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# Integrating IBM Application Discovery and Delivery Intelligence (ADDI) in CI/CD pipelines

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## Abstract

This document describes how to integrate IBM Application Discovery and Delivery Intelligence (ADDI) into Git-based CI/CD pipelines.

# Table of content

# 1 Introduction

IBM Application Discovery and Delivery Intelligence (ADDI) is a product that maps z/OS artifacts belonging to Mainframe applications, providing the developers with reports and graphs that help them understand the relationships between the different z/OS components. Initially introduced to support the most common languages of the z/OS platform (Cobol, PL/1 and Assembler), ADDI has been enhanced over the last few years to support more and more artifact types: CICS and IMS definitions, DB2 tables, JCL, job schedulers, and many more.

For IT departments using ADDI, this product has become the one-stop repository that contains all the necessary information to understand how the different components of a z/OS application work together. By providing detailed reports on cross-relationships and visual representation of artifact interconnections, ADDI facilitates the developers' tasks, especially when it comes to discovering a new application, searching for a text string over multiple files or performing an impact analysis before introducing a change.

ADDI builds its reference repository by scanning artifacts (Cobol, PL/1 or Assembler source code files, CICS CSD files, job scheduling plans, etc.) that are typically retrieved directly from the z/OS system. For source files, ADDI can integrate with popular legacy SCM solutions, like Endevor or ChangeMan, and extract the necessary information or source code, to perform its scan process. This step, known as a "Build" operation in ADDI, is driven by a major component of the product: the AD Build Client. To build the cross-reference database, the Build Client processes all the source files made available in the scope of an application and populates the corresponding tables in its repository.

# 2 Automating tasks in ADDI

With the growing number of projects and z/OS artifacts to manage, administrative users of ADDI raised the need for improved mechanisms to assist with their daily tasks. Originally, the Build Client was mainly a graphical interface, used for administrative tasks like creating a project, populating it with artifacts and building the project. To facilitate the management of ADDI and avoid manual intervention from the ADDI administration team, the Build Client was enhanced to support Batch commands. Through these additional capabilities, most (if not all) of the commands available through the graphical interface of the Build Client can be triggered through its command-line interface, which enables ADDI to be an integral part of the DevOps ecosystem. These Command-Line options are documented on the ADDI IBM Docs website[1].

## 2.1 Automating the scan process

The two main features that are essential to take full advantage of the ADDI product are the *Build* function (or *Make* function) and the refresh of existing source artifacts. As explained above, the Build function performed by the Build Client is processing the whole list of files that are part of a given project. This Build function is typically used when the project is created in ADDI, to correctly set the repository up and make sure all the artifacts are scanned. When the project has been correctly created, another feature is preferably used, to update the project database in ADDI's repository: the *Make* function. This feature, instead of processing all the files of the project, only processes the files that have changed since the last scan. Using the Make function drastically optimizes the scan process, both in terms of resources needed and elapsed time, and it is the recommended scan action for existing projects. This Make command can be called in a batch command as follows:

```
IBMApplicationDiscoveryBuildClient /m1 ProjectName /m2 y /m3 y
```

## 2.2 Automating the refresh of source artifacts

The second important feature to leverage in this integration process is known as *Upgrade Mainframe Members* (UMM) in the Build Client. The purpose of this function is to refresh the source artifacts of a given project by retrieving them from their original location. For it to work properly, a Synchronization file must be created prior to using this function, in which references to storage locations for each type of artifacts are declared. The ADDI documentation contains a section[2] which details the expected content for this Synchronization file. The path of this Synchronization file must then be specified in the project's configuration to fully enable this feature. Once the configuration is set up, this Synchronization task can be triggered through the Build Client command-line interface with the following command:

```
IBMApplicationDiscoveryBuildClient /umm1 ProjectName
```

[1] Build Client batch commands: https://www.ibm.com/docs/en/addi/6.1.1?topic=commands-ii-description-ad-build-client-batch

[2] Synchronize Member configuration file: https://www.ibm.com/docs/en/addi/6.1.1?topic=samples-synchronize-members-configuration-file-examples

# 3 Integrating ADDI with Git

As mentioned earlier, the *Upgrade Mainframe Members* feature is used to retrieve the latest versions of z/OS artifacts as defined by the Synchronization file. In ADDI 6.0.2 (released in June 2021), this function was enhanced to support an additional synchronization mechanism, based on local filesystem changes. With this new capability, ADDI can detect new versions of files that are already on the filesystem of the machine hosting the ADDI product. This new synchronization capability enables the use of Git to retrieve the source artifacts.

