zOSSEC1 – Liberty and IBM z/OS Connect Security

A dive into Liberty and z/OS Connect Security

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Topics

- Liberty and z/OS Connect Security Overview
- Authentication
  - Basic Authentication
  - Mutual Authentication using TLS
  - Third Party Tokens
- Encryption and Message Integrity using TLS
- Authorization
- Propagating identities to z/OS subsystems
- z/OS Connect API Requester and third-party tokens

Disclaimer

- The information in this presentation was derived from various product Knowledge Centers (KC).
- Additional information included in this presentation was distilled from years of experience implementing security using RACF with z/OS products like CICS, IMS, Db2, MQ, etc. as well as Java runtimes environments like WebSphere Application Server and Liberty.
- There will be additional information on slides that will designated as Tech/Tips. These contain information that at perhaps at least interesting and hopefully, useful to the reader.
- A Liberty or z/OS Connect icon will appear on slides where the information is specific to these products. Don't hesitate to ask questions as to why the icon does or does not appear on certain slides.
- The examples, tips, etc. present in this material are based on firsthand experiences and are not necessarily sanctioned by z/OS Connect development.

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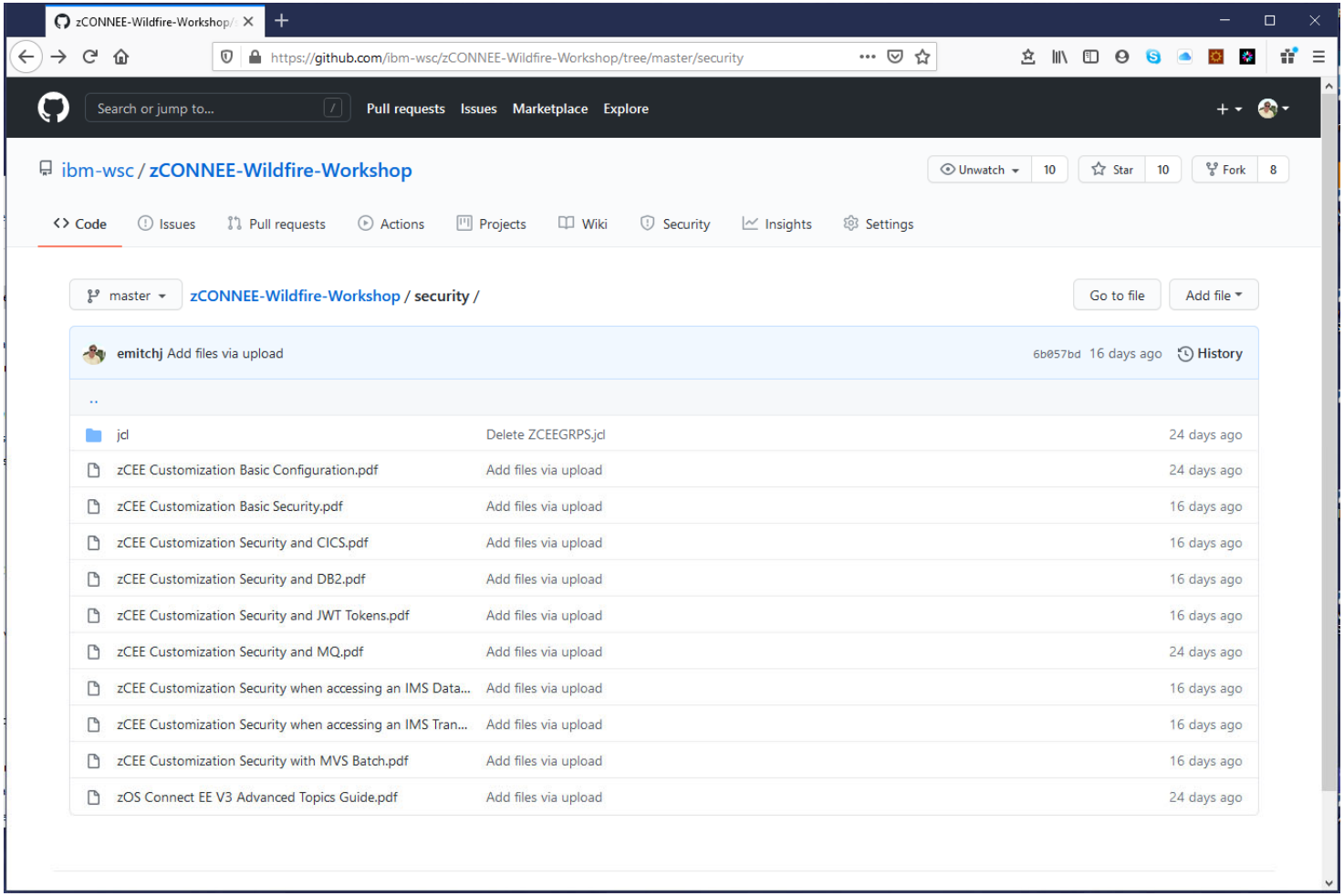
Detailed examples of the topics covered today are available on GitHub



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https://github.com/ibm-wsc/zCONNEE-Wildfire-Workshop/tree/master/security

We need to understand the challenges

- Providing secure access between middleware components involves combining disparate security technologies e.g., different registries like LDAP and SAF along with TLS in order to propagate security credentials from a client though various hops all the way to the targeted resource.
  - ➢This is a driver for implementing open security models like OAuth and OpenID Connect and standard tokens like JSON Web Tokens (covered in this presentation)
- Integrating security involves integrating security between different products like z/OS Connect, WebSphere Liberty Profile on z/OS along with CICS, IMS, Db2, MQ,… probably for the first time in your environment.
  - ➢ Security details for of these components are documented in different places
- Considering that security is often at odds with **performance**, the more secure techniques often mean more processing overhead, especially if not configured optimally
  - ➢Remember, security is probably not a choice but a requirement.

A single simple step-by-step linear path is not always possible, the best approach may be to build a solution using components, one step at a time based on the waypoints involved and the ultimate security goal. Providing security by understanding these waypoints and the corresponding options is the focus of this presentation. In fact, you may want to implement security by working backwards.

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z/OS Connect Security

Overview

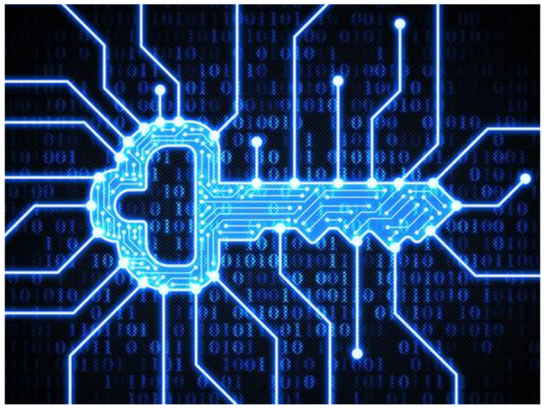
General security terms or considerations

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.



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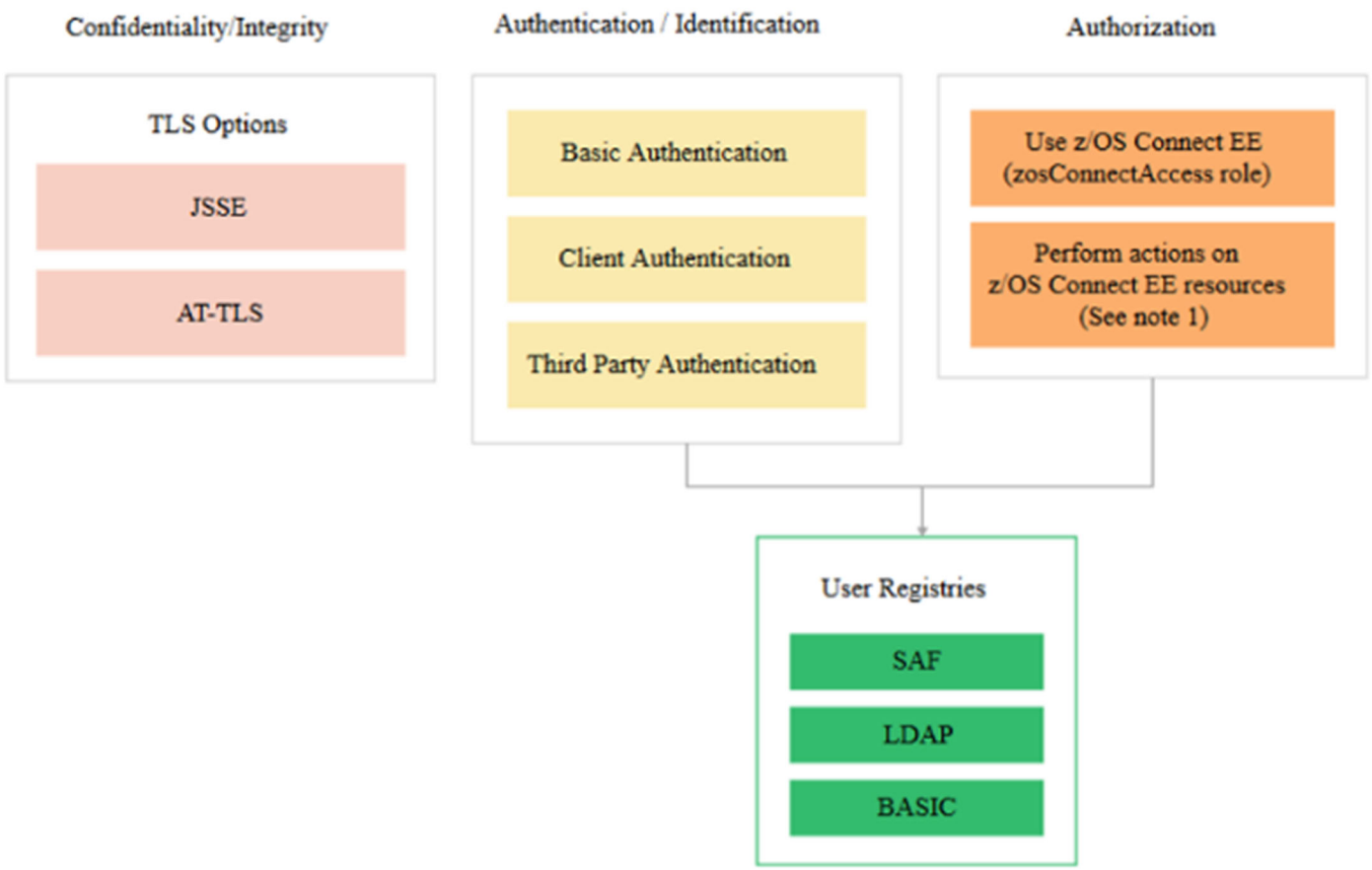
Liberty and z/OS Connect EE security options



[1]The actions which can be controlled by authorization are deploying, querying, updating, starting, stopping and deleting of APIs, services and API requesters.

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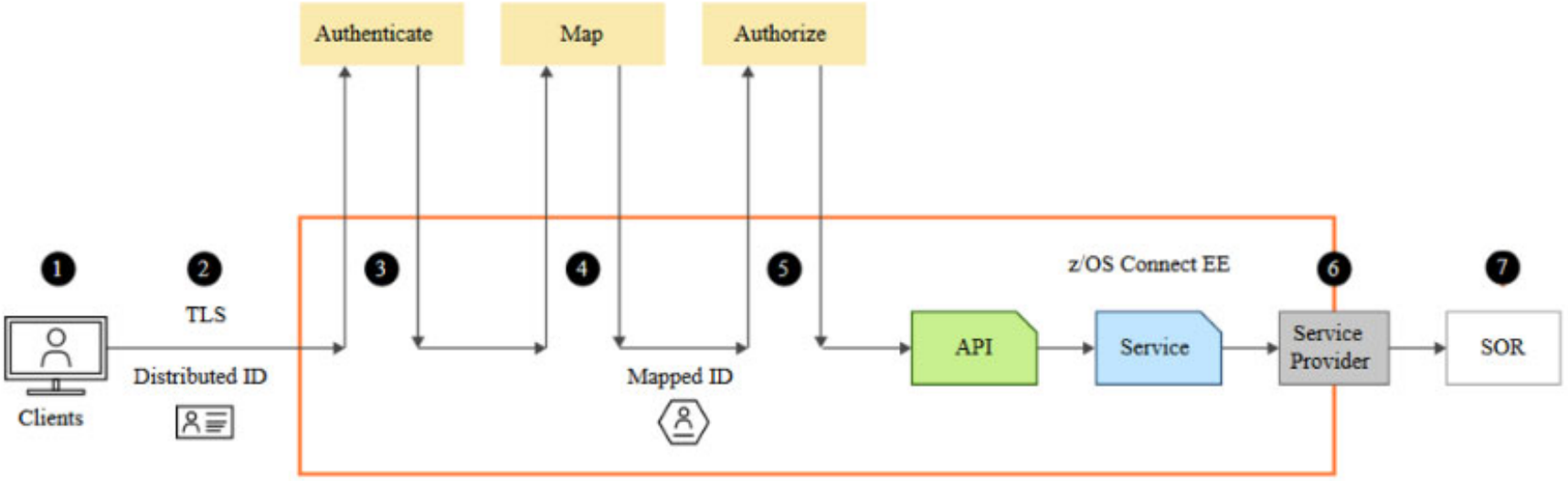
Details of a typical z/OS Connect EE API Provider security flow



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

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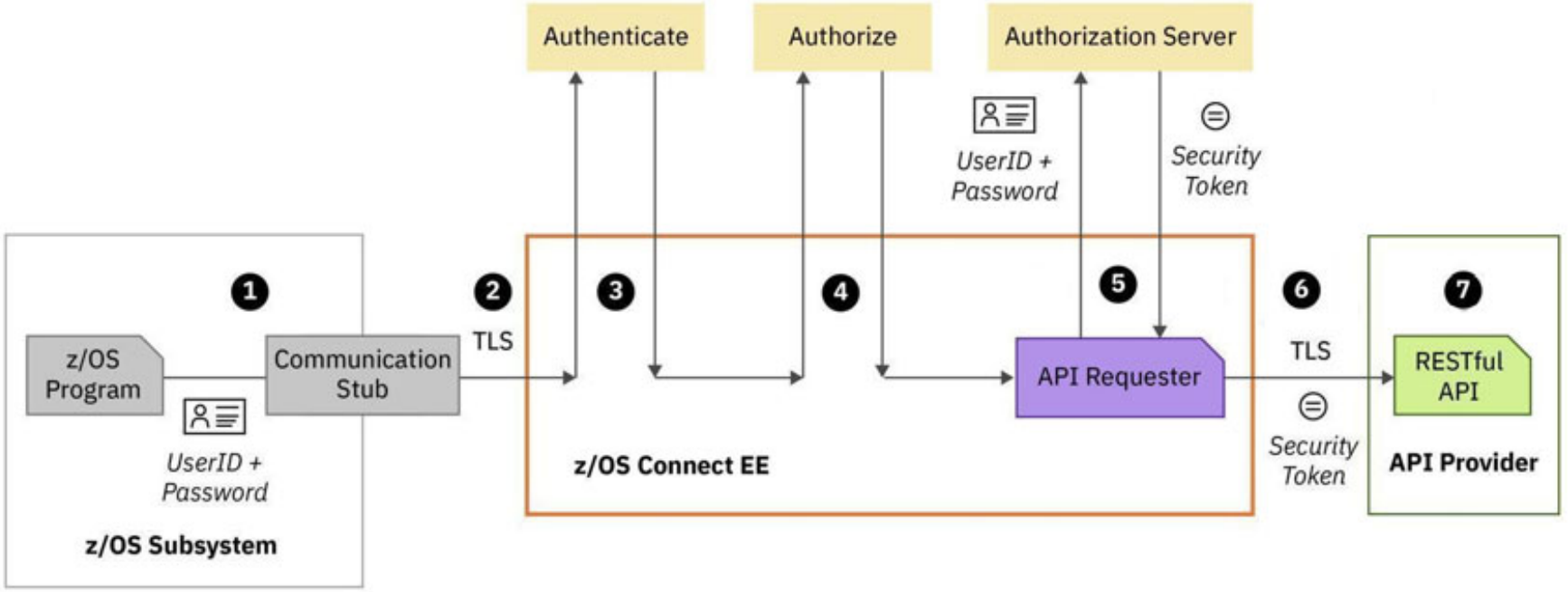
Details of a typical z/OS Connect EE API Requester security flow



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

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Now let’s explore the security options for inbound connections

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)**
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- Controlling access (**Authorization)**
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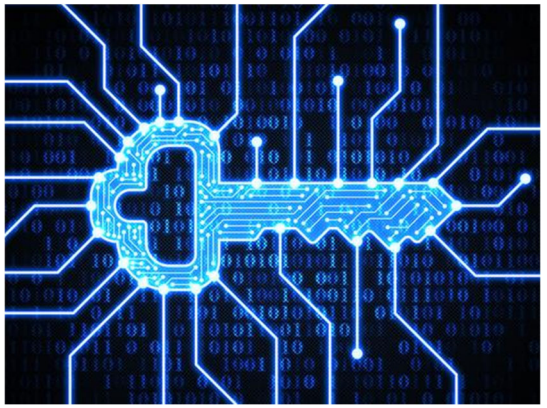

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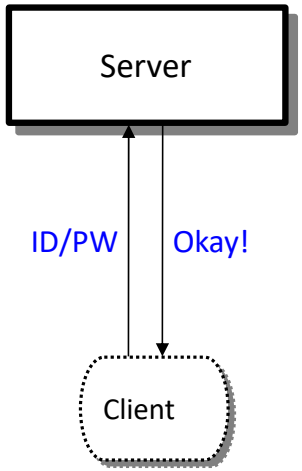
Liberty Authentication Options

Several different ways this can be accomplished:

Basic Authentication

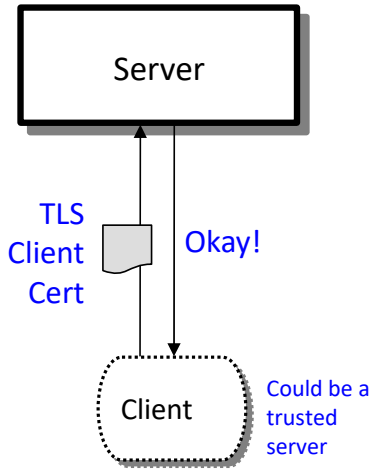


Client supplies ID/PW or ID/PassTicket

Server checks registry:

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

Client Certificate



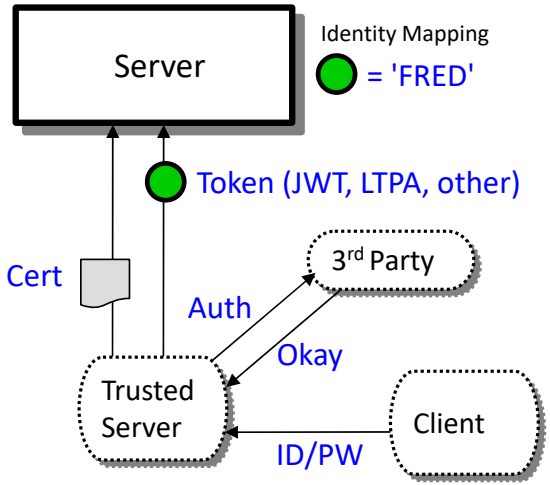
Client supplies client personal certificate

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.**

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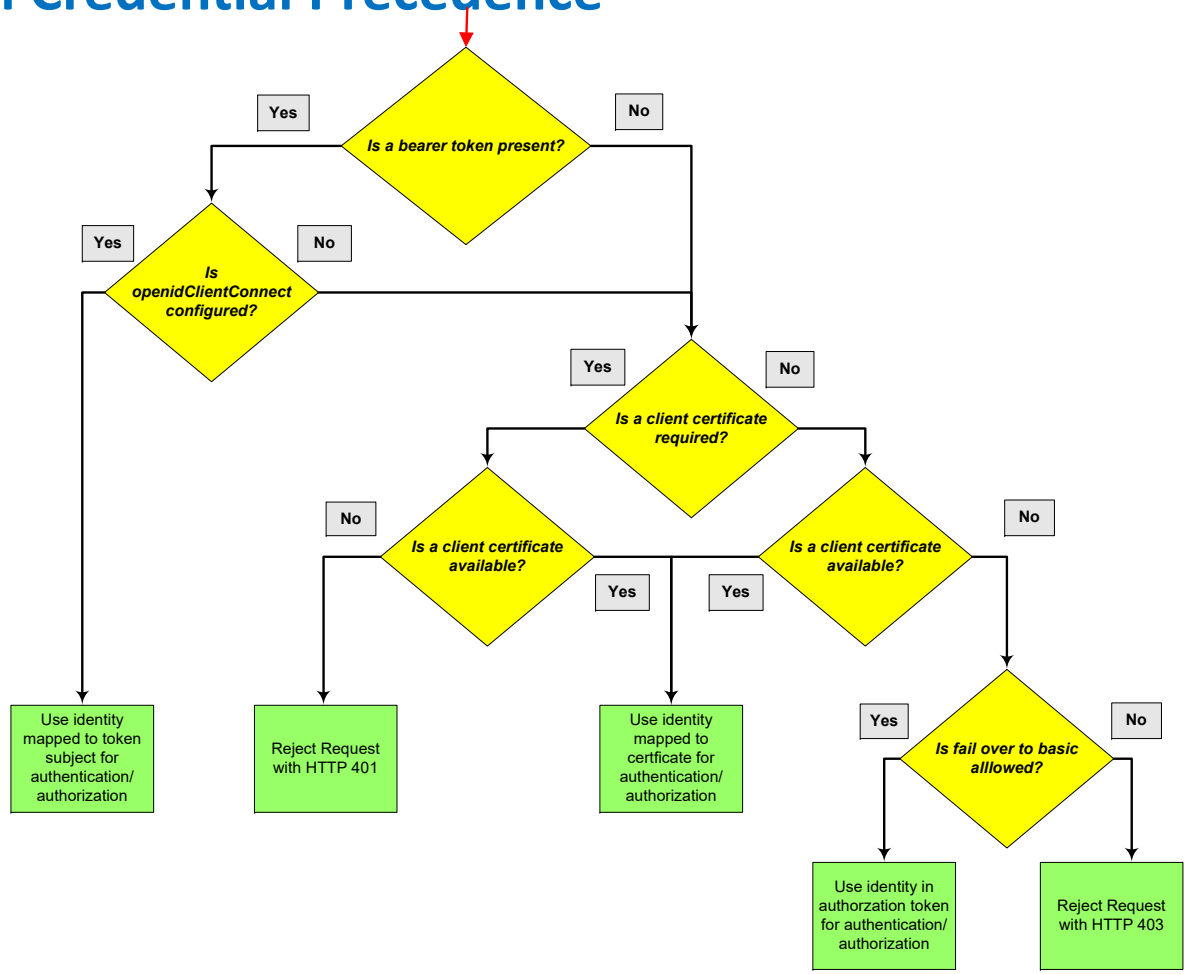
Authentication Credential Precedence



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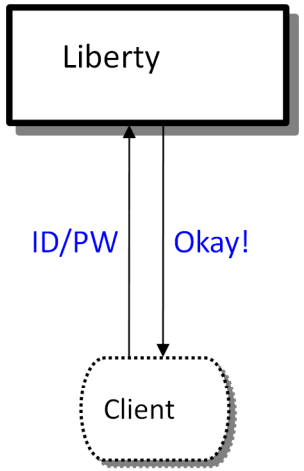
Authentication - Basic Authentication

Several different ways this can be accomplished:

Basic Authentication

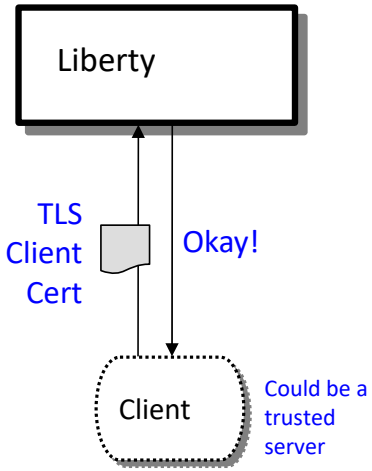


Client supplies an identity/password or an identity/PassTicket

Server checks registry:

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

Client Certificate



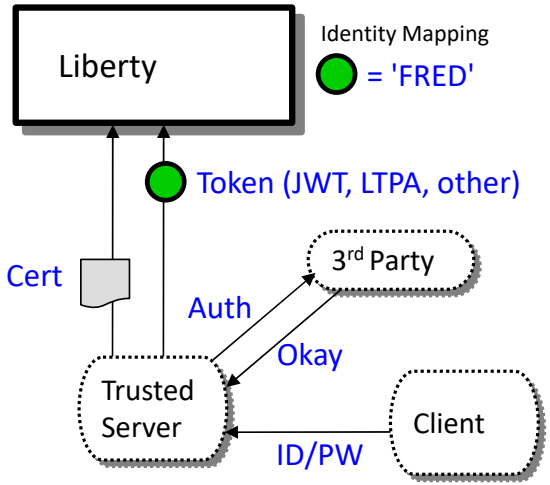
Client supplies client certificate

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.

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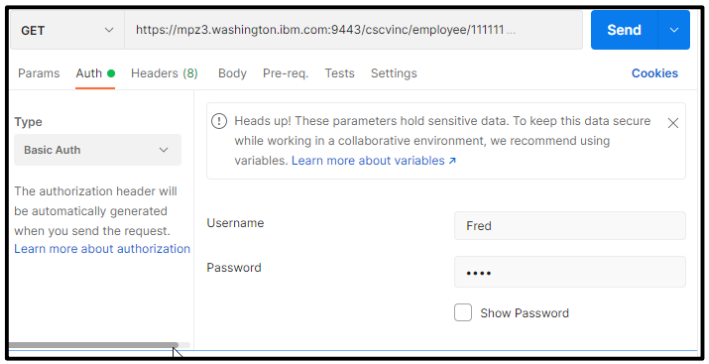
Basic authentication – Where the client provides an identity and password

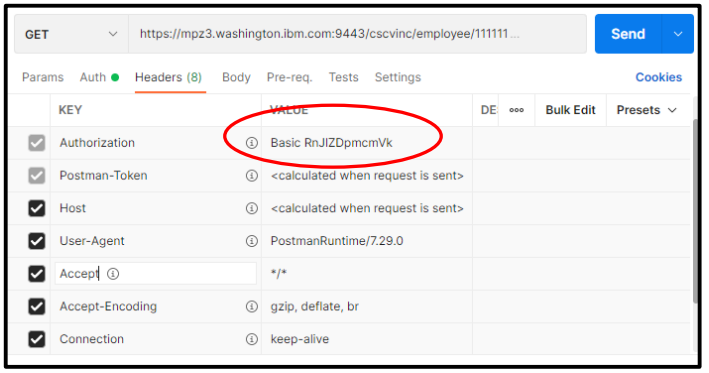
- server XML security configuration:

```
<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" />
```

Note that these are Liberty configuration elements documented in the Liberty KC, i.e., no *zosconnect_* prefix.

- 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.
  - An example with Postman:





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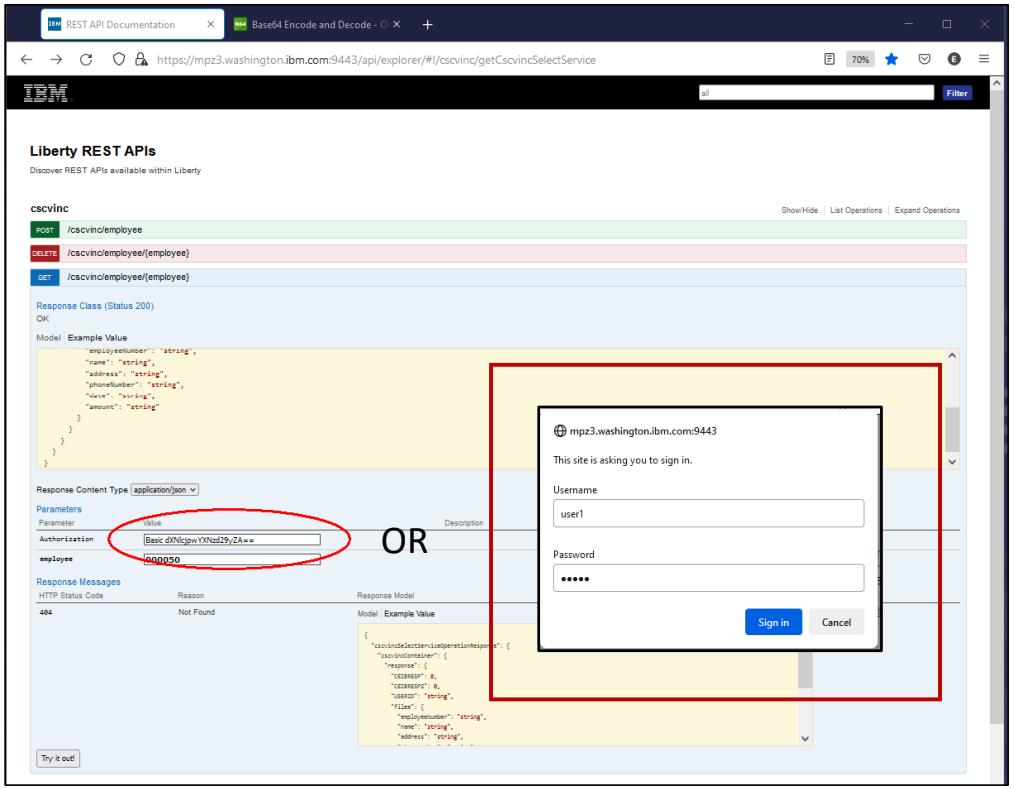
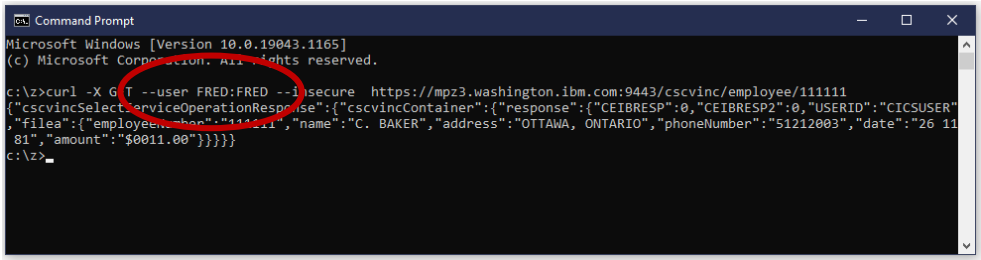
Basic authentication – Where the client provides an identity and password

- 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 Discovery feature , cURL, and a Java client.





