

TABLE OF CONTENTS

1

KUBERNETES INTRODUCTION

- Monolithic Architecture VS Microservices
- Architecture?
- Features of Kubernetes
- Alternatives of Kubernetes
- Docker Swarm VS Kubernetes
- Master-Slave/ Client-Server Architecture in Kubernetes

2

KUBERNETES ARCHITECTURE- MASTER NODE

- API Server
- Etcdb
- Controller Manager
- Scheduler
- Explained with Shopping Mall Example

3

KUBERNETES ARCHITECTURE- WORKER NODE

- kubelet
 - kub-proxy
 - pods
 - container engine
- 
- Explained with Store Managers Example

4

SETTING UP MINIKUBE ON YOUR MACHINE

- Prerequisites
- HandsOn
- Creating Your First Pod
- Deploy the Pod



5

KUBECONFIG, SERVICES, AND DEPLOYMENTS FILES EXPLAINED

Kubeconfig Files

Service File

Deployment files

HandsOn

6

DEPLOYING YOUR FIRST NODEJS APPLICATION ON KUBERNETES CLUSTER

Demonstration



7

KUBERNETES LABELS, SELECTORS, AND NODE SELECTORS

Labels

Labels-Selectors

Node Selector

HandsOn

8

REPLICATIONCONTROLLER & REPLICASET

ReplicationController

ReplicaSet

HandsOn



9

DEPLOYMENT OBJECT IN KUBERNETES

Use Cases for the Deployment Object

HandsOn

10

KUBERNETES CLUSTER(MASTER+WORKER NODE)

USING KUBEADM ON AWS

ReplicationController

ReplicaSet

HandsOn

11

KUBERNETES NETWORKING (SERVICES)

Cluster IP
NodePort
LoadBalancer
ExternalName
HandsOn

12

KUBERNETES ADVANCED NETWORKING: CNI AND CALICO

Alternative of Calico CNI
Key Concepts and Real-time
Example
HandsOn

13

KUBERNETES VOLUMES AND LIVENESSPROBES

EmptyDir
HandsOn
hostPath
HandsOn
Persistent Volume
Persistent Volume Claim(PVC)
HandsOn
LivenessProbe(HealthCheck)
HandsOn

14

KUBERNETES CONFIGMAPS & SECRETS

ConfigMaps
HandsOn
CM from file
CM from the env file
CM from the YAML file
Secrets
HandsOn
Creating Secrets from literal
Secrets from file
Secrets from the env file
CM from the YAML file



15

KUBERNETES JOBS

Use cases
Key-Features
HandsOn

16

KUBERNETES INITCONTAINER

Use cases
HandsOn



17

KUBERNETES POD LIFECYCLE

Types of Pod state

18

KUBERNETES NAMESPACE

When should we consider Kubernetes Namespaces?
HandsOn



19

KUBERNETES RESOURCEQUOTA

Limit & Request
HandsOn



20

KUBERNETES AUTOSCALING

Types of Autoscaling
Key Features of Horizontal Pod AutoScaler
HandsOn

21

MULTI-CLUSTER KUBERNETES WITH HAProxy

HAproxy
Demonstration

22

KUBERNETES INGRESS

Path-based routing
Host-based routing
HandsOn



Google Cloud

23

KUBERNETES STATEFULSETS

Stateful VS Stateless applications
StatefulSets VS Deployment
Key Features StatefulSets
HandsOn

24

KUBERNETES DAEMONSET

DaemonSet Key Features
UseCases
HandsOn



25

KUBERNETES NETWORK POLICIES

Network Policy
Key Features
Use cases of Network Policy
HandsOn

26

KUBERNETES OPERATORS

What are Operators?
Features of Operators:
Custom Resource Definition
Custom Controller
Custom Resource



27

HELM & HELM CHARTS

Helm

Helm Deployment

HandsOn



28

HELM PROJECT

Deploy Flask Application using Helm Chart and many more features

29

AWS ELASTIC KUBERNETES SERVICE(EKS)

What is AWS EKS?

Key Features

AWS EKS Costing

HandsOn

30

AZURE KUBERNETES SERVICE(AKS)

What is AKS?

Key Features

Azure AKS Costing

HandsOn



31

GOOGLE KUBERNETES ENGINE (GKE)

What is GKE?

Key Features

HandsOn

32

END-TO-END DEVSECOPS KUBERNETES PROJECT

Tools

GitHub

AWS (Cloud)

Jenkins

Prometheus, Node Exporter, Grafana

Trivy, Sonarqube, OWASP

Kubernetes



Introduction to Kubernetes

Official Definition of Kubernetes

Kubernetes is an open-source container orchestration engine designed for automating the deployment, scaling, and management of containerized applications. This open-source project is hosted by the Cloud Native Computing Foundation (CNCF).

Understanding of Kubernetes and Docker

To grasp Kubernetes, also known as K8s, it's essential to have a foundation in Docker. In Docker, we deploy our applications inside containers. However, in Kubernetes, we manage containers on a larger scale, often numbering in the thousands or more, depending on the application's traffic.

Visualizing Docker and Kubernetes

In Docker, imagine a ship containing containers.

Now, in Kubernetes, picture that same ship, but this time, it has a steering wheel. Just like a captain operates the ship's wheel to make decisions about its course, Kubernetes acts as the "ship wheel" for managing containers.

Kubernetes is an open-source platform, meaning its source code is freely available for anyone to use, modify, and redistribute.

What are Monolithic Architecture and Microservices Architecture?

Monolithic Architecture:

Imagine a restaurant where everything happens in one big kitchen. This kitchen handles taking orders, cooking food, and serving customers all in a single place.

In this scenario, if the kitchen gets too crowded or if there's a problem with one part of the kitchen, it can affect the entire restaurant's operation.

If the chef is sick, the entire kitchen may come to a halt, impacting the entire dining experience.

Microservices Architecture:

Now, consider a food delivery service like Zomato or Swiggy. Instead of one big kitchen, they have a network of different restaurants, each specializing in a specific type of regional food or cuisine.

When you place an order, it's not prepared in a single kitchen rather, each restaurant (microservice) prepares its own portion of the order. These portions are then assembled and delivered to you.

If one restaurant has an issue, it doesn't necessarily impact the others. For example, if the burger place is busy, it won't affect the rolls restaurant's ability to fulfill orders.

Key Differences:

- Monolithic architecture is like a single kitchen handling all tasks, while microservices architecture is like multiple specialized restaurants working together.
- Monoliths are typically easier to set up and manage initially, while microservices offer more flexibility and scalability.
- Monoliths can have a single point of failure, while microservices are more fault-tolerant because a failure in one microservice doesn't necessarily affect the others.

In the end, Kubernetes helps to achieve microservice-based architecture which is good for business aspects, etc.

Why do we need Kubernetes?

After Docker came into the Picture, the deployment of the applications was very easy on the containers because containers are lightweight. But after some time, there were a lot of issues arose such as managing the huge amount of containers in the Production environment where Containers failed leading to huge Business losses.

After Kubernetes came, it automates many tasks such as:

- Autoscaling of Containers according to the peak or normal hours.
- Load balancing of multiple containers.
- Automatically deployment of containers to the available nodes in the cluster.
- Self-healing if containers fail.

Kubernetes Origins and Open Source:

Kubernetes was created by Google in 2013 in Golang. Initially, Kubernetes was not open source but in 2014, google introduced Kubernetes open source and donated to CNCF.

Languages Supported by Kubernetes

Kubernetes supports both YAML and JSON for configuration.

Features of Kubernetes

- **AutoScaling:** Kubernetes supports two types of autoscaling horizontal and vertical scaling for large-scale production environments which helps to reduce the downtime of the applications.
- **Auto Healing:** Kubernetes supports auto healing which means if the containers fail or are stopped due to any issues, with the help of Kubernetes components(which will talk in upcoming days), containers will automatically repaired or heal and run again properly.
- **Load Balancing:** With the help of load balancing, Kubernetes distributes the traffic between two or more containers.
- **Platform Independent:** Kubernetes can work on any type of infrastructure whether it's On-premises, Virtual Machines, or any Cloud.
- **Fault Tolerance:** Kubernetes helps to notify nodes or pods failures and create new pods or containers as soon as possible
- **Rollback:** You can switch to the previous version.
- **Health Monitoring of Containers:** Regularly check the health of the monitor and if any container fails, create a new container.
- **Orchestration:** Suppose, three containers are running on different networks (On-premises, Virtual Machines, and On the Cloud). Kubernetes can create one cluster

that has all three running containers from different networks.

Alternatives of Kubernetes

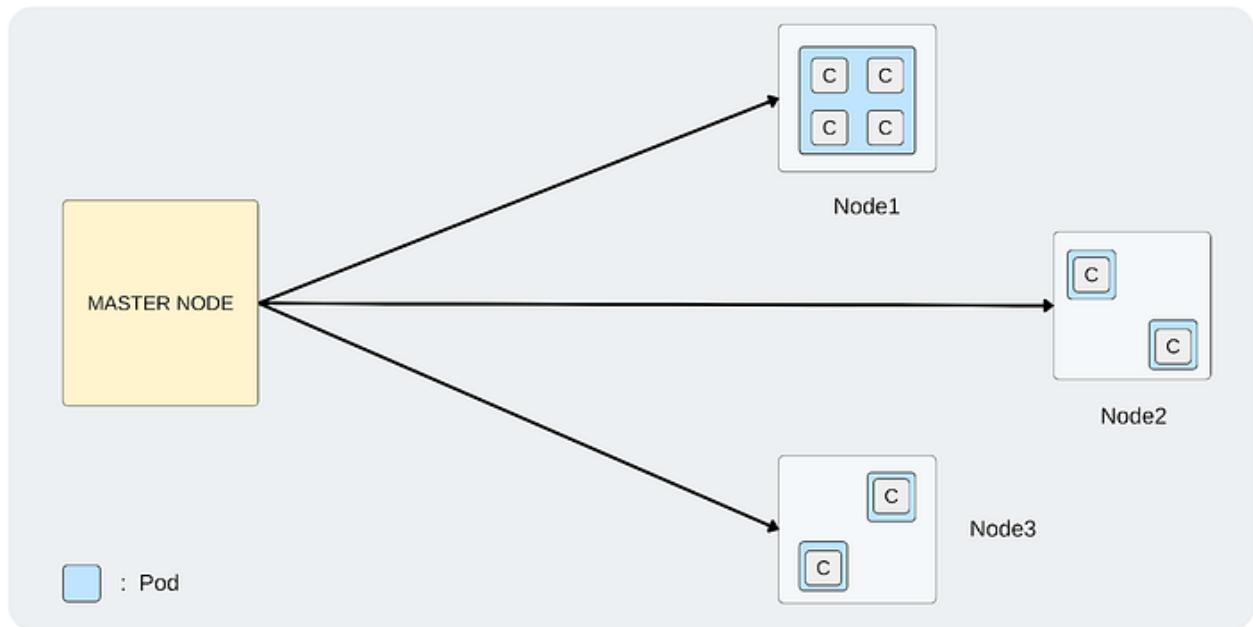
- Docker Swarm
- Apache Mesos
- Openshift
- Nomad, etc

We don't need to know the other alternative in depth except Docker Swarm as our main focus is Kubernetes.

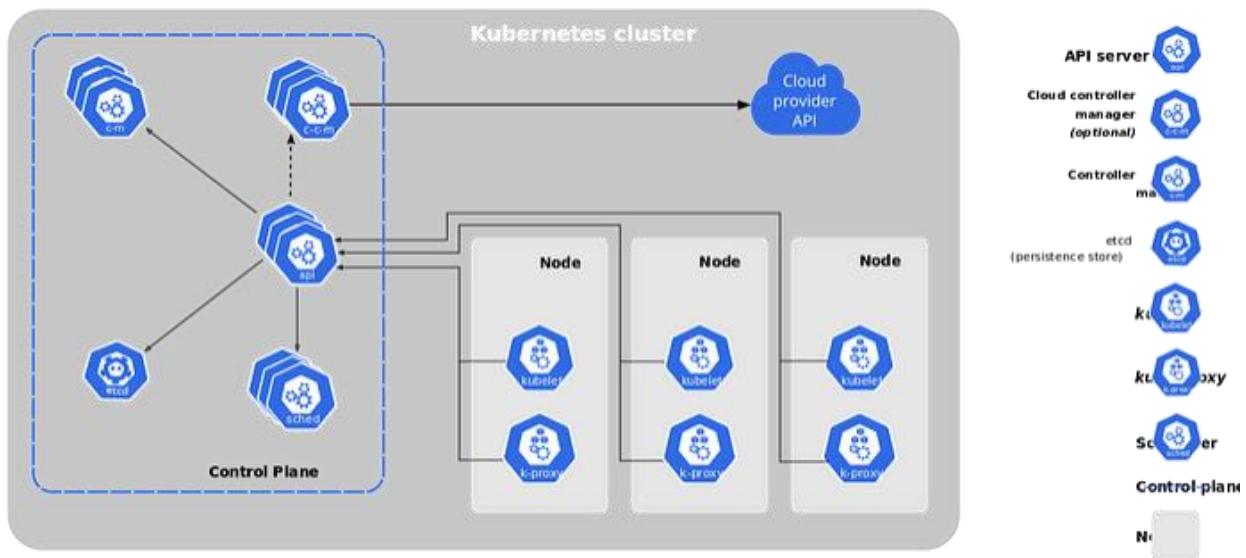
Difference between Docker Swarm and Kubernetes

Docker Swarm VS Kubernetes		
	DOCKER SWARM	KUBERNETES
INSTALL & CONFIGURATIONS	Quite Easy and Fast	Complicated and Time Consuming
SUPPORTS	Only work with Docker Containers	Can work with any other containers such as Docker, ContainerD, etc.
DATA VOLUMES	Can be shared with any other Containers	Can be shared to the same pod's containers
GUI	Not Supported	Supported
AUTOSCALING	Not Supported	Supported

Master-Slave/ Client-Server Architecture in Kubernetes



Kubernetes Architecture- Master Node



Kubernetes Architecture By Kubernetes

Kubernetes follows client-server architecture where the Master Node and Worker node exist which constitutes a ‘Kubernetes Cluster’. We can have multiple worker nodes and Master nodes according to the requirement.

Control Plane

The control plane components, including the API server, etcd, scheduler, and controller manager, are typically found on the master node(s) of a Kubernetes cluster. These components are responsible for managing and controlling the cluster as a whole.

Master Node

The master node is responsible for the entire Kubernetes cluster and manages all the activities inside the cluster in which master nodes communicate with the worker node to run the applications on the containers smoothly. Master Node has four primary components which help to manage all the things that we have discussed earlier:

1. **API Server:** In Simple terms, after installing the kubectl on the master node developers run the commands to create pods. So, the command will go to the API Server, and then, the API Server forwards it to that component which will help to create the pods. In other words, the API Server is an entry point for any Kubernetes task where the API Server follows the hierarchical approach to implement the things.
2. **Etcd:** Etcd is like a database that stores all the pieces of information of the Master node and Worker node(entire cluster) such as Pods IP, Nodes, networking configs, etc. Etcd stored data in key-value pair. The data comes from the API Server to store in etc.
3. **Controller Manager:** The controller Manager collects the data/information from the API Server of the Kubernetes cluster like the desired state of the cluster and then decides what to do by sending the instructions to the API Server.
4. **Scheduler:** Once the API Server gathers the information from the Controller Manager, the API Server notifies the Scheduler to perform the respective task such as increasing the number of pods, etc. After getting notified, the Scheduler takes action on the provided work.

Let's understand all four components with a real-time example.

Master Node — Mall Management:

- In a shopping mall, you have a management office that takes care of everything. In Kubernetes, this is the Master Node.
- The Master Node manages and coordinates all activities in the cluster, just like mall management ensures the mall runs smoothly.

kube-apiserver — Central Control Desk:

- Think of the kube-apiserver as the central control desk of the mall. It's where all requests (like store openings or customer inquiries) are directed.
- Just like mall management communicates with stores, kube-apiserver communicates with all Kubernetes components.

etcd — Master Records:

- etcd can be compared to the master records of the mall, containing important information like store locations and hours.

- It's a key-value store that stores configuration and cluster state data.

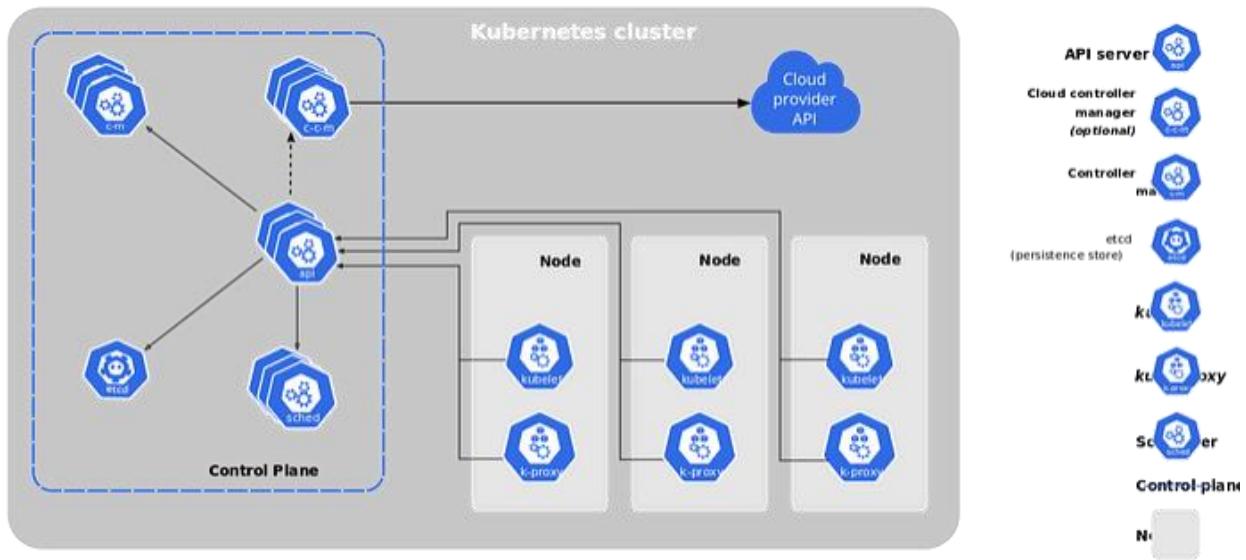
kube-controller-manager — Task Managers:

- Imagine having specialized task managers for different mall departments, like security and maintenance.
- In Kubernetes, the kube-controller-manager handles various tasks, such as ensuring the desired number of Pods are running.

kube-scheduler — Scheduler Manager:

- Think of the kube-scheduler as a manager who decides which employees (Pods) should work where (on which Worker Node).
- It ensures even distribution and efficient resource allocation.

Kubernetes Architecture- Worker Node



Kubernetes Architecture By Kubernetes(Credit)

Worker Node

The Worker Node is the mediator who manages and takes care of the containers and communicates with the Master Node which gives the instructions to assign the resources to the containers scheduled. A Kubernetes cluster can have multiple worker nodes to scale resources as needed.

The Worker Node contains four components that help to manage containers and communicate with the Master Node:

1. **Kubelet:** kubelet is the primary component of the Worker Node which manages the Pods and regularly checks whether the pod is running or not. If pods are not working properly, then kubelet creates a new pod and replaces it with the previous one because the failed pod can't be restarted hence, the IP of the pod might be changed. Also, kubelet gets the details related to pods from the API Server which exists on the Master Node.
2. **Kube-proxy:** kube-proxy contains all the network configuration of the entire cluster such as pod IP, etc. Kube-proxy takes care of the load balancing and routing which comes under networking configuration. Kube-proxy gets the information about pods from the API Server which exists on Master Node.

3. **Pods:** A pod is a very small unit that contains a container or multiple containers where the application is deployed. Pod has a Public or Private IP range that distributes the proper IP to the containers. It's good to have one container under each pod.
4. **Container Engine:** To provide the runtime environment to the container, Container Engine is used. In Kubernetes, the Container engine directly interacts with container runtime which is responsible for creating and managing the containers. There are a lot of Container engines present in the market such as CRI-O, containerd, rkt(rocket), etc. But Docker is one of the most used and trusted Container Engine. So, we will use that in our upcoming day while setting up the Kubernetes cluster.

Let's continue to understand all four components with a real-time example.

Worker Nodes — Storefronts:

Kubelet — Store Managers:

- In each store (Worker Node), you have a store manager (Kubelet) who ensures employees (Pods) are working correctly.
- Kubelet communicates with the Master Node and manages the Pods within its store.

kube-proxy — Customer Service Desk:

- kube-proxy acts like a customer service desk in each store. It handles customer inquiries (network requests) and directs them to the right employee (Pod).
- It maintains network rules for load balancing and routing.

Container Runtime — Employee Training:

- In each store, you have employees (Pods) who need training to perform their tasks.
- The container runtime (like Docker) provides the necessary training (runtime environment) for the employees (Pods) to execute their tasks.

Setting up Minikube on Your Machine

Why Set Up Minikube?

Before we begin, you might be wondering why it's essential to set up Minikube. Well, Minikube provides an excellent environment for learning and experimenting with Kubernetes without the need for a full-scale cluster. It's perfect for developers and enthusiasts who want to get hands-on experience with Kubernetes in a controlled environment.

Prerequisites

To follow along with this tutorial, you'll need the following:

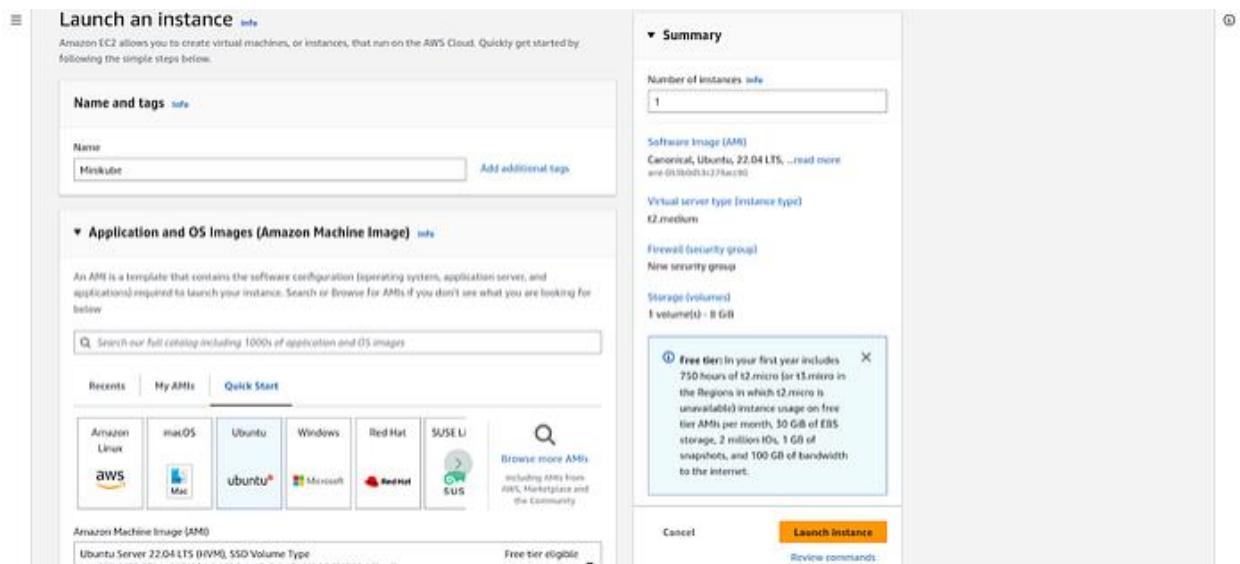
- An AWS account (if you're setting up on an AWS instance).
- Basic knowledge of AWS and Linux terminal commands.

Let's get started!

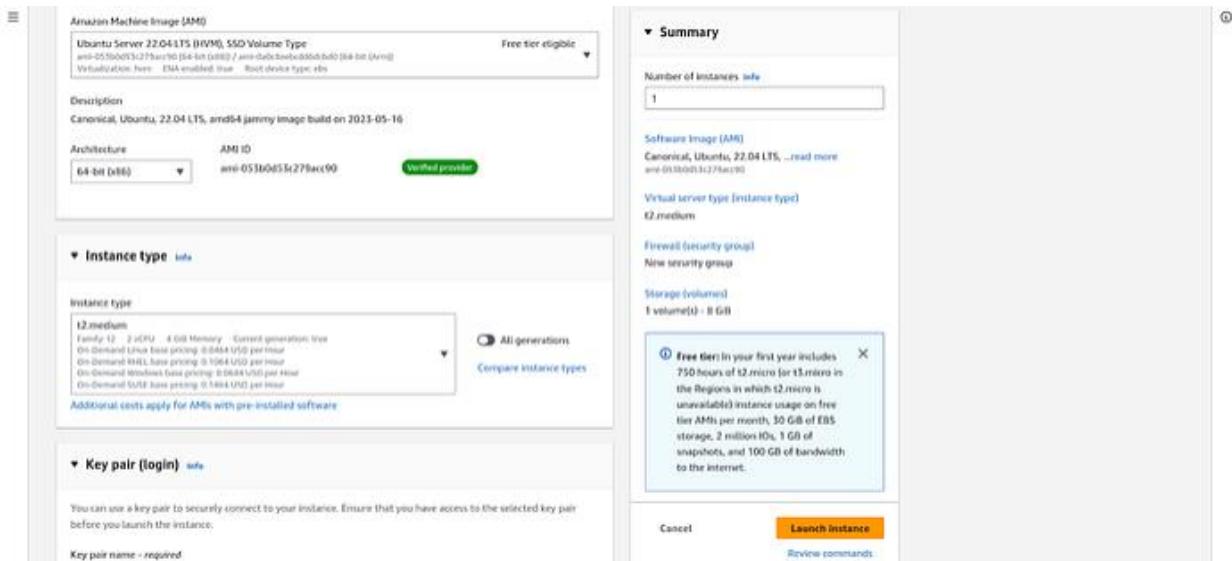
Setting Up Minikube on AWS Instance

Here, I am creating an EC2 Instance to set up minikube on the server. If you are comfortable setting up minikube on your local then feel free to jump on the minikube setup.

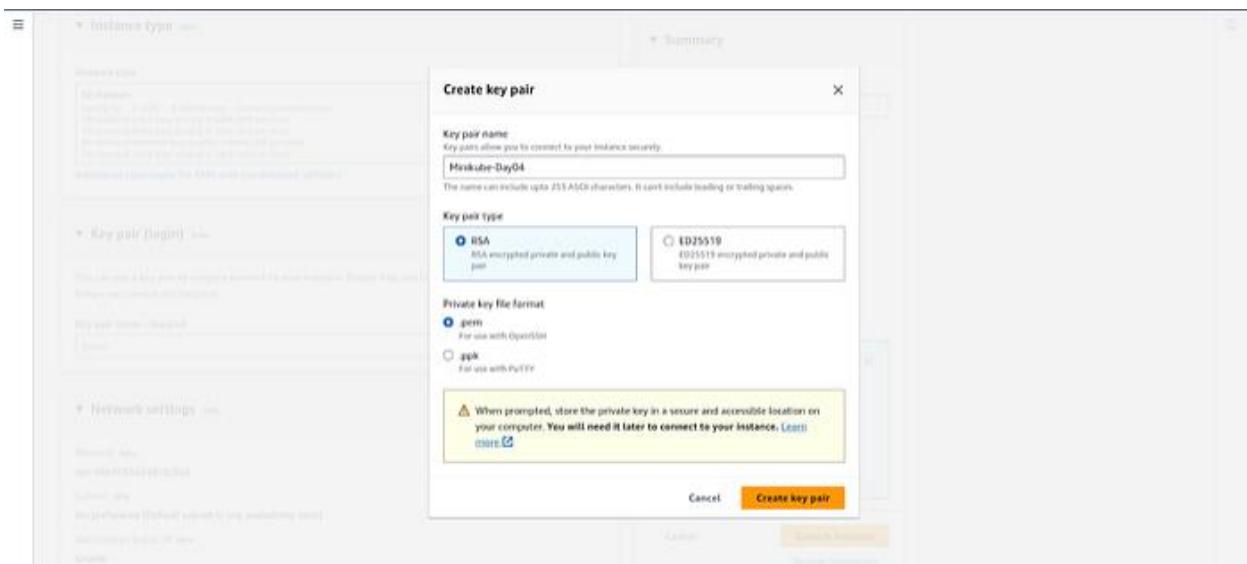
Enter the name of the machine and select the Ubuntu22.04 AMI Image.



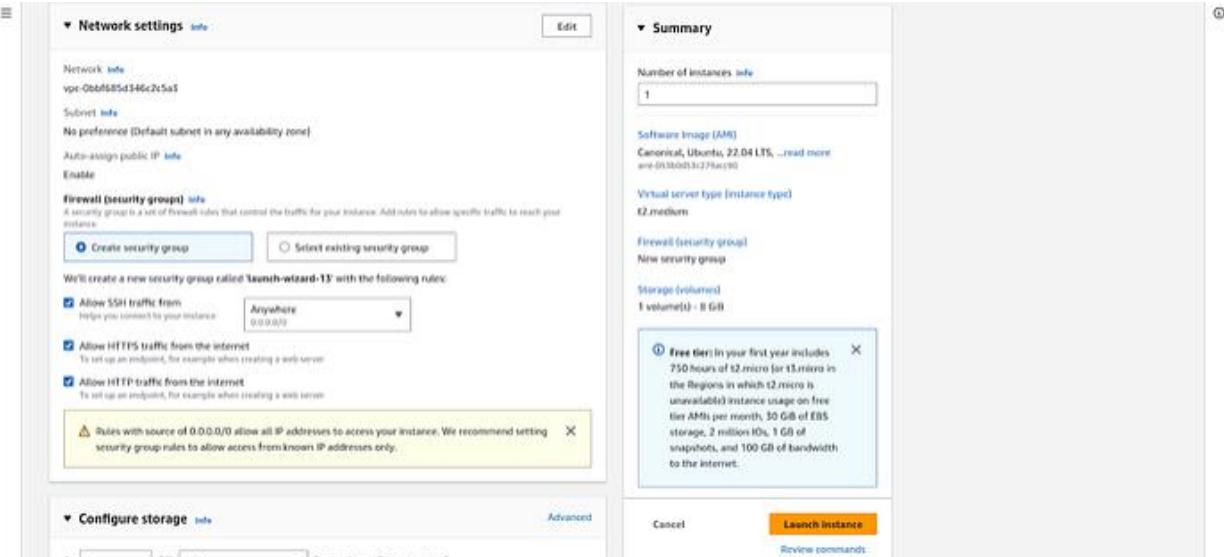
Make sure to select the t2.medium instance type as Master node 2CPU cores which is present in the t2.medium instance type.



Create a new key pair and select the Private key file format according to your OS(For Windows select .pk or for Linux select .pem).



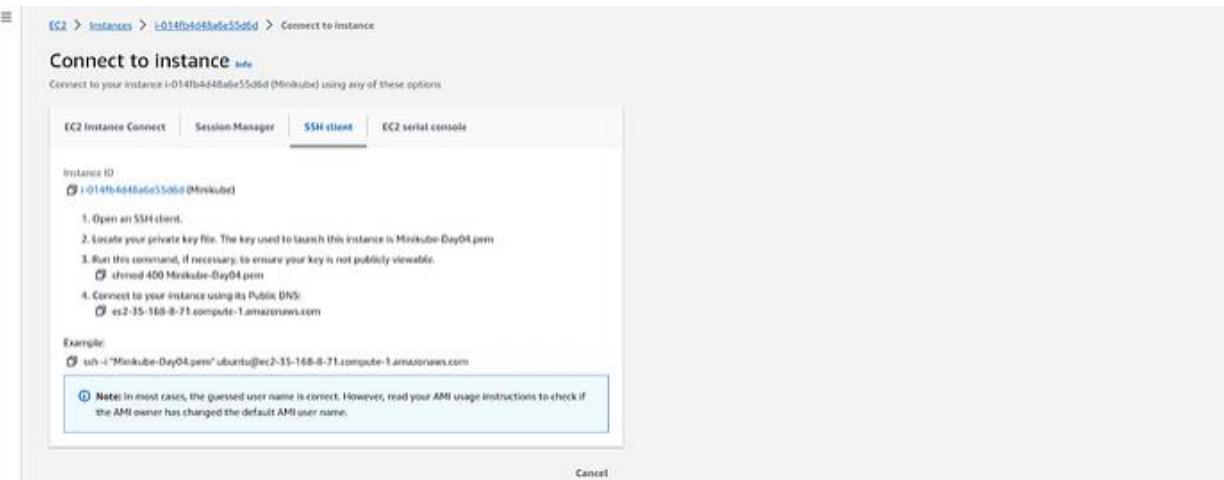
Open port 22 and rest you can leave it.



Now, go to your Downloads folder or where you have downloaded your pem file and change the permission by running the command ‘chmod 400 <Pem_file_name>

```
anupathak@pop-os:~/Downloads$ ls | grep Minikube
Minikube-Day04.pem
anupathak@pop-os:~/Downloads
anupathak@pop-os:~/Downloads
anupathak@pop-os:~/Downloads$ sudo chmod 400 Minikube-Day04.pem
[sudo] password for anupathak:
anupathak@pop-os:~/Downloads$
```

Now, connect your instance by copying the given command below.



As you can see I logged in to the Instance.

```

anupathak@pop-os:~/Downloads$ ls | grep Minikube
Minikube-Day04.pem
anupathak@pop-os:~/Downloads$ 
anupathak@pop-os:~/Downloads$ 
anupathak@pop-os:~/Downloads$ sudo chmod 400 Minikube-Day04.pem
[sudo] password for anupathak:
anupathak@pop-os:~/Downloads$ ssh -l "Minikube-Day04.pem" ubuntu@ec2-35-168-8-71.compute-1.amazonaws.com
The authenticity of host 'ec2-35-168-8-71.compute-1.amazonaws.com (35.168.8.71)' can't be established.
ED25519 key fingerprint is SHA256:G/8kRr9IJZcIPkpjwFG5MaPQnvtVeOM4dExVJWtI0.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-35-168-8-71.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.19.0-1625-aws x86_64)

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

System information as of Fri Oct  6 09:39:35 UTC 2023

System load: 0.02978515625  Processes:           111
Usage of /: 20.6% of 7.57GB  Users logged in:    0
Memory usage: 6%            IPv4 address for eth0: 172.31.58.28
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

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-58-28:~$ 

```

Now, run the following commands to install minikube on your local machine or AWS machine.

sudo apt update -y && sudo apt upgrade -y

sudo reboot

After 3 to 4 minutes, reconnect with the instance through ssh

sudo apt install docker.io

sudo usermod -aG docker \$USER && newgrp docker

sudo apt install -y curl wget apt-transport-https

curl -LO https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64

sudo install minikube-linux-amd64 /usr/local/bin/minikube

minikube version

I have given the line break in the below curl command, Kindly avoid the break and any whitespaces after ` . You can refer to the below screenshot.

curl -LO https://storage.googleapis.com/kubernetes-release/release/`

curl -s https://storage.googleapis.com/kubernetes-release/release/stable.txt`/bin/linux/amd64/kubect
tl

```

curl -LO https://storage.googleapis.com/kubernetes-release/release/`curl -s https://storage.googleapis.com/kubernetes-release/release/stable.txt`/bin/linux/amd64/kubectl

```

```
chmod +x kubectl
```

```
sudo mv kubectl /usr/local/bin
```

```
kubectl version -o yaml
```

```
minikube start - vm-driver=docker
```

Now, to verify the installation you can run the given command and if you get the result in the snippet then your installation is completed.

```
minikube status
```

```
root@ip-172-31-58-28:/home/ubuntu# minikube status
minikube
  type: Control Plane
  host: Running
  kubelet: Running
  apiserver: Running
  kuberconfig: Configured
```

You can also validate your kubectl version by running the command.

```
kubectl version
```

Now, run the given command after 4 to 5 minutes which will show the nodes.

```
kubectl get nodes
```

```
root@ip-172-31-58-28:/home/ubuntu# kubectl get nodes
NAME      STATUS    ROLES      AGE      VERSION
minikube  Ready     control-plane   5m5s    v1.27.4
root@ip-172-31-58-28:/home/ubuntu# 
```

Creating Your First Pod

To get some hands-on experience, let's create a simple manifest file and deploy a pod on your Minikube cluster. Don't worry if you don't understand everything in the manifest file; we'll cover that in later days.

Create a new file and copy the given content to your file without editing anything. While running the manifest file, if you get any error then it must be related to the indentation of the file. So, check the file again.

```
vim Day04.yaml
kind: Pod
apiVersion: v1
metadata:
  name: testpod
spec:
  containers:
    - name: c00
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo Hello-Kubernetes; sleep 5 ; done"]
```

```
- name: container2
  image: ubuntu
  command: ["/bin/bash", "-c", "while true; do echo Second Container is still running; sleep 3 ; done"]
  restartPolicy: Never
```

Deploy the Pod:

Run the following command to deploy the pod:

```
kubectl apply -f Day04.yml
```

List Pods:

To list all the pods, use this command:

```
kubectl get pods
```

```
root@ip-172-31-58-28:/home/ubuntu# kubectl get pods
NAME    READY    STATUS    RESTARTS   AGE
pod1   2/2     Running   0          35s
root@ip-172-31-58-28:/home/ubuntu# 
```

Check Logs:

You can check the logs of the primary container with:

```
kubectl logs -f pod1
```

```
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
```

To check the logs of the primary container, specify the container name:

```
kubectl logs -f pod1 -c container1
```

```
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
This is Day04 and We are setting up the Minikube
```

To check the logs of the second container, specify the container name:

```
kubectl logs -f pod1 -c container2
```

```
Second Container is still running  
Second Container is still running
```

Delete the Pod:

To delete the pod, use this command:

```
kubectl delete pod pod1
```

```
root@ip-172-31-58-28:/home/ubuntu# kubectl delete pod pod1  
pod "pod1" deleted
```

To list the IP of the pod, use the below command.

```
kubectl get pod pod1 -c container1 -- hostname -i
```

```
root@ip-172-31-58-28:/home/ubuntu# kubectl exec pod1 -c container1 -- hostname -i  
10.244.0.4  
root@ip-172-31-58-28:/home/ubuntu# kubectl exec pod1 -c container2 -- hostname -i  
10.244.0.4  
root@ip-172-31-58-28:/home/ubuntu# 
```

To delete the pod by specifying the manifest file name

```
kubectl delete -f Day04.yml
```

```
root@ip-172-31-58-28:/home/ubuntu# kubectl delete -f Day04.yml  
pod "pod1" deleted  
root@ip-172-31-58-28:/home/ubuntu# 
```

Kubeconfig, Services, and Deployments Files Explained

Kubeconfig Files

- **Purpose:** Kubeconfig files are used for cluster access and authentication. Kubeconfig defines how 'kubectl' or any other Kubernetes clients interact with the Kubernetes cluster.
- **Contents:** The Kubeconfig file contains information about the cluster, user credentials, certificates, and context.
- **Usage:** Kubeconfig files are used by Administrators, developers, or CI/CD systems to authenticate the Kubernetes cluster. They decide who can access and how to access the cluster.

Kubeconfig files can be stored in the user's home directory (~/.kube/config) or specified using the KUBECONFIG environment variable.

Service File

- **Purpose:** Service files contain all information about networking. The service file defines how networking will be handled on the cluster. Also, the Service file enabled the load balancing option for the applications which is a premium feature of Kubernetes.
- **Contents:** The service file specifies the service's name, type(ClusterIP, NodePort, LoadBalancer, etc[Discuss in Upcoming Blogs]), and selectors to route traffic to pods.
- **Usage:** Service files are used by developers and administrators to expose and connect applications within the Kubernetes cluster.

Note: Services can also be used for internal communication between Pods within the cluster, not just for exposing applications externally.

Deployment files

- **Purpose:** Deployment files contain all information about the application and define how the application or microservices will be deployed on the Kubernetes cluster. In deployment files, we can define the desired state, pod replicas, update strategies, and pod templates.
- **Contents:** Deployment files define the desired state of a deployment, pod replicas, container images, and resource limits.
- **Usage:** Deployment files are mainly used by developers and administrators to manage the application lifecycle within Kubernetes. They enable declarative application management, scaling, and rolling updates.

Practical Examples

To make things even clearer, let's dive into some practical examples:

Kubeconfig file explained

```
apiVersion: v1
kind: Config
clusters: [REDACTED]
- name: my-cluster
  cluster: [REDACTED]
    server: https://api.example.com
    certificate-authority-data: <ca-data>
users: [REDACTED]
- name: my-user
  user: [REDACTED]
    client-certificate-data: <client-cert-data>
    client-key-data: <client-key-data>
contexts: [REDACTED]
- name: my-context
  context: [REDACTED]
    cluster: my-cluster
    user: my-user
    namespace: my-namespace
current-context: my-context
```

In this example,

- **apiVersion** and **kind** define the resource type.
- **clusters** specifies the clusters with its server and URL and Certificate Authority(CA) data. Here we have to define the server link or Kubernetes API Server of the Kubernetes cluster. So, when we run any command using kubectl then kubectl interacts with the given link or Kubernetes API Server of the Kubernetes cluster.
- **users** specify the users with their client certificate and client key name. So, only authorized users can access the Kubernetes cluster.
- **contexts** specify the cluster, user, and namespace information that has been defined above. You can create multiple contexts and switch between any different clusters at any time.
- **current-context** specifies that on which cluster the command should run. If you set the current-context one time then you won't have to specify again and again while running the commands.

