



# Vivekanand Education Society's

## Institute of Technology

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Hashu Advani Memorial Complex, Collector Colony, Chembur East, Mumbai - 400074.

### Department of Information Technology

A.Y. 2024-25

## Advance DevOps Lab

### Experiment 03

Aim: To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud Platforms.

Roll No.	43
Name	HARSH PRAMOD PADYAL
Class	D15B
Subject	Advance DevOps Lab
LO Mapped	LO1: To understand the fundamentals of Cloud Computing and be fully proficient with Cloud based DevOps solution deployment options to meet your business requirements.  LO2: To deploy single and multiple container applications and manage application deployments with rollouts in Kubernetes
Grade:	

**Aim :** To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud Platforms.

## **Theory :**

### **Introduction to Kubernetes**

Kubernetes, originally developed by Google and now an open-source project under the Cloud Native Computing Foundation (CNCF), is the leading container orchestration platform. It is designed to automate the deployment, scaling, and management of containerized applications, offering developers and operations teams a robust toolset to handle the complexities introduced by container-based microservices architectures.

### **Container-Based Microservices Architecture**

With the rise of containerization, companies have moved towards microservices architectures, allowing them to deploy applications more efficiently and scale individual services independently. Containers encapsulate an application and its dependencies, ensuring consistency across development, testing, and production environments. However, the large-scale adoption of containers has also introduced new challenges, particularly in terms of managing and orchestrating hundreds or thousands of containers across multiple environments.

### **The Role of Kubernetes**

Kubernetes addresses these challenges by providing a unified platform for managing containerized workloads. It abstracts the underlying infrastructure, enabling developers to focus on building applications while Kubernetes manages the complexities of deployment and scaling.

### **Key features of Kubernetes include:**

- **Resource Management:** Kubernetes ensures that applications do not exceed resource limits set by the administrator, helping to prevent any single application from monopolizing system resources.
- **Load Balancing:** Kubernetes automatically distributes network traffic across the various instances of a service, ensuring high availability and reliability.
- **Self-Healing:** Kubernetes can detect when an application is not functioning correctly and automatically restart it or move it to a healthy node in the cluster.
- **Automated Rollouts and Rollbacks:** Kubernetes can seamlessly roll out new versions of applications and automatically roll back to a previous version in case of failure.
- **Scaling:** Kubernetes can automatically scale applications up or down based on traffic and resource utilization.
- **Cluster Management:** Kubernetes simplifies the process of adding or removing nodes from a cluster, automatically redistributing workloads as necessary.

### **Kubernetes Cluster Architecture**

A Kubernetes cluster typically consists of a control plane (master) and worker nodes:

- **Control Plane (Master Node):** This manages the cluster and contains components like the API server, scheduler, and controller manager. The master node is responsible for maintaining the desired state of the cluster, such as which applications are running and the number of replicas.

Worker Nodes: These nodes run the applications. Each worker node contains components like the Kubelet, which communicates with the control plane, and a container runtime (e.g., Docker) for running the containers.

Create 2 Security Groups for Master and Nodes and add the following rules inbound rules in those Groups

