Open Beta for Zowe

Installation and User's Guide

Contents

About this documentation

This documentation describes how to install, configure, use, and extend Open Beta for Zowe.

Who should read this documentation

This documentation is intended for system programmers who are responsible for installing and configuring Zowe, application developers who want to use Zowe to improve z/OS user experience, and anyone who wants to understand how Zowe works or is interested in extending Zowe to add their own plug-ins or applications.

The information provided assumes that you are familiar with the mainframe and z/OSMF configuration.

How to send your feedback on this documentation

We value your feedback. If you have comments about this documentation, you can use one of the following ways to provide feedback:

- Send a GitHub pull request to provide a suggested edit for the content by clicking the **Propose content change in GitHub** link on each documentation page.
- Open an issue in GitHub to request documentation to be updated, improved, or clarified by providing a comment.

Sending a GitHub pull request

You can provide suggested edit to any documentation page by using the **Propose content change in GitHub** link on each page. After you make the changes, you submit updates in a pull request for the Zowe content team to review and merge.

Follow these steps:

1. Click **Propose content change in GitHub** on the page that you want to update.
2. Click the **Edit the file** icon  .
3. Make the changes to the file.
4. Scroll to the end of the page and enter a brief description about your change.
5. Optional: Enter an extended description.
6. Select **Propose file change**.
7. Select **Create pull request**.

Opening an issue for the documentation

You can request the documentation to be improved or clarified, report an error, or submit suggestions and ideas by opening an issue in GitHub for the Zowe content team to address. The content team tracks the issues and works to address your feedback.

Follow these steps:

1. Click the **GitHub** link at the top of the page.
2. Select **Issues**.
3. Click **New issue**.
4. Enter a title and description for the issue.

5. Click **Submit new issue**.

Summary of changes for Open Beta

Learn about what is new, changed, and removed in Open Beta for Zowe.

Version 0.9.0 (August 2018)

Version 0.9.0 is the first Open Beta version for Zowe. This version contains the following changes since the last Closed Beta version.

What's new

New component - API Mediation Layer

Zowe now contains a component named API Mediation Layer. You install API Mediation Layer when you install the Zowe runtime on z/OS. For more information, see API Mediation Layer and Installing zLUX, explorer server, and API Mediation Layer.

What's changed

Naming

- The project is now named Zowe.
- Zoe Brightside is renamed to Zowe CLI.

Installation

- The System Display and Search Facility (SDSF) of z/OS is no longer a prerequisite for installing explorer server.
- The name of the PROC is now ZOWESVR rather than ZOESVR.

zLUX

The mainframe account under which the ZSS server runs must have UPDATE permission on the BPX.DAEMON and BPX.SERVER facility class profiles.

Explorer server

The URL to access the explorer server UI is changed from `https://<your.server>:<atlasport>/ui/#/` to the following ones:

- `https://<your.server>:<atlasport>/explorer-jes/#/`
- `https://<your.server>:<atlasport>/explorer-mvs/#/`
- `https://<your.server>:<atlasport>/explorer-uss/#/`

What's removed

Removed all references to SYSLOG.

Chapter 1. Zowe overview

Zowe offers modern interfaces to interact with z/OS and allows you to work with z/OS in a way that is similar to what you experience on cloud platforms today. You can use these interfaces as delivered or through plug-ins and extensions that are created by clients or third-party vendors.

Zowe consists of the following main components.

- **zLUX**: Contains a Web user interface (UI) that provides a full screen interactive experience. The Web UI includes many interactions that exist in 3270 terminals and web interfaces such as IBM z/OSMF.
- **Explorer server**: Provides a range of APIs for the management of jobs, data sets, z/OS UNIX System Services files, and persistent data.
- **API Mediation Layer**: Provides an API abstraction layer through which APIs can be discovered, catalogued, and presented uniformly.
- **Zowe CLI**: Provides a command-line interface that lets you interact with the mainframe remotely and use common tools such as Integrated Development Environments (IDEs), shell commands, bash scripts, and build tools for mainframe development. It provides a set of utilities and services for application developers that want to become efficient in supporting and building z/OS applications quickly.

For details of each component, see the corresponding section.

zLUX

zLUX modernizes and simplifies working on the mainframe. With zLUX, you can create applications to suit your specific needs. zLUX contains a web UI that has the following features:

- The web UI works with the underlying REST APIs for data, jobs, and subsystem, but presents the information in a full screen mode as compared to the command line interface.
- The web UI makes use of leading-edge web presentation technology and is also extensible through web UI plug-ins to capture and present a wide variety of information.
- The web UI facilitates common z/OS developer or system programmer tasks by providing an editor for common text-based files like REXX or JCL along with general purpose data set actions for both Unix System Services (USS) and Partitioned Data Sets (PDS) plus Job Entry System (JES) logs.

zLUX consists of the following components:

- **Mainframe Virtual Desktop (MVD)**

  The desktop, accessed through a browser.

- **Zowe Node Server**

  The Zowe Node Server runs zLUX. It consists of the Node.js server plus the Express.js as a webservices framework, and the proxy applications that communicate with the z/OS services and components.

- **ZSS Server**

  The ZSS Server provides secure REST services to support the Zowe Node Server.

- **Application plug-ins**

  Several application-type plug-ins are provided. For more information, see Using zLUX application plug-ins.

Explorer server

The explorer server is a z/OS® RESTful web service and deployment architecture for z/OS microservices. The server is implemented as a Liberty Profile web application that uses z/OSMF services to provide a range of APIs for the management of jobs, data sets, z/OS UNIX™ System Services (USS) files, and persistent data.

These APIs have the following features:

- These APIs are described by the Open API Specification allowing them to be incorporated to any standard-based REST API developer tool or API management process.
- These APIs can be exploited by off-platform applications with proper security controls.

Any client application that calls RESTful APIs directly can use the explorer server.

As a deployment architecture, the explorer server accommodates the installation of other z/Tool microservices into its Liberty instance. These microservices can be used by explorer server APIs and client applications.

Zowe CLI

Zowe CLI is a command-line interface that lets application developers interact with the mainframe in a familiar format. Zowe CLI helps to increase overall productivity, reduce the learning curve for developing mainframe applications, and exploit the ease-of-use of off-platform tools. Zowe CLI lets application developers use common tools such as Integrated Development Environments (IDEs), shell commands, bash scripts, and build tools for mainframe development. It provides a set of utilities and services for application developers that want to become efficient in supporting and building z/OS applications quickly.

Zowe CLI provides the following benefits:

- Enables and encourages developers with limited z/OS expertise to build, modify, and debug z/OS applications.
- Fosters the development of new and innovative tools from a PC that can interact with z/OS.
- Ensure that business critical applications running on z/OS can be maintained and supported by existing and generally available software development resources.
- Provides a more streamlined way to build software that integrates with z/OS.

The following sections explain the key features and details for Zowe CLI:

Note: For information about prerequisites, software requirements, installing and upgrading Zowe CLI, see Installing Zowe.

Zowe CLI capabilities

With Zowe CLI, you can interact with z/OS remotely in the following ways:

- **Interact with mainframe files:** Create, edit, download, and upload mainframe files (data sets) directly from Zowe CLI.
- **Submit jobs:** Submit JCL from data sets or local storage, monitor the status, and view and download the output automatically.
- **Issue TSO and z/OS console commands:** Issue TSO and console commands to the mainframe directly from Zowe CLI.
- **Integrate z/OS actions into scripts:** Build local scripts that accomplish both mainframe and local tasks.
- **Produce responses as JSON documents:** Return data in JSON format on request for consumption in other programming languages.

For more information about the available functionality in Zowe CLI, see Zowe CLI Command Groups.

Zowe CLI Third-Party software agreements

Zowe CLI uses the following third-party software:

Third-party Software	Version	File name
chalk	2.3.0	Legal_Doc_00002285_56.pdf
cli-table2	0.2.0	Legal_Doc_00002310_5.pdf
dataobject-parser	1.2.1	Legal_Doc_00002310_36.pdf
find-up	2.1.0	Legal_Doc_00002310_33.pdf
glob	7.1.1	Legal_Doc_00001713_45.pdf
js-yaml	3.9.0	Legal_Doc_00002310_16.pdf
jsonfile	4.0.0	Legal_Doc_00002310_40.pdf
jsonschema	1.1.1	Legal_Doc_00002310_17.pdf
levenshtein	1.0.5	See UNLICENSE
log4js	2.5.3	Legal_Doc_00002310_37.pdf
merge-objects	1.0.5	Legal_Doc_00002310_34.pdf
moment	2.20.1	Legal_Doc_00002285_25.pdf
mustache	2.3.0	Legal_Doc_mustache.pdf
node.js	6.11.1	Legal_Doc_nodejs.pdf
node-ibm_db	2.3.1	Legal_Doc_00002310_38.pdf
node-mkdirp	0.5.1	Legal_Doc_00002310_35.pdf
node-progress	2.0.0	Legal_Doc_00002310_7.pdf
prettyjson	1.2.1	Legal_Doc_00002310_22.pdf
rimraf	2.6.1	Legal_Doc_00002310_8.pdf
Semver	5.5.0	Legal_Doc_00002310_42.pdf
stack-trace	0.0.10	Legal_Doc_00002310_10.pdf
string-width	2.1.1	Legal_Doc_00002310_39.pdf
wrap-ansi	3.0.1	Legal_Doc_00002310_12.pdf
yamljs	0.3.0	Legal_Doc_00002310_13.pdf
yargs	8.0.2	Legal_Doc_00002310_1.pdf

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To read each complete license, navigate to the GitHub repository and download the file named Zowe_CLI_TPSRs.zip. The .zip file contains the licenses for all of the third-party components that Zowe CLI uses.

More Information:

- System requirements for Zowe CLI
- Installing Zowe CLI

API Mediation Layer

The API Mediation Layer provides a single point of access for mainframe service REST APIs. The layer offers enterprise, cloud-like features such as high-availability, scalability, dynamic API discovery, consistent security, a single sign-on experience, and documentation. The API Mediation Layer facilitates secure communication across loosely coupled microservices through the API Gateway. The API Mediation Layer includes an API Catalog that provides an interface to view all discovered microservices, their associated APIs, and Swagger documentation in a user-friendly manner. The Discovery Service makes it possible to determine the location and status of microservice instances running inside the ecosystem.

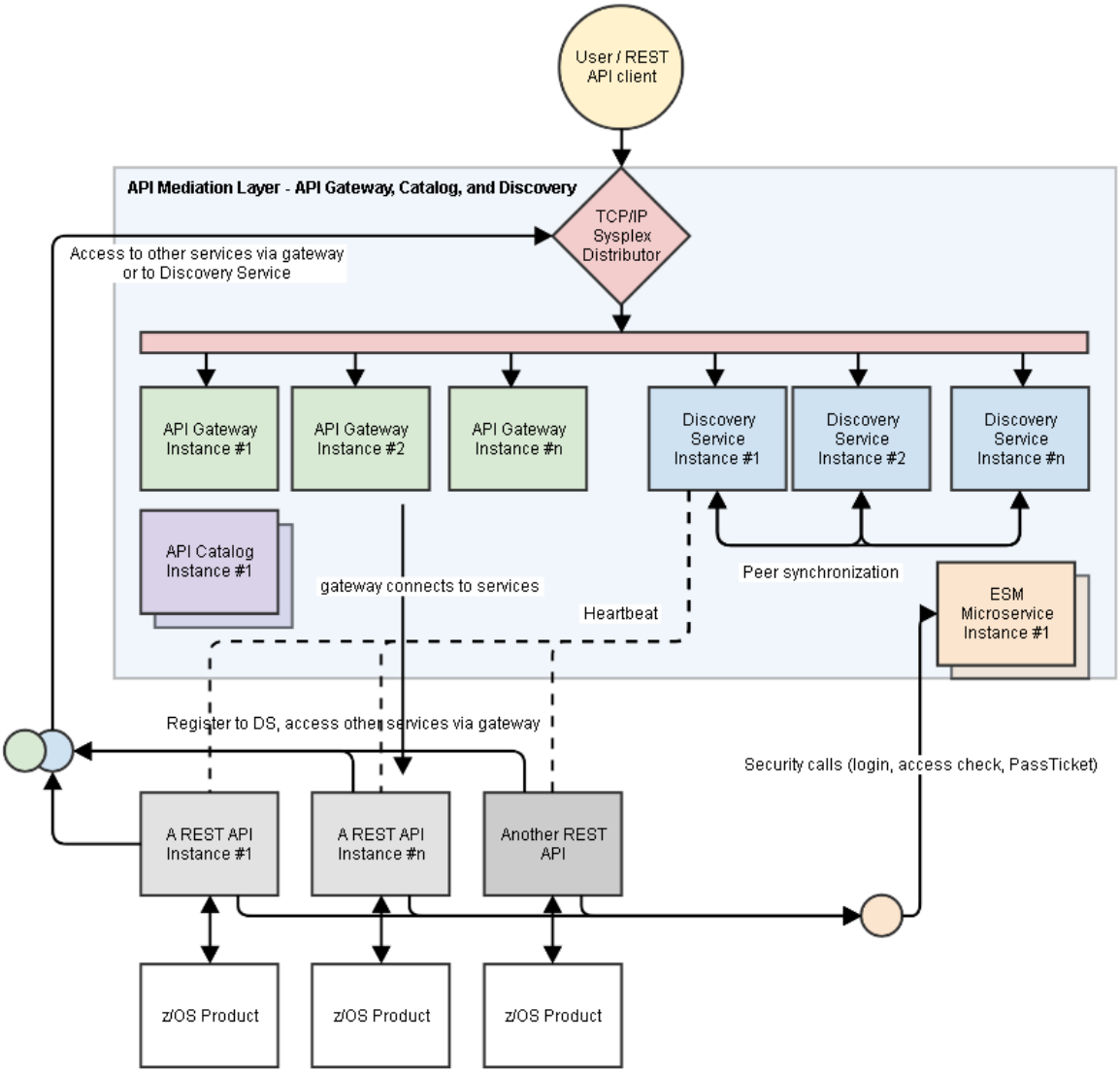
More Information: - Onboard an existing Spring Boot REST API service using Zowe API Mediation Layer - Using API Catalog

Key features

- High availability of services in which application instances on a failing node are distributed among surviving nodes
- Microservice UIs available through the API Gateway and API Catalog by means of reverse proxying
- Support for standardization and normalization of microservice URLs and routing to provide API Mediation Layer users with a consistent way of accessing microservices.
- Minimal effort to register a microservice with the gateway (configuration over code)
- Runs on Windows, Linux, and z/OS (target platform)
- Written in Java utilizing Spring Boot (2.x), Angular 5, and the Netflix CloudStack
- Supports multiple client types for discovery (including Spring Boot, Java, and NodeJS)
- Contains enablers that allow for easy discovery and exposure of REST APIs and Swagger documentation for each microservice

API Mediation Layer architecture

The following diagram illustrates the single point of access with the API Gateway and the interactions between the API Gateway, API Catalog, and the Discovery Service:



Components

The API Layer consists of the following key components:

API Gateway

The microservices that are contained within the ecosystem are located behind a reverse proxy. Clients interact with the gateway layer (reverse proxy). This layer forwards API requests to the appropriate corresponding service through the microservice endpoint UI. The gateway is built using Netflix Zuul and Spring Boot technology.

Discovery Service

The Discovery service is the central point in the API Gateway infrastructure that accepts "announcements of REST services" and serves as a repository of active services. Back-end microservices register with this service either directly by using a Eureka client. Non-Spring Boot applications register with the Discover Service indirectly through a Sidecar. The Discovery Service is built on Eureka and Spring Boot technology.

API Catalog

The API Catalog is the catalog of published APIs and their associated documentation that are discoverable or can be available if provisioned from the service catalog. The API documentation is visualized using the Swagger UI. The API Catalog contains APIs of services available as product versions.

A service can be implemented by one or more service instances, which provide exactly the same service for high-availability or scalability.

More Information: - Onboard an existing Spring Boot REST API service using Zowe API Mediation Layer - Using API Catalog

Zowe API Mediation Layer Third-Party software agreements

Zowe API Mediation Layer uses the following third-party software:

Third-party Software	Version	File name
angular	5.2.0	Legal_Doc_00002377_15.pdf
angular2-notifications	0.9.5	Legal_Doc_00002499_11.pdf
Apache Tomcat	8.0.39	Legal_Doc_00001505_6.pdf
Bootstrap	3.0.3	Legal_Doc_12955_5.pdf
Bootstrap	3.3.7	Legal_Doc_00001682_11.pdf
bootstrap-submenu	2.0.4	Legal_Doc_00001456_44.pdf
Commons Validator	1.6.0	Legal_Doc_00002105_1.pdf
copy-webpack-plugin	4.4.1	Legal_Doc_00002499_13.pdf
core-js	2.5.3	Legal_Doc_corejs_MIT.pdf
eureka-client	1.8.6	Legal_Doc_00002499_3.pdf
eventsource	1.0.5	Legal_Doc_00002499_9.pdf
google-gson	2.8.2	Legal_Doc_00002252_4.pdf
Guava	23.2-jre	Legal_Doc_00002499_22.pdf
H2	1.4.196	Legal_Doc_00002499_19.pdf
hamcrest	1.3	Legal_Doc_00001170_33.pdf
httpclient	4.5.3	Legal_Doc_00001843_2.pdf
jackson	2.9.2	Legal_Doc_00002259_6.pdf
jackson	2.9.3	Legal_Doc_00001505_16.pdf
javamail	1.4.3	Legal_Doc_00000439_22.pdf
javax servlet api	3.1.0	Legal_Doc_00002499_23.pdf
javax.validation	2.0.1.Final	Legal_Doc_00002499_27.pdf
Jersey	2.26	Legal_Doc_00002499_2.pdf
Jersey Media JSON Jackson	2.26	Legal_Doc_00002019_68.pdf
jquery	2.0.3	Legal_Doc_00000379_69.pdf
JSON Web Token	0.8.0	Legal_Doc_00002499_21.pdf
json-path	2.4.0	Legal_Doc_00001454_30.pdf
lodash	4.17.5	Legal_Doc_00002499_8.pdf
Logback	1.0.1	Legal_Doc_00002499_1.pdf
lombok	1.16.20	Legal_Doc_00002499_18.pdf
mockito	2.15.0	Legal_Doc_00002499_28.pdf

Third-party Software	Version	File name
netflix-infix	0.3.0	Legal_Doc_00002499_4.pdf
ng2-cookies	1.0.12	Legal_Doc_00002499_15.pdf
ng2-destroy-subscribers	0.0.28	Legal_Doc_00002499_16.pdf
ng2-simple-timer	1.3.3	Legal_Doc_00002499_17.pdf
NPM	5.6.0	Legal_Doc_00002499_10.pdf
powermock	1.7.3	Legal_Doc_00002499_25.pdf
reactor-core	3.0.7.RELEASE	Legal_Doc_00001938_51.pdf
Roaster	2.20.1.Final	Legal_Doc_00002499_20.pdf
RxJS	5.5.6	Legal_Doc_rxjs_Apache.pdf
Spring Cloud Config	2.0.0.M9	Legal_Doc_00002499_33.pdf
Spring Hateoas	0.23.0.RELEASE	Legal_Doc_00002377_10.pdf
Spring Retry	1.2.2	Legal_Doc_00002499_14.pdf
spring security	5.0.3.RELEASE	Legal_Doc_00002499_29.pdf
spring-boot	2.0.0.RELEASE	Legal_Doc_spring_boot_Apache.pdf
Spring-Cloud-Netflix	2.0.0.M8	Legal_Doc_00002499_30.pdf
Springfox	2.8.0	Legal_Doc_00002499_31.pdf
spring-ws	3.0.0.RELEASE	Legal_Doc_00002499_32.pdf
swagger-core	1.5.18	Legal_Doc_00002499_24.pdf
swagger-jersey2-jaxrs	1.5.17	Legal_Doc__00001528_32.pdf
swagger-schema-ts	2.0.8	Legal_Doc_00002499_12.pdf
zone.js	0.8.20	Legal_Doc_zonejs_MIT.pdf

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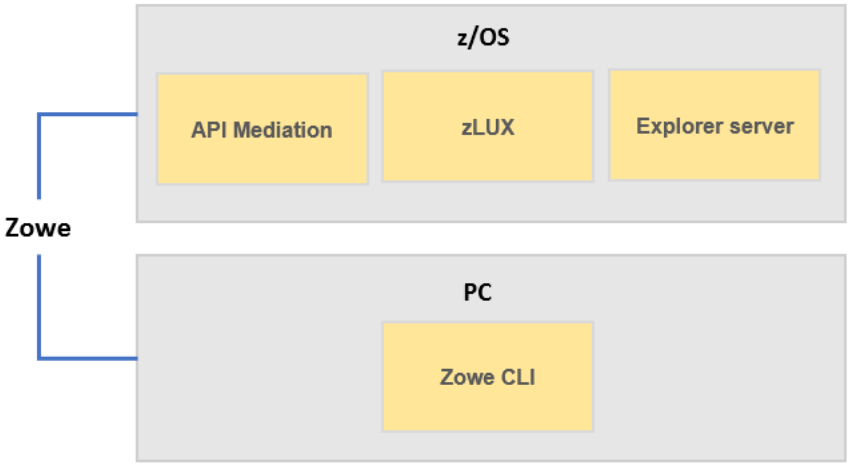
To read each complete license, navigate to the GitHub repository and download the file named Zowe_APIML_TPSRs.zip. The .zip file contains the licenses for all of the third-party components that Zowe API Mediation Layer uses.

Chapter 2. Installing Zowe

Zowe consists of four main components: zLUX, the explorer server, API Mediation Layer, and Zowe CLI. You install zLUX, the explorer server, and API Mediation on z/OS and install Zowe CLI on PC. The installations on z/OS and on PC are independent.



To get started with installing Zowe, review the Installation roadmap topic.

Installation roadmap

Installing Zowe involves several steps that you must complete in the appropriate sequence. Review the following installation roadmap that presents the task-flow for preparing your environment and installing and configuring Zowe before you begin the installation process.

Tasks	Description
1. Prepare your environment to meet the installation requirements.	See System requirements.
2. Obtain the Zowe installation files.	The Zowe installation files are released in a PAX file format. The PAX file contains the runtimes and the scripts to install and launch the z/OS runtime, as well as the Zowe CLI package. For information about how to download, prepare, and install the Zowe runtime, see Obtaining the installation files.
3. Allocate enough space for the installation.	The installation process requires approximately 1 GB of available space. Once installed on z/OS, API Mediation Layer requires approximately 150MB of space, zLUX requires approximately 50 MB of space before configuration, and explorer server requires approximately 200 MB. Zowe CLI requires approximately 200 MB of space on your PC.
4. Install components of Zowe.	To install Zowe runtime (zLUX, explorer server, and API Mediation Layer) on z/OS, see Installing the Zowe runtime on z/OS. To install Zowe CLI on PC, see Installing Zowe CLI.

