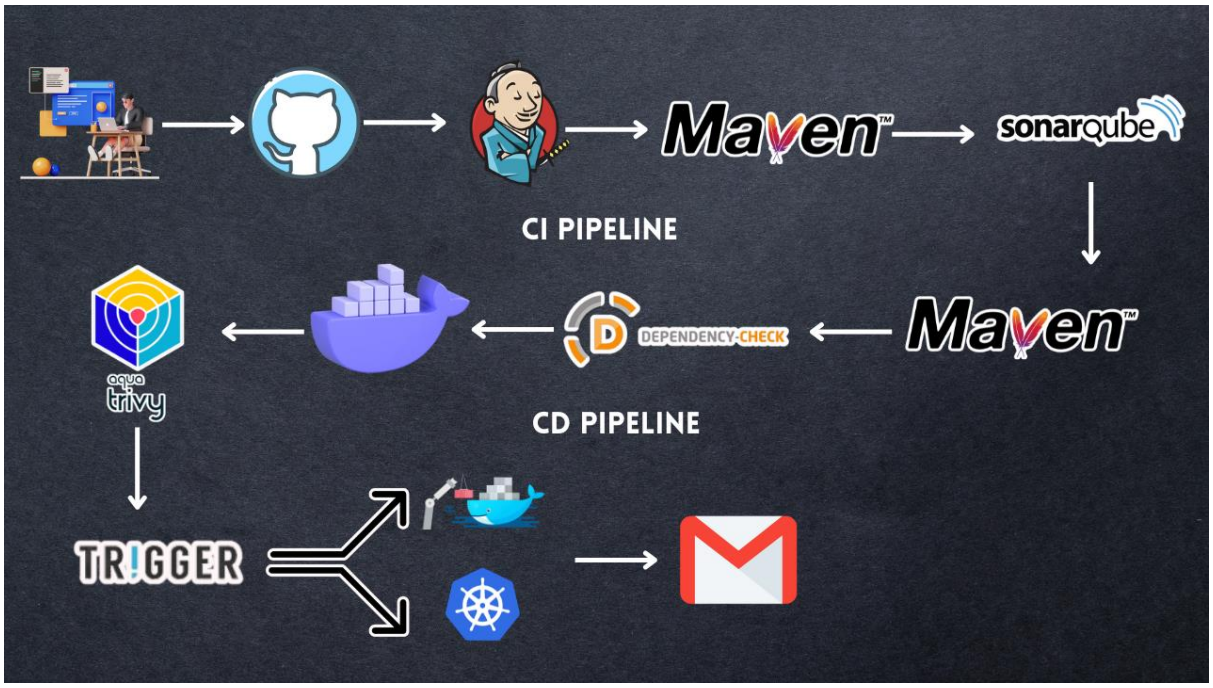
DEVSECOPS Project : Complete CI-CD (3 tier app)-Petshop



Hello friends, we will be deploying a Petshop Java Based Application. This is an everyday use case scenario used by several organizations. We will be using Jenkins as a CICD tool and deploying our application on a Docker container and Kubernetes cluster. Hope this detailed blog is useful.

We will be deploying our application in two ways, one using Docker Container and the other using K8S cluster.

Project Repo: https://github.com/Aj7Ay/jpetstore-6.git

Steps:-

Step 1 — Create an Ubuntu(22.04) T2 Large Instance

Step 2 — Install Jenkins, Docker and Trivy. Create a Sonarqube Container using Docker.

Step 3 — Install Plugins like JDK, Sonarqube Scanner, Maven, and OWASP Dependency Check.

Step 4 — Create a Pipeline Project in Jenkins using a Declarative Pipeline

Step 5 — Install OWASP Dependency Check Plugins

Step 6 — Docker Image Build and Push

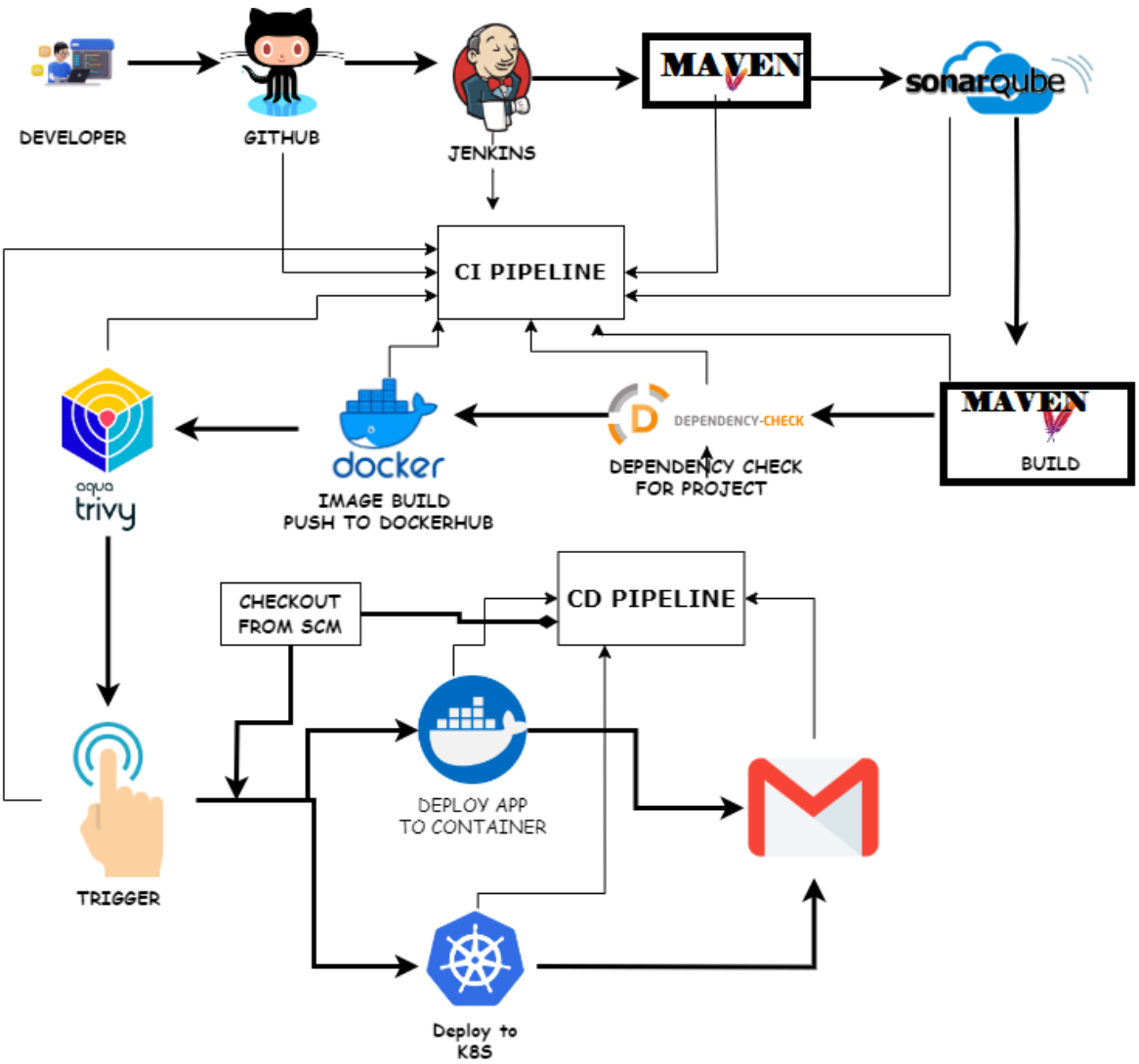
Step 7 — Deploy the image using Docker

Step 8 — Kubernetes master and slave setup on Ubuntu (20.04)

Step 9 — Access the Real World Application

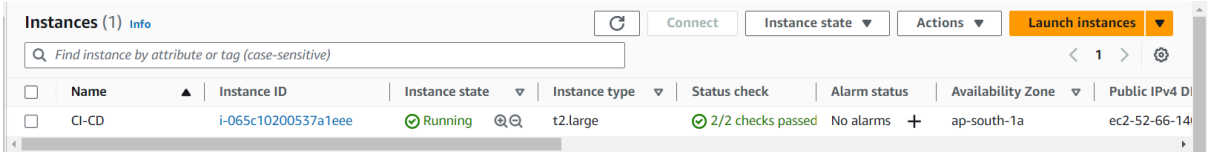
Step 10 — Terminate the AWS EC2 Instances.

Now, let's get started and dig deeper into each of these steps:-



STEP1:Create an Ubuntu(22.04) T2 Large Instance

Launch an AWS T2 Large Instance. Use the image as Ubuntu. You can create a new key pair or use an existing one. Enable HTTP and HTTPS settings in the Security Group and open all ports (not best case to open all ports but just for learning purposes it's okay).



Step 2 — Install Jenkins, Docker and Trivy

2A — To Install Jenkins

Connect to your console, and enter these commands to Install Jenkins

vi jenkins.sh

#!/bin/bash

sudo apt update -y

```
#sudo apt upgrade -y

wget -O - https://packages.adoptium.net/artifactory/api/gpg/key/public | tee
/etc/apt/keyrings/adoptium.asc

echo "deb [signed-by=/etc/apt/keyrings/adoptium.asc]
https://packages.adoptium.net/artifactory/deb $(awk -F= '/^VERSION_CODENAME/{print$2}'
/etc/os-release) main" | tee /etc/apt/sources.list.d/adoptium.list

sudo apt update -y

sudo apt install temurin-17-jdk -y

/usr/bin/java --version

curl -fsSL https://pkg.jenkins.io/debian-stable/jenkins.io-2023.key | sudo tee \

        /usr/share/keyrings/jenkins-keyring.asc > /dev/null

echo deb [signed-by=/usr/share/keyrings/jenkins-keyring.asc] \

        https://pkg.jenkins.io/debian-stable binary/ | sudo tee \

                /etc/apt/sources.list.d/jenkins.list > /dev/null

sudo apt-get update -y

sudo apt-get install jenkins -y

sudo systemctl start jenkins

sudo systemctl status jenkins

sudo chmod 777 jenkins.sh

./jenkins.sh  # this will installl jenkins
```

Once Jenkins is installed, you will need to go to your AWS EC2 Security Group and open Inbound Port 8080, since Jenkins works on Port 8080.

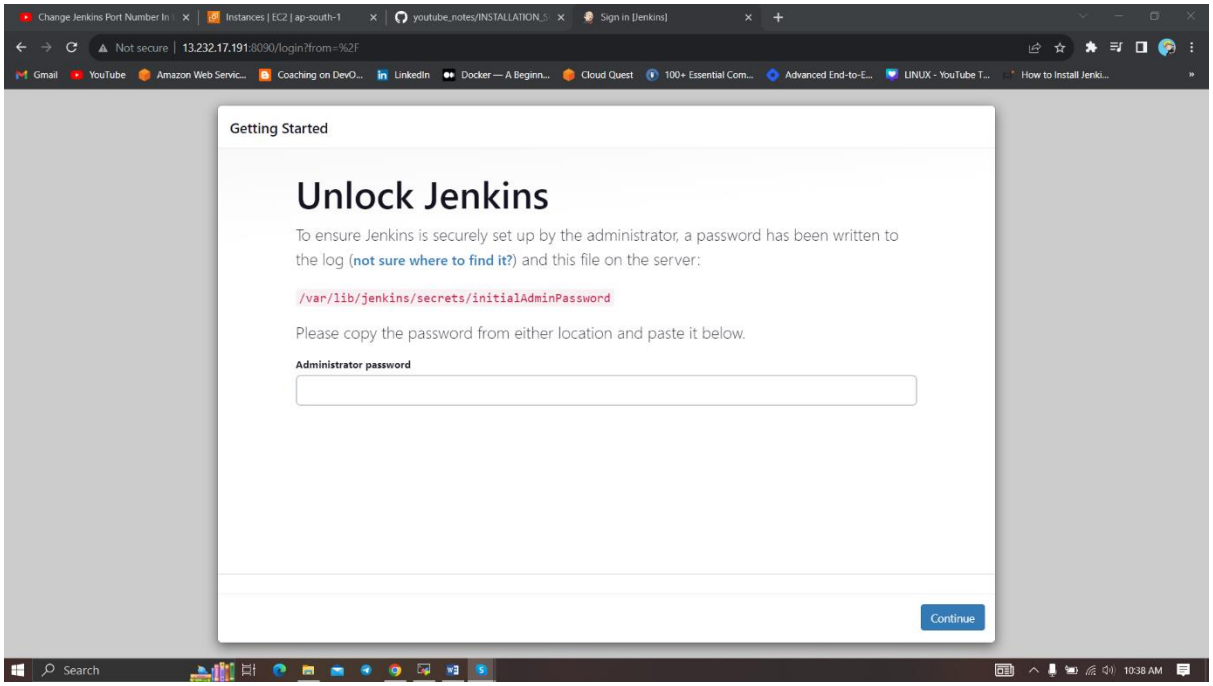
But for this Application case, we are running Jenkins on another port. so change the port to 8090 using the below commands.

```
sudo systemctl stop jenkins

sudo systemctl status jenkins

cd /etc/default

sudo vi jenkins   #chnage port HTTP_PORT=8090 and save and exit

cd /lib/systemd/system

sudo vi jenkins.service  #change Environments="Jenkins_port=8090" save and exit

sudo systemctl daemon-reload

sudo systemctl restart jenkins

sudo systemctl status jenkins
```

