Build a Docker Jenkins Pipeline to Implement CI/CD Workflow

- Sai Ram Upparipally

Contents

1.Introduction to the Project

Objective: Demonstrate the continuous integration and delivery by building a Docker Jenkins Pipeline.

Solution build should demonstrate below capabilities:
• Availability of the application and its versions in the GitHub

o Track their versions every time a code is committed to the repository

- ***Create a Docker Jenkins Pipeline that will create a Docker image from the Docker file***
  and host it on Docker Hub

- ***It should also pull the Docker image and run it as a Docker container***

- ***Build the Docker Jenkins Pipeline to demonstrate the continuous integration and continuous delivery workflow***
  Project goal is to deliver the software product frequently to the production with high-end quality.

- ***Tools required: Docker, Docker Hub, GitHub, Git, Linux (Ubuntu), Jenkins***

2. Installation of pre-requisites/tools

In this section we can see how the required tools are installed to execute the project

Installing Git

Step 1: Verifying the Git installation

Use the following command to check the version of Git: git --version

```
sairamslcgmail@ip-172-31-29-202:~$ git --version
git version 2.39.0
```

Step 2: Installing the latest version of Git

Execute the following commands on the terminal to install Git: sudo apt-get update
sudo apt-get install git

```
etadata [130 kB]
Get:23 http://security.ubuntu.com/ubuntu xenial-security/multiverse amd64 DEP-11
 Metadata [2,468 B]
Get:25 http://ppa.launchpad.net/ansible/ansible/ubuntu xenial/main amd64 Package
s [696 B]
Fetched 1,206 kB in 1s (954 kB/s)
Reading package lists... Done
W: http://repo.zabbix.com/zabbix/3.0/ubuntu/dists/trusty/InRelease: Signature by
 key FBABD5FB20255ECAB22EE194D13D58E479EA5ED4 uses weak digest algorithm (SHA1)
vikidvggmail@ip-172-31-29-62:~$ sudo apt-get install git
Reading package lists... Done
Building dependency tree
Reading state information... Done
git is already the newest version (1:2.7.4-0ubuntu1.10).
0 upgraded, 0 newly installed, 0 to remove and 85 not upgraded.
```

Creating GitHub Account

Make sure you have a Github Account available. If not, please create one using the given link. *https://github.com/join?ref_cta=Sign+up&ref_loc=header+logged+out&ref_page=%2F&source=header-home*

Setting up Jenkins

Step 1: Downloading the Java Runtime Environment

1.1 Open the terminal.
1.2 Run sudo apt-get update to update the package lists.
1.3 Run sudo apt-get install openjdk-8-jdk to install the Java Runtime Environment.
1.4 Run java -version to verify the installation. It will print the JDK version as shown below:

```
sairamslcgmail@ip-172-31-29-202:~$ java -version
openjdk version "11.0.13" 2021-10-19
OpenJDK Runtime Environment (build 11.0.13+8-Ubuntu-0ubuntu1.20.04)
OpenJDK 64-Bit Server VM (build 11.0.13+8-Ubuntu-0ubuntu1.20.04, mixed mode, sha
ring)
```

Step 2: Downloading and installing the Jenkins app

1.1 Open the terminal.
1.2 Run ***wget -q -O - https://pkg.jenkins.io/debian/jenkins.io.key | sudo apt-key add -*** *to install Jenkins.*

```
sairamslcgmail@ip-172-31-21-159:~$ wget -q -O - https://pkg.jenkins.io/debian-st
able/jenkins.io.key |sudo apt-key add -
OK
```

2.3 Run ***sudo sh -c 'echo deb http://pkg.jenkins.io/debian-stable binary/ > /etc/apt/sources.list.d/jenkins.list'*** command.

```
sairamslcgmail@ip-172-31-21-159:~$ sudo sh -c 'echo deb http://pkg.jenkins.io/de
bian-stable binary/ > /etc/apt/sources.list.d/jenkins.list'
```

2.4 Run ***sudo apt-get update***
2.5 Run ***sudo apt-get install jenkins*** to install Jenkins.

```
sairamslcgmail@ip-172-31-29-202:~$ sudo apt-get install jenkins
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:
  daemon
Use 'sudo apt autoremove' to remove it.
The following packages will be upgraded:
  jenkins
1 upgraded, 0 newly installed, 0 to remove and 407 not upgraded.
Need to get 92.9 MB of archives.
After this operation, 21.3 MB of additional disk space will be used.
Get:1 https://pkg.jenkins.io/debian-stable binary/ jenkins 2.375.1 [92.9 MB]
Fetched 92.9 MB in 8s (11.5 MB/s)
(Reading database ... 242343 files and directories currently installed.)
Preparing to unpack .../jenkins_2.375.1_all.deb ...
Unpacking jenkins (2.375.1) over (2.319.2) ...
Setting up jenkins (2.375.1) ...
Installing new version of config file /etc/default/jenkins ...
Installing new version of config file /etc/init.d/jenkins ...
Created symlink /etc/systemd/system/multi-user.target.wants/jenkins.service → /lib/systemd/syste
m/jenkins.service.
Processing triggers for systemd (245.4-4ubuntu3.15) ...
```

2.6 Run sudo service jenkins status to check the status of the installation. Once you verify the status as active, you can press Ctrl+z to exit from the process.

```
sairamslcgmail@ip-172-31-29-202:~$ sudo service jenkins status
● jenkins.service - Jenkins Continuous Integration Server
     Loaded: loaded (/lib/systemd/system/jenkins.service; enabled; vendor preset: enabled)
     Active: active (running) since Fri 2022-12-23 15:33:14 UTC; 2min 14s ago
   Main PID: 13155 (java)
      Tasks: 45 (limit: 18834)
     Memory: 2.3G
     CGroup: /system.slice/jenkins.service
             └─13155 /usr/bin/java -Djava.awt.headless=true -jar /usr/share/java/jenkins.war --

Dec 23 15:33:12 ip-172-31-29-202 jenkins[13155]: WARNING: Use --illegal-access=warn to enable w
Dec 23 15:33:12 ip-172-31-29-202 jenkins[13155]: WARNING: All illegal access operations will be
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.829+0000 [id=31]        IN
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.829+0000 [id=31]        IN
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.841+0000 [id=31]        IN
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.846+0000 [id=35]        IN
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.986+0000 [id=36]        IN
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.995+0000 [id=37]        IN
Dec 23 15:33:14 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:14.029+0000 [id=23]        IN
Dec 23 15:33:14 ip-172-31-29-202 systemd[1]: Started Jenkins Continuous Integration Server.

[1]+  Stopped                 sudo service jenkins status
```

2.7 Run the following commands to start Jenkins.

sudo systemctl start jenkins
sudo systemctl status jenkins

```
sairamslcgmail@ip-172-31-29-202:~$ sudo systemctl start jenkins
sairamslcgmail@ip-172-31-29-202:~$ sudo systemctl status jenkins
● jenkins.service - Jenkins Continuous Integration Server
     Loaded: loaded (/lib/systemd/system/jenkins.service; enabled; vendor preset: enabled)
     Active: active (running) since Fri 2022-12-23 15:33:14 UTC; 12min ago
   Main PID: 13155 (java)
      Tasks: 45 (limit: 18834)
     Memory: 2.3G
     CGroup: /system.slice/jenkins.service
             └─13155 /usr/bin/java -Djava.awt.headless=true -jar /usr/share/java/jenkins.war --webroot=/var/cache/jenkins/war --httpPort=8080

Dec 23 15:33:12 ip-172-31-29-202 jenkins[13155]: WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations
Dec 23 15:33:12 ip-172-31-29-202 jenkins[13155]: WARNING: All illegal access operations will be denied in a future release
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.829+0000 [id=31]        INFO        jenkins.InitReactorRunner$1#onAttained: System conf
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.829+0000 [id=31]        INFO        jenkins.InitReactorRunner$1#onAttained: System conf
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.841+0000 [id=31]        INFO        jenkins.InitReactorRunner$1#onAttained: Loaded all
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.846+0000 [id=35]        INFO        jenkins.InitReactorRunner$1#onAttained: Configurati
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.986+0000 [id=36]        INFO        j.install.InstallState$Upgrade#applyForcedChanges:
Dec 23 15:33:13 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:13.995+0000 [id=37]        INFO        jenkins.InitReactorRunner$1#onAttained: Completed i
Dec 23 15:33:14 ip-172-31-29-202 jenkins[13155]: 2022-12-23 15:33:14.029+0000 [id=23]        INFO        hudson.lifecycle.Lifecycle#onReady: Jenkins is full
Dec 23 15:33:14 ip-172-31-29-202 systemd[1]: Started Jenkins Continuous Integration Server.
lines 1-19/19 (END)
```

Open localhost:8080 in the browser, and you will need to enter the initial password.