Tasks	Description
5. Verify that Zowe is installed correctly.	To verify that zLUX, explorer server, and API Mediation Layer are installed correctly, see Verifying installation. To verify that Zowe CLI is installed correctly, see Testing connection to z/OSMF.
6. Optional: Troubleshoot problems that occurred during installation.	See Troubleshooting the installation.

To uninstall Zowe, see Uninstalling Zowe.

System requirements

Before installing Zowe, ensure that your environment meets all of the prerequisites.

1. Ensure that IBM z/OS Management Facility (z/OSMF) is installed and configured correctly. z/OSMF is a prerequisite for the Zowe microservice that must be installed and running before you use Zowe. For details, see z/OSMF requirements.
2. Review component specific requirements.
   - System requirements for zLUX, explorer server, and API Mediation
   - System requirements for Zowe CLI

z/OSMF requirements

The following information contains procedures and tips for meeting z/OSMF requirements. For complete information, go to IBM Knowledge Center and read the following documents.

- IBM z/OS Management Facility Configuration Guide
- IBM z/OS Management Facility Help

z/OS requirements

Ensure that the z/OS system meets the following requirements:

Requirements	Description	Resources in IBM Knowledge Center
AXE (System REXX)	z/OS uses AXR (System REXX) component to perform Incident Log tasks. The component enables REXX executable files to run outside of conventional TSO and batch environments.	System REXX
Common Event Adapter (CEA) server	The CEA server, which is a co-requisite of the Common Information Model (CIM) server, enables the ability for z/OSMF to deliver z/OS events to C-language clients.	Customizing for CEA
Common Information Model (CIM) server	z/OSMF uses the CIM server to perform capacity-provisioning and workload-management tasks. Start the CIM server before you start z/OSMF (the IZU* started tasks).	Reviewing your CIM server setup

Requirements	Description	Resources in IBM Knowledge Center
CONSOLE and CONSPROF commands	The CONSOLE and CONSPROF commands must exist in the authorized command table.	Customizing the CONSOLE and CONSPROF commands
IBM z/OS Provisioning Toolkit	The IBM® z/OS® Provisioning Toolkit is a command line utility that provides the ability to provision z/OS development environments. If you want to provision CICS or Db2 environments with the Zowe CLI, this toolkit is required.	What is IBM Cloud Provisioning and Management for z/OS?
Java level	IBM® 64-bit SDK for z/OS®, Java Technology Edition V7.1 or later is required.	Software prerequisites for z/OSMF
TSO region size	To prevent **exceeds maximum region size** errors, verify that the TSO maximum region size is a minimum of 65536 KB for the z/OS system.	N/A
User IDs	User IDs require a TSO segment (access) and an OMVS segment. During workflow processing and REST API requests, z/OSMF might start one or more TSO address spaces under the following job names: userid; substr(userid, 1, 6) CN (Console).	N/A

Configuring z/OSMF

1. From the console, issue the following command to verify the version of z/OS:

   ```
   /D IPLINFO
   ```

   Part of the output contains the release, for example,

   ```
   RELEASE z/OS 02.02.00.
   ```

2. Configure z/OSMF.

   z/OSMF is a base element of z/OS V2.2 and V2.3, so it is already installed. But it might not be configured and running on every z/OS V2.2 and V2.3 system.

   In short, to configure an instance of z/OSMF, run the IBM-supplied jobs IZUSEC and IZUMKFS, and then start the z/OSMF server. The z/OSMF configuration process occurs in three stages, and in the following order: - Stage 1 - Security setup - Stage 2 - Configuration - Stage 3 - Server initialization

This stage sequence is critical to a successful configuration. For complete information about how to configure z/OSMF, see Configuring z/OSMF if you use z/OS V2.2 or Setting up z/OSMF for the first time if V2.3.

Note: In z/OS V2.3, the base element z/OSMF is started by default at system initial program load (IPL). Therefore, z/OSMF is available for use as soon as you set up the system. If you prefer not to start z/OSMF automatically, disable the autostart function by checking for START commands for the z/OSMF started procedures in the *COMMNDxx parmlib* member.

The z/OS Operator Consoles task is new in Version 2.3. Applications that depend on access to the operator console such as Zowe CLI's RestConsoles API require Version 2.3.

1. Verify that the z/OSMF server and angel processes are running. From the command line, issue the following command:

   ```
   /D A,IZU*
   ```

   If jobs IZUANG1 and IZUSVR1 are not active, issue the following command to start the angel process:

   ```
   /S IZUANG1
   ```

   After you see the message ""CWWKB0056I INITIALIZATION COMPLETE FOR ANGEL"", issue the following command to start the server:

   ```
   /S IZUSVR1
   ```

   The server might take a few minutes to initialize. The z/OSMF server is available when the message ""CWWKF0011I: The server zosmfServer is ready to run a smarter planet."" is displayed.
2. Issue the following command to find the startup messages in the SDSF log of the z/OSMF server:

   ```
   f IZUG349I
   ```

   You could see a message similar to the following message, which indicates the port number:

   ```
   IZUG349I: The z/OSMF STANDALONE Server home page can be accessed at  https://
   mvs.hursley.ibm.com:443/zosmf after the z/OSMF server is started on your system.
   ```

   In this example, the port number is 443. You will need this port number later.

   Point your browser at the nominated z/OSMF STANDALONE Server home page and you should see its Welcome Page where you can log in.

z/OSMF REST services for the Zowe CLI

The Zowe CLI uses z/OSMF Representational State Transfer (REST) APIs to work with system resources and extract system data. Ensure that the following REST services are configured and available.

z/OSMF REST services	**Requirements**	**Resources in IBM knowledge Center**
Cloud provisioning services	Cloud provisioning services are required for the Zowe CLI CICS and Db2 command groups. Endpoints begin with `/zosmf/provisioning/`	Cloud provisioning services
TSO/E address space services	TSO/E address space services are required to issue TSO commands in the Zowe CLI. Endpoints begin with `/zosmf/tsoApp`	TSO/E address space services
z/OS console services	z/OS console services are required to issue console commands in the Zowe CLI. Endpoints begin with `/zosmf/restconsoles/`	z/OS console

z/OSMF REST services	Requirements	Resources in IBM knowledge Center
z/OS data set and file REST interface	z/OS data set and file REST interface is required to work with mainframe data sets and UNIX System Services files in the Zowe CLI. Endpoints begin with `/zosmf/restfiles/`	z/OS data set and file interface
z/OS jobs REST interface	z/OS jobs REST interface is required to use the zos-jobs command group in the Zowe CLI. Endpoints begin with `/zosmf/restjobs/`	z/OS jobs interface
z/OSMF workflow services	z/OSMF workflow services is required to create and manage z/OSMF workflows on a z/OS system. Endpoints begin with `/zosmf/workflow/`	z/OSMF workflow services

Zowe uses symbolic links to the z/OSMF `bootstrap.properties`, `jvm.security.override.properties`, and `ltpa.keys` files. Zowe reuses SAF, SSL, and LTPA configurations; therefore, they must be valid and complete.

For more information, see Using the z/OSMF REST services in IBM z/OSMF documentation.

To verify that z/OSMF REST services are configured correctly in your environment, enter the REST endpoint into your browser. For example: https://mvs.ibm.com:443/zosmf/restjobs/jobs

Note:

- Browsing z/OSMF endpoints requests your user ID and password for defaultRealm; these are your TSO user credentials.
- The browser returns the status code 200 and a list of all jobs on the z/OS system. The list is in raw JSON format.

System requirements for zLUX, explorer server, and API Mediation Layer

zLUX, explorer server, and API Mediation Layer are installed together. Before the installation, make sure your system meets the following requirements:

- z/OS® Version 2.2 or later.
- 64-bit Java™ 8 JRE or later.
- 833 MB of HFS file space.
- Supported browsers:
  - Chrome 54 or later
  - Firefox 44 or later
  - Safari 11 or later
  - Microsoft Edge
- Node.js Version 6.11.2 or later on the z/OS host where you install the Zowe Node Server.
  1. To install Node.js on z/OS, follow the procedures at https://developer.ibm.com/node/sdk/ztp. Note that installation of the C/C++ compiler is not necessary for running zLUX.
  2. Set the *NODE_HOME* environment variable to the directory where Node.js is installed. For example, `NODE_HOME=/proj/mvd/node/installs/node-v6.11.2-os390-s390x`.
- npm 5.4 or later for building zLUX applications.

To update npm, issue the following command:

```
npm install -g npm
```

Planning for installation

The following information is required during the installation process. Make the decisions before the installtion.

- The HFS directory where you install Zowe, for example, `/var/zowe`.
- The HFS directory that contains a 64-bit Java™ 8 JRE.
- The z/OSMF installation directory that contains `derby.jar`, for example, `/usr/lpp/zosmf/lib`.
- The z/OSMF configuration user directory that contains the following z/OSMF files:
  - `/bootstrap.properties`
  - `/jvm.security.override.properties`
  - `/resources/security/ltpa.keys`
- The HTTP and HTTPS port numbers of the explorer server. By default, they are 7080 and 7443.
- The API Mediation Layer HTTP and HTTPS port numbers. You will be asked for 3 unique port numbers.
- The user ID that runs the Zowe started task.

  Tip: Use the same user ID that runs the z/OSMF `IZUSVR1` task, or a user ID with equivalent authorizations.
- The mainframe account under which the ZSS server runs must have UPDATE permission on the `BPX.DAEMON` and `BPX.SERVER` facility class profiles.

System requirements for Zowe CLI

Before you install Zowe CLI, make sure your system meets the following requirements:

Supported platforms

You can install Zowe CLI on any Windows or Linux operating system. For more information about known issues and workarounds, see Troubleshooting installing Zowe CLI.

Important!

- Zowe CLI is not officially supported on Mac computers. However, Zowe CLI *might* run successfully on some Mac computers.
- Oracle Linux 6 is not supported.

Free disk space

Zowe CLI requires approximately **100 MB** of free disk space. The actual quantity of free disk space consumed might vary depending on the operating system where you install Zowe CLI.

Prerequisite software

Zowe CLI is designed and tested to integrate with z/OSMF running on IBM z/OS Version 2.2 or later. Before you can use Zowe CLI to interact with the mainframe, system programmers must install and configure IBM z/OSMF in your environment. This section provides supplemental information about Zowe CLI-specific tips or requirements that system programmers can refer to.

Before you install Zowe CLI, also install the following prerequisite software depending on the system where you install Zowe CLI:

Note: It's highly recommended that you update Node.js regularly to the latest Long Term Support (LTS) version.

Windows operating systems

Windows operating systems require the following software:

- Node.js V8.0 or later

  Click here to download Node.js.
- Node Package Manager (npm) V5.0 or later

  Note: npm is included with the Node.js installation.
- Python V2.7

  The command that installs C++ Compiler also installs Python on Windows.
- C++ Compiler (gcc 4.8.1 or later)

  From an administrator command prompt, issue the following command:

```
npm install --global --production --add-python-to-path windows-build-tools
```

Mac operating systems

Mac operating systems require the following software:

- Node.js V8.0 or later

  Click here to download Node.js.
- Node Package Manager (npm) V5.0 or later

  Note: npm is included with the Node.js installation.

  Tip: If you install Node.js on a macOS operating system, it's highly recommended that you follow the instructions on the Node.js website (using package manager) to install `nodejs` and `nodejs-legacy`. For example, you can issue command `sudo apt install nodejs-legacy` to install `nodejs-legacy`. With `nodejs-legacy`, you can issue command `node` rather than `nodejs`.
- Python V2.7

  Click here to download Python 2.7.
- C ++ Compiler (gcc 4.8.1 or later)

  The gcc compiler is included with macOS. To confirm that you have the compiler, issue the command `gcc –help`.

Linux operating systems

Linux operating systems require the following software:

- Node.js V8.0 or later

  Click here to download Node.js.
- Node Package Manager (npm) V5.0 or later

  Note: npm is included with the Node.js installation.

  Tip: If you install Node.js on a Linux operating system, it's highly recommended that you follow the instructions on the Node.js website (using package manager) to install `nodejs` and `nodejs-legacy`. For example, you can issue command `sudo apt install nodejs-legacy` to install `nodejs-legacy`. With `nodejs-legacy`, you can issue command `node` rather than `nodejs`.
- Python V2.7

  Included with most Linux distributions.
- C ++ Compiler (gcc 4.8.1 or later)

  Gcc is included with most Linux distributions. To confirm that gcc is installed, issue the command `gcc –version`.

To install gcc, issue one of the following commands:

- Red Hat

```
sudo yum install gcc
```

- Debian/Ubuntu

```
sudo apt-get update
```

```
sudo apt-get install build-essential
```

- Arch Linux

```
sudo pacman -S gcc
```

- Libsecret

  To install Libsecret, issue one of the following commands:

  - Red Hat

```
sudo yum install libsecret-devel
```

  - Debian/Ubuntu

```
sudo apt-get install libsecret-1-dev
```

  - Arch Linux

```
sudo pacman -S libsecret
```

- Make

  Make is included with most Linux distributions. To confirm that Make is installed, issue the command `make --version`.

  To install Make, issue one of the following commands:

  - Red Hat

```
sudo yum install devtoolset-7
```

  - Debian/Ubuntu

```
sudo apt-get install build-essential
```

  - Arch Linux

```
sudo pacman -S base-devel
```

Obtaining installation files

The Zowe installation files are distributed as a PAX file that contains the runtimes and the scripts to install and launch the z/OS runtime and the runtime for the command line interface. For each release, there is a PAX file named `zowe-v.r.m.pax`, where

- `v` indicates the version
- `r` indicates the release number
- `m` indicates the modification number

The numbers are incremented each time a release is created so the higher the numbers, the later the release. Use your web browser to download the PAX file by saving it to a folder on your desktop.

You can download the PAX file from the Zowe website. After you obtain the PAX file, verify the PAX file and prepare it to install the Zowe runtime.

Follow these steps:

1. Verify the downloaded PAX file.

   After you download the PAX file, verify the integrity of the PAX file to ensure that the file you download is officially distributed by the Zowe project.

   Notes:

   - The commands in the following steps are tested on both Mac OS X V10.13.6 and Ubuntu V16.04 and V17.10.
   - Ensure that you have GPG installed. Click here to download and install GPG.
   - The `v.r.m` in the commands of this step is a variable. You must replace it with the actual PAX file version, for example, `0.9.0`.

   a. Verify the hash code.

   Download the hash code file `zowe-v.r.m.pax.sha512` from the Zowe website. Then, run the following commands to check:

   ```
   (gpg --print-md SHA512 zowe-v.r.m.pax > zowe-v.r.m.pax.sha512.my) && diff zowe-v.r.m.pax.sha512.my zowe-v.r.m.pax.sha512 && echo matched || echo "not match"
   ```

   When you see "matched", it means the PAX file that you download is the same one that is officially distributed by the Zowe project. You can delete the temporary "zowe-v.r.m.pax.sha512.my" file.

   You can also use other commands such as `sha512`, `sha512sum`, or `openssl dgst -sha512` to generate SHA512 hash code. These hash code results are in a different format from what Zowe provides but the values are the same.

   b. Verify with signature file.

   In addition to the SHA512 hash, the hash is also verifiable. This is done by digitally signing the hash text file with a KEY from one of the Zowe developers.

   Follow these steps:

   a. Download the signature file `zowe-v.r.m.pax.asc` from Zowe website, and download the public key KEYS from https://github.com/zowe/release-management/.

   b. Import the public key with command `gpg --import KEYS`.

   c. If you never use gpg before, generate keys with command `gpg --gen-key`.

   d. Sign the downloaded public key with command `gpg --sign-key DC8633F77D1253C3`.

   e. Verify the file with command `gpg --verify zowe-v.r.m.pax.asc zowe-v.r.m.pax`.

   f. Optional: You can remove the imported key with command: `gpg --delete-key DC8633F77D1253C3`.

   When you see output similar to the followin one, it means the PAX file that you download is the same one that is officially distributed by the Zowe project.

   ```
   gpg: Signature made Tue 14 Aug 2018 08:29:46 AM EDT gpg: using RSA key DC8633F77D1253C3 gpg: Good signature from "Matt Hogstrom (CODE SIGNING KEY) " [full]
   ```

2. Transfer the PAX file to z/OS.

   a. Open a terminal in Mac OS/Linux, or command prompt in Windows OS, and navigate to the directory where you downloaded the Zowe PAX file.

   b. Connect to z/OS using SFTP. Issue the following command:

   ```
   sftp <userID@ip.of.zos.box>
   ```

If SFTP is not available or if you prefer to use FTP, you can issue the following command instead:

```
ftp <userID@ip.of.zos.box>
```

Note: When you use FTP, switch to binary file transfer mode by issuing the following command:

```
bin
```

c. Navigate to the target directory that you wish to transfer the Zowe PAX file into on z/OS.

Note: After you connect to z/OS and enter your password, you enter into the Unix file system. The following commands are useful:

- To see what directory you are in, type `pwd`.
- To switch directory, type `cd`.
- To list the contents of a directory, type `ls`.
- To create a directory, type `mkdir`.

d. When you are in the directory you want to transfer the Zowe PAX file into, issue the following command:

```
put <pax-file-name>.pax
```

Where *pax-file-name* is a variable that indicates the full name of the PAX file you downloaded.

Note: When your terminal is connected to z/OS through FTP or SFTP, you can prepend commands with `l` to have them issued against your desktop. To list the contents of a directory on your desktop, type `lls` where `ls` will list contents of a directory on z/OS.

3. When the PAX file is transferred, expand the PAX file by issuing the following command in an ssh session:

```
pax -ppx -rf <pax-file-name>.pax
```

Where *pax-file-name* is a variable that indicates the name of the PAX file you downloaded.

This will expand to a file structure.

```
/files
/install
/scripts
...
```

Note: The PAX file will expand into the current directory. A good practice is to keep the installation directory apart from the directory that contains the PAX file. To do this, you can create a directory such as `/zowe/paxes` that contains the PAX files, and another such as `/zowe/builds`. Use SFTP to transfer the Zowe PAX file into the `/zowe/paxes` directory, use the `cd` command to switch into `/zowe/builds` and issue the command `pax -ppx -rf ../paxes/<zowe-v.r.m>.pax`. The `/install` folder will be created inside the `zowe/builds` directory from where the installation can be launched.

Installing zLUX, explorer server, and API Mediation Layer

You install zLUX, explorer server, and API Mediation Layer on z/OS.

Before you install the runtime on z/OS, ensure that your environment meets the requirements. See System requirements.

Installing the Zowe runtime on z/OS

To install API Mediation Layer, zLUX, and explorer server, you install the Zowe runtime on z/OS.

Follow these steps:

1. Navigate to the directory where the installation archive is extracted. Locate the `/install` directory.

```
     /install
        /zowe-install.sh
        /zowe-install.yaml
```

2. Review the `zowe-install.yaml` file which contains the following properties:

   - `install:rootDir` is the directory that Zowe will be installed into to create a Zowe runtime. The default directory is `~/zowe/0.9.0`. The user's home directory is the default value to ensure that the installing user has permission to create the directories that are required for the install. If the Zowe runtime will be maintained by multiple users it might be more appropriate to use another directory, such as `/var/zowe/v.r.m`.

   You can run the installation process multiple times with different values in the `zowe-install.yaml` file to create separate installations of the Zowe runtime. The directory that Zowe is installed into must be empty. The install script exits if the directory is not empty and creates the directory if it does not exist.

   - API Mediation Layer has three ports - two HTTP ports and one HTTPS port, each for a micro-service.
   - Explorer-server has two ports - one for HTTP and one for HTTPS. The liberty server is used for the explorer-ui components.
   - zLUX-server has three ports - the HTTP and HTTPS ports that are used by the zLUX window manager server, and the port that is used by the ZSS server.

```
install:
 rootDir=/var/zowe/0.9.0

api-mediation:
  catalogHttpPort=7552
  discoveryHttpPort=7553
  gatewayHttpsPort=7554

explorer-server:
  httpPort=7080
  httpsPort=7443

# http and https ports for the node server
zlux-server:
  httpPort=8543
  httpsPort=8544
  zssPort=8542
```

   If all of the default port values are acceptable, then you do not need to change them. The ports must not be in use for the Zowe runtime servers to be able to allocate them.

   To determine which ports are not available, follow these steps:

   - To display a list of ports that are in use, issue the following command:

```
TSO NETSTAT
```

   - To display a list of reserved ports, issue the following command:

```
TSO NETSTAT PORTLIST
```

   The `zowe-install.yaml` also contains the telnet and SSH port with defaults of 23 and 22. If your z/OS LPAR is using different ports, edit the values. This is to allow the TN3270 terminal desktop application to connect as well as the VT terminal desktop application. Unlike the ports needed by the Zowe runtime for its zLUX and explorer server which must be unused, the terminal ports are expected to be in use.

```
# Ports for the TN3270 and the VT terminal to connect to
terminals:
    sshPort=22
    telnetPort=23
```

3. Execute the `zowe-install.sh` script.

   With the current directory being the `/install` directory, execute the script `zowe-install.sh` by issuing the following command:

   ```
   zowe-install.sh
   ```

   You might receive the following error that the file cannot be executed.

   ```
   zowe-install.sh: cannot execute
   ```

   The error is due to that the install script does not have execute permission. To add execute permission, issue the following command:

   ```
   chmod u+x zowe-install.sh.
   ```

4. Configure Zowe as a started task.

   The ZOWESVR must be configured as a started task (STC) under the IZUSVR user ID.

   - If you use RACF, issue the following commands:

     ```
     RDEFINE STARTED ZOWESVR.* UACC(NONE) STDATA(USER(IZUSVR) GROUP(IZUADMIN) PRIVILEGED(NO)
      TRUSTED(NO) TRACE(YES))
     SETROPTS REFRESH RACLIST(STARTED)
     ```

   - If you use CA ACF2, issue the following commands:

     ```
     SET CONTROL(GSO)
     INSERT STC.ZOWESVR LOGONID(ZIUSVR) GROUP(IZUADMIN) STCID(ZOWESVR)
     F ACF2,REFRESH(STC)
     ```

   - If you use CA Top Secret, issue the following commands:

     ```
     TSS ADDTO(STC) PROCNAME(ZOWESVR) ACID(IZUSVR)
     ```

5. Add the users to the required groups, IZUADMIN for administrators and IZUUSER for standard users.

   - If you use RACF, issue the following command:

     ```
     CONNECT (userid) GROUP(IZUADMIN)
     ```

   - If you use CA ACF2, issue the following commands:

     ```
     ACFNRULE TYPE(TGR) KEY(IZUADMIN) ADD(UID(<uid string of user>) ALLOW)
     F ACF2,REBUILD(TGR)
     ```

   - If you use CA Top Secret, issue the following commands:

     ```
     TSS ADD(userid)  PROFILE(IZUADMIN)
     TSS ADD(userid)  GROUP(IZUADMGP)
     ```

   When the `zowe-install.sh` script runs, it performs a number of steps broken down into sections. These are covered more in the section Troubleshooting the installation.