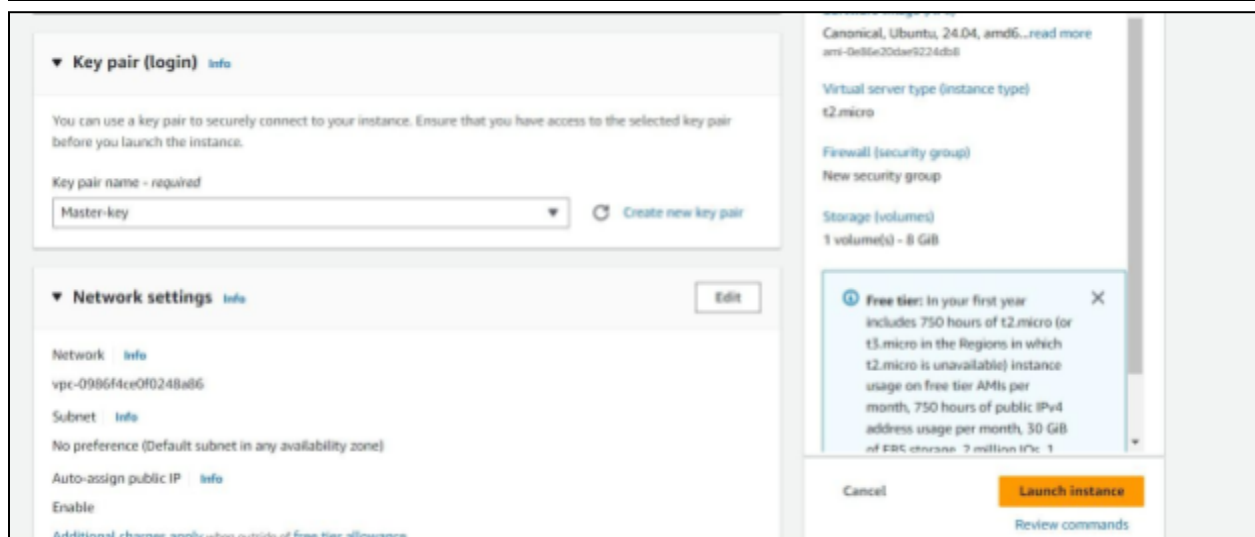
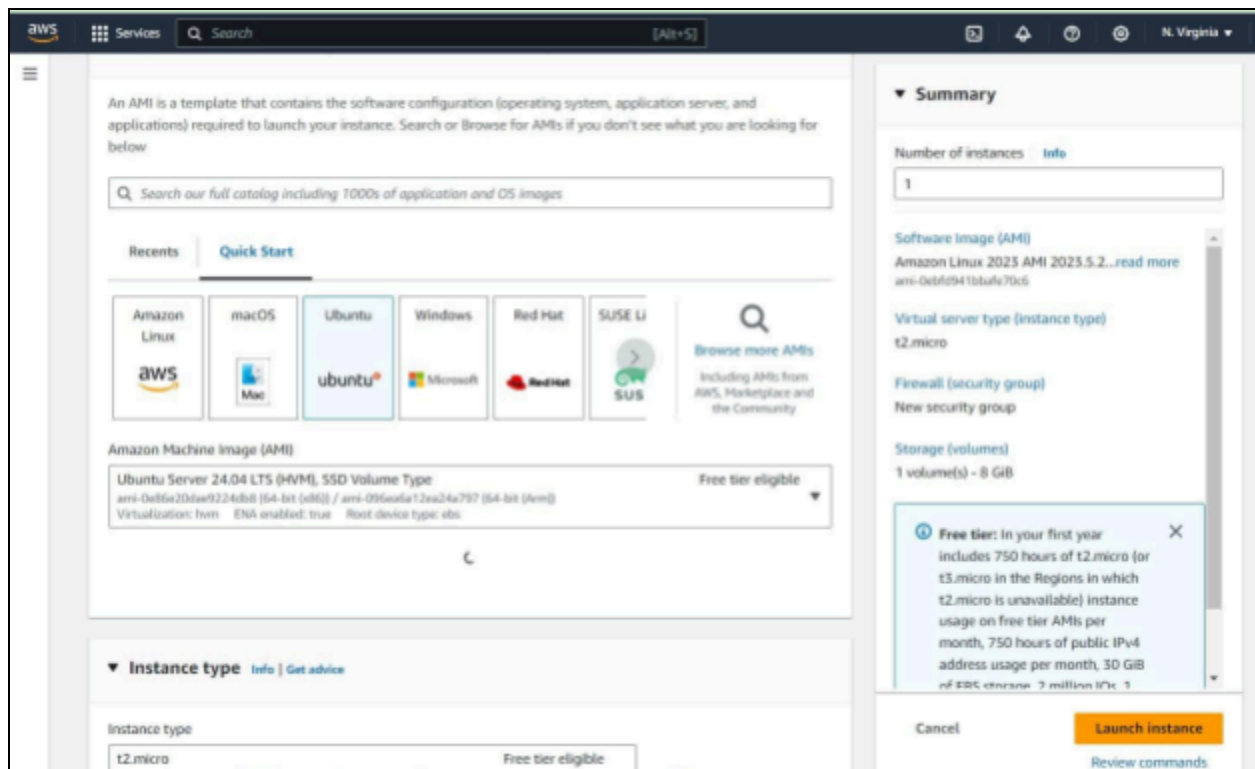
Master:

Inbound rules (8)								
<input type="text" value="Search"/> <span>&lt; 1 &gt;</span>								
<input type="checkbox"/>	Name	Security group rule...	IP version	Type	Protocol	Port range	Source	
<input type="checkbox"/>	-	sgr-010dfb1dae5e4accd	IPv4	SSH	TCP	22	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-06ec059fb77854de2	IPv4	HTTP	TCP	80	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-0701f1c4a639290b1	IPv4	All traffic	All	All	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-01fa9ed06e48ca15f	IPv4	Custom TCP	TCP	6443	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-0795f6ad9dc2b793e	IPv4	All TCP	TCP	0 - 65535	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-032bcbfb1d6472ed9	IPv4	Custom TCP	TCP	10250	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-041d15a528e1e83...	IPv4	Custom TCP	TCP	10251	0.0.0.0/0	
<input type="checkbox"/>	-	sgr-05b499dff47b52b49	IPv4	Custom TCP	TCP	10252	0.0.0.0/0	

Node :

Inbound rules Info						
Type	Protocol	Port range	Source	Description - optional		
Custom TCP	TCP	10250	Anywhere...	0.0.0.0/0		Delete
All traffic	All	All	Anywhere...	0.0.0.0/0		Delete
Custom TCP	TCP	30000 - 32767	Anywhere...	0.0.0.0/0		Delete
HTTP	TCP	80	Anywhere...	0.0.0.0/0		Delete
Add rule						

Step 1: Log in to your AWS Academy/personal account and launch 3 new Ec2 Instances. Select Ubuntu as AMI and t2.medium as Instance Type and create a key of type RSA with .pem extension and move the downloaded key to the new folder. We can use 3 Different keys or 1 common key also. Note: A minimum of 2 CPUs are required so Please select t2.medium and do not forget to stop the instance after the experiment because it is not available in the free tier. Also Select Security groups from existing. Master:



Do Same for 2 Nodes and use security groups of Node for that.

Step 2: After creating the instances click on Connect & connect all 3 instances and navigate to SSH Client.

