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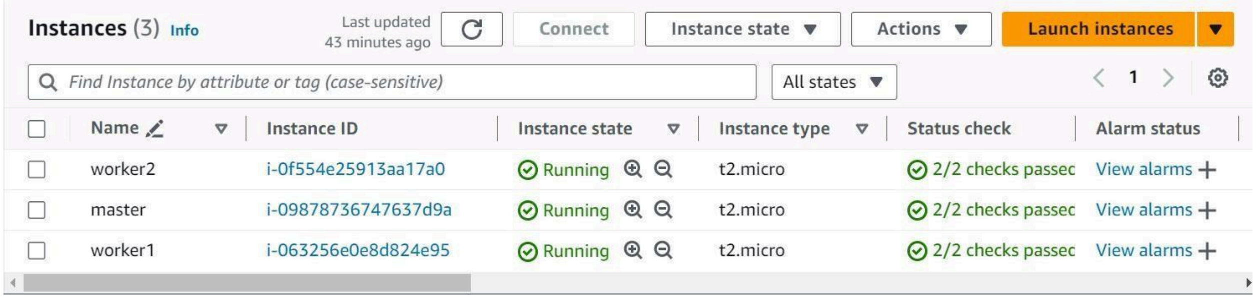
Aim: To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud Platforms.

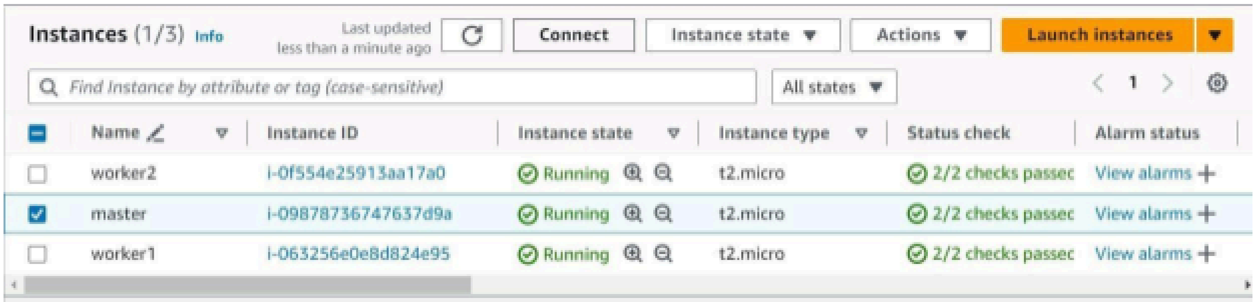
Steps:

1. We will create 3 EC2 instances. One will be the master node and the other 2 will be slave/worker nodes.



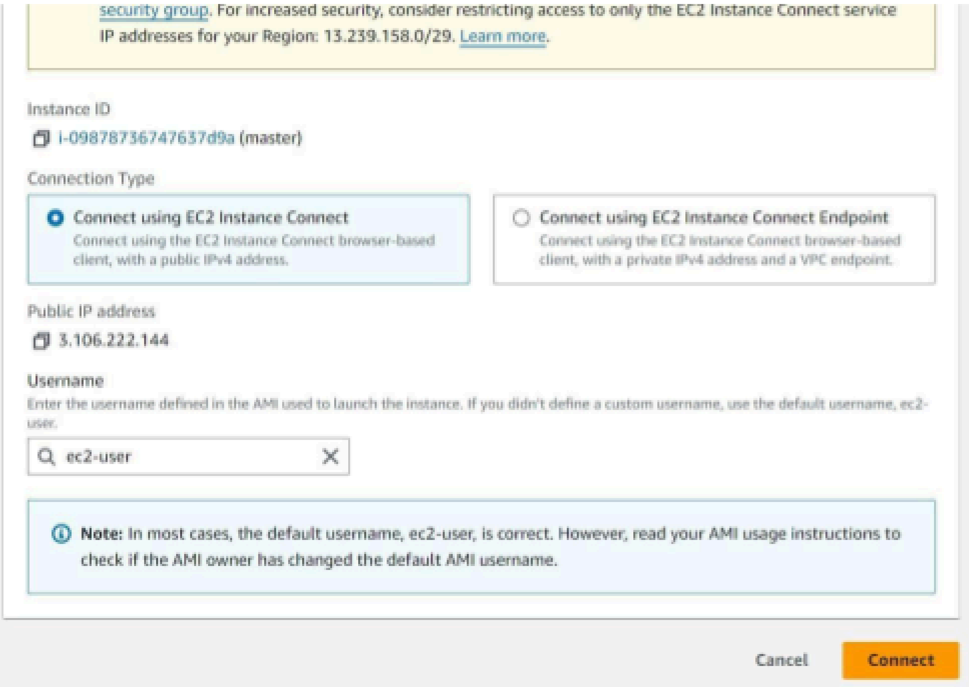
□	Name	Instance ID	Instance state	Instance type	Status check	Alarm status
□	worker2	i-0f554e25913aa17a0	✓ Running	t2.micro	✓ 2/2 checks passec	View alarms +
□	master	i-09878736747637d9a	✓ Running	t2.micro	✓ 2/2 checks passec	View alarms +
□	worker1	i-063256e0e8d824e95	✓ Running	t2.micro	✓ 2/2 checks passec	View alarms +

2. After the instances have been created, we will connect them one by one.



Instances (1/3) Info
Last updated less than a minute ago
Connect
Instance state ▼
Actions ▼
Launch instances
Find Instance by attribute or tag (case-sensitive)
All states ▼
1

	Name	Instance ID	Instance state	Instance type	Status check	Alarm status
□	worker2	i-0f554e25913aa17a0	Running	t2.micro	2/2 checks passec	View alarms +
☑	master	i-09878736747637d9a	Running	t2.micro	2/2 checks passec	View alarms +
□	worker1	i-063256e0e8d824e95	Running	t2.micro	2/2 checks passec	View alarms +



security group. For increased security, consider restricting access to only the EC2 Instance Connect service IP addresses for your Region: 13.239.158.0/29. Learn more.

Instance ID
i-09878736747637d9a (master)

Connection Type

● Connect using EC2 Instance Connect
Connect using the EC2 Instance Connect browser-based client, with a public IPv4 address.

○ Connect using EC2 Instance Connect Endpoint
Connect using the EC2 Instance Connect browser-based client, with a private IPv4 address and a VPC endpoint.

