ZCINTRO - IBM z/OS Connect
An introduction and overview

Mitch Johnson
mitchj@us.ibm.com
Washington System Center

IBM Z
Wildfire Team –
Washington System Center

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*

mitchj@us.ibm.com

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 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 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.

mitchj@us.ibm.com

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

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

API Requester Code and Security Considerations

Mitch Johnson
mitchj@us.ibm.com
Washington System Center

Wildfire
Technical Hands-On Workshops

mitchj@us.ibm.com

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

Wildfire
Technical Hands-On Workshops
IBM
IBM Z
Wildfire Team –
Washington System Center

Slide 1

z/OS Connect Open API 3

Designer and z/OS Native server
Experiences and Observations

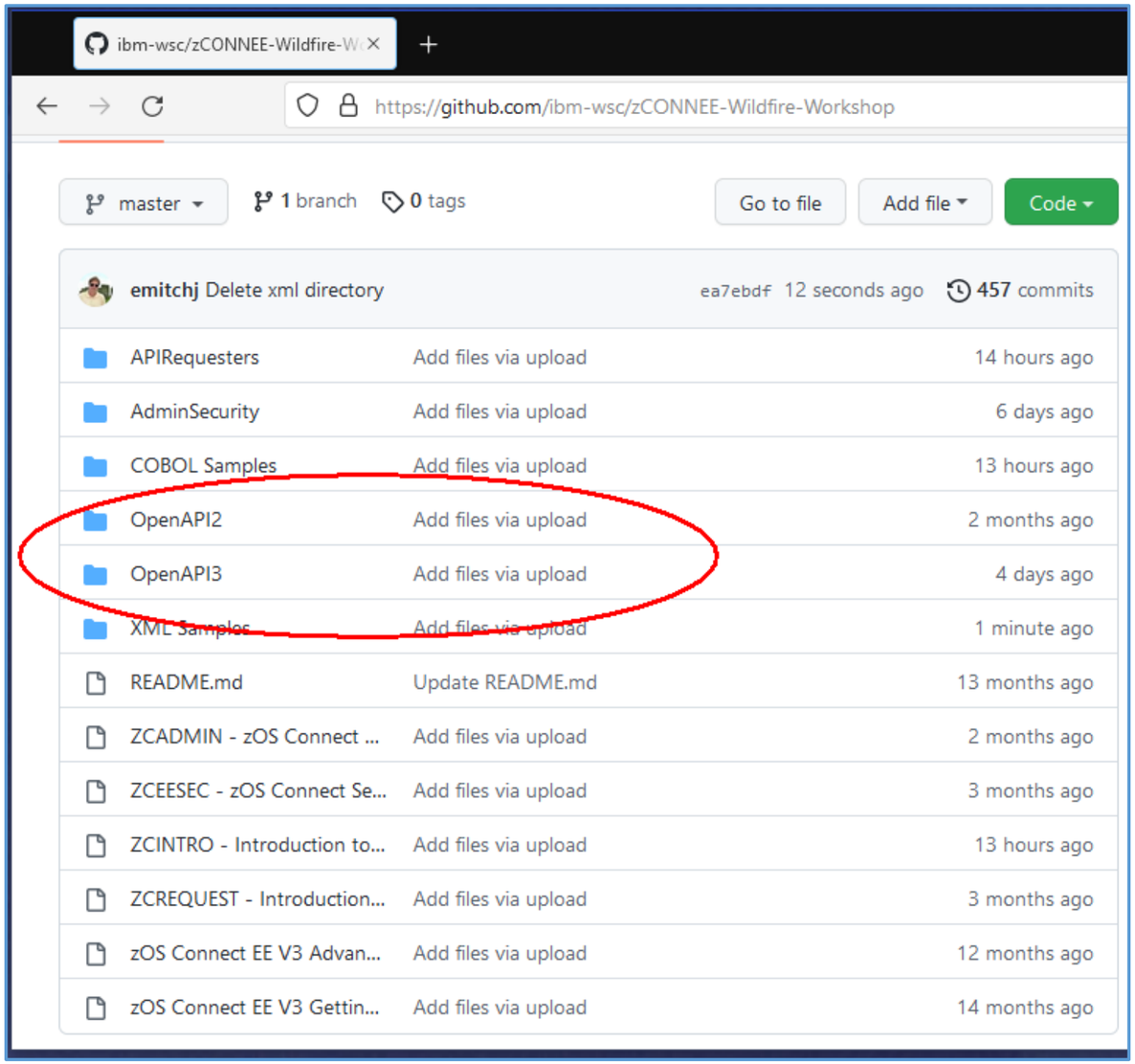
Mitch Johnson
mitchj@us.ibm.com
Washington Systems Center

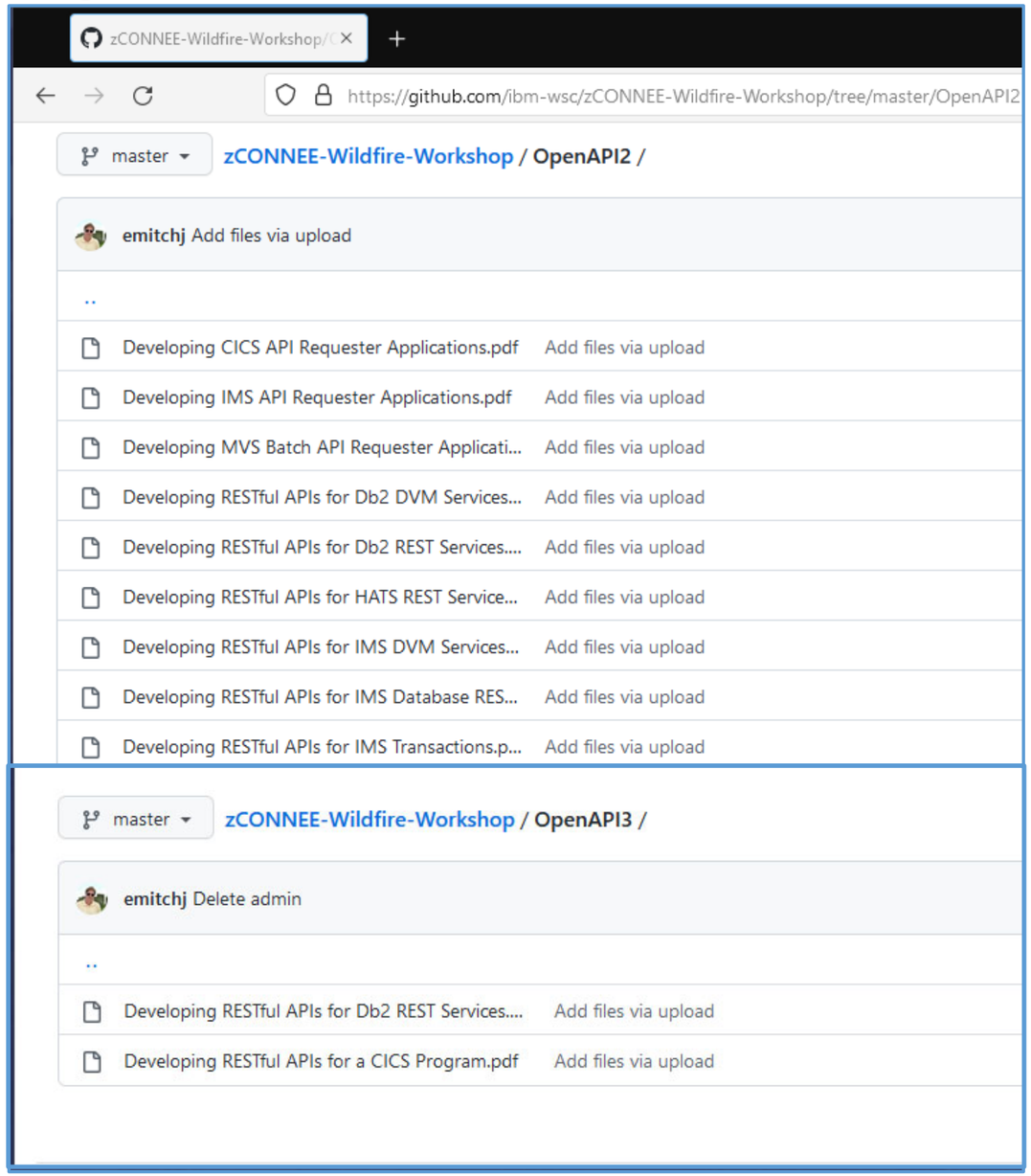
Wildfire
Technical Hands-On Workshops
IBM
IBM Z
Wildfire Team –
Washington System Center

Slide 1

z/OS Connect Wildfire Github Site

https://ibm.biz/zCEEWorkshopMaterial





mitchj@us.ibm.com

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

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

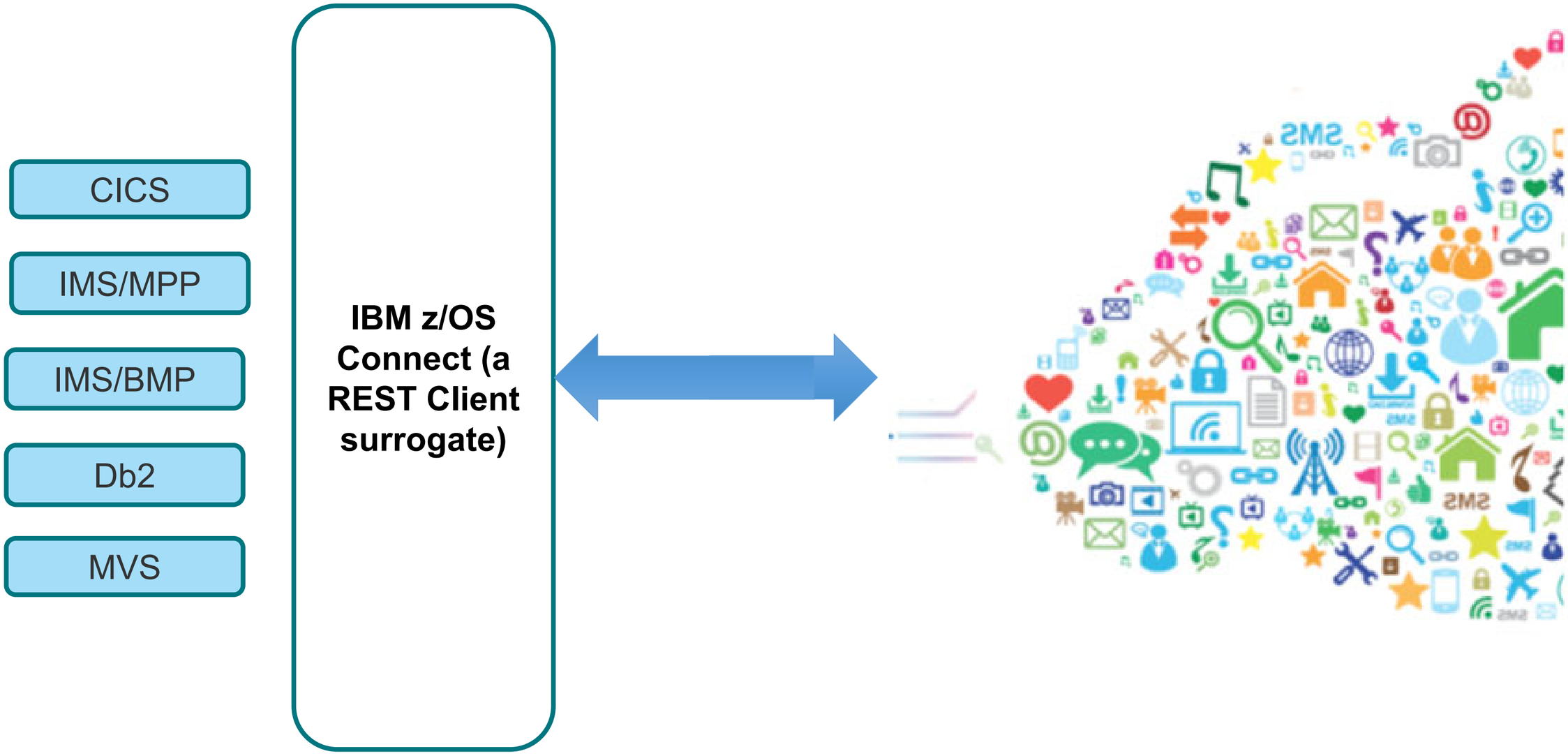
IBM z/OS Connect (an API Gateway)

- CICS
- IMS/TM
- IMS/DB
- Db2
- MQ
- IBM File Manager+
- HATS(3270)
- IBM DVM+
- MVS
- WAS
- Custom*

+ HCL and Rocket Software
*Other Vendors or your own implementation

mitchj@us.ibm.com

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



mitchj@us.ibm.com

Before we go any further, let ask

/but_first, what_is_REST?

What makes an API “RESTful”?

mitchj@us.ibm.com

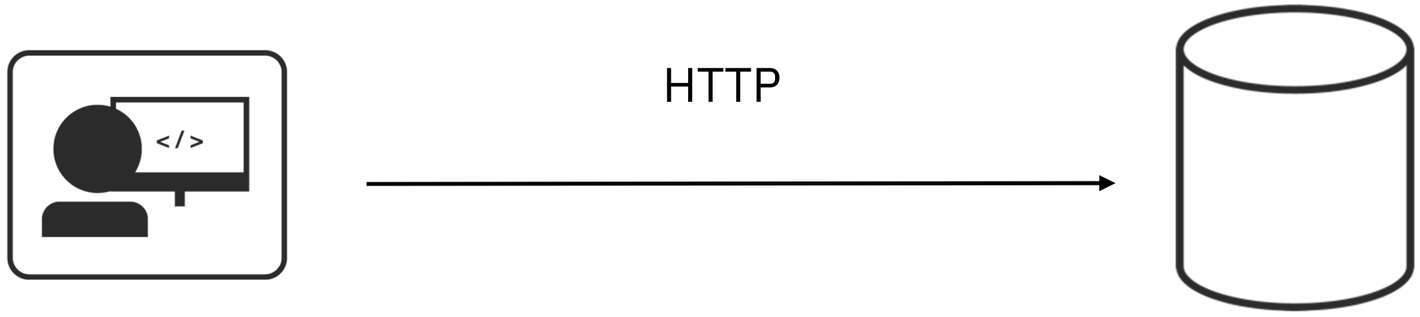
REST is architectural programming style

REST is acronym standing for **Re**presentational **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.

mitchj@us.ibm.com

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” }
```

mitchj@us.ibm.com

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

mitchj@us.ibm.com

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

mitchj@us.ibm.com

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" }
```

mitchj@us.ibm.com

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
```

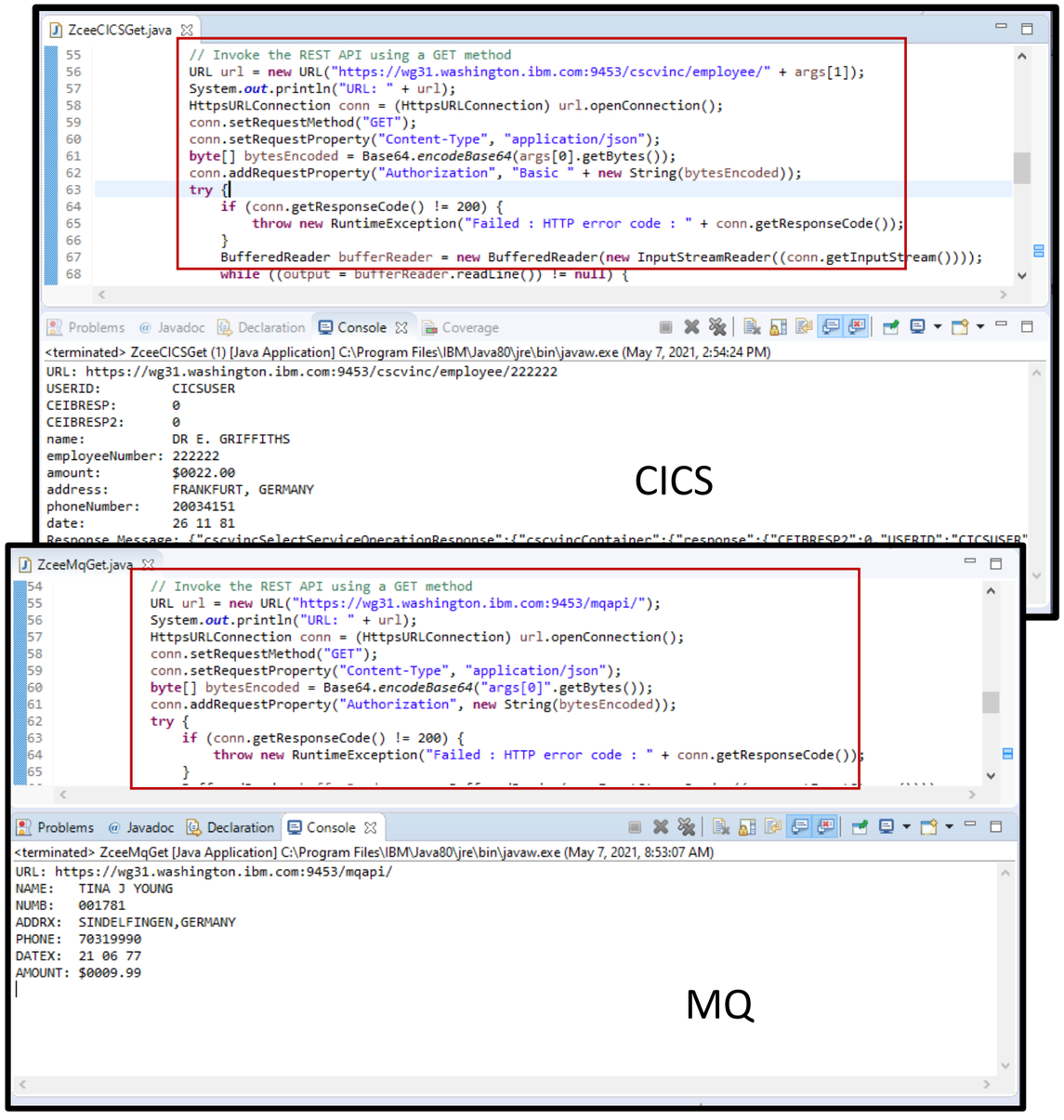
mitchj@us.ibm.com

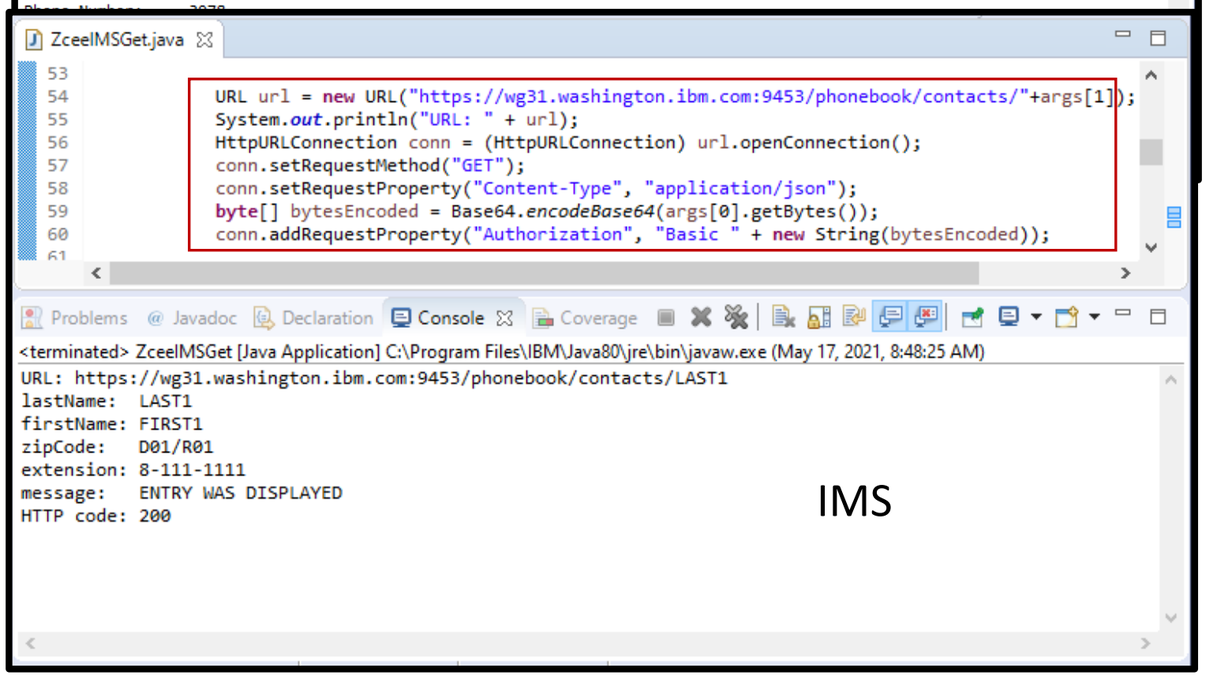
Why is REST popular?

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.

mitchj@us.ibm.com

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





mitchj@us.ibm.com

How do we describe and/or document an API?

mitchj@us.ibm.com

/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.

mitchj@us.ibm.com

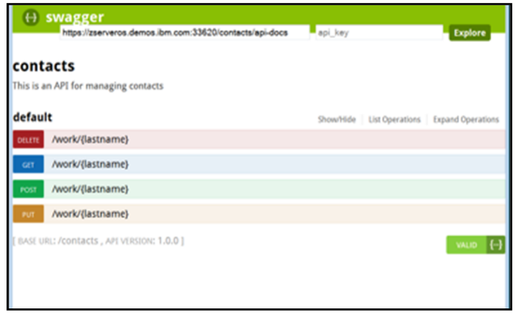
We use an Open API specification

- It is more than just an API framework

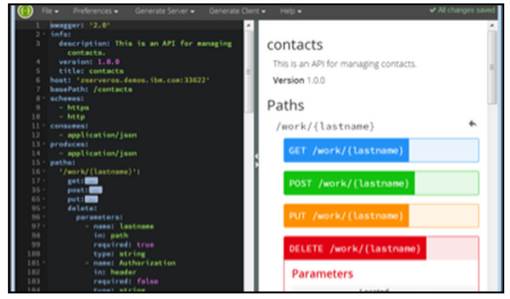
There are a number of tools available to aid consumption:

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 specifcations.

mitchj@us.ibm.com

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 consumes 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**

mitchj@us.ibm.com

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",
```

Ln 18, Col 7 | 100% | Windows (CRLF) | UTF-8

YAML Format*

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:
    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

mitchj@us.ibm.com

https://swagger.io/blog/api-strategy/difference-between-swagger-and-openapi/

*Yet Another Markup Language

Why /zos_connect?

Truly RESTful APIs to and from your mainframe.

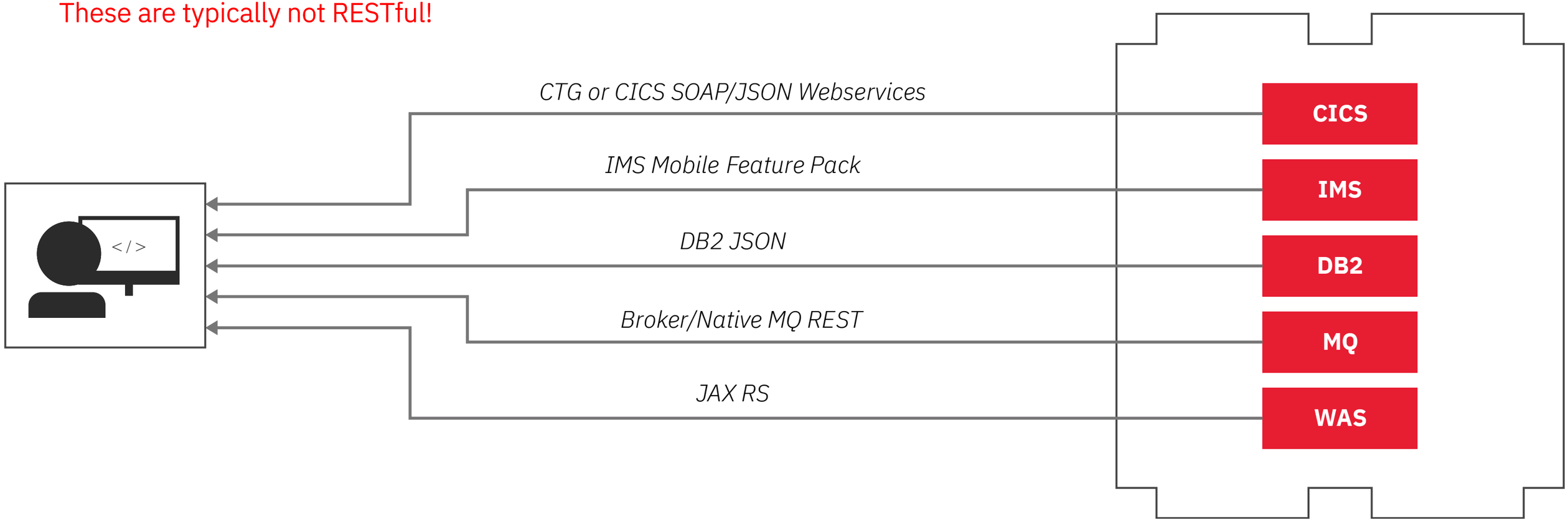
mitchj@us.ibm.com

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!



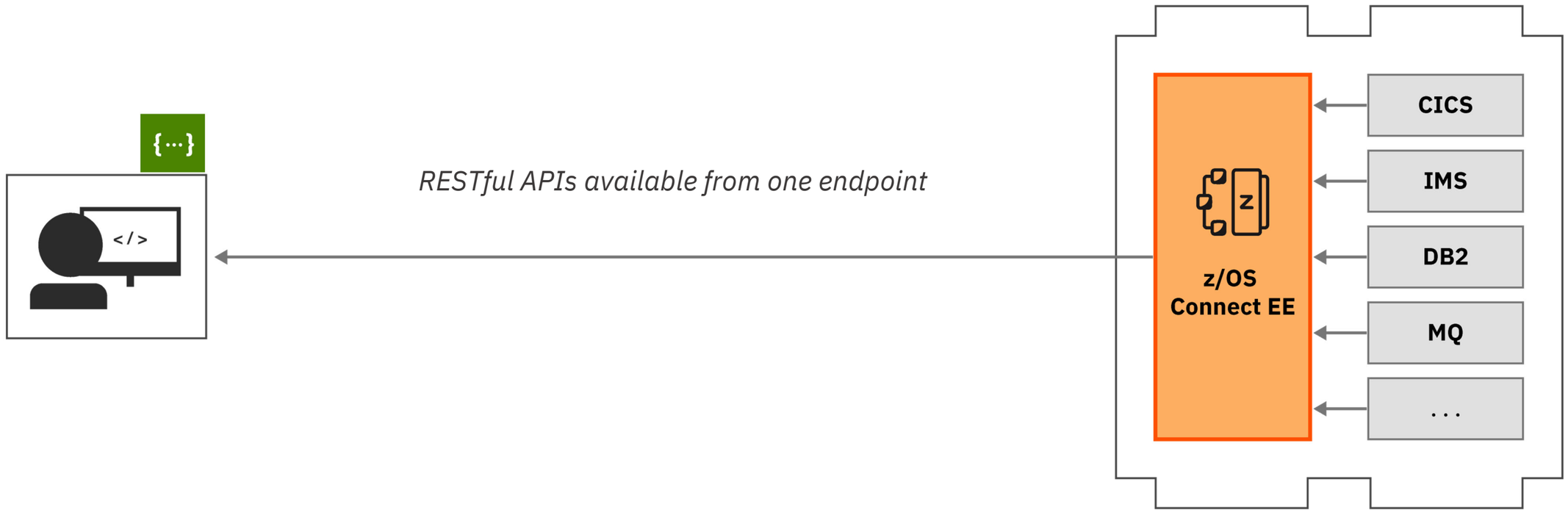
mitchj@us.ibm.com

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.



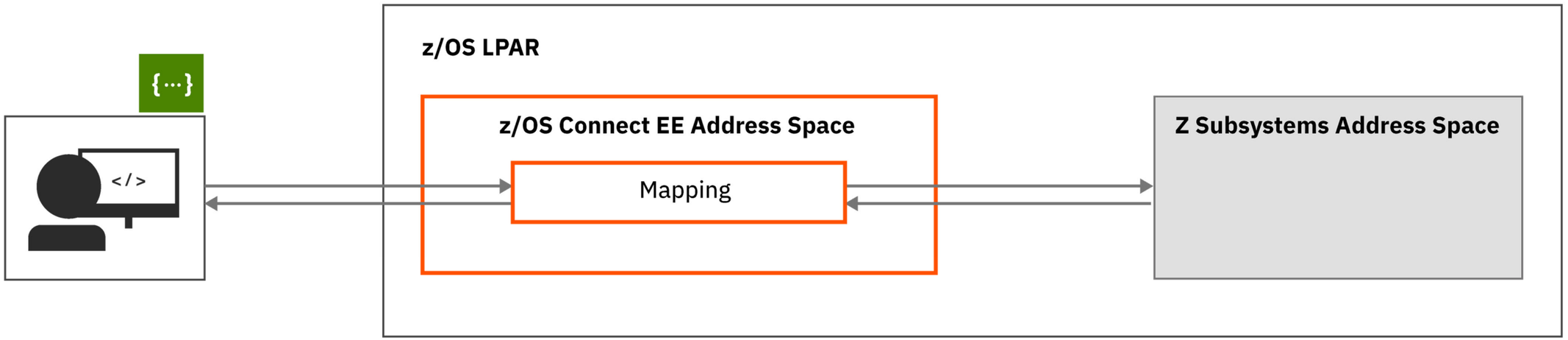
mitchj@us.ibm.com

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

mitchj@us.ibm.com

Data mapping

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

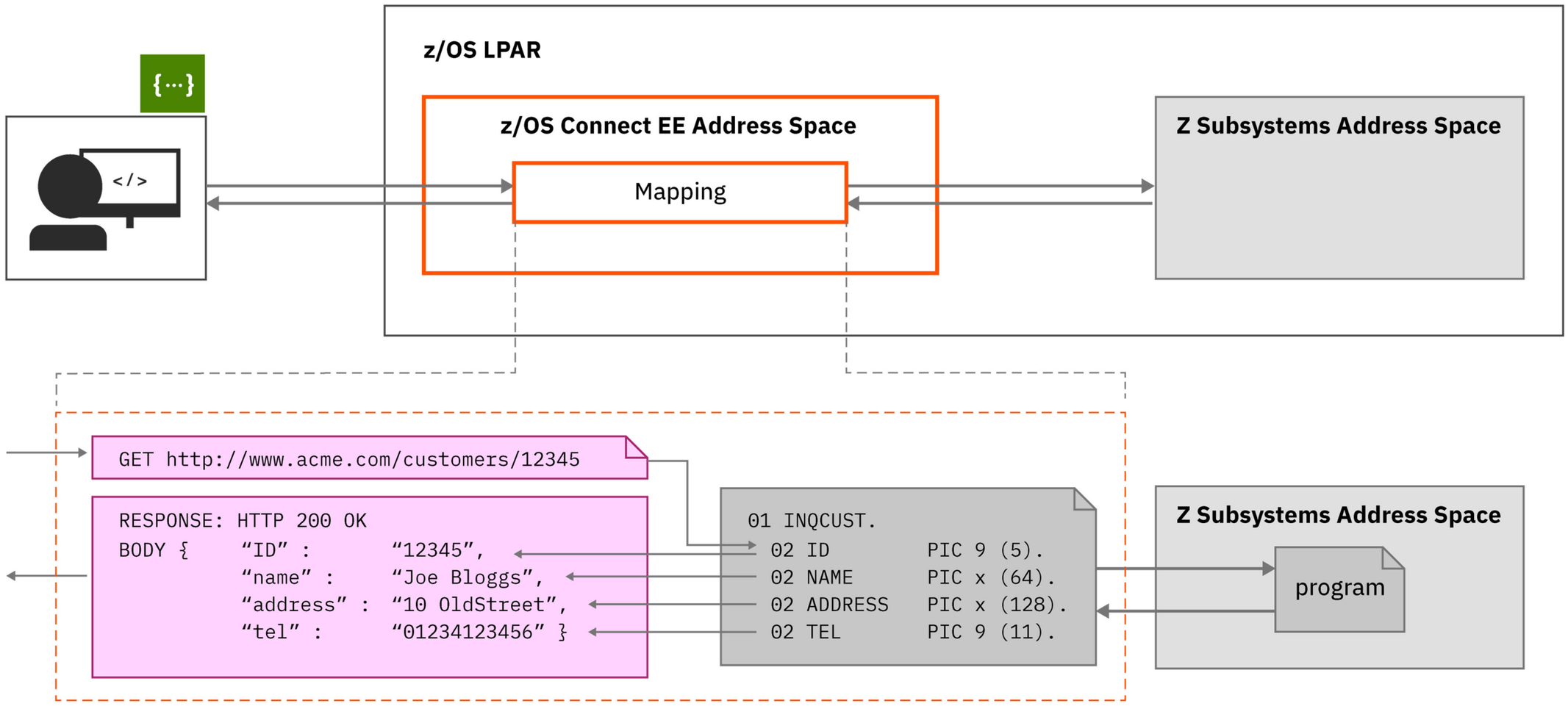


* Most z/OS subsystems depend information in a serial data format and do not normally work with JSON request/response messages. Examples of non-JSON formats are CICS COMMAREAs and CONTAINERS, IMS or MQ messages, or records stored in sequential or VSAM data sets. Data mapping and transformation refers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

mitchj@us.ibm.com

Data mapping and transformation example

- A closer look

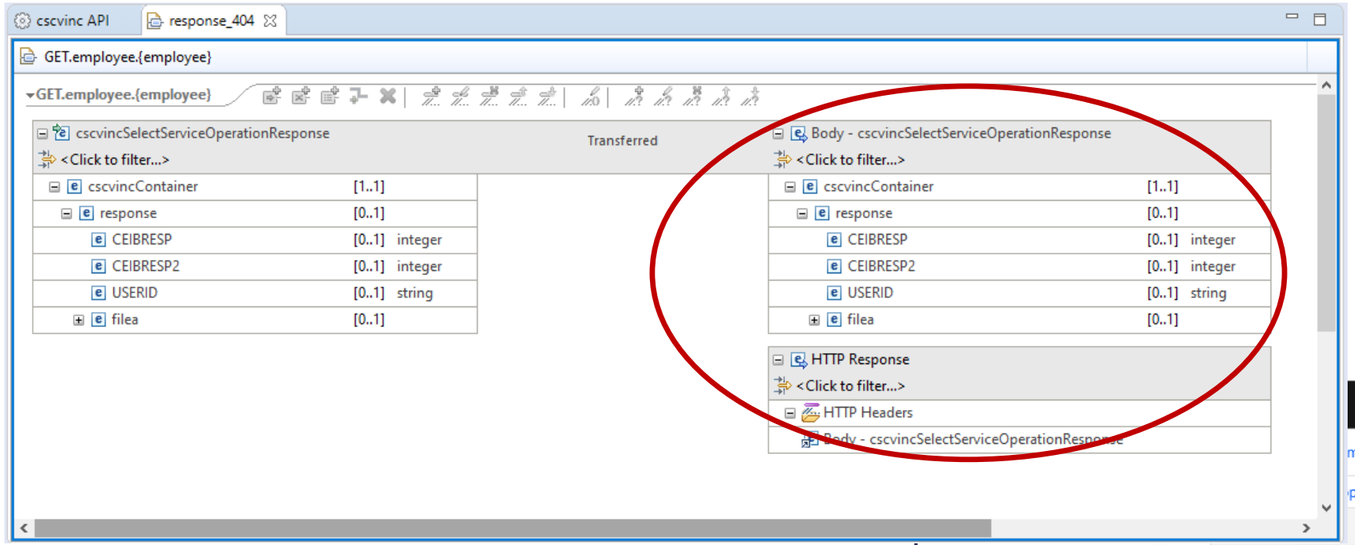


mitchj@us.ibm.com

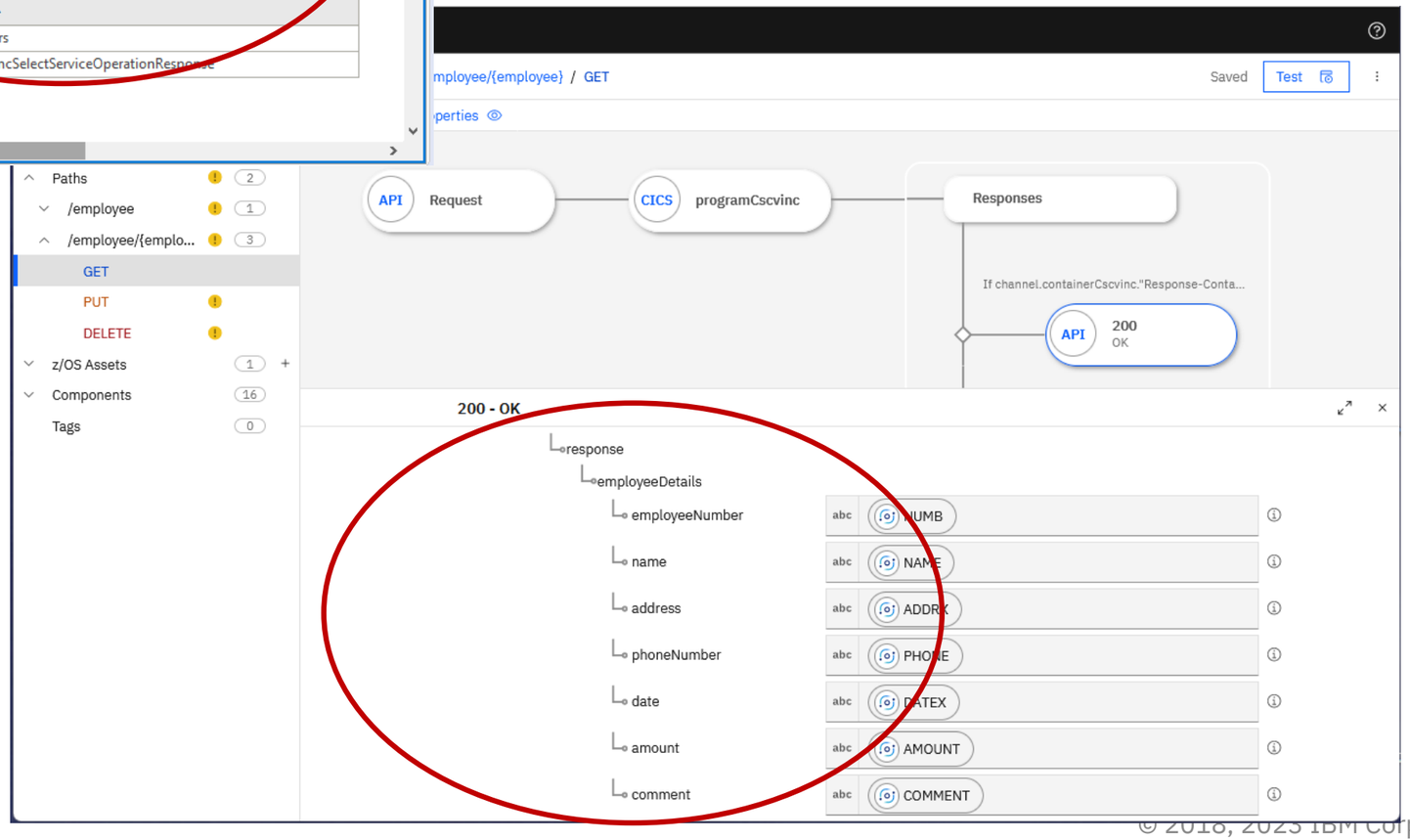
z/OS Connect OpenAPI Tooling

mitchj@us.ibm.com

Describing an OPENAPI 2 versus an OPENAPI 3 Response Message



Eclipse based - z/OS Connect API Toolkit



Web browser - z/OS Connect Designer

mitchj@us.ibm.com

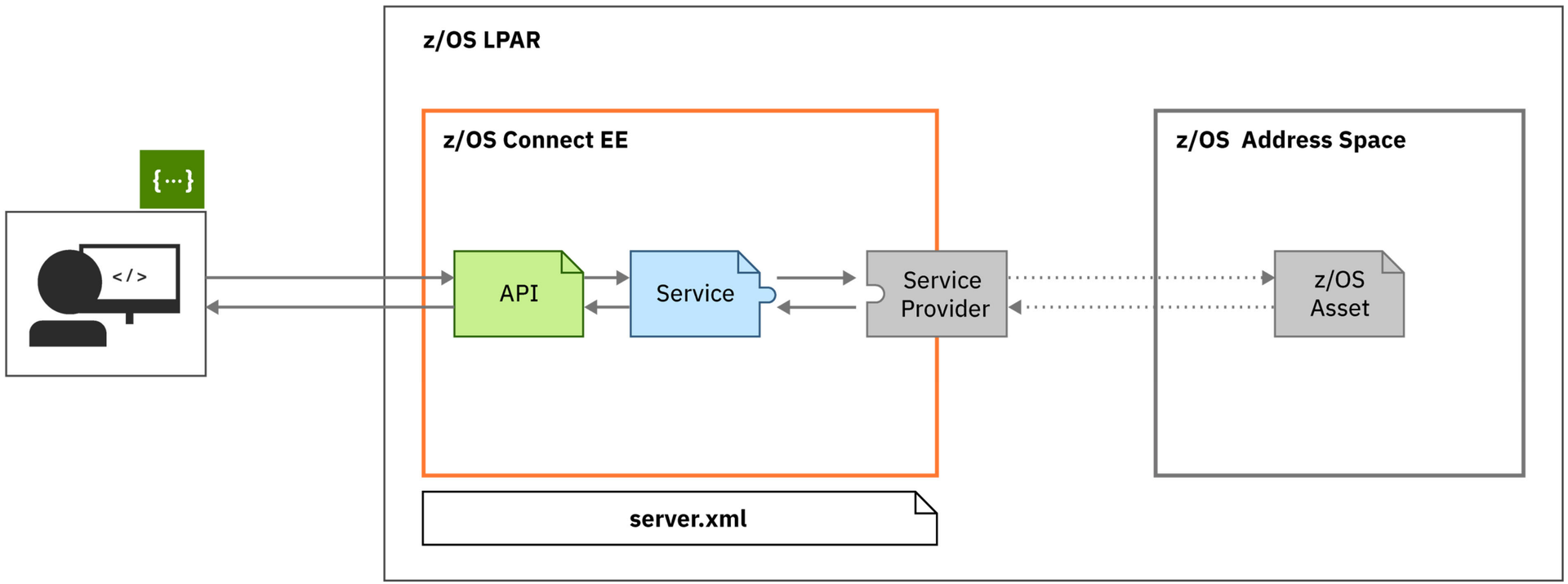
/api_toolkit/services

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

mitchj@us.ibm.com

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)

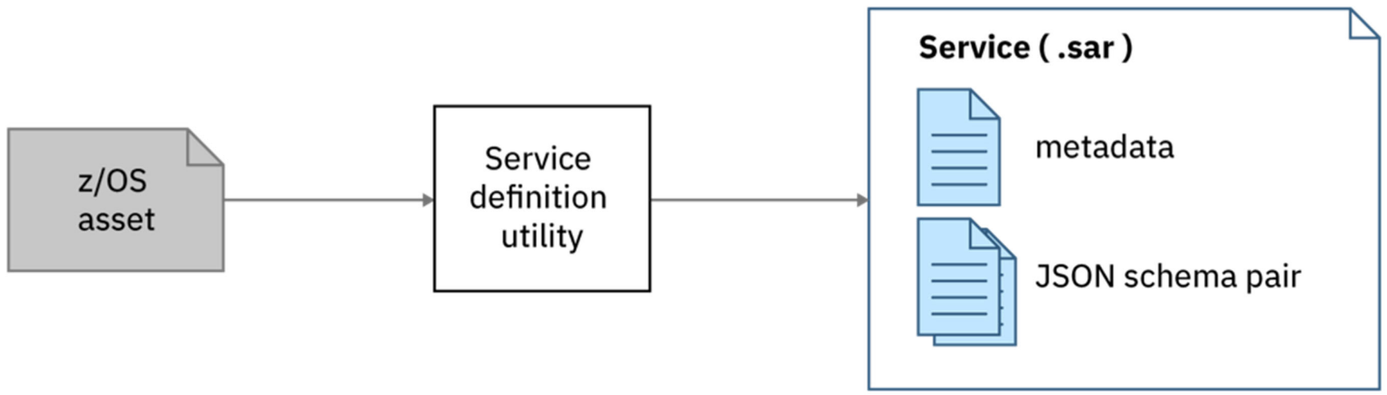
mitchj@us.ibm.com

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




```
        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.
```

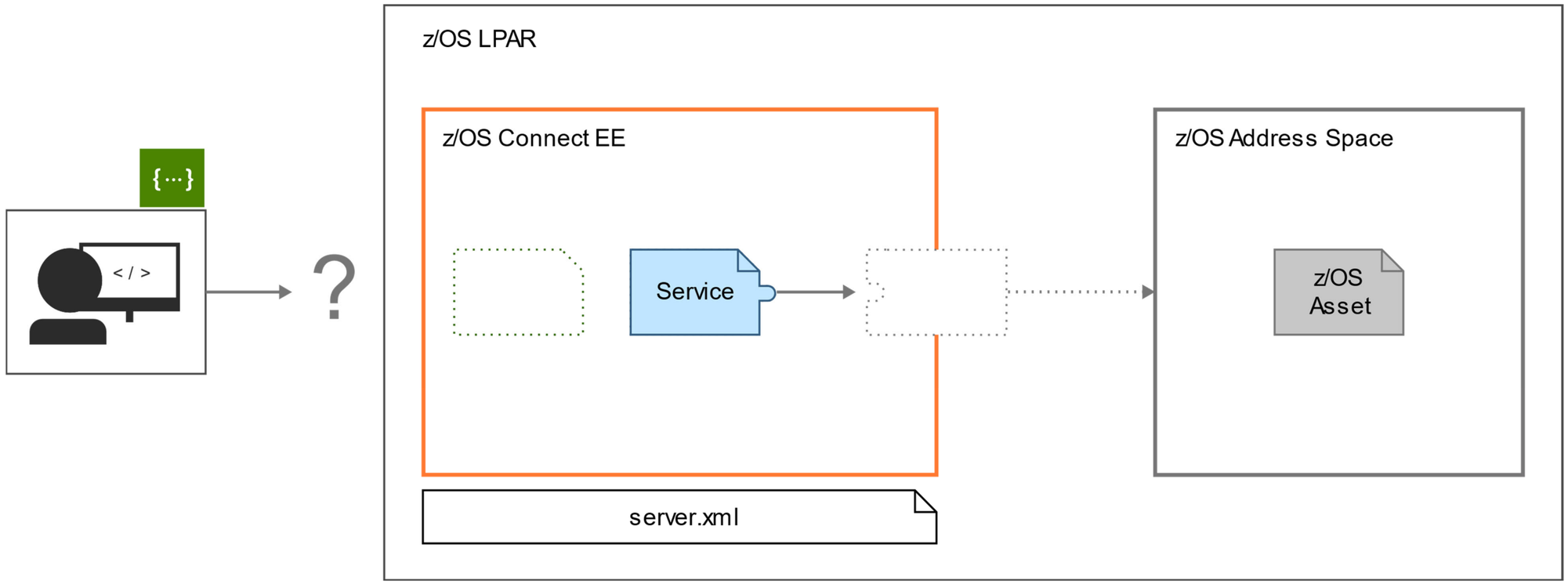
Use a system-appropriate utility to generate a service archive file for the z/OS application

- 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

mitchj@us.ibm.com

Deploy and export the service archive (OpenAPI 2)

Deploy and export the service archive file

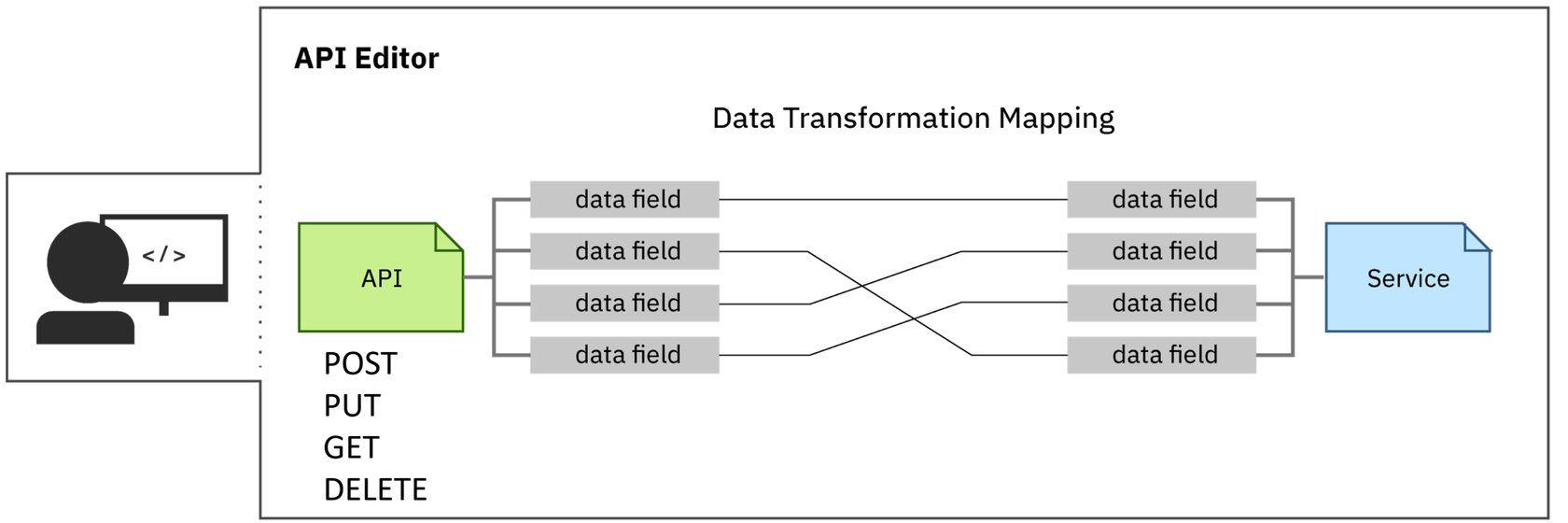


Deploy the service archive file generated in **Step 1** using the right-click deploy in **the API toolkit**.

