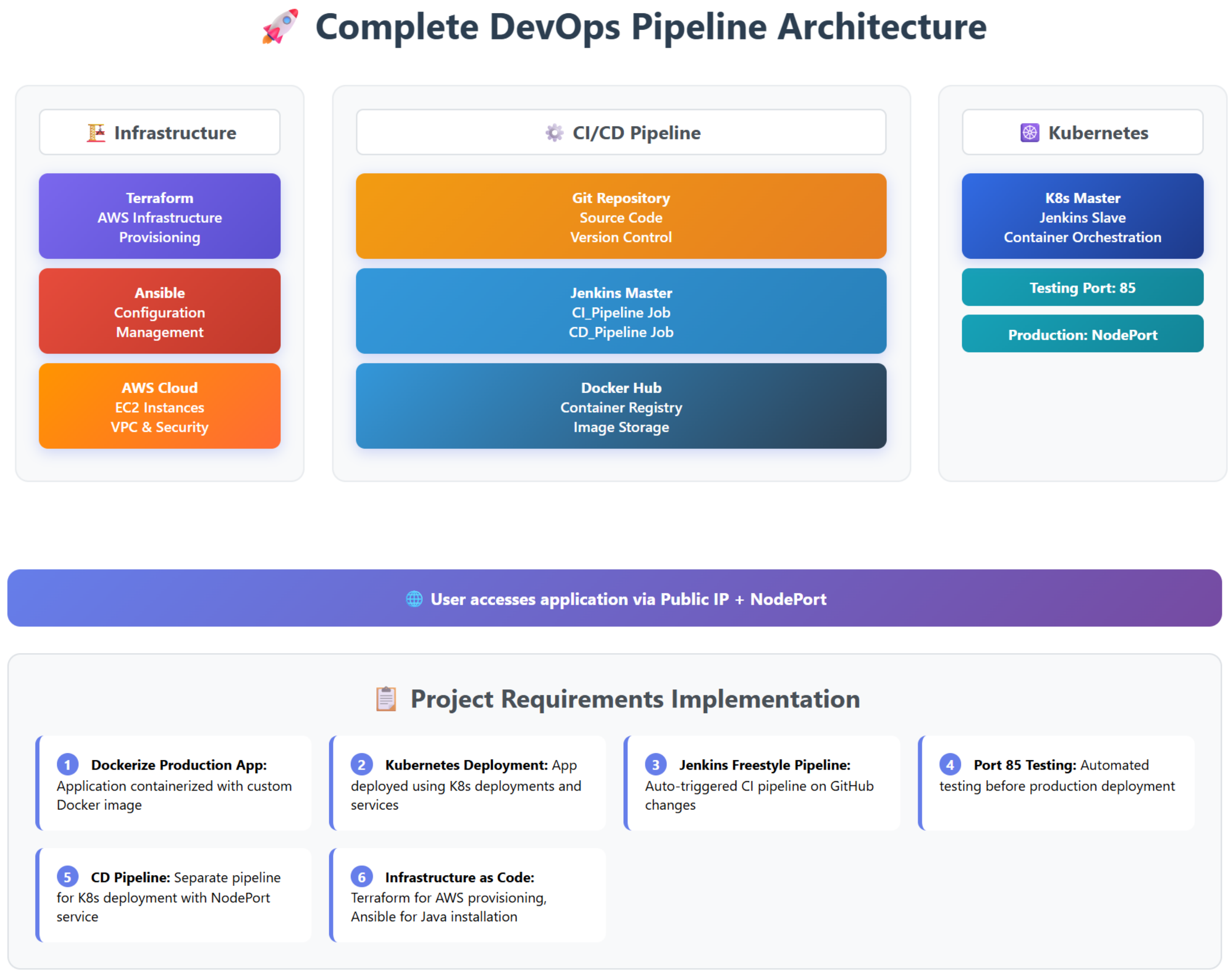


🚀 Complete DevOps Pipeline Architecture

🏗️ Infrastructure

Terraform
AWS Infrastructure Provisioning

Ansible
Configuration Management

AWS Cloud
EC2 Instances
VPC & Security

⚙️ CI/CD Pipeline

Git Repository
Source Code
Version Control

Jenkins Master
CI_Pipeline Job
CD_Pipeline Job

Docker Hub
Container Registry
Image Storage

☸️ Kubernetes

K8s Master
Jenkins Slave
Container Orchestration

Testing Port: 85

Production: NodePort

🌐 **User accesses application via Public IP + NodePort**

📋 Project Requirements Implementation

1 **Dockerize Production App:** Application containerized with custom Docker image

2 **Kubernetes Deployment:** App deployed using K8s deployments and services

3 **Jenkins Freestyle Pipeline:** Auto-triggered CI pipeline on GitHub changes

4 **Port 85 Testing:** Automated testing before production deployment

5 **CD Pipeline:** Separate pipeline for K8s deployment with NodePort service

6 **Infrastructure as Code:** Terraform for AWS provisioning, Ansible for Java installation

Create a Role with AdministratorAccess and attach to user till resource creation is done.