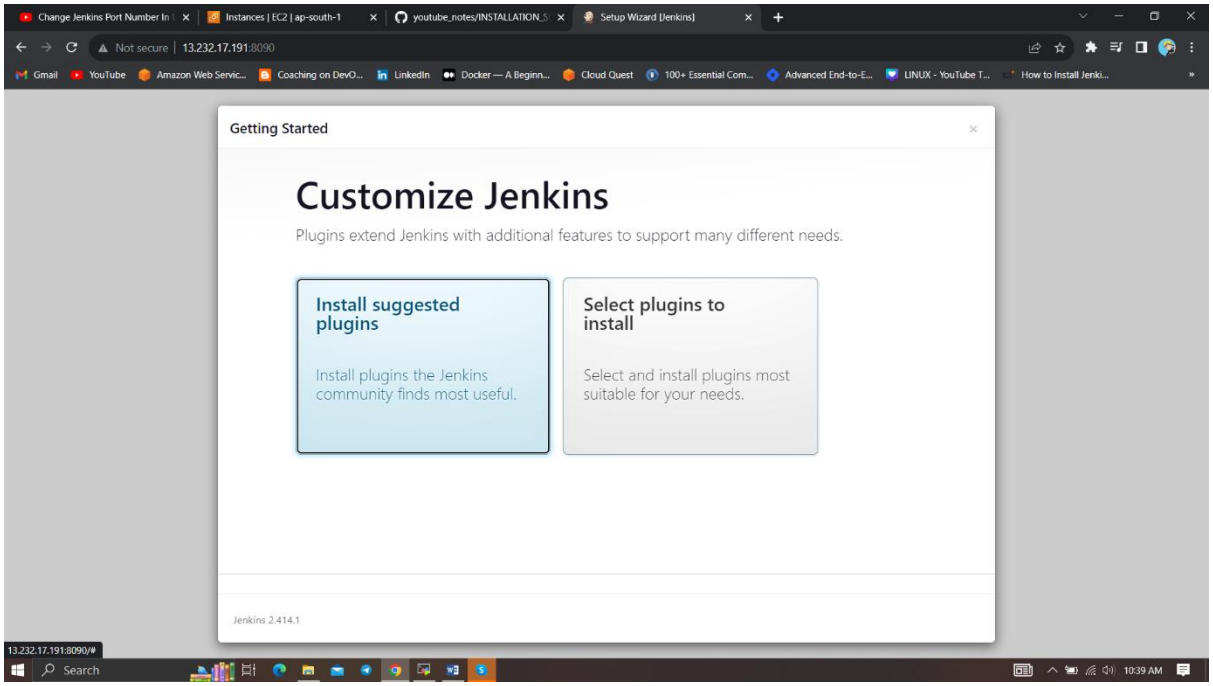
Now, grab your Public IP Address

EC2 Public IP Address:8090

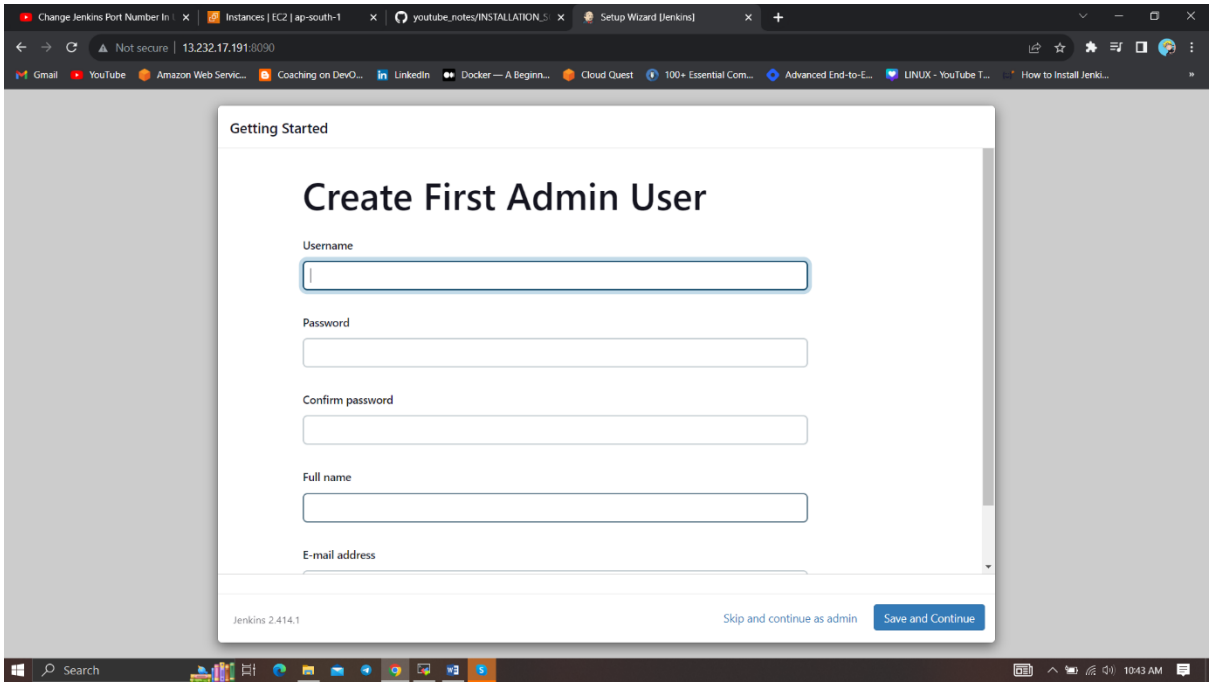
sudo cat /var/lib/jenkins/secrets/initialAdminPassword



Unlock Jenkins using an administrative password and install the suggested plugins.

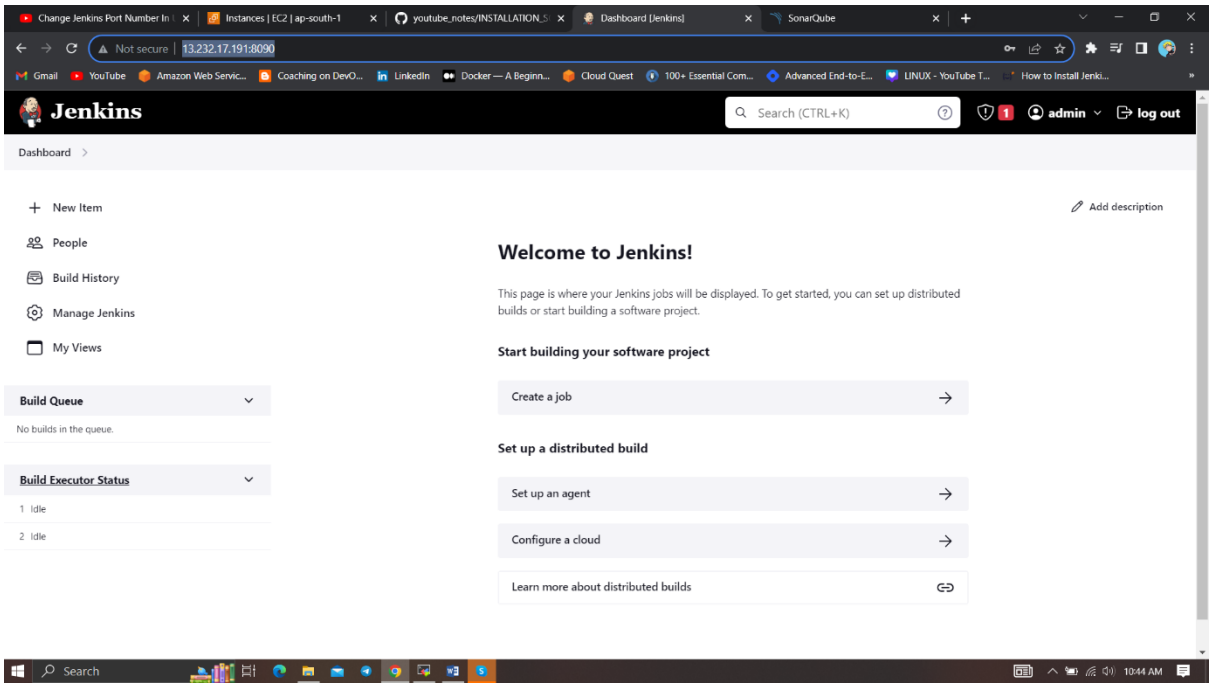


Jenkins will now get installed and install all the libraries.



Create a user click on save and continue.

Jenkins Getting Started Screen.



2B — Install Docker

sudo apt-get update

sudo apt-get install docker.io -y

sudo usermod -aG docker $USER

newgrp docker

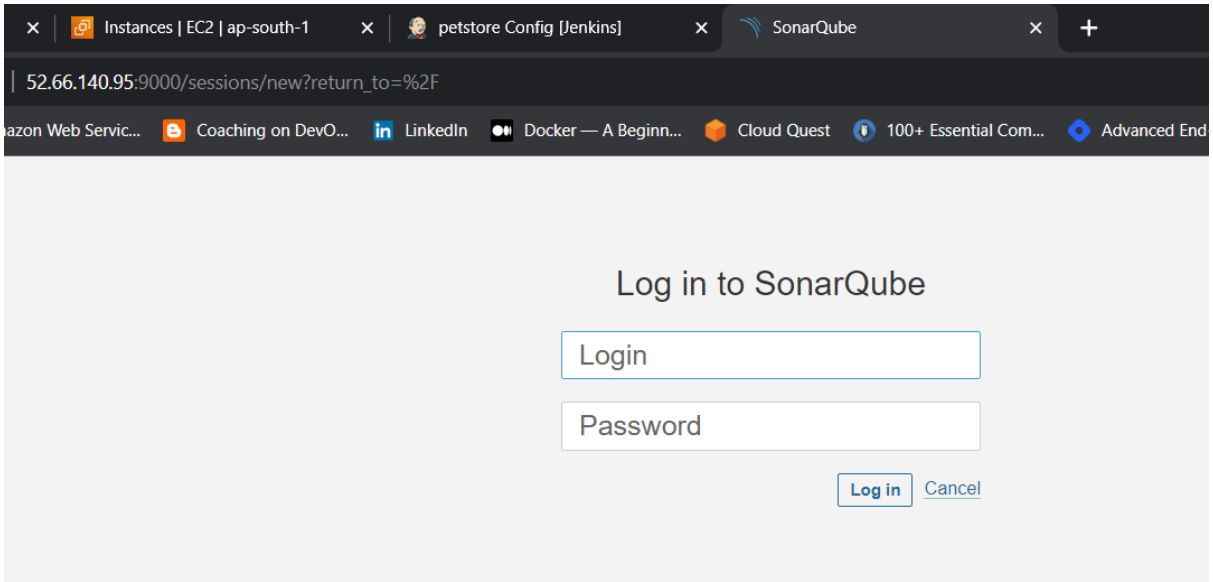
sudo chmod 777 /var/run/docker.sock

After the docker installation, we create a sonarqube container (Remember added 9000 ports in the security group).

docker run -d --name sonar -p 9000:9000 sonarqube:lts-community

```
ubuntu@ip-172-31-42-253:~$ sudo chmod 777 /var/run/docker.sock
ubuntu@ip-172-31-42-253:~$ docker run -d --name sonar -p 9000:9000 sonarqube:lts-community
Unable to find image 'sonarqube:lts-community' locally
lts-community: Pulling from library/sonarqube
44ba2882f8eb: Pull complete
2cabec57fa36: Pull complete
c20481384b6a: Pull complete
bf7b17ee74f8: Pull complete
38617faac714: Pull complete
706f20f58f5e: Pull complete
65a29568c257: Pull complete
Digest: sha256:1a118f8ab960d6c3d4ea8b4455a5a6560654511c88a6816f1603f764d5dcc77c
Status: Downloaded newer image for sonarqube:lts-community
4b60c96bf9ad3d62289436af7f752fdb04993092d0ca3065e2f2e32301b50139
ubuntu@ip-172-31-42-253:~$ docker ps
CONTAINER ID   IMAGE                   COMMAND                  CREATED         STATUS         PORTS                                       NAMES
4b60c96bf9ad   sonarqube:lts-community   "/opt/sonarqube/dock…"   9 seconds ago   Up 5 seconds   0.0.0.0:9000->9000/tcp, :::9000->9000/tcp   sonar
ubuntu@ip-172-31-42-253:~$
```

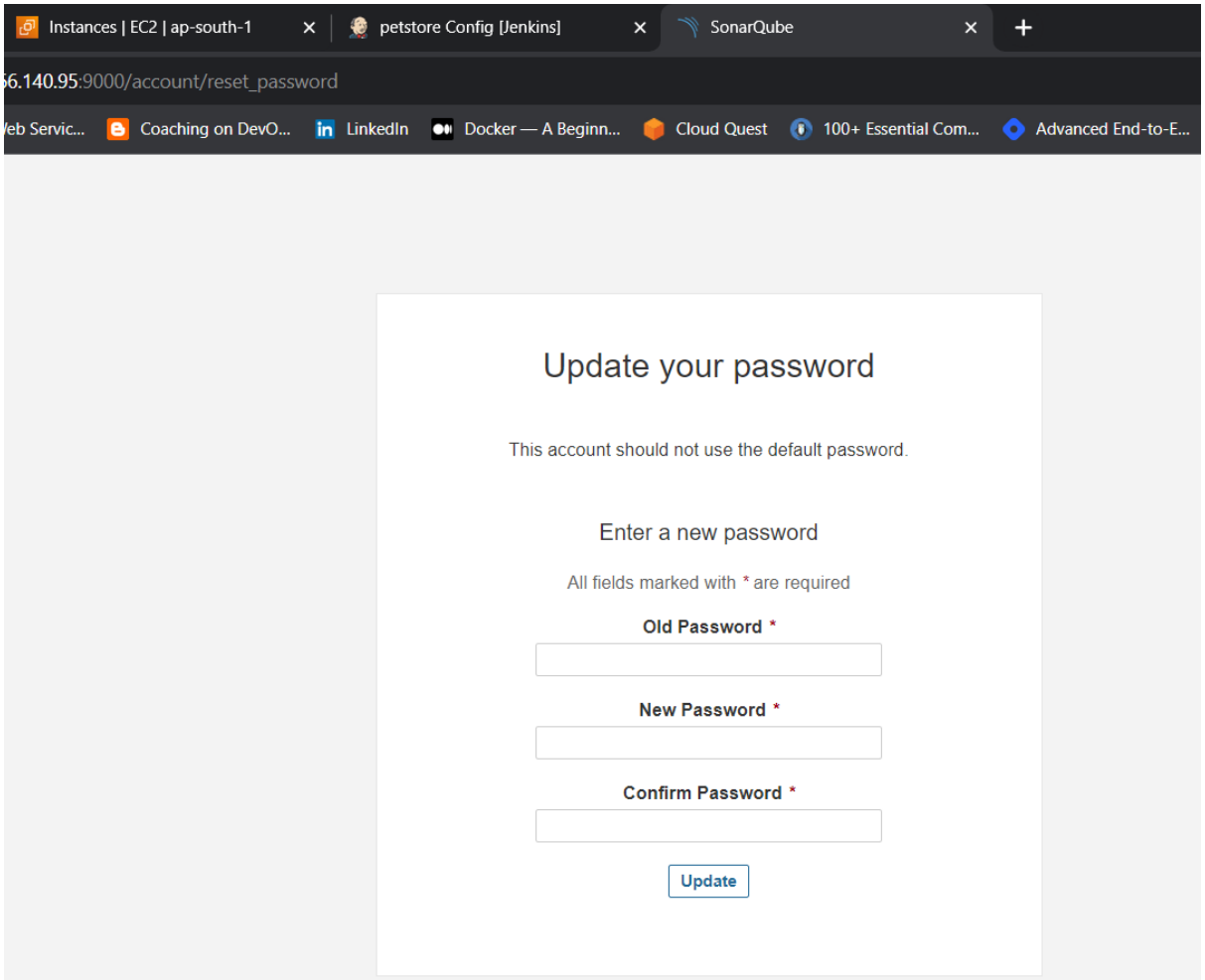
Now our sonarqube is up and running



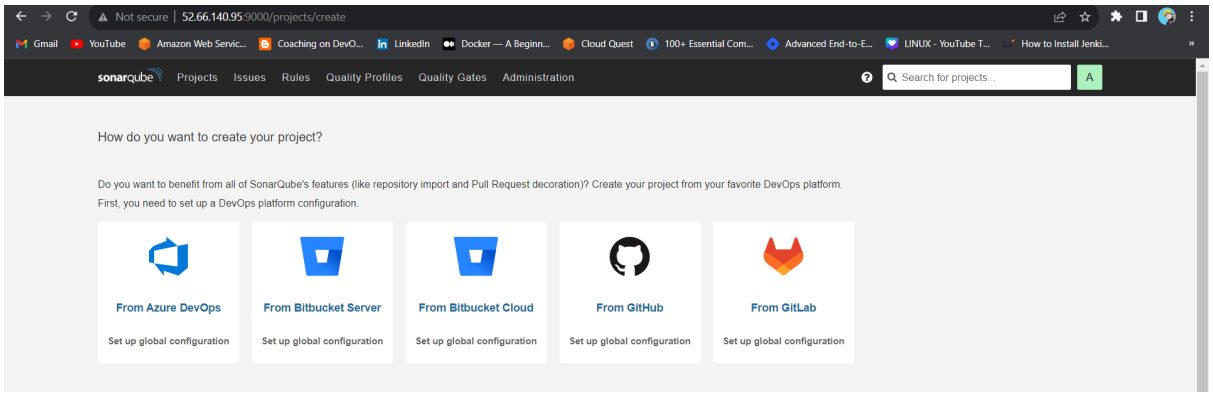
Enter username and password, click on login and change password

username admin

password admin



Update New password, This is Sonar Dashboard.