To support this new feature, an additional keyword was introduced in the Synchronization file, to specify that updates be checked against the local filesystem. The *LOCAL_REMOTE* keyword is a new option for the second field, known as "Library Type", of each Synchronization file entry. The syntax is described in the ADDI documentation[3]. The path of the directory containing the sources on the machine hosting ADDI must then be specified, to allow the Build Client to refresh the members that have changed since the last update. Filters can also be applied to narrow down the selection criteria. Using filters can be extremely helpful if directories contain different types of artifacts mixed together.

As described in the ADDI documentation, the *LOCAL_REMOTE* keyword can be used in the Synchronization file entries as follows:

```
MyProject, LOCAL_REMOTE, C:\IBM AD\Mainframe Sources\Local Sources, zOS Cobol, COBOL_MVS

MyProject, LOCAL_REMOTE, C:\IBM AD\Mainframe Sources\Local Sources, zOS Cobol, COBOL_MVS,
filter(*.cbl|*.cob)
```

With this configuration, it is not the responsibility of ADDI to retrieve the members from z/OS or from any other source, as it only checks which files have changed on the filesystem. This is where Git plays a major role to retrieve  these files from a central Git provider. Assuming the source code files of a z/OS application are stored in a Git repository, a Git client installed on the machine where ADDI is hosted can retrieve the source files, by issuing Git commands like clone and/or fetch.

[3] Synchronize Member configuration file: https://www.ibm.com/docs/en/addi/6.1.1?topic=samples-synchronize-members-configuration-file-examples

# 4 Integrating ADDI in the CI/CD pipeline

The primary objective of integrating ADDI into a DevOps CI/CD pipeline is to provide the developers with valuable insights about the structure of the z/OS applications they are maintaining or enhancing. ADDI helps the developers understand the relationships between the different z/OS components, and is a powerful solution to perform impact analysis or document applications' structures. However, it is important for developers to work on up-to-date information, and the freshness and accuracy of the data collected by ADDI plays a crucial role to ensure the analysis is correct. To keep up with all the changes occurring on z/OS source code files or artifacts, the best strategy to keep the ADDI model up to date is to implement automation, to update and build changes in ADDI on a regular basis.

## 4.1 Setting pre-requisites up

In the previous sections, the integration with Git and the command-line options of the Build client were described. All the necessary pieces are now available to complete the integration of ADDI into an automated CI/CD pipeline. Before implementing the automated process to update and build ADDI projects, some technical pre-requisites must first be set up.

To enable the use of Git to synchronize source files stored in a Git repository, a Git client must be installed on the machine where ADDI is running, because the source components will be cloned there. To ensure the Git repository is accessible and can be safely cloned to the ADDI machine, a *git clone* operation can be manually performed. In subsequent steps, it is assumed this clone process will be performed by the CI/CD orchestrator, typically through its own mechanism.

On ADDI, a project must exist prior to the use of the Synchronization feature. It is recommended to create the project first, either through the Build Client user interface or with a command-line option. The project must then be enabled to support the Synchronization file, and this option is set through the *AD Configuration Server*[4].

The Synchronization file must exist and be populated with correct entries before running the automation process. To create the Synchronization file, the structure of the Git repository must be known: typically, each type of artifact lives in its own subdirectory in the Git repository. With this layout, each subdirectory will likely correspond to a line entry in the Synchronization file, potentially with filtering.

Though the automated process could be enabled when the above pre-requisites are met, it is highly recommended to manually test these operations beforehand. The list of tasks to perform are as follows:

1. Manual *git clone* of the Git repository on the ADDI machine
2. Manual *Upgrade Mainframe Members* operation through the ADDI's Build Client
3. ADDI Build Client's *Build* operation, to make sure the project can be built cleanly without any errors
4. Verification of the project in ADDI's *Analyze Client*

[4] Synchronizing Mainframe Members: https://www.ibm.com/docs/en/addi/6.1.1?topic=tasks-synchronizing-mainframe-members

Performing a manual *Build* through the Build Client helps to verify the correct execution of this task, including the correct processing performed by the *Batch Server* in ADDI (i.e., the generation of the Cross database and the creation of graphs in the GraphDB Database). At the end of this Build process, users should be able to consult reports and graphs for the given project in ADDI's *Analyze Client*.

