SPRING BOOT

CI/CD WITH

JENKINS

- Rohan Thapa

thaparohan2019@gmail.com

What is Jenkins?

Jenkins is an **open-source** automation server written in **Java** that helps **automate** parts of software development related to **building**, **testing**, and **deploying**, facilitating continuous integration and continuous delivery **(CI/CD).**

It's one of the most popular **CI/CD** tools used by developers to create a seamless pipeline for code delivery.

History of Jenkins

- Originally developed as **Hudson** at **Sun Microsystems in 2004**.

- Jenkins emerged after a dispute between Oracle and the Hudson open-source community in 2011.

- Now, Jenkins is maintained by a **large community** and has become the **go-to tool for CI/CD**.

Key Concepts of Jenkins

Jenkins Pipeline

A **pipeline** in Jenkins is a **set of tasks** that are automated to build, test, and deploy your software. It's a workflow that defines the steps to take your code from **version control to production**.

Jobs

A job in Jenkins represents a **task or a step** in a **pipeline**. Jenkins can have multiple jobs for different stages in the pipeline (e.g., build, test, deploy).

Key Concepts of Jenkins

Builds

A **build** is the **result of executing a job**. Builds can represent compiled code or simply the outcome of running automated tests.

Nodes and Executors

- **Nodes:** Jenkins uses master-slave architecture to manage different machines that execute jobs.
- **Master Node:** Handles scheduling and orchestration of jobs.
- **Slave/Agent Nodes**: Execute jobs, and they can be on different machines/servers.
- **Executors:** Slots on a node that execute jobs. You can configure how many jobs an executor can run simultaneously.

Key Concepts of Jenkins

Plugins

Jenkins has a **plugin-based architecture** that allows it to integrate with almost any development tool (SCM systems, build tools, deployment tools, etc.).

Popular plugins include:

- **Git Plugin:** For source code integration.
- **Maven Plugin:** To build Maven projects.
- **Docker Plugin:** To interact with Docker.
- **Slack Plugin:** For sending notifications.

Setting Up Jenkins

Prerequisites

- **Java:** Jenkins runs on Java, so you need to have Java installed on your machine (**JDK 17 is recommended**).

- **Web Browser:** Jenkins is accessed via a **web interface**.

- **Server:** You can run Jenkins on your **local machine**, a **server**, or **in the cloud**.

Setting Up Jenkins

Installation
You can install Jenkins on **different platforms**.
Let’s go through a few common options.

On Windows:

- Download Jenkins from the official website and run the installer.

On Linux(Ubuntu/Debian):

```
sudo wget -O /usr/share/keyrings/jenkins-keyring.asc \
  https://pkg.jenkins.io/debian-stable/jenkins.io-2023.key
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
sudo apt-get install jenkins
```

```
sudo systemctl start jenkins
```

Initial Setup and Unlocking Jenkins

- After installation, Jenkins runs on http://localhost:8080.
- You will be prompted to enter an initial admin password, which can be found in the log file at:

```
/var/lib/jenkins/secrets/initialAdminPassword
```

- Complete the setup wizard and install recommended plugins.

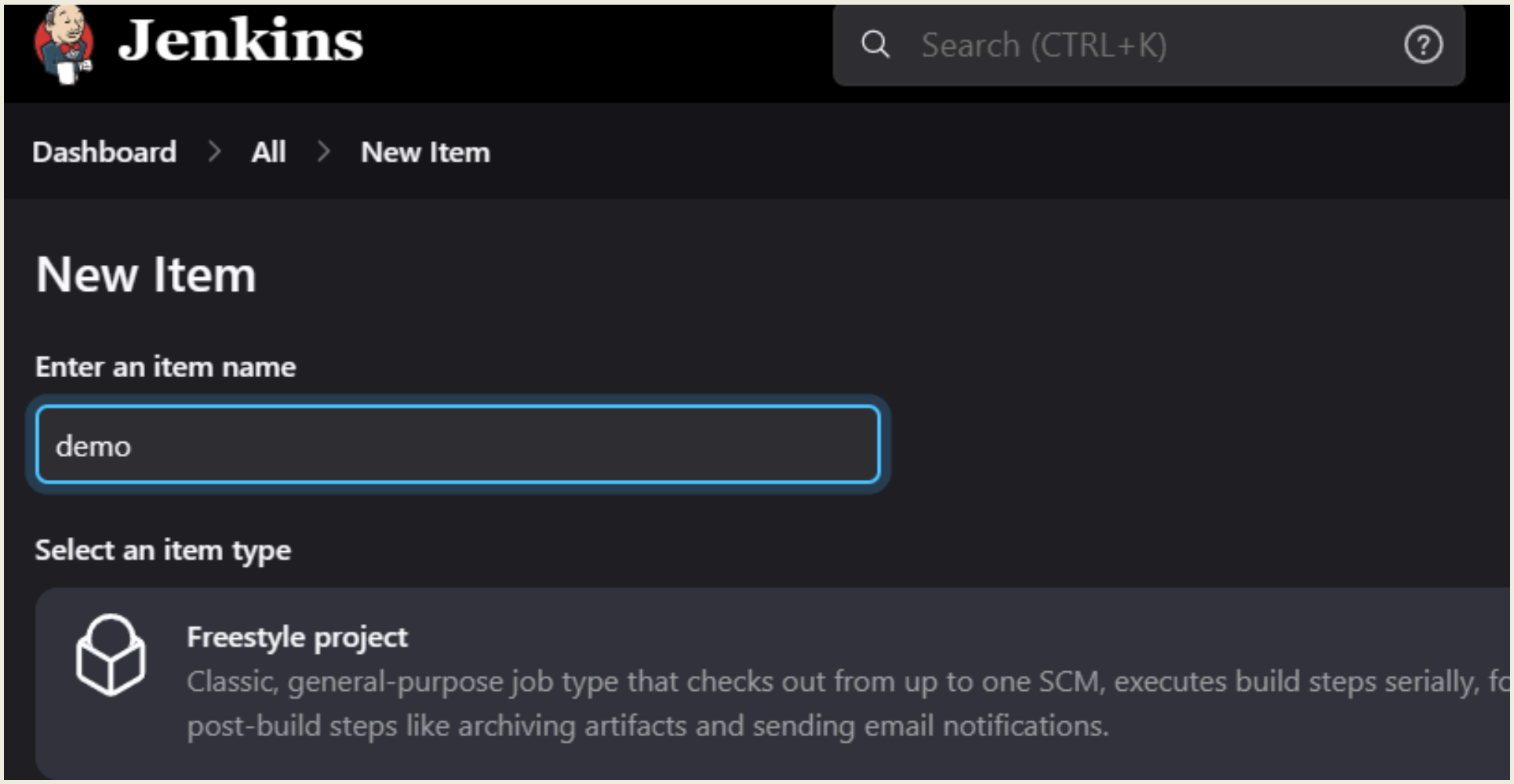
Jenkins Basics

Freestyle Projects

A **Freestyle Project** is the simplest type of Jenkins job. It allows you to define a series of build steps that Jenkins will execute.