mitchj@us.ibm.com

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

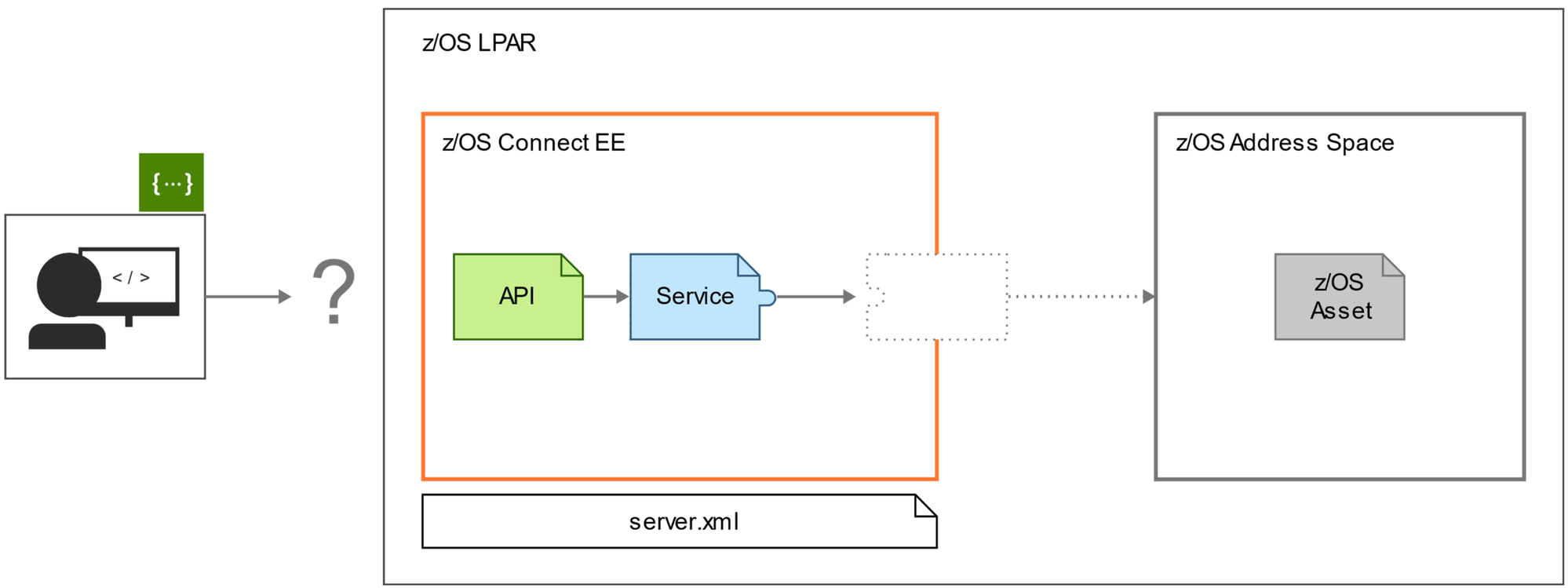


- Import the service archive file into the **API toolkit** and start designing the RESTful API.
- Provides additional data mapping
- Use the editor to describe the API and how it maps to underlying services.

mitchj@us.ibm.com

Deploy the API (Open API 2)

Deploy the API archive file

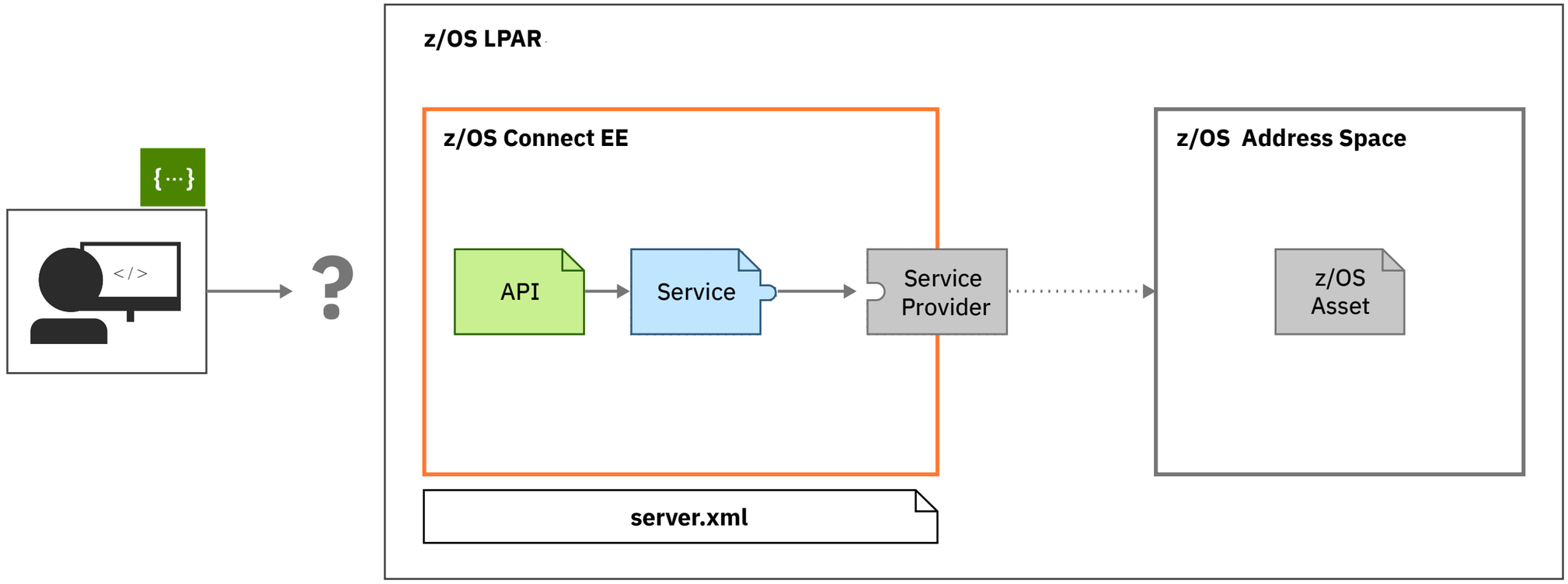


Deploy your API using the right-click deploy in **the API toolkit**

mitchj@us.ibm.com

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

Configure the service provider

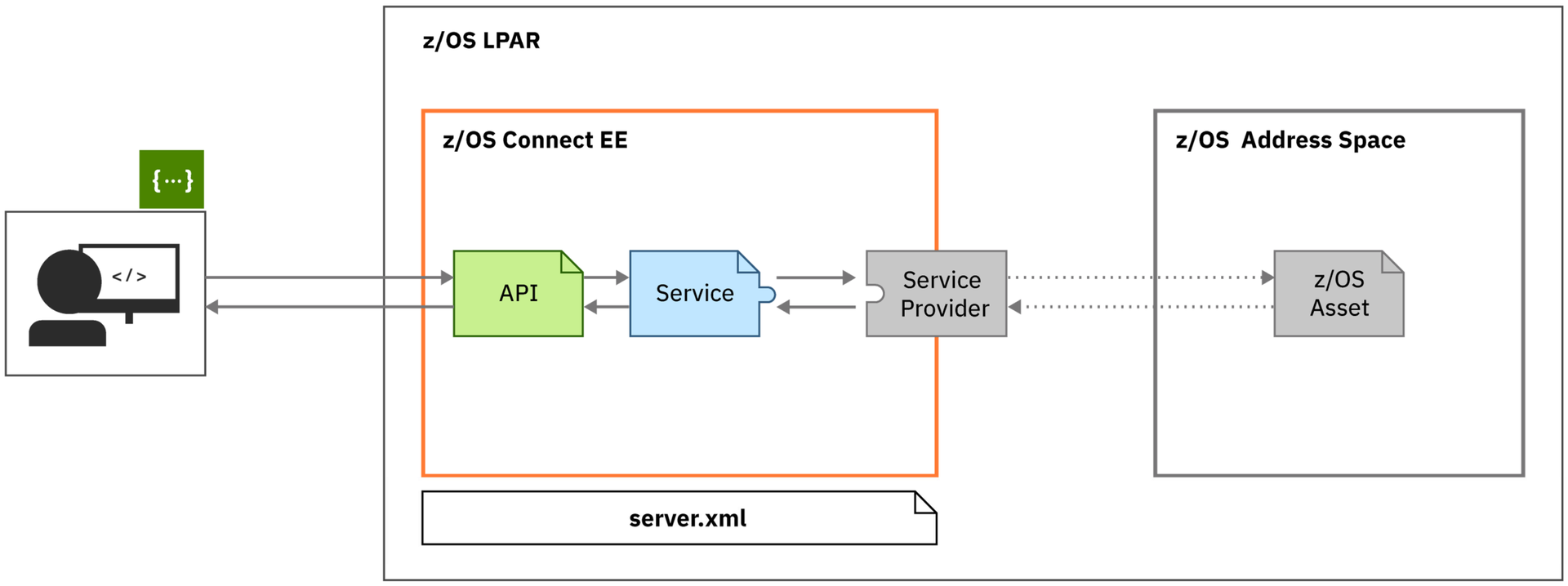


Configure the system-appropriate service provider to connect to your backend system in your `server.xml`.

mitchj@us.ibm.com

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)

mitchj@us.ibm.com

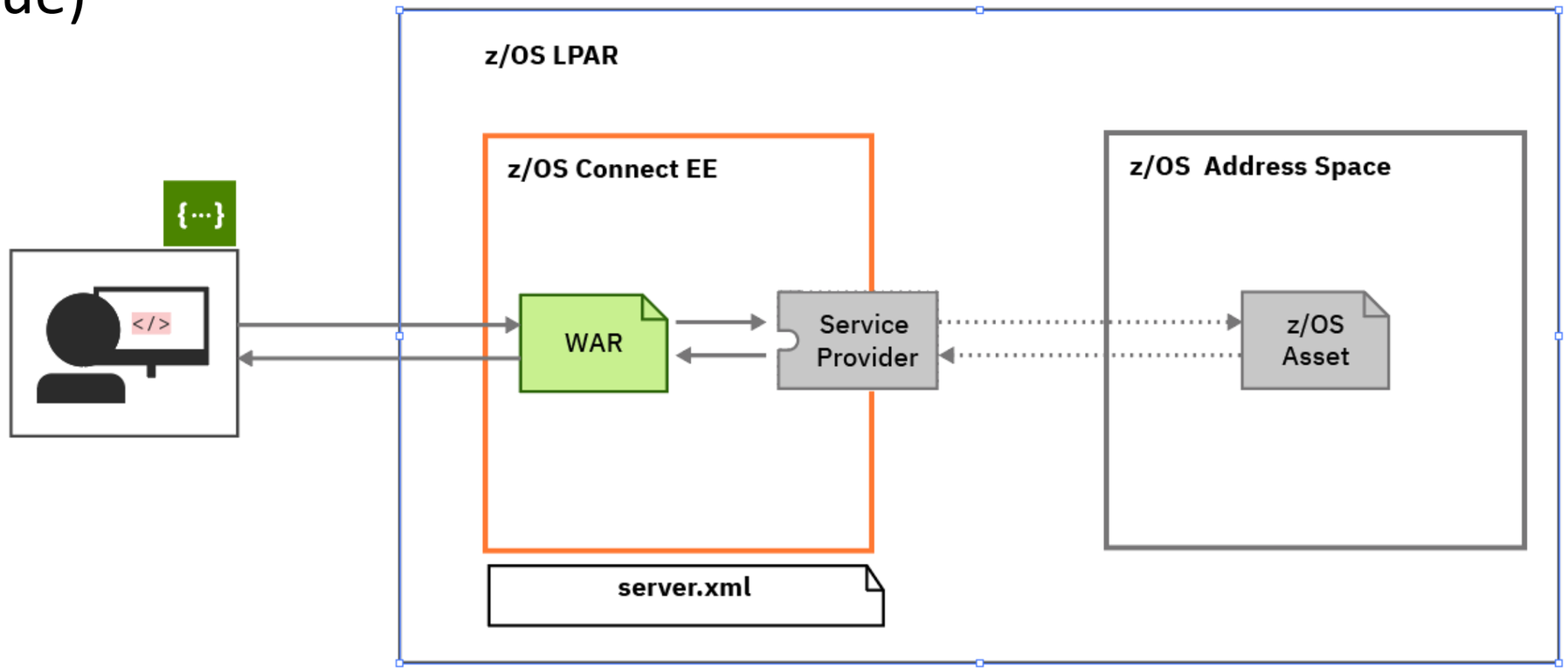
/zosConnect/designer

Simple API Development using the z/OS Connect Designer

mitchj@us.ibm.com

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)



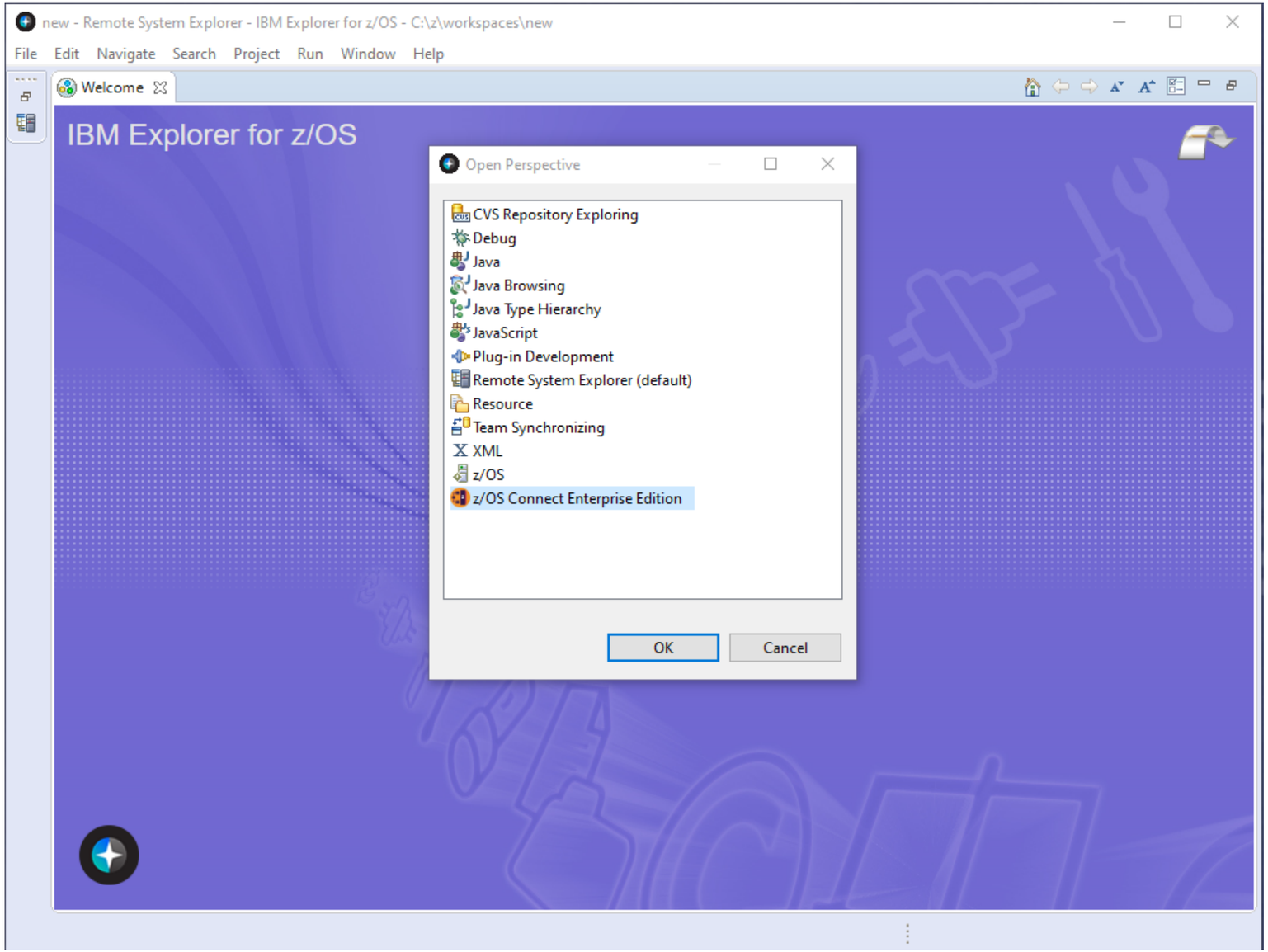
- The WAR provides the RESTful interface is ready to be consumed by a client and it requires the client to have no knowledge that a z/OS resource is being accessed as well as the mapping and transformation for accessingg the resource.
- The Service Provider is tightly coupled to a specific instance of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

/api_toolkit/services

Simple service creation for OpenAPI 2 APIs

mitchj@us.ibm.com

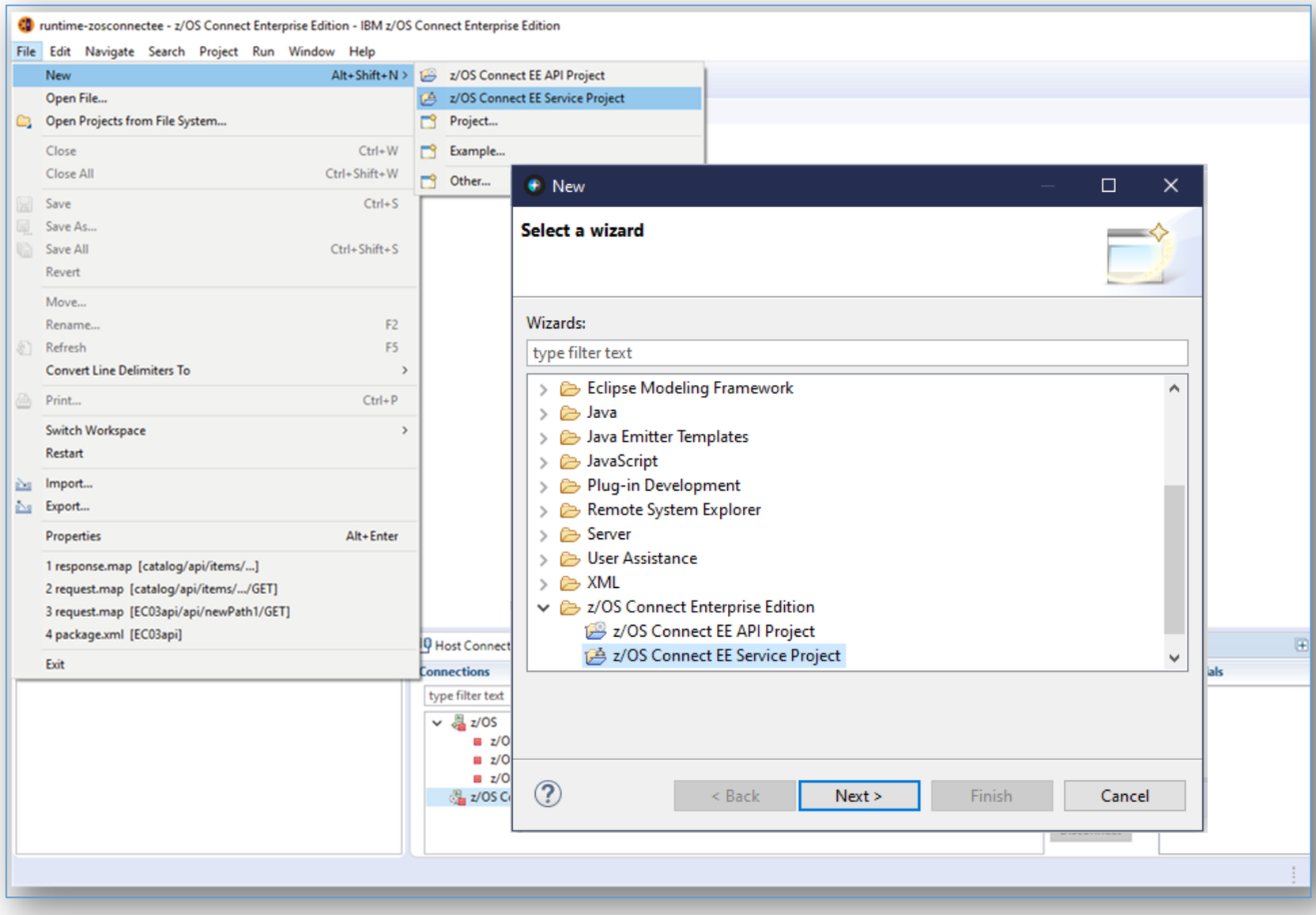
Eclipse API toolkit – Creating Services for CICS, IMS TM, IMS DB, Db2 and MQ



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



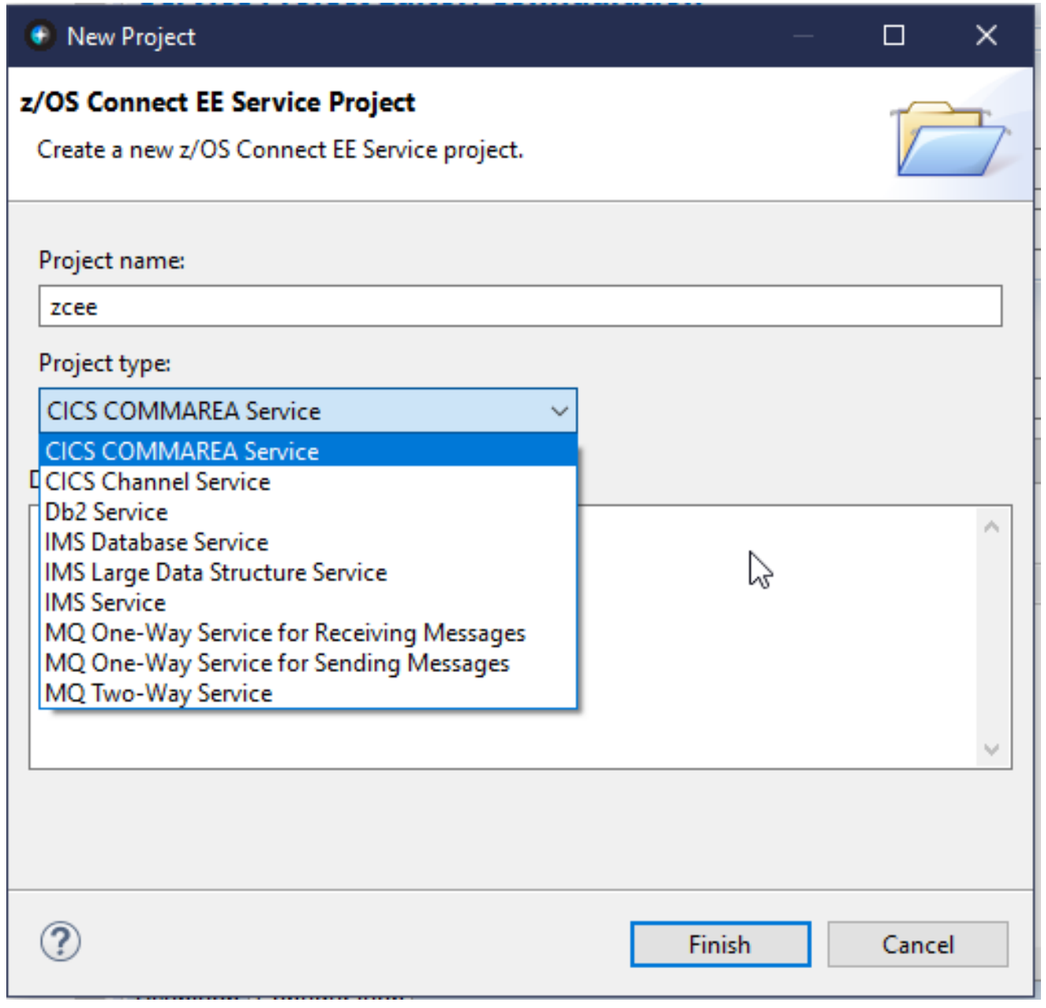
Use the **API toolkit** to create services through Eclipse-based tooling.

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

mitchj@us.ibm.com

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

Service creation – a common interface



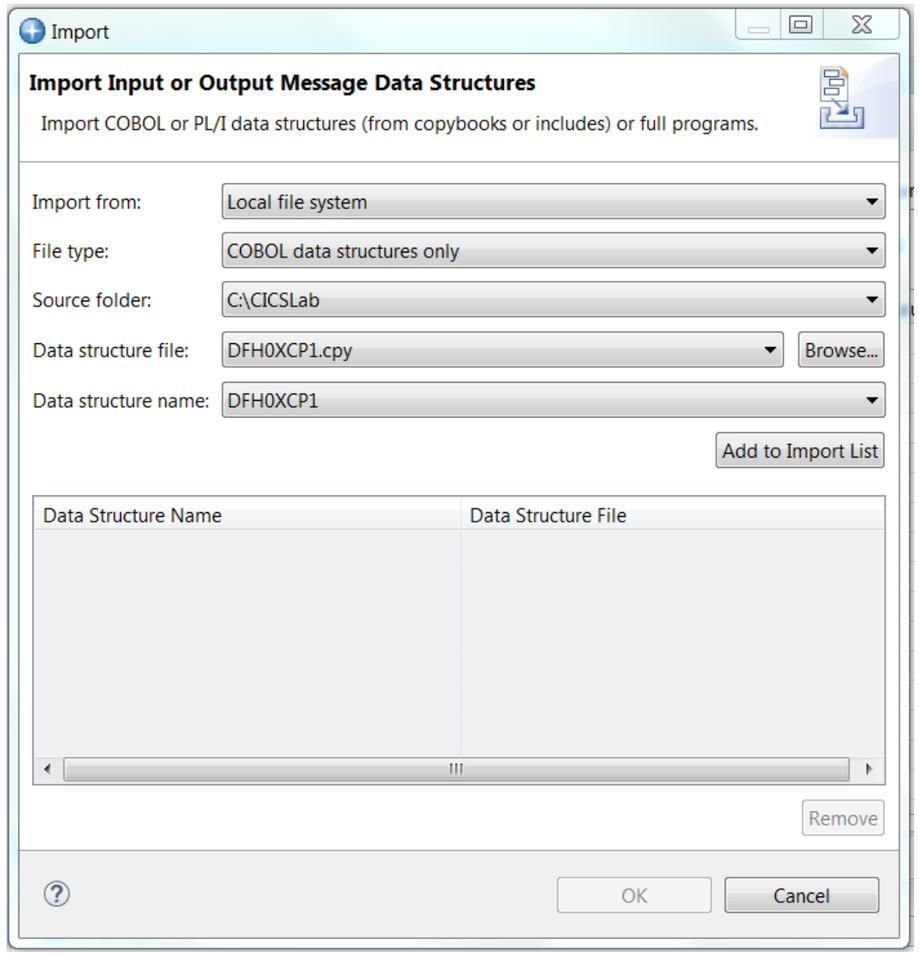
- CICS services that can invoke almost any CICS programs accessed by EXEC CICS LINK request (COMMAREA or CHANNEL). See URL http://www.ibm.com/docs/en/cics-ts/5.6?topic=link-exception-conditions-command for a list of EXEC CICS APIs not allowed in a program when invoked using a CICS Dynamic Program Link 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

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

mitchj@us.ibm.com

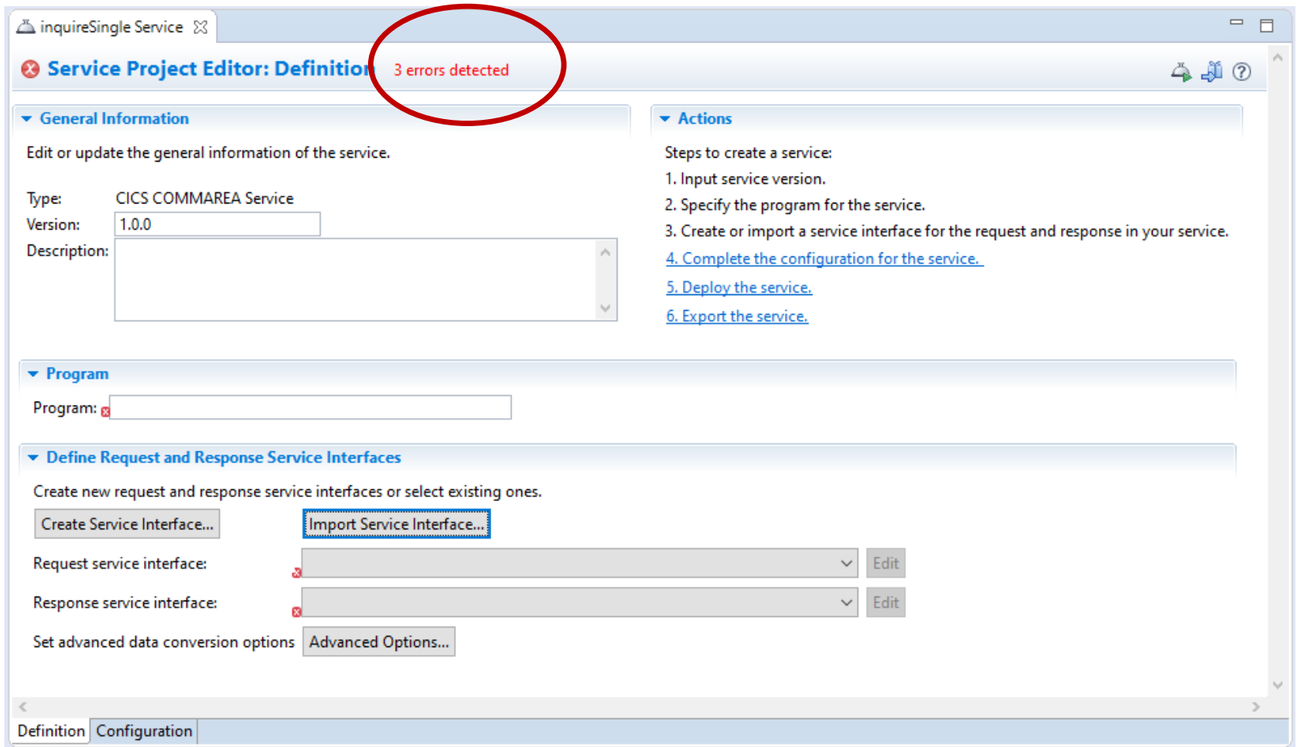
API toolkit – Creating Services for CICS, IMS TM and MQ

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.



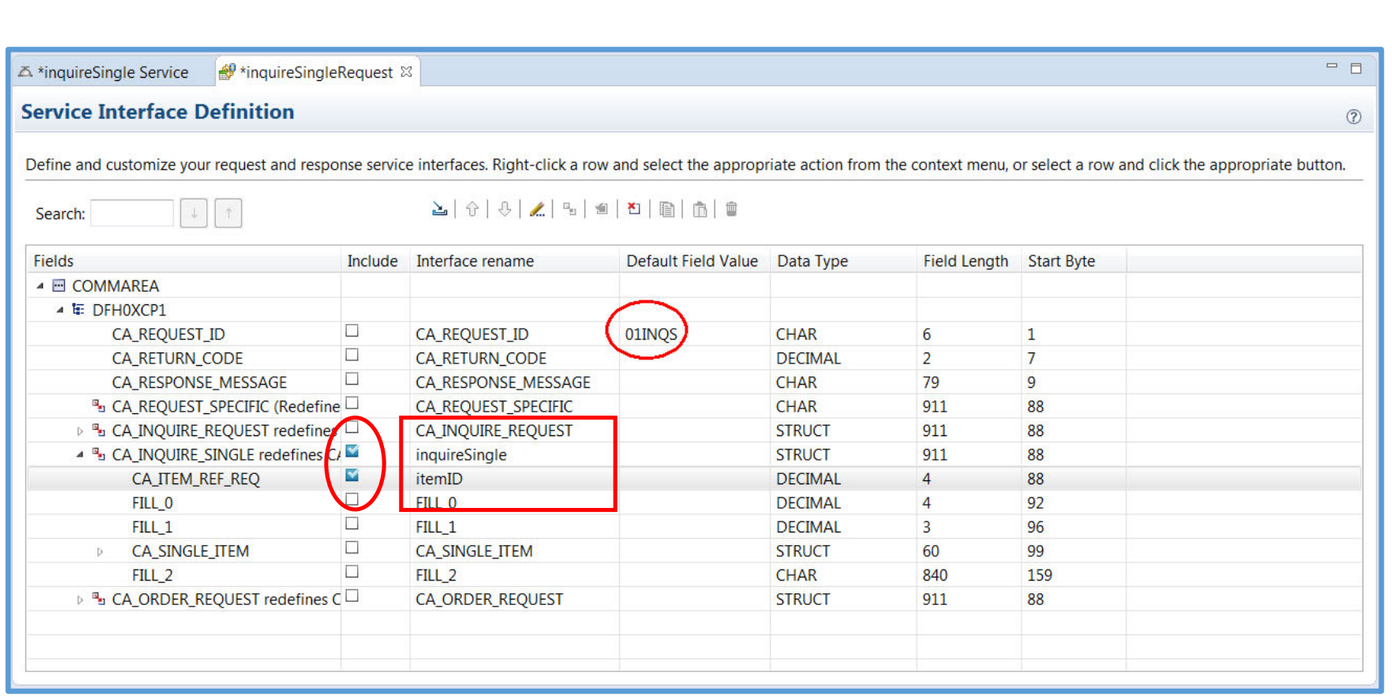
mitchj@us.ibm.com

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

Allows editing a request service interface definition

```
*---------------------------------------------------------------*
* Check which operation in 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
```

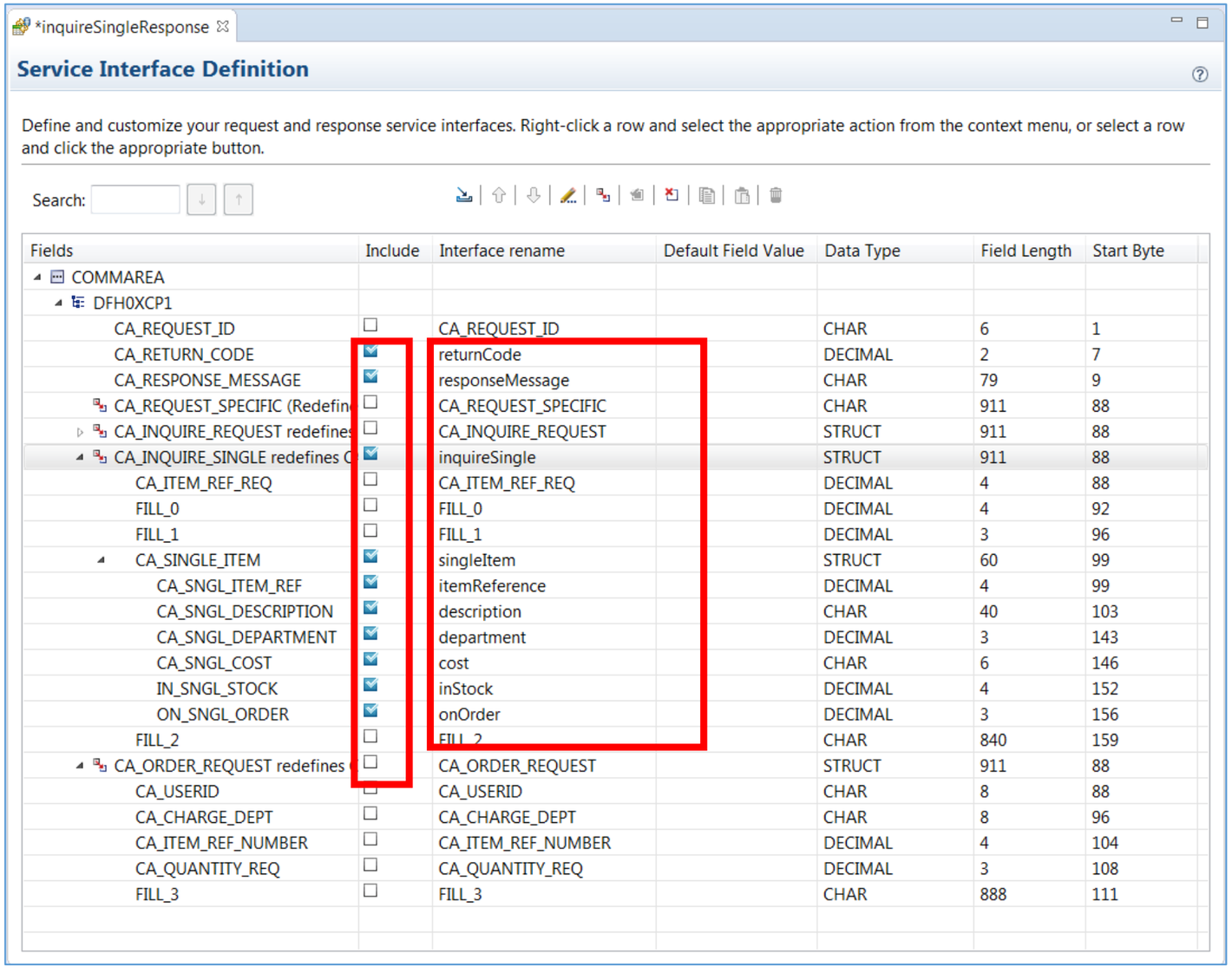
See the imported data structure and then can **redact fields**, **rename fields**, and **add default values to fields** to make the service more consumable for an API developer.



mitchj@us.ibm.com

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

And editing a response message service interface definition



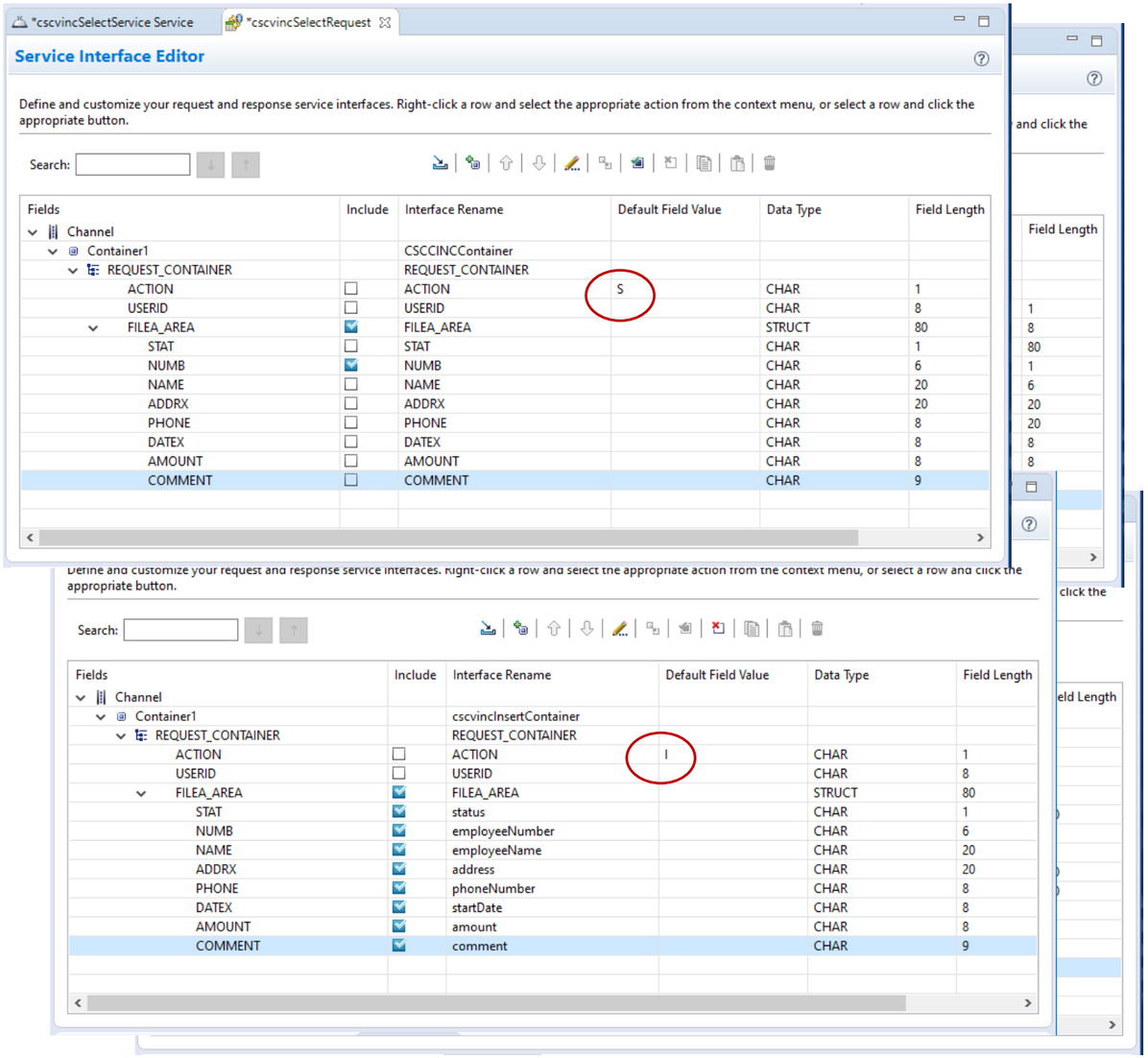
Fields	Include	Interface rename	Default Field Value	Data Type	Field Length	Start Byte
COMMAREA						
DFH0XCP1						
CA_REQUEST_ID	☐	CA_REQUEST_ID		CHAR	6	1
CA_RETURN_CODE	☑	returnCode		DECIMAL	2	7
CA_RESPONSE_MESSAGE	☑	responseMessage		CHAR	79	9
CA_REQUEST_SPECIFIC (Redefin	☐	CA_REQUEST_SPECIFIC		CHAR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

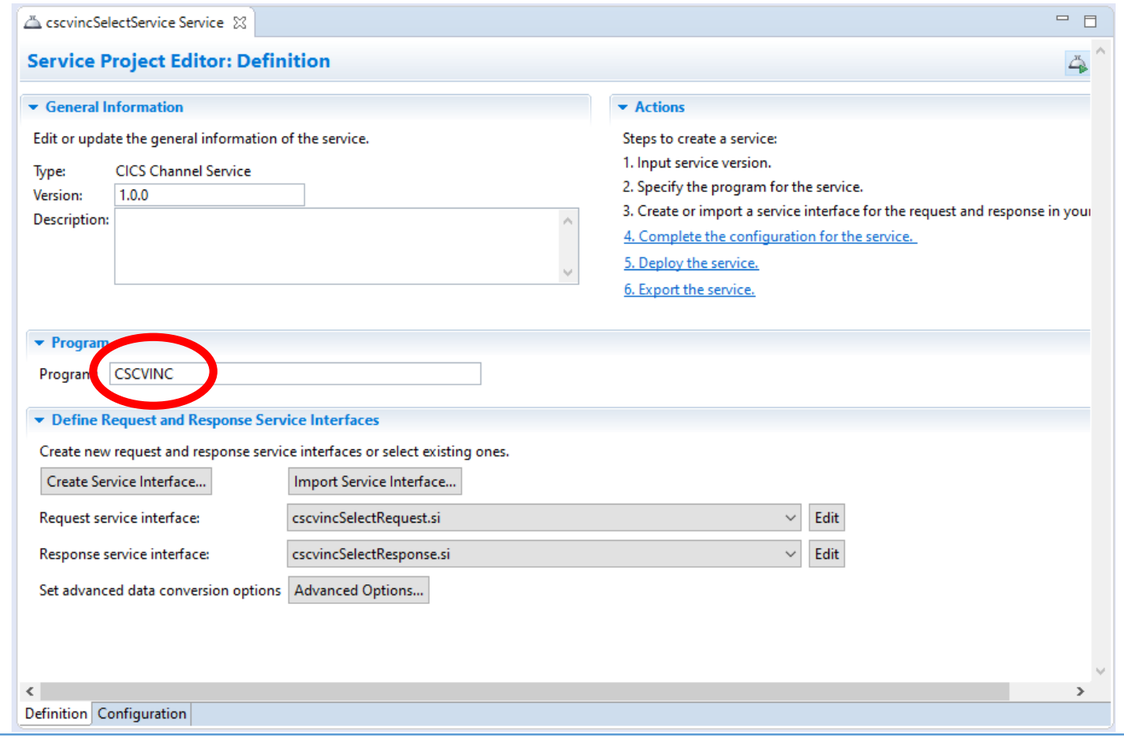
See the imported data structure and can **redact fields** and **rename fields**

mitchj@us.ibm.com

API toolkit – Creating Services for CICS

Creating multiple services definitions to the same resource



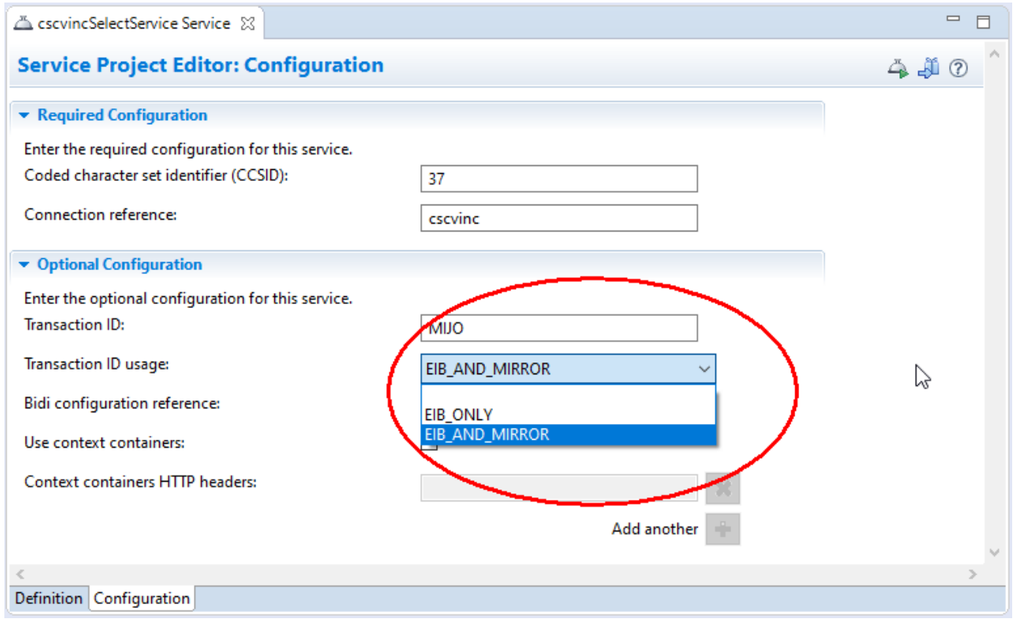



```
EVALUATE ACTION of Request-Container
    WHEN 'D'
      PERFORM Delete-Record
    WHEN 'I'
      PERFORM Insert-Record
    WHEN 'U'
      PERFORM Update-Record
    WHEN 'S'
      PERFORM Select-Record
 END-EVALUATE.
```

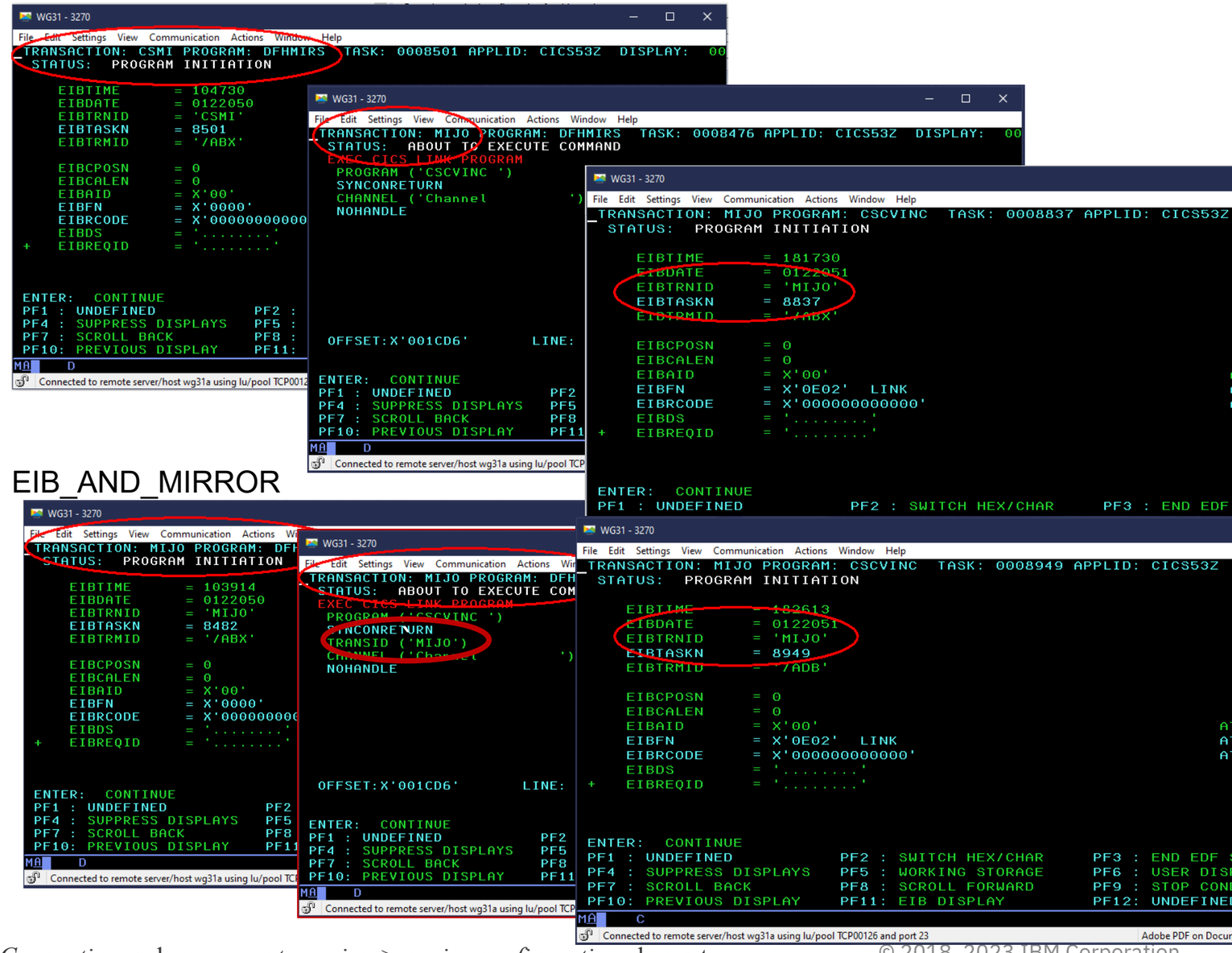
The service developer creates distinct services for each function by setting the ACTION field to S for select, I for insert, U for update or D for delete

mitchj@us.ibm.com

Accessing a CICS program – Transaction ID Usage



EIB_ONLY



EIB_AND_MIRROR

- **Transaction ID** attaches a CICS transaction (CSMI is the default) that starts the CICS DFHMIRS program.

