Set up a CI/CD Pipeline to Automate Application Deployment to Kubernetes Using Jenkins

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Introduction

CI/CD pipelines automate the process of integrating code changes, testing, and deploying applications. In this guide, we'll set up **Jenkins** on a Windows machine and configure it to deploy applications to a **Kubernetes** cluster using the **Kubernetes Plugin**. Jenkins will run the deployments in Kubernetes pods, which will allow seamless integration and testing directly within the cluster environment.

Problem Statement

Manually deploying applications to Kubernetes can be time-consuming and error-prone. By setting up a CI/CD pipeline using Jenkins and Kubernetes, we can automate the deployment process, ensuring quick, reliable, and continuous integration of code changes to our Kubernetes environment.

Prerequisites

Completion of all previous lab guides (up to Lab Guide-09) is required before proceeding with Lab Guide-10.

- A **Kubernetes** cluster running on **Minikube** or another environment.
- **kubectl** configured to interact with the Kubernetes cluster.
- A Windows machine to install Jenkins.

Software Requirements

- **Jenkins** (download as MSI)
- **Java Development Kit (JDK)** 8 or later (required for Jenkins)
- **Minikube** (if using a local Kubernetes cluster)
- **kubectl** CLI tool for managing Kubernetes

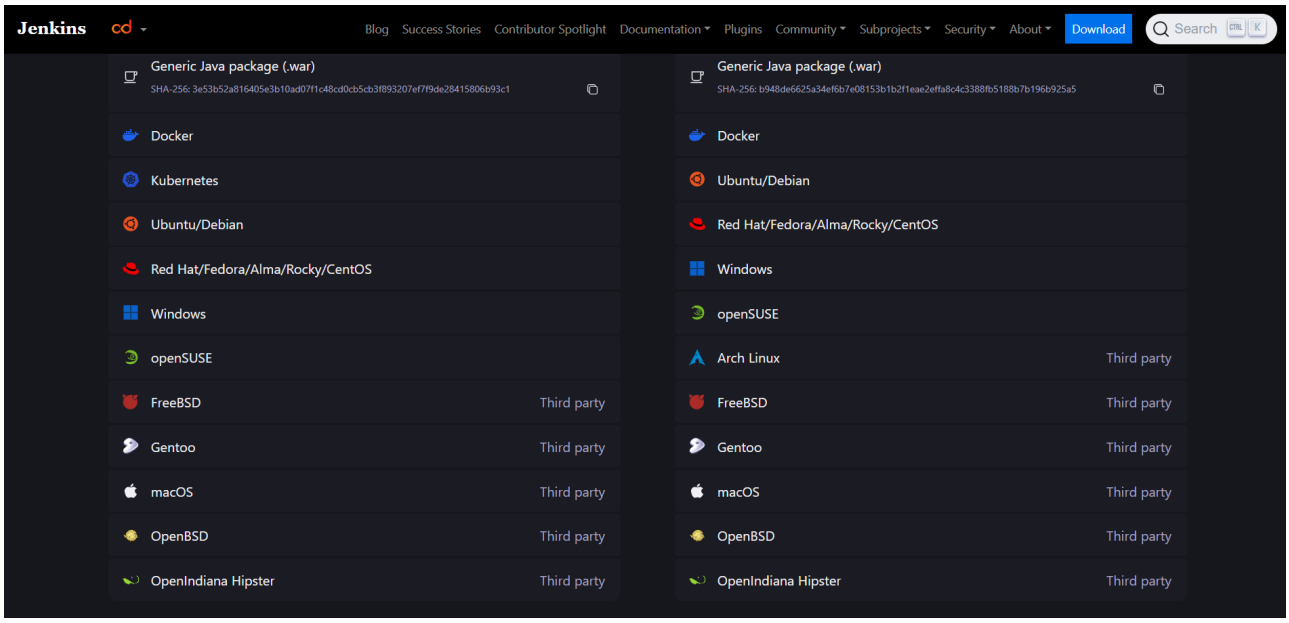
Hardware Requirements

- Minimum 2 CPU cores
- 4GB RAM for Minikube and Jenkins

Lab Guide: Setting Up CI/CD Pipeline with Jenkins and Kubernetes

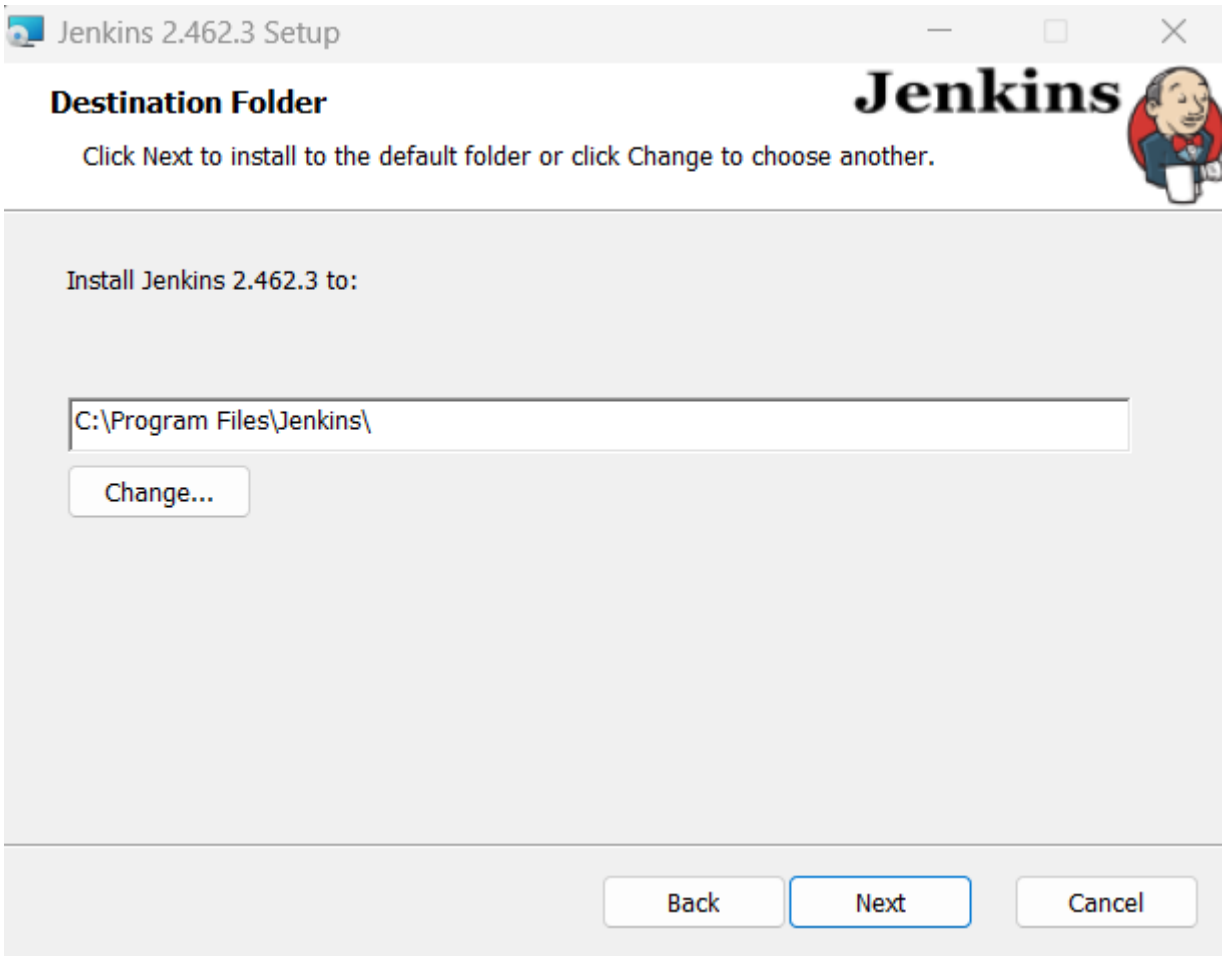
Step 1: Download and Install Jenkins

1. **Download Jenkins MSI**
   Go to the Jenkins website and download the Windows installer here.

