



ZCINTRO - IBM z/OS Connect

An 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
 - Outbound REST APIs
- Accessing RESTful API from z/OS COBOL Applications
- A brief overview of z/OS Connect Security

*For more on administration and security, contact your local IBM rep regarding the schedule of workshop *zCADMIN IBM z/OS Connect Administration Wildfire Workshop*

Notes and Disclaimers



- The information in this presentation was derived from various product documentation web sites.
- Additional information included in this presentation was distilled from years of experience implementing security using RACF with z/OS products like CICS, IMS, Db2, MQ, etc. as well as Java runtimes environments like WebSphere Application Server and WebSphere Application Server Liberty which is commonly called Liberty.
- There will be additional information on slides that will be designated as Tech/Tips. These contain information that at perhaps at least interesting and hopefully, useful to the reader.
- **IBM z/OS Connect (OpenAPI 2)** refers to the z/OS Connect EE product prior to service level V3.0.55. **IBM z/OS Connect (OpenAPI 3)** refers to the additional functions and features added with service level V3.0.55. Important - servers configured for OpenAPI 2 can will continue to operate as is with service level V3.0.55 and later.
- A z/OS Connect OpenAPI 2, or a z/OS Connect OpenAPI 3 icon will appear on slides where the information is specific to these products. Don't hesitate to ask questions as to why the icon does or does not appear on certain slides.
- The examples, tips, etc. present in this material are based on firsthand experiences and are not necessarily sanctioned by Liberty or z/OS Connect development.

This session is part of a series of z/OS Connect workshops. . .



ZCREQUEST - IBM z/OS Connect An introduction to API Requesters

API Requester Code and Security Considerations

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z/OS Connect Open API 3

Designer and z/OS Native server
Experiences and Observations

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IBM

IBM Z
Wildfire Team –
Washington System Center

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Slide 1

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<https://www.ibm.com/support/pages/mainframe-system-education-wildfire-workshops>

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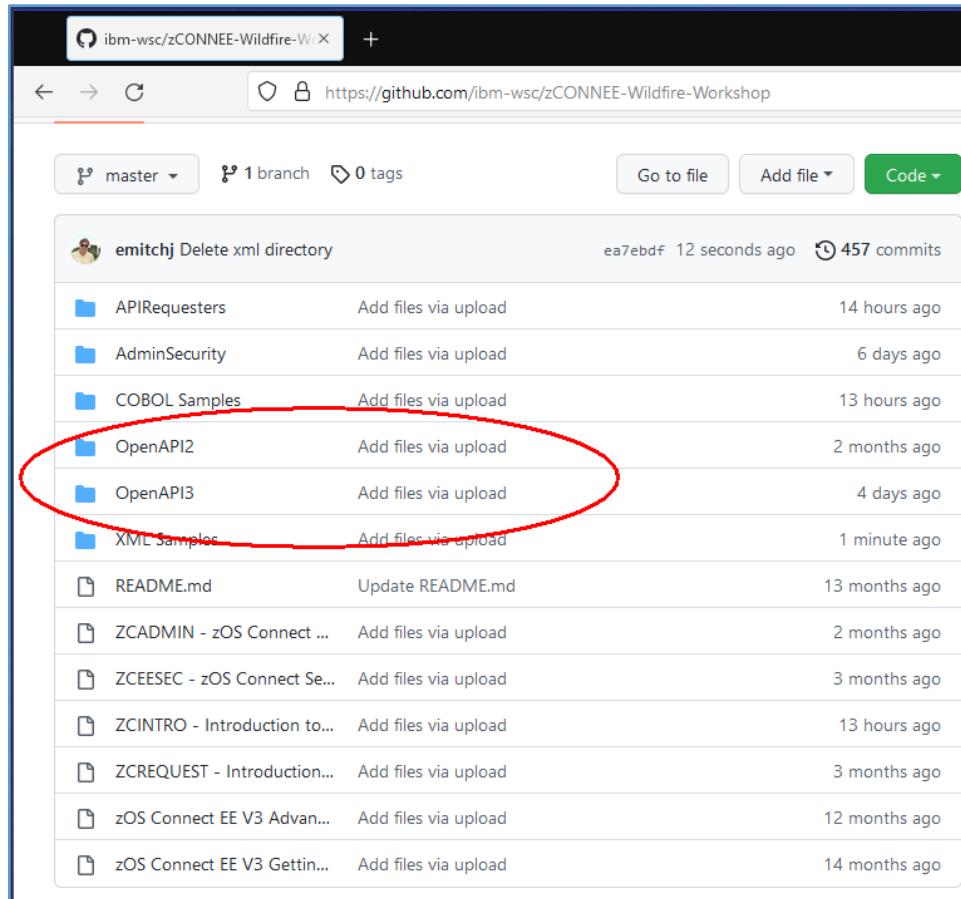
ZCADMIN – IBM z/OS Connect Administration

WebSphere Liberty Profile with
IBM z/OS Connect (OpenAPI 2) and/or
IBM z/OS Connect (OpenAPI 3)
Administration



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Slide 1

z/OS Connect Wildfire Github Site



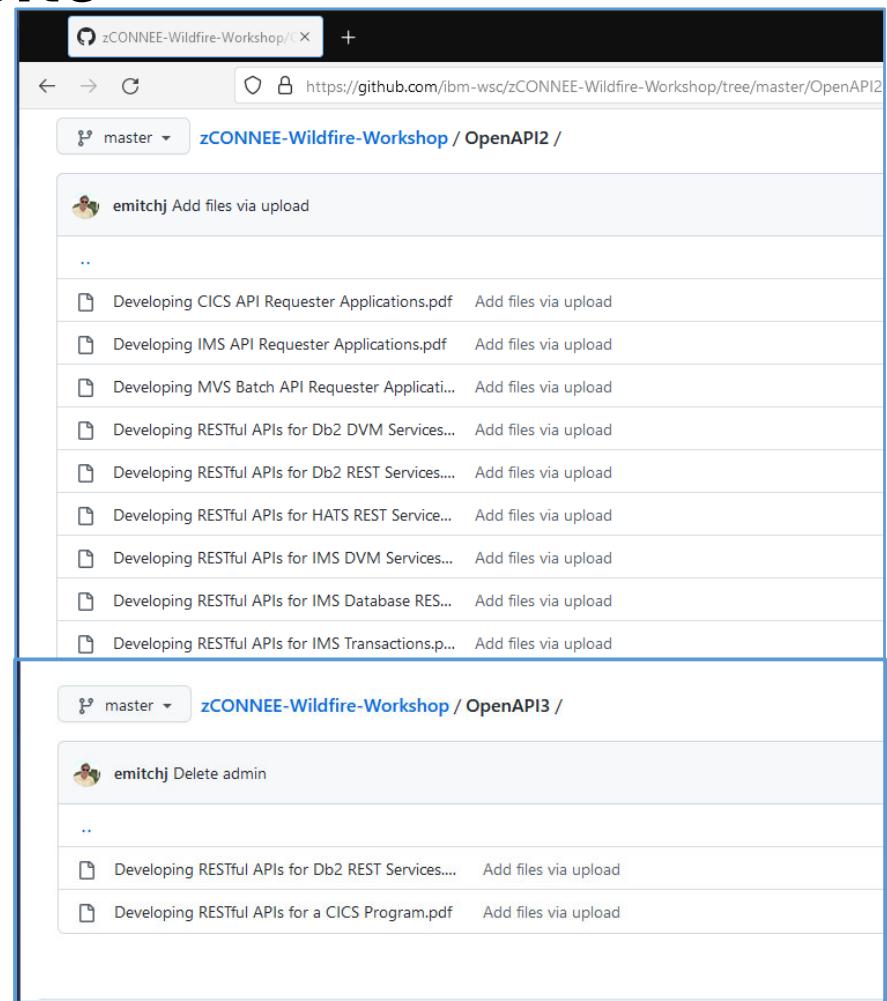
A screenshot of a GitHub repository page. The repository name is 'ibm-wsc/zCONNEE-Wildfire-Workshop'. The master branch has 1 branch and 0 tags. There are 457 commits. A red oval highlights the 'OpenAPI2' commit, which was added 2 months ago.

Commit	Message	Time Ago
emitchj Delete xml directory	ea7ebdf 12 seconds ago	457 commits
APIRequesters	Add files via upload 14 hours ago	
AdminSecurity	Add files via upload 6 days ago	
COBOL Samples	Add files via upload 13 hours ago	
OpenAPI2	Add files via upload 2 months ago	
OpenAPI3	Add files via upload 4 days ago	
XML Samples	Add files via upload 1 minute ago	
README.md	Update README.md 13 months ago	
ZCADMIN - zOS Connect ...	Add files via upload 2 months ago	
ZCEESEC - zOS Connect Se...	Add files via upload 3 months ago	
ZCINTRO - Introduction to...	Add files via upload 13 hours ago	
ZCREQUEST - Introduction...	Add files via upload 3 months ago	
zOS Connect EE V3 Advan...	Add files via upload 12 months ago	
zOS Connect EE V3 Gettin...	Add files via upload 14 months ago	

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- Contact your IBM representative to request access to these exercises

<https://ibm.biz/zCEEWorshopMaterial>



A screenshot of the GitHub repository 'zCONNEE-Wildfire-Workshop'. It shows two main branches: 'OpenAPI2' and 'OpenAPI3'. Each branch contains several PDF files related to API development.

- OpenAPI2 /**
 - emitchj Add files via upload
 - Developing CICS API Requester Applications.pdf
 - Developing IMS API Requester Applications.pdf
 - Developing MVS Batch API Requester Application.pdf
 - Developing RESTful APIs for Db2 DVM Services....
 - Developing RESTful APIs for Db2 REST Services....
 - Developing RESTful APIs for HATS REST Service...
 - Developing RESTful APIs for IMS DVM Services...
 - Developing RESTful APIs for IMS Database RES...
 - Developing RESTful APIs for IMS Transactions.pdf
- OpenAPI3 /**
 - emitchj Delete admin
 - Developing RESTful APIs for Db2 REST Services....
 - Developing RESTful APIs for a CICS Program.pdf

z/OS Connect EE exposes z/OS resources to the “cloud” via RESTful APIs

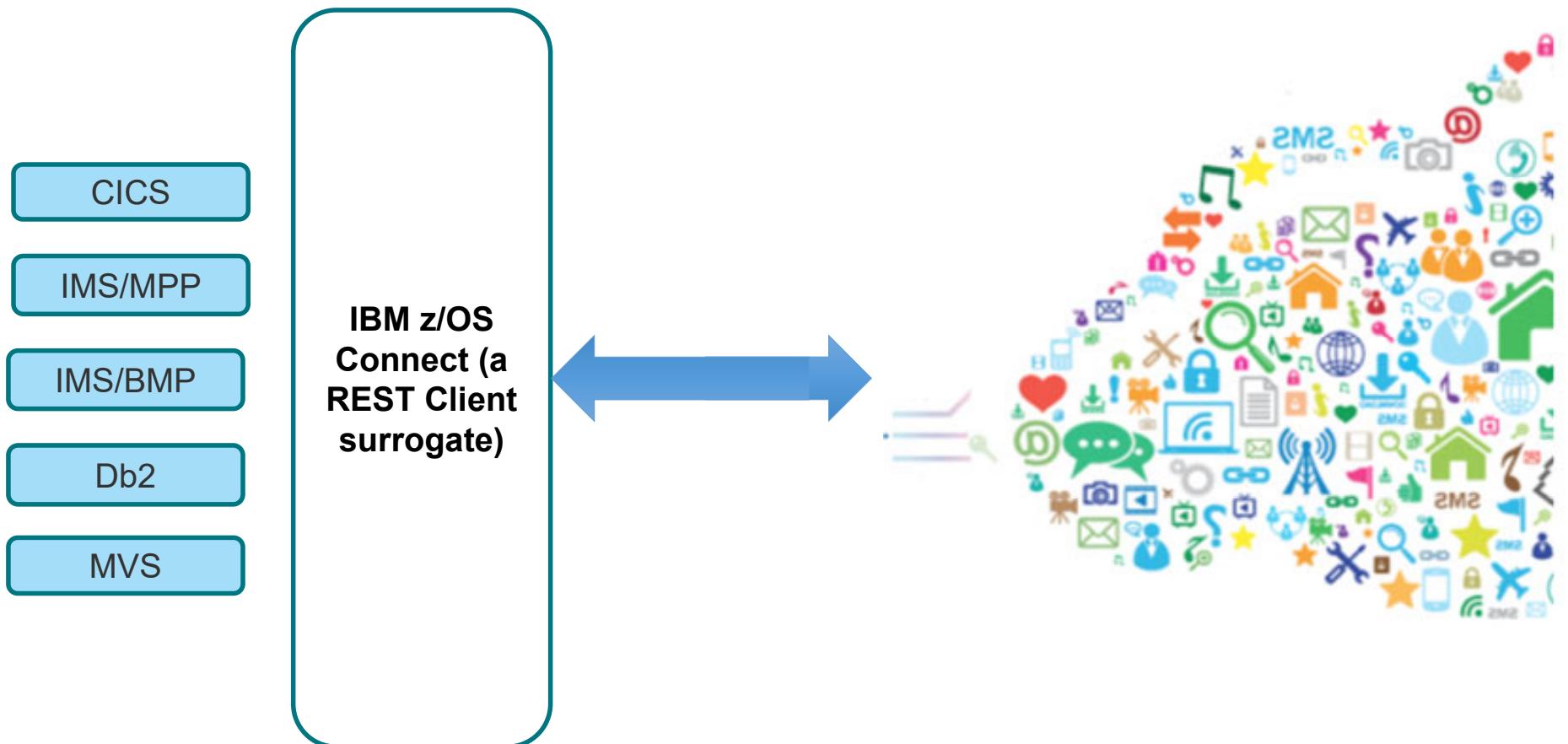


+ HCL and Rocket Software

*Other Vendors or your own implementation



z/OS Connect EE exposes external REST APIs in the “cloud” to z/OS applications



Before we go any further, let ask

/what_is_REST?

And what makes an API “RESTful”?



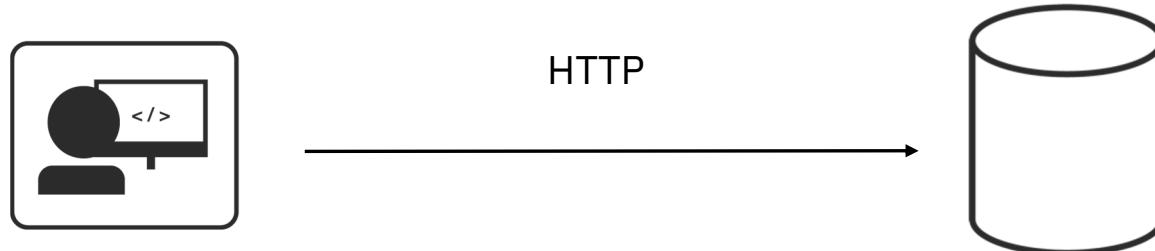
REST is architectural programming style

REST is acronym standing 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 the REST API

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

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" }



The goal is to strive to design API to use RESTful properties

1. Use the same URIs for the same resource with the appropriate method for operations

```
GET http://www.acme.com/customers/12345
```

```
PUT http://www.acme.com/customers/12345?address=10%20New%20Street
```

2. Use the same JSON property names between request and response messages

```
POST http://www.acme.com/customers/12345  
BODY { "name": "Joe Bloggs",  
       "address": "10 Old Street",  
       "phoneNo": "01234 0123456" }
```



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

3. Use JSON name/value pairs

```
PUT http://www.acme.com/customers/12345  
BODY { "address" : "10 New Street" }
```



```
RESPONSE HTTP 200 OK
```



Why is REST popular?

Ubiquitous Foundation	It's based on HTTP, which operates on TCP/IP, which is a ubiquitous networking topology.
Relatively Lightweight	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.
Relatively Easy Development	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.
Increasingly Common	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.
Stateless	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.



Results or goal: Client code is unaware of the z/OS infrastructure

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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) {
    
```

CICS

```

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
CE1BRESP0: 0
CE1BRESP2: 0
name: DR E. GRIFFITHS
employeeNumber: 22222
amount: $0022.00
address: FRANKFURT, GERMANY
phoneNumber: 20034151
date: 26 11 81
Response Message: {"cscvincSelectServiceOperationResponse": {"cscvincContainer": {"response": {"CE1BRESP2": "0", "USERID": "CICSUMER", "CE1BRESP0": "0", "CE1BRESP2": "0", "name": "DR E. GRIFFITHS", "employeeNumber": "22222", "amount": "$0022.00", "address": "FRANKFURT, GERMANY", "phoneNumber": "20034151", "date": "26 11 81"}}, "status": "OK", "message": "Success", "code": 200}
    
```

```

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    // Invoke the REST API using a GET method
    URL url = new URL("https://wg31.washington.ibm.com:9453/mqapi/");
    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());
        }
    } catch (Exception e) {
        e.printStackTrace();
    }
    
```

MQ

```

Problems @ Javadoc Declaration Console Coverage
<terminated> ZceeMqGet [Java Application] C:\Program Files\IBM\Java80\jre\bin\javaw.exe (May 7, 2021, 8:53:07 AM)
URL: https://wg31.washington.ibm.com:9453/mqapi/
NAME: TINA J YOUNG
NUMB: 001781
ADDRX: SINDELINGEN,GERMANY
PHONE: 70319990
DATEX: 21 06 77
AMOUNT: $0009.99
    
```

```

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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) {
    
```

Db2

```

Problems @ Javadoc Declaration Console Coverage
<terminated> ZceeMqPut [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: 7030
    
```

```

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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));
    
```

IMS

```

Problems @ Javadoc Declaration Console Coverage
<terminated> ZceeIMSGet [Java Application] C:\Program Files\IBM\Java80\jre\bin\javaw.exe (May 17, 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
    
```

How do we describe and/or document an API?



/oai/open_api_initiative

The industry standard framework for describing REST APIs

The OpenAPI Initiative (OAI) was created by a consortium of forward-looking industry experts who recognize the immense value of standardizing on how APIs are described. As an open governance structure under the Linux Foundation, the OAI is focused on creating, evolving and promoting a vendor neutral description format. The OpenAPI Specification was originally based on the Swagger Specification, donated by SmartBear Software.



We use an Open API specification

- It is more than just an API framework



There are a number of tools available to aid consumption:

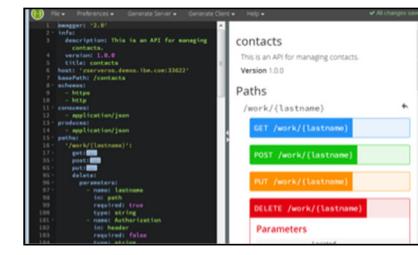
Code Generation* - create stub code to consume APIs from various languages



Test UIs - allows API consumers to easily browse and try APIs based on an OpenAPI document.



Editors - allows API developers to design their OpenAPI documents.



* z/OS Connect API Requester +z/OS Connect, MQ REST support, Zowe

Important - You may have used or heard of the term Swagger with the use of APIs. As the use of APIs has grown this term has become in some respects misleading. To be more precise, OpenAPI refers to the API specifications (OpenAPI 2 and OpenAPI3) where Swagger refers to the tooling used to implement the specifications.



Let's stop and ask what is the significance of the OpenAPI Specification to z/OS Connect?

The industry standard framework for describing REST APIs

- **z/OS Connect and Swagger 2.0 (Open API Specification 2), supported initially by z/OS Connect**

Initially, accessing z/OS resources was the only desire for developing APIs .The interactions with the z/OS resources was driven by the layout of the CICS COMMAREA or CONTAINER, the IMS or MQ messages or the Db2 REST service.

- The details of the interactions with the z/OS resource determined the contents of the API request and response messages and the subsequent specification document.
- **z/OS Connect produces the specification document that describes the methods and request and response messages.**

- **z/OS Connect and Open API Specification 3, supported by z/OS Connect starting in March 2022 service, V3.0.55**

As companies mature their API strategy, they begin to introduce API governance boards to drive consistency in their API design. As more public APIs are created, government and industry standards bodies begin to regulate and drive for standardization. This drives the need for “API first” functional mapping capabilities within the integration platform. The external API design determined the layouts of the API request and response messages provided by the specification documents which was consumed by z/OS Connect to describe the z/OS resource interactions.

- The API details of the methods and layouts of request and response messages are provided in advance and access to the z/OS resource is driven by the API design
- **z/OS Connect consumes the specification document that describes the methods and request and response messages**



An OPENAPI 2 versus an OPENAPI 3 specification document

JSON
format

```
cscvinc.json - Notepad
File Edit Format View Help
{
  "swagger": "2.0",
  "info": {
    "description": "",
    "version": "1.0.0",
    "title": "cscvincapi"
  },
  "basePath": "/cscvincapi",
  "schemes": [
    "https",
    "http"
  ],
  "consumes": [
    "application/json"
  ],
  "produces": [
    "application/json"
  ],
  "paths": {
    "/employee/{employee}": {
      "get": {
        "tags": [
          "cscvincapi"
        ],
        "operationId": "getCscvincSelectService",
        "parameters": [
          {
            "name": "Authorization",
            "in": "header",
            "required": false,
            "type": "string"
          },
          {
            "name": "employee",
            "in": "path",
            "required": true,
            "type": "string",
            "maxLength": 6
          }
        ],
        "responses": {
          "200": {
            "description": "OK",
            "schema": {
              "$ref": "#/definitions/getCscvincSelectService_response_200"
            }
          },
          "404": {
            "description": "Not Found",
          }
        }
      }
    }
  }
}
```