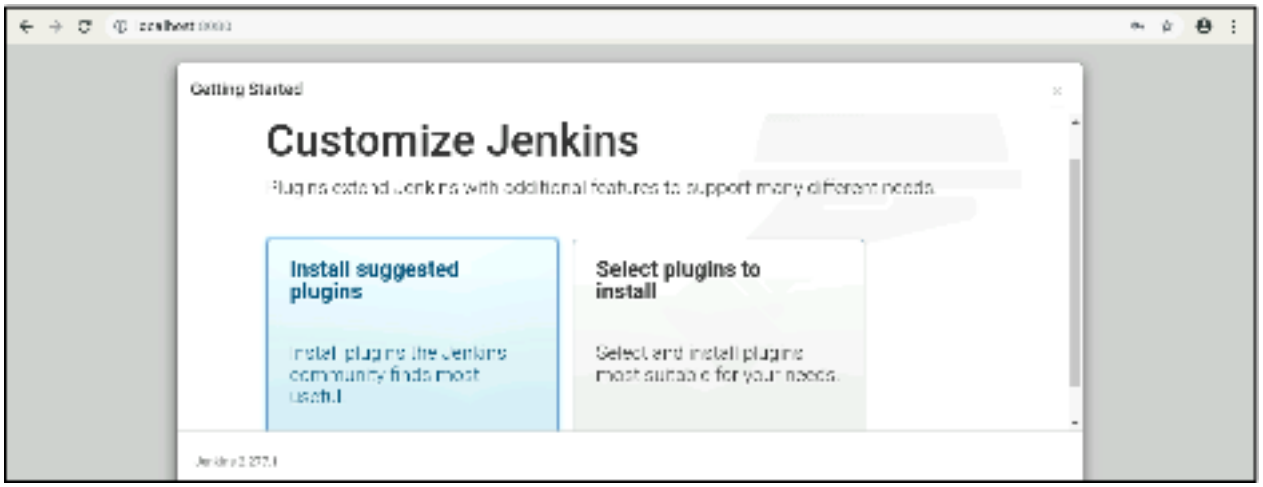
In your terminal run the following command:

sudo cat /var/lib/jenkins/secrets/initialAdminPassword

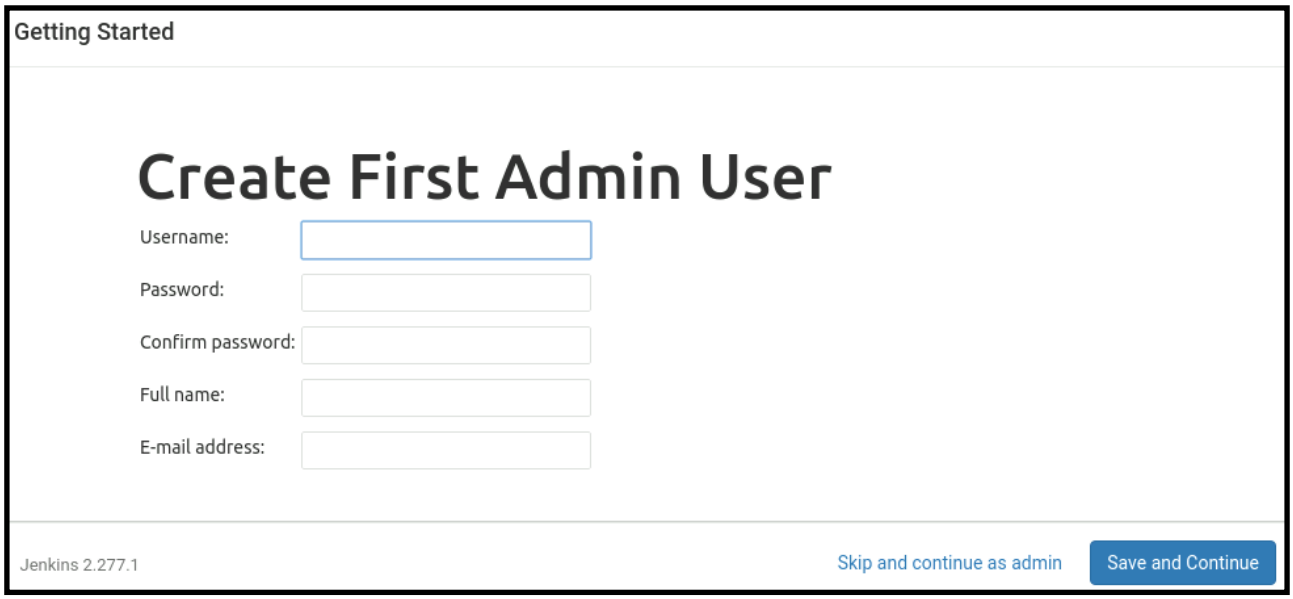
```
sairamslcgmail@ip-172-31-26-40:~$ sudo cat /var/lib/jenkins/secrets/initialAdmin
Password
3c28f5b471124036943f58dcc27859b2
```

Copy this password and paste it on your Jenkins page in the browser.

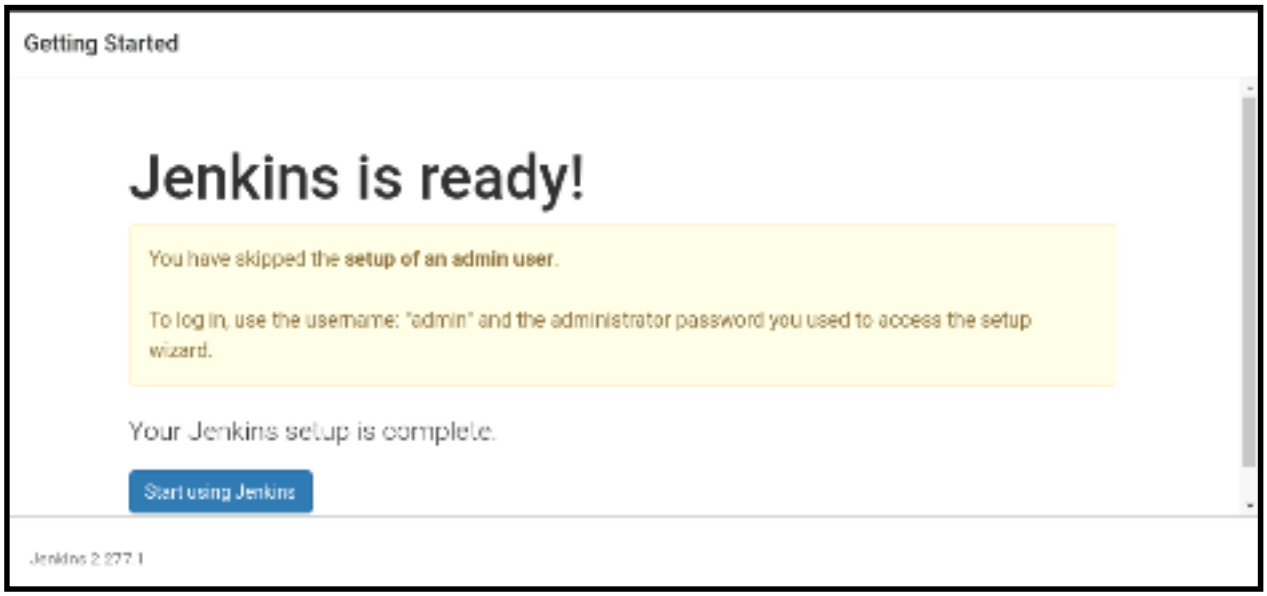
Now, click on ***Install the suggested plugins****.*