2C — Install Trivy

vi trivy.sh

sudo apt-get install wget apt-transport-https gnupg lsb-release -y

wget -qO - https://aquasecurity.github.io/trivy-repo/deb/public.key | gpg --dearmor | sudo tee /usr/share/keyrings/trivy.gpg > /dev/null

echo "deb [signed-by=/usr/share/keyrings/trivy.gpg] https://aquasecurity.github.io/trivy-repo/deb $(lsb_release -sc) main" | sudo tee -a /etc/apt/sources.list.d/trivy.list

sudo apt-get update

sudo apt-get install trivy -y

Next, we will log in to Jenkins and start to configure our Pipeline in Jenkins

Step 3 — Install Plugins like JDK, Sonarqube Scanner, Maven, OWASP Dependency Check

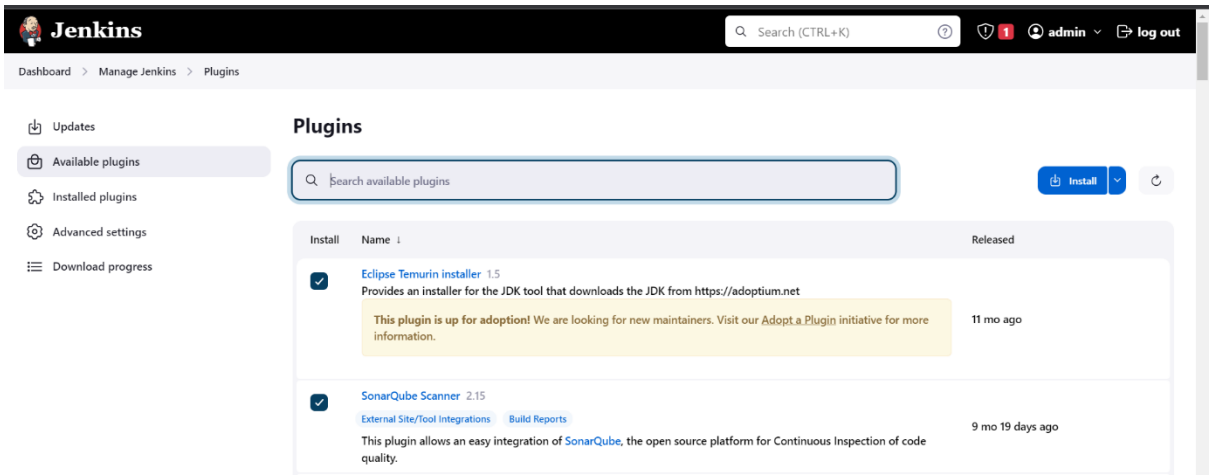
3A — Install Plugin

Goto Manage Jenkins →Plugins → Available Plugins →

Install below plugins

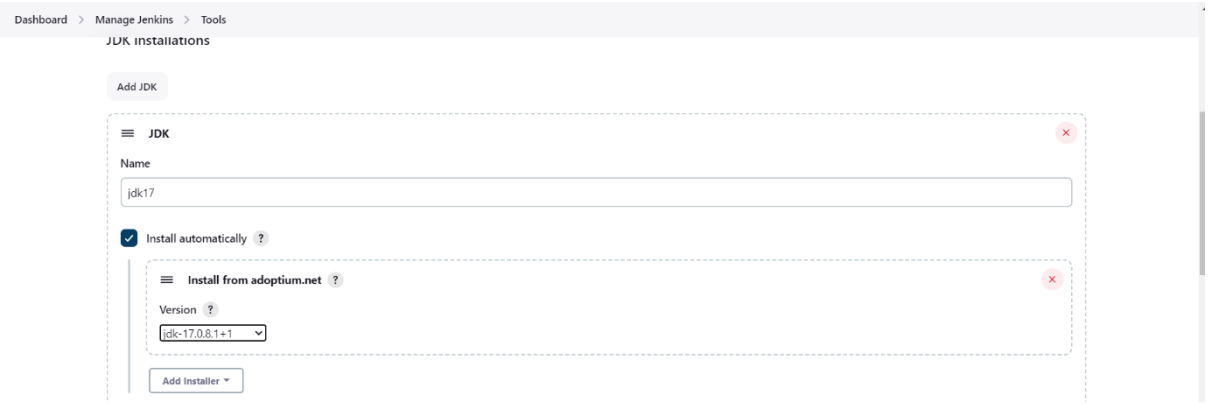
1 → Eclipse Temurin Installer (Install without restart)

2 → SonarQube Scanner (Install without restart)



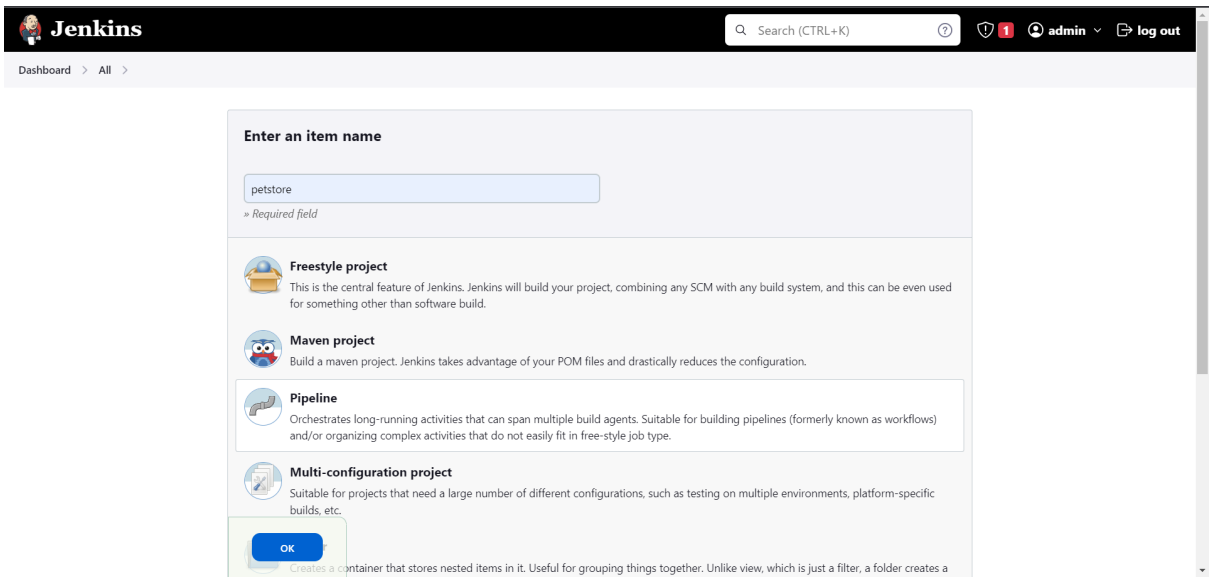
3B — Configure Java and Maven in Global Tool Configuration

Goto Manage Jenkins → Tools → Install JDK(17) and Maven3(3.6.0) → Click on Apply and Save



3C — Create a Job

Label it as PETSHOP, click on Pipeline and OK.

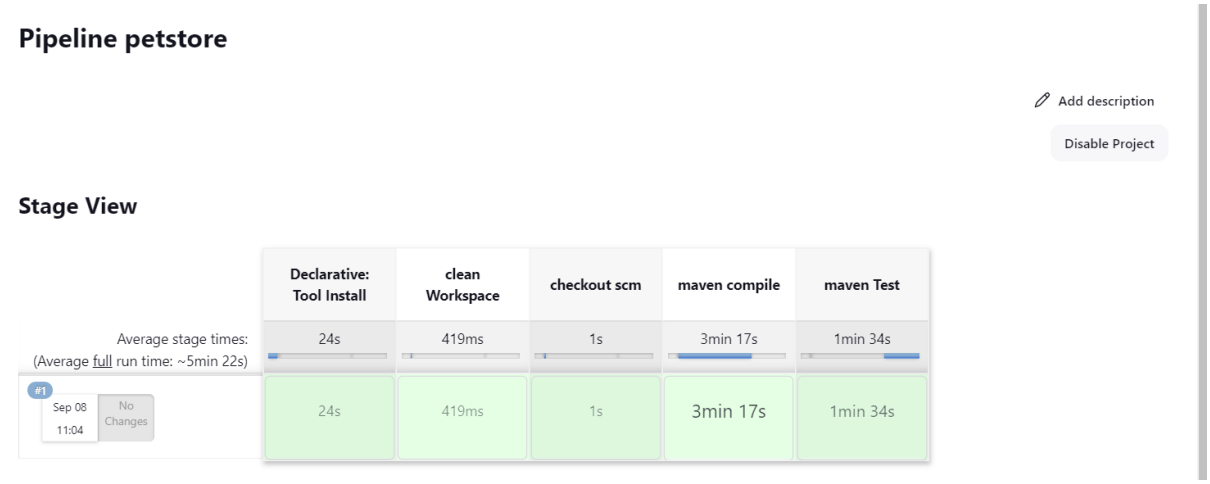


Enter this in Pipeline Script,

```
pipeline{
   agent any
   tools {
      jdk 'jdk17'
      maven 'maven3'
```

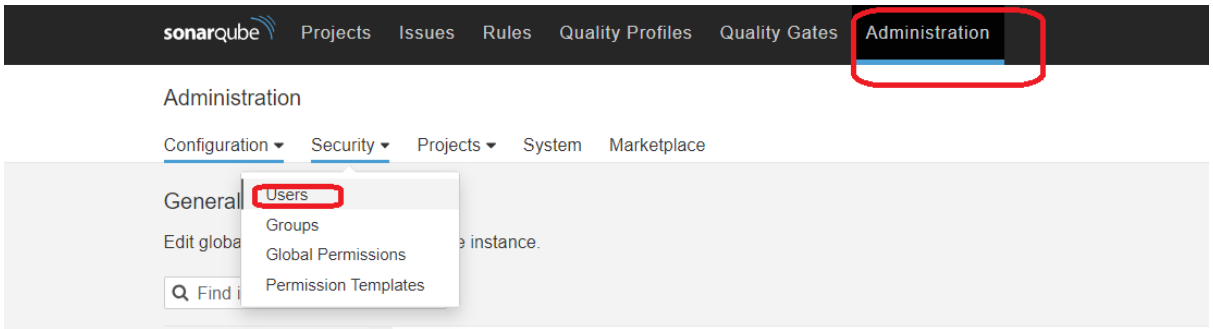
```
    }
    stages{
        stage ('clean Workspace'){
            steps{
                cleanWs()
            }
        }
        stage ('checkout scm') {
            steps {
                git 'https://github.com/Aj7Ay/jpetstore-6.git'
            }
        }
        stage ('maven compile') {
            steps {
                sh 'mvn clean compile'
            }
        }
        stage ('maven Test') {
            steps {
                sh 'mvn test'
            }
        }
    }
}
```

The stage view would look like this,

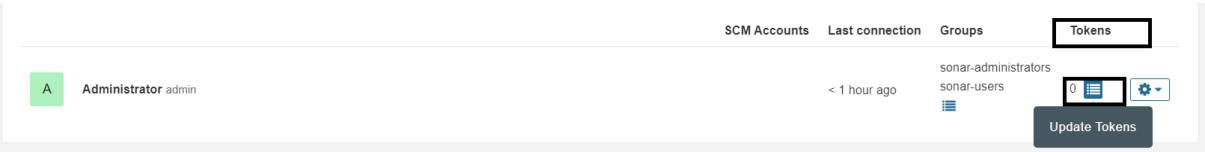


Step 4 — Configure Sonar Server in Manage Jenkins

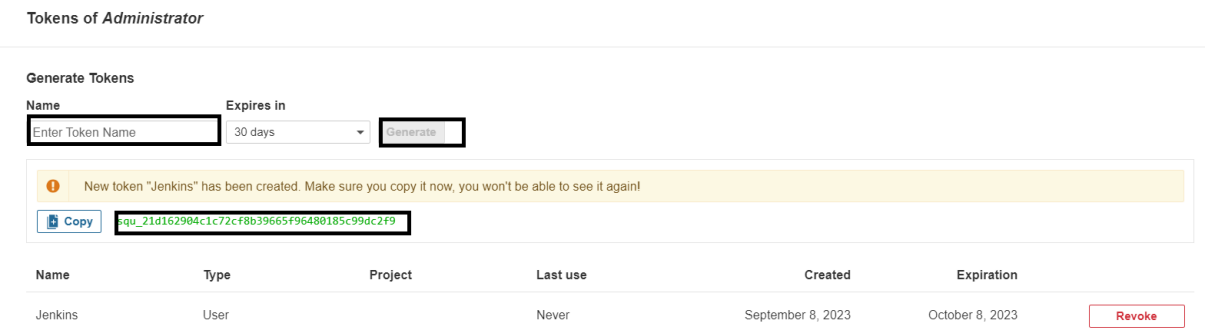
Grab the Public IP Address of your EC2 Instance, Sonarqube works on Port 9000, so <Public IP>:9000. Goto your Sonarqube Server. Click on Administration → Security → Users → Click on Tokens and Update Token → Give it a name → and click on Generate Token



click on update Token

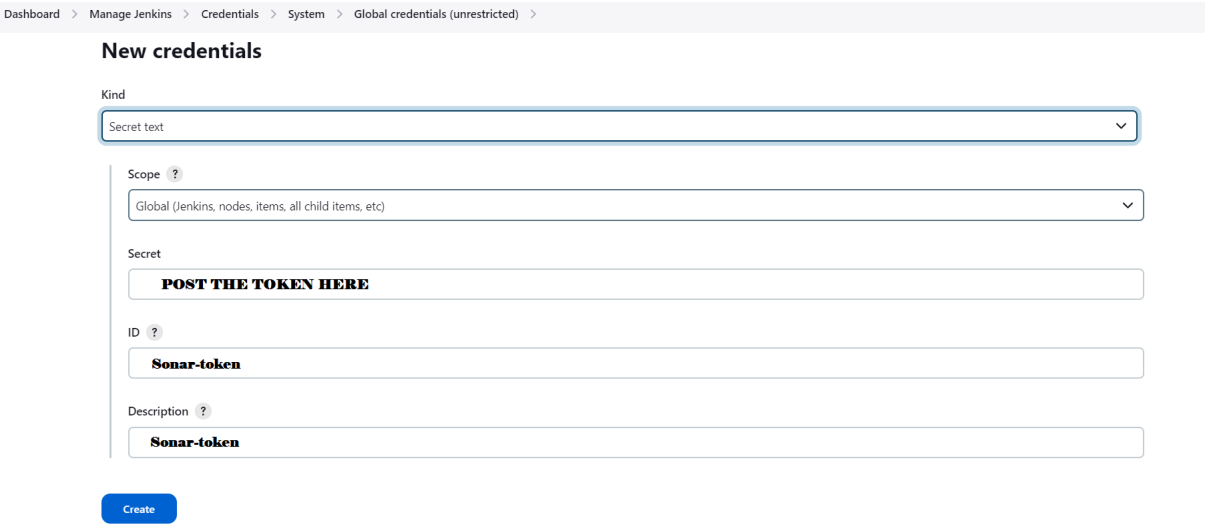


Create a token with a name and generate

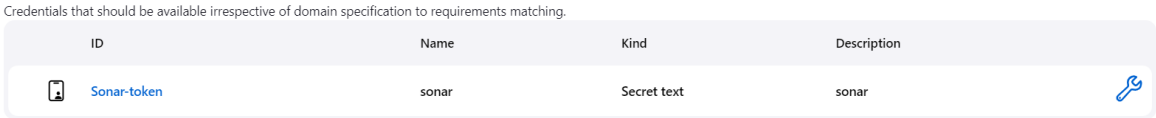


copy Token

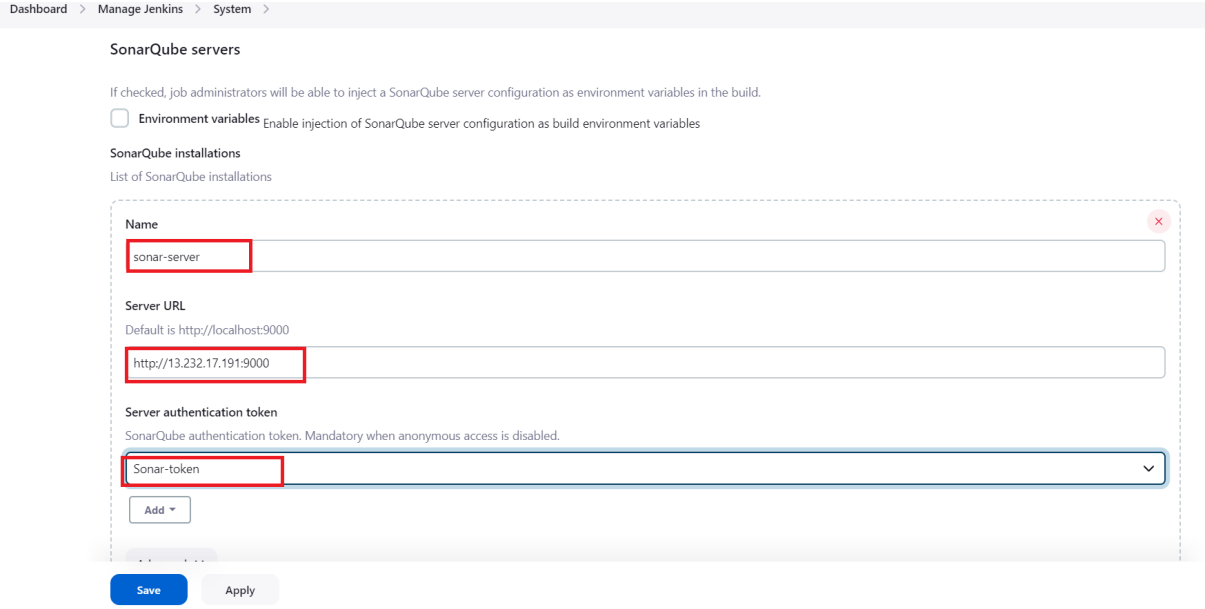
Goto Jenkins Dashboard → Manage Jenkins → Credentials → Add Secret Text. It should look like this



You will this page once you click on create



Now, go to Dashboard → Manage Jenkins → System and Add like the below image.