```
cscvinc.yaml - Notepad
File Edit Format View Help
openapi: 3.0.1
info:
  title: cscvinc
  description: ""
  version: 1.0.0
servers:
  - url: /cscvinc
x-ibm-zcon-roles-allowed:
  - Manager
paths:
  /employee/{employee}:
    post:
      tags:
        - cscvinc
      operationId: postCscvincInsertService
      x-ibm-zcon-roles-allowed:
        - Staff
      parameters:
        - name: Authorization
          in: header
          schema:
            type: string
      requestBody:
        description: request body
        content:
          application/json:
            schema:
              $ref: '#/components/schemas/postCscvincInsertService_request'
            required: true
      responses:
        200:
          description: OK
          content:
            application/json:
              schema:
                $ref: '#/components/schemas/postCscvincInsertService_response_200'
              x-codegen-request-body-name: postCscvincInsertService_request
  /employee/{employee}:
    get:
      tags:
        - cscvinc
      operationId: getCscvincSelectService
      x-ibm-zcon-roles-allowed:
        - Staff
      parameters:
        - name: Authorization
          in: header
          schema:
            type: string

```

YAML
Format*



Why /zos_connect?

Truly RESTful APIs to and from your mainframe.

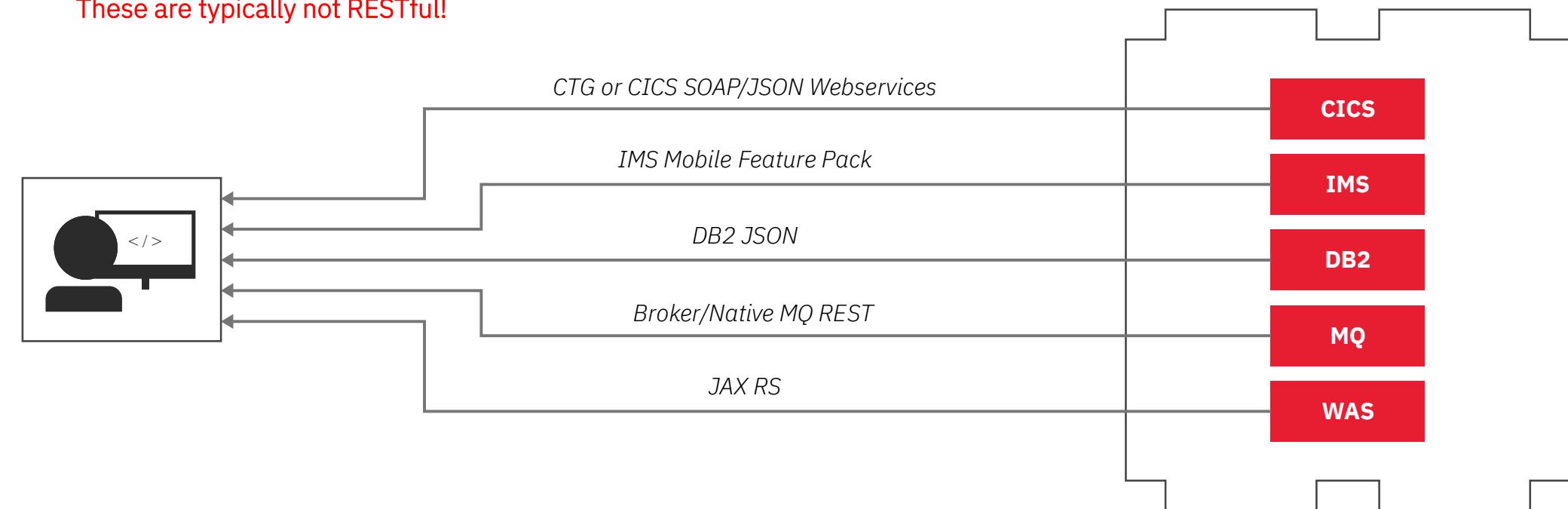


There was support for REST before z/OS Connect but..

Completely different configuration and management.

Multiple endpoints for developers to call/maintain access to.

These are typically not RESTful!



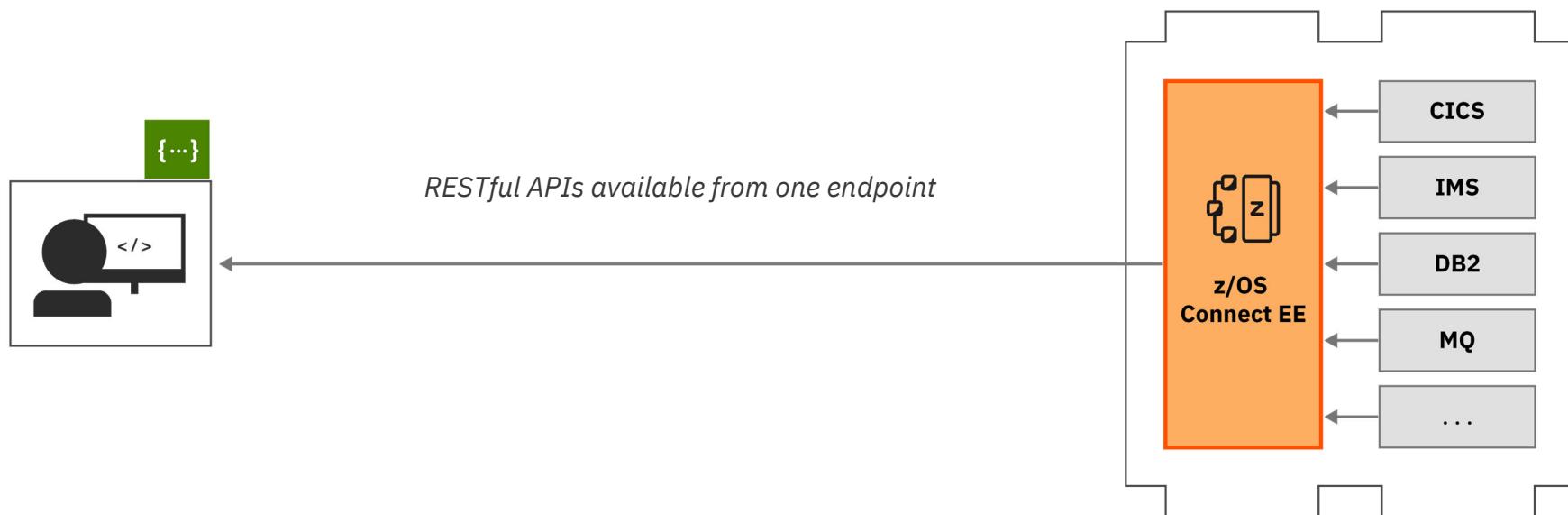


z/OS Connect provides a single-entry point

- And exposes 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.



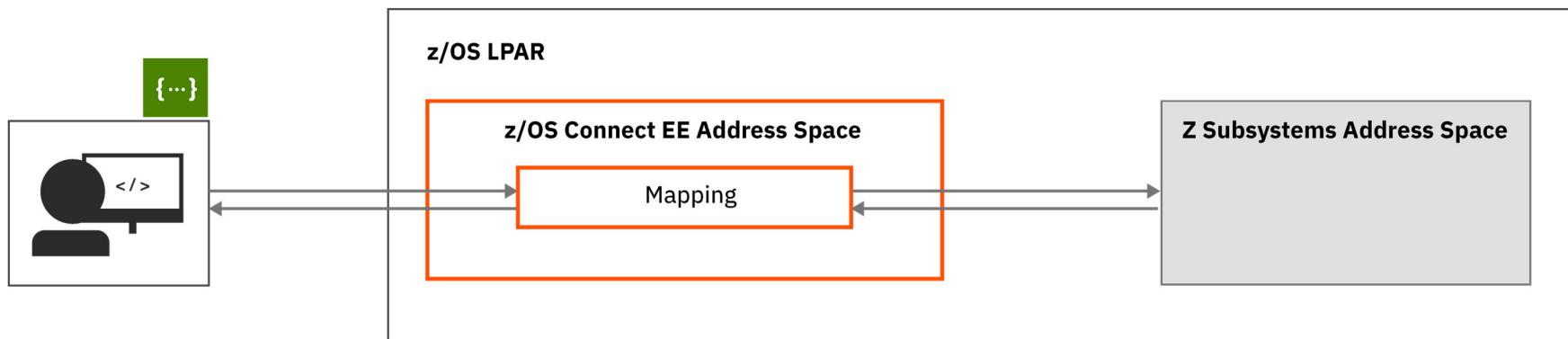


**Other than a RESTful interface,
what else does z/OS Connect provide?**



Data mapping

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

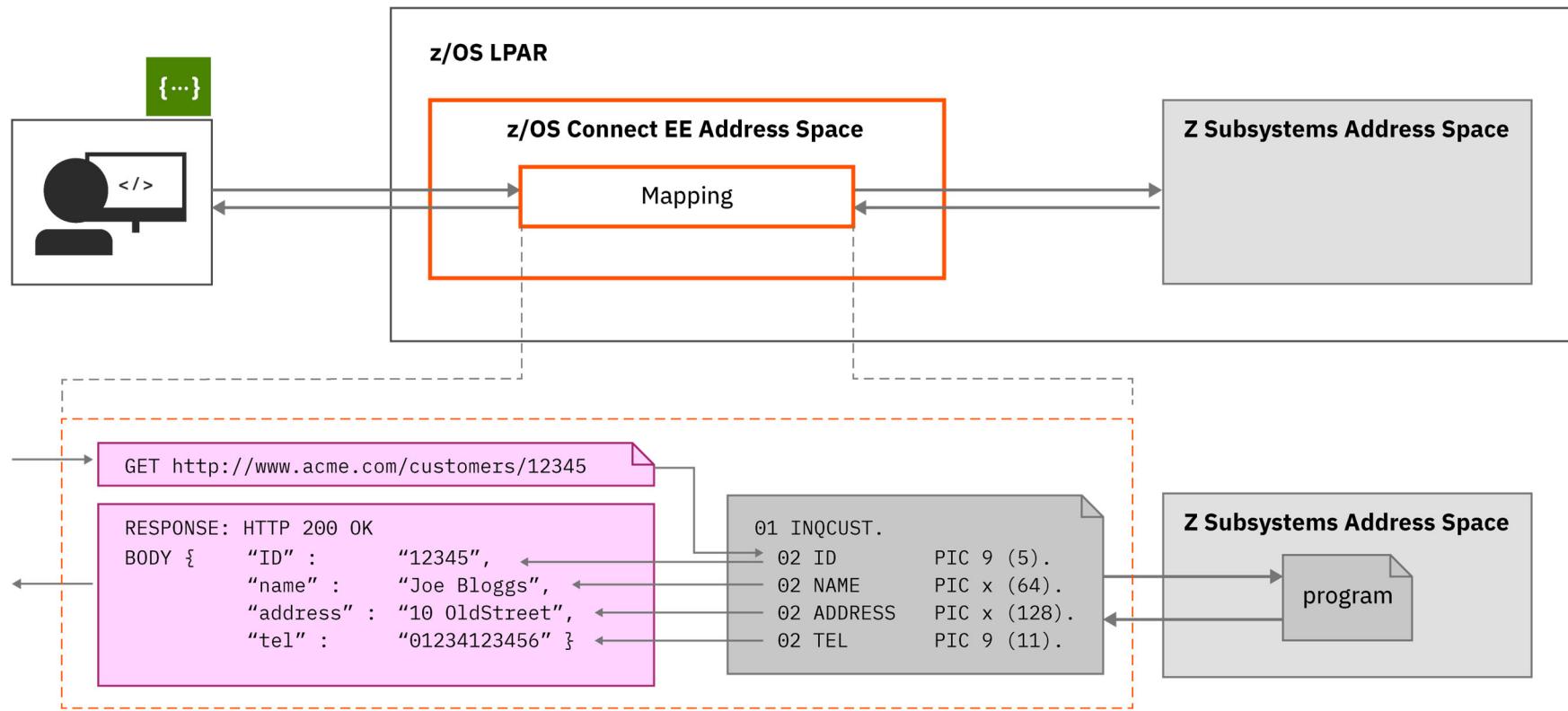


* Most z/OS subsystems depend on information in a serial data format and do not normally work with JSON request/response messages. Examples of serialized messages are CICS COMMAREAAs and CONTAINERS, IMS or MQ messages, or records stored in sequential or VSAM data sets. Data mapping and transformation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



Data mapping and transformation example

- A closer look





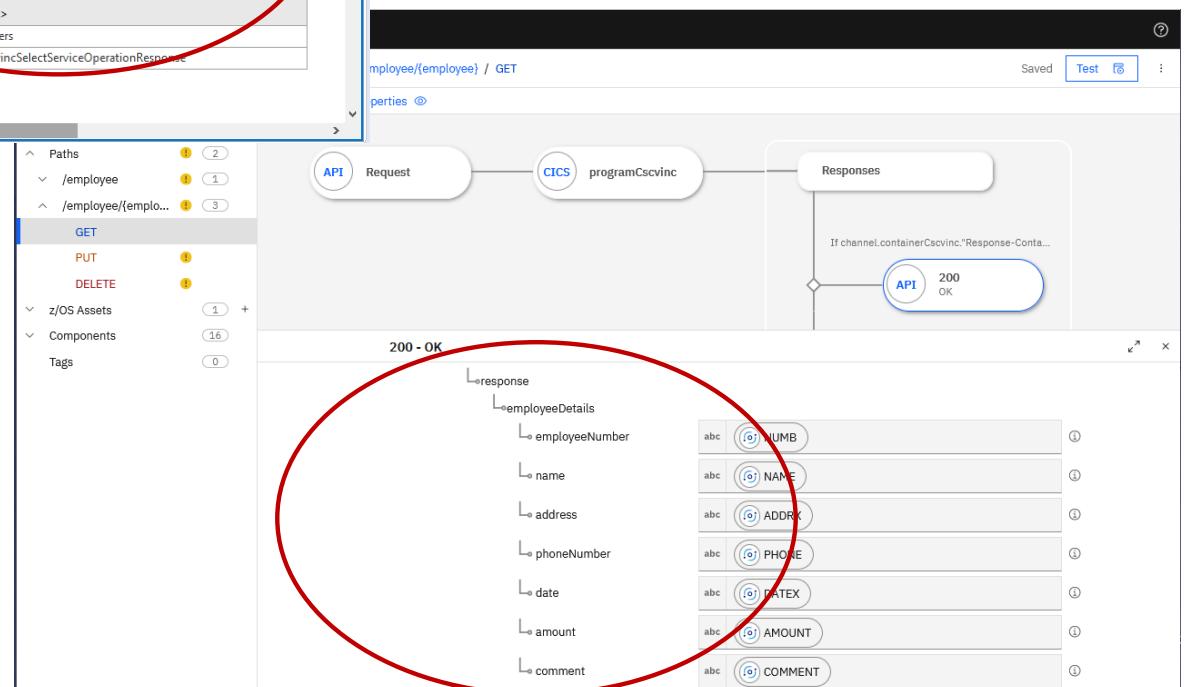
z/OS Connect OpenAPI Tooling

Describing an OPENAPI 2 versus an OPENAPI 3 Response Message



The screenshot shows the Eclipse-based z/OS Connect API Toolkit interface. A red circle highlights the 'Body - cscvincSelectServiceOperationResponse' section, which contains detailed schema information for various fields like CEIBRESP, CEIBRESP2, and USERID. Below this is the 'HTTP Response' section, also highlighted by a red circle, which includes 'HTTP Headers' and the 'Body - cscvincSelectServiceOperationResponse' section.

Eclipse based - z/OS Connect API Toolkit



Web browser - z/OS Connect Designer



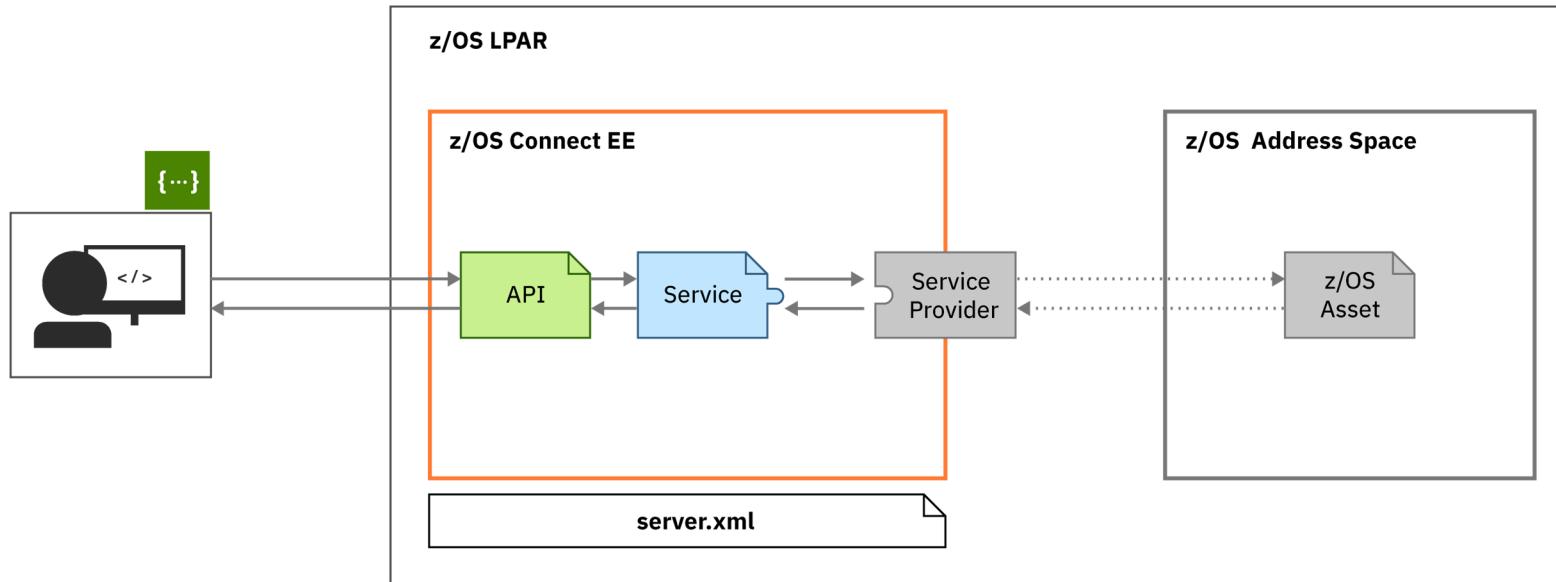
/api_toolkit/services

Simple **service creation** not using the Eclipse Toolkit



Accessing a z/OS asset (Open API 2)

z/OS Connect OpenAPI 2 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)

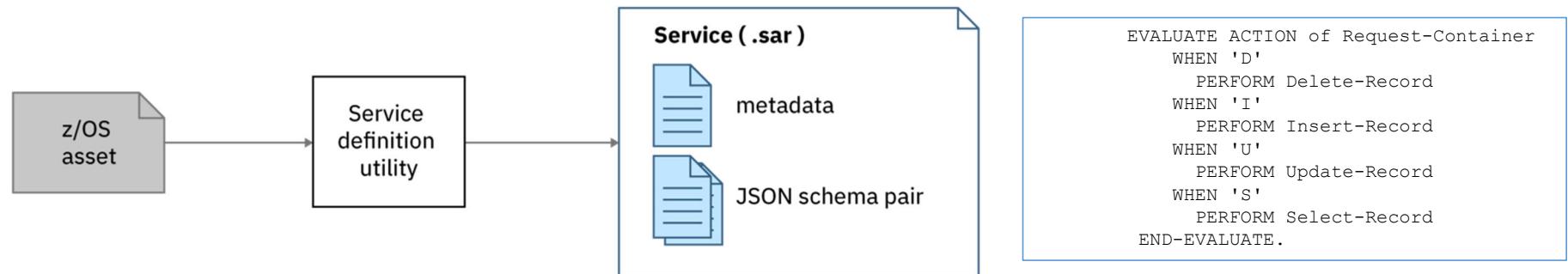


Describing the interaction (service) with the z/OS resource (OpenAPI 2)

Start by creating a service to represent an interaction with the z/OS 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



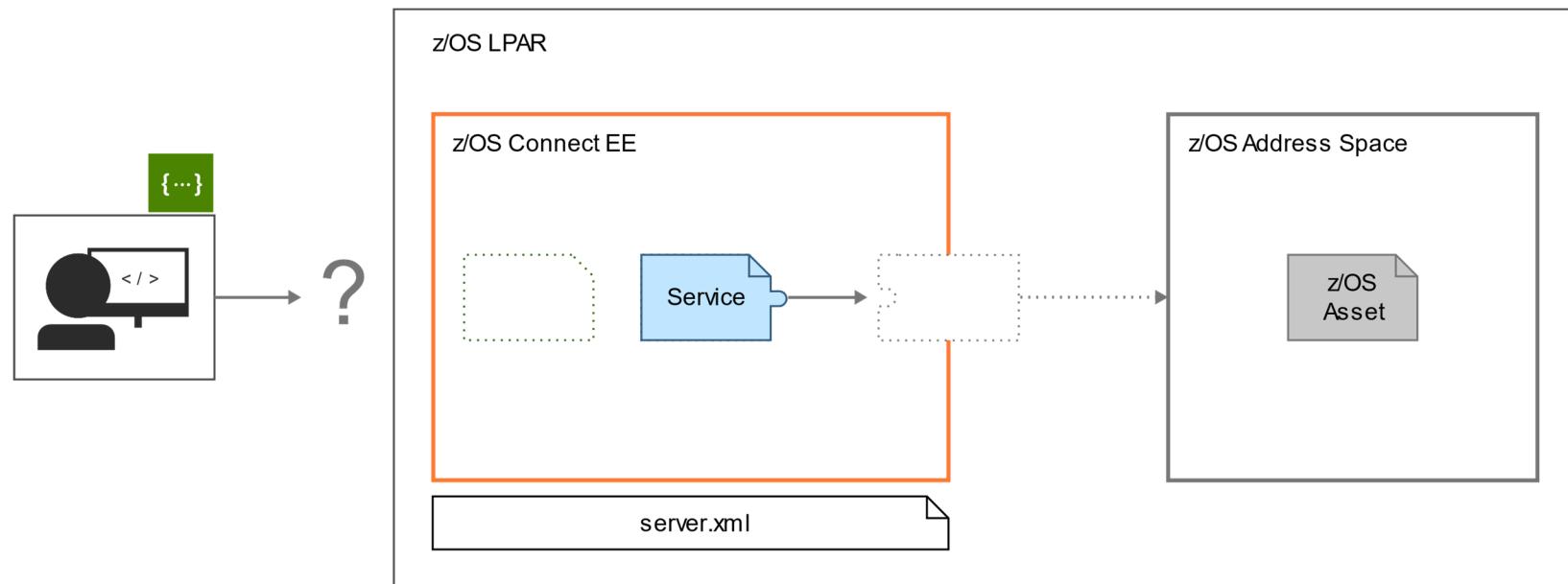
Use a system-appropriate utility to generate a service archive file for the z/OS application

- 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



Deploy and export the service archive (OpenAPI 2)

Deploy and export the service archive file

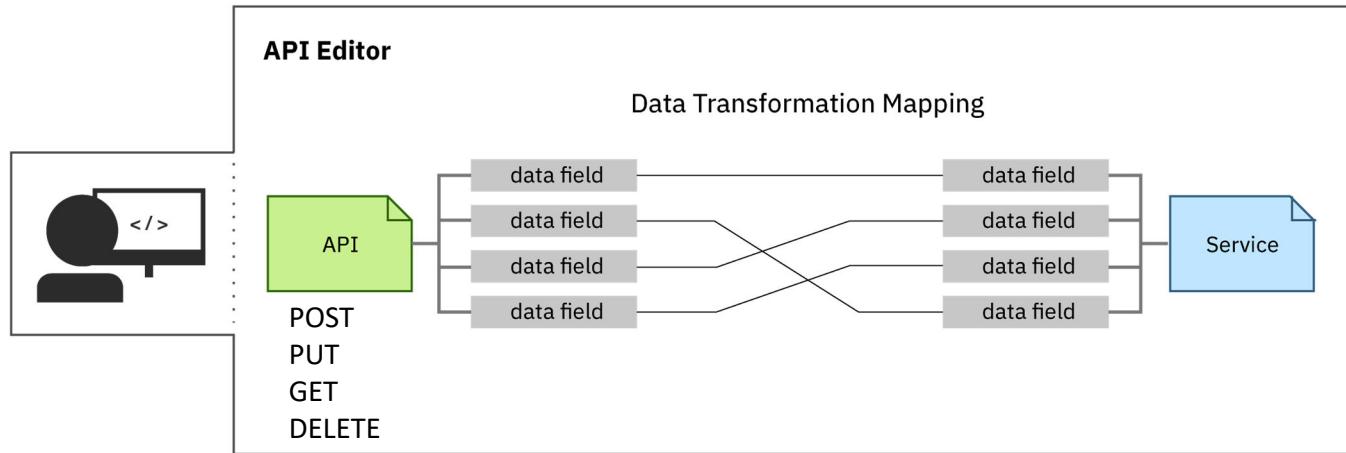


Deploy the service archive file generated in **Step 1** using the right-click deploy in **the API toolkit**.

Develop an API using the service interactions (Open API 2)



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

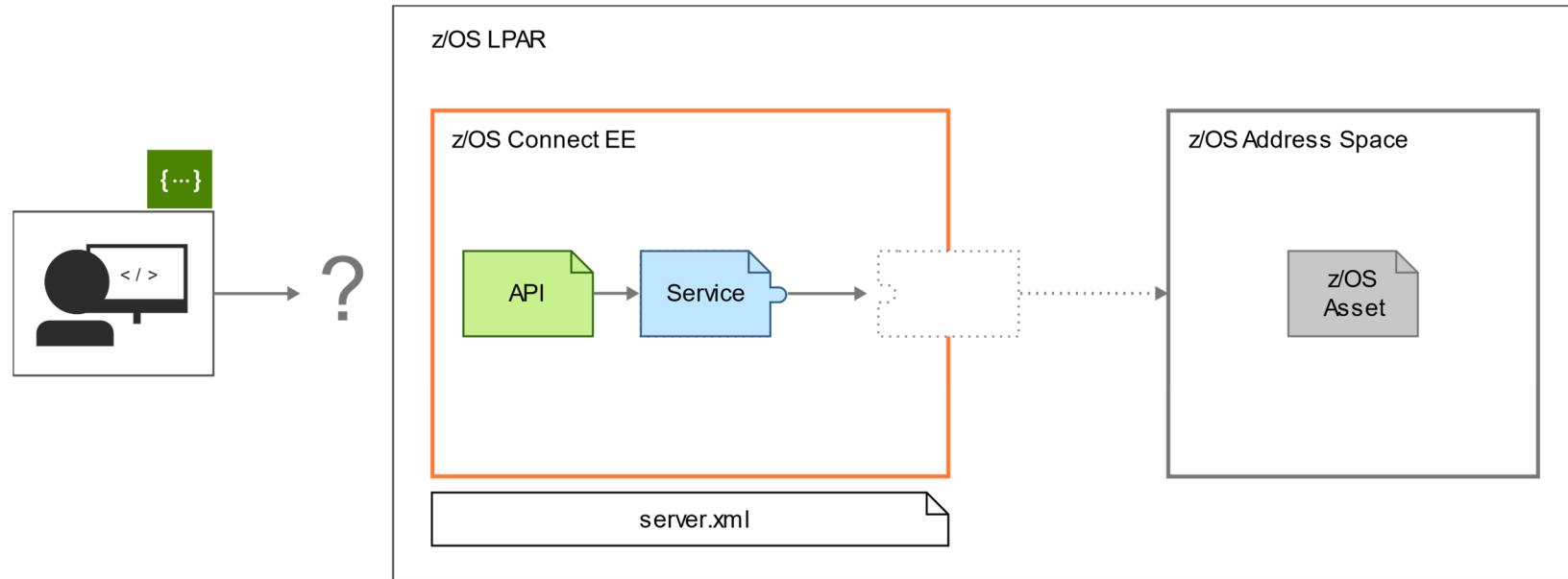


- Import the service archive file into the **API toolkit** and start designing the RESTful API.
- Provides additional data mapping
- Use the editor to describe the API and how it maps to underlying services.



Deploy the API (Open API 2)

Deploy the API archive file

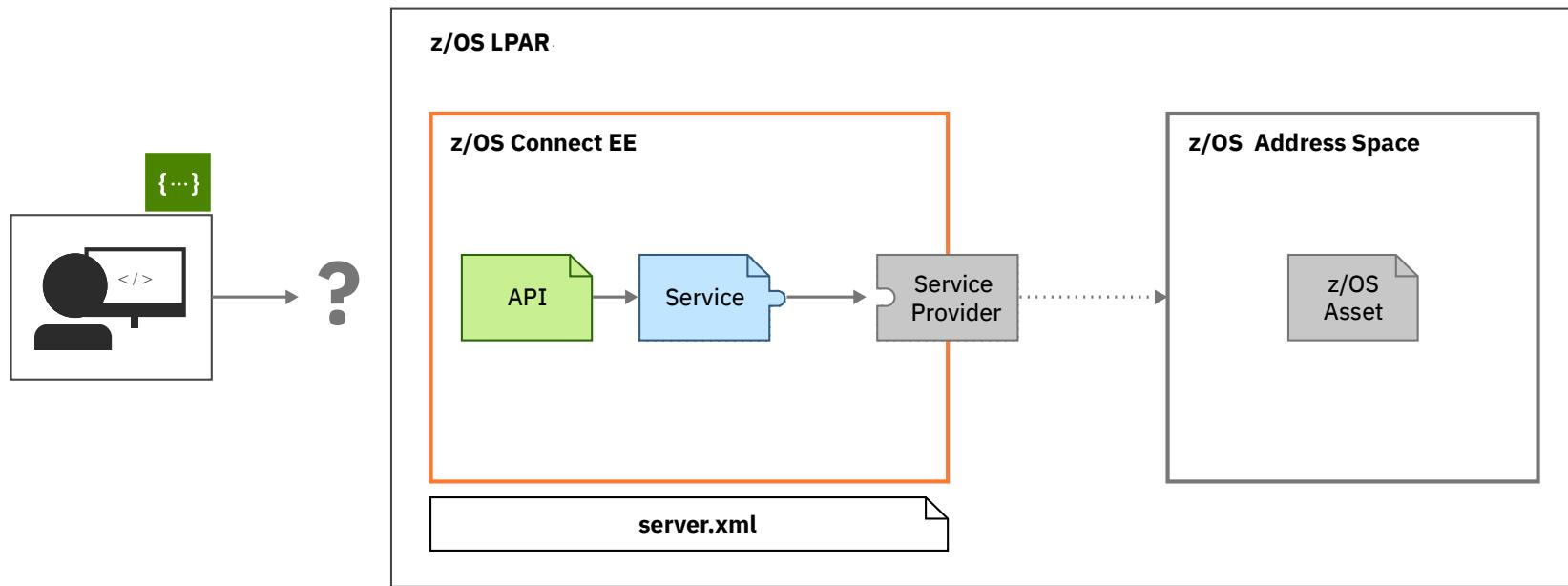


Deploy your API using the right-click deploy in **the API toolkit**



Configure access the z/OS sub system (Open API 2)

Configure the service provider

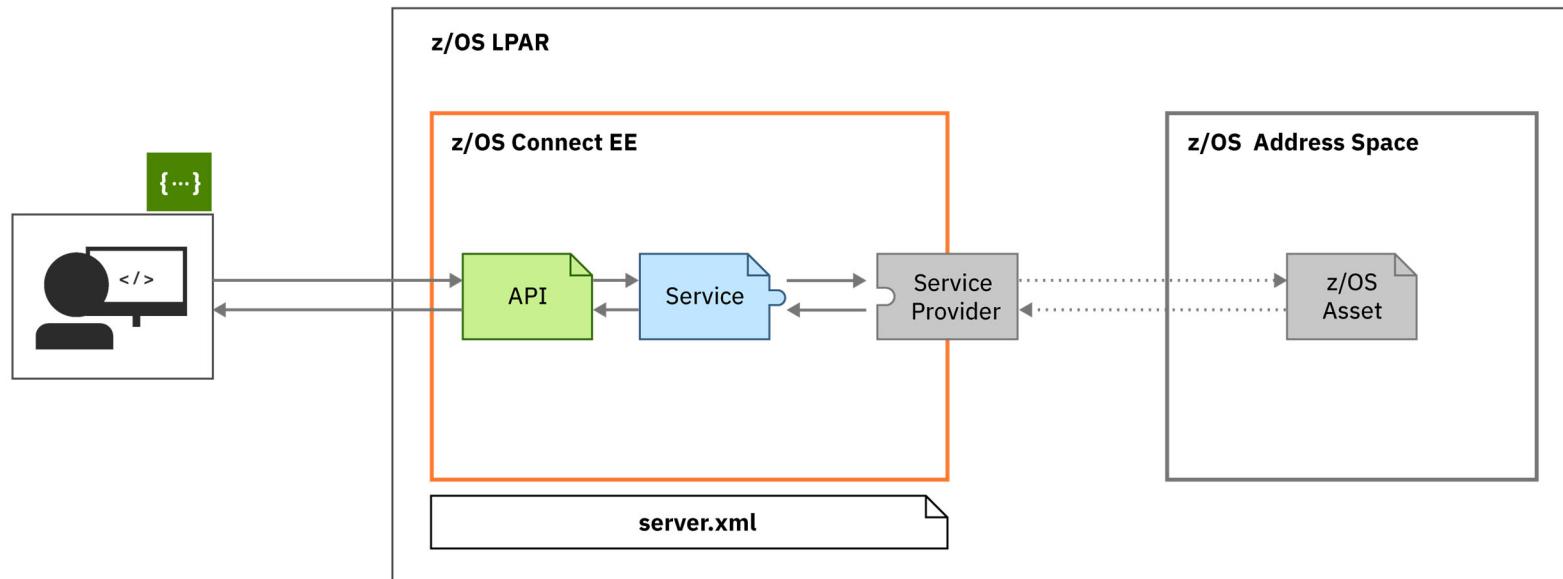


Configure the system-appropriate service provider to connect to your backend system in your **server.xml**.



Complete access to a z/OS Asset (Open API 2)

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)



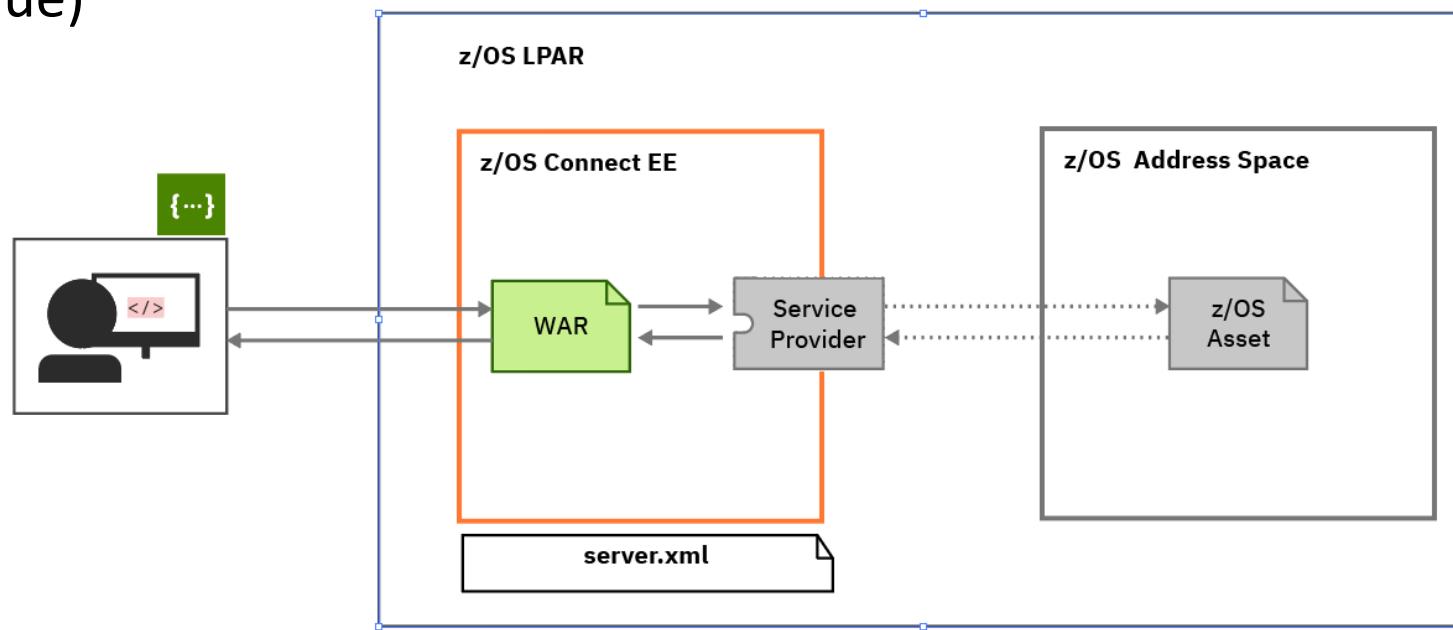
/zosConnect/designer

Simple API Development using the z/OS Connect Designer



Accessing the CICS or Db2 asset (Open API 3)

- z/OS Connect OpenAPI 3 APIs are developed using a z/OS Connect Designer web browser tool to developer Web ARchive (WAR) files (a traditional Java packaging technique)



- The WAR provides the RESTful interface is ready to be consumed by a client and it requires the client to have no knowledge that a z/OS resource is being accessed as well as the mapping and transformation for accessingg the resource.
- The Service Provider is tightly coupled to a specific instance of a resource (e.g., host and port)

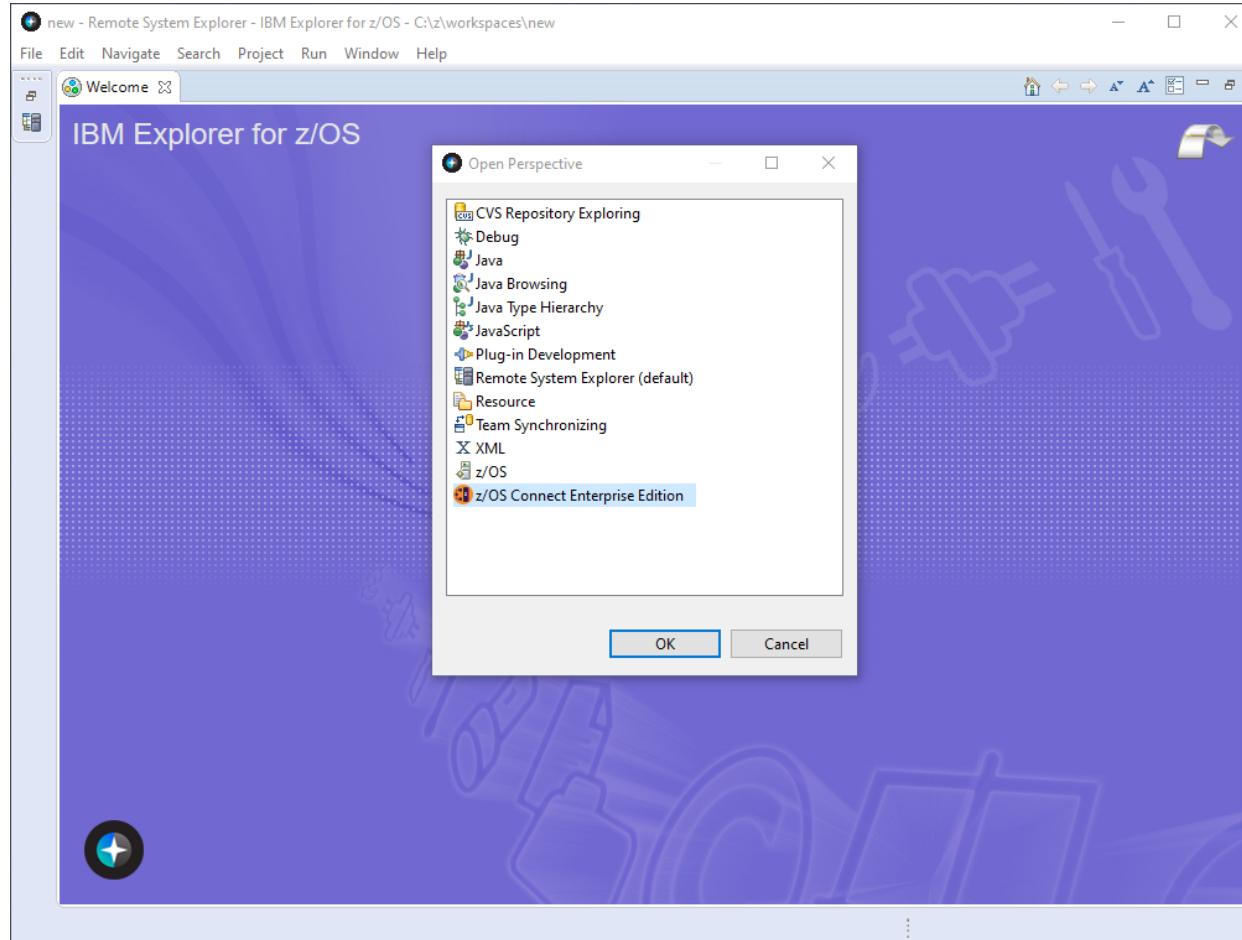


/api_toolkit/services

Simple service creation for OpenAPI 2 APIs



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

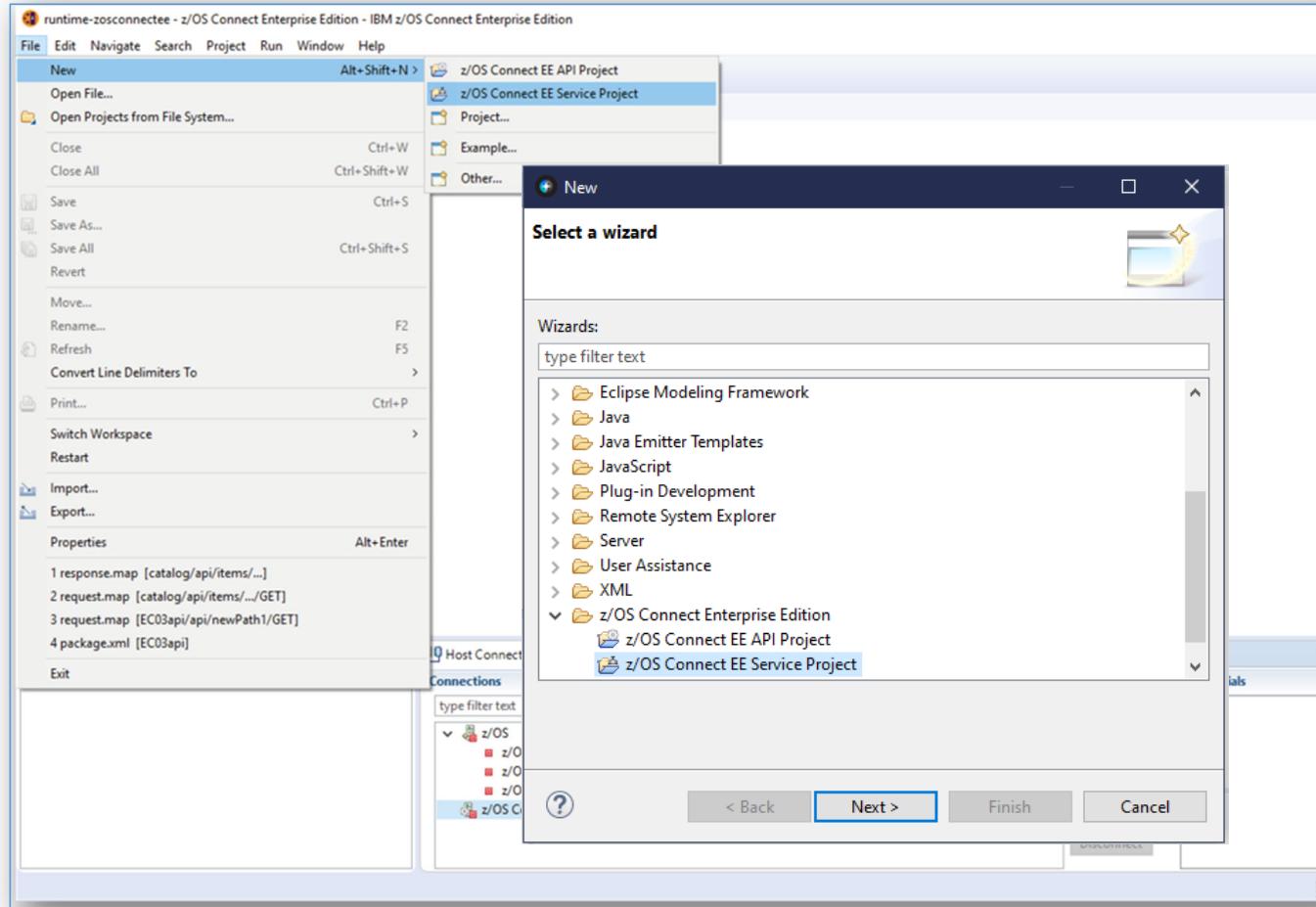


Use the **API toolkit** to create services through Eclipse-based tooling.

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



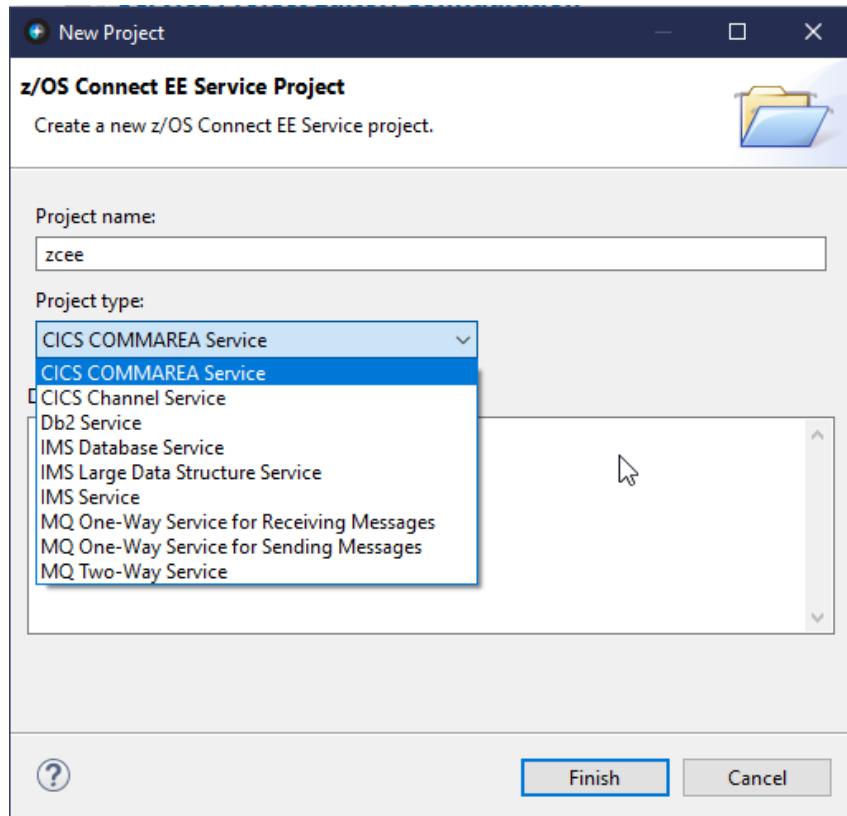
Use the **API toolkit** to create services through Eclipse-based tooling.

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



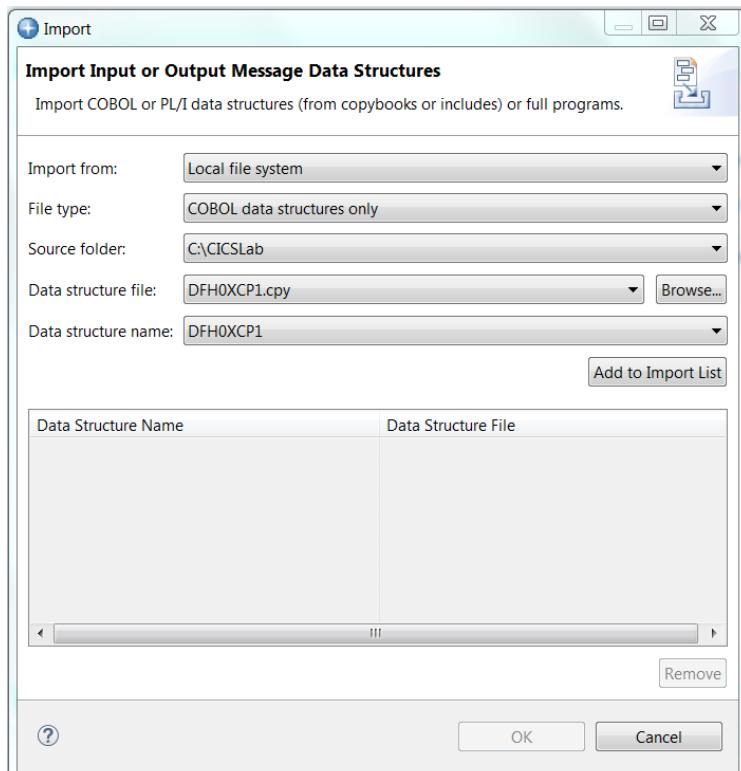
A common interface for service creation, irrespective of back-end subsystem.

- CICS services that can invoke almost any CICS programs accessed by EXEC CICS LINK request (COMMAREA or CHANNEL). See URL <http://www.ibm.com/docs/en/cics-ts/5.6?topic=link-exception-conditions-command> for a list of EXEC CICS APIs not allowed in a program when invoked using a CICS Dynamic Program Link request.
- Db2 services that invoke a Db2 REST service.
- IMS DB services that access an IMS database.
- IMS TM services that sends a messages on an IMS message processing region.
- MQ services that use MQ request/reply queues for two-way services or access a single queue for MQ PUTs and MQ GETs on a either a local or remote queue manager



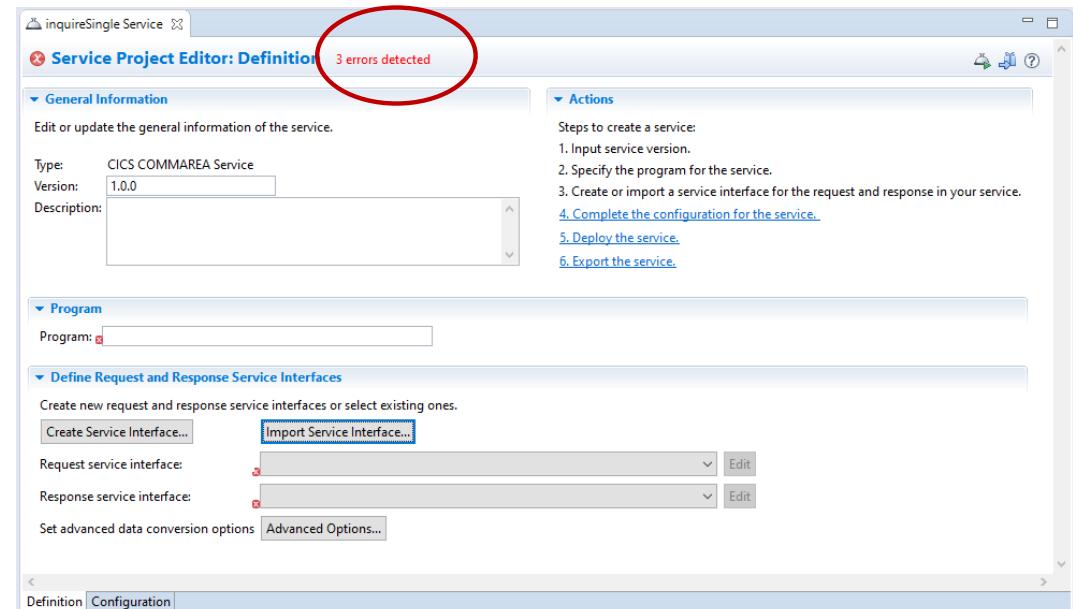
API toolkit – Creating Services for CICS, IMS TM and MQ

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 software interface titled "Service Interface Definition". It displays a table of fields with columns: Fields, Include, Interface rename, Default Field Value, Data Type, Field Length, and Start Byte. The table lists various fields from a data structure, including CA_REQUEST_ID, CA_RETURN_CODE, CA_RESPONSE_MESSAGE, CA_REQUEST_SPECIFIC, CA_INQUIRE_REQUEST, CA_INQUIRE_SINGLE, CA_ITEM_REF_REQ, CA_SINGLE_ITEM, and CA_ORDER_REQUEST. A red circle highlights the "Default Field Value" column for CA_REQUEST_ID, which is set to "01INQS". A red box highlights the "Interface rename" column for CA_INQUIRE_SINGLE, which is set to "inquireSingle". The "Include" column for CA_INQUIRE_SINGLE is checked.

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.

Search:

Fields	Include	Interface rename	Default Field Value	Data Type	Field Length	Start Byte
COMAREA	<input type="checkbox"/>					
DFH0XCP1	<input checked="" 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_INQUIRE_REQUEST	<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 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_INQUIRE_SINGLE	<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

The screenshot shows the Service Interface Editor with two rows for the REQUEST_CONTAINER interface. The first row has ACTION set to S (Select) and the second row has ACTION set to I (Insert). Both rows have other fields like USERID, FILEA_AREA, and STAT filled out.

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
Channel		CSCCINCContainer			
REQUEST_CONTAINER		REQUEST_CONTAINER			
ACTION	<input type="checkbox"/>	ACTION	S	CHAR	1
USERID	<input type="checkbox"/>	USERID		CHAR	8
FILEA_AREA	<input checked="" type="checkbox"/>	FILEA_AREA		STRUCT	80
STAT	<input type="checkbox"/>	STAT		CHAR	1
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

The screenshot shows the Service Interface Editor with two rows for the REQUEST_CONTAINER interface. The first row has ACTION set to I (Insert) and the second row has ACTION set to S (Select). Both rows have other fields like USERID, FILEA_AREA, and STAT filled out.

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
Channel		cscvincInsertContainer			
REQUEST_CONTAINER		REQUEST_CONTAINER			
ACTION	<input type="checkbox"/>	ACTION	I	CHAR	1
USERID	<input type="checkbox"/>	USERID		CHAR	8
FILEA_AREA	<input checked="" type="checkbox"/>	FILEA_AREA		STRUCT	80
STAT	<input checked="" type="checkbox"/>	status		CHAR	1
NUMB	<input checked="" type="checkbox"/>	employeeNumber		CHAR	6
NAME	<input checked="" type="checkbox"/>	employeeName		CHAR	20
ADDRX	<input checked="" type="checkbox"/>	address		CHAR	20
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

The screenshot shows the Service Project Editor with the service definition for cscvincSelectService. The program field is set to CSCVINC. The configuration tab shows the evaluate action logic.

