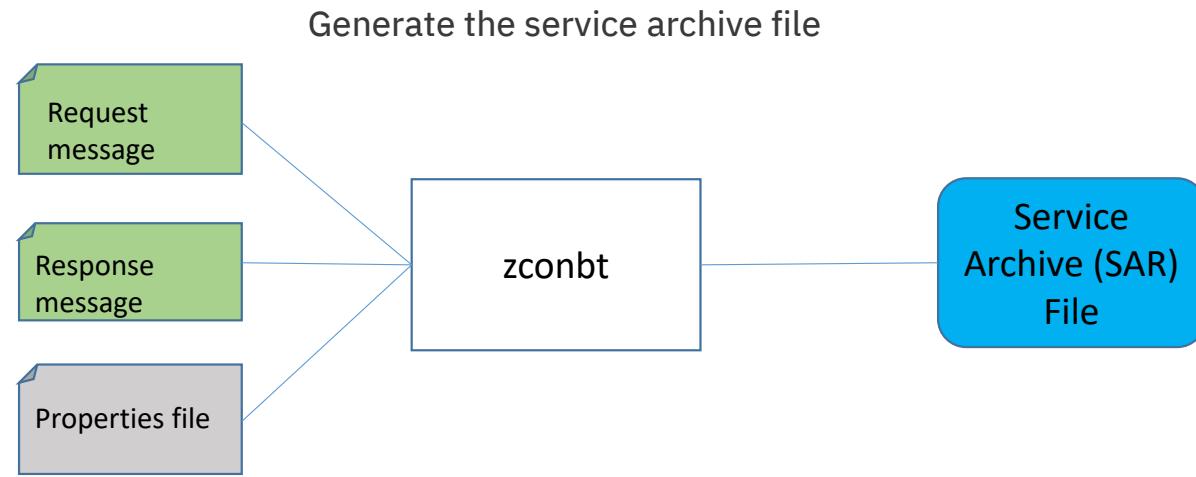
```

provider=rest
name=getCompany
version=1.0
description=Obtain a list of companies
requestSchemaFile=getCompanyRequest.json
responseSchemaFile=getCompanyResponse.json
verb=POST
uri=/Trader/rest/GetCompany
connectionRef=HatsConn
  
```

## Command line(zconbt) – MVS Batch

For batch WOLA services use the z/OS Connect Build toolkit (zconbt)

```
name=Filea
version=1.0
provider=wola
description=COBOL batch program
language=COBOL
program=ATSFFILEA
register=FILEAZCON
connectionRef=wolaCF
requestStructure=fileareq.cpy
responseStructure=filearsp.cpy
```

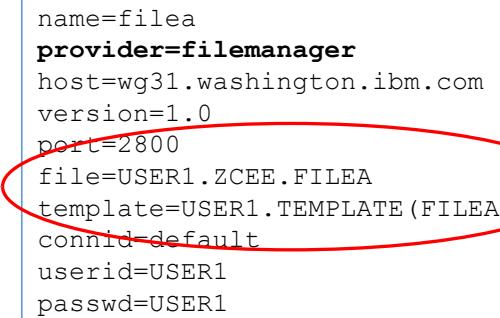
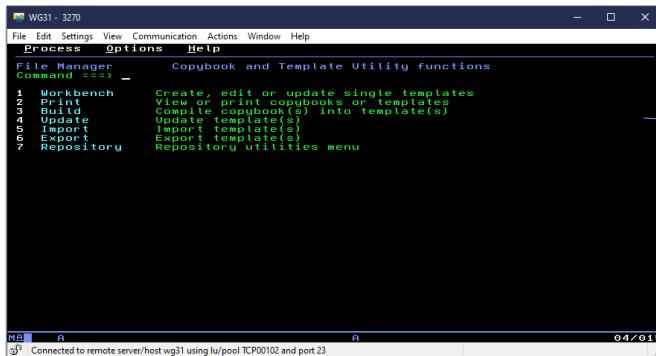
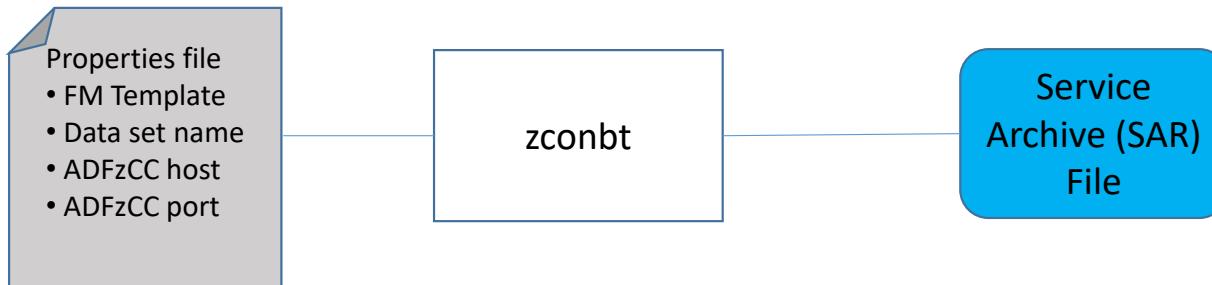


**WebSphere Optimized Local Adapter** – a protocol for cross memory communications between address spaces

# Command line(zconbt) – File Manager

For File Manager Services use the z/OS Connect Build toolkit (zconbt)

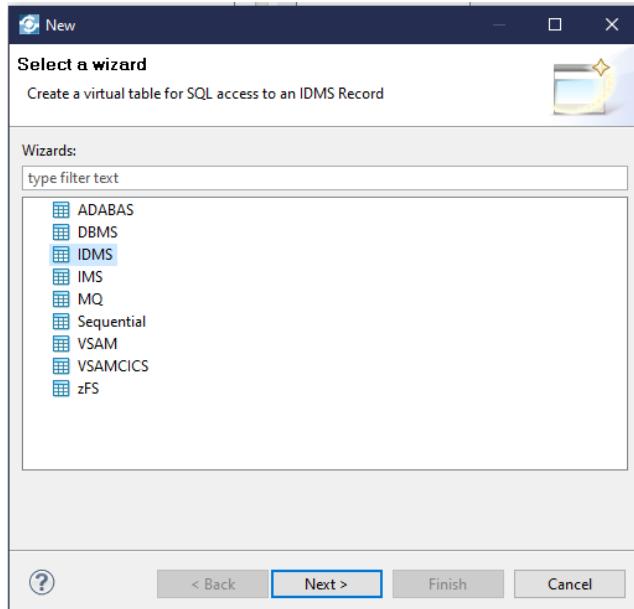
Generate the service archive file



```
name=filea
provider=filemanager
host=wg31.washington.ibm.com
version=1.0
port=2800
file=USER1.ZCEE.FILEA
template=USER1 TEMPLATE(FILEA)
connid=default
userid=USER1
passwd=USER1
```

# DVM Studio

For DVM use the DVM Studio



The screenshot shows the DVM Studio interface. The title bar says 'DV Data - Data Virtualization Manager/SQL Samples/Generated.sql - IBM Data Virtualization Manager for z/OS'. The top menu includes File, Edit, Navigate, Search, Project, SQL, Run, Window, Help. The toolbar has various icons. The left sidebar has sections for Data (Navigator, JDBC), Data Sources, and Services (Web Services, REST, /REST/, INSERT, UPD, Set Tree Filter, Target System, WSC, Admin). The central pane displays a SQL script named 'Generated.sql' with code related to EXMPCAT and EXMPCAT tables. The bottom right pane shows a table result with columns WS\_DESCRIPTION, WS\_DEPARTMENT, and WS\_C. A red circle highlights the 'Generate SAR File(s)' button in the 'z/OS Connect REST Interface' toolbar.

WS_DESCRIPTION	WS_DEPARTMENT	WS_C
Mitch Johnson	10	002.
Mitch Johnson	10	002.
	10	002.



## Once we have a Service Archive (SAR) What's next?

Quick and easy **API mapping**.

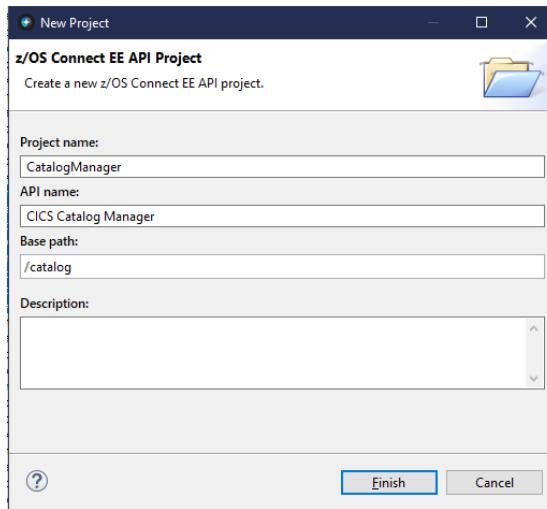
*Remember: All service archives files are functionally equivalent regardless of how they are created*



## **/api\_toolkit/api\_editor**

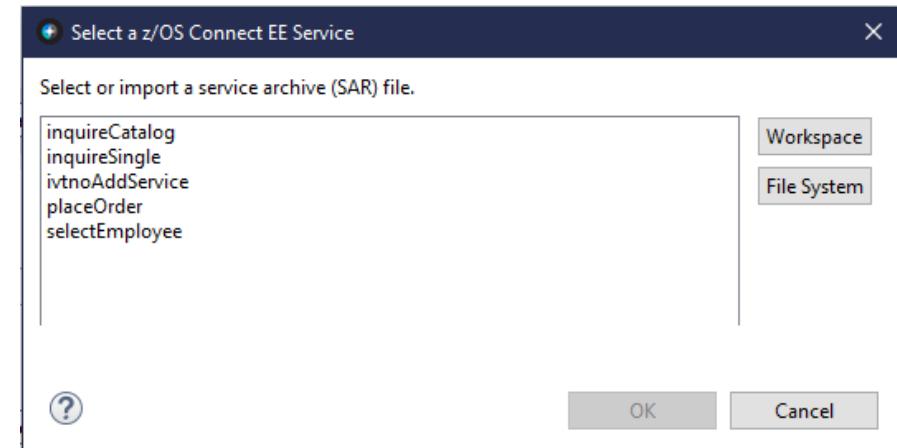
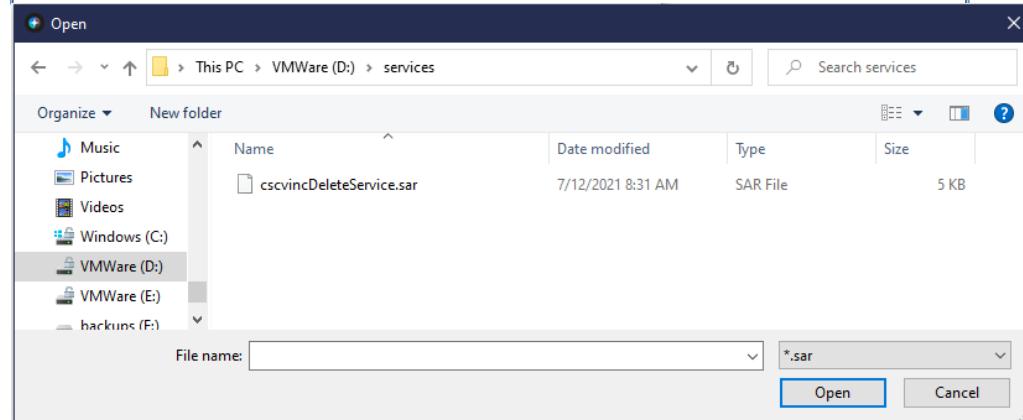
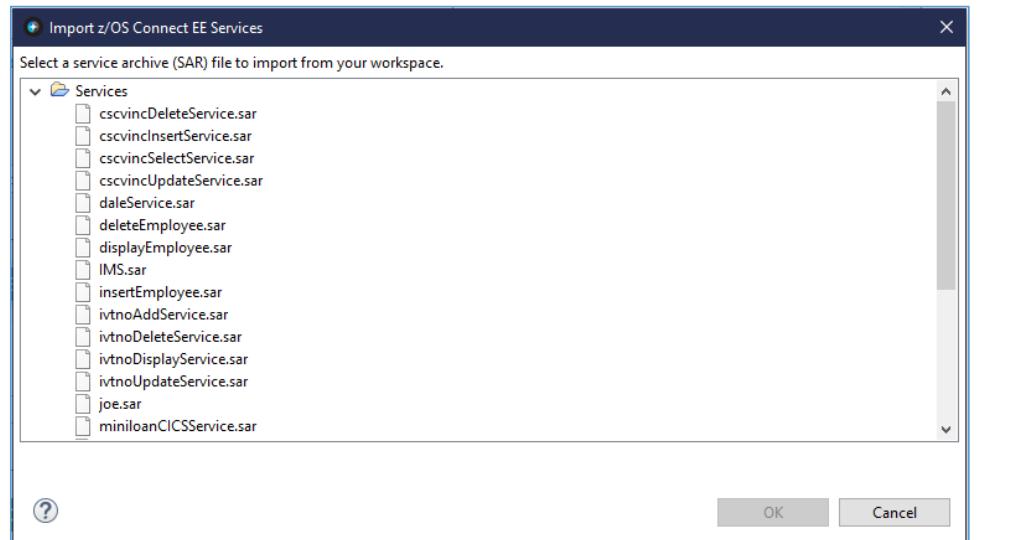
Quick and easy **API mapping**.

# API toolkit – API Editor

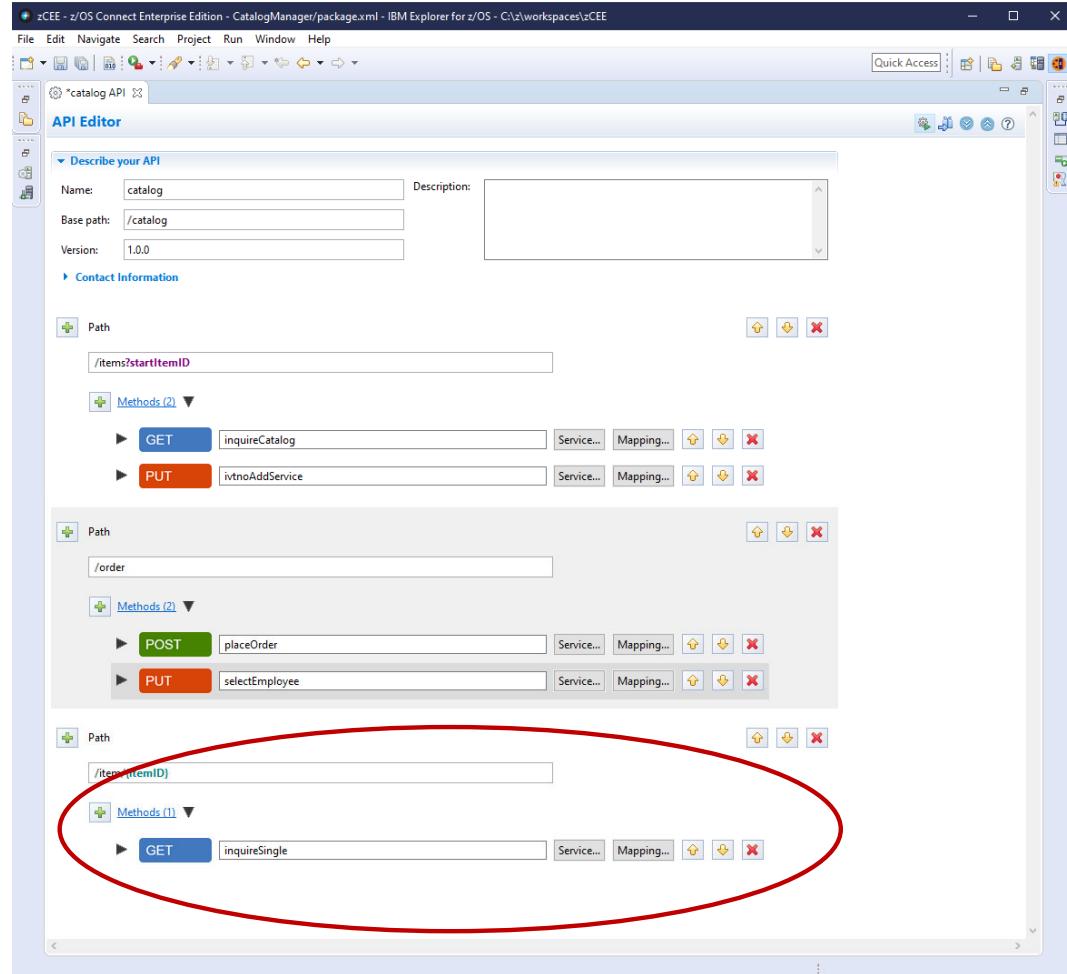


A screenshot of the API Editor interface for the CICS Catalog Manager API. The "Describe your API" section includes fields for Name (CICS Catalog Manager), Description, Base path (/catalog), and Version (1.0.0). The "Contact Information" section is collapsed. Below is a "Path" section with a path entry field containing /newPath1 and a delete button. Underneath is a "Methods (4)" section with four entries: POST, GET, PUT, and DELETE, each with a service selection dropdown and mapping buttons. A large red circle highlights the entire Methods section.

# Importing the service archives files



# API toolkit – API Editor



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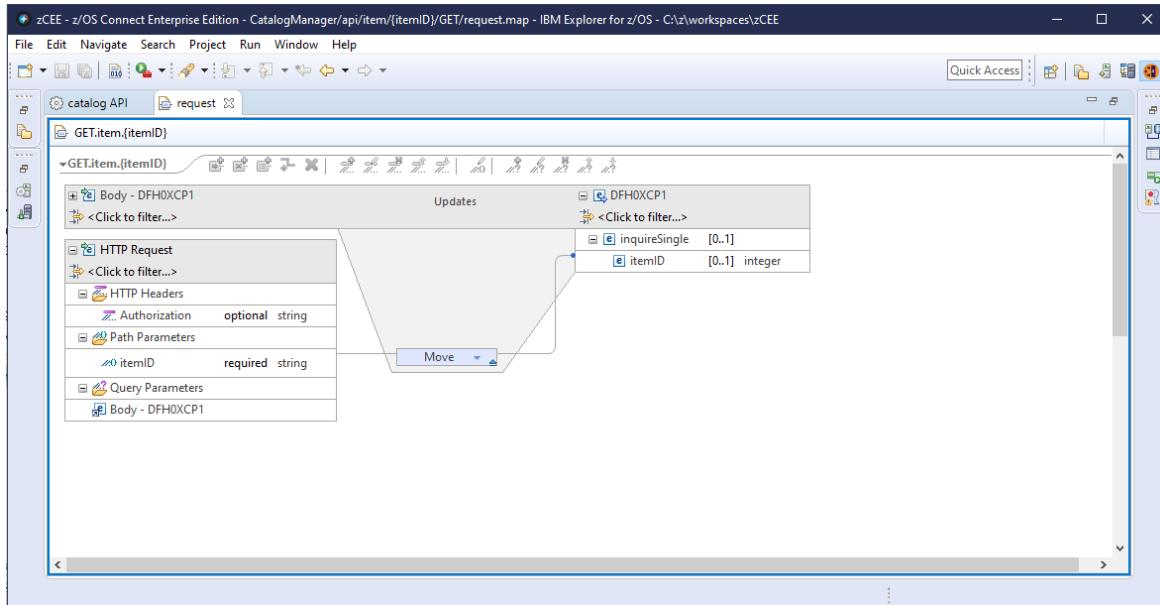
The **API toolkit** is designed to encourage RESTful API design.

