Program: Post Graduate Program in DevOps

Name of Institution: Edureka/ Purdue University

Name: Wezi Bonono Chipeta

Industrial Grade Project 1

Title: Building a CI/CD Pipeline for ABC Technologies

Project GitHub Repository: https://github.com/Izewdevlabs/igpaug26

Date: 7th September 2025

Table of Contents

Table of Figures

1. Introduction

This document provides a detailed solution using DevOps for ABC Technologies, an online retailer, which has been using conventional development and deployment approaches which have led to significant losses and issues such as low availability, scalability, and performance, along with difficult builds, maintenance, and slow-release cycles.

In the DevOps solutions provided, five tasks and steps to accomplish them are outlined. Using the provided source code to work with, complete Continuous Integration/ Continuous Deployment (CI/CD) pipeline involving source code management using Git, continuous integration using Jenkins, continuous integration using Docker, container orchestration using Kubernetes, and continuous monitoring using Prometheus and Grafana. Among others, complete code developed such as dockerfile, CI/CD pipeline job scripts for both Docker and Kubernetes deployments are provided. In addition, code for manifest files deployment.yaml, service.yaml, namespace.yaml, ingress.yaml and hpa.yaml are provided. All in all, snapshots of the command and outputs either on the terminal or within Github, Dockerhub, Jenkins, Docker, Grafana and AWS were provided.

This DevOps solution provided for ABC Technologies would ensure that operational benefits would make the service that is: highly available, highly scalable, highly performant; easily built and maintained; developed and deployed quickly; lower production bugs; frequent releases; better customer experience and less time to market. Now, let's explore what business challenges ABC Technologies online retailer is faced with as provided in the project brief.

2. Business Challenge/Requirement

ABC Technologies, a top online retailer, has acquired a large offline retail business with stores worldwide. However, the conventional development and deployment approach has led to significant losses and issues such as low availability, scalability, and performance, along with difficult builds, maintenance, and slow-release cycles.

ABC will acquire the data from all these storage systems and plan to use it for analytics and prediction of the firm's growth and sales prospects. In the first phase ABC must create the servlets to Add a product and Display product details. Add servlet dependencies required to compile the servlets. It is required to create an HTML page which will be used to add a product. Team is using git to keep all the source code.

ABC has decided to use DevOps model and once source code is available in GitHub, it is

required to integrate it with Jenkins and provide continuous build generation for continuous delivery, integrate with Ansible and Kubernetes for deployment. It would be required to use docker hub to pull and push images between ansible and Kubernetes.

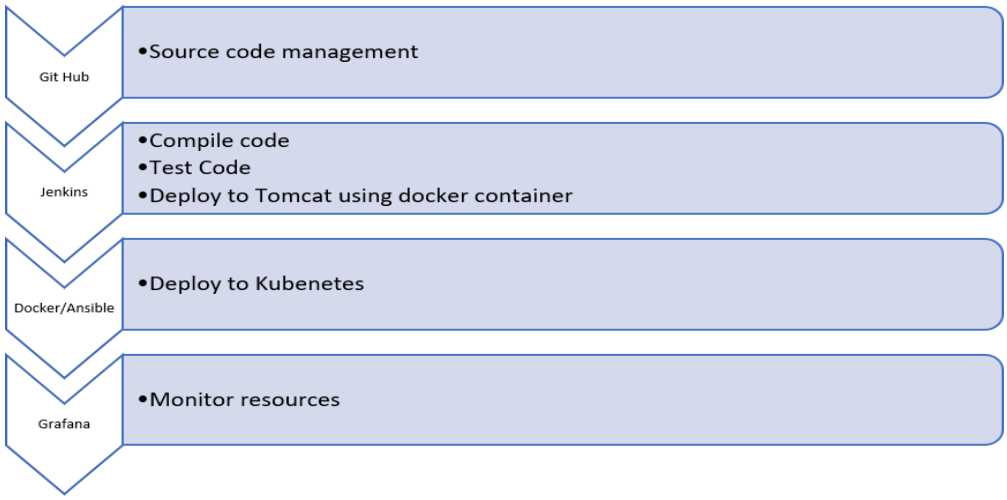
3. The Goal of the Project

According to the project brief, some of the high-level goals of the project comprise implementing CI/CD such as ABC Technologies can be *highly available; highly scalable; highly performant; easily built and maintained and developed and deployed quickly.*

4. Data Flow Architecture/Process Flow

Figure 1 shows the data flow architecture/ process flow architecture to be followed in proving solution to ABC Technologies. According to this architecture data would flow from GitHub as part of Source code management, then to Jenkins where the source code would be compiled, tested and deployed to Tomcat using Docker container. Then, deployment would occur to Kubernetes from Docker. After deployment to Kubernetes, the resources would be monitored using Grafana dashboards.

Figure 1:Data Flow Architecture/ Process Flow



5. Data Explanation and Schema:

Sample Java project had been shared for usage. It was a maven project and had source code (SRC) and test folders created into it. It had a POM.xml file which listed all needed dependencies to execute this project.

6. Problem Statements/Tasks

As per problem statement, it was required to develop a CICD pipeline to automate the software

development, testing, packaging, and deploying, thereby reducing the time to market of app and ensuring good quality service is experienced by end users. In this project it was required to:

- Push the code to GitHub repository
- Create a continuous integration pipeline using Jenkins to compile, test and package the code present in GitHub
- Write docker file to push the war file to tomcat server
- Integrate docker with Ansible and write playbook *(optional according to class of 23 August 2025)*
- Deploy artifacts to Kubernetes cluster
- Monitor resources using Grafana

7. Pre-requisites:

Before building the CICD pipeline, it was necessary to verify following software installed in the working machine. *Java, Maven, Git, Jenkins, Docker, Ansible, Kubernetes, Grafana and Prometheus.*

8. Approach to Solve:

The following were the suggested approach to solving the problem which was followed. However, the class on 23 August 2025 provided additional technical guide on the approach by the instructor.

Task 1: *Clone the project from GitHub link shared in resources to your local machine. Build the code using maven commands.*

Task 2: *Setup git repository and push the source code. Login to Jenkins*

- Create a build pipeline containing a job each
    - One for compiling source code
    - Second for testing source code
    - Third for packing the code
- Execute CICD pipeline to execute the jobs created in step1
- Setup master-slave node to distribute the tasks in pipeline

Task 3: *Write a Docker file to create an Image and container on docker host. Integrate docker host with Jenkins. Create CI/CD job on Jenkins to build and deploy on a container*

- Enhance the package job created in step 1 of task 2 to create a docker image
- In the docker image add code to move the war file to tomcat server and build the image

Task 4: *Deploy Artifacts on Kubernetes; Write pod, service, and deployment manifest file*

Task 5: *Using Prometheus monitors resources like CPU utilization: Total Usage, Usage per core, usage breakdown, Memory, Network on the instance by providing the end points in local host. Install node exporter and add URL to target Prometheus. Using this data login to Grafana and create a dashboard to show the metrics.*

9. Considerations/ Assumptions

Provision of the DevOps solution to ABC Technologies had considerations and assumptions on the resources needed such as:

- An AWS account
- A GitHub account
- MobaXterm / Putty
- Git Bash setup
- Source Code

All the above resources were available. In addition to the above, Docker hub Account was added to the list.

10. DevOps Solution to ABC Technologies

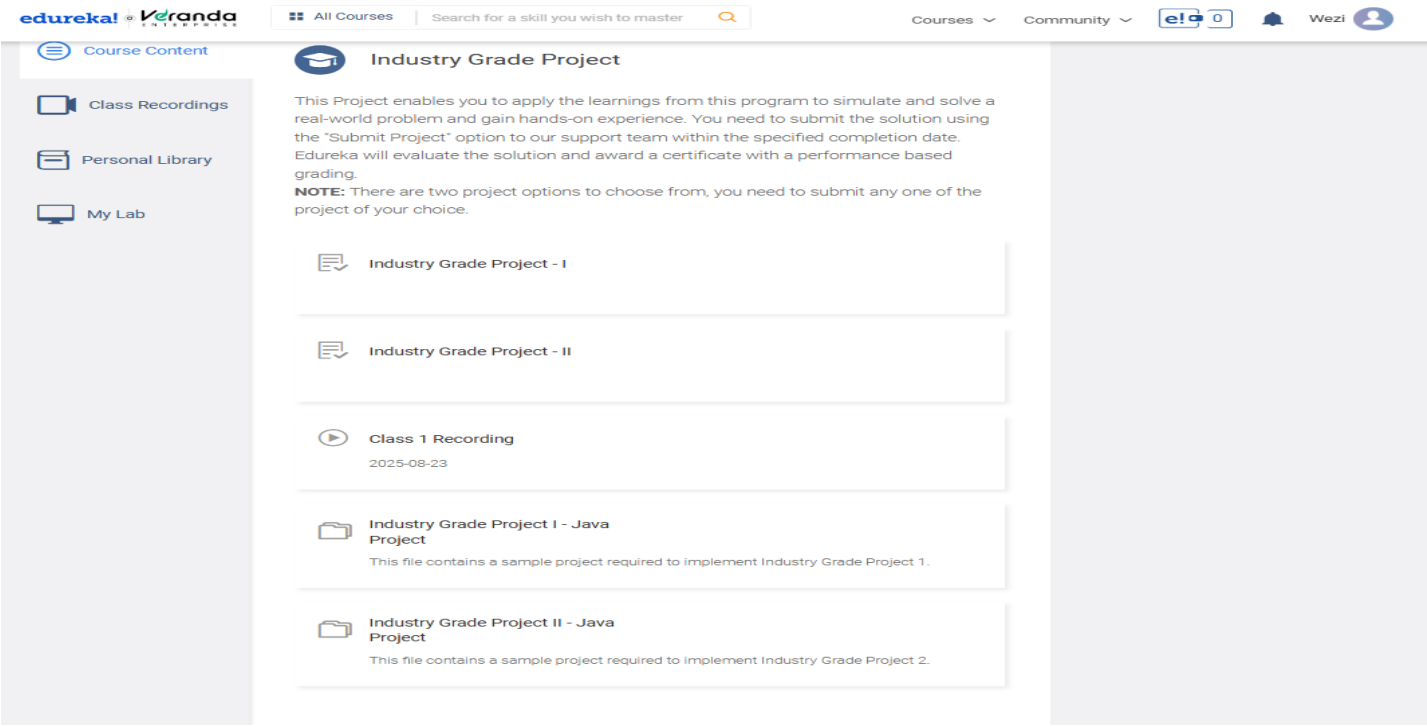
Following sections cover steps that were taken to provide the DevOps solution to the problem faced by ABC Technologies for each task as per the data scheme. The first one was source code management which covered next.

10.1 Source Code Management

Task 1: *Clone the project from GitHub link shared in resources to your local machine. Build the code using maven commands.*

No GitHub link was provided to clone the resources in one's local machine. However, for the ABC Technologies project, a zipped file *"Industry Grade Project 1- Java Project.zip"* was downloaded from Eureka's LMS portal to the local Windows laptop. *Figure 2* shows the setup within LMS portal of the files for the Industry Grade Project (IGP).

Figure 2:Edureka's Industry Grade Project File Repository



The downloaded file was unzipped. Figure 3 shows the screenshot of the directory structure of the folders and files for the project.

Figure 3:Directory Structure of the Source Code on the Local Machine (Laptop)

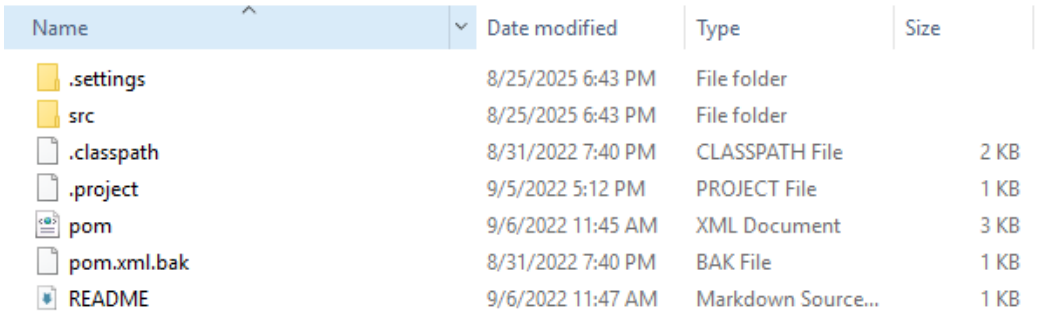
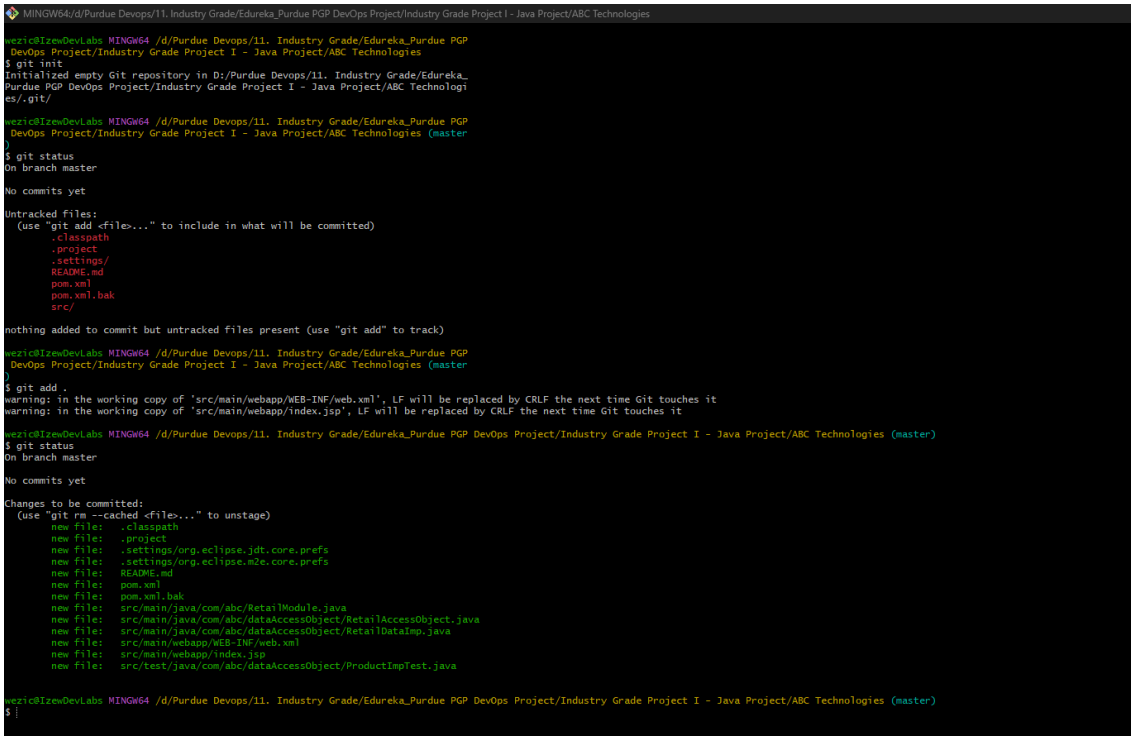


Figure 3 above shows the necessary codebase for the project. As such it was necessary to create a local repository to track the files on the local machine. To track the codebase, Git Bash was used, where the new local repo was created, with files added and able to be tracked. By using Git Bash in Windows, the following commands were executed on CLI:

```
>git init  # initiate a git repository
>git status
>git add .
```

Figure 4 shows the screenshot of the commands that ensured that the local repo was created, and files added and able to be tracked but not yet committed.