```
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.
```

```
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



Accessing a CICS program – Transaction ID Usage

cscvincSelectService Service

Service Project Editor: Configuration

Required Configuration

Enter the required configuration for this service.

Coded character set identifier (CCSID):

Connection reference:

Optional Configuration

Enter the optional configuration for this service.

Transaction ID:

Transaction ID usage:

Bidi configuration reference:

Use context containers:

Context containers HTTP headers:

Add another

Definition **Configuration**

EIB_ONLY

```

TRANSACTION: CSMI PROGRAM: DFHMIRS TASK: 0008501 APPLID: CICS53Z DISPLAY: 00
STATUS: PROGRAM INITIATION

EIBTIME = 104730
EIBDATE = 0122050
EIBTRNID = 'CSMI'
EIBTRSKN = 8501
EIBTRMID = '/RBX'

EIBCPOSN = 0
EIBCALEN = 0
EIBAID = X'00'
EIBFN = X'0000'
EIBRCODE = X'000000000000
EIBDS = '.....'
+ EIBREQID = '.....'

ENTER: CONTINUE PF1 : UNDEFINED PF2 :
PF4 : SUPPRESS DISPLAYS PF5 :
PF7 : SCROLL BACK PF8 :
PF10: PREVIOUS DISPLAY PF11 :
M A D
Connected to remote server/host wg31a using lu/pool TCP00126 and port 23

```


EIB_AND_MIRROR

```

TRANSACTION: MIJO PROGRAM: DFHMIRS TASK: 0008476 APPLID: CICS53Z DISPLAY: 00
STATUS: ABOUT TO EXECUTE COMMAND

EXEC CSMVINC PROGRAM
TRANSMIT ('MIJO')
INQUIRE NBR
CHANNEL ('Channel')
NOHANDLE

ENTER: CONTINUE PF1 : UNDEFINED PF2 :
PF4 : SUPPRESS DISPLAYS PF5 :
PF7 : SCROLL BACK PF8 :
PF10: PREVIOUS DISPLAY PF11 :
M A D
Connected to remote server/host wg31a using lu/pool TCP00126 and port 23

```


EIB_AND_MIRROR

```

TRANSACTION: MIJO PROGRAM: CSCVINC TASK: 0008837 APPLID: CICS53Z DISPLAY: 00
STATUS: PROGRAM INITIATION

EIBTIME = 181730
EIBDATE = 0122051
EIBTRNID = 'MIJO'
EIBTRSKN = 8837
EIBTRMID = '/ADB'

EIBCPOSN = 0
EIBCALEN = 0
EIBAID = X'00'
EIBFN = X'0E02' LINK
EIBRCODE = X'000000000000
EIBDS = '.....'
+ EIBREQID = '.....'

ENTER: CONTINUE PF1 : UNDEFINED PF2 : SWITCH HEX/CHAR PF3 : END EDF
PF4 : SUPPRESS DISPLAYS PF5 : WORKING STORAGE PF6 : USER DIS
PF7 : SCROLL BACK PF8 : SCROLL FORWARD PF9 : STOP CON
PF10: PREVIOUS DISPLAY PF11 : EIB DISPLAY PF12 : UNDEFIN
M A D
Connected to remote server/host wg31a using lu/pool TCP00126 and port 23

```

- Transaction ID** attaches a CICS transaction (CSMI is the default) that starts the CICS DFHMIRS program.
- Transaction ID Usage** attribute useful for:
 - Transaction security requirements
 - Db2 plan selection
 - Transaction classification and reporting

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These attributes also be used in `zosconnect_cicsIpicConnection` and `zosconnect_services>service configuration` elements.

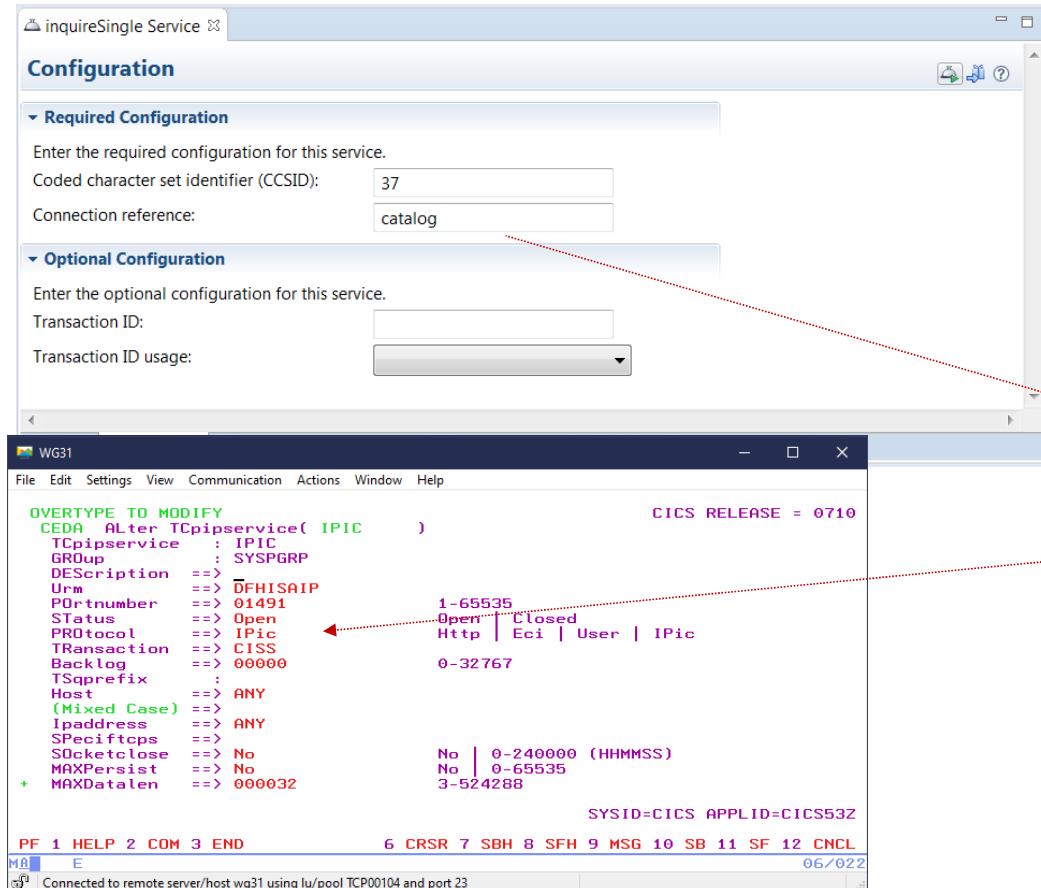
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Slide 48

Accessing a CICS program uses CICS IP interconnectivity (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

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

Define IPIC connection to CICS



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.

Search:            

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
ivtnoDisplayRequest					
Segment 1					
INPUT_MSG	<input type="checkbox"/>	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)

ivtnoDisplayService Service

Service Project Editor: 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:

Definition Configuration

IMS/TM Meta Data

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Slide 50



IMS Connections and Interactions

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>
```



API toolkit – Creating Services for IMS DB

Creating a service project from the IMS Catalog

The screenshot shows the 'Service Project Editor: Definition' window for an 'IMS Database Service'. The 'General Information' section shows 'Type: IMS Database Service', 'Version: 1.0.0', and a 'Description' field. The 'Actions' section lists steps: 1. Input service version, 2. Specify the SQL command for the service, 3. Specify Database Connection Properties and Generate Service Interface, 4. Complete the configuration for the service, 5. Deploy the service, and 6. Export the service. The 'Enter or import SQL Command' section contains the SQL query: 'SELECT FIRSTNAME, ZIPCODE, PHONENBR, A1111111 FROM ATSVPA.A1111111 WHERE A1111111=?'. This query is circled in red. Below it, the 'Specify Database Connection Properties and Generate Service Interface' section shows 'Database Connection: wg31:5555' and 'Database Name: DFSIVPA'. There is also a 'Generate Service Interface...' button.

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=DFSIVD1,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=FIRSTNAME,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 'response X'. The main area is titled 'Service Interface Editor' with a help icon. A message at the top says: '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 set of toolbar icons. The main content is a table with columns: 'Fields', 'Include', 'Interface Rename', 'Default Field Value', 'Data Type', and 'Field Length'. The 'Fields' column lists service interface definitions. The 'Include' column has checkboxes. The 'Interface Rename' column contains field names. The 'Default Field Value' column is empty. The 'Data Type' column shows data types like ARRAY and CHAR. The 'Field Length' column shows lengths like 0, 10, and 7. A red circle highlights the checkbox for 'result' in the 'Include' column. A red box highlights the entire row for 'result'.

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
selectByName_Response					
Segment 1					
Output Columns					
Result [0..*]	<input checked="" type="checkbox"/>	response			
FIRSTNAME	<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



IMS Connection Factory in the server XML

Service Project Editor: Configuration

Required Configuration

Enter the required configuration for this service.

Connection profile: DFSIVPACConn

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)
```



API toolkit – Creating Services for MQ

Creating a MQ PUT (“POST”) service interface definition

The screenshot displays two windows from the API toolkit:

- Service Interface Editor:** Shows a table of fields for a service interface named "minilnServiceRequest". A red box highlights the "Interface Rename" column for the "loan application" row, which contains the renamed field names: "name", "credit score", "yearly income", "age", "loan amount", "aproved?", "effective date", "yearly interest rate", "yearly payment", "authorization identity", "MESSAGES_NUM", and "disapproval message". A red circle highlights the "Include" checkboxes for the first four fields.
- Service Project Editor: Configuration:** Shows configuration settings for a service named "twoway Service". A red circle highlights the JNDI name fields:
 - Connection factory JNDI name: jms/qmgrCf
 - Request destination JNDI name: jms/requestQueue
 - Reply destination JNDI name: jms/replyQueue

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.



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: jms/qmgrCf

Destination JNDI name: jms/default

Coded character set identifier (CCSID): 37

Optional Configuration

Enter the optional configuration for this service.

Wait interval:

Message selector:

Definition Configuration

mqClient.xml

Read only Close

Design Source

```
<server description="MQ Service Provider">
<featureManager>
    <feature>zosconnect:mqService-1.0</feature>
</featureManager>
<variable name="wmqJmsClient.rar.location"
    value="/usr/lpp/mqm/V9R1M1/java/lib/jca/wmq.jmsra.rar"/>
<wmqJmsClient nativeLibraryPath="/usr/lpp/mqm/V9R1M1/java/lib"/>
<zosconnect_services>
    <service name="mqPutService">
        <property name="useCallerPrincipal" value="false"/>
    </service>
</zosconnect_services>
<connectionManager id="ConMgr1" maxPoolSize="5"/>
<jmsConnectionFactory id="qmgrCF" jndiName="jms/qmgrCF">
    <connectionManagerRef>ConMgr1</connectionManagerRef>
    <properties.wmqJMS transportType="CLIENT"
        queueManager="ZMQ1"
        channel="LIBERTY.DEF.SVRCONN"
        hostname="wg31.washington.ibm.com"
        port="1422" />
</jmsConnectionFactory>
<jmsQueue id="q1" jndiName="jms/default">
    <properties.wmqJMS
        baseQueueName="ZCEE.DEFAULT.MQZCEE.QUEUE"
        CCSID="37"/>
</jmsQueue>
</server>
```



Using JMS to access MQ (Two-Way)

*twoWay Service X

Service Project Editor: Configuration

Required Configuration

Enter the required configuration for this service.

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:

Reply selection: msgIDToCorrelID

Expiry: -1

Definition Configuration

mq.xml

Read only Close

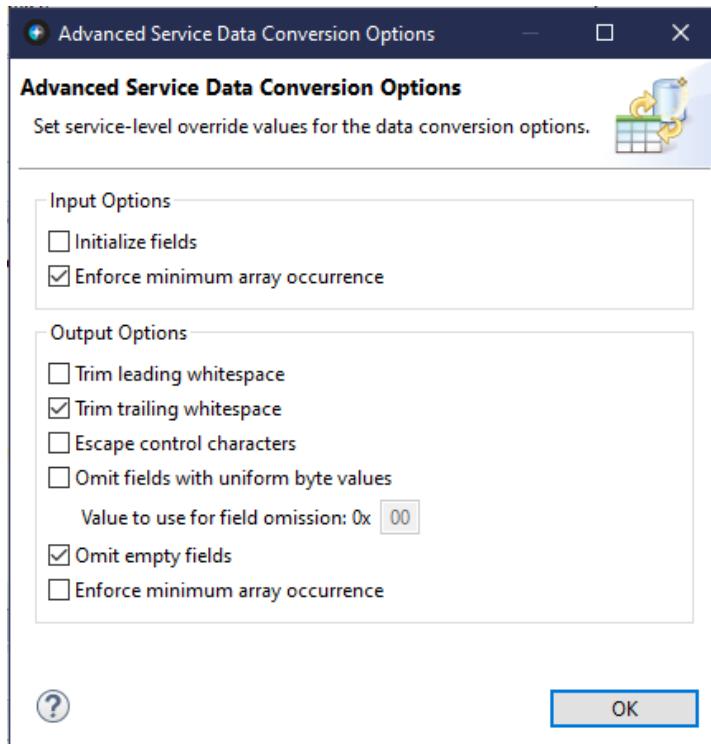
Design Source

```
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.MQZEE.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
```

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API toolkit – Advanced Data Conversion Options



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
Response JSON schema: response-schema.json

Import from local machine...
Import from local machine...

The service developer retrieves details about the Db2 REST services

Note there is no service interface editor available

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:

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 configuration to the "basicAuthRef" attribute in the XML code, and from the "WG31.WASHINGTON.IBM.COM" host entry in the configuration to the "host" attribute in the XML code.



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' connection selected in the left-hand navigation bar. A context menu is open, with 'Deploy Service to z/OS Connect EE Server' highlighted. To the right, two dialog boxes are displayed: 'Deploy Service to z/OS Connect EE Server Result' and 'Export Service Package'. Both dialog boxes have red circles around specific sections.

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.

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

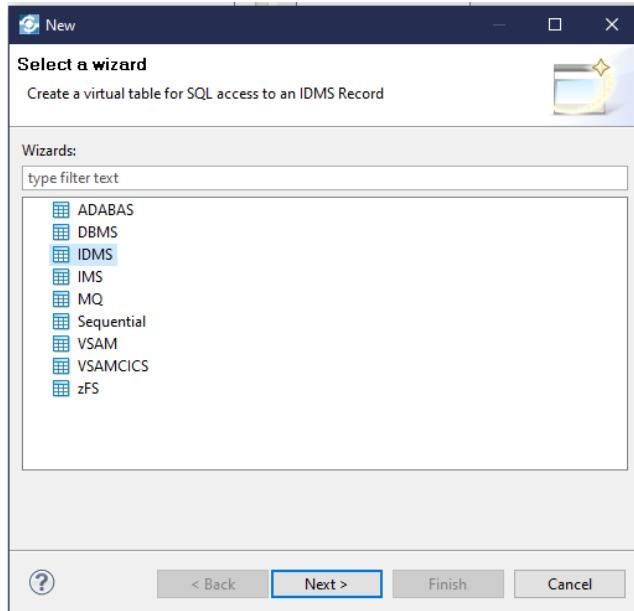
File name: cscvincDeleteService.sar

Overwrite service package file

DVM Studio



DVM uses the DVM Studio



The screenshot shows the DVM Studio interface. On the left, there's a 'Select a wizard' dialog for creating a virtual table for SQL access to an IDMS Record. The main area shows a tree view of data sources and services. Under 'Services', 'Web Services' is selected, with a context menu open over the 'Admin' option. The 'Generate SAR File(s)' option in this menu is highlighted with a red circle. The right side of the interface shows a SQL editor with generated code for EXMPCAT and a results grid displaying data.



z/OS Resources accessible from DVM using SQL*

Data Source	SELECT	INSERT	UPDATE	DELETE	CALL Statement
CA IDMS	Yes	No	No	No	N/A
CICS COMMAREA	N/A	N/A	N/A	N/A	Yes
DB2 for z/OS	Yes	Yes	Yes	Yes	Yes
Db2 Direct	Yes	No	No	No	N/A
Db2 other platforms	Yes	Yes	Yes	Yes	Yes
IMS DBCTL	Yes	Yes	Yes	Yes	N/A
IMS Direct	Yes	No	No	No	N/A
IMS OTMA	N/A	N/A	N/A	N/A	Yes
MQ	Yes	No	No	No	N/A
Natural	N/A	N/A	N/A	N/A	Yes
SMF	Yes	No	No	No	N/A
Sequential data set	Yes	Yes	No	No	N/A
VSAM data set*	Yes	Yes	Yes	Yes	N/A
z/OS Syslog	Yes	No	No	No	N/A
OMVS files	Yes	No	No	No	Yes

*Administering IBM DVM Manager, SC27-9303

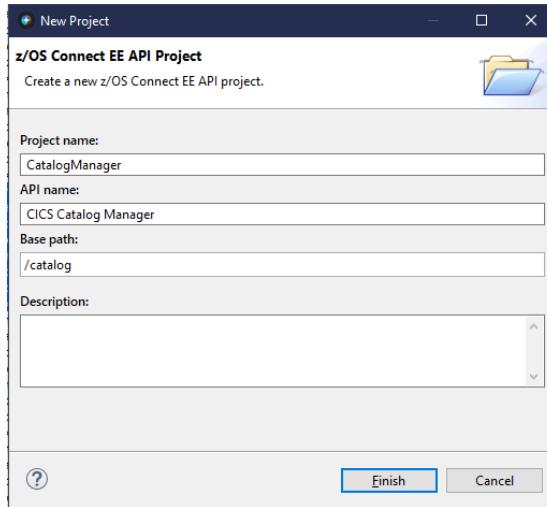


Once we have a Service Archive (SAR) What's next?

Quick and easy **API mapping**.

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

API toolkit – API Editor



Name: CICS Catalog Manager Description:

Base path: /catalog

Version: 1.0.0

>Contact Information

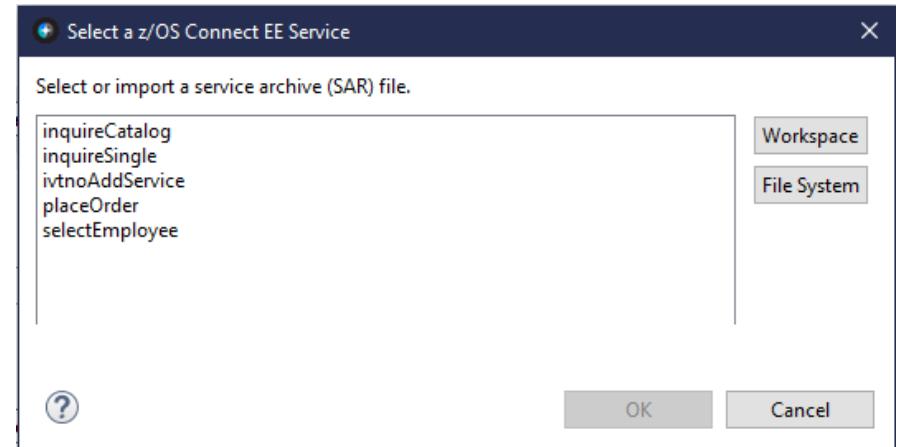
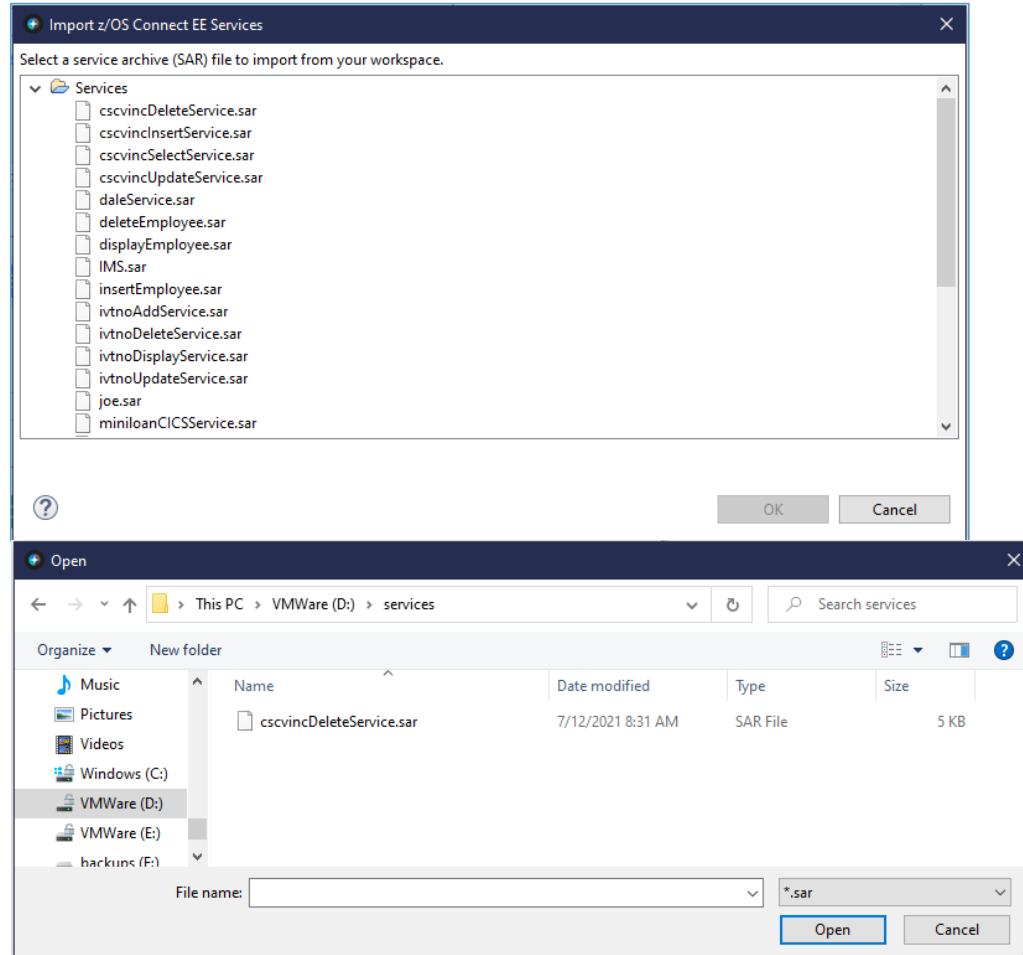
Path: /newPath1

Methods (4)

Method	Service...	Mapping...	Up	Down	Delete
POST					
GET					
PUT					
DELETE					



Importing the service archives files



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API toolkit – API Editor

The screenshot shows the API Toolkit API Editor interface. It displays three API endpoints:

- catalog**: Path: /catalog, Methods: GET (inquireCatalog), PUT (ivtnoAddService)
- order**: Path: /order, Methods: POST (placeOrder), PUT (selectEmployee)
- item**: Path: /item/{itemID}, Methods: GET (inquireSingle)

A large red oval highlights the **item** endpoint.