Public IP address
3.106.222.144

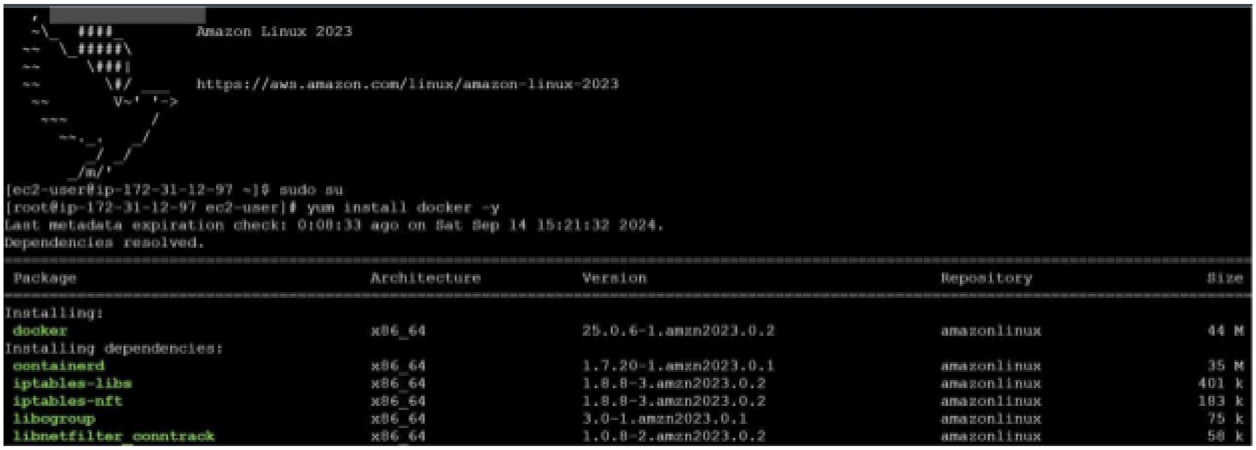
Username
Enter the username defined in the AMI used to launch the instance. If you didn't define a custom username, use the default username, ec2-user.

ec2-user

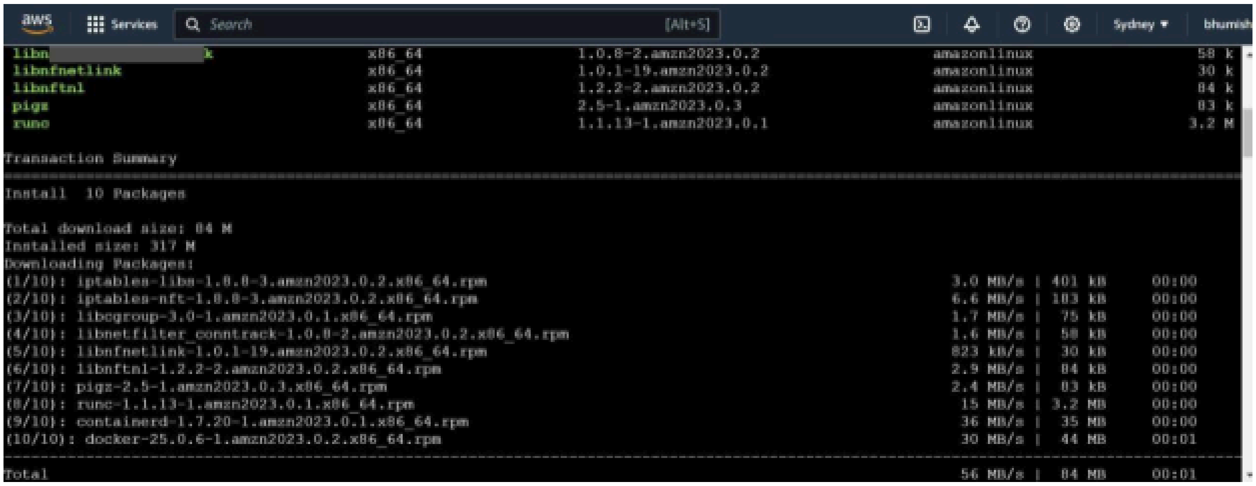
Note: In most cases, the default username, ec2-user, is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI username.

3. Docker installation:

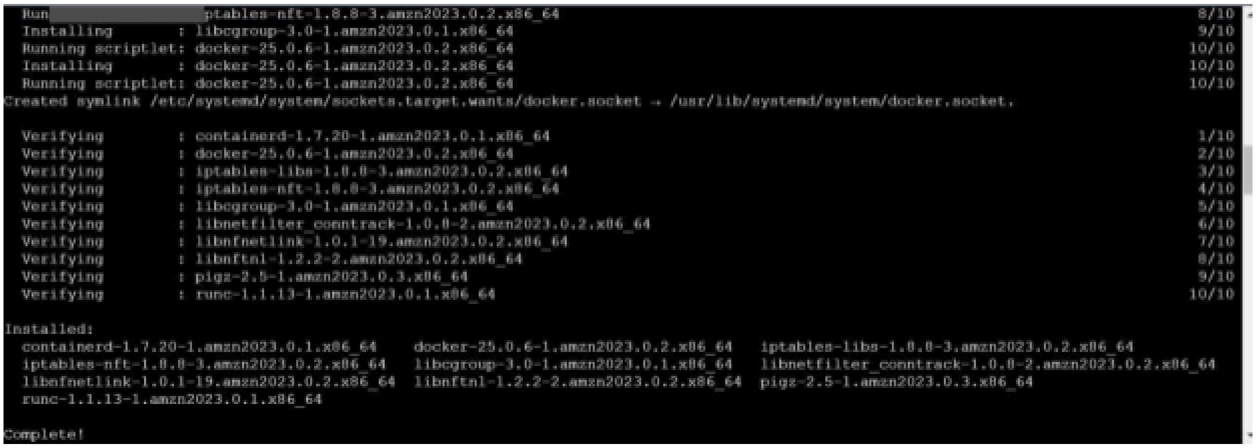
   This step has to be performed on all the 3 instances. The following command has to be run: yum install docker -y



```
   ,     [redacted]
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
[ec2-user@ip-172-31-12-97 ~]$ sudo su
[root@ip-172-31-12-97 ec2-user]# yum install docker -y
Last metadata expiration check: 0:08:33 ago on Sat Sep 14 15:21:32 2024.
Dependencies resolved.
==============================================================================================================
 Package                        Architecture       Version                            Repository          Size
==============================================================================================================
Installing:
 docker                         x86_64             25.0.6-1.amzn2023.0.2              amazonlinux         44 M
Installing dependencies:
 containerd                     x86_64             1.7.20-1.amzn2023.0.1              amazonlinux         35 M
 iptables-libs                  x86_64             1.8.8-3.amzn2023.0.2               amazonlinux        401 k
 iptables-nft                   x86_64             1.8.8-3.amzn2023.0.2               amazonlinux        183 k
 libcgroup                      x86_64             3.0-1.amzn2023.0.1                 amazonlinux         75 k
 libnetfilter_conntrack         x86_64             1.0.8-2.amzn2023.0.2               amazonlinux         58 k
```