Service file explained

```
apiVersion: v1
kind: Service
metadata: [REDACTED]
name: my-app-service
spec: [REDACTED]
selector: [REDACTED]
```

```
app: my-app
ports:
- protocol: TCP
  port: 80
  targetPort: 8080
```

In this example,

- **apiVersion** and **kind** specify the resource type
- **metadata** specify the name of the service
- **spec** specify the desired state of the Service
- **selector** specifies on which pod the configurations will be invoked. If the pod label matches by app value then it will apply the configuration on that pod
- In the **ports** section, **protocol** specifies the network protocol such as TCP, UDP, etc.
- **ports** specifies on which port the service listens for the incoming traffic from the external sources.
- **targetports** specify on which port the pod is listening.

Example for port and targetports:

Suppose you have a React.js application running inside a Kubernetes Pod, and it's configured to listen on port 3000 within the Pod. However, you want external traffic to reach your application on port 80 because that's the standard HTTP port. To achieve this, you create a Kubernetes Service with a targetPort set to 3000 and a port set to 80. The Service acts as a bridge, directing incoming traffic from port 80 to the application running on port 3000 inside the Pod. This redirection allows users to access your React.js app seamlessly over the standard HTTP port.

Deployment file explained

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-app
spec:
  replicas: 3
  selector:
    matchLabels:
      app: my-app
  template:
    metadata:
      labels:
        app: my-app
    spec:
      containers:
        - name: my-app-container
          image: my-app-image:latest
```

In this example,

- **apiVersion** and **kind** define the resource type
- **metadata** specify the details of deployment such as the name of the deployment, and labels.
- **spec** defines the desired state of the Deployment.
- **replicas** specify the desired number of pods to maintain.
- The **selector** specifies on which pod the replica configuration should be applied with the help of the label of the pod.
- **template** describes the pod template and how deployment will use it to create new pods.
- **containers** will list the containers to run within the pod.
- **name** specifies the name of the container
- **image** specifies the name that will be used to run the container. The image will be a Docker Image.
- **containerport** specifies the port at which the container will listen for incoming traffic.

Deploying Your First Nodejs Application on Kubernetes Cluster

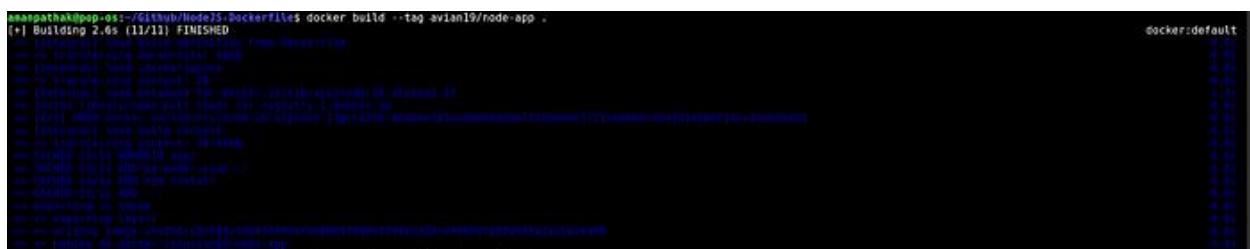
To follow this, you need to install minikube on your local/AWS machine. If you don't know then you can refer to my step-by-step blog which will help you to do it.

[Day 04: Setting up Minikube on Your Local Machine or AWS Instance | by Aman Pathak | DevOps.dev](#)

Step 1: Create a Docker Image

Assuming you're already familiar with Docker, let's create a Docker image for your Node.js project. Open your terminal and use the following command to build the image:

```
docker build --tag avian19/node-app .
```



```
amarpathak@pop-os:~/Github/NodeJS-Dockerfiles$ docker build --tag avian19/node-app .
[+] Building 2.6s (11/11) FINISHED
   context: ./..
      +--> c8c589c3d307: Pull complete
      +--> 13af011e3d27750e99ff12d37e8493ac0ff3e40e0d6cba2a: Pull complete
      +--> 36650b131297: Pull complete
      +--> 0044c06a7c9d: Pull complete
      +--> 1ec4d8be48b2: Pull complete
      +--> fb58a361cad0: Pull complete
      +--> ab44c4d4d407: Pull complete
      +--> ef0ccfcd811: Pull complete
      +--> e9303a3a234d: Pull complete
      +--> 11c11fd6eae: Pull complete
      +--> 0044c06a7c9d: Pull complete
      +--> 1ec4d8be48b2: Pull complete
      +--> fb58a361cad0: Pull complete
      +--> latest: Digest: sha256:f406af12c91eaac13af011e3d27750e99ff12d37e8493ac0ff3e40e0d6cba2a size: 1994
```

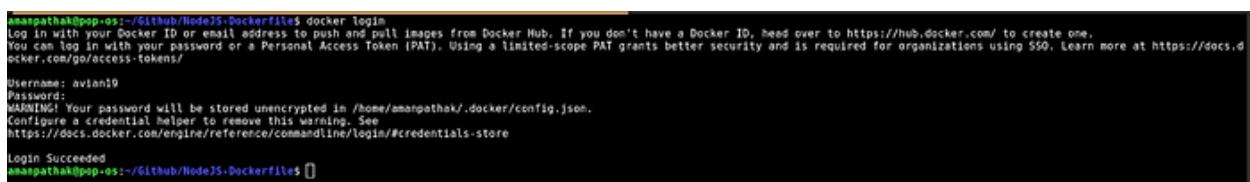


```
amarpathak@pop-os:~/Github/NodeJS-Dockerfiles$ docker images
REPOSITORY          TAG      IMAGE ID      CREATED             SIZE
avian19/node-app   latest   c8c589c3d307  23 minutes ago   193MB
amarpathak@pop-os:~/Github/NodeJS-Dockerfiles$
```

Step 2: Push the Docker Image to Docker Hub

To share your Docker image with your Kubernetes cluster, you can push it to Docker Hub. First, log in to Docker Hub using your terminal:

```
docker login
```



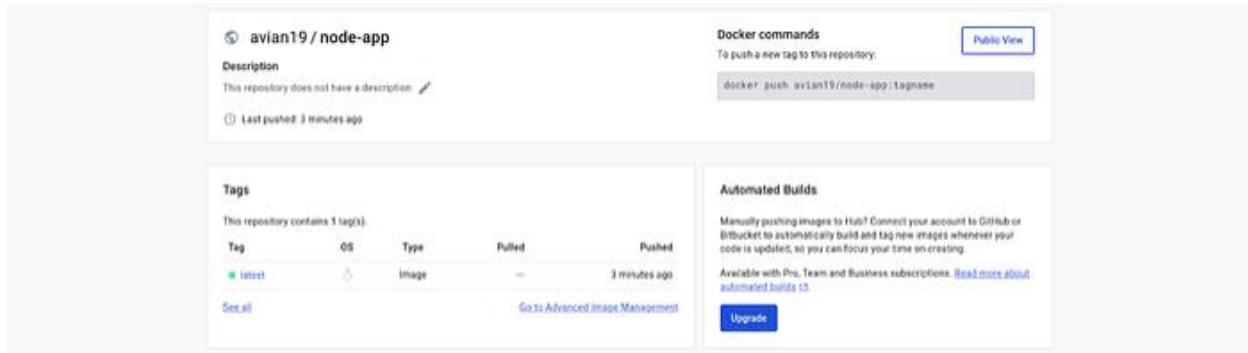
```
amarpathak@pop-os:~/Github/NodeJS-Dockerfiles$ docker login
Log in with your Docker ID or email address to push and pull images from Docker Hub. If you don't have a Docker ID, head over to https://hub.docker.com/ to create one.
You can log in with your password or a Personal Access Token (PAT). Using a limited-scope PAT grants better security and is required for organizations using SSO. Learn more at https://docs.docker.com/go/access-tokens/
Username: avian19
Password:
WARNING! Your password will be stored unencrypted in /home/amarpathak/.docker/config.json.
Configure a credential helper to remove this warning. See
https://docs.docker.com/engine/reference/commandline/login/#credentials-store
Login Succeeded
amarpathak@pop-os:~/Github/NodeJS-Dockerfiles$
```

Then, push the Docker image:



```
amarpathak@pop-os:~/Github/NodeJS-Dockerfiles$ docker push avian19/node-app:latest
The push refers to repository [docker.io/avian19/node-app]
ab44c4d4d407: Pushed
ef0ccfcd811: Pushed
e9303a3a234d: Pushed
11c11fd6eae: Pushed
0044c06a7c9d: Pushed
1ec4d8be48b2: Pushed
fb58a361cad0: Pushed
36650b131297: Pushed
latest: digest: sha256:f406af12c91eaac13af011e3d27750e99ff12d37e8493ac0ff3e40e0d6cba2a size: 1994
```

You can confirm that your image has been successfully pushed to Docker Hub.



Step 3: Prepare Kubernetes Deployment and Service Files

Create a dedicated directory for your Node.js application's deployment. Inside this directory, add the contents of your deployment.yml and service.yml files.

deployment.yml file

```
apiVersion: apps/v1
kind: Deployment
metadata: [REDACTED]
  name: node-app-deployment
labels: [REDACTED]
  app: node-app
spec: [REDACTED]
  replicas: 2
  selector: [REDACTED]
    matchLabels:
      app: node-app
  template: [REDACTED]
    metadata: [REDACTED]
    labels: [REDACTED]
      app: node-app
  spec: [REDACTED]
    containers:
      - name: node-container
        image: avian19/node-app:latest
        ports: [REDACTED]
          - containerPort: 3000
service.yml file [REDACTED]
apiVersion: v1
kind: Service
metadata: [REDACTED]
  name: node-app-service
spec: [REDACTED]
  selector: [REDACTED]
    app: node-app
  type: LoadBalancer
```

```
ports:  
- protocol: TCP  
  port: 5000  
  targetPort: 3000  
  nodePort: 30001
```

```
ubuntu@ip-172-31-49-109:~/node-app$ mkdir node-app  
ubuntu@ip-172-31-49-109:~/node-app$ cd node-app/  
ubuntu@ip-172-31-49-109:~/node-app$ sudo vim deployment.yml  
ubuntu@ip-172-31-49-109:~/node-app$ sudo vim service.yml  
ubuntu@ip-172-31-49-109:~/node-app$ █
```

Step 4: Deploy Pods

To deploy the pods, use the deployment.yml file with the following command:

```
kubectl apply -f deployment.yml
```

```
ubuntu@ip-172-31-49-109:~/node-app$ kubectl apply -f deployment.yml  
deployment.apps/node-app-deployment created  
ubuntu@ip-172-31-49-109:~/node-app$ kubectl get pods  
NAME           READY   STATUS    RESTARTS   AGE  
node-app-deployment-99d848784-g568r   1/1     Running   0          13s  
node-app-deployment-99d848784-nf9b6   1/1     Running   0          13s  
ubuntu@ip-172-31-49-109:~/node-app$ █
```

Step 5: Deploy Services

Next, deploy the services using the service.yml file:

```
kubectl apply -f service.yml
```

```
ubuntu@ip-172-31-49-109:~/node-app$ kubectl apply -f service.yml  
service/node-app-service created  
ubuntu@ip-172-31-49-109:~/node-app$ kubectl get svc  
NAME      TYPE      CLUSTER-IP      EXTERNAL-IP      PORT(S)      AGE  
kubernetes   ClusterIP   10.96.0.1      <none>        443/TCP      85m  
node-app-service   LoadBalancer   10.101.148.185  <pending>      5000:30001/TCP  5s  
ubuntu@ip-172-31-49-109:~/node-app$ █
```

Step 6: Validate the Deployment

You can check the status of your deployment by running the following command:

```
kubectl get deployment
```

```
ubuntu@ip-172-31-49-109:~/node-app$ kubectl get deployment  
NAME      READY   UP-TO-DATE   AVAILABLE   AGE  
node-app-deployment   2/2     2          2          2m36s  
ubuntu@ip-172-31-49-109:~/node-app$ .█
```

Step 7: Access Your Application

To access your deployed application, use the following command to get the URL:

```
minikube service node-app-service
```

You can now use curl to access the content of your Node.js application through the provided URL.



```
ubuntu@ip-172-31-49-109:~/node-app$ minikube service node-app-service
|-----+-----+-----+-----+
| NAMESPACE | NAME | TARGET PORT | URL
|-----+-----+-----+-----+
| default   | node-app-service | 5000 | http://192.168.49.2:3000 |
|-----+-----+-----+-----+
ubuntu@ip-172-31-49-109:~/node-app$ curl http://192.168.49.2:3000
[{"name": "Bill", "email": "billy.gates@gates.com"}, {"name": "Jeff", "email": "bezos.jeff@bezos.com"}, {"name": "Mark", "email": "zuckerberg.mark@fb.com"}]ubuntu@ip-172-31-49-109:~/node-app$
```

In nodejs code, you can see that the content is the same at both places.



```
nodejs
src
  index.js
  Dockerfile
  package-lock.json
  package.json

index.js
1 const express = require('express')
2 const app = express()
3 const port = 3000
4
5 app.get('/', (req, res) => res.json([
6   {
7     name: 'Bill',
8     email: 'billy.gates@gates.com'
9   },
10  {
11    name: 'Jeff',
12    email: 'bezos.jeff@bezos.com'
13  },
14  {
15    name: 'Mark',
16    email: 'zuckerberg.mark@fb.com'
17  }
18])
19
20 app.listen(port, () => {
21   console.log(`Example app listening on port ${port}`)
22 })
```

Kubernetes Labels, Selectors, and Node Selectors

Labels

- Labels are used to organize Kubernetes Objects such as Pods, nodes, etc.
- You can add multiple labels over the Kubernetes Objects.
- Labels are defined in key-value pairs.
- Labels are similar to tags in AWS or Azure where you give a name to filter the resources quickly.
- You can add labels like environment, department or anything else according to you.

Labels-Selectors

Once the labels are attached to the Kubernetes objects those objects will be filtered out with the help of labels-Selectors known as Selectors.

The API currently supports two types of label-selectors equality-based and set-based. Label selectors can be made of multiple selectors that are comma-separated.

Node Selector

Node selector means selecting the nodes. If you are not aware of what is nodes. There are two types of nodes Master Nodes and Worker Nodes.

Master Nodes is responsible for the entire Kubernetes Cluster that communicates with the Worker Node and runs the applications on containers smoothly. Master nodes can have multiple Worker Nodes.

Worker Nodes work as a mediator where the nodes communicate with Master nodes and run the applications on the containers smoothly.

So, the use of node selector is choosing the nodes which means on which worker node the command should be applied. This is done by Labels where in the manifest file, we mentioned the node label name. While running the manifest file, master nodes find the node that has the same label and create the pod on that container. Make sure that the node must have the label. If the node doesn't have any label then, the manifest file will jump to the next node.

Label and Label-Selector HandsOn

If you don't understand properly, don't worry. We will do hands-on which will make it easy to understand the concepts of labels, labels-selectors, and node selectors.

YAML file

```

apiVersion: v1
kind: Pod
metadata:
  name: day07
  labels:
    env: testing
    department: DevOps
spec:
  containers:
    - name: containers1
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo This is Day07 of 30DaysOfKubernetes; sleep 5 ; done"]

```

After creating the pods by the following command.

List the pods to see the labels that are attached to the pod by the given command
`kubectl get pods — show-labels`

```

ubuntu@ip-172-31-63-3:~$ kubectl apply -f pod.yml
pod/day07 created
ubuntu@ip-172-31-63-3:~$ kubectl get pods --show-labels
NAME     READY   STATUS    RESTARTS   AGE   LABELS
day07   1/1     Running   0          13s   department=DevOps,env=testing
ubuntu@ip-172-31-63-3:~$ 

```

I have created one more manifest file that doesn't have any label as you can see in the below screenshot.

```

ubuntu@ip-172-31-63-3:~$ sudo vim pod2.yml
ubuntu@ip-172-31-63-3:~$ kubectl apply -f pod2.yml
pod/testpod created
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME     READY   STATUS    RESTARTS   AGE
day07   1/1     Running   0          2m44s
testpod 2/2     Running   0          8s
ubuntu@ip-172-31-63-3:~$ kubectl get pods --show-labels
NAME     READY   STATUS    RESTARTS   AGE   LABELS
day07   1/1     Running   0          2m53s   department=DevOps,env=testing
testpod 2/2     Running   0          17s    <none>
ubuntu@ip-172-31-63-3:~$ 

```

Now, I want to list those pods that have the label `env=testing`.

As we have discussed earlier, there are two types of label-selectors equality and set-based.

This is the example of equality based where we used `equalsTo(=)`.

`kubectl get pods -l env=testing`

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods -l env=testing
NAME      READY   STATUS    RESTARTS   AGE
day07    1/1     Running   0          4m13s
ubuntu@ip-172-31-63-3:~$ 
```

Now, here I want to list those pods that don't have the label department=DevOps.

```
kubectl get pods -l department!=DevOps
```

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods -l department!=DevOps
NAME      READY   STATUS    RESTARTS   AGE
testpod   2/2     Running   0          3m53s
ubuntu@ip-172-31-63-3:~$ 
```

Now, Suppose I forgot to add the label through the declarative(via manifest) method. So, I can add labels after creating the pods as well which is known as the imperative(via command) method.

In the below screenshot, I have added the new label location and given it the value India.

```
kubectl label pods day07 Location=India
```

```
ubuntu@ip-172-31-63-3:~$ kubectl label pods day07 Location=India
pod/day07 labeled
ubuntu@ip-172-31-63-3:~$ kubectl get pods --show-labels
NAME      READY   STATUS    RESTARTS   AGE      LABELS
day07    1/1     Running   0          9m34s   Location=India,department=DevOps,env=testing
testpod   2/2     Running   0          6m58s   <none>
ubuntu@ip-172-31-63-3:~$ 
```

As we discussed the type of label-selector, let's see the example of a set-based label-selector where we use in, notin, and exists.

In the below screenshot, we are trying to list all those pods that have an env label with value for either testing or development.

```
kubectl get pods -l 'env in (testing, development)'
```

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods -l 'env in (testing,development)'
NAME      READY   STATUS    RESTARTS   AGE
day07    1/1     Running   0          13m
ubuntu@ip-172-31-63-3:~$ 
```

Here, we are trying to list all those pods that don't have the India or US value for the Location key in the Label.

```
kubectl get pods -l 'Location not in (India, US)'
```

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods -l 'Location notin (India,US)'  
NAME      READY   STATUS    RESTARTS   AGE  
testpod   2/2     Running   0          12m  
ubuntu@ip-172-31-63-3:~$ █
```

We can also delete the pods as per the label.

Here, We have deleted all those pods that don't have the Chinda value for the location key in the Label.

```
kubectl delete pod -l Location!=China
```

```
ubuntu@ip-172-31-63-3:~$ kubectl delete pod -l Location!=China  
pod "day07" deleted  
pod "testpod" deleted  
ubuntu@ip-172-31-63-3:~$ .█
```

Here, We have completed the HandsOn for the label and label-selector. You can explore more yourself.

Let's move it to **node-selector**

nodeSelector HandsOn

As you remember, we have set up minikube on our machine. So, our master and worker node is on the same machine.

To list the nodes on the master node, use the command

```
kubectl get nodes
```

```
ubuntu@ip-172-31-63-3:~$ kubectl get nodes  
NAME      STATUS   ROLES      AGE   VERSION  
minikube  Ready    control-plane  72m   v1.27.4  
ubuntu@ip-172-31-63-3:~$ █
```

```
apiVersion: v1  
kind: Pod  
metadata:  
  name: nodelabels  
  labels:  
    env: testing  
spec:  
  containers:  
    - name: container1
```

```

image: ubuntu
command: ["/bin/bash", "-c", "while true; do echo Node-Selector Example; sleep 5 ; done"]
nodeSelector:
hardware: t2-medium

```

Here, I have created the pod but when I list the pods the status is pending for the created pod.

```

ubuntu@ip-172-31-63-3:~$ kubectl apply -f pod3.yml
pod/nodelabels created
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
nodelabels  0/1    Pending   0          5s
ubuntu@ip-172-31-63-3:~$ 

```

If you observe the manifest file, the master node is looking for that worker node which has the label hardware=t2-medium.

```

containers:
- name: container1
  image: ubuntu
  command: ["/bin/bash", "-c", "while true; do echo Node-Selector Example; sleep 5 ; done"]
nodeSelector:
hardware: t2-medium
~ 

```

As you can see there is no label added like hardware=t2-medium

```

ubuntu@ip-172-31-63-3:~$ kubectl get nodes --show-labels
NAME      STATUS   ROLES   AGE   VERSION   LABELS
minikube   Ready    control-plane   8m   v1.27.4   beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.io/arch=amd64,kubernetes.io/hostname=minikube,kubernetes.io/os=linux,minikube.k8s.io/commit=f7edcd9c4599be1f9f04c0986c4a09187f5d0d396e,minikube.k8s.io/name=minikube,minikube.k8s.io/primary=true,minikube.k8s.io/updated_at=2023_10_09T09_53_35_0780,minikube.k8s.io/version=v1.31.2,node-role.kubernetes.io/control-plane=node,kubernetes.io/exclude-from-external-load-balancers=
ubuntu@ip-172-31-63-3:~$ 

```

Here we have added the label to the worker node

`kubectl label nodes minikube hardware=t2-medium`

```

ubuntu@ip-172-31-63-3:~$ kubectl label nodes minikube hardware=t2-medium
node/minikube labeled
ubuntu@ip-172-31-63-3:~$ 

```

As sooner the label is added, the sooner the pod will be in a running state.

```

ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
nodelabels  1/1    Running   0          6m31s
ubuntu@ip-172-31-63-3:~$ 

```

ReplicationController & ReplicaSet

Before Kubernetes, other tools did not provide important and customized features like scaling and replication.

When Kubernetes was introduced, replication and scaling were the premium features that increased the popularity of this container orchestration tool.

Replication means that if the pod's desired state is set to 3 and whenever any pod fails, then with the help of replication, the new pod will be created as soon as possible. This will lead to a reduction in the downtime of the application.

Scaling means if the load becomes increases on the application, then Kubernetes increases the number of pods according to the load on the application.

ReplicationController is an object in Kubernetes that was introduced in v1 of Kubernetes which helps to meet the desired state of the Kubernetes cluster from the current state. ReplicationController works on equality-based controllers only.

ReplicaSet is an object in Kubernetes and it is an advanced version of ReplicationController. ReplicaSet works on both equality-based controllers and set-based controllers.

Let's do some hands-on to get a better understanding of ReplicationController & ReplicaSet.

YML file

```
apiVersion: v1
kind: ReplicationController
metadata: [REDACTED]
  name: myreplica
spec: [REDACTED]
  replicas: 2
  selector: [REDACTED]
    Location: India
  template: [REDACTED]
    metadata: [REDACTED]
      name: testpod6
    labels: [REDACTED]
      Location: India
  spec: [REDACTED]
    containers:
      - name: c00
        image: ubuntu
        command: ["/bin/bash", "-c", "while true; do echo ReplicationController Example; sleep 5 ; done"]
```

Create the replication controller by running the command

```
kubectl apply -f myrc.yml
```

```
ubuntu@ip-172-31-63-3:~$ kubectl apply -f myrc.yml
replicationcontroller/myreplica created
ubuntu@ip-172-31-63-3:~$
```

Now, you can see the replication controller that we created earlier and observe the desired state, current state, ready, and age.

```
ubuntu@ip-172-31-63-3:~$ kubectl get rc
NAME      DESIRED   CURRENT   READY   AGE
myreplica  2         2         2       11s
ubuntu@ip-172-31-63-3:~$
```

If you list all the pods, you will see that my replica created two pods that are running.

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
myreplica-bktvt  1/1     Running   0          54s
myreplica-cmqrh  1/1     Running   0          54s
ubuntu@ip-172-31-63-3:~$
```

If you try to delete the pods, you will see that the new pod will be created quickly. You can observe through the AGE of both pods.

```
ubuntu@ip-172-31-63-3:~$ kubectl delete pod myreplica-bktvt
pod "myreplica-bktvt" deleted
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
myreplica-cmqrh  1/1     Running   0          2m3s
myreplica-xcbxn  1/1     Running   0          37s
ubuntu@ip-172-31-63-3:~$
```

If you want to modify the replicas, you can do that by running the command

```
kubectl scale --replicas=5 rc -l Location=India
```

```

ubuntu@ip-172-31-63-3:~$ kubectl get rc
NAME      DESIRED   CURRENT   READY    AGE
myreplica 2          2          2        3m16s
ubuntu@ip-172-31-63-3:~$ kubectl scale --replicas=5 rc -l Location=India
replicationcontroller/myreplica scaled
ubuntu@ip-172-31-63-3:~$ kubectl get rc
NAME      DESIRED   CURRENT   READY    AGE
myreplica 5          5          5        3m32s
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
myreplica-bx8dr 1/1     Running   0          15s
myreplica-cmqrh 1/1     Running   0          3m42s
myreplica-tnpssp 1/1     Running   0          15s
myreplica-wrz6p  1/1     Running   0          15s
myreplica-xcbxn 1/1     Running   0          2m16s
ubuntu@ip-172-31-63-3:~$ 

```

If you try to delete pods, you will see again that the new pod is creating quickly.

```

ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
myreplica-bx8dr 1/1     Running   0          45s
myreplica-cmqrh 1/1     Running   0          4m12s
myreplica-tnpssp 1/1     Running   0          45s
myreplica-wrz6p  1/1     Running   0          45s
myreplica-xcbxn 1/1     Running   0          2m46s
ubuntu@ip-172-31-63-3:~$ kubectl delete pod myreplica-cmqrh myreplica-xcbxn
pod "myreplica-cmqrh" deleted
pod "myreplica-xcbxn" deleted
myreplica-xcbxnubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
myreplica-bx8dr 1/1     Running   0          106s
myreplica-q9rgd 1/1     Running   0          46s
myreplica-qwgzv 1/1     Running   0          46s
myreplica-tnpssp 1/1     Running   0          106s
myreplica-wrz6p  1/1     Running   0          106s
ubuntu@ip-172-31-63-3:~$ 

```

Now, if you want to delete all the pods. You can do it by just deleting the replicationController by the given command.

```
kubectl delete -f myrc.yml
```

```

ubuntu@ip-172-31-63-3:~$ kubectl delete -f myrc.yml
replicationcontroller "myreplica" deleted
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
myreplica-bx8dr  1/1     Terminating   0          3m56s
myreplica-q9rgd  1/1     Terminating   0          2m56s
myreplica-qwgzv  1/1     Terminating   0          2m56s
myreplica-tnpsp  1/1     Terminating   0          3m56s
myreplica-wrz6p  1/1     Terminating   0          3m56s
ubuntu@ip-172-31-63-3:~$ kubectl get rc
No resources found in default namespace.
ubuntu@ip-172-31-63-3:~$ 

```

ReplicaSet HandsOn

YML file

```

apiVersion: apps/v1
kind: ReplicaSet
metadata: []
name: myrs
spec: []
replicas: 2
selector: []
  matchExpressions: []
    - {key: Location, operator: In, values: [India, US, Russia]}
    - {key: env, operator: NotIn, values: [testing]}
template: []
  metadata: []
    name: testpod7
  labels: []
    Location: Russia
spec: []
  containers: []
    - name: container1
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo ReplicaSet Example; sleep 5 ; done"]

```

Create the replicaSet by running the command

```
kubectl apply -f myrs.yml
```

```

ubuntu@ip-172-31-63-3:~$ kubectl apply -f myrs.yml
replicaset.apps/myrs created
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME  DESIRED  CURRENT  READY  AGE
myrs  2         2         2      7s

```

Now, you can see the pods that have been created through replicaSet with labels

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods --show-labels
NAME      READY   STATUS    RESTARTS   AGE   LABELS
myrs-6rxbp  1/1    Running   0          20s   Location=Russia
myrs-hmdzm  1/1    Running   0          20s   Location=Russia
ubuntu@ip-172-31-63-3:~$ 
```

If you try to delete the pods, you will see that the new pod is created with the same configuration.

```
ubuntu@ip-172-31-63-3:~$ kubectl delete pod myrs-6rxbp
pod "myrs-6rxbp" deleted
```

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods --show-labels
NAME      READY   STATUS    RESTARTS   AGE   LABELS
myrs-hmdzm  1/1    Running   0          2m30s  Location=Russia
myrs-xj4v9  1/1    Running   0          61s   Location=Russia
ubuntu@ip-172-31-63-3:~$ 
```

If you want to increase or decrease the number of replicas, you can do it by the given command.

`kubectl scale --replicas=5 rs myrs`

```
ubuntu@ip-172-31-63-3:~$ kubectl scale --replicas=5 rs myrs
replicaset.apps/myrs scaled
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME  DESIRED  CURRENT  READY  AGE
myrs  5         5         5     3m41s
ubuntu@ip-172-31-63-3:~$ 
```

If you want to delete all the pods, you can do it by deleting the replicaSet with the help of the given command.

`kubectl delete -f myrs.yml`

```
ubuntu@ip-172-31-63-3:~$ kubectl delete -f myrs.yml
replicaset.apps "myrs" deleted
ubuntu@ip-172-31-63-3:~$ kubectl get rs
No resources found in default namespace.
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
myrs-25znk  1/1    Terminating   0          56s
myrs-c48tv  1/1    Terminating   0          56s
myrs-hmdzm  1/1    Terminating   0          4m31s
myrs-j2w5r  1/1    Terminating   0          56s
myrs-xj4v9  1/1    Terminating   0          3m2s
ubuntu@ip-172-31-63-3:~$ 
```

Deployment Object in Kubernetes

- Replication Controller and Replica Set don't provide the updates and rollback for the application in the cabinets cluster. But in a deployment, the object does.
- The deployment object works as a supervisor for the pods which gives granular control over the pods. Deployment objects can decide how and when the pods should be deployed, rollback or updated.
- In Deployment, we define the desired state and the deployment controller will help to achieve the desired state from the current state.
- You can achieve this by declarative(manifest) method only.
- A Deployment provides declarative updates for Pods and ReplicaSets.
- The deployment object supports updates which means if there is any update in the applications that needs to be deployed in the new version then, the deployment object helps to achieve it.
- Deployment object supports rollback which means if the app is crashing in a new update then you can easily switch to the previous version by rollback.
- The deployment object doesn't work directly with the pods. Under the deployment object, there will be a replica set or replica controller that manages the pods and helps to manage the desired state.

Use Cases for the Deployment Object

- With the help of deployment, the replica set will be rolled out, which will deploy the pods and check the status in the background whether the rollout has succeeded or not.
- If the pod template spec is modified then, the new replica set will be created with the new desired state and the old replica set will still exist and you can roll back according to the situation.
- You can roll back to the previous deployment if the current state of the deployment is not stable.
- You can scale up the deployment to manage the loads.
- You can pause the deployment if you are fixing something in between the deployment and then resume it after fixing it.
- You can clean up those replica sets which are older and no longer needed.

HandsOn

YML file

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: thedeployment
spec:
  replicas: 3
  selector:
```

```

matchLabels:
  name: deploy-pods
template:
  metadata:
    name: ubuntu-pods
  labels:
    name: deploy-pods
spec:
  containers:
    - name: container1
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo This is Day09 of
30DaysOfKubernetes; sleep 5; done"]

```

Creating the deployment by running the command '`kubectl apply -f da-deployment.yml`'.

If you observe that the replica set has 3 desired states and same as the current state.

Also, all three pods are in ready and running status.

```

ubuntu@ip-172-31-63-3:~$ kubectl apply -f da-deployment.yml
deployment.apps/thedeployment created
ubuntu@ip-172-31-63-3:~$ kubectl get deploy
NAME      READY  UP-TO-DATE  AVAILABLE  AGE
thedeployment  3/3     3          3          7s
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME      DESIRED  CURRENT  READY  AGE
thedeployment-5d7fc7899  3        3        3       14s
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY  STATUS  RESTARTS  AGE
thedeployment-5d7fc7899-lcf6s  1/1    Running  0          20s
thedeployment-5d7fc7899-pdhdl  1/1    Running  0          20s
thedeployment-5d7fc7899-vgsw6  1/1    Running  0          20s
ubuntu@ip-172-31-63-3:~$ 

```

Now, if you try to delete any pod, because of a replica set, the new pod will be created quickly.

```

ubuntu@ip-172-31-63-3:~$ kubectl delete pod thedeployment-5d7fc7899-pdhdl
pod "thedeployment-5d7fc7899-pdhdl" deleted
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY  STATUS  RESTARTS  AGE
thedeployment-5d7fc7899-lcf6s  1/1    Running  0          2m4s
thedeployment-5d7fc7899-t2j1l7  1/1    Running  0          34s
thedeployment-5d7fc7899-vgsw6  1/1    Running  0          2m4s
ubuntu@ip-172-31-63-3:~$ 

```

Here, we have increased the number of replicas set from 3 to 5 by the command

`'kubectl scale — replicas=5 deployment <deployment_name>'.`

```

ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME             DESIRED   CURRENT   READY   AGE
thedeployment-5d7fc7899   3         3         3     3m52s
ubuntu@ip-172-31-63-3:~$ kubectl scale --replicas=5 deployment thedeployment
deployment.apps/thedeployment scaled
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME             DESIRED   CURRENT   READY   AGE
thedeployment-5d7fc7899   5         5         5     4m11s
ubuntu@ip-172-31-63-3:~$ 

```

Here, we are checking the logs for the particular pod.

```

ubuntu@ip-172-31-63-3:~$ kubectl logs -f thedeployment-5d7fc7899-t2j17
This is Day09 of 30DaysOfKubernetes

```

Here, I made some changes in the previous YML file as you can see in the file. I have updated the image and command for the needed YML file.

```

apiVersion: apps/v1
kind: Deployment
metadata:
  name: thedeployment
spec:
  replicas: 3
  selector:
    matchLabels:
      name: deploy-pods
  template:
    metadata:
      name: ubuntu-pods
      labels:
        name: deploy-pods
    spec:
      containers:
        - name: container1
          image: centos
          command: ["/bin/bash", "-c", "while true; do echo DevOps is a Culture; sleep 5; done"]

```

After updating the file, I have applied the updated file and as you can see, 'thedeployment' has 3 replicas which were previously 5. This happened because, in the YML file the replicas are 3.

Also, if you observe that the previous rs is still present with 0 desired and current state.

```

ubuntu@ip-172-31-63-3:~$ kubectl apply -f da-deployment.yml
deployment.apps/thedeployment configured
ubuntu@ip-172-31-63-3:~$ kubectl get deploy
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
thedeployment  3/3     1           3           7m45s
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME          DESIRED   CURRENT   READY   AGE
thedeployment-5d7fc7899  0         0         0       7m54s
thedeployment-7bcc7b8d89  3         3         3       16s
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get pod
NAME          READY   STATUS      RESTARTS   AGE
thedeployment-5d7fc7899-lcf6s  1/1   Terminating   0       8m1s
thedeployment-5d7fc7899-sj98t  1/1   Terminating   0       3m54s
thedeployment-5d7fc7899-t2jl7  1/1   Terminating   0       6m31s
thedeployment-5d7fc7899-v9nbj  1/1   Terminating   0       3m54s
thedeployment-5d7fc7899-vgsw6  1/1   Terminating   0       8m1s
thedeployment-7bcc7b8d89-5vn29  1/1   Running      0       23s
thedeployment-7bcc7b8d89-j2nsf  1/1   Running      0       12s
thedeployment-7bcc7b8d89-ph7rc  1/1   Running      0       14s
ubuntu@ip-172-31-63-3:~$ 

```

Now, if you will check the logs of the new pods. You will see the updated command running that we have written in the YML file.

```

ubuntu@ip-172-31-63-3:~$ kubectl logs -f thedeployment-7bcc7b8d89-5vn29
DevOps is a Culture

```

Also, We have updated the image for the OS and you can see that we are getting the expected result for the image.

```

ubuntu@ip-172-31-63-3:~$ kubectl exec thedeployment-7bcc7b8d89-5vn29 -- cat /etc/os-release
NAME="CentOS Linux"
VERSION="8"
ID="centos"
ID_LIKE="rhel fedora"
VERSION_ID="8"
PLATFORM_ID="platform:el8"
PRETTY_NAME="CentOS Linux 8"
ANSI_COLOR="0;31"
CPE_NAME="cpe:/o:centos:centos:8"
HOME_URL="https://centos.org/"
BUG_REPORT_URL="https://bugs.centos.org/"
CENTOS_MANTISBT_PROJECT="CentOS-8"
CENTOS_MANTISBT_PROJECT_VERSION="8"
ubuntu@ip-172-31-63-3:~$ 

```

Here, we have increased the number of replicas set from 3 to 5 by the command ‘`kubectl scale — replicas=5 deployment <deployment_name>`’.

```
ubuntu@ip-172-31-63-3:~$ kubectl scale --replicas=5 deployment thedeployment
deployment.apps/thedeployment scaled
ubuntu@ip-172-31-63-3:~$ kubectl get deploy
NAME      READY  UP-TO-DATE  AVAILABLE  AGE
thedeployment  5/5     5          5          12m
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME      DESIRED  CURRENT  READY  AGE
thedeployment-5d7fcd7899  0        0        0        12m
thedeployment-7bcc7b8d89  5        5        5        4m34s
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl pods
error: unknown command "pods" for "kubectl"

Did you mean this?
    logs
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME      READY  STATUS  RESTARTS  AGE
thedeployment-7bcc7b8d89-5vn29  1/1   Running  0          4m45s
thedeployment-7bcc7b8d89-767j8  1/1   Running  0          29s
thedeployment-7bcc7b8d89-j2nsf  1/1   Running  0          4m34s
thedeployment-7bcc7b8d89-ph7rc  1/1   Running  0          4m36s
thedeployment-7bcc7b8d89-qzpqw  1/1   Running  0          29s
ubuntu@ip-172-31-63-3:~$ 
```

Now, if you want to switch to the previous deployment you can do it by the given command.

`kubectl rollout undo deployment <deployment_name>`

If you compare the first `kubectl get rs` command with the second `kubectl get rs`, then the desired state shifts to the other deployment.

```
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME      DESIRED  CURRENT  READY  AGE
thedeployment-5d7fcd7899  0        0        0        20m
thedeployment-7bcc7b8d89  5        5        5        12m
ubuntu@ip-172-31-63-3:~$ kubectl rollout undo deployment thedeployment
deployment.apps/thedeployment rolled back
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME      DESIRED  CURRENT  READY  AGE
thedeployment-5d7fcd7899  5        5        3        20m
thedeployment-7bcc7b8d89  1        1        1        13m
ubuntu@ip-172-31-63-3:~$ kubectl get rs
NAME      DESIRED  CURRENT  READY  AGE
thedeployment-5d7fcd7899  5        5        5        21m
thedeployment-7bcc7b8d89  0        0        0        13m
ubuntu@ip-172-31-63-3:~$ 
```

Now, if you see the logs of the running pods. You will see that the previous command is running because we have switched to the previous deployment.

```

ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME                               READY   STATUS    RESTARTS   AGE
thedeployment-5d7fcd7899-99kz2   1/1    Running   0          61s
thedeployment-5d7fcd7899-gncm9   1/1    Running   0          61s
thedeployment-5d7fcd7899-grhvt   1/1    Running   0          59s
thedeployment-5d7fcd7899-hld4n   1/1    Running   0          61s
thedeployment-5d7fcd7899-rpk86   1/1    Running   0          59s
ubuntu@ip-172-31-63-3:~$ kubectl logs -f thedeployment-5d7fcd7899-grhvt
This is Day09 of 30DaysOfKubernetes

```

If you see the OS Image, you will understand that in our previous deployment, we used an Ubuntu image which is expected.

```

ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME                               READY   STATUS    RESTARTS   AGE
thedeployment-5d7fcd7899-99kz2   1/1    Running   0          2m27s
thedeployment-5d7fcd7899-gncm9   1/1    Running   0          2m27s
thedeployment-5d7fcd7899-grhvt   1/1    Running   0          2m25s
thedeployment-5d7fcd7899-hld4n   1/1    Running   0          2m27s
thedeployment-5d7fcd7899-rpk86   1/1    Running   0          2m25s
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl exec thedeployment-5d7fcd7899-grhvt -- cat /etc/os-release
PRETTY_NAME="Ubuntu 22.04.3 LTS"
NAME="Ubuntu"
VERSION_ID="22.04"
VERSION="22.04.3 LTS (Jammy Jellyfish)"
VERSION_CODENAME=jammy
ID=ubuntu
ID_LIKE=debian
HOME_URL="https://www.ubuntu.com/"
SUPPORT_URL="https://help.ubuntu.com/"
BUG_REPORT_URL="https://bugs.launchpad.net/ubuntu/"
PRIVACY_POLICY_URL="https://www.ubuntu.com/legal/terms-and-policies/privacy-policy"
UBUNTU_CODENAME=jammy
ubuntu@ip-172-31-63-3:~$ 

```

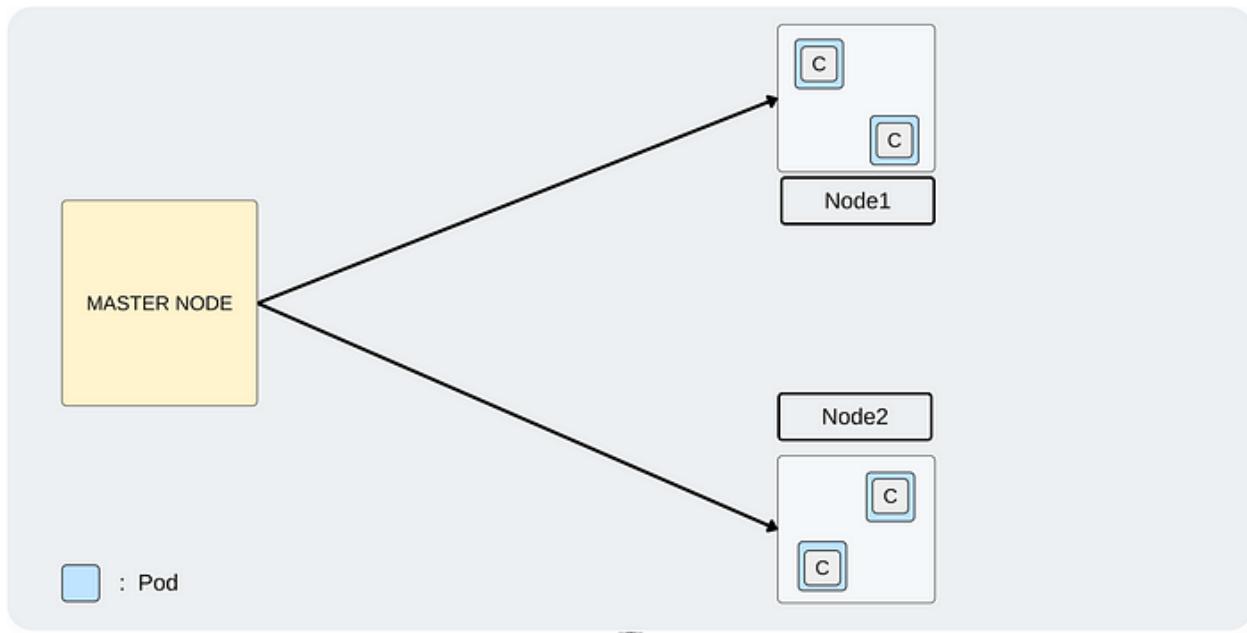
If you want to delete all those running pods and replica sets, then use the given command.