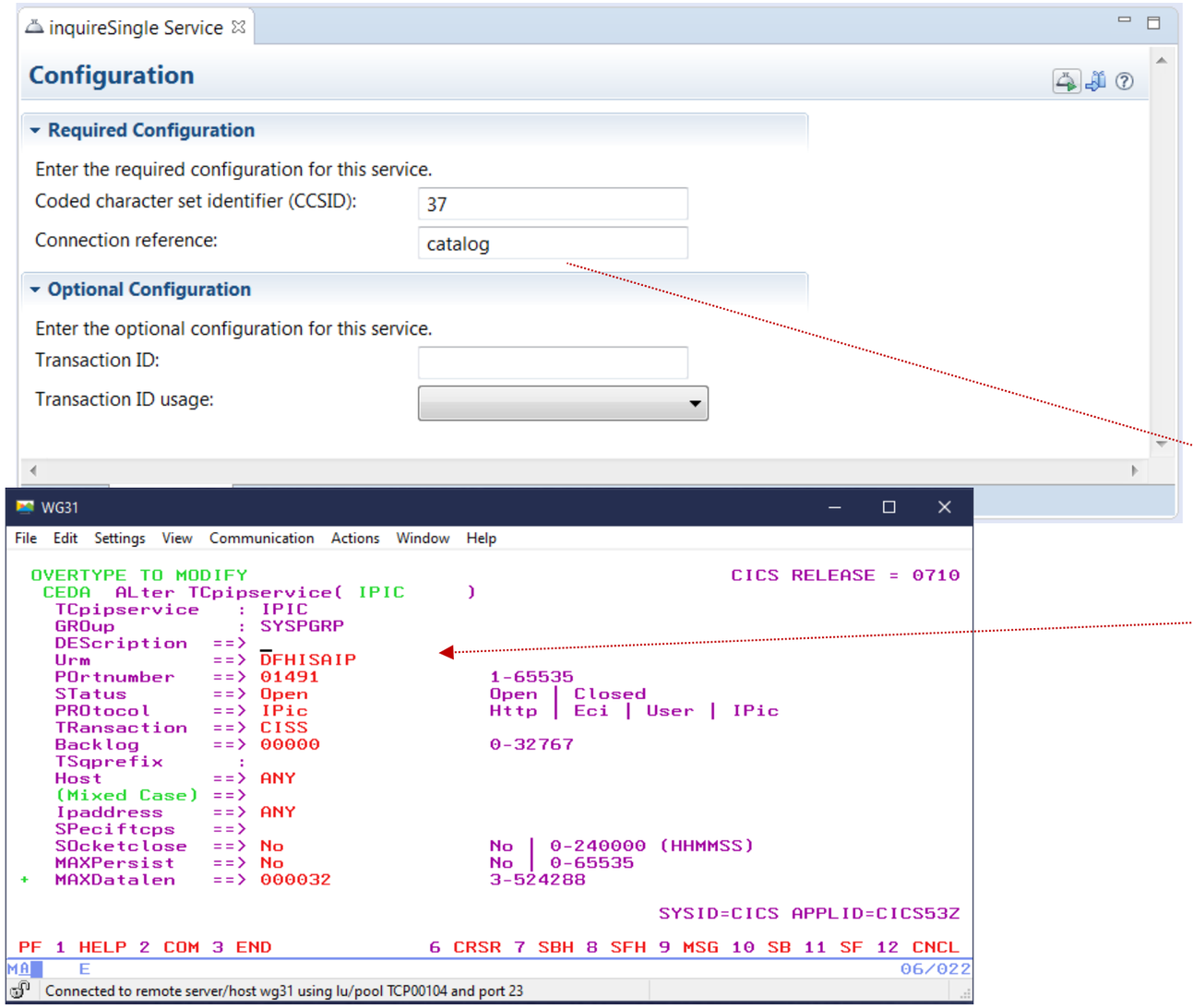
- **Transaction ID Usage** attribute useful for:
  - Transaction security requirements
  - Db2 plan selection
  - Transaction classification and reporting

mitchj@us.ibm.com

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

Accessing a CICS program using IPIC

The server.xml file is the key configuration file:



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

catalog.xml

Design Source

```
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

mitchj@us.ibm.com

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		phonebookRequest			
IN_LL	☐	IN_LL		SHORT	2
IN_ZZ	☐	IN_ZZ		SHORT	2
IN_TRANCDE	☐	IN_TRANCDE	IVTNO	CHAR	10
IN_COMMAND	☐	IN_COMMAND	DISPLAY	CHAR	8
IN_LAST_NAME	☑	lastName		CHAR	10
IN_FIRST_NAME	☐	IN_FIRST_NAME		CHAR	10
IN_EXTENSION	☐	IN_EXTENSION		CHAR	10
IN_ZIP_CODE	☐	IN_ZIP_CODE		CHAR	7

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

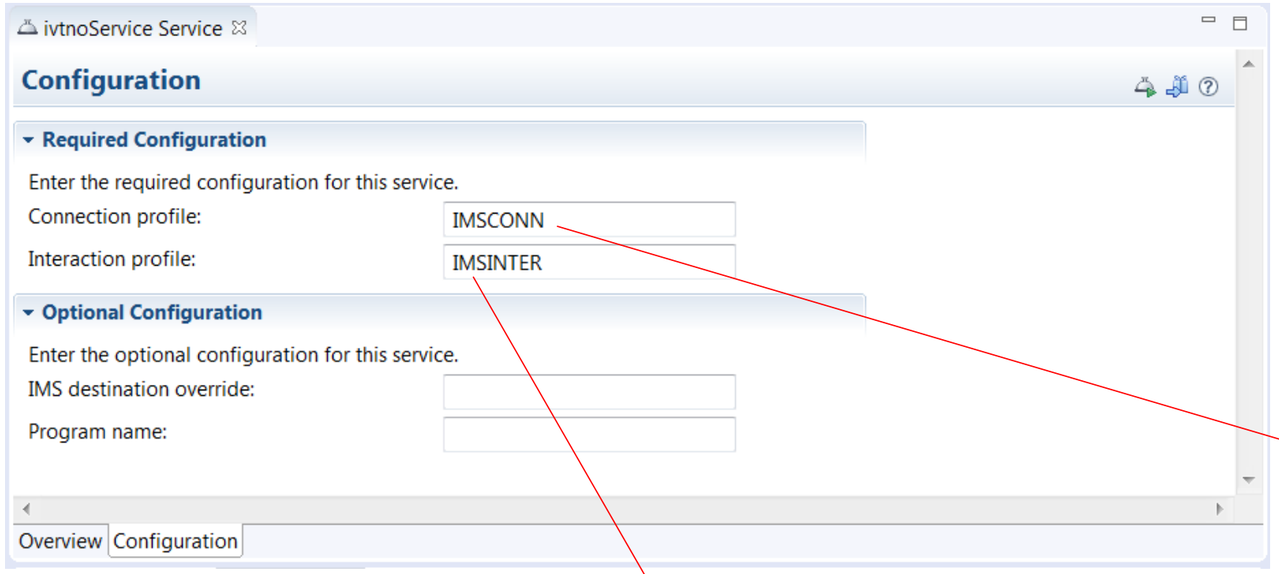
Enter the optional configuration for this service.

IMS destination override:

Program name:

Definition | Configuration

IMS Connections and Interactions (server XML)



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,TMEMBER=OTMAMEM)
IMSPLEX=(MEMBER=IMS14HWS,TMEMBER=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>
```

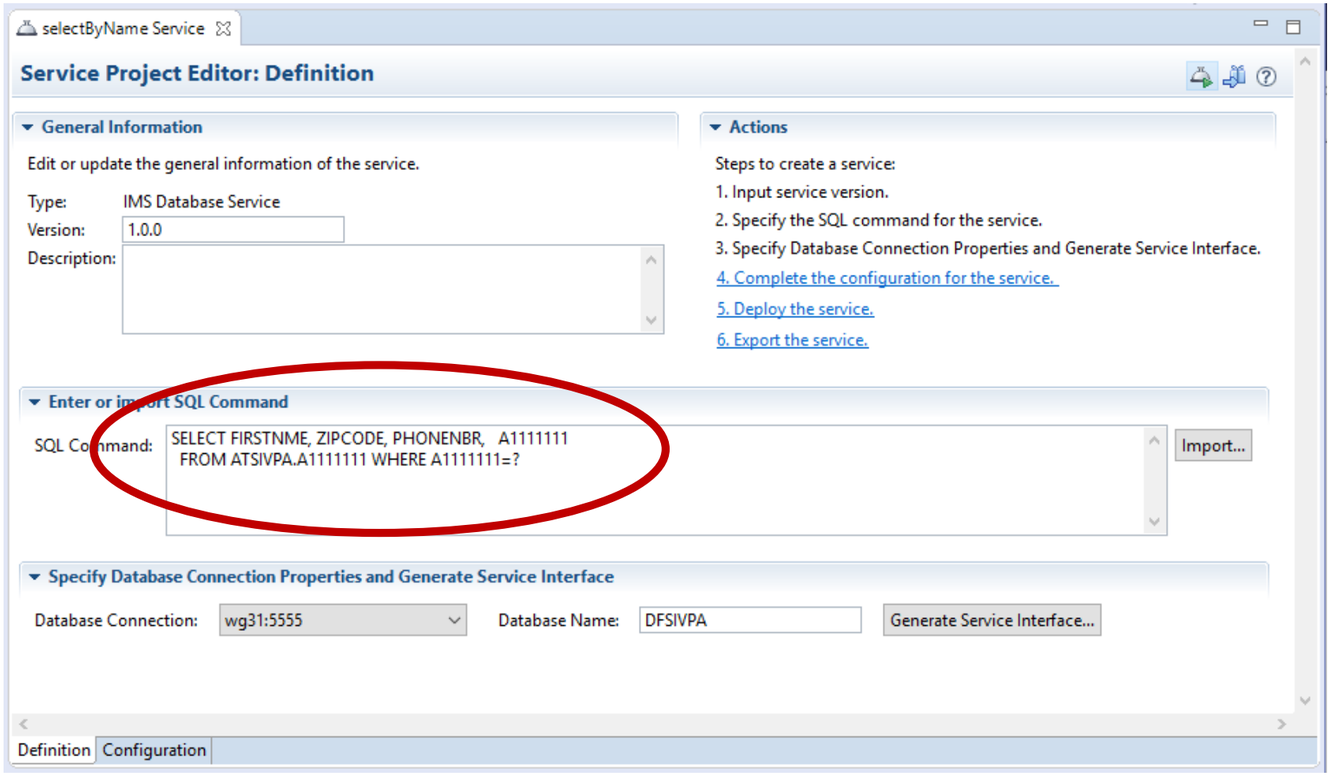
Interaction

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

mitchj@us.ibm.com

API toolkit – Creating Services for IMS DB

Creating a service project from the IMS Catalog



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

```
*-----------------------------------------------------------------*
*  SEGMENT DESCRIPTION                                            *
*    ROOT ONLY DATABASE                                           *
*      BYTES  1-10  LAST NAME (CHARACTER) - KEY                   *
*      BYTES  11-20 FIRST NAME (CHARACTER)                        *
*      BYTES  21-30 INTERNAL PHONE NUMBER (NUMERIC)               *
*      BYTES  31-37 INTERNAL ZIP (CHARACTER)                      *
*      BYTES  38-40 RESERVED                                      *
*                                                                 *
*-----------------------------------------------------------------*
         DBD    NAME=IVPDB1,ACCESS=(HIDAM,OSAM)
         DATASET DD1=DFSIVD1,DEVICE=3380,SIZE=2048
         SEGM   NAME=A1111111,PARENT=0,BYTES=40,RULES=(LLV,LAST),      x
               PTR=(TB,CTR)
         FIELD  NAME=(A1111111,SEQ,U),BYTES=010,START=00001,TYPE=C
         FIELD  NAME=FIRSTNME,BYTES=010,START=00011,TYPE=C
         FIELD  NAME=PHONENBR,BYTES=010,START=00021,TYPE=C
         FIELD  NAME=ZIPCODE,BYTES=7,START=00031,TYPE=C
         LCHILD NAME=(A1,IVPDB1I),POINTER=INDX,RULES=LAST
         DBDGEN
         FINISH
         END
```

mitchj@us.ibm.com

API toolkit – Creating Services for IMS DB

The Toolkit allows editing a service interface definitions*

response

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.

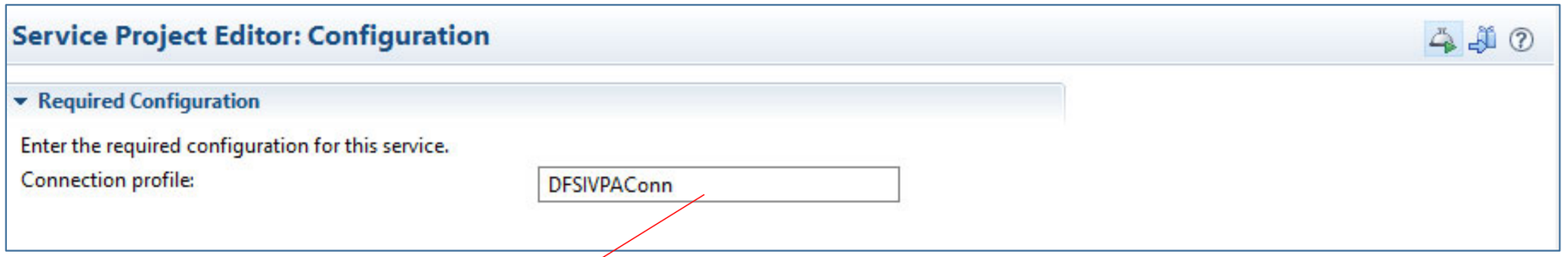
Search:

Fields	Include	Interface Rename	Default Field Value	Data Type	Field Length
selectByName_Response					
Segment 1					
Output Columns		response			
Result [0..*]	☑	result		ARRAY	0
FIRSTNME	☑	firstName		CHAR	10
ZIPCODE	☑	zipCode		CHAR	7
PHONENBR	☑	phoneNuber		CHAR	10
A1111111	☑	lastName		CHAR	10

*Using a slightly different process

mitchj@us.ibm.com

IMS Connection Factory in the server XML



ConnectionFactory

```
<connectionFactory id="DFSIVPAConn">
<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,RACF=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=(ODBMAUTOCONN=Y,
DRDAPORT=(ID=5555,PORTTMOT=6000),ODBMTMOT=6000)
```

mitchj@us.ibm.com

API toolkit – Creating Services for MQ

Creating a “POST” service interface definition

MQ Meta Data

*minilonServiceRequest

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 button.

Search:

Fields	Include	Interface Rename	Default Field Value	Data Type
COMMAREA				
MINILOAN_COMMAREA		loan application		
NAME	☑	name		CHAR
CREDITSCORE	☑	credit score		DECIMAL
YEARLYINCOME	☑	yearly income		DECIMAL
AGE	☑	age		DECIMAL
AMOUNT	☑	loan amount		DECIMAL
APPROVED	☐	aproved?	F	CHAR
EFFECTDATE	☐	effective date		CHAR
YEARLYINTERESTRATE	☐	yearly interest rate	00005	DECIMAL
YEARLYREPAYMENT	☑	yearly payment		DECIMAL
UID	☐	authorization identity		CHAR
MESSAGES_NUM	☒	MESSAGES_NUM		DECIMAL
MESSAGES [1..99]	☐	disapproval message		ARRAY

*twoway Service

Service Project Editor: Configuration

Required Configuration

Enter the required configuration for this service.

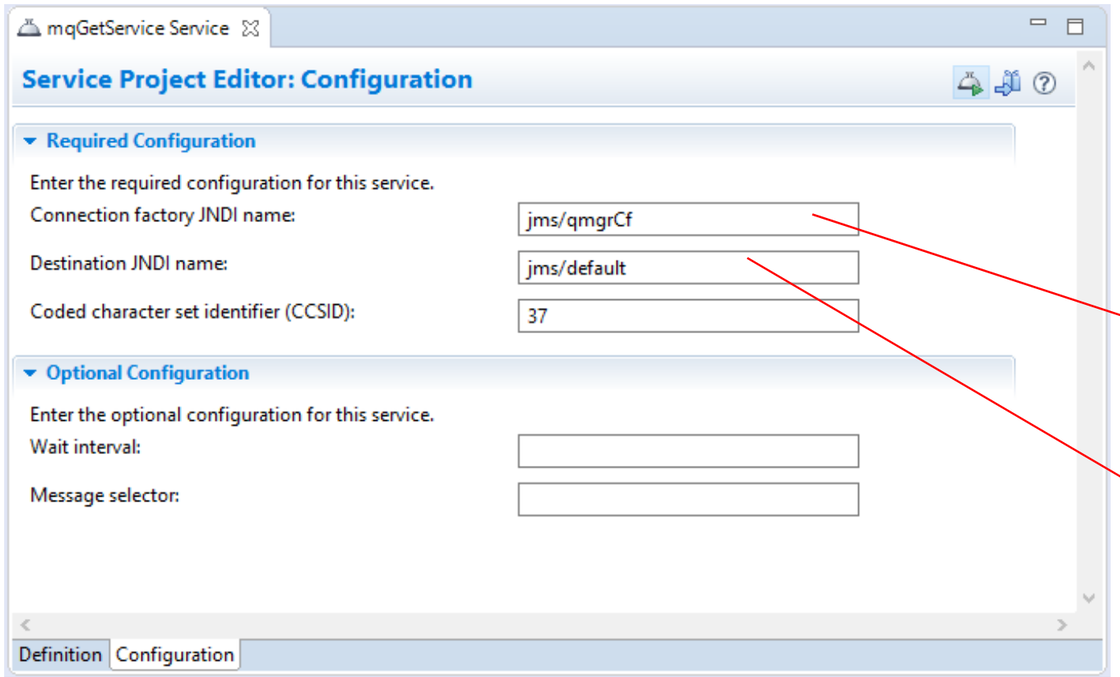
Connection factory JNDI name:	jms/qmgrCf
Request destination JNDI name:	jms/requestQueue
Reply destination JNDI name:	jms/replyQueue
Wait interval:	3000
MQMD format:	MQSTR
Coded character set identifier (CCSID):	37
Is message persistent:	☐
Reply selection:	msgIDToCorrelID
Expiry:	-1

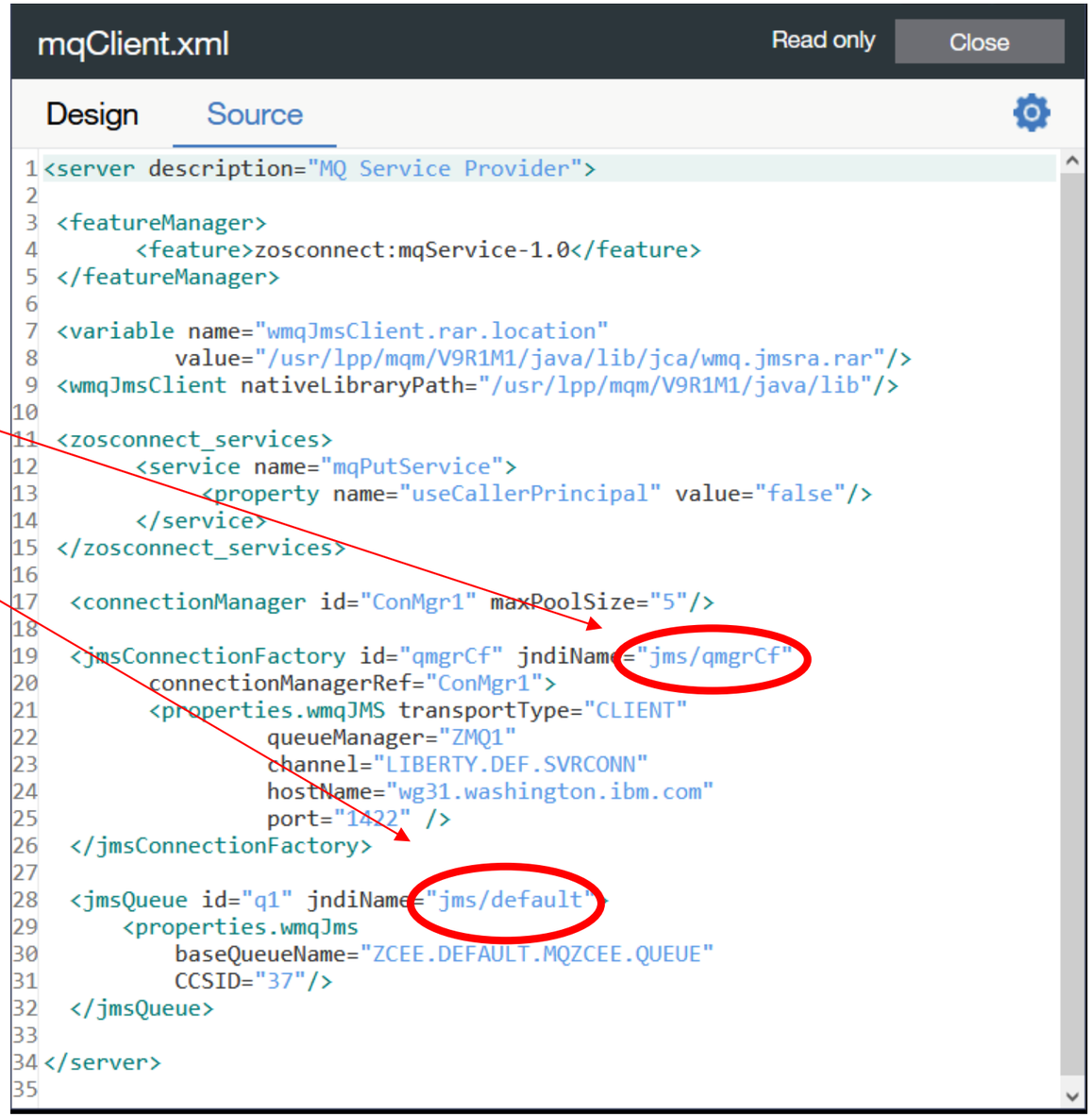
Definition | Configuration

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.

mitchj@us.ibm.com

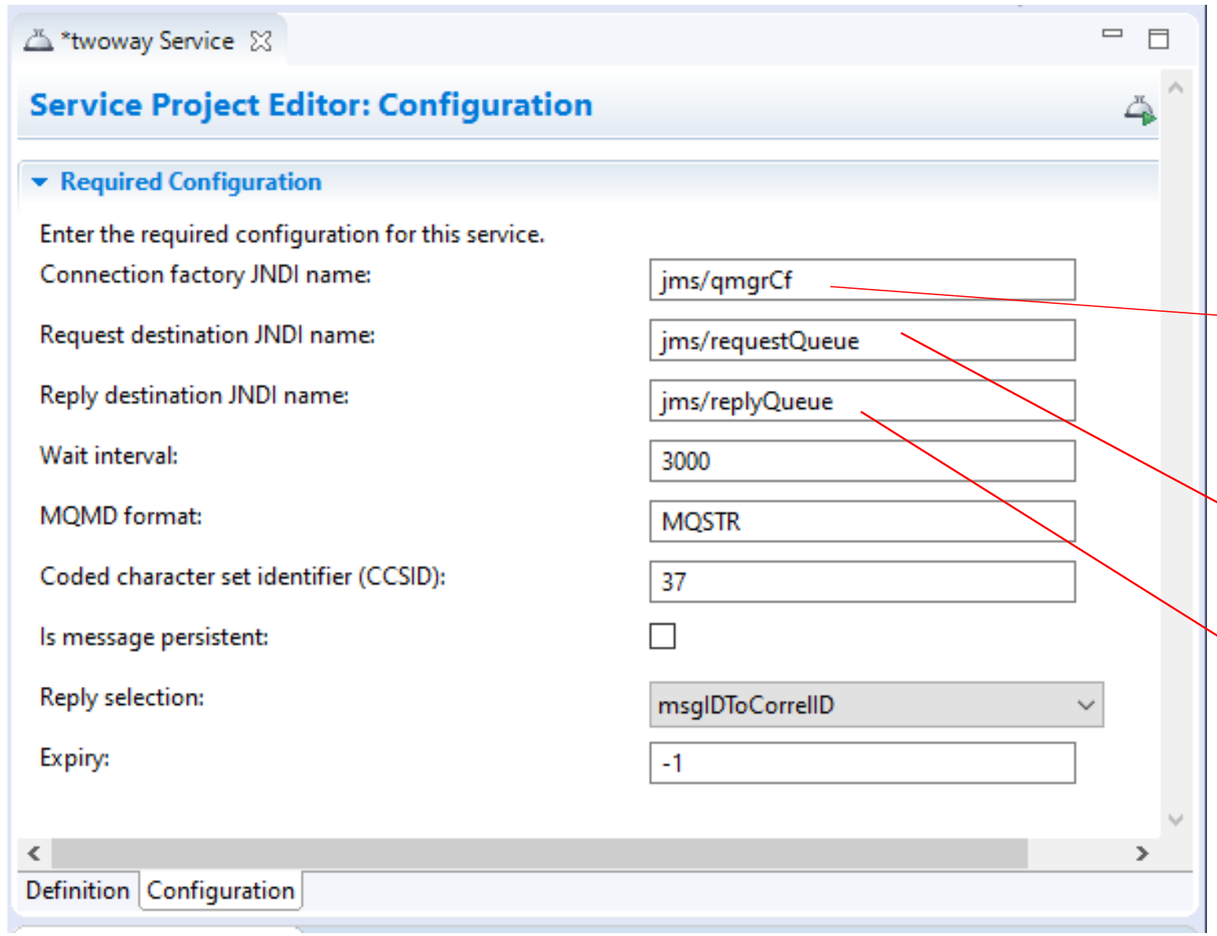
Using JMS to access MQ (One-Way)

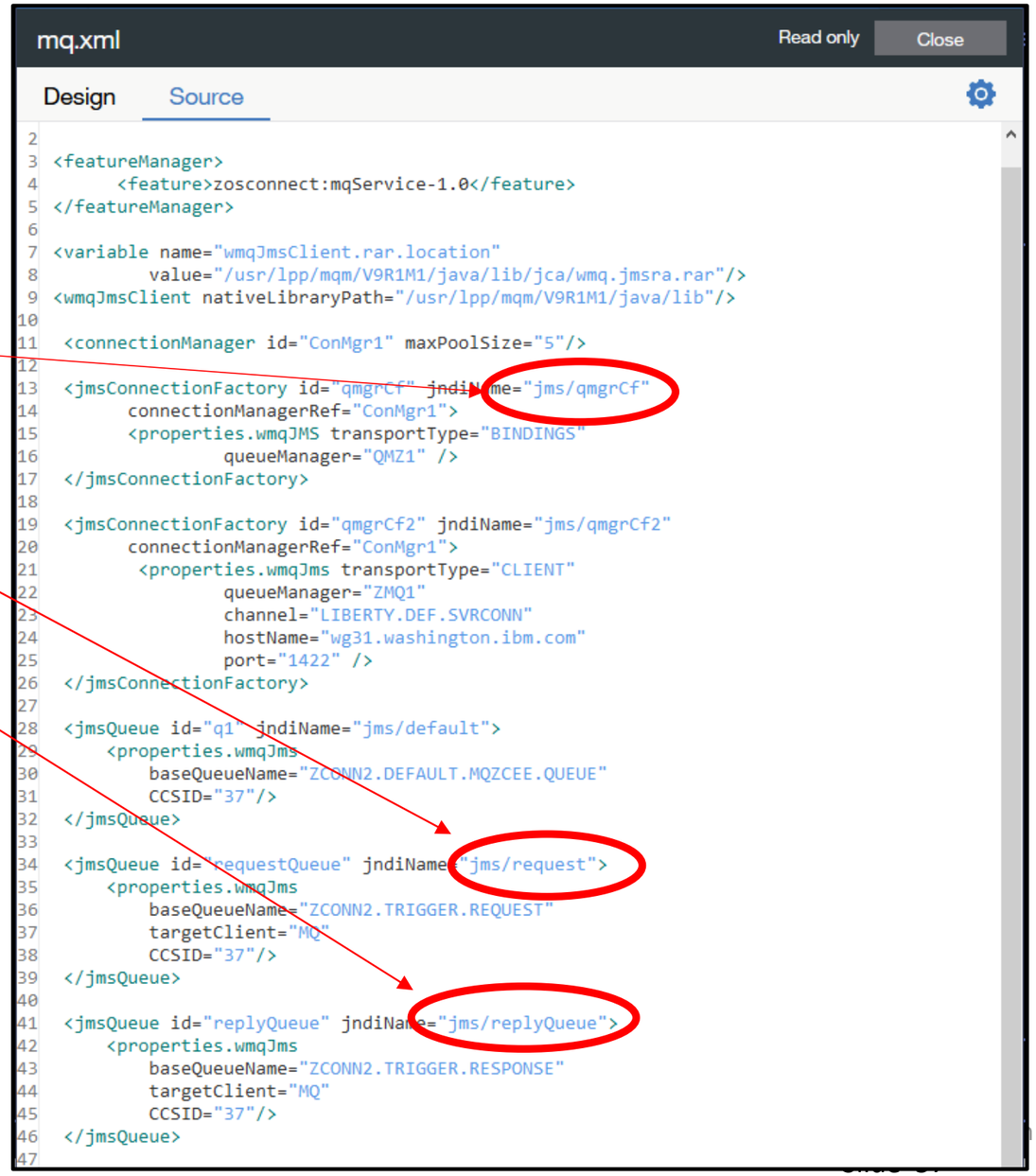




mitchj@us.ibm.com

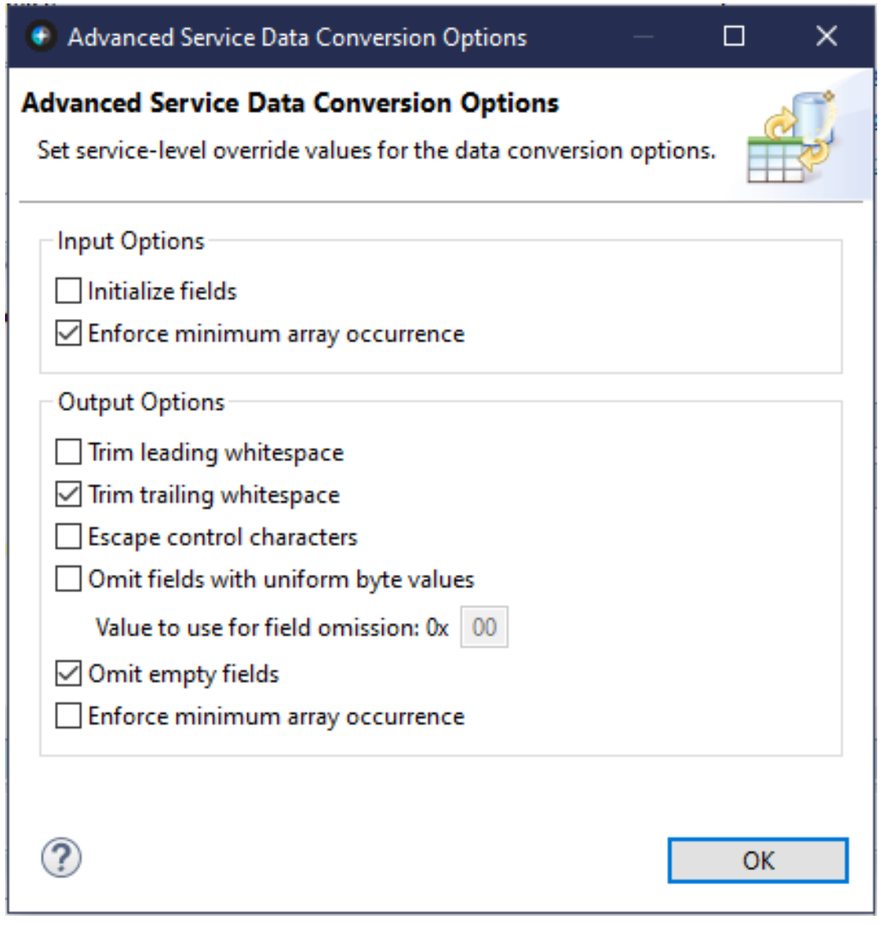
Using JMS to access MQ (Two-Way)





mitchj@us.ibm.com

API toolkit – Advanced Data Conversion Options



Request Messages:

- Initialize fields
- Enforce minimum array occurrence

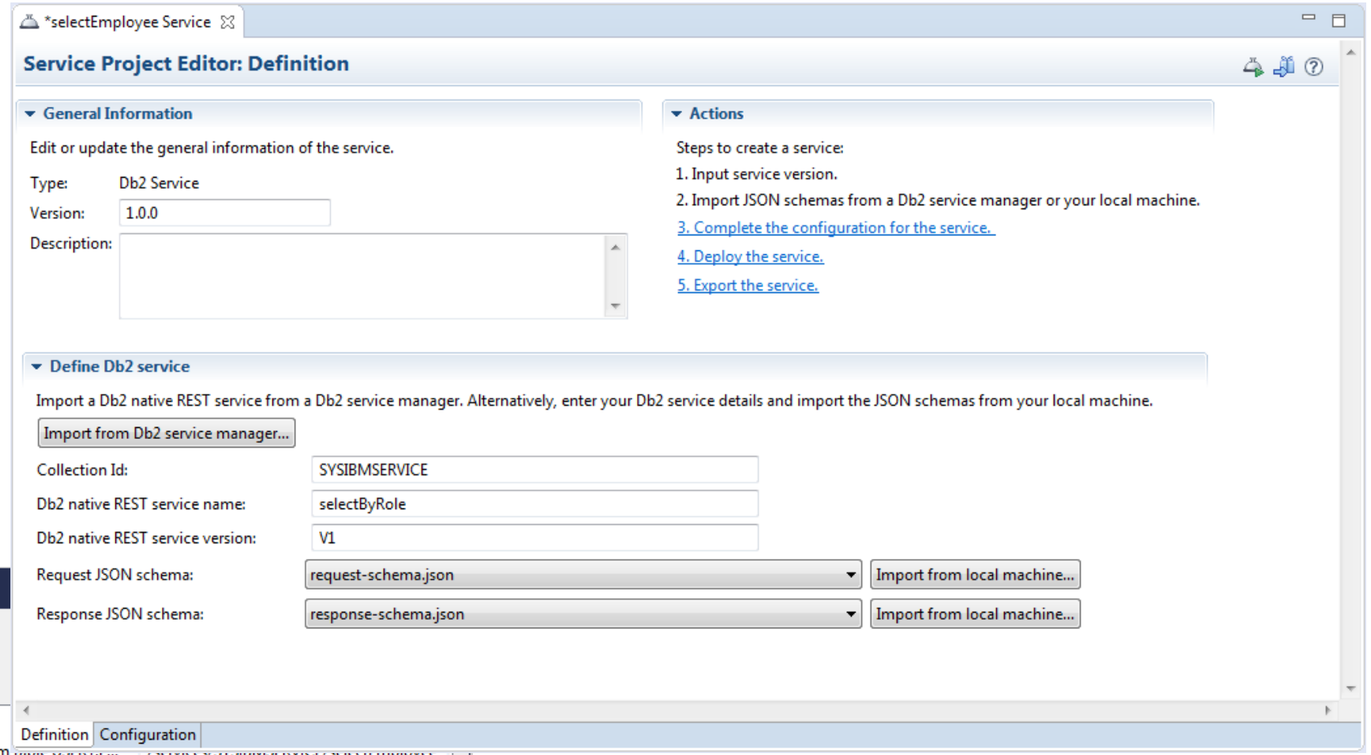
Response Messages:

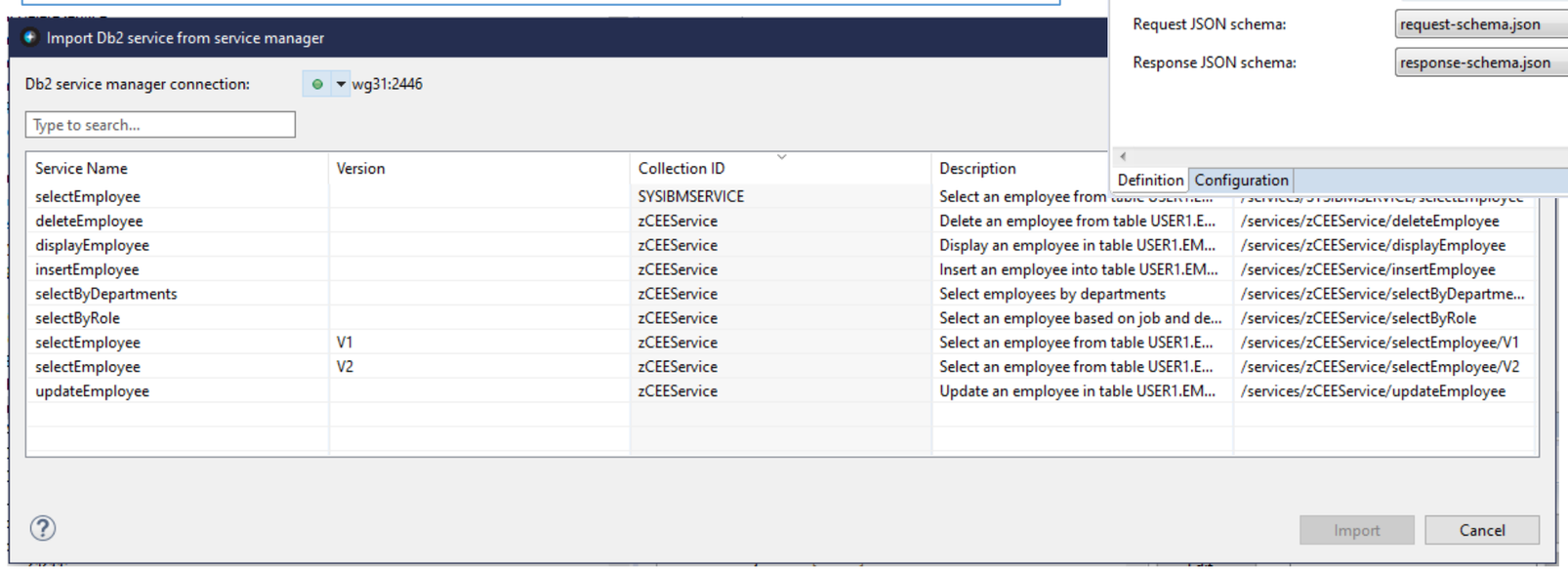
- Trim leading whitespace
- Trim trailing whitespace
- Escape control characters
- Omit fields with uniform byte values
- Omit empty fields
- Enforce minimum array occurrence

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", FIRSTNME 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')
```



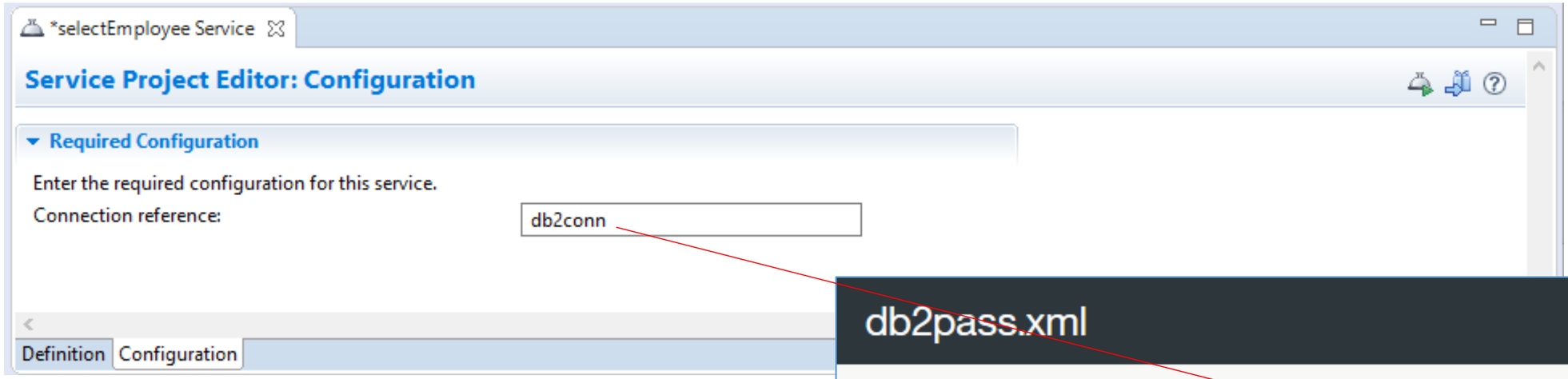


The service developer retrieves details about the Db2 REST services

Note there is no service interface editor available

mitchj@us.ibm.com

Accessing a Db2 REST service resource




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

db2pass.xml

Design | Source

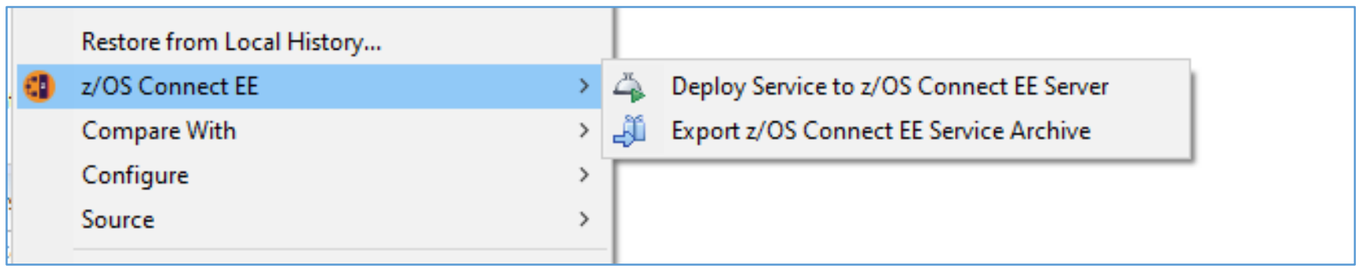
```
1  <server description="DB2 REST">
2
3   <zosconnect_zosConnectServiceRestClientConnection id="db2conn"
4         host="wg31.washington.ibm.com"
5         port="2446"
6         basicAuthRef="dsn2Auth" />
7
8   <zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth"
9         applName="DSN2APPL"/>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

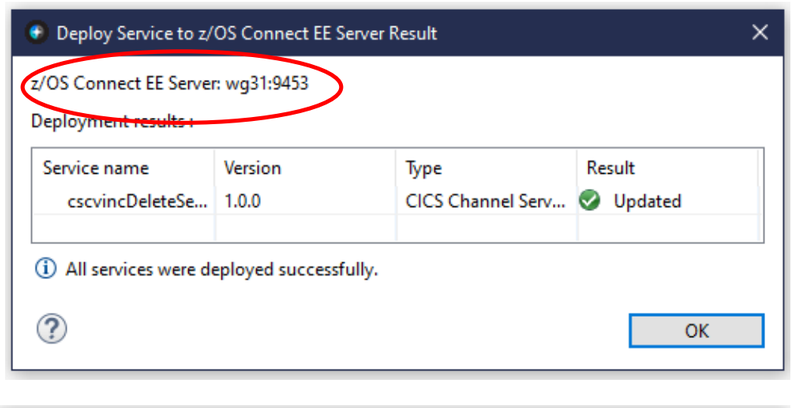
mitchj@us.ibm.com

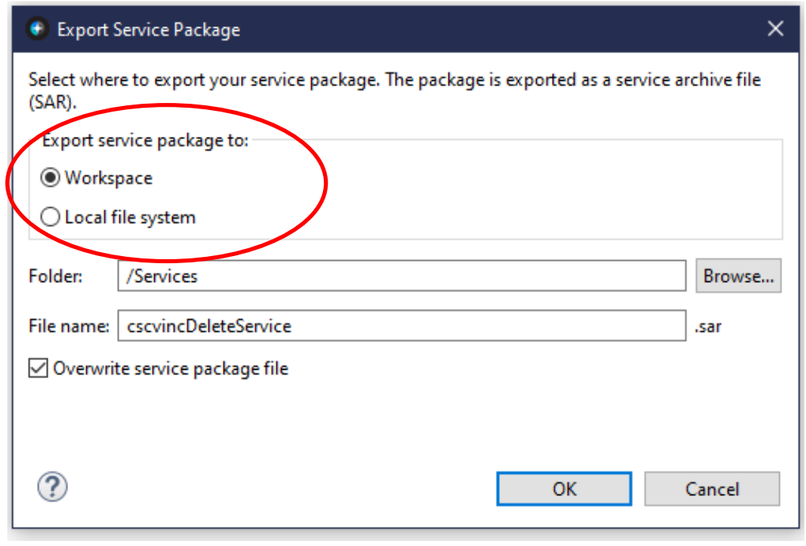
API toolkit – Services Editor

Server connection and Services deployment

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



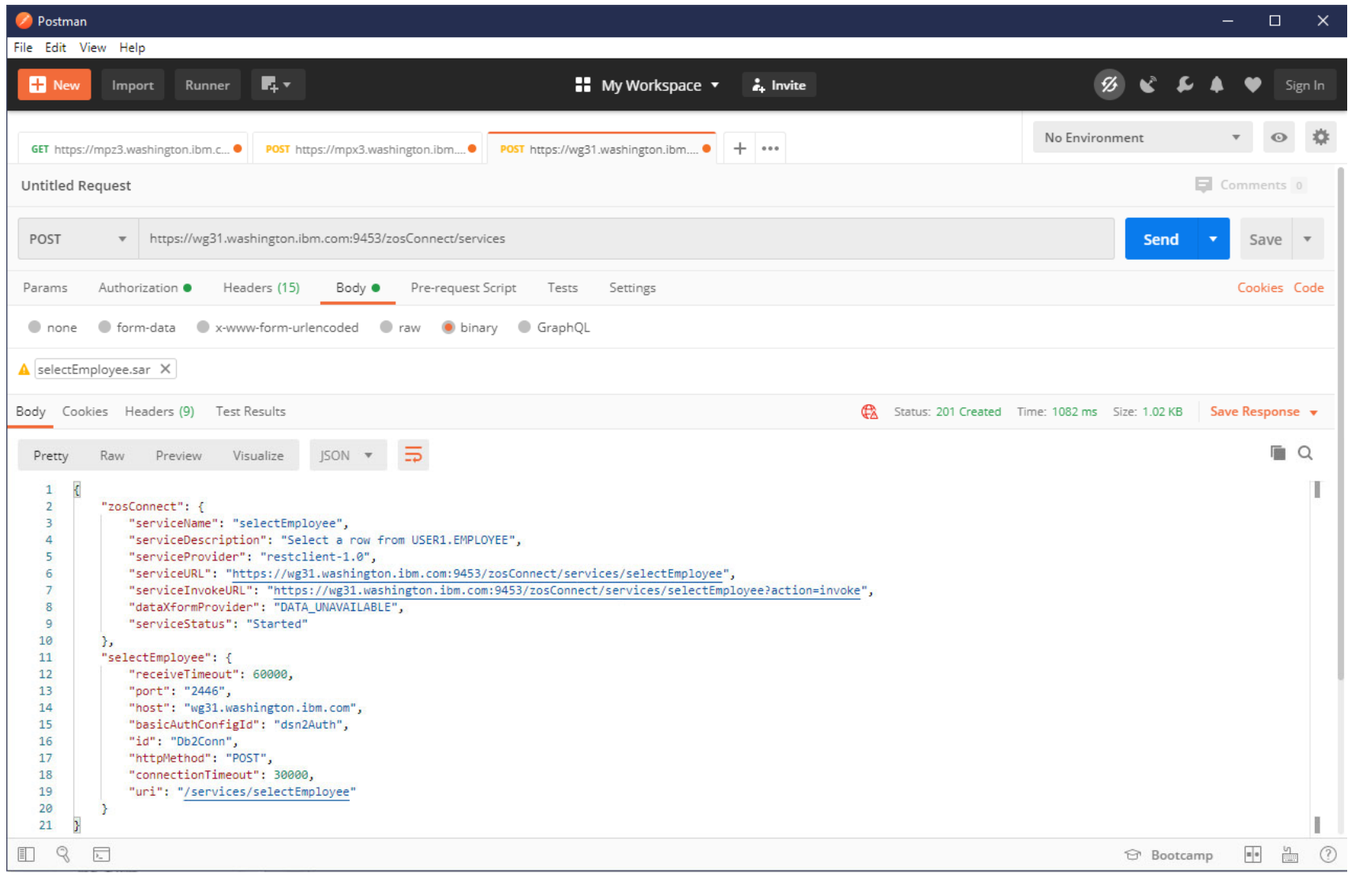




mitchj@us.ibm.com

Deploying Service Archive files outside of the Eclipse tooling

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



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

Results:


```
{"zosConnect":{"serviceName":"selectEmployee","serviceDescrip
tion":"Select a row from
USER1.EMPLOYEE","serviceProvider":"IBM_ZOS_CONNECT_SERVICE_RE
ST_CLIENT-1.0
","serviceURL":"https://mpxm:9453/zosConnect/services/selectE
mployee","serviceInvokeURL":"https://mpxm:9453/zosConnect/ser
vices/selectEmployee?action=invoke","dataXformProvider":"DATA
_UNAVAILABLE","serviceStatus":"Started"},"selectEmployee"
:{"receiveTimeout":0,"port":null,"host":null,"httpMethod":"PO
ST","connectionTimeout":0,"uri":"/services/selectEmployee"}}
```


mitchj@us.ibm.com

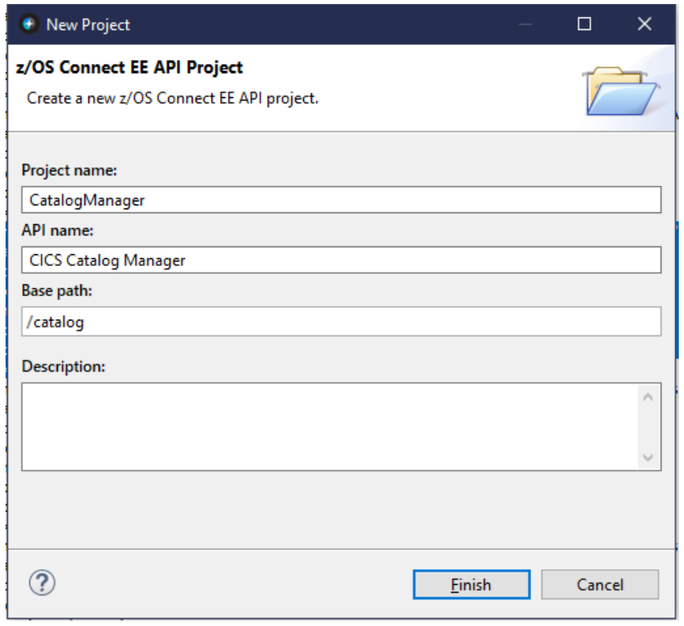
Once we have a Service Archive (SAR) What's next?