***Figure 4**:* Local Repo Created with Untracked Files



To commit the changes to the local repository, the following commands were ran:

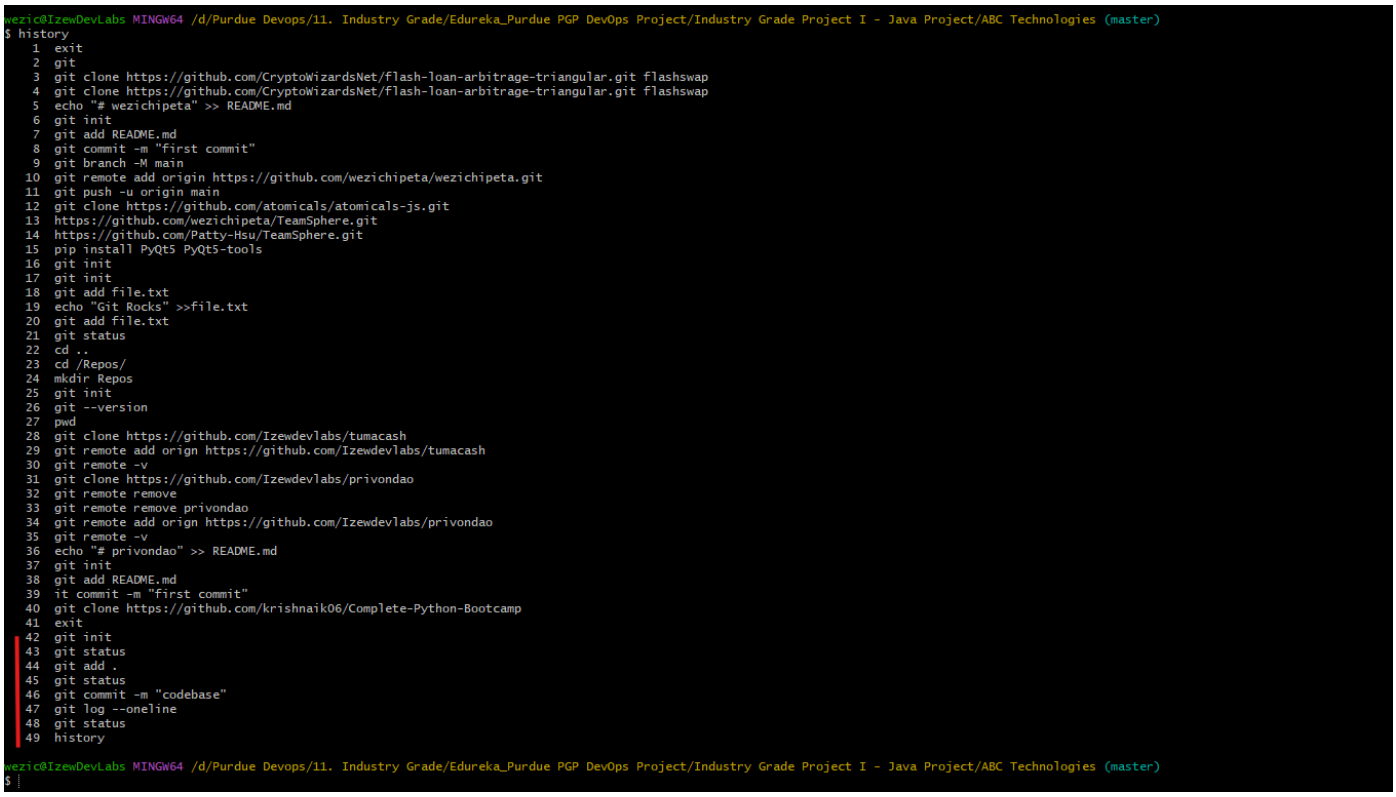
```
>git commit -m “codebase”
>git log --oneline
>git status
```

Figure 5 shows the screenshot of the output after executing the command in which 13 files were changed.

***Figure 5**:* Committed Changes to the Local Repository

To check which commands were executed thus far, history command within Git Bash was used. *Figure 6* below shows the history of commands executed as highlighted from lines 42-48.

Figure 6: History of commands to create a local Git repository and have changes committed



The above activities concluded Task 1 of the project. Task 2 involved setting up a remote git repository and pushing the source code. In addition, it was required to log into Jenkins. This is covered next.

Task 2: *Setup git repository and push the source code. Login to Jenkins*
Creation of Remote Repository on GitHub

To push the source code from the local repository to GitHub so that it can be accessed by Jenkins, it was required to create a remote repository on GitHub. A public repository was created for the project called *"igpaug26.git"* with the following URL: *https://github.com/Izewdevlabs/igpaug26* . Figure 7 shows the screenshot of the series of commands executed to push the local codebase to remote repo. These comprised:

```
>git remote -v
>git remote add origin https://github.com/Izewdevlabs/igpaug26.git
>git remote -v
>git branch
>git push -u origin master #upload codebase upstream from the master
  branch
```

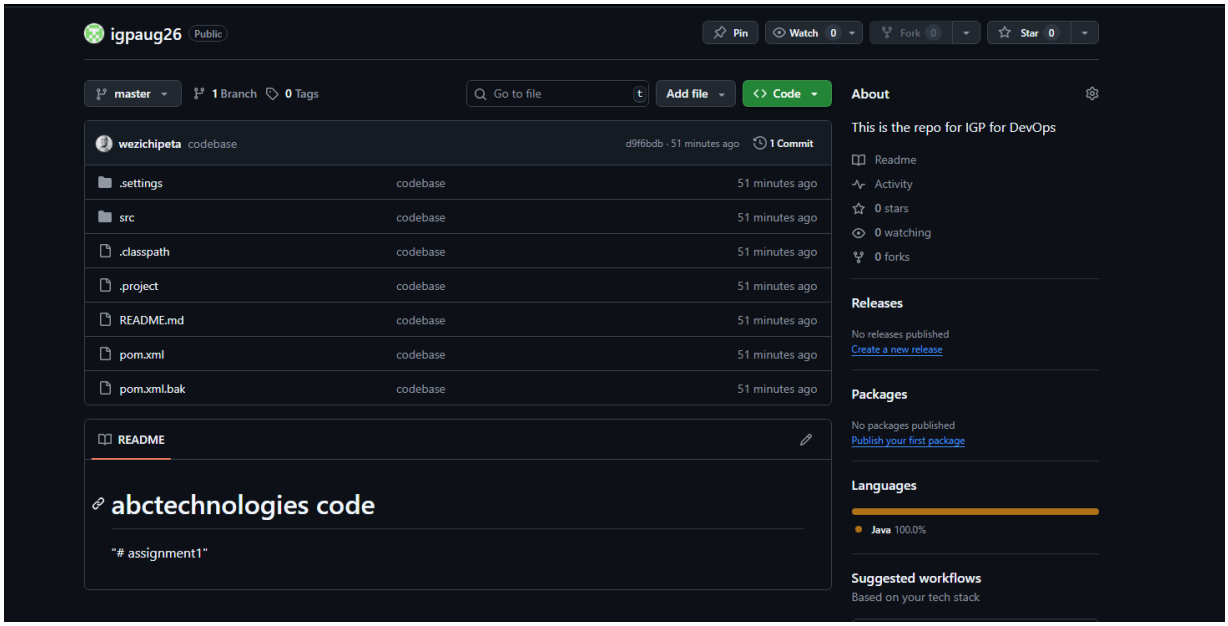
Figure 7 shows the above commands executed and associated outputs.

Figure 7: Executed Commands to Push the Codebase to Remote GitHub Repository

```
wezic@IzewDevLabs MINGW64 /d/Purdue Devops/11. Industry Grade/Edureka_Purdue PGP DevOps Project/Industry Grade Project I - Java Project/ABC Technologies (master)
$ git remote add origin https://github.com/Izewdevlabs/igpaug26.git

wezic@IzewDevLabs MINGW64 /d/Purdue Devops/11. Industry Grade/Edureka_Purdue PGP DevOps Project/Industry Grade Project I - Java Project/ABC Technologies (master)
$ git remote -v
origin  https://github.com/Izewdevlabs/igpaug26.git (fetch)
origin  https://github.com/Izewdevlabs/igpaug26.git (push)

wezic@IzewDevLabs MINGW64 /d/Purdue Devops/11. Industry Grade/Edureka_Purdue PGP DevOps Project/Industry Grade Project I - Java Project/ABC Technologies (master)
$ git push -u origin master
info: please complete authentication in your browser...
Enumerating objects: 29, done.
Counting objects: 100% (29/29), done.
Delta compression using up to 8 threads
Compressing objects: 100% (20/20), done.
Writing objects: 100% (29/29), 4.44 KiB | 101.00 KiB/s, done.
Total 29 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
To https://github.com/Izewdevlabs/igpaug26.git
 * [new branch]      master -> master
branch 'master' set up to track 'origin/master'.

wezic@IzewDevLabs MINGW64 /d/Purdue Devops/11. Industry Grade/Edureka_Purdue PGP DevOps Project/Industry Grade Project I - Java Project/ABC Technologies (master)
$
```

Having executed the commands above, Figure 8 shows the screenshot of the GitHub *"igpaug26.git "* repository to verify that the codebase had been pushed successfully from local to GitHub. The successful pushing of the codebase on GitHub marked the end of the source code management part of the pipeline.

Figure 8*:* Remote GitHub Repository of the Codebase to Verify Successful Push from Local Repository



Having dealt with the source code management of the pipeline, the next step was to deal with the integration of the source code management with Jenkins.

10.2 Integration and Build

10.2.1 EC2 Setup

Integration setup was still part of Task 2 and the tools required comprised Jenkins and Maven.

The first step was to configure a Linux Virtual Machine (VM) within any public cloud of choice (AWS/GCP/Azure) and install Jenkins and Maven there. For this project, Amazon Web Services (AWS) public cloud was used. Using the existing AWS account, the VM was configured with the following Elastic Cloud Compute (EC2) specs as follows:

- Name: *IGP_ABCTech*
- Operating System (OS) Image: Ubuntu Linux 22.04 LTS
- Memory: 2core CPU & 4GB RAM
- Secondary Storage: 8GB

Figures 9 to 12 below show screenshots in the process of configuring the VM in AWS. Figure 8 shows the configuration of EC2 instance name and Linux OS image version. Figure 9 shows the key pair and network setup. Figure 10 shows the secondary storage setup for the VM. Figure 11 shows the successful launch of the EC2 instance and shows it was successfully running. Figure 12 shows access to the EC2 instance using PuTTY and successfully logged as ubuntu user.