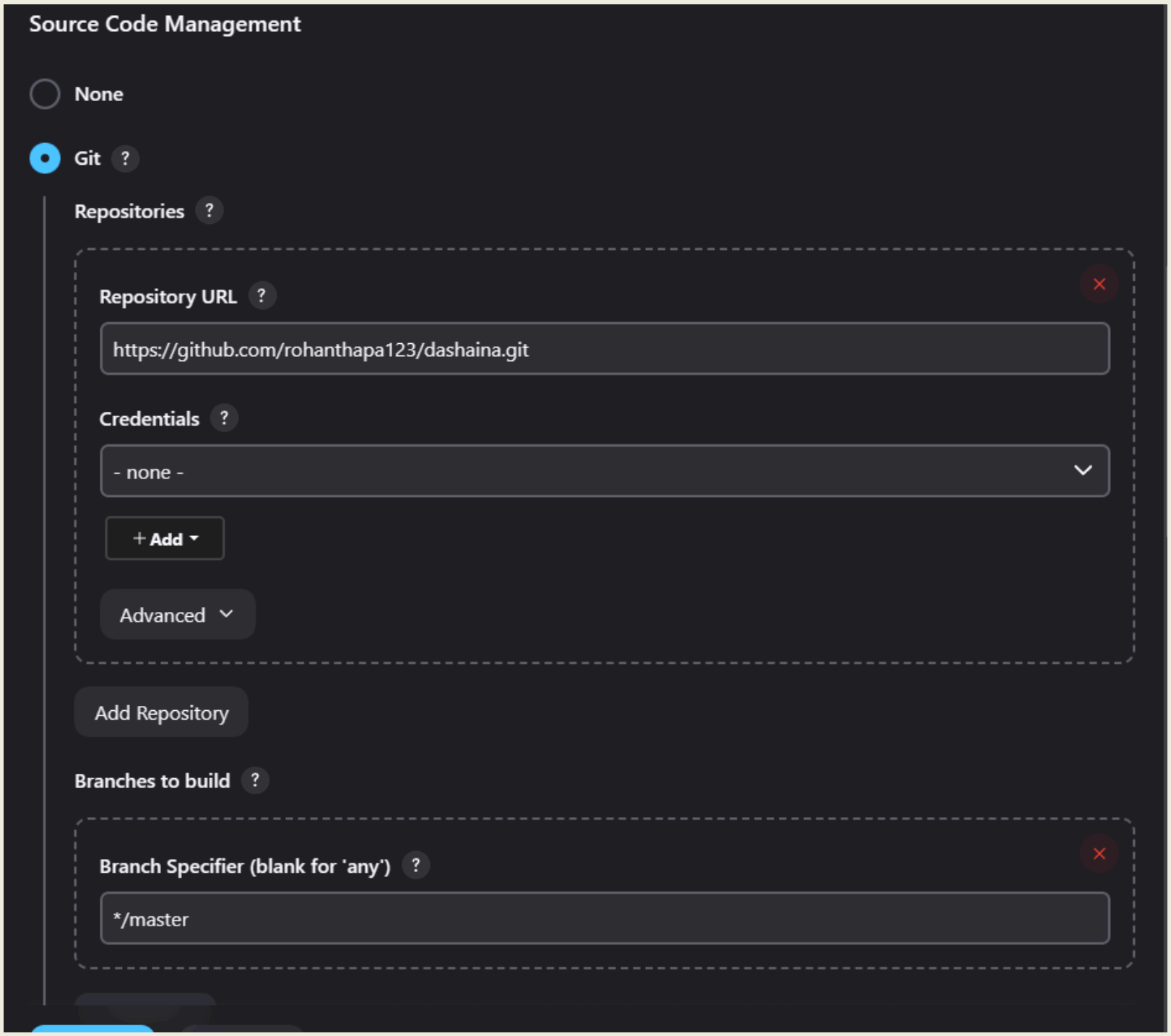
Steps to create a Freestyle Project:

1.Click on "**New Item**" and select "**Freestyle Project**."



