

# COBOL Programming Course#1

## 3.2.0

### Getting Started

- [PREFACE](#)
- [AUTHORS](#)
- [1 VS CODE WITH ZOWE EXPLORER](#)
- [2 VS CODE WITH Z OPEN EDITOR](#)
- [3 VS CODE WITH CODE4Z OPEN-SOURCE EXTENSION PACKAGE](#)
- [4 ZOWE CLI AND ZOWE CLI PLUG-INS](#)
- [5 INSTALLATION OF VS CODE AND EXTENSIONS](#)
- [6 INSTALLATION OF ZOWE CLI AND PLUG-INS](#)

# PREFACE

One computer programming language was designed specifically for business, Common Business-Oriented Language, COBOL. Today COBOL remains as relevant as ever, handling \$3 trillion in commerce every day.

This publication is aimed at beginners looking to build a working understanding of COBOL programming. It describes how to work with COBOL using modern tools including Visual Studio Code with Zowe and Z Open Editor extensions. It describes how to write, test, execute, and debug COBOL programs.

# AUTHORS

**Michael Bauer** is a development leader for the Open Mainframe value stream at Broadcom and is a squad lead for the Zowe open source initiative. Zowe, a popular framework of modern interfaces for z/OS, opens the mainframe to DevOps tools and practices. Mike leads the Command Line Interface (CLI) squad, which created and recently spun-off the successful Zowe Explorer extension for Visual Studio Code. A frequent speaker and blogger, Mike runs interactive workshops around the world for those interested in incorporating mainframe in their enterprise DevOps initiatives.

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**Jonathan Sayles** is a technical educator at IBM, where he conducts presentations, seminars and training courses, as well as producing educational materials. His more than 40 years in the IT education and computer industries encompass work within both academic and corporate development organizations. He has also been engaged as a software developer/designer/consultant, educator, and author, with a focus on relational database, IDE, and object technologies. In addition to authoring/publishing 16 books, Jon has written and published more than 150 articles in technical journals, and served as technical editor for several IT magazines. He is also co-author of IBM Redbook publications Transitioning: Informix 4GL to Enterprise Generation Language (EGL), SG24-6673 and z/OS Traditional Application Maintenance and Support, SG24-7868.

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**William Yates** is a Software engineer working for IBM UK. For the majority of his career he has been working on the CICS TS product mainly as a software tester and now as Test Architect. He has delivered technical content for many Redbooks, video courses and at conferences around the world. He is also one of the leaders of the Galasa project, building an open source integration test framework for hybrid cloud applications available at <https://galasa.dev/>.

## ACKNOWLEDGEMENTS

Special thanks to the following people for participating in the residency to shape the content in this publication.

- Dr. Tak Auyeung, Professor, American River College
- Jeffrey Bisti, Z Ecosystem Architect, IBM
- Ilicena Elliott, IT Specialist II, Employment Development Department
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# 1 VS CODE WITH ZOWE EXPLORER

Zowe Explorer is an open-source extension for VS Code that lets developers and system administrators interact with z/OS mainframes.

- **Introduction to Zowe Explorer**
- **Using Zowe Explorer**
- **Profiles in Zowe Explorer**
  - **Secure Credentials**
  - **Creating a Team Configuration File**
  - **Editing Profiles**
- **Summary**

## 1.1 INTRODUCTION TO ZOWE EXPLORER

The Zowe Explorer extension modernizes the way developers and system administrators interact with z/OS mainframes. Working with data sets and USS files from VS Code can be more convenient than using 3270 emulators. The extension provides the following benefits:

- Create, modify, rename, copy and upload data sets directly to a z/OS mainframe.
- Create, modify, rename and upload USS files directly to a z/OS mainframe.
- Streamlined process to access data sets, USS files, and jobs.
- Easy interaction with multiple z/OS systems

The Zowe Explorer can be installed into VS Code by searching the Extensions Marketplace inside VS Code for “Zowe Explorer” and selecting install. To see more detailed instructions on installing this extension, refer to “Installation of VSCode and Extensions”.

## 1.2 USING ZOWE EXPLORER

Zowe Explorer allows you to work with data sets, Unix System Service (USS) files, and jobs.

Zowe Explorer offers the following functions:

## Data sets

- Search for data sets matching desired filters and view their contents
- Download, edit, and upload existing PDS members
- Create and delete both data sets and data set members
- Interact with data sets from multiple systems simultaneously
- Rename data sets
- Copy data sets
- Submit JCL from a chosen data set member

## USS Files

- View multiple Unix System Services (USS) files simultaneously
- Download, edit, and upload existing USS files
- Create and delete USS files and directories
- Interact with USS files from multiple systems simultaneously
- Rename USS files

## Jobs

- View multiple jobs simultaneously
- Download spool content
- Interact with jobs from multiple systems simultaneously

For more information about Zowe Explorer and the different use cases, visit the [marketplace](#)

## 1.3 PROFILES IN ZOWE EXPLORER

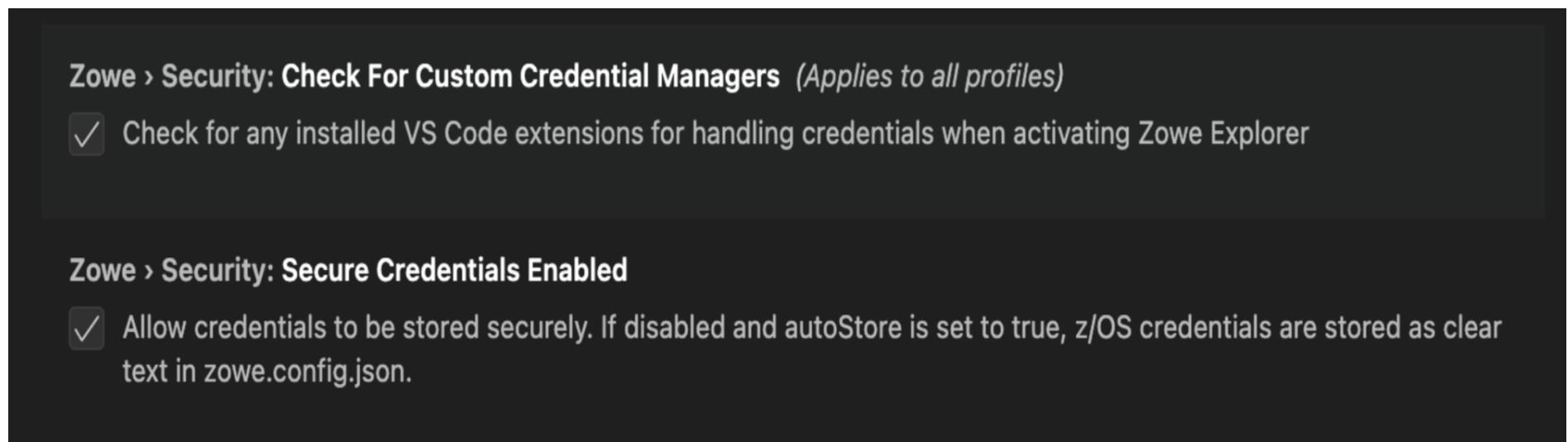
Profiles serve as a point-of-contact for Zowe Explorer and the Mainframe. Profiles contain the URL for the API services that you want to connect to and your credentials. The main profile information that you need for Zowe Explorer is the z/OSMF Connection. If you have the Zowe Explorer installed, you can follow the steps in this section to connect to the mainframe.

### 1.3.1 Secure Credentials

Zowe Explorer has a built-in Secure Credential Store. This enables you to encrypt the credentials that are stored in your machine, and as a result, secure your connection to the Mainframe.

To enable this feature, follow these steps:

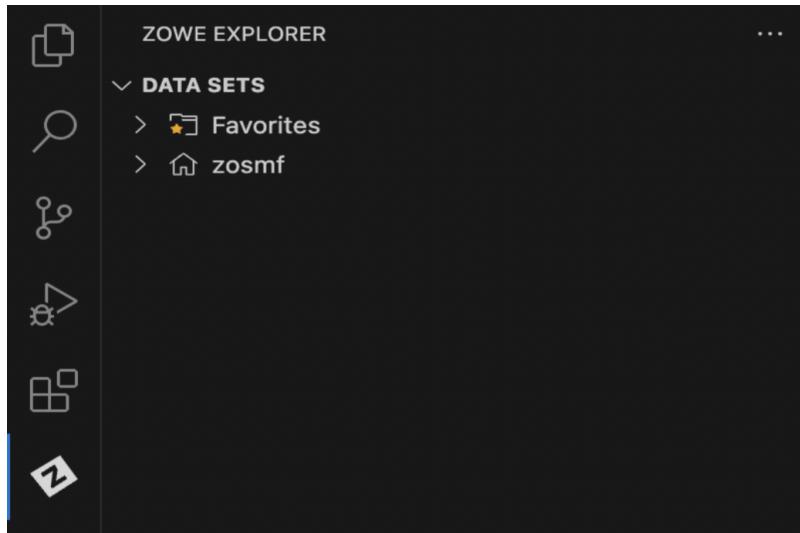
1. Click the **Gear Icon** at the bottom left and select **Settings**
2. Click **User Settings > Extensions > Zowe Explorer**
3. Look for the **Zowe Security: Check For Custom Credential Managers and Secure Credentials Enabled** field



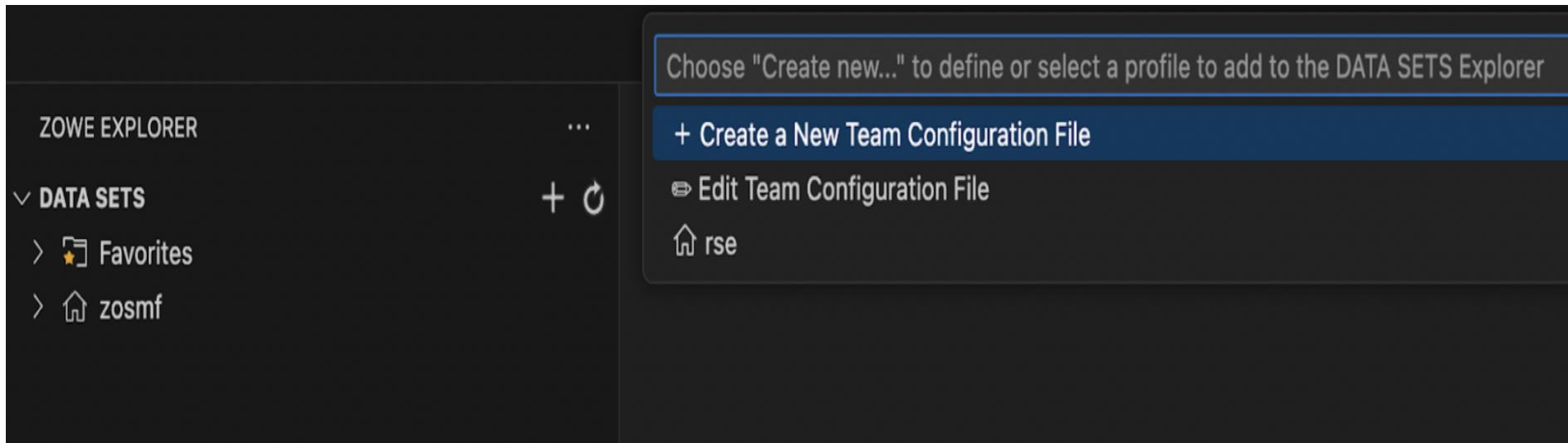
### 1.3.2 Creating A Team Configuration File

Follow these steps:

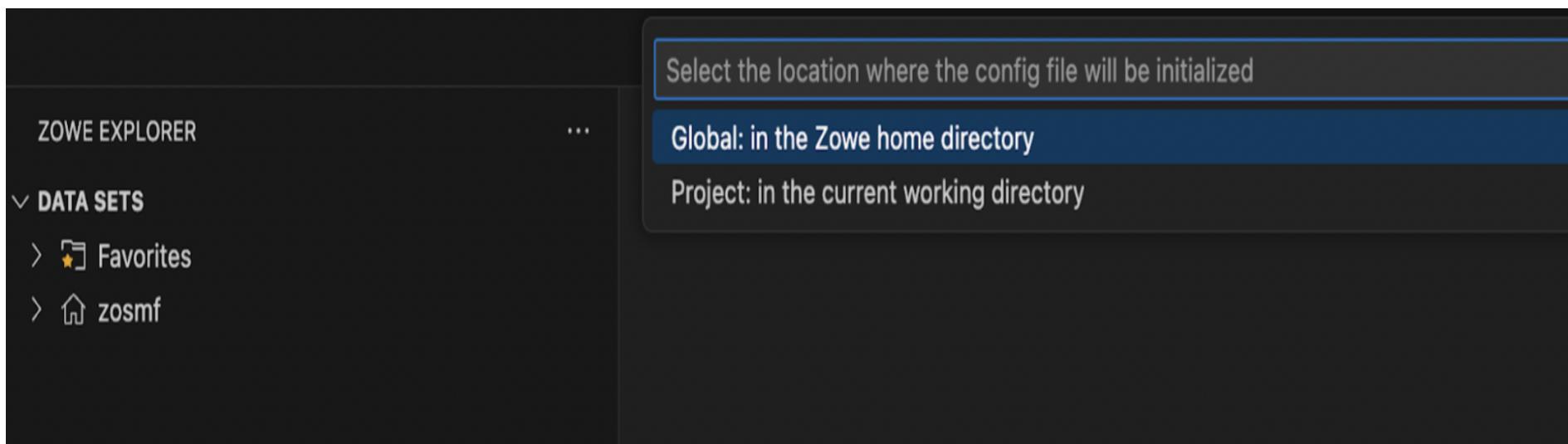
1. Navigate to the Zowe Explorer tree and check if you already have a zosmf team configuration file.