## 4.2 Implementing the automation process

When all the pre-requisites are met and verified, the automation process can be implemented and enabled. To enable the developers with fresh data, the automated update and build typically occurs when the state of a branch in the Git repository changes, as described by the adopted Git branching model. In a traditional branching model, a branch corresponds to the application currently being in development (called the *Development* branch) and a second branch describes the application currently running in production (often called the *Main* branch). Developers can be interested in browsing the corresponding projects in ADDI, to visualize the differences between these two states.

In a DevOps implementation, CI/CD pipelines are typically triggered after each change on specific branches. This mechanism can be leveraged to implement the required automation to update ADDI. In this configuration, an additional *git clone* action can be driven by the pipeline orchestrator to take place on the ADDI machine, and ADDI Build Client command-line interface actions can be integrated in the pipeline logic, as described in a previous section.

# 5 Example of ADDI integration into an existing CI/CD pipeline

The following example is leveraging the GitLab platform, but a similar implementation could easily be performed for any other CI/CD orchestrators using similar mechanisms to clone the Git repository to the Windows Virtual Machine hosting the ADDI installation, and to remotely execute commands on this machine.

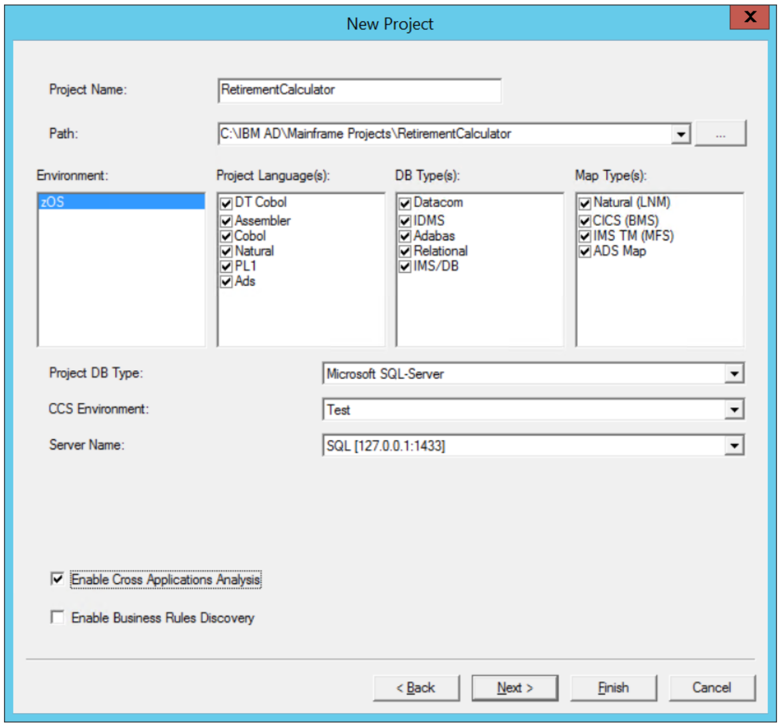
## 5.1 Pre-requisites for the GitLab platform

As the CI/CD pipeline is driven by the *GitLab CI/CD feature*, a *GitLab Runner* must be installed on the machine where ADDI is running. The purpose of the GitLab Runner is to execute commands that are configured for the pipeline steps, including an automatic Git clone/fetch command to refresh the local clone of the project's Git repository. The installation of the GitLab Runner is not covered in this documentation, but it is detailed in the official GitLab documentation[5].

Another pre-requisite to fulfill is the installation of a *Git client* on the same machine. This Git client will be used to clone the content of the Git repository that contains the source code to analyze with ADDI. The Git client is available on many platforms and can be downloaded from the official Git website[6]. Documentation about the installation of the Git client can be found online[7].

## 5.2 Setting up the pre-requisites on ADDI

The next step of the setup would be the creation of the project in ADDI. In the ADDI Build Client, navigate to *File* → *New* → *New Project…* to create a new project. Specify the *Mainframe main languages* option for the type of project to create. You are then prompted to name the project to create and the types of artifacts your project can contain:



Project Name: RetirementCalculator

Path: C:\IBM AD\Mainframe Projects\RetirementCalculator

| Environment: | Project Language(s): | DB Type(s): | Map Type(s): |
|---|---|---|---|
| zOS | ✓ DT Cobol | ✓ Datacom | ✓ Natural (LNM) |
| | ✓ Assembler | ✓ IDMS | ✓ CICS (BMS) |
| | ✓ Cobol | ✓ Adabas | ✓ IMS TM (MFS) |
| | ✓ Natural | ✓ Relational | ✓ ADS Map |
| | ✓ PL1 | ✓ IMS/DB | |
| | ✓ Ads | | |

