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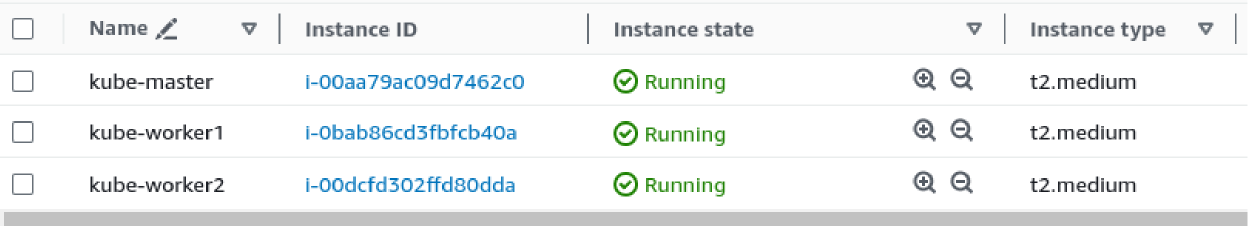
EXPERIMENT NO. 3

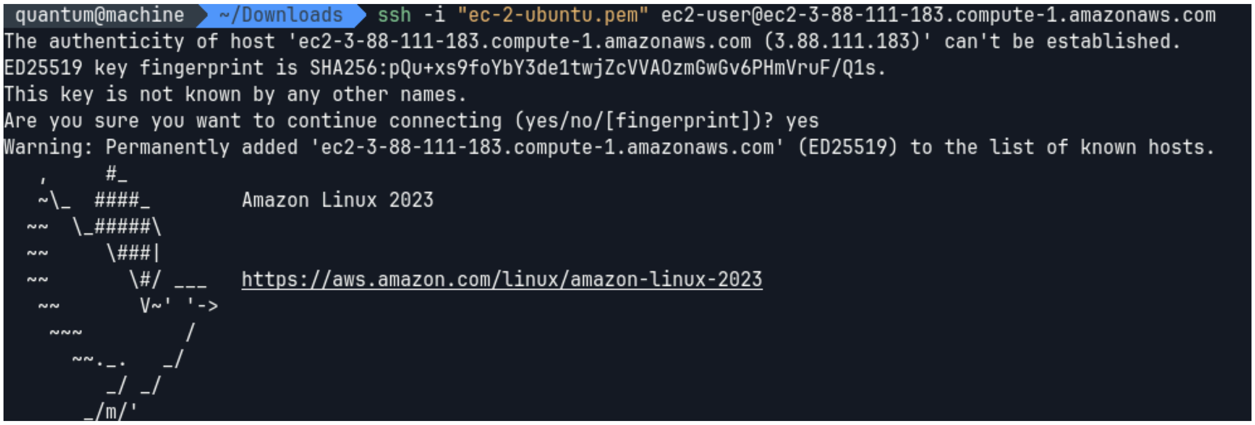
Aim: To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud

1. Create 3 EC-2 instances with all running on Amazon Linux as OS with inbound SSH allowed
   To efficient run kubernetes cluster select instance type of at least t2.medium as kubernetes recommends at least 2 vCPU to run smoothly



□	Name	Instance ID	Instance state	Instance type
□	kube-master	i-00aa79ac09d7462c0	✓ Running	t2.medium
□	kube-worker1	i-0bab86cd3fbfcb40a	✓ Running	t2.medium
□	kube-worker2	i-00dcfd302ffd80dda	✓ Running	t2.medium

