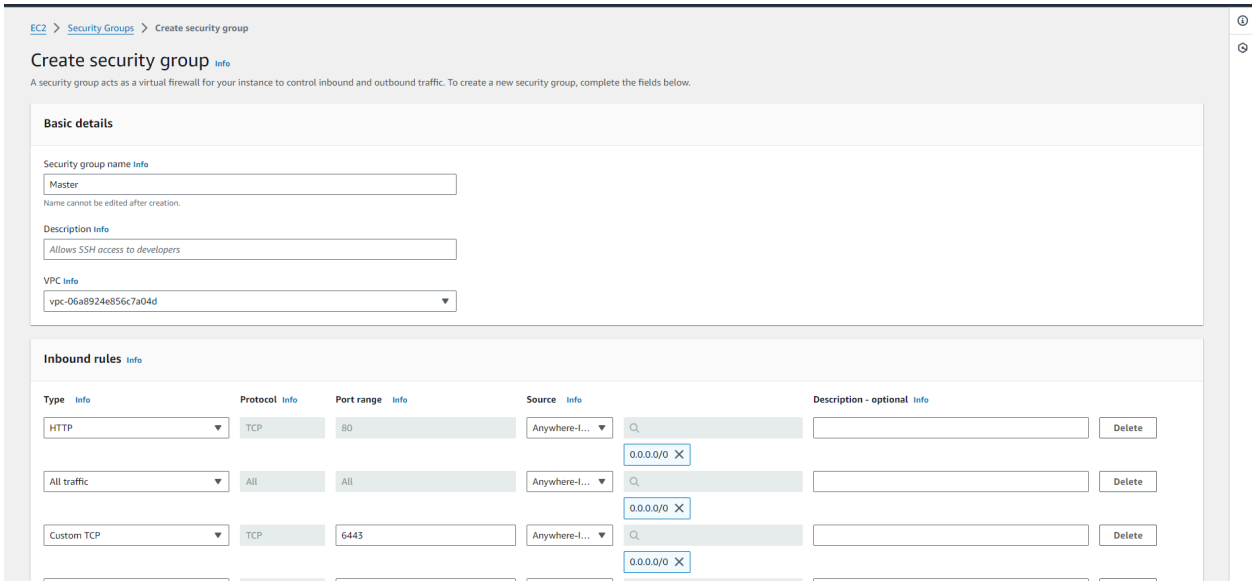
NAME: VEDANT DHOKE CLASS/ROLL NO: D15C/ 9

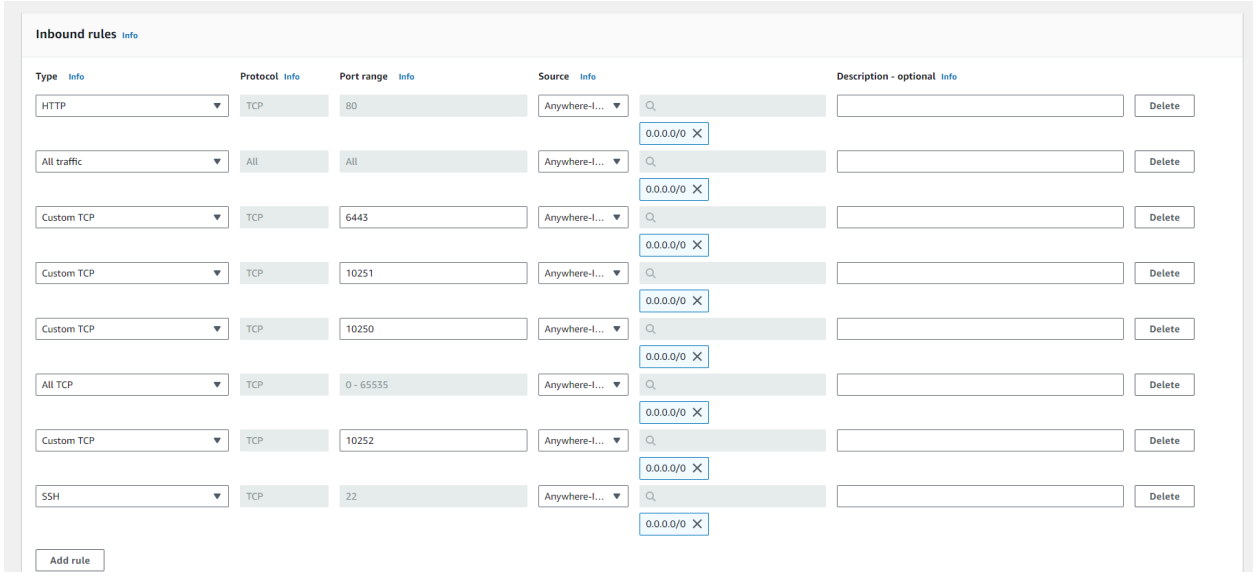
EXPERIMENT NO: 3

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

STEPS :

