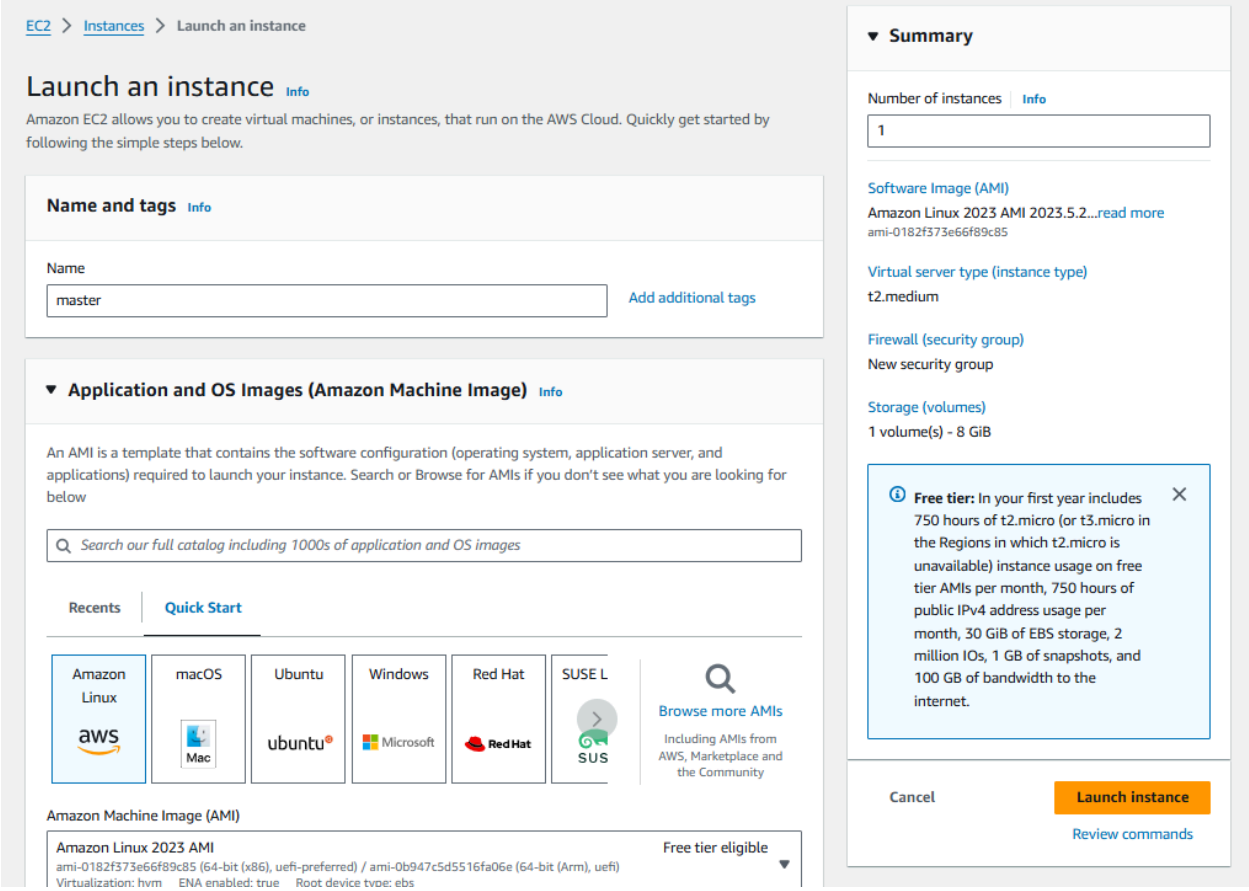
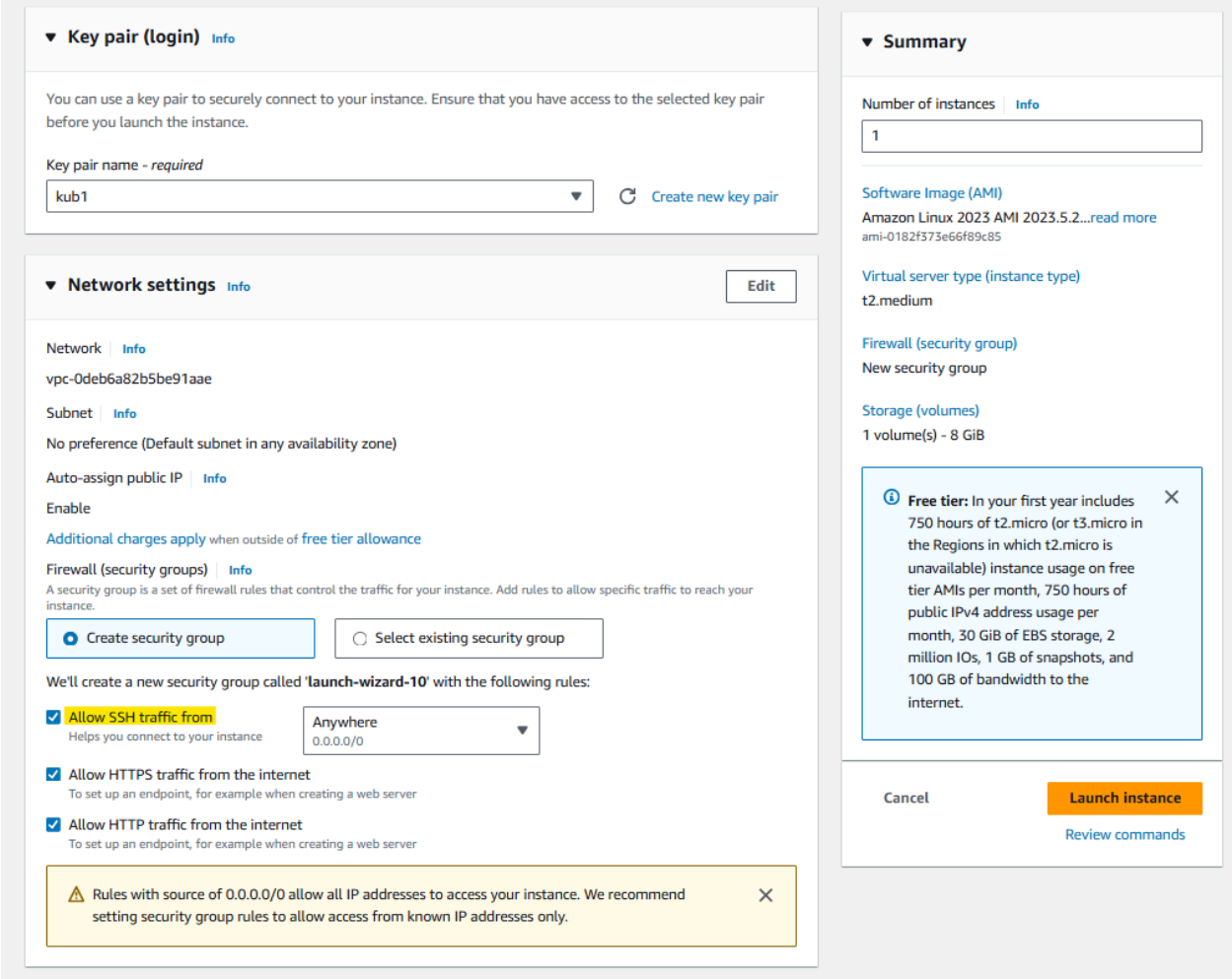
Aim: To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud

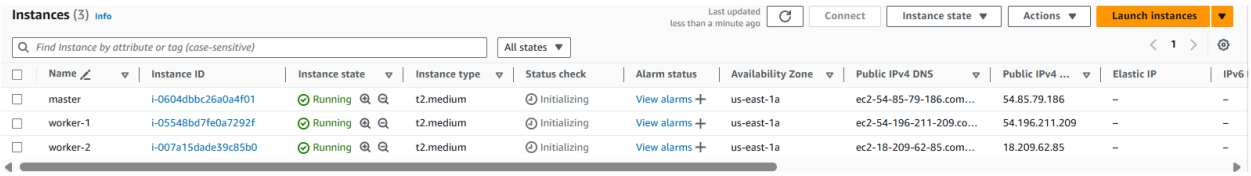
1. Create 3 EC-2 instances with all running on Amazon Linux as OS with inbound SSH allowed and the proper key



To efficient run kubernetes cluster select instance type of at least t2.medium as kubernetes recommends at least 2 vCPU to run smoothly



In this way create 3 instances namely master, worker-1 and worker-2



2. SSH into all 3 machines each in separate terminal
   a. You can do it through the aws console directly

```
C:\Users\Avan>ssh -i "C:\Users\Avan\Downloads\kub1.pem" ec2-user@3.85.237.93
The authenticity of host '3.85.237.93 (3.85.237.93)' can't be established.
ED25519 key fingerprint is SHA256:Nz2iC26abFyhATf/8i4F0IgWmDoxTXBbzY9/NkMwYyM.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '3.85.237.93' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Thu Sep 12 13:11:49 2024 from 18.206.107.29
```

Or

b. Locate your key from the Downloads folder and open it in cmd and paste this command

ssh -i <-your-key->.pem ec2-user<ip-address of instance>

```
C:\Users\Avan\Downloads>ssh -i C:\Users\Avan\Downloads\kub1.pem ec2-user@54.85.79.186
The authenticity of host '54.85.79.186 (54.85.79.186)' can't be established.
ED25519 key fingerprint is SHA256:ffz946cqlxbNvBsPqtNcxLlfXmhW8VJhyLD4n4jStto.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '54.85.79.186' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Sat Sep 14 06:03:27 2024 from 18.206.107.27
[ec2-user@ip-172-31-20-75 ~]$
```

With this you can continue your commands through local terminal

3. From now on, until mentioned, perform these steps on all 3 machines.

Install Docker

sudo yum install docker -y

```
[ec2-user@ip-172-31-31-212 ~]$ sudo yum install docker -y
Last metadata expiration check: 0:33:43 ago on Thu Sep 12 13:11:13 2024.
Dependencies resolved.
================================================================================
 Package                    Architecture          Version
================================================================================
Installing:
 docker                     x86_64                25.0.6-1.amzn2023.0.2
Installing dependencies:
 containerd                 x86_64                1.7.20-1.amzn2023.0.1
 iptables-libs              x86_64                1.8.8-3.amzn2023.0.2
 iptables-nft               x86_64                1.8.8-3.amzn2023.0.2
 libcgroup                  x86_64                3.0-1.amzn2023.0.1
 libnetfilter_conntrack     x86_64                1.0.8-2.amzn2023.0.2
 libnfnetlink               x86_64                1.0.1-19.amzn2023.0.2
 libnftnl                   x86_64                1.2.2-2.amzn2023.0.2
 pigz                       x86_64                2.5-1.amzn2023.0.3
 runc                       x86_64                1.1.13-1.amzn2023.0.1

Transaction Summary
```

Then, configure cgroup in a daemon.json file by using following commands

- cd /etc/docker
- cat <<EOF | sudo tee /etc/docker/daemon.json
  {
  "exec-opts": ["native.cgroupdriver=systemd"],
  "log-driver": "json-file",
  "log-opts": {
  "max-size": "100m"
  },
  "storage-driver": "overlay2"
  }
  EOF

```
[ec2-user@ip-172-31-20-75 ~]$ cd /etc/docker
[ec2-user@ip-172-31-20-75 docker]$ cat <<EOF | sudo tee /etc/docker/daemon.json
{
"exec-opts": ["native.cgroupdriver=systemd"],
"log-driver": "json-file",
"log-opts": {
"max-size": "100m"
},
"storage-driver": "overlay2"
}
EOF
{
"exec-opts": ["native.cgroupdriver=systemd"],
"log-driver": "json-file",
"log-opts": {
"max-size": "100m"
},
"storage-driver": "overlay2"
}
[ec2-user@ip-172-31-20-75 docker]$ ls
daemon.json  kubectl
```