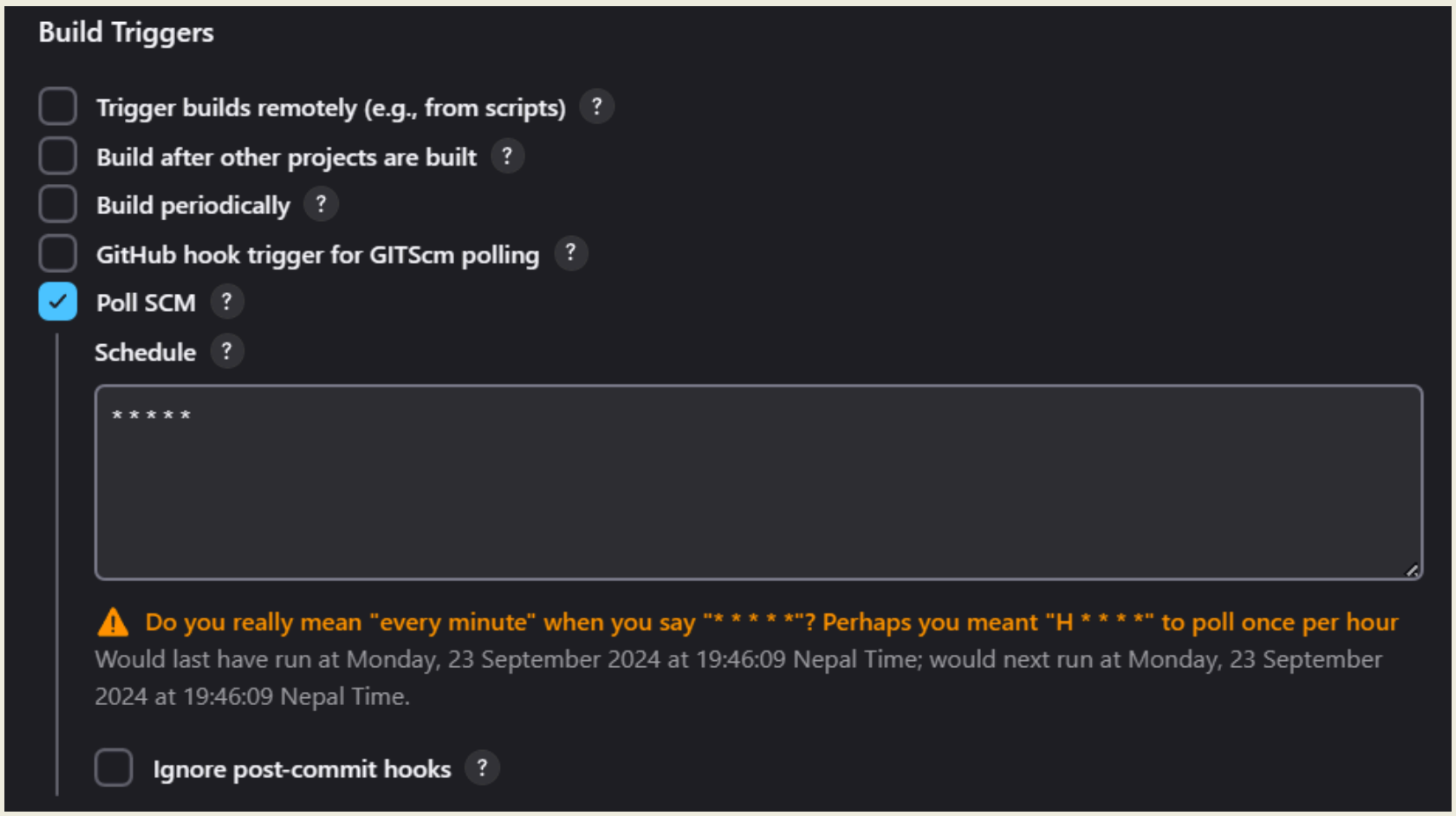
Jenkins Basics

2. Define your **Source Code Management** (SCM) system (e.g., **Git**).



Jenkins Basics

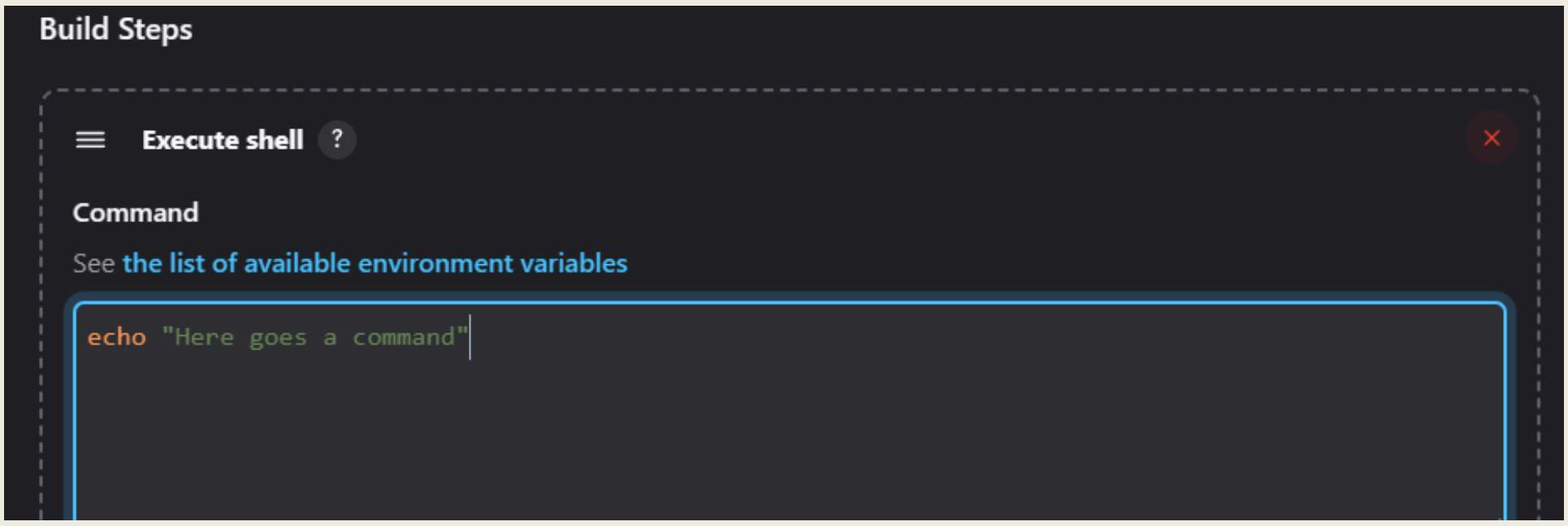
3. Define Build Triggers (when you want the job to run—manually, periodically, on a SCM change, etc.).