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

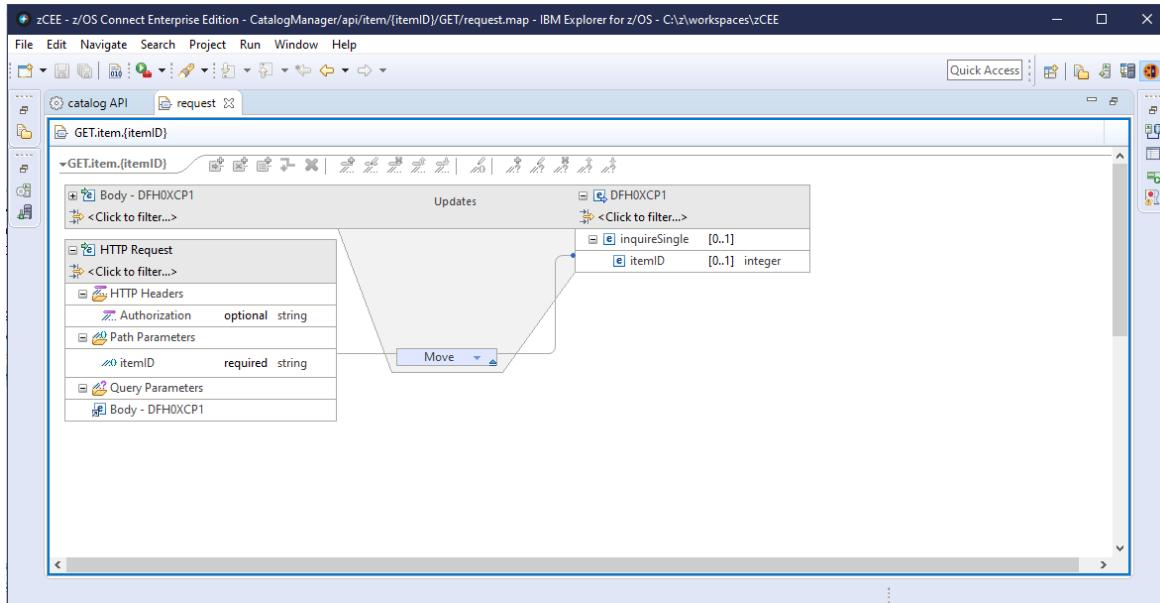
Once you define your API, you can map backend services to each request.

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.

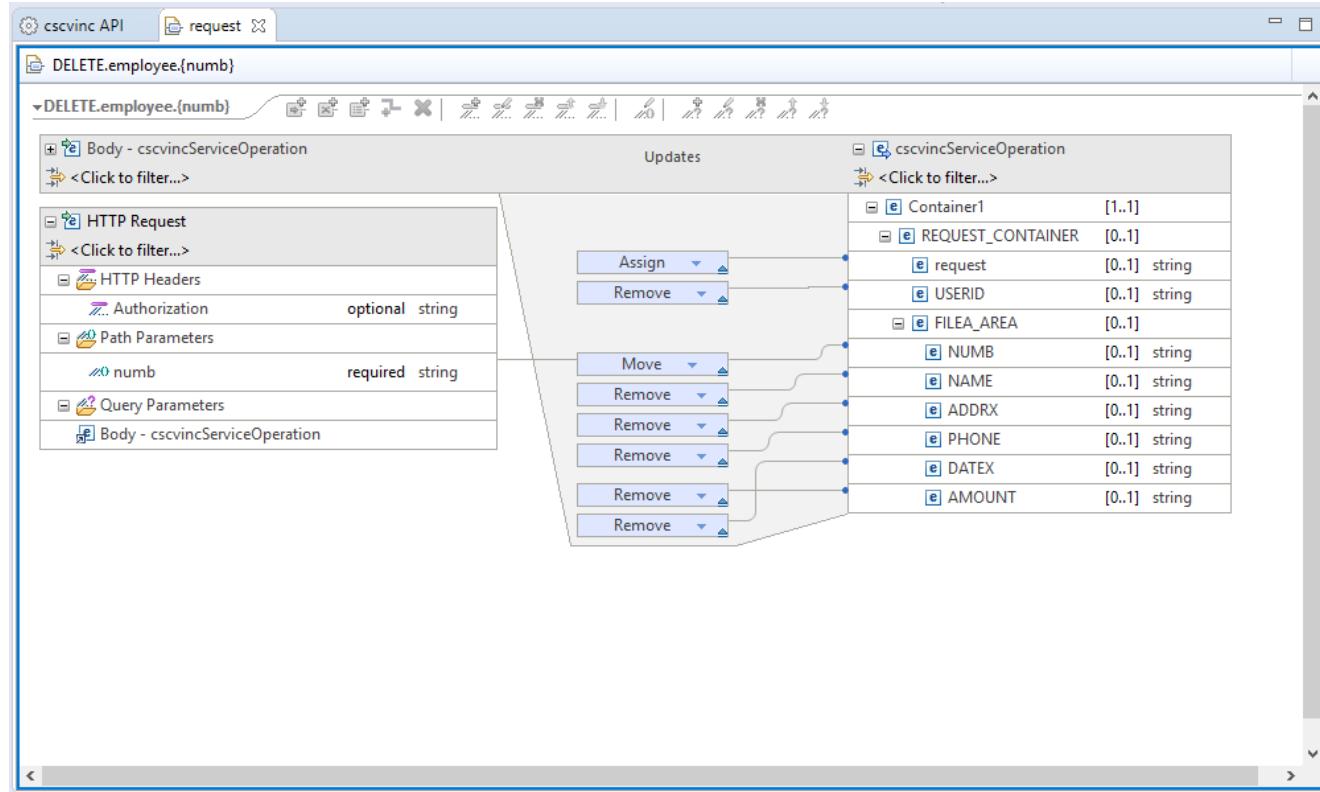
Assign static values to fields, useful for Op codes.

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



API toolkit – API Editor

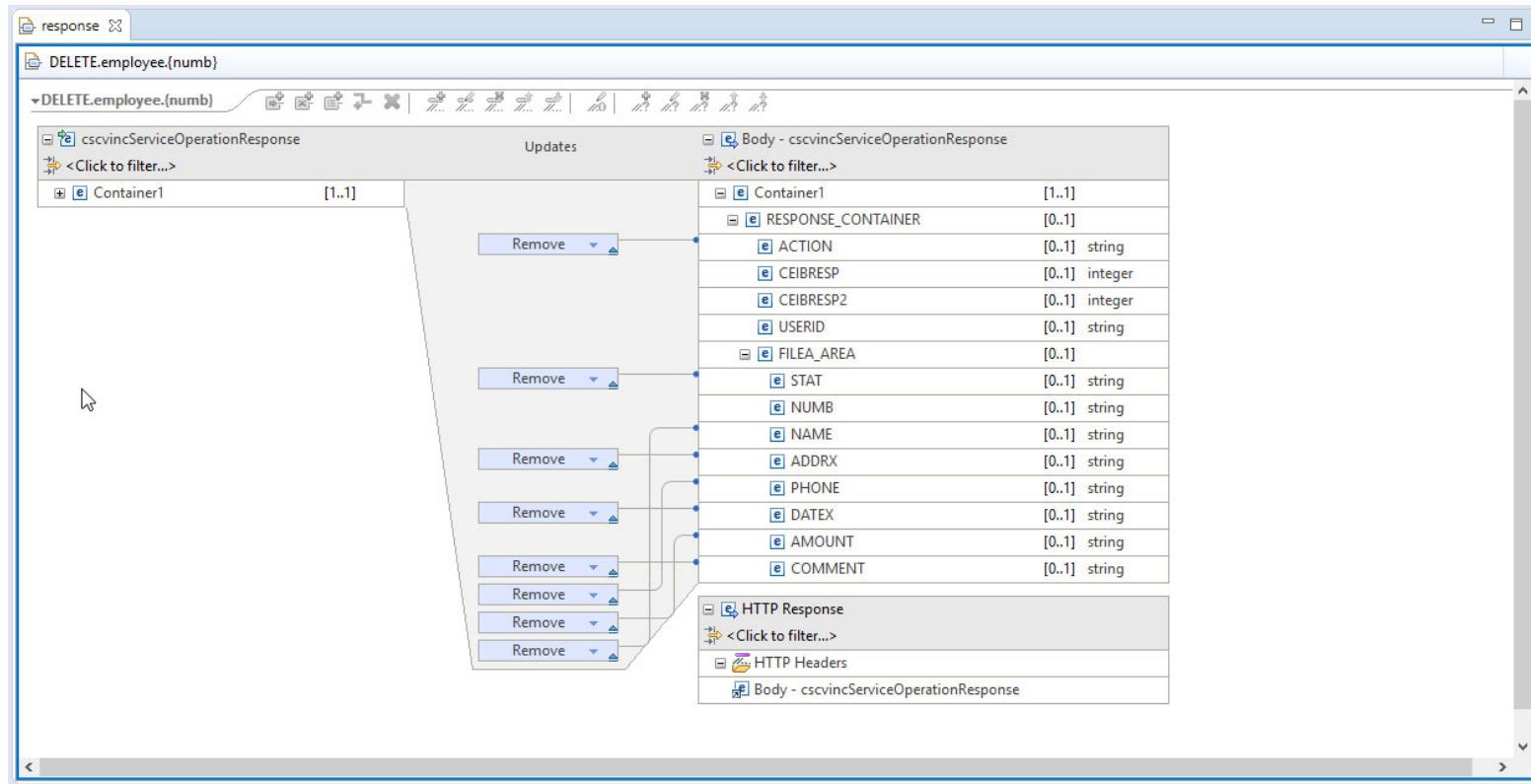
API mapping: Remove or assign values to the fields exposed by service developer





API toolkit – API Editor

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





API toolkit – Header properties

API mapping: Allows adding HTTP header properties

The screenshot shows the API toolkit interface with the 'request' tab selected. The left pane displays the request structure for a 'POST.queue' operation, which includes an 'HTTP Request' section. Within this section, there is an 'HTTP Headers' section that is highlighted with a red oval. This section contains two entries: 'Authorization' (optional string) and 'ibm-mq-md-correlID' (optional string). The right pane shows the response structure, which is an 'MQPUTOperation' message. This message contains an 'mqmessage' field with several properties: stat, numb, name, addrx, phone, datex, amount, and comment, all of which are of type [1..1] string.

Property	Type	Description
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 operations and their mappings. On the left, the API path is defined as `/employee/{employee}`. The main panel shows the `Methods (4)` section for a `GET` operation named `cscvincSelectService`. Under the `Responses (2)` section, two responses are defined: `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`. Below this, rules are defined to apply this response based on specific conditions. The rule definitions are:

- 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.

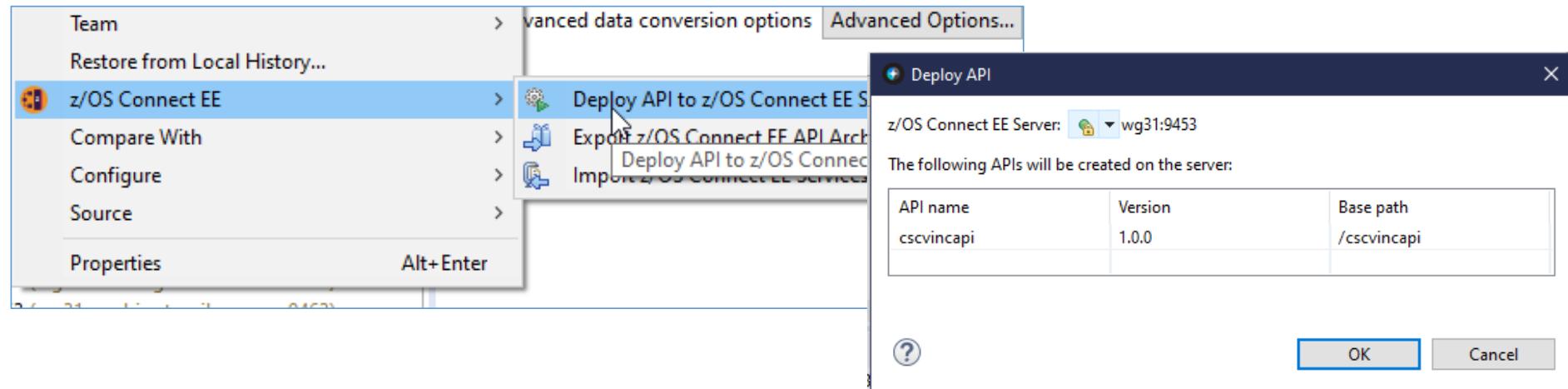
You can define rules based on fields in the service's return interface to tell z/OS Connect EE which response code to return



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 Servers interface with the API Editor open. On the left, the navigation pane shows 'wg31:9443 (wg31.washington.ibm.com:9443)' with 'APIs (1)' expanded, revealing 'cscvinc (S)'. A context menu for 'cscvinc' is open, with 'Open In Swagger UI' selected. The main pane displays the Swagger UI for the 'cscvinc' service. The URL is 'localhost:55221/?url=/api-docs/'. The Swagger UI interface includes:

- swagger** header
- cscvinc** service name
- Operations**:
 - POST /employee**
 - DELETE /employee/{employee}**
 - GET /employee/{employee}**
 - PUT /employee/{employee}**
- Model Example Value**:

```
{ "cscvincSelectServiceOperationResponse": { "cscvincContainer": { "response": { "CEIBRESP": 0, "CEIBRESP2": 0, "USERID": "string", "file": { "employeeNumber": "string", "name": "string" } } } }
```
- Response Content Type**: application/json
- Parameters**:

Parameter	Value	Description	Parameter Type	Data Type
Authorization			header	string
employee	(required)		path	string
- Response Messages**:

HTTP Status Code	Reason	Response Model	Headers
404	Not Found	Model Example Value	



/zosConnect/designer

Create a Web Archive file for OpenAPI 3 APIs

Accessing a z/OS asset starting with a YAML description of an API (OpenAPI 3)

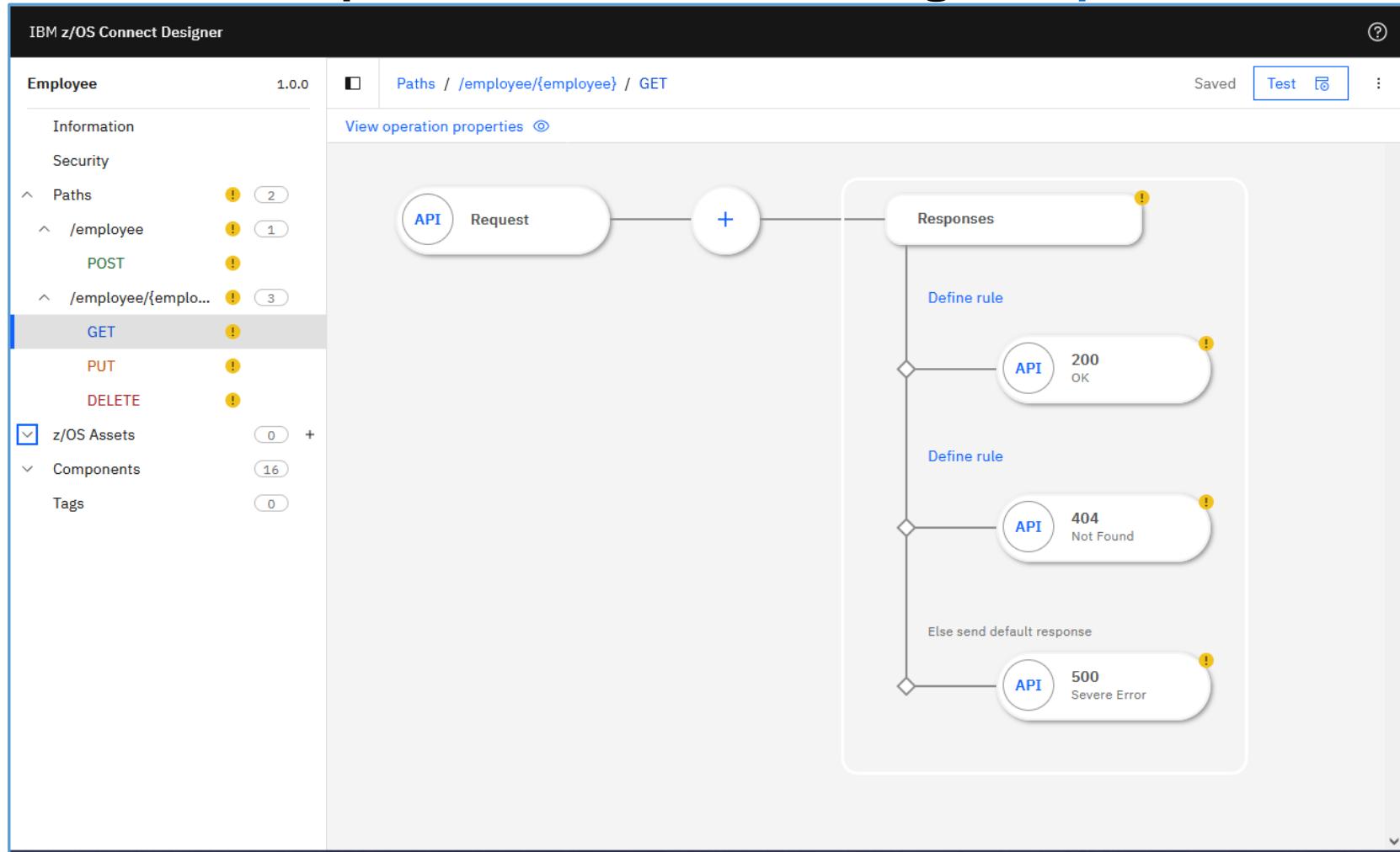


```
cscvinc.yaml - Notepad
File Edit Format View Help
openapi: 3.0.0
info:
  description: "CICS Filea Sample VSAM Application"
  version: 1.0.0
  title: cscvinc
x-ibm-zcon-roles-allowed:
- Manager
paths:
  /employee:
    post:
      tags:
        - cscvinc
      operationId: postCscvincInsertService
      parameters:
        - name: Authorization
          in: header
          required: false
          schema:
            type: string
      requestBody:
        content:
          application/json:
            schema:
              $ref: "#/components/schemas/postCscvincInsertService_request"
        description: request body
        required: true
      responses:
        "200":
          description: OK
          content:
            application/json:
              schema:
                $ref: "#/components/schemas/postCscvincInsertService_response_200"
        "400":
          description: Bad Request
          content:
            application/json:
              schema:
                $ref: "#/components/schemas/postCscvincInsertService_response_400"
Ln 33, Col 74 100% Windows (CRLF) UTF-8
```

```
cscvinc.yaml - Notepad
File Edit Format View Help
getEmployeeSelectService_response_200:
  type: object
  properties:
    summary:
      $ref: '#/components/schemas/getEmployeeSelectService_response_200_message'
    detail:
      $ref: '#/components/schemas/getEmployeeSelectService_response_200_detail'
getEmployeeSelectService_response_200_message:
  type: object
  properties:
    message:
      type: string
    example:
      message: record retrieved
getEmployeeSelectService_response_200_detail:
  type: object
  properties:
    EmployeeSelectServiceOperationResponse:
      type: object
      properties:
        employeeData:
          type: object
          properties:
            response:
              type: object
              properties:
                employeeDetails:
                  type: object
                  properties:
                    employeeNumber:
                      type: string
                      maxLength: 6
                    name:
                      type: string
                      maxLength: 20
                    address:
                      type: string
                      maxLength: 20
                    phoneNumber:
                      type: string
                      maxLength: 8
                    date:
                      type: string
                      maxLength: 8
Ln 196, Col 27 100% Windows (CRLF) UTF-8
```



Import the YAML description of an API into the Designer (OpenAPI 3)





Describe the z/OS asset, a CICS program (OpenAPI 3)

IBM z/OS Connect Designer

cscvinc 1.0.0

Information
Security
Paths 2
z/OS Assets 1
programCscvinc
Components 8
Tags 0

Step 2 of 5
Add z/OS Asset

Select a z/OS Asset type
CICS channel program

CICS program name
CSCVINC

Program language
COBOL

CCSID
037

Select a CICS connection
cicsConn

Optional configuration
Transaction ID (optional)
Input Transaction ID

Transaction ID usage (optional)
Select usage

Previous Next



Accessing a z/OS CICS program (OpenAPI 3)

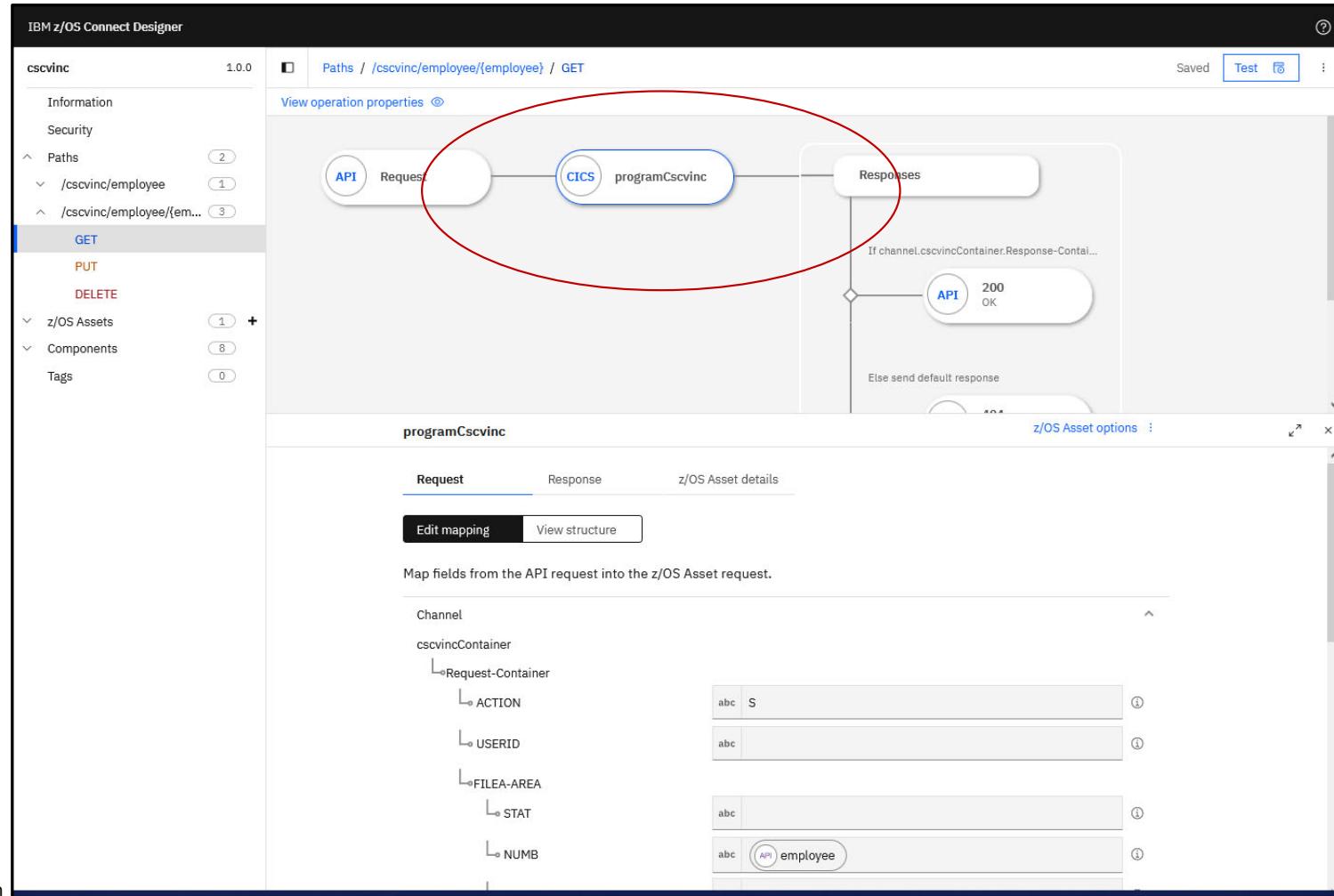
The screenshot shows the IBM z/OS Connect Designer interface. On the left, there is a navigation sidebar with the following structure:

- cscvinc** (selected) 1.0.0
- Information
- Security
- Paths 2
- z/OS Assets** 1 +
- programCscvinc** (selected)
- Components 8
- Tags 0

The main panel displays the configuration for the selected asset:

- General**
 - Name: programCscvinc
 - Type: cicsChannel-1.0
 - Description: -
- CICS channel program**
 - CICS program name: CSCVINC
 - Program language: COBOL
 - CCSID: 037
 - Connection reference: cicsConn
- Request channel**
 - cscvincContainer BIT container
- Response channel**
 - cscvincContainer BIT container

Map the method and request message with the CICS program (OpenAPI 3)





Map the response message (OpenAPI 3)

Paths / /employee/{employee} / GET

200 - OK

Edit mapping View structure

Map fields from the z/OS Asset response into the API response.

Body

summary

- message

detail

- cscvincSelectServiceOperationResponse
 - *cscvincContainer
 - response
 - CEIBRESP
 - CEIBRESP2
 - USERID
 - filea
 - employeeNumber
 - name
 - address
 - phoneNumber
 - date
 - amount
 - comment

abc Record (NUMB) successfull retrieved by (USERID)

123

123

abc

abc (NUMB)

abc (NAME)

abc (ADDRX)

abc phone

abc (DATEX)

abc (AMOUNT)

abc (COMMENT)





Add the z/OS asset, a Db2 REST service (OpenAPI 3)

IBM z/OS Connect Designer

EmployeesApi 1.1

Information

Security

Paths

/employees/{id}

GET

PUT

DELETE

/employees

GET

POST

z/OS Assets

addEmployee

deleteEmployee

getEmployee

getEmployees

selectByRole

updateEmployee

Components

Tags

Step 3 of 4

Add z/OS Asset

Select a Db2 connection

db2Conn

Import from Db2 service manager

Db2 native REST service collection ID

e.g. SYSIBMSERVICE

Db2 native REST service name

e.g. myService

Db2 native REST service version (optional)

e.g. V1

Import Db2 native REST service request schema

Drag and drop or select a file
JSON schema specification draft 4 and 5 supported

Specify a URL

http://github.com/example/api-docs

Import file

Import Db2 native REST service response schema

Drag and drop or select a file
JSON schema specification draft 4 and 5 supported

Previous

Next



Select the z/OS Db2 REST Service (OpenAPI 3)

Add z/OS Asset / Import Db2 native REST service

Import Db2 native REST service

Select a Db2 connection

db2Conn

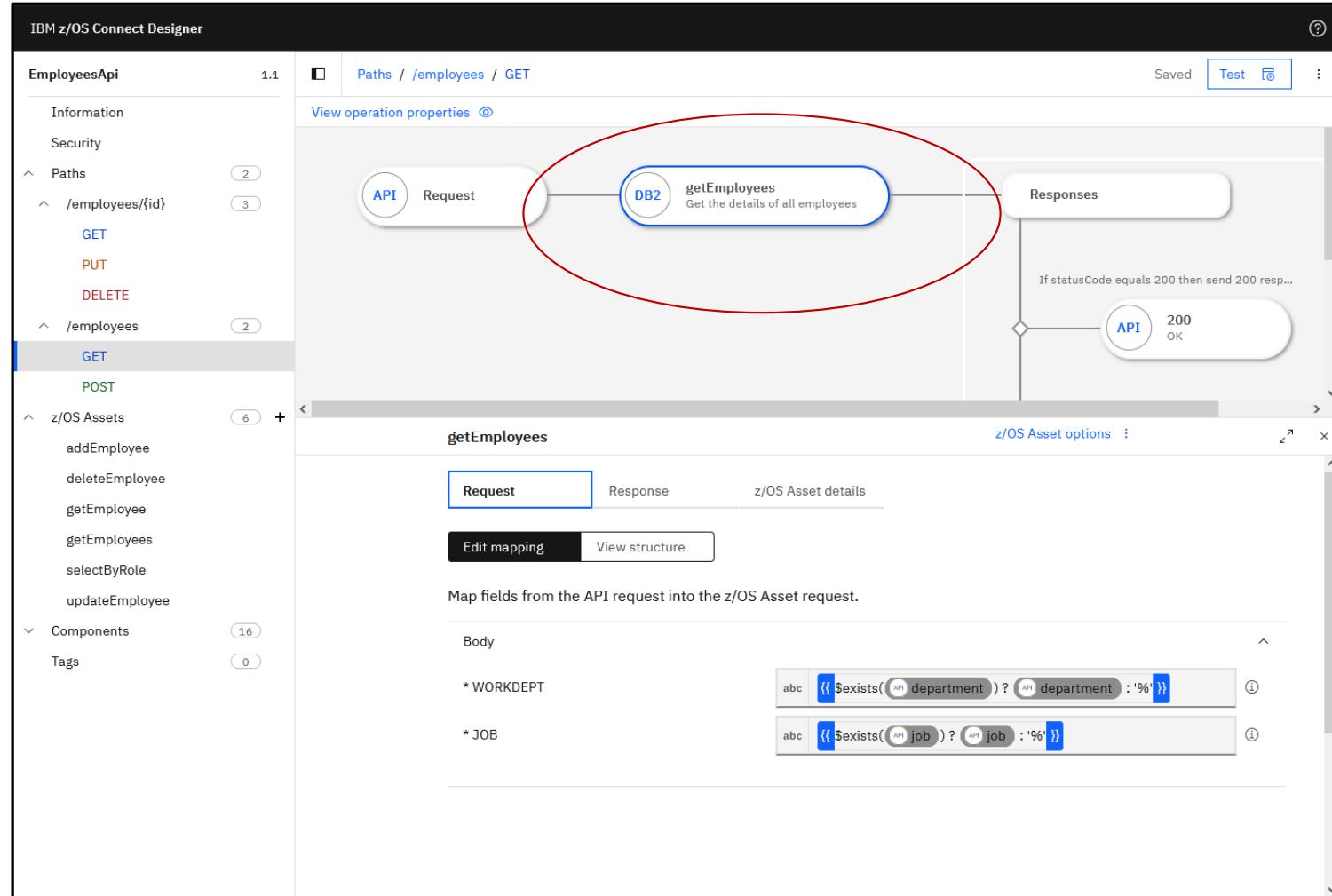
Service name	Version	Collection ID	Path	Description	Status
addEmployee	V1	SYSIBMSERVICE	/services/SYSIBMSERVI...	Add the details of an ind...	Available
deleteEmployee	V1	SYSIBMSERVICE	/services/SYSIBMSERVI...	Remove the details of a...	Available
getEmployee	V1	SYSIBMSERVICE	/services/SYSIBMSERVI...	Get the details of a spec...	Available
getEmployees	V1	SYSIBMSERVICE	/services/SYSIBMSERVI...	Get the details of all em...	Available
updateEmployee	V1	SYSIBMSERVICE	/services/SYSIBMSERVI...	Update the details of an...	Available
deleteEmployee	V1	zCEEService	/services/zCEEService/...	Delete an employee fro...	Available
displayEmployee	V1	zCEEService	/services/zCEEService/...	Display an employee in ...	Available
insertEmployee	V1	zCEEService	/services/zCEEService/i...	Insert an employee into...	Available
selectByDepartments	V1	zCEEService	/services/zCEEService/s...	Select employees by de...	Available
selectByRole	V1	zCEEService	/services/zCEEService/s...	Select an employee bas...	Available

