

Lab Assignment 10

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

LO2. To deploy single and multiple container applications and manage application deployments with rollouts in Kubernetes.

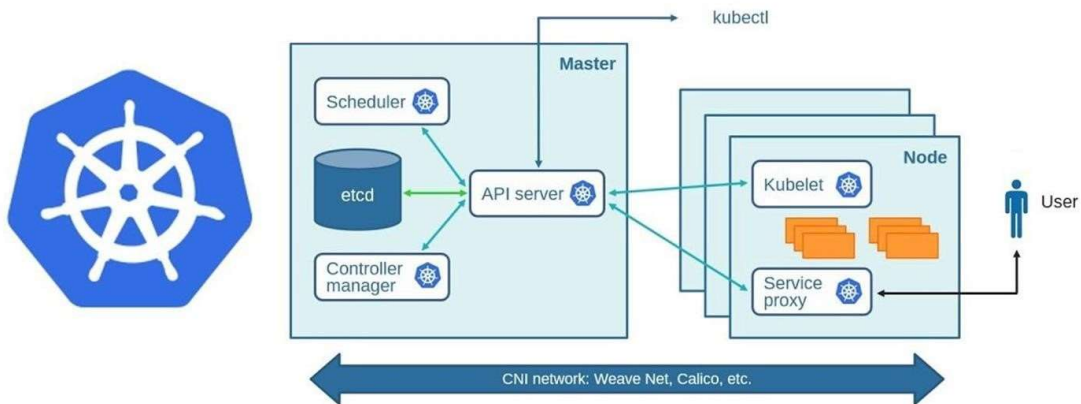
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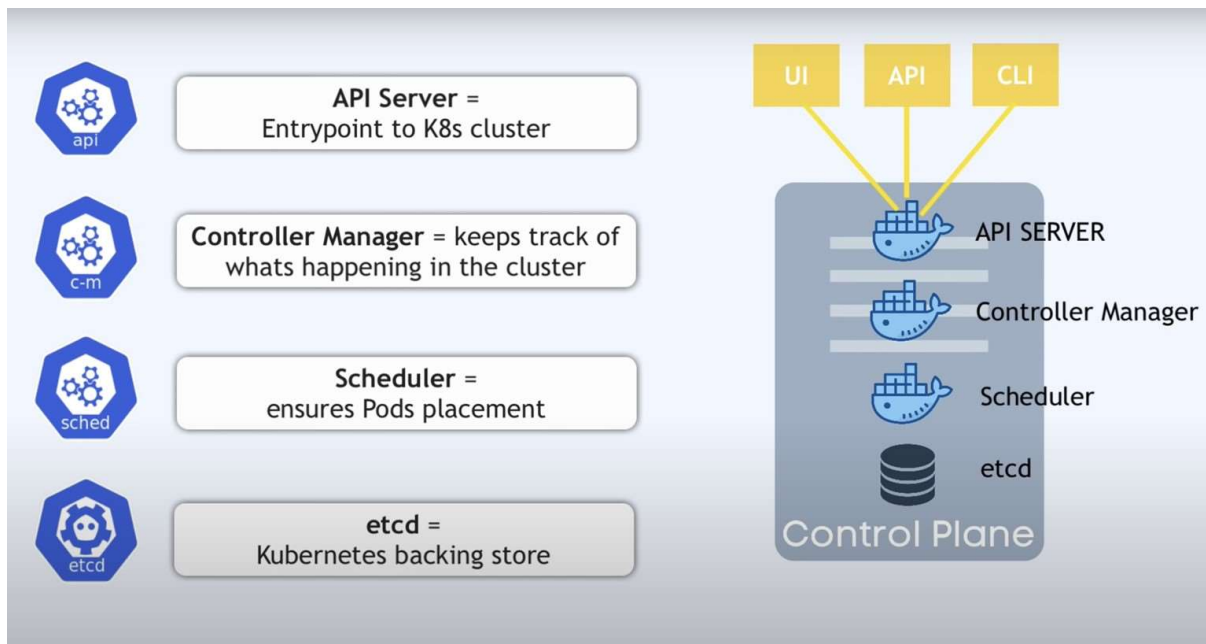
Kubernetes is an open-source container management tool that automates container deployment, scaling & load balancing.

It schedules, runs, and manages isolated containers that are running on virtual/physical/cloud machines.

All top cloud providers support Kubernetes. One popular name for Kubernetes is K8s.