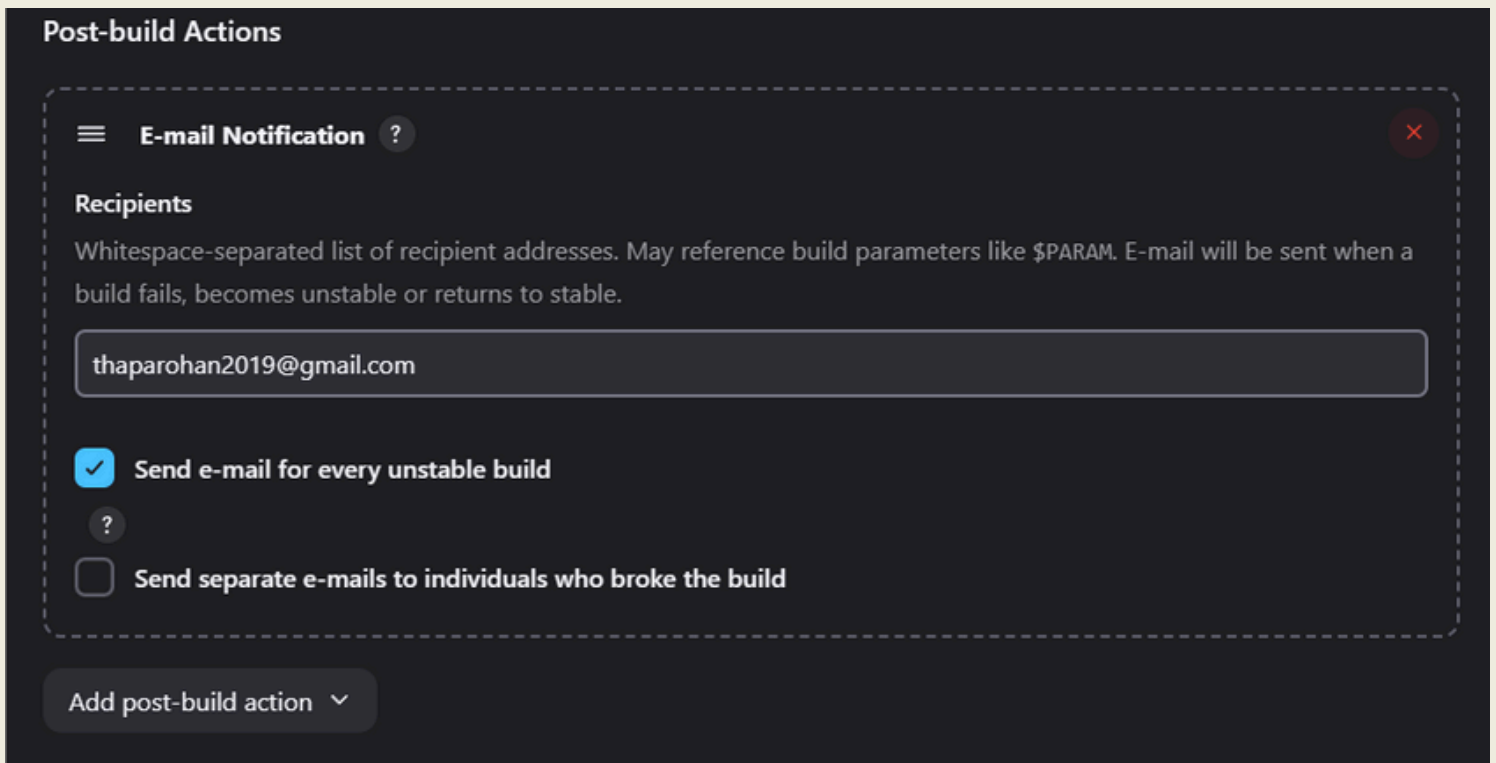
- Add Build Steps (e.g., **invoking a shell command, running a Maven build**).
- Define Post-Build Actions (e.g., **sending notifications, archiving artifacts**).

Jenkins Basics

4. Add Build Steps (e.g., **invoking a shell command, running a Maven build**).



5. Define Post-Build Actions (e.g., **sending notifications, archiving artifacts**).



Jenkins Basics

Pipelines

Jenkins Pipelines are scripted workflows that give more control and flexibility than Freestyle Projects.

You define pipelines using **Jenkinsfile**, a text file that contains the definition of the pipeline.

Declarative vs Scripted Pipelines

- **Declarative Pipelines:** A simpler, structured way to define a pipeline using pipeline syntax.
- **Scripted Pipelines:** Uses more advanced Groovy syntax, offering more flexibility and control.

Jenkins Basics

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Jenkins Basics

```
pipeline {
    agent any
    stages {
        stage('Build') {
            steps {
                echo 'Building...'
                sh 'mvn clean package'
            }
        }
        stage('Test') {
            steps {
                echo 'Testing...'
                sh 'mvn test'
            }
        }
        stage('Deploy') {
            steps {
                echo 'Deploying...'
                sh 'scp target/*.jar user@server:/path/to/deploy'
            }
        }
    }
}
```

CI/CD with Jenkins

Jenkins enables **Continuous Integration** (CI) by running automated **builds** and **tests** when code is pushed to **version control**. **Continuous Deployment** (CD) is achieved by **automatically deploying** the application to **staging/production** if the build and tests are successful.

Basic CI/CD Pipeline

Here's a simple **CI/CD** workflow using **Jenkins**:

1. **Build**:
    - Jenkins **pulls code from GitHub**.
    - Runs the build process (**using Maven/Gradle**).
    - Stores build artifacts (e.g., **JAR/WAR** files).
2. **Test**:
    - Jenkins runs **unit tests**, **integration tests**, or other tests (e.g., using JUnit).
3. **Deploy:**
    - If tests pass, Jenkins can deploy the application to a **production** or **staging** environment.

Triggering Builds

- **Poll SCM:** Jenkins periodically checks the repository for changes.
- **Webhooks:** Jenkins triggers a build when GitHub/Bitbucket sends a webhook event.
- **Manual:** You can manually trigger builds.

Advanced Jenkins Concepts

Jenkins Agents (Nodes)

Jenkins uses a **master-slave** architecture. **Master** manages the **build process**, while **Agents** (formerly called "slaves") **execute the build tasks**.

Agent Types:

- **Static agents:** Pre-configured machines or VMs.
- **Dynamic agents:** Can be spun up on-demand (e.g., Docker containers, Kubernetes pods).

Advanced Jenkins Concepts

Distributed Builds
Jenkins can distribute build jobs across different machines to balance the load and speed up the process.

Jenkins Pipelines as Code
You can define Jenkins pipelines as code using the **Jenkinsfile**. This allows version control for your pipeline and makes it easier to maintain.

Jenkins Plugins for CI/CD

- **Pipeline Plugin:** Allows Jenkins to support **pipeline-as-code**.

- **Blue Ocean:** Provides a modern UI for Jenkins.
- **JUnit Plugin:** Displays test results within Jenkins.
- **Email Extension Plugin:** Sends notifications based on the status of builds.
- **GitHub Plugin:** Integrates GitHub as an SCM provider.
- **Docker Pipeline Plugin:** Builds and deploys Docker images.

Jenkins and Docker

Jenkins and Docker are often used together to:

- **Build Docker images** within Jenkins.
- **Deploy applications** using Docker containers.
- **Run Jenkins** inside a Docker container (Jenkins-in-Docker).