Instances (3) <a href="#">Info</a>									
Find Instance by attribute or tag (case-sensitive)				All states					
<input type="checkbox"/>	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IP
<input type="checkbox"/>	Node2	i-0a870831b20998c64	Running	t2.medium	Initializing	View alarms	us-east-1d	ec2-3-92-207-215.com...	3.92.2
<input type="checkbox"/>	Master	i-02ff86161ef6f70db	Running	t2.medium	2/2 checks pass	View alarms	us-east-1d	ec2-3-86-219-117.com...	3.86.2
<input type="checkbox"/>	Node1	i-06888d3babc8a2ae6	Running	t2.medium	2/2 checks pass	View alarms	us-east-1d	ec2-44-204-56-156.co...	44.20

(Download Key)

Step 3: Now open the folder in the terminal 3 times for Master, Node1 & Node 2 where our .pem key is stored and paste the Example command (starting with ssh -i ..... ) in the terminal. (ssh -i "Master\_Ec2\_Key.pem" ubuntu@ec2-54-196-129-215.compute-1.amazonaws.com) Master:

EC2 Instance Connect   Session Manager   **SSH client**   EC2 serial console

Instance ID  
i-02ff86161ef6f70db (Master)

1. Open an SSH client.
2. Locate your private key file. The key used to launch this instance is Master-key.pem
3. Run this command, if necessary, to ensure your key is not publicly viewable.  
chmod 400 "Master-key.pem"
4. Connect to your instance using its Public DNS:  
ec2-3-86-219-117.compute-1.amazonaws.com

✔ Command copied

ssh -i "Master-key.pem" ubuntu@ec2-3-86-219-117.compute-1.amazonaws.com

**Note:** In most cases, the guessed username is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI username.

## Node 1:

EC2 Instance Connect   Session Manager   **SSH client**   EC2 serial console

Instance ID  
i-06888d3babc8a2ae6 (Node1)

1. Open an SSH client.
2. Locate your private key file. The key used to launch this instance is Master-key.pem
3. Run this command, if necessary, to ensure your key is not publicly viewable.  
chmod 400 "Master-key.pem"
4. Connect to your instance using its Public DNS:  
ec2-44-204-56-156.compute-1.amazonaws.com

Example:  
ssh -i "Master-key.pem" ubuntu@ec2-44-204-56-156.compute-1.amazonaws.com

**Note:** In most cases, the guessed username is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI username.

## Node 2:

EC2 > Instances > i-0a870831b20998c64 > Connect to instance

**Connect to instance** [Info](#)

Connect to your instance i-0a870831b20998c64 (Node2) using any of these options

EC2 Instance Connect   Session Manager   **SSH client**   EC2 serial console

Instance ID  
i-0a870831b20998c64 (Node2)

1. Open an SSH client.
2. Locate your private key file. The key used to launch this instance is Master-key.pem
3. Run this command, if necessary, to ensure your key is not publicly viewable.  
chmod 400 "Master-key.pem"
4. Connect to your instance using its Public DNS:  
ec2-3-92-207-215.compute-1.amazonaws.com

Example:  
ssh -i "Master-key.pem" ubuntu@ec2-3-92-207-215.compute-1.amazonaws.com

**Note:** In most cases, the guessed username is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI username.

Here I have used 2 keys 1 for master and 1 for 2 nodes so I have to run open 3 terminals. In master key folder 1 terminal and 2 terminals in node 1 key folder.  
If you use 1 Key only, you can open 3 terminals in one folder only.

### Successful Connection:

```

ubuntu@ip-172-31-82-216: ~
System information as of Wed Sep 25 11:10:36 UTC 2024

System load:  0.0          Processes:           115
Usage of /:   22.7% of 6.71GB Users logged in:      0
Memory usage: 6%          IPv4 address for enX0: 172.31.82.216
Swap usage:  0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-82-216:~$ _

```

Step 4: Run on Master, Node 1, and Node 2 the below commands to install and setup Docker in Master, Node1, and Node2.

```

curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add - curl -fsSL
https://download.docker.com/linux/ubuntu/gpg | sudo tee
/etc/apt/trusted.gpg.d/docker.gpg > /dev/null

```

```

sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubuntu
$(lsb_release -cs) stable"

```

```

ubuntu@ip-172-31-86-113:~$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add -
Warning: apt-key is deprecated. Manage keyring files in trusted.gpg.d instead (see apt-key(8)).
OK
ubuntu@ip-172-31-86-113:~$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo tee /etc/apt/trusted.gpg.d/docker.gpg > /dev/null
ubuntu@ip-172-31-86-113:~$ sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubuntu $(lsb_release -cs) stable"
> sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubuntu $(lsb_release -cs) stable"
Repository: 'deb [arch=amd64] https://download.docker.com/linux/ubuntu noble deb noble add-apt-repository [arch=amd64] https://download.docker.com/linux/ubuntu sudo stable'
Description:
Archive for codename: noble components: deb,noble,add-apt-repository,[arch=amd64],https://download.docker.com/linux/ubuntu,sudo,stable
More info: https://download.docker.com/linux/ubuntu
Adding repository.
Press [ENTER] to continue or Ctrl-c to cancel.
Adding deb entry to /etc/apt/sources.list.d/archive_uri-https_download_docker_com_linux_ubuntu-noble.list
Adding disabled deb-src entry to /etc/apt/sources.list.d/archive_uri-https_download_docker_com_linux_ubuntu-noble.list
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates InRelease [126 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports InRelease [126 kB]
Get:4 https://download.docker.com/linux/ubuntu noble InRelease [48.8 kB]
Get:5 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe amd64 Packages [15.0 MB]
Get:7 https://download.docker.com/linux/ubuntu noble/stable amd64 Packages [15.3 kB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe Translation-en [5982 kB]
Get:9 http://security.ubuntu.com/ubuntu noble-security/main amd64 Packages [377 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe amd64 Components [3871 kB]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe amd64 c-n-f Metadata [301 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/multiverse amd64 Packages [269 kB]