This Terraform configuration provisions a complete AWS infrastructure setup for Jenkins CI/CD and Kubernetes cluster deployment.
Architecture Overview
The infrastructure creates:

1. A VPC with DNS support in the us-east-2 region
2. Two Public Subnets across different availability zones (us-east-2a, us-east-2b) for HA
3. One Jenkins Server for CI/CD operations which will servers as jenkins master and pass job to jenkins worker aka K8s master
4. Three Kubernetes Nodes for container orchestration (out of 3 k8s nodes 2 will be worker nodes and 1 will be master node)
5. Security Groups with appropriate access rules
6. Internet Gateway and routing for public access

Details about each resources:-

1. VPC: 10.0.0.0/16 CIDR block with DNS hostnames and support enabled
2. Public Subnet 1: 10.0.1.0/24 in us-east-2a
3. Public Subnet 2: 10.0.2.0/24 in us-east-2b
4. Internet Gateway: Provides internet access to public subnets
5. Route Table: Routes all traffic (0.0.0.0/0) through the internet gateway

6. Security Groups for our instances:-

a.Jenkins Security Group (Jenkins-sg):-

Inbound Rules:

HTTP (80): Web traffic
HTTPS (443): Secure web traffic
SSH (22): Remote access
Port 8080: Jenkins web interface

Outbound Rules: All traffic allowed

b. Kubernetes Security Group (K8s-sg):-

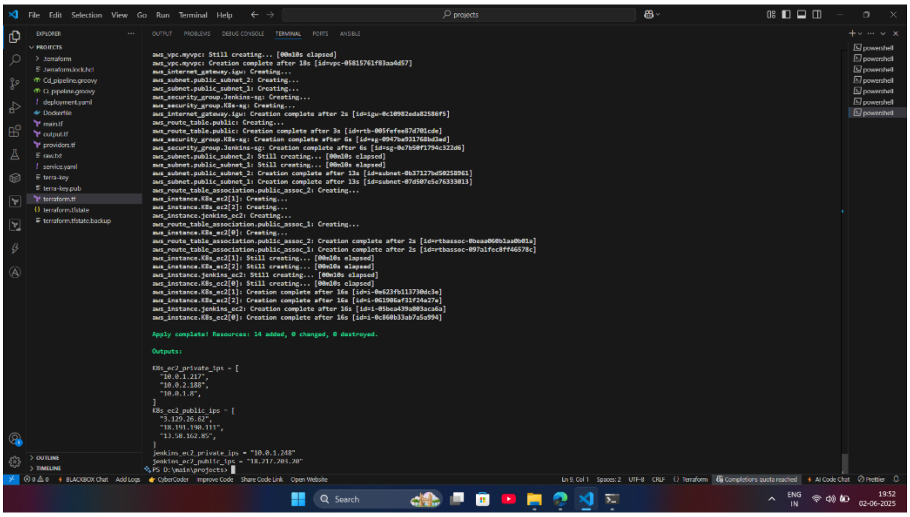
Inbound/Outbound Rules: All traffic allowed (temporary for installation)
Note: This is intentionally I put all traffic allow during setup phase and should be restricted in production.