ARCHITECTURE





Working with Kubernetes

- We create a Manifest (.yaml) file
- Apply those to cluster (to master) to bring it into the desired state.
- POD runs on a node, which is controlled by the master.

● Role of Master Node

- Kubernetes cluster contains containers running on Bare Metal / VM instances/cloud instances/ all mix.
- Kubernetes designates one or more of these as masters and all others as workers.
- The master is now going to run a set of K8s processes. These processes will ensure the smooth functioning of the cluster. These processes are called the 'Control Plane'.
- Can be Multi-Master for high availability.
- Master runs control plane to run cluster smoothly.

● Components of Control Plane

■ Kube-api-server → (For all communications)

- This api-server interacts directly with the user (i.e we apply .yaml or .json manifest to kubeapi-server)
- This kube-api-server is meant to scale automatically as per load.
- Kube-api-server is the front end of the control plane.

■ etcd

- Stores metadata and status of the cluster.
- etcd is a consistent and high-available store (key-value-store)

- Source of truth for cluster state (info about the state of the cluster)

→ **etcd has the following features**

1. Fully Replicated → The entire state is available on every node in the cluster.
2. Secure → Implements automatic TLS with optional client-certificate authentication.
3. Fast → Benchmarked at 10,000 writes per second.

■ Kube-scheduler (action)

- When users request the creation & management of Pods, Kube-scheduler is going to take action on these requests.
- Handles POD creation and Management.
- Kube-scheduler match/assign any node to create and run pods.
- A scheduler watches for newly created pods that have no node assigned. For every pod that the scheduler discovers, the scheduler becomes responsible for finding the best node for that pod to run.
- The scheduler gets the information for hardware configuration from configuration files and schedules the Pods on nodes accordingly.

■ Controller-Manager

- Make sure the actual state of the cluster matches the desired state.

→ Two possible choices for controller manager—

1. If K8s is on the cloud, then it will be a cloud controller manager.
2. If K8s is on non-cloud, then it will be kube-controller-manager.

Components on the master that runs the controller

Node Controller → For checking the cloud provider to determine if a node has been detected in the cloud after it stops responding.

Route-Controller → Responsible for setting up a network, and routes on your cloud.

Service-Controller → Responsible for load Balancers on your cloud against services of type Load Balancer.

Volume-Controller → For creating, attaching, and mounting volumes and interacting with the cloud provider to orchestrate volume.

■ Nodes (Kubelet and Container Engine)

- Node is going to run 3 important pieces of software/process.

Kubelet

- The agent running on the node.
- Listens to Kubernetes master (eg- Pod creation request).
- Use port 10255.

- Send success/Fail reports to master.

Container Engine

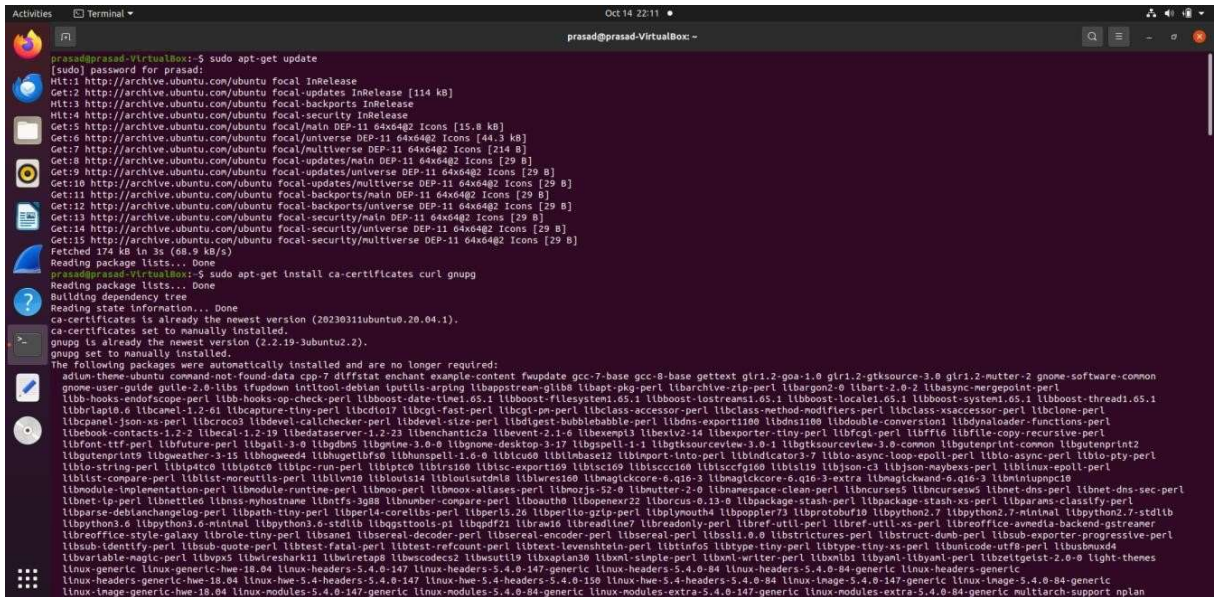
- Works with kubelet
- Pulling images
- Start/Stop Containers
- Exposing containers on ports specified in the manifest.

