WebSphere Liberty Profile Administration and Management

With focus on IBM z/OS Connect and IBM MQ Console and REST support

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

Notes and Disclaimers

- Additional information included in this presentation was distilled from 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 (commonly called Liberty).

- There will be additional information on slides that will be designated as Tech/Tips. These contain information that at perhaps at least interesting and hopefully, useful to the reader.

- A z/OS ,or a Java , or a Liberty , or a z/OS Connect OpenAPI2 , or a z/OS Connect OpenAPI3 ,or a CICS or a MQ 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.

- **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.

- The examples, tips, etc. present in this material are based on firsthand experiences.

mitchj@us.ibm.com

Agenda

- Review the OMVS and Liberty basics
  - The OMVS, Java and Liberty execution environments
  - Creating Liberty servers
  - Managing the server XML configuration
- Liberty Security
  - Security provided by the Angel process
  - Liberty authentication and authorization using basic, digital certificates and third-party tokens
- Security when accessing z/OS subsystems
- Security when accessing non-z/OS subsystems
- Useful Liberty features and MVS commands
- Managing and Monitoring Liberty servers
  - WLM configurations
  - SMF options
  - Monitoring OMVS processes
  - Connection pooling options
  - Above the bar storage
  - High availability options
- Where do I look when things go wrong?
  - Problem determination techniques
  - Understand the anatomy of messages
- Appendix - Sample administrative JCL

mitchj@us.ibm.com

Let’s start by reviewing some of the basic configuration details and options for Java on z/OS, OMVS and Liberty

mitchj@us.ibm.com

Verifying that the Java and OMVS environments are properly configured*

Basic system configuration settings which have more than once, have caused issues

- Prevent out-of-memory or other storage issues:
  - Verify the Java runtime is not being limited by system parameters, e.g., *MAXASSIZE (2 147 483 647*), *MAXTHREADS*, etc., for details see *BPXPRM setting* at URL https://www.ibm.com/docs/en/sdk-java-technology/8?topic=SSYKE2_8.0.0/com.ibm.java.vm.80.doc/docs/j9_configure_zos_bpxprm.html
  - Check the value of *ASSIZEMAX* in the OMVS segments of the identifies involved and ensure it is adequate, see *MAXASSIZE* above.
  - Exclude OMVS from any IEFUSI exit, SUBSYS(OMVS,NOEXITS) in PARMLIB member *SMFRPMxx*.
  - Verify the JCL MEMLIMIT parameter value is within reason for your system.

CWWKB0125I: This server requested a REGION size of 0KB. The below-the-line storage limit is 8MB and the above-the-line storage limit is 1527MB.
CWWKB0126I: MEMLIMIT=1000. MEMLIMIT CONFIGURATION SOURCE=JCL.

- Start an OMVS shell session using the identity under which a server is running and verify that the required version of Java is fully **operational** and **current** by entering command ***java –version***, you see should results like this:

- Verify that RACF identities associated with started tasks have OMVS segments with UIDs and GIDs and valid HOME directories and that the identities can invoke Java commands.

mitchj@us.ibm.com

***The first step of problem determination is to be sure the power adapter of the device is plugged into the outlet.**

Tech-Tip - Check the Java version information using JCL

```
//JOHNSONS JOB (ACCOUNT),JOHNSON,NOTIFY=JOHNSON,REGION=0M,
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1),USER=LIBSERV
//*****************************************************************
//*  SET SYMBOLS
//*****************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
//*****************************************************************
//*  STEP JAVA - INVOKE THE java -version COMMAND
//*****************************************************************
//JAVA  EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//STDENV   DD DUMMY
//SYSTSIN  DD *,SYMBOLS=EXECSYS
BPXBATCH SH +
export JAVA_HOME=&JAVAHOME; +
$JAVA_HOME/bin/java -version
```

```
java version "1.8.0_301"
Java(TM) SE Runtime Environment (build 8.0.6.35 - pmz6480sr6fp35-20210714_01(SR6 FP35))
IBM J9 VM (build 2.9, JRE 1.8.0 z/OS s390x-64-Bit Compressed References 20210622_7763 (JIT enabled, AOT
enabled)
OpenJ9   - b1f3adb
OMR      - c2f4a18
IBM      - c24a144)
JCL - 20210625_01 based on Oracle jdk8u301-b09
```

mitchj@us.ibm.com

Requires RACF SUROGAT access

Tech-Tip: Using the SAF SURROGAT resources for administration

RACF Surrogate access allows a designated administrative identity the ability to invoke commands and perform functions as if they were running under the identity that will be used for the z/OS Connect server started task. This may be useful because identities associated with started task are normally restricted and cannot be used for accessing TSO or OMVS shells,

Use the following examples as guides and create the surrogate resources and permit access. In these examples, ***LIBSERV*** represents the RACF identity under which the z/OS Connect server will be running and ***adminGrp*** represent the administrative RACF administrative group.

Define a SURROGAT profile for the server's SAF identity

RDEFINE SURROGAT BPX.SRV.*LIBSERV*

Define a SURROGAT submit profile to allow job submission as the server's SAF identity

RDEFINE SURROGAT *LIBSERV*.SUBMIT

Permit a member of the administrative group to act as a surrogate of the Liberty task identity

PERMIT BPX.SRV.*LIBSERV* CLASS(SURROGAT) ID(*adminGrp*) ACC(READ)
PERMIT *LIBSERV*.SUBMIT CLASS(SURROGAT) ID(*adminGrp*) ACC(READ)

Refresh the SURROGAT in storage profiles

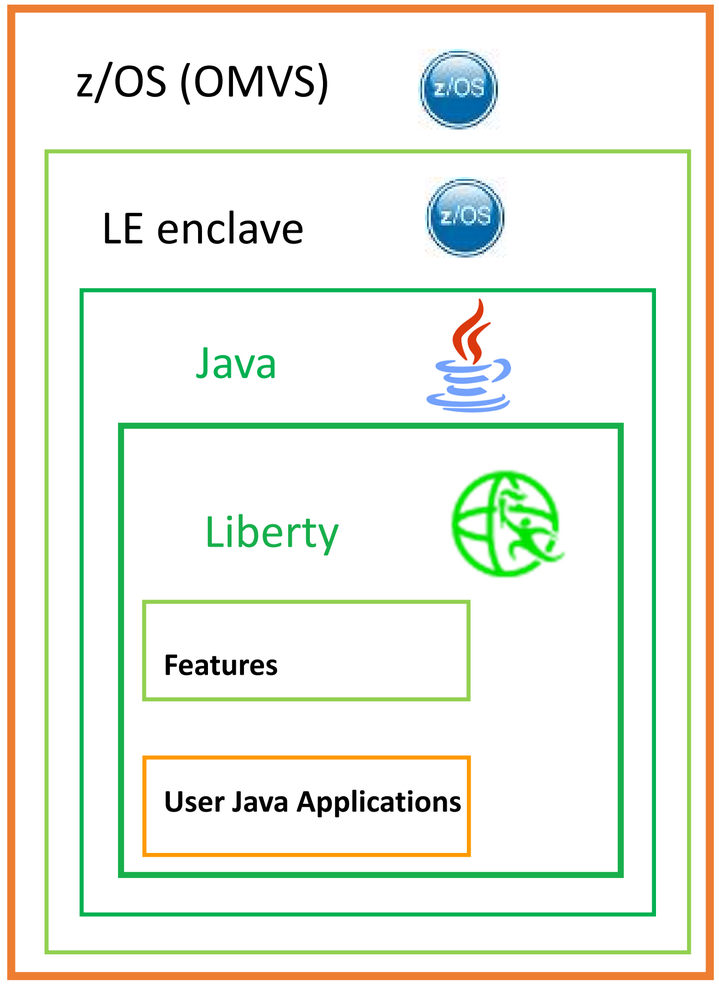
SETROPTS RACLIST(SURROGAT) REFRESH

Now any identity in group *adminGrp* can submit JCL with the *USER=LIBSERV* parameter on the job card or use the OMVS switch user command (*su –s LIBSERV*) to execute OMVS scripts or commands as LIBSERV.

mitchj@us.ibm.com

It helps to think of a Liberty server as consisting as a layers of software products

- Liberty servers are started by a command (either a script or binary executable) that initalizes an OMVS process. A process which has been tailored for Java applications.
- Liberty runs in a Language Environment (LE) enclave configured to support OMVS and Java processes.
- Liberty is a Java application and on z/OS. There are Liberty features that provide access to z/OS services like SAF, WLM, RRS, SMF, JCL, etc. to other Java applications.
- The Liberty Java application provides an exeuction environment for multiple concurrent Java applications.



Knowing and understanding the different layers and their relationships is important regarding:

- Understanding which layer a configuration options, e.g., environment variables, Java directives, etc., applies.
- Monitoring and understanding the health of the server
- Performing problem determination and performance tuning

mitchj@us.ibm.com

The *WLP_USER_DIR* environment variable

- The WLP_USER_DIR environment variable provides a directory location where:
  - A server's configuration files can be located
  - A default directory for writing logs and other files
  - A default directory where a server can locate application artifacts
- The same value for WLP_USER_DIR must be used for starting a server that was used when the server was created.
- There can be multiple "WLP_USER_DIR" directories on an LPAR
- Each server (serverName) will have a unique subdirectory in the location specified by WLP_USER_DIR.

```
${WLP_USER_DIR}
  /servers
    /serverName1
    /serverName2
    /serverName3
  |--shared/
    |--apps/
    |--config/
    |--resources/
```

- The location of the *serverName* directory is based on the concatenation of the value of the *WLP_USER_DIR* environment variable with the constant *servers*
- The serverName directory structure and its initial contents are created when the server is created
- *serverName* can be a mount point with a dedicated file system mounted at this mount point (see above). This can be used to isolate servers to dedicated file systems.
- The number, size and output location of messages.log and trace files in the *logs* directory can be controlled with the Liberty <*logging*> configuration element or the output location controlled by using the *com.ibm.ws.logging.log.directory* Java directive as a JVM options override, more on this later.
- #These directories maintain state information and it is a good practice is to add the --*clean* parameter to the server startup JCL, e.g., PARMS='serverName --clean', especially after service is applied.
- By default, the 'owner' of these directories and files is the identity that creates them.

mitchj@us.ibm.com

Tech-Tip: Use JCL to create the *WLP_USER_DIR* directory and its subdirectories

Permission bit are set properly by taking advantage of RACF **SURROGAT** or **UNIXPRIV** resources

Example of using **UNIXPRIV** privileges

```
/MYSERVER JOB CLASS=A,REGION=0M,MSGCLASS=H,NOTIFY=&SYSUID
//*****************************************************************
//*  SET SYMBOLS
//*****************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET WLPUSER='/var/wlp'
// SET USER='LIBGRP'
// SET GROUP='LIBSERV'
//*****************************************************************
//*  Step CREATE - Use the mkdir command to create direcotries
//*****************************************************************
//CREATE EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export WLP_USER_DIR=&WLPUSER; +
 mkdir -p &WLPUSER/shared/apps; +
 mkdir -p &WLPUSER/shared/config; +
 mkdir -p &WLPUSER/shared/resources; +
 chown -R &USER:&GROUP $WLP_USER_DIR/shared
```

Example of using **SURROGAT** privileges

```
/MYSERVER JOB CLASS=A,REGION=0M,MSGCLASS=H,NOTIFY=&SYSUID,USER=LIBSERV
//*****************************************************************
//*  SET SYMBOLS
//*****************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET WLPUSER='/var/wlp'
//*****************************************************************
//*  Step CREATE - Use the mkdir command to create direcotries
//*****************************************************************
//CREATE EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export WLP_USER_DIR=&WLPUSER; +
 mkdir -p &WLPUSER/shared/apps; +
 mkdir -p &WLPUSER/shared/config; +
 mkdir -p &WLPUSER/shared/resources
```

N.B. Multiple OMVS commands can be entered as input to *BPXBATCH* utility. Individual OMVS commands are terminated with a semi-colon. The semi-colon should be followed by at least one space. A plus symbol is used to indicate continuation. It is a good practice to not start a command in column 1.

mitchj@us.ibm.com

Tech/Tip: Also consider using the SAF UNIXPRIV/FACILITY resources

An alternative to using a surrogate access is to permit the identity under which the customization will be done to enhanced Unix privileges. Specially, permitting the identity to Unix privileges SUPERUSER.FILESYS, SUPERUSER.FILESYS.CHANGEPERMS and SUPERUSER.FILESYS.CHOWN.

- *Permit an administrative identity to write to any local directory or file*
  PERMIT SUPERUSER.FILESYS CLASS(UNIXPRIV)
  ID(adminUser) ACC(CONTROL)
- *Permit an administrative identity to change permission bit of any local directory or file*
  PERMIT SUPERUSER.FILESYS.CHANGEPERMS CLASS(UNIXPRIV)
  ID(adminUser) ACC(READ)
- *Permit an administrative identity to change the ownership of any directory or file*
  PERMIT SUPERUSER.FILESYS.CHOWN CLASS(UNIXPRIV)
  ID(*adminUser*) ACC(READ)
- *Permit an administrative identity switch to root (su –s root) or the Enable superuser mode(SU) Setup option in ISHELL*
  PERMIT BPX.SUPERUSER CLASS(FACILITY) ID(adminUser) ACC(READ)

- *Refresh the UNIXPRIV and/or FACILITY instorage profiles*
  SETROPTS RACLIST(UNIXPRIV,FACILITY) REFRESH

https://www.ibm.com/support/knowledgecenter/en/SSLTBW_2.4.0/com.ibm.zos.v2r4.bpxb200/usspriv.htm

Use the power of these commands provide carefully and only when necessary

mitchj@us.ibm.com

Basic Liberty servers are created by invoking a Liberty command *server create*

Invoking the command creates the server's required directory structure and populates key configuration files.

To create a basic Liberty server, use the Liberty ***server create*** command, as in ***server create* serverName**

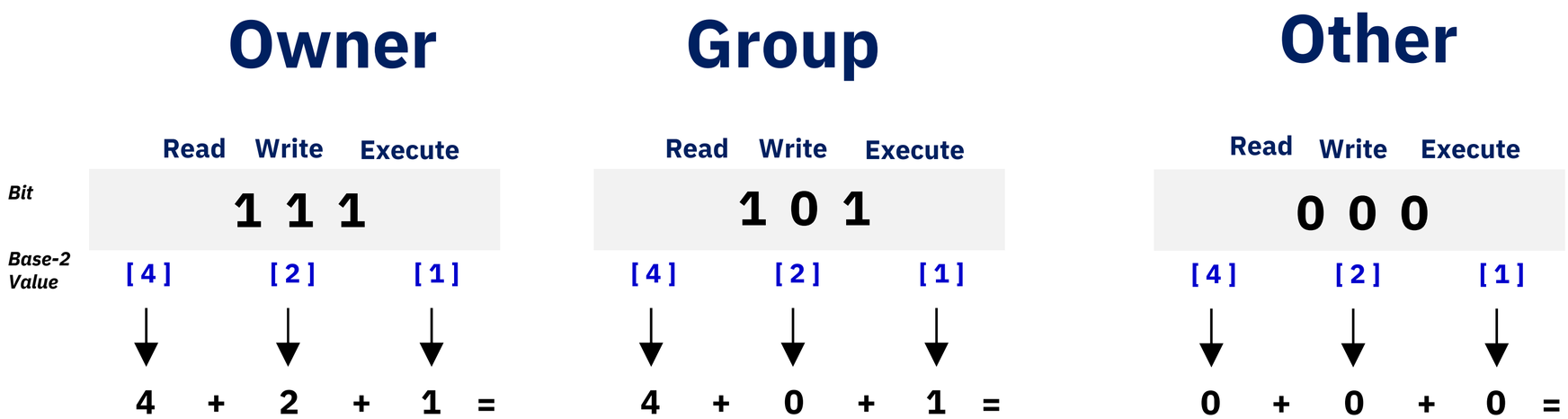
- Where ***serverName*** is any value you wish, such as ***wlpopsrv*** or ***wlpOpenIDAuthServer*** and this value will be the name of the server instance. The default value for the serve name is *defaultServer*
- Environment variable ***WLP_USER_DIR*** must be set to determine the location of the configuration directory and files created by this command. The constant **servers** is appended to the value of this variable, e.g., **{$WLP_USER_DIR}/servers** and the server's name is appended to this root directory and full directory path is the location where the server's configuration files, and default directories are created, e.g., **{$WLP_USER_DIR}/servers/serverName.** The WLP_USER_NAME variables is required when starting a server and must be the same value used when the server was created. The default value for a Liberty server is ../..wlp/usr.

N.B. The name of the server does not have to be same as the started task name, as shown in this example (note in this example how the value for WLP_USER_DIR is provided by the PATH attribute of the WLPUDIR DD statement):

```
//WLPOPID PROC PARMS='wlpOpenIDAuthServer'
//*
// SET INSTDIR='/usr/lpp/liberty_zos/22.0.0.9'
// SET USERDIR='/var/wlp'
//*
//STEP1   EXEC PGM=BPXBATSL,REGION=0M,TIME=NOLIMIT,
//  PARM='PGM &INSTDIR./lib/native/zos/s390x/bbgzsrv &PARMS'
//WLPUDIR  DD PATH='&USERDIR.'
//STDOUT   DD SYSOUT=*
//STDERR   DD SYSOUT=*
//*MSGLOG   DD SYSOUT=*
//*STDENV   DD PATH='/etc/system.env',PATHOPTS=(ORDONLY)
```

mitchj@us.ibm.com

Tech-Tip: Let's do a quick review of permissions bits



mitchj@us.ibm.com

Issues with permission bits and ownership and group access for directories and files is a common problem.

Details of a Liberty servers' configuration directories and files

```
export WLP_USER_DIR=/var/zosconnect
```

```
                                        Permission
                                        Bits  Owner    Group
$WLP_USER_DIR                           750   LIBSERV  LIBGRP
 |--servers/                            750   LIBSERV  LIBGRP
 |    |--server1_name1/                 750   LIBSERV  LIBGRP
 |    |    |--bootstrap.properties      700   LIBSERV  LIBGRP
 |    |    |--jvm.options               700   LIBSERV  LIBGRP
 |    |    |--server.env                640   LIBSERV  LIBGRP
 |    |    |--server.xml                640   LIBSERV  LIBGRP
 |    |    |--apps/                     750   LIBSERV  LIBGRP
 |    |    |--dropins/                  750   LIBSERV  LIBGRP
 |    |    |--configDropins/            750   LIBSERV  LIBGRP
 |    |         |--defaults/            750   LIBSERV  LIBGRP
 |    |         |--overrides/           750   LIBSERV  LIBGRP
 |    |    |--logs/                     750   LIBSERV  LIBGRP
 |    |         |--messages.log         666   LIBSERV  LIBGRP
 |    |    |--resources/                750   LIBSERV  LIBGRP
 |    |         |--security/            750   LIBSERV  LIBGRP
 |    |--server2_name/                  750   LIBSERV  LIBGRP
 |    |      . . .
 |    |--server3_name/                  750   LIBSERV  LIBGRP
 |    |      . . .
 |--shared/                             750   LIBSERV  LIBGRP
      |--apps/                          750   LIBSERV  LIBGRP
      |--config/                        750   LIBSERV  LIBGRP
      |--resources/
```

The create command will create the directories and files under the *<WLP_USER_DIR>* and assign ownership based on the ID and Group that created the server

There are some questions that need answers with this in a production setting:

- If you have multiple people with a need to change configuration files, do you share the password of LIBSERV?

  No. In fact, LIBSERV should be a PROTECTED identity with no password in the first place. Better to take advantage SAF SURROGAT so permitted users can switch to the owning ID so they can make changes.

- If you have multiple people with a need to read or update configuration files, do you simply connect them to LIBGRP?

  No. The owner group may be granted access to other resources (on z/OS SAF profiles notably: SERVER) and you do not want others inheriting that. Better to make the configuration group be something different from the owner group and grant READ/WRITE through that group.

- **The *shared* directory structure is shared among all servers started that have a common value for the *WLP_USER_DIR* environment variable. Each server can access common server configuration files using the *shared.config.dir* environment variable or access web applications using the *shared.app.dir* environment variable.**

mitchj@us.ibm.com

https://www.ibm.com/docs/en/was-liberty/base?topic=liberty-directory-locations-properties

Tech-Tip: Use JCL to create a Liberty *server* by invoking the *server* command using IKJEFT01

```
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
// SET WLPPATH='/usr/lpp/liberty_zos/22.0.0.9'
// SET SERVER='myServer'
// SET TEMPLATE='defaultServer'
// SET WLPUSER='/var/wlp'
// SET USER='LIBSERV'
// SET GROUP='LIBGRP'
//*************************************************************
//*  Step CREATE - Use the server command to create a server
//*************************************************************
//CREATE EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 export WLX_USER_DIR=&WLPUSER; +
 &WLPPATH/bin/server create &SERVER +
 --template=&TEMPLATE; +
 chown -R &USER:&GROUP $WLP_USER_DIR/servers/&SERVER
```

- Set and export JCL symbols variables

- Export the JCL symbols passed to OMVS environment
- Invoke the *server* command to create the Liberty server
- Use the chown command to set the correct owner/group settings

mitchj@us.ibm.com

Creating a Liberty server involves creating the server's required OMVS directory structure and an initial server configuration file, e.g., *server.xml*

The server's directory structure will be located at *{$WLP_USER_DIR}/***servers**/*serverName* and is the *server.xml* file is key configuration file for any Liberty server.

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">

    <!-- Enable features -->
    <featureManager>
        <feature>jsp-2.3</feature>
    </featureManager>

    <!-- To access this server from a remote client add a host
attribute to the following element, e.g. host="*" -->
    <httpEndpoint id="defaultHttpEndpoint"
                  httpPort="9080"
                  httpsPort="9443" />

    <!-- Automatically expand WAR files and EAR files -->
    <applicationManager autoExpand="true"/>

</server>
```

A sample initial server.xml configuration file

An administrator adds or removes features (security, and other required functions) as needed in the *featureManager* configuration elements.

Configures connectivity in *httpEndpoint* configuration elements

Adds other configuration elements as needed.

mitchj@us.ibm.com

And MQ Console/REST servers are created by invoking the MQ *crtmqweb* command

```
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
// SET MQPATH='/usr/lpp/mqm/V9R3M4/web'
// SET WLPUSER='/var/mqm/V9R3M4'
// SET USER= 'MQSERV'
// SET GROUP= 'MQGRP'
//*************************************************************
//*  Step CRTMQWEB - Use the crtmqweb command
//*************************************************************
//CRTMQWEB EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 export WLP_USER_DIR=&WLPUSER; +
 &MQPATH/bin/crtmqweb &WLPUSER -p MQ; +
 chown -R &USER:&GROUP $WLP_USER_DIR/servers/&SERVER
```

- Set JCL symbols

- Export the JCL symbols passed to the OMVS environment
- Invoke the *crtmqweb* command to create the MQ Console and REST server. The default value for a MQ Console server is */var/mqm/web/installation1*
- Use the chown command to set the correct owner/group settings

mitchj@us.ibm.com

While z/OS Connect servers are created using the z/OS Connect *zosconnect* command

To create a z/OS Connect server, use the *zosconnect* command using one of these templates, as in:

zosconnect create serverName --template=templateName

Where ***templateName*** can be:

- ***zosconnect:apiRequester*** for an OpenAPI2 z/OS Connect API requester enabled server
- ***zosconnect:default*** template for base OpenAPI2 z/OS Connect servers
- ***zosconnect:openApi3*** template for base OpenAPI3 z/OS Connect native servers
- ***zosconnect:openApi3Requester*** template for base OpenAPI3 z/OS Connect native API requester servers

- Where ***serverName*** is any value you wish, such as ***zceesrvr*** or ***zCEEServer***, and this value will be the name of the server instance. The templates can be found in directory */usr/lpp/IBM/zosconnect/v3r0/runtime/templates/servers*.

- Environment variable ***WLP_USER_DIR*** will be used to set the location of the configuration directory and files created by this command, default location is */var/zosconnect/servers* where */var/zosconnect* is default value for *WLP_USER_DIR* for z/OS Connect.

- The zosconnect:openApi3 template installs feature **zosconnect:zosConnect-3.0**. z/OS Connect service provider features, e.g., zosconnect:cics-1.0, zosconnect:mqService-1.0, zosconnect:dbService-1.0 and imsmobile:imsmobile-2.0 have dependencies on feature **zosconnect:zosconnect-2.0** and are not compatible with feature **zosconnect:zosConnect-3.0**.

- The zosconnect:openApi3Requester template installs feature **zosconnect:oasRequester-1.0**.

- See URL https://www.ibm.com/docs/en/zos-connect/zosconnect/3.0?topic=reference-configuration-elements for a current list of OpenAPI2 configuration elements and URL https://www.ibm.com/docs/en/zos-connect/zos-connect/3.0?topic=reference-configuration-elements for the current list of OpenAPI3 configuration elements.

mitchj@us.ibm.com

There are other templates, but they are essentially only useful as samples of service provider configuration options.

Tech-Tip: Use JCL to make the creation and configuration of servers repeatable and portable

And take advantage of RACF SURROGAT and UNIXPRIV resources

Example of using **SURROGAT** privileges

```
//ZCEESRVR JOB CLASS=A,REGION=0M,NOTIFY=&SYSUID,USER=LIBSERV
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
// SET ZCEEPATH='/usr/lpp/IBM/zosconnect/v3r0'
// SET SERVER=`zceeSrvr'
// SET TEMPLATE='zosconnect:default'
// SET WLPUSER='/var/ats/zosconnect'
// SET USER='ATSSERV'
// SET GROUP='ATSGRP'
//*************************************************************
//*  Step ZCEESRVR - Use the zosconnect command to create a server
//*************************************************************
//ZCEESRVR EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 export WLP_USER_DIR=&WLPUSER; +
 &ZCEEPATH/bin/zosconnect create &SERVER +
  --template=&TEMPLATE; +
```

Example of using **UNIXPRIV** privileges

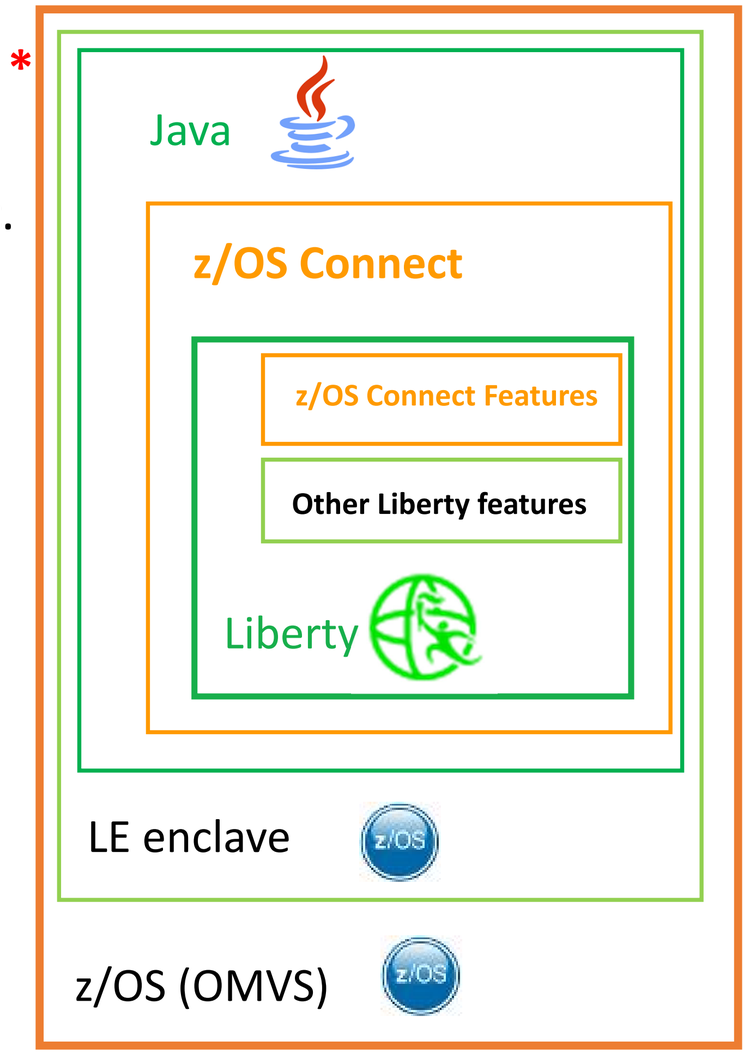
```
//ZCEESRVR JOB CLASS=A,REGION=0M,NOTIFY=&SYSUID
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
// SET ZCEEPATH='/usr/lpp/IBM/zosconnect/v3r0'
// SET SERVER='openApi3'
// SET TEMPLATE='zosconnect:openApi3'
// SET WLPUSER='/var/ats/zosconnect'
// SET USER='ATSSERV'
// SET GROUP='ATSGRP'
//*************************************************************
//*  Step ZCEEAPI3 - Use the zosconnect command to create a server
//*************************************************************
//ZCEEAPI3 EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 export WLP_USER_DIR=&WLPUSER; +
 &ZCEEPATH/bin/zosconnect create &SERVER +
  --template=&TEMPLATE; +
chown -R &USER:&GROUP $WLP_USER_DIR/servers/&SERVER
```

mitchj@us.ibm.com

Adding z/OS Connect to a Liberty server adds an additional software layer

z/OS Connect is both a Java application and a set of Liberty features

- The z/OS Connect Java application provides code that spawns a Liberty process *
- The z/OS Connect Liberty features provides a REST interface to user application artifacts that access to common z/OS subsystems, e.g., CICS, Db2, IMS, MQ, etc. and external REST endpoints.



* z/OS Connect starts a Liberty process using a system programming interface (SPI). See the Note regarding environment variables and *jvm.options* and *server.env* files at URL https://www.ibm.com/docs/en/was-liberty/zos?topic=liberty-embedding-server-in-your-applications regarding restrictions in this environment.

mitchj@us.ibm.com

Differences between z/OS Connect OpenAPI2 and OpenAPI3 server.xml files

default template – OpenAPI 2 server.xml configuration file

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
    <!-- Enable features -->
   <featureManager>
        <feature>zosconnect:zosConnect-2.0</feature>
        <feature>zosconnect:zosConnectCommands-1.0</feature>
        <feature>apiDiscovery-1.0</feature>  *
    </featureManager>

    <!-- To access this server from a remote client add a host attribute
    <httpEndpoint id="defaultHttpEndpoint"
                  host="*"
                  httpPort="9080"
                  httpsPort="9443" />
 <!-- add cors to allow cross origin access, e.g. when using swagger UI
to fetch swagger doc from zOS Connect Enterprise Edition  -->
    <cors id="defaultCORSConfig"
-  -  -  -  -  - 24 Line(s) not Displayed

 <!-- config requires updateTrigger="mbean" for REFRESH command support
-->
 <config updateTrigger="mbean" monitorInterval="500"/>

    <zosconnect_zosConnectManager setUTF8ResponseEncoding="true"/>

    <!-- zosConnect APIs -->
    <zosconnect_zosConnectAPIs updateTrigger="disabled" pollingRate="5s"
    <!-- zosConnect Services -->
 <zosconnect_services updateTrigger="disabled" pollingRate="5s"/>

 <!-- applicationMonitor is not applicable for z/OS Connect EE servers -
->
 <applicationMonitor updateTrigger="disabled" dropinsEnabled="false"/>

</server>
```

openApi3 template – OpenAPI 3 server.xml configuration file

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
    <!-- Enable features -->
   <featureManager>
        <feature>zosconnect:zosConnect-3.0</feature>
        <feature>openapi-3.0</feature>
</featureManager>

    <!-- To access this server from a remote client add a host attribute
    <httpEndpoint id="defaultHttpEndpoint"
                  host="*"
                  httpPort="9080"
                  httpsPort="9443" />
-  -  -  -  -  -  -  -  -  -  -  -  -  -  - 12 Line(s) not Displayed
    <!-- config requires updateTrigger="mbean" for REFRESH command support
   config updateTrigger="mbean"/>

    <!-- applicationMonitor requires updateTrigger="mbean" for REFRESH command
support -->
    <applicationMonitor updateTrigger="mbean" dropinsEnabled="false"/>

    <!-- Automatic expansion of WAR files is required for z/OS Connect native
servers running the zosConnect-3.0 feature  -->
    <applicationManager autoExpand="true" />

    <!-- APIs are deployed as WAR files and a webApplication element must be
used to specify the location of the API WAR and optionally the name of the API
-->
    <webApplication id="My API" location="${server.config.dir}/apps/api.war"
name="MyAPI"/>

</server>
```

Note there are no *zosconnect* or *cors* configuration elements present with Open API 3.

mitchj@us.ibm.com

* Include these features if not already present.

Contrast a Liberty JCL procedure versus a z/OS Connect JCL procedure

```
//ZCEESRVR PROC PARMS='serverName'
//*
// SET ZCONHOME='/usr/lpp/IBM/zosconnect/v3r0'
// SET INSTDIR='/usr/lpp/liberty_zos/21.0.0.9'
//*
//ZCON     EXEC PGM=BPXBATSL,REGION=0M,MEMLIMIT=8G,
//  PARM='PGM &ZCONHOME./bin/zosconnect run &PARMS. --clean'
//  PARM='PGM &INSTDIR./lib/native/zos/s390x/bbgzsrv &PARMS'
//STDOUT   DD   SYSOUT=*
//STDERR   DD   SYSOUT=*
//STDIN    DD   DUMMY
//MSGLOG   DD   SYSOUT=*
//STDENV   DD   *
_BPX_SHAREAS=YES
_CEE_RUNOPTS=HEAPPOOLS(ON),HEAPPOOLS64(ON)
JAVA_HOME=/usr/lpp/java/J8.0_64
WLP_USER_DIR=/var/zosconnect
JVM_OPTIONS=-Dcom.ibm.ws.zos.core.angelName=zCEEAngel -Xmx512m
OPENJ9_JAVA_OPTIONS=-Xoptionsfile=/var/zcee/properties/myServer.property
```

OMVS
LE
JAVA
LIBERTY
z/OS Connect

mitchj@us.ibm.com

https://www.ibm.com/docs/en/zos/2.5.0?topic=bpxbatch-guidelines-defining-stdenv

Tech-Tip: Displaying Liberty messages on the console and/or STDERR spool

server.xml

```
<zosLogging wtoMessage=
    "BAQR0657E,BAQR0658E,BAQR0660E,BAQR0686E,BAQR0687E"
    hardCopyMessage=
    "BAQR0657E,BAQR0658E,BAQR0660E,BAQR0686E,BAQR0687E"/>
```

MVS Console

```
18.12.02 STC00137  +BAQR0686E: Program CSCVINC is not available in the CICS region with
   811              connection ID cscvinc; service cscvincService failed.
18.12.02 STC00137  +BAQR0686E: Program CSCVINC is not available in the CICS region with
   812              connection ID cscvinc; service cscvincService failed.
19.07.12 STC00137  +BAQR0657E: Transaction abend MIJO occurred in CICS while using
   745              connection cscvinc and service cscvincService.
```

STDERR

```
ÝERROR    ¨ BAQR0686E: Program CSCVINC is not available in the CICS region with connection cscvinc and service cscvincService.
ÝERROR    ¨ BAQR0686E: Program CSCVINC is not available in the CICS region with connection cscvinc and service cscvincService.
ÝERROR    ¨ BAQR0657E: Transaction abend MIJO occurred in CICS while using CICS connection cscvinc and service cscvincService.
```

mitchj@us.ibm.com

Liberty JCL parameters and server XML environment variables

- **serverName** – This JCL parameter is used to provides the name of the server and used to set the value of several environment variables.
- **WLP_USER_DIR** – This environment variable is used when a server is created to determine where the server's working directories will be created and where the initial *server.xml* file will be created. This variable is also to by the runtime environment to locate the server's existing working directories and the *server.xml* file. Also, the WLP_USER_DIR is used to set the shared variables.
- **JAVA_HOME** – The OMVS directory where the Java executables (*/bin* directory) can be located.
- **JVM_OPTIONS – A z/OS Connect environment variables that provides Java options and/or system properties. The contents of *JVM_OPTIONS* is added to the *java* command line in the *zosconnect* startup script.**
- **IBM_JAVA_OPTIONS –** An IBM JAVA environment variable (deprecated and eventually will be replaced by *environment variable OPENJ9_JAVA_OPTIONS*). Environment variable *IBM_JAVA_OPTIONS* variable can be used to provide Java options and/or system properties.
- **OPENJ9_JAVA_OPTIONS –** An OpenJ9 environment variable (eventually will replace the deprecated environment variable *IBM_JAVA_OPTIONS*). Environment variable *OPENJ9_JAVA_OPTIONS* variable can be used to provide Java options and/or system properties.

Note: Any Java option or system property using JVM_OPTIONS supersedes the same Java non-standard options or system property when provided by IBM_JAVA_OPTIONS or OPEN9_JAVA_OPTIONS

The following environment variables are automatically set in a Liberty server and can be used as variables in the server XML configuration files.

- **server.config.dir** – whose value will automatically be set to the value of variable *WLP_USER_DIR* concatenated with the name of the server, e.g. */var/zosconnect/servers/serverName*
- **shared.config.dir** – whose value will automatically be set to the value of variable *WLP_USER_DIR* concatenated with /shared/config, e.g. */var/zosconnect/shared/config*
- **shared.app.dir** – whose value will automatically be set to the value of variable *WLP_USER_DIR* concatenated with /shared/apps, e.g. */var/zosconnect/shared/apps*
- **wlp.server.name -** whose value will automatically be set to the value of the server as provided in the PARMS value provided in the JCL procedure.

mitchj@us.ibm.com

Tech-Tip: The z/OS Connect *zconsetup* script must be invoked once per LPAR per install path

The *zconsetup* script creates a symbolic link from the z/OS Connect's WLP *../v3r0/wlp/etc* directory in the product path (normally R/O) to a local R/W directory (creating a default configuration and local extension directories). This provides a means for administrator to configure the image.

```
JOHNSON:/usr/lpp/IBM/zosconnect/v3r0/wlp/etc: ls -al
total 32
drwxrwxr-x    2 OMVSKERN 0            8192 Jun 24 10:24 .
drwxrwxr-x   10 OMVSKERN 0            8192 Jun 24 10:24 ..
lrwxrwxrwx    1 990023   0              31 Jul 27  2020 extensions -> /var/zosconnect/v3r0/extensions
```

```
/var/zosconnect
  /servers
  /v3r0
    /extensions
      imsmobile.properties
      zosconnect.properties
      filemanager.properties
      omegamon.properties
```

```
com.ibm.websphere.productId=com.ibm.ims.mobile
com.ibm.websphere.productInstall=imsmobile/wlp-ext
```

relative path

```
com.ibm.websphere.productId=com.ibm.zosconnect
com.ibm.websphere.productInstall=runtime
```

```
com.ibm.websphere.productId=omegamonRequestMonitor-2.0
com.ibm.websphere.productInstall=/var/zosconnect/omegamon
```

absolute path

- This directory structure and contents is created by by invoking the *zconsetup* script and **must be created on each LPAR** on which z/OS Connect will execute. This is how the z/OS Connect Liberty server locates service provider executables. Note: the *com.ibm.websphere.productInstall* directive value that is **relative** to directory /usr/lpp/IBM/zosconnect/v3r0.
- Not creating this link will cause messages *CWWKF0001E: A feature definition could not be found for zosconnect*:…. or *CWWKE0054E: Unable to open /usr/lpp/IBM/zosconnect/v3r0/wlp/etc/extensions/zosconnect.properties*

Tech-Tip: Verify the *zconsetup* script has been executed. My recommendation is to execute this script in the SMP/E target environment, otherwise it will be lost when service is applied and propagated to other images.

mitchj@us.ibm.com

Tech-Tip: Executing the z/OS Connect zconsetup script using JCL

```
//JOHNSONS JOB (ACCOUNT),JOHNSON,NOTIFY=JOHNSON,REGION=0M,
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1)
//*************************************************************
//*  Set symbols
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
// SET ZCEEPATH='/usr/lpp/IBM/zosconnect/v3r0'
//*************************************************************
//*  Step ZCSETUP - Invoke the zconsetup script
//*************************************************************
//ZCSETUP  EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 &ZCEEPATH/bin/zconsetup install
```

mitchj@us.ibm.com

A z/OS Connect Liberty server's configuration directories and files

ID=**LIBSERV**
Group=**LIBGRP**

```
export WLP_USER_DIR=/var/zosconnect          Owner    Group
$WLP_USER_DIR                          750   LIBSERV LIBGRP
 |--servers/                           750   LIBSERV LIBGRP
 |    |--server1_name1/                750   LIBSERV LIBGRP
 |    |    |--bootstrap.properties     700   LIBSERV LIBGRP
 |    |    |--jvm.options              700   LIBSERV LIBGRP
 |    |    |--server.env               640   LIBSERV LIBGRP
 |    |    |--server.xml               640   LIBSERV LIBGRP
 |    |    |--apps/                    750   LIBSERV LIBGRP
 |    |    |--dropins/                 750   LIBSERV LIBGRP
 |    |    |--configDropins/           750   LIBSERV LIBGRP
 |    |         |--defaults/           750   LIBSERV LIBGRP
 |    |         |--overrides/          750   LIBSERV LIBGRP
 |    |    |--logs/                    777   LIBSERV LIBGRP
 |    |         |--messages.log        666   LIBSERV LIBGRP
 |    |    |--resources/               777   LIBSERV LIBGRP
 |    |         |--security/           777   LIBSERV LIBGRP
 |    |         |--zosconnect/         750   LIBSERV LIBGRP
 |    |              |--apis/          750   LIBSERV LIBGRP
 |    |              |--apiRequesters/ 750   LIBSERV LIBGRP
 |    |              |--rules/         750   LIBSERV LIBGRP
 |    |              |--services/      750   LIBSERV LIBGRP
 |    |--server2_name/                750   LIBSERV LIBGRP
 |    |     . . .
 |    |--server3_name/                750   LIBSERV LIBGRP
 |    |     . . .
 |--shared/                           750   LIBSERV LIBGRP
      |--apps/                        750   LIBSERV LIBGRP
      |--config/                      750   LIBSERV LIBGRP
      |--resources/                   750   LIBSERV LIBGRP
```

- **OpenAPI3 application artifacts**
- **OpenAPI2 application artifacts**

mitchj@us.ibm.com

https://www.ibm.com/docs/en/was-liberty/base?topic=liberty-directory-locations-properties

Tech-Tip: Using permission bits to control access

ID=**LIBSERV**
Group=**LIBGRP**

```
export JAVA_HOME=<path_to_64_bit_Java>
export WLP_USER_DIR=/var/zosconnect
./server create zceesrvr
```

```
/var/zosconnect              751  LIBSERV LIBGRP
  /servers                   751  LIBSERV LIBGRP
    /zceesrv1                751  LIBSERV LIBGRP
      /apps                  761  LIBSERV LIBGRP
      /configDropins         761  LIBSERV LIBGRP
         /overrides          761  LIBSERV LIBGRP
      /logs                  771  LIBSERV LIBGRP
         messages.log        644  LIBSERV LIBGRP
      /resources             751  LIBSERV ADMGRP
        /security            777  LIBSERV LIBGRP
        /zosconnect          751  LIBSERV ADMGRP
         /apis               761  LIBSERV ADMGRP
         /apiRequesters      761  LIBSERV ADMGRP
         /rules              761  LIBSERV ADMGRP
         /services           761  LIBSERV ADMGRP
       server.xml            460  LIBSERV ADMGRP
/shared                      750  LIBSERV LIBGRP
   /apps                     750  LIBSERV LIBGRP
   /config                   750  LIBSERV LIBGRP
```

~~Often you may be tempted to use command ***chmod –R 777 ****~~

Sample of OMVS commands to manage permission bits

```
export WLP_USER_DIR=/var/zosconnect
cd $WLP_USER_DIR
chmod o+x -R servers
chmod o+x servers/zceesrvr/resources
chmod -R o+x servers/zceesrvr/resources/*
chmod g+r -R servers
chmod g+r servers/zceesrvr/resources
chmod -R g+r servers/zceesrvr/resources/*
chmod g+w server.xml
```

Warning: Access for Owner (u), Group(g), Others(o) depend on user ID (UID) and group ID (GID) as stored with the directory or file, not the actual SAF identity or group.
This has implications when moving entire filesystems from one LPAR to another using utilities like ADRDSSU.

mitchj@us.ibm.com

Tech Tip: Use multiple mount points and dedicated ZFS file systems

- Create mount points in the “administrative” directory for shared r/w directories
- Avoid creating directories and files in the root file system.
- Use a common or shared mount point
  - Use /var mount point for local read/write file systems
  - Use /global for sharing a mount point across multiple LPARs
- Use ZFS filesystems and use AGGRGROW to allow R/W ZFS filesystems to automatically go into extents (>16).

```
SYS1.PARMLIB(BPXPRM##)
MOUNT FILESYSTEM('OMVS.ZCEEVAR.ZFS')
      MOUNTPOINT('/var/zosconnect')
      TYPE(ZFS) MODE(READ)
MOUNT FILESYSTEM('OMVS.ZCEE.SERVERS.ZFS')
      MOUNTPOINT('/var/zosconnect/servers')
      TYPE(ZFS) PARM('AGGRGROW') MODE(RDWR)
MOUNT FILESYSTEM('OMVS.ZCEE.GROUP1.ZFS')
      MOUNTPOINT('/var/zosconnect/group1')
      TYPE(ZFS) PARM('AGGRGROW') MODE(RDWR)
MOUNT FILESYSTEM('OMVS.ZCEE.GROUP2.ZFS')
      MOUNTPOINT('/var/zosconnect/group2')
      TYPE(ZFS) PARM('AGGRGROW') MODE(RDWR)
MOUNT FILESYSTEM('OMVS.ZCEE.GROUP.ZFS')
      MOUNTPOINT('/var/zosconnect/group3')
      TYPE(ZFS) PARM('AGGRGROW') MODE(RDWR)
```

- Create a dedicated filesystem for the root z/OS Connect /var directory, e.g., /var/zosconnect/v3r0/extensions. This directory structure can not be changed. This provides portability for migrations and system upgrades. Note: MODE(READ) will apply to /var/zosconnect/servers.

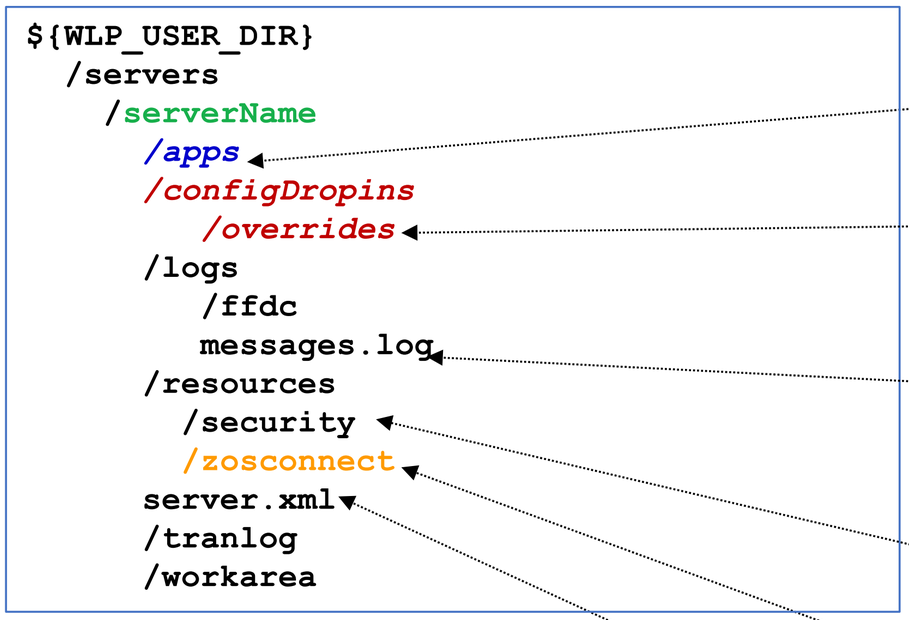
- Create a dedicated filesystem for each set or groups of servers. These filesystems will contain the server configuration directories for 1 or more servers.
- Each server’s WLP_USER_DIR environment variable will be set to the mount point, e.g., *WLP_USER_DIR=/var/zosconnect/group1* when the server is created and in the server’s startup JCL.

```
df -P | grep /var/zosconnect
Filesystem            512-blocks        Used  Available  Capacity Mounted on
OMVS.ZCEEVAR.ZFS           69120       68658        462      100% /var/zosconnect
OMVS.ZCEE.SERVERS.ZFS     159120       76455      82665       48% /var/zosconnect/servers
OMVS.ZCEE.GROUP1.ZFS      135360        1506     133854        2% /var/zosconnect/group1
OMVS.ZCEE.GROUP2.ZFS     4059360     2591284    1468076       64% /var/zosconnect/group2
OMVS.ZCEE.GROUP3.ZFS      135360       17858     117502       14% /var/zosconnect/group3
```

mitchj@us.ibm.com

More details of the contents of a server's directory structure

A server's configuration structure looks like this (N.B. OpenAPI 2 and OpenAPI 3 servers do not coexist as shown here):



The */apps* directory is the location to where EAR and WAR (OpenAPI3) files are deployed.

The */configDropins/overrides* directory is the location where server XML configuration files are placed.

The ***messages.log*** file is the key output file for messages about Liberty and the processing taking place in the Liberty server. The output written to this file can be written to the SPOOL by including DD statement MSGLOG in the startup JCL, e.g., //MSGLOG DD SYSOUT=*,FREE=CLOSE,SPIN=(UNALLOC,1M)

The */security* directory contains files **ltpa.keys** and **key.p12**. **ltpa,keys** is the server specific LTPA token. **key.p12** is a self-signed certificate that expires in one year.

The */zosconnect* directory is where the OpenAPI2 APIs, services, and API requester files will be placed for an OpenAPI 2 server.

The **server.xml** file is the key configuration file. It is here that z/OS Connect definitions go which define the essential configuration of the server and backend connectivity.

The *WLP_USER_DIR* environment variables sets the value of the root directory of the server's configuration files and directories, e.g., WLP_USER_DIR=/var/zosconnect

mitchj@us.ibm.com

Use “include” files to extend and manage a server’s configuration

- Setup a server.xml using ‘include’ statements and allow other administrator to manage those included files, but not the server.xml itself.
- Control what configuration can be overridden in included files using the ‘onConflict’ option provided with the include element (see Ignore, Replace, Merge).

https://www.ibm.com/support/knowledgecenter/en/SSAW57_liberty/com.ibm.websphere.wlp.nd.multiplatform.doc/ae/cwlp_config_include.html

server.xml (owned by ID ADMIN1)

```
<include location="${server.config.dir}/includes/db2.xml onConflict=“IGNORE”/>
<include location="${server.config.dir}/includes/cics.xml onConflict=“IGNORE”/>
<include location="${server.config.dir}/includes/imsDb.xml onConflict=“IGNORE”/>
<featureManager>
    <feature>zosconnect:zosConnect-2.0</feature>
   <feature>zosconnect:zosConnectCommands-1.0</feature>
   <feature>apiDiscovery-1.0</feature>
 <featureManager>
```

db2.xml (owned and managed by a DBA)

```
<server description="Db2 REST">
 <zosconnect_zosConnectServiceRestClientConnection
   id="Db2Conn" host="wg31.washington.ibm.com"   port="2446“basicAuthRef="dsn2Auth" />
 <zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth"
     applName=DSN2APPL”/>
</server>
```

cics.xml (owned and managed by a CICS administrator)

```
<server description=“CICS">
<featureManager>  <feature>zosconnect:cicsService-1.0</feature>  </featureManager>
<zosconnect_cicsIpicConnection id="catalog"  host="wg31“ port="1491"/>
<zosconnect_cicsIpicConnection id="cscvinc"  host="wg31“ port="1493"/>
</server>
```

imsDB.xml (owned and managed by a IMS administrator)

```
<server description="IMS DATABASE">
<featureManager>  <feature>zosconnect:dbService-1.0</feature> </featureManager>
<connectionFactory id="DFSIVPAConn">  <properties.imsudbJLocal
databaseName="DFSIVPA“  datastoreName="IVP1“driverType="4“   portNumber="5555"
datastoreServer="wg31"   user="USER1"   password="USER1“
flattenTables="True"/>  </connectionFactory>
</server>
```

Nesting of an include file within a include file is possible

mitchj@us.ibm.com

Tech-Tip: Review configuration conflicts

```
ÝAUDIT    ¨ CWWKG0102I: Found conflicting settings for cscvincAPI instance of zosconnect_endpointConnection configuration.
  Property port has conflicting values:
    Value 9443 is set in file:/var/zosconnect/servers/myServer/includes/apiRequesterHTTPS.xml.
    Value 9443 is set in file:/var/zosconnect/servers/myServer/includes/apiRequesterHTTPS.xml.
    Value 9463 is set in file:/var/zosconnect/servers/myServer/includes/oauth.xml.
  Property port will be set to 9463.
  Property host has conflicting values:
    Value https://dvipa.washington.ibm.com is set in file:/var/zosconnect/servers/myServer/includes/apiRequesterHTTPS.xml.
    Value https://dvipa.washington.ibm.com is set in file:/var/zosconnect/servers/myServer/includes/apiRequesterHTTPS.xml.
    Value https://mpz3.washington.ibm.com is set in file:/var/zosconnect/servers/myServer/includes/oauth.xml.
  Property host will be set to https://mpz3.washington.ibm.com.
  Property authenticationConfigRef has conflicting values:
    Value mySAFAuth is set in file:/var/zosconnect/servers/myServer/includes/apiRequesterHTTPS.xml.
    Value myoAuthConfig is set in file:/var/zosconnect/servers/myServer/includes/oauth.xml.
  Property authenticationConfigRef will be set to myoAuthConfig.
```

onConflict="MERGE"	Conflicting elements will be merged, and the last value encountered will be used.
onConflict="REPLACE"	When elements conflict, the element in the included file will be ignored
onConflict="IGNORE"	Conflicting elements in the included file are ignored.

Tech-Tip: Understand the difference between a singleton XML configuration entry versus entries where multiple entries are allowed. During the XML parsing of the configuration files, multiple occurrences of singleton XML configuration entry are combined as they are encountered whereas multiple entries are kept separate based on the value of their *id.*

mitchj@us.ibm.com

Use a *bootstrap.properties* file to help customize a server's XML configuration#

zceesrv1's bootstrap.properties

```
httpPort=9080
httpsPort=9443
ipicPort=1491
host=*
cicsHost=wg31.washington.ibm.com
network=ZOSCONN1
applid=ZOSCONN1
com.ibm.ws.zos.core.angelName=namedAngel
bootstrap.include=/var/liberty/common-bootstrap.properties
```

zceesrv2's bootstrap.properties

```
httpPort=9090
httpsPort=9453
ipicPort=1492
host=wg31.washington.ibm.com
cicsHost=wg31.washington.ibm.com
network=ZOSCONN2
applid=ZOSCONN2
com.ibm.ws.zos.core.angelName=namedAngel
bootstrap.include=/var/liberty/common-bootstrap.properties
```

server.xml

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

ipicIDProp.xml

```
<zosconnect_cicsIpicConnection id="catalog"
  host="${cicsHost}" port="${ipicPort}"
  zosConnectNetworkid="${network}"  zosConnectApplid="${applid}"/>

<zosconnect_cicsIpicConnection id="cscvinc"
 host="${cicsHost}" port="${ipicPort}"
 zosConnectNetworkid="${network}"  zosConnectApplid="${applid}"/>

<zosconnect_cicsIpicConnection id="miniloan"
 host="${cicsHost}" port="${ipicPort}"
 zosConnectNetworkid="${network}"  zosConnectApplid="${applid}"/>
```

N.B. Java directives can also be provided.

N.B. Boot strap properties can be included from a common boot strap properties file

mitchj@us.ibm.com

#The bootstrap properties file is located in directory **${server.config.dir}** and uses EBCDIC encoding

Tech-Tip: A suggestion for managing the server.xml configuration file

Default server.xml configuration file

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
    <!-- Enable features -->
   <featureManager>
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    </featureManager>

    <!-- To access this server from a remote client add a host attribute
    <httpEndpoint id="defaultHttpEndpoint"
                  host="*"
                  httpPort="9080"
                  httpsPort="9443" />
 <!-- add cors to allow cross origin access, e.g. when using swagger
    <cors id="defaultCORSConfig"
          domain="/"
          allowedOrigins="*"
          allowedMethods="GET, POST, PUT, DELETE, OPTIONS"
          allowedHeaders="Origin, Content-Type, Authorization, Cache-Con
          allowCredentials="true"
          maxAge="3600"/>
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - 30 Line(s) not Displayed
</server>
```

Modified server.xml configuration file

```
<server description="zCEE Server">
<include location="${server.config.dir}/includes/safSecurity.xml"/>
<include location="${server.config.dir}/includes/ipicIDProp.xml"/>
<include location="${server.config.dir}/includes/keyring.xml"/>
<include location="${server.config.dir}/includes/groupAccess.xml"/>
<include location="${server.config.dir}/includes/shared.xml"/>
<include location="${server.config.dir}/includes/apiRequesterHTTPS.xml"/
<include location="${server.config.dir}/includes/imsDatabase.xml"/>
 <!-- Enable features -->
   <featureManager>
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    </featureManager>
 <!-- To access this server from a remote client add a host attribute
    <httpEndpoint id="defaultHttpEndpoint"
                  host="${host}"
                  httpPort="${httpPort}"
                  httpsPort="${httpsPort}" />
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - 36 Line(s) not Displayed
</server>
```

The simplifies administration by :

- Using a *bootstrap.properties* file to customize the ports in the *server.xml* file.
- Using “include” statements to make further changes such as adding additional features and additional XML configuration elements.
- Review https://www.ibm.com/docs/en/was-liberty/nd?topic=liberty-configuration-element-merging-rules to understand merging rules.
- **Consider providing configuration elements by placing server XML files in the …*/configDropins/original* subdirectory.**

Two ways to provide STDENV input in a JCL Procedure

Use the STDENV DD statement to scale servers and share configuration properties horizontally

```
//ZCON      EXEC PGM=BPXBATSL,REGION=0M,MEMLIMIT=8G,
//            PARM='PGM &ZCONHOME./bin/zosconnect run &PARMS. --clean'
//STDERR    DD SYSOUT=*,FREE=CLOSE,SPIN=(UNALLOC,1M)
//STDOUT    DD SYSOUT=*
//STDIN     DD DUMMY
//STDENV    DD PATH='/var/zcee/properties/&PARMS..property',
//              PATHOPTS=ORDONLY
 or
//STDENV    DD DISP=SHR,DSN=JOHNSON.ZCEE.STDENV(COMMON)
//            DD DISP=SHR,DSN=JOHNSON.ZCEE.STDENV(ZCEESRVR)
```

```
Member COMMON
_BPX_SHAREAS=YES
_CEE_RUNOPTS=HEAPPOOLS(ON),HEAPPOOLS64(ON)
JAVA_HOME=/usr/lpp/java/J8.0_64
ZCON_ENV_DEBUG=TRUE
WLP_USER_DIR=/var/zosconnect
```

```
Member ZCEESRVR
OPENJ9_JAVA_OPTIONS=-Dcom.ibm.ws.zos.core.angelName=ZCEEANGL
JVM_OPTIONS=-Xoptionsfile=/var/zcee/properties/javaHCD.property -Xmx512m -verbose:sizes
JAVA_HOME=/u/johnson/java/J8.0_64
WLP_USER_DIR=/var/ats/zosconnect
```

Either one OMVS property file or multiple PDS members.

The last occurrence environment variable encountered determines the value of the environment variable.

Which value used for a Java option or property depends on which environment variable is used to specify the option or property.

Using //STDENV DD * is discouraged because of the 80 character record limit.

mitchj@us.ibm.com

BTW, the DCB characteristics the STDENV PDS/PDSE data set were (LRECL=400,BLKSIZE=32400).

Tech/Tip: Liberty Java Directives for controlling output

com.ibm.ws.logging.console.format (consoleFormat)- The required format for the console. Valid values are basic or json format.

com.ibm.ws.logging.console.log.level (consoleLogLevel) - This filter controls the granularity of messages that go to the console. The valid values are INFO, AUDIT, WARNING, ERROR, and OFF. By default, the console log level is set to AUDIT.

com.ibm.ws.logging.hideMessage (hideMessage) - Use this attribute to configure the messages that you want to hide from the *console.log* and *message.log* files. If the messages are configured to be hidden, then they are redirected to the *trace.log* file.

com.ibm.ws.logging.log.directory (logDirectory) - Use this attribute to set a directory for all log files, excluding the *console.log* file, but including *FFDC*. The default log location path is *WLP_OUTPUT_DIR/serverName/logs*

com.ibm.ws.logging.max.file.size (maxFileSize) - The maximum size (in MB) that a log file can reach before it is rolled. The Liberty runtime does only size-based log rolling. To disable this attribute, set the value to 0. The maximum file size is approximate. By default, the value is 20.

com.ibm.ws.logging.max.files (maxFiles) - If a maximum file size exists, this setting is used to determine how many of each of the log files are kept. This setting also applies to the number of exception logs that summarize exceptions that occurred on any day. So, if this number is 10, you might have 10 message logs, 10 trace logs, and 10 exception summaries in the *ffdc* directory. The default value is 2.

com.ibm.ws.logging.message.format (messageFormat) - The required format for the messages.log file. Valid values are basic or json format. By default, messageFormat is set to the environment variable WLP_LOGGING_MESSAGE_FORMAT (if set) or basic.

com.ibm.ws.logging.trace.file.name (traceFileName) - The *trace.log* file is only created if additional or detailed trace is enabled. *stdout* is recognized as a special value; and causes trace to be directed to the original standard out stream.

bootstrap.properties example:

```
com.ibm.ws.logging.message.file.name=basqstrtMessages.log
com.ibm.ws.logging.log.directory=/u/common/logs
```

N.B. *consoleFormat, logDirectory*, etc. can be specified in the <*logging/*> Liberty configuration element. Note the recommendation for the attributes in red is for them to be provided in Java directives.

mitchj@us.ibm.com

Tech-Tip: Consider using symbolic links as an administrative shortcut

- Create an “administration” subdirectory, e.g., *LibertyConfigs* in directory */var*
- Then create a symbolic link in the “administration” directory to each Liberty server’s configuration directory and other frequently accessed directories.

```
ls -al /var/LibertyConfigs
drwxrwxrwx   4 JOHNSON  SYS1        8192 Aug 16 12:23 .
drwxrwxrwt  25 OMVSKERN SYS1        8192 Aug 16 11:56 ..
lrwxrwxrwx   1 JOHNSON  SYS1          57 Aug 16 12:22 CSCWLP -> /var/wlp/cics/CICS53Z/CSCWLP/wlp/usr/servers/defaultServer
lrwxrwxrwx   1 JOHNSON  SYS1          57 Aug 16 12:22 CICSWLP -> /var/wlp/cics/CICS53Z/CICSWLP/wlp/usr/servers/cicswlp
drwxrwxrwx   2 JOHNSON  SYS1        8192 Aug 16 15:30 hcd
lrwxrwxrwx   1 JOHNSON  SYS1          27 Jun 10 15:55 includes -> /global/zosconnect/includes
lrwxrwxrwx   1 JOHNSON  SYS1          28 Aug 16 10:12 mqweb -> /var/mqm/mqweb/servers/mqweb
lrwxrwxrwx   1 JOHNSON  SYS1          32 Jun  4 12:49 myServer -> /var/zosconnect/servers/myServer
drwxr-xr-x   2 JOHNSON  SYS1        8192 Aug 16 13:14 properties
lrwxrwxrwx   1 JOHNSON  SYS1          18 Aug 17 12:47 shared -> /var/shared/zosconnect/resources/zosconnect
lrwxrwxrwx   1 JOHNSON  SYS1          24 May 13  2020 walop3a -> /var/wlp/servers/walop3a
lrwxrwxrwx   1 JOHNSON  SYS1          24 May 13  2020 walrp3a -> /var/wlp/servers/walrp3a
lrwxrwxrwx   1 JOHNSON  SYS1          31 May 14  2020 wazs34a -> /var/zosconnect/servers/wazs34a
lrwxrwxrwx   1 JOHNSON  SYS1          24 Aug 16 10:32 wlphats -> /var/wlp/servers/wlphats
lrwxrwxrwx   1 JOHNSON  SYS1          36 Aug 16 10:31 zceeapir -> /var/ats/zosconnect/servers/zceeapir
lrwxrwxrwx   1 JOHNSON  SYS1          39 Aug 16 10:18 zceecics -> /var/cicsts/zosconnect/servers/zceecics
lrwxrwxrwx   1 JOHNSON  SYS1          35 Aug 16 10:31 zceedvm -> /var/ats/zosconnect/servers/zceedvm
lrwxrwxrwx   1 JOHNSON  SYS1          32 Jun 10 15:54 zceeopid -> /var/zosconnect/servers/zceeopid
lrwxrwxrwx   1 JOHNSON  SYS1          36 Aug 16 10:14 zceesrvr -> /var/ats/zosconnect/servers/zceesrvr
lrwxrwxrwx   1 JOHNSON  SYS1          44 Aug 16 11:57 zosmfServer -> /var/zosmf/configuration/servers/zosmfServer
```

There are various Liberty servers shown here. There are CICS Liberty servers, z/OS Connect servers, a MQ Web Console Liberty server, a zOSMF Liberty server, a HATS Liberty server and a few standard Liberty servers for Java applications.

One administration directory to manage them all!

mitchj@us.ibm.com

Tech-Tip: Be aware of the default for update polling

```
<!- Application Monitoring      -->
<applicationMonitor updateTrigger="polled" dropinsEnabled="true"/>

<!-- config requires updateTrigger="mbean" for REFRESH command support -->
 <config updateTrigger="polled" monitorInterval="500ms"/>           Change to mbean

<!-- zosConnect APIs -->
 <zosconnect_zosConnectAPIs pollingRate="5s" updateTrigger="disabled"    />

<!-- zosConnect API requesters -->
 <zosconnect_apiRequesters updateTrigger="disabled" pollingRate="5s"/>

<!-- zosConnect Services -->
 <zosconnect_services pollingRate="5s" updateTrigger="disabled"/>

<!-- zosConnect policies -->
 <zosconnect_policy pollingRate="1m" updateTrigger="disabled"/>

<!-- zosConnect data transformer -->
 <zosconnect_zosConnectDataXform pollingrate="2s" updateTrigger="polled"/>

<!—A security certificate repository -->
 <keystore pollingrate="500ms" updateTrigger="mbean"/>
```

mitchj@us.ibm.com

Sharing XML configuration files between servers using ${shared.config.dir}

Add an "*includes"* subdirectories {shared.config.dir} with a symbolic links to a common location. This common directory an be accessed from multiple servers on a single or from multiple LPARs. Additions and updates to the "include" files are then made in one single administrative directory.

Symbolic links from servers shared configuration ${shared.config.dir} to common directory

Symbolic links to a shared local LPAR directory

```
ln -s /var/shared/zosconnect/includes /var/zosconnect/shared/config
ln -s /var/shared/zosconnect/includes /var/ats/zosconnect/shared/config
ln -s /var/shared/zosconnect/includes /var/wsc/zosconnect/shared/config
```

Symbolic links to a shared Sysplex directory *

```
ln -s /global/zosconnect/includes /var/zosconnect/servers/shared/config
ln -s /global/zosconnect/includes /var/ats/zosconnect/shared/config
ln -s /global/zosconnect/includes /var/wsc/zosconnect/shared/config
```

```
<include location="${shared.config.dir}/safSecurity.xml"/>
<include location="${shared.config.dir}/ipicIDProp.xml"/>
<include location="${shared.config.dir}/keyringOutboundMutual.xml"/>
<include location="${shared.config.dir}/groupAccess.xml"/>
<include location="${shared.config.dir}/shared.xml"/>
<include location="${shared.config.dir}/db2.xml"/>
<include location="${shared.config.dir}/oauth.xml"/>
```

/var/shared/*zosconnect/includes*

/global/zosconnect/*includes*

Contents of the common "includes" directory

```
basicSecurity.xml
db2.xml
db2TLS.xml
groupAccess.xml
ipic.xml
ipicIDProp.xml
keyringInbound.xml
keystore.xml
keyringMutual.xml
keyringOutboundMutual.xml
safSecurity.xml
```

The server.xml file contains these "include" statements and the server XML is portable regardless of the underlying filesystem infrastructure.

For example, changing *basicSecurity.xml* to *safSecurity.xml* and refreshing the configuration changes security from basic to SAF

F ZCEESRVR ,REFRESH,CONFIG

mitchj@us.ibm.com

*https://www.ibm.com/docs/en/zos/2.3.0?topic=zuapbfizv-zos-unix-add-global-directory-sysplex-root-file-system

A practical example-PTF V3.0.35 included a CORS update

July 2020	
V3.0.35 (APAR PH26291) Server code update	**Enhancements** • The text of messages BAQR0417W and BAQR0418W has been updated. For more information, see z/OS Connect EE Runtime Messages. **Fixes** • PH21761 A CICS region reports **`SOS DFHSM0133 WBSETBUF`** when z/OS Connect EE requester is in use. • PH25345 Passing user credentials in the request body to the authentication server to obtain a JWT causes a NPE in z/OS Connect EE. • PH21819 z/OS Connect EE sets some CORS headers automatically. **Attention** When this fix is applied, additional CORS configuration is required in `server.xml` to enable connections from the z/OS Connect EE API toolkit and JavaScript clients. For more information, see Configuring Cross-Origin Resource Sharing on a z/OS Connect Enterprise Edition Server

cors.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="CORS entries">

    <!-- add cors to allow cross origin access, e.g. when using swagger doc from zOS Connect Enterprise
Edition  -->
    <cors id="defaultCORSConfig"
          domain="/"
          allowedOrigins="*"
          allowedMethods="GET, POST, PUT, DELETE, OPTIONS"
          allowedHeaders="Origin, Content-Type, Authorization, Cache-Control, Expires, Pragma"
          allowCredentials="true"
          maxAge="3600"/>

</server>
```

server.xml

```
<include location="${server.config.dir}/cors.xml"/>
```

mitchj@us.ibm.com

Sharing XML configuration files – using '*variables*' files

"variables" files whose names are based on the name of the server, e.g., ${wlp.server.name}

myServer.xml

```
<variable name= "unauthenticatedUser" value= "WSGUEST" />
<variable name="profilePrefix" value= "BBGZDFLT" />
```

zceeopid.xml

```
<variable name= "unauthenticatedUser" value="ZCGUEST" />
<variable name="profilePrefix" value="EMJZDFLT" />
```

server.xml

```
<server description="new server">
<include location="${server.config.dir}/includes/safSecurity.xml"/>
<include location="${server.config.dir}/includes/${wlp.server.name}.xml"/>

     <!-- Enable features -->
     <featureManager>
         <feature>zosconnect:zosConnect-2.0</feature>
         <feature>zosconnect:zosConnectCommands-1.0</feature>
     </featureManager>
```

safSecurity.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="SAF security">

    <!-- Enable features -->
    <featureManager>
        <feature>appSecurity-2.0</feature>
        <feature>zosSecurity-1.0</feature>
    </featureManager>

    <webAppSecurity allowFailOverToBasicAuth="true" />
    <safRegistry id="saf" />
    <safAuthorization racRouteLog="ASIS" />
    <safCredentials unauthenticatedUser="${unauthenticatedUser}"
       profilePrefix="${profilePrefix}"/>
</server>
```

mitchj@us.ibm.com

Using the Liberty server's configuration drop-in's directories

Located in the same directory as the *server.xml* configuration file.

- Configuration files in the */default* directory provides defaults for configuration elements not present in *server.xml*
- Configuration files in the */overrides* directory adds to or replaces the configuration elements found in *server.xml*

```
${WLP_USER_DIR}
  /servers
    /serverName
      /apps
      /configDropins
         /default
         /overrides
      /logs
         /ffdc
         messages.log
      /resources
        /security
      server.xml
      /tranlog
      /workarea
```

commonFeatures.xml

```
<server description="Common Server Features">

  <!-- Enable features -->
  <featureManager>
     <feature>adminCenter-1.0</feature>
     <feature>restConnector-2.0</feature>
  </featureManager>

  <remoteFileAccess>
     <readDir>/var/zcee/includes</readDir>
     <readDir>/global/zosconnect/includes</readDir>
     <writeDir>${server.config.dir}</writeDir>
  </remoteFileAccess>

</server>
```

safSecurity.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="SAF security">

    <!-- Enable features -->
    <featureManager>
        <feature>appSecurity-2.0</feature>
        <feature>zosSecurity-1.0</feature>
    </featureManager>

    <webAppSecurity allowFailOverToBasicAuth="true" />
    <safRegistry id="saf" />
    <safAuthorization racRouteLog="ASIS" />
    <safCredentials unauthenticatedUser="${unauthenticatedUser}"
       profilePrefix="${profilePrefix}"/>
</server>
```

Another directory that must be manually created.

mitchj@us.ibm.com

Consider simplifying administration by combining include files and by using server variables

Default server.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
<include location="${server.config.dir}/includes/${wlp.server.name}.xml"/>

    <!-- Enable features -->
    <featureManager>
        <feature>zosconnect:zosConnect-3.0</feature>
        <feature>openapi-3.0</feature>
    </featureManager>

    <!-- To access this server from a remote client add a host attribute
to the following element, e.g. host="*" -->
    <httpEndpoint id="defaultHttpEndpoint"
                  host="*"
                  httpPort="9080"
                  httpsPort="9443" />
```

${server.config.dir}/includes/${wlp.server.name}.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="new server">
<variable name="httpPort" value="9081"/>
<variable name="httpsPort" value="9445"/>
<variable name="hostName" value="*"/>
<variable name="CICS_HOST" value="wg31.washington.ibm.com"/>
<variable name="CICS_PORT" value="1491"/>
<variable name="DB2_HOST" value="wg31.washington.ibm.com"/>
<variable name="DB2_PORT" value="2446"/>
<variable name="DB2_USERNAME" value="USER2"/>
<variable name="DB2_PASSWORD" value="USER2"/>
<include location="${shared.config.dir}/safSecurity.xml"/>
<include location="${shared.config.dir}/httpEndpoint.xml"/>
<include location="${shared.config.dir}/db2.xml"/>
<include location="${shared.config.dir}/cics.xml"/>
<include location="${shared.config.dir}/keystore.xml"/>
</server>
```

${server.config.dir}/includes/httpEndpoint.xml”/>

```
<server description="basic security">
   <httpEndpoint id="defaultHttpEndpoint"
                 host="${hostName}"
                 httpPort="${httpPort}"
                 httpsPort="${httpsPort}" />
</server>
```

${server.config.dir}/includes/db2.xml”/>

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="Default server">
    <featureManager>
        <feature>zosconnect:db2-1.0</feature>
    </featureManager>
 <zosconnect_credential user="${DB2_USERNAME}"
       password="${DB2_PASSWORD}" id="commonCredentials" />
 <zosconnect_db2Connection id="db2Conn" host="${DB2_HOST}"
      port="${DB2_PORT}" credentialRef="commonCredentials" />
</server>
```

${server.config.dir}/includes/cics.xml”/>

```
<server description="CICS IPIC connections">
<!-- Enable features -->
<featureManager>
  <feature>zosconnect:cics-1.0</feature>
</featureManager>
 <zosconnect_cicsIpicConnection id="cicsConn" host="${CICS_HOST}"
    port="${CICS_PORT}" />
 </server>
```

mitchj@us.ibm.com

For example, the MQ Console Liberty configuration uses a R/O common configuration file

The server.xml only contain ‘include’ commands.

server.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!--
This file defines the configuration for the mqweb server. Please do not
make changes to this file. Any changes made by users should be in the
referenced mqwebuser.xml file.
-->
<server>
    <include location="${wlp.install.dir}/mq/etc/mqweb.xml"/>
    <include location="mqwebuser.xml"/>
</server> >
```

‘Include’ file *mqweb.xml* is provided by MQ and usually a read only file. It sets default values for variables and the required Liberty configuration elements.

‘Include’ file *mqwebuser.xml* is a read/write file and provides overrides for the default values of variables and any other Liberty configuration elements.

mitchj@us.ibm.com

Sharing XML configuration files – using '*variables*' files

/usr/lpp/mqm/V3R3M4/web/mqm/etc/mqweb.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server>

    <featureManager>
        <feature>jaxrs-2.1</feature>
        <feature>ssl-1.0</feature>
        <feature>jndi-1.0</feature>
        <feature>concurrent-1.0</feature>
        <feature>websocket-1.0</feature>
        <feature>applicationMonitorMQ-1.0</feature>
    </featureManager>

    <!--
    Configurable properties. These can be overridden by setting appropri
    -->
    <variable name="httpHost" value="localhost"/>
    <variable name="httpPort" value="-1"/>
    <variable name="httpsPort" value="9443"/>
    <variable name="mqRestRequestTimeout" value="30"/>
    <variable name="mqConsoleAutostart" value="true"/>
    <variable name="mqRestAutostart" value="true"/>
    <variable name="mqRestGatewayQmgr" value=""/>
    <variable name="mqRestGatewayEnabled" value="true"/>
    <variable name="traceSpec" value="*=info"/>
    <variable name="maxTraceFileSize" value="20"/>
    <variable name="maxTraceFiles" value="2"/>
    <variable name="maxMsgTraceFileSize" value="200"/>
    <variable name="maxMsgTraceFiles" value="5"/>
    <variable name="ltpaExpiration" value="120"/>
    <variable name="ltpaCookieName" value="LtpaToken2_${httpsPort}"/>
    <variable name="secureLtpa" value="true"/>
    <variable name="mqRestCsrfValidation" value="true"/>
    <variable name="mqRestCorsAllowedOrigins" value=""/>
    <variable name="mqRestCorsMaxAgeInSeconds" value="0"/>
    <variable name="mqRestMftCoordinationQmgr" value=""/>
    <variable name="mqRestMftCommandQmgr" value=""/>
    <variable name="mqRestMftEnabled" value="false"/>
    <variable name="mqRestMftReconnectTimeoutInMinutes" value="30"/>
    <variable name="mqRestMessagingEnabled" value="true"/>
    <variable name="mqRestMessagingMaxPoolSize" value="20"/>
```

mqwebuser.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<server>
    <featureManager>
        <feature>appSecurity-2.0</feature>
        <feature>zosSecurity-1.0</feature>
        <feature>basicAuthenticationMQ-1.0</feature>
        <feature>apiDiscovery-1.0</feature>
    </featureManager>

    <enterpriseApplication id="com.ibm.mq.console"/>
    <enterpriseApplication id="com.ibm.mq.rest"/>

    <safAuthorization racRouteLog="ASIS"/>
    <safRegistry id="saf"/>
    <safAuthorization id="saf"
       reportAuthorizationCheckDetails="true" />
    <safCredentials profilePrefix="MQWEB" unauthenticatedUser="WSGUEST"/

    <webAppSecurity allowFailOverToBasicAuth="true" />

    <variable name="httpsPort" value="1419"/>
    <variable name="httpHost" value="-1"/>
    <variable name="mqRestMessagingEnabled" value="true"/>

    <config monitorInterval="5s" updateTrigger="mbean"/>

</server>
```

mitchj@us.ibm.com

Tech-Tip: Use Symbolic links to simplify commands used in OMVS and JCL

```
Performing commands:
ln -s /global/zosconnect/includes /var/zcee/includes
ln -s /var/zosconnect/servers/zceesrv1 /var/zcee/zceesrv1
ln -s /var/zosconnect/servers/zceesrv2 /var/zcee/zceesrv2

Will change these OMVS commands from:
ln -s /global/zosconnect/includes /var/zosconnect/servers/zceesrv1/includes
ln -s /global/zosconnect/includes /var/zosconnect/servers/zceesrv2/includes

To simpler (and shorter) OMVS commands:
ln -s /var/zcee/includes /var/zcee/zceesrv1/includes
ln -s /var/zcee/includes /var/zcee/zceesrv2/includes
```

Directory Shortcuts

- Create a shortcut from the shared administrative *include* directory to the Sysplex or LPAR shared directory
- Create shortcuts from the server's administrative directories to each server's configuration directory.

N.B. These are symbolic links to symbolic links.

ln –s oldname newname

These symbolic links can be used as JCL symbols

```
//EXPORT EXPORT SYMLIST=(*)
// SET SERVER= 'zceesrv1'
// SET SHARED='/var/zcee/includes'
// SET WLPUSER='/var/zosconnect'
//ZCEELN EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
  BPXBATCH SH +
  ln -s &SHARED /var/zcee/&SERVER/includes
    instead of entering the full directory names as in
  ln -s /global/zosconnect/includes  +
            &WLPUSER/servers/&SERVER/includes
```

And added as exports to /u/*home*/.profile or /etc/profile files

```
export serverName=zceesrv1
export shared=/var/zcee/includes
export WLP_USER_DIR=/var/zosconnect
```

```
//ZCEELN EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *
  BPXBATCH SH +
  ln -s $shared /var/zcee/$serverName/includes
instead of entering the full directory names as in
  ln -s /global/zosconnect/includes +
            $WLPUSER/servers/$serverName/includes
```

mitchj@us.ibm.com

Combine these techniques to standardized the creation and customization of new servers