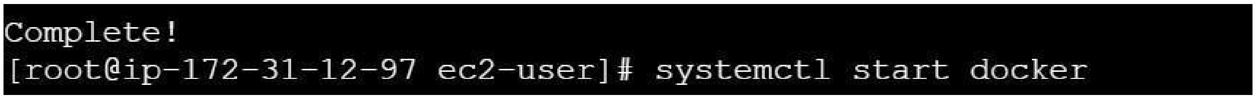


```
 libn[redacted]k                x86_64             1.0.8-2.amzn2023.0.2               amazonlinux         58 k
 libnfnetlink                   x86_64             1.0.1-19.amzn2023.0.2              amazonlinux         30 k
 libnftnl                       x86_64             1.2.2-2.amzn2023.0.2               amazonlinux         84 k
 pigz                           x86_64             2.5-1.amzn2023.0.3                 amazonlinux         83 k
 runc                           x86_64             1.1.13-1.amzn2023.0.1              amazonlinux        3.2 M

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

Total download size: 84 M
Installed size: 317 M
Downloading Packages:
(1/10): iptables-libs-1.8.8-3.amzn2023.0.2.x86_64.rpm                         3.0 MB/s | 401 kB     00:00
(2/10): iptables-nft-1.8.8-3.amzn2023.0.2.x86_64.rpm                          6.6 MB/s | 183 kB     00:00
(3/10): libcgroup-3.0-1.amzn2023.0.1.x86_64.rpm                               1.7 MB/s |  75 kB     00:00
(4/10): libnetfilter_conntrack-1.0.8-2.amzn2023.0.2.x86_64.rpm                1.6 MB/s |  58 kB     00:00
(5/10): libnfnetlink-1.0.1-19.amzn2023.0.2.x86_64.rpm                         823 kB/s |  30 kB     00:00
(6/10): libnftnl-1.2.2-2.amzn2023.0.2.x86_64.rpm                              2.9 MB/s |  84 kB     00:00
(7/10): pigz-2.5-1.amzn2023.0.3.x86_64.rpm                                    2.4 MB/s |  83 kB     00:00
(8/10): runc-1.1.13-1.amzn2023.0.1.x86_64.rpm                                  15 MB/s | 3.2 MB     00:00
(9/10): containerd-1.7.20-1.amzn2023.0.1.x86_64.rpm                            36 MB/s |  35 MB     00:00
(10/10): docker-25.0.6-1.amzn2023.0.2.x86_64.rpm                               30 MB/s |  44 MB     00:01
--------------------------------------------------------------------------------------------------------------
Total                                                                          56 MB/s |  84 MB     00:01
```



```
  Run[redacted]ptables-nft-1.8.8-3.amzn2023.0.2.x86_64                                                  8/10
  Installing        : libcgroup-3.0-1.amzn2023.0.1.x86_64                                                 9/10
  Running scriptlet: docker-25.0.6-1.amzn2023.0.2.x86_64                                                 10/10
  Installing        : docker-25.0.6-1.amzn2023.0.2.x86_64                                                 10/10
  Running scriptlet: docker-25.0.6-1.amzn2023.0.2.x86_64                                                 10/10
Created symlink /etc/systemd/system/sockets.target.wants/docker.socket → /usr/lib/systemd/system/docker.socket.

  Verifying         : containerd-1.7.20-1.amzn2023.0.1.x86_64                                              1/10
  Verifying         : docker-25.0.6-1.amzn2023.0.2.x86_64                                                  2/10
  Verifying         : iptables-libs-1.8.8-3.amzn2023.0.2.x86_64                                            3/10
  Verifying         : iptables-nft-1.8.8-3.amzn2023.0.2.x86_64                                             4/10
  Verifying         : libcgroup-3.0-1.amzn2023.0.1.x86_64                                                  5/10
  Verifying         : libnetfilter_conntrack-1.0.8-2.amzn2023.0.2.x86_64                                   6/10
  Verifying         : libnfnetlink-1.0.1-19.amzn2023.0.2.x86_64                                            7/10
  Verifying         : libnftnl-1.2.2-2.amzn2023.0.2.x86_64                                                 8/10
  Verifying         : pigz-2.5-1.amzn2023.0.3.x86_64                                                       9/10
  Verifying         : runc-1.1.13-1.amzn2023.0.1.x86_64                                                   10/10

Installed:
  containerd-1.7.20-1.amzn2023.0.1.x86_64    docker-25.0.6-1.amzn2023.0.2.x86_64    iptables-libs-1.8.8-3.amzn2023.0.2.x86_64
  iptables-nft-1.8.8-3.amzn2023.0.2.x86_64   libcgroup-3.0-1.amzn2023.0.1.x86_64    libnetfilter_conntrack-1.0.8-2.amzn2023.0.2.x86_64
  libnfnetlink-1.0.1-19.amzn2023.0.2.x86_64  libnftnl-1.2.2-2.amzn2023.0.2.x86_64   pigz-2.5-1.amzn2023.0.3.x86_64
  runc-1.1.13-1.amzn2023.0.1.x86_64

Complete!
```