Starting and stopping the Zowe runtime on z/OS

Zowe has three runtime components on z/OS, the explorer server, the zLUX server, and API Mediation Layer. When you run the ZOWESVR PROC, it starts all these components. The zLUX server startup script also starts the zSS server, so starting the ZOWESVR PROC starts all the four servers, and stopping it stops all four.

Starting the ZOWESVR PROC

To start the ZOWESVR PROC, run the `zowe-start.sh` script at the Unix Systems Services command prompt:

```
cd $ZOWE_ROOT_DIR/scripts
./zowe-start.sh
```

where *$ZOWE_ROOT_DIR* is the directory where you installed the Zowe runtime. This script starts the ZOWESVR PROC for you so you don't have to log on to TSO and use SDSF.

Note: The default startup allows self signed and expired certificates from zLUX proxy data services such as the explorer server.

If you prefer to use SDSF to start Zowe, start ZOWESVR by issuing the following operator command in SDSF:

```
/S ZOWESVR
```

By default, Zowe uses the runtime version that you most recently installed. To start a different runtime, specify its server path on the START command:

```
/S ZOWESVR,SRVRPATH='$ZOWE_ROOT_DIR/explorer-server'
```

To test whether the explorer server is active, open the URL `https://<hostname>:7443/explorer-mvs`.

The port number 7443 is the default port and can be overridden through the `zowe-install.yaml` file before the `zowe-install.sh` script is run. See Installing Zowe runtime on z/OS.

Stopping the ZOWESVR PROC

To stop the ZOWESVR PROC, run the `zowe-stop.sh` script at the Unix Systems Services command prompt:

```
cd $ZOWE_ROOT_DIR/scripts
./zowe-stop.sh
```

If you prefer to use SDSF to stop Zowe, stop ZOWESVR by issuing the following operator command in SDSF:

```
/C ZOWESVR
```

Either of the methods will stop the explorer server, the zLUX server, and the zSS server.

When you stop the ZOWESVR, you might get the following error message:

```
IEE842I ZOWESVR DUPLICATE NAME FOUND- REENTER COMMAND WITH 'A='
```

This is because there is more than one started task named ZOWESVR. To resolve the issue, stop the required ZOWESVR instance by issuing the following commands:

```
/C ZOWESVR,A=asid
```

You can obtain the *asid* from the value of `A=asid` when you issue the following commands:

```
/D A,ZOWESVR
```

Verifying installation

After you complete the installation of API Mediation, zLUX, and explorer server, use the following procedures to verify that the components are installed correctly and are functional.

Verifying zLUX installation

If zLUX is installed correctly, you can open the MVD from a supported browser.

From a supported browser, open the MVD at `https://myhost:httpsPort/ZLUX/plugins/com.rs.mvd/web/index.html`

where:

- *myHost* is the host on which you installed the Zowe Node Server.
- *httpPort* is the port number that is assigned to *node.http.port* in `zluxserver.json`.
- *httpsPort* is the port number that is assigned to *node.https.port* in `zluxserver.json`. For example, if the Zowe Node Server runs on host *myhost* and the port number that is assigned to *node.http.port* is 12345, you specify `https://myhost:12345/ZLUX/plugins/com.rs.mvd/web/index.htm`.

Verifying explorer server installation

After explorer server is installed and the ZOWESVR procedure is started, you can verify the installation from an Internet browser by using the following case-sensitive URL:

`https://<your.server>:<atlasport>/Atlas/api/system/version`

where *your.server* is the host name or IP address of the z/OS® system where explorer server is installed, and *atlasport* is the port number that is chosen during installation. You can verify the port number in the `server.xml` file that is located in the explorer server installation directory, which is `/var/zowe/explorer-server/wlp/usr/servers/Atlas/server.xml` by default. Look for the `httpsPort` assignment in the `server.xml` file, for example: httpPort="7443".

This URL sends an HTTP GET request to the Liberty Profile explorer server. If explorer server is installed correctly, a JSON payload that indicates the current explorer server application version is returned. For example:

```
{ "version": "V0.0.1" }
```

Note: The first time that you interact with the explorer server, you are prompted to enter an MVS™ user ID and password. The MVS user ID and password are passed over the secure HTTPS connection to establish authentication.

After you verify that explorer server is successfully installed, you can access the UI at the following URLs:

- `https://<your.server>:<atlasport>/explorer-jes/#/`
- `https://<your.server>:<atlasport>/explorer-mvs/#/`
- `https://<your.server>:<atlasport>/explorer-uss/#/`

If explorer server is not installed successfully, see Troubleshooting installation for solutions.

Verifying the availability of explorer server REST APIs

To verify the availability of all explorer server REST APIs, use the Liberty Profile's REST API discovery feature from an internet browser with the following URL. This URL is case-sensitive.

`https://<your.server>:<atlasport>/ibm/api/explorer`

With the discovery feature, you can also try each discovered API. The users who verify the availability must have access to their data sets and job information by using relevant explorer server APIs. This ensures that your z/OSMF configuration is valid, complete, and compatible with the explorer server application. For example, try the following APIs:

Explorer server: JES Jobs APIs

`GET /Atlas/api/jobs`

This API returns job information for the calling user.

Explorer server: Data set APIs

`GET /Atlas/api/datasets/userid.**`

This API returns a list of the userid.** MVS data sets.

Verifying API Mediation installation

Use your preferred REST API client to review the value of the status variable of the API Catalog service that is routed through the API Gateway using the following URL:

```
https://hostName:basePort/api/v1/apicatalog/application/state
```

The `hostName` is set during install, and `basePort` is set as the `gatewayHttpsPort` parameter.

Example:

The following example illustrates how to use the **curl** utility to invoke API Mediation Layer endpoint and the **grep** utility to parse out the response status variable value

```
$ curl -v -k --silent https://hostName:basePort/api/v1/apicatalog/application/state 2>&1 | grep
 -Po '(?<=\"status\"\:\")[^\"]+'
UP
```

The response UP confirms that API Mediation Layer is installed and is running properly.

Installing Zowe CLI

As a systems programmer or application developer, you install Zowe CLI on your PC.

Methods to install Zowe CLI

You can use either of the following methods to install Zowe CLI. - Install Zowe CLI from local package - Install Zowe CLI from Bintray registry

Installing Zowe CLI from local package

Install Zowe CLI on PCs that are running a Windows, Linux, or macOS operating system.

Follow these steps:

1. Address the prerequisites.
2. Obtain the Zowe installation files, which includes the zowe-cli-bundle.zip file. Use FTP to distribute the zowe-cli-bundle.zip file to client workstations.
3. Open a command line window. For example, Windows Command Prompt. Browse to the directory where you downloaded the Zowe CLI installation bundle (.zip file). Issue the following command to unzip the files:

   ```
   unzip zowe-cli-bundle.zip
   ```

   The command expands four TGZ packages into your working directory - Zowe CLI, one plug-in, and the odbc_cli folder.
4. Issue the following command to install Zowe CLI on your PC:

   ```
   npm install -g zowe-cli-1.1.0-next.201808072010.tgz
   ```

   Note: On Linux systems, you might need to prepend `sudo` to your `npm` commands so that you can issue the install and uninstall commands. For more information, see Troubleshooting installing Zowe CLI.

   Zowe CLI is installed on your PC. See Installing Plug-ins for information about the commands for installing plug-ins from the package.
5. Create a `zosmf` profile so that you can issue commands that communicate with z/OSMF.

Note: For information about how to create a profile, see Creating a Zowe CLI profile.

Tip: Zowe CLI profiles contain information that is required for the product to interact with remote systems. For example, host name, port, and user ID. Profiles let you target unique systems, regions, or instances for a command. Most Zowe CLI command groups require a Zowe CLI `zosmf` profile.

After you install and configure Zowe CLI, you can issue the `zowe --help` command to view a list of available commands. For more information, see Display Help.

Installing Zowe CLI from Bintray registry

If your PC is connected to the Internet, you can use the following method to install Zowe CLI from an npm registry.

Follow these steps:

1. Issue the following command to set the registry to the Zowe CLI scoped package on Bintray. In addition to setting the scoped registry, your non-scoped registry must be set to an npm registry that includes all of the dependencies for Zowe CLI, such as the global npm registry:

   ```
   npm config set @brightside:registry https://api.bintray.com/npm/ca/brightside
   ```

2. Issue the following command to install Zowe CLI from the registry:

   ```
   npm install -g @brightside/core@next
   ```

   Zowe CLI is installed on your PC. For information about plug-ins for Zowe CLI, see Extending Zowe CLI.

3. Create a `zosmf` profile so that you can issue commands that communicate with z/OSMF. For information about how to create a profile, see Creating a Zowe CLI profile.

   Tip: Zowe CLI profiles contain information that is required for the product to interact with remote systems. For example, host name, port, and user ID. Profiles let you target unique systems, regions, or instances for a command. Most Zowe CLI command groups require a Zowe CLI `zosmf` profile.

After you install and configure Zowe CLI, you can issue the `zowe --help` command to view a list of available commands. For more information, see How to display Zowe CLI help.

Note: You might encounter problems when you attempt to install Zowe CLI depending on your operating system and environment. For more information and workarounds, see Troubleshooting installing Zowe CLI.

Creating a Zowe CLI profile

Profiles are a Zowe CLI functionality that let you store configuration information for use on multiple commands. You can create a profile that contains your username, password, and connection details for a particular mainframe system, then reuse that profile to avoid typing it again on every command. You can switch between profiles to quickly target different mainframe subsystems.

Important! A `zosmf` profile is required to issue most Zowe CLI commands. The first profile that you create becomes your default profile. When you issue any command that requires a `zosmf` profile, the command executes using your default profile unless you specify a specific profile name on that command.

Follow these steps:

1. To create a `zosmf` profile, issue the following command. Refer to the available options in the help text to define your profile:

   ```
   zowe profiles create zosmf-profile --help
   ```

Note: After you create a profile, verify that it can communicate with z/OSMF. For more information, see (#Testing Zowe CLI connection to z/OSMF).

Testing Zowe CLI connection to z/OSMF

After you configure a Zowe CLI `zosmf` profile to connect to z/OSMF on your mainframe systems, you can issue a command at any time to receive diagnostic information from the server and confirm that your profile can communicate with z/OSMF.

Tip: In this documentation we provide command syntax to help you create a basic profile. We recommend that you append `--help` to the end of commands in the product to see the complete set of commands and options available to you. For example, issue `zowe profiles --help` to learn more about how to list profiles, switch your default profile, or create different profile types.

After you create a profile, run a test to verify that Zowe CLI can communicate properly with z/OSMF. You can test your default profile and any other Zowe CLI profile that you created.

Default profile

- Verify that you can use your default profile to communicate with z/OSMF by issuing the following command:

```
zowe zosmf check status
```

Specific profile

- Verify that you can use a specific profile to communicate with z/OSMF by issuing the following command:

```
zowe zosmf check status --zosmf-profile <profile_name>
```

The commands return a success or failure message and display information about your z/OSMF server. For example, the z/OSMF version number and a list of installed plug-ins. Report any failure to your systems administrator and use the information for diagnostic purposes.

Troubleshooting the installation

Review the following troubleshooting tips and known issues if you have problems with Zowe installation.

Security message when you open MVD

When you initially open the MVD, a security message alerts you that you are attempting to open a site that has an invalid HTTPS certificate. Other applications within the MVD might also encounter this message. To prevent this message, add the URLs that you see to your list of trusted sites.

Note: If you clear the browser cache, you must add the URL to your trusted sites again.

Message ICH408I during runtime

During runtime, the information message ICH408I may present identifying insufficient write authority to a number of resources, these resources may include:

- `zowe/explorer-server/wlp/usr/servers/.pid/Atlas.pid`
- `zowe/zlux-example-server/deploy/site/plugins/`
- `zowe/zlux-example-server/deploy/instance/plugins/`

Note: This should not affect the runtime operations of Zowe. This is a known issue and will be addressed in the next build.

zLUX APIs

zLUX APIs exist but are under development. Features might be reorganized if it simplifies and clarifies the API, and features might be added if applications can benefit from them.

Troubleshooting installing the Zowe runtime

1. Environment variables

   To prepare the environment for the Zowe runtime, a number of ZFS folders need to be located for prerequisites on the platform that Zowe needs to operate. These can be set as environment variables before the script is run. If the environment variables are not set, the install script will attempt to locate default values.

   - ZOWE_ZOSMF_PATH: The path where z/OSMF is installed. Defaults to `/usr/lpp/zosmf/lib/defaults/servers/zosmfServer`
   - ZOWE_JAVA_HOME: The path where 64 bit Java 8 or later is installed. Defaults to `/usr/lpp/java/J8.0_64`
   - ZOWE_EXPLORER_HOST: The IP address of where the explorer servers are launched from. Defaults to running `hostname -c`

   The first time the script is run if it has to locate any of the environment variables, the script will add lines to the current user's home directory `.profile` file to set the variables. This ensures that the next time the same user runs the install script, the previous values will be used.

   Note: If you wish to set the environment variables for all users, add the lines to assign the variables and their values to the file `/etc/.profile`.

   If the environment variables for ZOWE_ZOSMF_PATH, ZOWE_JAVA_HOME are not set and the install script cannot determine a default location, the install script will prompt for their location. The install script will not continue unless valid locations are provided.

2. Expanding the PAX files

   The install script will create the Zowe runtime directory structure using the `install:rootDir` value in the `zowe-install.yaml` file. The runtime components of the Zowe server are then unpaxed into the directory that contains a number of directories and files that make up the Zowe runtime.

   If the expand of the PAX files is successful, the install script will report that it ran its install step to completion.

3. Changing Unix permissions

   After the install script lay down the contents of the Zowe runtime into the `rootDir`, the next step is to set the file and directory permissions correctly to allow the Zowe runtime servers to start and operate successfully.

   The install process will execute the file `scripts/zowe-runtime-authorize.sh` in the Zowe runtime directory. If the script is successful, the result is reported. If for any reason the script fails to run because of insufficient authority by the user running the install, the install process reports the errors. A user with sufficient authority should then run the `zowe-runtime-authorize.sh`. If you attempt to start the Zowe runtime servers without the `zowe-runtime-authorize.sh` having successfully completed, the results are unpredictable and Zowe runtime startup or runtime errors will occur.

4. Creating the PROCLIB member to run the Zowe runtime

   Note: The name of the PROCLIB member might vary depending on the standards in place at each z/OS site, however for this documentation, the PROCLIB member is called ZOWESVR.

   At the end of the installation, a Unix file `ZOWESVR.jcl` is created under the directory where the runtime is installed into, `$INSTALL_DIR/files/templates`. The contents of this file need to be tailored and placed in a JCL member of the PROCLIB concatenation for the Zowe runtime to be executed as a started task. The install script does this automatically, trying data sets `USER.PROCLIB`, other PROCLIB data sets found in the PROCLIB concatenation and finally `SYS1.PROCLIB`.

   If this succeeds, you will see a message like the following one:

   ```
   PROC ZOWESVR placed in USER.PROCLIB
   ```

   Otherwise you will see messages beginning with the following information:

```
Failed to put ZOWESVR.JCL in a PROCLIB dataset.
```

In this case, you need to copy the PROC manually. Issue the TSO `oget` command to copy the `ZOWESVR.jcl` file to the preferred PROCLIB:

```
oget '$INSTALL_DIR/files/templates/ZOWESVR.jcl' 'MY.USER.PROCLIB(ZOWESVR)'
```

You can place the PROC in any PROCLIB data set in the PROCLIB concatenation, but some data sets such as `SYS1.PROCLIB` might be restricted, depending on the permission of the user.

You can tailor the JCL at this line

```
//ZOWESVR PROC SRVRPATH='/zowe/install/path/explorer-server'
```

to replace the `/zowe/install/path` with the location of the Zowe runtime directory that contains the explorer server. Otherwise you must specify that path on the START command when you start Zowe in SDSF:

```
/S ZOWESVR,SRVRPATH='$ZOWE_ROOT_DIR/explorer-server'
```

Troubleshooting installing zLUX

To help zLUX research any problems you might encounter, collect as much of the following information as possible and open an issue in GitHub with the collected information.

- Project Zowe version and release level
- z/OS release level
- Job output and dump (if any)
- Javascript console output (Web Developer toolkit accessible by pressing F12)
- Log output from the Zowe Node Server
- Error message codes
- Screenshots (if applicable)
- Other relevant information (such as the version of Node.js that is running on the Zowe Node Server and the browser and browser version).

Troubleshooting installing explorer server

If explorer server REST APIs do not function properly, check the following items:

- Check whether your Liberty explorer server is running.

  You can check this in the Display Active (DA) panel of SDSF under ISPF. The ZOWESVR started task should be running. If the ZOWESVR task is not running, start the explorer server by using the following START operator command:

  ```
  /S ZOWESVR
  ```

  You can also use the operator command `/D A,ZOWESVR` to verify whether the task is active, which alleviates the need for the DA panel of SDSF. If the started task is not running, ensure that your ZOWESVR procedure resides in a valid PROCLIB data set, and check the task's job output for errors.
- Check whether the explorer server is started without errors.

  In the DA panel of SDSF under ISPF, select the ZOWESVR job to view the started task output. If the explorer server is started without errors, you can see the following messages:

  ```
  CWWKE0001I: The server Atlas has been launched.
  ```

  ```
  CWWKF0011I: The server Atlas is ready to run a smarter planet.
  ```

  If you see error messages that are prefixed with "ERROR" or stack traces in the ZOWESVR job output, respond to them.

- Check whether the URL that you use to call explorer server REST APIs is correct. For example: https://your.server:atlasport/Atlas/api/system/version. The URL is case-sensitive.
- Ensure that you enter a valid z/OS® user ID and password when initially connecting to the explorer server.
- If testing the explorer server REST API for jobs information fails, check the z/OSMF IZUSVR1 task output for errors. If no errors occur, you can see the following messages in the IZUSVR1 job output:

```
CWWKE0001I : The server zosmfServer has been launched.
```

```
CWWKF0011I: The server zosmfServer is ready to run a smarter planet.
```

  If you see error messages, respond to them.

  For RESTJOBS, you can see the following message if no errors occur:

```
CWWKZ0001I: Application IzuManagementFacilityRestJobs started in n.nnn seconds.
```

  You can also call z/OSMF RESTJOBS APIs directly from your Internet browser with a URL, for example,

  https://your.server:securezosmfport/zosmf/restjobs/jobs

  where the *securezosmfport* is 443 by default. You can verify the port number by checking the *izu.https.port* variable assignment in the z/OSMF `bootstrap.properties` file.

  You might get error message IZUG846W, which indicates that a cross-site request forgery (CSRF) was attempted. To resolve the issue, update your browser by adding the `X-CSRF-ZOSMF-HEADER` HTTP custom header to every cross-site request. This header can be set to any value or an empty string (""). For details, see the z/OSMF documentation. If calling the z/OSMF RESTJOBS API directly fails, fix z/OSMF before explorer server can use these APIs successfully.
- If testing the explorer server REST API for data set information fails, check the z/OSMF IZUSVR1 task output for errors and confirm that the z/OSMF RESTFILES services are started successfully. If no errors occur, you can see the following message in the IZUSVR1 job output:

```
CWWKZ0001I: Application IzuManagementFacilityRestFiles started in n.nnn seconds.
```

  You can also call z/OSMF RESTFILES APIs directly from your internet browser with a URL, for example,

  https://your.server:securezosmfport/zosmf/restfiles/ds?dslevel=userid.**

  where the *securezosmfport* is 443 by default. You can verify the port number by checking the *izu.https.port* variable assignment in the z/OSMF `bootstrap.properties` file.

  You might get error message IZUG846W, which indicates that a cross-site request forgery (CSRF) was attempted. To resolve the issue, update your browser by adding the `X-CSRF-ZOSMF-HEADER` HTTP custom header to every cross-site request. This header can be set to any value or an empty string (""). For details, see the z/OSMF documentation. If calling the z/OSMF RESTFILES API directly fails, fix z/OSMF before explorer server can use these APIs successfully.

  Tip: The z/OSMF installation step of creating a valid IZUFPROC procedure in your system PROCLIB might be missed. For more information, see the z/OSMF Configuration Guide.

  The IZUFPROC member resides in your system PROCLIB, which is similar to the following sample:

```
//IZUFPROC PROC ROOT='/usr/lpp/zosmf'  /* zOSMF INSTALL ROOT     */
//IZUFPROC EXEC PGM=IKJEFT01,DYNAMNBR=200
//SYSEXEC  DD DISP=SHR,DSN=ISP.SISPEXEC
//         DD DISP=SHR,DSN=SYS1.SBPXEXEC
//SYSPROC  DD DISP=SHR,DSN=ISP.SISPCLIB
//         DD DISP=SHR,DSN=SYS1.SBPXEXEC
//ISPLLIB  DD DISP=SHR,DSN=SYS1.SIEALNKE
//ISPPLIB  DD DISP=SHR,DSN=ISP.SISPPENU
//ISPTLIB  DD RECFM=FB,LRECL=80,SPACE=(TRK,(1,0,1))
//         DD DISP=SHR,DSN=ISP.SISPTENU
//ISPSLIB  DD DISP=SHR,DSN=ISP.SISPSENU
//ISPMLIB  DD DISP=SHR,DSN=ISP.SISPMENU
//ISPPROF  DD DISP=NEW,UNIT=SYSDA,SPACE=(TRK,(15,15,5)),
```

```
//         DCB=(RECFM=FB,LRECL=80,BLKSIZE=3120)
//IZUSRVMP DD PATH='&ROOT./defaults/izurf.tsoservlet.mapping.json'
//SYSOUT   DD SYSOUT=H
//CEEDUMP  DD SYSOUT=H
//SYSUDUMP DD SYSOUT=H
//
```

Note: You might need to change paths and data sets names to match your installation.

A known issue and workaround for RESTFILES API can be found at TSO SERVLET EXCEPTION ATTEMPTING TO USE RESTFILE INTERFACE.

- Check your system console log for related error messages and respond to them.