EC2 Instances
1. Jenkins Server

a.Instance Type: t2.micro
b.AMI: ami-04f167a56786e4b09 (ubuntu)

2. Kubernetes Cluster

a. Node Count: 3 instances
b. Instance Type: t3.medium
c. AMI: ami-04f167a56786e4b09 (Amazon Linux 2)
d. Naming: k8s-node-1, k8s-node-2, k8s-node-3



```
aws_vpc.myvpc: Still creating... [00m10s elapsed]
aws_vpc.myvpc: Creation complete after 18s [id=vpc-05815761f83aa4d57]
aws_internet_gateway.igw: Creating...
aws_subnet.public_subnet_2: Creating...
aws_subnet.public_subnet_1: Creating...
aws_security_group.Jenkins-sg: Creating...
aws_security_group.K8s-sg: Creating...
aws_internet_gateway.igw: Creation complete after 2s [id=igw-0c10982eda82586f5]
aws_route_table.public: Creating...
aws_route_table.public: Creation complete after 3s [id=rtb-005fefee87d701cde]
aws_security_group.K8s-sg: Creation complete after 6s [id=sg-0947ba931768bd3ed]
aws_security_group.Jenkins-sg: Creation complete after 6s [id=sg-0e7b50f1794c322d6]
aws_subnet.public_subnet_2: Still creating... [00m10s elapsed]
aws_subnet.public_subnet_1: Still creating... [00m10s elapsed]
aws_subnet.public_subnet_2: Creation complete after 13s [id=subnet-0b37127bd50258961]
aws_subnet.public_subnet_1: Creation complete after 13s [id=subnet-07d507e5e76333013]
aws_route_table_association.public_assoc_2: Creating...
aws_instance.K8s_ec2[1]: Creating...
aws_instance.K8s_ec2[2]: Creating...
aws_instance.jenkins_ec2: Creating...
aws_route_table_association.public_assoc_1: Creating...
aws_instance.K8s_ec2[0]: Creating...
aws_route_table_association.public_assoc_2: Creation complete after 2s [id=rtbassoc-0beaa060b1aa0b01a]
aws_route_table_association.public_assoc_1: Creation complete after 2s [id=rtbassoc-097a1fec8ff46578c]
aws_instance.K8s_ec2[1]: Still creating... [00m10s elapsed]
aws_instance.K8s_ec2[2]: Still creating... [00m10s elapsed]
aws_instance.jenkins_ec2: Still creating... [00m10s elapsed]
aws_instance.K8s_ec2[0]: Still creating... [00m10s elapsed]
aws_instance.K8s_ec2[1]: Creation complete after 16s [id=i-0e623fb113730dc3e]
aws_instance.K8s_ec2[2]: Creation complete after 16s [id=i-061906af31f24a27e]
aws_instance.jenkins_ec2: Creation complete after 16s [id=i-05bea439a803aca6a]
aws_instance.K8s_ec2[0]: Creation complete after 16s [id=i-0c860b33ab7a5a994]

Apply complete! Resources: 14 added, 0 changed, 0 destroyed.

Outputs:

K8s_ec2_private_ips = [
  "10.0.1.217",
  "10.0.2.188",
  "10.0.1.8",
]
K8s_ec2_public_ips = [
  "3.129.26.62",
  "18.191.190.111",
  "13.58.162.85",
]
jenkins_ec2_private_ips = "10.0.1.248"
jenkins_ec2_public_ips = "18.217.203.20"
PS D:\main\projects>
```

# Ansible Jenkins & Kubernetes Cluster Setup

This Ansible configuration automates the installation and configuration of Jenkins CI/CD server and a Kubernetes cluster across multiple hosts.

The playbook manages three types of hosts in hosts file:
- localhost: Jenkins CI/CD server
- KMaster: Kubernetes master node (1 node)
- KWorker: Kubernetes worker nodes (2 nodes)

cat /etc/ansible/hosts

KMaster (Kubernetes Master)
- host-1: `10.0.1.217` - Controls the Kubernetes cluster

KWorker (Kubernetes Workers)
- host-2: `10.0.2.188` - Worker node in subnet 2
- host-3: `10.0.1.8` - Worker node in subnet 1

Global Variables
- User: `ubuntu` - SSH user for all remote hosts
- SSH Key: `/etc/ansible/terra-key` - Private key for authentication