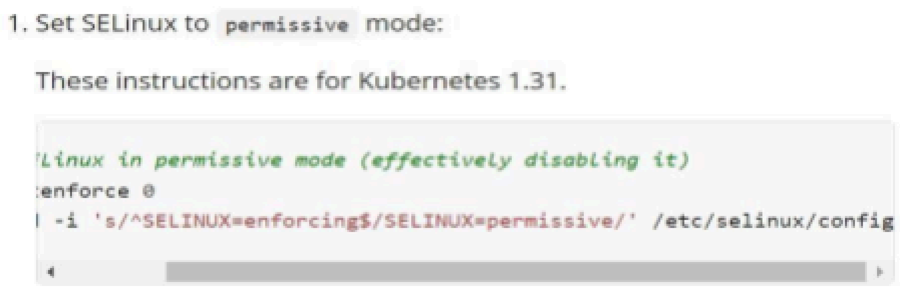
4. After successfully docker has been installed it has to be started on all machines by using the command “systemctl start docker”



```
Complete!
[root@ip-172-31-12-97 ec2-user]# systemctl start docker
```

5. Kubernetes installation:

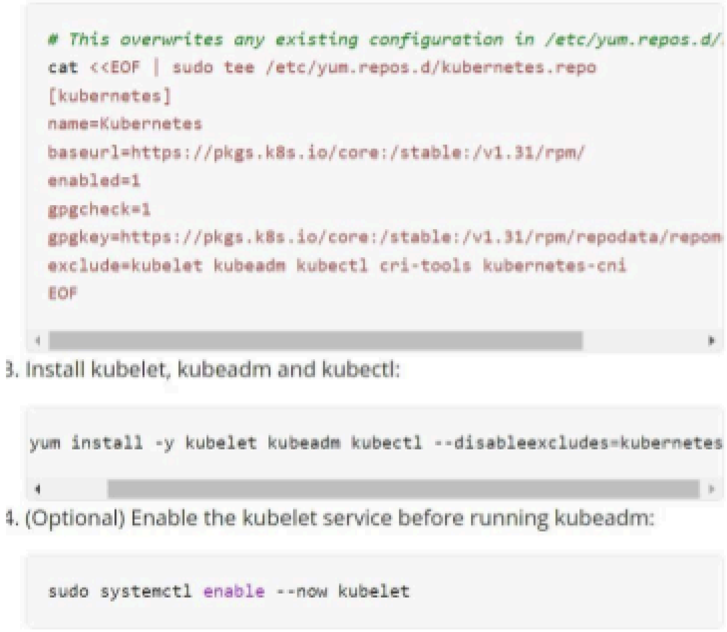
   Search kubeadm installation on your browser and scroll down and select red hatbased distributions.



1. Set SELinux to `permissive` mode:

These instructions are for Kubernetes 1.31.

```
'Linux in permissive mode (effectively disabling it)
:enforce 0
| -i 's/^SELINUX=enforcing$/SELINUX=permissive/' /etc/selinux/config
```



```
# This overwrites any existing configuration in /etc/yum.repos.d/
cat <<EOF | sudo tee /etc/yum.repos.d/kubernetes.repo
[kubernetes]
name=Kubernetes
baseurl=https://pkgs.k8s.io/core:/stable:/v1.31/rpm/
enabled=1
gpgcheck=1
gpgkey=https://pkgs.k8s.io/core:/stable:/v1.31/rpm/repodata/repom
exclude=kubelet kubeadm kubectl cri-tools kubernetes-cni
EOF
```

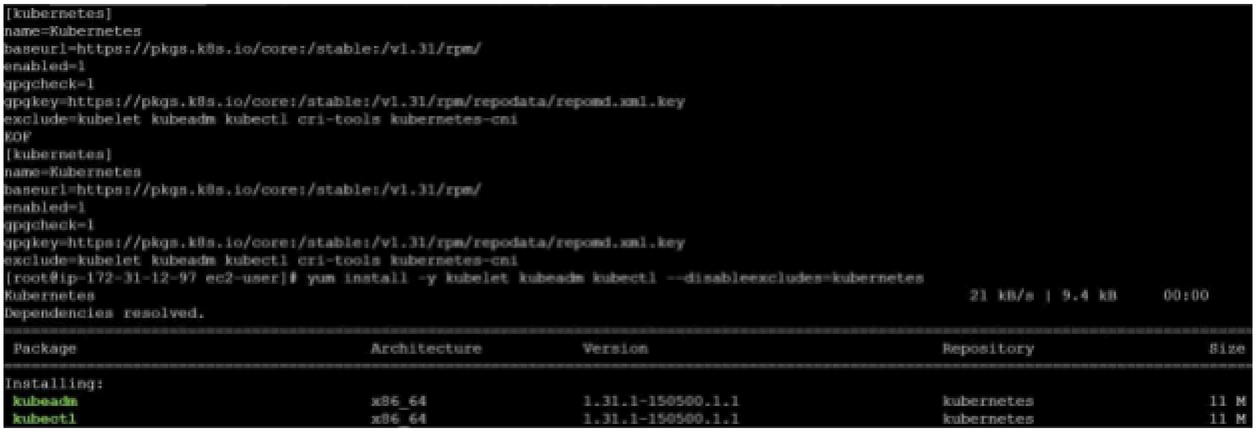
3. Install kubelet, kubeadm and kubectl:

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

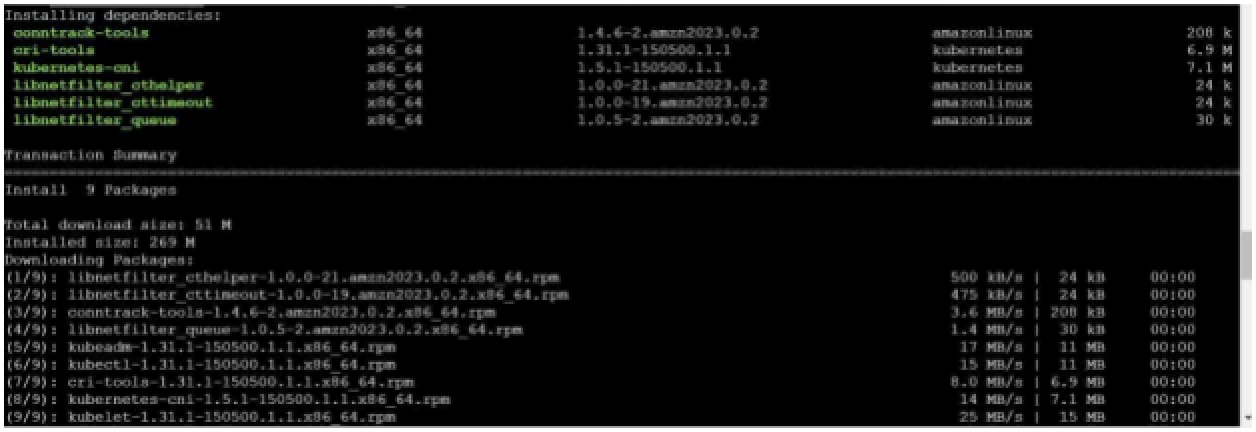
4. (Optional) Enable the kubelet service before running kubeadm:

```
sudo systemctl enable --now kubelet
```