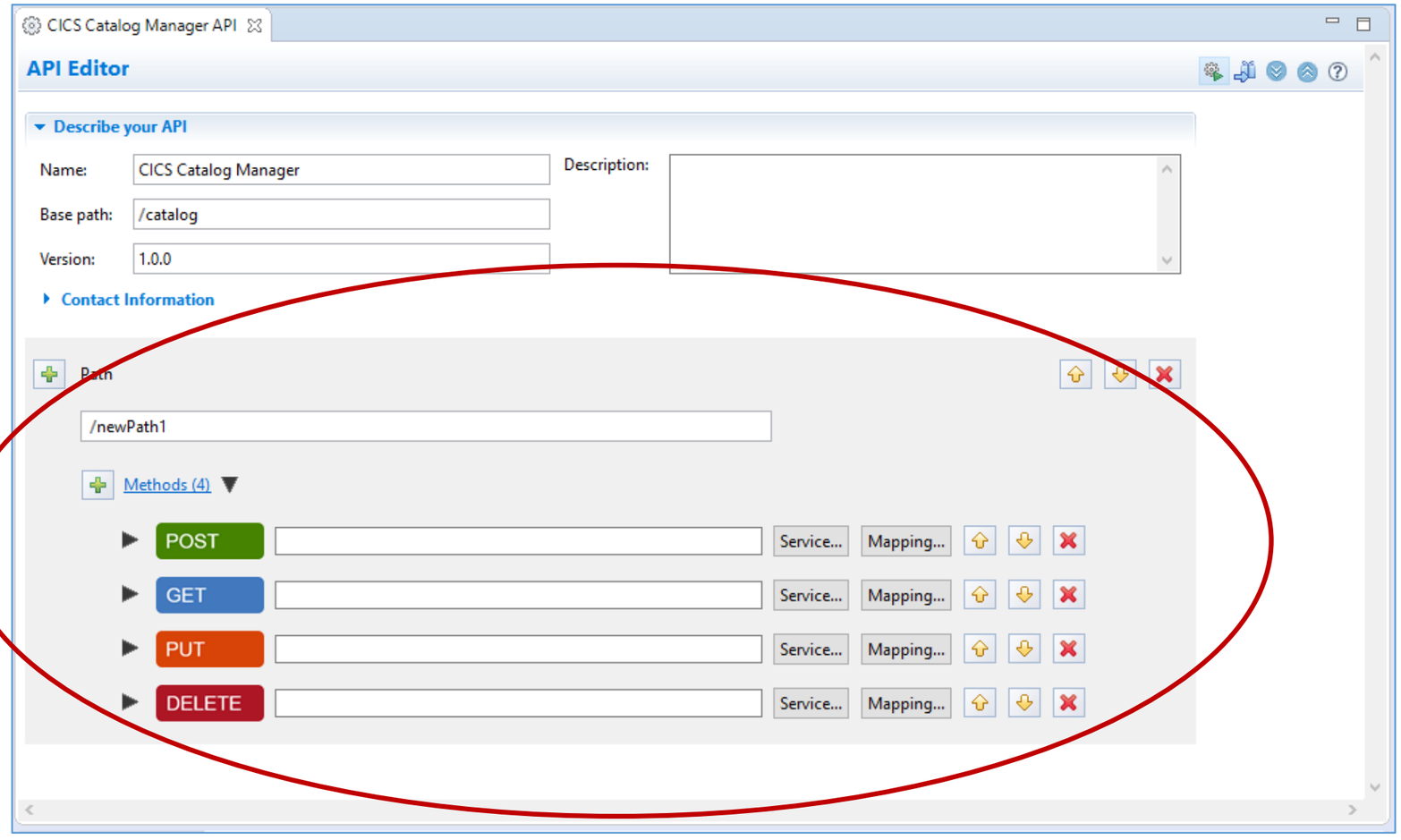
Quick and easy **API mapping.**

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

mitchj@us.ibm.com

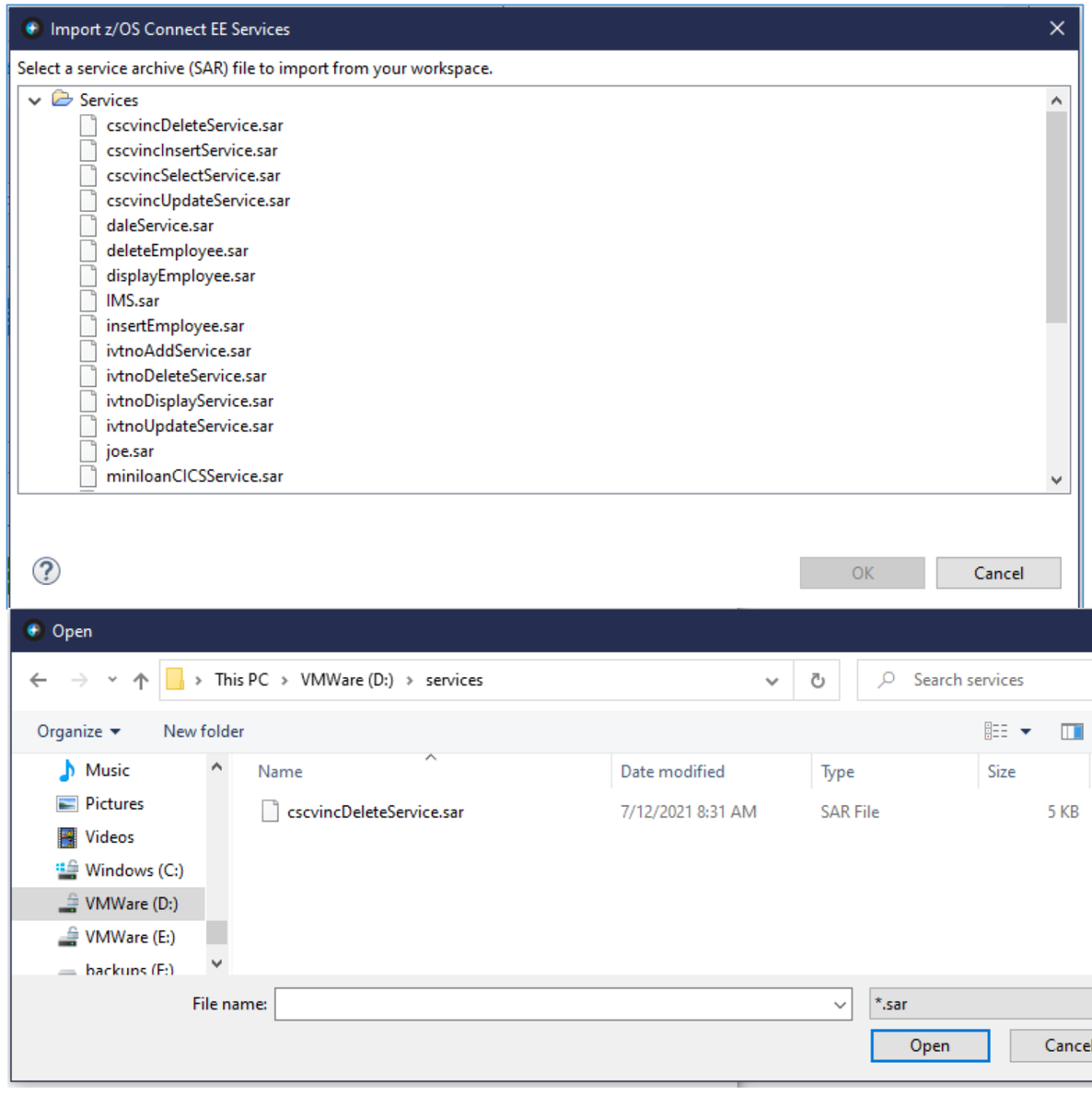
API toolkit – API Editor

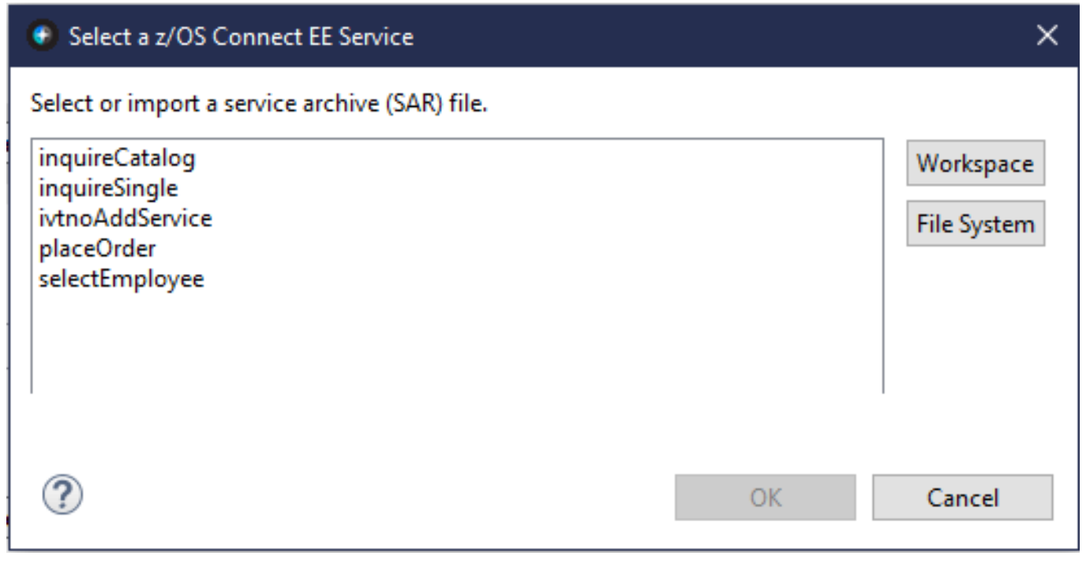




mitchj@us.ibm.com

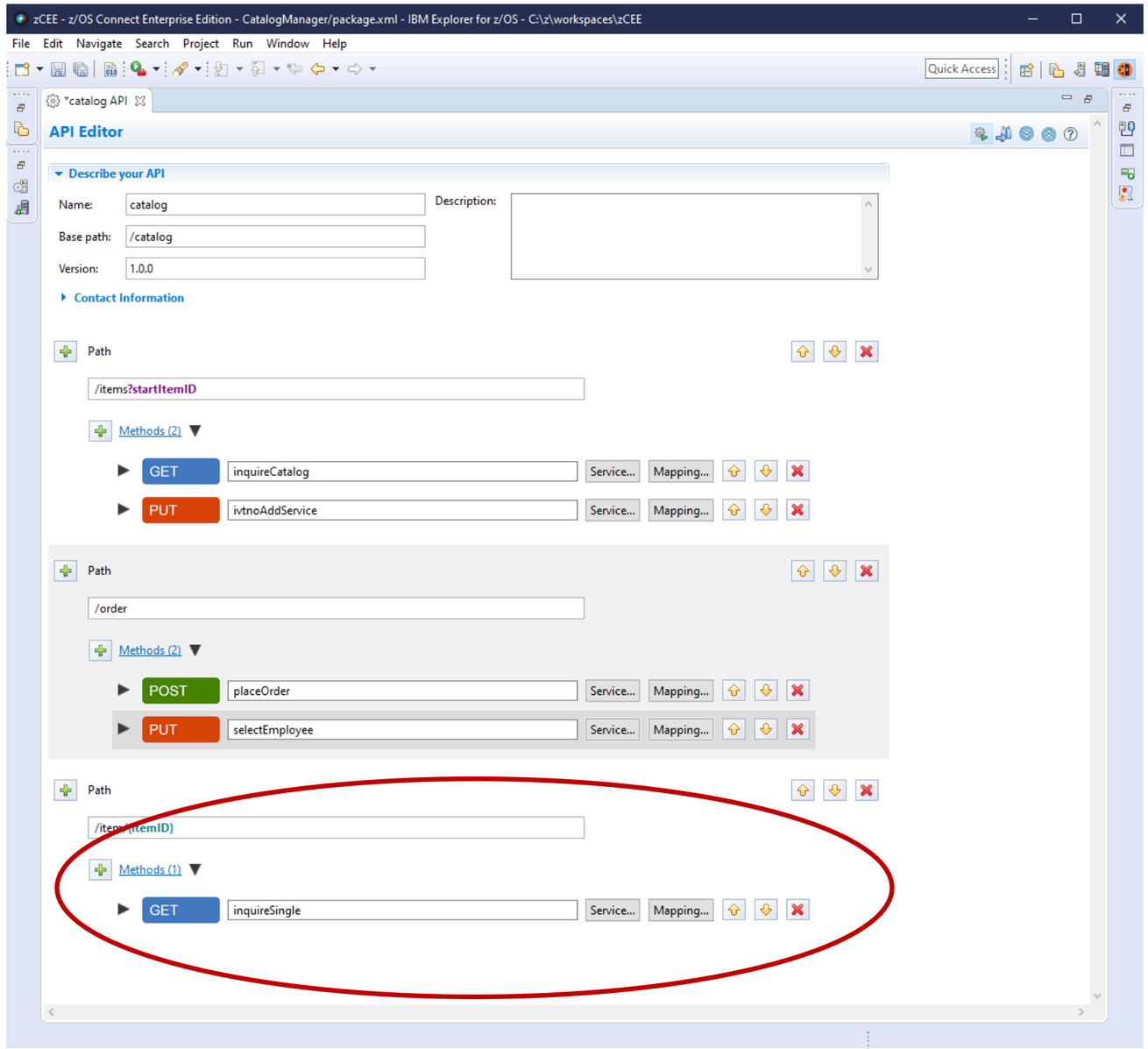
Importing the service archives files





mitchj@us.ibm.com

API toolkit – API Editor



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

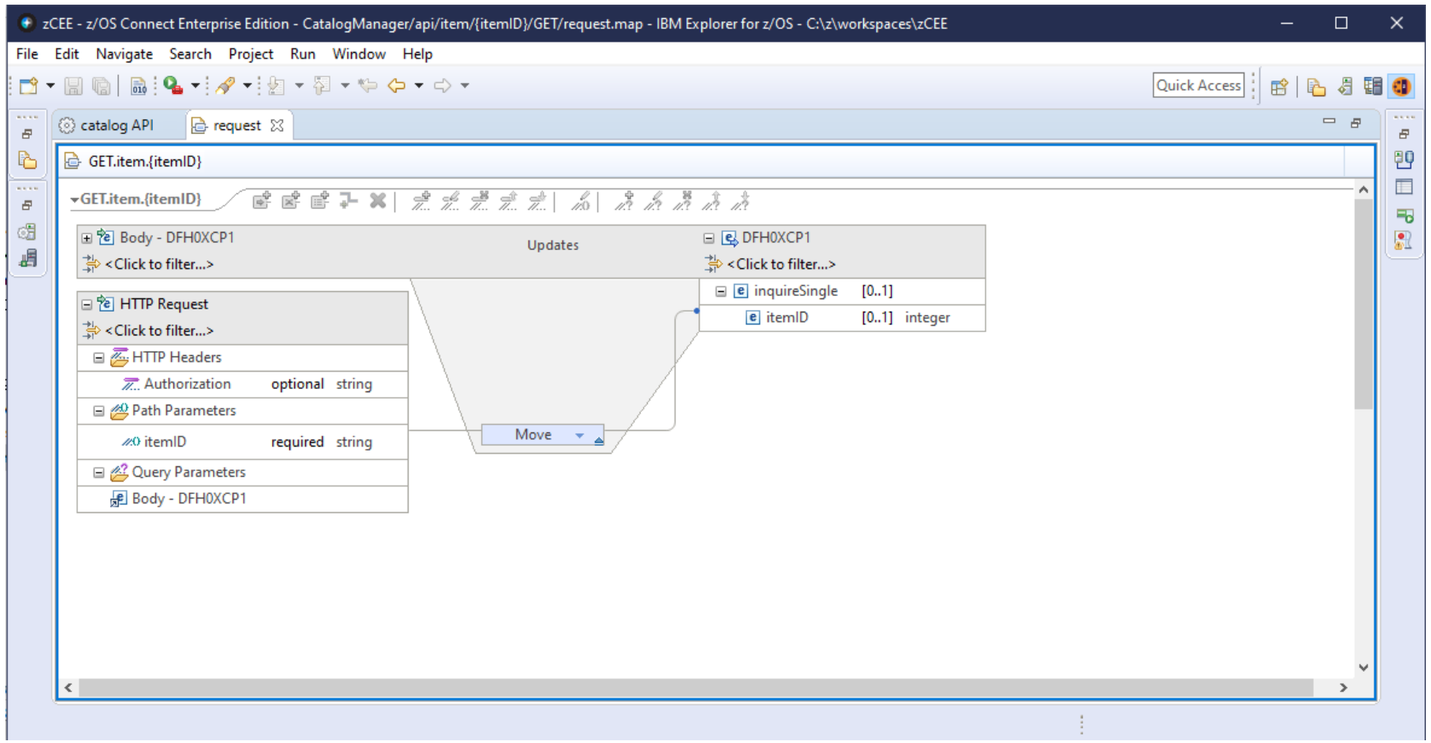
Once you define your API, you can map backend services to each request.

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

mitchj@us.ibm.com

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.

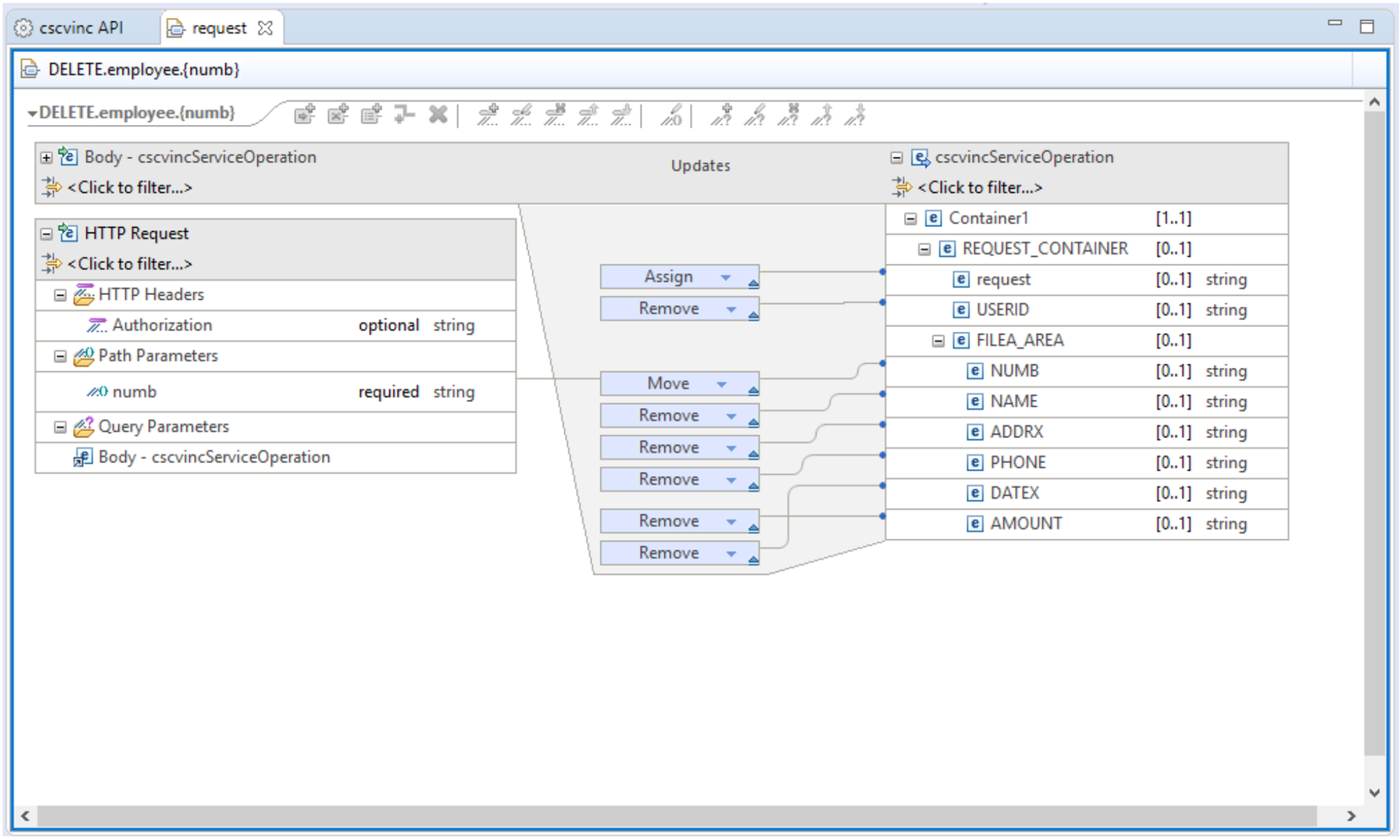
Assign static values to fields, useful for Op codes.

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

mitchj@us.ibm.com

API toolkit – API Editor

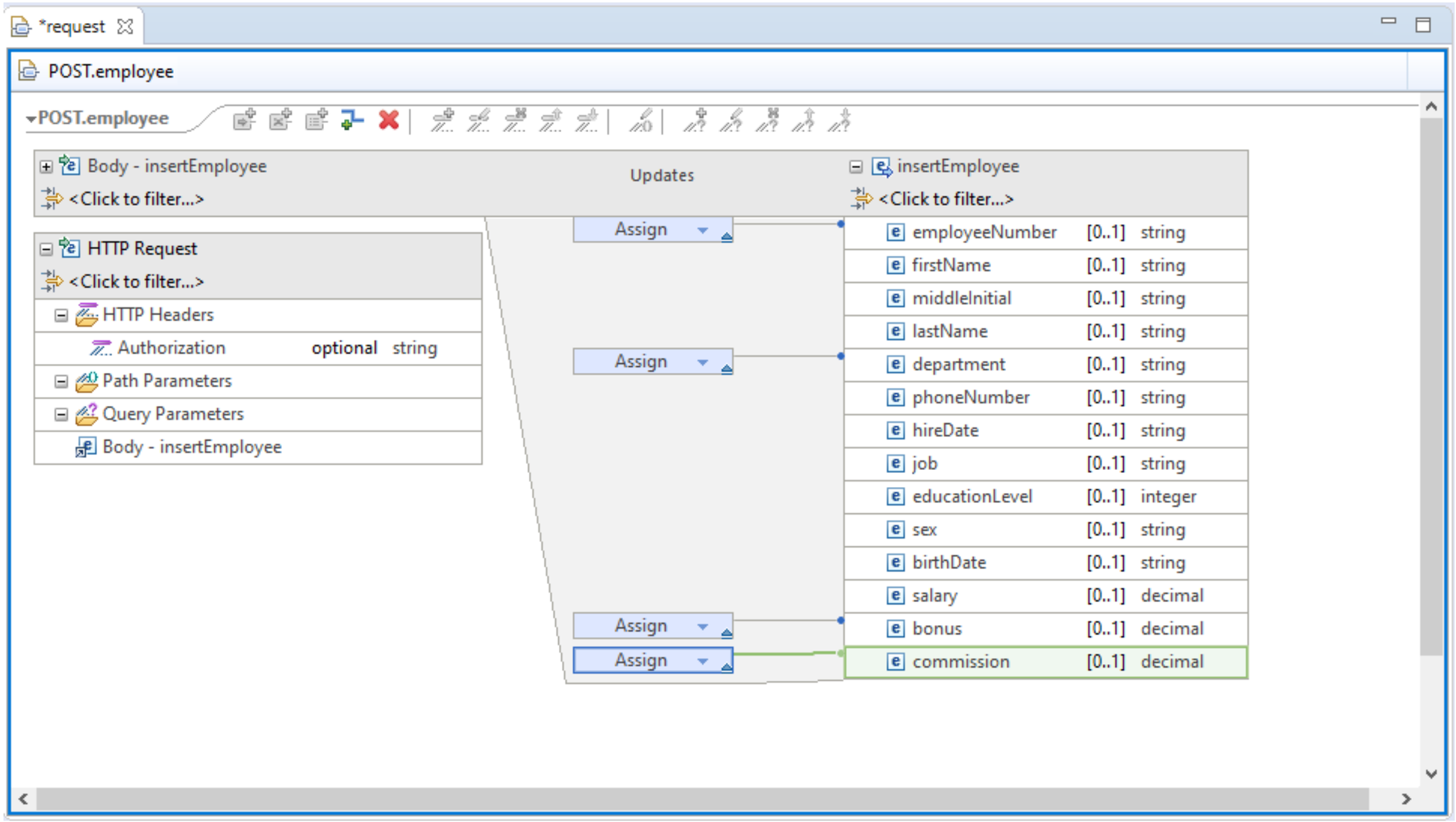
API mapping: Remove or assign values to the fields exposed by service developer



mitchj@us.ibm.com

API toolkit – API Editor and Db2 REST service

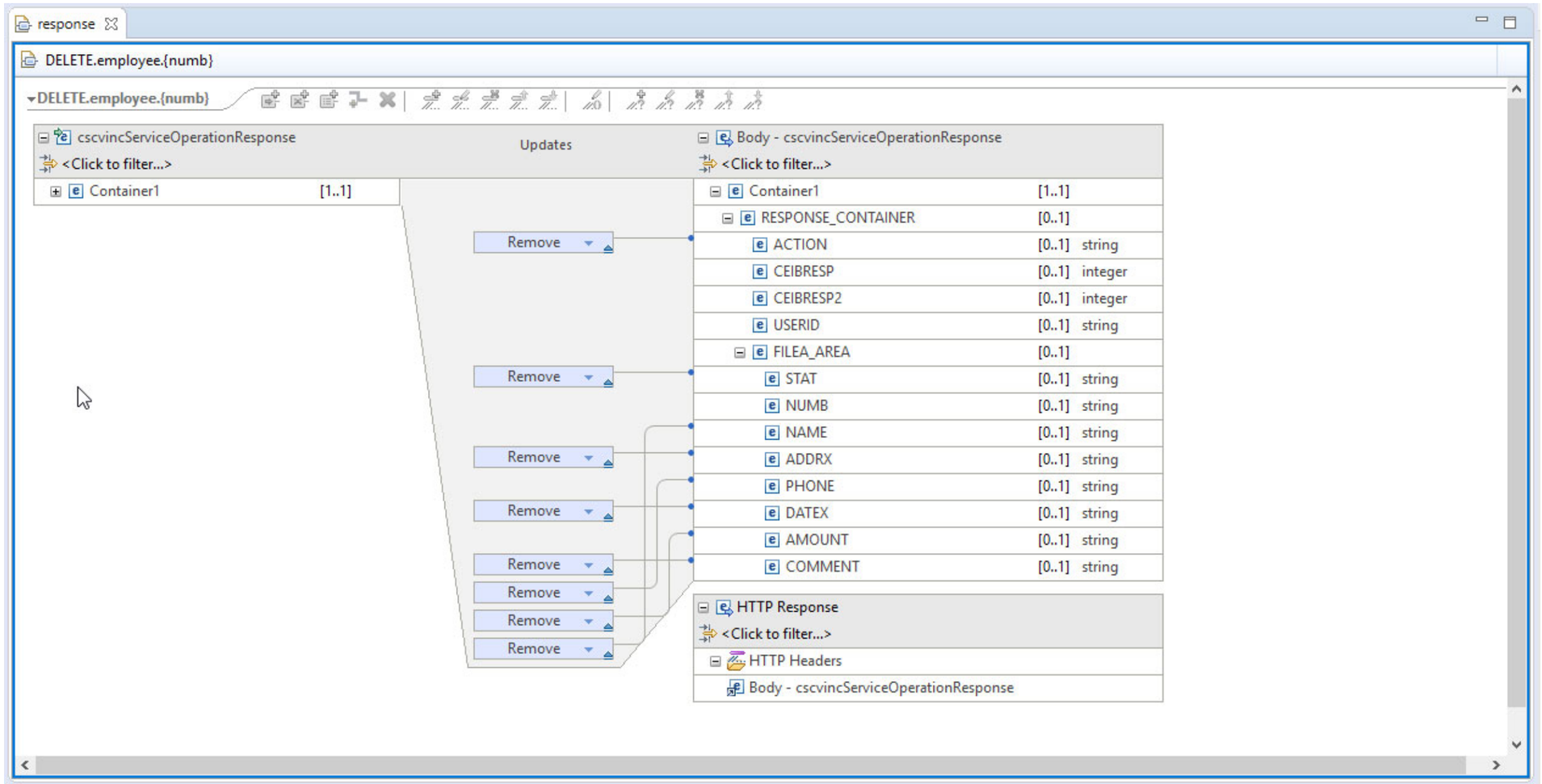
API mapping: Remove/Assign values columns exposed in Db2 REST service



mitchj@us.ibm.com

API toolkit – API Editor

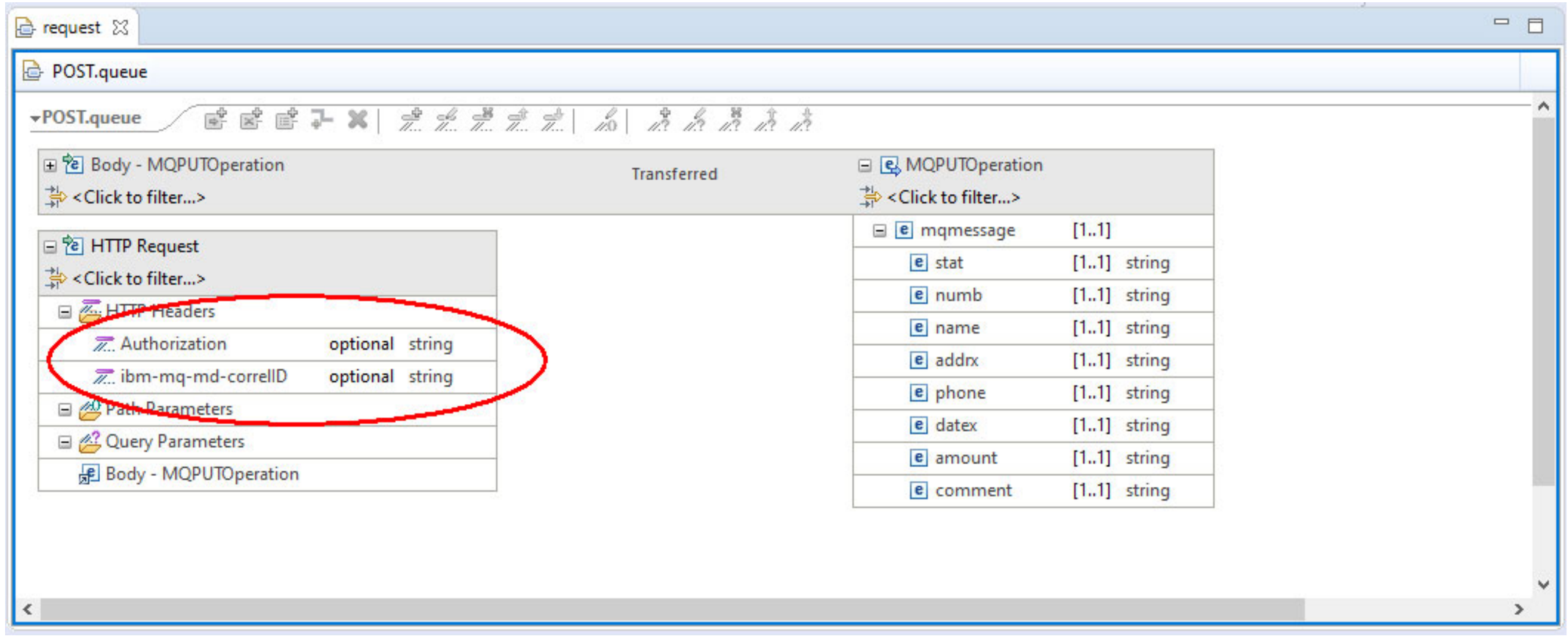
API mapping: Allows the API Developer to remove fields from the response to tailor the API



mitchj@us.ibm.com

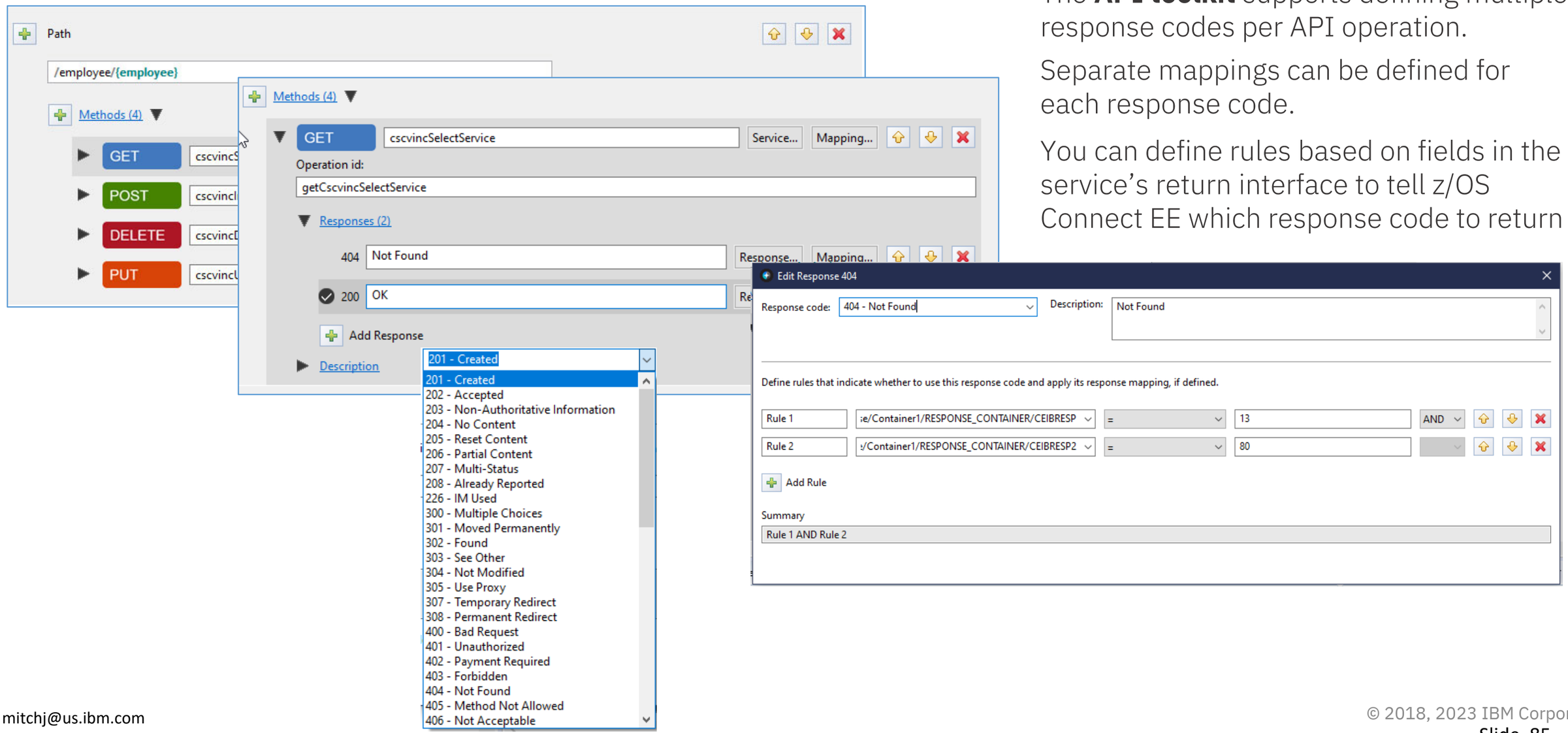
API toolkit – API Editor

API mapping: Allows adding HTTP header properties



API toolkit

API mapping: API definition with multiple response codes



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

Separate mappings can be defined for each response code.

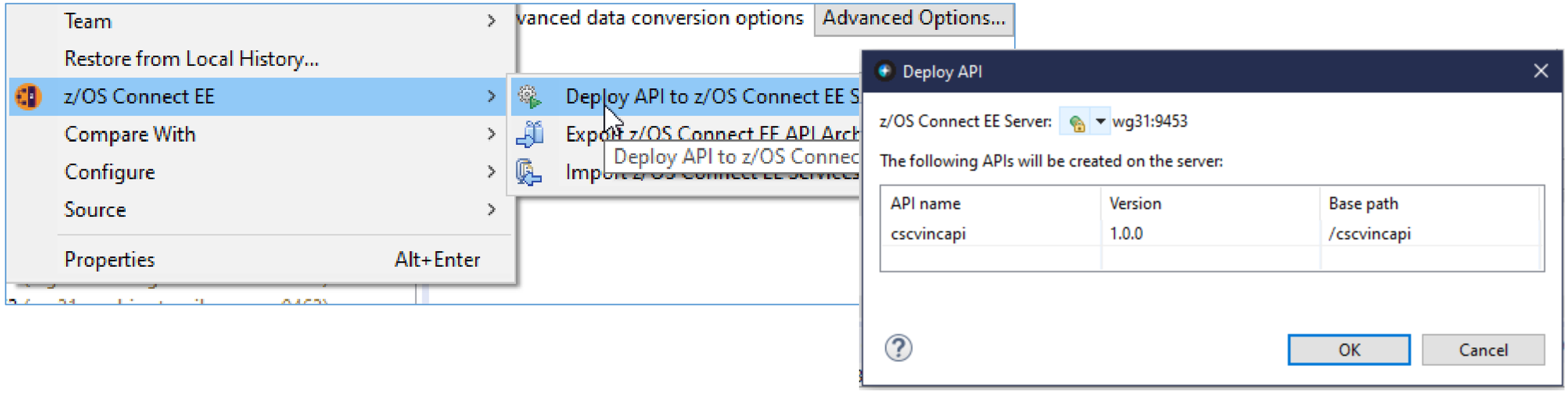
You can define rules based on fields in the service's return interface to tell z/OS Connect EE which response code to return

mitchj@us.ibm.com

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.

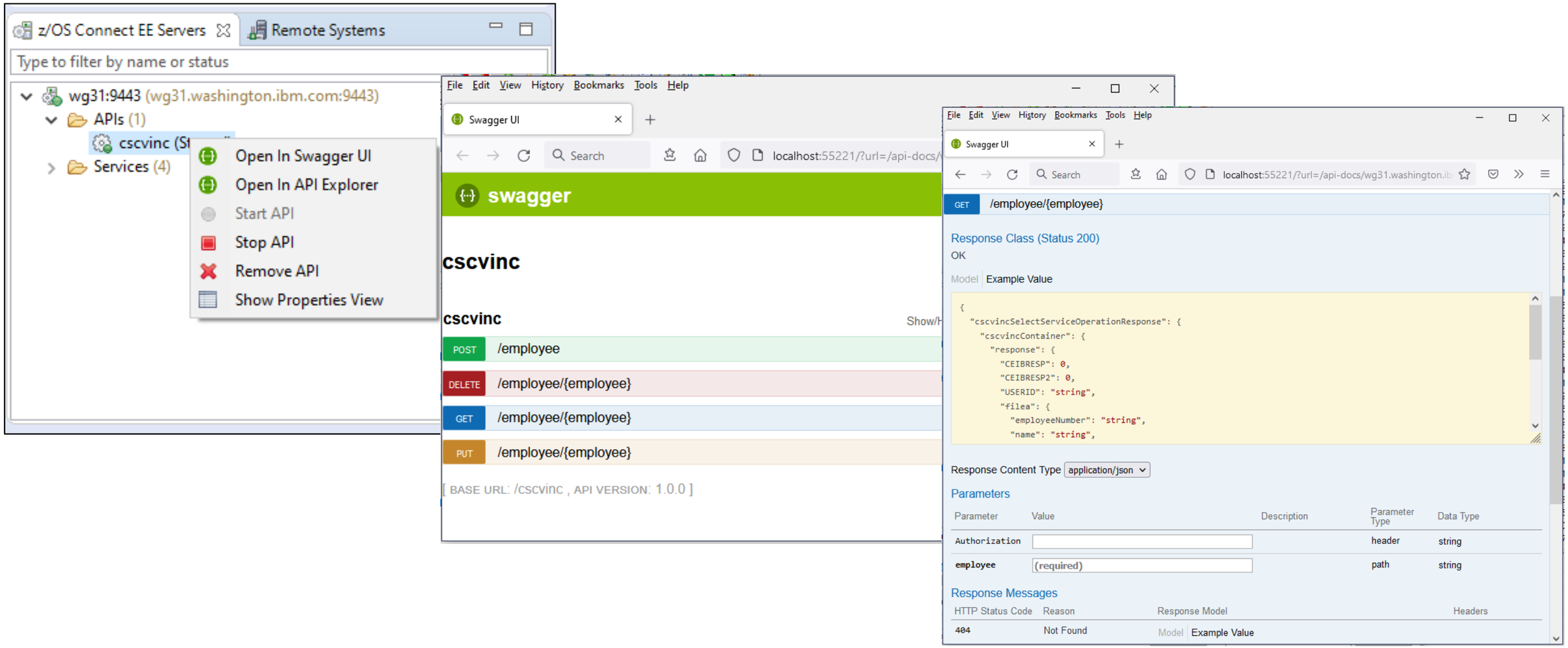
z/OS Connect EE servers view allows you to start, stop, and remove APIs from a running server.

mitchj@us.ibm.com

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.



mitchj@us.ibm.com

/zosConnect/designer

Create a Web Archive file for OpenAPI 3 APIs

mitchj@us.ibm.com

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

cscvinc.yaml - Notepad

File Edit Format View Help

```yaml
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:
        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

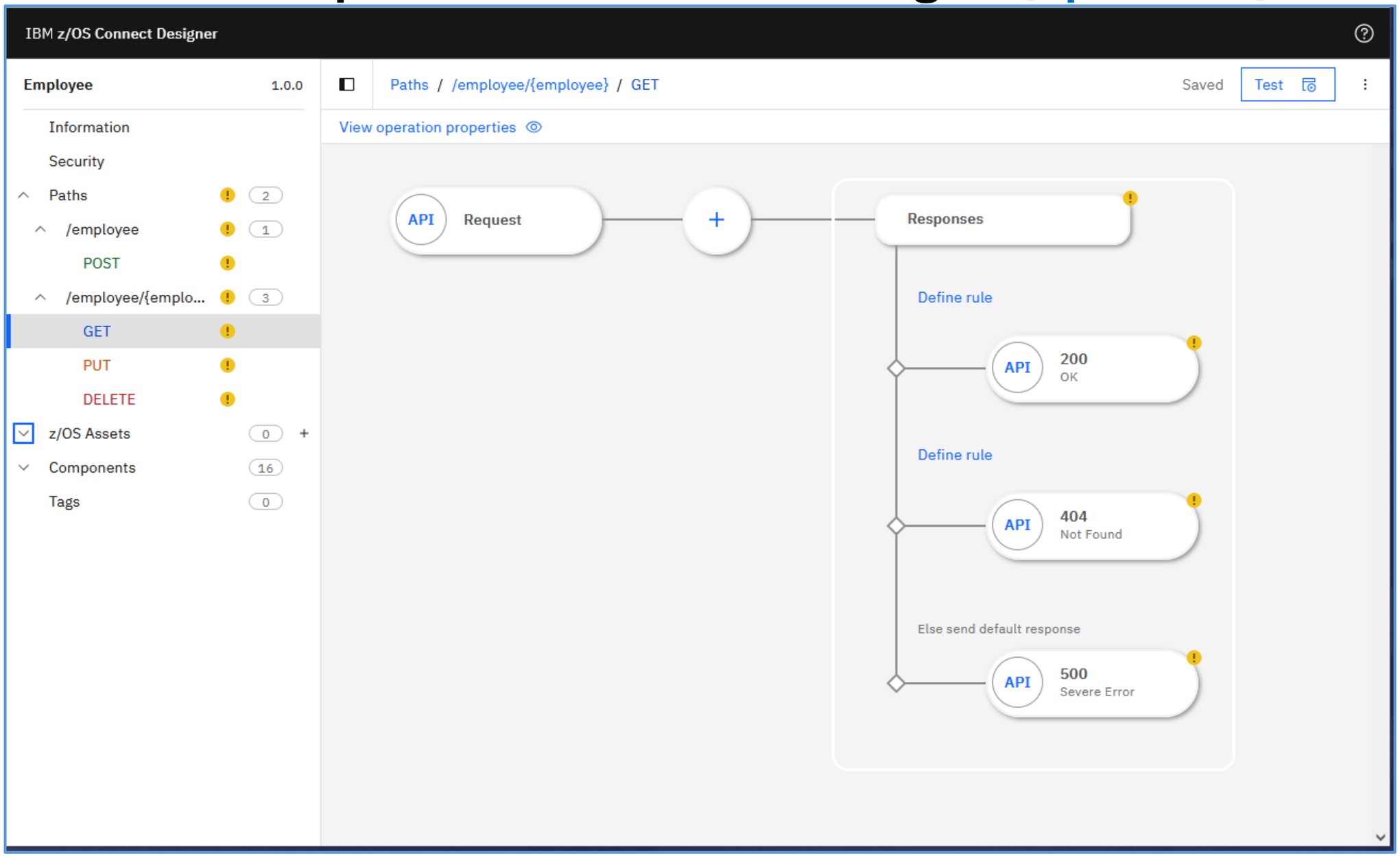
File Edit Format View Help

```yaml
    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

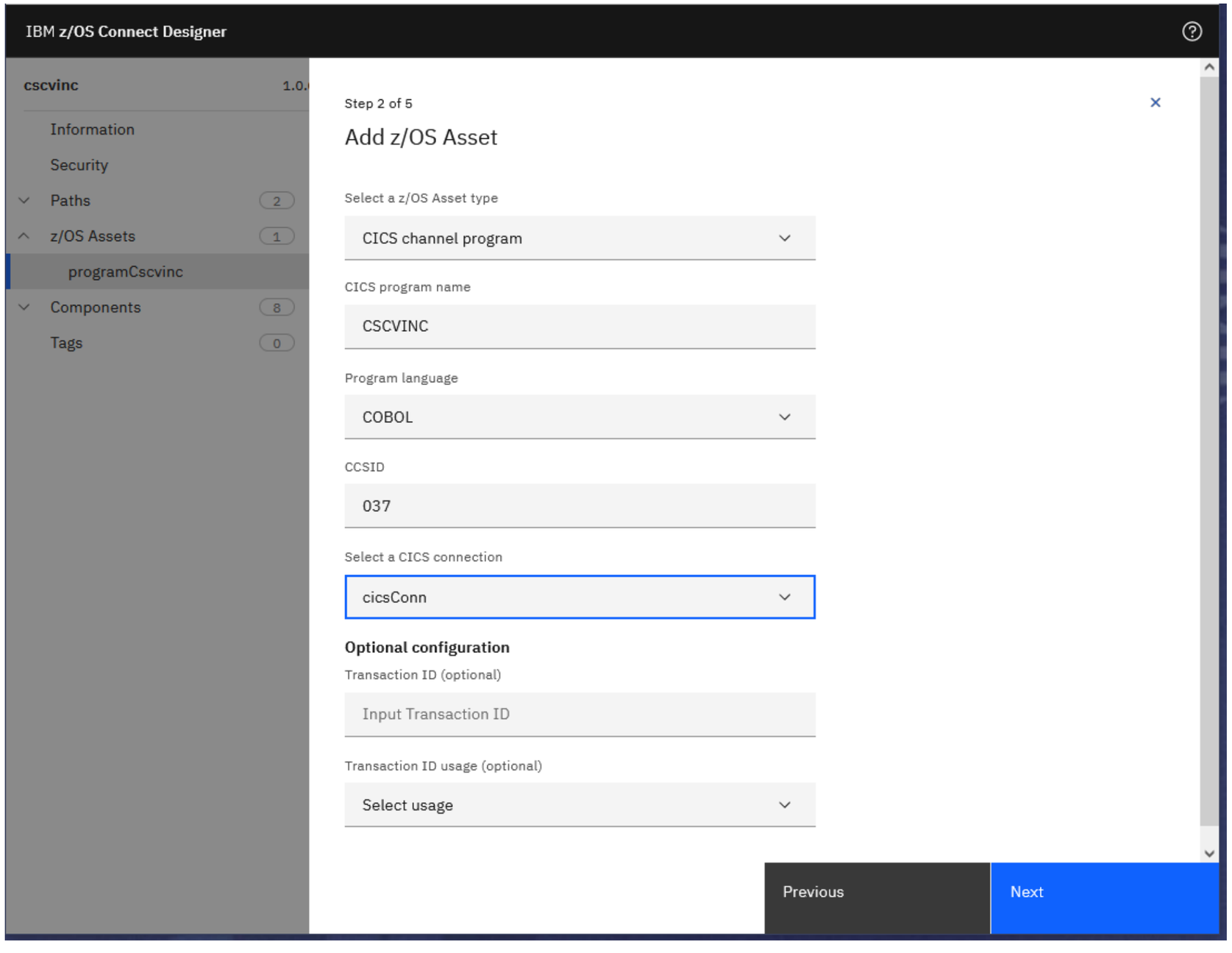
mitchj@us.ibm.com

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



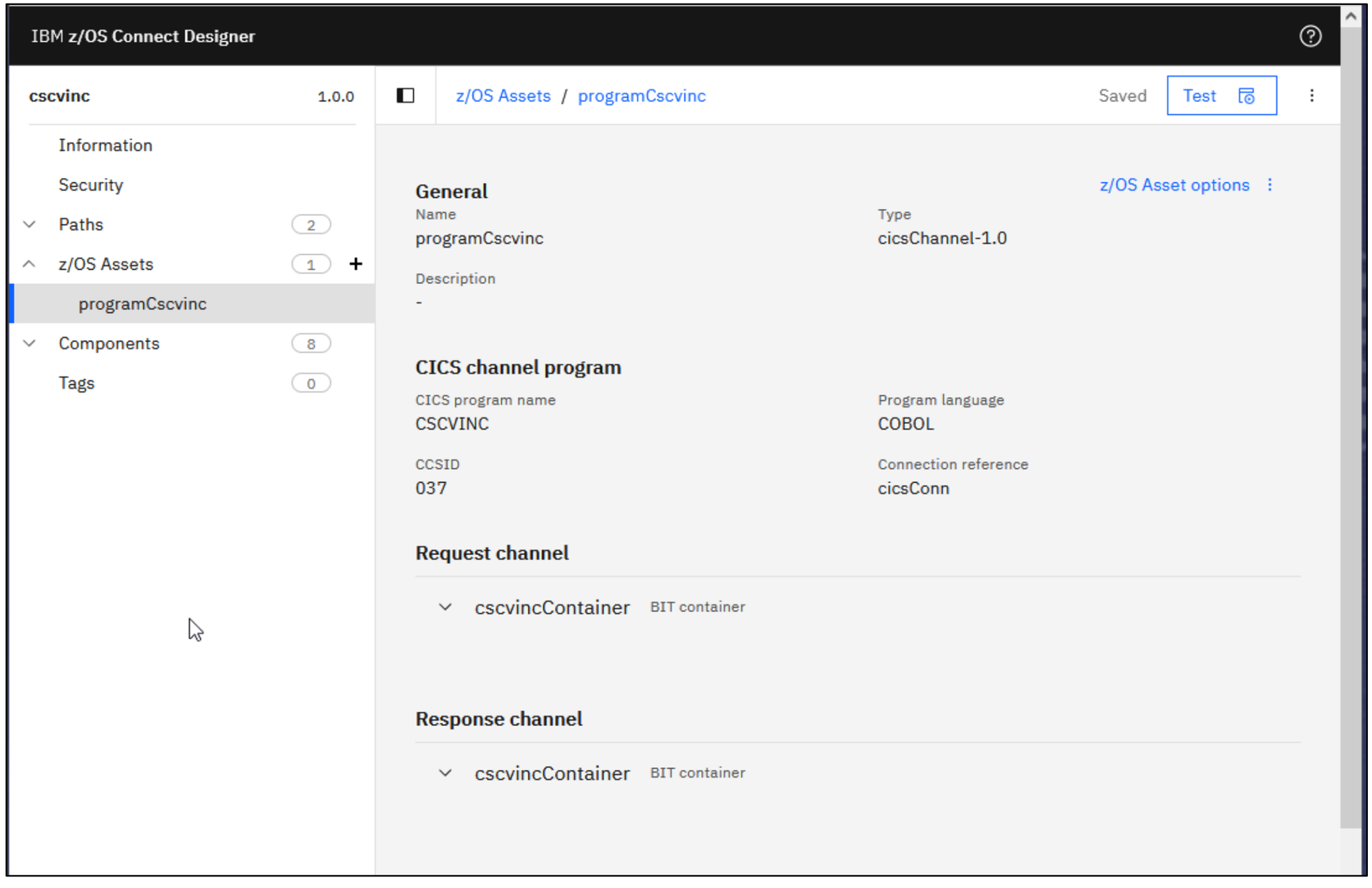
mitchj@us.ibm.com

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



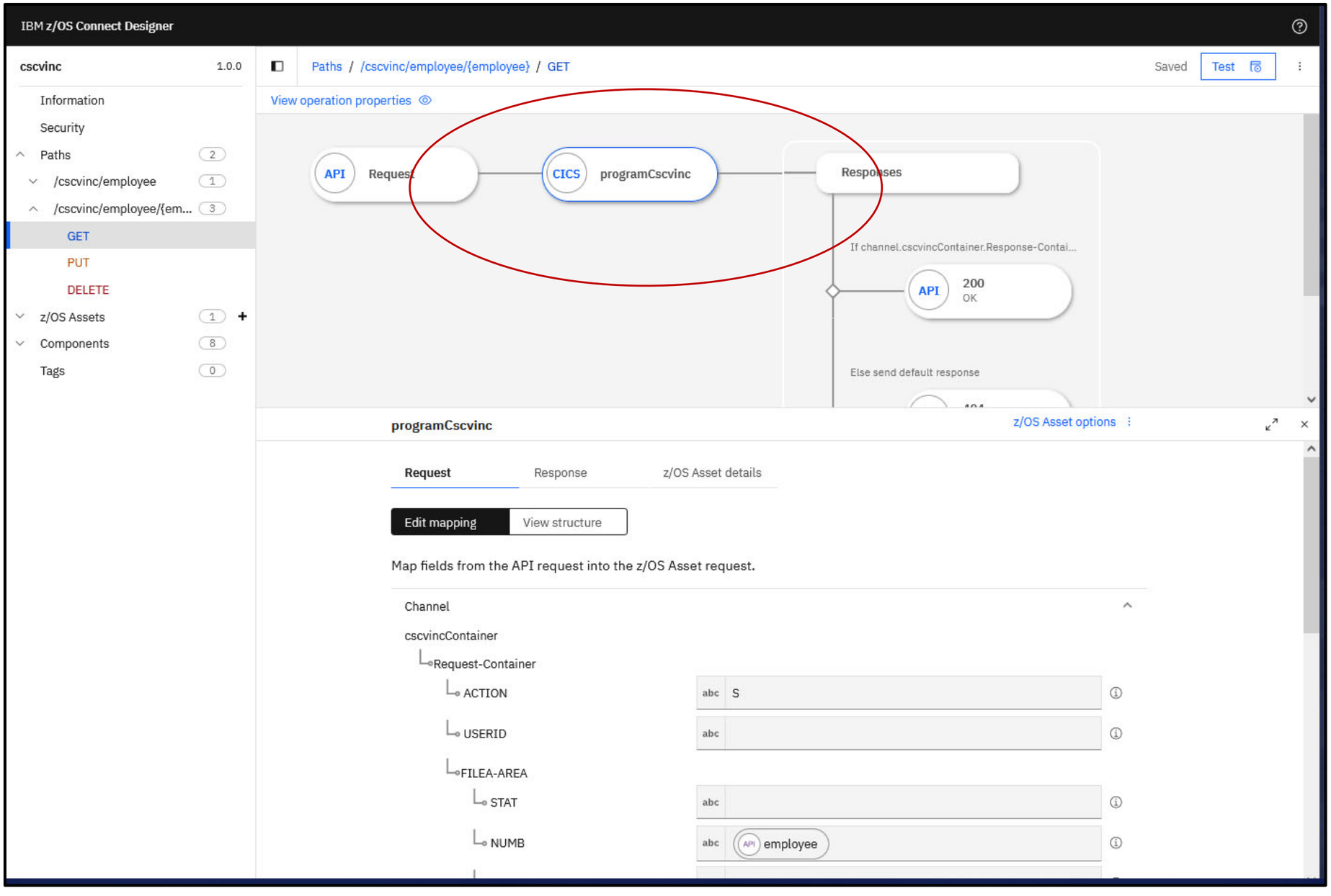
mitchj@us.ibm.com

Accessing a z/OS CICS program (OpenAPI 3)