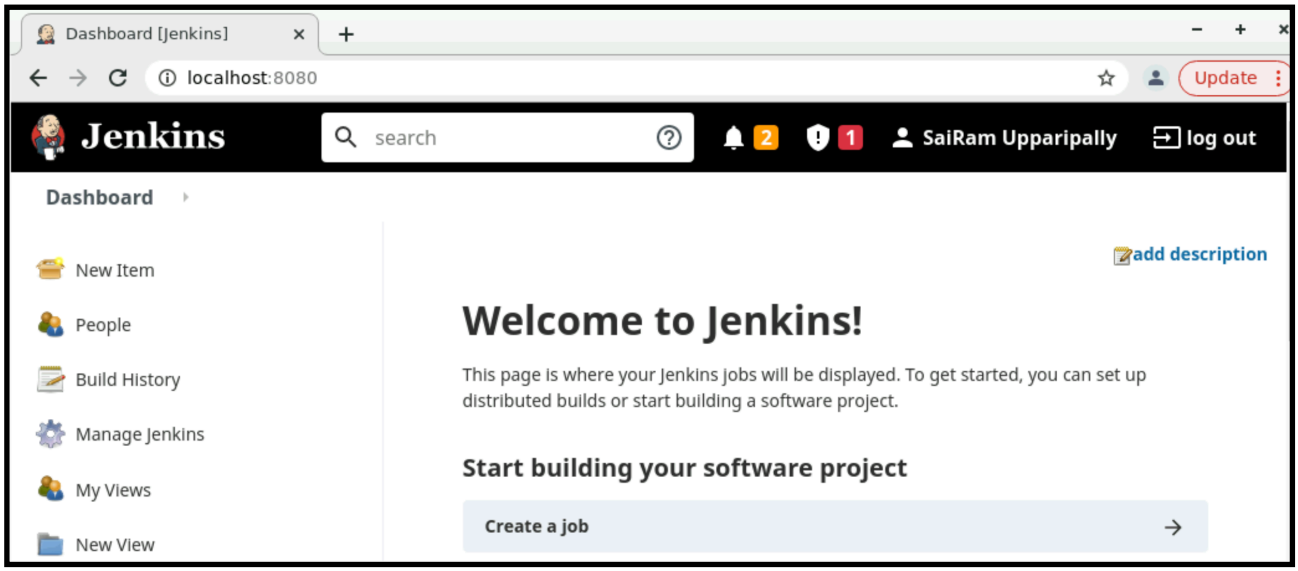
You can either create an admin user or skip and continue as admin. Select Skip and continue as admin.



In the Instance configuration page, click on the Start using Jenkins button.



Now, you can work with Jenkins as shown in the screenshot below.



Docker Community Edition Installation

Step 1: Install the Docker CE from Docker Repository

Use the following command to update the apt package:

sudo apt-get update

```
sairamslcgmail@ip-172-31-26-40:~$ sudo apt-get update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu xenial InRelease
Hit:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu xenial-updates InRelease
Hit:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu xenial-backports InRelease
Get:4 http://dl.google.com/linux/chrome/deb stable InRelease [1,811 B]
Hit:5 https://artifacts.elastic.co/packages/7.x/apt stable InRelease
Hit:6 https://deb.nodesource.com/node_14.x xenial InRelease
Hit:7 http://repo.zabbix.com/zabbix/3.0/ubuntu trusty InRelease
Hit:8 http://ppa.launchpad.net/ansible/ansible/ubuntu xenial InRelease
Hit:9 http://security.ubuntu.com/ubuntu xenial-security InRelease
Hit:10 http://ppa.launchpad.net/deadsnakes/ppa/ubuntu xenial InRelease
```

Use the following command to install packages to allow the apt to use a repository over HTTPS

***sudo apt-get install ***

***apt-transport-https ***

***ca-certificates \ curl ***
gnupg \ lsb-release

```
sairamslcgmail@ip-172-31-26-40:~$ sudo apt-get install \
> apt-transport-https \
> ca-certificates \
> curl \
> gnupg \
> lsb-release
Reading package lists... Done
Building dependency tree
Reading state information... Done
apt-transport-https is already the newest version (1.2.35).
ca-certificates is already the newest version (20210119~16.04.1).
curl is already the newest version (7.47.0-1ubuntu2.19).
gnupg is already the newest version (1.4.20-1ubuntu3.3).
lsb-release is already the newest version (9.20160110ubuntu0.2).
0 upgraded, 0 newly installed, 0 to remove and 92 not upgraded.
sairamslcgmail@ip-172-31-26-40:~$
```

Use the following curl command to add Docker's official GPG key:

curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor -o /usr/share/keyrings/docker-archive-keyring.gpg

```
sairamslcgmail@ip-172-31-21-159:~$ curl -fsSL https://download.docker.com/linux/
ubuntu/gpg | sudo gpg --dearmor -o /etc/apt/keyrings/docker.gpg
```

Use the following command to set up a stable repository:

***echo ***

*"deb [arch=amd64 signed-by=/usr/share/keyrings/docker-archive-keyring.gpg] https://download.docker.com/linux/ubuntu *

$(lsb_release -cs) stable" | sudo tee /etc/apt/sources.list.d/docker.list > /dev/null

```
sairamslcgmail@ip-172-31-26-40:~$ echo \
> "deb [arch=amd64 signed-by=/usr/share/keyrings/docker-archive-keyring.gpg]https://do
wnload.docker.com/linux/ubuntu \
> $(lsb_release -cs) stable" |sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
```

Use the following commands to install the latest version of Docker CE and check the version:

sudo apt-get install docker-ce

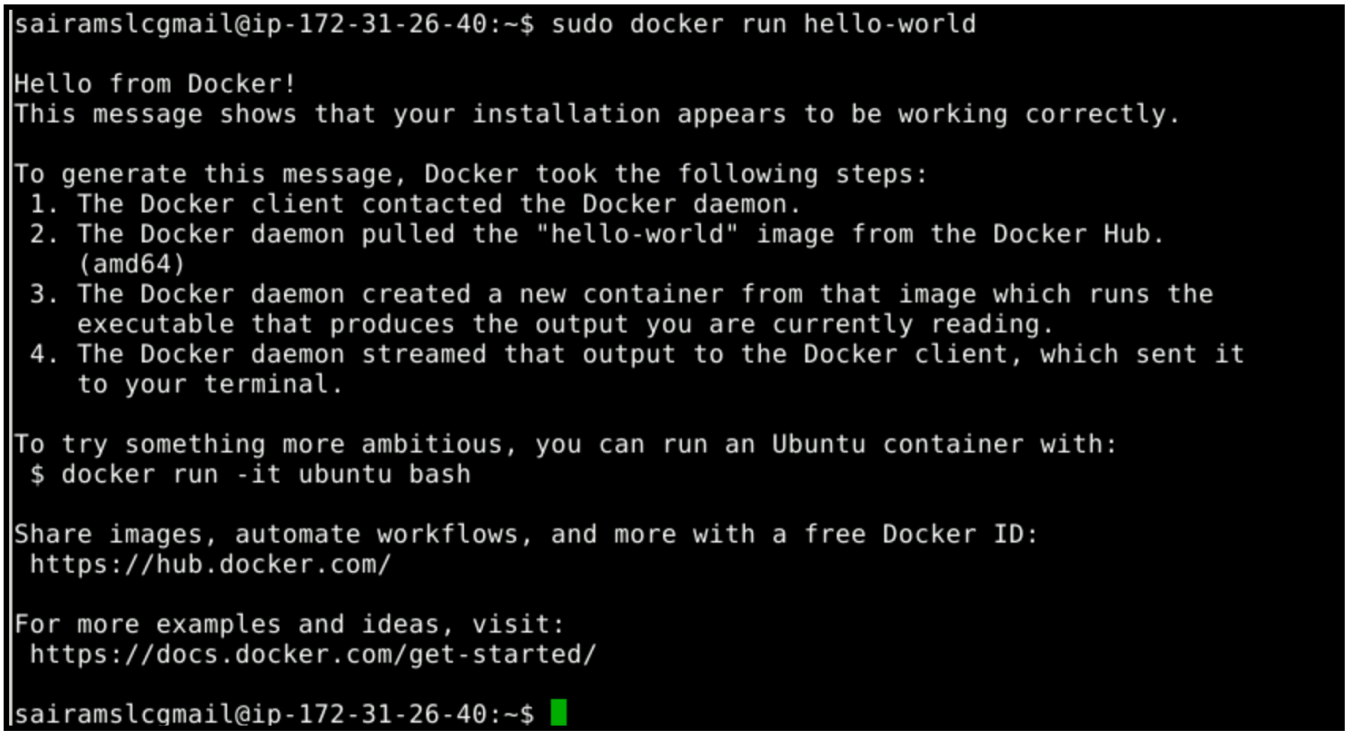
docker --version

```
sairamslcgmail@ip-172-31-26-40:~$ docker --version
Docker version 19.03.14, build 5eb3275d40
```