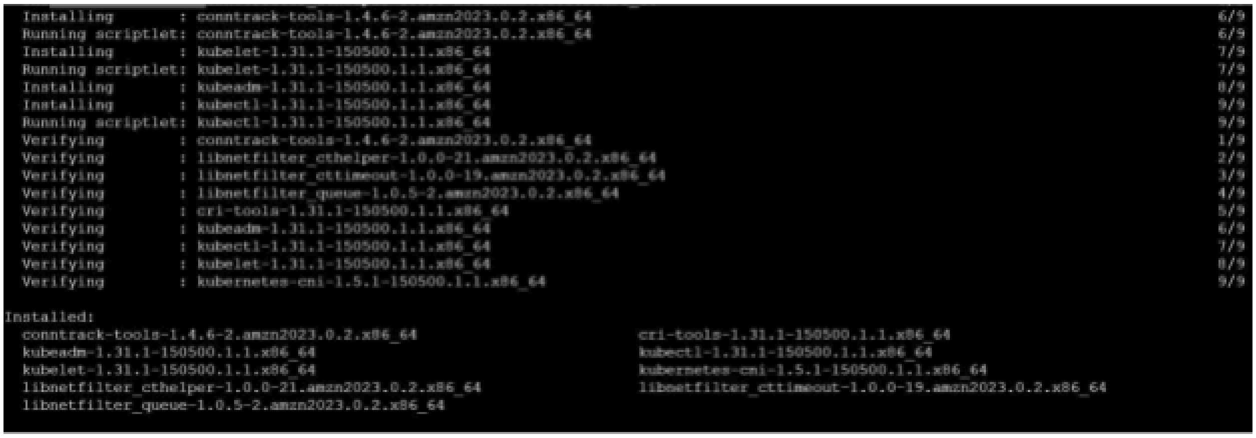
Copy the above given steps and paste in the terminal. This will create a Kubernetes repository, install kubelet, kubeadm and kubectl and also enable the services.



```
[kubernetes]
name=Kubernetes
baseurl=https://pkgs.k8s.io/core:/stable:/v1.31/rpm/
enabled=1
gpgcheck=1
gpgkey=https://pkgs.k8s.io/core:/stable:/v1.31/rpm/repodata/repomd.xml.key
exclude=kubelet kubeadm kubectl cri-tools kubernetes-cni
EOF
[kubernetes]
name=Kubernetes
baseurl=https://pkgs.k8s.io/core:/stable:/v1.31/rpm/
enabled=1
gpgcheck=1
gpgkey=https://pkgs.k8s.io/core:/stable:/v1.31/rpm/repodata/repomd.xml.key
exclude=kubelet kubeadm kubectl cri-tools kubernetes-cni
[root@ip-172-31-12-97 ec2-user]# yum install -y kubelet kubeadm kubectl --disableexcludes=kubernetes
Kubernetes                                                                          21 kB/s | 9.4 kB     00:00
Dependencies resolved.
================================================================================================================
 Package                    Architecture      Version                           Repository                 Size
================================================================================================================
Installing:
 kubeadm                    x86_64            1.31.1-150500.1.1                 kubernetes                 11 M
 kubectl                    x86_64            1.31.1-150500.1.1                 kubernetes                 11 M
```

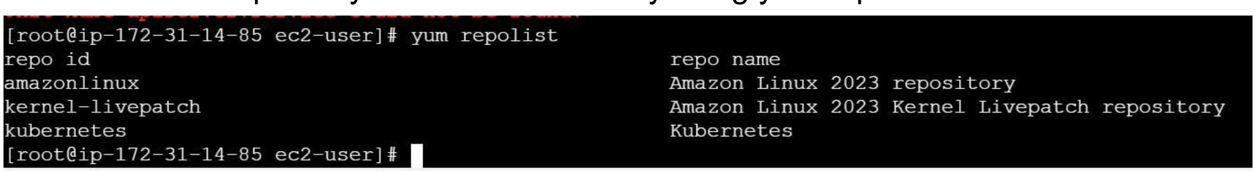


```
Installing dependencies:
 conntrack-tools            x86_64           1.4.6-2.amzn2023.0.2              amazonlinux               208 k
 cri-tools                  x86_64           1.31.1-150500.1.1                 kubernetes                6.9 M
 kubernetes-cni             x86_64           1.5.1-150500.1.1                  kubernetes                7.1 M
 libnetfilter_cthelper      x86_64           1.0.0-21.amzn2023.0.2             amazonlinux                24 k
 libnetfilter_cttimeout     x86_64           1.0.0-19.amzn2023.0.2             amazonlinux                24 k
 libnetfilter_queue         x86_64           1.0.5-2.amzn2023.0.2              amazonlinux                30 k

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

Total download size: 51 M
Installed size: 269 M
Downloading Packages:
(1/9): libnetfilter_cthelper-1.0.0-21.amzn2023.0.2.x86_64.rpm                      500 kB/s |  24 kB     00:00
(2/9): libnetfilter_cttimeout-1.0.0-19.amzn2023.0.2.x86_64.rpm                     475 kB/s |  24 kB     00:00
(3/9): conntrack-tools-1.4.6-2.amzn2023.0.2.x86_64.rpm                             3.6 MB/s | 208 kB     00:00
(4/9): libnetfilter_queue-1.0.5-2.amzn2023.0.2.x86_64.rpm                          1.4 MB/s |  30 kB     00:00
(5/9): kubeadm-1.31.1-150500.1.1.x86_64.rpm                                         17 MB/s |  11 MB     00:00
(6/9): kubectl-1.31.1-150500.1.1.x86_64.rpm                                         15 MB/s |  11 MB     00:00
(7/9): cri-tools-1.31.1-150500.1.1.x86_64.rpm                                      8.0 MB/s | 6.9 MB     00:00
(8/9): kubernetes-cni-1.5.1-150500.1.1.x86_64.rpm                                   14 MB/s | 7.1 MB     00:00
(9/9): kubelet-1.31.1-150500.1.1.x86_64.rpm                                         25 MB/s |  15 MB     00:00
```