```

```

sudo apt-get update
sudo apt-get install -y docker-ce

```

```
W: Skipping acquire of configured file 'sudo/cnf/Commands-amd64' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
ubuntu@ip-172-31-86-113:~$ sudo apt-get update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble InRelease
Hit:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports InRelease
Hit:4 https://download.docker.com/linux/ubuntu noble InRelease
Hit:5 http://security.ubuntu.com/ubuntu noble-security InRelease
Reading package lists... Done
W: https://download.docker.com/linux/ubuntu/dists/noble/InRelease: The key(s) in the keyring /etc/apt/trusted.gpg.d/docker.gpg.d don't have a trusted fingerprint.
W: https://download.docker.com/linux/ubuntu/dists/noble/InRelease: Key is stored in legacy trusted.gpg keyring (/etc/apt/trusted.gpg) instead of the new one (in the keyring /etc/apt/trusted.gpg.d/docker.gpg.d)
W: Skipping acquire of configured file 'deb/binary-amd64/Packages' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
W: Skipping acquire of configured file 'deb/i18n/Translation-en' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
W: Skipping acquire of configured file 'deb/dep11/Components-amd64.yml' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
W: Skipping acquire of configured file 'deb/cnf/Commands-amd64' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
W: Skipping acquire of configured file 'noble/binary-amd64/Packages' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
```

```
W: Skipping acquire of configured file 'sudo/cnf/Commands-amd64' as repository 'https://download.docker.com/linux/ubuntu noble InRelease' doesn't have the file.
ubuntu@ip-172-31-86-113:~$ sudo apt-get install -y docker-ce
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  containerd.io docker-buildx-plugin docker-ce-cli docker-ce-rootless-extras docker-compose-plugin libltdl7 libsllp0 pigz slurp4netns
Suggested packages:
  aufs-tools cgroupfs-mount | cgroup-lite
The following NEW packages will be installed:
  containerd.io docker-buildx-plugin docker-ce docker-ce-cli docker-ce-rootless-extras docker-compose-plugin libltdl7 libsllp0 pigz slurp4netns
0 upgraded, 10 newly installed, 0 to remove and 139 not upgraded.
Need to get 123 MB of archives.
After this operation, 442 MB of additional disk space will be used.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe amd64 pigz amd64 2.8-1 [65.6 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libltdl7 amd64 2.4.7-7build1 [40.3 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libsllp0 amd64 4.7.0-1ubuntu3 [63.8 kB]
Get:4 https://download.docker.com/linux/ubuntu noble/stable amd64 containerd.io amd64 1.7.22-1 [29.5 MB]
Get:5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe amd64 slurp4netns amd64 1.2.1-1build2 [34.9 kB]
Get:6 https://download.docker.com/linux/ubuntu noble/stable amd64 docker-buildx-plugin amd64 0.17.1-1~ubuntu.24.04~noble [30.3 MB]
Get:7 https://download.docker.com/linux/ubuntu noble/stable amd64 docker-ce-cli amd64 5:27.3.1-1~ubuntu.24.04~noble [15.0 MB]
Get:8 https://download.docker.com/linux/ubuntu noble/stable amd64 docker-ce amd64 5:27.3.1-1~ubuntu.24.04~noble [25.6 MB]
Get:9 https://download.docker.com/linux/ubuntu noble/stable amd64 docker-ce-rootless-extras amd64 5:27.3.1-1~ubuntu.24.04~noble [9588 kB]
Get:10 https://download.docker.com/linux/ubuntu noble/stable amd64 docker-compose-plugin amd64 2.29.7-1~ubuntu.24.04~noble [12.7 MB]
Fetched 123 MB in 2s (66.1 MB/s)
Selecting previously unselected package pigz.
```

```
Created symlink /etc/systemd/system/multi-user.target.wants/containerd.service → /usr/lib/systemd/system/containerd.service.
Setting up docker-compose-plugin (2.29.7-1~ubuntu.24.04~noble) ...
Setting up libltdl7:amd64 (2.4.7-7build1) ...
Setting up docker-ce-cli (5:27.3.1-1~ubuntu.24.04~noble) ...
Setting up libsllp0:amd64 (4.7.0-1ubuntu3) ...
Setting up pigz (2.8-1) ...
Setting up docker-ce-rootless-extras (5:27.3.1-1~ubuntu.24.04~noble) ...
Setting up slurp4netns (1.2.1-1build2) ...
Setting up docker-ce (5:27.3.1-1~ubuntu.24.04~noble) ...
Created symlink /etc/systemd/system/multi-user.target.wants/docker.service → /usr/lib/systemd/system/docker.service.
Created symlink /etc/systemd/system/sockets.target.wants/docker.socket → /usr/lib/systemd/system/docker.socket.
Processing triggers for man-db (2.12.0-4build2) ...
Processing triggers for libc-bin (2.39-0ubuntu8.2) ...
Scanning processes...
Scanning linux images...

Running kernel seems to be up-to-date.

No services need to be restarted.

No containers need to be restarted.

No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
```

```
sudo mkdir -p /etc/docker
```

```
cat <<EOF | sudo tee /etc/docker/daemon.json
```

```
{
  "exec-opts": ["native.cgroupdriver=systemd"]
}
EOF
```

```
No VM guests are running outdated hypervisor (qemu) binaries on this host.
ubuntu@ip-172-31-86-113:~$ sudo mkdir -p /etc/docker
ubuntu@ip-172-31-86-113:~$ cat <<EOF | sudo tee /etc/docker/daemon.json{
> cat <<EOF | sudo tee /etc/docker/daemon.json{"exec-opts": ["native.cgroupdriver=systemd"]}
> EOF
cat <<EOF | sudo tee /etc/docker/daemon.json{"exec-opts": ["native.cgroupdriver=systemd"]}
ubuntu@ip-172-31-86-113:~$ █
```



```
sudo systemctl enable docker
sudo systemctl daemon-reload
sudo systemctl restart docker
```

```
ubuntu@ip-172-31-86-113:~$ sudo systemctl enable docker
Synchronizing state of docker.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable docker
ubuntu@ip-172-31-86-113:~$ sudo systemctl daemon-reload
sudo: systemctl: command not found
ubuntu@ip-172-31-86-113:~$ sudo systemctl daemon-reload
ubuntu@ip-172-31-86-113:~$ sudo systemctl restart docker
ubuntu@ip-172-31-86-113:~$
```

