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Jenkins Introduction

Jenkins offers a simple way to set up a continuous integration or continuous delivery (CI/CD) environment for almost any combination of languages and source code repositories using pipelines, as well as automating other routine development tasks. While Jenkins doesn't eliminate the need to create scripts for individual steps, it does give you a faster and more robust way to integrate your entire chain of build, test, and deployment tools than you can easily build yourself.

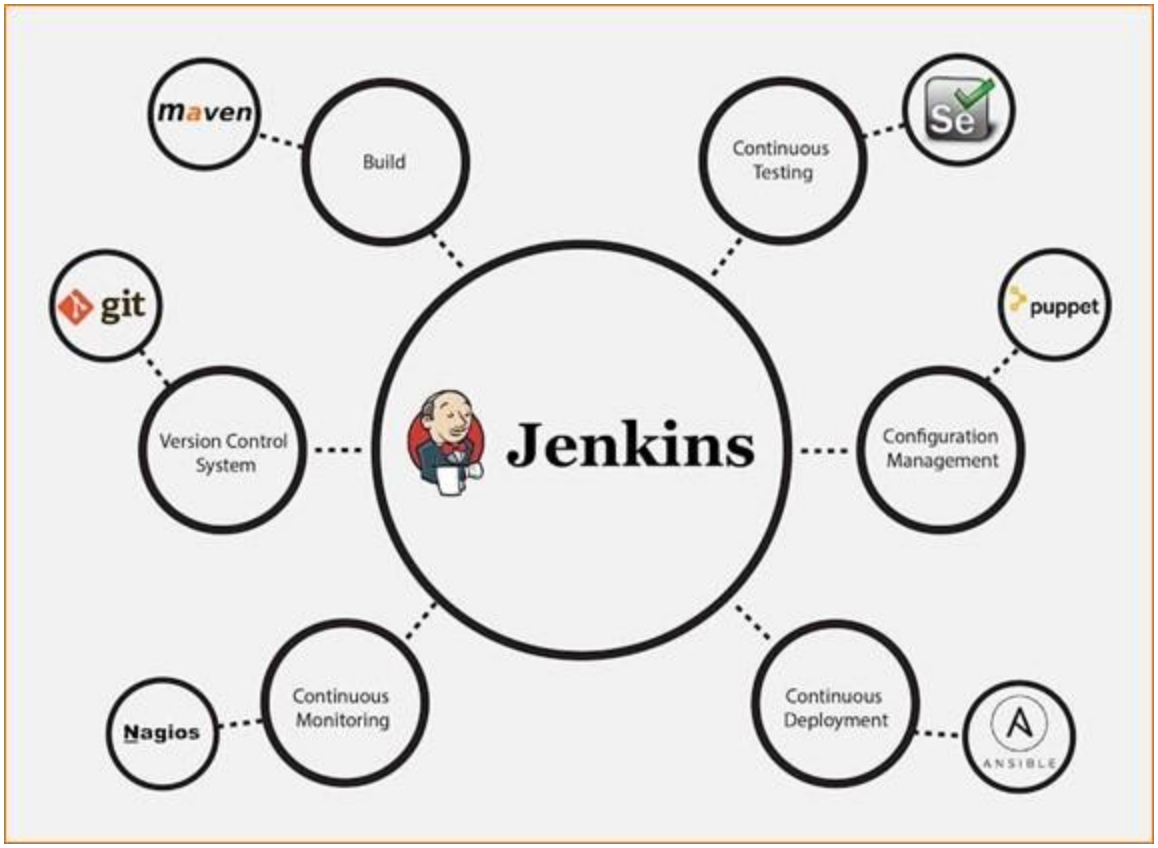
What is Jenkins and why do we use it?

Jenkins is an open-source automation tool written in Java with plugins built for Continuous Integration purposes. Jenkins is used to build and test your software projects continuously making it easier for developers to integrate changes to the project, and making it easier for users to obtain a fresh build. It also allows you to continuously deliver your software by integrating with a large number of testing and deployment technologies.

With Jenkins, organizations can accelerate the software development process through automation. Jenkins integrates development life-cycle processes of all kinds, including build, document, test, package, stage, deploy, static analysis, and much more.

Jenkins achieves Continuous Integration with the help of plugins. Plugins allow the integration of Various DevOps stages. If you want to integrate a particular tool, you need to install the plugins for that tool. For example: Git, Maven 2 project, Amazon EC2, HTML publisher etc.

The image below depicts that Jenkins is integrating various DevOps stages:



Jenkins Features

The following are some facts about Jenkins that makes it better than other Continuous Integration tools:

Adoption: Jenkins is widespread, with more than 147,000 active installations and over 1 million users around the world.

Plugins: Jenkins is interconnected with well over 1,000 plugins that allow it to integrate with most of the development, testing and deployment tools.

It is evident from the above points that Jenkins has a very high demand globally.

Workflow

Jenkins Workflow is a plugin for Jenkins. Once installed, a new item type becomes available: a "Workflow". Workflow projects can be used for the same purposes as regular "Freestyle" Jenkins projects, but they also have the ability to orchestrate much larger tasks that can span multiple projects, and even create and manage multiple workspaces in a single Workflow. What's more, all of this management can be organized into a single script, rather than spread out across a collection of configurations, projects, and steps.

Advantages

· It is an open-source tool with great community support.

· It is easy to install.

· It has 1000+ plugins to ease your work. If a plugin does not exist, you can code it and share it with the community.

· It is free of cost.

· It is built with Java and hence, it is portable to all the major platforms.