```
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
// SET ZCEEPATH='/usr/lpp/IBM/zosconnect/v3r0'
// SET SERVER='zceeSrvr'
// SET TEMPLATE='zosconnect:default'
// SET WLPUSER='/var/ats/zosconnect'
// SET USER='ATSSERV'
// SET GROUP='ATSGRP'
//*************************************************************
//*  Step ZCEESRVR - Use the zosconnect command to create a server
//*************************************************************
//ZCEESRVR EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
 BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 export WLP_USER_DIR=&WLPUSER; +
 &ZCEEPATH/bin/zosconnect create &SERVER +
  --template=&TEMPLATE; +
 ln -s $WLP_USER_DIR/servers/&SERVER /var/liberty/&SERVER; +
 cp /var/liberty/properties/bootstrap.properties +
    /var/liberty/&SERVER; +
 cp /var/liberty/properties/server.xml +
    /var/liberty/&SERVER; +
 chown -R &USER:&GROUP $WLP_USER_DIR/servers/&SERVER
```

- Export environment variables
- Create the server and its configuration directories, etc.
- Create a symbolic link from the server's configuration directory to common administration directory
- Copy a default bootstrap.properties and server.xml files into the server's configuration directory
- Change owner and group of the server's configuration directories and files to the SAF identity under which the server will run

mitchj@us.ibm.com

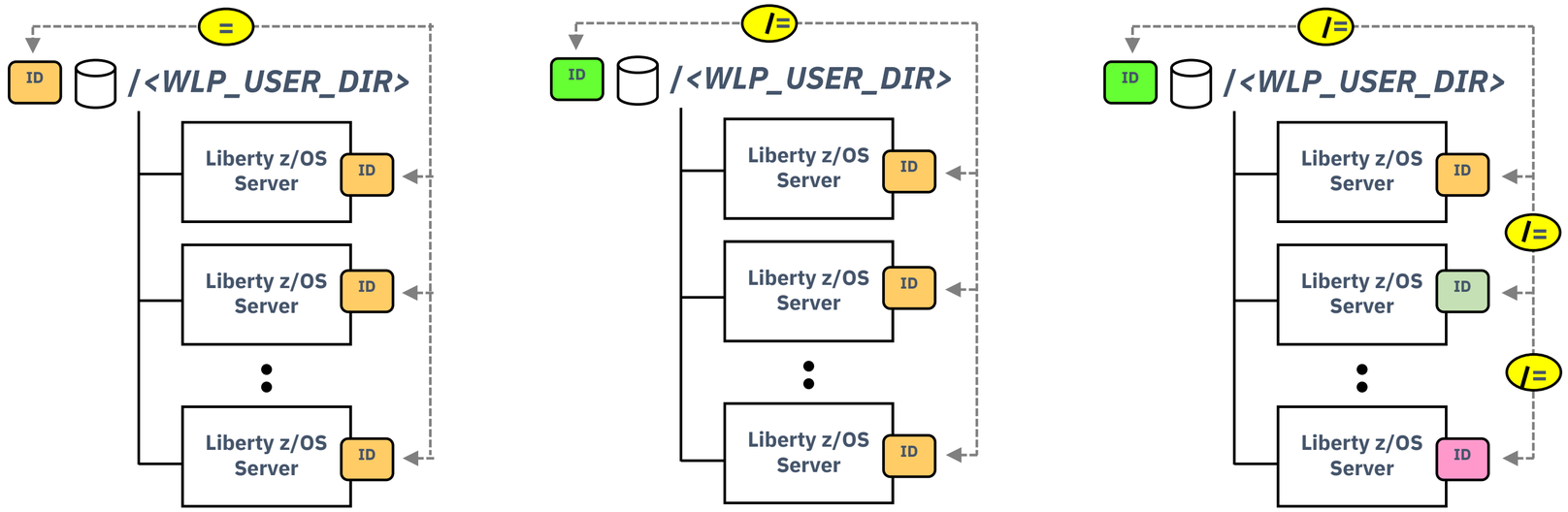
Liberty Security

Overview

mitchj@us.ibm.com

z/OS Security – Range of options – Started Task IDs

On z/OS, the best practice for Liberty servers in production is that they run as ‘Started Tasks’ (STCs).



- Multiple servers
- All have same STC ID
- STC ID = File Owner ID

- Multiple servers
- All have same STC ID
- STC ID ǂ File Owner ID

- Multiple servers
- Different STC IDs
- STC IDs ǂ File Owner ID

Should all servers sharing WLP_USER_DIR share the same STC ID?
It is a matte of the degree of identity isolation that is required

mitchj@us.ibm.com

z/OS Security: Assigning ID to started tasks: SAF STARTED class

The first question here is whether you wish to have a common started task ID that is shared among servers, or if you wish each server to have a unique ID

Then the second question is whether servers under a WLP_USER_DIR will share a common JCL start proc, or use unique start procs for each server

	Common Identity per task	*Unique Identities per task*

Common JCL Procedure	`RDEFINE STARTED ZCEEPROC.*`
	
	`S ZCEEPROC,JOBNAME=server1,PARMS='server1'`
	`S ZCEEPROC,JOBNAME=server2,PARMS='server2'`
	1
		`RDEFINE STARTED ZCEEPROC.server1`
		`RDEFINE STARTED ZCEEPROC.server2`
		
		`S ZCEEPROC,JOBNAME=server1,PARMS='server1'`
		`S ZCEEPROC,JOBNAME=server2,PARMS='server2'`
		3

Unique JCL Procedure per server	`RDEFINE STARTED ZCEE*.*`
	
	`S ZCEESRV1,JOBNAME=server1,PARMS='server1'`
	`S ZCEESRV2,JOBNAME=server2,PARMS='server2'`
	2
		`RDEFINE STARTED ZCEESRV1.*`
		`RDEFINE STARTED ZCEESRV2.*`
		
		`S ZCEESRV1,JOBNAME=server1,PARMS='server1'`
		`S ZCEESRV2,JOBNAME=server2,PARMS='server2'`
		4

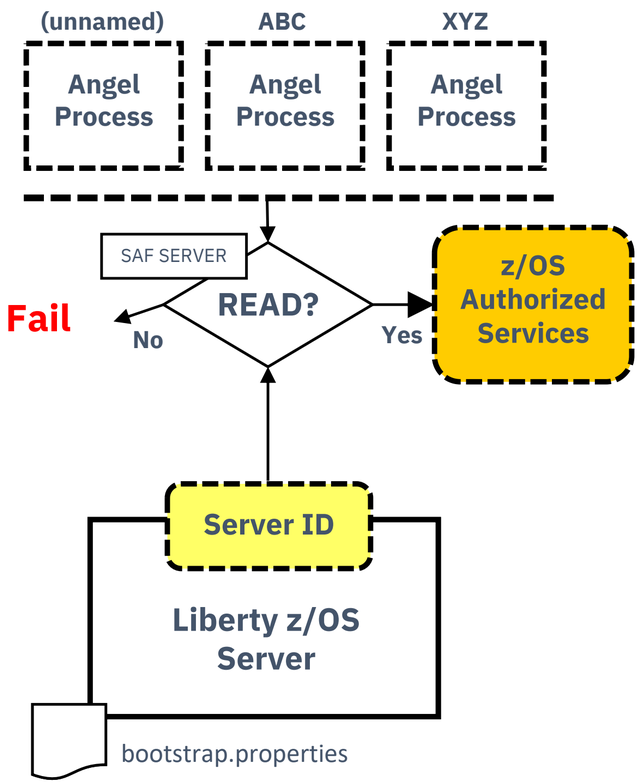
Note: Using unique JCL procedure eliminates the need to specify PARMS on the start commands

1. The same identity is used for all servers using a RACF STARTED class resource where the JCL procedure is discrete, and the job name is generic.
2. The same identity is used for all servers using a RACF STARTED class resource where both the JCL procedure and job names are generic
3. Different identities are used for each server using a RACF STARTED class resource where both the JCL procedure and job name are discrete.
4. Different identities are used for each server using a RACF STARTED class resource where the JCL procedure is discrete and job name is generic.

It's possible to use a combination of the above, even under the same WLP_USER_DIR. So there's no "one best answer" here. What's best is what's best for you.

mitchj@us.ibm.com

z/OS Security: The Angel process – what is this about?



The Angel Process is a started task that is used to protect access to z/OS privileged or authorized services. This is done with SAF SERVER profiles.

- Authorized services include: WOLA, SAF, WLM, RRS, DUMP
- The ability to start multiple Angel processes on an LPAR was introduced in 16.0.0.4. This is called "Named Angels". It provides a way to separate Angel usage between Liberty servers:
  - An Angel process can be started with a NAME='*<name>*' parameter (or it can be started as a "default" without a name). The name may be up to 54 characters.
  - Liberty servers can be pointed at a specific Angel with a bootstrap property

Best practice:

- **You may create separate named Angels for isolation of Test and Production, but do not take this practice too far. A few Angels, yes; dozens, no.**
- **Establish automation routines to start the Angels at IPL**
- **Grant SAF GROUP access to the SERVER profiles, then connect server IDs as needed**

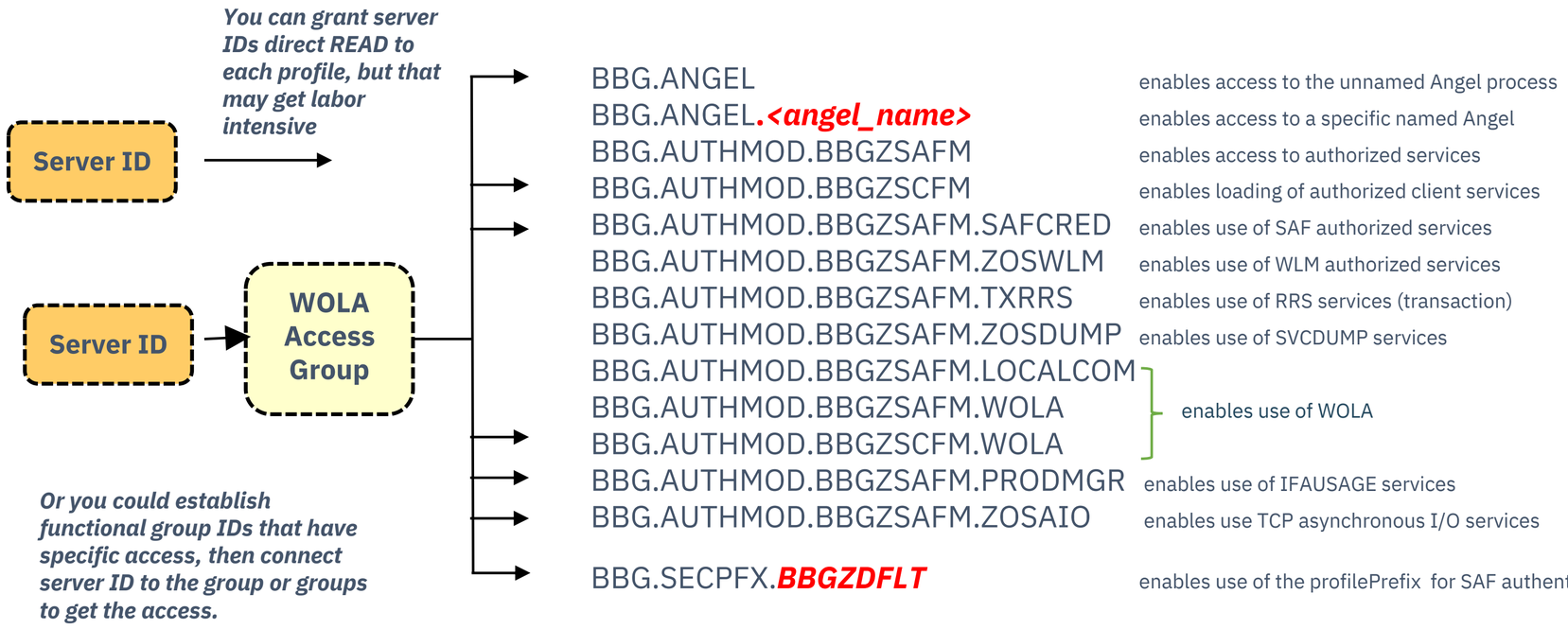
```
com.ibm.ws.zos.core.angelRequired=true
com.ibm.ws.zos.core.angelName=<name>
com.ibm.ws.zos.core.angelRequiredServices=SAFCRED,ZOSWLM,TXRRS,ZOSDUMP
```

List of current Liberty Features

https://www.ibm.com/support/knowledgecenter/SSEQTP_liberty/com.ibm.websphere.wlp.doc/ae/rwlp_feat.html

mitchj@us.ibm.com

z/OS Security: SAF SERVER profiles related to the Angel



Best practice:

- **Establish all the SERVER profiles ahead of time. Existence of profile does not grant access; READ access does.**
- **Determine what access a server needs and grant only that; check "is available" messages in messages.log to verify**

Tech/Tip: The SAFLOG parameter was added in a recent Liberty service. If this parameter is set to Y, additional security related messages will be written to the JES messages and console if a Liberty server does not have authorization to use an angel-controlled privileged function. See URL
https://www.ibm.com/support/knowledgecenter/SS7K4U_liberty/com.ibm.websphere.wlp.zseries.doc/ae/rwlp_newinrelease.html
Liberty 21.0.6 add a new property to identity required services, com.ibm.ws.zos.core.angelRequiredServices, for more details see URL
https://www.ibm.com/docs/en/was-liberty/zos?topic=overview-process-types-zos

mitchj@us.ibm.com

z/OS Authorized service security: Angel Required Services

To use z/OS authorized services, you must have a Liberty Angel process and grant access for your Liberty server's SAF identity to use these services.

- LOCALCOM - Required to use *WebSphere Optimized Local Adapters* (WOLA).
- PRODMGR - Required to use IFAUSAGE services for SMF reporting.
- SAFCRED - Required to use SAF authorized user registry services and SAF authorization services.
- TXRRS - Required by the IBM® MQ resource adapter when the connection to IBM MQ is made in BINDINGS mode
- WOLA - Required to use *WebSphere Optimized Local Adapters* (WOLA).
- ZOSAIO - Required to use AsyncIO on z/OS. **It is a good practice to enable this service**
- ZOSDUMP - Only required if asked to obtain an SVC dump by IBM service. It provides access to SVCDUMP services.
- ZOSWLM - Required to use WLM services. For more information, see Measuring API workloads with WLM at URL https://www.ibm.com/docs/en/zos-connect/zosconnect/3.0?topic=considerations-measuring-api-workloads-wlm

- When a Liberty server connects to an angel process during server startup, it checks that the server's identity has access to the z/OS authorized services. By default, access checks are performed for all authorized services.
- You can restrict the Liberty server to check and use only the authorized services it requires, which then makes other authorized services unavailable by using property, **com.ibm.ws.zos.core.angelRequiredServices**
- The value for this property, **com.ibm.ws.zos.core.angelRequiredServices,** must be a comma-separated list of valid angel process services, as described above. This property must be specified with the **com.ibm.ws.zos.core.angelRequired** property set to **true**. Only these services, when properly specified, are the ones used by the server.

Lack of access to the angel process itself or any of these listed required services will cause a server startup failure.

mitchj@us.ibm.com

Tech/Tip: Sample RACF Commands for SERVER resources

```
RDEFINE SERVER BBG.ANGEL.angelName UACC(NONE) OWNER(SYS1)
PERMIT  BBG.ANGEL.angelName CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSAFM CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.SAFCRED UACC(NONE)
PERMIT  BBG.AUTHMOD.BBGZSAFM.SAFCRED CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.ZOSWLM UACC(NONE)
PERMIT  BBG.AUTHMOD.BBGZSAFM.ZOSWLM CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.TXRRS UACC(NONE)
PERMIT  BBG.AUTHMOD.BBGZSAFM.TXRRS CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.ZOSDUMP UACC(NONE)
PERMIT  BBG.AUTHMOD.BBGZSAFM.ZOSDUMP CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.SECPFX.BBGZDFLT UACC(NONE)
PERMIT  BBG.SECPFX.BBGZDFLT CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.WOLA UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSAFM.WOLA CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.LOCALCOM UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSAFM.LOCALCOM CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSCFM UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSCFM CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSCFM.WOLA UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSCFM.WOLA CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.PRODMGR UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSAFM.PRODMGR CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
RDEFINE SERVER BBG.AUTHMOD.BBGZSAFM.ZOSAIO UACC(NONE) OWNER(SYS1)
PERMIT  BBG.AUTHMOD.BBGZSAFM.ZOSAIO CLASS(SERVER) ACCESS(READ) ID(LIBSERV)
SETROPTS RACLIST(SERVER) REFRESH
```

mitchj@us.ibm.com

Example: Use the *bootstrap.properties* file to specify the required z/OS privileges

zceesrv1's bootstrap.properties

```
httpPort=9080
httpsPort=9443
ipicPort=1491
host=*
cicsHost=wg31.washington.ibm.com
network=ZOSCONN1
applid=ZOSCONN1
com.ibm.ws.zos.core.angelName=namedAngel
com.ibm.ws.zos.core.angelRequired=true
com.ibm.ws.zos.core.angelRequiredServices=SAFCRED,ZOSWLM,PRODMGR,ZOSAIO,TXRRS,LOCALCOM
```

zceesrv2's bootstrap.properties

```
httpPort=9090
httpsPort=9453
ipicPort=1492
host=wg31.washington.ibm.com
cicsHost=wg31.washington.ibm.com
network=ZOSCONN2
applid=ZOSCONN2
com.ibm.ws.zos.core.angelName=namedAngel
com.ibm.ws.zos.core.angelRequired=true
com.ibm.ws.zos.core.angelRequiredServices=SAFCRED,ZOSWLM,PRODMGR,ZOSAIO,TXRRS,LOCALCOM
```

mitchj@us.ibm.com

Tech-Tip: SAF APPL and EJBRole Resources

Connect z/OS Connect users to a common group

CONNECT (FRED,USER1,JOHNSON) GROUP(ZCEEUSRS)

Define a APPL profile for the server's SAF profilePrefix and permit access

RDEFINE APPL BBGZDFLT UACC(NONE) OWNER(SYS1)
PERMIT BBGZDFLT CLASS(APPL) ACCESS(READ) ID(WSGUEST#, ZCEEUSRS)
SETROPTS RACLIST(APPL) REFRESH

Example of defining an EJBROLE profile for the server's SAF profilePrefix and permit access

RDEFINE EJBROLE BBGZDFLT.zos.connect.access.roles.zosConnectAccess OWNER(SYS1) UACC(NONE)
PERMIT BBGZDFLT.zos.connect.access.roles.zosConnectAccess +
CLASS(EJBROLE) ID(ZCEEUSRS) ACCESS(READ)
SETROPTS RACLIST(EJBROLE) REFRESH

```
<safCredentials unauthenticatedUser="WSGUEST" profilePrefix="BBGZDFLT"/>
<safAuthorization racRouteLog=ASIS reportAuthorizationCheckDetails="true"/>
```

https://www.ibm.com/support/knowledgecenter/SS7K4U_liberty/com.ibm.websphere.wlp.zseries.doc/ae/twlp_config_security_saf.html
hhttps://www.ibm.com/docs/en/zos-connect/zosconnect/3.0?topic=registry-saf-unauthenticated-user-id

mitchj@us.ibm.com

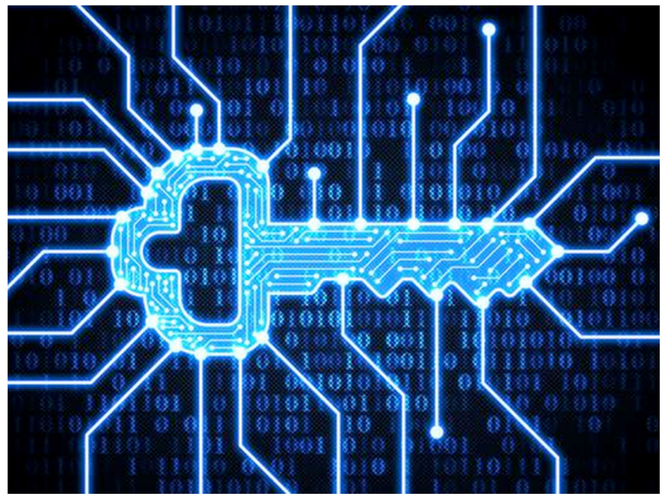
General security terms or considerations

Security involves

- Identifying who or what is requesting access (**Authentication)**
  - Basic Authentication
  - Mutual Authentication using Transport Layer Security (TLS), formerly known as SSL
  - Third Party Tokens

- Ensuring that the message has not been altered in transit (**Data Integrity)** and ensuring the confidentiality of the message in transit (**Encryption)**
  - TLS (encrypting messages and using a digital signature)

- Controlling access (**Authorization)**
  - Is the authenticated identity authorized to access to z/OS Connect
  - Is the authenticated identity authorized to access a specific API, Services, etc.

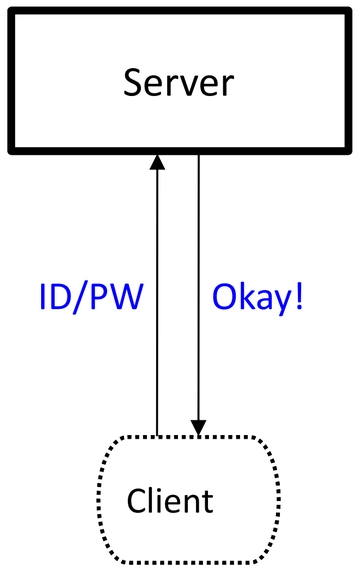


mitchj@us.ibm.com

Liberty Authentication Options

Several different ways this can be accomplished:

Basic Authentication

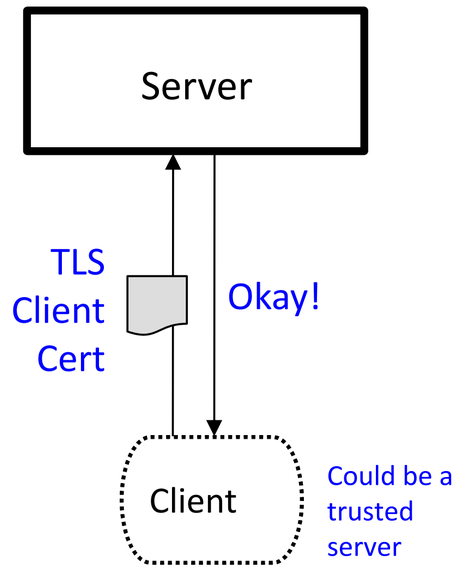


Client supplies ID/PW or ID/PassTicket

Server checks registry:

- **Basic (server.xml)**
- **SAF**

Client Certificate



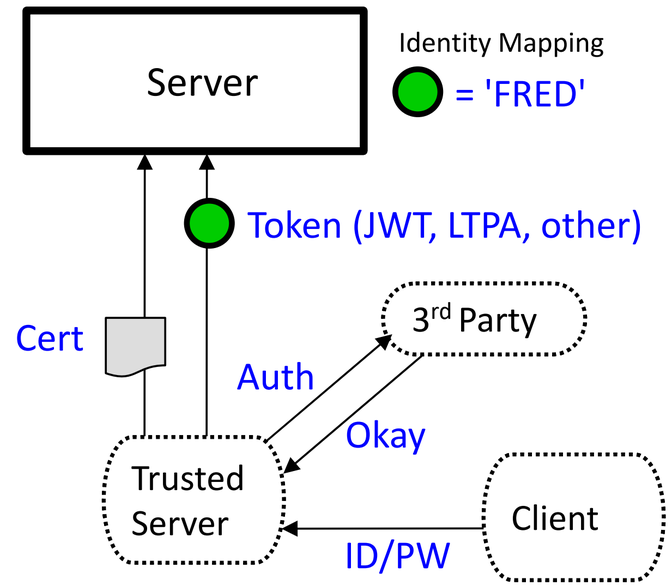
Client supplies client personal certificate

Server validates client personal certificate and maps it to an identity

Registry options:

- **SAF**

Third Party Authentication



Client authenticates to 3rd party sever

Client receives a trusted 3rd party token

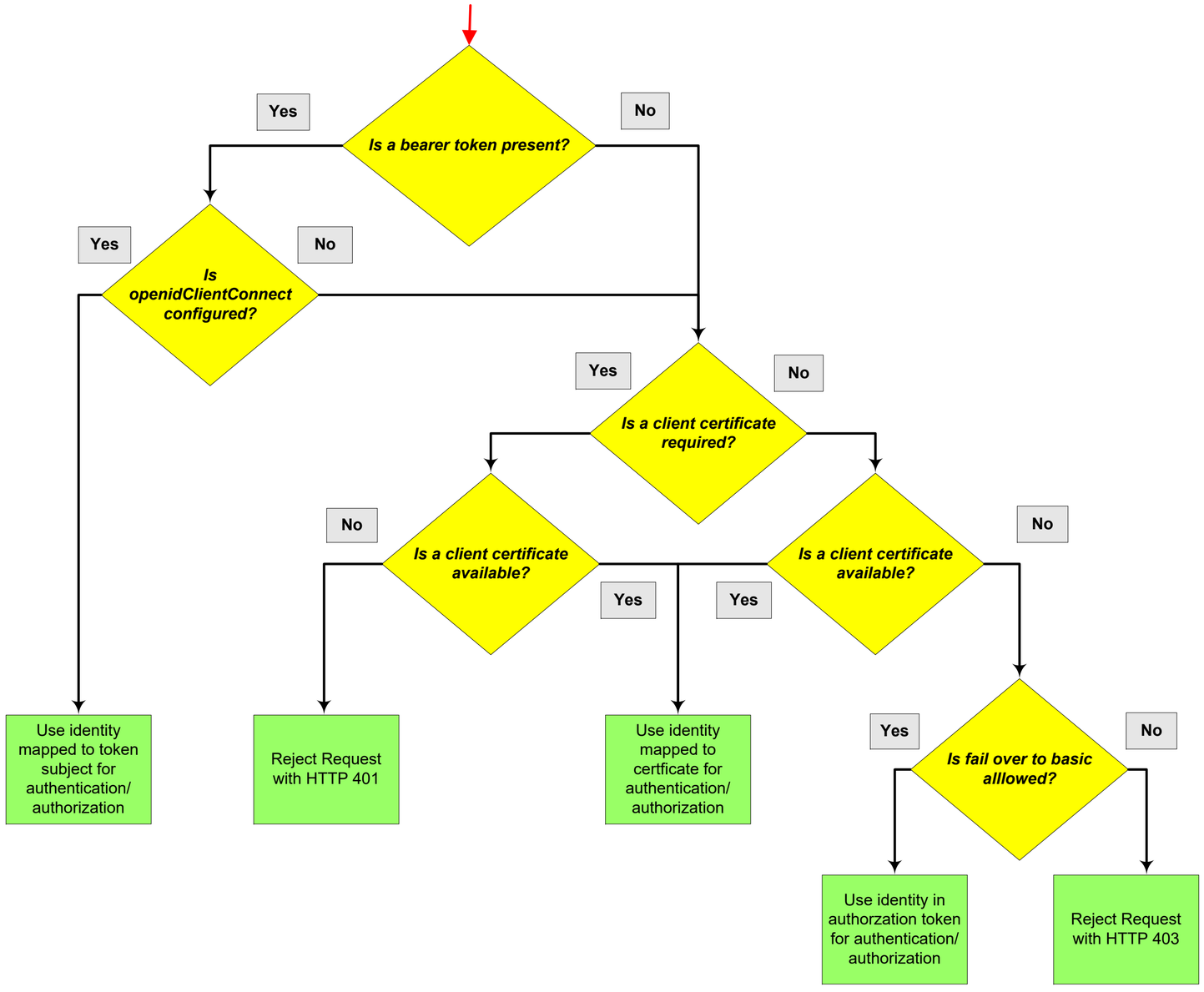
Token flows to server and is mapped to an identity

Registry options:

- **We may not need to know these details.**

mitchj@us.ibm.com

Authentication credential precedence order for determining authorization identity

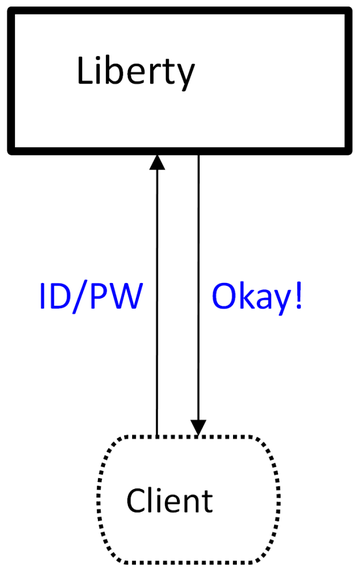


mitchj@us.ibm.com

Authentication - Basic Authentication

Several different ways this can be accomplished:

Basic Authentication

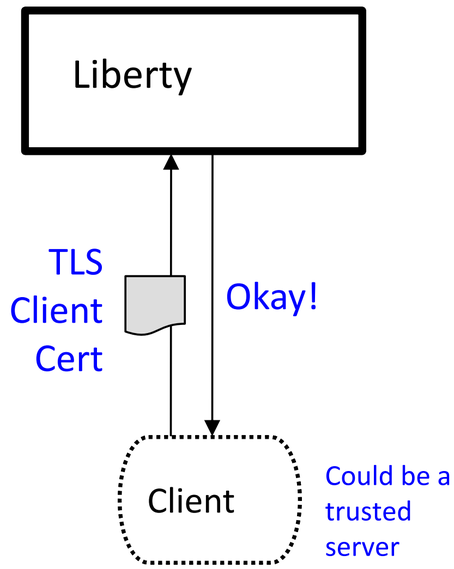


Client supplies an identity/password or an identity/PassTicket

Server checks registry:

- **Basic (server.xml)**
- **SAF**

Client Certificate



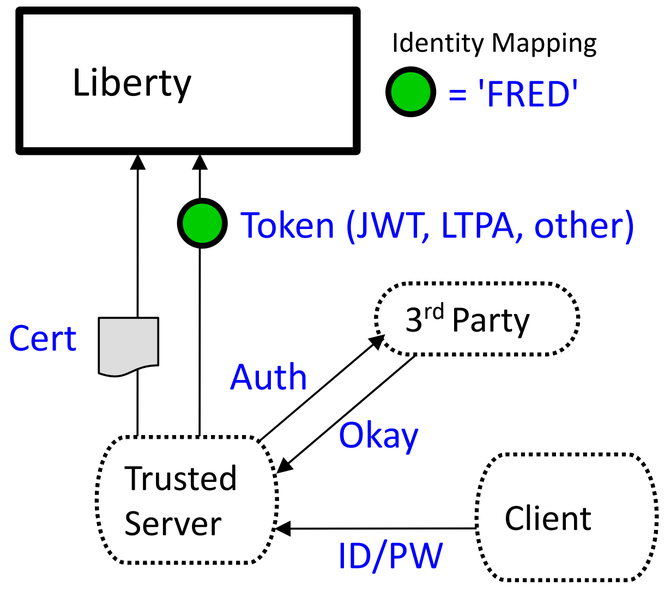
Client supplies client certificate

Server validates client certificate and maps it to an identity

Registry options:

- SAF

Third Party Authentication



Client authenticates to 3rd party sever

Client receives a trusted 3rd party token

Token flows to server and is mapped to an identity

Registry options:

- We do not need to know the details.

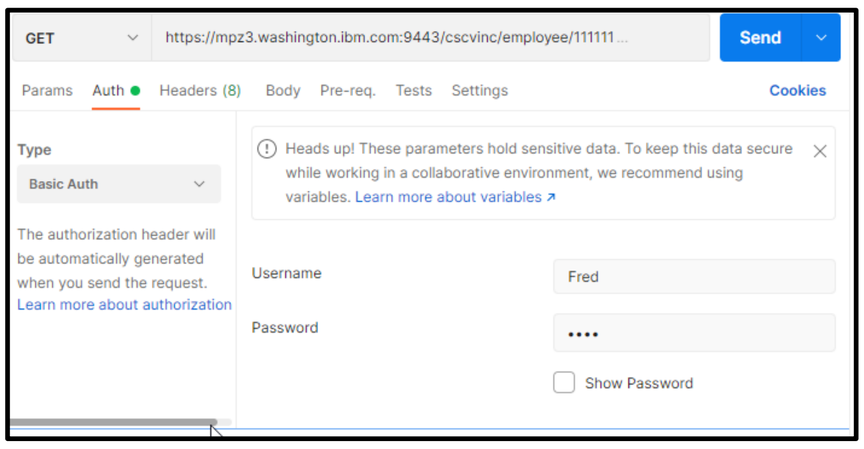
mitchj@us.ibm.com

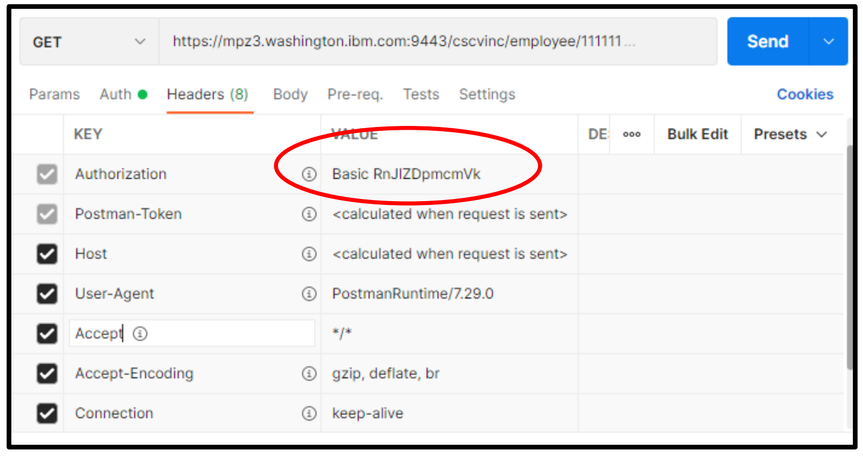
Basic authentication – Where the client provides an identity and password

- server XML security configuration:

```
<featureManager>
     <feature>appSecurity-2.0</feature>
     <feature>zosSecurity-1.0</feature>
 </featureManager>

 <webAppSecurity allowFailOverToBasicAuth="true" />

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

- When sending a request to a Liberty server, basic authentication information (identity and password) is provided in the HTTP header in a Basic *Authorization t*oken with the identity and password encoded or formatted using Base64.
  - An example with Postman:



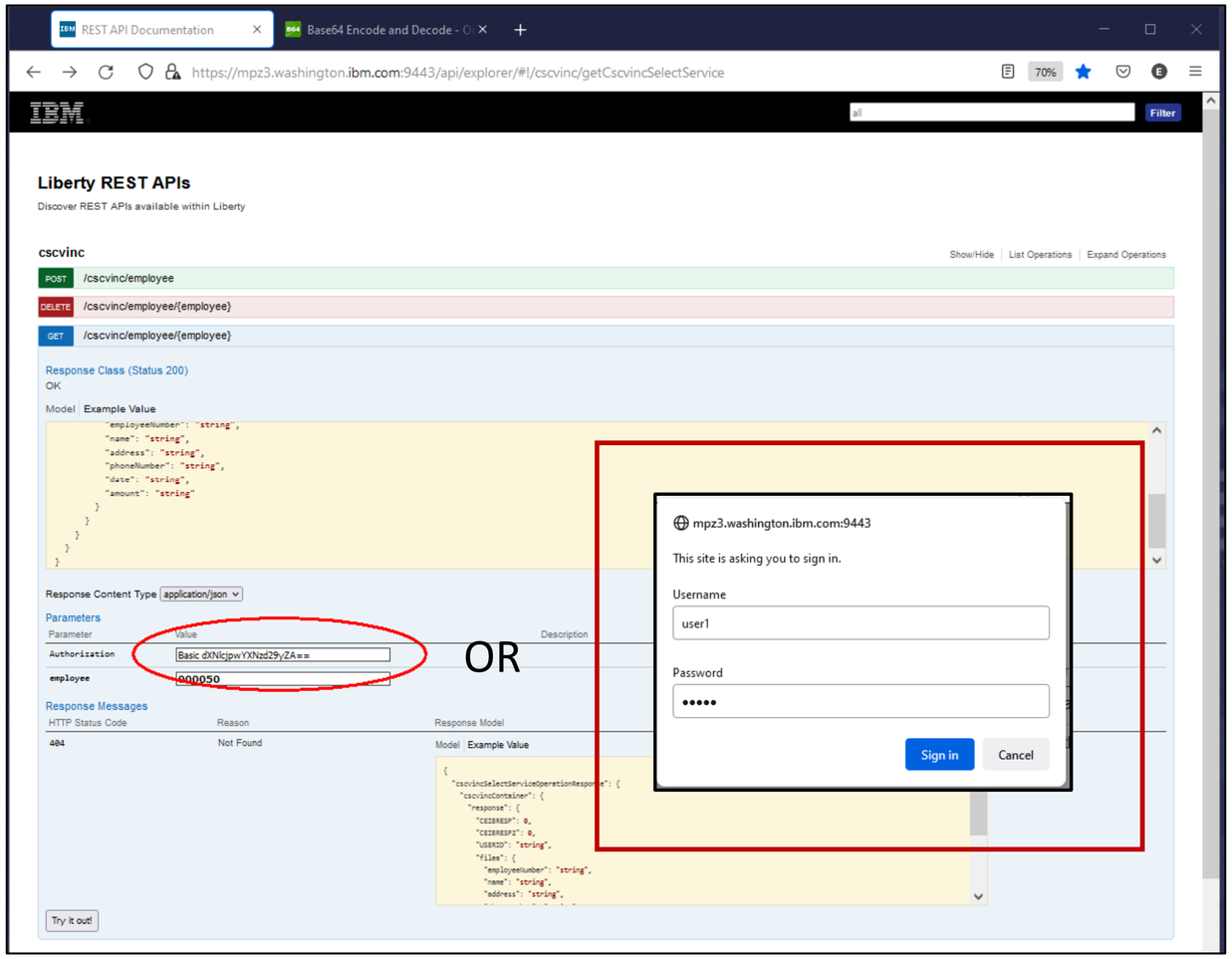


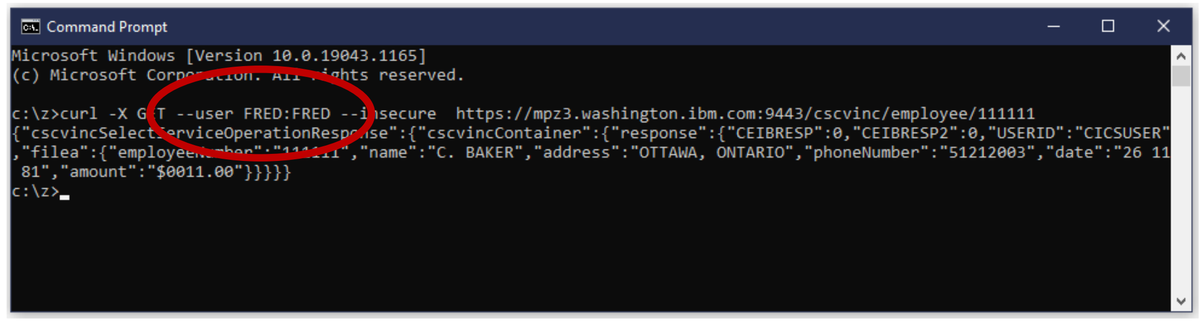
https://www.base64encode.org/

mitchj@us.ibm.com

There are multiple ways to provide an identity and password

- When sending a request to a Liberty server running z/OS Connect, basic authentication information (identity and password) is provided in the HTTP header in a Basic *Authorization t*oken with the identity and password encoded or formatted using Base64.
  - Examples using the API Explorer feature , cURL, and a Java client.





https://www.base64encode.org/

mitchj@us.ibm.com

Tech-TIP: A RACF 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*.

mitchj@us.ibm.com

Tech/Tip: RACF resources for using PassTickets

- Aa PTKTDATA resource is defined using the *applName* assigned to the target subsystem:

RDEFINE PTKTDATA applName SSIGNON(KEYMASK(keymaskValue))
APPLDATA('NO REPLAY PROTECTION')

Where:

applName	is an application name assigned to the resource, e.g., BBGZDFLT
keymaskValue	is the value of the secured sign-on application key, a 64-bit hex value
replayProtection	indicates if a pass ticket can be reused

- Access to using PassTickets is controlled by another PTKTDATA resource, *IRRPTAUTH.applName.identity.* UPDATE access is required. For example, to use PassTickets to access a z/OS Connect server the resources below need to be defined and access permitted.

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

```
RDEFINE PTKTDATA BBGZDFLT SSIGNON(0123456789ABCDEF))
          APPLDATA('NO REPLAY PROTECTION') UACC(NONE)
RDEFINE PTKTDATA IRRPTAUTH.BBGZDFLT.* UACC(NONE)
PERMIT IRRPTAUTH.BBGZDFLT.* ID(LIBSERV) CLASS(PTKTDATA) ACCESS(UPDATE)
PERMIT IRRPTAUTH.BBGZDFLT.USER1 ID(USER1) CLASS(PTKTDATA) ACCESS(UPDATE)
```


mitchj@us.ibm.com

z/OS Connect Security server XML Authentication Configuration (OpenAPI 2)

- requireAuth - requires the client to provide credentials

```
<zosconnect_zosConnectManager
        requireAuth="true|false"
        requireSecure="true"/>

<zosconnect_zosConnectAPIs>
   <zosConnectAPI name="catalog"
        requireAuth="true|false"
        requireSecure="true"/>
</zosconnect_zosConnectAPIs>

<zosconnect_services>
  <service id="selectByEmployee"
      name="selectEmployee"
      requireAuth="true|false"
      requireSecure="true"/>
</zosconnect_services>

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

Globally, requires that users specify security credentials to be authenticated order to access APIs, services and API requesters, unless overridden on the specific resource definitions.

Requires that users specify security credentials to be authenticated in order to access the API.

Requires that users specify security credentials to be authenticated in order to directly access the service. This attribute is ignored when the service is invoked from an API, then only the API requireAuth attribute is relevant.

Requires that users specify security credentials to be authenticated in order to access all API requesters. If the requireAuth attribute is not set, the global setting on the zosconnect_zosConnectManager element is used instead, unless the requireAuth attribute is overridden on the specific API requester.

The requireAuth attribute controls whether an inbound request must provide credentials using one of the three authentication methods, e.g., basic, client certificate, or third-party token.

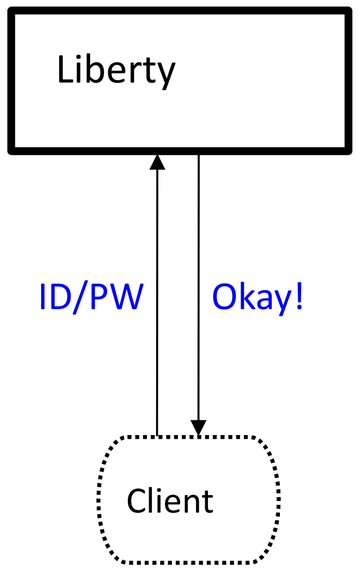
Note that there are no equivalent configuration elements for an z/OS Connect OpenAPI 3 server.

mitchj@us.ibm.com

Authentication - TLS Mutual Authentication

Several different ways this can be accomplished:

Basic Authentication

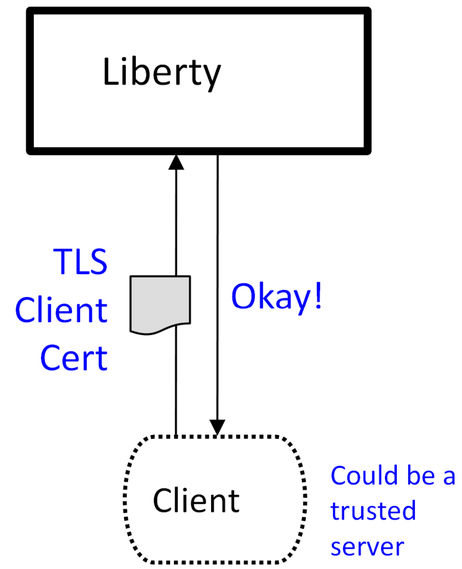


Server prompts for ID/PW

Client supplies ID/PW or ID/PassTicket

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

Client Certificate



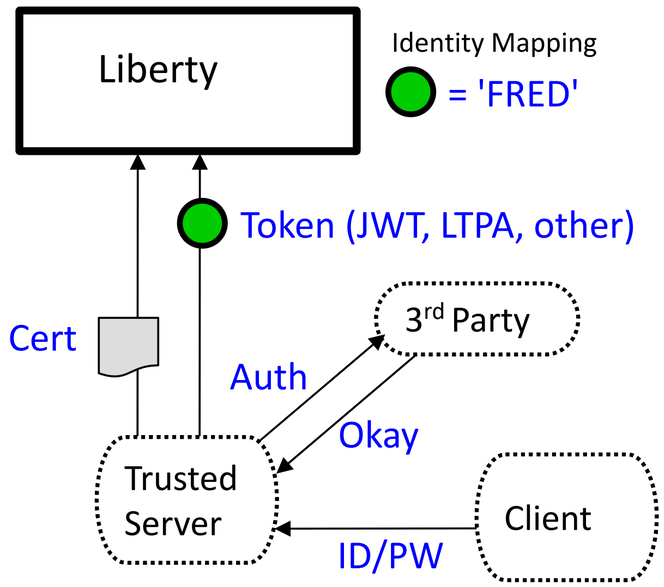
Server prompts for client certificate.

Client supplies personal certificate

Server validates client certificate and maps it to an identity

Registry options:
- **SAF**

Third Party Authentication



Client authenticates to 3rd party sever

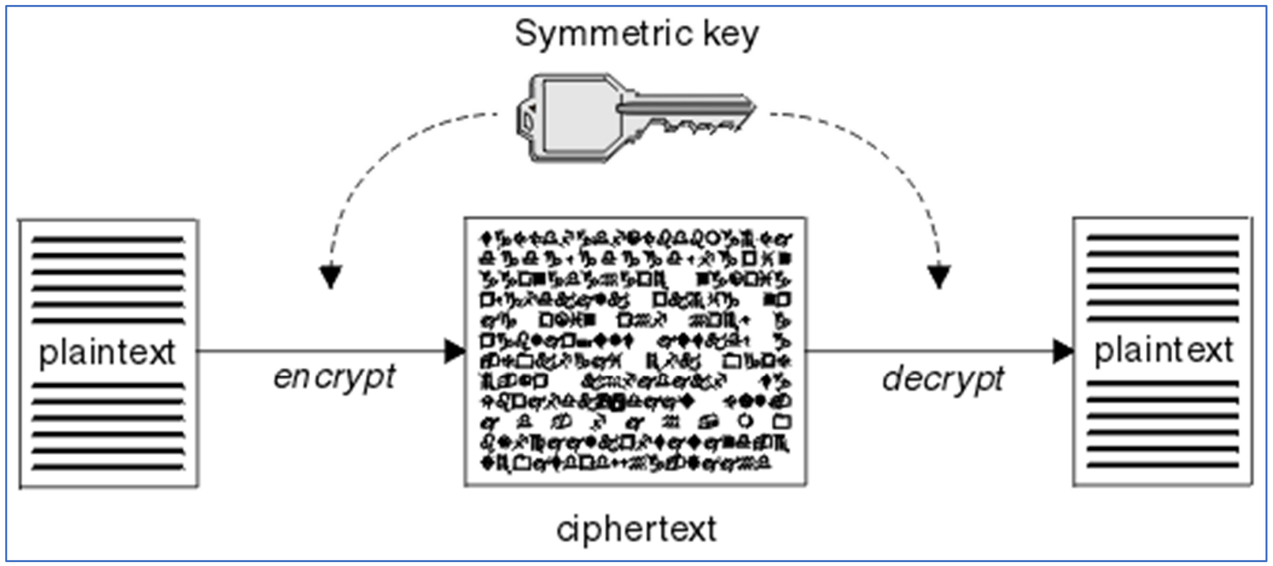
Client receives a trusted 3rd party token

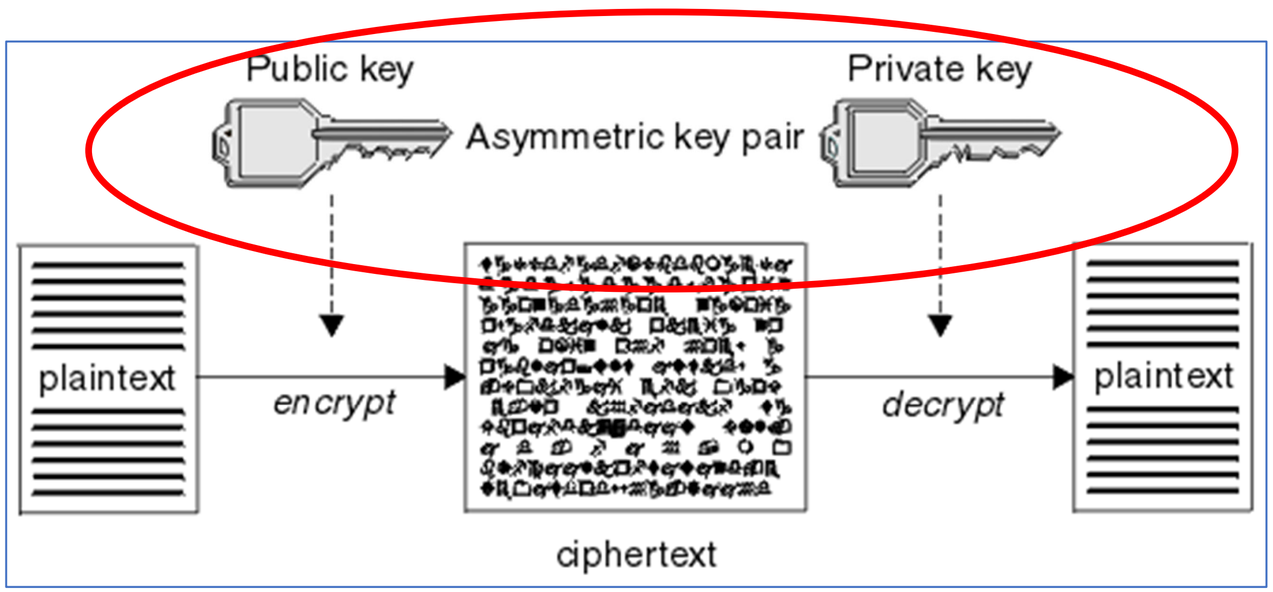
Token flows to Liberty z/OS and is mapped to an identity

Registry options:
- We may not need to know these details.

mitchj@us.ibm.com

Tech-Tip: Symmetric key v. Asymmetric key pairs





A symmetric key is a key shared by the endpoints. Both endpoints use the same key to encrypt and decrypt messages.

An asymmetric key pair is the preferred solution. There is no risk of compromise by sending a symmetric or shared key outside of a protected communication flow.

A message encrypted with a public key can only be decrypted by endpoint that has the private key. The privacy of the messages is ensured.

If an endpoint can successfully decrypt a message message encrypted received with a private key, the endpoint sending the message has successfully asserted its validity by proving it has the private used to encrypt the message.

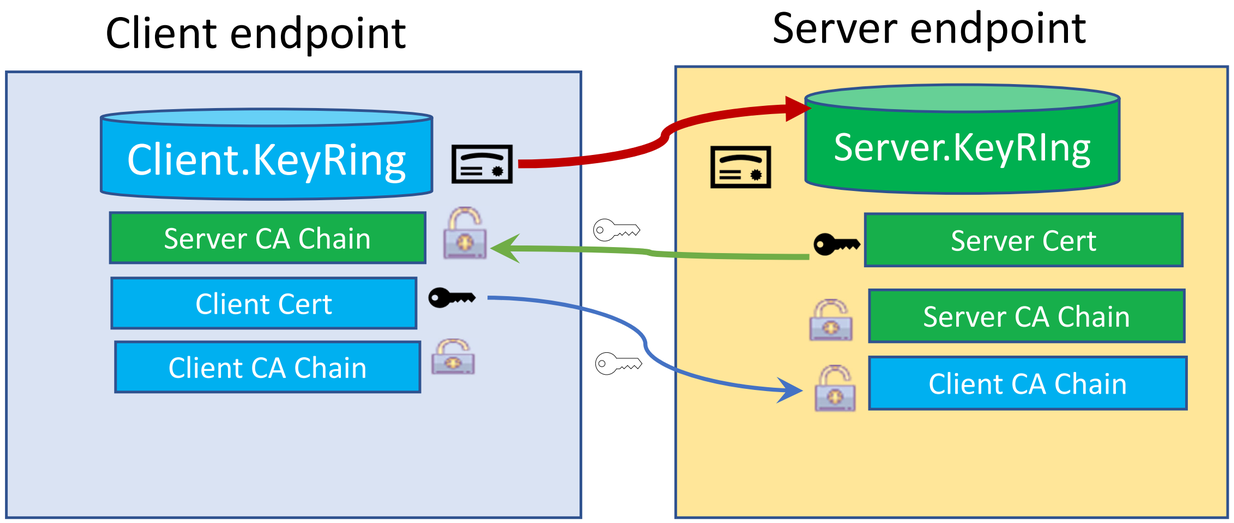
mitchj@us.ibm.com

The basic TLS Handshake Flow (HTTPS)

The HTTPS protocol involves a TLS handshake –

Server Authentication (always occurs when HTTPS is the protocol)

Mutual Authentication (optional, at the request of the server endpoint)



Certificate with a private key*

Certificate and public key

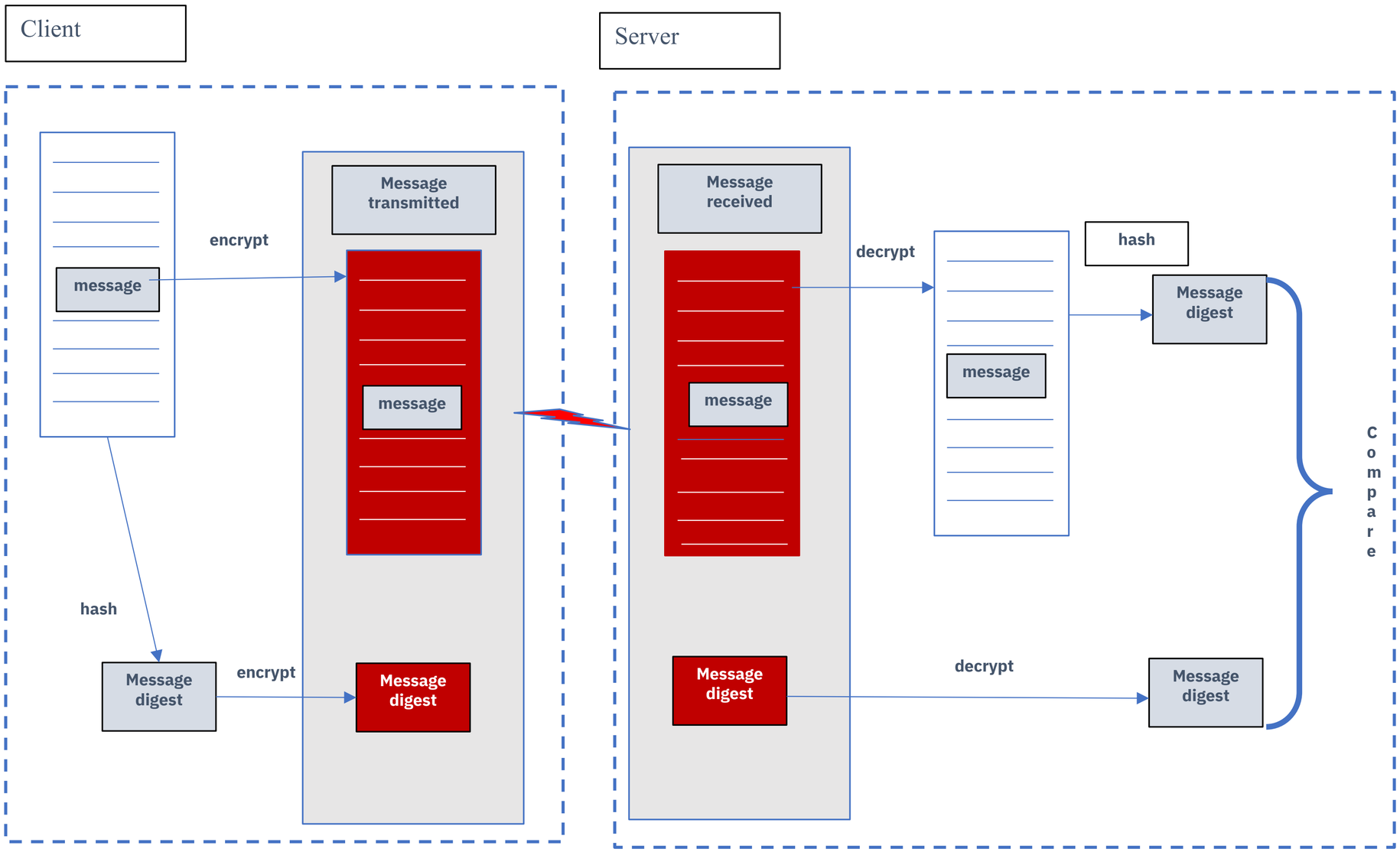
Certificate Authority (CA) certificate chain#

*For server and/or mutual authentication to work, the endpoint sending the client certificate must use a personal certificate with a private key. The private key is required to decrypt (or encrypt) a message digest that is sent from the other endpoint during the handshake flow. Generation of a message digest also requires access to the CA certificate used to sign the certificate.

#Refers to the set or of certificates used to issue the server or client personal certificate including any intermediate certificates up to and including the root CA.

mitchj@us.ibm.com

Tech-Tip: Message Integrity and Encryption (client to server endpoint)



mitchj@us.ibm.com

Tech-Tip: Accessing a certificate's private key in non-virtual key rings

Two types of RACF profiles resources are used to control access to key ring and certificates

- **RDATALIB** for controlling access to a specific key ring
- **FACILITY** for controlling access to key rings globally

User certificates (connected to the key ring with usage PERSONAL)

- **Global profiles uses the FACILITY** resource **IRR.DIGTCERT.LISTRING**:
  - **READ** access is required to access one's own key ring and private key
  - **UPDATE** access is required to access another user's key private key

- **Specific key rings uses the** RDATALIB class **<ring owner>.<ring name>.LST**
  - **READ** access is required to access one's own private key
  - **UPDATE** access is required to access another identity's private keys

CERTAUTH and SITE certificates (connected to the key ring with usage PERSONAL)

- **Global profiles uses the FACILITY** resource **IRR.DIGTCERT.GENCERT**:
  - **CONTROL** access is required to access a CERTAUTH or SITE certificate private key ring

- **Specific key rings uses the** RDATALIB class **<ring owner>.<ring name>.LST**
  - **CONTROL** access is required to access the private keys of CERTAUTH and SITE certificates

Remember: When switching from global FACILITY class profiles to specific ring RDATALIB class profiles, the RDATLIB resources will be checked first

mitchj@us.ibm.com

Tech/Tip: RACF digital certificate (RACDCERT) command review

```
RACDCERT ID(LIBSERV) GENCERT SUBJECTSDN(CN('wg31.washington.ibm.com') +
 O('IBM') OU('LIBERTY')) WITHLABEL('Liberty Server Cert') ALTNAME(DOMAIN('wg31z.washington.ibm.com')
RACDCERT ID(LIBSERV) GENREQ(LABEL('Liberty Server Cert')) DSN(CERT.REQ)

 Send the certificate to your Certificate Authority to be signed

racdcert CERTAUTH withlabel('Liberty CA')  add('USER1.LIBCA.PEM') TRUST
racdcert id(LIBSERV) withlabel('Liberty Server Cert') add('LIBSERV.P12) password('secret') TRUST
```

```
 /* Create Liberty key ring and connect CA and personal certificates */
racdcert id(libserv) addring(Liberty.KeyRing)
racdcert id(libserv) connect(ring(Liberty.KeyRing) label('CICS CA') certauth usage(certauth))
racdcert id(libserv) connect(ring(Liberty.KeyRing) label('Liberty CA') certauth usage(certauth)
 /* Connect default personal certificate */
racdcert id(libserv) connect(ring(Liberty.KeyRing) label('Liberty Client Cert') default
```

```
setropts raclist(digtcert) refresh
```

Broadcom Support web pages

Site of *What ACF2 security setup is needed for IBM's z/OS Connect Enterprise Edition V3.0?*
https://knowledge.broadcom.com/external/article/128597/what-acf2-security-setup-is-needed-for-i.html
Site of *ACF2 setup for z/OS Connect Enterprise Edition V3.0*
https://knowledge.broadcom.com/external/article/142172/acf2-setup-for-zos-connect-enterprise-ed.html
Site of *Setting up Liberty Server for z/OS with Top Secret*
https://knowledge.broadcom.com/external/article/37272/setting-up-liberty-server-for-zos-with-t.html

[1] mitchj@us.ibm.com

Tech/Tip: Anatomy of a RACF Personal Digital Certificate

```
Digital certificate information for user ATSSERV:

  Label: RPServer-Server
  Certificate ID: 2QfB4+Lixdnl2dfihZmlhZlg4oWZpYWZ
  Status: TRUST
  Start Date: 2020/11/12 00:00:00
  End Date:   2029/12/31 23:59:59
  Serial Number:
       >01<
  Issuer's Name:
       >CN=RPServer-CertAuth.OU=CertAuth<
  Subject's Name:
       >CN=RPServer-Server.OU=ATS.O=IBM.C=USA<
  Subject's AltNames:
    Domain: wg31.washington.ibm.com
Signing Algorithm: sha1RSA
Key Type: RSA
Key Size: 2048
Private Key: YES
Ring Associations:
  Ring Owner: ATSSERV
  Ring:
     >RpServer.KeyRing<
  Ring Owner: LIBSERV
  Ring:
     >RpServer.KeyRing<
```

Some clients are more sensitive than others when checking common names (CN). They will check the endpoint's actual host name versus the CN and if they do not match, the certificate is rejected. The *AltName* attribute can be used to resolves this issue.

mitchj@us.ibm.com

Tech/Tip: RACF Certificate Filtering and Mapping

Filters for mapping certificates can be created with a RACDCERT command.

- Enter command RACDCERT ID MAP to create a filter that assigns RACF identity ATSUSER to any digital certificate signed with the ATS client signer certificate and where the subject is organizational unit ATS in organization IBM.

```
racdcert id(atsuser) map sdnfilter('OU=ATS.O=IBM’)
idnfilter('CN=ATS Client CA.OU=ATS.O=IBM’) withlabel('ATS USERS')
```

- Enter command RACDCERT ID MAP to create a filter that assigns RACF identity OTHUSER to any digital certificate signed by the ATS client signer certificate and where the subject is in organization IBM.

```
racdcert id(othuser) map sdnfilter('O=IBM’)
idnfilter('O=IBM') withlabel('IBM USERS')
```

- Refresh the in-storage profiles for digital certificate maps.

```
SETRPTS RACLIST(DIGTNMAP) REFRESH
```

mitchj@us.ibm.com

Liberty JSSE (HTTPS) server XML configuration

```
<!-- Enable features -->
   <featureManager>
        <feature>transportSecurity-1.0</feature>
   </featureManager>

   <sslDefault sslRef="DefaultSSLSettings"
     outboundSSLRef="OutboundSSLSettings" />

   <ssl id="DefaultSSLSettings"
      keyStoreRef="CellDefaultKeyStore"
      trustStoreRef="CellDefaultKeyStore"
      clientAuthenticationSupported="true"
      clientAuthentication="true"/>

   <keyStore id="CellDefaultKeyStore"
      location="safkeyring:///Liberty.KeyRing"
      password="password" type="JCERACFKS"
      fileBased="false" readOnly="true" />

   <ssl id="OutboundSSLSettings"
      keyStoreRef="OutboundKeyStore"
      trustStoreRef="OutboundKeyStore"/>

   <keyStore id="OutboundKeyStore"
      location="safkeyring:///zCEE.KeyRing"
      password="password" type="JCERACFKS"
      fileBased="false" readOnly="true" />
```

SSL repertoires

Key ring for server certificate send to for clients

Key ring for client connections to server endpoints

safkeyring:///**KeyRing** v safkeyring:**//owner/KeyRing**

Tech/Tip: Regarding *clientAuthentication* and *clientAuthenticationSupported*. Understand the implications of the interactions between these attributes. There may instances where you want to use HTTPS, but not always with mutual authentication Consider setting *clientAuthentication* to false when setting *clientAuthenticationSupported* to true.

mitchj@us.ibm.com

Tech/Tip: Combining TLS mutual and basic authentication

```
//*************************************************************
//*  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
```

```
<httpEndpoint id="defaultHttpEndpoint"
    host="*"
    httpPort="9080"
    httpsPort="9443" />

<sslDefault sslRef="DefaultSSLSettings"
   outboundSSLRef="DefaultSSLSettings" />

<ssl id="DefaultSSLSettings"
    keyStoreRef="CellDefaultKeyStore"
    trustStoreRef="CellDefaultKeyStore"
    clientAuthenticationSupported="true"
    clientAuthentication="true"/>

<keyStore id="CellDefaultKeyStore"
    location="safkeyring:///Liberty.KeyRing"
    password="password" type="JCERACFKS"
    fileBased="false" readOnly="true" />
```

```
<httpEndpoint id="AdminHttpEndpoint"
    host="*"
    httpPort="-1"
    httpsPort="9445"
    sslOptionsRef="mySSLOptions"/>

<sslOptions id="mySSLOptions"
    sslRef="BatchSSLSettings"/>

<ssl id="BatchSSLSettings"
   keyStoreRef="CellDefaultKeyStore"
   trustStoreRef="CellDefaultKeyStore"
   clientAuthenticationSupported="true"
   clientAuthentication="false"/>
```

https://www.rocketsoftware.com/products/rocket-open-source/rocket-open-appdev-z

mitchj@us.ibm.com

The Liberty JSSE server XML configuration for outbound connections

```
<!-- Enable features -->
   <featureManager>
        <feature>transportSecurity-1.0</feature>
   </featureManager>

   <ssl id="cicsTLSSettings"
      keyStoreRef="CICSKeyStore"
      trustStoreRef="CICSKeyStore"
      clientKeyAlias="Liberty Client Cert"/>
   <keyStore id="CICSKeyStore"
      location="safkeyring:///Liberty.CICS.KeyRing"
      password="password" type="JCERACFKS"
      fileBased="false" readOnly="true" />
   <ssl id="db2TLSSettings"
      keyStoreRef="Db2KeyStore"
      trustStoreRef="Db2KeyStore"
      clientKeyAlias="Liberty Client Cert"/>
   <keyStore id="Db2KeyStore"
      location="safkeyring:///Liberty.Db2.KeyRing"
      password="password" type="JCERACFKS"
     fileBased="false" readOnly="true" />
<ssl id="otherTLSSettings"
      keyStoreRef="OtherKeyStore"
      trustStoreRef="OtherKeyStore">
      outboundConnection
        host="wg31.washington.ibm.com"
        port="9555"
        clientCertificate="Client Cert"/>
 </ssl>
 <keyStore id="OtherKeyStore"
      location="safkeyring:///Other.KeyRing"
      password="password" type="JCERACFKS"
      fileBased="false" readOnly="true" />
```

```
<sslDefault sslRef="DefaultSSLSettings"
            outboundSSLRef="OutboundSSLSettings" />

<zosconnect_authorizationServer sslCertsRef="SSL repertoire"/>
<zosconnect_cicsIpicConnection sslCertsRef="cicsTLSSettings"/>
<zosconnect_db2Connection sslCertsRef="db2TLSettings"> *
<zosconnect_endpointConnect sslCertsRef= "SSL repertoire"/>
<zosconnect_zosConnectRestClient sslCertsRef="SSL repertoire"/>
<zosconnect_zosConnectServiceRestClientConnection sslCertsRef="SSL repertoire"/>
```

F BAQSTRT,REFRESH,KEYSTORE
F BAQSTRT,REFRESH,KEYSTORE,ID=CICSKeyStore
F BAQSTRT,REFRESH,KEYSTORE,ID=Db2KeyStore
F BAQSTRT,REFRESH,KEYSTORE,ID=OtherKeyStore

mitchj@us.ibm.com

* OpenAPI 3 only

Tech-Tip: Enabling hardware cryptography

jvm.options

```
-Djava.security.properties=${server.config.dir}/java.security
```

java.security

```
security.provider.1=com.ibm.crypto.hdwrCCA.provider.IBMJCECCA
security.provider.2=com.ibm.crypto.provider.IBMJCE
security.provider.3=com.ibm.jsse2.IBMJSSEProvider2
security.provider.4=com.ibm.security.jgss.IBMJGSSProvider
. . . . . .
```

Enabling the IBMJCECCA provider

```
<keyStore id="CellDefaultKeyStore"
   location="safkeyringhw:///Liberty.KeyRing"
   password="password" type="JCECCARACFKS"
   fileBased="false" readOnly="true" />
```

Enabling the IBMJCEHYBRID provider

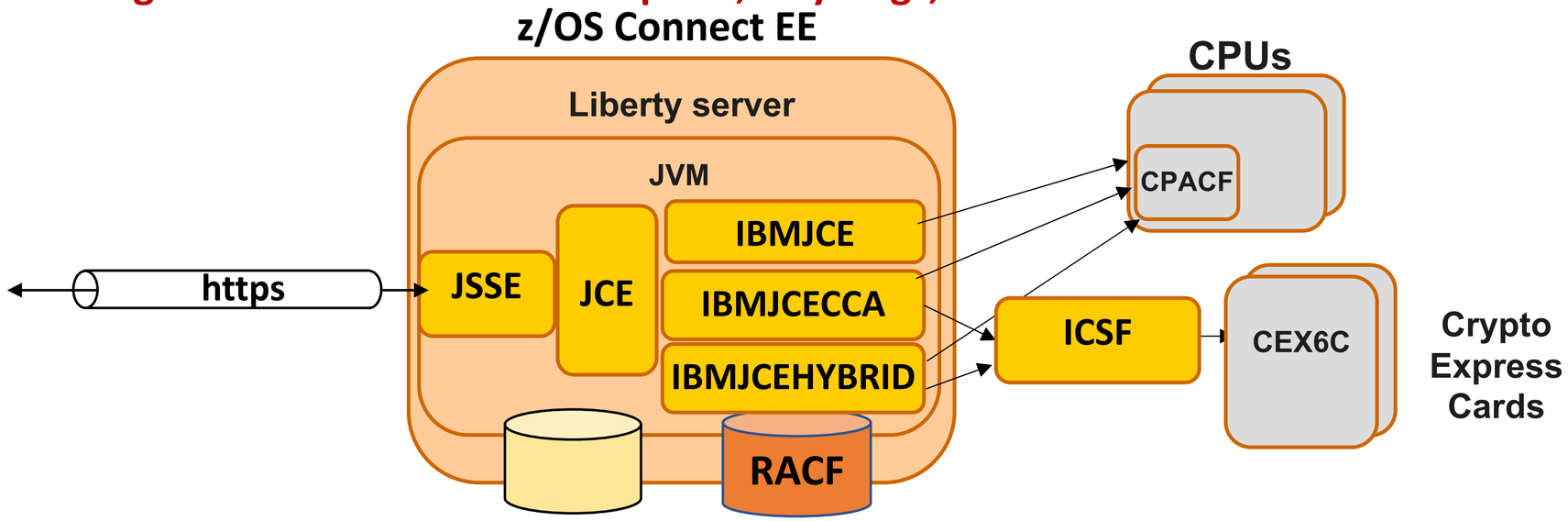
```
<keyStore id="CellDefaultKeyStore"
   location="safkeyringhybrid:///Liberty.KeyRing"
   password="password" type="JCEHYBRIDRACFKS"
   fileBased="false" readOnly="true" />
```

See URL https://www.ibm.com/support/pages/node/6209109 for details on implementing IBMJCECCA and IBMJCEHYBRID hardware encryption providers

mitchj@us.ibm.com

Liberty and using Java Secure Socket Extension (JSSE)

The server XML configuration defines the HTTPS ports, key rings, and other JSSE attributes



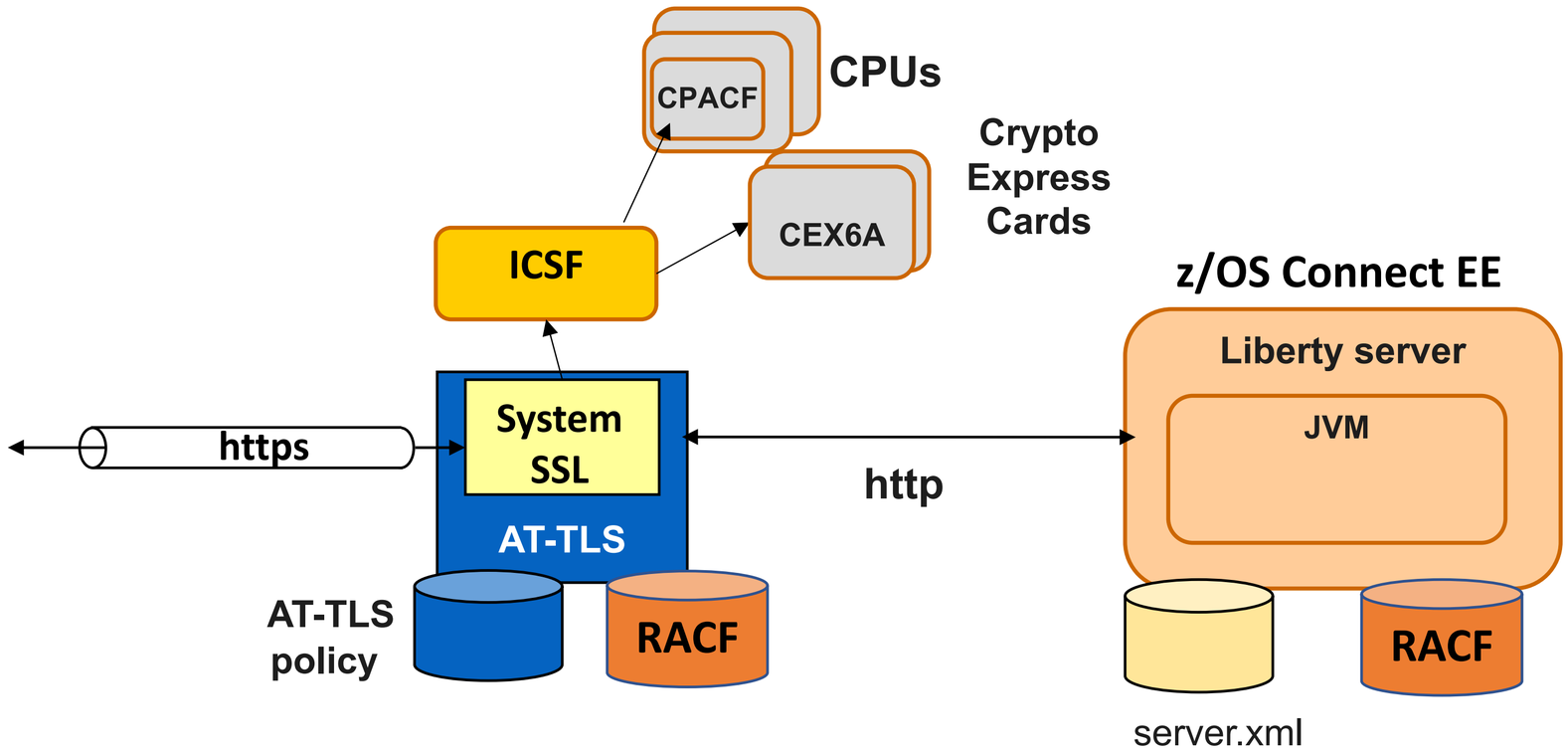
server.xml

- z/OS Connect EE support for TLS is based on **Liberty** server support
- **Java Secure Socket Extension** (JSSE) API provides framework and Java implementation of TLS protocols used by Liberty HTTPS support
- **Java Cryptography Extension** (JCE) is standard extension to the Java Platform that provides implementation for cryptographic services
- **IBM Java SDK** for z/OS provides three different JCE providers, **IBMJCE, IBMJCECCA and IBMJCEHYBRID**.
- The JCE providers access CPACF (**CP Assist for Cryptographic Functions)** directly, therefore keep your Java service levels current.

mitchj@us.ibm.com

Liberty and using AT-TLS

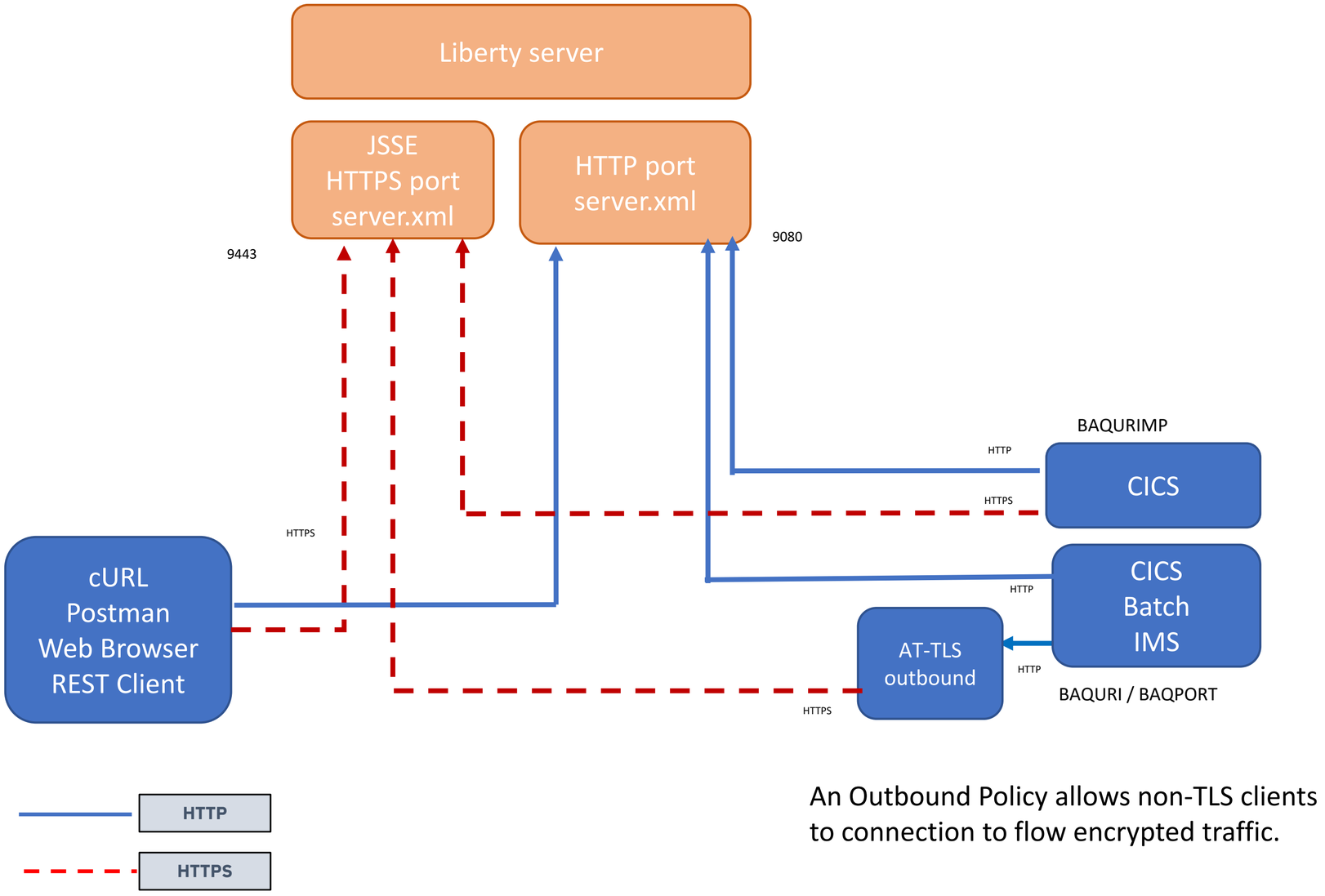
The server XML configuration uses <u>no</u> HTTPS protocol, key rings or other JSSE attributes



- **Application Transparent TLS** (AT-TLS) creates a secure session on behalf of z/OS Connect
- Only define http ports in server.xml (z/OS Connect does not know that TLS session exists)
- Define TLS protection for all applications (including z/OS Connect) in **AT-TLS policy**
- AT-TLS uses **System SSL** which exploits the CPACF and Crypto Express cards via ICSF

mitchj@us.ibm.com

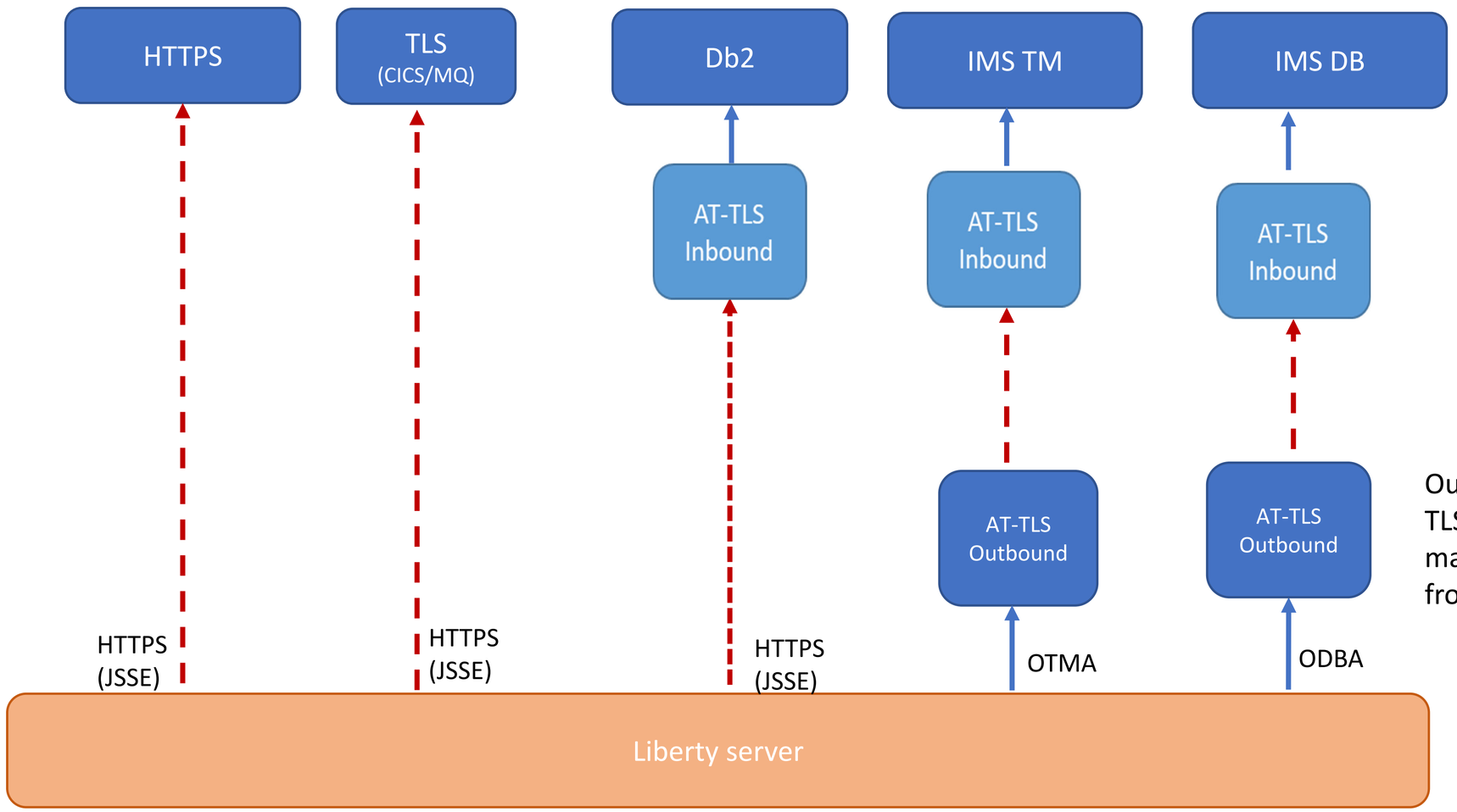
Tech-Tip: TLS client encryption to a Liberty server scenarios



An Outbound Policy allows non-TLS clients to connection to flow encrypted traffic.

[1] mitchj@us.ibm.com

Tech-Tip: TLS encryptions from a Liberty server (HTTPS/native to HTTPS/TLS/OTMA/ODBA)



Inbound Policies
Provide TLS support for incoming requests to Db2 and IMS Connect

Outbound Policies provide TLS support for non-JSSE managed request outbound from Liberty

mitchj@us.ibm.com

z/OS Connect Security server XML TLS Security Configuration (OpenAPI 2)

- requireSecure - requires the client to connect using HTTPS

```
<zosconnect_zosConnectManager
         requireAuth="true"
         requireSecure="true|false"/>

<zosconnect_zosConnectAPIs>
   <zosConnectAPI name="catalog"
         requireAuth="true"
         requireSecure="true|false"/>"/>
</zosconnect_zosConnectAPIs>

<zosconnect_services>
  <service id="selectByEmployee"
      name="selectEmployee"
         requireAuth="true"
         requireSecure="true|false"/>
</zosconnect_services>

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

Globally, requires that client connections use HTTPS, unless overridden on the specific resource definitions.

Requires that client connections use HTTPS (true) or HTTP(false) in order to access the API.

Requires that client connections use HTTPS (true) or HTTP(false) to directly access the service. This attribute is ignored when the service is invoked from an API, then only the API requireSecure attribute is relevant.

Requires that client connections use HTTPS (true) or HTTP(false) ito access the PI requesters. If the requireSecure attribute is not set, the global setting on the zosconnect_zosConnectManager element is used instead, unless the requireSecure attribute is overridden on the specific API requester.

The requireSecure attribute controls whether an inbound must be using HTTPS(true) or if HTTP(false) is allowed.