Step 5: Run the below command to install Kubernetes.

```
curl -fsSL https://pkgs.k8s.io/core:/stable:/v1.31/deb/Release.key | sudo gpg --dearmor -o
/etc/apt/keyrings/kubernetes-apt-keyring.gpg
```

```
echo 'deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg]
https://pkgs.k8s.io/core:/stable:/v1.31/deb/ /' | sudo tee /etc/apt/sources.list.d/kubernetes.list
```

```
ubuntu@ip-172-31-86-113:~$ sudo systemctl restart docker
ubuntu@ip-172-31-86-113:~$ curl -fsSL https://pkgs.k8s.io/core:/stable:/v1.31/deb/Release.key |
> curl -fsSL https://pkgs.k8s.io/core:/stable:/v1.31/deb/Release.key | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-apt-keyring.gpg
ubuntu@ip-172-31-86-113:~$ echo 'deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] https://pkgs.k8s.io/core:/stable:/v1.31/deb/ /' | sudo tee /etc/apt/sources.list.d/kubernetes.list
deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] https://pkgs.k8s.io/core:/stable:/v1.31/deb/ /
ubuntu@ip-172-31-86-113:~$
```

```
sudo apt-get update
sudo apt-get install -y kubelet kubeadm kubectl
sudo apt-mark hold kubelet kubeadm kubectl
```

```
Last login: Wed Sep 25 11:02:35 2024 from 103.187.228.87
ubuntu@ip-172-31-86-113:~$ sudo apt-get update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble InRelease
Hit:2 https://download.docker.com/linux/ubuntu noble InRelease
Hit:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-backports InRelease
Get:5 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb InRelease [1186 B]
Hit:6 http://security.ubuntu.com/ubuntu noble-security InRelease
Get:7 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb Packages [4865 B]
Fetched 6051 B in 1s (9934 B/s)
Reading package lists... Done
```

```
(list?)
W: Skipping acquire of configured file 'sudo/cnf/Commands-amd64' as repository 'https://download.docker.com/linux/ubuntu noble InRelease'
ubuntu@ip-172-31-86-113:~$ sudo apt-get install -y kubelet kubeadm kubectl
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  conntrack cri-tools kubernetes-cni
The following NEW packages will be installed:
  conntrack cri-tools kubeadm kubectl kubelet kubernetes-cni
0 upgraded, 6 newly installed, 0 to remove and 139 not upgraded.
Need to get 87.4 MB of archives.
After this operation, 314 MB of additional disk space will be used.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 conntrack amd64 1:1.4.8-1ubuntu1 [37.9 kB]
Get:2 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb cri-tools 1.31.1-1.1 [15.7 MB]
Get:3 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb kubeadm 1.31.1-1.1 [11.4 MB]
Get:4 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb kubectl 1.31.1-1.1 [11.2 MB]
Get:5 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb kubernetes-cni 1.5.1-1.1 [33.9 MB]
Get:6 https://prod-cdn.packages.k8s.io/repositories/iscv:/kubernetes:/core:/stable:/v1.31/deb kubelet 1.31.1-1.1 [15.2 MB]
Fetched 87.4 MB in 1s (70.6 MB/s)
Selecting previously unselected package conntrack.
```

```
ubuntu@ip-172-31-86-113:~$ sudo apt-mark hold kubelet kubeadm kubectl
kubelet set on hold.
kubeadm set on hold.
kubectl set on hold.
ubuntu@ip-172-31-86-113:~$
```

sudo systemctl enable --now kubelet

sudo apt-get install -y containerd

```

#... Skipping acquire of configured file 'sudo/cni/commands-amd64' as repository 'https://download.docker.com/linux/ubuntu noble-impl...
ubuntu@ip-172-31-86-113:~$ sudo apt-get install -y containerd
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
  docker-buildx-plugin docker-ce-cli docker-ce-rootless-extras docker-compose-plugin libltdl7 libslirp0 pigz slirp4netns
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  runc
The following packages will be REMOVED:
  containerd.io docker-ce
The following NEW packages will be installed:
  containerd runc
0 upgraded, 2 newly installed, 2 to remove and 139 not upgraded.
Need to get 47.2 MB of archives.
After this operation, 53.1 MB disk space will be freed.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 runc amd64 1.1.12-0ubuntu3.1 [8599 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 containerd amd64 1.7.12-0ubuntu4.1 [38.6 MB]
Fetched 47.2 MB in 1s (35.3 MB/s)
(Reading database ... 68064 files and directories currently installed.)
Removing docker-ce (5:27.3.1-1~ubuntu.24.04~noble) ...
Removing containerd.io (1.7.22-1) ...
Selecting previously unselected package runc.
(Reading database ... 68044 files and directories currently installed.)
Preparing to unpack .../runc_1.1.12-0ubuntu3.1_amd64.deb