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https://www.base64encode.org/

z/OS Connect Security server XML Authentication Configuration

```
<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.

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Basic authentication – COBOL API Requester

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

- The variables can be provided in JCL using CEEOPTS DD statement:

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

Note that the 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

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

- A PassTicket is generated by or for a client by using a secured sign-on key (whose value is masked or encrypted) to encrypt a valid *RACF identity* combined with the *application name* of the targeted resource. Also embedded in the PassTicket is a time stamp (based on the current Universal Coordinated Time (UCT)) which sets the time when the PassTicket will expire (usually 10 minutes).

- Access to PassTickets is managed using the RACF PTKTDATA class.

- For z/OS Connect, a RACF PassTicket can be used for basic authentication when connecting from any REST client on any platform to a z/OS Liberty server and for requests from a z/OS Connect server accessing IMS and Db2.

- ***PassTickets do not have to be generated on z/OS using RACF services.*** IBM has published the algorithm used to generate a PassTickets, see manual *z/OS Security Server RACF Macros and Interfaces, SA23-2288-40. Github has examples using Java, Python and other example are available on other sites*.

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

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Tech/Tip: Generating PassTickets on z/OS

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

```
      *-------------------------------------------------------------*
      * 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.
       CALL-RACF-END.
```

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

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Tech/Tip: RACF resources for using PassTickets

- First define a PTKTDATA resource 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)
```

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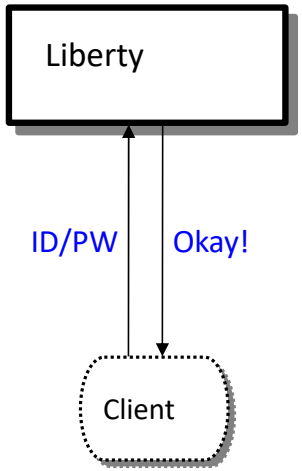
Authentication - TLS Mutual Authentication

Several different ways this can be accomplished:

Basic Authentication

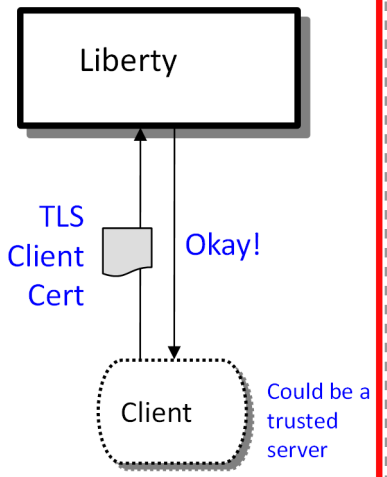


Server prompts for ID/PW

Client supplies ID/PW or ID/PassTicket

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

Client Certificate



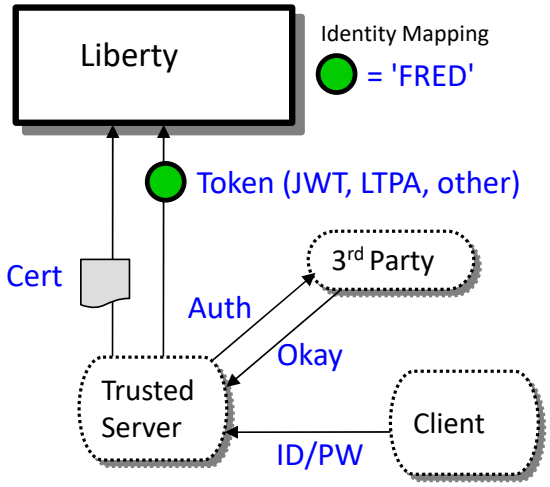
Server prompts for client certificate.

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.

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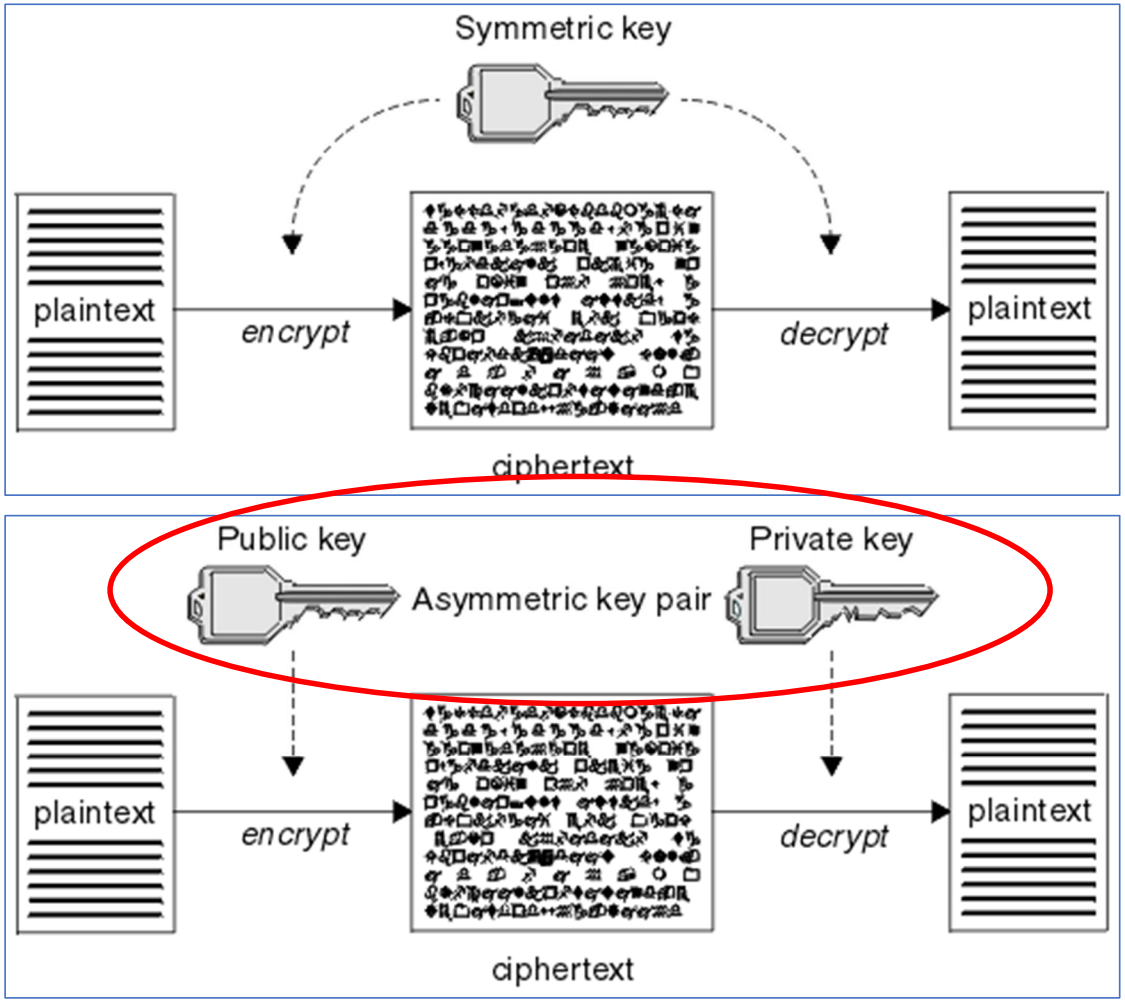
Tech-Tip: Symmetric key v. Asymmetric key pair



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.

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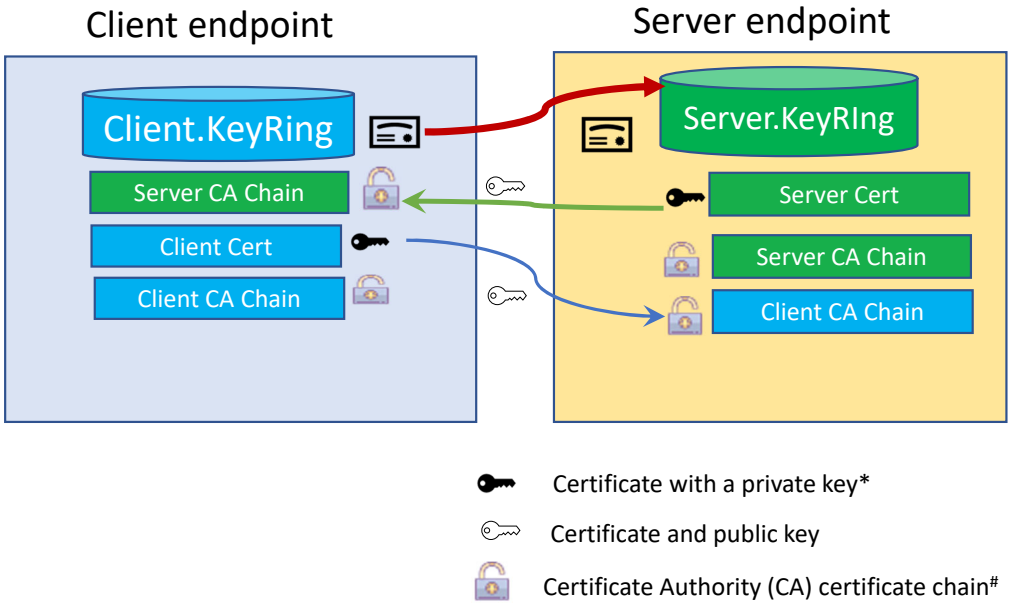
Let's explore the basic TLS Handshake Flow (HTTPS)

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)



*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.

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Tech/Tip: Details of the flow with mutual authentication

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 (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 personal certificate 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.

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Tech/Tip: Using a cURL trace to show the flow with mutual authentication

```
* successfully set certificate verify locations:
* TLSv1.3 (OUT), TLS handshake, Client hello (01):
* TLSv1.3 (IN), TLS handshake, Server hello (02):
* TLSv1.2 (IN), TLS handshake, Certificate (11):
* 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):
* 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: Jan  4 04:00:00 2021 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.
```

```
enum {
hello_request(0),
client_hello(1),
server_hello(2),
certificate(11),
server_key_exchange (12),
certificate_request(13),
server_hello_done(14),
certificate_verify(15),
client_key_exchange(16),
finished(20),
 (255) }
 HandshakeType;
```

* TLS 1.2 https://tools.ietf.org/html/rfc5246
TLS 1.3 https://tools.ietf.org/html/rfc8446

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

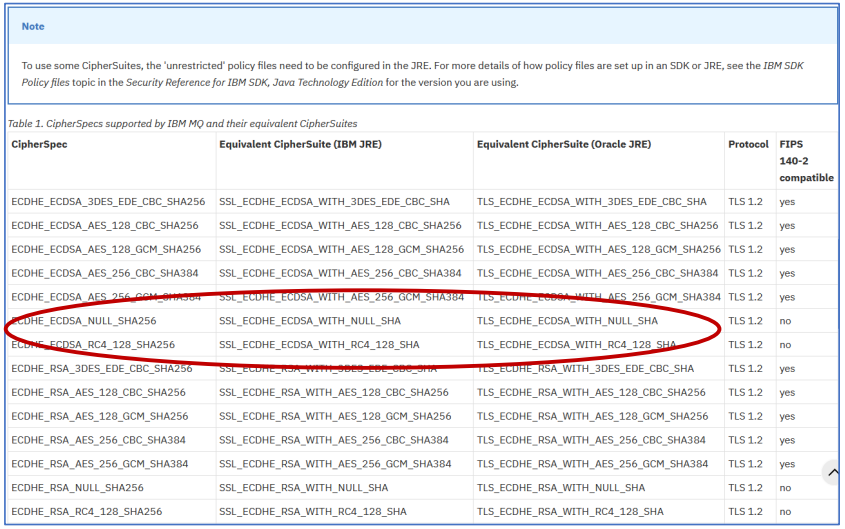
Tech/Tip: A note on cipher suite names

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/support/knowledgecenter/SSFKSJ_9.1.0/com.ibm.mq.dev.doc/q113210_.htm

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Using this Liberty JSSE server XML configuration (require 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>
```

```
<!-- 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.

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Tech-Tip: Key Rings are protected by RACF resource profiles

Two types of profiles are checked: **Ring Specific** or **Global**

- **Ring Specific** uses RDATALIB class profiles:
  - **<ring owner>.<ring name>.LST**
  - **<virtual ring owner>.IRR_VIRTUAL_KEYRING.LST**
    - **READ** access – read all certificates and own private key
    - **UPDATE** access – read other user's private keys
    - **CONTROL** access – read CA / SITE private keys
- **Global** uses FACILITY class profiles:
  - **IRR.DIGTCERT.LISTRING**:
    - **READ** access – read own key rings and own private keys and read SITE and CA Virtual key rings.
    - **UPDATE** access – read other user's rings (Can not read others user's private keys)
  - **IRR.DIGTCERT.GENCERT:**
    - **CONTROL** access – read CA / SITE private keys
- **Note:** Private keys are only returned when certificate usage is **PERSONAL**
- **Remember:** When switching from Global FACILITY class profiles to Ring Specific RDATALIB class profiles, the Ring specific will be checked first.

❑Shared key ring

RACF RDATALIB resources

- RDEFINE RDATALIB LIBSERV.ClientKeyRing.LST UACC(NONE)
- PERMIT LIBSERV.ClientKeyRing.LST CLASS(RDATALIB) ID(LIBSERV) ACCESS(READ)

JSSE - safkeyring://LIBSERV/Liberty.KeyRing
AT-TLS - LIBSERV/Liberty.KeyRing

❑Shared Virtual key ring

RACF RDATALIB resources

- RDEFINE RDATALIB CERTIFAUTH.IRR_VIRTUAL_KEYRING_LST UACC(NONE)
- PERMIT CERTIFAUTH.IRR_VIRTUAL_KEYRING_LST CLASS(RDATALIB) ID(LIBSERV) ACCESS(READ)

JSSE - safkeyring://*AUTH*/*
AT-TLS - *AUTH*/*

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F BAQSTRT,REFRESH,KEYSTORE

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

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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.

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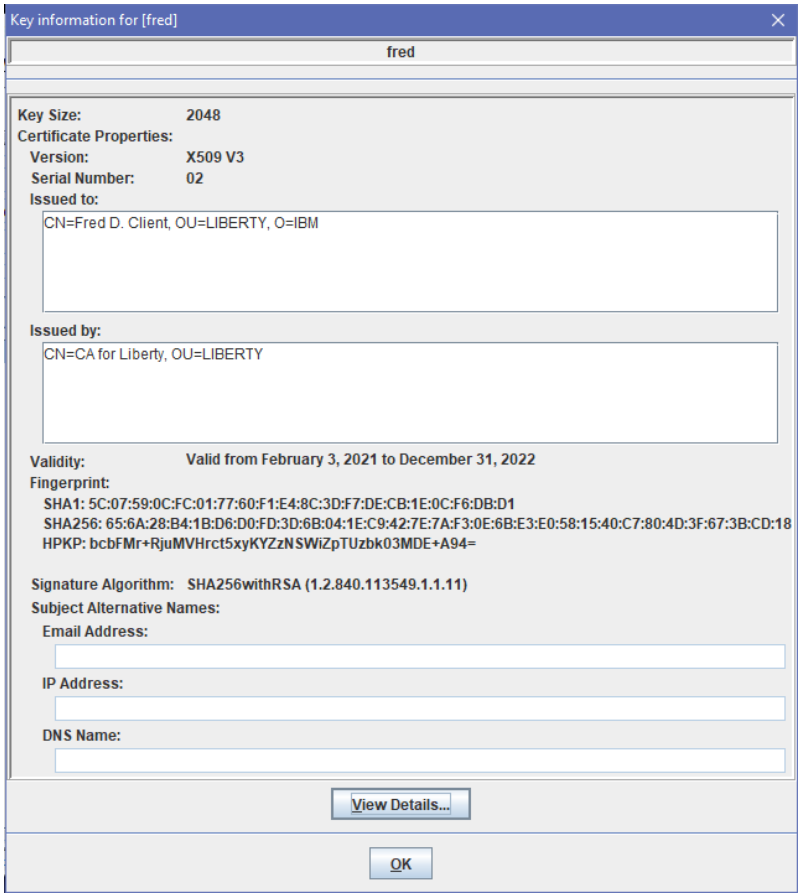
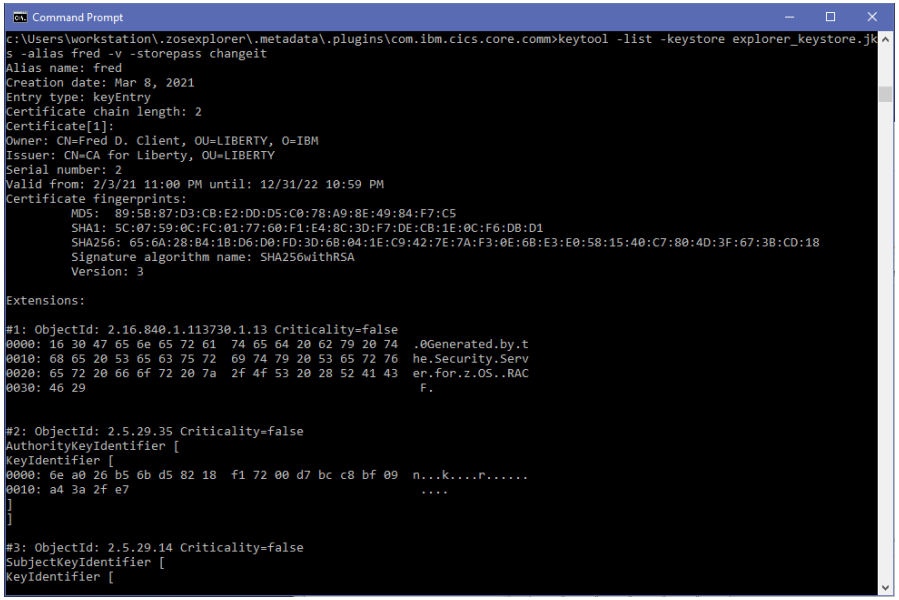
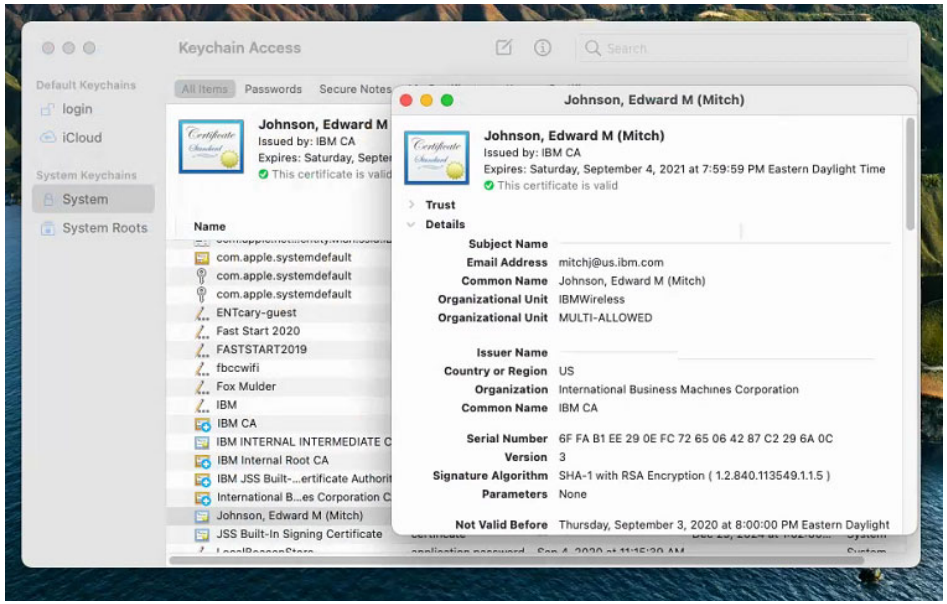
Tech/Tip: Anatomy of a certificate – IkeyMan/keytool

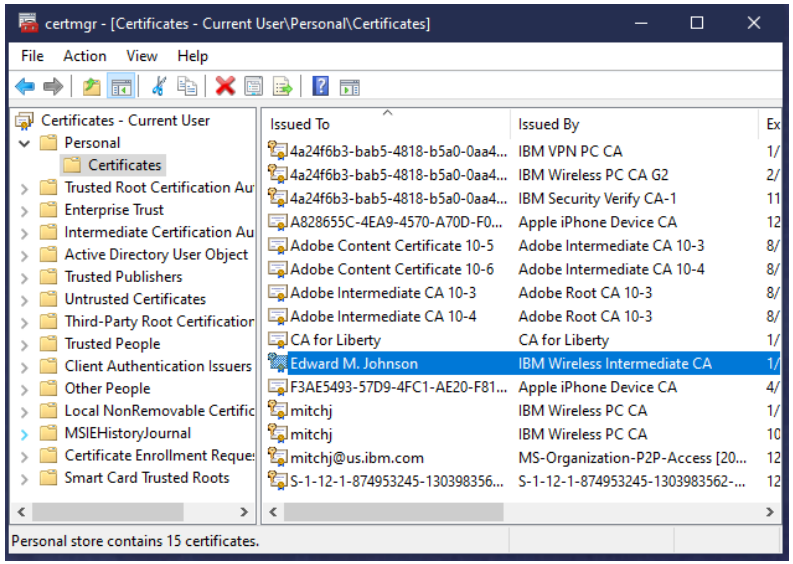




Both can be found in /usr/lpp/java/J8.0_64/bin or c:/Program Files/IBM/Java80/jre/bin

Tech/Tip: Anatomy of a certificate – Mac/Windows





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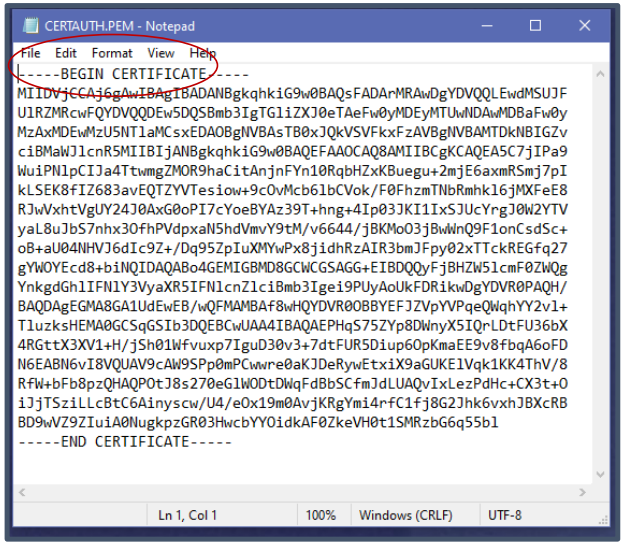
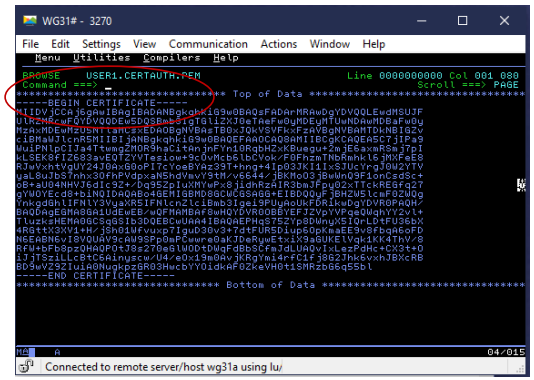
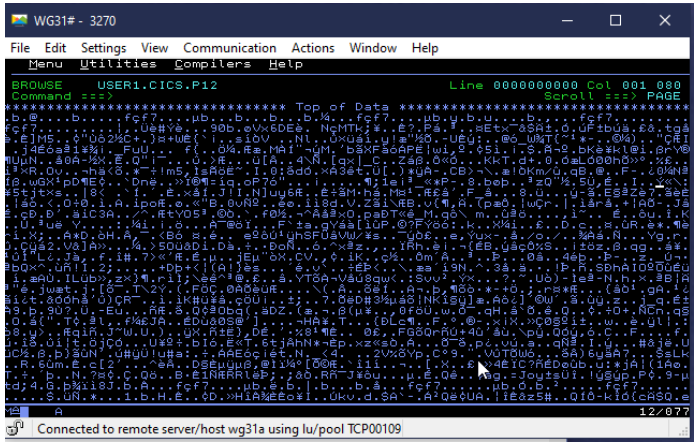
Tech/Tip: How to tell the difference?