Step 2: Verify the correctly installed Docker engine

Use the following command to verify the Docker engine:

sudo docker run hello-world



Step 3: Create a Docker Hub account to store or get images from remote repository

Go to https://hub.docker.com/ and create your own account

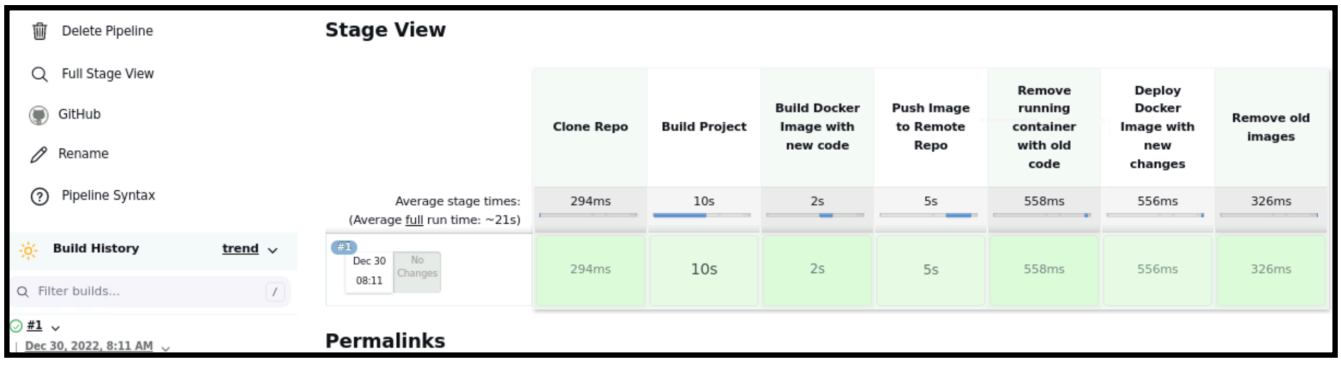
3.Execution of the Project

The Repo contains a sample Spring Boot Application and when the Jenkins pipeline runs, the spring boot application is built with maven tools and it is deployed in OpenJDK docker image.

Any commit made in the repo automatically triggers the Jenkins pipeline, which does all the actions of below:

- ***1) Create build with Maven by using the new code committed***
- ***2) Create a new docker image***
- ***3) Push the new image to docker hub***
- ***4) Remove already running container in the server with old code***
- ***5) Deploy the new code with the updated version of image from Docker Hub***
- ***6) Remove the outdated images stored locally***

Below are the stages in the Jenkins pipeline to fulfil the objectives of this project:



Step 1:

Upload the source code to git by installing git to local machine .

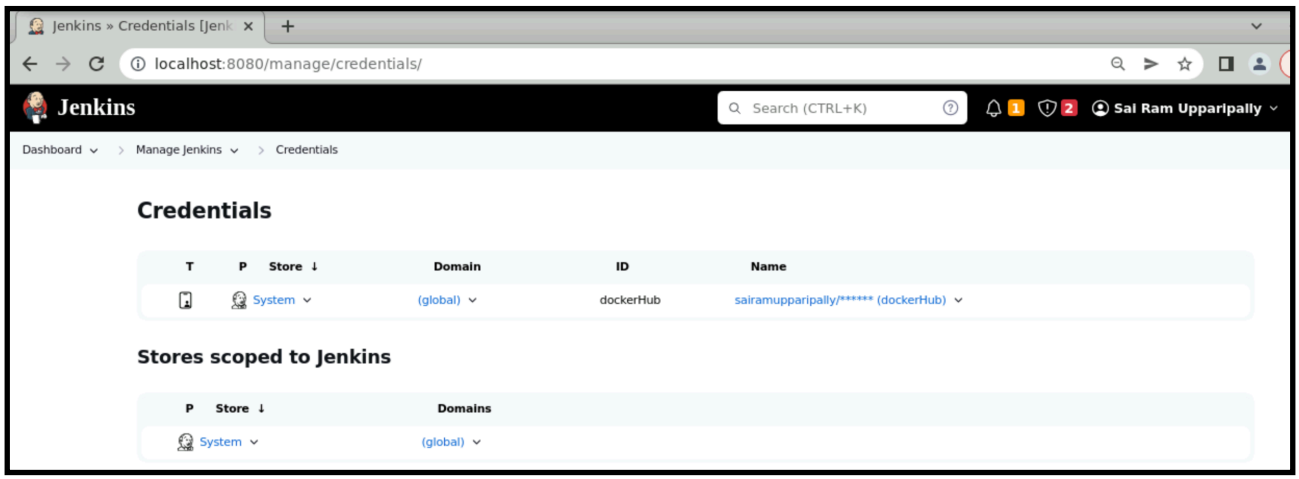
Step 2:

Docker Hub Credentials to be maintained in Jenkins server as mentioned in the

Jenkinsfile

```
    //push image to remote repository , in your jenkins you na
stage('Push Image to Remote Repo'){
     echo "Docker Image Tag Name ---> ${dockerImageTag}"
         docker.withRegistry('', 'dockerHub') {
         dockerImage.push("${env.BUILD_NUMBER}")
         dockerImage.push("latest")
        }
    }
```

In the Jenkins server , go to Manage Jenkins -> Manage Credentials to maintain the Docker hub userID and Password with the same Credential ID 'dockerHub' as maintained in Jenkins file of the repository



Step 3:

The user jenkins needs to be added to the group docker with the below linux command: *sudo usermod -a -G docker Jenkins*

Note: If this is not done, then the Jenkins server cannot create docker containers and we will get permission error

You can check if the above command was successful by doing grep docker /etc/group
and you can see something like below:

docker:x:998:[user]

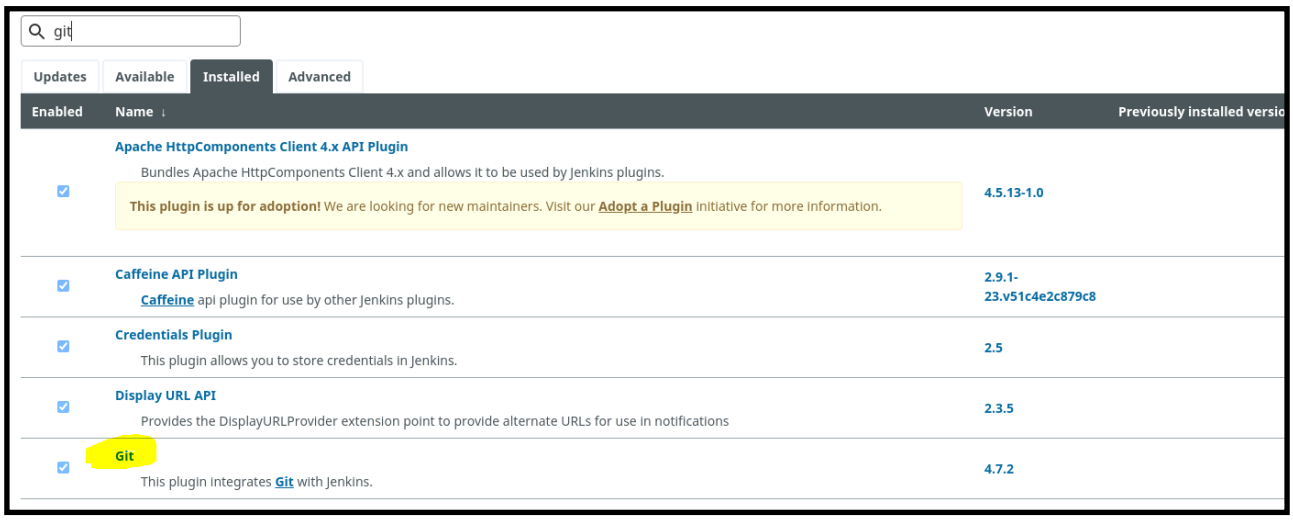
Step 4:

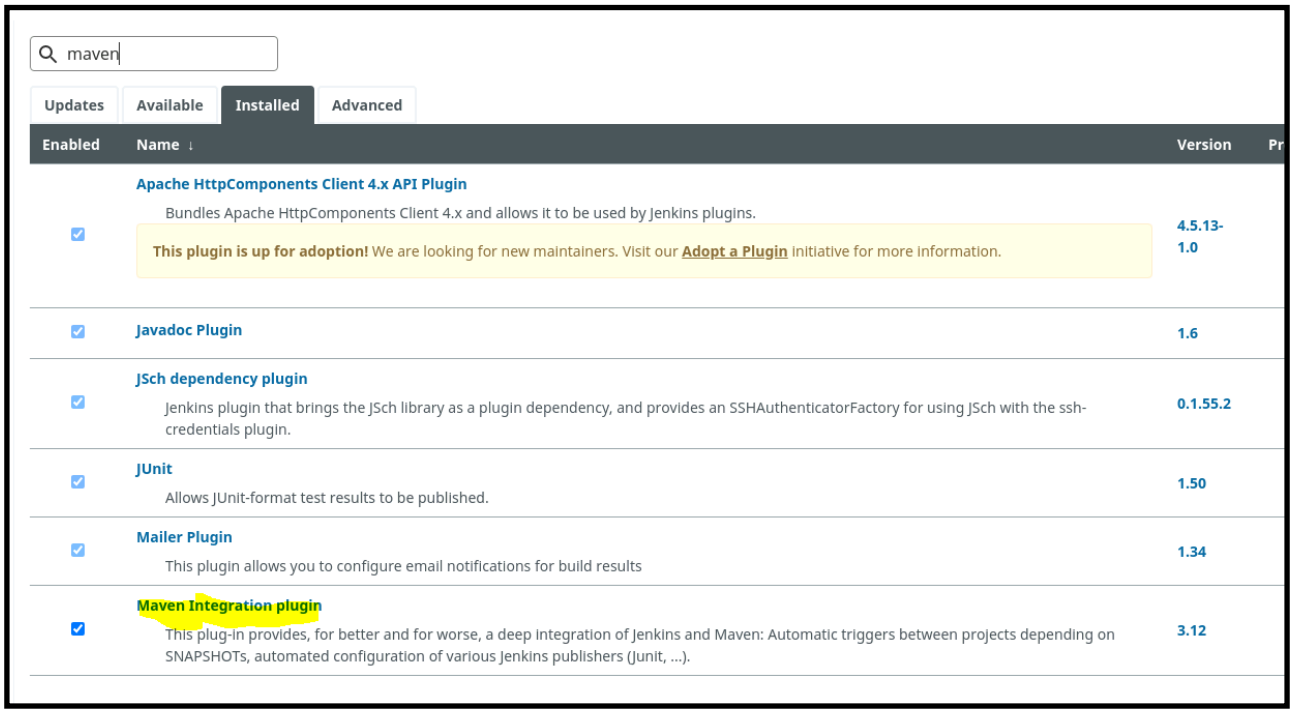
Review the Dockerfile available in the repo.

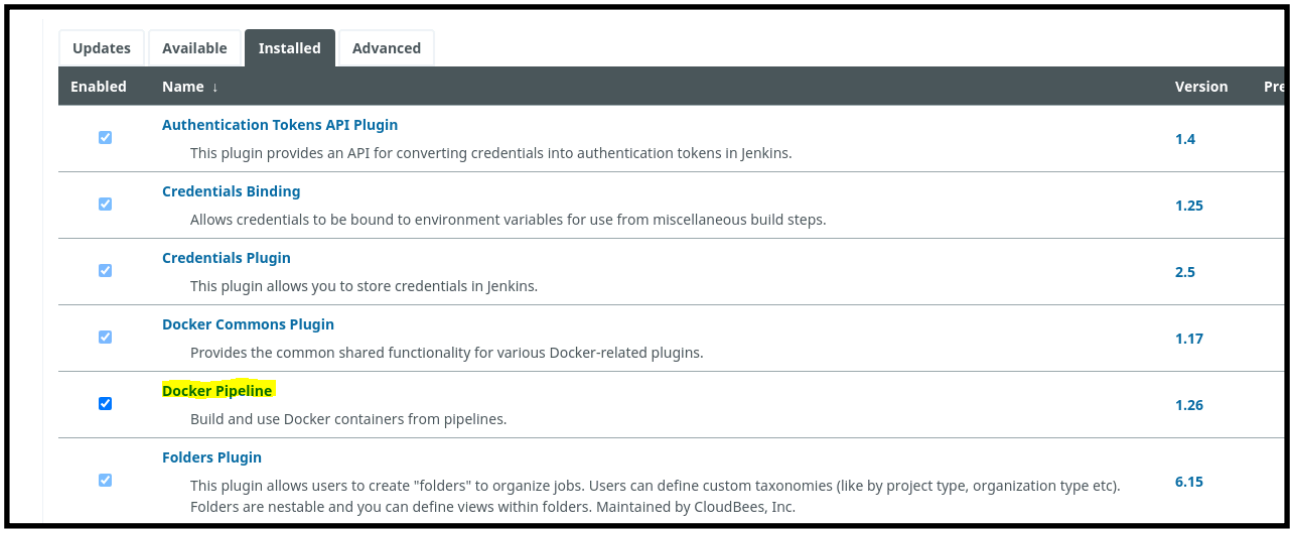
It uses the OpenJDK image where we place our executable JAR file in the required path and expose port 2222

Step 5:

Install required Jenkins plugins if not installed already Use manage plugins option to install the plugins