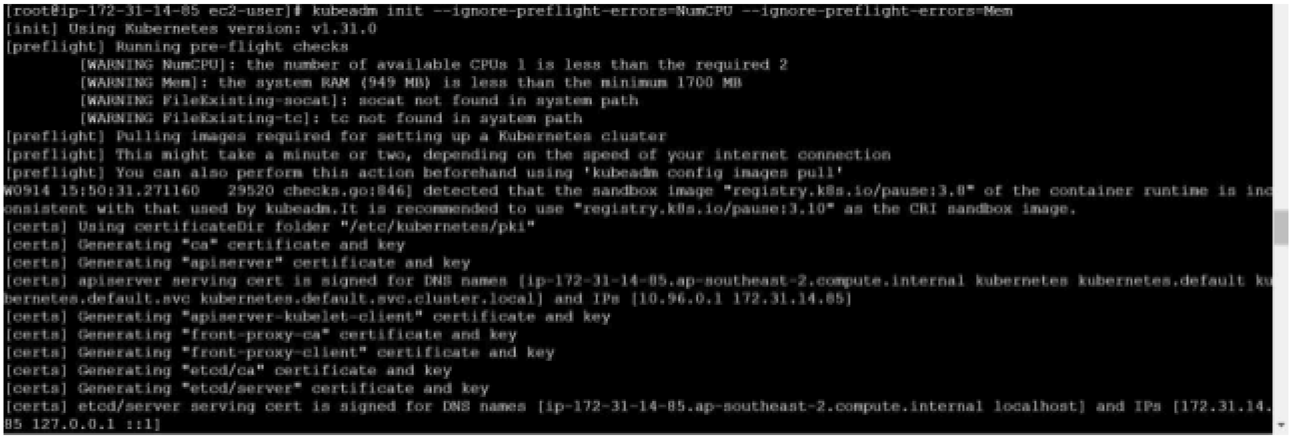
```
  Installing       : conntrack-tools-1.4.6-2.amzn2023.0.2.x86_64                                            6/9
  Running scriptlet: conntrack-tools-1.4.6-2.amzn2023.0.2.x86_64                                            6/9
  Installing       : kubelet-1.31.1-150500.1.1.x86_64                                                       7/9
  Running scriptlet: kubelet-1.31.1-150500.1.1.x86_64                                                       7/9
  Installing       : kubeadm-1.31.1-150500.1.1.x86_64                                                       8/9
  Installing       : kubectl-1.31.1-150500.1.1.x86_64                                                       9/9
  Running scriptlet: kubectl-1.31.1-150500.1.1.x86_64                                                       9/9
  Verifying        : conntrack-tools-1.4.6-2.amzn2023.0.2.x86_64                                            1/9
  Verifying        : libnetfilter_cthelper-1.0.0-21.amzn2023.0.2.x86_64                                     2/9
  Verifying        : libnetfilter_cttimeout-1.0.0-19.amzn2023.0.2.x86_64                                    3/9
  Verifying        : libnetfilter_queue-1.0.5-2.amzn2023.0.2.x86_64                                         4/9
  Verifying        : cri-tools-1.31.1-150500.1.1.x86_64                                                     5/9
  Verifying        : kubeadm-1.31.1-150500.1.1.x86_64                                                       6/9
  Verifying        : kubectl-1.31.1-150500.1.1.x86_64                                                       7/9
  Verifying        : kubelet-1.31.1-150500.1.1.x86_64                                                       8/9
  Verifying        : kubernetes-cni-1.5.1-150500.1.1.x86_64                                                 9/9

Installed:
  conntrack-tools-1.4.6-2.amzn2023.0.2.x86_64                 cri-tools-1.31.1-150500.1.1.x86_64
  kubeadm-1.31.1-150500.1.1.x86_64                            kubectl-1.31.1-150500.1.1.x86_64
  kubelet-1.31.1-150500.1.1.x86_64                            kubernetes-cni-1.5.1-150500.1.1.x86_64
  libnetfilter_cthelper-1.0.0-21.amzn2023.0.2.x86_64          libnetfilter_cttimeout-1.0.0-19.amzn2023.0.2.x86_64
  libnetfilter_queue-1.0.5-2.amzn2023.0.2.x86_64
```

6. We can check if repository has been created by using yum repolist command.

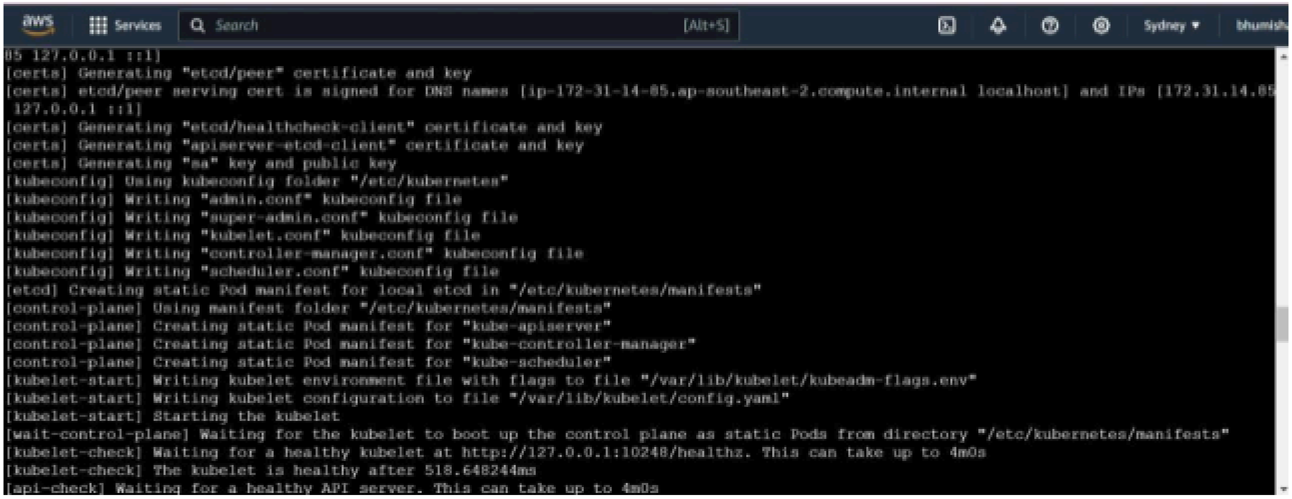


```
[root@ip-172-31-14-85 ec2-user]# yum repolist
repo id                                        repo name
amazonlinux                                    Amazon Linux 2023 repository
kernel-livepatch                               Amazon Linux 2023 Kernel Livepatch repository
kubernetes                                     Kubernetes
[root@ip-172-31-14-85 ec2-user]#
```