Public certificate (site or certificate authority or certificate request)





Personal certificate with private key



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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
```

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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/platforms/ibm-z/curl-for-zos

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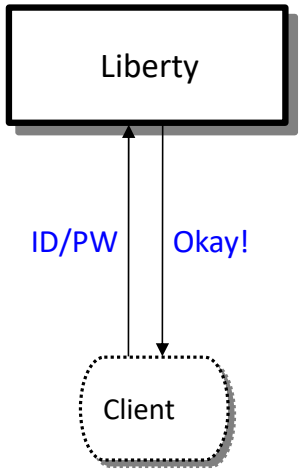
Authentication - Third Party Authentication

Several different ways this can be accomplished:

Basic Authentication

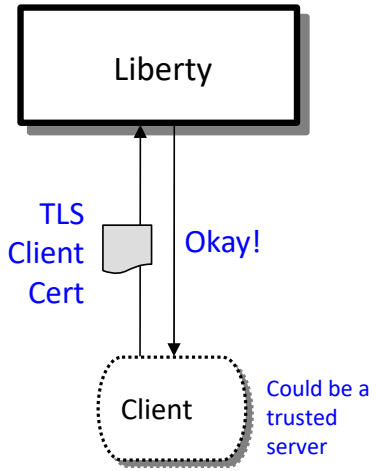


Server prompts for ID/PW

Client supplies ID/PW or ID/PassTicket

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

Client Certificate



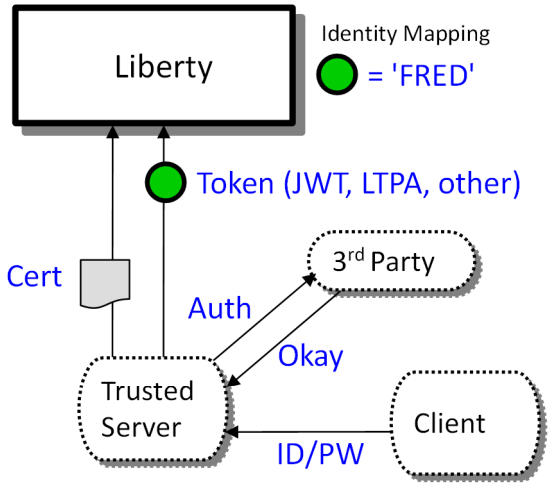
Server prompts for client certificate.

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.**

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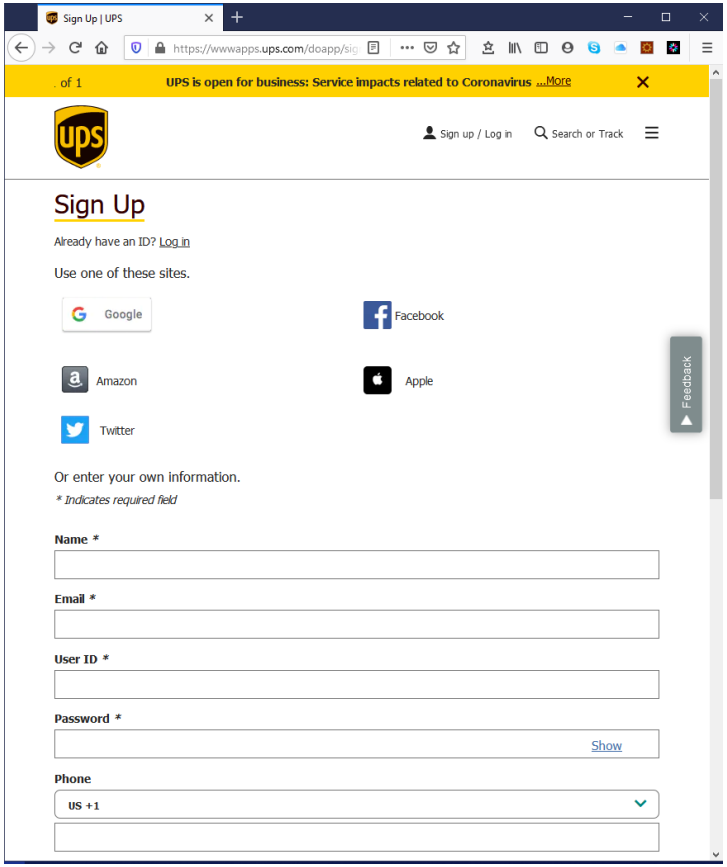
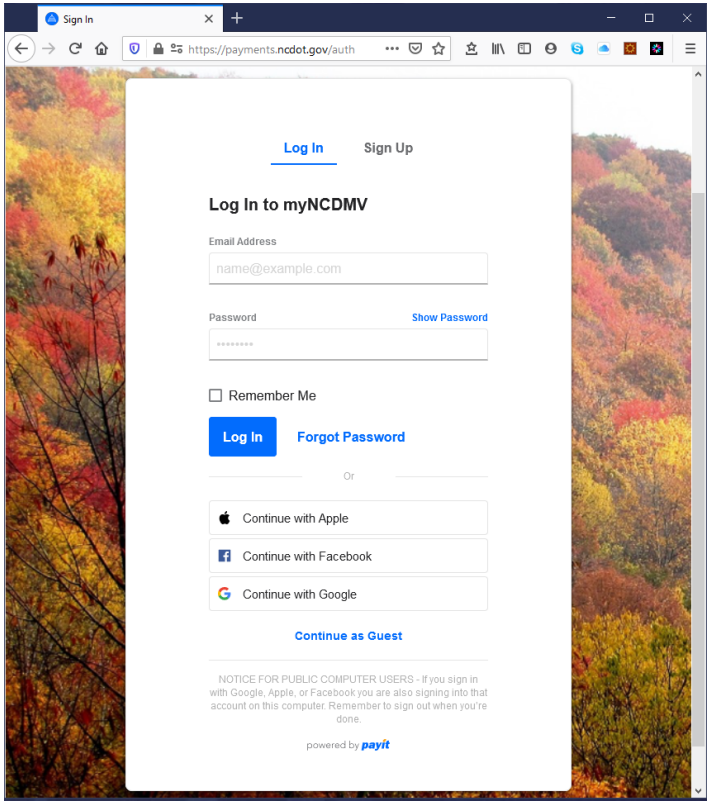
Third Party Authentication Examples





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Security token types by Liberty

Token type	How used	Pros	Cons
LTPA	Authentication technology used in IBM WebSphere	• Easy to use with WebSphere and DataPower	• IBM Proprietary token
SAML	XML-based security token and set of profiles	• Token includes user id and claims • Used widely with SoR applications	• Tokens can be heavy to process • No refresh token
OAuth 2.0 access token	Facilitates the authorization of one site to access and use information related to the user's account on another site	• Used widely for social applications e.g., with Google, Facebook, Microsoft, Twitter …	• Needs introspection endpoint to validate token
JWT	JSON security token format	• More compact than SAML • Ease of client-side processing especially mobile	

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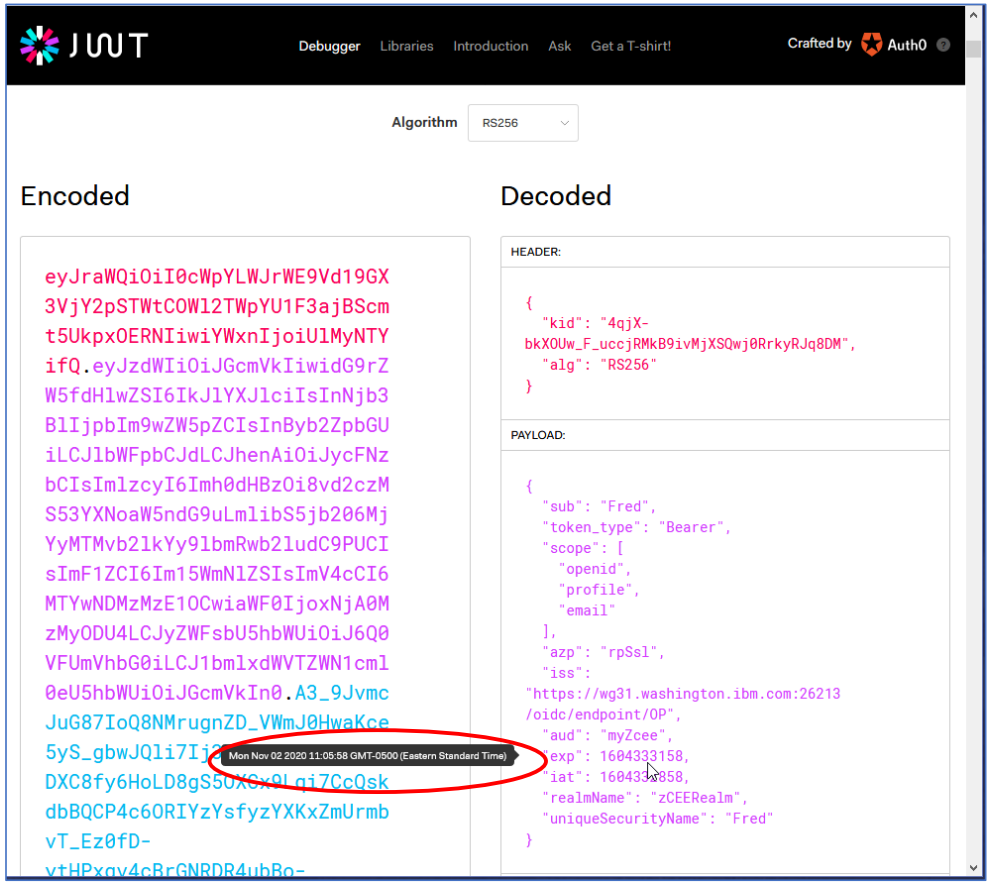
What is a JWT (JSON Web Token) ?

- 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

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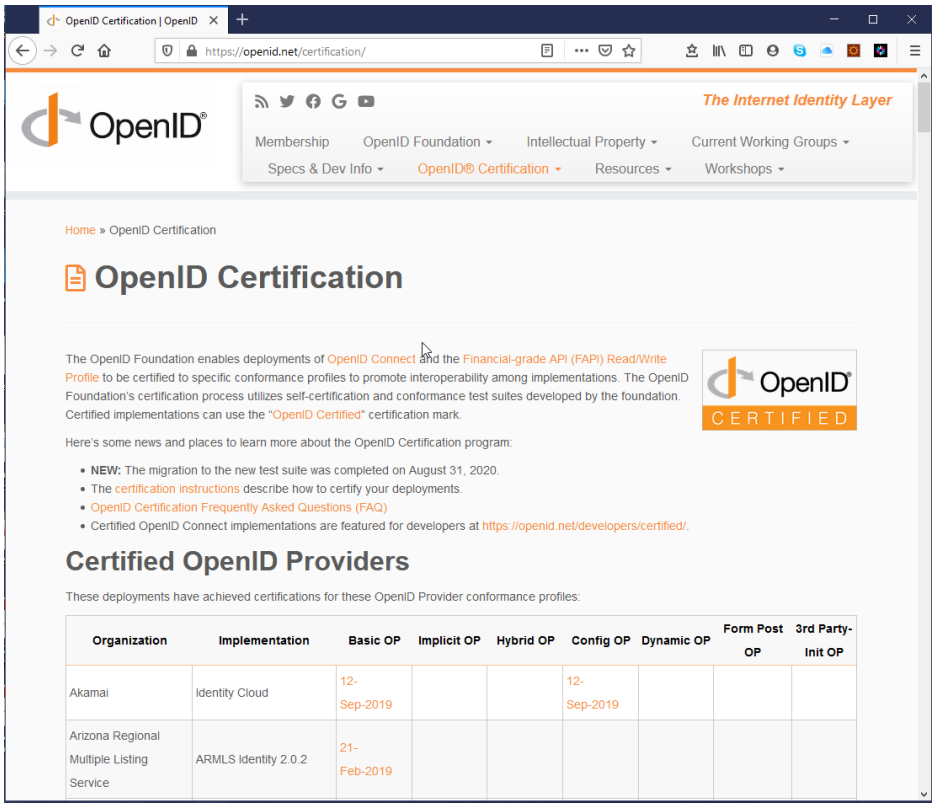
Tech-Tip: There are a multitude of OpenID Certified Providers



https://openid.net/certification/

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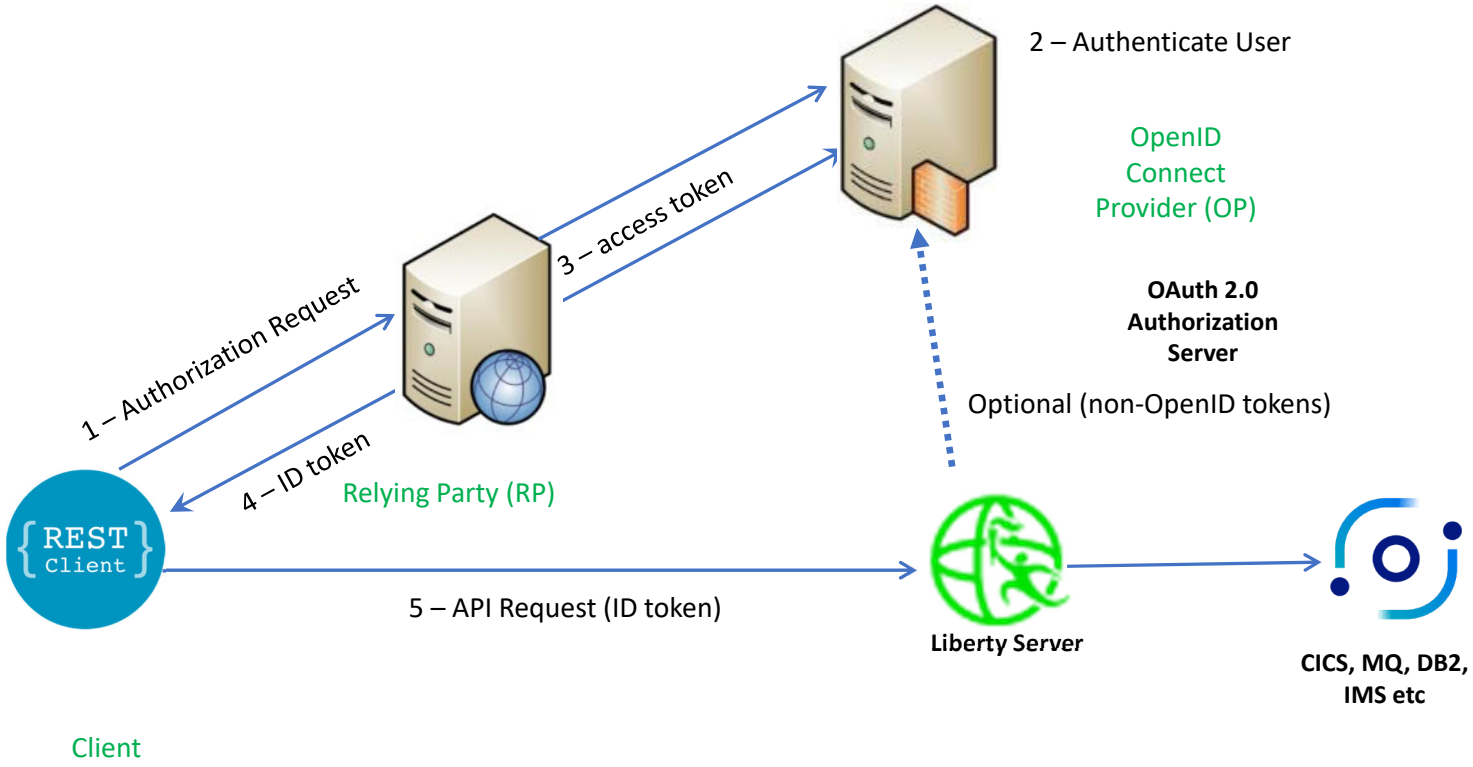
Typical Authorization Flow for am OpenID Connect token to a z/OS Connect API Provider



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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.

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Tech/Tip: Generating a JWT using Liberty s the 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')
```

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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:
  >*<
```

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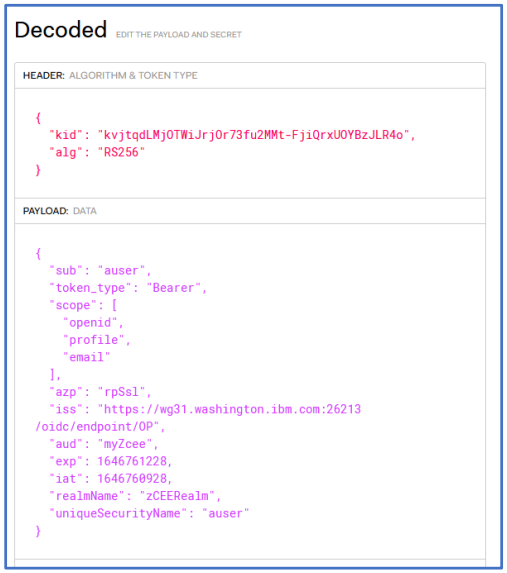
Liberty OpenID Client identity mapping configuration attributes (z/OS Connect)




```
<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.

```
<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.

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Liberty/zCEE 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"
    authFilterRef="jwkAuthFilter"
    inboundPropagation="required"
    signatureAlgorithm="RS256"
    userIdentifier="sub"
    mapIdentityToRegistryUser="true"
    issuerIdentifier=https://wg31.washington.ibm.com:26213/oidc/endpoint/OP
    disableLtpaCookie="true"
    audiences="myZcee"
    jwkEndpointUrl=https://wg31.washington.ibm.com:26213/oidc/endpoint/OP/jwk
    jwkClientId="jwtClient"
    jwkSecret="jwtSecret"/>
  </openidConnectClient>
```

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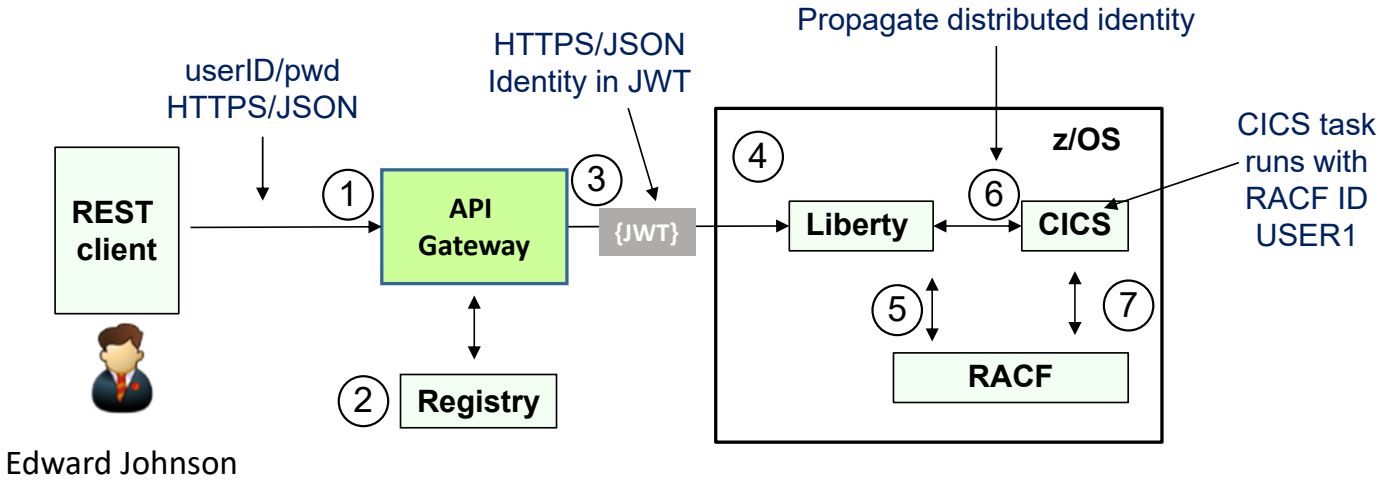
Example scenario – security flow




```
RACMAP ID(USER1) MAP USERDIDFILTER(NAME('Edward Johnson'))
REGISTRY(NAME('*'))
```

1. User authenticates with the gateway using a "distributed" identity and a password
2. An external registry is used as the user registry for distributed users and groups
3. The API Gateway generates a JWT and forwards the token with the request to z/OS Connect EE
4. Liberty validates JWT
5. Liberty calls RACF to map distributed ID to RACF user ID and authorizes access to API
6. CICS service provider propagates distributed ID to CICS
7. CICS calls RACF to map distributed ID to RACF user ID and performs resource authorization checks

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JWT used in scenario – putting it all together

```
{
  "alg": "RS256"
}
{
  "sub": "Edward Johnson",
  "token_type": "Bearer",
  "azp": "rpSsl",
  "iss": "https://wg31.washington.ibm.com:26213/oidc/endpoint/OPssl",
  "aud": "myZcee",
  "realmName": "zCEERealm",
  "uniqueSecurityName": "Edward Johnson"
}
RSASHA256(base64UrlEncode(header)+ base64UrlEncode(payload)
```

- 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

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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

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Using authorization filters

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.

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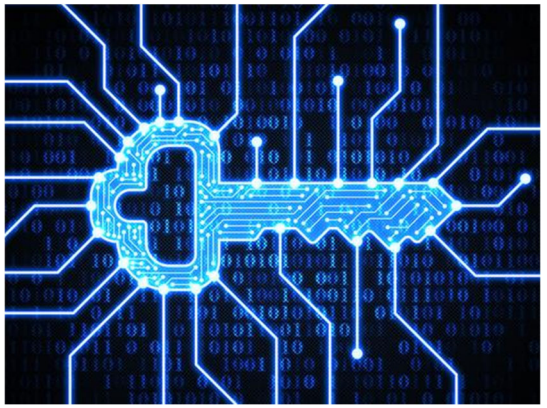
General security terms or considerations

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.



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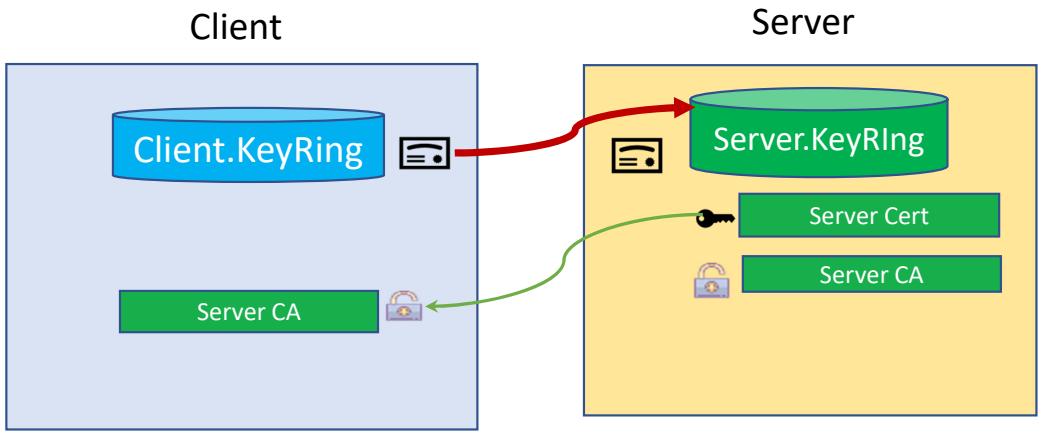
Basic TLS Handshake Flow

TLS handshake –

Encryption/Message Integrity



Client does not need a personal certificate with a private key

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

RACF FACILITY resources

- IRR.DIGTCERT.LISTRING
  - READ to list your own key ring
  - UPDATE to list another user's key ring
- IRR.DIGTCERT.LIST
  - READ to list your own certificate
  - UPDATE to list another user's certificate
  - CONTROL to list SITE of CERTAUTH certificates

Certificate with a private key*

Certificate Authority (CA) certificate chain#

*For server and/or mutual authentication to work, the endpoint sending its server or 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 all the way to the root CA.

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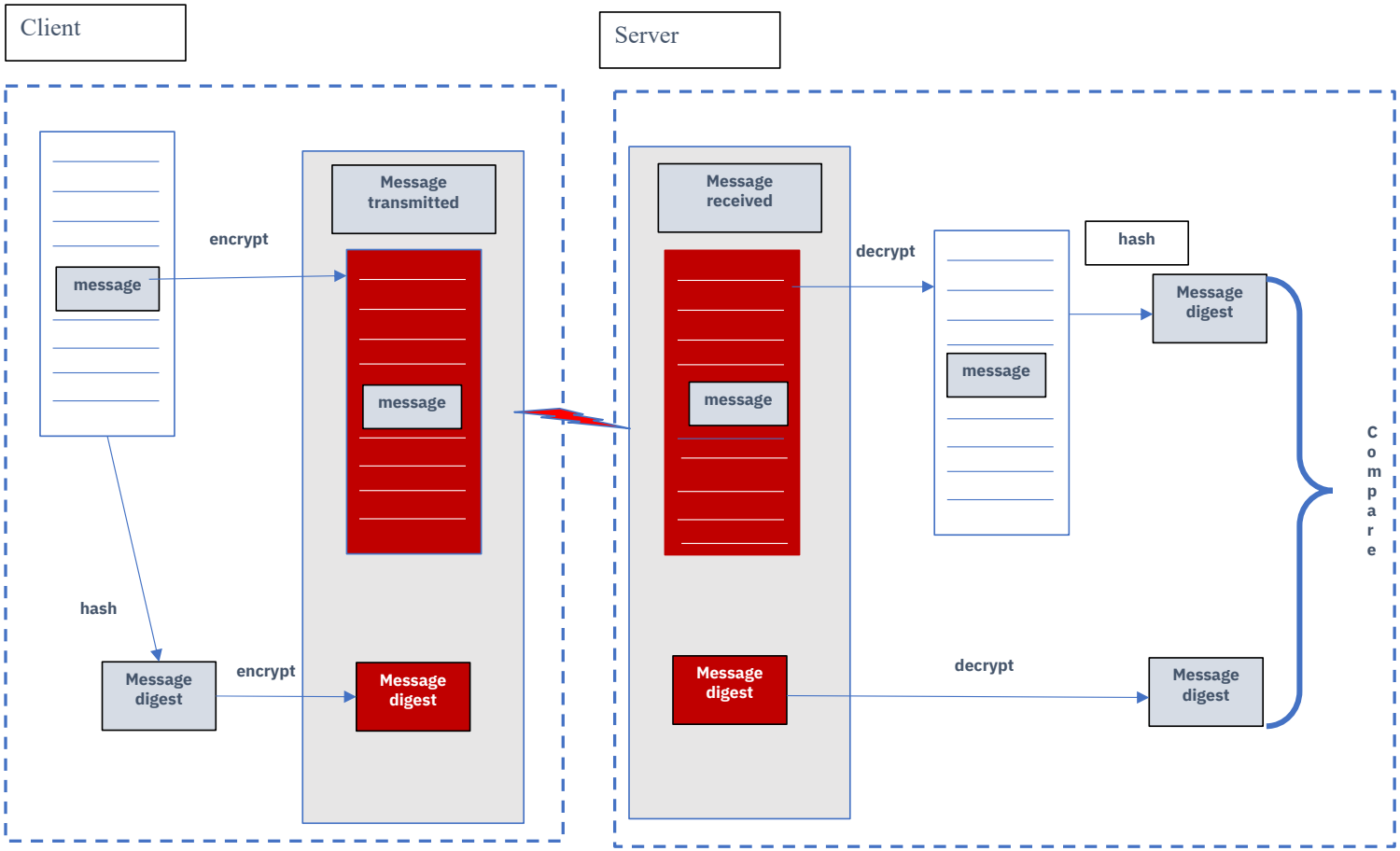
Message Integrity and Encryption (client to server endpoint)