## Playbook Structure

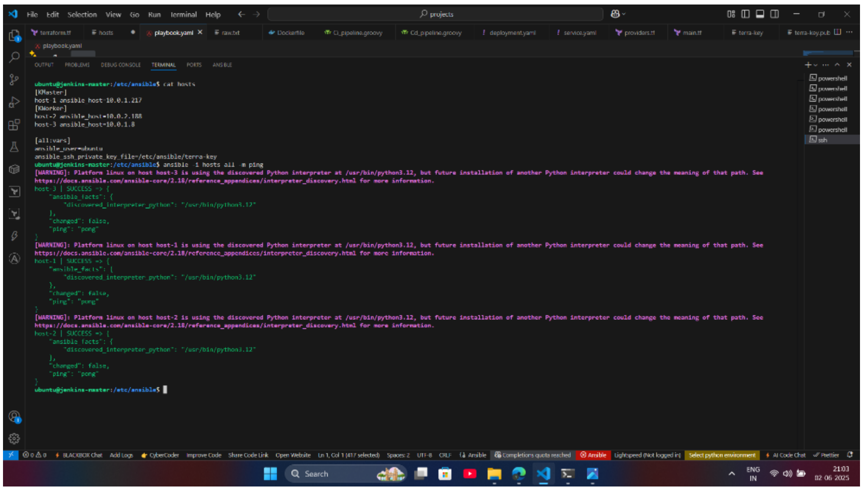
1. Jenkins Installation (localhost)
Target: localhost
Roles:
- `java` - Installs Java runtime
- `jenkins` - Installs and configures Jenkins

2. Kubernetes Master Setup
Target: KMaster group
Roles:
- `java` - Java runtime for Kubernetes components
- `docker` - Container runtime
- `kubernetes` - Master node configuration

3. Kubernetes Workers Setup
Target: KWorker group
Roles:
- `package-update` - Updates system packages
- `docker` - Container runtime
- `kubernetes` - Worker node configuration

SSH Access: Verify connectivity to all hosts:-

ansible -i hosts all -m ping



```
ubuntu@jenkins-master:/etc/ansible$ cat hosts
[KMaster]
host-1 ansible_host=10.0.1.217
[KWorker]
host-2 ansible_host=10.0.2.188
host-3 ansible_host=10.0.1.8

[all:vars]
ansible_user=ubuntu
ansible_ssh_private_key_file=/etc/ansible/terra-key
ubuntu@jenkins-master:/etc/ansible$ ansible -i hosts all -m ping
[WARNING]: Platform linux on host host-3 is using the discovered Python interpreter at /usr/bin/python3.12, but future installation of another Python interpreter could change the meaning of that path. See
https://docs.ansible.com/ansible-core/2.18/reference_appendices/interpreter_discovery.html for more information.
host-3 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.12"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Platform linux on host host-1 is using the discovered Python interpreter at /usr/bin/python3.12, but future installation of another Python interpreter could change the meaning of that path. See
https://docs.ansible.com/ansible-core/2.18/reference_appendices/interpreter_discovery.html for more information.
host-1 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.12"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Platform linux on host host-2 is using the discovered Python interpreter at /usr/bin/python3.12, but future installation of another Python interpreter could change the meaning of that path. See
https://docs.ansible.com/ansible-core/2.18/reference_appendices/interpreter_discovery.html for more information.
host-2 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.12"
    },
    "changed": false,
    "ping": "pong"
}
ubuntu@jenkins-master:/etc/ansible$
```

Required Ansible Roles

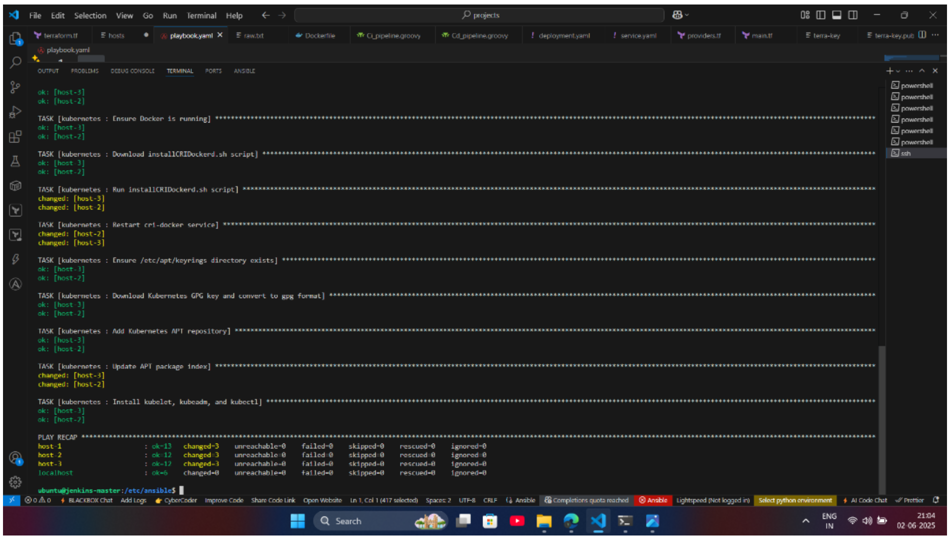
Create the following role directories in your Ansible project:
https://github.com/Rakshitsen/ansible-roles-setup.git

```
roles/
├──── java/
│     └──── tasks/main.yml
├──── jenkins/
│     └──── tasks/main.yml
├──── docker/
│     └──── tasks/main.yml
├──── kubernetes/
│     └──── tasks/main.yml
└──── package-update/
    └──── tasks/main.yml
```