2. If you don't have one, click on the + sign. A dialog box will appear and ask if you want to "Create a New Team Configuration File".
3. Press enter or click on that selection.



4. You can initialize the config file either in the Zowe home directory or in the current working directory.

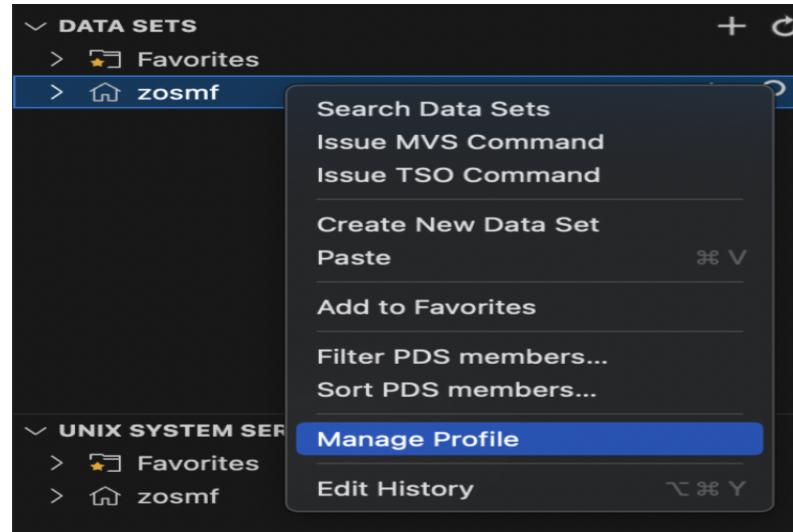


### 1.3.3 Editing Profiles

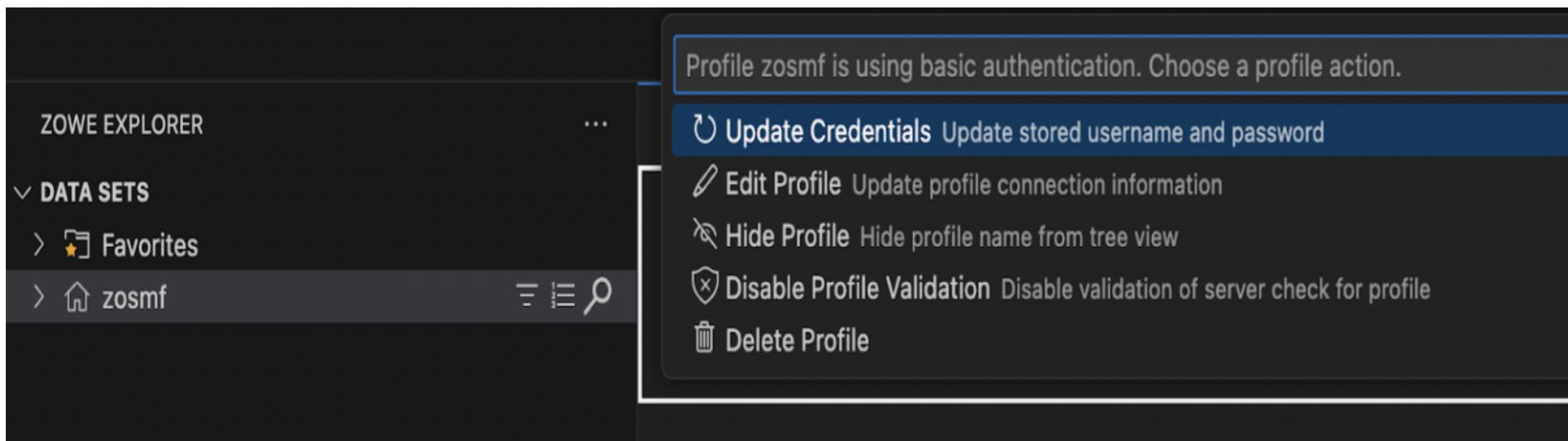
The Zowe Explorer v3.0 enables users to edit their profiles, allowing them to update their existing profile information and continue using Zowe Explorer.

Follow these steps:

1. Right-click on the Team Configuration File you want to edit.
2. from the dropdown choose **Manage Profile**



3. A dialog box opens, displaying a list of available profile modifications.

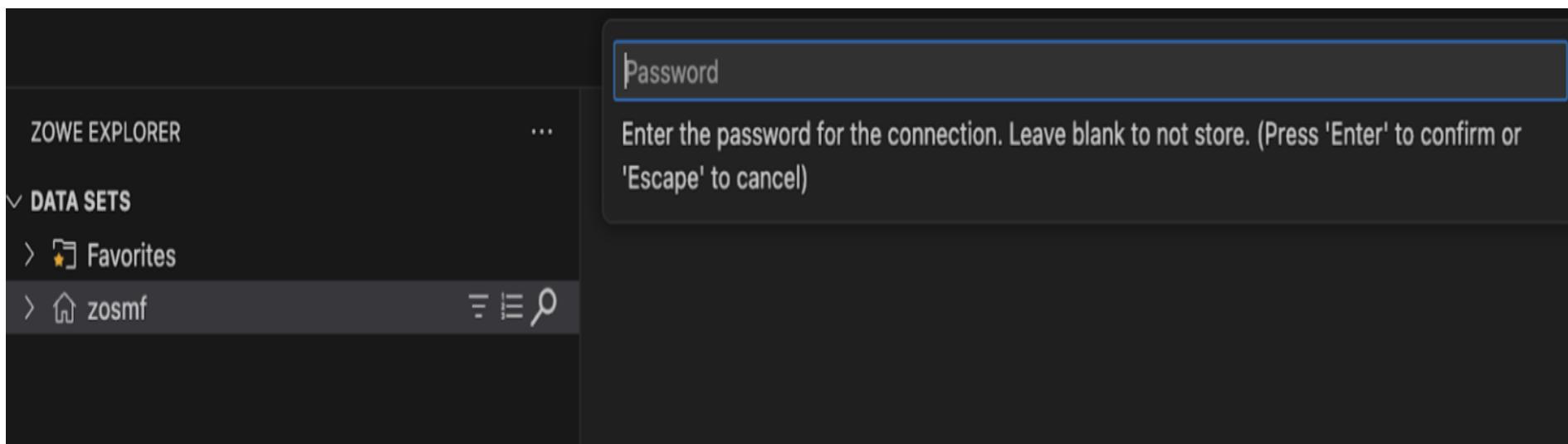
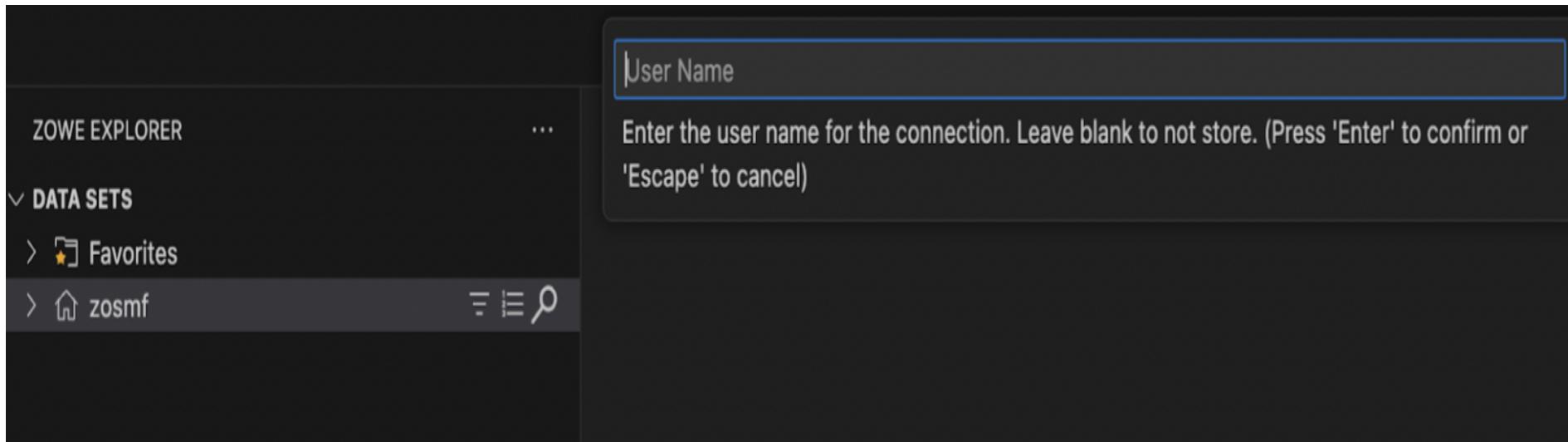


4. Click on Edit Profile. Now you will be getting the zowe.config.json file.

```
{} zowe.config.json X  
Users > riturajmahato > .zowe > {} zowe.config.json > {} profiles > {} ssh > [ ] secure  
1 {  
2   "$schema": "./zowe.schema.json",  
3   "profiles": {  
4     "zosmf": {  
5       "type": "zosmf",  
6       "properties": {  
7         "port": 10443  
8       },  
9       "secure": []  
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```

5. Ensure you are connected to the correct host: 204.90.115.200, and set 'rejectUnauthorized' to false for a successful connection.

```
{} zowe.config.json X  
Users > riturajmahato > .zowe > {} zowe.config.json > ...  
3   "profiles": {  
35  },  
36  "base": {  
37    "type": "base",  
38    "properties": {  
39      "host": "204.90.115.200",  
40      "rejectUnauthorized": false  
41    },  
42    "secure": [  
43      "user",  
44      "password"  
45    ]  
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```



## 1.4 SUMMARY

In this section, you have learned the basic features of the Zowe Explorer extension and how to create and work with Zowe compatible **zosmf** profile.

# 2 VS CODE WITH Z OPEN EDITOR

In this chapter we will explain how to use the IBM Z Open Editor extension for VSCode and how using it can help you develop COBOL source code in a feature-rich environment.

- **Introduction to the IBM Z Open Editor**

- **What is the IBM Z Open Editor?**
- **The role of the Language Server Protocol**
- **Installing the IBM Z Open Editor for VS Code**

- **Basic editing**

- **Known file extensions**
- **Margins**
- **Variable expansion**
- **Syntax highlighting**

- **Navigation of code**

- **Outline view**
- **Breadcrumb view**
- **Jump to declaration / reference**

- **Code-completion**

- **COBOL reserved word completion**
- **Variable completion**
- **CICS, MQ, DB2 API completion**

- **Refactoring code**

- **Renaming variables**
- **Handling errors**

- **Summary**

## 2.1 INTRODUCTION TO THE IBM Z OPEN EDITOR

This section introduces the IBM Z Open Editor.

### 2.1.1 What Is The IBM Z Open Editor?

The IBM Z Open Editor is a free extension for Visual Studio Code (VSCode) that provides language support for COBOL, PL/I, and JCL languages. Along with this language support it also provides content assistance for applications that call CICS, MQ, and DB2 APIs. The source code doesn't even need to reside on z/OS, it could be in a source code repository, locally in a file, or on z/OS. Although this course focuses on COBOL as a source language, a lot of the functions we will discuss will also apply to PL/I and JCL.

### 2.1.2 The Role Of The Language Server Protocol

Integrated development environments always want to provide a rich platform for all supported programming languages, however, the proliferation of programming languages and the speed at which new editors reach the market makes keeping pace difficult. Each editor would need to provide an editor-specific plugin for each language they wished to support, thus support for a certain language would differ between different editors.

Microsoft designed the Language Server Protocol (LSP) to act as a common description of how features like auto-complete should be implemented for a specific language. Languages which have an implemented LSP server can therefore be used within any editor that supports LSP. Many companies and the open-source community have collaborated to provide LSP servers for an array of different languages.

The language server protocol defines six broad capabilities that should be implemented for a language server to be LSP compliant. These capabilities include code completion, hover, jump to definition, workspace symbols, find references, and diagnostics. The IBM Z Open Editor provides compliant language servers for both the Enterprise COBOL and Enterprise PL/I for z/OS languages. In addition to being compliant, they also provide additional capabilities that we will discuss further on.

**Note:** More information on Language Server Protocol implementations can be found at: <https://langserver.org>

## 2.1.3 Installing The IBM Z Open Editor For VS Code

The IBM Z Open Editor can be installed into VS code by searching the Extensions Marketplace inside VSCode for “IBM Z Open Editor” and selecting install. Once installed, the default editor will be enabled to provide a rich editing experience for COBOL, PL/I, and JCL. There is no need to use a specific editor for these languages. To see a more detailed instruction on installing this extension, refer to “Installation of VSCode and extensions”.

## 2.2 BASIC EDITING

For the rest of this chapter, we will use the CBL0001 sample program to demonstrate how rich of an experience editing COBOL in VSCode can be. So, let’s fire up VSCode, install IBM Z Open Editor (if it’s not already), open up CBL0001, and get started.

