

ADVANCE DEVOPS EXPERIMENT - 3

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

Step 1:Pre-requisites

1.1 Create 3 EC2 instances,one for the master node and two for the worker nodes.

Launch an instance Info

Amazon EC2 allows you to create virtual machines, or instances, that run on the AWS Cloud. Quickly get started by following the simple steps below.

Name and tags Info

[Add additional tags](#)

▼ Application and OS Images (Amazon Machine Image) Info

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. Search or Browse for AMIs if you don't see what you are looking for below

Quick Start

Amazon Linux
aws

macOS
Mac

Ubuntu
ubuntu

Windows
Microsoft

Red Hat
RedHat

SUSE L
SUSE

[Browse more AMIs](#)
Including AMIs from AWS, Marketplace and the Community

▼ Summary

Number of instances Info

Software Image (AMI)

Canonical, Ubuntu, 22.04 LTS, ...read more
ami-0c2af51e265bd5e0e

Virtual server type (instance type)

t2.medium

Firewall (security group)

New security group

Storage (volumes)

1 volume(s) - 8 GiB

Free tier: In your first year includes 750 hours of t2.micro (or t3.micro in the Regions in which t2.micro is unavailable) instance usage on free tier AMIs per month, 750 hours of public IPv4 address usage per month.

Cancel

Launch instance

[Review commands](#)

1.2 Proceed with the following settings and create a new key pair as follows(use the same key pair for all the three nodes)

▼ Instance type [Info](#) | [Get advice](#)

Instance type

t2.medium
Family: t2 2 vCPU 4 GiB Memory Current generation: true
On-Demand Linux base pricing: 0.0496 USD per Hour
On-Demand Windows base pricing: 0.0676 USD per Hour
On-Demand RHEL base pricing: 0.0784 USD per Hour
On-Demand SUSE base pricing: 0.1496 USD per Hour

▼

☒ All generations

[Compare instance types](#)

Additional costs apply for AMIs with pre-installed software

▼ Key pair (login) [Info](#)

You can use a key pair to securely connect to your instance. Ensure that you have access to the selected key pair before you launch the instance.

Key pair name - *required*

two-tier-app-k8s

▼

↻

[Create new key pair](#)

▼ Network settings [Info](#)

Edit

Network | [Info](#)

vpc-04007898e59a6979f

Subnet | [Info](#)

Create key pair

Key pair name

Key pairs allow you to connect to your instance securely.

two-tier-app-k8s

The name can include up to 255 ASCII characters. It can't include leading or trailing spaces.

Key pair type

☒ RSA

RSA encrypted private and public key pair

☐ ED25519

ED25519 encrypted private and public key pair

Private key file format

☒ .pem

For use with OpenSSH

☐ .ppk

For use with PuTTY

⚠ When prompted, store the private key in a secure and accessible location on

Cancel

Create key pair

Instances (1/3) Info

Last updated less than a minute ago

Refresh

Connect

Instance state ▼

Actions ▼

Launch instances ▼

Find Instance by attribute or tag (case-sensitive)

All states ▼

Instance state = running

Clear filters

< 1 >

⚙

<input checked="" type="checkbox"/>	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IP
<input type="checkbox"/>	Worker-2	i-0e3930ceb2d892d01	Running	t2.medium	2/2 checks passed	View alarms	ap-south-1a	ec2-13-234-226-219.ap...	13.234.226.219
<input type="checkbox"/>	Worker-1	i-0d16e01d1824e0e3a	Running	t2.medium	2/2 checks passed	View alarms	ap-south-1a	ec2-65-0-104-95.ap-so...	65.0.104.95
<input checked="" type="checkbox"/>	Master	i-01ae3d388db90ad73	Running	t2.medium	2/2 checks passed	View alarms	ap-south-1a	ec2-13-232-36-34.ap-s...	13.232.36.34

1.3 After the instances have been created, copy the text given in the example part of each of the three instances into git bash.