Once you define your API, you can map backend services to each request.

Your services are represented by a `.sar` files, which you import into the **API toolkit**, regardless of how the service archive file was generated.

# API toolkit – API Editor

API mapping: Assign values to the interface fields exposed by the service developer



Map both the request and response for each API.

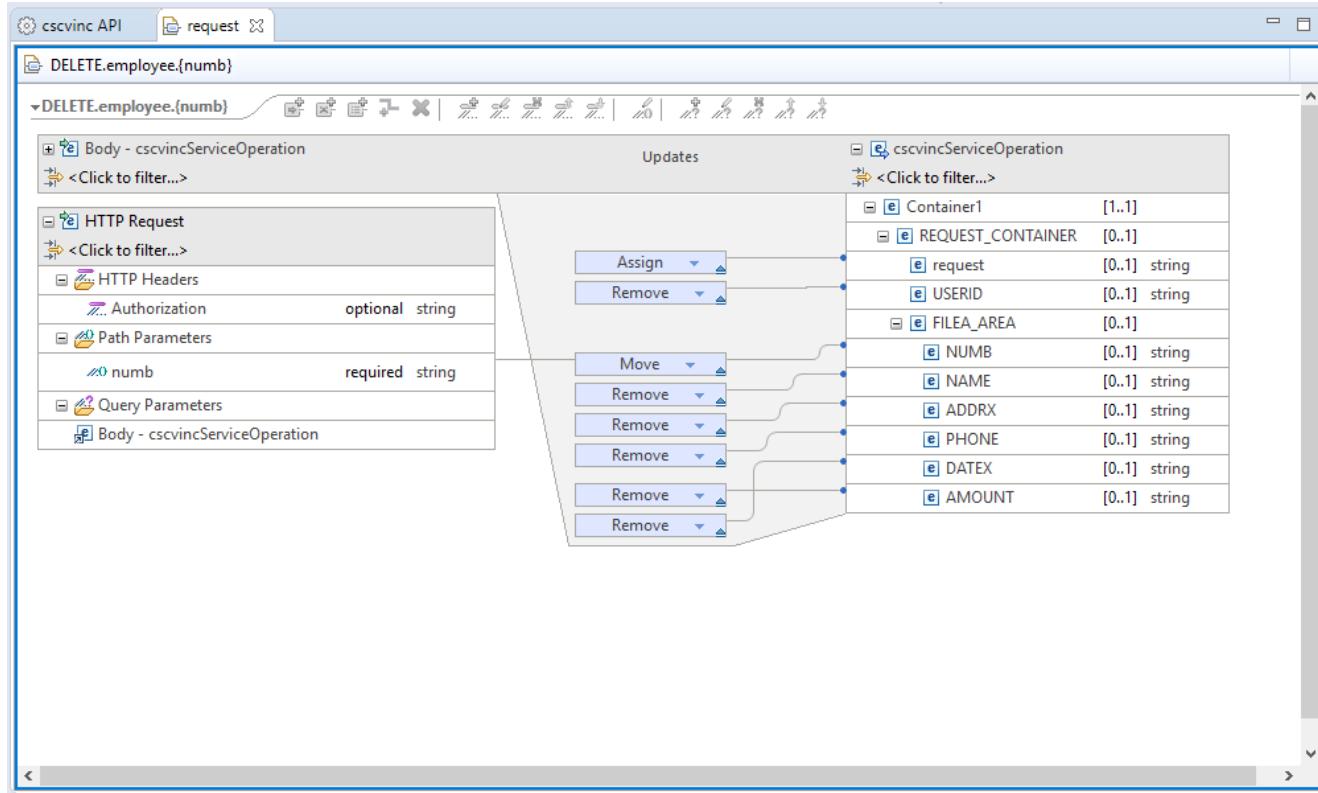
Map path and query parameters to native data structures.

Assign static values to fields, useful for Op codes.

Remove unwanted fields to simplify the API (remember request was set to 01INQC in the SAR).

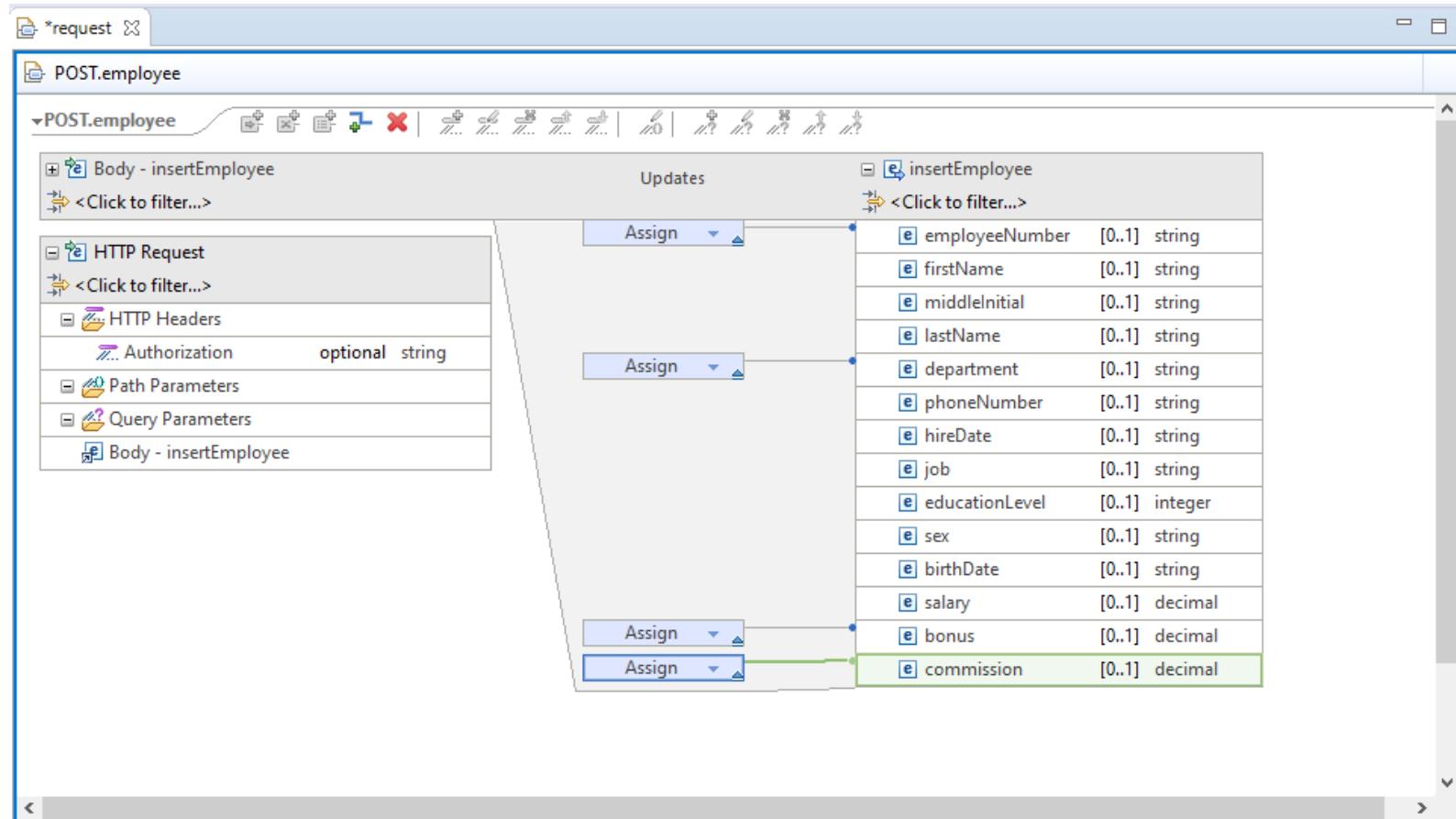
# API toolkit – API Editor

API mapping: Remove or assign values to the fields exposed by service developer



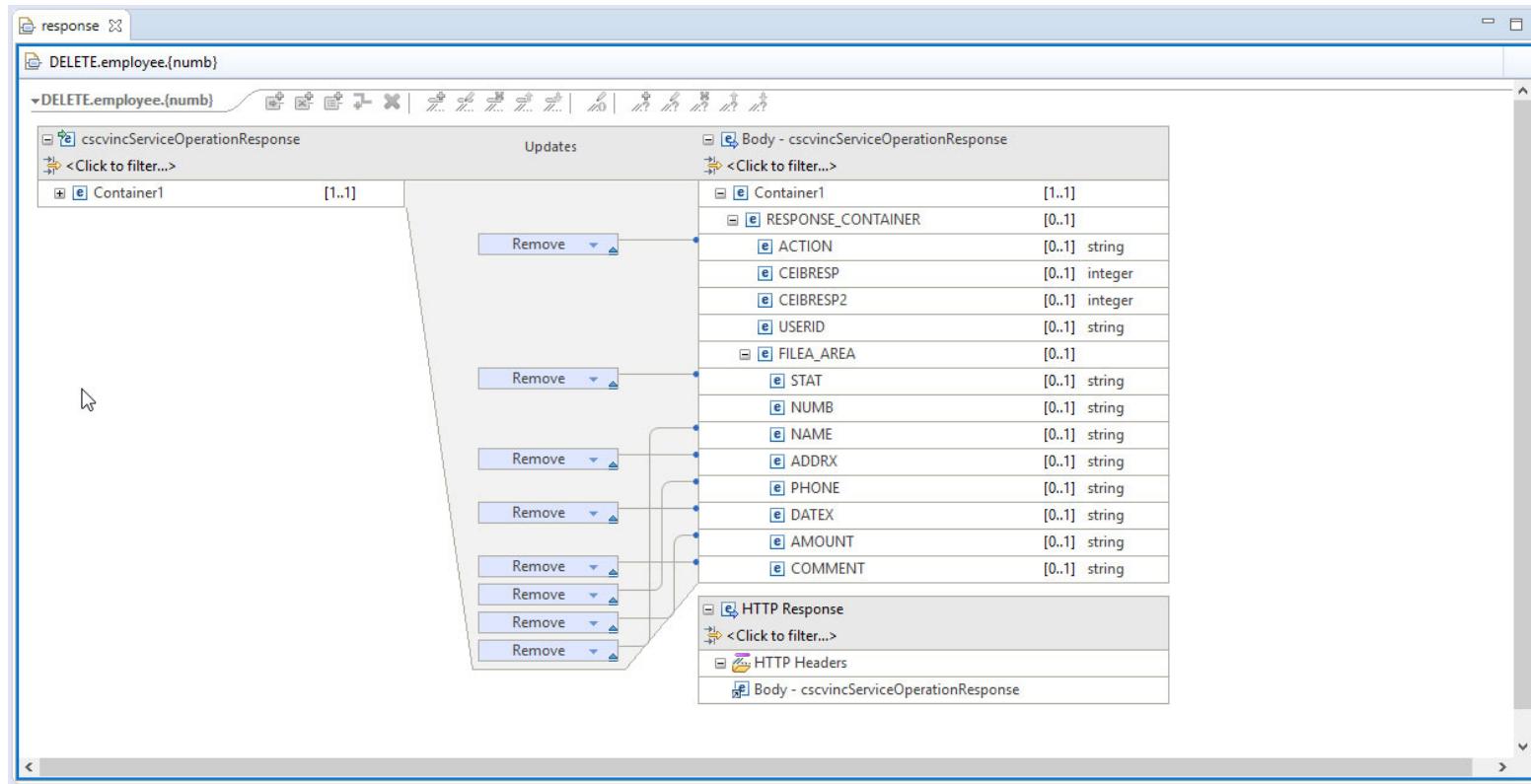
# API toolkit – API Editor and Db2 REST service

API mapping: Remove/Assign values columns exposed in Db2 REST service



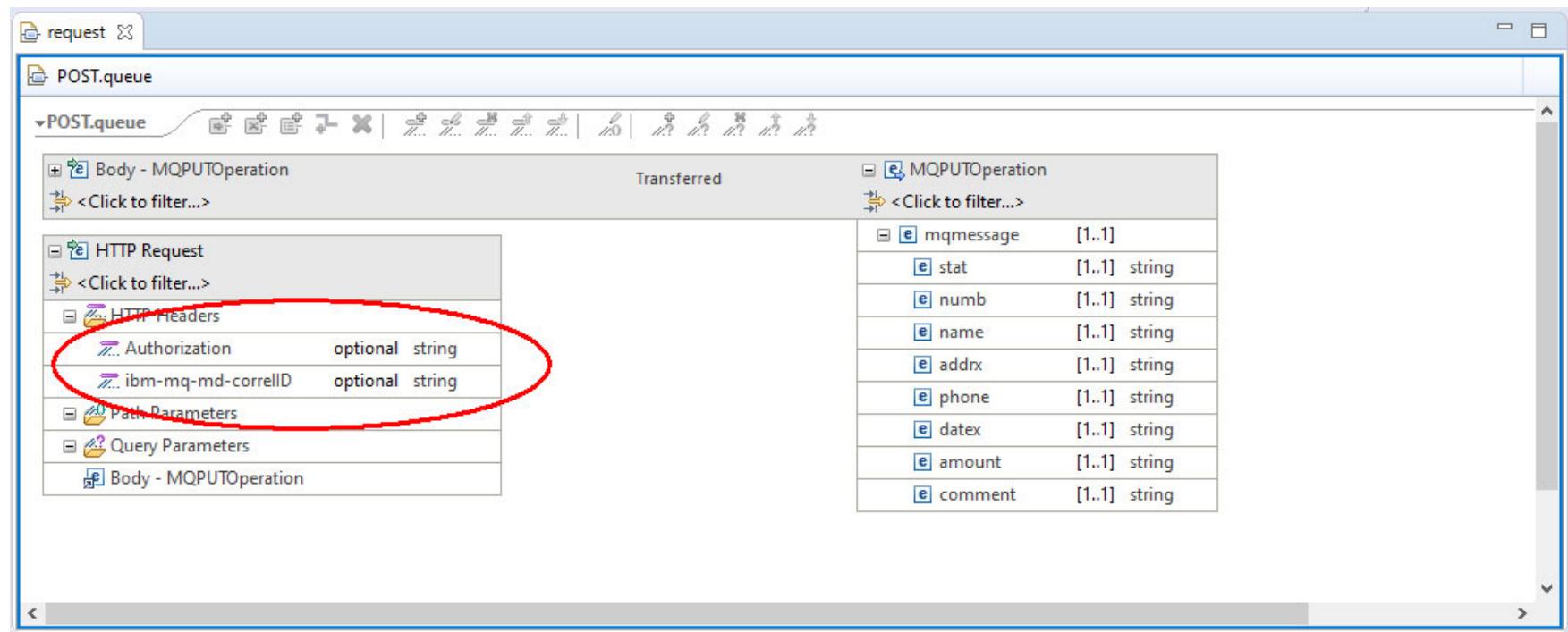
# API toolkit – API Editor

API mapping: Allows the API Developer to remove fields from the response to tailor the API



# API toolkit – API Editor

API mapping: Allows adding HTTP header properties



The screenshot shows the API Editor interface with two main sections: 'POST.queue' on the left and 'MQPUTOperation' on the right.

**POST.queue (Left):**

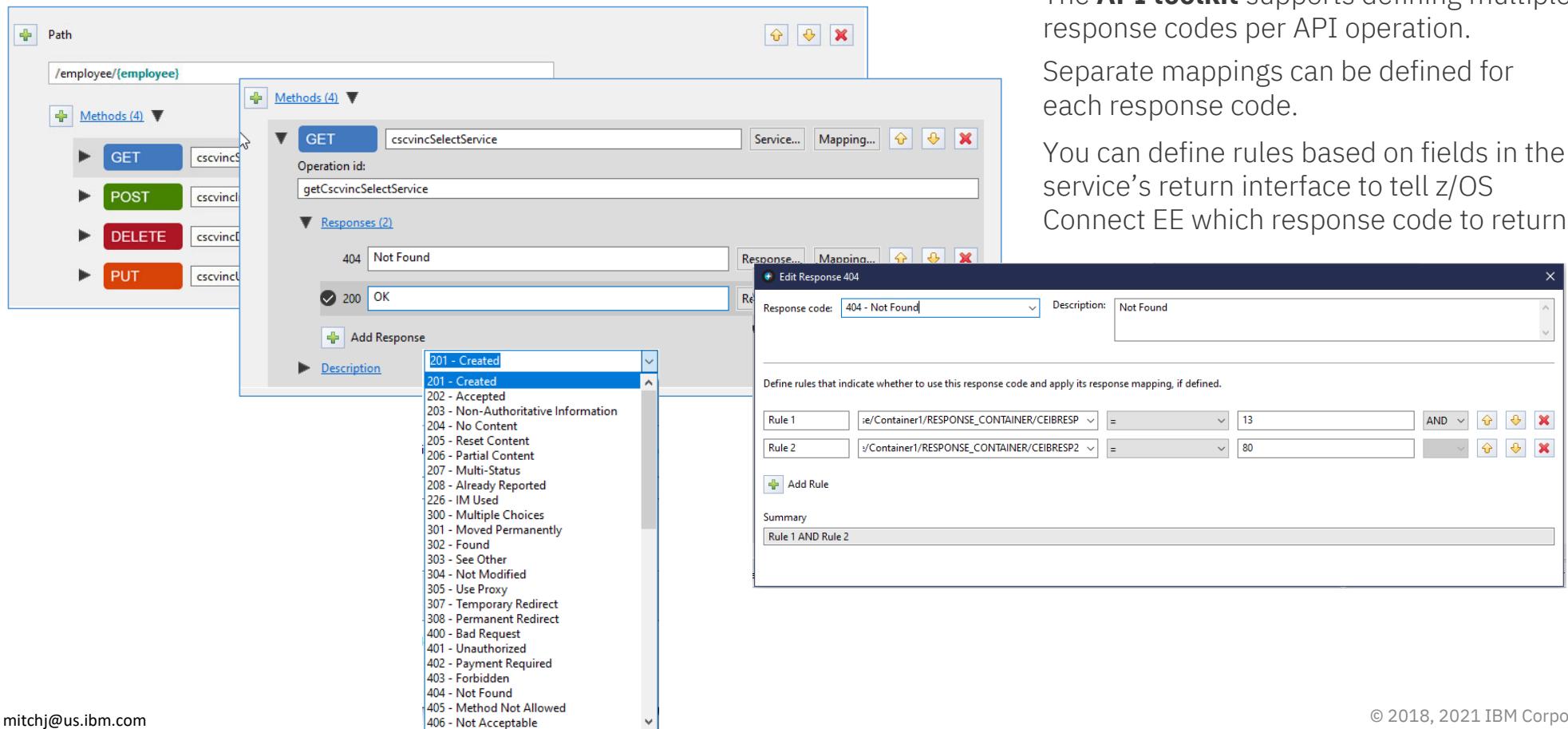
- Body - MQPUTOperation
- HTTP Request
  - HTTP Headers
    - Authorization optional string
    - ibm-mq-md-correlID optional string
  - Path Parameters
  - Query Parameters
  - Body - MQPUTOperation

**MQPUTOperation (Right):**

- MQPUTOperation
- mqmessage [1..1]
  - stat [1..1] string
  - numb [1..1] string
  - name [1..1] string
  - addrx [1..1] string
  - phone [1..1] string
  - datex [1..1] string
  - amount [1..1] string
  - comment [1..1] string

# API toolkit

## API mapping: API definition with multiple response codes



The screenshot shows the API toolkit interface for defining API mappings. On the left, the API path `/employee/{employee}` is selected. Under the `Methods (4)` section, a `GET` method is highlighted, pointing to the service `cscvincSelectService`. The `Operation id:` is set to `getCscvincSelectService`. Below this, the `Responses (2)` section shows two entries: `404 Not Found` and `200 OK`. A modal window titled `Edit Response 404` is open, showing the response code as `404 - Not Found` and the description as `Not Found`. It also contains a rule editor with two rules defined:

- `Rule 1`: `se/Container1/RESPONSE_CONTAINER/CEIBRESP` = 13
- `Rule 2`: `z/Container1/RESPONSE_CONTAINER/CEIBRESP2` = 80

The summary of the rules is `Rule 1 AND Rule 2`.