### 2.2.1 Known File Extensions

For VSCode to use the capabilities of the IBM Z Open Editor, it needs to know that the file we are editing is a COBOL file. VSCode accomplishes this by comparing the location and name of the file being opened against a list of known extensions to map the file to a known language. For COBOL the following associations are used:

- \*.COBOL\*
- \*.CBL\*
- \*.COB\*
- \*.COBCOPY\*
- \*.COPYBOOK\*
- \*.COPY\*

These are applied to both local files and files held in a Partitioned Data Set or PDS on the mainframe, which for simplicity you can think of as a folder. Thus, a PDS called:

Z9994.COBOL

Or a file on the local file system called:

PROGA1.COBOL

Will be assumed to be COBOL code. This information is stored in the global VSCode settings.json file that can be accessed through VSCode preferences. This allows for a user to tailor VSCode's known extensions to a particular site naming convention.

## 2.2.2 Margins

The first thing you will notice when editing COBOL source code is that VSCode will have inserted five vertical lines down the file. These lines segment each line of code into the areas reserved for sequence numbers, comment/continuation characters, area A, and area B. When coding without this basic aid I cannot recount the number of times I have made a compilation error because I started coding in the wrong column. This alone is a very useful aid to a new COBOL programmer. More information about COBOL syntax, and in particular, the columns, will be discussed later

## 2.2.3 Variable Expansion

As you browse through CBL0001 type **CTRL + G** to jump to a specific line of code. A small dialog will open asking you for the line you wish to jump to, type **87**, and press the enter key. VSCode will highlight that line of code and navigate you directly to it, as shown in Figure 1.

The screenshot shows a COBOL program in a text editor. The file is named Z99998.CB and is at line 87. The status bar indicates the file is at line 87. A blue bar at the top says "C: > Users > Go to line 87." and "learnCOBOL >". The code is as follows:

```
86
87      WRITE-RECORD.
88      MOVE ACCT-NO      TO ACCT-NO-0.
89      MOVE ACCT-LIMIT   TO ACCT-LIMIT-0.
90      MOVE ACCT-BALANCE TO ACCT-BALANCE-0.
91      MOVE LAST-NAME    TO LAST-NAME-0.
92      MOVE FIRST-NAME   TO FIRST-NAME-0.
93      MOVE COMMENTS     TO COMMENTS-0.
94      WRITE PRINT-REC.
95      *
```

Figure 1. Navigating to a specific line of code

If you hover your mouse over the 'ACCT-NO-0' field a pop-up will appear displaying the declaration of that variable, shown in Figure 2.

The screenshot shows the same COBOL program as Figure 1, but with a tooltip for the 'ACCT-NO-0' field. The tooltip contains the following declaration:

01 PRINT-REC.  
05 ACCT-NO-0 PIC X(8).

The rest of the code is identical to Figure 1.

Figure 2. View declaration of variable

Since this field is a 05-level variable nested within a 01-level variable, the pop-up shows the declaration of the field as an eight-byte picture variable, the name of the parent structure, and the file definition that it is within. If you hold the CMD/Ctrl key while hovering over

the field, then the pop-up will additionally contain the line of code where the variable is defined as well as the following three lines of code. These features can be extremely helpful when analyzing existing code.

## 2.2.4 Syntax Highlighting

The COBOL code that you are editing will also be highlighted to help you understand the different elements of the COBOL language. Depending on the color theme that you have selected in VSCode, comments, COBOL reserved words, literal values, and variables will be colored differently allowing you to spot obvious syntax issues early on before even submitting the code to a build.

## 2.3 NAVIGATION OF CODE

Although the code examples we are using in this section are fairly small, the code that you could be writing could have hundreds or thousands of lines. Being able to understand the general structure of the source code and being able to find your way around it without getting lost is a big advantage when editing COBOL. Fortunately, there are some great features to help you out, which we will discuss next.

### 2.3.1 Outline View

Within the explorer sidebar of VSCode, there is an outline view that will be populated whenever you are editing a COBOL file. This view contains a collapsible look at each division, data structure, and paragraph within your code. This allows you to easily view the structure of the source code. Clicking on a particular paragraph, division or data element will simultaneously move the editor to show that section of the code and highlight it, depicted in Figure 3. This makes jumping to a specific part of the code very easy.

```

PROGRAM: CBL0001 > DATA DIVISION. > FILE SECTION. > FD PRINT
 05 ACCT-NO-0          PIC X(8).
 05 ACCT-LIMIT-0        PIC $9,999,999.99.
 05 ACCT-BALANCE-0      PIC $9,999,999.99.
* PIC $9,999,999.99 -- Alternative for PIC on chapter 7.2.3,
* using $ to allow values of different amounts of digits
* and .99 instead of .99 to allow period display on output
 05 LAST-NAME-0         PIC X(20).
 05 FIRST-NAME-0        PIC X(15).
 05 COMMENTS-0          PIC X(50).
* since the level 05 is higher than level 01,
* all variables belong to PRINT-REC (see chapter 7.3.3)

FD ACCT-REC RECORDING MODE F.
 05 ACCT-FIELDS.
    05 ACCT-NO          PIC X(8).
    05 ACCT-LIMIT        PIC S9(7)V99 COMP-3.
    05 ACCT-BALANCE      PIC S9(7)V99 COMP-3.
    * PIC S9(7)V99 COMP-3 seven-digit number with sign digit value
    * and packed BCD (binary coded decimal) representation
    05 LAST-NAME         PIC X(20).
    05 FIRST-NAME        PIC X(15).
    05 CLIENT-ADDR.
      10 STREET-ADDR      PIC X(25).
      10 CITY-COUNTY      PIC X(20).
      10 USA-STATE         PIC X(15).
      05 RESERVED          PIC X(1).
      05 COMMENTS          PIC X(50).

WORKING-STORAGE SECTION.
 01 FLAGS.
    05 LASTREC            PIC X VALUE SPACE.

PROCEDURE DIVISION.
  OPEN-FILES.
    OPEN INPUT ACCT-REC.
    OPEN OUTPUT PRINT-LINE.
    READ-NEXT-RECORD.
    PERFORM READ-RECORD.

```

Figure 3. Outline view in VSCode

### 2.3.2 Breadcrumb View

Similarly, the breadcrumb view across the top of the editor can show where the current line of code exists within the structure of the COBOL source code. As you navigate the source code in the editor, the breadcrumb trail will automatically update to reflect where you are in the structure of the program and provides you a mechanism to move to a different element of the code. Again, if you open CBL0001 in VSCode and jump to line 50, this line is a declaration of the field USA-STATE within the structure ACET-FIELDS, in the FILE-SECTION of the DATA-DIVISION. Across the top of the editor, the breadcrumb trail will show the information displayed in Figure 4.

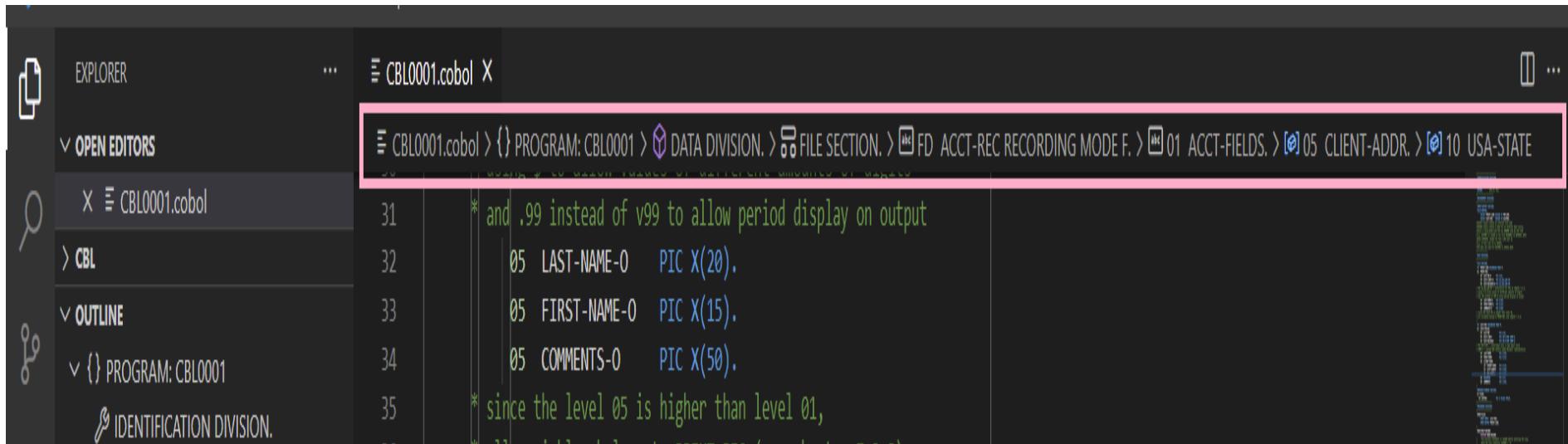


Figure 4. Breadcrumb trail in VSCode

Clicking on any of the items in the breadcrumb trail will highlight that element of the code in the editor, quickly showing you the location of that element within the code. It will also show a view of the code in a pop-up window, shown in Figure 5., similar to the outline view previously discussed.

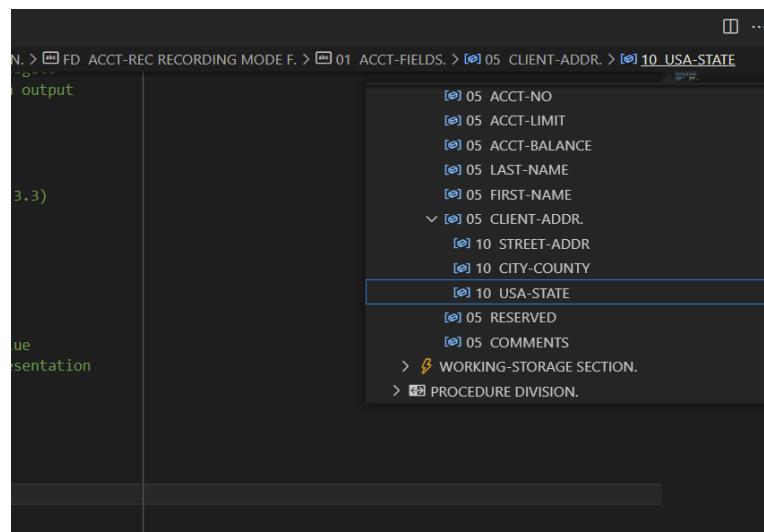


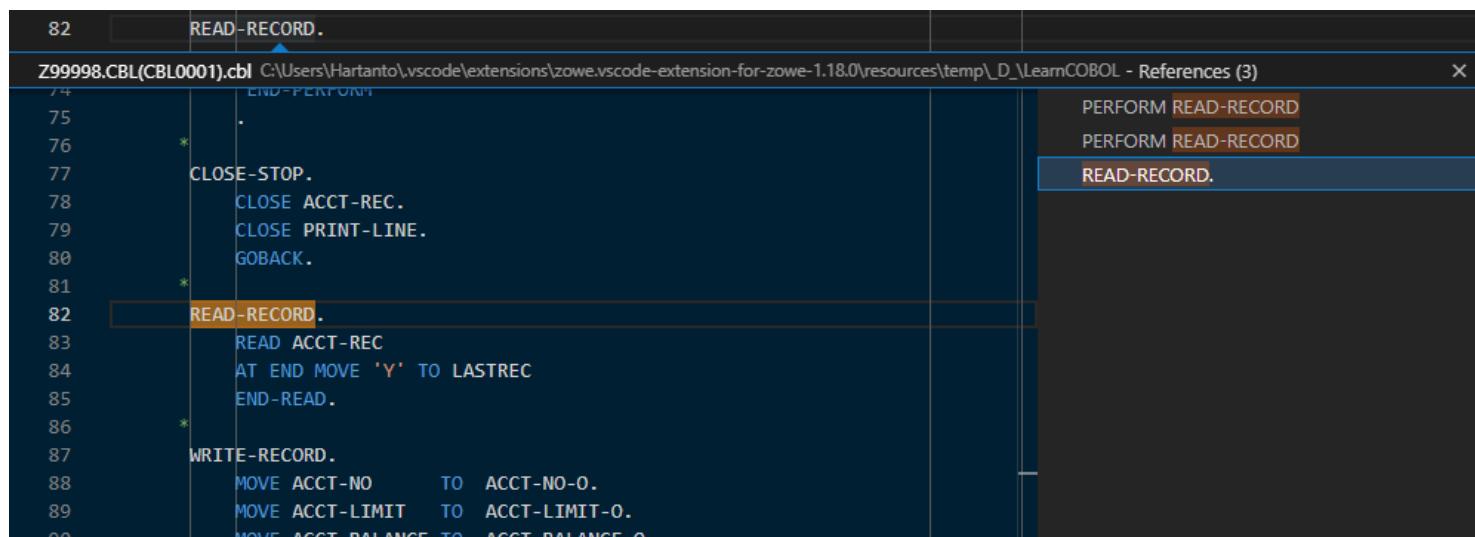
Figure 5. Pop-up view of code via breadcrumb selection

### 2.3.3 Jump To Declaration / Reference

As you browse through code you will come across COBOL PERFORM statements or variable references. Often you will need to navigate to the definition of that paragraph or variable to follow the execution of the code. At line 64 of CBL0001, we see a set of PERFORM statements. Place the cursor within the name, READ-RECORD, on line 65, right-click and select **Go to Definition**. The editor then navigates to the READ-RECORD paragraph on line 82. Instead of right-clicking, the same function can be reached by using the F12 key.

“Go to References” does the reverse of this operation and allows you to navigate from the definition of a paragraph or variable to all the places within the application that reference that paragraph or variable. To demonstrate this, navigate to line 82 of CBL0001, which again is the declaration of the READ-RECORD paragraph. To see all of the places where this paragraph is called, right-click and select **Go to References**, or hit the key combination **SHIFT+F12**. This will summon a new pop-up dialog that shows all the references to this paragraph in the code, shown in Figure 6.