Kube-Proxy

- Assign IP to each pod.
- It is required to assign IP addresses to Pods (dynamic)
- Kube-proxy runs on each node & this makes sure that each pod will get its unique IP Address.
- These 3 components collectively consist of 'node'.

INSTALLATION:

1. Install Docker



```
prasad@prasad-VirtualBox:~$ sudo apt-get update
[sudo] password for prasad:
Hit:1 http://archive.ubuntu.com/ubuntu focal InRelease
Hit:2 http://archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Hit:3 http://archive.ubuntu.com/ubuntu focal-backports InRelease
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Fetched 174 kB in 3s (66.9 kB/s)
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prasad@prasad-VirtualBox:~$ sudo apt-get install ca-certificates curl gnupg
Reading package lists... Done
Building dependency tree
Reading state information... Done
ca-certificates is already the newest version (20230311ubuntu0.20.04.1).
ca-certificates set to manually installed.
gnupg is already the newest version (2.2.19-3ubuntu2.2).
gnupg set to manually installed.
The following packages were automatically installed and are no longer required:
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libisc1998 libisc1999 libisc2000 libisc2001 libisc2002 libisc2003 libisc2004 libisc2005 libisc2006 libisc2007 libisc2008 libisc20
```



```

prasad@prasad-VirtualBox: ~$ curl -LO https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64
% Total % Received % Xferd Average Speed Time Time Current
Dload Upload Total Spent Left Speed
100 82.4M 100 82.4M 0 0 5315k 0 0:00:15 0:00:15 --:--:-- 5916k
prasad@prasad-VirtualBox: ~$ sudo install minikube-linux-amd64 /usr/local/bin/minikube
[sudo] password for prasad:
prasad@prasad-VirtualBox: ~$ minikube start --driver=docker
minikube v1.31.2 on Ubuntu 20.04 (vbox/amd64)
Using the docker driver based on user configuration

Exiting due to PROVIDER_DOCKER_NEWGRP: "docker version --format {{no value}}:{{no value}}:{{no value}} exit status 1: permission denied while trying to connect to the Docker daemon socket at unix:///var/r
un/docker.sock: Get "http://127.0.0.1:2375/v1.24/version": dial unix /var/run/docker.sock: connect: permission denied
Suggestion: Add your user to the 'docker' group: 'sudo usermod -aG docker $USER && newgrp docker'
Documentation: https://docs.docker.com/engine/install/linux-postinstall/

prasad@prasad-VirtualBox: ~$ sudo usermod -aG docker $USER && newgrp docker
prasad@prasad-VirtualBox: ~$ minikube start --driver=docker
minikube v1.31.2 on Ubuntu 20.04 (vbox/amd64)
Using the docker driver based on user configuration

The requested memory allocation of 1971MB does not leave room for system overhead (total system memory: 1971MB). You may face stability issues.
Suggestion: Start minikube with less memory allocated: 'minikube start --memory=1971mb'

Using Docker driver with root privileges
Starting control plane node minikube in cluster minikube
Pulling base image ...
Downloading Kubernetes v1.27.4 preloa...
> preloaded-images-k8s-v18-v1...: 393.21 MiB / 393.21 MiB 100.00% 2.85 Mi
> gcr.io/k8s-minikube/kicbase...: 447.62 MiB / 447.62 MiB 100.00% 2.99 Mi
Creating docker container (CPUs=2, Memory=1971MB) ...

Docker is nearly out of disk space, which may cause deployments to fail! (94% of capacity). You can pass '--force' to skip this check.
Suggestion:
Try one or more of the following to free up space on the device:
1. Run "docker system prune" to remove unused Docker data (optionally with "-a")
2. Increase the storage allocated to Docker for Desktop by clicking on:
Docker icon > Preferences > Resources > Disk Image Size
3. Run "minikube ssh -- docker system prune" if using the Docker container runtime
Related issue: https://github.com/kubernetes/minikube/issues/9024

This container is having trouble accessing https://registry.k8s.io
To pull new external images, you may need to configure a proxy: https://minikube.sigs.k8s.io/docs/reference/networking/proxy/
Preparing Kubernetes v1.27.4 on Docker 24.0.4 ...
Generating certificates and keys ...

prasad@prasad-VirtualBox: ~$
  