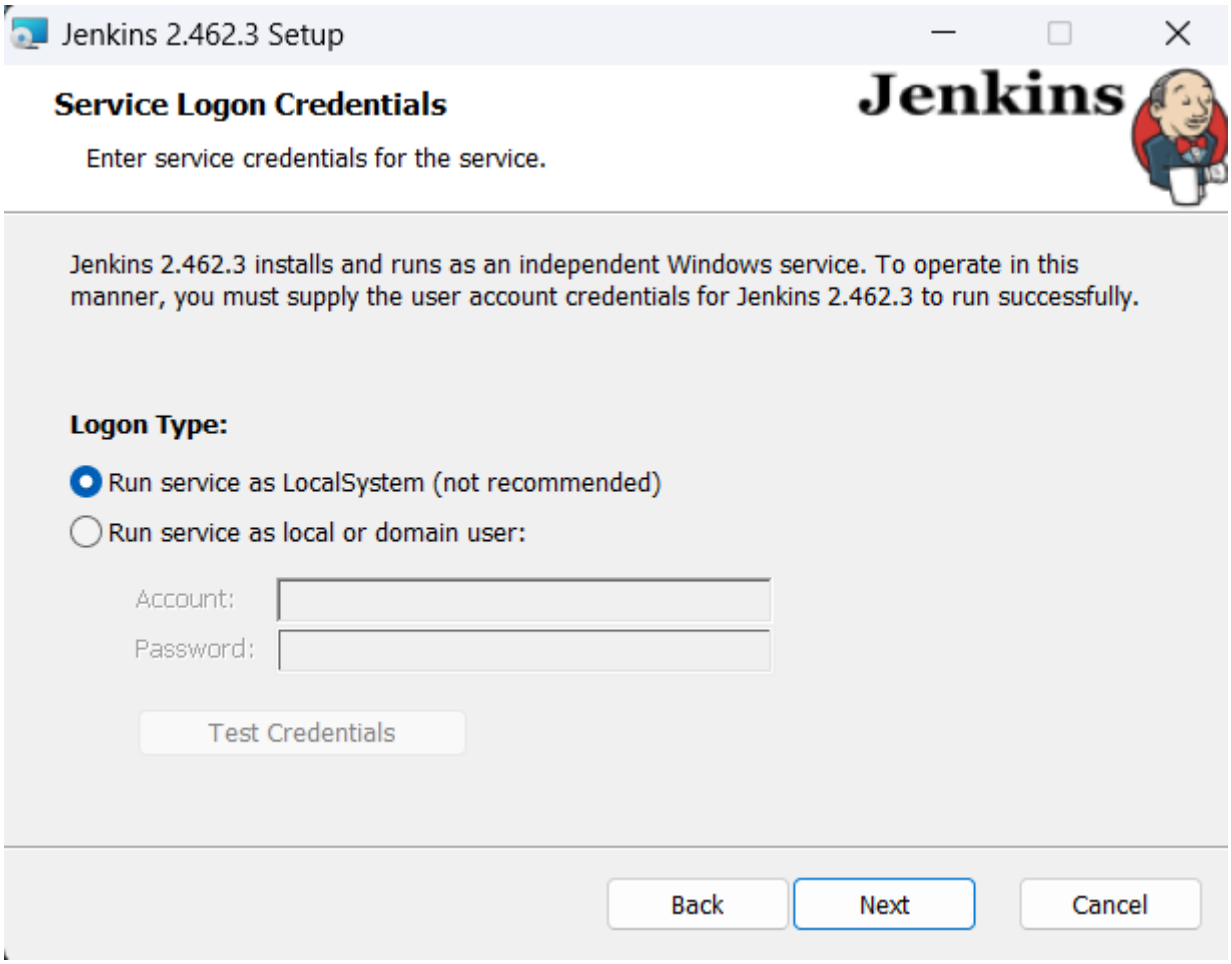


2. **Install Jenkins**
   - Double-click the MSI file and follow the instructions to install Jenkins.