Note that there are no equivalent configuration elements for an z/OS Connect OpenAPI 3 server.

mitchj@us.ibm.com

Let’s explore using TLS for encryption and data integrity using samples in various scenarios

mitchj@us.ibm.com

Using this Liberty JSSE server XML configuration


```
<!-- Enable features -->
   <featureManager>
        <feature>transportSecurity-1.0</feature>
   </featureManager>

   <sslDefault sslRef="DefaultSSLSettings"
     outboundSSLRef="OutboundSSLSettings" />

   <ssl id="DefaultSSLSettings"
      keyStoreRef="CellDefaultKeyStore"
      trustStoreRef="CellDefaultKeyStore"
      clientAuthenticationSupported="true"
      clientAuthentication="true"
      serverKeyAlias="Liberty Server Cert"/>

   <keyStore id="CellDefaultKeyStore"
      location="safkeyring:///Liberty.KeyRing"
      password="password" type="JCERACFKS"
      fileBased="false" readOnly="true" />

   <ssl id="OutboundSSLSettings"
      keyStoreRef="OutboundKeyStore"
      trustStoreRef="OutboundKeyStore"
      clientKeyAlias="Liberty Client Cert"/>

   <keyStore id="OutboundKeyStore"
      location="safkeyring:///zCEE.KeyRing"
      password="password" type="JCERACFKS"
     fileBased="false" readOnly="true" />
```

```
<zosconnect_authorizationServer sslCertsRef="SSL repertoire"/>
<zosconnect_cicsIpicConnection sslCertsRef="SSL repertoire"/>
<zosconnect_endpointConnect sslCertsRef="SSL repertoire"/>
<zosconnect_zosConnectRestClient sslCertsRef="SSL repertoire"/>
<zosconnect_zosConnectServiceRestClientConnection sslCertsRef="SSL repertoire"/>
```

F BAQSTRT,REFRESH,KEYSTORE

mitchj@us.ibm.com

Using the contents of these key rings

Liberty's outbound key ring

Liberty's inbound key ring

Liberty's outbound key ring to CICS

Liberty's outbound key ring to Db2

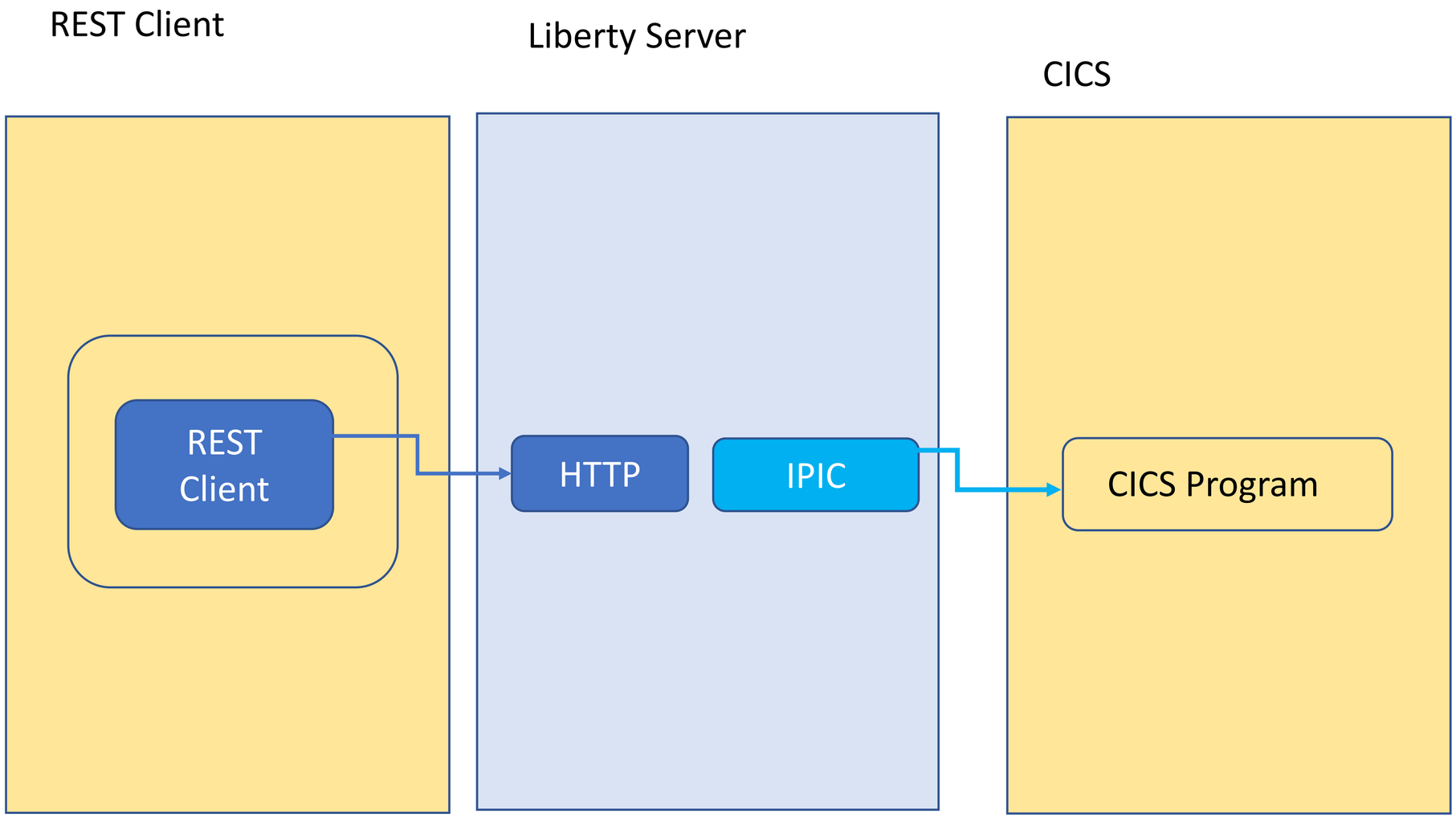
```
Digital ring information for user LIBSERV:
  Ring:
       >zCEE.KeyRing<
  Certificate Label Name              Cert Owner     USAGE      DEFAULT
  --------------------------------    ------------   --------   -------
  zCEE CA                             CERTAUTH       CERTAUTH     NO
  Liberty CA                          CERTAUTH       CERTAUTH     NO
  zCEE Client Cert                    ID(LIBSERV)    PERSONAL     YES
  xyz Client Cert                     ID(LIBSERV)    PERSONAL     No
  DB2 CA                              CERTAUTH       CERTAUTH     NO
  MQ CA                               CERTAUTH       CERTAUTH     NO
  CICS CA                             CERTAUTH       CERTAUTH     NO

  Ring:
       >Liberty.KeyRing<
  Certificate Label Name              Cert Owner     USAGE      DEFAULT
  --------------------------------    ------------   --------   -------
  Liberty Server Cert                 ID(LIBSERV)    PERSONAL     YES
  Liberty CA                          CERTAUTH       CERTAUTH     NO
  zCEE CA                             CERTAUTH       CERTAUTH     NO
  CICS CA                             CERTAUTH       CERTAUTH     NO

Digital ring information for user CICSSTC:
  Ring:
       >CICS.KeyRing<
  Certificate Label Name              Cert Owner     USAGE      DEFAULT
  --------------------------------    ------------   --------   -------
  CICS CA                             CERTAUTH       CERTAUTH     NO
  CICS Client Cert                    ID(CICSSTC)    PERSONAL     YES
  Liberty CA                          CERTAUTH       CERTAUTH     NO
  zCEE CA                             CERTAUTH       CERTAUTH     NO

Digital ring information for user DB2USER:
  Ring:
       >Db2.KeyRing<
  Certificate Label Name              Cert Owner     USAGE      DEFAULT
  --------------------------------    ------------   --------   -------
  DB2 CA                              CERTAUTH       CERTAUTH     NO
  zCEE CA                             CERTAUTH       CERTAUTH     NO
  DB2USER                             ID(DB2USER)    PERSONAL     YES
```

Tech-Tip: when Liberty is the client endpoint, and more than one personal certificate is connected to a key ring. Use the SSL repertoire *clientKeyAlias* attributes to select the personal certificate to be used in a handshake.

Tech-Tip: when Liberty is the server endpoint, and more than one personal certificate is connected to a key ring. Use the SSL repertoire *serverKeyAlias* attributes to select the personal certificate to be used in a handshake.

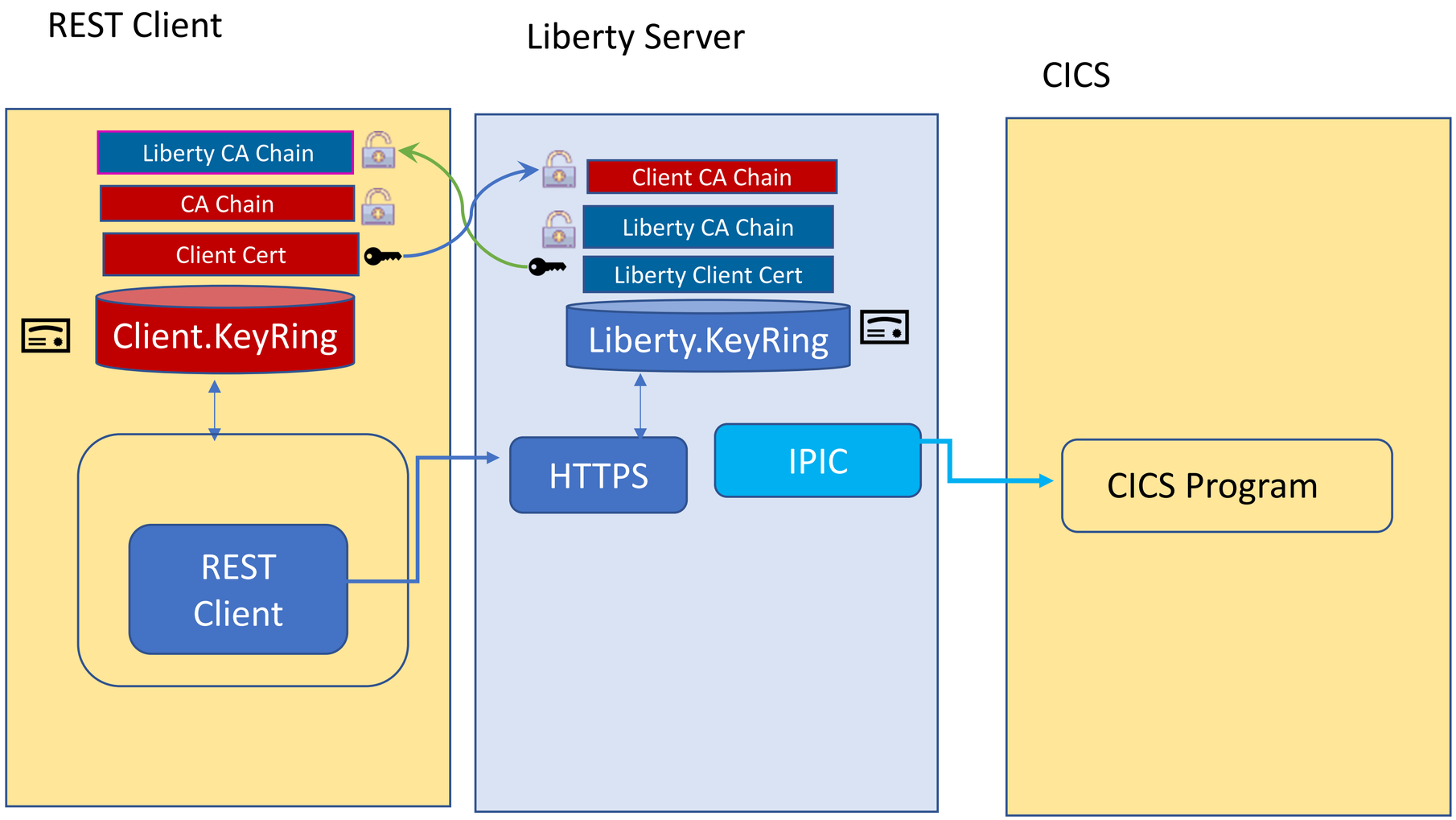
mitchj@us.ibm.com

No TLS between any endpoints



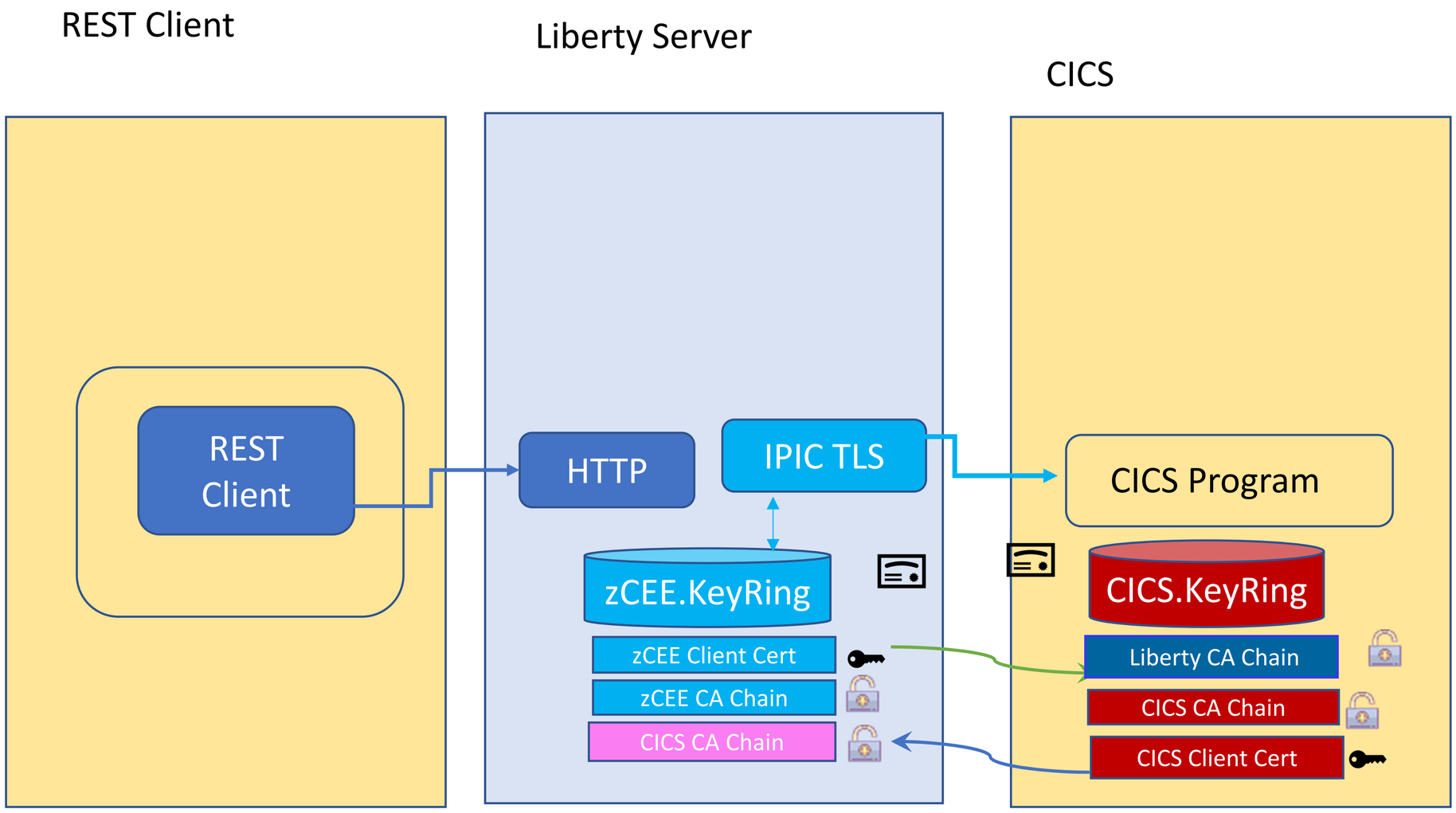
mitchj@us.ibm.com

TLS handshake between the client and Liberty server



mitchj@us.ibm.com

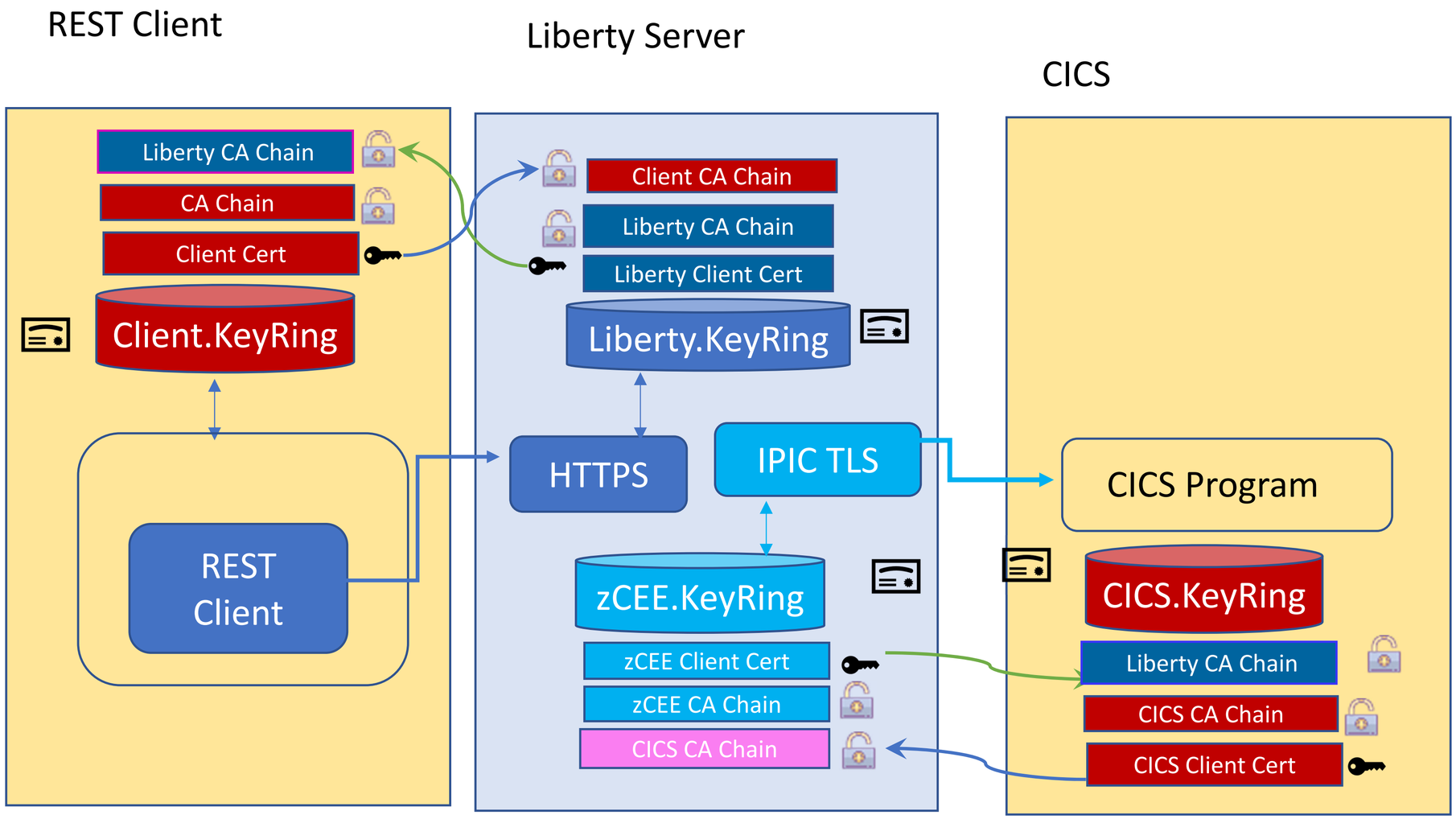
TLS handshake between the Liberty server and the target endpoint




```
KEYRING=CICS.KeyRing,
ENCRYPTION=STRONG,
MAXSSLTCBS=8,
SSLDELAY=600
```

mitchj@us.ibm.com

TLS handshakes between all endpoints

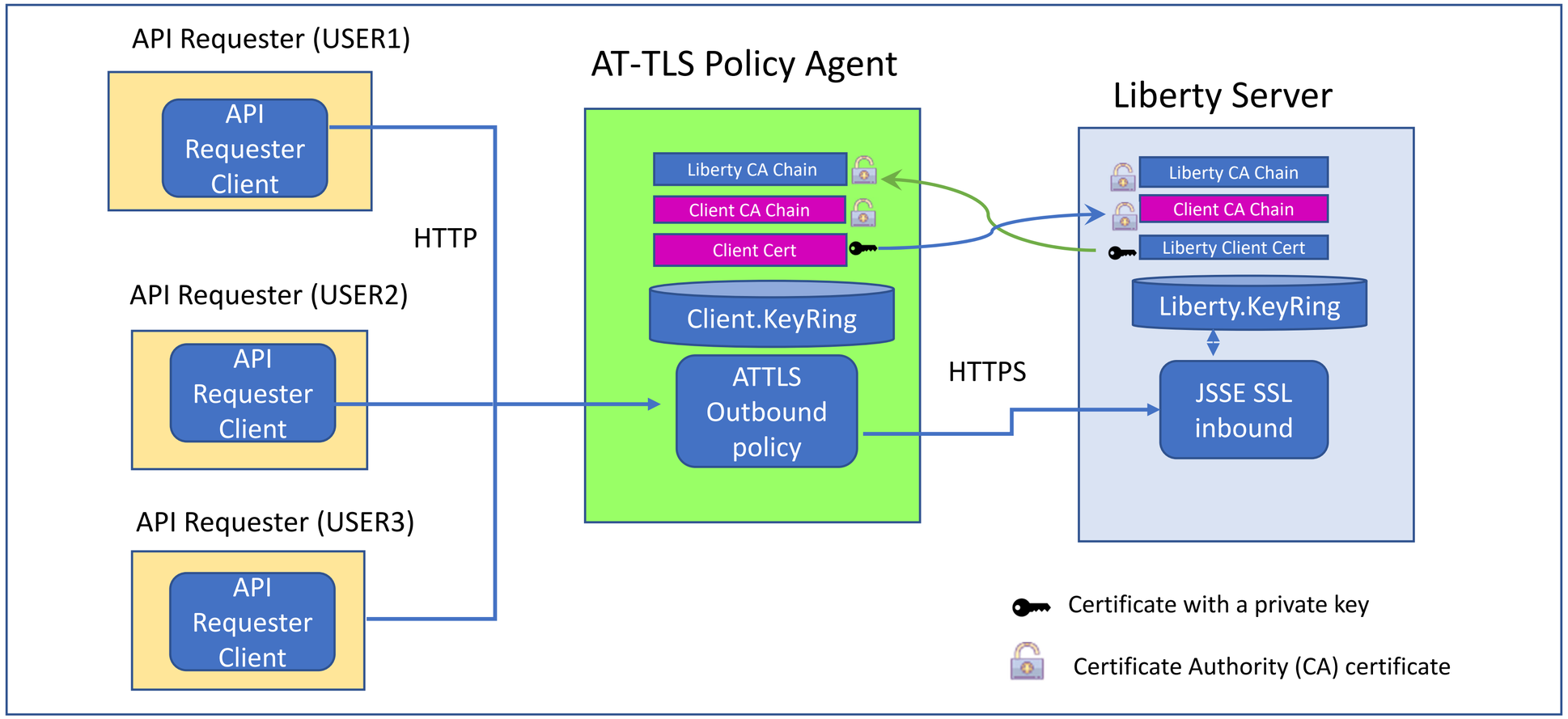



```
KEYRING=CICS.KeyRing,
ENCRYPTION=STRONG,
MAXSSLTCBS=8,
SSLDELAY=600
```

mitchj@us.ibm.com

AT-TLS - outbound policy handshake scenario

Use of a common key ring name for multiple client identities



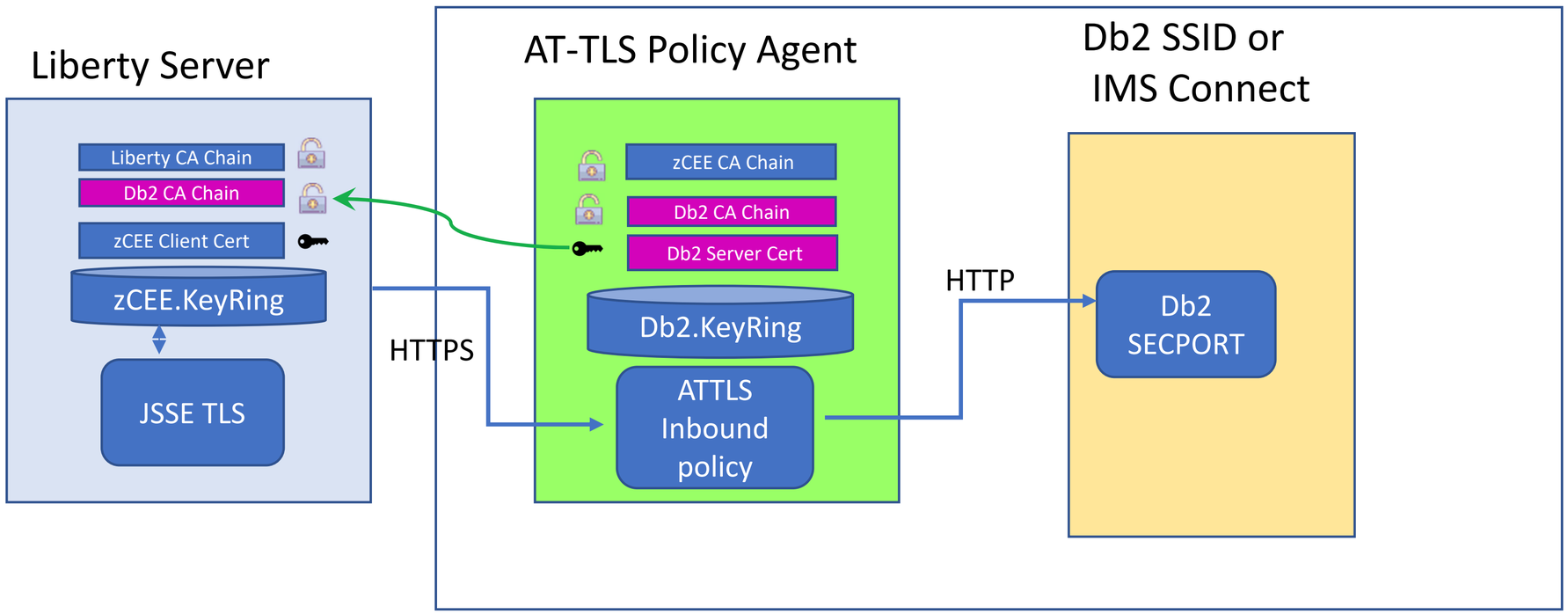
- Each user owns a keyring with the name Liberty.KeyRing.
- Each key ring has a different default client certificate for mutual authentication purposes.

This is a situation when AT-TLS mutual authentication has a benefit.

mitchj@us.ibm.com

AT-TLS - inbound policy handshake scenario (Db2 and IMS)

Policy Agent uses an inbound policy and acts a surrogate TLS server



Note that DB2 is AT-TLS aware
IMS is AT-TLS unware

Certificate with a private key

Certificate Authority (CA) certificate

mitchj@us.ibm.com

Ciphers

- During the TLS handshake, the TLS protocol and data exchange cipher are negotiated
- Choice of cipher and key length has an impact on performance
- You can restrict the protocol (TLS) and ciphers to be used
- Example setting server.xml file

```
<ssl id="DefaultSSLSettings" keyStoreRef="defaultKeyStore"
sslProtocol="TLSv1.2"
enabledCiphers="TLS_RSA_WITH_AES_256_CBC_SHA256
TLS_RSA_WITH_AES_256_GCM_SHA384"/>
```

- This configures use of TLS 1.2 and two supported ciphers
- It is recommended to control what ciphers can be used in the server rather than the client

For cipher details, see IBM SDK Java 8.0.0 Cipher Suites at URL
https://www.ibm.com/support/knowledgecenter/SSYKE2_8.0.0/com.ibm.java.security.component.80.doc/security-component/jsse2Docs/ciphersuites.html

Tech/Tip: A note on cipher suite names

A CipherSuite is a suite of cryptographic algorithms used by a TLS connection. A suite comprises three distinct algorithms:

- The key exchange and authentication algorithm, used during the handshake
- The encryption algorithm, used to encipher the data
- The MAC (Message Authentication Code) algorithm, used to generate the message digest

There are several options for each component of the suite, but only certain combinations are valid when specified for a TLS connection. The name of a valid CipherSuite defines the combination of algorithms used. For example, the CipherSuite ***TLS_RSA_WITH_AES_128_CBC_SHA*** specifies:

- The RSA key exchange and authentication algorithm
- The AES encryption algorithm, using a 128-bit key and cipher block chaining (CBC) mode
- The SHA-1 Message Authentication Code (MAC)

Note

To use some CipherSuites, the 'unrestricted' policy files need to be configured in the JRE. For more details of how policy files are set up in an SDK or JRE, see the *IBM SDK Policy files* topic in the *Security Reference for IBM SDK, Java Technology Edition* for the version you are using.

Table 1. CipherSpecs supported by IBM MQ and their equivalent CipherSuites

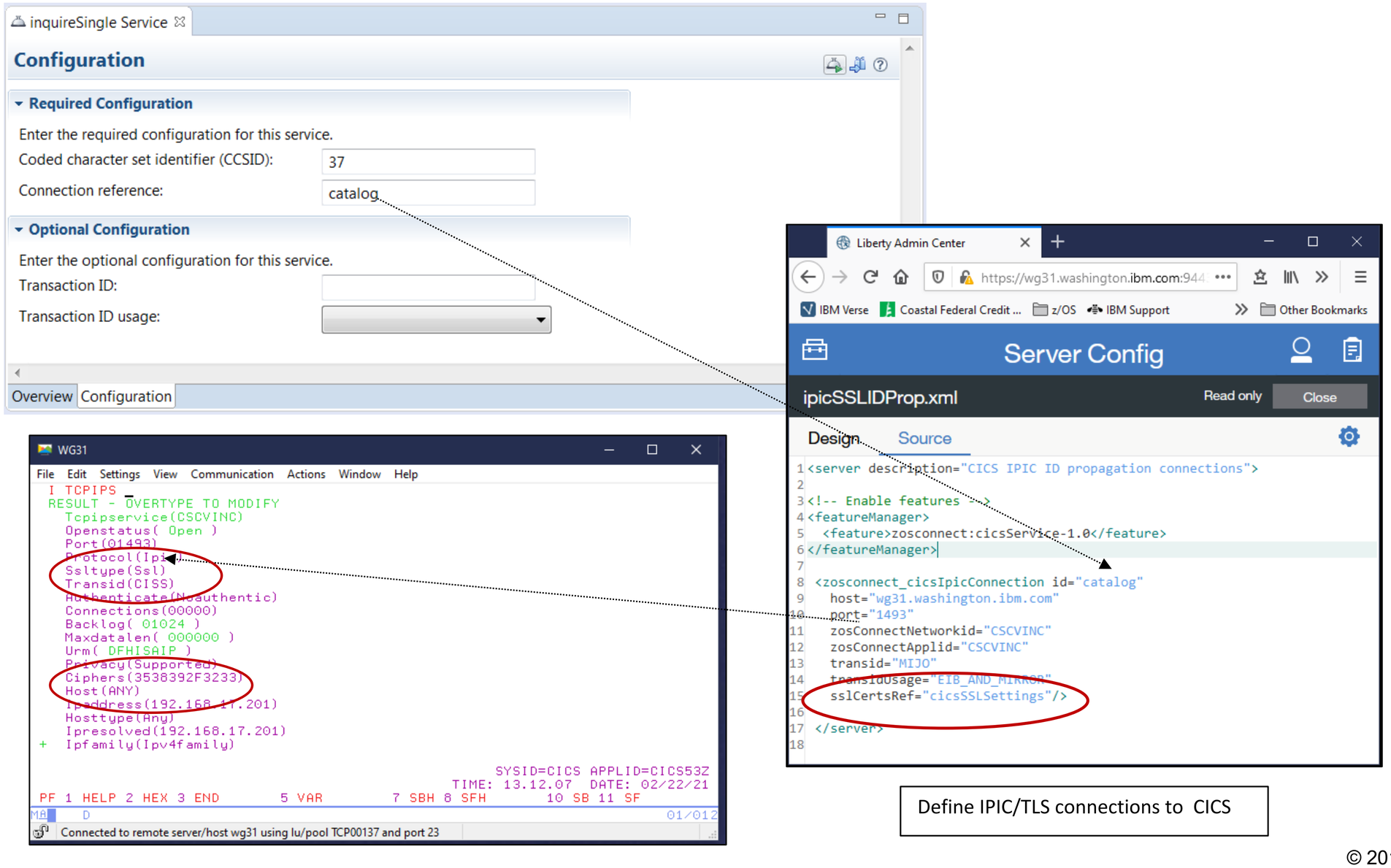
CipherSpec	Equivalent CipherSuite (IBM JRE)	Equivalent CipherSuite (Oracle JRE)	Protocol	FIPS 140-2 compatible
ECDHE_ECDSA_3DES_EDE_CBC_SHA256	SSL_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA	TLS_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA	TLS 1.2	yes
ECDHE_ECDSA_AES_128_CBC_SHA256	SSL_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256	TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256	TLS 1.2	yes
ECDHE_ECDSA_AES_128_GCM_SHA256	SSL_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	TLS 1.2	yes
ECDHE_ECDSA_AES_256_CBC_SHA384	SSL_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384	TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384	TLS 1.2	yes
ECDHE_ECDSA_AES_256_GCM_SHA384	SSL_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384	TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384	TLS 1.2	yes
ECDHE_ECDSA_NULL_SHA256	SSL_ECDHE_ECDSA_WITH_NULL_SHA	TLS_ECDHE_ECDSA_WITH_NULL_SHA	TLS 1.2	no
ECDHE_ECDSA_RC4_128_SHA256	SSL_ECDHE_ECDSA_WITH_RC4_128_SHA	TLS_ECDHE_ECDSA_WITH_RC4_128_SHA	TLS 1.2	no
ECDHE_RSA_3DES_EDE_CBC_SHA256	SSL_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA	TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA	TLS 1.2	yes
ECDHE_RSA_AES_128_CBC_SHA256	SSL_ECDHE_RSA_WITH_AES_128_CBC_SHA256	TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256	TLS 1.2	yes
ECDHE_RSA_AES_128_GCM_SHA256	SSL_ECDHE_RSA_WITH_AES_128_GCM_SHA256	TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	TLS 1.2	yes
ECDHE_RSA_AES_256_CBC_SHA384	SSL_ECDHE_RSA_WITH_AES_256_CBC_SHA384	TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384	TLS 1.2	yes
ECDHE_RSA_AES_256_GCM_SHA384	SSL_ECDHE_RSA_WITH_AES_256_GCM_SHA384	TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	TLS 1.2	yes
ECDHE_RSA_NULL_SHA256	SSL_ECDHE_RSA_WITH_NULL_SHA	TLS_ECDHE_RSA_WITH_NULL_SHA	TLS 1.2	no
ECDHE_RSA_RC4_128_SHA256	SSL_ECDHE_RSA_WITH_RC4_128_SHA	TLS_ECDHE_RSA_WITH_RC4_128_SHA	TLS 1.2	no

https://www.ibm.com/docs/en/ibm-mq/9.3?topic=java-tls-cipherspecs-ciphersuites-in-mq-classes

mitchj@us.ibm.com

CICS IPIC using TLS

The server.xml file is the key configuration file:



Define IPIC/TLS connections to CICS

[1] mitchj@us.ibm.com

https://www.ibm.com/support/knowledgecenter/SSLTBW_2.4.0/com.ibm.zos.v2r4.gska100/csdcwh.htm

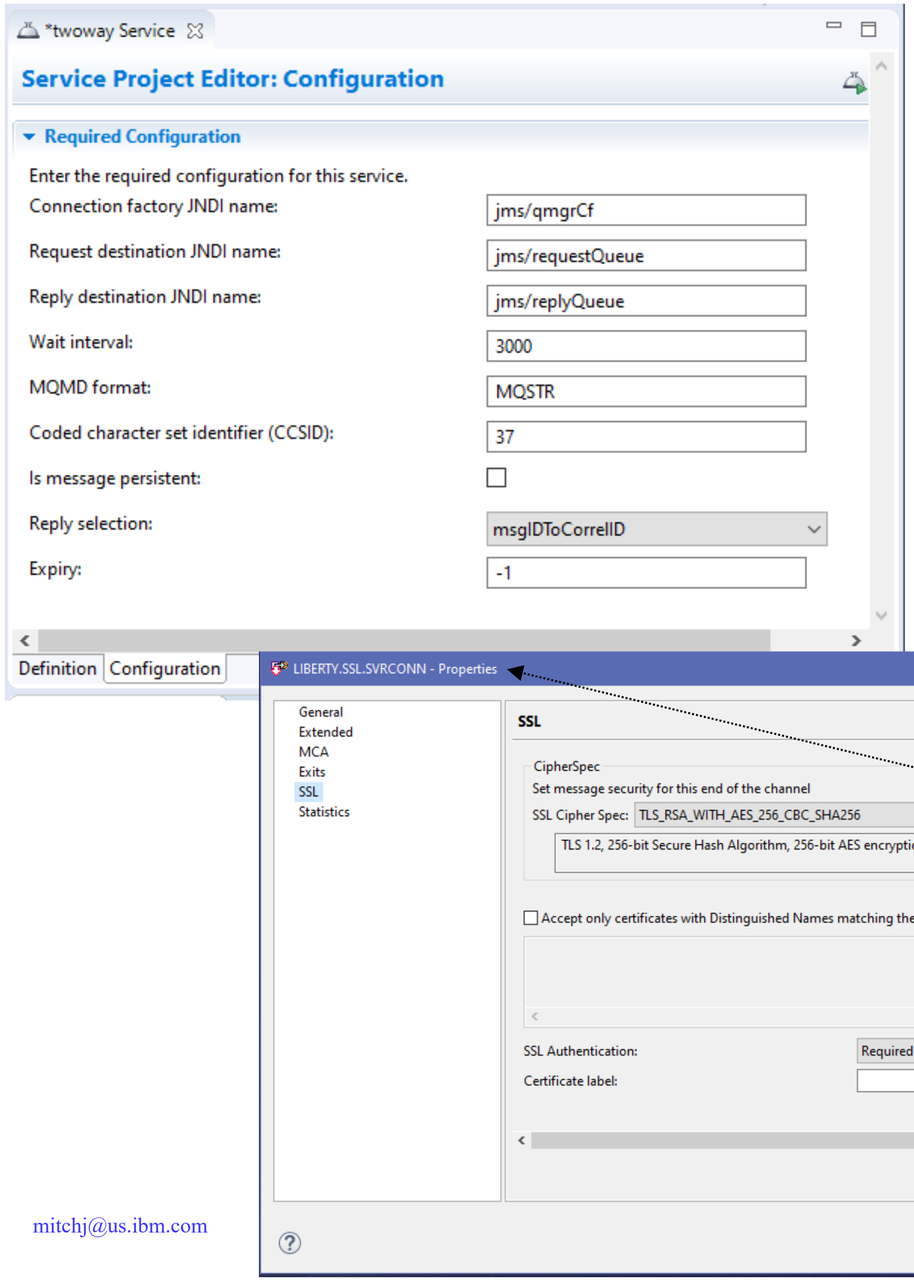
Tech/Tip: Cipher Suite numbers (CICS TCPIPService):

Table 2. 2-character and 4-character cipher suite definitions for SSL V3, TLS V1.0, TLS V1.1, TLS V1.2, and TLS V1.3

2-character cipher number	4-character cipher number	Short name	Description [1]	FIPS 140-2	Base security level FMID HCPT440	Security level 3 FMID JCPT441
00	0000	TLS_NULL_WITH_NULL_NULL	No encryption or message authentication and RSA key exchange		X	X
01	0001	TLS_RSA_WITH_NULL_MD5	No encryption with MD5 message authentication and RSA key exchange		X	X
02	0002	TLS_RSA_WITH_NULL_SHA	No encryption with SHA-1 message authentication and RSA key exchange		X	X
03	0003	TLS_RSA_EXPORT_WITH_RC4_40_MD5	40-bit RC4 encryption with MD5 message authentication and RSA (export) key exchange		X	X
04	0004	TLS_RSA_WITH_RC4_128_MD5	128-bit RC4 encryption with MD5 message authentication and RSA key exchange			X
05	0005	TLS_RSA_WITH_RC4_128_SHA	128-bit RC4 encryption with SHA-1 message authentication and RSA key exchange			X

https://www.ibm.com/docs/en/zos/3.1.0?topic=programming-cipher-suite-definitions

MQ JMS using TLS



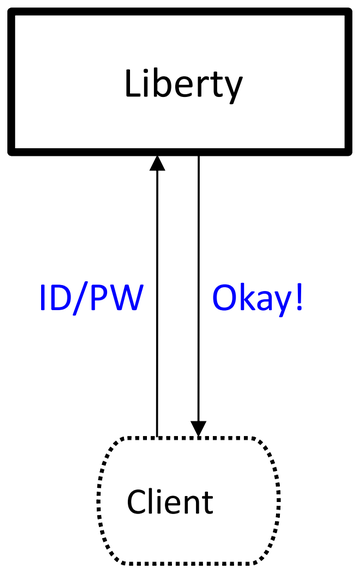
The server.xml file is the key configuration file:

mitchj@us.ibm.com

Authentication - Third Party Authentication

Several different ways this can be accomplished:

Basic Authentication

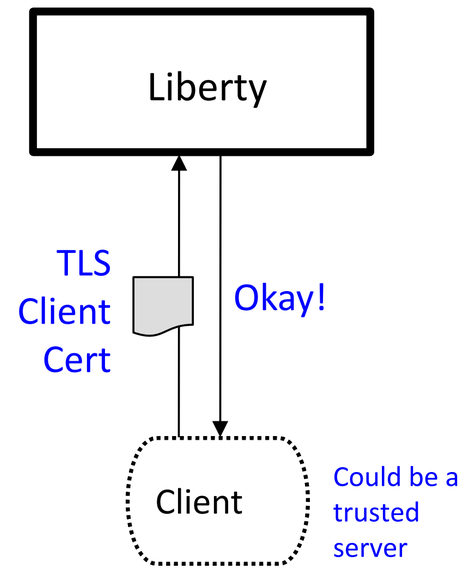


Server prompts for ID/PW

Client supplies ID/PW or ID/PassTicket

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

Client Certificate



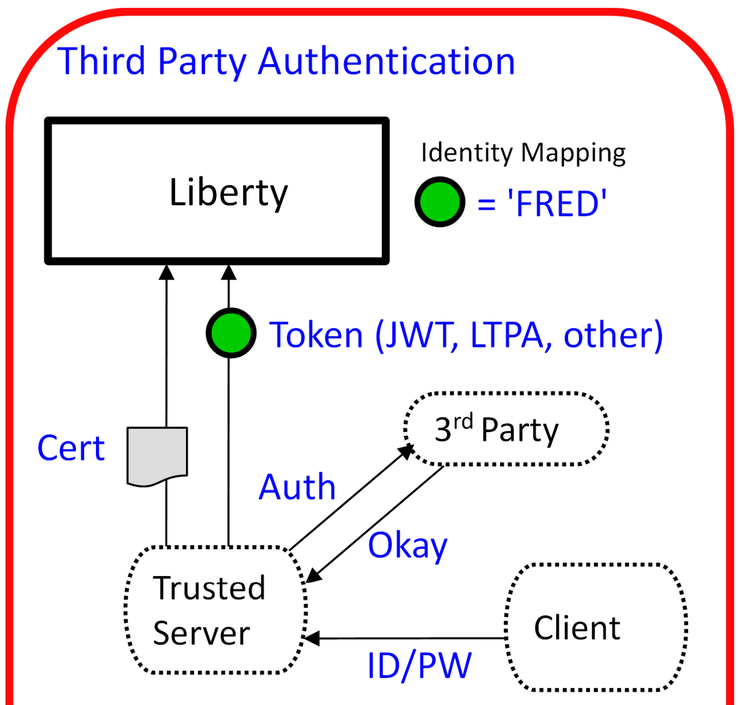
Server prompts for client certificate.

Client supplies certificate

Server validates client certificate and maps to an identity

Registry options:
- SAF

Third Party Authentication



Client authenticates to 3rd party sever

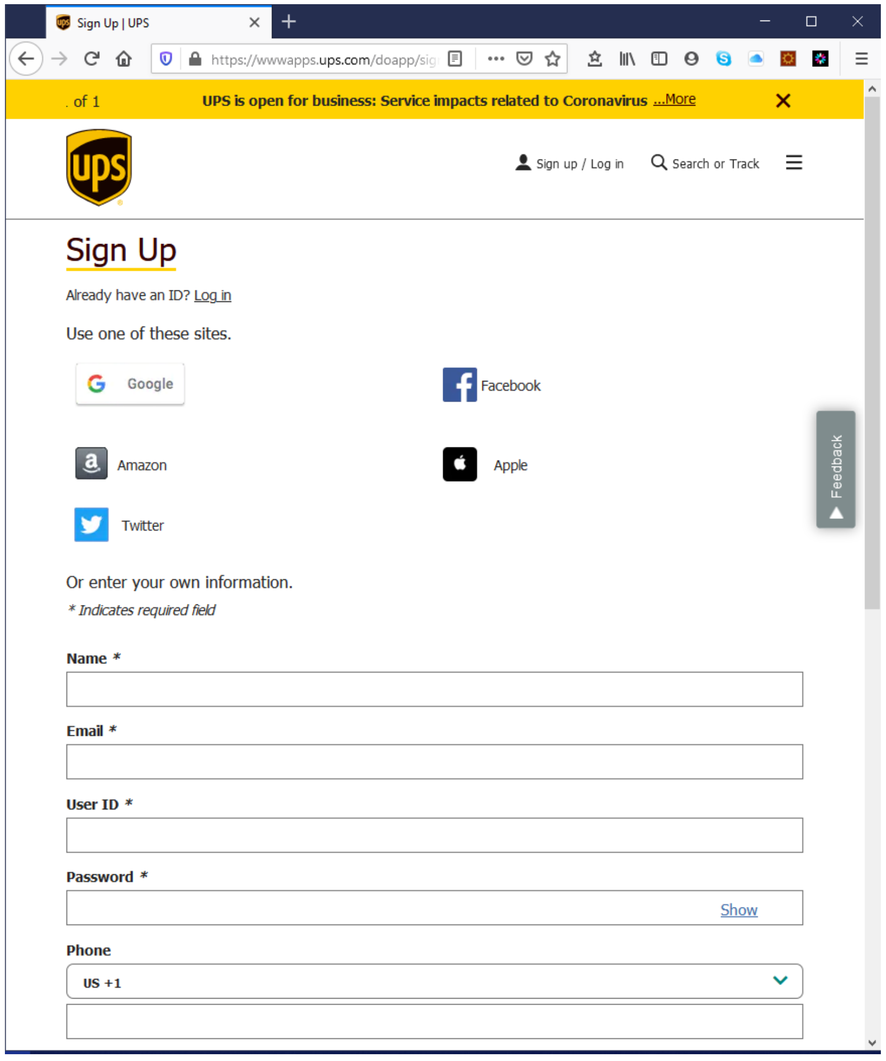
Client receives a trusted 3rd party token

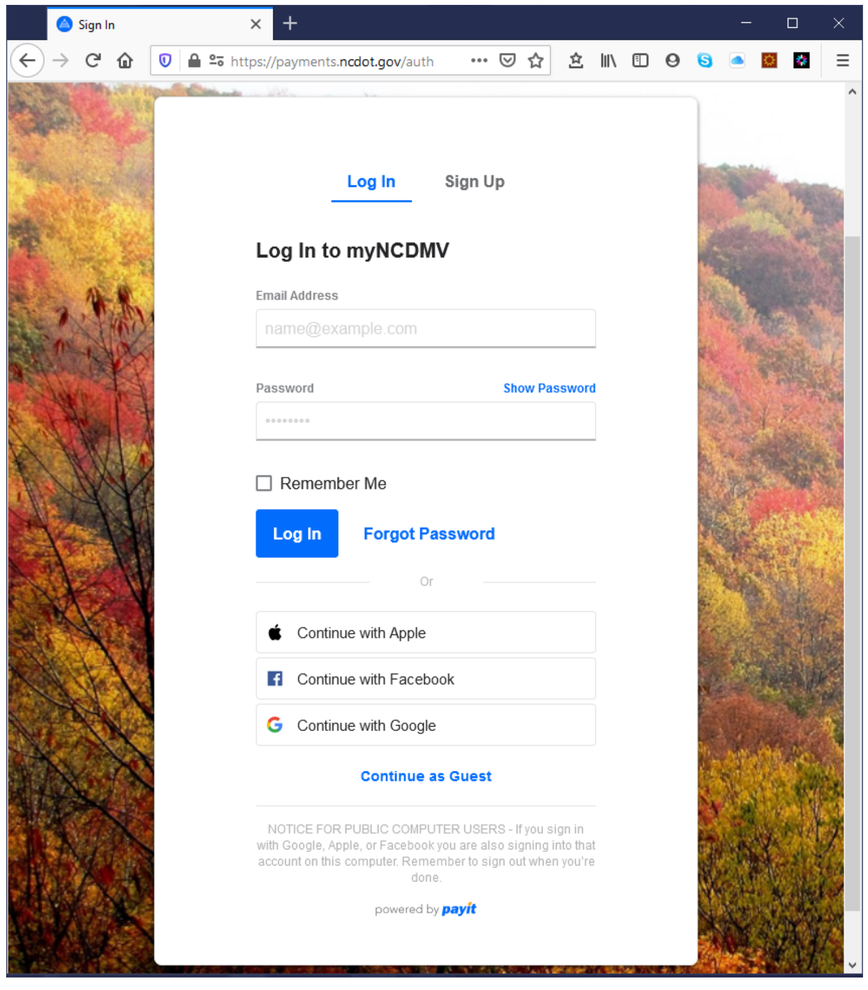
Token flows to Liberty z/OS and is mapped to an identity

Registry options:
- **We may know these detail.**

mitchj@us.ibm.com

Third Party Authentication Examples





mitchj@us.ibm.com

Open security standards

- **OAuth** is an open standard for access delegation, used as a way to grant websites or applications access to their information without requiring a password.

- ***From the OpenID Core specification:*** *OpenID Connect 1.0 is a simple identity layer on top of the OAuth 2.0 protocol. It enables Clients to verify the identity of the End-User based on the authentication performed by an Authorization Server, as well as to obtain basic profile information about the End-User in an interoperable and REST-like manner.*

- ***OAuth 2.0 Core (RFC 6749) Specifications:*** https://tools.ietf.org/html/rfc6749

- ***OpenID Connect Core Specifications***: https://openid.net/specs/openid-connect-core-1_0.html

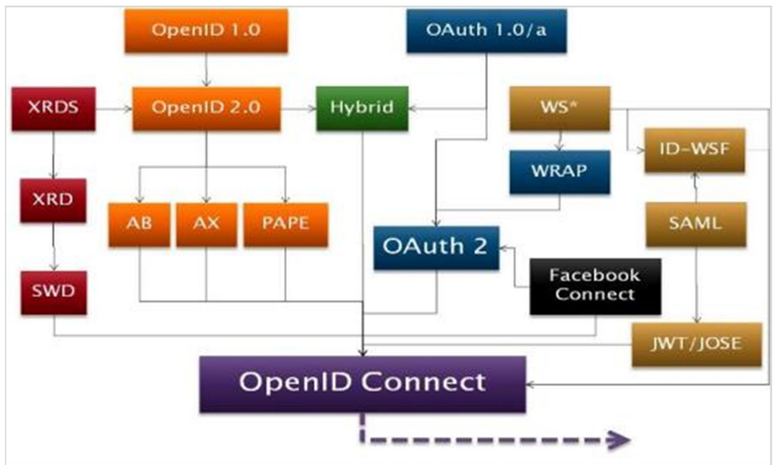
See the YouTube videos:

OAuth 2.0 and OpenID Connect (in plain English)

https://www.youtube.com/watch?v=996OiexHze0

OpenID Connect on Liberty

https://www.youtube.com/watch?v=fuajCS5bG4c



mitchj@us.ibm.com

OpenID Connect/OAuth

- ***From the z/OS Connect Knowledge Center:*** *z/OS Connect EE security can operate with traditional z/OS security, for example, System Authorization Facility (SAF) and also with open standards such as Transport Layer Security (TLS), JSON Web Token (JWT), and* ***OpenID Connect.***

- ***From the OpenID Core specification:*** *OpenID Connect 1.0 is a simple identity layer on top of the OAuth 2.0 protocol. It enables Clients to verify the identity of the End-User based on the authentication performed by an Authorization Server, as well as to obtain basic profile information about the End-User in an interoperable and REST-like manner.*

- ***OAuth 2.0 Core (RFC 6749) Specifications:*** https://tools.ietf.org/html/rfc6749

- ***OpenID Connect Core Specifications***: https://openid.net/specs/openid-connect-core-1_0.html

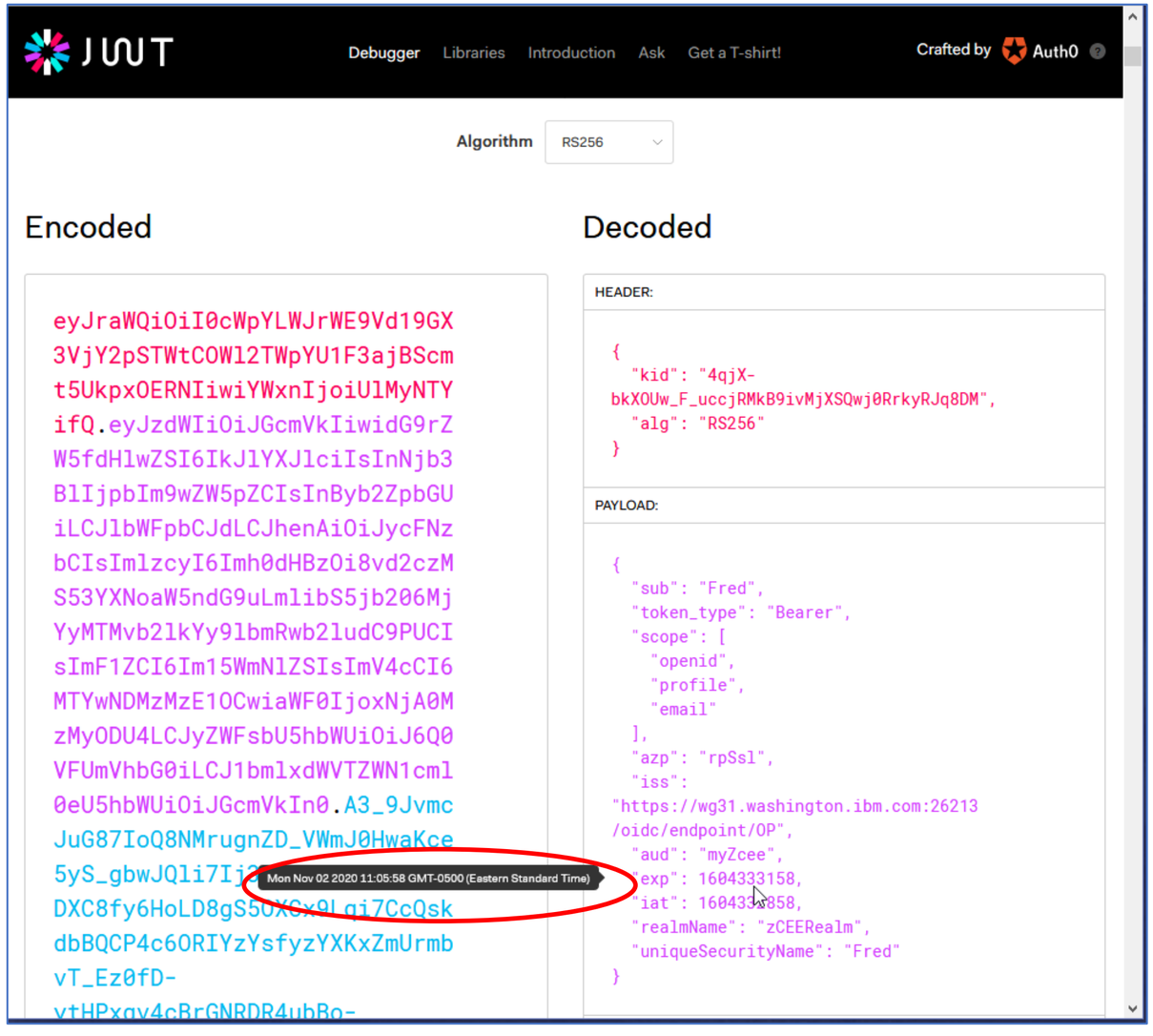
- ***Again, for a very good explanation of this topic see YouTube video*** *OAuth 2.0 and OpenID Connect (in plain English)* https://www.youtube.com/watch?v=996OiexHze0

What is a JWT (JSON Web Token) ?

- JWT is a compact way of representing claims that are to be transferred between two parties

- Normally transmitted via HTTP header

- Consists of three parts
  - Header
  - Payload
  - Signature



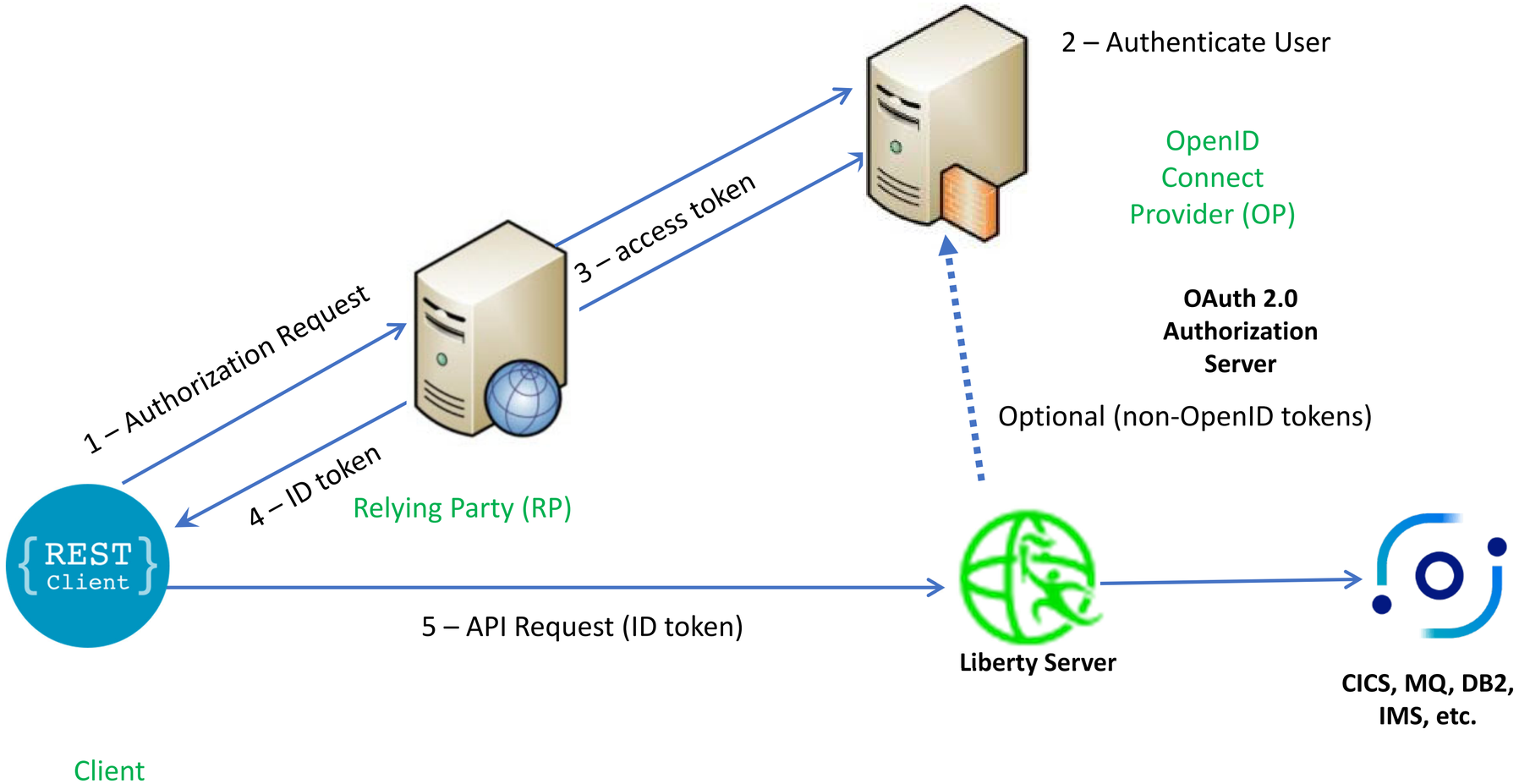
Values derived from the OAUTH configuration:

- signatureAlgorithm="**RS256**“
- accessTokenLifetime="**300**"
- resourceIds="**myZcee**"

https://jwt.io

mitchj@us.ibm.com

Typical Authorization Flow for am OpenID Connect token to a z/OS Connect API Provider



mitchj@us.ibm.com

Some basic OAuth/OpenID Connect terms

- ***Authorization server -*** The server that issues access tokens to the client after authenticating the resource owner and obtaining authorization. *In a z/OS Connect EE API requester scenario, the authorization server is called by the z/OS Connect EE server to retrieve an access token.*

- ***Authorization Endpoint*** - A service or endpoint on an OAuth authorization server that accepts an authorization request from a client to perform authentication and authorization of a user. The authorization endpoint returns an authorization grant, or code, to the client in the Authorization Code Flow. In the Implicit Flow, the authorization endpoint returns an access token to the client.

- **Token Endpoint** – A service or endpoint on an OP that accepts an authorization grant, or code, from a client in exchange for an access token, ID token, and refresh token

- ***Access Token*** – A credential that is used to access protected resources. An access token is a string that represents an authorization that is issued to the client. The access token is usually opaque to the client (it does not have to be opaque) and can be JSON Web Token (JTW). See URL https://tools.ietf.org/html/rfc6749 Section 1.4 for more information.

- ***OAuth token -*** With OAuth 2.0, access tokens are used to access protected resources. An access token is normally a string that represents an authorization that is issued to the client. The string is usually opaque to the client. Opaque tokens may require that the token recipient call back to the server that issued the token. *However, an access token can also be in the form of a JSON Web Token (JWT) which does not require a call back (introspection).*

- **Scope -** Privilege or permission that allows access to a set of resources of a third party.

Some basic OAuth/OpenID Connect terms

- **Relying Party (RP) –** An entity that relies on an OP to authenticate a user and obtain an authorization to access a user's resource. *For z/OS Connect API Requester, it is the Liberty server configured as an OpenID Connect Client, e.g., using <openidConnectClient/> XML configuration elements.*

- **OpenID Connect Provider (OP) -** An OAuth 2.0 authorization server that is capable of providing claims to a client or Relying Party (RP) , *an OpenID component.*

- ***Resource owner*** **-** An entity capable of granting access to a protected resource. When the resource owner is a person, it is referred to as an end user. *In a z/OS Connect EE API requester scenario, the resource owner might be the user of the CICS, IMS, or z/OS application.*

- ***Resource server*** **-** The server that hosts the protected resources and accepts and responds to protected resource requests by using access tokens. *In a z/OS Connect API provider, the resource server is the z/OS Connect server. In a z/OS Connect EE API requester scenario, the resource server is the request endpoint for the remote RESTful API*

- ***ID Token*** **-** is an OpenID Connect token that is an extension to OAuth 2.0 specification access tokens. This token is a JSON Web Token (JWT). See URL https://openid.net/specs/openid-connect-core-1_0.html#IDToken for more information about the extensions.

Tech/Tip: Let's explore a flow using a Liberty OpendID Provider as an example

This Liberty server configuration provides a good example of the workings of an authorization server.

```
<httpEndpoint host="*" httpPort="26212" httpsPort="26213" id="defaultHttpEndpoint"/>

<openidConnectProvider id="OP"
    signatureAlgorithm="RS256"
    keyStoreRef="jwtStore"
   oauthProviderRef="OIDCssl" >
</openidConnectProvider>

<oauthProvider id="OIDCssl"
   httpsRequired="true"
   jwtAccessToken="true"
   autoAuthorize ="true"
   accessTokenLifetime="300">

<!-- Define OIDC Client for zCEE Authentication  -->
 <autoAuthorizeClient>zCEEClient</autoAuthorizeClient>
    <localStore>
      <client name="zCEEClient"
      secret="secret"
      displayname="zCEEClient"
      scope="openid"
      enabled="true"
      resourceIds="myZcee"/>
    </localStore>
</oauthProvider>
```

Key Points:

- **keyStoreRef -** A keystore containing the private key necessary for signing with an asymmetric algorithm.
- **jwtAccessToken -** generate a JSON Web Token, serialize it as a string and put in the place of the access token.

[1] mitchj@us.ibm.com

Tech/Tip: Generating a JWT using Liberty's as an example OPID provider

The Liberty server authorization server's XML configuration

```
<!--Key store that contains certificate used to sign JWT-->
<keyStore fileBased="false" id="jwtStore"
  location="safkeyring:///JWT.KeyRing"
  password="password" readOnly="true" type="JCERACFKS"/>

<!-- Define a basic user registry -->
<basicRegistry id="basicRegistry"
  realm="zCEERealm">
  <user name="auser" password="pwd"/>
  <user name="distributed_User1" password="pwd"/>
  <user name="Fred" password="fredpwd"/>
  <user name="distuser1" password="pwd"/>
  <user name="distuser2" password="pwd"/>
</basicRegistry>
```

```
RACMAP ID(FRED)  MAP USERDIDFILTER(NAME('Fred'))
     REGISTRY(NAME('*')) WITHLABEL('zCEE JWT FRED')
RACMAP ID(USER1)  MAP USERDIDFILTER(NAME('distributed_User1'))
     REGISTRY(NAME('*')) WITHLABEL('zCEE JWT distributedUser1')
RACMAP ID(USER1)  MAP USERDIDFILTER(NAME('distuser1'))
     REGISTRY(NAME('*')) WITHLABEL('zCEE JWT distuser1')
RACMAP ID(USER2)  MAP USERDIDFILTER(NAME('distuser2'))
     REGISTRY(NAME('*')) WITHLABEL('zCEE JWT distuser2')
```

[1] mitchj@us.ibm.com

Tech/Tip: RACMAP Command Summary

```
RACMAP ID(USER1) MAP USERDIDFILTER(NAME('distuser1'))
     REGISTRY(NAME('*')) WITHLABEL('zCEE token user1')
RACMAP ID(USER1) MAP USERDIDFILTER(NAME('distribute_User1'))
     REGISTRY(NAME('zCEERealm')) WITHLABEL('zCEE user1')
RACMAP ID(USER1) MAP USERDIDFILTER(NAME('UID=user1,CN=User Name,OU=IBM ATG,O=IBM,C=US'))
     registry(name('*')) withlabel('USER X500 DN’)
RACMAP ID(ATSUSER) MAP USERDIDFILTER(NAME('OU=IBM ATS,O=IBM,C=US'))
     registry(name('*')) withlabel('ATS USER’)
RACMAP ID(IBMUSER) MAP USERDIDFILTER(NAME('O=IBM,C=US'))
     registry(name('*')) withlabel('IBM USER')
```

```
RACMAP ID(USER1) LISTMAP(LABEL('USER X500 DN’)

RACMAP ID(USER1) DELMAP (LABEL('zCEE distuser1’)

RACMAP QUERY USERDIDFILTER(NAME('USER1')) REGISTRY(NAME('*'))
```

```
RACMAP ID(USER1) LISTMAP
Label: zCEE token user1
Distributed Identity User Name Filter:
  >distuser1<
Registry Name:
  >*<

Label: zCEE user1
Distributed Identity User Name Filter:
  >distributed_User1<
Registry Name:
  >zCEERealm<

Label: USER X500 DN
Distributed Identity User Name Filter:
  >UID=user1,CN=User Name,OU=IBM ATG,O=IBM,C=US<
Registry Name:
  >*<
```

mitchj@us.ibm.com

Liberty OpenID Client identity mapping configuration attributes

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

Use distributed identity filters to map the distributed identities to SAF user IDs, using IDIDMAP resources and the RACMAP command.

Decoded EDIT THE PAYLOAD AND SECRET

HEADER: ALGORITHM & TOKEN TYPE

```
{
  "kid": "kvjtqdLMjOTWiJrjOr73fu2MMt-FjiQrxUOYBzJLR4o",
  "alg": "RS256"
}
```

PAYLOAD: DATA

```
{
  "sub": "auser",
  "token_type": "Bearer",
  "scope": [
    "openid",
    "profile",
    "email"
  ],
  "azp": "rpSsl",
  "iss": "https://wg31.washington.ibm.com:26213
/oidc/endpoint/OP",
  "aud": "myZcee",
  "exp": 1646761228,
  "iat": 1646760928,
  "realmName": "zCEERealm",
  "uniqueSecurityName": "auser"
}
```

```
<authFilter id="ATSAuthFilter">
   <requestUrl  id="ATSDemoUrl"
    name="ATSRefererUri"
    matchType="contains"
    urlPattern="/cscvinc/employee|/db2/employee|/mqapi/loan"/>
</authFilter>
<openidConnectClient id="ATS"
      httpsRequired="true"
      authFilterRef="ATSAuthFilter"
      inboundPropagation="required"
      scope="openid profile email"
      audiences="myZcee"
      issuerIdentifier=https://wg31.washington.ibm.com:26213/oidc/endpoint/OP
      mapIdentityToRegistryUser="false"
      signatureAlgorithm="RS256"
      userIdentityToCreateSubject="sub"
      trustAliasName="JWT-Signer-Certificate"
      trustStoreRef="jwtTrustStore"
      authnSessionDisabled="true"
      disableLtpaCookie="true">
  </openidConnectClient>
<keyStore fileBased="false" id="jwtTrustStore"
     location="safkeyring:///JWT.KeyRing"
     password="password" readOnly="true" type="JCERACFKS"/>
```

Specifies whether to map the identity to a registry user. If this is set to false, then the user registry (SAF) is not used to create the user subject.

mitchj@us.ibm.com

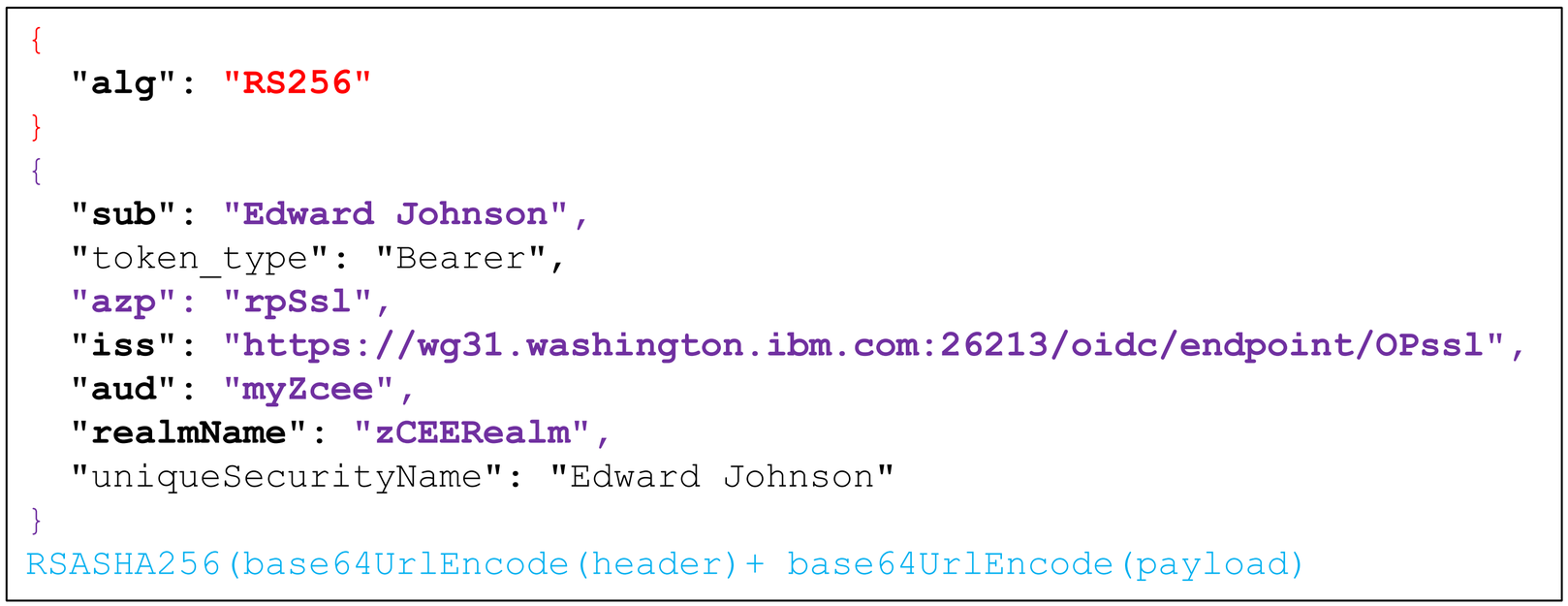
Liberty OpenID Client identity mapping configuration attributes (JWK)

```
{
  "kid": "574eafad-fcb5-412e-97a3-8100a1c1fa5b",
  "alg": "RS256"
}
{
  "sub": "mitchj",
  "aud": "myZCEE",
  "iss": "https://wg31.washington.ibm.com:26213/oidc/endpoint/OP",
  "exp": 1610451176,
  "iat": 1610451876
}
```

```
<openidConnectClient
    id="ATSJWK"
    clientId="RS-JWT-ZCEE"
    httpsRequired="true"
    authFilterRef="jwkAuthFilter"
    inboundPropagation="required"
    signatureAlgorithm="RS256"
    userIdentifier="sub"
    mapIdentityToRegistryUser="true"
    issuerIdentifier=https://wg31.washington.ibm.com:26213/oidc/endpoint/OP
    disableLtpaCookie="true"
    audiences="myZcee"
    tokenReuse="true"
    jwkEndpointUrl=https://wg31.washington.ibm.com:26213/oidc/endpoint/OP/jwk
    jwkClientId="jwtClient"
    jwkSecret="jwtSecret"/>
  </openidConnectClient>
```

mitchj@us.ibm.com

JWT used in scenario – putting it all together



- The header contains an **alg** (algorithm) element value **RS256**
  - **RS256** (RSA Signature with SHA-256) is an asymmetric algorithm which uses a **public/private** key pair
  - **ES512** (Elliptic Curve Digital Signature Algorithm with SHA-512) link for more info
  - **HS256** (HMAC with SHA-256) is a symmetric algorithm with only one (**secret**) key
- The **iss** (issuer) claim identifies the principal that issued the JWT
- The **sub** (subject) claim **distuser** identifies the principal that is the subject of the JWT
- The **aud** (audience) claim **myZcee** identifies the recipients for which the JWT is intended

Configuring authentication with JWT

Liberty can perform user authentication with JWT using the support that is provided by the *openidConnectClient-1.0* feature. The ***<openidConnectClient>*** element is used to accept a JWT token as an authentication token

```
<openidConnectClient id="RPssl" inboundPropagation="required"
    signatureAlgorithm="RS256" trustAliasName="JWT-Signer"
    trustStoreRef="jwtTrustStore"
     userIdentityToCreateSubject="sub" mapIdentityToRegistryUser="false"
    issuerIdentifier="https://wg31.washington.ibm.com:26213/oidc/endpoint/OPssl"
    authnSessionDisabled="true" audiences="myZcee"/>
```

- ***inboundPropagation*** is set to required to allow z/OS Connect EE to use the received JWT as an authentication token
- ***signatureAlgorithm*** specifies the algorithm to be used to verify the JWT signature
- ***trustStoreRef*** specifies the name of the keystore element that defines the location of the validating certificate
- ***trustAliasName*** gives the alias or label of the certificate to be used for signature validation
- ***userIdentityToCreateSubject*** indicates the claim to use to create the user subject
- ***mapIdentityToRegistryUser*** indicates whether to map the retrieved identity to the registry user
- ***issuerIdentifier*** defines the expected issuer
- ***authnSessionDisabled*** indicates whether a WebSphere custom cookie should be generated for the session
- ***audiences*** defines a list of target audiences

mitchj@us.ibm.com

Use authorization filters to associate request for security configurations

Authentication filter can be used to filter criteria that are specified in the **authFilter** element to determine whether certain requests are processed by certain providers, such as OpenID Connect, for authentication.

```
<openidConnectClient id="RPssl" inboundPropagation="required"
     signatureAlgorithm="RS256" trustAliasName="JWT-Signer"
     trustStoreRef="jwtTrustStore"
      userIdentityToCreateSubject="sub" mapIdentityToRegistryUser= "true"
     issuerIdentifier="https://wg31.washington.ibm.com:26213/oidc/endpoint/OPssl"
     authnSessionDisabled="true" audiences="myZcee"
     authFilterRef="JwtAuthFilter"/>
<openidConnectClient id="RPsslG" . . . authFilterRef= "API Gateway"/>
<openidConnectClient id="RPsslURL" . . . authFilterRef= "URLFilter"/>
<authFilter id="API Gateway">
     <remoteAddress id="ApiAddress" ip="10.7.1.*" matchType="equals"/>
</authFilter>
<authFilter id="URLFilter">
      <requestUrl id="URL"  urlPattern="/cscvinc/employee/|/db2/employee|/mqapi/loan"/>"
          matchType="equals"/> </authFilter>
<authFilter id="JwtAuthFilter" >
  <requestHeader id="authHeader" name="Authorization" value="Bearer" matchType="contains"/>
</authFilter>
```

Some alternative filter types

- A ***remoteAddress*** element is compared against the TCP/IP address of the client that sent the request.
- The ***host*** element is compared against the "Host" HTTP request header, which identifies the target host name of the request.
- The ***requestUrl*** element is compared against the URL that is used by the client application to make the request.

mitchj@us.ibm.com

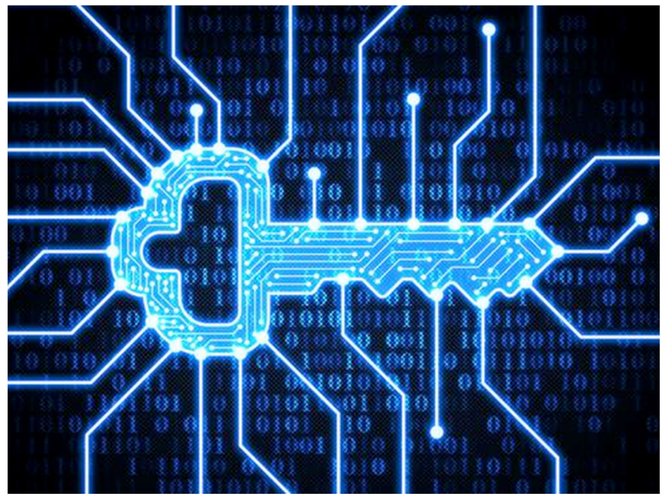
General security terms or considerations

Security involves

- Identifying who or what is requesting access (**Authentication)**
  - Basic Authentication
  - Mutual Authentication using Transport Layer Security (TLS), formerly known as SSL
  - Third Party Tokens

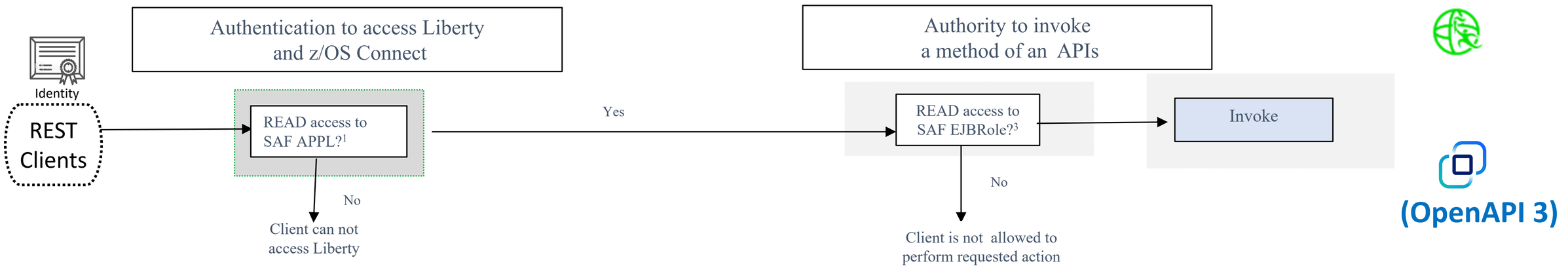
- Ensuring that the message has not been altered in transit (**Data Integrity)** and ensuring the confidentiality of the message in transit (**Encryption)**
  - TLS (encrypting messages and using a digital signature)

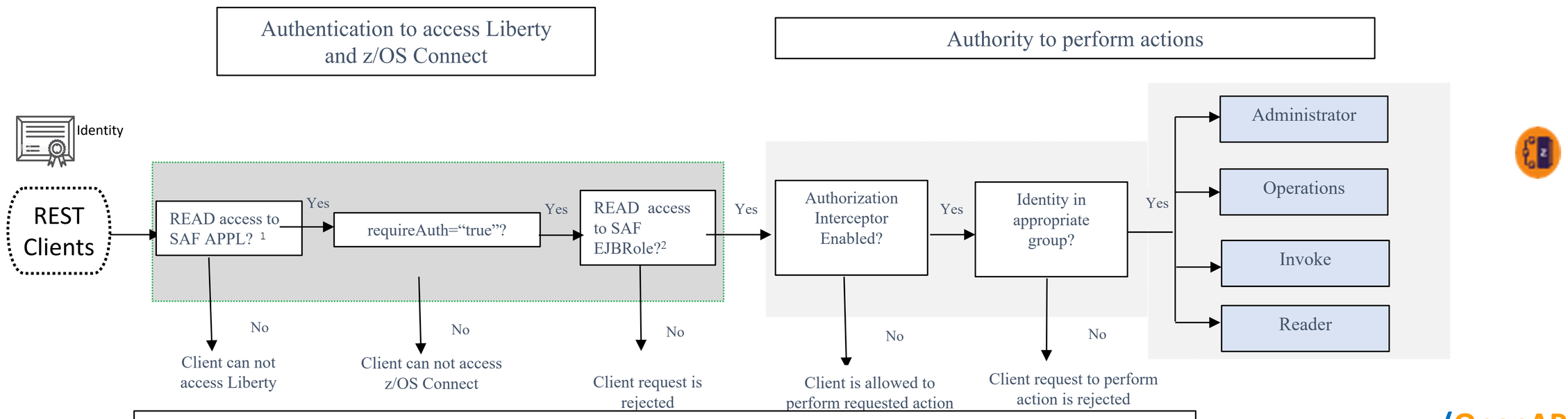
- Controlling access (**Authorization)**
  - Is the authenticated identity authorized to access to z/OS Connect
  - Is the authenticated identity authorized to access a specific API, Services, etc.



mitchj@us.ibm.com

Security flow – authentication/authorization





[1]RDEFINE APPL *profilePrefix*
[2]**RDEFINE EJBROLE *profilePrefix*.zos.connect.access.roles.zosConnectAccess**
[3]**REDFINE EJBROLE *profilePrefix.resourceName.role***

[1] mitchj@us.ibm.com

Security for OpenAPI 3 z/OS Connect APIs is configured using Liberty elements

```
<safCredentials unauthenticatedUser="WSGUEST" profilePrefix="BBGZDFLT" />

<webApplication id="catalogManager" name="catalogManager"
                location="${server.config.dir}/apps/api.war" contextRoot="/catalogManager" />

<safRoleMapper profilePattern=%profilePrefix%.%resourceName%.%role%
```

The *name* attribute of the webApplication for the deployed WAR file determines the name of the EJBRoles used manage access to the API's methods.

*From the example 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

API Requester – authorization (OpenAPI 3 only)

```
<safCredentials unauthenticatedUser="WSGUEST" profilePrefix="BBGZDFLT" />

<safRoleMapper profilePattern=%profilePrefix%.%resourceName%.%role%

<webApplication location="${server.config.dir}/apps/cscvinc.war">
   <appProperties> <property name="connectionRef" value="cscvincConnection"/> </appProperties>
</webApplication>

<webApplication name="catalogManager" location="${server.config.dir}/apps/catalog.war">
   <appProperties> <property name="connectionRef" value="catalogConnection"/> </appProperties>
</webApplication>
```

The *resourceName* defaults to the name of the WAR file if no name attribute is provided, otherwise the ***resourceName*** is value of the *name* attribute.

So, the required SAF EJB roles to be defined would be (*invoke* is the only role).

- *BBGZDFLT.**cscvinc**.**invoke***
- *BBGZDFLT.**catalogManager**.**invoke***

Authorization to invoke the API requester would require that the authenticated identity be a member of the STAFFGROUP or identity FRED.

mitchj@us.ibm.com

Security for MQ Console and REST

/usr/lpp/mqm/web/mq/etc/mqweb.xml

```
<enterpriseApplication id="com.ibm.mq.console" location="${wlp.install.dir}/mq/apps/com.ibm.mq.webconsole.ear"
name="com.ibm.mq.console" . . .
</enterpriseApplication>

 <enterpriseApplication id="com.ibm.mq.rest" location="${wlp.install.dir}/mq/apps/com.ibm.mq.rest.ear"
   name="com.ibm.mq.rest"  . . .
 </enterpriseApplication>
```

/var/mqm/servers/mqweb/mqwebuser.xml

<safCredentials profilePrefix="**MQWEB**" unauthenticatedUser="WSGUEST"/

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

- REDFINE EJBROLE *MQWEB.com.ibm.mq.console.MQWebAdmin*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.console.MQWebAdminRO*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.console.MQWebUser*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.rest.MFTWebAdmin*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.rest.MFTWebAdminRO*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.rest.MQWebAdmin*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.rest.MQWebAdminRO*
- REDFINE EJBROLE *MQWEB.com.ibm.mq.rest.MQWebUser* .

https://www.ibm.com/docs/en/ibm-mq/9.3?topic=roles-mq-console-rest-api

mitchj@us.ibm.com

z/OS Connect authentication/authorization is based on group access

z/OS Connect uses group security for controlling authorization for accessing APIs. There are sets of default global groups for functional roles are configured in a zosConnectManager configuration element as shown below:

```
<zosconnect_zosConnectManager
          globalInterceptorsRef="interceptorList_g"
          globalAdminGroup="SYSPGRP " globalOperationsGroup="GBLOPERS"
          globalInvokeGroup="GBLINVKE" globalReaderGroup="GBLRDR"/>
```

There are four classes of groups available controlling z/OS Connect functions, administration, operations, invoking and reader in our server. An authenticated identity membership in one or more of these groups provides access to the corresponding function to that identity.

There is also a way to provide an alternative set of groups for functional roles for specific APIs, services, and API requesters in subordinate configuration elements in our server.

```
<zosConnectAPI name="cscvinc"
        adminGroup="CSCADMIN"  operationsGroup="CSCOPERS"
        invokeGroup="CSCINVKE" readerGroup="CSCREADR"/>

<service name="cscvincSelectService"
        adminGroup="CSCADMIN"  operationsGroup="CSCOPERS"
        invokeGroup="CSCINVKE" readerGroup="CSCREADR"/>

<apiRequester name="cscvinc_1.0.0"
        adminGroup="CSCADMIN"  operationsGroup="CSCOPERS"
        invokeGroup="CSCINVKE" readerGroup="CSCREADR"/
```

[1] mitchj@us.ibm.com

z/OS Connect interceptors - server XML example

```
<zosconnect_zosConnectManager
         globalInterceptorsRef="interceptorList_g"
         globalAdminGroup="SYSPGRP"
         globalOperationsGroup="GBLOPERS"
         globalInvokeGroup="GBLINVKE"
         globalReaderGroup="GBLRDR"/>

<zosconnect_authorizationInterceptor id="auth"/>
<zosconnect_auditInterceptor id="audit"/>
<zosconnect_zosConnectInterceptors id="interceptorList_g"
       interceptorRef="auth"/>
<zosconnect_zosConnectInterceptors id="interceptorList_a"
       interceptorRef="auth,audit"/>

<zosconnect_zosConnectAPIs>
   <zosConnectAPI name="catalog"
       runGlobalInterceptorsRef="true"
       adminGroup="aapigrp1,aapigrp2"
       operationsGroup="oapigrp1,oapigrp2"
       invokeGroup="iapigrp1,oapigrp2"
       readerGroup="rapigrp1,rapigrp2"/>
</zosconnect_zosConnectAPIs>

<zosconnect_apiRequesters>
   <apiRequester name="cscvincapi_1.0.0"
       runGlobalInterceptorsRef="false"
       interceptorsRef="interceptorList_a"
       adminGroup="aaprgrp1,aaprgrp2"
       operationsGroup="oaprgrp1,oaprgrp2"
       invokeGroup="iaprgrp1,oaprgrp2"
       readerGroup="raprgrp1,raprgrp2"/>
</zosconnect_apiRequesters>

<zosconnect_services>
  <service id="selectByEmployee" name="selectEmployee"
       runGlobalInterceptorsRef="false"
       interceptorsRef="interceptorList_a"
       adminGroup="asrvgrp1,asrvgrp2"
       operationsGroup="osrvgrp1,osrvgrp2"
       invokeGroup="isrvgrp1,isrvgrp2"
       readerGroup="rsrvrgrp1,rsrvgrp2"/>
</zosconnect_services>
```

Global interceptor list – authorization interceptor only

Alternative interceptor list – authorization and audit interceptors

This avoids duplication of interceptors

Note that these are z/OS Connect configuration elements. Documented in the z/OS Connect KC

[1] mitchj@us.ibm.com

z/OS Connect OpenAPI 2 RESTful Administrative APIs

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

[1] mitchj@us.ibm.com

z/OS Connect Authorization Functions

Operations - Ability to perform all z/OS Connect EE operations and actions except for function *Invoke*. The following operations/actions are allowed:

APIs:

- *To obtain a list of all APIs (GET).**
- For a specific API, get its details and API Swagger document (GET) and *deploy (POST)*,* update (PUT), start(PUT), stop(PUT), and delete(DELETE) it.