The **API toolkit** supports defining multiple response codes per API operation.

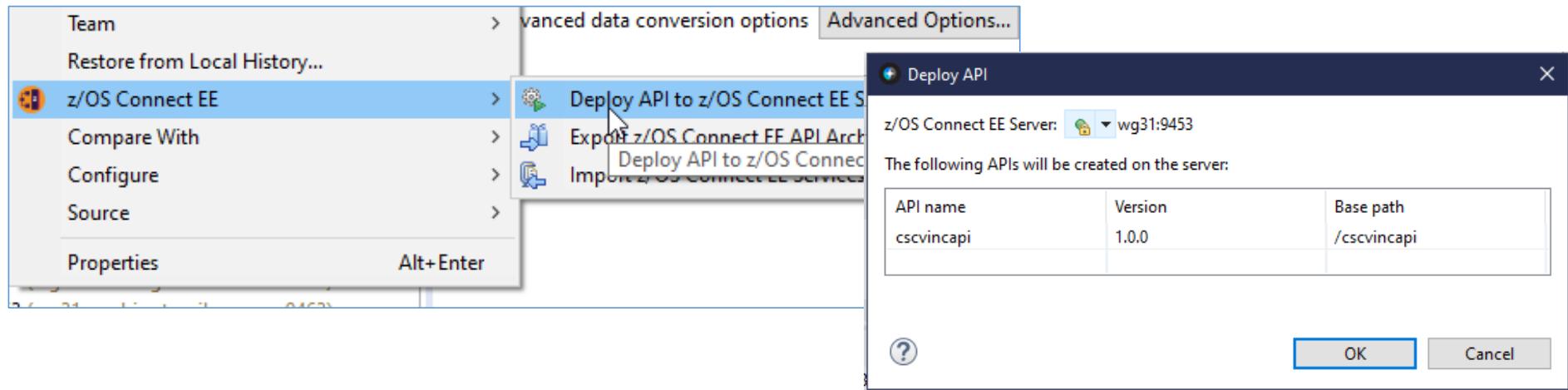
Separate mappings can be defined for each response code.

You can define rules based on fields in the service's return interface to tell z/OS Connect EE which response code to return

# API toolkit – API Editor

## Server connection and API deployment

Manage z/OS Connect EE server connections in the **Host Connections** view:



**Right-click deploy to server** enables developers to quickly deploy, test, and iterate on their APIs.

**z/OS Connect EE servers view** allows you to start, stop, and remove APIs from a running server.



# API toolkit – API Editor

## Testing with Swagger UI

Test your deployed APIs directly with **Swagger UI** inside the editor.  
No need to export the Swagger doc to a separate tool.

The screenshot shows the z/OS Connect EE API Editor interface. On the left, the 'API Catalog' window displays a tree view of deployed services and APIs. A context menu is open over the 'cscvinc' service, showing options like 'Open In Swagger UI'. Two separate browser windows are open, both titled 'Swagger UI', showing the Swagger documentation for the '/employee' endpoint of the 'cscvinc' service. The left window shows the full list of methods (POST, DELETE, GET, PUT) for '/employee'. The right window is a detailed view of the GET method, showing the response model (a JSON object with properties like 'CEIBRESP', 'CEIBRESP2', 'USERID', 'file', and 'employeeNumber') and parameters (Authorization header and employee path parameter). Both windows also show the base URL as /cscvinc and API version 1.0.0.



# API Testing with Postman

A screenshot of the Postman application interface. The top navigation bar shows "File", "Edit", "View", "Help", "Home", "Workspaces", "Reports", and "Explore". A search bar says "Search Postman". On the right, there are icons for cloud, file, settings, and a gear, with a "Upgrade" button. The main workspace shows a list of requests. One request is selected: "GET https://mpz3.washington.ibm.com:9443/cscvinc/employee/111111". Below it, the "Params" tab is selected, showing a table with columns "KEY", "VALUE", "DESCRIPTION", and "Bulk Edit". The table has one row with a single entry. At the bottom, tabs for "Body", "Cookies (1)", "Headers (8)", and "Test Results" are visible. The "Test Results" tab is selected, displaying a JSON response. The response body is:

```
1  "cscvincSelectServiceOperationResponse": {  
2      "cscvincContainer": {  
3          "response": {  
4              "CEIBRESP": 0,  
5              "CEIBRESP2": 0,  
6              "USERID": "CICSUSER",  
7              "filea": {  
8                  "employeeNumber": "111111",  
9                  "name": "C. BAKER",  
10                 "address": "OTTAWA, ONTARIO",  
11                 "phoneNumber": "51212003",  
12                 "date": "26 11 81",  
13                 "amount": "00011 00"  
14             }  
15         }  
16     }  
17 }
```

The status bar at the bottom shows "Status: 200 OK", "Time: 205 ms", and "Size: 899 B".

Postman

File Edit View Help

Home Workspaces Reports Explore

Search Postman

Save

Send

Params Authorization Headers (10) Body Pre-request Script Tests Settings Cookies

Query Params

KEY	VALUE	DESCRIPTION	Bulk Edit
..	..	..	..

Body Cookies (1) Headers (8) Test Results

Status: 200 OK Time: 205 ms Size: 899 B Save Response

Pretty Raw Preview Visualize JSON

1 "cscvincSelectServiceOperationResponse": {  
2 "cscvincContainer": {  
3 "response": {  
4 "CEIBRESP": 0,  
5 "CEIBRESP2": 0,  
6 "USERID": "CICSUSER",  
7 "filea": {  
8 "employeeNumber": "111111",  
9 "name": "C. BAKER",  
10 "address": "OTTAWA, ONTARIO",  
11 "phoneNumber": "51212003",  
12 "date": "26 11 81",  
13 "amount": "00011 00"  
14 }  
15 }  
16 }  
17 }

Find and Replace Console

Bootcamp Runner Trash

mitchj@us.ibm.com

<https://www.postman.com/downloads/>

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# API Testing with cURL

A screenshot of a Microsoft Windows Command Prompt window titled "Command Prompt". The window shows the following text:

```
Microsoft Windows [Version 10.0.19043.1165]
(c) Microsoft Corporation. All rights reserved.

c:\z>curl -X GET --user FRED --insecure https://mpz3.washington.ibm.com:9443/cscvinc/employee/111111
{"cscvincSelectServiceOperationResponse":{"cscvincContainer":{"response":{"CEIBRESP":0,"CEIBRESP2":0,"USERID":"CICSUSER","filea":{"employeeNumber":"111111","name":"C. BAKER","address":"OTTAWA, ONTARIO","phoneNumber":"51212003","date":"26 11 81","amount":"$0011.00"}}}}
c:\z>
```

The window has a dark blue header bar and a black body. It includes standard window controls (minimize, maximize, close) and scroll bars on the right side.

<https://curl.se/download.html>

# API Testing with the API Explorer (zCEE V3.0.48)



IBM

all Filter

## Liberty REST APIs

Discover REST APIs available within Liberty

**cscvinc**

Show/Hide | List Operations | Expand

POST	/cscvinc/employee
DELETE	/cscvinc/employee/{employee}
GET	/cscvinc/employee/{employee}
PUT	/cscvinc/employee/{employee}

**db2employee**

Show/Hide | List Operations | Expand

**filemgr**

Show/Hide | List Operations | Expand

**imsPhoneBook**

Show/Hide | List Operations | Expand

**jwtlvpDemoApi**

Show/Hide | List Operations | Expand

**miniloancics**

Show/Hide | List Operations | Expand

**mqapi**

Show/Hide | List Operations | Expand

**phonebook**

Show/Hide | List Operations | Expand

File Edit View History Bookmarks Tools Help REST API Documentation + https://mpz3.washington.ibm.com:9443/api/explorer/#/cscvinc/employee/111111

Curl Try it out! Hide Response

```
curl -X GET --header 'Accept: application/json' --header 'Authorization: Basic RnJlZDpmcmVk' 'https://mpz3.washington.ibm.com:9443/cscvinc/employee/111111'
```

Request URL

https://mpz3.washington.ibm.com:9443/cscvinc/employee/111111

Response Body

```
{
  "cscvincSelectServiceOperationResponse": {
    "cscvincContainer": {
      "response": {
        "CEIBRESP": 0,
        "CEIBRESP2": 0,
        "USERID": "CICCSUSER",
        "file": {
          "employeeNumber": "111111",
          "name": "C. BAKER",
          "address": "OTTAWA, ONTARIO",
          "phoneNumber": "51121003",
          "date": "26 11 81",
          "amount": "$0011.00"
        }
      }
    }
  }
}
```

Response Code

200

Response Headers

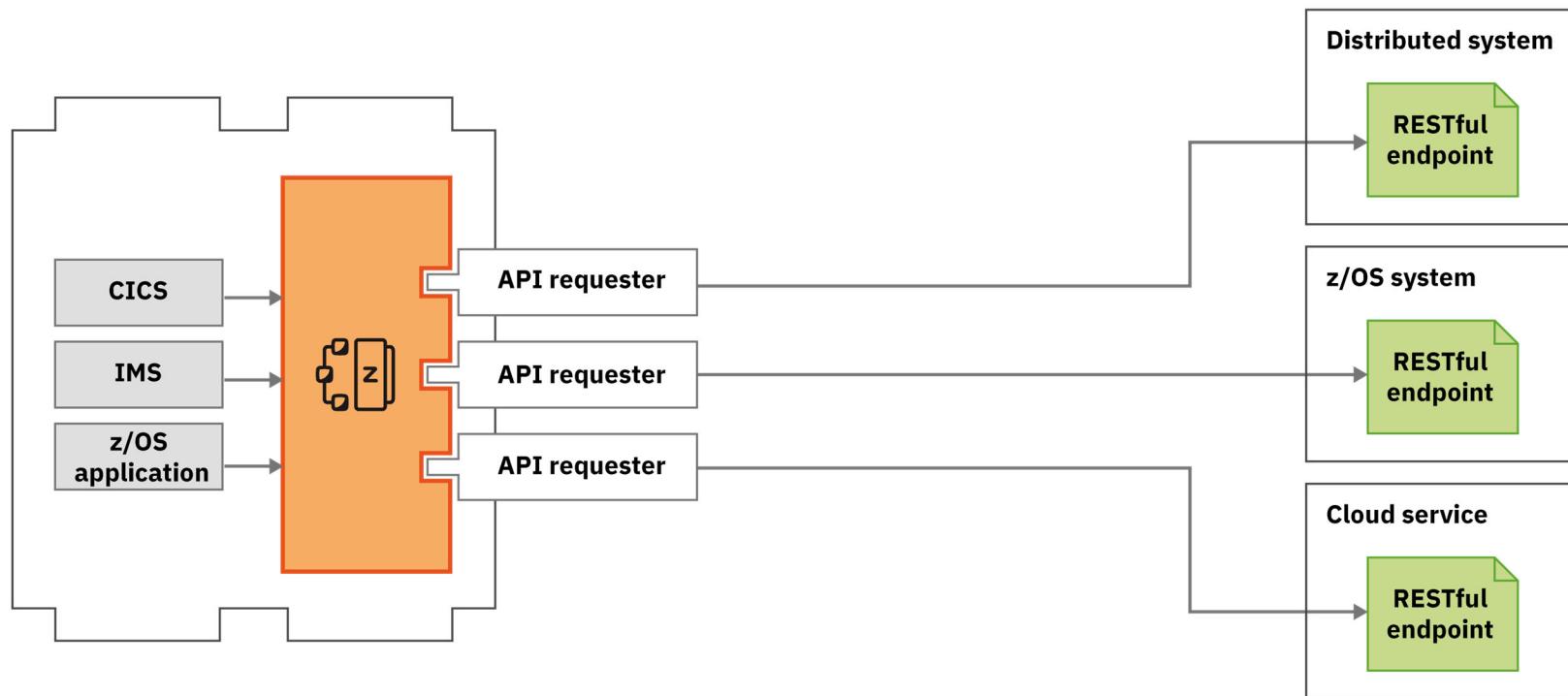
```
{
  "content-language": "en-US",
  "content-length": "269",
  "content-type": "application/json; charset=UTF-8"
}
```



## **/api\_toolkit/apiRequesters**

Quick and easy **API mapping**.

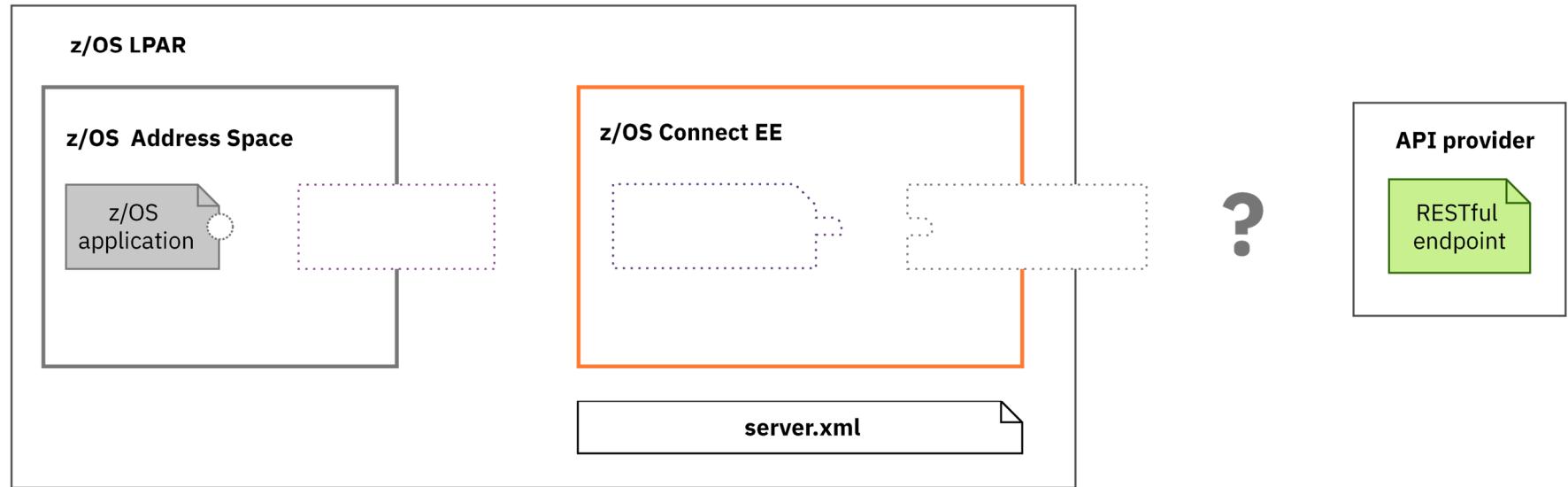
# Use API requester to call external APIs from z/OS assets





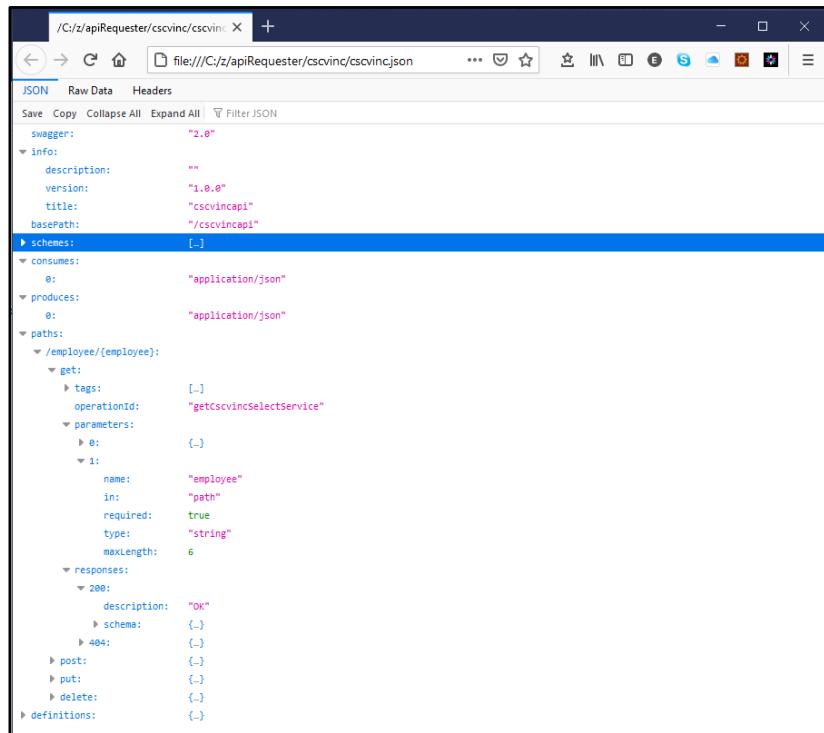
# Steps to calling an external API

Starting point



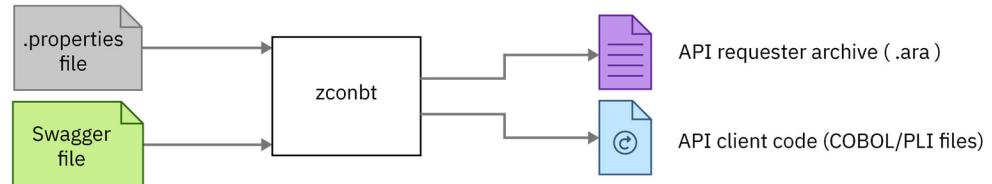
# Steps to calling an external API

Generate API requester archive and API client code from Swagger



```

{
  "swagger": "2.0",
  "info": {
    "description": "",
    "version": "1.0.0",
    "title": "cscvincapi",
    "basePath": "/cscvincapi"
  },
  "schemes": [],
  "consumes": [
    {
      "o": "application/json"
    }
  ],
  "produces": [
    {
      "o": "application/json"
    }
  ],
  "paths": {
    "/employee/{employee}": {
      "get": {
        "tags": [
          "getCscvincSelectService"
        ],
        "parameters": [
          {
            "o": {}
          },
          {
            "name": "employee",
            "in": "path",
            "required": true,
            "type": "string",
            "maxLength": 6
          }
        ],
        "responses": {
          "200": {
            "description": "OK",
            "schema": {}
          },
          "404": {}
        }
      }
    }
  }
}
  