**Note:** If **SHIFT+F12** does not work for your machine, you may need to use the key combination, **Fn+F12 instead**.



The screenshot shows a COBOL source code file in VSCode. Line 82 contains the declaration of the READ-RECORD paragraph. A context menu is open at the end of the READ-RECORD line, showing three entries: 'PERFORM READ-RECORD', 'PERFORM READ-RECORD', and 'READ-RECORD.'. The third entry, 'READ-RECORD.', is highlighted with a blue selection bar. The status bar on the right indicates 'COBOL Programming Course #1 3.3.2.0 250207-0043'.

Figure 6. Finding paragraph/variable references in VSCode

## 2.4 CODE-COMPLETION

Code completion isn't exactly a new concept in most IDEs. For example, the Eclipse editor has provided auto-completion for Java APIs for a long time. The same key combination, **CTRL+SPACE**, triggers this auto-completion function while you are coding and can be used to help guide you through COBOL syntax and CICS API calls.

### 2.4.1 COBOL Reserved Word Completion

As you are typing a COBOL reserved word, you can type **CTRL+SPACE** and the IBM Z Open Editor will present, in a pop-up, a list of possible COBOL reserved words that you might be trying to use. Using the cursor keys or the mouse allows you to select the correct recommended keyword and press enter to select it and the rest of the reserved word will be entered for you, aka auto-completed!

### 2.4.2 Variable Completion

The same technique can be applied to variable completion. This can be particularly useful when you are referencing a variable that exists multiple times within different structures. In these cases, auto-completion can help you identify the variable you want to use. As an example, create a new line within the WRITE-RECORD paragraph. On the new line, enter the code **MOVE ACCT-BA** and then press **CTRL+SPACE** to invoke code auto-completion. You should see a pop-up similar to the one shown in Figure 7. below.

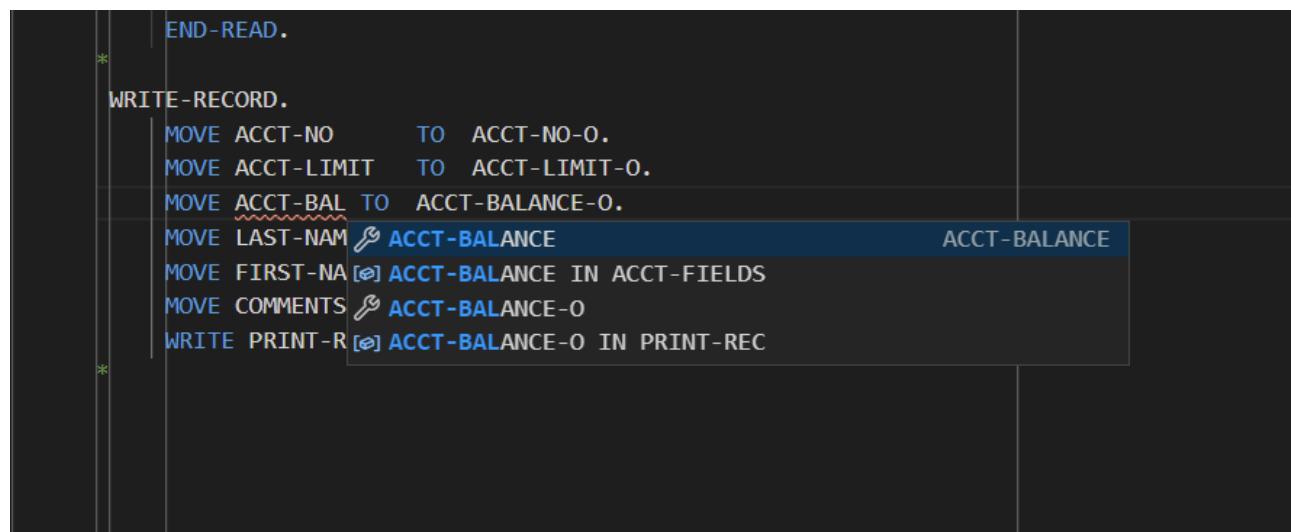


Figure 7. Auto-completion in VSCode

You can see that not only is the variable ACCT-BALANCE prompted as a potential candidate, but it also presents ACCT\_BALANCE IN ACCT-FIELDS.

## 2.4.3 CICS, MQ, DB2 API Completion

The auto-completion of variables also extends to the CICS and DB2 APIs, known as EXEC CICS and EXEC SQL statements. Although COBOL programming for DB2 and CICS is not a primary focus here, note that if you find yourself programming for either of these APIs that the capability is available.

# 2.5 REFACTORING CODE

Working with source code is seldom just about the initial creation, during a program's life cycle it will be changed and re-worked we often call this work refactoring. This section explores renaming variables and handling errors.

## 2.5.1 Renaming Variables

During maintenance of existing code, you might need to refactor variable names or paragraph names. Doing this manually can be a painful process, as you probably need to update both the original declaration and all the references within the source code. Fortunately, there is a function for that, let's work through an example. Back in CBL0001 hit **CTRL+G** to bring up the go-to line function and go to line 40. This is the declaration of the variable ACCT-NO. Right-click on the variable and select “**Find All References**”. From this, we can see that apart from the declaration, the variable is also referenced on line 88. So, if we rename the variable, we probably need to update this reference as well. To perform the rename, ensure that the cursor is on the variable and then press **SHIFT/Fn+F2**. This will bring up a small pop-up asking you to provide a new variable name, as shown in Figure 8. Enter **ACCT-NO-TEST** and press **enter**.

The screenshot shows a COBOL program in the IBM Z Open Editor. A tooltip is displayed over the variable 'ACCT-NO-TEST' at line 88, indicating it is being renamed. The code includes declarations for FD ACCT-REC, 01 ACCT-FIELDS, and various 05-level fields like ACCT-NO, LAST-NAME, FIRST-NAME, and CLIENT-ADDR.

```
85  COMMENTS 0      PIC X(50).  
* since the level 05 is higher than level 01,  
* all variables belong to PRINT-REC (see chapter 7.3.3)  
*  
FD  ACCT-REC RECORDING MODE F.  
01  ACCT-FIELDS.  
    05  ACCT-NO          PIC X(8).  
    05  ACCT-NO-TEST    7)V99 COMP-3.  
    05  Enter to Rename, Shift+Enter to Preview 7)V99 COMP-3.  
* PIC S9(7)v99 -- seven-digit plus a sign digit value  
* COMP-3 -- packed BCD (binary coded decimal) representation  
    05  LAST-NAME        PIC X(20).  
    05  FIRST-NAME       PIC X(15).  
    05  CLIENT-ADDR.
```

Figure 8. Renaming variables

You will note that both the declaration of the variable and the reference on line 88 have been updated to the new value. As stated previously, the same process also works for paragraph names. For example, go ahead and refactor the name of the paragraph READ-RECORD to be READ-NEW-RECORD.

## 2.5.2 Handling Errors

The IBM Z Open Editor plugin also provides a level of syntax checking for local source code. Although not as thorough as the compiler, it is a method of quickly identifying basic errors in your code before submitting it for compilation. To demonstrate, let's create an error and then see how the editor shows it to us. First, open the problems view by selecting **View** and then **Problems** from the editor menu. The problems view should open at the bottom of the window, as depicted in Figure 9.

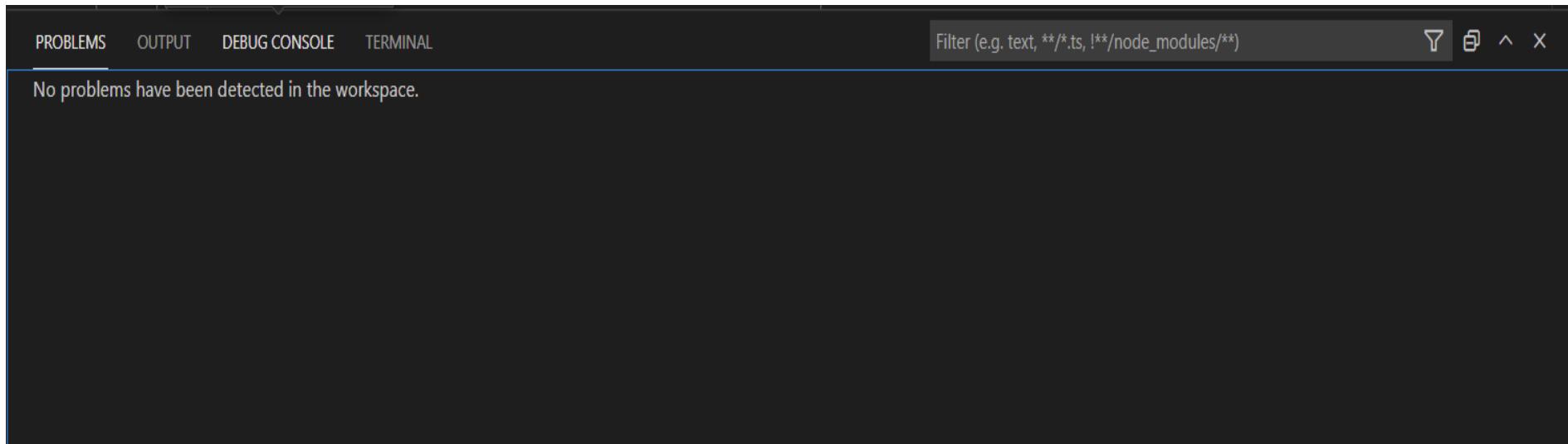


Figure 9. Problems view

Now we need to introduce an error into the code. After line 87, add the line:

MOVE ACCT-NO TO ACCT-NO-NO.

Note that this line incorrectly identifies the second variable, which doesn't exist. Once entering that line, you will notice that the invalid variable has been underlined in red to highlight it as an error. Also, the problems view has a new error. Clicking on the error will highlight the line of code at fault in the editor, shown in Figure 10., allowing you to view the error directly.

The screenshot shows a COBOL source code editor in VS Code. The code is as follows:

```
86      *  
87      WRITE-RECORD.  
88      MOVE ACCT-NO      TO ACCT-NO-NO.  
89      MOVE ACCT-NO      TO ACCT-NO-0.  
90      MOVE ACCT-LIMIT   TO ACCT-LIMIT-0.  
91      MOVE ACCT-BALANCE TO ACCT-BALANCE-0.  
92      MOVE LAST-NAME   TO LAST-NAME-0.  
93      MOVE FIRST-NAME  TO FIRST-NAME-0.  
94      MOVE COMMENTS    TO COMMENTS-0.  
95      WRITE PRINT-REC.  
96      *
```

The word "ACCT-NO-NO" is highlighted in red, indicating an unresolved reference. Below the editor, the VS Code interface is visible, including the navigation bar (PROBLEMS, OUTPUT, TERMINAL, DEBUG CONSOLE) and the Problems panel which displays the error message: "Unable to resolve reference to ACCT-NO-NO symbol [88, 34]".

Figure 10. Highlighting error in source code

Now that you see where the error is located, it can now be corrected. As soon as the error has been rectified, the problem disappears from the problem view.

## 2.6 SUMMARY

In this chapter, you have been able to go through some of the editing features of the Z Open Editor for VSCode. These capabilities make editing COBOL, PL/I, and JCL a lot friendlier and easier than some of the other editors in the market.

# 3 VS CODE WITH CODE4Z OPEN-SOURCE EXTENSION PACKAGE

This section introduces the Code4z extension package, in particular, the COBOL Language Support extension.

- **What is Code4z?**
- **Known File Extensions**
- **Syntax Highlighting and Coloring**
- **Syntax and Semantic Check**
- **Navigation of Code**
  - Go To Definition
  - Find All References
- **Copybook Support**
- **Autocomplete**
- **Summary**

## 3.1 WHAT IS CODE4Z?

Code4z is an all-in-one, open-source mainframe extension package for Visual Studio Code. The Code4z package contains extensions that provide language support for COBOL and High-Level Assembler language, a debugger for COBOL programs, as well as tools that enable developers to access mainframe data sets and CA Endevor code repositories using the Visual Studio Code interface. This guide focuses on the COBOL Language Support extension. The Zowe Explorer extension is also included in the Code4z package.

The COBOL Language Support extension leverages the Language Server Protocol to provide autocomplete, highlighting and diagnostic features for COBOL code. Together with Zowe Explorer, you can load COBOL code from a mainframe data set, and edit it leveraging the LSP features of the extension. Once you finish editing, you can save the file back on the mainframe, and store a copy locally.

The Code4z Extension Pack can be installed into VS Code by searching the Extensions Marketplace inside VS Code for “Code4z” and selecting install. The extension pack contains a number of extensions that can be leveraged when working with the mainframe, including the COBOL Language Support extension which provides similar functionality to the Z Open Editor extension discussed earlier. Therefore, ensure only one of these two extensions is enabled. Other extensions included in the pack will work with either COBOL Language Support or Z Open Editor. To see more detailed instructions on installing this extension, refer to “Installation of VSCode and Extensions”.