Jenkins Alternatives

Following are some of the best alternatives to Jenkins:

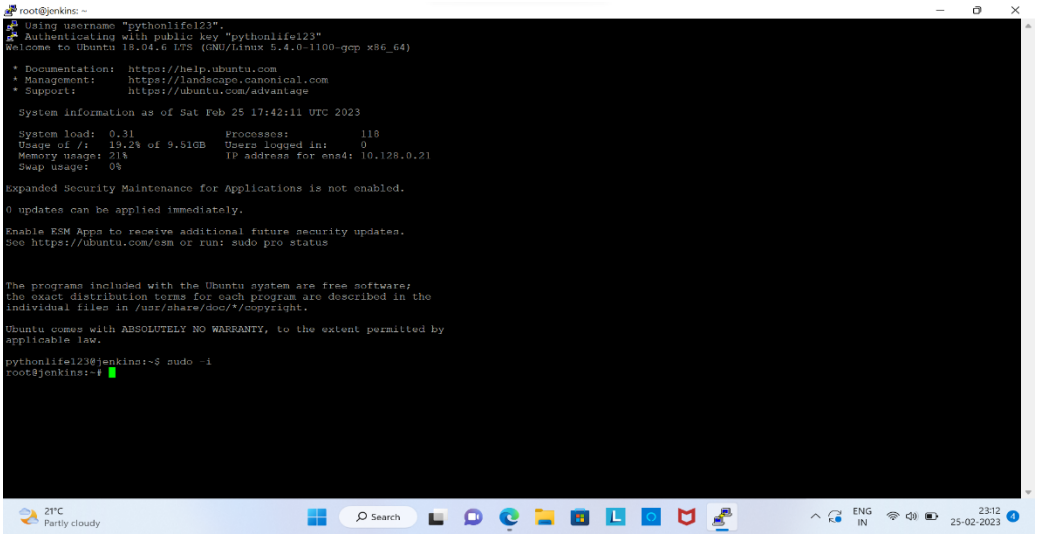
- GitHub Actions.
- GitLab.
- Atlassian Bamboo.
- JFrog Pipelines.
- Spinnaker.
- JetBrains TeamCity.
- AWS CodePipeline.
- Azure DevOps Server (formerly Microsoft Team Foundation Server)
- Buddy
- FinalBuilder
- GoCD
- IBM Urbancode
- TeamCity

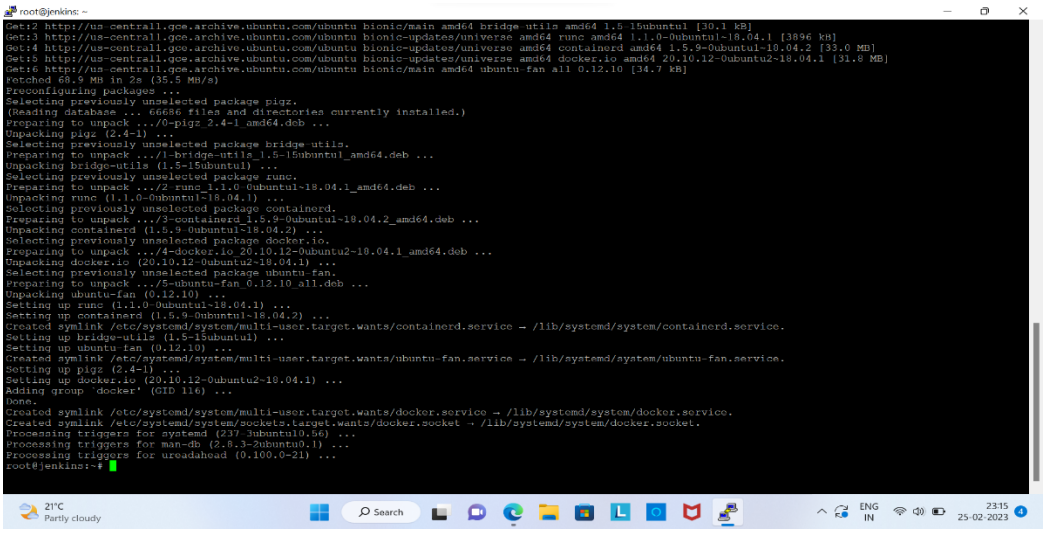
Jenkins installation on docker:

1. Install Docker on your ubuntu server by running the following command:

   sudo apt update

   sudo apt install docker.io



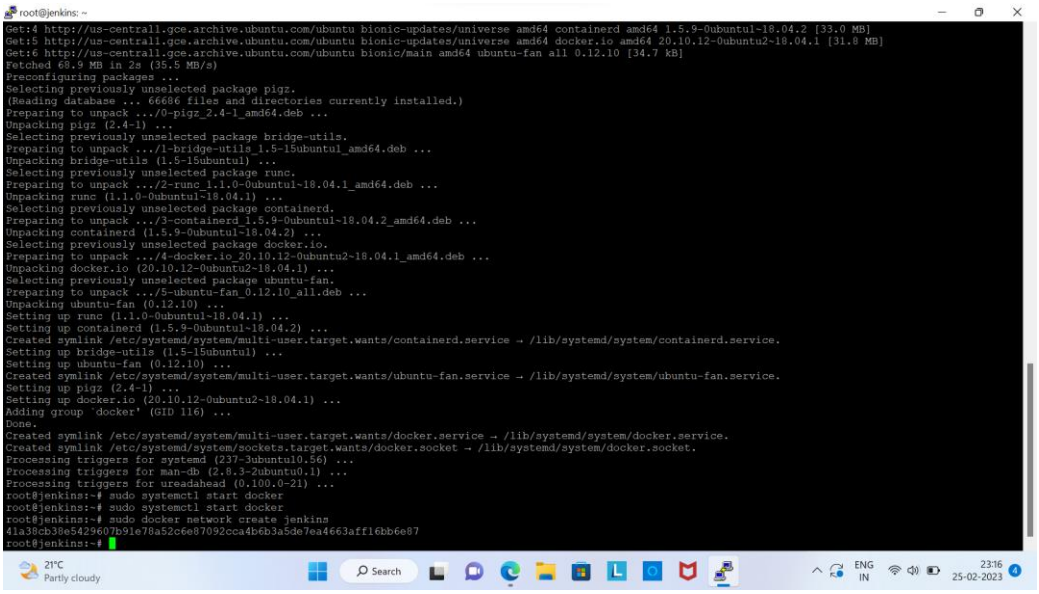


2. Start docker service by running the following command:

   sudo systemctl start docker

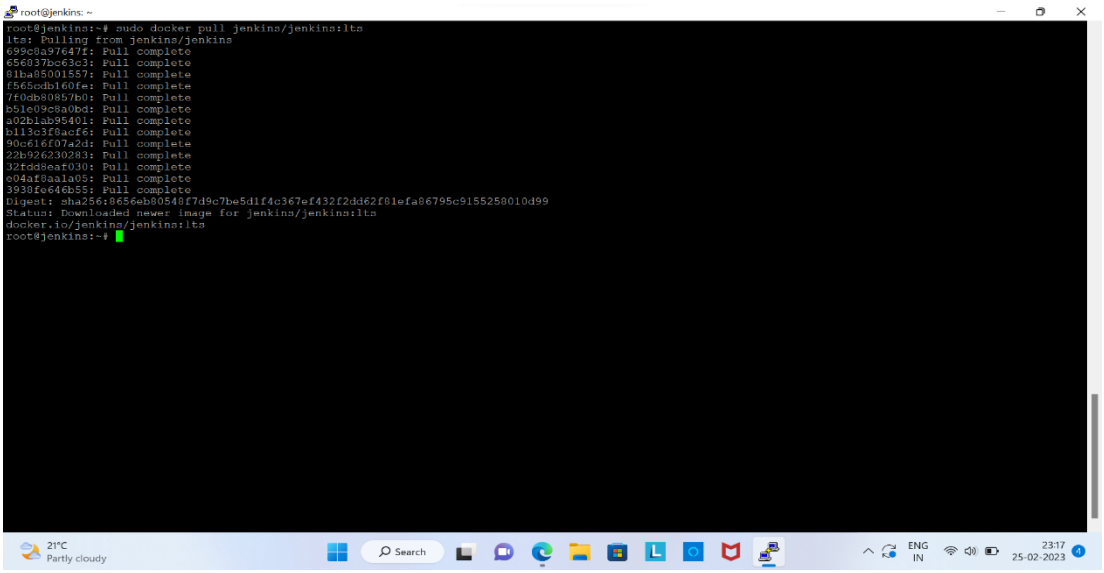
3. Create a Docker network by running the following command:

   sudo docker network create jenkins



4. Pull the latest Jenkins image from from Docker Hub by running the following command:

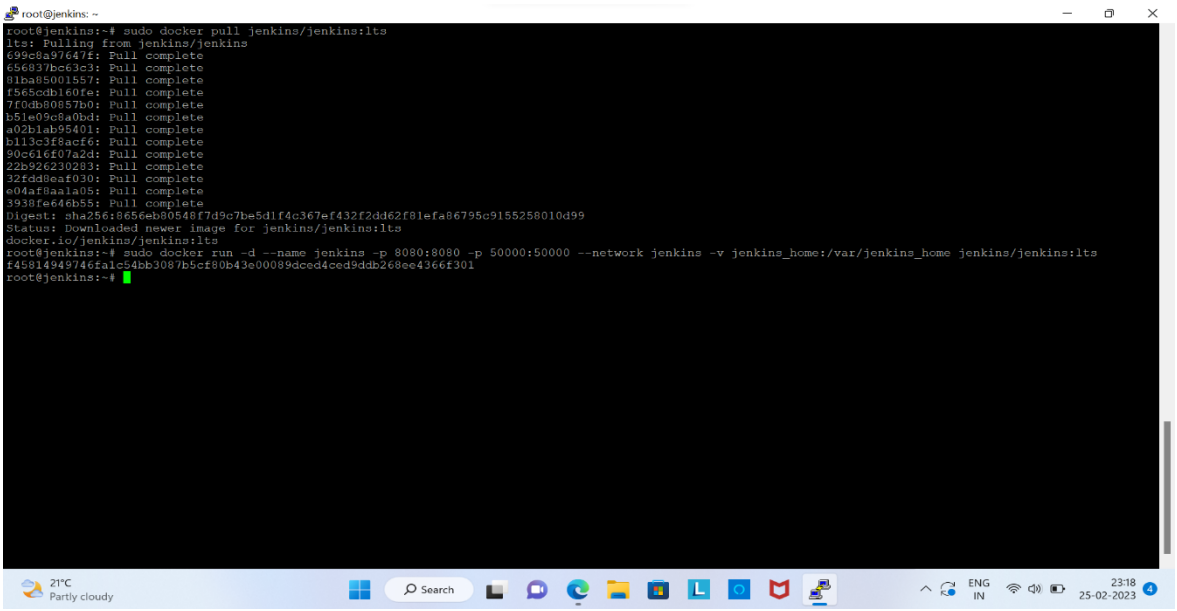
   sudo docker pull jenkins/jenkins:lts



5. Run the Jenkins container with the following command:

   sudo docker run -d --name jenkins -p 80:8080 -p 50000:50000 --network jenkins -v jenkins_home:/var/jenkins_home jenkins/jenkins:lts

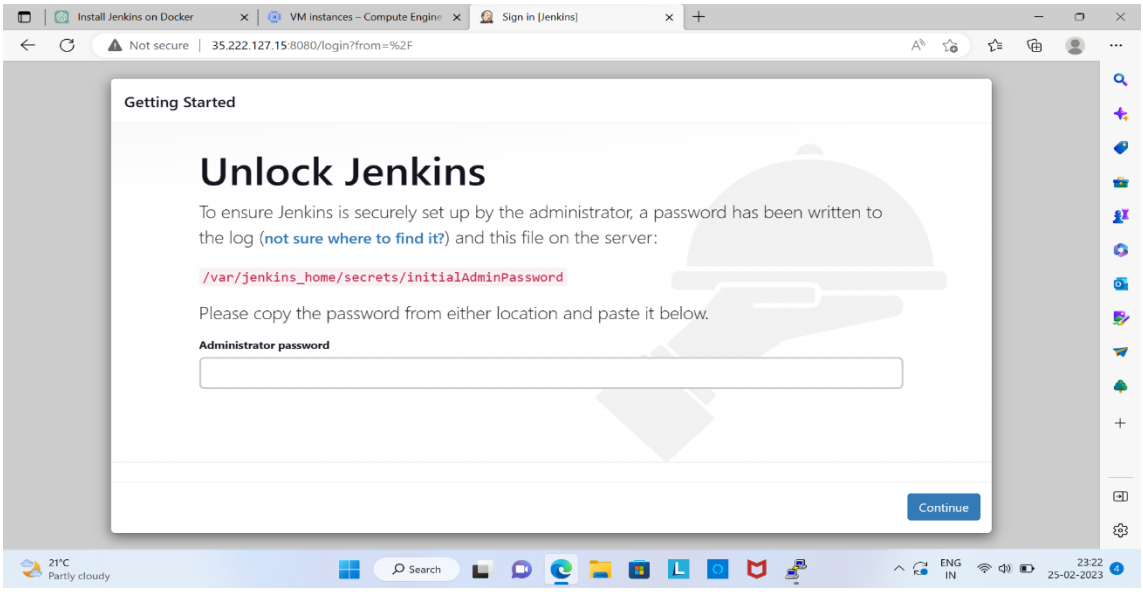
This command will start the Jenkins container in detached mode(-d) with the name “jenkins”. It maps the container’s port 8080 to the host’s port 8080(-p 8080:8080) and port 50000 to the host’s port 50000(-p 50000:50000).