Items per page: 10 ▾ 1–10 of 12 items

Previous Import

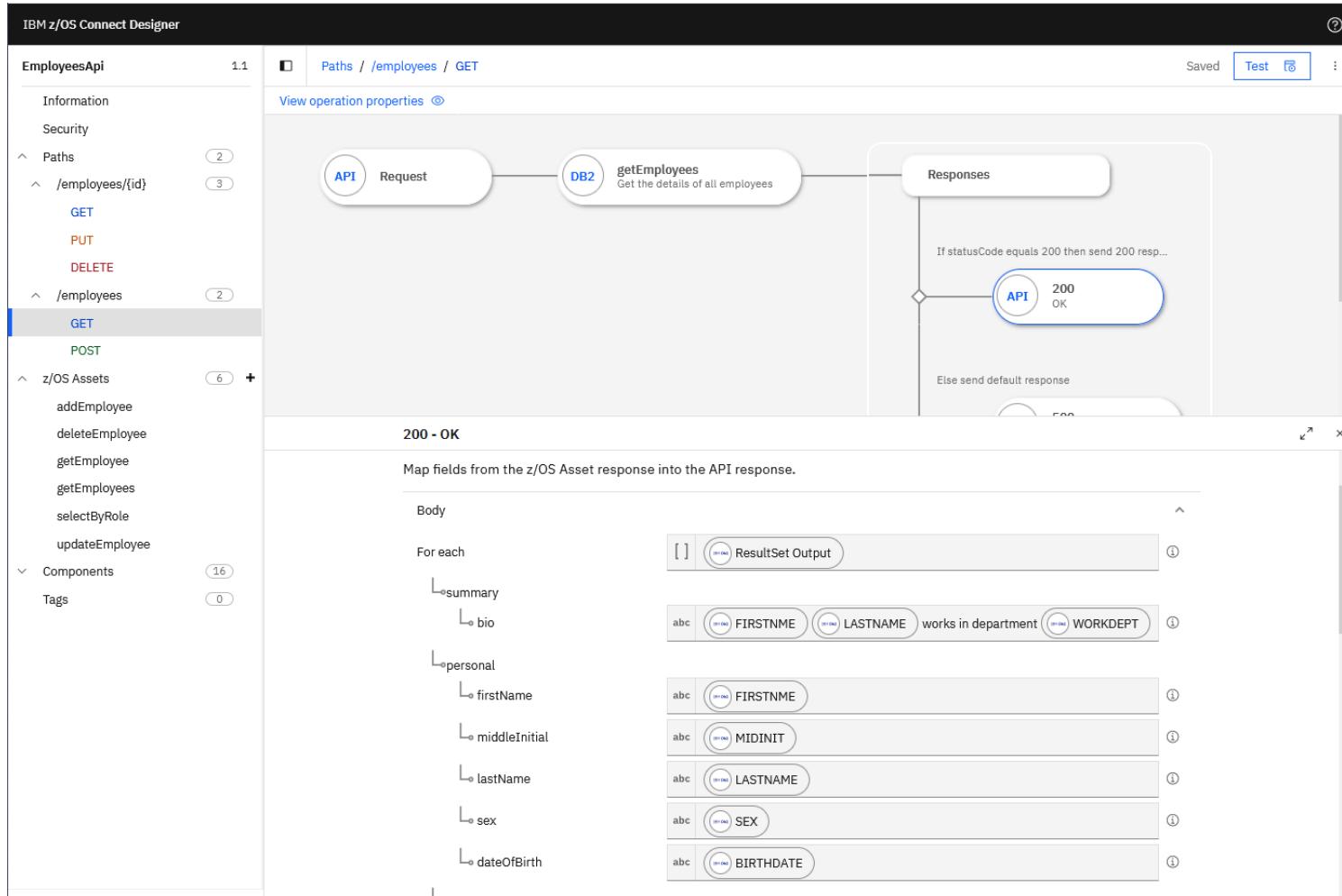
1 ▾ of 2 pages ▶

Map the method and the response message with a Db2 REST service (OpenAPI 3)





Map the response message (OpenAPI 3)





z/OS Connect Designer for OpenAPI 3 (200)

The screenshot shows the IBM z/OS Connect Designer interface for creating an API operation. The left sidebar lists the API definition, including paths like /employees/{id} and /employees, and various HTTP methods (GET, PUT, DELETE). The main workspace displays the flow for the GET operation on the /employees path. The flow starts with an 'API Request' node, followed by a 'DB2' node labeled 'getEmployees' which describes getting the details of all employees. This leads to a 'Responses' block. Inside the responses block, a condition 'If statusCode equals 200 then send 200 resp...' leads to a '200 OK' API response node. Below the flow, the '200 - OK' response body is defined, showing a 'ResultSet Output' structure with fields like FIRSTNAME, LASTNAME, and WORKDEPT, along with personal fields like firstName and middleInitial.



z/OS Connect Designer for OpenAPI 3 (404)

IBM z/OS Connect Designer

EmployeesApi 1.1 Paths / /employees/{id} / PUT Saved Test

Information Security Paths /employees/{id} 2 3

GET PUT DELETE

/employees 2 z/OS Assets 6 + Components 16 Tags 0

View operation properties

200 Updated

If "Update Count" equals 0 then send 404 res...

404 Not Found

Else send default response

500 Internal Server Error

404 - Not Found

Edit mapping View structure

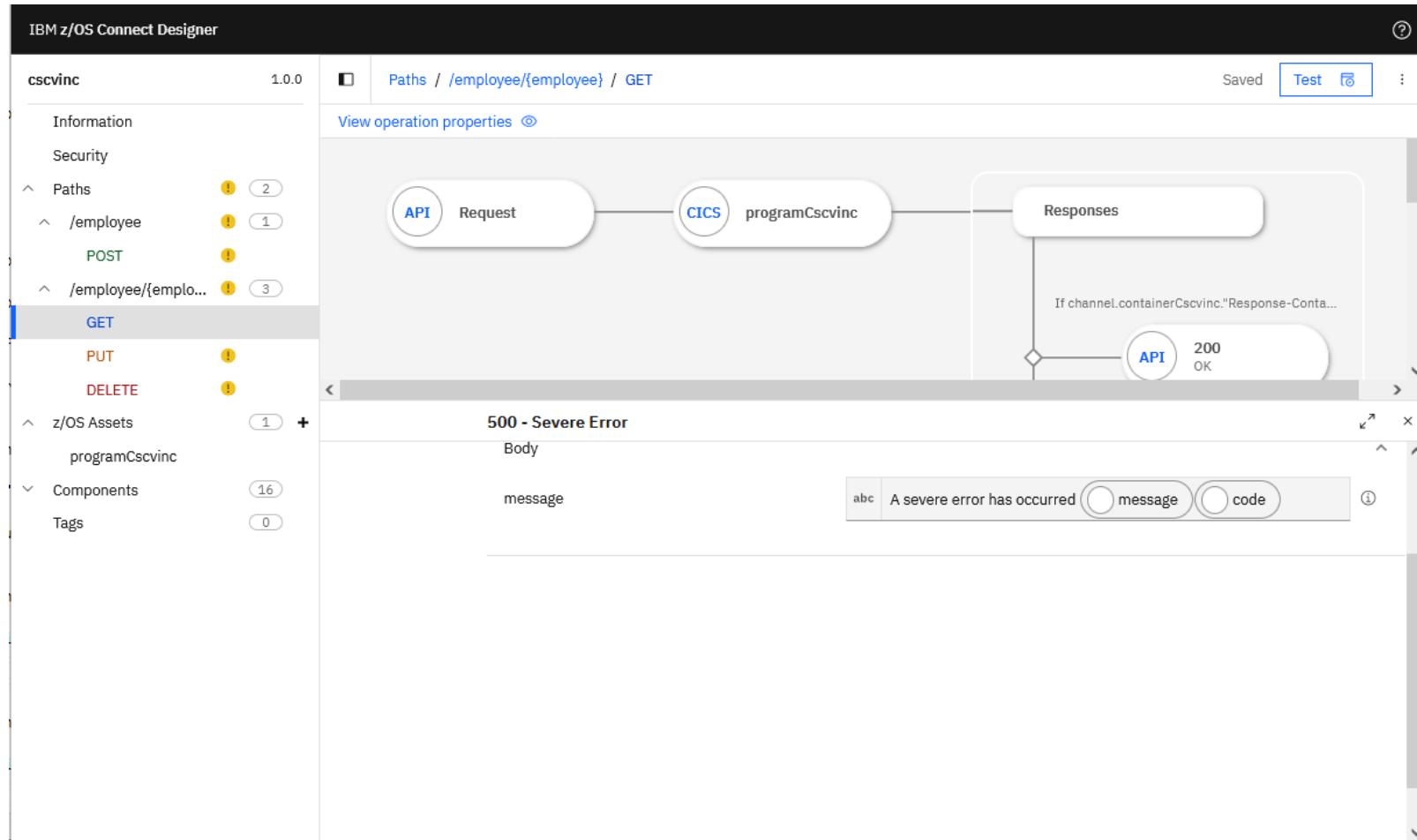
Map fields from the z/OS Asset response into the API response.

Body

message abc Employee not found ⓘ

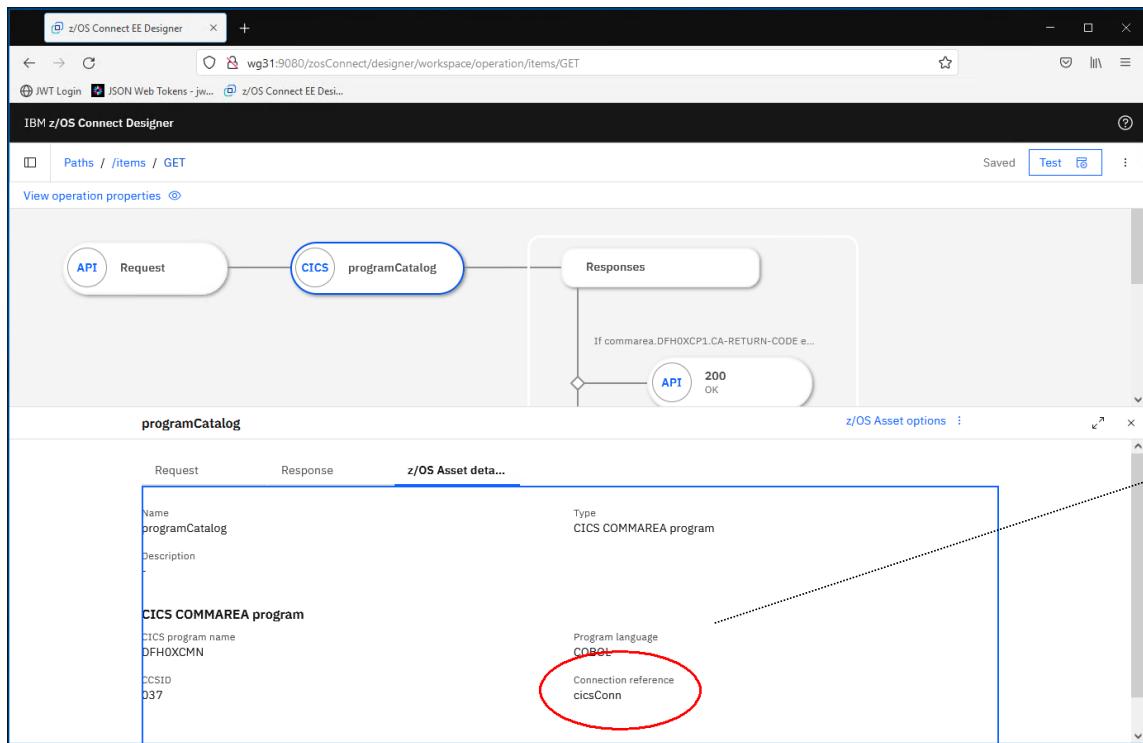


z/OS Connect Designer for OpenAPI 3 (500)





Server XML - Accessing a CICS program using IPIC (OpenAPI 3)



The screenshot shows the 'Server Config' interface with the 'cics.xml' file open. The 'Source' tab is selected, displaying the XML configuration code. A callout box points to the 'zosconnect_cicsIpicConnection' element, which is highlighted with a red oval.

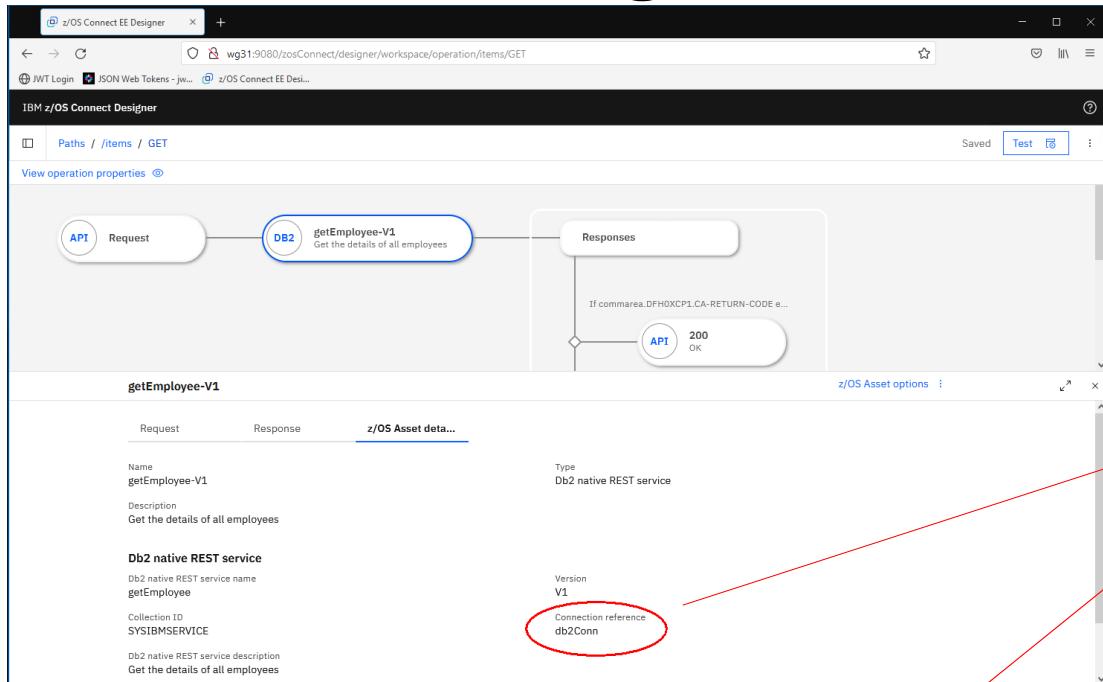
```
1<server description="CICS IPIC connections">
2
3<!-- Enable features -->
4<featureManager>
5  <feature>zosconnect:cics-1.0</feature>
6</featureManager>
7
8<zosconnect_cicsIpicConnection id="cicsConn" host="${CICS_HOST}">
9  port="${CICS_PORT}" />
10
11</server>
12
```

Callout Box Text: Define IPIC connection to CICS using variables defined in bootstrap.properties file

The connection references identifies a `zosconnect_cicsIpicConnection` configuration element. Which provides the connection details to a CICS region.



Server XML - Accessing a Db2 REST service (OpenAPI 3)



The screenshot shows the 'Server Config' interface with the 'db2.xml' configuration file open. The 'Source' tab displays the XML code:

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <server description="Db2 Connections">
3   <featureManager>
4     <feature>zosconnect:db2-1.0</feature>
5   </featureManager>
6   <zosconnect_credential user="${DB2_USERNAME}">
7     password="${DB2_PASSWORD}" id="commonCredentials" />
8   <zosconnect_db2Connection id="db2Conn" host="${DB2_HOST}">
9     port="${DB2_PORT}" credentialRef="commonCredentials" />
10 </server>
11

```

A red arrow points from the 'Connection reference db2Conn' in the Designer to the 'id="db2Conn"' in the XML code. A callout box on the right says: 'Define connections to Db2 using variables defined in bootstrap.properties file'.

```

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

```

The connection references identifies a `zosconnect_db2Connection` configuration element. Which provides the connection details to a DB2 DDF task.



EJB roles for z/OS Connect (OpenAPI 3)

```
<safCredentials unauthenticatedUser="WSGUEST" profilePrefix="BBGZDFLT" />  
  
<webApplication id="CatalogManager" location="${server.config.dir}/apps/api.war" contextRoot="catalog"  
name="CatalogManager"/>  
  
<safRoleMapper profilePattern=%profilePrefix%.%resourceName%.%role%
```

```
openapi: 3.0.0  
...  
servers:  
- url: /  
x-ibm-zcon-roles-allowed:  
- Manager  
...  
paths:  
/items:  
  get:  
    operationId: itemsGet  
    ...  
/items/{id}:  
  get:  
    ...  
    operationId: itemsIdGet  
    x-ibm-zcon-roles-allowed:  
    - Staff  
/orders:  
  post:  
    ...  
    operationId: ordersPost  
    x-ibm-zcon-roles-allowed:  
    - Staff
```

From the OpenApi document, the value for %role% would be either Manager or Staff.

So, the required SAF EJB roles to be defined would be:

- *BBGZDFLT.CatalogManager.Manager*
- *BBGZDFLT.CatalogManager.Staff*

*REDFINE EJBROLE BBGZDFLT.CatalogManager.Manager
REDFINE EJBROLE BBGZDFLT.CatalogManager.Staff*

Access to use the GET method to invoke /items would require read access to EJB role *BBGZDFLT.CatalogManager.Manager*.

Access to use the GET method to invoke /items/{id} and the POST method to invoke /orders would require read access to EJB role *BBGZDFLT.CatalogManager.Staff*.



What REST test tooling is available?



API Testing with Postman

The screenshot shows the Postman application interface. At the top, there's a navigation bar with 'File', 'Edit', 'View', 'Help', and a search bar labeled 'Search Postman'. Below the navigation is a toolbar with icons for cloud, collection, report, settings, and a bell. A 'Upgrade' button is also present. The main workspace shows a list of collections and a current request. The request details are as follows:

- Method: GET
- URL: https://mpz3.washington.ibm.com:9443/cscvinc/employee/111111
- Authorization: (highlighted in green)
- Headers: (10)
- Body: (empty)
- Pre-request Script: (empty)
- Tests: (empty)
- Settings: (empty)

Under 'Query Params', there is a table with columns 'KEY', 'VALUE', 'DESCRIPTION', and 'Bulk Edit'. The table currently has one row with a single entry. The 'Body' tab is selected, showing the raw JSON response. The response body is:1
2 "cscvincSelectServiceOperationResponse": {
3 "cscvincContainer": {
4 "response": {
5 "CEIBRESP": 0,
6 "CEIBRESP2": 0,
7 "USERID": "CICSUSER",
8 "filea": {
9 "employeeNumber": "111111",
10 "name": "C. BAKER",
11 "address": "OTTAWA, ONTARIO",
12 "phoneNumber": "511212003",
13 "date": "26 11 81",
14 "amount": "00011 00"

mitchj@us.ibm.com

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



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

IBM

all Filter

Liberty REST APIs

Discover REST APIs available within Liberty

cscvinc

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

db2employee

filemgr

imsPhoneBook

jwltlpvDemoApi

miniloancics

mqapi

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": "51212003",
          "date": "26 11 81",
          "amount": "$0011.00"
        }
      }
    }
  }
}
```

Response Code

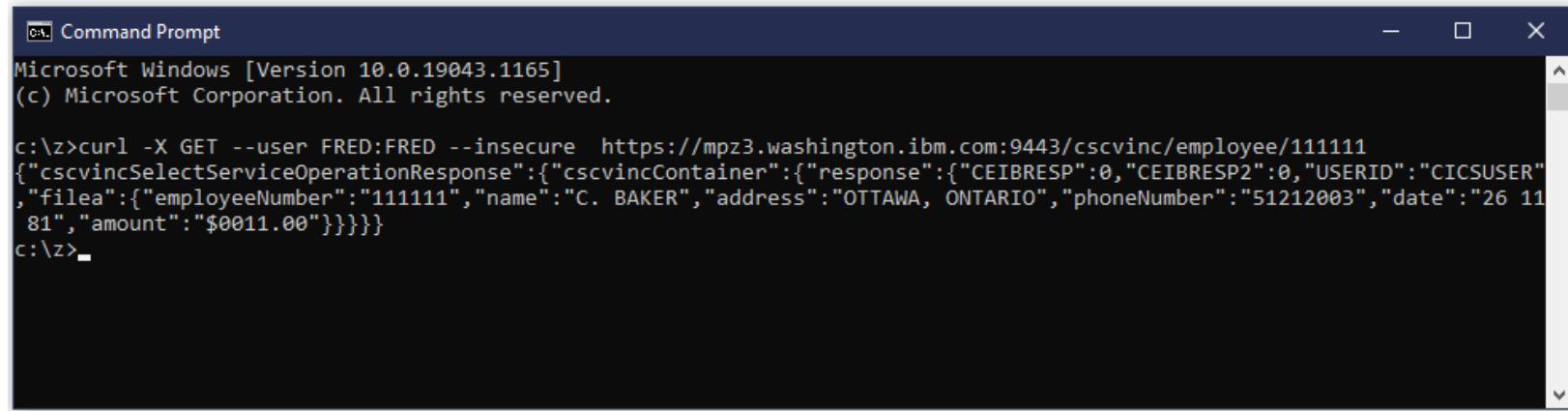
200

Response Headers

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



API Testing with cURL



The screenshot shows a Microsoft Windows Command Prompt window titled "Command Prompt". The window displays 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>
```

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

MVS JCL Invoking curl using Rocket Software's tooling



```
//*****  
/* SET SYMBOLS  
*****  
//EXPORT EXPORT SYMLIST=(*  
// SET CURL= '/usr/lpp/rocket/curl'  
*****  
/* CURL Procedure  
*****  
//CURL PROC  
//CURL EXEC PGM=IKJEFT01,REGION=0M  
//SYSTSPRT DD SYSOUT=*  
//SYSERR DD SYSOUT=*  
//STDOUT DD SYSOUT=*  
// PEND  
*****  
/* STEP CURL - use curl to deploy API cscvinc  
*****  
//DEPLOY EXEC CURL  
BPXBATCH SH export CURL=&CURL; +  
$curl/bin/curl -X PUT -s +  
--cacert /u/johnson/CERTAUTH.PEM --user FRED:FRED +  
https://wg31.washington.ibm.com:9445/zosConnect/apis/cscvinc?status=stop  
pped > null; +  
$curl/bin/curl -X DELETE -s +  
--cacert /u/johnson/CERTAUTH.PEM --user FRED:FRED +  
https://wg31.washington.ibm.com:9445/zosConnect/apis/cscvinc > null; +  
$curl/bin/curl -X POST -s +  
--cacert /u/johnson/CERTAUTH.PEM --user FRED:FRED +  
--data-binary @/u/johnson/cscvinc.aar +  
--header "Content-Type: application/zip" +  
https://wg31.washington.ibm.com:9445/zosConnect/apis  
*****  
/* STEP CURL - use curl to invoke the API cscvinc  
*****  
//INVOKE EXEC CURL  
//SYSTSIN DD *,SYMBOLS=EXEC SYS  
BPXBATCH SH export CURL=&CURL; $curl/bin/curl -X GET -s +  
--cacert /u/johnson/CERTAUTH.PEM --user FRED:FRED +  
https://wg31.washington.ibm.com:9445/cscvinc/employee/000100
```

Change the status of API to stopped

Delete or remove the API from the server

Deploy the API to the server

Execute the API



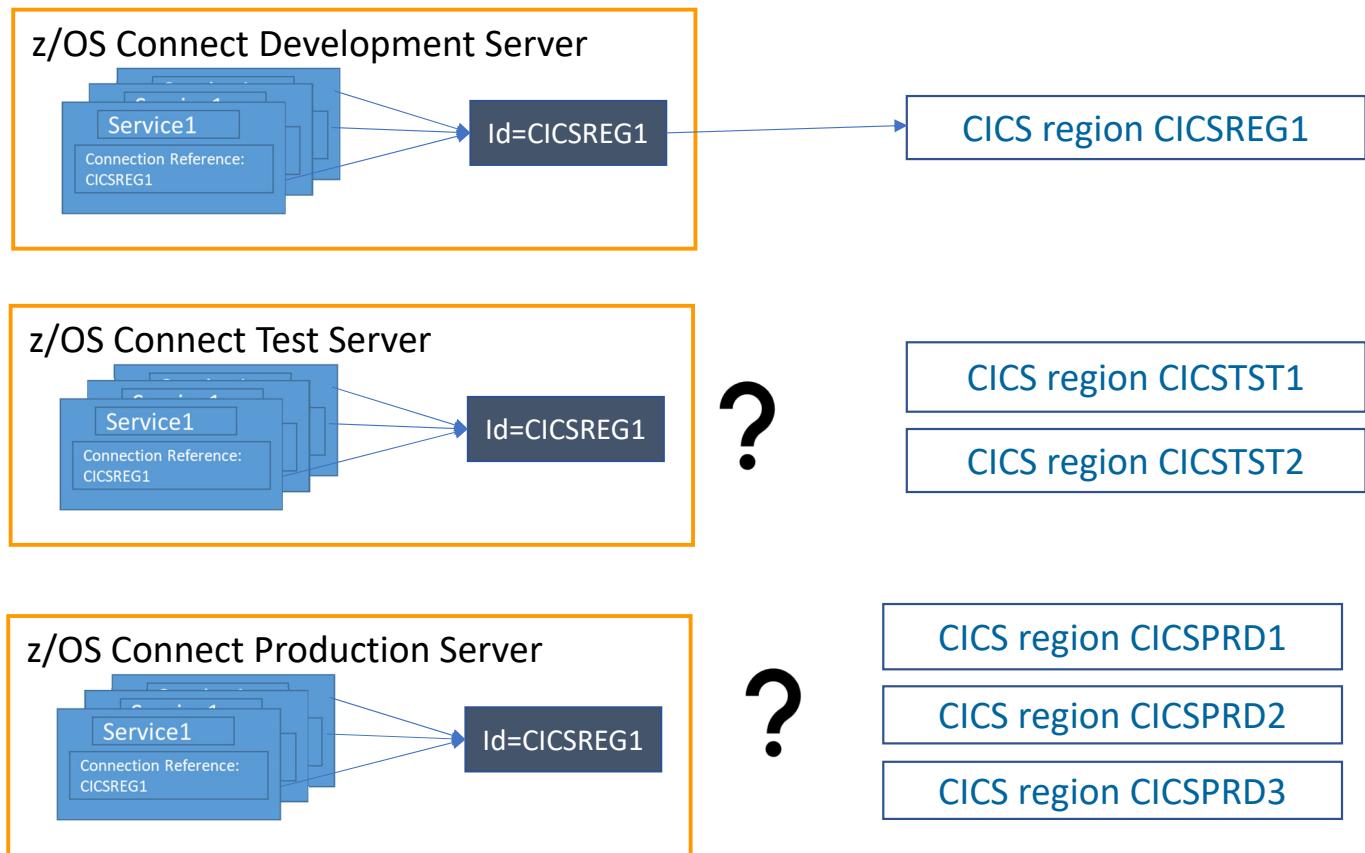
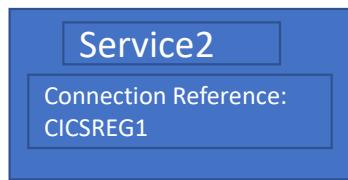
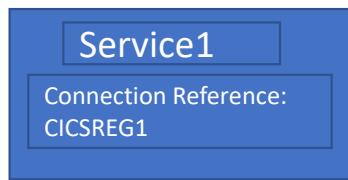
Connection Reference Consideration

Carefully consider the names used for connections



Use naming conventions for service/endpoint connection references (OpenAPI 2)

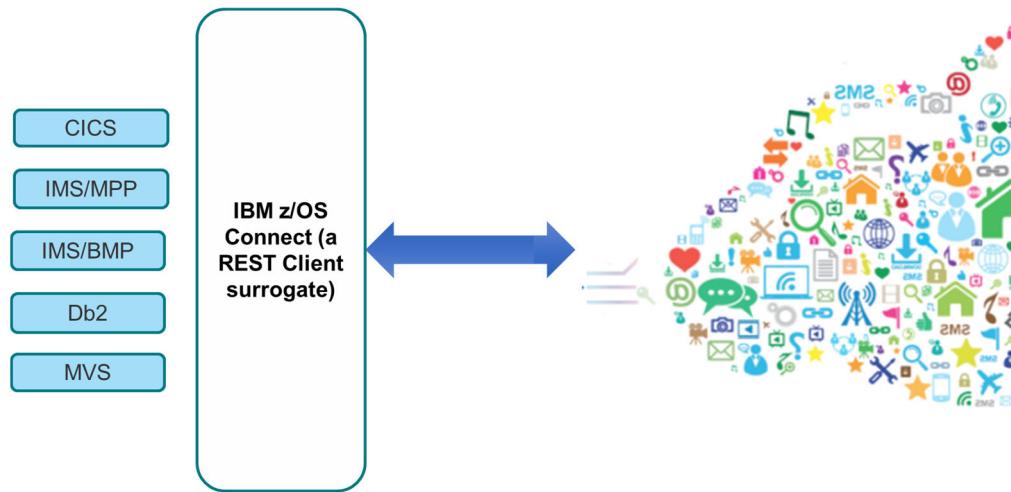
Don't couple service and API requester connection names to specific systems or endpoints





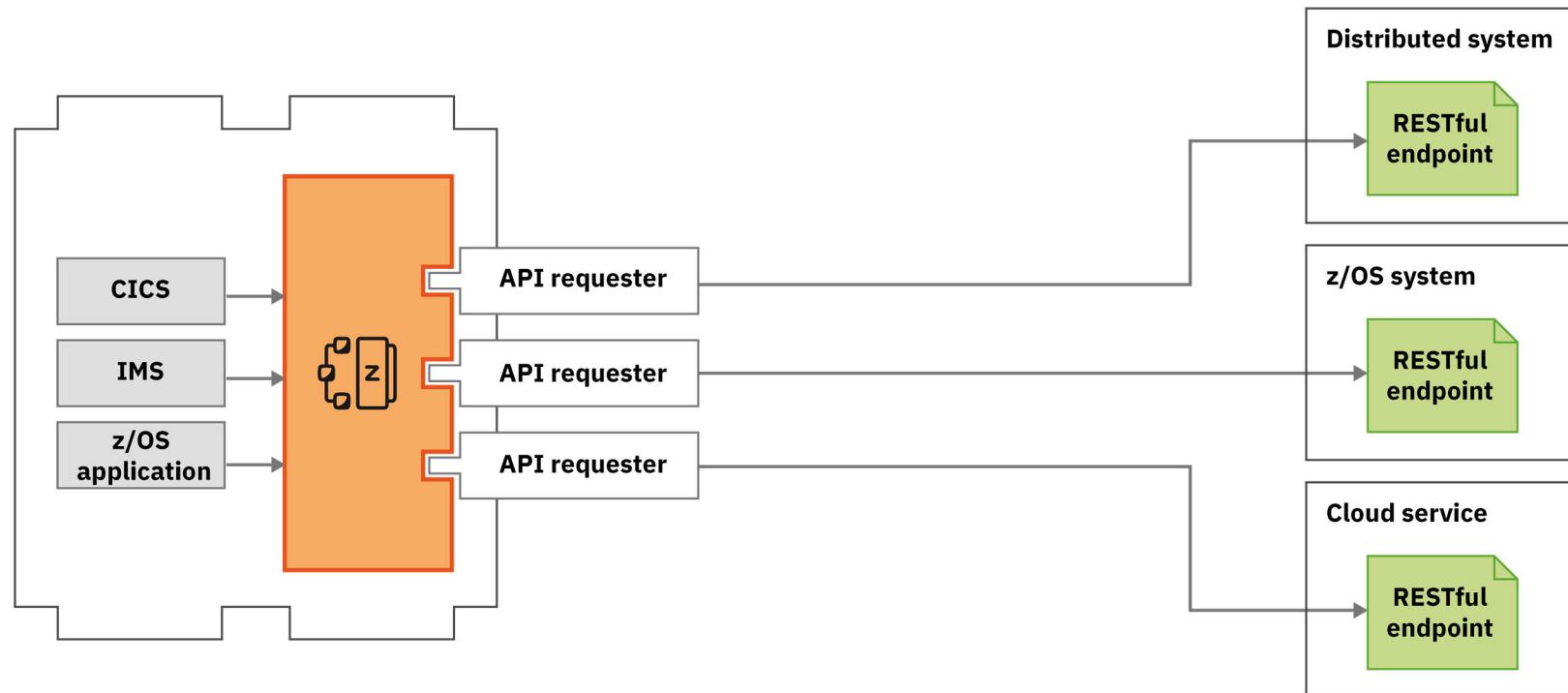
/api_toolkit/apiRequesters

Quick and easy **API mapping**.





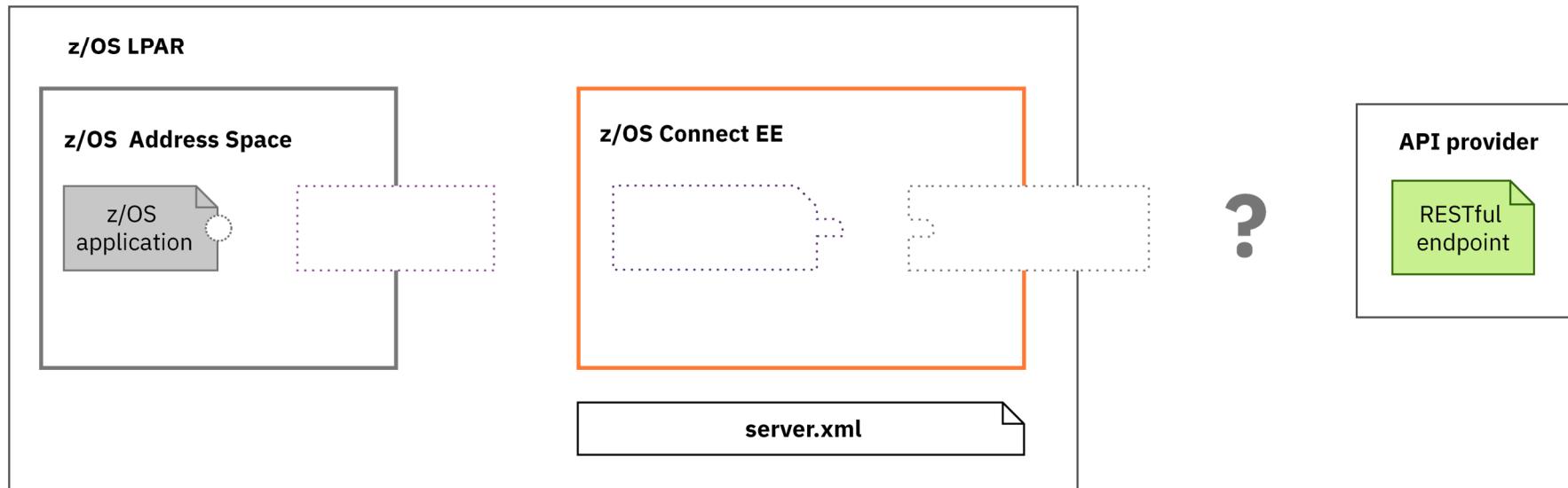
Use API requester to call external APIs from z/OS assets





Steps to calling an external API

Starting point



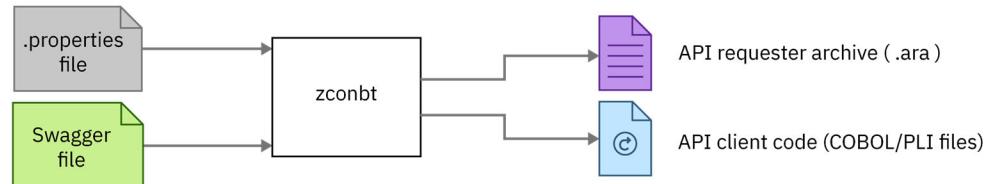


Steps to calling an external API

Generate API requester archive and API client code from Swagger

The screenshot shows a JSON editor window displaying a Swagger JSON file. The file defines an API endpoint for employees, including parameters, responses, and definitions. Key sections include:

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