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z/OS Connect Security server XML Configuration (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"
    <apiRequester name="cscvincapi_1.0.0"
        requireAuth="true"
        requireSecure="true|false"/>
 </zosconnect_apiRequesters>
```

Globally, requires that inbound request using HTTPS in order to access APIs, services and API requesters, unless overridden on the specific resource definitions.

Requires that inbound request use HTTPS in order to access the API.

Requires that inbound request use HTTPS when directly accessing this service.

Requires that all inbound request for this API requester use HTTPS.

requireSecure="true" means the inbound TLS connection must be using HTTPS

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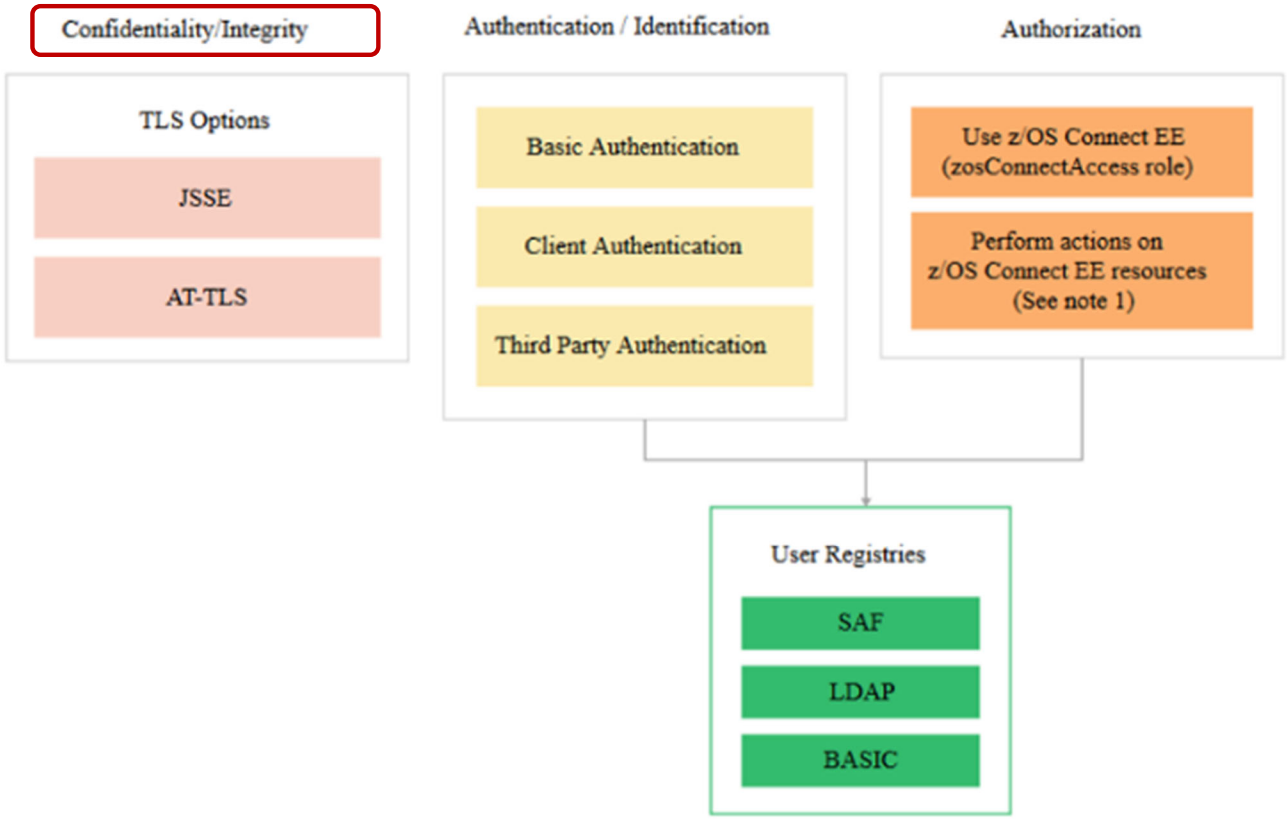
Liberty and z/OS Connect EE security options



The actions which can be controlled by authorization are deploying, querying, updating, starting, stopping and deleting of APIs, services and API requesters.

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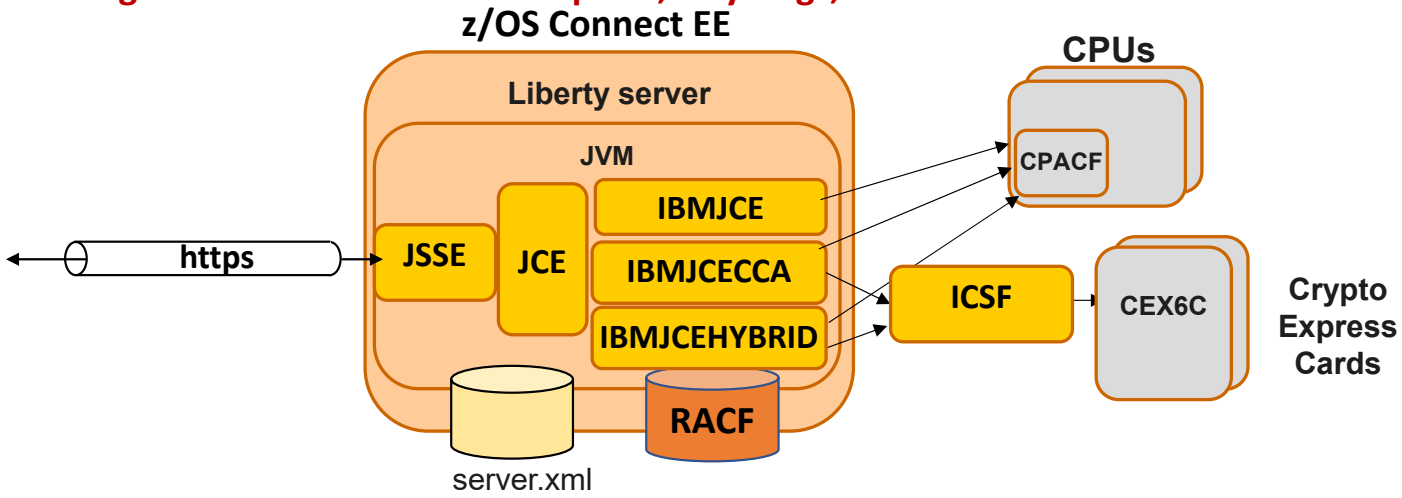
Using JSSE with Liberty

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



- 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.

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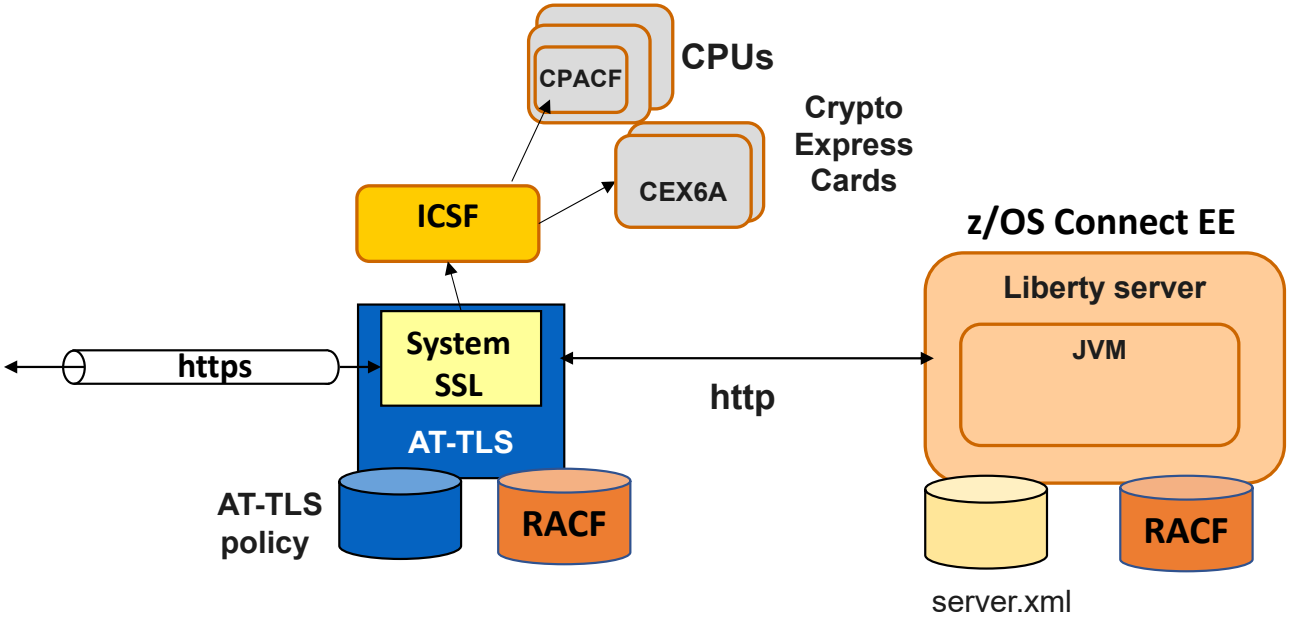
Using AT-TLS with Liberty

The server XML configuration uses no 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

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JSSE and AT-TLS comparison

Capability	Description	JSSE	AT-TLS
Server authentication	Verification of z/OS Connect server certificate by client	Yes	Yes
Mutual authentication	Verification of client certificate by z/OS Connect	Yes	Yes
TLS client authentication	Use of client certificate for authentication	Yes	**No**
Support for requireSecure option on APIs, etc.	Requires that API requests are sent over HTTPS	Yes	**No**
Persistent connections	To reduce number of handshakes	Yes	Yes
Re-use of TLS session	To reduce number of full handshakes	Yes	Yes
Shared TLS sessions	To share TLS sessions across cluster of z/OS Connect instances	**No**	Yes
zIIP processing	Offload TLS processing to zIIP	Yes	**No**
CPACF	Offload symmetric encryption to CPACF	Yes	Yes
CEX6	Offload asymmetric operations to Crypto Express cards	Yes	Yes

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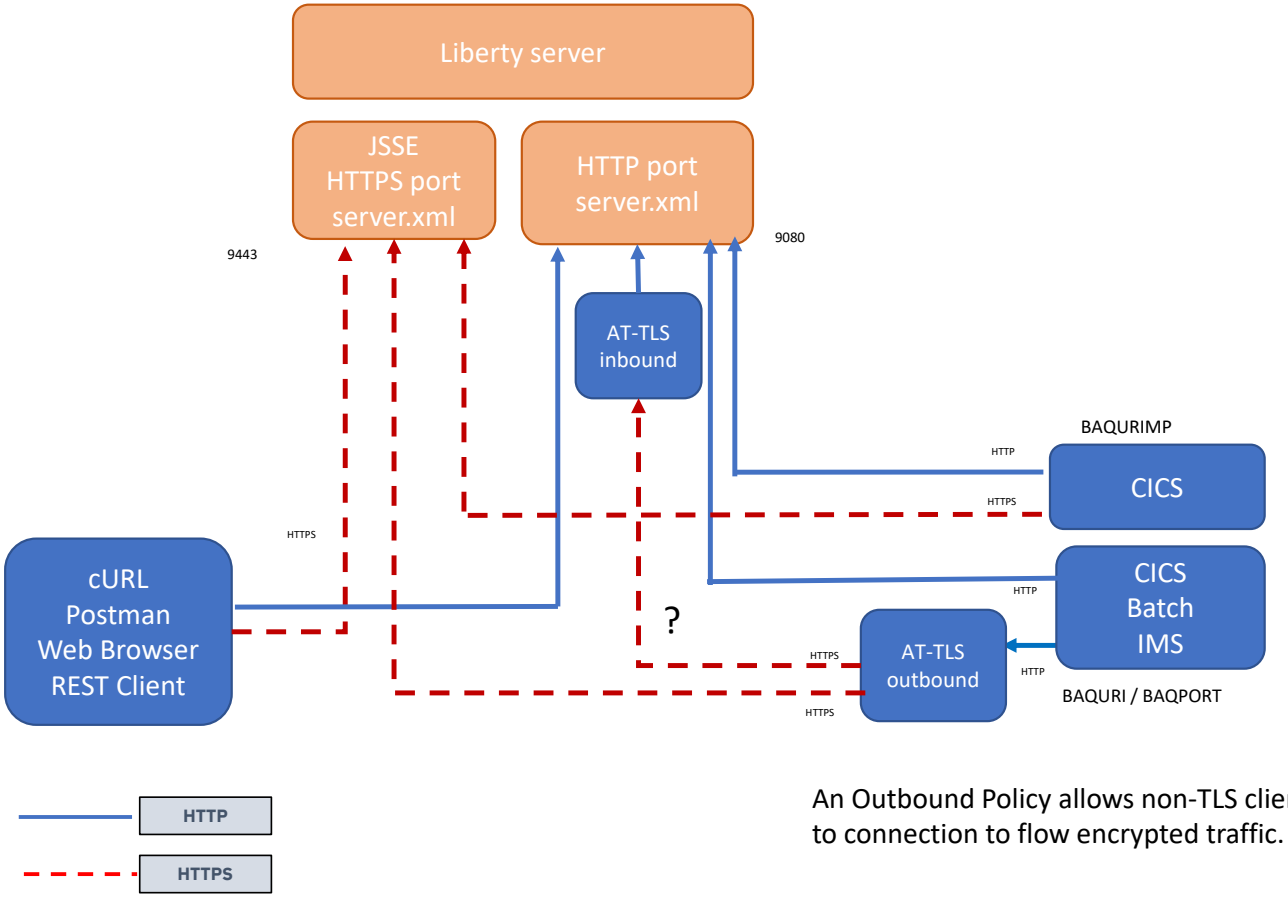
TLS client encryption to a Liberty server scenarios



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

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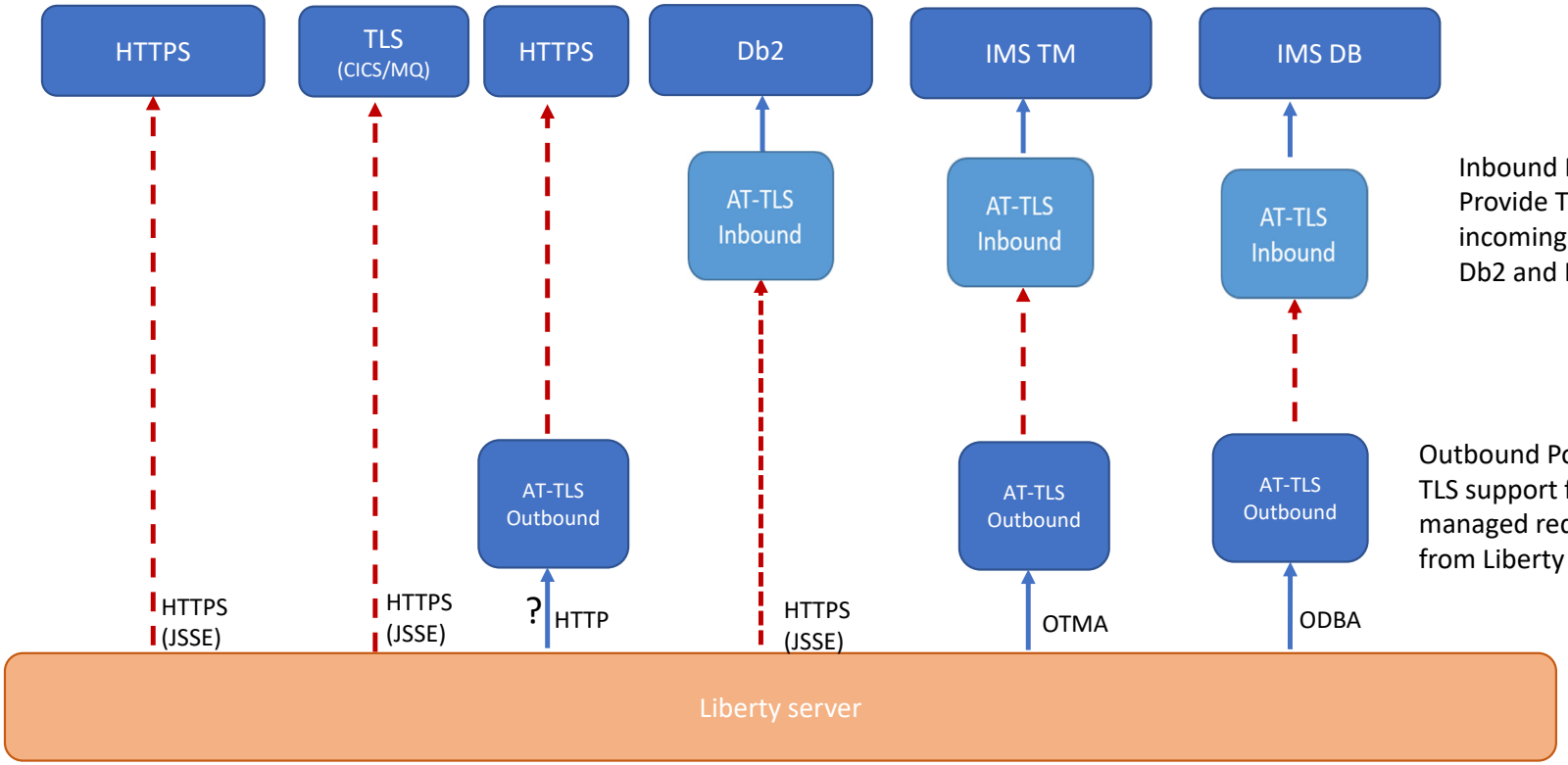
TLS encryptions from a Liberty server (HTTPS/native to HTTPS/TLS/OTMA/ODBA)



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

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

Let's explore TLS options using the contents of these key rings

Liberty's outbound key ring

Liberty's inbound key ring

```
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.

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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" />
```

SSL repertoires

```
<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

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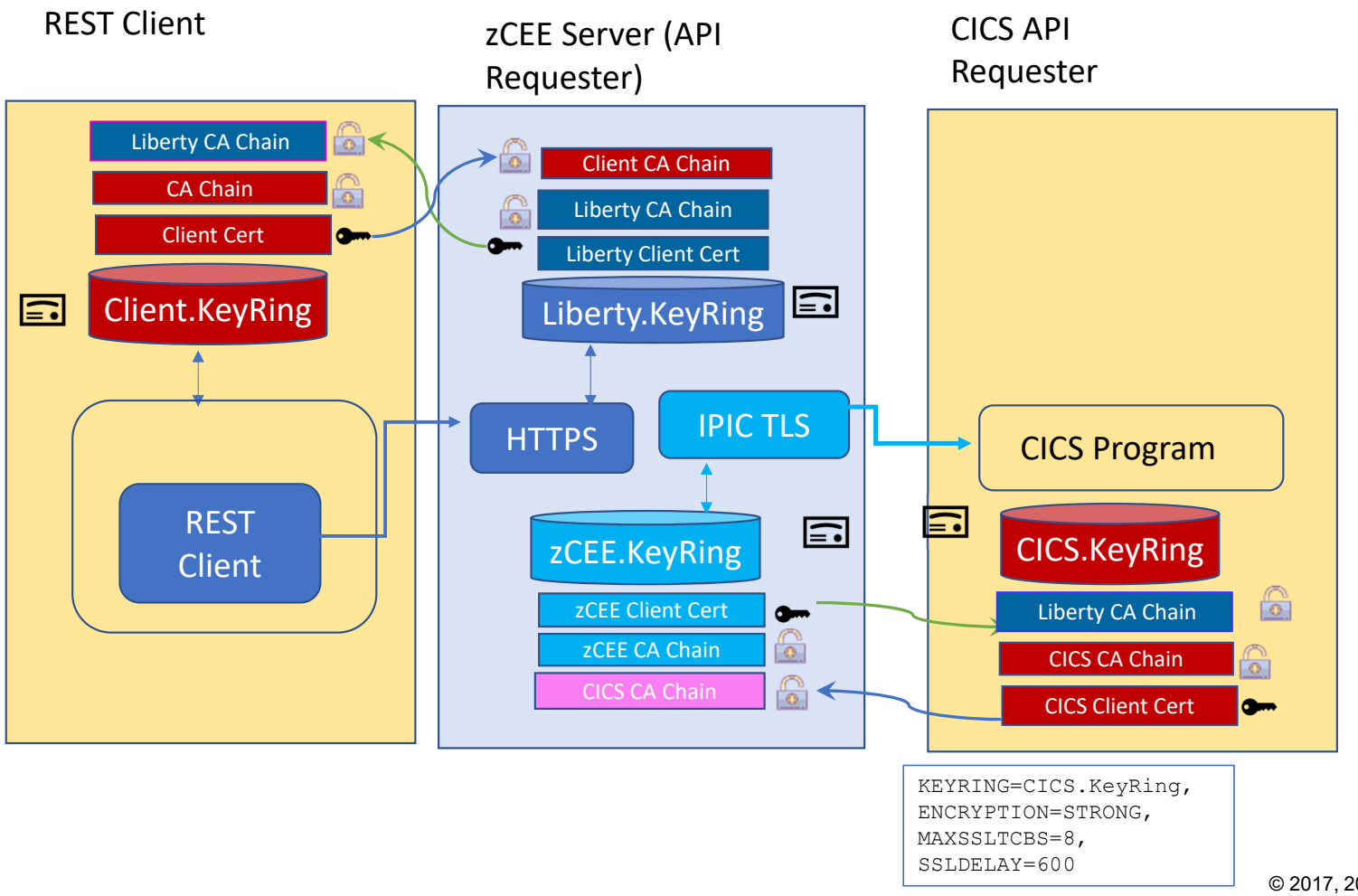
TLS handshake scenario (IPIC TLS)



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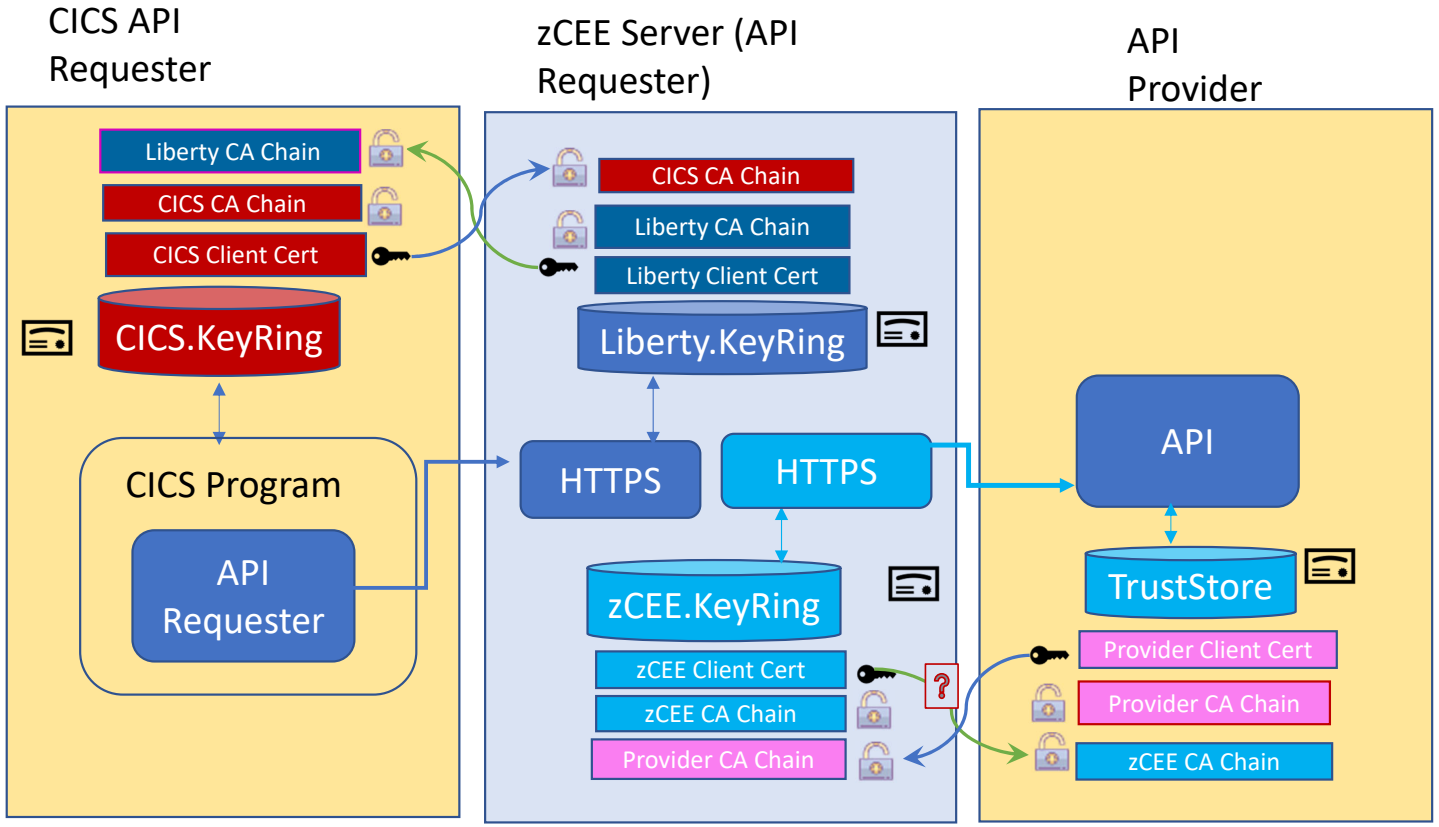
TLS handshake scenario (multiple handshakes)



Tech/Tip: This is perhaps the best way to enable group member authorization from a CICS region to a z/OS Connect server.

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

Tech-Tip: The use of HTTPS is not required and can be intermixed with HTTP.

? Remember, TLS encryption is independent of TLS authentication. So mutual authentication may not be needed.

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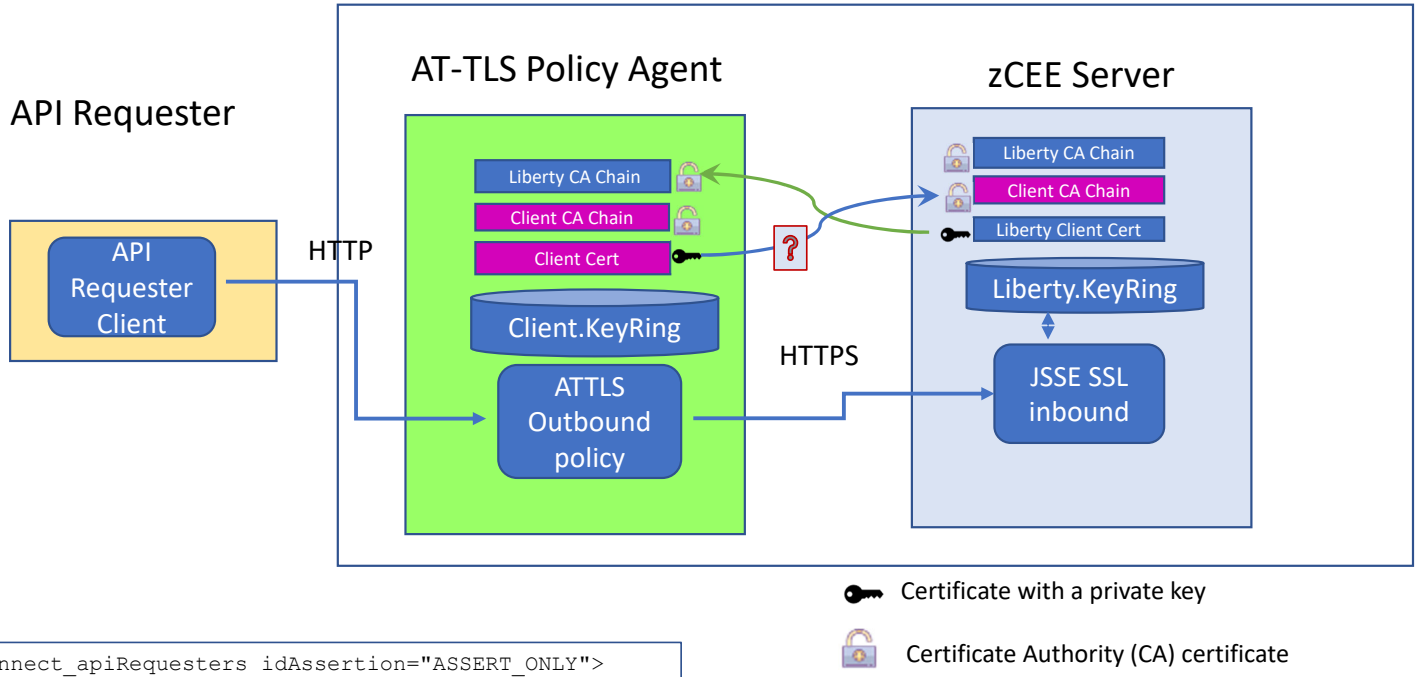
AT-TLS - outbound policy handshake scenarios

Policy Agent uses an outbound policy and acts a surrogate TLS client




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

Question if this really needed, remember TLS encryption is independent of TLS authentication.

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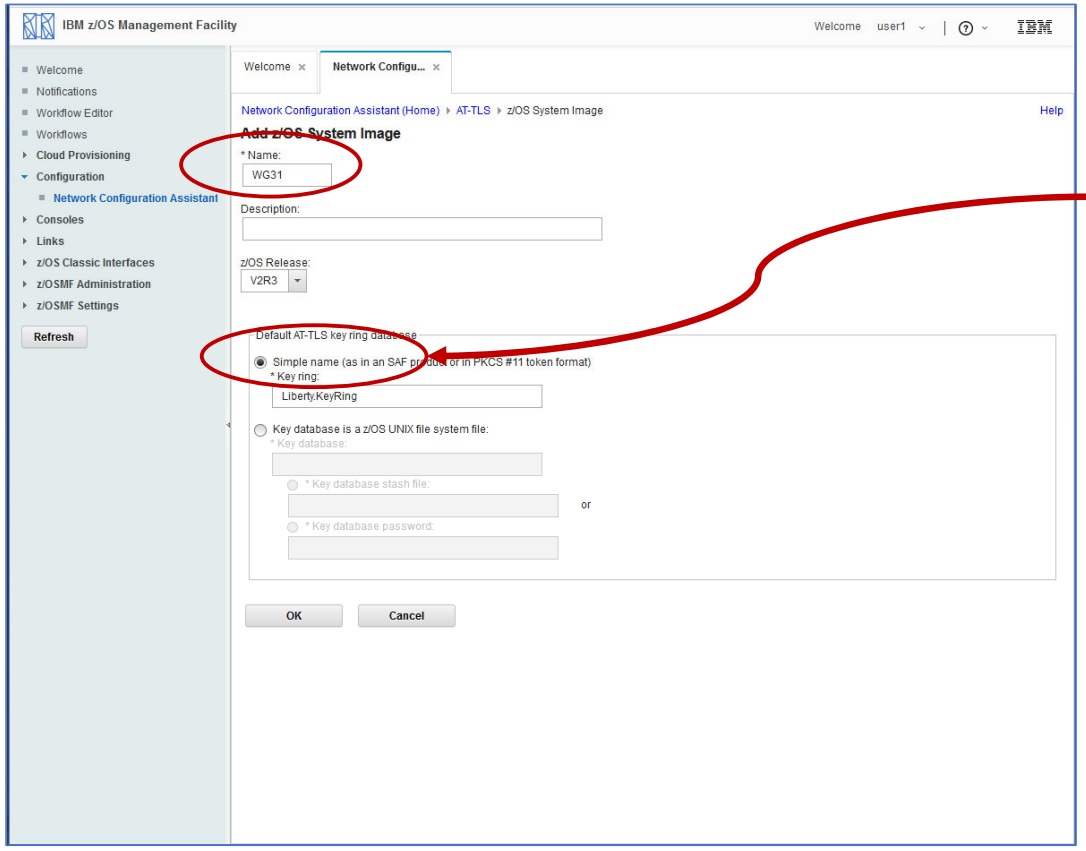
AT-TLS – setting a default key ring

Using zOSMF Network Configuration Assistant to provide default Key Ring name



An SAF key ring name is specified as “identity/keyring". The identity of the current client is used if the identity field is omitted.