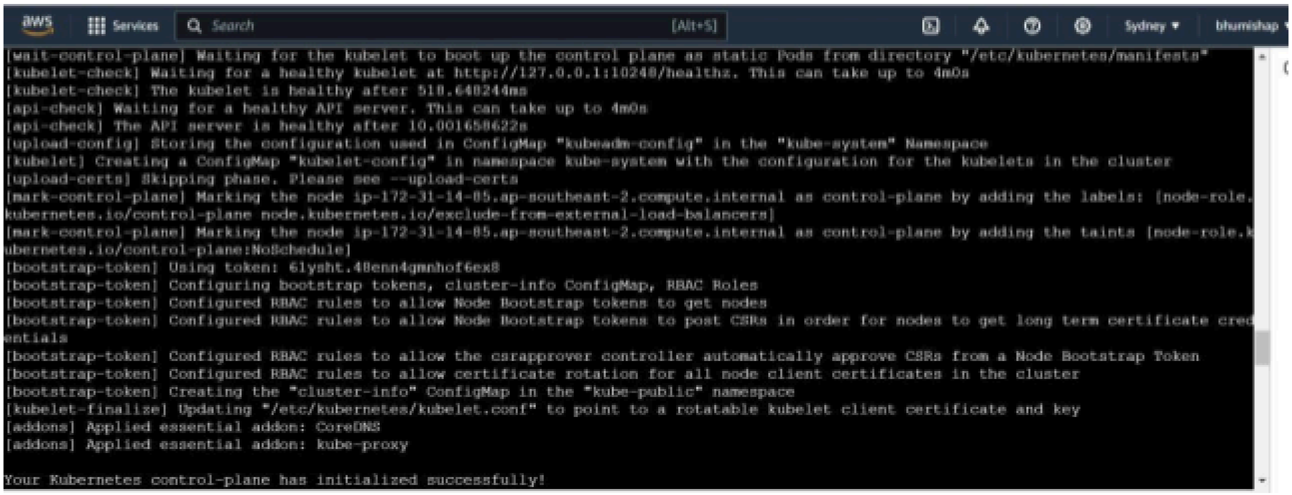
7. Now we will be initializing the kubeadm. For that “kubeadm init” command has to be used. It may show errors but those can be ignored by using --ignore-preflighterrors=all



```
[root@ip-172-31-14-85 ec2-user]# kubeadm init --ignore-preflight-errors=NumCPU --ignore-preflight-errors=Mem
[init] Using Kubernetes version: v1.31.0
[preflight] Running pre-flight checks
        [WARNING NumCPU]: the number of available CPUs 1 is less than the required 2
        [WARNING Mem]: the system RAM (949 MB) is less than the minimum 1700 MB
        [WARNING FileExisting-socat]: socat not found in system path
        [WARNING FileExisting-tc]: tc not found in system path
[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'
W0914 15:50:31.271160   29520 checks.go:846] detected that the sandbox image "registry.k8s.io/pause:3.8" of the container runtime is inc
onsistent 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
[certs] Generating "apiserver" certificate and key
[certs] apiserver serving cert is signed for DNS names [ip-172-31-14-85.ap-southeast-2.compute.internal kubernetes kubernetes.default ku
bernetes.default.svc kubernetes.default.svc.cluster.local] and IPs [10.96.0.1 172.31.14.85]
[certs] Generating "apiserver-kubelet-client" certificate and key
[certs] Generating "front-proxy-ca" certificate and key
[certs] Generating "front-proxy-client" certificate and key
[certs] Generating "etcd/ca" certificate and key
[certs] Generating "etcd/server" certificate and key
[certs] etcd/server serving cert is signed for DNS names [ip-172-31-14-85.ap-southeast-2.compute.internal localhost] and IPs [172.31.14.
85 127.0.0.1 ::1]
```

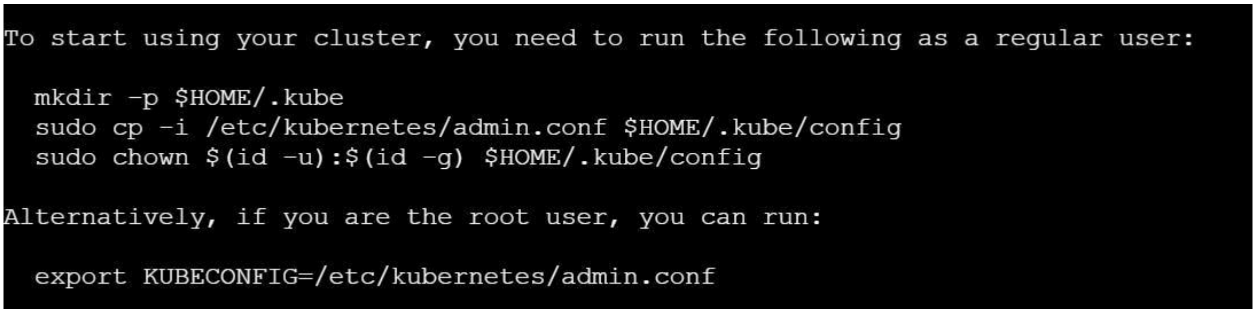


```
85 127.0.0.1 ::1]
[certs] Generating "etcd/peer" certificate and key
[certs] etcd/peer serving cert is signed for DNS names [ip-172-31-14-85.ap-southeast-2.compute.internal localhost] and IPs [172.31.14.85
 127.0.0.1 ::1]
[certs] Generating "etcd/healthcheck-client" certificate and key
[certs] Generating "apiserver-etcd-client" certificate and key
[certs] Generating "sa" key and public key
[kubeconfig] Using kubeconfig folder "/etc/kubernetes"
[kubeconfig] Writing "admin.conf" kubeconfig file
[kubeconfig] Writing "super-admin.conf" kubeconfig file
[kubeconfig] Writing "kubelet.conf" kubeconfig file
[kubeconfig] Writing "controller-manager.conf" kubeconfig file
[kubeconfig] Writing "scheduler.conf" kubeconfig file
[etcd] Creating static Pod manifest for local etcd in "/etc/kubernetes/manifests"
[control-plane] Using manifest folder "/etc/kubernetes/manifests"
[control-plane] Creating static Pod manifest for "kube-apiserver"
[control-plane] Creating static Pod manifest for "kube-controller-manager"
[control-plane] Creating static Pod manifest for "kube-scheduler"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Starting the kubelet
[wait-control-plane] Waiting for the kubelet to boot up the control plane as static Pods from directory "/etc/kubernetes/manifests"
[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 518.648244ms
[api-check] Waiting for a healthy API server. This can take up to 4m0s
```