Services:

- *To obtain a list of all services or statistics for all services (GET).**
- For a specific service, get its details, request and response schemas, statistics (GET) and *deploy(POST)*,* update(PUT), start(PUT), stop(PUT), and delete(DELETE) it.

API Requesters:

- *To obtain a list of all API requesters* (GET).*
- For a specific API requester, get its details (GET) and *deploy (POST)*,* update(PUT), start(PUT), stop(PUT), and delete(DELETE) it.

*These APIs use either the POST or GET method to invoke the REST APIs whose URIs have no path parameter. Therefore, the name of the API, or service or API Requester is not available. For authorization, only the default or global groups list can be used since no specific group list can be determined (for deployment, the name is embedded in the archive file).

mitchj@us.ibm.com

z/OS Connect Authorization Levels

Reader - Ability for:

APIs:

- *To obtain a list of all APIs* (GET) .*
- For a specific API, get its details and API Swagger document (GET).

Services:

- *To obtain a list of all services* (GET). *
- For a specific service, get its details and request and response schemas (GET).

API Requesters:

- *To obtain a list of all API requesters* (GET).*
- For a specific API requester, get its details (GET) .

Invoke - Ability to invoke user APIs, services and/or API requesters (POST,PUT,GET,DELETE,+).

Admin - All z/OS Connect EE actions are allowed, including all corresponding *Operations*, *Invoke*, and *Reader* actions configured for the same z/OS Connect resource.

*These APIs use either the POST or GET method to invoke the REST APIs whose URIs have no path parameter. Therefore, the name of the API, service or API Requester is not available. For authorization, only the default or global groups list since no specific group list can be determined (for deployment, the name is embedded in the archive file.

mitchj@us.ibm.com

Example of z/OS Connect Authorization Levels

(this config has issues)

```
<zosconnect_zosConnectManager
         globalInterceptorsRef="interceptorList_g"
         globalAdminGroup="SYSPGRP" globalOperationsGroup="GBLOPERS"
         globalInvokeGroup="GBLINVKE" globalReaderGroup="GBLRDR"/>

<zosconnect_zosConnectAPIs>
    <zosConnectAPI name="cscvinc"
        adminGroup="CSCADMIN"  operationsGroup="CSCOPERS"
        invokeGroup="CSCINVKE" readerGroup="CSCREADR"/>
    <zosConnectAPI name="db2employee"
        adminGroup="DB2ADMIN"  operationsGroup="DB2OPERS"
        invokeGroup="DB2INVKE" readerGroup="DB2READR"/>
</zosconnect_zosConnectAPIs>

<zosconnect_services>
    <service name="cscvincSelectService"
        adminGroup="CSCADMIN"  operationsGroup="CSCOPERS"
        invokeGroup="CSCINVKE" readerGroup="CSCREADR"/>
    <service name="selectEmployee"
        adminGroup="DB2ADMIN"  operationsGroup="DB2OPERS"
        invokeGroup="DB2INVKE" readerGroup="DB2READR"/>
</zosconnect_services>

<zosconnect_apiRequesters>
    <apiRequester name="cscvincSelectService"
        adminGroup="CSCADMIN"  operationsGroup="CSCOPERS"
        invokeGroup="CSCINVKE" readerGroup="CSCREADR"/>
    <apiRequester name="selectEmployee"
        adminGroup="DB2ADMIN"  operationsGroup="DB2OPERS"
        invokeGroup="DB2INVKE" readerGroup="DB2READR"/>
</zosconnect_apiRequesters>
```

This works as you expect once the artifacts are deployed but:

- Only members of groups SYSPGRP, GBLOPERS or GBLRDR can connect to a z/OS server from the API toolkit (the tooling attempts a GET request for a list of all deployed services and APIs).
- Only members of groups SYSPGRP or GBLOPERS can deploy new z/OS Connect API, service or API requester artifacts (POST access for operations is not available until after the artifact is deployed)

Tech-Tip: When groups are specified for zosConnectAPI, service, or apiRequester configuration elements, the global groups are ignored for certain functions. Other functions, e.g., deploy new artifact, get a list or service statistics, only use the global group membership.

[1] mitchj@us.ibm.com

z/OS Connect Authorization Summary (OpenAPI 2)

- Members of groups SYSPGRP, GBLOPERS, DB2ADMIN or DB2OPERS can not manage (e.g., change, stop or delete) z/OS Connect artifacts managed by group CSCOPERS or CSCADMIN.
- Members of groups SYSPGRP, GBLOPERS, CSCADMIN or CSCOPERS can not manage (e.g., change, stop or delete) z/OS Connect artifacts managed by group DB2OPERS or DB2ADMIN.
- Only members of group CSCADMIN, CSCINV, DB2ADMIN or DB2INVKE can invoke the artifacts defined in the subordinate element:
- Members of group CSCADMIN or CSCVINKE can invoke artifacts managed by CSCINVKE
- Members of group DB2ADMIN or DB2INVKE can invoke artifacts managed by DB2INVKE
- Members of groups SYSPGRP or GBLINVKE can not invoke any artifacts protected these specific subordinate groups.
- Only members of groups SYSPGRP, GBLOPERS or GBLRDR can connect to a z/OS server from the API toolkit.
- Only members of groups SYSPGRP or GBLOPERS can deploy new z/OS Connect API, service or API requester artifacts.

mitchj@us.ibm.com

Tech-Tip: Solution for z/OS Connect Authorization Levels (OpenAPI 2)

```
<zosconnect_zosConnectManager
         globalInterceptorsRef="interceptorList_g"
         globalAdminGroup="SYSPGRP" globalOperationsGroup="GBLOPERS,CSCOPERS,DB2OPERS"
         globalInvokeGroup="GBLINVKE" globalReaderGroup="GBLRDR"/>

<zosconnect_zosConnectAPIs>
    <zosConnectAPI name="cscvinc" operationsGroup="CSCOPERS" invokeGroup="CSCINV"/>
    <zosConnectAPI name="db2employee" operationsGroup="DB2OPERS‟ invokeGroup="DB2INVKE"/>
</zosconnect_zosConnectAPIs>

<zosconnect_services>
    <service name="cscvincSelectService" operationsGroup="CSCOPERS" invokeGroup="CSCINV"/>
    <service name="selectEmployee" operationsGroup="DB2OPERS" invokeGroup="DB2INVKE"/>
</zosconnect_services>

<zosconnect_apiRequesters>
    <apiRequester name="cscvincSelectService" operationsGroup="CSCOPERS" invokeGroup="CSCINV"/>
    <apiRequester name="selectEmployee" operationsGroup="DB2OPERS" invokeGroup="DB2INVKE"/>
</zosconnect_apiRequesters>
```

- Now members of groups SYSPGRP, GBLOPERS,CSCOPERS, DB2OPERS and GBLRDR can connect to a z/OS server from the API toolkit.
- Members of groups SYSPGRP, GBLOPERS,CSCOPERS, and DB2OPERS can deploy new artifacts.
- Only members of group CSCOPERS and DB2OPERS can manage artifacts after they are deployed.

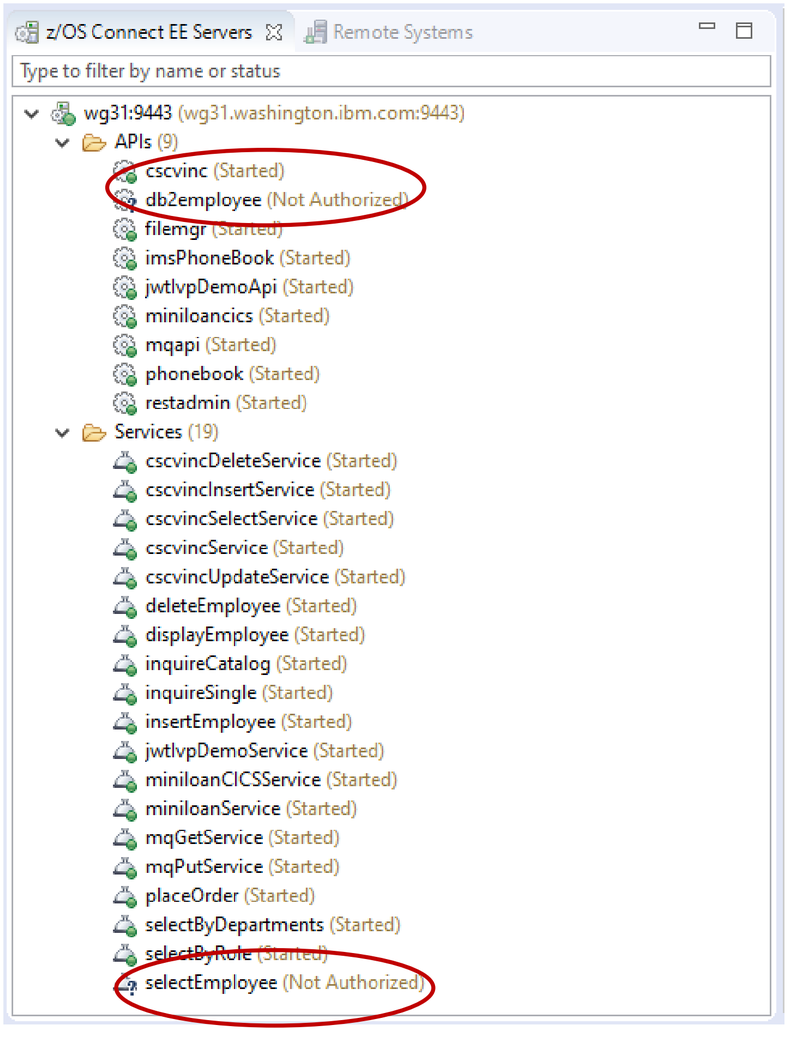
[1] mitchj@us.ibm.com

When a partial list of subordinate groups are provided, the corresponding default global groups for the absence groups are used.

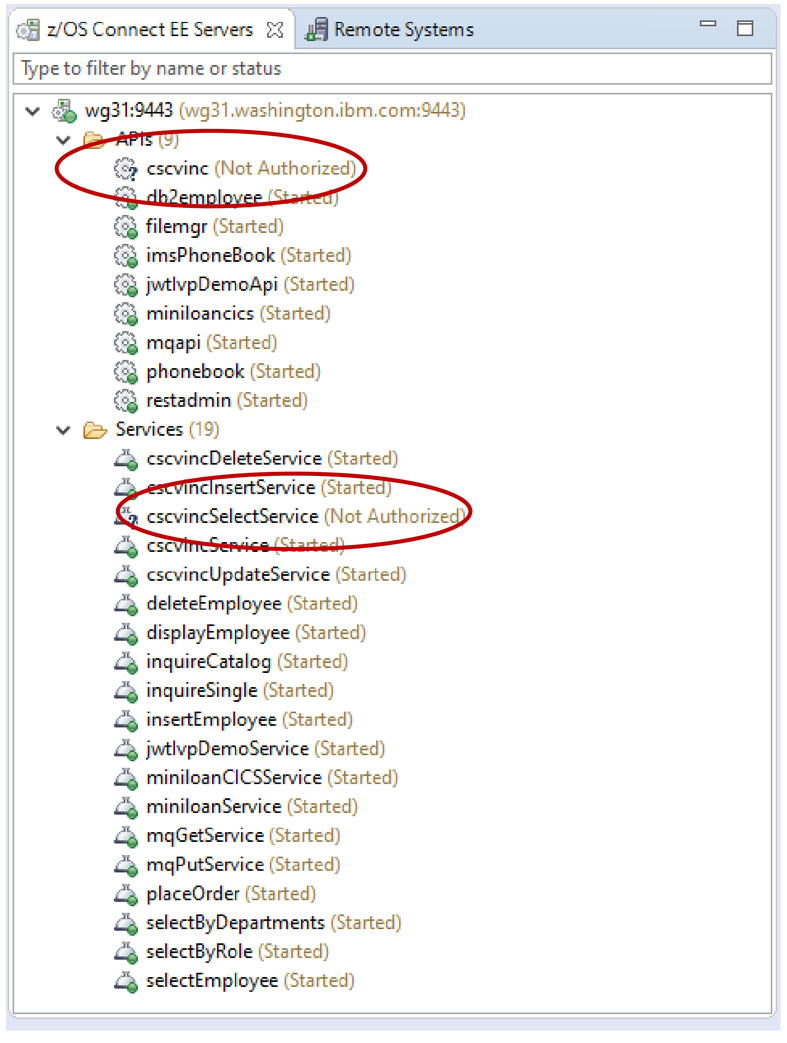
Tech-Tip: z/OS Toolkit and authorization status (OpenAPI 2)

Members of CSCOPERS and DB2OPERS can now connect to a server from the API Toolkit

CSCOPERS



DB2OPERS



[1] mitchj@us.ibm.com

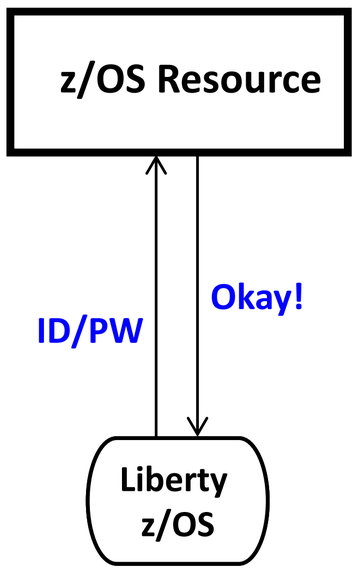
Security when accessing z/OS subsystems

mitchj@us.ibm.com

Accessing z/OS resources

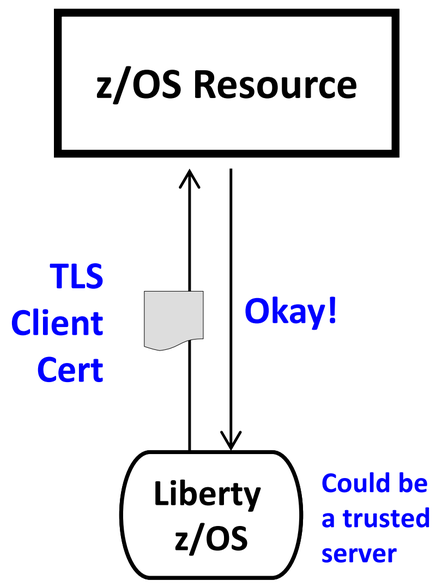
Several different ways this can be accomplished:

Basic Authentication



Liberty supplies ID/PW or ID/PassTicket

Client Certificate



Server prompts for certificate

Liberty supplies certificate

mitchj@us.ibm.com

Liberty Basic authentication - Identity and Password

Server XML Configuration elements where basic authentication can be provided.

```
<resourceAdapter autoStart="true" id="eciResourceAdapter" location="/usr/lpp/cicstg/ctg93/deployable/cicseci.rar"/>
<library id="DB2JCCLib">
   <fileset dir=“/usr/lpp/db2/jdbc/classes includes="db2jcc4.jar db2jcc_license_cisuz.jar"/>
</library>

<connectionFactory id=“cics">
<properties.eciResourceAdapter connectionURL=“tcp://wg31.Washington.ibm.com” port=“2006” serverName=“CICSZ” userName="identity"
password="password"/>
</connectionFactory>

<connectionFactory id="imsTM"> containerAuthDataRef=“IMScredentials">
<authData id=“IMScredentials" user= "identity" password= "password"/>

<connectionFactory id="imsDB">
<properties.imsudbJLocal  databaseName="DFSIVPA"   user="identity" password="password"/>
</connectionFactory>

<jmsQueueConnectionFactory jndiName=“MQ“>
            <properties.wasJms userName=“identity" password=“password"   />
</jmsQueueConnectionFactory>

<dataSource id="DefaultDataSource" jndiName="jdbc/db2"">
<jdbcDriver libraryRef="DB2JCCLib"/>
   <properties.db2.jcc databaseName="SAMPLEDB" serverName="localhost" portNumber="50000"
         user=“identity" password="password"/>
</dataSource>
```

mitchj@us.ibm.com

The value of the password can be encoded in the server XML configuration file. Using the ***securityUtility*** shipped with WebSphere Liberty Profile.

z/OS Connect Basic authentication - Identity and Password

Server XML Configuration elements where basic authentication can be provided.

```
<connectionFactory id="imsTM"> containerAuthDataRef=“IMScredentials">
<authData id=“IMScredentials" user= "identity" password= "password"/>

<connectionFactory id="imsDB">
<properties.imsudbJLocal  databaseName="DFSIVPA"   user="identity" password="password"/>
</connectionFactory>

<jmsQueueConnectionFactory jndiName=“MQ“>
          <properties.wasJms userName=“identity" password=“password"   />
</jmsQueueConnectionFactory>

<zosconnect_cicsIpicConnection id="CICS"  authDataRef=“CICScredentials"/>
<zosconnect_authData id=“CICScredentials" user= "identity" password= "password"/>

<zosconnect_zosConnectServiceRestClientConnection id="Db2" basicAuthRef=“db2Auth"/>
<zosconnect_zosConnectServiceRestClientBasicAuth id="db2Auth"
    userName="identity"  password="password"/>

<zosconnect_db2Connection id="Db2" host=“wg31.Washington.ibm.com” port=‘2446”
    userName="identity"  password="password"/>
```

The value of the password can be encoded in the server XML configuration file. Using the ***securityUtility*** shipped with WebSphere Liberty Profile.

mitchj@us.ibm.com

Using securityUtility to encrypt passwords

Best practice : use encryption for passwords instead of base64 encoding

- **securityUtility** – located in <wlp_install_dir>/wlp/bin Usage: securityUtility {encode|createSSLCertificate|help} [options]
  - For encryption, use encode --key=encryption_key
    - Specifies the key to be used when encoding using AES encryption. This string is hashed to produce an encryption key that is used to encrypt and decrypt the password. The key can be provided to the server by defining the variable **wlp.password.encryption.key** whose value is the key. If this option is not provided, a default key is used.

    ./securityUtility encode --encoding=aes --key=myKey myPassWord

    {aes}AHO0aXdiVD96u4oMRhoKeYH3U7aDqtFXTuHFBsO98Wlb
  - Support was added at Liberty 22.0.0.1 for storing an AES password encryption key in a SAF key ring, see URL https://www.ibm.com/docs/en/was-liberty/zos?topic=slia-storing-aes-password-encryption-key-in-saf-key-ring

    ./securityUtility encode --encoding=aes --keyring=safkeyring://JOHNSON/Liberty.KeyRing --keyringType=JCERACFKS
    --keyLabel="Johnson Client Cert" myPassWord
  - Also supports 1-way hash encoding – for passwords in server.xml with basicRegistry
    - For hash, use encode –encoding=hash

    ./securityUtility encode –-encoding=hash XXXXXXXX

    {hash}ATAAAAAIcqTmHn5qZahAAAAAIMjzy+hP8YFaIO6LiCreVe4etRLUS9a25eVuYtx6WKiv

See the WebSphere Application Server for z/OS Liberty *securityUtility* command at URL:
https://www.ibm.com/docs/en/was-liberty/zos?topic=applications-securityutility-command

mitchj@us.ibm.com

Tech-Tip: Sample JCL - Executing the Liberty *securityUtility* command

```
//*************************************************************
//* Use securityUtility to encrypt a password using an
//* encryption key of a certificate
//*************************************************************
//IKJEFT01 EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *
BPXBATCH SH +
/usr/lpp/IBM/zosconnect/v3r0/wlp/bin/securityUtility encode +
--encoding=aes +
--keyring=safkeyring://JOHNSON/Liberty.KeyRing +
--keyringType=JCERACFKS --keyLabel="Johnson Client Cert" +
passwordToEncrypt
```

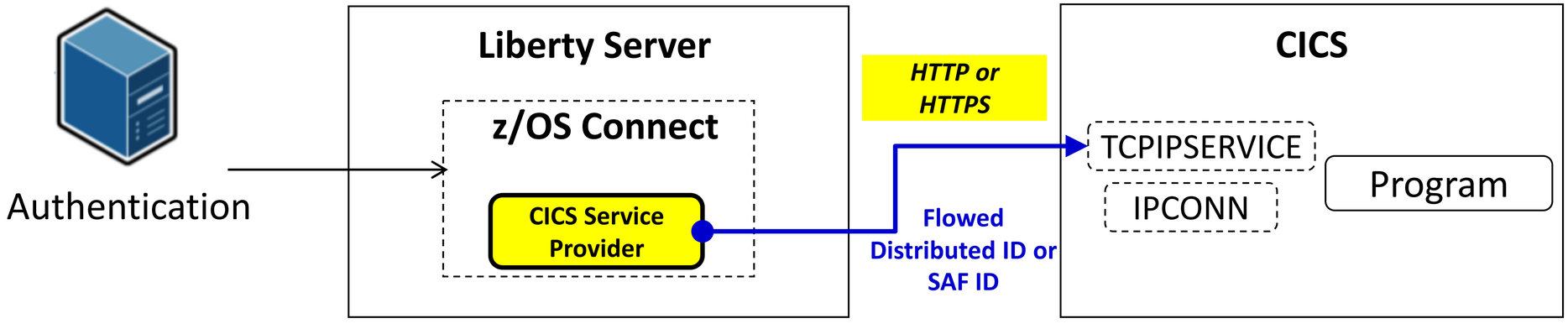
```
<featureManager>
 <feature>zosPasswordEncryptionKey-1.0</feature>
</featureManager>

<zosPasswordEncryptionKey
keyring="safkeyring://JOHNSON/Liberty.KeyRing"
label="Johnson Client Cert" type="JCERACFKS"/>
```

```
//*************************************************************
//* Use securityUtility to encrypt a password using an
//* encryption key string
//*************************************************************
//IKJEFT01 EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *
BPXBATCH SH +
/usr/lpp/IBM/zosconnect/v3r0/wlp/bin/securityUtility encode +
--encoding=aes -key myEncryptionKey +
passwordToEncrypt
```

```
wlp.password.encryption.key=myEncryptionKey
```

mitchj@us.ibm.com

Flowing a user ID with CICS service provider



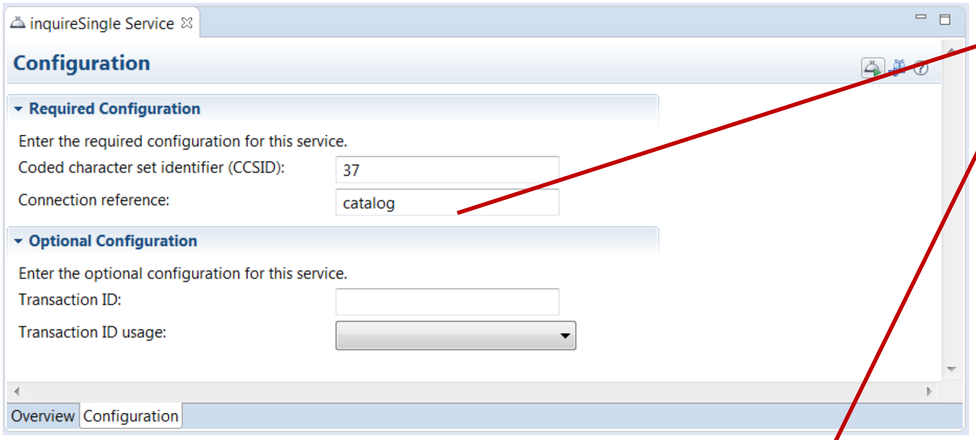
Distributed identities can be propagated to CICS and then mapped to a RACF user ID by CICS. You can then view the distinguished name and realm for a distributed identity in the association data of the CICS task. **Important**: If the z/OS Connect server is not in the same Sysplex as the CICS system, you must use an IPIC TLS (JSSE) connection that is configured with client authentication.

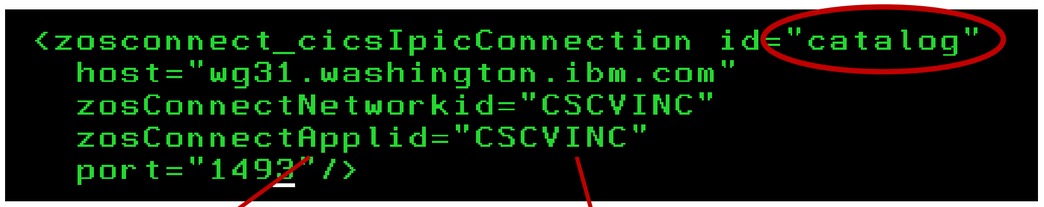
If a SAF ID is used for authentication (e.g., basic authentication with a SAF registry) then the SAF ID is passed to CICS.

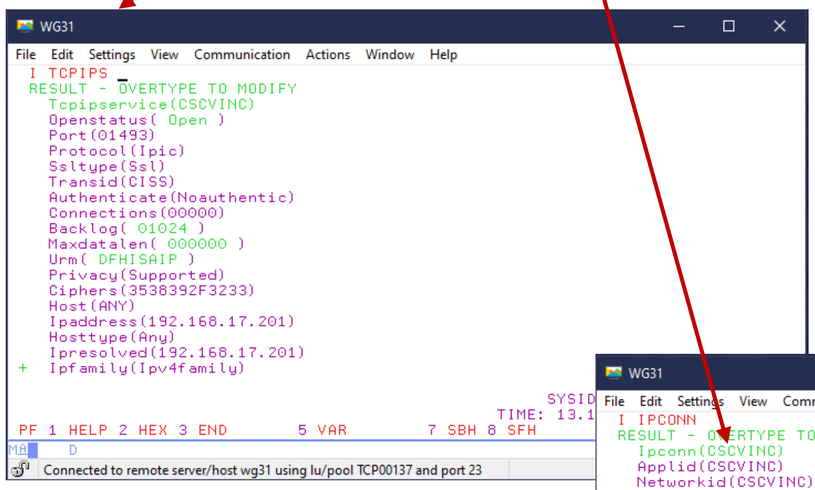
[1] mitchj@us.ibm.com

Flowing an identity to CICS

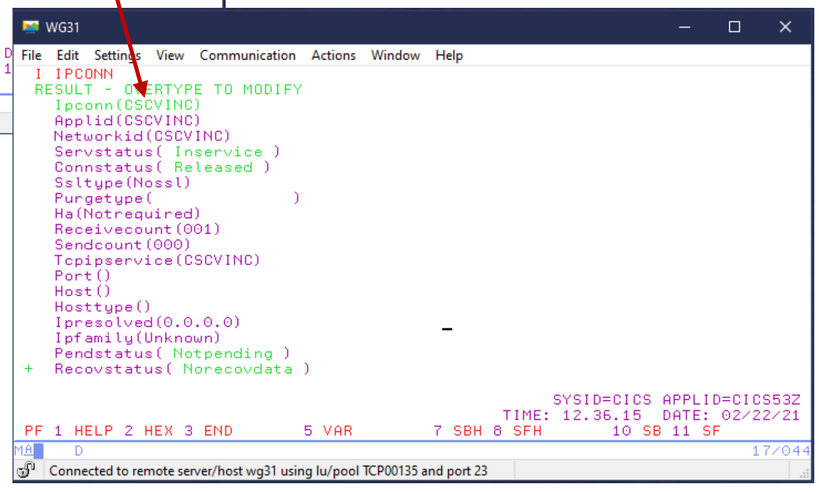
The zosconnect_cicsIpicConnection element is the key :



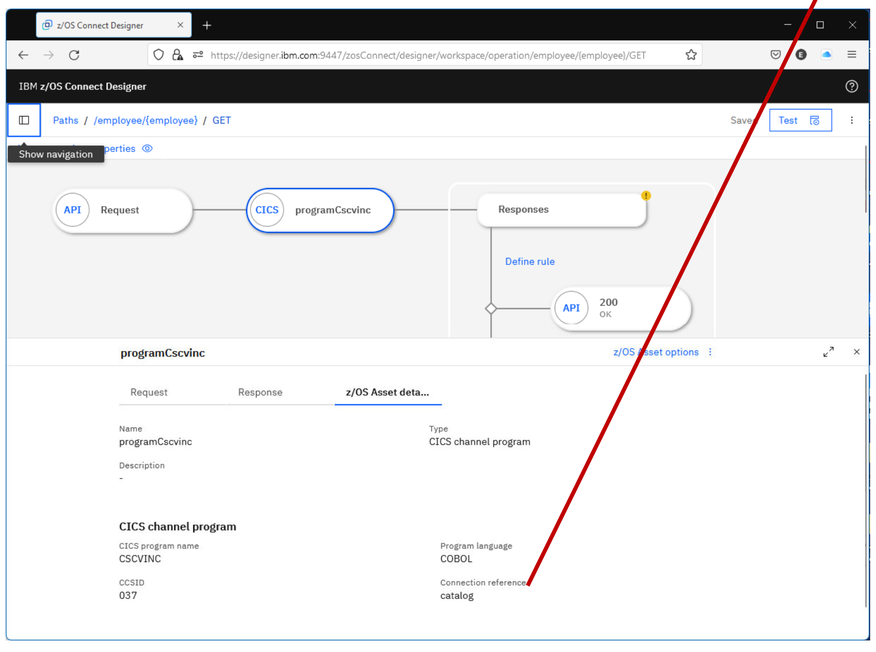




CICS TCPIPService

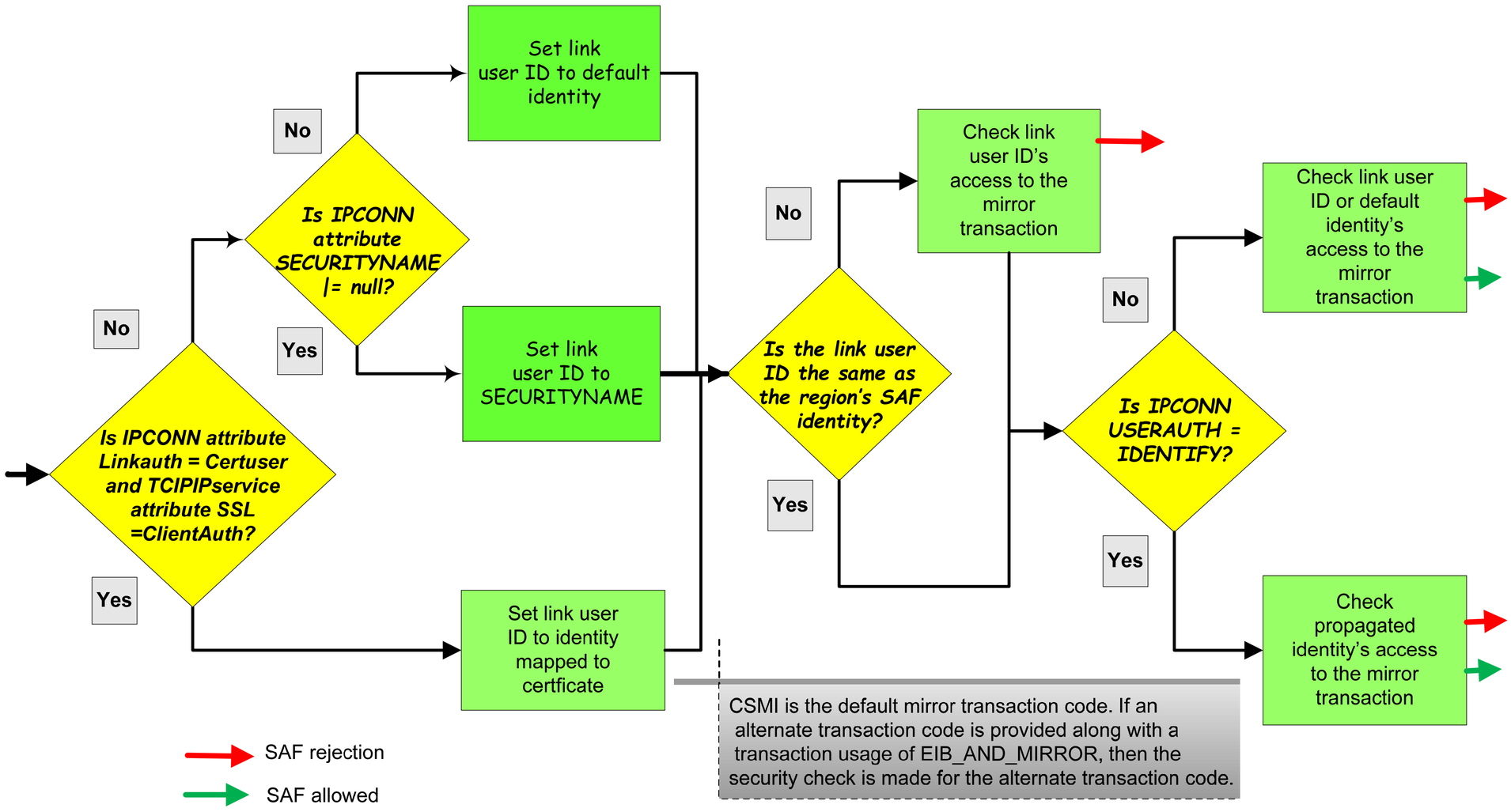


CICS IPCONN



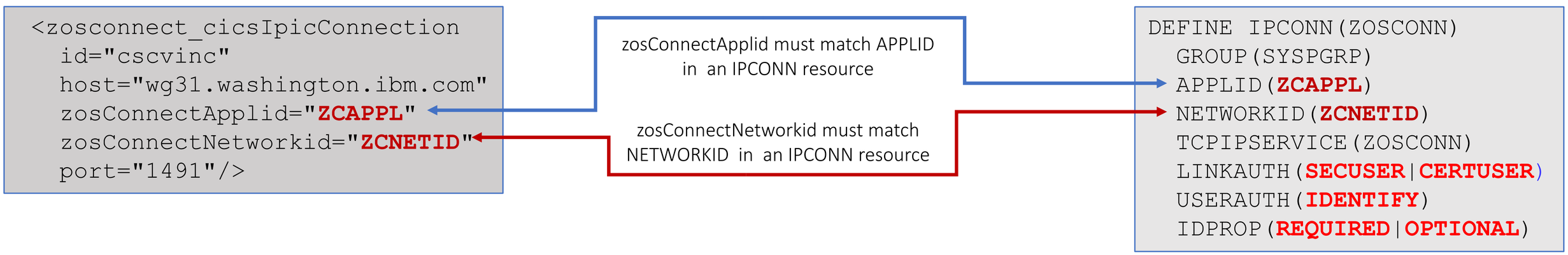
mitchj@us.ibm.com

Tech/Tip: CICS IPIC Security with USERAUTH(IDENTIFY)



mitchj@us.ibm.com

CICS IPCONN Resources



LINKAUTH Determines the user identity to be used for link security. The value is either ***CERTUSER*** or ***SECUSER***. A value of ***CERTUSER*** sets the link identity to the identity associated with the client certificate received from the client endpoint (TLS mutual authentication is required). A value of ***SECUSER*** sets the link identity to the value of the *SECURITYNAME* attribute as defined in the IPCONN resource.

USERAUTH Identifies how the identity under which the attached transaction attach security will run. Since a password is not available, a value of ***VERIFY*** is not possible. A value of ***LOCAL*** means the current link identity is used. A value of ***DEFAULTUSER*** means the CICS default identity is used. For identity propagation purposes, the value of **USERAUTH** should be ***IDENTIFY*** (no password will be required) so the identity provided by the client is used for executing the attached transaction. TLS must be used if the client is in a different Sysplex.

IDPROP Determines whether the original distributed identity authenticated by the z/OS Connect server is also propagated to CICS in addition to the mapped identity used for z/OS Connect authorization checks. A value of ***NOTALLOWED*** does not propagate the original distributed identity. A value of ***OPTIONAL*** will propagate to CICS the original distributed identity, if available. A value of ***REQUIRED*** requires that the original distributed identity be propagated to CICS. TLS must be used if the client is in a different Sysplex.

CERTIFICATE Provides the label of the certificate connected to the CICS key ring to be used for server endpoint certificate during a TLS handshake.

mitchj@us.ibm.com

Identity Propagation and CICS High Availability

Assume the service installed in a server files use the following *Connection reference* values:
- cscvinc
- catalog
- miniloan

If identity propagation is required for all connection, then the CICS IPCONN resources defined in the CICs that correspond to a zosconnect_cicsIpicConnection configuration elements must be dedicated to that z/OS Connect server and connection reference can not be reused.

Simplify administration by still sharing a common cicsIpicConnection XML configuration element by using variables and a bootstrap properties file or "variables" XML file

Server baqsvr1's bootstrap.properties

```
ipicPort=1491
cicsHost=dvipa.washington.ibm.com
serverPrefix=baqsvr1
```

Server baqsvr2's bootstrap.properties

```
cicsHost=dvipa.washington.ibm.com
ipicPort=1491
serverPrefix=baqsvr2
```

Server baqsvr3's bootstrap.properties

```
cicsHost=dvipa.washington.ibm.com
ipicPort=1491
serverPrefix=baqsvr3
```

ipicIDProp.xml

```
<zosconnect_cicsIpicConnection id="cscvinc"
  host="${cicsHost}"
  zosConnectNetworkid="${wlp.server.name}"        → baqsvr1 or baqsvr2
  zosConnectApplid="${wlp.server.name}"
  sharedPort="true" port="${ipicPort}"/>
<zosconnect_cicsIpicConnection id="catalog"
  host="${cicsHost}"
  zosConnectNetworkid="${serverPrefix}C"          → baqsvr1C or baqsvr2C
  zosConnectApplid="${serverPrefix}C"
  sharedPort="true" port="${ipicPort}"/>
<zosconnect_cicsIpicConnection id="miniloan"
  host="${cicsHost}"
  zosConnectNetworkid="${serverPrefix}M"          → baqsvr1M or baqsvr2M
  zosConnectApplid="${serverPrefix}M"
  sharedPort="true" port="${ipicPort}"/>
```

mitchj@us.ibm.com

Tech-Tip: CICS IPCONN and TCPIPService resources for HA

CICS Specific TCPIPService - IPIC

```
TCpipservice    : IPIC[1]
GROup           : SYSPGRP
Urm          ==> DFHISAIP
POrtnumber   ==> 01492
STatus       ==> Open
PROtocol     ==> IPic
TRansaction  ==> CISS
Host         ==> ANY
Ipaddress    ==> ANY
SPeciftcps   ==>
```

CICS Generic TCPIPService - IPICG

```
TCpipservice    : IPICG[1]
GROup           : SYSPGRP
Urm          ==> DFHISAIP
POrtnumber   ==> 01491
STatus       ==> Open
PROtocol     ==> IPic
TRansaction  ==> CISS
Host         ==> ANY
Ipaddress    ==> ANY
SPeciftcps   ==> IPIC
```

A client connects first to the CICS region's generic port (1491) and then the CICS region redirects the client to the region's specific port (1492).

```
I IPCONN ACQ
STATUS:  RESULTS - OVERTYPE TO MODIFY
 Ipc(BAQSVR1 ) App(BAQSVR1 ) Net(BAQSVR1 ) Ins Acq Nos
       Rece(001) Sen(000) Tcp(IPIC     )
 Ipc(BAQSVR1C) App(BAQSVR1C) Net(BAQSVR1C) Ins Acq Nos
       Rece(001) Sen(000) Tcp(IPIC     )
 Ipc(BAQSVR1M) App(BAQSVR1M) Net(BAQSVR1M) Ins Acq Nos
       Rece(001) Sen(000) Tcp(IPIC     )
 Ipc(BAQSVR2 ) App(BAQSVR2 ) Net(BAQSVR2 ) Ins Acq Nos
       Rece(001) Sen(000) Tcp(IPIC     )
 Ipc(BAQSVR2C) App(BAQSVR2C) Net(BAQSVR2C) Ins Acq Nos
       Rece(001) Sen(000) Tcp(IPIC     )
 Ipc(BAQSVR2M) App(BAQSVR2M) Net(BAQSVR2M) Ins Acq Nos
       Rece(001) Sen(000) Tcp(IPIC     )
```

Number of IPCONN resources equals the number of zCEE server times the number of unique connection references

[1]CICS requires the specific TCPIPService be installed before the corresponding generic TCPIPService resource. TCPIPServices are installed in alphabetically order, so the name of specific service must be alphabetically prior to the name of the generic TCPIPService.

mitchj@us.ibm.com

CICS IPIC connection processing for high availability load balancing*

If the *reconnectInterval* attribute is set, at the specified time interval, a check is made to see if a new connection attempt should be attempted

A new connection is established if the current connection properties are not the preferred connection properties:

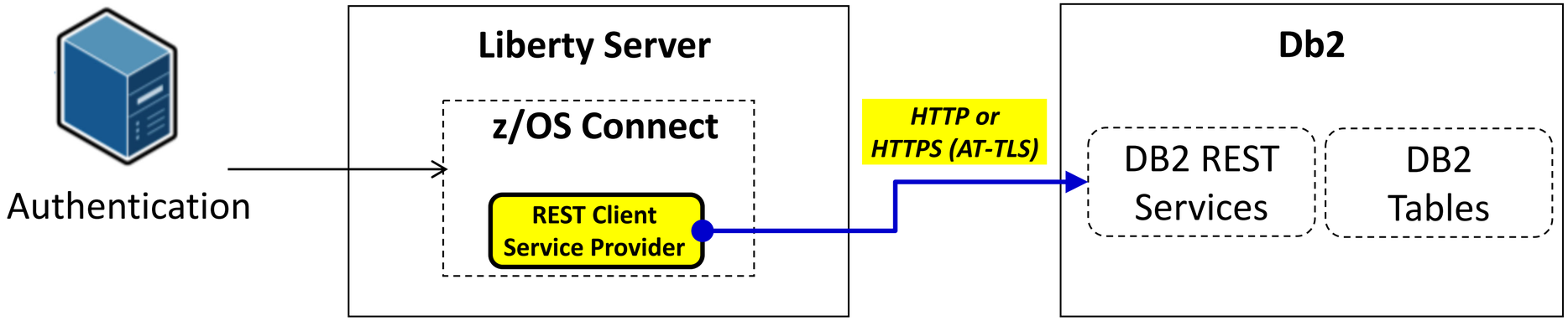
- If *reconnectInterval, preferredSpecificHost* and *preferredSpecificPort* are not set,
  - New connection attempts are disabled (this is the default behavior).
- If *reconnectInterval* is set and *preferredSpecificHost* and *preferredSpecificPort* are not set,
  - A new connection is attempted at the interval specified by the *reconnectInterval* time. Use this to enable regular connection rebalancing.
- If *reconnectInterval* and *preferredSpecificPort* are set and *preferrredSpecificHost* is not set,
  - A new connection is attempted at the expiration time interval and if the current connected port in use does not match the preferred port
  - Relevant when shared port is for a single LPAR
  - Specific CICS region is preferred
- If *reconnectInterval* and *preferredSpecificHost* are set and *preferredSpecificPort* is not set
  - A new connection is attempted at the expiration time interval and if the current host in use does not match the preferred port
  - Relevant when shared port is across Sysplex
  - Any CICS region on a specific LPAR is preferred
- If *reconnectInterval*, *preferredSpecificHost* and *preferredSpecificPort* are all set
  - A new connection is attempted at the expiration time interval time and if both the current host and port in use do not match the preferred host and port
  - Relevant when shared port is on a single LPAR or across a Sysplex
  - Specific CICS region is preferred.

When the reconnection attempt results in a new connection to a CICS region, new requests are sent over the new connection. Previous connections will continue and when all requests have completed processing, the previous or old connection will be closed.

mitchj@us.ibm.com

*Available at V3.0.56 and later

Flowing the identity for the REST client SP (Db2)




```
<zosconnect_zosConnectServiceRestClientConnection id="Db2Conn"
    host="wg31.washington.ibm.com"
    port="2446"
    basicAuthRef="dsn2Auth" />
<zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth"
    userName="USER1"
    password="USER1"/>
```

Authentication options:

1. **User ID / password**
2. **TLS Client Certificate (JSSE)**
3. **PassTicket support**

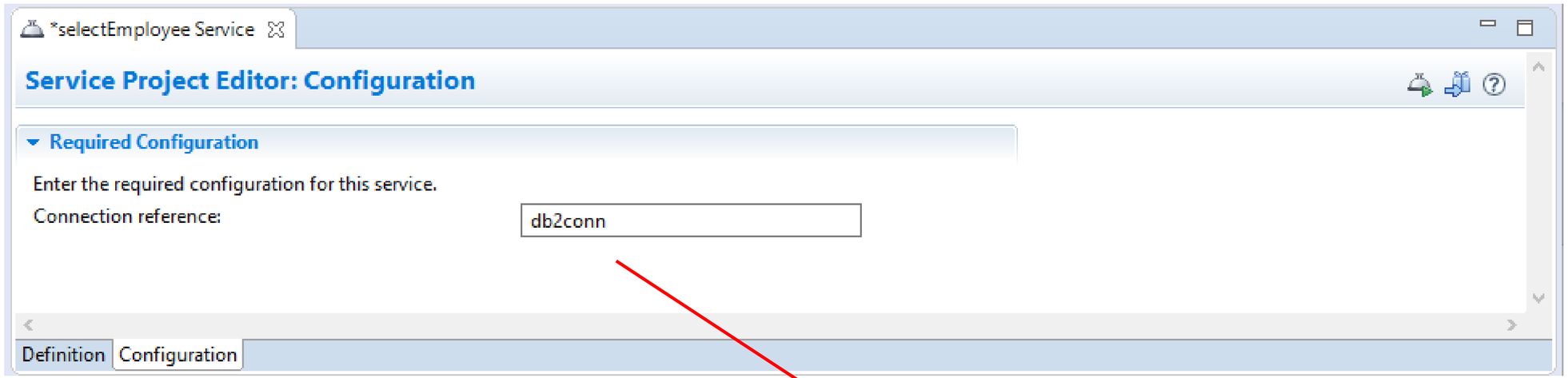
Specify a user identity and password to be used in the HTTP header with the Db2 REST Service

```
<zosconnect_zosConnectServiceRestClientConnection id="Db2Conn"
    host="wg31.washington.ibm.com"
    port="2446"
    basicAuthRef="dsn2Auth" />

<zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth"
    applName="DSN2APPL"/>
```

z/OS Connect requests a PassTicket from RACF

[1] mitchj@us.ibm.com

Server XML - Accessing a Db2 REST service




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

```
<zosconnect_zosConnectServiceRestClientConnection id="db2conn"
      host="wg31.washington.ibm.com"
      port="2446"
      basicAuthRef="dsn2Auth" />

<zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth"
      applName="DSN2APPL"/>
```

```
<featureManager>
  <feature>zosconnect:db2-1.0</feature>
</featureManager>

<zosconnect_credential user="${DB2_USERNAME}"
       password="${DB2_PASSWORD}" id="commonCredentials" />

<zosconnect_db2Connection id="db2Conn" host="${DB2_HOST}"
      port="${DB2_PORT}" credentialRef="commonCredentials" />
```

mitchj@us.ibm.com

PassTickets and Db2

- Basic authentication Db2 using a PassTicket depends on the Db2 configuration.

```
DSNL080I  -DSN2 DSNLTDDF DISPLAY DDF REPORT FOLLOWS:
DSNL081I STATUS=STARTD
DSNL082I LOCATION           LUNAME            GENERICLU
DSNL083I DSN2LOC            USIBMWZ.DSN2APPL  USIBMWZ.DSN0APPL
DSNL084I TCPPORT=2446  SECPORT=2445  RESPORT=2447  IPNAME=-NONE
DSNL085I IPADDR=::192.168.17.201
DSNL086I SQL    DOMAIN=WG31.WASHINGTON.IBM.COM
DSNL105I CURRENT DDF OPTIONS ARE:
DSNL106I PKGREL = COMMIT
DSNL106I SESSIDLE = 001440
DSNL099I DSNLTDDF DISPLAY DDF REPORT COMPLETE
```

```
DSNL080I  -DSNC DSNLTDDF DISPLAY DDF REPORT FOLLOWS:
DSNL081I STATUS=STARTD
DSNL082I LOCATION           LUNAME            GENERICLU
DSNL083I DSN2LOC            -NONE             -NONE
DSNL084I TCPPORT=2446  SECPORT=2445  RESPORT=2447  IPNAME=DB2IPNM
DSNL085I IPADDR=::192.168.17.252
DSNL086I SQL    DOMAIN=WG31.WASHINGTON.IBM.COM
DSNL086I RESYNC DOMAIN=WG31.WASHINGTON.IBM.COM
DSNL089I MEMBER IPADDR=::192.168.17.252
DSNL105I CURRENT DDF OPTIONS ARE:
DSNL106I PKGREL = COMMIT
DSNL106I SESSIDLE = 001440
DSNL099I DSNLTDDF DISPLAY DDF REPORT COMPLETE
```

```
RDEFINE PTKTDATA DSN2APPL SSIGNON(0123456789ABCDEF))
APPLDATA('NO REPLAY PROTECTION') UACC(NONE)

RDEFINE PTKTDATA IRRPTAUTH.DSN2APPL.* UACC(NONE)
PERMIT IRRPTAUTH.DSN2APPL.* ID(LIBSERV) CLASS(PTKTDATA)
ACCESS(UPDATE)
```

Which value should be used for applName is determine for use in RACF resources is determine as shown below.

- If GENERICLU is defined, use the second part of GENERICLU for *applName*, e.g., ***DSN0APPL***
- If GENERICLU is not defined, use the second part of LUNAME for *applName*, e.g., ***DSN2APPL***
- If neither GENERICLU or LUNAME is defined, use the value of the IPNAME for *applName,* e.g., ***DB2IPNM***

mitchj@us.ibm.com

Tech/Tip: Db2 REST Security

- Access to Db2 REST services requires READ access to the Db2 subsystem DSNR REST resource. i.e., permit READ access to this resource to the identity in question, for example

  PERMIT DSN2.REST CLASS(DSNR) ID(USER2) ACC(READ) where DSN2 is the Db2 subsystem ID
  SETROPTS RACLIST(DSNR) REFRESH

- Db2 package access is also required. If a user is not able to display a valid Db2 REST services in the z/OS Connect Db2 services development tooling or by using a **POST** to the Db2 provided REST interface URL of http://wg31.washington.ibm.com:2446/services/DB2ServiceDiscover, then they may not have sufficient access to the package containing the service.

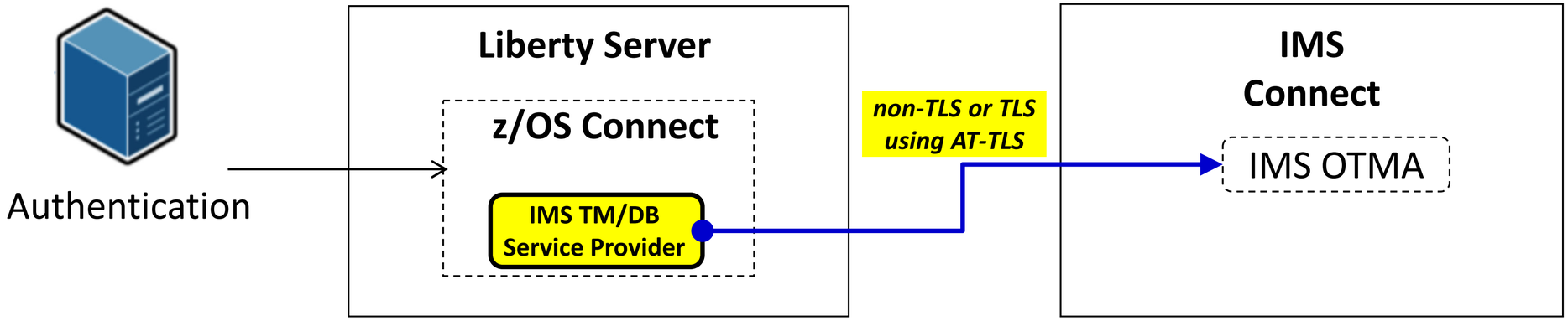
  For example, if service *zCEEService.selectEmployee* is defined to Db2 but not visible in the z/OS Connect tooling or if a **GET** request to URL http://wg31.washington.ibm.com:2446/services/zCEEService/selectEmployee fails with message:

```
{
  "StatusCode": 500,
  "StatusDescription": "Service zCEEService.selectEmployee discovery failed due to
  SQLCODE=-551 SQLSTATE=42501, USER2 DOES NOT HAVE THE PRIVILEGE TO PERFORM OPERATION EXECUTE
  PACKAGE ON OBJECT zCEEService.selectEmployee. Error Location:DSNLJACC:35"
}
```

The user needs to be granted execute authority on package *zCEEService.selectEmployee* with command:

GRANT EXECUTE ON PACKAGE "zCEEService"."selectEmployee" TO USER2 or
GRANT EXECUTE ON PACKAGE "zCEEService"."*“ TO USER2

Flowing an identity to IMS Connect (TM)




```
HWS=(ID=IMS15HWS,XIBAREA=100,RACF=Y,RRS=Y)
TCPIP=(HOSTNAME=TCPIP,PORTID=(4000,LOCAL),RACFID=JOHNSON,TIMEOUT=5000)
DATASTORE=(GROUP=OTMAGRP,ID=IVP1,MEMBER=HWSMEM,DRU=HWSYDRU0,
TMEMBER=OTMAMEM,APPL=IMSTMAPL)
```

Authentication options:

1. **User ID / password**
2. **PassTicket support**

```
<connectionFactory containerAuthDataRef="Connection1_Auth" id="IVP1">
<properties.gmoa hostName="wg31.washington.ibm.com" portNumber="4000"/>
</connectionFactory>
<authData id="Connection1_Auth"  user="USER1“password="{xor}GhIPExAGDwg="/>
```

Specify a user identity and password to be used in the request to IMS Connect

```
<connectionFactory containerAuthDataRef="Connection1_Auth" id="IVP1">
<properties.gmoa hostName="wg31.washington.ibm.com" portNumber="4000
applicationName="IMSTMAPL"/>
</connectionFactory>
```

Request a PassTicket
And use it in the request to IMS Connect

mitchj@us.ibm.com

PassTickets and IMS

- Basic authentication to IMS Connect using a PassTicket depends on the APPL parameters configured in IMS Connect.

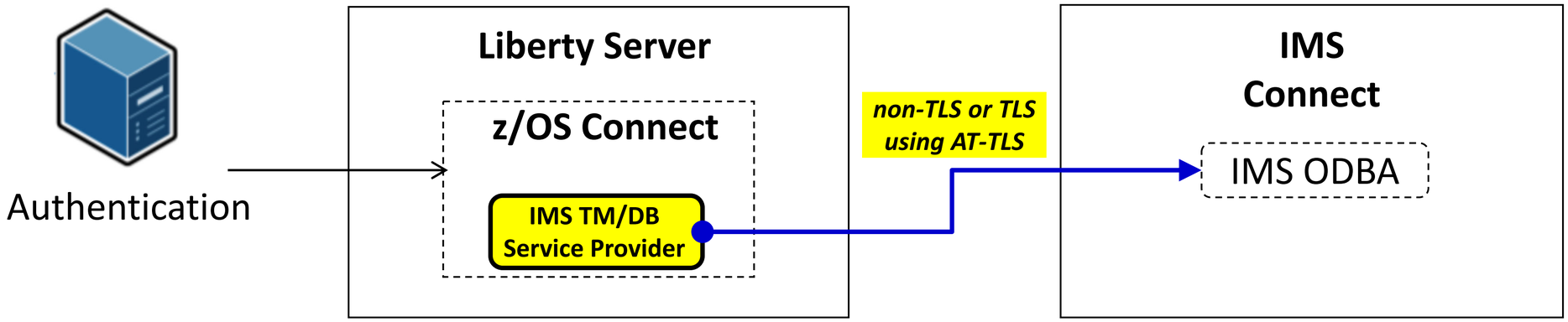
```
HWS=(ID=IMS15HWS,XIBAREA=100,RACF=Y,RRS=Y)
TCPIP=(HOSTNAME=TCPIP,PORTID=(4000,LOCAL),RACFID=JOHNSON,TIMEOUT=5000)
DATASTORE=(GROUP=OTMAGRP,ID=IVP1,MEMBER=HWSMEM,DRU=HWSYDRU0,
TMEMBER=OTMAMEM,APPL=IMSTMAPL)
ODACCESS=(ODBMAUTOCONN=Y,IMSPLEX=(MEMBER=IMS15HWS,TMEMBER=PLEX1),
     DRDAPORT=(ID=5555,PORTTMOT=6000),ODBMTMOT=6000,APPL=IMSDBAPL)
```

RDEFINE PTKTDATA IMSTMAPL SSIGNON(0123456789ABCDEF)) APPLDATA('NO REPLAY PROTECTION') UACC(NONE)
RDEFINE PTKTDATA IRRPTAUTH.IMSTMAPL.* UACC(NONE)
PERMIT IRRPTAUTH.IMSTMAPL.* ID(LIBSERV) CLASS(PTKTDATA) ACCESS(UPDATE)

RDEFINE PTKTDATA IMSDBAPL SSIGNON(0123456789ABCDEF)) APPLDATA('NO REPLAY PROTECTION') UACC(NONE)
RDEFINE PTKTDATA IRRPTAUTH.IMSDBAPL.* UACC(NONE)
PERMIT IRRPTAUTH.IMSDBAPL .* ID(LIBSERV) CLASS(PTKTDATA) ACCESS(UPDATE)

mitchj@us.ibm.com

Flowing an identity to IMS Connect (DB)




```
HWS=(ID=IMS15HWS,XIBAREA=100,RACF=Y,RRS=Y)
TCPIP=(HOSTNAME=TCPIP,PORTID=(4000,LOCAL),RACFID=JOHNSON,TIMEOUT=5000)
ODACCESS=(ODBMAUTOCONN=Y,IMSPLEX=(MEMBER=IMS15HWS,TMEMBER=PLEX1),
    DRDAPORT=(ID=5555,PORTTMOT=6000),ODBMTMOT=6000,APPL=IMSDBAPL)
```

Authentication options:

1. **User ID / password**
2. **PassTicket support**

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

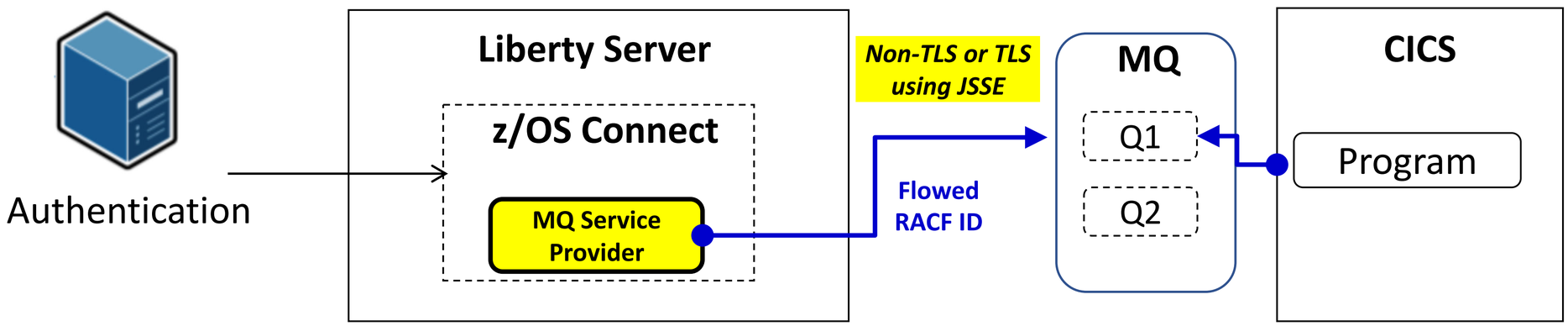
Specify a user identity and password to be used in the request to IMS Connect

```
<connectionFactory id="DFSIVPAConn">    <properties.imsudbJLocal
databaseName="DFSIVPA" datastoreName="IVP1" portNumber="5555"
datastoreServer="wg31.washington.ibm.com«  driverType="4" flattenTables="True"
applicationName="IMSDBAPL"  "/>
</connectionFactory>
```

Request a PassTicket
And use it in the request
to IMS Connect

mitchj@us.ibm.com

Flowing a user ID with MQ service provider



Set **`useCallerPrincipal=true`** to flow the authenticated RACF user ID, note that this is set at the service.

```
<zosconnect_services>
    <service name="mqPut">
        <property name="destination" value="jms/default"/>
        <property name="useCallerPrincipal" value=“true"/>
    </service>
</zosconnect_services>
```

Define identity propagation to MQ

mitchj@us.ibm.com

API Policies

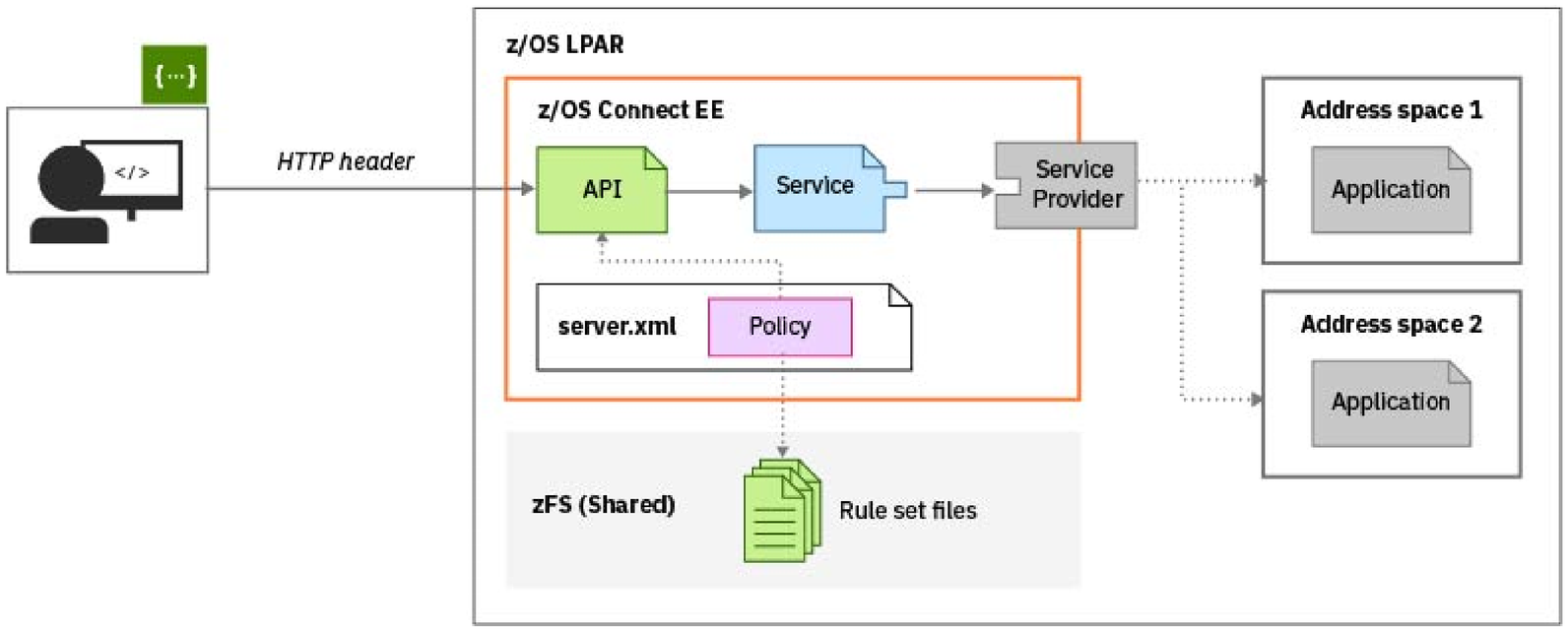
- HTTP header properties can be used to select alternative for IMS (V3.0.4) , CICS (V3.0.10), Db2 (V3.0.36) or MQ (V3.0.39)
- Policies can be configured globally for every API in the server or for individual APIs (V3.0.11)

CICS attributes
- cicsCcsid
- cicsConnectionRef
- cicsTransId

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

Db2 attributes
- db2ConnectionRef
- db2CollectionID

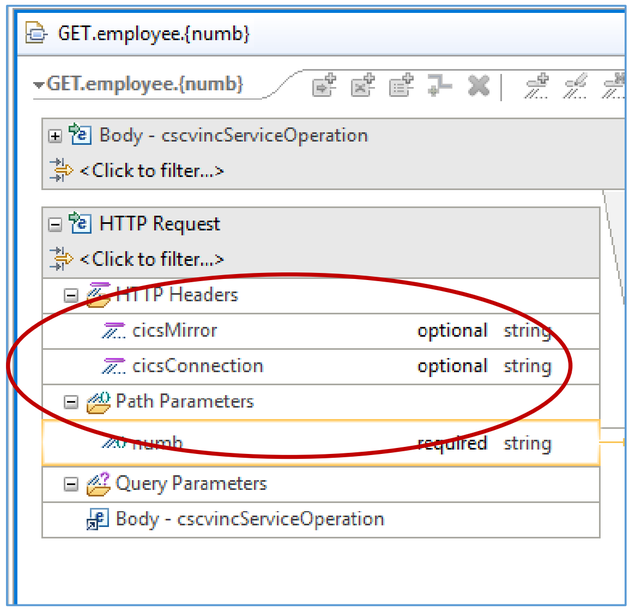
MQ attributes
- mqConnectionFactory
- mqDestination
- mqReplyDestination



mitchj@us.ibm.com

A sample API Policies for CICS

```
<ruleset name="CICS rules">
     <rule name="csmi-rule">
         <conditions>
             <header name="cicsMirror" match="ANY_VALUE"/> *
         </conditions>
         <actions>
             <set property="cicsTransId" value="${cicsMirror}"/>
         </actions>
     </rule>
     <rule name="connection-rule">
         <conditions>
             <header name="cicsConnection" value=" match="ANY_VALUE"/>
         </conditions>
         <actions>
             <set property="cicsConnectionRef" value="${cicsConnection}"
         </actions>
     </rule>
</ruleset>
```



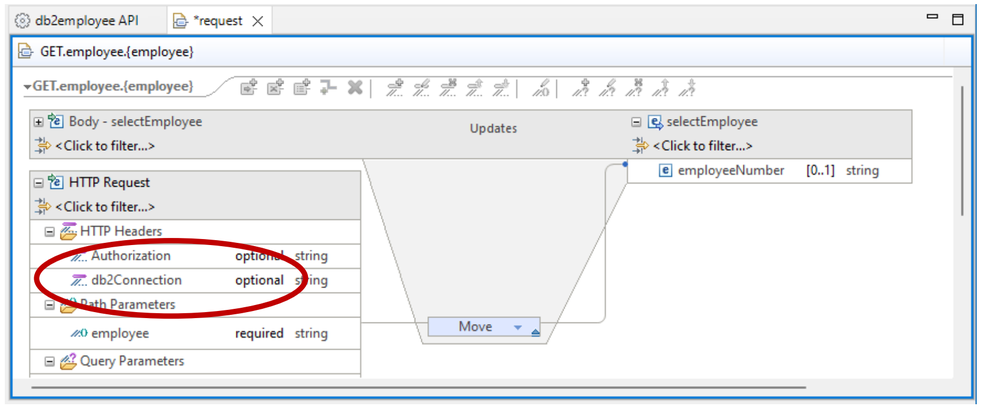
Curl

```
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)

A sample API Policies for Db2

```
<ruleset name="Db2 rules">
     <rule name="connection-rule">
       <conditions>
           <header name="db2Connection" value="" match="ANY_VALUE"/>
       </conditions>
       <actions>
           <set property="db2ConnectionRef" value="${db2Connection}"/>
       </actions>
     </rule>
 </ruleset>
```




```
<zosconnect_zosConnectServiceRestClientConnection id="Db2Conn"
       sslCertsRef="db2SSLSettings" host="wg31.washington.ibm.com" port="2445" basicAuthRef="dsn2Auth" />
<zosconnect_zosConnectServiceRestClientBasicAuth id="dsn2Auth" applName="DSN2APPL"/>
<ssl id="db2SSLSettings"  keyStoreRef="Db2KeyStore"  trustStoreRef="Db2KeyStore"/>

<zosconnect_zosConnectServiceRestClientConnection id="fred"
       sslCertsRef="fredSSLSettings"  host="wg31.washington.ibm.com" port="2445" />
<ssl id="fredSSLSettings" keyStoreRef="Db2KeyStore"  trustStoreRef="Db2KeyStore" clientKeyAlias="FRED"/>

<zosconnect_zosConnectServiceRestClientConnection id="user1"
       sslCertsRef="user1SSLSettings"  host="wg31.washington.ibm.com"  port="2445" />
<ssl id="user1SSLSettings" keyStoreRef="Db2KeyStore"  trustStoreRef="Db2KeyStore" clientKeyAlias="USER1"/>

<keyStore id="Db2KeyStore" location="safkeyring:///zCEE.Db2.KeyRing"
       password="password" type="JCERACFKS" fileBased="false" readOnly="true" />
```

Requires APAR PH53162

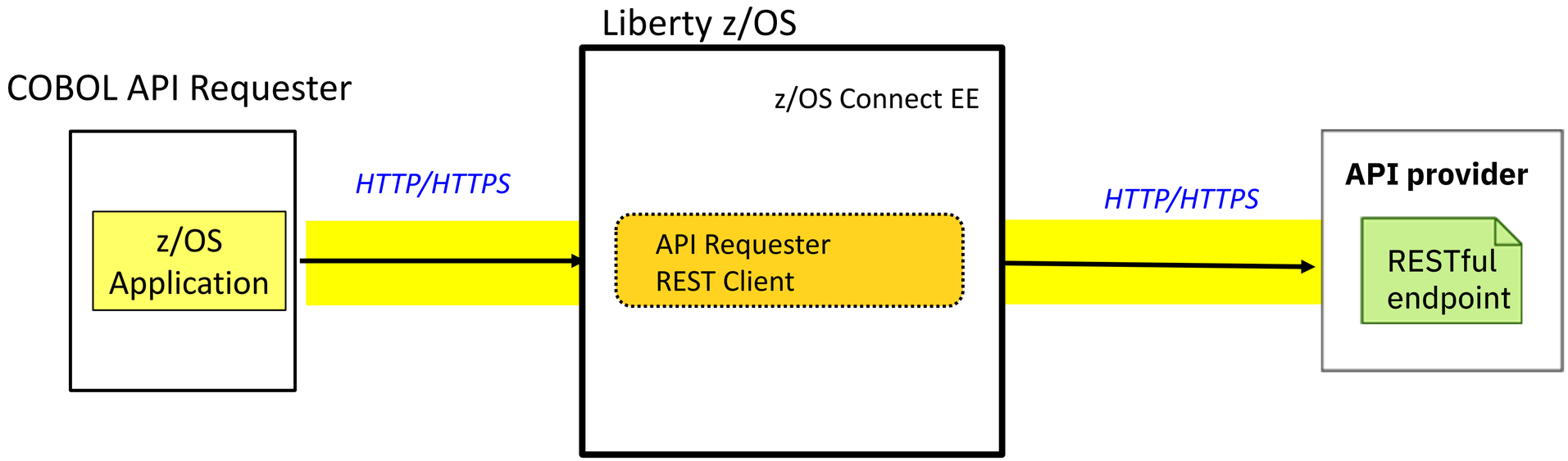
mitchj@us.ibm.com

Security when accessing non-z/OS systems

z/OS Connect API Requester Security

mitchj@us.ibm.com

End to end API requester to API Provider connection overview



MVS Batch, IMS HTTP and Db2 stored procedure connection details provided by:

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

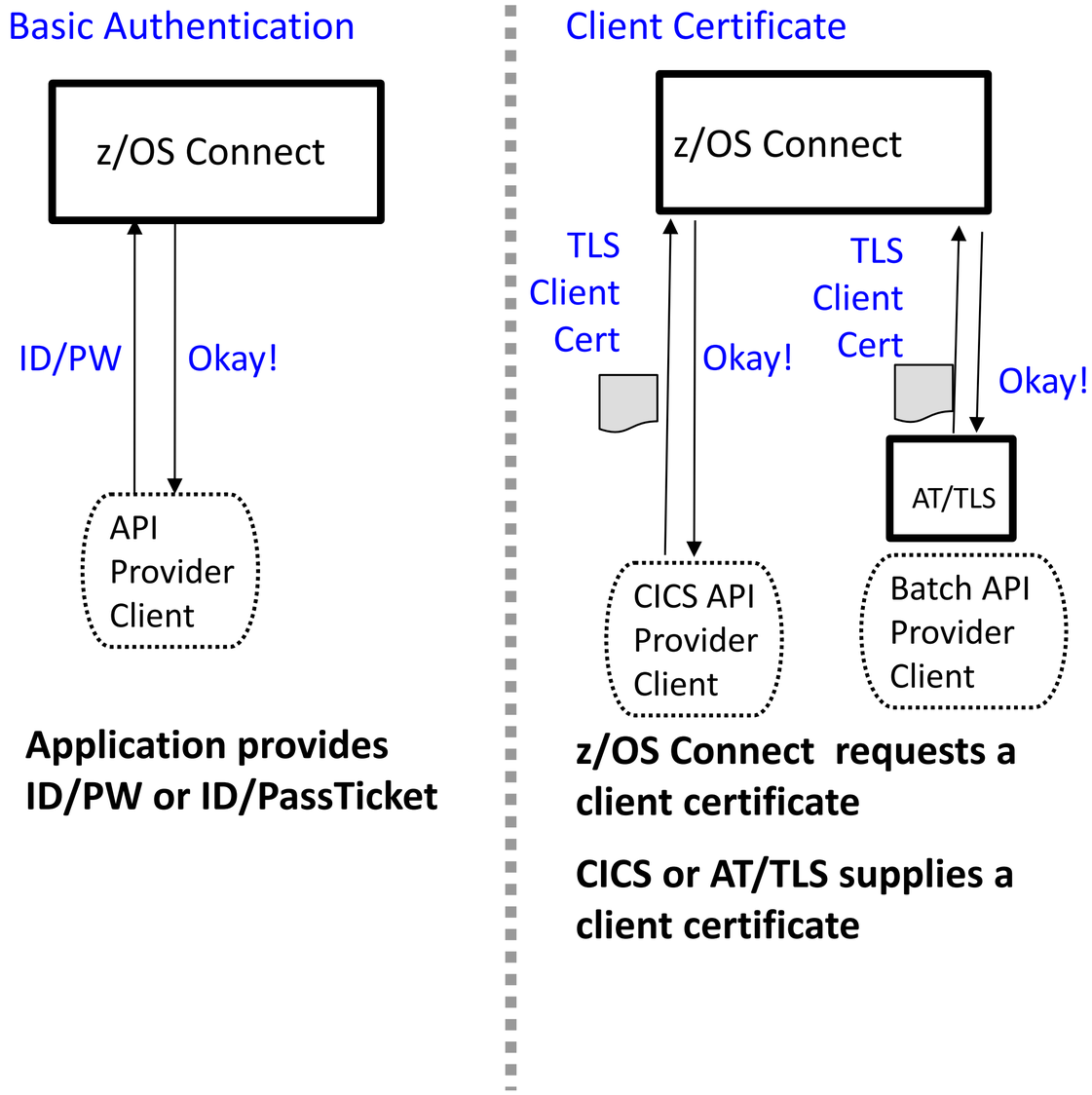
CICS HTTP connection details provided by:

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

mitchj@us.ibm.com

API Requester – Security from the application to the z/OS Connect server

Two options for providing credentials for authentication



Application provides ID/PW or ID/PassTicket

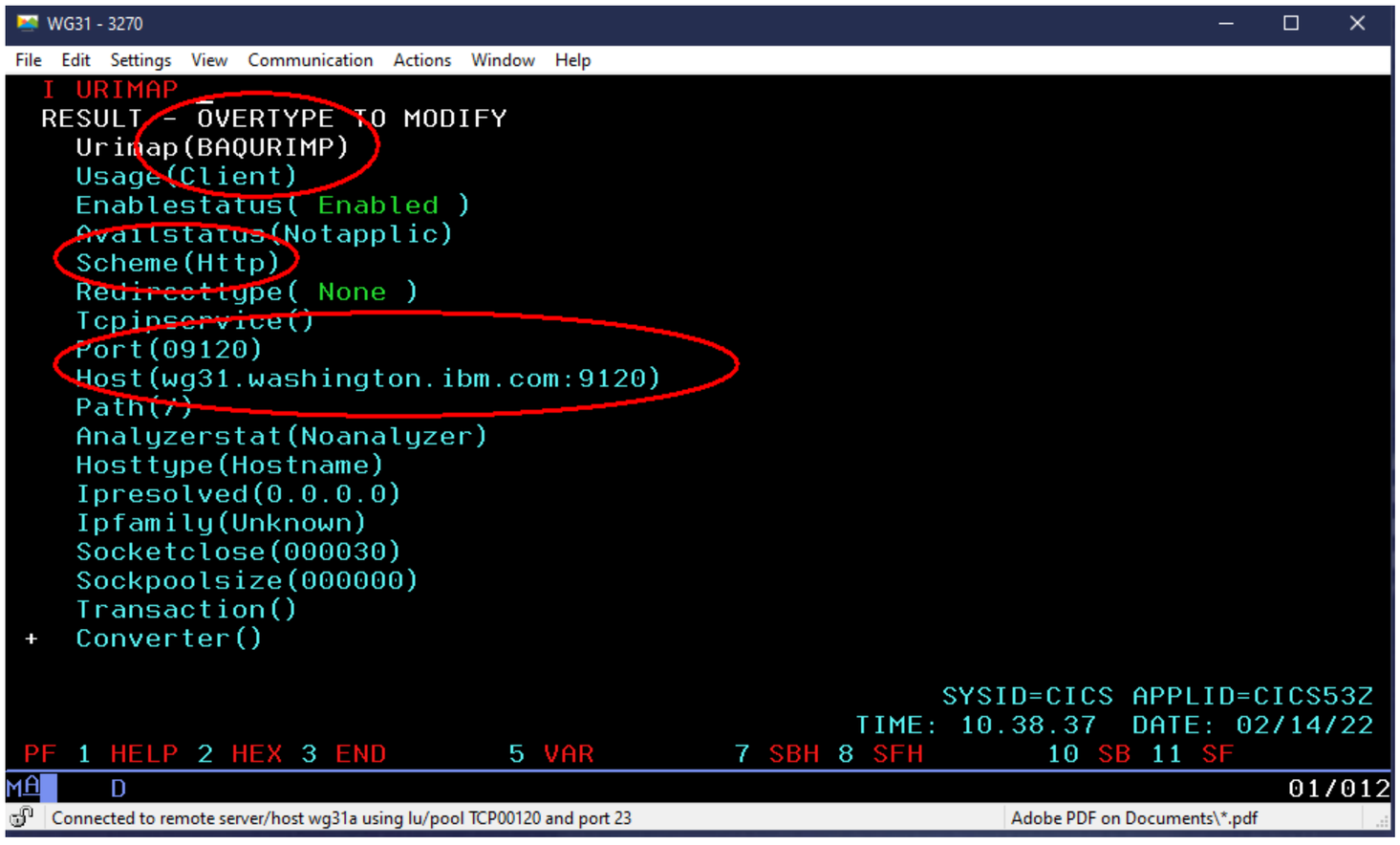
z/OS Connect requests a client certificate

CICS or AT/TLS supplies a client certificate

mitchj@us.ibm.com

Configuring 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

A COBOL API Requester using basic authentication

- A MVS batch or IMS requester application sends basic authentication information (identity and password) by using environment variables.
  - BAQUSERNAME
  - BAQPASSWORD

- The environment 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")
```

Note that the z/OS Connect communications stub generates the Authentication header token we saw earlier

- 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

Environment variables for non-CICS clients

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.

mitchj@us.ibm.com

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

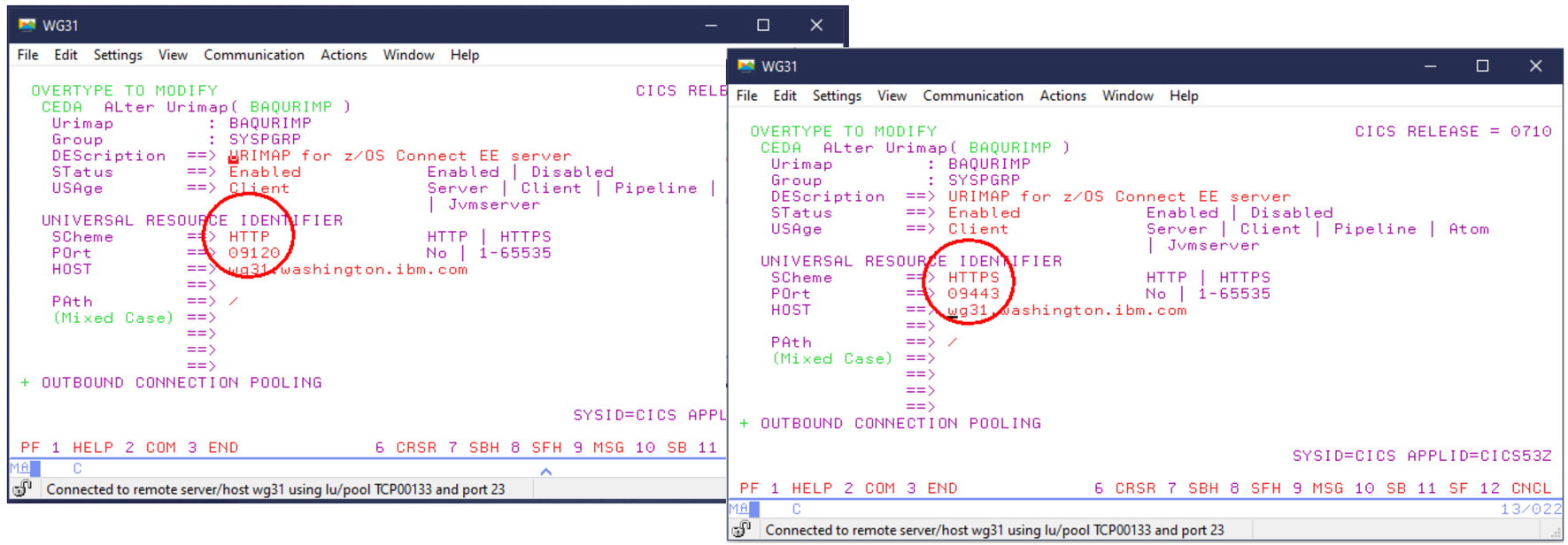
Tech/Tip: API Requester - HTTP v HTTPS

MVS Batch and IMS with and without an outbound AT-TLS policy

```
CEEOPTS DD *
 POSIX(ON),
 ENVAR("BAQURI=wg31.washington.ibm.com",
 "BAQPORT=9080")
```

```
CEEOPTS DD *
 POSIX(ON),
 ENVAR("BAQURI=wg31.washington.ibm.com",
 "BAQPORT=9443")
```

CICS URIMAPs

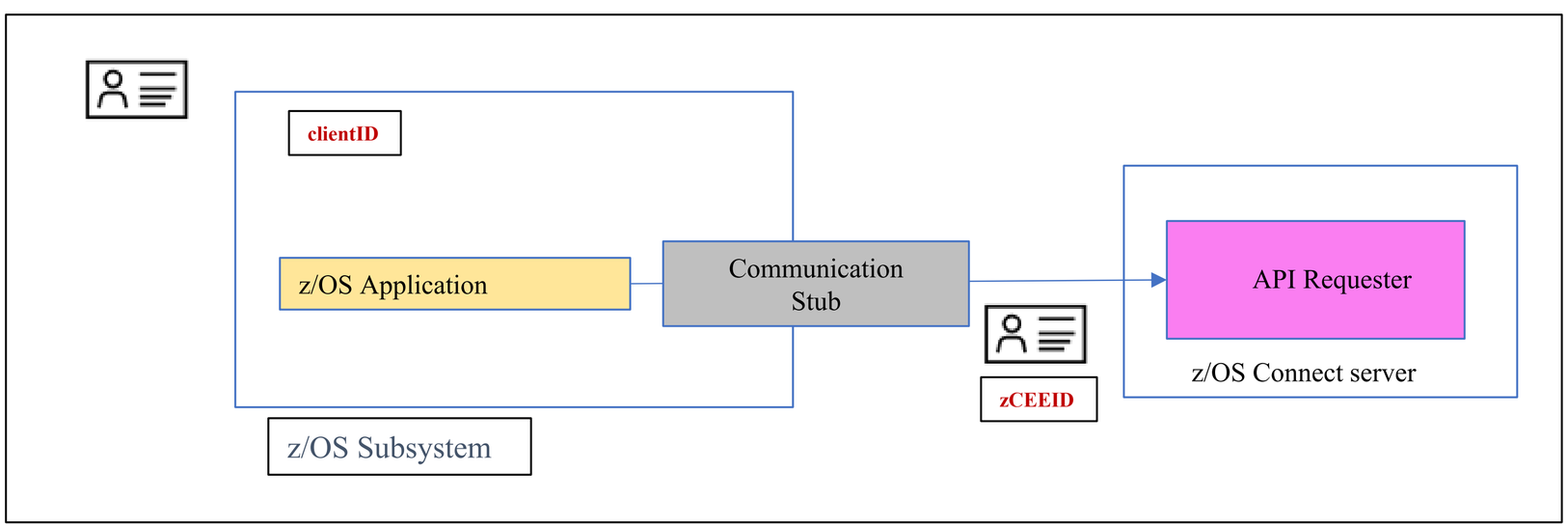


Field BAQ-ZCON-SERVER-URI was added to BAQRINFO in V3.0.37.