Build and Push Docker Images in Jenkins

- Install Docker Pipeline plugin.
- Define a pipeline to build and push Docker images:

```
pipeline {
    agent {
        docker { image 'maven:3.6.3-jdk-11' }
    }
    stages {
        stage('Build') {
            steps {
                sh 'mvn clean package'
            }
        }
        stage('Build Docker Image') {
            steps {
                script {
                    docker.build('my-app-image')
                }
            }
        }
        stage('Push Docker Image') {
            steps {
                script {
                    docker.withRegistry('https://registry.hub.docker.com', 'docker-hub-credentials') {
                        docker.image('my-app-image').push('latest')
                    }
                }
            }
        }
    }
}
```

Complete CI/CD Example

Let's walk through a **full CI/CD pipeline** setup with **Jenkins**, using **GitHub** as the source code repository. In this example, we'll have a workflow that:

- Runs **tests** on every **code push** to GitHub.
- Builds a **Docker image** if the **tests pass**.
- Deploys the application (e.g., to a server or cloud).
- **Sends notifications** (e.g., via **Slack** or **email**) after the build completes.

Complete CI/CD Example

This workflow will cover:

- **Continuous Integration:** Running tests on every push.
- **Continuous Delivery:** Automatically building and deploying if tests pass.
- **Notifications:** Sending notifications based on the result.

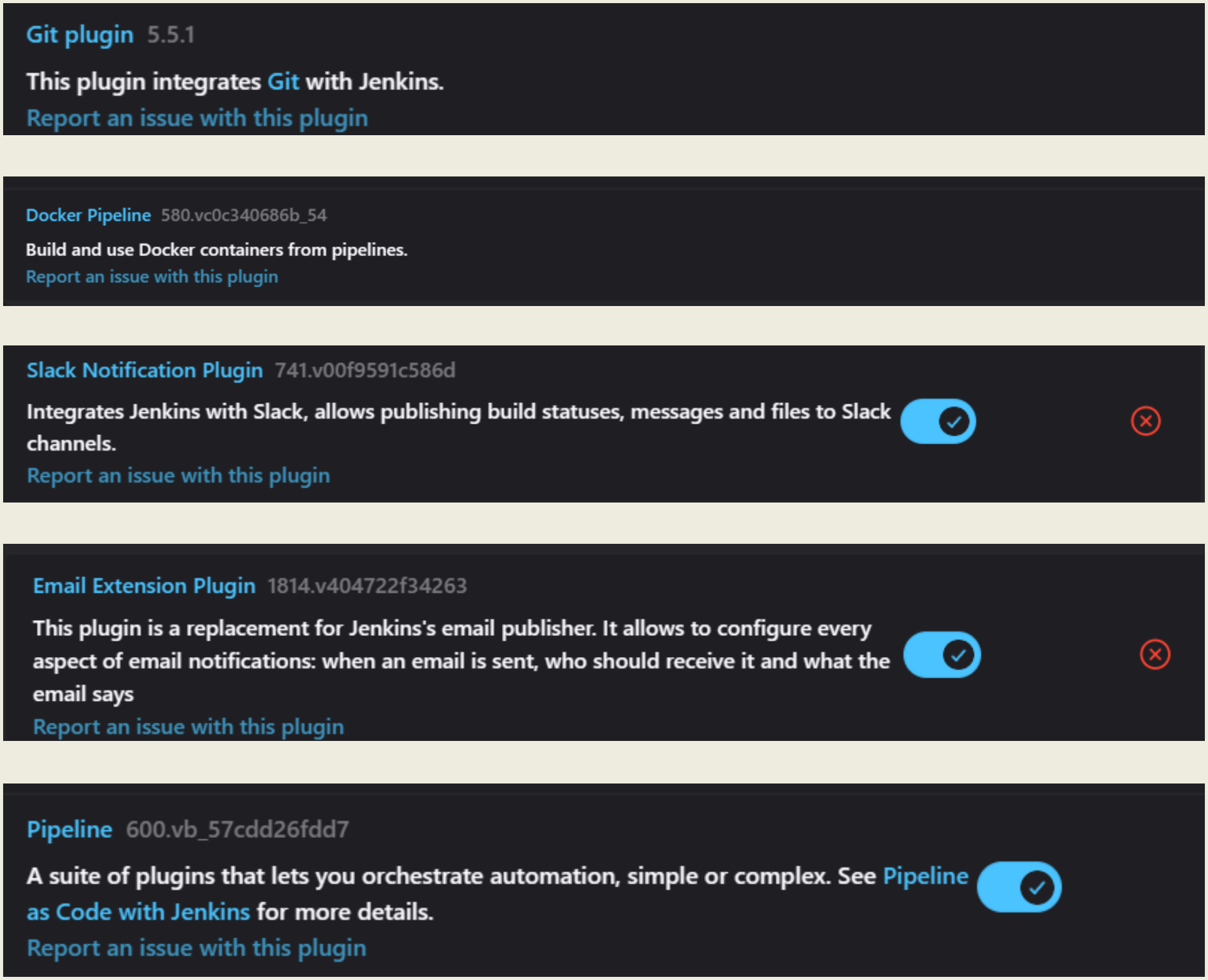
Complete CI/CD Example

Set Up Jenkins

If Jenkins isn't already installed, follow the installation steps for your system. Refer to the **previous explanation** for detailed installation steps.

- Ensure Jenkins is running and accessible at **http://localhost:8080.**
- Install the necessary plugins for this pipeline:
  a. **Git Plugin** (for GitHub integration)
  b. **Pipeline Plugin** (for using Jenkins pipelines as code)
  c. **Docker Pipeline Plugin** (for Docker integration)
  d. **Slack Notification Plugin** or **Email Extension Plugin** (for notifications)

Complete CI/CD Example



Complete CI/CD Example

GitHub Repository Setup

Ensure to have code repository on GitHub. We'll assume the following structure for the project:

Complete CI/CD Example

Create a Jenkins Pipeline (Jenkinsfile)

In the root of your GitHub repository, create a file named Jenkinsfile to define your pipeline.

```
pipeline {
    agent any

    environment {
        // Define Docker image name and Slack webhook URL as environment variables
        DOCKERHUB_CREDENTIALS = credentials('docker-hub-access-token')
        DOCKER_IMAGE = 'rohanthapa02/jenkinsdemo'
        SLACK_WEBHOOK_URL = credentials('slackjenkinsci')
        GITHUB_CREDENTIALS =  credentials('github-personal-token')
    }

    tools {
        maven 'Maven 3.9.9'
        jdk 'JDK 17'
    }

    stages {
        stage('Checkout') {
            steps {
                echo 'Cloning repository...'
                // Clone the repository from GitHub
                git branch: 'master', url: 'https://github.com/rohanthapa123/Jenkins.git' , credentialsId : 'github-personal-token'
            }
        }
```