```
kubectl delete -f <deployment_file>
```

```
ubuntu@ip-172-31-63-3:~$ kubectl delete -f da-deployment.yml
deployment.apps "thedeployment" deleted
ubuntu@ip-172-31-63-3:~$ kubectl get deploy
No resources found in default namespace.
ubuntu@ip-172-31-63-3:~$ kubectl get rs
No resources found in default namespace.
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
thedeployment-5d7fcd7899-99kz2   1/1     Terminating   0   5m40s
thedeployment-5d7fcd7899-gncm9   1/1     Terminating   0   5m40s
thedeployment-5d7fcd7899-grhvt   1/1     Terminating   0   5m38s
thedeployment-5d7fcd7899-hld4n   1/1     Terminating   0   5m40s
thedeployment-5d7fcd7899-rpk86   1/1     Terminating   0   5m38s
ubuntu@ip-172-31-63-3:~$ █
```

Kubernetes Cluster(Master+Worker Node) using kubeadm on AWS

Create three EC2 instances with Ubuntu 22.04 and the necessary security group settings.
Configure the instances to prepare for Kubernetes installation.
Install Docker and Kubernetes components on all nodes.
Initialize the Kubernetes cluster on the master node.
Join the worker nodes in the cluster.
Deploy an Nginx application on the cluster for validation.



Step 1:

Create three EC2 Instances with the given configuration

Instance type- t2.medium

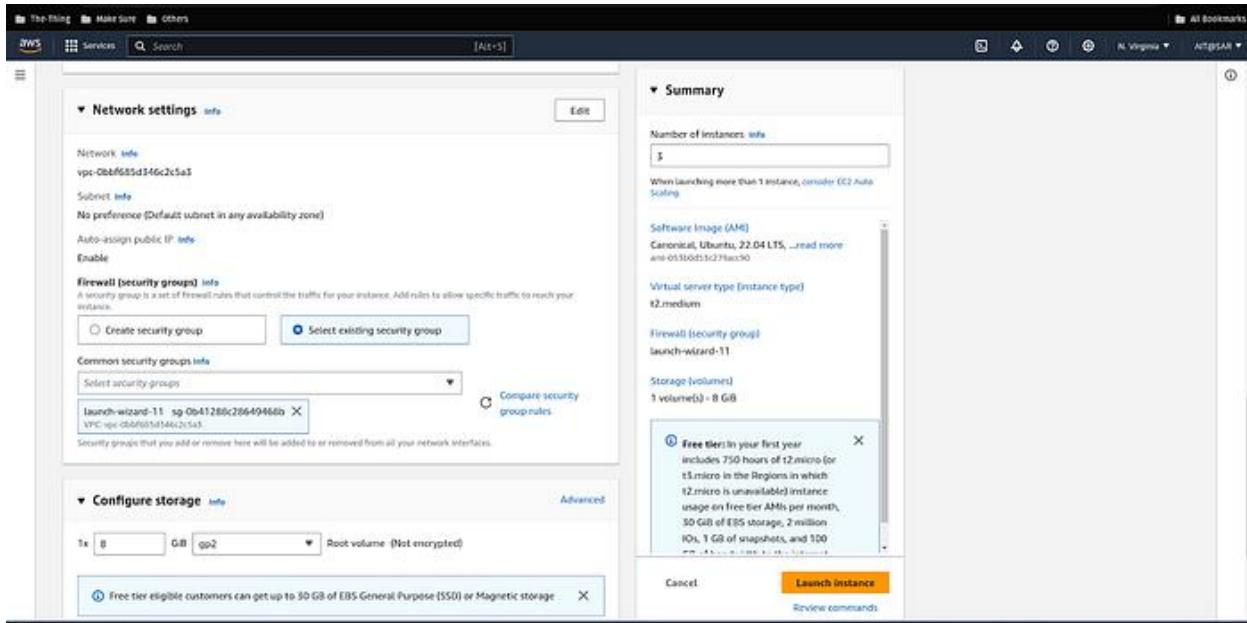
Ubuntu Version- 22.04

Create the keypair so you can connect to the instance using SSH.

Create the new Security group and once the instances are initialized/created then, make sure to add the Allow All traffic in inbound rule in the attached security group.

The screenshot shows the AWS EC2 console interface for launching a new instance. The main page displays a summary of the launch configuration, including the number of instances (1), software image (Ubuntu 22.04 LTS), virtual server type (t2.micro), and storage (1 volume - 8 GB). A tooltip for the free tier is visible, stating: "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, 50 GiB of EBS storage, 2 million I/Os, 1 GB of snapshots, and 100 snapshots." Below the summary, there are tabs for "Recent AMIs", "My AMIs", and "Quick Start". Under "Quick Start", there are icons for Amazon Linux, macOS, Ubuntu, Windows, Red Hat, SUSE, and a search bar for "Search our full catalog including 3000s of application and OS images". At the bottom, it shows "Amazon Machine Image (AMI)" and "Ubuntu Server 22.04 LTS (HVM, SSD Volume Type)".

This screenshot shows the detailed configuration step for launching an instance. It focuses on the "Amazon Machine Image (AMI)" selection. The specific AMI chosen is "Ubuntu Server 22.04 LTS (HVM, SSD Volume Type)" (ami-055b0d5c279acc90). The configuration pane on the right side is identical to the one in the previous screenshot, showing the same summary details and free tier information.



Rename the instances according to you. Currently, I am setting up the One Master and two Workers nodes.

Instances (3) <small>Info</small>										
<input type="text"/> Find instance by attribute or tag (case-sensitive) <input type="button"/> Node <input type="button"/> Clear filters										
Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IP	Actions	Launch instances
Master Node	i-048cc948f737b4b67	Running	t2.medium	2/2 checks passed	No alarms	us-east-1e	ec2-100-26-120-90.co...	100.26	Actions	Launch instances
Worker Node1	i-05b075d31176a7213	Running	t2.medium	2/2 checks passed	No alarms	us-east-1e	ec2-35-155-18-118.co...	35.153	Actions	Launch instances
Worker Node2	i-01f73fb7509456cd4	Running	t2.medium	2/2 checks passed	No alarms	us-east-1e	ec2-100-26-247-154.co...	100.26	Actions	Launch instances

After creating the instances, we have to configure the all instances. Let's do that and follow the steps carefully.

Commands need to run on all Nodes(Master and Worker)

Once we log in the all three instances, run the following command.

Step 2:

```
sudo su
swapoff -a; sed -i '/swap/d' /etc/fstab
```

```
root@ip-10-0-0-215:/home/ubuntu# sudo swapoff -a
root@ip-10-0-0-215:/home/ubuntu# sudo sed -i '/ swap / s/^/#/' /etc/fstab
```

Step 3:

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

```

sudo modprobe overlay
sudo modprobe br_netfilter
# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF
# Apply sysctl params without reboot
sudo sysctl --system

```

```

root@ip-10-0-0-215:/home/ubuntu# cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF

sudo modprobe overlay
sudo modprobe br_netfilter
# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF

# Apply sysctl params without reboot
sudo sysctl --system
overlay
br_netfilter
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 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.disable_ipv6 = 2
net.ipv6.conf.default.disable_ipv6 = 2
* Applying /etc/sysctl.d/10-kernel-hardening.conf ...
kernel.kptr_restrict = 1
* Applying /etc/sysctl.d/10-magic-sysrq.conf ...
kernel.sysrq = 176
* Applying /etc/sysctl.d/10-network-security.conf ...
net.ipv4.conf.default.rp_filter = 2
net.ipv4.conf.all.rp_filter = 2
* Applying /etc/sysctl.d/10-pttrace.conf ...
kernel.yama.ptrace_scope = 1
* Applying /etc/sysctl.d/10-zeroceph.conf ...
vm.mmap_min_addr = 65536
* Applying /usr/lib/sysctl.d/50-default.conf ...
kernel.core_uses_pid = 1
net.ipv4.conf.default.rp_filter = 2
net.ipv4.conf.all.rp_filter = 2
sysctl: setting key "net.ipv4.conf.all.accept_source_route": Invalid argument
net.ipv4.conf.default.promote_secondaries = 1
sysctl: setting key "net.ipv4.conf.all.promote_secondaries": Invalid argument
net.ipv4.ping_group_range = 0 2147483647
net.core.default_qdisc = fq_codel
fs.protected_hardlinks = 1
fs.protected_symlinks = 1

```

Step 4:

`apt update`

```

root@ip-10-0-0-215:/home/ubuntu# apt update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-security InRelease [119 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [116 kB]
Get:5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [14.1 MB]
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 Packages [217 kB]
Get:9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 c-n-f Metadata [112 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [1842 kB]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main c-n-f Metadata [1842 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main Translation-en [234 kB]
Get:13 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 c-n-f Metadata [16.0 kB]
Get:14 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 Packages [974 kB]
Get:15 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted Translation-en [157 kB]
Get:16 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [532 kB]
Get:17 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe Translation-en [211 kB]
Get:18 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 c-n-f Metadata [32.0 kB]
Get:19 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 Packages [41.6 kB]
Get:20 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse Translation-en [9768 kB]
Get:21 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 c-n-f Metadata [472 kB]
Get:22 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/main amd64 Packages [41.7 kB]
Get:23 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/main Translation-en [10.5 kB]
Get:24 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/main amd64 c-n-f Metadata [388 kB]
Get:25 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/restricted amd64 c-n-f Metadata [116 kB]
Get:26 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/restricted amd64 Packages [789 kB]
Get:27 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe amd64 Packages [16.4 kB]
Get:28 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe Translation-en [640 kB]
Get:29 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe amd64 c-n-f Metadata [640 kB]
Get:30 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/multiverse amd64 c-n-f Metadata [116 kB]
Get:31 http://security.ubuntu.com/ubuntu jammy-security/main amd64 Packages [856 kB]
Get:32 http://security.ubuntu.com/ubuntu jammy-security/main Translation-en [175 kB]
Get:33 http://security.ubuntu.com/ubuntu jammy-security/main amd64 c-n-f Metadata [31.4 kB]
Get:34 http://security.ubuntu.com/ubuntu jammy-security/restricted amd64 Packages [154 kB]
Get:35 http://security.ubuntu.com/ubuntu jammy-security/restricted Translation-en [154 kB]
Get:36 http://security.ubuntu.com/ubuntu jammy-security/restricted amd64 c-n-f Metadata [532 kB]
Get:37 http://security.ubuntu.com/ubuntu jammy-security/universe amd64 c-n-f Metadata [16.7 kB]
Get:38 http://security.ubuntu.com/ubuntu jammy-security/universe Translation-en [145 kB]
Get:39 http://security.ubuntu.com/ubuntu jammy-security/universe amd64 c-n-f Metadata [16.7 kB]
Get:40 http://security.ubuntu.com/ubuntu jammy-security/multiverse amd64 Packages [36.5 kB]
Get:41 http://security.ubuntu.com/ubuntu jammy-security/multiverse Translation-en [7060 kB]
Get:42 http://security.ubuntu.com/ubuntu jammy-security/multiverse amd64 c-n-f Metadata [2660 kB]
Fetched 6777 kB/s (6777 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
134 packages can be upgraded. Run "apt list --upgradable" to see them.

```

Step 5:

Install dependencies by running the command

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

```

root@ip-10-0-0-215:/home/ubuntu# sudo apt-get install -y apt-transport-https ca-certificates curl
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  libcurl4
The Following NEW packages will be installed:
  apt-transport-https
The following packages will be upgraded:
  ca-certificates curl libcurl4
3 upgraded, 1 newly installed, 0 to remove and 131 not upgraded.
Need to get 641 kB of archives.
After this operation, 193 kB of additional disk space will be used.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 ca-certificates all 20230311ubuntu0.22.04.1 [155 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 apt-transport-https all 2.4.10 [1510 B]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 curl amd64 7.81.0-lubuntu1.14 [194 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libcurl4 amd64 7.81.0-lubuntu1.14 [290 kB]
Fetched 641 kB in 0s (12.5 MB/s)
Preconfiguring packages ...
(Reading database ... 64295 files and directories currently installed.)
Preparing to unpack .../ca-certificates_20230311ubuntu0.22.04.1_all.deb ...
Unpacking ca-certificates_20230311ubuntu0.22.04.1_all.deb ... (20230311ubuntu0.22.04.1) ...
Selecting previously unselected package apt-transport-https.
Preparing to unpack .../apt-transport-https_2.4.10_all.deb ...
Unpacking apt-transport-https (2.4.10) ...
Preparing to unpack .../curl_7.81.0-lubuntu1.14_amd64.deb ...
Unpacking curl (7.81.0-lubuntu1.14) over (7.81.0-lubuntu1.10) ...
Preparing to unpack .../libcurl4_7.81.0-lubuntu1.14_amd64.deb ...
Unpacking libcurl4_amd64 (7.81.0-lubuntu1.14) over (7.81.0-lubuntu1.10) ...
Setting up ca-certificates (20230311ubuntu0.22.04.1) ...
Updating certificates in /etc/ssl/certs...
rehash: warning: skipping ca-certificates.crt, it does not contain exactly one certificate or CRL
19 added, 6 removed; done.
Setting up libcurl4_amd64 (7.81.0-lubuntu1.14) ...
Setting up curl (7.81.0-lubuntu1.14) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu1.1) ...
Processing triggers for ca-certificates (20230311ubuntu0.22.04.1) ...
Updating certificates in /etc/ssl/certs...
0 added, 0 removed; done.
Running hooks in /etc/ca-certificates/update.d...
done.
Scanning processes...
Scanning linux images...
Running kernel seems to be up-to-date.

```

Step 6:

Fetch the public key from Google to validate the Kubernetes packages once it will be installed.

```
curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-archive-keyring.gpg
```

```
root@ip-10-0-0-215:/home/ubuntu# curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-archive-keyring.gpg
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu#
```

Step 7:

Add the Kubernetes package in the sources.list.d directory

```
echo "deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg]
https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee
/etc/apt/sources.list.d/kubernetes.list
```

```
root@ip-10-0-0-215:/home/ubuntu# echo "deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg] https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee /etc/apt/sources.list.d/
kubernetes.list
deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg] https://apt.kubernetes.io/ kubernetes-xenial main
root@ip-10-0-0-215:/home/ubuntu#
```

Step 8:

Update the packages as we have added some keys and packages.

```
apt update
```

```
root@ip-10-0-0-215:/home/ubuntu# apt update
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
Get:5 https://packages.cloud.google.com/apt kubernetes-xenial InRelease [6993 B]
Get:6 https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 Packages [69.9 kB]
Fetched 78.9 kB in 1s (344 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
131 packages can be upgraded. Run 'apt list --upgradable' to see them.
```

Step 9:

Install kubelet, kubeadm, kubectl and kubernets-cni

```
apt-get install -y kubelet kubeadm kubectl kubernetes-cni
```

```
root@ip-10-0-0-215:/home/ubuntu# apt-get install -y kubelet kubeadm kubectl kubernetes-cni
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  conctrack cri-tools ebttables socat
The following NEW packages will be installed:
  conctrack cri-tools ebtables kubelet kubeadm kubectl kubernetes-cni socat
0 upgraded, 8 newly installed, 0 to remove and 131 not upgraded.
Need to get 87.1 MB of archives.
After this operation, 381 MB of additional disk space will be used.
Get:1 https://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 conctrack amd64 1:3.4.6-2build2 [33.5 kB]
Get:2 https://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 ebttables amd64 2.0.11-4build2 [84.9 kB]
Get:3 https://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 socat amd64 1.7.4.1-3ubuntu1 [349 kB]
Get:4 https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 cri-tools amd64 1.26.0-00 [18.9 kB]
Get:5 https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubernetes-cni amd64 1.2.0-00 [27.6 kB]
Get:6 https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubelet amd64 1.28.2-00 [19.5 kB]
Get:7 https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubectl amd64 1.28.2-00 [18.3 kB]
Get:8 https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubeadm amd64 1.28.2-00 [18.3 kB]
Fetched 87.1 MB in 1s
Selecting previously unselected package conctrack.
(Reading database ... 64312 files and directories currently installed.)
Preparing to unpack .../0.conctrack_1%3a1.4.6-2build2_amd64.deb ...
Unpacking conctrack (1:1.4.6-2build2) ...
Selecting previously unselected package cri-tools.
Preparing to unpack .../1.cri-tools_1.26.0-00_amd64.deb ...
Unpacking cri-tools (1.26.0-00) ...
Selecting previously unselected package ebtables.
Preparing to unpack .../2.ebtables_2.0.11-4build2_amd64.deb ...
Unpacking ebtables (2.0.11-4build2) ...
Selecting previously unselected package kubernetes-cni.
Preparing to unpack .../3.kubernetes-cni_1.2.0-00_amd64.deb ...
Unpacking kubernetes-cni (1.2.0-00) ...
Selecting previously unselected package socat.
Preparing to unpack .../4.socat_1.7.4.1-3ubuntu4_amd64.deb ...
Unpacking socat (1.7.4.1-3ubuntu4) ...
Selecting previously unselected package kubelet.
Preparing to unpack .../5.kubelet_1.28.2-00_amd64.deb ...
Unpacking kubelet (1.28.2-00) ...
Selecting previously unselected package kubectl.
Preparing to unpack .../6.kubectl_1.28.2-00_amd64.deb ...
Unpacking kubectl (1.28.2-00) ...
Selecting previously unselected package kubeadm.
Preparing to unpack .../7.kubeadm_1.28.2-00_amd64.deb ...
Unpacking kubeadm (1.28.2-00) ...
Setting up conctrack (1:1.4.6-2build2) ...
Setting up kubelet (1.28.2-00) ...
Setting up ebtables (2.0.11-4build2) ...
Setting up socat (1.7.4.1-3ubuntu4) ...
```

Step 10:

This is one of the important dependencies to setting up the Master and Worker nodes.
Installing docker.

```
apt install docker.io -y
```

```
root@ip-10-0-0-215:/home/ubuntu# sudo apt install docker.io
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
bridge-utils containerd dns-root-data dnsmasq-base pigz runc ubuntu-fan
Suggested packages:
liftpdown auto-tools cgroups-mount | cgroup-lite debootstrap docker-doc rinse zfs-fuse | zfsutils
The Following packages will be installed:
bridge-utils containerd dns-root-data dnsmasq-base docker.io pigz runc ubuntu-fan
0 upgraded, 8 newly installed, 0 to remove and 131 not upgraded.
Need to get 69.7 MB of archives.
After this operation, 267 MB of additional disk space will be used.
Do you want to continue? [Y/n]
Get: http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 pigz amd64 2.6.1 [63.6 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 bridge-utils amd64 1.7.ubuntu3 [34.4 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 runc amd64 1.1.7-ubuntu1-22.04.1 [4249 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 contained amd64 1.7.2-ubuntu1-22.04.1 [36.0 MB]
Get:5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 dns-root-data all 2023011101 [5256 B]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 dnsmasq-base amd64 2.86-1.ubuntu0.3 [354 kB]
Get:7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 docker.io amd64 24.0.5-ubuntu1-22.04.1 [28.9 MB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 ubuntu-fan all 0.2.16 [35.2 kB]
Fetched 267 MB in 31s (127.3 MB/s)
Preconfiguring packages...
Selecting previously unselected package pigz.
(Reading database ... 64406 files and directories currently installed.)
Preparing to unpack .../0-pigz_2.6.1_amd64.deb ...
Unpacking pigz (2.6.1) ...
Selecting previously unselected package bridge-utils.
Preparing to unpack .../1-bridge-utils_1.7-ubuntu3_amd64.deb ...
Unpacking bridge-utils (1.7-ubuntu3) ...
Selecting previously unselected package runc.
Preparing to unpack .../2-runc_1.1.7-ubuntu1-22.04.1_amd64.deb ...
Unpacking runc (1.1.7-ubuntu1-22.04.1) ...
Selecting previously unselected package containedr.
Preparing to unpack .../3-containedr_1.7.2-ubuntu1-22.04.1_amd64.deb ...
Unpacking containedr (1.7.2-ubuntu1-22.04.1) ...
Selecting previously unselected package dns-root-data.
Preparing to unpack .../4-dns-root-data_2023011101_all.deb ...
Unpacking dns-root-data (2023011101) ...
Selecting previously unselected package dnsmasq-base.
Preparing to unpack .../5-dnsmasq-base_2.86-1.ubuntu0.3_amd64.deb ...
Unpacking dnsmasq-base (2.86-1.ubuntu0.3) ...
Selecting previously unselected package docker.io.
Preparing to unpack .../6-docker.io_24.0.5-ubuntu1-22.04.1_amd64.deb ...
Unpacking docker.io (24.0.5-ubuntu1-22.04.1) ...
Selecting previously unselected package ubuntu-fan.
Preparing to unpack .../7-ubuntu-fan_0.2.16_all.deb ...
Unpacking ubuntu-fan (0.2.16) ...
```

Step 11:

Configuring containerd to ensure compatibility with Kubernetes

```
sudo mkdir /etc/containerd
```

```
sudo sh -c "containerd config default > /etc/containerd/config.toml"
```

```
sudo sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml
```

```
root@ip-10-0-0-215:/home/ubuntu# sudo mkdir /etc/containerd
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu# sudo sh -c "containerd config default > /etc/containerd/config.toml"
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu# sudo sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml
root@ip-10-0-0-215:/home/ubuntu#
```

Step 12:

Restart containerd, kubelet, and enable kubelet so when we reboot our machine the nodes will restart it as well and connect properly.

```
systemctl restart containerd.service
```

```
systemctl restart kubelet.service
```

```
systemctl enable kubelet.service
```

```
root@ip-10-0-0-215:/home/ubuntu# sudo systemctl restart containerd.service
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu# sudo systemctl restart kubelet.service
root@ip-10-0-0-215:/home/ubuntu#
root@ip-10-0-0-215:/home/ubuntu# sudo systemctl enable kubelet.service
root@ip-10-0-0-215:/home/ubuntu#
```

Now, we have completed the installation of the things that are needed on both nodes (Master and Worker). But in the next steps, we have to configure things only on the Master Node.

Only on the Master Node

Step 13:

Initialize the Kubernetes cluster and it will pull some images such as kube-apiserver, kube-controller, and many other important components.

```
kubeadm config images pull
```

```
root@ip-10-0-0-15:/home/ubuntu# sudo kubeadm config images pull
[config/images] Pulled registry.k8s.io/kube-apiserver:v1.28.2
[config/images] Pulled registry.k8s.io/kube-controller-manager:v1.28.2
[config/images] Pulled registry.k8s.io/kube-scheduler:v1.28.2
[config/images] Pulled registry.k8s.io/kube-proxy:v1.28.2
[config/images] Pulled registry.k8s.io/pause:3.9
[config/images] Pulled registry.k8s.io/etcd:3.5.9-0
[config/images] Pulled registry.k8s.io/coredns:coredns:v1.10.1
root@ip-10-0-0-15:/home/ubuntu#
```

Step 14:

Now, initialize the Kubernetes cluster which will give you the token or command to connect with this Master node from the Worker node. At the end of this command, you will get some commands that need to run and at the bottom, you will get the kubeadm join command that will be run from the Worker Node to connect with the Master Node. I have highlighted the commands in the second next snipped. Please keep the kubeadm join command somewhere in the notepad.

```
kubeadm init
```

```
root@ip-10-0-0-15:/home/ubuntu# kubeadm init
[init] Using Kubernetes version: v1.28.2
[preflight] Running pre-flight checks
[preflight] Verifying system requirements
[preflight] Verifying configuration 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 in beforehand using "kubeadm config images pull"
[init] Node IP: 10.0.0.15
[init] Version: v1.28.2
[init] Kubelet endpoint: https://10.0.0.15:10250
[init] API endpoint: https://10.0.0.15:6443
[init] Certificate Authority key length: 4096
[init] Using certificate authority folder "/etc/kubernetes/pki"
[certs] Generating "ca" certificate and key
[certs] Generating "apiserver-kubelet-client" certificate and key
[certs] Generating "apiserver" certificate and key
[certs] Generating "front-proxy-client" certificate and key
[certs] Generating "etcd/ca" certificate and key
[certs] Generating "etcd/peer" certificate and key
[certs] Generating "etcd/server" certificate and key
[certs] Etcd/Server serving cert is signed for DNS names [ip-10-0-0-15 kubernetes.kubernetes.default kubernetes.default.svc.kubernetes.default.svc.cluster.local] and IPs [10.96.0.1 10.0.0.15]
[certs] Generating "apiserver-kubelet-client" certificate and key
[certs] Generating "front-proxy-client" certificate and key
[certs] Generating "etcd/ca" certificate and key
[certs] Generating "etcd/peer" certificate and key
[certs] Generating "etcd/server" certificate and key
[certs] Etcd/Server serving cert is signed for DNS names [ip-10-0-0-15 localhost] and IPs [10.0.0.15 127.0.0.1 ::1]
[certs] Generating "etcd-peer" certificate and key
[certs] Generating "etcd-server" certificate and key
[certs] Generating "etcd/healthcheck-client" certificate and key
[certs] Generating "apiserver-etcd-client" certificate and key
[certs] Generating "sa" key and public key
[kubecfg] Using Kubecfg folder "/etc/kubernetes"
[kubecfg] Writing "admin.conf" kubecfg file
[kubecfg] Writing "kubelet.conf" kubecfg file
[kubecfg] Writing "controller-manager.conf" kubecfg file
[kubecfg] Writing "etcd-peer" kubecfg file
[control-plane] 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
[control-plane] Waiting for the control plane to come up...
[control-plane] Waiting for the control plane to boot up the control plane as static Pods from directory "/etc/kubernetes/manifests". This can take up to 4m0s
[api-client] All control plane components are healthy after 7.584239 seconds
[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-10-0-0-15 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-10-0-0-15 as control-plane by adding the taints {node-role.kubernetes.io/control-plane:NoSchedule}
[bootstrap-token] Using token: 6c8a30-5r8959cf81nunrep
[bootstrap-token] Configuring 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 credentials
[bootstrap-token] Configured RBAC rules to allow the ciscoprover 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
```

Keep the kubeadm join command in your notepad or somewhere for later.

```
[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!

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 10.0.0.15:443 --token 6cbw3o.5r89f9cfbhjuncrep \
--discovery-token-ca-cert-hash sha256:eecc45892dc7341879fc9f2a3399ad6089ed9e86d4eec950ac541363dbc87e6aa
```

Step 15:

As you have to manage the cluster that's why you need to create a .kube file copy it to the given directory and change the ownership of the file.

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

```
root@ip-10-0-0-15:/home/ubuntu# mkdir -p $HOME/.kube
root@ip-10-0-0-15:/home/ubuntu# sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
root@ip-10-0-0-15:/home/ubuntu#
root@ip-10-0-0-15:/home/ubuntu# sudo chown $(id -u):$(id -g) $HOME/.kube/config
root@ip-10-0-0-15:/home/ubuntu#
```

Step 16:

Verify the kubeconfig by kube-system which will list all the pods. If you observe, there are starting two pods that are not ready status because the network plugin is not installed.

```
kubectl get po -n kube-system
```

```
root@ip-10-0-0-15:/home/ubuntu# kubectl get po -n kube-system
NAME          READY   STATUS    RESTARTS   AGE
coredns-5dd5756668-61rb   0/1     Pending   0          66s
coredns-5dd5756668-9xkvz  0/1     Pending   0          66s
etcd-ip-10-0-0-15        1/1     Running   0          71s
kube-controller-manager-ip-10-0-0-15  1/1     Running   0          71s
kube-proxy-mm44           1/1     Running   0          67s
kube-scheduler-ip-10-0-0-15  1/1     Running   0          71s
root@ip-10-0-0-15:/home/ubuntu#
```

Step 17:

Verify all the cluster component health statuses

```
kubectl get --raw='/readyz?verbose'
```

```

root@ip-10-0-0-15:/home/ubuntu# kubectl get --raw='/readyz?verbose'
+ping ok
+log ok
+etcd ok
+etcd-readiness ok
+informer-sync
+poststarthook/start-kube-apiserver-admission-initializer ok
+poststarthook/generic-apiserver-start-informers ok
+poststarthook/priority-and-fairness-config-consumer ok
+poststarthook/priority-and-fairness-filter ok
+poststarthook/storage-object-count-tracker-hook ok
+poststarthook/start-apisextensions-informers ok
+poststarthook/start-apisextensions-controllers ok
+poststarthook/crd-informer-synced ok
+poststarthook/start-apiservice-discovery-controller ok
+poststarthook/rbac/bootstrap-roles ok
+poststarthook/scheduling/bootstrap-system-priority-classes ok
+poststarthook/priority-and-fairness-config-producer ok
+poststarthook/start-system-namespaces-controller ok
+poststarthook/bootstrap-controller ok
+poststarthook/start-cluster-authentication-info-controller ok
+poststarthook/start-kube-apiserver-identity-lease-controller ok
+poststarthook/start-kube-apiserver-identity-lease-garbage-collector ok
+poststarthook/start-kube-apiserver-identity-lease-garbage-collector ok
+poststarthook/start-legacy-token-tracking-controller ok
+poststarthook/aggregator-reload-proxy-client-cert ok
+poststarthook/start-kube-aggregator-informers ok
+poststarthook/apiservice-registration-controller ok
+poststarthook/apiservice-status-available-controller ok
+poststarthook/kube-apiserver-autoregistration ok
+auto-register-completion ok
+poststarthook/apiservice-opensapi-controller ok
+poststarthook/apiservice-opensapi3-controller ok
+poststarthook/apiservice-discovery-controller ok
+shutdown ok
readyz check passed
root@ip-10-0-0-15:/home/ubuntu#

```

Step 18:

Check the cluster-info

```
kubectl cluster-info
```

```

root@ip-10-0-0-15:/home/ubuntu# kubectl cluster-info
Kubernetes control plane is running at https://10.0.0.15:6443
CoreDNS is running at https://10.0.0.15:6443/api/v1/namespaces/kube-system/services/kube-dns:dns/proxy
To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.
root@ip-10-0-0-15:/home/ubuntu#

```

Step 19:

To install the network plugin on the Master node

```
kubectl apply -f
```

```
https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
```

```

root@ip-10-0-0-15:/home/ubuntu# kubectl apply -f https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
poddisruptionbudget/calico-kube-controllers created
serviceaccount/calico-kube-controllers created
serviceaccount/calico-node created
configmap/calico-config created
customresourcedefinition.apirextensions.k8s.io/gcpconfigurations.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/peers.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/blockaffinities.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/caliconodestatuses.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/clusterinformations.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/felixconfiguration.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/globalnetworkpolicies.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/hostendpoints.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/labelaffinity.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/ipamconfigs.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/iphandles.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/ippools.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/ipreservations.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/kubecontrollersconfigurations.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/networkpolicies.crd.projectcalico.org created
customresourcedefinition.apirextensions.k8s.io/networksets.crd.projectcalico.org created
clusterrole/rbac.authorization.k8s.io/calico-kube-controllers created
clusterrolebinding/rbac.authorization.k8s.io/calico-kube-controllers created
clusterrolebinding/rbac.authorization.k8s.io/calico-node created
daemonset.apps/calico-node created
deployment.apps/calico-kube-controllers created

```

Step 20:

Now, If you run the below command, you will observe the two remaining pods are in ready status which means we are ready to bootstrap by our Workers Node or connect to the Master node through the Worker Node.

```
kubectl get po -n kube-system
```

```

root@ip-10-0-0-15:/home/ubuntu# kubectl get po -n kube-system
NAME                                READY   STATUS    RESTARTS   AGE
calico-kube-controllers-658d97c59c-pthv   1/1    Running   0          3d5s
calico-node-5dd575668-6l1rb             1/1    Running   0          3d5s
coredns-5dd575668-9xnv2                1/1    Running   0          2m38s
etcd-ip-10-0-0-15                     1/1    Running   0          2m43s
kube-apiserver-ip-10-0-0-15            1/1    Running   0          2m43s
kube-controller-manager-ip-10-0-0-15    1/1    Running   0          2m43s
kube-proxy-mm44                         1/1    Running   0          2m39s
kube-scheduler-ip-10-0-0-15            1/1    Running   0          2m43s
root@ip-10-0-0-15:/home/ubuntu#

```

Step 21:

Now, you have to run the command on Worker Node1. If you remember, I told you to keep the command somewhere in Step 14. Here you have to use your command because your token is different as well as mine.

Worker Node1

```

kubeadm join 10.0.0.15:6443 — token 6c8w3o.5r89f9cfbhiunrep —
discovery-token-ca-cert-hash [REDACTED]
sha256:eec45092dc7341079fc9f2a3399ad6089ed9e86d4eec950ac541363dbc87e6aa

```

```

root@ip-10-0-0-215:/home/ubuntu# kubeadm join 10.0.0.15:6443 --token 6c8w3o.5r89f9cfbhiunrep --discovery-token-ca-cert-hash sha256:eec45092dc7341079fc9f2a3399ad6089ed9e86d4eec950ac541363dbc87e6aa
[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap...
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.
root@ip-10-0-0-215:/home/ubuntu# 

```

Step 22:

Follow the Step 21.

Worker Node2

```

kubeadm join 10.0.0.15:6443 --token 6c8w3o.5r89f9cfbhiunrep
--discovery-token-ca-cert-hash [REDACTED]
sha256:eec45092dc7341079fc9f2a3399ad6089ed9e86d4eec950ac541363dbc87e6aa

```

```

root@ip-10-0-0-250:/home/ubuntu# kubeadm join 10.0.0.15:6443 --token 6c8w3o.5r89f9cfbhiunrep --discovery-token-ca-cert-hash sha256:eec45092dc7341079fc9f2a3399ad6089ed9e86d4eec950ac541363dbc87e6aa
[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap...
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.
root@ip-10-0-0-250:/home/ubuntu# 

```

Step 23:

Now, from here all the commands will be run on Master Node only.

If you run the below command you will see that the Worker Nodes are present with their respective Private IPs and it is in Ready. status

```
kubectl get nodes
```

```
root@ip-10-0-0-15:/home/ubuntu# kubectl get nodes
NAME      STATUS   ROLES      AGE     VERSION
ip-10-0-0-15 Ready    control-plane   7m46s   v1.28.2
ip-10-0-0-215 Ready    <none>    4m32s   v1.28.2
ip-10-0-0-258 Ready    <none>    27s    v1.28.2
```

Here, we have completed our Setup of Master and Worker Node. Now let's try to deploy a simple nginx pod on both worker nodes.

Step 23:

Run the command, which includes the deployment file to deploy nginx on both worker Node.

```
cat <<EOF | kubectl apply -f -
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 2
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: nginx:latest
        ports:
          - containerPort: 80
EOF
```

```
root@ip-10-0-0-15:/home/ubuntu# cat <<EOF | kubectl apply -f -
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 2
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: nginx:latest
        ports:
          - containerPort: 80
EOF
deployment.apps/nginx-deployment created
```

Step 24:

To expose your deployment on NodePort 32000 which means you can access your nginx application on port 32000 through your browser easily.

```
cat <<EOF | kubectl apply -f -
apiVersion: v1
kind: Service
metadata:
  name: nginx-service
```

```

spec:
selector:
  app: nginx
type: NodePort
ports:
  - port: 80
    targetPort: 80
    nodePort: 32000
EOF

```

```

root@ip-10-0-0-15:/home/ubuntu# cat <<EOF | kubectl apply -f -
apiVersion: v1
kind: Service
metadata:
  name: nginx-service
spec:
  selector:
    app: nginx
  type: NodePort
  ports:
    - port: 80
      targetPort: 80
      nodePort: 32000
EOF
service/nginx-service created

```

Step 25:

Now, check the pods by the below command and you can see that your pods are in running status.

```
kubectl get pods
```

```

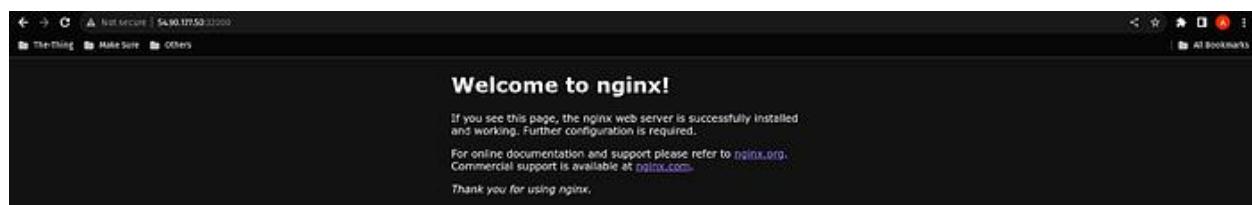
root@ip-10-0-0-15:/home/ubuntu# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-deployment-7c79d4bf97-6nvhb   1/1     Running   0          24s
nginx-deployment-7c79d4bf97-rdzyb   1/1     Running   0          24s

```

Step 26:

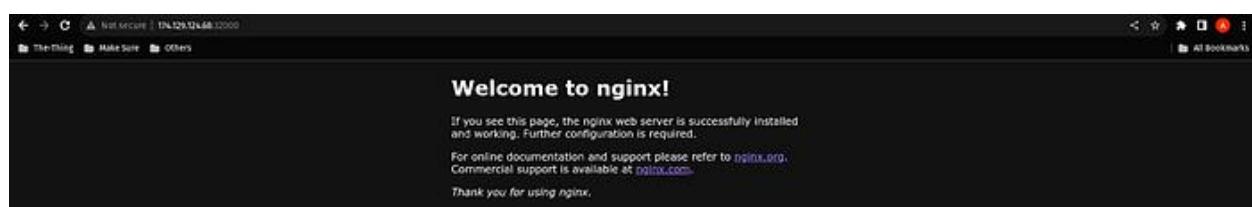
On Worker Node1

You can validate your deployment by copying the Public IP of your WorkerNode1 and adding a colon(:) with port(32000).



On Worker Node2

You can validate your deployment by copying the Public IP of your WorkerNode2 and adding a colon(:) with port(32000).



Kubernetes Networking (Services)

Objectives

By the end of this topic, you will:

Understand the basics of how pods and containers can communicate within the same pod and node.

Explore the critical role of Service objects in Kubernetes networking.

Gain insights into different Service types, including ClusterIP, NodePort, LoadBalancer, and ExternalName.

Things to know about accessing pods or containers in some scenarios:

- Multiple containers within the pod access each other through a loopback address(localhost).
- The cluster provides communication between multiple pods.
- To access your application from outside of the cluster, you need a Services object in Kubernetes.
- You can also use the Services object to publish services only for access within the cluster.

Access containers within the same pod

```
apiVersion: v1
kind: Pod
metadata:
  name: day10
  labels:
    env: testing
    department: DevOps
spec:
  containers:
    - name: container1
      image: nginx
    - name: container2
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo This is Day07 of 30DaysOfKubernetes; sleep 5 ; done"]
  ports:
    - containerPort: 80
```

```
ubuntu@ip-172-31-63-3:~$ kubectl apply -f two-cont.yaml
pod/day07 created
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME     READY   STATUS    RESTARTS   AGE
day07   2/2     Running   0          11s
ubuntu@ip-172-31-63-3:~$
```

`kubectl exec day07 -it -c container2 — /bin/bash`

Update the packages and install the curl

```
ubuntu@ip-172-31-63-3:~$ kubectl exec day07 -it -c container2 -- /bin/bash
root@day07:#
root@day07:#
root@day07:~# curl localhost:80
bash: curl: command not found
root@day07:~#
root@day07:~# apt update && apt install curl
Get:1 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:2 http://security.ubuntu.com/ubuntu jammy-security/universe amd64 Packages [1064 kB]
Get:3 http://security.ubuntu.com/ubuntu jammy-security/restricted amd64 Packages [1226 kB]
Get:4 http://security.ubuntu.com/ubuntu jammy-security/multiverse amd64 Packages [44.0 kB]
Get:5 http://security.ubuntu.com/ubuntu jammy-security/main amd64 Packages [1081 kB]
Get:6 http://archive.ubuntu.com/ubuntu jammy-updates InRelease [109 kB]
Get:7 http://archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Get:8 http://archive.ubuntu.com/ubuntu jammy/multiverse amd64 Packages [206 kB]
Get:9 http://archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [17.5 MB]
Get:10 http://archive.ubuntu.com/ubuntu jammy/main amd64 Packages [1792 kB]
Get:11 http://archive.ubuntu.com/ubuntu jammy/restricted amd64 Packages [164 kB]
Get:12 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [1269 kB]
Get:13 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [1347 kB]
Get:14 http://archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 Packages [1252 kB]
Get:15 http://archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 Packages [6.0 kB]
Get:16 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [50.4 kB]
Get:17 http://archive.ubuntu.com/ubuntu jammy-backports/main amd64 Packages [50.4 kB]
Get:18 http://archive.ubuntu.com/ubuntu jammy-backports/universe amd64 Packages [28.1 kB]
Fetched 27.7 MB in 3s (8158 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Building package lists... Done
Building dependency tree... 50%
```

Run the below command.

`curl localhost:80`

```
root@day07:~# curl localhost:80
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light dark; }
body { width: 33em; margin: 0 auto;
      font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>if you see this page, the nginx web server is successfully installed and
working. Further configuration is required.</p>
<p>For online documentation and support please refer to
<a href="http://nginx.org/">http://nginx.org/.<br/>
Commercial support is available at
<a href="http://nginx.com/">http://nginx.com/.</p>
<p>Thank you for using nginx.</p>
</body>
</html>
root@day07:~#
```

Access containers within the same Node.