MOVE "URIMAP01" TO BAQ-ZCON-SERVER-URI.

mitchj@us.ibm.com

API Requester - basic authentication and identity assertion



zCEEID – The identity that is used for authenticating connectivity the z/OS subsystem to the zCEE server. It is configured using basic authentication or for CICS, TLS client authentication. For MVS batch, IMS and Db2 stored procedures, the *zCEEID* is the provided by the environment variable ***BAQUSERNAME***. For CICS, the value for *zCEEID* is usually provided by the identity mapped to the CICS client certificate.

clientID – the identity under which the z/OS application is executing.

- For CICS, the CICS task identity
- For IMS, the transaction owner
- For batch, the job card USERID

requireAuth	idAssertion	Actions performed by z/OS Connect
true	OFF	Identity assertion is disabled. The zCEE server authenticates *zCEEID* and checks whether *zCEEID* has the authority to invoke an API requester.
	ASSERT_SURROGATE	Identity assertion is enabled. The zCEE server authenticates *zCEEID* and checks whether *zCEEID* is a surrogate of *clientID*. If *zCEEID* is a surrogate of *clientID*, the server further checks whether *clientID* has the authority to invoke an API requester; otherwise, a BAQR7114E message occurs.
	ASSERT_ONLY	Identity assertion is enabled. The zCEE server authenticates *zCEEID* and directly checks whether *clientID* has the authority to invoke an API requester
false	OFF	Identity assertion is disabled. A BAQR0407W message occurs.
	ASSERT_SURROGATE	Identity assertion is enabled. The zCEE server checks whether *clientID* has the authority to invoke an API requester, and a warning message occurs to indicate that the ASSERT_ONLY value is used instead of the ASSERT_SURROGATE value.
	ASSERT_ONLY	Identity assertion is enabled. The zCEE server checks whether *clientID* has the authority to invoke an API requester

```
 <zosconnect_zosConnectManager
            requireAuth="true|false"
            requireSecure="true|false"/>

<zosconnect_apiRequesters idAssertion="OFF">

<zosconnect_apiRequester name="cscvinc_1.0.0"
            requireAuth="true|false"
            requireSecure="true|false"/>
            idAssertion="ASSERT_ONLY"> *

<zosconnect_apiRequester name="db2employee_1.0.0"
            requireAuth="true|false"
            requireSecure="true|false"/>
            idAssertion="ASSERT_SURROGATE"> *

</zosconnect_apiRequesters>
```

* Added in V3.0.45

mitchj@us.ibm.com

Tech-Tip: Identity assertion requires setting a program control extended attribute

As root or superuser, set the *libifaedjreg64.so* program control extended attribute bit

- ***Permit the server's identity to the required FACILITY resource***

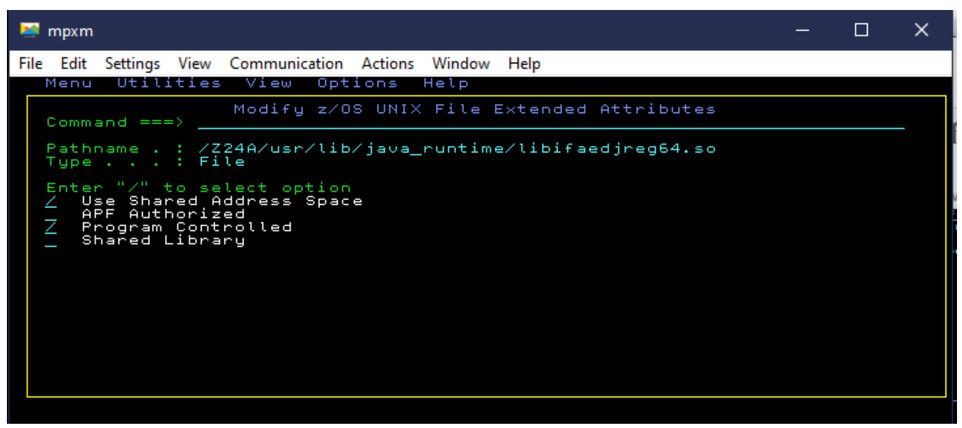
  PERMIT BPX.SERVER CLASS(FACILITY) ID(LIBSERV) ACCESS(READ)
  SETROPTS RACLIST(FACILITY) REFRESH

- ***Define a SURROGAT profile for the asserted identity and permit access to connection identity***

  RDEFINE SURROGAT clientID.BAQASSRT UACC(NONE) OWNER(SYS1)
  PERMIT clientID.BAQASSRT CLASS(SURROGAT) ACCESS(READ) ID(zCEEID)
  OR
  RDEFINE SURROGAT *.BAQASSRT UACC(NONE) OWNER(SYS1)
  PERMIT *.BAQASSRT CLASS(SURROGAT) ACCESS(READ) ID(zCEEID)
  SETROPTS RACLIST(SURROGAT) REFRESH

- ***Enable the program control bit for Java shared object ifaedjreg64***

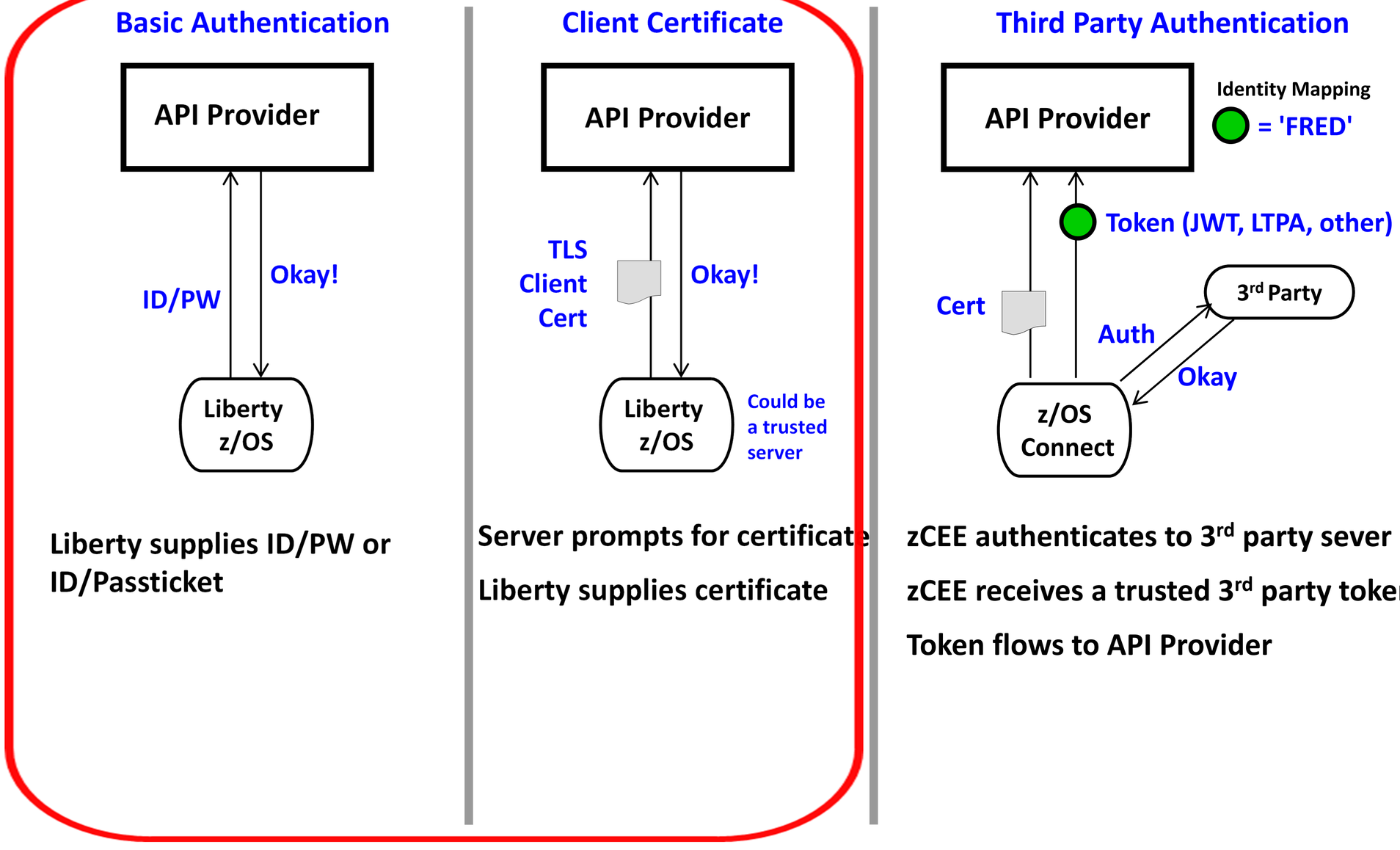
  su ***(switching to root is required)***
  cd /usr/lib/java_runtime
  extattr +p libifaedjreg64.so



mitchj@us.ibm.com

Accessing non-z/OS resources

Several different ways this can be accomplished:



Liberty supplies ID/PW or ID/Passticket

Server prompts for certificate

Liberty supplies certificate

zCEE authenticates to 3rd party sever

zCEE receives a trusted 3rd party token

Token flows to API Provider

mitchj@us.ibm.com

Configuring Basic and/or TSL support

Basic authentication with HTTP protocol

```
<zosconnect_endpointConnection id="cscvincAPI"
       host="http://wg31.washington.ibm.com" port="9080"
       authenticationConfigRef="myAuthData" />

<zosconnect_authData id="myAuthData"
  user="zCEEClient" password="secret"/>
```

TLS with HTTPS protocol

```
<zosconnect_endpointConnection id="cscvincAPI"
       host="https://wg31.washington.ibm.com" port="9443"
       authenticationConfigRef="myAuthData"  1
       sslCertsRef="OutboundSSLSettings" />

<zosconnect_authData id="myAuthData"   1
  user="zCEEClient" password="secret"/>
```

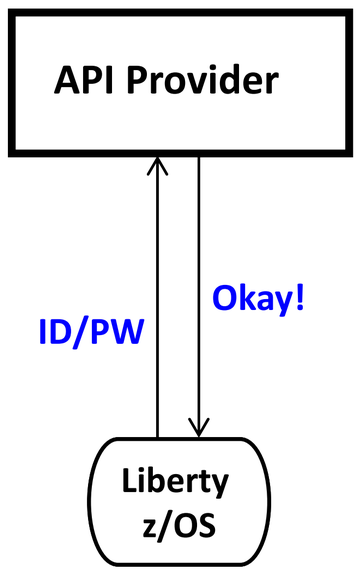
[1] Optional, if mutual authentication is enabled by the server endpoint

mitchj@us.ibm.com

API Requester – Security from the z/OS Connect server to the API provider

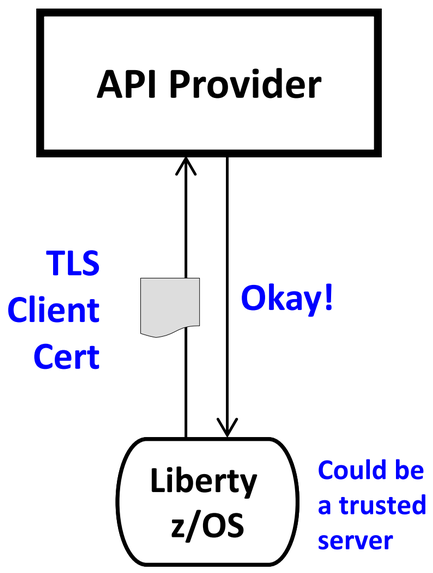
Several different ways this can be accomplished:

Basic Authentication



zCEE supplies ID/PW or ID/Passticket

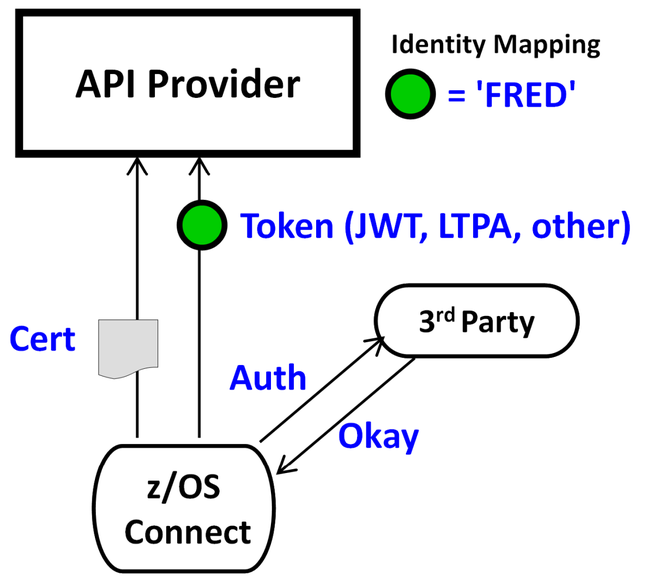
Client Certificate



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

z/OS Connect API Requester - Token Support

z/OS Connect EE provides ***three*** ways of calling an API secured with a token

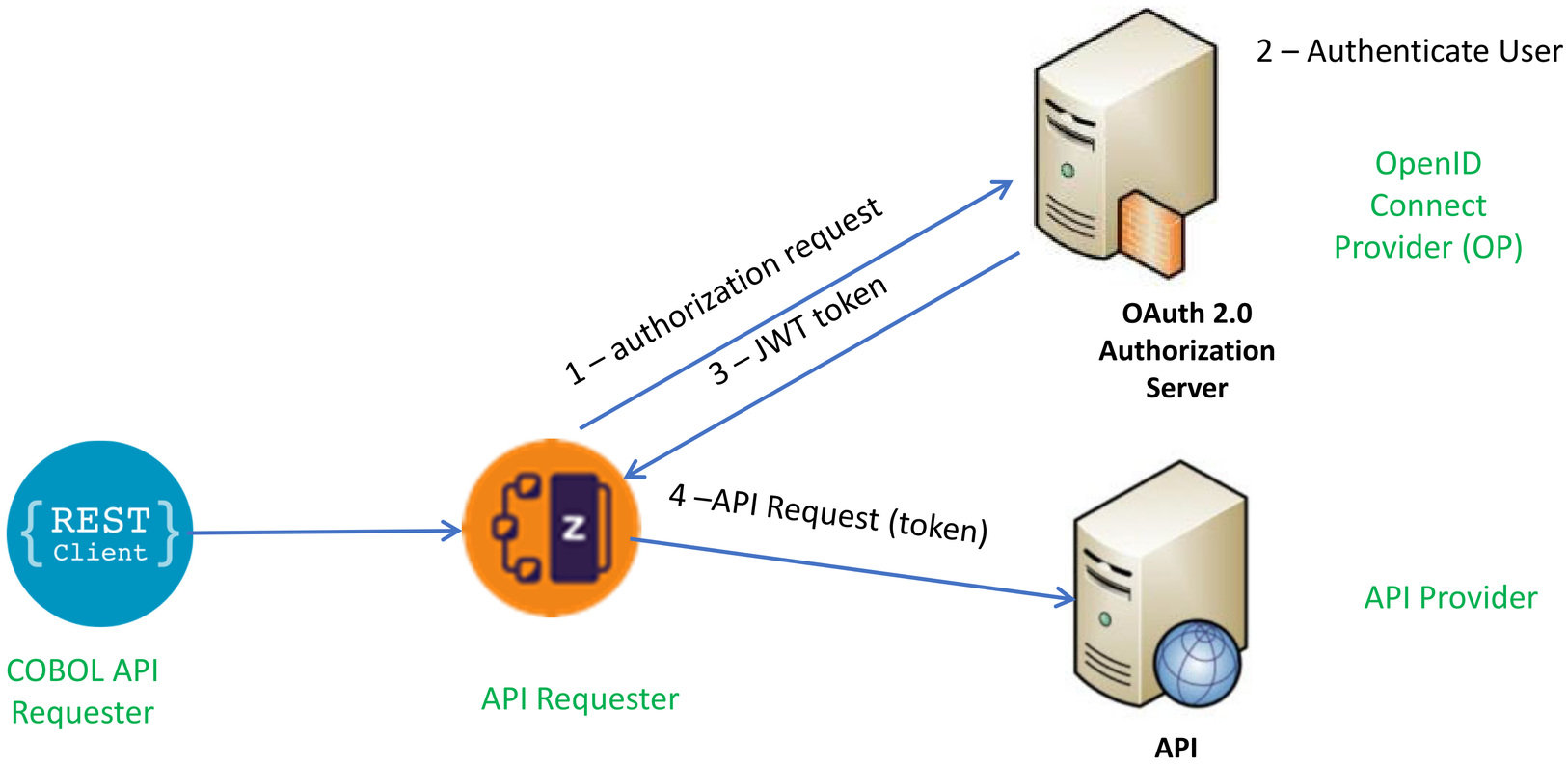
1. Use the OAuth 2.0 support when the request is part of an OAuth 2.0 flow. With OAUTH configured, the token can be an opaque token or a JWT token.

2. In a non-OAuth 2.0 scenario, a JWT token is used in a custom flow, for example: when you need to specify the HTTP verb that is used in the request to the authentication server.
   - When you need to specify the HTTP verb that is used in the request to the authentication server
   - When you need to specify how the JWT is returned from the authentication server (for example, in an HTTP header or in a custom field in a JSON response message).
   - When you need to use a custom header name for sending the JWT to the request endpoint.

3. Use the locally generated JWT support when you need to send a JWT that is generated by the z/OS Connect EE server.

mitchj@us.ibm.com

z/OS Connect OAuth Flow for API requester



Grant Types:

- client_credentials
- password

mitchj@us.ibm.com

OAuth Grant Types Supported by z/OS Connect

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 When this grant type is used, the z/OS Connect EE server sends the client credentials and the access scope to the authorization server.*

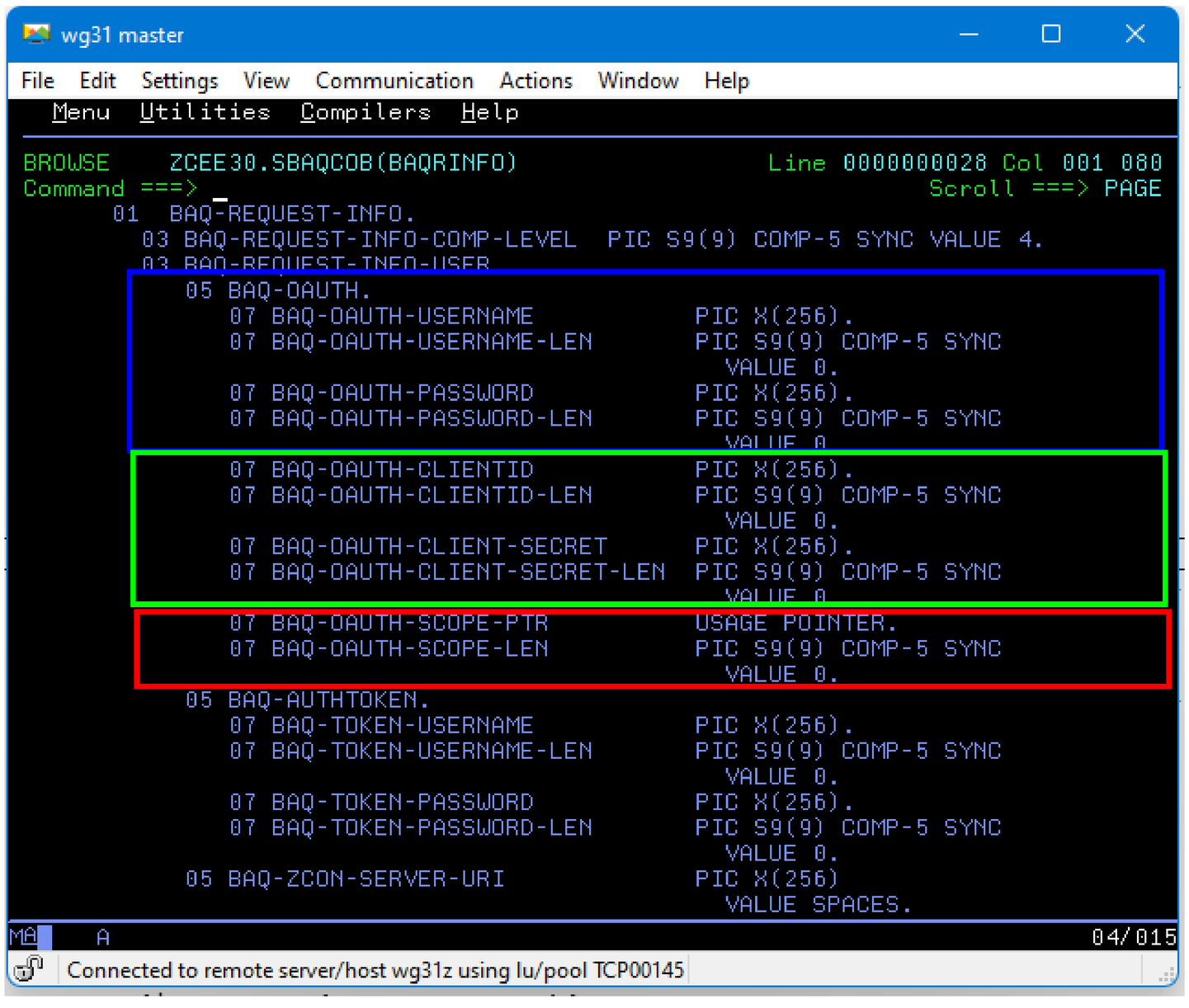
```
<zosconnect_oAuthConfig id="myoAuthConfig"
      grantType="client_credentials"
      authServerRef="myoAuthServer"/>
```

password - *The identity of the user of the CICS, IMS, or z/OS application, or it might be another entity**.** When this grant type is used, the z/OS Connect EE server sends the resource owner's credentials, the client credentials, and the access scope to the authorization server.*

```
<zosconnect_oAuthConfig id="myoAuthConfig"
      grantType="password"
      authServerRef="myoAuthServer"/>
```

mitchj@us.ibm.com

Configuring OAuth support – BAQRINFO copy book



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.

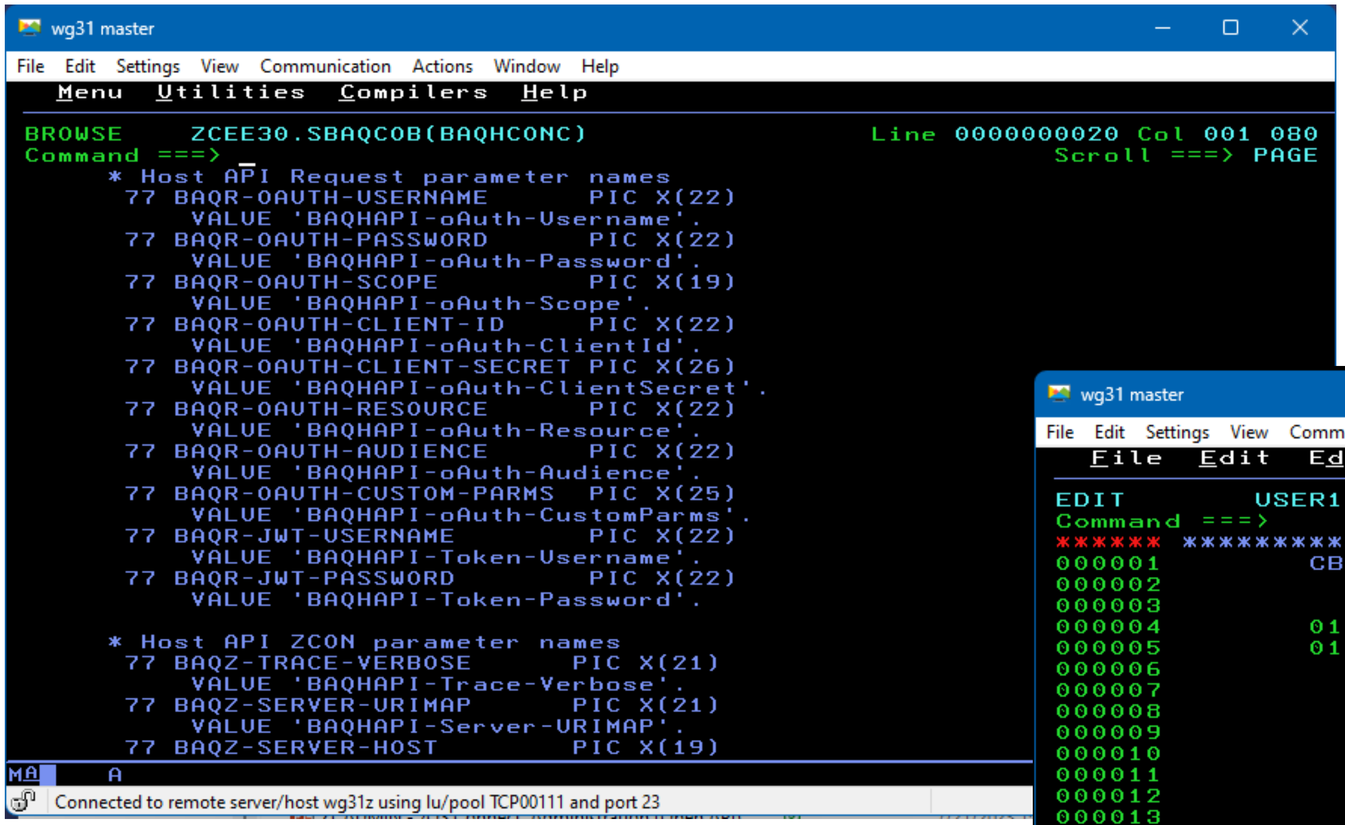
Grant Type: *client_credentials* - the identity associated with the combination of the CICS, IMS, or z/OS application, and the z/OS Connect EE server that calls the RESTful API on behalf of the CICS, IMS, or z/OS application

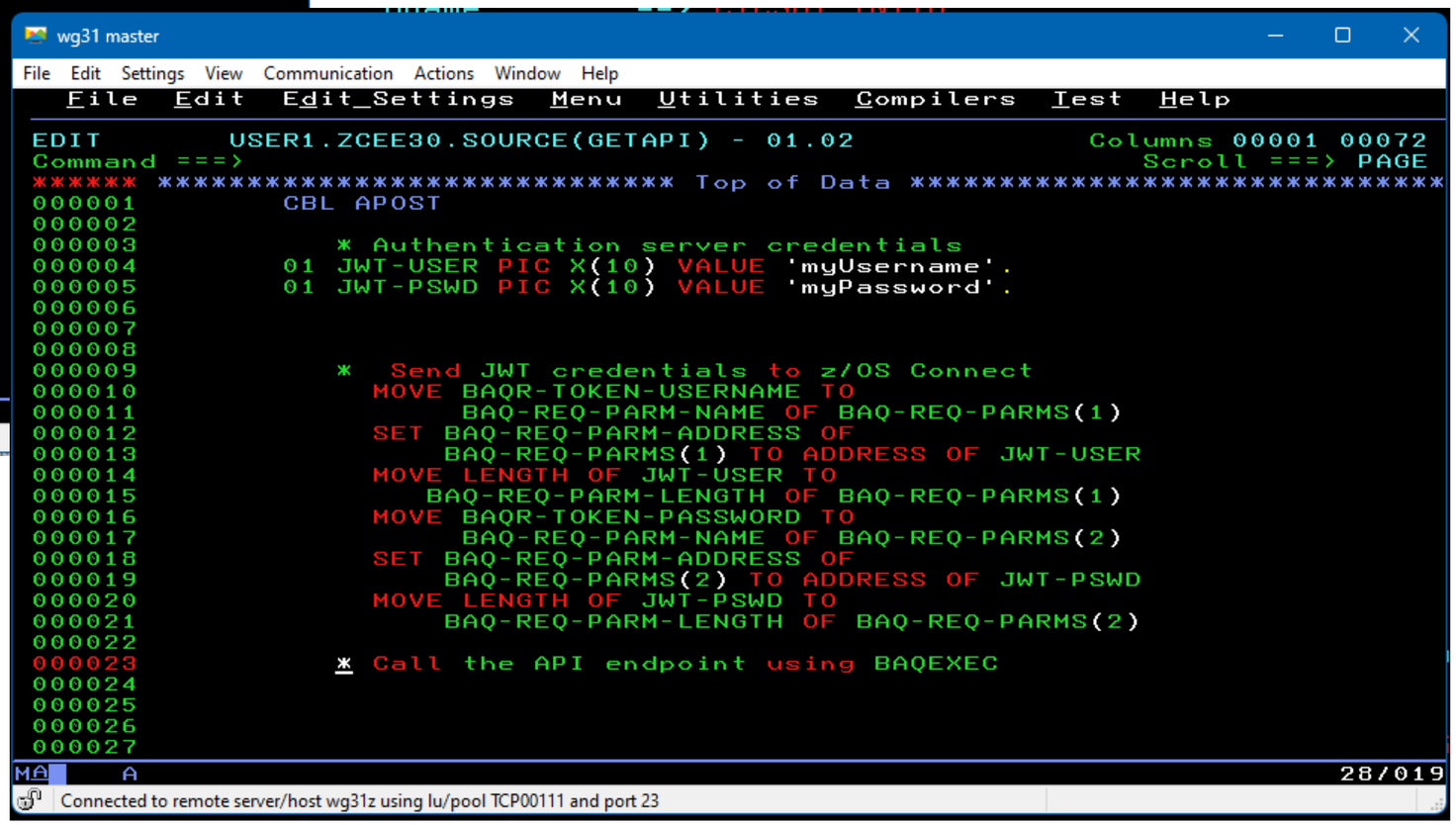
Scope is always required.

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

Obtaining a JWT using request parameters





Configuring OAuth support – z/OS Connect API Requester

```
<zosconnect_endpointConnection id="cscvincAPI"
       host="http://wg31.washington.ibm.com" port="9080"
       authenticationConfigRef="myoAuthConfig"/>

<zosconnect_oAuthConfig id="myoAuthConfig"
      grantType="client_credentials|password"
      authServerRef="myoAuthServer"/>

<zosconnect_authorizationServer id="myoAuthServer"
      tokenEndpoint=https://wg31.washington.ibm.com:59443/oidc/endpoint/OP/token[1]
      basicAuthRef="tokenCredential"  [2]
      sslCertsRef="OutboundSSLSettings" />

<zosconnect_authData id="tokenCredential" [2]
  user="zCEEClient" password="secret"/>
```

```
openidConnectProvider id="OP"
   signatureAlgorithm="RS256"
   keyStoreRef="jwtStore"
  oauthProviderRef="OIDCssl" >
</openidConnectProvider>
```

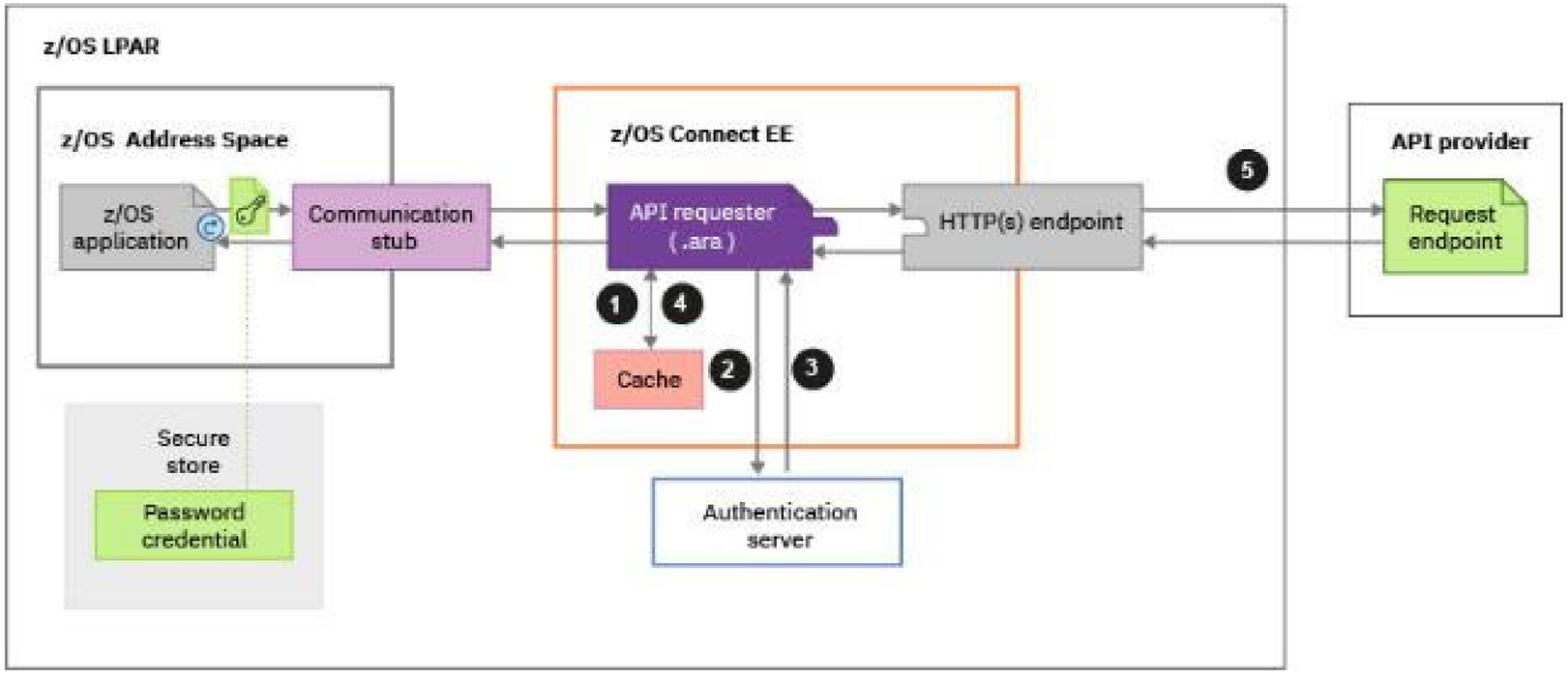
[1] See URL https://www.ibm.com/support/knowledgecenter/SS7K4U_liberty/com.ibm.websphere.wlp.zseries.doc/ae/twlp_oidc_token_endpoint.html

[2] These credentials can be specified by the application

mitchj@us.ibm.com

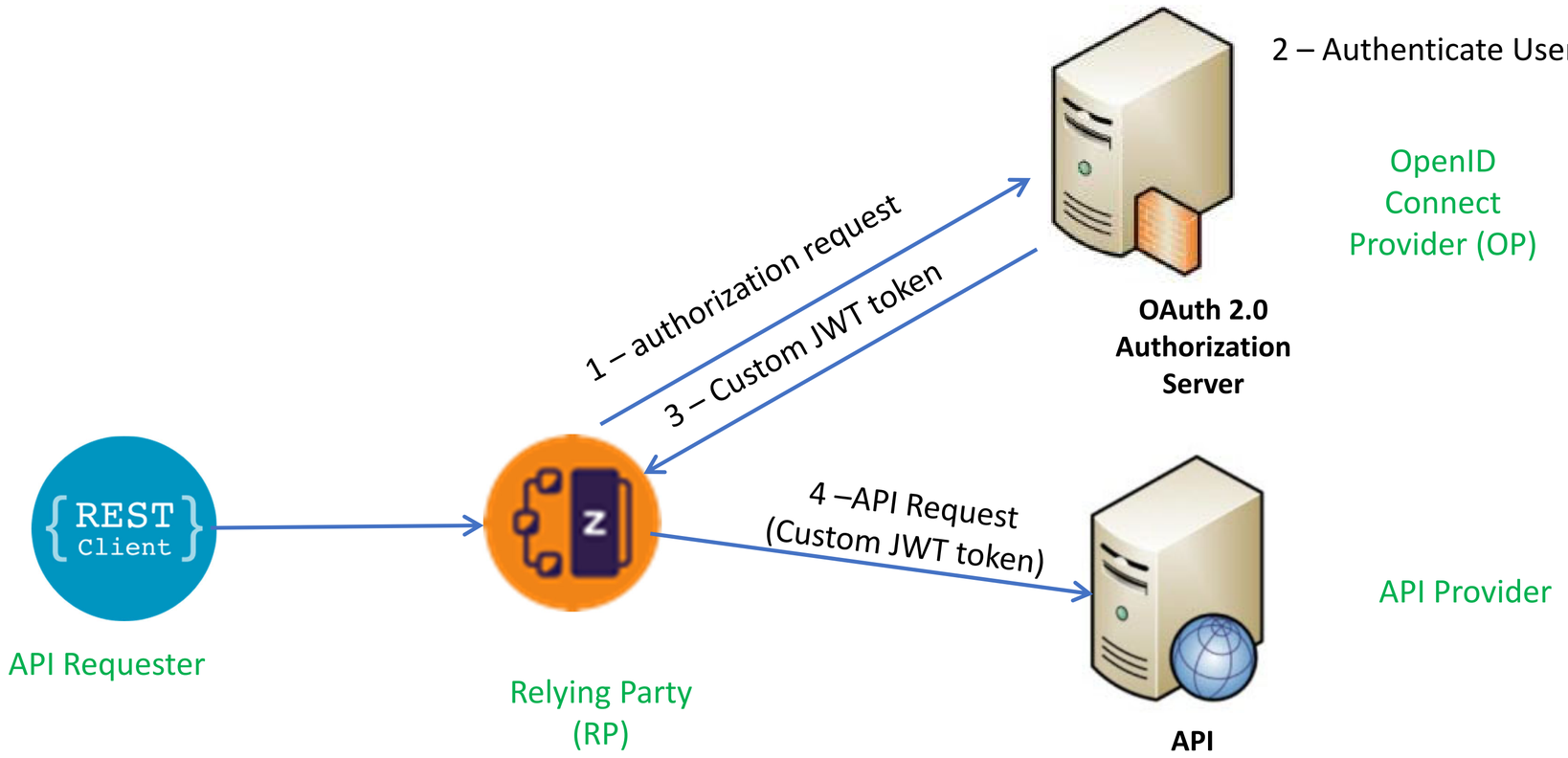
Calling an API with using a JWT custom flow

- In a non-OAuth 2.0 scenario, a JWT token is used in a custom flow, for example:
  - When you need to specify the HTTP verb that is used in the request to the authentication server.
  - When you need to specify how the JWT is returned from the authentication server (for example, in an HTTP header or in a custom field in a JSON response message).
  - When you need to use a custom header name for sending the JWT to the request endpoint.



mitchj@us.ibm.com

z/OS Connect OAuth Custom Flow



mitchj@us.ibm.com

API Requester – JWT Custom flow

wg31 master

File Edit Settings View Communication Actions Window Help

Menu Utilities Compilers Help

```
BROWSE    ZCEE30.SBAQCOB(BAQRINFO)                Line 0000000028 Col 001 080
Command ===>                                                Scroll ===> PAGE
      01  BAQ-REQUEST-INFO.
        03 BAQ-REQUEST-INFO-COMP-LEVEL  PIC S9(9) COMP-5 SYNC VALUE 4.
        03 BAQ-REQUEST-INFO-USER.
           05 BAQ-OAUTH.
              07 BAQ-OAUTH-USERNAME           PIC X(256).
              07 BAQ-OAUTH-USERNAME-LEN       PIC S9(9) COMP-5 SYNC
                                                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
                                                VALUE 0.
           05 BAQ-AUTHTOKEN.
              07 BAQ-TOKEN-USERNAME           PIC X(256).
              07 BAQ-TOKEN-USERNAME-LEN       PIC S9(9) COMP-5 SYNC
                                                VALUE 0.
              07 BAQ-TOKEN-PASSWORD           PIC X(256).
              07 BAQ-TOKEN-PASSWORD-LEN       PIC S9(9) COMP-5 SYNC
                                                VALUE 0.
           05 BAQ-ZCON-SERVER-URI             PIC X(256)
                                                VALUE SPACES.
MA    A                                                        04/015
```

Connected to remote server/host wg31z using lu/pool TCP00145

BAQRINFO copy book

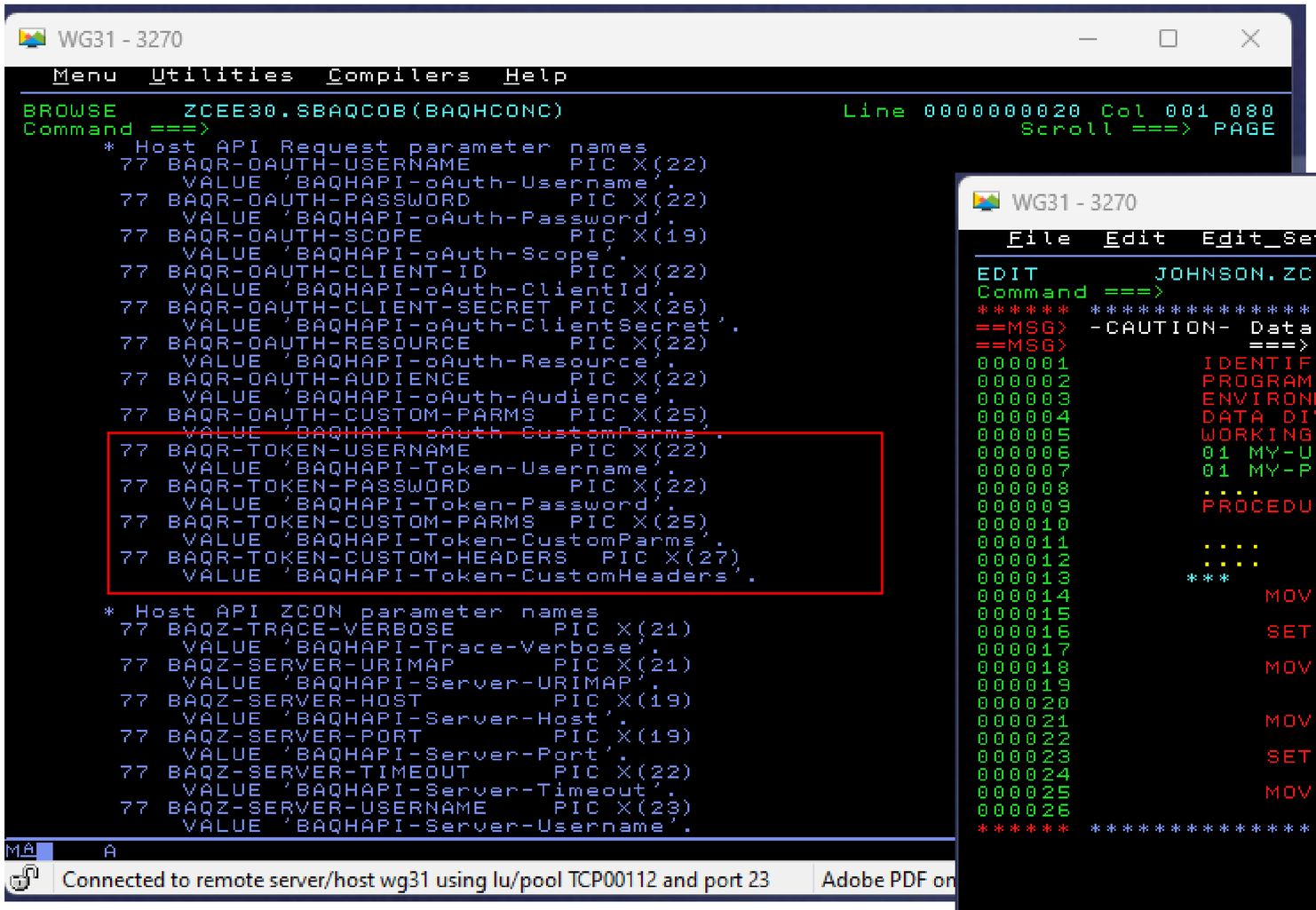
COBOL application

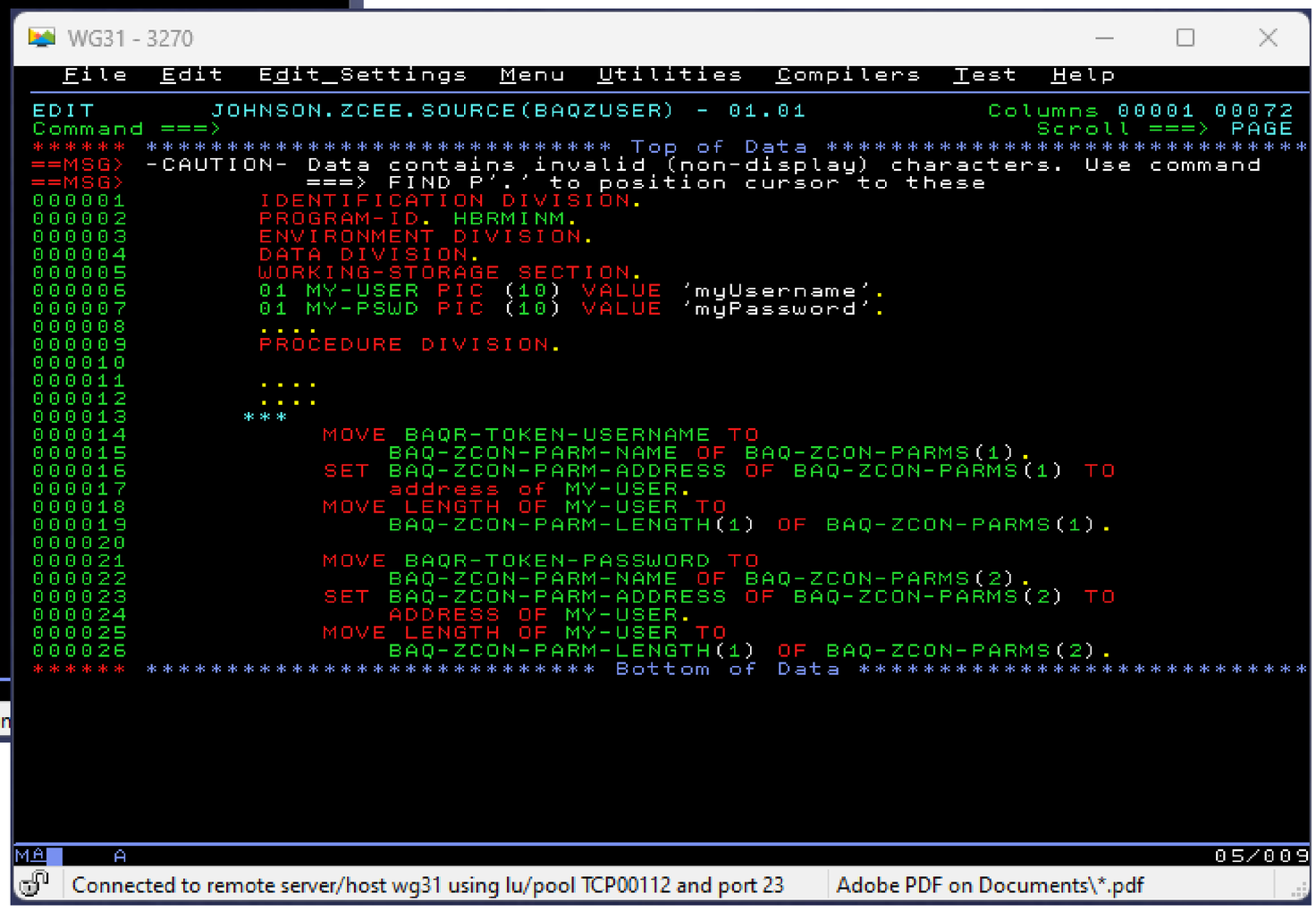
```
MOVE "ATSTOKENUSERNAME" to envVariableName.
PERFORM CALL-CEEENV THRU CALL-CEEENV-END
MOVE VAR(1:valueLength) to BAQ-TOKEN-USERNAME
MOVE valueLength TO BAQ-TOKEN-USERNAME-LEN
MOVE "ATSTOKENPASSWORD" to envVariableName.
PERFORM CALL-CEEENV THRU CALL-CEEENV-END
MOVE VAR(1:valueLength) to BAQ-TOKEN-PASSWORD
MOVE valueLength to BAQ-TOKEN-PASSWORD-LEN
```

Note that this example is using environment variables to provide token credentials, as documented in the z/OS Connect Advanced Topics Guide.

mitchj@us.ibm.com

API Requester – JWT Custom flow





mitchj@us.ibm.com

Configuring JWT Custom flow

```
<zosconnect_endpointConnection id="cscvincAPI"
       host="http://wg31.washington.ibm.com" port="9080"
       authenticationConfigRef="myJWTConfig"/>

<zosconnect_authToken id="myJWTConfig" authServerRef="myJWTServer"
        header="myJWT-header-name"
      <tokenRequest/>      See next slide
      <tokenReponse/>      See next slide
</zosconnect_authToken>

<zosconnect_authorizationServer id="myJWTServer"
      tokenEndpoint=https://wg31.washington.ibm.com:59443/oidc/endpoint/OP/token[1]
      basicAuthRef="tokenCredential"  [2]
      sslCertsRef="OutboundSSLSettings" />

<zosconnect_authData id="tokenCredential" [2]
  user="zCEEClient" password="secret"/>
```

[1] See URL https://www.ibm.com/support/knowledgecenter/SS7K4U_liberty/com.ibm.websphere.wlp.zseries.doc/ae/twlp_oidc_token_endpoint.html

[2] These credentials can be specified by the application

mitchj@us.ibm.com

Configuring Custom JWT flow

Request Token Example 1

```
<tokenRequest
    credentialLocation="header"
    header="Authorization"
    requestMethod="GET" />
```

Response Token

```
<tokenResponse
   tokenLocation="header"
   header="JWTAuthorization" />
```

Response Token Example 2

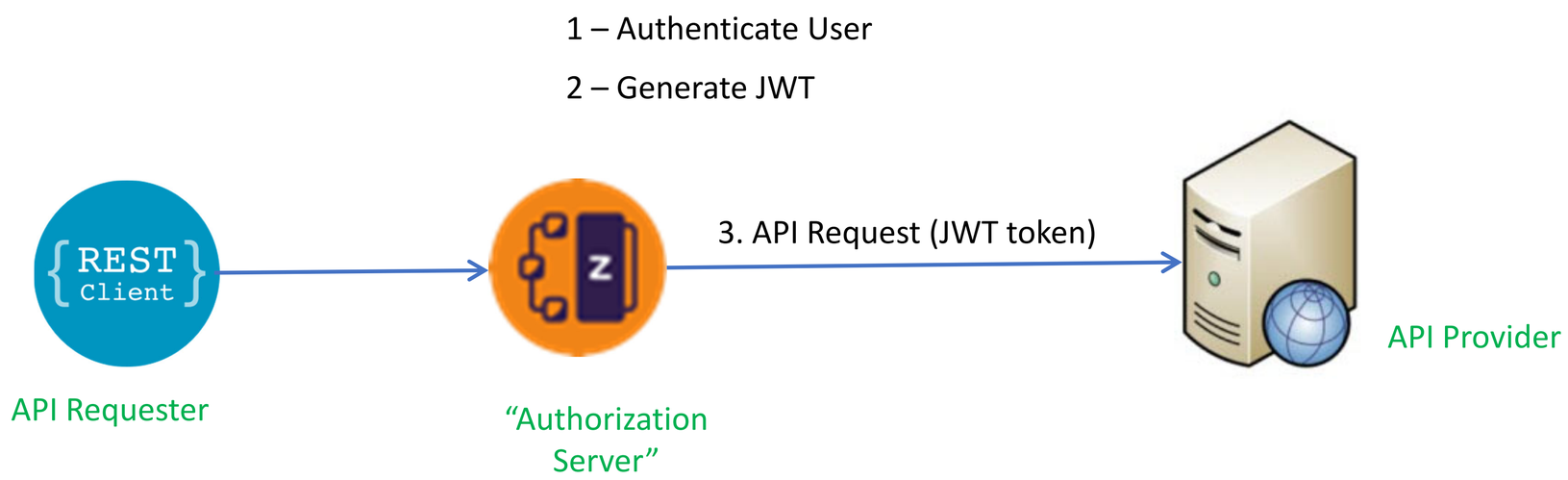
```
<tokenRequest credentialLocation="body"
    requestMethod="POST"
   // Use XML escaped characters in requestBody
   requestBody="{&amp;quot;apiuser&amp;quot;:&amp;quot;${userid}&amp;quot;,&amp;quot;apipassword&amp;quot;:&amp;quot;${password}&amp;quot;}" />
```

Response Token

```
<tokenResponse
    tokenLocation="body"
  responseFormat="JSON"
  tokenPath="$.tokenname" />
```

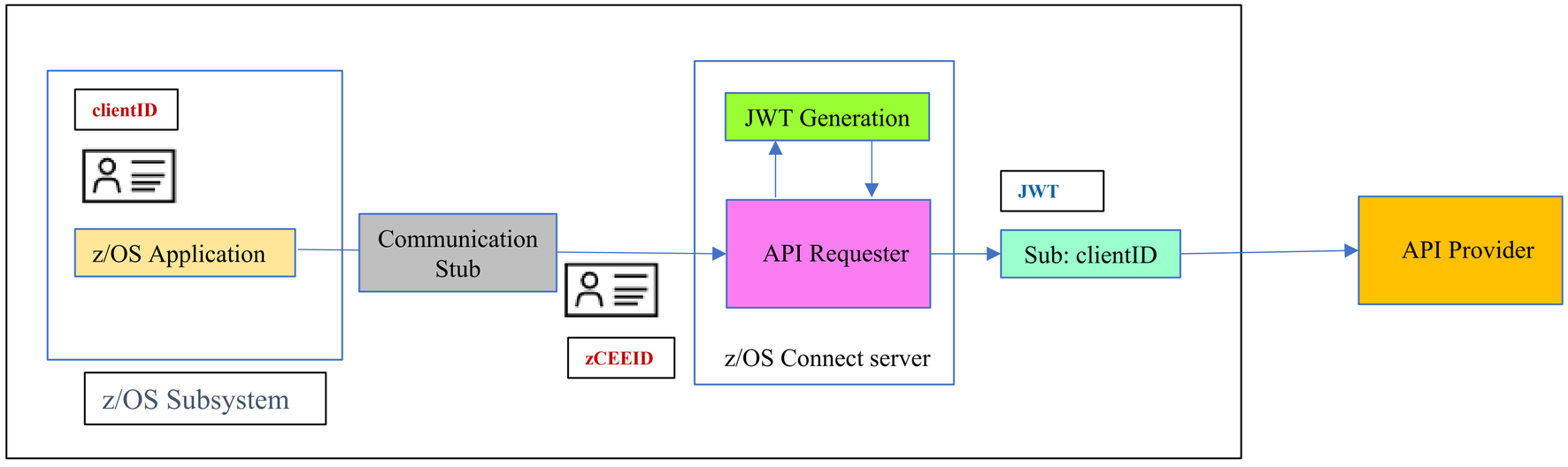
mitchj@us.ibm.com

z/OS Connect JWT Generation – V3.0.43



mitchj@us.ibm.com

API Requester – JWT Generation



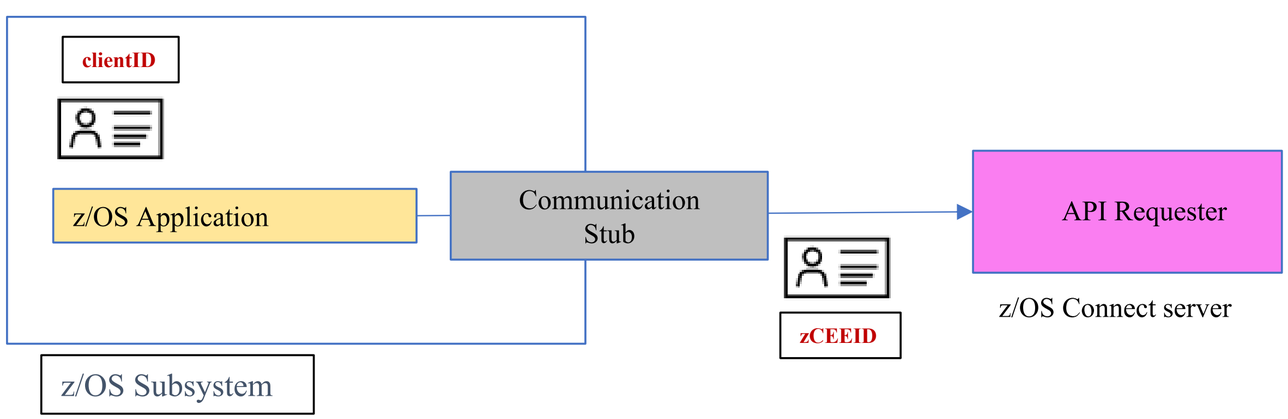
zCEEID – The identity that is used for authenticating connectivity the z/OS subsystem to the zCEE server. It is configured using basic authentication or for CICS, TLS client authentication.
clientID – the identity under which the z/OS application is executing.

- For CICS, the task owner
- For IMS, the transaction owner
- For batch, the job owner

requireAuth	idAssertion	Actions performed by z/OS Connect
true	ASSERT_SURROGATE	Identity assertion is enabled. The zCEE server authenticates *zCEEID* and checks whether *zCEEID* is a surrogate of *clientID*. If *zCEEID* is a surrogate of *clientID*, the server further checks whether *clientID* has the authority to invoke an API requester; otherwise, a BAQR7114E message occurs.
	ASSERT_ONLY	Identity assertion is enabled. The zCEE server authenticates *zCEEID* and directly checks whether *clientID* has the authority to invoke an API requester
false	ASSERT_SURROGATE	Identity assertion is enabled. The zCEE server checks whether *clientID* has the authority to invoke an API requester, and a warning message occurs to indicate that the ASSERT_ONLY value is used instead of the ASSERT_SURROGATE value.
	ASSERT_ONLY	Identity assertion is enabled. The zCEE server checks whether *clientID* has the authority to invoke an API requester

[1] mitchj@us.ibm.com

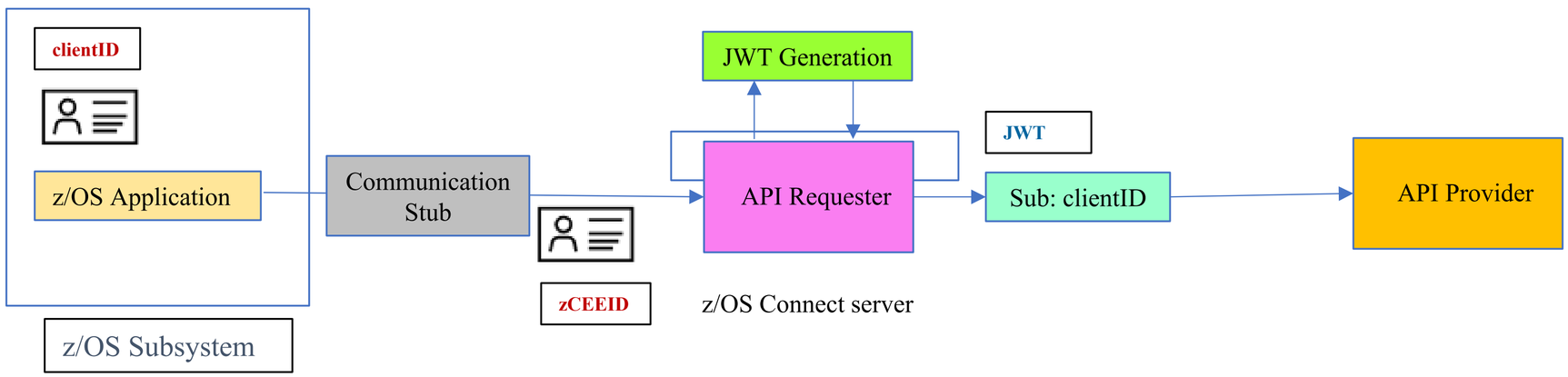
API Requester - authentication with identity assertion and JWT generation



zCEEID – The identity that is used for authenticating connectivity the z/OS subsystem to the zCEE server. It is configured using basic authentication or for CICS, TLS client authentication.

clientID – the identity under which the z/OS application is executing.

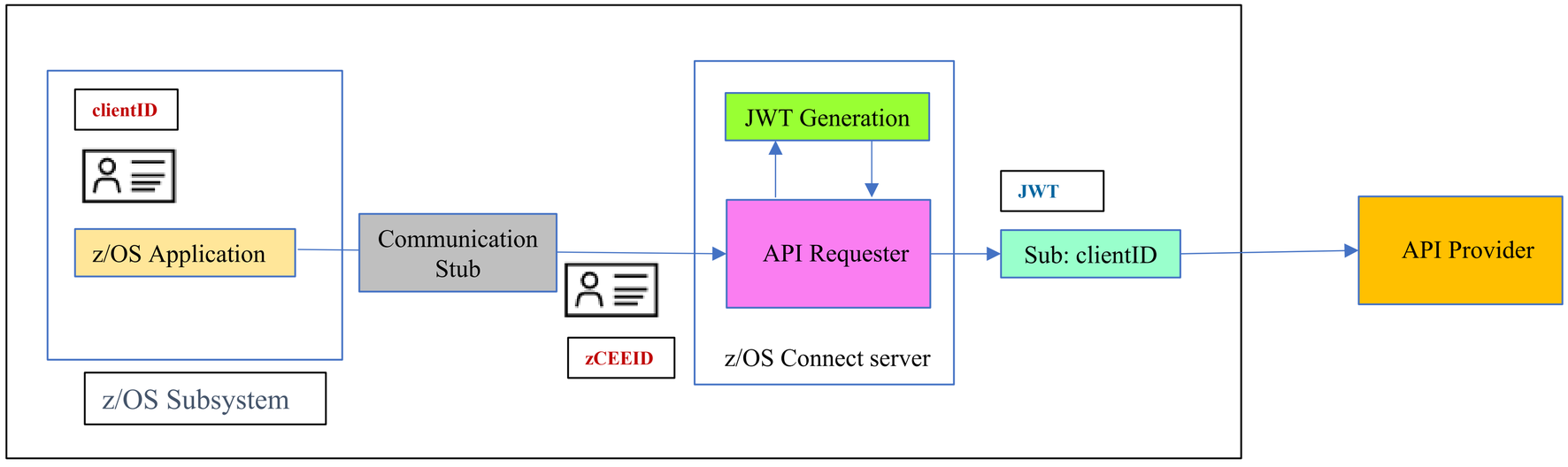
- For CICS, the task owner
- For IMS, the transaction owner
- For batch, the job owner




```
<zosconnect_apiRequesters idAssertion="ASSERT_ONLY">
</zosconnect_apiRequesters>
```

mitchj@us.ibm.com

API Requester – JWT Generation



zCEEID – The identity that is used for authenticating connectivity the z/OS subsystem to the zCEE server. It is configured using basic authentication or for CICS, TLS client authentication.
clientID – the identity under which the z/OS application is executing.

- For CICS, the task owner
- For IMS, the transaction owner
- For batch, the job owner

requireAuth	idAssertion	Actions performed by z/OS Connect
true	ASSERT_SURROGATE	Identity assertion is enabled. The zCEE server authenticates *zCEEID* and checks whether *zCEEID* is a surrogate of *clientID*. If *zCEEID* is a surrogate of *clientID*, the server further checks whether *clientID* has the authority to invoke an API requester; otherwise, a BAQR7114E message occurs.
	ASSERT_ONLY	Identity assertion is enabled. The zCEE server authenticates *zCEEID* and directly checks whether *clientID* has the authority to invoke an API requester
false	ASSERT_SURROGATE	Identity assertion is enabled. The zCEE server checks whether *clientID* has the authority to invoke an API requester, and a warning message occurs to indicate that the ASSERT_ONLY value is used instead of the ASSERT_SURROGATE value.
	ASSERT_ONLY	Identity assertion is enabled. The zCEE server checks whether *clientID* has the authority to invoke an API requester

mitchj@us.ibm.com

Tech-Tip: JWT generation requires setting a program control extended attribute

As root or superuser, set the *libifaedjreg64.so* program control extended attribute bit

- ***Permit the server's identity to the required FACILITY resource***

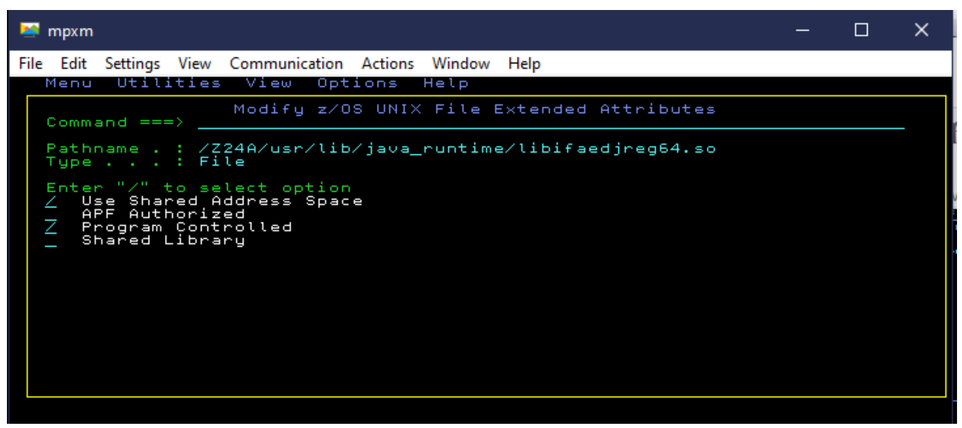
  PERMIT BPX.SERVER CLASS(FACILITY) ID(LIBSERV) ACCESS(READ)
  SETROPTS RACLIST(FACILITY) REFRESH

- ***Define a SURROGAT profile for the asserted identity and permit access to connection identity***

  RDEFINE SURROGAT clientID.BAQASSRT UACC(NONE) OWNER(SYS1)
  PERMIT clientID.BAQASSRT CLASS(SURROGAT) ACCESS(READ) ID(zCEEID)
  OR
  RDEFINE SURROGAT *.BAQASSRT UACC(NONE) OWNER(SYS1)
  PERMIT *.BAQASSRT CLASS(SURROGAT) ACCESS(READ) ID(zCEEID)
  SETROPTS RACLIST(SURROGAT) REFRESH

- ***Enable the program control bit for Java shared object ifaedjreg64***

  su
  cd /usr/lib/java_runtime
  extattr +p libifaedjreg64.so



mitchj@us.ibm.com

Configuring JWT Generation support

```
<zosconnect_endpointConnection id="conn"
    host="http://api.server.com" port="8080"
    authenticationConfigRef="jwtConfig" />

<zosconnect_authTokenLocal id="jwtConfig"
   tokenGeneratorRef="jwtBuilder"
   header="Authorization" >
   <claims>{"name":"JohnSmith,
             "ID":"1234567890"}
   </claims>

<jwtBuilder id="jwtBuilder"
    scope="scope1"
    audiences="myApp1"
    jti="true"
    signatureAlgorithm="RS256"
    keyStoreRef="myKeyStore"
    keyAlias="jwtsigner"
    issuer="z/OS Connect EE Default"/>
```

One or more Public claim (e.g., *aud,exp,nbf,iat,jti*) or one or more private claims

The "sub" claim value will be application asserted user ID.

mitchj@us.ibm.com

Configuring JWT Generation support

```
 <zosconnect_endpointConnection id="conn1"
    host="http://api.server.com" port="8080"
    authenticationConfigRef="jwtConfig" />
<zosconnect_endpointConnection id="conn2"
    host="http://api.server.com" port="8080"
    authenticationConfigRef="jwtConfig" />
<zosconnect_authTokenLocal id="jwtConfig"
   tokenGeneratorRef="jwtBuilder"
   header="Authorization" >
   <claims>{"scope":"Scope1"}</claims>
<zosconnect_authTokenLocal id="jwtConfig"
   tokenGeneratorRef="jwtBuilder"
   header="Authorization" >
   <claims>{"scope":"Scope2"}</claims>
<jwtBuilder id="jwtBuilder"
    scope="scope"
    audiences="myApp1"
    jti="true"
    signatureAlgorithm="RS256"
    keyStoreRef="myKeyStore"
    keyAlias="jwtsigner"
    issuer="z/OS Connect EE Default"/>
```

mitchj@us.ibm.com

server XML Configuration

```
<jwtBuilder id=”jwtBuilder”
    scope=“scope1”
    audiences=“myApp1”
    jti=“true”
    signatureAlgorithm=“RS256”
    keyStoreRef=”myKeyStore"
    keyAlias="jwtsigner"
    issuer="z/OS Connect EE Default”/>

<zosconnect_authTokenLocal id=”jwtConfig”
    tokenGeneratorRef=“jwtBuilder”
    header=“JWTAuthorization” >
    <claims>{"name":"JohnSmith,
            "ID":"1234567890"}</claims>
</ zosconnect_authTokenLocal >

<zosconnect_endpointConnection id="conn"
    host="http://api.server.com" port="8080"
    authenticationConfigRef=”jwtConfig" />
```

Configure the Liberty jwtBuilder element in server.xml.

Configure the zosconnect_authTokenLocal element, specifying any additional private claims required and the name of the header used to send the JWT to the endpoint.

header default value is Authorization

Finally, reference the JWT configuration from the zosconnect_endpointConnection element.

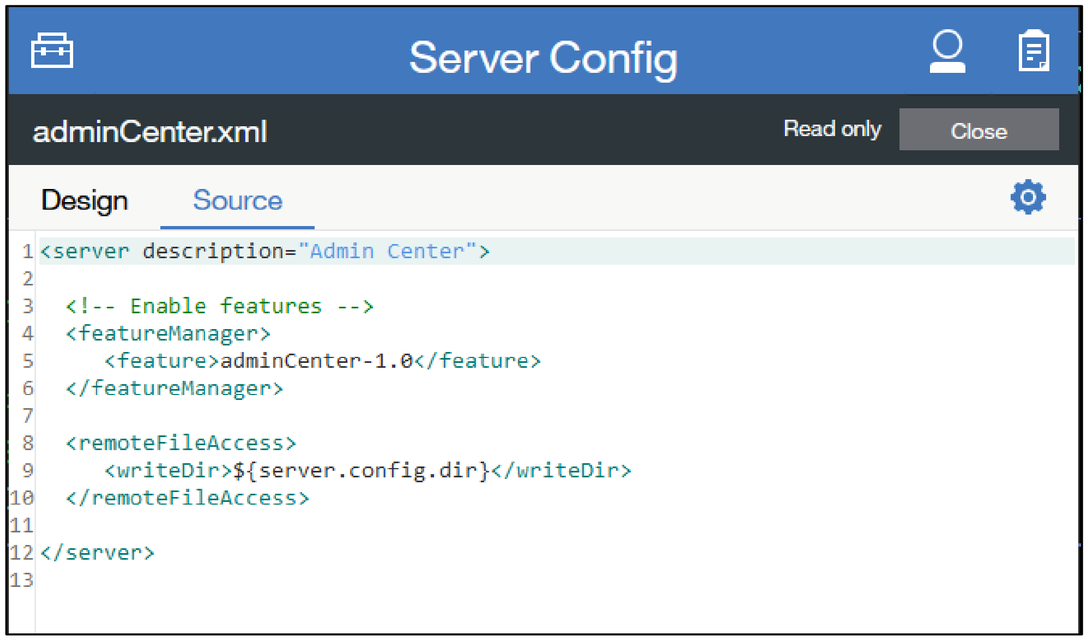
mitchj@us.ibm.com

Useful Liberty functions/features and MVS commands

mitchj@us.ibm.com

Use the adminCenter-1.0 feature to update the server XML from a browser

Administrators can use a web interface to maintain the server XML configuration.

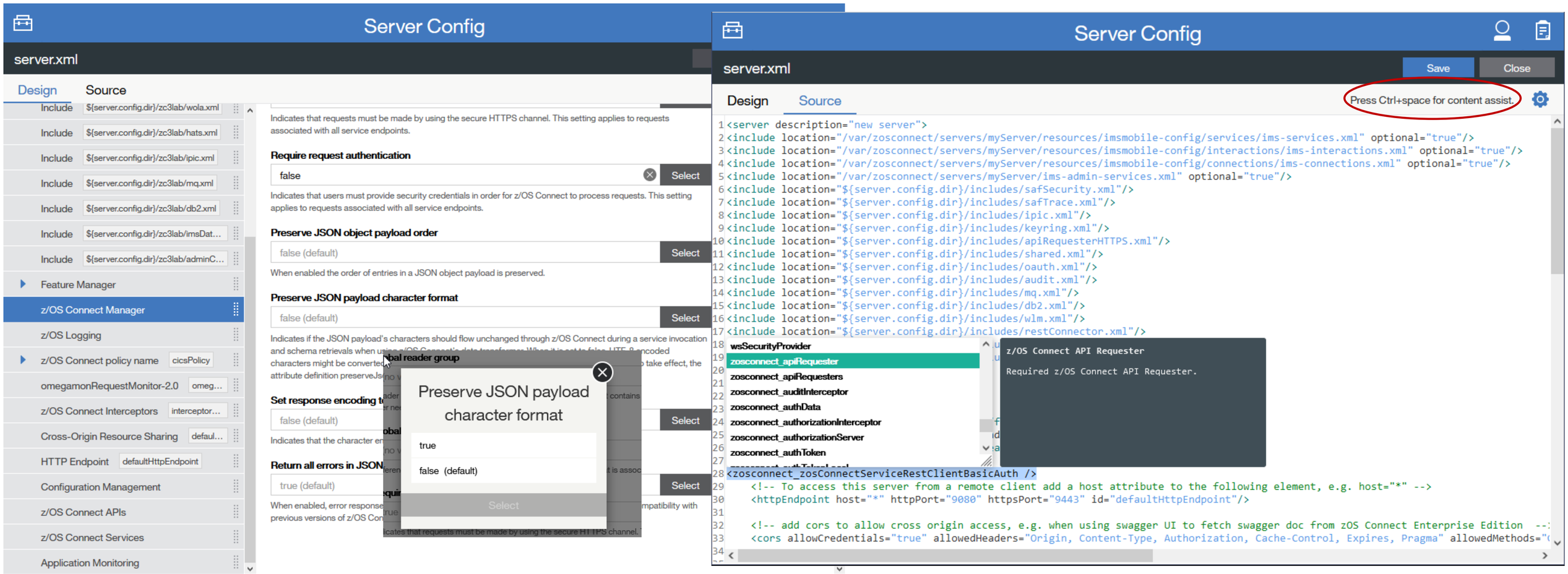



```
RDEFINE EJBROLE BBGZDFLT.com.ibm.ws.management.security.resource.Administrator OWNER(SYS1) UACC(NONE)
RDEFINE EJBROLE BBGZDFLT.com.ibm.ws.management.security.resource.Reader OWNER(SYS1) UACC(NONE)

PERMIT BBGZDFLT.com.ibm.ws.management.security.resource.Administrator  CLASS(EJBROLE) ID(FRED) ACCESS(READ)
PERMIT BBGZDFLT.com.ibm.ws.management.security.resource.Reader CLASS(EJBROLE) ID(FRED) ACCESS(READ

SETR RACLIST(EJBROLE) REFRESH
```

mitchj@us.ibm.com

Use Liberty's "adminCenter" Feature to manage server XML

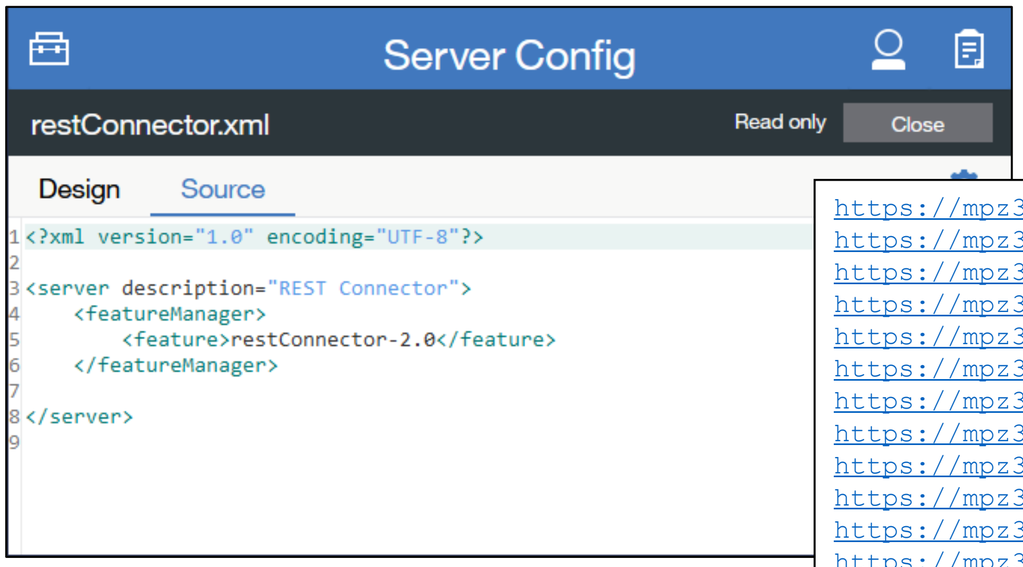
- Web browser interface to the server's configuration files



mitchj@us.ibm.com

Use the restConnector-2.0 feature to see real time configuration details

A secure, REST administrative connector that enables remote access from a Java client or Web browser (GET only) or directly through an HTTPS call to the current runtime configuration.



URI Path is the concatenation of the path */ibm/api/config* with the server XML configuration element and any optional query strings.