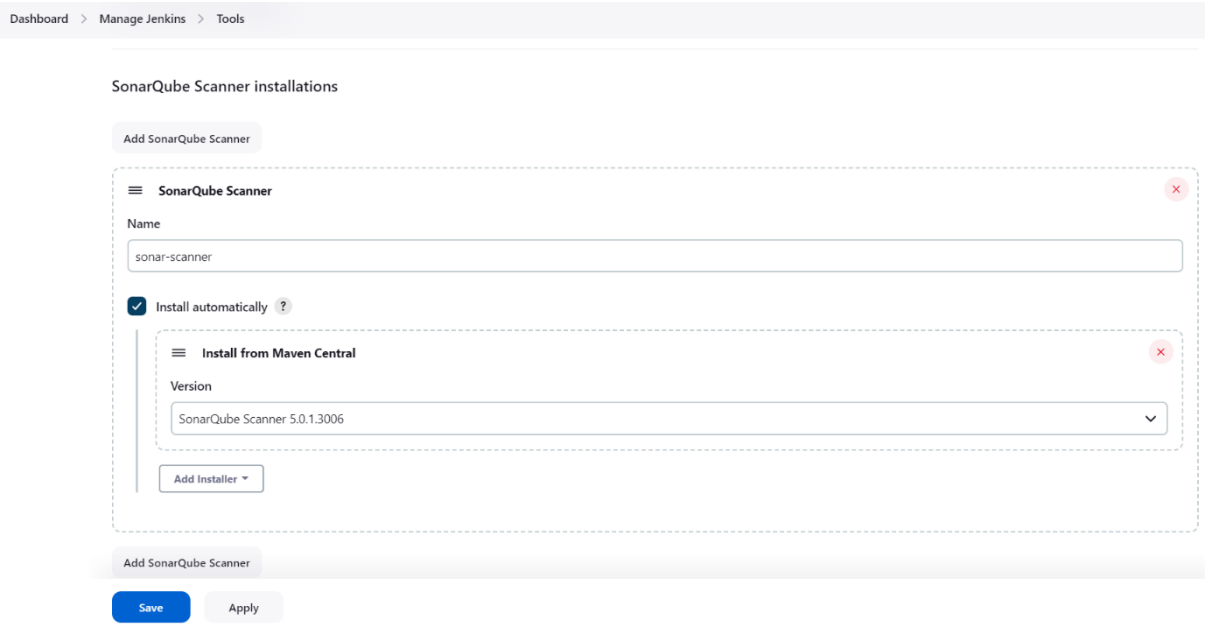


Click on Apply and Save

The Configure System option is used in Jenkins to configure different server

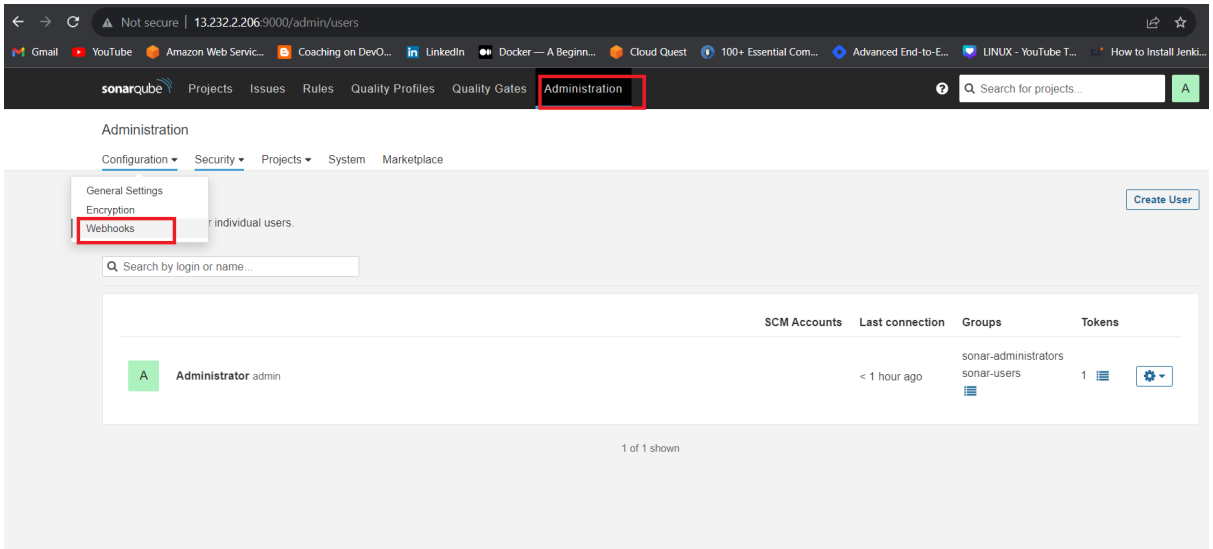
Global Tool Configuration is used to configure different tools that we install using Plugins

We will install a sonar scanner in the tools.

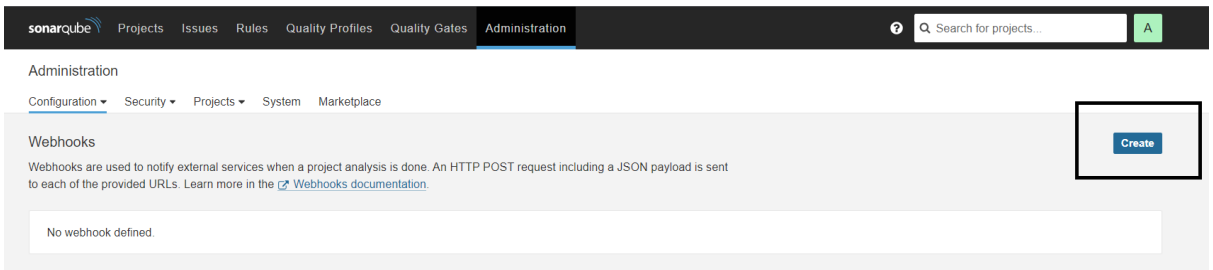


In the Sonarqube Dashboard add a quality gate also

Administration–> Configuration–>Webhooks



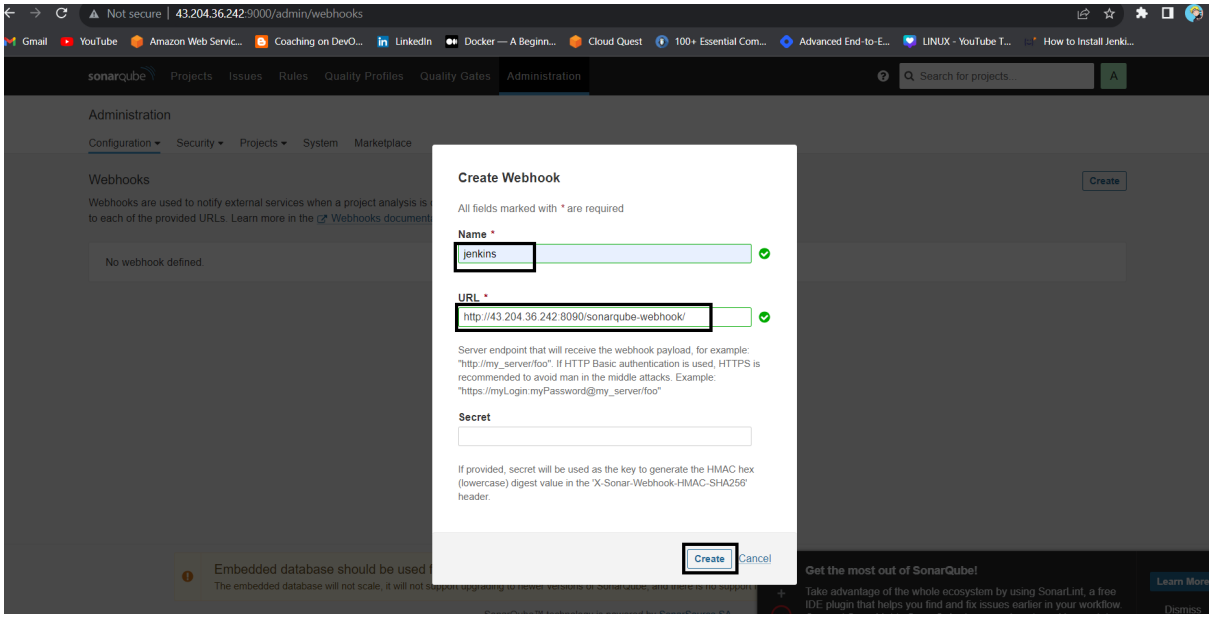
Click on Create



Add details

#in url section of quality gate

http://jenkins-public-ip:8090/sonarqube-webhook/

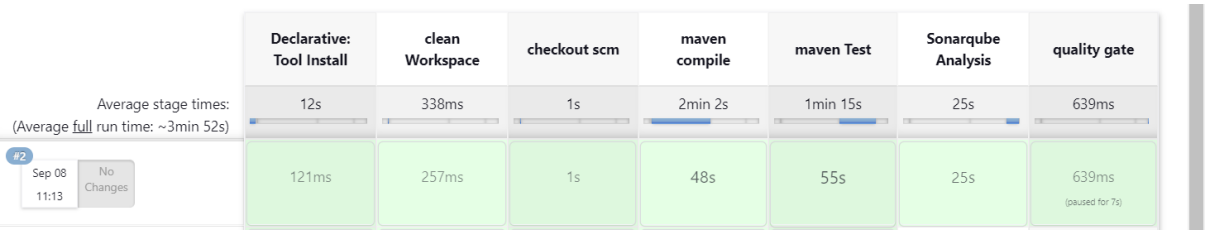


Let's go to our Pipeline and add Sonarqube Stage in our Pipeline Script.

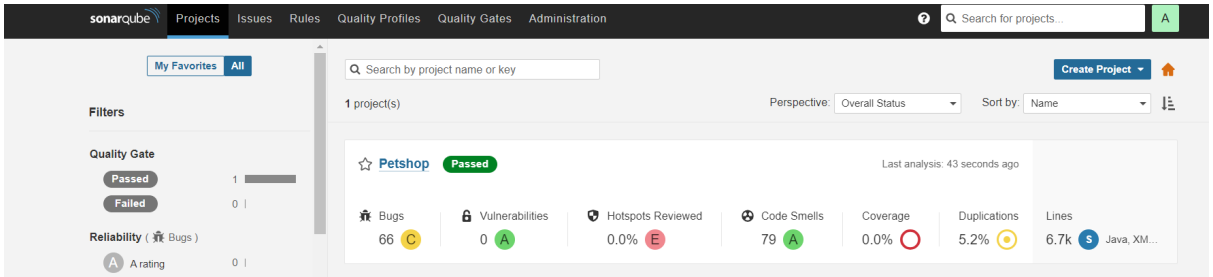
```
#under tools section add this environment
environment {
      SCANNER_HOME=tool 'sonar-scanner'
   }
# in stages add this
stage("Sonarqube Analysis "){
         steps{
            withSonarQubeEnv('sonar-server') {
               sh ''' $SCANNER_HOME/bin/sonar-scanner -Dsonar.projectName=Petshop \
               -Dsonar.java.binaries=. \
               -Dsonar.projectKey=Petshop '''
            }
         }
      }
      stage("quality gate"){
         steps {
            script {
              waitForQualityGate abortPipeline: false, credentialsId: 'Sonar-token'
            }
```

```
        }
    }
```

Click on Build now, you will see the stage view like this



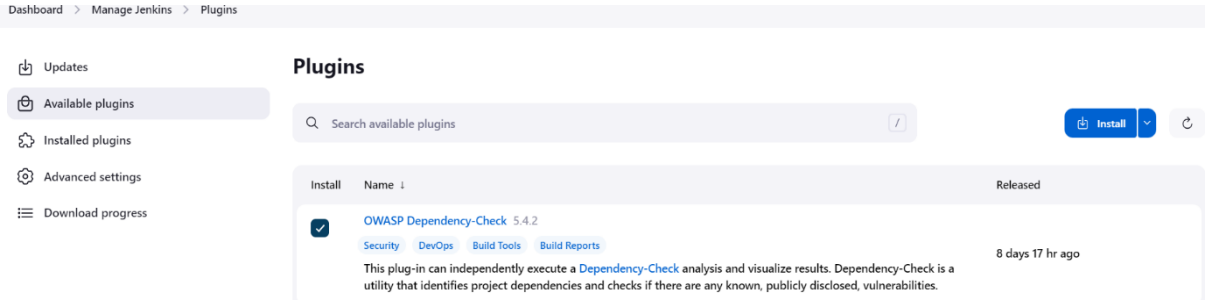
To see the report, you can go to Sonarqube Server and go to Projects.



You can see the report has been generated and the status shows as passed. You can see that there are 6.7k lines. To see a detailed report, you can go to issues.

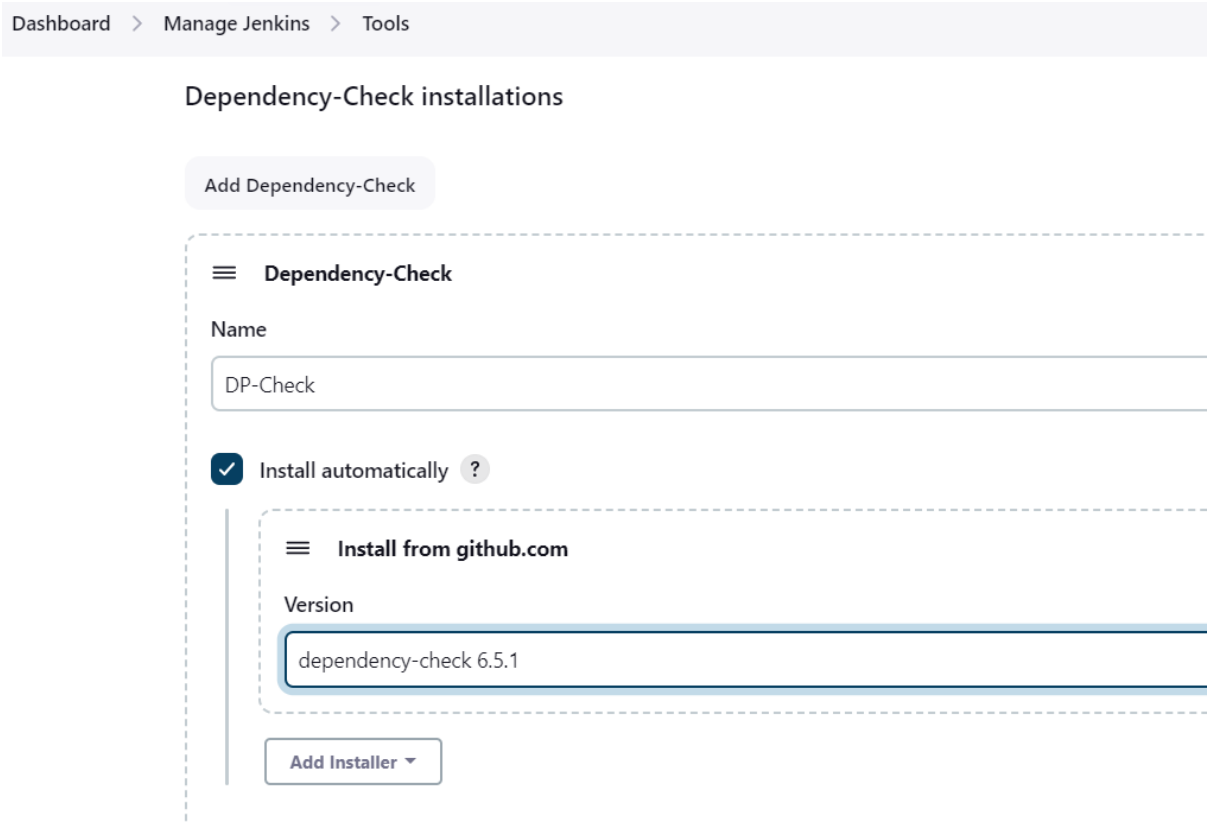
Step 5 — Install OWASP Dependency Check Plugins

GotoDashboard → Manage Jenkins → Plugins → OWASP Dependency-Check. Click on it and install it without restart.