If the explorer server cannot connect to the z/OSMF server, check the following item:

By default, the explorer server communicates with the z/OSMF server on the localhost address. If your z/OSMF server is on a different IP address to the explorer server, for example, if you are running z/OSMF with Dynamic Virtual IP Addressing (DVIPA), you can change this by adding a ZOSMF_HOST parameter to the `server.env` file. For example: `ZOSMF_HOST=winmvs27`.

Troubleshooting installing Zowe CLI

The following topics contain information that can help you troubleshoot problems when you encounter unexpected behavior using Zowe CLI.

npm install -gCommand Fails Due to an EPERM Error

Valid on Windows

Symptom:

This behavior is due to a problem with Node Package Manager (npm). There is an open issue on the npm GitHub repository to fix the defect.

Solution:

If you encounter this problem, some users report that repeatedly attempting to install Zowe CLI yields success. Some users also report success using the following workarounds:

- Issue the `npm cache clean` command.
- Uninstall and reinstall Zowe CLI. For more information, see Install Zowe CLI.
- Add `the --no-optional` flag to the end of the `npm install` command.

Sudo syntax required to complete some installations

Valid on Linux

Symptom:

The installation fails on Linux.

Solution:

Depending on how you configured Node.js on Linux or Mac, you might need to add the prefix `sudo` before the `npm install -g` command or the `npm uninstall -g` command. This step gives Node.js write access to the installation directory.

npm install -g command fails due to npm ERR! Cannot read property 'pause' of undefined error

Valid on Windows or Linux

Symptom:

You receive the error message `npm ERR! Cannot read property 'pause' of undefined` when you attempt to install the product.

Solution:

This behavior is due to a problem with Node Package Manager (npm). If you encounter this problem, revert to a previous version of npm that does not contain this defect. To revert to a previous version of npm, issue the following command:

```
npm install npm@5.3.0 -g
```

Node.js commands do not respond as expected

Valid on Windows or Linux

Symptom:

You attempt to issue node.js commands and you do not receive the expected output.

Solution:

There might be a program that is named *node* on your path. The Node.js installer automatically adds a program that is named *node* to your path. When there are pre-existing programs that are named *node* on your computer, the program that appears first in the path is used. To correct this behavior, change the order of the programs in the path so that Node.js appears first.

Installation fails on Oracle Linux 6

Valid on Oracle Linux 6

Symptom:

You receive error messages when you attempt to install the product on an Oracle Linux 6 operating system.

Solution:

Install the product on Oracle Linux 7 or another Linux or Windows OS. Zowe CLI is not compatible with Oracle Linux 6.

Uninstalling Zowe

You can uninstall Zowe if you no longer need to use it. Follow these procedures to uninstall each Zowe component.

- Uninstalling zLUX
- Uninstalling explorer server
- Uninstalling API Mediation Layer
- Uninstalling Zowe CLI

Uninstalling zLUX

Follow these steps:

1. The zLUX server (`zlux-server`) runs under the ZOWESVR started task, so it should terminate when ZOWESVR is stopped. If it does not, use one of the following standard process signals to stop the server:
   - `SIGHUP`
   - `SIGTERM`
   - `SIGKILL`
2. Delete or overwrite the original directories. If you modified the `zluxserver.json` file so that it points to directories other than the default directories, do not delete or overwrite those directories.

Uninstalling explorer server

Follow these steps:

1. Stop your Explorer Liberty server by running the following operator command:

```
C ZOWESVR
```

2. Delete the ZOWESVR member from your system PROCLIB data set.
3. Remove RACF® (or equivalent) definitions with the following command:

```
RDELETE STARTED (ZOWESVR.*)
SETR RACLIST(STARTED) REFRESH
REMOVE (userid) GROUP(IZUUSER)
```

4. Delete the z/OS® UNIX™ System Services explorer server directory and files from the explorer server installation directory by issuing the following command:

```
rm -R /var/zowe #*Explorer Server Installation Directory*
```

Or

```
rm -R /var/zowe/<v.r.m> #*Explorer Server Installation Directory*
```

Where *<v.r.m>* indicates the package version such as `0.9.0`.

Notes:

- You might need super user authority to run this command.
- You must identify the explorer server installation directory correctly. Running a recursive remove command with the wrong directory name might delete critical files.

Uninstalling API Mediation Layer

Note: Be aware of the following considerations:

- You might need super-user authority to run this command.
- You must identify the API Mediation installation directory correctly. Running a recursive remove command with the incorrect directory name can delete critical files.

Follow these steps:

1. Stop your API Mediation Layer services using the following command:

```
C ZOWESVR
```

2. Delete the ZOWESVR member from your system PROCLIB data set.
3. Remove RACF® (or equivalent) definitions using the following command:

```
RDELETE STARTED (ZOWESVR.*)
SETR RACLIST(STARTED) REFRESH
REMOVE (userid) GROUP(IZUUSER)
```

4. Delete the z/OS® UNIX™ System Services API Mediation Layer directory and files from the API Mediation Layer installation directory using the following command:

```
rm -R /var/zowe_install_directory/api-mediation #*Zowe Installation Directory*
```

Uninstalling Zowe CLI

Important! The uninstall process does not delete the profiles and credentials that you created when using the product from your PC. To delete the profiles from your PC, delete them before you uninstall Zowe CLI.

The following steps describe how to list the profiles that you created, delete the profiles, and uninstall Zowe CLI.

Follow these steps:

1. Open a command line window.

   Note: If you do not want to delete the Zowe CLI profiles from your PC, go to Step 5.

2. List all profiles that you created for a Command Group by issuing the following command:

   ```
   zowe profiles list <profileType>
   ```

   Example:

   ```
   $ zowe profiles list zosmf
   The following profiles were found for the module zosmf:
   'SMITH-123' (DEFAULT)
   smith-123@SMITH-123-W7 C:\Users\SMITH-123
   $
   ```

3. Delete all of the profiles that are listed for the command group by issuing the following command:

   Tip: For this command, use the results of the `list` command.

   Note: When you issue the `delete` command, it deletes the specified profile and its credentials from the credential vault in your PC's operating system.

   ```
   zowe profiles delete <profileType> <profileName> --force
   ```

   Example:

   ```
   zowe profiles delete zosmf SMITH-123 --force
   ```

4. Repeat Steps 2 and 3 for all Zowe CLI command groups and profiles.
5. Uninstall Zowe CLI by issuing one of the following commands:
   - If you installed Zowe CLI from the package, issue the following command

     ```
     npm uninstall --global @brightside/core
     ```

   - If you installed Zowe CLI from the online registry, issue the following command:

     ```
     npm uninstall --global brightside
     ```

     The uninstall process removes all Zowe CLI installation directories and files from your PC.

6. Delete the `C:\Users\<user_name>\.brightside` directory on your PC. The directory contains the Zowe CLI log files and other miscellaneous files that were generated when you used the product.

   Tip: Deleting the directory does not harm your PC.

7. If you installed Zowe CLI from the online registry, issue the following command to clear your scoped npm registry:

   ```
   npm config set @brightside:registry
   ```

Chapter 3. Configuring Zowe

Follow these procedures to configure the components of Zowe.

zLUX configuration

After you install Zowe, you can optionally configure the terminal application plug-ins or modify the zLUX Proxy Server and ZSS configuration, if needed.

Setting up terminal application plug-ins

Follow these optional steps to configure the default connection to open for the terminal application plug-ins.

Setting up the TN3270 mainframe terminal application plug-in

`_defaultTN3270.json` is a file in `tn3270-ng2/`, which is deployed during setup. Within this file, you can specify the following parameters to configure the terminal connection:

```
    "host": <hostname>
    "port": <port>
    “security”: {
    type: <”telnet” or “tls”>
}
```

Setting up the VT Terminal application plug-in

`_defaultVT.json` is a file in `vt-ng2/`, which is deployed during setup. Within this file, you can specify the following parameters to configure the terminal connection:

```
“host”:<hostname>
“port”:<port>
“security”: {
  type: <”telnet” or “ssh”>
}
```

Configuring the zLUX Proxy Server and ZSS

Configuration file

The zLUX Proxy Server and ZSS rely on many parameters to run, which includes setting up networking, deployment directories, plug-in locations, and more.

For convenience, the zLUX Proxy Server and ZSS read from a JSON file with a common structure. ZSS reads this file directly as a startup argument, while the zLUX Proxy Server as defined in the `zlux-proxy-server` repository accepts several parameters, which are intended to be read from a JSON file through an implementer of the server, such as the example in the `zlux-example-server` repository, the `js/zluxServer.js` file. This file accepts a JSON file that specifies most, if not all, of the parameters needed. Other parameters can be provided through flags, if needed.

An example JSON file can be found in the `zlux-example-server` repository, in the zluxserver.json in the `config` directory.

Note: All examples are based on the *zlux-example-server* repository.

Network configuration

Note: The following attributes are to be defined in the server's JSON configuration file.

The zLUX server can be accessed over HTTP, HTTPS, or both, provided it has been configured for either (or both).

HTTP

To configure the server for HTTP, complete these steps:

1. Define an attribute *http* within the top-level *node* attribute.
2. Define *port* within *http*. Where *port* is an integer parameter for the TCP port on which the server will listen. Specify 80 or a value between 1024-65535.

HTTPS

For HTTPS, specify the following parameters:

1. Define an attribute *https* within the top-level *node* attribute.
2. Define the following within *https*:

- *port*: An integer parameter for the TCP port on which the server will listen. Specify 443 or a value between 1024-65535.
- *certificates*: An array of strings, which are paths to PEM format HTTPS certificate files.
- *keys*: An array of strings, which are paths to PEM format HTTPS key files.
- *pfx*: A string, which is a path to a PFX file which must contain certificates, keys, and optionally Certificate Authorities.
- *certificateAuthorities* (Optional): An array of strings, which are paths to certificate authorities files.
- *certificateRevocationLists* (Optional): An array of strings, which are paths to certificate revocation list (CRL) files.

Note: When using HTTPS, you must specify *pfx*, or both *certificates* and *keys*.

Network example

In the example configuration, both HTTP and HTTPS are specified:

```
  "node": {
    "https": {
      "port": 8544,
      //pfx (string), keys, certificates, certificateAuthorities, and certificateRevocationLists
are all valid here.
      "keys": ["../deploy/product/ZLUX/serverConfig/server.key"],
      "certificates": ["../deploy/product/ZLUX/serverConfig/server.cert"]
    },
    "http": {
      "port": 8543
    }
  }
```

Deploy configuration

When the zLUX Proxy Server is running, it accesses the server's settings and reads or modifies the contents of its resource storage. All of this data is stored within the `Deploy` folder hierarchy, which is spread out into a several scopes:

- `Product`: The contents of this folder are not meant to be modified, but used as defaults for a product.
- `Site`: The contents of this folder are intended to be shared across multiple zLUX Proxy Server instances, perhaps on a network drive.
- `Instance`: This folder represents the broadest scope of data within the given zLUX Proxy Server instance.
- `Group`: Multiple users can be associated into one group, so that settings are shared among them.
- `User`: When authenticated, users have their own settings and storage for the application plug-ins that they use.

These directories dictate where the Configuration Dataservice stores content.

Deploy example

```
// All paths relative to zlux-example-server/js or zlux-example-server/bin
// In real installations, these values will be configured during the installation process.
  "rootDir":"../deploy",
  "productDir":"../deploy/product",
  "siteDir":"../deploy/site",
  "instanceDir":"../deploy/instance",
  "groupsDir":"../deploy/instance/groups",
  "usersDir":"../deploy/instance/users"
```

Application plug-in configuration

This topic describes application plug-ins that are defined in advance.

In the configuration file, you can specify a directory that contains JSON files, which tell the server what application plug-in to include and where to find it on disk. The backend of these application plug-ins use the server's plug-in structure, so much of the server-side references to application plug-ins use the term *plug-in*.

To include application plug-ins, define the location of the plug-ins directory in the configuration file, through the top-level attribute **pluginsDir**.

Note: In this example, the directory for these JSON files is `/plugins`. Yet, to separate configuration files from runtime files, the `zlux-example-server` repository copies the contents of this folder into `/deploy/instance/ZLUX/plugins`. So, the example configuration file uses the latter directory.

Plug-ins directory example

```
// All paths relative to zlux-example-server/js or zlux-example-server/bin
// In real installations, these values will be configured during the install process.
//...
  "pluginsDir":"../deploy/instance/ZLUX/plugins",
```

Logging configuration

For more information, see Logging Utility.

ZSS configuration

Running ZSS requires a JSON configuration file that is similar or the same as the one used for the zLUX Proxy Server. The attributes that are needed for ZSS, at minimum, are:*rootDir*, *productDir*, *siteDir*, *instanceDir*, *groupsDir*, *usersDir*, *pluginsDir* and *zssPort*. All of these attributes have the same meaning as described above for the Proxy Server, but if the Proxy Server and ZSS are not run from the same location, then these directories can be different.

The *zssPort* attribute is specific to ZSS. This is the TCP port on which ZSS listens in order to be contacted by the zLUX server. Define this port in the configuration file as a value between 1024-65535.

Connecting the zLUX Proxy Server to ZSS

When you run the zLUX Proxy Server, specify the following flags to declare which ZSS instance zLUX will proxy ZSS requests to:

- *-h*: Declares the host where ZSS can be found. Use as "-h <hostname>"
- *-P*: Declares the port at which ZSS is listening. Use as "-P <port>"

zLUX logging

The zLUX log files contain processing messages and statistics. zLUX generates log files in the following default locations:

- Zowe Node Server: `zlux-example-server/log/nodeServer-yyyy-mm-dd-hh-mm.log`
- ZSS: `zlux-example-server/log/zssServer-yyyy-mm-dd-hh-mm.log`

The Zowe Node Server logs and ZSS logs are timestamped in the format yyyy-mm-dd-hh-mm and older logs are deleted when a new log is created at server startup.

Controlling the zLUX logging location

zLUX writes log information to a file and to the screen. (On Windows, logs are written to a file only.)

ZLUX_NODE_LOG_DIR and ZSS_LOG_DIR environment variables

To control where the information is logged, use the environment variable *ZLUX_NODE_LOG_DIR*, for the Zowe Node Server, and *ZSS_LOG_DIR*, for ZSS. While these variables are intended to specify a directory, if you specify a location that is a file name, zLUX will write the logs to the specified file instead (for example: `/dev/null` to disable logging).

When you specify the environment variables *ZLUX_NODE_LOG_DIR* and *ZSS_LOG_DIR* and you specify directories rather than files, zLUX will timestamp the logs and delete the older logs that exceed the *ZLUX_NODE_LOGS_TO_KEEP* threshold.

ZLUX_NODE_LOG_FILE and ZSS_LOG_FILE environment variables

If you set the log file name for the node server by setting the *ZLUX_NODE_LOG_FILE* environment variable, or if you set the log file for ZSS by setting the *ZSS_LOG_FILE* environment variable, there will only be one log file, and it will be overwritten each time the server is launched.

Note: When you set the *ZLUX_NODE_LOG_FILE* or *ZSS_LOG_FILE* environment variables, zLUX will not override the log names, set a timestamp, or delete the logs.

If zLUX cannot create the directory or file, the server will run (but it might not perform logging properly).

Retaining logs

By default, zLUX retains the last five logs. To specify a different number of logs to retain, set *ZLUX_NODE_LOGS_TO_KEEP* (Zowe Node Server logs) or *ZSS_LOGS_TO_KEEP* (ZSS logs) to the number of logs that you want to keep. For example, if you set *ZLUX_NODE_LOGS_TO_KEEP* to 10, when the eleventh log is created, the first log is deleted. The default is 5.

Configuring Zowe CLI

After you install Zowe, you can optionally perform Zowe CLI configurations.

Setting environment variables for Zowe CLI

You can set environment variables on your operating system to modify Zowe CLI behavior, such as the log level and the location of the *.brightside* directory, where the logs, profiles, and plug-ins are stored. Refer to your PC operating system documentation for information about how to set environmental variables.

Setting log levels

You can set the log level to adjust the level of detail that is written to log files:

Important! Setting the log level to TRACE or ALL might result in "sensitive" data being logged. For example, command line arguments will be logged when TRACE is set.

Environment Variable	Description	Values	Default
`BRIGHTSIDE\_APP \_LOG\_LEVEL`	Zowe CLI logging level	Log4JS log levels (OFF, TRACE, DEBUG, INFO, WARN, ERROR, FATAL)	DEBUG
`BRIGHTSIDE \_IMPERATIVE\_LOG \_LEVEL`	Imperative CLI Framework logging level	Log4JS log levels (OFF, TRACE, DEBUG, INFO, WARN, ERROR, FATAL)	DEBUG

Setting the .brightside directory

You can set the location on your PC where Zowe CLI creates the *.brightside* directory, which contains log files, profiles, and plug-ins for the product:

Environment Variable	Description	Values	Default
BRIGHTSIDE_CLI _HOME	Zowe CLI home directory location	Any valid path on your PC	Your PC default home directory

Chapter 4. Using Zowe

After you install and start Zowe, you can perform tasks with each component. See the following sections for details.

Using zLUX

zLUX provides the ability to create application plug-ins. For more information, see Creating zLUX application plug-ins.

Navigating MVD

From the Mainframe Virtual Desktop (MVD), you can access the Project Zowe applications.

Accessing the MVD

From a supported browser, open the MVD at `https://myhost:httpsPort/ZLUX/plugins/com.rs.mvd/web/index.html`

where:

- *myHost* is the host on which you are running the Zowe Node Server.
- *httpsPort* is the value that was assigned to *node.https.port* in `zluxserver.json`. For example, if you run the Zowe Node Server on host *myhost* and the value that is assigned to *node.https.port* in `zluxserver.json` is 12345, you would specify `https://myhost:12345/ZLUX/plugins/com.rs.mvd/web/index.html`.

Logging in and out of the MVD

1. To log in, enter your mainframe credentials in the **Username** and **Password** fields.
2. Press Enter. Upon authentication of your user name and password, the desktop opens.

To log out, click the the avatar in the lower right corner and click **Sign Out**.

Using Explorers within zLUX

The explorer server provides a sample web client that can be used to view and manipulate the Job Entry Subsystem (JES), data sets, z/OS UNIX System Services (USS), and System log.

The following views are available from the explorer server Web UI and are accessible via the explorer server icon located in the application draw of MVD (Navigation between views can be performed using the menu draw located in the top left corner of the explorer server Web UI):

JES Explorer

Use this view to query JES jobs with filters, and view the related steps, files, and status. You can also purge jobs from this view.

Data set Explorer

Use this view to browse the MVS™ file system by using a high-level qualifier filter. With the Dataset Explorer, you can complete the following tasks:

- List the members of partitioned data sets.
- Create new data sets using attributes or the attributes of an existing data set ("Allocate Like").
- Submit data sets that contain JCL to Job Entry Subsystem (JES).
- Edit sequential data sets and partitioned data set members with basic syntax highlighting and content assist for JCL and REXX.

- Conduct basic validation of record length when editing JCL.
- Delete data sets and members.
- Open data sets in full screen editor mode, which gives you a fully qualified link to that file. The link is then reusable for example in help tickets.

UNIX file Explorer

Use this view to browse the USS files by using a path. With the UNIX file Explorer, you can complete the following tasks:

- List files and folders.
- Create new files and folders.
- Edit files with basic syntax highlighting and content assist for JCL and REXX.
- Delete files and folders.

Using zLUX application plug-ins

Application plug-ins are applications that you can use to access the mainframe and to perform various tasks. Developers can create application plug-ins using a sample application as a guide. The following application plug-ins are installed by default:

Hello World

This sample application plug-in for developers demonstrates how to create a dataservice and how to create an application plug-in using Angular.

IFrame

This sample application plug-in for developers demonstrates how to embed pre-made webpages within the desktop as an application and how an application can request an action of another application (see the source code for more information).

ZOS Subsystems

This application plug-in helps you find information about the important services on the mainframe, such as CICS, Db2, and IMS.

TN3270

This application plug-in provides a 3270 connection to the mainframe on which the Zowe Node Server runs.

VT Terminal

This application plug-in provides a connection to UNIX System Services and UNIX.

Using APIs

Access and modify your z/OS resources such as jobs, data sets, z/OS UNIX System Services files by using APIs.

Using explorer server REST APIs

Explorer server REST APIs provide a range of REST APIs through a Swagger defined description, and a simple interface to specify API endpoint parameters and request bodies along with the response body and return code. With explorer server REST APIs, you can see the available API endpoints and try the endpoints within a browser. Swagger documentation is available from an Internet browser with a URL, for example, https://your.host:atlas-port/ibm/api/explorer.

Data set APIs

Use data set APIs to create, read, update, delete, and list data sets. See the following table for the operations available in data set APIs and their descriptions and prerequisites.

REST API	Description	Prerequisite
`GET /Atlas/api/datasets/{filter}`	Get a list of data sets by filter. Use this API to get a starting list of data sets, for example, **userid.****.	z/OSMF restfiles
`GET /Atlas/api/datasets/{dsn}/attributes`	Retrieve attributes of a data set(s). If you have a data set name, use this API to determine attributes for a data set name. For example, it is a partitioned data set.	z/OSMF restfiles
`GET /Atlas/api/datasets/{dsn}/members`	Get a list of members for a partitioned data set. Use this API to get a list of members of a partitioned data set.	z/OSMF restfiles
`GET /Atlas/api/datasets/{dsn}/content`	Read content from a data set or member. Use this API to read the content of a sequential data set or partitioned data set member. Or use this API to return a checksum that can be used on a subsequent PUT request to determine if a concurrent update has occurred.	z/OSMF restfiles
`PUT /Atlas/api/datasets/{dsn}/content`	Write content to a data set or member. Use this API to write content to a sequential data set or partitioned data set member. If a checksum is passed and it does not match the checksum that is returned by a previous GET request, a concurrent update has occurred and the write fails.	z/OSMF restfiles
`POST /Atlas/api/datasets/{dsn}`	Create a data set. Use this API to create a data set according to the attributes that are provided. The API uses z/OSMF to create the data set and uses the syntax and rules that are described in the z/OSMF Programming Guide.	z/OSMF restfiles
`POST /Atlas/api/datasets/{dsn}/{basedsn}`	Create a data set by using the attributes of a given base data set. When you do not know the attributes of a new data set, use this API to create a new data set by using the same attributes as an existing one.	z/OSMF

REST API	Description	Prerequisite
`DELETE /Atlas/api/datasets/{dsn}`	Delete a data set or member. Use this API to delete a sequential data set or partitioned data set member.	z/OSMF restfiles

Job APIs

Use Jobs APIs to view the information and files of jobs, and submit and cancel jobs. See the following table for the operations available in Job APIs and their descriptions and prerequisites.