2. SSH into all 3 machines each in separate terminal

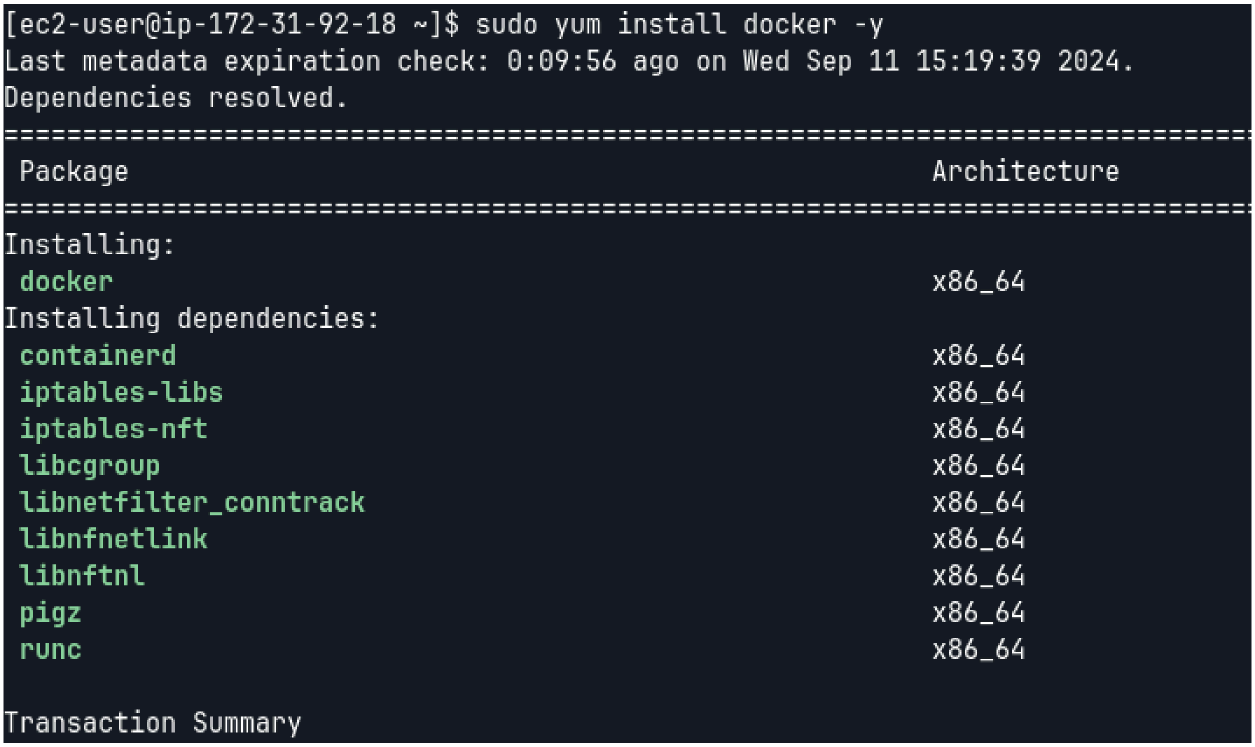


```
quantum@machine  ~/Downloads  ssh -i "ec-2-ubuntu.pem" ec2-user@ec2-3-88-111-183.compute-1.amazonaws.com
The authenticity of host 'ec2-3-88-111-183.compute-1.amazonaws.com (3.88.111.183)' can't be established.
ED25519 key fingerprint is SHA256:pQu+xs9foYbY3de1twjZcVVAOzmGwGv6PHmVruF/Q1s.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-3-88-111-183.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
```

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

Install Docker

sudo yum install docker -y



```
[ec2-user@ip-172-31-92-18 ~]$ sudo yum install docker -y
Last metadata expiration check: 0:09:56 ago on Wed Sep 11 15:19:39 2024.
Dependencies resolved.
================================================================================
 Package                                                   Architecture
================================================================================
Installing:
 docker                                                    x86_64
Installing dependencies:
 containerd                                                x86_64
 iptables-libs                                             x86_64
 iptables-nft                                              x86_64
 libcgroup                                                 x86_64
 libnetfilter_conntrack                                    x86_64
 libnfnetlink                                              x86_64
 libnftnl                                                  x86_64
 pigz                                                      x86_64
 runc                                                      x86_64

Transaction Summary
```

Then, configure cgroup in a daemon.json file by using following commands. This allows kubernetes to manage host more efficiently