First, we configured the Plugin and next, we had to configure the Tool

Goto Dashboard → Manage Jenkins → Tools →



Click on Apply and Save here.

Now go configure → Pipeline and add this stage to your pipeline and build.

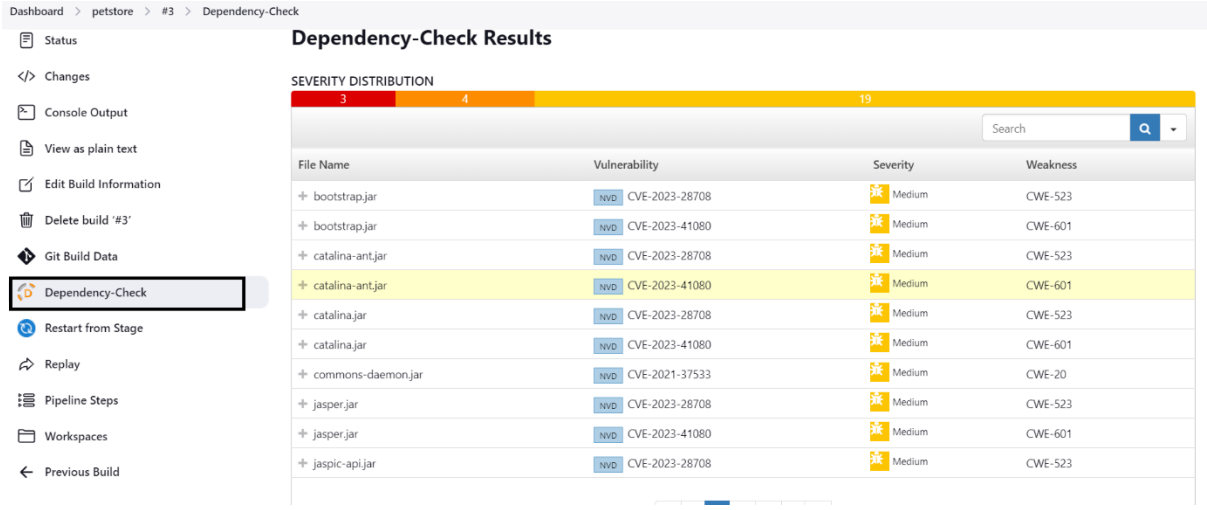
```
stage ('Build war file'){
        steps{
            sh 'mvn clean install -DskipTests=true'
        }
    }
    stage("OWASP Dependency Check"){
        steps{
            dependencyCheck additionalArguments: '--scan ./ --format XML ', odcInstallation: 'DP-Check'
            dependencyCheckPublisher pattern: '**/dependency-check-report.xml'
        }
    }
```

The stage view would look like this,

Stage View

	Declarative: Tool Install	clean Workspace	checkout scm	maven compile	maven Test	Sonarqube Analysis	quality gate	Build war file	OWASP Dependency Check
Average stage times: (Average full run time: ~5min 33s)	8s	305ms	1s	1min 38s	1min 9s	23s	519ms	2min 8s	4min 32s
#3 Sep 08 11:17 No Changes	117ms	240ms	1s	48s	56s	21s	400ms (paused for 4s)	2min 8s	4min 32s

You will see that in status, a graph will also be generated and Vulnerabilities.



Step 6 — Docker Image Build and Push

We need to install the Docker tool in our system, Goto Dashboard → Manage Plugins → Available plugins → Search for Docker and install these plugins

Docker

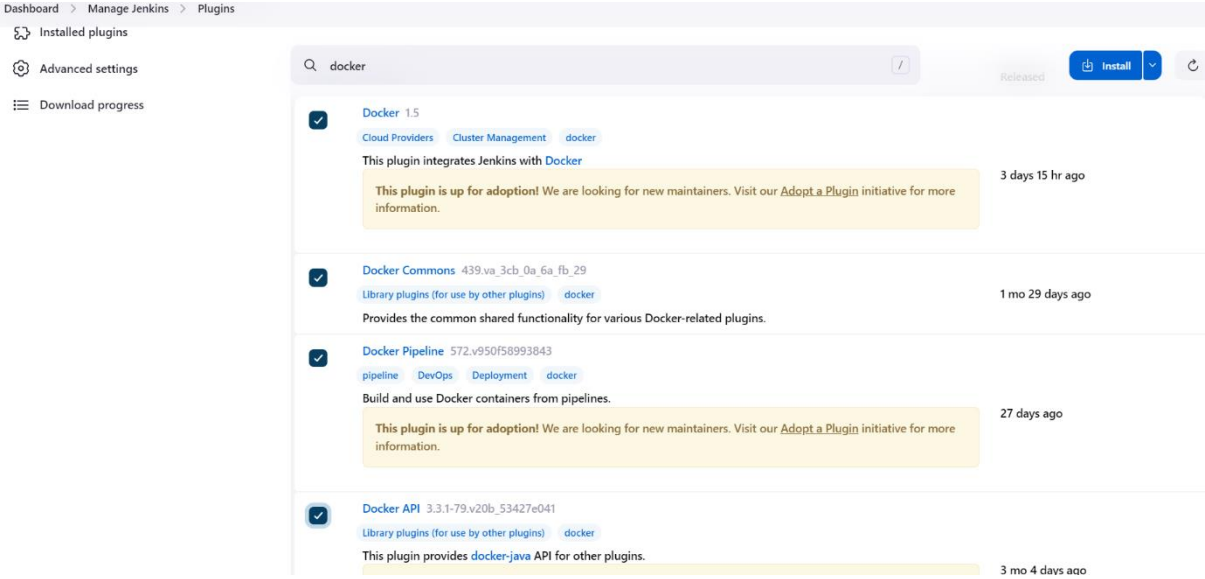
Docker Commons

Docker Pipeline

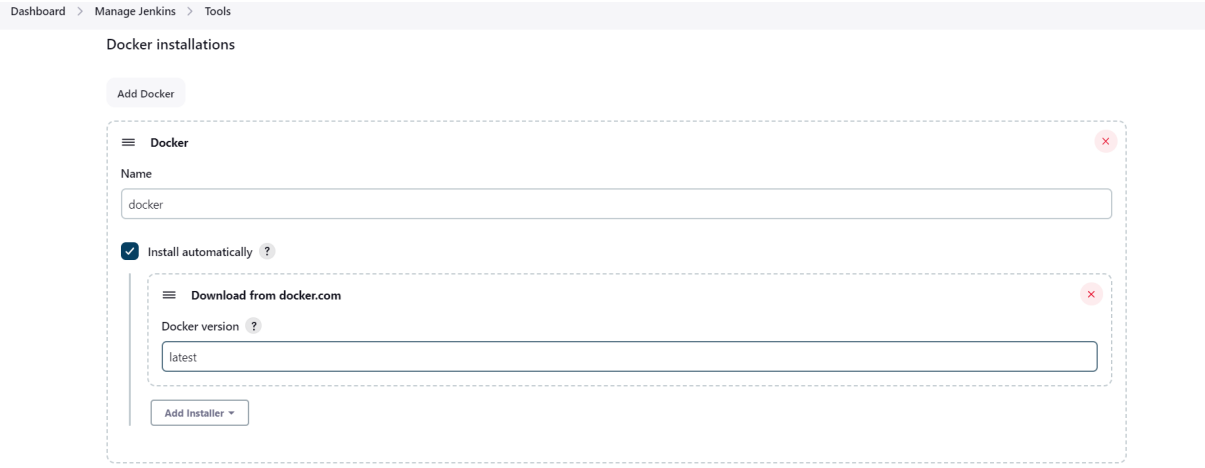
Docker API

docker-build-step

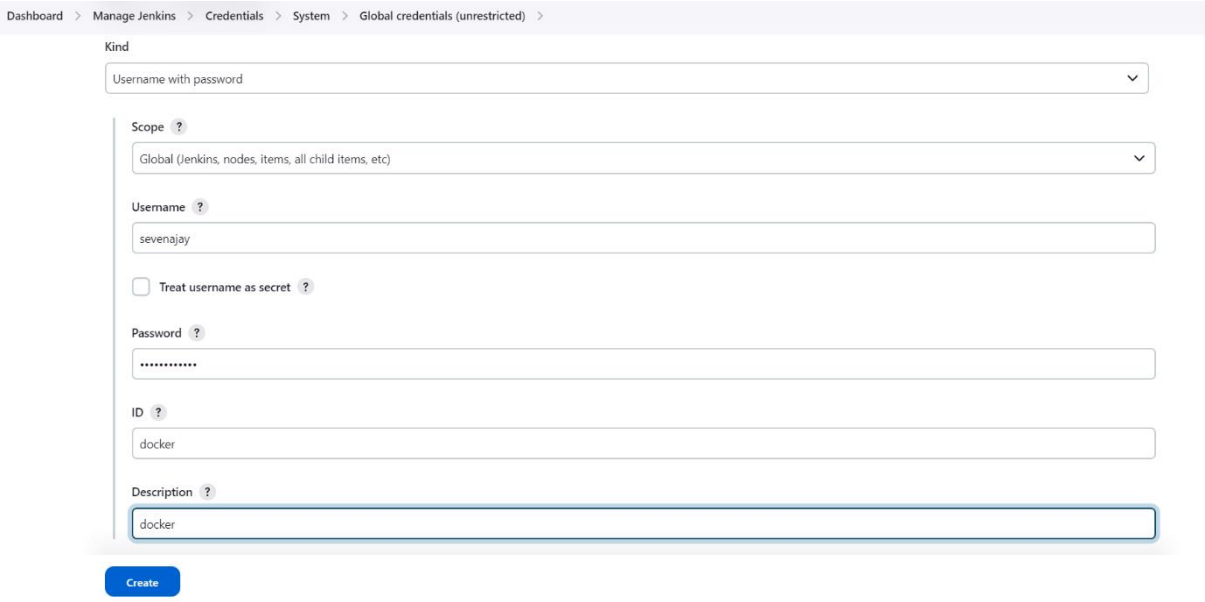
and click on install without restart



Now, goto Dashboard → Manage Jenkins → Tools →



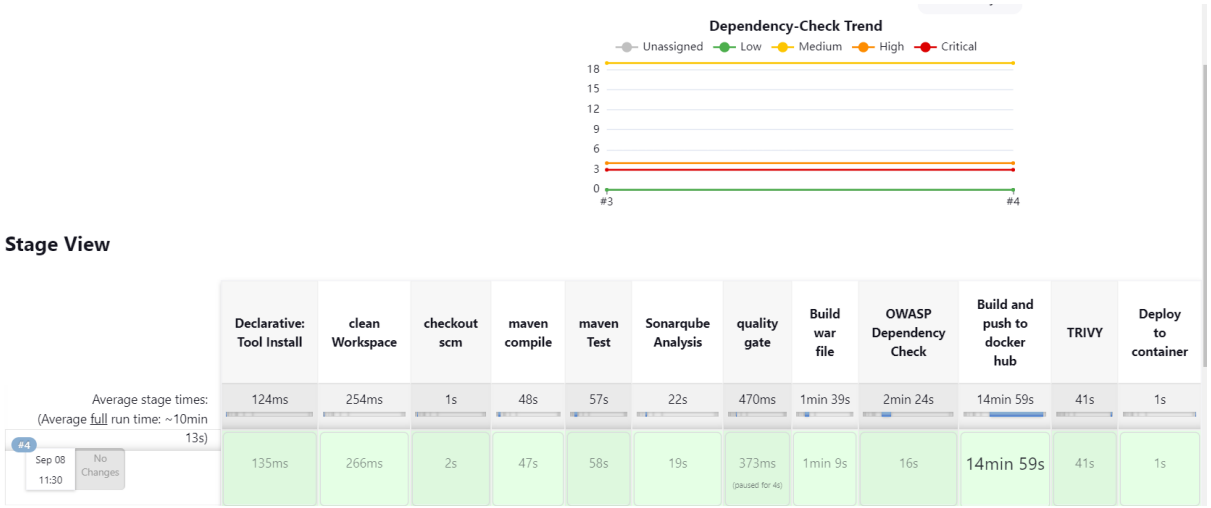
Add DockerHub Username and Password under Global Credentials



Add this stage to Pipeline Script

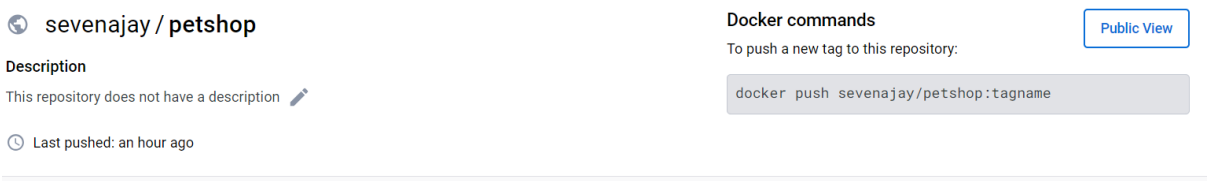
```
stage ('Build and push to docker hub'){
        steps{
            script{
                withDockerRegistry(credentialsId: 'docker', toolName: 'docker') {
                    sh "docker build -t petshop ."
                    sh "docker tag petshop sevenajay/petshop:latest"
                    sh "docker push sevenajay/petshop:latest"
                }
            }
        }
    }
    stage("TRIVY"){
        steps{
            sh "trivy image sevenajay/petshop:latest > trivy.txt"
        }
    }
    stage ('Deploy to container'){
        steps{
            sh 'docker run -d --name pet1 -p 8080:8080 sevenajay/petshop:latest'
        }
    }
```

You will see the output below, with a dependency trend.