## 3.2 KNOWN FILE EXTENSIONS

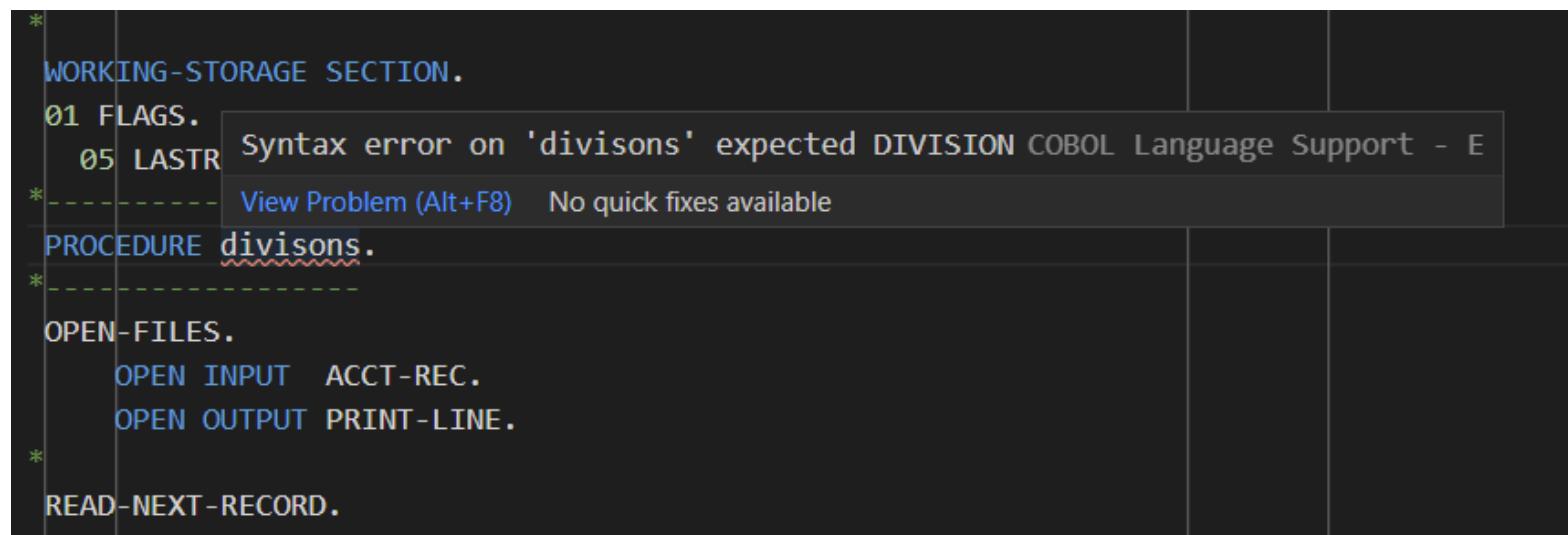
Code4z recognizes files with the extensions .COB and .CBL as COBOL files. This applies to both local files and files held in a PDS on the mainframe. COBOL Language Support features are automatically enabled when you open any file with an extension identifying it as a COBOL file.

## 3.3 SYNTAX HIGHLIGHTING AND COLORING

The COBOL Language Support extension enables the coloring of keywords, paragraphs, and variables in different colors to make the code easier to navigate.

## 3.4 SYNTAX AND SEMANTIC CHECK

The COBOL Language Support extension checks for mistakes and errors in the COBOL code. The syntax check feature reviews the whole content of the code, highlights errors, and suggests fixes.



The screenshot shows a COBOL program in a text editor. A tooltip is displayed over the word 'divisons' in the PROCEDURE division, indicating a syntax error: 'Syntax error on 'divisons' expected DIVISION COBOL Language Support - E'. Below the tooltip, there are two dashed green lines pointing to the same word, with the message 'View Problem (Alt+F8) No quick fixes available'. The code itself includes sections for WORKING-STORAGE SECTION, PROCEDURE DIVISION, OPEN FILES, and READ-NEXT-RECORD.

```
*  
WORKING-STORAGE SECTION.  
01 FLAGS.  
 05 LASTR Syntax error on 'divisons' expected DIVISION COBOL Language Support - E  
*----- View Problem (Alt+F8) No quick fixes available  
PROCEDURE divisons.  
*-----  
OPEN-FILES.  
OPEN INPUT ACCT-REC.  
OPEN OUTPUT PRINT-LINE.  
  
READ-NEXT-RECORD.
```

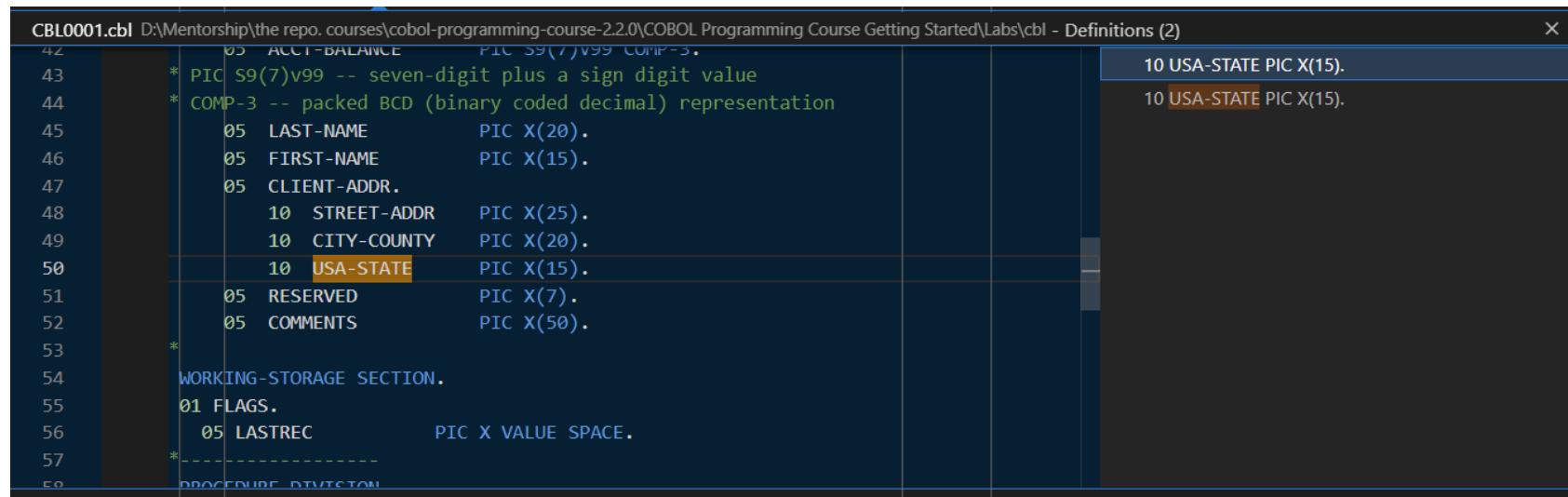
Figure 1. The syntax and semantic check feature highlight an error.

## 3.5 NAVIGATION OF CODE

The COBOL Language Support extension enables several features for ease of navigation through code.

### 3.5.1 Go To Definition

While your cursor is placed on a variable or paragraph name, you can press **F12** or **CTRL+click** to use the **Go To Definition** functionality to display the point in the code where the variable or paragraph is defined.



The screenshot shows a COBOL source code editor window titled "CBL0001.cbl". The code is as follows:

```
42      05 ACCT-BALANCE      PIC S9(7)V99 COMP-5.
43      * PIC S9(7)V99 -- seven-digit plus a sign digit value
44      * COMP-3 -- packed BCD (binary coded decimal) representation
45      05 LAST-NAME          PIC X(20).
46      05 FIRST-NAME         PIC X(15).
47      05 CLIENT-ADDR.
48          10 STREET-ADDR    PIC X(25).
49          10 CITY-COUNTY     PIC X(20).
50          10 USA-STATE        PIC X(15). 10 USA-STATE PIC X(15).
51          05 RESERVED          PIC X(7).
52          05 COMMENTS          PIC X(50).
53      *
54      WORKING-STORAGE SECTION.
55      01 FLAGS.
56      05 LASTREC            PIC X VALUE SPACE.
57      *
58      PROCEDURE DIVISION.
```

A tooltip is displayed over the line "10 USA-STATE PIC X(15)." containing the text "10 USA-STATE PIC X(15.)". The "COBOL Programming Course Getting Started" sidebar is visible on the right, and the bottom right corner shows "COBOL Programming Course #1 3.2.0 250207-0043".

Figure 2. Go To Definition shows the point at which the USA-STATE variable is first defined.

### 3.5.2 Find All References

The **Find All References** functionality (**SHIFT+ALT+F12**) highlights all references to a variable or paragraph and displays them in a list in the sidebar so that you can easily navigate between them.

2 results in 1 file

cb1 > CBL0001.cbl > COBOL > PROGRAM-ID. CBL0001 > DATA DIVISION >

```

29      * PIC $$,$$$,$$9.99 -- Alternative for PIC on chapter 7.3
30      * using $ to allow values of different amounts of digits
31      * and .99 instead of v99 to allow period display on
32          05 LAST-NAME-0    PIC X(20).
33          05 FIRST-NAME-0  PIC X(15).
34          05 COMMENTS-0   PIC X(50).
35      * since the level 05 is higher than level 01,
36      * all variables belong to PRINT-REC (see chapter 7.3)
37
38 FD ACCT-REC RECORDING MODE F.
39 01 ACCT-FIELDS.
40      05 ACCT-NO          PIC X(8).
41      05 ACCT-LIMIT        PIC S9(7)V99 COMP-3.
42      05 ACCT-BALANCE      PIC S9(7)V99 COMP-3.
43      * PIC S9(7)V99 -- seven-digit plus a sign digit value
44      * COMP-3 -- packed BCD (binary coded decimal) representation
45      05 LAST-NAME        PIC X(20).
46      05 FIRST-NAME       PIC X(15).
47 05 CLIENT-ADDR.
48      10 STREET-ADDR      PIC X(25).
49      10 CITY-COUNTY      PIC X(20).
50      10 USA-STATE         PIC X(15).
51      05 RESERVED          PIC X(7).

```

Figure 3. Find All References lists all references to the STREET-ADDR variable in the code.

## 3.6 COPYBOOK SUPPORT

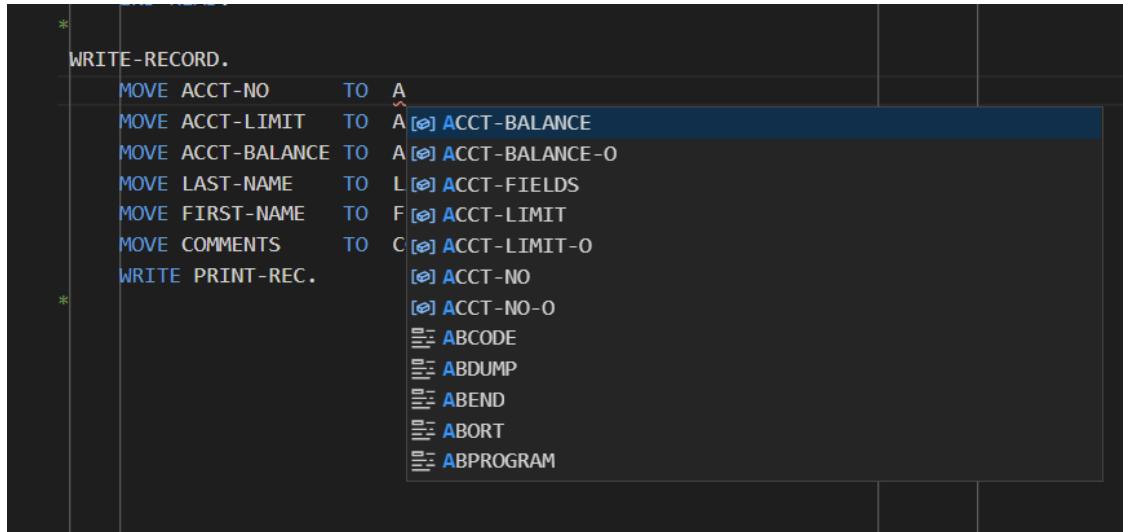
Copybooks are pieces of source code stored in separate data sets which are referenced in a program. The COBOL Language Support extension enables you to download all copybooks referenced in your program from the mainframe to a folder in your workspace. In order for this feature to work, you need to set up and configure a Zowe CLI `zosmf` profile. You can also enable support for copybooks stored locally in folders in your workspace. This is useful when working with a COBOL project stored in a Github repository.

The COBOL Language Support extension helps to ensure that copybooks called in the code remain compatible through semantic analysis of keywords, variables, and paragraphs within copybooks, and ensures the consistency of code by defining variables and paragraphs across copybooks. The extension also helps to protect against unwanted errors caused by recursive or missing copybooks.

The **Go To Definition** and **Find All References** functionalities are extended to work for occurrences of variables and paragraphs from copybooks called in the program as well as from the program itself. You can also use the **Go To Definition** feature on a copybook name in order to open it.

## 3.7 AUTOCOMPLETE

The COBOL Language Support extension provides live suggestions while you type for COBOL keywords, as well as variables and paragraphs which are already referenced in the code or copybooks used by the program.



A screenshot of a VS Code editor window displaying COBOL code. The cursor is positioned at the end of a MOVE statement, specifically after 'MOVE ACCT-NO TO A'. A dropdown menu is open, listing several suggestions starting with 'ACCT-BALANCE'. Other visible suggestions include 'ACCT-BALANCE-O', 'ACCT-FIELDS', 'ACCT-LIMIT', 'ACCT-LIMIT-O', 'PRINT-REC.', and a list of error codes: 'ABCODE', 'ABDUMP', 'ABEND', 'ABORT', and 'ABPROGRAM'. The background shows parts of other COBOL statements like 'WRITE RECORD.' and 'MOVE LAST-NAME TO L'.

Figure 4. Autocomplete lists possible variables and keywords beginning with the typed string in a list.