```
apiVersion: v1
kind: Pod
metadata:
  name: day10-pod1
  labels:
    env: testing
    department: DevOps
spec:
  containers:
    - name: container1
      image: nginx
      ports:
        - containerPort: 80
apiVersion: v1
```

```

kind: Pod
metadata:
  name: day10-pod2
  labels:
    env: testing
    department: DevOps
spec:
  containers:
    - name: container2
      image: httpd
      ports:
        - containerPort: 80

```

```

ubuntu@ip-172-31-63-3:~$ kubectl apply -f day10-pod1.yaml
pod/day10-pod1 created
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl apply -f day10-pod2.yaml
pod/day10-pod2 created
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME     READY   STATUS    RESTARTS   AGE
day10-pod1   2/2   Running   0          1m
day10-pod2   1/1   Running   0          38s
day10-pod3   1/1   Running   0          19s
ubuntu@ip-172-31-63-3:~$ 

```

```

ubuntu@lp-172-31-63-3:~$ kubectl get pods -o wide
NAME     READY   STATUS    RESTARTS   AGE   IP           NODE   NOMINATED NODE   READINESS GATES
day10-pod1   1/1   Running   0          75s   10.244.0.66   minikube   <none>        <none>
day10-pod2   1/1   Running   0          15s   10.244.0.67   minikube   <none>        <none>
ubuntu@lp-172-31-63-3:~$ kubectl exec -it day10-pod1 -c container1 -- /bin/bash
root@day10-pod1:/# curl 10.244.0.66:80
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light-dark; }
body { width: 35em; margin: 0 auto;
font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and working. Further configuration is required.</p>
<p>For online documentation and support please refer to
<a href="http://nginx.org/en/docs/">http://nginx.org/en/docs/<></p>
<p>Commercial support is available at
<a href="http://nginx.com/">http://nginx.com/<></p>
<p><em>Thank you for using nginx.</em></p>
</body>
</html>
root@day10-pod1:/# curl 10.244.0.67:80
<html><head></head><body>It works!</body></html>
root@day10-pod1:/# 
root@day10-pod1:/# 

```

```

ubuntu@ip-172-31-63-3:~$ kubectl get pods -o wide
NAME      READY   STATUS    RESTARTS   AGE     IP           NODE   NOMINATED NODE   READINESS GATES
day10-pod1 1/1    Running   0          3m13s  10.244.0.66  minikube <none>        <none>
day10-pod2 1/1    Running   0          2m13s  10.244.0.67  minikube <none>        <none>
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl exec -it day10-pod2 -c container2 -- /bin/bash
root@day10-pod2:/usr/local/apache2#
root@day10-pod2:/usr/local/apache2#
root@day10-pod2:/usr/local/apache2# curl 10.244.0.67:80
bash: curl: command not found
root@day10-pod2:/usr/local/apache2#
root@day10-pod2:/usr/local/apache2# apt update && apt install curl
Get:1 http://deb.debian.org/debian bookworm InRelease [11.1 kB]
Get:2 http://deb.debian.org/debian-security bookworm-security InRelease [52.1 kB]
Get:3 http://deb.debian.org/debian bookworm-updates/main amd64 Packages [8789 kB]
Get:4 http://deb.debian.org/debian bookworm-updates/main amd64 Packages [6400 kB]
Get:5 http://deb.debian.org/debian-security bookworm-security/main amd64 Packages [79.7 kB]
Fetched 9117 kB in 1s (6400 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
E: Invalid operation Inatal
root@day10-pod2:/usr/local/apache2# apt update && apt install curl
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  curl
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 315 kB of archives.
After this operation, 500 kB of additional disk space will be used.
Get:1 http://deb.debian.org/debian-security bookworm-security/main amd64 curl amd64 7.88.1-10+deb12u4 (315 kB)
Fetched 315 kB in 9s (14.1 MB/s)
debconf: delaying package configuration, since apt-utils is not installed
Selecting previously unselected package curl.
(Reading database ... 8502 files and directories currently installed.)
Preparing to unpack .../curl_7.88.1-10+deb12u4_amd64.deb ...
Unpacking curl_7.88.1-10+deb12u4 ...
Setting up curl_7.88.1-10+deb12u4 ...
root@day10-pod2:/usr/local/apache2#

```

```

root@day10-pod2:/usr/local/apache2# curl 10.244.0.67:80
<html><body><h1>It works!</h1></body></html>
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light-dark; }
body { width: 33em; margin: 0 auto; font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and working. Further configuration is required.</p>
<p>For online documentation and support please refer to
<a href="http://nginx.org/">http://nginx.org/.<br/>
Commercial support is available at
<a href="http://nginx.com/">http://nginx.com/.</p>
<p>Thank you for using nginx.</p>
</body>
</html>
root@day10-pod2:/usr/local/apache2#

```

Service Object in Kubernetes

To configure Networking for deployed applications on pods and containers, we use Service objects.

There are four main types of Kubernetes Services:

- ClusterIP:** As the name suggests, With the help of this Service. Kubernetes expose the service within the cluster which means the service or application won't be accessible outside of the cluster.

You can view the Service YML file and see how to use this service.

```

apiVersion: v1
kind: Service
metadata: []
  name: httpd-service
spec: []
  ports: []
    - port: 80

```

```
targetPort: 80
selector: [REDACTED]
  name: DevOps
type: ClusterIP
```

2. **NodePort:** This is the next stage of the ClusterIP where you want to deploy your application or service that should be accessible to the world without any interruption. In this Service, the node port exposes the service or application through the static port on each node's IP.

You can view the Service YML file and see how to use this service.

```
apiVersion: v1
kind: Service
metadata: [REDACTED]
  name: httpd-service
spec: [REDACTED]
  ports:
    - port: 80
      targetPort: 80
  selector: [REDACTED]
    name: DevOps
type: NodePort
```

3. **LoadBalancer:** Load balancers are used to distribute the traffic between the multiple pods. With the help of this service object, the services will be exposed via the cloud's load balancer.

You can view the Service YML file and see how to use this service.

```
apiVersion: v1
kind: Service
metadata: [REDACTED]
  name: svc-lb
spec: [REDACTED]
  type: LoadBalancer
  selector: [REDACTED]
    tag: DevOps
  ports:
    - name: port-lb
      protocol: TCP
      port: 80
      targetPort: 80
```

4. **ExternalName:** This is a similar object service to ClusterIP but it does have DNS CName instead of Selectors and labels. In other words, services will be mapped to a DNS name.

You can view the Service YML file and see how to use this service.

```
apiVersion: v1
```

```
kind: Service
metadata:
  name: k8-service
  namespace: dev
spec:
  type: ExternalName
  externalName: k8.learning.com
```

Kubernetes Advanced Networking: CNI and Calico

What is CNI?

CNI stands for Container Network Interface. As the name suggests, CNI works on the networking level where CNI takes care of the pods and other things in Kubernetes. CNI ensures how the containers and pods should connect to the network. There are many CNIs available in the market but today we will discuss Calico CNI.

What is Calico CNI?

Calico is an open-source network and network security solution designed for Kubernetes.

Calico is one of the most popular CNIs which used to manage the networking between containers, pods, nodes, or multiple clusters. Calico works only on networking to provide fine-grained control over the containers, pods, nodes, or multiple clusters where Services and

Alternative of Calico CNI

- **Flannel:** Flannel is a straightforward CNI plugin that uses Layer 3 networking. It is good for small to medium size clusters but the networking policies feature is not good where Calico provides good control over networking policies.
- **Weave:** Weave is quite a good CNI plugin as compared to Flannel as it provides secure, scalable networking and networking policies as well. But it does not have rich features as Calico does.
- **Cilium:** Cilium is one of the best CNI plugins which competes with Calico CNI where Cilium provides the best security and observability. Cilium is a good choice for large complex clusters where security is a top concern.
- **kube-router:** kube-router is a lightweight CNI plugin where that provides good features like serving load balancing and network policies. It is good for small to medium size clusters.

Why you should use Calico CNI over other CNIs(Features)

- **Advanced Networking Policies:** With Calico CNI, we can define fine-grained networking policies over the containers or pods such as which pod can communicate to which other pod and apply rules based on labels, ports, and more. This level of control is not possible through Kubernetes Native Networking.
- **Scalability:** Calico is known for its Scalability where it can handle large clusters with ease and efficiently manage network traffic which makes it suitable for enterprise-level applications with multiple pods.
- **Cross-Cluster Networking:** Calico can be used to connect multiple Kubernetes clusters together, which can be beneficial in hybrid or multi-cluster scenarios.

- **Border Gateway Protocol(BGP) routing:** Calico supports BGP for routing which is quite good if you want to integrate with on-premises data centers or public cloud environments.
- **Security:** Calico supports a very good level of security over the network traffic where Calico encrypts the network traffic so only authorized pods can communicate with the respective pods.

Key Concepts and Real-time Example

- **IP Address Management:** Calico supports managing the IP address for each pod where each pod is assigned to a unique IP address from the cluster's IP address range.
- **Routing and Network Policy:** Calico enables routing for the network traffic between pods. The Network policies can be applied to control traffic between pods. So, you can allow or deny communications between specific pods.
- **Load Balancing:** Calico handles load balancing in which it distributes the traffic between multiple pods.
- **Security and Encryption:** Calico provides security features to protect your Kubernetes clusters. It encrypts the network traffic so that you can ensure only authorized pods can communicate.

Think of Calico as a traffic control system in a city, where every vehicle(pod) gets a unique plate number and license and follows the traffic rules. The Traffic lights(network policies) ensure safe and fully controlled movement. Police officers(security) check for unauthorized actions and keep the movement controlled.

HandsOn

If you want to do HandsOn where you want to install the Calico Network. So you can refer to the Day10 of #30DaysOfKubernetes where we have set up the Master and Worker Node on the AWS EC2 Instance in which I have installed the Calico CNI Plugin.

For now, this is a link to install the Calico and list all the networks, and validate the Calico network

```
kubectl get pods -n kube-system
```

```
root@ip-10-0-0-15:/home/ubuntu# kubectl get po -n kube-system
NAME          READY   STATUS    RESTARTS   AGE
coredns-5dd5756668-6l1rb   0/1     Pending   0          66s
coredns-5dd5756668-9xkvz   0/1     Pending   0          66s
etcd-ip-10-0-0-15        1/1     Running   0          71s
kube-apiserver-ip-10-0-0-15 1/1     Running   0          71s
kube-controller-manager-ip-10-0-0-15 1/1     Running   0          71s
kube-scheduler-ip-10-0-0-15 1/1     Running   0          67s
root@ip-10-0-0-15:/home/ubuntu#
```

```
kubectl apply -f
```

```
https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
```

```

root@ip-10-0-0-15:/home/ubuntu# kubectl apply -f https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
poddisruptionbudget.policy/calico-kube-controllers created
serviceaccount/calico-node created
configmap/calico-ing created
customresourcedefinition.apilextensions.k8s.io/bgpconfigurations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/bgppeers.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/blockaffinities.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/caliconodestatuses.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/clusterinformations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/felixconfigurations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/globalnetworkpolicies.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/globalnetworksets.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/ipamendpoints.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/ipamhandles.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/ippools.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/irpreservations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/kubecontrollersconfigurations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/networkpolicies.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/networksets.crd.projectcalico.org created
clusterrole.rbac.authorization.k8s.io/calico-node created
clusterrolebinding.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrolebinding.rbac.authorization.k8s.io/calico-node created
daemonset.apps/calico-node created
deployment.apps/calico-kube-controllers created

```

`kubectl get pods -n kube-system`

```

root@ip-10-0-0-15:/home/ubuntu# kubectl get po -n kube-system
NAME                               READY   STATUS    RESTARTS   AGE
etcd-ip-10-0-0-15                 1/1     Running   0          2m43s
kube-apiserver-ip-10-0-0-15        1/1     Running   0          2m43s
kube-controller-manager-ip-10-0-0-15 1/1     Running   0          2m43s
kube-proxy-mm44                     1/1     Running   0          2m39s
kube-scheduler-ip-10-0-0-15        1/1     Running   0          2m43s
root@ip-10-0-0-15:/home/ubuntu#

```

Kubernetes Volumes and LivenessProbes

The data is a very important thing for an application. In Kubernetes, data is kept for a short time in the applications in the pods/containers. There is no data persistent things available by default by Kubernetes. To overcome this issue, Kubernetes supports Volumes.

But before going into the types of Volumes. Let's understand some facts about pods and containers' short live data.

- The volumes reside inside the Pod which stores the data of all containers in that pod.
- If the container gets deleted, then the data will persist and it will be available for the new container which was created recently.
- Multiple containers within a pod can share one volume because the volume is attached to the pod.
- If the Pod gets deleted, then the volume will also get deleted which leads to a loss of data for all containers permanently.
- After deleting the pod, the new pod will be created with volume but this time volumes don't have any previous data or any data.

There are some types of Volumes supported by Kubernetes

EmptyDir

- This is one of the basic volume types that we have discussed earlier in the facts. This volume is used to share the volumes between multiple containers within a pod instead of the host machine or any Master/Worker Node.
- EmptyDir volume is created when the pod is created and it exists as long as a pod.
- There is no data available in the EmptyDir volume type when it is created for the first.
- Containers within the pod can access the other containers' data. However, the mount path can be different for each container.
- If the Containers get crashed then, the data will still persist and can be accessible by other or newly created containers.

HandsOn

In this snippet, I have created one file in container1 and looking for the same file and content from container2 which is possible.

EmptyDir YML file

```
apiVersion: v1
kind: Pod
metadata:
  name: emptydir
spec:
  containers:
```

```

- name: container1
  image: ubuntu
  command: ["/bin/bash", "-c", "while true; do echo This is Day13 of 30DaysOfKubernetes; sleep 5 ; done"]
  volumeMounts:
    - name: day13
      mountPath: "/tmp/container1"
- name: container2
  image: centos
  command: ["/bin/bash", "-c", "while true; do echo Chak de INDIA!; sleep 5 ; done"]
  volumeMounts:
    - name: day13
      mountPath: "/tmp/container2"
volumes:
- name: day13
  emptyDir: {}

```

```

ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
emptydir     2/2     Running   0          7m14s
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ kubectl exec -it emptydir -c container1 -- /bin/bash
root@emptydir:#
root@emptydir:#
root@emptydir:/# cd /tmp/container1/
root@emptydir:/tmp/container1#
root@emptydir:/tmp/container1# cat >> abc.txt
Welcome
TO
Kubernetes
Learning
root@emptydir:/tmp/container1#
root@emptydir:/tmp/container1#
root@emptydir:/tmp/container1# cat abc.txt
Welcome abc.txt
root@emptydir:/tmp/container1# ls
Welcome abc.txt
root@emptydir:/tmp/container1# 

```

In this snippet, I am creating a file in container2 and looking for the file and the same content through container1 which is possible.

```

ubuntu@ip-172-31-67-3:~/Day13-K8sVolumes$ kubectl exec -it emptydir -c container2 -- /bin/bash
[root@emptydir ~]#
[root@emptydir ~]#
[root@emptydir ~]# cd /tmp/container2/
[root@emptydir container2]#
[root@emptydir container2]# ls
Welcome abc.txt
[root@emptydir container2]#
[root@emptydir container2]# cat abc.txt
[root@emptydir container2]# cat >> container2.txt
I am Container 2
[root@emptydir container2]#
[root@emptydir container2]# cat container2.txt
I am Container 2
[root@emptydir container2]#
[root@emptydir container2]# exit
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ kubectl exec -it emptydir -c container1 -- /bin/bash
root@emptydir:#
root@emptydir:#
root@emptydir:/# cd /tmp/container1/
root@emptydir:/tmp/container1#
root@emptydir:/tmp/container1# ls
Welcome abc.txt container2.txt
root@emptydir:/tmp/container1# cat container2.txt
I am Container 2
root@emptydir:/tmp/container1# 

```

2. hostPath

This volume type is the advanced version of the previous volume type EmptyDir.

In EmptyDir, the data is stored in the volumes that reside inside the Pods only where the host machine doesn't have the data of the pods and containers.

hostpath volume type helps to access the data of the pods or container volumes from the host machine.

hostpath replicates the data of the volumes on the host machine and if you make the changes from the host machine then the changes will be reflected to the pods volumes(if attached).

HandsOn

In this snippet, once the pod has been created the data directory is also created on the local machine(Minikube Cluster).

hostPath YML file

```
apiVersion: v1
kind: Pod
metadata:
  name: hostpath
spec:
  containers:
    - name: container1
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo This is Day13 of 30DaysOfKubernetes; sleep 5 ; done"]
      volumeMounts:
        - mountPath: "/tmp/cont"
          name: hp-vm
  volumes:
    - name: hp-vm
      hostPath:
        path: /tmp/data
```

```
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ kubectl apply -f hostpath.yml
pod/hostpath created
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ ls /tmp/data/
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ kubectl exec -it hostpath -c container1 -- bash
root@hostpath:/# 
root@hostpath:/# ls /tmp/cont/
root@hostpath:/# 
```

In this snippet, I am creating a txt file inside the pod's mapped directory /tmp/cont which is mapped to the local directory /tmp/data and after that, I am looking for the same file and content on the local machine directory /tmp/data.

```
root@hostpath:/# echo "This is K8 Learning" >> /tmp/cont/abc.txt
root@hostpath:/#
root@hostpath:/#
root@hostpath:/# cat /tmp/cont/abc.txt
This is K8 Learning
root@hostpath:/#
root@hostpath:/#
root@hostpath:/# exit
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ ls /tmp/data/
abc.txt
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ cat /tmp/data/abc.txt
This is K8 Learning
ubuntu@ip-172-31-63-3:~/Day13-K8sVolumes$ 
```

3. Persistent Volume

- Persistent Volume is an advanced version of EmptyDir and hostPath volume types. • Persistent Volume does not store the data over the local server. It stores the data on the cloud or some other place where the data is highly available.

- In previous volume types, if pods get deleted then the data will be deleted as well. But with the help of Persistent Volume, the data can be shared with other pods or other worker node's pods as well after the deletion of pods.
- One Persistent Volume is distributed across the entire Kubernetes Cluster. So that, any node or any node's pod can access the data from the volume accordingly.
- With the help of Persistent Volume, the data will be stored on a central location such as EBS, Azure Disks, etc.
- Persistent Volumes are the available storage(remember for the next volume type).
- If you want to use Persistent Volume, then you have to claim that volume with the help of the manifest YAML file.

4. Persistent Volume Claim(PVC)

- To get the Persistent Volume, you have to claim the volume with the help of PVC.
- When you create a PVC, Kubernetes finds the suitable PV to bind them together.
- After a successful bound to the pod, you can mount it as a volume.
- Once a user finishes its work, then the attached volume gets released and will be used for recycling such as new pod creation for future usage.
- If the pod is terminating due to some issue, the PV will be released but as you know the new pod will be created quickly then the same PV will be attached to the newly created Pod.

Now, As you know the Persistent Volume will be on Cloud. So, there are some facts and terms and conditions are there for EBS because we are using AWS cloud for our K8 learning. So, let's discuss it as well:

- EBS Volumes keeps the data forever where the emptydir volume did not. If the pods get deleted then, the data will still exist in the EBS volume.
- The nodes on which running pods must be on AWS Cloud only(EC2 Instances).
- Both(EBS Volume & EC2 Instances) must be in the same region and availability zone.
- EBS only supports a single EC2 instance mounting a volume

HandsOn

To perform this demo, Create an EBS volume by clicking on 'Create volume'.



Pass the Size for the EBS according to you, and select the Availability zone where your EC2 instance is created, and click on Create volume.

The screenshot shows the 'Create volume' wizard in the AWS Management Console. The 'Volume settings' section includes fields for Volume type (General Purpose SSD), Size (20 GiB), IOPS (100 / 3000), Throughput (Mbps) (Not applicable), Availability Zone (us-east-1a), Snapshot ID (optional), Encryption (Optional), and Tags (optional). The 'Tags - optional' section shows no tags associated with the resource. At the bottom, there are 'Cancel' and 'Create volume' buttons.

Now, copy the volume ID and paste it into the PV YML file(12th line)

Volumes (1/1) Info										
Actions Create volume										
<input type="checkbox"/> None EC2 Experience X Volumes (1/1) Info										
Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Created	Availability Zone	Volume status	Attached Instances
PV-C-Demo	ebs-0000000000000000	gp2	20 GiB	100	-	-	2023/10/25 23:16 GMT+5:30	us-east-1a	Available	No alarms

PV YML file

In this snippet, we have created a Persistent Volume where the EBS volume is attached and created 1GB of capacity.

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: myebsvol
spec:
  capacity:
    storage: 1Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Recycle
  awsElasticBlockStore:
    volumeID: #Your_VolumeID
  fsType: ext4
```

```
ubuntu@ip-172-31-63-3:~/PV-C$ sudo vim day13-pv.yml
ubuntu@ip-172-31-63-3:~/PV-C$ kubectl apply -f day13-pv.yml
persistentvolume/mysbvol created
ubuntu@ip-172-31-63-3:~/PV-C$
ubuntu@ip-172-31-63-3:~/PV-C$ kubectl get pv
NAME      CAPACITY   ACCESS MODES  RECLAIM POLICY  STATUS    CLAIM   STORAGECLASS  REASON  AGE
mysbvol   1Gi        RWO          Recycle        Available             8s
```

PVC YML file

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
```

```

name: myebsvolclaim
spec:
accessModes:
- ReadWriteOnce
resources:
requests:
storage: 1Gi

```

In this snippet, we have created a Persistent Volume Claim in which PVC requests PV to get 1GB, and as you can see the volume is bound successful.

```

ubuntu@ip-172-31-63-3:~/Pv$ vim day13-pvc.yml
ubuntu@ip-172-31-63-3:~/Pv$ kubectl apply -f day13-pvc.yml
persistentvolumeclaim/myebsvolclaim created
ubuntu@ip-172-31-63-3:~/Pv$ kubectl get pvc
NAME      STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   AGE
myebsvolclaim   Bound    pvc-13110c6a-f147-4b42-bb16-d3379fc62ec   1Gi        RWO            standard     14s
ubuntu@ip-172-31-63-3:~/Pv$ 

```

Deployment YML file

```

apiVersion: apps/v1
kind: Deployment
metadata:
  name: pvdeploy
spec:
  replicas: 1
  selector:
    matchLabels:
      app: mypv
  template:
    metadata:
      labels:
        app: mypv
    spec:
      containers:
        - name: shell
          image: centos
          command: ["bin/bash", "-c", "sleep 10000"]
      volumeMounts:
        - name: mypd
          mountPath: "/tmp/persistent"
      volumes:
        - name: mypd
          persistentVolumeClaim:
            claimName: myebsvolclaim

```

In this snippet, we have created a deployment for PV and PVC demonstration.

```

ubuntu@ip-172-31-63-3:~/PV-CS$ sudo vim day13-deploy.yml
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl apply -f day13-deploy.yml
deployment "pvdeploy" created
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl get deploy
NAME      READY   UP-TO-DATE   AVAILABLE   AGE
pvdeploy  1/1     1           1           6s
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl get rs
NAME      DESIRED   CURRENT   READY   AGE
pvdeploy-5c885cf554  1         1         1         12s
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl get pods
NAME            READY   STATUS    RESTARTS   AGE
hostpath        1/1     Running   0          91m
pvdeploy-5c885cf554-5gvhl  1/1     Running   0          22s
ubuntu@ip-172-31-63-3:~/PV-CS

```

In this snippet, we have logged in to the created container and created one file with some text.

```

ubuntu@ip-172-31-63-3:~/PV-CS kubectl get pod
NAME      READY   STATUS    RESTARTS   AGE
pvdeploy-5c885cf554-5gvhl  1/1     Running   0          2m
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl exec -it pvdeploy-5c885cf554-5gvhl -c shell -- /bin/bash
[root@pvdeploy-5c885cf554-5gvhl ~]#
[root@pvdeploy-5c885cf554-5gvhl ~]#
[root@pvdeploy-5c885cf554-5gvhl ~]# ls /tmp/
.. .ICE-unix/ .Test-unix/ .X11-unix/ .XIM-unix/ .font-unix/ ks-script-4luisyola ks-script-a2317rc2 ks-script-xde14wuu persistent/
[root@pvdeploy-5c885cf554-5gvhl ~]#
[root@pvdeploy-5c885cf554-5gvhl ~]# echo "Data is Present in Persistent" >> /tmp/persistent/data.txt
[root@pvdeploy-5c885cf554-5gvhl ~]# cat /tmp/persistent/data.txt
Data is Present in Persistent
[root@pvdeploy-5c885cf554-5gvhl ~]# 

```

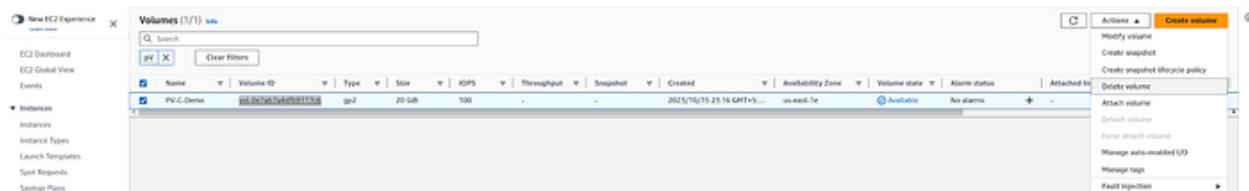
In this snippet, we have deleted the pod, and then because of replicas the new pod was created quickly. Now, we have logged in to the newly created pod and checked for the file that we created in the previous step, and as you can see the file is present which is expected.

```

ubuntu@ip-172-31-63-3:~/PV-CS kubectl get pod
NAME      READY   STATUS    RESTARTS   AGE
pvdeploy-5c885cf554-5gvhl  1/1     Running   0          4m26s
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl delete pod pvdeploy-5c885cf554-5gvhl
pod "pvdeploy-5c885cf554-5gvhl" deleted
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl get pod
NAME      READY   STATUS    RESTARTS   AGE
pvdeploy-5c885cf554-sqtvb  1/1     Running   0          42s
ubuntu@ip-172-31-63-3:~/PV-CS
ubuntu@ip-172-31-63-3:~/PV-CS kubectl exec -it pvdeploy-5c885cf554-sqtvb -c shell -- /bin/bash
[root@pvdeploy-5c885cf554-sqtvb ~]#
[root@pvdeploy-5c885cf554-sqtvb ~]#
[root@pvdeploy-5c885cf554-sqtvb ~]# ls /tmp/persistent/
.. .ICE-unix/ .Test-unix/ .X11-unix/ .XIM-unix/ .font-unix/ ks-script-4luisyola ks-script-a2317rc2 ks-script-xde14wuu persistent/
[root@pvdeploy-5c885cf554-sqtvb ~]#
[root@pvdeploy-5c885cf554-sqtvb ~]# cat /tmp/persistent/data.txt
Data is Present in Persistent
[root@pvdeploy-5c885cf554-sqtvb ~]# 

```

The demonstration has been completed now feel free to delete the volume.



LivenessProbe (HealthCheck)

- LivenessProbe is a rich feature in Kubernetes that is used to check the health of your application.
- Kubernetes by default doesn't check the health check of the applications.
- If you want to use the livenessProbe feature and want to check the health of your application, you have to mention it in the manifest file.

- livenessProbe expects a 0 output which means the application is running perfectly. But if there is any other output except 0 then livenessProbe recreates the container and repeats the same process.
- livenessProbe repeats the process after particular seconds or minutes(specified by you) to check the health of the application.
- If there is a load balancer attached to multiple pods then, livenessProbe checks the health of the application and if the application's health check status is not healthy then livenessProbe removes the particular pod from the load balancer and recreates the new pod and repeats the same process.

HandsOn

In this snippet, we have created a pod, and if you observe there is a new thing added while describing the pod through the kubectl describe pod command in the bottom which comes under Containers liveness.

```
livenessProbe YML file
apiVersion: v1
kind: Pod
metadata:
labels: [REDACTED]
  test: liveness
name: mylivenessprobe
spec: [REDACTED]
  containers:
  - name: liveness
    image: ubuntu
    args: [REDACTED]
    - /bin/sh
    - -c
    - - touch /tmp/healthy; sleep 1000
  livenessProbe: [REDACTED]
    exec: [REDACTED]
      command:
      - cat [REDACTED]
        - /tmp/healthy
    initialDelaySeconds: 5
    periodSeconds: 5
    timeoutSeconds: 30
```

```

ubuntu@ip-172-31-63-3:~/livenessProbes$ sudo vim livenessprobe.yml
ubuntu@ip-172-31-63-3:~/livenessProbes
ubuntu@ip-172-31-63-3:~/livenessProbes$ kubectl apply -f livenessprobe.yml
pod/mylivenessprobe created
ubuntu@ip-172-31-63-3:~/livenessProbes
ubuntu@ip-172-31-63-3:~/livenessProbes$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
mylivenessprobe   1/1     Running   0          8s
ubuntu@ip-172-31-63-3:~/livenessProbes$ kubectl describe pod mylivenessprobe
Name:           mylivenessprobe
Namespace:      default
Priority:      0
Service Account: default
Node:          minikube/192.168.49.2
Start Time:    Sun, 15 Oct 2023 18:27:53 +0000
Labels:        test=liveness
Annotations:   <none>
Status:        Running
IP:           10.244.0.10
IPs:          IP: 10.244.0.10
Containers:
  liveness:
    Container ID: docker://c2d2b9090a1823518000b093dde24aa7b1124af090bf846426dd9beedd1f783
    Image:         ubuntu
    Image ID:     docker-pullable://ubuntu@sha256:2b7412e6445c3c7fc5bb21d3e6f1017c167358449fecac8176c6e496e5c1f05f
    Port:          <none>
    Host Port:    <none>
    Args:          /bin/sh
                  -c
                  touch /tmp/healthy; sleep 1000
    State:        Running
    Started:     Sun, 15 Oct 2023 18:27:54 +0000
    Ready:        True
    Containers Count: 1
    Liveness:     exec [cat /tmp/healthy] delay=5s timeout=30s period=5s #success=1 #failure=3
    Environment:  <none>
    Mounts:       /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-h4fjr (ro)

```

If you see the YML file, there is one condition if the file healthy is not present in /tmp directory then livenessProbe will recreate the container. So, we have deleted that file.

```

ubuntu@ip-172-31-63-3:~/livenessProbes$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
mylivenessprobe   1/1     Running   0          93s
ubuntu@ip-172-31-63-3:~/livenessProbes$ kubectl exec -it mylivenessprobe -c liveness -- /bin/bash
root@mylivenessprobe:/# 
root@mylivenessprobe:/# 
root@mylivenessprobe:/# cat /tmp/healthy
root@mylivenessprobe:/# echo $?
1
root@mylivenessprobe:/# rm /tmp/healthy
root@mylivenessprobe:/# 
root@mylivenessprobe:/# cat /tmp/healthy
cat: /tmp/healthy: No such file or directory
root@mylivenessprobe:/# 
root@mylivenessprobe:/# echo $?
1
root@mylivenessprobe:/# 

```

After deleting the file, if you run kubectl describe pod <pod-name> you will see in the last two lines that the container is failing because the condition is not meeting.

Events:	Type	Reason	Age	From	Message
	Normal	Scheduled	3m18s	default-scheduler	Successfully assigned default/mylivenessprobe to minikube
	Normal	Pulling	3m17s	kubelet	Pulling image "ubuntu"
	Normal	Pulled	3m17s	kubelet	Successfully pulled image "ubuntu" in 150.222253ms (151.4008942ms including waiting)
	Normal	Created	3m17s	kubelet	Created container liveness
	Normal	Started	3m17s	kubelet	Started container liveness
	Warning	Unhealthy	22s (x3 over 32s)	kubelet	Liveness probe failed: cat: /tmp/healthy: No such file or directory
	Normal	Killing	22s	kubelet	Container liveness failed liveness probe, will be restarted

Kubernetes ConfigMaps & Secrets

ConfigMap

ConfigMap is used to store the configuration data in key-value pairs within Kubernetes. This is one of the ways to decouple the configuration from the application to get rid of hardcoded values. Also, if you observe some important values keep changing according to the environments such as development, testing, production, etc ConfigMap helps to fix this issue to decouple the configurations. ConfigMap stores non-confidential data. ConfigMap can be created through an imperative or declarative way.

- Creating the configMap is the first process which can be done by commands only or a YAML file.
- After creating the configMap, we use the data in the pod by injecting the pods.
- After injecting the pods, if there is any update in the configuration we can modify the configMap, and the changes will be reflected in the injected pod.

Secrets

There are lot of confidential information that needs to be stored on the server such as database usernames, passwords, or API Keys. To keep all the important data secure, Kubernetes has a Secrets feature that encrypts the data. Secrets can store data up to 1MB which would be enough. Secrets can be created via imperative or declarative ways. Secrets are stored in the /tmps directory and can be accessible to pods only.

- Creating the Secrets is the first process that can be created by commands or a YAML file.
- After creating the Secrets, applications need to use the credentials or database credentials which will be done by injecting with the pods.

ConfigMap HandsOn

Creating ConfigMap from literal

In this snippet, we have created the configMap through — from-literal which means you just need to provide the key value instead of providing the file with key-value pair data.

At the bottom, you can see the data that we have created through the Literal.

```

ubuntu@ip-172-31-63-3:~$ kubectl get cm
NAME      DATA   AGE
kube-root-ca.crt   23h
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl create cm literal-cm --from-literal=Location=India --from-literal=Username=kabir --from-literal=Password=password0123
configmap/literal-cm created
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get cm
NAME      DATA   AGE
kube-root-ca.crt   23h
literal-cm   3    5h
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl describe cm literal-cm
Name:          literal-cm
Namespace:     default
Labels:        <none>
Annotations:   <none>
Data
=====
Location:     India
Password:     password0123
Username:     kabir
BinaryData
=====
Events:       <none>
ubuntu@ip-172-31-63-3:~$ 

```

CM from file

In this snippet, We have created one file first.conf which has some data, and created the configMap with the help of that file.

At the bottom, you can see the data that we have created through the file.

```

ubuntu@ip-172-31-63-3:~$ kubectl get cm
NAME      DATA   AGE
kube-root-ca.crt   23h
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ echo "This is my first Configmap file" >> first.conf
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl create cm cml --from-file=first.conf
configmap/cml created
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get cm
kubectl: command not found
ubuntu@ip-172-31-63-3:~$ kubectl get cm
NAME      DATA   AGE
cml      1    13s
kube-root-ca.crt   23h
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl describe cm cml
Name:          cml
Namespace:     default
Labels:        <none>
Annotations:   <none>
Data
=====
first.conf:
This is my first Configmap file
BinaryData
=====
Events:       <none>
ubuntu@ip-172-31-63-3:~$ 

```

CM from the env file

In this snippet, We have created one environment file first.env which has some data in key-value pairs, and created the configMap with the help of the environment file.

At the bottom, you can see the data that we have created through the env file.

```

ubuntu@ip-172-31-63-3:~$ kubectl get cm
NAME      DATA   AGE
kube-root-ca.crt  1    23h
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ cat file.env
Subject1= Hindi
Subject2= Tamil
Subject3= Science
Subject4= Maths
Subject5= Sanskrit
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl create cm env-cm --from-env-file=file.env
configmap/env-cm created
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get cm
NAME      DATA   AGE
env-cm    3    8s
kube-root-ca.crt  1    23h
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl describe cm env-cm
Name:          env-cm
Namespace:     default
Labels:        <none>
Annotations:   <none>
Data
====
Subject3:
-----
Science
Subject4:
-----
Maths
Subject5:
-----
Sanskrit
Subject1:
-----
Hindi
Subject2:
-----
Tamil
BinaryData
=====
Events:  <none>

```

What if you have to create configMap for tons of files?

In this snippet, We have created multiple files in a directory with different extensions that have different types of data and created the configMap for the entire directory.

At the bottom, you can see the data that we have created for the entire directory.

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME      DATA   AGE
kube-root-ca.crt  1    23h
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ ls
file.env first.conf password.txt second.conf username.txt
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl create cm cm-directory --from-file=../Properties
configmap/cm-directory created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME      DATA   AGE
cm-directory  3    5s
kube-root-ca.crt  1    23h
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe cm cm-directory
Name:          cm-directory
Namespace:     default
Labels:        <none>
Annotations:   <none>
Data
=====
first.conf:
-----
This is my first Configumap file
password.txt:
-----
password=prem@prem123
second.conf:
-----
Somebody is here
username.txt:
-----
username=prem
file.env:
-----
Subject1= Hindi
Subject2= Tamil
Subject3= Science
Subject4= Maths
Subject5= Sanskrit
BinaryData
=====
```

CM from the YAML file

The imperative way is not very good if you have to repeat the same tasks again and again. Now, we will look at how to create configMap through the YAML file.

In this snippet, We have created one file and run the command with --from-file, and in the end, we add -o yaml which generates the YAML file. You can copy that YAML file modify it according to your key-value pairs and apply the file.

At the bottom, you can see the data that we have created through the YAML file.

```
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME        DATA   AGE
kube-root-ca.crt   1    24h
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ cat file.env
Subject1: Hindi
Subject2: Tamil
Subject3: Science
Subject4: Maths
Subject5: Sanskrit
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ ubuntu@ip-172-31-63-3:~/Properties$ kubectl create cm cm.yaml --from-file=file.env --dry-run -o yaml
W1010 09:52:33.815778 1279964 helpers.go:692] --dry-run is deprecated and can be replaced with --dry-run=client.
spiversion: v1
Data
file.env: |
  Subject1: Hindi
  Subject2: Tamil
  Subject3: Science
  Subject4: Maths
  Subject5: Sanskrit
kind: ConfigMap
metadata:
  creationTimestamp: null
  name: cm.yaml
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ sudo vim cm.yaml
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm.yaml
configmap/cm.yaml created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME        DATA   AGE
cm.yaml     1    5s
kube-root-ca.crt   1    24h
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe cm cm.yaml
error: the server doesn't have a resource type "cm.yaml"
Name:      cm.yaml
Namespace: default
Labels:    <none>
Annotations: <none>
Annotations: <none>
Data
=====
file.env:
-----
Subject1: Hindi
Subject2: Tamil
Subject3: Science
Subject4: Maths
Subject5: Sanskrit
BinaryData
=====
Events:  <none>
ubuntu@ip-172-31-63-3:~/Properties$ 
```

In the above steps, we have created four types of configMaps but here, we will learn how to use those configMaps by injecting configMaps into the pods.

Injecting CM into the pod with specific key pairs

In this snippet, We have created a YAML file in which we have mentioned the configMap name with the key name which will be added to the pod's environment variable.

```
apiVersion: v1
kind: Pod
metadata:
  name: firstpod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never
```

```

env:
  - name: valuefromenv
    valueFrom: [REDACTED]
      configMapKeyRef:
        key: Subject2
        name: cm-from-env

```

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME          DATA   AGE
kube-root-ca.crt   1    24h
ubuntu@ip-172-31-63-3:~/Properties$ kubectl create cm cm-from-env --from-env-file=file.env
configmap/cm-from-env created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
kubect: command not found
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME          DATA   AGE
cm-from-env   1    11s
kube-root-ca.crt   1    24h
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe cm cm-from-env
Name:         cm-from-env
Namespace:   default
Labels:      <none>
Annotations: <none>
Data
-----
Subject1: [REDACTED]
Mindi: [REDACTED]
Subject2: [REDACTED]
Tamil: [REDACTED]
Subject3: [REDACTED]
Science: [REDACTED]
Subject4: [REDACTED]
Maths: [REDACTED]
Subject5: [REDACTED]
Sanskrit: [REDACTED]
BinaryData
none
Events: <none>
ubuntu@ip-172-31-63-3:~/Properties$ sudo vim cm-pod.yml
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm-pod.yml
pod/cm-pod created

```

At the bottom, you can see the configuration in the pod's environment.

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm-pod.yml
pod/firstpod created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME      READY   RESTARTS   AGE
firstpod  1/1     Running   0      5s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- env
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
HOSTNAME=firstpod
TERM=xterm-256color
TERM=xterm-256color
KUBERNETES_PORT_443_TCP_ADDR=10.96.0.1
KUBERNETES_SERVICE_HOST=10.96.0.1
KUBERNETES_SERVICE_PORT=443
KUBERNETES_SERVICE_PORT_HTTPS=443
KUBERNETES_PORT=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP_PROTO=tcp
KUBERNETES_PORT_443_TCP_PORT=443
MINIKUBE_VERSION=v1.17.6
MJS_VERSION=0.3.7
PKG_RELEASE=1-buster
HOME=/root
ubuntu@ip-172-31-63-3:~/Properties$ 

```

Injecting multiple CMs with specific and multiple values

In this snippet, we have added multiple key pairs from different files.