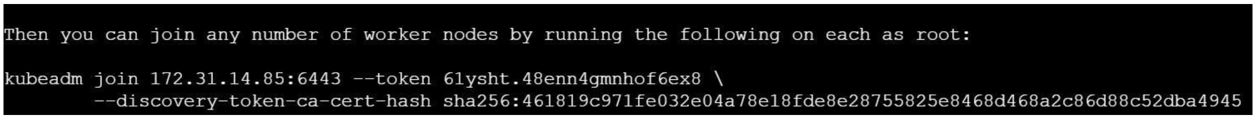
```
[wait-control-plane] Waiting for the kubelet to boot up the control plane as static Pods from directory "/etc/kubernetes/manifests"
[kubelet-check] Waiting for a healthy kubelet at http://127.0.0.1:10248/healthz. This can take up to 4m0s
[kubelet-check] The kubelet is healthy after 518.648244ms
[api-check] Waiting for a healthy API server. This can take up to 4m0s
[api-check] The API server is healthy after 10.001658622s
[upload-config] Storing the configuration used in ConfigMap "kubeadm-config" in the "kube-system" Namespace
[kubelet] Creating a ConfigMap "kubelet-config" in namespace kube-system with the configuration for the kubelets in the cluster
[upload-certs] Skipping phase. Please see --upload-certs
[mark-control-plane] Marking the node ip-172-31-14-85.ap-southeast-2.compute.internal as control-plane by adding the labels: [node-role.
kubernetes.io/control-plane node.kubernetes.io/exclude-from-external-load-balancers]
[mark-control-plane] Marking the node ip-172-31-14-85.ap-southeast-2.compute.internal as control-plane by adding the taints [node-role.k
ubernetes.io/control-plane:NoSchedule]
[bootstrap-token] Using token: 61ysht.48enn4gmnhof6ex8
[bootstrap-token] Configuring bootstrap tokens, cluster-info ConfigMap, RBAC Roles
[bootstrap-token] Configured RBAC rules to allow Node Bootstrap tokens to get nodes
[bootstrap-token] Configured RBAC rules to allow Node Bootstrap tokens to post CSRs in order for nodes to get long term certificate cred
entials
[bootstrap-token] Configured RBAC rules to allow the csrapprover controller automatically approve CSRs from a Node Bootstrap Token
[bootstrap-token] Configured RBAC rules to allow certificate rotation for all node client certificates in the cluster
[bootstrap-token] Creating the "cluster-info" ConfigMap in the "kube-public" namespace
[kubelet-finalize] Updating "/etc/kubernetes/kubelet.conf" to point to a rotatable kubelet client certificate and key
[addons] Applied essential addon: CoreDNS
[addons] Applied essential addon: kube-proxy

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

8. On successful initialization we need to copy and paste the following commands on the master machine itself:



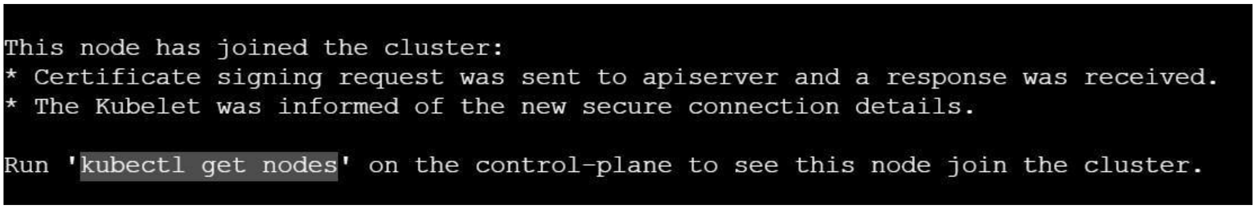
```
To start using your cluster, you need to run the following as a regular user:

  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
```

9. Next copy and paste the join link in the worker nodes so that the worker nodes can join the cluster.



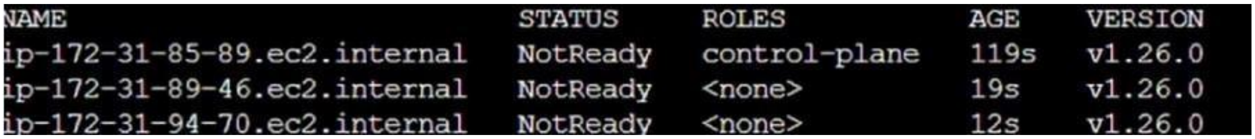
```
Then you can join any number of worker nodes by running the following on each as root:

kubeadm join 172.31.14.85:6443 --token 61ysht.48enn4gmnhof6ex8 \
        --discovery-token-ca-cert-hash sha256:461819c971fe032e04a78e18fde8e28755825e8468d468a2c86d88c52dba4945
```

10. After performing join commands on the worker nodes, we will get following output:



```
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.
```

11. Once again when you run kubectl get nodes you will now see all 3 nodes have joined the cluster.



```
NAME                          STATUS     ROLES           AGE    VERSION
ip-172-31-85-89.ec2.internal  NotReady   control-plane   119s   v1.26.0
ip-172-31-89-46.ec2.internal  NotReady   <none>          19s    v1.26.0
ip-172-31-94-70.ec2.internal  NotReady   <none>          12s    v1.26.0
```

Conclusion:

This experiment successfully demonstrated the creation of a Kubernetes cluster and the successful addition of all three nodes using various commands. Errors encountered during initialization can be addressed in two ways: 1) by ignoring the errors, or 2) by upgrading the instance type to t3.medium or t3.large if the issues are due to insufficient memory or CPU resources.