# Now time to run ansible playbook commands

1. ansible-playbook –syntax-check playbook.yaml

2. ansible-playbook playbook.yaml (all tasks written in playbook file start executing)



```
ok: [host-3]
ok: [host-2]

TASK [kubernetes : Ensure Docker is running] ************************************************
ok: [host-3]
ok: [host-2]

TASK [kubernetes : Download installCRIDockerd.sh script] ************************************
ok: [host-3]
ok: [host-2]

TASK [kubernetes : Run installCRIDockerd.sh script] *****************************************
changed: [host-3]
changed: [host-2]

TASK [kubernetes : Restart cri-docker service] **********************************************
changed: [host-2]
changed: [host-3]

TASK [kubernetes : Ensure /etc/apt/keyrings directory exists] *******************************
ok: [host-3]
ok: [host-2]

TASK [kubernetes : Download Kubernetes GPG key and convert to gpg format] *******************
ok: [host-3]
ok: [host-2]

TASK [kubernetes : Add Kubernetes APT repository] *******************************************
ok: [host-3]
ok: [host-2]

TASK [kubernetes : Update APT package index] ************************************************
changed: [host-3]
changed: [host-2]

TASK [kubernetes : Install kubelet, kubeadm, and kubectl] ***********************************
ok: [host-3]
ok: [host-2]

PLAY RECAP **********************************************************************************
host-1                     : ok=13   changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
host-2                     : ok=12   changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
host-3                     : ok=12   changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
localhost                  : ok=6    changed=0    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0

ubuntu@jenkins-master:/etc/ansible$
```

Although k8s install on all three nodes but still we can't consider which one is master nodes and which are worker nodes for this I manually select k8s-ec2-1 as master and run **this commands for master only are as follows:-**

Validate : to check everything is here :-

- docker -v
- cri-dockerd --version
- kubeadm version -o short
- kubelet --version
- kubectl version --client

- sudo kubeadm init --cri-socket unix:///var/run/cri-dockerd.sock --ignore-preflight-errors=all

- sudo mkdir -p $HOME/.kube
- sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
- sudo chown $(id -u):$(id -g) $HOME/.kube/config

## below installs calico networking driver

- kubectl apply -f https://raw.githubusercontent.com/projectcalico/calico/v3.24.1/manifests/calico.yaml

# Validate: kubectl get nodes

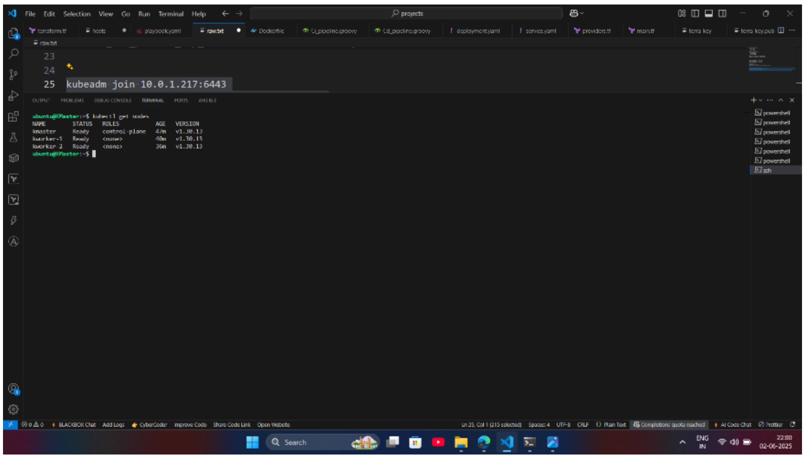
Master is ready now , it was turn of both worker nodes to connect with master.