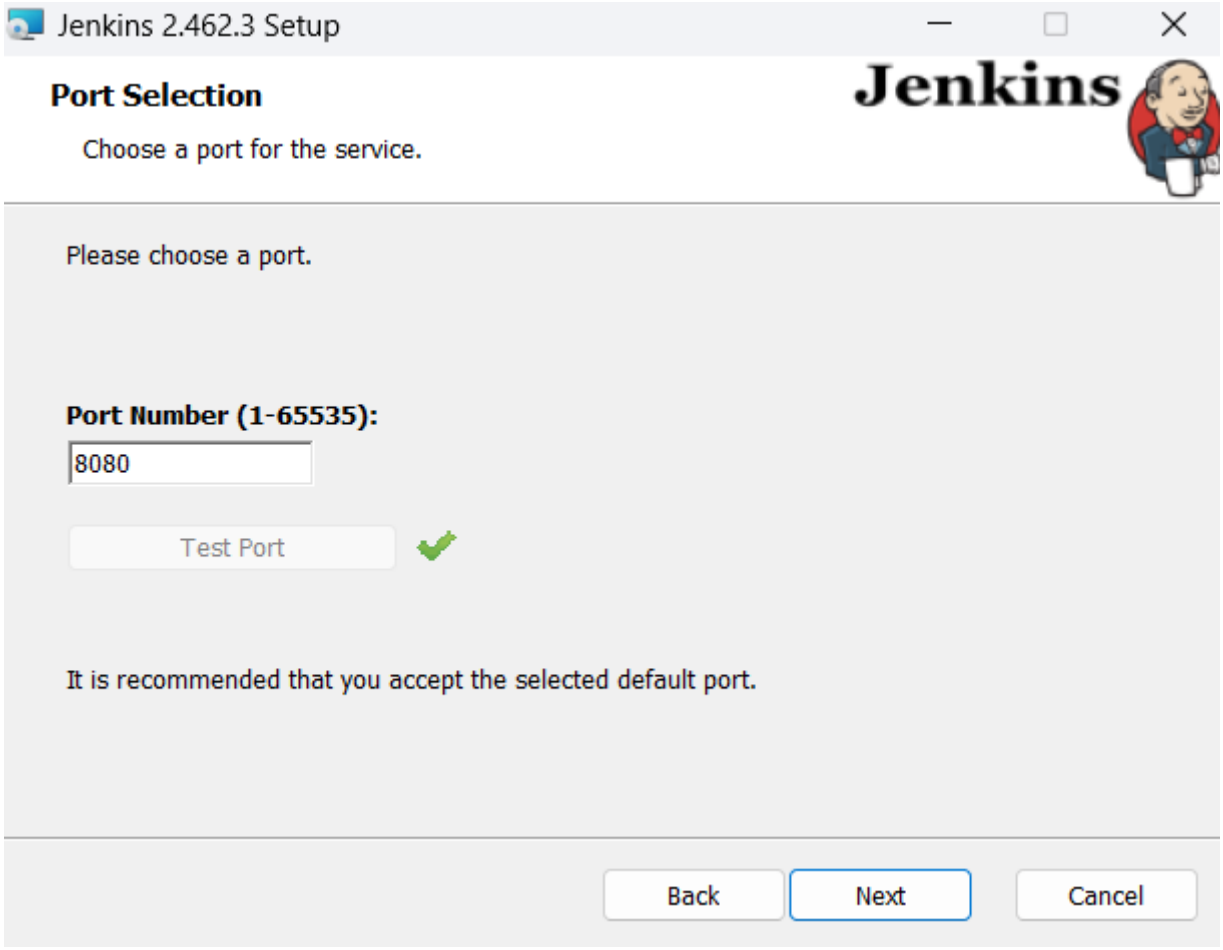
- Add Destination folder



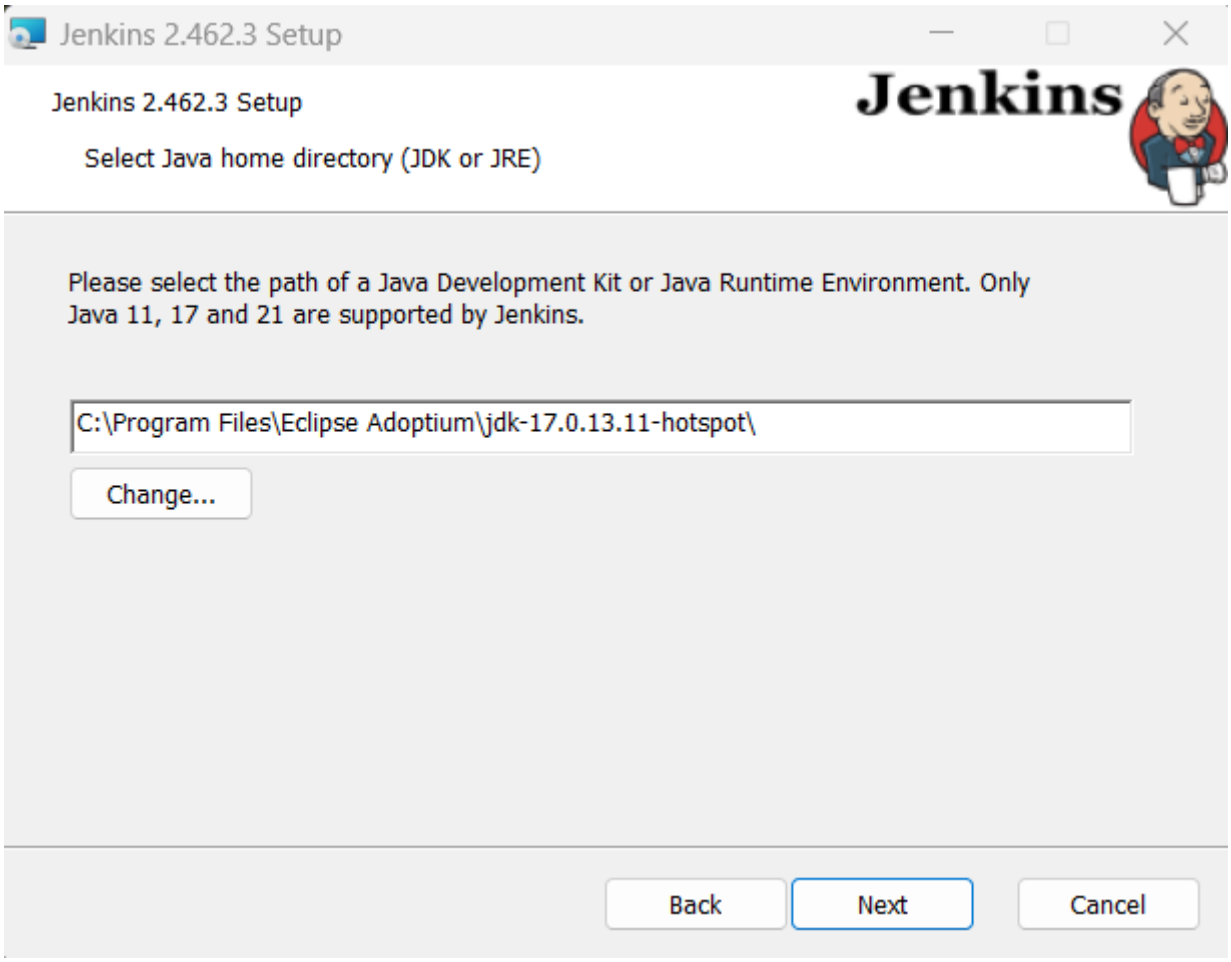
- Run Service on Local System

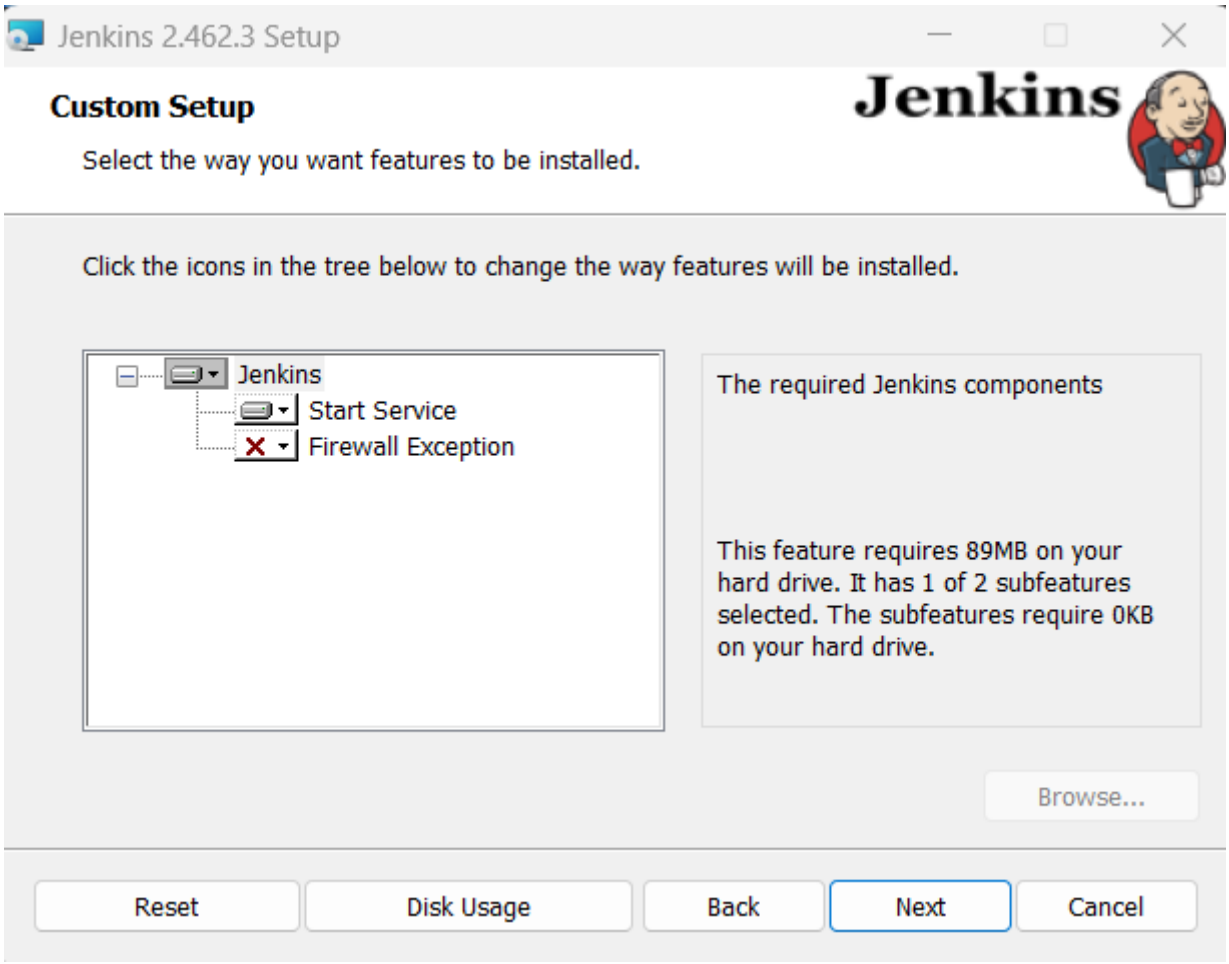


- Add port number `8080` and `Test Port`

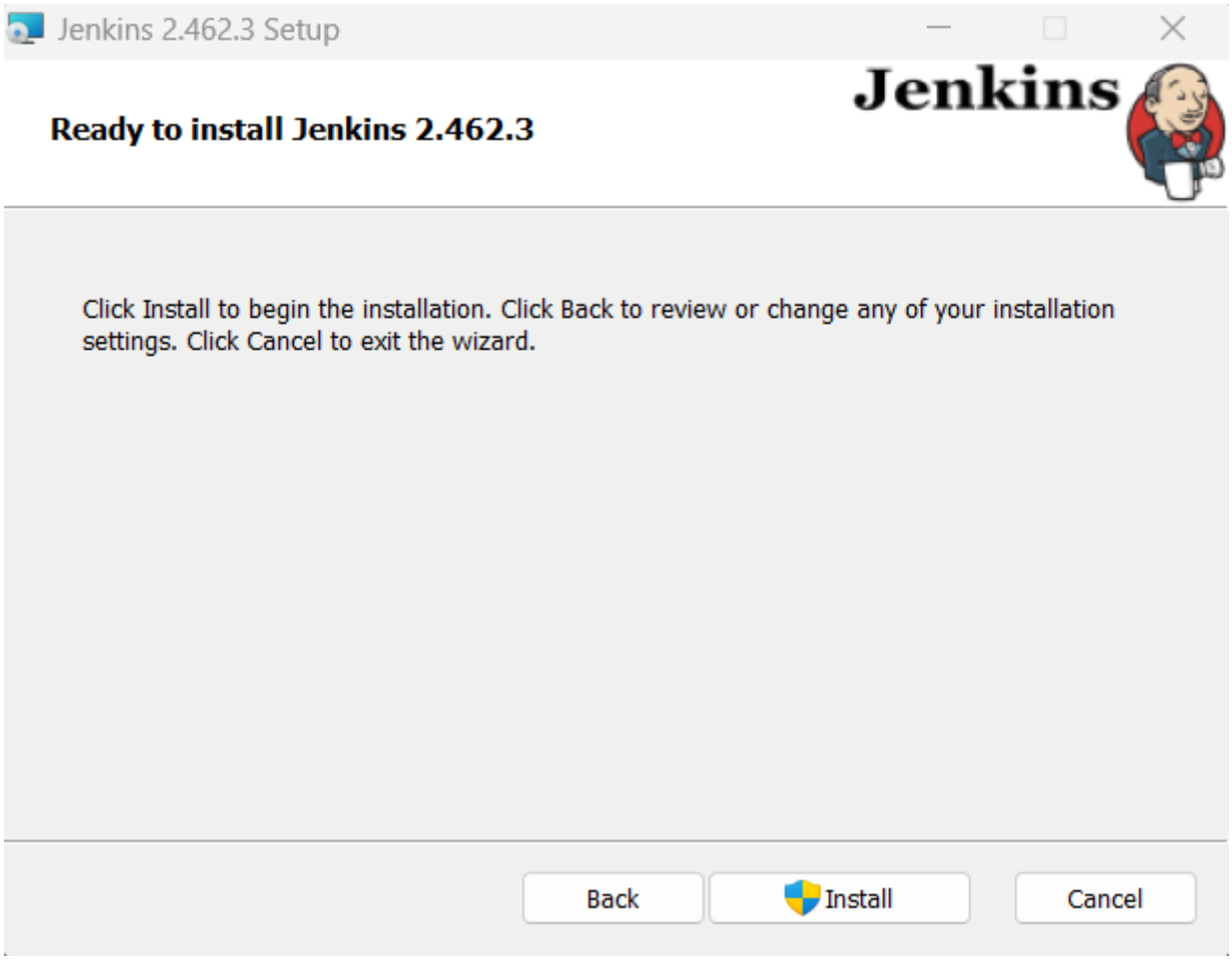


- Select java home directory



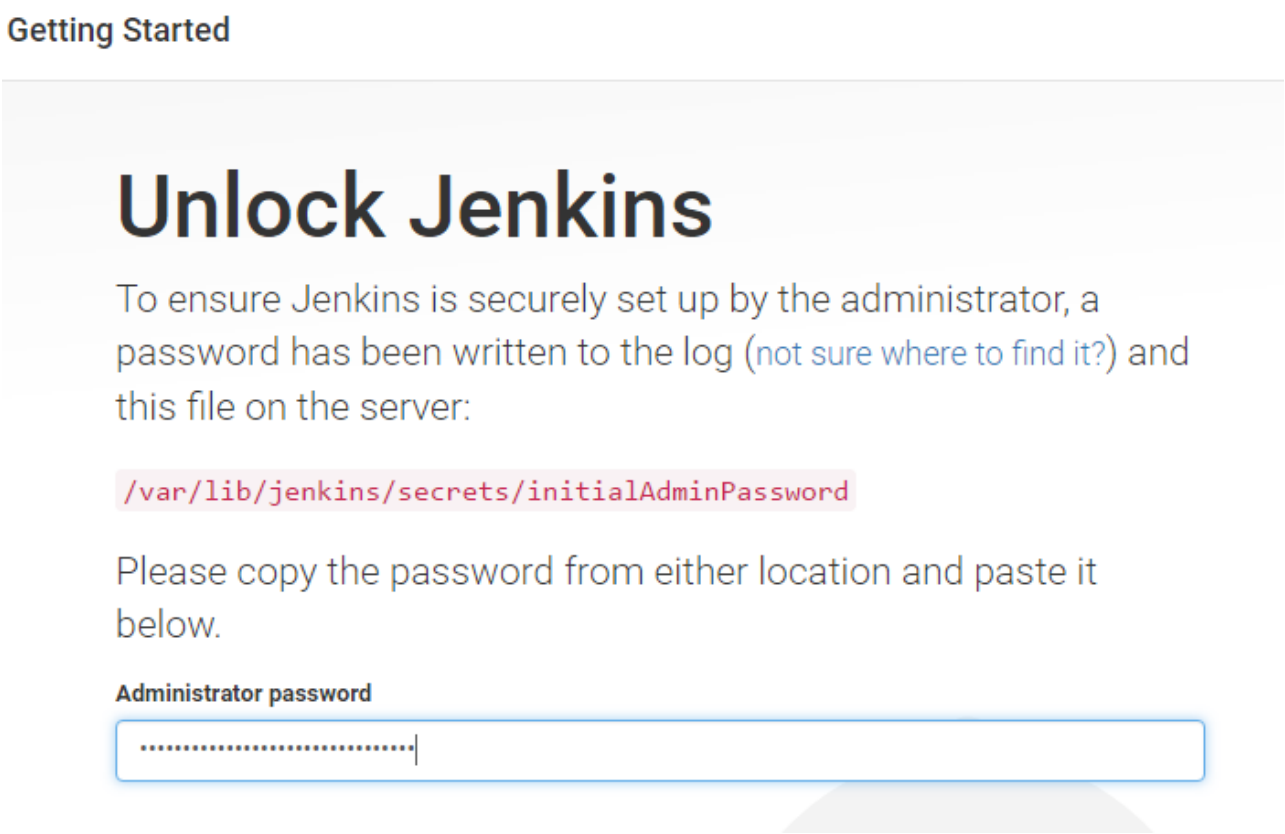