REST API	Description	Prerequisite
`GET /Atlas/api/jobs`	Get a list of jobs. Use this API to get a list of job names that match a given prefix, owner, or both.	z/OSMF restjobs
`GET /Atlas/api/jobs/{jobName}/ids`	Get a list of job identifiers for a given job name. If you have a list of existing job names, use this API to get a list of job instances for a given job name.	z/OSMF restjobs
`GET /Atlas/api/jobs/{jobName}/ids/{jobId}/steps`	Get job steps for a given job. With a job name and job ID, use this API to get a list of the job steps, which includes the step name, the executed program, and the logical step number.	z/OSMF restjobs
`GET /Atlas/api/jobs/{jobName}/ids/{jobId}/steps/{stepNumber}/dds`	Get data set definitions (DDs) for a given job step. If you know a step number for a given job instance, use this API to get a list of the DDs for a given job step, which includes the DD name, the data sets that are described by the DD, the original DD JCL, and the logical order of the DD in the step.	z/OSMF restjobs
`GET /Atlas/api/jobs/{jobName}/ids/{jobId}/files`	Get a list of output file names for a job. Job output files have associated DSIDs. Use this API to get a list of the DSIDs and DD name of a job. You can use the DSIDs and DD name to read specific job output files.	z/OSMF restjobs
`GET /Atlas/api/jobs/{jobName}/ids/{jobId}/files/{fileId}`	Read content from a specific job output file. If you have a DSID or field for a given job, use this API to read the output file's content.	z/OSMF restjobs
`GET /Atlas/api/jobs/{jobName}/ids/{jobId}/files/{fileId}/tail`	Read the tail of a job's output file. Use this API to request a specific number of records from the tail of a job output file.	z/OSMF restjobs

REST API	Description	Prerequisite
`GET /Atlas/api/jobs/{jobName}/ids/{jobId}/subsystem`	Get the subsystem type for a job. Use this API to determine the subsystem that is associated with a given job. The API examines the JCL of the job to determine if the executed program is CICS®, Db2®, IMS™, or IBM® MQ.	z/OSMF restjobs
`POST /Atlas/api/jobs`	Submit a job and get the job ID back. Use this API to submit a partitioned data set member or UNIX™ file.	z/OSMF restjobs
`DELETE /Atlas/api/jobs/{jobName}/{jobId}`	Cancel a job and purge its associated files. Use this API to purge a submitted job and the logged output files that it creates to free up space.	z/OSMF Running Common Information Model (CIM) server

Persistent Data APIs

Use Persistent Data APIs to create, read, update, delete metadata from persistent repository. See the following table for the operations available in Persistent Data APIs and their descriptions and prerequisites.

REST API	Description	Prerequisite
`PUT /Atlas/api/data`	Update metadata in persistent repository for a given resource and attribute name. With explorer server, you can store and retrieve persistent data by user, resource name, and attribute. A resource can have any number of attributes and associated values. Use this API to set a value for a single attribute of a resource. You can specify the resource and attribute names.	None
`POST /Atlas/api/data`	Create metadata in persistent repository for one or more resource/attribute elements. Use this API to set a group of resource or attributes values.	None
`GET /Atlas/api/data`	Retrieve metadata from persistent repository for a given resource (and optional attribute) name. Use this API to get all the attribute values or any particular attribute value for a given resource.	None

REST API	Description	Prerequisite
`DELETE /Atlas/api/data`	Remove metadata from persistent repository for a resource (and optional attribute) name. Use this API to delete all the attribute values or any particular attribute value for a given resource.	None

System APIs

Use System APIs to view the version of explorer server. See the following table for available operations and their descriptions and prerequisites.

REST API	Description	Prerequisite
`GET /Atlas/api/system/version`	Get the current explorer server version. Use this API to get the current version of the explorer server microservice.	None

USS File APIs

Use USS File APIs to create, read, update, and delete USS files. See the following table for the available operations and their descriptions and prerequisites.

REST API	Description	Prerequisite
`POST /Atlas/api/uss/files`	Use this API to create new USS directories and files.	z/OSMF restfiles
`DELETE /Atlas/api/uss/files{path}`	Use this API to delete USS directories and files.	z/OSMF resfiles
`GET /Atlas/api/files/{path}`	Use this API to get a list of files in a USS directory along with their attributes.	z/OSMF restfiles
`GET /Atlas/api/files/{path}/content`	Use this API to get the content of a USS file.	z/OSMF restfiles
`PUT /Atlas/api/files/{path}/content`	Use this API to update the content of a USS file.	z/OSMF resfiles

z/OS System APIs

Use z/OS system APIs to view information about CPU, PARMLIB, SYSPLEX, and USER. See the following table for available operations and their descriptions and prerequisites.

REST API	Description	Prerequisite
`GET /Atlas/api/zos/cpu`	Get current system CPU usage. Use this API to get the current system CPU usage and other current system statistics.	None
`GET /Atlas/api/zos/parmlib`	Get system PARMLIB information. Use this API to get the PARMLIB data set concatenation of the target z/OS system.	None

REST API	Description	Prerequisite
GET /Atlas/api/zos/sysplex	Get target system sysplex and system name. Use this API to get the system and sysplex names.	None
GET /Atlas/api/zos/username	Get current userid. Use this API to get the current user ID.	None

Programming explorer server REST APIs

You can program explorer server REST APIs by referring to the examples in this section.

Sending a GET request in Java

Here is sample code to send a GET request to explorer server in Java™.

```
public class JobListener implements Runnable {


    /*
    *   Perform an HTTPs GET at the given jobs URL and credentials
    *   targetURL e.g "https://host:port/Atlas/api/jobs?owner=IBMUSER&prefix=*"
    *   credentials in the form of base64 encoded string of user:password
    */
    private String executeGET(String targetURL, String credentials) {
        HttpURLConnection connection = null;
        try {
            //Create connection
            URL url = new URL(targetURL);
            connection = (HttpURLConnection) url.openConnection();
            connection.setRequestMethod("GET");
            connection.setRequestProperty("Authorization", credentials);

            //Get Response
            InputStream inputStream = connection.getInputStream();
            BufferedReader bufferedReader = new BufferedReader(new
 InputStreamReader(inputStream));
            StringBuilder response = new StringBuilder();
            String line;

            //Process the response line by line
            while ((line = bufferedReader.readLine()) != null) {
                System.out.println(line);
            }

            //Cleanup
            bufferedReader.close();

            //Return the response message
            return response.toString();
        } catch (Exception e) {
            //handle any error(s)
        } finally {
            //Cleanup
            if (connection != null) {
                connection.disconnect();
            }
        }
    }
}
```

Sending a GET request in JavaScript

Here is sample code written in JavaScript™ using features from ES6 to send a GETrequest to explorer server.

```
const BASE_URL = 'hostname.com:port/Atlas/api';

// Call the jobs GET api to get all jobs with the userID IBMUSER
function getJobs(){
    let parameters = "prefix=*&owner=IBMUSER";
    let contentURL = `${BASE_URL}/jobs?${parameters}`;
    let result = fetch(contentURL, {credentials: "include"})
```

```
                    .then(response => response.json())
                        .catch((e) => {
                            //handle any error
                            console.log("An error occoured: " + e);
                        });
     return result;
}
```

Sending a POST request in JavaScript

Here is sample code written in JavaScript™ using features from ES6 to send a POST request to explorer server.

```
// Call the jobs POST api to submit a job from a data set (ATLAS.TEST.JCL(TSTJ0001))

function submitJob(){
    let payload = "{\"file\":\"'ATLAS.TEST.JCL(TSTJ0001)'\"}";
    let contentURL = `${BASE_URL}/jobs`;
    let result = fetch(contentURL,
                    {
                        credentials: "include",
                        method: "POST",
                        body:   payload
                    })
                        .then(response => response.json())
                            .catch((e) => {
                                //handle any error
                                console.log("An error occoured: " + e);
                            });
    return result;
}
```

Extended API sample in JavaScript

Here is an extended API sample that is written using JavaScript™ with features from ES62015 (map).

```
////////////////////////////////////////////////////////////////////////////
// Extended API Sample
// This Sample is written using Javascript with features from ES62015 (map).
// The sample is also written using JSX giving the ability to return HTML elements
// with Javascript variables embedded. This sample is based upon the codebase of the
// sample UI (see- hostname:port/explorer-mvs) which is written using Facebook's React, Redux,
// Router and Google's material-ui
////////////////////////////////////////////////////////////////////////////

// Return a table with rows detailing the name and jobID of all jobs matching
// the specified parameters
function displayJobNamesTable(){
    let jobsJSON = getJobs("*","IBMUSER");
    return  (<table>
                {jobsJSON.map(job => {
                    return <tr><td>{job.name}</td><td>{job.id}</td></tr>
                })}
            </table>);
}

// Call the jobs GET api to get all jobs with the userID IBMUSER
function getJobs(owner, prefix){
    const BASE_URL = 'hostname.com:port/Atlas/api';
    let parameters = "prefix=" + prefix + "&owner=" + owner;
    let contentURL = `${BASE_URL}/jobs?${parameters}`;
    let result = fetch(contentURL, {credentials: "include"})
                    .then(response => response.json())
                        .catch((e) => {
                            //handle any error
                            console.log("An error occoured: " + e);

                        });
     return result;
}
```

Using explorer server WebSocket services

The explorer server provides WebSocket services that can be accessed by using the WSS scheme. With explorer server WebSocket services, you can view the system log in the System log UI that is refreshed

automatically when messages are written. You can also open a JES spool file for an active job and view its contents that refresh through a web socket.

Server Endpoint	Description	Prerequisites
`/api/sockets/jobs/{jobname}/ids/{jobid}/files/{fileid}`	Tail the output of an active job. Use this WSS endpoint to read the tail of an active job's output file in real time.	z/OSMF restjobs

Using API Catalog

As an application developer, use the API Catalog to view what services are running in the API Mediation Layer. Through the API Catalog, you can also view the associated API documentation corresponding to a service, descriptive information about the service, and the current state of the service. The tiles in the API Catalog are customized according to the configuration of the mfaas.catalog.ui section in the application.yml for a service. A microservice that is onboarded with the API Mediation Layer and configured appropriately, registers automatically with the API Catalog and a tile for that service is added to the Catalog.

Prerequisites

- Ensure that the service you would like to view in the API Catalog is configured to be displayed in the API Catalog.

Note: For more information about how to configure the API Catalog in the application.yml, see: Add API Onboarding Configuration.

View a service in the API Catalog

Use the API Catalog to view services, API documentation, descriptive information about the service, the current state of the service, service endpoints, and detailed descriptions of these endpoints.

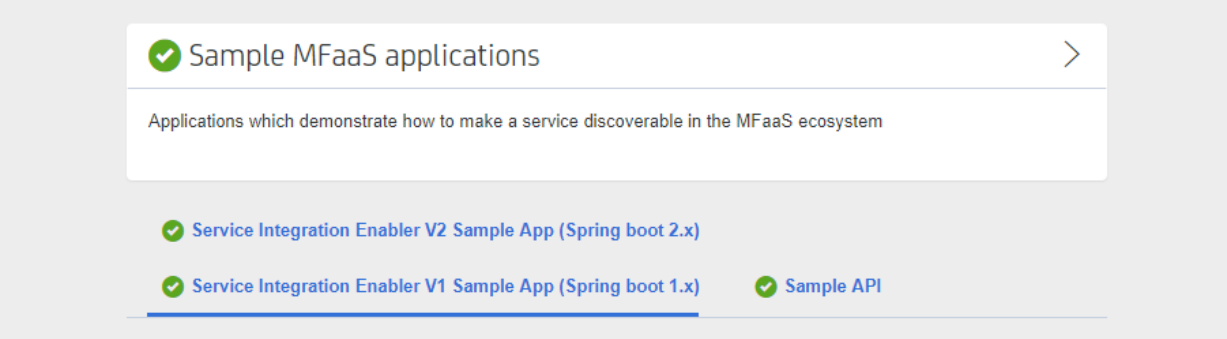
Tip: If the home page of the service is configured you can click Home Page to open the services home page.

Follow these steps:

1. Verify that your service is running. At least one started and registered instance with the Discovery Service is needed for your service to be visible in the API catalog.
2. In the API Catalog, find the tile that describes the product family of the API documentation that you are looking for.

   Example: `Sample Applications, Endevor, SDK Application`
3. Click the tile. Header information and the registered services under that family ID is displayed.

   Example:

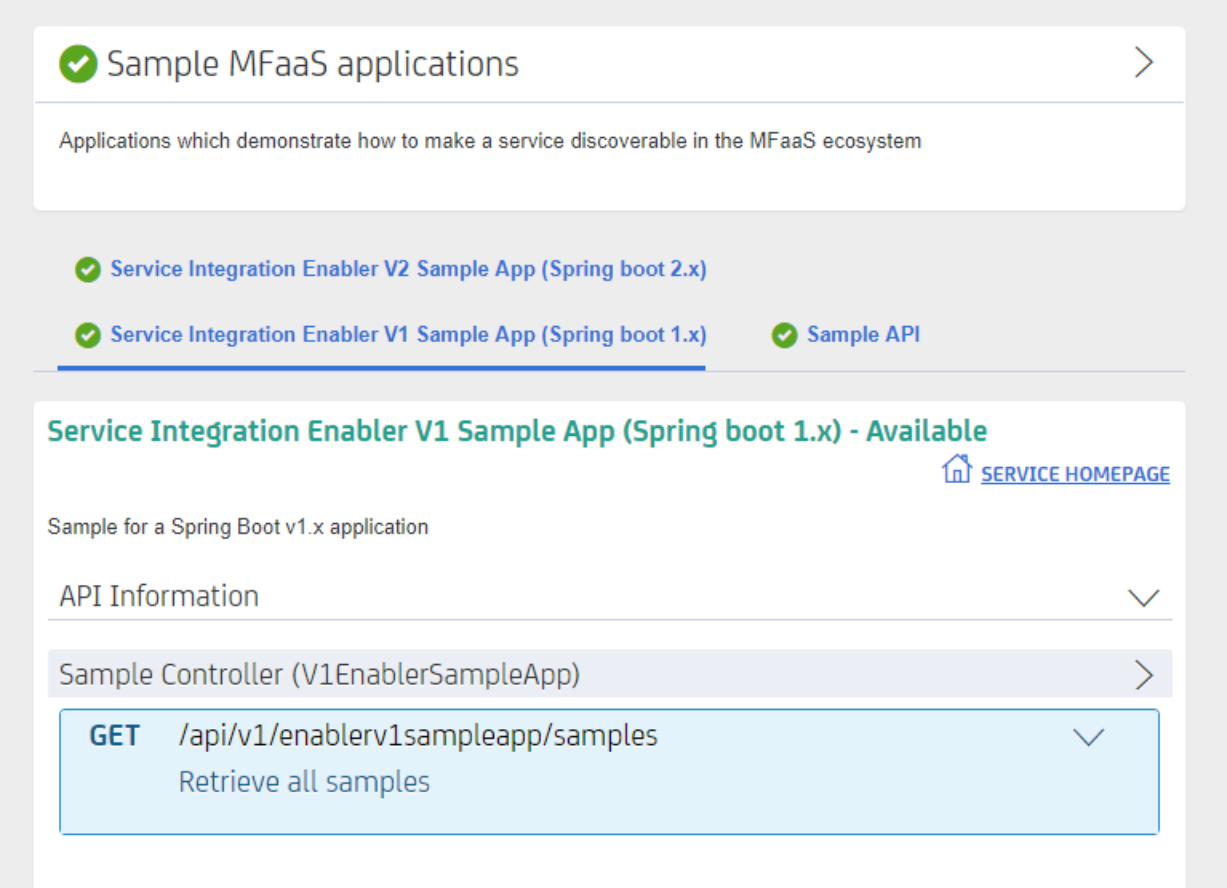


Note: The state of the service is indicated in the tab. If at least one instance of the service is running,

the state of the service is represented with a checkmark . If no instances of the service are currently running the state of the service is represented as an 'x' . At least one instance of a service must be started and registered with the discovery service for it to be visible in the API Catalog. If a service was started and the corresponding API documentation was viewed, then that information is cached and is visible even when the service and all instances are stopped.

4. Click the tab to view the API documentation for that service. Descriptive information about the service and a link to the home page of the service is displayed.
5. Expand the panel to see the high-level description of the API and endpoint groups.

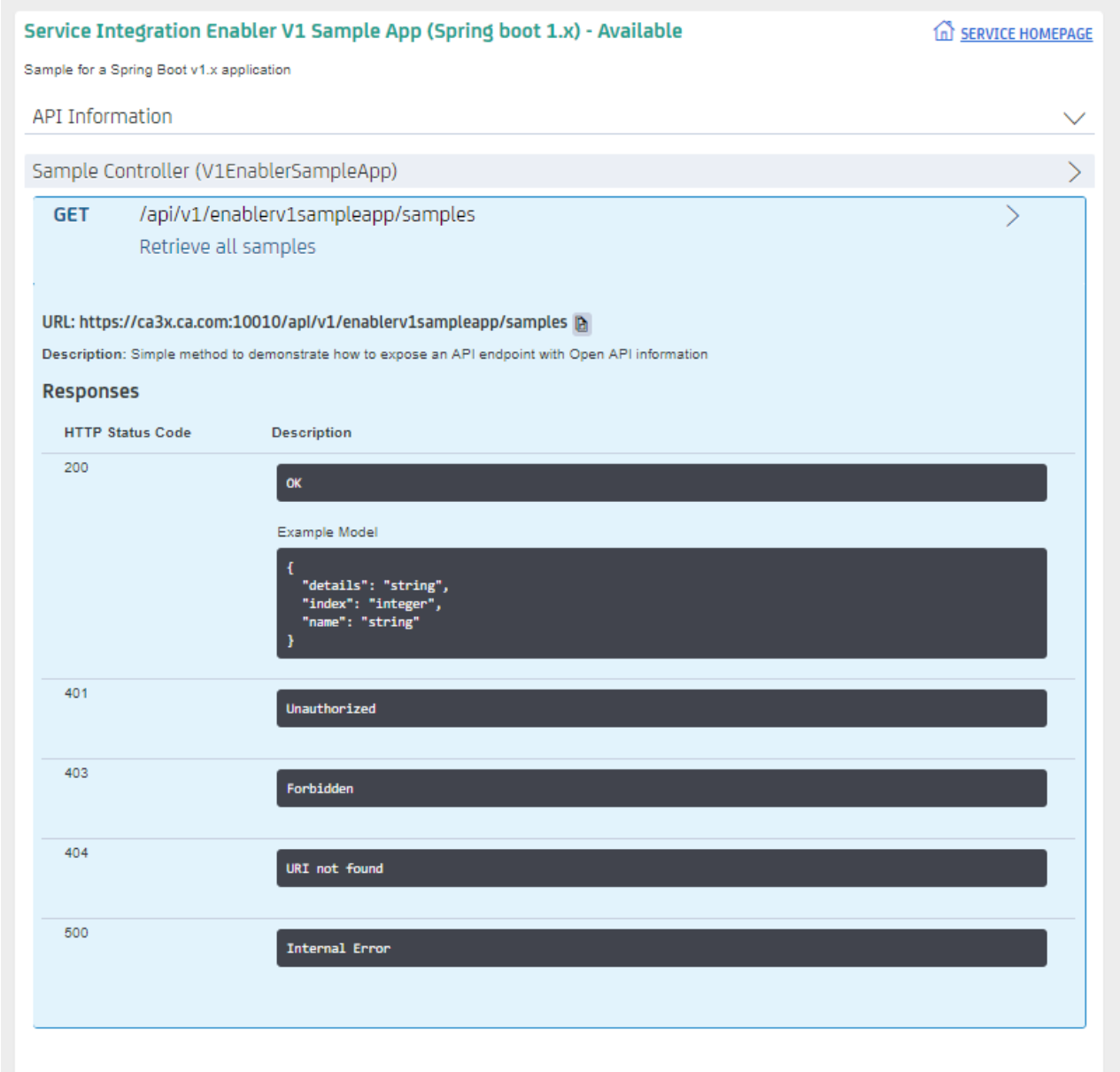
   Example:



6. Expand the endpoints to see a detailed description of the endpoints including the responses and parameters of each endpoint. The summary of the endpoint and the full structure of the endpoint including the base URL and description of the endpoint is displayed.

Note: If a lock is visible, the endpoint requires authentication.

Example:



The structure of the endpoint is displayed relative to the base URL.

Example:

In the Endpoint panel header section, the abbreviated endpoint relative to the base URL is displayed as the following path: `aidl /api/v1/discoverableclient/movies/list` A full URL that includes the base URL is also displayed as the following path: `aidl https://hostName:basePort/api/v1/discoverableclient/movies/list` Both links target the same endpoint location.

Using Zowe CLI

This section contains the following articles about using Zowe CLI.

Display Zowe CLI help

Zowe CLI contains a help system that is embedded directly into the command-line interface. When you want help with Zowe CLI, you issue help commands that provide you with information about the product, syntax, and usage.

Display top-level help

To begin using the product, open a command line window and issue the following command to view the top-level help descriptions:

```
zowe --help
```

Tip: The command `zowe` initiates the product on a command line. All Zowe CLI commands begin with `zowe`.

Help structure

The help displays the following types of information:

- **Description:** An explanation of the functionality for the command group, action, or option that you specified in a `--help` command.
- **Usage:** The syntax for the command. Refer to usage to determine the expected hierarchical structure of a command.
- **Options:** Flags that you can append to the end of a command to specify particular values or booleans. For example, the volume size for a data set that you want to create.
- **Global Options:** Flags that you can append to any command in Zowe CLI. For example, the `--help` flag is a global option.

Displaying command group, action, and object help

You can use the `--help` global option get more information about a specific command group, action, or object. Use the following syntax to display group-level help and learn more about specific command groups (for example, *zos-jobs* and *zos-files*):

```
zowe <group, action, or object name> --help
```

```
zowe zos-files create --help
```

Zowe CLI command groups

Zowe CLI contains command groups that focus on specific business processes. For example, the `zos-files` command group provides the ability to interact with mainframe data sets. This article provides you with a brief synopsis of the tasks that you can perform with each group. For more information, see Display Zowe CLI Help.

The commands available in the product are organized in a hierarchical structure. Command groups (for example, `zos-files`) contain actions (for example, `create`) that let you perform actions on specific objects (for example, a specific type of data set). For each action that you perform on an object, you can specify options that affect the operation of the command.

Important! Before you issue these commands, verify that you completed the steps in Create a Zowe CLI profile and Test Connection to z/OSMF to help ensure that Zowe CLI can communicate with z/OS systems.