Project DB Type: Microsoft SQL-Server

CCS Environment: Test

Server Name: SQL [127.0.0.1:1433]

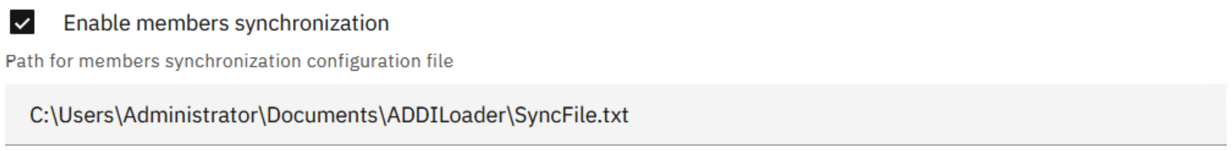
✓ Enable Cross Applications Analysis

☐ Enable Business Rules Discovery

5 GitLab Runner Installation on Windows: https://docs.gitlab.com/runner/install/windows.html
6 Git Downloads website: https://git-scm.com/downloads
7 Git installation documentation: https://git-scm.com/book/en/v2/Getting-Started-Installing-Git

In this example, the project is called *RetirementCalculator*. Additional options like the database attachment to use are also specified, along with the Cross Applications Analysis or the Business Rules Discovery. The creation of the project can now be finalized. The database for this project is then created.

The next step is to configure the project to enable the use of a Synchronization file. Using the ADDI's Administration Dashboard, select the *Configure* → *Install Configurations* tab, and navigate to the *IBM Application Discovery Build Client install configuration* link. On the displayed panel, the members synchronization must be enabled, and the path to a Synchronization file must be specified:



✓ Enable members synchronization

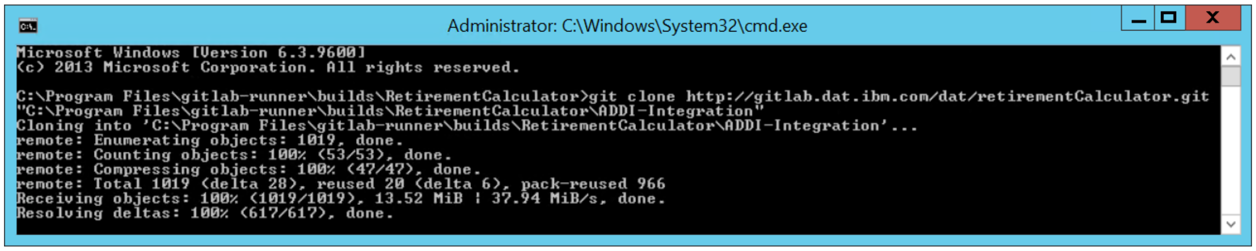
Path for members synchronization configuration file

C:\Users\Administrator\Documents\ADDILoader\SyncFile.txt

This file will contain the locations where the Build Client searches for updates on project's source files. The contents of the file will be detailed later in this document.

To first build the project, source files must be added to the project. In the process of setting up the integration, a manual Git Clone command will be run, to properly initialize the local Git repository. In this sample setup, the Git repository is made up of several branches which correspond to different states of the application. The GitLab Runner is configured to clone projects to a specific location containing the name of the branch in Git, controlled by the *GIT_CLONE_PATH* parameter. Using this capability, the location of the local Git repository is set to *C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration*, where the branch that will be scanned through ADDI is called ADDI-Integration. The Git repository is locally cloned using a *git clone* command:

```
git clone http://gitlab.dat.ibm.com/dat/retirementCalculator.git "C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration"
```