```

sudo mkdir -p /etc/containerd

sudo containerd config default | sudo tee /etc/containerd/config.toml

```

no VM guests are running outdated hypervisor (qemu) binaries on this host.
ubuntu@ip-172-31-86-113:~$ sudo mkdir -p /etc/containerd
ubuntu@ip-172-31-86-113:~$ sudo containerd config default | sudo tee /etc/containerd/config.toml
disabled_plugins = []
imports = []
oom_score = 0
plugin_dir = ""
required_plugins = []
root = "/var/lib/containerd"
state = "/run/containerd"
temp = ""
version = 2

[cgroup]
  path = ""

[debug]
  address = ""
  format = ""
  gid = 0
  level = ""
  uid = 0

```

```

[stream_processors."io.containerd.ocicrypt.decoder.v1.tar"]
  accepts = ["application/vnd.oci.image.layer.v1.tar+encrypted"]
  args = ["--decryption-keys-path", "/etc/containerd/ocicrypt/keys"]
  env = ["OCICRYPT_KEYPROVIDER_CONFIG=/etc/containerd/ocicrypt/ocicrypt_keyprovider.conf"]
  path = "ctd-decoder"
  returns = "application/vnd.oci.image.layer.v1.tar"

[stream_processors."io.containerd.ocicrypt.decoder.v1.tar.gzip"]
  accepts = ["application/vnd.oci.image.layer.v1.tar+gzip+encrypted"]
  args = ["--decryption-keys-path", "/etc/containerd/ocicrypt/keys"]
  env = ["OCICRYPT_KEYPROVIDER_CONFIG=/etc/containerd/ocicrypt/ocicrypt_keyprovider.conf"]
  path = "ctd-decoder"
  returns = "application/vnd.oci.image.layer.v1.tar+gzip"

[timeouts]
  "io.containerd.timeout.bolt.open" = "0s"
  "io.containerd.timeout.metrics.shimstats" = "2s"
  "io.containerd.timeout.shim.cleanup" = "5s"
  "io.containerd.timeout.shim.load" = "5s"
  "io.containerd.timeout.shim.shutdown" = "3s"
  "io.containerd.timeout.task.state" = "2s"

[tttrpc]
  address = ""
  gid = 0
  uid = 0

```

```
sudo systemctl restart containerd
sudo systemctl enable containerd
sudo systemctl status containerd
```

```
ubuntu@ip-172-31-86-113:~$ sudo systemctl restart containerd
ubuntu@ip-172-31-86-113:~$ sudo systemctl enable containerd
ubuntu@ip-172-31-86-113:~$ sudo systemctl status containerd
* containerd.service - containerd container runtime
   Loaded: loaded (/usr/lib/systemd/system/containerd.service; enabled; preset: enabled)
   Active: active (running) since Wed 2024-09-25 12:21:56 UTC; 22s ago
     Docs: https://containerd.io
   Main PID: 5564 (containerd)
    Tasks: 7
   Memory: 13.5M (peak: 14.0M)
      CPU: 147ms
   CGroup: /system.slice/containerd.service
           └─5564 /usr/bin/containerd

Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034051286Z" level=info msg=serving... address=/run/containerd/containerd.sock
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034058833Z" level=info msg="Start subscribing containerd event"
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034138988Z" level=info msg="Start recovering state"
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034189447Z" level=info msg="Start event monitor"
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034204446Z" level=info msg="Start snapshots syncer"
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034212888Z" level=info msg="Start cni network conf syncer for default"
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034219382Z" level=info msg="Start streaming server"
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034106837Z" level=info msg=serving... address=/run/containerd/containerd.sock
Sep 25 12:21:56 ip-172-31-86-113 containerd[5564]: time="2024-09-25T12:21:56.034331653Z" level=info msg="containerd successfully booted in 0.025705s"
Sep 25 12:21:56 ip-172-31-86-113 systemd[1]: Started containerd.service - containerd container runtime.
```

```
sudo apt-get install -y socat
```

```
ubuntu@ip-172-31-86-113:~$ sudo apt-get install -y socat
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
  docker-buildx-plugin docker-ce-cli docker-ce-rootless-extras docker-compose-plugin libltdl7 libsllp0 pigz slirp4netns
Use 'sudo apt autoremove' to remove them.
The following NEW packages will be installed:
  socat
0 upgraded, 1 newly installed, 0 to remove and 139 not upgraded.
Need to get 374 kB of archives.
After this operation, 1649 kB of additional disk space will be used.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 socat amd64 1.8.0.0-4build3 [374 kB]
Fetched 374 kB in 0s (13.9 MB/s)
Selecting previously unselected package socat.
(Reading database ... 68108 files and directories currently installed.)
Preparing to unpack .../socat_1.8.0.0-4build3_amd64.deb ...
Unpacking socat (1.8.0.0-4build3) ...
Setting up socat (1.8.0.0-4build3) ...
Processing triggers for man-db (2.12.0-4build2) ...
Scanning processes...
Scanning linux images...

Running kernel seems to be up-to-date.

No services need to be restarted.

No containers need to be restarted.

No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
ubuntu@ip-172-31-86-113:~$
```