- Click on Install



- During the installation, Jenkins will ask for the installation path, Java path, and a port number (default is 8080).

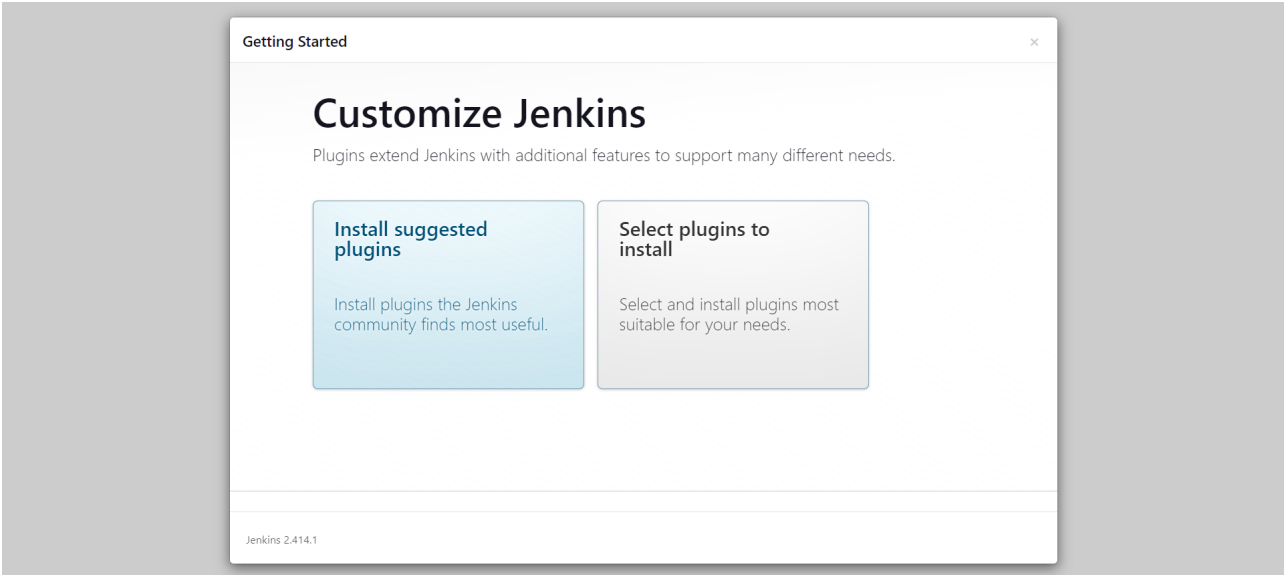
3. **Start Jenkins**
   Once the installation is complete, start Jenkins by visiting `http://localhost:8080` in your browser.