At the bottom, you can see the data that is from different files.

```

apiVersion: v1
kind: Pod
metadata:
  name: firstpod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never

```

```

env:
- name: valuefromenv
  valueFrom:
    configMapKeyRef:
      key: Subject2
      name: cm-from-env
- name: valuefromenv2
  valueFrom:
    configMapKeyRef:
      key: env.sh
      name: cm2
- name: valuefromenv3
  valueFrom:
    configMapKeyRef:
      key: Subject4
      name: cm-from-env

```

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm-pod.yml
pod/firstpod created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pod
kubectl: command not found
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pod
NAME        READY   STATUS    RESTARTS   AGE
firstpod   1/1     Running   0          8s
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- env
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/bin
HOSTNAME=firstpod
TERM=xterm
valuefromenv2=value1=Class
value2=Subject
value3=Function
valuefromenv3=Maths
valuefromenv4=Tamil
KUBERNETES_PORT=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP_PROTO=tcp
KUBERNETES_PORT_443_TCP_PORT=443
KUBERNETES_SERVICE_HOST=10.96.0.1
KUBERNETES_SERVICE_PORT=443
KUBERNETES_SERVICE_PORT_HTTPS=443
NGINX VERSION=1.17.6
NJS VERSION=0.3.7
PKG RELEASE=1-buster
HOME=/root
ubuntu@ip-172-31-63-3:~/Properties$ ubuntu@ip-172-31-63-3:~/Properties$ cat env.sh
value1=Class
value2=Subject
value3=Function
ubuntu@ip-172-31-63-3:~/Properties$ 

```

Injecting the created environment file single cms and getting all the value

```

apiVersion: v1
kind: Pod
metadata:
  name: firstpod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never
      envFrom:
        - configMapRef:
            name: cm-from-env

```

```

ubuntu@ip-172-31-63-3:~/Properties$ sudo vim cm-pod2.yaml
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get cm
NAME          DATA   AGE
cm-from-env   5      7m
cm2           1      25m
kube-root-ca.crt   1      25h
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm-pod2.yaml
pod/firstpod created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
firstpod   1/1     Running   0          5s
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- env
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
HOSTNAME=firstpod
TERM=xterm
TERM=xterm
Subject1= English
Subject2= Science
Subject3= Maths
Subject4= Sanskrit
Subject5= Hindi
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP_PROTO=tcp
KUBERNETES_PORT_443_TCP_PORT=443
KUBERNETES_PORT_443_TCP_ADDR=10.96.0.1
KUBERNETES_SERVICE_HOST=10.96.0.1
KUBERNETES_SERVICE_PORT=443
KUBERNETES_SERVICE_PORT_HTTPS=443
KUBERNETES_PORT_+tcp://10.96.0.1:443
NGINX VERSION=1.17.6
NJS VERSION=0.3.7
PKG RELEASE=1-buster
HOME=/root
ubuntu@ip-172-31-63-3:~/Properties$ []

```

Injecting cm in the pod with the entire proper file

```

apiVersion: v1
kind: Pod
metadata:
  name: firstpod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never
      volumeMounts:
        - name: test
          mountPath: "/env-values"
          readOnly: true
      volumes:
        - name: test
      configMap:
        name: cm-from-env

```

```

ubuntu@ip-172-31-63-3:~/Properties$ sudo vim cm-pod3.yaml
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm-pod3.yaml
pod/firstpod created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
firstpod   1/1     Running   0          35s
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- ls /env-values
Error from server (NotFound): pods "first" not found
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- ls /env-values
Subject1 Subject2 Subject3 Subject4 Subject5
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- cat /env-values/Subject4
Maths
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- cat /env-values/Subject5
Tamil
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ []

```

Injecting CM and creating a file in the pod with the selected key pairs

```

apiVersion: v1
kind: Pod
metadata:
  name: firstpod
spec:
  containers:
    - image: coolgourav147/nginx-custom

```

```

name: firstcontainer
imagePullPolicy: Never
volumeMounts:
- name: test
  mountPath: "/env-values"
  readOnly: true
volumes:
- name: test
configMap:
  name: cm-from-env
  items:
    - key: Subject3
      path: "topic3"
    - key: Subject5
      path: "topic5"

```

```

ubuntu@ip-172-31-63-3:~/Properties$ sudo vim cm-pod4.yaml
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f cm-pod4.yaml
pod/firstpod created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
firstpod  1/1     Running   0          6s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- ls /env-values
topic3
topic5
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- cat /env-values/topic3
Scienceubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it firstpod -- cat /env-values/topic5
Sanskritubuntu@ip-172-31-63-3:~/Properties$ 

```

Secrets HandsOn

Creating Secrets from literal

In this snippet, we have created the Secrets through — from-literal which means you just need to provide the key value instead of providing the file with key-value pair data.

At the bottom, you can see the key and encrypted value because Kubernetes encrypts the secrets.

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl create secret generic first --from-literal=username=aman19
secret/first created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets
NAME      TYPE     DATA   AGE
first     Opaque   3      5s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe secret first
Name:         first
Namespace:   default
Labels:      <none>
Annotations: <none>
Type:        Opaque
Data
====
username: 6 bytes
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe secret first -o yaml
error: unknown shorthand flag: 'o' in -o
See 'kubectl describe --help' for usage.
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets first -o yaml
apiVersion: v1
data:
  username: 01hbb15
kind: Secret
metadata:
  creationTimestamp: "2023-10-16T13:00:24Z"
  name: first
  namespace: default
  resourceVersion: "67336"
  uid: 46fffa3ab-3efb-4039-a5a7-ed8ccce8566
type: Opaque
ubuntu@ip-172-31-63-3:~/Properties$ 

```

Secrets from file

In this snippet, We have created one file first.conf which has some data, and created the Secrets with the help of that file.

At the bottom, you can see the encrypted data..

```
ubuntu@ip-172-31-63-3:~/Properties$ kubectl create secret generic seonc --from-file=file.env
secret/seonc created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets
NAME          TYPE        DATA   AGE
seonc         Opaque      3     3m6s
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets seonc
error: the server doesn't have a resource type "seonc"
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe secret seonc
Name:         seonc
Namespace:    default
Labels:       <none>
Annotations: <none>
Type:        Opaque
Data
=====
file.env: 85 bytes
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets seonc -o yaml
apiVersion: v1
data:
  file.env: U3ViamVjdDE9IEhpemRpC1N1Yqg1Y30yPS8UWlpApTdWJqZWN0Hl0gU2NpZh5jZ0gTdw3eZWV0ND0gTHF0ahMKU3VianVjdDU9IFNhbnNrcn14Cp==
kind: Secret
metadata:
  creationTimestamp: "2023-10-16T13:03:16Z"
  name: seonc
  namespace: default
  resourceVersion: "67473"
  uid: ccfadfa1-4306-42ab-a651-7013efcfa248
type: Opaque
ubuntu@ip-172-31-63-3:~/Properties$ 
```

Secrets from the env file

In this snippet, We have created one environment file first.env which has some data in key-value pairs, and created the Secrets with the help of the environment file.

At the bottom, you can see the encrypted data.

```
ubuntu@ip-172-31-63-3:~/Properties$ kubectl create secret generic third --from-env-file=file.env
secret/third created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets
NAME          TYPE        DATA   AGE
third         Opaque      5     3m43s
third         Opaque      6     6s
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe secret third
Name:         third
Namespace:    default
Labels:       <none>
Annotations: <none>
Type:        Opaque
Data
=====
Subjects:  6 bytes
Subjects:  6 bytes
Subjects:  8 bytes
Subjects:  0 bytes
Subjects:  0 bytes
Subjects:  9 bytes
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secret third -o yaml
apiVersion: v1
data:
  Subject1: IFNgbd0
  Subject2: IFR0bD0
  Subject3: IFMhNWhY2U=
  Subject4: IE1ndGhr
  Subjects: IFMhbNrcm10
kind: Secret
metadata:
  creationTimestamp: "2023-10-16T13:05:55Z"
  name: third
  namespace: default
  resourceVersion: "67683"
  uid: 8c7cf93-7061-461b-8692-aefed2e9a5fc
type: Opaque
ubuntu@ip-172-31-63-3:~/Properties$ 
```

What if you have to create Secrets for tons of files?

In this snippet, We have created multiple files in a directory with a different extension that has different types of data and created the Secrets for the entire directory.

At the bottom, you can see the encrypted data.

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl create secret generic fourth --from-file=..../Properties
secret/fourth created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets
NAME      TYPE     DATA   AGE
first     Opaque   1      6m51s
fourth    Opaque   13     7s
second   Opaque   5      5m59s
third    Opaque   5      69s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe secret fourth
Name:          fourth
Namespace:    default
Labels:        <none>
Annotations:  <none>

Type:  Opaque

Data
====

cm-pod4.yaml:  478 bytes
cm.yml:        207 bytes
first.conf:    33 bytes
password.txt:  22 bytes
second.conf:   17 bytes
tp.yaml:       348 bytes
username.txt:  10 bytes
third.yaml:    574 bytes
cm-pod1.yaml:  236 bytes
cm-pod2.yaml:  341 bytes
env.sh:         44 bytes
file.env:      85 bytes
abc.txt:       26339 bytes
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secret fourth -o yaml
apiVersion: v1
data:
  abc.txt: ICAGIDfIgHmBzI2G8yXK80JHvWZGF02SAteSmA3J2bzdrVifGyf0LIC5C1AgIAyCAYCBzdrVihJ3Yv9dAgICAgMyAgc3VkybHcQoWa5zdgfSbcAtcSBjdXs1HdnZxQyB0LXRyM5zC9yDc0LHrcRwcoq1CaQnAgY3VwCATEFgph0B0eH6ly2idG9yYmldnlndvbdzs2WfuxXm029112pb1nrdJ1L31b6Vh2V2L2zhdGVd9tahc5pa3VlZ51saK51e3hN02nAaog1Caghp5pc33by8pbmP9Ymks1G1gbpmlrdW11Nxkav4VLMFTzd010C91c31vb691YmWvYslnL2pbnldzJ1L31b6Vh2V2L2zhdGVd9tahc5pa3VlZ51saK51e3hN02nAaog1CagIAc13(CB)j0Xs1C1mtb0dthC2zov13h0e33h2u2U2922x1YXpbc5j2b3va3v12XuZxR1c1y2xh1YXNL31b6Vh20vYGN1lQmXqabRch06L9y2d9yY6d2lLndvbd5e2zFuax0MhY2912T1YmVym0W2X0MtcmvN2Xk259yZwxLYXNL31N0WYmz2550d31pb19saw51e9hbm02N02rhdW31Y38s1cAgIAc4ICBjg1v2CAreCBrdW31Y38s1cAgIAcASICBzdrWig12161YmJd0gwpL3Vzc19s2NbNhbC91o4K1CAGhTAgI6zCiaG10ExI
  data:
    abc.txt: ICAGIDfIgHmBzI2G8yXK80JHvWZGF02SAteSmA3J2bzdrVifGyf0LIC5C1AgIAyCAYCBzdrVihJ3Yv9dAgICAgMyAgc3VkybHcQoWa5zdgfSbcAtcSBjdXs1HdnZxQyB0LXRyM5zC9yDc0LHrcRwcoq1CaQnAgY3VwCATEFgph0B0eH6ly2idG9yYmldnlndvbdzs2WfuxXm029112pb1nrdJ1L31b6Vh2V2L2zhdGVd9tahc5pa3VlZ51saK51e3hN02nAaog1Caghp5pc33by8pbmP9Ymks1G1gbpmlrdW11Nxkav4VLMFTzd010C91c31vb691YmWvYslnL2pbnldzJ1L31b6Vh2V2L2zhdGVd9tahc5pa3VlZ51saK51e3hN02nAaog1CagIAc13(CB)j0Xs1C1mtb0dthC2zov13h0e33h2u2U2922x1YXpbc5j2b3va3v12XuZxR1c1y2xh1YXNL31b6Vh20vYGN1lQmXqabRch06L9y2d9yY6d2lLndvbd5e2zFuax0MhY2912T1YmVym0W2X0MtcmvN2Xk259yZwxLYXNL31N0WYmz2550d31pb19saw51e9hbm02N02rhdW31Y38s1cAgIAcASICBzdrWig12161YmJd0gwpL3Vzc19s2NbNhbC91o4K1CAGhTAgI6zCiaG10ExI

```

CM from the YAML file

In this snippet, We have created one file and run the command with — from-file, and in the end, we add -o yaml which generates the YAML file. You can copy that YAML file modify it according to your key-value pairs and apply the file.

At the bottom, you can see the encrypted data.

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl create secret generic fifth --from-file=file.env -o yaml >> secrets.yaml
apiVersion: v1
kind: Secret
metadata:
  creationTimestamp: "2023-10-16T13:11:08Z"
  name: fifth
  namespace: default
  resourceVersion: "67857"
  uid: 1beaeeb1-fee1-4120-8786-81fd5eb0721e
type: Opaque
ubuntu@ip-172-31-63-3:~/Properties$ kubectl delete secret fifth
secret "fifth" deleted
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f secrets.yaml
secret/fifth created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get secrets
NAME      TYPE      DATA   AGE
fifth     Opaque    1      4m
first    Opaque    1      11m
fourth   Opaque    13     4m41s
seconc   Opaque    1      8m35s
third    Opaque    5      5m54s
ubuntu@ip-172-31-63-3:~/Properties$ k
K: command not found
ubuntu@ip-172-31-63-3:~/Properties$ kubectl describe secrets fifth
Name:          fifth
Namespace:    default
Labels:        <none>
Annotations:  <none>

Type:  Opaque

Data
====

file.env:  85 bytes
ubuntu@ip-172-31-63-3:~/Properties$ 
```

In the above steps, we have created four types of Secrets but here, we will learn how to use those Secrets by injecting Secrets to the pods.

Injecting Secret with a pod for a particular key pairs

In this snippet, We have created a YAML file in which we have mentioned the Secrets name with the key name which will be added to the pod's environment variable.

with the key `apiVersion: v1`

```

kind: Pod
metadata:
  name: secret-pod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never
      env:
        - name: the-variable
          valueFrom:
            secretKeyRef:
              key: Subject1
              name: third

```

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f secret2.yml
pod/secret-pod created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME     READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   0          4s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- env
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
HOSTNAME=secret-pod
TERM=xterm
file.env>Subject1= Hindi
Subject2= Tamil
Subject3= Science
Subject4= Maths
Subject5= Sanskrit

KUBERNETES_SERVICE_PORT=443
KUBERNETES_SERVICE_PORT_HTTPS=443
KUBERNETES_PORT_443_TCP://10.96.0.1:443
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP_PROTO=tcp
KUBERNETES_PORT_443_TCP_PORT=443
KUBERNETES_PORT_443_TCP_ADDR=10.96.0.1
KUBERNETES_SERVICE_HOST=10.96.0.1
NGINX VERSION=1.17.6
NJS VERSION=0.3.7
PKG RELEASE=1~buster
HOME=/root
ubuntu@ip-172-31-63-3:~/Properties$ 

```

Injecting the created environment file single cms and getting all the value

```

apiVersion: v1
kind: Pod
metadata:
  name: secret-pod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never
      volumeMounts:
        - name: test
          mountPath: "/secrets-values"
  volumes:
    - name: test
      secret:
        secretName: seonc

```

```

ubuntu@ip-172-31-63-3:~/Properties$ sudo vim secrets3.yaml
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f secrets3.yaml
pod/secret-pod created
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
secret-pod  1/1     Running   0          4s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- ls /secret-value
ls: cannot access '/secret-value': No such file or directory
Command terminated with exit code 2
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- ls /secret-values
ls: cannot access '/secret-values': No such file or directory
Command terminated with exit code 2
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- bash
root@secret-pod:/#
root@secret-pod:/# ls
bin boot dev etc home lib lib64 media mnt opt proc root run sbin secrets-values srv sys tmp usr var
root@secret-pod:/# cd secrets-values/
root@secret-pod:/secrets-values# ls
file.env
root@secret-pod:/secrets-values# cat file.env
Subject1= Hindi
Subject2= Tamil
Subject3= Science
Subject4= Maths
Subject5= Sanskrit
root@secret-pod:/secrets-values# 

```

Injecting Secrets and creating a file in the pod with the selected key pairs

```

apiVersion: v1
kind: Pod
metadata:
  name: secret-pod
spec:
  containers:
    - image: coolgourav147/nginx-custom
      name: firstcontainer
      imagePullPolicy: Never
    volumeMounts:
      - name: test
        mountPath: "/secrets-values"
  volumes:
    - name: test
      secret:
        secretName: third
        items:
          - key: Subject3
            path: "topic3"
          - key: Subject5
            path: "topic5"

```

```

ubuntu@ip-172-31-63-3:~/Properties$ kubectl apply -f secret4.yaml
pod/secret-pod created
ubuntu@ip-172-31-63-3:~/Properties$ kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
SECRET-pod  1/1     Running   0          7s
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- ls secrets-values/
topic3 topic5
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- cat secrets-values/topic3
Science
ubuntu@ip-172-31-63-3:~/Properties$ 
ubuntu@ip-172-31-63-3:~/Properties$ kubectl exec -it secret-pod -- cat secrets-values/topic5
Sanskrit
ubuntu@ip-172-31-63-3:~/Properties$ 

```

Kubernetes Jobs

Kubernetes Jobs is a resource that is used to achieve a particular work such as a backup script and, once the work is completed the pod will be deleted.

Use cases:

- Database backup script needs to run
- Running batch processes
- Running the task on the scheduled interval
- Log Rotation

Key-Features:

- **One-time Execution:** If you have a task that needs to be executed one time whether it's succeed or fail then the job will be finished.
- **Parallelism:** If you want to run multiple pods at the same time.
- **Scheduling:** If you want to schedule a specific number of pods after a specific time.
- **Restart Policy:** You can specify whether the Job should restart if fails.

Let's do some **hands-on work** to get a better understanding of Kubernetes Jobs.

Work completed and pod deleted

```
apiVersion: batch/v1
kind: Job
metadata:
  name: testjob
spec:
  template:
    metadata:
      name: testjob
    spec:
      containers:
        - image: ubuntu
          name: container1
          command: ["bin/bash", "-c", "sudo apt update; sleep 30"]
      restartPolicy: Never
```

```

ubuntu@ip-172-31-63-3:~/Jobs$ sudo vim job1.yml
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl apply -f job1.yml --dry-run=client
job.batch/testjob created (dry run)
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl apply -f job1.yml
job.batch/testjob created
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-rrt9p 1/1     Running   0          5s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-rrt9p 1/1     Running   0          10s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-rrt9p 1/1     Running   0          18s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-rrt9p 1/1     Running   0          27s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-rrt9p 1/1     Running   0          31s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-rrt9p 0/1     Completed  0          35s
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl delete -f job1.yml
job.batch "testjob" deleted
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ []

```

Create and run the pods simultaneously and delete once the work is completed.

```

apiVersion: batch/v1
kind: Job
metadata: 
name: testjob
spec: 
  parallelism: 3 # Create 3 pods and run simultaneously
  activeDeadlineSeconds: 10 # Pods will terminate after 40 secs(10+30(command sleep time))
  template: 
    metadata: 
      name: testjob
    spec: 
      containers: 
        - image: ubuntu
          name: container1
          command: ["bin/bash", "-c", "sudo apt update; sleep 30"]
      restartPolicy: Never

```

```

ubuntu@ip-172-31-63-3:~/Jobs$ sudo vim job2.yml
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl apply -f job2.yml
job.batch/testjob created
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
testjob-2pdsk 1/1     Terminating   0          30s
testjob-7fk6r 1/1     Terminating   0          30s
testjob-w5frw 1/1     Terminating   0          10s
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
secret-pod   1/1     Running   1 (18h ago)  18h
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ []

```

Scheduling a pod after each minute

```

apiVersion: batch/v1
kind: CronJob
metadata: 
name: testjob
spec: 
  schedule: "* * * * *"
  jobTemplate: 

```

```

spec:
template:
spec:
  containers:
    - image: ubuntu
      name: container1
      command: ["bin/bash", "-c", "sudo apt update; sleep 30"]
restartPolicy: Never

```

```

ubuntu@ip-172-31-63-3:~/Jobs$ sudo vim job3.yaml
ubuntu@ip-172-31-63-3:~/Jobs$ sudo vim job3.yaml
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl apply -f job3.yaml
cronjob.batch/testjob created
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
testjob-2892220-57gv6   1/1     Running   0          35s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
testjob-2892220-57gv6   1/1     Running   0          35s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
testjob-2892220-57gv6   1/1     Running   0          145s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
testjob-2892220-57gv6   0/1     Completed   0          2d4s
testjob-2892221-1pl18   0/1     Completed   0          64s
testjob-2892222-7lwxl   1/1     Running   0          4s
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
testjob-2892220-57gv6   0/1     Completed   0          3m
testjob-2892221-1pl18   0/1     Completed   0          2m
testjob-2892222-7lwxl   0/1     Completed   0          60s
testjob-2892223-rj6br   0/1     ContainerCreating   0          0s
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
testjob-2892220-57gv6   0/1     Completed   0          3m11s
testjob-2892221-1pl18   0/1     Completed   0          2m11s
testjob-2892222-7lwxl   0/1     Completed   0          71s
testjob-2892223-rj6br   0/1     Running   0          11s
ubuntu@ip-172-31-63-3:~/Jobs$ 

```

Kubernetes InitContainer

- Init Containers are those containers that run before the main or app container for the particular work.
- Init Containers motive for completion which means that the given work needs to be completed.
- If a pod fails due to Init Containers then, Kubernetes restarts the init Container until it will succeed.

Use cases:

- To Install the dependencies before running the application on the main container
- Clone a git repository into the volume
- Generate configuration files dynamically
- Database Configuration

Let's do some **hands-on** to get a better understanding of Init Containers.

In this snippet, we are creating a new pod in which we have created two containers and the first container is initcontainer.

```
apiVersion: v1
kind: Pod
metadata:
  name: initcontainer
spec:
  initContainers:
    - name: container1
      image: ubuntu
      command: ["bin/bash", "-c", "echo We are at 16 Days of 30DaysOfKubernetes > /tmp/xchange/testfile; sleep 15"]
      volumeMounts:
        - name: xchange
          mountPath: "/tmp/xchange"
  containers:
    - name: container2
      image: ubuntu
      command: ["bin/bash", "-c", "while true; do echo `cat /tmp/data/testfile`; sleep 10; done"]
      volumeMounts:
        - name: xchange
          mountPath: /tmp/data
  volumes:
    - name: xchange
      emptyDir: {}
```

```

ubuntu@ip-172-31-63-3:~/Jobs$ sudo vim init.yml
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl apply -f init.yml --dry-run=client
pod/initcontainer created (dry run)
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl apply -f init.yml
error: initcontainer already exists
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
initcontainer  0/1     Init:0/1   0          7s
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
initcontainer  0/1     Init:0/1   0          29s
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl describe pod initcontainer
Name:           initcontainer
Namespace:      default
Priority:       0
Service Account: default
Mode:           minikube/192.168.49.2
Start Time:    Tue, 17 Oct 2023 09:26:14 +0000
Labels:         <none>
Annotations:   <none>
Status:        Running
IP:            10.244.0.67
IPs:
  IP: 10.244.0.67
Init Containers:
  containers:
    Container ID: docker://c9a509e0610elf4el62b7d950ef8f37751200bdd1fd1238c7f461031a7ac20f6
    Image:         ubuntu
    Image ID:     docker-pullable://ubuntu@sha256:2b7412e6465c3c7fc5bb21d3e6f1917c167358449fecac8176c6e496e5c1f05f
    Port:          <none>
    Host Port:    <none>
    Command:
      bin/bash
      -c
      echo We are at 16 Days of 300DaysOfKubernetes > /tmp/xchange/testfile; sleep 15
    Status:       Terminated
    Reason:      Completed
    Exit Code:   0
    Started:    Tue, 17 Oct 2023 09:26:15 +0000
    Finished:   Tue, 17 Oct 2023 09:26:30 +0000
    Ready:       True
    Restart Count: 0
    Environment: <none>
    Mounts:
      /tmp/xchange from xchange [rw]
      /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-dzknz [ro]
Containers:

```

In this snippet, you will see the initcontainer is configured and then the main application container is running.

```

Events:
Type  Reason  Age   From            Message
----  ----   --   ---             -----
Normal Scheduled 36s  default-scheduler  Successfully assigned default/initcontainer to minikube
Normal Pulling  35s  kubelet          Pulling image "ubuntu"
Normal Pulled   35s  kubelet          Successfully pulled image "ubuntu" in 160.622359ms (160.646389ms including waiting)
Normal Created  35s  kubelet          Created container container1
Normal Started  35s  kubelet          Started container container1
Normal Pulling  19s  kubelet          Pulling image "ubuntu"
Normal Pulled   19s  kubelet          Successfully pulled image "ubuntu" in 190.310697ms (190.332802ms including waiting)
Normal Created  19s  kubelet          Created container container2
Normal Started  19s  kubelet          Started container container2
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
initcontainer  1/1     Running   0          46s
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl logs -f pod/initcontainer
Defaulted container "container2" out of: container2, container1 (init)
We are at 16 Days of 300DaysOfKubernetes
`c
ubuntu@ip-172-31-63-3:~/Jobs$ 
ubuntu@ip-172-31-63-3:~/Jobs$ kubectl exec -it initcontainer -c container2 -- cat /tmp/data/testfile
We are at 16 Days of 300DaysOfKubernetes
ubuntu@ip-172-31-63-3:~/Jobs$ 

```

Kubernetes Pod Lifecycle

There are multiple types of states for the Pod lifecycle that we will discuss here:

1. **Pending**: When a pod is created it has to go through the pending status in which Master nodes allocate the nodes to where to create the pod. The pods will remain in the pending state until all the necessary resources are allocated such as CPU, memory, and storage.
2. **Running**: Once the pod has been scheduled to a node, it comes into the Running Status. Once the pod comes into a running state, the containers within the pods will be creating and doing the tasks that have been provided in the manifest file.
3. **Succeeded**: Once the pods have completed their task then, the pods come in the Succeeded state and then terminates.
4. **Failed**: Once the pods intend to create but due to some issues the pods are not creating and showing the Failed state leads to issues with the configurations which need to be addressed by the creator of the file.
5. **CrashLoopBackOff**: This is the advanced state of a Failed state where the container is crashing and restarts. To fix this issue, the creator of the file needs to check the manifest file.
6. **Unknown**: In some cases, the Kubernetes may lose the connection with the nodes to create the pods that show the unknown status of the particular pod.
7. **Termination**: When a pod is no longer available it comes in the termination process. Once the pod is deleted, it can not restart again the same pods and is removed from the entire Kubernetes cluster.

There are some conditions that come under while creating Pods:

- **Initialized**: This condition shows whether all the init containers have started successfully or not. If the status is false it means the init containers have not started.
- **Ready**: This condition shows the pod is ready to use.
- **ContainersReady**: As the name suggests, if the containers are ready within a pod it will show True in the status.
- **PodScheduled**: This condition shows that the pod has been scheduled on the node.

If you create any pod and describe that pod by running the command `kubectl describe pod <pod-name>`. You will see the status like this, the pod is scheduled but other things are not because it is in progress.

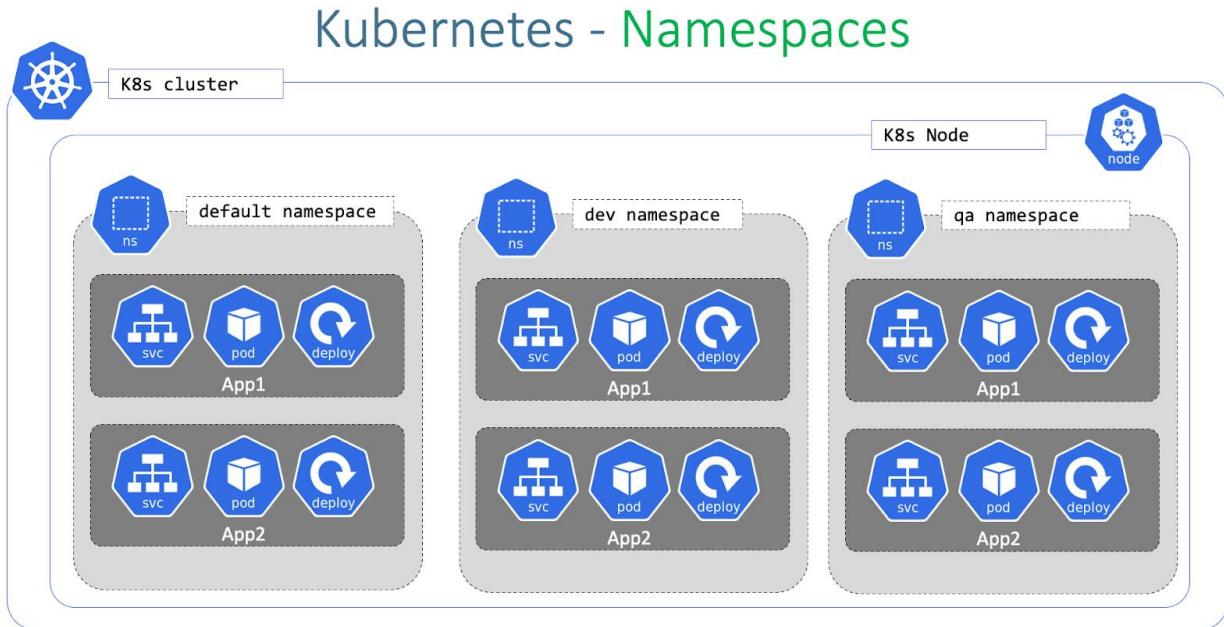
Conditions:

Type	Status
Initialized	False
Ready	False
ContainersReady	False
PodScheduled	True

After some seconds, if you describe again the same pod. You will see that everything is perfect and configured properly.

Conditions:	
Type	Status
Initialized	True
Ready	True
ContainersReady	True
PodScheduled	True

Kubernetes Namespace



About Namespace

- A namespace is a logical entity that is used to organize the Kubernetes Cluster into virtual sub-clusters.
- The namespace is used when an organization shares the same Kubernetes cluster for multiple projects.
- There can be any number of namespaces can be created inside the Kubernetes cluster.
- Nodes and Kubernetes Volumes do not come under the namespaces and are visible to every namespace.

Pre-existed Kubernetes namespaces

- **default:** As the name suggests, whenever we create any Kubernetes object such as pod, replicas, etc it will create in the default namespace. If you want to create the particular pod in the different namespace you have to create the namespace and while creating the pod you have to mention the namespace(Will do in handsOn).
- **kube-system:** This namespace contains the Kubernetes components such as kube-controller-manager, kube-scheduler, kube-dns or other controllers. This

namespace must be avoided to create pods or other objects if you want to keep the Kubernetes cluster stable.

- **kube-public:** This namespace is used to share non-sensitive information that can be viewed by any of the members who are part of the Kubernetes cluster.

When should we consider Kubernetes Namespaces?

- **Isolation:** When there are multiple numbers of projects running then we can consider making namespaces and put the projects accordingly in the namespaces.
- **Organization:** If there is only one Kubernetes Cluster which has different environments to keep isolated. If something happens to the particular environment then it won't affect the other environments.
- **Permission:** If some objects are confidential and must need access to the particular persons then, Kubernetes provides RBAC roles as well which we can use in the namespace. It means that only authorized users can access the objects within the namespaces.

HandsOn

If you observe the first command, while running the command 'kubectl get pods' you are getting 'No resources found in default namespace' which means that we are trying to list the pods from the default namespace.

If you observe the second command 'kubectl get namespaces' which is used to list all the namespaces.

The default one is created for pods and others for Kubernetes itself which we don't use for ourselves.

```
ubuntu@ip-172-31-63-3:~$ kubectl get pods
No resources found in default namespace.
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ 
ubuntu@ip-172-31-63-3:~$ kubectl get namespaces
kubect: command not found
ubuntu@ip-172-31-63-3:~$ kubectl get namespaces
NAME      STATUS  AGE
default   Active  2d23h
kube-node-lease  Active  2d23h
kube-public  Active  2d23h
kube-system  Active  2d23h
ubuntu@ip-172-31-63-3:~$ 
```

In this snippet, we have created one new namespace named tech-mahindra and you can validate whether the namespace is created or not by running 'kubectl get namespaces' command.

```

apiVersion: v1
kind: Namespace
metadata:
  name: tech-mahindra
  labels:
    name: tech-mahindra

ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ sudo vim new-ns.yml
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl apply -f new-ns.yml
namespace/tech-mahindra created
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl get namespaces
NAME          STATUS  AGE
default       Active  2d23h
kube-node-lease  Active  2d23h
kube-public    Active  2d23h
kube-system    Active  2d23h
tech-mahindra  Active  9s
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 

```

In this snippet, we have created one pod in a namespace that we created in the previous step(tech-mahindra). If you want to list the pods from the other namespace except the default namespace then you have to mention the namespace name by following -n <namespace-name>.

```

apiVersion: v1
kind: Pod
metadata:
  name: ns-demo-pod
spec:
  containers:
  - name: container1
    image: ubuntu
    command: ["bin/bash", "-c", "while true; do echo We are on 18th Day of
30DaysOfKubernetes; sleep 30; done"]
  restartPolicy: Never

```

```

ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ sudo vim ns-pod.yml
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl apply -f ns-pod.yml -n tech-mahindra
pod/ns-demo-pod created
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl get pods
No resources found in default namespace.
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl get pods -n tech-mahindra
NAME      READY  STATUS   RESTARTS  AGE
ns-demo-pod  1/1   Running  0        16s
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 

```

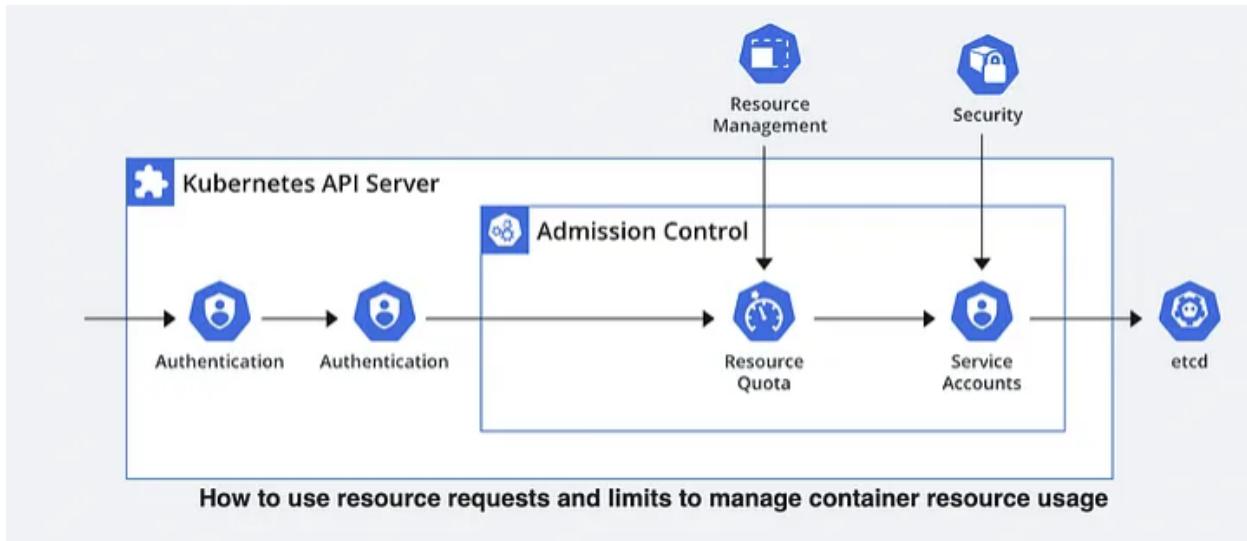
If you want to delete the pod from the different namespace except default then you have to mention the namespace otherwise it will throw the error.