EC2 Instance Connect	Session Manager	SSH client	EC2 serial console
<p>Instance ID 📄 i-0e3930ceb2d892d01 (Worker-2)</p> <ol style="list-style-type: none">1. Open an SSH client.2. Locate your private key file. The key used to launch this instance is two-tier-app-k8s.pem3. Run this command, if necessary, to ensure your key is not publicly viewable. 📄 <code>chmod 400 "two-tier-app-k8s.pem"</code>4. Connect to your instance using its Public DNS: 📄 <code>ec2-13-234-226-219.ap-south-1.compute.amazonaws.com</code> <p>Example: 📄 <code>ssh -i "two-tier-app-k8s.pem" ubuntu@ec2-13-234-226-219.ap-south-1.compute.amazonaws.com</code></p>			

```
acer@TMP214-53 MINGW64 ~/Downloads
$ ssh -i "two-tier-app-k8s.pem" ubuntu@ec2-13-232-36-34.ap-south-1.compute.amazonaws.com
The authenticity of host 'ec2-13-232-36-34.ap-south-1.compute.amazonaws.com (13.232.36.34)' can't be established.
ED25519 key fingerprint is SHA256:uVGE0+FWYefj60j0ft70Sra1v8Nrzi/IwxAtBY+EPE.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-13-232-36-34.ap-south-1.compute.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.4 LTS (GNU/Linux 6.5.0-1022-aws x86_64)

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

System information as of Wed Sep 11 14:07:10 UTC 2024

System load:  0.0               Processes:            106
Usage of /:   20.7% of 7.57GB   Users logged in:     0
Memory usage: 5%               IPv4 address for eth0: 172.31.45.227
Swap usage:   0%

Expanded Security Maintenance for Applications is not enabled.

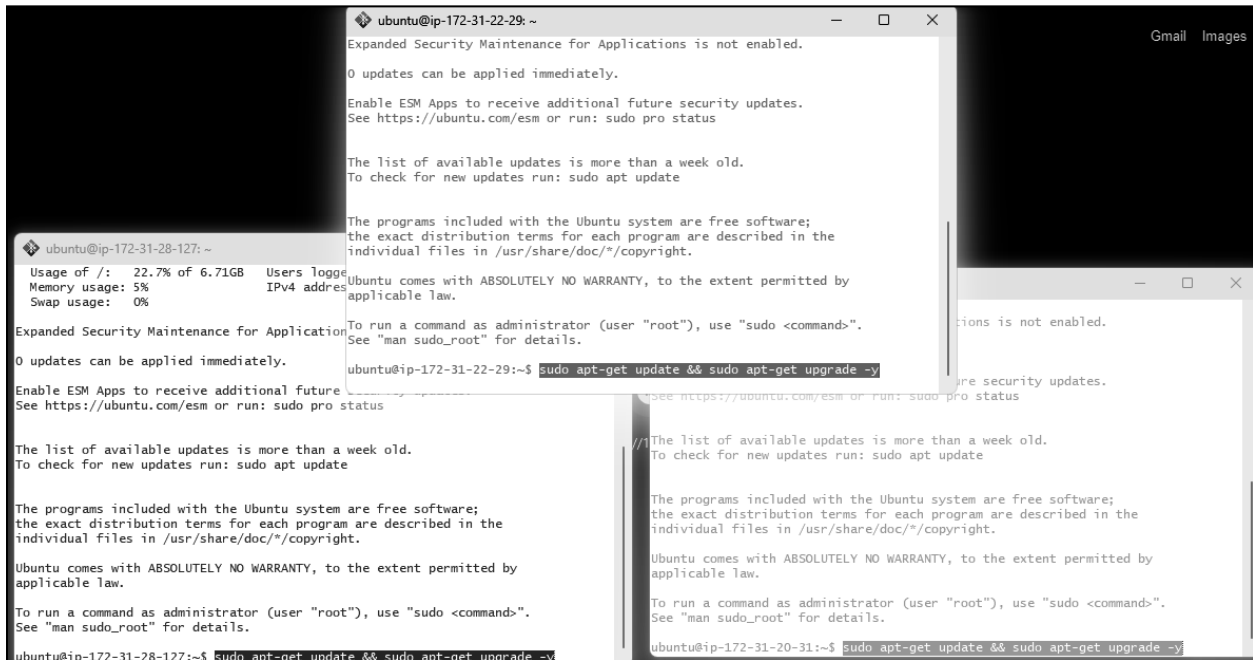
0 updates can be applied immediately.

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

Step 2: Prepare Nodes

2.1. Update the package manager on all nodes:

`sudo apt-get update && sudo apt-get upgrade -y`



The screenshot displays three terminal windows from different Ubuntu nodes. The top window (ip-172-31-22-29) shows the output of `sudo apt-get update`, indicating that the list of available updates is more than a week old and that the system is free software. The bottom-left window (ip-172-31-28-127) shows the output of `sudo apt-get upgrade -y`, which includes system statistics (Usage of /: 22.7% of 6.71GB, Memory usage: 5%, Swap usage: 0%) and the same update information. The bottom-right window (ip-172-31-20-31) also shows the output of `sudo apt-get update && sudo apt-get upgrade -y`. All windows show the same update information, including the URL `https://ubuntu.com/esm` and the command `sudo pro status`.