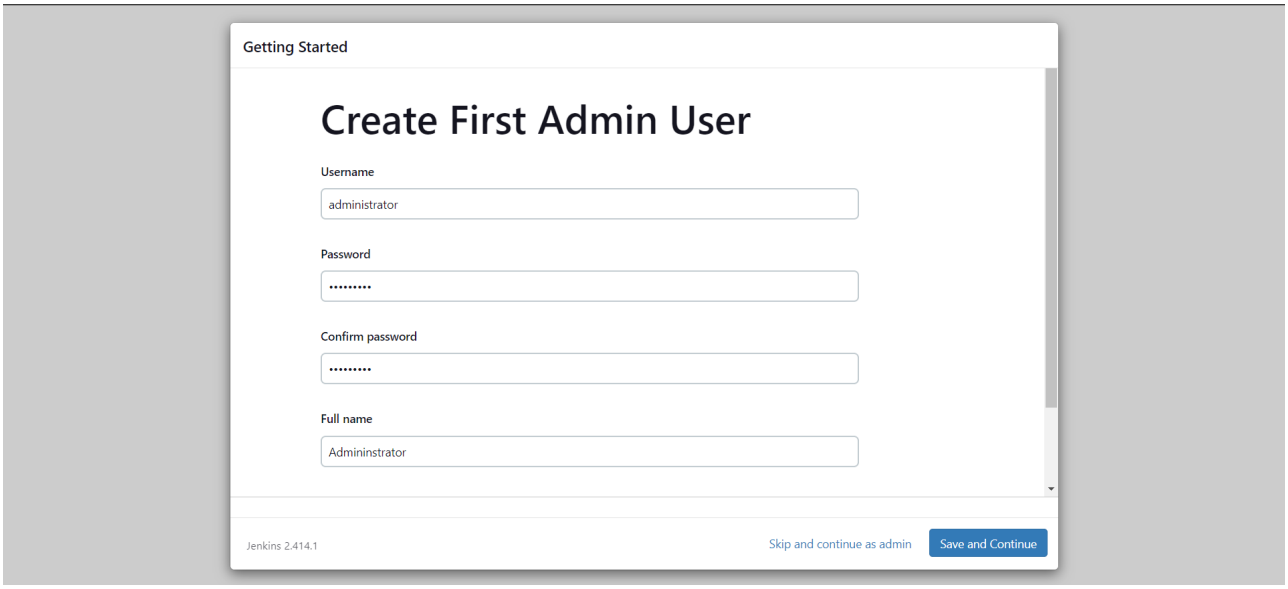


4. **Unlock Jenkins**
   During the initial setup, Jenkins will ask for an admin password. Find the password in the following file:

```
C:\Program Files (x86)\Jenkins\secrets\initialAdminPassword
```

5. **Install Suggested Plugins**
   Jenkins will prompt you to install the suggested plugins. Complete this step and create an admin user when prompted.





Step 2: Create a Kubernetes Service Account for Jenkins

1. **Create the Jenkins Namespace**
   Run the following command to create a namespace for Jenkins:

```
kubectl create namespace jenkins
```

```
C:\Windows\System32>kubectl create namespace jenkins
namespace/jenkins created
```

2. **Create a Service Account for Jenkins**
   In the Jenkins namespace, create a service account for Jenkins to access the Kubernetes cluster:

```
kubectl create sa jenkins -n jenkins
```

```
C:\Windows\System32>kubectl create sa jenkins -n jenkins
serviceaccount/jenkins created
```

3. **Generate a Token for Jenkins**
   Generate a token for the Jenkins service account with a duration of one year:

```
kubectl create token jenkins -n jenkins --duration=8760h
```

```
C:\Windows\System32>kubectl create token jenkins -n jenkins --duration=8760h
eyJhbGciOiJSUzI1NiIsImtpZCI6ImZZcERSb0dPZ1VUUDN0LUZTc2xyblI5cGFNai03d0QzU2I3OXUyZTVuYlEifQ.eyJhdWQiOlsiaHR0cHM6Ly9rdWJlcm5ldGVzLmRlZmF1bHQuc3ZjLmNsdXN0ZXIubG9jYWwiXSwiZXhwIjoxNzYxMzY2NTYwLCJpYXQiOjE3Mjk4MzA1NjAsImlzcyI6Imh0dHBzOi8va3ViZXJuZXRlcy5kZWZhdWx0LnN2Yy5jbHVzdGVyLmxvY2FsIiwianRpIjoiZTcwZTcyN2ItNDAyMi00NmJkLWE5MWUtZGI5ZWE2Y2FkM2Q3Iiwia3ViZXJuZXRlcy5pbyI6eyJuYW1lc3BhY2UiOiJqZW5raW5zIiwic2VydmljZWFjY291bnQiOnsibmFtZSI6Implbmtpbnbn MiLCJ1aWQiOiIyODRmYzFhYi1iODI5LTRiNzItOWJlMi0zOGJkNTFjZjI5NzIifX0sIm5iZiI6MTcyOTgzMDU2MCwic3ViIjoic3lzdGVtOnNlcnZpY2VhY2NvdW50Omplbmtpbnbn M6amVua2lucyJ9.VF-1qmg9PTMVQwBSfv0guwffdD2-nCgWTSJ59wJ6c1cIYHyz_CxT9AgP9io0Nv8iHGfbeeViPebFYUkG09IAP36Qce599OGYhoGOk9b7RkBzZej_aKYoSfm6cE1EujGzYGUJ51l_tSNrycuKqs4 JsqWzGFPf84vuxASF3h7mWQbcqvX2RzeZCh9oWSepVya8Sbwm6A0Wy-JrwScDeKEqpqtgFU7_ay4JVQ4VCYa6kJVGbJ7EhFgJPOBOfJWgRm7SFmBesNoI25XeSI83ljINL3cdssWiz2MLoruhkQ mBKZEH51PCxqCrICl7ybZkZ6fFM4vBBuLYIBaQJxGHNSPcZw
```

   Save the token as it will be needed when configuring Jenkins.

4. **Create a RoleBinding for Jenkins**
   Assign admin-level access to Jenkins using the following RoleBinding command:

```
kubectl create rolebinding jenkins-admin-binding --clusterrole=admin --
serviceaccount=jenkins:jenkins --namespace=jenkins
```

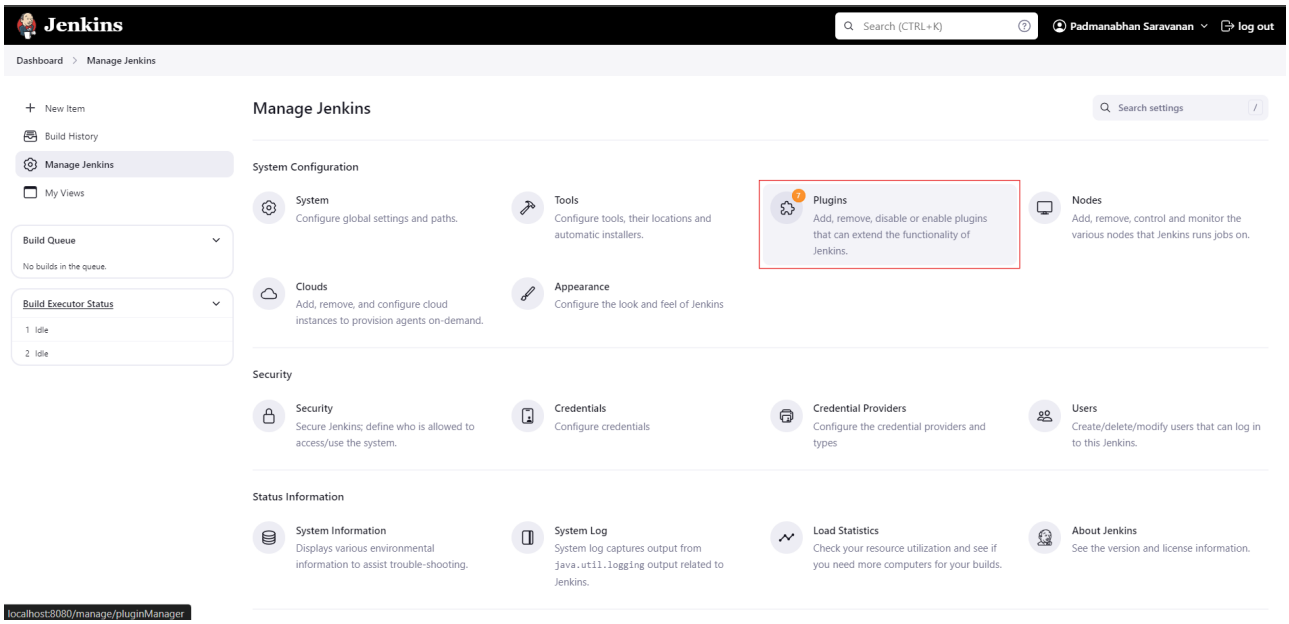
```
C:\Windows\System32>kubectl create rolebinding jenkins-admin-binding --clusterrole=admin --serviceaccount=jenkins:jenkins --namespace=jenkins
rolebinding.rbac.authorization.k8s.io/jenkins-admin-binding created
```