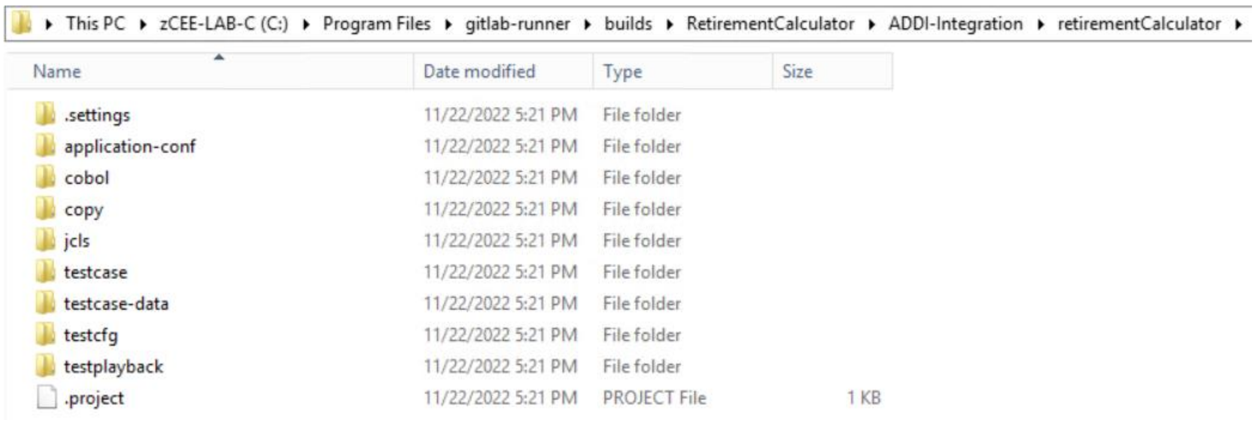


Administrator: C:\Windows\System32\cmd.exe

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Program Files\gitlab-runner\builds\RetirementCalculator>git clone http://gitlab.dat.ibm.com/dat/retirementCalculator.git
"C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration"
Cloning into 'C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration'...
remote: Enumerating objects: 1019, done.
remote: Counting objects: 100% (53/53), done.
remote: Compressing objects: 100% (47/47), done.
remote: Total 1019 (delta 28), reused 20 (delta 6), pack-reused 966
Receiving objects: 100% (1019/1019), 13.52 MiB | 37.94 MiB/s, done.
Resolving deltas: 100% (617/617), done.
```

The content of the Git repository is now available on the local filesystem of the machine where ADDI runs:

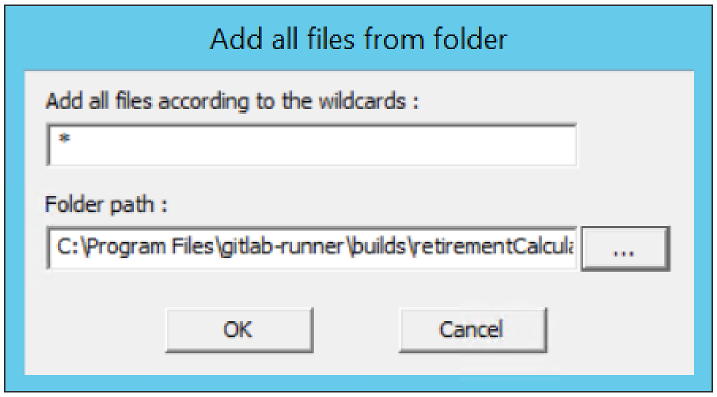


This PC ▸ zCEE-LAB-C (C:) ▸ Program Files ▸ gitlab-runner ▸ builds ▸ RetirementCalculator ▸ ADDI-Integration ▸ retirementCalculator ▸

| Name | Date modified | Type | Size |
|---|---|---|---|
| .settings | 11/22/2022 5:21 PM | File folder | |
| application-conf | 11/22/2022 5:21 PM | File folder | |
| cobol | 11/22/2022 5:21 PM | File folder | |
| copy | 11/22/2022 5:21 PM | File folder | |
| jcls | 11/22/2022 5:21 PM | File folder | |
| testcase | 11/22/2022 5:21 PM | File folder | |
| testcase-data | 11/22/2022 5:21 PM | File folder | |
| testcfg | 11/22/2022 5:21 PM | File folder | |
| testplayback | 11/22/2022 5:21 PM | File folder | |
| .project | 11/22/2022 5:21 PM | PROJECT File | 1 KB |

The source files can now be added to the project through the Build Client. For all the artifact types of your project, right-click on the corresponding virtual folder, and select the *Add All Files from Folder* menu. In the next panel, specify the folder path where your source files where cloned.

Here, the path *C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\cobol* is specified for the *zOS Cobol* virtual folder, for instance.


Add all files from folder
Add all files according to the wildcards :
*
Folder path :
C:\Program Files\gitlab-runner\builds\retirementCalcula
...
OK
Cancel

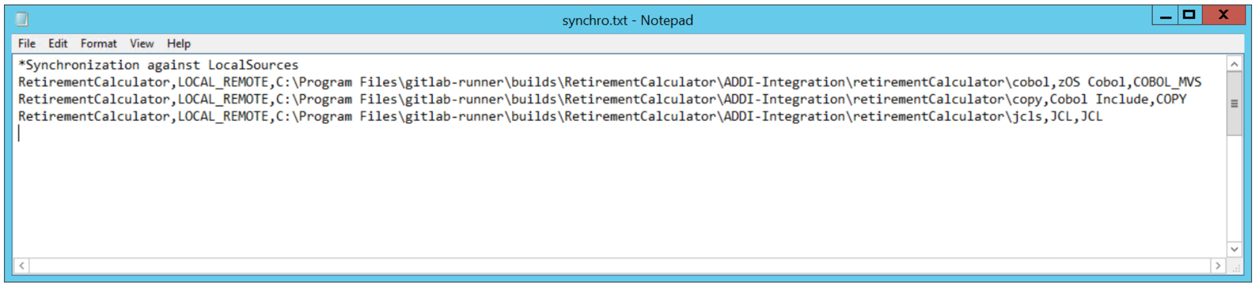
The same operation must be repeated for the different types of artifacts of the project. When done, the project is ready to be built with the Build Client. Select the *Build* → *Build Project* menu option to build the project. If any major error is encountered, some other artifacts may be needed to complete the build process. When the project is successfully built, the initial ADDI setup can be marked as complete.

## 5.3 Implementing the integration with the CI/CD pipeline

To automate the synchronization and the *Make* of the ADDI project, the next step is to test the command-line options of the Build Client. However, prior to running the Build Client batch commands, the Synchronization file must be correctly populated. This file contains entries that dictate where the Build Client will look for updates. Each line describes the type of artifacts to load and the folder location where these artifacts are stored.

For the *RetirementCalculator* project used as an example in this document, the files are stored in subfolders of the *C:\Program Files\gitlab-runner\builds\RetirementCalculator\retirementCalculator* folder. Three main artifact types are part of this project: Cobol programs, Cobol Include files and JCLs. The Synchronization file contains 3 entries referring to this setup:

```
*Synchronization against LocalSources
RetirementCalculator,LOCAL_REMOTE,C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\cobol,zOS Cobol,COBOL_MVS
RetirementCalculator,LOCAL_REMOTE,C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\copy,Cobol Include,COPY
RetirementCalculator,LOCAL_REMOTE,C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\jcls,JCL,JCL
```



```
*Synchronization against LocalSources
RetirementCalculator,LOCAL_REMOTE,C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\cobol,zOS Cobol,COBOL_MVS
RetirementCalculator,LOCAL_REMOTE,C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\copy,Cobol Include,COPY
RetirementCalculator,LOCAL_REMOTE,C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration\retirementCalculator\jcls,JCL,JCL
```

To validate the update of source files through the Synchronization file, the following command can be used:

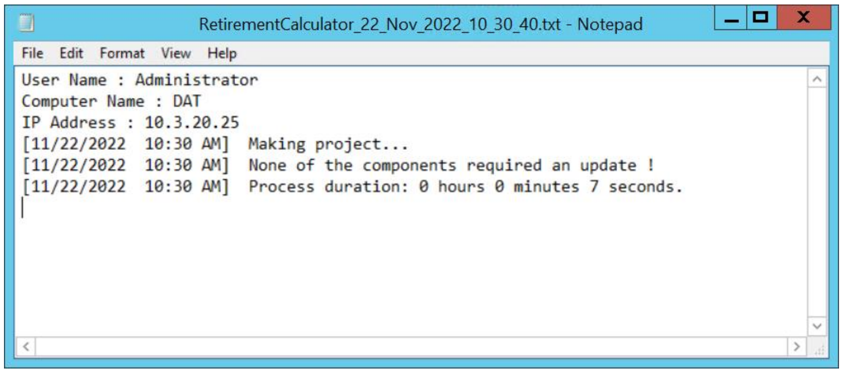
```
IBMApplicationDiscoveryBuildClient /umm1 RetirementCalculator
```

This command launches the Build Client with no graphical interface, to update the source files from the local filesystem.

The next command to check is the *make* of the project.

```
IBMApplicationDiscoveryBuildClient /m1 RetirementCalculator /m2 y /m3 y
```

When the process is complete, a log file is created, and made available in the project folder. It should show that no updates are found (since the Build was previously performed on the same source files):


RetirementCalculator_22_Nov_2022_10_30_40.txt - Notepad
File Edit Format View Help