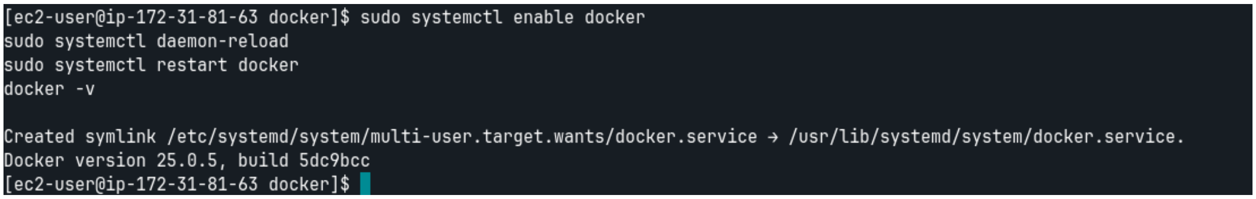
- cd /etc/docker

- 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
```

After configuring restart docker service service :

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



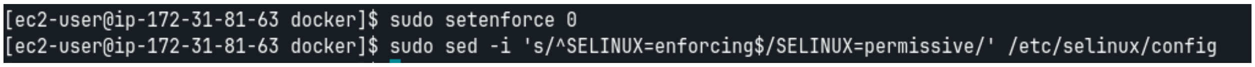
```
[ec2-user@ip-172-31-81-63 docker]$ sudo systemctl enable docker
sudo systemctl daemon-reload
sudo systemctl restart docker
docker -v

Created symlink /etc/systemd/system/multi-user.target.wants/docker.service → /usr/lib/systemd/system/docker.service.
Docker version 25.0.5, build 5dc9bcc
[ec2-user@ip-172-31-81-63 docker]$
```

4. Install Kubernetes on all 3 machines

SELinux needs to be disabled before configuring kubelet to avoid interference with kubernetes api server

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



```
[ec2-user@ip-172-31-81-63 docker]$ sudo setenforce 0
[ec2-user@ip-172-31-81-63 docker]$ sudo sed -i 's/^SELINUX=enforcing$/SELINUX=permissive/' /etc/selinux/config
```

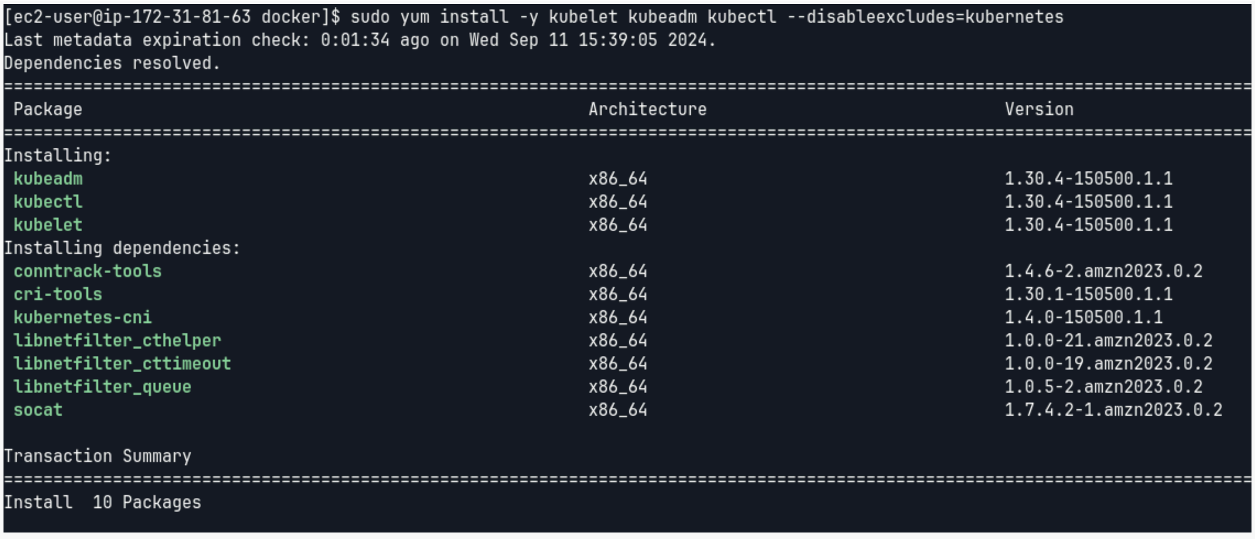
Add kubernetes repository (paste in terminal)