6. To access Jenkins, open a web browser and enter the following URL.

   http://<Server IP Address or Hostname>:8080

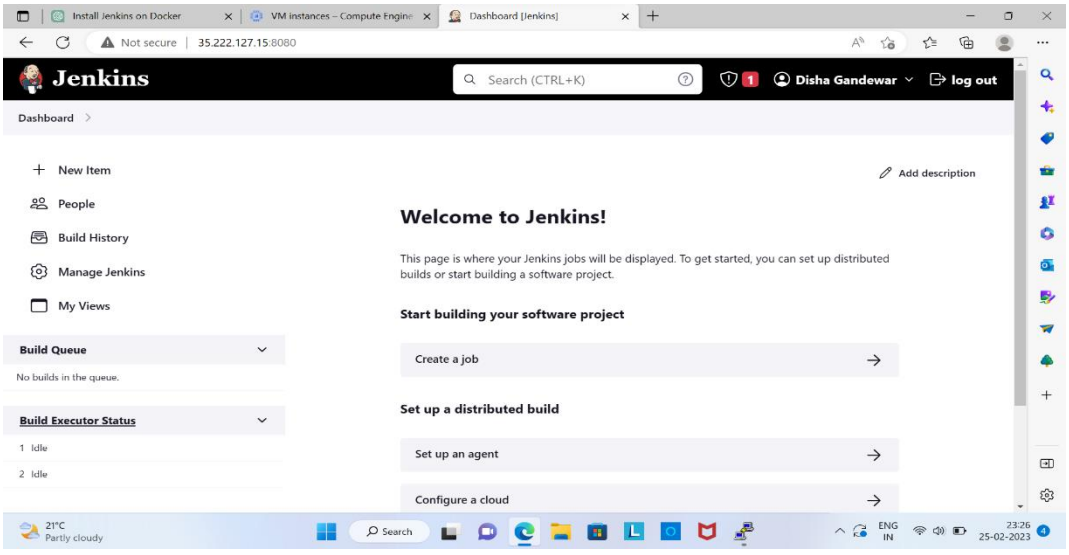
   This will open the Jenkins login page. Follow the on-screen instructions to setup Jenkins.



7. After installing Jenkins on Docker, the Jenkins administration password can be obtained from the logs of the Jenkins container.

   sudo docker logs Jenkins (OR)

sudo docker exec jenkins cat /var/jenkins_home/secrets/initialAdminPassword



Stages of CI-CD

Stages in CI-CD of Jenkins.

- Stage 1 (Continuous Download)

Whenever developers upload some code into the Git repository Jenkins will receive a notification and it will download all that code. This is called Continuous Download.

- Stage 2 (Continuous Build)

The code downloaded in the previous stage had to be converted into a setup file commonly known as artifact. To create this artifact jenkins uses certain build tools like ANT, Maven etc. The artifact can be in the format of a .jar/.war/.ear file etc. This stage is called Continuous Build.

- Stage 3 (Continuous Deployment)

The artifact created in the previous stage has to be deployed into the QA Servers where a team of testers can start accessing it. This QA environment can be running on some application servers like tomcat, Weblogic etc. Jenkins deploys the artifact into these application servers and this is called Continuous Deployment.

- Stage 4 (Continuous Testing)

Testers create automation test scripts using tools like selenium, UFT etc. Jenkins runs these automation test scripts and checks if the

application is working according to client's requirement or not, if testing fails Jenkins will send automated email notifications to the corresponding team members and developers will fix the defects and upload the modified code into Git, Jenkins will again start from stage 1.

- Stage 5 (Continuous Delivery)

Once the application is found to be defect free Jenkins will deploy it into the Prod servers where the end user or client can start accessing it. This is called continuous delivery.

Git Integration

How does Jenkins integrate with Git? Go to Jenkins dashboard, click on "Manage Jenkins." Now follow these steps- Manage Plugins -> 'Available' tab -> Enter Git in search bar and filter -> Install required plugin. After the installation, all you need to do is click on "Configure System" and go to the 'GitHub' section.

Jobs in Jenkins

Jenkins jobs are done in various stages and concepts like pipeline jobs.The major difference between any Jenkins job and a Jenkins Pipeline Job is that the Pipeline Scripted job runs on the Jenkins master. This uses a lightweight executor which uses only some resources to translate in the master to atomic commands that execute or send to the agents.

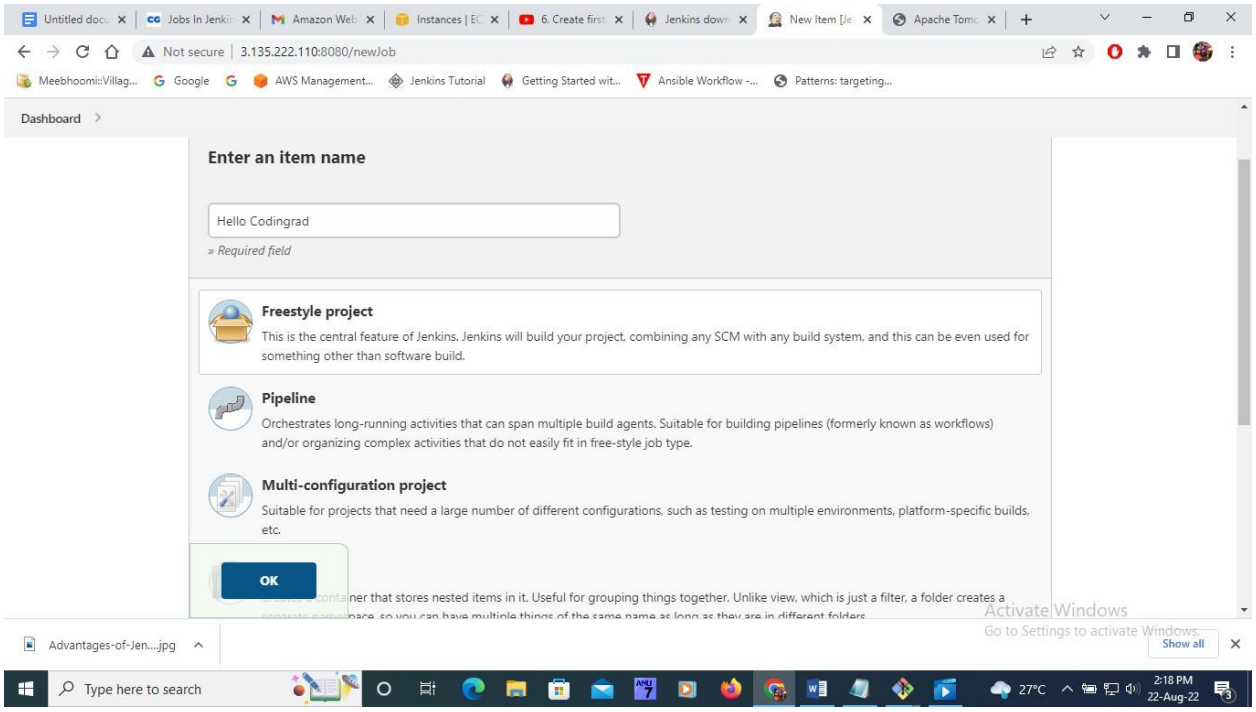
The following steps are the example for Jenkins jobs.