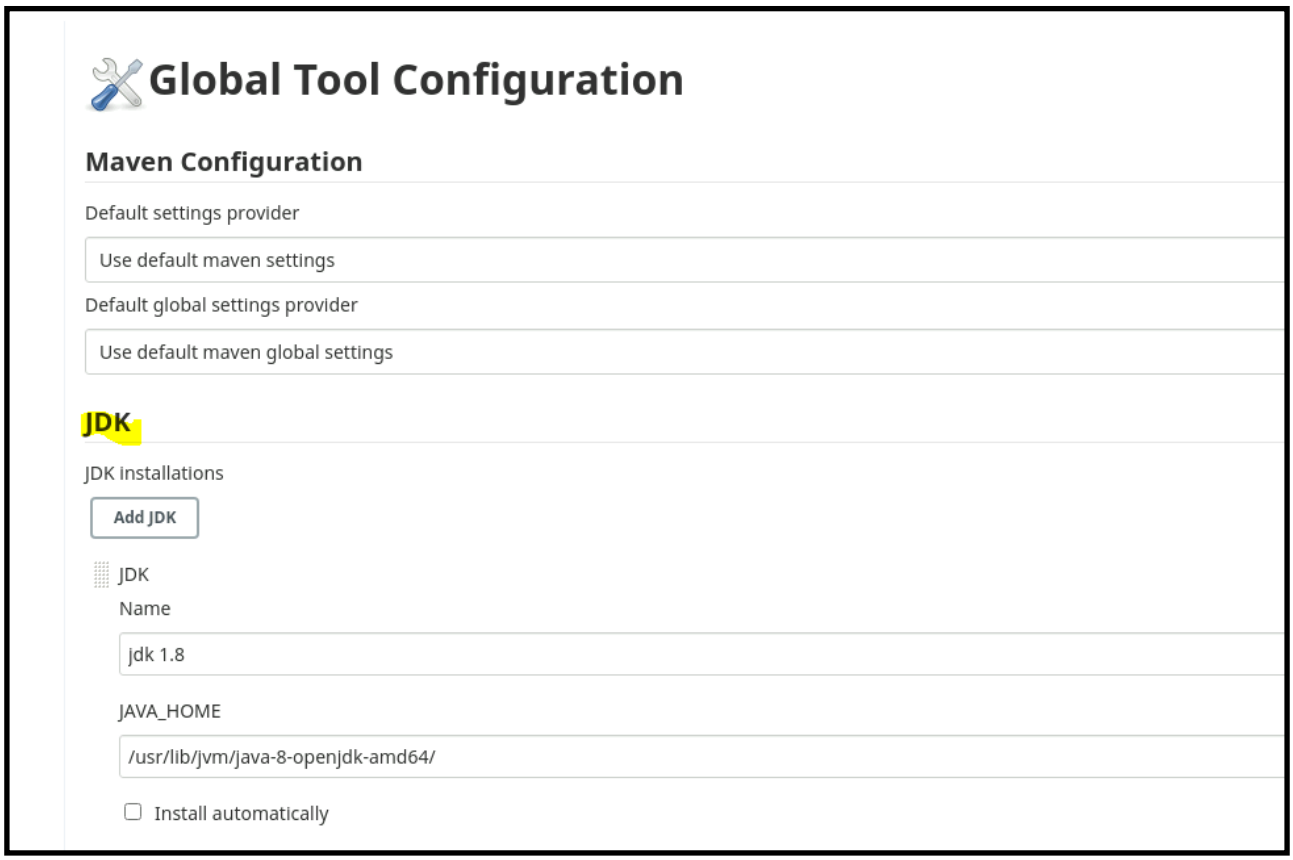





Updates
Available
Installed
Advanced
Enabled
Name ↓
Version
Authentication Tokens API Plugin
This plugin provides an API for converting credentials into authentication tokens in Jenkins.
1.4
Credentials Binding
Allows credentials to be bound to environment variables for use from miscellaneous build steps.
1.25
Credentials Plugin
This plugin allows you to store credentials in Jenkins.
2.5
Docker Commons Plugin
Provides the common shared functionality for various Docker-related plugins.
1.17
Docker Pipeline
Build and use Docker containers from pipelines.
1.26
Folders Plugin
This plugin allows users to create "folders" to organize jobs. Users can define custom taxonomies (like by project type, organization type etc). Folders are nestable and you can define views within folders. Maintained by CloudBees, Inc.
6.15

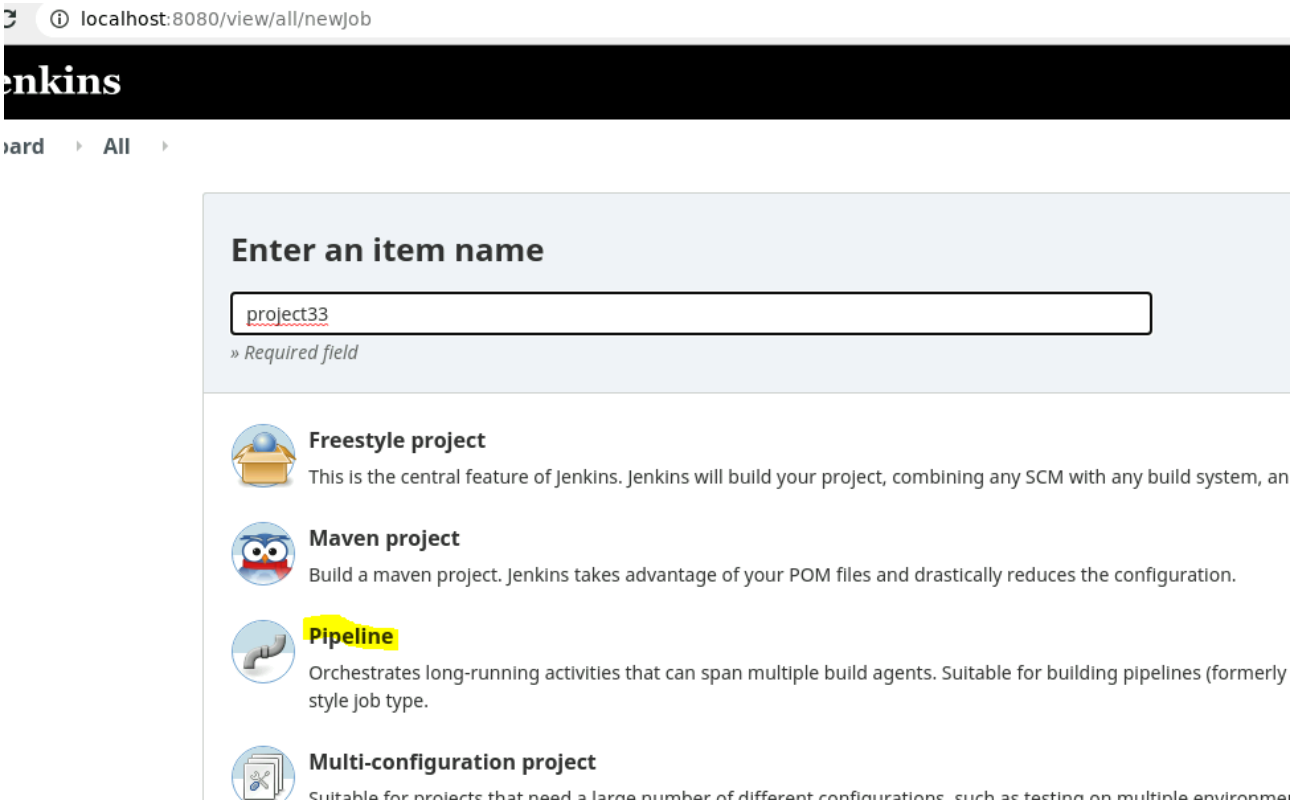
Step 6:

Global tools configuration in Jenkins is required as below:

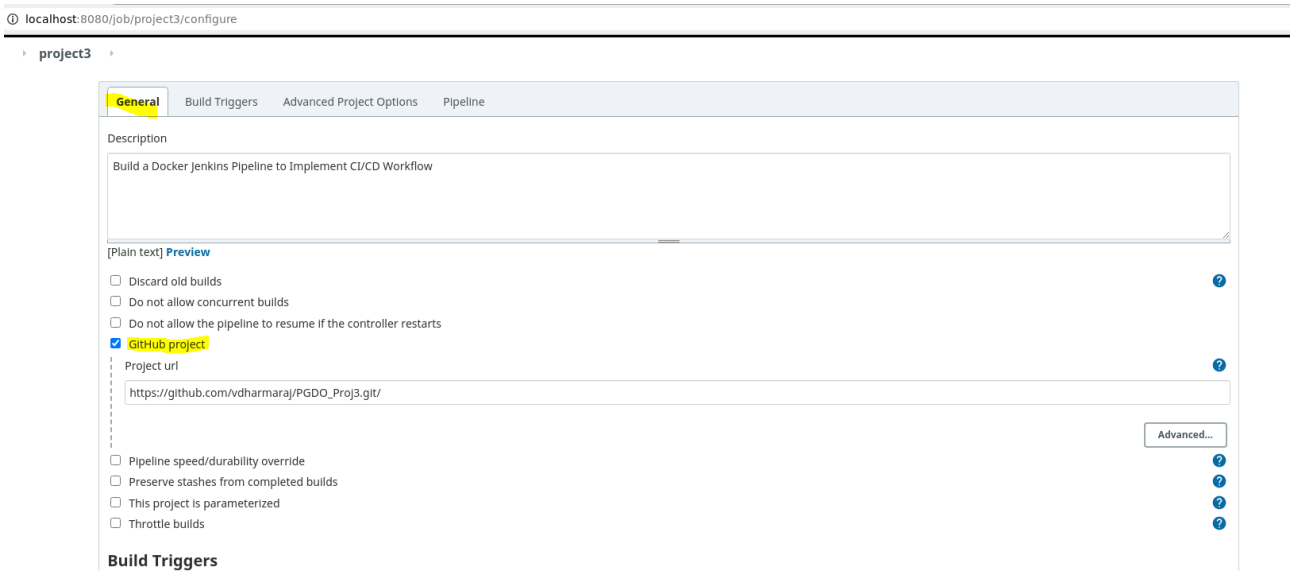


Step 07:

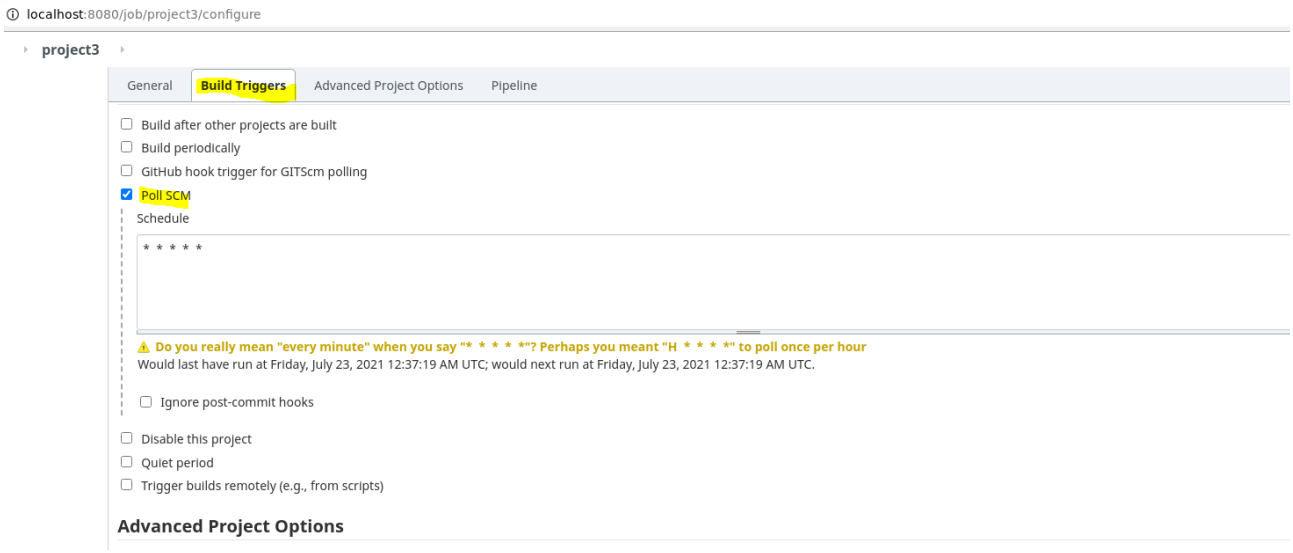
Create a Jenkins pipeline form the Git repository
New Pipeline Project has to be created in Jenkins server as below



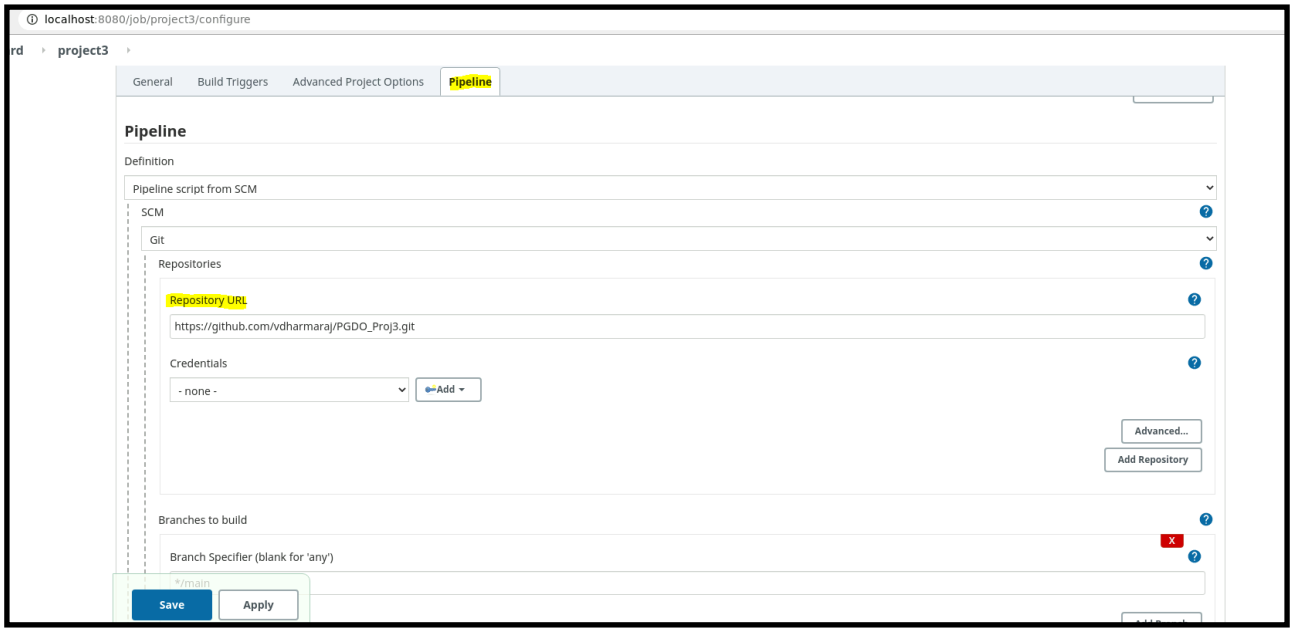
In General Tab, GitHub Project URL to be configured