1.Create Security Groups with the following inbound rules





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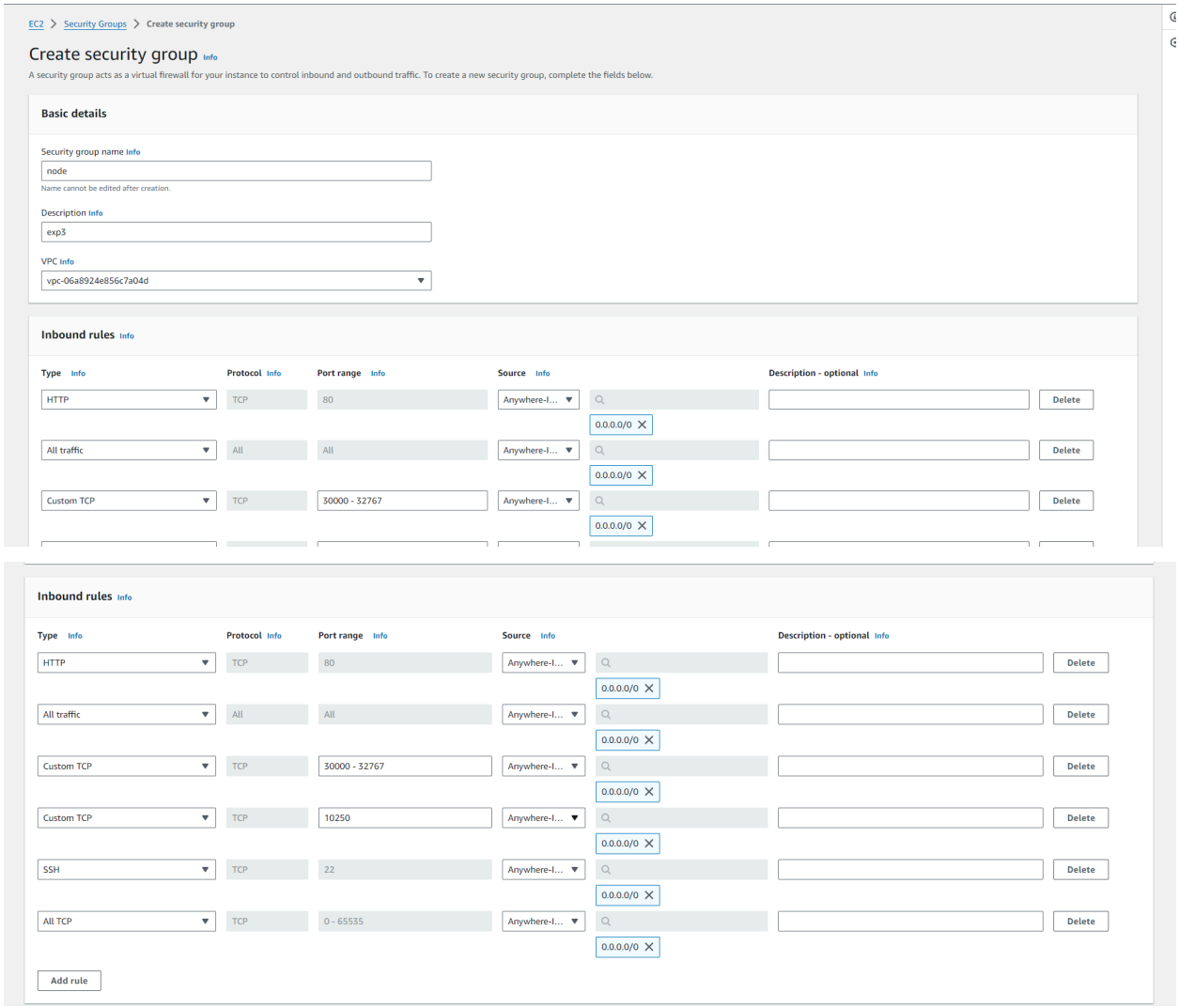
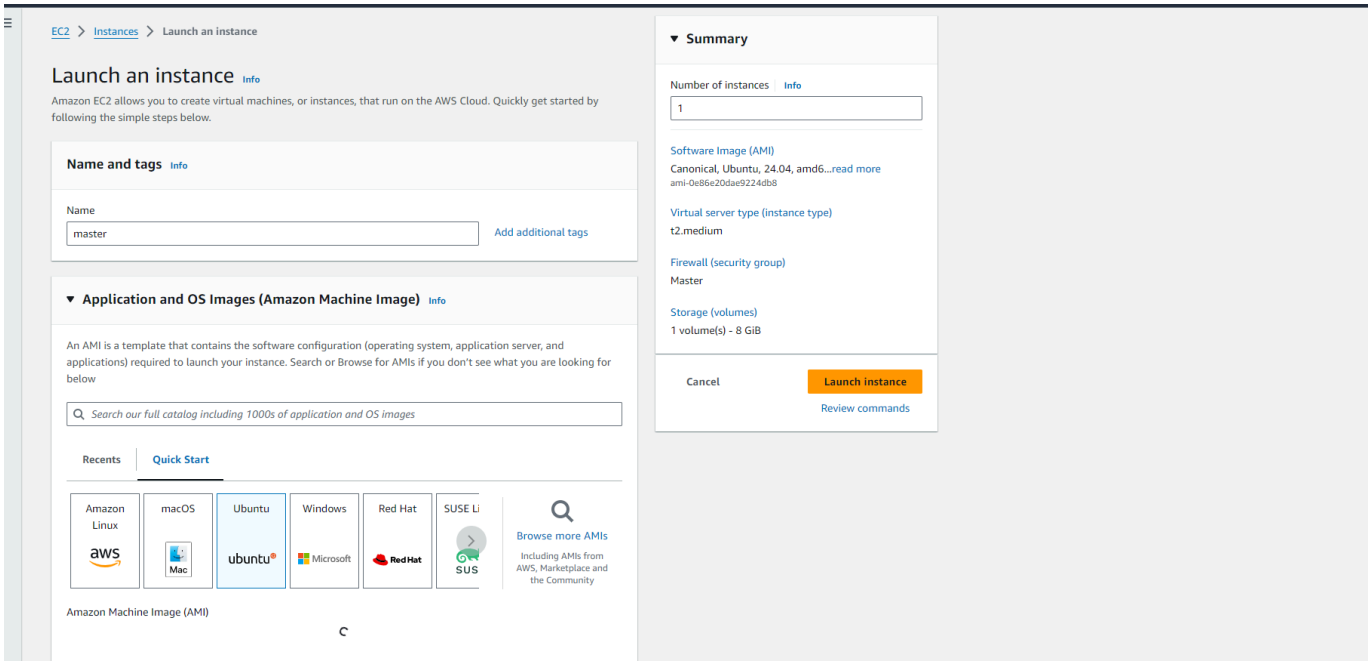
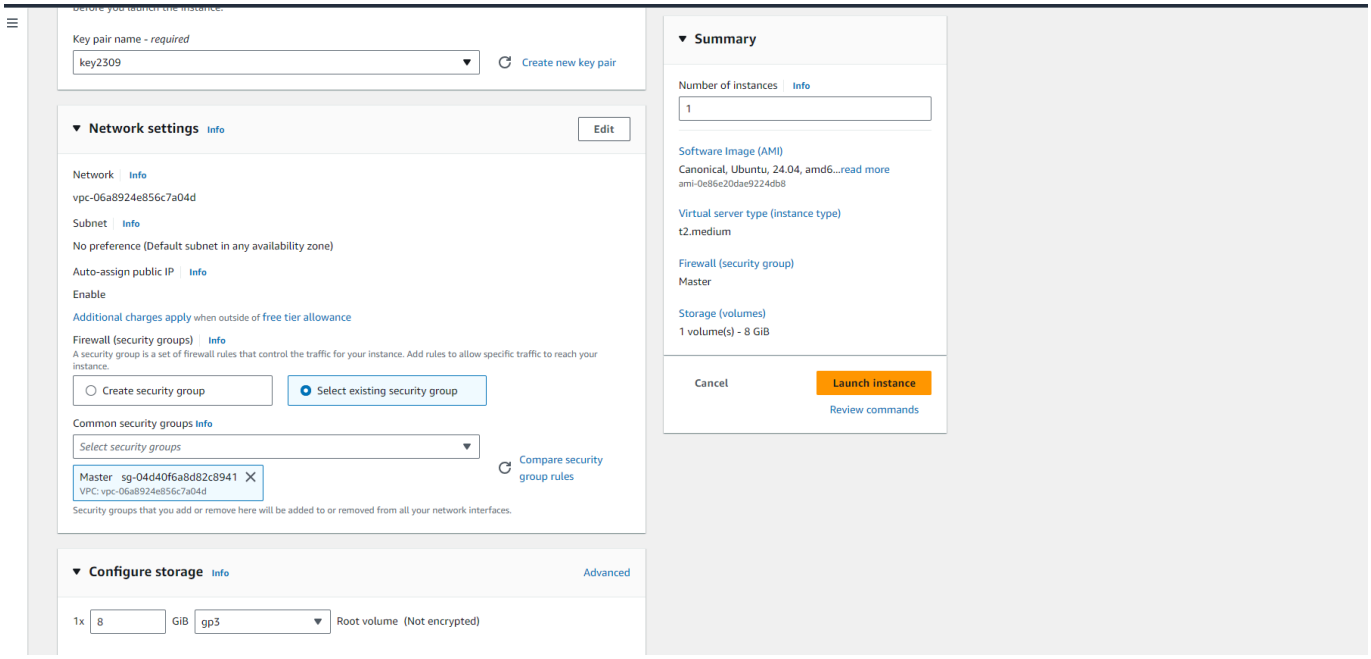