```
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl get pods -n tech-mahindra
NAME        READY   STATUS    RESTARTS   AGE
ns-demo-pod 1/1     Running   0          9m49s
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl delete pod ns-demo-pod
Error from server (NotFound): pods "ns-demo-pod" not found
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl delete pod ns-demo-pod -n tech-mahindra
pod "ns-demo-pod" deleted
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
```

If you want to set your namespace as the default namespace, you can use the command ‘kubectl config set-context \$(kubectl config current-context) — namespace <namespace-name>’ and if you want to see the default namespace use the command ‘kubectl config view | grep namespace’

```
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl config set-context $(kubectl config current-context) --namespace=tech-mahindra
Context "minikube" modified.
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl config view | grep namespace:
  namespace: =tech-mahindra
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
```

Kubernetes ResourceQuota



ResourceQuota is one of the rich features of Kubernetes that helps to manage and distribute resources according to the requirements.

Suppose in an Organization, two teams share the same Kubernetes Cluster where the first team needs more CPUs and Memory because of heavy workload tasks. Now, in this situation, if the CPUs and other resources go to another team then it might increase the chance of failure. To resolve this issue, we can allocate particular CPU cores and Memory to every project.

- A pod in Kubernetes will run with no limits on CPU and memory by default.
- You can specify the RAM, Memory, or CPUs for each container and pod.
- The scheduler decides which node will create pods, if the node has enough CPU resources available then, the node will place the pods.
- CPU is specified in units of cores and memory is specified in units of bytes.
- As you know, the Kubernetes cluster can be divided into namespaces and if a container is created in a namespace that has a default CPU limit and container does not specify the CPU limit then the container will have the default CPU limit.
- A namespace can be assigned to ResourceQuota objects, this will help to limit the amount of usage to the objects within the namespaces. You can limit the computer (CPU), Memory, and Storage.
- Restrictions that a resource-quotas imposes on namespaces

- Every container that is running on the namespace must have its own CPU limit.
- The total amount of CPU used by all the containers in the namespace should not exceed a specified limit.

There are two types of constraints that need to be mentioned while using ResourceQuota:

- **Limit:** Limit specifies that the container, pod, or namespace will have the limit resources where if the objects will exceed the limit then, the object won't create.
- **Request:** The request specifies that the container, pod, or namespace needs a particular amount of resources such as CPU and memory. But if the request is greater than the limit then, Kubernetes won't allow the creation of pods or containers.

Now, there are some conditions or principles for requests and limit which needs to be understood.

Let's understand with hands-on and theoretical.

1. If the requests and limits are given in the manifest file, it works accordingly.
2. If the requests are given but the limit is not provided then, the default limit will be used.
3. If the requests are not provided but the limit is provided then, the requests will be equal to the limit.

When both requests and limits have been mentioned for a pod then it will create the pod according to the provided resources

```
apiVersion: v1
kind: Pod
metadata:
  name: resources
spec:
  containers:
    - image: ubuntu
      name: res-pod
      command: ["bin/bash", "-c", "while true; do echo We are on 18th Day of 30DaysOfKubernetes; sleep 30; done"]
  resources:
    requests:
      memory: "32Mi"
      cpu: "200m"
    limits:
      memory: "64Mi"
      cpu: "400m"
```

```

ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ sudo vim resource.yaml
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl apply -f resource.yaml
pod/quotapod created
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
quotapod      1/1     Running   0          5s
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl describe pod resources
Name:         quotapod
Namespace:    default
Priority:    0
Service Account: default
Node:        minikube/192.168.49.2
Start Time:   Wed, 18 Oct 2023 11:31:48 +0000
Labels:      <none>
Annotations: <none>
Status:      Running
IP:          10.244.0.75
IPs:         IP: 10.244.0.75
Containers:
  res-pod:
    Container ID: docker://1be01473d1ce36705ee86607c5a1a30ac4331e492a35e45976ad7d633c1104a6
    Image:        ubuntu
    Image ID:    docker-pullable://ubuntu@sha256:2b7412e6465c3c7fc58b2103e6f1917c167358449fecac8176c6e496e5c1f05f
    Port:        <none>
    Host Port:   <none>
    Command:
      bin/bash
      -c
      while true; do echo We are on 18th Day of 360daysOfKubernetes; sleep 30; done
    State:       Running
      Started:   Wed, 18 Oct 2023 11:31:49 +0000
    Ready:      True
    Restart Count: 0
    Limits:
      cpu: 400m
      memory: 64Mi
    Requests:
      cpu: 200m
      memory: 32Mi
    Environment: <none>
    Mounts:
      /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-fp7zq (ro)

```

Creating ResourceQuota

```

apiVersion: v1
kind: ResourceQuota
metadata: []
  name: res-quota
spec: []
  hard:
    limits.cpu: "200m"
    requests.cpu: "150m"
    limits.memory: "38Mi"
    requests.memory: "12Mi"

```

```

ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ sudo vim resourcequota.yaml
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl apply -f resourcequota.yaml
resourcequota/res-quota created
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ kubectl get resourcequotas
NAME          AGE   REQUESTS   LIMITS
res-quota   28s   200m/150m   400m/200m, 64Mi/38Mi
ubuntu@ip-172-31-63-3:~/ResourceQuota-Namespace$ 

```

Creating deployment but the pod is not creating due to out of limit

```

apiVersion: apps/v1
kind: Deployment
metadata: []
  name: rq-deployments
spec: []
  replicas: 4
  selector: []
    matchLabels: []
    objtype: rq-deployments
  template: []

```

```

metadata:
  name: rq-pod
  labels: [REDACTED]
    objtype: rq-deployments
spec:
  containers:
    - name: rq-cont
      image: ubuntu
      command: ["bin/bash", "-c", "while true; do echo We are on 18th Day of 30DaysOfKubernetes; sleep 30; done"]
  resources:
    requests:
      cpu: "50m"

```

```

ubuntu@ip-172-31-63-3:~/k8source>Data-Namespace$ sudo vim rq-pod.yaml
ubuntu@ip-172-31-63-3:~/k8source>Data-Namespace$ kubectl apply -f rq-pod.yaml
deployment.apps/rq-deployments created
ubuntu@ip-172-31-63-3:~/k8source>Data-Namespace$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
ubuntu@ip-172-31-63-3:~/k8source>Data-Namespace$ kubectl get deploy
NAME        READY   UP-TO-DATE   AVAILABLE   AGE
rq-deployments   0/4     0          0          16s
ubuntu@ip-172-31-63-3:~/k8source>Data-Namespace$ kubectl get rs
NAME        DESIRED   CURRENT   AGE
rs-rq-deployments-549c9455b5   0         0         22s
ubuntu@ip-172-31-63-3:~/k8source>Data-Namespace$ kubectl describe rs rs-rq-deployments-549c9455b5
Name:           rs-rq-deployments-549c9455b5
Namespace:      default
Selector:       objtype=rq-deployments,pod-template-hash=549c9455b5
Labels:         objtype=rq-deployments
                pod-template-hash=549c9455b5
Annotations:   deployment.kubernetes.io/desired-replicas: 4
                deployment.kubernetes.io/max-replicas: 5
                deployment.kubernetes.io/revision: 1
Controlled By: Deployment/rq-deployments
Replicas:       0 current / 4 desired
Pod Status:    0 Running / 0 Waiting / 0 Succeeded / 0 Failed
Pod Template:
  Labels:  objtype=rq-deployments
          pod-template.hash=549c9455b5
  Containers:
    rq-cont:
      Image:      ubuntu
      Ports:      <none>
      Host Port: <none>
      Command:
        bin/bash
        -c
        while true; do echo We are on 18th Day of 30DaysOfKubernetes; sleep 30; done
      Requests:
        CPU:        50m
      Environment: <none>
      Mounts:     <none>
      Volumes:    <none>
    Conditions:
      Type        Status  Reason

```

Error logs for the above work

Type	Reason	Age	From	Message
Warning	FailedCreate	30s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-gscwm" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	30s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-lsBsh" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	30s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-9vwwb" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	30s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-dkLrj" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	30s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-45dp2" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	29s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-198pq" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	29s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-jhqmb" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	29s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-bckdv" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	20s	replicaset-controller	Error creating: pods "rq-deployments-549c9455b5-vjbkj" is forbidden: failed quota: res-quota: must specify limits.cpu for: rq-cont; limits.memory for: rq-cont; requests.memory for: rq-cont
Warning	FailedCreate	9s (x4 over 27s)	replicaset-controller	(combined from similar events); Error creating: pods "rq-deployments-549c9455b5-dvbqn" is forbidden: failed quota: res-quota

When I did not provide requests

In this snippet, we have created a limit range where we have set the default value for CPU as 1 and from that 1 cpu we are requesting 0.5 CPU only to create a container, if the container needs more than 0.5 CPU then due to the limit range it won't happen

```
apiVersion: v1
```

```

kind: LimitRange
metadata:
  name: cpulimitrange
spec:
  limits:
    - default:
        cpu: 1
      defaultRequest:
        cpu: 0.5
    type: Container

```

```

ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ kubectl apply -f no-req-demo.yaml
pod/default-cpu-demo-2 created
ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
default-cpu-demo-2   1/1     Running   0          12s
ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ kubectl describe pod default-cpu-demo-2
Name:           default-cpu-demo-2
Namespace:      default
Priority:       0
Service Account: default
Node:           minikube/192.168.49.2
Start Time:    Wed, 18 Oct 2023 13:03:42 +0000
Labels:         <none>
Annotations:   <none>
Status:         Running
IP:            10.244.0.78
IPs:           IP: 10.244.0.78
Containers:
  default-cpu-demo-2:
    Container ID: docker://8e0a745d353e5a94378a8557b1c762138d95c97c5d222413588cce83b7130d0
    Image:          nginx
    Image ID:      docker-pullable://nginx@sha256:b4af4f8b6470feb45dc10f564551af682a802eda1743055a7dfc8332dffa595
    Port:          <none>
    Host Port:    <none>
    State:         Running
      Started:    Wed, 18 Oct 2023 13:03:43 +0000
    Ready:         True
    Limits:        <none>
      CPU: 1
    Requests:      <none>
      CPU: 1
    Environment:  <none>

```

When I did not provide the limit

```

ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ sudo vim no-resourc.yaml
ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ kubectl apply -f no-resourc.yaml
pod/default-cpu-demo-3 created
ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
default-cpu-demo-2   1/1     Running   0          2m12s
default-cpu-demo-3   0/1     Pending   0          4s
ubuntu@ip-172-31-63-3:~/ResourceData-Namespace$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
default-cpu-demo-2   1/1     Running   0          2m18s
default-cpu-demo-3   0/1     Pending   0          10s

```

```

apiVersion: v1
kind: Pod
metadata:
  name: no-request-demo
spec:
  containers:
    - name: container1
      image: ubuntu
      resources:
        limits:
          cpu: "2"

```

When I did not provide limits

```
QoS Class:           Burstable
Node-Selectors:      <none>
Tolerations:        node.kubernetes.io/not-ready:NoExecute op=Exists for 300s
                    node.kubernetes.io/unreachable:NoExecute op=Exists for 300s
Events:             Type  Reason          Age   From            Message
...              ...
Warning FailedScheduling 31s default-scheduler 0/1 nodes are available: 1 Insufficient cpu. preemption: 0/1 nodes are available: 1 No preemption victims found for incoming pod..
ubuntu@ip-172-31-63-3:/~$ kubectl delete -f no-req-demo.yaml
pod "default-cpu-demo-2" deleted
ubuntu@ip-172-31-63-3:/~$ kubectl get pods
NAME                READY   STATUS    RESTARTS   AGE
default-cpu-demo-3  1/1     Running   0          74s
ubuntu@ip-172-31-63-3:/~$
```

```
apiVersion: v1
kind: Pod
metadata:
  name: default-cpu-demo-3
spec:
  containers:
  - name: default-cpu-demo-3-ctr
    image: nginx
    resources:
      requests:
        cpu: "0.75"
```

Kubernetes AutoScaling

Kubernetes supports autoscaling. If you don't know about autoscaling, let me explain you in a simple way. As you know, to run the application we need CPU and memory. Sometimes, there will be a chance where the CPU gets loaded, and this might fail the server or affect the application. Now, we can't afford the downtime of the applications. To get rid of these, we need to increase the number of servers or increase the capacity of servers.

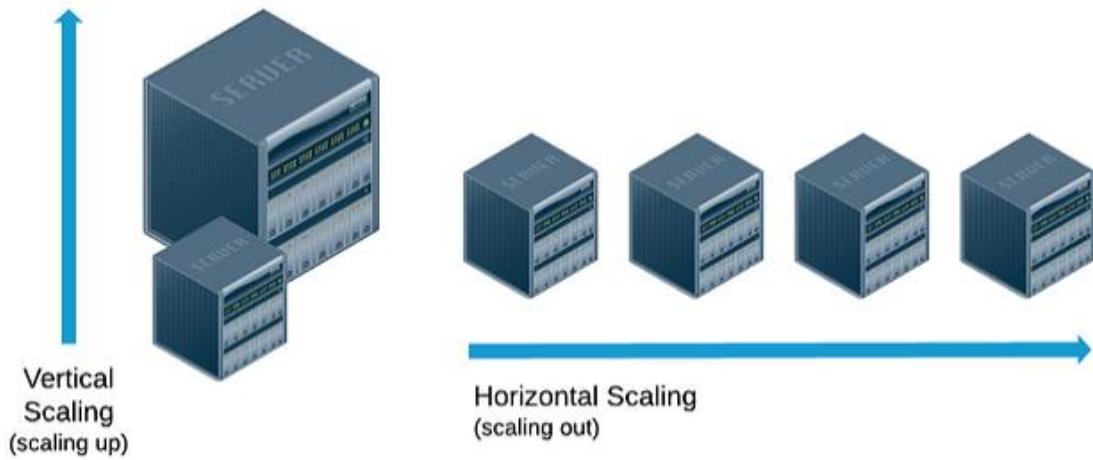
Let's understand with a real-time example

There are some OTT platforms such as Netflix or Hotstar. If any web show or movie is coming on the platform the audience is eagerly waiting for that. Then, the OTT platform can't handle the lot of users that might crash the application. This will lead to a loss of business and the OTT platform can't afford this business loss. Now, they have two options to solve this.

- First, The Platform knows that they need a particular amount of servers such as 100. So, they can buy those servers forever but in this situation, when the load decreases then the other servers will become unused. Now, if the server is unused, still they have paid for those servers which is not a cost-effective method.
- Second, The Platform doesn't know when the load will increase. So, they have one option which is autoscaling in which when the CPU utilization crosses a particular number, it creates new servers. So, the platform can handle loads easily which is very cost effective as well.

Types of Autoscaling

- **Horizontal Pod AutoScaling:** In this type of scaling, the number of servers will increase according to CPU utilization. In this, you define the minimum number of servers, maximum number of servers, and CPU utilization. If the CPU utilization crosses more than 50% then, it will add the one server automatically.
- **Vertical Pod AutoScaling:** In this type of scaling, the server will remain the same in numbers but the server's configuration will increase such as from 4GB RAM to 8GM RAM, and the same with the other configurations. But this is not cost-effective and business-effective. So, we use Horizontal Pod AutoScaling.



Key Features of Horizontal Pod AutoScaler

- By default, Kubernetes does not provide AutoScaling. If you need AutoScaling, then you have to create hpa(Horizontal Pod AutoScaling) and vpa(Vertical Pod AutoScaling) objects.
- Kubernetes supports the autoscaling of the pods based on Observed CPU Utilization.
- Scaling only supports Scalable objects like Controller, deployment, or ReplicaSet.
- HPA is implemented as a Kubernetes API resource and a controller.
- The Controller periodically adjusts the number of replicas in a replication controller or deployment to match the observed average CPU utilization to the target specified in the manifest file or command.

We will not cover Vertical Scaling, but you must be aware of it. To get a better understanding of VPA. Refer this:

[Kubernetes VPA](#)

Let's do some hands-on for Horizontal Pod AutoScaler.

We can perform HPA through two types:

- **Imperative** way: In this way, you will create hpa object by command only.
- **Declarative** way: In this way, you will create a proper manifest file and then create an object by applying the manifest file.

HandsOn

To perform HPA, we need one Kubernetes component which is a metrics server. To download this, use the below command.

```
curl -LO
```

```
https://github.com/kubernetes-sigs/metrics-server/releases/latest/download/components.yaml
```

```

ubuntu@ip-172-31-63-3:~$ curl -L0 https://github.com/kubernetes-sigs/metrics-server/releases/latest/download/components.yaml
% Total    % Received % Xferd  Average Speed   Time   Time  Current
          Dload  Upload   Total Spent  Left Speed
0       0     0     0     0     0      0 *--:--:-- *--:--:-- *--:--:-- 0
0       0     0     0     0     0      0 *--:--:-- *--:--:-- *--:--:-- 0
100 4186 100 4186 0    0 12614 0 *--:--:-- *--:--:-- *--:--:-- 12614
ubuntu@ip-172-31-63-3:~$ ls | grep comp
components.yaml
ubuntu@ip-172-31-63-3:~$ 

```

Now, edit the components.yaml file

add

hostNetwork: true

under spec: line and,

add

- --kubelet-insecure-tls

under the metric-resolutions line, then save the file.

```

132   spec:
133     hostNetwork: true
134     containers:
135       - args:
136         - --cert-dir=/tmp
137         - --secure-port=4443
138         - --kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname
139         - --kubelet-use-node-status-port
140         - --metric-resolution=15s
141         - --kubelet-insecure-tls
142         image: k8s.gcr.io/metrics-server/metrics-server:v0.6.4
143         imagePullPolicy: IfNotPresent

```

Now, you have to apply this by the below command

kubectl apply -f components.yaml

To validate, run the command below

kubectl get pods -n kube-system

If the metrics-server pod is running then, you are ready to scale.

```

ubuntu@ip-172-31-63-3:~$ kubectl get pods -n kube-system
NAME           READY   STATUS    RESTARTS   AGE
coredns-5d78c9869d-rd7dr   1/1    Running   4 (3d26h ago)   7d2h
etcd-minikube   1/1    Running   4 (3d26h ago)   7d2h
kube-apiserver-minikube   1/1    Running   4 (3d26h ago)   7d2h
kube-controller-manager-minikube   1/1    Running   4 (3d26h ago)   7d2h
kube-proxy-91f91   1/1    Running   4 (3d26h ago)   7d2h
kube-scheduler-minikube   1/1    Running   4 (3d26h ago)   7d2h
metrics-server-604694c468-rpxrk  1/1    Running   0 (61s ago)    61s
storage-provisioner   1/1    Running   9 (7m29s ago)   7d2h
ubuntu@ip-172-31-63-3:~$ 

```

Through Imperative way

Create the deployment by the below file

kind: Deployment

apiVersion: apps/v1

metadata:

name: thdeploy

spec:

replicas: 1

selector:

matchLabels:

name: deployment

template:

metadata:

name: testpod8

labels:

name: deployment

spec:

containers:

- name: container1

image: nginx

ports:

- containerPort: 80

```

resources:
limits:
cpu: 500m
requests:
cpu: 200m

```

Apply the deployment file

```
kubectl apply -f <file_name.yml>
```

Now, I have opened two windows to show you whether the pod is scaling or not.

Run the watch 'kubectl get all' command to see the pod creation.

On the other window, we are creating an hpa object through command.

```
kubectl autoscale deployment <deployment_name_from_yml> --cpu-percent=20 --min=1 --max=5
```

Now on the other window, go into the container using the below command:

```
kubectl exec <pod_name> -it -- /bin/bash/
```

Now run the below command inside the container and see the magic.

```
while true; do apt update; done
```

```

Every 2.0s: kubectl get all                                         ip-172-31-63-3: Sun Oct 22 12:27:02 2023

NAME          READY   STATUS    RESTARTS   AGE
pod/thdeploy-75455bf0fb-4nmh6   1/1     Running   0          7m35s
service/kubernetes   ClusterIP  10.96.0.1   <none>        443/TCP   7d2h
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/thdeploy   1/1     1           1          7m35s
NAME          DESIRED  CURRENT   READY   AGE
replicaset.apps/thdeploy-75455bf0fb  1       1       1       7m35s
NAME          REFERENCE          TARGETS   MINPODS   MAXPODS   REPLICAS   AGE
horizontalpodautoscaler.autoscaling/thdeploy   Deployment/thdeploy   <unknown>/20%   1         5         1         37s
NAME          COMPLETIONS   DURATION   AGE
job.batch/testjob  0/1 of 3      5d3h      5d3h

Terminal - ubuntu@ip-172-31-63-3:~ -
```

```

File Edit View Terminal Tabs Help
ubuntu@ip-172-31-63-3:~$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
thdeploy-75455bf0fb-4nmh6   1/1     Running   0          6m15s
ubuntu@ip-172-31-63-3:~$ kubectl autoscale deployment thdeploy --cpu-percent=20 --min=1 --max=5
horizontalpodautoscaler.autoscaling/thdeploy autoscaled
ubuntu@ip-172-31-63-3:~$ kubectl exec thdeploy-75455bf0fb-4nmh6 -it -- /bin/bash
root@thdeploy-75455bf0fb-4nmh6:/#
```

In this scenario, you can observe that the pod count has increased, reaching its maximum value of 5. If you intend to downscale, simply halt the command currently executing within the container. Afterward, Kubernetes will automatically delete the pods within approximately 5 minutes. This delay is designed to allow Kubernetes to assess the system load, if the load surges once more, Kubernetes will need to scale up the number of pods. This phase is commonly referred to as the "cooldown period."

```
Every 2.0s: kubectl get all
NAME           READY   STATUS    RESTARTS   AGE
pod/thedeploy-644b69989d-5jcpv   1/1     Running   0          42s
pod/thedeploy-644b69989d-ch9f7   1/1     Running   0          57s
pod/thedeploy-644b69989d-fg8t7   1/1     Running   0          57s
pod/thedeploy-644b69989d-lxf84   1/1     Running   0          57s
pod/thedeploy-644b69989d-z67sg   1/1     Running   0          3m30s

NAME          TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
service/kubernetes  ClusterIP  10.96.0.1   <none>        443/TCP   7d3h

NAME          READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/thedeploy  5/5      5           5           3m30s

NAME          DESIRED   CURRENT   READY   AGE
replicaset.apps/thedeploy-644b69989d  5       5         5         3m30s

NAME          REFERENCE   TARGETS   MINPODS   MAXPODS   REPLICAS   AGE
horizontalpodautoscaler.autoscaling/thedeploy   Deployment/thedeploy  25%/20%   1         5         5         87s

NAME          COMPLETIONS   DURATION   AGE
job.batch/testjob  0/1 of 3   5d4h      5d4h

Terminal - ubuntu@ip-10-21-42-2 ~
File Edit View Terminal Help
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date
root@thedeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thedeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thedeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thedeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thedeploy-644b69989d-z67sg:/#
```

Here, you can see the pod number again comes to 1 because there is no load on the container.

```
Every 2.0s: kubectl get all                                         1p-172-31-63-3: Sun Oct 22 13:23:43 2023
NAME                         READY   STATUS    RESTARTS   AGE
pod/thdeploy-644b69989d-lx84   1/1     Running   0          13n
NAME           TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
service/kubernetes   ClusterIP   10.96.0.1   <none>      443/TCP   7d3h
NAME              READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/thdeploy   1/1     1           1           15m
NAME           DESIRED   CURRENT   READY   AGE
replicaset.apps/thdeploy-644b69989d   1       1       1       15m
NAME           REFERENCE   TARGETS   MINPODS   MAXPODS   REPLICAS   AGE
horizontalpodautoscaler.autoscaling/thdeploy   Deployment/thdeploy   0%/20%   1       5       1       13n
NAME           COMPLETIONS   DURATION   AGE
job.batch/testjob   0/1 of 3   5d4h      5d4h

[Terminal - ubuntu@ip-172-31-63-3: ~]# http://deb.debian.org/debian-security bookworm-security InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
root@thdeploy-644b69989d-267sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thdeploy-644b69989d-267sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thdeploy-644b69989d-267sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thdeploy-644b69989d-267sg:/# command terminated with exit code 137
ubuntu@ip-172-31-63-3: ~]$
```

```
Through declarative way  
apiVersion: autoscaling/v2  
kind: HorizontalPodAutoscaler  
metadata:  
  name: demo-hpa  
spec:  
  scaleTargetRef:
```

```

apiVersion: apps/v1
kind: Deployment
  name: thdeploy
  minReplicas: 1
  maxReplicas: 5
  metrics:
    - type: Resource
      resource:
        name: cpu
        target:
          type: Utilization
          averageUtilization: 20

```

Create a file for the hpa object and copy the above content in the file.

```
kubectl apply -f <hpa.yml>
```

The hpa object has been created. Now, you can perform the above steps to increase the load on the container to see the pod scaling.

I have opened two windows to show you whether the pod is scaling or not.

Run the watch 'kubectl get all' command to see the pod creation.

Now on the other window, go into the container using the below command:

```
kubectl exec <pod_name> -it — /bin/bash/
```

Now run the below command inside the container and see the magic.

```
while true; do apt update; done
```

```

Every 2.0s: kubectl get all
NAME           READY   STATUS    RESTARTS   AGE
pod/thdeploy-644b69989d-bdshr   1/1     Running   0          21s
pod/thdeploy-644b69989d-cq599   1/1     Running   0          21s
pod/thdeploy-644b69989d-9xsm    1/1     Running   0          6m57s
pod/thdeploy-644b69989d-sdj7k   1/1     Running   0          21s
pod/thdeploy-644b69989d-stdpb   1/1     Running   0          6s

NAME             TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
service/kubernetes   ClusterIP  10.96.0.1   <none>        443/TCP   764h

NAME           READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/thdeploy   5/5       5/5       5/5       6m57s

NAME           DESIRED   CURRENT   READY   AGE
replicaset.apps/thdeploy-644b69989d  5         5         5         6m57s

NAME           REFERENCE   TARGETS   MINPODS   MAXPODS   REPLICAS   AGE
horizontalpodautoscaler.autoscaling/demo-hpa   Deployment/thdeploy   152%/20%  1         5         4         6m36s

NAME           COMPLETIONS   DURATION   AGE
job.batch/testjob  0/1 of 3   5d5h      5d5h

```

Terminal - ubuntu@ip-172-31-63-3: ~

```

File Edit View Terminal Help Help
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... 0%

```

In this scenario, you can observe that the pod count has increased, reaching its maximum value of 5. If you intend to downscale, simply halt the command currently executing within the container. Afterward, Kubernetes will automatically delete the pods within approximately 5 minutes. This delay is designed to allow Kubernetes to assess

the system load, if the load surges once more, Kubernetes will need to scale up the number of pods. This phase is commonly referred to as the “cooldown period.

```
Every 2.0s: kubectl get all
NAME          READY   STATUS    RESTARTS   AGE
pod/thdeploy-644b69989d-5jcp   1/1     Running   0          42s
pod/thdeploy-644b69989d-ckv9f   1/1     Running   0          57s
pod/thdeploy-644b69989d-fg8t7   1/1     Running   0          57s
pod/thdeploy-644b69989d-lxf84   1/1     Running   0          57s
pod/thdeploy-644b69989d-z67sg   1/1     Running   0          3m30s

NAME           TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)      AGE
service/kubernetes   ClusterIP   10.96.0.1   <none>       443/TCP     7d3h

NAME          READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/thdeploy   5/5        5            5           2m30s

NAME          DESIRED  CURRENT  READY   AGE
replicaset.apps/thdeploy-644b69989d   5      5      5      3m30s

NAME           REFERENCE          TARGETS  MINPODS  MAXPODS   REPLICAS   AGE
horizontalpodautoscaler.autoscaling/thdeploy   Deployment/thdeploy   25%/20%  1         5         5         87s

NAME          COMPLETIONS  DURATION   AGE
job.batch/testjob  0/1 of 3   5d4h      5d4h

Terminal - ubuntu@ip-172-31-63-3: ~
```

```
Hit:1 http://deb.debian.org/debian bookworm-updates InRelease
Hit:2 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
root@thdeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thdeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thdeploy-644b69989d-z67sg:/# apt upgrade -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@thdeploy-644b69989d-z67sg:/#
```

Here, you can see the pod number again comes to 1 because there is no load on the container.

```
Every 2.0s: kubectl get all
NAME          READY   STATUS    RESTARTS   AGE
pod/thdeploy-644b69989d-h9xdm   1/1     Running   0          41m
pod/thdeploy-644b69989d-h9xdm   1/1     Running   0          41m

NAME           TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)      AGE
service/kubernetes   ClusterIP   10.96.0.1   <none>       443/TCP     7d4h

NAME          READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/thdeploy   1/1        1            1           41m

NAME          DESIRED  CURRENT  READY   AGE
replicaset.apps/thdeploy-644b69989d   1      1      1      41m

NAME           REFERENCE          TARGETS  MINPODS  MAXPODS   REPLICAS   AGE
horizontalpodautoscaler.autoscaling/demo-hpa   Deployment/thdeploy   0%/20%  1         5         1         41m

NAME          COMPLETIONS  DURATION   AGE
job.batch/testjob  0/1 of 3   5d5h      5d5h

Terminal - ubuntu@ip-172-31-63-3: ~
```

```
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian bookworm-updates InRelease
Hit:3 http://deb.debian.org/debian-security bookworm-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
^C
root@thdeploy-644b69989d-h9xdm:/# while true; do apt update; done
```

Multi-Cluster Kubernetes with HAProxy

Why Multi Cluster

Multi-cluster Kubernetes setups are beneficial for various reasons, including high availability, disaster recovery, and geographical distribution. Having multiple clusters can ensure that if one cluster fails, your application remains available in other clusters. It also helps distribute workloads geographically, improving latency for users in different regions.

HAproxy

HAProxy is used as a load balancer to distribute traffic across multiple Kubernetes clusters. It plays a crucial role in maintaining high availability by redirecting traffic to available clusters. In the provided setup, it acts as an entry point, routing requests to the appropriate Kubernetes cluster.

I have added the details for all Five servers. So, you will be able to understand the high overview of all the servers

Role	HostName	IP	OS	RAM	CPU
HAproxy	lb.node.com	172.31.22.132	Ubuntu 22.04	1GB	1
Master	k8master1.node.com	172.31.23.243	Ubuntu 22.04	4GB	2
Master	k8master2.node.com	172.31.28.74	Ubuntu 22.04	4GB	2
Worker	k8worker1.node.com	172.31.31.111	Ubuntu 22.04	1GB	1
Worker	k8worker2.node.com	172.31.22.133	Ubuntu 22.04	1GB	1

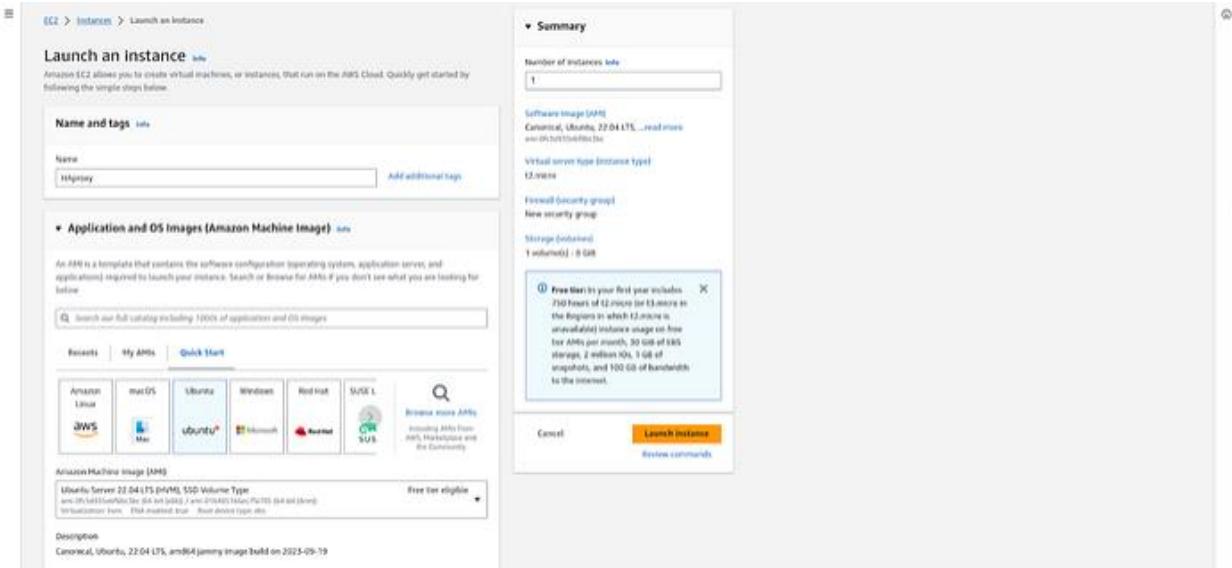
We have to set up five servers where two will be Master Nodes, the other two will be Worker Nodes, and the last one HAproxy.

Create HAproxy Server(EC2 Instance)

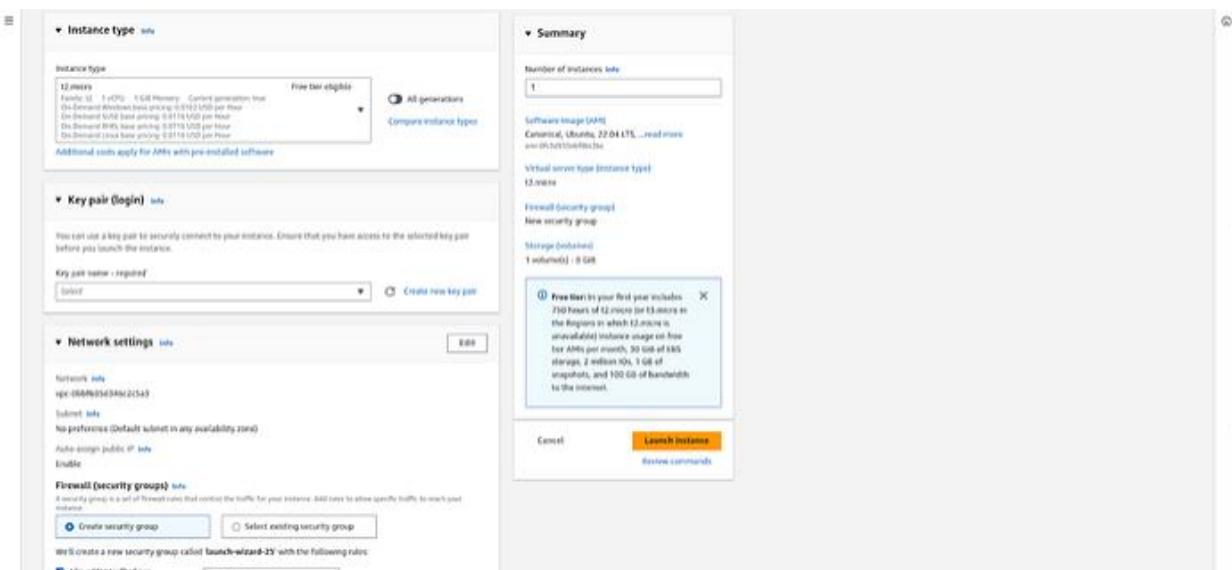
Click on **Launch instances**



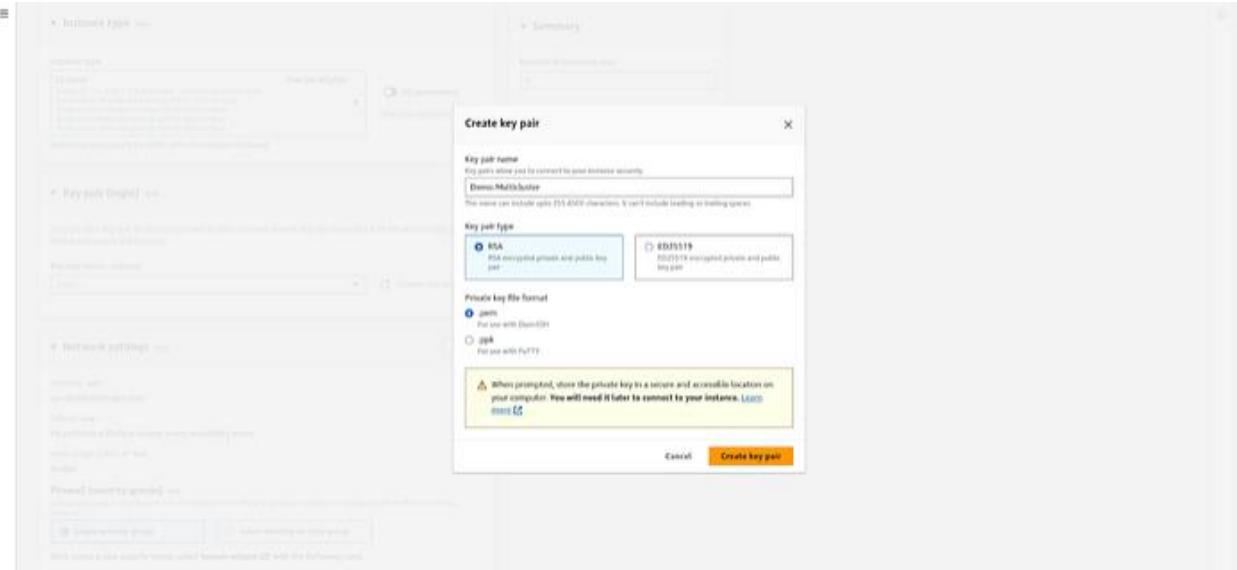
Enter the name of the instance and select Ubuntu 22.04(must).



The instance type will be t2.micro and click on Create new key pair for this demo.

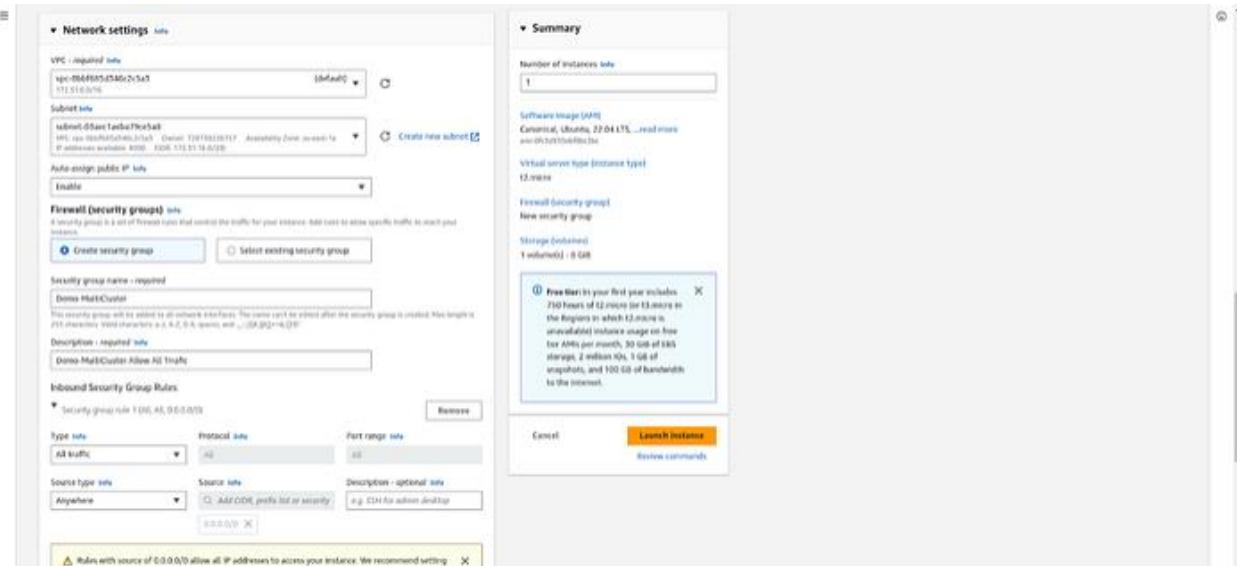


Enter the name, keep the things as it is, and click on Create key pair.



Select the default vpc and select the subnet from the availability zone us-east-1a and create the new security group with All Traffic type where the Source type will be Anywhere.

Here we have configured everything for HAProxy, So click on Launch Instance.



Creating Master Nodes(EC2 Instance)

Here, we have to set up the two Master Nodes.

Enter the name of the instance and select Ubuntu 22.04(must) and in the right number of instances will be 2. So that, we will save us some time.

The master node needs 2CPU that will get in the t2.medium instance type.

Provide the same key that we have provided for the HAProxy server.

Select the same VPC and same Subnet that we have provided for the HAProxy server.

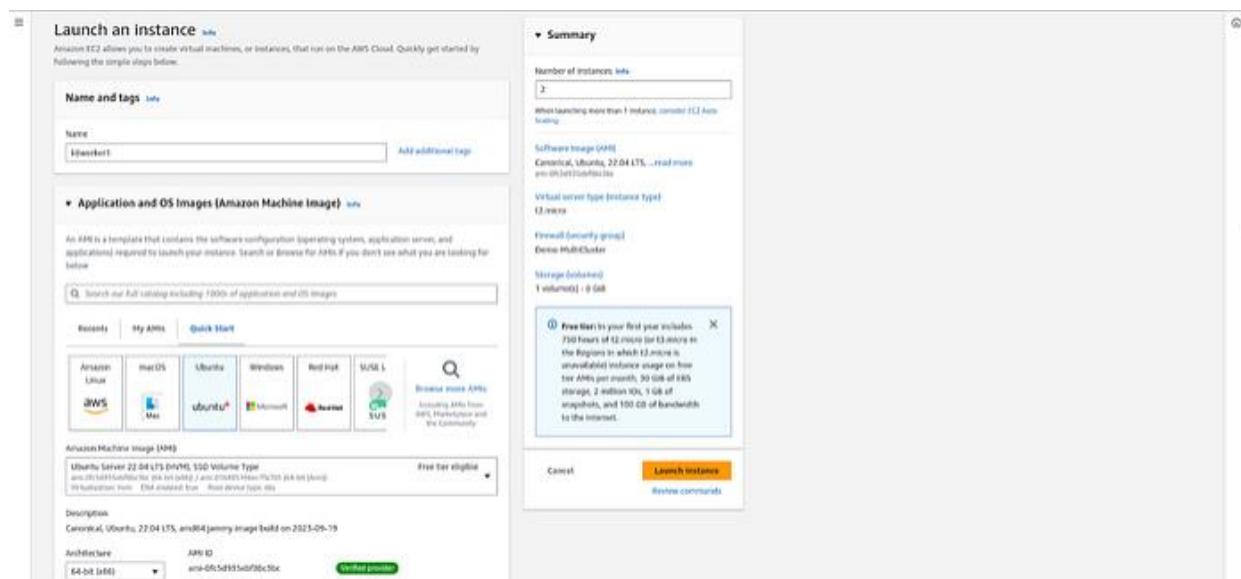
Select the same Security Group that we have created for the HAProxy server.



Creating Worker Nodes(EC2 Instance)

Here, we have to set up the two Worker Nodes.

Enter the name of the instance and select Ubuntu 22.04(must) and in the right number of instances will be 2. So that, we will save us some time.



The master node doesn't need 2CPU that's why the instance type will be the same t2.micro

Provide the same key that we have provided for the HAProxy server.

Select the same VPC and same Subnet that we have provided for the HAProxy server.

Runtime

Node.js 12.x

Handler

index.handler

Note

Lambda functions run in Node.js 12.x by default. If you choose a different runtime, Lambda will automatically update your function's code to run in the chosen runtime.

Select the same Security Group that we have created for the HAProxy server.



Now, both the master and worker nodes' names will be the same. So, you can modify the name of each by masternode1 and masternode2, the same for the worker node.

This is the total of five servers that we have created.

Instances (5) <small>Last updated: 1 hour ago</small>													
<small>Find instance by attribute or log base settings</small>													
<small>Instance state + filtering</small>													
Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv4	Elastic IP	IPv6 IPv4			
Masternode1	i-02f74060644a6e57db	Running	t2.micro	2/2 checks passed	No alarms	us-east-1a	ec2-34-229-0-90.90.90.90	34.229.0.90	-	-			
Masternode1	i-07973170bd3d4ade	Running	t2.medium	2/2 checks passed	No alarms	us-east-1a	ec2-3-93-141-152.140.141.142	3.93.141.152	-	-			
Masternode2	i-051744xam8660ca9	Running	t2.medium	2/2 checks passed	No alarms	us-east-1a	ec2-54-208-132-155.154.153.155	54.208.132.155	-	-			
Masternode2	i-02023505c20f94f16	Running	t2.micro	2/2 checks passed	No alarms	us-east-1a	ec2-54-147-150-55.150.151.152	54.147.150.55	-	-			
HAProxy	i-003d00120d4ea2	Running	t2.micro	2/2 checks passed	No alarms	us-east-1a	ec2-2-19-230-142.142.143.144	2.19.230.142	-	-			

Now, we have to do the configurations in all the servers. Let's do this and start with the HAProxy server.

On HAProxy Server

Before doing SSH, modify the permission of the PEM file that we will use to do SSH.

```
sudo su
```

```
chmod 400 Demo-MultiCluster.pem
```

Now, use the command to SSH into the HAProxy server.

```

manpathak@pop-es:~/Downloads$ chmod 400 Demo-MultiCluster.pem
manpathak@pop-es:~/Downloads$ 
manpathak@pop-es:~/Downloads$ ssh -i "Demo-MultiCluster.pem" ubuntu@ec2-18-212-230-142.compute-1.amazonaws.com
The authenticity of host 'ec2-18-212-230-142.compute-1.amazonaws.com ([18.212.230.142])' can't be established.
ED25519 key fingerprint is SHA256:L4uK25AXXhw+H13AghhLm3J6xGn7HKKoQdH5s.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-18-212-230-142.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-1022-aws x86_64)

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

System information as of Tue Oct 24 06:50:14 UTC 2023

System load: 0.0          Processes:      97
Usage of /: 20.5% of 7.57GB   Users logged in:  0
Memory usage: 23%           IPv4 address for eth0: 172.31.22.132
Swap usage:  0%             IPv6 address for eth0: fe80::42:1ff:fe22:132%eth0

Expanded Security Maintenance for Applications is not enabled.

9 updates can be applied immediately.

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

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-22-132:~$ 

```

To become a root user run the below command

```
sudo su
```

Now, update the package and install haproxy which will help us to set our Kubernetes multi-cluster

```
apt update && apt install -y haproxy
```

```

ubuntu@ip-172-31-22-132:~$ sudo su
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# apt update && apt install -y haproxy

```

Here, we have to set the backend and frontend to set up Kubernetes Multi-Cluster.

Open the file haproxy.cfg and add the code snippets according to your Private IPs
vim /etc/haproxy/haproxy.cfg

Remember, in frontend block HAProxy Private IP needs to be present.

In the backend block, Both Master Node IP needs to be present.

```
frontend kubernetes-frontend
```

```

bind 172.31.22.132:6443
mode tcp
option tcplog
default_backend kubernetes-backend

```

```
backend kubernetes-backend
```

```

mode tcp
option tcp-check
balance roundrobin
server kmaster1 172.31.23.243:6443 check fall 3 rise 2
server kmaster2 172.31.28.74:6443 check fall 3 rise 2

```

```

frontend kubernetes-frontend
    bind 172.31.22.132:6443
    mode tcp
    option tcplog
    default_backend kubernetes-backend

backend kubernetes-backend
    mode tcp
    option tcp-check
    balance roundrobin
    server master1 172.31.23.243:6443 check fall 3 rise 2
    server master2 172.31.28.74:6443 check fall 3 rise 2

```

Once you add the frontend and backend, restart the haproxy service
systemctl restart haproxy

Now, check the status of whether the haproxy service is running or not

systemctl status haproxy

If you look at some bottom lines, the kmaster1 and kmaster2 nodes are down which is correct. But this indicates that the frontend and backend code are reflected.