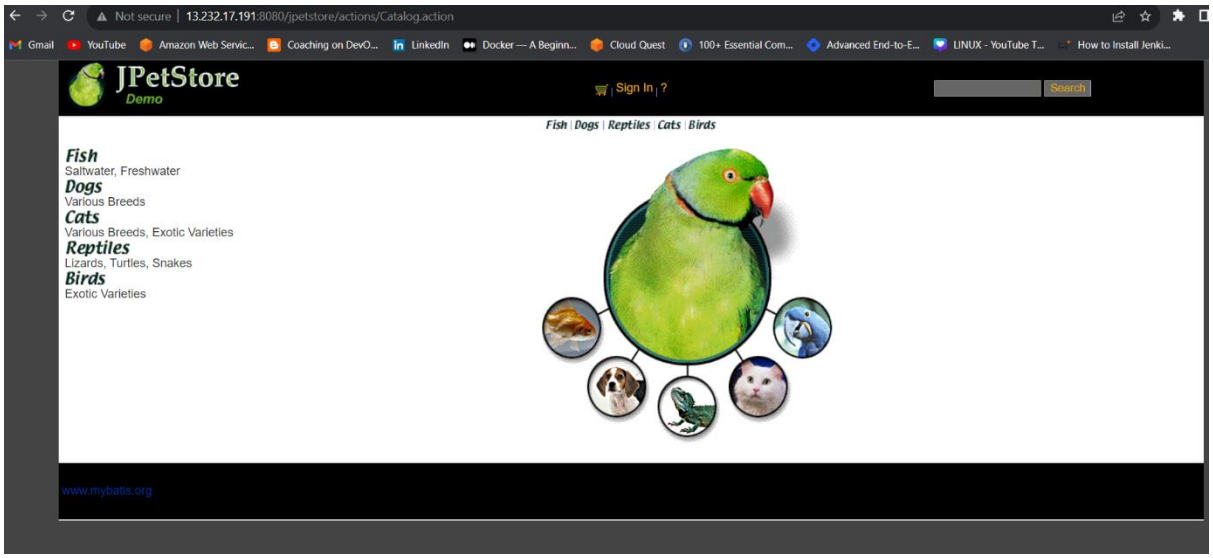
Now, when you do

When you log in to Dockerhub, you will see a new image is created



<Ec2-public-ip:8080/jpetstore>

You will get this output



Step 8 — Kuberenetes Setup

Connect your machines to Putty or Mobaxtreme

Take-Two Ubuntu 20.04 instances one for k8s master and the other one for worker.

Install Kubectl on Jenkins machine also.

Kubectl on Jenkins to be installed

```
sudo apt update

sudo apt install curl

curl -LO https://dl.k8s.io/release/$(curl -L -s
https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl

sudo install -o root -g root -m 0755 kubectl /usr/local/bin/kubectl

kubectl version --client
```

Part 1 ———-Master Node————

```
sudo su

hostname master

bash

clear
```

———-Worker Node————

```
sudo su

hostname worker

bash

clear
```

Part 2 ————Both Master & Node ————

```
sudo apt-get update


sudo apt-get install -y docker.io

sudo usermod –aG docker Ubuntu

newgrp docker

sudo chmod 777 /var/run/docker.sock


sudo curl -s https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo apt-key add -


sudo tee /etc/apt/sources.list.d/kubernetes.list &lt;&lt;EOF

deb https://apt.kubernetes.io/ kubernetes-xenial main

EOF


sudo apt-get update
```

sudo apt-get install -y kubelet kubeadm kubectl

sudo snap install kube-apiserver

Part 3 ————— Master —————

sudo kubeadm init --pod-network-cidr=10.244.0.0/16

in case your in root exit from it and run below commands

mkdir -p $HOME/.kube

sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config

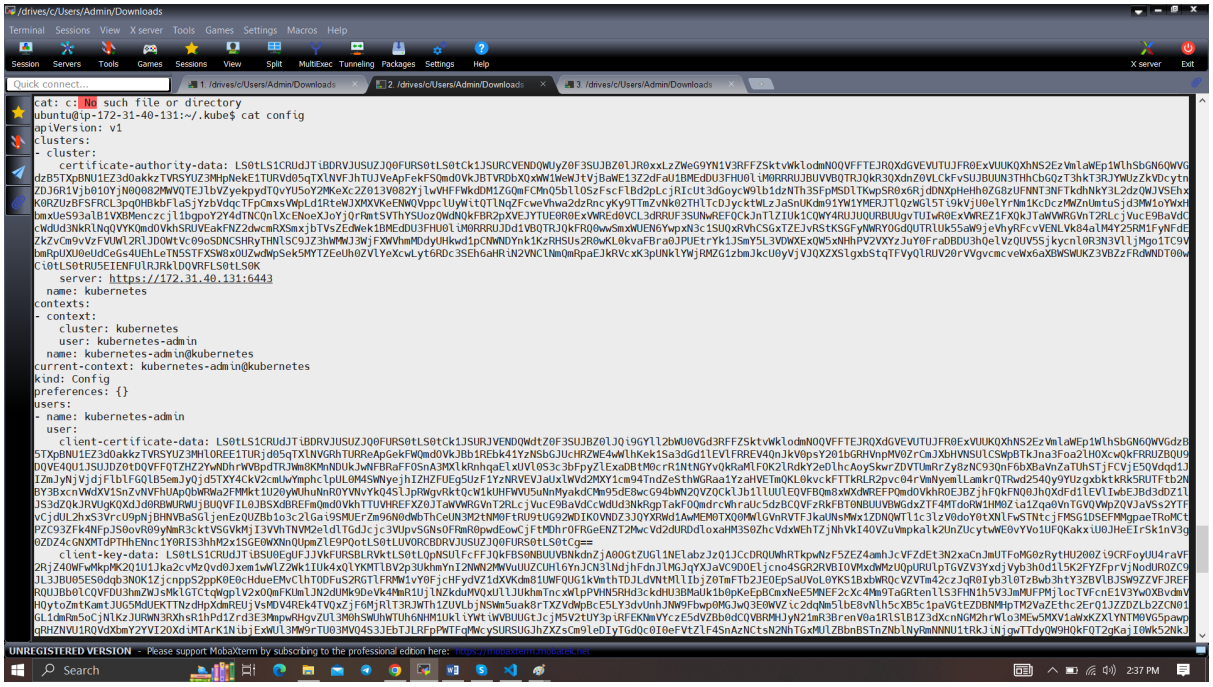
sudo chown $(id -u):$(id -g) $HOME/.kube/config

kubectl apply -f https://raw.githubusercontent.com/coreos/flannel/master/Documentation/kube-flannel.yml

———-Worker Node————

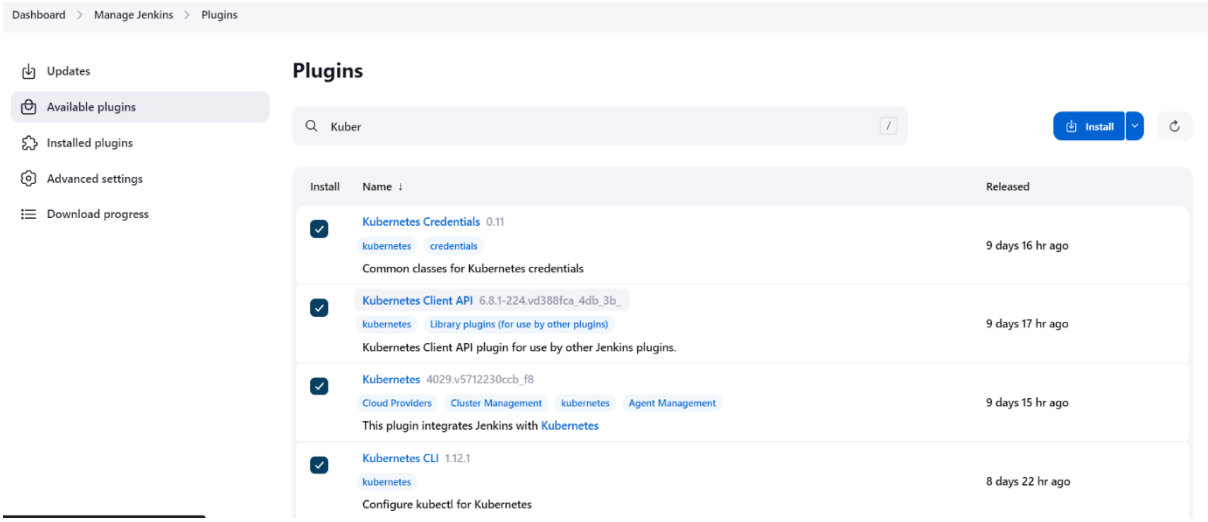
sudo kubeadm join <master-node-ip>:<master-node-port> --token <token> --discovery-token-ca-cert-hash <hash>

Copy the config file to Jenkins master or the local file manager and save it

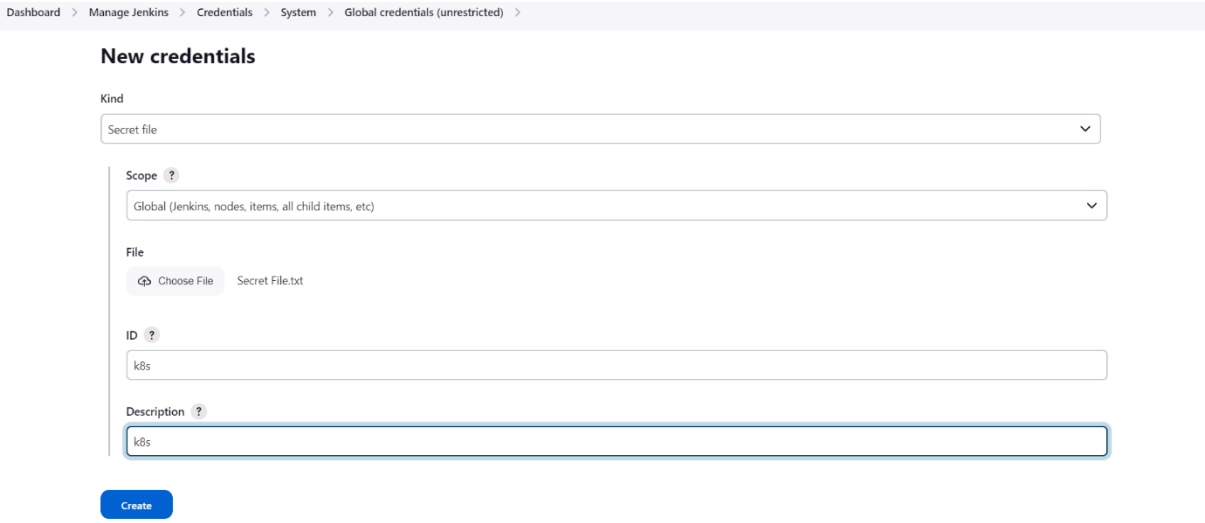


copy it and save it in documents or another folder save it as secret-file.txt

Install Kubernetes Plugin, Once it’s installed successfully

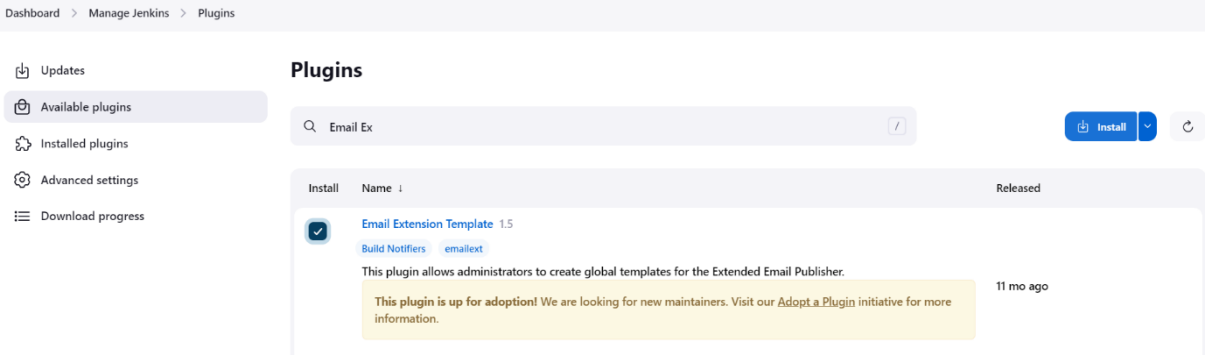


goto manage Jenkins –> manage credentials –> Click on Jenkins global –> add credentials



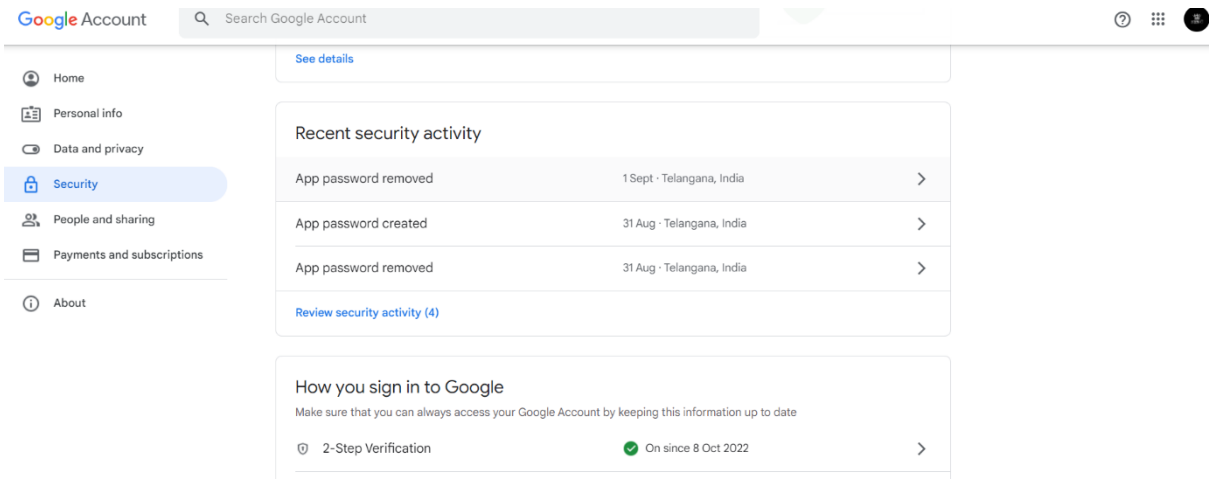
Configuring mail server in Jenkins (Gmail)

Install Email Extension Plugin in Jenkins



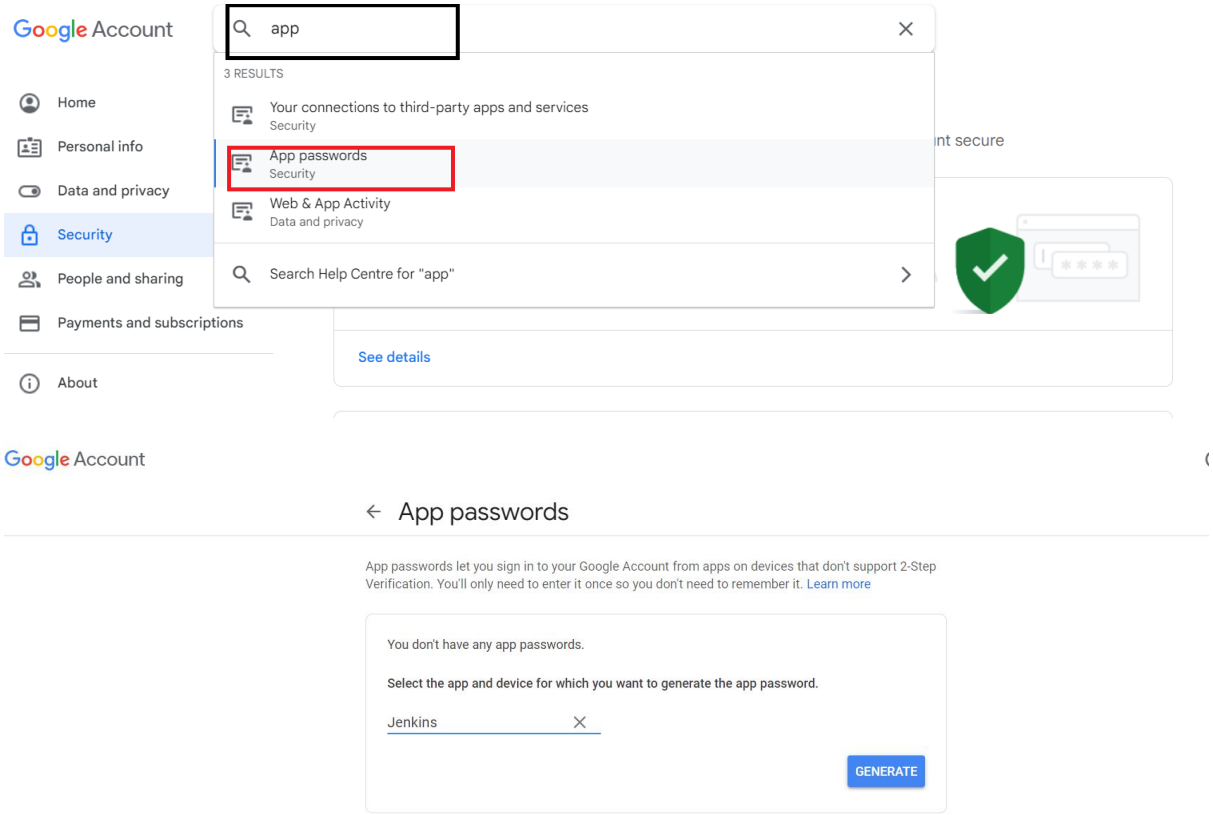
Go to your Gmail and click on your profile