Step 3: Set Up Jenkins Kubernetes Plugin

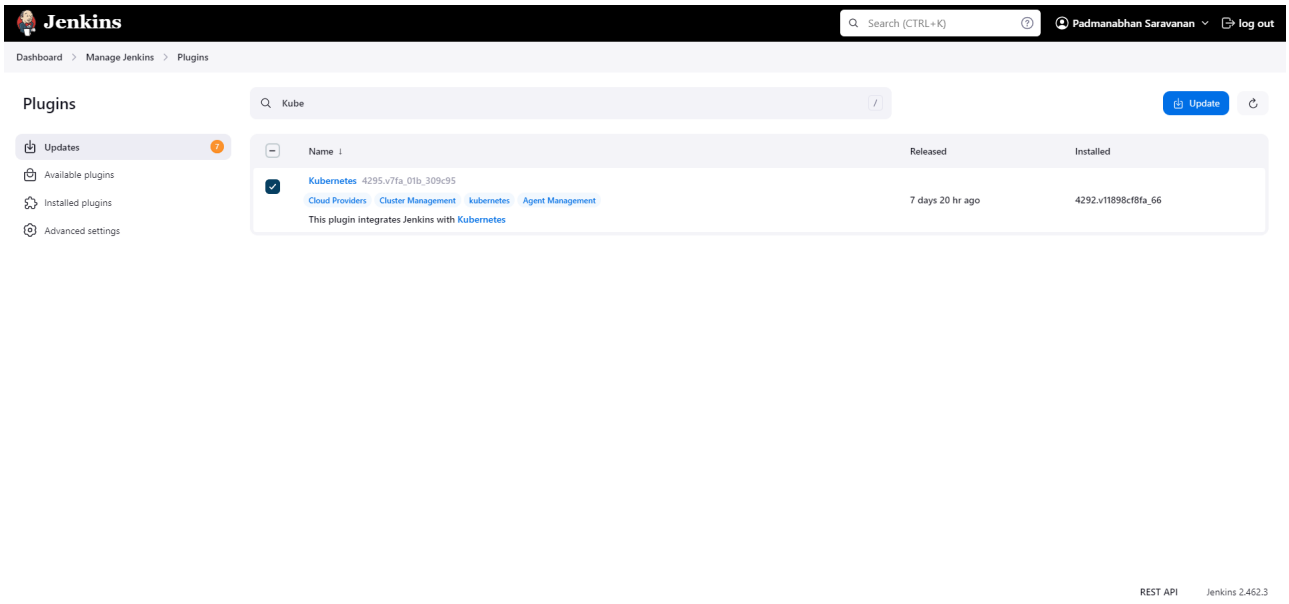
1. **Access Jenkins**
   Open your browser and go to `http://localhost:8080`.

2. **Install Kubernetes Plugin**

   - Go to **Manage Jenkins > Manage Plugins**.

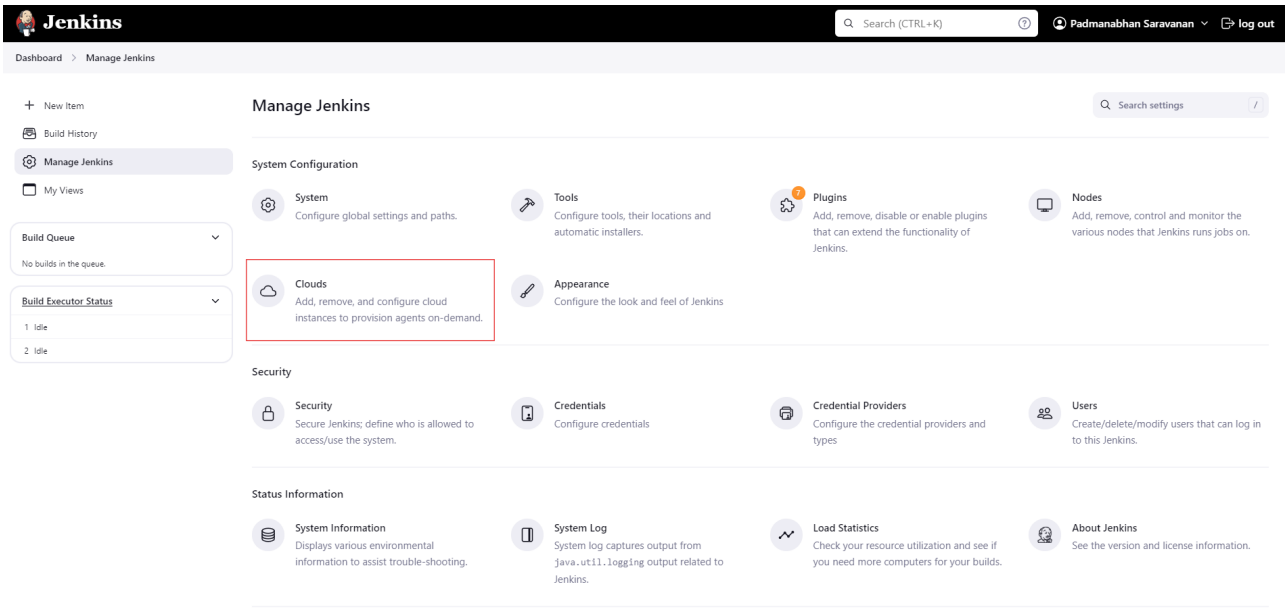


- In the **Available** tab, search for "Kubernetes" and install the **Kubernetes Plugin**.

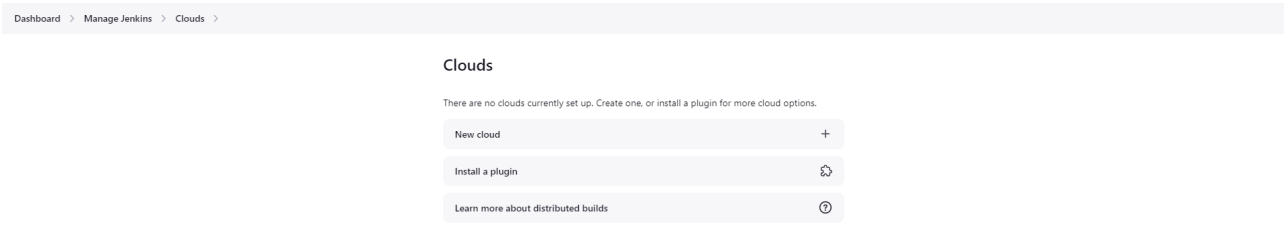


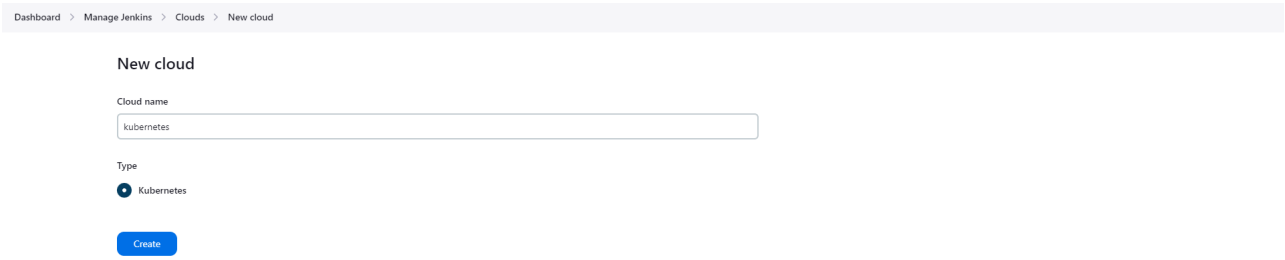
3. **Configure Jenkins to Connect to Kubernetes**

- Go to **Manage Jenkins > Cloud**.