***Figure 9**:* VM Name and OS Image Setup

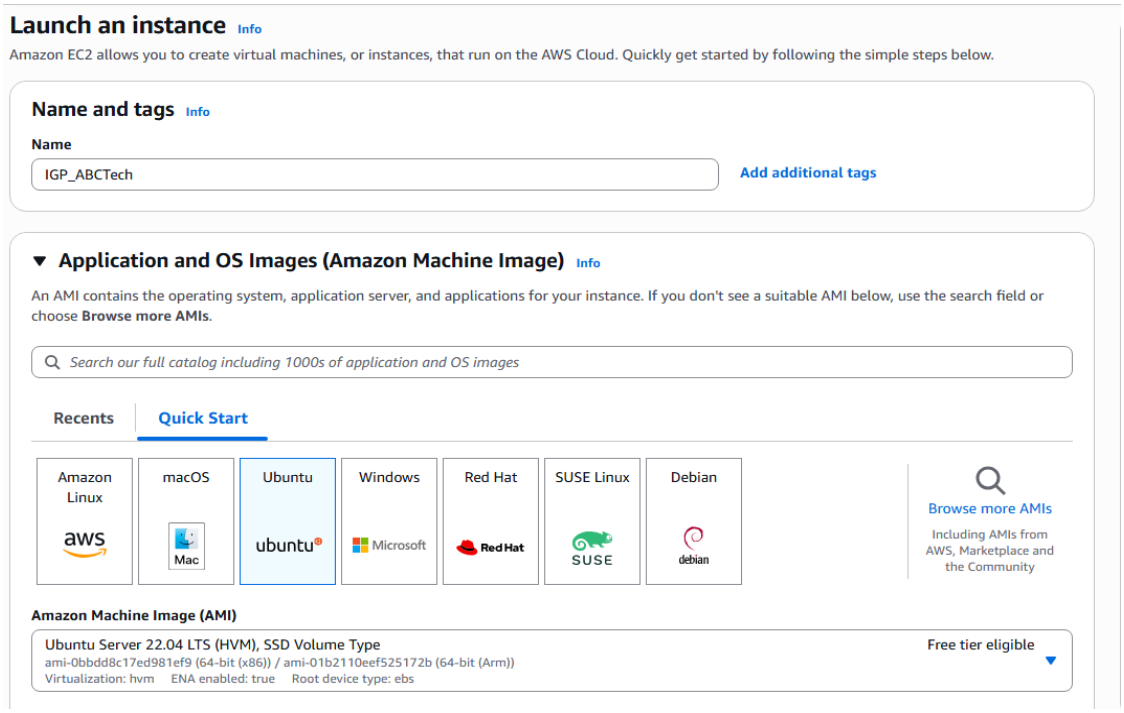


Figure 10: Keypair and Network Setups

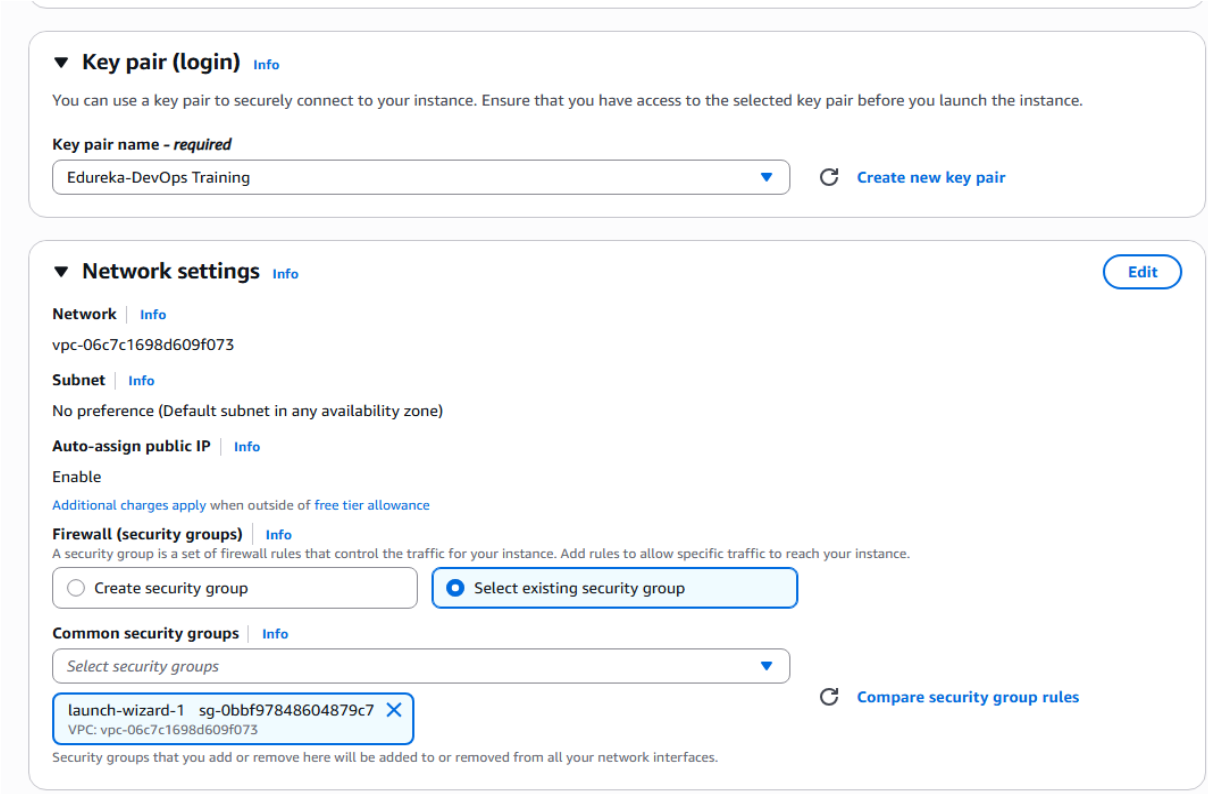


Figure 11: *8GB* Secondary Storage

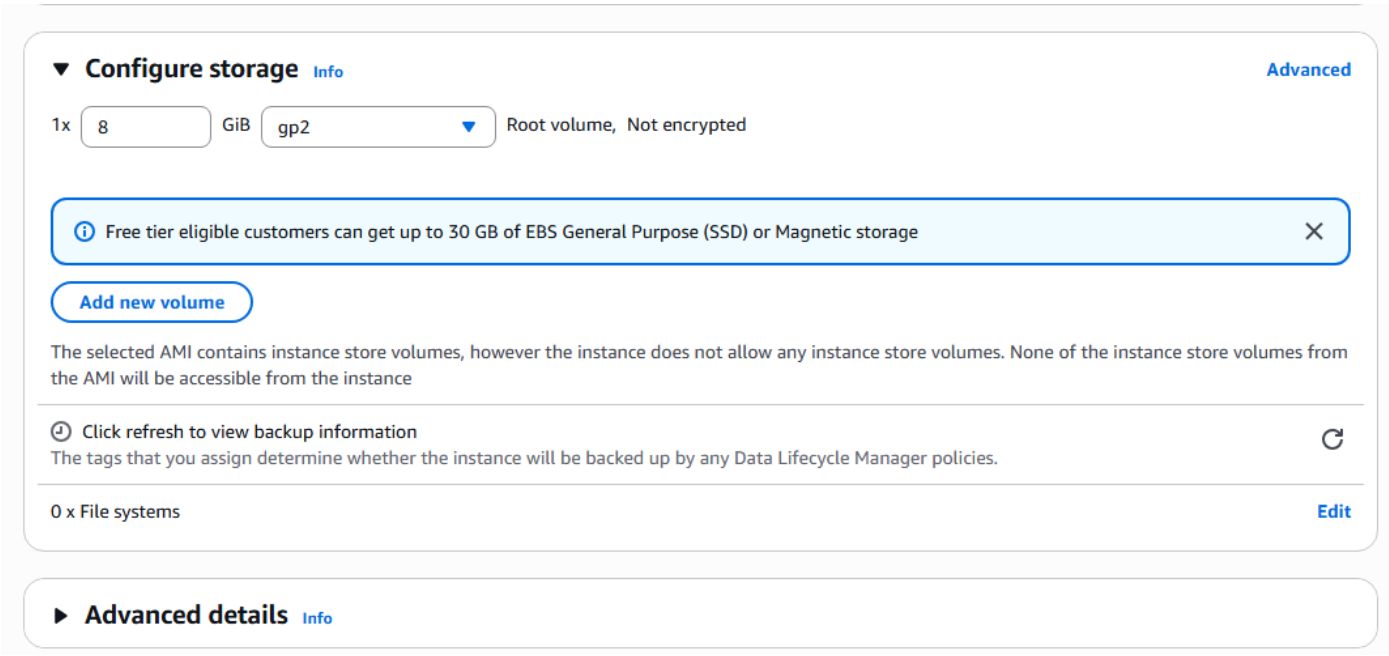
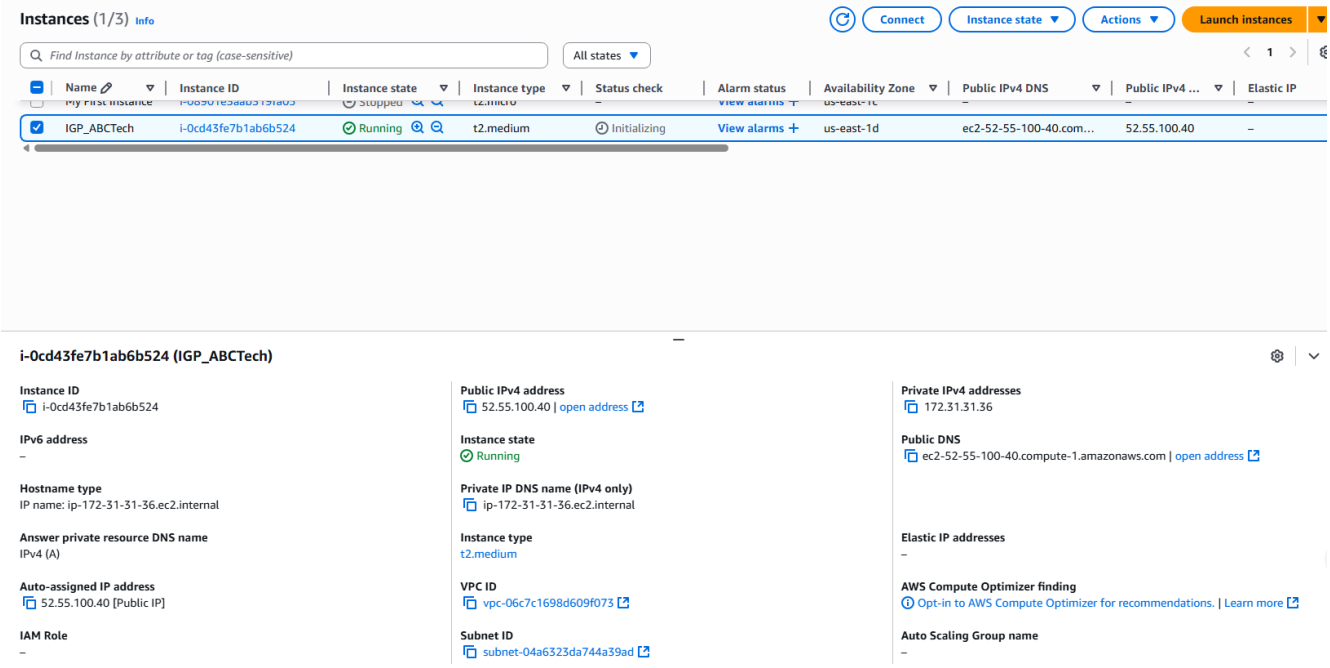


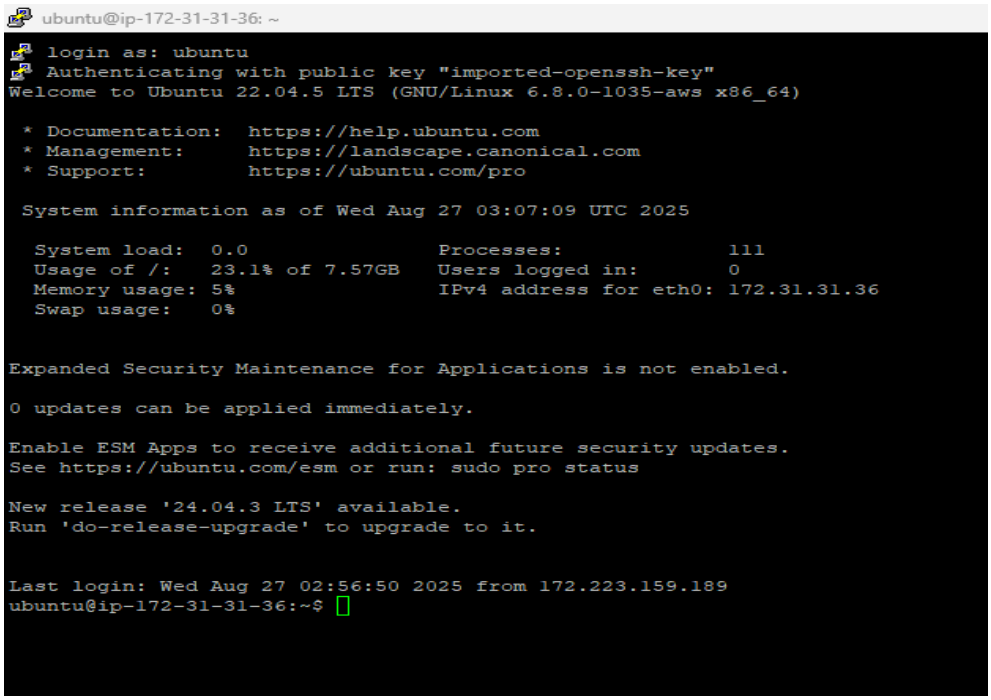
Figure 12: Launching the EC2 Instance



10.2.2 Access of the VM with PuTTY

Having set up and configured the VM, it was necessary to have access. PuTTY was installed and ensured all CLI commands were run using it. Figure Ubuntu user logged in to the VM.

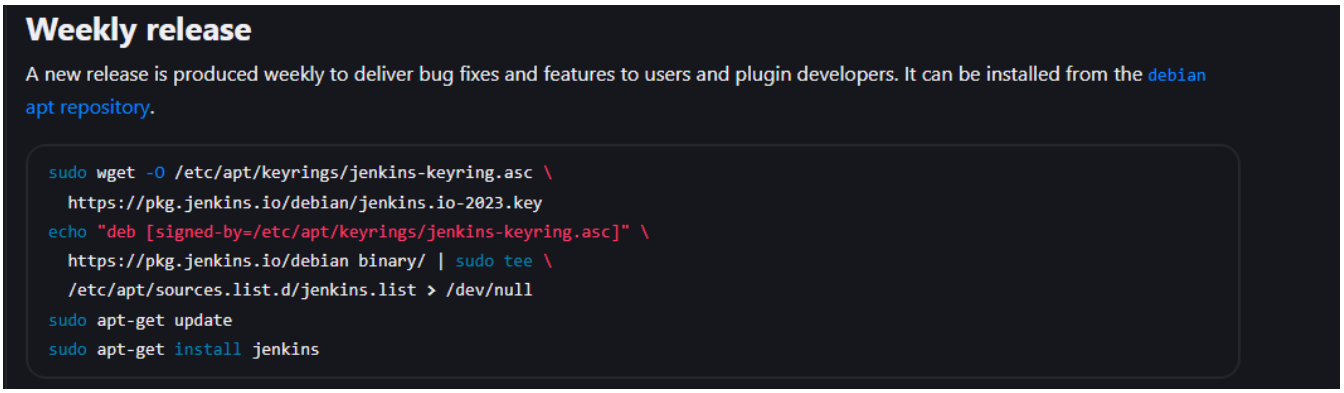
Figure 13*:* Access of the EC2 Instance Using PuTTY and Logged in as Ubuntu User.



10.2.3 Installation and Configuration of Jenkins

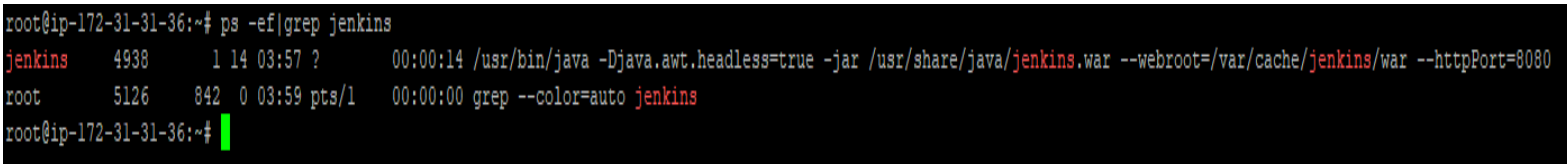
After the ability to access EC2 instance via PuTTY, the next stage involved was to install Jenkins on the VM. However, since Jenkins is written in Java language, there was prerequisite to install Java. Going to the official Jenkins installation webpage, commands were copied from this Jenkins webpage (URL: https://www.jenkins.io/doc/book/installing/linux/) to VM's CLI via PuTTY. Figure 14 shows Jenkins installation commands from the Jenkins website.

***Figure 14**:* Jenkins Installation Commands from Jenkins Website



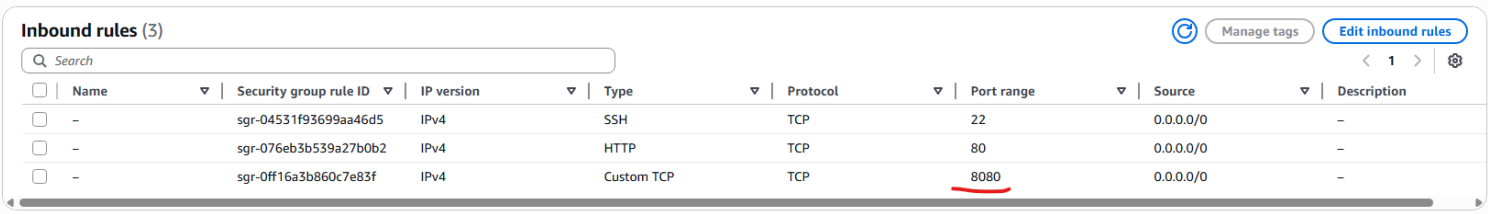
Logged as Ubuntu user, it was necessary to change to root user. To execute Jenkins installation commands, it was necessary to become a root user (>sudo su-), and commands above were used to install Jenkins. Figure 15 shows the screenshot to confirm Jenkins was successfully installed on the VM and was configured to be accessed on port 8080. It is important to note that when Jenkins is installed, Jenkins' user was also created to be able to issue command on the terminal.

Figure 15: Successful Jenkins Installation Confirmation



Since Jenkins was by default configured to run on TCP port 8080, this port had to be opened in the Security Group for inbound traffic to EC2 within AWS. Figure 16 shows the TCP port 8080 allowed for the inbound traffic enabling Jenkins to be accessed via the browser.

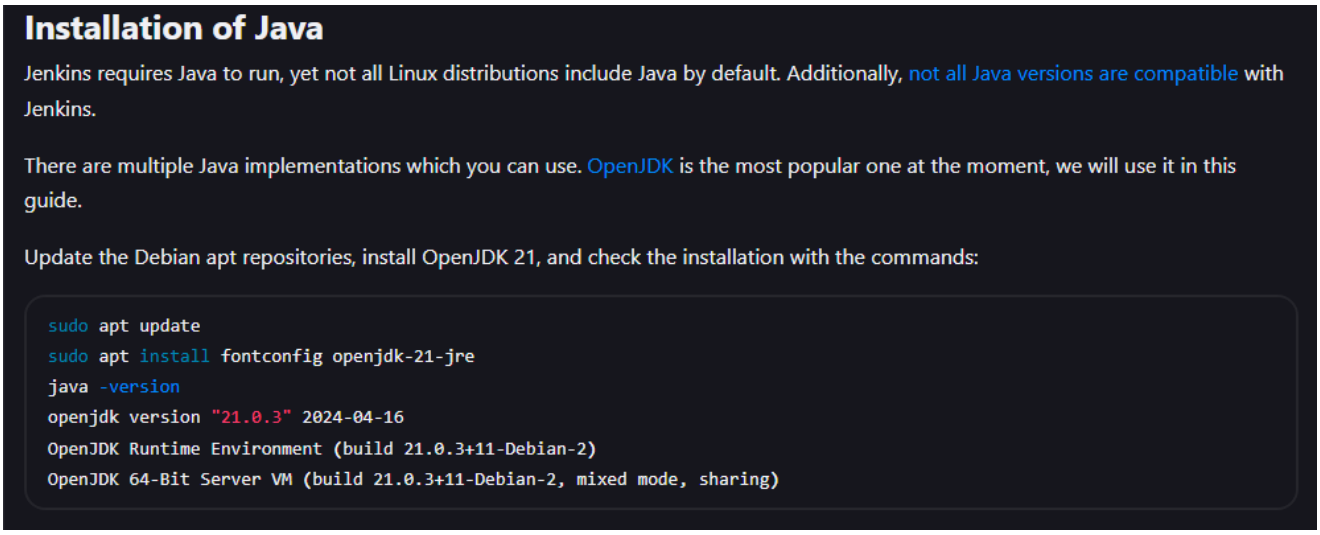
***Figure 16**:* TCP Port 8080 Allowed for Inbound Traffic to Allow Jenkins to be Accessed via the Browser



10.2.4 Installation of Java

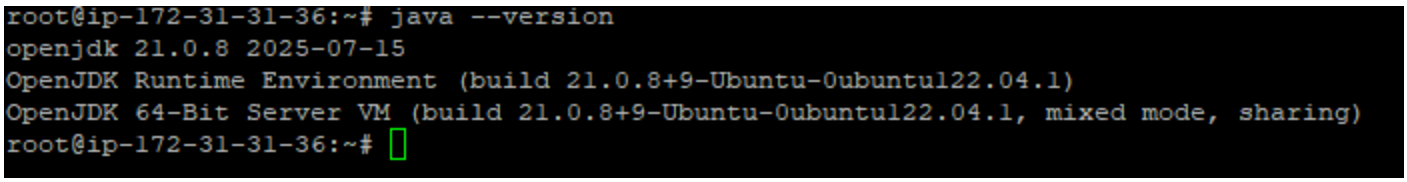
Having installed and configured Jenkins, the next step involved installation of Java. Using the same Jenkins URL: https://www.jenkins.io/doc/book/installing/linux/), commands were copied and pasted on the CLI of PuTTY. Figure 17 shows the commands used to install Java.

***Figure 17**:* Java Installation Commands from Jenkins Webpage.



To confirm that Java had been installed successfully, command (> java --version) was used. Figure 18 shows the screenshot of command and its output. Java 21.0 was confirmed as successfully installed.

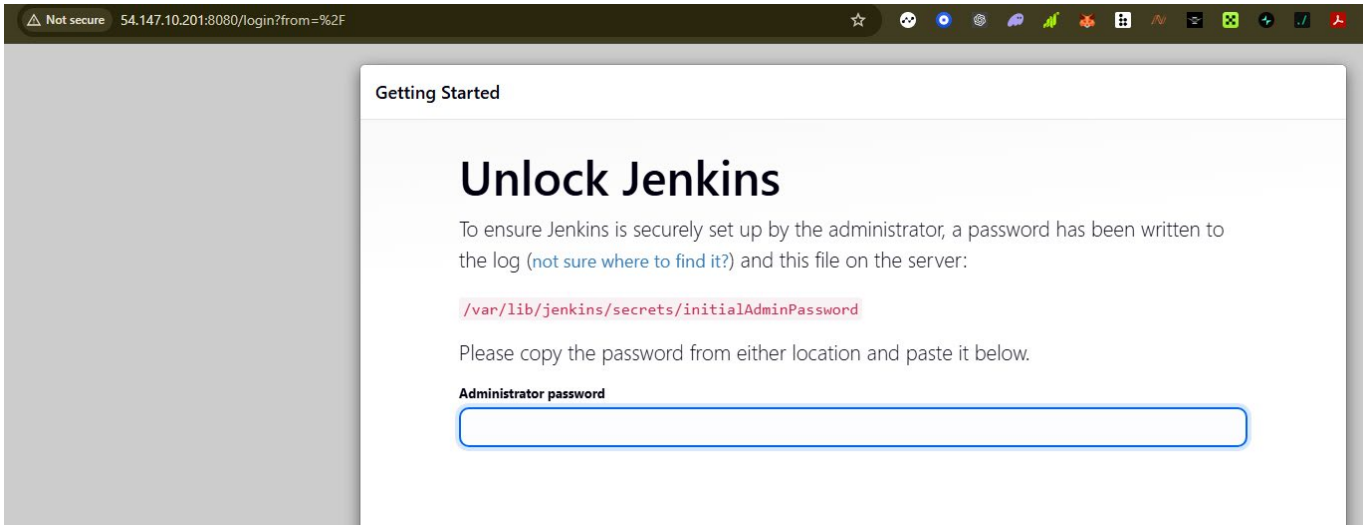
***Figure 18**:* Java 21.0 Version Confirmed as Installed.