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

```
[ec2-user@ip-172-31-31-212 docker]$ sudo systemctl enable docker
Created symlink /etc/systemd/system/multi-user.target.wants/docker.service → /usr/lib/systemd/system/docker.service.
[ec2-user@ip-172-31-31-212 docker]$ sudo systemctl daemon-reload
[ec2-user@ip-172-31-31-212 docker]$ sudo systemctl restart docker
[ec2-user@ip-172-31-31-212 docker]$ docker -v
Docker version 25.0.5, build 5dc9bcc
[ec2-user@ip-172-31-31-212 docker]$
```

4. **Install Kubernetes on all 3 machines**

   SELinux needs to be disabled before configuring kubelet

- sudo setenforce 0
- sudo sed -i 's/^SELINUX=enforcing$/SELINUX=permissive/' /etc/selinux/config

```
[ec2-user@ip-172-31-26-2 docker]$ sudo setenforce 0
[ec2-user@ip-172-31-26-2 docker]$ sudo sed -i 's/^SELINUX=enforcing$/SELINUX=permissive/' /etc/selinux/config
[ec2-user@ip-172-31-26-2 docker]$
```

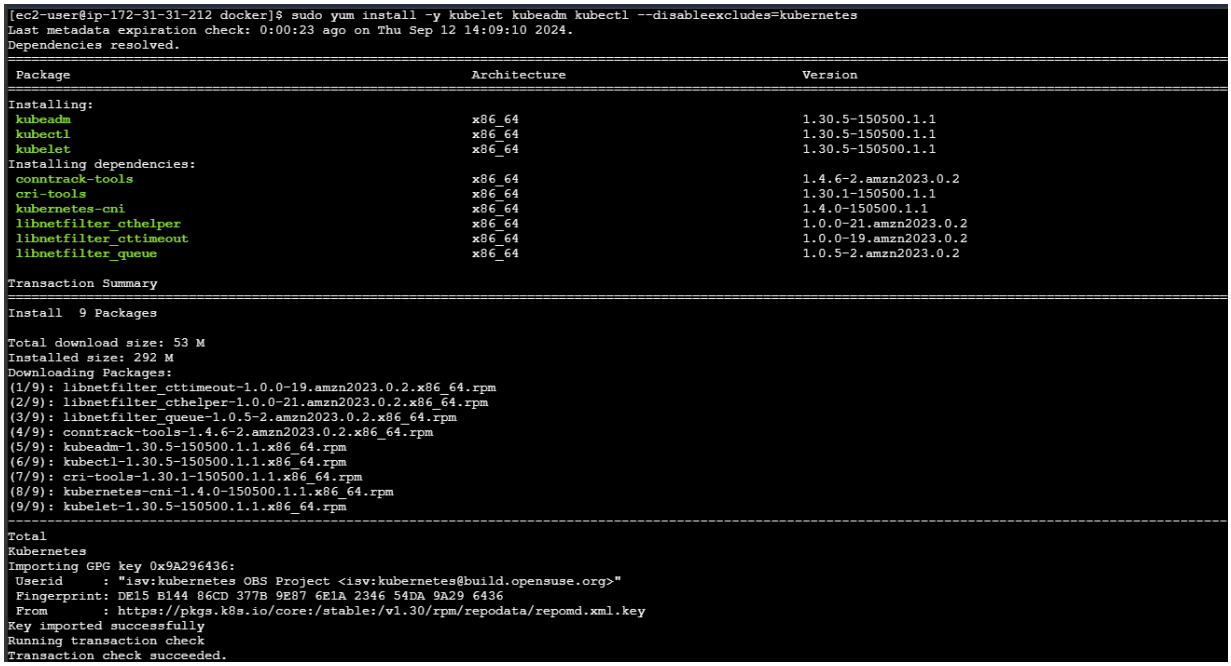
Add kubernetes repository (paste in terminal)

```
cat <<EOF | sudo tee /etc/yum.repos.d/kubernetes.repo
[kubernetes]
name=Kubernetes
baseurl=https://pkgs.k8s.io/core:/stable:/v1.30/rpm/
enabled=1
gpgcheck=1
gpgkey=https://pkgs.k8s.io/core:/stable:/v1.30/rpm/repodata/repomd.xml.key
exclude=kubelet kubeadm kubectl cri-tools kubernetes-cni
EOF
```