Zowe CLI contains the following command groups:

plugins

The plugins command group lets you install and manage third-party plug-ins for the product. Plug-ins extend the functionality of Zowe CLI in the form of new commands.

With the plugins command group, you can perform the following tasks:

- Install or uninstall third-party plug-ins.
- Display a list of installed plug-ins.
- Validate that a plug-in integrates with the base product properly.

Note: For more information about `plugins` syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe plugins -h
```

profiles

The profiles command group lets you create and manage profiles for use with other Zowe CLI command groups. Profiles allow you to issue commands to different mainframe systems quickly, without specifying your connection details with every command.

With the profiles command group, you can perform the following tasks:

- Create, update, and delete profiles for any Zowe CLI command group that supports profiles.
- Set the default profile to be used within any command group.
- List profile names and details for any command group, including the default active profile.

Note: For more information about `profiles` syntax, actions, and options, open Zowe CLI, and issue the following command:

```
zowe profiles -h
```

provisioning

The provisioning command group lets you perform IBM z/OSMF provisioning tasks with templates and provisioned instances from Zowe CLI.

With the provisioning command group, you can perform the following tasks:

- Provision cloud instances using z/OSMF Software Services templates.
- List information about the available z/OSMF Service Catalog published templates and the templates that you used to publish cloud instances.
- List summary information about the templates that you used to provision cloud instances. You can filter the information by application (for example, DB2 and CICS) and by the external name of the provisioned instances.
- List detail information about the variables used (and their corresponding values) on named, published cloud instances.

Note: For more information about provisioning syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe provisioning -h
```

zos-console

The zos-console command group lets you issue commands to the z/OS console by establishing an extended Multiple Console Support (MCS) console.

With the zos-console command group, you can perform the following tasks: **Important!** Before you issue z/OS console commands with Zowe CLI, security administrators should ensure that they provide access to commands that are appropriate for your organization. - Issue commands to the z/OS console. - Collect command responses and continue to collect solicited command responses on-demand.

Note: For more information about `zos-console` syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe zos-console -h
```

zos-files

The zos-files command group lets you interact with data sets on z/OS systems.

With the zos-files command group, you can perform the following tasks:

- Create partitioned data sets (PDS) with members, physical sequential data sets (PS), and other types of data sets from templates. You can specify options to customize the data sets you create.
- Download mainframe data sets and edit them locally in your preferred Integrated Development Environment (IDE).
- Upload local files to mainframe data sets.
- List available mainframe data sets.
- Interact with VSAM data sets directly, or invoke Access Methods Services (IDCAMS) to work with VSAM data sets.

Note: For more information about `zos-console` syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe zos-files -h
```

zos-jobs

The zos-jobs command group lets you submit jobs and interact with jobs on z/OS systems.

With the zos-jobs command group, you can perform the following tasks:

- Submit jobs from JCL that resides on the mainframe or a local file.
- List jobs and spool files for a job.
- View the status of a job or view a spool file from a job.

Note: For more information about `zos-jobs` syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe zos-jobs -h
```

zos-tso

The zos-tso command group lets you issue TSO commands and interact with TSO address spaces on z/OS systems.

With the zos-tso command group, you can perform the following tasks:

- Excecute REXX scripts
- Create a TSO address space and issue TSO commands to the address space.
- Review TSO command response data in Zowe CLI.

Note: For more information about `zos-tso` syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe zos-tso -h
```

zosmf

The zosmf command group lets you work with Zowe CLI profiles and get general information about z/OSMF.

With the zosmf command group, you can perform the following tasks:

- Create and manage your Zowe CLI zosmf profiles. You must have at least one zosmf profile to issue most commands. Issue the `zowe help explain profiles` command in Zowe CLI to learn more about using profiles.
- Verify that your profiles are set up correctly to communicate with z/OSMF on your system. For more information, see Test Connection to z/OSMF.
- Get information about the current z/OSMF version, host, port, and plug-ins installed on your system.

Note: For more information about `zosmf` syntax, actions, and options, open Zowe CLI and issue the following command:

```
zowe zosmf -h
```

Chapter 5. Extending zLUX

You can create plug-ins to extend the capabilities of zLUX.

Creating zLUX application plug-ins

A zLUX application plug-in is an installable set of files that present resources in a web-based user interface, as a set of RESTful services, or in a web-based user interface and as a set of RESTful services.

Before you build a zLUX application plug-in, you must set the UNIX environment variables that support the plug-in environment.

Setting the environment variables for plug-in development

To set up the environment, the node must be accessible on the PATH. To determine if the node is already on the PATH, issue the following command from the command line:

```
node --version
```

If the version is returned, the node is already on the PATH.

If nothing is returned from the command, you can set the PATH using the *NODE_HOME* variable. The *NODE_HOME* variable must be set to the directory of the node install. You can use the export command to set the directory. For example:

```
export NODE_HOME=node_installation_directory
```

Using this directory, the node will be included on the PATH in `nodeServer.sh`. (`nodeServer.sh` is located in `zlux-example-server/bin`).

Using the zLUX sample application plug-in

You can experiment with the sample application plug-in called `sample-app` that is provided with zLUX.

To build the sample application plug-in, node and npm must be included in the PATH. You can use the `npm run build` or `npm start` command to build the sample application plug-in. These commands are configured in `package.json`.

Note:

- If you change the source code for the sample application, you must rebuild it.
- If you want to modify `sample-app`, you must run `_npm install_` in the virtual desktop and the `sample-app/webClient`. Then, you can run `_npm run build_` in `sample-app/webClient`.
- Ensure that you set the `MVD_DESKTOP_DIR` system variable to the virtual desktop plug-in location. For example: `<ZLUX_CAP>/zlux-app-manager/virtual-desktop`.

1. Add an item to `sample-app`. The following figure shows an excerpt from `app.component.ts`:

   ```
   export class AppComponent { items = ['a', 'b', 'c', 'd'] title = 'app';
   helloText: string; serverResponseMessage: string;
   ```

2. Save the changes to `app.component.ts`.
3. Issue one of the following commands:
   - To rebuild the application plug-in, issue the following command: `npm run build`
   - To rebuild the application plug-in and wait for additional changes to `app.component.ts`, issue the following command: `npm start`
4. Reload the web page.

5. If you make changes to the sample application source code, follow these steps to rebuild the application:
   a. Navigate to the `sample-app` subdirectory where you made the source code changes.
   b. Issue the following command: `npm run build`
   c. Reload the web page.

zLUX plug-ins definition and structure

The zLUX Application Server `zlux-proxy-server` enables extensiblity with application plug-ins. Application plug-ins are a subcategory of the unit of extensibility in the server called a *plug-in*.

The files that define a plug-in are located in the `pluginsDir` directory.

zLUX application plug-in filesystem structure

A zLUX application plug-in can be loaded from a filesystem that is accessible to the zLUX Application Server, or it can be loaded dynamically at runtime. When accessed from a filesystem, there are important considerations for the developer and the user as to where to place the files for proper build, packaging, and operation.

Root files and directories

The root of an application plug-in directory contains the following files and directories.

pluginDefinition.json

This file describes an application plug-in to the zLUX Application Server. (A plug-in is the unit of extensibility for the zLUX Application Server. An application plug-in is a plug-in of the type "Application", the most common and visible type of plug-in). A definition file informs the server whether the application plug-in has server-side dataservices, client-side web content, or both.

Dev and source content

Aside from demonstration or open source application plug-ins, the following directories should not be visible on a deployed server because the directories are used to build content and are not read by the server.

nodeServer

When an application plug-in has router-type dataservices, they are interpreted by the zLUX Application Server by attaching them as ExpressJS routers. It is recommended that you write application plug-ins using Typescript, because it facilitates well-structured code. Use of Typescript results in build steps because the pre-transpilation Typescript content is not to be consumed by NodeJS. Therefore, keep server-side source code in the `nodeServer` directory. At runtime, the server loads router dataservices from the `lib` directory.

webClient

When an application plug-in has the *webContent* attribute in its definition, the server serves static content for a client. To optimize loading of the application plug-in to the user, use Typescript to write the application plug-in and then package it using Webpack. Use of Typescript and Webpack result in build steps because the pre-transpilation Typescript and the pre-webpack content are not to be consumed by the browser. Therefore, separate the source code from the served content by placing source code in the `webClient` directory.

Runtime content

At runtime, the following set of directories are used by the server and client.

lib

The `lib` directory is where router-type dataservices are loaded by use in the zLUX Application Server. If the JS files that are loaded from the `lib` directory require NodeJS modules, which are not provided by the server base (modules `ZLUX-proxy-server` requires are added to `NODE_PATH` at runtime), then you must include these modules in `lib/node_modules` for local directory lookup or ensure that they are found on the `NODE_PATH` environment variable. `nodeServer/node_modules` is not automatically accessed at runtime because it is a dev and build directory.

web

The `web` directory is where the server serves static content for an application plug-in that includes the *webContent* attribute in its definition. Typically, this directory contains the output of a webpack build. Anything you place in this directory can be accessed by a client, so only include content that is intended to be consumed by clients.

Location of plug-in files

The files that define a plug-in are located in the `pluginsDir` directory.

pluginsDir directory

At start up, the server reads from the `pluginsDir` directory. The server loads the valid plug-ins that are found by the information that is provided in the JSON files.

Within the `pluginsDir` directory are a collection of JSON files. Each file has two attributes, which serve to locate a plug-in on disk:

location: This is a directory path that is relative to the server's executable (such as `zlux-example-server/bin/nodeServer.sh`) at which a `pluginDefinition.json` file is expected to be found.

identifier: The unique string (commonly styled as a Java resource) of a plug-in, which must match what is in the `pluginDefinition.json` file.

Plug-in definition file

`pluginDefinition.json` is a file that describes a plug-in. Each zLUX plug-in requires this file, because it defines how the server will register and use the backend of an application plug-in (called a *plug-in* in the terminology of the proxy server). The attributes in each file are dependent upon the `pluginType` attribute. Consider the following `pluginDefinition.json` file from `sample-app`:

```
{
  "identifier": "com.rs.mvd.myplugin",
  "apiVersion": "1.0",
  "pluginVersion": "1.0",
  "pluginType": "application",
  "webContent": {
    "framework": "angular2",
    "launchDefinition": {
      "pluginShortNameKey": "helloWorldTitle",
      "pluginShortNameDefault": "Hello World",
      "imageSrc": "assets/icon.png"
    },
    "descriptionKey": "MyPluginDescription",
    "descriptionDefault": "Base MVD plugin template",
    "isSingleWindowApp": true,
    "defaultWindowStyle": {
      "width": 400,
      "height": 300
    }
  },
  "dataServices": [
    {
      "type": "router",
      "name": "hello",
      "serviceLookupMethod": "external",
      "fileName": "helloWorld.js",
      "routerFactory": "helloWorldRouter",
      "dependenciesIncluded": true
    }
```

```
  ]
}
```

Plug-in attributes

There are two categories of attributes: General and Application.

General attributes

identifier

Every application plug-in must have a unique string ID that associates it with a URL space on the server.

apiVersion

The version number for the pluginDefinition scheme and application plug-in or dataservice requirements. The default is 1.0.0.

pluginVersion

The version number of the individual plug-in.

pluginType

A string that specifies the type of plug-in. The type of plug-in determines the other attributes that are valid in the definition.

- **application**: Defines the plug-in as an application plug-in. Application plug-ins are composed of a collection of web content for presentation in the zLUX web component (such as the virtual desktop), or a collection of dataservices (REST and websocket), or both.
- **library**: Defines the plug-in as a library that serves static content at a known URL space.
- **node authentication**: Authentication and Authorization handlers for the zLUX Application Server.

Application attributes

When a plug-in is of *pluginType* application, the following attributes are valid:

webContent

An object that defines several attributes about the content that is shown in a web UI.

dataServices

An array of objects that describe REST or websocket dataservices.

configurationData

An object that describes the resource structure that the application plug-in uses for storing user, group, and server data.

Application web content attributes

An application that has the *webContent* attribute defined provides content that is displayed in a zLUX web UI.

The following attributes determine some of this behavior:

framework

States the type of web framework that is used, which determines the other attributes that are valid in *webContent*.

- **angular2**: Defines the application as having an Angular (2+) web framework component. This is the standard for a "native" framework zLUX application.
- **iframe**: Defines the application as being external to the native zLUX web application environment, but instead embedded in an iframe wrapper.

launchDefinition

An object that details several attributes for presenting the application in a web UI.

- **pluginShortNameDefault**: A string that gives a name to the application when i18n is not present. When i18n is present, i18n is applied by using the *pluginShortNameKey*.
- **descriptionDefault**: A longer string that specifies a description of the application within a UI. The description is seen when i18n is not present. When i18n is present, i18n is applied by using the *descriptionKey*.
- **imageSrc**: The relative path (from `/web`) to a small image file that represents the application icon.

defaultWindowStyle

An object that details the placement of a default window for the application in a web UI.

- **width**: The default width of the application plug-in window, in pixels.
- **height**: The default height of the application plug-in window, in pixels.

IFrame application web content

In addition to the general web content attributes, when the framework of an application is "iframe", you must specify the page that is being embedded in the iframe. To do so, incude the attribute *startingPage* within *webContent*. *startingPage* is relative to the application's `/web` directory.

Specify *startingPage* as a relative path rather than an absolute path because the `pluginDefinition.json` file is intended to be read-only, and therefore would not work well when the hostname of a page changes.

Within an IFrame, the application plug-in still has access to the globals that are used by zLUX for application-to-application communication; simply access *window.parent.RocketMVD*.

zLUX dataservices

Dataservices are a dynamic component of the backend of a zLUX application. Dataservices are optional, because the proxy server might only serve static content for a particular application. However, when included in an application, a dataservice defines a URL space for which the server will run the extensible code from the application. Dataservices are primarily intended to be used to create REST APIs and Websocket channels.

Defining a dataservice

Within the `sample-app` repository, in the top directory, you will find a `pluginDefinition.json` file. Each zLUX application requires this file, because it defines how the server registers and uses the backend of an application (called a plug-in in the terminology of the proxy server).

Within the JSON file, there is a top level attribute, *dataServices*:

```
"dataServices": [
  {
    "type": "router",
    "name": "hello",
    "serviceLookupMethod": "external",
    "fileName": "helloWorld.js",
    "routerFactory": "helloWorldRouter",
    "dependenciesIncluded": true
  }
]
```

Dataservices defined in pluginDefinition

The following attributes are valid for each dataservice in the *dataServices* array:

type

Specify one of the following values:

- **router**: Router dataservices are dataservices that run under the proxy server, and use ExpressJS Routers for attaching actions to URLs and methods.
- **service**: Service dataservices are dataservices that run under ZSS, and utilize the API of ZSS dataservices for attaching actions to URLs and methods.

name

The name of the service that must be unique for each `pluginDefinition.json` file. The name is used to reference the dataservice during logging and it is also is used in the construction of the URL space that the dataservice occupies.

serviceLookupMethod

Specify `external` unless otherwise instructed.

fileName

The name of the file that is the entry point for construction of the dataservice, relative to the application's `/lib` directory. In the case of `sample-app`, upon transpilation of the typescript code, javascript files are placed into the `/lib` directory.

routerFactory (Optional)

When you use a router dataservice, the dataservice is included in the proxy server through a `require()` statement. If the dataservice's exports are defined such that the router is provided through a factory of a specific name, you must state the name of the exported factory using this attribute.

dependenciesIncluded

Must be `true` for anything in the `pluginDefinition.json` file. (This setting is false only when adding dataservices to the server dynamically.)

Dataservice API

The API for a dataservice can be categorized as Router-based or ZSS-based, and Websocket or not.

Note: Each Router dataservice can safely import express, express-ws, and bluebird without requiring the modules to be present, because these modules exist in the proxy server's directory and the *NODE_MODULES* environment variable can include this directory.

Router-based dataservices

HTTP/REST router dataservices

Router-based dataservices must return a (bluebird) Promise that resolves to an ExpressJS router upon success. For more information, see the ExpressJS guide on use of Router middleware: Using Router Middleware.

Because of the nature of Router middleware, the dataservice need only specify URLs that stem from a root '/' path, as the paths specified in the router are later prepended with the unique URL space of the dataservice.

The Promise for the Router can be within a Factory export function, as mentioned in the `pluginDefinition` specification for *routerFactory* above, or by the module constructor.

An example is available in `sample-app/nodeServer/ts/helloWorld.ts`

Websocket router dataservices

ExpressJS routers are fairly flexible, so the contract to create the Router for Websockets is not significantly different.

Here, the express-ws package is used, which adds websockets through the ws package to ExpressJS. The two changes between a websocket-based router and a normal router is that the method is 'ws', as in `router.ws(<url>,<callback>)`, and that the callback provides the websocket on which you must define event listeners.

See the ws and express-ws topics on www.npmjs.com for more information about how they work, as the API for websocket router dataservices is primarily provided in these packages.

An example is available in `zlux-proxy-server/plugins/terminal-proxy/lib/terminalProxy.js`

Router dataservice context

Every router-based dataservice is provided with a `Context` object upon creation that provides definitions of its surroundings and the functions that are helpful. The following items are present in the `Context` object:

serviceDefinition

The dataservice definition, originally from the `pluginDefinition.json` file within a plug-in.

serviceConfiguration

An object that contains the contents of configuration files, if present.

logger

An instance of a zLUX Logger, which has its component name as the unique name of the dataservice within a plug-in.

makeSublogger

A function to create a zLUX Logger with a new name, which is appended to the unique name of the dataservice.

addBodyParseMiddleware

A function that provides common body parsers for HTTP bodies, such as JSON and plaintext.

plugin

An object that contains more context from the plug-in scope, including:

- **pluginDef**: The contents of the `pluginDefinition.json` file that contains this dataservice.
- **server**: An object that contains information about the server's configuration such as:
  - **app**: Information about the product, which includes the *productCode* (for example: ZLUX).
  - **user**: Configuration information of the server, such as the port on which it is listening.

Virtual desktop and window management

The Mainframe Virtual Desktop (MVD) is a web component of Zowe, which is an implementation of `MVDWindowManagement`, the interface that is used to create a window manager.

The code for this software is in the `zlux-app-manager` repository.

The interface for building an alternative window manager is in the `zlux-platform` repository.

Window Management acts upon Windows, which are visualizations of an instance of an application plug-in. Application plug-ins are plug-ins of the type "application", and therefore the MVD operates around a collection of plug-ins.

Note: Other objects and frameworks that can be utilized by application plug-ins, but not related to window management, such as application-to-application communication, Logging, URI lookup, and Auth are not described here.

Loading and presenting application plug-ins

Upon loading the MVD, a GET call is made to `/plugins?type=application`. This returns a JSON list of all application plug-ins that are on the server, which can be accessed by the user. Application plug-ins

can be composed of dataservices, web content, or both. Application plug-ins that have web content are presented in the MVD UI.

The MVD has a taskbar at the bottom of the page, where it displays each application plug-in as an icon with a description. The icon that is used, and the description that is presented are based on the application plug-in's `PluginDefinition`'s `webContent` attributes.

Plug-in management

Application plug-ins can gain insight into the environment they were spawned in through the Plugin Manager. Use the Plugin Manager to determine whether a plug-in is present before you act upon the existence of that plug-in. When the MVD is running, you can access the Plugin Manager through `RocketMVD.PluginManager`

The following are the functions you can use on the Plugin Manager:

- getPlugin(pluginID: string)
- Accepts a string of a unique plug-in ID, and returns the Plugin Definition Object (DesktopPluginDefinition) that is associated with it, if found.

Application management

Application plug-ins within a Window Manager are created and acted upon in part by an Application Manager. The Application Manager can facilitate communication between application plug-ins, but formal application-to-application communication should be performed by calls to the Dispatcher. The Application Manager is not normally directly accessible by application plug-ins, instead used by the Window Manager.

The following are functions of an Application Manager:

Function	Description
`spawnApplication(plugin: DesktopPluginDefinition, launchMetadata: any): Promise<MVDHosting.InstanceId>;`	Opens an application instance into the Window Manager, with or without context on what actions it should perform after creation.
`killApplication(plugin:ZLUX.Plugin, appId:MVDHosting.InstanceId): void;`	Removes an application instance from the Window Manager.
`showApplicationWindow(plugin: DesktopPluginDefinitionImpl): void;`	Makes an open application instance visible within the Window Manager.
`isApplicationRunning(plugin: DesktopPluginDefinitionImpl): boolean;`	Determines if any instances of the application are open in the Window Manager.

Windows and Viewports

When a user clicks an application plug-in's icon on the taskbar, an instance of the application plug-in is started and presented within a Viewport, which is encapsulated in a Window within the Desktop. Every instance of an application plug-in's web content within Zowe is given context and can listen on events about the Viewport and Window it exists within, regardless of whether the Window Manager implementation utilizes these constructs visually. It is possible to create a Window Manager that only displays one application plug-in at a time, or to have a drawer-and-panel UI rather than a true windowed UI.

When the Window is created, the application plug-in's web content is encapsulated dependent upon its framework type. The following are valid framework types:

- *"angular2"*: The web content is written in Angular, and packaged with Webpack. Application plug-in framework objects are given through @injectables and imports.

- *"iframe"*: The web content can be written using any framework, but is included through an iframe tag. Application plug-ins within an iframe can access framework objects through *parent.RocketMVD* and callbacks.

In the case of the MVD, this framework-specific wrapping is handled by the Plugin Manager.

Viewport Manager

Viewports encapsulate an instance of an application plug-in's web content, but otherwise do not add to the UI (they do not present Chrome as a Window does). Each instance of an application plug-in is associated with a viewport, and operations to act upon a particular application plug-in instance should be done by specifying a viewport for an application plug-in, to differentiate which instance is the target of an action. Actions performed against viewports should be performed through the Viewport Manager.

The following are functions of the Viewport Manager:

Function	Description
`createViewport(providers: ResolvedReflectiveProvider[]): MVDHosting.ViewportId;`	Creates a viewport into which an application plug-in's webcontent can be embedded.
`registerViewport(viewportId: MVDHosting.ViewportId, instanceId: MVDHosting.InstanceId): void;`	Registers a previously created viewport to an application plug-in instance.
`destroyViewport(viewportId: MVDHosting.ViewportId): void;`	Removes a viewport from the Window Manager.
`getApplicationInstanceId(viewportId: MVDHosting.ViewportId): MVDHosting.InstanceId | null;`	Returns the ID of an application plug-in's instance from within a viewport within the Window Manager.

Injection Manager

When you create Angular application plug-ins, they can use injectables to be informed of when an action occurs. iframe application plug-ins indirectly benefit from some of these hooks due to the wrapper acting upon them, but Angular application plug-ins have direct access to these.