## 3.8 SUMMARY

In this chapter, you have been introduced to all the COBOL language support features of the Code4z package of open-source extensions for VS Code.

# 4 ZOWE CLI AND ZOWE CLI PLUG-INS

In this chapter, we will explain what a CLI is and why you would use it, how to use Zowe CLI interactively, how to abstract CLI commands into useful scripts, and how Zowe CLI enables the use of familiar open-source tooling while developing COBOL applications on the mainframe.

- **What is a CLI and why would you use it?**
- **What is Zowe CLI?**
- **Zowe CLI interactive use**
  - **Installing Zowe CLI**
  - **Interactive Help**
  - **Zowe Profiles**
  - **Interacting with z/OS Data Sets**
  - **Interacting with z/OS Jobs**
- **Automating tasks using Zowe CLI**
  - **Automated Job Submission**
  - **Using Other Programming Languages and Continuous Integration**
  - **Additional Examples**
- **The world of modern open source tooling**
- **Summary**

## 4.1 WHAT IS A CLI AND WHY WOULD YOU USE IT?

CLI stands for Command Line Interface. It is a program that allows for user interaction through text-based input. In the early days of computing, command-line interfaces were the only means to interact with operating systems. The invention of the mouse and the

development of graphical user interfaces led to the experience we are familiar with today. Well-designed GUIs certainly yield an improved interactive experience. However, CLIs are still heavily used today and are very powerful. Windows shell and bash are common examples of terminals where command-line tools are run interactively.

If well-designed GUIs yield an improved interactive experience, why would you use a CLI? Simply put, automation. Command-line interfaces can be used interactively allowing for quick exploration of available commands. They are also usually self-guided and some even offer modern help displays by launching content in a browser. But, they are also programmatic interfaces where command sequences and tasks can be easily abstracted into scripts.

## 4.2 WHAT IS ZOWE CLI?

Zowe CLI is an open-source CLI for the mainframe. It is a tool that can be run on Windows, Linux, and Mac offering a means to interact with the mainframe from an environment where modern open-source tooling is available. Cloud platforms like Amazon Web Services, Azure, and Google Cloud Platform all provide heavily used CLIs. The Zowe CLI helps make interacting with the mainframe like interacting with other cloud services.

At its core, Zowe CLI provides remote interaction with z/OS data sets & jobs, Unix System Services files, TSO and Console commands, and provisioning services. Zowe CLI is also an extensible technology and numerous plug-ins exist that extend its reach to z/OS subsystems and vendor software.

Zowe CLI is a bridge tool between distributed systems and the mainframe. Pick your favorite language or open-source tool and leverage it for mainframe development with the assistance of the Zowe CLI. Want to develop automation in Python? Want to write tests in Node? Want to run Jenkins pipelines for continuous integration? Want to use open-source testing frameworks like Mocha or Facebook's Jest? Want to leverage code quality tools like SonarQube? Go for it!

CLIs are useful for automating repeated tasks. For mainframe COBOL apps, Zowe CLI can help you automate your build, deployment, and testing processes. Check out this [blog](#) for more info and the sample code that made it possible! Zowe CLI can also help you to automate administrative tasks.

Most IDEs have integrated terminals as well so the CLI can be leveraged from your favorite distributed development environment, including VS Code!

## 4.3 ZOWE CLI INTERACTIVE USE

The Zowe CLI can be leveraged for quick exploration of z/OS services as well as issuing commands that are not yet available in your IDE of choice. Before developing automation, it is common to first accomplish a commonly repeated task from the CLI interactively.

### 4.3.1 Installing Zowe CLI

The Zowe CLI is a node package and is one of over 1.2 million node packages available on the public npm registry. After Node.js and npm are installed on the client machine, the core CLI can be installed by simply issuing `npm install -g @zowe/cli@zowe-v3-lts`. There is an alternative installation method if your workstation does not have access to the public registry. More details on installing Zowe CLI and Zowe CLI plug-ins are provided in a future section titled “Installation of Zowe CLI and plug-ins”.

### 4.3.2 Interactive Help

To get started, you can simply open a terminal and issue `zowe`. This will yield the top-level help.

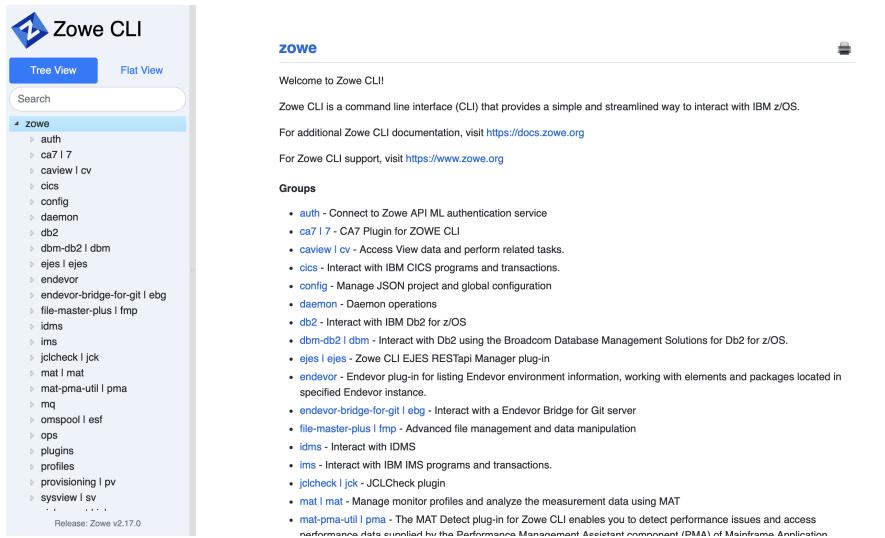
```
DESCRIPTION
-----
Welcome to Zowe CLI!
Zowe CLI is a command line interface (CLI) that provides a simple and
streamlined way to interact with IBM z/OS.

For additional Zowe CLI documentation, visit https://docs.zowe.org
For Zowe CLI support, visit https://www.zowe.org

USAGE
-----
zowe <group>
Where <group> is one of the following:
GROUPS
-----
auth          Connect to Zowe API ML authentication
config        Manage JSON project and global
              configuration
daemon        Daemon operations
plugins       Install and manage plug-ins
provisioning | pv Perform z/OSMF provisioning tasks
secure-credential-store | scs Work with securely stored credentials
zos-console | console Issue z/OS console commands and collect
              responses
zos-files | files Manage z/OS data sets
zos-jobs | jobs Manage z/OS jobs
zos-logs | logs Interact with z/OS logs
zos-ssh | ssh | zos-uss | uss Issue z/OS USS commands and receive
              responses
zos-tso | tso Interact with TSO
zos-workflows | wf Create and manage z/OSMF workflows
zosmf         Interact with z/OSMF
```

Figure 1. Zowe CLI Help

In the example above, multiple extensions are installed. The structure of commands is `zowe <group> <action> <object>` followed by various parameters and options specific to the command. For example, a valid command is `zowe files list data-set "HLQ.*"`. This command will list data sets matching a pattern of "HLQ.\*". You can append `-h` to any command to find out more information. Frequently referring to the help can be difficult and time-consuming so if your environment has access to a web browser, simply append `--help-web` or `--hw` to any command to launch interactive web help.



*Figure 2. Zowe CLI Web Help*

Don't have the CLI installed yet? You can also check out a copy of the web help for the core Zowe CLI and Zowe plug-ins [here](#).

### 4.3.3 Zowe Profiles

Zowe client technologies like Zowe CLI and the Zowe Explorer VS Code Extension store connection information in files commonly known as profiles. This provides convenience as after profiles for services are created, users do not have to constantly provide this information.

### 4.3.4 Interacting With Z/OS Data Sets

Zowe CLI provides a significant suite of z/OS data set interaction functionality. See the following figures for details on available actions and a sample list command.

GROUPS	
<hr/>	
compare   cmp	Compare the contents of z/OS data sets or USS files
copy   cp	Copy a data set
create   cre	Create data sets
delete   del	Delete a data set or Unix System Services file
download   dl	Download content from data sets and USS files
edit   ed	Edit the contents of a data set or USS file
invoke   call	Invoke various z/OS utilities
list   ls	List the details for data sets and the members in the data sets
migrate   hmigr   hMigrate	Migrate data sets
mount	Mount file systems
recall   hrec   hRecall	Recall migrated data sets
rename	Rename a data set or member
search	Search Files
unmount   umount	Unmount file systems
upload   ul	Upload the contents of a file to data sets
view   vw	View the contents of a data set or USS file

Figure 3. Zowe CLI zos-files actions

```
[Riturajs-MacBook-Pro% zowe files list ds "Z10512.*"
Z10512.CBL
Z10512.CONTEST
Z10512.DATA
Z10512.DBMLIB
Z10512.INPUT
Z10512.JCL
Z10512.LOAD
Z10512.OUTPUT
Z10512.SOURCE
Z10512.S0W1.ISPF.ISPPROF
Z10512.S0W1.SPFLG1.LIST
```

Figure 4. Sample Zowe CLI zos-files list ds command

#### 4.3.5 Interacting With Z/OS Jobs

Zowe CLI provides a significant suite of z/OS jobs interaction functionality. See the following figures for details on available actions and a sample job submission command.

```
GROUPS
-----
cancel | can Cancel a z/OS job
delete | del Delete a z/OS job or jobs
download | dl Download job output
list | ls List jobs and spool files
modify | mod Modify a z/OS job
search | sea Search the spool output of a z/OS job
submit | sub Submit a z/OS job
view | vw View details of a z/OS job
```

Figure 5. Zowe CLI zos-jobs actions

```
[Riturajs-MacBook-Pro% zowe jobs submit ds "Z10512.JCL(HELLO)" --wait-for-output
jobid: JOB03568
retcode: CC 0000
jobname: HELLOCBL
status: OUTPUT
```

Figure 6. Sample Zowe CLI zos-jobs submit ds command

## 4.4 AUTOMATING TASKS USING ZOWE CLI

Running commands interactively is a great way to learn the capabilities of the Zowe CLI. However, creating custom automation for your commonly repeated tasks and making use of valuable development tooling is where significant value lies. For COBOL development, significant time can be spent reviewing compiler output and testing programs. These repetitive tasks are excellent candidates for automation.

### 4.4.1 Automated Job Submission

Let's investigate automating submitting a job and verifying the return code is 0. Of course, we could also parse the spool output for specific messages of interest but we will keep it simple for now. For this sample, we will leverage Node.js to develop a new automation suite. To start, I will create a package.json file to make it easy for others to manage and install the project. It will contain the list of dependencies for my project as well as the automation tasks I will develop. A quick way to create a package.json is to issue `npm init` and answer the prompts. Once created I will add a submitJob task. You can add whatever automation you want here. My final package.json is shown in the next figure. You can learn more about package.json files [here](#).

```
{  
  "name": "automation",  
  "version": "1.0.0",  
  "description": "Sample automation project",  
  "main": "index.js",  
  "scripts": {  
    "submitJob": "node ./submitJobAndVerifySuccess"  
  },  
  "author": "MikeBauerCA",  
  "license": "MIT"  
}
```

Figure 7. Sample package.json

Then I will create a config.json file to store all the variables I may wish to change for my project. In this case, we will set the job to submit and the maximum allowable return code for that job.

```
{  
    ... "job": "CUST005.MARBLES.JCL(MARBDB2)",  
    ... "maxRC": 4  
}
```

Figure 8. Sample config.json

Next, we will write our automation. The Zowe CLI was built with scripting in mind and can output responses in JSON format which can be easily parsed.

```
user@ubuntu-base:~/automation$ zowe jobs submit data-set "CUST005.MARBLES.JCL(MARBDB2)" --wait-for-output --rfj  
{  
    "success": true,  
    "exitCode": 0,  
    "message": "Submitted JCL contained in \"dataset\": \"CUST005.MARBLES.JCL(MARBDB2)\"",  
    "stdout": "\u001b[33mjobid: \u001b[39m JOB02486\n\u001b[33mretcode: \u001b[39mCC 0000\n\u001b[33mjobname: \u001b[39m OUTPUT\n",  
    "stderr": "",  
    "data": {  
        "owner": "CUST005",  
        "phase": 20,  
        "subsystem": "JES2",  
        "phase-name": "Job is on the hard copy queue",  
        "job-correlator": "J00024865.....D7C70323.....:",  
        "type": "JOB",  
        "url": "https://[REDACTED]:443/zosmf/restjobs/jobs/J00024865.....D7C70323.....%3A",  
        "jobid": "JOB02486",  
        "class": "A",  
        "files-url": "https://[REDACTED]:443/zosmf/restjobs/jobs/J00024865.....D7C70323.....%3A/files",  
        "jobname": "MARBDB2",  
        "status": "OUTPUT",  
        "retcode": "CC 0000"  
    }  
}
```

Figure 9. Sample Zowe CLI response format JSON output

Now, instead of issuing this command and reviewing it to see if the retnode is less than or equal to 4, we want to automate it. See the implementation in a node script below.

```
const { exec } = require('child_process');
const config = require('./config.json');

exec('zowe jobs submit data-set "' + config.job + '" --wait-for-output --rfj', (err, stdout, stderr) => {
  if (err) {
    //some err occurred
    console.error(err)
  } else if (stderr) {
    console.log(new Error("\nCommand:\n" + command + "\n" + "stderr:\n" + stderr));
  } else {
    data = JSON.parse(stdout).data;
    retnode = data.retnode;

    //retnode should be in the form CC nnnn where nnnn is the return code
    if (retnode.split(" ")[1] <= config.maxRC) {
      console.log("Job completed successfully");
    } else {
      console.log(new Error("Job did not complete successfully. Additional diagnostics:" + JSON.stringify(data,null,1)));
    }
  }
});
```

Figure 10. Sample code to submit job and verify the output is less than or equal to a maximum allowable RC

I had to make the investment to write this automation but for future job submissions I can simply issue `npm run submitJob`. IDEs like VS Code can visualize these tasks making my commonly repeated tasks as easy as clicking a button :). This job could compile, link, and/or run a COBOL program.