```

```

prasad@prasad-VirtualBox: ~$ minikube start --driver=docker
minikube v1.31.2 on Ubuntu 20.04 (vbox/amd64)
Using the docker driver based on user configuration

The requested memory allocation of 1971MB does not leave room for system overhead (total system memory: 1971MB). You may face stability issues.
Suggestion: Start minikube with less memory allocated: 'minikube start --memory=1971mb'

Using Docker driver with root privileges
Starting control plane node minikube in cluster minikube
Pulling base image ...
Downloading Kubernetes v1.27.4 preloa...
> preloaded-images-k8s-v18-v1...: 393.21 MiB / 393.21 MiB 100.00% 2.85 Mi
> gcr.io/k8s-minikube/kicbase...: 447.62 MiB / 447.62 MiB 100.00% 2.99 Mi
Creating docker container (CPUs=2, Memory=1971MB) ...

Docker is nearly out of disk space, which may cause deployments to fail! (94% of capacity). You can pass '--force' to skip this check.
Suggestion:
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3. Run "minikube ssh -- docker system prune" if using the Docker container runtime
Related issue: https://github.com/kubernetes/minikube/issues/9024

This container is having trouble accessing https://registry.k8s.io
To pull new external images, you may need to configure a proxy: https://minikube.sigs.k8s.io/docs/reference/networking/proxy/
Preparing Kubernetes v1.27.4 on Docker 24.0.4 ...
Generating certificates and keys ...
Configuring RBAC roles ...
Configuring Bridge CNI (Container Networking Interface) ...
Using image gcr.io/k8s-minikube/storage-provisioner:v5
Verifying Kubernetes components...
Enabled addons: default-storageclass, storage-provisioner
kubectl not found. If you need it, try: 'minikube kubectl -- get pods -A'
Done! kubectl is now configured to use "minikube" cluster and "default" namespace by default

prasad@prasad-VirtualBox: ~$
  