```



## .properties file#

```

apiDescriptionFile=./cscvinc.json
dataStructuresLocation=./syslib
apiInfoFileLocation=./syslib
logFileDirectory=./logs
language=COBOL
connectionRef=cscvincAPI
requesterPrefix=csc
  
```

#Additional property file attributes, e.g., *defaultCharacterMaxLength*, *defaultArrayMaxItems*, etc. are described at **The build toolkit properties file** article at URL <https://www.ibm.com/docs/en/zosconnect/3.0?topic=toolkit-build-properties-file>

# Steps to calling an external API

Using `zconbt` to generate API requester archive and API client code from Swagger

```
zconbt.bat -p=./cscvinc.properties -f=./cscvinc.ara
BAQB0000I: z/OS Connect Enterprise Edition 3.0 Build Toolkit Version 1.5 (20210816-0926).
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.
. . .
Total 4 operation(s) (success: 4, ignored: 0) defined in api description file: ./cscvinc.json
----- Successfully processed operation(s) -----
operationId: getCscvincSelectService, basePath: /cscvincapi, relativePath: /employee/{employee}, method: GET
- request data structure : CSC00Q01
- response data structure : CSC00P01
- api info file : CSC00I01

operationId: putCscvincUpdateService, basePath: /cscvincapi, relativePath: /employee/{employee}, method: PUT
- request data structure : CSC01Q01
- response data structure : CSC01P01
- api info file : CSC01I01

operationId: postCscvincInsertService, basePath: /cscvincapi, relativePath: /employee/{employee}, method: POST
- request data structure : CSC02Q01
- response data structure : CSC02P01
- api info file : CSC02I01

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

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

# Tech-Tip: Copy books names

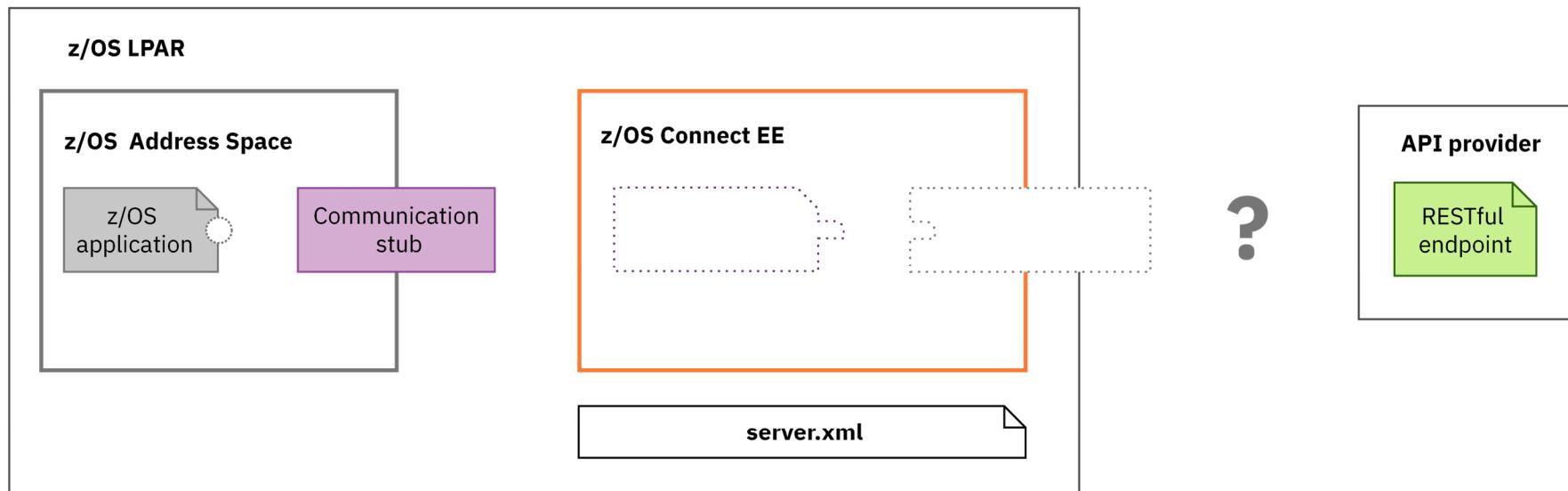


z/OS Connect EE

- Up to three copy books are generated for each method of each API found in the Swagger document. In the previous example, there were 4 APIs with each having 1 method for a total of 12 copy books.
- The naming convention for the generated COBOL copy books is based on the *requesterPrefix* value specified in the properties file. That value was set to CSC in this case, e.g., CSC#####. The next 2 characters in the name are assigned sequentially as each API and method is processed, e.g., CSC00### and CSC01###, CSC02### and CSC03CSC.
- The next character will be either a Q, P or an I. A “Q” for a **request** copy book, the “P” for a **response** copy book and the “I” for the copy book which contains **information**, e.g., method, path name etc. derived from the Swagger document

# Steps to calling an external API

Update the application by adding the copy books and a call to communication stub



Configure a communication stub.

- For CICS region systems using URIMAP resources
- For non CICS client the configuration is done via environment variables

 [ibm.biz/zosconnect-configure-comms-stub](http://ibm.biz/zosconnect-configure-comms-stub)

# Steps to calling an external API

Include the generated copy books in a COBOL program

```
GETAPI X
  * ERROR MESSAGE STRUCTURE
  01 ERROR-MSG.
    03 EM-ORIGIN          PIC X(8)  VALUE SPACES.
    03 EM-CODE            PIC S9(9) COMP-5 SYNC VALUE 0.
    03 EM-DETAIL          PIC X(1024) VALUE SPACES.

  * Copy API Requester required copybook
  COPY BAQRINFO.

  * Request and Response
  01 API-REQUEST.
    COPY CSC02Q01.
  01 API_RESPONSE.
    COPY CSC02P01.

  * Structure with the API information
  01 API-INFO-OPER1.
    COPY CSC02I01.

  * Request and Response segment used to store request and
    III
```

## API-REQUEST

```
CSC00I01  CSC00Q01 X
  * JSON schema keyword 'minLength' value: '0'.
  * JSON schema keyword 'maxLength' value: '6'.
  * This field contains a varying length array of characters or
  * binary data.
  *      09 employee-length          PIC S9999 COMP-5 SYNC.
  *      09 employee                PIC X(6).
  *
  * ++++++
  06 ReqPathParameters.
    09 employee-length          PIC S9999 COMP-5 SYNC.
    09 employee                PIC X(6).
```

## API-RESPONSE

```
CSC00I01  CSC00Q01  CSC00P01 X
  * ++++++
  06 RespBody.
    09 cscvincap0-num          PIC S9(9) COMP-5 SYNC.
    09 cscvincap0-operatio.
      12 Container1.
    15 RESPONSE-CONTAINER2-num PIC S9(9) COMP-5
      SYNC.
```

## API-INFO-OPER1

```
CSC00I01 X
  03 BAQ-APINAME           PIC X(255)
    VALUE 'cscvincapi_1.0.0'.
  03 BAQ-APINAME-LEN        PIC S9(9) COMP-5 SYNC
    VALUE 16.
  03 BAQ-APIPATH            PIC X(255)
    VALUE '%2Fcvincap%2Femployee%2F%7Bemployee%7D'.
  03 BAQ-APIPATH-LEN        PIC S9(9) COMP-5 SYNC
    VALUE 41.
  03 BAQ-APIMETHOD          PIC X(255)
    VALUE 'GET'.
  03 BAQ-APIMETHOD-LEN      PIC S9(9) COMP-5 SYNC
    VALUE 3.
```

# Steps to calling an external API

Add a call to the communication stub passing pointers to working storage of the copy books

The diagram illustrates the steps to calling an external API. It shows the GETAPI PGM code, the communication stub definitions (CSC00101, CSC00Q01, CSC00P01), and the zCEE code.

**GETAPI PGM:**

```
* Set up the data for the API Requester call
*
MOVE numb      of PARM-DATA TO numb IN API-REQUEST.
MOVE LENGTH of numb in API-REQUEST to
numb-length IN API-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 API-REQUEST.
MOVE LENGTH OF API-REQUEST TO BAQ-REQUEST-LEN.
SET BAQ-RESPONSE-PTR TO ADDRESS OF API_RESPONSE.
MOVE LENGTH OF API_RESPONSE TO BAQ-RESPONSE-LEN.

*
* Call the communication stub
*
* Call the subsystem-supplied stub code to send
* API request to zCEE
CALL COMM-STUB-PGM-NAME USING
BY REFERENCE API-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
```

**CSC00101:**

03 BAQ-APINAME	PIC X(255)
VALUE 'cscvincap1_1.0.0'.	
03 BAQ-APINAME-LEN	PIC S9(9) COMP-5 SYNC
VALUE 16.	
03 BAQ-APIPATH	PIC X(255)
VALUE 'S2fcsvincap1%2Femployee%7D'.	
03 BAQ-APIPATH-LEN	PIC S9(9) COMP-5 SYNC
VALUE 41.	
03 BAQ-APIMETHOD	PIC X(255)
VALUE 'GET'.	
03 BAQ-APIMETHOD-LEN	PIC S9(9) COMP-5 SYNC
VALUE 3.	

**CSC00Q01:**

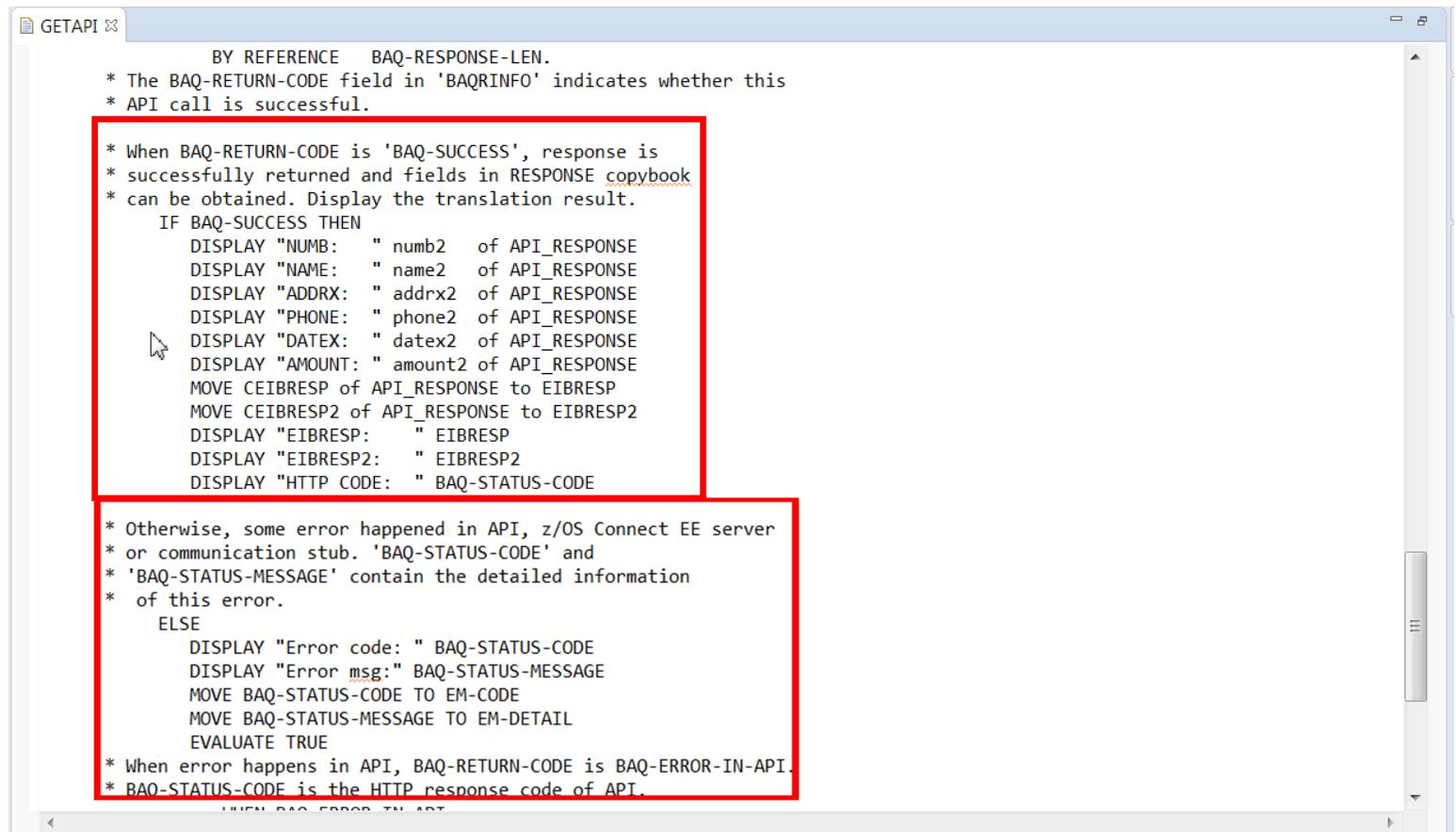
06 ReqPathParameters.	
09 employee-length	PIC S9999 COMP-5 SYNC.
09 employee	PIC X(6).
*	
*	
*	
06 ReqPathParameters.	
09 employee-length	PIC S9999 COMP-5 SYNC.
09 employee	PIC X(6).

**CSC00P01:**

06 RespBody.	
09 cscvincSelectServiceOp-num	PIC S9(9) COMP-5 SYNC.
09 cscvincSelectServiceOperatio-	
12 Container1.	
15 RESPONSE-CONTAINER2-num	PIC S9(9) COMP-5
SYNC.	

# Steps to calling an external API

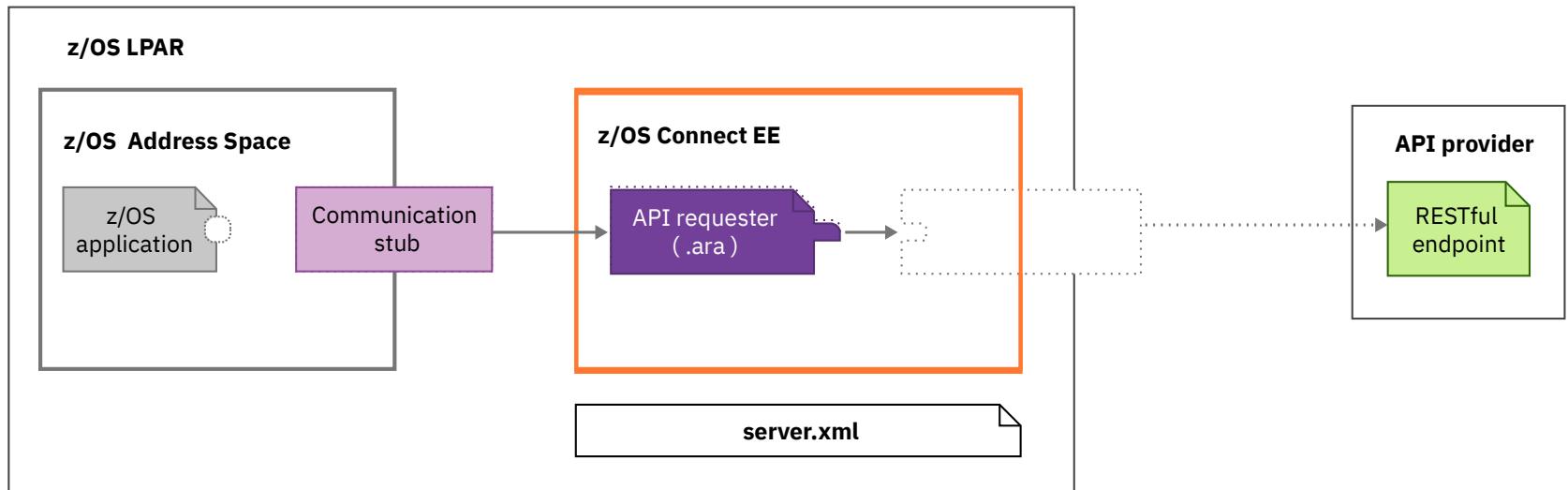
## Access the results



```
BY REFERENCE BAQ-RESPONSE-LEN.  
* The BAQ-RETURN-CODE field in 'BAQRINFO' indicates whether this  
* API call is successful.  
  