- click **Add a new cloud**. Select **Kubernetes**.

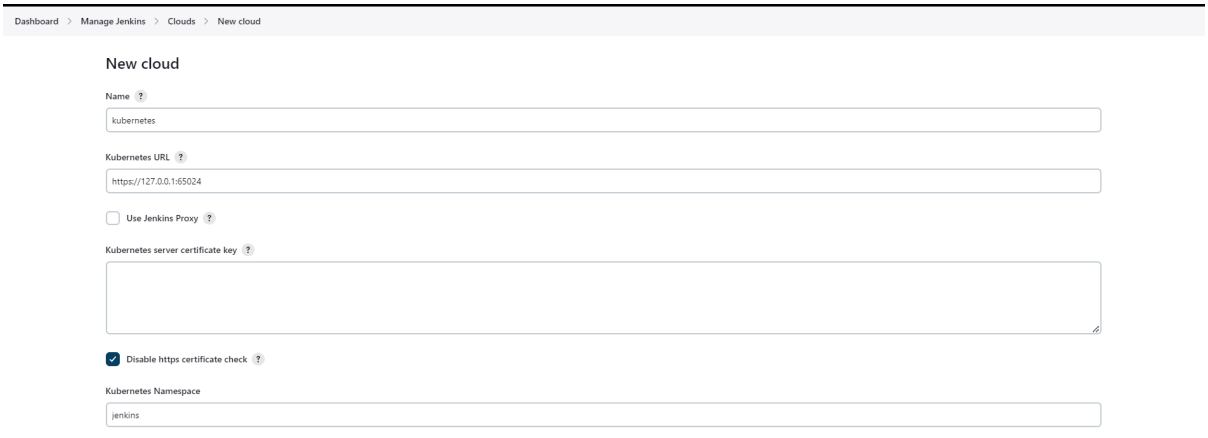




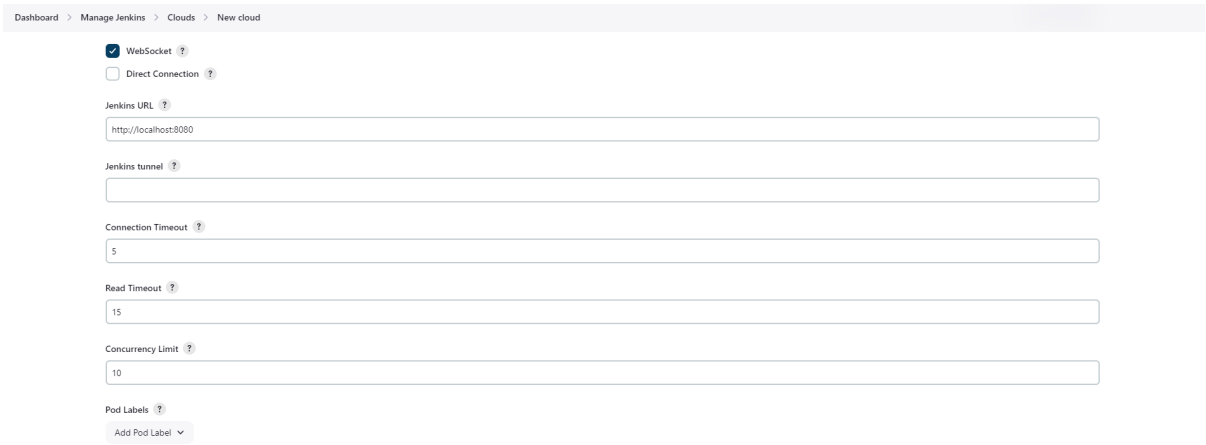
- Configure the following settings:
  - **Kubernetes URL**: Obtain the URL by running `kubectl config view` and look for the `cluster.server` field.

```
C:\Windows\System32>kubectl config view
apiVersion: v1
clusters:
- cluster:
    certificate-authority-data: DATA+OMITTED
    server: https://kubernetes.docker.internal:6443
  name: docker-desktop
- cluster:
    certificate-authority: C:\Users\vijay\.minikube\ca.crt
    extensions:
    - extension:
        last-update: Fri, 25 Oct 2024 09:12:05 IST
        provider: minikube.sigs.k8s.io
        version: v1.34.0
      name: cluster_info
    server: https://127.0.0.1:65024
  name: minikube
contexts:
- context:
    cluster: docker-desktop
    user: docker-desktop
  name: docker-desktop
- context:
    cluster: minikube
    extensions:
    - extension:
        last-update: Fri, 25 Oct 2024 09:12:05 IST
        provider: minikube.sigs.k8s.io
        version: v1.34.0
      name: context_info
    namespace: default
    user: minikube
  name: minikube
current-context: minikube
kind: Config
preferences: {}
users:
- name: docker-desktop
  user:
    client-certificate-data: DATA+OMITTED
    client-key-data: DATA+OMITTED
- name: minikube
  user:
    client-certificate: C:\Users\vijay\.minikube\profiles\minikube\client.crt
    client-key: C:\Users\vijay\.minikube\profiles\minikube\client.key
```

- **Kubernetes Namespace**: Enter `jenkins`.

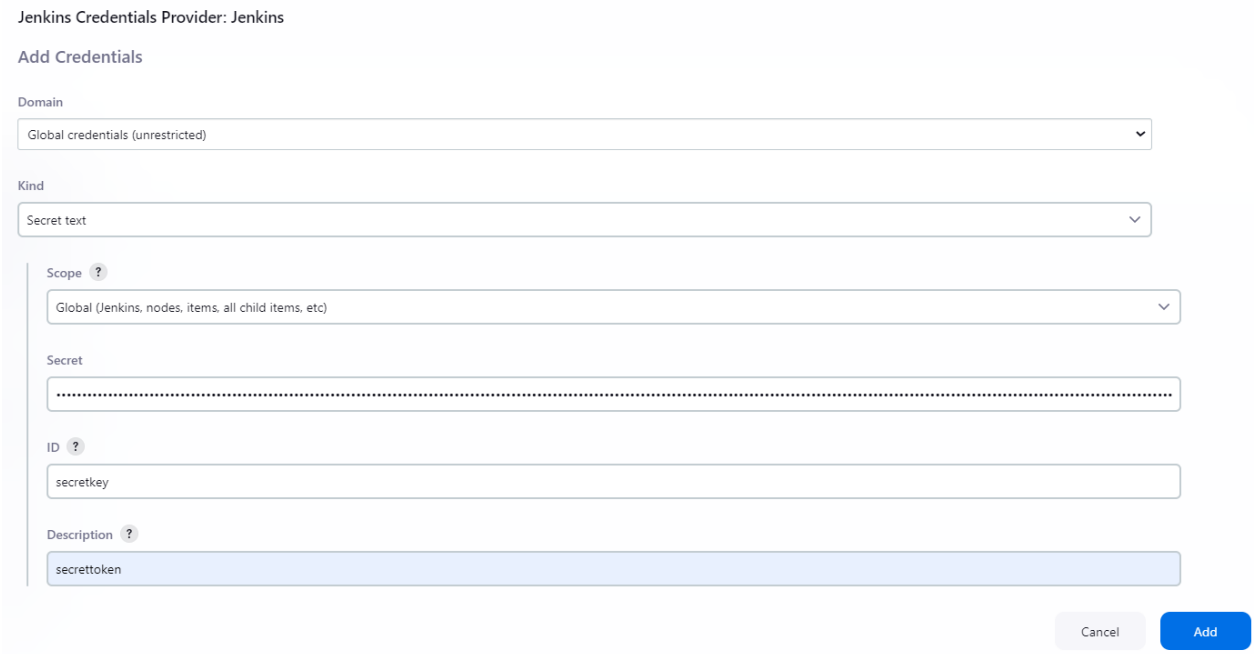


- **Jenkins URL**: Add your Jenkins URL (`http://localhost:8080`) and ensure **WebSocket** is enabled.