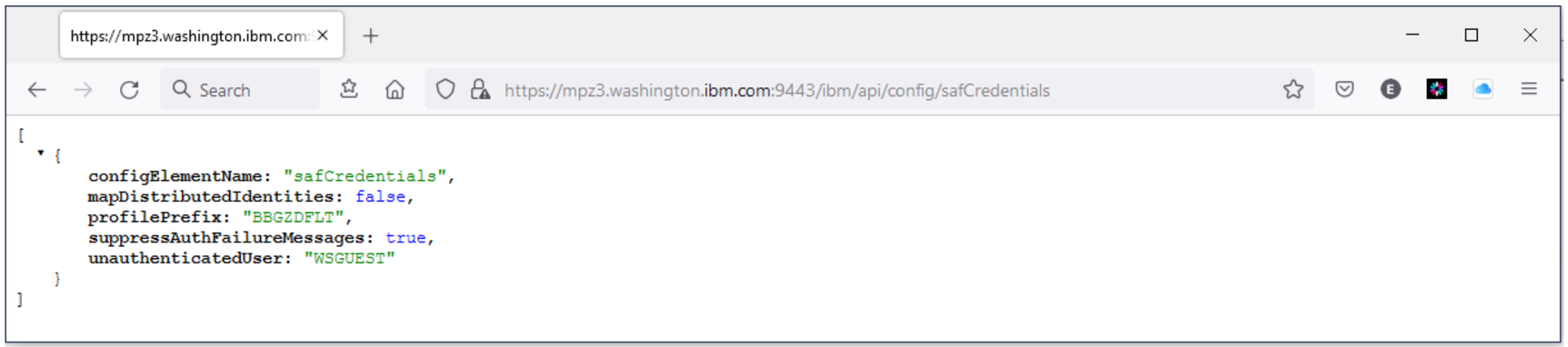
```
https://mpz3.washington.ibm.com:9443/ibm/api/config/jmsQueue
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_cicsIpicConnection?port=1491
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_zosConnectServiceRestClientConnection
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_cicsIpicConnection?id=miniloan
https://mpz3.washington.ibm.com:9443/ibm/api/config/safCredentials
https://mpz3.washington.ibm.com:9443/ibm/api/config/connectionFactory
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_zosConnectManager
https://mpz3.washington.ibm.com:9443/ibm/api/config/keyStore
https://mpz3.washington.ibm.com:9443/ibm/api/config/ssl
https://mpz3.washington.ibm.com:9443/ibm/api/config/sslDefault
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_zosConnectManager
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_zosConnectAPIs
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_services
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_apiRequesters
```

```
RDEFINE EJBROLE BBGZDFLT.com.ibm.ws.management.security.resource.Administrator OWNER(SYS1) UACC(NONE)
RDEFINE EJBROLE BBGZDFLT.com.ibm.ws.management.security.resource.Reader OWNER(SYS1) UACC(NONE)
RDEFINE EJBROLE BBGZDFLT.com.ibm.ws.management.security.resource.allAuthenticatedUsers OWNER(SYS1) UACC(NONE)
PERMIT BBGZDFLT.com.ibm.ws.management.security.resource.Administrator CLASS(EJBROLE) ID(ZCEEUSRS) ACCESS(READ)
PERMIT BBGZDFLT.com.ibm.ws.management.security.resource.Reader CLASS(EJBROLE) ID(ZCEEUSRS) ACCESS(READ)
PERMIT BBGZDFLT.com.ibm.ws.management.security.resource.allAuthenticatedUsers CLASS(EJBROLE) ID(ZCEEUSRS)
ACCESS(READ)
SETR RACLIST(EJBROLE) REFRESH
```

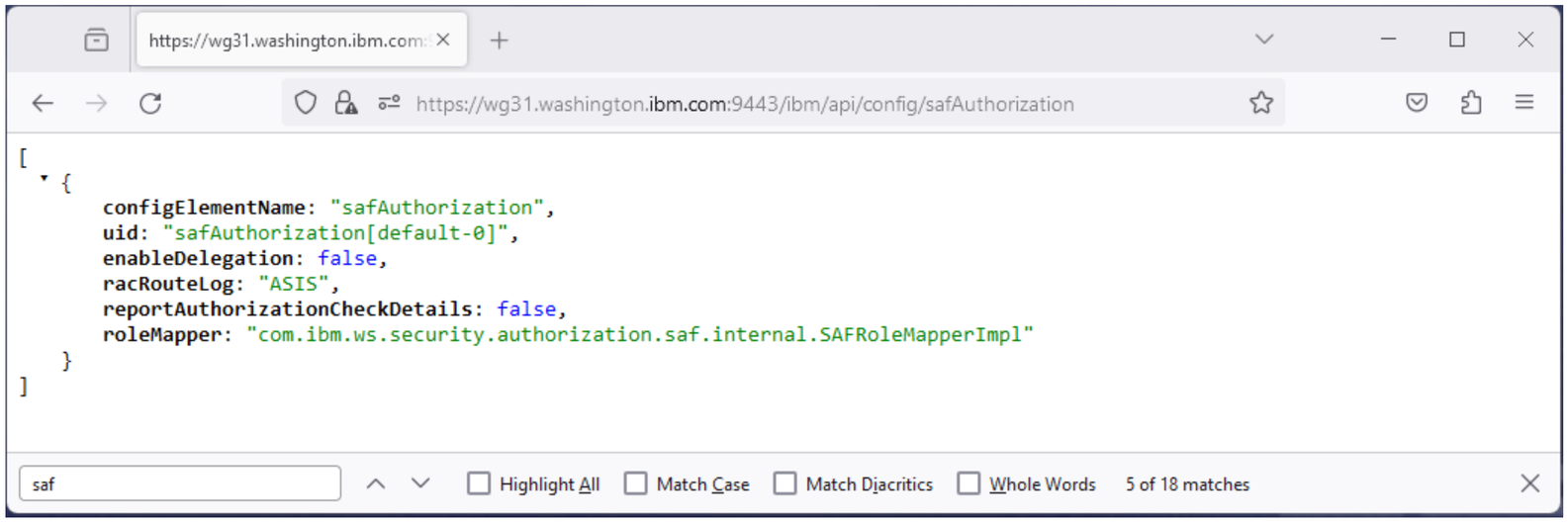
mitchj@us.ibm.com

restConnector-2.0 examples – safCredentials/safAuthorization

```
https://mpz3.washington.ibm.com:9443/ibm/api/config/safCredentials
```




```
https://mpz3.washington.ibm.com:9443/ibm/api/config/safAuthorization
```



mitchj@us.ibm.com

restConnector-2.0 examples – zosconnect_cicsIpicConnection

```
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_cicsIpicConnection?port=1491
```

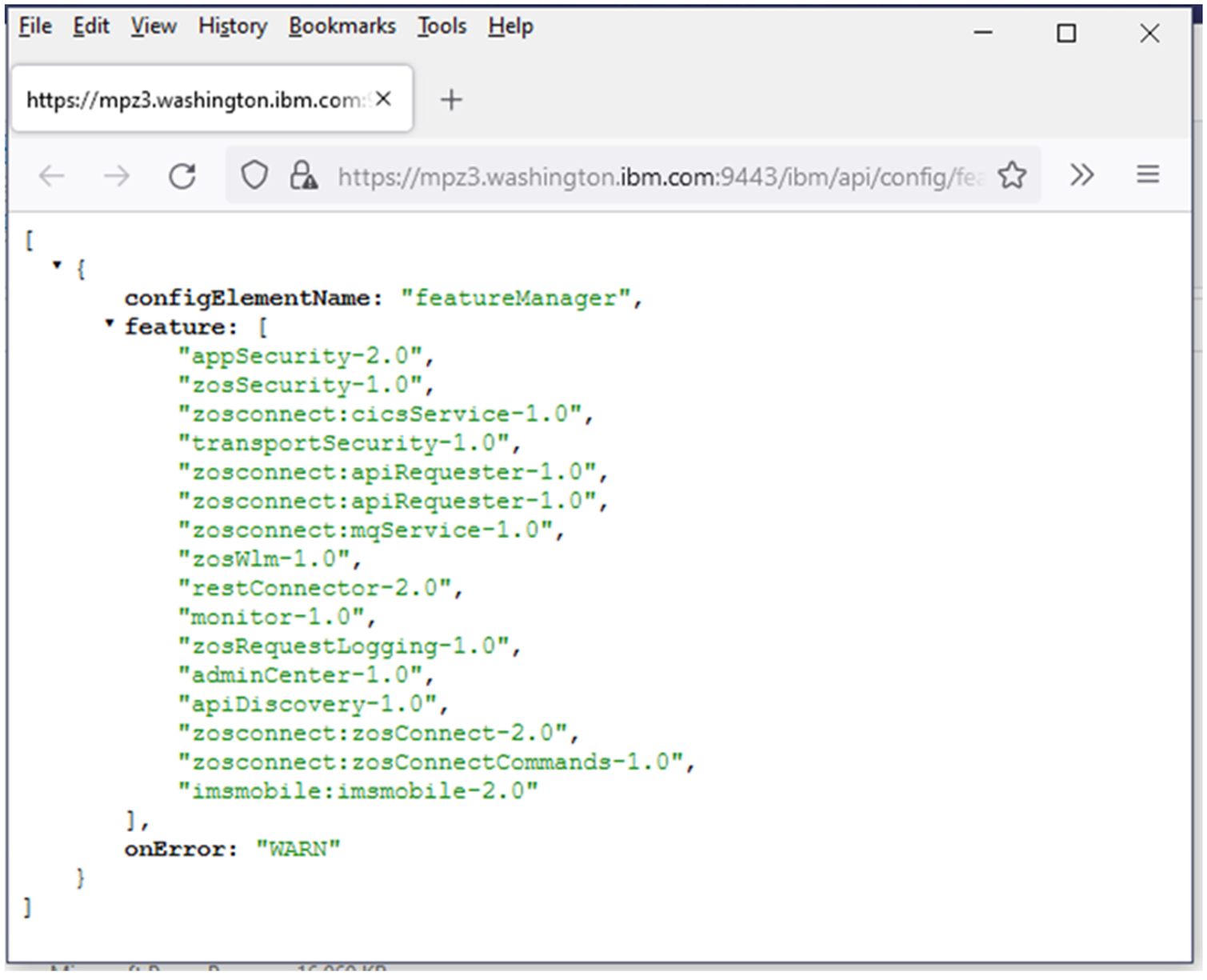
https://mpz3.washington.ibm.com:9443/ibm/api/config/zosconnect_cicsIpicConnection?port=1491


```
[
  {
    configElementName: "zosconnect_cicsIpicConnection",
    uid: "catalog",
    id: "catalog",
    connectionTimeout: 30000,
    heartbeatInterval: 30000,
    host: "wg31.washington.ibm.com",
    port: 1491,
    sharedPort: false,
    transidUsage: "EIB_AND_MIRROR"
  },
  {
    configElementName: "zosconnect_cicsIpicConnection",
    uid: "cscvinc",
    id: "cscvinc",
    connectionTimeout: 30000,
    heartbeatInterval: 30000,
    host: "wg31.washington.ibm.com",
    port: 1491,
    sharedPort: false,
    transidUsage: "EIB_AND_MIRROR"
  },
  {
    configElementName: "zosconnect_cicsIpicConnection",
    uid: "miniloan1",
    id: "miniloan1",
    connectionTimeout: 30000,
    heartbeatInterval: 30000,
    host: "wg31.washington.ibm.com",
    port: 1491,
    sharedPort: false,
    transidUsage: "EIB_AND_MIRROR"
  },
  {
    configElementName: "zosconnect_cicsIpicConnection",
    uid: "miniloan",
    id: "miniloan",
    connectionTimeout: 30000,
    heartbeatInterval: 30000,
    host: "wg31.washington.ibm.com",
    port: 1491,
    sharedPort: false,
    transidUsage: "EIB_AND_MIRROR"
  }
]
```


mitchj@us.ibm.com

restConnector-2.0 examples – featureManager

```
https://mpz3.washington.ibm.com:9443/ibm/api/config/featureManager
```



mitchj@us.ibm.com

restConnector-2.0 examples – keyStore

```
https://mpz3.washington.ibm.com:9443/ibm/api/config/keyStore
```

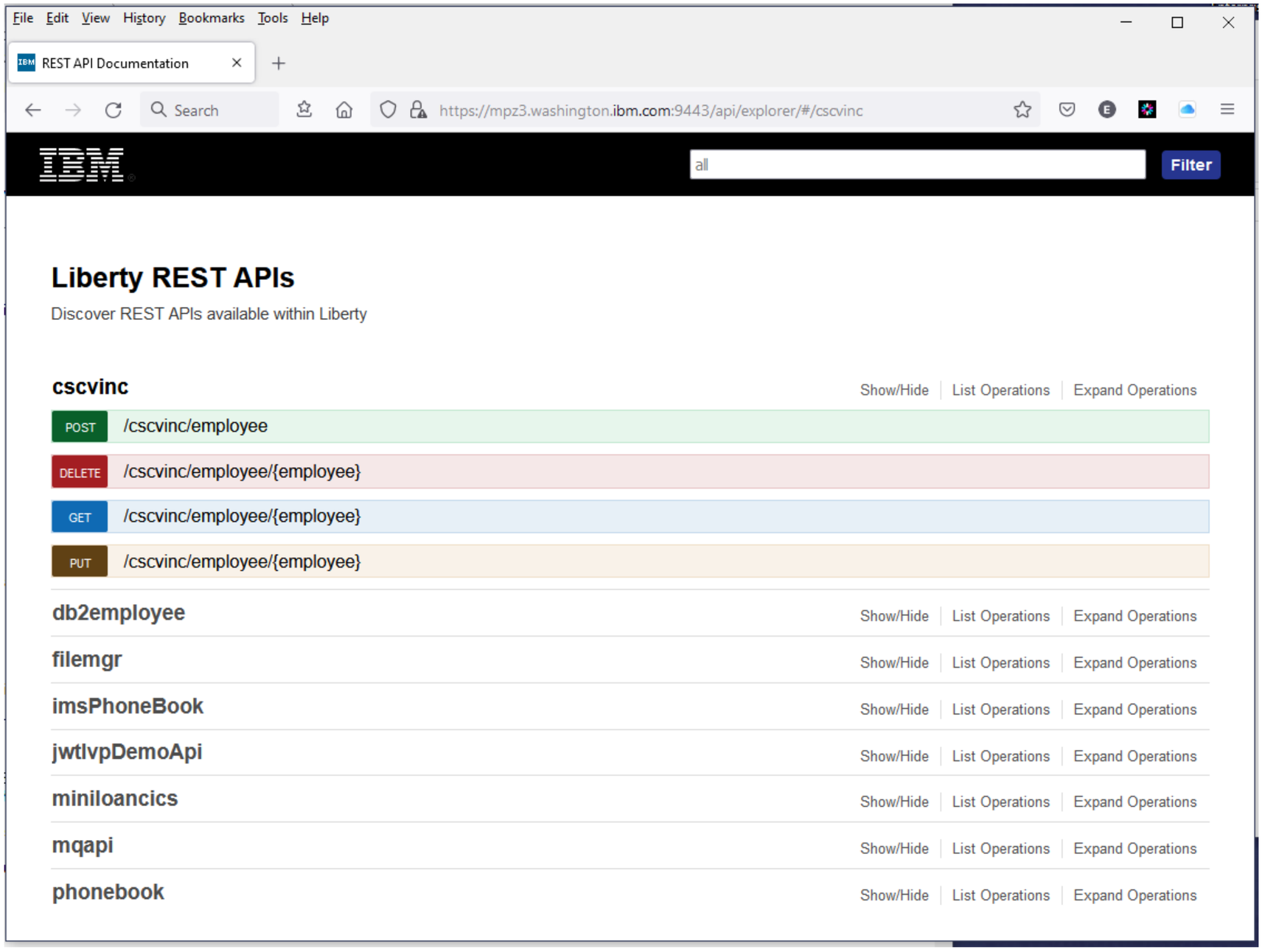
https://wg31.washington.ibm.com:9443/ibm/api/config/keyStore


```
[
  {
      configElementName: "keyStore",
      uid: "CellDefaultKeyStore",
      id: "CellDefaultKeyStore",
      fileBased: false,
      location: "safkeyring:///Liberty.KeyRing",
      password: "******",
      pollingRate: 500,
      readOnly: true,
      type: "JCERACFKS",
      updateTrigger: "mbean"
  },
  {
      configElementName: "keyStore",
      uid: "defaultKeyStore",
      id: "defaultKeyStore",
      fileBased: true,
      location: "/var/zosconnect/servers/myServer//resources/security/key.p12",
      pollingRate: 500,
      readOnly: false,
      type: "PKCS12",
      updateTrigger: "mbean"
  }
]
```


saf Highlight All Match Case Match Diacritics Whole Words 5 of 18

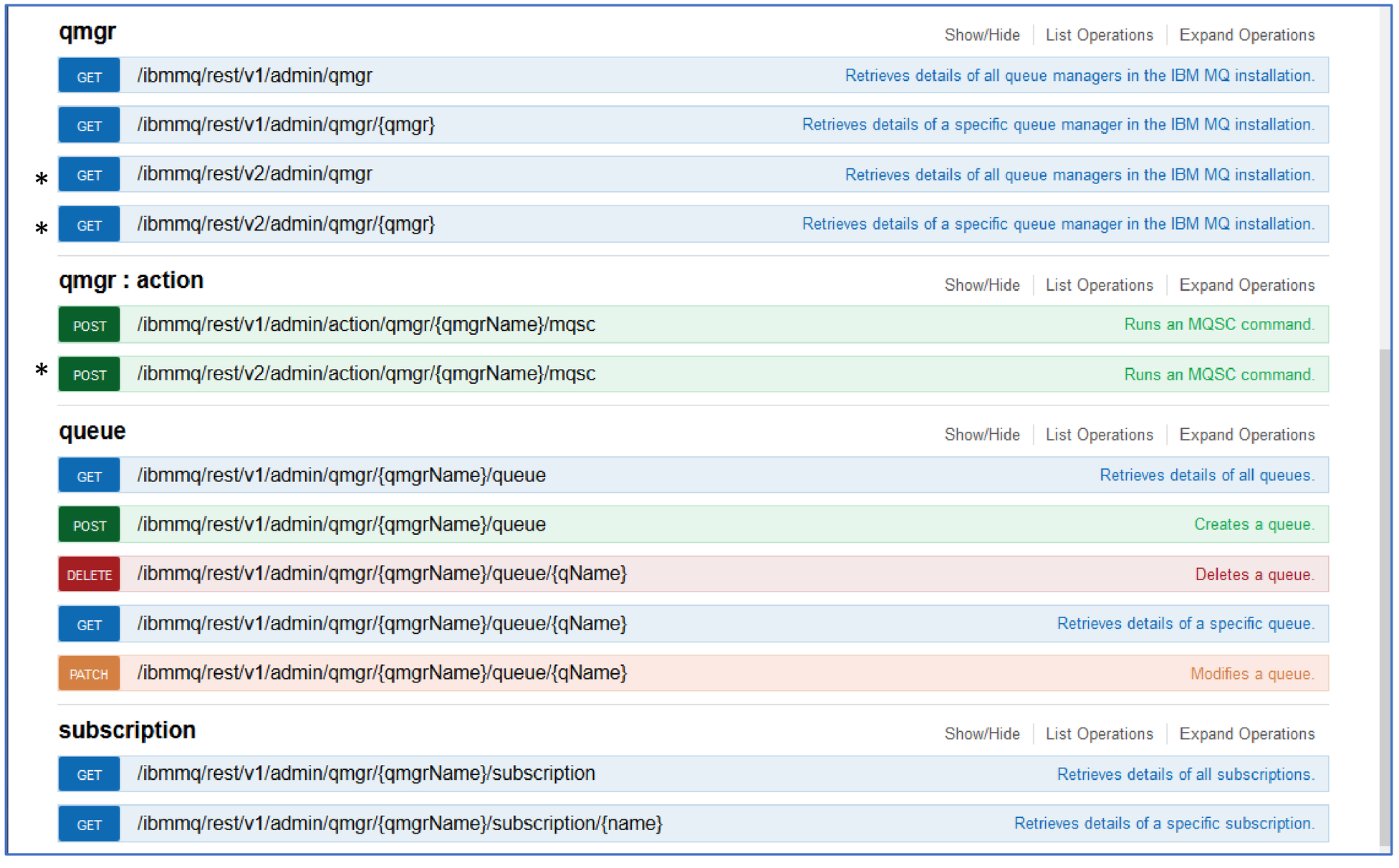
mitchj@us.ibm.com

Use the apiDiscovery-1.0 or OpenAPI-3.0 features to execute RESTful APIs directly



mitchj@us.ibm.com

IBM MQ Administrative REST API



qmgr — Show/Hide | List Operations | Expand Operations

	GET	/ibmmq/rest/v1/admin/qmgr	Retrieves details of all queue managers in the IBM MQ installation.
	GET	/ibmmq/rest/v1/admin/qmgr/{qmgr}	Retrieves details of a specific queue manager in the IBM MQ installation.
*	GET	/ibmmq/rest/v2/admin/qmgr	Retrieves details of all queue managers in the IBM MQ installation.
*	GET	/ibmmq/rest/v2/admin/qmgr/{qmgr}	Retrieves details of a specific queue manager in the IBM MQ installation.

qmgr : action — Show/Hide | List Operations | Expand Operations

	POST	/ibmmq/rest/v1/admin/action/qmgr/{qmgrName}/mqsc	Runs an MQSC command.
*	POST	/ibmmq/rest/v2/admin/action/qmgr/{qmgrName}/mqsc	Runs an MQSC command.

queue — Show/Hide | List Operations | Expand Operations

GET	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/queue	Retrieves details of all queues.
POST	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/queue	Creates a queue.
DELETE	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/queue/{qName}	Deletes a queue.
GET	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/queue/{qName}	Retrieves details of a specific queue.
PATCH	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/queue/{qName}	Modifies a queue.

subscription — Show/Hide | List Operations | Expand Operations

GET	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/subscription	Retrieves details of all subscriptions.
GET	/ibmmq/rest/v1/admin/qmgr/{qmgrName}/subscription/{name}	Retrieves details of a specific subscription.

mitchj@us.ibm.com

* If you are accessing a version earlier than V9.1.5 you must use v1

IBM MQ Messaging REST API Support

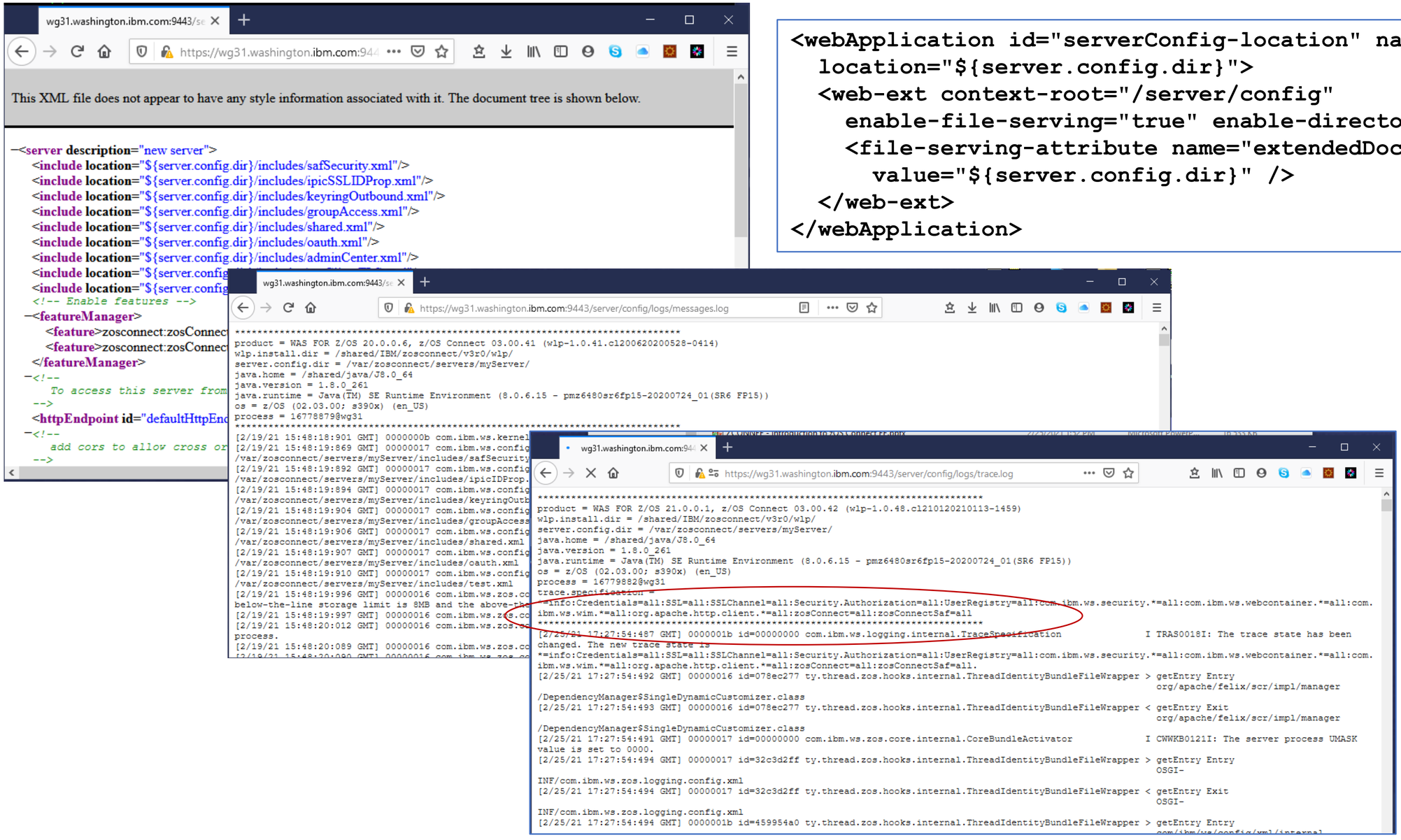
messaging Show/Hide | List Operations | Expand Operations

	DELETE	/ibmmq/rest/v1/messaging/qmgr/{qmgrName}/queue/{qName}/message	Retrieves the next message from a specified queue.
	GET	/ibmmq/rest/v1/messaging/qmgr/{qmgrName}/queue/{qName}/message	Browses the next message from a specified queue.
	POST	/ibmmq/rest/v1/messaging/qmgr/{qmgrName}/queue/{qName}/message	Sends a message to a specified queue.
	GET	/ibmmq/rest/v1/messaging/qmgr/{qmgrName}/queue/{qName}/messagelist	Browses messages from a specified queue.
*	DELETE	/ibmmq/rest/v2/messaging/qmgr/{qmgrName}/queue/{qName}/message	Retrieves the next message from a specified queue.
*	GET	/ibmmq/rest/v2/messaging/qmgr/{qmgrName}/queue/{qName}/message	Browses the next message from a specified queue.
*	POST	/ibmmq/rest/v2/messaging/qmgr/{qmgrName}/queue/{qName}/message	Sends a message to a specified queue.
*	GET	/ibmmq/rest/v2/messaging/qmgr/{qmgrName}/queue/{qName}/messagelist	Browses messages from a specified queue.
*	POST	/ibmmq/rest/v2/messaging/qmgr/{qmgrName}/topic/{topicString}/message	Publishes a message to a specified topic.

* If you are accessing a version earlier than V9.1.5 you must use v1 rather than v2

mitchj@us.ibm.com

Provide remote access to configuration/log information




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

mitchj@us.ibm.com

Liberty MVS Commands

F BAQSTRT,CACHE,CLEAR,AUTH
Clears all users that are cached in the Liberty authentication cache

F BAQSTRT,REFRESH,CONFIG
Process pending configuration updates. Configuration processing applies to the server.xml file, any files it includes

F BAQSTRT,REFRESH,APPS
Process pending application updates. (Applicable to OpenAPI 3 servers only)

F BAQSTRT,REFRESH,KEYSTORE
Use the command to refresh the keystore instorage profiles for the server.

F BAQSTRT,REFESH,KEYSTORE,ID=*OutboundKeyRing*
To refresh a specific keystore defined in the server XML with ID=OutboundKeyRing.

F BAQSTRT,CACHE,CLEAR,AUTH
Clears all users that are cached in the Liberty authentication cache.

F BAQSTRT,PAUSE
To pause the server

F BAQSTRT,STATUS
To display the current status of a server

F BAQSTRT,RESUME
To resume the server

For more details, see URL https://www.ibm.com/docs/en/was-liberty/zos?topic=zos-modify-commands

mitchj@us.ibm.com

Liberty MVS Angel Commands

F BAQZANGL,DISPLAY,SERVERS

Displays a list of servers currently connected to the angel

F BAQZANGL,DISPLAY,SERVERS,PID

Displays a list of servers currently connected to the angel code along with the server's PIDs.

```
CWWKB0067I ANGEL DISPLAY OF ACTIVE SERVERS
CWWKB0080I ACTIVE SERVER ASID 4d JOBNAME ZCEEAPIR PID 16777398
CWWKB0080I ACTIVE SERVER ASID 4b JOBNAME ZCEEDVM  PID 50331780
CWWKB0080I ACTIVE SERVER ASID 4f JOBNAME WLPRPSRV PID 138
CWWKB0080I ACTIVE SERVER ASID 4a JOBNAME ZCEESRVR PID 50331815
CWWKB0080I ACTIVE SERVER ASID 50 JOBNAME ZCEEOPID PID 33554605
CWWKB0080I ACTIVE SERVER ASID 4c JOBNAME ZCEEHATS PID 143
CWWKB0080I ACTIVE SERVER ASID 4e JOBNAME WLPOPSRV PID 33554565
CWWKB0080I ACTIVE SERVER ASID 58 JOBNAME MQWEBS   PID 152
```

F BAQZANGL,VERSION

Displays the version level of the angel

mitchj@us.ibm.com

z/OS Connect MVS Commands (OpenAPI 2)

```
<feature>zosconnect:zosConnectCommands-1.0</feature>
```

F BAQSTRT,ZCON,REFRESH
All updated z/OS Connect artifacts (APIs, services, and API Requesters) are reloaded.

F BAQSTRT,ZCON,CLEARTOKENCACHE
Clears all OAuth 2.0 access tokens and JWTs from the cache. The token cache is only applicable for OAuth 2.0 access tokens and JWTs that were generated either locally or by an external authentication server, when invoking API requesters.

F BAQSTRT,ZCON,CLEARSAFCACHE
Clears the SAF cache. The SAF cache contains SAF user IDs and any associated RACF groups in which the user ID resides. The SAF cache is only applicable to API requester, and only when ID assertion is enabled.

F BAQSTRT,REFRESH,APPS

mitchj@us.ibm.com

Monitoring Java, Liberty and z/OS Connect

mitchj@us.ibm.com

Java Health Center – Monitors the Java environment

Configuring the Monitoring Agent using JVM directives

Java Health Center Directives

- `healthcenter:level=headless` *run without a client*
- `com.ibm.java.diagnostics.healthcenter.headless.output.directory=/var/zcee/hcd` *directory where HCD will be stored*
- `com.ibm.java.diagnostics.healthcenter.socket.readwrite=on` *collect socket sent/receive data*
- `com.ibm.java.diagnostics.healthcenter.headless.files.to.keep=2` *number of HCD files to retain*
- `com.ibm.java.diagnostics.healthcenter.headless.delay.start=value=0` *delay start value in minutes*
- `com.ibm.java.diagnostics.healthcenter.headless.run.pause.duration=0` *pause between runs, in minutes*
- `com.ibm.java.diagnostics.healthcenter.headless.run.duration=0` *run duration, in minutes*
- `com.ibm.java.diagnostics.healthcenter.headless.run.number.of.runs=0` *number of runs*
- `com.ibm.diagnostics.healthcenter.readonly=on` *no client connections allowed*

Add directives to bootstrap.properties or a JVM properties file,e.g., /var/zcee/properties/zceeHCD.properties

```
   -Dcom.ibm.tools.attach.enable=yes
-Xhealthcenter:level=headless
   -Dcom.ibm.java.diagnostics.healthcenter.headless.output.directory=/var/zcee/hcd
   -Dcom.ibm.java.diagnostics.healthcenter.socket.readwrite=on -Dcom.ibm.diagnostics.healthcenter.readonly=on
   -Dcom.ibm.java.diagnostics.healthcenter.headless.run.duration=5
   -Dcom.ibm.java.diagnostics.healthcenter.headless.run.number.of.runs=1 #
```

All the health center directives should be on one line.

For details on these and other Health Center configuration properties, see URL
https://www.ibm.com/docs/en/mon-diag-tools?topic=agent-health-center-configuration-properties

mitchj@us.ibm.com

Java Health Center – Monitoring Agent Configuration

Set the JVM_OPTIONS environment variable to the properties file containing the health center directives

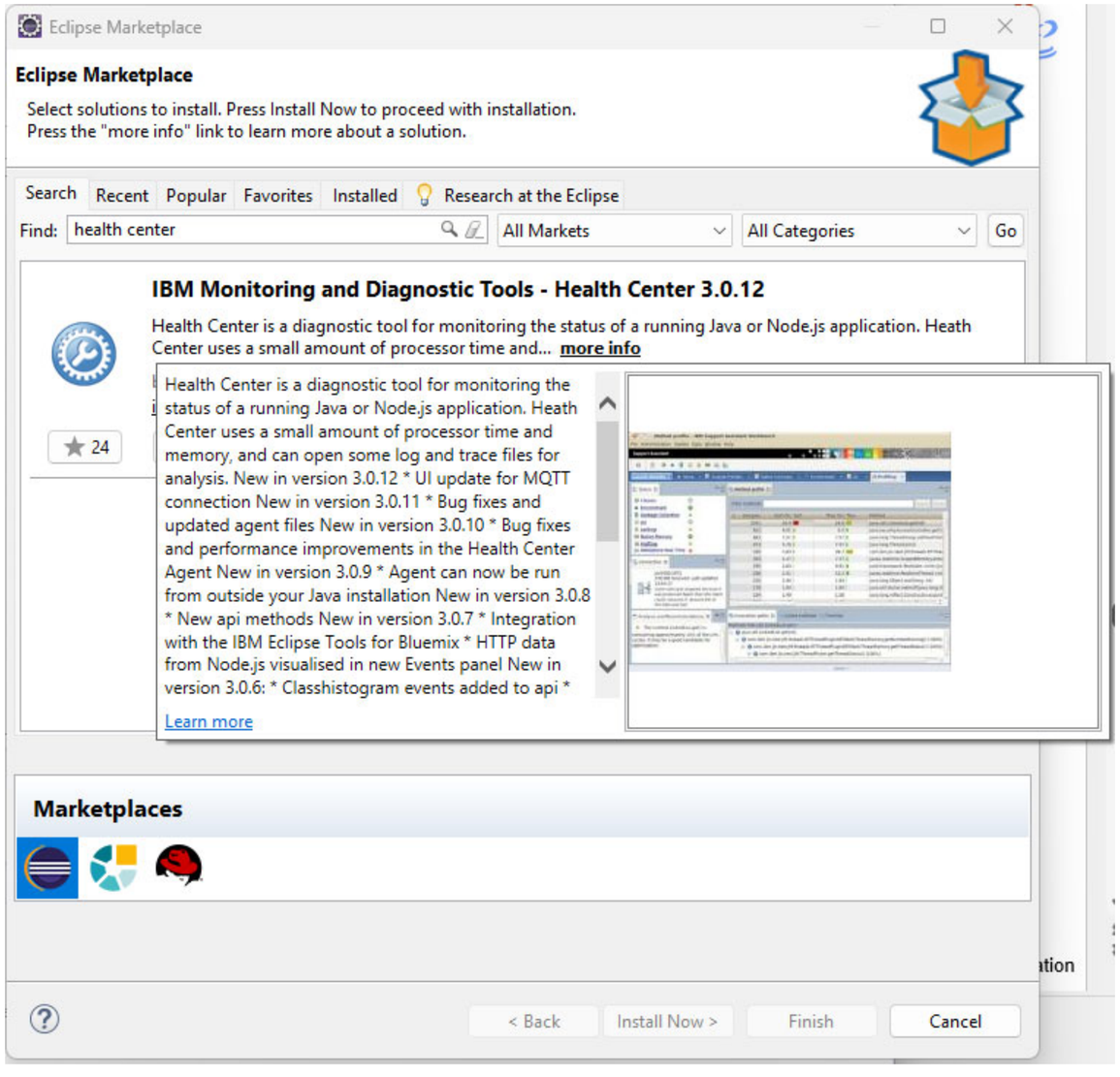
SYS1.PROCLIB(BAQSTRT)

```
//BAQSTRT  PROC PARMS='myServer --clean'
//*
// SET ZCONHOME='/usr/lpp/IBM/zosconnect/v3r0'
//*
//ZCON     EXEC PGM=BPXBATSL,REGION=0M,MEMLIMIT=8G,
//         PARM='PGM &ZCONHOME./bin/zosconnect run &PARMS.'
//STEPLIB  DD DISP=SHR,DSN=MQ91#.SCSQAUTH
//         DD DISP=SHR,DSN=MQ91#.SCSQANLE
//STDERR   DD   SYSOUT=*,FREE=CLOSE,SPIN=(UNALLOC,1M)
//STDOUT   DD   SYSOUT=*
//STDIN    DD   DUMMY
//STDENV   DD   *
_BPX_SHAREAS=YES
JAVA_HOME=/usr/lpp/java/J8.0_64/
WLP_USER_DIR=/var/zosconnect
JVM_OPTIONS=-Xoptionsfile=/var/zcee/properties/zceeHCD.properties
```

mitchj@us.ibm.com

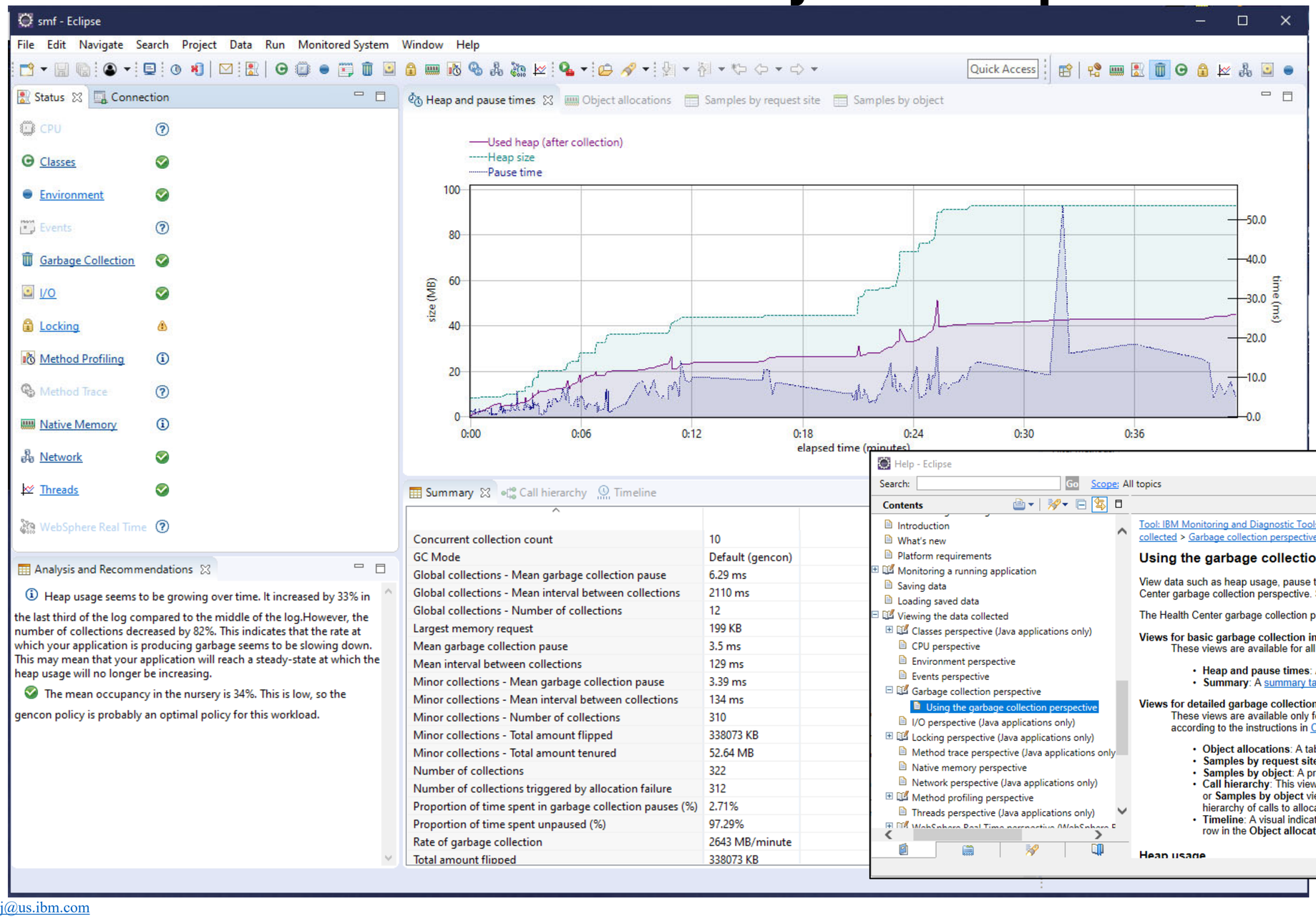
Java Health Center – Client Configuration

The Java health center client is available on the Eclipse Marketplace can be installed in most Eclipse workspace, e.g., IBM z/OS Explorer, etc.



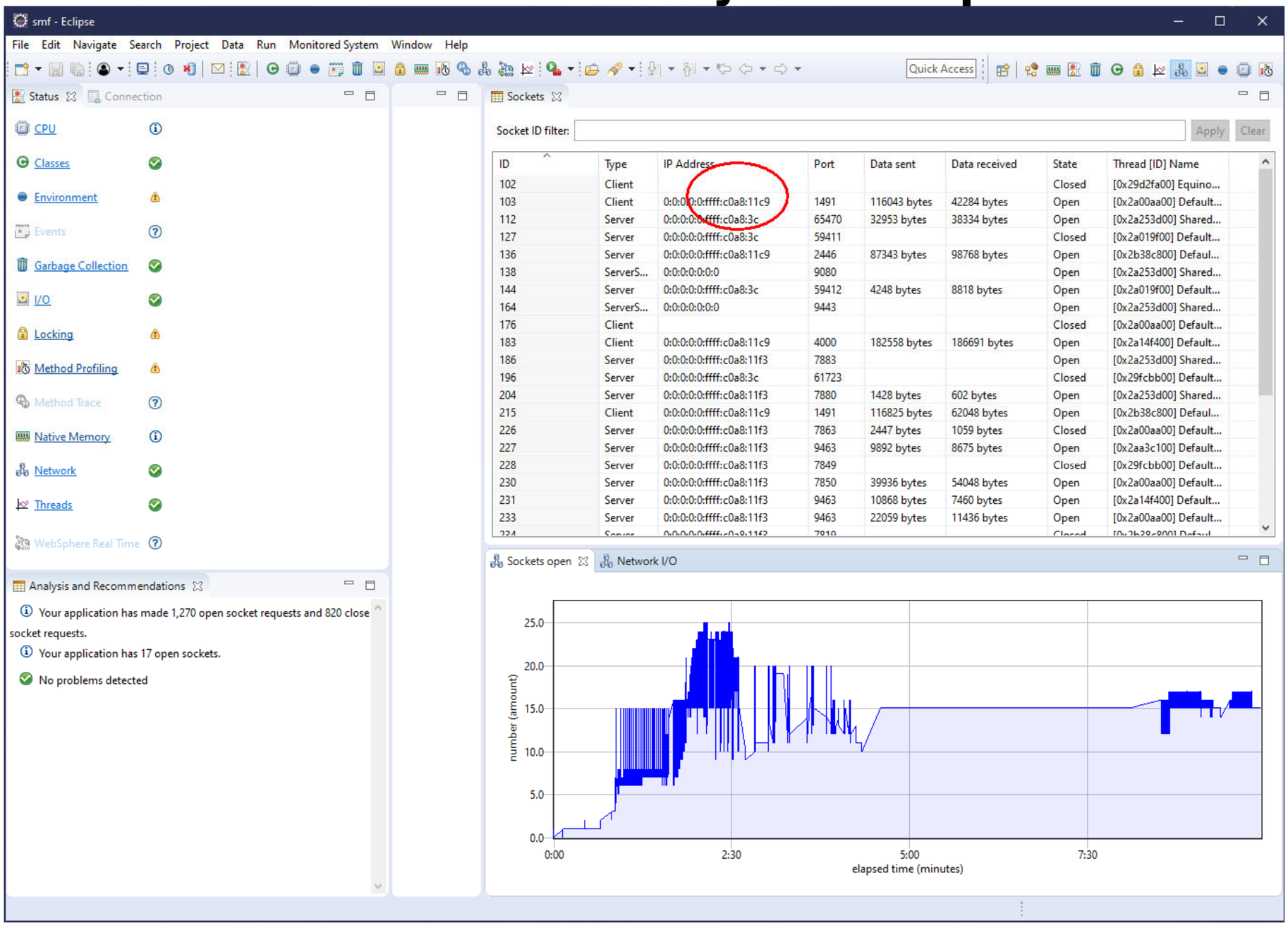
mitchj@us.ibm.com

Java Health Center – HEAP analysis example



mitchj@us.ibm.com

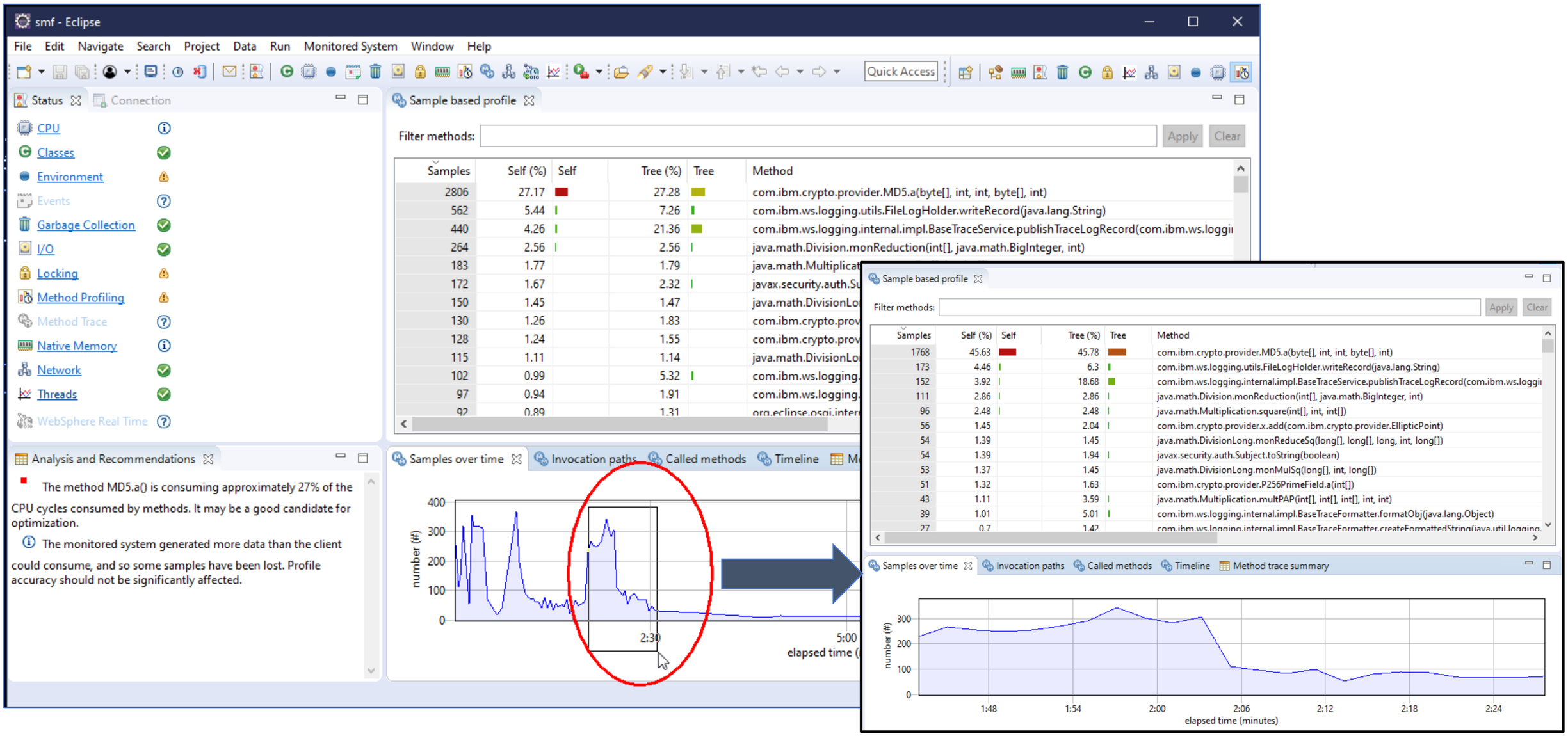
Java Health Center – Network analysis example



c0a8:11c9 = 192.168.17.201

mitchj@us.ibm.com

Java Health Center – Method Profiling



mitchj@us.ibm.com

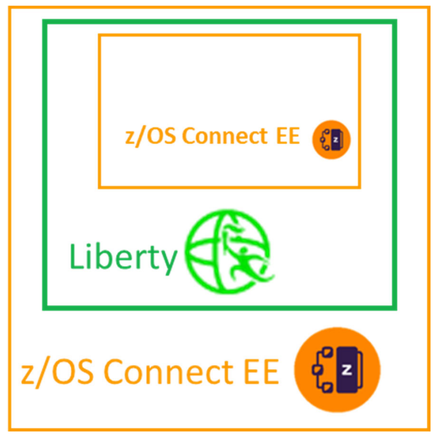
Tech-Tip: Sample JCL - Restarting the Java Health Center collection

```
SDSF PROCESS DISPLAY  MPZ3     ALL                      LINE 1-5 (5)
COMMAND INPUT ===>  PS                                    SCROLL ===> CSR
NP   JOBNAME  Status                          Owner    State CPU-Time        PID       PPID  ASID ASIDX LatchWaitPID Command
     BAQSTRT  WAITING FOR CHILD               LIBSERV  1W       40.01      69050   83955129    42 002A                /bin/sh /usr/lpp/IBM/zosconnect/v3r0/bin
     BAQSTRT  OTHER KERNEL WAIT               LIBSERV  HK       40.01   16846267      69050    42 002A                /usr/lpp/java/J8.0_64/bin/java -javagen
     BAQZANGL SWAPPED,RUNNING                 LIBANGE  1RI       0.01   50399398   83953829    77 004D                /usr/lpp/IBM/zosconnect/v3r0/wlplib/nat
     BAQZANGL SWAPPED,FILE SYS KERNEL WAIT    LIBANGE  1FI       0.01   83953829          1    77 004D                BPXBATA2
     BAQSTRT  FILE SYS KERNEL WAIT            LIBSERV  1F       40.01   83955129          1    42 002A                BPXBATSL
```

```
********************************************************************************
product = WAS FOR Z/OS 21.0.0.9, z/OS Connect 03.00.52 (wlp-1.0.56.cl210920210909-1618)
wlp.install.dir = /shared/IBM/zosconnect/v3r0/wlp/
server.config.dir = /var/zosconnect/servers/myServer/
java.home = /shared/java/J8.0_64
java.version = 1.8.0_301
java.runtime = Java(TM) SE Runtime Environment (8.0.6.36 - pmz6480sr6fp36-20210913_01(SR6 FP36))
os = z/OS (02.03.00; s390x) (en_US)
process = 16846267@wg31
********************************************************************************
```

```
//JOHNSONS JOB (ACCOUNT),NOTIFY=&SYSUID,REGION=0M,
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1),USER=LIBSERV
//JAVA     EXEC PGM=IKJEFT01,REGION=0M
//SYSERR   DD  SYSOUT=*
//STDOUT   DD  SYSOUT=*
//SYSTSPRT DD  SYSOUT=*
//SYSTSIN  DD  *
 BPXBATCH SH +
 java -jar /usr/lpp/java/J8.0_64/lib/ext/healthcenter.jar +
 ID=16846267 level=headless +
 -Dcom.ibm.java.diagnostics.healthcenter.headless.run.number.of.runs=1
```

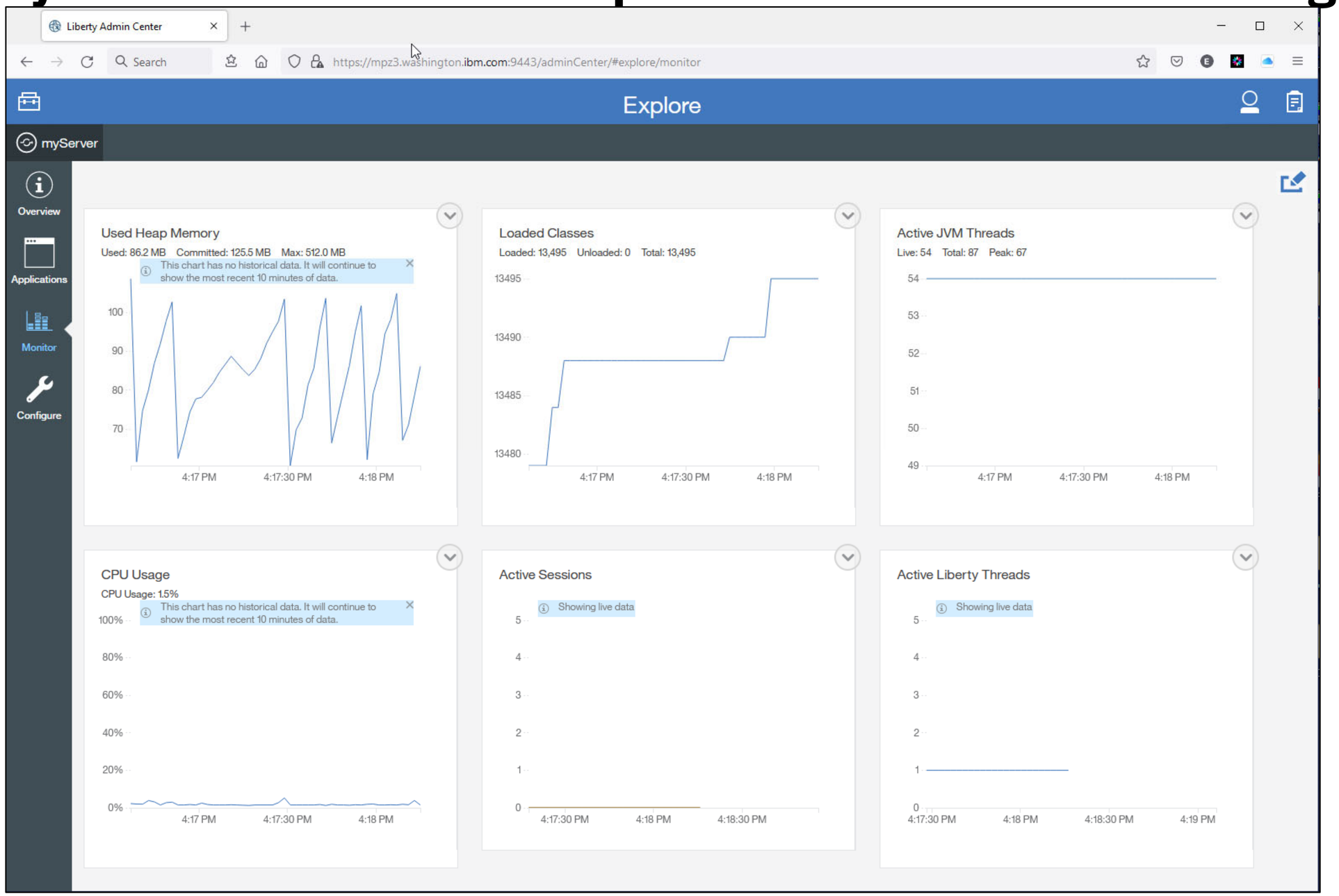
The job must be executed under the same identity under which the server is running.



mitchj@us.ibm.com

Tech-Tip: The ***PS*** SDSF command requires access to SAF SDSF resource ISFCMD.ODSP.PROCESS.*.

Liberty Admin Center feature provides real time monitoring



mitchj@us.ibm.com

Workload Manager - Definitions

WLM Report Classes

```
mpz3
File  Edit  Settings  View  Communication  Actions  Window  Help
  Report-Class  View  Notes  Options  Help
------------------------------------------------------------------------------
                    Report Class Selection List          Row 1 to 12 of 12
Command ===> ____________________________________________________________

Action Codes: 1=Create, 2=Copy, 3=Modify, 4=Browse, 5=Print, 6=Delete,
              /=Menu Bar
                                                -- Last Change ---
Action  Name      Description                   User      Date
  __    BAQSTC    ____________________________  JOHNSON   2021/09/04
  __    WMQFTE    ____________________________  JOHNSON   2011/08/31
  __    WMQFTER   ____________________________  JOHNSON   2011/08/31
  __    WMQFTEZ   ____________________________  JOHNSON   2011/08/31
  __    ZCEEADM   ____________________________  JOHNSON   2021/08/02
  __    ZCEEAPIR  ____________________________  JOHNSON   2021/08/05
  __    ZCEECICS  ____________________________  JOHNSON   2021/08/05
  __    ZCEEDB2   ____________________________  JOHNSON   2021/08/05
  __    ZCEEIMS   ____________________________  JOHNSON   2021/08/05
  __    ZCEEMQ    ____________________________  JOHNSON   2021/08/05
  __    ZCEEOTHR  ____________________________  JOHNSON   2021/08/02
  __    ZCEESTC   ____________________________  JOHNSON   2021/09/02
****************************** Bottom of data ********************************
MA    A                                                          10/004
Connected to remote server/host mpz3 using lu/pool MPZ30008 and port 23
```

WLM Service Classes

```
mpz3
File  Edit  Settings  View  Communication  Actions  Window  Help
  Service-Class  Xref  Notes  Options  Help
------------------------------------------------------------------------------
                    Modify a Service Class               Row 1 to 2 of 2
Command ===> ____________________________________________________________

Service Class Name . . . . . : OPS_HIGH
Description  . . . . . . . . . System Tasks Velocity 70
Workload Name  . . . . . . . . STC_WKL    (name or ?)
Base Resource Group  . . . . . ________   (name or ?)
Cpu Critical . . . . . . . . . NO         (YES or NO)
I/O Priority Group . . . . . . NORMAL     (NORMAL or HIGH)
Honor Priority . . . . . . . . DEFAULT    (DEFAULT or NO)

Specify BASE GOAL information. Action Codes: I=Insert new period,
E=Edit period, D=Delete period.

         -- Period --  ------------------- Goal --------------------
Action  #  Duration    Imp.  Description
  __    1  _________   1     Execution velocity of 70
****************************** Bottom of data ********************************
MA    A                                                          19/004
Connected to remote server/host mpz3 using lu/pool MPZ30008 and port 23
```

WLM "CB" Classification Rules

```
mpz3
File  Edit  Settings  View  Communication  Actions  Window  Help
  Subsystem-Type  Xref  Notes  Options  Help
------------------------------------------------------------------------------
                  Modify Rules for the Subsystem Type     Row 1 to 8 of 16
Command ===> ____________________________________________ Scroll ===> PAGE

Subsystem Type . : CB          Fold qualifier names?  N  (Y or N)
Description  . . . WLP/zCEE Transactions

Action codes:   A=After      C=Copy       M=Move      I=Insert rule
                B=Before     D=Delete row R=Repeat    IS=Insert Sub-rule
                                                          More ===>
          -------Qualifier--------                 -------Class--------
Action    Type      Name      Start                 Service     Report
                                          DEFAULTS: OPS_HIGH    ZCEEOTHR
  ____    1 CN      myServer  ___                   OPS_HIGH    BAQSTC
  ____    2 TC        TCADM   ___                   OPS_HIGH    ZCEEADM
  ____    2 TC        TCAPIR  ___                   OPS_HIGH    ZCEEAPIR
  ____    2 TC        TCCICS  ___                   OPS_HIGH    ZCEECICS
  ____    2 TC        TCDB2   ___                   OPS_HIGH    ZCEEDB2
  ____    2 TC        TCIMS   ___                   OPS_HILO    ZCEEIMS
  ____    2 TC        TCMQ    ___                   OPS_MED     ZCEEMQ
  ____    2 TC        TCOTHR  ___                   OPS_LOW     ZCEEOTHR
MA    A                                                          07/021
Connected to remote server/host mpz3 using lu/pool MPZ30008 and port 23
```

```
mpz3
File  Edit  Settings  View  Communication  Actions  Window  Help
  Subsystem-Type  Xref  Notes  Options  Help
------------------------------------------------------------------------------
                  Modify Rules for the Subsystem Type     Row 9 to 16 of 16
Command ===> ____________________________________________ Scroll ===> PAGE

Subsystem Type . : CB          Fold qualifier names?  N  (Y or N)
Description  . . . WLP/zCEE Transactions

Action codes:   A=After      C=Copy       M=Move      I=Insert rule
                B=Before     D=Delete row R=Repeat    IS=Insert Sub-rule
                                                          More ===>
          -------Qualifier--------                 -------Class--------
Action    Type      Name      Start                 Service     Report
                                          DEFAULTS: OPS_HIGH    ZCEEOTHR
  ____    1 CN      zcee*     ___                   OPS_HIGH    ZCEESTC
  ____    2 TC        TCADM   ___                   OPS_HIGH    ZCEEADM
  ____    2 TC        TCAPIR  ___                   OPS_HIGH    ZCEEAPIR
  ____    2 TC        TCDB2   ___                   OPS_HIGH    ZCEEDB2
  ____    2 TC        TCCICS  ___                   OPS_HILO    ZCEECICS
  ____    2 TC        TCIMS   ___                   OPS_HILO    ZCEEIMS
  ____    2 TC        TCMQ    ___                   OPS_MED     ZCEEMQ
  ____    2 TC        TCOTHR  ___                   OPS_HILO    ZCEEOTHR
MA    A                                                          07/021
Connected to remote server/host mpz3 using lu/pool MPZ30008 and port 23
```

mitchj@us.ibm.com

Workload Manager – WLM Classification server XML

The corresponding required server XML configuration

- Based on HTTP path matching (port and/or method can also be specified)
- The default value for the *wlmClassifcation* name is the name of the server
- See URL https://www.ibm.com/docs/en/was-liberty/zos?topic=zos-wlm-classification for more information
- The *transactionClass* attribute is required to ensure an enclave is created.

Server Config

wlm.xml Read only Close

Design Source

```
<?xml version="1.0" encoding="UTF-8"?>
<server description="wlm">

<featureManager>
 <feature>zosWlm-1.0</feature>
</featureManager>

<wlmClassification>
 <httpClassification transactionClass="TCCICS"
    resource="/cscvinc/employee/*" method="GET"/>
 <httpClassification transactionClass="TCDB2"
    resource="/db2/employee/*" method="GET"/>
 <httpClassification transactionClass="TCIMS"
    resource="/phonebook/contacts/*"/>
 <httpClassification transactionClass="TCIMS"
    resource="/phonebook/contacts" METHOD="POST"/>
 <httpClassification transactionClass="TCMQ"
    resource="/mqapi/*" METHOD="POST"/>
 <httpClassification transactionClass="TCMQ"
    resource="/mqapi/*" METHOD="GET"/>
 <httpClassification transactionClass="TCAPIR" resource="/zosConnect/apiRequesters/*"/>
 <httpClassification transactionClass="TCADM" resource="/zosConnect/**/*"/>
 <httpClassification transactionClass="TCOTHR" />
</wlmClassification>

<zosWorkloadManager collectionName="${wlp.server.name}"/>

<zosWlmHealth interval="30" increment="15"/>

</server>
```

Related to WLM CN name.

mpz3

File Edit Settings View Communication Actions Window Help

Subsystem-Type Xref Notes Options Help

Modify Rules for the Subsystem Type Row 9 to 16 of 16

Command ===> Scroll ===> PAGE

Subsystem Type . : CB Fold qualifier names? N (Y or N)

Description . . . WLP/zCEE Transactions

Action codes: A=After C=Copy M=Move I=Insert rule

B=Before D=Delete row R=Repeat IS=Insert Sub-rule

More ===>

Action	Type	Name	Start		Service	Report
				DEFAULTS:	OPS_HIGH	ZCEEOTHR
____	1 CN	zcee*	___		OPS_HIGH	ZCEESTC
____	2 TC	TCADM	___		OPS_HIGH	ZCEEADM
____	2 TC	TCAPIR	___		OPS_HIGH	ZCEEAPIR
____	2 TC	TCDB2	___		OPS_HIGH	ZCEEDB2
____	2 TC	TCCICS	___		OPS_HILO	ZCEECICS
____	2 TC	TCIMS	___		OPS_HILO	ZCEEIMS
____	2 TC	TCMQ	___		OPS_MED	ZCEEMQ
____	2 TC	TCOTHR	___		OPS_HILO	ZCEEOTHR

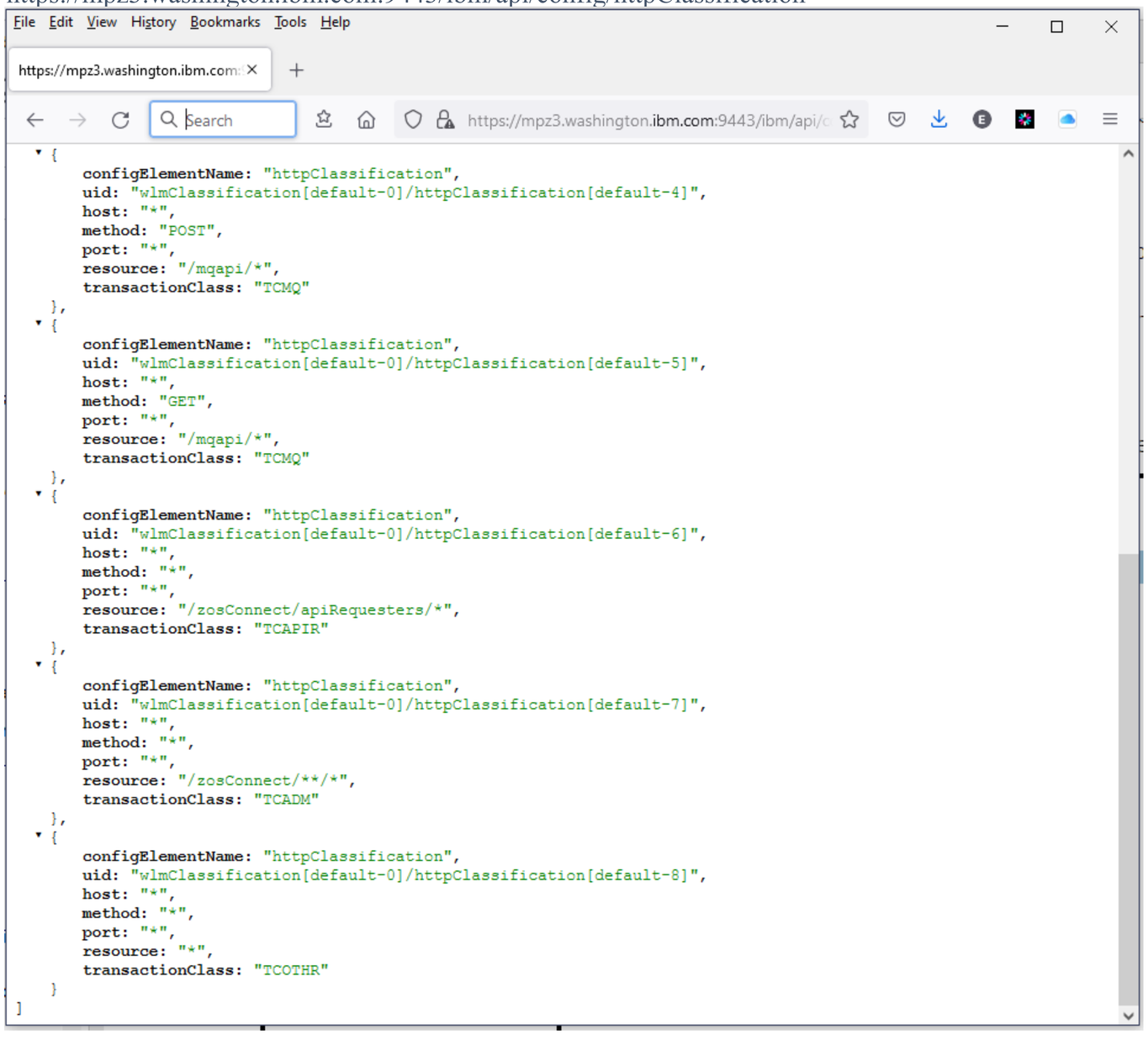
MA B 07/021

Connected to remote server/host mpz3 using lu/pool MPZ30048 and port 23

mitchj@us.ibm.com

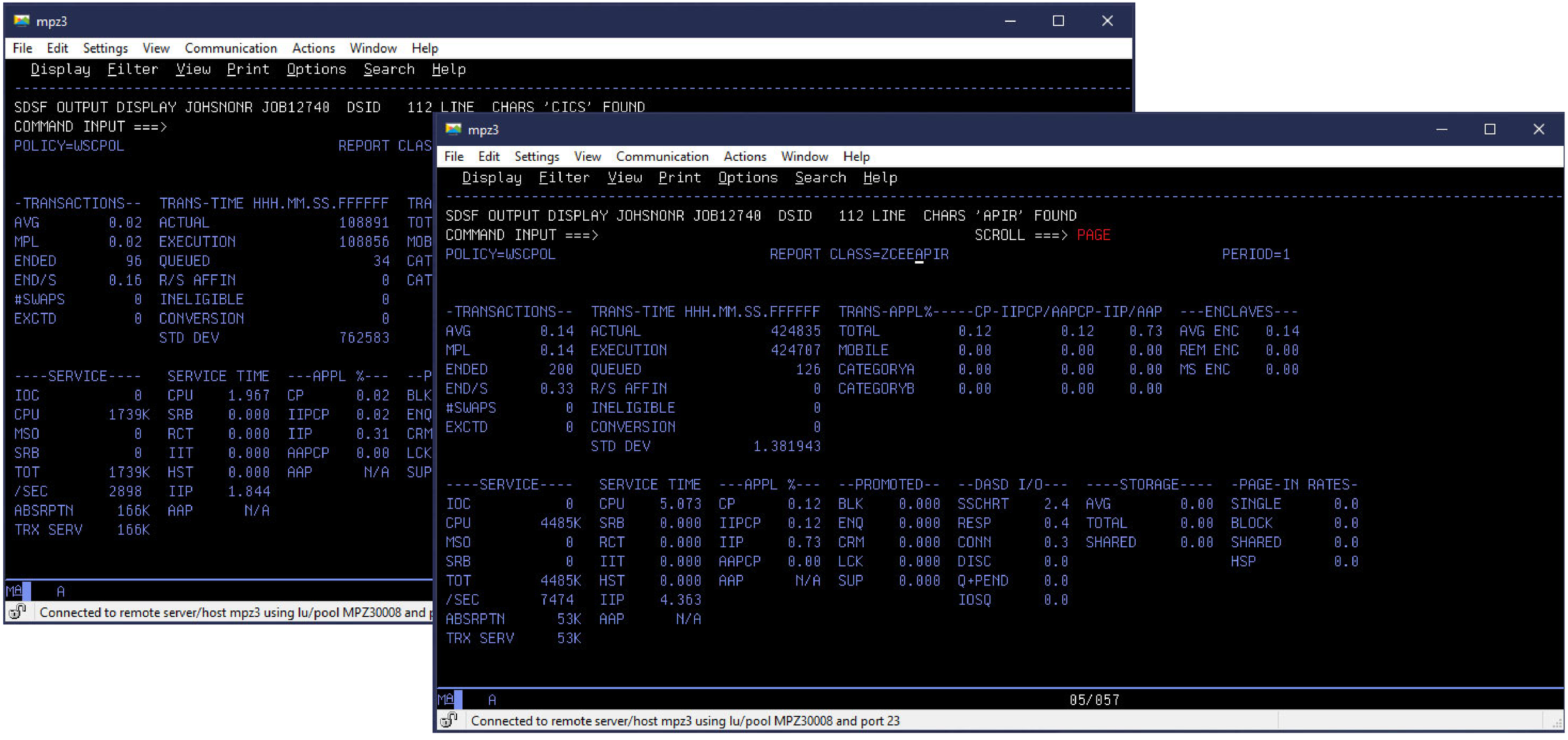
Workload Manager – Active HTTP Classification

https://mpz3.washington.ibm.com:9443/ibm/api/config/httpClassification



mitchj@us.ibm.com

RMF SMF Type 72 Service Class Reports



mitchj@us.ibm.com

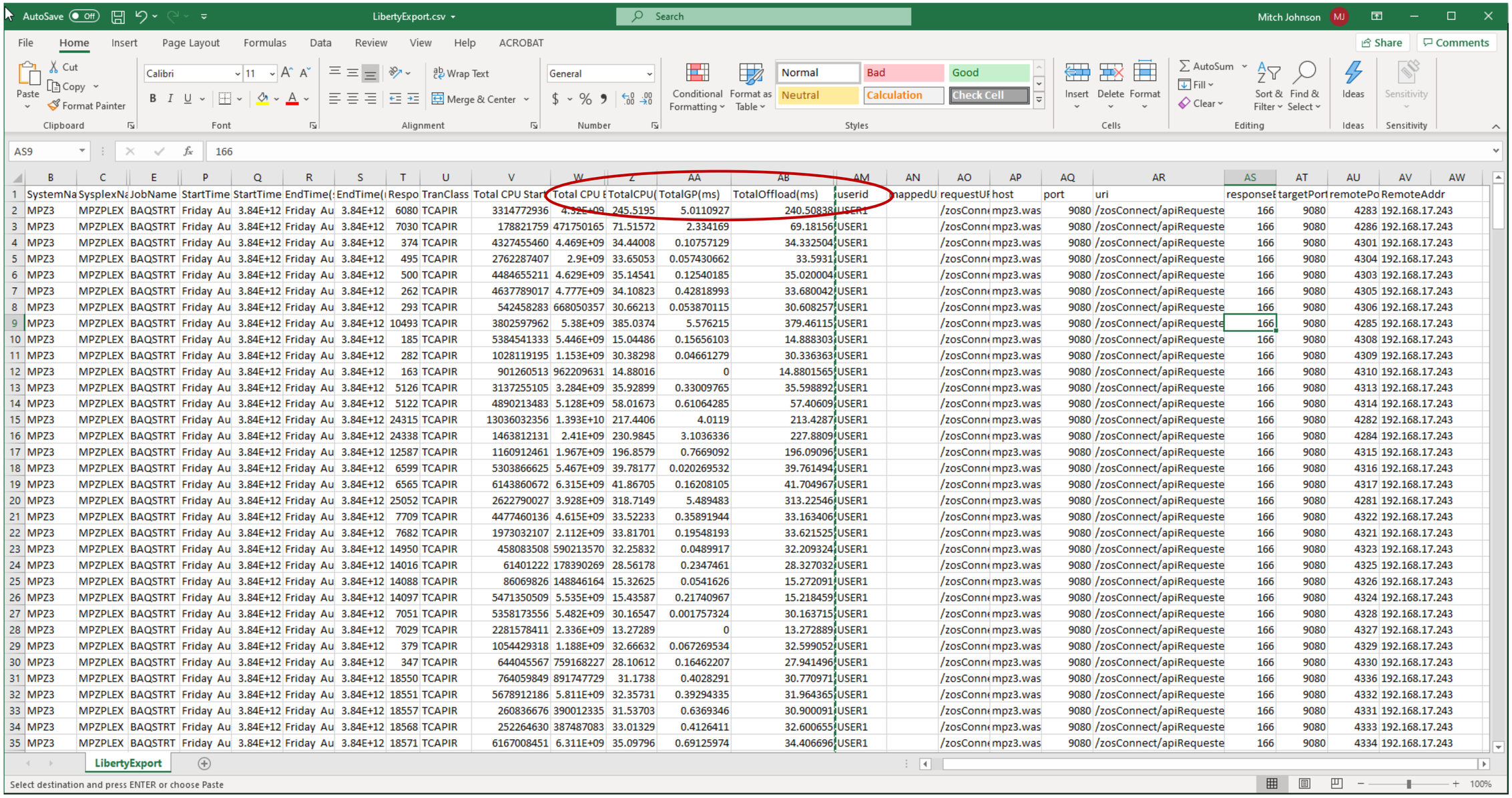
Liberty SMF 120 Subtype 11

WebSphere Liberty Profile (WLP) can generate various types of SMF 120 records. Support for a SMF 120 record relevant for z/OS Connect was added in WLP V16.0.0.2. This record, a SMF 120 Subtype 11, is generated for each HTTP request received by the Liberty server. For more details and a description of the contents of this record, see URL https://www.ibm.com/support/pages/liberty-zos-smf-120-11-version-2

Useful Plug-ins for WAS z/OS SMF 120.9 Browser

https://www.ibm.com/support/pages/node/6355403

Liberty SMF 120 Subtype 11 – WP102312 Plugin



AutoSave Off | LibertyExport.csv | Search | Mitch Johnson MJ

File Home Insert Page Layout Formulas Data Review View Help ACROBAT | Share | Comments

Paste | Cut | Copy | Format Painter | Clipboard | Calibri 11 | Font | Wrap Text | Merge & Center | Alignment | General | Number | Conditional Formatting | Format as Table | Normal | Bad | Good | Neutral | Calculation | Check Cell | Styles | Insert | Delete | Format | Cells | AutoSum | Fill | Clear | Sort & Filter | Find & Select | Editing | Ideas | Sensitivity

AS9 | 166

	B	C	E	P	Q	R	S	T	U	V	W	Z	AA	AB	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW
1	SystemNa	SysplexNa	JobName	StartTime	StartTime	EndTime(:	EndTime((	Respo	TranClass	Total CPU Start	Total CPU E	TotalCPU(	TotalGP(ms)	TotalOffload(ms)	userid	mappedU	requestUF	host	port	uri	responseE	targetPort	remotePo	RemoteAddr	
2	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	6080	TCAPIR	3314772936	4.32E+09	245.5195	5.0110927	240.50838	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4283	192.168.17.243	
3	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	7030	TCAPIR	178821759	471750165	71.51572	2.334169	69.18156	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4286	192.168.17.243	
4	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	374	TCAPIR	4327455460	4.469E+09	34.44008	0.10757129	34.332504	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4301	192.168.17.243	
5	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	495	TCAPIR	2762287407	2.9E+09	33.65053	0.057430662	33.5931	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4304	192.168.17.243	
6	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	500	TCAPIR	4484655211	4.629E+09	35.14541	0.12540185	35.020004	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4303	192.168.17.243	
7	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	262	TCAPIR	4637789017	4.777E+09	34.10823	0.42818993	33.680042	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4305	192.168.17.243	
8	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	293	TCAPIR	542458283	668050357	30.66213	0.053870115	30.608257	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4306	192.168.17.243	
9	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	10493	TCAPIR	3802597962	5.38E+09	385.0374	5.576215	379.46115	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4285	192.168.17.243	
10	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	185	TCAPIR	5384541333	5.446E+09	15.04486	0.15656103	14.888303	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4308	192.168.17.243	
11	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	282	TCAPIR	1028119195	1.153E+09	30.38298	0.04661279	30.336363	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4309	192.168.17.243	
12	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	163	TCAPIR	901260513	962209631	14.88016	0	14.8801565	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4310	192.168.17.243	
13	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	5126	TCAPIR	3137255105	3.284E+09	35.92899	0.33009765	35.598892	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4313	192.168.17.243	
14	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	5122	TCAPIR	4890213483	5.128E+09	58.01673	0.61064285	57.40609	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4314	192.168.17.243	
15	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	24315	TCAPIR	13036032356	1.393E+10	217.4406	4.0119	213.4287	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4282	192.168.17.243	
16	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	24338	TCAPIR	1463812131	2.41E+09	230.9845	3.1036336	227.8809	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4284	192.168.17.243	
17	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	12587	TCAPIR	1160912461	1.967E+09	196.8579	0.7669092	196.09096	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4315	192.168.17.243	
18	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	6599	TCAPIR	5303866625	5.467E+09	39.78177	0.020269532	39.761494	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4316	192.168.17.243	
19	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	6565	TCAPIR	6143860672	6.315E+09	41.86705	0.16208105	41.704967	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4317	192.168.17.243	
20	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	25052	TCAPIR	2622790027	3.928E+09	318.7149	5.489483	313.22546	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4281	192.168.17.243	
21	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	7709	TCAPIR	4477460136	4.615E+09	33.52233	0.35891944	33.163406	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4322	192.168.17.243	
22	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	7682	TCAPIR	1973032107	2.112E+09	33.81701	0.19548193	33.621525	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4321	192.168.17.243	
23	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	14950	TCAPIR	458083508	590213570	32.25832	0.0489917	32.209324	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4323	192.168.17.243	
24	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	14016	TCAPIR	61401222	178390269	28.56178	0.2347461	28.327032	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4325	192.168.17.243	
25	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	14088	TCAPIR	86069826	148846164	15.32625	0.0541626	15.272091	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4326	192.168.17.243	
26	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	14097	TCAPIR	5471350509	5.535E+09	15.43587	0.21740967	15.218459	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4324	192.168.17.243	
27	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	7051	TCAPIR	5358173556	5.482E+09	30.16547	0.001757324	30.163715	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4328	192.168.17.243	
28	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	7029	TCAPIR	2281578411	2.336E+09	13.27289	0	13.272889	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4327	192.168.17.243	
29	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	379	TCAPIR	1054429318	1.188E+09	32.66632	0.067269534	32.599052	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4329	192.168.17.243	
30	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	347	TCAPIR	644045567	759168227	28.10612	0.16462207	27.941496	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4330	192.168.17.243	
31	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	18550	TCAPIR	764059849	891747729	31.1738	0.4028291	30.770971	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4336	192.168.17.243	
32	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	18551	TCAPIR	5678912186	5.811E+09	32.35731	0.39294335	31.964365	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4332	192.168.17.243	
33	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	18557	TCAPIR	260836676	390012335	31.53703	0.6369346	30.900091	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4331	192.168.17.243	
34	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	18568	TCAPIR	252264630	387487083	33.01329	0.4126411	32.600655	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4333	192.168.17.243	
35	MPZ3	MPZPLEX	BAQSTRT	Friday Au	3.84E+12	Friday Au	3.84E+12	18571	TCAPIR	6167008451	6.311E+09	35.09796	0.69125974	34.406696	USER1		/zosConne	mpz3.was	9080	/zosConnect/apiRequeste	166	9080	4334	192.168.17.243	

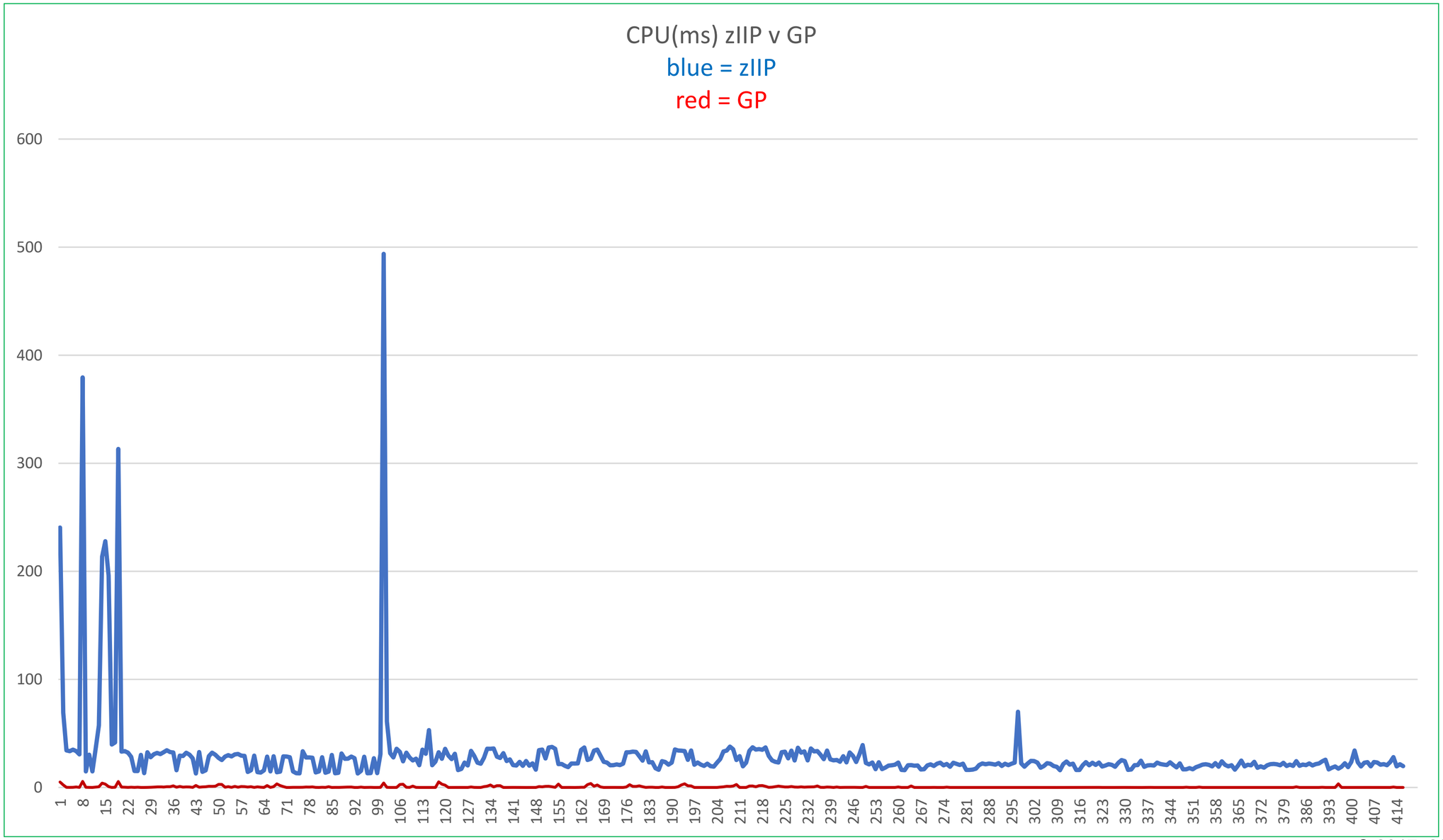
LibertyExport

Select destination and press ENTER or choose Paste | 100%

Some fields have been hidden

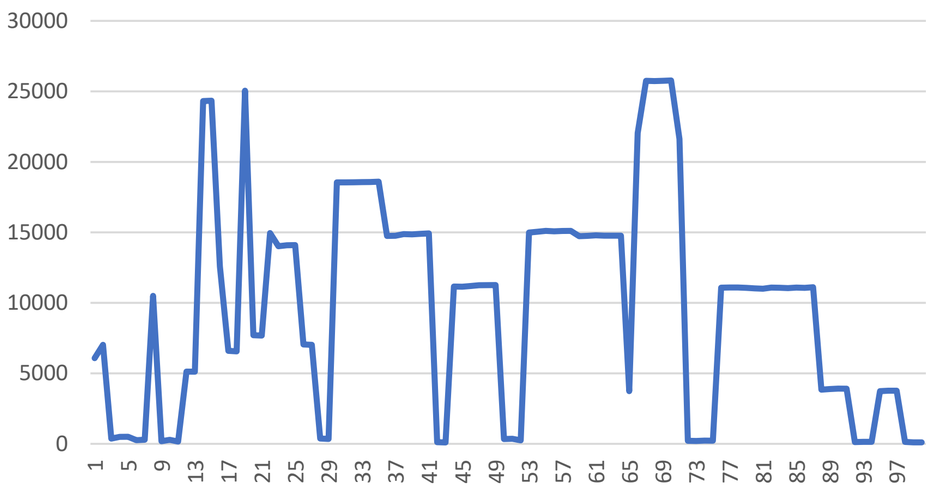
mitchj@us.ibm.com

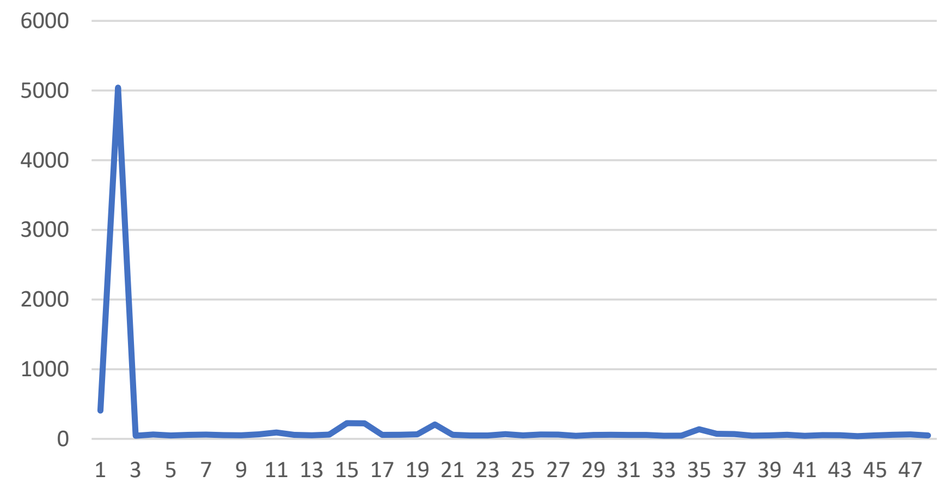
Liberty SMF 120 type 11 – GP v zIIP comparison example

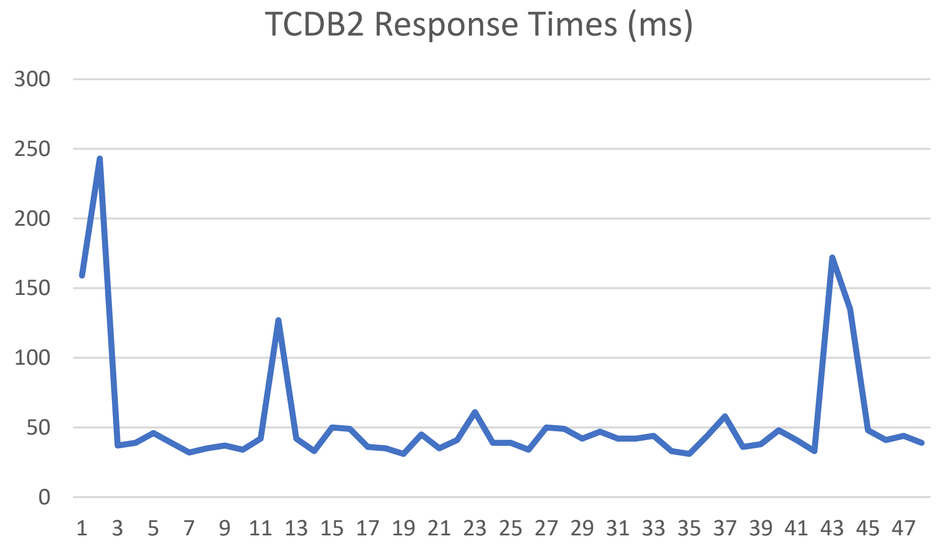


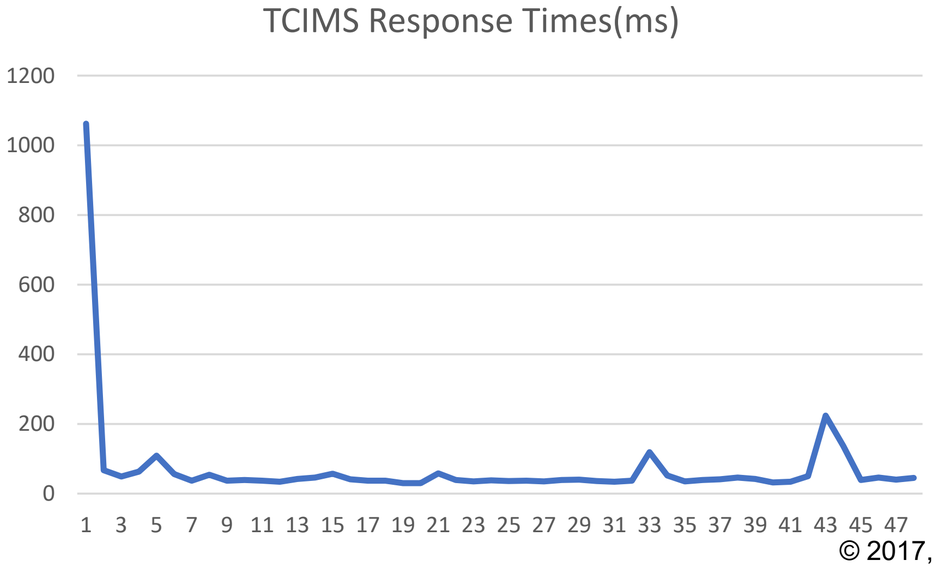
mitchj@us.ibm.com

Liberty SMF 120 type 11 – Response times comparisons example







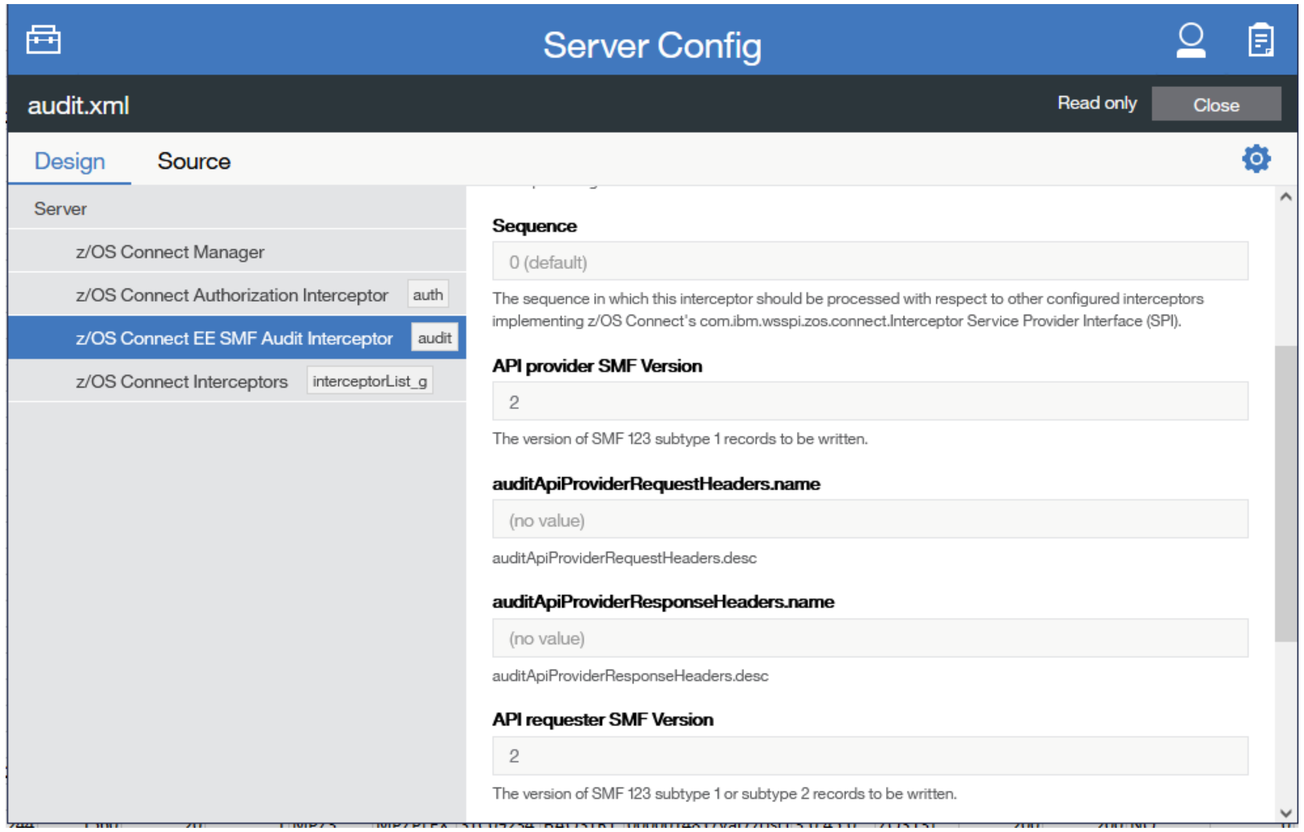


mitchj@us.ibm.com

z/OS Connect SMF 123 server XML configuration (OpenAPI 2)

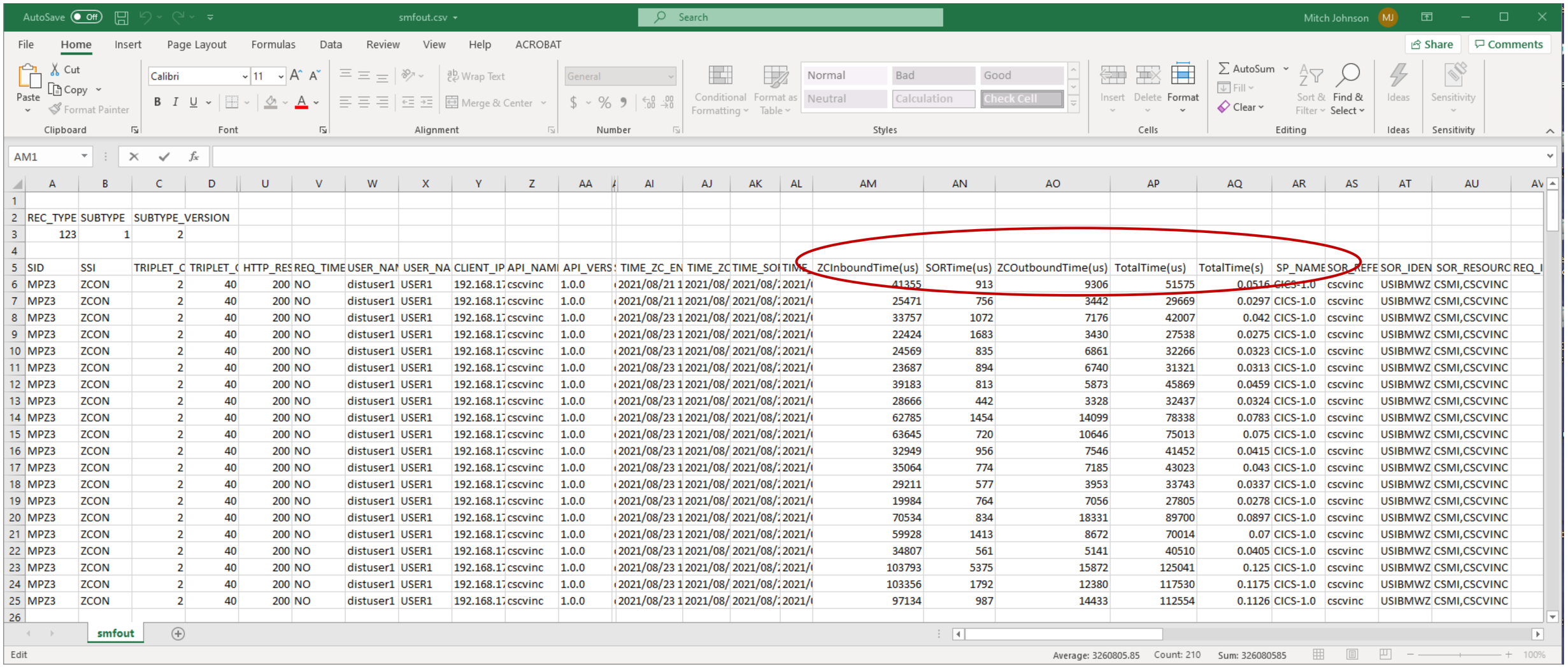
SMF 123 records have two subtypes, and each subtype can have different versions.