☐ Stage 1 (Continuous Download)

1 Open the dashboard of Jenkins.

2 Click on New item---->enter item name as "HelloPythonlife".

3 Select Free style project---->OK



4 Go to Source code management

5 Select Git

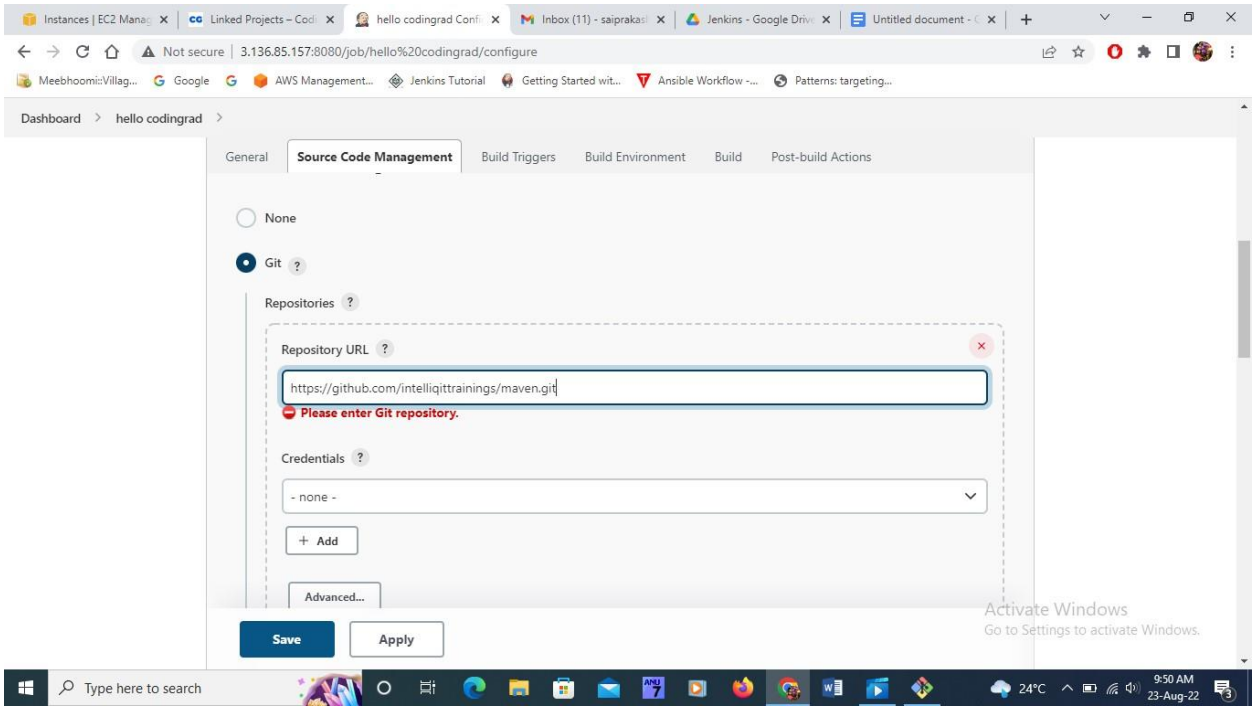
8 Enter github url where developers have uploaded the code https://github.com/intelliqittrainings/maven.git

9 Click on Apply--->Save

10 Go to the dashboard of Jenkins

11 Click on Build icon

This job will download all the code from github repository into the Jenkins server GCP instance.



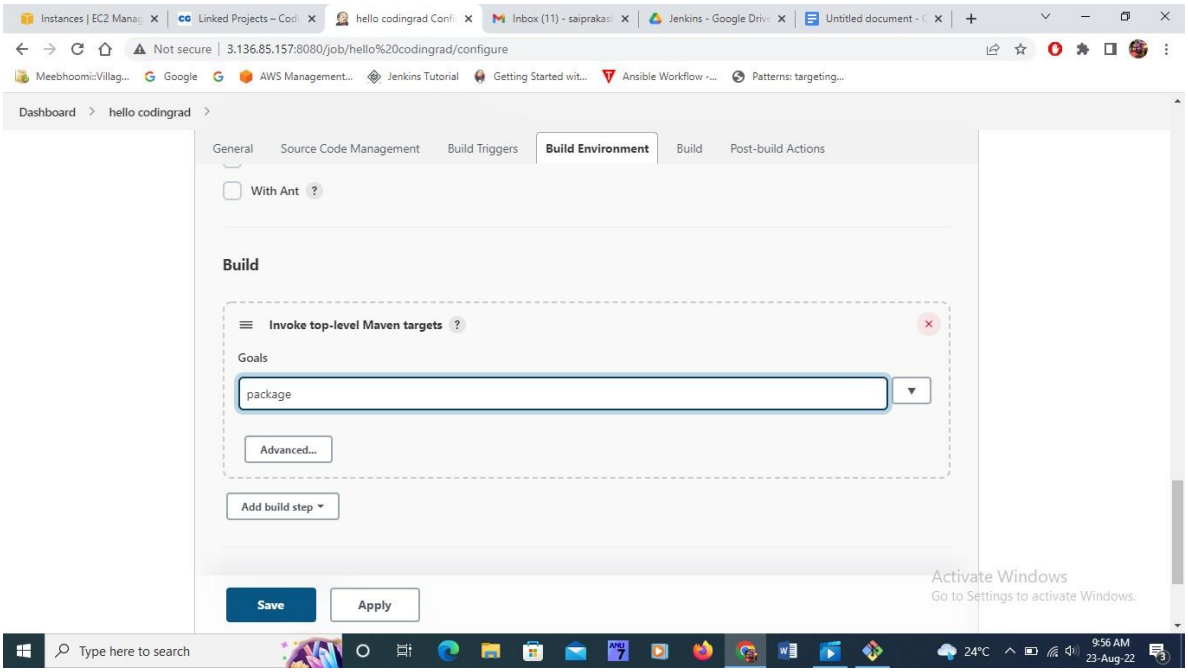
☐ Stage 2 (Continuous Build)