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
> Executing task: npm run submitJob <

> automation@1.0.0 submitJob /home/user/automation
> node ./submitJobAndVerifySuccess

Job completed successfully

Terminal will be reused by tasks, press any key to close it.
```

Figure 11. Visualization of npm script and sample run

More advanced code automating the compilation, deployment to test environment, and testing of a COBOL CICS application are described in this [blog](#).

#### 4.4.2 Using Other Programming Languages And Continuous Integration

Another good example of automating tasks using Zowe CLI is when you want to integrate other programming languages into your COBOL development. Similar to 3.4.1, you can use other languages such as Typescript to write a COBOL program generator and use Zowe CLI to create a “one-click” process for creating your program. The figure below is a representation of that “one-click” automated process where several tasks are executed such as creating your COBOL program, uploading it in the mainframe, compiling it, and running your JCL to test it.

```

> template@1.0.0 build C:\Users\jp669971\Documents\GitHub\Community\Cobol-Made-Easy
> npm run generate && npm run upload && npm run compile:cobol && npm run run:job

> template@1.0.0 generate C:\Users\jp669971\Documents\GitHub\Community\Cobol-Made-Easy
> node ./scripts/lib/append && node ./scripts/lib/generate

Created COBOL Template
Added Process
Added Closing
Generated custom JCL to ./build/compiler.jcl
Generated COBOL pgm to ./build/source.cbl
Generated run job to ./build/runjob.jcl

> template@1.0.0 upload C:\Users\jp669971\Documents\GitHub\Community\Cobol-Made-Easy
> zowe zos-files upload file-to-data-set "./build/source.cbl" "Z40607.SOURCE(CBLSRC)" --zosmf-p ztrial

success: true
from: C:\Users\jp669971\Documents\GitHub\Community\Cobol-Made-Easy\build\source.cbl
to: Z40607.SOURCE(CBLSRC)

file_to_upload: 1
success: 1
error: 0
skipped: 0

Data set uploaded successfully.

> template@1.0.0 compile:cobol C:\Users\jp669971\Documents\GitHub\Community\Cobol-Made-Easy
> zowe jobs submit lf "./build/compiler.jcl" --directory "./output" --zosmf-p ztrial
████████ | 30% 0 | Waiting for JOB007745 to enter OUTPUT

```

Figure 12. “One Click” COBOL build process

You can then level up this process by leveraging a CI/CD pipeline. What is a CI/CD pipeline? It is an automated way of building, testing, and deploying your application and you can do the same with your COBOL development. The figure below shows the pipeline for the same automated tasks that we did earlier.

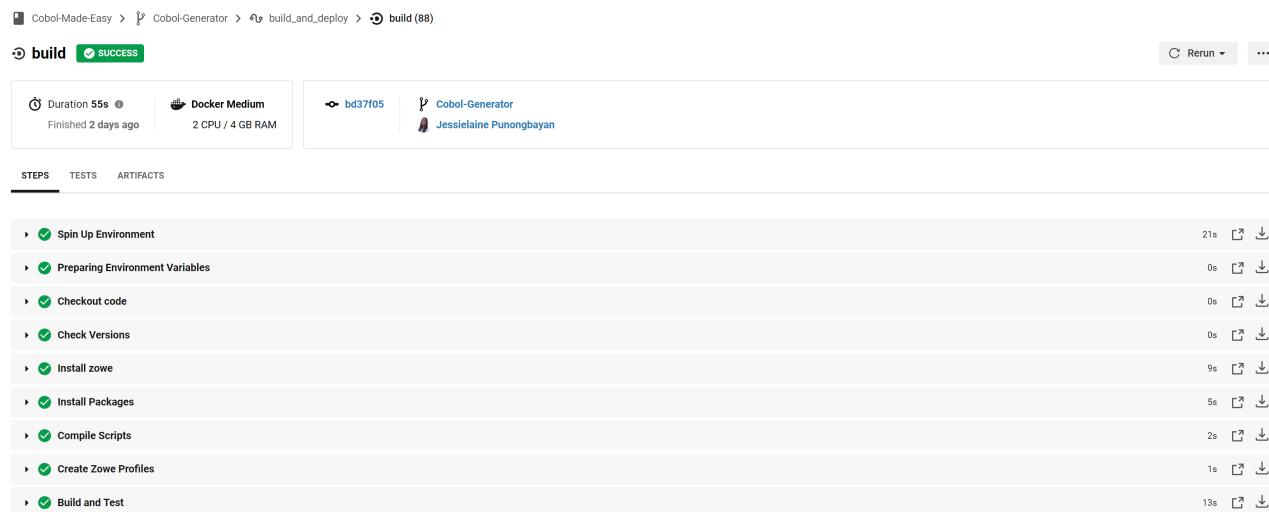


Figure 13. CI/CD pipeline of the “one-click” COBOL build process

To know more about this topic, check [this](#) out.

### 4.4.3 Additional Examples

If you are looking for an example on how to use Zowe Explorer and Zowe CLI with Db2 Stored Procedures, check out this [blog](#).

If you are interested in using open source tools in your development, you can review this [blog](#) where it talks about using Zowe CLI to leverage static code analysis tools when developing COBOL applications.

For additional blogs and articles on leveraging Zowe technologies, check out <https://medium.com/zowe>.

## 4.5 THE WORLD OF MODERN OPEN-SOURCE TOOLING

We have only scratched the surface of using modern tools and languages for mainframe development and incorporating mainframe applications into enterprise DevOps pipelines. As a bridge tool, the Zowe CLI enables the use of a plethora of tools being developed by an enormous community for mainframe development. If you are new to mainframe, hopefully this offers some familiarity as you transition into this space. If you are an experienced mainframe, hopefully you find time to give some of these available technologies a try to see if they can help you.

## 4.6 SUMMARY

As both a user and programmatic interface, command-line interfaces offer significant value in simplifying complex repeatable processes into single tasks. CLIs are commonly used when developing on popular cloud platforms like Amazon Web Services. The Zowe CLI is the CLI for the mainframe that has been extended via numerous plug-ins. Zowe CLI acts as a bridge tool enabling the use of distributed development tooling while working with mainframe applications. Numerous resources and articles are available for using Zowe CLI to create custom automation, build CI pipelines, and incorporate static analysis into your COBOL development processes. Development tooling created by the distributed open-source community can now be effectively leveraged for mainframe development.

# 5 INSTALLATION OF VS CODE AND EXTENSIONS

This chapter covers all aspects of download and installation of Visual Studio (VS) Code and any extensions that are needed. It includes:

- **Install VSCode**
- **Install VSCode extensions**
  - **Zowe Explorer**
  - **IBM Z Open Editor**
  - **Code4z**
- **Summary**

## 5.1 INSTALL VS CODE

If you do not already have VSCode installed on your workstation, please do so now by following the download and installation instructions at the link below:

<https://code.visualstudio.com/download>

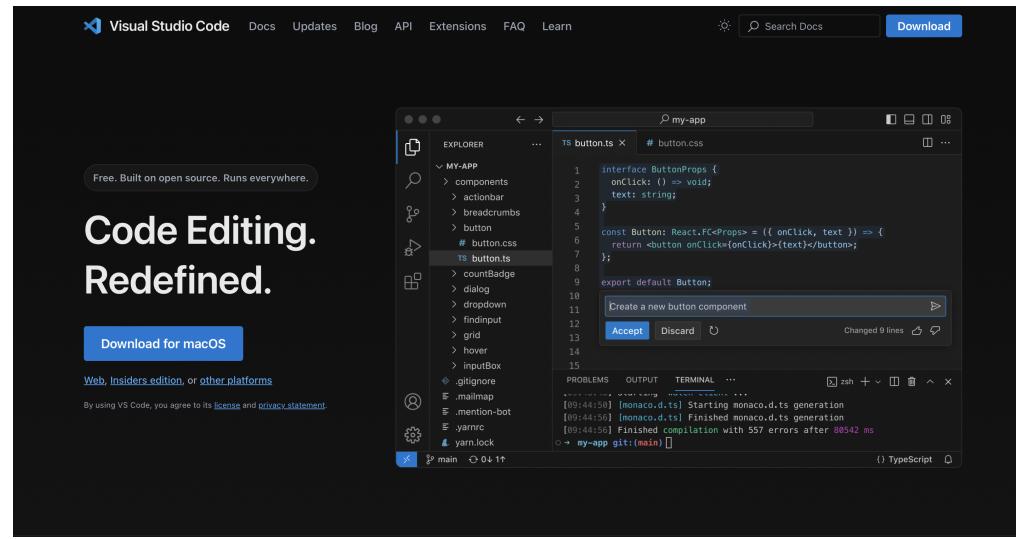


Figure 1. VSCode download site

**Note:** Be sure to select the correct installation file for your workstation's respective OS, shown in Figure 1.

## 5.2 INSTALL VS CODE EXTENSIONS

This section introduces Zowe Explorer, IBM Z Open Editor, and the Code4z extension pack listed in Figure 2., and instructions on how to install them. Note that you may choose to use either IBM Z Open Editor or the Code4z extension pack.



# Zowe Explorer v3.0.0-next.202404242037

Zowe [zowe.org](#) | ⚡ 137,336 | ★★★★★(4)

VS Code extension, powered by Zowe CLI, that streamlines interaction with mainframe data sets, ...

[Disable](#) | [Uninstall](#) |

DETAILS FEATURES CHANGELOG



# IBM Z Open Editor v4.3.0

IBM [ibm.com](#) | ⚡ 116,606 | ★★★★★(14)

Provides COBOL, PL/I, HLASM, and REXX language servers, as well as tools for IBM Z developme...

[Disable](#) | [Uninstall](#) |

DETAILS FEATURES CHANGELOG DEPENDENCIES

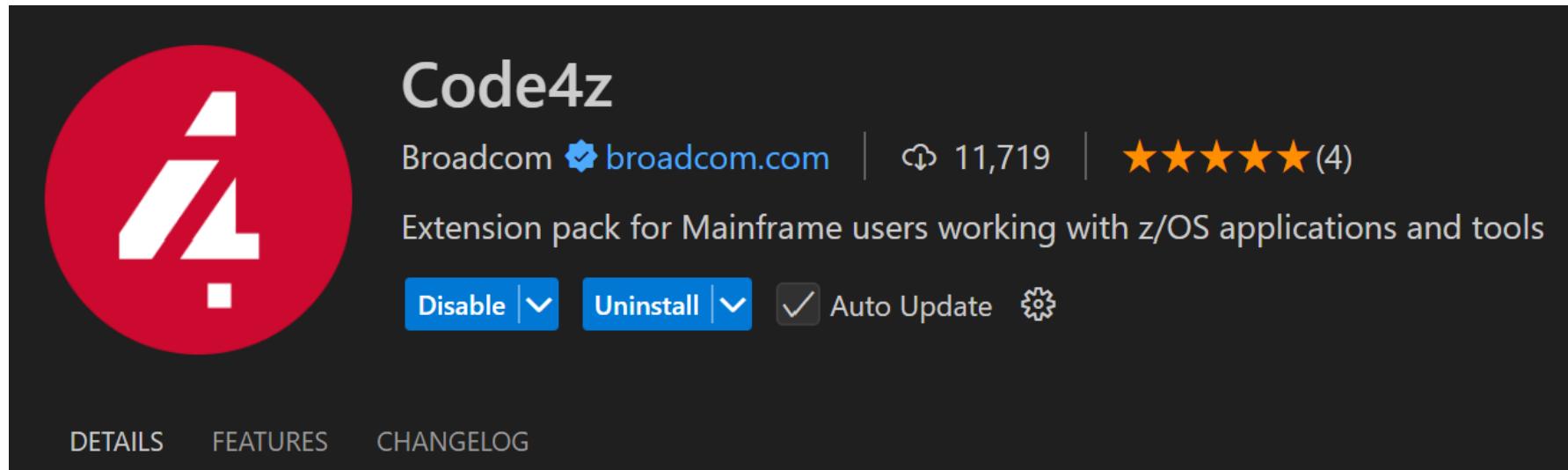


Figure 2. VSCode extensions

### 5.2.1 Zowe Explorer

Zowe is a new, and the first open-source framework for z/OS and provides solutions for development and operations teams to securely manage, control, script, and develop on the mainframe like any other cloud platform. Out of the box, the Zowe Explorer provides a lot of functionality allowing z/OS developers access to jobs, datasets, and (USS) files on a z/OS server. Backed by the Zowe CLI and z/OSMF, developers now have powerful features that make it easy to work with z/OS within the familiar VSCode environment. This extension can be used to edit COBOL and PL/I files opened on z/OS MVST™ and USS using the Zowe extension's Data Sets and USS views. It can even run JCL and lets you browse job spool files. For more information on Zowe Explorer and its interaction with z/OS please visit:

[https://ibm.github.io/zopeneditor-about/Docs/interact\\_zos\\_zowe\\_explorer.html](https://ibm.github.io/zopeneditor-about/Docs/interact_zos_zowe_explorer.html)

#### 5.2.1.1 Install Zowe Explorer

Open VSCode and in the left side tool menu select **Extensions**. From there, in the “Search Extensions in Marketplace” search field, type **Zowe Explorer**. Search results will begin populating, select “**Zowe Explorer**” and click **install**, depicted in Figure 3.

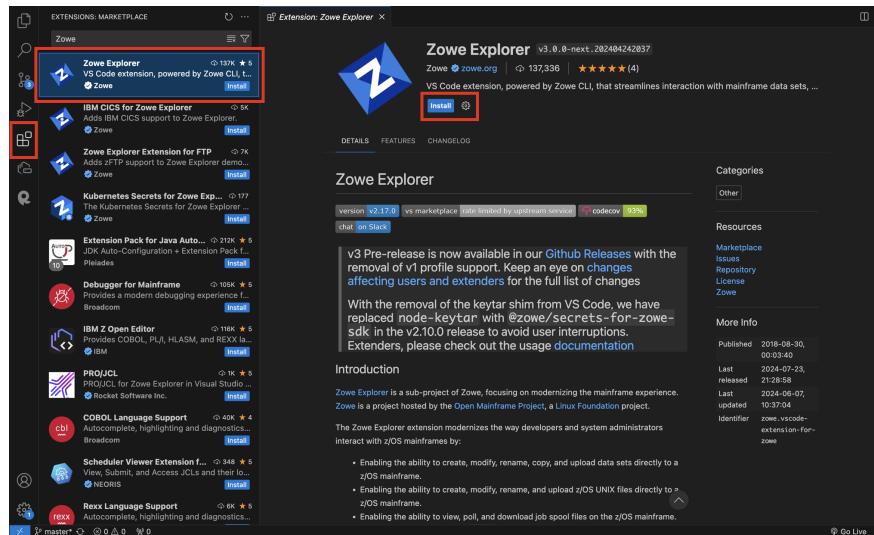


Figure 3. Install Zowe Explorer in VSCode

The Zowe community has a number of online videos that walk through the steps required to install, configure and operate the Zowe Explorer, see [Zowe Explorer VSC Extension \(part 1\)](#).

## 5.2.2 IBM Z Open Editor

IBM Z Open Editor brings COBOL and PL/I language support to Microsoft VSCode. It is one of the several next-generation capabilities for an open development experience for z/OS®. It also works in association with the Zowe Explorer plugin. For more information on IBM Z Open Editor, please visit:

<https://ibm.github.io/zopeneditor-about/Docs/introduction.html#key-capabilities>

### 5.2.2.1 Install IBM Z Open Editor

Prior to installing the extension, please review the prerequisites at <https://marketplace.visualstudio.com/items?itemName=IBM.zopeneditor#prerequisites>

Open VSCode and in the left side tool menu select **Extensions**. From there, in the “Search Extensions in Marketplace” search field, type **IBM Z Open Editor**. Search results will begin populating, select **“IBM Z Open Editor”** and click **install**, depicted in Figure 4.

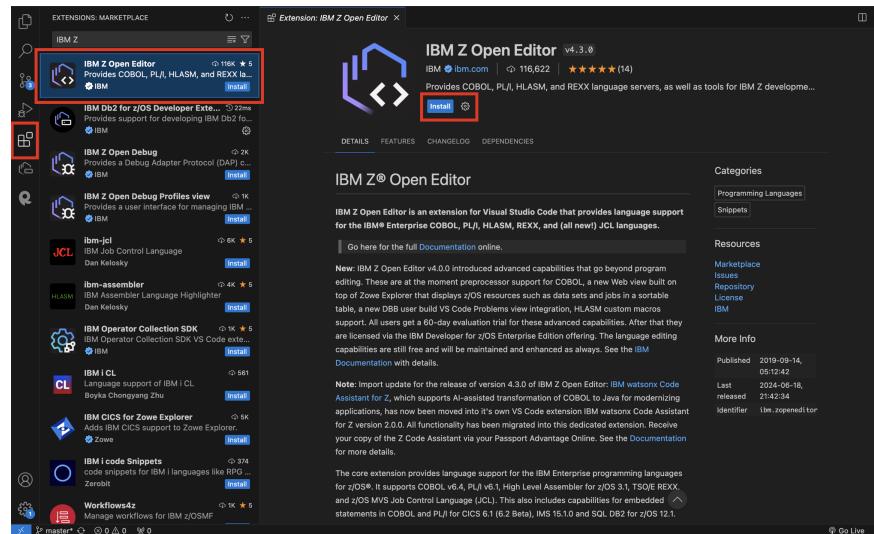


Figure 4. Install IBM Z Open Editor in VSCode

### 5.2.3 Code4z

Code4z is an all-in-one, open-source mainframe extension package for developers working with z/OS applications, suitable for all levels of mainframe experience, even beginners. Mainframe application developers can use the Code4z package for a modern, familiar, and seamless experience, which helps to overcome some developers' reservations or concerns about the traditional mainframe user experience. To find out more about Code4z, please visit <https://github.com/BroadcomMFD/code4z>.

#### 5.2.3.1 Install Code4z

Open VSCode and in the left side tool menu select **Extensions**. From there, in the “Search Extensions in Marketplace” search field, type **Code4z**. Search results will begin populating, select “**Code4z**” and click **install**.

The extension pack contains a number of extensions that can be leveraged when working with the mainframe, including the COBOL Language Support extension which provides similar functionality to the Z Open Editor extension. Therefore, ensure only one of these extensions is enabled. Extensions can be disabled within VS Code by locating the extension in the Extensions menu, clicking the settings gear, and selecting **Disable**. Other extensions included in the Code4z pack will work with either COBOL Language Support or Z Open Editor.

## 5.3 SUMMARY

In this chapter, you have been introduced to VSCode and some of the extension tools available to it. We have walked through the process of installing VSCode, Zowe Explorer, IBM Z Open Editor, and Code4z. You have also been briefly introduced to the utility of these extensions in VSCode. In the subsequent chapters, we will delve deeper into how and when to use them and get some practice through lab assignments.

# 6 INSTALLATION OF ZOWE CLI AND PLUG-INS

This chapter covers all aspects of the download and installation of Zowe CLI and Zowe CLI plug-ins.

- **Install prerequisites - Node.js**

- **Install Zowe CLI**

- **Public npm Registry**
- **Package from Zowe.org**

- **Install Zowe CLI Plug-ins**

- **Public npm Registry**
- **Package from Zowe.org**

- **Summary**

## 6.1 INSTALL PREREQUISITES - NODE.JS

Before installing Zowe CLI, please ensure a supported LTS (Long Term Support) version of Node.js is installed and that you have a version of npm (Node Package Manager) that is compatible with your version of Node.js. You can view the list of supported versions of Node and their associated npm version at <https://nodejs.org/en/about/previous-releases>

You can follow these steps to confirm the prerequisites are met:

Open your workstation's version of the command prompt (called Terminal on Mac OS X). Once the command prompt is open, use the command in Example 1. to check if your workstation currently has a version of node.js installed.