- SMF type 123 subtype 1 records - Version 1 contains some basic information about both API provider and API requester requests. Version 2 supersedes version 1 and contains more detailed information about each API provider request, including information about to which system of record (SOR) the request was sent
- ***SMF type 123 subtype 2 records - Version 2 supersedes subtype 1 version 1 and contains more detailed information about each API requester request, including information about to what HTTP endpoint the request was sent.***



mitchj@us.ibm.com

z/OS Connect SMF 123 subtype 1 version 2 (OpenAPI 2) *



AutoSave Off | smfout.csv | Search | Mitch Johnson MJ

File Home Insert Page Layout Formulas Data Review View Help ACROBAT | Share | Comments

Clipboard: Paste, Cut, Copy, Format Painter | Font: Calibri 11 | Alignment: Wrap Text, Merge & Center | Number: General | Styles: Normal, Bad, Good, Neutral, Calculation, Check Cell, Conditional Formatting, Format as Table | Cells: Insert, Delete, Format | Editing: AutoSum, Fill, Clear, Sort & Filter, Find & Select | Ideas | Sensitivity

AM1

	A	B	C	D	U	V	W	X	Y	Z	AA	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
1																								
2	REC_TYPE	SUBTYPE	SUBTYPE_VERSION																					
3	123	1	2																					
4																								
5	SID	SSI	TRIPLET_C	TRIPLET_(	HTTP_RES	REQ_TIME	USER_NAI	USER_NA	CLIENT_IP	API_NAMI	API_VERS	TIME_ZC_EN	TIME_ZC	TIME_SOI	TIME	ZCInboundTime(us)	SORTime(us)	ZCOutboundTime(us)	TotalTime(us)	TotalTime(s)	SP_NAME	SOR_REFE	SOR_IDEN	SOR_RESOURC	REQ_I
6	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/21 1	2021/08/	2021/08/2	2021/(	41355	913	9306	51575	0.0516	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
7	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/21 1	2021/08/	2021/08/2	2021/(	25471	756	3442	29669	0.0297	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
8	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	33757	1072	7176	42007	0.042	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
9	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	22424	1683	3430	27538	0.0275	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
10	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	24569	835	6861	32266	0.0323	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
11	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	23687	894	6740	31321	0.0313	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
12	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	39183	813	5873	45869	0.0459	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
13	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	28666	442	3328	32437	0.0324	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
14	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	62785	1454	14099	78338	0.0783	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
15	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	63645	720	10646	75013	0.075	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
16	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	32949	956	7546	41452	0.0415	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
17	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	35064	774	7185	43023	0.043	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
18	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	29211	577	3953	33743	0.0337	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
19	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	19984	764	7056	27805	0.0278	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
20	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	70534	834	18331	89700	0.0897	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
21	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	59928	1413	8672	70014	0.07	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
22	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	34807	561	5141	40510	0.0405	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
23	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	103793	5375	15872	125041	0.125	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
24	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	103356	1792	12380	117530	0.1175	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
25	MPZ3	ZCON	2	40	200	NO	distuser1	USER1	192.168.17	cscvinc	1.0.0	2021/08/23 1	2021/08/	2021/08/2	2021/(	97134	987	14433	112554	0.1126	CICS-1.0	cscvinc	USIBMWZ	CSMI,CSCVINC	
26																								

smfout

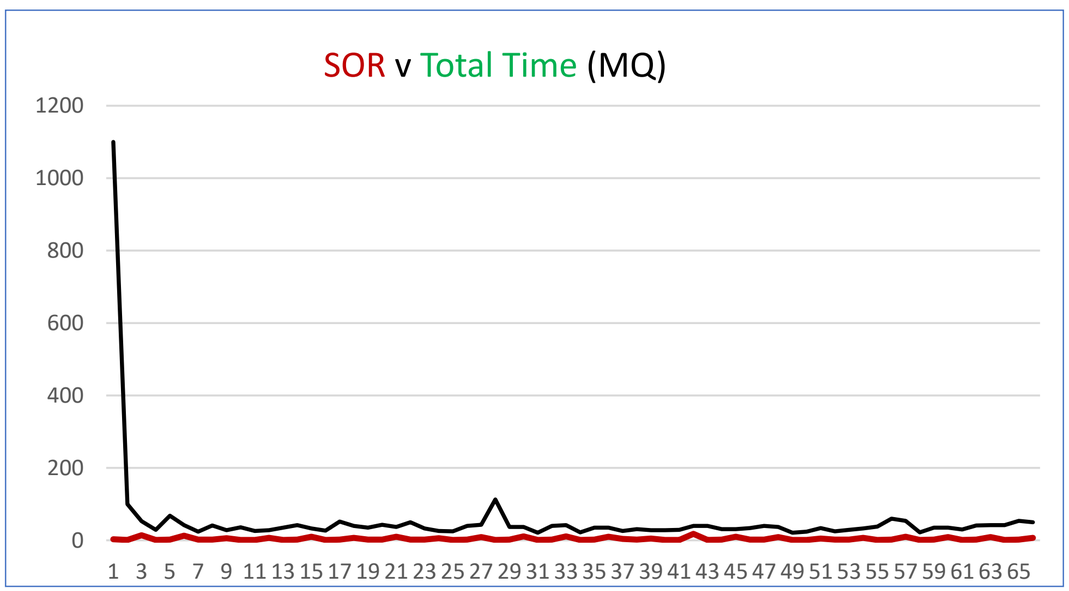
Edit | Average: 3260805.85 Count: 210 Sum: 326080585 | 100%

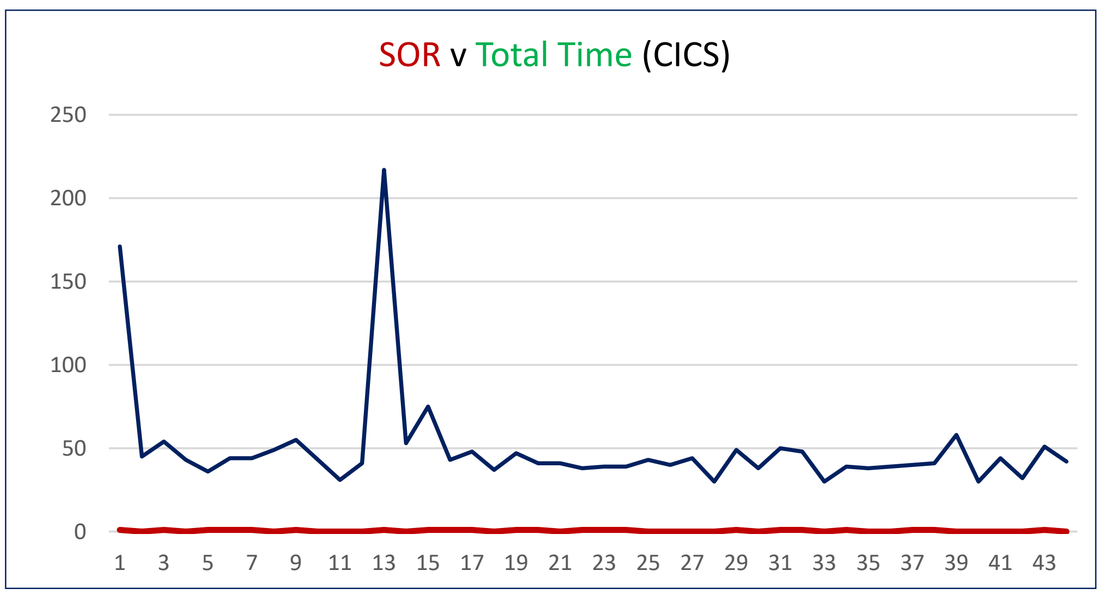
mitchj@us.ibm.com

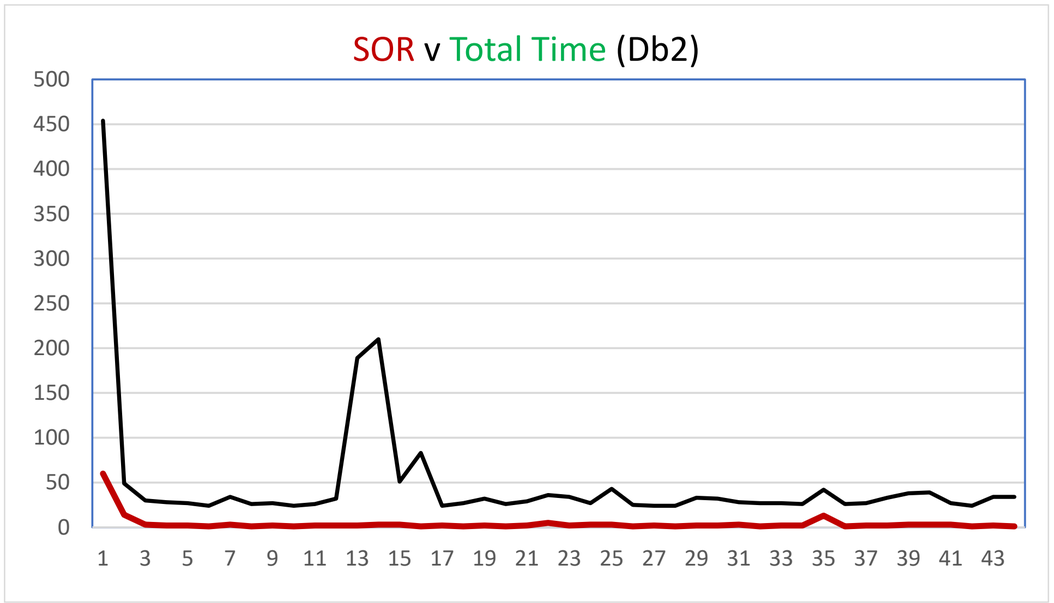
Some fields have been hidden

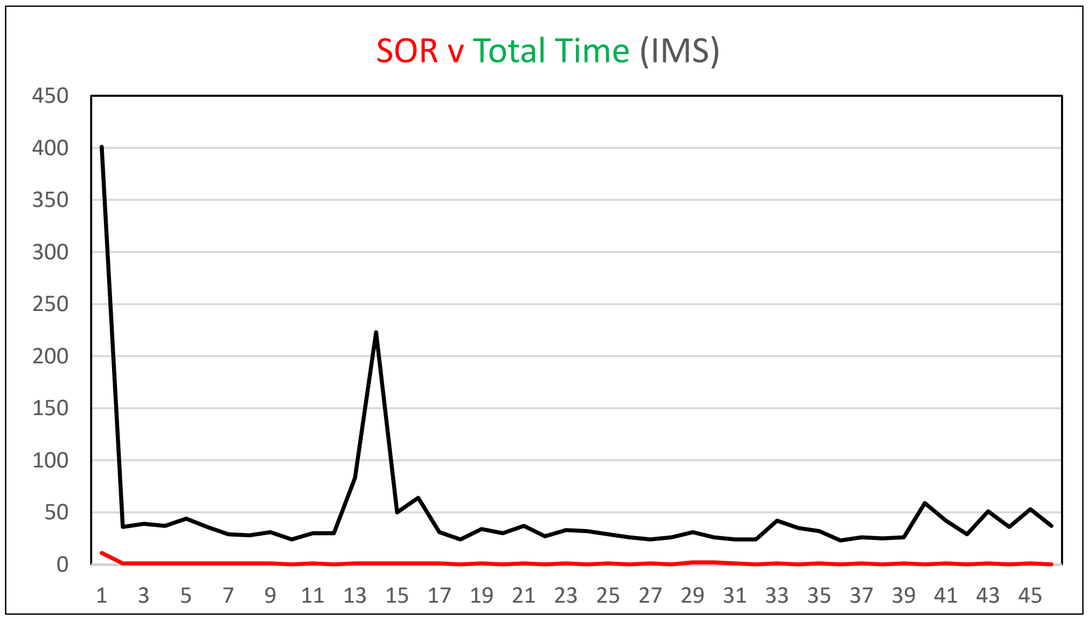
* Generated by using a modified version of the BAQSMFX sample program.

z/OS Connect SMF 123 subtype 1 version 2 graph examples (OpenAPI 2)



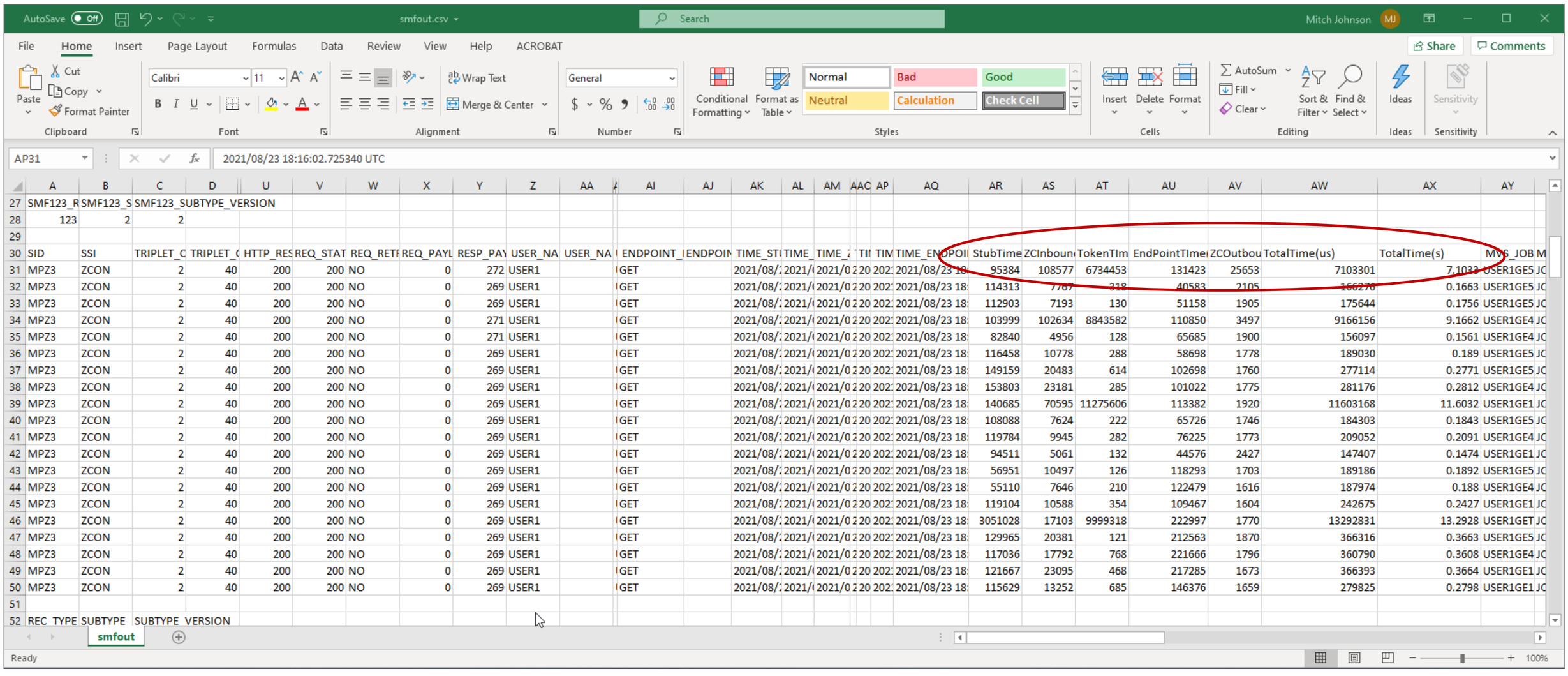






mitchj@us.ibm.com

z/OS Connect SMF 123 subtype 2 version 2 (OpenAPI 2) *



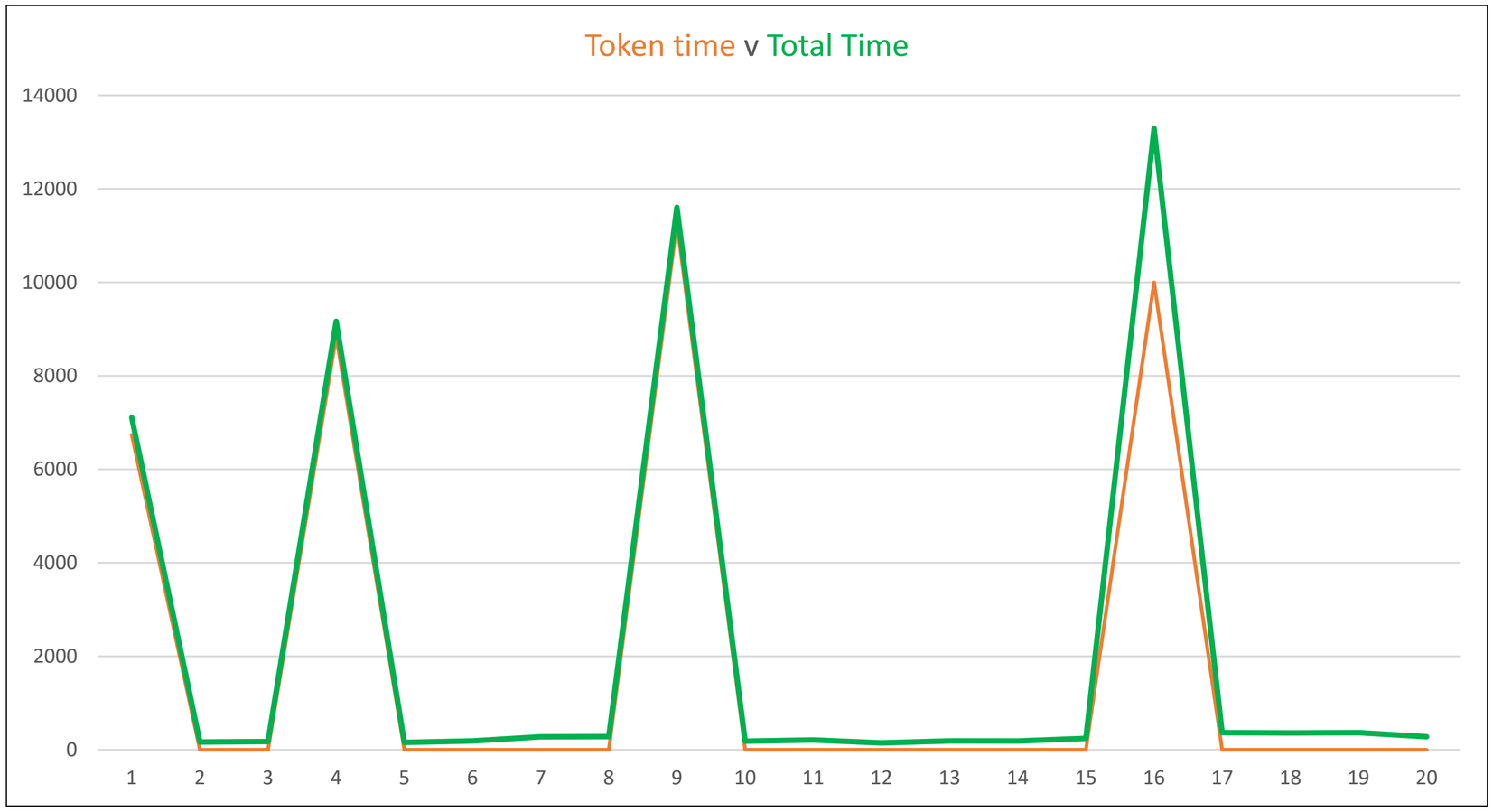
	A	B	C	D	U	V	W	X	Y	Z	AA	AI	AJ	AK	AL	AM	AAC	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
27	SMF123_R	SMF123_S	SMF123_SUBTYPE_VERSION																								
28	123	2	2																								
29																											
30	SID	SSI	TRIPLET_C	TRIPLET_(	HTTP_RES	REQ_STAT	REQ_RETF	REQ_PAYL	RESP_PAY	USER_NA	USER_NA	ENDPOINT_I	ENDPOIN	TIME_ST	TIME_	TIME_Z	TI	TIM	TIME_ENDPOI	StubTime	ZCInboun	TokenTim	EndPointTime	ZCOutbou	TotalTime(us)	TotalTime(s)	MVS_JOB	M
31	MPZ3	ZCON	2	40	200	200	NO	0	272	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	95384	108577	6734453	131423	25653	7103301	7.1033	USER1GE5	JC
32	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	114313	7767	318	40583	2105	166276	0.1663	USER1GE5	JC
33	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	112903	7193	130	51158	1905	175644	0.1756	USER1GE5	JC
34	MPZ3	ZCON	2	40	200	200	NO	0	271	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	103999	102634	8843582	110850	3497	9166156	9.1662	USER1GE4	JC
35	MPZ3	ZCON	2	40	200	200	NO	0	271	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	82840	4956	128	65685	1900	156097	0.1561	USER1GE4	JC
36	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	116458	10778	288	58698	1778	189030	0.189	USER1GE5	JC
37	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	149159	20483	614	102698	1760	277114	0.2771	USER1GE5	JC
38	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	153803	23181	285	101022	1775	281176	0.2812	USER1GE4	JC
39	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	140685	70595	11275606	113382	1920	11603168	11.6032	USER1GE1	JC
40	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	108088	7624	222	65726	1746	184303	0.1843	USER1GE5	JC
41	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	119784	9945	282	76225	1773	209052	0.2091	USER1GE4	JC
42	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	94511	5061	132	44576	2427	147407	0.1474	USER1GE1	JC
43	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	56951	10497	126	118293	1703	189186	0.1892	USER1GE5	JC
44	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	55110	7646	210	122479	1616	187974	0.188	USER1GE4	JC
45	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	119104	10588	354	109467	1604	242675	0.2427	USER1GE1	JC
46	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	3051028	17103	9999318	222997	1770	13292831	13.2928	USER1GET	JC
47	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	129965	20381	121	212563	1870	366316	0.3663	USER1GE5	JC
48	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	117036	17792	768	221666	1796	360790	0.3608	USER1GE4	JC
49	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	121667	23095	468	217285	1673	366393	0.3664	USER1GE1	JC
50	MPZ3	ZCON	2	40	200	200	NO	0	269	USER1		GET		2021/08/2	2021/(	2021/0	2	20	2021/08/23 18:	115629	13252	685	146376	1659	279825	0.2798	USER1GE1	JC
51																											
52	REC_TYPE	SUBTYPE	SUBTYPE_VERSION																								

Some fields have been hidden

* Generated by using a modified version of the BAQSMFX sample program.

mitchj@us.ibm.com

z/OS Connect SMF 123 subtype 2 version 2 graph example (OpenAPI 2)



mitchj@us.ibm.com

Connection Management

Liberty default connection pool management <connectionManager>

- agedTimeout — Amount of time before a connection can be discarded by pool maintenance.
- connectionTimeout — Amount of time after which a connection request times out.
- maxIdleTime — Amount of time a connection can be unused or idle until it can be discarded during pool maintenance.
- maxPoolSize — Maximum number of physical connections for a pool.
- minPoolSize — Minimum number of physical connections to maintain in the pool.
- purgePolicy — Specifies which connections to destroy when a stale connection is detected in a pool (EntirePool, FailingConnectionOnly or ValidateAllConnections)
- reapTime — Amount of time between runs of the pool maintenance thread.

```
<connectionManger id="ConMgr1"
      agedTimout=-1
      connectionTimeout=30s
      maxIdleTIme=1800s
      maxPoolSize=50
      minPoolSize=0
      purgePolicy= "EntirePool"
      reapTime=180/>
```

mitchj@us.ibm.com

https://www.ibm.com/docs/en/was-liberty/zos?topic=configuration-connectionmanager

Connection Management for IMS TM

Use the connectionManagerRef attribute in an IMS ConnectionFactory to provide a connection pool for connections to IMS Connect.

```
<connectionManger id="IMSTMConnMgr1" agedTimout=-1 connectionTimeout=30 maxIdleTIme=1800 maxPoolSize=50
minPoolSize=0 purgePolicy="EntirePool" reapTIme=180/>
<connectionManger id="IMSTMConnMgr2" agedTimout=-1 connectionTimeout=30 maxIdleTIme=1800 maxPoolSize=200
minPoolSize=0 purgePolicy="EntirePool" reapTIme=180/>

<imsmobile_imsConnection id="IMSCONN1" connectionFactoryRef="IMSCF1"/>
<connectionFactory id="IMSCF1" connectionManagerRef="IMSTMConnMgr1"  containerAuthDataRef="Connection1_Auth" >
    <properties.gmoa hostName="wg31.washington.ibm.com" portNumber="4000" applicationName="IMSTMAPL/>
</connectionFactory>

<imsmobile_imsConnection id="IMSCONN2" connectionFactoryRef="IMSCF2"/>
<connectionFactory id="IMSCF2" connectionManagerRef="IMSTMConnMgr2"  containerAuthDataRef="Connection1_Auth" >
    <properties.gmoa hostName="wg31.washington.ibm.com" portNumber="4000" applicationName="IMSTMAPL/>
</connectionFactory>

<imsmobile_interaction id="IMSINTER1" imsConnectTimeout="30000"
        interactionTimeout="20000" ... />
<imsmobile_interaction id="IMSINTER2" imsConnectTimeout="20000"
        interactionTimeout="15000" ... />
```

The total of *maxPoolSize* in the *connectionManager* configuration elements should not exceed the value of the IMS Connect *MAXSOC* attribute – 1,

- The imsConnectTimeout value is the time the service provider waits for a reply after sending a message to IMS Connect
- The interactionTimeout value is passed to IMS Connect. IMS Connect sends the message to IMS and then waits that long for a reply. If there is none there is a timeout in IMS Connect and IMS Connect sends a timeout to the service provider.

mitchj@us.ibm.com

TCP/IP considerations with IMS Connect

On the Liberty TCP/IP environment, ensure:

- TCPNODELAY=DISABLE. This allows optimization of transmission but depends on the client environment. Allows for multiple writes and waits for the buffer to be filled before sending.
- SO_Linger=Y,VALUE=10 ensures no loss of data. The close of the socket is blocked until ACK is received or 10 seconds, whichever comes first.

In PROFILE.TCPIP configuration on the IMS Connect endpoint, ensure:

- IMS Connect PORT set to NODELAYACKS. This allows ACKS to be sent immediately.
- Specify SHAREPORT, which allows IMS Connect PORTS to be shared by multiple IMS Connect instances on the same stack.
- TCPCONFIG INTERVAL or KEEPALIVEOPTIONS INTERVAL allows TCP/IP to maintain a connection that can be inactive for long periods of time.
- SOMAXCONN must be defined large enough for maximum concurrent connections.

From Redbook *IMS Performance and Tuning Guide*, SG24-7324-00

mitchj@us.ibm.com

Connection Management for IMS DB

Use the connectionManagerRef attribute in an IMS ConnectionFactory to provide a connection pool for connections to IMS Connect.

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

<connectionManger id="IMSDBConnMgr" agedTimout=-1 connectionTimeout=30
maxIdleTIme=1800 maxPoolSize=50 minPoolSize=0 purgePolicy="EntirePool"
reapTIme=180/>
```

The *maxPoolSize* in the *connectionManager* configuration element should not exceed the value of the IMS Connect *MAXSOC* attribute.

mitchj@us.ibm.com

Connection Management for MQ

Use the connectionManagerRef attribute in a JMS ConnectionFactory to provide a connection pool for connections to a queue manager.

```
<jmsConnectionFactory id="qmgrCf" jndiName="jms/qmgrCf"
        connectionManagerRef="MQConnMgr">
        <properties.wmqJMS transportType="CLIENT"
                queueManager="ZMQ1"
                channel="LIBERTY.DEF.SVRCONN"
                hostName="wg31.washington.ibm.com"
                port="1422" />
</jmsConnectionFactory>

<connectionManger id="MQConnMgr" agedTimout=-1 connectionTimeout=30
   maxIdleTIme=1800 maxPoolSize=50 minPoolSize=0 purgePolicy="EntirePool"
reapTIme=180/>
```

The *maxPoolSize* in the *connectionManager* configuration element should not exceed the value of the *MAXINST* or *MAXINSTC* attributes of the queue manager's server-connection channel.

mitchj@us.ibm.com

Connection Management for outbound HTTP request, e.g., Db2, etc.

Outbound connections to Db2, authorization servers, API requesters servers are managed by z/OS Connect code (as is any endpoint configured by the use of a z/OS Connection configuration element).

Connections are managed and/or configured by the use of Java system parameters (-D) *http.maxConnections* and *http.keepAlive*.

```
-Dhttp.maxConnections=5
-Dhttp.keepAlive=true
```

mitchj@us.ibm.com

TLS sessions

- When connections timeout, it is still possible to avoid the impact of full handshakes by reusing the TLS session id
- Configured by setting the `sslSessionTimeout` attribute on the sslOptions element to an amount of time
- Example setting server.xml file

```
 <httpEndpoint host="*" httpPort="80" httpsPort="443" id="defaultHttpEndpoint"
httpOptionsRef="httpOpts‟ sslOptionsRef="mySSLOptions"/>

<httpOptions id="httpOpts" keepAliveEnabled="true" maxKeepAliveRequests=‟100"
persistTimeout="1m"/>

<sslOptions id="mySSLOptions" sslRef="DefaultSSLSettings"
sslSessionTimeout=‟10m”/>
```

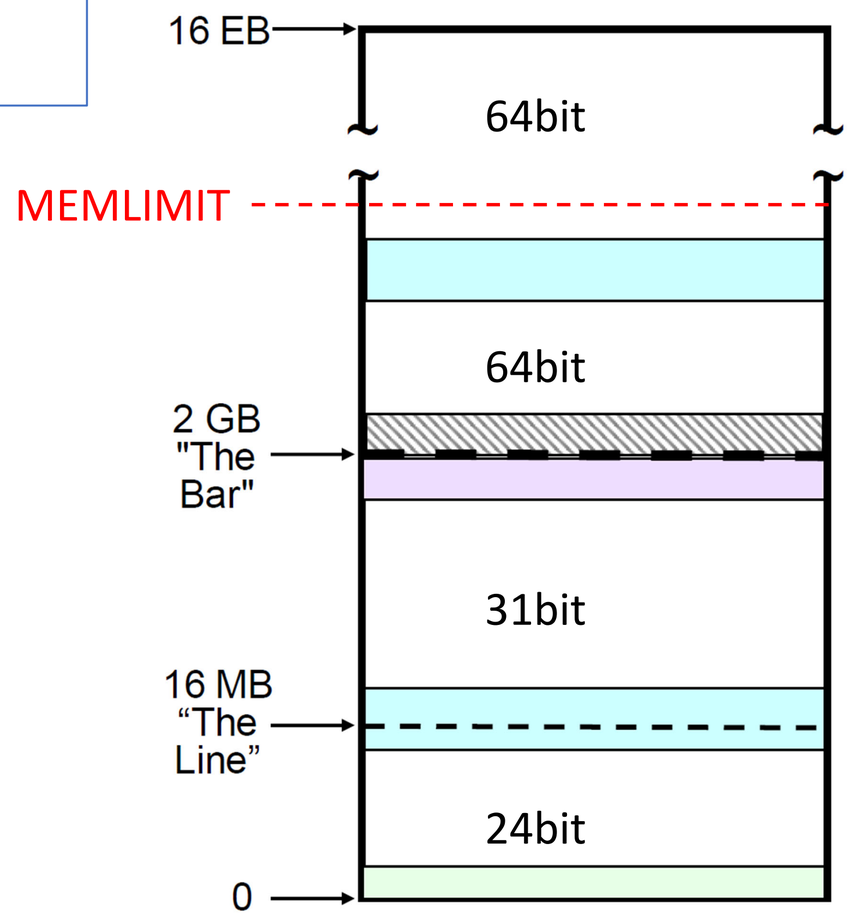
- This sets the timeout limit of an TLS session to **10 minutes** (default is 8640ms)

mitchj@us.ibm.com

MEMLIMIT - memory storage above-the-bar

```
//ZCON     EXEC PGM=BPXBATSL,REGION=0M,MEMLIMIT=4G,
//         PARM='PGM &ZCONHOME./bin/zosconnect run &PARMS.'
```

- Limits the amount of 64-bit storage
  - Only a limit, not pre-allocated
- z/OS uses above the bar storage for:
  - Native thread stack storage
- Java uses above the bar storage for:
  - Heap storage
  - Caches
  - Java thread



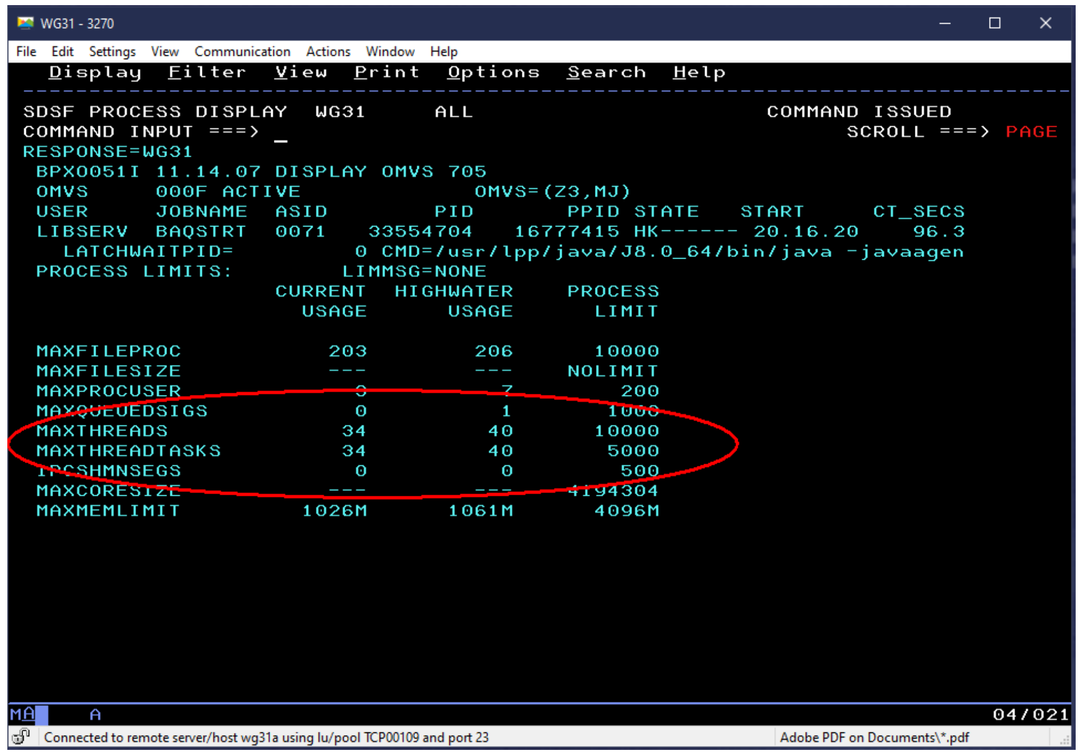
messages.log

CWWKB0125I: This server requested a REGION size of 0KB. The below-the-line storage limit is 8MB and the above-the-line storage limit is 1725MB.
CWWKB0126I: MEMLIMIT=1000. MEMLIMIT CONFIGURATION SOURCE=JCL.

mitchj@us.ibm.com

Native threads

- Native threads require 3Mb of above the bar storage (2Mb for LE and 1Mb for the JVM)
  - Monitor thread usage for the address space
    - *D OMVS,LIMITS,PID=<server pid>*



- MAXTHREADS mut be greater than or equal to MAXTHREADTASK
- Take action when USAGE comes within 80-90% of maxThreads

Tech-Tip: Java heap storage

- Java heap is the area of memory managed by the Java Virtual Machine (JVM) where Java class objects and other objects instantiated by Java applications running in the JVM are stored and resides above the bar. The JVM obtains storage in the heap storage on behalf of the Java applications.
- A process know as garbage collection reclaims the storage when the object is no longer, for more information see URL https://docs.oracle.com/cd/E15289_01/JRSDK/garbage_collect.htm

Non-standard Java options related to garbage collection and heap storage*

- ❑ -Xgcpolicy:gencon Garbage collection policy, the default is *gencon* and is the recommend garbage collection policy
- ❑ -Xms<size> Initial heap size, defaults to *8MB* on z/OS
- ❑ -Xmx<size> Maximum help size, defaults to half the available memory with a minimum of *16 MB* and a maximum of *512 MB*

https://www.ibm.com/docs/en/sdk-java-technology/8?topic=reference-default-settings

Standard Java options related garbage collection reporting*

- ❑ -verbose:gc Writes verbose garbage collection information.
- ❑ -verbose:sizes Writes information to stderr describing the active memory usage settings.

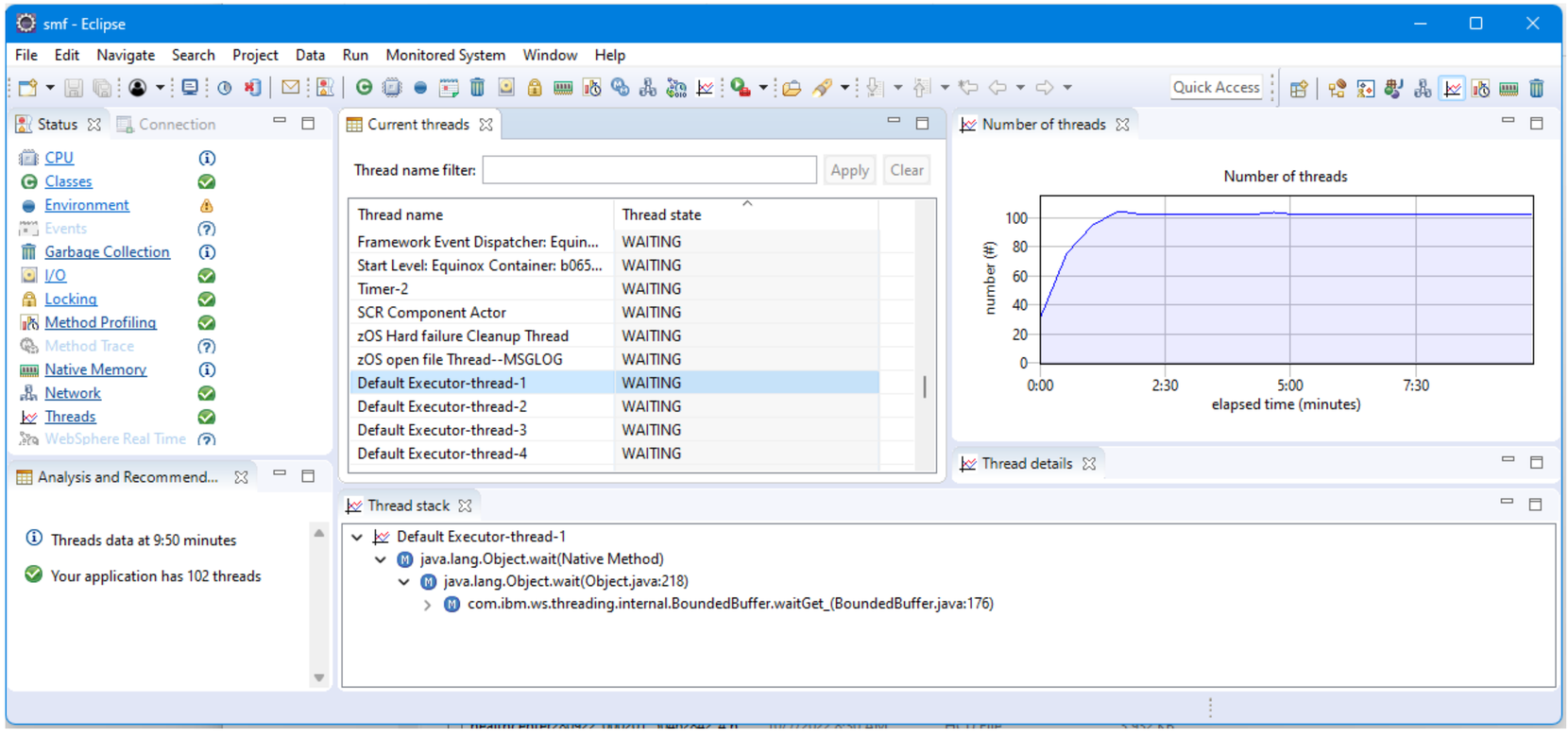
https://www.ibm.com/docs/en/sdk-java-technology/8?topic=options-standard

mitchj@us.ibm.com

*Multiple –verbose options can be provided concurrently

Java threads

- Java threads handle application requests (executor threads), garbage collection and other Java housekeeping functions.
  - Each Java thread require 1.6Kb of Java heap storage
  - The maximum number of executor threads defaults to unlimited.
    - The maximum number of executor threads can be limited with configuration element *<executor maxThreads="300"/>*
    - The attribute *maxOpenConnections* attribute in the *tcpOptions* configuration element should be set to less than or equal to the value of the maximum number of executor threads.



mitchj@us.ibm.com

MEMLIMIT Recommendations

- Don’t reach the maximum!
  - Results in Java Out Of Memory errors and system abends
  - z/OS Connect EE will stop processing API requests

- Ensure this doesn’t happen
  - Limit the Liberty Default Executor thread pool
    - maxThreads default value is -1 No Limit!

```
<executor maxThreads="300"/>
```

- MEMLIMIT =
  - Maximum JVM Heap Size (-Xmx)
  + 20% of the Maximum Heap Size (for JIT caches and other JVM requirements)
  + Default Executor pool maxThreads * 3MB

Maximum JVM Heap Size – half the available memory with a minimum of 16 MB and a maximum of 512 MB

mitchj@us.ibm.com

MEMLIMIT – management

- MEMLIMIT values
  - MEMLIMIT = maximum Java heap size + 50% of maximum heap size

  or
  - MEMLIMIT = maximum Java heap size + 20% of Java heap size + (number of executor threads * 3Mb)
- Monitor periodically
  - To track high water mark with MVS command *D OMVS,LIMITS,PID=<server pid>*
- Don't reach the maximum!
  - Results in Java Out Of Memory errors and system abends
  - Liberty will stop processing requests

Inbound persistent connections

- Persistent connections can be used to avoid too many handshakes
- Configured by setting the `keepAliveEnabled` attribute on the httpOptions element to **true**
- Example setting server.xml file

```
 <httpEndpoint host="*" httpPort="80" httpsPort="443" id="defaultHttpEndpoint"
httpOptionsRef="httpOpts"/>

<httpOptions id="httpOpts" keepAliveEnabled="true" maxKeepAliveRequests="500"
persistTimeout="1m"/>
```

- This sets the connection timeout to **1 minute** (default is 30 seconds) and sets the maximum number of persistent requests that are allowed on a single HTTP connection to **500**
- It is recommended to set a maximum number of persistent requests when connection workload balancing is configured
- It is also necessary to configure the client to support persistent connections

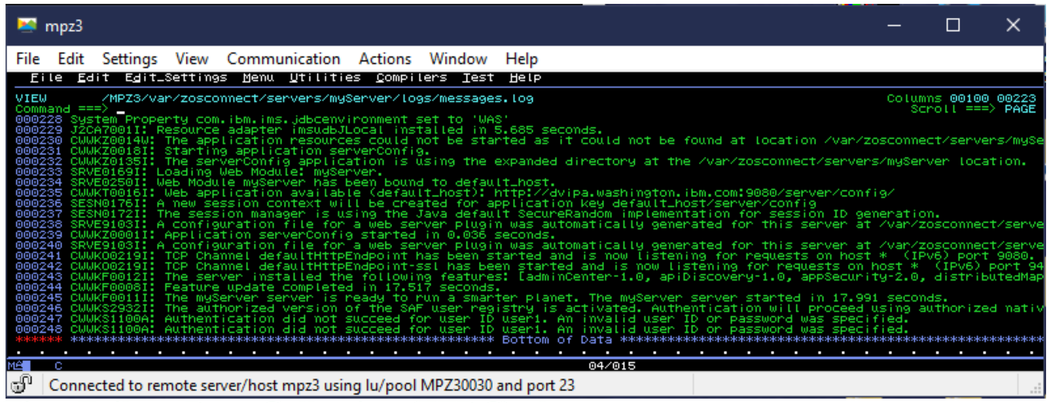
mitchj@us.ibm.com

Where do I look when things go wrong?

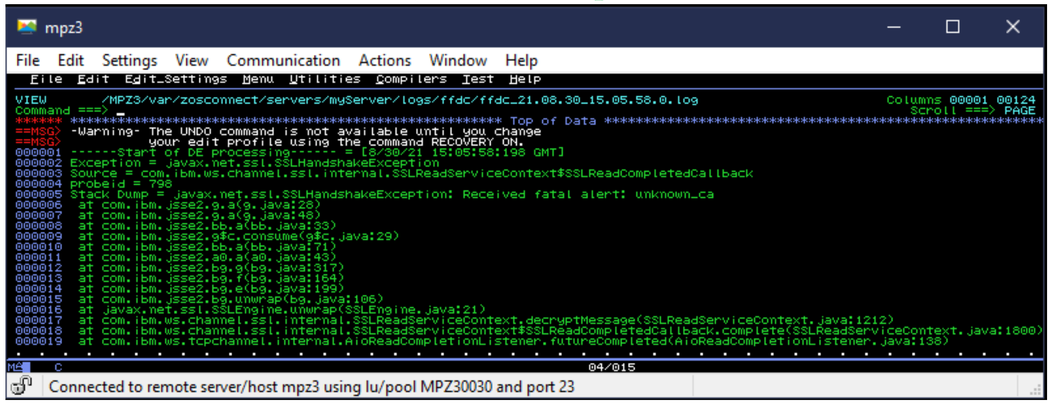
mitchj@us.ibm.com

Where to find information when a problem occurs.

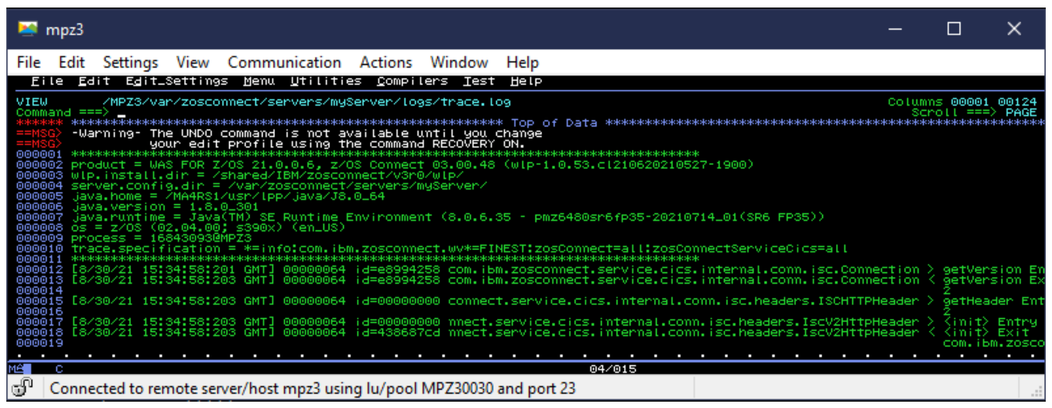
messages.log



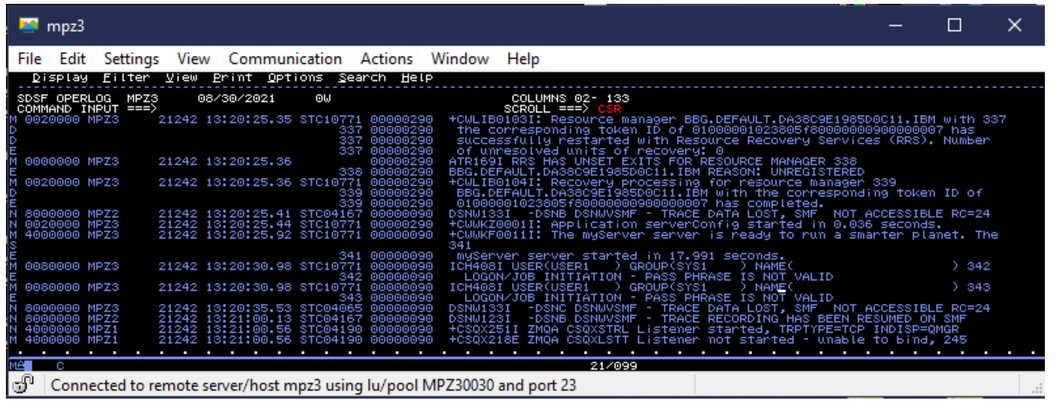
First Failure Data Collection (FFDC) dumps



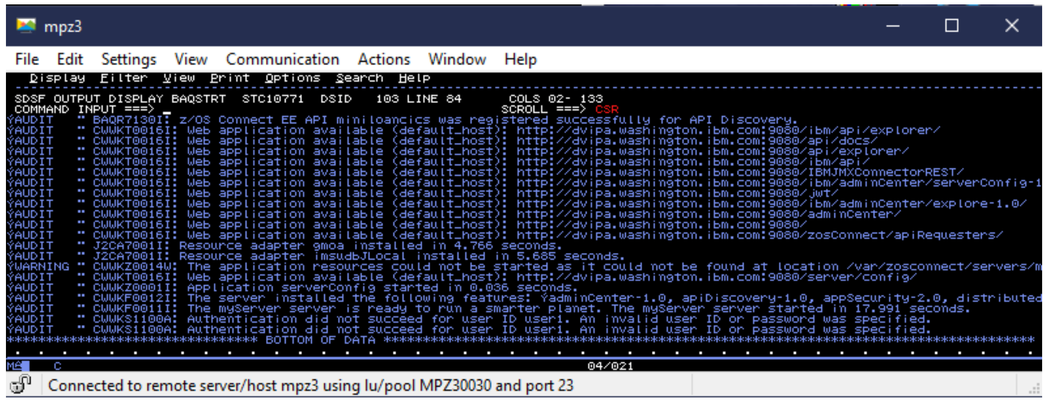
trace.out



SYSLOG/STC JESMSGLG DD



STC STDOUT DD



mitchj@us.ibm.com

Issues and problems can be categorized

- First realize that actual products problems do occur, but they are rare. In my experience most problems and issues can be resolved with a little investigation and some analysis. I have found that most problems and issues will fall in this these categories.

  - **Basic Security issues**
    - Insufficient access to local SAF resources, e.g., APPL, EJBROLE, SERVER resources
    - Security issues related to XML configuration elements, safCredentials, sslDefault, keystore, etc.
  - **Advanced Security issues**
    - Key ring access, e.g., FACILITY resources IRR.DIGTCERT or RDATALIB or IDIDMAP resources.
    - Key ring contents, e.g., missing certificates, key usage, personal and certificate authorities, private keys versus public keys.
    - Incorrect use of certificates in a TLS handshakes versus certificates used for token validation.
  - **z/OS Connect XML Configuration issues**
    - Missing or misspelled configuration attributes (remember the Liberty XML parser is too forgiving)
  - **External resource Issues**
    - Service provider configuration issues.
    - Timeouts
    - Network Firewalls
    - Resource Security
    - Other resource errors

Remember external symptoms will overlap. But the use of rigor in setting configuration standards and following a process in problem isolation/determination process will help reduce the impact of problems and issues.

mitchj@us.ibm.com

messages.log - The anatomy of a message in the messages.log file

```
********************************************************************************
product = WAS FOR Z/OS 21.0.0.6, z/OS Connect 03.00.48 (wlp-1.0.53.cl210620210527-1900)
wlp.install.dir = /shared/IBM/zosconnect/v3r0/wlp/
server.config.dir = /var/zosconnect/servers/zceeopid/
java.home = /MA4RS1/usr/lpp/java/J8.0_64
java.version = 1.8.0_301
java.runtime = Java(TM) SE Runtime Environment (8.0.6.35 - pmz6480sr6fp35-20210714_01(SR6 FP35))
os = z/OS (02.04.00; s390x) (en_US)
process = 16843186@MPZ3
********************************************************************************
[9/3/21 13:38:02:831 GMT] 00000013 com.ibm.ws.kernel.launch.internal.FrameworkManager          A CWWKE0001I: The server zceeopid has been launched.
[9/3/21 13:38:04:439 GMT] 0000001f com.ibm.ws.config.xml.internal.XMLConfigParser             A CWWKG0028A: Processing included configuration resource
[9/3/21 13:38:04:466 GMT] 0000001f com.ibm.ws.config.xml.internal.XMLConfigParser             A CWWKG0028A: Processing included configuration resource
[9/3/21 13:38:04:470 GMT] 0000001f com.ibm.ws.config.xml.internal.XMLConfigParser             A CWWKG0028A: Processing included configuration resource
[9/3/21 13:38:04:473 GMT] 0000001f com.ibm.ws.config.xml.internal.XMLConfigParser             A CWWKG0028A: Processing included configuration resource
[9/3/21 13:38:04:476 GMT] 0000001f com.ibm.ws.config.xml.internal.XMLConfigParser             A CWWKG0028A: Processing included configuration resource
[9/3/21 13:38:04:481 GMT] 0000001f com.ibm.ws.config.xml.internal.XMLConfigParser             A CWWKG0028A: Processing included configuration resource
[9/3/21 13:38:04:610 GMT] 00000021 com.ibm.ws.zos.core.internal.NativeServiceTracker          I CWWKB0125I: This server requested a REGION size of 0KB
[9/3/21 13:38:04:612 GMT] 00000021 com.ibm.ws.zos.core.internal.NativeServiceTracker          I CWWKB0126I: MEMLIMIT=2000. MEMLIMIT CONFIGURATION SOUR
[9/3/21 13:38:04:628 GMT] 00000021 com.ibm.ws.zos.core.internal.NativeServiceTracker          I CWWKB0122I: This server is connected to the default an
[9/3/21 13:38:04:679 GMT] 00000021 com.ibm.ws.zos.core.internal.NativeServiceTracker          I CWWKB0103I: Authorized service group KERNEL is availab
[9/3/21 13:38:04:680 GMT] 00000021 com.ibm.ws.zos.core.internal.NativeServiceTracker          I CWWKB0103I: Authorized service group LOCALCOM is avail
[9/3/21 13:38:04:680 GMT] 00000021 com.ibm.ws.zos.core.internal.NativeServiceTracker          I CWWKB0103I: Authorized service group PRODMGR is availa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - 148 Line(s) not Displayed
[9/3/21 13:38:42:347 GMT] 00000040 om.ibm.ws.app.manager.rar.internal.RARApplicationHandlerImpl A J2CA7001I: Resource adapter imsudbJLocal installed in
[9/3/21 13:38:42:419 GMT] 0000003e com.ibm.ws.jmx.connector.server.rest.RESTAppListener       I CWWKX0103I: The JMX REST connector is running and is a
[9/3/21 13:38:42:422 GMT] 0000003e com.ibm.ws.jmx.connector.server.rest.RESTAppListener       I CWWKX0103I: The JMX REST connector is running and is a
[9/3/21 13:38:42:428 GMT] 0000002c com.ibm.ws.tcpchannel.internal.TCPPort                     I CWWKO0219I: TCP Channel defaultHttpEndpoint has been s
[9/3/21 13:38:42:431 GMT] 0000002c com.ibm.ws.tcpchannel.internal.TCPPort                     I CWWKO0219I: TCP Channel defaultHttpEndpoint-ssl has be
[9/3/21 13:38:42:437 GMT] 00000042 com.ibm.ws.webcontainer.osgi.mbeans.PluginGenerator        I SRVE9103I: A configuration file for a web server plugi
[9/3/21 13:38:42:489 GMT] 0000002c com.ibm.ws.kernel.feature.internal.FeatureManager          A CWWKF0012I: The server installed the following feature
[9/3/21 13:38:42:490 GMT] 0000002c com.ibm.ws.kernel.feature.internal.FeatureManager          I CWWKF0008I: Feature update completed in 37.484 seconds
[9/3/21 13:38:42:490 GMT] 0000002c com.ibm.ws.kernel.feature.internal.FeatureManager          A CWWKF0011I: The zceeopid server is ready to run a smar
[9/3/21 13:41:31:640 GMT] 00000045 .security.openidconnect.client.internal.OidcClientConfigImpl I CWWKS1700I: OpenID Connect client ATS configuration su
[9/3/21 13:41:31:691 GMT] 00000045 rity.authentication.filter.internal.AuthenticationFilterImpl I CWWKS4358I: The authentication filter ATSAuthFilter co
[9/3/21 13:41:32:824 GMT] 00000053 com.ibm.zosconnect.service.cics.internal.conn.isc.Connection I BAQR0680I: CICS connection cscvinc established with 10
```

- **WLP_LOGGING_CONSOLE_FORMAT - SIMPLE -** Use the simple logging format. As of Liberty release 20.0.0.6 (z/OS Connect V3.034), this format writes the messages to STDOUT and STDERR with time stamps included.

Basic security issues – Sometimes the problem is easy to find

The STDOUT may show:

```
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified
```

And the messages.log displays:

```
CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
```

But the JESMSGLG and SYSLOG displays:

WG31

File Edit Settings View Communication Actions Window Help

```
  Display  Filter  View  Print  Options  Search  Help
------------------------------------------------------------------------------------------------------------------------
 SDSF OUTPUT DISPLAY BAQSTRT  STC12856  DSID     2 LINE 17      COLS 02- 133
 COMMAND INPUT ===>                                           SCROLL ===> PAGE
15.27.30 STC12856  +CWWKZ0001I: Application resources started in 0.086 seconds.
15.27.30 STC12856  +CWWKZ0001I: Application serverConfig started in 0.086 seconds.
15.27.31 STC12856  +CWWKF0011I: The myServer server is ready to run a smarter planet. The  001
   001              myServer server started in 36.923 seconds.
15.27.32 STC12856  ICH408I USER(FRED    ) GROUP(ATSGRP  ) NAME(USER FRED          )  002
   002               LOGON/JOB INITIATION - INVALID PASSWORD
15.27.32 STC12856  IRR013I  VERIFICATION FAILED. INVALID PASSWORD GIVEN.
15.27.32 STC12856  ICH408I USER(FRED    ) GROUP(ATSGRP  ) NAME(USER FRED          )  004
   004               LOGON/JOB INITIATION - INVALID PASSWORD
15.27.32 STC12856  IRR013I  VERIFICATION FAILED. INVALID PASSWORD GIVEN.
      1 //BAQSTRT  JOB MSGLEVEL=1                                          STC12856
      2 //STARTING EXEC BAQSTRT
      3 XXBAQSTRT  PROC PARMS='myServer --clean'
        XX*
      4 XX SET ZCONHOME='/usr/lpp/IBM/zosconnect/v3r0'
        XX*
      5 XXZCON     EXEC PGM=BPXBATSL,REGION=0M,MEMLIMIT=8G,
        XX         PARM='PGM &ZCONHOME./bin/zosconnect run &PARMS.'
        IEFC653I SUBSTITUTION JCL - PGM=BPXBATSL,REGION=0M,MEMLIMIT=8G,PARM='PGM
        /usr/lpp/IBM/zosconnect/v3r0/bin/zosconnect run myServer --clean'
      6 XXSTEPLIB  DD DISP=SHR,DSN=MQ91#.SCSQAUTH
      7 XX         DD DISP=SHR,DSN=MQ91#.SCSQANLE
      8 XXSTDERR   DD   SYSOUT=*,FREE=CLOSE,SPIN=(UNALLOC,1M)
MA    B                                                          16/074
```

Connected to remote server/host mpz3 using lu/pool MPZ30023 and port 23

mitchj@us.ibm.com

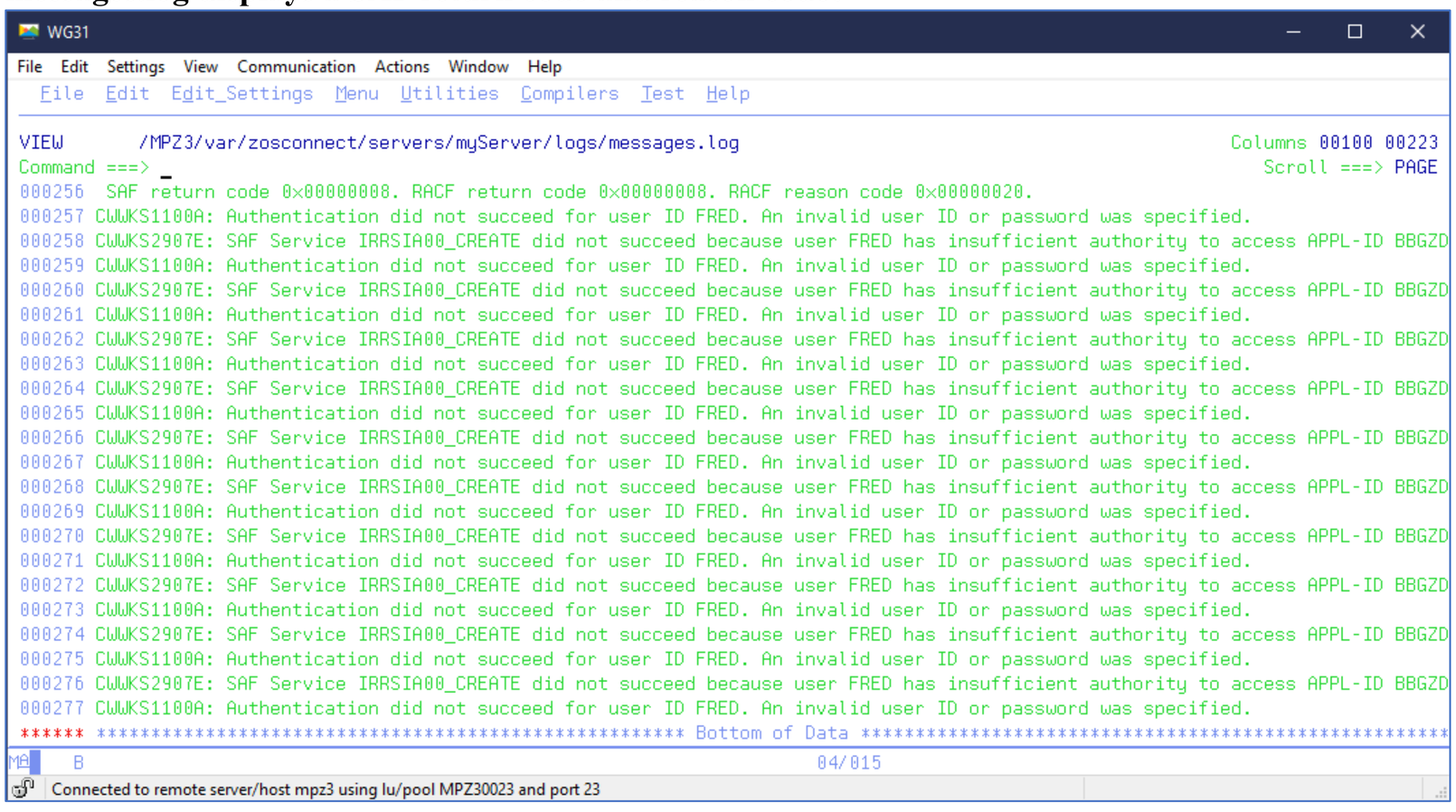
Basic security issues – Sometimes you must dig a little more

The STDOUT may show:

```
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified
```

But there are no SAF messages in the SYSLOG:

While the messages.log displays a SAF return code and reason code:



CWWKS2907E: SAF Service IRRSIA00_CREATE did not succeed because user FRED has insufficient authority to access APPL-ID BBGZDFLT. SAF return code 0x00000008. RACF return code 0x00000008. RACF reason code 0x00000020.

mitchj@us.ibm.com

Tech-Tip: And be aware of hex v. decimal in return and reason codes

RACF return code 0x00000008. RACF reason code 0x00000020.

Table 1. initACEE create return codes

SAF return code	RACF® return code	RACF reason code	Explanation
0	0	0	The service was successful.
4	0	0	RACF is not installed.
8	8	4	Parameter list error occurred.
8	8	8	An internal error occurred during RACF processing.
8	8	12	Recovery environment could not be established.
8	8	16	User ID is not defined to RACF.
8	8	20	Password, Password Phrase or Pass Ticket is not valid.
8	8	24	Password or Password Phrase is expired.
8	8	28	User ID is revoked or user access to group is revoked.
8	8	32	The user does not have appropriate RACF access to either the SECLABEL, SERVAUTH profile, or APPL specified in the parmlist.
8	8	36	Certificate is not valid.
8	8	40	No user ID is defined for this certificate. See Usage Note number 37.
8	8	44	The client security label is not equivalent to the server's security label.
8	8	48	A managed ACEE is requested with a nested RACO in the Envir_In parameter.
8	12	InitUSP reason code	initUSP failed. See initUSP reason codes in Return and reason codes.

Hex ’20’ = Dec ‘32’

Root cause – No READ access to APPL resource BBGZDFLT

From URL https://www.ibm.com/docs/en/zos/2.4.0?topic=acee-return-reason-codes

mitchj@us.ibm.com

Basis security issues - Use the SYSLOG/JESMSGLG output

The SYSLOG shows a ICH408I message:

WG31

File Edit Settings View Communication Actions Window Help

```
  Display  Filter  View  Print  Options  Search  Help
-------------------------------------------------------------------------------------------------------------------------------
SDSF OPERLOG  MPZ3     09/16/2021     0W                      COLUMNS 01- 132
COMMAND INPUT ===> _                                         SCROLL ===> PAGE
M 8000000 MPZ1     21259 16:50:10.13 STC11092 00000090  CSQY220I ZMQ1 CSQSCTL Queue manager storage usage: 057
E                                    057 00000090  local storage: used 607MB, free 787MB: above bar: used 256MB, free 1GB
M 8000000 MPZ1     21259 16:50:18.77 STC11094 00000090  CSQY220I ZMQA CSQSCTL Queue manager storage usage: 058
E                                    058 00000090  local storage: used 607MB, free 787MB: above bar: used 515MB, free 1GB
M 4000000 MPZ3     21259 16:50:19.01 STC11011 00000090  +CSQX123E ZMQC CSQXSMFT Failed to process channel initiator statistics,
S                                                       422
E                                    422 00000090   RC=00000024
N 4000000 MPZ3     21259 16:50:19.01 STC11011 00000090  +CSQX125I ZMQC CSQXSMFT SMF data incomplete
M 4000000 MPZ3     21259 16:50:19.10 STC11010 00000090  +CSQX123E ZMQ3 CSQXSMFT Failed to process channel initiator statistics,
S                                                       424
E                                    424 00000090   RC=00000024
N 4000000 MPZ3     21259 16:50:19.10 STC11010 00000090  +CSQX125I ZMQ3 CSQXSMFT SMF data incomplete
N 0000000 MPZ3     21259 16:50:20.66          00000281  IEA989I SLIP TRAP ID=X13E MATCHED.  JOBNAME=JOHNSON , ASID=004D.
N 8000000 MPZ1     21259 16:50:30.89 STC11087 00000090  DSNW133I  -DSNA DSNWVSMF - TRACE DATA LOST, SMF  NOT ACCESSIBLE RC=24
N 8000000 MPZ3     21259 16:50:31.08 STC11002 00000090  DSNW133I  -DSNC DSNWVSMF - TRACE DATA LOST, SMF  NOT ACCESSIBLE RC=24
N 8000000 MPZ3     21259 16:50:47.01 STC11002 00000090  DSNW123I  -DSNC DSNWVSMF - TRACE RECORDING HAS BEEN RESUMED ON SMF
M 00A0000 MPZ3     21259 16:50:54.67 STC12869 00000090  ICH408I USER(USER1   ) GROUP(SYS1    ) NAME(                    ) 429
D                                    429 00000090    BBGZDFLT.zos.connect.access.roles.zosConnectAccess
D                                    429 00000090    CL(EJBROLE )
D                                    429 00000090    INSUFFICIENT ACCESS AUTHORITY
E                                    429 00000090    ACCESS INTENT(READ   )  ACCESS ALLOWED(NONE   )
N 8000000 MPZ1     21259 16:51:00.70 STC11087 00000090  DSNW123I  -DSNA DSNWVSMF - TRACE RECORDING HAS BEEN RESUMED ON SMF
N 8000000 MPZ1     21259 16:51:20.97 STC11087 00000090  DSNW133I  -DSNA DSNWVSMF - TRACE DATA LOST, SMF  NOT ACCESSIBLE RC=24
MA    B                                                                    04/021
```

Connected to remote server/host mpz3 using lu/pool MPZ30023 and port 23

Symptom: client see HTTP 403 – Authorization Failed. There were no messages in STDOUT or messages.log locations. Root cause – No READ access to EJBROLE BBGZDFLT.zos.connect.access.roles.zosConnectAccess.

mitchj@us.ibm.com

Basic security issues – Sometimes there is misdirection

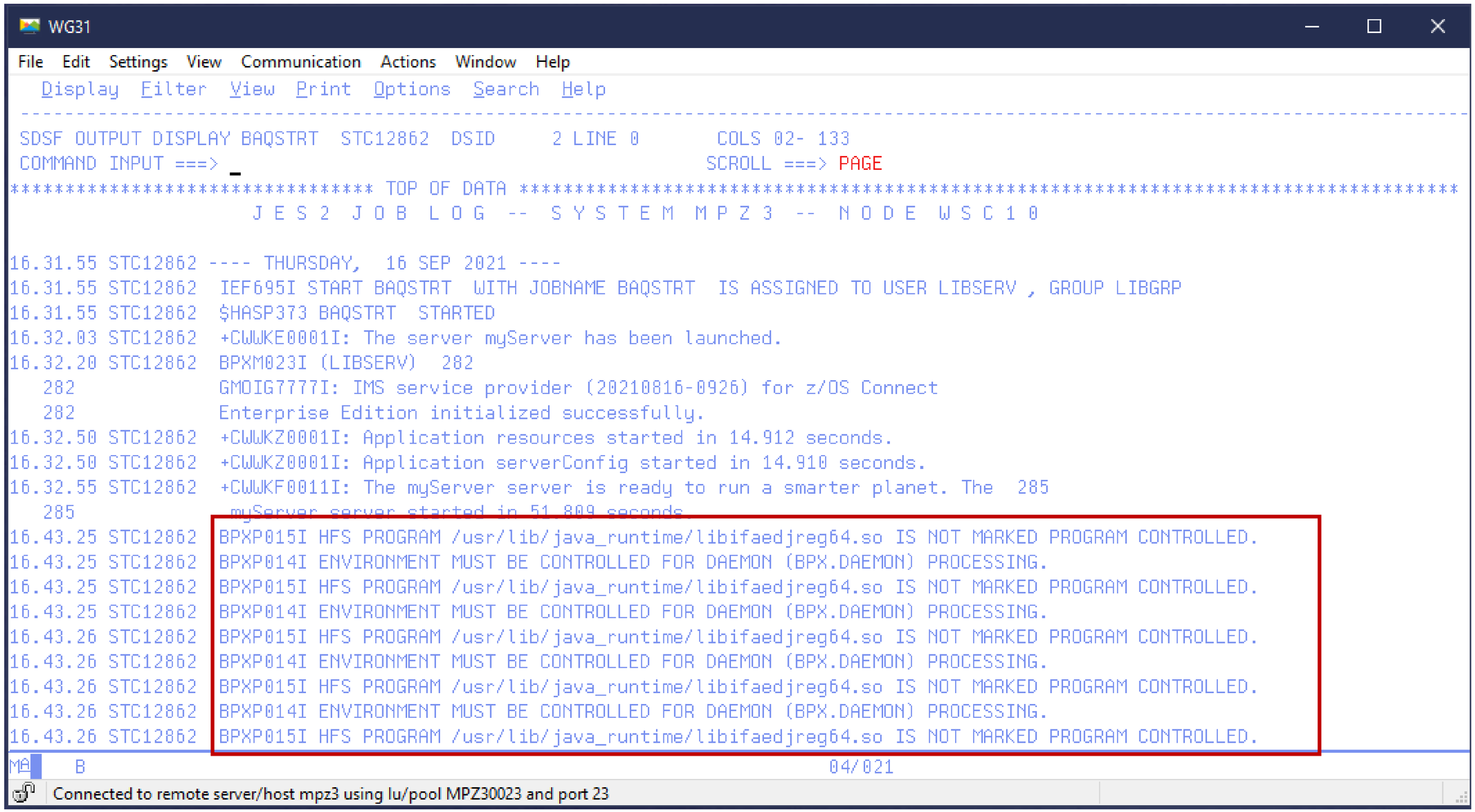
The STDOUT may show:

```
  Display  Filter  View  Print  Options  Search  Help
 ------------------------------------------------------------------------------------------------------------------------------------
 SDSF OUTPUT DISPLAY BAQSTRT  STC12844  DSID   103 LINE 98      COLS 02- 133
 COMMAND INPUT ===> _                                          SCROLL ===> PAGE
ÝAUDIT    ¨ CWWKZ0001I: Application serverConfig started in 4.006 seconds.
ÝAUDIT    ¨ CWWKZ0001I: Application resources started in 4.007 seconds.
ÝAUDIT    ¨ CWWKT0016I: Web application available (default_host): http://dvipa.washington.ibm.com:9080/zosConnect/apiRequesters/
ÝAUDIT    ¨ CWWKT0016I: Web application available (default_host): http://dvipa.washington.ibm.com:9080/
ÝAUDIT    ¨ CWWKF0012I: The server installed the following features: ÝadminCenter-1.0, apiDiscovery-1.0, appSecurity-2.0, distributed
ÝAUDIT    ¨ CWWKF0011I: The myServer server is ready to run a smarter planet. The myServer server started in 66.646 seconds.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
ÝAUDIT    ¨ CWWKS1100A: Authentication did not succeed for user ID FRED. An invalid user ID or password was specified.
******************************** BOTTOM OF DATA ***********************************************************************************

MA     B                                                                          04/021
```

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

mitchj@us.ibm.com

Basic security issues - SYSLOG/JESMSGLG output (even more misdirection)

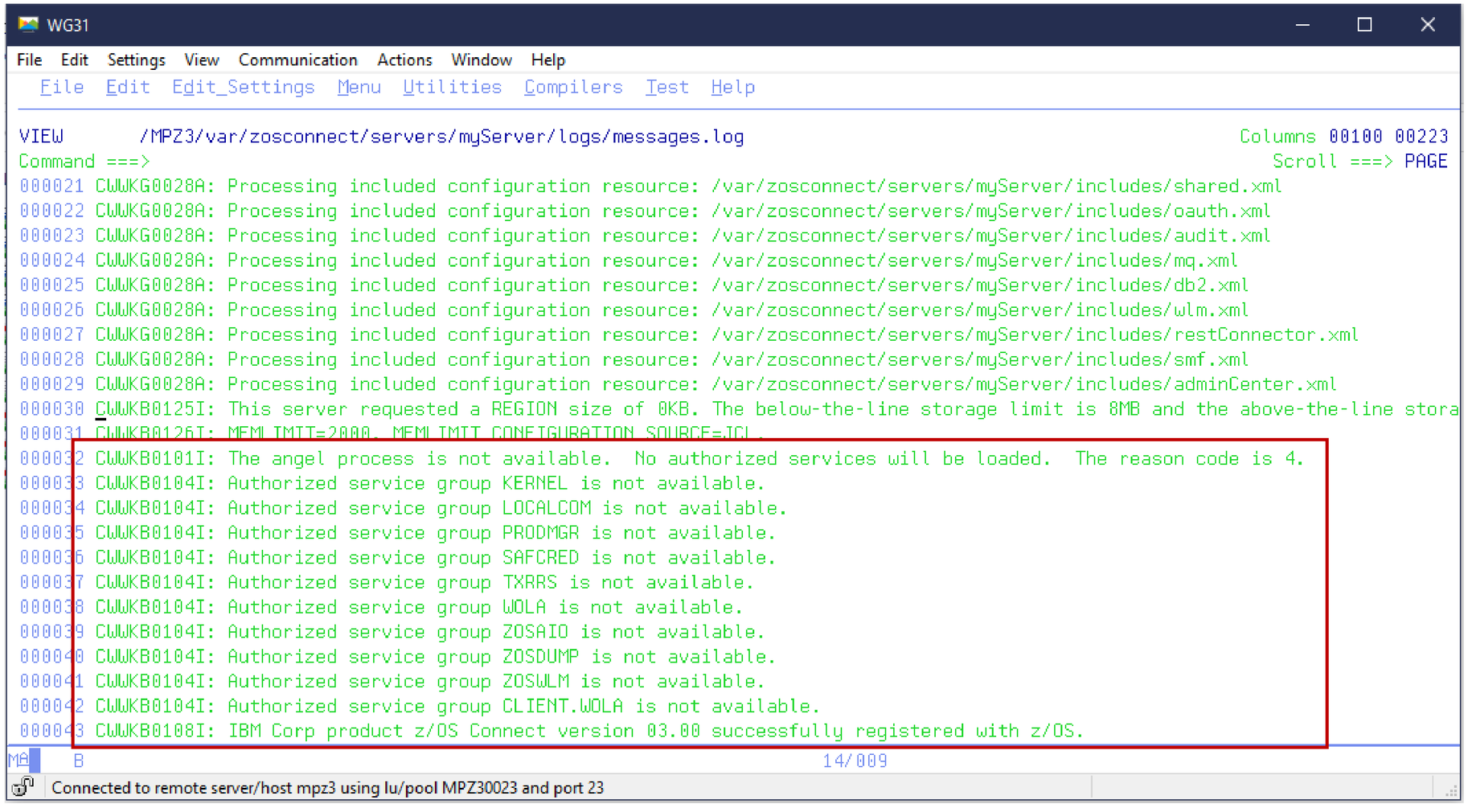


Symptom: Client unable to connect. STDOUT contains message *CWWKS1100A: Authentication did not succeed for user ID user1. An invalid user ID or password was specified.*

mitchj@us.ibm.com

Basic security issues - SYSLOG/JESMSGLG output (even more misdirection)

There is no need to set the extended protection attribute for this Java shared object executable.
The root cause was that the angel was not active.



mitchj@us.ibm.com

External resource issues (HTTP 500)

The client sees:

```
HTTP/1.1 500 Internal Server Error
```

The STDOUT may show:

```
ÝWARNING ¨ BAQR0429W: API db2employee encountered an error while processing a request under URL
https://mpz3.washington.ibm.com:9443/db2/employee/948478.
```

While the messages.log display

```
[9/16/21 21:00:55:811 GMT] 00000051 com.ibm.zosconnect.service.cics.internal.conn.ISCECIRequest  E BAQR0657E: Transaction
abend MIJO occurred in CICS while using CICS connection cscvinc and service cscvincDeleteService.
[9/16/21 21:00:55:815 GMT] 00000051 com.ibm.zosconnect.internal.web.ServiceProxyServlet          W BAQR0429W: API cscvinc
encountered an error while processing a request under URL https://mpz3.washington.ibm.com:9443/cscvinc/employee/948478.
```

The STDOUT may show:

```
ÝWARNING ¨ BAQR0429W: API db2employee encountered an error while processing a request under URL
https://mpz3.washington.ibm.com:9443/db2/employee/948478.
```

The messages.log displays:

```
[9/14/21 20:04:59:776 GMT] 00000048 osconnect.service.client.rest.internal.RestClientServiceImpl E BAQR0558E: The remote
service invocation failed with [9/14/21 20:04:59:776 GMT] 00000048
osconnect.service.client.rest.internal.RestClientServiceImpl E BAQR0558E: The remote service invocation failed with failed
due to SQLCODE=-204 SQLSTATE=42704, USER1.EMPLOYEE IS AN UNDEFINED NAME. Error Location:DSNLJACC:35"}
```

mitchj@us.ibm.com

Tech-Tip: An HTTP 500 shortcut – look elsewhere

A HTTP status code 500 occurs when a failure occurred at an external endpoint. It does not matter if the external endpoint is a z/OS resources or a REST API provider, or an authorization server, etc.

The details of the failure may not be provided **directly** to z/OS Connect, just the fact that a failure has occurred. The failure could be a security issue, an abend or something entirely. z/OS Connect may or may not have directly access to any details of the failure (it depends on the service provider). It does not mean the details do not exist; the details are just readily available.

The shortcut to identify the issue is review the messages in the messages.log and check to see if there is corresponding FFDC (first failure data collection) dump.

mitchj@us.ibm.com

What is a Java stack trace?