10.2.5 Unlocking Jenkins

Having installed Jenkins and Java, the next step involved unlocking Jenkins since it would be first time to access it on the VM. The publicIP of the VM was 54.147.10.201. Jenkins was accessed on 54.147.10.201:8080. Accessing Jenkins for the first time required unlocking by creating *initialAdminPassword.* Figure 19 shows the webpage requiring unlocking Jenkins.

***Figure 19**:* Request for initialAdminPassword to Unlock Jenkins



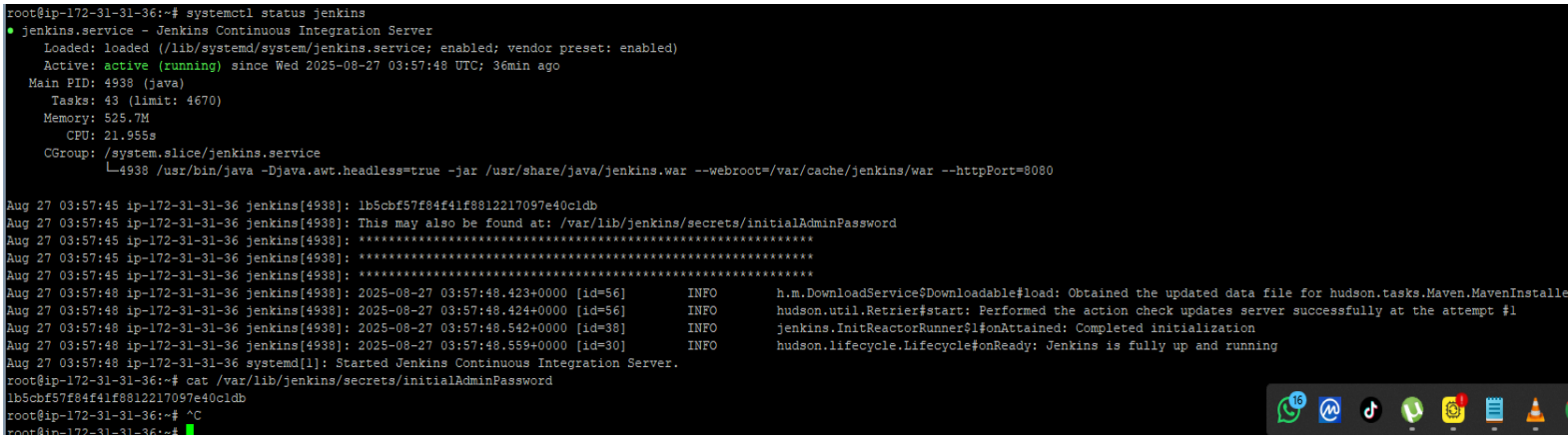
10.2.6 Creating initialAdminPassword

To create the initialAdminPassword the following command was used for the root user:

```
>cat /var/lib/Jenkins/secrets/initialAdminPassword
```

Execution of the above command provided the initialAdminPassword, which was copied and pasted in Jenkins. This unlocked Jenkins. Figure 20 shows the screenshot of the command and output.

***Figure 20**:* Creation of the initialAdminPassword

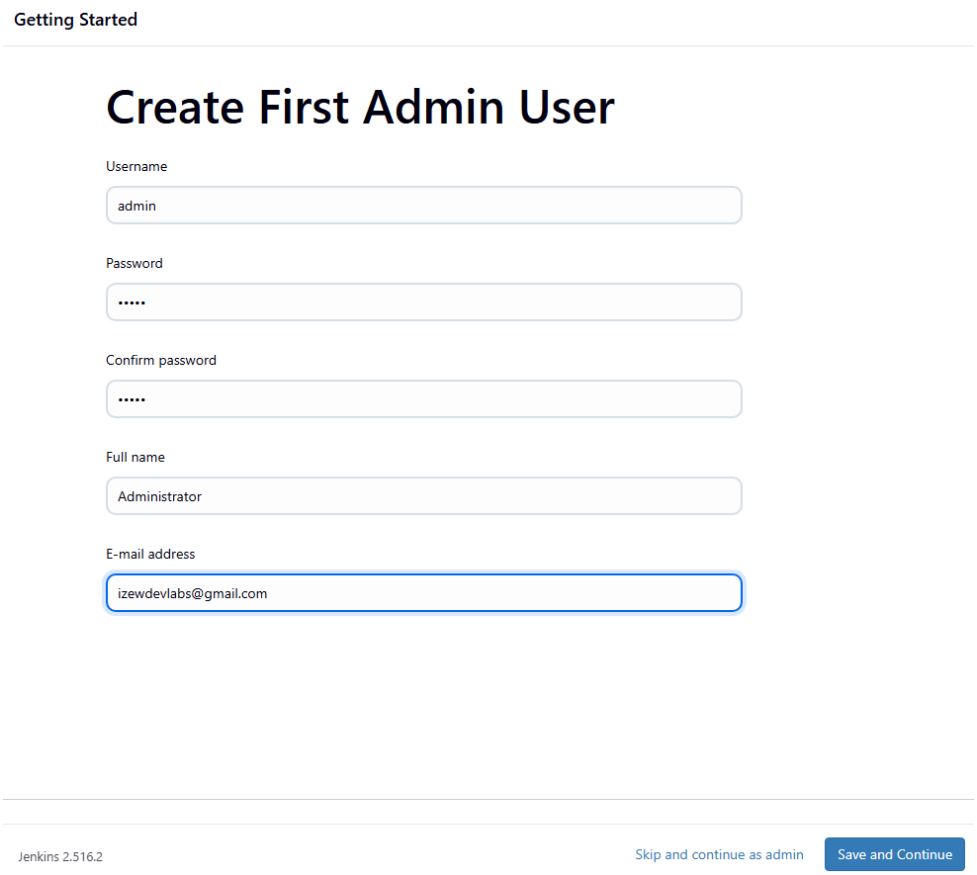


10.2.7 Creating First Admin User

Having unlocked Jenkins, it was now time to create first Admin user. The credentials for the first Admin user were filled in as per Figure 21.

.

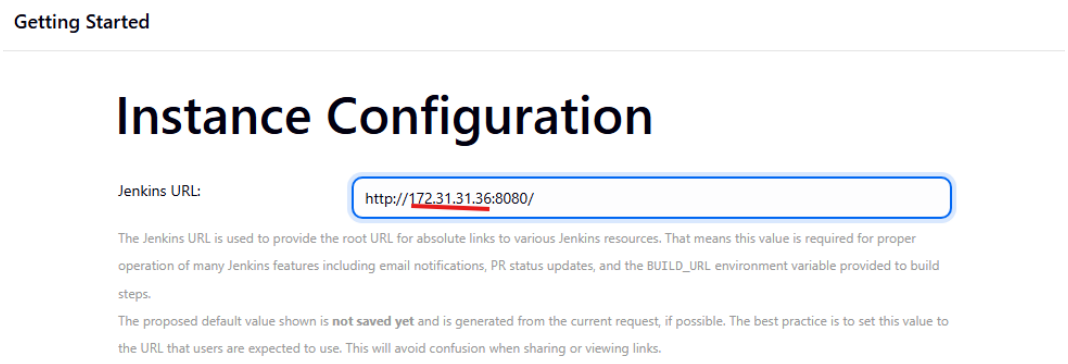
Figure 21:Creating first Admin user



10.2.8 Instance Configuration

The last step in configuring Jenkins involved replacing the external IP of the VM with internal IP. This is being done to ensure Jenkins and EC2 agents communicate securely and efficiently over AWS' private network, without exposing SSH connections to the public Internet. Figure shows the publicIP_vm:8080 (54.147.10.201:8080) replaced by internalIP_vm (172.31.31.36:8080). Figure 22 shows the replacement of Jenkins externalIP:8080 to internalIP:8080 in the configuration of the instance.

Figure 22:Replacing Jenkins URL from externalIP:8080 to internalIP:8080

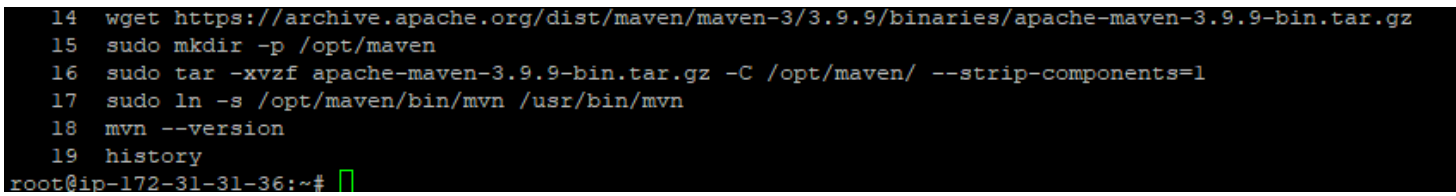


10.2.9 Installation of Maven on the IGP_ABCTech

Having installed Java, next step involved installation of Maven on the same VM (IGP_ABCTech) where Jenkins was installed. To create a pipeline job on Jenkins, there is a prerequisite to install Maven to compile, build and test artifacts. The following commands below were executed. Figure 23 shows the history of the commands executed to have Maven installed.

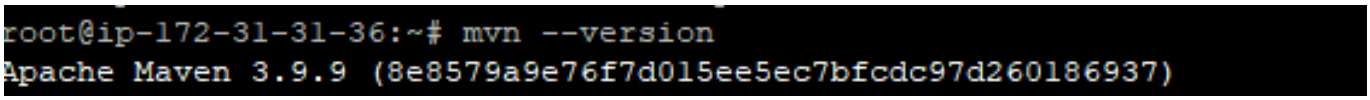
```
> wget https://archive.apache.org/dist/maven/maven-
  3/3.9.9/binaries/apache-maven-3.9.9-bin.tar.gz
> sudo mkdir -p /opt/maven
> sudo tar -xvzf apache-maven-3.9.9-bin.tar.gz -C /opt/maven/ --strip-
  components=1
> sudo ln -s /opt/maven/bin/mvn /usr/bin/mvn
> mvn --version
```

Figure 23: History of Maven Installation Commands



Having executed the Maven installation commands above, Maven version confirmation command (`> mvm –version`) revealed Apache Maven 3.9.9. Figure 24 shows the confirmation command. Now, with this Maven installation, Jenkins would be able to communicate with Maven that the former (Jenkins) is available.

***Figure 24**:* Apache Maven 3.9.9 Version Confirmation



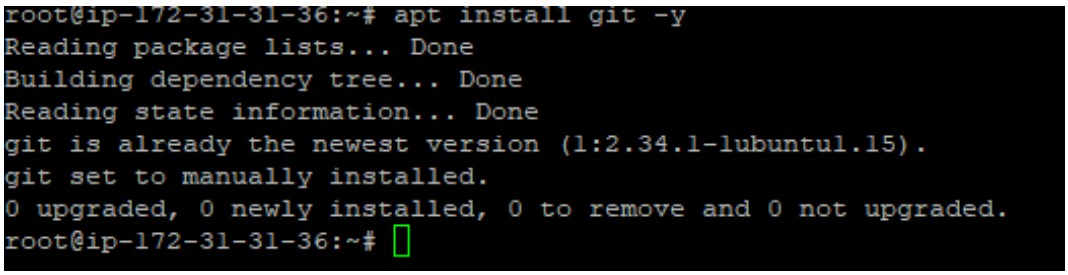
*10.2.10*Installation of Git on the IGP_ABCTech

Having installed Maven that would allow the pipeline job to be created to compile, test and build the artifact, it was a prerequisite to install git on the *IGP_Tech VM* to access the codebase on GitHub. The following commands were used:

```
> apt install git -y
```

Figure 25 shows the git installation command and its output.

***Figure 25**:* Git Installation Command and Output



Having installed both Maven and Git, it was necessary to configure Jenkins so that it knows where Java, Maven and git are installed. This was done through Global Tool Configuration by accessing Managing Jenkins. Using this tool home directory for Java (JAVA_HOME), Maven (MAVEN_HOME) and git's URL: (https://github.com/Izewdevlabs/igpaug26) were added in Jenkins. Jenkins home directory was /var/lib/Jenkins/. Figure 26 shows the Jenkins Home directory and files that reside in this home directory.

***Figure 26**:* Jenkins Home Directory and its Associated Files

```
root@ip-172-31-31-36:/var/lib/jenkins# ls -ltr
total 84
-rw-r--r--  1 jenkins jenkins    64 Aug 27 03:57 secret.key
-rw-r--r--  1 jenkins jenkins     0 Aug 27 03:57 secret.key.not-so-secret
drwxr-xr-x  2 jenkins jenkins  4096 Aug 27 03:57 jobs
-rw-r--r--  1 jenkins jenkins   171 Aug 27 03:57 jenkins.telemetry.Correlator.xml
drwxr-xr-x  2 jenkins jenkins  4096 Aug 27 03:57 userContent
drwxr-xr-x 89 jenkins jenkins 12288 Aug 27 04:38 plugins
drwxr-xr-x  2 jenkins jenkins  4096 Aug 27 04:39 updates
-rw-------  1 jenkins jenkins  1680 Aug 27 04:39 identity.key.enc
-rw-r--r--  1 jenkins jenkins   370 Aug 27 04:39 hudson.plugins.git.GitTool.xml
drwxr-xr-x  2 jenkins jenkins  4096 Aug 27 04:39 logs
drwxr-xr-x  3 jenkins jenkins  4096 Aug 27 04:42 users
-rw-r--r--  1 jenkins jenkins   182 Aug 27 04:47 jenkins.model.JenkinsLocationConfiguration.xml
-rw-r--r--  1 jenkins jenkins     7 Aug 27 04:47 jenkins.install.UpgradeWizard.state
-rw-r--r--  1 jenkins jenkins   258 Aug 27 04:56 queue.xml.bak
-rw-r--r--  1 jenkins jenkins   156 Aug 28 02:37 hudson.model.UpdateCenter.xml
-rw-r--r--  1 jenkins jenkins  1037 Aug 28 02:37 nodeMonitors.xml
-rw-r--r--  1 jenkins jenkins     7 Aug 28 02:37 jenkins.install.InstallUtil.lastExecVersion
-rw-r--r--  1 jenkins jenkins  1660 Aug 28 02:37 config.xml
drwx------  2 jenkins jenkins  4096 Aug 28 03:09 secrets
-rw-r--r--  1 jenkins jenkins  1267 Aug 28 03:36 hudson.plugins.emailext.ExtendedEmailPublisher.xml
root@ip-172-31-31-36:/var/lib/jenkins#
```

10.2.11 Installation of Maven Plugins in Jenkins

Before creating any pipeline job within Jenkins, it was necessary to install plugins that could facilitate artifact's compile, test and build tasks. For instance, for Maven to work, there is a need for pom.xml file, in which all the requirements are specified by the developers. Inspection of the pom.xml file revealed maven plugins that needed to be installed. These comprised mvn JUnit and mvn jacoco plugins. In addition, other plugins not specified in the pom.xml file of the project, but useful comprised the following:

- *build pipeline plugin*
- *warning plugin*
- *stage view plugin to allow UI view of the results of the compile, test and package*

10.2.12 Creation of First CI Job- ABCTechnologies- CI

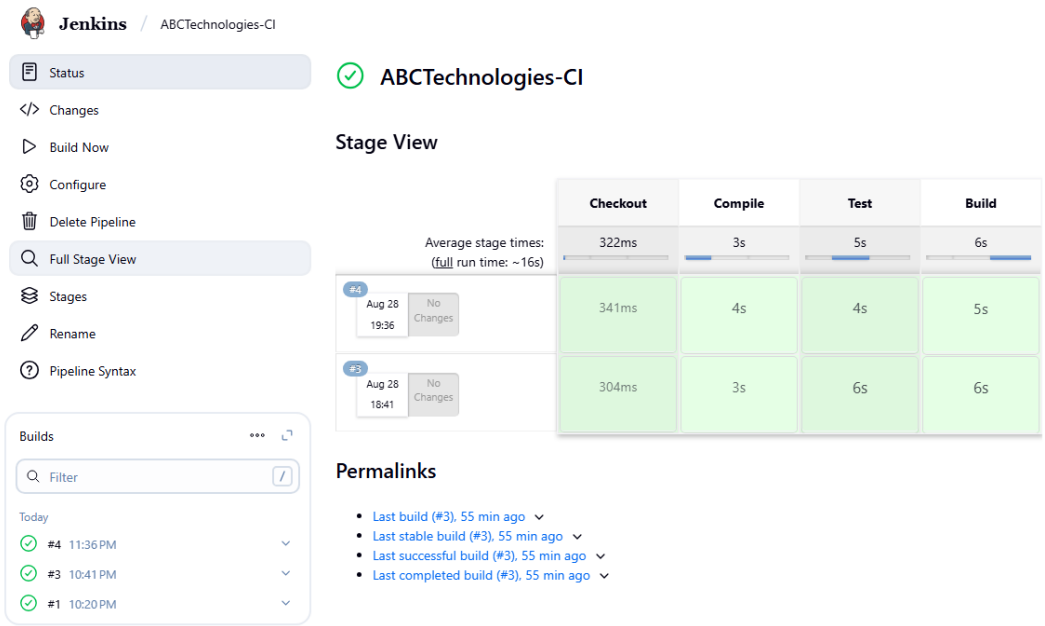
Having installed the necessary plugins, it was worth testing the continuous integration (CI) first to see if all was in good order. The first pipeline CI job involved writing the jenkinsfile written in Groovy language. The following CI script was added to the *ABCTechnologies- CI job*

```
pipeline
{
      agent any
      stages
      {
            stage('Checkout')
            {
```

```
                        steps
                        {
                                git
'https://github.com/Izewdevlabs/igpaug26.git'
                        }
                }

                stage('Compile')
        {
                        steps
                        {
                                sh 'mvn compile'
                        }
                }

                stage('Test')
                {
                        steps
                        {
                                sh 'mvn test'
                        }
                }

                stage('Build')
                {
                        steps
                        {
                                sh 'mvn package'
                        }
                }
        }
}
```