* When BAQ-RETURN-CODE is 'BAQ-SUCCESS', response is  
* successfully returned and fields in RESPONSE copybook  
* can be obtained. Display the translation result.  
IF BAQ-SUCCESS THEN  
    DISPLAY "NUMB: " numb2 of API_RESPONSE  
    DISPLAY "NAME: " name2 of API_RESPONSE  
    DISPLAY "ADDRX: " addrx2 of API_RESPONSE  
    DISPLAY "PHONE: " phone2 of API_RESPONSE  
    DISPLAY "DATEX: " datex2 of API_RESPONSE  
    DISPLAY "AMOUNT: " amount2 of API_RESPONSE  
    MOVE CEIBRESP of API_RESPONSE to EIBRESP  
    MOVE CEIBRESP2 of API_RESPONSE to EIBRESP2  
    DISPLAY "EIBRESP: " EIBRESP  
    DISPLAY "EIBRESP2: " EIBRESP2  
    DISPLAY "HTTP CODE: " BAQ-STATUS-CODE  
  
* Otherwise, some error happened in API, z/OS Connect EE server  
* or communication stub. 'BAQ-STATUS-CODE' and  
* 'BAQ-STATUS-MESSAGE' contain the detailed information  
* of this error.  
ELSE  
    DISPLAY "Error code: " BAQ-STATUS-CODE  
    DISPLAY "Error msg: " BAQ-STATUS-MESSAGE  
    MOVE BAQ-STATUS-CODE TO EM-CODE  
    MOVE BAQ-STATUS-MESSAGE TO EM-DETAIL  
    EVALUATE TRUE  
    * When error happens in API, BAQ-RETURN-CODE is BAQ-ERROR-IN-API.  
    * BAQ-STATUS-CODE is the HTTP response code of API.  
    WHEN BAQ-ERROR-IN-API
```

# Steps to calling an external API

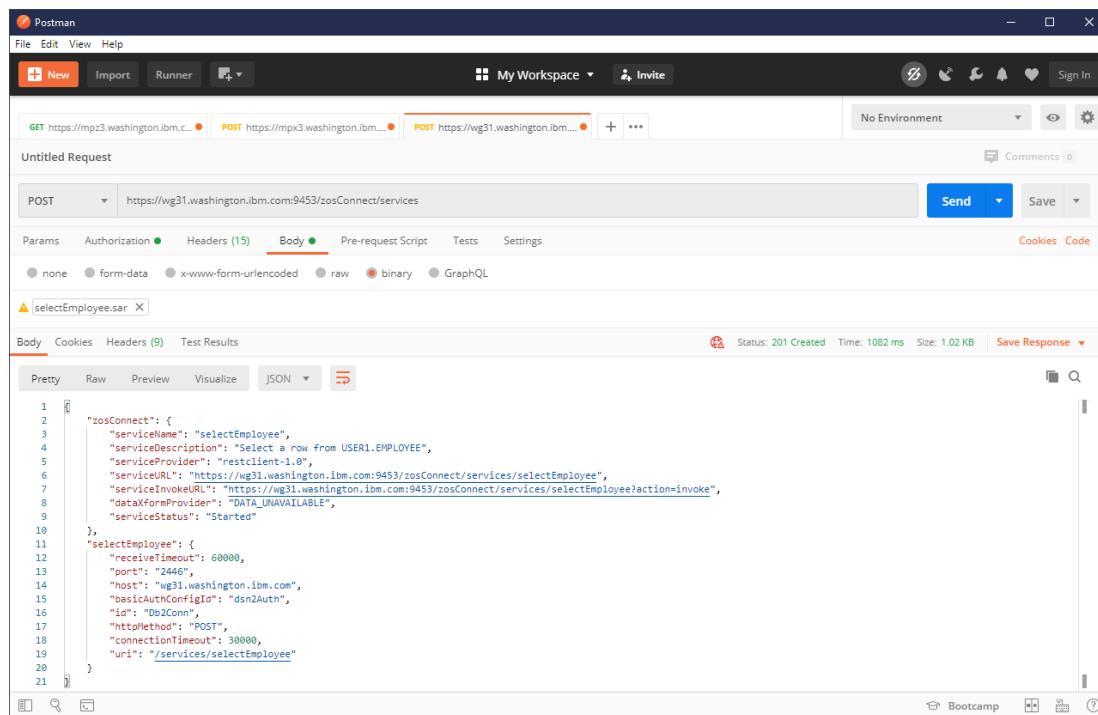
Deploy API requester (.ara) archive



Deploy your API requester archive to the *apiRequesters* directory.

# Deploying Service Archive options

- Use SAR as request message and use HTTP POST
- Use URI path /zosConnect/services
- Postman or cURL



The screenshot shows the Postman application interface. At the top, there are three tabs: 'GET https://mpx3.washington.ibm.com...', 'POST https://mpx3.washington.ibm.com...', and 'POST https://wg31.washington.ibm.com:9453/zosConnect/services'. The third tab is selected. Below the tabs, the URL 'https://wg31.washington.ibm.com:9453/zosConnect/services' is entered again. The 'Body' tab is selected, showing a file named 'selectEmployee.sar' with a binary content type. The file content is displayed as JSON code:

```

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
{
  "zosConnect": {
    "serviceName": "selectEmployee",
    "serviceDescription": "Select a row from USER1.EMPLOYEE",
    "serviceProvider": "restclient-1.0",
    "serviceURL": "https://wg31.washington.ibm.com:9453/zosConnect/services/selectEmployee",
    "dataFormProvider": "DATA_UNAVAILABLE",
    "serviceStatus": "Started"
  },
  "selectEmployee": {
    "receiveTimeout": 60000,
    "port": "2446",
    "host": "wg31.washington.ibm.com",
    "basicAuthConfigId": "dsn2Auth",
    "id": "Db2Conn",
    "httpMethod": "POST",
    "connectionTimeout": 30000,
    "uri": "/services/selectEmployee"
  }
}

```

## Command:

```

curl --data-binary @selectEmployee.sar
--header "Content-Type: application/zip"
https://mpxm:9453/zosConnect/services

```

## Results:

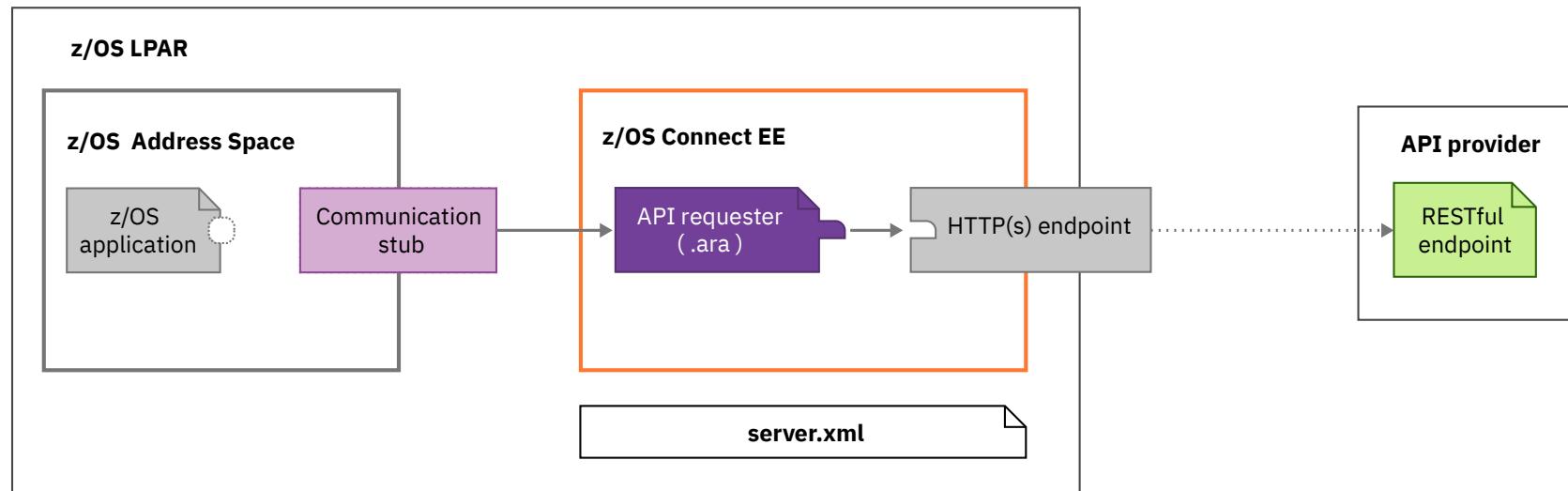
```

{
  "zosConnect": {
    "serviceName": "selectEmployee",
    "serviceDescription": "Select a row from USER1.EMPLOYEE",
    "serviceProvider": "IBM_ZOS_CONNECT_SERVICE_REST_CLIENT-1.0",
    "serviceURL": "https://mpxm:9453/zosConnect/services/selectEmployee",
    "serviceInvokeURL": "https://mpxm:9453/zosConnect/services/selectEmployee?action=invoke",
    "dataXformProvider": "DATA_UNAVAILABLE",
    "serviceStatus": "Started"
  },
  "selectEmployee": {
    "receiveTimeout": 0,
    "port": null,
    "host": null,
    "httpMethod": "POST",
    "connectionTimeout": 0,
    "uri": "/services/selectEmployee"
  }
}

```

# Steps to calling an external API

Configure HTTP(S) endpoint configuration element



Configure the connection between z/OS Connect EE and the external API.

 [ibm.biz/zosconnect-configure-endpoint-connection](http://ibm.biz/zosconnect-configure-endpoint-connection)

# Steps to calling an external API

Update the server XML configuration for the endpoint

A screenshot of a browser window displaying the Swagger JSON definition for the cscvinc API. The URL is /C:/apiRequester/cscvinc/swagger.json. The JSON structure shows the API's version, host, basePath, schemes, consumes, produces, and paths.

```
swagger: "2.0"
info:
  description: ""
  version: "1.0.0"
  title: "cscvinc"
  host: "localhost:8080"
  basePath: "/cscvinc"
schemes:
  0: "https"
  1: "http"
consumes:
  0: "application/json"
produces:
  0: "application/json"
paths:
  /employee:
    post:
```

A screenshot of the IBM ISPF editor showing the COBOL source code for the API endpoint. The code defines several parameters related to the API call.

```
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 '/cscvinc/employee/{numb}'.
03 BAQ-APIPATH-LEN   PIC S9(9) COMP-5 SYNC  VALUE 24.
03 BAQ-APIMETHOD     PIC X(255)          VALUE 'GET'.
03 BAQ-APIMETHOD-LEN PIC S9(9) COMP-5 SYNC  VALUE 3.
```

**cscvinc.properties**  
connectionRef=cscvincAPI

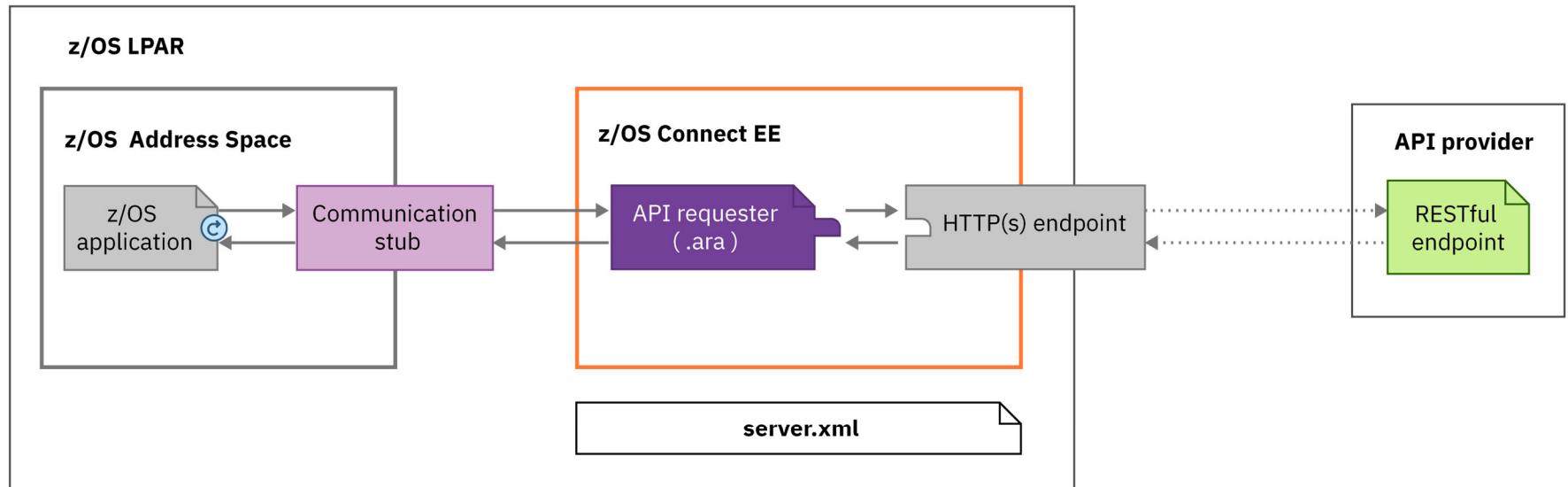
A screenshot of the Server Config interface showing the XML configuration for the apiRequesterHTTPS.xml file. A red oval highlights the <zosconnect\_endpointConnection> element. The XML code includes details such as host, port, authenticationConfigRef, and connectionTimeout.

```
<zosconnect_endpointConnection id="cscvincAPI"
  host="https://dvipa.washington.ibm.com"
  port="9443"
  authenticationConfigRef="mySAFAuth"
  connectionTimeout="10s"
  receiveTimeout="40s" />
```

<http://dvipa.washington.ibm.com:9443/cscvincapi/employee/{numb}>

# Steps to calling an external API

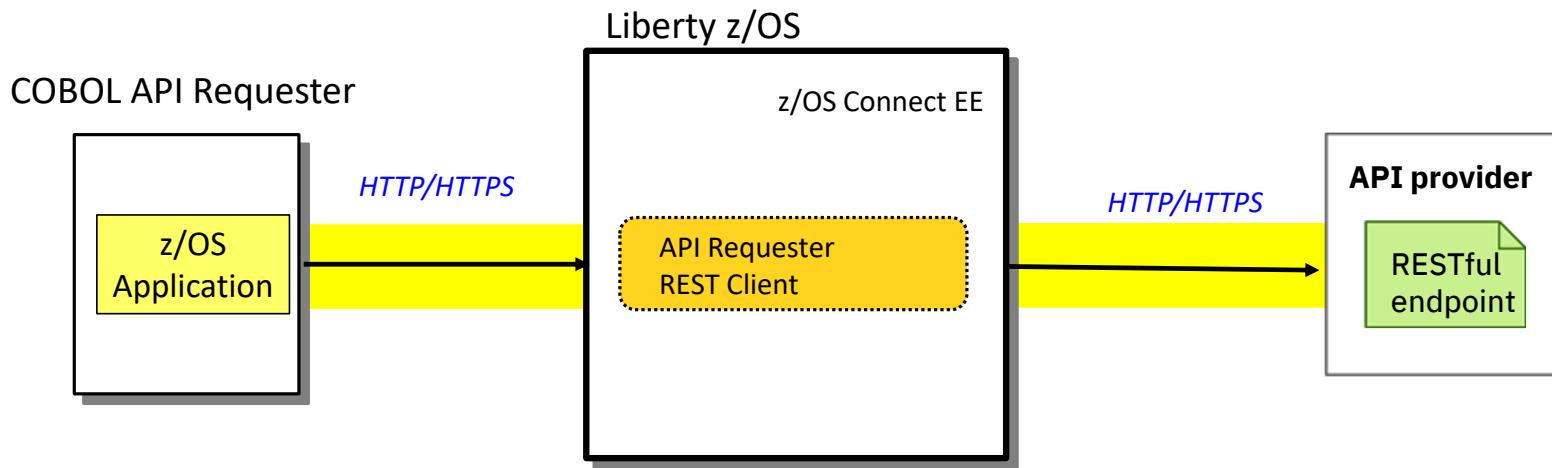
Done





z/OS Connect EE

## API requester to API Provider connection overview



MVS Batch and IMS HTTP connection details provided by:

- Environment Variables (BAQURI, BAQPORT)
  - Via JCL
  - LE Options (CEEROPTS)
  - Programmatically (CEEENV)
- HTTP or HTTPS

CICS HTTP connection details provided by:

- CICS URIMAP resource (default BAQURIMP)
  - HOST
  - PORT
  - SCHEME (HTTP/HTTPS)



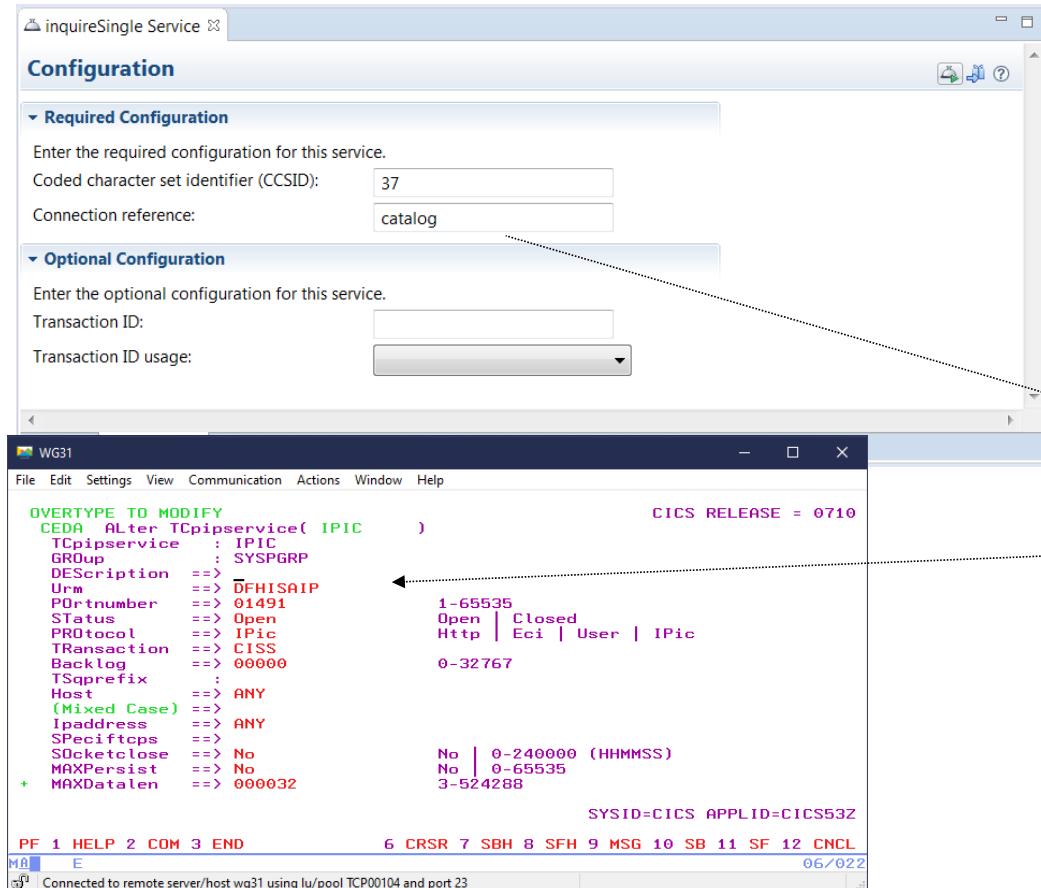
## **/common\_scenarios**

Typical connection patterns to different subsystems.



# Accessing a CICS program using IPIC

The server.xml file is the key configuration file:



Features are functional building blocks. When configured here, that function becomes available to the Liberty server

catalog.xml

Design	Source
	<pre>1&lt;server description="CICS IPIC - catalog"&gt; 2 3&lt;!-- Enable features --&gt; 4&lt;featureManager&gt; 5  &lt;feature&gt;zosconnect:cicsService-1.0&lt;/feature&gt; 6&lt;/featureManager&gt; 7 8&lt;zosconnect_cicsIpicConnection id="catalog"&gt; 9  host="wg31.washington.ibm.com" 10 port="1491" 11 transid="CSMI" 12 transidUsage="EIB_AND_MIRROR"/&gt; 13 14&lt;/server&gt; 15</pre>

Define IPIC connection to CICS

# IMS Connections and Interactions (server XML)



ivtnoService Service Configuration

**Required Configuration**

Enter the required configuration for this service.

Connection profile: **IMSCONN**

Interaction profile: **IMSINTER**

**Optional Configuration**

Enter the optional configuration for this service.

IMS destination override:

Program name:

Overview Configuration

## IMS Connect HWSCFG

```
HWS= (ID=IMS14HWS, XIBAREA=100, RACF=Y, RRS=N)
TCPIP= (HOSTNAME=TCPIP, PORTID= (4000, LOCAL) , RACFID=JOHNSON, TIMEOUT=
5000)
DATASTORE= (GROUP=OTMAGRP, ID=IVP1, MEMBER=HWSMEM, T MEMBER=OTMAMEM)
IMSPLEX= (MEMBER=IMS14HWS, T MEMBER=PLEX1)
ODACCESS= (ODBMAUTOCONN=Y,
DRDAPORT= (ID=5555, PORTTMOT=6000) , ODBMTMOT=6000)
```

## Connection

```
<server>
<imsmobile_imsConnection comment="" connectionFactoryRef="CF1" connectionTimeout="-1" connectionType="IMSCONNECT" id="IMSCONN"/>
<connectionFactory containerAuthDataRef="Connection1_Auth" id="CF1">
    <properties.gmoa hostName="wg31.washington.ibm.com" portNumber="4000"/>
</connectionFactory>

<authData id="Connection1_Auth" password="encryptedPassword1" user="userName1"/>
</server>
```

## Interaction