```
.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>



COBOL working storage implications

Specification properties are usually not constrained, this can lead to excessive working storage consumption

```
/C:/z/apiRequester/ATS/ATSContactX +  
file:///C:/z/apiRequester/ATS/ATSContactPreferences  
JSON Raw Data Headers  
Save Copy Collapse All Expand All Filter JSON  
maxItems: 10  
communicationPreferences:  
  items:  
    $ref: "#/definitions/member-communication-preferences"  
    type: "array"  
memberCodeableConcept:  
  description: "Multiple member codes"  
  items:  
    $ref: "#/definitions/member-codeable-concept"  
    type: "array"  
    type: "object"  
member-contacts-request:  
  title: "Member Contacts Request"  
  description: "Read-only request data to search for member contact information."  
  properties:  
    umi:  
      description: "Unique Member Id. This value is at a contract level. All members under one contract have the same UMI."  
      example: "122222444001"  
      type: "string"  
    firstName:  
      description: "Member first name or given name."  
      example: "Arthur"  
      type: "string"  
    lastName:  
      description: "Member last name or family name."  
      example: "Smith"  
      type: "string"  
    birthDate:  
      description: "Member date of birth in the format mm/dd/yyyy."  
      example: "12/19/2019"  
      type: "string"
```

mitchj@us.ibm.com

```
ATS01P01 - Notepad  
File Edit Format View Help  
* ++++++  
06 RespBody.  
09 memberContactsResponse-num PIC S9(9) COMP-5 SYNC.  
09 memberContactResponse OCCURS 255.  
12 umi-num PIC S9(9) COMP-5 SYNC.  
12 umi.  
 15 umi2-length  
 15 umi2 PIC X(255). SYNC.  
12 pin-num PIC S9(9) COMP-5 SYNC.  
12 pin.  
 15 pin2-length  
 15 pin2 PIC X(255). SYNC.  
12 firstName-num PIC S9(9) COMP-5 SYNC.  
12 firstName.  
 15 firstName2-length  
 15 firstName2 PIC X(255). SYNC.  
12 middleName-num PIC S9(9) COMP-5 SYNC.  
12 middleName.  
 15 middleName2-length  
 15 middleName2 PIC X(255). SYNC.  
12 lastName-num PIC S9(9) COMP-5 SYNC.  
12 lastName.  
 15 lastName2-length  
 15 lastName2 PIC X(255). SYNC.
```

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Slide 121



Consider adding constraints to the properties

Use the *maxItems* and *maxLength* attributes to set realistic maximum array and field sizes

A screenshot of a JSON editor window titled 'C:/z/apiRequester/ATS/MemberCo...'. The JSON code shows several properties with constraints highlighted by red circles:

- `maxItems: 10` (circled)
- `maxLength: 12` (circled)
- `maxLength: 30` (circled)

A screenshot of a Notepad window titled 'ATS01P01 - Notepad' containing COBOL-like definitions. Several fields and their descriptions are highlighted with red circles:

- `15 filler` (circled)
- `10 memberContactsResponse OCCURS 10.` (circled)
- `12 umi-num` (circled)
- `15 umi2-length` (circled)
- `15 umi2` (circled)
- `12 pin-num` (circled)
- `15 pin2-length` (circled)
- `15 pin2` (circled)
- `12 firstName-num` (circled)
- `15 firstName2-length` (circled)
- `15 firstName2` (circled)
- `12 middleName-num` (circled)
- `15 middleName2-length` (circled)
- `15 middleName2` (circled)



There are also API Requester generation properties available to help

Use these generation properties to set default array size and string field sizes

defaultArrayMaxItems - Specify the maximum array boundary to apply when no maximum occurrence information (maxItems) is implied in the Swagger. The value of this parameter can be a positive integer in the range 1 - 32767. By default, **defaultArrayMaxItems** is set to 255.

defaultCharacterMaxLength - Specify the default array length of character data in characters for mappings where no length is implied in the JSON schema document. When **characterVarying** is set to YES, the value of this parameter can be a positive integer in the range of 1 to 32767. When **characterVarying** is set to NO or NULL the value of this parameter can be a positive integer in the range of 1 to 16777214. By default, **defaultCharacterMaxLength** is set to 255.

characterVarying - Specifies how variable-length character data is mapped to the language structure.

- NO - Variable-length character data is mapped as fixed-length strings.
- NULL - Variable-length character data is mapped to null-terminated strings (defaultCharacterMaxLength + 1)
- YES - Variable-length character data is mapped to a CHAR VARYING data type in PL/I. In COBOL variable-length character data is mapped to an equivalent representation that consists of two related elements: the **data-length** and the **data**. By default, **characterVarying** is set to YES.

12 firstName-num	PIC S9(9) COMP-5	SYNC.
12 firstName.		
15 firstName2-length	PIC S9999 COMP-5	SYNC.

12 firstName-num	PIC S9(9) COMP-5	SYNC.
12 firstName	PIC X(31).	

```
MOVE 0 to ws-length
MOVE LENGTH OF firstName2 to firstName2-length.
INSPECT FUNCTION REVERSE (firstName2)
      TALLYING ws-length FOR ALL SPACES.
SUBTRACT ws-length FROM firstName2-length.
```

```
*-----*
 * Add null termination character to strings
 *-----*
 STRING firstName delimited by size
       X'00' delimited by size into _firstName.
 STRING ws-length delimited by size into _wsLength.
```



The number of specific entries can be ambiguous

The COBOL copy book will include a counter variable (*variable-num*) for each variable whose number of occurrences is ambiguously defined in the specification document. The number of occurrences of these variables must be provided.

```
wg31 base
File Edit Settings View Communication Actions Window Help
Menu Utilities Compilers Help
BROWSE    USER1.ZCEE.SOURCE(PUTAPI) - 01.05      Line 0000000062 Col 001 080
Command ==>                               Scroll ==> PAGE
MAINLINE SECTION.

*-----*
* Common code
*-----*
* initialize working storage variables
  INITIALIZE PUT-REQUEST.
  INITIALIZE PUT-RESPONSE.

*-----*
* Set up the data for the API Requester call
*-----*
  MOVE 1 to cscvincUpdateServiceOp-num in PUT-REQUEST
    request2-num in PUT-REQUEST
    filea2-num in PUT-REQUEST
    name-num in PUT-REQUEST
    Xaddress-num in PUT-REQUEST
    phoneNumber-num in PUT-REQUEST
    Xdate-num in PUT-REQUEST
    amount-num in PUT-REQUEST.

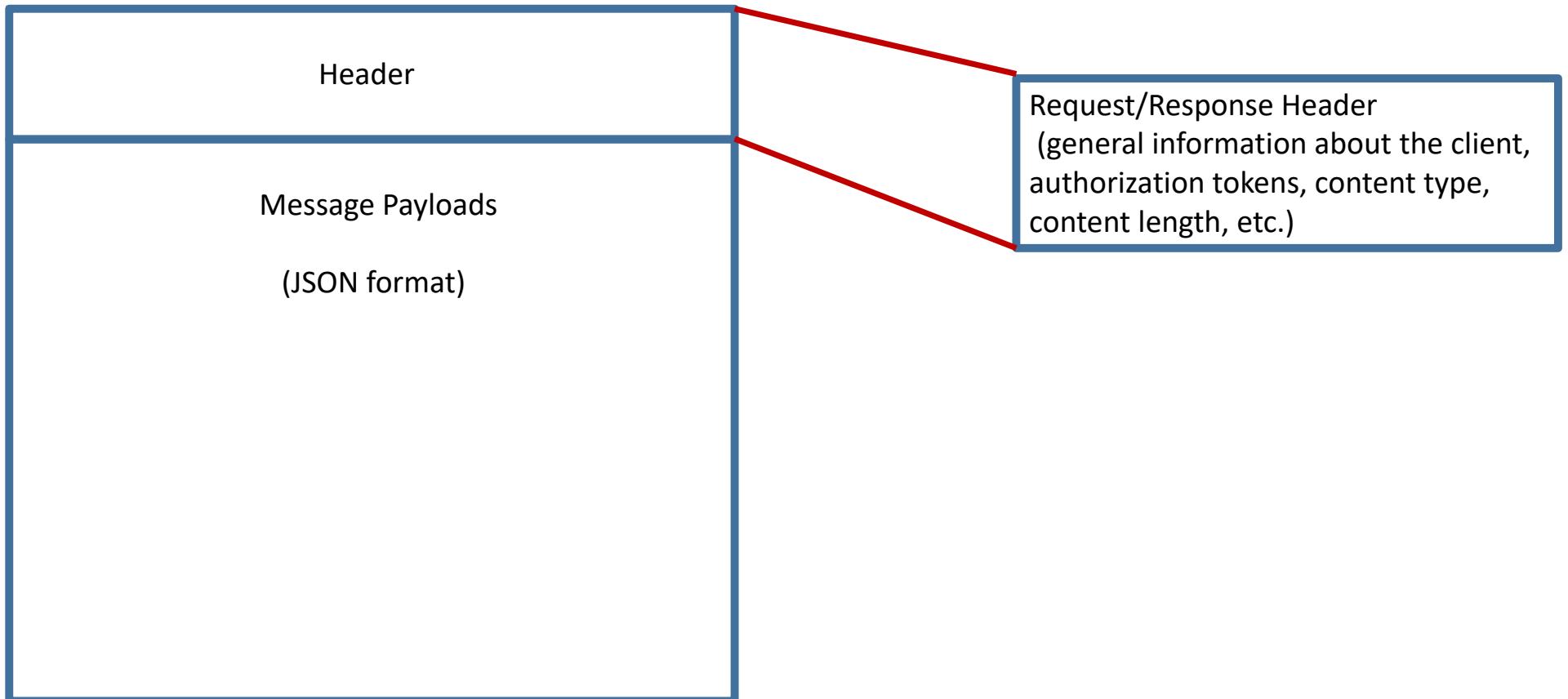
  MOVE num of PARM-DATA TO employee IN PUT-REQUEST.
  MOVE LENGTH of employee in PUT-REQUEST to
    employee-length IN PUT-REQUEST.

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

04 / 015
MA C
Connected to remote server/host wg31z using lu/pool TCP00108 and port 23
```



Request and Response Message Layout





Providing an API key to the request and the application

The application can provide the authentication credentials required by the API.

Via a HTTP header

GET /something HTTP/1.1

X-API-Key: abcdef12345

Or via a query parameter

GET /something?api_key=abcdef12345

When provided in the specification document as shown below or . . .

```
version: "1.2.8"
title: "NewMembers"
contact:
  name:
securityDefinitions:
  apiKeyHeader:
    type: "apiKey"
    name: "X-IBM-Client-ID"
    in: "header"
    host: "wg31.washington.ibm.com"
    basePath: "/v1"
  schemes:
    0: "https"
paths:
  /nms/members/search:
    post:
```



Or by using generation properties related to API keys

Use these generation properties to add API key information to the request message when not defined in specification document

apiKeyMaxLength - Specify the maximum length of the values set for API keys. The value of this parameter can be a positive integer in the range 1 - 32767. By default, **apiKeyMaxLength** is set to 255.

apiKeyParmNameInHeader - Specify the name of an API key that is sent as a request header. The value of this parameter can be set in a comma separated list of a combination of client ID and client secret. For example, you can set **apiKeyParmNameInHeader**=header-IBM-Client-ID, header-IBM-Client-secret when a client ID and a client secret are used to protect an API.

apiKeyParmNameInQuery - Specify the name of an API key that is sent in a query string. The value of this parameter can be set in a comma separated list of a combination of client ID and client secret. For example, you can set **apiKeyParmNameInQuery**=query-IBM-Client-ID, query-IBM-Client-secret when a client ID and a client secret are used to protect an API.

```
cscvinc.properties - Notepad
File Edit Format View Help
apiKeyDescriptionFile=../cscvinc.json
dataStructuresLocation=../syslib
apiInfoFileLocation=../syslib
logFileDirectory=../logs
language=COBOL
connectionRef=cscvincAPI
requesterPrefix=ats
apiKeyMaxLength=40
apiKeyParmNameInHeader=X-IBM-Client-ID

Ln 8, Col 19 100% Unix (LF) UTF-8
```

Support for an application to add an API key to the request



Either way, adds code to the request copy book which can be initialized by the application

The 'request.cpy' file contains the following COBOL copybook definition:

```
*      12 dob2-length          PIC S9999 COMP-5
* SYNC.
*      12 dob2                PIC X(255).
*
* ++++++
06 ReqHeaders.
09 X-IBM-Client-ID-length    PIC S9999 COMP-5 SYNC.
09 X-HZN-Client-ID           PIC X(255).
09 X-HZN-ClientName-length   PIC S9999 COMP-5 SYNC.
09 X-HZN-ClientName          PIC X(255).
09 X-HZN-ClientSubmitDateTime PIC S9(15) COMP-3.
09 X-HZN-ClientTransactio-num PIC S9(9) COMP-5 SYNC.
09 X-HZN-ClientTransactionId PIC S9999 COMP-5 SYNC.
12 X-HZN-ClientTransact-length PIC S9999 COMP-5
SYNC.
12 X-HZN-ClientTransactionId2 PIC X(255).
09 X-HZN-ClientSessionId-num  PIC S9(9) COMP-5 SYNC.
09 X-HZN-ClientSessionId     PIC S9999 COMP-5 SYNC.
12 X-HZN-ClientSessionId2    PIC X(255).
09 X-HZN-UserRole-num        PIC S9(9) COMP-5 SYNC.
09 X-HZN-UserRole            PIC S9999 COMP-5 SYNC.
12 X-HZN-UserRole2-length   PIC S9999 COMP-5
SYNC.
12 X-HZN-UserRole2          PIC X(255).
09 X-HZN-UserAssociationI-num PIC S9(9) COMP-5 SYNC.
09 X-HZN-UserAssociationI   PIC S9999 COMP-5 SYNC.
```

The 'mpz3' window shows the following AS/400 source code:

```
EDIT      USER1.ZCEE.SOURCE(GETAPIEN) - 01.01
Command ==> *-----
000081      *-----
000082      * Common code
000083      *-----
000084      * initialize working storage variables
000085      *----- INITIALIZE GET REQUEST.
000086      *----- INITIALIZE GET-RESPONSE.
000087      MOVE "abcdef12345" to X-IBM-Client-ID
000088      MOVE 11 to X-IBM-Client-ID-length
000089
000090
000091
000092
000093
000094      MOVE employee of PARM-DATA TO employee IN GET-REQUEST.
000095      MOVE LENGTH of employee in GET-REQUEST to
000096      employee-length IN GET-REQUEST.
000097
000098
000099
000100
000101
000102
000103      *----- Initialize API Requester PTRs & LENs
000104
000105
000106
000107
000108      *----- Use pointer and length to specify the location of
      *----- request and response segment.
      *----- This procedure is general and necessary.
      SET BAQ-REQUEST-PTR TO ADDRESS OF GET-REQUEST.
      MOVE LENGTH OF GET-REQUEST TO BAQ-REQUEST-LEN.
      SET BAQ-RESPONSE-PTR TO ADDRESS OF GET-RESPONSE.
      MOVE LENGTH OF GET-RESPONSE TO BAQ-RESPONSE-LEN.
```



Additional Swagger header properties

The application can also set values for additional header properties required by the API

```
/C:/apiRequester/ATS/decision-se X +  
file:///C:/apiRequester/ATS/decision-service-swagg  
JSON Raw Data Headers  
Save Copy Collapse All Expand All Filter JSON  
parameters:  
  0:  
    name: "ConsumerID"  
    in: "header"  
    description: "Consumer ID"  
    required: true  
    type: "string"  
    default: "ROMEDSv02.0"  
  1:  
    name: "ContextID"  
    in: "header"  
    description: "Context ID"  
    required: true  
    type: "string"  
    default: "RDSv02.0"  
  2:  
    in: "body"  
    name: "body"  
    schema:  
      properties:  
        ClaimInformation: {...}  
      required:  
        0: "ClaimInformation"  
    produces:
```

```
ATS00Q01 - Notepad  
File Edit Format View Help  
06 ReqHeaders.  
09 x-hmhs-keyId-length PIC S9999 COMP-5 SYNC.  
09 x-hmhs-keyId PIC X(255).  
09 ConsumerID-length PIC S9999 COMP-5 SYNC.  
09 ConsumerID PIC X(255).  
09 ContextID-length PIC S9999 COMP-5 SYNC.  
09 ContextID PIC X(255).  
06 ReqBody.  
09 ClaimInformation.  
12 claimID-num SYNC. PIC S9(9) COMP-5  
12 claimID. 15 claimID2-length SYNC. PIC S9999 COMP-5  
15 claimID2 PIC X(255).  
12 wsHostIndicator-num SYNC. PIC S9(9) COMP-5  
12 wsHostIndicator. 15 wsHostIndicator2-length SYNC. PIC S9999 COMP-5  
15 wsHostIndicator2 PIC X(255).  
12 wsTypeOfContract-num PIC S9(9) COMP-5  
Ln 130, Col 18 100% Windows (CRLF) UTF-8
```



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.
```

BTW, the z/OS Connect Build Toolkit can be executed on z/OS



```
//JOHNSONS JOB (ACCOUNT),JOHNSON,NOTIFY=&SYSUID,REGION=0M,  
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1)  
//*****  
///* SET SYMBOLS  
//*****  
//EXPORT EXPORT SYMLIST=(*  
// SET WORKDIR='u/johnson/zconbt'  
// SET ZCONDIR='/usr/lpp/IBM/zosconnect/v3r0/zconbt/bin'  
//ZCONBT EXEC PGM=IKJEFT01,REGION=0M,MEMLIMIT=4G  
//SYSTSPPRT DD SYSOUT=*  
//SYSERR DD SYSOUT=*  
//STDOUT DD SYSOUT=*  
//SYSTSIN DD *,SYMBOLS=EXECSYS  
BPXBATCH SH +  
  export WORKDIR=&WORKDIR; +  
  export ZCONDIR=&ZCONDIR; +  
  cd $WORKDIR; +  
  $ZCONDIR/zconbt.zos -p cscvinc.properties -f=cscvinc.ara; +  
  cp -v $WORKDIR/syslib/* //'JOHNSON.ZCONBT.COPYLIB'"
```

cscvinc.properties

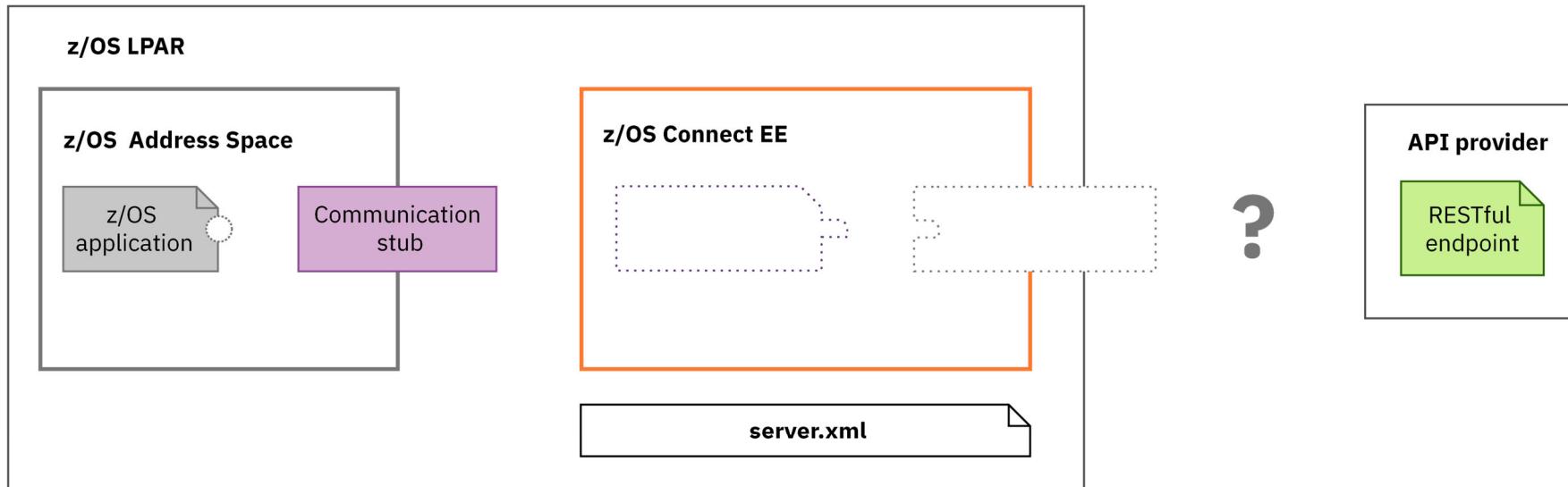
```
apiDescriptionFile=./cscvinc.json  
dataStructuresLocation=./syslib  
apiInfoFileLocation=./syslib  
logFileDirectory=./logs  
language=COBOL  
connectionRef=cscvincAPI  
requesterPrefix=csc
```

This assumes the zconbt.zip files was expanded into directory /usr/lpp/IBM/zosconnect/v3r0/zconbt using command *jar -tf zconbt.zip* and that the property file and Swagger JSON document are encoded in ASCII in directory /u/johnson/zconbt.



Steps for involving an external API from a COBOL program

Update the application by adding the generated copy books, a common BAQRINFO copy book 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

```
*-----*
* Call the communication stub
*-----*
*-----*
* Call the subsystem-supplied stub code to send
* API request to zCEE
    CALL COMM-STUB-PGM-NAME USING
        BY REFERENCE    GET-INFO-OPER1
        BY REFERENCE    BAQ-REQUEST-INFO
        BY REFERENCE    BAQ-REQUEST-PTR
        BY REFERENCE    BAQ-REQUEST-LEN
        BY REFERENCE    BAQ-RESPONSE-INFO
        BY REFERENCE    BAQ-RESPONSE-PTR
        BY REFERENCE    BAQ-RESPONSE-LEN
    END-CALL
    RETURN CODE 01 NO-ERRORS
```



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 screenshot shows the Rational Developer for z/OS interface with several windows open:

- GETAPI**: The main source code window. It contains comments and assembly code. A red box highlights the section from * Set up the data for the API Requester call to * Call the communication stub.
- CSC00101**: A copy book definition window showing declarations for API parameters. A red box highlights the declarations for BAQ-APINAME, BAQ-APIMETHOD, and BAQ-APIMETHOD-LEN.
- CSC00Q01**: A copy book definition window showing declarations for JSON schema keywords and employee data. A red box highlights the declarations for employee-length and employee.
- CSC00P01**: A copy book definition window showing declarations for response parameters. A red box highlights the declaration for RespBody.

Red arrows point from the highlighted sections in the GETAPI code to the corresponding declarations in the copy books. Specifically:

- From the first highlighted section in GETAPI to the declarations in CSC00101.
- From the second highlighted section in GETAPI to the declarations in CSC00Q01.
- From the third highlighted section in GETAPI to the declaration in CSC00P01.

```
* 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
```

```
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.

*+-----+
* 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).

*+-----+
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

```
GETAPI X
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.
    LINES BAQ-ERROR-IN-API
```

mpz3

BROWSE ZCEE30.SBAQC0B(BAQRINFO)

Line 000000066 Col 001 080
Scroll ==> PAGE

	BAQ-RESPONSE-INFO.	PIC S9(9) COMP-5 SYNC VALUE 0.
01	BAQ-RESPONSE-INFO.	PIC S9(9) COMP-5 SYNC VALUE 0.
03	BAQ-STUB-NAME	PIC X(8).
03	BAQ-RETURN-CODE	PIC S9(9) COMP-5 SYNC.
88	BAQ-SUCCESS	VALUE 0.
88	BAQ-ERROR-IN-API	VALUE 1.
88	BAQ-ERROR-IN-ZCEE	VALUE 2.
88	BAQ-ERROR-IN-STUB	VALUE 3.
88	BAQ-ERROR-NO-RESPONSE	VALUE 4.
03	BAQ-STATUS-CODE	PIC S9(9) COMP-5 SYNC.
03	BAQ-STATUS-MESSAGE	PIC X(1024).
03	BAQ-STATUS-MESSAGE-LEN	PIC S9(9) COMP-5 SYNC.