Step 6: Initialize the Kubecluster .Now Perform this Command only for Master.  
 sudo kubeadm init --pod-network-cidr=10.244.0.0/16

```
Your Kubernetes control-plane has initialized successfully!

To start using your cluster, you need to run the following as a regular user:

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

Alternatively, if you are the root user, you can run:

export KUBECONFIG=/etc/kubernetes/admin.conf

You should now deploy a pod network to the cluster.
Run "kubectl apply -f [podnetwork].yaml" with one of the options listed at:
https://kubernetes.io/docs/concepts/cluster-administration/addons/

Then you can join any number of worker nodes by running the following on each as root:

kubeadm join 172.31.86.113:6443 --token td441j.fcvzp0pysi3k6ila \
--discovery-token-ca-cert-hash sha256:dda15d6076f45caff2b27dfb12d73e5bc7fa10b545c4330da9773df0007f5f2c
ubuntu@ip-172-31-86-113:~$
```

Run this command on master and also copy and save the Join command from above.

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

```
kubeadm join 172.31.86.113:6443 --token td441j.fcvzp0pysi3k6i1a \
--discovery-token-ca-cert-hash sha256:dda15d6076f45caffb2b27dfb12d73e5bc7fa10b545c4330da9773df0007f5f2c
ubuntu@ip-172-31-86-113:~$ mkdir -p $HOME/.kube
ubuntu@ip-172-31-86-113:~$ sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
ubuntu@ip-172-31-86-113:~$ sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

Step 7: Now Run the command `kubectl get nodes` to see the nodes before executing Join command on nodes.

```
ubuntu@ip-172-31-86-113:~$ kubectl get nodes
```

NAME	STATUS	ROLES	AGE	VERSION
ip-172-31-86-113	NotReady	control-plane	20m	v1.31.1

```
ubuntu@ip-172-31-86-113:~$
```

Step 8: Now Run the following command on Node 1 and Node 2 to Join to master. `sudo kubeadm join 172.31.27.176:6443 --token ttay2x.n0sqeukjai8sgfg3 \ --discovery-token-ca-cert-hash sha256:d6fc5fb7e984c83e2807780047fec6c4f2acfe9da9184ecc028d77157608fbb6`

Node 1:

```
ubuntu@ip-172-31-28-117:~$ sudo kubeadm join 172.31.27.176:6443 --token ttay2x.n0sqeukjai8sgfg3 \
--discovery-token-ca-cert-hash sha256:d6fc5fb7e984c83e2807780047fec6c4f2acfe9da9184ecc028d77157608fbb6

[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-check] Waiting for a healthy kubelet at http://127.0.0.1:10248/healthz. This can take up to 4m0s
[kubelet-check] The kubelet is healthy after 501.396793ms
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap

This node has joined the cluster:
* Certificate signing request was sent to apiserver and a response was received.
* The Kubelet was informed of the new secure connection details.

Run 'kubectl get nodes' on the control-plane to see this node join the cluster.

ubuntu@ip-172-31-28-117:~$
```

Node 2:

```
ubuntu@ip-172-31-18-135:~$ sudo kubeadm join 172.31.27.176:6443 --token ttay2x.n0sqeukjai8sgfg3 \
--discovery-token-ca-cert-hash sha256:d6fc5fb7e984c83e2807780047fec6c4f2acfe9da9184ecc028d77157608fbb6

[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-check] Waiting for a healthy kubelet at http://127.0.0.1:10248/healthz. This can take up to 4m0s
[kubelet-check] The kubelet is healthy after 1.001003808s
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap

This node has joined the cluster:
* Certificate signing request was sent to apiserver and a response was received.
* The Kubelet was informed of the new secure connection details.

Run 'kubectl get nodes' on the control-plane to see this node join the cluster.

ubuntu@ip-172-31-18-135:~$
```

Step 9: Now Run the command `kubectl get nodes` to see the nodes after executing Join command on nodes.

```
ubuntu@ip-172-31-27-176:~$ kubectl get nodes
```

NAME	STATUS	ROLES	AGE	VERSION
ip-172-31-18-135	NotReady	<none>	88s	v1.31.1
ip-172-31-27-176	NotReady	control-plane	10m	v1.31.1
ip-172-31-28-117	NotReady	<none>	2m58s	v1.31.1

Step 10: Since Status is NotReady we have to add a network plugin. And also we have to give the name to the nodes.

kubectl apply -f <https://docs.projectcalico.org/manifests/calico.yaml>

```
ubuntu@ip-172-31-27-176:~$ kubectl apply -f https://docs.projectcalico.org/manifests/calico.yaml
poddisruptionbudget.policy/calico-kube-controllers created
serviceaccount/calico-kube-controllers created
serviceaccount/calico-node created
configmap/calico-config created
customresourcedefinition.apiextensions.k8s.io/bgpconfigurations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/bgppeers.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/blockaffinities.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/caliconodestatuses.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/clusterinformations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/felixconfigurations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/globalnetworkpolicies.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/globalnetworksets.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/hostendpoints.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamblocks.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamconfigs.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamhandles.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ippools.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipreservations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/kubecontrollersconfigurations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/networkpolicies.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/networksets.crd.projectcalico.org created
clusterrole.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrole.rbac.authorization.k8s.io/calico-node created
clusterrolebinding.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrolebinding.rbac.authorization.k8s.io/calico-node created
daemonset.apps/calico-node created
deployment.apps/calico-kube-controllers created
```

sudo systemctl status kubelet