Complete CI/CD Example

```
stage('Test') {
    steps {
        echo 'Running tests...'
        sh 'mvn clean test'
    }
}

stage('Package'){
            steps{
                echo "Packaging the application"
                sh "mvn clean package"
            }
        }

        stage('Build Docker Image') {
            when {
                // Only build the Docker image if the tests passed
                expression {
                    return currentBuild.resultIsBetterOrEqualTo('SUCCESS')
                }
            }
            steps {
                echo 'Building Docker image...'
                // Build Docker image
                script {
                    dockerImage = docker.build("${env.DOCKER_IMAGE}:latest")
                }
            }
        }

        stage('Deploy to Server') {
            when {
                // Only deploy if the image was built successfully
                expression {
                    return currentBuild.resultIsBetterOrEqualTo('SUCCESS')
                }
            }
            steps {
                echo 'Deploying Docker image...'
                sh '''
                docker login -u $DOCKERHUB_CREDENTIALS_USR -p $DOCKERHUB_CREDENTIALS_PSW
                docker push $DOCKER_IMAGE:latest
                '''
            }
        }
```

Complete CI/CD Example

```
        stage('Notify') {
            steps {
                script {
                    slackSend(
                        channel: '#jenkinsdemo',
                        tokenCredentialId: 'slackjenkinsci',
                        color: 'good',
                        message: 'Build was successful!',
                        username: 'Jenkins' // Change this to your desired bot name
                    )
                }
            }
        }


    }
     post {
            success {
                script {
                    slackSend(
                        channel: '#jenkinsdemo',
                        tokenCredentialId: 'slackjenkinsci',
                        color: 'good',
                        message: 'Build was successful!',
                        username: 'JenkinsBot' // Change this to your desired bot name
                    )
                }
            }
            failure {
                script {
                    slackSend(
                        channel: '#jenkinsdemo',
                        tokenCredentialId: 'slackjenkinsci',
                        color: 'danger',
                        message: 'Build failed! Please check the Jenkins console output.',
                        username: 'JenkinsBot' // Change this to your desired bot name
                    )
                }
            }
        }


}
```

Complete CI/CD Example

Checkout:

- This stage pulls your code from GitHub.

Test:

- Runs automated tests .
- If tests pass, the pipeline moves forward.

Build Docker Image:

- Uses Docker to build an image from your Dockerfile.
- Only executes if the previous stage (Test) was successful.
- The Docker image is tagged as latest and stored locally.

Complete CI/CD Example

Deploy to Server:

- This stage pushes the built Docker image to DockerHub.
- Then it SSHs into your remote server and pulls and runs the new image.

Post:

- Sends a Slack notification on both success and failure. If successful, it sends a green message; if the build fails, it sends a red message.

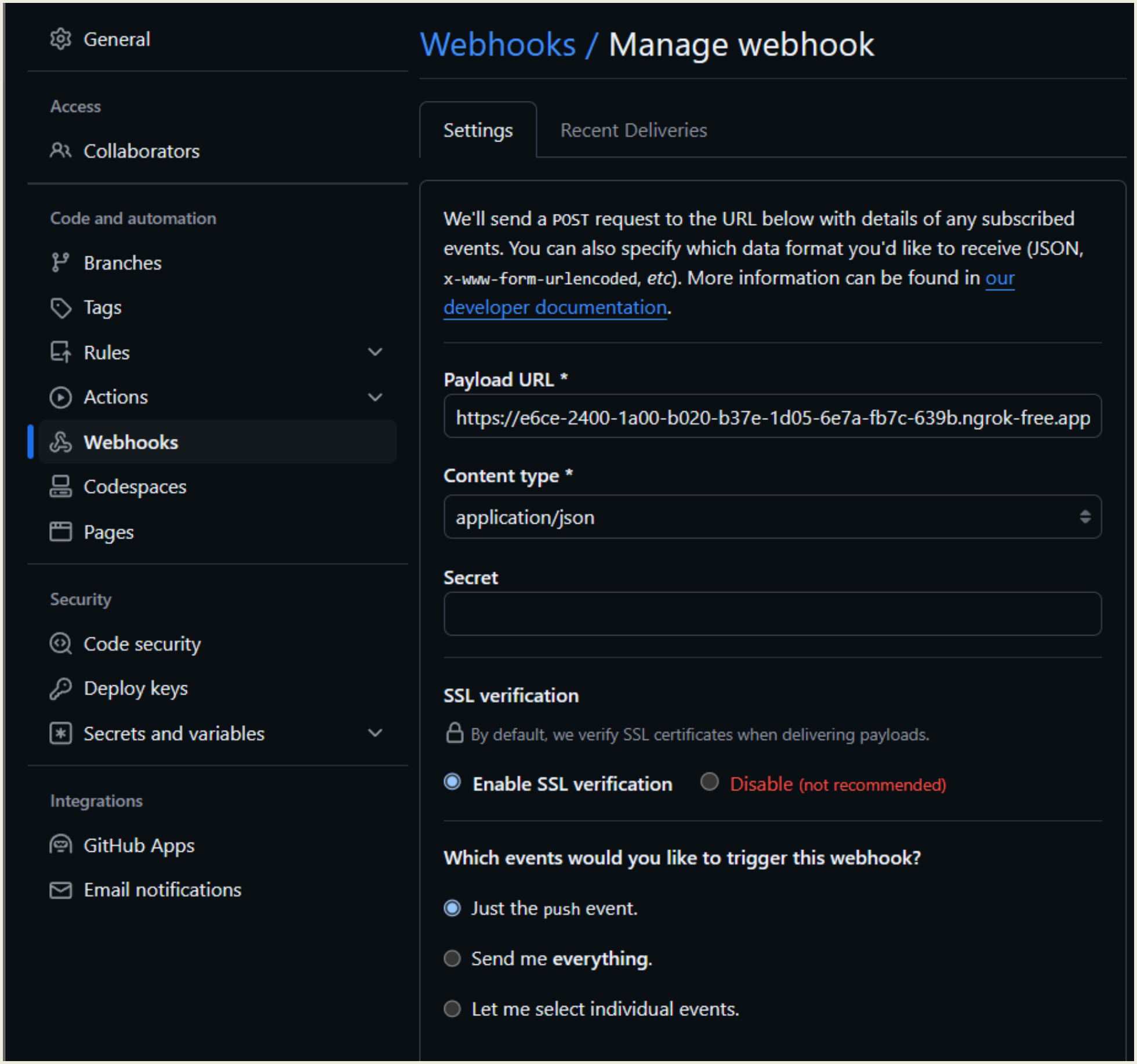
Set up Wekbooks for Github

To trigger the pipeline whenever code is pushed to **GitHub**, you need to set up a webhook.