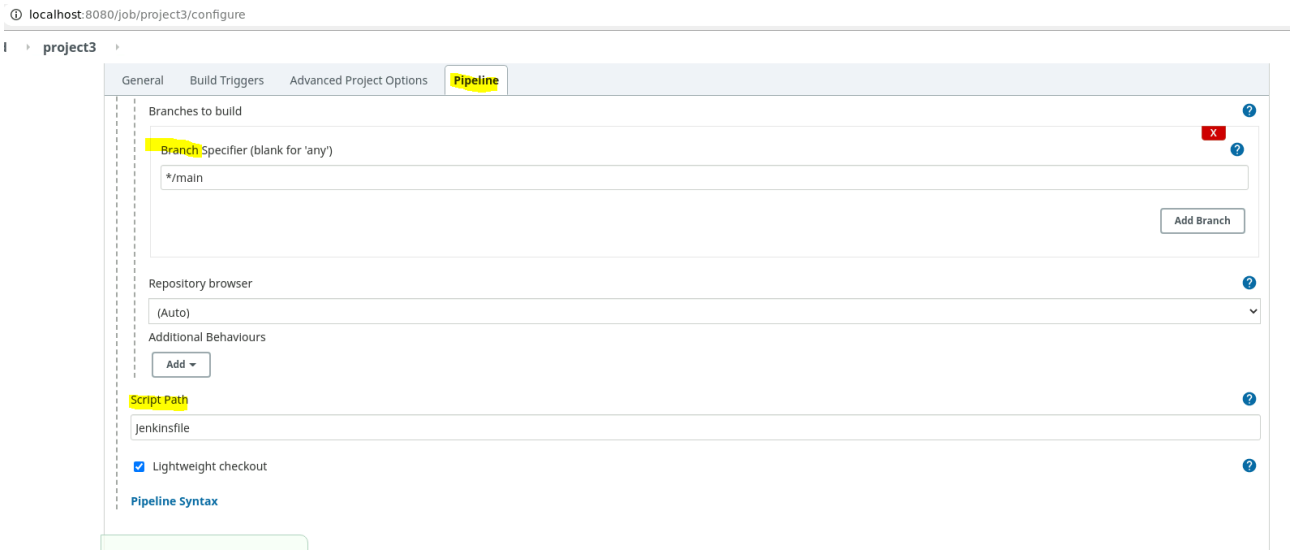


In the build triggers section, Poll SCM to be configured



In the pipeline section, our repo needs to be configured





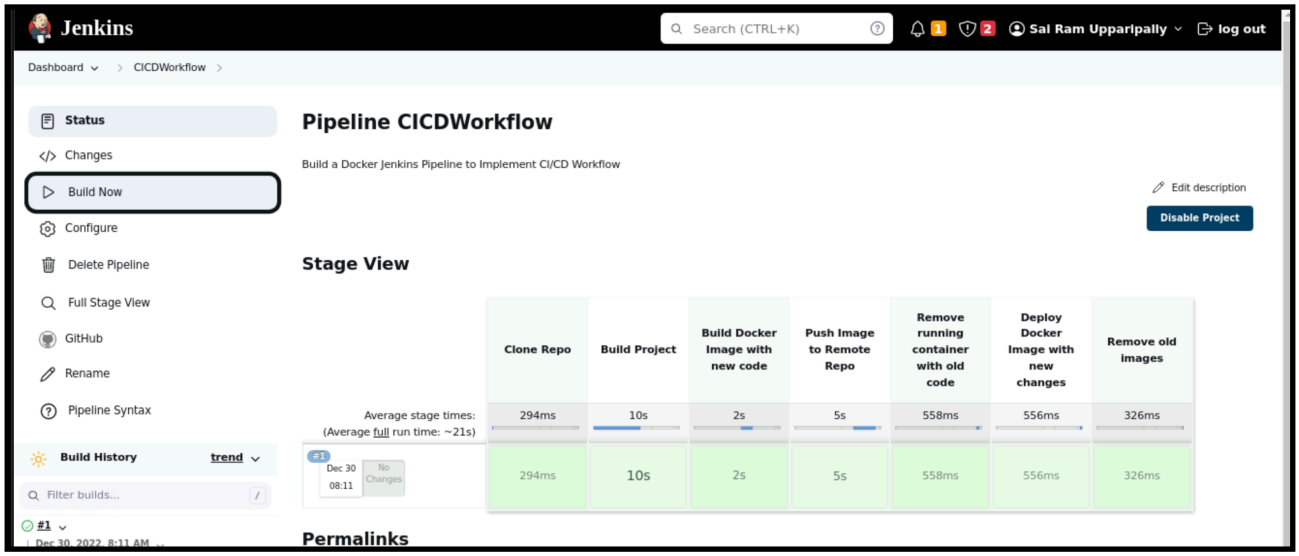
Step 8:

In out Repository the index.html file, this HTML file can be modified and the changes can be committed to the repository which will trigger the Jenkins Poll SCM job and the CI/CD process will be triggered to deploy the new application changes

4.Project Results

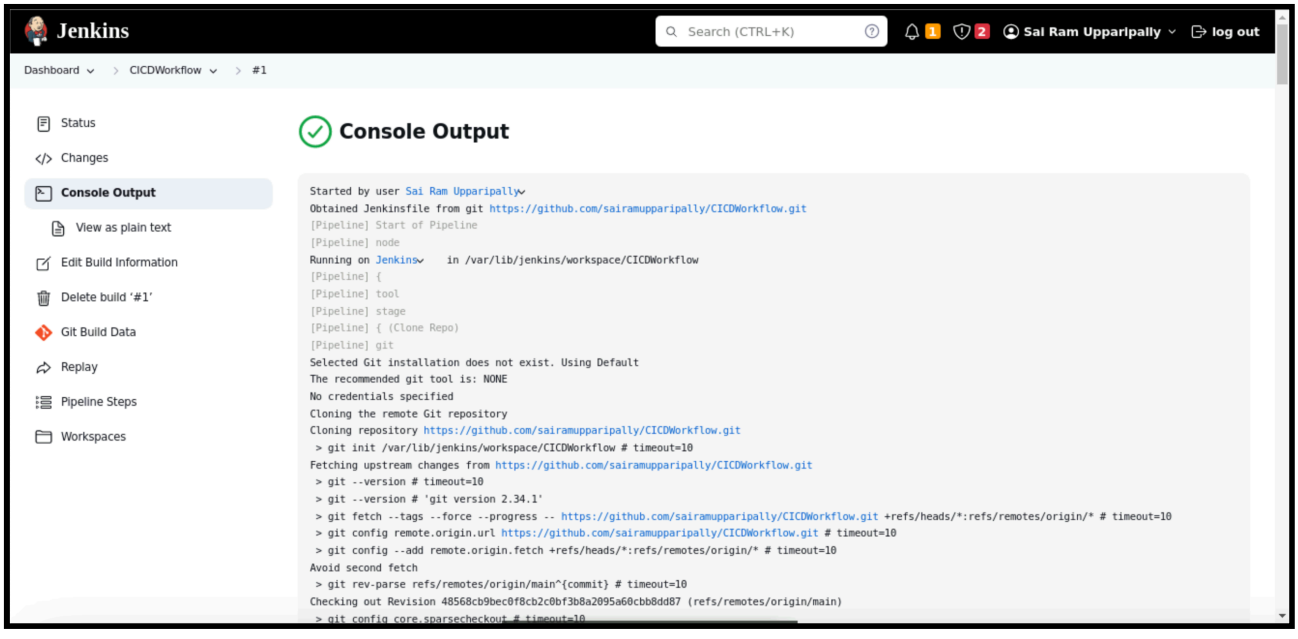
Result 1:

Jenkins job will be triggered automatically corresponding to the repository commit version, this can be seen in the Job build history



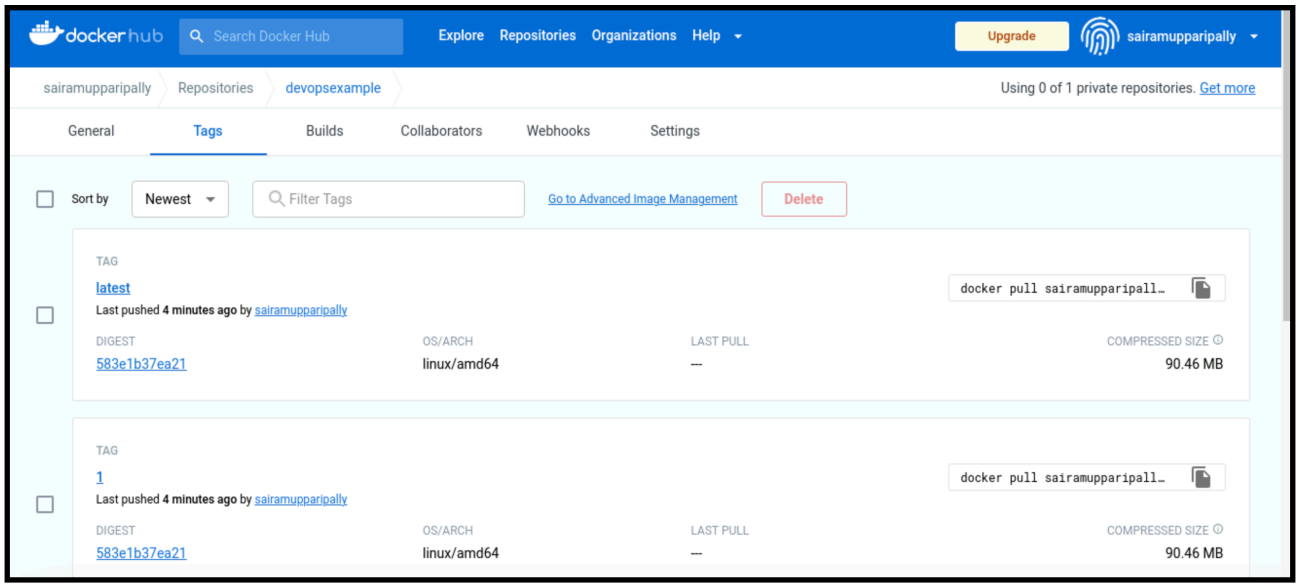
Result 2:

Every build and its console output can be seen to check the status of every Stage in the Jenkins pipeline



Result 3:

You can check in the Docker Hub for the latest image version published, which is having the latest repository code



5. Conclusion

Results shown is the previous section is the evidence that the Docker Jenkins Pipeline is implemented, enabling the CI/CD workflow.