```
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-172-31-81-63 docker]$ sudo yum install -y kubelet kubeadm kubectl --disableexcludes=kubernetes
Last metadata expiration check: 0:01:34 ago on Wed Sep 11 15:39:05 2024.
Dependencies resolved.
==============================================================================================================================
 Package                                                      Architecture                           Version
==============================================================================================================================
Installing:
 kubeadm                                                      x86_64                                 1.30.4-150500.1.1
 kubectl                                                      x86_64                                 1.30.4-150500.1.1
 kubelet                                                      x86_64                                 1.30.4-150500.1.1
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
 socat                                                        x86_64                                 1.7.4.2-1.amzn2023.0.2

Transaction Summary
==============================================================================================================================
Install  10 Packages
```

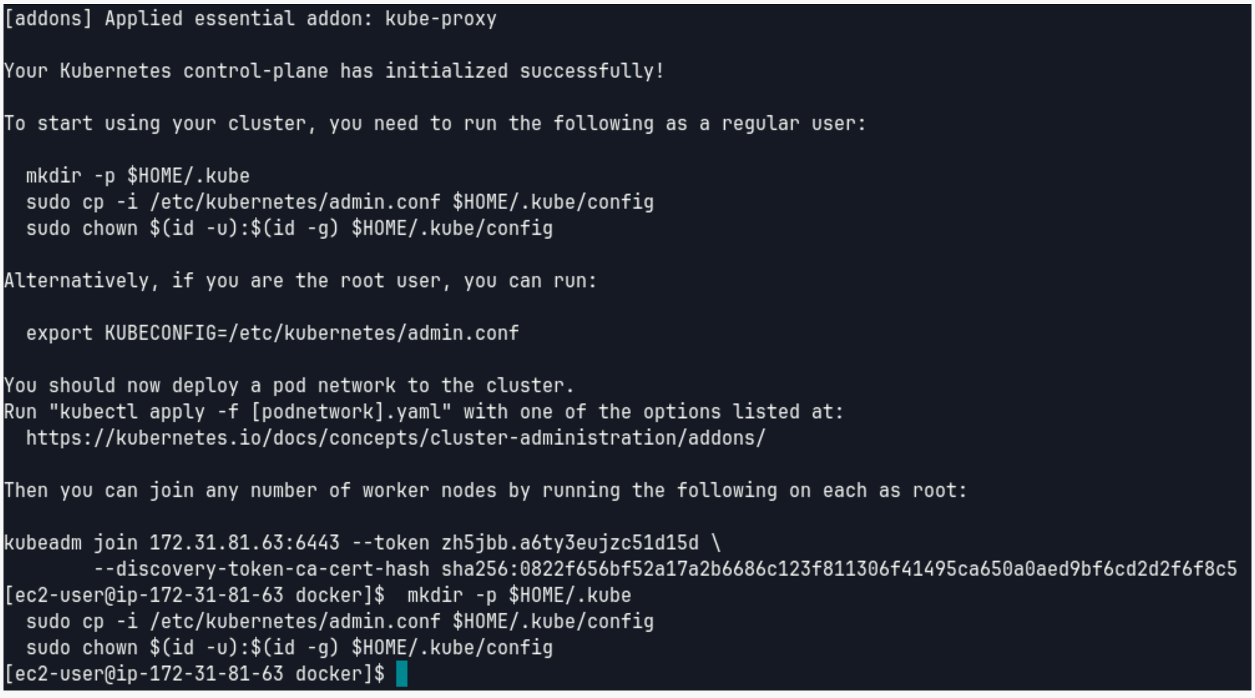
After installing Kubernetes, we need to configure internet options to allow bridging.

- `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: 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 172.31.81.63:6443 --token zh5jbb.a6ty3eujzc51d15d \
        --discovery-token-ca-cert-hash sha256:0822f656bf52a17a2b6686c123f811306f41495ca650a0aed9bf6cd2d2f6f8c5
[ec2-user@ip-172-31-81-63 docker]$  mkdir -p $HOME/.kube
  sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
  sudo chown $(id -u):$(id -g) $HOME/.kube/config
[ec2-user@ip-172-31-81-63 docker]$ 
```