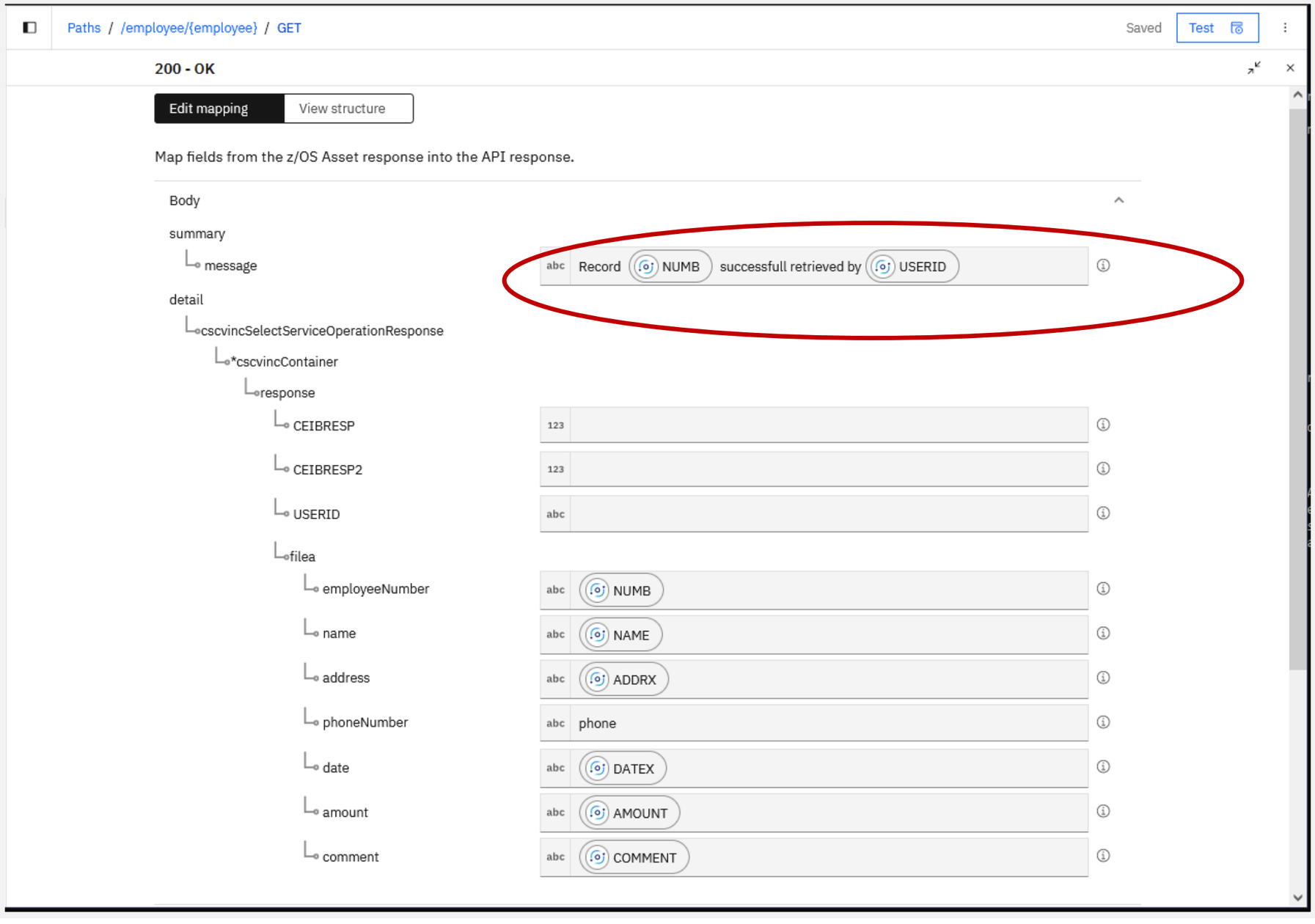
mitchj@us.ibm.com

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



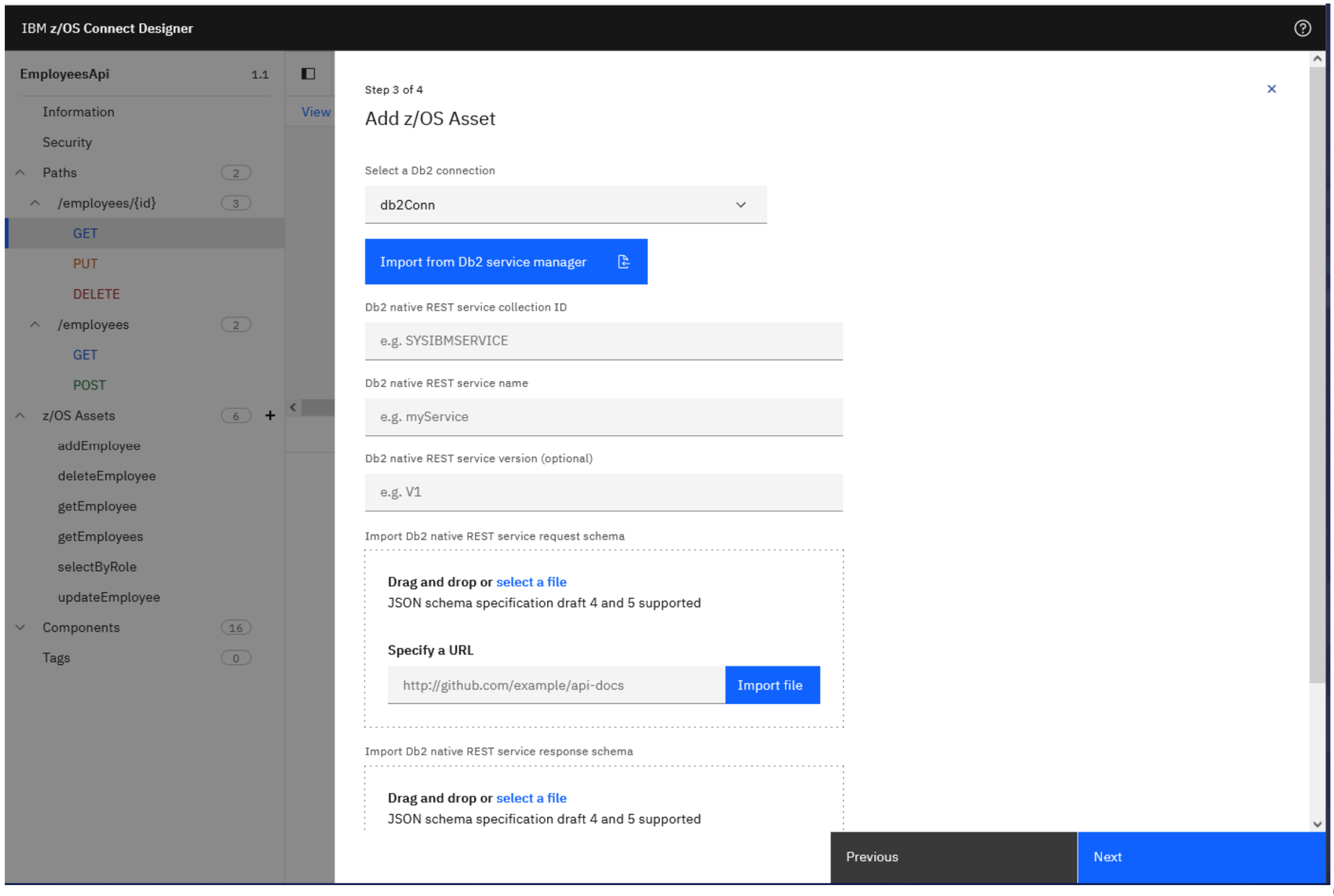
mitchj@us.ibm.com

Map the response message (OpenAPI 3)



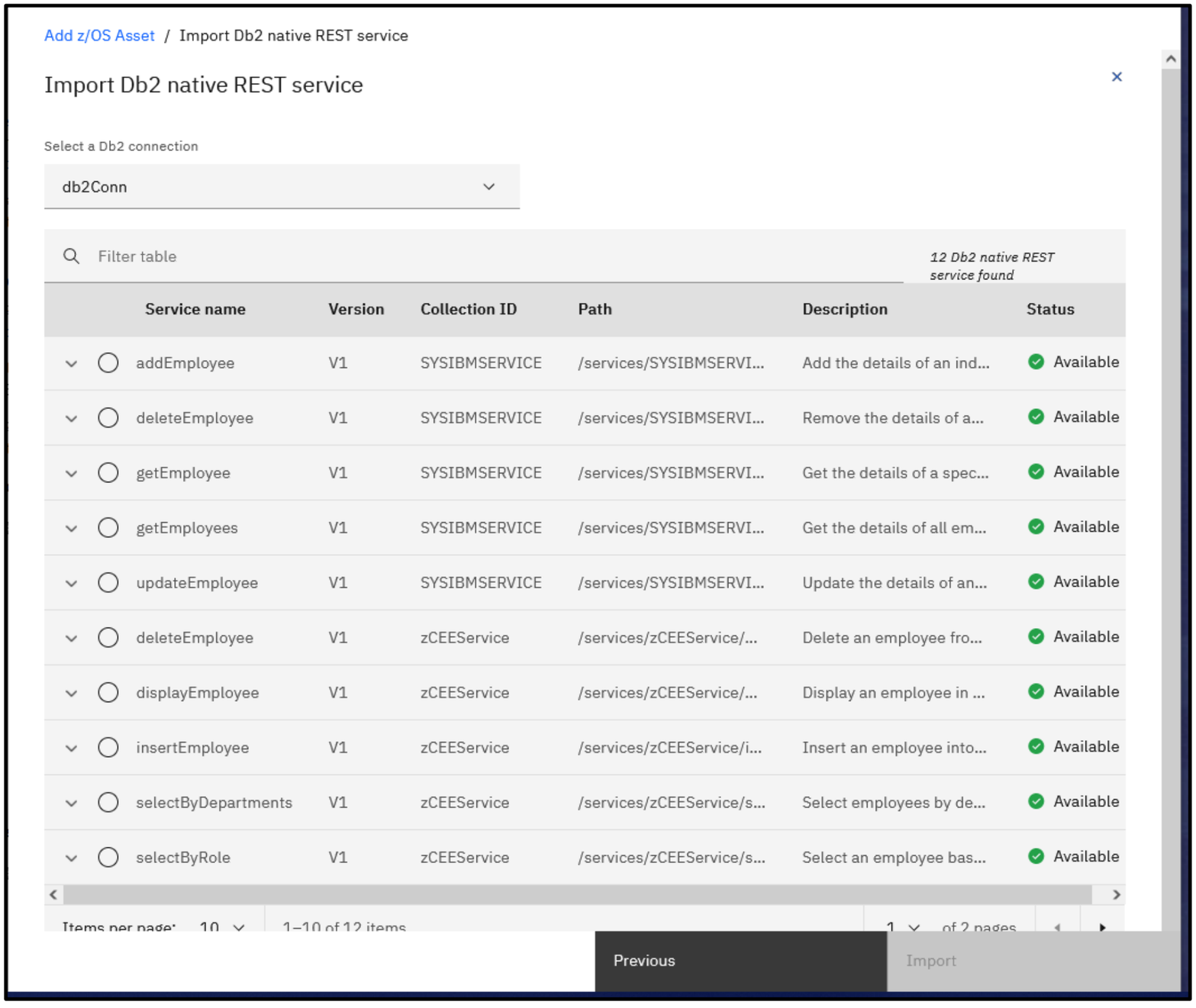
mitchj@us.ibm.com

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



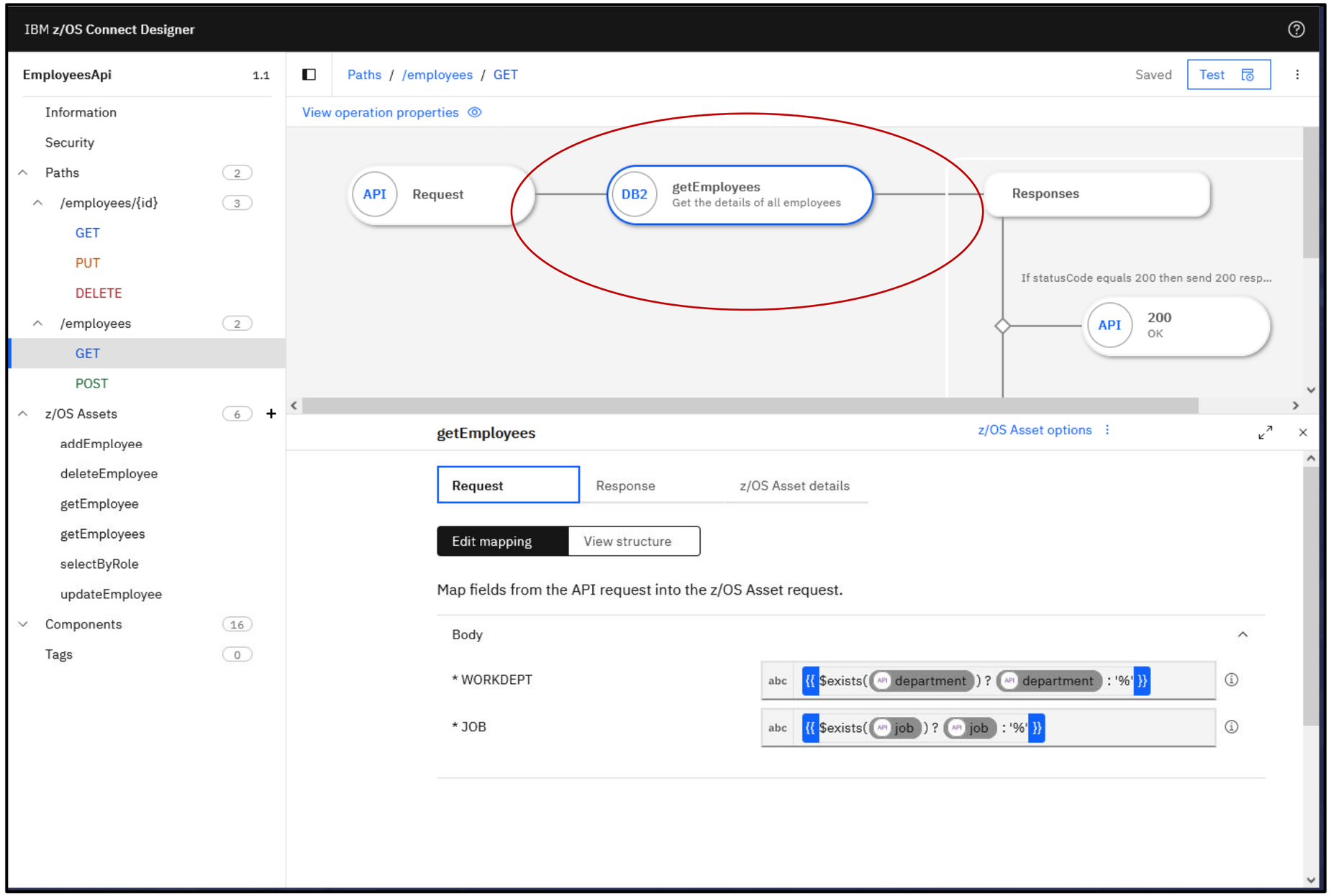
mitchj@us.ibm.com

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



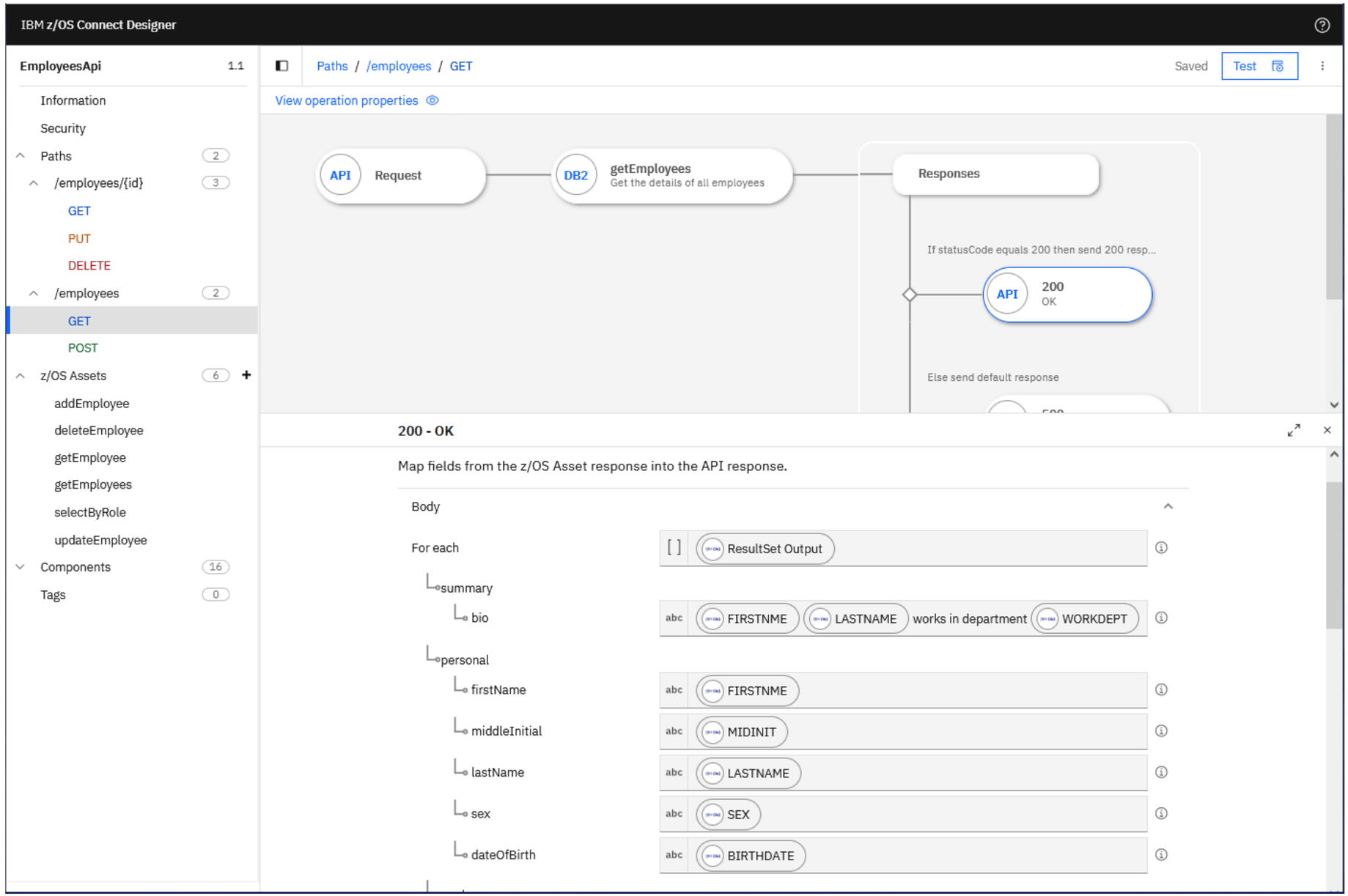
mitchj@us.ibm.com

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



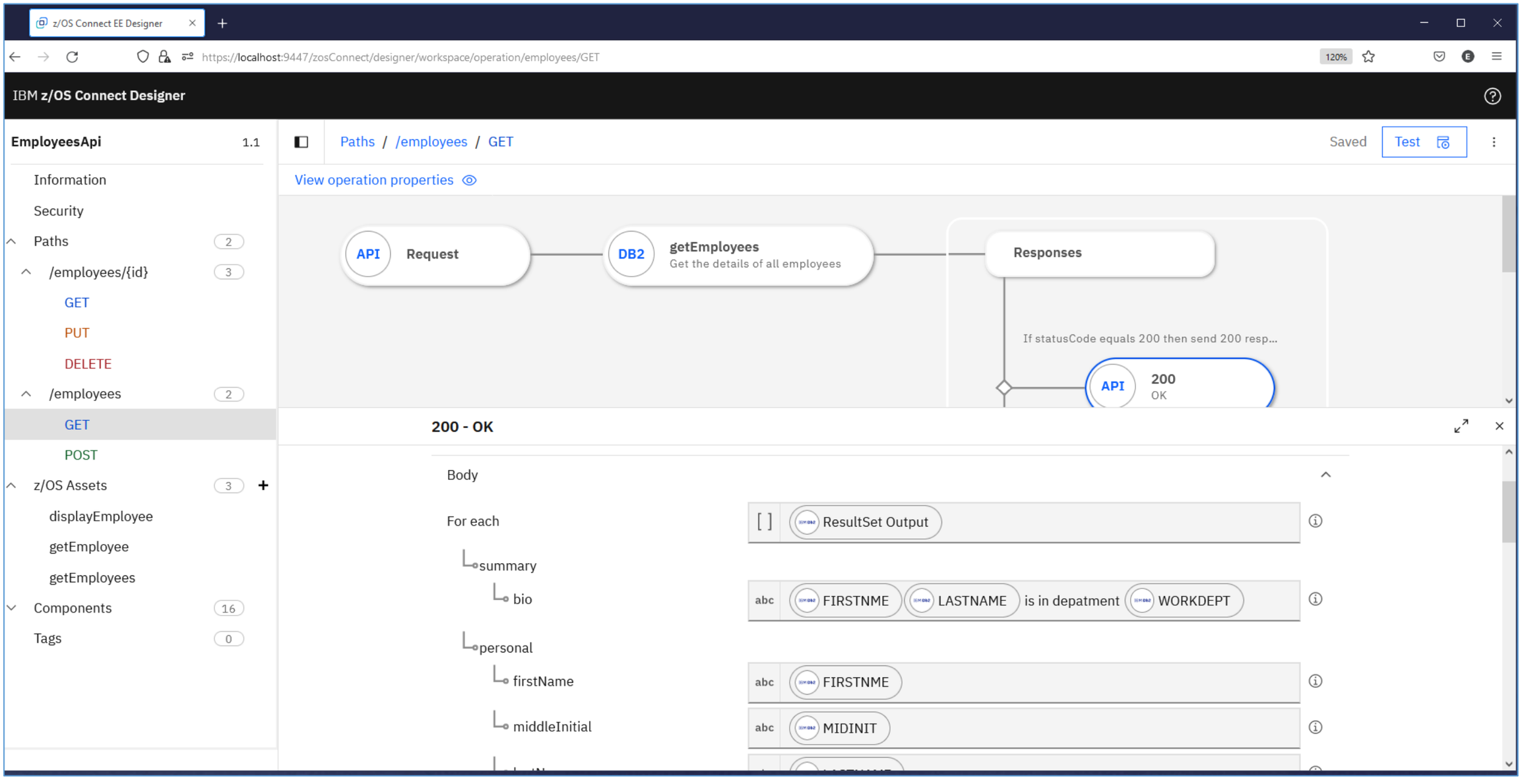
mitchj@us.ibm.com

Map the response message (OpenAPI 3)



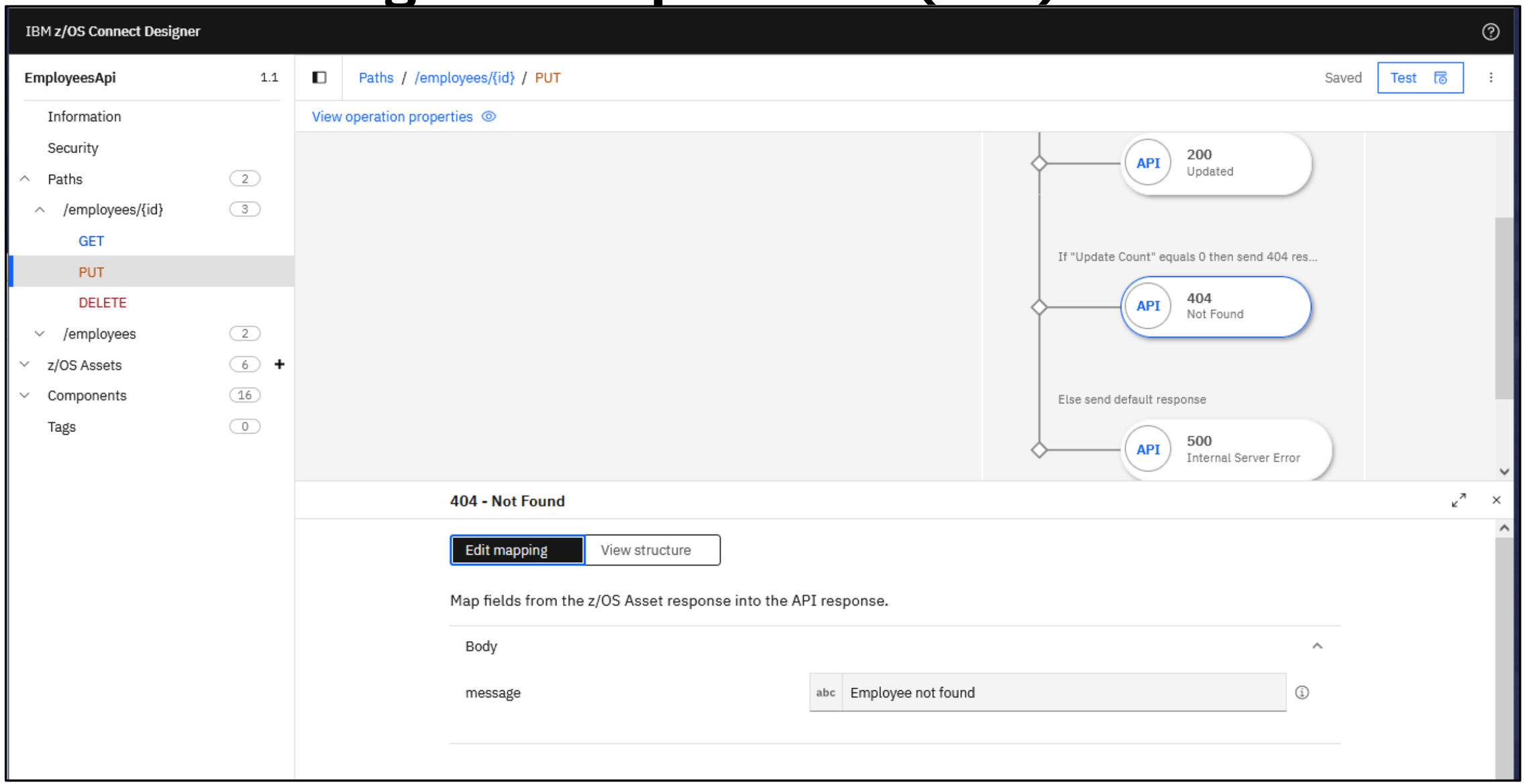
mitchj@us.ibm.com

z/OS Connect Designer for OpenAPI 3 (200)



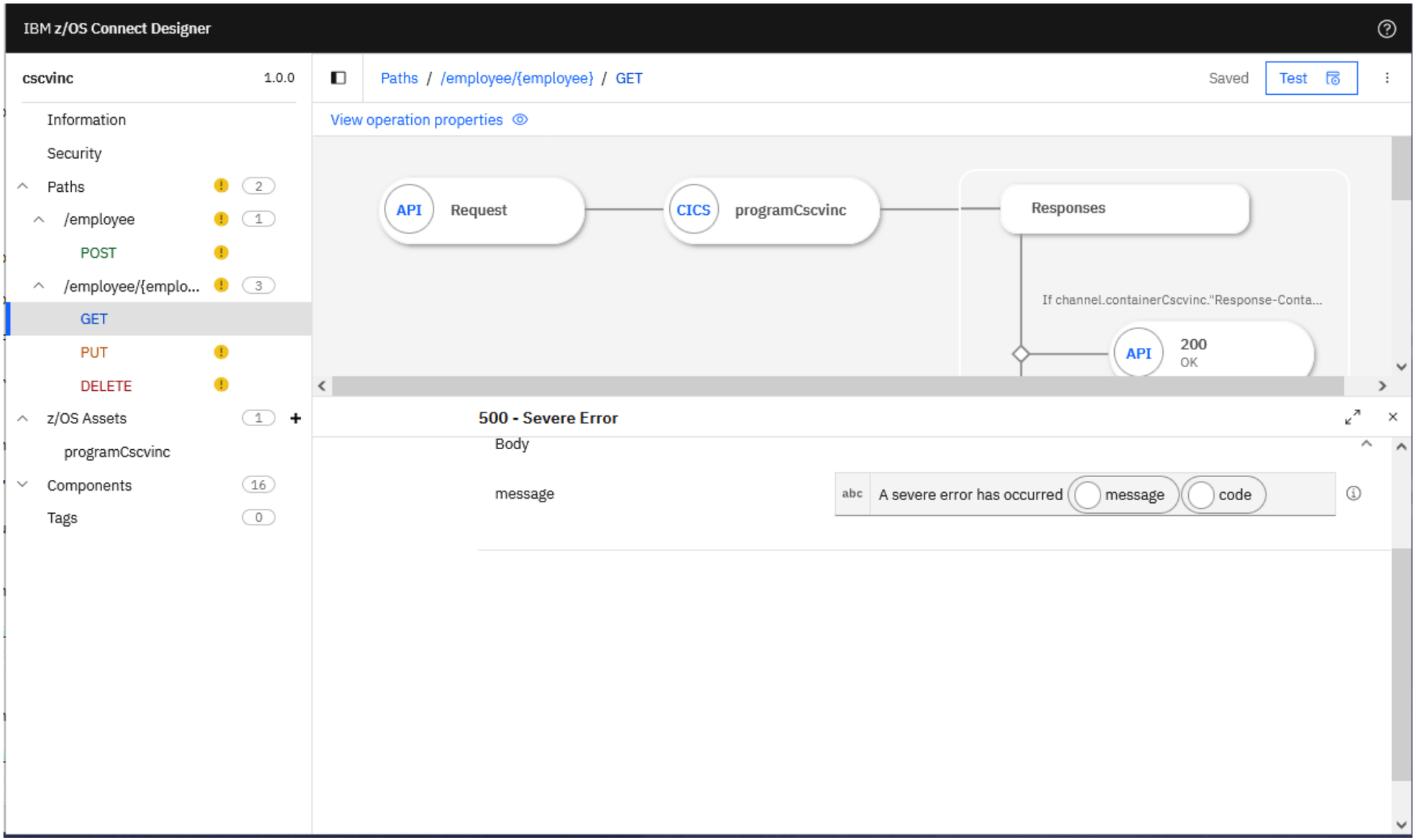
mitchj@us.ibm.com

z/OS Connect Designer for OpenAPI 3 (404)



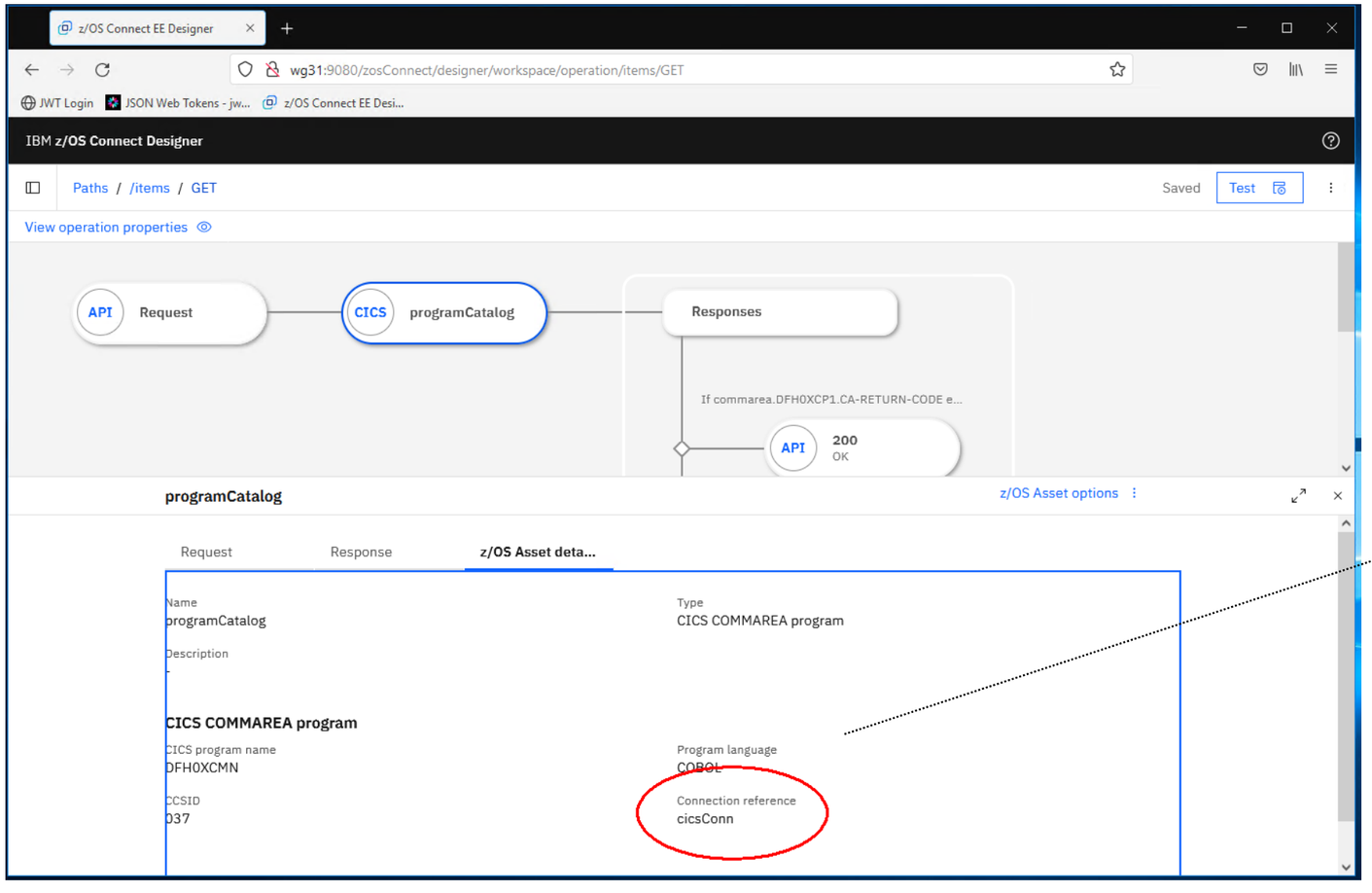
mitchj@us.ibm.com

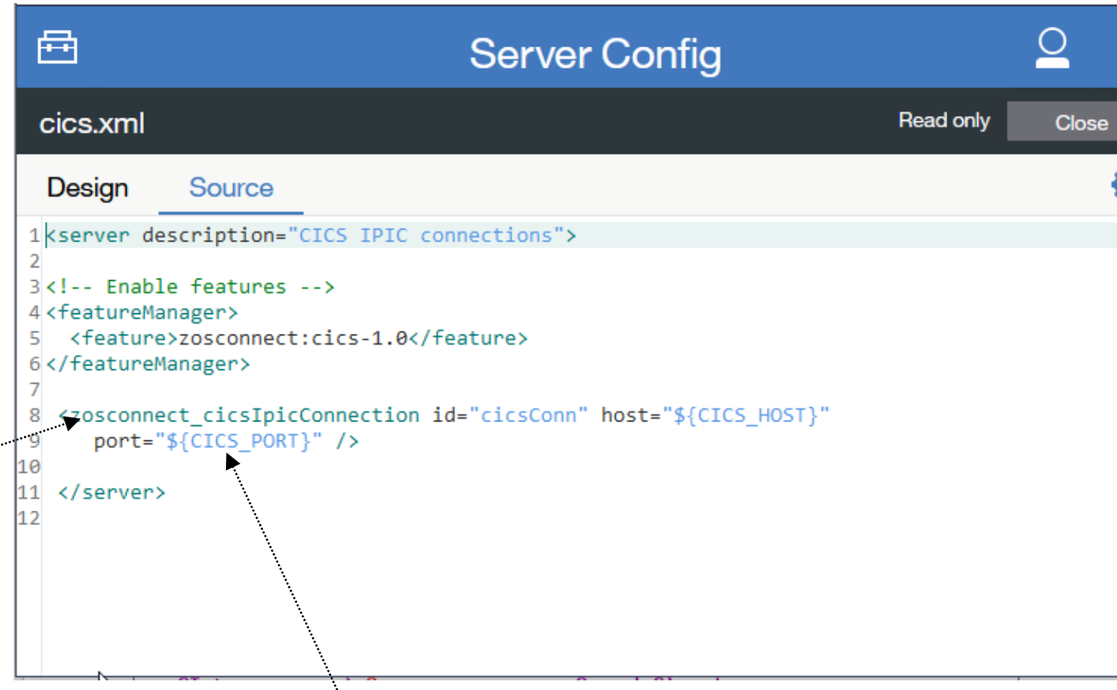
z/OS Connect Designer for OpenAPI 3 (500)



mitchj@us.ibm.com

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



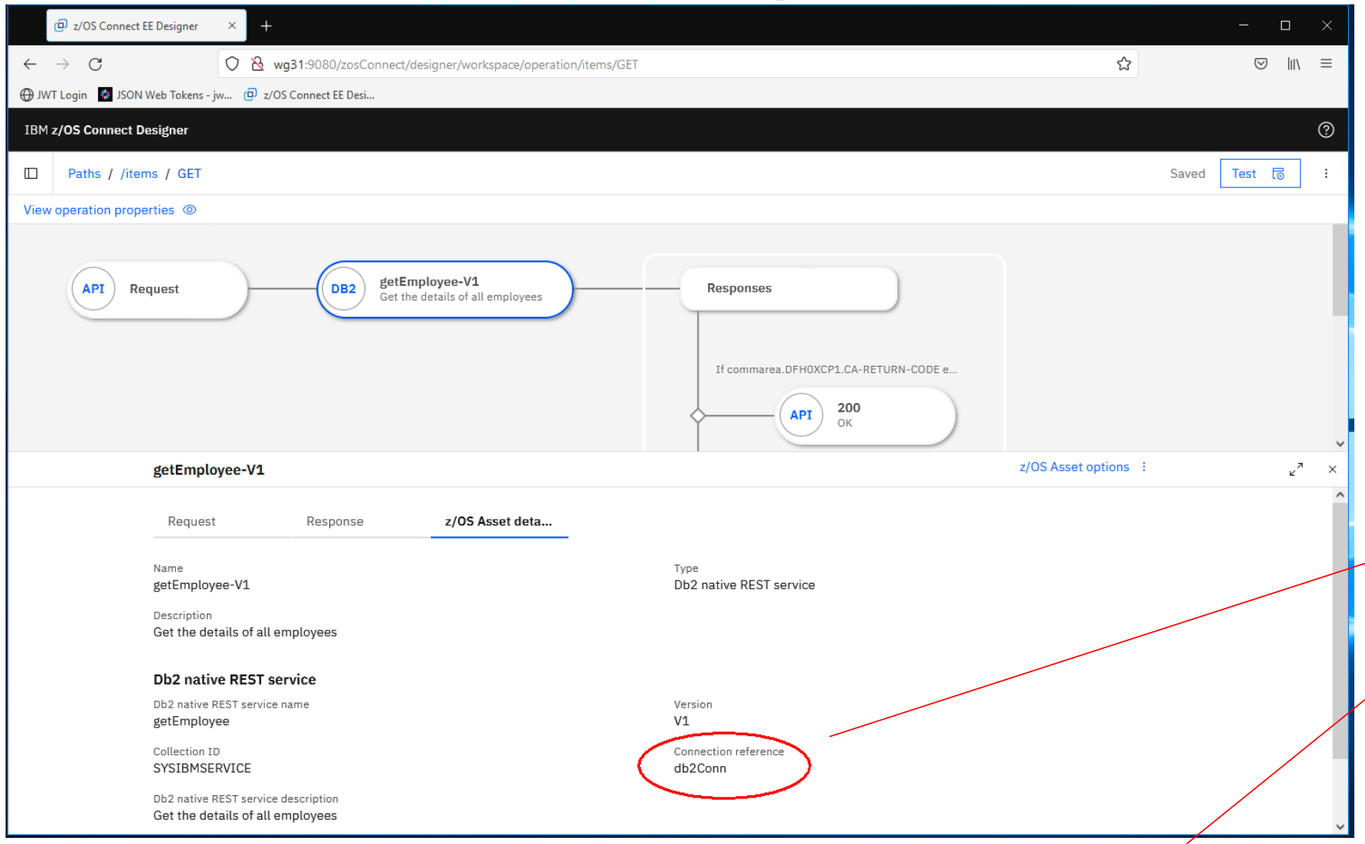


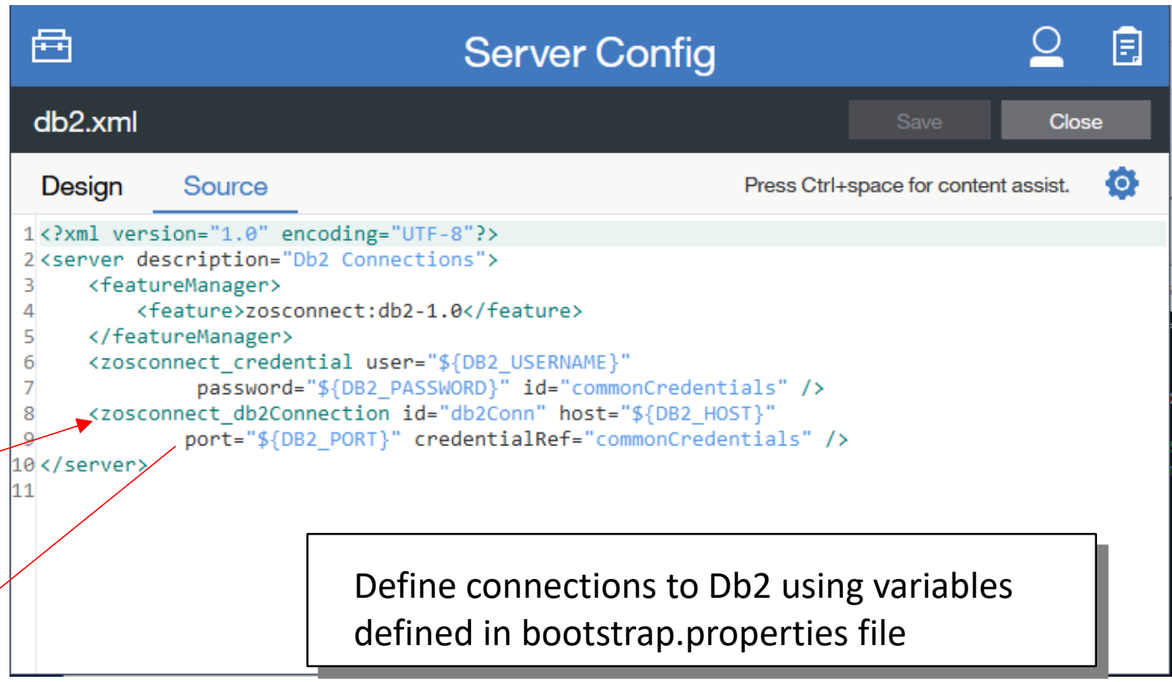
Define IPIC connection to CICS using variables defined in bootstrap.properties file

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

mitchj@us.ibm.com

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





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.

mitchj@us.ibm.com

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.*

mitchj@us.ibm.com

z/OS Server Issues and Considerations – API Deployment

https://www.ibm.com/docs/en/zos-connect/zos-connect/3.0?topic=server-devops-overview

Gradle plug-in and it's requirements, see Using Gradle with z/OS Connect.

Important: In order for multiple API project `.war` files to function when deployed to a single z/OS Connect native server, you must ensure that your OpenAPI specification includes a `contextRoot` defined within the `servers` section. The `contextRoot` attribute specifies the entry point of the deployed application. For example, to use a context root of `/myContextRoot` in the API's OpenAPI definition server's section:

```
openapi: 3.0.0
...
servers:
url: "https://localhost:9443/myContextRoot"
...
```

This definition must match the `contextRoot` attribute value of the `webApplication` element in your `server.xml` file. An example of the configuration might be:

```
<webApplication location="${server.config.dir}/apps/api.war" name="EmployeesApi" contextRoot="/myContextRoot"/>
```

If the server entry in the server section of the OpenAPI definition includes a `contextRoot` value, then this value must be specified in the `contextRoot` attribute of the corresponding `webApplication` element, even when only a single API is deployed to the z/OS Connect server.

Each API deployed to the same IBM z/OS Connect server requires a unique context root.

4. Copy the server configuration.
   Copy the server configuration files from the API project `/scr/main/liberty/config` directory into the `${server.config.dir}/configDropins/overrides` directory of the server or another directory via FTP. For more information, see Overview of IBM z/OS Connect Server configuration
5. Deploy the generated API files to the z/OS Connect native server
   Deploy API `.war` files into a permanent USS directory. An example directory, such as the one provided by the z/OS Connect native server template, is `${server.config.dir}/apps`. API files can also be deployed to other directories, such as in separately mounted zFS file systems.

   For each deployed API define a webApplication element in the configuration file. An example element is included in the supplied openApi3 server template. An example element might be the following:

```
<webApplication id="My API" location="${server.config.dir}/apps/api.war" name="MyAPI"/>
```

mitchj@us.ibm.com

z/OS Server Issues and Considerations – Context Root

https://www.ibm.com/docs/en/zos-connect/zos-connect/3.0?topic=image-devops-overview

The drop-ins directory

The *drop-ins* directory, `/config/dropins` is a special directory that is supported by WebSphere® Application Server for Liberty. It allows `.war` files to be deployed and dynamically loaded into the running IBM z/OS Connect with no additional definitions that are required in the configuration file.

By default, z/OS Connect Designer deploys the API `.war` file to this directory. Using the same directory in your API container image simplifies the creation of that image because the configuration remains the same.

A directory other than drop-ins

This is required in any of the following situations:

- The API's OpenAPI definition server's section contains server entry that includes a context root value, which is not just `/`.
- Multiple APIs are to be deployed to the same IBM z/OS Connect container. Because the API `.war` file will be generated with a context root of `/`, and multiple API `.war` files in the same server must have unique context root values.
  You need to include a context root value (not `/`) in the API's OpenAPI definition server's section, for example to use a context root of `/MyCompany`:

```
openapi: 3.0.0
   ...
   servers:
      url: https://localhost:9443/MyCompany
   ...
```

- Requests to start an API require authentication only, without authorization, so the authorization roles need to be mapped to the WebSphere Application Server for Liberty special subject ALL_AUTHENTICATED_USERS. For more information, see How to define authorization roles.

If you choose not to use the drop-ins directory, you must alter the configuration that is used in z/OS Connect Designer during the creation of the API container image.