2.**Create Instances:**

We initiated the creation of three virtual machines or instances, naming them Master, node-1, and node-2. These instances will act as the nodes in our Kubernetes cluster.





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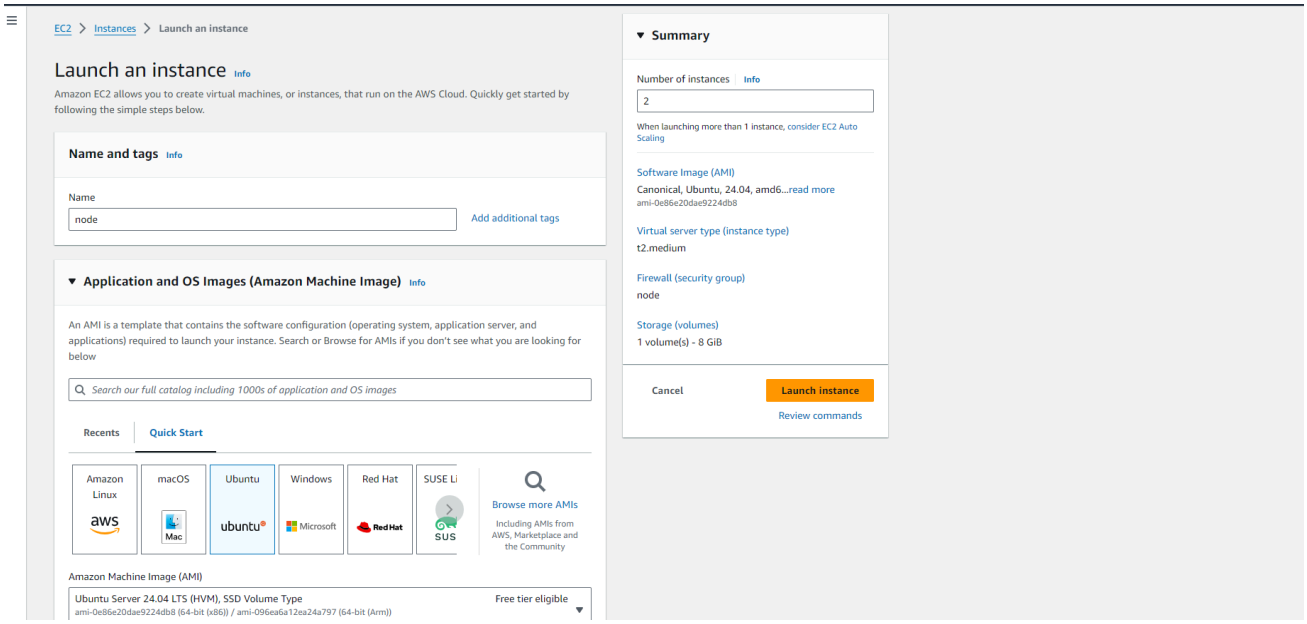
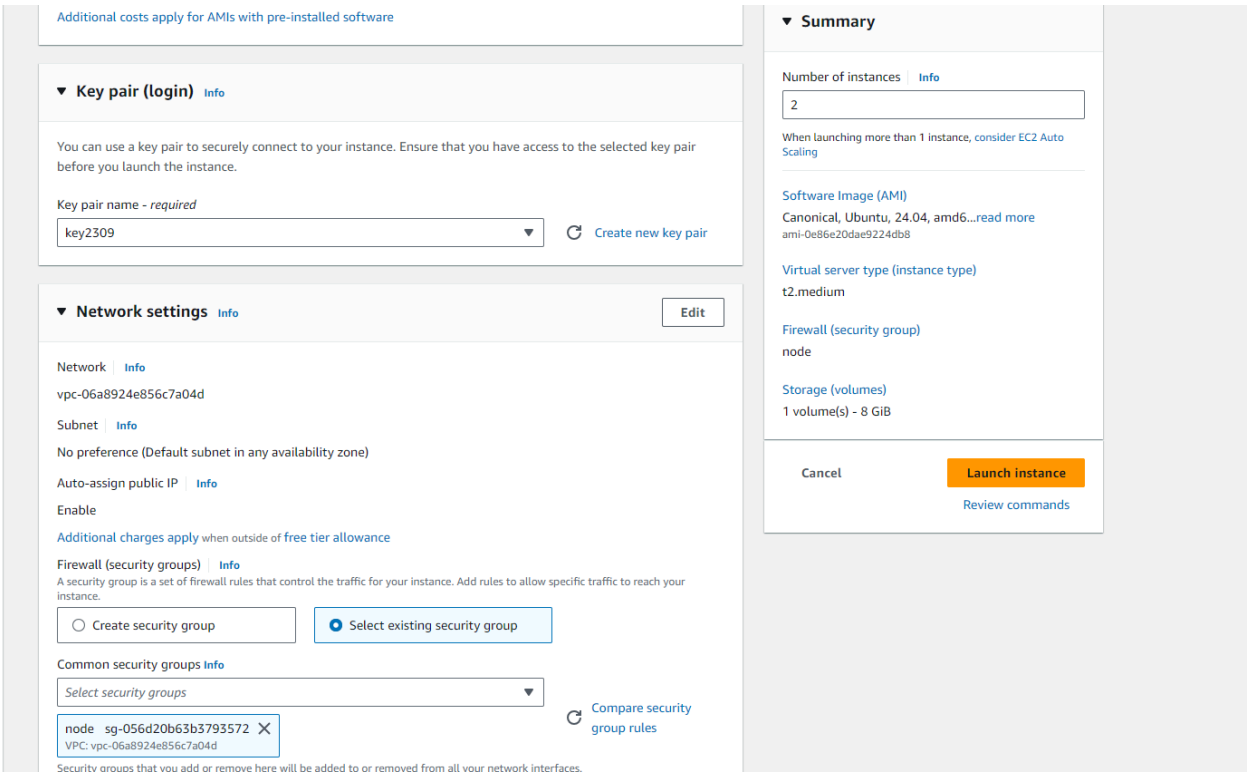
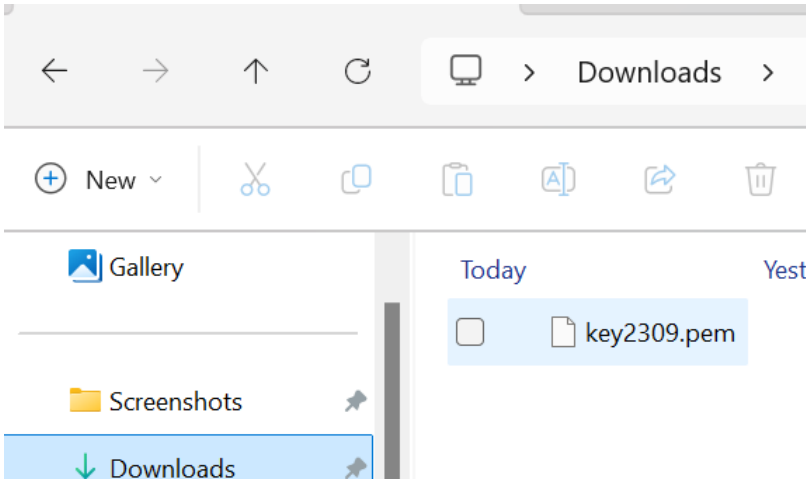