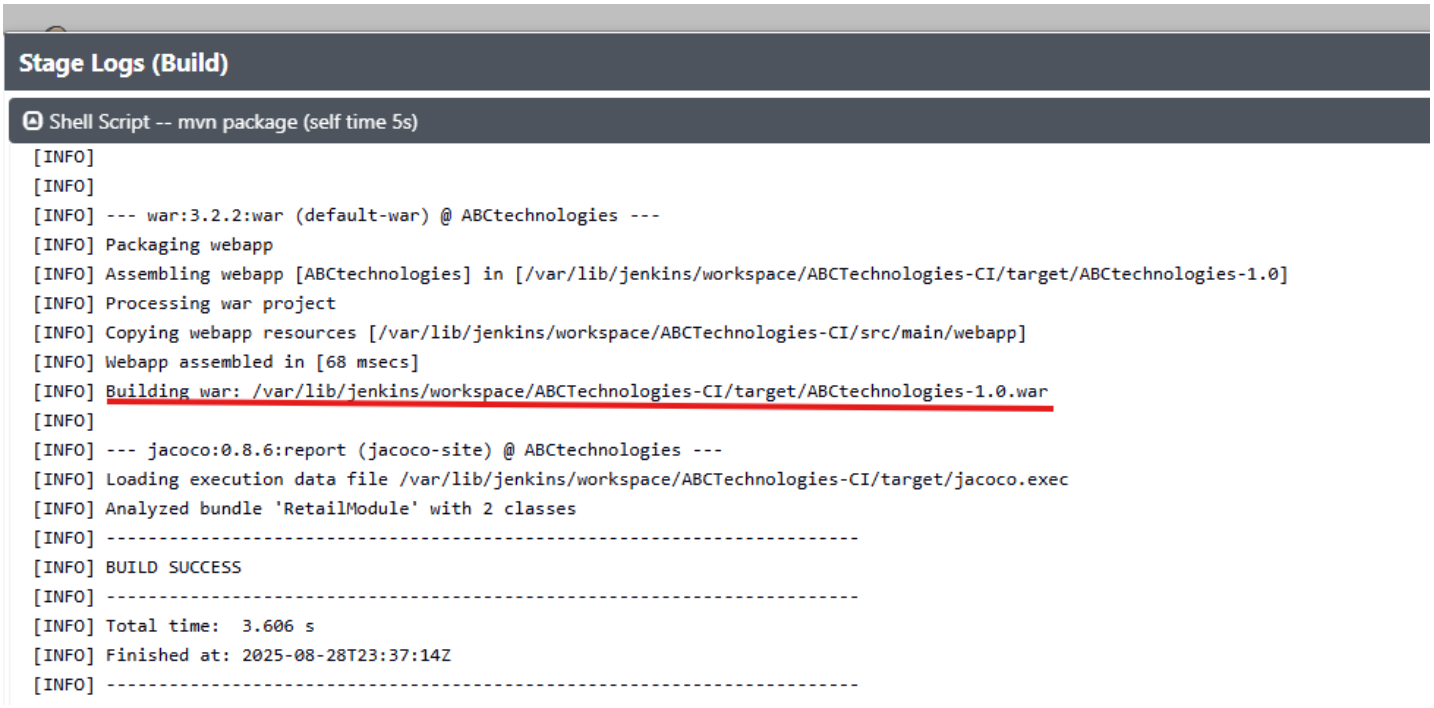
Building the above simple CI pipeline job yielded success, evidenced by the output as per stage view within Jenkins shown in Figure 27.

Figure 27: Simple *ABCTechnologies- CI* Job Builds #3 & #4 Successful Results



By inspecting the build output logs in Figure 27 below , the artifact web app was downloaded in: */var/lib/Jenkins/workspace/ABCTechnologies-CI/target/ABCtechnolgies-1.0.war*

Figure 28: Build logs of the *ABCTechnologies- CI* Job



This marked the end of the integration and building stages of the pipeline, confirming that it was working properly . The next step was to go into deployment of the artifact using Docker to Docker hub, which led to Task 3.

10.3 Deployment Using Docker Container

Task 3: Write a Docker file Create an Image and container on docker host. Integrate docker host with Jenkins. Create CI/CD job on Jenkins to build and deploy on a container

- ***Enhance the packagejob created in step 1 of task 2 to create a docker image***
- ***In the docker image add code to move the war file to tomcat server and build the image***

To be ready to create CI/CD pipeline job on Jenkins, five prerequisite steps had to be followed that comprised the following:

Step1: Installation of the docker on the same VM where Jenkins was installed

Step 2: Giving privileges to Jenkins user not run docker commands

Step 3: Store the dockerhub credentials in Jenkins global credentials that will be referred using some

ID (mydockerhubcred)

Step 4: Installation of docker pipeline plugin on Jenkins to pass credentials ID (mydockerhubcred)

Step 5: Writing of the dockerfile and push it to GitHub along with source code

The above steps were followed as follows:

10.3.1 Step 1: Installation of Docker on IGP_ABCTech VM

Having built the ABTechnologies-1.0.war artifact, the next step would be to create a Docker image and have it pushed onto Dockehub. The first step involved installation of Docker `(> apt install docker.io -y )` on to the IGP_ABCTech VM where Jenkins was installed. The installation of Docker ensured that the default ownership on this file was the root user and the docker group. It was necessary to change ownership of the file from docker group to Jenkins, so that Jenkins users should be able to run Docker commands. This was done by this command:

```
> sudo chown root:jenkins /var/run/docker.sock
```

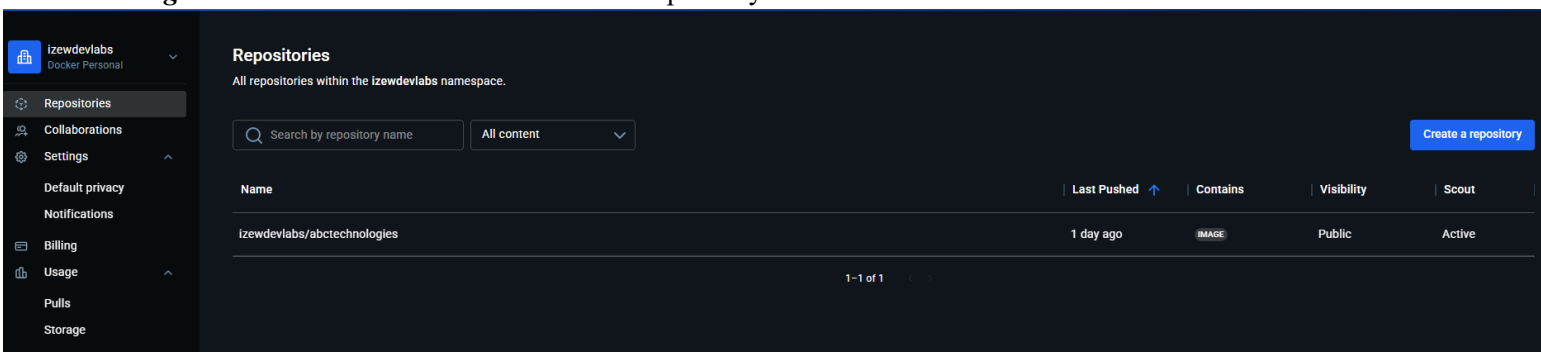
10.3.2 Step 2: Giving Privileges to Jenkins User to Run Docker Commands

To allow Jenkins user to run docker commands, it was required to store the Dockerhub of the repository (URL: https://hub.docker.com/repositories/izewdevlabs) credentials in Jenkins.

10.3.3 Step 3: Store the Dockerhub Credentials in Some ID (mydockerhubcred)

This was done in Global Tool Configuration within Managing Jenkins. These credentials would be referred to using an id *(mydockerhubcred).* Figure 29 shows the screenshot of the Dockerhub Account, showing one repository for the project.

Figure 29: Dockerhub Account with One Repository



Once the Dockerhub credentials had been stored in Jenkins, it would be possible for Jenkins' user to log into the Dockerhub account to push an image.

10.3.4 Step 4: Installation of Docker Pipeline Plugin to Pass Credentials

Before creating *ABCTechnologies- CI-CD* pipeline job, it was important to install docker pipeline plugin on Jenkins to pass the credentials Id *(mydockerhubcred)* to Docker. This would ensure

Jenkins' user is able to securely log into Dockerhub account without comprising security. This was done with Managing Jenkins and searching for it among the available plugins

10.3.5 Step 5: Writing a Dockerfile and Pushing to GitHub Repository

To create an image and push it to dockerhub, the dockerfile needed to be written and pushed to GitHub along with the source code. Firstly, the contents of the dockerfile were as follows:

```
FROM iamdevopstrainer/tomcat:base
COPY ABCtechnologies-1.0.war /usr/local/tomcat/webapps/
CMD ["catalina.sh", "run"]
```

This docker file was first added to the local repository, allowed to be tracked and pushed to remotely to GitHub. Figure 30 shows the dockerfile added to the local repository.

Figure 30: Adding Dockerfile to Local Repository

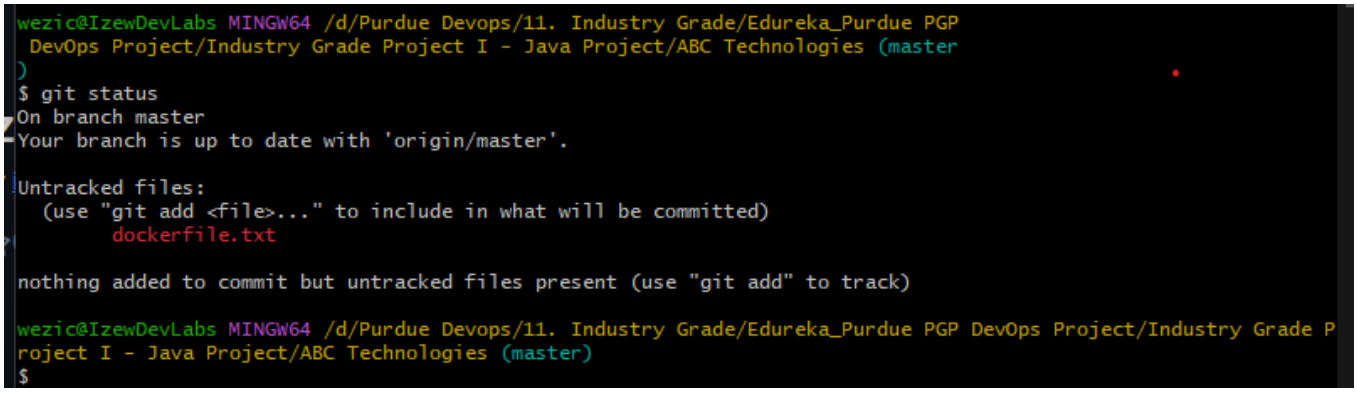
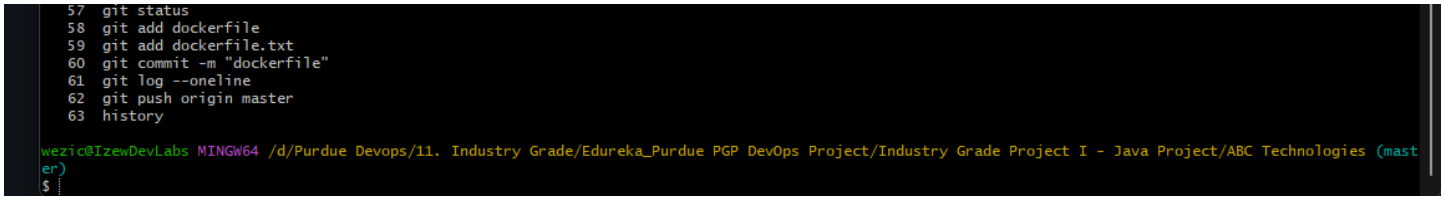


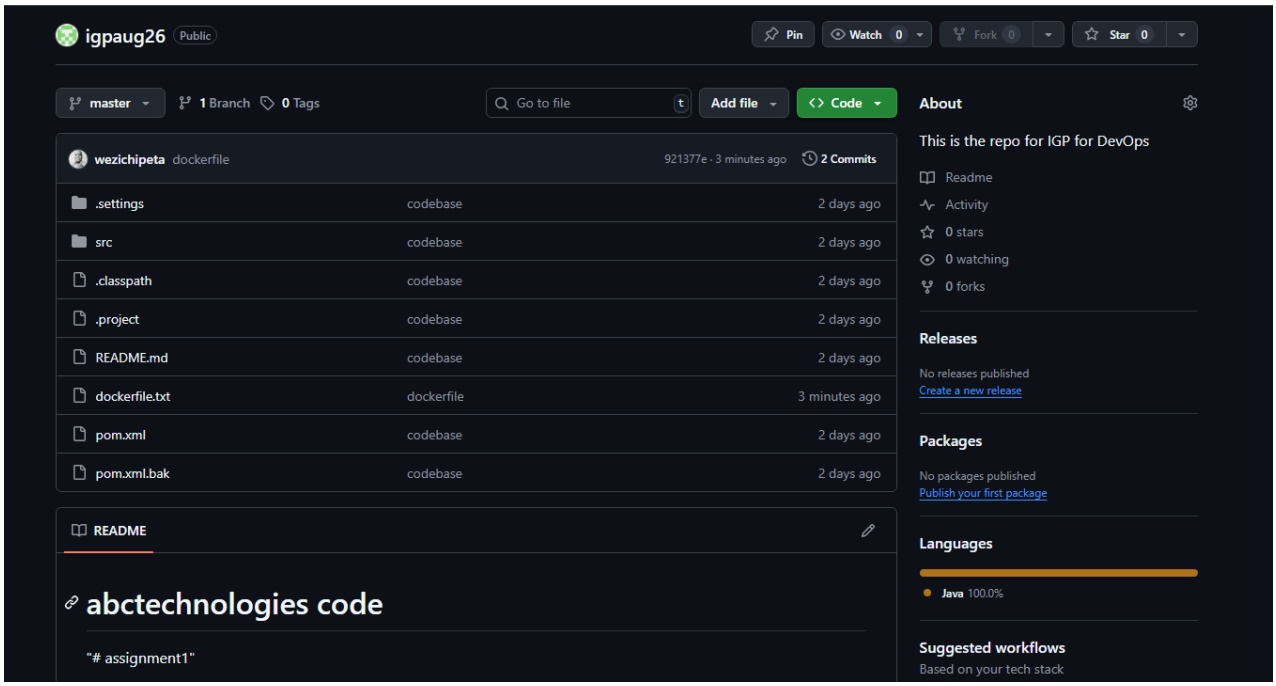
Figure 31 shows the history of commands used to have the dockerfile pushed to the remote repository.

Figure 31: History of commands to have the Dockerfile Pushed to the Remote Repository



Having pushed the dockerfile in the remote repository, Figure 32 shows the snapshot of the GitHub repository that includes the dockerfile.