The following topics describe injectables that application plug-ins can use.

Plug-in definition

```
@Inject(Angular2InjectionTokens.PLUGIN_DEFINITION) private pluginDefinition:
 ZLUX.ContainerPluginDefinition
```

Provides the plug-in definition that is associated with this application plug-in. This injectable can be used to gain context about the application plug-in. It can also be used by the application plug-in with other application plug-in framework objects to perform a contextual action.

Logger

```
@Inject(Angular2InjectionTokens.LOGGER) private logger: ZLUX.ComponentLogger
```

Provides a logger that is named after the application plug-in's plugin definition ID.

Launch Metadata

```
@Inject(Angular2InjectionTokens.LAUNCH_METADATA) private launchMetadata: any
```

If present, this variable requests the application plug-in instance to initialize with some context, rather than the default view.

Viewport Events

```
@Inject(Angular2InjectionTokens.VIEWPORT_EVENTS) private viewportEvents:
 Angular2PluginViewportEvents
```

Presents hooks that can be subscribed to for event listening. Events include:

`resized: Subject<{width: number, height: number}>`

Fires when the viewport's size has changed.

Window Events

```
@Inject(Angular2InjectionTokens.WINDOW_ACTIONS) private windowActions:
 Angular2PluginWindowActions
```

Presents hooks that can be subscribed to for event listening. The events include:

Event	Description
`maximized: Subject<void>`	Fires when the Window is maximized.
`minimized: Subject<void>`	Fires when the Window is minimized.
`restored: Subject<void>`	Fires when the Window is restored from a minimized state.
`moved: Subject<{top: number, left: number}>`	Fires when the Window is moved.
`resized: Subject<{width: number, height: number}>`	Fires when the Window is resized.
`titleChanged: Subject<string>`	Fires when the Window's title changes.

Window Actions

```
@Inject(Angular2InjectionTokens.WINDOW_ACTIONS) private windowActions:
 Angular2PluginWindowActions
```

An application plug-in can request actions to be performed on the Window through the following:

Item	Description
`close(): void`	Closes the Window of the application plug-in instance.
`maximize(): void`	Maximizes the Window of the application plug-in instance.
`minimize(): void`	Minimizes the Window of the application plug-in instance.
`restore(): void`	Restores the Window of the application plug-in instance from a minimized state.
`setTitle(title: string):void`	Sets the title of the Window.
`setPosition(pos: {top: number, left: number, width: number, height: number}): void`	Sets the position of the Window on the page and the size of the window.
`spawnContextMenu(xPos: number, yPos: number, items: ContextMenuItem[]): void`	Opens a context menu on the application plug-in instance, which uses the Context Menu framework.

Item	Description
`registerCloseHandler(handler: () => Promise<void>): void`	Registers a handler, which is called when the Window and application plug-in instance are closed.

Configuration Dataservice

The Configuration Dataservice is an essential component of the zLUX framework, which acts as a JSON resource storage service, and is accessible externally by REST API and internally to the server by dataservices.

The Configuration Dataservice allows for saving preferences of applications, management of defaults and privileges within a zLUX ecosystem, and bootstrapping configuration of the server's dataservices.

The fundamental element of extensibility of the zLUX framework is a plug-in. The Configuration Dataservice works with data for plug-ins. Every resource that is stored in the Configuration Service is stored for a particular plug-in, and valid resources to be accessed are determined by the definition of each plug-in in how it uses the Configuration Dataservice.

The behavior of the Configuration Dataservice is dependent upon the Resource structure for a zLUX plug-in. Each plug-in lists the valid resources, and the administrators can set permissions for the users who can view or modify these resources.

Resource Scope

Data is stored within the Configuration Dataservice according to the selected *Scope*. The intent of *Scope* within the Dataservice is to facilitate company-wide administration and privilege management of zLUX data.

When a user requests a resource, the resource that is retrieved is an override or an aggregation of the broader scopes that encompass the *Scope* from which they are viewing the data.

When a user stores an resource, the resource is stored within a *Scope* but only if the user has access privilege to update within that *Scope*.

Scope is one of the following:

Product

Configuration defaults that come with the product. Cannot be modified.

Site

Data that can be used between multiple instances of the zLUX Server.

Instance

Data within an individual zLUX Server.

Group

Data that is shared between multiple users in a group.

User

Data for an individual user.

Note: While Authorization tuning can allow for settings such as GET from Instance to work without login, *User* and *Group* scope queries will be rejected if not logged in due to the requirement to pull resources from a specific user. Because of this, *User* and *Group* scopes will not be functional until the Security Framework is available.

Where *Product* is the broadest scope and *User* is the narrowest scope.

When you specify *Scope User*, the service manages configuration for your particular username, using the authentication of the session. This way, the *User* scope is always mapped to your current username.

Consider a case where a user wants to access preferences for their text editor. One way they could do this is to use the REST API to retrieve the settings resource from the *Instance* scope.

The *Instance* scope might contain editor defaults set by the administrator. But, if there are no defaults in *Instance*, then the data in *Group* and *User* would be checked.

Therefore, the data the user receives would be no broader than what is stored in the *Instance* scope, but might have only been the settings they saved within their own *User* scope (if the broader scopes do not have data for the resource).

Later, the user might want to save changes, and they try to save them in the *Instance* scope. Most likely, this action is rejected because of the preferences set by the administrator to disallow changes to the *Instance* scope by ordinary users.

REST API

When you reach the Configuration Service through a REST API, HTTP methods are used to perform the desired operation.

The HTTP URL scheme for the configuration dataservice is:

```
<Server>/plugins/com.rs.configjs/services/data/<plugin ID>/<Scope>/<resource>/
<optional subresources>?<query>
```

Where the resources are one or more levels deep, using as many layers of subresources as needed.

Think of a resource as a collection of elements, or a directory. To access a single element, you must use the query parameter "name="

REST query parameters

Name (string)

Get or put a single element rather than a collection.

Recursive (boolean)

When performing a DELETE, specifies whether to delete subresources.

REST HTTP methods

Below is an explanation of each type of REST call.

Each API call includes an example request and response against a hypothetical application called the "code editor".

GET

GET `/plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>?name=<element>`

- This returns JSON with the attribute "content" being a JSON resource that is the entire configuration that was requested. For example:

```
/plugins/com.rs.configjs/services/data/org.openmainframe.zowe.codeeditor/user/
sessions/default?name=tabs
```

The parts of the URL are:

- Plugin: org.openmainframe.zowe.codeeditor
- Scope: user
- Resource: sessions
- Subresource: default

- Element = tabs

The response body is a JSON config:

```
{
 "_objectType" : "com.rs.config.resource",
 "_metadataVersion" : "1.1",
 "resource" : "org.openmainframe.zowe.codeeditor/USER/sessions/default",
 "contents" : {
  "_metadataVersion" : "1.1",
  "_objectType" : "org.openmainframe.zowe.codeeditor.sessions.tabs",
  "tabs" : [{
    "title" : "TSSPG.REXX.EXEC(ARCTEST2)",
    "filePath" : "TSSPG.REXX.EXEC(ARCTEST2)",
    "isDataset" : true
   }, {
    "title" : ".profile",
    "filePath" : "/u/tsspg/.profile"
   }
  ]
 }
}
```

GET `/plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>`

This returns JSON with the attribute `content` being a JSON object that has each attribute being another JSON object, which is a single configuration element.

GET `/plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>`

(When subresources exist.)

This returns a listing of subresources that can, in turn, be queried.

PUT

PUT `/plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>?name=<element>`

Stores a single element (must be a JSON object {...}) within the requested scope, ignoring aggregation policies, depending on the user privilege. For example:

`/plugins/com.rs.configjs/services/data/org.openmainframe.zowe.codeeditor/user/sessions/default?name=tabs`

Body:

```
{
  "_metadataVersion" : "1.1",
  "_objectType" : "org.openmainframe.zowe.codeeditor.sessions.tabs",
  "tabs" : [{
      "title" : ".profile",
      "filePath" : "/u/tsspg/.profile"
    }, {
      "title" : "TSSPG.REXX.EXEC(ARCTEST2)",
      "filePath" : "TSSPG.REXX.EXEC(ARCTEST2)",
      "isDataset" : true
    }, {
      "title" : ".emacs",
      "filePath" : "/u/tsspg/.emacs"
    }
  ]
}
```

Response:

```
{
  "_objectType" : "com.rs.config.resourceUpdate",
  "_metadataVersion" : "1.1",
  "resource" : "org.openmainframe.zowe.codeeditor/USER/sessions/default",
  "result" : "Replaced item."
}
```

DELETE

`DELETE /plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>?recursive=true`

Deletes all files in all leaf resources below the resource specified.

`DELETE /plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>?name=<element>`

Deletes a single file in a leaf resource.

`DELETE /plugins/com.rs.configjs/services/data/<plugin>/<scope>/<resource>`

- Deletes all files in a leaf resource.
- Does not delete the directory on disk.

Administrative access and group

By means not discussed here, but instead handled by the server's authentication and authorization code, a user might be privileged to access or modify items that they do not own.

In the simplest case, it might mean that the user is able to do a PUT, POST, or DELETE to a level above *User*, such as *Instance*.

The more interesting case is in accessing another user's contents. In this case, the shape of the URL is different. Compare the following two commands:

`GET /plugins/com.rs.configjs/services/data/<plugin>/user/<resource>`

Gets the content for the current user.

`GET /plugins/com.rs.configjs/services/data/<plugin>/users/<username>/<resource>`

Gets the content for a specific user if authorized.

This is the same structure that is used for the *Group* scope. When requesting content from the *Group* scope, the user is checked to see if they are authorized to make the request for the specific group. For example:

`GET /plugins/com.rs.configjs/services/data/<plugin>/group/<groupname>/<resource>`

Gets the content for the given group, if the user is authorized.

Application API

Retrieves and stores configuration information from specific scopes.

Note: This API should only be used for configuration administration user interfaces.

```
ZLUX.UriBroker.pluginConfigForScopeUri(pluginDefinition: ZLUX.Plugin, scope: string, resourcePath:string, resourceName:string): string;
```

A shortcut for the preceding method, and the preferred method when you are retrieving configuration information, is simply to "consume" it. It "asks" for configurations using the *User* scope, and allows the configuration service to decide which configuration information to retrieve and how to aggregate it. (See below on how the configuration service evaluates what to return for this type of request).

```
ZLUX.UriBroker.pluginConfigUri(pluginDefinition: ZLUX.Plugin, resourcePath:string, resourceName:string): string;
```

Internal and bootstrapping

Some dataservices within plug-ins can take configuration that affects their behavior. This configuration is stored within the Configuration Dataservice structure, but it is not accessible through the REST API.

Within the deploy directory of a zLUX installation, each plug-in might optionally have an _internal directory. An example of such a path is:

deploy/instance/ZLUX/pluginStorage/<pluginName>/_internal

Within each _internal directory, the following directories might exist:

- services/<servicename>: Configuration resources for the specific service.
- plugin: Configuration resources that are visible to all services in the plug-in.

The JSON contents within these directories are provided as Objects to dataservices through the dataservice context Object.

Plug-in definition

Because the Configuration Dataservices stores data on a per-plug-in basis, each zLUX plug-in must define their resource structure to make use of the Configuration Dataservice. The resource structure definition is included in the plug-in's pluginDefinition.json file.

For each resource and subresource, you can define an aggregationPolicy to control how the data of a broader scope alters the resource data that is returned to a user when requesting a resource from a narrower scope.

For example:

```
  "configurationData": { //is a direct attribute of the pluginDefinition JSON
    "resources": { //always required
      "preferences": {
        "locationType": "relative", //this is the only option for now, but later absolute paths
 may be accepted
        "aggregationPolicy": "override" //override and none for now, but more in the future
      },
      "sessions": { //the name at this level represents the name used within a URL, such as /
plugins/com.rs.configjs/services/data/org.openmainframe.zowe.codeeditor/user/sessions
        "aggregationPolicy": "none",
        "subResources": {
          "sessionName": {
            "variable": true, //if variable=true is present, the resource must be the only
 one in that group but the name of the resource is substituted for the name given in the REST
 request, so it represents more than one
            "aggregationPolicy": "none"
          }
        }
      }
    }
  }
```

Aggregation policies

Aggregation policies determine how the Configuration Dataservice aggregates JSON objects from different Scopes together when a user requests a resource. If the user requests a resource from the *User* scope, the data from the User scope might replace or be merged with the data from a broader scope such as *Instance*, to make a combined resource object that is returned to the user.

Aggregation policies are defined by a plug-in developer in the plug-in's definition for the Configuration Service, as the attribute aggregationPolicy within a resource.

The following policies are currently implemented:

- **NONE**: If the Configuration Dataservice is called for *Scope User*, only user-saved settings are sent, unless there are no user-saved settings for the query, in which case the dataservice attempts to send data that is found at a broader scope.
- **OVERRIDE**: The Configuration Dataservice obtains data for the resource that is requested at the broadest level found, and joins the resource's properties from narrower scopes, overriding broader attributes with narrower ones, when found.

URI Broker

The URI Broker is an object in the application plug-in web framework, which facilitates calls to the zLUX Application Server by constructing URIs that use the context from the calling application plug-in.

Accessing the URI Broker

The URI Broker is accessible independent of other frameworks involved such as Angular, and is also accessible through iframe. This is because it is attached to a global when within the MVD. For more information, see Virtual desktop and window management. Access the URI Broker through one of two locations:

Natively:

```
window.RocketMVD.uriBroker
```

In an iframe:

```
window.parent.RocketMVD.uriBroker
```

Functions

The URI Broker builds different categories of URIs depending upon what the application plug-in is designed to call. Each category is listed below.

Accessing an application plug-in's dataservices

zLUX dataservices can be based on HTTP (REST) or Websocket. For more information, see zLUX dataservices.

HTTP Dataservice URI

```
pluginRESTUri(plugin:ZLUX.Plugin, serviceName: string, relativePath:string):
string
```

Returns: A URI for making an HTTP service request.

Websocket Dataservice URI

```
pluginWSUri(plugin: ZLUX.Plugin, serviceName:string, relativePath:string):
string
```

Returns: A URI for making a Websocket connection to the service.

Accessing application plug-in's configuration resources

Defaults and user storage might exist for an application plug-in such that they can be retrieved through the Configuration Dataservice.

There are different scopes and actions to take with this service, and therefore there are a few URIs that can be built:

Standard configuration access

```
pluginConfigUri(pluginDefinition: ZLUX.Plugin, resourcePath:string,
resourceName?:string): string
```

Returns: A URI for accessing the requested resource under the user's storage.

Scoped configuration access

```
pluginConfigForScopeUri(pluginDefinition: ZLUX.Plugin, scope: string,
resourcePath:string, resourceName?:string): string
```

Returns: A URI for accessing a specific scope for a given resource.

Accessing static content

Content under an application plug-in's web directory is static content accessible by a browser. This can be accessed through:

```
pluginResourceUri(pluginDefinition: ZLUX.Plugin, relativePath: string): string
```

Returns: A URI for getting static content.

For more information about the web directory, see zLUX application plug-in filesystem structure.

Accessing the application plug-in's root

Static content and services are accessed off of the root URI of an application plug-in. If there are other points that you must access on that application plug-in, you can get the root:

```
pluginRootUri(pluginDefinition: ZLUX.Plugin): string
```

Returns: A URI to the root of the application plug-in.

Server queries

A client can find different information about a server's configuration or the configuration as seen by the current user by accessing specific APIs.

Accessing a list of plug-ins

```
pluginListUri(pluginType: ZLUX.PluginType): string
```

Returns: A URI, which when accesseds returns the list of existing plug-ins on the server by the type specified, such as "Application" or "all".

Application-to-application communication

zLUX application plug-ins can opt-in to various application framework abilities, such as the ability to have a Logger, use of a URI builder utility, and more. One ability that is unique to a zLUX environment with multiple application plug-ins is the ability for one application plug-in to communicate with another. The application framework provides constructs that facilitate this ability. The constructs are: the Dispatcher, Actions, Recognizers, Registry, and the features that utilize them such as the framework's Context menu.

1. Why use application-to-application communication?
2. Actions
3. Recognizers
4. Dispatcher

Why use application-to-application communication?

When working with a computer, people often use multiple applications to accomplish a task, for example checking a dashboard before digging into a detailed program or checking email before opening a bank statement in a browser. In many environments, the relationship between one program and another is not well defined (you might open one program to learn of a situation, which you solve by opening another and typing or pasting in content). Or perhaps a hyperlink is provided or an attachment, which opens program by using a lookup table of which the program is the default for handling a certain file extension. The application framework attempts to solve this problem by creating structured messages that can be sent from one application plug-in to another. An application plug-in has a context of the information that it contains. You can use this context to invoke an action on another application plug-in that is better suited to deal with some of the information discovered in the first application plug-in. Well-structured messages facilitate knowing what application plug-in is "right" to handle a situation, and explain in detail what that application plug-in should do. This way, rather than finding out that the attachment with the extension ".dat" was not meant for a text editor, but instead for an email client, one application plug-in might instead be able to invoke an action on an application plug-in, which can handle opening of an

email for the purpose of forwarding to others (a more specific task than can be explained with filename extensions).

Actions

To manage communication from one application plug-in to another, a specific structure is needed. In the application framework, the unit of application-to-application communication is an Action. The typescript definition of an Action is as follows:

```
export class Action implements ZLUX.Action {
    id: string;           // id of action itself.
    i18nNameKey: string;  // future proofing for I18N
    defaultName: string;  // default name for display purposes, w/o I18N
    description: string;
    targetMode: ActionTargetMode;
    type: ActionType;   // "launch", "message"
    targetPluginID: string;
    primaryArgument: any;

    constructor(id: string,
                defaultName: string,
                targetMode: ActionTargetMode,
                type: ActionType,
                targetPluginID: string,
                primaryArgument:any) {
       this.id = id;
       this.defaultName = defaultName;
       // proper name for ID/type
       this.targetPluginID = targetPluginID;
       this.targetMode = targetMode;
       this.type = type;
       this.primaryArgument = primaryArgument;
    }

    getDefaultName():string {
      return this.defaultName;
    }
}
```

An Action has a specific structure of data that is passed, to be filled in with the context at runtime, and a specific target to receive the data. The Action is dispatched to the target in one of several modes, for example: to target a specific instance of an application plug-in, an instance, or to create a new instance. The Action can be less detailed than a message. It can be a request to minimize, maximize, close, launch, and more. Finally, all of this information is related to a unique ID and localization string such that it can be managed by the framework.

Action target modes

When you request an Action on an application plug-in, the behavior is dependent on the instance of the application plug-in you are targeting. You can instruct the framework how to target the application plug-in with a target mode from the `ActionTargetMode` enum:

```
export enum ActionTargetMode {
  PluginCreate,                // require pluginType
  PluginFindUniqueOrCreate,    // required AppInstance/ID
  PluginFindAnyOrCreate,       // plugin type
  //TODO PluginFindAnyOrFail
  System,                      // something that is always present
}
```

Action types

The application framework performs different operations on application plug-ins depending on the type of an Action. The behavior can be quite different, from simple messaging to requesting that an application plug-in be minimized. The types are defined by an `enum`:

```
export enum ActionType {       // not all actions are meaningful for all target modes
  Launch,                      // essentially do nothing after target mode
  Focus,                       // bring to fore, but nothing else
  Route,                       // sub-navigate or "route" in target
  Message,                     // "onMessage" style event to plugin
```

```
  Method,                       // Method call on instance, more strongly typed
  Minimize,
  Maximize,
  Close,                        // may need to call a "close handler"
}
```

Loading actions

Actions can be created dynamically at runtime, or saved and loaded by the system at login.

Dynamically

You can create Actions by calling the following Dispatcher method: `makeAction(id: string, defaultName: string, targetMode: ActionTargetMode, type: ActionType, targetPluginID: string, primaryArgument: any):Action`

Saved on system

Actions can be stored in JSON files that are loaded at login. The JSON structure is as follows:

```
{
  "actions": [
    {
      "id":"org.zowe.explorer.openmember",
      "defaultName":"Edit PDS in MVS Explorer",
      "type":"Launch",
      "targetMode":"PluginCreate",
      "targetId":"org.zowe.explorer",
      "arg": {
        "type": "edit_pds",
        "pds": {
          "op": "deref",
          "source": "event",
          "path": [
            "full_path"
          ]
        }
      }
    }
  ]
}
```

Recognizers

Actions are meant to be invoked when certain conditions are met. For example, you do not need to open a messaging window if you have no one to message. Recognizers are objects within the application framework that use the context that the application plug-in provides to determine if there is a condition for which it makes sense to execute an Action. Each recognizer has statements about what condition to recognize, and upon that statement being met, which Action can be executed at that time. The invocation of the Action is not handled by the Recognizer; it simply detects that an Action can be taken.

Recognition clauses

Recognizers associate a clause of recognition with an action, as you can see from the following class:

```
export class RecognitionRule {
  predicate:RecognitionClause;
  actionID:string;

  constructor(predicate:RecognitionClause, actionID:string){
    this.predicate = predicate;
    this.actionID = actionID;
  }
}
```

A clause, in turn, is associated with an operation, and the subclauses upon which the operation acts. The following operations are supported:

```
export enum RecognitionOp {
  AND,
  OR,
```

```
  NOT,
  PROPERTY_EQ,
  SOURCE_PLUGIN_TYPE,      // syntactic sugar
  MIME_TYPE,         // ditto
}
```

Loading Recognizers at runtime

You can add a Recognizer to the application plug-in environment in one of two ways: by loading from Recognizers saved on the system, or by adding them dynamically.

Dynamically

You can call the Dispatcher method, `addRecognizer(predicate:RecognitionClause, actionID:string):void`

Saved on system

Recognizers can be stored in JSON files that are loaded at login. The JSON structure is as follows:

```
{
  "recognizers": [
    {
      "id":"<actionID>",
      "clause": {
        <clause>
      }
    }
  ]
}
```

clause can take on one of two shapes:

```
"prop": ["<keyString>", <"valueString">]
```

Or,

```
"op": "<op enum as string>",
"args": [
  {<clause>}
]
```

Where this one can again, have subclauses.

Recognizer example

Recognizers can be simple or complex. The following is an example to illustrate the mechanism:

```
{
  "recognizers":[
    {
      "id":"org.zowe.explorer.openmember",
      "clause": {
        "op": "AND",
        "args": [
         {"prop":["sourcePluginID","com.rs.mvd.tn3270"]},{"prop":["screenID","ISRUDSM"]}
        ]
      }
    }
  ]
}
```

In this case, the Recognizer detects whether it is possible to run the `org.zowe.explorer.openmember` Action when the TN3270 Terminal application plug-in is on the screen ISRUDSM (an ISPF panel for browsing PDS members).