```
<server>
<imsmobile_interaction comment="" commitMode="1" id="IMSINTER" imsConnectCodepage="Cp1047" imsConnectTimeout="0"
    imsDatastoreName="IVP1" interactionTimeout="-1" ltermOverrideName="" syncLevel="0"/>
</server>
```



# IMS Connection Factory in the server XML

Service Project Editor: Configuration

Required Configuration

Enter the required configuration for this service.

Connection profile:

## ConnectionFactory

```
<connectionFactory id="DFSIVPACConn">
<properties.imsudbJLocal
    databaseName="DFSIVPA"
    datastoreName="IVP1"
    datastoreServer="wg31.washington.ibm.com"
    driverType="4"
    portNumber="5555"
    user="USER1"
    password="password"
    flattenTables="True"/>
</connectionFactory>
```

## IMS Connect HWSCFG

```
HWS=(ID=IMS14HWS,XIBAREA=100,RACE=N,RRS=N)
TCPIP=(HOSTNAME=TCPIP,PORTID=(4000,LOCAL),RACFID=JOHNSON,TIMEOUT=5000)
DATASTORE=(GROUP=OTMAGRP,ID=IVP1, MEMBER=HWSMEM, TMEMBER=OTMAMEM)
IMSPLEX=(MEMBER=IMS14HWS, TMEMBER=PLEX1)
ODACCESS=(ODBMAUTOCCONN=Y,
DRDAPORT=(ID=5555,PORTTMOT=6000), ODBMTMOT=6000)
```

# Accessing a Db2 REST service resource



Screenshot of the Service Project Editor: Configuration window for the "selectEmployee Service".

The left pane shows the configuration details:

- Connection reference: db2conn
- DSNL004I -DSN2 DDF START COMPLETE
- LOCATION DSN2LOC
- LU
- USIBMWZ.DSN2APPL
- GENERICLU -NONE
- DOMAIN
- WG31.WASHINGTON.IBM.COM
- TCPPORT 2446
- SECPORT 2445
- RESPORT 2447

The right pane shows the XML configuration file "db2pass.xml" with the "Source" tab selected:

```
1 <server description="DB2 REST">
2
3   <zosconnect_zosConnectServiceRestClientConnection id="db2conn">
4     host="wg31.washington.ibm.com"
5     port="2446"
6     basicAuthRef="dsn2Auth" />
7
8   <zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth">
9     applName="DSN2APPL"/>
10
11</server>
12
```

Red arrows point from the "db2conn" connection reference in the left pane to the "basicAuthRef" attribute in the XML code, and from the "WG31.WASHINGTON.IBM.COM" host entry in the left pane to the "host" attribute in the XML code.



# Using JMS to access MQ (One-Way)

mqGetService Service

Service Project Editor: Configuration

Required Configuration

Enter the required configuration for this service.

Connection factory JNDI name:  (Red arrow points from here)

Destination JNDI name:  (Red arrow points from here)

Coded character set identifier (CCSID):

Optional Configuration

Enter the optional configuration for this service.

Wait interval:

Message selector:

Definition Configuration

mq.xml

Read only Close

Design Source

```
2 <featureManager>
3   <feature>zosconnect:mqService-1.0</feature>
4 </featureManager>
5
6 <variable name="wmqJmsClient.rar.location"
7   value="/usr/lpp/mqm/V9R1M1/java/lib/jca/wmq.jmsra.rar"/>
8 <wmqJmsClient nativeLibraryPath="/usr/lpp/mqm/V9R1M1/java/lib"/>
9
10 <connectionManager id="ConMgr1" maxPoolSize="5"/>
11
12 <jmsConnectionFactory id="qmgrCf" jndiName="jms/qmgrCf"
13   connectionManagerRef="ConMgr1">
14   <properties.wmqJMS transportType="BINDINGS"
15     queueManager="QMZ1" />
16 </jmsConnectionFactory>
17
18 <jmsConnectionFactory id="qmgrCf2" jndiName="jms/qmgrCf2"
19   connectionManagerRef="ConMgr1">
20   <properties.wmqJMS transportType="CLIENT"
21     queueManager="ZMQ1"
22       channel="LIBERTY.DEF.SVRCONN"
23       hostName="wg31.washington.ibm.com"
24       port="1422" />
25 </jmsConnectionFactory>
26
27 <jmsQueue id="q1" jndiName="jms/default">
28   <properties.wmqJms
29     baseQueueName="ZCONN2.DEFAULT.MQZCEE.QUEUE"
30     CCSID="37"/>
31 </jmsQueue>
32
33 <jmsQueue id="requestQueue" jndiName="jms/request">
34   <properties.wmqJms
35     baseQueueName="ZCONN2.TRIGGER.REQUEST"
36     targetClient="MQ"
37     CCSID="37"/>
38 </jmsQueue>
39
40 <jmsQueue id="replyQueue" jndiName="jms/replyQueue">
41   <properties.wmqJms
42     baseQueueName="ZCONN2.TRIGGER.RESPONSE"
43     targetClient="MQ"
44     CCSID="37"/>
45 </jmsQueue>
46
47
```



# Using JMS to access MQ (Two-Way)

\*twoway Service

## Service Project Editor: Configuration

**Required Configuration**

Enter the required configuration for this service.

Connection factory JNDI name:  (Red arrow points from here)

Request destination JNDI name:  (Red arrow points from here)

Reply destination JNDI name:  (Red arrow points from here)

Wait interval:

MQMD format:

Coded character set identifier (CCSID):

Is message persistent:

Reply selection:

Expiry:

**Definition** **Configuration**

mq.xml

Read only Close

Design Source

```
2 <featureManager>
3   <feature>zosconnect:mqService-1.0</feature>
4 </featureManager>
5
6 <variable name="wmqJmsClient.rar.location"
7   value="/usr/lpp/mqm/V9R1M1/java/lib/jca/wmq.jmsra.rar"/>
8 <wmqJmsClient nativeLibraryPath="/usr/lpp/mqm/V9R1M1/java/lib"/>
9
10 <connectionManager id="ConMgr1" maxPoolSize="5"/>
11
12 <jmsConnectionFactory id="qmgrCf" jndiName="jms/qmgrCf"
13   connectionManagerRef="ConMgr1">
14   <properties.wmqJMS transportType="BINDINGS"
15     queueManager="QMZ1" />
16 </jmsConnectionFactory>
17
18 <jmsConnectionFactory id="qmgrCf2" jndiName="jms/qmgrCf2"
19   connectionManagerRef="ConMgr1">
20   <properties.wmqJMS transportType="CLIENT"
21     queueManager="ZMQ1"
22       channel="LIBERTY.DEF.SVRCONN"
23       hostName="wg31.washington.ibm.com"
24       port="1422" />
25 </jmsConnectionFactory>
26
27 <jmsQueue id="q1" jndiName="jms/default">
28   <properties.wmqJms
29     baseQueueName="ZCONN2.DEFAULT.MQZCEE.QUEUE"
30     CCSID="37"/>
31 </jmsQueue>
32
33 <jmsQueue id="requestQueue" jndiName="jms/request">
34   <properties.wmqJms
35     baseQueueName="ZCONN2.TRIGGER.REQUEST"
36     targetClient="NO"
37     CCSID="37"/>
38 </jmsQueue>
39
40 <jmsQueue id="replyQueue" jndiName="jms/replyQueue">
41   <properties.wmqJms
42     baseQueueName="ZCONN2.TRIGGER.RESPONSE"
43     targetClient="MQ"
44     CCSID="37"/>
45 </jmsQueue>
46
47
```

# HATS server XML configuration



```
getCompany.properties - Notepad
File Edit Format View Help
provider=rest
name=getCompany
version=1.0
description=Obtain a list of companies
requestSchemaFile=getCompanyRequest.json
responseSchemaFile=getCompanyResponse.json
verb=POST
uri=/Trader/rest/GetCompany
connectionRef=HatsConn
```

Server Config

hats.xml

Read only Close

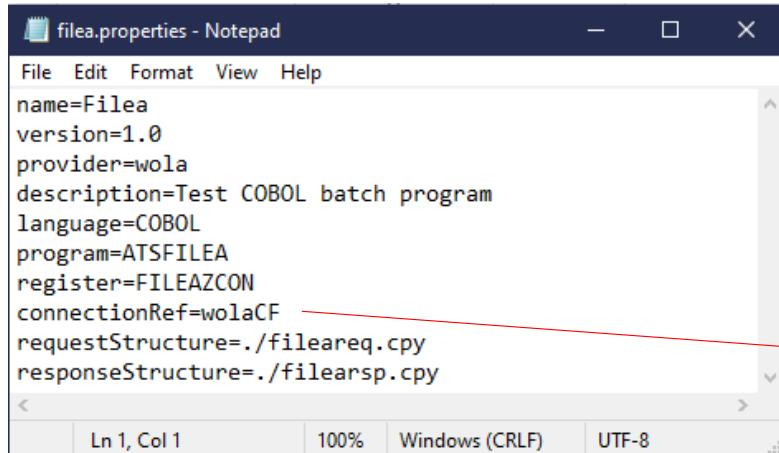
Design Source

```
<server description="HATS">
  <zosconnect_zosConnectServiceRestClientConnection id="HatsConn">
    host="wg31.washington.ibm.com"
    port="29080" />
</server>
```

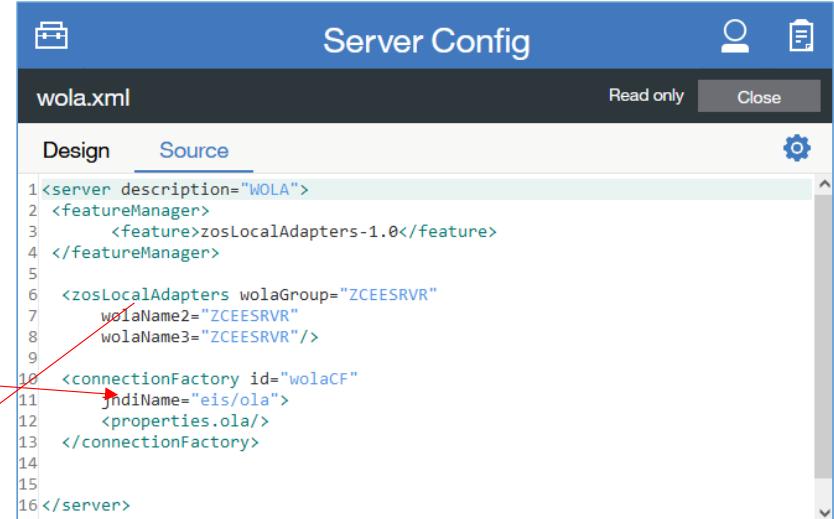
## HATS Liberty server.xml

```
<!-- To access this server from a remote client, add a host attribute to the following element, e.g. host="*" -->
<httpEndpoint id="defaultHttpEndpoint"
  httpPort="29080" host="*"
  httpsPort="29443" />
```

# MVS batch server XML



```
filea.properties - Notepad
File Edit Format View Help
name=Filea
version=1.0
provider=wola
description=Test COBOL batch program
language=COBOL
program=ATSFIL
register=FILEAZCON
connectionRef=wolaCF
requestStructure=./fileareq.cpy
responseStructure=./filearsp.cpy
```

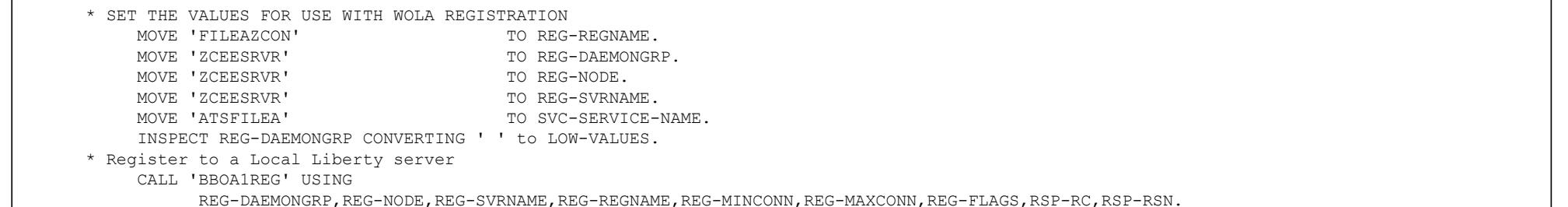


Server Config

wola.xml

Design      Source

```
<server description="WOLA">
  <featureManager>
    <feature>zosLocalAdapters-1.0</feature>
  </featureManager>
  <zosLocalAdapters wolaGroup="ZCEESRVR">
    wolaName2="ZCEESRVR"
    wolaName3="ZCEESRVR"/>
  <connectionFactory id="wolaCF">
    jndiName="eis/ola">
      <properties.ola/>
    </connectionFactory>
  </server>
```



```
* SET THE VALUES FOR USE WITH WOLA REGISTRATION
MOVE 'FILEAZCON'          TO REG-REGNAME.
MOVE 'ZCEESRVR'            TO REG-DAEMONGRP.
MOVE 'ZCEESRVR'            TO REG-NODE.
MOVE 'ZCEESRVR'            TO REG-SVRNAME.
MOVE 'ATSFIL'              TO SVC-SERVICE-NAME.
INSPECT REG-DAEMONGRP CONVERTING ' ' to LOW-VALUES.
* Register to a Local Liberty server
CALL 'BBOA1REG' USING
  REG-DAEMONGRP,REG-NODE,REG-SVRNAME,REG-REGNAME,REG-MINCONN,REG-MAXCONN,REG-FLAGS,RSP-RC,RSP-RSN.
```



# DVM server XML

Server Config

dvs.xml

Read only Close

Design Source

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
<!-- Enable features -->
<featureManager>
<feature>usr:dvsProvider</feature>
<feature>zosLocalAdapters-1.0</feature>
</featureManager>
<!-- Adapter Details with WOLA Group Name (ZCEEDVM) -->
<zosLocalAdapters wolaName3="NAME3"
wolaName2="NAME2"
wolaGroup="ZCEEDVM"/>
<!-- DVS Service Details with Register Name (ZCEEDVM) -->
<zosconnect_zosConnectService invokeURI="/dvs"
serviceDescription=""
serviceRef="dvsService"
serviceName="dvsService"
id="zosConnectDvsService"/>
<usr_dvsService invokeURI="/dvs"
serviceName="DVSS1"
registerName="ZCEEDVM"
connectionFactoryRef="wolaCF"
id="dvsService"/>
<connectionFactory jndiName="eis/ola" id="wolaCF">
<properties.ola/>
</connectionFactory>
<zosconnect_zosConnectService serviceRef="svc1"
serviceAsyncRequestTimeout="600s"
serviceName="dvs1" id="sdef1"/>
<zosconnect_localAdaptersConnectService
connectionWaitTimeout="7200"
connectionFactoryRef="wolaCF"
serviceName="DVSS1"
registerName="ZCEEDVM"
id="svc1"/>
</server>
```

**DVS . AVZS . SAVZEXEC (AVZSIN00)**

```
/*
 * Enable z/OS Connect interface facility
 */
if DoThis then
do
/*
 * The following parameter enables the z/OS Connect interface
 * facility.
*/
/*
"MODIFY PARM NAME(ZCONNECT)           VALUE(YES)"
"MODIFY PARM NAME(NETWORKBUFFERSIZE)   VALUE(96K)"
/*
/* The "DEFINE ZCPATH" command(s) can be used to define
/* paths to z/OS Connect regions to handle requests.
/* Use a separate 'DEFINE ZCPATH' command to define each
/* path required (Note that a single path can handle
/* several different requests)
/* refer to the documentation for details about the parameters,
/* and information about optional parameters.
*/
"DEFINE ZCPATH",
"  NAME(ZCEE)          '',
"  RNAME(ZCEEDVM)      '',
"  WNAME(ZCEEDVM)      '',
"
end
```

# File Manager server XML



```
filea.properties - Notepad
File Edit Format View Help
name=filea
provider=filmanager
host=wg31.washington.ibm.com
version=1.0
port=2800
file=USER1.ZCEE.FILEA
template=USER1.ZCEE.TEMPLATE(FILEA)
connid=default
userid=USER1
passwd=USER1
```

Server Config

filemgr.xml

Read only Close

Design Source

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
  <!-- Enable features -->
  <featureManager>
    <feature>filemanager:fmProvider-2.0</feature>
  </featureManager>
  <FileManager_Connection id="default"
    runport="2800"
    max_timeout="1800"/>
</server>
```

**SYS1.PROCLIB(IPVSRV1)**