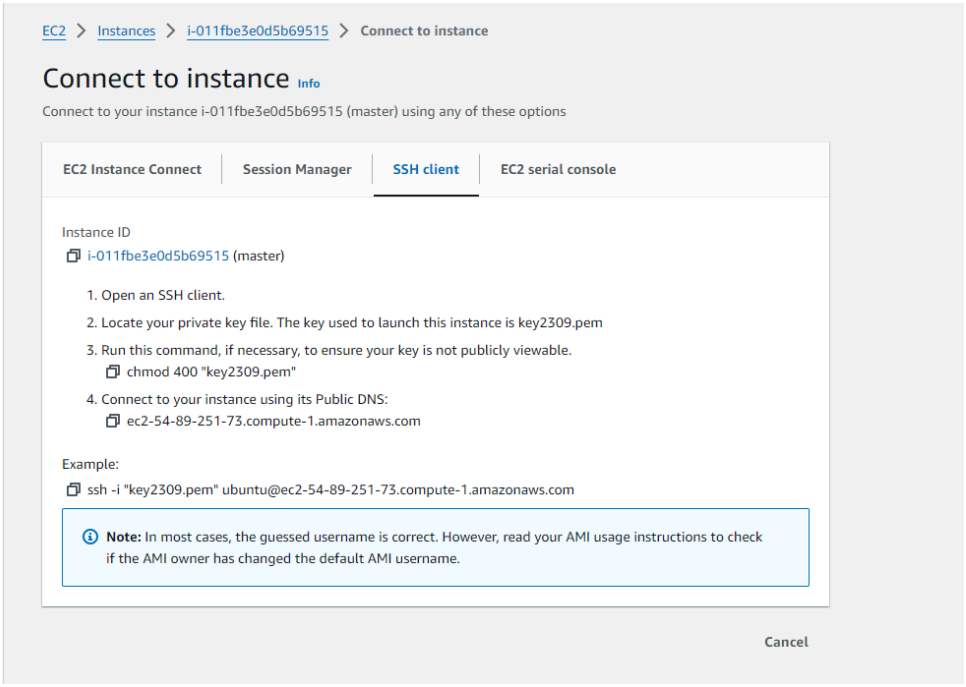
These the instances we have created successfully.

☐	node-1	i-019d881a62651c90d	Running	t2.medium	Initializing	View alarms +	us-east-1b	ec2-3-86-95-118.comp...	3.86.95.118
☐	node-2	i-05333ee8d27d26a64	Running	t2.medium	Initializing	View alarms +	us-east-1b	ec2-35-174-170-105.co...	35.174.170.105
☐	master	i-011fbe3e0d5b69515	Running	t2.medium	Initializing	View alarms +	us-east-1b	ec2-54-89-251-73.com...	54.89.251.73

It is important to have the download file of your key.



Copy the command below in the example part and paste it in the cmd.



2.**Install Docker**:

```
PS C:\Users\91900> ssh -i "key2309.pem" ubuntu@ec2-35-174-170-105.compute-1.amazonaws.com
The authenticity of host 'ec2-35-174-170-105.compute-1.amazonaws.com (35.174.170.105)' can't be established.
ED25519 key fingerprint is SHA256:777d6VJLUANXWdvC2Rqcqg6Jscu79S7iwHCjSgnMwM0.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-35-174-170-105.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 24.04 LTS (GNU/Linux 6.8.0-1012-aws x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

 System information as of Mon Sep 23 15:19:47 UTC 2024

  System load:  0.0               Processes:             112
  Usage of /:   22.8% of 6.71GB   Users logged in:       0
  Memory usage: 5%                IPv4 address for enX0: 172.31.86.235
  Swap usage:   0%
```

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-172-31-95-11:~$ 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"
Warning: apt-key is deprecated. Manage keyring files in trusted.gpg.d instead (see apt-key(8)).
OK
-----BEGIN PGP PUBLIC KEY BLOCK-----

mQINBFit2ioBEADhWpZ8/wvZ6hUTiXOwQHXMAlaFHcPH9hAtr4F1y2+OYdbtMuth
lqqwp028AqyY+PRfVMtSYMbjuQuu5byyKR01BbqYhuS3jtqQmljZ/bJvXqnmiVXh
38UuLa+z077PxyxQhu5BbqntTPQMfiyqEiU+BKbq2WmANUKQf+1AmZY/IruOXbnq
L4C1+gJ8vfmXQt99npCaxEjaNRVYfOS8QcixNzHUYnb6emjlANyEVlZzeqo7XKl7
UrwV5inawTSzWNvtjEjj4nJL8NsLwscpLPQUhTQ+7BbQXAwAmeHCUTQIvvWXqw0N
```

```
Get:51 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 Components [208 B]
Get:52 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 c-n-f Metadata [344 B]
Fetched 29.1 MB in 5s (6401 kB/s)
Reading package lists... Done
W: https://download.docker.com/linux/ubuntu/dists/noble/InRelease: Key is stored in legacy trusted.gpg keyring (/etc/apt/trusted.gpg)
, see the DEPRECATION section in apt-key(8) for details.
```

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

```
ubuntu@ip-172-31-95-11:~$ sudo apt-get update
sudo apt-get install -y docker-ce
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 http://security.ubuntu.com/ubuntu noble-security InRelease
Hit:5 https://download.docker.com/linux/ubuntu noble InRelease
Reading package lists... Done
W: https://download.docker.com/linux/ubuntu/dists/noble/InRelease: Key is stored in l
, see the DEPRECATION section in apt-key(8) for details.
Reading package lists... Done
```