Then click on Manage Your Google Account –> click on the security tab on the left side panel you will get this page

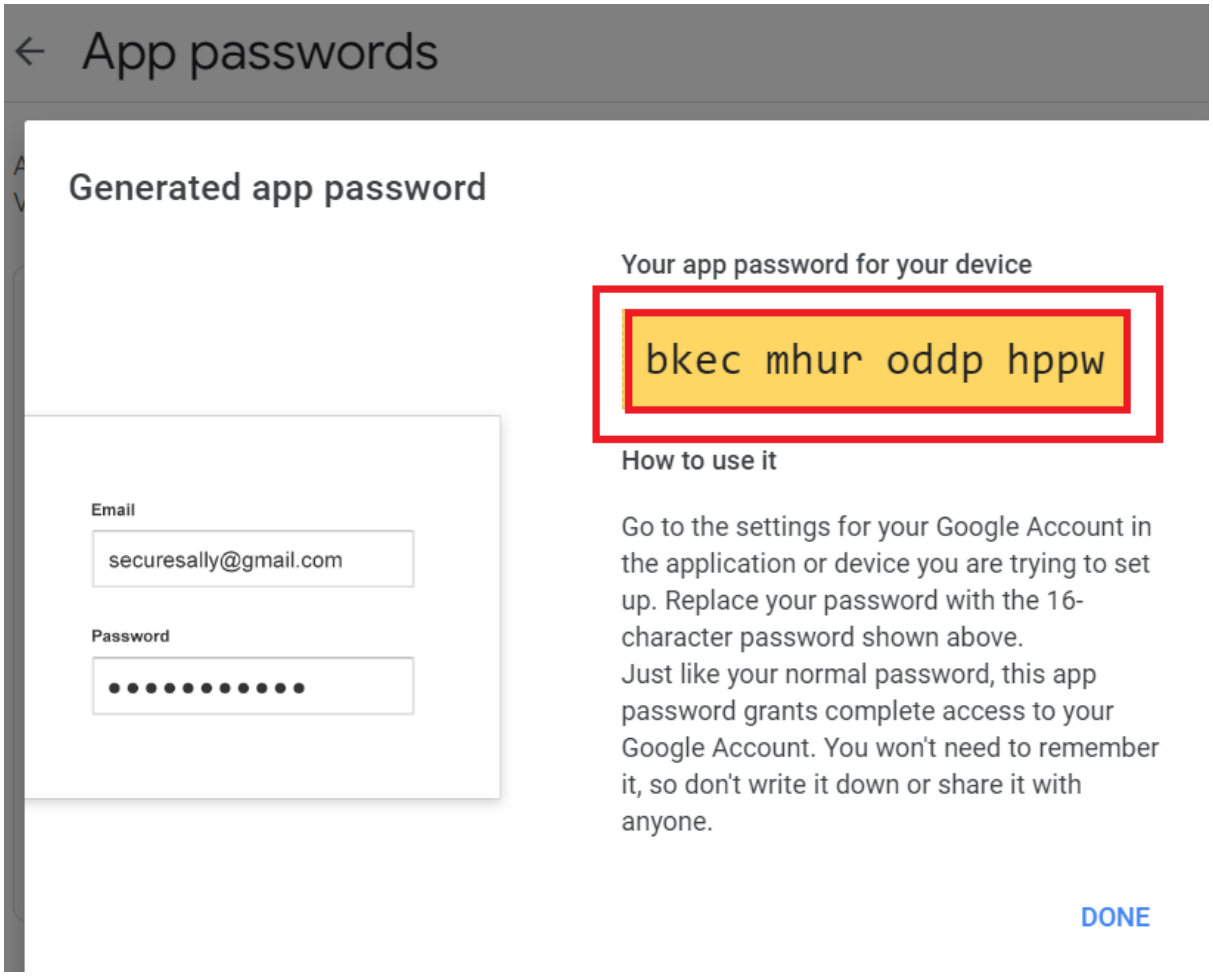


2-step verification should be enabled.

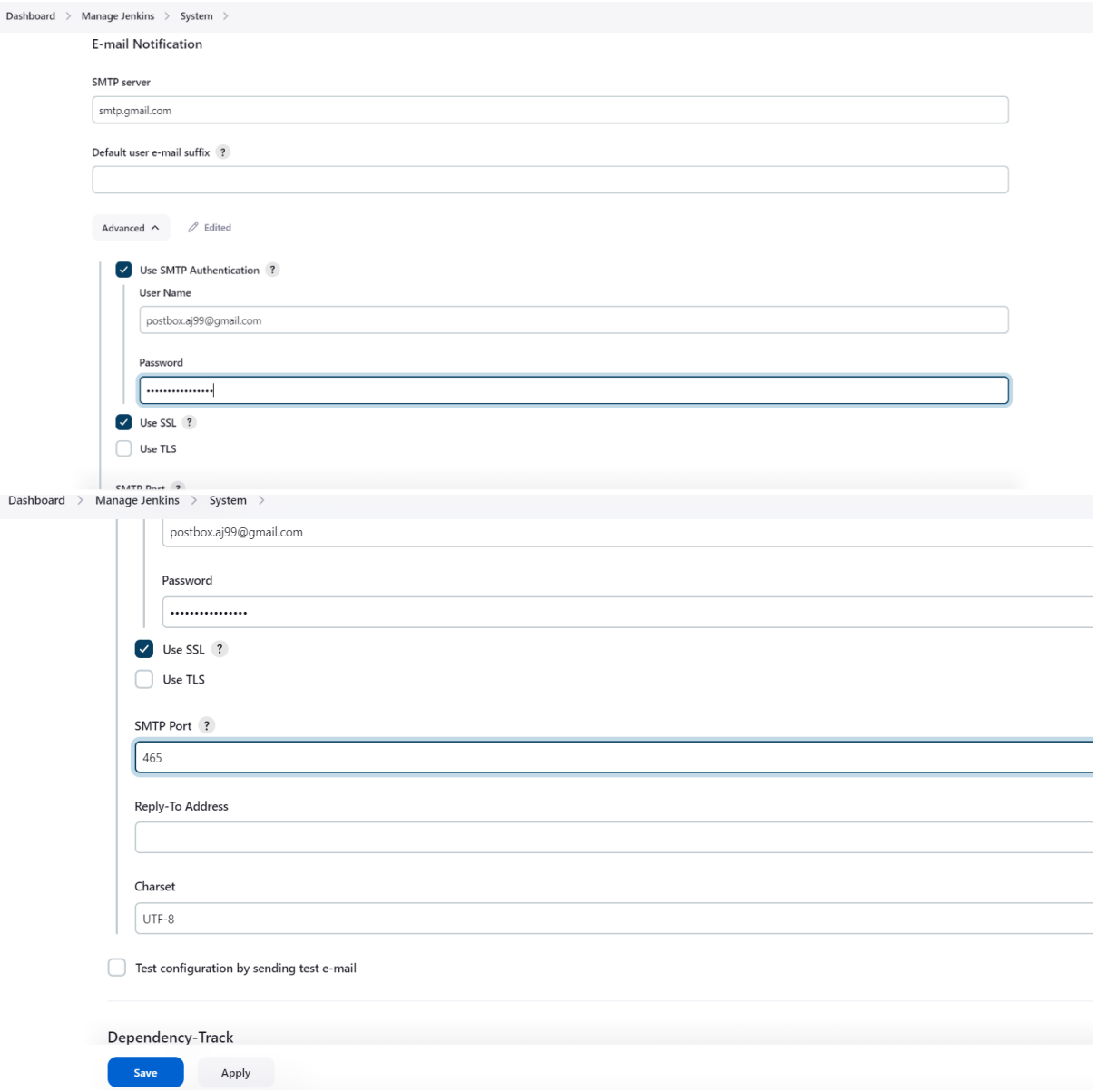
Search for the app in the search bar you will get app passwords like the below image



Click on other and provide your name and click on Generate and copy the password

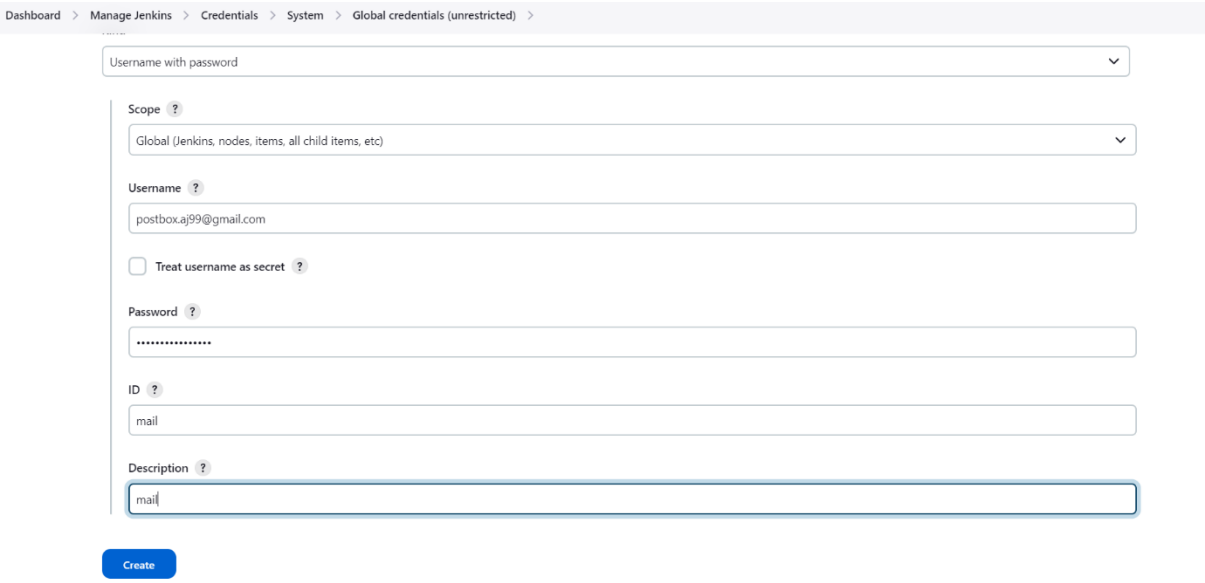


Once the plugin is installed in Jenkins, click on manage Jenkins –> configure system there under the E-mail Notification section configure the details as shown in the below image



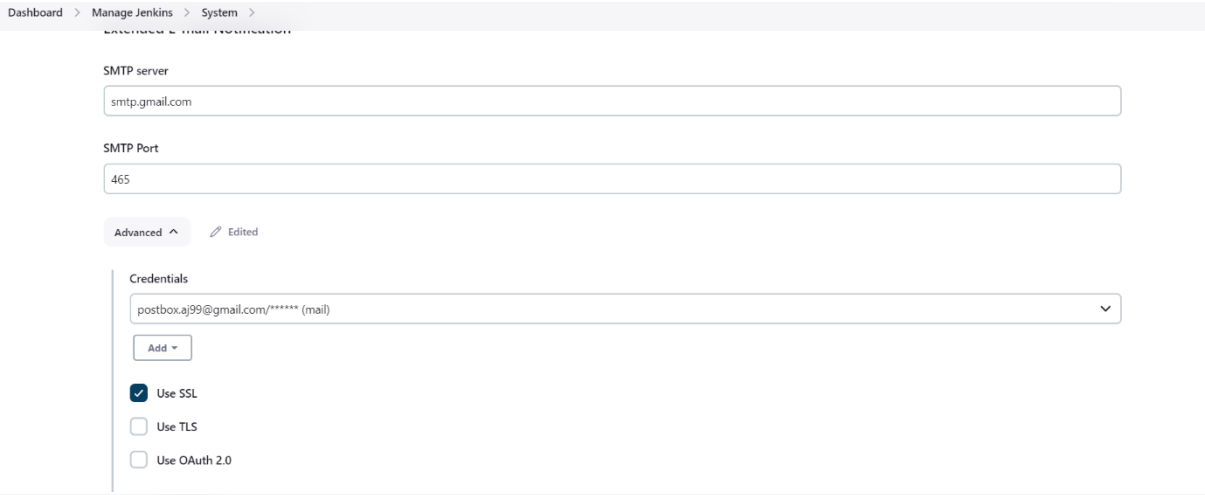
Click on Apply and save.

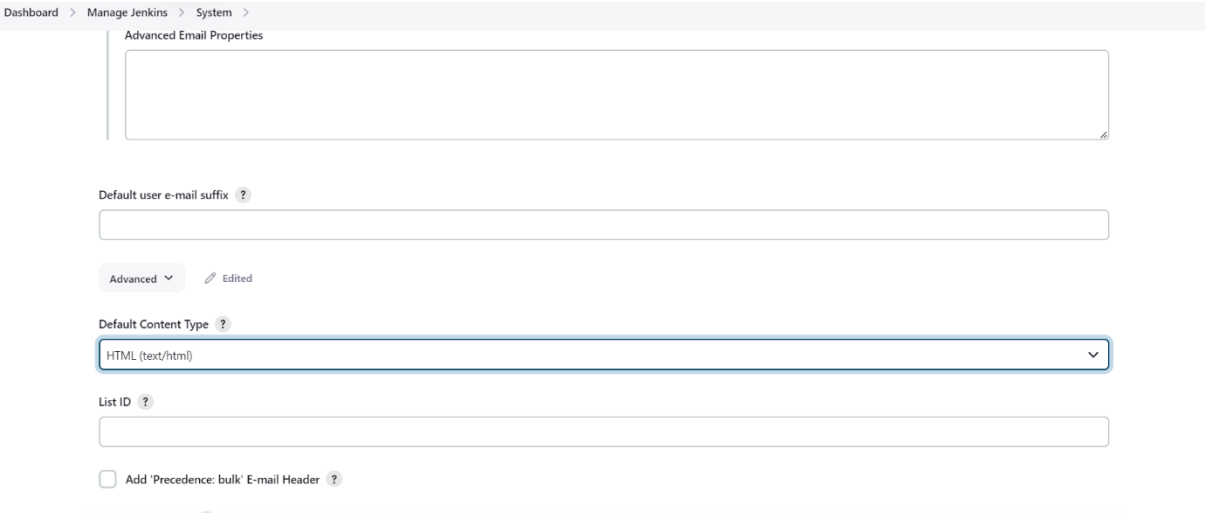
Click on Manage Jenkins–> credentials and add your mail username and generated password