***** Bottom of Data *****

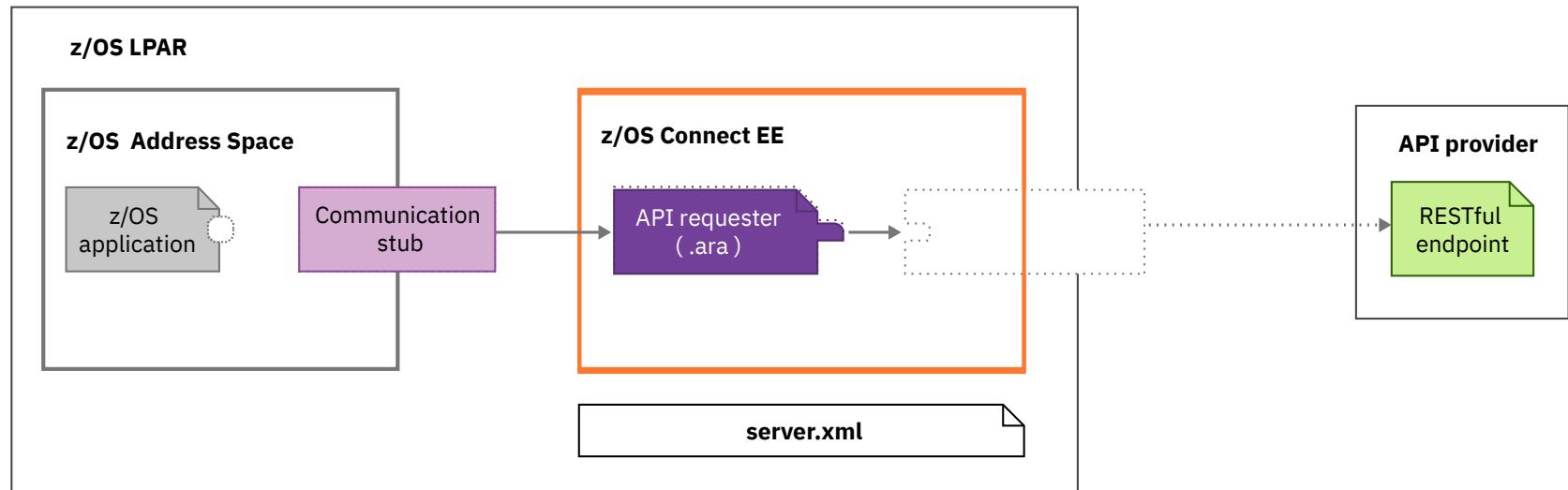
Connected to remote server/host mpz3 using lu/pool MPZ30021 and port 23

18 / 058



Steps to calling an external API

Deploy API requester (.ara) archive



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



Tech-Tip-Deploying API requester archive files

- Use API requester archive as request message and use HTTP POST
- Use URI path /zosConnect/apiRequesters
- Postman or cURL

The screenshot shows the Postman application interface. A POST request is being made to the URL <https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters>. The 'Body' tab is selected, and the content type is set to 'binary'. A file named 'filea.ara' is attached. The response status is 201 Created, and the response body is displayed in JSON format:

```
1
2   "name": "filea_2.0.0",
3   "version": "2.0.0",
4   "description": "",
5   "status": "Started",
6   "apiRequesterUrl": "https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters/filea\_2.0.0",
7   "connection": "fileaAPI"
8 }
```

Command:

```
curl --data-binary @filea.ara
--header "Content-Type: application/zip"
https://mpxm:9453/zosConnect/apiRequesters
```

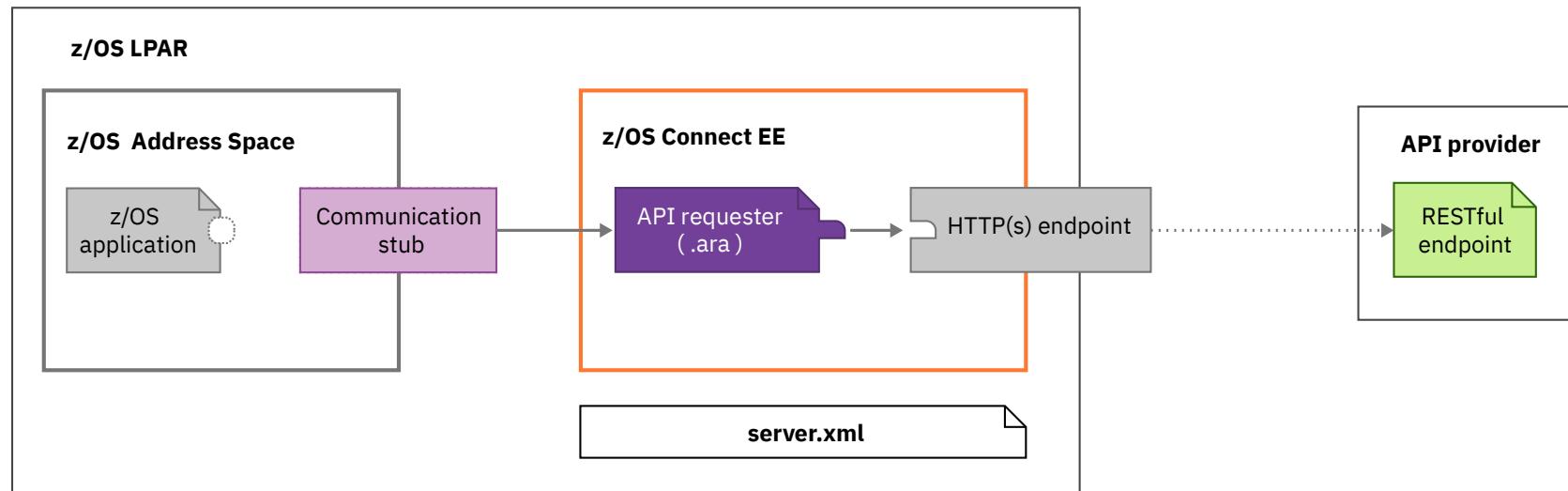
Results:

```
{"name": "filea_2.0.0", "version": "2.0.0", "description": "", "status": "Started", "apiRequesterUrl": "https://wg31.washington.ibm.com:9483/zosConnect/apiRequesters/filea_2.0.0", "connection": "fileaAPI"}
```



Steps to calling an external API

Configure HTTP(S) endpoint configuration element



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

i ibm.biz/zosconnect-configure-endpoint-connection



Steps to calling an external API

Update the server XML configuration for the endpoint

```
cscvinc.properties  
connectionRef=cscvincAPI
```

Server Config

apiRequesterHTTPS.xml Read only Close

Design Source

```
30 <!--  
31 <zosconnect_endpointConnection id="cscvincAPI"  
32 host="https://dvipa.washington.ibm.com"  
33 port="9443"  
34 authenticationConfigRef="mySAFAuth"  
35 connectionTimeout="10s"  
36 receiveTimeout="40s" /-->  
37  
38  
39 <zosconnect_authData id="mySAFAuth"  
40 user="USER1"  
41 password="user1" />  
42</server>  
43
```

File Edit View History Bookmarks Tools Help
/C:/z/apiRequester/cscvinc/swagger.json +

JSON Raw Data Headers
Save Copy Collapse All Expand All Filter JSON

```
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:
```

CSC02I01

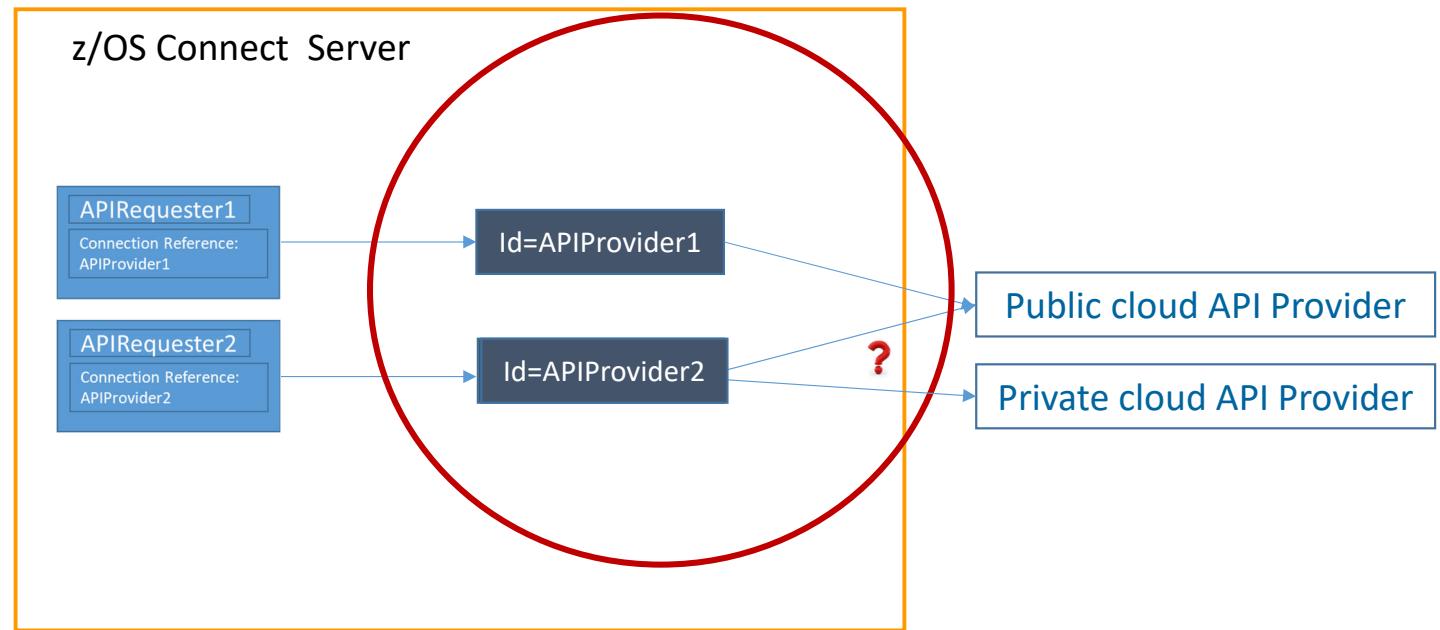
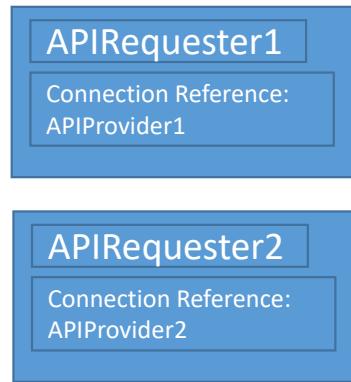
03 BAQ-APINAME	PIC X(255)
VALUE 'cscvinc_1.0.0'.	
03 BAQ-APINAME-LEN	PIC S9(9) COMP-5 SYNC
VALUE 13.	
03 BAQ-APIPATH	PIC X(255)
VALUE '/cscvinc/employee/{numb}'.	
03 BAQ-APIPATH-LEN	PIC S9(9) COMP-5 SYNC
VALUE 24.	
03 BAQ-APIMETHOD	PIC X(255)
VALUE 'GET'.	
03 BAQ-APIMETHOD-LEN	PIC S9(9) COMP-5 SYNC
VALUE 3.	

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



Use naming conventions for connection references

Use application meaningful names or an extendable convention for connection reference names

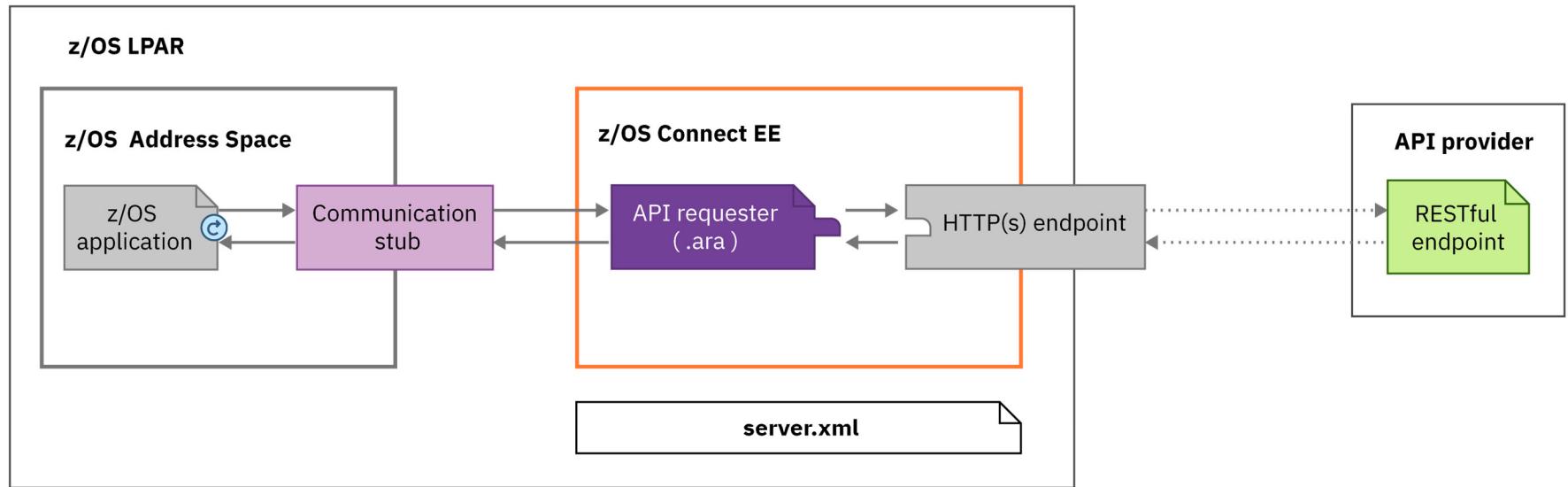


```
<zosconnect_apiRequesters>
  requireAuth="true|false"
  <apiRequester name="cscvincapi 1.0.0"
    connectionRef="APIProvider2"
  </zosconnect_apiRequesters>
```



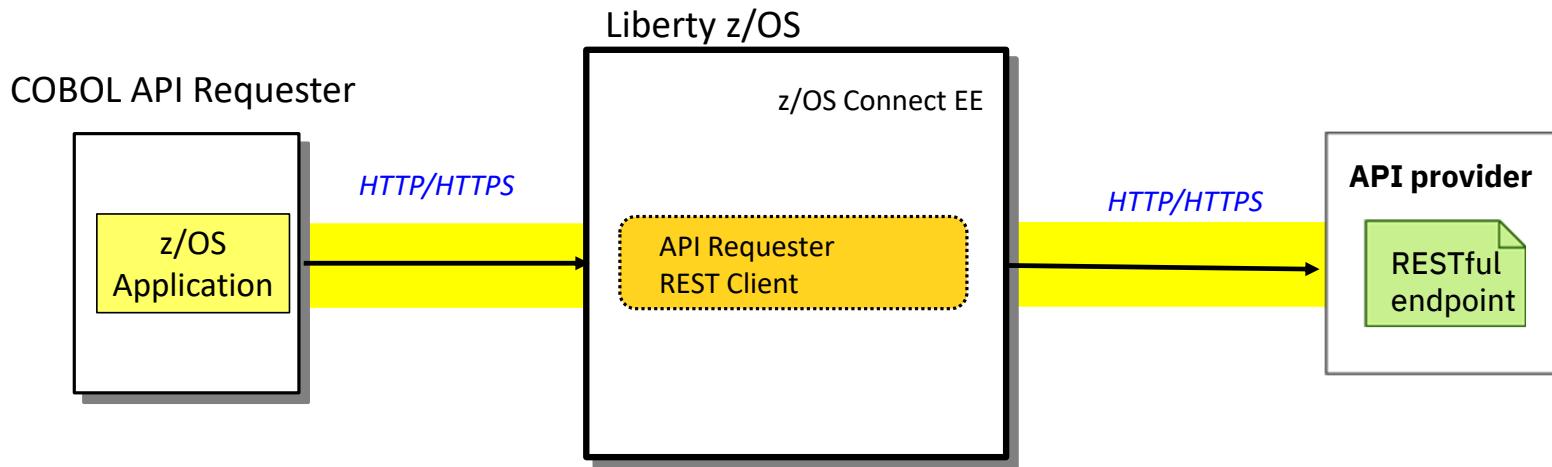
Steps to calling an external API

Done





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)



Configure connections to the z/OS API requester server

Default CICS URI MAP*

```

WG31 - 3270
File Edit Settings View Communication Actions Window Help
I URIMAP
RESULT - OVERTYPE TO MODIFY
Urimap(BAQURIMP)
Usage(Client)
Enablestatus(Enabled)
Availstatus(Notapplic)
Scheme(Http)
Redirecttype( None )
Tcpinservice()
Port(09120)
Host(wg31.washington.ibm.com:9120)
Path(/)
Analyzerstat(Noanalyzer)
Hosttype(Hostname)
Ipresolved(0.0.0.0)
Ipfamily(Unknown)
Socketclose(0000030)
Sockpoolsize(0000000)
Transaction()
+ Converter()

SYSID=CICS APPLID=CICS53Z
TIME: 10.38.37 DATE: 02/14/22
PF 1 HELP 2 HEX 3 END      5 VAR      7 SBH 8 SFH      10 SB 11 SF
01/012
M A D
Connected to remote server/host wg31a using lu/pool TCP00120 and port 23
Adobe PDF on Documents\*.pdf

```

* V3.0.37 added support for a CICS application to specify or request a specific URIMAP resource the using BAQ-ZCON-SERVER-URI variable in BAQRINFO

LE Environment Variables

```

//DELTAPI EXEC PGM=DELTAPI,PARM='323232'
//STEPLIB DD DISP=SHR,DSN=USER1.ZCEE.LOADLIB
//          DD DISP=SHR,DSN=ZCEE30.SBAQLIB
//SYSOUT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//CEEOPTS DD *
  POSIX(ON),
ENVAR("BAQURI=wg31.washington.ibm.com",
"BAQPORT=9120")

```

```

mpz3
File Edit Settings View Communication Actions Window Help
BROWSE ZCEE30.SBAQCOB(BAQRINFO) Line 000000010 Col 001 080
Command ==> Scroll ==> PAGE
* (C) Copyright IBM Corp. 2017, 2021
* US Government Users Restricted Rights - Use, duplication or
* disclosure restricted by GSA ADP Schedule Contract with
* IBM Corp
*****
* This file contains the generated language structure(s) for
* Request and Response Info
*****
* BAQ-REQUEST-INFO-COMP-LEVEL permitted values
* VALUE
*   0  Base support
*   1  Added support for BAQ-OAUTH
*   2  Added support for BAQ-TOKEN (JWT)
*   3  Added support for setting z/OS Connect EE server URI
*   4  Added support for BAQ-OAUTH-EXT
*****
01 BAQ-REQUEST-INFO.
03 BAQ-REQUEST-INFO-COMP-LEVEL PIC S9(9) COMP-5 SYNC VALUE 4.
03 BAQ-REQUEST-INFO-USER
05 BAQ-OAUTH.
07 BAQ-OAUTH-USERNAME PIC X(256).
07 BAQ-OAUTH-USERNAME-LEN PIC S9(9) COMP-5 SYNC
07 BAQ-OAUTH-PASSWORD VALUE 0.
07 BAQ-OAUTH-PASSWORD-LEN PIC X(256).
PIC S9(9) COMP-5 SYNC
04/015
Connected to remote server/host mpz3 using lu/pool MPZ30044 and port 23

```



Runtime Environment variables

Use these runtime environment variables when connecting to a z/OS Connect server

BAQPASSWORD - Specifies the password, in clear text, for the specified BAQUSERNAME to be authenticated with the z/OS Connect server. The username and password that are used for basic authentication, when SSL mutual authentication is not enabled.

BAQPORT - Specifies the port number for the z/OS Connect server.

BAQTIMEOUT - An optional 4-byte integer to set a timeout value in seconds for waiting for an API response. Valid range is 1 - 2,678,400 seconds. The default timeout value is 10 seconds.

BAQURI - Specifies either an IPv4 or IPV6 address, or a hostname of the host where the z/OS Connect server resides.

BAQUSERNAME - Specifies the username for connections if basic authentication is used.

BAQVERBOSE - An optional value to turn on verbose messages to assist debugging of runtime and configuration issues. Valid values are **OFF**, **ON**, **ERROR**, **AUDIT** and **ALL**. See URL <https://www.ibm.com/docs/en/zos-connect/zosconnect/3.0?topic=car-configuring-other-zos-applications-access-zos-connect-api-calls> for more information.



Basic authentication – COBOL API Requester

- ❑ A MVS batch, IMS or Db2 stored procedure requester application sends basic authentication information (identity and password) by using environment variables.
 - BAQUSERNAME
 - BAQPASSWORD
- ❑ The variables can be provided in JCL using CEEOPTS DD statement:

```
//CEELOPTS DD *  
  POSIX(ON),  
  ENVAR("BAQURI=wg31.washington.ibm.com",  
"BAQPORT=9080",  
"BAQUSERNAME=USER1",  
"BAQPASSWORD=USER1")
```

- ❑ Or, provided by using a CEEROPT or CEEUOPT module:

```
CEEROPT CSECT  
CEEROPT AMODE ANY  
CEEROPT RMODE ANY  
CEEXOPT POSIX=((ON),OVR),  
  ENVAR=((('BAQURI=wg31.washington.ibm.com',  
'BAQPORT=9120',  
'BAQUSERNAME=USER1',  
'BAQPASSWORD=USER1'),OVR),  
  RPTOPTS=((ON),OVR)  
END
```

Tech/Tip: This is good opportunity to use a pass ticket rather than a password

Tech/Tip: A PassTicket provides an alternative to a password



- ❑ A PassTicket is generated by or for a client by using a secured sign-on key (whose value is masked or encrypted) to encrypt a valid *RACF identity* combined with the *application name* of the targeted resource. Also embedded in the PassTicket is a time stamp (based on the current Universal Coordinated Time (UCT)) which sets the time when the PassTicket will expire (usually 10 minutes).
- ❑ Access to PassTickets is managed using the RACF PTKTDATA class.
- ❑ For z/OS Connect, a RACF PassTicket can be used for basic authentication when connecting from any REST client on any platform to a z/OS Liberty server and for requests from a z/OS Connect server accessing IMS and Db2.
- ❑ ***PassTickets do not have to be generated on z/OS using RACF services.*** IBM has published the algorithm used to generate a PassTickets, see manual *z/OS Security Server RACF Macros and Interfaces, SA23-2288-40*. *Github has examples using Java, Python and other example are available on other sites.*

```
<safRegistry id="saf" />
  <safAuthorization racRouteLog="ASIS" />
  <safCredentials unauthenticatedUser="WSGUEST"
    profilePrefix="BBGZDFLT" />
```



Tech/Tip: Generating PassTickets on z/OS

- On z/OS, a COBOL user application can generate a pass tickets by calling RACF service IRRSPK00:

```
77 COMM-STUB-PGM-NAME          PIC X(8) VALUE 'BAQCSTUB'.
77 PTKT-STUB-PGM-NAME         PIC X(8) VALUE 'ATSPKTTC'.
*-----
***** L I N K A G E   S E C T I O N *****
LINKAGE SECTION.
***** P R O C E D U R E S *****
PROCEDURE DIVISION using PARM-BUFFER.

*-----*
MAINLINE SECTION.

*-----*
* Common code *
*-----*
* initialize working storage variables
  INITIALIZE GET-REQUEST.
  INITIALIZE GET-RESPONSE.
  CALL PTKT-STUB-PGM-NAME.
```

JOHNSON. PASSTCKT. SOURCE (ATSPKTTC)

```
*-----*
* Build IRRSPK00 parameters *
*-----*
      MOVE 0 to ws-length
      MOVE LENGTH OF identity to identity-length.
      INSPECT FUNCTION REVERSE (identity)
          TALLYING ws-length FOR ALL SPACES.
      SUBTRACT ws-length FROM identity-length.
      MOVE 0 to ws-length
      MOVE LENGTH OF applid to applid-length.
      INSPECT FUNCTION REVERSE (applid)
          TALLYING ws-length FOR ALL SPACES.
      SUBTRACT ws-length FROM applid-length.
      MOVE 8 to passTicket-length.
      MOVE 'NOTICKET' to passTicket.
      MOVE X'0003' to irr-functionCode.
      MOVE X'00000001' to irr-ticketOptions.
      SET irr-ticketOptions-ptr to ADDRESS OF irr-ticketOptions.
*-----*
* Call RACF service IRRSPK00 to obtain a pass ticket based *
*   on identity and applid                                     *
*-----*
      PERFORM CALL-RACF.
      IF irr-safrc NOT = zero then
          DISPLAY "SAF_return_code:      " irr-safrc
          DISPLAY "RACF_return_code:     " irr-racfrc
          DISPLAY "RACF_reason_code:    " irr-racfrsn
      End-if
*-----*
* Call IRRSPK00 requesting a pass ticket *
*-----*
      CALL-RACF.
      CALL W-IRRSPK00 USING irr-workarea,
          IRR-ALET, irr-safrc,
          IRR-ALET, irr-racfrc,
          IRR-ALET, irr-racfrsn,
          IRR-ALET, irr-functionCode,
          irr-optionWord,
          IRR-PASSTICKET,
          irr-ticketOptions-ptr,
          IRR-IDENTITY,
          IRR-APPLID
```



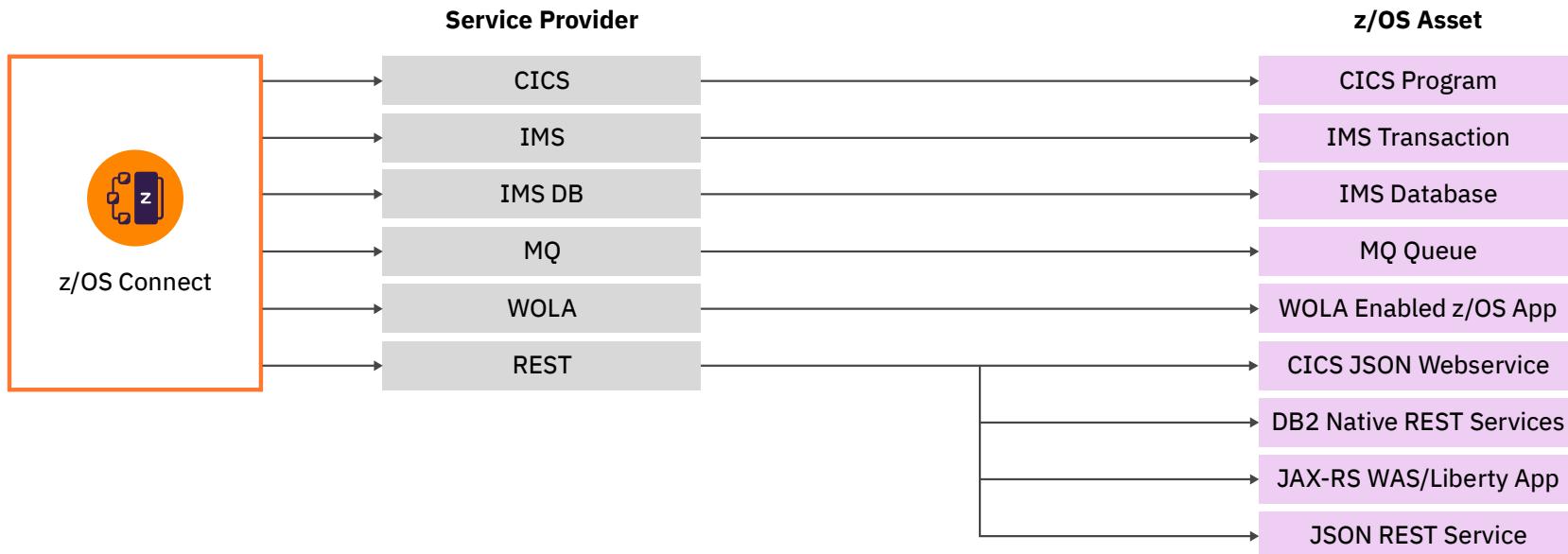
/miscellaneousTopics

performance, high availability, Liberty



What assets can z/OS Connect EE map to?

And which service provider could I use?

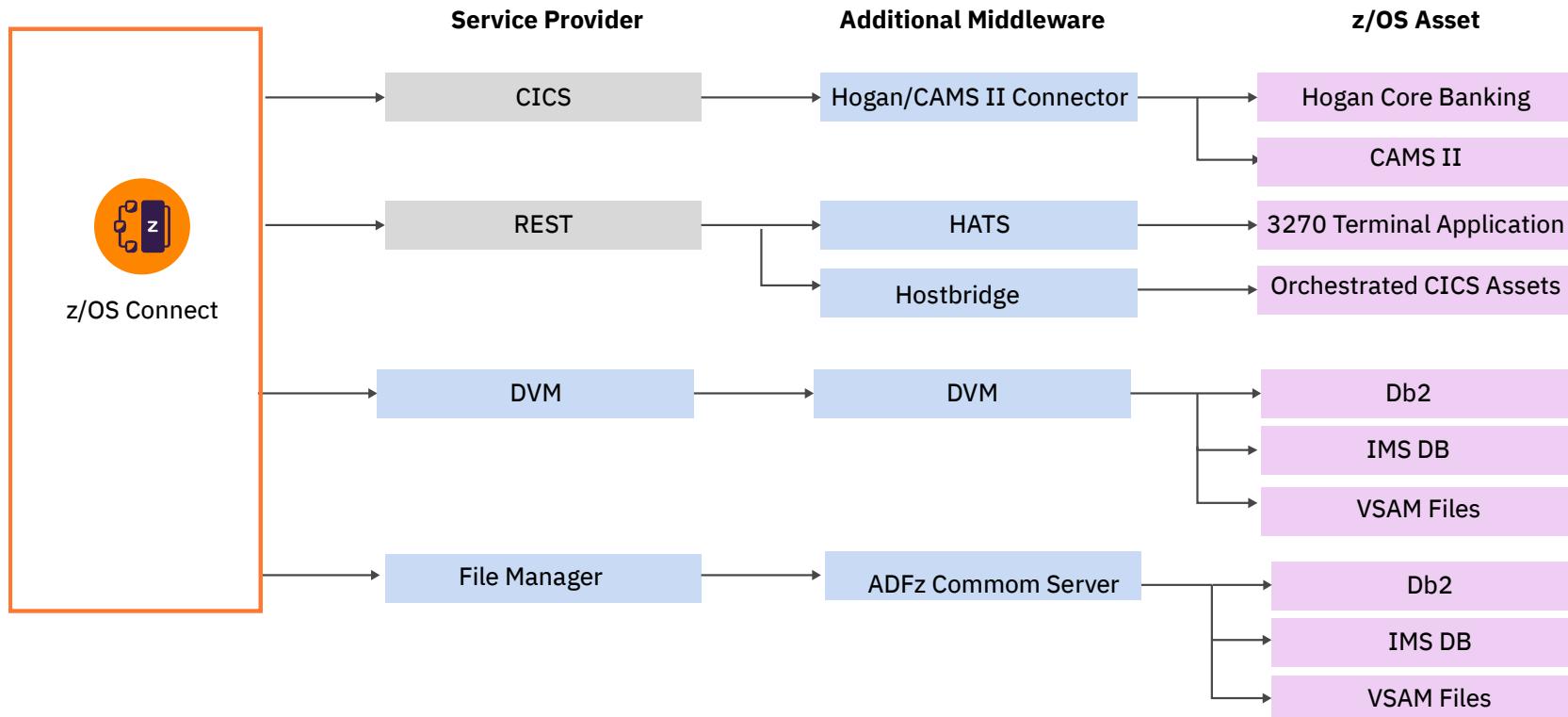


The core **service providers** included with z/OS Connect EE provide API access to a wide range of z/OS assets.