- **Required to define applications and add context root**

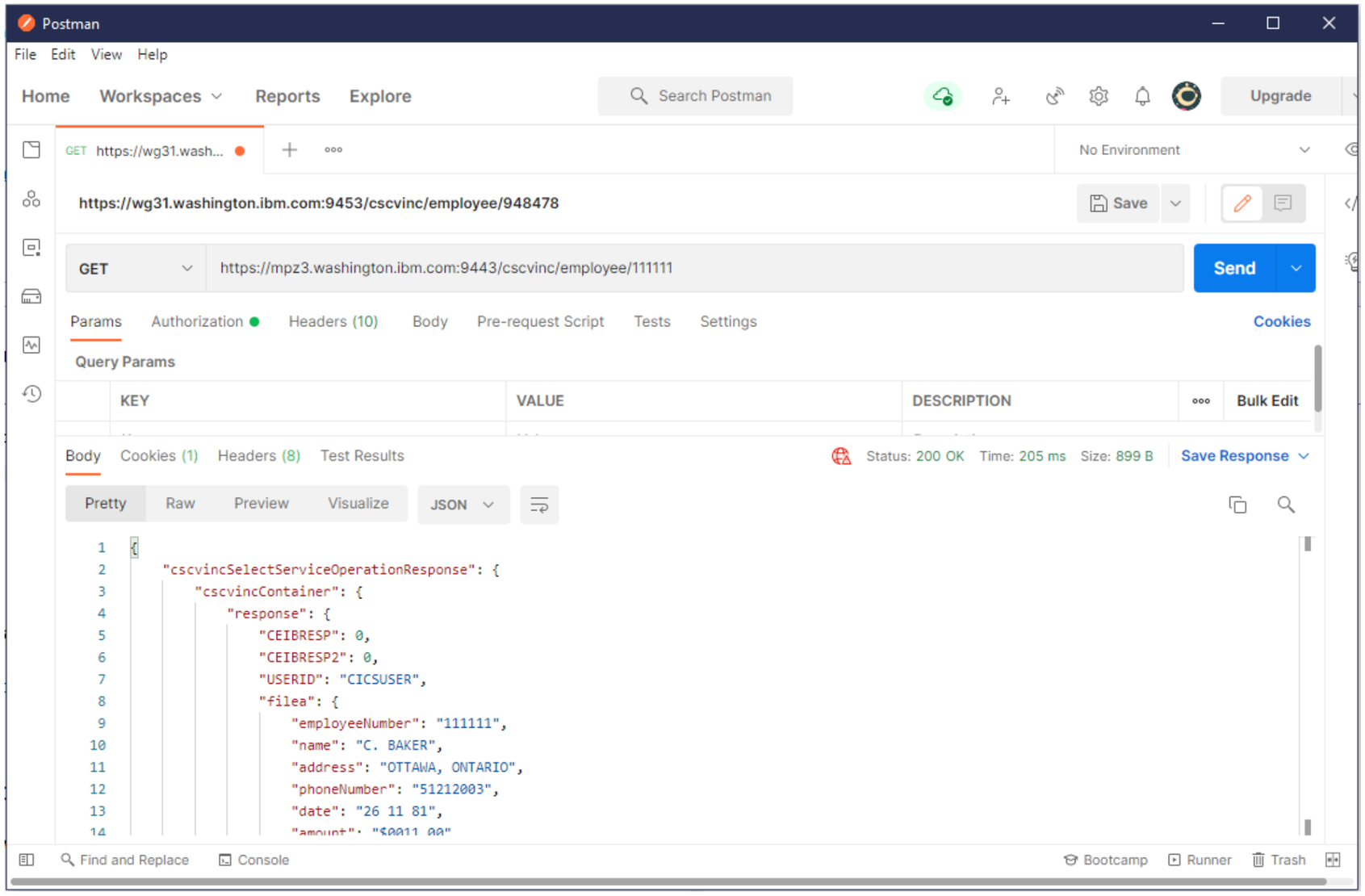
<webApplication id="cics" contextRoot="/cics" name="cicsAPI"
location="${server.config.dir}apps/cscvinc.war"/>
<webApplication id="db2" contextRoot="/db2" name="db2API"
location="${server.config.dir}apps/employees.war"/>

mitchj@us.ibm.com

What REST test tooling is available?

mitchj@us.ibm.com

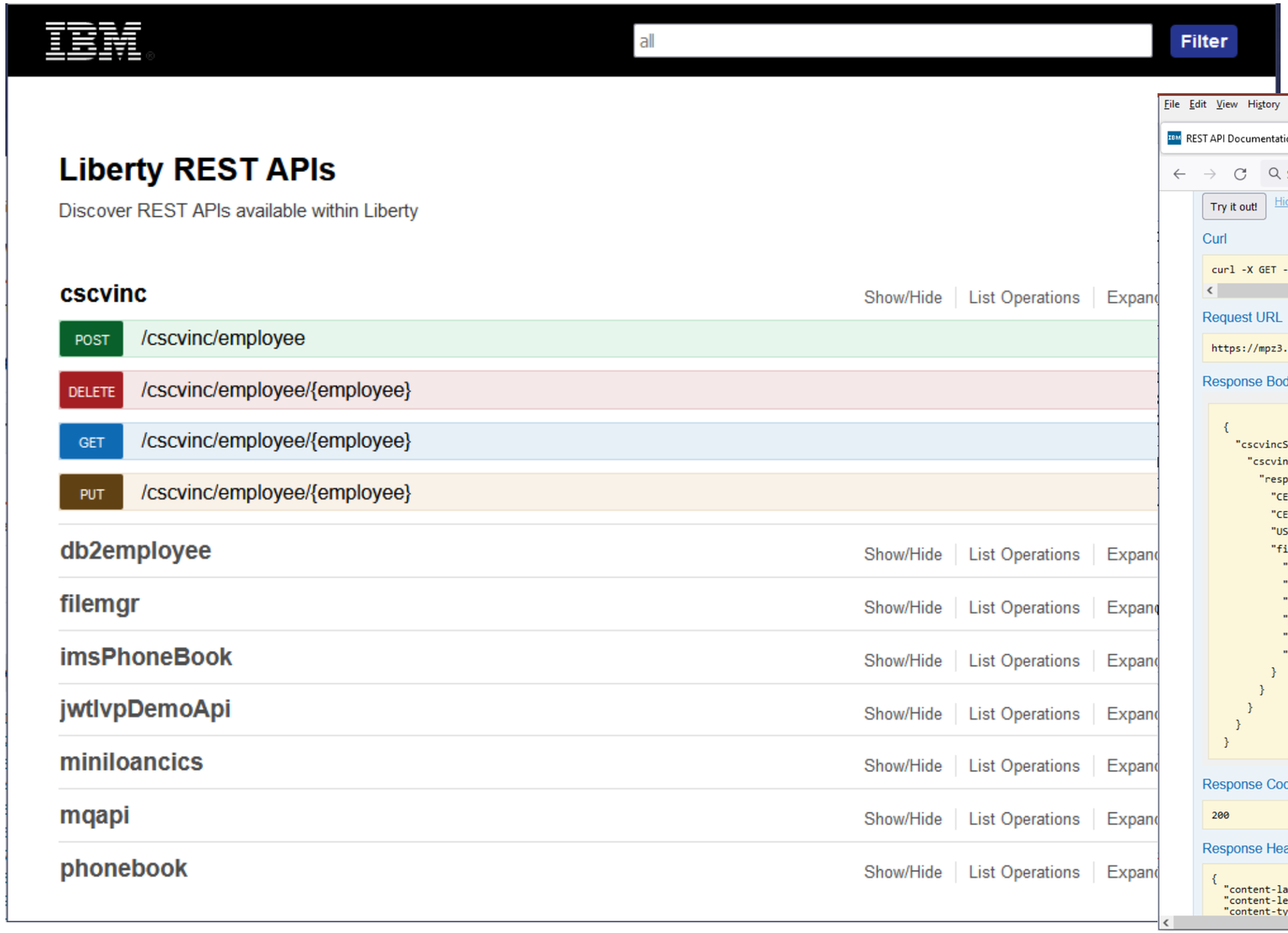
API Testing with Postman

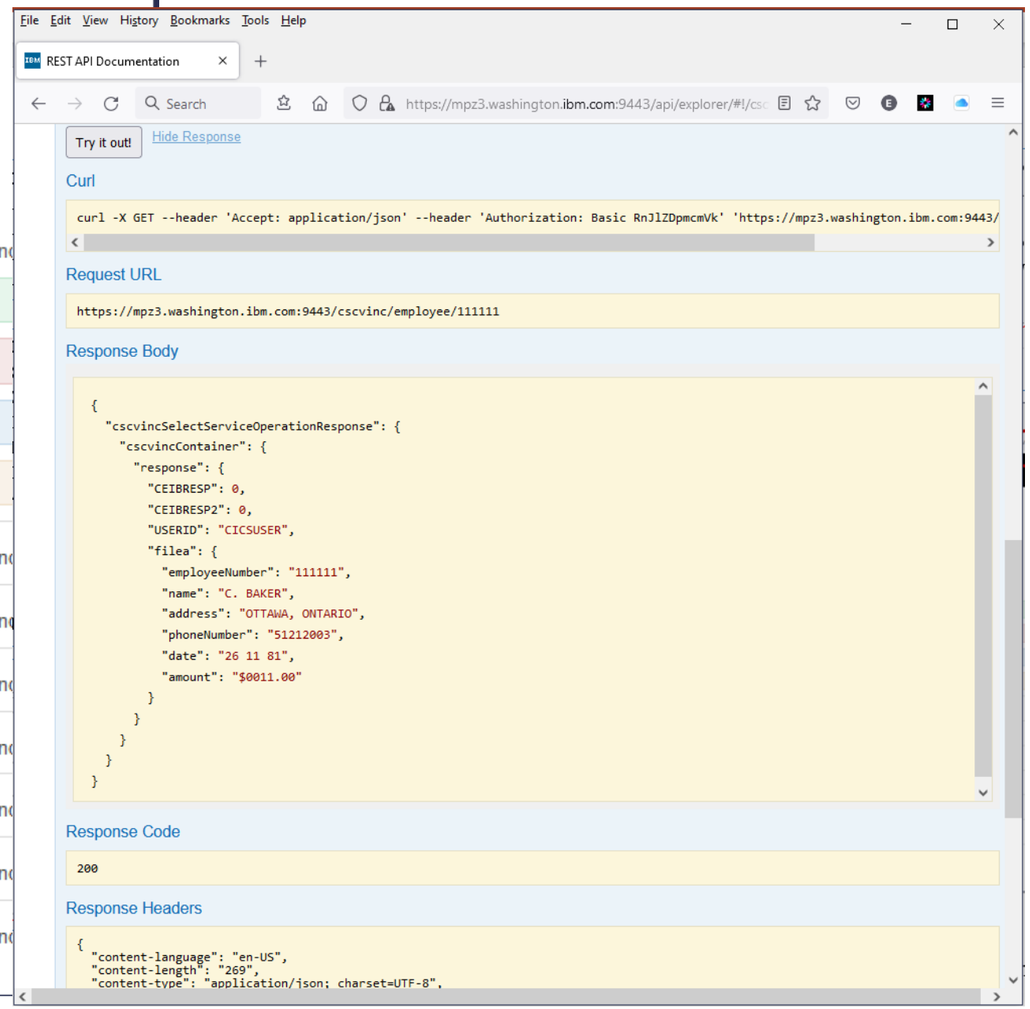


https://www.postman.com/downloads/

mitchj@us.ibm.com

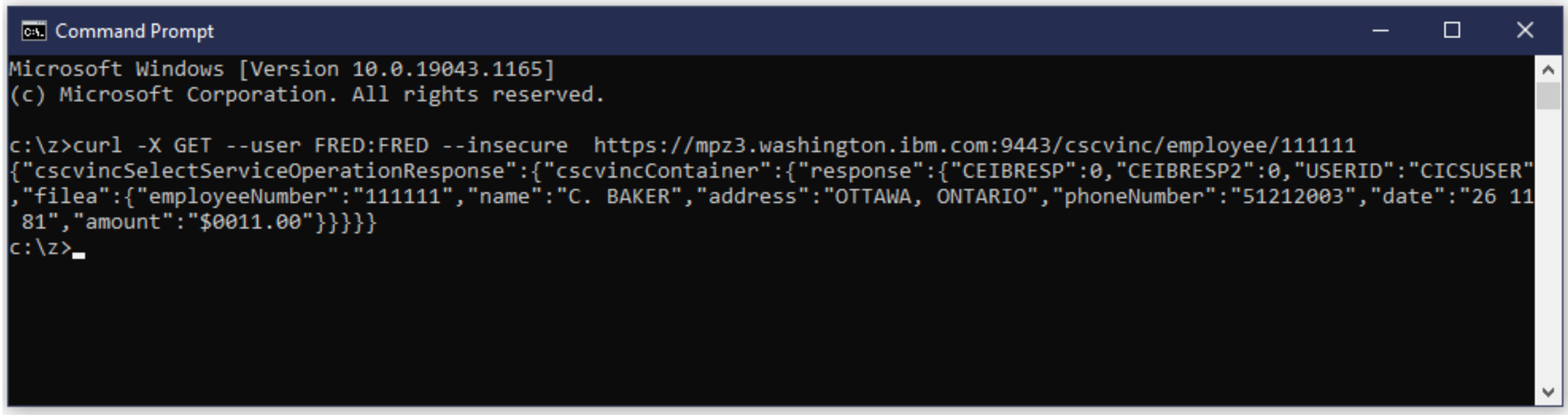
API Testing with the API Explorer (zCEE V3.0.48)





mitchj@us.ibm.com

API Testing with cURL



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=sto+
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=EXECSYS
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

mitchj@us.ibm.com

https://www.rocketsoftware.com/platforms/ibm-z/curl-for-zos

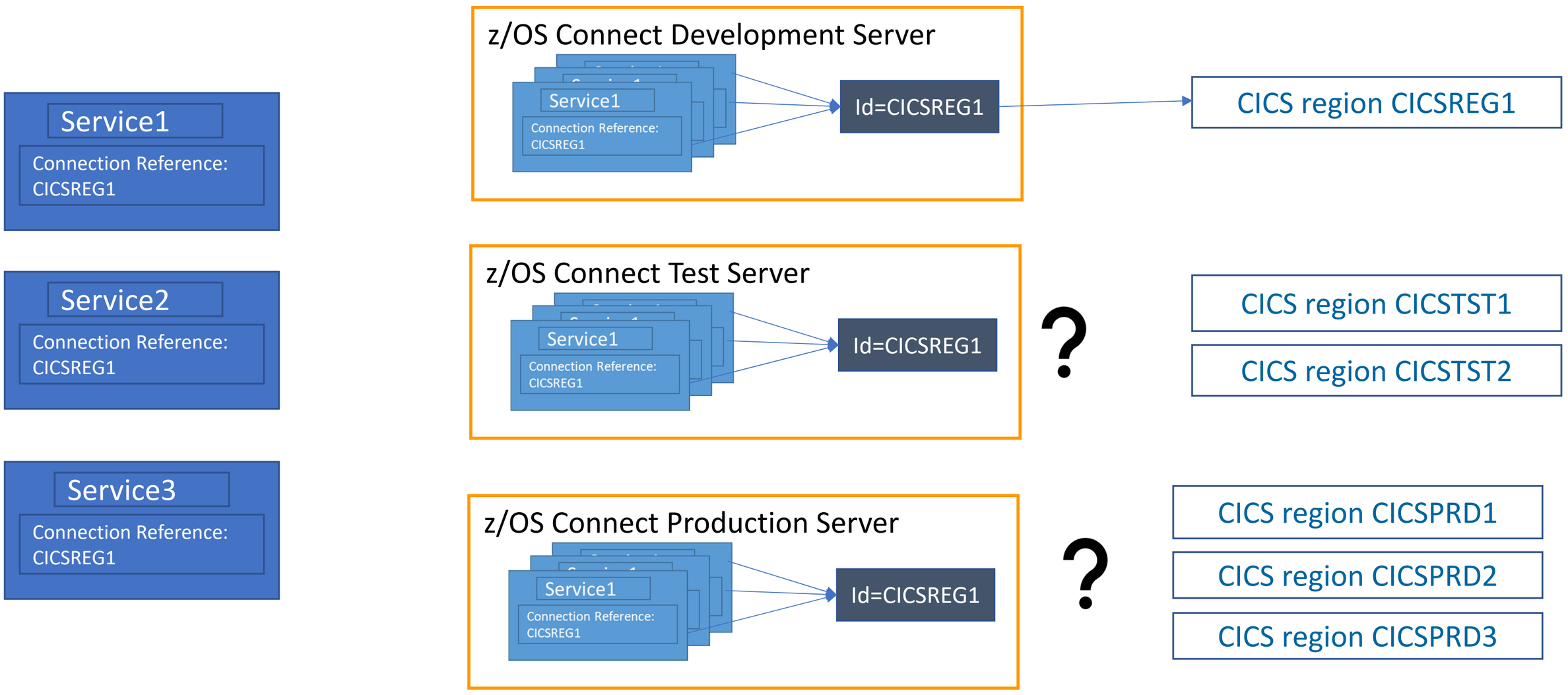
Connection References

Carefully consider the names used for connections

mitchj@us.ibm.com

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

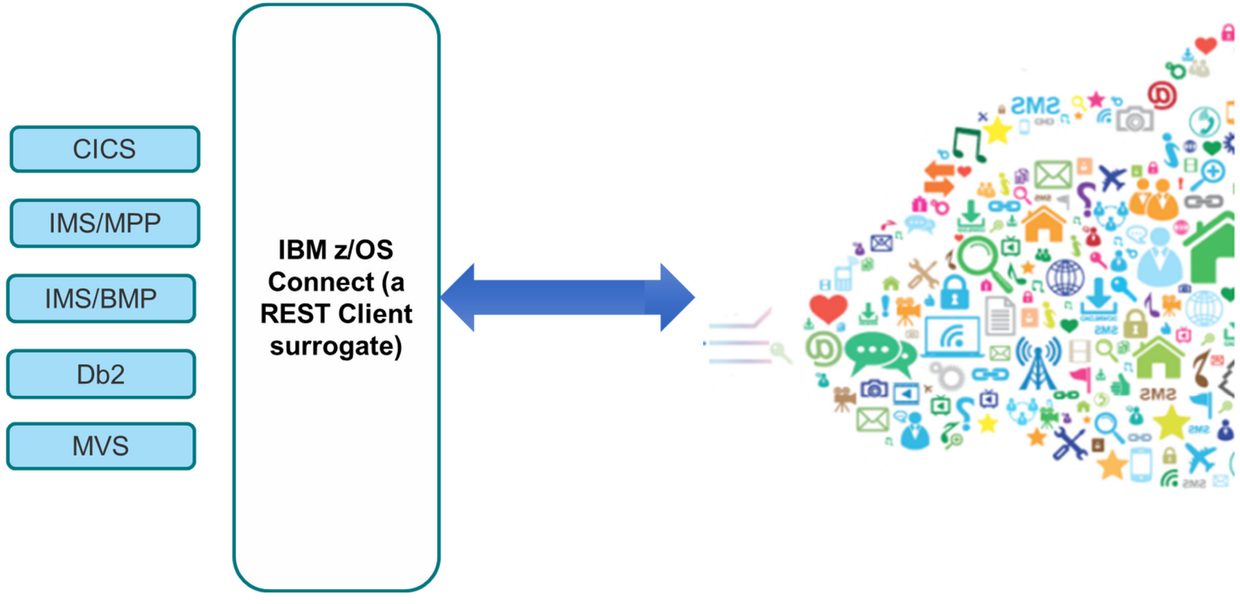
Don’t couple service and API requester connection names to specific systems or endpoints



mitchj@us.ibm.com

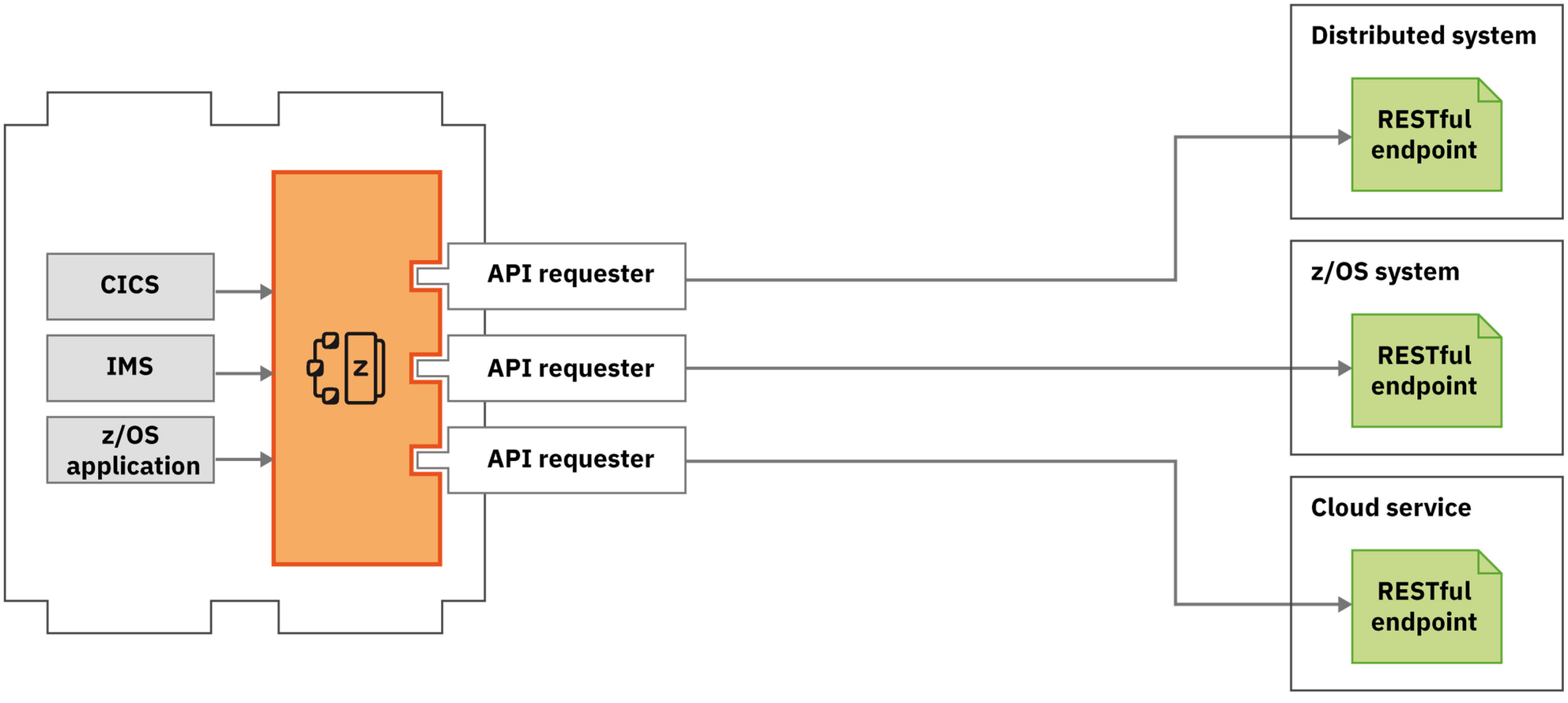
/api_toolkit/apiRequesters

Quick and easy **API mapping.**



mitchj@us.ibm.com

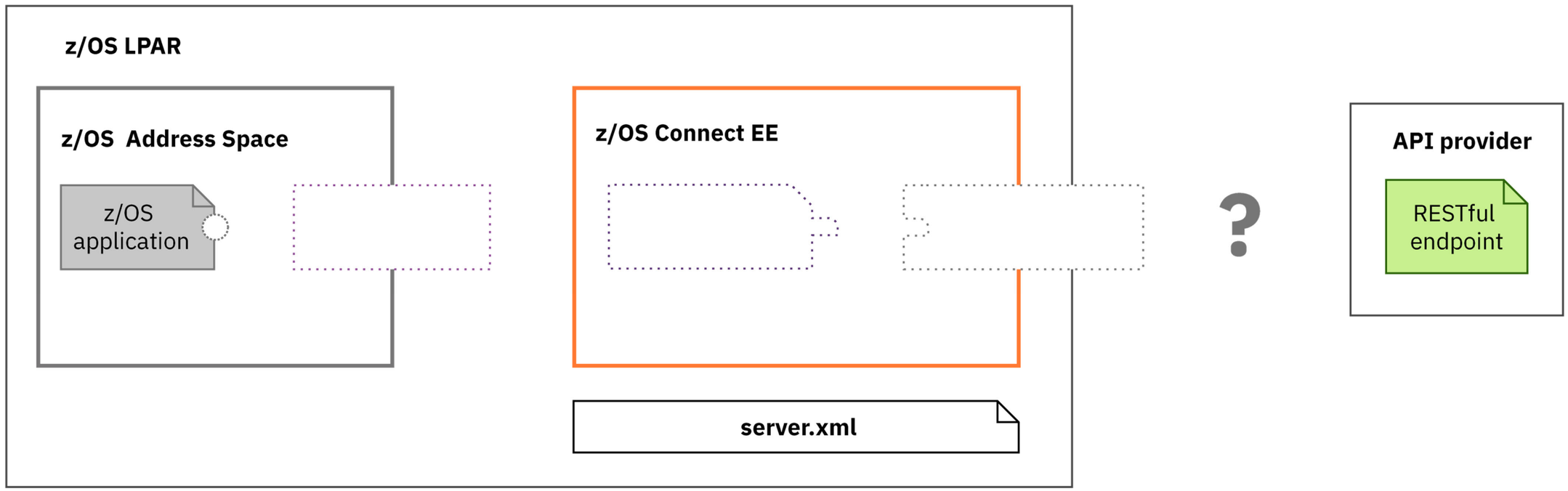
Use API requester to call external APIs from z/OS assets



mitchj@us.ibm.com

Steps to calling an external API

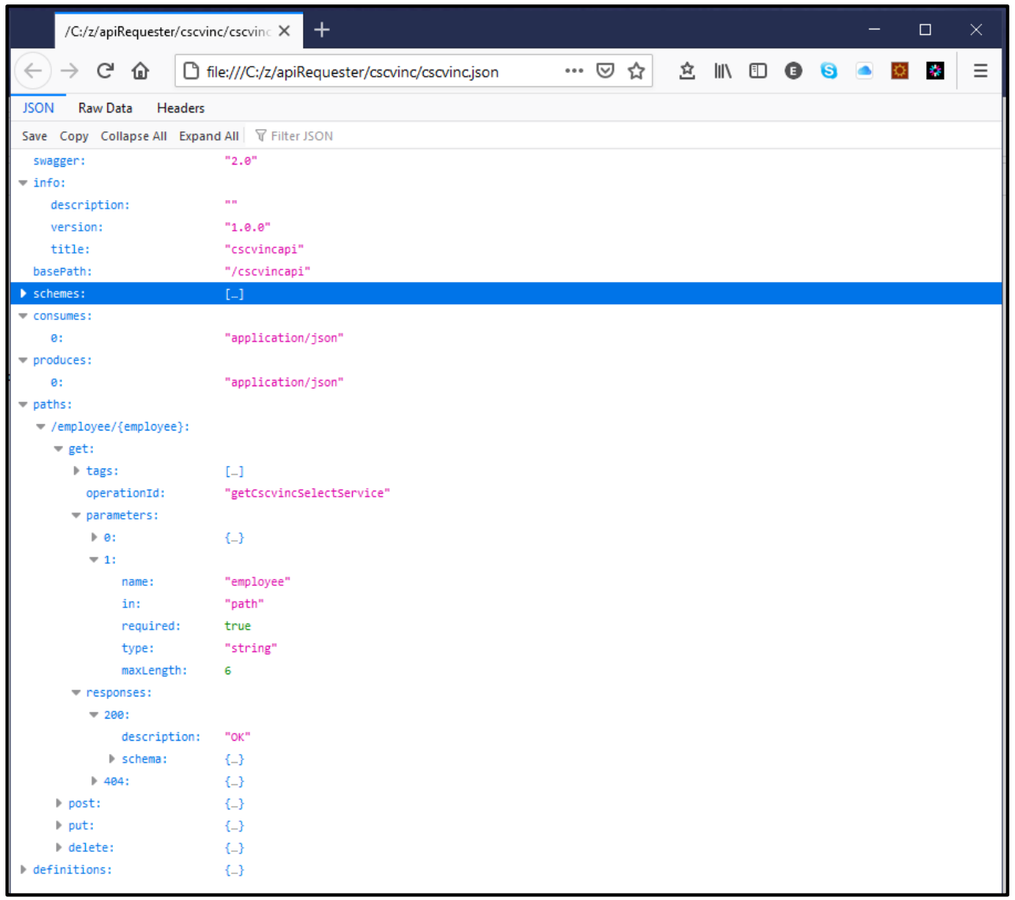
Starting point

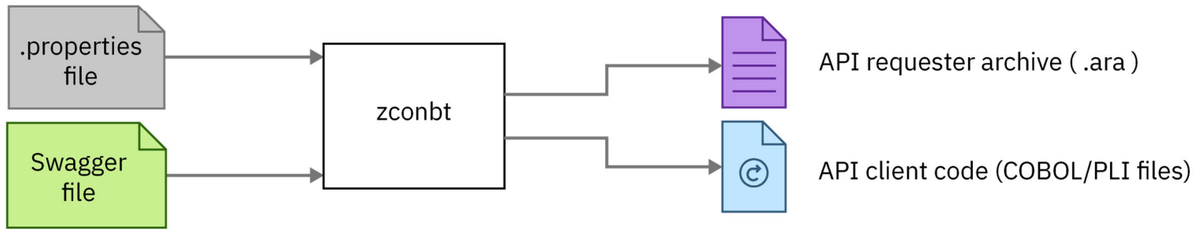


mitchj@us.ibm.com

Steps to calling an external API

Generate API requester archive and API client code from Swagger





.properties file#

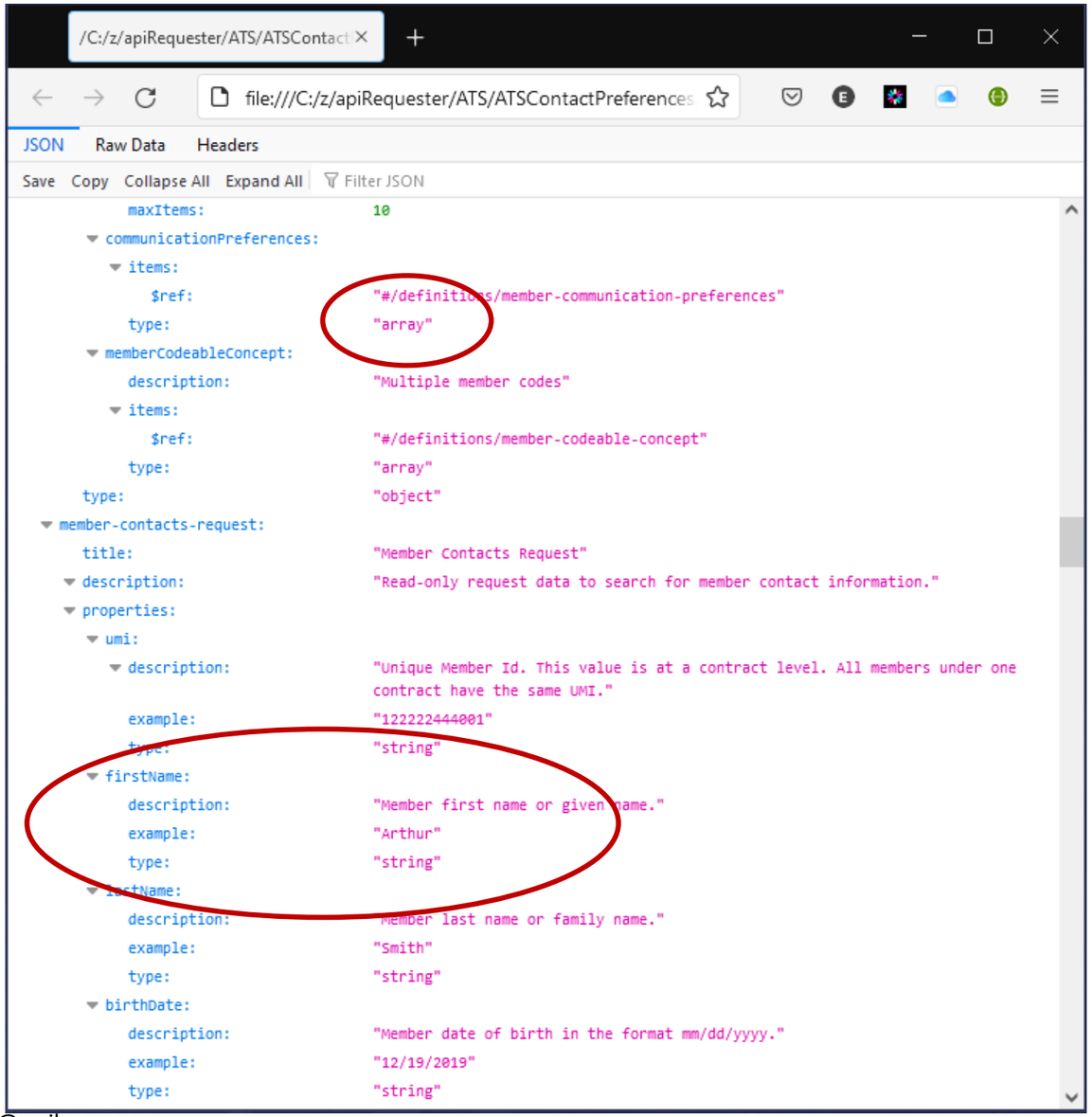
```
apiDescriptionFile=./cscvinc.json
dataStructuresLocation=./syslib
apiInfoFileLocation=./syslib
logFileDirectory=./logs
language=COBOL
connectionRef=cscvincAPI
requesterPrefix=csc
```

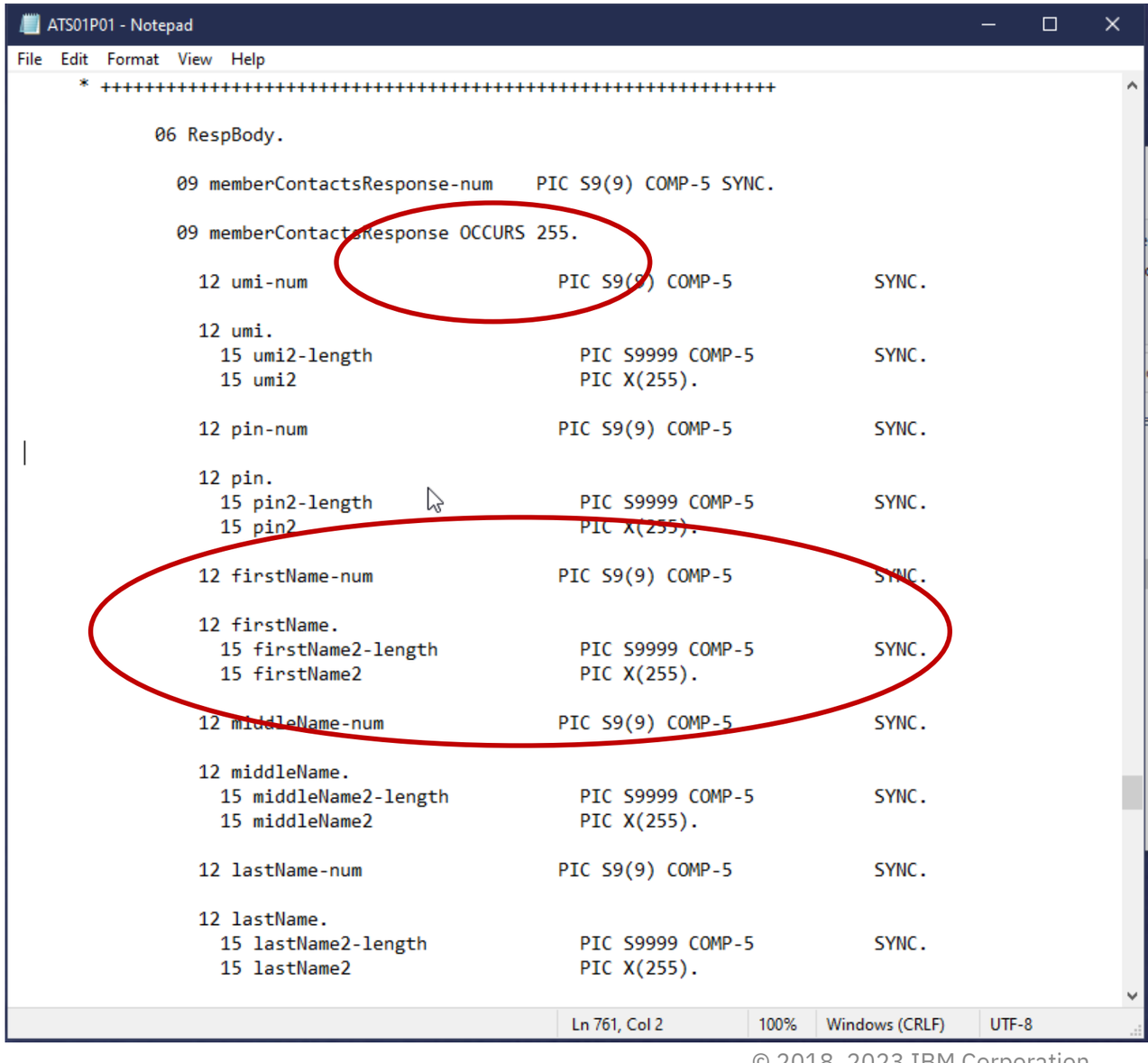
#Additional property file attributes, e.g., *defaultCharacterMaxLength*, *defaultArrayMaxItems*, etc. are described at **The build toolkit properties file** article at URL https://www.ibm.com/docs/en/zosconnect/3.0?topic=toolkit-build-properties-file

mitchj@us.ibm.com

COBOL working storage implications

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

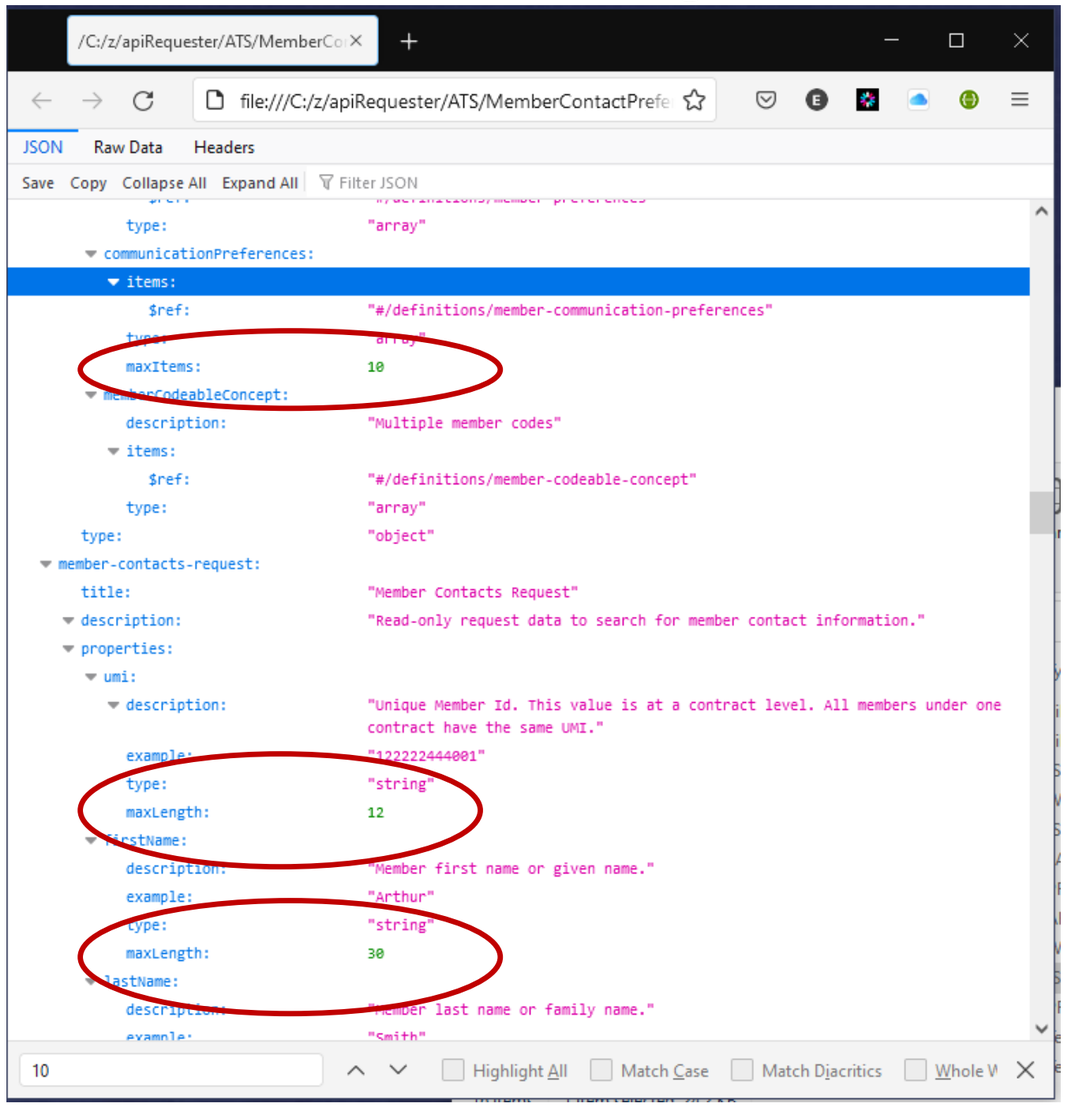


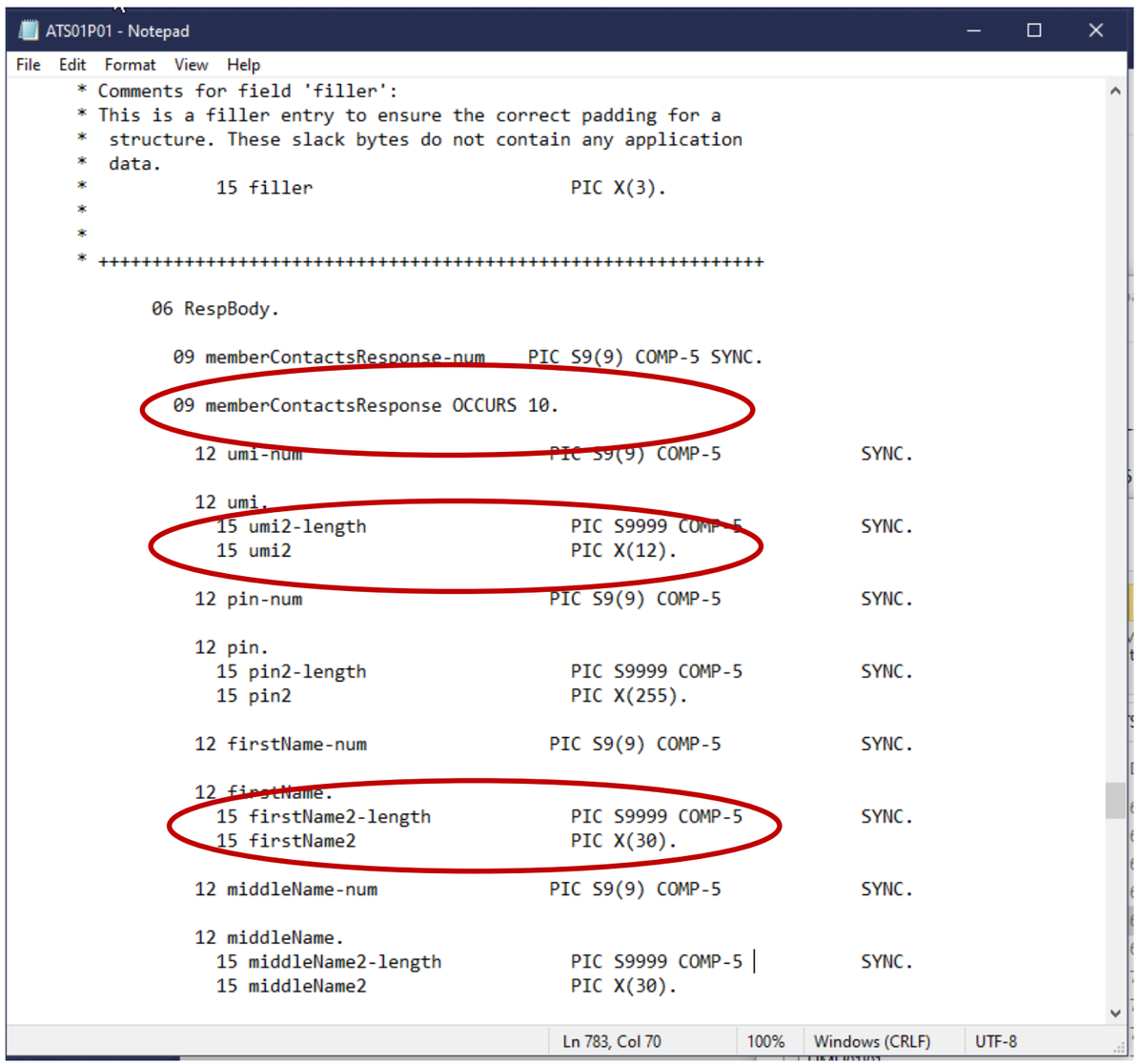


mitchj@us.ibm.com

Consider adding constraints to the properties

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





mitchj@us.ibm.com

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.
  15 firstName2                 PIC X(30).
```

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

12 firstName                    PIC X(31).
```

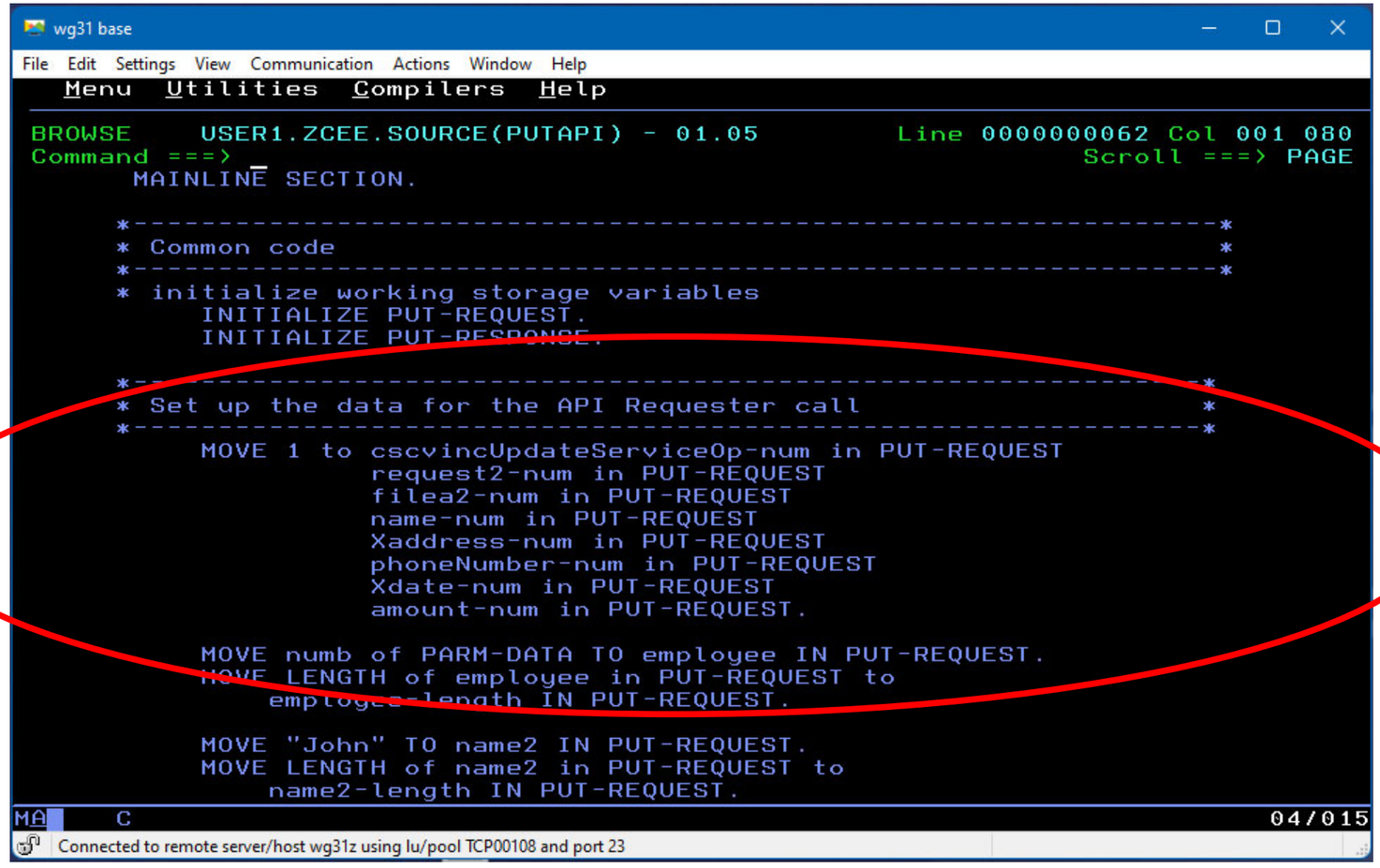
```
MOVE 0 to ws-length
MOVE LENGTH OF firstName2 to firstName2-length.
INSPECT FUNCTION REVERSE (firstName2)
      TALLYING ws-length FOR ALL SPACES.
SUBTRACT ws-length FROM firstName2-length.
```

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

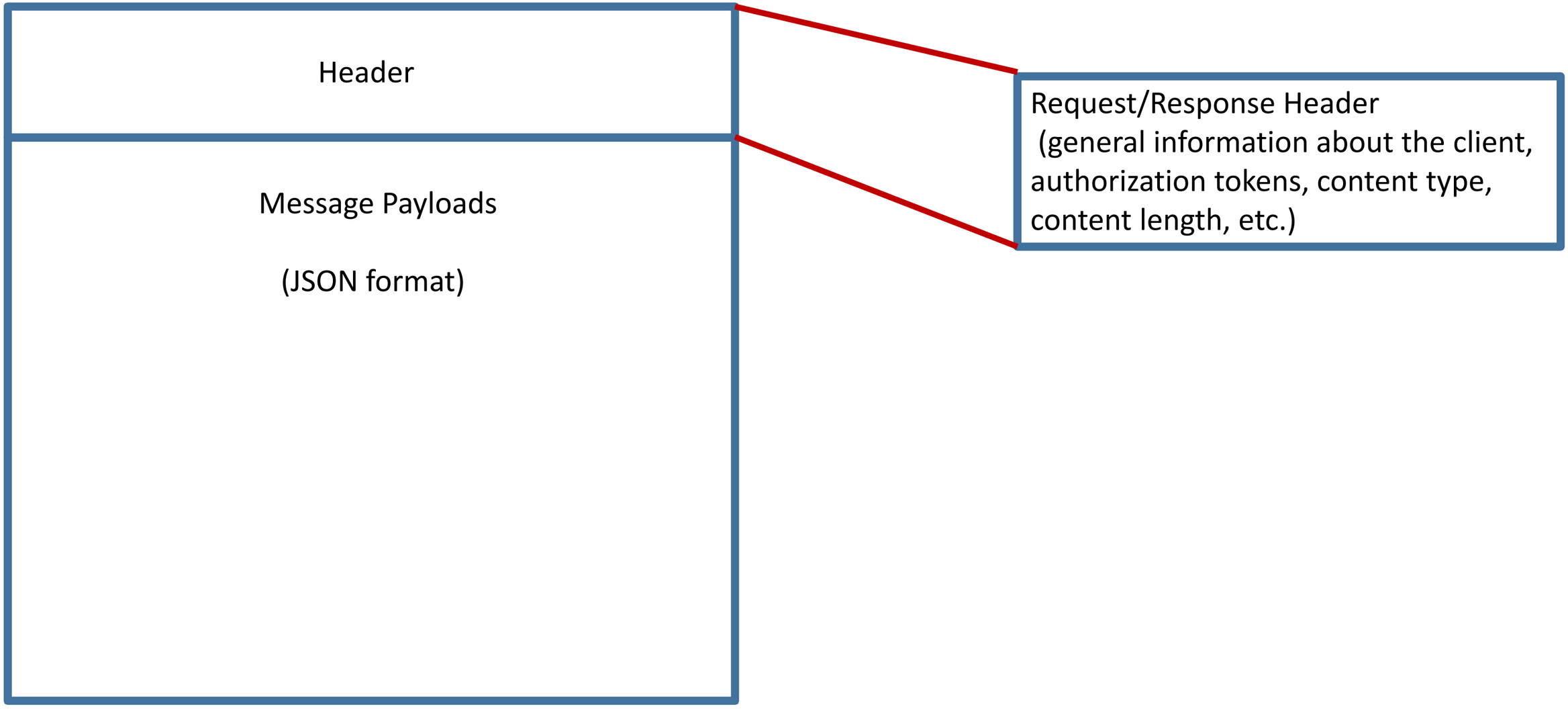
mitchj@us.ibm.com

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.