Type following commands to install set of kubernetes packages:

- sudo yum update

- sudo yum install -y kubelet kubeadm kubectl --disableexcludes=kubernetes



```
[ec2-user@ip-172-31-31-212 docker]$ sudo yum install -y kubelet kubeadm kubectl --disableexcludes=kubernetes
Last metadata expiration check: 0:00:23 ago on Thu Sep 12 14:09:10 2024.
Dependencies resolved.
================================================================================
 Package                 Architecture            Version
================================================================================
Installing:
 kubeadm                 x86_64                  1.30.5-150500.1.1
 kubectl                 x86_64                  1.30.5-150500.1.1
 kubelet                 x86_64                  1.30.5-150500.1.1
Installing dependencies:
 conntrack-tools         x86_64                  1.4.6-2.amzn2023.0.2
 cri-tools               x86_64                  1.30.1-150500.1.1
 kubernetes-cni          x86_64                  1.4.0-150500.1.1
 libnetfilter_cthelper   x86_64                  1.0.0-21.amzn2023.0.2
 libnetfilter_cttimeout  x86_64                  1.0.0-19.amzn2023.0.2
 libnetfilter_queue      x86_64                  1.0.5-2.amzn2023.0.2

Transaction Summary
================================================================================
Install  9 Packages

Total download size: 53 M
Installed size: 292 M
Downloading Packages:
(1/9): libnetfilter_cttimeout-1.0.0-19.amzn2023.0.2.x86_64.rpm
(2/9): libnetfilter_cthelper-1.0.0-21.amzn2023.0.2.x86_64.rpm
(3/9): libnetfilter_queue-1.0.5-2.amzn2023.0.2.x86_64.rpm
(4/9): conntrack-tools-1.4.6-2.amzn2023.0.2.x86_64.rpm
(5/9): kubeadm-1.30.5-150500.1.1.x86_64.rpm
(6/9): kubectl-1.30.5-150500.1.1.x86_64.rpm
(7/9): cri-tools-1.30.1-150500.1.1.x86_64.rpm
(8/9): kubernetes-cni-1.4.0-150500.1.1.x86_64.rpm
(9/9): kubelet-1.30.5-150500.1.1.x86_64.rpm
--------------------------------------------------------------------------------
Total
Kubernetes
Importing GPG key 0x9A296436:
 Userid     : "isv:kubernetes OBS Project <isv:kubernetes@build.opensuse.org>"
 Fingerprint: DE15 B144 86CD 377B 9E87 6E1A 2346 54DA 9A29 6436
 From       : https://pkgs.k8s.io/core:/stable:/v1.30/rpm/repodata/repomd.xml.key
Key imported successfully
Running transaction check
Transaction check succeeded.
```

After installing Kubernetes, we need to configure internet options to allow bridging.

- sudo swapoff -a
- echo "net.bridge.bridge-nf-call-iptables=1" | sudo tee -a /etc/sysctl.conf
- sudo sysctl -p

5. **Perform this ONLY on the Master machine**

   Initialize kubernetes by typing below command

   - sudo kubeadm init --pod-network-cidr=10.244.0.0/16 --ignore-preflight-errors=all

```
[addons] Applied essential addon: CoreDNS
[addons] Applied essential addon: kube-proxy

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 172.31.26.2:6443 --token 6cjsz0.8ei243v0zn9k7erg \
        --discovery-token-ca-cert-hash sha256:abd917ec30e12c5616bf647a3d174bef3d271e92c30b8f2f7768cfb3181341d4
[ec2-user@ip-172-31-26-2 docker]$
```