Commands only for worker nodes:-

- sudo su
- modprobe br_netfilter
- echo 1 > /proc/sys/net/bridge/bridge-nf-call-iptables
- echo 1 > /proc/sys/net/ipv4/ip_forward

```
kubeadm join 10.128.15.231:6443  --token mks3y2.v03tyyru0gy12mbt \
--discovery-token-ca-cert-hash
sha256:3de23d42c7002be0893339fbe558ee75e14399e11f22e3f0b34351077b7c4b56 --cri-socket
unix:///var/run/cri-dockerd.sock
```

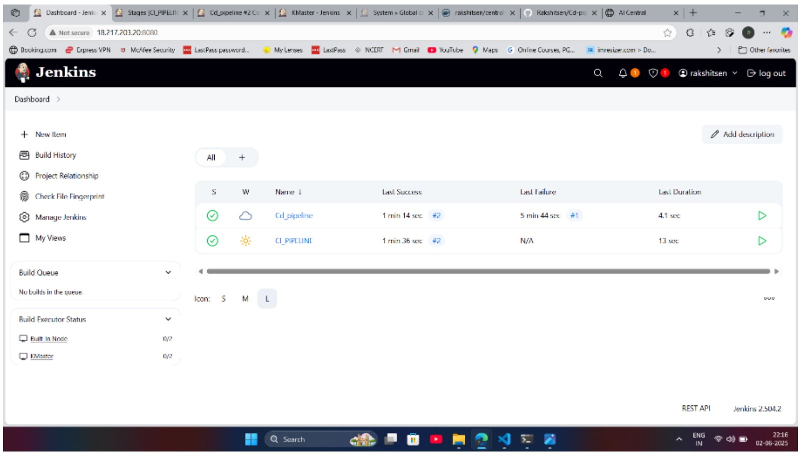
Done workers are conneted now go to master and run kubectl get nodes



```
kubeadm join 10.0.1.217:6443
```

```
ubuntu@KMaster:~$ kubectl get nodes
NAME        STATUS   ROLES           AGE   VERSION
kmaster     Ready    control-plane   47m   v1.30.13
kworker-1   Ready    <none>          40m   v1.30.13
kworker-2   Ready    <none>          36m   v1.30.13
ubuntu@KMaster:~$
```

# CI/CD process
start with jenkins setup:-



18.217.203.20:8080

Build Queue

No builds in the queue.

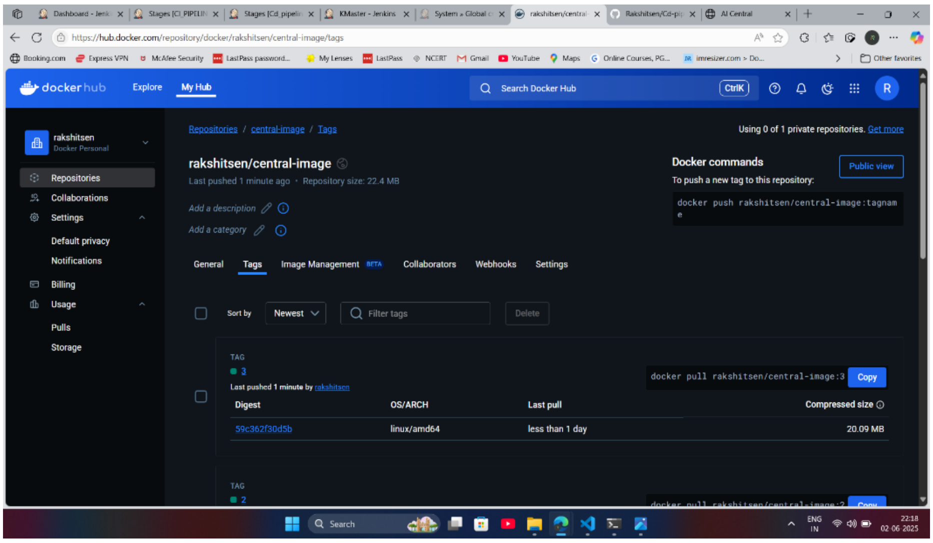
Build Executor Status

Built In Node	0/2
KMaster	0/2

S	W	Name ↓	Last Success	Last Failure	Last Duration
✓	☁	Cd_pipeline	1 min 14 sec #2	5 min 44 sec #1	4.1 sec
✓	☀	CI_PIPELINE	1 min 36 sec #2	N/A	13 sec

1. I add docker credential so that jenkins can push the image to docker hub
2. Create a new job in jenkins and select the Pipeline option name CI_Pipeline
3. CI_Pipeline: Git Repository → Jenkins Trigger → Build Process → Docker Hub
  - Trigger by Git webhook