```

root@ip-172-31-22-132:/home/ubuntu# sudo vim /etc/haproxy/haproxy.cfg
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# systemctl restart haproxy
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# systemctl status haproxy
● haproxy.service - HAProxy Load Balancer
   Loaded: loaded (/lib/systemd/system/haproxy.service; enabled; vendor preset: enabled)
     Active: active (running) since Tue 2023-10-24 06:55:44 UTC; 7s ago
       Docs: man:haproxy(1)
           File:/usr/share/doc/haproxy/configuration.txt.gz
     Process: 2013 ExecStartPre=/usr/sbin/haproxy -Ns -f $CONFIG -c -q $EXTRAOPTS (code=exited, status=0/SUCCESS)
      Main PID: 2015 (haproxy)
         Tasks: 1 (limit: 1923)
        Memory: 71.1M
          CPU: 109ms
        CGroup: /system.slice/haproxy.service
               ├─2015 /usr/sbin/haproxy -Ns -f /etc/haproxy/haproxy.cfg -p /run/haproxy.pid -S /run/haproxy/master.sock
               ├─2017 /usr/sbin/haproxy -Ns -f /etc/haproxy/haproxy.cfg -p /run/haproxy.pid -S /run/haproxy/master.sock

Oct 24 06:55:44 ip-172-31-22-132 systemd[1]: Starting HAProxy Load Balancer...
Oct 24 06:55:44 ip-172-31-22-132 haproxy[2013]: [WARNING] [2015] : New worker #1 [2017] forked
Oct 24 06:55:44 ip-172-31-22-132 haproxy[2013]: [WARNING] [2015] : Old worker #0 [2017] died. Backend 'kubernetes-backend' is DOWN, reason: Layer7 connection problem, info: "Connection refused at initial connect"
Oct 24 06:55:45 ip-172-31-22-132 haproxy[2017]: [WARNING] [2017] : Server 'kubernetes-backend/kmaster1' is DOWN, reason: Layer7 connection problem, info: "Connection refused at initial connect"
Oct 24 06:55:45 ip-172-31-22-132 haproxy[2017]: [WARNING] [2017] : Server 'kubernetes-backend/kmaster2' is DOWN, reason: Layer7 connection problem, info: "Connection refused at initial connect"
Oct 24 06:55:45 ip-172-31-22-132 haproxy[2017]: [NOTICE] [2017] : path to executable is /usr/sbin/haproxy
Oct 24 06:55:45 ip-172-31-22-132 haproxy[2017]: [NOTICE] [2017] : backend 'kubernetes-backend' has no server available!
Oct 24 06:55:45 ip-172-31-22-132 haproxy[2017]: [ALERT] [2017] : backend 'kubernetes-backend' has no server available!
lines 1-22/22 (END)

```

Now, add the hostnames in the /etc/hosts files with all five servers' Private IPs like below

vim /etc/hosts

```

172.31.23.243 k8master1.node.com node.com k8master1
172.31.28.74 k8master2.node.com node.com k8master2
172.31.31.111 k8worker1.node.com node.com k8worker1
172.31.22.133 k8worker2.node.com node.com k8worker2
172.31.22.132 lb.node.com node.com lb

```

```

127.0.0.1 localhost
172.31.23.243 k8master1.node.com node.com k8master1
172.31.28.74 k8master2.node.com node.com k8master2
172.31.31.111 k8worker1.node.com node.com k8worker1
172.31.22.133 k8worker2.node.com node.com k8worker2
172.31.22.132 lb.node.com node.com lb

# The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::3 ip6-allhosts

```

Now, try to ping all four servers(Master+Worker) from Haproxy. If your machine is receiving the packets then we are good to go for the next step which is configuring the Master Nodes

```

root@ip-172-31-22-132:/home/ubuntu# sudo vim /etc/hosts
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# ping k8master1
PING k8master1.node.com (172.31.23.243) 56(84) bytes of data.
64 bytes from k8master1.node.com (172.31.23.243): icmp_seq=1 ttl=64 time=0.527 ms
64 bytes from k8master1.node.com (172.31.23.243): icmp_seq=2 ttl=64 time=0.522 ms
"C"
... k8master1.node.com ping statistics ...
2 packets transmitted, 2 received, 0% packet loss, time 1006ms
rtt min/avg/max/mdev = 0.522/0.524/0.527/0.002 ms
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# ping k8master2
PING k8master2.node.com (172.31.28.74) 56(84) bytes of data.
64 bytes from k8master2.node.com (172.31.28.74): icmp_seq=1 ttl=64 time=0.424 ms
64 bytes from k8master2.node.com (172.31.28.74): icmp_seq=2 ttl=64 time=0.494 ms
"C"
... k8master2.node.com ping statistics ...
2 packets transmitted, 2 received, 0% packet loss, time 1007ms
rtt min/avg/max/mdev = 0.424/0.459/0.494/0.035 ms
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# ping k8worker1
PING k8worker1.node.com (172.31.31.111) 56(84) bytes of data.
64 bytes from k8worker1.node.com (172.31.31.111): icmp_seq=1 ttl=64 time=1.02 ms
64 bytes from k8worker1.node.com (172.31.31.111): icmp_seq=2 ttl=64 time=0.479 ms
"C"
... k8worker1.node.com ping statistics ...
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.479/0.748/1.017/0.269 ms
root@ip-172-31-22-132:/home/ubuntu#
root@ip-172-31-22-132:/home/ubuntu# ping k8worker2
PING k8worker2.node.com (172.31.22.133) 56(84) bytes of data.
64 bytes from k8worker2.node.com (172.31.22.133): icmp_seq=1 ttl=64 time=1.20 ms
64 bytes from k8worker2.node.com (172.31.22.133): icmp_seq=2 ttl=64 time=0.478 ms
"C"
... k8worker2.node.com ping statistics ...
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.478/0.838/1.199/0.360 ms
root@ip-172-31-22-132:/home/ubuntu[ ]

```

On Master Nodes

I have provided you the snippets of One Master Nodes only. But I configured both Master nodes. So, make sure to configure each and everything simultaneously on both Master Nodes.

Login to your both Master Nodes

Once you log into both machines, run the command that is necessary for both Master Nodes

Now, add the hostnames in the /etc/hosts files with all five servers' Private IPs like below
vim /etc/hosts

```

172.31.23.243 k8master1.node.com node.com k8master1
172.31.28.74 k8master2.node.com node.com k8master2
172.31.31.111 k8worker1.node.com node.com k8worker1
172.31.22.133 k8worker2.node.com node.com k8worker2
172.31.22.132 lb.node.com node.com lb

```

```

127.0.0.1 localhost
172.31.23.243 k8master1.node.com node.com k8master1
172.31.28.74 k8master2.node.com node.com k8master2
172.31.31.111 k8worker1.node.com node.com k8worker1
172.31.22.133 k8worker2.node.com node.com k8worker2
172.31.22.132 lb.node.com node.com lb

# The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::1:1 ip6-allnodes
ff02::2:1 ip6-allrouters
ff02::3 ip6-allhosts

```

After closing the host's file, run the below commands.

```

sudo su
ufw disable
reboot

```

Now, log in again to your both machines after 2 to 3 minutes.

Run the below commands

```

sudo su
swapoff -a; sed -i '/swap/d' /etc/fstab

```

```
ubuntu@lp-172-31-23-243:~$ sudo su
root@lp-172-31-23-243:/home/ubuntu#
root@lp-172-31-23-243:/home/ubuntu# swapoff -a; sed -i "/swap/d" /etc/fstab
root@lp-172-31-23-243:/home/ubuntu#
```

Run the below commands

```
cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF
sudo modprobe overlay
sudo modprobe br_netfilter
# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF
# Apply sysctl params without reboot
sudo sysctl - system
```

```
root@lp-172-31-23-243:/home/ubuntu# cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF
sudo modprobe overlay
sudo modprobe br_netfilter
# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF
# Apply sysctl params without reboot
sudo sysctl --system
overlay
br_netfilter
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
* Applying /etc/sysctl.d/10-console-messages.conf ...
* Applying /etc/sysctl.d/10-ip6-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
* Applying /etc/sysctl.d/10-magic-syrq.conf ...
kernel.syrq = 176
* Applying /etc/sysctl.d/10-network-security.conf ...
net.ipv4.conf.all.rtt_filter = 2
net.ipv4.conf.all.rp_filter = 2
* Applying /etc/sysctl.d/10-ptrace.conf ...
kernel.yama.ptrace_scope = 1
* Applying /etc/sysctl.d/10-zeropage.conf ...
vm.mmap_min_addr = 65536
* Applying /usr/lib/sysctl.d/50-default.conf ...
kernel.core_uses_pid = 1
net.ipv4.conf.default.rtt_filter = 2
net.ipv4.conf.default.accept_source_route = 0
sysctl: setting key "net.ipv4.conf.all.accept_source_route": Invalid argument
net.ipv4.conf.default.promote_secondaries = 1
sysctl: setting key "net.ipv4.conf.all.promote_secondaries": Invalid argument
net.ipv4.ping_group_range = 0 2147483647
net.core.default_qdisc = fq_codel
```

Install some dependencies packages and add the Kubernetes package

```
sudo apt-get install -y apt-transport-https ca-certificates curl
curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg - dearmor -o
/etc/apt/keyrings/kubernetes-archive-keyring.gpg
echo "deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg]
https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee
/etc/apt/sources.list.d/kubernetes.list
```

```

root@ip-172-31-23-243:/home/ubuntu# sudo apt-get install -y apt-transport-https ca-certificates curl
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Note, this is the latest version of 'apt-transport-https'
apt is already the newest version (2.4.10).
apt set to manually installed.
ca-certificates is already the newest version (20230311ubuntu0.22.04.1).
ca-certificates set to manually installed.
curl is already the newest version (7.81.0-1ubuntu1.13).
curl set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-archive-keyring.gpg
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# echo "deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg] https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee /etc/apt/sources.list.d/kubernetes.list
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu#
```

As we have added the gpg keys, we need to run the update command
apt update

```

root@ip-172-31-23-243:/home/ubuntu# apt update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-security InRelease [119 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:5 https://packages.cloud.google.com/apt/kubernetes-xenial InRelease [8993 kB]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [14.1 MB]
Get:7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe Translation-en [5652 kB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 c-n-f Metadata [286 kB]
Get:9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 Packages [217 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse Translation-en [111 kB]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [8322 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [1103 kB]
Get:13 http://security.ubuntu.com/ubuntu jammy-security/main amd64 Packages [896 kB]
Get:14 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main Translation-en [239 kB]
Get:15 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 c-n-f Metadata [56.0 kB]
Get:16 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 Packages [3036 kB]
Get:17 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted Translation-en [367 kB]
Get:18 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 Metadata [536 kB]
Get:19 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [992 kB]
Get:20 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe Translation-en [218 kB]
Get:21 http://security.ubuntu.com/ubuntu jammy-security/main Translation-en [180 kB]
Get:22 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 c-n-f Metadata [22.0 kB]
Get:23 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 Packages [41.6 kB]
Get:24 http://security.ubuntu.com/ubuntu jammy-security/main amd64 c-n-f Metadata [11.4 kB]
Get:25 http://security.ubuntu.com/ubuntu jammy-security/restricted amd64 Packages [1814 kB]
```

Now, we have to install docker on our both master nodes
apt install docker.io -y

```

root@ip-172-31-23-243:/home/ubuntu# apt install docker.io -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
bridge-vtols containerd dns-root-data dnsmasq-base pigz runc ubuntu-fan
Suggested packages:
ifupdown autofs-tools cgroups-pnmt | cgroup-lite debbootstrap docker-doc rinse zfs-fuse | zfsutils
The following NEW packages will be installed:
bridge-vtols containerd dns-root-data dnsmasq-base docker.io pigz runc ubuntu-fan
0 upgraded, 0 newly installed, 0 to remove and 31 not upgraded.
Need to get 69.7 MB of additional archive files.
After this operation, 267 MB of additional disk space will be used.
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 pigz amd64 2.6.1 [63.6 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 bridge-utils amd64 1.7-1ubuntu3 [34.4 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 runc amd64 1.1.7-1ubuntu12.22.04.1 [4249 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 containerd amd64 1.7.2-2ubuntu12.22.04.1 [36.0 MB]
Get:5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 dns-root-data all 202101101 [576 B]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 libltdl7 amd64 2.4.6-1ubuntu0.3 [354 kB]
Get:7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 docker.io amd64 24.0.5-0ubuntu12.22.04.1 [28.9 MB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 ubuntu-fan all 0.12.16 [35.2 kB]
Fetched 69.7 MB in 2s (37.6 MB/s)
Preconfiguring packages...
Selecting previously unselected package pigz.
(Reading database ... 64726 files and directories currently installed.)
Preconfiguring package runc.
Prerunscript to unpack /var/lib/dpkg/tmp.ci/debs/0.12.16_amd64.deb
```

Do some configurations for containerd service

mkdir /etc/containerd

sh -c "containerd config default > /etc/containerd/config.toml"

sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml
systemctl restart containerd.service

```

root@ip-172-31-23-243:/home/ubuntu# mkdir /etc/containerd
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# sh -c "containerd config default > /etc/containerd/config.toml"
root@ip-172-31-23-243:/home/ubuntu# sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# systemctl restart containerd.service
root@ip-172-31-23-243:/home/ubuntu#
```

Now, we will install our kubelet, kubeadm, and kubectl services on the Master node
apt-get install -y kubelet kubeadm kubectl kubernetes-cni

```

root@ip-172-31-23-243:/home/ubuntu# apt-get install -y kubelet kubeadm kubectl kubernetes-cni
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages will be upgraded:
  cni-project-cni kubeadm kubelet kubernetes-cni socat
The following NEW packages will be installed:
  containerd cri-tools etcd kubeadm kubectl kubernetes-cni socat
Need to get 87.1 MB of additional disk space will be used.
After this operation, 336 MB of additional disk space will be used.
Get: http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 containerd amd64 1.1.4.6~Build02 [103.5 kB]
Get: http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 cri-tools amd64 1.7.4.1-0ubuntu1 [349 kB]
Get: http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 etcd amd64 1.2.4.1-0ubuntu1 [27.6 MB]
Get: https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 cri-tools amd64 1.26.0-0~0 [18.9 MB]
Get: https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubelet amd64 1.28.2-0~0 [19.5 MB]
Get: https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubectl amd64 1.28.2-0~0 [10.3 MB]
Get: https://packages.cloud.google.com/apt kubernetes-xenial/main amd64 kubeadm amd64 1.28.2-0~0 [10.3 MB]
Fetched 87.1 MB in 2s (46.5 MB/s)

```

Now, restart the kubelet service, and don't forget to enable the kubelet service. So that, if any master node will reboot then we don't need to start the kubelet service.

```

sudo systemctl restart kubelet.service
sudo systemctl enable kubelet.service

```

```

root@ip-172-31-23-243:/home/ubuntu# sudo systemctl restart kubelet.service
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# sudo systemctl enable kubelet.service
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu#

```

Only on Master Node1

This command must need to run on Master Node1

We have to init the kubeadm and provide the endpoint which will be the haproxy server Private IP and in the end provide the Master Node1 IP only.

```

kubeadm init — control-plane-endpoint=<hap-private-ip:6443> — upload-certs —
apiserver-advertise-address=<master-node1-private-ip>

```

```

kubeadm init — control-plane-endpoint="172.31.22.132:6443" — upload-certs —
apiserver-advertise-address=172.31.28.74

```

Once you run the above command, scroll down.

```

root@ip-172-31-23-243:/home/ubuntu# kubeadm init --control-plane-endpoint="172.31.22.132:6443" --upload-certs --apiserver-advertise-address=172.31.23.243
[init] Using Kubernetes version: v20.3
[init] Using Docker version: 20.3.5
[preflight] Pre-flight checks
[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 in beforehand using "kubeadm config images pull"
[Warning] 07:37:08.409676   5866:checks.go:835] detected that the sandbox image "registry.k8s.io/pause:3.8" of the container runtime is inconsistent with that used by kubeadm. It is recommended that using "registry.k8s.io/pause:3.9" as the CRI sandbox image.
[certs] Using certificate-dir folder "/etc/kubernetes/pki"
[certs] Generating "ca" certificate and key
[certs] Generating "apiserver" certificate and key
[certs] Generating serving cert is signed for DNS names [ip-172-31-23-243 kubernetes kubernetes.default kubernetes.default.svc kubernetes.default.svc.cluster.local] and IPs [10.96.0.1 172.31.23.243 172.31.22.132]
[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] Generating "etcd/server" certificate and key
[certs] etcd/server serving cert is signed for DNS names [ip-172-31-23-243 localhost] and IPs [172.31.23.243 127.0.0.1 ::1]
[certs] etcd/peer serving cert is signed for DNS names [ip-172-31-23-243 localhost] and IPs [172.31.23.243 127.0.0.1 ::1]
[certs] Generating "etcd/healthcheck-client" certificate and key
[certs] Generating "apiserver-etcd-client" certificate and key
[certs] Generating "sa" keys and public key
[kubeconfig] Using kubeconfig folder "/etc/kubernetes"
[kubeconfig] Writing "admin.conf" kubeconfig file
[kubeconfig] Writing "kubelet.conf" kubeconfig file
[kubeconfig] Writing "controller-manager.conf" kubeconfig file
[kubeconfig] Writing "scheduler.conf" kubeconfig file

```

Once you scroll down, you will see Kubernetes control plan has initialized successfully which means Master node1 joined the HAProxy server. Now, we have to initialize Kubernetes Master Node2 as well. Follow the below steps:

- Copy the Red highlighted commands, Blue highlighted commands and Green highlighted commands and paste them into your notepad.
- Now, run the Red highlighted commands on the Master node1 itself.

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

```
[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/
You can now join any number of the control-plane node running the following command on each as root:
kubeadm join 172.31.22.132:6443 --token y0hfbub.8x2amvb09390me1 \
--discovery-token-ca-cert-hash sha256:661bd2ab43cd5711ee12e7f681750118ef620b0797a05b0d1643c2737fc72bc \
--control-plane --certificate-key b427ea5e716cd570670abd276c6607356a9ff7c2f13cf4c9b5fb7753b6b50b
Please note that the certificate-key gives access to cluster sensitive data, keep it secret!
As a safeguard, uploaded certs will be deleted in two hours; If necessary, you can use
"kubeadm init phase upload-certs --upload-certs" to reload certs afterward.
Then you can join any number of worker nodes by running the following on each as root:
kubeadm join 172.31.22.132:6443 --token y0hfbub.8x2amvb09390me1 \
--discovery-token-ca-cert-hash sha256:661bd2ab43cd5711ee12e7f681750118ef620b0797a05b0d1643c2737fc72bc
```

On Master Node2

Now, we need to do one more thing so that Master Node2 joins the HAProxy server as well. Follow the steps:

- We have to use the Blue highlighted command, but we need to add one more thing with the command, refer to the below(add —
apiserver-advertise-address=<PrivateIP-of-MasterNode2>

```
kubeadm join 172.31.22.132:6443 - token 0vzbaf.slplmyokc1lqlanl \
- discovery-token-ca-cert-hash [REDACTED]
sha256:75c9d830b358fd6d372e03af0e7965036bce657901757e8b0b789a2e82475223 \
control-plane - certificate-key [REDACTED]
0a5bec27de3f27d623c6104a5e46a38484128cfabb57dbd506227037be6377b4 - \
apiserver-advertise-address=172.31.28.74
```

```
root@ip-172-31-28-74:~/home/ubuntu# kubeadm join 172.31.22.132:6443 --token 0vzbaf.slplmyokc1lqlanl \
--discovery-token-ca-cert-hash sha256:75c9d830b358fd6d372e03af0e7965036bce657901757e8b0b789a2e82475223 \
--control-plane --certificate-key 0a5bec27de3f27d623c6104a5e46a38484128cfabb57dbd506227037be6377b4 -apiserver-advertise-address=172.31.28.74
[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[preflight] This might take a few seconds as kubeadm is initializing the new control plane instance
[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 in beforehand using 'kubeadm config images pull'
[info] 07:43:29.109232 5049 checks.go:355] detected that the sandbox image "registry.k8s.io/pause:3.0" of the container runtime is inconsistent with that used by kubeadm. It is recommended that using "registry.k8s.io/pause:3.9" as the CRISandbox image.
[download-certs] Downloading the certificates in Secret "kubeadm-certs" in the "kube-system" Namespace
[download-certs] Saving the certificates to the folder: "/etc/kubernetes/pki"
[certs] Using certificateDir folder: "/etc/kubernetes/pki"
[certs] Generation "root.ca.crt" certificate and key
```

Once you followed the above steps, you can run the below commands on Master Node2

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

```
root@ip-172-31-23-243:~/home/ubuntu# mkdir -p $HOME/.kube
root@ip-172-31-23-243:~/home/ubuntu#
root@ip-172-31-23-243:~/home/ubuntu# cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
root@ip-172-31-23-243:~/home/ubuntu# chown $(id -u):$(id -g) $HOME/.kube/config
root@ip-172-31-23-243:~/home/ubuntu#
root@ip-172-31-23-243:~/home/ubuntu#
```

Now, if you run the command ‘kubectl get nodes’ on Master Node1 to see the nodes. You will get both nodes but they are not in ready status because we did not configure the network. We will configure that once the Worker Nodes are configured.

Note: Copy the Green highlighted command, which we will use to connect with Worker Nodes

```
root@ip-172-31-23-243:/home/ubuntu# kubectl get nodes
NAME      STATUS    ROLES   AGE     VERSION
ip-172-31-23-243  NotReady  control-plane  7m24s  v1.26.2
ip-172-31-28-74  NotReady  control-plane  3m10s  v1.26.2
root@ip-172-31-23-243:/home/ubuntu#
```

Now, if you run the command ‘kubectl get nodes’ on Master Node2 to see the nodes. You will get both nodes but they are not in ready status because we did not configure the network. We will configure that once the Worker Nodes are configured.

Note: Copy the Green highlighted command, which we will use to connect with Worker Nodes

```
root@ip-172-31-28-74:/home/ubuntu# kubectl get nodes
NAME      STATUS    ROLES   AGE     VERSION
ip-172-31-23-243  NotReady  control-plane  7m19s  v1.26.2
ip-172-31-28-74  NotReady  control-plane  3m5s   v1.26.2
root@ip-172-31-28-74:/home/ubuntu#
```

On Both Worker Nodes

Now, Let's configure our Worker Nodes.

I have provided you the snippets of One Master Nodes only. But I configured both Worker nodes. So, make sure to configure each and everything simultaneously on both Worker Nodes.

Login to your both Worker Nodes

Once you log into your both machines, run the command that is necessary for both Master Nodes

Now, add the hostnames in the /etc/hosts files with all five servers' Private IPs like below
vim /etc/hosts

```
172.31.23.243 k8master1.node.com node.com k8master1
172.31.28.74 k8master2.node.com node.com k8master2
172.31.31.111 k8worker1.node.com node.com k8worker1
172.31.22.133 k8worker2.node.com node.com k8worker2
172.31.22.132 lb.node.com node.com lb
```

```
127.0.0.1 localhost
172.31.23.243 k8master1.node.com node.com k8master1
172.31.28.74 k8master2.node.com node.com k8master2
172.31.31.111 k8worker1.node.com node.com k8worker1
172.31.22.133 k8worker2.node.com node.com k8worker2
172.31.22.132 lb.node.com node.com lb

# The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::3 ip6-allhosts
```

After closing the host's file, run the below commands.

```
sudo su
ufw disable
```

reboot

```
ubuntu@ip-172-31-22-133:~$ sudo su
root@ip-172-31-22-133:/home/ubuntu#
root@ip-172-31-22-133:/home/ubuntu# ufw disable
Firewall stopped and disabled on system startup
root@ip-172-31-22-133:/home/ubuntu#
root@ip-172-31-22-133:/home/ubuntu# reboot
root@ip-172-31-22-133:/home/ubuntu# Connection to ec2-54-147-150-55.compute-1.amazonaws.com closed by remote host.
Connection to ec2-54-147-150-55.compute-1.amazonaws.com closed.
mnapathak@pop-os:~/Downloads$
```

Now, log in again to both machines after 2 to 3 minutes.

Run the below commands

```
sudo su
swapoff -a; sed -i '/swap/d' /etc/fstab
```

```
ubuntu@ip-172-31-22-133:~$ sudo su
root@ip-172-31-22-133:/home/ubuntu#
root@ip-172-31-22-133:/home/ubuntu# swapoff -a; sed -i '/swap/d' /etc/fstab
root@ip-172-31-22-133:/home/ubuntu#
```

Run the below commands:

```
cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF
sudo modprobe overlay
sudo modprobe br_netfilter
# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF
# Apply sysctl params without reboot
sudo sysctl - system
```

```
root@ip-172-31-22-133:/home/ubuntu# cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF

sudo modprobe overlay
sudo modprobe br_netfilter

# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF

# Apply sysctl params without reboot
sudo sysctl --system
overlay
br_netfilter
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 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
* Applying /etc/sysctl.d/10-manifests.conf ...
```

Install some dependencies packages and add the Kubernetes package

```
sudo apt-get install -y apt-transport-https ca-certificates curl
curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg - dearmor -o
/etc/apt/keyrings/kubernetes-archive-keyring.gpg
echo "deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg]
https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee
/etc/apt/sources.list.d/kubernetes.list
```

```

root@ip-172-31-22-133:/home/ubuntu# sudo apt-get install -y apt-transport-https ca-certificates curl
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Note, selecting 'apt-transport-https' instead of 'apt-transport-https'
apt is already the newest version (2.4.10).
apt set to manually installed.
ca-certificates is already the newest version (2023031ubuntu0.22.04.1).
ca-certificates set to manually installed.
curl is already the newest version (7.81.0-1ubuntu1.13).
curl set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
root@ip-172-31-22-133:/home/ubuntu#
root@ip-172-31-22-133:/home/ubuntu# curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-archive-keyring.gpg
root@ip-172-31-22-133:/home/ubuntu#
root@ip-172-31-22-133:/home/ubuntu# curl -fsSL https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee /etc/apt/sources.list.d/kubernetes.list
deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg] https://apt.kubernetes.io/ kubernetes-xenial main
root@ip-172-31-22-133:/home/ubuntu# []

```

As we have added the gpg keys, we need to run the update command
apt update

```

root@ip-172-31-22-133:/home/ubuntu# apt update
Hit: 1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Get: 2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Get: 3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Get: 4 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get: 5 https://packages.cloud.google.com/apt kubernetes-xenial InRelease [8993 B]
Get: 6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [14.1 MB]
Get: 7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe Translation-en [5652 kB]
Get: 8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 c-n-f Metadata [286 kB]
Get: 9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [120 kB]
Get: 10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe Translation-en [112 kB]
Get: 11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 c-n-f Metadata [8372 B]
Get: 12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [1103 kB]
Get: 13 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main Translation-en [239 kB]
Get: 14 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 c-n-f Metadata [16.0 kB]
Get: 15 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 Packages [1036 kB]
Get: 16 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted Translation-en [167 kB]
Get: 17 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 c-n-f Metadata [1936 B]
Get: 18 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [1103 kB]
Get: 19 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe Translation-en [218 kB]
Get: 20 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 c-n-f Metadata [22.0 kB]
Get: 21 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 Packages [41.6 kB]

```

Now, we have to install docker on our both worker nodes

apt install docker.io -y

```

root@ip-172-31-22-133:/home/ubuntu# apt install docker.io -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  bridge-utils containerd dns-root-data dnsmasq-base pignz runc ubuntu-fan
Suggested packages:
  libappArmor1 libaudit1 libcgroupfs-mount liblxc-lite debbootstrap docker-doc rinse zfs-fuse | zfsutils
The following NEW packages will be installed:
  bridge-utils containerd dns-root-data dnsmasq-base docker.io pignz runc ubuntu-fan
0 upgraded, 8 newly installed, 0 to remove and 31 not upgraded,
Need to get 69.7 MB of archives.
After this operation, 267 MB of additional disk space will be used.
Get: 1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 pignz amd64 2.6.1 [63.6 kB]
Get: 2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 bridge-utils amd64 1.7~ubuntu3 [34.4 kB]
Get: 3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 runc amd64 1.7~ubuntu3-22.04.1 [4249 kB]
Get: 4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 containerd amd64 1.7~ubuntu3-22.04.1 [36.0 MB]
Get: 5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 dns-root-data all 20210111101 [5256 B]
Get: 6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 dnsmasq-base amd64 2.86.1ubuntu0.3 [354 kB]
Get: 7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 docker.io amd64 24.0.5-0ubuntu1-22.04.1 [28.9 MB]
Get: 8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 ubuntu-fan all 12.16 [35.2 kB]
Fetched 69.7 MB in 2s (41.2 MB/s)

```

Do some configurations for containerd service

mkdir /etc/containerd

sh -c "containerd config default > /etc/containerd/config.toml"

sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml

systemctl restart containerd.service

```

root@ip-172-31-22-133:/home/ubuntu# mkdir /etc/containerd
root@ip-172-31-22-133:/home/ubuntu#
root@ip-172-31-22-133:/home/ubuntu# root@ip-172-31-22-133:/home/ubuntu# sh -c "containerd config default > /etc/containerd/config.toml"
root@ip-172-31-22-133:/home/ubuntu# root@ip-172-31-22-133:/home/ubuntu# sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml
root@ip-172-31-22-133:/home/ubuntu# root@ip-172-31-22-133:/home/ubuntu# systemctl restart containerd.service
root@ip-172-31-22-133:/home/ubuntu# []

```

Now, we will install our kubelet, kubeadm, and kubectl services on the Worker node

apt-get install -y kubelet kubeadm kubectl kubernetes-cni

```
root@ip-172-31-22-133:/home/ubuntu# apt-get install -y kubelet kubeadm kubectl kubernetes-cni
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  cni-project-containernetworking-k8s kubelet kubernetes-cni socat
The following packages will be upgraded:
  cni-project-containernetworking-k8s kubelet kubernetes-cni socat
0 upgraded, 3 newly installed, 0 to remove and 31 not upgraded.
Need to get 87.1 MB of additional disk space.
After this operation, 338 MB of additional disk space will be used.
Get: http://us-east-1.archive.ubuntu.com/ubuntu/main amd64 cni-project-containernetworking-k8s amd64 1:1.4.6-2build2 [33.5 kB]
```

Now, restart the kubelet service, and don't forget to enable the kubelet service. So that, if any worker node will reboot then we don't need to start the kubelet service.

```
sudo systemctl restart kubelet.service
sudo systemctl enable kubelet.service
```

```
root@ip-172-31-23-243:/home/ubuntu# sudo systemctl restart kubelet.service
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# sudo systemctl enable kubelet.service
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu#
```

If you remember, I told you to copy the Green highlighted command. Paste that command, on both Worker Node1 and Worker Node2.

Once you do that, you will see the output like the below snippet.

```
root@ip-172-31-22-133:/home/ubuntu# kubeadm join 172.31.22.132:6443 --token 0vzbaf.s1plmyokclqjland \
--discovery-token-ca-cert-hash sha256:75c9db30b358fdd372e03af0e7965036bc657001757e8b0b789a2e82475223
[preflight] Running pre-flight checks
[preflight] Verifying configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap...
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.
root@ip-172-31-22-133:/home/ubuntu#
```

Run on any Master Node

Let's validate whether both Worker Nodes are joined in the Kubernetes Cluster by running the below command.

```
kubectl get nodes
```

If you can see four servers then, Congratulations you did 99% work.

```
root@ip-172-31-23-243:/home/ubuntu# kubectl get nodes
NAME      STATUS    ROLES   AGE     VERSION
ip-172-31-22-133  NotReady <none>   33s   v1.28.2
ip-172-31-23-243  NotReady control-plane  9m33s  v1.28.2
ip-172-31-28-74   NotReady control-plane  5m19s   v1.28.2
ip-172-31-31-111  NotReady <none>   26s   v1.28.2
root@ip-172-31-23-243:/home/ubuntu#
```

As you know, our all nodes are not in ready status because of network components.

Run the below command to add the Calico networking components in the Kubernetes Cluster.

```
kubectl apply -f
```

```
https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
```

```

root@ip-172-31-23-243:/home/ubuntu# kubectl apply -f https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
poddisruptionbudget.policy/calico-kube-controllers created
serviceaccount/calico-node created
serviceaccount/calico-node-edited
configmap/calico-config created
customresourcedefinition.apilextensions.k8s.io/bgpconfigurations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/bppeers.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/blockaffinities.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/calicomodestatuses.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/clusterinformations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/felixconfigurations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/globalmetadatasets.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/hostendpoints.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/ipamblocks.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/ipamhandles.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/ippools.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/jpresevation.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/kubecontrollersconfigurations.crd.projectcalico.org created
customresourcedefinition.apilextensions.k8s.io/networkpolicies.crd.projectcalico.org created
clusterrole.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrole.rbac.authorization.k8s.io/calico-node created
clusterrolebinding.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrolebinding.rbac.authorization.k8s.io/calico-node created
daemonset.apps/calico-node created
deployment.apps/calico-kube-controllers created
root@ip-172-31-23-243:/home/ubuntu#

```

After 2 to 3 minutes, if you run the command ‘kubectl get nodes’. You will see that all nodes are getting ready.

```

root@ip-172-31-23-243:/home/ubuntu# kubectl get nodes
NAME      STATUS   ROLES   AGE     VERSION
ip-172-31-22-133 Ready    <none>   95s    v1.26.2
ip-172-31-22-133 Ready    control-plane   10m    v1.26.2
ip-172-31-28-74 Ready    control-plane   4m23s   v1.26.2
ip-172-31-31-111 Ready    <none>   88s    v1.26.2
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# kubectl get nodes
NAME      STATUS   ROLES   AGE     VERSION
ip-172-31-22-133 Ready    <none>   2m3s   v1.26.2
ip-172-31-22-133 Ready    control-plane   11m    v1.26.2
ip-172-31-28-74 Ready    control-plane   6m49s   v1.26.2
ip-172-31-31-111 Ready    <none>   116s   v1.26.2
root@ip-172-31-23-243:/home/ubuntu#

```

Let's deploy the Nginx Container on Worker Node1 and the Apache Container on Worker Node2

To achieve this, you have to perform the commands on Master Nodes only.

Add a label on both worker nodes

For WorkerNode1

```
kubectl label nodes <WorkerNode1-Private-IP> mynode=node1
```

For WorkerNode2

```
kubectl label nodes <WorkerNode2-Private-IP> mynode=node2
```

You can also validate whether the labels are added to both Worker Nodes or not by running the below command

```
kubectl get nodes — show-labels
```

```

root@ip-172-31-23-243:/home/ubuntu# kubectl get nodes
NAME      STATUS   ROLES   AGE     VERSION
ip-172-31-22-133 Ready    <none>   3m59s   v1.26.2
ip-172-31-22-133 Ready    control-plane   12m    v1.26.2
ip-172-31-28-74 Ready    control-plane   8m55s   v1.26.2
ip-172-31-31-111 Ready    <none>   3m52s   v1.26.2
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# kubectl label nodes ip-172-31-22-133 mynode=node1
node/ip-172-31-22-133 labeled
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# kubectl label nodes ip-172-31-31-111 mynode=node2
node/ip-172-31-31-111 labeled
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# kubectl get nodes --show-labels
NAME      STATUS   ROLES   AGE     VERSION   LABELS
ip-172-31-22-133 Ready    <none>   5m42s   v1.26.2   beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.io/arch=amd64,kubernetes.io/hostname=ip-172-31-22-133,kubernetes.io/os=linux,mynode=node1
ip-172-31-28-74 Ready    control-plane   10m    v1.26.2   beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.io/arch=amd64,kubernetes.io/hostname=ip-172-31-28-74,kubernetes.io/os=linux,node-role.kubernetes.io/control-plane=none,kubernetes.io/exclude-from-external-load-balancers=
ip-172-31-31-111 Ready    <none>   5m35s   v1.26.2   beta.kubernetes.io/arch=amd64,beta.kubernetes.io/os=linux,kubernetes.io/arch=amd64,kubernetes.io/hostname=ip-172-31-31-111,kubernetes.io/os=linux,mynode=node2
root@ip-172-31-23-243:/home/ubuntu#

```

Let's create two Container on both different Worker nodes from different Master nodes

I am creating an Nginx Container on Worker Node1 from Master node1

Here is the deployment YML file

```
apiVersion: apps/v1
kind: Deployment
metadata: [REDACTED]
  name: nginx-deployment
spec: [REDACTED]
  replicas: 1
  selector: [REDACTED]
    matchLabels:
      app: nginx
  template: [REDACTED]
    metadata:
      labels:
        app: nginx
  spec: [REDACTED]
    nodeSelector:
      mynode: node1 # This deploys the container on node1
  containers:
    - name: nginx
      image: nginx:latest
      ports:
        - containerPort: 80
```

Here is the service YML file

```
apiVersion: v1
kind: Service
metadata: [REDACTED]
  name: nginx-service
spec: [REDACTED]
  selector:
    app: nginx
  ports:
    - protocol: TCP
      port: 80
      targetPort: 80
  type: LoadBalancer # Use LoadBalancer for external access
```

Apply both files by the below commands

```
kubectl apply -f deployment.yml
kubectl apply -f service.yml
```

Validate whether the deployment is complete or not by running the below commands

```
kubectl get deploy
kubectl get pods
kubectl get svc
```

Now, to check whether the application is running or not from outside of the cluster. Copy the worker node1 public ip and then use the port that is showing when you run the 'kubectl get svc' command that i have highlighted in the snippet.

```

root@ip-172-31-23-243:/home/ubuntu# mkdir Node1
root@ip-172-31-23-243:/home/ubuntu#
root@ip-172-31-23-243:/home/ubuntu# cd Node1/
root@ip-172-31-23-243:/home/ubuntu/Node1# sudo vim deployment.yaml
root@ip-172-31-23-243:/home/ubuntu/Node1# sudo vim svc.yaml
root@ip-172-31-23-243:/home/ubuntu/Node1# sudo vim svc.yaml
root@ip-172-31-23-243:/home/ubuntu/Node1# kubectl apply -f deployment.yaml
deployment.apps/nginx-deployment created
root@ip-172-31-23-243:/home/ubuntu/Node1# kubectl apply -f svc.yaml
error: error parsing svc.yaml: error converting YAML to JSON: line 2: mapping values are not allowed in this context
root@ip-172-31-23-243:/home/ubuntu/Node1# sudo vim svc.yaml
root@ip-172-31-23-243:/home/ubuntu/Node1# kubectl apply -f svc.yaml
service/nginx-service created
root@ip-172-31-23-243:/home/ubuntu/Node1#
root@ip-172-31-23-243:/home/ubuntu/Node1# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-deployment   1/1     Running   0          58s
root@ip-172-31-23-243:/home/ubuntu/Node1# kubectl get deploy
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
nginx-deployment   1/1     1           1           68s
root@ip-172-31-23-243:/home/ubuntu/Node1# kubectl get svc
NAME          TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
kubernetes   ClusterIP   <none>       <none>       443/TCP   29m
nginx-service   LoadBalancer   10.10.213.172   <pending>   80:31974/TCP   29m
root@ip-172-31-23-243:/home/ubuntu/Node1# 

```

Here, you can see our nginx container is perfectly running outside of the Cluster.



The second Container from the Second Master Node on the Second Worker Node

I am creating Apache Container on Worker Node2 from Master node2

Here is the deployment YML file

```

apiVersion: apps/v1
kind: Deployment
metadata:
  name: apache-deployment
spec:
  replicas: 1
  selector:
    matchLabels:
      app: apache
  template:
    metadata:
      labels:
        app: apache
    spec:
      nodeSelector:
        mynode: node2 # This deploys the container on node1
      containers:

```

```

- name: apache
  image: httpd:latest
  ports:
    - containerPort: 80

```

Here is the service YML file

```

apiVersion: v1
kind: Service
metadata:
  name: apache-service
spec:
  selector:
    app: apache
  ports:
    - protocol: TCP
      port: 80
      targetPort: 80
  type: LoadBalancer # Use LoadBalancer for external access

```

Apply both files by the below commands

```

kubectl apply -f deployment.yml
kubectl apply -f service.yml

```

Validate whether the deployment is complete or not by running the below commands

```

kubectl get deploy
kubectl get pods
kubectl get svc

```

Now, to check whether the application is running or not from outside of the cluster. Copy the worker node2 public IP and then use the port that is showing when you run the 'kubectl get svc' command corresponding to port 80.