1. Go to your GitHub repository settings.
2. Select Webhooks and click Add webhook.
3. For the Payload URL, use **http://<JENKINS_URL>:<PORT>/github-webhook/**
4. Set Content type to **application/json.**
5. Choose Let me select individual events and **select Push**.

Now, every time code is pushed to GitHub, Jenkins will be notified and trigger the pipeline.

Set up Wekbooks for Github



Format: https://jenkins-url/github-webhook/

Dockerfile Example

Your **Dockerfile** should be configured to build and containerize your application. Here's a simple example for a Spring Boot application:

```
FROM openjdk:17

# Set the working directory
WORKDIR /app

# Copy the application JAR file to the container
COPY target/jenkins.jar /app/jenkins.jar

# Expose the application port
EXPOSE 8085

# Run the application
CMD ["java", "-jar", "/app/jenkins.jar"]
```

Deployment Setup

- If uploading to cloud server:
- Ensure you have Docker installed and running on your remote server.
- Set up SSH keys so Jenkins can SSH into your server without a password.
- In Jenkins, store the SSH credentials and DockerHub login credentials in the Jenkins credentials store.
- Your deployment can either pull the latest Docker image and run it or do a more sophisticated deployment using Kubernetes, Docker Swarm, or a similar orchestration tool.

Configure for slack Notification

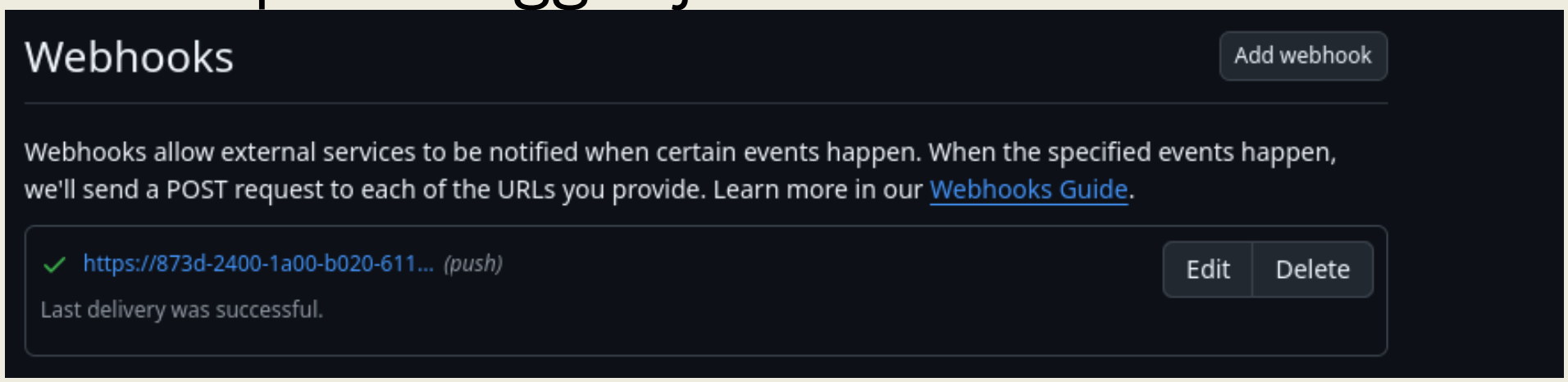
- Install the Slack Notification Plugin from the **Jenkins Plugin Manager**.
- Configure the Slack plugin with your Slack workspace and channel.
- Create a Slack Webhook (go to Slack > Apps > Custom Integrations > Jenkins CI).
- Store your Slack workspace name and credentials Jenkins credentials (slack-credentials).

Result

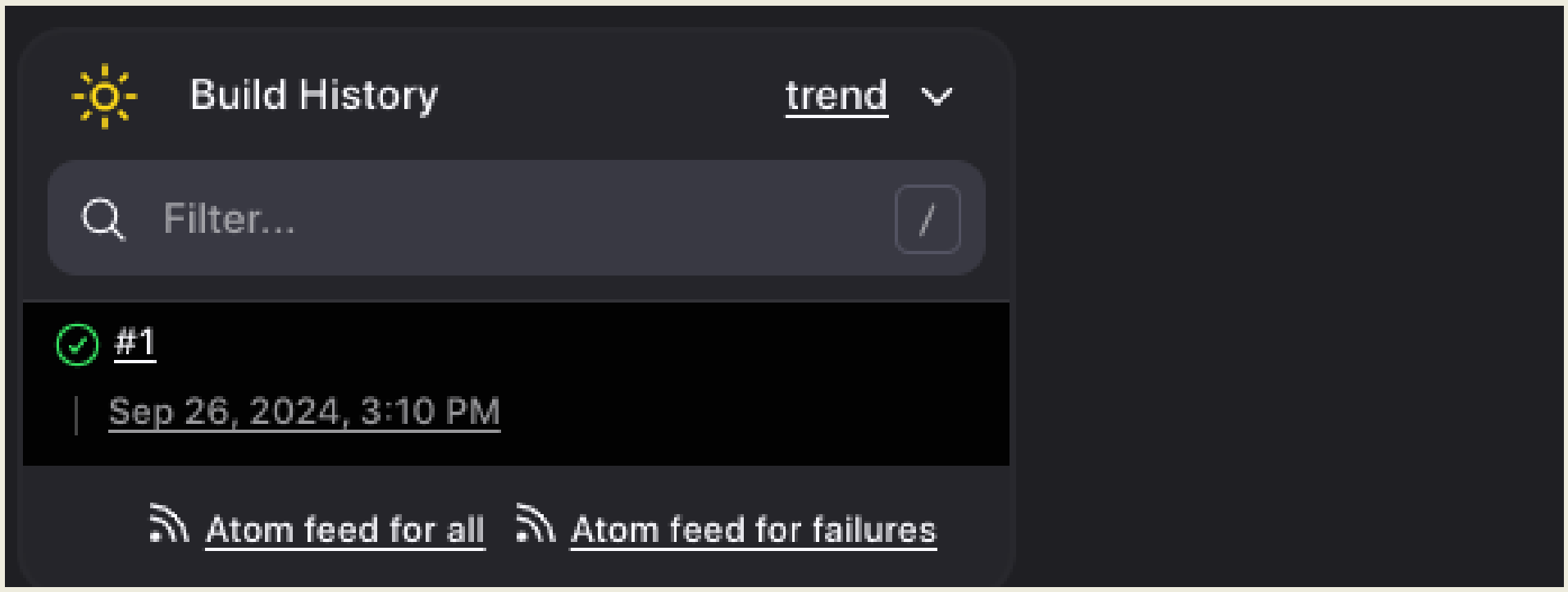
Push code to Github

```
❯ git push
Enumerating objects: 19, done.
Counting objects: 100% (19/19), done.
Delta compression using up to 8 threads
Compressing objects: 100% (6/6), done.
Writing objects: 100% (10/10), 734 bytes | 183.00 KiB/s, done.
Total 10 (delta 2), reused 0 (delta 0), pack-reused 0
remote: Resolving deltas: 100% (2/2), completed with 2 local objects.
To github.com:rohanthapa123/Jenkins.git
   c3d0fad..5d27e48  master -> master
```