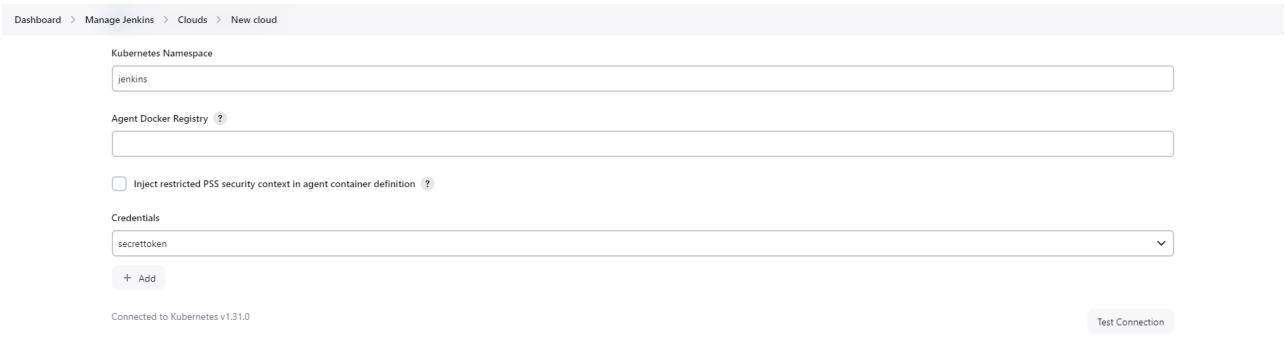
- **Disable HTTPS Certificate Check**: Ensure this is checked for local environments.

- In the **Credentials** section, use the token created earlier by selecting **Add > Jenkins** and selecting **Secret Text**. Paste the Kubernetes token from the earlier step.



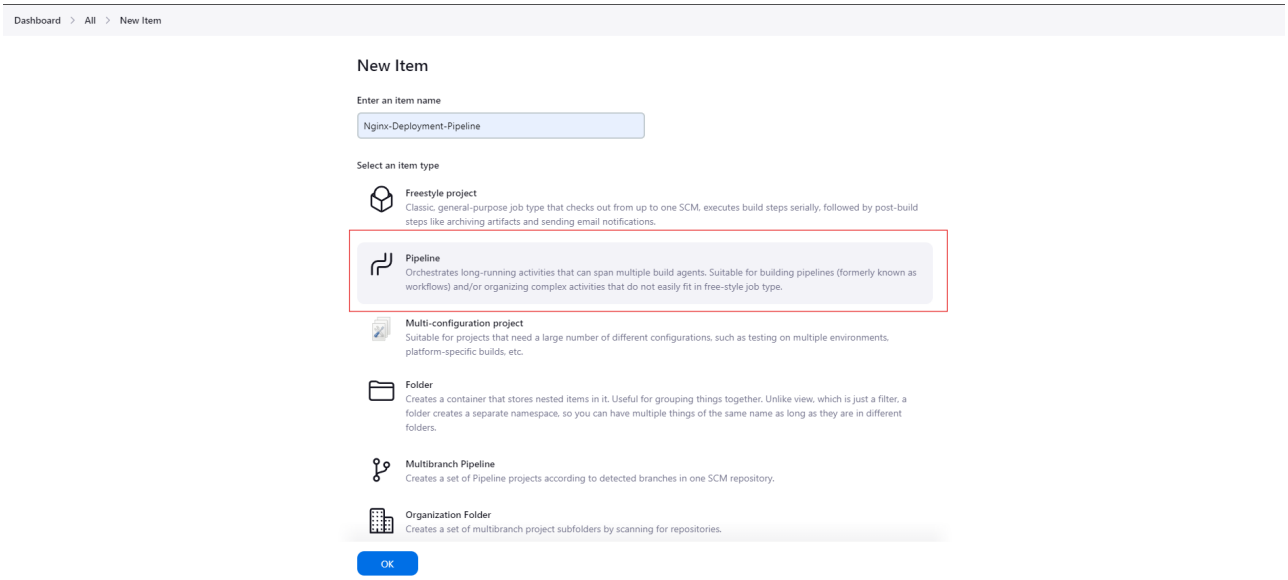
4. **Test the Connection**

- Click **Test Connection** to verify Jenkins can connect to Kubernetes. If the connection is successful, click **Save**.



Step 4: Create and Run a Jenkins Pipeline

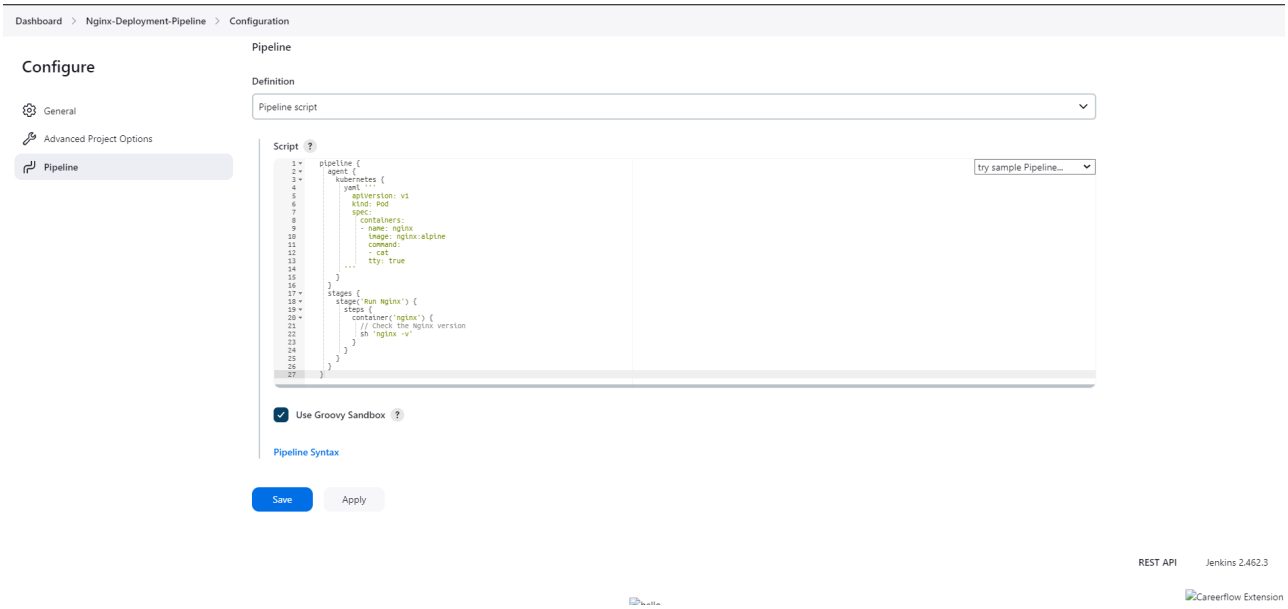
1. **Create a New Pipeline Job**
   - In Jenkins, click **New Item**, select **Pipeline**, and give it a name.



2. **Define the Pipeline Script**
   In the pipeline script section, use the following code to create a pipeline that deploys and runs an Nginx container in a Kubernetes pod:

```
pipeline {
  agent {
    kubernetes {
      yaml '''
        apiVersion: v1
        kind: Pod
        spec:
          containers:
          - name: nginx
            image: nginx:alpine
            command:
            - cat
            tty: true
      '''
    }
  }
  stages {
    stage('Run Nginx') {
      steps {
        container('nginx') {
          // Check the Nginx version
          sh 'nginx -v'
        }
      }
    }
```

```
    }
}
```



3. **Run the Pipeline**
   - Click **Build Now** to run the pipeline.
   - Jenkins will create a pod in your Kubernetes cluster and run the Nginx container inside it.

4. **Verify Deployment**
   To check if the pod was created successfully, run the following command in your terminal:

```
kubectl get pods -n jenkins
```

```
C:\Users\Administrator>kubectl get pods -n jenkins
NAME                                          READY   STATUS    RESTARTS   AGE
nginx-deployment-pipeline-3-qf14m-lqzqg-1jvjd   2/2     Running   0          11s
```

   You should see a pod with the Nginx container running.

References

- Jenkins Official Website
- Kubernetes Official Documentation
- Minikube Documentation