```
[9/6/21 22:51:19:981 GMT] 00000039 com.ibm.ejs.j2c.ConnectionEventListener                    A J2CA0056I: The Connection Manager received
a fatal connection error from the Resource Adapter for resource null. The exception is: javax.resource.spi.EISSystemException: ICO0001E:
com.ibm.connector2.ims.ico.IMSTCPIPManagedConnection@c341a0aa.processOutputOTMAMsg(Connection, InteractionSpec, Record, Record) error. IMS
Connect returned an error: RETCODE=[4], REASONCODE=[NFNDDST] [Datastore not found.   ]
 at com.ibm.connector2.ims.ico.IMSManagedConnection.processOutputOTMAMsg(IMSManagedConnection.java:4042)
 at com.ibm.connector2.ims.ico.IMSTCPIPManagedConnection.callSendRecv(IMSTCPIPManagedConnection.java:241)
 at com.ibm.connector2.ims.ico.IMSManagedConnection.call(IMSManagedConnection.java:1625)
 at com.ibm.connector2.ims.ico.IMSConnection.call(IMSConnection.java:213)
 at com.ibm.connector2.ims.ico.IMSInteraction.execute(IMSInteraction.java:586)
 at com.ibm.ims.gateway.services.IMSGatewayServiceImpl.executeTranServiceInputTMRA(Unknown Source)
 at com.ibm.ims.gateway.services.IMSGatewayServiceImpl.invokeTransactionService(Unknown Source)
 at com.ibm.ims.gateway.services.IMSGatewayServiceImpl.invoke(Unknown Source)
 at com.ibm.ims.zconnect.provider.clients.GatewayServiceClient.doPost(Unknown Source)
 at com.ibm.ims.zconnect.provider.clients.IMSClient.doInvoke(Unknown Source)
 at com.ibm.ims.gateway.config.services.IMSZServiceHandlerImpl.invoke(Unknown Source)
 at com.ibm.ims.gateway.config.services.IMSZServiceImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.internal.ZosConnectServiceImpl.apiInvoke(Unknown Source)
 at com.ibm.zosconnect.internal.ServiceManagerImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.internal.ApiManagerImpl.invokeApi(Unknown Source)
 at com.ibm.zosconnect.internal.web.ServiceProxyServlet$3.run(Unknown Source)
 at com.ibm.ws.webcontainer.async.ServiceWrapper.wrapAndRun(ServiceWrapper.java:236)
 at com.ibm.ws.webcontainer.async.ContextWrapper.run(ContextWrapper.java:28)
 at com.ibm.ws.webcontainer.async.WrapperRunnableImpl.run(WrapperRunnableImpl.java:89)
 at com.ibm.ws.threading.internal.ExecutorServiceImpl$RunnableWrapper.run(ExecutorServiceImpl.java:238)
 at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1160)
 at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:635)
 at java.lang.Thread.run(Thread.java:825)
```

IMS service provider classes
z/OS Connect Java classes

A Google search of ICO00001E returned an explanation at URL: `https://www.ibm.com/docs/en/ims/13.1.0?topic=exceptions-ico0001e`

Root cause – Datastore mistyped in the interaction configuration

mitchj@us.ibm.com

First Failure Data Collection (FFDC)

```
------Start of DE processing------ = [9/7/21 14:19:29:291 GMT]
Exception = com.ibm.msg.client.jms.DetailedIllegalStateException
Source = com.ibm.zosconnect.service.mq.OneWayMQServiceInvocation
probeid = 0004
Stack Dump = com.ibm.msg.client.jms.DetailedIllegalStateException: JMSWMQ2002: Failed to get a message from destination
'ZCONN2.DEFAULT.MQZCEE.QUEUE'.
IBM MQ classes for JMS attempted to perform an MQGET; however IBM MQ reported an error.
Use the linked exception to determine the cause of this error.
 at com.ibm.msg.client.wmq.common.internal.Reason.reasonToException(Reason.java:489)
 at com.ibm.msg.client.wmq.common.internal.Reason.createException(Reason.java:215)
.
.
.
 at com.ibm.zosconnect.service.mq.MQService.invoke(Unknown Source)
 at com.ibm.zosconnect.internal.ZosConnectServiceImpl.apiInvoke(Unknown Source)
 at com.ibm.zosconnect.internal.ServiceManagerImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.internal.ApiManagerImpl.invokeApi(Unknown Source)
 at com.ibm.zosconnect.internal.web.ServiceProxyServlet$3.run(Unknown Source)
 at com.ibm.ws.webcontainer.async.ServiceWrapper.wrapAndRun(ServiceWrapper.java:236)
 at com.ibm.ws.webcontainer.async.ContextWrapper.run(ContextWrapper.java:28)
 at com.ibm.ws.webcontainer.async.WrapperRunnableImpl.run(WrapperRunnableImpl.java:89)
 at com.ibm.ws.threading.internal.ExecutorServiceImpl$RunnableWrapper.run(ExecutorServiceImpl.java:238)
 at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1160)
 at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:635)
 at java.lang.Thread.run(Thread.java:825)
Caused by: com.ibm.mq.MQException: JMSCMQ0001: IBM MQ call failed with compcode '2' ('MQCC_FAILED') reason '2016' ('MQRC_GET_INHIBITED').
 at com.ibm.msg.client.wmq.common.internal.Reason.createException(Reason.java:203)
 ... 25 more
```

MQ service provider classes

Root cause – Queue was configured to disable the MQPUT request

mitchj@us.ibm.com

The FFDC dump is more than just a Java stack trace

```
------Start of DE processing------ = [9/7/21 20:26:12:394 GMT]
Exception = com.ibm.zosconnect.endpoint.connection.TokenConfigException
Source = com.ibm.zosconnect.endpoint.connection.internal.OAuthConfigImpl
probeid = 265
Stack Dump = com.ibm.zosconnect.endpoint.connection.TokenConfigException: BAQR1006E: An error occurred when z/OS Connect EE attempted to
access the authentication/authorization server. Error: javax.net.ssl.SSLHandshakeException: SSLHandshakeException invoking
https://wg31.washington.ibm.com:26213/oidc/endpoint/OP/token: com.ibm.jsse2.util.j: PKIX path building failed:
com.ibm.security.cert.IBMCertPathBuilderException: unable to find valid certification path to requested target
 at com.ibm.zosconnect.endpoint.connection.internal.OAuthConfigImpl.requestAuthorizationServer(Unknown Source)
 at com.ibm.zosconnect.endpoint.connection.internal.OAuthConfigImpl.getAuthData(Unknown Source)
 at com.ibm.zosconnect.apirequester.internal.restclient.RestClientImpl.handleAuthConfig(Unknown Source)
 at com.ibm.zosconnect.apirequester.internal.restclient.RestClientImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.apirequester.internal.ARInvokeHandler.handle(Unknown Source)
 at com.ibm.zosconnect.apirequester.internal.ApiRequesterManagerImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.apirequester.internal.proxy.ApiRequesterManagerProxyImpl$1.run(Unknown Source)
.  .  .
Dump of callerThis
Object type = com.ibm.zosconnect.endpoint.connection.internal.OAuthConfigImpl
  copyright_notice = "Licensed Materials - Property of IBM 5655-CE3 (c) Copyright IBM Corp. 2017, 2021 All Rights Reserved
  tc = class com.ibm.websphere.ras.TraceComponent@2d85bccc
    strings[0] = "TraceComponent[com.ibm.zosconnect.endpoint.connection.internal.OAuthConfigImpl,class
com.ibm.zosconnect.endpoint.connection.internal.OAuthConfigImpl,[zosConnectApiRequesterToken],com.ibm.zosconnect.endpoint
.connection.internal.resources.ZosConnectEndpointConnection,null]"
  CFG_ELEMENT_ID = "id"
  CFG_GRANTTYPE = "grantType"
  id = "myoAuthConfig"
  grantType = "password"
  authServer = class com.ibm.zosconnect.endpoint.connection.internal.AuthorizationServerImpl@ed6c1e8c
 .  .  .
 sslCertsRef = "OutboundSSLSettings"
   connectionTimeout = 30000
   receiveTimeout = 60000
   id = "myoAuthServer"
```

z/OS Connect Java classes

The FFDC dump for a network issue

```
------Start of DE processing------ = [6/6/21 14:56:01:242 GMT]
Exception = java.net.UnknownHostException
Source = com.ibm.zosconnect.service.cics.internal.conn.isc.ConnectionManager
probeid = 131
Stack Dump = java.net.UnknownHostException: wg31.washington.ibm.com
 at java.net.InetAddress.getAllByName0(InetAddress.java:1419)
 at java.net.InetAddress.getAllByName(InetAddress.java:1323)
 at java.net.InetAddress.getAllByName(InetAddress.java:1246)
 at java.net.InetAddress.getByName(InetAddress.java:1196)
 at com.ibm.zosconnect.service.cics.internal.conn.isc.ConnectionManager.createConnection(Unknown Source)
 at com.ibm.zosconnect.service.cics.internal.conn.isc.ConnectionManager.getConnection(Unknown Source)
 at com.ibm.zosconnect.service.cics.internal.conn.isc.SessionManager.getNewConversation(Unknown Source)
 at com.ibm.zosconnect.service.cics.ServerECIRequest.executeISC(Unknown Source)
 at com.ibm.zosconnect.service.cics.ServerECIRequest.execute(Unknown Source)
 at com.ibm.zosconnect.service.cics.internal.CicsIpicConnection.flow(Unknown Source)
 at com.ibm.zosconnect.service.cics.internal.CicsServiceImpl.flowRequest(Unknown Source)
 at com.ibm.zosconnect.service.cics.internal.CicsServiceImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.internal.ZosConnectServiceImpl.apiInvoke(Unknown Source)
 at com.ibm.zosconnect.internal.ServiceManagerImpl.invoke(Unknown Source)
 at com.ibm.zosconnect.internal.ApiManagerImpl.invokeApi(Unknown Source)
```

Base Java classes
z/OS Connect Java classes

Root cause – Host wg31.washington.ibm.com was not configured in the DNS server

mitchj@us.ibm.com

Use the messages.log and FFDC log together

The messages.log states a First Failure Data Collection dump of the issues has been created.

```
[9/12/21 14:56:45:613 GMT] 00000045 com.ibm.ws.logging.internal.impl.IncidentImpl                I FFDC1015I: An FFDC Incident has been
created: "com.ibm.mq.connector.DetailedResourceException: MQJCA1011: Failed to allocate a JMS connection., error code: MQJCA1011 An
internal error caused an attempt to allocate a connection to fail. See the linked exception for details of the failure.
com.ibm.ejs.j2c.poolmanager.FreePool.createManagedConnectionWithMCWrapper 199" at ffdc_21.09.12_14.56.45.0.log

[9/12/21 14:56:45:652 GMT] 00000045 com.ibm.ws.logging.internal.impl.IncidentImpl                I FFDC1015I: An FFDC Incident has been
created: "com.ibm.msg.client.jms.DetailedJMSException: MQJCA1011: Failed to allocate a JMS connection.

An internal error caused an attempt to allocate a connection to fail.

See the linked exception for details of the failure. com.ibm.zosconnect.service.mq.OneWayMQServiceInvocation 0004" at
ffdc_21.09.12_14.56.45.1.log

[9/12/21 14:56:45:652 GMT] 00000045 com.ibm.zosconnect.service.mq.MQServiceInvocation            E BAQM0056E: An unexpectedJMSException
occurred while processing a request for service 'mqGetService'. The exception message was 'MQJCA1011: Failed to allocate a JMS
connection.'.
```

mitchj@us.ibm.com

Spacing added between lines to improve readability

The FFDC dump showing additional JMS information

```
------Start of DE processing------ = [9/12/21 14:56:45:567 GMT]
Exception = com.ibm.mq.connector.DetailedResourceException
Source = com.ibm.ejs.j2c.poolmanager.FreePool.createManagedConnectionWithMCWrapper
probeid = 004
Stack Dump = com.ibm.mq.connector.DetailedResourceException: MQJCA1011: Failed to allocate a JMS connection., error code: MQJCA1011 An
internal error caused an attempt to allocate a connection to fail. See the linked exception for details of the failure.
 at com.ibm.mq.connector.services.JCAExceptionBuilder.buildException(JCAExceptionBuilder.java:169)
 at com.ibm.mq.connector.services.JCAExceptionBuilder.buildException(JCAExceptionBuilder.java:135)
 at com.ibm.mq.connector.ConnectionBuilder.createConnection(ConnectionBuilder.java:162)
 at com.ibm.mq.connector.outbound.ManagedConnectionFactoryImpl.createConnection(ManagedConnectionFactoryImpl.java:655)
 at com.ibm.mq.connector.outbound.ManagedConnectionImpl.<init>(ManagedConnectionImpl.java:200)
 at com.ibm.mq.connector.outbound.ManagedConnectionFactoryImpl.createManagedConnection(ManagedConnectionFactoryImpl.java:248
 at com.ibm.ejs.j2c.FreePool.createManagedConnectionWithMCWrapper(FreePool.java:1376)
 at com.ibm.ejs.j2c.FreePool.createOrWaitForConnection(FreePool.java:1246)
 at com.ibm.ejs.j2c.PoolManager.reserve(PoolManager.java:1438)
 at com.ibm.ejs.j2c.ConnectionManager.allocateMCWrapper(ConnectionManager.java:574)
 at com.ibm.ejs.j2c.ConnectionManager.allocateConnection(ConnectionManager.java:306)
 at com.ibm.mq.connector.outbound.ConnectionFactoryImpl.createManagedJMSConnection(ConnectionFactoryImpl.java:309)
 at com.ibm.mq.connector.outbound.ConnectionFactoryImpl.createConnectionInternal(ConnectionFactoryImpl.java:252)
 at com.ibm.mq.connector.outbound.ConnectionFactoryImpl.createConnection(ConnectionFactoryImpl.java:225)
. . .
 at java.lang.Thread.run(Thread.java:818)
 Caused by: com.ibm.msg.client.jms.DetailedJMSException: JMSFMQ6312: An exception occurred in the Java(tm) MQI.
 The Java(tm) MQI has thrown an exception describing the problem.
 See the linked exception for further information.
 at sun.reflect.NativeConstructorAccessorImpl.newInstance0(Native Method)
. . .
... 27 more
aused by: com.ibm.mq.jmqi.JmqiException: CC=2;RC=2495;AMQ8568: The native JNI library 'mqjrrs64' was not found. For a client installation
this is expected. [3=mqjrrs64]
at com.ibm.mq.jmqi.local.LocalMQ.loadLib(LocalMQ.java:1178)
Caused by: java.lang.UnsatisfiedLinkError: /usr/lpp/mqm/V9R1M0/java/lib/libmqjrrs64.so (EDC5205S DLL module not found.)
```

Root cause – configuration issue in the MQ resource adapter configuration, e.g., nativeLibraryPath.

mitchj@us.ibm.com

Tech/Tip: Details of the flow with mutual authentication (TLS 1.2)

1. A Client sends a request to server for a protected session in a ***ClientHello*** message. Included in the request is the TLS capabilities of the client (e.g., TLS 1.2 or 1.3) and a list of supported ciphers in preference order.
2. The server selects the TLS version and selects cipher from the list sent by the client and returns this information in a ***ServerHello*** message.
3. The server's certificate public information (including the **public key**) is sent to the client in a ***Certificate*** message.
4. The server sends cryptographic information for the client to use for encrypting a pre-master key in a **Server key exchange** message.
5. **For mutual authentication, the server sends a *CertificateRequest* message requesting a client's personal certificate.**
6. The server concludes by sending a ***ServerHelloDone*** message.
7. The client verifies the server's certificate with its trust store.
8. **If mutual authentication is requested, the client sends its public personal certificate information in a *Certificate* message**
9. The client then uses the ***server's public* key** to generate and encrypt a 48 byte "premaster secret" message which is sent to the server in a ***ClientKeyExchange*** message.
10. **When mutual authentication is requested, a digitally signature (hashed) of the concatenation of all previous handshake messages is encrypted with the client's private key sent in a *CertificateVerify* message.**
11. The ***Change Cipher*** message is used to change the from cipher used during the handshake so all subsequent messages will be encrypted using a different cipher.
12. The server uses its **private key** to decrypt the "premaster secret" message (**only the private key can be used to decrypt the message**).
13. **If mutual authentication is requested, the server verifies the client's personal certificate with its key ring and uses the client's public key to decrypt and verify the message sent in the *CertificateVerify* message.**
14. Both the Client and Server use the "premaster secret" to compute a 'master secret', also know as "shared secret" or "session key" (symmetric encryption)
15. Client and server will use this "shared secret" or "session key" to encrypts messages sent between the endpoints.

mitchj@us.ibm.com

Tech/Tip: cURL trace of a TLS Handshake

```
* successfully set certificate verify locations:
*   CAfile: certauth.pem
  CApath: none
* TLSv1.3 (OUT), TLS handshake, Client hello (1):
* TLSv1.3 (IN), TLS handshake, Server hello (2):
* TLSv1.2 (IN), TLS handshake, Certificate (11):
* TLSv1.2 (IN), TLS handshake, Server key exchange (12):
* TLSv1.2 (IN), TLS handshake, Server finished (14):
* TLSv1.2 (OUT), TLS handshake, Client key exchange (16):
* TLSv1.2 (OUT), TLS change cipher, Change cipher spec (1):
* TLSv1.2 (OUT), TLS handshake, Finished (20):
* TLSv1.2 (IN), TLS handshake, Finished (20):
* SSL connection using TLSv1.2 / ECDHE-RSA-AES256-GCM-SHA384
* Server certificate:
*  subject: O=IBM; OU=LIBERTY; CN=wg31.washington.ibm.com
*  start date: Dec 23 04:00:00 2020 GMT
*  expire date: Jan  1 03:59:59 2023 GMT
*  common name: wg31.washington.ibm.com (matched)
*  issuer: OU=LIBERTY; CN=CA for Liberty
*  SSL certificate verify ok.
```

```
* TLSv1.2 (IN), TLS handshake, Server key exchange (12):
* TLSv1.2 (IN), TLS handshake, Request CERT (13):
* TLSv1.2 (IN), TLS handshake, Server finished (14):
* TLSv1.2 (OUT), TLS handshake, Certificate (11):
* TLSv1.2 (OUT), TLS handshake, Client key exchange (16):
* TLSv1.2 (OUT), TLS handshake, CERT verify (15):
* TLSv1.2 (OUT), TLS change cipher, Change cipher spec (01):
```

TLS 1.2 https://tools.ietf.org/html/rfc5246
TLS 1.3 https://tools.ietf.org/html/rfc8446

mitchj@us.ibm.com

A FFDC dump showing an SSL Handshake issue

```
. . . ------Start of DE processing------ = [6/16/21 17:59:45:534 GMT]
Exception = java.security.cert.CertPathValidatorException
Source = com.ibm.ws.ssl.core.WSX509TrustManager
probeid = checkServerTrusted
Stack Dump = java.security.cert.CertPathValidatorException: The certificate issued by CN=OpenIdProv, OU=CertAuth is not trusted; internal
cause is: java.security.cert.CertPathValidatorException: Certificate chaining error
 at com.ibm.security.cert.BasicChecker.<init>(BasicChecker.java:111)
 at com.ibm.security.cert.PKIXCertPathValidatorImpl.engineValidate(PKIXCertPathValidatorImpl.java:220)
 at java.security.cert.CertPathValidator.validate(CertPathValidator.java:278)
 at com.ibm.jsse2.util.f.a(f.java:40)
 at com.ibm.jsse2.util.f.b(f.java:143)
. . .
     e = class com.ibm.jsse2.util.f@5728f8dd
     f = null
     z = class java.lang.String[37]
 tsCfgAlias = "OutboundKeyRing"
 tsFile = "safkeyring:///zCEE.KeyRing"
extendedInfo = class java.util.HashMap@5ebd51b
  serialVersionUID = 362498820763181265
```

Root cause – CA used to sign server certificate was not present in outbound key ring.

Tech-Tip: Use the Java JSSE debugging utility to enable SSL tracing at the Java level.
Use the Java runtime directive –Djavax.net.debug to enable this tracing by setting this directive value to ssl, e.g. ***–Djavax.net.debug=ssl.*** For more options regarding additional trace options SSL tracing available, see URL https://www.ibm.com/docs/en/sdk-java-technology/8?topic=troubleshooting-debugging-utilities

Using this directive requires the Java SDK be at Version 8, service release 6, fix pack 36 or later release level.

mitchj@us.ibm.com

Tech/Tip: Use the Java directive javax.net.debug to enable Java SSL tracing

Add this directive to the JVM properties *-Djavax.net.debug=ssl,handshake*

```
.java:1168|JsseJCE:  Using cipher DES/CBC/NoPadding from provider TBD via init
.java:1168|JsseJCE:  Using cipher RC4 from provider TBD via init
.java:1168|JsseJCE:  Using cipher DES/CBC/NoPadding from provider TBD via init
.java:1168|JsseJCE:  Using cipher DESede/CBC/NoPadding from provider TBD via init
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|JsseJCE:  Using cipher AES/GCM/NoPadding from provider TBD via init
.java:1168|JsseJCE:  Using cipher ChaCha20-Poly1305 from provider TBD via init
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|JsseJCE:  Using KeyGenerator IbmTlsExtendedMasterSecret from provider TBD via init
.java:1168|JsseJCE:  Using signature SHA1withECDSA from provider TBD via init
.java:1168|JsseJCE:  Using signature NONEwithECDSA from provider TBD via init
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Consuming ClientHello handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Consumed extension: supported_versions
.java:1168|Negotiated protocol version: TLSv1.2
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Produced ServerHello handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Produced server Certificate handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Produced ECDH ServerKeyExchange handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Produced ServerHelloDone handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Consuming ECDHE ClientKeyExchange handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Consuming ChangeCipherSpec message
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Consuming client Finished handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
.java:1168|Produced ChangeCipherSpec message
.java:1168|Produced server Finished handshake message (
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
```

For more details, see URL https://www.ibm.com/docs/en/sdk-java-technology/8?topic=troubleshooting-debugging-utilities

mitchj@us.ibm.com

Other common TLS handshake issues

- ***Error occurred during a read, exception:javax.net.ssl.SSLHandshakeException: null cert chain***

  This exception occurs when the server configuration set to require client certificates (*clientAuthenication="true")* and the client had no certificate to provide and no alternative authentication method was available.

- ***Error occurred during a read, exception:javax.net.ssl.SSLException: Received fatal alert: bad_certificate error (handshake), vc=1083934466 Caught exception during unwrap, javax.net.ssl.SSLException: Received fatal alert: bad_certificate***

  This is usually caused when the client certificate presented to the server did not have a certificate authority(CA) certificate for the CA that signed the client's personal certificate in the server's trust store key ring.

- ***CWWKO0801E: Unable to initialize SSL connection. Unauthorized access was denied or security settings have expired. Exception is javax.net.ssl.SSLHandshakeException: no cipher suites in common***

- There may be many causes for this issue but first confirm the RACF identity under which the server is running has either READ access to FACILITY resources IRR.DIGTCERT.LISTRING and IRR.DIGTCERT.LIST or access to RDATALIB resources if virtual keyrings are being used.

  The first FACILITY resource gives the identity access to their own key ring and the second allows access to the certificates. Of if virtual keyrings are in use, then the identity needs READ or UPDATE authority to the <ringOwner>.<ringName>.LST resource in the RDATALIB class. READ access enables retrieving one's own private key, UPDATE access enables retrieving another's private key.

  An alternative cause: For a TLS handshake to occur, the server must first have access to a private or site certificate that has a private key and the server must have access to that certificate's private key and no certificate with a private key is available.

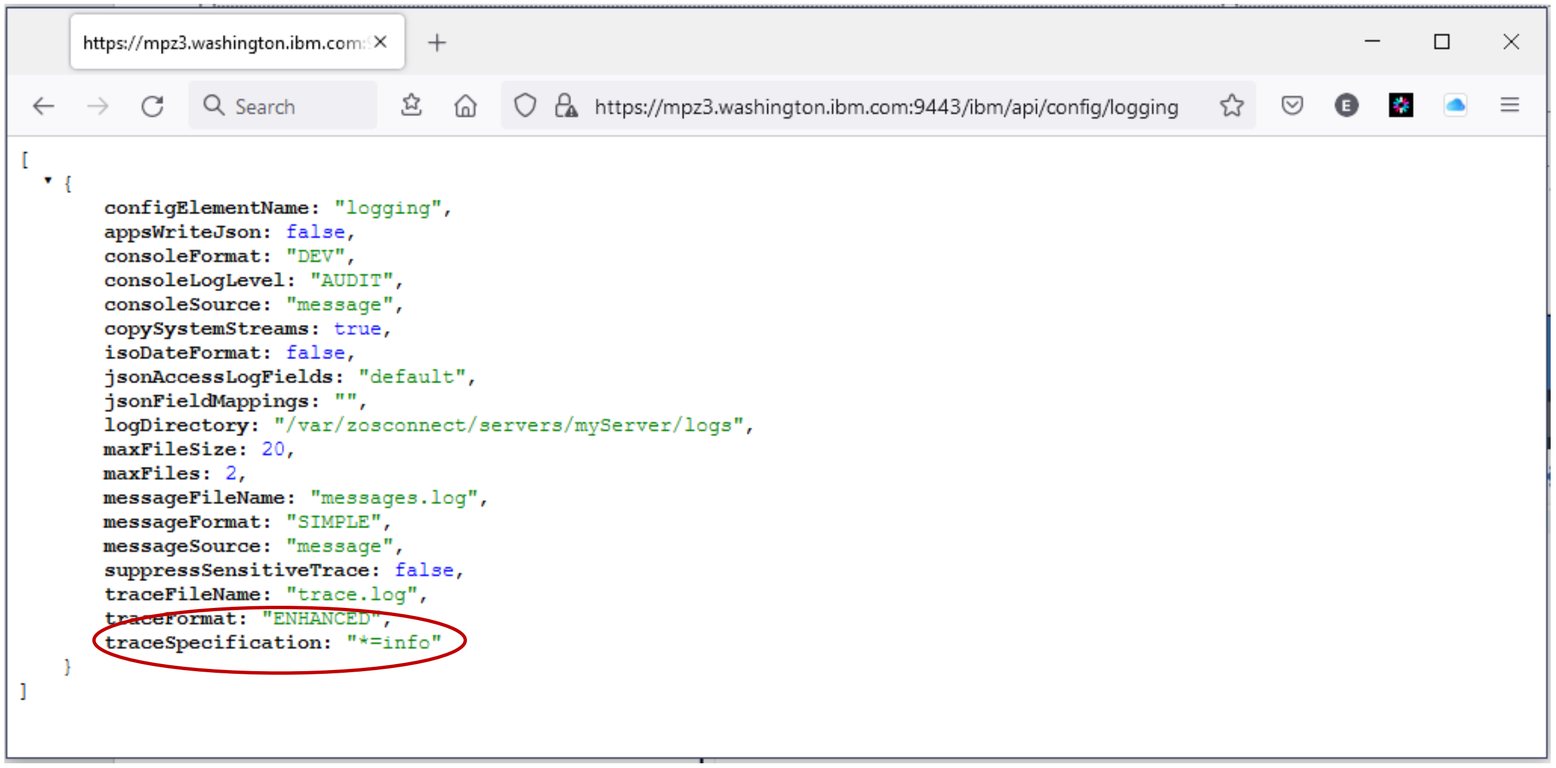
- Another possibility is that the TLS handshake the negotiations between the client and server failed, e.g*., javax.net.ssl.SSLHandshakeException: Client requested protocol SSLv3 is not enabled or supported in server context*

mitchj@us.ibm.com

trace.out – use as a last resort or at the request of Level 2

First, the current active trace specification settings can be display using the *restConnector* feature.

`https://mpz3.washington.ibm.com:9443/ibm/api/config/logging`



Enabling trace in z/OS Connect EE server
`https://www.ibm.com/docs/en/zosconnect/3.0?topic=problems-enabling-trace-in-zos-connect-ee`

mitchj@us.ibm.com

Managing trace specifications

- Use “include” file to save commonly used trace specifications.
- Add the “include” after the sever has started to avoid tracing the startup activity.

server.xml
```
<include location="${server.config.dir}/includes/safTrace.xml"/>
```

safTrace.xml
```
<?xml version="1.0" encoding="UTF-8"?>
<server description="security trace">
<logging traceSpecification="com.ibm.ws.security.*=all:
         SSLChannel=all:SSL=all:zosConnectSaf=all:zosConnect=all"/>
</server>
```

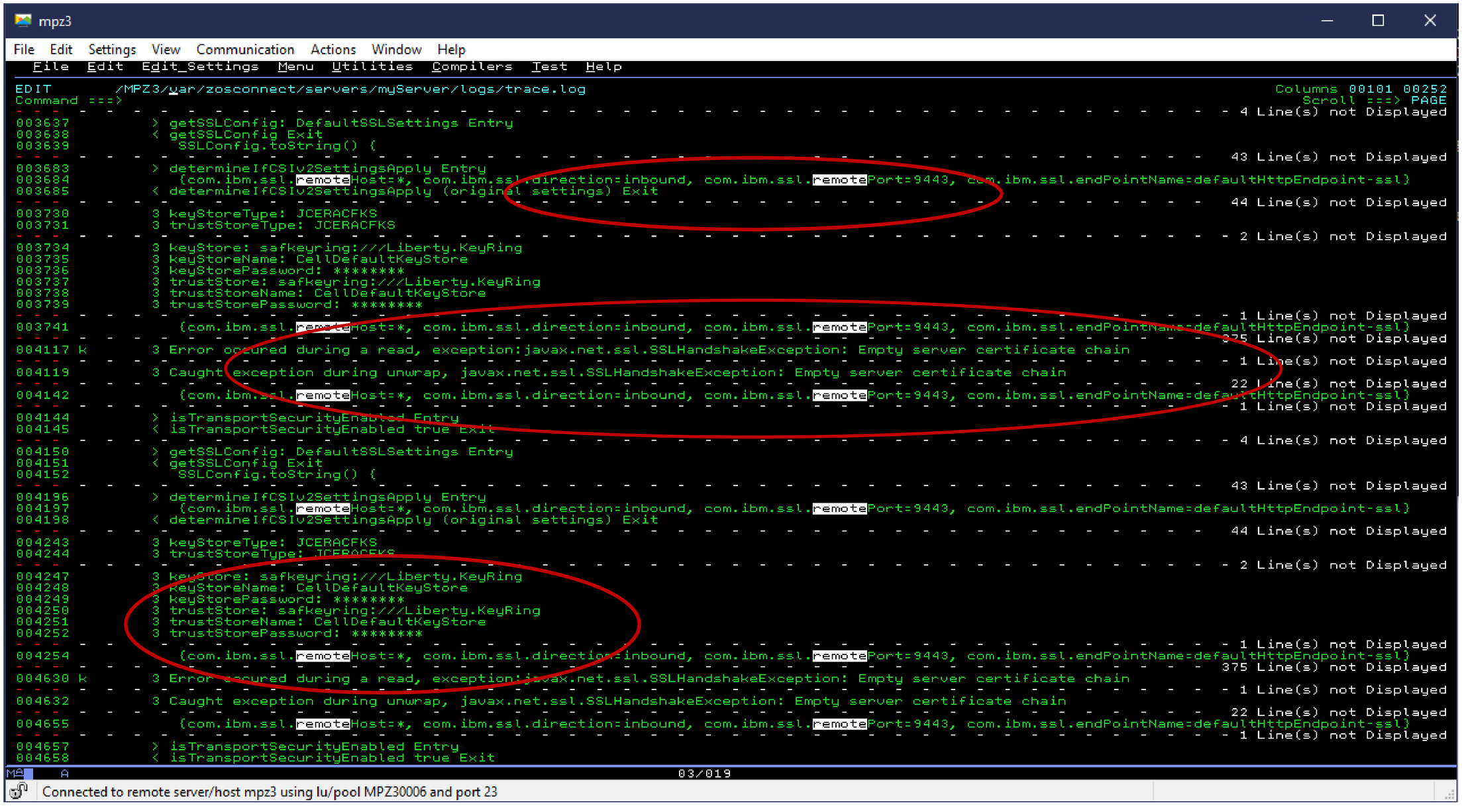
cicsTrace.xml
```
<?xml version="1.0" encoding="UTF-8"?>
<server description="CICS trace">
<logging traceSpecification="zosConnectServiceCics=all:
         com.ibm.zosconnect.wv*=FINEST:zosConnect=all"/>
</server>
```

imsTrace.xml
```
<?xml version="1.0" encoding="UTF-8"?>
<server description="IMS trace">
<logging traceSpecification="com.ibm.ims.*=all:
         com.ibm.j2ca.RAIMSTM=all:com.ibm.zosconnect.wv*=FINEST:
         zosConnect=all"/>
</server>
```

Enables enhanced tracing
(after adding an “include” file)
```
F BAQSTRT,REFRESH,CONFIG
```

Disable enhanced tracing
```
F BAQSTRT,LOGGING='*=INFO’
```
Or
```
F BAQSTRT,REFRESH,CONFIG
(after removing the “include” file
```

trace.out file



mitchj@us.ibm.com

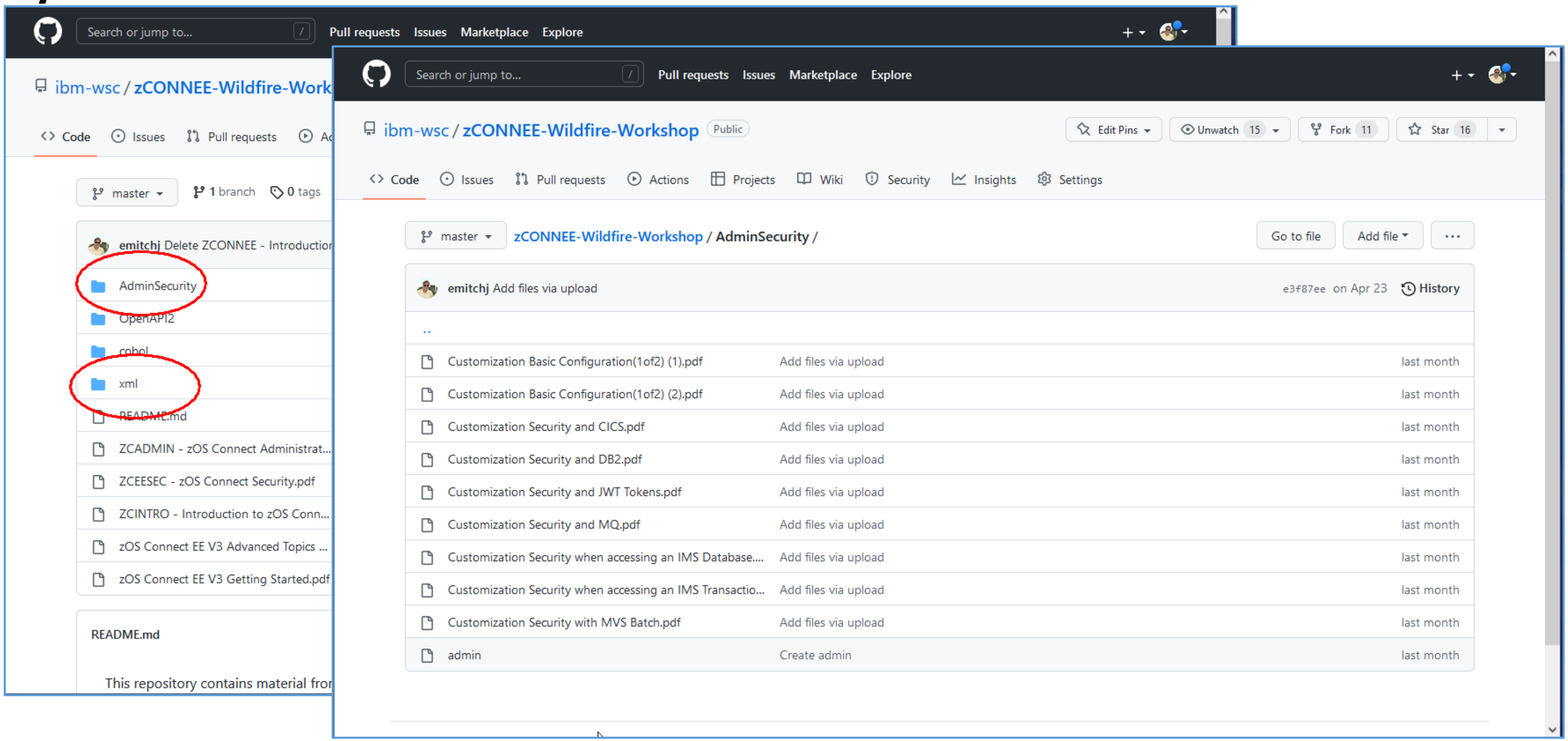
Use thread number and/or package name to control which trace records are displayed

Agenda

- Review the OMVS and Liberty basics
  - The OMVS, Java and Liberty execution environments
  - Creating Liberty servers
  - Managing the server XML configuration
- Liberty Security
  - Security provided by the Angel process
  - Liberty authentication and authorization using basic, digital certificates and third-party tokens
- Security when accessing z/OS subsystems
- Security when accessing non-z/OS subsystems
- Useful Liberty features and MVS commands
- Managing and Monitoring Liberty servers
  - WLM configurations
  - SMF options
  - Monitoring OMVS processes
  - Connection pooling options
  - Above the bar storage
  - High availability options
- Where do I look when things go wrong?
  - Problem determination techniques
  - Understand the anatomy of messages
- Appendix - Sample administrative JCL

mitchj@us.ibm.com

z/OS Connect Wildfire Github Site https://ibm.biz/BdPRGD



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

mitchj@us.ibm.com

Thank you for listening and your questions.

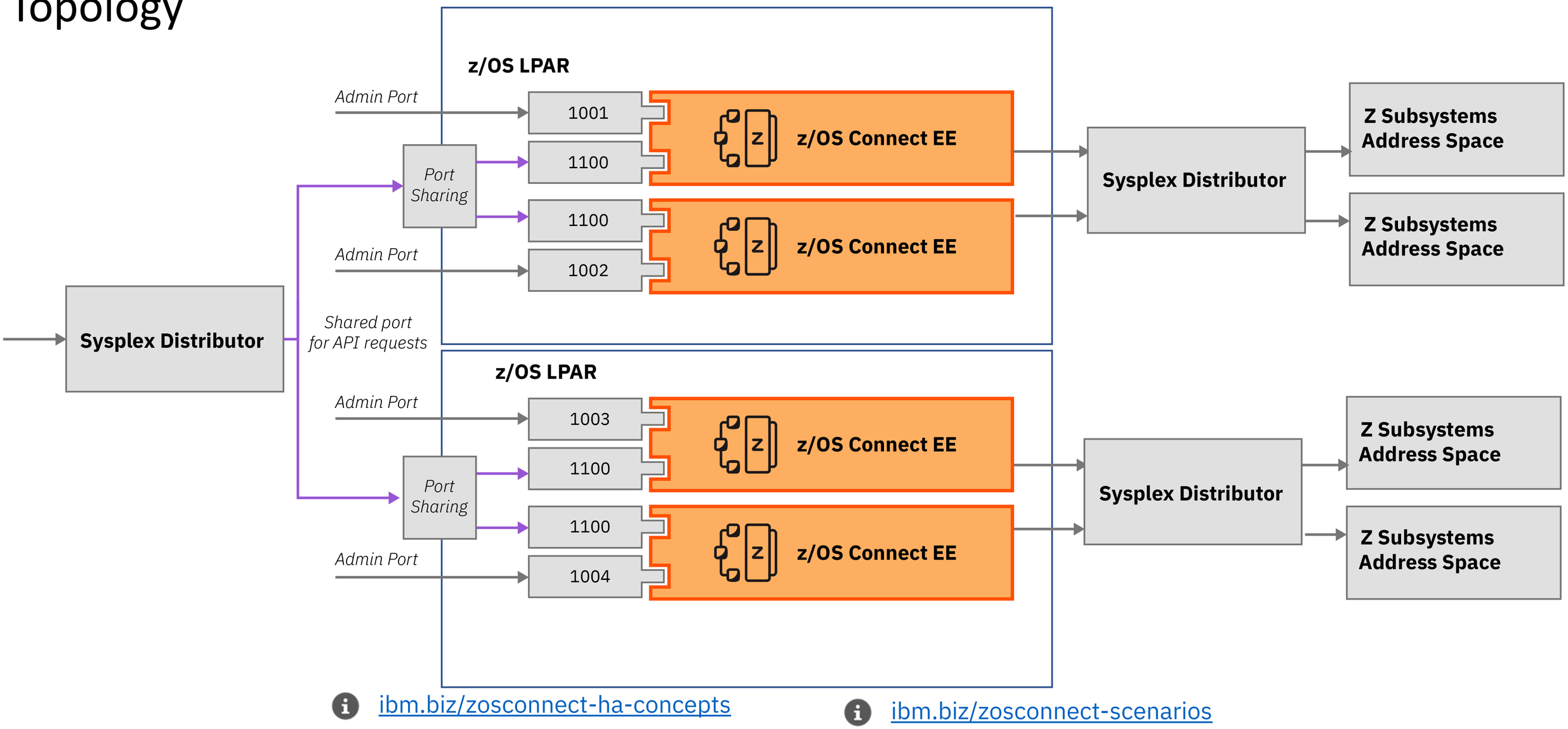
mitchj@us.ibm.com

Miscellaneous Odds and Ends

mitchj@us.ibm.com

High Availability

- Topology



ibm.biz/zosconnect-ha-concepts

ibm.biz/zosconnect-scenarios

mitchj@us.ibm.com

Sysplex DVIPAs

SYS1.TCPIP.TCPPARMS(IPNODES)

```
192.168.17.241 MPZ1.DMZ MPZ1 mpz1.washington.ibm.com
192.168.17.242 MPZ2.DMZ MPZ2 mpz2.washington.ibm.com
192.168.17.243 MPZ3.DMZ MPZ3 mpz3.washington.ibm.com
192.168.17.240 dvipa dvipa.washington.ibm.com
```

SYS1.TCPIP.TCPPARMS(PROFMPZ3)

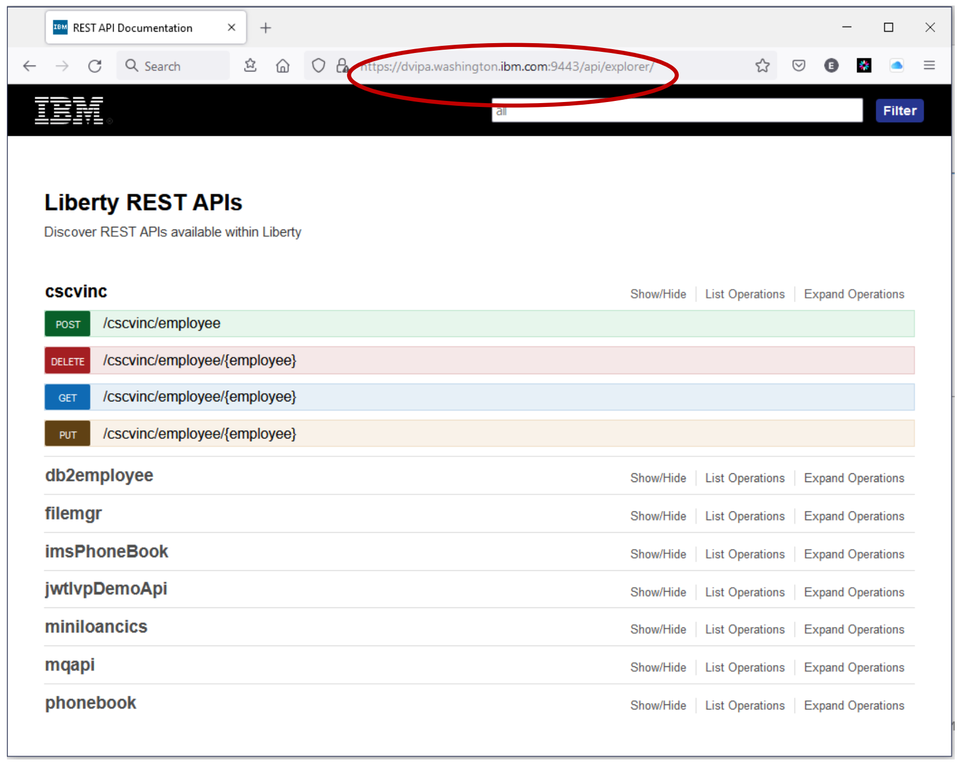
```
IPCONFIG SYSPLEXROUTING
  DYNAMICXCF 172.1.1.243 255.255.255.0 3
VIPADYNAMIC
VIPADEFINE 255.255.255.0 192.168.17.240
VIPADISTRIBUTE DEFINE DISTM ROUNDROBIN|BASEWLM 192.168.17.240
PORT 23 1416 1491 2446 9443 9453 9463
  DESTIP
  172.1.1.241
  172.1.1.242
  172.1.1.243
ENDVIPADYNAMIC
```

SERVERWLM is not an option

HOMETEST

```
EZA0619I Running IBM MVS TCP/IP CS V2R4 TCP/IP Configuration Tester
EZA0602I TCP Host Name is: MPZ3

EZA0605I Using Name Server to Resolve MPZ3
EZA0611I The following IP addresses correspond to TCP Host Name: MPZ3
EZA0612I 192.168.17.243
EZA0614I The following IP addresses are the HOME IP addresses defined in PROFILE.TCPIP:
EZA0615I 192.168.17.243
EZA0615I 172.1.1.243
EZA0615I 192.168.17.240
EZA0615I 127.0.0.1

EZA0618I All IP addresses for MPZ3 are in the HOME list!
EZA0622I Hometest was successful - all Tests Passed!
```

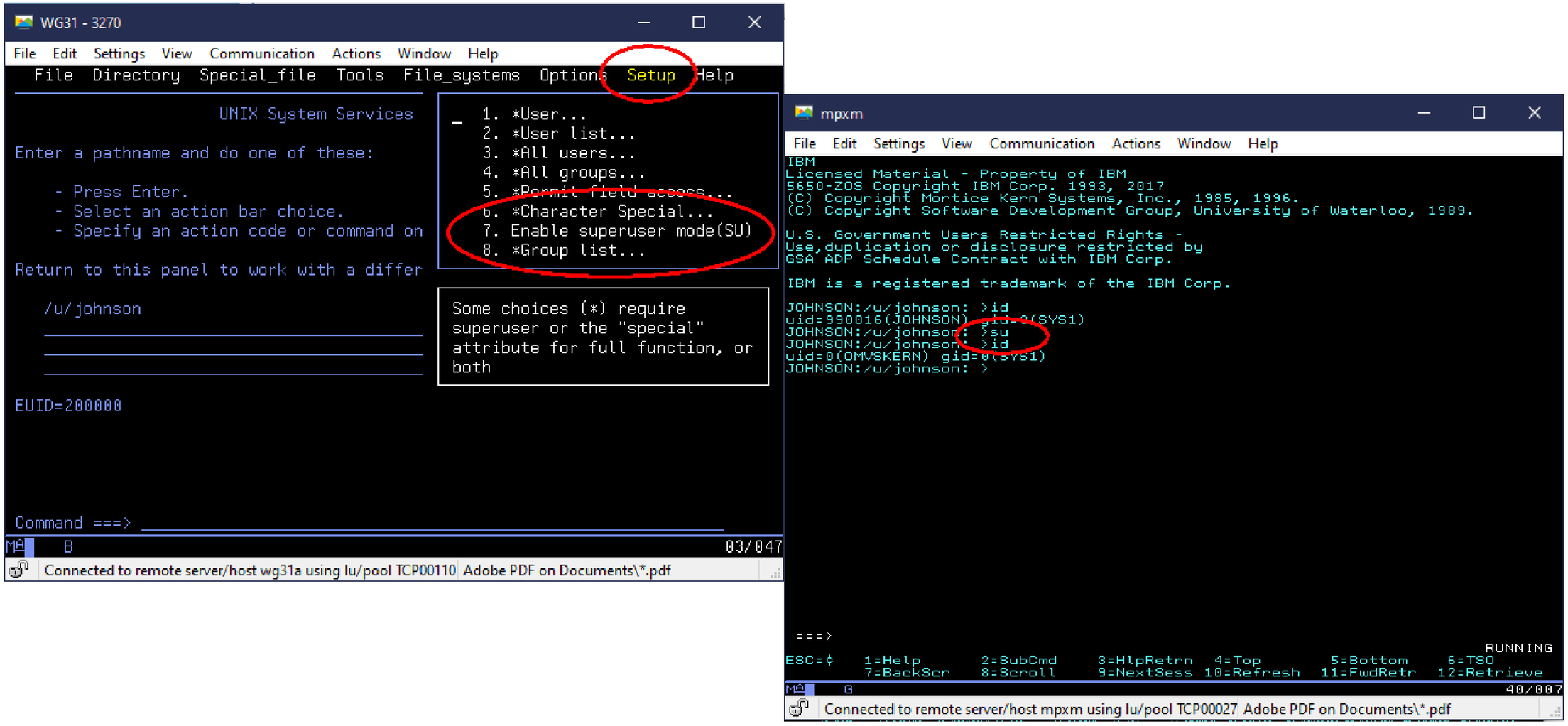
```
<zosconnect_cicsIpicConnection id="cscvinc"
  host="dvipa.washington.ibm.com"
  port="1491"/>
<zosconnect_endpointConnection id="mqapi"
  host="http://dvipa.washington.ibm.com"
  port="9453"
  basicAuthRef="myBasicAuth"
  connectionTimeout="10s"
  receiveTimeout="20s" />
```



mitchj@us.ibm.com

BASEWLM uses the Target Server Responsiveness (TSR) value to select the image (*tso netstat vdpt detail*)

Tech/Tip: z/OS : Switching to root authority



Tech-Tip: Super user is required to set the program control extended attribute (*extattr +p*) bit for the Java shared object ***ifaedjreg64.so*****.** This extended attribute must be set for identity assertion in certain situations.

mitchj@us.ibm.com

Sample JCL - Executing the z/OS Connect Build Toolkit 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

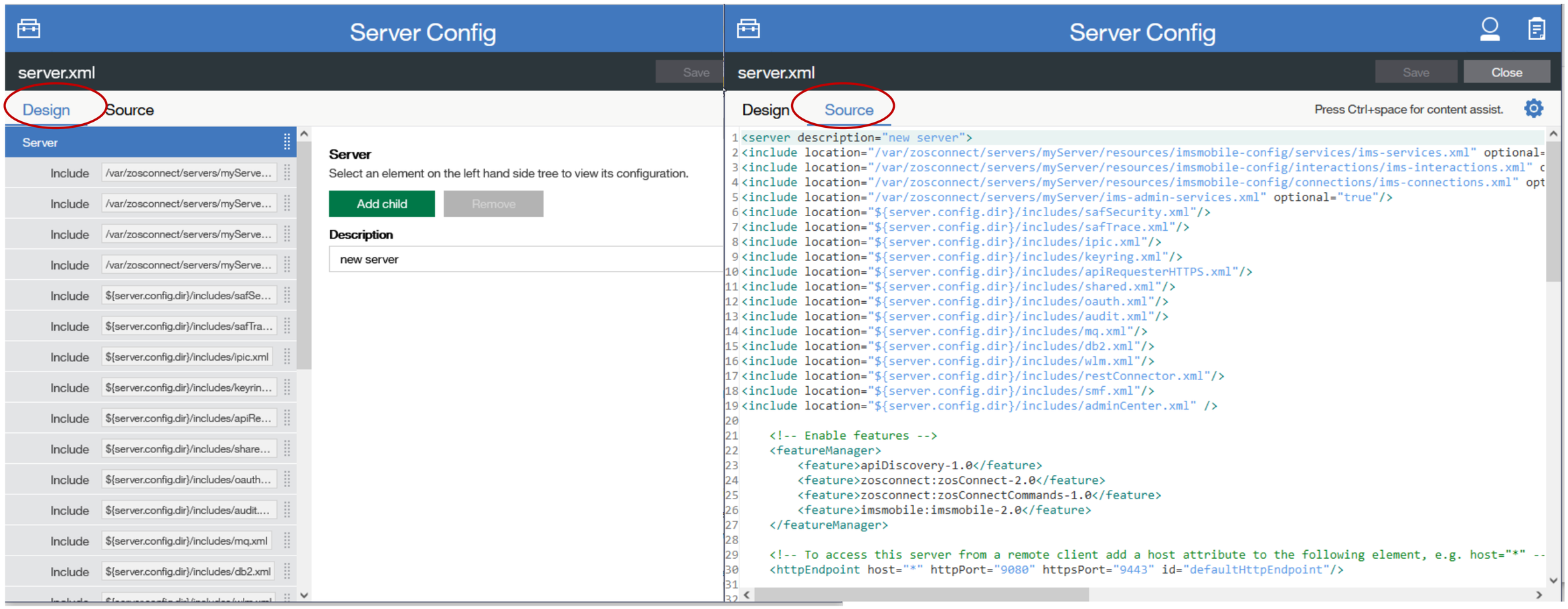
```
apiDescriptionFile=./cscvinc.json
dataStructuresLocation=./syslib
apiInfoFileLocation=./syslib
logFileDirectory=./logs
language=COBOL
connectionRef=cscvincAPI
requesterPrefix=csc
```

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.

mitchj@us.ibm.com

Tech-Tip: Liberty's "adminCenter" Feature

- The Web browser interface feature "adminCenter" was used to display the server's configuration files



mitchj@us.ibm.com

Tech/Tip: Use the TCPIP resolver trace to display name resolution information

```
ALLOC FILE(SYSTCPT) DA(*)
ping wg31.washington.ibm.com
Resolver Trace Initialization Complete -> 2021/09/12 12:54:37.36

res_init Resolver values:
Setup file warning messages = No
CTRACE TRACERES option = No
Global Tcp/Ip Dataset  = SYS1.TCPIP.TCPPARMS(TCPDAT3)
Default Tcp/Ip Dataset = SYS1.TCPIP.TCPPARMS(TCPDAT3)
Local Tcp/Ip Dataset   = //DD:SYSTCPD
                       ==> SYS1.TCPIP.TCPPARMS(TCPDAT3)
Translation Table      = SYS1.TCPIP.STANDARD.TCPXLBIN
UserId/JobName         = JOHNSON
Caller API             = TCP/IP Sockets Extended
Caller Mode            = EBCDIC
System Name            = WSC13 (from VMCF)
UnresponsiveThreshold  = 25
(G) DataSetPrefix = SYS1.TCPIP
(G) HostName      = MPZ3
. . . .
res_query Failed:  RetVal = -1, RC = 1, Reason = 0x78981005
res_querydomain Failed:  RetVal = -1, RC = 1, Reason = 0x78981005
res_search Failed:  RetVal = -1, RC = 1, Reason = 0x78981005
GetAddrInfo Closing IOCTL Socket 0x00000000
 BPX1CLO:  RetVal = 0, RC = 0, Reason = 0x00000000
GetAddrInfo Failed:  RetVal = -1, RC = 1, Reason = 0x78AE1004
GetAddrInfo Ended: 2021/09/12 12:55:32.364732
************************************************************************
EZZ3111I Unknown host 'WG31.WASHINGTON.IBM.COM'
```

Root cause – Host wg31.washington.ibm.com was missing from SYS1.TCPIP.TCPPARMS(IPNODES)

mitchj@us.ibm.com

Sample JCL - Executing multiple OMVS commands in one step

```
//*************************************************************
//*  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
```

Always be aware of the beginning and trailing spaces.

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

mitchj@us.ibm.com

Sample JCL - Executing the Liberty *productInfo* command

```
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET WLPDIR='/usr/lpp/IBM/zosconnect/v3r0/wlp'
//PRODINFO EXEC PGM=IKJEFT01,REGION=0M,MEMLIMIT=4G
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
BPXBATCH SH +
Export WLPDIR=&WLPDIR; +
$WLPDIR/bin/productInfo version; +
$WLPDIR/bin/productInfo featureInfo | grep cics; +
$WLPDIR/bin/productInfo featureInfo | grep mq; +
$WLPDIR/bin/productInfo featureInfo | grep ims; +
$WLPDIR/bin/productInfo validate | grep 'Product validation'
```

```
productInfo featureInfo
productInfo version
productInfo validate
```

```
Product name: z/OS Connect
Product version: 03.00.48
Product edition: z/OS Connect Enterprise Edition

cicsService-1.0 Ý1.0.0¨
wmqJmsClient-1.1 Ý1.0.0¨
wmqJmsClient-2.0 Ý1.0.0¨
Product Extension: mqzosconnect
mqService-1.0 Ý1.0.0¨
Product Extension: imsmobile
imsmobile-2.0 Ý2.0.0.202108160933¨
Product validation completed successfully.
```

mitchj@us.ibm.com

Sample JCL - Copy WOLA executables from OMVS to a PDSE

```
//JOHNSONS JOB (ACCOUNT),JOHNSON,NOTIFY=JOHNSON,REGION=0M,
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1)
//*************************************************************
//*  SET SYMBOLS
//*************************************************************
//EXPORT EXPORT SYMLIST=(*)
// SET DSNAME='USER1.WOLA2106.LOADLIB'
// SET ZCEEPATH='/usr/lpp/IBM/zosconnect/v3r0'
// SET JAVAHOME='/usr/lpp/java/J8.0_64'
//*************************************************************
//*  Step ALLOC    - Allocate a PDSE load library
//*************************************************************
//ALLOC EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *,SYMBOLS=EXECSYS
  DELETE '&DSNAME'
  SET MAXCC=0
  ALLOC DSNAME('&DSNAME') -
     NEW CATALOG SPACE(2,1) DSORG(PO) CYLINDERS -
     RECFM(U) DSNTYPE(LIBRARY)
//*************************************************************
//*  Step WOLACOPY - copy the WOLA executables to the PDSE
//*************************************************************
//WOLACOPY EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSERR   DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=EXECSYS
BPXBATCH SH +
 export JAVA_HOME=&JAVAHOME; +
 export DSNAME=&DSNAME; +
 cp -Xv &ZCEEPATH/wlp/clients/zos/* "//'$DSNAME'"
```

mitchj@us.ibm.com

Sample JCL - BBOSMFV (Extract Liberty SMF 120 Subtype 11 records)

```
//JOHNSONS JOB (ACCOUNT),JOHNSON,NOTIFY=JOHNSON,REGION=0M,
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1)
//EXPORT EXPORT SYMLIST=(*)
// SET REPORT='LibertyExport'
//JAVA EXEC PROC=JVMPRC86,
// JAVACLS='com.ibm.ws390.sm.smfview.JclSmf'
//STDENV  DD DISP=SHR,DSN=JOHNSON.JCLLIB.CNTL(STDENV)
//SMFDATA DD DISP=SHR,DSN=MPZ3.DUMPSMF
//SMFENV  DD *,SYMBOLS=EXECSYS
# Specify the plugin to use
plugin=&REPORT
# Specify where the output goes
output=/u/johnson/&REPORT..csv
# Uncomment (and change the value as appropriate) to filter
#matchServer=BAQSTRT
```

JOHNSON.JCLLIB.CNTL(STDENV)

```
. /etc/profile
export JAVA_HOME=/usr/lpp/java/J8.0_64
export PATH=/bin:"${JAVA_HOME}"/bin

LIBPATH=/lib:/usr/lib:"${JAVA_HOME}"/bin
LIBPATH="$LIBPATH":"${JAVA_HOME}"/lib/s390x
LIBPATH="$LIBPATH":"${JAVA_HOME}"/lib/s390x/j9vm
LIBPATH="$LIBPATH":"${JAVA_HOME}"/bin/classic
export LIBPATH="$LIBPATH":

# Customize your CLASSPATH here
APP_HOME=$JAVA_HOME
CLASSPATH=$APP_HOME:"${JAVA_HOME}"/lib:"${JAVA_HOME}"/lib/ext
CLASSPATH=/u/johnson/lib/bbomsmfv.jar:$CLASSPATH
CLASSPATH=/u/johnson/lib/WP102312_Plugins.jar:$CLASSPATH

# Add Application required jars to end of CLASSPATH
for i in "${APP_HOME}"/*.jar; do
    CLASSPATH="$CLASSPATH":"$i"
    done
export CLASSPATH="$CLASSPATH":

# Configure JVM options
IJO="-Xms16m -Xmx128m"
export IBM_JAVA_OPTIONS="$IJO "
```

mitchj@us.ibm.com

Sample JCL – Using ADRDSSU to dump/restore MVS data sets

ZCEEDUMP

```
//EXPORT EXPORT SYMLIST=(*)
// SET ZCEELVL=349
//DELETE EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *,SYMBOLS=EXECSYS
  DELETE IBM.ZCEE30.BKUP&ZCEELVL.
  SET MAXCC=0
//DUMP    EXEC PGM=ADRDSSU,REGION=2048K
//SYSPRINT DD SYSOUT=*
//DUMPDD DD DSN=IBM.ZCEE30.BKUP&ZCEELVL.,
//         DISP=(NEW,CATLG),
//         UNIT=SYSDA,SPACE=(CYL,(3000,2000,0),RLSE)
//SYSIN    DD *,SYMBOLS=EXECSYS
  DUMP DATASET(INCLUDE( -
  ZCEE30.SBAQ* -
  ZCEE30.WOLA*.** -
  OMVS.ZCEE*.** -
           )) OPTIMIZE(4) OUTDDNAME(DUMPDD) TOLERATE(ENQF)
```

ZCEERSTR

```
//RESTORE EXEC PGM=ADRDSSU,REGION=2048K
//SYSPRINT DD SYSOUT=*
//DUMPDD DD DISP=SHR,DSN=JOHNSON.ZCEE30.BKUP349
//SYSIN    DD *
 RESTORE DATASET(INCLUDE(**)) -
 INDDNAME(DUMPDD) OUTDYNAM(WAS004) -
  NULLSTORCLAS -
   REPLACE CATALOG TOLERATE(ENQF)
```

mitchj@us.ibm.com

Sample JCL – Define and format a ZFS data set using IOEAGFMT

ZFS

```
//DEFINE EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//AMSDUMP  DD SYSOUT=*
//SYSIN    DD *
  SET MAXCC=0
  DEFINE CLUSTER (NAME(OMVS.ZCEE.GROUP1.ZFS) -
    LINEAR CYLINDERS(100 100) SHAREOPTIONS(3))
//CREATE EXEC PGM=IOEAGFMT,REGION=0M,
// PARM=('-aggregate OMVS.ZCEE.GROUP1.ZFS -compat')
//SYSPRINT DD SYSOUT=*
//STDOUT   DD SYSOUT=*
//STDERR   DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//CEEDUMP  DD SYSOUT=*
```

mitchj@us.ibm.com

Sample JCL – Generate WLM Workload Activity Reports

```
//JOHNSONS JOB (ACCOUNT),NOTIFY=&SYSUID,REGION=0M,
// CLASS=A,MSGCLASS=H,MSGLEVEL=(1,1)
//DELETE EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 DELETE JOHNSON.DUMPSMF.SORT
//RMFSORT  EXEC PGM=SORT,REGION=0M
//SORTIN   DD  DISP=SHR,DSN=MPZ3.DUMPSMF
//SORTOUT  DD  DISP=(,CATLG),DSN=JOHNSON.DUMPSMF.SORT,
//         SPACE=(CYL,(100,50),RLSE),UNIT=SYSDA
//SORTWK01 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SORTWK02 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SORTWK03 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SORTWK04 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SORTWK05 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SORTWK06 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SORTWK07 DD   DISP=(NEW,DELETE),UNIT=SYSDA,SPACE=(CYL,(100))
//SYSPRINT DD   SYSOUT=(,)
//SYSOUT   DD   SYSOUT=(,)
//SYSIN    DD   *
  SORT FIELDS=(11,4,CH,A,7,4,CH,A),EQUALS
  MODS E15=(ERBPPE15,36000,,N),E35=(ERBPPE35,3000,,N)
 //RMFPP    EXEC PGM=ERBRMFPP,REGION=0M
 //SYSUDUMP DD SYSOUT=*
 //STEPLIB  DD DSN=SYS1.COMBINED.LINKLIB,DISP=SHR
 //MFPINPUT DD DISP=SHR,DSN=JOHNSON.DUMPSMF.SORT
 //MFPMSGDS DD SYSOUT=*
//SYSIN    DD   *
 SYSOUT(O)
 SYSRPTS(WLMGL(RCPER))   /*WORKLOAD ACTIVITY REPORT  */
```

mitchj@us.ibm.com

BAQSMFP output (OpenAPI 2)

```
************************************
* SMF123.1 V2 Request Data Section *
************************************
SMF123S1_REQ_TYPE = API (1)
SMF123S1_HTTP_RESP_CODE = 500
SMF123S1_REQ_TIMED_OUT = NO
SMF123S1_USER_NAME = FRED
SMF123S1_USER_NAME_MAPPED =
SMF123S1_CLIENT_IP_ADDR = 192.168.0.60
SMF123S1_API_NAME = db2employee
SMF123S1_API_VERSION = 1.0.0
SMF123S1_SERVICE_NAME = selectEmployee
SMF123S1_SERVICE_VERSION = 1.0.0
SMF123S1_REQ_METHOD = GET
SMF123S1_REQ_QUERY_STR =
SMF123S1_REQ_TARGET_URI = /db2/employee/000010
SMF123S1_REQ_PAYLOAD_LEN = 0
SMF123S1_RESP_PAYLOAD_LEN = 0
SMF123S1_TIME_ZC_ENTRY = 0x00DA2FB8 38ED5494 04000000 08880001
UTC_CONV_TIME_ZC_ENTRY = 2021/08/19 15:30:24.905545 UTC
SMF123S1_TIME_ZC_EXIT  = 0x00DA2FB8 38F3883F A8000000 08880001
UTC_CONV_TIME_ZC_EXIT  = 2021/08/19 15:30:24.930947 UTC
SMF123S1_TIME_SOR_SENT = 0x00DA2FB8 38F232A9 76000000 08A00001
UTC_CONV_TIME_SOR_SENT = 2021/08/19 15:30:24.925482 UTC
SMF123S1_TIME_SOR_RECV = 0x00DA2FB8 38F300A4 AA000000 08880001
UTC_CONV_TIME_SOR_RECV = 2021/08/19 15:30:24.928778 UTC
SMF123S1_SP_NAME = restclient-1.0
SMF123S1_SOR_REFERENCE = Db2Conn
SMF123S1_SOR_IDENTIFIER = Db2:DSN2LOC,wg31.washington.ibm.com:2446
SMF123S1_SOR_RESOURCE = services/zCEEService/selectEmployee
SMF123S1_REQ_ID = 302
SMF123S1_TRACKING_TOKEN = 0x42415131 77734859 41514159 314E6670 31395046
35304455 312B6E7A 51454241
 514E6F76 75446A74 564A5145 41413D3D 40404040 40404040 40404040 40404040
SMF123S1_REQ_HDR1 =
SMF123S1_REQ_HDR2 =
SMF123S1_REQ_HDR3 =
SMF123S1_REQ_HDR4 =
SMF123S1_RESP_HDR1 =
SMF123S1_RESP_HDR2 =
SMF123S1_RESP_HDR3 =
```

```
************************************
* SMF123.2 V2 Request Data Section *
************************************
SMF123S2_REQ_APP_TYPE = ZOS (3)
SMF123S2_HTTP_RESP_CODE = 200
SMF123S2_REQ_STATUS_CODE = 200
SMF123S2_REQ_RETRIED = NO
SMF123S2_REQ_PAYLOAD_LEN = 0
SMF123S2_RESP_PAYLOAD_LEN = 269
SMF123S2_USER_NAME = USER1
SMF123S2_USER_NAME_MAPPED =
SMF123S2_USER_NAME_ASSERTED = USER1
SMF123S2_API_REQ_NAME = cscvinc_1.0.0
SMF123S2_API_REQ_VERSION = 1.0.0
SMF123S2_ENDPOINT_REFERENCE = cscvincAPI
SMF123S2_ENDPOINT_HOST = https://mpz3.washington.ibm.com
SMF123S2_ENDPOINT_PORT = 9463
SMF123S2_ENDPOINT_FULL_PATH = /cscvinc/employee/111111
SMF123S2_ENDPOINT_METHOD = GET
SMF123S2_ENDPOINT_QUERY_STR =
SMF123S2_TIME_STUB_SENT = 0x00DA2FC1 7D34CE8B 4A000000 084C0001
UTC_CONV_TIME_STUB_SENT = 2021/08/19 16:11:52.420584 UTC
SMF123S2_TIME_ZC_ENTRY  = 0x00DA2FC1 7D58AEE0 0E000000 08A00001
UTC_CONV_TIME_ZC_ENTRY  = 2021/08/19 16:11:52.567534 UTC
SMF123S2_TIME_ZC_EXIT   = 0x00DA2FC1 87DCB806 E6000000 08880001
UTC_CONV_TIME_ZC_EXIT   = 2021/08/19 16:12:03.594112 UTC
SMF123S2_TIME_TOKEN_GET_START   = 0x00DA2FC1 7D59D3A6 E6000000 08A00001
UTC_CONV_TIME_TOKEN_GET_START   = 2021/08/19 16:11:52.572218 UTC
SMF123S2_TIME_TOKEN_GET_FINISH  = 0x00DA2FC1 7D59DF85 CC000000 088C0001
UTC_CONV_TIME_TOKEN_GET_FINISH  = 2021/08/19 16:11:52.572408 UTC
SMF123S2_TIME_ENDPOINT_SENT     = 0x00DA2FC1 7D5A0328 04000000 088C0001
UTC_CONV_TIME_ENDPOINT_SENT     = 2021/08/19 16:11:52.572978 UTC
SMF123S2_TIME_ENDPOINT_RECEIVED = 0x00DA2FC1 87DC8216 58000000 08880001
UTC_CONV_TIME_ENDPOINT_RECEIVED = 2021/08/19 16:12:03.593249 UTC
SMF123S2_MVS_JOBNAME = USER1GE2
SMF123S2_MVS_JOBID = JOB09543
SMF123S2_MVS_SYSNAME = MPZ3
SMF123S2_MVS_ASID = 54
SMF123S2_MVS_SID = MPZ3
SMF123S2_REQ_ID = 732
SMF123S2_TRACKING_TOKEN = 0x42415131 77734859 41514159 314E6670 31395046 35304455 312B6E7A 51454241
 514E6F76 77583159 7275414F 40404040 40404040 40404040 40404040 40404040
SMF123S2_REQ_HDR1 =
SMF123S2_REQ_HDR2 =
SMF123S2_REQ_HDR3 =
```

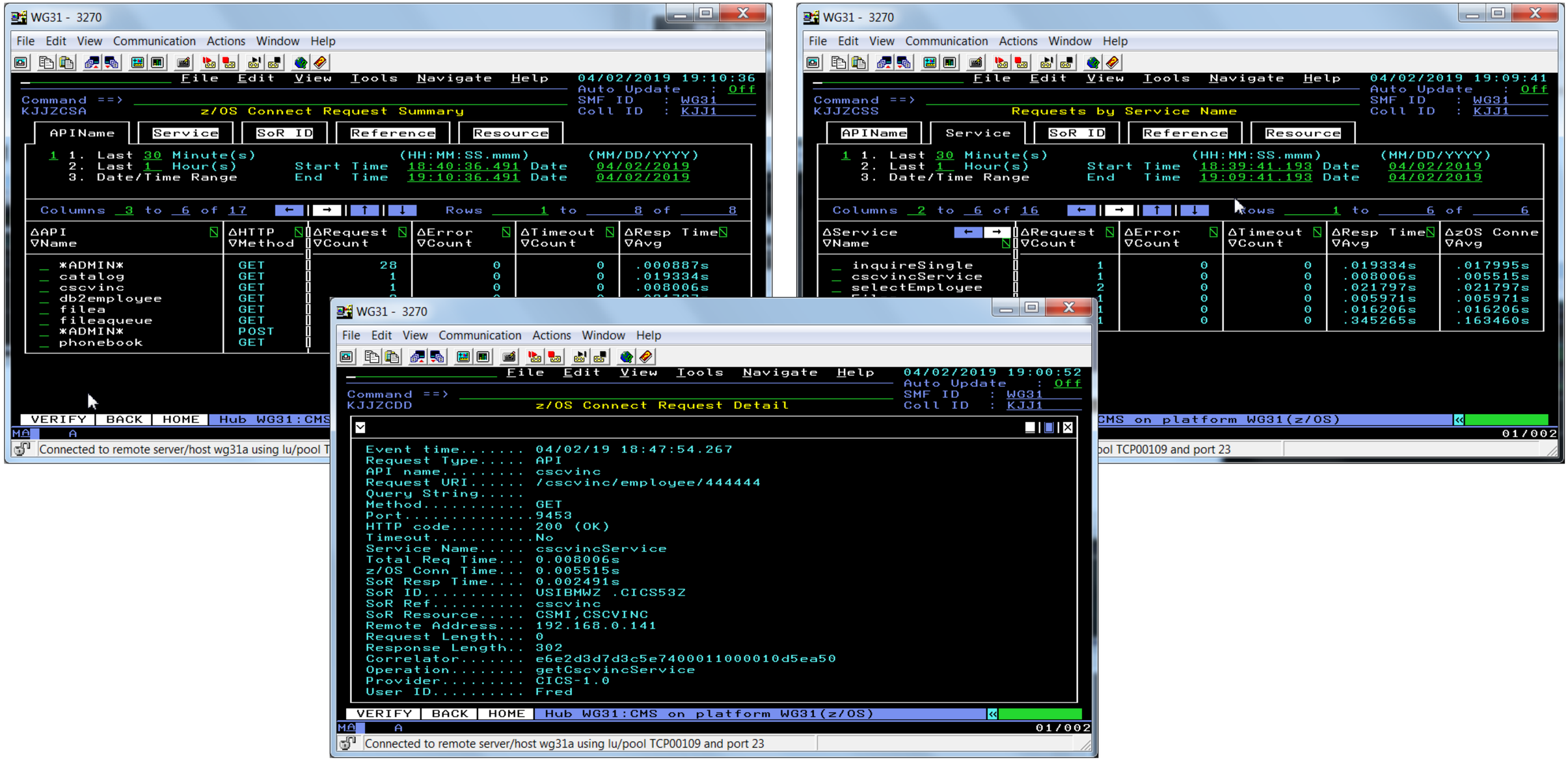
mitchj@us.ibm.com

CICS Performance Analyzer

```
 V5R4M0                                              CICS Performance Analyzer
                                                       z/OS Connect Summary

ZCEE0001 Printed at 13:35:01  8/21/2021     Data from 11:30:24  8/19/2021 to 12:11:24  8/19/2021                    Page       1
Initial CICS PA report

JOBNAME : BAQSTRT   SPNAME  : imsmobile-2.0

Request:         49  Fail:          0  Timed out:          0  Get:         49  Post:          0  Put:           0  Delete:          0

                                        ----- Maximum value Request details -----
                            Avg         Max      Req ID    ZC Entry
SOR Sent Latency          .0326       .3781         551    19/08/2021 12:09:45.036778
SOR Response              .0016       .0183         551    19/08/2021 12:09:45.036778
ZC  Exit Latency          .0025       .0048         504    19/08/2021 12:09:36.823661
ZC  Response              .0367       .3982         551    19/08/2021 12:09:45.036778
ZC  Time                  .0351       .3799         551    19/08/2021 12:09:45.036778


JOBNAME : BAQSTRT   SPNAME  : restclient-1.0

Request:         50  Fail:         50  Timed out:          0  Get:         50  Post:          0  Put:           0  Delete:          0

                                        ----- Maximum value Request details -----
                            Avg         Max      Req ID    ZC Entry
SOR Sent Latency          .0478       .5953         488    19/08/2021 12:09:33.386614
SOR Response              .0027       .0127         594    19/08/2021 12:09:52.016624
ZC  Exit Latency          .0014       .0029         524    19/08/2021 12:09:40.369997
ZC  Response              .0519       .6004         488    19/08/2021 12:09:33.386614
ZC  Time                  .0492       .5972         488    19/08/2021 12:09:33.386614


JOBNAME : BAQSTRT   SPNAME  : CICS-1.0

Request:         49  Fail:          0  Timed out:          0  Get:         49  Post:          0  Put:           0  Delete:          0

                                        ----- Maximum value Request details -----
                            Avg         Max      Req ID    ZC Entry
SOR Sent Latency          .0300       .0589         450    19/08/2021 12:09:26.478282
SOR Response              .0011       .0049         517    19/08/2021 12:09:39.019456
ZC  Exit Latency          .0077       .0138         450    19/08/2021 12:09:26.478282
ZC  Response              .0387       .0741         450    19/08/2021 12:09:26.478282
ZC  Time                  .0376       .0727         450    19/08/2021 12:09:26.478282
```

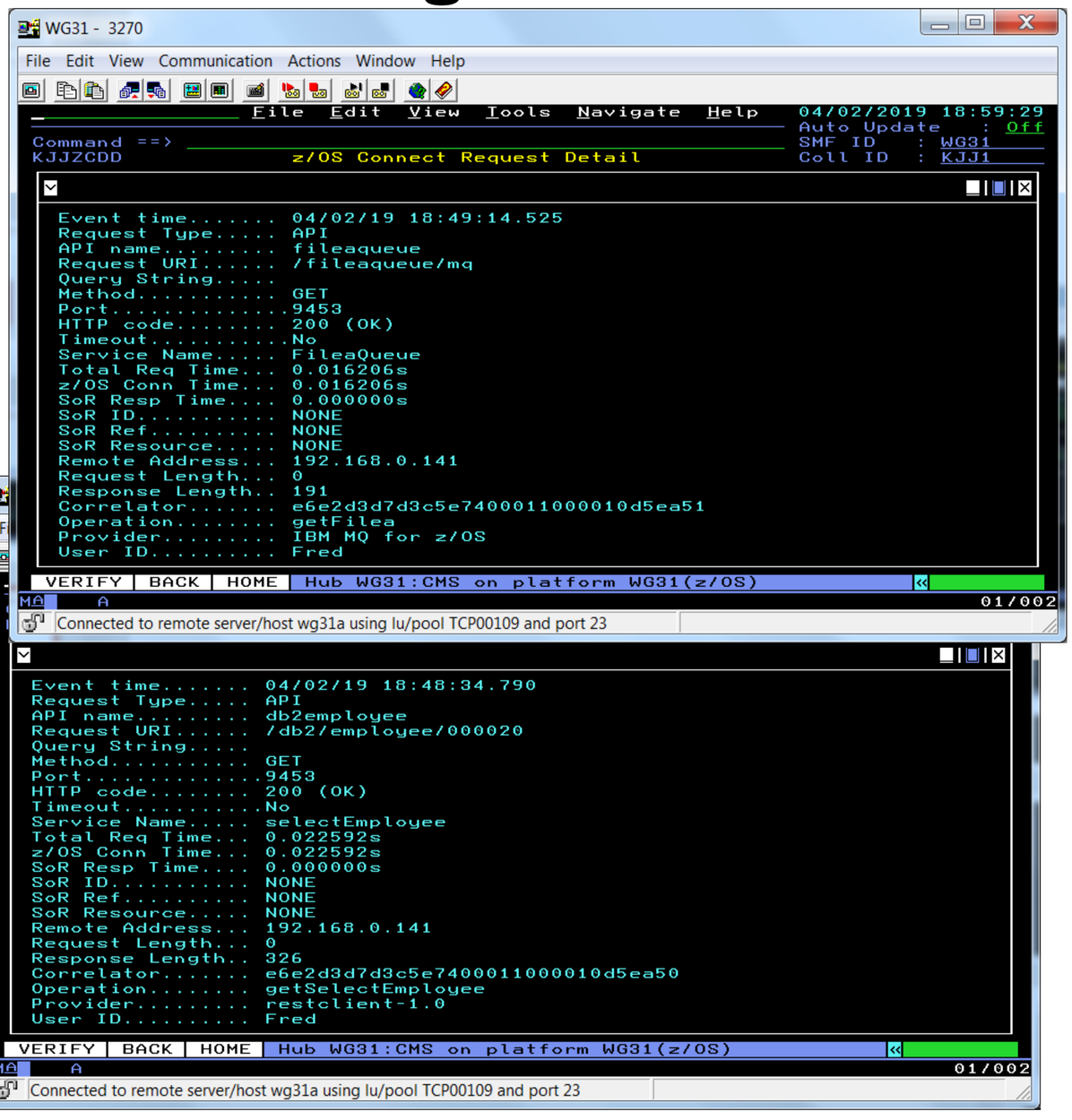
mitchj@us.ibm.com

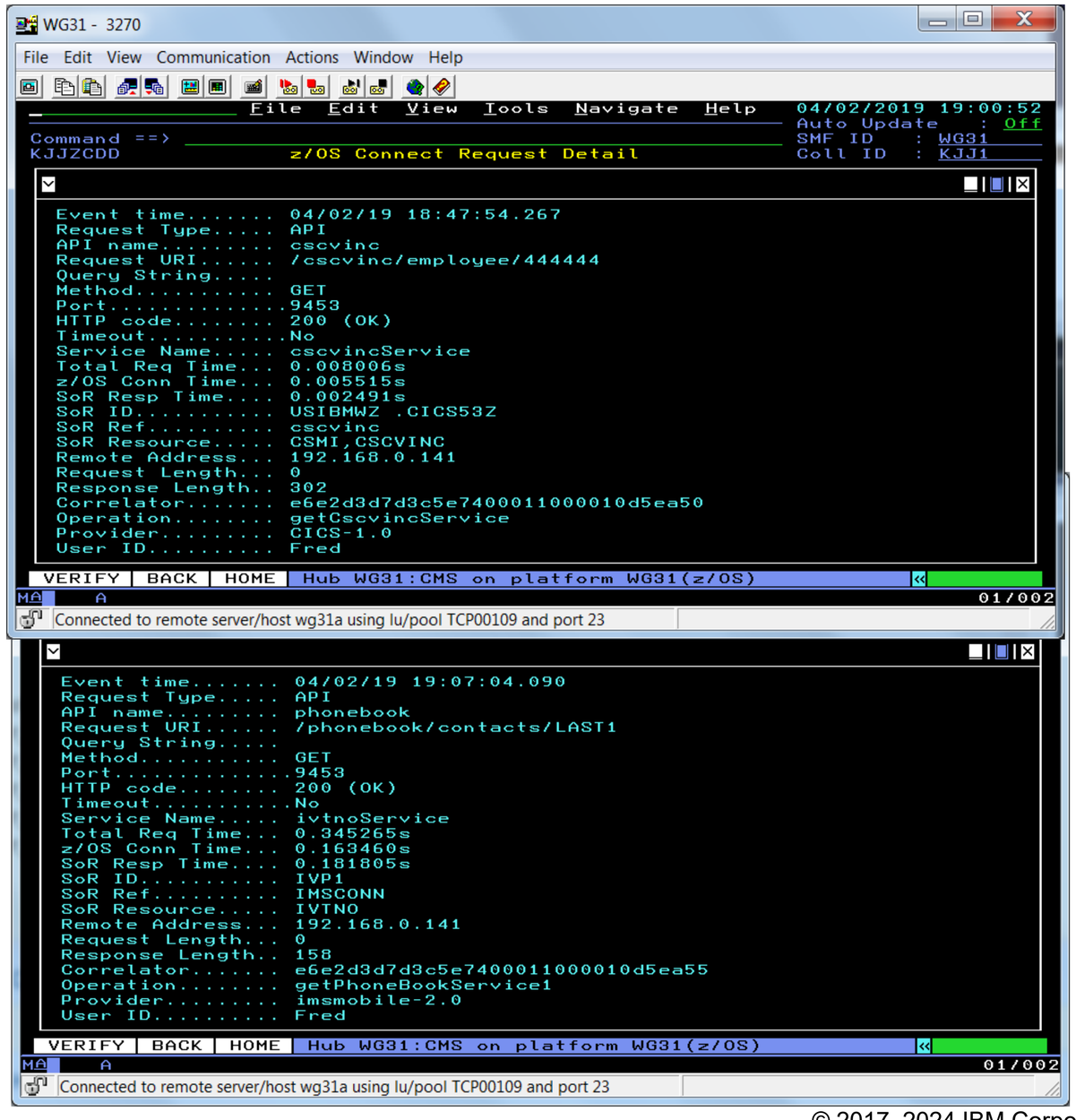
IBM z Omegamon for JVM



mitchj@us.ibm.com

IBM z Omegamon for JVM





mitchj@us.ibm.com