Request and Response Message Layout



mitchj@us.ibm.com

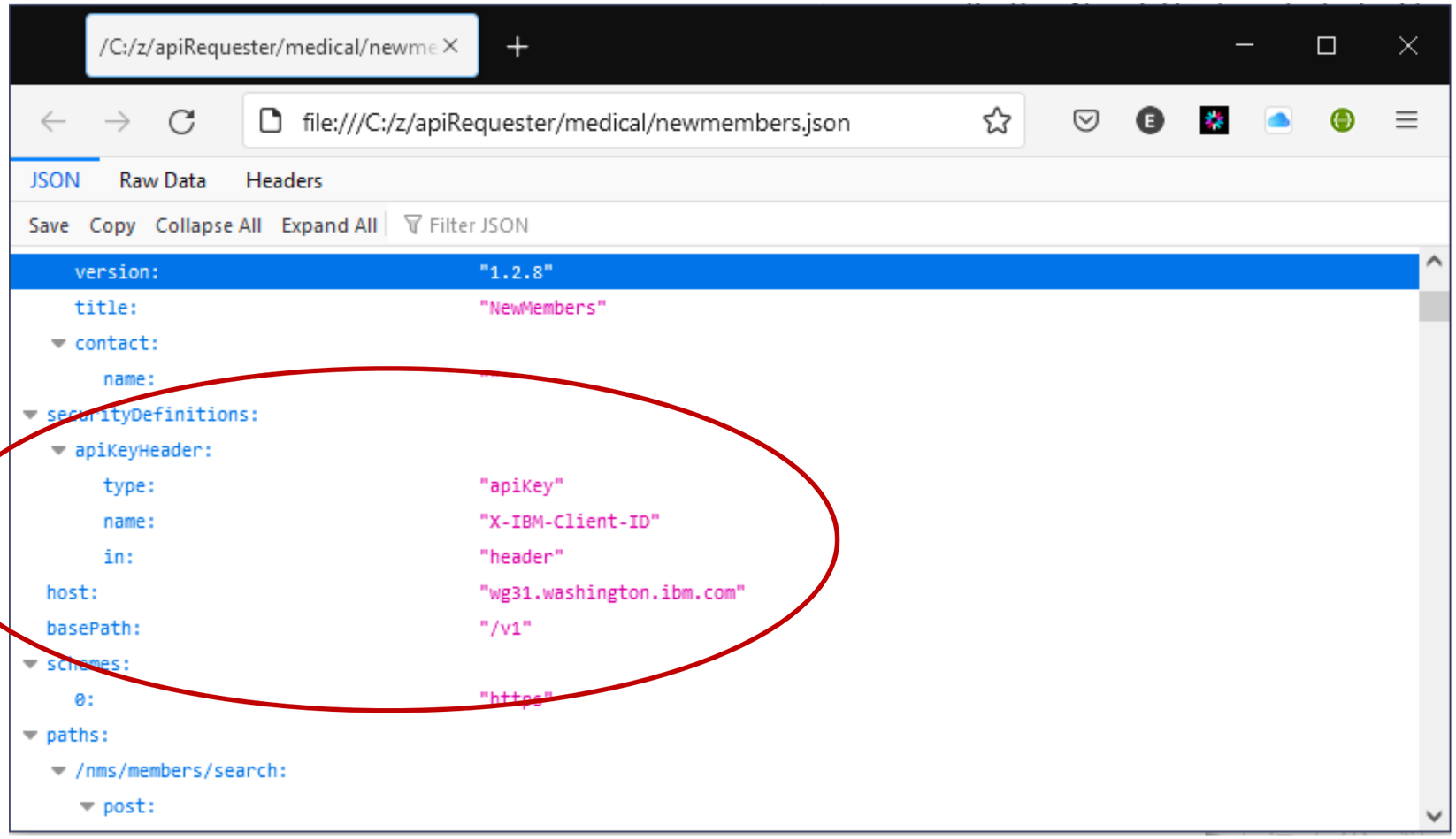
Providing an API key to the request and the application

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 . . .



mitchj@us.ibm.com

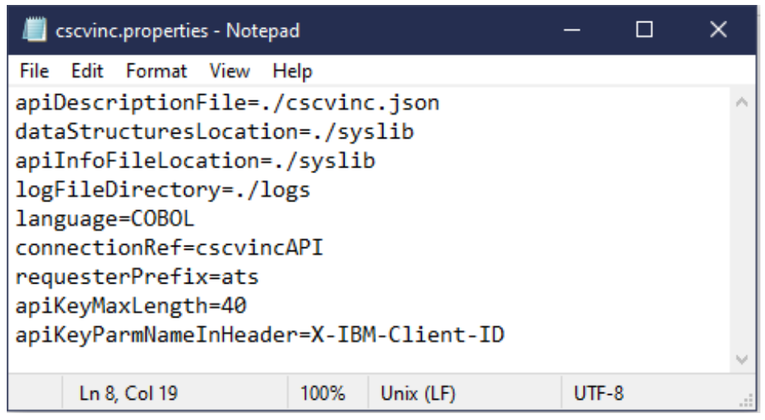
Or by using generation properties related to API keys

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.



mitchj@us.ibm.com

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

request.cpy - Notepad

File Edit Format View Help

```
      *          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-IBM-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.
               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.
               12 X-HZN-ClientSessionI-length   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.
               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.
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

mpz3

File Edit Settings View Communication Actions Window Help

File Edit Edit_Settings Menu Utilities Compilers Test Help

```
EDIT       USER1.ZCEE.SOURCE(GETAPIEN) - 01.01          Columns 00001 00072
Command ===>                                              Scroll ===> PAGE
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          * Set up the data for the API Requester call                  *
000092          *-------------------------------------------------------------*
000093               MOVE employee of PARM-DATA TO employee IN GET-REQUEST.
000094               MOVE LENGTH of employee in GET-REQUEST to
000095                  employee-length IN GET-REQUEST.
000096
000097          *-------------------------------------------------------------*
000098          * Initialize API Requester PTRs & LENs                        *
000099          *-------------------------------------------------------------*
000100          * Use pointer and length to specify the location of
000101          *  request and response segment.
000102          * This procedure is general and necessary.
000103               SET BAQ-REQUEST-PTR TO ADDRESS OF GET-REQUEST.
000104               MOVE LENGTH OF GET-REQUEST TO BAQ-REQUEST-LEN.
000105               SET BAQ-RESPONSE-PTR TO ADDRESS OF GET-RESPONSE.
000106               MOVE LENGTH OF GET-RESPONSE TO BAQ-RESPONSE-LEN.
000107
000108          *-------------------------------------------------------------*
```

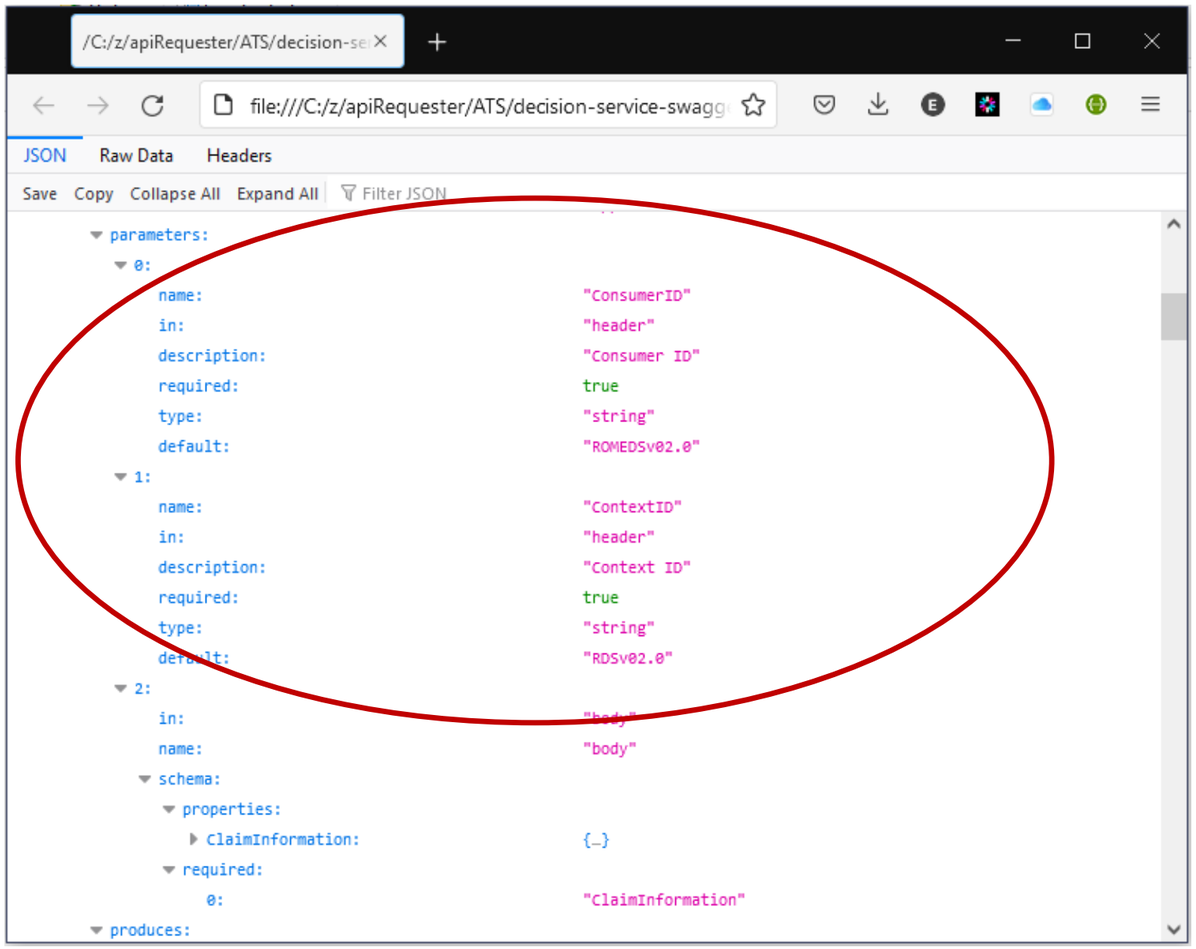
MA A 13/002

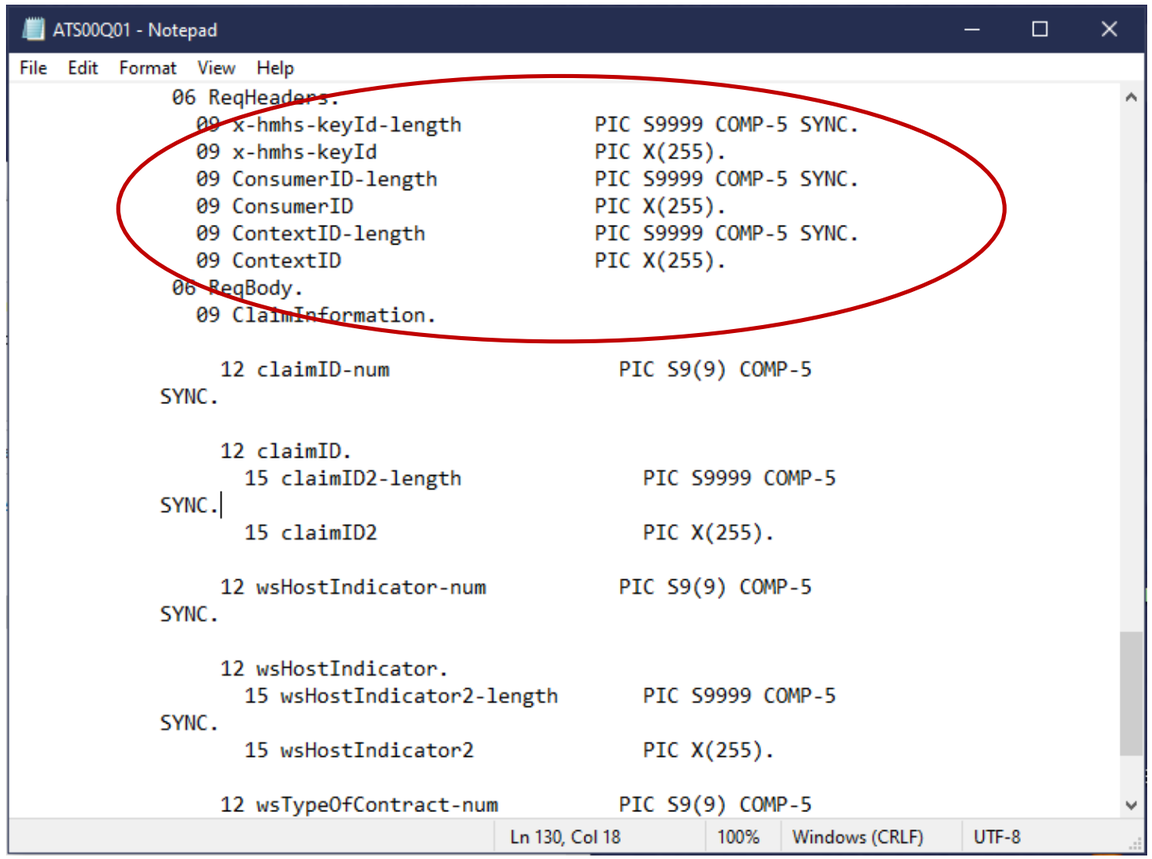
Connected to remote server/host mpz3 using lu/pool MPZ30019 and port 23

mitchj@us.ibm.com

Additional Swagger header properties

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





mitchj@us.ibm.com

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.
```

mitchj@us.ibm.com

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
//SYSTSPRT 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.

Tech-Tip: Copy books naming convention

- Up to three copy books are generated for each method of each API found in the Swagger document.
  - In the previous example, there were 4 APIs with each having 1 method for a total of 12 copy books.
  - If there is no request message or no response message, then no copy book will be generated. But the messages stills need to have addressable storage in the application's working area.

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

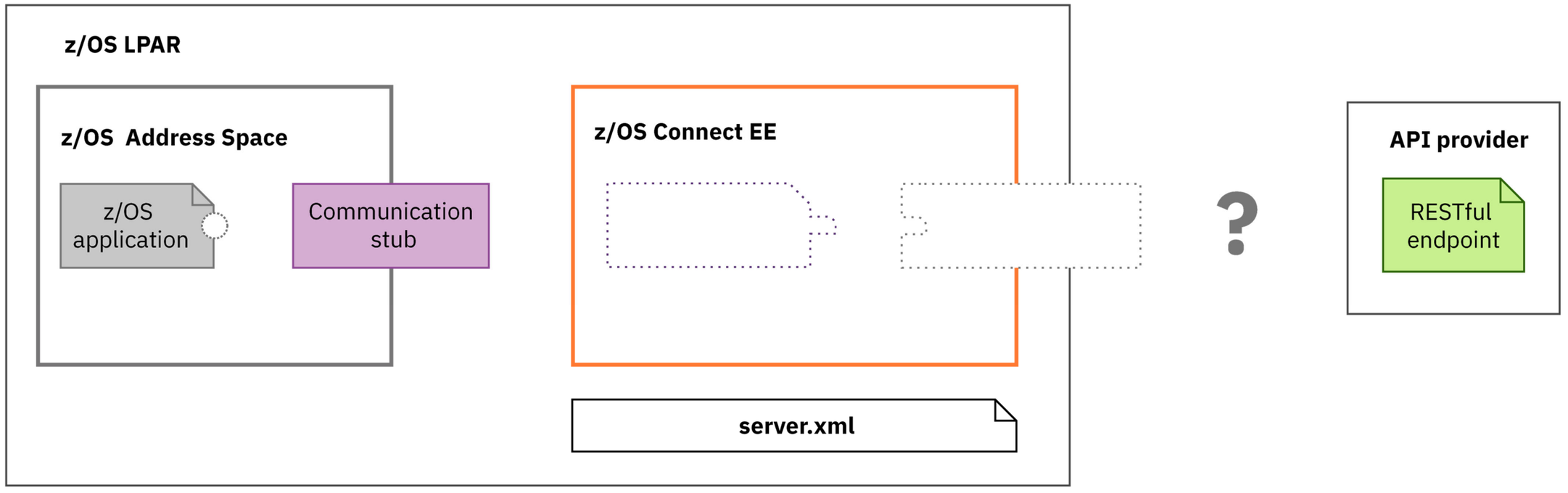
- The naming convention for the generated COBOL copy books is based on the *requesterPrefix* value specified in the properties file. That value was set to CSC in this case, e.g., CSC######. The next 2 characters in the name are assigned sequentially as each API and method is processed, e.g., CSC00### and CSC01###, and CSC02###.

- The next character will be either a Q, P or an I. A “Q” for a re**q**uest copy book, the “P” for a res**p**onse copy book and the “I” for the copy book which contains **i**nformation, e.g., method, path name etc. derived from the Swagger document

mitchj@us.ibm.com

Steps for involving an external API from a COBOL progam

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.
```

mitchj@us.ibm.com

ibm.biz/zosconnect-configure-comms-stub

Steps to calling an external API

Include the generated copy books in a COBOL program

GETAPI

```
      * 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
```

API-REQUEST

CSC00I01 | CSC00Q01

```
      * 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

```
      *
      * ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

           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.
```

API-INFO-OPER1

CSC00I01

```
           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 '%2Fcscvincapi%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.
```

mitchj@us.ibm.com

Steps to calling an external API

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

GETAPI

```
*-------------------------------------------------------------*
* 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
```

CSC00I01

```
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 '%2Fcscvincapi%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.
```

CSC00I01 CSC00Q01

```
* 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).
```

CSC00I01 CSC00Q01 CSC00P01

```
*
* ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

       06 RespBody.

         09 cscvincSelectServiceOp-num    PIC S9(9) COMP-5 SYNC.

         09 cscvincSelectServiceOperatio.
           12 Container1.

              15 RESPONSE-CONTAINER2-num       PIC S9(9) COMP-5
SYNC.
```

mitchj@us.ibm.com

Steps to calling an external API

Access the results

GETAPI

```
            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.
```

mpz3

File Edit Settings View Communication Actions Window Help

Menu Utilities Compilers Help

```
BROWSE     ZCEE30.SBAQCOB(BAQRINFO)                Line 0000000066 Col 001 080
Command ===>                                         Scroll ===> PAGE

      01  BAQ-RESPONSE-INFO.
        03 BAQ-RESPONSE-INFO-COMP-LEVEL 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 ********************************
```

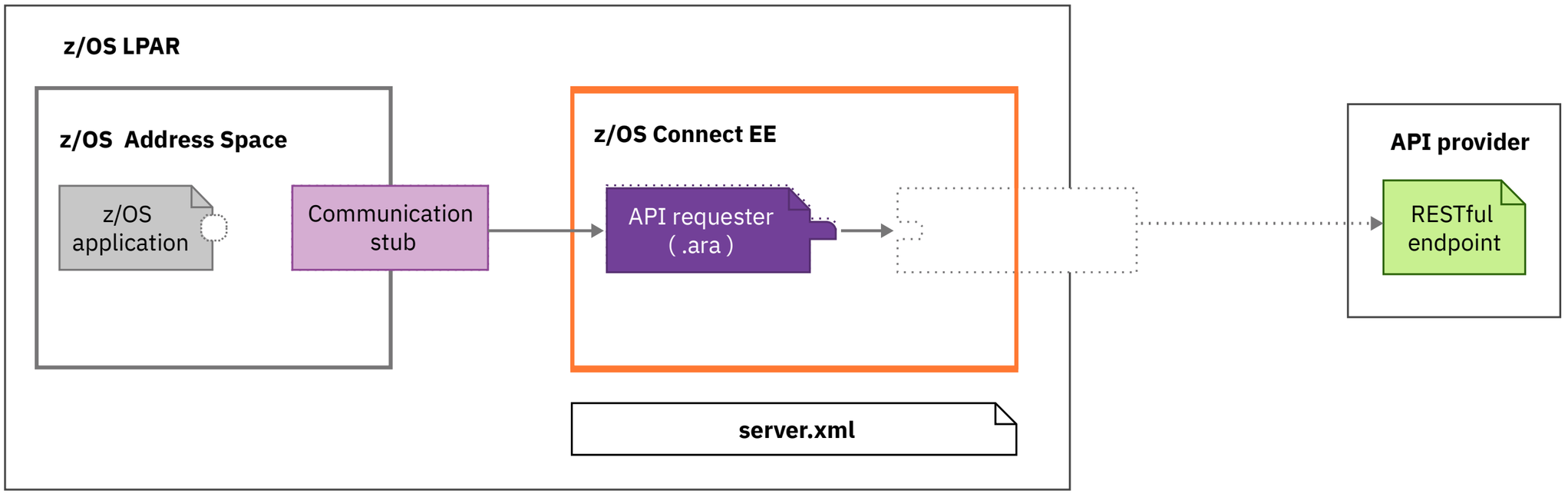
MA B 18/058

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

mitchj@us.ibm.com

Steps to calling an external API

Deploy API requester (.ara) archive

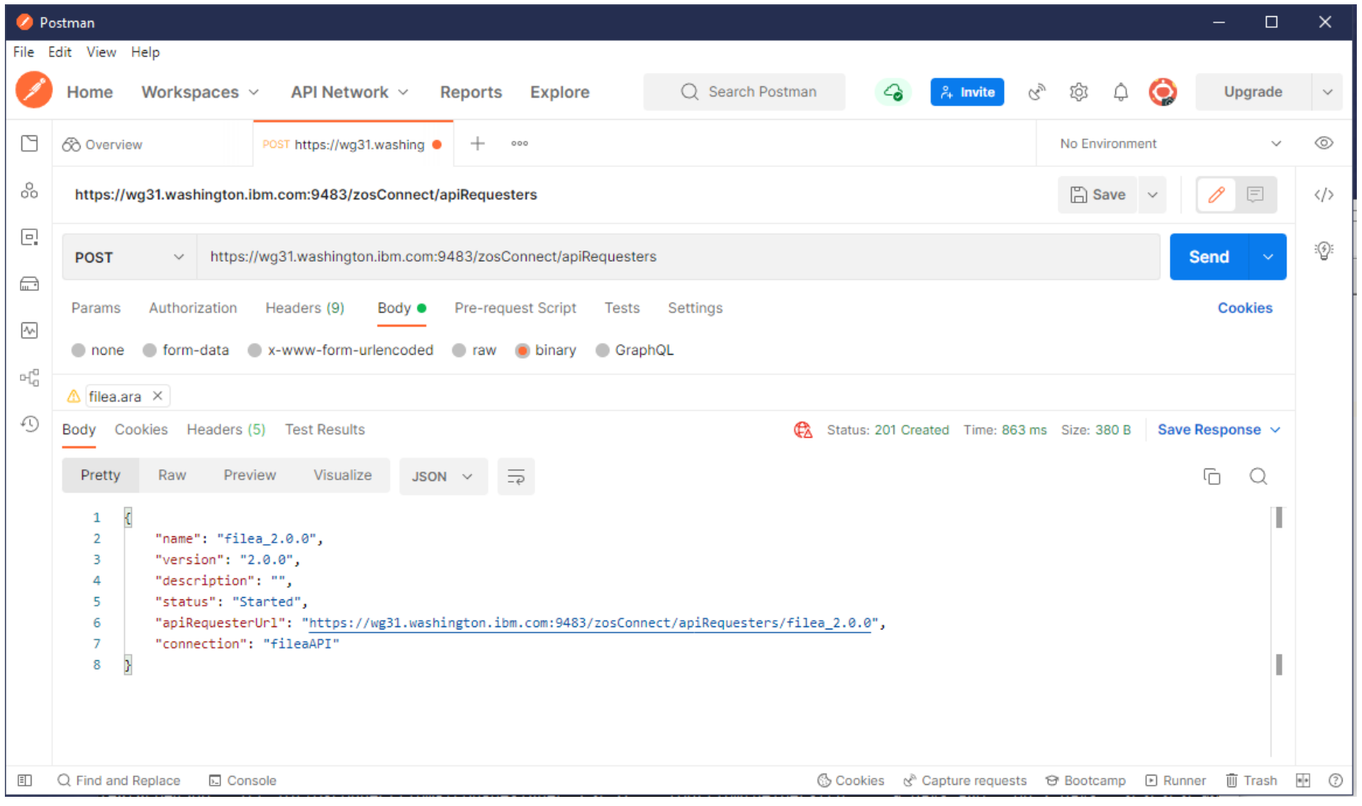


Deploy your API requester archive to the *apiRequesters* directory.

mitchj@us.ibm.com

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



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

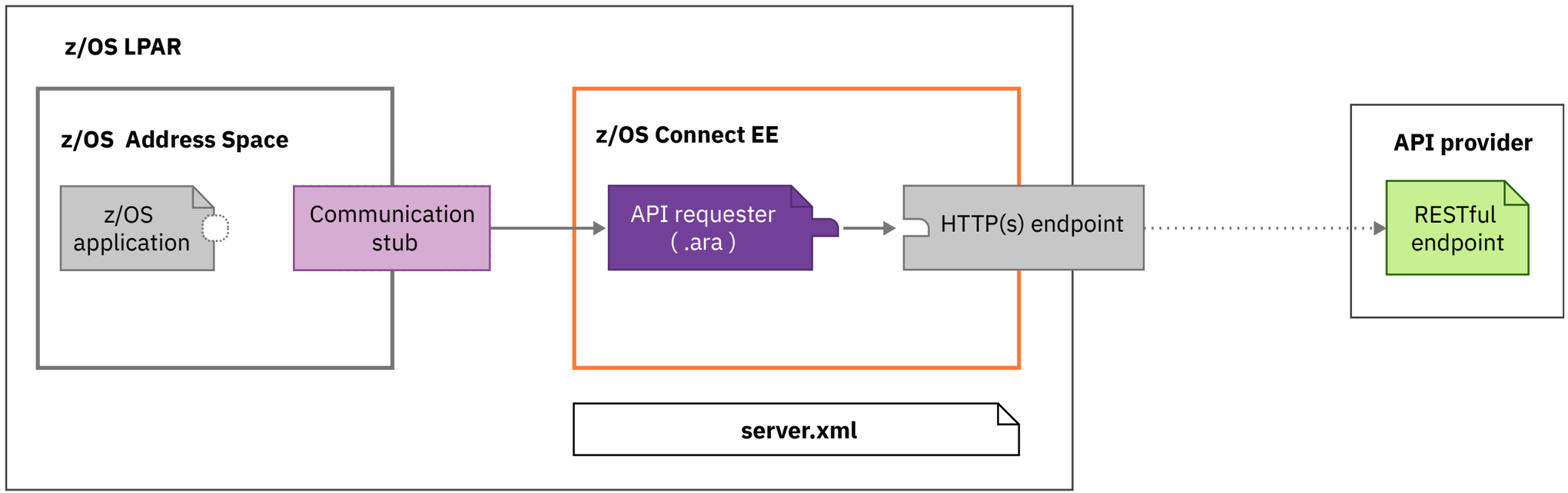
Results:

```
{"name":"filea_2.0.0","version":"2.0.0","description":"",
"status":"Started","apiRequesterUrl":"https:\/\/wg31.wash
ington.ibm.com:9483\/zosConnect\/apiRequesters\/filea_2.0
.0","connection":"fileaAPI"}
```


mitchj@us.ibm.com

Steps to calling an external API

Configure HTTP(S) endpoint configuration element



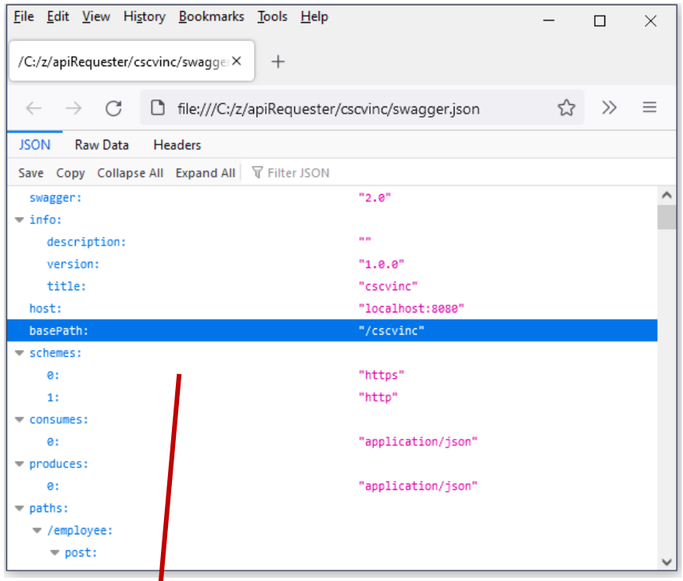
Configure the connection between z/OS Connect EE and the external API.

ibm.biz/zosconnect-configure-endpoint-connection

mitchj@us.ibm.com

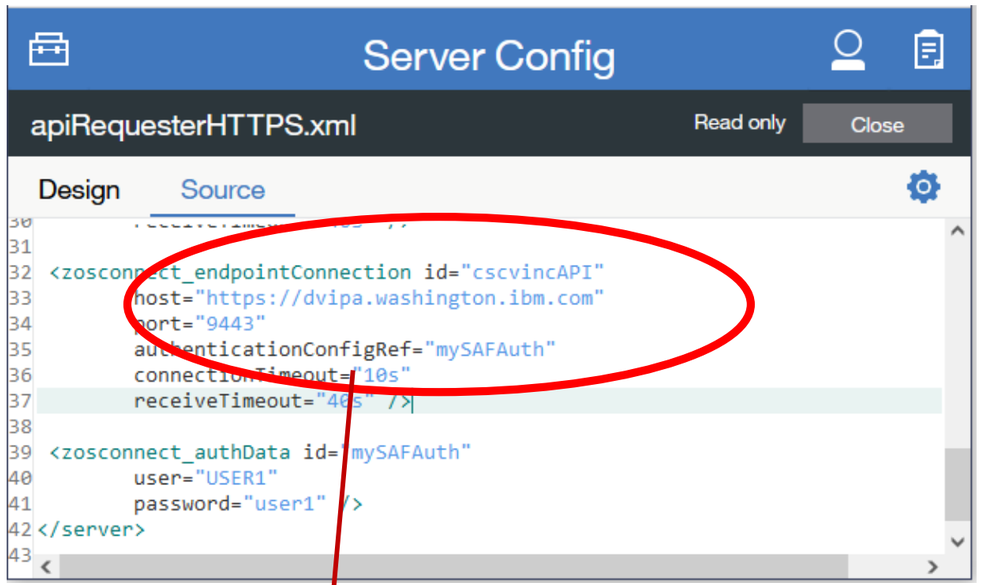
Steps to calling an external API

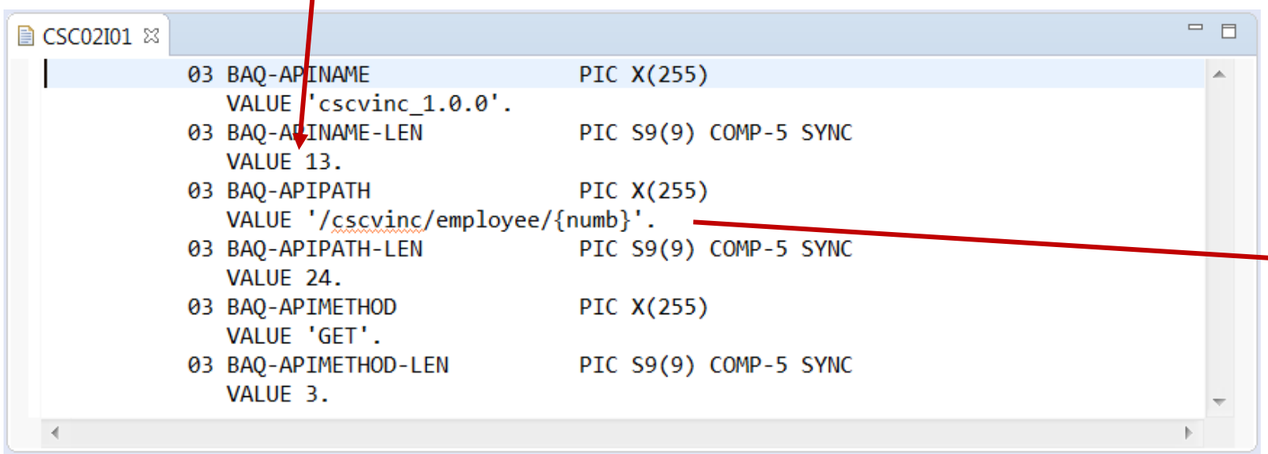
Update the server XML configuration for the endpoint



cscvinc.properties

```
connectionRef=cscvincAPI
```



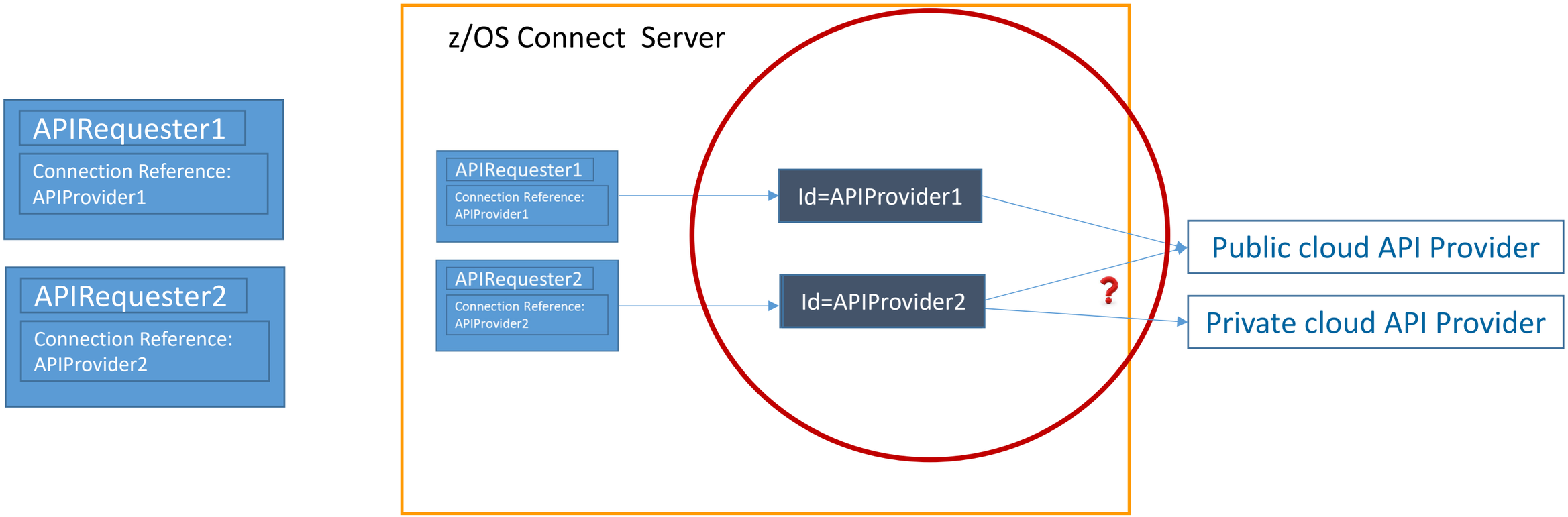


http://dvipa.washington.ibm.com:9443/cscvincapi/employee/{numb}

mitchj@us.ibm.com

Use naming conventions for connection references

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

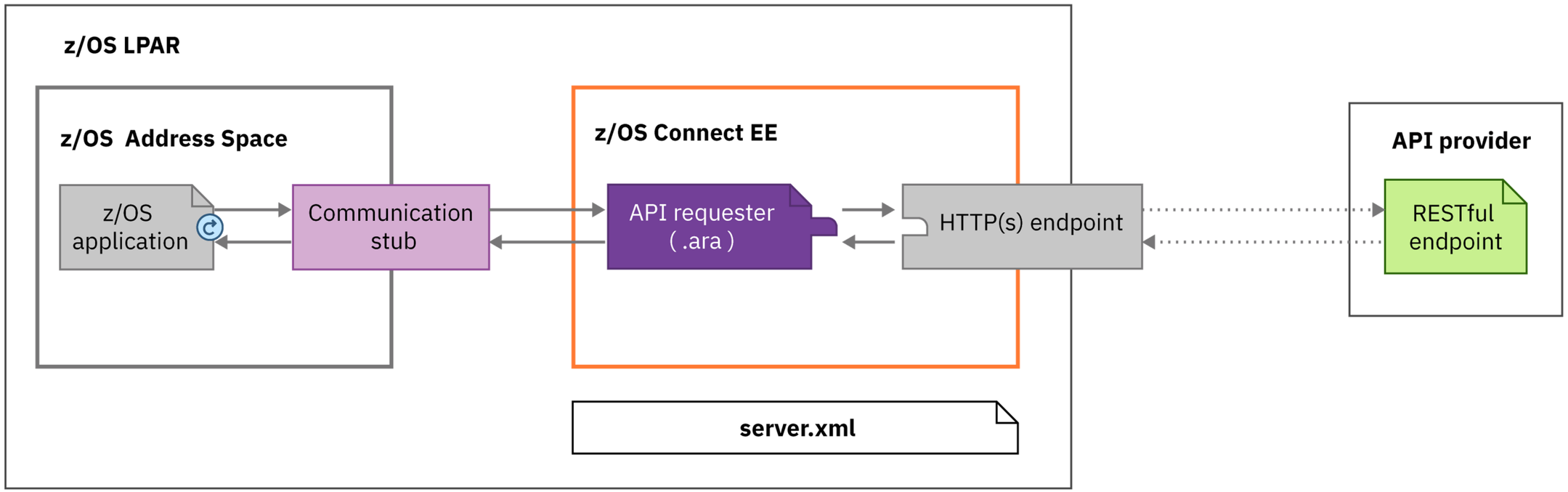



```
<zosconnect_apiRequesters>
    requireAuth="true|false"
    <apiRequester name="cscvincapi_1.0.0"
        connectionRef="APIProvider2"
</zosconnect_apiRequesters>
```

mitchj@us.ibm.com

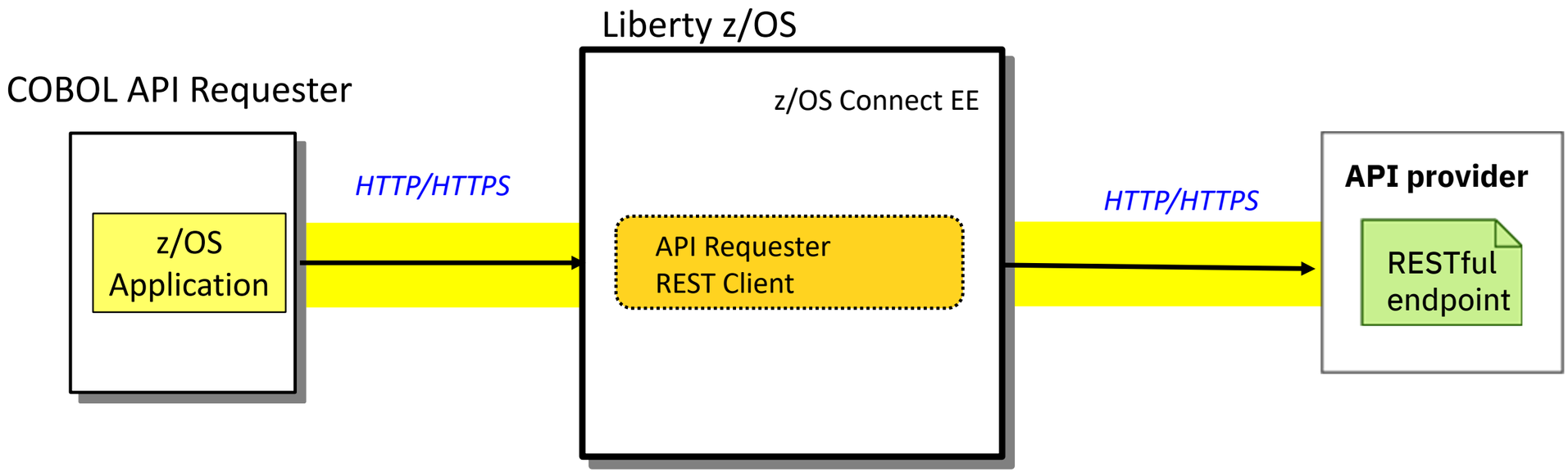
Steps to calling an external API

Done



mitchj@us.ibm.com

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

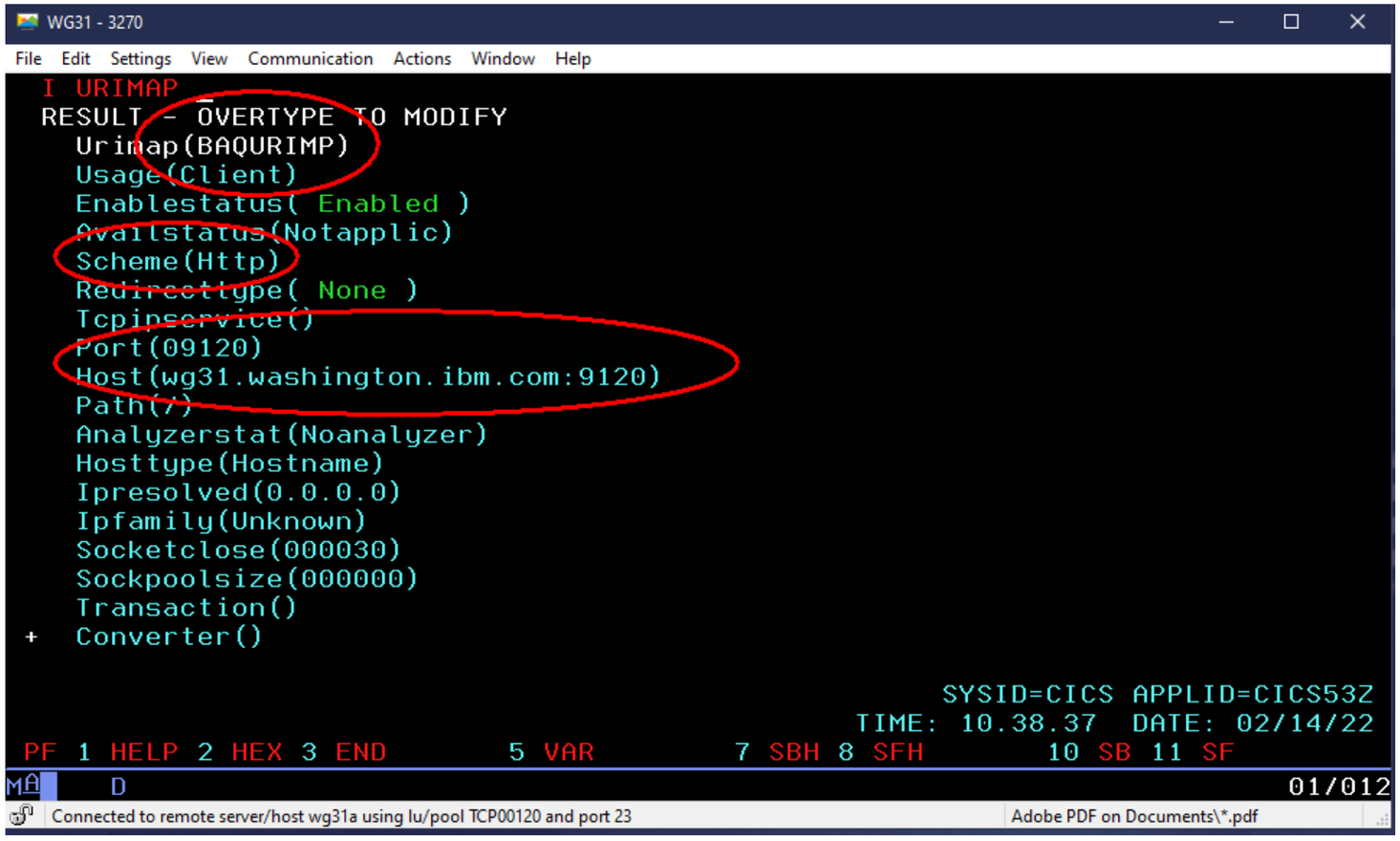
CICS HTTP connection details provided by:

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

mitchj@us.ibm.com

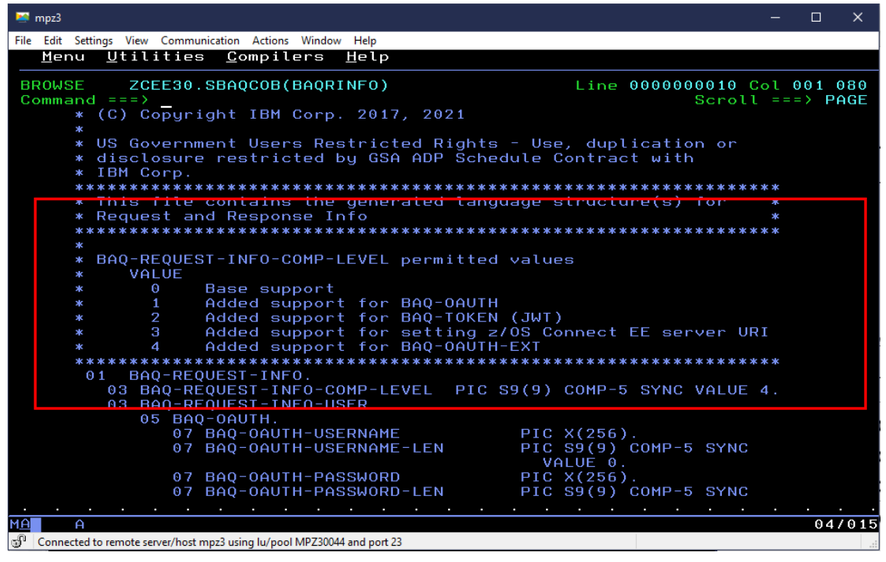
Configure connections to the z/OS API requester server

Default CICS URI MAP*



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")
```



* 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

mitchj@us.ibm.com

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:

```
//CEEOPTS  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

mitchj@us.ibm.com

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 'ATSPTKTC'.

*-----------------------------------------------------------------*

*****************************************************************
*    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(ATSPTKTC)

```
      *-----------------------------------------------------------------*
      * 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
```

mitchj@us.ibm.com

See the full source of the program at URL https://ibm.biz/BdPXny

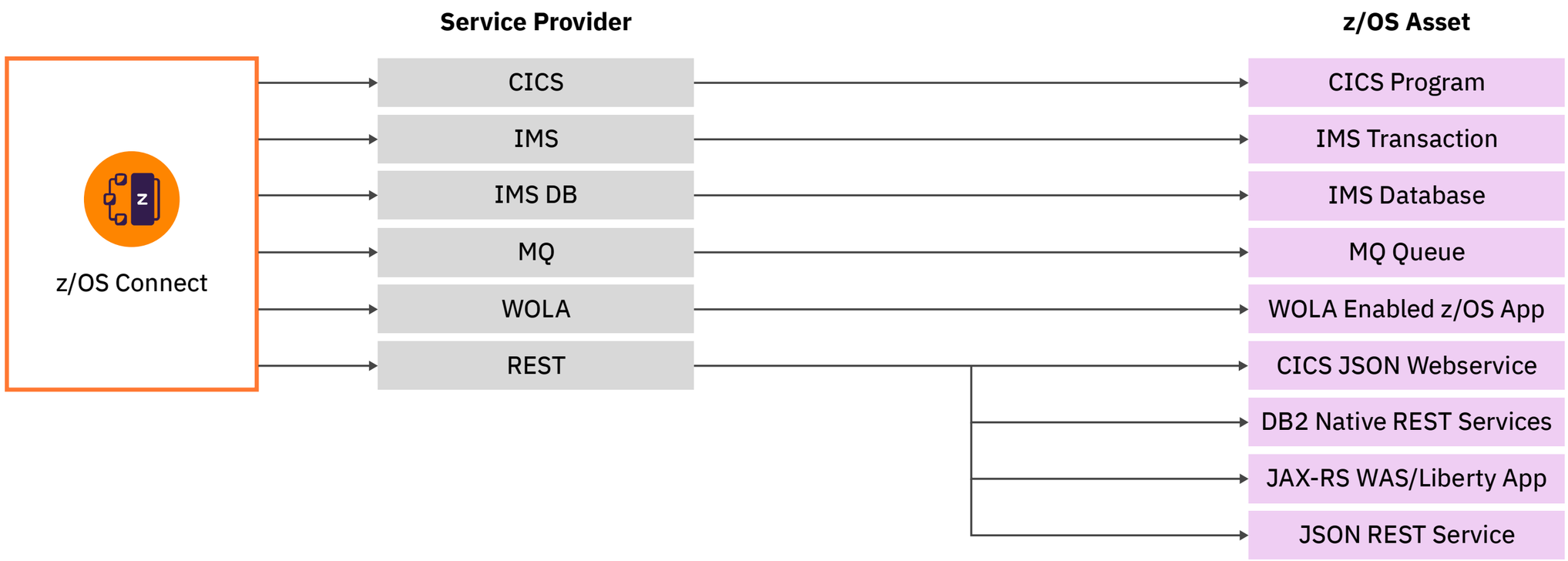
/miscellaneousTopics

performance, high availability, Liberty

mitchj@us.ibm.com

What assets can z/OS Connect EE map to?