```
User Name : Administrator
Computer Name : DAT
IP Address : 10.3.20.25
[11/22/2022  10:30 AM]  Making project...
[11/22/2022  10:30 AM]  None of the components required an update !
[11/22/2022  10:30 AM]  Process duration: 0 hours 0 minutes 7 seconds.
```

The next setup phase is to implement these two command-line actions in the CI/CD pipeline. In this example, GitLab will be used to drive the execution of the CI/CD pipeline. An additional step of the pipeline is then declared to call the ADDI Build Client with the two command-line options.

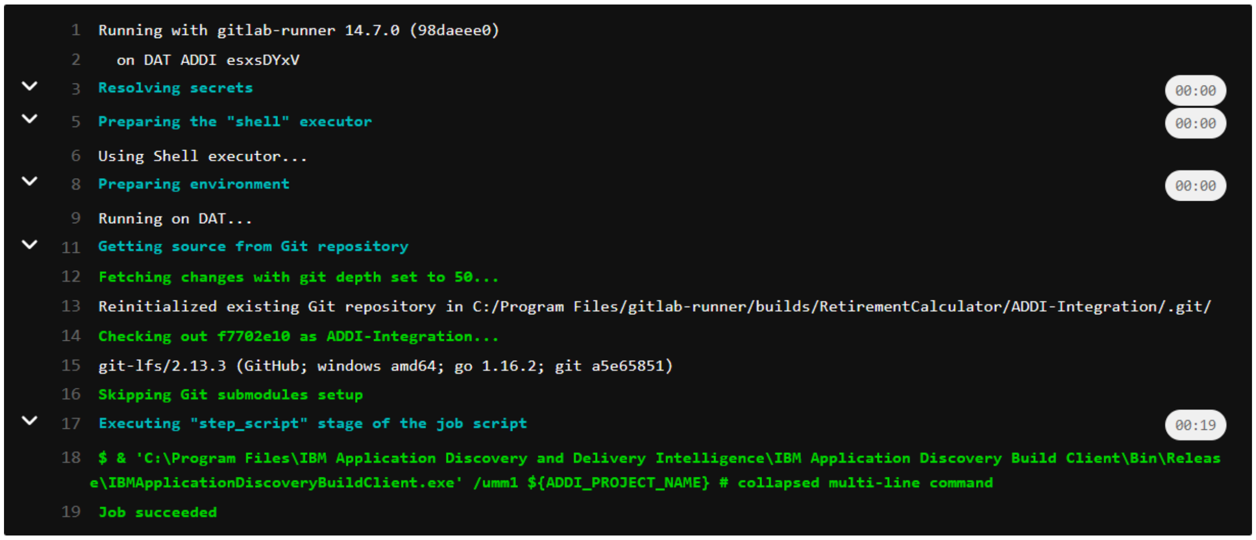
The pipeline description for GitLab is as follows:

```
ADDI Refresh:
    stage: Analysis
    tags: [addi]
    dependencies: []
    variables:
        ADDI_PROJECT_NAME: RetirementCalculator
    script:
        - |
            & 'C:\Program Files\IBM Application Discovery and Delivery Intelligence\IBM Application Discovery Build Client\Bin\Release\IBMApplicationDiscoveryBuildClient.exe' /umm1 ${ADDI_PROJECT_NAME}
            & 'C:\Program Files\IBM Application Discovery and Delivery Intelligence\IBM Application Discovery Build Client\Bin\Release\IBMApplicationDiscoveryBuildClient.exe' /m1 ${ADDI_PROJECT_NAME} /m2 y /m3 y
```

In the script section, the two Build Client commands are run in sequence, in a synchronous way. The first command will synchronize the project based on the content of the Synchronization file, and the second command will trigger the *Make* processing in ADDI.

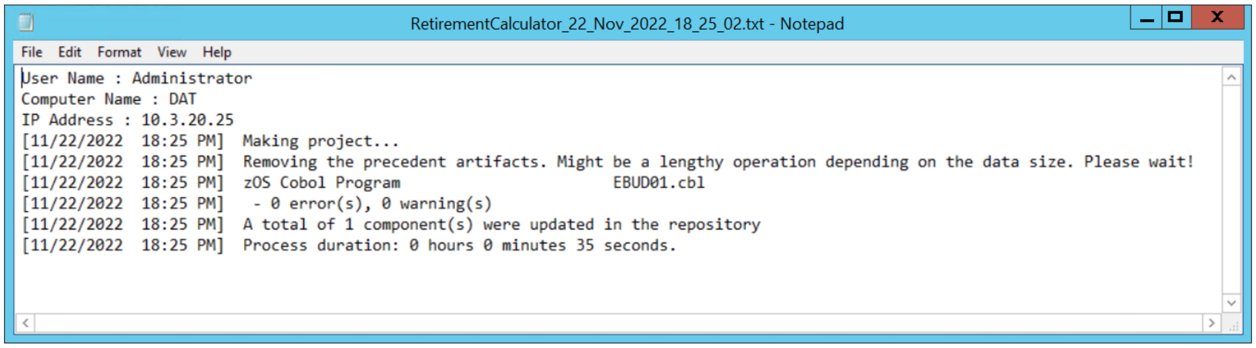
The GitLab Runner has been configured to clone into a specific location, as specified by the *GIT_CLONE_PATH* variable. In this sample setup, this variable is set to *$CI_BUILDS_DIR/$CI_PROJECT_NAME/$CI_COMMIT_REF_NAME*, which resolves to *C:\Program Files\gitlab-runner\builds\RetirementCalculator\ADDI-Integration* on the Windows machine where ADDI is running. It is necessary to ensure that this path is consistent with the path configured in the Synchronization file, to take updates of source files into account.

After applying a change to the EBUD01 Cobol program of the RetirementCalculator project, the execution of the CI/CD pipeline shows the integration of the *ADDI Refresh* step. This step executed successfully and shows the following output log:



```
Running with gitlab-runner 14.7.0 (98daeee0)
  on DAT ADDI esxsDYxV
Resolving secrets                                                              00:00
Preparing the "shell" executor                                                 00:00
Using Shell executor...
Preparing environment                                                          00:00
Running on DAT...
Getting source from Git repository
Fetching changes with git depth set to 50...
Reinitialized existing Git repository in C:/Program Files/gitlab-runner/builds/RetirementCalculator/ADDI-Integration/.git/
Checking out f7702e10 as ADDI-Integration...
git-lfs/2.13.3 (GitHub; windows amd64; go 1.16.2; git a5e65851)
Skipping Git submodules setup
Executing "step_script" stage of the job script                                00:19
$ & 'C:\Program Files\IBM Application Discovery and Delivery Intelligence\IBM Application Discovery Build Client\Bin\Releas
e\IBMApplicationDiscoveryBuildClient.exe' /umm1 ${ADDI_PROJECT_NAME} # collapsed multi-line command
Job succeeded
```

On the machine where ADDI runs, a log file is created in the ADDI project's folder once the *Make* process is finished. This log file shows that the update to the EBUD01 program was correctly processed and built by ADDI:



RetirementCalculator_22_Nov_2022_18_25_02.txt - Notepad

```
User Name : Administrator
Computer Name : DAT
IP Address : 10.3.20.25
[11/22/2022  18:25 PM]  Making project...
[11/22/2022  18:25 PM]  Removing the precedent artifacts. Might be a lengthy operation depending on the data size. Please wait!
[11/22/2022  18:25 PM]  zOS Cobol Program                       EBUD01.cbl
[11/22/2022  18:25 PM]   - 0 error(s), 0 warning(s)
[11/22/2022  18:25 PM]  A total of 1 component(s) were updated in the repository
[11/22/2022  18:25 PM]  Process duration: 0 hours 0 minutes 35 seconds.
```

Shortly after this successful processing, the updated analysis is available through the Analyze Client in eclipse.

# 6 Conclusion

This document describes how the integration of ADDI could be performed in a CI/CD pipeline. Depending on the SCM solution and CI/CD orchestrator being used, this integration can slightly differ, thereby leveraging other provided capabilities.

In this sample implementation, only one project is created in ADDI, but it may be interesting to have different projects for different states of the same application. A project in ADDI could represent the application in its ‘development’ state and another project could represent the application in production. This implementation would require two distinct projects in ADDI, and some changes in the Synchronization file and the CI/CD process. In this configuration, the number of entries in the Synchronization file would double, due to configuration for the two projects referring to different locations on the filesystem where branches are checked out.

Another option for the implementation would be to optimize the execution of the ADDI Build Client commands. In the sample implementation described in this documentation, each change to the *Development* branch of the Git repository triggers the pipeline to refresh ADDI. If too many updates are occurring on the application, especially in its ‘development’ state, there may be some interest to run the update process only once a day. This can be managed by a CI/CD orchestrator or using the *cron* utility.

In the pre-requisites setup, it is recommended to run the creation of the project manually, along with some other Git commands to initially clone the Git repository to the local filesystem. Also, adding the files from Git to the project through the Build Client is manually performed, to ensure the sources are correctly loaded and eventually built. This whole process could also be automated as the Build Client provides command-line options to create projects and add files to the projects. However, it is safer, at least for the first project, to manually perform these operations to ensure a correct configuration. Automation could be setup once the whole process is understood and mastered.