1 Open the dashboard of Jenkins

2 Go to the hello pythonlife job--->Click on Configure3 Go to Build section

4 Click on "Add build step"

5 Click on "Invoke top level maven target"

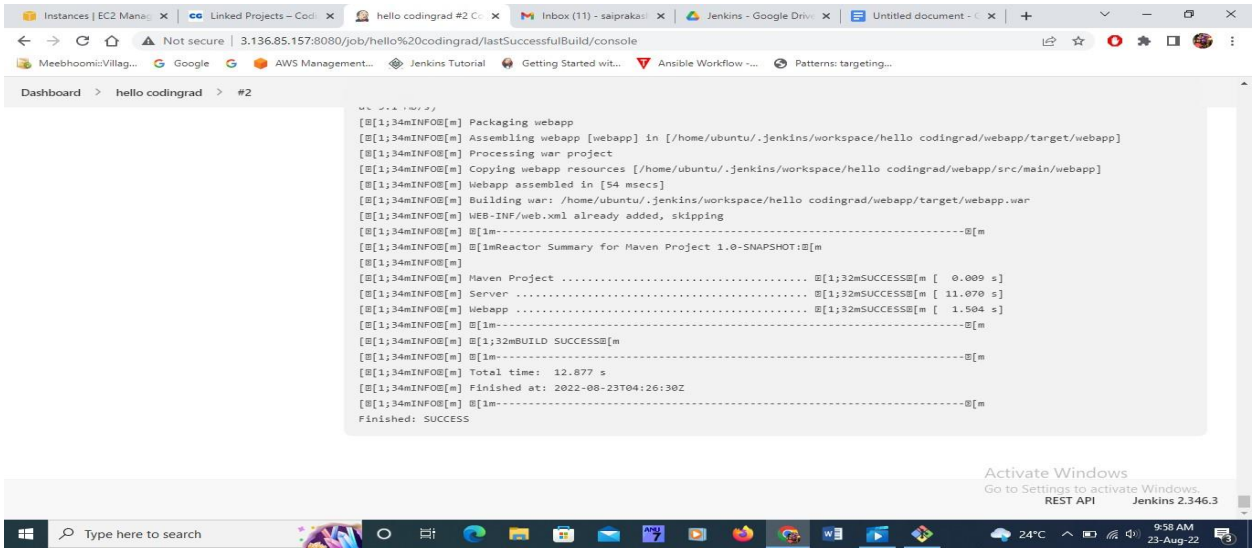


6 Enter Goal as: package

7 Apply--->Save

8 Go to the dashboard of Jenkins

9 Go to the hello pythonlife job and click on Build iconThis job will convert the code into an artifact and this artifact comes in the format of a war file.



☐ Stage 3 (Continuous Deployment)

1 Open the dashboard of Jenkins
2 Click on Manage Jenkins
3 Click on Manage Plugins
4 Go to Available section
5 Search for "Deploy to container" plugin
6 Click on Install without restart
7 Go to the dashboard of jenkins
8 Go to the hello pythonlife job
9 Click on Configure
10 Go to Post build actions
11 Click on Add post build action
12 Click on Deploy war/ear to containerswar/ear file: ***.war Context path: testapp
Click on Add container
Select tomcat9
Enter tomcat credentials
Tomcat url: private_ip_qaserver:8080
13 Apply--->Save
14 Go to the dashboard of jenkins
15 Go to the hello pythonlife job---->Click on buildThis job will deploy the artifact into the QAServers and to access

the application from the level of browser public_ip_qaserver:8080/testapp.

☐ Stage 4 (Continuous Testing)

1 Open the dashboard of Jenkins
2 Click on New item--->Enter some item name(Testing)
3 Go to Source Code management---->Select Git4 Enter the github url where testers have uploaded the selenium code

https://github.com/intelliqittrainings/FunctionalTesting.git

5 Go to Build section
6 Click on Add build step
7 Click on Execute shelljava -jar path_of_testing.jar
8 Click on Apply--->Save
9 Go to the dashboard of Jenkins
10 Go to the Testing job--->Click on Build icon

This job will download all the selenium test scripts and execute them.
Linking the "hello pythonlife job" with the "Testing job".

1 Open the dashboard of Jenkins
2 Go to the hello pythonlife job--->Click on Configure
3 Go to Post build actions
4 Click on Add Post Build action
5 Click on Build other projects
6 Enter project name as Testing
7 Click on Save

Now if we run the hello pythonlife job,it will finish the first 3 stages of CI and then call the Testing job.
Copy artifacts from hello pythonlife job to Testing job.

1 Open the dashboard of Jenkins
2 Click on Manage Jenkins
3 Click on Manage Plugins

4 Go to Available section
5 Search for Copy artifact plugin
6 Click on Install without restart
7 Go to the dashboard of Jenkins
8 Go to hello pythonlife job--->Click on configure
9 Go to Post build actions--->Click on Add post build actions
10 Click on Archive the artifacts
11 Enter files to be archived as **/*.war
12 Apply--->Save
13 Go to dashboard of Jenkins
14 Go to Testing job--->Configure
15 Go to Build section--->Click on Add build step
16 Click on Copy artifacts from other projects
17 Enter project name as "hello pythonlife"
18 Apply--->Save

☐ Stage 5 (Continuous Delivery)

1 Go to the dashboard of Jenkins
2 Go to the Testing job--->Configure
3 Go to Post build actions
4 Click on add post build actions
5 Click on Deploy war/ear to containerwar/ear file: **/*war
context path: prodapp
Click on Add container---->Select tomcat9

Enter username and password of tomcat9

Tomcat url: private_ip_prodserver:8080
6 Apply--->Save

Pipeline as Code:

This is the process of implementing all the stages of CI-CD from the level of a Groovy script file called Jenkinsfile.