- stages:
  - Clone repository
  - Build Docker image
  - Push to Docker Hub
  - Deploy test container (port 85)
  - Trigger CD pipeline on success
  - stop the run container (port 85)



rakshitsen/central-image

Last pushed 1 minute ago • Repository size: 22.4 MB

Docker commands

To push a new tag to this repository:

```
docker push rakshitsen/central-image:tagnam
e
```

TAG 3

Last pushed 1 minute by rakshitsen

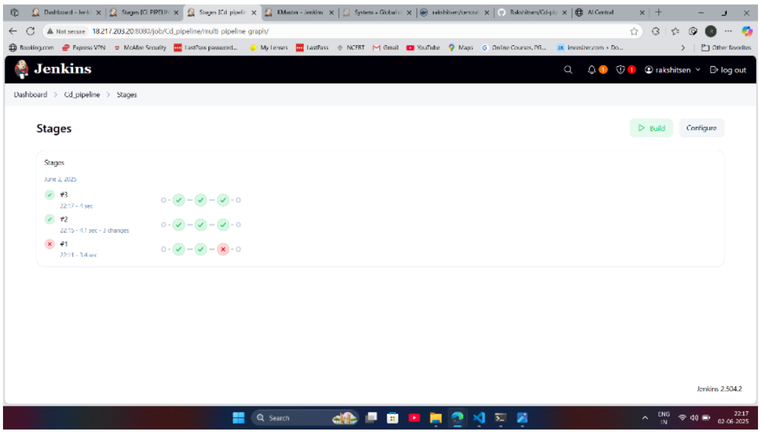
```
docker pull rakshitsen/central-image:3
```

Digest	OS/ARCH	Last pull	Compressed size
59c362f30d5b	linux/amd64	less than 1 day	20.09 MB

TAG 2

4. Create a another job in jenkins and select the Pipeline option name Cd_pipeline.

5. CI Success → Pull Latest Image → Production Deployment


18.217.203.20:8080/job/Cd_pipeline/multi-pipeline-graph/
Jenkins
rakshitsen
log out
Dashboard > Cd_pipeline > Stages
Build
Configure
Jenkins 2.504.2

Stages

Stages

June 2, 2025

- ✓ #3 22:17 - 4 sec
- ✓ #2 22:15 - 4.1 sec - 3 changes
- ✗ #1 22:11 - 3.4 sec

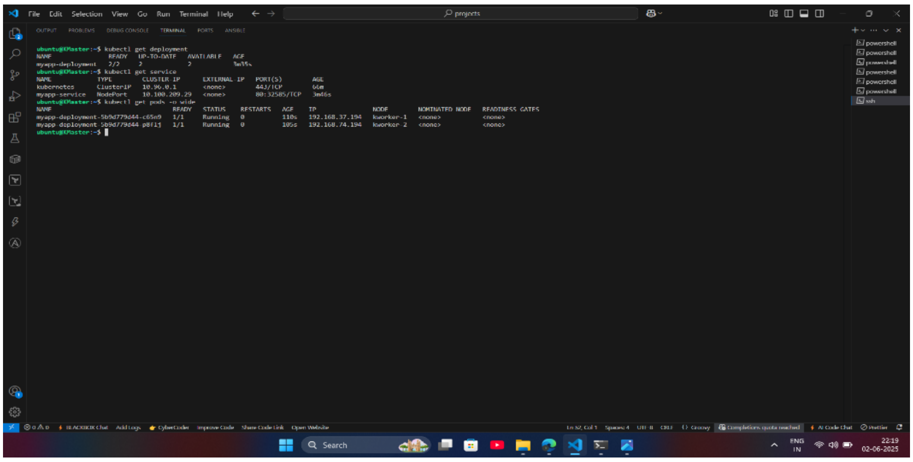
Workflow:

Trigger: Activated by successful CI pipeline

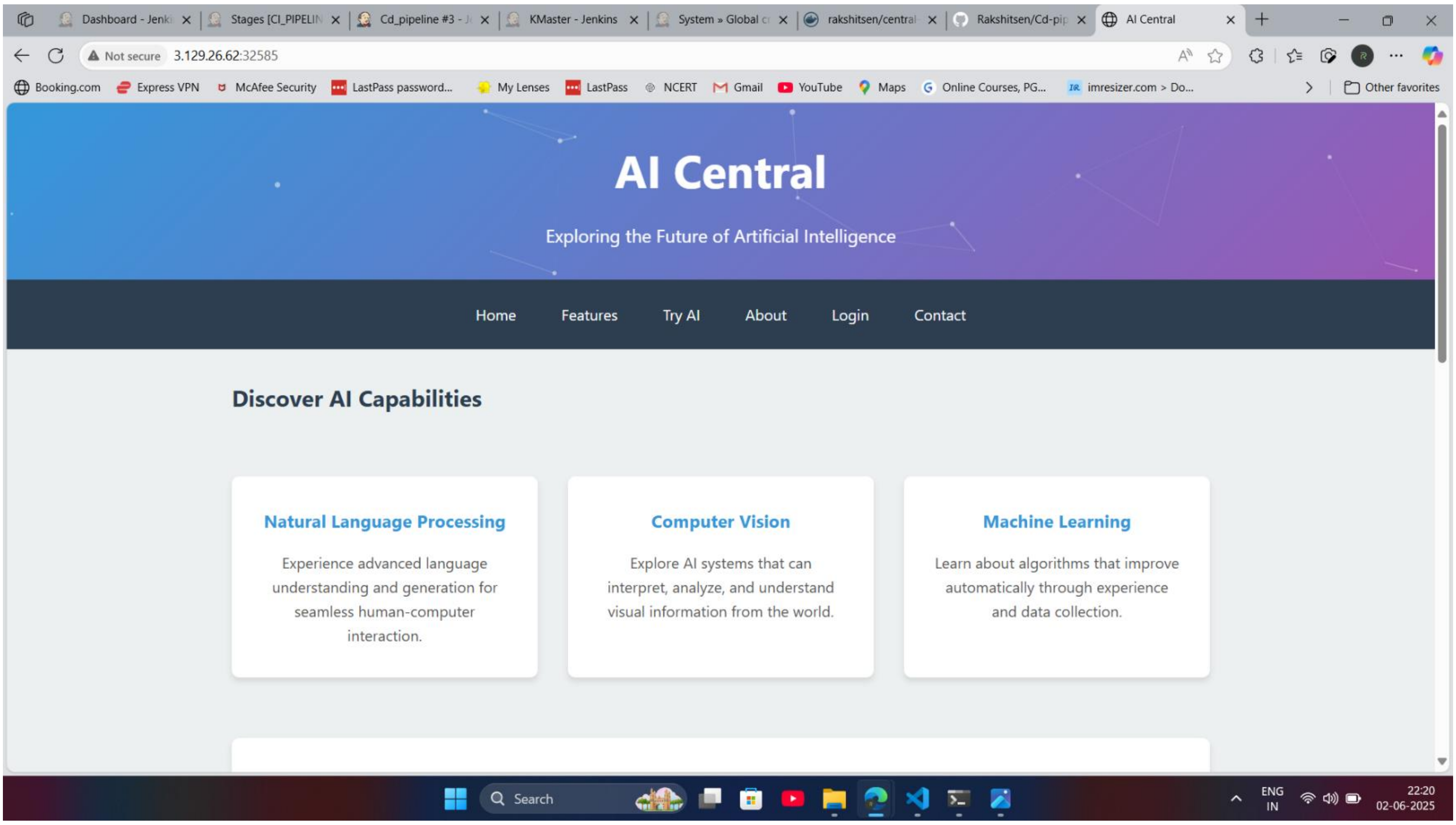
Image Pull: Fetches latest Docker image from Docker Hub

Deployment: Creates Kubernetes deployment

Service Exposure: Creates NodePort service for external access



```
ubuntu@KMaster:~$ kubectl get deployment
NAME               READY   UP-TO-DATE   AVAILABLE   AGE
myapp-deployment   2/2     2            2           3m35s
ubuntu@KMaster:~$ kubectl get service
NAME            TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
kubernetes      ClusterIP   10.96.0.1        <none>        443/TCP        66m
myapp-service   NodePort    10.100.209.29    <none>        80:32585/TCP   3m46s
ubuntu@KMaster:~$ kubectl get pods -o wide
NAME                                READY   STATUS    RESTARTS   AGE    IP               NODE        NOMINATED NODE   READINESS GATES
myapp-deployment-5b9d779d44-c65n9   1/1     Running   0          110s   192.168.37.194   kworker-1   <none>           <none>
myapp-deployment-5b9d779d44-p8flj   1/1     Running   0          105s   192.168.74.194   kworker-2   <none>           <none>
ubuntu@KMaster:~$
```



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