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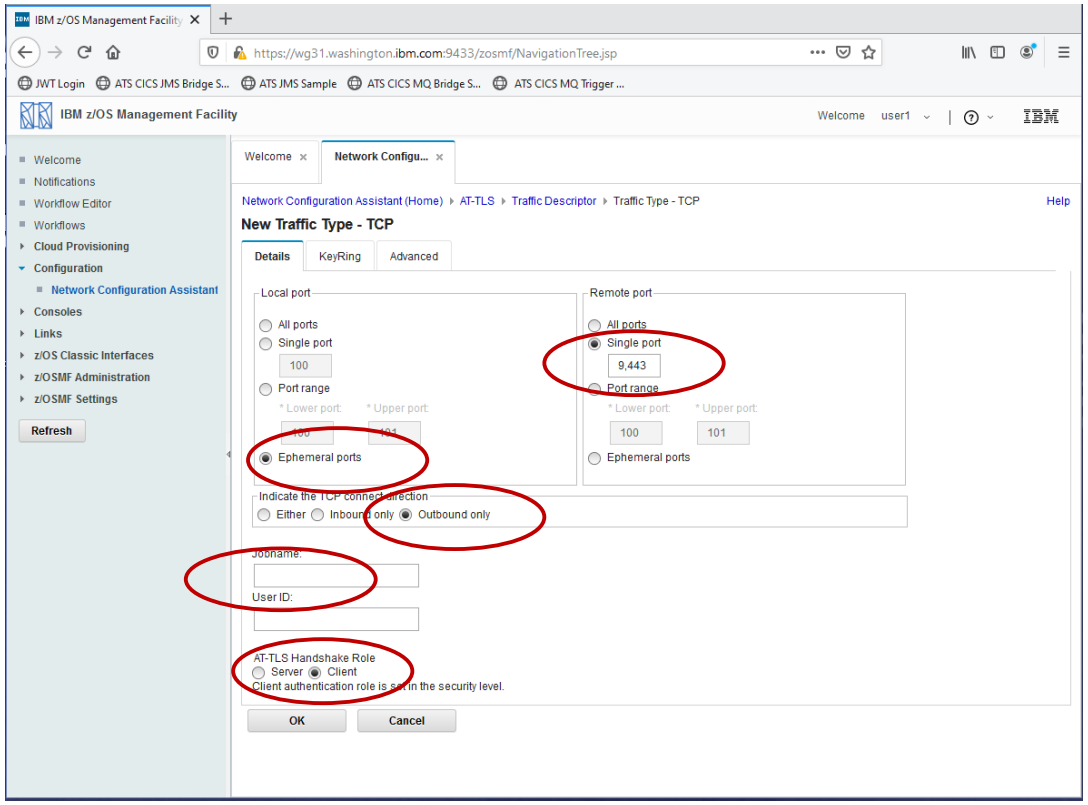
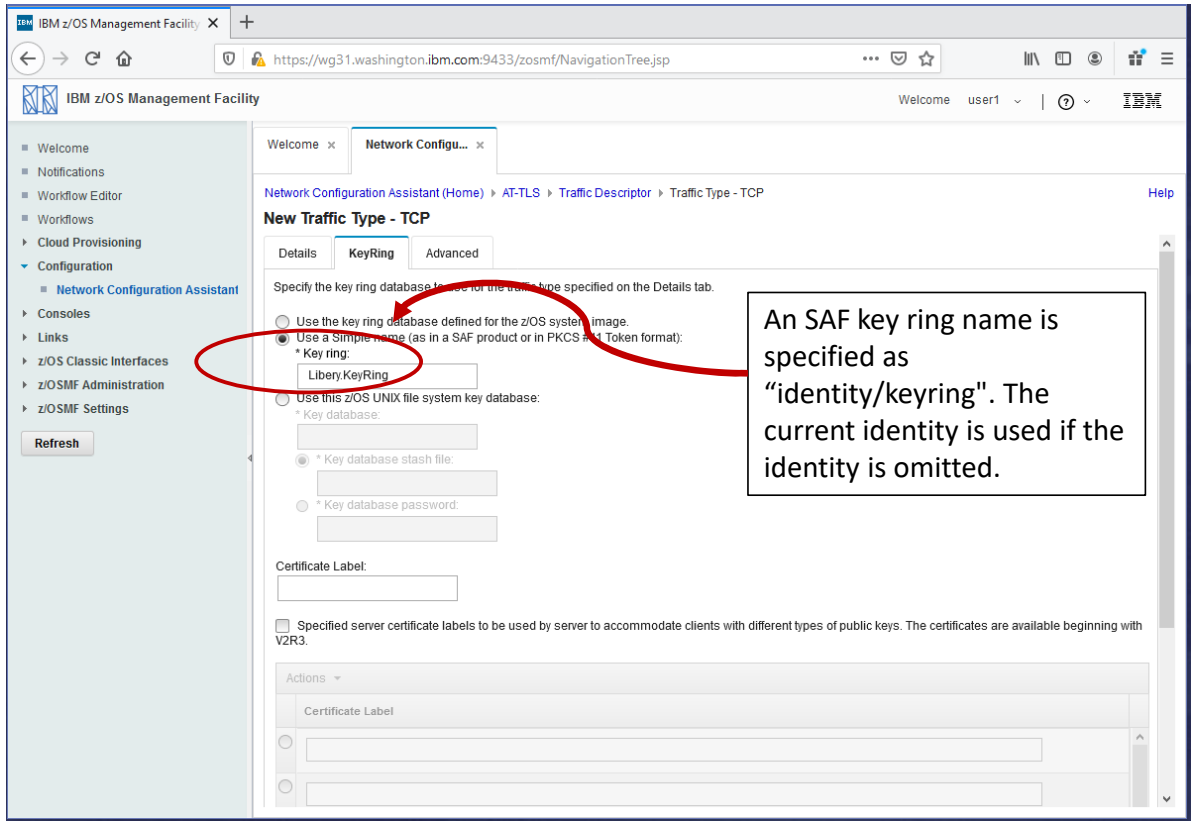
AT-TLS – configuring an outbound policy

Using zOSMF Network Configuration Assistant to configure traffic descriptor



AT-TLS - setting a policy key ring

Using zOSMF Network Configuration Assistant to **traffic descriptor** Key Ring name



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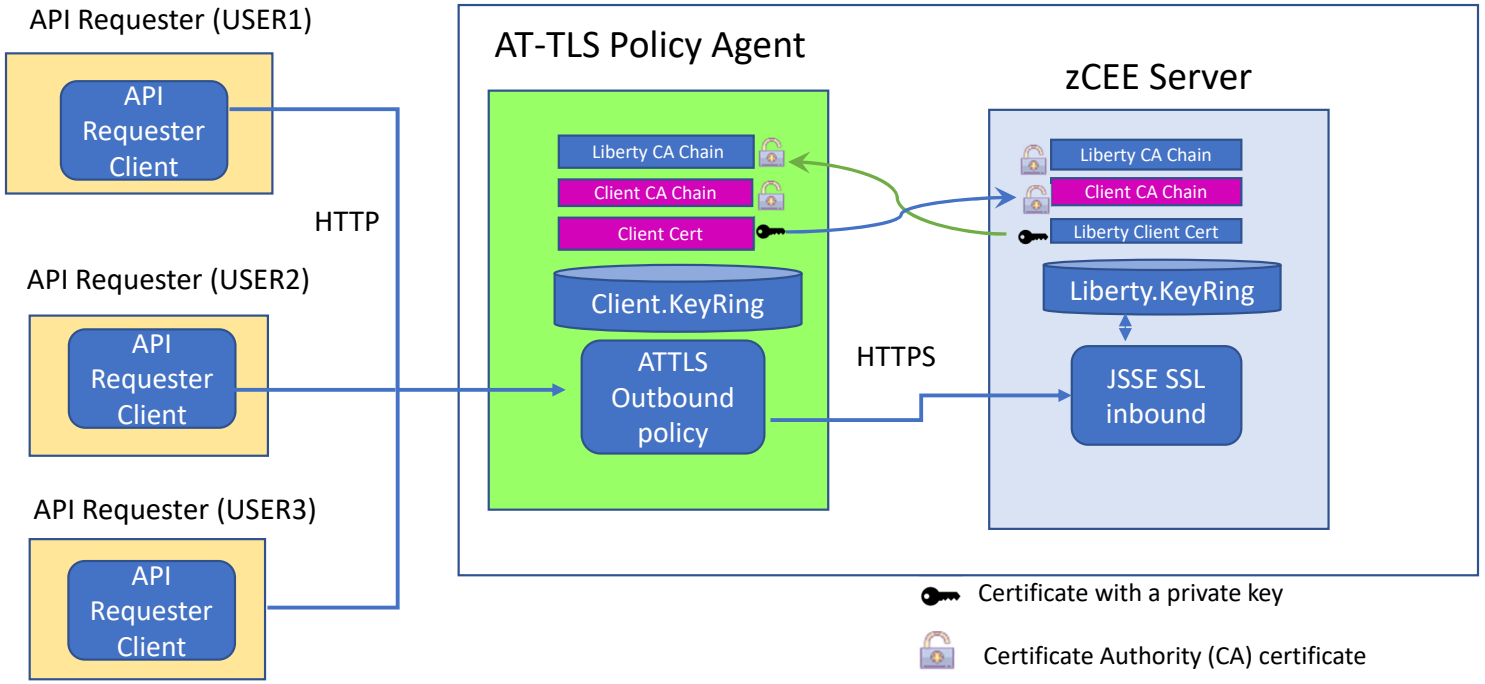
AT-TLS - outbound policy handshake scenario

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.

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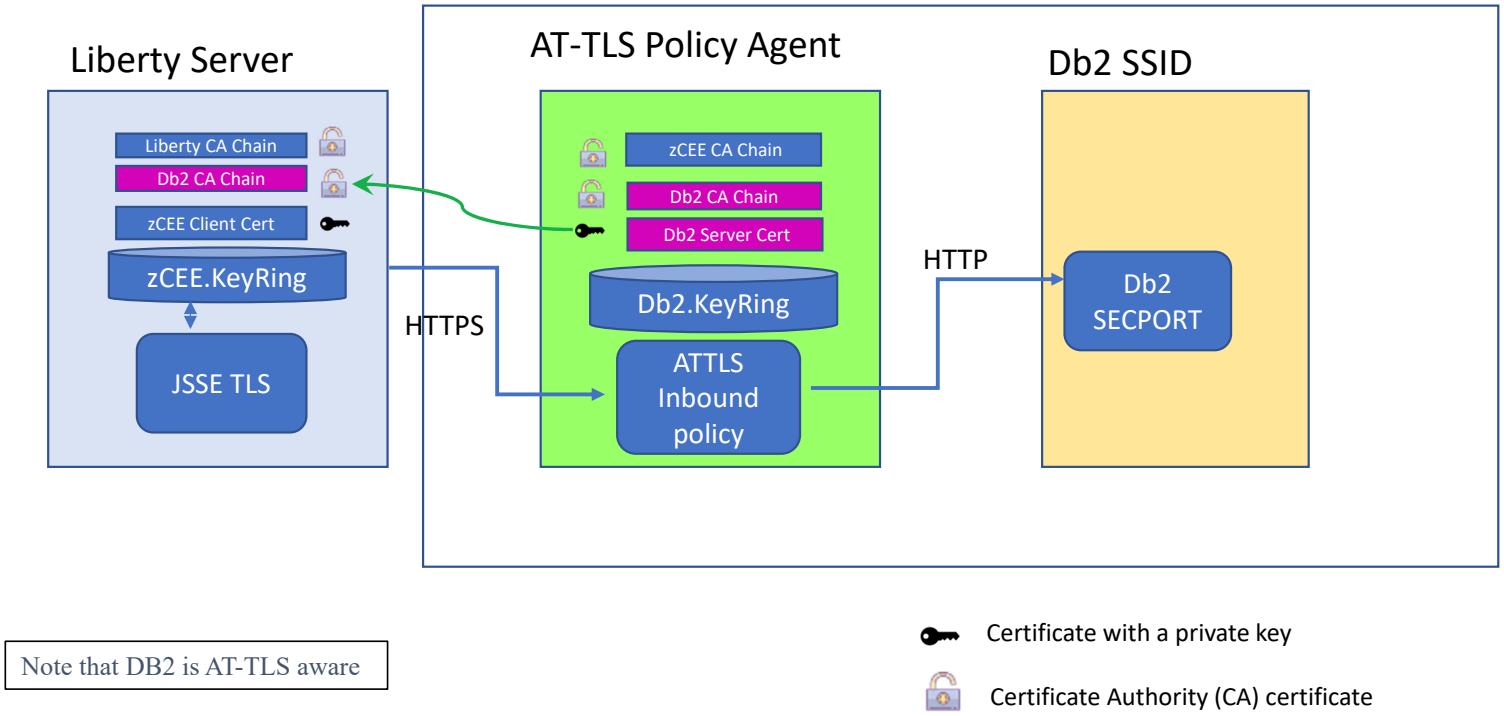
AT-TLS - inbound policy handshake scenario (Db2)

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



Note that DB2 is AT-TLS aware

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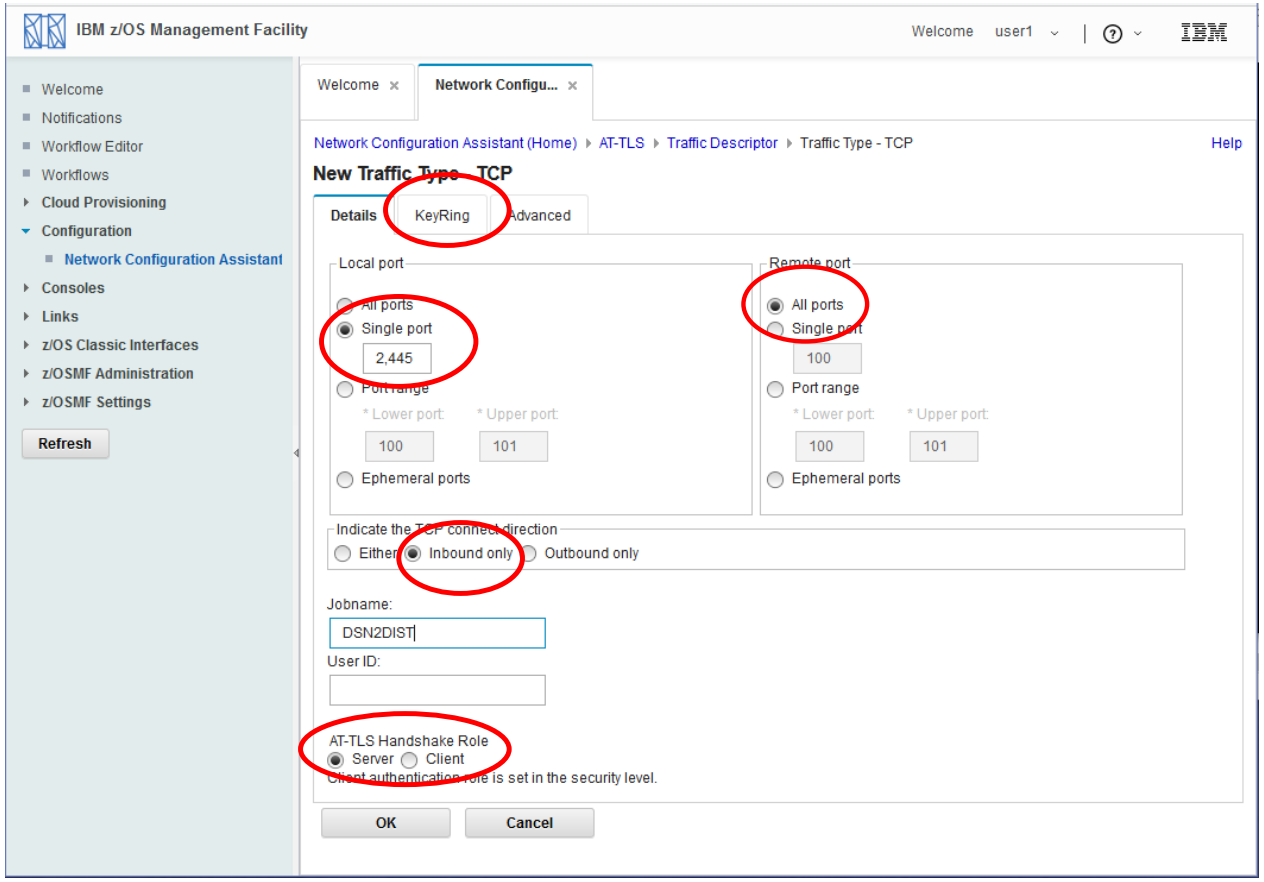
AT-TLS – configuring an inbound policy

Using zOSMF Network Configuration Assistant



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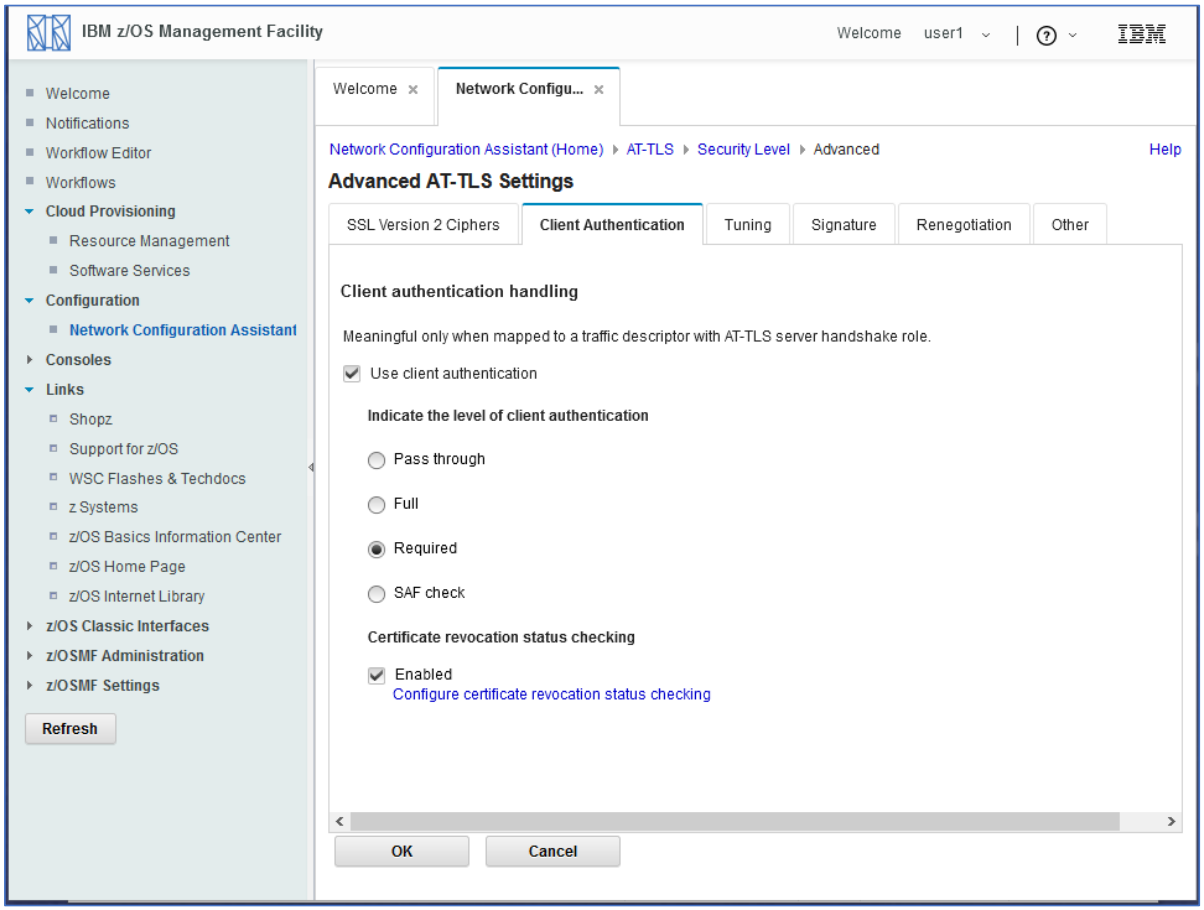
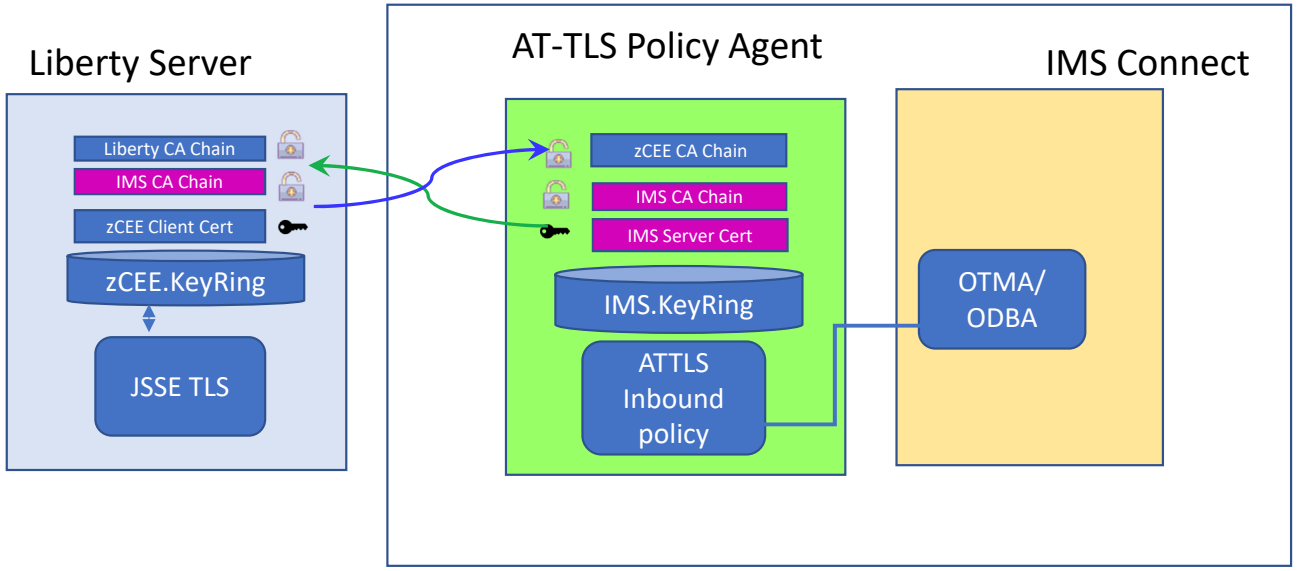
AT-TLS – configuring client authentication

Using zOSMF Network Configuration Assistant (mutual authentication)



AT-TLS multiple policies handshake scenario (IMS)

Policy Agent uses both inbound and outbound policies and acts a surrogate TLS client with one and a TLS server with the other



Question if this really needed, TLS encryption is independent of TLS authentication. Use PassTickets to assert identity.

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Configuring TLS Encryption with JSSE

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

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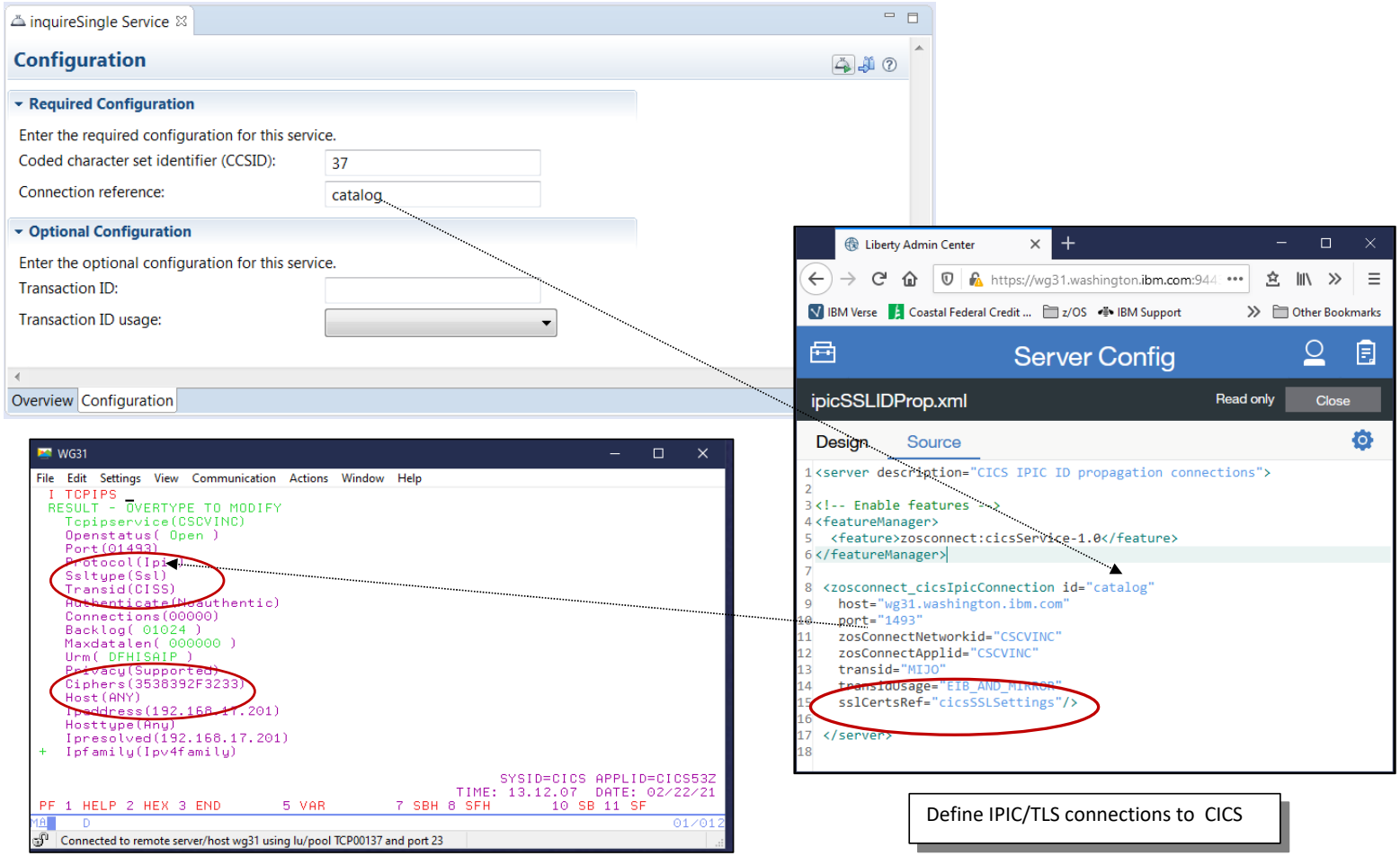
CICS IPIC using TLS

The server.xml file is the key configuration file:



Define IPIC/TLS connections to CICS

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

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

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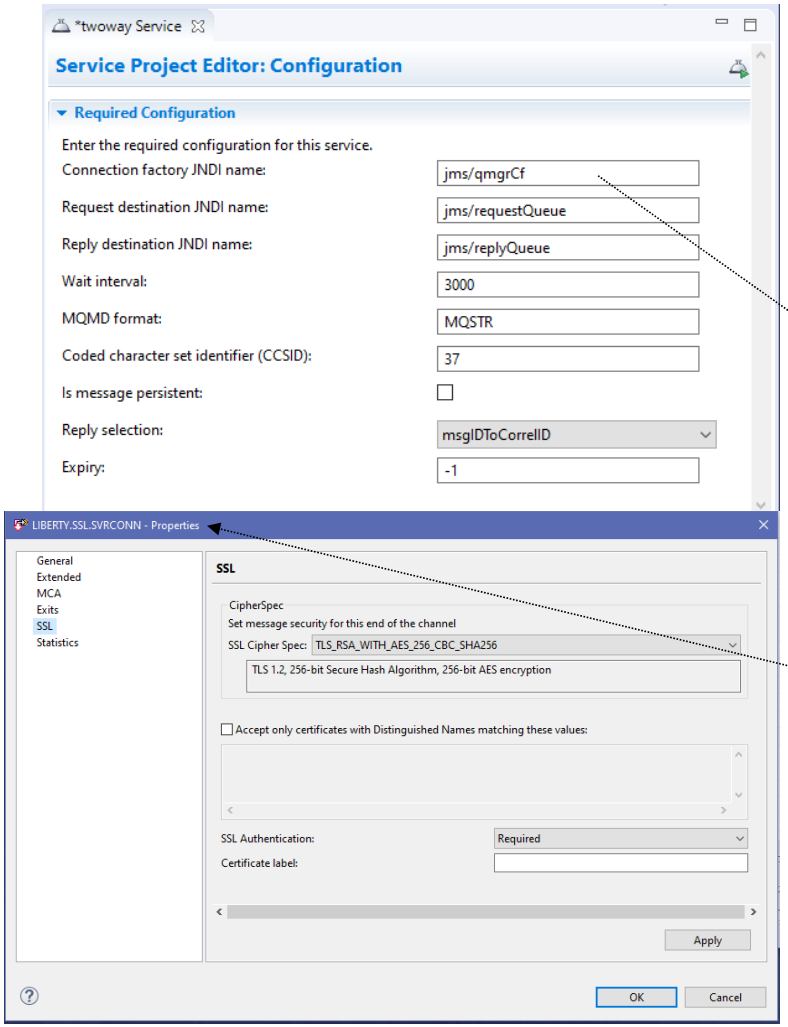
MQ JMS using TLS

The server.xml file is the key configuration file:



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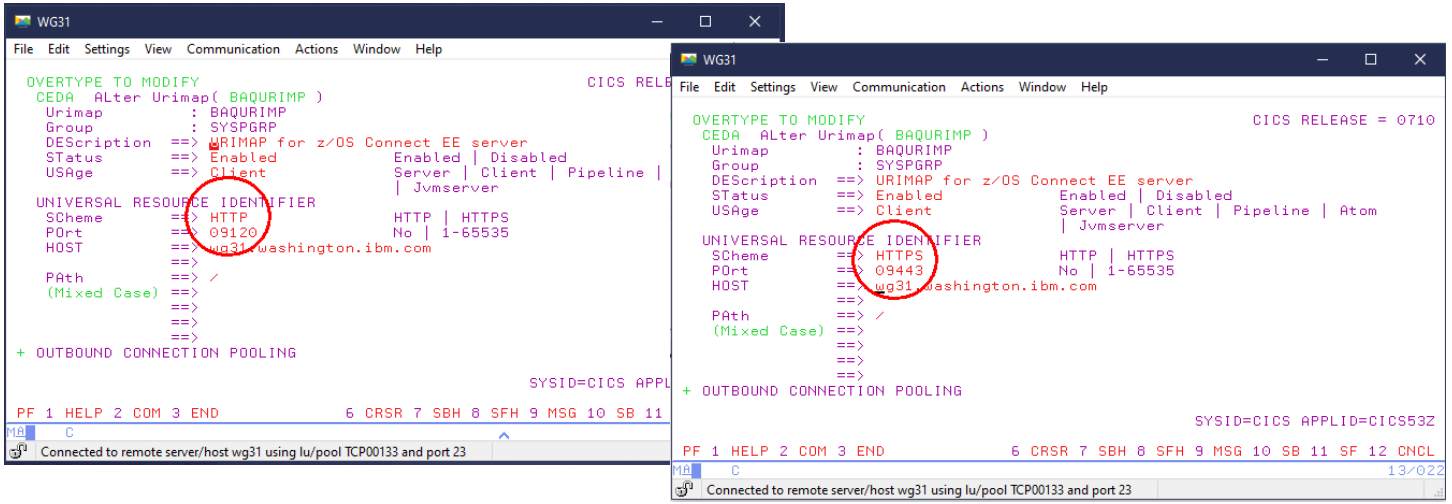
Tech/Tip: API Requester - HTTP v HTTPS

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.