```
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packag
es [14.1 MB]
Get:5 http://security.ubuntu.com/ubuntu jammy-security InRelease [129 kB]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe Translation-
en [5652 kB]
Get:7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 c-n-f
Metadata [286 kB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 Pack
ages [217 kB]
Get:9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse Translatio
n-en [112 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 c-n
-f Metadata [8372 B]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 P
ackages [2023 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main Transla
tion-en [352 kB]
Get:13 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 c
-n-f Metadata [17.8 kB]
Get:14 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted a
md64 Packages [2437 kB]
Get:15 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted T
ranslation-en [419 kB]
Get:16 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted a
```

2.2. Disable Swap (Kubernetes requires swap to be off):

`sudo swapoff -a`

`sudo sed -i ' / swap / s/^#/' /etc/fstab`

```
ubuntu@ip-172-31-22-29:~$ sudo swapoff -a
sudo sed -i ' / swap / s/^#/' /etc/fstab
```

2.3. Load necessary kernel modules for networking and iptables:

`cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf`

`overlay`

`br_netfilter`

`EOF`

`sudo modprobe overlay`

`sudo modprobe br_netfilter`

```
ubuntu@ip-172-31-22-29:~$ cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF
sudo modprobe overlay
sudo modprobe br_netfilter
overlay
br_netfilter
```

2.4. Configure sysctl settings for Kubernetes networking:

`cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf`

`net.bridge.bridge-nf-call-ip6tables = 1`

`net.bridge.bridge-nf-call-iptables = 1`

`EOF`

`sudo sysctl --system`

```

ubuntu@ip-172-31-22-29:~$ cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF
sudo modprobe overlay
sudo modprobe br_netfilter
overlay
br_netfilter
ubuntu@ip-172-31-22-29:~$ cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-ip6tables = 1
net.bridge.bridge-nf-call-iptables = 1
EOF
sudo sysctl --system
net.bridge.bridge-nf-call-ip6tables = 1
net.bridge.bridge-nf-call-iptables = 1
* Applying /etc/sysctl.d/10-console-messages.conf ...
kernel.printk = 4 4 1 7
* Applying /etc/sysctl.d/10-ipv6-privacy.conf ...
net.ipv6.conf.all.use_tempaddr = 2
net.ipv6.conf.default.use_tempaddr = 2
* Applying /etc/sysctl.d/10-kernel-hardening.conf ...
kernel.kptr_restrict = 1

```

Step 3: Install Docker

Kubernetes uses container runtimes like Docker. Install Docker on all nodes.