Advantages:-

- Since this is a code it can be uploaded into git and all the team members can review and edit the code and still git will maintain multiple versions and we can decide what version to use.
- Jenkinsfiles can withstand planned and unplanned restart of the Jenkins master.
- They can perform all stages of ci-cd with minimum no of plugins so they are faster and more secure.
- We can handle real world challenges like if conditions, loops, exception handling etc.ie if a stage in ci-cd passes we want to execute some steps and if it fails we want to execute some other steps.

Pipeline as code can be implemented in 2 ways.

1 Scripted Pipeline

2 Declarative Pipeline

Syntax of Scripted Pipeline:-

```
node('built-in')
{
  stage('Stage name in ci-cd')
  {
    Groovy code to implement this stage
  }
}
```

Syntax of Declarative Pipeline:-

```
pipeline
{ agent
  any
  stages
  { stage('Stage name in CI-CD')
    {
      step
      s
      {
        Groovy code to implement this stage
      }
    }
}
```

Types of Parameters

Jenkins supports several parameter types. Below is a list of the most common ones, but keep in mind that different plugins may add new parameter types:

- *Choice*: a predefined set of strings from which a user can pick a value.

- *Multi-line String*: same as *String*, but allows newline characters.
- *Credentials*: a predefined Jenkins credential.
- *String*: any combination of characters and numbers.

- *File*: the full path to a file on the filesystem.
- *Password*: similar to the *Credentials* type, but allows us to pass a plain text parameter specific to the job or pipeline.
- *Run*: an absolute URL to a single run of another job.

Branch Building

When the pipeline build starts, Jenkins uses the Jenkinsfile in that branch for build stages. SCM (Source Control) can be Github, Bitbucket, or a Gitlab repo. You can choose to exclude selected branches if you don't want them to be in the automated pipeline with
Java regular expressions.

Schedule Project

Scheduling the job for a particular date and time.

1 Open the dashboard of jenkins
2 Go to the configuration page of the job
3 Go to Build triggers
4 Click on Build periodically
5 Schedule the date and time
6 Click on Save

Jenkins Job Scheduling Syntax:

First, let's look at the Jenkins job scheduling configuration. It looks a lot like Linux's cron syntax, but you don't have to be familiar with command line Linux to figure it out.

A scheduling entry consists of five whitespace-separated fields. You can schedule a job for more than one time by adding more than one entry.

Minute	Hour	Day of Month	Month	Day of Week

Each field can contain an exact value or use a set of special expressions:

- The familiar asterisk "*" indicates all valid values. So, a job that runs every day has a "*" in the third field.
- A dash separates ranges of values. For example, a job that runs every hour from 9:00 a.m. to 5:00 p.m. would have 9-17 in the second field.
- Intervals are specified with a slash /. A job that runs every 15 minutes has H/15 in the first field. Note that the H in the first field has a special meaning. If you wanted a job to run every 15 minutes, you could configure it as 0/15, which would make it run at the start of every hour. However, if you configure too many jobs this way, you can overload your Jenkins controller. Ultimately, the H tells Jenkins to pick a minute based on a hash of the job name.
- Finally, you can specify multiple values with a comma. So, a job that runs Monday, Wednesday, and Friday would have 1,3,5 in the fifth field.

Jenkins provides a few examples in their help section for scheduling.

```
# Every fifteen minutes (perhaps at :07, :22, :37, :52):H/15 * * * *
# Every ten minutes in the first half of every hour (three times, perhaps at :04, :14, :24):H(0-29)/10 * * * *
# Once every two hours at 45 minutes past the hour starting at 9:45 AM and finishing at 3:45 PM every weekday:45 9-16/2 * * 1-5
# Once in every two hour slot between 8 AM and 4 PM every weekday (perhaps at 9:38 AM, 11:38 AM, 1:38 PM, 3:38 PM):H H(8-15)/2 * * 1-5
# Once a day on the 1st and 15th of every month except December: H H 1,15 1-11 *
```

Jenkins also has a set of aliases that makes using common intervals easier.

Macro	Equivalent	Explanation
@hourly	H * * * *	any time during the hour
@daily	H H * * *	sometime during the day
@midnight	H H(0-2) * * *	sometime between 12:00 a.m. and 2:59 a.m.
@weekly	H H * * H	sometime during the week
@monthly	H H H * *	sometime during the month

Now that we've seen some examples, let's create a job and set it up with a schedule.

User Administration in Jenkins

Creating users in Jenkins

1) Open the dashboard of jenkins
2) click on manage jenkins
3) click on manage users
4) click on create users
5) enter user credentials

Creating roles and assigning

1) Open the dashboard of jenkins
2) click on manage jenkins3) click on manage plugins
4) click on role based authorization strategy plugin
5) install it
6) go to dashboard-->manage jenkins
7) click on configure global security
8) check enable security checkbox
9) go to authorization section-->click on role based strategyradio button
10) apply-->save

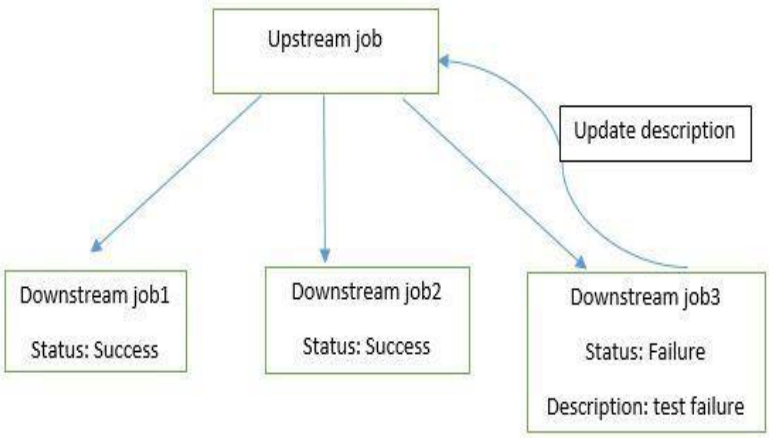
11) go to dashboard of jenkins
12) click on manage jenkins
13) click on manage and assign roles
14) click on manage roles
15) go to global roles and create a role "employee"
16) for this employee in overall give read accessand in view section give all access
17) go to project roles-->Give the role as developerand pattern as Dev.* (ie developer role can access only those jobs whose name start with Dev)
18) similarly create another role as tester and assign the patternas "Test.*"
19) give all permissions to developers and tester
20) apply--save
21) click on assign roles
22) go to global roles and add user1 and user2
23) check user1 and user2 as employees
24) go to item roles
25) add user1 and user2
26) check user1 as developer and user2 as tester
27) apply-->save

If we login into jenkins as user1 we can access only the development related jobs and user2 can access only the testing related jobs.