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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

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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)
- TLS session ids are not shared across z/OS Connect servers

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Tech/Tip: Enabling hardware cryptography key rings

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

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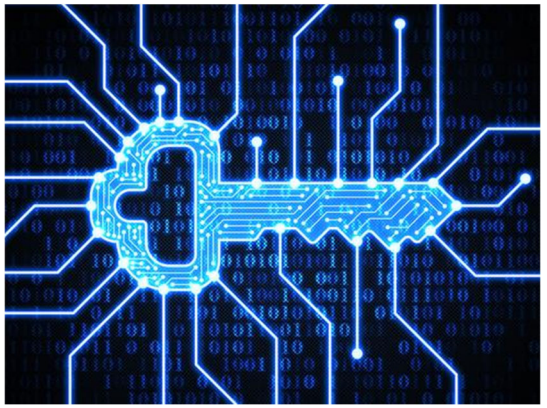
General security terms or considerations

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.



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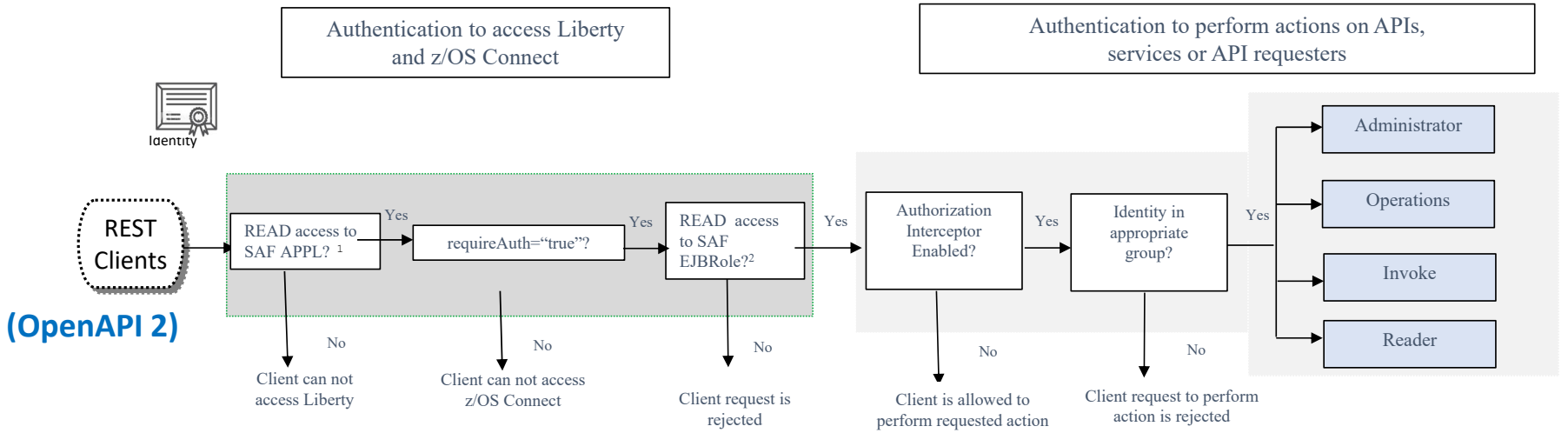
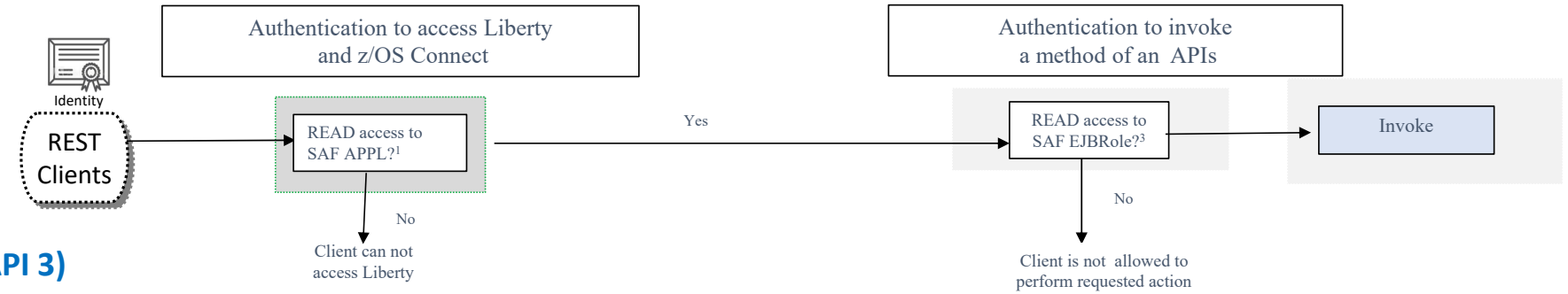
Authorization

Once we have an identity, then what?

Security flow with z/OS Connect EE



(OpenAPI 2)



(OpenAPI 3)

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

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EJB roles for z/OS Connect EE (OpenAPI 3)

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

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

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

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

*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*

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.*

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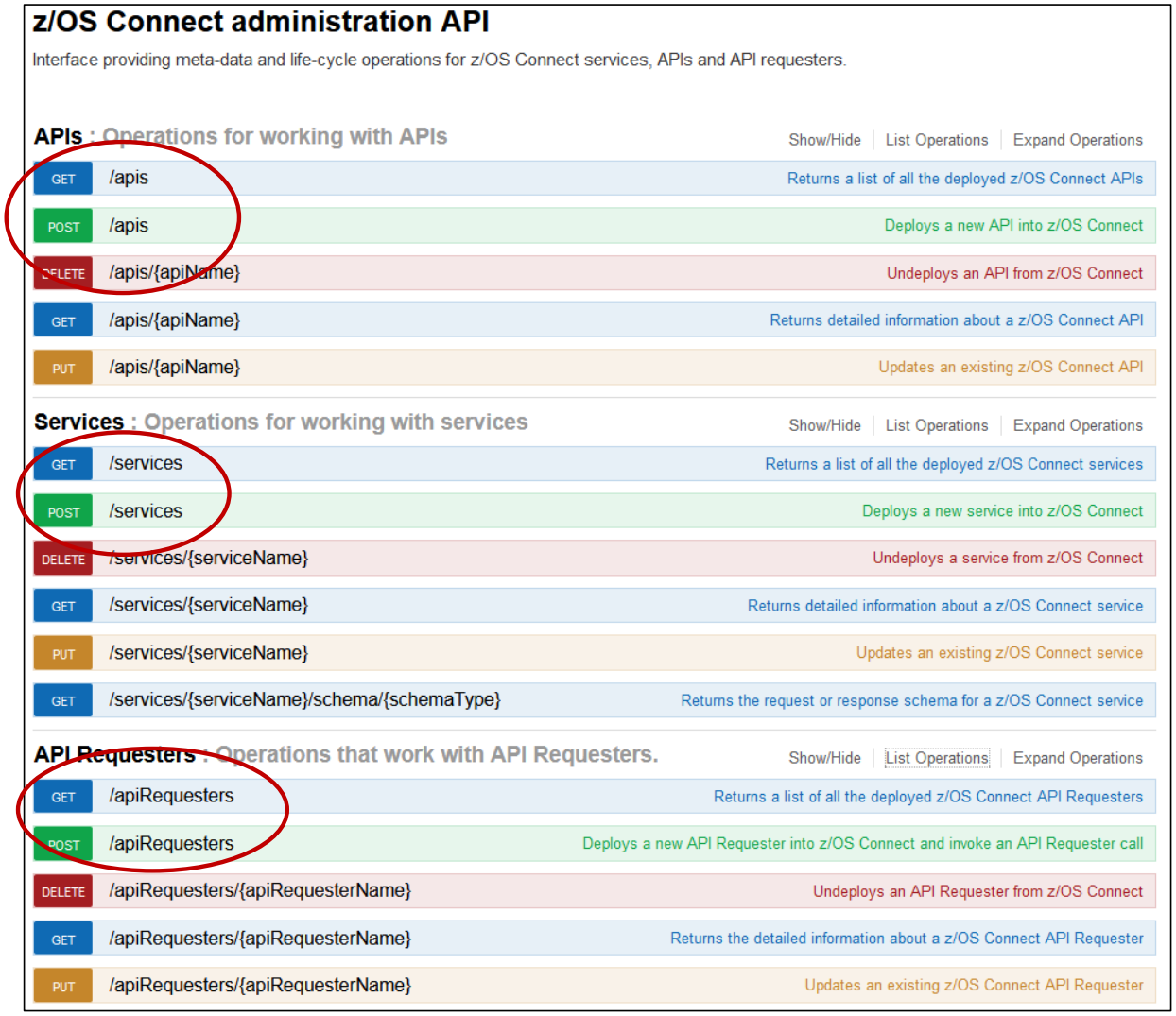
(OpenAPI 2)



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

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z/OS Connect Authorization Functions (OpenAPI 2)

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 ignored. 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).

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z/OS Connect Authorization Levels (OpenAPI 2)

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.

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z/OS Connect RESTful Administrative APIs Security (OpenAPI 2)

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"/
```

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Interceptor - server XML example (OpenAPI 2)

```
<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>
```

```
ADDGROUP SYSPGRP OMVS(AUTOGID)*
ADDGROUP GBLINVKE OMVS(AUTOGID) *
CONNECT FRED GROUP(SYSPGRP)
CONNECT USER1 GROUP(GBLINVKE)
```

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

*RDEFINE FACILITY BPX.NEXT.USER APPLDATA('2001/201')

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Tech/Tip: Server XML example – combining TLS/AUTH interceptor (OpenAPI 2)

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

<zosconnect_authorizationInterceptor id="auth"/>
<zosconnect_zosConnectInterceptors id="interceptorList_g"
         interceptorRef="auth"/>

  <zosconnect_apiRequesters>
     <apiRequester name="cscvincapi_1.0.0"
         requireSecure="false"
         invokeGroup="iaprgrp1"/>
  </zosconnect_apiRequesters>
```

Global TLS security and authentication are enabled.

TLS security is disabled for this API requester archive artifact. Avoiding the HTTP 302 REDIRECT error.

This configuration would allow a MVS batch job to authenticate to z/OS Connect and use HTTP for the protocol (when an AT-TLS outbound policy is not available). Only authorization identities which are members of groups identified as administrators or invokers would be authorized to invoke this API requester.

F BAQSTRT,ZCON,CLEARSAFCACHE

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Example of z/OS Connect Authorization Levels (Open API 2) (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.

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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.

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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.

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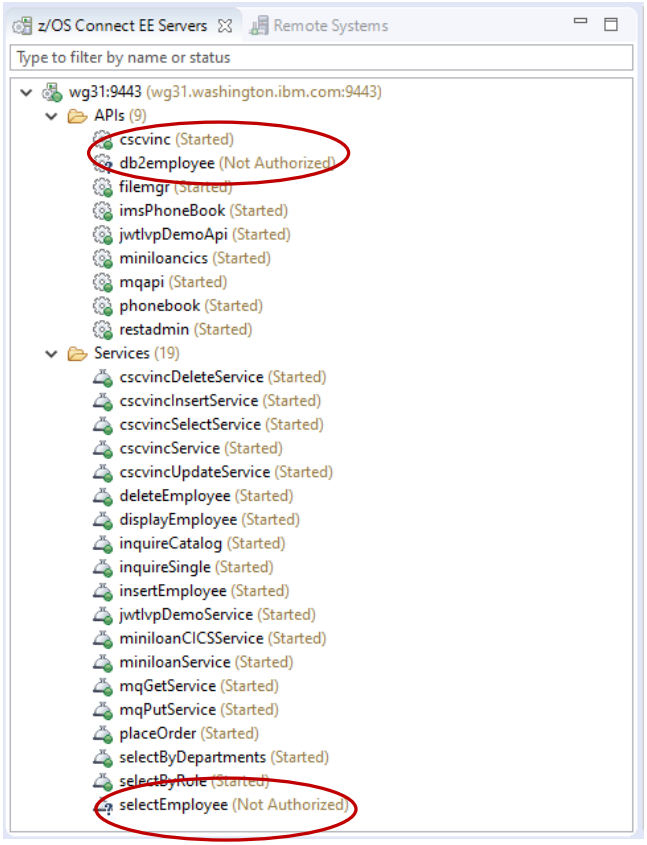
When a partial list of subordinate groups are provided, the corresponding default global groups for the absence groups are used.

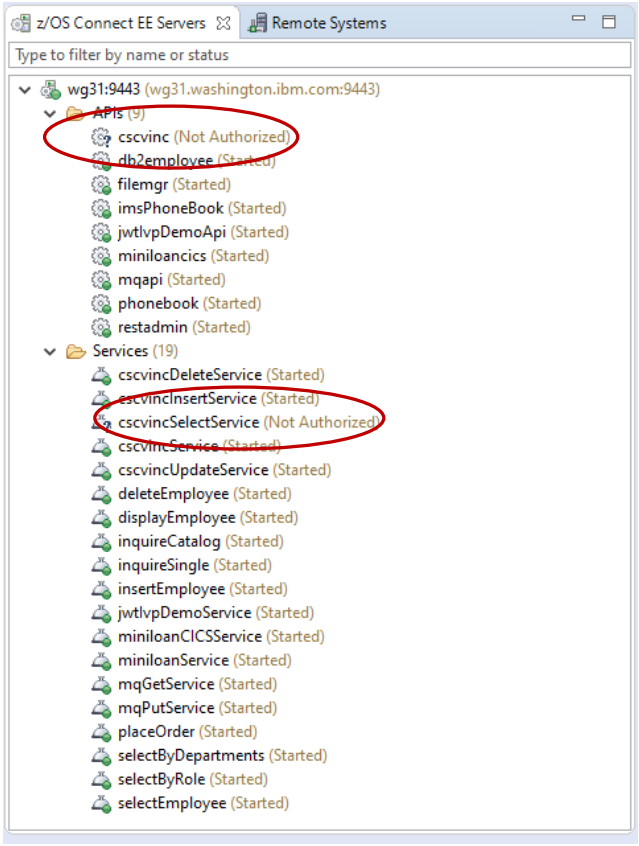
Tech-Tip: z/OS Toolkit and authorization status (OpenAPI 2)

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

CSCOPERS



DB2OPERS



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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>

<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"/>

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

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

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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

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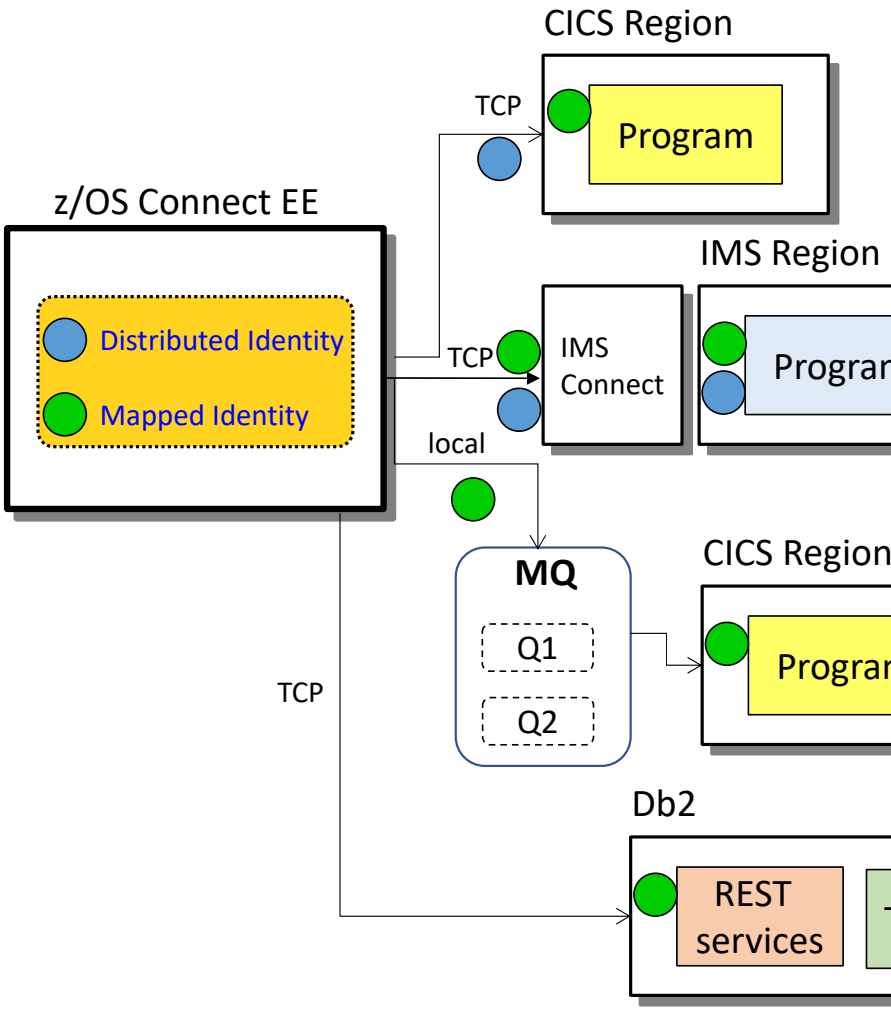
Flowing an identity to a back-end subsystem



The CICS SP propagates the distributed id to CICS (or sends the SAF id if it has been used for authentication)

The IMS SP can request a PassTicket and send the PassTicket to IMS Connect (available in V3.0.33)

The MQ SP asserts the mapped id to MQ

The REST client SP can request a PassTicket and send with mapped ID to Db2 (available in V3.0.15)

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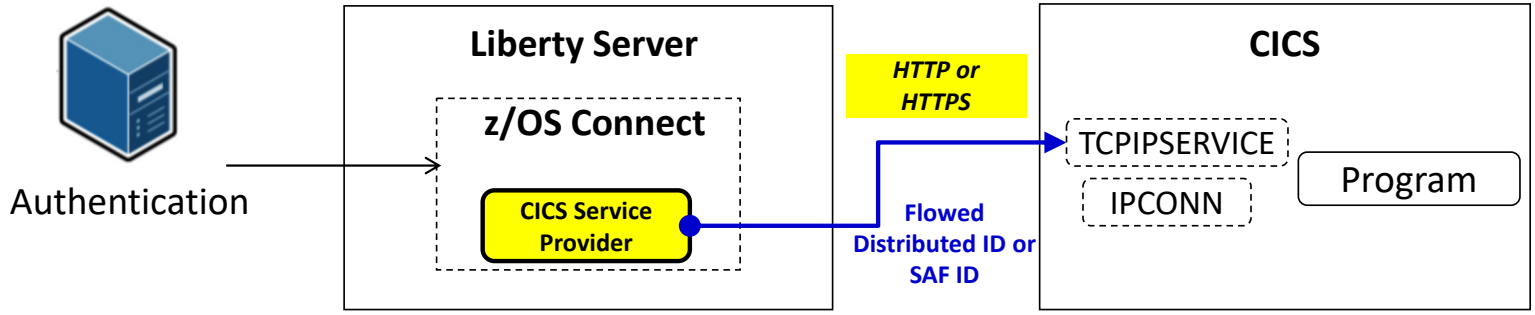
Flowing a user ID with CICS service provider



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 EE 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.

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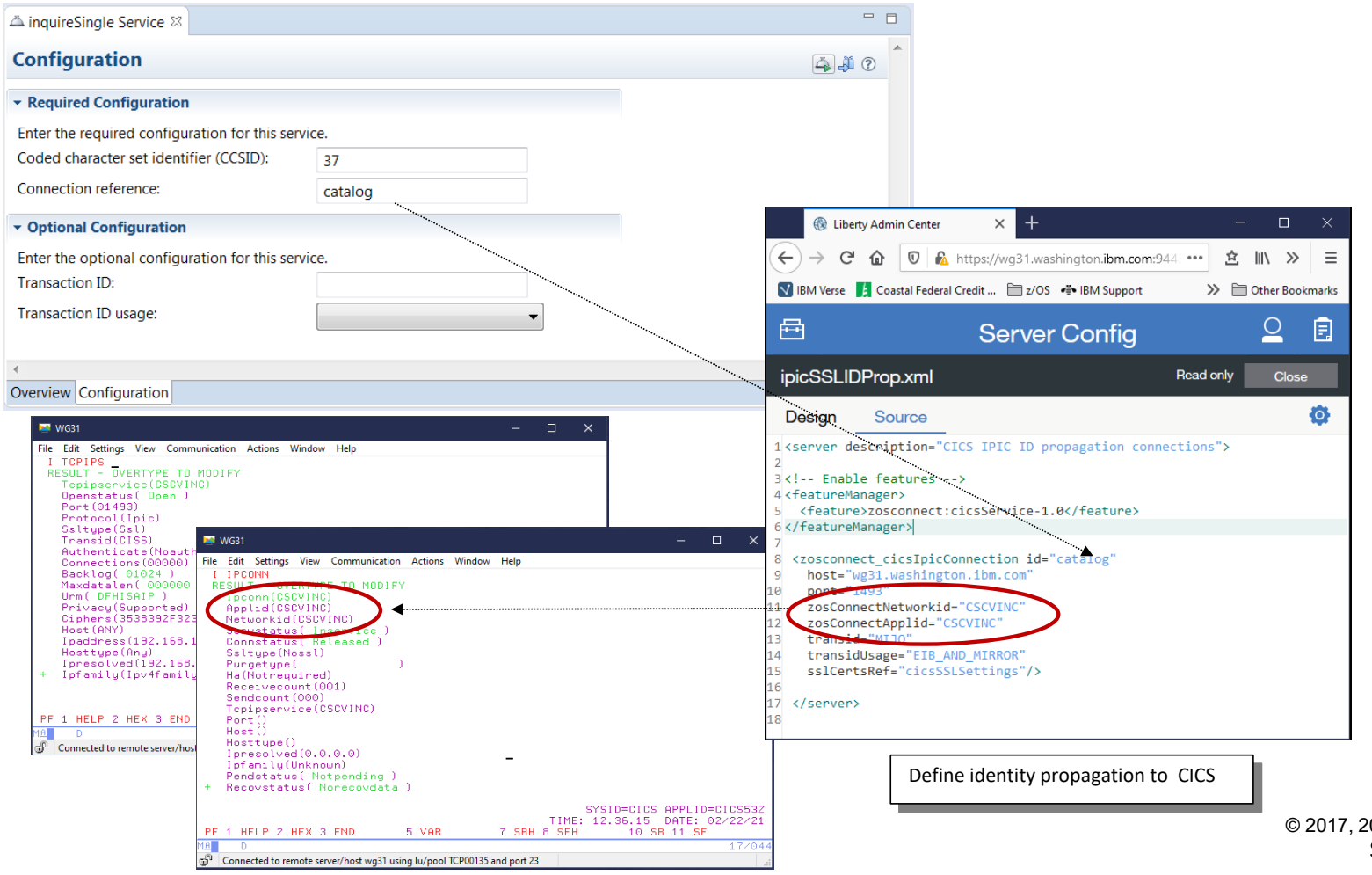
Flowing an identity to CICS

The server.xml file is the key configuration file:



Define identity propagation to CICS

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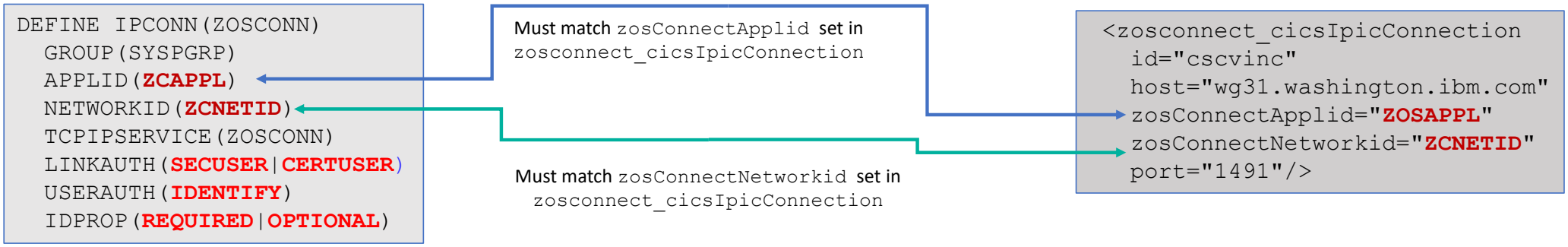
CICS IPCONN Resource



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.