And which service provider could I use?

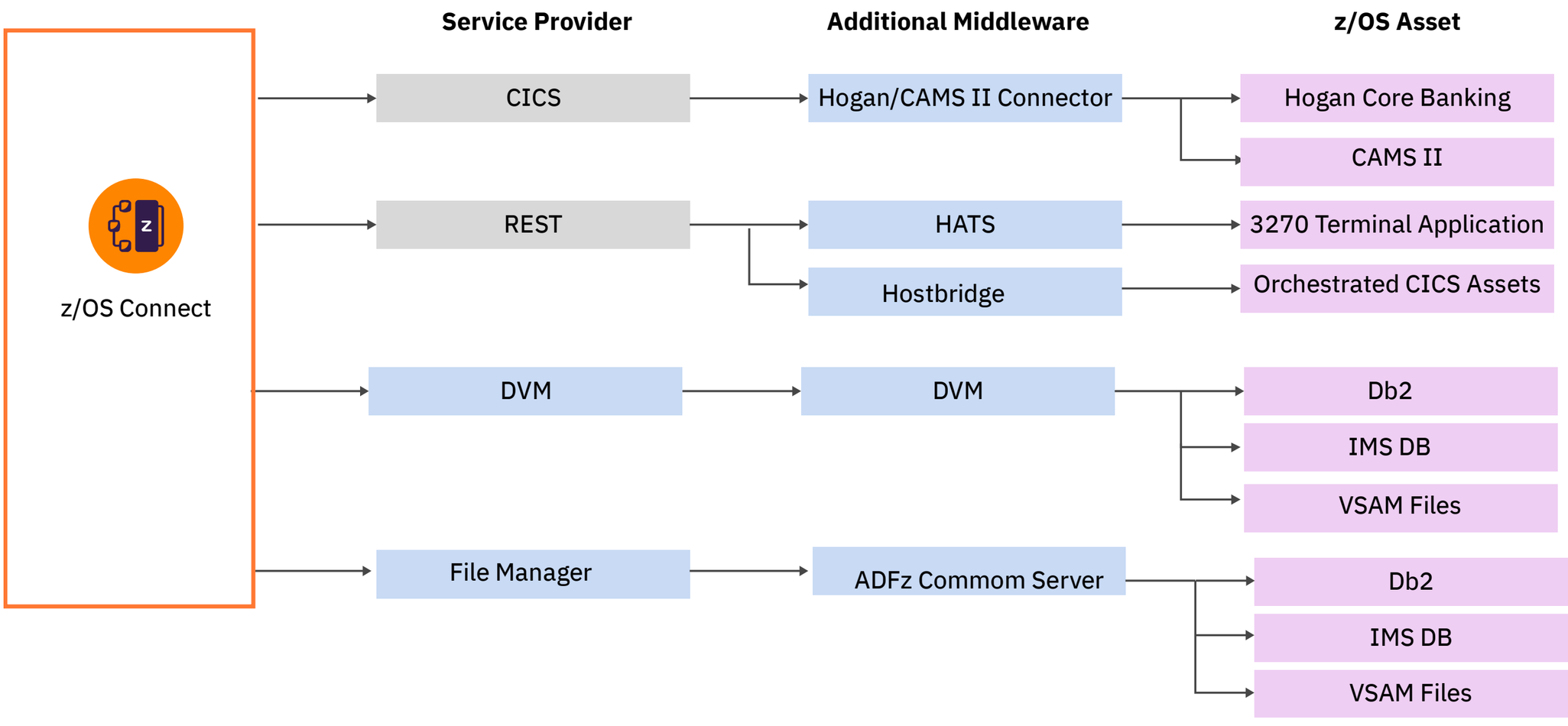


The core **service providers** included with z/OS Connect EE provide API access to a wide range of z/OS assets.

mitchj@us.ibm.com

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

mitchj@us.ibm.com

API Policies

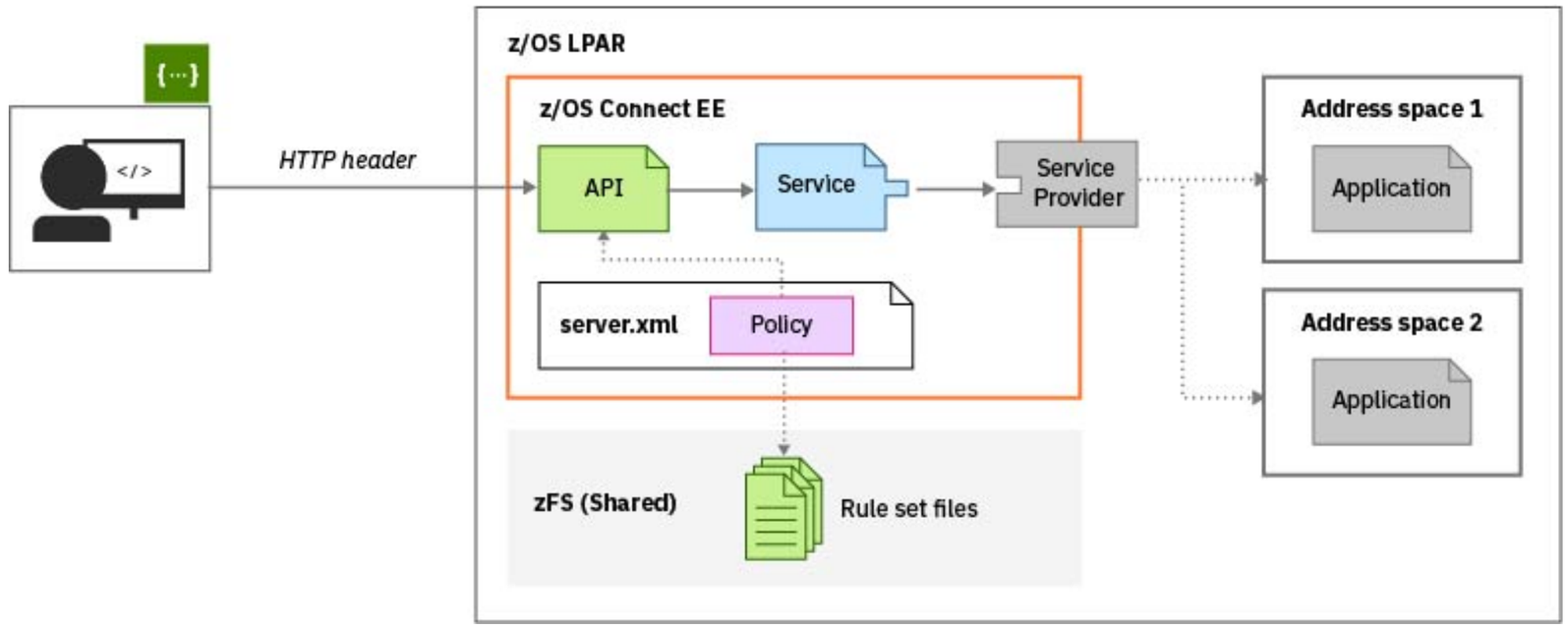
- HTTP header properties can be used to select alternative for IMS (V3.0.4) , CICS (V3.0.10), Db2 (V3.0.36) or MQ (V3.0.39)
- Policies can be configured globally for every API in the server or for individual APIs (V3.0.11)

CICS attributes
- cicsCcsid
- cicsConnectionRef
- cicsTransId

IMS attributes
- imsConnectionRef
- imsInteractionRef
- imsInteractionTimeout
- imsLtermOverrideName
- imsTranCode
- imsTranExpiration

Db2 attributes
- db2ConnectionRef
- db2CollectionID

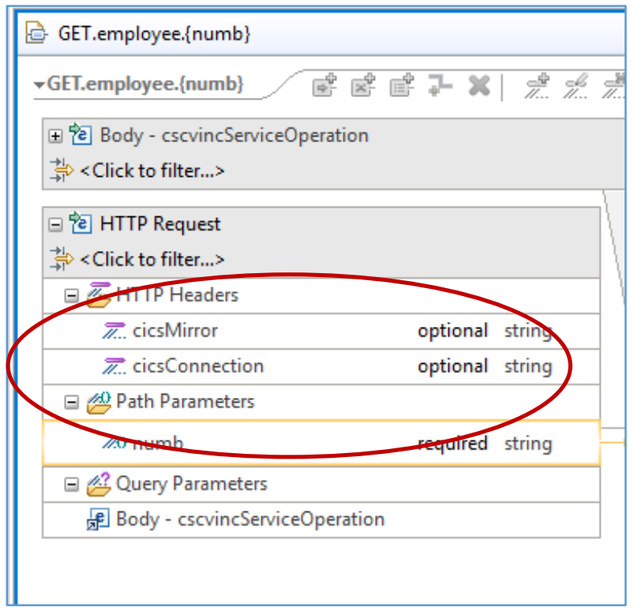
MQ attributes
- mqConnectionFactory
- mqDestination
- mqReplyDestination



mitchj@us.ibm.com

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>
```

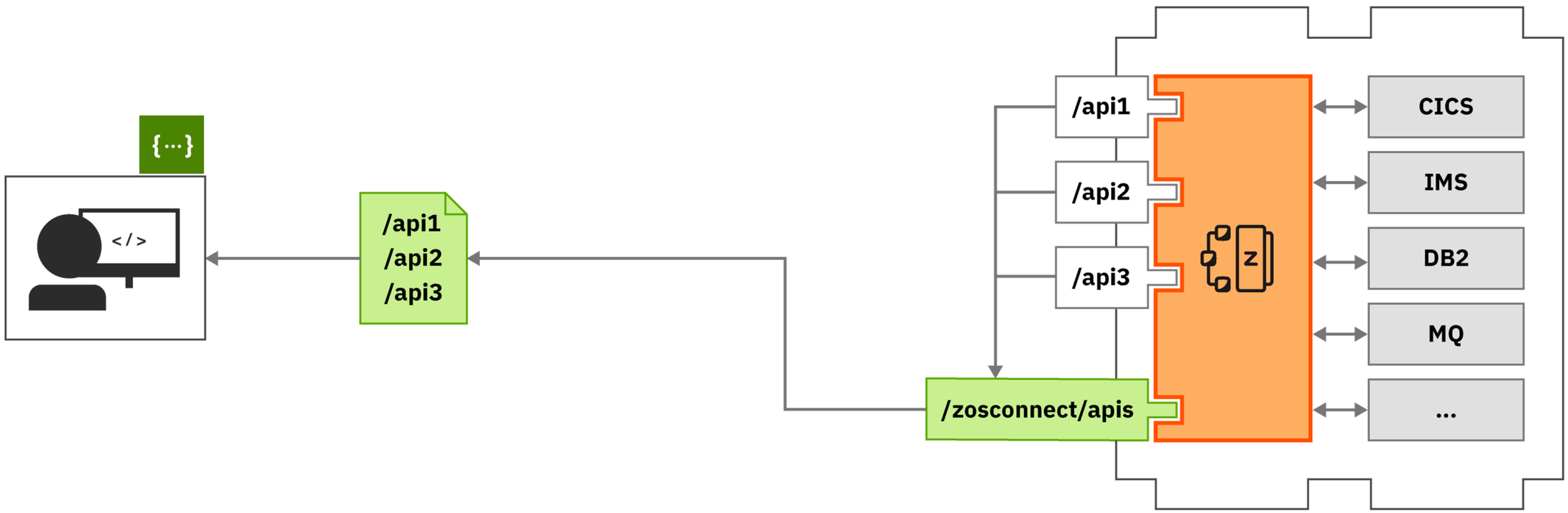


Curl

```
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.

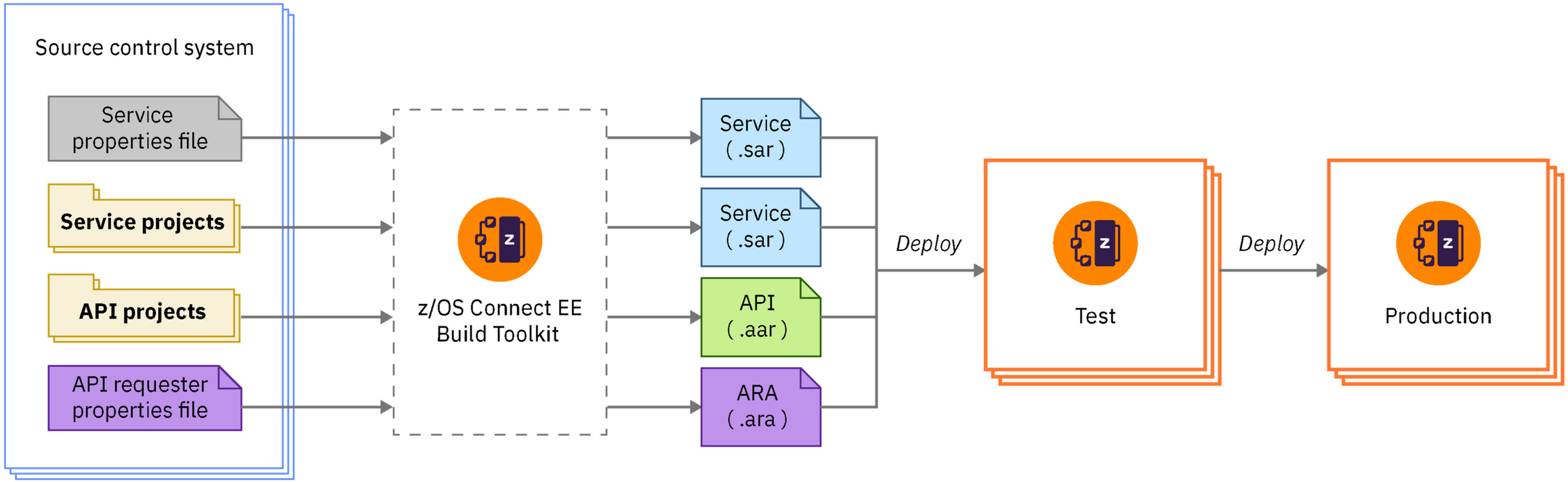
Show/Hide | List Operations | Expand Operations

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



mitchj@us.ibm.com

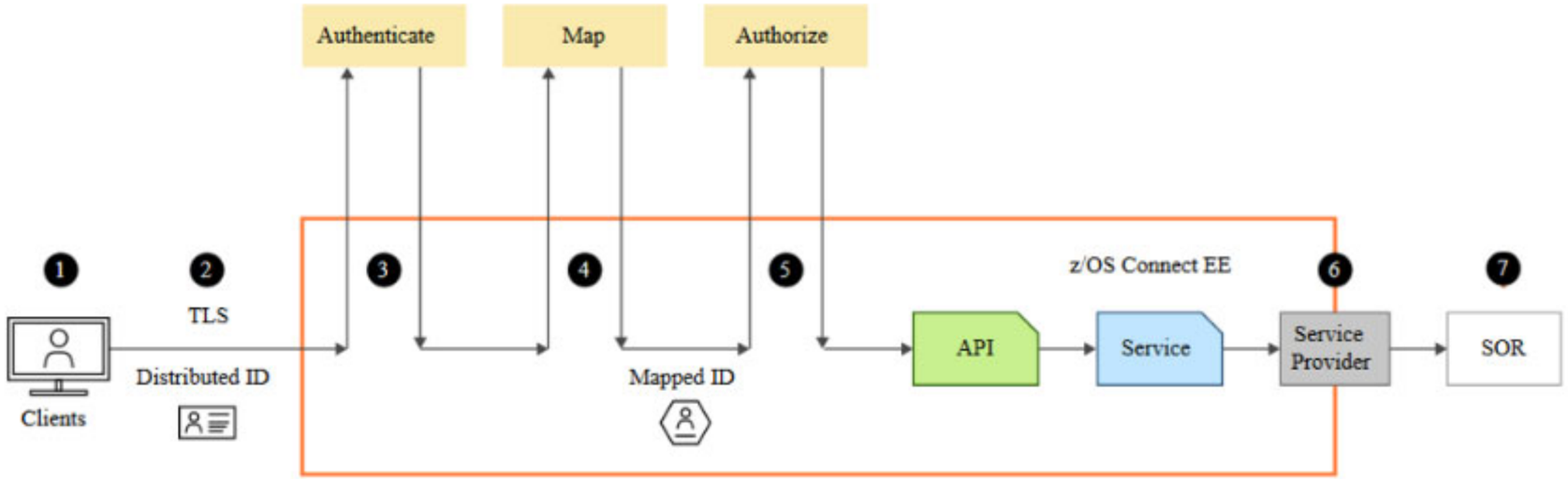
ibm.biz/zosconnect-devops

/security

How is security implement?

mitchj@us.ibm.com

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

mitchj@us.ibm.com

OPENAPI 3 roles

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:
    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

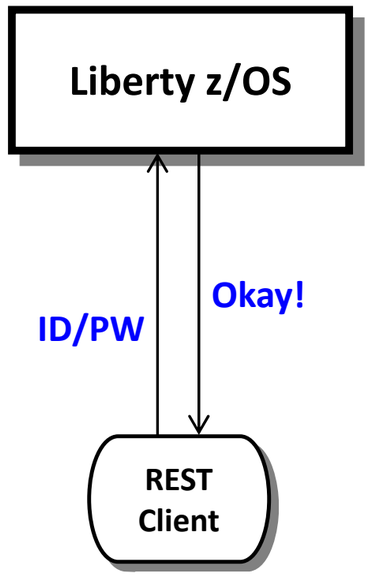
```
<!-- Enable features -->
    <featureManager>
        <feature>appSecurity-2.0</feature>
    </featureManager>
    <webAppSecurity allowFailOverToBasicAuth="true" />

    <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>
```

mitchj@us.ibm.com

API Provider Authentication

Several different ways this can be accomplished:

Basic Authentication

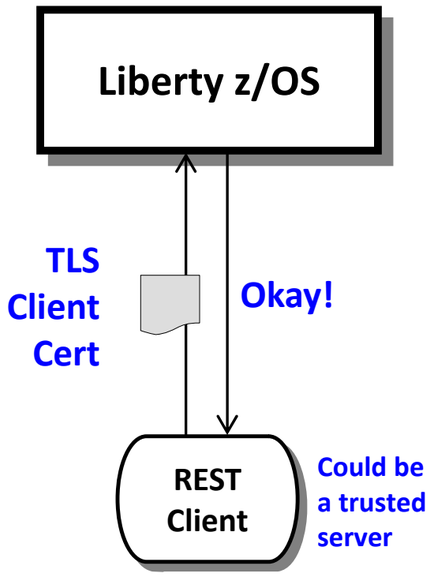


Server prompts for ID/PW

Client supplies ID/PW or ID/Passticket

Server checks registry:
- Basic (server.xml)
- LDAP
- SAF

Client Certificate



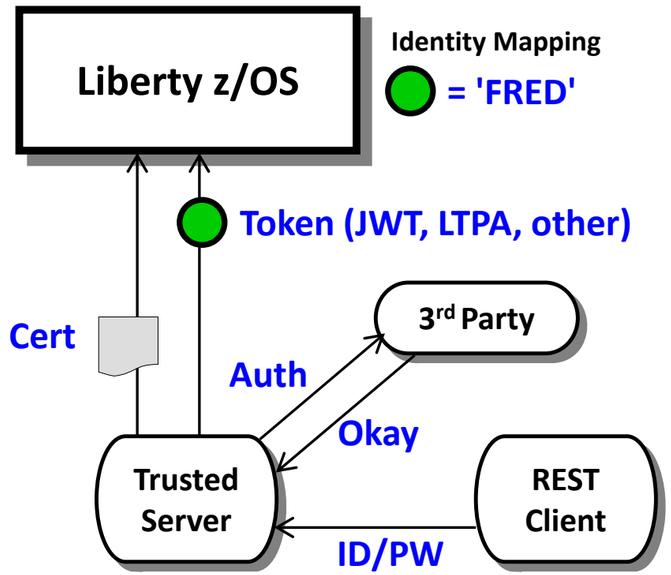
Server prompts for cert.

Client supplies certificate

Server validates cert and maps to an identity

Registry options:
- LDAP
- SAF

Third Party Authentication



Client authenticates to 3rd party sever

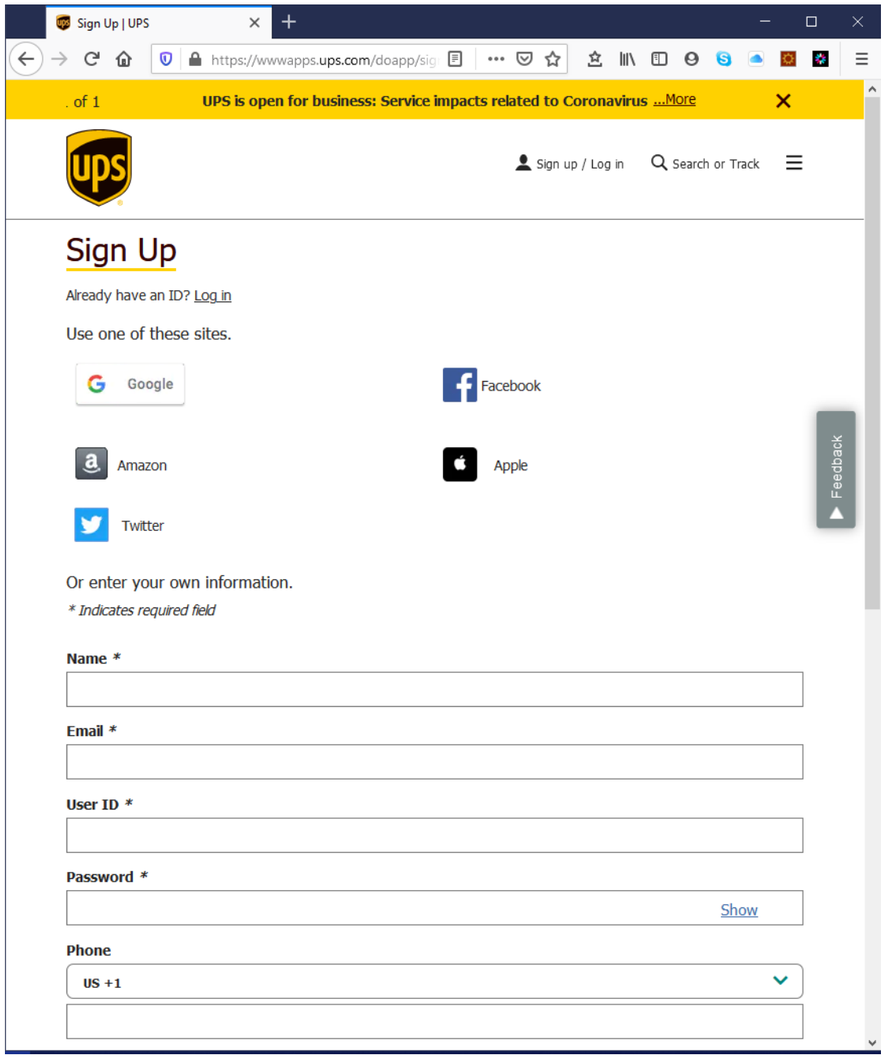
Client receives a trusted 3rd party token

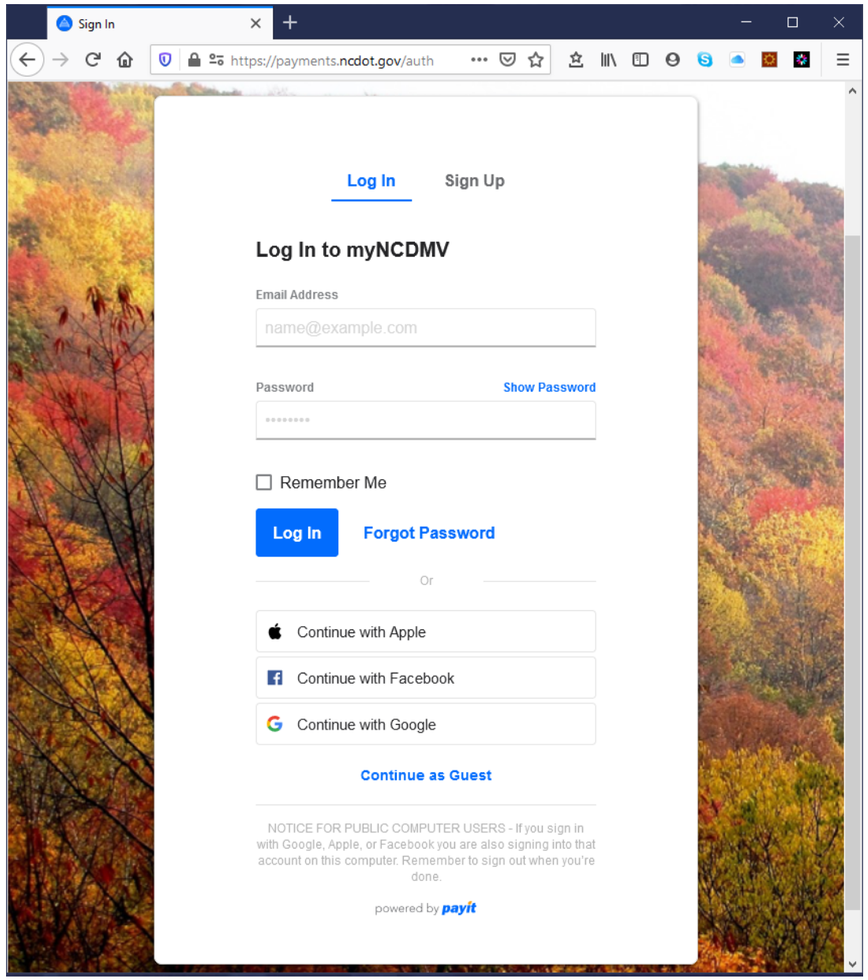
Token flows to Liberty z/OS and is mapped to an identity

Registry options:
- LDAP
- SAF

mitchj@us.ibm.com

Third Party Authentication Examples

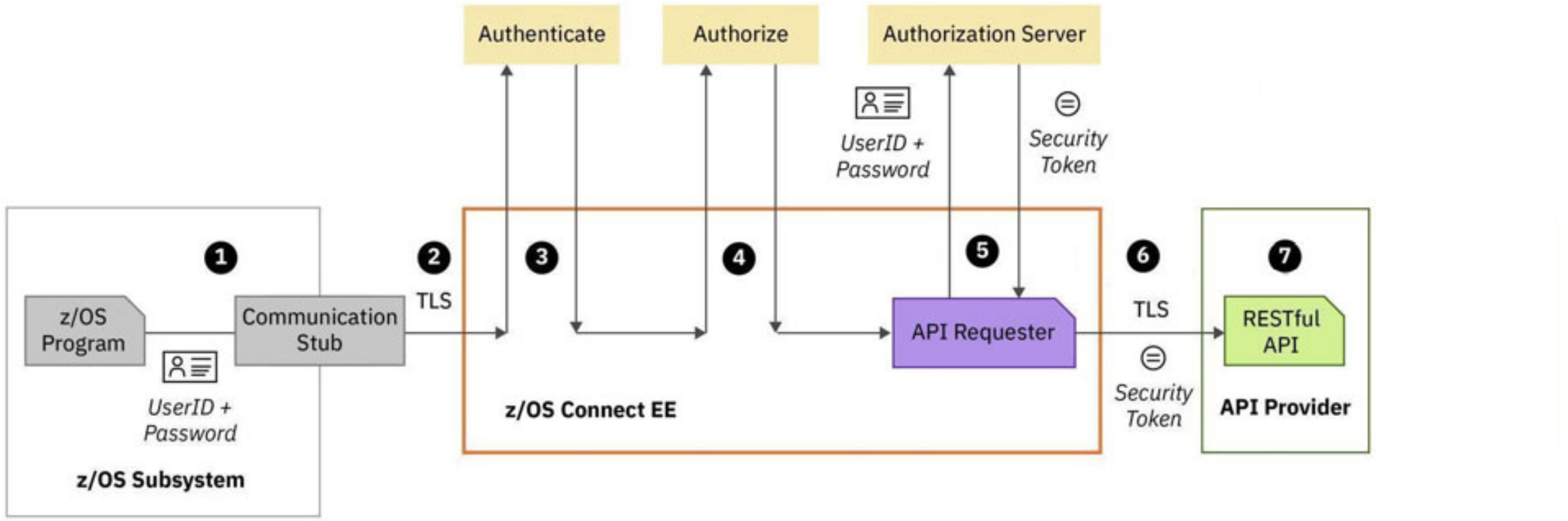




mitchj@us.ibm.com

mitchj@us.ibm.com

Typical z/OS Connect EE API Requester security flow

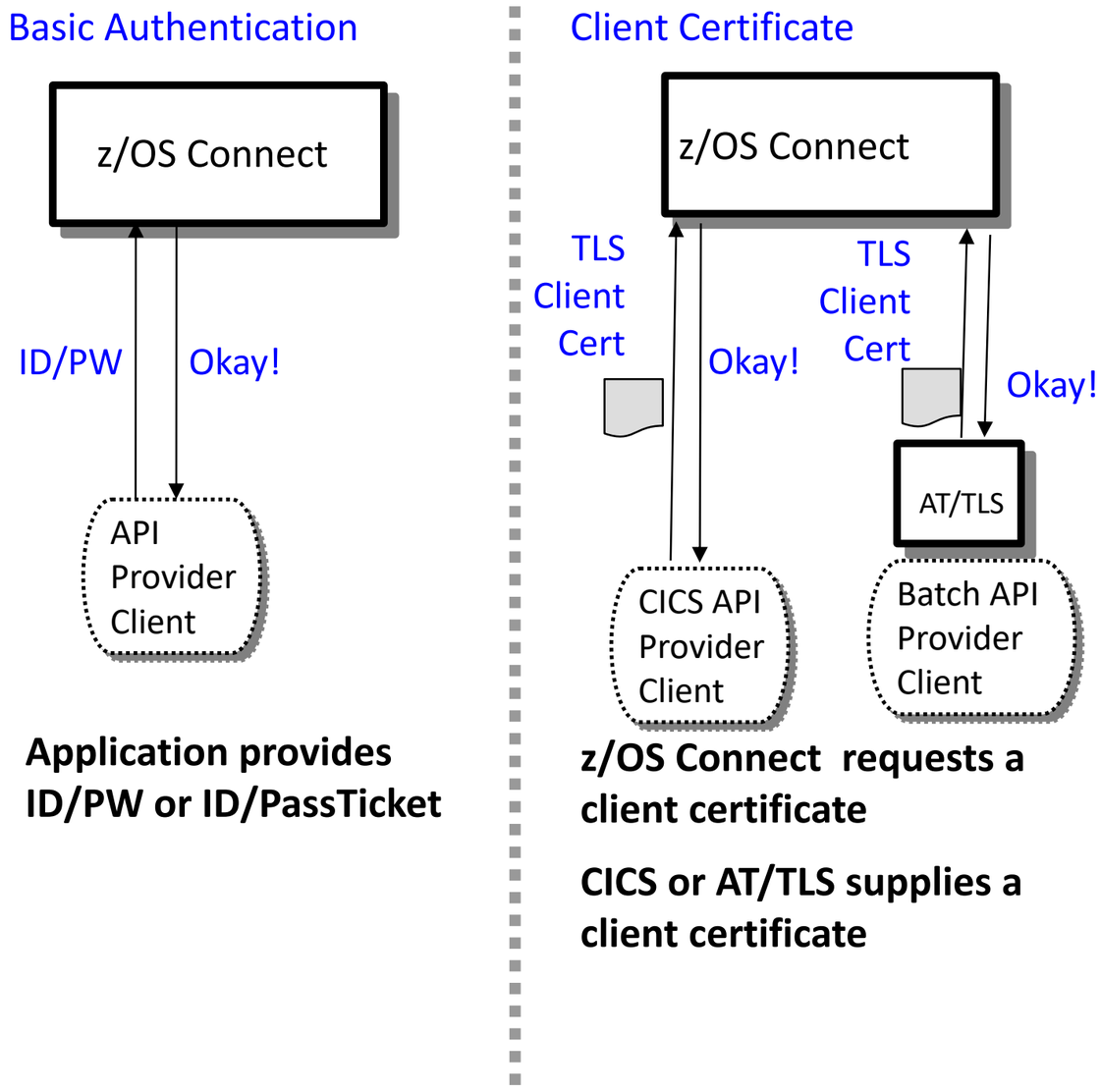


1. A user ID and password can be used for basic authentication by the z/OS Connect EE server
2. Connection between the CICS, IMS, or z/OS application and the z/OS Connect EE server can use TLS
3. Authenticate the CICS, IMS, or z/OS application.
4. Authorize the authenticated user ID to connect to z/OS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

mitchj@us.ibm.com

z/OS Application to z/OS Connect API Requester

Two options for providing credentials for authentication



Application provides ID/PW or ID/PassTicket

z/OS Connect requests a client certificate

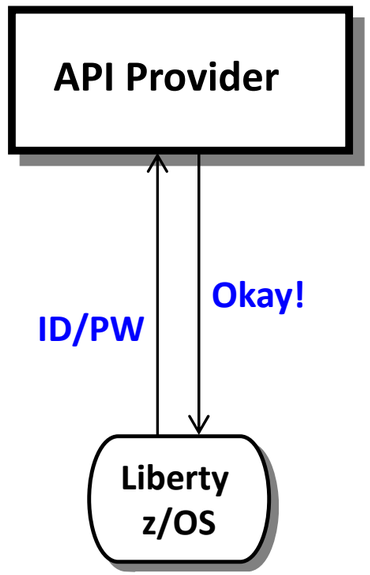
CICS or AT/TLS supplies a client certificate

mitchj@us.ibm.com
mitchj@us.ibm.com

API Requester - API Provider Authentication

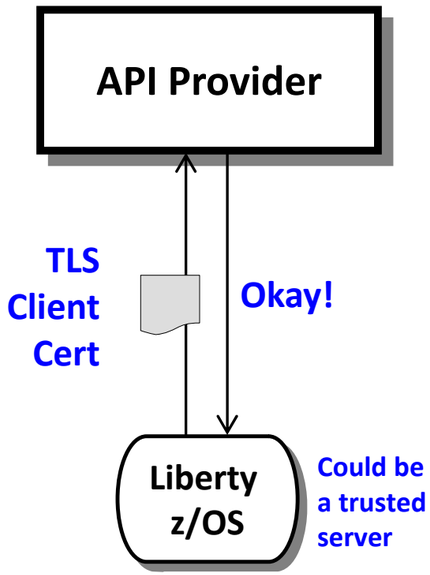
Several different ways this can be accomplished:

Basic Authentication



zCEE supplies ID/PW or ID/Passticket

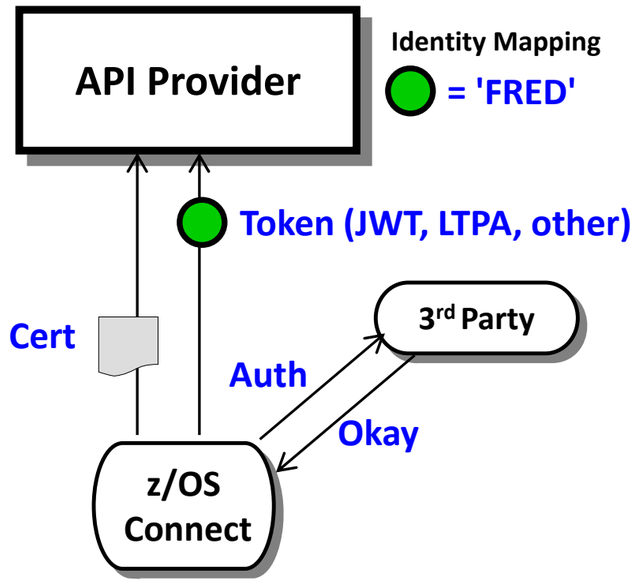
Client Certificate



Server prompts for certificate

zCEE supplies certificate

Third Party Authentication



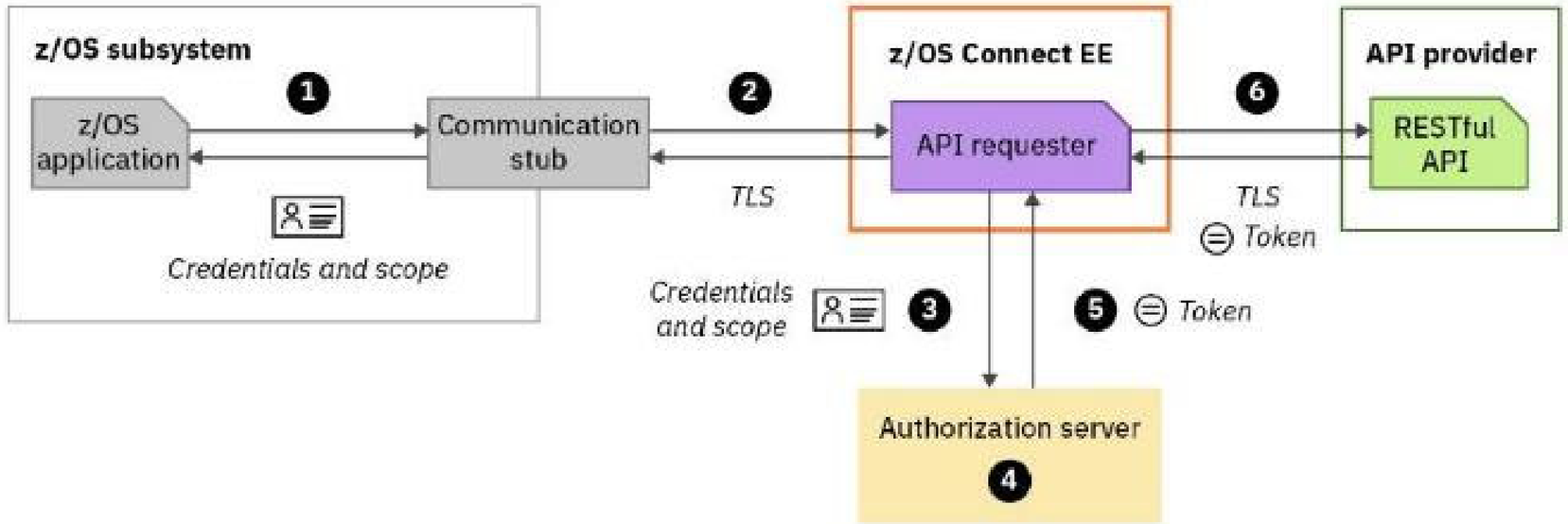
zCEE authenticates to 3rd party sever

zCEE receives a trusted 3rd party token

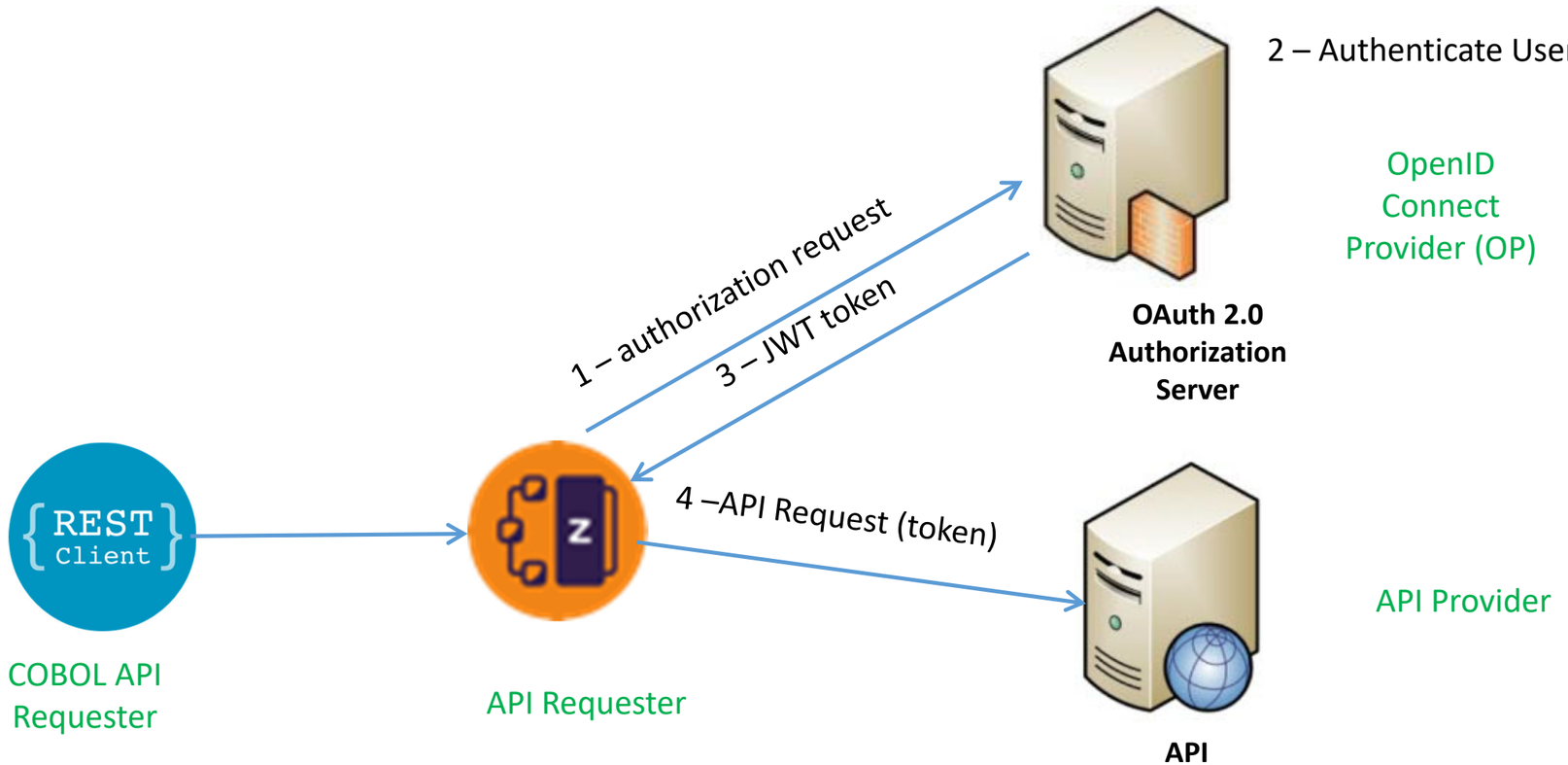
Token flows to API Provider

mitchj@us.ibm.com

Calling an API with OAuth 2.0 support



z/OS Connect OAuth Flow for API requester



Grant Types:

- client_credentials
- password

mitchj@us.ibm.com

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

mitchj@us.ibm.com

Agenda

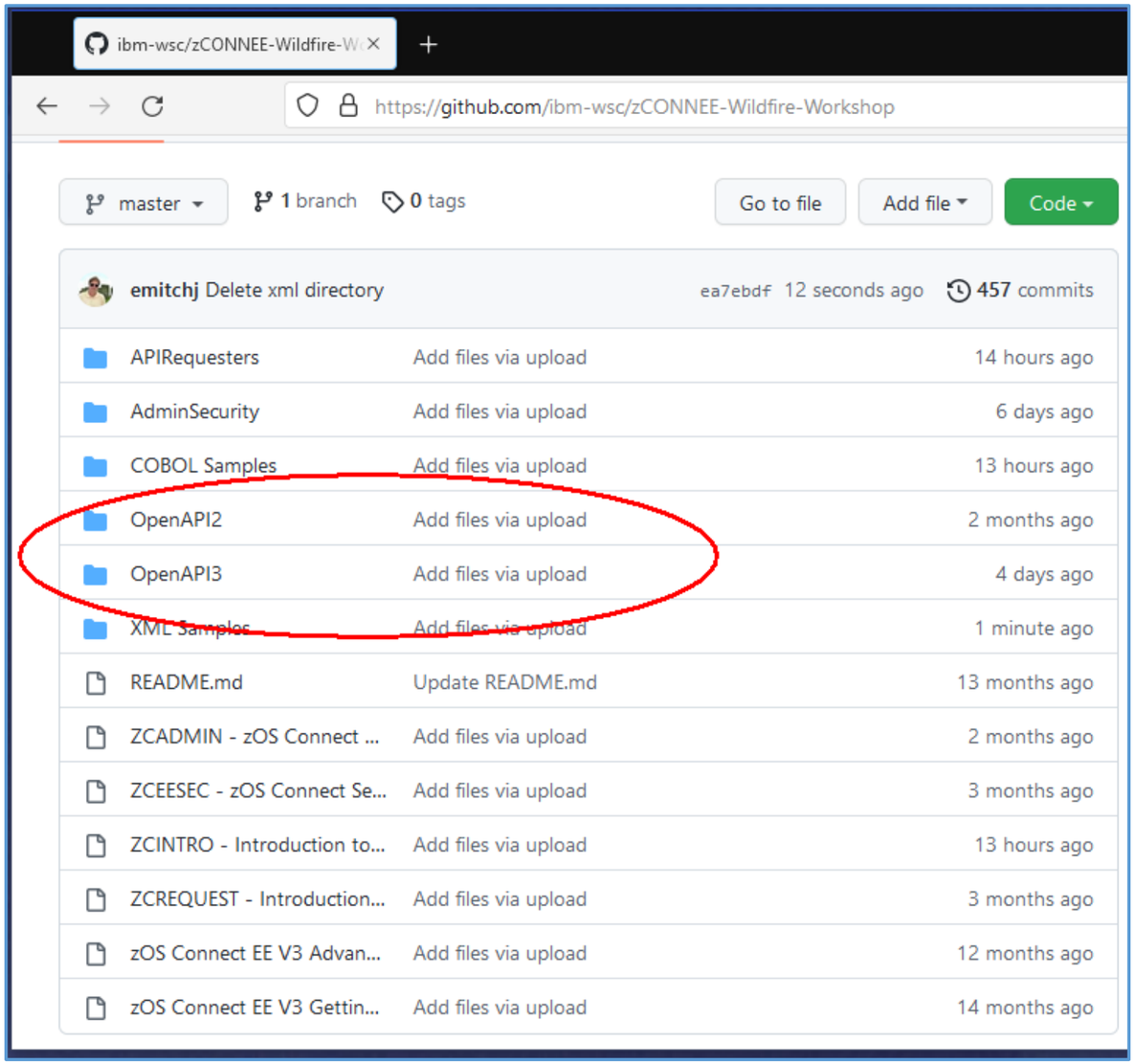
- An Introduction and Overview of using REST API
- Enabling RESTful API to various z/OS resources, e.g.
  - CICS
  - Db2
  - IMS/TM
  - IMS/DB
  - MQ
  - Outbound REST APIs
- Accessing RESTful API from z/OS COBOL Applications
- A brief overview of z/OS Connect Security*

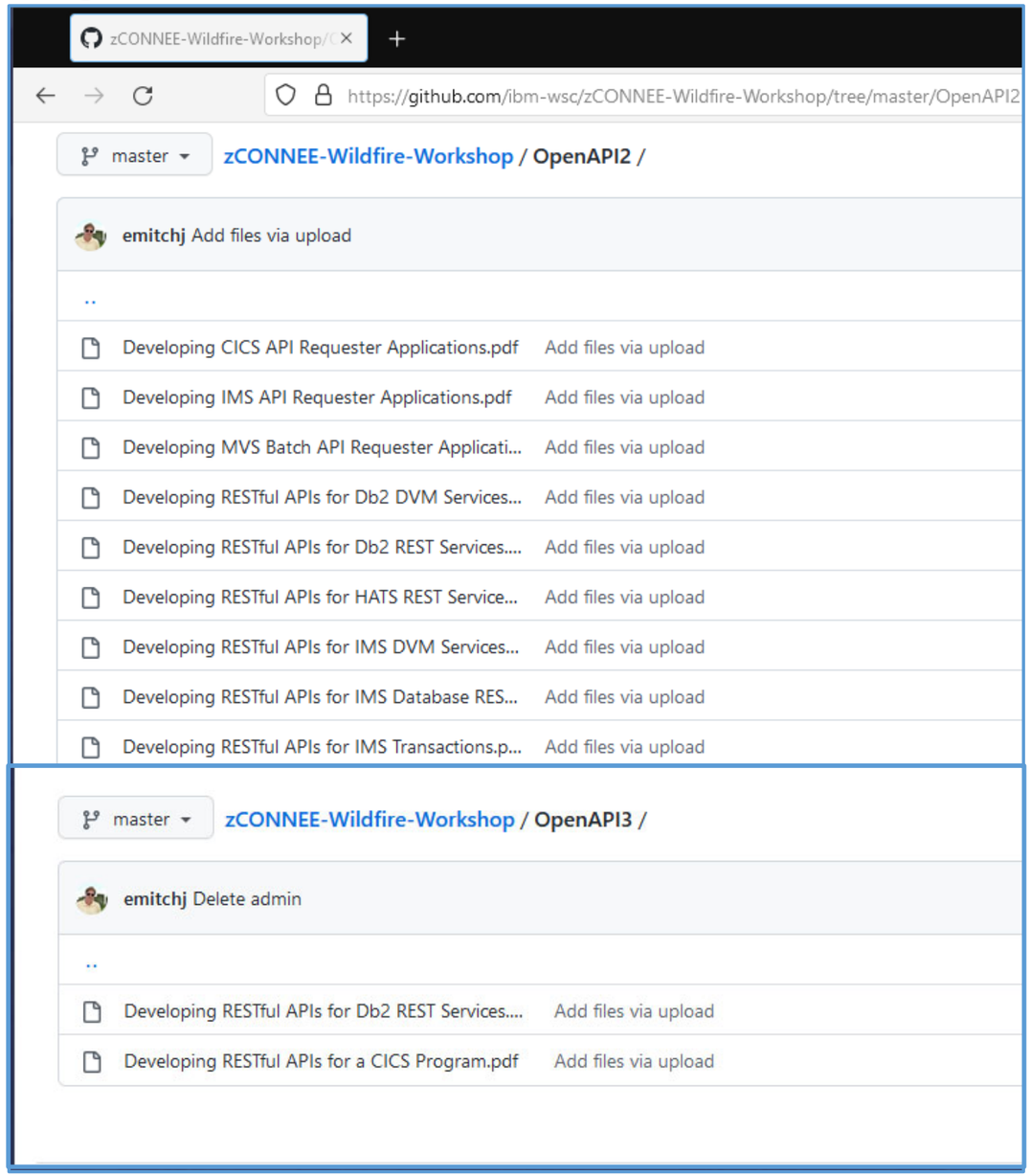
*For more on security, contact your local IBM rep regarding the schedule of workshop *zOSSEC1 IBM z/OS Connect Administration/Security Wildfire Workshop*

mitchj@us.ibm.com

z/OS Connect Wildfire Github Site

https://ibm.biz/zCEEWorkshopMaterial





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

IBM

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?

Not at all likely										Extremely likely
0	1	2	3	4	5	6	7	8	9	10

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

mitchj@us.ibm.com