```
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.
```

```
No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qe
```

3.Start Docker:
sudo mkdir -p /etc/docker
cat <<EOF | sudo tee /etc/docker/daemon.json
{
"exec-opts": ["native.cgroupdriver=systemd"]
}
EOF

```
ubuntu@ip-172-31-95-11:~$ sudo mkdir -p /etc/docker
cat <<EOF | sudo tee /etc/docker/daemon.json
{
  "exec-opts": ["native.cgroupdriver=systemd"]
}
EOF
{
  "exec-opts": ["native.cgroupdriver=systemd"]
}
```

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

```
ubuntu@ip-172-31-95-11:~$ sudo systemctl enable docker
sudo systemctl daemon-reload
sudo systemctl restart 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
```

5: Run the below command to install Kubernets.
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-172-31-95-11:~$ curl -fsSL https://pkgs.k8s.io/core:/stable:/v1.31/deb/Release.key | sudo gpg --dearmor -o /etc/apt/keyring
s/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/ap
t/sources.list.d/kubernetes.list
deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] https://pkgs.k8s.io/core:/stable:/v1.31/deb/ /
```

Install Kubernetes components:

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

```
ubuntu@ip-172-31-95-11:~$ sudo apt-get update
sudo apt-get install -y kubelet kubeadm kubectl
sudo apt-mark hold kubelet kubeadm kubectl
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/isv:/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/isv:/kubernetes:/core:/stable:/v1.31/deb  Packages [4865 B]
Fetched 6051 B in 1s (11.5 kB/s)
```

```
No VM guests are running outdated hypervisor (qemu) binaries on this host.
kubelet set on hold.
kubeadm set on hold.
kubectl set on hold.
```

sudo systemctl enable --now kubelet
sudo apt-get install -y containerd

```
ubuntu@ip-172-31-95-11:~$ sudo systemctl enable --now kubelet
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:
```

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

```
ubuntu@ip-172-31-95-11:~$ sudo mkdir -p /etc/containerd
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
```

```
[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"

[ttrpc]
  address = ""
  gid = 0
  uid = 0
```

sudo systemctl restart containerd

```
ubuntu@ip-172-31-95-11:~$ sudo systemctl restart containerd
sudo systemctl enable containerd
sudo systemctl status containerd
● containerd.service - containerd container runtime
     Loaded: loaded (/usr/lib/systemd/system/containerd.service; enabled; preset: enabled)
     Active: active (running) since Mon 2024-09-23 15:35:29 UTC; 229ms ago
       Docs: https://containerd.io
   Main PID: 4614 (containerd)
      Tasks: 7
     Memory: 13.1M (peak: 14.4M)
        CPU: 64ms
     CGroup: /system.slice/containerd.service
             └─4614 /usr/bin/containerd

Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.093975568Z" level=info msg=serving... address=/run/conta>
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094023950Z" level=info msg=serving... address=/run/conta>
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094053439Z" level=info msg="Start subscribing containerd>
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094080493Z" level=info msg="Start recovering state"
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094120880Z" level=info msg="Start event monitor"
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094128980Z" level=info msg="Start snapshots syncer"
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094137306Z" level=info msg="Start cni network conf synce>
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094142936Z" level=info msg="Start streaming server"
Sep 23 15:35:29 ip-172-31-95-11 containerd[4614]: time="2024-09-23T15:35:29.094178857Z" level=info msg="containerd successfully boot>
Sep 23 15:35:29 ip-172-31-95-11 systemd[1]: Started containerd.service - containerd container runtime.
lines 1-21/21 (END)
```

```
ubuntu@ip-172-31-95-11:~$ 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 libslirp0 pigz slirp4netns
Use 'sudo apt autoremove' to remove them.
The following NEW packages will be 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.
```

6.Initialize kubeadm on Master Node:

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

On the Master node, initialize the Kubernetes cluster using kubeadm. This process sets up the Kubernetes control plane and generates commands for joining worker nodes:
Copy the commands displayed in the output of the initialization process to configure permissions and obtain the join token. This includes a join command link needed for worker nodes to connect to the master.

```
ubuntu@ip-172-31-95-11:~$ sudo kubeadm init --pod-network-cidr=10.244.0.0/16
[init] Using Kubernetes version: v1.31.0
[preflight] Running pre-flight checks
[preflight] Pulling images required for setting up a Kubernetes cluster
[preflight] This might take a minute or two, depending on the speed of your internet connection
[preflight] You can also perform this action beforehand using 'kubeadm config images pull'
W0923 15:48:50.266640    5352 checks.go:846] detected that the sandbox image "registry.k8s.io/pause:3.8" of the container runtime is
inconsistent with that used by kubeadm.It is recommended to use "registry.k8s.io/pause:3.10" as the CRI sandbox image.
[certs] Using certificateDir folder "/etc/kubernetes/pki"
[certs] Generating "ca" certificate and key
```

```
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 172.31.95.11:6443 --token 16q9ib.pv09d9wixd10d50s \
        --discovery-token-ca-cert-hash sha256:7ec275faa3af2297d3e809dea0a29175b2d2af6db63d2673456039bdba306fc6
ubuntu@ip-172-31-95-11:~$
```