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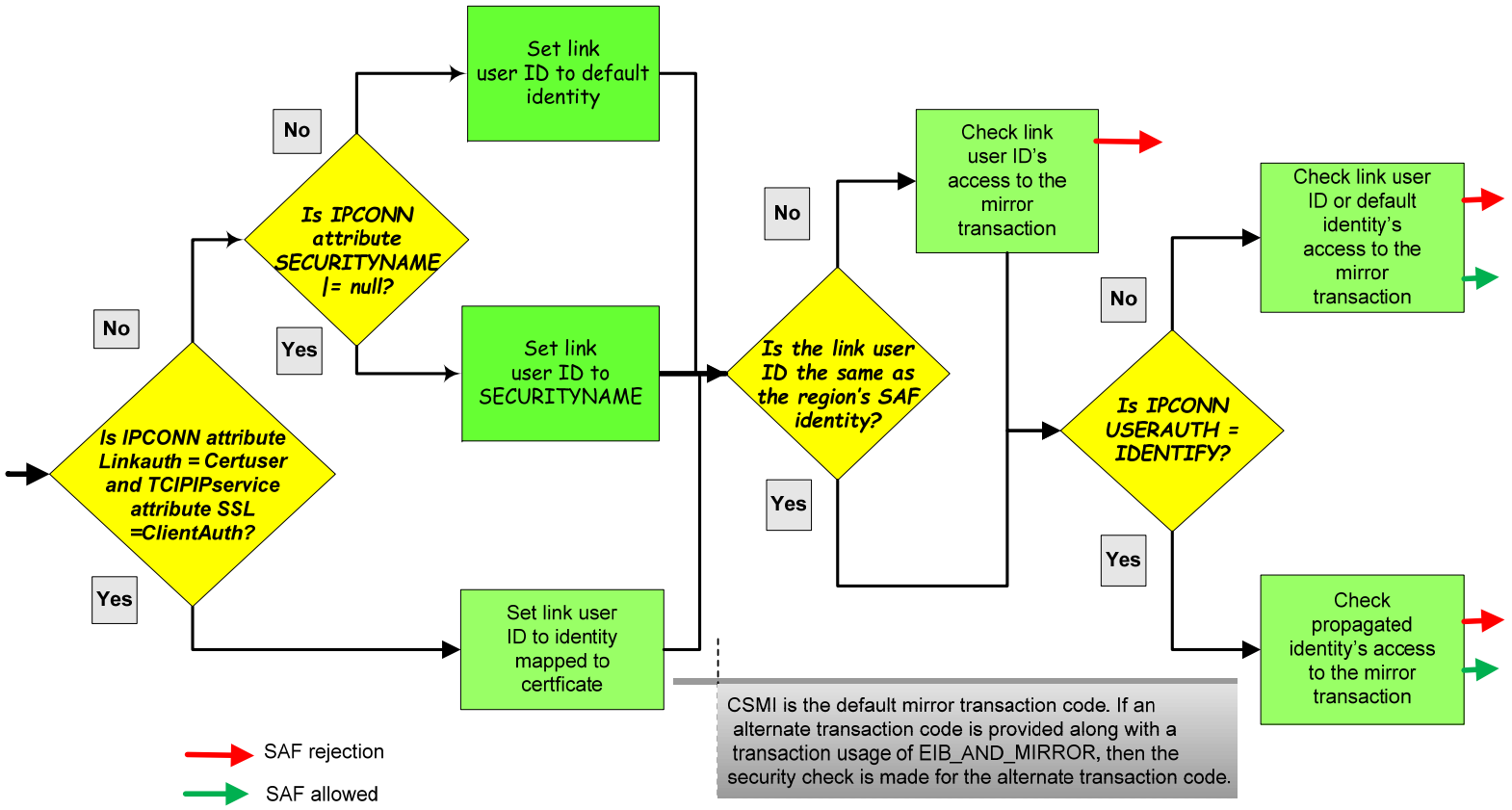
Tech/Tip: CICS IPIC Security with USERAUTH(IDENTIFY)



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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}"/>
```

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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.

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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)

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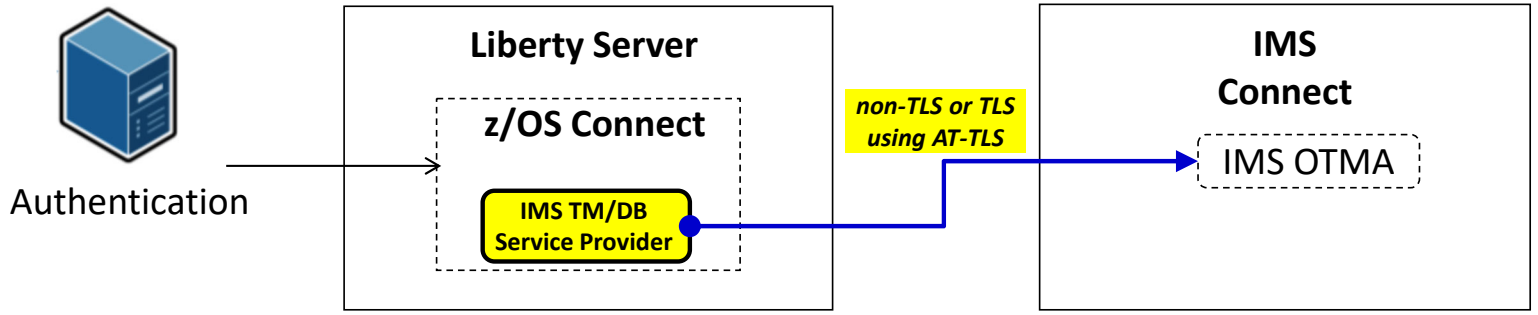
Flowing an identity to IMS Connect (TM)




```
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

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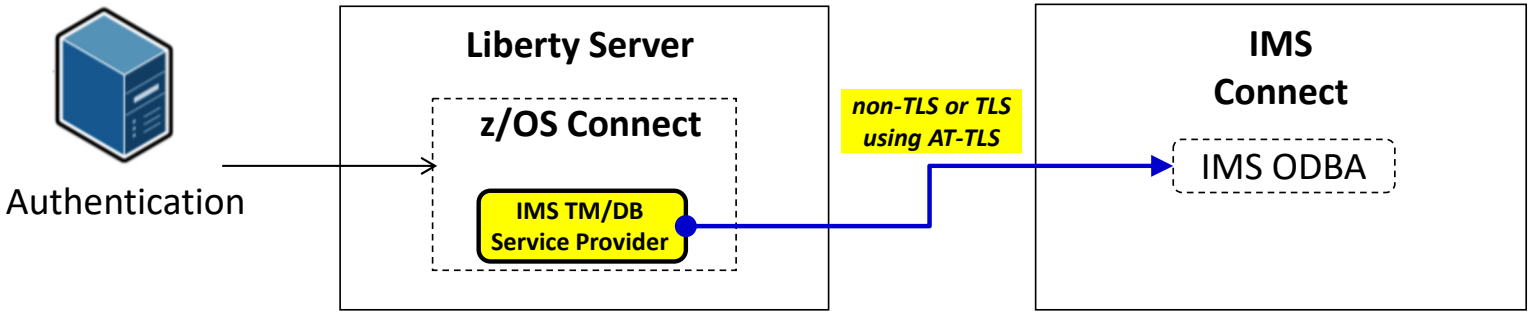
Flowing an identity to IMS Connect (DB)




```
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

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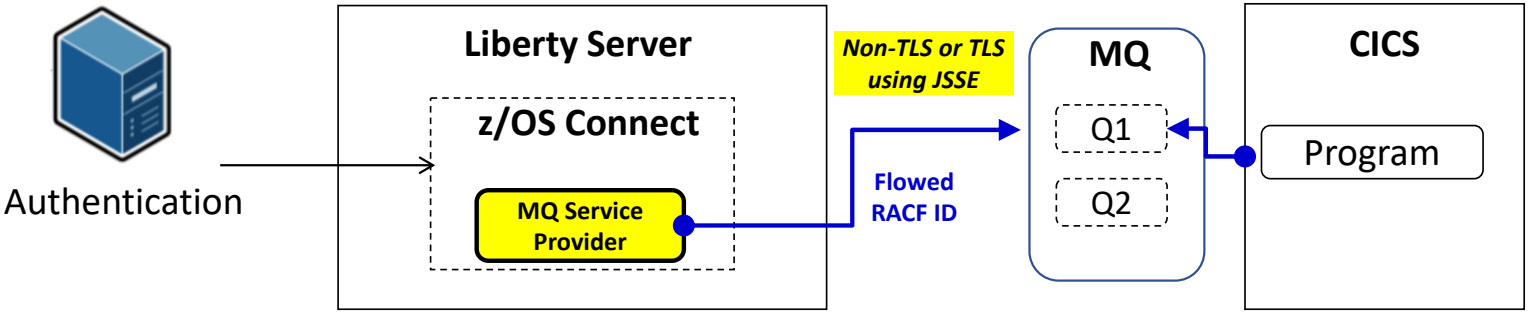
Flowing a user ID with MQ service provider



Set **`useCallerPrincipal=true`** to flow the authenticated RACF user ID

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

Define identity propagation to MQ

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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
```

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***

```
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)
```

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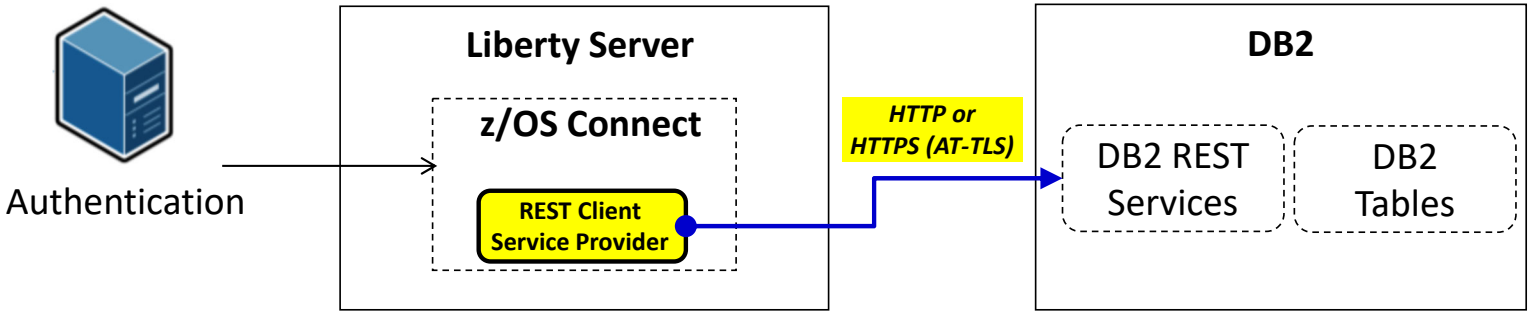
Flowing the identity for the REST client SP (Db2)




```
<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

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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

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WOLA Security

- MVS Batch

```
<zosLocalAdapters wolaGroup="ZCEESRVR"
    wolaName2="ZCEESRVR"
    wolaName3="ZCEESRVR"/>
```

```
RDEFINE CBIND BBG.WOLA.ZCEESRVR.ZCEESRVR.ZCEESRVR UACC(NONE) OWNER(SYS1)
PERMIT BBG.WOLA.ZCEESRVR.ZCEESRVR.ZCEESRVR CLASS(CBIND) ACCESS(READ) ID(USER1,START1)
SETROPTS RACLIST(CBIND) REFRESH
```

- Data Virtualization Manager

```
"DEFINE ZCPATH",
  "  NAME(ZCEE)                  ",
  "  RNAME(ZCEEDVM)              ",
  "  WNAME(ZCEEDVM)              ",
  ""
```

```
<!-- Adapter Details with WOLA Group Name (ZCEEDVM) -->
     <zosLocalAdapters wolaName3="NAME3"
       wolaName2="NAME2"
       wolaGroup="ZCEEDVM"/>
```

```
RDEFINE CBIND BBG.WOLA.ZCEEDVM.** UACC(NONE)
PERMIT BBG.WOLA.ZCEEDVM.** CLASS(CBIND)  ID(LIBSERV) ACC(READ)
SETROPTS RACLIST(CBIND) REFRESH
```

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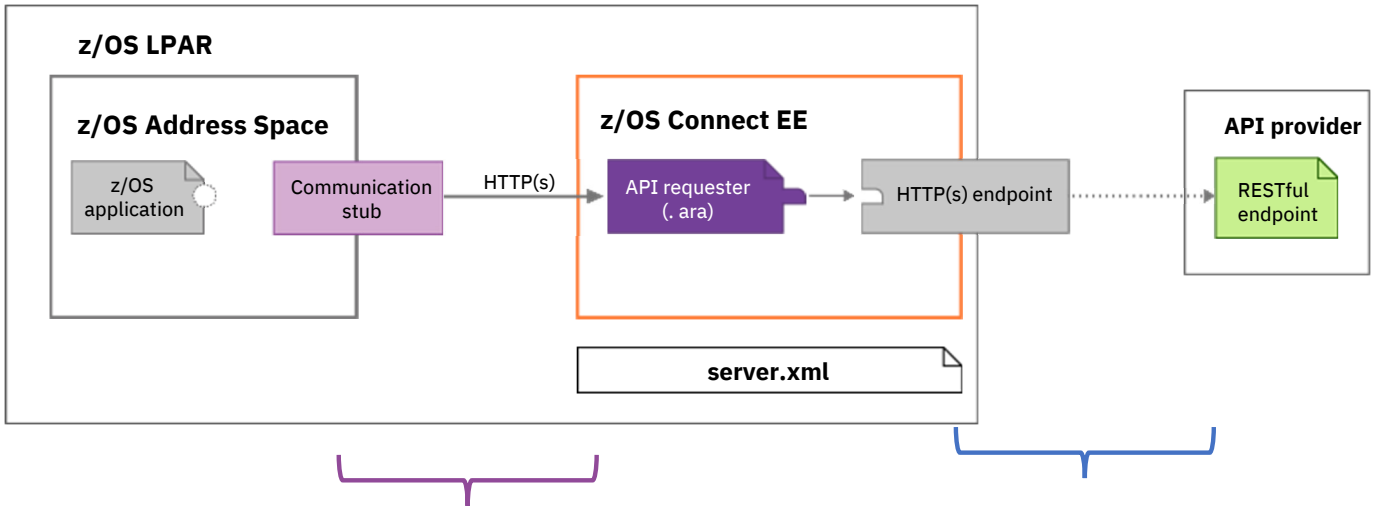
z/OS Connect API Requester Security

Details

Authentication



Options:

1. Basic Authentication
2. TLS Client/Server

1. Basic Authentication
2. TLS Client/Server
3. Third Party token

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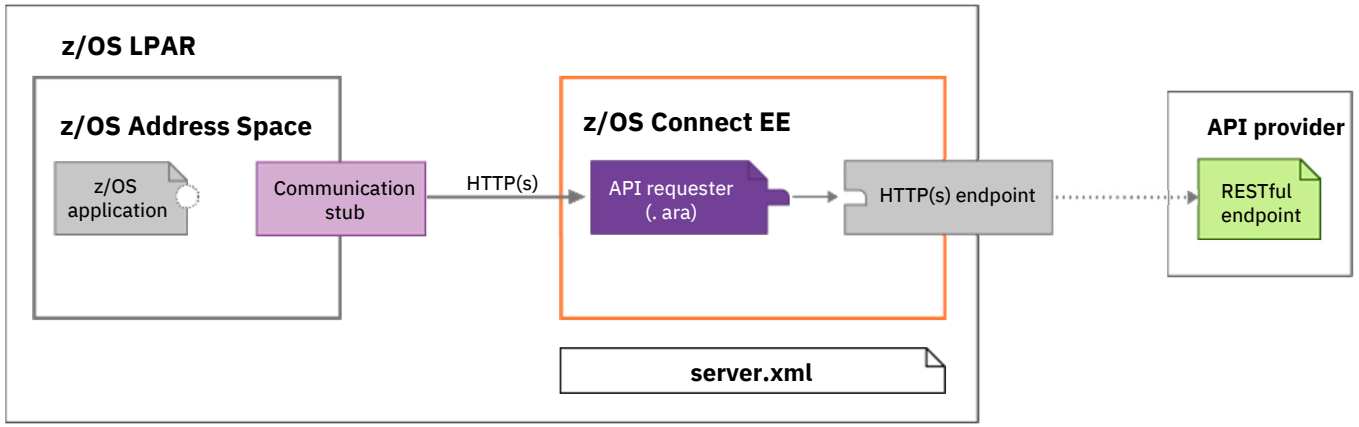
Encryption



Options:

1. AT-TLS
2. CICS TLS (System TLS)

1. JSSE
2. AT-TLS

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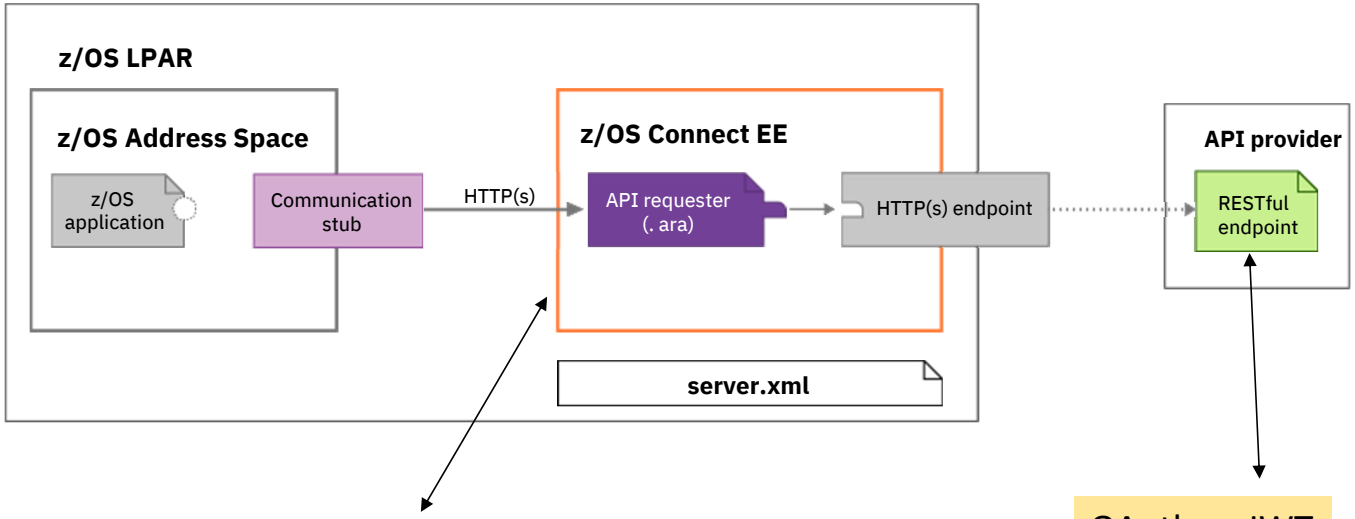
Authorization



Authorization interceptor options:

- Global level
- API requester level

OAuth or JWT access token

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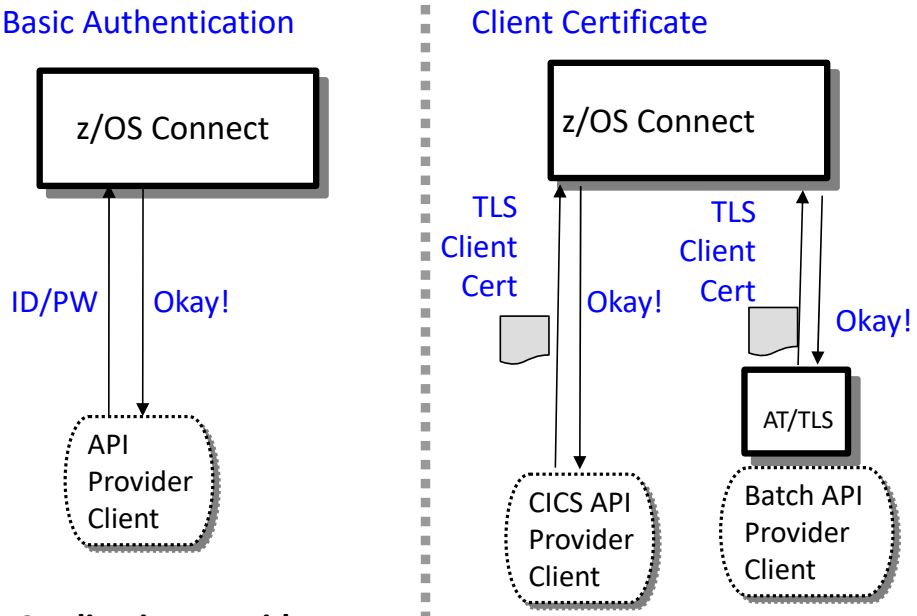
Application to z/OS Connect API Requester

Two options for providing credentials for authentication



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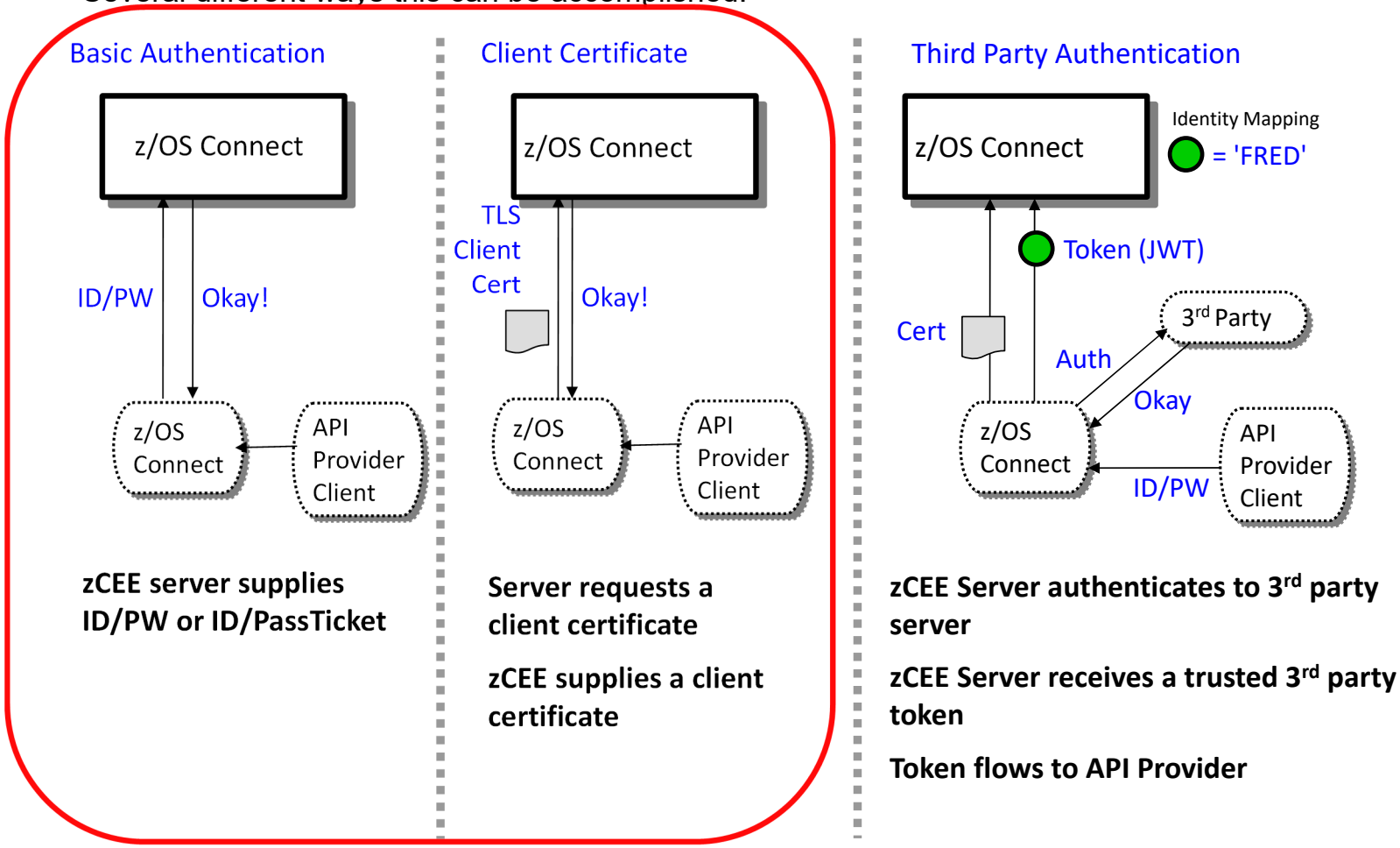
API Requester - API Provider Authentication

Several different ways this can be accomplished:



zCEE server supplies ID/PW or ID/PassTicket

Server requests a client certificate

zCEE supplies a client certificate

zCEE Server authenticates to 3rd party server

zCEE Server receives a trusted 3rd party token

Token flows to API Provider

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Configuring Basic and/or TSL support – z/OS Connect API Requester

Basic 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

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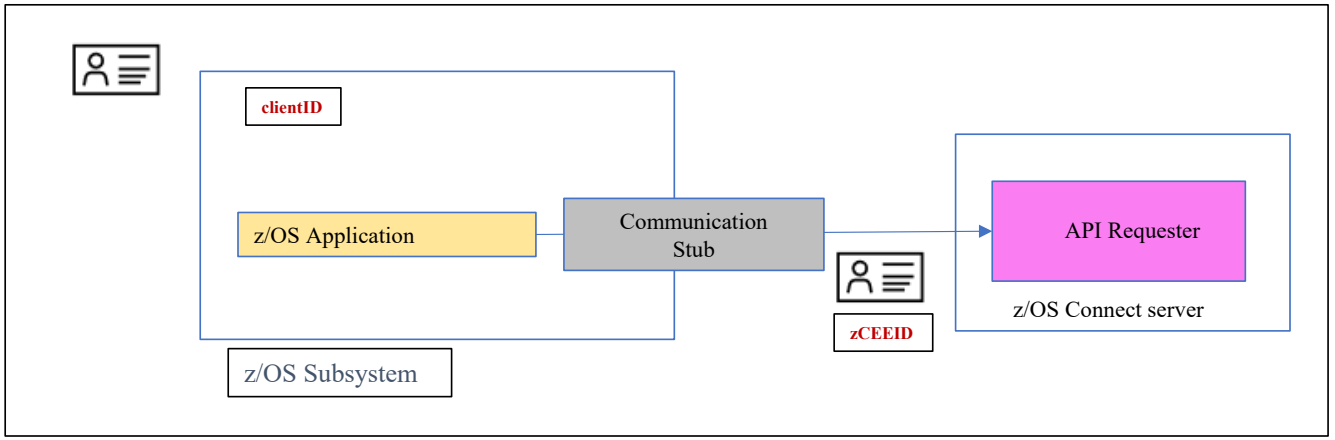
API Requester - basic authentication and identity assertion



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_apiRequesters idAssertion="OFF">

 <zosconnect_apiRequester name="cscvinc_1.0.0"
           idAssertion="ASSERT_ONLY"> *

 <zosconnect_apiRequester name="db2employee_1.0.0"
           idAssertion="ASSERT_SURROGATE"> *

</zosconnect_apiRequesters>
```

* Added in V3.0.45

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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***

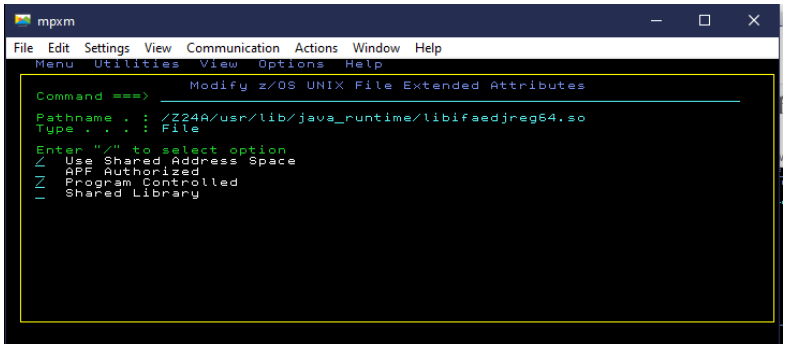
  PERMIT BPX.SERVER CLASS(FACILITY) ID(LIBSERV) ACCESS(READ)
  SETROPTS RACLIST(FACILITY) REFRESH

- ***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
  cd /usr/lib/java_runtime
  extattr +p libifaedjreg64.so



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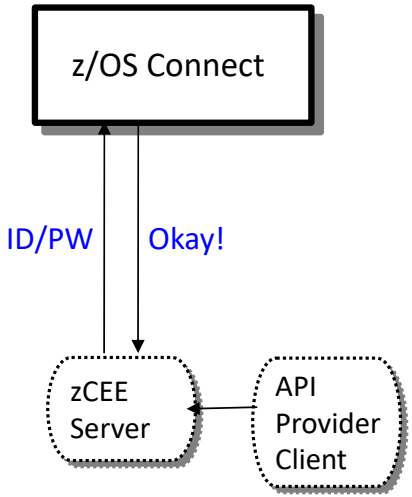
API Requester- API Provider Authentication

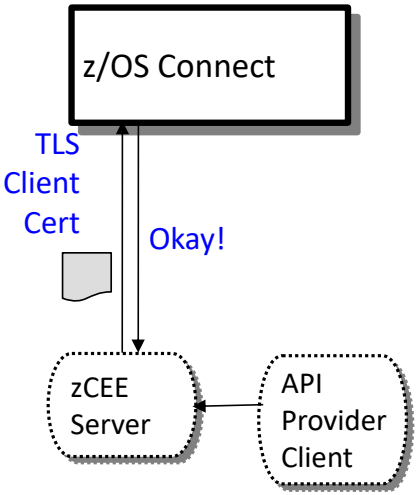
Several different ways this can be accomplished:

Basic Authentication



zCEE server supplies ID/PW or ID/PassTicket

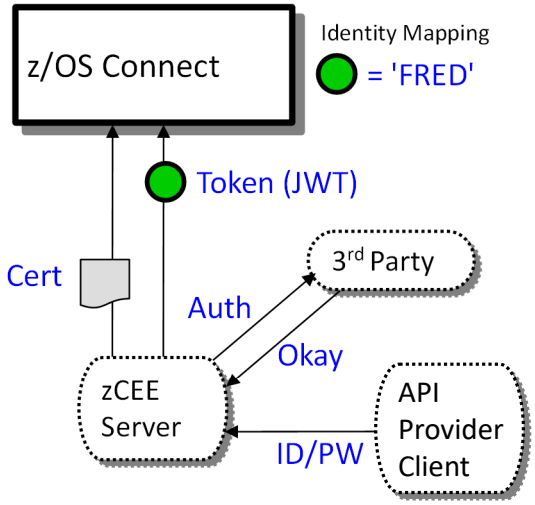
Client Certificate



Server requests a client certificate

zCEE supplies a client certificate

Third Party Authentication



zCEE Server authenticates to 3rd party server

zCEE Server receives a trusted 3rd party token

Token flows to API Provider

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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.

1. 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.