Copy the mkdir and chown commands from the top and execute them

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

Copy this join link and save it in clipboard (copy from your output as it different for each master instance)
Example :

```
kubeadm join 172.31.20.75:6443 --token 66kg9u.2bc0kze31hrwbzvr \
        --discovery-token-ca-cert-hash
sha256:5e478da328b199e17d9b5da68e78bc9a6daab2043b05860552f4c184a7b3cb66
```

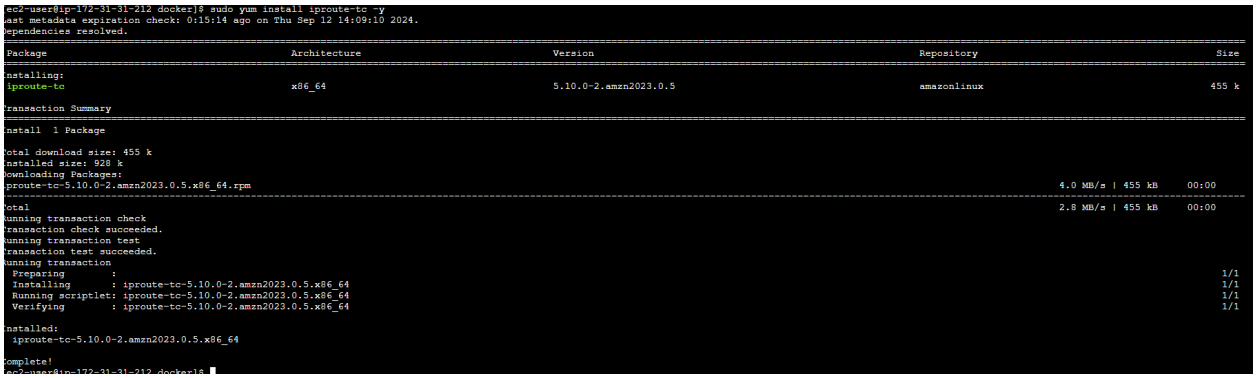
Then, add a common networking plugin called flamel file as mentioned in the code.
Command:

```
kubectl apply -f
https://raw.githubusercontent.com/coreos/flannel/master/Documentation/kube-flannel.yml
```

```
[ec2-user@ip-172-31-26-2 docker]$ kubectl apply -f https://raw.githubusercontent.com/coreos/flannel/master/Documentation/kube-flannel.yml
namespace/kube-flannel created
clusterrole.rbac.authorization.k8s.io/flannel created
clusterrolebinding.rbac.authorization.k8s.io/flannel created
serviceaccount/flannel created
configmap/kube-flannel-cfg created
daemonset.apps/kube-flannel-ds created
```

6. **Perform this ONLY on the worker machines**

   Paste the below command on all 2 worker machines
   - sudo yum install iproute-tc -y
   - sudo systemctl enable kubelet
   - sudo systemctl restart kubelet



Now paste the hash that yo copied in these worker note to connect to master cluster

- kubeadm join 172.31.20.75:6443 --token 66kg9u.2bc0kze31hrwbzvr \
  --discovery-token-ca-cert-hash sha256:5e478da328b199e17d9b5da68e78bc9a6daab2043b05860552f4c184a7b3cb66

Now we can see in the master/control node of kubernetes that worker nodes are connected by this command

- **watch kubectl get nodes**

(in the master node instance)

<u>Errors faced during the execution</u> :

1. In the end kubelet might not respond or the connectivity of nodes to master might not happen
2. You can see this error

3. Try to restart the kubelet from worker instance and try the commands again

Conclusion :

In this experiment, we aimed to deploy Kubernetes in Docker, connecting a master node with two worker nodes. We encountered several challenges, starting with SSH inbound rule misconfigurations, which were resolved by enabling the correct rules for secure access. It became clear that using **t2.medium** or **t3** instances was essential for sufficient resources to run Kubernetes smoothly. Despite these adjustments, the worker nodes failed to join the cluster. Although the master node was ready, the issue seemed to stem from improper configuration of the worker nodes' kubelet or a networking problem, such as the worker nodes being unable to reach the master node's API server. This could be due to incorrect firewall settings, missing API server certificates, or failure in configuring the kubeadm join process on the worker nodes.