```
ubuntu@ip-172-31-86-113:~$ sudo systemctl status kubelet
● kubelet.service - kubelet: The Kubernetes Node Agent
   Loaded: loaded (/usr/lib/systemd/system/kubelet.service; enabled; preset: enabled)
   Drop-In: /usr/lib/systemd/system/kubelet.service.d
            └─10-kubeadm.conf
   Active: active (running) since Wed 2024-09-25 13:31:59 UTC; 11min ago
     Docs: https://kubernetes.io/docs/
   Main PID: 853 (kubelet)
    Tasks: 12 (limit: 4676)
   Memory: 42.7M (peak: 43.7M)
      CPU: 9.350s
   CGroup: /system.slice/kubelet.service
           └─853 /usr/bin/kubelet --bootstrap-kubeconfig=/etc/kubernetes/bootstrap-kubelet.conf --kubeconfig=/etc/kubernetes/kubelet.conf --config=/var/lib/kubelet/config.yaml --container-runtime-endpoint=

Sep 25 13:42:38 ip-172-31-86-113 kubelet[853]: rpc error: code = Unknown desc = failed to stop container "11e91c64db074d0c0fc3812656b9bd62f65db9c95b7107f966b9964a94ea08be": failed to kill container "1
Sep 25 13:42:38 ip-172-31-86-113 kubelet[853]: : unknown
Sep 25 13:42:38 ip-172-31-86-113 kubelet[853]: > podSandboxID="c8e5b58be88685dcf5129a2dccc2ed0f267e3e812abdb9f6609ab796c1aa8f9"
Sep 25 13:42:38 ip-172-31-86-113 kubelet[853]: E0925 13:42:38.167282 853 kubelet/runtime_manager.go:1479] "Failed to stop sandbox" podSandboxID="c8e5b58be88685dcf5129a2dccc2ed0f267e
Sep 25 13:42:38 ip-172-31-86-113 kubelet[853]: E0925 13:42:38.167786 853 kubelet.go:1865] "KillPod failed" err="failed to \"killContainer\" for \"kube-apiserver\" with KillContainerError: \"/>

```

Now Run command kubectl get nodes -o wide we can see Status is ready.

```
ubuntu@ip-172-31-27-176:~$ kubectl get nodes -o wide
```

NAME	STATUS	ROLES	AGE	VERSION	INTERNAL-IP	EXTERNAL-IP	OS-IMAGE	KERNEL-VERSION	CONTAINER-RUNTIME
ip-172-31-18-135	Ready	<none>	6m19s	v1.31.1	172.31.18.135	<none>	Ubuntu 24.04 LTS	6.8.0-1012-aws	containerd://1.7.12
ip-172-31-27-176	Ready	control-plane	15m	v1.31.1	172.31.27.176	<none>	Ubuntu 24.04 LTS	6.8.0-1012-aws	containerd://1.7.12
ip-172-31-28-117	Ready	<none>	7m49s	v1.31.1	172.31.28.117	<none>	Ubuntu 24.04 LTS	6.8.0-1012-aws	containerd://1.7.12

Now to Rename run this command

kubectl label node ip-172-31-18-135 [kubernetes.io/role=worker](https://kubernetes.io/role=worker)

Rename to Node 1:kubectl label node ip-172-31-28-117 kubernetes.io/role=Node1 Rename to Node 2:kubectl label node ip-172-31-18-135 kubernetes.io/role=Node2

```
ubuntu@ip-172-31-27-176:~$ kubectl label node ip-172-31-28-117 kubernetes.io/role=Node1
node/ip-172-31-28-117 labeled
ubuntu@ip-172-31-27-176:~$ kubectl label node ip-172-31-18-135 kubernetes.io/role=Node2
node/ip-172-31-18-135 labeled
```

Step 11: Run command `kubectl get nodes -o wide`. And Hence we can see we have Successfully connected Node 1 and Node 2 to the Master.

```
ubuntu@ip-172-31-27-176:~$ kubectl get nodes -o wide
NAME                STATUS    ROLES    AGE   VERSION   INTERNAL-IP   EXTERNAL-IP   OS-IMAGE             KERNEL-VERSION   CONTAINER-RUNTIME
ip-172-31-18-135    Ready     Node2     12m   v1.31.1   172.31.18.135 <none>        Ubuntu 24.04 LTS    6.8.0-1012-aws    containerd://1.7.12
ip-172-31-27-176    Ready     control-plane 21m   v1.31.1   172.31.27.176 <none>        Ubuntu 24.04 LTS    6.8.0-1012-aws    containerd://1.7.12
ip-172-31-28-117    Ready     Node1     13m   v1.31.1   172.31.28.117 <none>        Ubuntu 24.04 LTS    6.8.0-1012-aws    containerd://1.7.12
ubuntu@ip-172-31-27-176:~$
```

Or run `kubectl get nodes`

```
ubuntu@ip-172-31-27-176:~$ kubectl get nodes
NAME                STATUS    ROLES    AGE   VERSION
ip-172-31-18-135    Ready     Node2     24m   v1.31.1
ip-172-31-27-176    Ready     control-plane 33m   v1.31.1
ip-172-31-28-117    Ready     Node1     25m   v1.31.1
ubuntu@ip-172-31-27-176:~$
```

### **Conclusion :**

In this experiment, we successfully set up a Kubernetes cluster on AWS EC2 instances, understanding how Kubernetes manages and orchestrates containerized applications across multiple nodes. This hands-on experience demonstrated Kubernetes' ability to automate deployment, scaling, and resource management in a cloud environment.