```
//IPVSRV1 PROC PORT=2800,FAMILY='AF_INET',TRACE=N
//      SET ENV=''
//RUN      EXEC PGM=IPVSRV,REGION=40M,
//      PARM='(&ENV/&PORT &FAMILY &TRACE')
// SET IPV=SYSP.ADFZ.JCL          <== Update HLQ
//** Common component authorised library
//STEPLIB  DD DISP=SHR,DSN=ADFZ.SIPVMODA      <== ADFzCC APF LIBRARY
//SYSPRINT DD SYSOUT=*
//IPVTRACE DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//** Server wide, then participating product configurations
//CONFIG   DD DISP=SHR,DSN=&IPV.(IPVCFG)
```

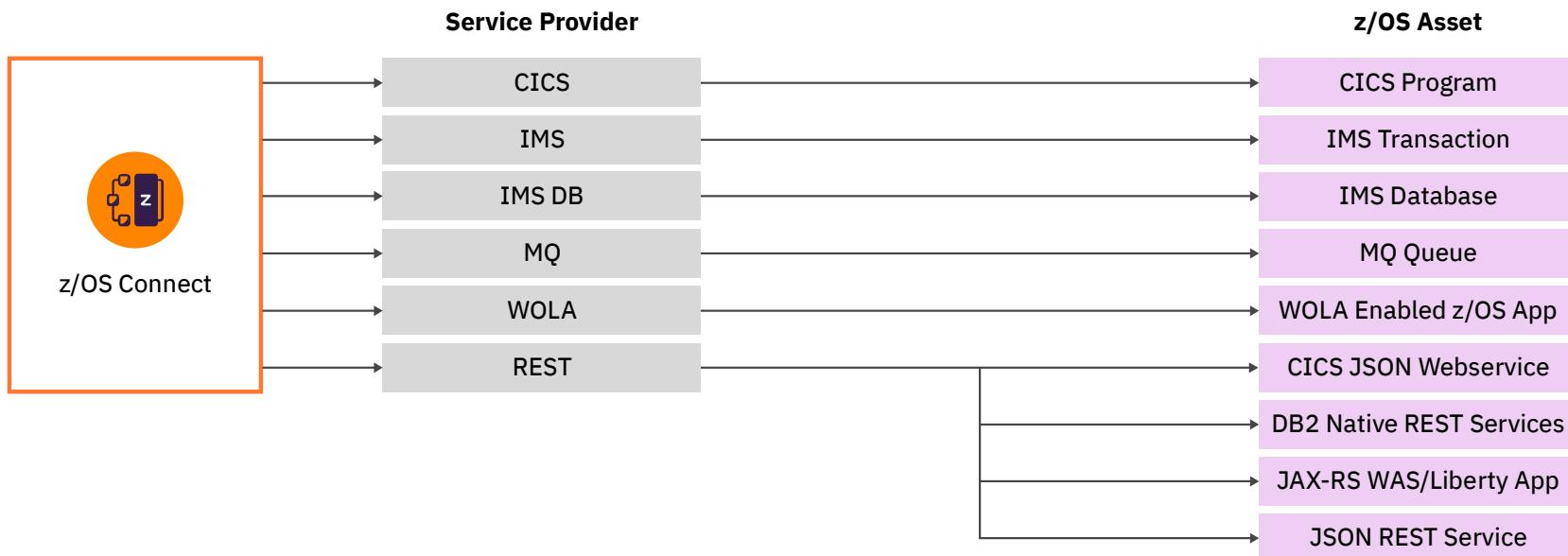


## /miscellaneousTopics

performance, high availability, Liberty

# What assets can z/OS Connect EE map to?

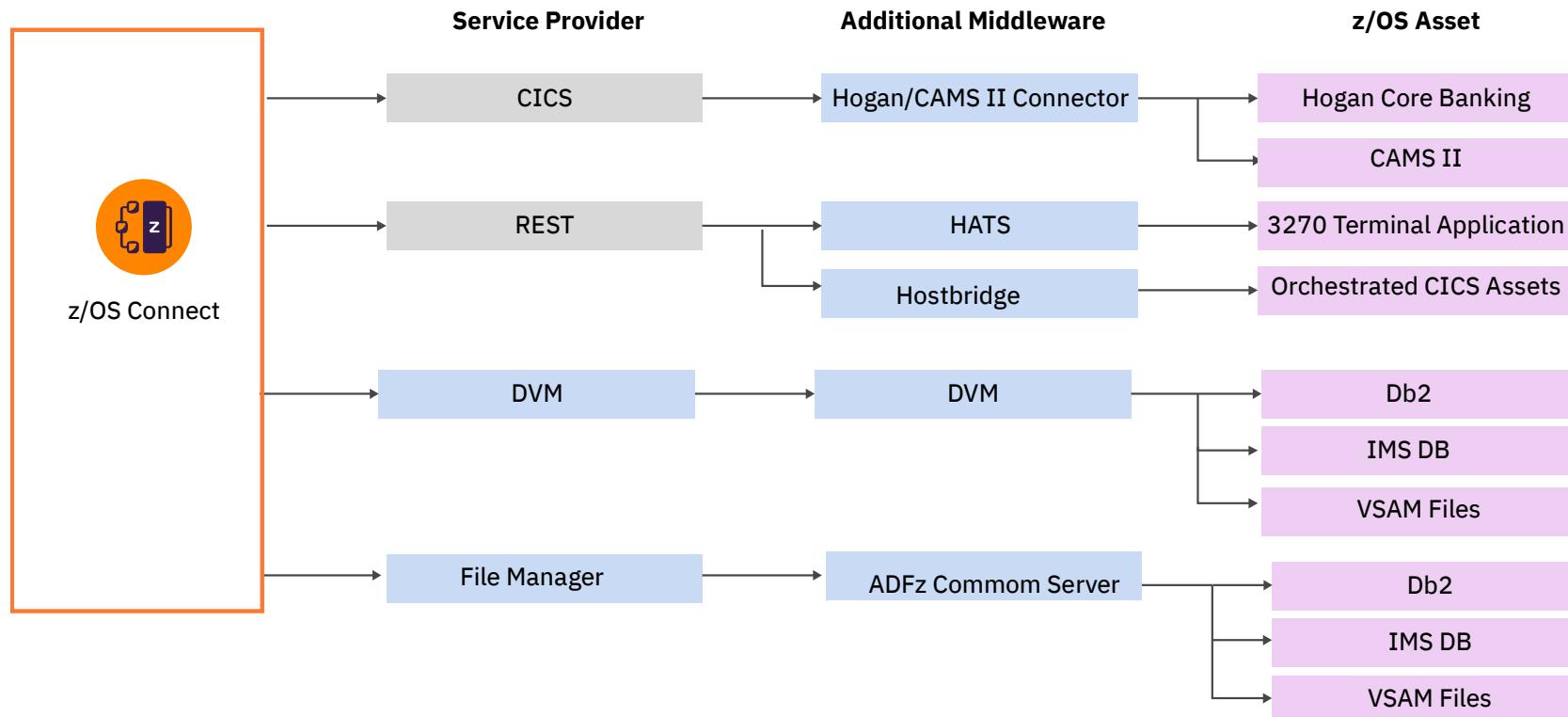
And which service provider could I use?



The core **service providers** included with z/OS Connect EE provide API access to a wide range of z/OS assets.

# Additional Middleware

Additional value from the ecosystem



z/OS Connect EE is **pluggable** and **extensible** allowing the use of additional middleware to expand the list of z/OS assets you can expose as APIs

# Tech/Tip: Providing access to service archives files



Name	Last Modified	Size	Description
<a href="#">apis</a>	Fri Feb 19 13:46:13 GMT 2021	-	Directory
<a href="#">services</a>	Sat Feb 20 20:54:41 GMT 2021	-	Directory
<a href="#">apiRequesters</a>	Wed Feb 07 17:59:04 GMT 2018	-	Directory
<a href="#">rules</a>	Tue Jan 26 20:34:05 GMT 2021	-	Directory

```
<webApplication id="resources-location" name="resources"
    location="${server.config.dir}/resources/zosconnect">
    <web-ext context-root="/resources/zosConnect"
        enable-file-serving="true" enable-directory-
        browsing="true">
        <file-serving-attribute name="extendedDocumentRoot"
            value="${server.config.dir}/resources/zosconnect" />
    </web-ext>
</webApplication>
```

Name	Last Modified	Size	Description
<a href="#">csvincDeleteService.sar</a>	Thu Feb 18 18:02:19 GMT 2021	4362	File
<a href="#">csvincInsertService.sar</a>	Thu Feb 18 18:02:19 GMT 2021	4491	File
<a href="#">csvincSelectService.sar</a>	Thu Feb 18 18:02:19 GMT 2021	4590	File

Opening csvincSelectService.sar

You have chosen to open:  
csvincSelectService.sar  
which is: SAR file (4.5 KB)  
from: https://wg31.washington.ibm.com:9453

What should Firefox do with this file?  
 Open with Applications\WINZIP32.EXE (default)  
 Save File

OK Cancel



# Tech/Tip: Providing access to configuration/log information

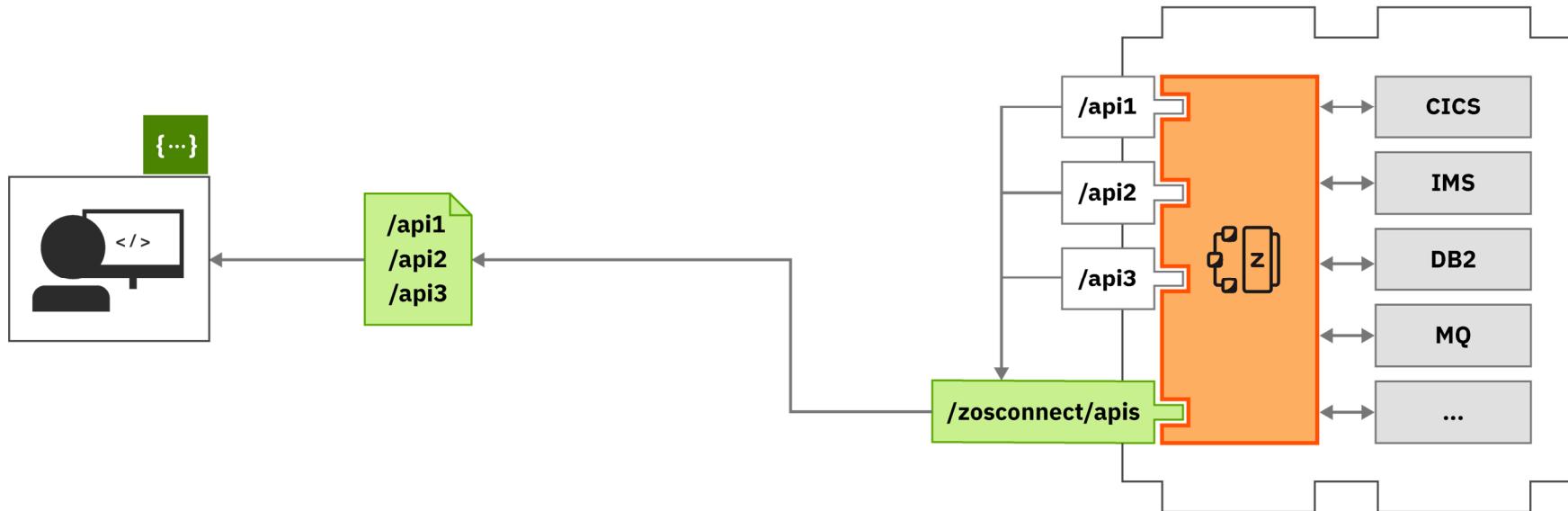
This XML file does not appear to have any style information associated with it. The document tree is shown below.

```
<!--<server description="new server">
<include location="${server.config.dir}/includes/safSecurity.xml"/>
<include location="${server.config.dir}/includes/ipicSSLIDProp.xml"/>
<include location="${server.config.dir}/includes/keyringOutbound.xml"/>
<include location="${server.config.dir}/includes/groupAccess.xml"/>
<include location="${server.config.dir}/includes/shared.xml"/>
<include location="${server.config.dir}/includes/oauth.xml"/>
<include location="${server.config.dir}/includes/adminCenter.xml"/>
<include location="${server.config.dir}/includes/mqClientTLS.xml"/>
<include location="${server.config.dir}/includes/web.xml"/>
<!-- Enable features -->
<featureManager>
<feature>zosconnect:zosConnect-2.0</feature>
<feature>zosconnect:zosConnectCommands-1.0</feature>
</featureManager>
<!--<br>
To access this server from a remote client add a host at
-->
<httpEndpoint id="defaultHttpEndpoint" host="*" httpPort="9080" ht
<!--<br>
add cors to allow cross origin access, e.g. when using s
-->
```