Figure 32: History of Commands to have the Dockerfile Pushed to the Remote Repository



10.3.6 ABCTechnologies CI-CD Pipeline and Deployment to Docker

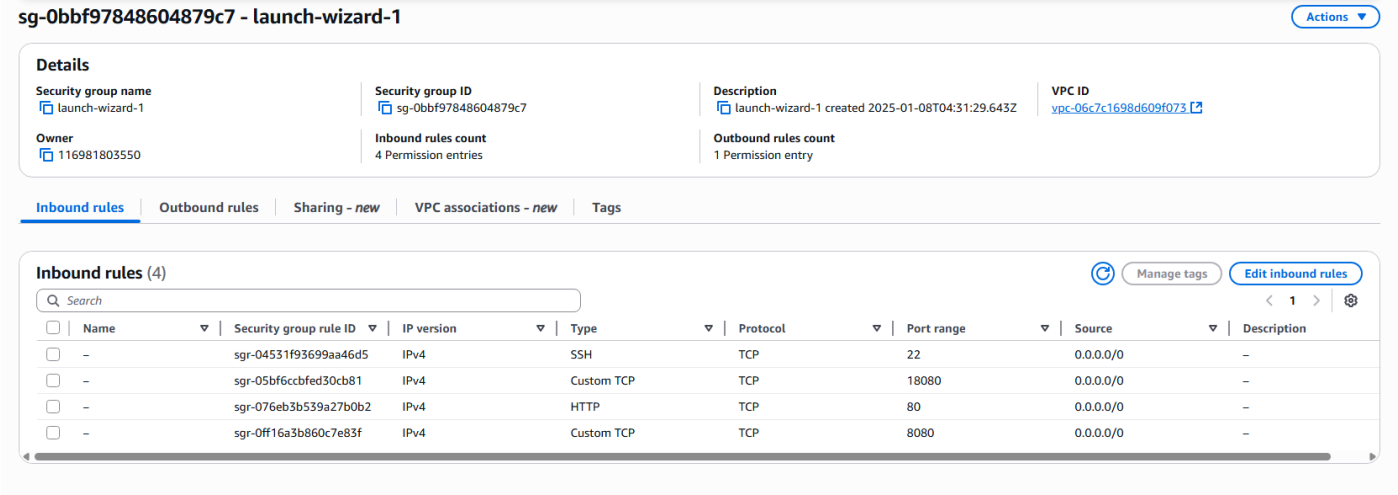
After going through the five steps above, the CI/CD pipeline job could now be created with Jenkins. The CI/CD pipeline job called *" ABCTechnologies CI-CD"* was created with the following script.

```
ABCTechnologies CI-CD Script within Jenkins
Deploy to a Docker Container
pipeline {
  agent any
  environment {
    IMAGE_LOCAL  = "abctechnologies"
    IMAGE_REMOTE = "izewdevlabs/abctechnologies"
    TAG          = "${BUILD_NUMBER}"
  }
  stages {
    stage('Checkout') { steps { git
   'https://github.com/Izewdevlabs/igpaug26.git' } }
    stage('Compile')  { steps { sh 'mvn -B compile' } }
    stage('Test')     { steps { sh 'mvn -B test' } }
    stage('Build WAR'){ steps { sh 'mvn -B -DskipTests package' } }

    stage('Build Docker Image') {
      steps {
        sh "docker build -t ${IMAGE_LOCAL}:${TAG} ."
        sh "docker tag ${IMAGE_LOCAL}:${TAG} ${IMAGE_REMOTE}:${TAG}"
      }
    }

    stage('Push Docker Image') {
  steps {
```

```
          withCredentials([usernamePassword(credentialsId:
'mydockerhubcred',
                                            usernameVariable: 'DH_USER',
                                            passwordVariable: 'DH_PASS')]) {
            sh '''
              set -e
              echo "$DH_PASS" | docker login -u "$DH_USER" --password-stdin
              docker push izewdevlabs/abctechnologies:${BUILD_NUMBER}
            '''
          }
        }
      }

         stage('Deploy as container') {
        steps {
          sh """
            set -e
            docker rm -f abctechnologies >/dev/null 2>&1 || true
            docker ps --filter 'publish=8080' -q | xargs -r docker rm -f ||
true

            # Optional: pull from Hub to ensure the right tag is present
            docker pull ${env.IMAGE_REMOTE}:${env.TAG} || true

            # Run the container
            docker run -d --name abctechnologies -p 18080:8080
izewdevlabs/abctechnologies:${BUILD_NUMBER}

            docker ps --filter 'name=abctechnologies'
          """
              }
          }
        }
      }
```

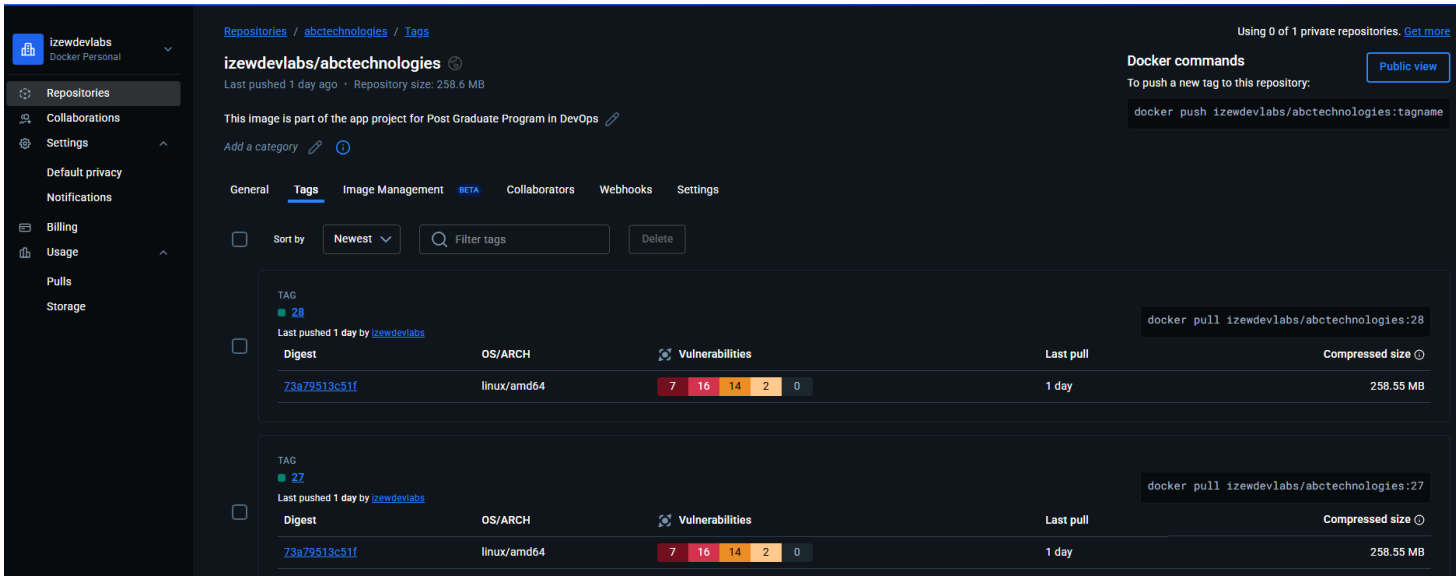
The above script was the final one after some debugging because of docker failing to bind 0.0.0.0:8080. This was solved by mapping Apache Tomcat's 8080 inside to another host port 18080. This was a hard coded approach and worked. Port 18080 had to be opened to allow inbound traffic within Security Group of the VM in AWS. Figure 33 shows the screenshot of the port 18080 open.

Figure 33: Port 18080 Opened for Apache Tomcat in the VM's Security Group with AWS



In order to confirm that the docker image was able to be pushed to the Dockerhub (https://hub.docker.com/repository/docker/izewdevlabs/abctechnologies/general) for each build. Figure 33 shows docker images pushed and deployed in a container.

Figure 34:Snapshots of Docker Image Pushed Dockerhub



To confirm that Apache Tomcat had been successfully installed and that the artifact was able to be viewed, it was possible to access the browser with the following VM's address: *PublicIP_vm:port number/artifactName -------><u>13.218.96.178:18080/ABCtechnologies-1.0/</u>.* Figure 35 shows the artifact (webapp) view on the browser.

Figure 35: Webapp View on the Browser

The above step marked the end of Task 3 and therefore the need to move to Task 4. According to the class session on 23 August 2025, Task 4 would require deployment to Kubernetes cluster (EKS/GKE) depending on public cloud being used. Integrating Docker host with Ansible, writing ansible playbook and integrating Ansible with Jenkins were optional and not emphasized. However, the deployment to Kubernetes was a must. Therefore, Task 4 would comprise this deployment of the artifact to Kubernetes.

10.4 Deployment to Kubernetes

The deployment to Kubernetes was part of Task 4 with steps which would enable deployment of a k8s EKS cluster with two worker nodes in AWS. The modified CI/CD pipeline job with associated script would ensure that the pipeline builds WAR file with Maven, packages into Docker image and pushes to Dockerhub; deploys automatically to Amazon EKS; and accessible publicly via AWS ELB.

Task 4: Deployment to Kubernetes with the following steps.

Step 1: Update Packages and Install Dependencies

Step 2: Install AWS CLI

Step 3: Install kubectl

Step 4: Install eksctl

Step 5: Configure AWS CLI on the EC2

Step 6: Create an EKS cluster with 2 worker nodes

Step 7: Writing deployment.yaml, service.yaml, ingress.yaml, namespace.yaml and hpa.yaml manifest files

Step 8: Pipeline Script with Deployment to Kubernetes

Step 9: Getting the Service ELB URL

Step 10: Testing the App

10.4.1 Step 1: Update Packages and Install Dependencies

```
>sudo apt update && sudo apt -y upgrade
>sudo apt -y install unzip curl git jq apt-transport-https ca-
 certificates gnupg lsb-release
```

10.4.2 Step 2: Install AWS CLI v2

```
>curl -sSL "https://awscli.amazonaws.com/awscli-exe-linux-x86_64.zip"
-o /tmp/awscliv2.zip
>unzip -q /tmp/awscliv2.zip -d /tmp
>sudo /tmp/aws/install
# Verify
>aws --version
```

Figure 36 below shows the output of above commands:

Figure 36: Commands for installation of AWS CLI

```
root@ip-172-31-31-36:~# curl -sSL "https://awscli.amazonaws.com/awscli-exe-linux
-x86_64.zip" -o /tmp/awscliv2.zip
root@ip-172-31-31-36:~# unzip -q /tmp/awscliv2.zip -d /tmp
root@ip-172-31-31-36:~# sudo /tmp/aws/install
You can now run: /usr/local/bin/aws --version
root@ip-172-31-31-36:~# aws --version
aws-cli/2.28.21 Python/3.13.7 Linux/6.8.0-1035-aws exe/x86_64.ubuntu.22
root@ip-172-31-31-36:~#
```

10.4.3 Step 3: Install kubectl

```
>K_VER=$(curl -sL https://dl.k8s.io/release/stable.txt)
>curl -LO "https://dl.k8s.io/release/${K_VER}/bin/linux/amd64/kubectl"
>chmod +x kubectl
>sudo mv kubectl /usr/local/bin/
# Verify
>kubectl version –client
```

Figure 37 below shows the output of above commands:

Figure 37: Install kubectl Command

```
root@ip-172-31-31-36:~# K_VER=$(curl -sL https://dl.k8s.io/release/stable.txt)
root@ip-172-31-31-36:~# curl -LO "https://dl.k8s.io/release/${K_VER}/bin/linux/amd64/kubectl"
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   138  100   138    0     0   1345      0 --:--:-- --:--:-- --:--:--  1352
100 57.7M  100 57.7M    0     0  78.2M      0 --:--:-- --:--:-- --:--:--  114M
root@ip-172-31-31-36:~# chmod +x kubectl
root@ip-172-31-31-36:~# sudo mv kubectl /usr/local/bin/
root@ip-172-31-31-36:~# kubectl version --client
Client Version: v1.34.0
Kustomize Version: v5.7.1
root@ip-172-31-31-36:~#
```

10.4.4 Step 4: Install eksctl

```
>curl -sSL "https://github.com/eksctl-
io/eksctl/releases/latest/download/eksctl_Linux_amd64.tar.gz" \
  | sudo tar -xz -C /usr/local/bin eksctl
# Verify
>eksctl version
```

Figure 38 below shows the output of above commands:

Figure 38: Install ekctl Command

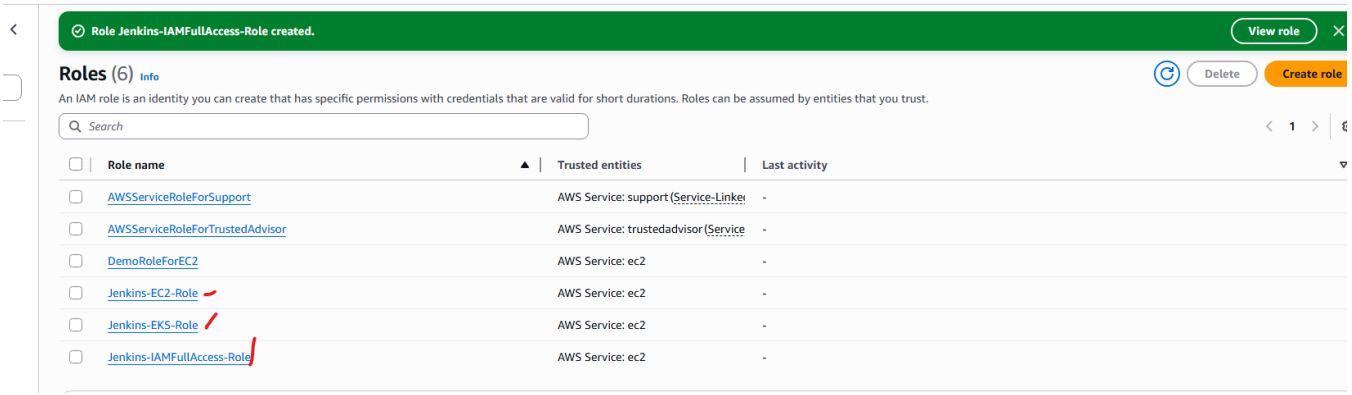
```
root@ip-172-31-31-36:~# curl -sSL "https://github.com/eksctl-io/eksctl/releases/latest/download/eksctl_Linux_amd64.tar.gz" \
  | sudo tar -xz -C /usr/local/bin eksctl

# Verify
eksctl version
0.214.0
root@ip-172-31-31-36:~#
```

10.4.5 Step 5: Configure AWS CLI on the EC2

```
>aws configure
```

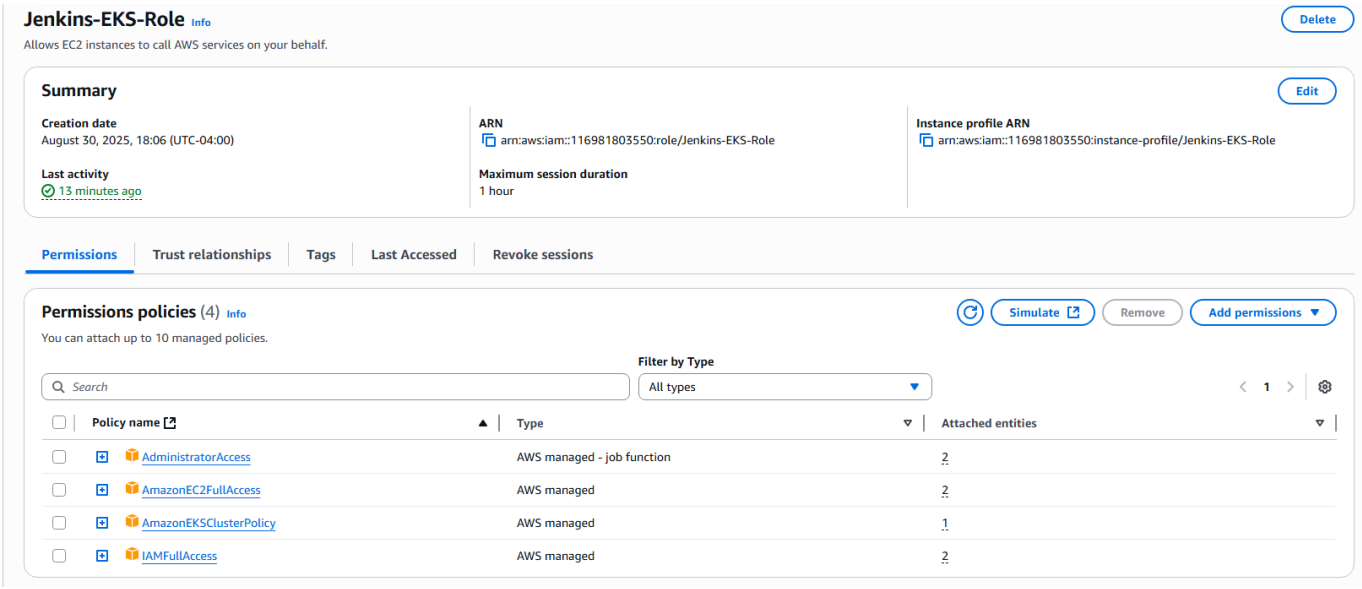
Jenkins- EKS role had to be created and attached to the EC2 instance. Figure 39 shows the Jenkins-EKS Role created that would need to be attached to the EC2 instance.

Figure 39: Created Jenkins-EKS Role



With the Jenkins-EKS Role created, permission policies had to be assigned. Figure 40 shows policies such as *AdministratorAccess*, *AmazonEC2FullAccess*, *AmazonEKSClusterPolicy* & *IAMFullAccess.*

Figure 40: Permission policies attached to Jenkins-EKS Role



Having created these permission policies, the commands below shown were able to be executed by copying information from the Jenkins-EKS Role within AWS. Figure 41 shows the screenshot of the commands and associated outputs.