Upstream & Downstream

An upstream job is a configured project that triggers a project as part of its execution.

A downstream job is a configured project that is triggered as part of a pipeline execution.



Upstream and downstream jobs help you to configure the sequence of execution for different operations and hence you can orchestrate the flow of execution. We can configure one or more projects as downstream jobs in Jenkins.

Linked Projects

Linking different jobs to create pipelines in Jenkins. With the emergence of trends such as continuous deployment and delivery, the continuous integration server is not limited to integrating your products, but has become a central piece of infrastructure. Many of these jobs depend on the other jobs to be successfully completed. So you would want to proceed with a certain action only if the previous action is completed or do a different action. So you can either create a massive job or create small jobs which are linked together. If you go with creating many small jobs, you can re-execute that job(read as redo that action), and not do the previous related jobs to it. In other words, you can start from a failing step rather than from the very initial stage. So it's always

advisable to create multiple small jobs and link them together to create a pipeline.

In this Scenario, we'll learn how to create linking between different jobs or projects in Jenkins. For our learning purposes, we have created two small jobs named 'Job 01' and 'Job 02' in Jenkins server:

Two Small Jobs for creating linking

These two jobs contain nothing but a simple echo statement echoing the name of the job. One to One Relationship between Jobs. The first approach is pretty simple: one job triggers another one after successful completion. To achieve it, you can either configure a post-build action starting the next job (downstream) or configure the trigger of the current build (upstream). Both ways are totally equivalent. In order to this, let's go to job 02 and select configure from dropdown:

Select Configure from black triangle next to job name.

Now go to 'Build triggers' and select 'Build after other projects are built'. Under 'Projects to Watch' to select 'job 01':

Let's select 'Trigger only if build is stable' so that 'Job 02' is executed only when 'Job 01' is successfully completed. After this, select save and apply. Now when you build 'Job 01' and see the log output, it should be something like this:

Job 01 build output after configuring upstream for job 02

If you look at the last 2nd line, you can see that it started a new build of 'Job 02'. Since it contains a link, instead of going to the dashboard, you can directly click on the link to go to job. It contains a new section named 'Upstream Projects' and would have listed 'job 01' as the build. Again from the build history pane, you can see the recent build of this 'Job 02'.

Using this one-to-one dependency approach is probably the simplest way to orchestrate jobs on Jenkins.

One to Many Relationship between Jobs

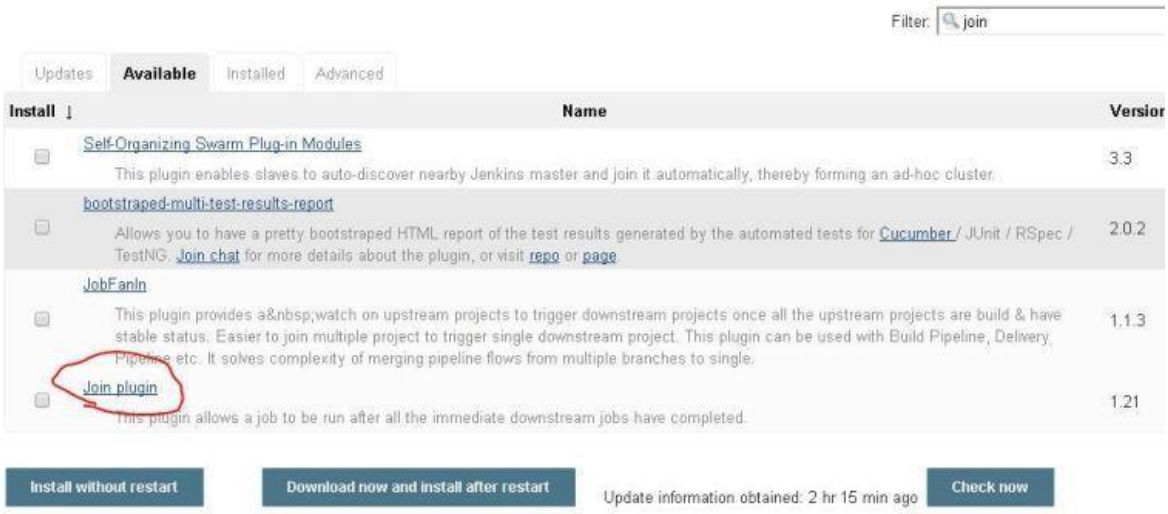
You can also create a master job and associate various child jobs to it. So let's say we have 'Job 01' as a master job and 'Job 02', 'Job 03', 'Job 04' as child jobs. Again, we'll use the same method to create links between jobs as above and initiate build.

Job 01 build output after configuring upstream for job 02, job 03 and job 04.

Kindly keep below points in mind, before going for one-to-many relationship:

1. If one of the child jobs fails, other child jobs will still be triggered. They may or may not have some inter-dependency later in the flow. Of Course, you can use the success of multiple jobs as the trigger as well. So you need to plan it carefully.
2. There is no order defined for calling the child jobs. This is because Jenkins threads are asynchronous in nature.

We can use the 'Join Plugin' for the same. This plugin allows a job to be run after all the immediate downstream jobs have completed. In this way, the execution can branch out and perform many steps in parallel, and then run a final aggregation step just once after all the parallel work is finished. You can go to Manage Jenkins -> Manage
Plugins -> Available tab and search for this plugin:



Install Join Plugin from Manage Plugins.JPG Select

and install it.

Now Let's go to 'Job 01' and go to the post-build section. In order to build other projects, add 'Job 02' and 'Job 03'. Then add a join trigger from post build steps and enter 'Job 04'. This will ensure that 'Job 04' is executed only when both 'Job 02' and 'Job 03' are completed. Again, you can use this plugin to create multiple diamond shape dependencies like above. So this helps in creating complex pipelines.