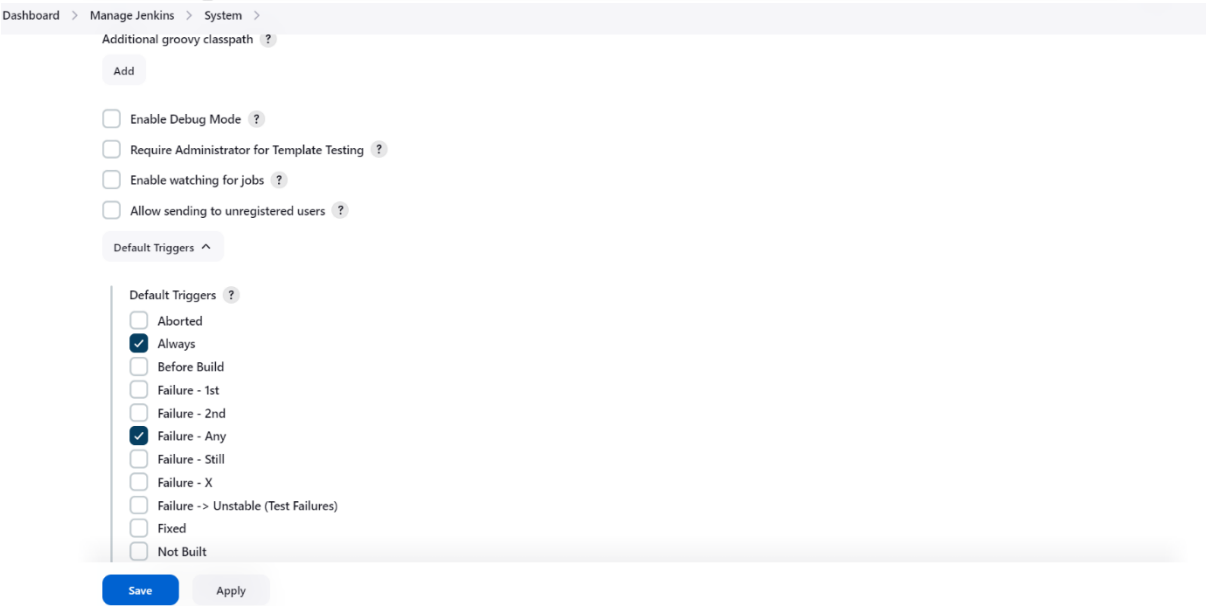


This is to just verify the mail configuration

Now under the Extended E-mail Notification section configure the details as shown in the below images







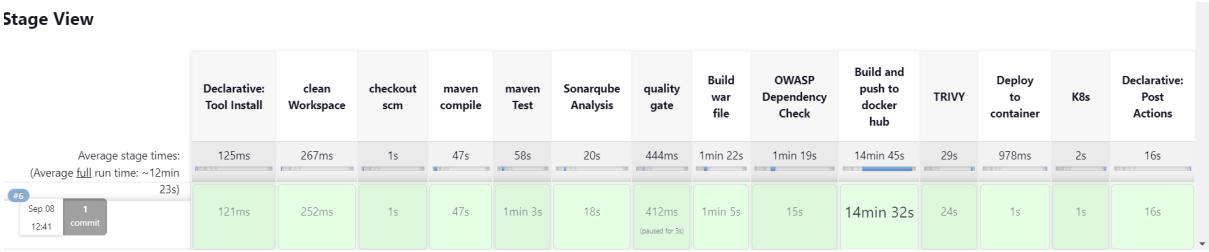
Click on Apply and save.

final step to deploy on the Kubernetes cluster and email pipeline.

```
stage('K8s'){
        steps{
```

```
            script{
                withKubeConfig(caCertificate: '', clusterName: '', contextName: '', credentialsId: 'k8s',
namespace: '', restrictKubeConfigAccess: false, serverUrl: '') {
                    sh 'kubectl apply -f deployment.yaml'
                }
            }
        }
    }
#post block after stages
post {
    always {
        emailext attachLog: true,
            subject: "'${currentBuild.result}'",
            body: "Project: ${env.JOB_NAME}<br/>" +
                "Build Number: ${env.BUILD_NUMBER}<br/>" +
                "URL: ${env.BUILD_URL}<br/>",
            to: 'postbox.aj99@gmail.com',
            attachmentsPattern: 'trivy.txt'
        }
    }
```

stage view



Stage View

	Declarative: Tool Install	clean Workspace	checkout scm	maven compile	maven Test	Sonarqube Analysis	quality gate	Build war file	OWASP Dependency Check	Build and push to docker hub	TRIVY	Deploy to container	K8s	Declarative: Post Actions
Average stage times: (Average full run time: ~12min 23s)	125ms	267ms	1s	47s	58s	20s	444ms	1min 22s	1min 19s	14min 45s	29s	978ms	2s	16s
#6 Sep 08 12:41 1 commit	121ms	252ms	1s	47s	1min 3s	18s	412ms (paused for 3s)	1min 5s	15s	14min 32s	24s	1s	1s	16s

In the Kubernetes cluster give this command

kubectl get all

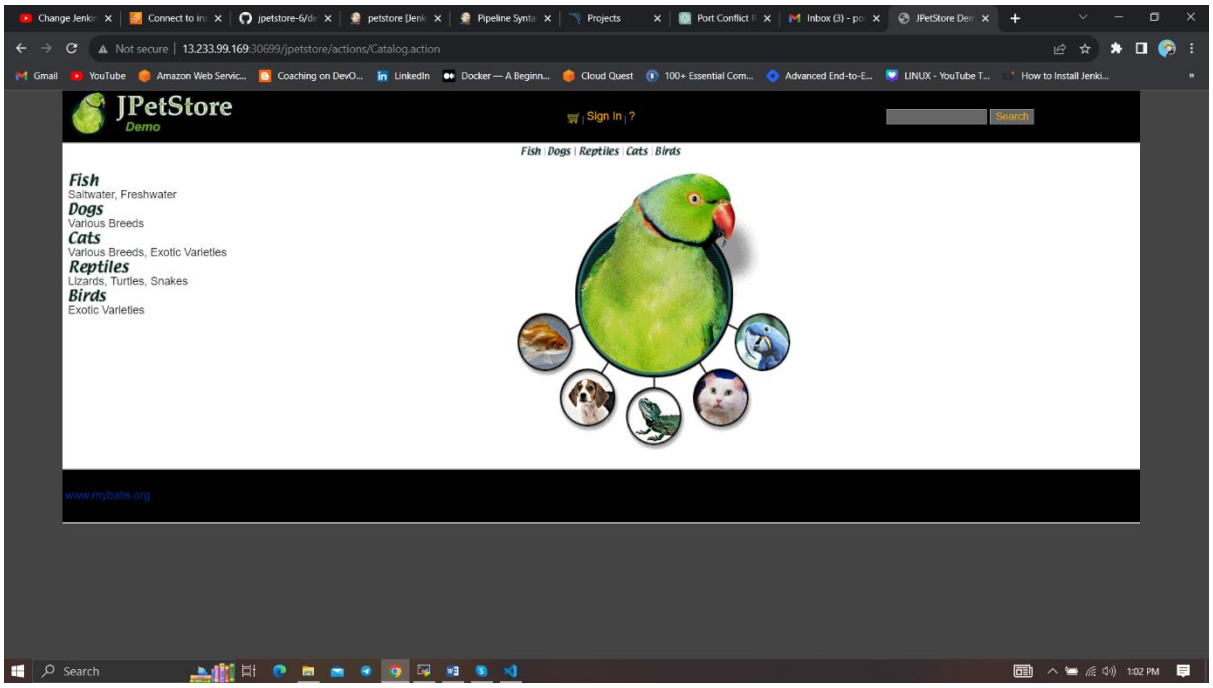
kubectl get svc

```
ubuntu@ip-172-31-40-131:~$ kubectl get all
NAME                              READY   STATUS    RESTARTS   AGE
pod/petshop-768578655f-kzcd9      1/1     Running   0          43s

NAME                 TYPE           CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
service/kubernetes   ClusterIP      10.96.0.1        <none>        443/TCP        58m
service/petshop      LoadBalancer   10.104.122.152   <pending>     80:30699/TCP   21m

NAME                      READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/petshop   1/1     1            1           43s

NAME                                 DESIRED   CURRENT   READY   AGE
replicaset.apps/petshop-768578655f   1         1         1       43s
ubuntu@ip-172-31-40-131:~$
```

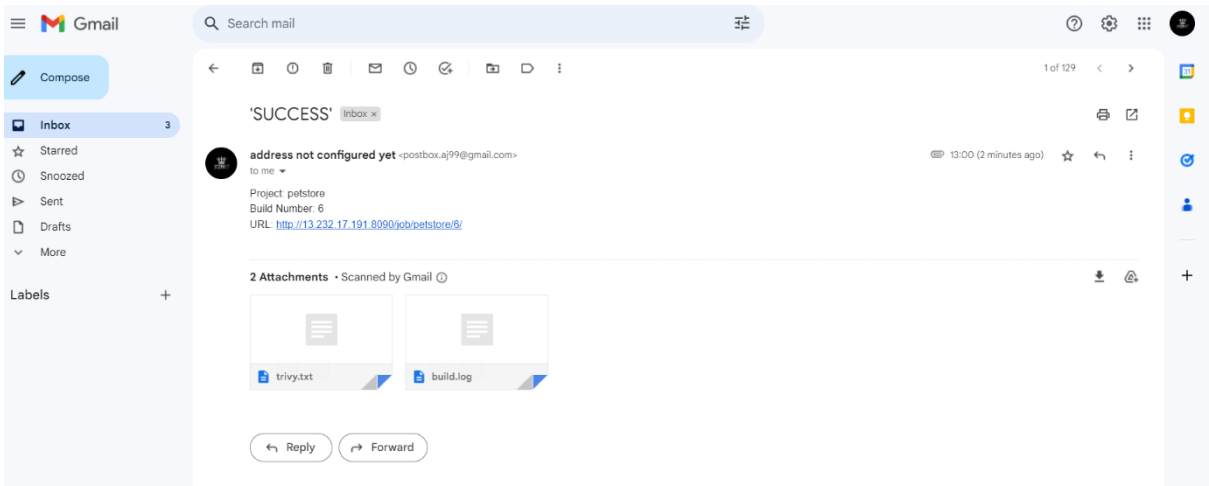
STEP9:Access from a Web browser with

<public-ip-of-slave:30699>

output:



Mail



Step 10: Terminate instances.

Complete Pipeline

```
pipeline{
  agent any
  tools {
    jdk 'jdk17'
    maven 'maven3'
  }
  environment {
    SCANNER_HOME=tool 'sonar-scanner'
  }
  stages{
    stage ('clean Workspace'){
      steps{
        cleanWs()
      }
    }
    stage ('checkout scm') {
      steps {
        git 'https://github.com/Aj7Ay/jpetstore-6.git'
      }
    }
    stage ('maven compile') {
      steps {
        sh 'mvn clean compile'
      }
    }
    stage ('maven Test') {
      steps {
        sh 'mvn test'
      }
```

```
    }
    stage("Sonarqube Analysis "){
      steps{
        withSonarQubeEnv('sonar-server') {
          sh ''' $SCANNER_HOME/bin/sonar-scanner -Dsonar.projectName=Petshop \
          -Dsonar.java.binaries=. \
          -Dsonar.projectKey=Petshop '''
        }
      }
    }
    stage("quality gate"){
      steps {
        script {
          waitForQualityGate abortPipeline: false, credentialsId: 'Sonar-token'
        }
      }
    }
    stage ('Build war file'){
      steps{
        sh 'mvn clean install -DskipTests=true'
      }
    }
    stage("OWASP Dependency Check"){
      steps{
        dependencyCheck additionalArguments: '--scan ./ --format XML ', odcInstallation: 'DP-
Check'
        dependencyCheckPublisher pattern: '**/dependency-check-report.xml'
      }
    }
    stage ('Build and push to docker hub'){
      steps{
```

```
            script{
                withDockerRegistry(credentialsId: 'docker', toolName: 'docker') {
                    sh "docker build -t petshop ."
                    sh "docker tag petshop sevenajay/petshop:latest"
                    sh "docker push sevenajay/petshop:latest"
                }
            }
        }
    }
    stage("TRIVY"){
        steps{
            sh "trivy image sevenajay/petshop:latest > trivy.txt"
        }
    }
    stage ('Deploy to container'){
        steps{
            sh 'docker run -d --name pet1 -p 8080:8080 sevenajay/petshop:latest'
        }
    }
    stage('K8s'){
        steps{
            script{
                withKubeConfig(caCertificate: '', clusterName: '', contextName: '', credentialsId: 'k8s',
namespace: '', restrictKubeConfigAccess: false, serverUrl: '') {
                    sh 'kubectl apply -f deployment.yaml'
                }
            }
        }
    }
}
post {
```

```
    always {
      emailext attachLog: true,
        subject: "'${currentBuild.result}'",
        body: "Project: ${env.JOB_NAME}<br/>" +
          "Build Number: ${env.BUILD_NUMBER}<br/>" +
          "URL: ${env.BUILD_URL}<br/>",
        to: 'postbox.aj99@gmail.com',
        attachmentsPattern: 'trivy.txt'
      }
    }
}
```

Trigger code

CI-petshop-pipeline

```
pipeline{
   agent any
   tools {
      jdk 'jdk17'
      maven 'maven3'
   }
   environment {
      SCANNER_HOME=tool 'sonar-scanner'
   }
   stages{
      stage ('clean Workspace'){
         steps{
            cleanWs()
         }
      }
      stage ('checkout scm') {
         steps {
            git 'https://github.com/Aj7Ay/jpetstore-6.git'
```

```
    }
}
stage ('maven compile') {
    steps {
        sh 'mvn clean compile'
    }
}
stage ('maven Test') {
    steps {
        sh 'mvn test'
    }
}
stage("Sonarqube Analysis "){
    steps{
        withSonarQubeEnv('sonar-server') {
            sh ''' $SCANNER_HOME/bin/sonar-scanner -Dsonar.projectName=Petshop \
            -Dsonar.java.binaries=. \
            -Dsonar.projectKey=Petshop '''
        }
    }
}
stage("quality gate"){
    steps {
        script {
          waitForQualityGate abortPipeline: false, credentialsId: 'Sonar-token'
        }
   }
}
stage ('Build war file'){
    steps{
        sh 'mvn clean install -DskipTests=true'
```

```
        }
    }
    stage("OWASP Dependency Check"){
        steps{
            dependencyCheck additionalArguments: '--scan ./ --format XML ', odcInstallation: 'DP-
Check'
            dependencyCheckPublisher pattern: '**/dependency-check-report.xml'
        }
    }
    stage ('Build and push to docker hub'){
        steps{
            script{
                withDockerRegistry(credentialsId: 'docker', toolName: 'docker') {
                    sh "docker build -t petshop ."
                    sh "docker tag petshop sevenajay/petshop:latest"
                    sh "docker push sevenajay/petshop:latest"
                }
            }
        }
    }
    stage("TRIVY"){
        steps{
            sh "trivy image sevenajay/petshop:latest > trivy.txt"
        }
    }
    stage("Trigger deployment"){
        steps{
            // Trigger the deployment pipeline and wait for it to complete
            build job: 'CD-petshop', wait: true
        }
    }
```

```
    }
    post {
     always {
        emailext attachLog: true,
            subject: "'${currentBuild.result}'",
            body: "Project: ${env.JOB_NAME}<br/>" +
                "Build Number: ${env.BUILD_NUMBER}<br/>" +
                "URL: ${env.BUILD_URL}<br/>",
            to: 'postbox.aj99@gmail.com',
            attachmentsPattern: 'trivy.txt'
        }
    }
}
```

CD-petshop-pipeline

```
pipeline{
    agent any
    stages{
        stage ('clean Workspace'){
            steps{
                cleanWs()
            }
        }
        stage ('checkout scm') {
            steps {
                git 'https://github.com/Aj7Ay/jpetstore-6.git'
            }
        }
        stage ('Deploy to container'){
            steps{
                sh 'docker run -d --name pet1 -p 8080:8080 sevenajay/petshop:latest'
            }
```

```
        }
        stage('K8s'){
            steps{
                script{
                    withKubeConfig(caCertificate: '', clusterName: '', contextName: '', credentialsId: 'k8s',
namespace: '', restrictKubeConfigAccess: false, serverUrl: '') {
                        sh 'kubectl apply -f deployment.yaml'
                    }
                }
            }
        }
    }
    post {
     always {
        emailext attachLog: true,
            subject: "'${currentBuild.result}'",
            body: "Project: ${env.JOB_NAME}<br/>" +
                "Build Number: ${env.BUILD_NUMBER}<br/>" +
                "URL: ${env.BUILD_URL}<br/>",
            to: 'postbox.aj99@gmail.com',
            attachmentsPattern: 'trivy.txt'
        }
    }
}
```