Figure 41: AWS CLI Configuration on the EC2

```
root@ip-172-31-31-36:~# sed -i '/aws_access_key_id/d;/aws_secret_access_key/d' ~/.aws/credentials 2>/dev/null || true
root@ip-172-31-31-36:~# aws configure set region us-east-1
root@ip-172-31-31-36:~# aws configure set output json
root@ip-172-31-31-36:~# aws sts get-caller-identity
{
    "UserId": "AROARWPFIVIPLLT35EYA4:i-0cd43fe7blab6b524",
    "Account": "116981803550",
    "Arn": "arn:aws:sts::116981803550:assumed-role/Jenkins-EKS-Role/i-0cd43fe7blab6b524"
}
```

10.4.6 Step 6: Create an EKS Cluster with 2 Worker Nodes

To create an EKS cluster with 2 worker nodes, the following commands were used:

```
eksctl create cluster \
  --name abctech-eks \
  --region us-east-1 \
  --version 1.29 \
  --nodegroup-name ng-general \
  --node-type t3.medium \
  --nodes 2 \
  --nodes-min 2 \
  --nodes-max 4
```

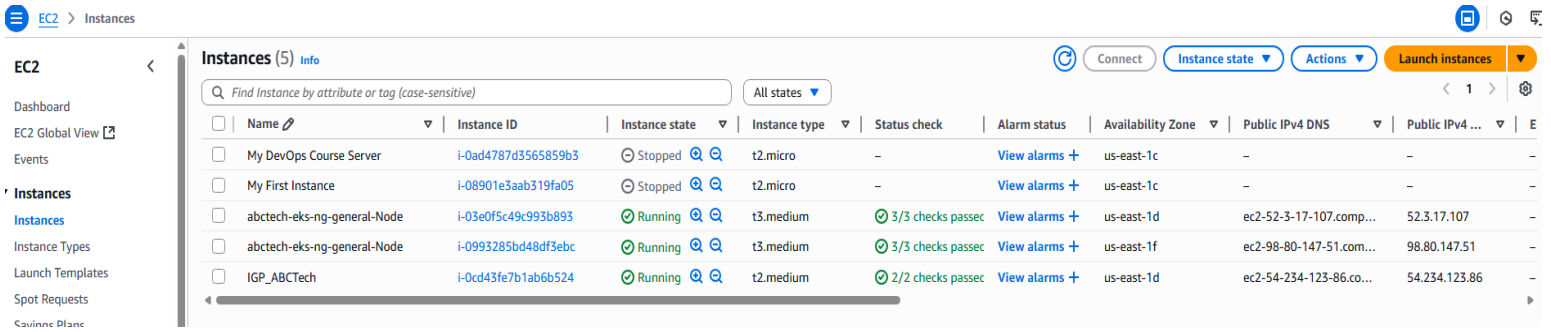
With the above commands, an EKS cluster was created with 2 worker nodes. Figure 42 shows the worker nodes ready to be scheduled for workloads.

Figure 42: AWS EKS Cluster with Nodes Ready to be Scheduled for Workloads

```
root@ip-172-31-31-36:~# aws eks update-kubeconfig --region us-east-1 --name abctech-eks
Added new context arn:aws:eks:us-east-1:116981803550:cluster/abctech-eks to /root/.kube/config
root@ip-172-31-31-36:~# kubectl get nodes
NAME                            STATUS   ROLES    AGE     VERSION
ip-192-168-1-126.ec2.internal   Ready    <none>   6m2s    v1.29.15-eks-3abbec1
ip-192-168-47-181.ec2.internal  Ready    <none>   6m14s   v1.29.15-eks-3abbec1
root@ip-172-31-31-36:~#
```

Within AWS, Figure 43 shows the cluster with 2 worker nodes running. There are *2 x abctech-eks-ng-general -Node* instances with different instance IDs and IP addresses.

Figure 43: Cluster with 2 Worker Nodes Running



10.4.7 Step 7: Writing deployment.yaml, service.yaml, ingress.yaml, namespace.yaml and hpa.yaml manifest files

Having set up the EKS cluster, the next step was to add a local Git repo and add a folder k8s/ and include the .yaml files.

Firstly, the following are the contents of each ***.yaml files***

K8s/namespace.yaml

```
apiVersion: v1
kind: Namespace
metadata:
  name: abctech
```

K8s/deployment.yaml

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: abctechnologies
  namespace: abctech
spec:
  replicas: 2
  selector:
    matchLabels:
      app: abctechnologies
  template:
    metadata:
```

```
        labels:
          app: abctechnologies
      spec:
        containers:
          - name: web
            image: izewdevlabs/abctechnologies:latest   # or use
:${BUILD_NUMBER} in Jenkins
            ports:
              - containerPort: 8080
```

K8s/service.yaml

```
apiVersion: v1
kind: Service
metadata:
  name: abctechnologies
  namespace: abctech
spec:
  type: LoadBalancer
  selector:
    app: abctechnologies
  ports:
    - port: 80
      targetPort: 8080
```

The following ***.yaml files*** were optional, that would be needed at later stage (but still included)

K8s/ingress.yaml (requires AWS Load Balancer Controller)

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: abctechnologies
  namespace: abctech
  annotations:
    kubernetes.io/ingress.class: alb
    alb.ingress.kubernetes.io/scheme: internet-facing
    alb.ingress.kubernetes.io/target-type: ip
spec:
  rules:
    - http:
        paths:
          - path: /
            pathType: Prefix
            backend:
              service:
                name: abctechnologies
                port:
```

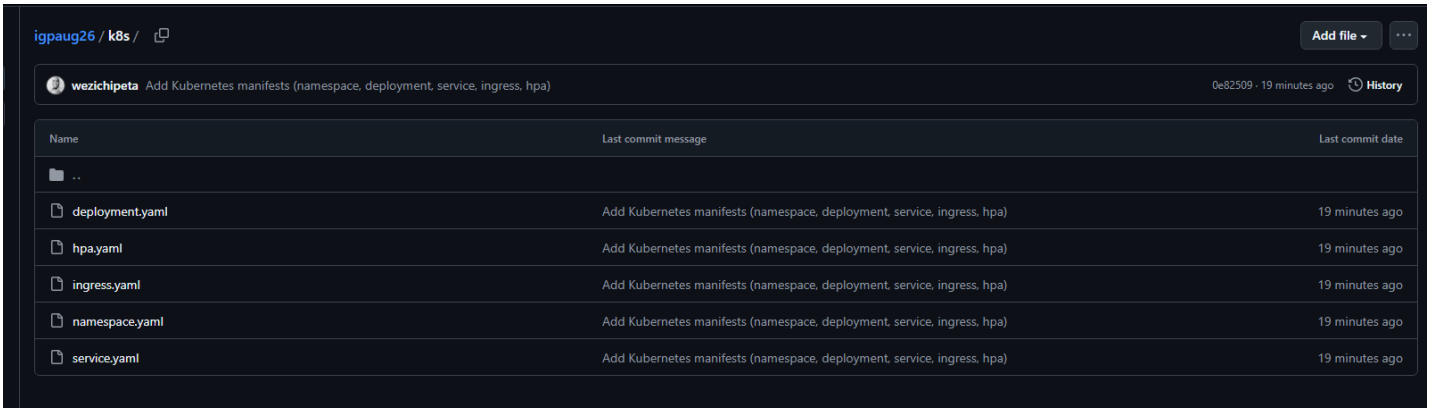
```
                number: 80
```

K8s/hpa.yaml (Horizonatal Pod Autoscaler)

```
apiVersion: autoscaling/v2
kind: HorizontalPodAutoscaler
metadata:
  name: abctechnologies
  namespace: abctech
spec:
  scaleTargetRef:
    apiVersion: apps/v1
    kind: Deployment
    name: abctechnologies
  minReplicas: 2
  maxReplicas: 6
  metrics:
    - type: Resource
      resource:
        name: cpu
        target:
          type: Utilization
          averageUtilization: 60
```

Having written the manifest files, the next step involved adding the folder k8s/ and files to local repository and then pushing it remotely to GitHub. *Figure 44* shows the remote GitHub with the added folder k8s.

Figure 44: K8s folder and manifest files pushed to Github Repository "igpaug26"



10.4.8 Step 8: Pipeline Script with Deployment to Kubernetes

Now that all the prerequisites' steps were carried out, the jenkinsfile was enhanced so that it builds and pushes the docker image through application of Kubernetes manifests to the EKS cluster. The enhanced pipeline script is shown below.

```
pipeline {
  agent any
  environment {
    IMAGE_LOCAL   = "abctechnologies"
    IMAGE_REMOTE  = "izewdevlabs/abctechnologies"
    TAG           = "${BUILD_NUMBER}"
    AWS_REGION    = "us-east-1"
    CLUSTER_NAME  = "abctech-eks"
    K8S_NS        = "abctech"
    K8S_DEPLOY    = "abctechnologies"
  }
  stages {
    stage('Checkout') { steps { git 'https://github.com/Izewdevlabs/igpaug26.git' } }
    stage('Compile')  { steps { sh 'mvn -B compile' } }
    stage('Test')     { steps { sh 'mvn -B test' } }
    stage('Build WAR'){ steps { sh 'mvn -B -DskipTests package' } }

    stage('Build Docker Image') {
      steps {
        sh "docker build -t ${IMAGE_LOCAL}:${TAG} ."
        sh "docker tag ${IMAGE_LOCAL}:${TAG} ${IMAGE_REMOTE}:${TAG}"
      }
    }

    stage('Push Docker Image') {
  steps {
    withCredentials([usernamePassword(credentialsId: 'mydockerhubcred',
                                      usernameVariable: 'DH_USER',
                                      passwordVariable: 'DH_PASS')]) {
      sh '''
        set -e
        echo "$DH_PASS" | docker login -u "$DH_USER" --password-stdin
        docker push izewdevlabs/abctechnologies:${BUILD_NUMBER}
      '''
    }
  }
}

  stage('Deploy to EKS') {
      steps {
        sh """
          set -e

          # point kubectl at your cluster (uses EC2 IAM role)
          aws eks update-kubeconfig --region ${AWS_REGION} --name ${CLUSTER_NAME}

          # apply base manifests (namespace/deploy/service/ingress/hpa if present)
          kubectl apply -f k8s/namespace.yaml
          kubectl apply -f k8s/deployment.yaml
          kubectl apply -f k8s/service.yaml || true
          test -f k8s/ingress.yaml && kubectl apply -f k8s/ingress.yaml || true
          test -f k8s/hpa.yaml && kubectl apply -f k8s/hpa.yaml || true

          # roll the deployment to the exact image tag of this build
          kubectl -n ${K8S_NS} set image deploy/${K8S_DEPLOY}
   web=${IMAGE_REMOTE}:${TAG}

          # wait for rollout
          kubectl -n ${K8S_NS} rollout status deploy/${K8S_DEPLOY} --timeout=180s

          # print service/ingress info
          kubectl -n ${K8S_NS} get pods,svc,ingress
        """
      }
    }
  }
```

```
post {
  always {
    sh '''
      set +e
      echo "=== Docker disk usage BEFORE ==="
      docker system df || true

      docker container prune -f || true
      docker image prune -f || true
      docker builder prune -f || true

      echo "=== Docker disk usage AFTER ==="
      docker system df || true
    '''
       }
    }
 }
```

According to this CI/CD pipeline code, Maven built the WAR; Docker built and pushed the image to Dockerhub; Jenkins connected to the EKS cluster; Kubernetes deployed the app via manifests in k8s/; rollout finished with pods in ready to use state. Post stage was added to save resources after each build. To confirm success of the CI/CD pipeline, Figure 45 shows the stage view of the 3 builds in the Jenkins dashboard.

Figure 45: Stage View of the 3 Builds in the Jenkins Dashboard of the ABCTechnologies-CI-CD Job

10.4.9 Step 9: Getting the Service ELB URL

Having deployed the app successfully, it was required to get the service ELB URL. There were two ways to get it. One way was within Jenkins' dashboard. Figure 46 shows the following information for the service.

- Name: service/abctechnologies
- Type: LoadBalancer
- Cluster- IP: 100.100.79.130
- External-IP: http://afaa13523188c414c8f97bd9eaaaa8c2-1297544135.us-east-1.elb.amazonaws.com/ABCtechnologies-1.0/
- Port(s): 80:31103/TCP

Figure 46: Service ELB URL View in Jenkins

```
NAME                                  READY   STATUS    RESTARTS   AGE
pod/abctechnologies-859458fd66-nhxp6  1/1     Running   0          2s
pod/abctechnologies-859458fd66-s9t55  1/1     Running   0          3s

NAME                     TYPE           CLUSTER-IP      EXTERNAL-IP                                                                PORT(S)        AGE
service/abctechnologies  LoadBalancer   10.100.79.130   afaa13523188c414c8f97bd9eaaaa8c2-1297544135.us-east-1.elb.amazonaws.com   80:31103/TCP   2m26s

NAME                                      CLASS    HOSTS   ADDRESS   PORTS   AGE
ingress.networking.k8s.io/abctechnologies   <none>   *                 80      2m25s
```

Another way to get the service ELB URL was through the terminal by running the command. Figure 47 shows the output of running this command and displays the same service URL information as the one acquired within Jenkins.

```
>kubectl -n abctech get svc abctechnologies
```

Figure 47: Service ELB URL Output Using the Terminal

```
root@ip-172-31-31-36:~# kubectl -n abctech get svc abctechnologies
NAME              TYPE           CLUSTER-IP      EXTERNAL-IP                                                                PORT(S)        AGE
abctechnologies   LoadBalancer   10.100.79.130   afaa13523188c414c8f97bd9eaaaa8c2-1297544135.us-east-1.elb.amazonaws.com   80:31103/TCP   12m
root@ip-172-31-31-36:~#
```

To have app access to the browser, the following URL was used. http://<ELB>/ABCtechnologies-1.0/. Replacing the <ELB> with 'afaa13523188c414c8f97bd9eaaaa8c2-1297544135.us-east-1.elb.amazonaws.com', the app could be accessed on this ELB URL via browser: http://afaa13523188c414c8f97bd9eaaaa8c2-1297544135.us-east-1.elb.amazonaws.com/ABCtechnologies-1.0/

Figure 48 shows the web applications landing page.

Figure 48: ABCtechnologies Web app Landing Page (accessed via AWS ELB)

The above activity/ step marked the end of Task 4 and ready to move to Task 5 involving the use of Prometheus to monitor resources. The section of Task 5 is covered next.

10.5 Monitoring Using Prometheus and Grafana

Task 5: Using Prometheus monitors resources like CPU utilization: Total Usage, Usage per core, usage breakdown, Memory , Network on the instance by providing the end points in local host. Install node exporter and add URL to targeting Prometheus. Using this data login to Grafana and create a dashboard to show the metrics.

10.5.1 Installation of the Stack

The fastest way to add monitoring was to install Prometheus and Grafana via Helm. This option would give the following in one installation a stack that would give all this in one installation.

- *Prometheus (metrics DB)*
- *Alertmanager (alerts)*
- *Grafana (dashboards)*
- *kube-state-metrics & node-exporter (cluster/node metrics)*

The following commands were run on Jenkins EC2 (kubectl already pointing to your cluster):

```
# Namespace for monitoring
kubectl create namespace monitoring || true

# Add Helm repo
helm repo add prometheus-community https://prometheus-community.github.io/helm-
   charts
helm repo update

# Install/upgrade the stack and expose Grafana via LoadBalancer on port 80
helm upgrade --install kps prometheus-community/kube-prometheus-stack \
  -n monitoring \
  --set grafana.service.type=LoadBalancer \
  --set grafana.service.port=80 \
  --set grafana.defaultDashboardsEnabled=true
```

Figure 49 shows the history of commands executed on the Jenkins machine and output that ensured the whole stack was installed.