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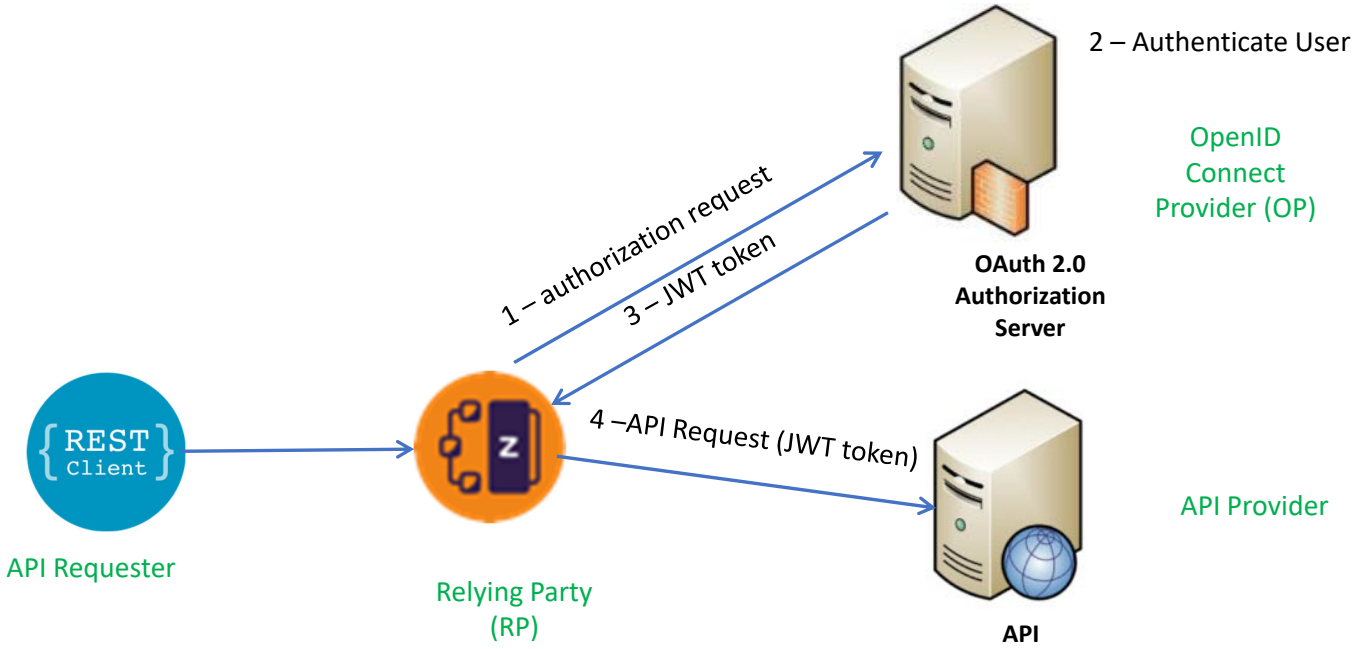
z/OS Connect OAuth Flow for API requester



Grant Types:

- client_credentials
- password

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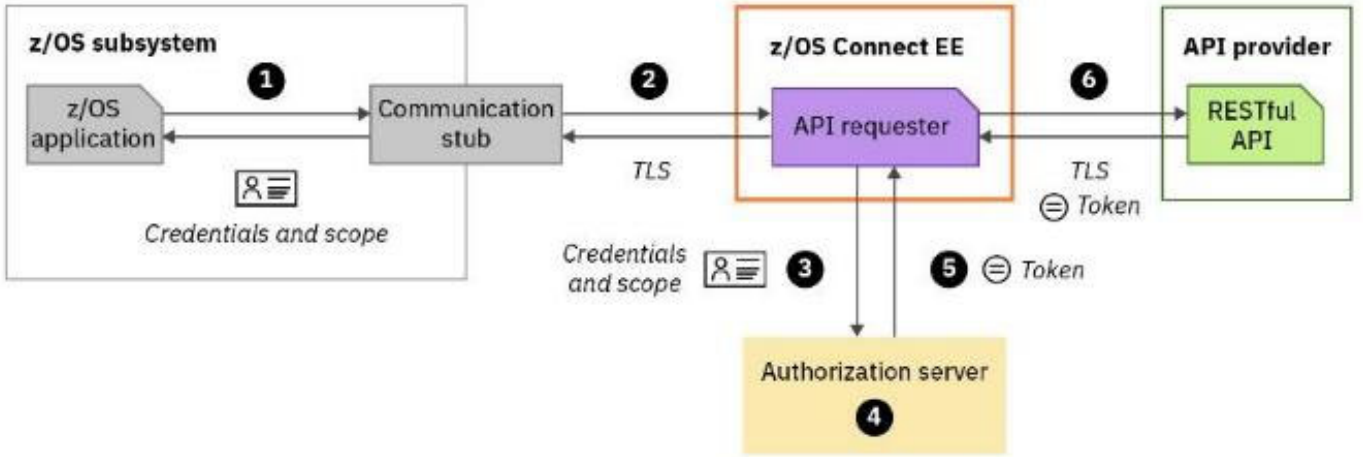
Calling an API with OAuth 2.0 support



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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"/>
```

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Configuring OAuth support – BAQRINFO copy book

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

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

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

Scope is always required.

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

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Sample program and JCL

COBOL Application

```
        MOVE "ATSOAUTHUSERNAME" to envVariableName.
        PERFORM CALL-CEEENV THRU CALL-CEEENV-END
        MOVE VAR(1:valueLength) to BAQ-OAUTH-USERNAME
        MOVE valueLength TO BAQ-OAUTH-USERNAME-LEN
        MOVE "ATSOAUTHPASSWORD" to envVariableName.
        PERFORM CALL-CEEENV THRU CALL-CEEENV-END
        MOVE VAR(1:valueLength) to BAQ-OAUTH-PASSWORD
        MOVE valueLength to BAQ-OAUTH-PASSWORD-LEN
        MOVE " "          to BAQ-OAUTH-CLIENTID.
        MOVE 0            to BAQ-OAUTH-CLIENTID-LEN.
        MOVE " "          to BAQ-OAUTH-CLIENT-SECRET.
        MOVE 0            to BAQ-OAUTH-CLIENT-SECRET-LEN.
        MOVE "openid"     to BAQ-OAUTH-SCOPE.
        MOVE 6            to BAQ-OAUTH-SCOPE-LEN.
        SET BAQ-OAUTH-SCOPE-PTR TO ADDRESS OF BAQ-OAUTH-SCOPE.
```

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

Execution JCL

```
//GETAPI  EXEC PGM=GETAPIPT,PARM='111111'
//STEPLIB  DD DISP=SHR,DSN=USER1.ZCEE30.LOADLIB
//         DD DISP=SHR,DSN=ZCEE30.SBAQLIB
//         DD DISP=SHR,DSN=JOHNSON.ZCEE.SDFHLOAD
//SYSOUT   DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//CEEOPTS  DD *
 POSIX(ON),
 ENVAR("BAQURI=wg31.washington.ibm.com",
 "BAQPORT=9080",
 "BAQUSERNAME=USER1",
 "ATSAPPL=BBGZDFLT",
 "ATSOAUTHUSERNAME=distuser1",
 "ATSOAUTHPASSWORD=pwd")
```

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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

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Security Scenarios

```
BAQ-OAUTH-USERNAME:  distuser1
BAQ-OAUTH-PASSWORD:  pwd
EmployeeNumber: 111111
EmployeeName:   C. BAKER
USERID:         USER1
```

distuser1 is mapped to RACF identity USER1 who has full access

```
BAQ-OAUTH-USERNAME:  distuserx
BAQ-OAUTH-PASSWORD:  pwd
Error code: 00000500
Error msg:{"errorMessage":"BAQR1092E: Authentication or authorization failed for the z/OS Connect EE server."}
```

distuserx is unknown by the OAuth Provider

```
BAQ-OAUTH-USERNAME:  auser
BAQ-OAUTH-PASSWORD:  pwd
Error code: 0000000403
rror msg:{"errorMessage":"BAQR1144E: Authentication or authorization failed for the z/OS Connect EE server."}
Syslog:
ICH408I USER(ATSSERV ) GROUP(ATSGRP  ) NAME(LIBERTY SERVER
  DISTRIBUTED IDENTITY IS NOT DEFINED:
  auser zCEERealm
```

auser is not mapped to a valid RACF identity

```
BAQ-OAUTH-USERNAME:  distuser2
BAQ-OAUTH-PASSWORD:  pwd
Error code: 0000000403
Error msg:{"errorMessage":"BAQR1144E: Authentication or authorization failed for the z/OS Connect EE server."}
Syslog:
ICH408I USER(USER2   ) GROUP(SYS1    ) NAME(WORKSHOP USER2
  ATSZDFLT.zos.connect.access.roles.zosConnectAccess
  CL(EJBROLE )
  INSUFFICIENT ACCESS AUTHORITY
  ACCESS INTENT(READ   )  ACCESS ALLOWED(NONE   )
```

distuser2 is mapped to RACF identity USER2 which has no access to the EJBRole protecting z/OS Connect

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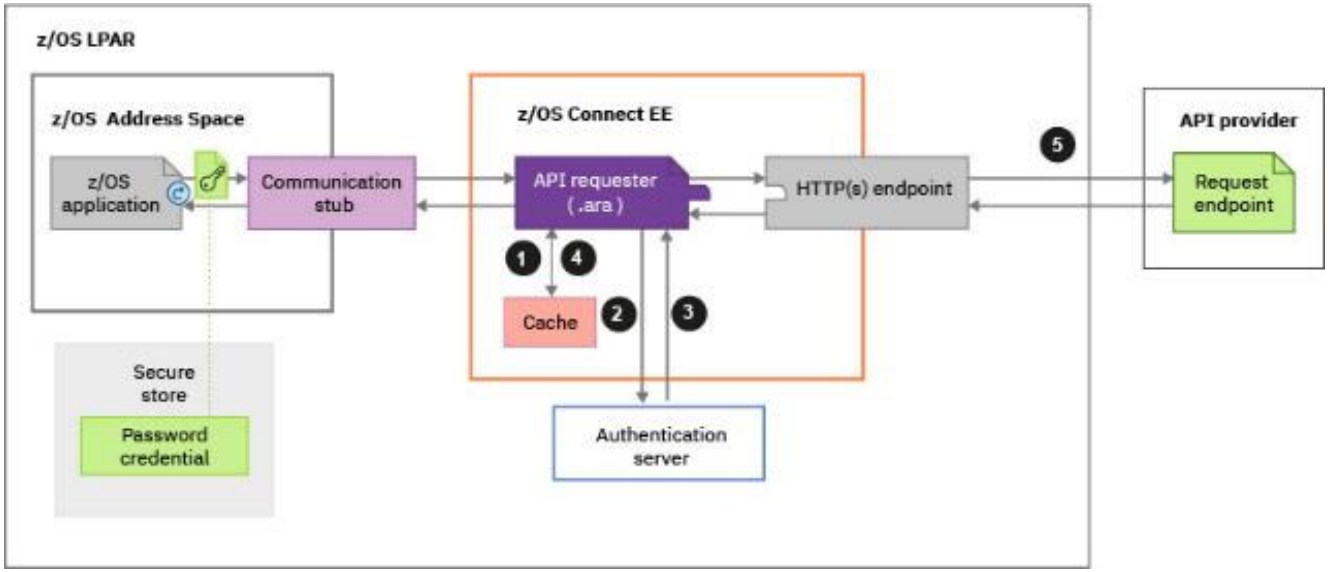
Calling an API with using a JWT custom flow

- 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.



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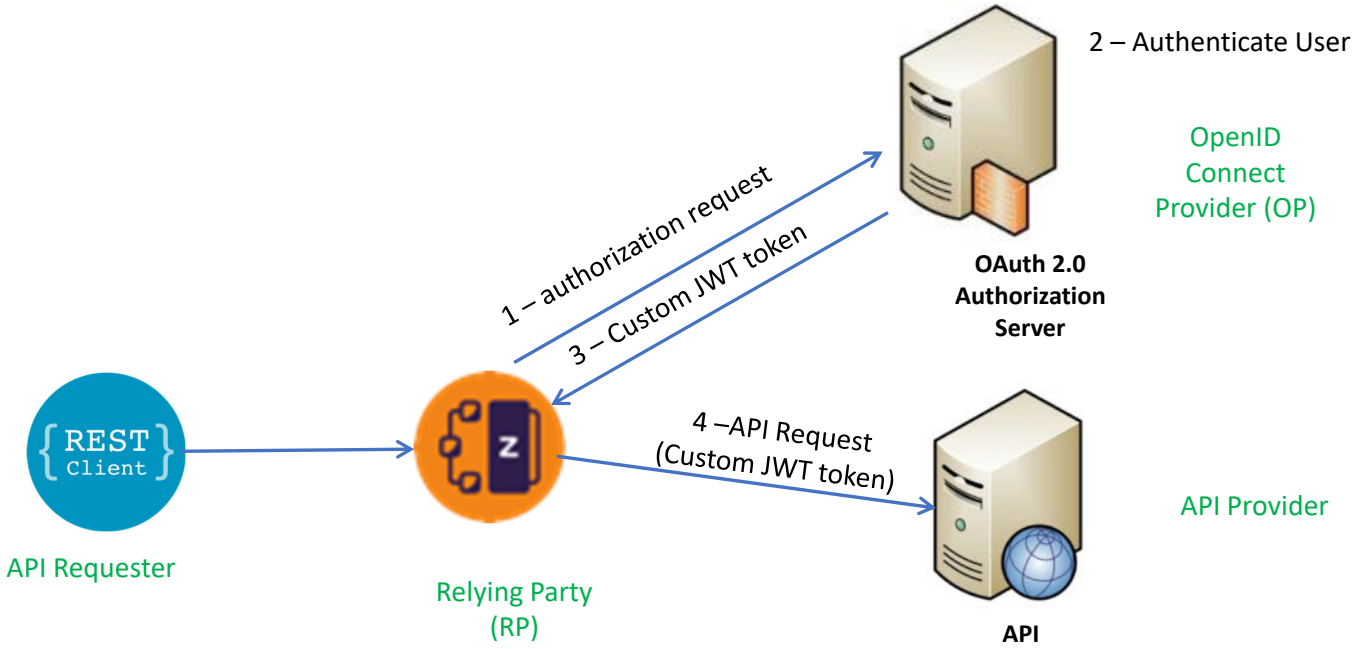
z/OS Connect OAuth Customer Flow



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API Requester – JWT Custom flow

BAQRINFO copy book

```
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.
```

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.

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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

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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" />
```

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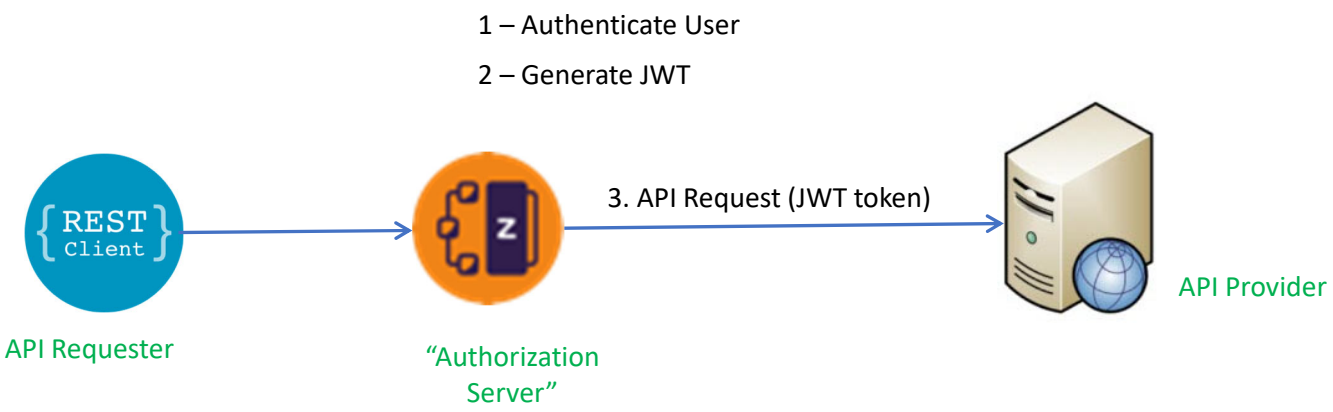
z/OS Connect JWT Generation – V3.0.43



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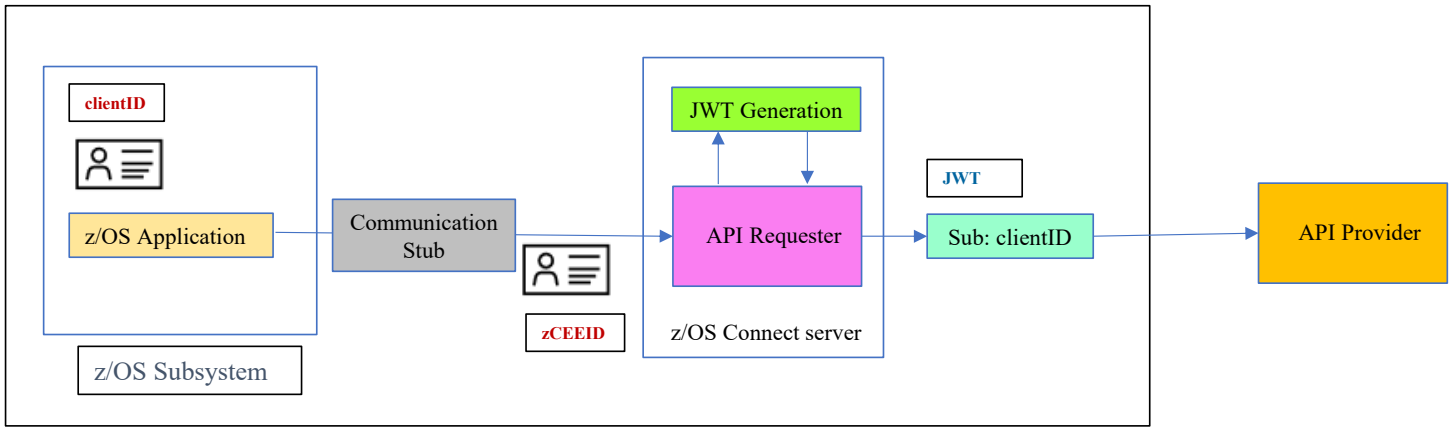
API Requester – JWT Generation



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

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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***

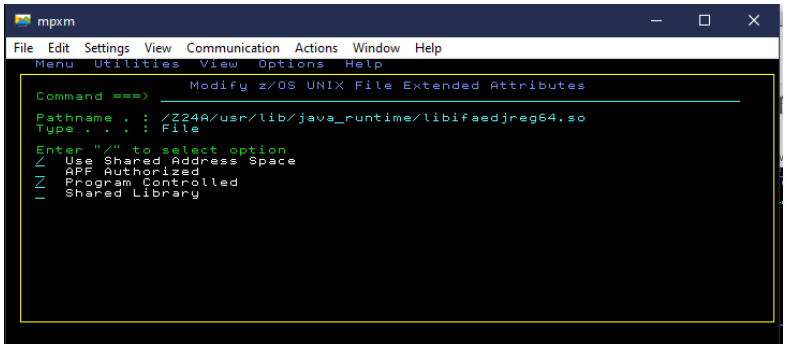
  PERMIT BPX.SERVER CLASS(FACILITY) ID(LIBSERV) ACCESS(READ)
  SETROPTS RACLIST(FACILITY) REFRESH

- ***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



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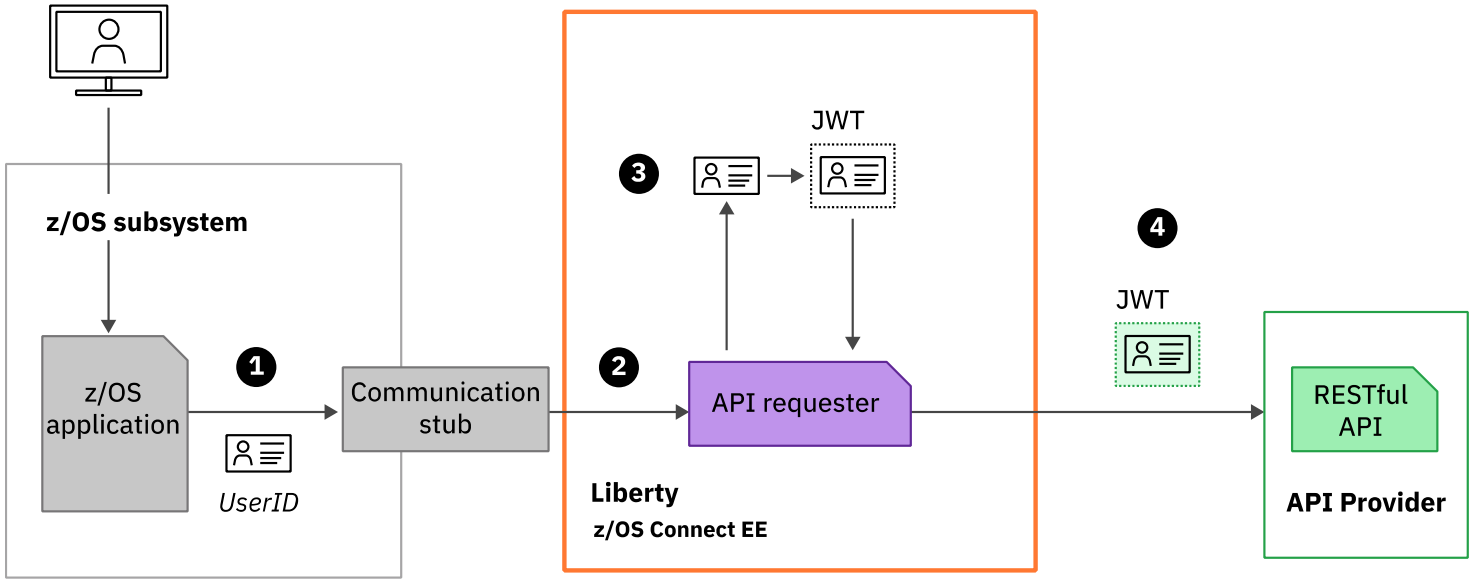
JWT Generation



1. Communication stub extracts the ID from the application environment
2. z/OS Connect generates a JWT token containing the z/OS application asserted user ID
3. The JWT is used to authorise the request to the API endpoint

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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.

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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"/>
```

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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.

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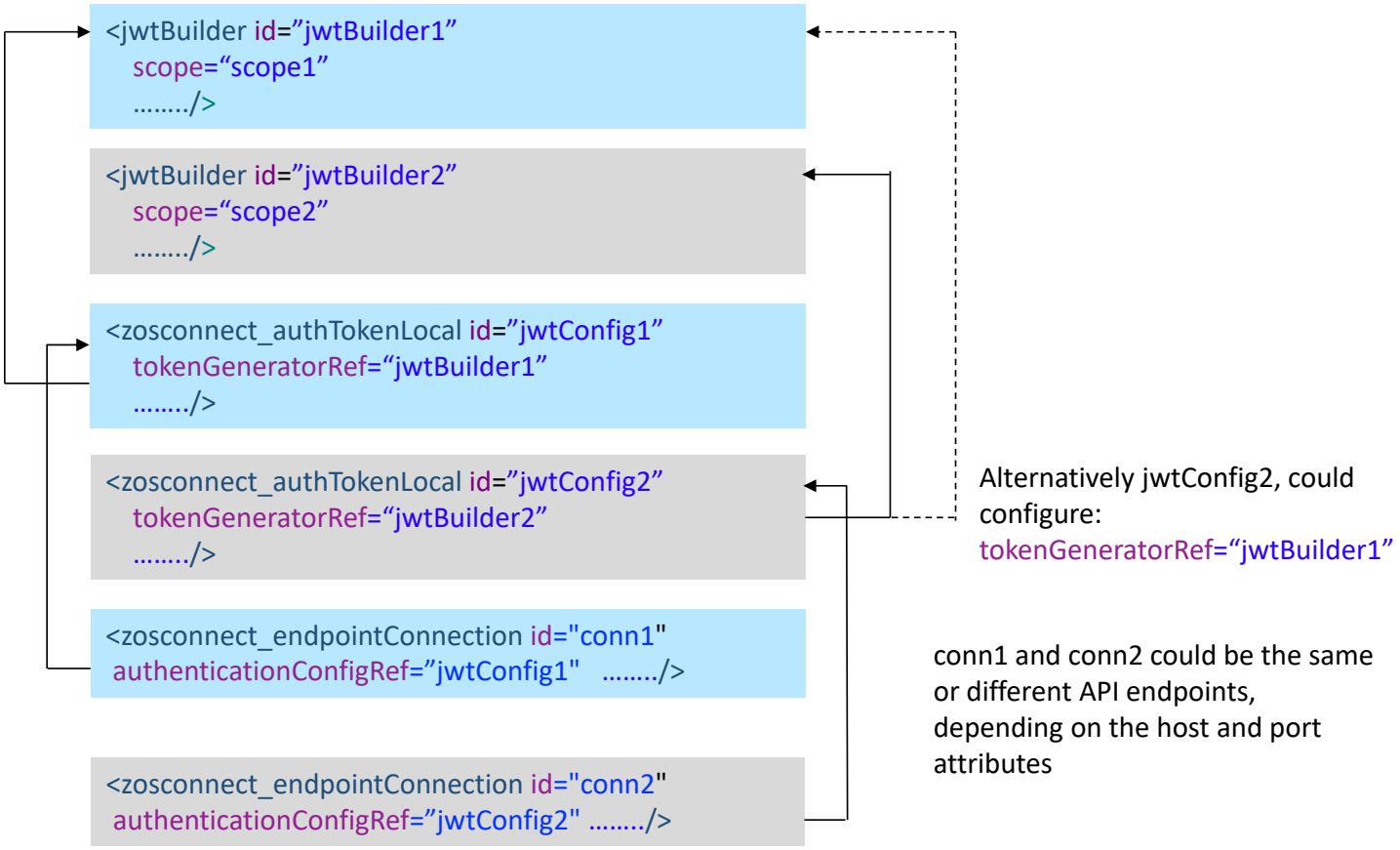
Using different claims for different API endpoints



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In this presentation we covered

- Liberty and z/OS Connect Security Overview
- Authentication
  - –Basic Authentication
  - –Mutual Authentication using TLS
  - –Third Party Tokens
- Encryption and Message Integrity using TLS
- Authorization
- Propagating identities to z/OS subsystems
- z/OS Connect API Requester and third-party tokens

Summary

- Remember that because z/OS Connect EE is based on Liberty, it benefits from a wide range of Liberty security capabilities

- Security design needs to consider
  - Authentication
  - Encryption
  - Authorization

- Understand your security requirements, identify the waypoints and their security requirements.

- Consider security requirements from ending to beginning (not necessarily from beginning to end), e.g.
  - Do you need to flow the original authenticated identity all the way to the end?
  - Do you need to map individual identities to an application or server identity?

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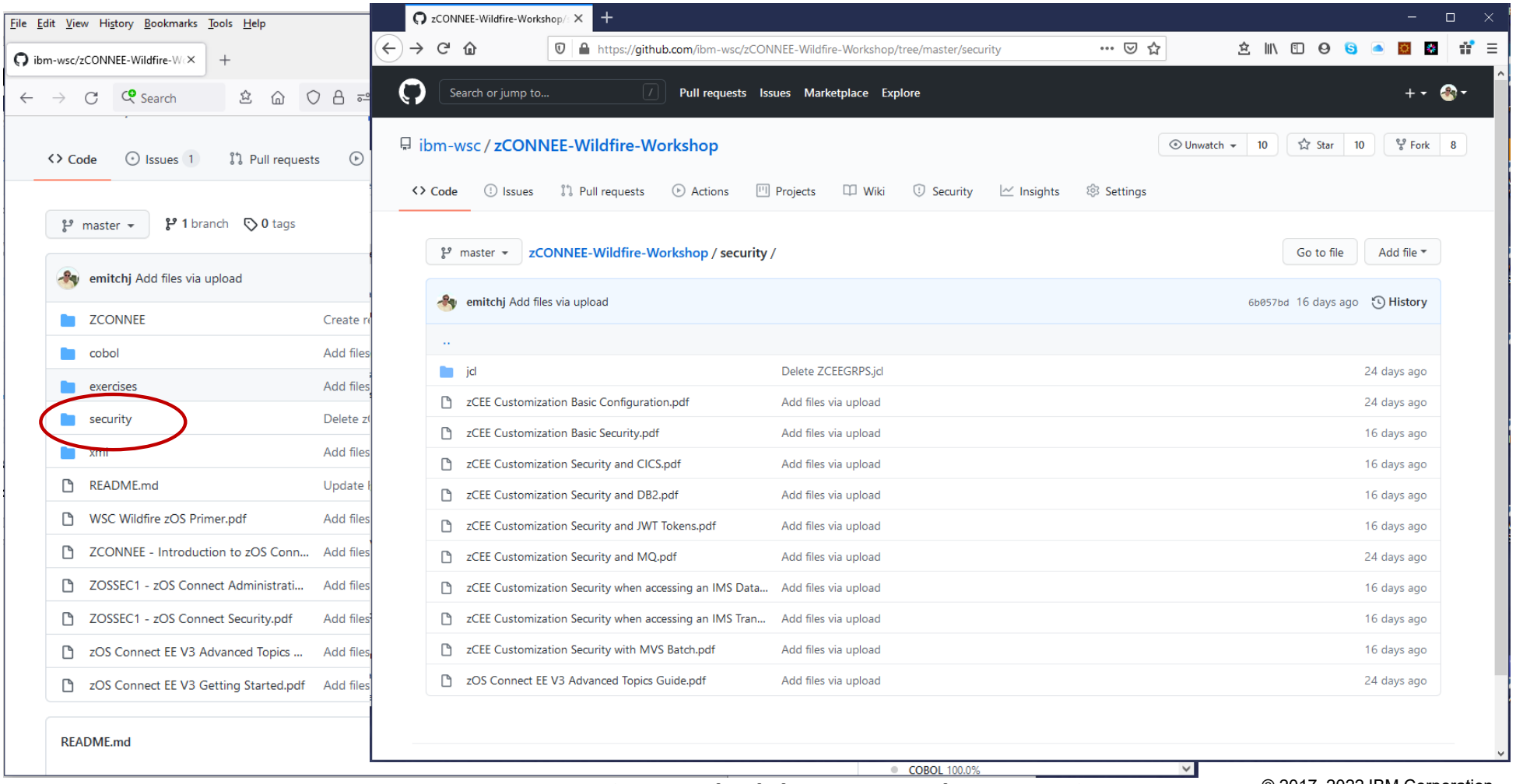
Step by step exercises available on GitHub

https://ibm.biz/Bdf8BZ



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Contact your IBM representative to schedule access to these exercises