Github push trigger jenkins

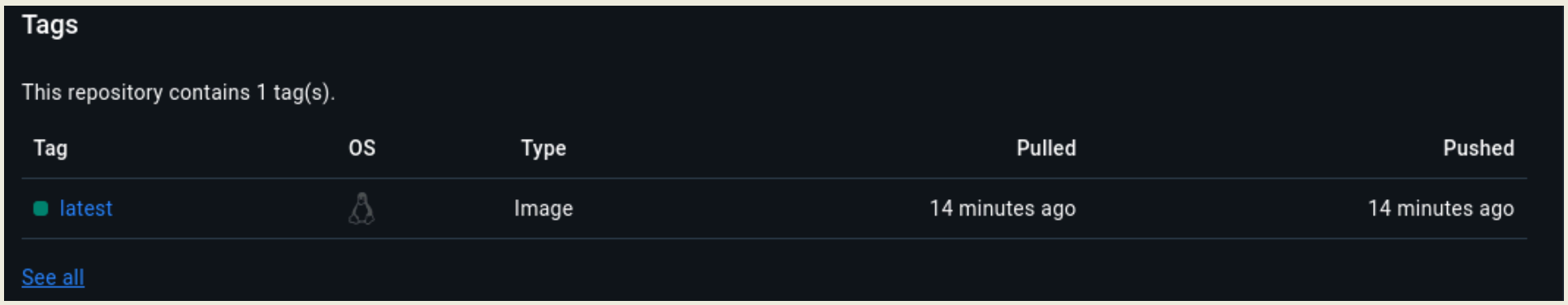


Jenkins perfoming ci/cd

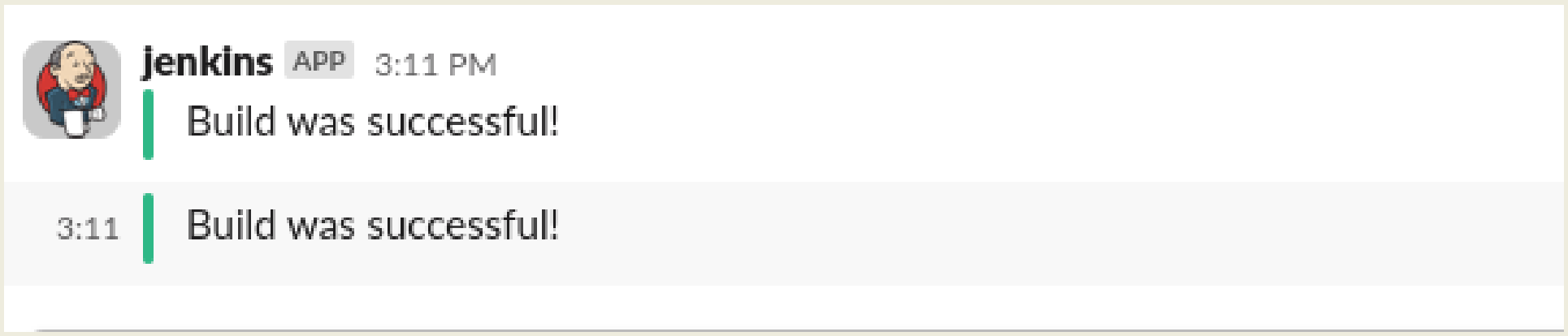


Result

Uploaded to docker hub



Notification sent to slack channel



Jenkins with Kubernetes

Jenkins can be integrated with **Kubernetes** to dynamically create Jenkins agents (**pods**) in **Kubernetes clusters**, making your **CI/CD** pipeline more scalable.

Advantages of Jenkins

- **Extensibility:** With over 1,800 plugins, Jenkins can integrate with almost every tool.
- **Automation:** Completely automates the CI/CD pipeline.
- **Flexibility:** Highly customizable and supports any kind of project (Java, Node.js, Python, etc.).
- **Community Support**: Jenkins has a large, active community providing documentation, tutorials, and plugins.
- **Cross-Platform:** Can run on any operating system (Windows, Linux, macOS).

Tips and Best Practices for Jenkins

- **Use Pipelines as Code:** Always prefer Jenkins Pipelines (via **Jenkinsfile**) over Freestyle Projects.

- **Leverage Parallelism:** Run different stages of the **pipeline in parallel** for faster builds.

- **Use Credentials Safely:** Store sensitive information (like **tokens, passwords**) using **Jenkins credentials**.

- **Build on Separate Agents:** Distribute your builds on different nodes to avoid overloading the master node.

Tips and Best Practices for Jenkins

- **Regularly Backup Jenkins Config:** Ensure you backup Jenkins configurations (including pipelines, plugins, and credentials).
- **Monitor Jenkins Performance:** Use monitoring tools and plugins to keep an eye on Jenkins performance and system load.

Conclusion

By mastering Jenkins, you can **automate** nearly **every part** of your **software delivery process**—from **building** and **testing** to **deploying** applications across environments.

Jenkins' flexibility, combined with its extensive **plugin ecosystem**, makes it a critical tool for any DevOps workflow. Whether you're working with **Docker, Kubernetes,** or deploying **Spring Boot applications,** Jenkins provides the foundation for robust CI/CD pipelines.

Thank You

Rohan Thapa
thaparohan2019@gmail.com