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



API Policies

- HTTP header properties can be used to select alternative for IMS (V3.0.4) , CICS (V3.0.10), Db2 (V3.0.36) or MQ (V3.0.39)
- Policies can be configured globally for every API in the server or for individual APIs (V3.0.11)

CICS attributes

- cicsCcsid
- cicsConnectionRef
- cicsTransId

IMS attributes

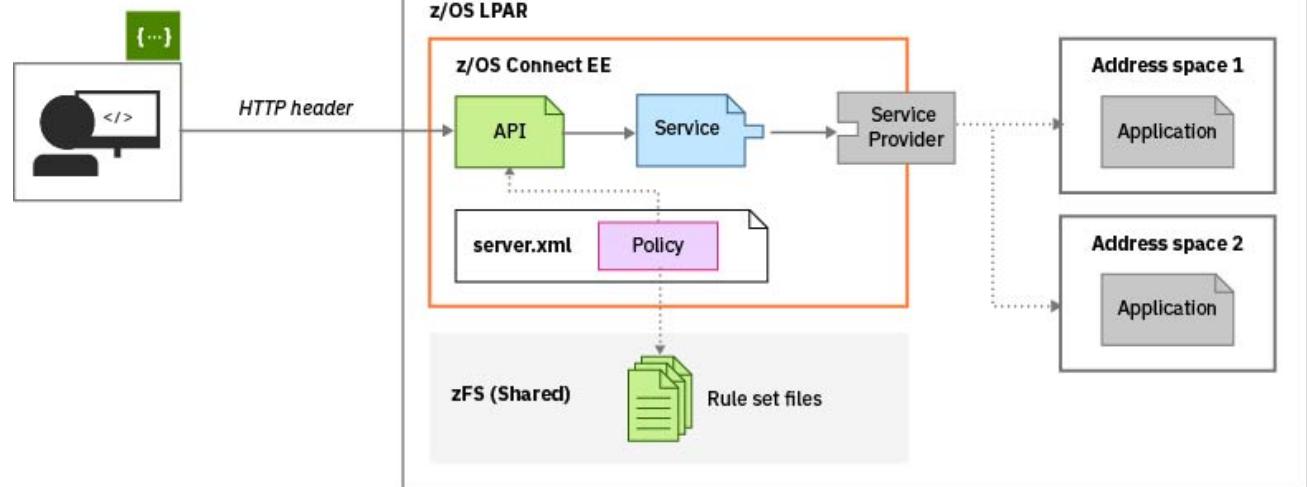
- imsConnectionRef
- imsInteractionRef
- imsInteractionTimeout
- imsLtermOverrideName
- imsTranCode
- imsTranExpiration

Db2 attributes

- db2ConnectionRef
- db2CollectionID

MQ attributes

- mqConnectionFactory
- mqDestination
- mqReplyDestination





A sample API Policies for CICS

```
<ruleset name="CICS rules">
  <rule name="csmi-rule">
    <conditions>
      <header name="cicsMirror" value="CSMI,MIJO"/> *
    </conditions>
    <actions>
      <set property="cicsTransId" value="${cicsMirror}"/>
    </actions>
  </rule>
  <rule name="connection-rule">
    <conditions>
      <header name="cicsConnection"
             value="cscvinc,cics92,cics93"/>
    </conditions>
    <actions>
      <set property="cicsConnectionRef" value="${cicsConnection}">
    </actions>
  </rule>
</ruleset>
```

GET.employee.(numb)

GET.employee.(numb)

Body - cscvincServiceOperation

HTTP Request

HTTP Headers

cicsMirror optional string

cicsConnection optional string

Path Parameters

numb Required string

Query Parameters

Body - cscvincServiceOperation

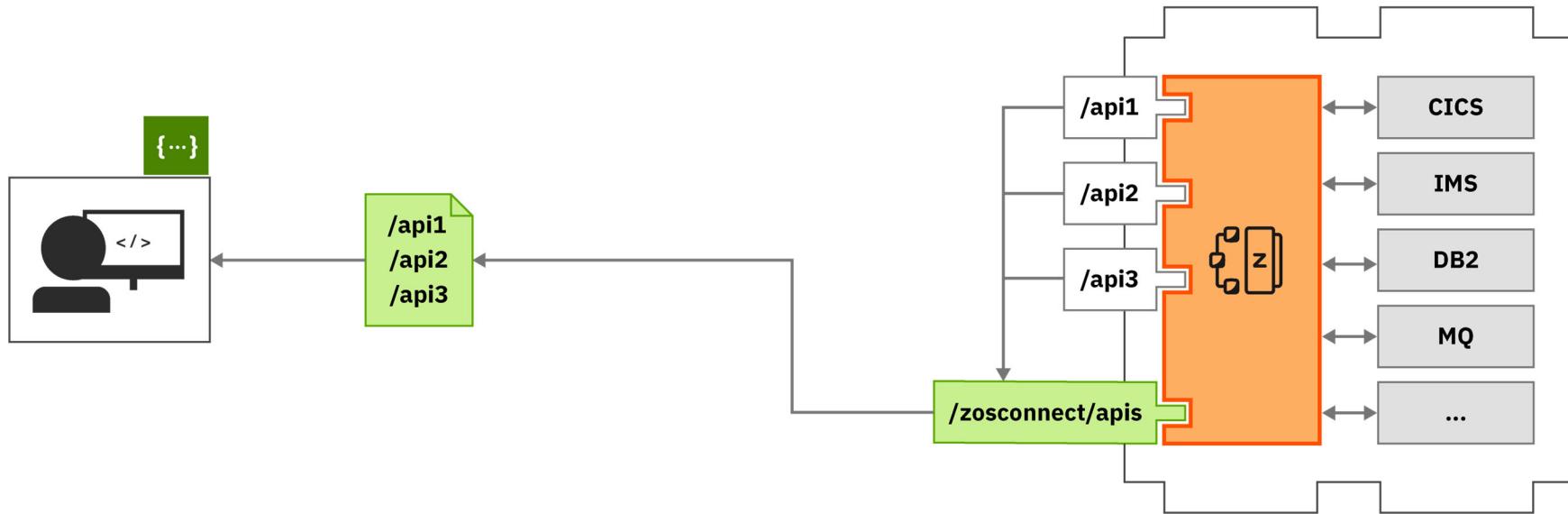
Curl

```
curl -X GET --header 'Accept: application/json' --header 'cicsMirror: MIJO' --header 'cicsConnection: cscvinc' 'https://m...
```

*Transaction MIJO needs to be a clone of CSMI (e.g., invoke program DFHMIRS)



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

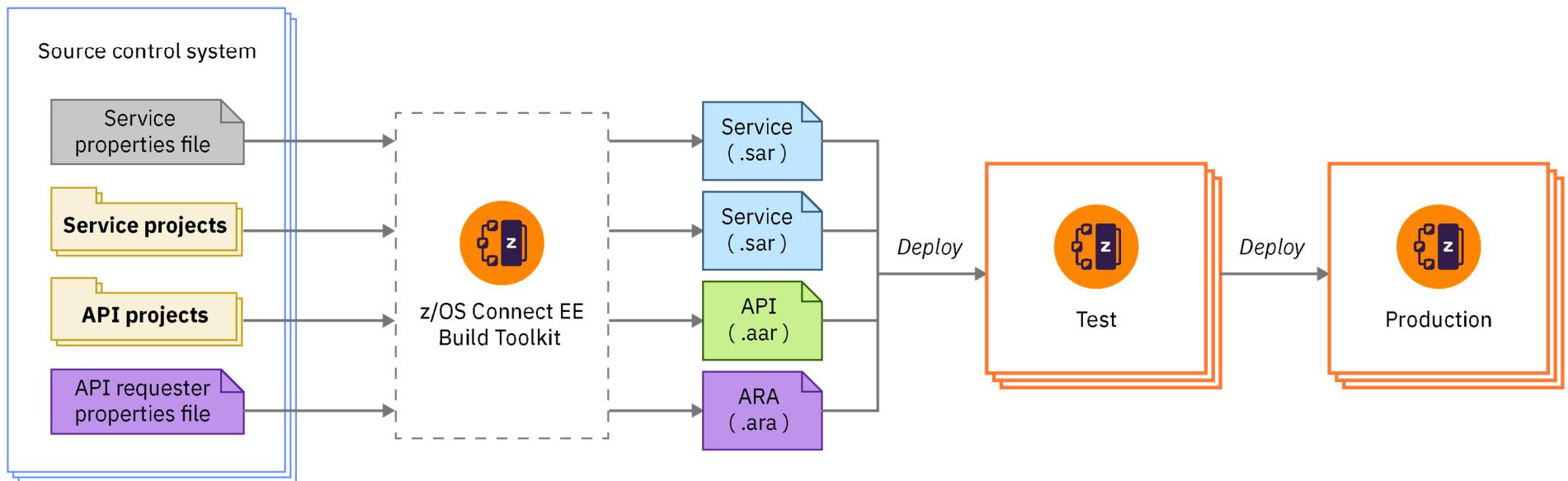
GET	/apiRequesters	Returns a list of all the deployed z/OS Connect API Requesters
POST	/apiRequesters	Deploys a new API Requester into z/OS Connect and invoke an API Requester call
DELETE	/apiRequesters/{apiRequesterName}	Undeploys an API Requester from z/OS Connect
GET	/apiRequesters/{apiRequesterName}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



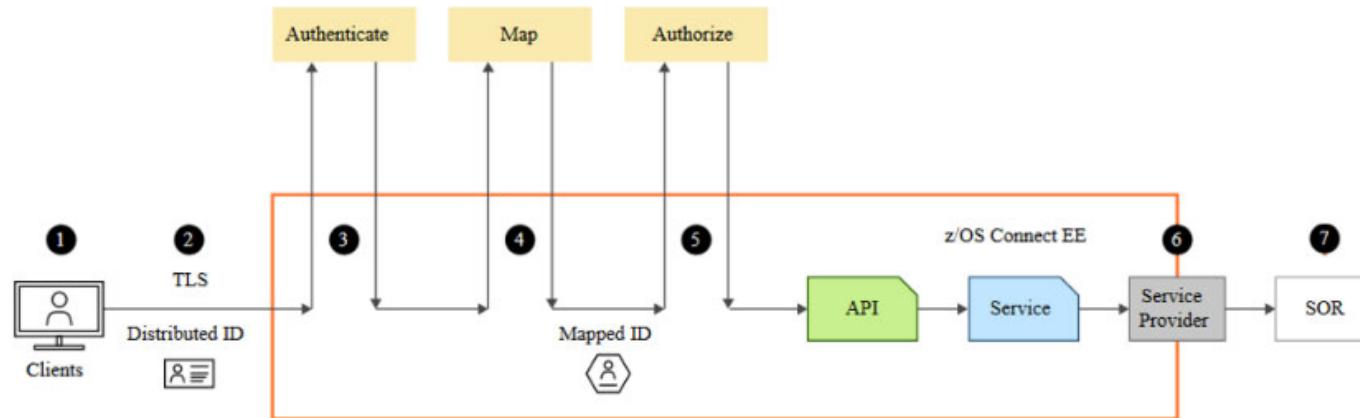


/security

How is security implement?



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



OPENAPI 3 roles

```
File Edit Format View Help
openapi: 3.0.1
info:
  title: cscvinc
  description: ""
  version: 1.0.0
servers:
- url: /cscvinc
  x-ibm-zcon-roles-allowed:
    - Manager
paths:
  /employee:
    post:
      tags:
        - cscvinc
      operationId: postCscvincInsertService
      x-ibm-zcon-roles-allowed:
        - Staff
      parameters:
        - name: Authorization
          in: header
          schema:
            type: string
      requestBody:
        description: request body
        content:
          application/json:
            schema:
              $ref: '#/components/schemas/postCscvincInsertService_request'
            required: true
      responses:
        200:
          description: OK
          content:
            application/json:
              schema:
                $ref: '#/components/schemas/postCscvincInsertService_response_200'
            x-codegen-request-body-name: postCscvincInsertService_request
      /employee/{employee}:
        get:
          tags:
            - cscvinc
          operationId: getCscvincSelectService
          x-ibm-zcon-roles-allowed:
            - Staff
          parameters:
            - name: Authorization
              in: header
              schema:
                type: string
Ln 44, Col 16 100% Unix (LF) UTF-8
```

```
<!-- Enable features -->
<featureManager>
  <feature>appSecurity-2.0</feature>
</featureManager>
<webAppSecurity allowFailOverToBasicAuth="true" />

<basicRegistry id="basic" realm="zosConnect">
  <user name="Fred" password="fredpwd" />
  <user name="user1" password="user1" />
  <user name="user2" password="user2" />
  <user name="user3" password="user3" />
  <group name="Manager">
    <member name="Fred"/>
  </group>
  <group name="Staff">
    <member name="Fred"/>
    <member name="user1"/>
    <member name="user2"/>
  </group>
</basicRegistry>

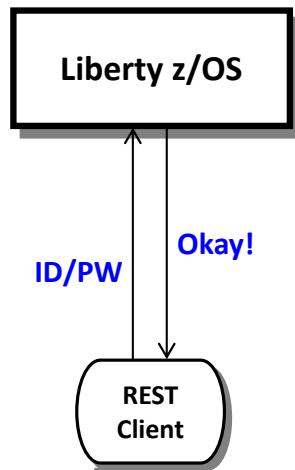
<authorization-roles id="Manager">
  <security-role name="Manager">
    <group name="managerGroup"/>
  </security-role>
</authorization-roles>
<authorization-roles id="Staff">
  <security-role name="Staff">
    <group name="staffGroup"/>
  </security-role>
</authorization-roles>
```



API Provider Authentication

Several different ways this can be accomplished:

Basic Authentication



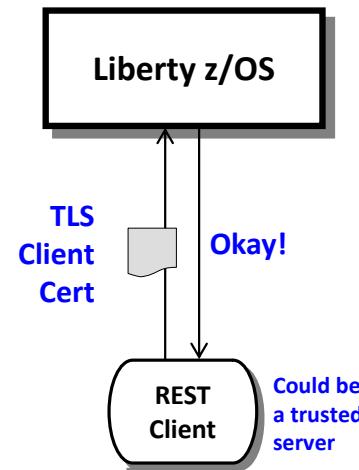
Server prompts for ID/PW

Client supplies ID/PW or
ID/Passticket

Server checks registry:

- Basic (server.xml)
- LDAP
- SAF

Client Certificate



Server prompts for cert.

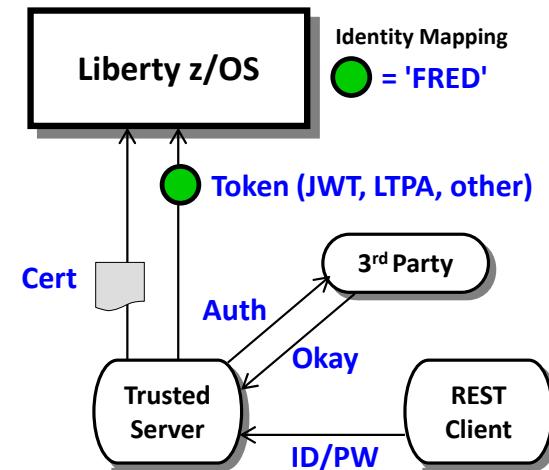
Client supplies certificate

Server validates cert and
maps to an identity

Registry options:

- LDAP
- SAF

Third Party Authentication



Client authenticates to 3rd party sever

Client receives a trusted 3rd 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

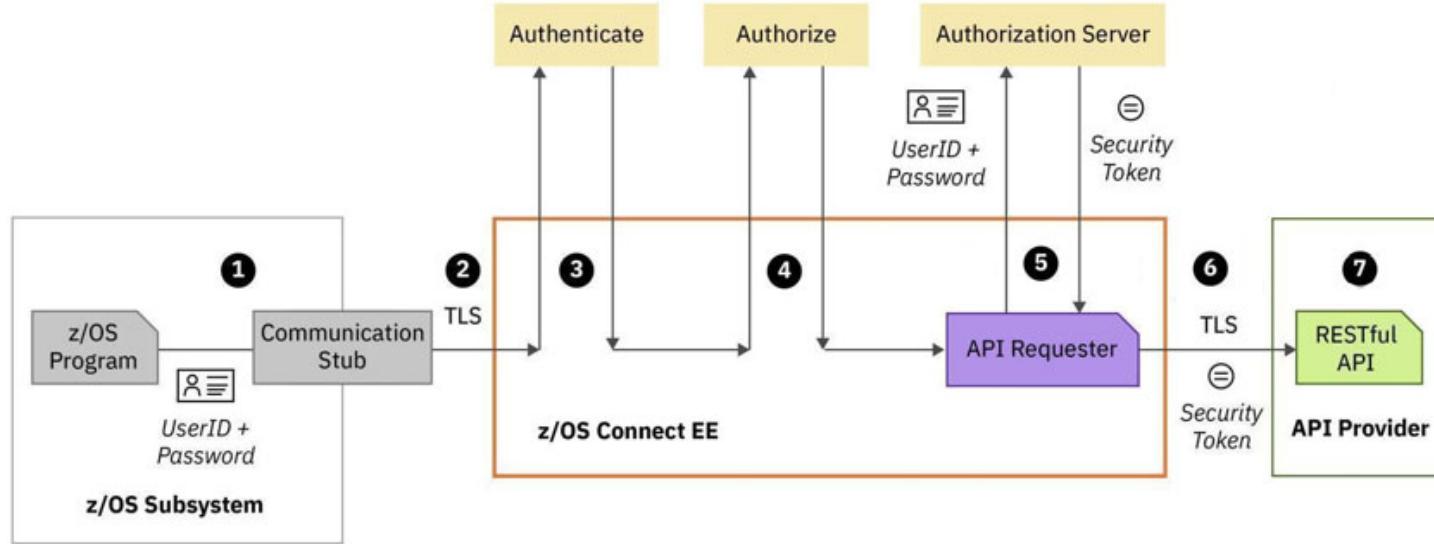
This screenshot shows the UPS Sign Up page. At the top, there's a banner stating "UPS is open for business: Service impacts related to Coronavirus ...More". Below the banner, the UPS logo is displayed. A "Sign Up / Log in" link and a "Search or Track" input field are visible. The main section is titled "Sign Up" and includes a link for users who already have an ID. It provides several social media sign-in options: Google, Facebook, Amazon, Apple, and Twitter. Below these, there are fields for entering personal information: Name*, Email*, User ID*, Password*, and Phone. The "Password" field has a "Show" link next to it. A "Feedback" button is located on the right side of the form.

Right Screenshot: myNCDMV Log In

This screenshot shows the myNCDMV Log In page. The background features a scenic view of autumn foliage. The page has "Log In" and "Sign Up" tabs at the top. The "Log In" tab is selected. It contains fields for "Email Address" (with placeholder "name@example.com") and "Password" (with placeholder "*****"). There is a "Remember Me" checkbox, a "Log In" button, a "Forgot Password" link, and links for "Continue with Apple", "Continue with Facebook", and "Continue with Google". Below these, a "Continue as Guest" link is available. A notice at the bottom states: "NOTICE FOR PUBLIC COMPUTER USERS - If you sign in with Google, Apple, or Facebook you are also signing into that account on this computer. Remember to sign out when you're done." The page is powered by "payit".



Typical z/OS Connect EE API Requester security flow



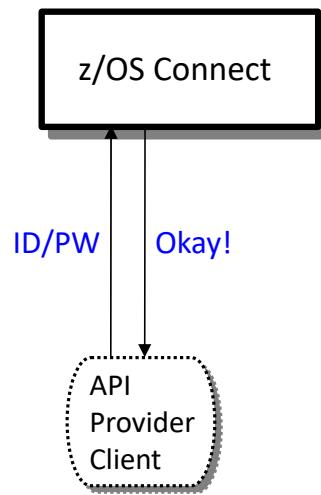
1. A user ID and password can be used for basic authentication by the z/OS Connect EE server
2. Connection between the CICS, IMS, or z/OS application and the z/OS Connect EE server can use TLS
3. Authenticate the CICS, IMS, or z/OS application.
4. Authorize the authenticated user ID to connect to z/OS 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



z/OS Application to z/OS Connect API Requester

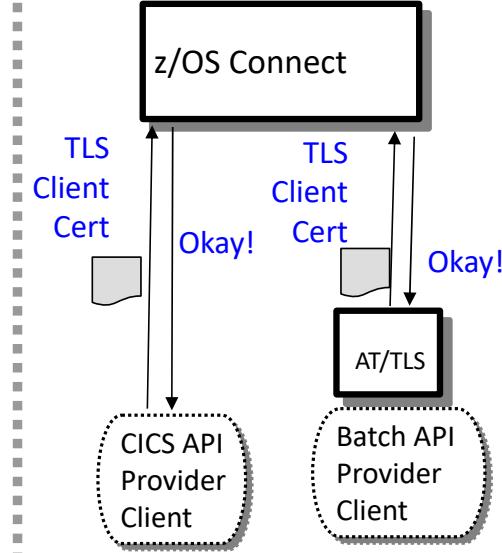
Two options for providing credentials for authentication

Basic Authentication



**Application provides
ID/PW or ID/PassTicket**

Client Certificate



**z/OS Connect requests a
client certificate**

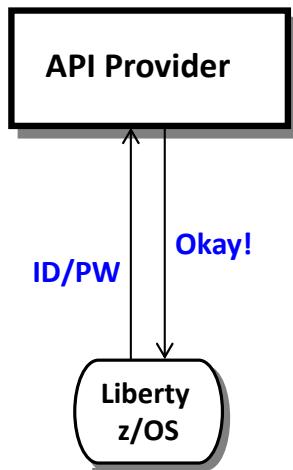
**CICS or AT/TLS supplies a
client certificate**



API Requester - API Provider Authentication

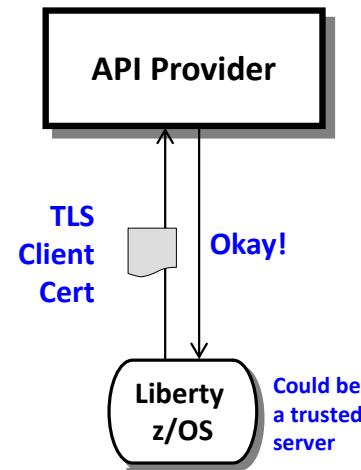
Several different ways this can be accomplished:

Basic Authentication



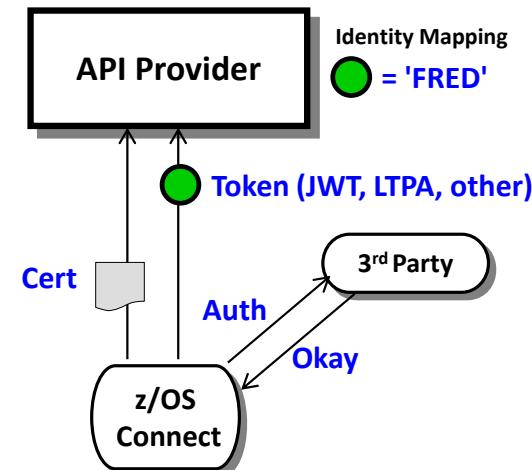
zCEE supplies ID/PW or
ID/Passticket

Client Certificate



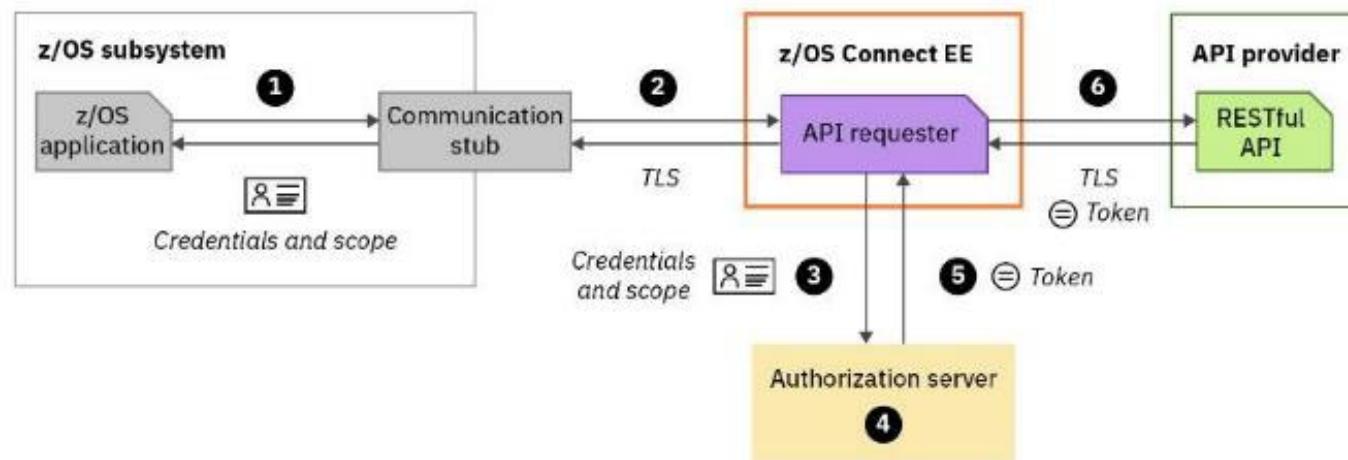
Server prompts for certificate
zCEE supplies certificate

Third Party Authentication

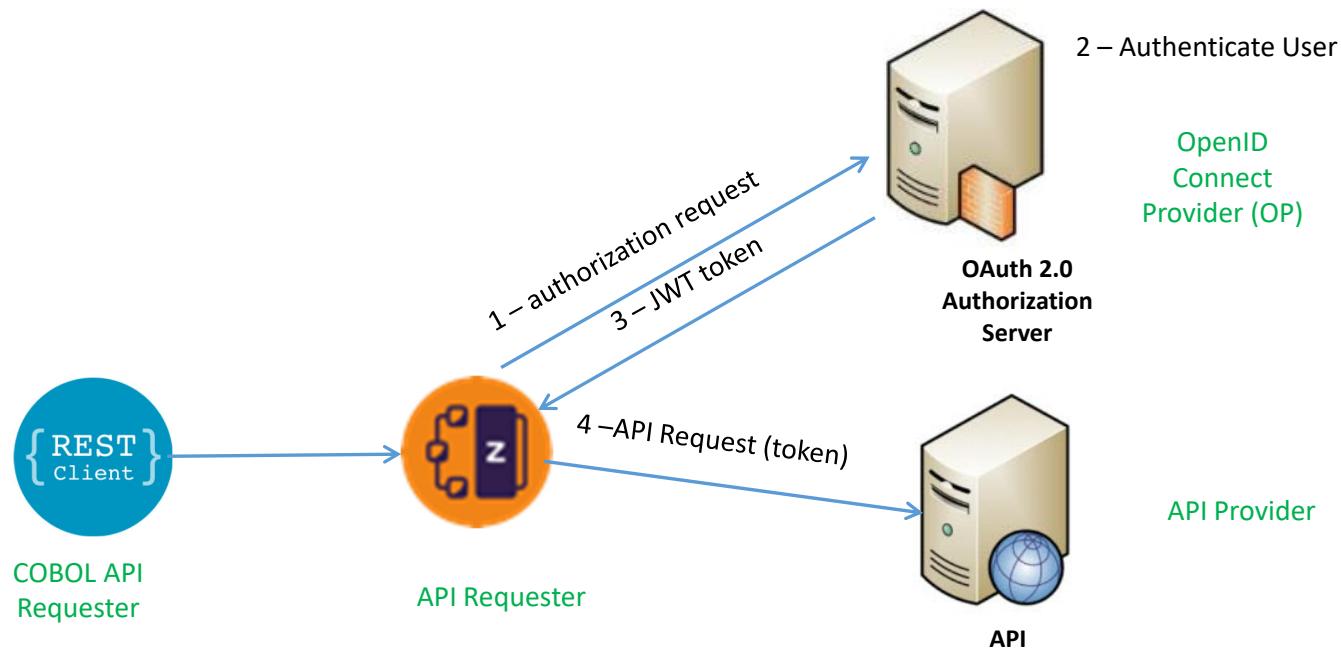


zCEE authenticates to 3rd party sever
zCEE receives a trusted 3rd party token
Token flows to API Provider

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.

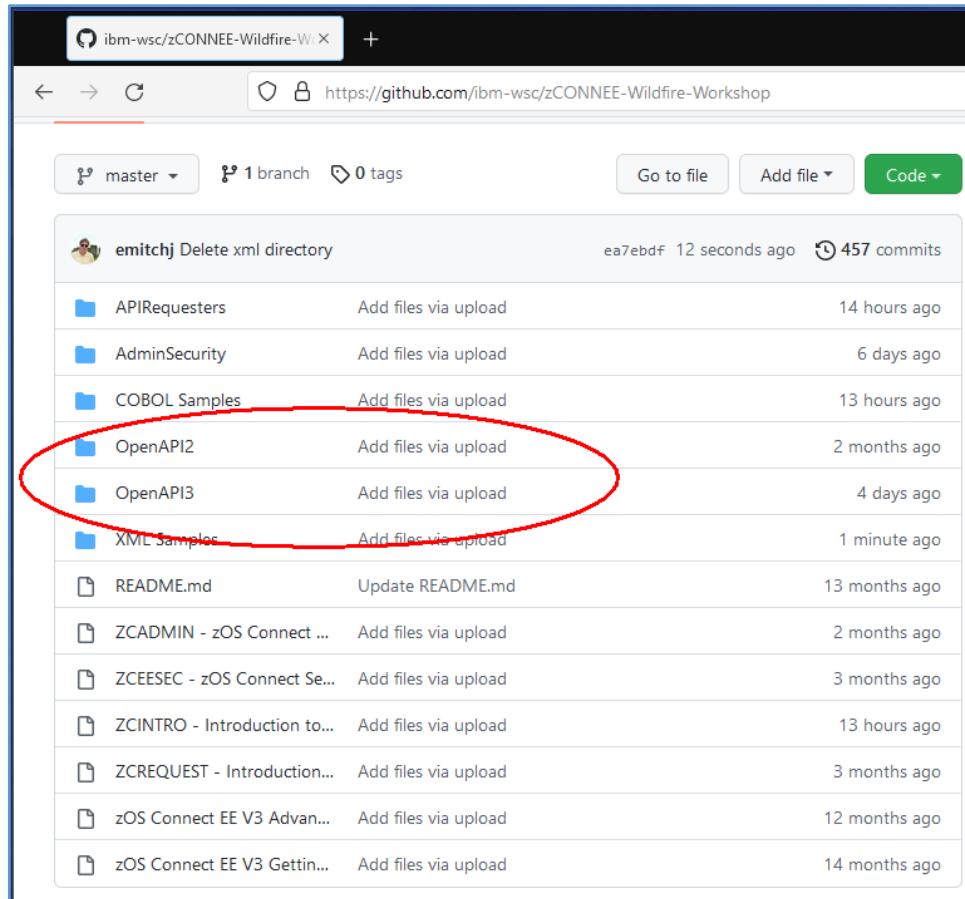
OAuth 2.0 specification entity	password	client_credentials	Where Set
Client ID	required	Required	server.xml or by application
Client Secret	optional	Required	server.xml or by application
Username	required	N/A	by application
Password	required	N/A	by application

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
 - Outbound REST APIs
- 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*

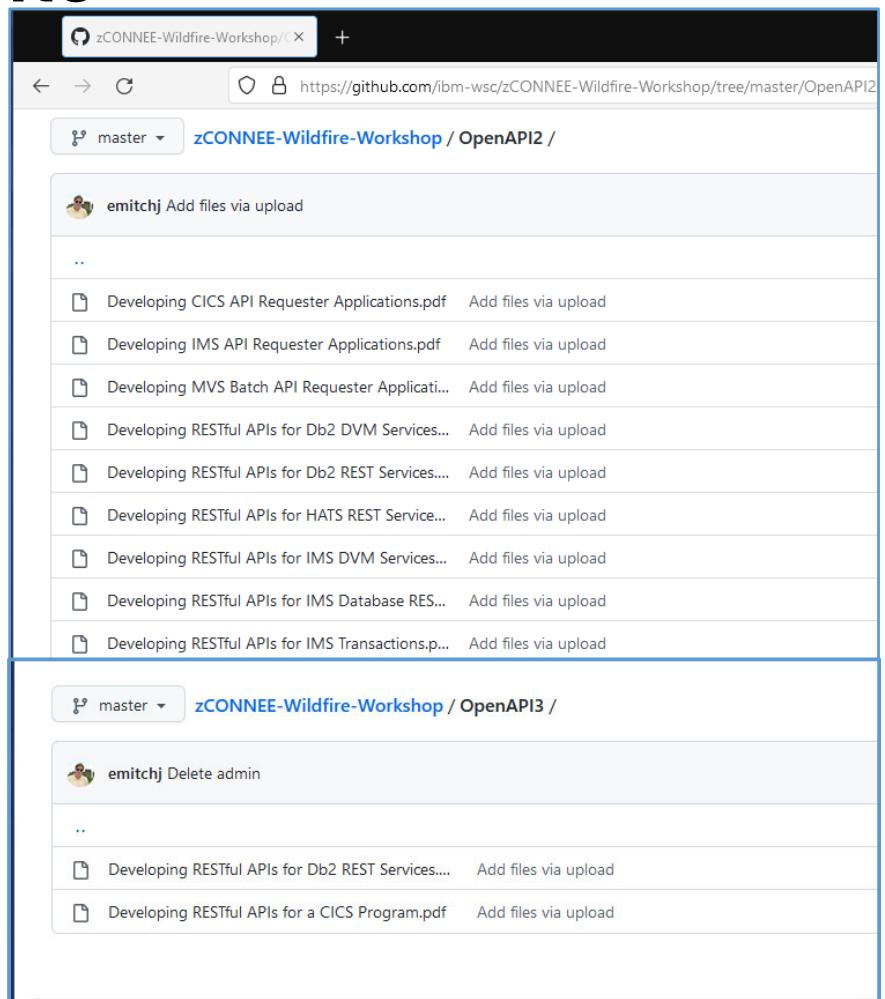
z/OS Connect Wildfire Github Site



A screenshot of a GitHub repository page. The repository name is 'ibm-wsc/zCONNEE-Wildfire-Workshop'. The commit list shows several entries:

- emitchj Delete xml directory ea7ebdf 12 seconds ago 457 commits
- APIRequesters Add files via upload 14 hours ago
- AdminSecurity Add files via upload 6 days ago
- COBOL Samples Add files via upload 13 hours ago
- OpenAPI2** Add files via upload 2 months ago
- OpenAPI3** Add files via upload 4 days ago
- XML Samples Add files via upload 1 minute ago
- README.md Update README.md 13 months ago
- ZCADMIN - zOS Connect ... Add files via upload 2 months ago
- ZCEESEC - zOS Connect Se... Add files via upload 3 months ago
- ZCINTRO - Introduction to... Add files via upload 13 hours ago
- ZCREQUEST - Introduction... Add files via upload 3 months ago
- zOS Connect EE V3 Advan... Add files via upload 12 months ago
- zOS Connect EE V3 Gettin... Add files via upload 14 months ago

<https://ibm.biz/zCEEWorshopMaterial>



A screenshot of a GitHub repository page for 'zCONNEE-Wildfire-Workshop'. The repository has two main branches: 'OpenAPI2' and 'OpenAPI3'.

- OpenAPI2 /**
 - emitchj Add files via upload
 - Developing CICS API Requester Applications.pdf
 - Developing IMS API Requester Applications.pdf
 - Developing MVS Batch API Requester Application...
 - Developing RESTful APIs for Db2 DVM Services...
 - Developing RESTful APIs for Db2 REST Services....
 - Developing RESTful APIs for HATS REST Service...
 - Developing RESTful APIs for IMS DVM Services...
 - Developing RESTful APIs for IMS Database RES...
 - Developing RESTful APIs for IMS Transactions.p...
- OpenAPI3 /**
 - emitchj Delete admin
 - Developing RESTful APIs for Db2 REST Services....
 - Developing RESTful APIs for a CICS Program.pdf

mitchj@us.ibm.com

- Contact your IBM representative to schedule access to these exercises**

WSC wants your
feedback!

What you will see:

From: IBM Client Feedback <ibm@feedback.ibm.com>
Subject: Got a minute? Two questions on your IBM Z Washington Systems Center experience

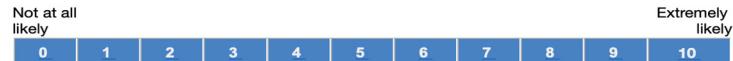


Dear

Thank you for engaging with our team. At IBM Z Washington Systems Center, we make it a priority to listen to our clients and want to continuously improve your experience. So, we would love your candid feedback on how we are doing. Please take a moment to answer two short questions about your experience.

You can begin the survey by answering this question.

How likely are you to recommend IBM Z Washington Systems Center to others?



Sincerely,

IBM Advocacy Team

****you will NOT receive a new survey if you already responded to an IBM Survey from Medallia in the last **60 days** OR if you haven't responded within the last **30 days******



Thank you for listening and your questions

And thank you for completing the Medallia survey