Figure 49:History of Commands Executed to Install the Stack

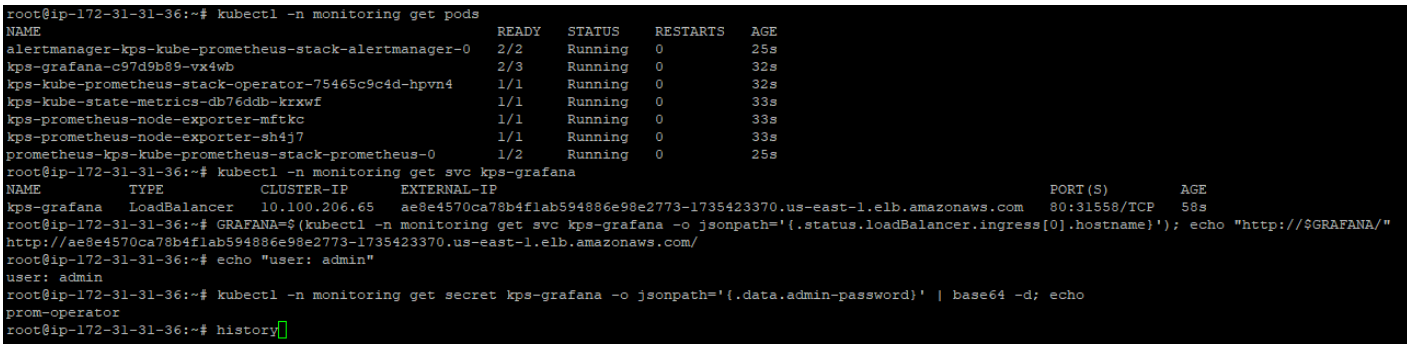
```
  85  kubectl create namespace monitoring || true
  86  helm repo add prometheus-community https://prometheus-community.github.io/helm-charts
  87  snap install helm
  88  helm repo update
  89  # Download the install script
  90  curl -fsSL https://raw.githubusercontent.com/helm/helm/main/scripts/get-helm-3 | bash
  91  helm version
  92  helm repo add prometheus-community https://prometheus-community.github.io/helm-charts
  93  helm repo update
  94  helm upgrade --install kps prometheus-community/kube-prometheus-stack   -n monitoring   --set grafana.service.ty
pe=LoadBalancer   --set grafana.service.port=80   --set grafana.defaultDashboardsEnabled=true
  95  kubectl -n monitoring get pods
  96  kubectl -n monitoring get svc kps-grafana
  97  GRAFANA=$(kubectl -n monitoring get svc kps-grafana -o jsonpath='{.status.loadBalancer.ingress[0].hostname}'); e
cho "http://$GRAFANA/"
  98  echo "user: admin"
  99  kubectl -n monitoring get secret kps-grafana -o jsonpath='{.data.admin-password}' | base64 -d; echo
 100  http://aee84570ca78b4f1ab594886e98e2773-1735423370.us-east-1.elb.amazonaws.com/
 101  kubectl -n monitoring get svc kps-grafana
```

To verify if the stack was installed successfully, the following commands were executed:

```
kubectl -n monitoring get pods
kubectl -n monitoring get svc kps-grafana
```

Figure 50 shows the command and output. It could be verified that the monitoring stack was installed and running. All Prometheus, Alertmanager, Grafana, node-exporter, kube-state-metrics pods were up

Figure 50:Verification the Monitoring was Installed and Running



10.5.2 Getting Grafana URL + Admin Password

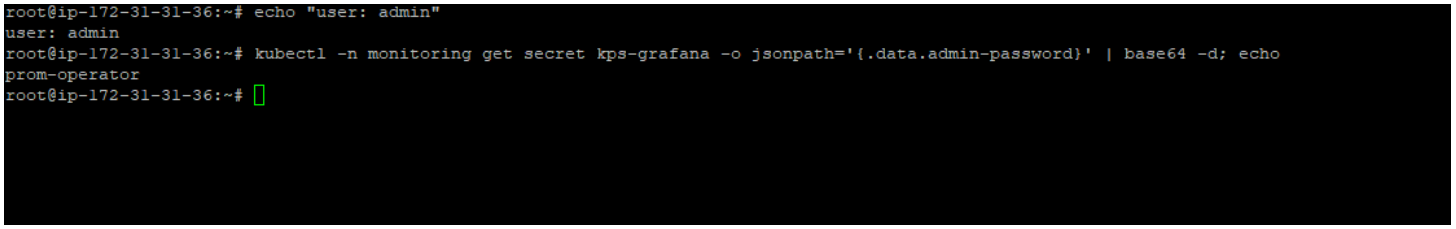
To be able to access Grafana, password for the user admin was required. This was obtained by running the following commands:

```
# ELB URL (appears in ~1–3 mins)
GRAFANA=$(kubectl -n monitoring get svc kps-grafana -o
   jsonpath='{.status.loadBalancer.ingress[0].hostname}'); echo
   "http://$GRAFANA/"

# Credentials
echo "user: admin"
kubectl -n monitoring get secret kps-grafana -o jsonpath='{.data.admin-
   password}' | base64 -d; echo
```

Figure 51 shows the credentials retrieved via the above commands. The following were the credentials:

```
Grafana admin user: admin
Grafana password:prom-operator
```

Figure 51:Getting Grafana Password



To get the Grafana URL that would give an AWS ELB, the following command was executed:

```
kubectl -n monitoring get svc kps-grafana
```

Output of this command provided the following as shown in Figure 52:

Name: kps-grafana
Type: LoadBalancer
Cluster-IP: 10.100.206.65
External IP: ae8e4570ca78b4flab594886e98e2773-1735423370.us-east-1.elb.amazonaws.com

Ports: 80:31556/TCP

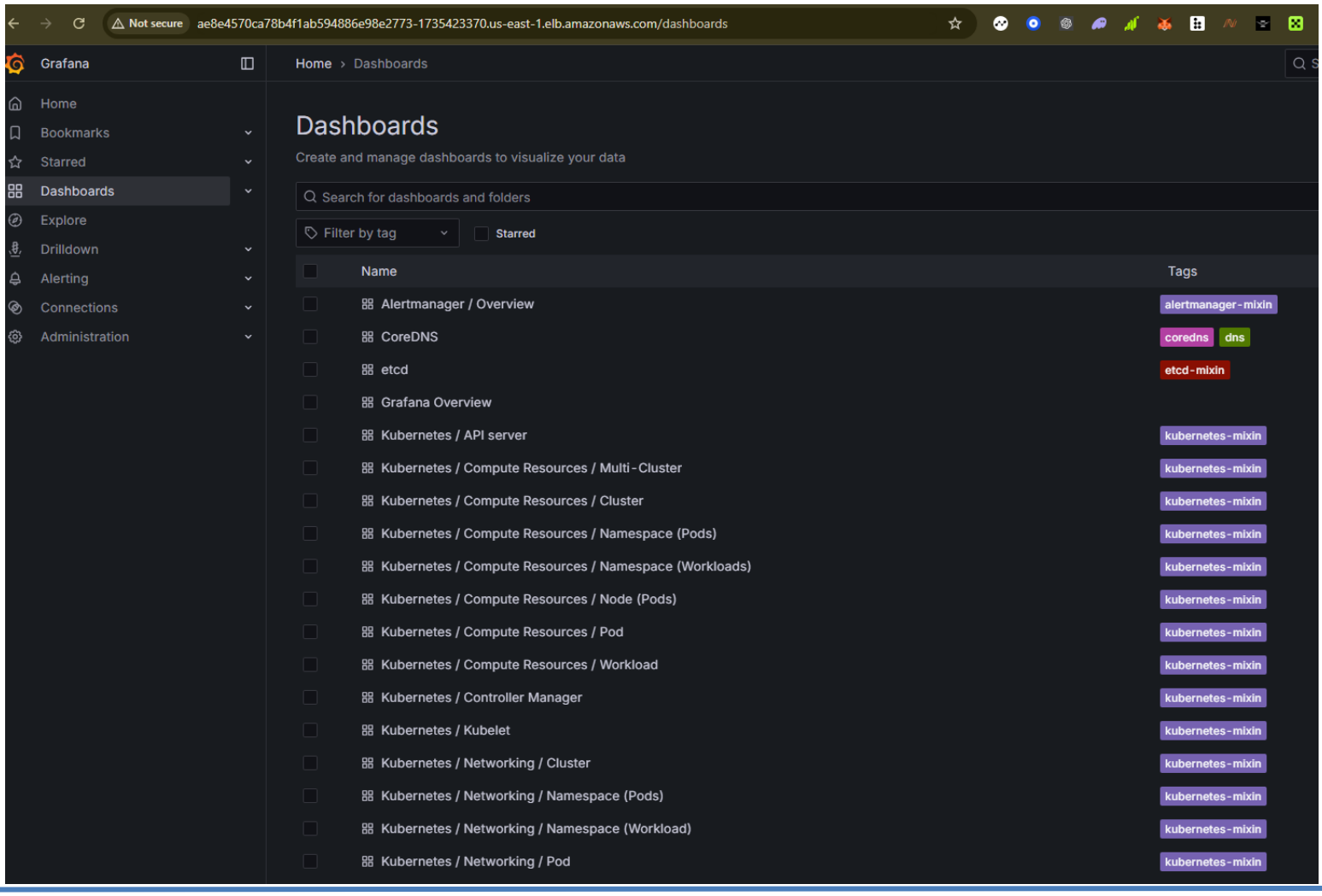
Figure 52:ELB URL for Grafana

```
root@ip-172-31-31-36:~# kubectl -n monitoring get svc kps-grafana
NAME          TYPE           CLUSTER-IP      EXTERNAL-IP                                                              PORT(S)        AGE
kps-grafana   LoadBalancer   10.100.206.65   ae8e4570ca78b4f1ab594886e98e2773-1735423370.us-east-1.elb.amazonaws.com   80:31558/TCP   42h
root@ip-172-31-31-36:~# ^C
root@ip-172-31-31-36:~#
```

This meant that Grafana was now exposed via an AWS LoadBalancer and could be accessed on the browser. Opening http://ae8e4570ca78b4flab594886e98e2773-1735423370.us-east-1.elb.amazonaws.com on the browser gave access to Grafana.

Inside Grafana, one was able to browse through the dashboards and a set of Kubernetes / Compute Resources dashboards (Pods, Nodes, Deployments, etc.) from the chart. Figure 53 shows the screenshot of different Kubernetes/ Compute dashboards.

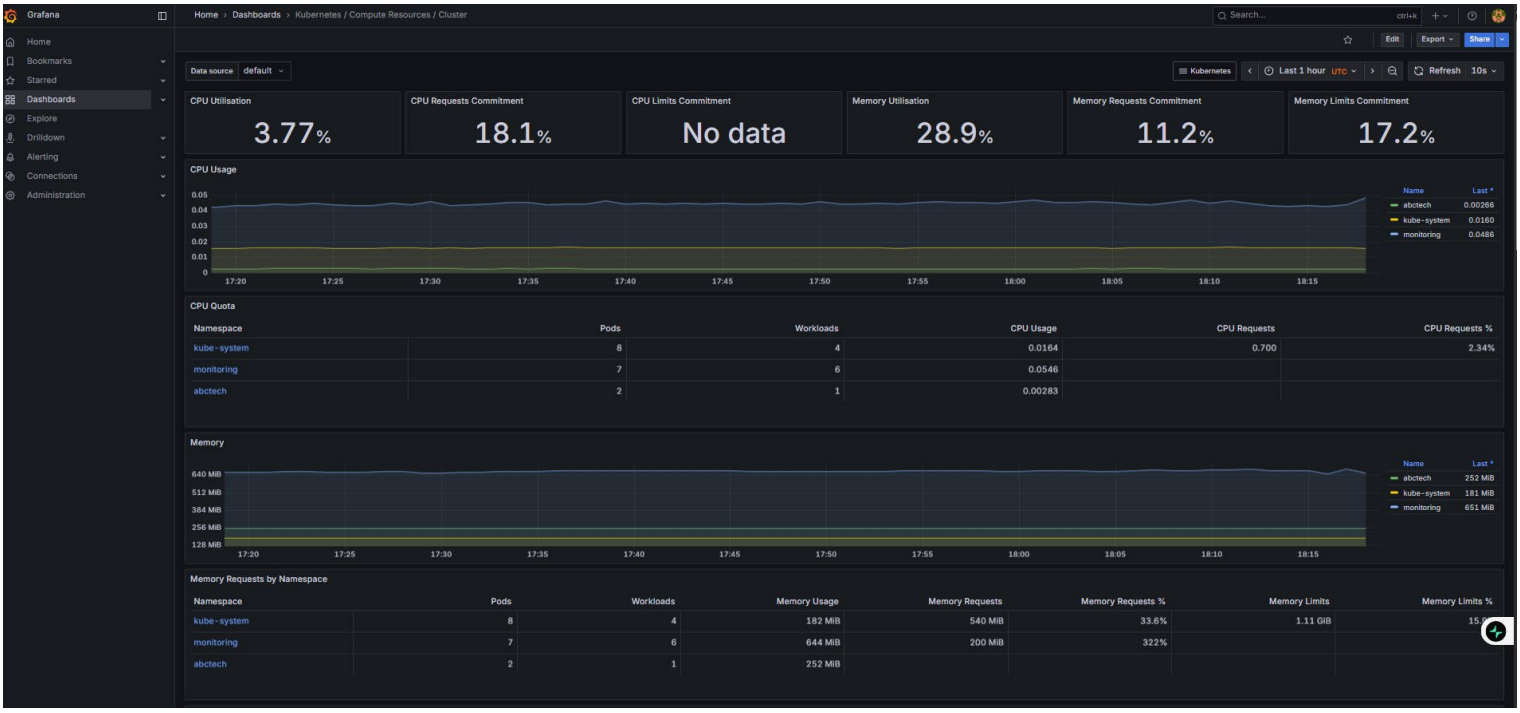
Figure 53: Different Kubernetes/ Compute dashboards within Grafana



10.5.3 Dashboards Monitored

One of the dashboards explored was for the whole cluster, which included CPU utilization, CPU usage, CPU quota and memory. This was done by following: **Kubernetes / Compute Resources / Cluster → CPU/mem of the whole cluster .** Figure 53 shows the screenshot of the dashboard.

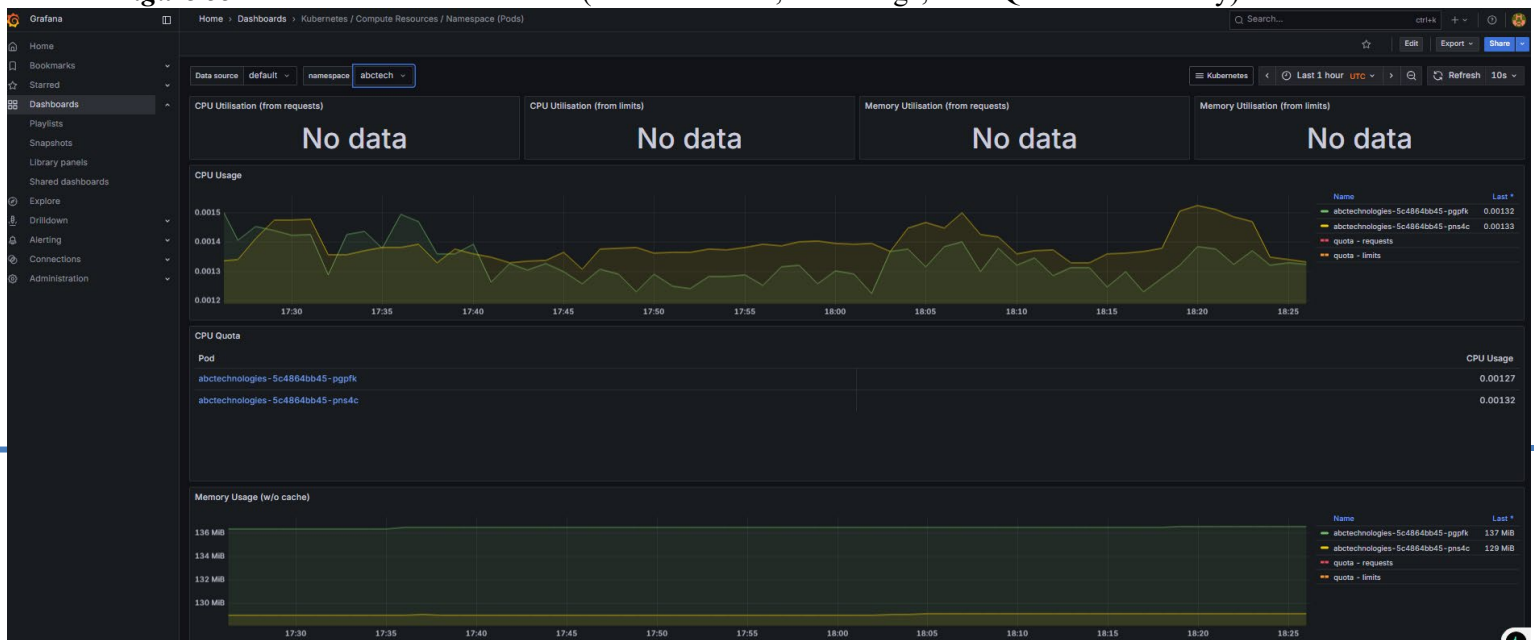
Figure 54: Cluster Dashboard (CPU utilization, CPU usage, CPU Quota and Memory)



The second dashboard was monitoring per pod metrics in a cluster, shown in Figure 55. This was done by following :

Kubernetes / Compute Resources / Pod → Per-pod metrics (including abctechnologies pods).

Figure 55: Per Pod Metrics Dashboard (CPU utilization, CPU usage, CPU Quota and Memory)



11. Summary

This document provided a detailed solution using DevOps where five tasks and steps to accomplish them were outlined. Complete code developed such as dockerfile, CI pipeline job script, CI/CD pipeline job scripts for both docker and Kubernetes deployments were provided. In addition, code for manifest files deployment.yaml, service.yaml, namespace.yaml, ingress.yaml and hpa.yaml were provided. All in all, snapshots of the command and outputs either on the terminal or within Github, Dockerhub, Jenkins, Docker, Grafana and AWS were provided. This DevOps solution for ABC Technologies would ensure that operational benefits below would accrue.

- Highly available
- Highly scalable
- Highly Performant
- Easily built and maintained
- Developed and deployed quickly
- Lower production bugs
- Frequent releases
- Better customer experiences
- Lesser time to market