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

```
ubuntu@ip-172-31-95-11:~$ mkdir -p $HOME/.kube
sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

```
ubuntu@ip-172-31-95-11:~$ kubectl get nodes
NAME              STATUS     ROLES           AGE     VERSION
ip-172-31-95-11   NotReady   control-plane   2m50s   v1.31.1
```

7.Join Worker Nodes:

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

```
ubuntu@ip-172-31-86-235:~$ sudo kubeadm join 172.31.95.11:6443 --token 16q9ib.pv09d9wixd10d50s \
        --discovery-token-ca-cert-hash sha256:7ec275faa3af2297d3e809dea0a29175b2d2af6db63d2673456039bdba306fc6
[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 501.238074ms
[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-172-31-95-11:~$ kubectl get nodes
NAME               STATUS     ROLES           AGE     VERSION
ip-172-31-86-235   NotReady   <none>          70s     v1.31.1
ip-172-31-91-211   NotReady   <none>          61s     v1.31.1
ip-172-31-95-11    NotReady   control-plane   5m25s   v1.31.1
ubuntu@ip-172-31-95-11:~$ 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
```

```
ubuntu@ip-172-31-95-11:~$ kubectl get nodes -o wide
NAME               STATUS   ROLES           AGE     VERSION   INTERNAL-IP     EXTERNAL-IP   OS-IMAGE           KERNEL-VERSION   CONTA
INER-RUNTIME
ip-172-31-86-235   Ready    <none>          3m44s   v1.31.1   172.31.86.235   <none>        Ubuntu 24.04 LTS   6.8.0-1012-aws   conta
inerd://1.7.12
ip-172-31-91-211   Ready    <none>          3m35s   v1.31.1   172.31.91.211   <none>        Ubuntu 24.04 LTS   6.8.0-1012-aws   conta
inerd://1.7.12
ip-172-31-95-11    Ready    control-plane   7m59s   v1.31.1   172.31.95.11    <none>        Ubuntu 24.04 LTS   6.8.0-1012-aws   conta
inerd://1.7.12
```

```
ubuntu@ip-172-31-95-11:~$ kubectl label node ip-172-31-91-211 kubernetes.io/role=Node1
node/ip-172-31-91-211 labeled
```

```
ubuntu@ip-172-31-95-11:~$ kubectl label node ip-172-31-95-11 kubernetes.io/role=worker
node/ip-172-31-95-11 labeled
```

```
ubuntu@ip-172-31-95-11:~$ kubectl label node ip-172-31-86-235 kubernetes.io/role=Node2
error: 'kubernetes.io/role' already has a value (Node1), and --overwrite is false
```

```
ubuntu@ip-172-31-95-11:~$ kubectl label node ip-172-31-86-235 kubernetes.io/role=Node2 --overwrite
node/ip-172-31-86-235 labeled
```

```
ubuntu@ip-172-31-95-11:~$ kubectl get nodes -o wide
NAME               STATUS   ROLES                  AGE     VERSION   INTERNAL-IP     EXTERNAL-IP   OS-IMAGE           KERNEL-VERSION
  CONTAINER-RUNTIME
ip-172-31-86-235   Ready    Node2                  9m29s   v1.31.1   172.31.86.235   <none>        Ubuntu 24.04 LTS   6.8.0-1012-aws
  containerd://1.7.12
ip-172-31-91-211   Ready    Node1                  9m20s   v1.31.1   172.31.91.211   <none>        Ubuntu 24.04 LTS   6.8.0-1012-aws
  containerd://1.7.12
ip-172-31-95-11    Ready    control-plane,worker   13m     v1.31.1   172.31.95.11    <none>        Ubuntu 24.04 LTS   6.8.0-1012-aws
  containerd://1.7.12
ubuntu@ip-172-31-95-11:~$
```

CONCLUSION :

Docker installation: After installing docker on all instances, sometimes docker services may fail to restart.

Network Configuration Issue: Connectivity issue between master and worker modes might be caused by the firewall blocking that required ports.

CrashLoopBackOff: There are errors indicating that the containers for Kubernetes components are restarting repeatedly but failing to start properly.

.