```

3. Install kubectl

```

prasad@prasad-VirtualBox: ~
$ minikube start
Using Docker driver with root privileges
Starting control plane node minikube in cluster minikube
Pulling base image ...
Downloading Kubernetes v1.27.4 preloader ...
> preloaded-images-k8s-v18-v1...: 393.21 MiB / 393.21 MiB 100.00% 2.85 Mi
> gcr.io/k8s-minikube/kicbase...: 447.02 MiB / 447.02 MiB 100.00% 2.99 Mi
Creating docker container (CPUs=2, Memory=1971MB) ...
Docker is nearly out of disk space, which may cause deployments to fail! (94% of capacity). You can pass '--force' to skip this check.
Suggestion:
Try one or more of the following to free up space on the device:
1. Run "docker system prune" to remove unused Docker data (optionally with "--a")
2. Increase the storage allocated to Docker for Desktop by clicking on:
Docker icon > Preferences > Resources > Disk Image Size
3. Run "minikube ssh -- docker system prune" if using the Docker container runtime
Related issue: https://github.com/kubernetes/minikube/issues/9024
This container is having trouble accessing https://registry.k8s.io
To pull new external images, you may need to configure a proxy: https://minikube.sigs.k8s.io/docs/reference/networking/proxy/
Preparing Kubernetes v1.27.4 on Docker 24.0.4 ...
# Generating certificates and keys ...
# Booting up control plane ...
# Configuring RBAC rules ...
# Configuring bridge CNI (Container Networking Interface) ...
# Using image gcr.io/k8s-minikube/storage-provisioner:v5
# Verifying Kubernetes components...
Enabled addons: default-storageclass, storage-provisioner
Kubectl not found. If you need it, try: "minikube kubectl -- get pods -A"
Done! kubectl is now configured to use "minikube" cluster and "default" namespace by default
prasad@prasad-VirtualBox: ~$ ^C
prasad@prasad-VirtualBox: ~$ sudo snap install kubectl --classic
[sudo] password for prasad:
kubectl 1.28.2 from Canonical++ installed
prasad@prasad-VirtualBox: ~$ kubectl get po -A
NAMESPACE      NAME                                READY   STATUS    RESTARTS   AGE
kube-system     coredns-5d78c986d-dwdgp            1/1     Running   0           16m
kube-system     etcd-minikube                      1/1     Running   0           16m
kube-system     kube-apiserver-minikube            1/1     Running   0           16m
kube-system     kube-controller-manager-minikube   1/1     Running   0           17m
kube-system     kube-proxy-smjnt                   1/1     Running   0           16m
kube-system     kube-scheduler-minikube            1/1     Running   0           16m
kube-system     storage-provisioner                1/1     Running   1 (16m ago)  16m
prasad@prasad-VirtualBox: ~$

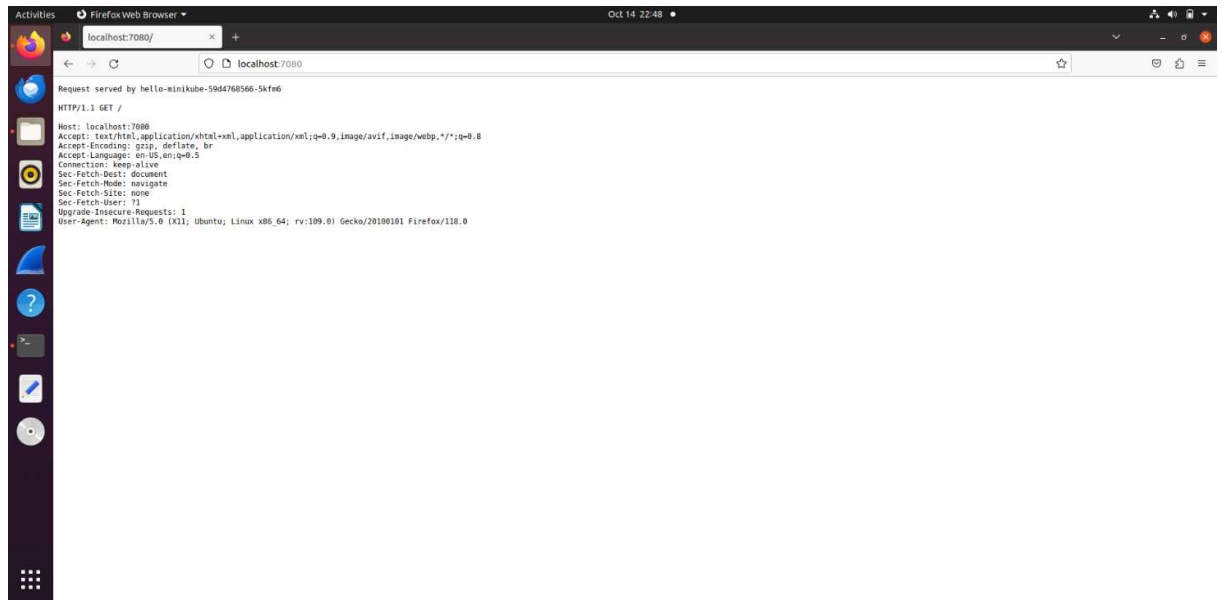
```

4. Create a sample deployment.

```

prasad@prasad-VirtualBox: ~$ kubectl create deployment hello-minikube --image=kicbase/echo-server:1.0
deployment.apps/hello-minikube created
prasad@prasad-VirtualBox: ~$ kubectl expose deployment hello-minikube --type=NodePort --port=8080
service/hello-minikube exposed
prasad@prasad-VirtualBox: ~$ kubectl get services hello-minikube
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)          AGE
hello-minikube  NodePort  10.108.233.37  <none>        8080:31242/TCP   86s
prasad@prasad-VirtualBox: ~$ kubectl port-forward service/hello-minikube 7080:8080
Forwarding from 127.0.0.1:7080 -> 8080
Forwarding from [::]:7080 -> 8080
Handling connection for 7080

```



CONCLUSION:

Here we studied Kubernetes cluster architecture in detail. Also we installed Kubernetes in ubuntu machine and created a sample deployment.