Dispatcher

The dispatcher is a core component of the application framework that is accessible through the Global ZLUX Object at runtime. The Dispatcher interprets Recognizers and Actions that are added to it at

runtime. You can register Actions and Recognizers on it, and later, invoke an Action through it. The dispatcher handles how the Action's effects should be carried out, acting in combination with the Window Manager and application plug-ins themselves to provide a channel of communication.

Registry

The Registry is a core component of the application framework, which is accessible through the Global ZLUX Object at runtime. It contains information about which application plug-ins are present in the environment, and the abilities of each application plug-in. This is important to application-to-application communication, because a target might not be a specific application plug-in, but rather an application plug-in of a specific category, or with a specific featureset, or capable of responding to the type of Action requested.

Pulling it all together in an example

The standard way to make use of application-to-application communication is by having Actions and Recognizers that are saved on the system. Actions and Recognizers are loaded at login, and then later, through a form of automation or by a user action, Recognizers can be polled to determine if there is an Action that can be executed. All of this is handled by the Dispatcher, but the description of the behavior lies in the Action and Recognizer that are used. In the Action and Recognizer descriptions above, there are two JSON definitions: One is a Recognizer that recognizes when the Terminal application plug-in is in a certain state, and another is an Action that instructs the MVS Explorer to load a PDS member for editing. When you put the two together, a practical application is that you can launch the MVS Explorer to edit a PDS member that you have selected within the Terminal application plug-in.

Error reporting UI

The `zLUX Widgets` repository contains shared widget-like components of the mainframe virtual desktop, including Button, Checkbox, Paginator, various pop-ups, and others. To maintain consistency in desktop styling across all applications, use, reuse, and customize existing widgets to suit the purpose of the application's function and look.

Ideally, a program should have little to no logic errors. Once in a while a few slip through, but more commonly an error occurs from misconfigured user settings. A user might request an action or command that requires certain prerequisites, for example: a proper ZSS-Server configuration. If the program or method fails, the program should notify the user through the UI about the error and how to fix it. For the purposes of this discussion, we will use the zLUX Workflow application plug-in in the `zlux-workflow` repository.

ZluxPopupManagerService

The `ZluxPopupManagerService` is a standard popup widget that can, through its `reportError()` method, be used to display errors with attributes that specify the title (or error code), severity, text, whether it should block the user from proceeding, whether it should output to the logger, and other options you want to add to the error dialog. `ZluxPopupManagerService` uses both `ZluxErrorSeverity` and `ErrorReportStruct`.

```
`export declare class ZluxPopupManagerService {`

    eventsSubject: any;
    listeners: any;
    events: any;
    logger: any;
    constructor();
    setLogger(logger: any): void;
    on(name: any, listener: any): void;
    broadcast(name: any, ...args: any[]): void;
    processButtons(buttons: any[]): any[];
    block(): void;
    unblock(): void;
    getLoggerSeverity(severity: ZluxErrorSeverity): any;
    reportError(severity: ZluxErrorSeverity, title: string, text: string, options?: any):
 Rx.Observable<any>;
```

```
`}`
```

ZluxErrorSeverity

`ZluxErrorSeverity` classifies the type of report. Under the popup-manager, there are the following types: error, warning, and information. Each type has its own visual style and the desired error or pop-up should be classified accordingly to accurately indicate the type of issue to the user.

```
`export declare enum ZluxErrorSeverity {`

    ERROR = "error",
    WARNING = "warning",
    INFO = "info",
`}`
```

ErrorReportStruct

`ErrorReportStruct` contains the main interface that brings the specified parameters of `reportError()` together.

```
`export interface ErrorReportStruct {`

    severity: string;
    modal: boolean;
    text: string;
    title: string;
    buttons: string[];
`}`
```

Implementation

Import `ZluxPopupManagerService` and `ZluxErrorSeverity` from widgets. If you are using additional services with your error prompt, import those too (for example, `LoggerService` to print to the logger or `GlobalVeilService` to create a visible semi-transparent gray veil over the program and pause background tasks). Here, widgets is imported from `node_modules\@zlux\` so you must ensure zLUX widgets is used in your `package-lock.json` or `package.json` and you have run `npm install`.

```
import { ZluxPopupManagerService, ZluxErrorSeverity } from '@zlux/widgets';
```

Declaration

Create a member variable within the constructor of the class you want to use it for. For example, in the Workflow application plug-in under `\zlux-workflow\src\app\app\zosmf-server-config.component.ts` is a `ZosmfServerConfigComponent` class with the pop-up manager service variable. If you want to automatically report the error to the console, you must set a logger.

```
`export class ZosmfServerConfigComponent {`

    constructor(
    private popupManager: ZluxPopupManagerService, )
    {  popupManager.setLogger(logger); } //Optional
`}`
```

Usage

Now that you have declared your variable within the scope of your program's class, you are ready to use the method. The following example describes an instance of the `reload()` method in Workflow that catches an error when the program attempts to retrieve a configuration from a `configService` and set it to the program's `this.config`. This method fails when the user has a faulty zss-Server configuration and the error is caught and then sent to the class' `popupManager` variable from the constructor above.

```
`reload(): void {`

    this.globalVeilService.showVeil();
    this.configService
      .getConfig()
```

```
      .then(config => (this.config = config))
      .then(_ => setTimeout(() => this.test(), 0))
      .then(_ => this.globalVeilService.hideVeil())
      .catch(err => {
        this.globalVeilService.hideVeil()
        let errorTitle: string = "Error";
        let errorMessage: string = "Server configuration not found. Please check your zss
 server.";
        const options = {
          blocking: true
        };
          this.popupManager.reportError(ZluxErrorSeverity.ERROR, errorTitle.toString()+":
 "+err.status.toString(), errorMessage+"\n"+err.toString(), options);
        });
`}`
```

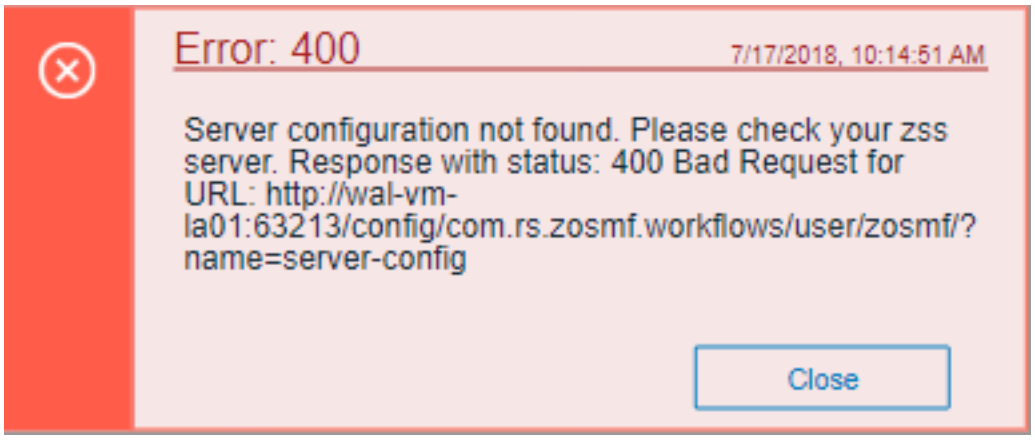
Here, the `errorMessage` clearly describes the error with a small degree of ambiguity as to account for all types of errors that might occur from that method. The specifics of the error are then generated dynamically and are printed with the `err.toString()`, which contains the more specific information that is used to pinpoint the problem. The `this.popupManager.report()` method triggers the error prompt to display. The error severity is set with `ZluxErrorSeverity.ERROR` and the `err.status.toString()` describes the status of the error (often classified by a code for example: 404). The optional parameters in `options` specify that this error will block the user from interacting with the application plug-in until the error is closed or it until goes away on its own. `globalVeilService` is optional and is used to create a gray veil on the outside of the program when the error is caused. You must import `globalVeilService` separately (see `zlux-workflow` for more information).

HTML

The final step is to have the recently created error dialog appear in the application plug-in. If you do `this.popupManager.report()` without adding the component to your template, the error will not be displayed. Navigate to your component's `.html` file. On the Workflow application plug-in, this file will be in `\zlux-workflow\src\app\app\zosmf-server-config.component.html` and the only item left is to add the popup manager component alongside your other classes.

```
<zlux-popup-manager></zlux-popup-manager>
```

So now when the error is called, the new UI element should resemble the following:



The order in which you place the pop-up manager determines how the error dialog will overlap in your UI. If you want the error dialog to overlap other UI elements, place it at the end of the `.html` file. You can also create custom styling through a CSS template, and add it within the scope of your application plug-in.

Logging utility

The `zlux-shared` repository provides a logging utility for use by dataservices and web content for a Zowe application plug-in.

Logging objects

The logging utility is based on the following objects:

- **Component Loggers**: Objects that log messages for an individual component of the environment, such as a REST API for an application plug-in or to log user access.
- **Destinations**: Objects that are called when a component logger requests a message to be logged. Destinations determine how something is logged, for example, to a file or to a console, and what formatting is applied.
- **Logger**: Central logging object, which can spawn component loggers and attach destinations.

Logger IDs

Because Zowe application plug-ins have unique identifiers, both dataservices and an application plug-in's web content are provided with a component logger that knows this unique ID such that messages that are logged can be prefixed with the ID. With the association of logging to IDs, you can control verbosity of logs by setting log verbosity by ID.

Accessing logger objects

Logger

The core logger object is attached as a global for low-level access.

zLUX Application Server

NodeJS uses `global` as its global object, so the logger is attached to:
`global.COM_RS_COMMON_LOGGER`

Web

Browsers use `window` as the global object, so the logger is attached to:
`window.COM_RS_COMMON_LOGGER`

Component logger

Component loggers are created from the core logger object, but when working with an application plug-in, allow the application plug-in framework to create these loggers for you. An application plug-in's component logger is presented to dataservices or web content as follows.

App Server

See **Router Dataservice Context** in the topic zLUX dataservices.

Web

(Angular App Instance Injectible). See **Logger** in Virtual desktop and window management.

Logger API

The following constants and functions are available on the central logging object.

Attribute	Type	Description	Arguments
`makeComponentLogger`	function	Creates a component logger - Automatically done by the application framework for dataservices and web content	`componentIDString`

Attribute	Type	Description	Arguments
setLogLevelForComponentName	function	Sets the verbosity of an existing component logger	componentIDString, logLevel

Component Logger API

The following constants and functions are available to each component logger.

Attribute	Type	Description	Arguments
SEVERE	const	Is a const for logLevel	
WARNING	const	Is a const for logLevel	
INFO	const	Is a const for logLevel	
FINE	const	Is a const for logLevel	
FINER	const	Is a const for logLevel	
FINEST	const	Is a const for logLevel	
log	function	Used to write a log, specifying the log level	logLevel, messageString
severe	function	Used to write a SEVERE log.	messageString
warn	function	Used to write a WARNING log.	messageString
info	function	Used to write an INFO log.	messageString
debug	function	Used to write a FINE log.	messageString
makeSublogger	function	Creates a new component logger with an ID appended by the string given	componentNameSuffix

Log Levels

An enum, LogLevel, exists for specifying the verbosity level of a logger. The mapping is:

Level	Number
SEVERE	0
WARNING	1
INFO	2
FINE	3
FINER	4
FINEST	5

Note: The default log level for a logger is **INFO**.

Logging verbosity

Using the component logger API, loggers can dictate at which level of verbosity a log message should be visible. The user can configure the server or client to show more or less verbose messages by using the core logger's API objects.

Example: You want to set the verbosity of the org.zowe.foo application plug-in's dataservice, bar to show debugging information.

```
logger.setLogLevelForComponentName('org.zowe.foo.bar',LogLevel.DEBUG)
```

Configuring logging verbosity

The application plug-in framework provides ways to specify what component loggers you would like to set default verbosity for, such that you can easily turn logging on or off.

Server startup logging configuration

The server configuration file, allows for specification of default log levels, as a top-level attribute `logLevel`, which takes key-value pairs where the key is a regex pattern for component IDs, and the value is an integer for the log levels.

For example:

```
"logLevel": {
    "com.rs.configjs.data.access": 2,
    //the string given is a regex pattern string, so .* at the end here will cover that service
 and its subloggers.
    "com.rs.myplugin.myservice.*": 4
    //
    // '_' char reserved, and '_' at beginning reserved for server. Just as we reserve
    // '_internal' for plugin config data for config service.
    // _unp = universal node proxy core logging
    //"_unp.dsauth": 2
  },
```

For more information about the server configuration file, see Configuring the zLUX Proxy Server and ZSS.

Chapter 6. Extending Zowe CLI

You can install plug-ins to extend the capabilities of Zowe CLI. Plug-ins add functionality to the product in the form of new command groups, actions, objects, and options.

Important! Plug-ins can gain control of your CLI application legitimately during the execution of every command. Install third-party plug-ins at your own risk. We make no warranties regarding the use of third-party plug-ins.

Note: For information about how to install, update, and validate a plug-in, see Installing Plug-ins.

The following plug-ins are available:

Zowe CLI plug-in for IBM Db2 Database

The Zowe CLI plug-in for Db2 enables you to interact with IBM Db2 Database on z/OS to perform tasks with modern development tools to automate typical workloads more efficiently. The plug-in also enables you to interact with IBM Db2 to foster continuous integration to validate product quality and stability.

For more information, see Zowe CLI plug-in for IBM Db2 Database.

Installing plug-ins

Use commands in the plugins command group to install and manage plug-ins for Zowe CLI.

Important! Plug-ins can gain control of your CLI application legitimately during the execution of every command. Install third-party plug-ins at your own risk. We make no warranties regarding the use of third-party plug-ins.

You can install the following plug-ins:

- **IBM Db2 Database** Use `@brightside/db2` in your command syntax to install, update, and validate the IBM Db2 Database plug-in.

Setting the registry

If you installed Zowe CLI from the zowe-cli-bundle.zip distributed with the Zowe PAX media, proceed to the Install step.

If you installed Zowe CLI from a registry, confirm that NPM is set to target the registry by issuing the following command:

```
npm config set @brightside:registry https://api.bintray.com/npm/ca/brightside
```

Meeting the prerequisites

Ensure that you meet the prerequisites for a plug-in before you install the plug-in to Zowe CLI. For documentation related to each plug-in, see Extending Zowe CLI.

Installing plug-ins

Issue an `install` command to install plug-ins to Zowe CLI. The `install` command contains the following syntax:

```
zowe plugins install [plugin...] [--registry <registry>]
```

- **`[plugin...]`** (Optional) Specifies the name of a plug-in, an npm package, or a pointer to a (local or remote) URL. When you do not specify a plug-in version, the command installs the latest plug-in version and specifies the prefix that is stored in npm save-prefix. For more information, see npm save prefix.

For more information about npm semantic versioning, see npm semver. Optionally, you can specify a specific version of a plug-in to install. For example, `zowe plugin install pluginName@^1.0.0`.

Tip: You can install multiple plug-ins with one command. For example, issue `zowe plugin install plugin1 plugin2 plugin3`

- **`[--registry <registry>]`** (Optional) Specifies a registry URL from which to install a plug-in when you do not use `npm config set` to set the registry initially.

Examples: Install plug-ins

- The following example illustrates the syntax to use to install a plug-in that is distributed with the zowe-cli-bundle.zip. If you are using zowe-cli-bundle.zip, issue the following command for each plug-in .tgz file:

```
zowe plugins install ./zowe-cli-db2-1.0.0-next.20180531.tgz
```

- The following example illustrates the syntax to use to install a plug-in that is named "my-plugin" from a specified registry:

```
zowe plugins install @brightside/my-plugin
```

- The following example illustrates the syntax to use to install a specific version of "my-plugins"

```
 zowe plugins install @brightside/my-plugin@"^1.2.3"
```

Validating plug-ins

Issue the plug-in validation command to run tests against all plug-ins (or against a plug-in that you specify) to verify that the plug-ins integrate properly with Zowe CLI. The tests confirm that the plug-in does not conflict with existing command groups in the base application. The command response provides you with details or error messages about how the plug-ins integrate with Zowe CLI.

Perform validation after you install the plug-ins to help ensure that it integrates with Zowe CLI.

The `validate` command has the following syntax:

```
zowe plugins validate [plugin]
```

- **`[plugin]`** (Optional) Specifies the name of the plug-in that you want to validate. If you do not specify a plug-in name, the command validates all installed plug-ins. The name of the plug-in is not always the same as the name of the NPM package.

Examples: Validate plug-ins

- The following example illustrates the syntax to use to validate a specified installed plug-in:

```
zowe plugins validate @brightside/my-plugin
```

- The following example illustrates the syntax to use to validate all installed plug-ins:

```
zowe plugins validate
```

Updating plug-ins

Issue the `update` command to install the latest version or a specific version of a plug-in that you installed previously. The `update` command has the following syntax:

```
zowe plugins update [plugin...] [--registry <registry>]
```

- **`[plugin...]`**

Specifies the name of an installed plug-in that you want to update. The name of the plug-in is not always the same as the name of the NPM package. You can use npm semantic versioning to specify a plug-in version to which to update. For more information, see npm semver.

- **[--registry <registry>]**

  (Optional) Specifies a registry URL that is different from the registry URL of the original installation.

Examples: Update plug-ins

- The following example illustrates the syntax to use to update an installed plug-in to the latest version:

```
zowe plugins update @brightside/my-plugin@latest
```

- The following example illustrates the syntax to use to update a plug-in to a specific version:

```
zowe plugins update @brightside/my-plugin@"^1.2.3"
```

Uninstalling plug-ins

Issue the `uninstall` command to uninstall plug-ins from a base application. After the uninstall process completes successfully, the product no longer contains the plug-in configuration.

Tip: The command is equivalent to using npm uninstall to uninstall a package.

The `uninstall` command contains the following syntax:

```
zowe plugins uninstall [plugin]
```

- **[plugin]** Specifies the plug-in name to uninstall.

Example: Uninstall plug-ins

- The following example illustrates the syntax to use to uninstall a plug-in:

```
zowe plugins uninstall @brightside/my-plugin
```

Zowe CLI plug-in for IBM Db2 Database

The Zowe CLI plug-in for IBM Db2 Database lets you interact with Db2 for z/OS to perform tasks with modern development tools to automate typical workloads more efficiently. The plug-in also enables you to interact with Db2 to advance continuous integration to validate product quality and stability.

Plug-in overview

Zowe CLI Plug-in for IBM Db2 Database lets you execute SQL statements against a Db2 region, export a Db2 table, and call a stored procedure.The plug-in also exposes its API so that the plug-in can be used directly in other products.

Use cases

Example use cases for Zowe CLI Db2 plug-in include: - Execute SQL and interact with databases - Execute a file with SQL statements - Export tables to a local file on your PC in SQL format - Call a stored procedure and pass parameters

Prerequisites

Ensure that Zowe CLI is installed.

More Information:

- Installing Zowe CLI

Installing

There are **two methods** that you can use to install the Zowe CLI Plug-in for IBM Db2 Database.

Method 1

If you installed **Zowe CLI** from **bintray**, complete the following steps:

1. Open a command line window and issue the following command:

```
zowe plugins install @brightside/db2
```

2. After the command execution completes, issue the following command to validate that the installation completed successfully.

```
zowe plugins validate db2
```

   Successful validation of the IBM Db2 plug-in returns the response: `Successfully validated`.

Method 2

If you downloaded the **Zowe** installation package from **Github**, complete the following steps:

1. Open a command line window and change the directory to the location where you extracted the `zowe-cli-bundle.zip` file. If you do not have the `zowe-cli-bundle.zip` file, see the topic **Install Zowe CLI from local package** in Installing Zowe CLI for information about how to obtain and extract it.
2. From the command line window, set the `IBM_DB_INSTALLER_URL` environment variable by issuing the following command:

   • Windows operating systems:

   `set IBM_DB_INSTALLER_URL=%cd%/odbc_cli` - Linux and Mac operating systems:

   `export IBM_DB_INSTALLER_URL=`pwd`/odbc_cli`
3. Issue the following command to install the plug-in:

```
zowe plugins install zowe-cli-db2-1.0.0.tgz
```

4. After the command execution completes, issue the following command to validate that the installation completed successfully.

```
zowe plugins validate db2
```

   Successful validation of the IBM Db2 plug-in returns the response: `Successfully validated`.

Profile setup

Before you start using the IBM Db2 plug-in, create a profile.

Creating a profile

Issue the command `-DISPLAY DDF` in the SPUFI or ask your DBA for the following information:

- The Db2 server host name
- The Db2 server port number
- The database name (you can also use the location)
- The user name
- The password
- If your Db2 systems use a secure connection, you can also provide an SSL/TSL certificate file.

To create a db2 profile in Zowe CLI, issue a command in the command shell in the following format:

```
zowe profiles create db2 <profile name> -H <host> -P <port> -d <database> -u <user> -p
 <password>
```

The profile is created successfully with the following output:

```
Profile created successfully! Path:
/home/user/.brightside/profiles/db2/<profile name>.yaml
type: db2
name: <profile name>
hostname: <host>
port: <port>
username: securely_stored
password: securely_stored
database: <database>
Review the created profile and edit if necessary using the profile update command.
```

Commands

The following commands can be issued with the Zowe CLI Plug-in for IBM Db2:

Tip: At any point, you can issue the help command `-h` to see a list of available commands.

Calling a stored procedure

Issue the following command to call a stored procedure that returns a result set:

```
$ zowe db2 call sp "DEMOUSER.EMPBYNO('000120')"
```

Issue the following command to call a stored procedure and pass parameters:

```
$ zowe db2 call sp "DEMOUSER.SUM(40, 2, ?)" --parameters 0
```

Issue the following command to call a stored procedure and pass a placeholder buffer:

```
$ zowe db2 call sp "DEMOUSER.TIME1(?)" --parameters "....placeholder..
```

Executing an SQL statement

Issue the following command to count rows in the EMP table:

```
$ zowe db2 execute sql -q "SELECT COUNT(*) AS TOTAL FROM DSN81210.EMP;"
```

Issue the following command to get a department name by ID:

```
$ zowe db2 execute sql -q "SELECT DEPTNAME FROM DSN81210.DEPT WHERE DEPTNO='D01'
```

Exporting a table in SQL format

Issue the following command to export the PROJ table and save the generated SQL statements:

```
$ zowe db2 export table DSN81210.PROJ
```

Issue the following command to export the PROJ table and save the output to a file:

```
$ zowe db2 export table DSN81210.PROJ --outfile projects-backup.sql
```

You can also pipe the output to gzip for on-the-fly compression.