```
<webApplication id="serverConfig-location" name="serverConfig"
location="${server.config.dir}">
<web-ext context-root="/server/config"
enable-file-serving="true" enable-directory-browsing="true">
<file-serving-attribute name="extendedDocumentRoot"
value="${server.config.dir}" />
</web-ext>
</webApplication>
```

\*\*\*\*\*  
product = WAS FOR z/OS 20.0.0.6, z/OS Connect 03.00.41 (wlp-1.0.41.cl200620200528-0414)  
wlp.install.dir = /shared/IBM/zosconnect/v3r0/wlp/  
server.config.dir = /var/zosconnect/servers/myServer/  
java.home = /shared/java/J8\_0\_64  
java.version = 1.8.0\_261  
java.runtime = Java(TM) SE Runtime Environment (8.0.6.15 - pmz6480sr6fp15-20200724\_01(SR6 FP15))  
os = z/OS (02.03.00; s390x) (en\_US)  
process = 16778879@wg31  
\*\*\*\*\*  
[2/19/21 15:48:18:901 GMT] 0000000b com.ibm.ws.kernel.launch.internal.FrameworkManager  
[2/19/21 15:48:18:869 GMT] 00000017 com.ibm.ws.config.xml.internal.XMLConfigParser  
/var/zosconnect/servers/myServer/includes/safSecurity.xml  
/var/zosconnect/servers/myServer/includes/ipicIDProp.xml  
/var/zosconnect/servers/myServer/includes/oauth.xml  
/var/zosconnect/servers/myServer/includes/test.xml  
/var/zosconnect/servers/myServer/includes/keystoreOutbound.xml  
/var/zosconnect/servers/myServer/includes/groupAccess.xml  
[2/19/21 15:48:19:906 GMT] 00000017 com.ibm.ws.config.xml.internal.XMLConfigParser  
/var/zosconnect/servers/myServer/includes/shared.xml  
[2/19/21 15:48:19:907 GMT] 00000017 com.ibm.ws.config.xml.internal.XMLConfigParser  
/var/zosconnect/servers/myServer/includes/oauth.xml  
[2/19/21 15:48:19:911 GMT] 00000017 com.ibm.ws.config.xml.internal.XMLConfigParser  
/var/zosconnect/servers/myServer/includes/test.xml  
[2/19/21 15:48:19:994 GMT] 00000016 com.ibm.ws.zos.core.internal.NativeServiceTracker  
below-the-line storage limit is 8MB and the above-the-line storage limit is 1729MB.  
[2/19/21 15:48:19:997 GMT] 00000016 com.ibm.ws.zos.core.internal.NativeServiceTracker  
[2/19/21 15:48:20:012 GMT] 00000016 com.ibm.ws.zos.core.internal.NativeServiceTracker  
process.  
[2/19/21 15:48:20:089 GMT] 00000016 com.ibm.ws.zos.core.internal.NativeServiceTracker  
[2/19/21 15:48:20:091 GMT] 00000016 com.ibm.ws.zos.core.internal.NativeServiceTracker  
\*\*\*\*\*  
A CNWKE0001I: The server myServer has been launched.  
A CNWKG0028A: Processing included configuration resource:  
I CNWKB0125I: This server requested a REGION size of 0KB. The  
I CNWKB0126I: MEMLIMIT=1000. MEMLIMIT CONFIGURATION SOURCE=JCL.  
I CNWKB0122I: This server is connected to the default angel  
I CNWKB0103I: Authorized service group KERNEL is available.  
I CNWKB0103I: Authorized service group LOCALCOM is available

# API Documentation



APIs are discoverable via Swagger docs served from **z/OS Connect EE**.



## z/OS Connect administration API

Interface providing meta-data and life-cycle operations for z/OS Connect services, APIs and API requesters.

### APIs : Operations for working with APIs

Show/Hide | List Operations | Expand Operations

GET	/apis	Returns a list of all the deployed z/OS Connect APIs
POST	/apis	Deploys a new API into z/OS Connect
DELETE	/apis/{apiName}	Undeploys an API from z/OS Connect
GET	/apis/{apiName}	Returns detailed information about a z/OS Connect API
PUT	/apis/{apiName}	Updates an existing z/OS Connect API

### Services : Operations for working with services

Show/Hide | List Operations | Expand Operations

GET	/services	Returns a list of all the deployed z/OS Connect services
POST	/services	Deploys a new service into z/OS Connect
DELETE	/services/{serviceName}	Undeploys a service from z/OS Connect
GET	/services/{serviceName}	Returns detailed information about a z/OS Connect service
PUT	/services/{serviceName}	Updates an existing z/OS Connect service
GET	/services/{serviceName}/schema/{schemaType}	Returns the request or response schema for a z/OS Connect service

### API Requesters : Operations that work with API Requesters.

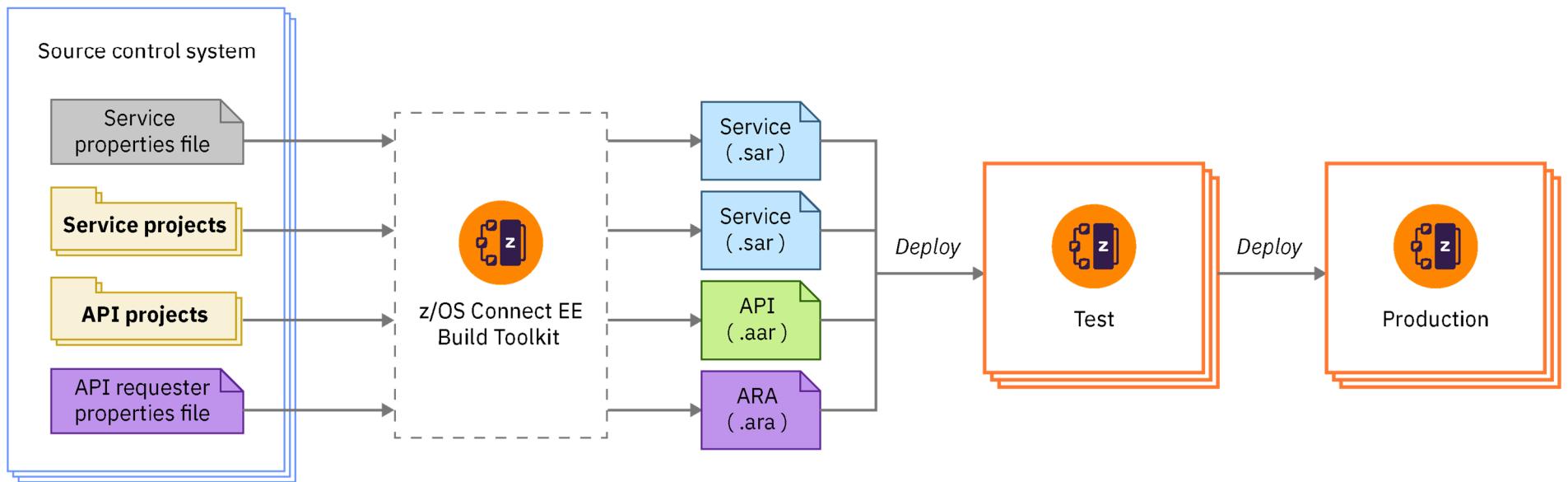
Show/Hide | List Operations | Expand Operations

GET	/apiRequesters	Returns a list of all the deployed z/OS Connect API Requesters
POST	/apiRequesters	Deploys a new API Requester into z/OS Connect and invoke an API Requester call
DELETE	/apiRequesters/{apiRequesterName}	Undeploys an API Requester from z/OS Connect
GET	/apiRequesters/{apiRequesterName}	Returns the detailed information about a z/OS Connect API Requester
PUT	/apiRequesters/{apiRequesterName}	Updates an existing z/OS Connect API Requester

# DevOps using z/OS Connect EE

Automate the development and deployment of services, APIs, and API requesters for continuous integration and delivery.

- The build toolkit supports the generation of service archives and API archives from projects created in the z/OS Connect EE API toolkit
- The build toolkit also supports the use of properties files to generate API requester archives
- Run the build toolkit from a build script to generate these archive files
- Deploy them to z/OS Connect servers by copying them to their deployment directories or by using the REST Admin API





# **/security**

How is security implement?

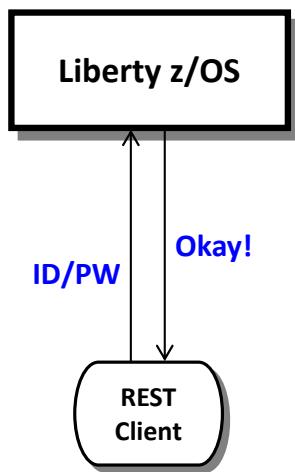
# API Provider Authentication



z/OS Connect EE

Several different ways this can be accomplished:

## Basic Authentication



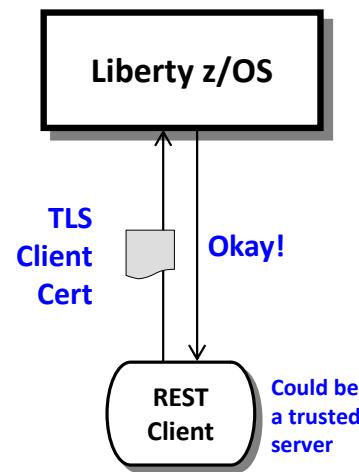
Server prompts for ID/PW

Client supplies ID/PW or  
ID/Passticket

Server checks registry:

- Basic (server.xml)
- LDAP
- SAF

## Client Certificate



Server prompts for cert.

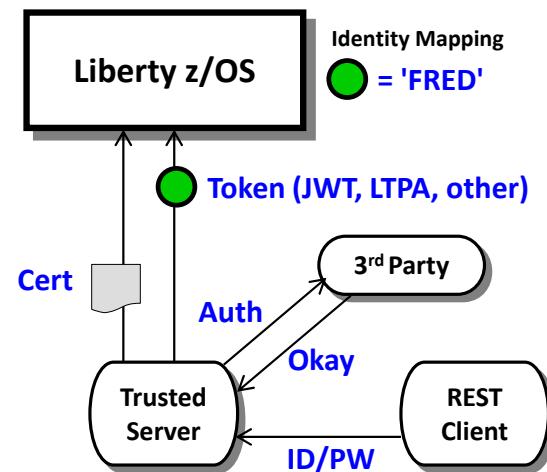
Client supplies certificate

Server validates cert and  
maps to an identity

Registry options:

- LDAP
- SAF

## Third Party Authentication



Client authenticates to 3<sup>rd</sup> party sever

Client receives a trusted 3<sup>rd</sup> party token

Token flows to Liberty z/OS and is  
mapped to an identity

Registry options:

- LDAP
- SAF

# Third Party Authentication Examples



The image displays two side-by-side screenshots of web pages illustrating third-party authentication:

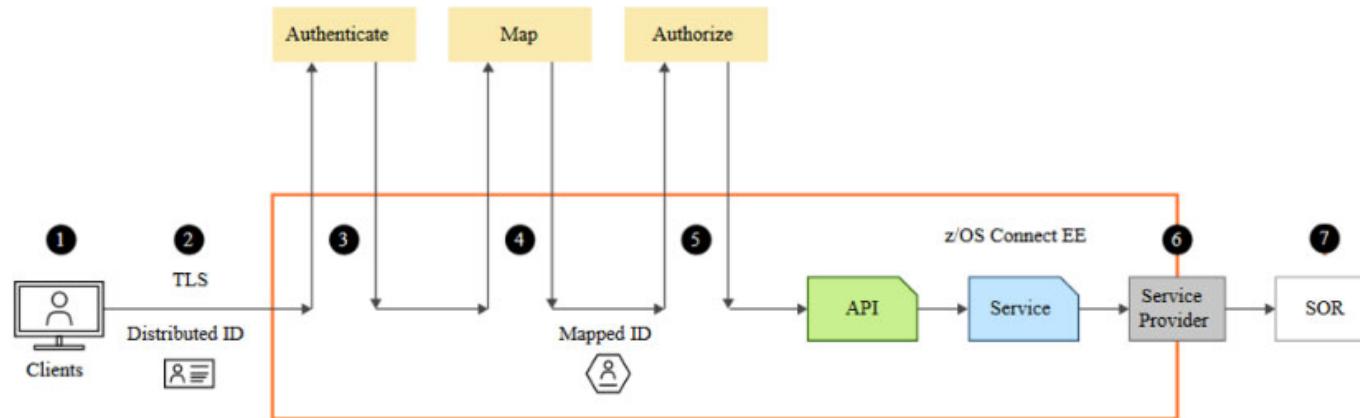
**Left Screenshot (UPS Sign Up):** A screenshot of the UPS Sign Up page. At the top, it says "Sign Up" and "UPS is open for business: Service impacts related to Coronavirus". Below this, there's a "Feedback" button. The main area contains fields for "Name \*", "Email \*", "User ID \*", "Password \*", and "Phone". There are also links for "Already have an ID? Log in" and "Use one of these sites" with icons for Google, Facebook, Amazon, Apple, and Twitter.

**Right Screenshot (myNCDMV Log In):** A screenshot of the myNCDMV Log In page. It features a "Log In" button and a "Sign Up" link. The main form includes fields for "Email Address" and "Password", a "Remember Me" checkbox, and "Forgot Password" link. Below the form are three "Continue with" buttons for Apple, Facebook, and Google. A "Continue as Guest" link is also present. The page has a background image of autumn foliage.

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# Typical z/OS Connect EE API Provider security flow



1. The credentials provided by the client
2. Secure the connection to the z/OS Connect EE server
3. Authenticate the client. This can be within the z/OS Connect EE server or by requesting verification from a third-party server
4. Map the authenticated identity to a user ID in the user registry
5. Authorize the mapped user ID to connect to z/OS Connect EE and optionally authorize user to invoke actions on APIs
6. Secure the connection to the System of Record (SoR) and provide security credentials to be used to invoke the program or to access the data resource
7. The program or database request may run in the SoR under the mapped ID

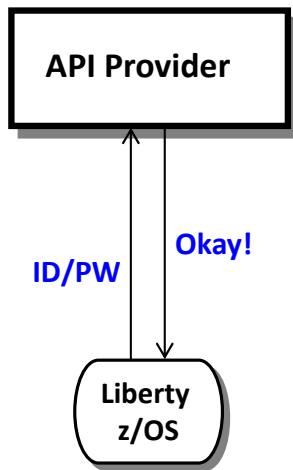
# API Requester Authentication



z/OS Connect EE

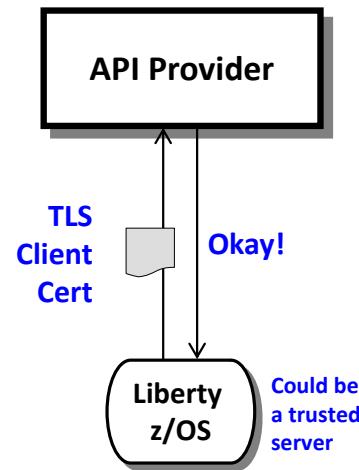
Several different ways this can be accomplished:

## Basic Authentication



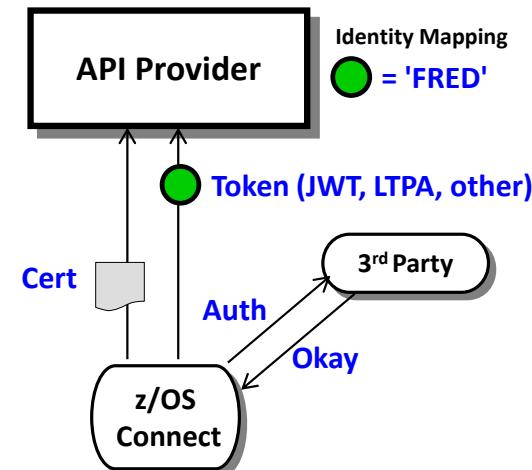
zCEE supplies ID/PW or  
ID/Passticket

## Client Certificate



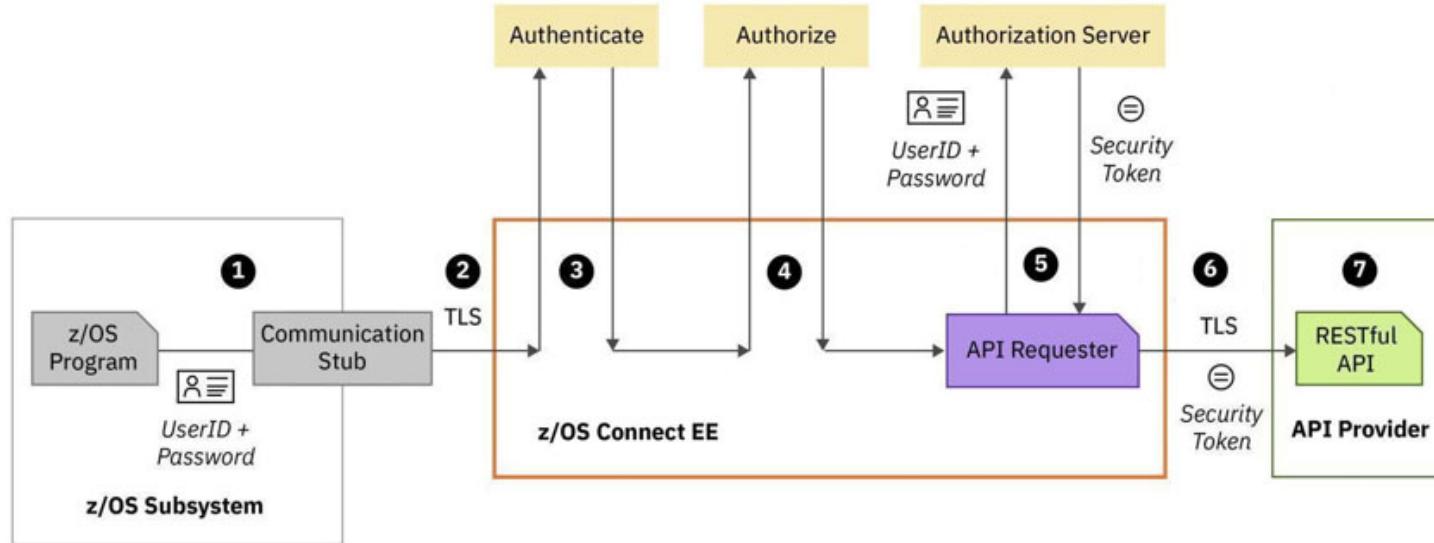
Server prompts for certificate  
zCEE supplies certificate

## Third Party Authentication



zCEE authenticates to 3<sup>rd</sup> party sever  
zCEE receives a trusted 3<sup>rd</sup> party token  
Token flows to API Provider

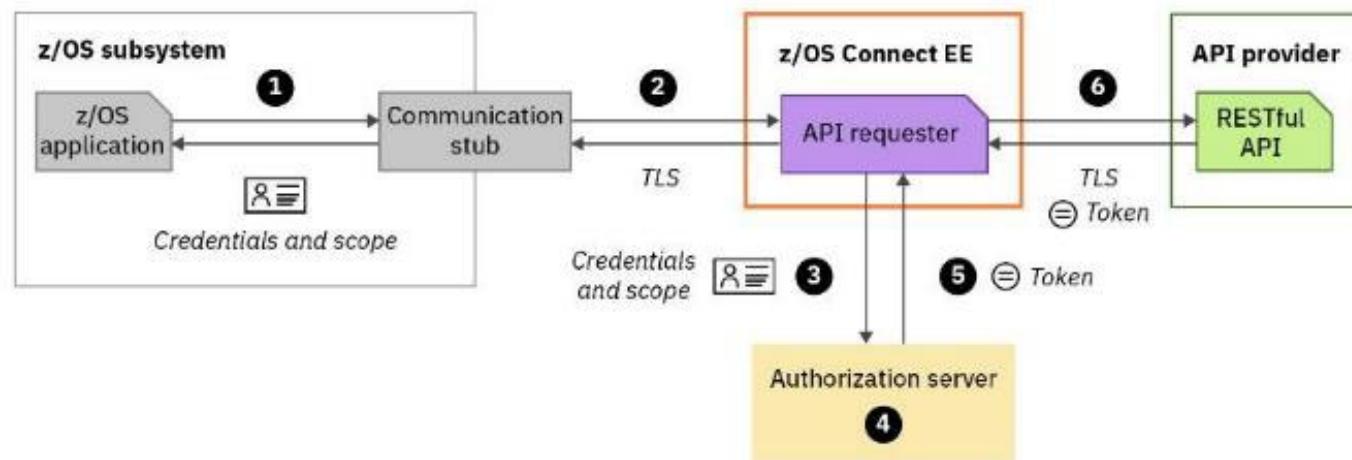
# Typical z/OS Connect EE API Requester security flow



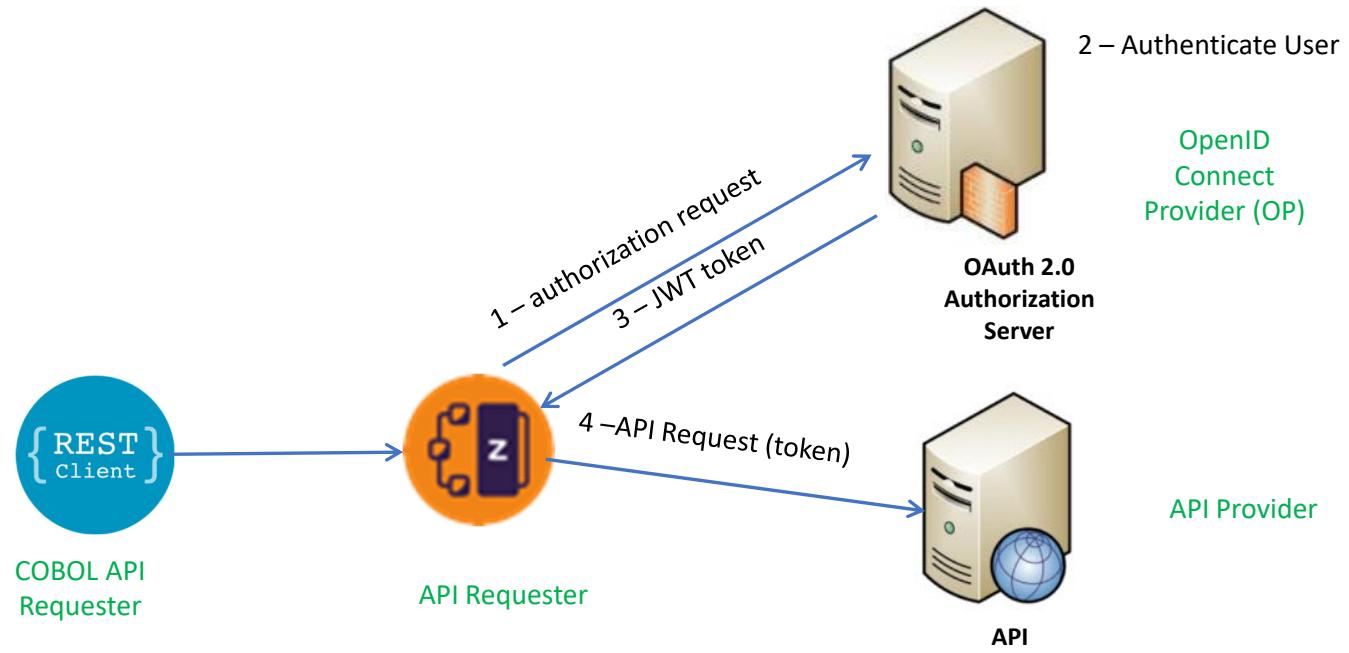
1. A user ID and password can be used for basic authentication by the z/OS Connect EE server
2. Connection between the CICS, IMS, or z/OS application and the z/OS Connect EE server can use TLS
3. Authenticate the CICS, IMS, or z/OS application.
4. Authorize the authenticated user ID to connect to z/OS Connect EE and to perform specific actions on z/OS Connect EE API requesters
5. Pass the user ID and password credentials to an authorization server to obtain a security token.
6. Secure the connection to the external API provider, and provide security credentials such as a security token to be used to invoke the RESTful API
7. The RESTful API runs in the external API provider



# Calling an API with OAuth 2.0 support



# z/OS Connect OAuth Flow for API requester



## Grant Types:

- client\_credentials
- password



## Configuring OAuth support – BAQRINFO copy book

```
05 BAQ-OAUTH.  
07 BAQ-OAUTH-USERNAME          PIC X(256) .  
07 BAQ-OAUTH-USERNAME-LEN      PIC S9(9) COMP-5 SYNC VALUE 0.  
07 BAQ-OAUTH-PASSWORD          PIC X(256) .  
07 BAQ-OAUTH-PASSWORD-LEN      PIC S9(9) COMP-5 SYNC VALUE 0.  
07 BAQ-OAUTH-CLIENTID          PIC X(256) .  
07 BAQ-OAUTH-CLIENTID-LEN      PIC S9(9) COMP-5 SYNC VALUE 0.  
07 BAQ-OAUTH-CLIENT-SECRET     PIC X(256) .  
07 BAQ-OAUTH-CLIENT-SECRET-LEN PIC S9(9) COMP-5 SYNC VALUE 0.  
07 BAQ-OAUTH-SCOPE-PTR        USAGE POINTER.  
07 BAQ-OAUTH-SCOPE-LEN        PIC S9(9) COMP-5 SYNC.
```

Grant Type: *client\_credentials* - the identity associated with the combination of the CICS, IMS, or z/OS application, and the z/OS Connect EE server that calls the RESTful API on behalf of the CICS, IMS, or z/OS application

Grant Type: *password* - The identity of the user provided by the CICS, IMS, or z/OS application, or it might be another entity. Client\_credentials can be supplied by the program or in the server XML configuration.

Scope is always required.

OAuth 2.0 specification entity	password	client_credentials	Where Set
Client ID	required	Required	server.xml or by application
Client Secret	optional	Required	server.xml or by application
Username	required	N/A	by application
Password	required	N/A	by application

# Agenda

- An Introduction and Overview of using REST API
- Enabling RESTful API to various z/OS resources, e.g.
  - CICS
  - Db2
  - IMS/TM
  - IMS/DB
  - MQ
  - MVS Batch
  - Outbound REST APIs
  - IBM DVM
  - Host Access Transformation Services (3270 screen-based applications)
  - IBM File Manager
- Accessing RESTful API from z/OS COBOL Applications
- A brief overview of z/OS Connect Security\*

\*For more on security, contact your local IBM rep regarding the schedule of workshop *zOSSEC1 IBM z/OS Connect Administration/Security Wildfire Workshop*  
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# z/OS Connect Wildfire Github Site

<https://ibm.biz/Bdf8BZ>



The screenshot shows a GitHub repository page for 'ibm-wsc/zCONNEE-Wildfire-Workshop'. The left sidebar lists various branches and topics, with 'exercises' highlighted and circled in red. The main content area shows a list of files under the 'master' branch, all uploaded by user 'emitchj'. The files are primarily PDFs related to developing APIs for various IBM services like CICS, IMS, MVS, RESTful APIs, and MQ.

File Name	Description	Last Updated
Developing CICS API Requester Applications.pdf	Add files via upload	2 months ago
Developing IMS API Requester Applications.pdf	Add files via upload	2 months ago
Developing MVS Batch API Requester Applications.pdf	Add files via upload	2 months ago
Developing RESTful APIs for DVM VSAM Services.pdf	Add files via upload	20 days ago
Developing RESTful APIs for DVM VSAMCICS Services.pdf	Add files via upload	20 days ago
Developing RESTful APIs for Db2 REST Services.pdf	Add files via upload	2 months ago
Developing RESTful APIs for HATS REST Services.pdf	Add files via upload	2 months ago
Developing RESTful APIs for IMS Database REST Services....	Add files via upload	2 months ago
Developing RESTful APIs for IMS Transactions.pdf	Add files via upload	2 months ago
Developing RESTful APIs for MQ.pdf	Add files via upload	2 months ago
Developing RESTful APIs for MVS Batch.pdf	Add files via upload	2 months ago
Developing RESTful APIs for a CICS COMMAREA program.pdf	Add files via upload	2 months ago
Developing RESTful APIs for a CICS Container program.pdf	Add files via upload	2 months ago

- Contact your IBM representative to schedule access to these exercises

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## **/questions?thanks=true**

Thank you for listening.

- z/OS Connect EE Users Group: <https://www.linkedin.com/groups/8731382/>