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

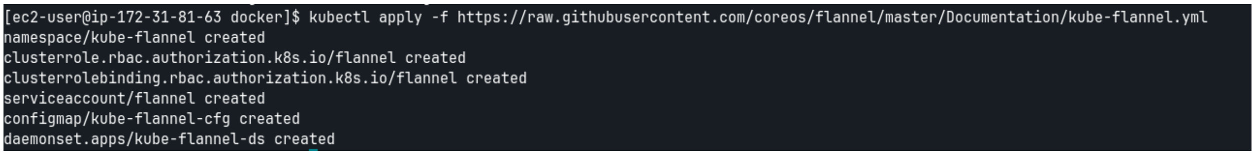
```
  mkdir -p $HOME/.kube
  sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
  sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

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

```
kubeadm join 172.31.81.63:6443 --token
zh5jbb.a6ty3eujzc51d15d \
        --discovery-token-ca-cert-hash
sha256:0822f656bf52a17a2b6686c123f811306f41495ca650a0aed9bf6c
d2d2f6f8c5
```

Then, add a common networking plugin called flammel file as mentioned in the code.

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



```
[ec2-user@ip-172-31-81-63 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
```

Check the created pod using this command

- kubectl get pods

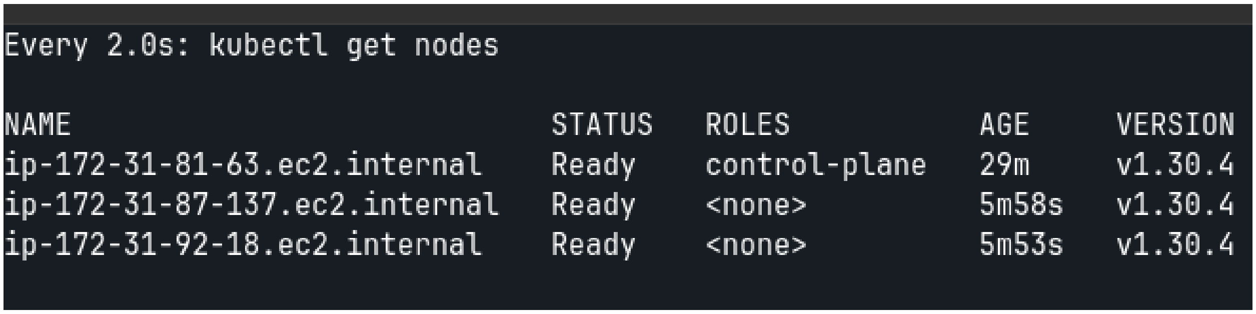
6. **Perform this ONLY on the worker machines**

   Paste the below command on all 2 worker machines
   - sudo yum install iproute-tc socat -y (necessary packages required by kubernetes)
   - sudo systemctl enable kubelet
   - sudo systemctl restart kubelet

- kubeadm join 172.31.81.63:6443 --token zh5jbb.a6ty3eujzc51d15d \
  --discovery-token-ca-cert-hash
sha256:0822f656bf52a17a2b6686c123f811306f41495ca650a0aed9bf6cd2d2f6f8c5

With the help of command the worker nodes are connected master node and is ready to do task assigned by master node

Now we can see in the master/control node of kubernetes that worker nodes are connected by typing **watch kubectl get nodes** in the **master node instance**



```
Every 2.0s: kubectl get nodes

NAME                            STATUS   ROLES           AGE     VERSION
ip-172-31-81-63.ec2.internal    Ready    control-plane   29m     v1.30.4
ip-172-31-87-137.ec2.internal   Ready    <none>          5m58s   v1.30.4
ip-172-31-92-18.ec2.internal    Ready    <none>          5m53s   v1.30.4
```

Conclusion: We began with installation and configuration of necessary packages required by kubernetes. Some of them were available in the repository of the distribution of linux but some of them were not available so had to add their repository for installation. Even after setting up, the nodes were tainted which was the reason kubernetes api server was crashing, we then fixed it by making them untainted.We even disabled SELINUX to prevent any interference. In this experiment we successfully connected worker nodes with master nodes of kubernetes.