```
C:\Users\User> node -v
```

```
V22.12.0
```

## Example 1. Node.js version

If you do not see a version number after you submit the command, you do not have node.js installed, or if it shows an unsupported version, then you need to install a recent LTS version.

Updating node.js to the appropriate version is a relatively simple process because the installer takes care of most of the “heavy lifting”. All you will need to do is visit the Node.js download site, provided below, and follow the download and installation instructions for your specific workstation platform.

<https://nodejs.org/en/download/>

This process will install the latest versions of Node.js and the node package manager (npm) and overwrite any older version files in your system. This removes the step of needing to manually uninstall the previous versions beforehand.

Once completed, verify the installation and proper version number, as shown previously in Example 1.

**Note:** The version numbers in our examples are provided purely for reference and may not reflect the latest versions of the software.

To confirm you have the correct version of npm installed, you can similarly issue `npm --version` and see if it matches the correct Node.js version at <https://nodejs.org/en/about/previous-releases>.

## 6.2 INSTALL ZOWE CLI

There are two recommended methods for installing the Zowe CLI. If you have access to the public npm registry from your workstation, we recommend using that installation method as pulling updates is seamless. If you do not have access to this registry, we recommend downloading the package from zowe.org and installing it from the bundled package.

### 6.2.1 Install From Public Npm Registry

Issue the following command in your terminal (e.g. Command Prompt or if you are using VS Code, Terminal -> New Terminal):

```
npm install -g @zowe/cli@zowe-v3-lts
```

If the command returns an EACCESS error, refer to [Resolving EACCESS permissions errors when installing packages globally](#) in the npm documentation. If other issues are encountered in your environment, please review [known Zowe CLI issues](#) for solutions.

We also highly recommend installing the Secure Credential Store plug-in before using the CLI. The Secure Credential Store Plug-in for Zowe CLI lets you store your credentials securely in the default credential manager in your computer's operating system. On Linux, libsecret will need to be installed.

If running Linux, please run the following command for your Linux distribution:

- Debian/Ubuntu: `sudo apt-get install libsecret-1-dev`
- Red Hat-based: `sudo yum install libsecret-devel`
- Arch Linux: `sudo pacman -S libsecret`

User profiles, which contain connection information for interacting with various z/OS services, created after installing the plug-in will automatically store your credentials securely.

To securely store credentials in existing user profiles (profiles that you created prior to installing the SCS plug-in), issue the following command:

```
zowe scs update
```

### 6.2.2 Install From Bundled Package

Navigate to [Zowe.org Downloads](#) and click the CLI Core button to download the core package which includes Zowe CLI and the Secure Credential Store plug-in. After accepting the EULA for Zowe, a package named `zowe-cli-package-v.r.m.zip` will be downloaded to your machine. Unzip the contents of `zowe-cli-package-v.r.m.zip` to a preferred location on your machine.

Open your terminal (e.g. Command Prompt or if you are using VS Code, Terminal -> New Terminal), change your working directory to wherever you unzipped the contents, and issue the following command:

```
npm install -g zowe-cli.tgz
```

If the command returns an EACCESS error, refer to [Resolving EACCESS permissions errors when installing packages globally](#) in the npm documentation. If other issues are encountered in your environment, please review [known Zowe CLI issues](#) for solutions.

The highly recommended Secure Credential Store Plug-in for Zowe CLI lets you store your credentials securely in the default credential manager in your computer's operating system. On Linux, libsecret will need to be installed.

If running Linux, please run the following command for your Linux distribution:

- Debian/Ubuntu: `sudo apt-get install libsecret-1-dev`
- Red Hat-based: `sudo yum install libsecret-devel`
- Arch Linux: `sudo pacman -S libsecret`

User profiles, which contain connection information for interacting with various z/OS services, created after installing the plug-in will automatically store your credentials securely.

To securely store credentials in existing user profiles (profiles that you created prior to installing the SCS plug-in), issue the following command:

```
zowe scs update
```

## 6.3 INSTALL ZOWE CLI PLUG-INS

Zowe CLI is an extendable technology that can be enhanced by installing plug-ins. Zowe offers a number of [plug-ins](#). At the time of this writing, these include plug-ins for [CICS](#), [Db2](#), [FTP](#), and [MQ](#). There are also many vendor plug-ins, many of which are available on the [public registry](#). At the time of this writing, these include plug-ins for [CA Endevor](#), [CA Endevor Bridge for Git](#), [CA File Master Plus](#), [CA OPS/MVS](#), [CA View](#), [IBM CICS Bundle Generation and Deployment](#), and [IBM z/OS Connect EE](#).

### 6.3.1 Install From Public Npm Registry

To install a Zowe CLI plug-in from the registry, simply locate the plug-in you wish to install, e.g. `@zowe/cics-for-zowe-cli`, find the distribution tag for the distribution you want to install, e.g. `zowe-v3-lts`, and issue the following command:

```
zowe plugins install <name>@<distTag>
```

For example,

```
zowe plugins install @zowe/cics-for-zowe-cli@zowe-v3-lts
```

Multiple plug-ins can be installed in a single command. For example, to install all Zowe CLI plug-ins available from the Zowe organization, you could issue:

```
zowe plugins install @zowe/cics-for-zowe-cli@zowe-v3-lts @zowe/mq-for-zowe-cli@zowe-v3-lts @zowe/zos-ftp-for-zowe-cli@zowe-v3-lts @zowe/db2-for-zowe-cli@zowe-v3-lts
```

Vendor plug-ins on the registry are installed in the same way. For example, to install the CA Endevor plug-in, you would issue

```
zowe plugins install @broadcom/endevor-for-zowe-cli@zowe-v3-lts
```

### 6.3.2 Install From Bundled Package

Navigate to [Zowe.org Downloads](#) and click the CLI Plugins button to download the package which includes all Zowe CLI plug-ins for the Zowe organization. After accepting the EULA for Zowe, a package named `zowe-cli-plugins-v.r.m.zip` will be downloaded to your machine. Unzip the contents of `zowe-cli-plugins-v.r.m.zip` to a preferred location on your machine. You can select which plug-ins you want to install. The IBM Db2 plug-in requires [additional configuration](#) when installing from a local package. To install all plug-ins you can issue:

```
zowe plugins install cics-for-zowe-cli.tgz zos-ftp-for-zowe-cli.tgz mq-for-zowe-cli.tgz db2-for-zowe-cli.tgz
```

For offline installation of vendor plug-ins, please reach out to the specific vendor for details.

## 6.4 SUMMARY

In this chapter, we walked through the process of installing the prerequisite software, Node.js, and npm, as well as Zowe CLI and various plug-ins.