```
sudo apt-get update
```

```
sudo apt-get install -y apt-transport-https ca-certificates curl software-properties-common
```

```
curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add -
```

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

```
sudo apt-get update
```

```
sudo apt-get install -y docker-ce docker-ce-cli containerd.io
```

```

ubuntu@ip-172-31-22-29:~$ sudo apt-get update
sudo apt-get install -y apt-transport-https ca-certificates curl software-proper
ties-common
curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add -
sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubun
tu $(lsb_release -cs) stable"
sudo apt-get update
sudo apt-get install -y docker-ce docker-ce-cli containerd.io
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [129 kB]
Fetched 129 kB in 1s (241 kB/s)
Reading package lists... Done
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
ca-certificates is already the newest version (20230311ubuntu0.22.04.1).
ca-certificates set to manually installed.
curl is already the newest version (7.81.0-1ubuntu1.17).
curl set to manually installed.
software-properties-common is already the newest version (0.99.22.9).
software-properties-common set to manually installed.

```

Configure Docker for Kubernetes:

```
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
sudo systemctl restart docker
```

```
ubuntu@ip-172-31-22-29:~$ 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
sudo systemctl restart docker
{
  "exec-opts": ["native.cgroupdriver=systemd"],
  "log-driver": "json-file",
  "log-opts": {
    "max-size": "100m"
  },
  "storage-driver": "overlay2"
}
```

Step 4: Install kubeadm, kubelet, kubectl

Install Kubernetes tools on all nodes.

4.1. Add Kubernetes APT repository:

```
sudo curl -fsSLo /usr/share/keyrings/kubernetes-archive-keyring.gpg
https://packages.cloud.google.com/apt/doc/apt-key.gpg
echo "deb [signed-by=/usr/share/keyrings/kubernetes-archive-keyring.gpg]
https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee
/etc/apt/sources.list.d/kubernetes.list
```



```
ubuntu@ip-172-31-22-29:~$ sudo curl -fsSLo /usr/share/keyrings/kubernetes-archive-keyring.gpg https://packages.cloud.google.com/apt/doc/apt-key.gpg
echo "deb [signed-by=/usr/share/keyrings/kubernetes-archive-keyring.gpg] https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee /etc/apt/sources.list.d/kubernetes.list
deb [signed-by=/usr/share/keyrings/kubernetes-archive-keyring.gpg] https://apt.kubernetes.io/ kubernetes-xenial main
```

4.2. Install kubeadm, kubelet, and kubectl:

sudo apt-get update

sudo apt-get install -y kubelet kubeadm kubectl

sudo apt-mark hold kubelet kubeadm kubectl

```
ubuntu@ip-172-31-22-29:~$ 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 jammy InRelease
Hit:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu jammy-security InRelease
Hit:5 https://download.docker.com/linux/ubuntu jammy InRelease
```

Step 5: Initialize the Kubernetes Cluster on Master Node

On the master node:

sudo kubeadm init --pod-network-cidr=10.244.0.0/16

```
ubuntu@ip-172-31-22-29:~$ sudo kubeadm init --pod-network-cidr=10.244.0.0/16 --v=5
Found multiple CRI endpoints on the host. Please define which one do you wish to use by setting the 'criSocket' field in the kubeadm configuration file: unix:///var/run/containerd/containerd.sock, unix:///var/run/crio/crio.sock
k8s.io/kubernetes/cmd/kubeadm/app/util/runtime.detectCRISocketImpl
cmd/kubeadm/app/util/runtime/runtime.go:167
k8s.io/kubernetes/cmd/kubeadm/app/util/runtime.DetectCRISocket
cmd/kubeadm/app/util/runtime/runtime.go:175
k8s.io/kubernetes/cmd/kubeadm/app/util/config.SetNodeRegistrationDynamicDefaults
cmd/kubeadm/app/util/config/initconfiguration.go:118
k8s.io/kubernetes/cmd/kubeadm/app/util/config.SetInitDynamicDefaults
cmd/kubeadm/app/util/config/initconfiguration.go:64
k8s.io/kubernetes/cmd/kubeadm/app/util/config.DefaultedInitConfiguration
cmd/kubeadm/app/util/config/initconfiguration.go:248
k8s.io/kubernetes/cmd/kubeadm/app/util/config.LoadOrDefaultInitConfiguration
cmd/kubeadm/app/util/config/initconfiguration.go:282
k8s.io/kubernetes/cmd/kubeadm/app/cmd.newInitData
cmd/kubeadm/app/cmd/init.go:319
k8s.io/kubernetes/cmd/kubeadm/app/cmd.newCmdInit.func3
cmd/kubeadm/app/cmd/init.go:170
k8s.io/kubernetes/cmd/kubeadm/app/cmd/phases/workflow.(*Runner).InitData
cmd/kubeadm/app/cmd/phases/workflow/runner.go:183
k8s.io/kubernetes/cmd/kubeadm/app/cmd.newCmdInit.func1
```

5.1. Set up kubectl on the master node:

```
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-172-31-22-29:~$ sudo kubeadm config images pull
sudo kubeadm init

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

# Network Plugin = calico
kubectl apply -f https://raw.githubusercontent.com/projectcalico/calico/v3.26.0/manifests/calico.yaml

kubeadm token create --print-join-command --v=5
Found multiple CRI endpoints on the host. Please define which one do you wish to use by setting the 'criSocket' field in the kubeadm configuration file: unix:///var/run/containerd/containerd.sock, unix:///var/run/crio/crio.sock
To see the stack trace of this error execute with --v=5 or higher
Found multiple CRI endpoints on the host. Please define which one do you wish to use by setting the 'criSocket' field in the kubeadm configuration file: unix:///var/run/containerd/containerd.sock, unix:///var/run/crio/crio.sock
```

Step 6: Install a Pod Network Add-on

To enable communication between pods, install a pod network plugin like Flannel or Calico.

Install Flannel:

```
kubectl apply -f
```

<https://raw.githubusercontent.com/coreos/flannel/master/Documentation/kube-flannel.yml>

```
ubuntu@ip-172-31-22-29:~$ kubectl apply -f https://raw.githubusercontent.com/coreos/flannel/master/Documentation/kube-flannel.yml --validate=false
E0913 15:35:04.261458 19259 memcache.go:265] couldn't get current server API group list: Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
E0913 15:35:04.261902 19259 memcache.go:265] couldn't get current server API group list: Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
E0913 15:35:04.263424 19259 memcache.go:265] couldn't get current server API group list: Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
E0913 15:35:04.263795 19259 memcache.go:265] couldn't get current server API group list: Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
E0913 15:35:04.265840 19259 memcache.go:265] couldn't get current server API group list: Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
E0913 15:35:04.266524 19259 memcache.go:265] couldn't get current server API group list: Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
unable to recognize "https://raw.githubusercontent.com/coreos/flannel/master/Documentation/kube-flannel.yml": Get "http://localhost:8080/api?timeout=32s": dial tcp 127.0.0.1:8080: connect: connection refused
```

Step 7: Join Worker Nodes to the Cluster

On the **worker nodes**, run the command provided by the master node during initialization . It looks something like this:

```
sudo kubeadm join <master-ip>:6443 --token <token> --discovery-token-ca-cert-hash sha256:<hash>
```

```
clusterrolebinding.rbac.authorization.k8s.io/calico-cni-plugin created
daemonset.apps/calico-node created
deployment.apps/calico-kube-controllers created
kubeadm join 172.31.62.216:6443 --token br7fe5.hq28adbmn1mu17ky --discovery-token-ca-cert-hash sha256:2bc469a8d14fbeb0f879328d2b416fad32b29a8505d3f448b98703fff3b014d9
```

Step 8: Verify the Cluster

Once the worker node joins, check the status on the **master node**

```
ubuntu@ip-172-31-45-227:~$ kubectl get nodes
NAME                STATUS    ROLES    AGE   VERSION
ip-172-31-43-211    Ready    <none>    50s   v1.29.0
ip-172-31-45-13     Ready    <none>    34s   v1.29.0
ip-172-31-45-227    Ready    control-plane 5m17s  v1.29.0
ubuntu@ip-172-31-45-227:~$ |
```