```

root@ip-172-31-28-74:/home/ubuntu# mkdir Node2
root@ip-172-31-28-74:/home/ubuntu#
root@ip-172-31-28-74:/home/ubuntu# cd Node2/
root@ip-172-31-28-74:/home/ubuntu# vim deployment.yml
root@ip-172-31-28-74:/home/ubuntu# vim svc.yml
root@ip-172-31-28-74:/home/ubuntu# kubectl apply -f deployment.yml
deployment.apps/apache-deployment created
root@ip-172-31-28-74:/home/ubuntu# kubectl get svc
nginx-service 10.103.215.136 <pending> 80:30813/TCP 12s
root@ip-172-31-28-74:/home/ubuntu# kubectl apply -f svc.yml
service/apache-service created
root@ip-172-31-28-74:/home/ubuntu# kubectl get pods
root@ip-172-31-28-74:/home/ubuntu# kubectl get pods
NAME        READY   STATUS    RESTARTS   AGE
apache-deployment-65fdff77488-912jh 1/1   Running   0          13s
nginx-deployment-6592f48fb9-qgqvc 1/1   Running   0          5m9s
root@ip-172-31-28-74:/home/ubuntu# kubectl get svc
NAME         TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
apache-service   LoadBalancer  10.103.215.136  <pending>   80:30813/TCP  12s
kubernetes     ClusterIP   10.96.0.1    <none>       443/TCP   24m
nginx-service   LoadBalancer  10.110.213.172  <pending>   80:31978/TCP  4m27s
root@ip-172-31-28-74:/home/ubuntu# 

```

Here, you can see our Apache container is perfectly running outside of the Cluster.



Kubernetes Ingress

In the world of Kubernetes, Ingress is your ticket to managing external traffic to services within the cluster. Before we dive into the details, let's recap what we've learned so far. Before Ingress, the Service provides a Load balancer, which is used to distribute the traffic between multiple applications or pods.

Ingress helps to expose the HTTP and HTTPS routes from outside of the cluster.

Ingress enables Path-based and Host-based routing.

Ingress supports Load balancing and SSL termination.

Simple Definition/Explanation

Kubernetes Ingress is like a cop for your applications that are running on your Kubernetes cluster. It redirects the incoming requests to the right services based on the Web URL or path in the address.

Ingress provides the encryption feature and helps to balance the load of the applications.

In simple words, Ingress is like a receptionist who provides the correct path for the hotel room to the visitor or person.

Why do we use Ingress because the load balancer supports the same thing?

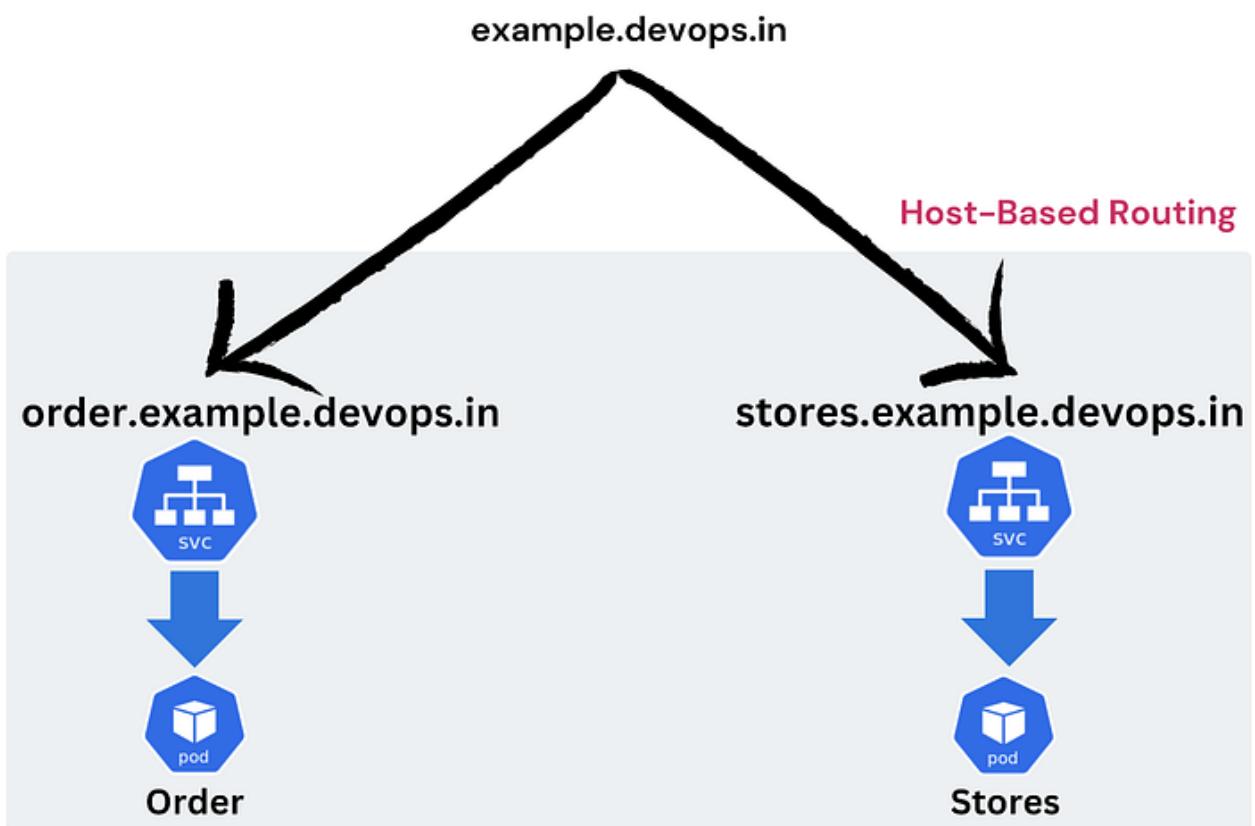
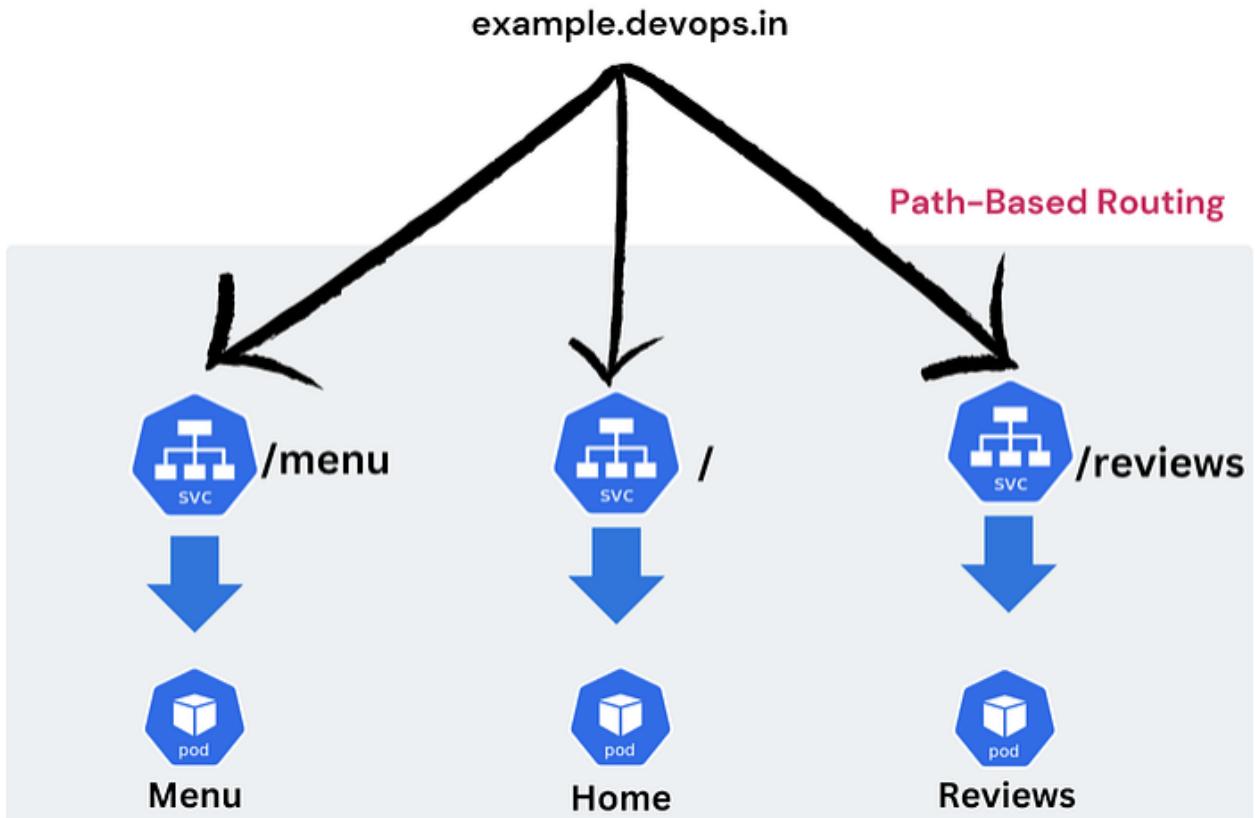
Ingress is used to manage the external traffic to the services within the cluster which provides features like host-based routing, path-based routing, SSL termination, and more. Where a Load balancer is used to manage the traffic but the load balancer does not provide the fine-grained access control like Ingress.

Example:

Suppose you have multiple Kubernetes services running on your cluster and each service serves a different application such as example.com/app1 and example.com/app2. With the help of Ingress, you can achieve this. However, the Load Balancer routes the traffic based on the ports and can't handle the URL-based routing.

There are two types of Routing in Ingress:

- **Path-based routing:** Path-based routing directs traffic to the different services based on the path such as example.com/app1.
- **Host-based routing:** Host-based routing directs traffic to the different services based on the Website's URL such as demo.example.com.



To implement Ingress, we have to deploy Ingress Controllers. We can use any Ingress Controllers according to our requirements.

Hands-On

Here, we will use the nginx ingress controller.

To install it, use the command.

```
minikube addons enable ingress
```

```
ubuntu@ip-172-31-59-195:~$ kubectl get pod -n kube-system
NAME                  READY   STATUS    RESTARTS   AGE
coredns-5d78c9869d-xqt2t  1/1     Running   0          55m
etcd-minikube           1/1     Running   0          55m
kube-apiserver-minikube  1/1     Running   0          55m
kube-controller-manager-minikube  1/1     Running   0          55m
kube-proxy-5rczz         1/1     Running   0          55m
kube-scheduler-minikube  1/1     Running   0          56m
storage-provisioner      1/1     Running   1 (55m ago)  55m
ubuntu@ip-172-31-59-195:~$ 
ubuntu@ip-172-31-59-195:~$ minikube addons enable ingress
💡 ingress is an addon maintained by Kubernetes. For any concerns contact minikube on GitHub.
You can view the list of minikube maintainers at: https://github.com/kubernetes/minikube/blob/master/OWNERS
  • Using image registry.k8s.io/ingress-nginx/controller:v1.8.1
  • Using image registry.k8s.io/ingress-nginx/kube-webhook-certgen:v20230407
  • Using image registry.k8s.io/ingress-nginx/kube-webhook-certgen:v20230407
🌐 Verifying ingress addon...
🌟 The 'ingress' addon is enabled
ubuntu@ip-172-31-59-195:~$ 
```

Validate whether the controller is deployed or not

```
kubectl get pods -n ingress-nginx
```

```
ubuntu@ip-172-31-59-195:~$ kubectl get pods -n ingress-nginx
NAME                  READY   STATUS    RESTARTS   AGE
ingress-nginx-admission-create-zmrsg  0/1     Completed   0          116s
ingress-nginx-admission-patch-zc6q7    0/1     Completed   1          116s
ingress-nginx-controller-7799c6795f-jfrct  1/1     Running   0          116s
ubuntu@ip-172-31-59-195:~$ 
```

Now, let's do some hands-on for Path-based routing.

Deploy home page

```
deployment1.yaml file
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 1
  selector:
```

```
matchLabels:  
  app: nginx  
template:  
  metadata:  
    labels:  
      app: nginx  
spec:  
  containers:  
    - name: nginx  
      image: avian19/choco-shop-home  
      ports:  
        - containerPort: 80  
service1.yml file  
apiVersion: v1  
kind: Service  
metadata:  
  name: nginx-service  
spec:  
  selector:  
    app: nginx  
  ports:  
    - protocol: TCP  
      port: 80  
  type: NodePort
```

```
kubectl apply -f deployment1.yml  
kubectl apply -f service1.yml
```

Once you created the deployment and service, now we have to create the ingress for path-based routing. As we want to direct the requests to the default path use the below YAML file.

ingress.yml

```
kind: Ingress  
metadata:  
  name: ingress-deployment  
annotations:  
  nginx.ingress.kubernetes.io/rewrite-target: /$1  
spec:  
  rules:  
    - host: example.devops.in  
      http:  
        paths:  
          - path: /  
            pathType: Prefix  
            backend:  
              service:  
                name: nginx-service  
                port:
```

number: 80

kubectl apply -f ingress.yml

```
anupathak@pop-os:~/Minikube/Ingress$ kubectl apply -f deployment.yaml
deployment.apps/nginx-deployment created
anupathak@pop-os:~/Minikube/Ingress$ anupathak@pop-os:~/Minikube/Ingress$ kubectl apply -f service.yaml
service/nginx-service created
anupathak@pop-os:~/Minikube/Ingress$ anupathak@pop-os:~/Minikube/Ingress$ anupathak@pop-os:~/Minikube/Ingress$ kubectl apply -f ingress.yaml
ingress.networking.k8s.io/ingress-deployment created
anupathak@pop-os:~/Minikube/Ingress$ anupathak@pop-os:~/Minikube/Ingress$ kubectl get ing
NAME          CLASS      HOSTS            ADDRESS        PORTS   AGE
ingress-deployment  nginx    example.devops.in    80           9s
anupathak@pop-os:~/Minikube/Ingress$ anupathak@pop-os:~/Minikube/Ingress$ kubectl get ing
NAME          CLASS      HOSTS            ADDRESS        PORTS   AGE
ingress-deployment  nginx    example.devops.in    192.168.49.2  80     49s
anupathak@pop-os:~/Minikube/Ingress$
```

Add the IP ADDRESS that you got in the above snippet from ingress-deployment(192.168.49.2).

vim /etc/hosts

```
127.0.0.1      localhost
192.168.49.2  example.devops.in
0.0.0.0         localhost
127.0.1.1      pop-os.localdomain  pop-os
```

If you do curl from the terminal then you can able to see the content of your application.

```
anupathak@pop-os:~/Minikube/Ingress$ curl example.devops.in
<h1><marquee><p> Blood Sweet(Chocolate Shop)</p></marquee></h1>
<h1><center>This is HomePage</center> </h1>
```

If you map the DNS name with ingress Private IP, then you can able to see the content of your application from the browser.



Now I have one more module whose name is Menu that I want to deploy on the other services.

To do that, Create a deployment file and a service file.

deploy2.yaml file

```
apiVersion: apps/v1
kind: Deployment
metadata: []
  name: nginx-deployment2
spec: []
  replicas: 1
  selector: []
    matchLabels:
      app: nginx2
  template: []
    metadata: []
```

```

labels:
  app: nginx2
spec: [REDACTED]
  containers:
    - name: nginx2
      image: avian19/choco-shop-menu
      ports:
        - containerPort: 80
service2.yml file
apiVersion: v1
kind: Service
metadata:
  name: nginx-service2
spec: [REDACTED]
  selector:
    app: nginx2
  ports:
    - protocol: TCP
      port: 80
type: NodePort

```

```

kubectl apply -f deploy2.yml
kubectl apply -f service2.yml

```

Now, Here we have to modify our ingress file as we have added a new service which has a new application. To avoid confusion, just remove the previous content from the ingress.yml file copy and paste the entire content in the ingress.yml file, and apply the updated configurations.

Updated ingress.yml file

```

apiVersion: networking.k8s.io/v1
kind: Ingress
metadata: [REDACTED]
  name: ingress-deployment
  annotations:
    nginx.ingress.kubernetes.io/rewrite-target: /$1
spec: [REDACTED]
  rules:
    - host: example.devops.in
      http: [REDACTED]
        paths:
          - path: /
            pathType: Prefix
            backend: [REDACTED]
              service:
                name: nginx-service
                port:
                  number: 80
          - path: /menu
            pathType: Prefix
            backend: [REDACTED]

```

```

service:
  name: nginx-service2
  port: [REDACTED]
    number: 80

```

kubectl apply -f ingress.yml

```

amarpathak@pop-os:~/Minikube/Ingress$ kubectl apply -f deploy2.yml
deployment.apps/nginx-deployment2 created
amarpathak@pop-os:~/Minikube/Ingress$ amarpathak@pop-os:~/Minikube/Ingress$ kubectl apply -f service2.yml
service/nginx-service2 created
amarpathak@pop-os:~/Minikube/Ingress$ amarpathak@pop-os:~/Minikube/Ingress$ kubectl apply -f ingress.yml
ingress.yaml unchanged
amarpathak@pop-os:~/Minikube/Ingress$ curl example.devops.in/menu
<h1><marquee>p style="color:red"> Blood Sweet(Chocolate Shop)</p></marquee></h1>
<h1> <center>This is Menu Page</center> </h1>
amarpathak@pop-os:~/Minikube/Ingress$ 

```

Now, we can access our application on the /menu path.



Now I have one more module which name is Reviews that I want to deploy on other services.

To do that, Create a deployment file and a service file.

deploy3.yml file

```

apiVersion: apps/v1
kind: Deployment
metadata: [REDACTED]
  name: nginx-deployment3
spec: [REDACTED]
  replicas: 1
  selector:
    matchLabels:
      app: nginx3
  template:
    metadata:
      labels:
        app: nginx3
    spec:
      containers:
        - name: nginx3
          image: avian19/choco-shop-reviews
          ports:
            - containerPort: 80
service3.yml file
apiVersion: v1

```

```
kind: Service
metadata:
  name: nginx-service3
spec:
  selector:
    app: nginx3
  ports:
    - protocol: TCP
      port: 80
  type: NodePort
```

```
kubectl apply -f deploy3.yml
kubectl apply -f service3.yml
```

Now, Here we have to modify our ingress file as we have added a new service which has a new application. To avoid confusion, just remove the previous content from the ingress.yml file copy and paste the entire content in the ingress.yml file, and apply the updated configurations.

Updated ingress.yml file

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: ingress-deployment
  annotations:
    nginx.ingress.kubernetes.io/rewrite-target: /$1
spec:
  rules:
    - host: example.devops.in
      http:
        paths:
          - path: /
            pathType: Prefix
            backend:
              service:
                name: nginx-service
                port:
                  number: 80
          - path: /menu
            pathType: Prefix
            backend:
              service:
                name: nginx-service2
                port:
                  number: 80
          - path: /reviews
            pathType: Prefix
            backend:
              service:
```

```
name: nginx-service3
port:
  number: 80
```

```
kubectl apply -f ingress.yml
```

```
amapathak@pop-os:~/Minikube/Ingress$ kubectl apply -f deploy3.yml
deployment.apps/nginx-deployment3 created
amapathak@pop-os:~/Minikube/Ingress$ amapathak@pop-os:~/Minikube/Ingress$ amapathak@pop-os:~/Minikube/Ingress$ kubectl apply -f service3.yml
service/nginx-service created
amapathak@pop-os:~/Minikube/Ingress$ amapathak@pop-os:~/Minikube/Ingress$ curl example.devops.in/reviews
<h1><marquee><p style="color:red"> Blood Sweet(Chocolate Shop)</p></marquee></h1>
<h1><center>This is Reviews & Ratings Page</center> </h1>
amapathak@pop-os:~/Minikube/Ingress$
```

Now, we can access our application on the /reviews path.



Host-based Routing

Now, we have completed our hands-on for Path-based Routing.

I want to create one more application to order anything from different hosts. Let's do that.

Deploy the applications and services.

deploy4.yml file

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment4
spec:
  replicas: 1
  selector:
    matchLabels:
      app: nginx4
  template:
    metadata:
      labels:
        app: nginx4
    spec:
      containers:
        - name: nginx4
          image: avian19/choco-shop-order
          ports:
            - containerPort: 80
```

```
service4.yml file
apiVersion: v1
kind: Service
metadata:
  name: nginx-service4
spec:
  selector:
    app: nginx4
  ports:
    - protocol: TCP
      port: 80
  type: NodePort
```

```
kubectl apply -f deploy4.yml
kubectl apply -f service4.yml
```

Now, Here we have to modify our ingress file as we have added a new service which has a new application. To avoid confusion, just remove the previous content from the ingress.yml file copy and paste the entire content into the ingress.yml file, and apply the updated configurations.

Updated ingress.yml file

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: ingress-deployment
  annotations:
    nginx.ingress.kubernetes.io/rewrite-target: /$1
spec:
  rules:
    - host: example.devops.in
      http:
        paths:
          - path: /
            pathType: Prefix
            backend:
              service:
                name: nginx-service
                port:
                  number: 80
          - path: /menu
            pathType: Prefix
            backend:
              service:
                name: nginx-service2
                port:
                  number: 80
    - path: /reviews
      pathType: Prefix
      backend:
        service:
```

```

name: nginx-service3
port:
  number: 80
# Host Based Routing
- host: example2.devops.in
  http:
    paths:
      - path: /
        pathType: Prefix
      backend:
        service:
          name: nginx-service4
          port:
            number: 80

```

kubectl apply -f ingress.yml

```

amarpatah@pop-os:~/Minikube/Ingress$ vim deploy4.yml
amarpatah@pop-os:~/Minikube/Ingress$ vim service4.yml
amarpatah@pop-os:~/Minikube/Ingress$ vim service4.yml
amarpatah@pop-os:~/Minikube/Ingress$ kubectl apply -f deploy4.yml
deployment.apps/nginx-deployment created
amarpatah@pop-os:~/Minikube/Ingress$ kubectl apply -f service4.yml
service/nginx-service created
amarpatah@pop-os:~/Minikube/Ingress$ kubectl get svc
NAME           TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)        AGE
kubernetes     ClusterIP  10.101.149.99  <none>        443/TCP       16d
nginx-service  NodePort   10.101.149.99  <none>        80:32281/TCP  16m
nginx-service2 ModePort   10.109.28.22   <none>        80:30251/TCP  10m
nginx-service3 ModePort   10.109.24.108  <none>        80:30243/TCP  16m
nginx-service4 ModePort   10.107.3.117   <none>        80:30105/TCP  4s

```

Now, if you try to curl from the terminal then you will be able to get the content. But if you try from the browser then you won't be able to get the content.

```

amarpatah@pop-os:~/Minikube/Ingress$ curl example2.devops.in
<h1><marquee><p style="color:red"> Blood Sweet(Chocolate Shop)</p></marquee></h1>
<h1><center>This is Host Base Routing Application</center></h1>
<h1><center><p style="color:brown"> Order your Coffee ASAP</p></h1>
amarpatah@pop-os:~/Minikube/Ingress$ 

```

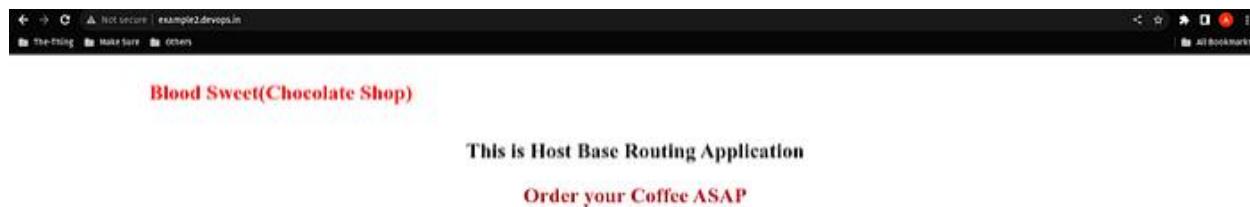
Now, we have added a new host in the ingress file. To get the content on our local host, we need to add this host in the /etc/hosts file.

```

127.0.0.1      localhost
192.168.49.2  example.devops.in example2.devops.in
#192.168.49.2 hello-world.info
::1            localhost
127.0.1.1      pop-os.localdomain  pop-os

```

Now check on the browser by hitting the new hostname.



Kubernetes StatefulSets

What are the Stateful applications?

Stateful applications are those applications that contain the previous states or data of the applications. If the applications restart or move to other environments then, the data and the state of the applications still exist.

Examples of Stateful applications includes PostgreSQL, MySQL, messages queues. These applications ensures that the data, application reliability, and state of the applications will be taken care of by the StatefulSets Object in Kubernetes.

Difference between Stateful and Stateless applications

Let's understand the Stateful and Stateless applications with real-time examples.

Stateful applications

- “Remember when we used to play GTA Vice City during our teen years? Completing that game required hours because we were in school at the time.”
- “Once I completed a mission, I saved the game. So, whenever I wanted to continue, I just went to the save game section and resumed from where I left off.”
- “At that moment, we didn’t think about how it worked, but now we understand that there were sessions that helped us save the game data, which was stored in our root folder.”

Stateless applications

- “If you used old keypad mobiles, you might have used a calculator application.”
- “Your father asked you to perform operations like addition and subtraction.”
- “By mistake, you tapped the red button, which took you back to the home screen.”
- “Now, you can’t retrieve the numbers you were entering. This means there is no session involved.”

StatefulSets VS Deployment

Kubernetes has rich features like StatefulSets and deployment. But Statefulsets eliminates the previous states and data stored problems.

Let's understand both.

StatefulSets

- **Identity and Stable Network hostnames:** StatefulSets are used for those applications that require stable network identity and hostnames. Whenever the pod is created, it gets a unique name, an ordinal index appended to its name. For example, the pod name looks like web-1, web-2, web-3, and so on.
- **Order deployment and Scaling:** StatefulSets deploy the pods in sequential order. If you observe in deployment, the multiple pods in replicas are created at one time. But In StatefulSets, each pod will be created once the previous pod is created. If pods

are deleted, the newest created pod will be deleted first which means, that to delete the pod StatefulSets follows the reverse order.

- **Data Persistence:** StatefulSets are used for those applications that require data persistence such as databases. StatefulSets allow to attachment and mount of the permanent volumes to the disk. So, if any pod is rescheduled or restarted it will have the all data.
- **Headless Services:** StatefulSets have one more rich feature which is Headless Services. StatefulSets can be associated with the headless services that provide the DNS for each pod's hostnames. This will help to communicate with the specific pods.

Deployment

- **Scalability and Rolling updates:** Deployments are often used for stateless applications. Deployments provide the replicas and no downtime feature.
- **No Stable Hostnames:** Deployments do not provide the feature of stable hostnames which means, that if the pod is created then it will have a randomly generated name.
- **No Data Persistence:** As deployment objects are often used for stateless applications So, pods are stateless too which means it does not provide data persistence. Whenever a pod is replaced, the data will be lost of the previous pod.
- **Load Balancing:** Deployment works with Services objects which provides Load Balancing. It distributes the traffic between multiple pods to make the application highly available.

Key Features and Facts of StatefulSets:

1. StatefulSets provides the Order pod creation which provides the unique name to each pod in a predictable order such as web-1, web-2, and so on.
2. StatefulSets provides the Stable Network Identity which makes it easy to connect with the pods.
3. StatefulSets provides the Data Persistence which stores the data in the databases and whenever the pod is restarted or rescheduled, the pods get the same persistent data.
4. StatefulSets provides the PV and PVC to provide the persistent storage to StatefulSets pods.
5. StatefulSets provides the Backup and Recovery features which are very crucial for maintaining data integrity with StatefulSets.

Hands-On

Open the two terminals

We have to see how the pods are created. To do that, run the below command on terminal1

```
kubectl get pods -w -l app=nginx
```

```
prashanthak@prashanthak-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -w -l app=nginx
```

Create a service file and StatefulSet file copy the below content in the respective file and apply it.

service.yml

```
apiVersion: v1
kind: Service
metadata: [REDACTED]
  name: nginx
  labels: [REDACTED]
    app: nginx
spec: [REDACTED]
  ports: [REDACTED]
    - port: 80
      name: web
  clusterIP: None
  selector: [REDACTED]
    app: nginx
StatefulSets.yml
apiVersion: apps/v1
kind: StatefulSet
metadata: [REDACTED]
  name: web
spec: [REDACTED]
  serviceName: "nginx"
  replicas: 2
  selector: [REDACTED]
    matchLabels: [REDACTED]
      app: nginx
  template: [REDACTED]
    metadata: [REDACTED]
      labels: [REDACTED]
        app: nginx
    spec: [REDACTED]
      containers: [REDACTED]
        - name: nginx
          image: registry.k8s.io/nginx-slim:0.8
          ports: [REDACTED]
            - containerPort: 80
              name: web
          volumeMounts: [REDACTED]
            - name: www
              mountPath: /usr/share/nginx/html
  volumeClaimTemplates: [REDACTED]
    - metadata: [REDACTED]
      name: www
    spec: [REDACTED]
      accessModes: [ "ReadWriteOnce" ]
      resources: [REDACTED]
        requests: [REDACTED]
        storage: 1Gi
```

```

anapathak@pop-os:~/Minikube/StatefulSets$ vim service.yml
anapathak@pop-os:~/Minikube/StatefulSets$ anapathak@pop-os:~/Minikube/StatefulSets$ vim StatefulSet.yml
anapathak@pop-os:~/Minikube/StatefulSets$ anapathak@pop-os:~/Minikube/StatefulSets$ kubectl apply -f service.yml
service "nginx" created
anapathak@pop-os:~/Minikube/StatefulSets$ anapathak@pop-os:~/Minikube/StatefulSets$ kubectl apply -f StatefulSet.yml
statefulset.apps/web created
anapathak@pop-os:~/Minikube/StatefulSets$ 

```

The Pods are creating sequential, observations in the first command output.

```

anapathak@pop-os:~/Minikube/StatefulSets$ kubectl get pods -w -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0     0/1     Pending   0          0s
web-0     0/1     Pending   0          0s
web-0     0/1     Pending   0          1s
web-0     0/1     ContainerCreating   0          2s
web-0     1/1     Running   0          13s
web-1     0/1     Pending   0          0s
web-1     0/1     Pending   0          0s
web-1     0/1     Pending   0          0s
web-1     0/1     Pending   0          1s
web-1     0/1     ContainerCreating   0          2s
web-1     1/1     Running   0          25s
"Canapathak@pop-os:~/Minikube/StatefulSets$"
anapathak@pop-os:~/Minikube/StatefulSets$ kubectl get service nginx
NAME        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
nginx       None         <none>        80/TCP    2m3s
anapathak@pop-os:~/Minikube/StatefulSets$ anapathak@pop-os:~/Minikube/StatefulSets$ kubectl get statefulset web
NAME      READY   AGE
web      2/2     2m3s
anapathak@pop-os:~/Minikube/StatefulSets$ anapathak@pop-os:~/Minikube/StatefulSets$ 

```

As we have created pods from statefulset, So the pod's names have sticky and unique names.

```

anapathak@pop-os:~/Minikube/StatefulSets$ kubectl get pods -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0     1/1     Running   0          3m59s
web-1     1/1     Running   0          3m46s
anapathak@pop-os:~/Minikube/StatefulSets$ 

```

If you run the below command, you will see that both pods have stable hostnames on their ordinal index.

```
for i in 0 1; do kubectl exec "web-$i" -- sh -c 'hostname'; done
```

```

anapathak@pop-os:~/Minikube/StatefulSets$ for i in 0 1; do kubectl exec "web-$i" -- sh -c 'hostname'; done
web-0
web-1
anapathak@pop-os:~/Minikube/StatefulSets$ 

```

Now, I want to check the pod's dns addresses. Run the below command

```
kubectl run -i --tty --image busybox:1.28 dns-test --restart=Never --rm
```

```

anapathak@pop-os:~/Minikube/StatefulSets$ kubectl run -i --tty --image busybox:1.28 dns-test --restart=Never --rm

```

Once you enter the container, run the below command.

```
nslookup web-0.nginx
```

Now, you can check the dns address.

```

anapathak@pop-os:~/Minikube/StatefulSets$ kubectl run -i --tty --image busybox:1.28 dns-test --restart=Never --rm
If you don't see a command prompt, try pressing enter.
/ #
/ # nslookup web-0.nginx
Server:  10.96.0.10 kube-dns.kube-system.svc.cluster.local
Address 1: 10.96.0.10 kube-dns.kube-system.svc.cluster.local
Name:   web-0.nginx
Address 1: 10.244.0.61 web-0.nginx.default.svc.cluster.local
/ # 

```

Open two terminals, run the below command on terminal1

```
kubectl get pod -w -l app=nginx
```

As you can see both pods are running.

```
anarpatahak@pop-os:~/Minikube/StatefulSets$ kubectl get pod -w -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0    1/1     Running   0          14m
web-1    1/1     Running   0          14m
```

Now, run the below command to delete both pods on terminal 2.

```
kubectl delete pod -l app=nginx
```

```
anarpatahak@pop-os:~/Minikube/StatefulSets$ kubectl delete pod -l app=nginx
pod "web-0" deleted
pod "web-1" deleted
anarpatahak@pop-os:~/Minikube/StatefulSets$
```

As you know, we have set up the replicas=2. So, if we delete any pod it will create a new pod to meet with the desired state of the replicas.

But there is one more thing to notice here, that the pod is deleting sequentially.

If you run the last command, you will see that both pods have been created again.

```
anarpatahak@pop-os:~/Minikube/StatefulSets$ kubectl get pod -w -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0    1/1     Running   0          14m
web-1    1/1     Running   0          14m
web-0    1/1     Terminating   0          16m
web-1    1/1     Terminating   0          16m
web-1    0/1     Terminating   0          16m
web-0    0/1     Terminating   0          16m
web-0    0/1     Terminating   0          16m
web-1    0/1     Terminating   0          16m
web-1    0/1     Terminating   0          16m
web-0    0/1     Terminating   0          16m
web-0    0/1     Pending      0          0s
web-0    0/1     Pending      0          0s
web-0    0/1     ContainerCreating   0          0s
web-0    1/1     Pending      0          1s
web-1    0/1     Pending      0          0s
web-0    0/1     Pending      0          0s
web-1    0/1     ContainerCreating   0          0s
web-1    1/1     Running   0          1s
"Canarpatahak@pop-os:~/Minikube/StatefulSets$ anarpatahak@pop-os:~/Minikube/StatefulSets$ anarpatahak@pop-os:~/Minikube/StatefulSets$ kubectl get pod
NAME      READY   STATUS    RESTARTS   AGE
dns-test  0/1     Completed   0          56m44s
web-0    1/1     Running   0          44s
web-1    1/1     Running   0          43s
anarpatahak@pop-os:~/Minikube/StatefulSets$
```

If you run the below command, you will see the same hostnames that were present for previous delete pods.

```
for i in 0 1; do kubectl exec web-$i -- sh -c 'hostname'; done
```

```
anarpatahak@pop-os:~/Minikube/StatefulSets$ for i in 0 1; do kubectl exec web-$i -- sh -c 'hostname'; done
web-0
web-1
anarpatahak@pop-os:~/Minikube/StatefulSets$
```

Now, if you log in to the container. You will be able to see the same dns address but the IP might have changed.

```
anarpatahak@pop-os:~/Minikube/StatefulSets$ kubectl run -i --tty --image busybox:1.28 dns-test --restart=Never --rm
If you don't see a command prompt, try pressing enter.
/ # nslookup web-0.nginx
Server: 10.96.0.10
Address 1: 10.96.0.10 kube-dns.kube-system.svc.cluster.local
Name: web-0.nginx
Address 1: 10.244.0.64 web-0.nginx.default.svc.cluster.local
/ #
```

Run the command to get a list of all the persistent volume claims that are attached to the app nginx.

```
anupathak@pop-os:~/Minikube/StatefulSets$ kubectl get pvc -l app=nginx
NAME      STATUS   VOLUME          CAPACITY   ACCESS MODES   STORAGECLASS   AGE
www-web-0  Bound   pvc-976c12ac-2c80-4e60-a347-3e3134530d99  1Gi        RWO           standard       26m
www-web-1  Bound   pvc-55aa2ff-04bf-4329-8c28-603bd07de117  1Gi        RWO           standard       26m
anupathak@pop-os:~/Minikube/StatefulSets$
```

As we have mounted our persistent volume to the path /usr/share/nginx/html in the Stateful.yml file. So, the path will be backed by the Persistent Volume.

Now, to check the hostnames of both pods run the below command.

```
for i in 0 1; do kubectl exec "web-$i" - sh -c 'echo "$(hostname)" > /usr/share/nginx/html/index.html'; done
```

```
for i in 0 1; do kubectl exec -i -t "web-$i" - curl http://localhost/; done
```

```
anupathak@pop-os:~/Minikube/StatefulSets$ for i in 0 1; do kubectl exec "web-$i" -- sh -c 'echo "$(hostname)" > /usr/share/nginx/html/index.html'; done
anupathak@pop-os:~/Minikube/StatefulSets$ for i in 0 1; do kubectl exec -i -t "web-$i" -- curl http://localhost/; done
web-0
web-1
anupathak@pop-os:~/Minikube/StatefulSets$
```

Delete both pods

```
kubectl delete pod -l app=nginx
```

```
anupathak@pop-os:~/Minikube/StatefulSets$ kubectl delete pod -l app=nginx
joe "web-0" deleted
joe "web-1" deleted
anupathak@pop-os:~/Minikube/StatefulSets$
```

Validate the pods' deletion and creation on the other window

```
kubectl get pod -w -l app=nginx
```

```
anupathak@pop-os:~/Minikube/StatefulSets$ kubectl get pod -w -l app=nginx
NAME     READY   STATUS    RESTARTS   AGE
web-0    1/1    Running   0          26m
web-3    1/1    Running   0          26m
web-0    1/1    Terminating   0          27m
web-1    1/1    Terminating   0          27m
web-0    0/1    Terminating   0          27m
web-3    0/1    Terminating   0          27m
web-0    0/1    Terminating   0          27m
web-3    0/1    Terminating   0          27m
web-0    0/1    Terminating   0          27m
web-1    0/1    Terminating   0          27m
web-0    0/1    Pending      0          0s
web-3    0/1    Terminating   0          27m
web-3    0/1    Terminating   0          27m
web-0    0/1    Pending      0          0s
web-0    0/1    ContainerCreating   0          0s
web-0    1/1    Running   0          2s
web-3    1/1    Pending      0          0s
web-3    0/1    Pending      0          0s
web-3    0/1    ContainerCreating   0          0s
web-3    1/1    Running   0          1s
anupathak@pop-os:~/Minikube/StatefulSets$
```

Now, validate the web servers whether the hostname is the same or not

```
for i in 0 1; do kubectl exec -i -t "web-$i" -- curl http://localhost/; done
```

```
anupathak@pop-os:~/Minikube/StatefulSets$ for i in 0 1; do kubectl exec -i -t "web-$i" -- curl http://localhost/; done
web-0
web-1
anupathak@pop-os:~/Minikube/StatefulSets$
```

Now, let's scale up the StatefulSets. You can use the kubectl scale or kubectl patch to scale up or scale down the replicas.

```
kubectl scale sts web -- replicas=5
```

```
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl scale sts web --replicas=5
statefulset.apps/web scaled
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
web-0     1/1     Running   0          6m9s
web-1     1/1     Running   0          6m8s
web-2     1/1     Running   0          14s
web-3     1/1     Running   0          13s
web-4     1/1     Running   0          8s
anupathak@pp-os:~/Minikube/StatefulSets$
```

If you see the persistent volume claim, it will be increased as pods are created.

```
kubectl get pvc -l app=nginx
```

```
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl get pvc -l app=nginx
NAME      STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   AGE
web-0     Bound    pvc-976c12ac-2cb8-4e50-a347-2e3134538699   1Gi       RWO           standard      315s
web-1     Bound    pvc-55aa2ff-44bf-4329-8c28-6038d07d1117   1Gi       RWO           standard      315s
web-2     Bound    pvc-3b0ced0b-3b3-4234-9d79-c20801057095   1Gi       RWO           standard      7m14s
web-3     Bound    pvc-e6cc0f9-3e61-4ab9-a145-b6afce1e24a0   1Gi       RWO           standard      7m11s
web-4     Bound    pvc-d1b75023-4628-4f42-83cf-e902349de999   1Gi       RWO           standard      7m8s
anupathak@pp-os:~/Minikube/StatefulSets$
```

Now, scale down the number of replicas through the kubectl patch

```
kubectl patch sts web -p '{"spec":{"replicas":3}}'
```

```
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl patch sts web -p '{"spec":{"replicas":3}}'
statefulset.apps/web patched
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
web-0     1/1     Running   0          75m
web-1     1/1     Running   0          75m
web-2     1/1     Running   0         9m45s
anupathak@pp-os:~/Minikube/StatefulSets$
```

If you list the Persistent volume claims, you will see all 5 PVCs present. This is because StatefulSets assumes that you deleted the pods by mistake.

```
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl get pvc -l app=nginx
NAME      STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   AGE
www-web-0  Bound    pvc-976c12ac-2cb8-4e50-a347-2e3134538699   1Gi       RWO           standard      218s
www-web-1  Bound    pvc-55aa2ff-44bf-4329-8c28-6038d07d1117   1Gi       RWO           standard      218s
www-web-2  Bound    pvc-3b0ced0b-3b3-4234-9d79-c20801057095   1Gi       RWO           standard      10m
www-web-3  Bound    pvc-e6cc0f9-3e61-4ab9-a145-b6afce1e24a0   1Gi       RWO           standard      9m55s
www-web-4  Bound    pvc-d1b75023-4628-4f42-83cf-e902349de999   1Gi       RWO           standard      9m55s
anupathak@pp-os:~/Minikube/StatefulSets$
```

Now, to rollback use the below command

```
kubectl patch statefulset web -p '{"spec":{"updateStrategy":{"type":"RollingUpdate"}}}'
```

The below command will change the image of the container.

```
kubectl patch statefulset web -- type='json' -p='[{"op": "replace", "path": "/spec/template/spec/containers/0/image", "value": "gcr.io/google_containers/nginx-slim:0.8"}]'
```

```
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl patch statefulset web -p '{"spec":{"updateStrategy":{"type":"RollingUpdate"}}}'
statefulset.apps/web patched (no change)
anupathak@pp-os:~/Minikube/StatefulSets$ kubectl patch statefulset web --type='json' -p='[{"op": "replace", "path": "/spec/template/spec/containers/0/image", "value": "gcr.io/google_containers/nginx-slim:0.8"}]'
statefulset.apps/web patched
```

Use the below command to check the container image

```
for p in 0 1 2; do kubectl get pod "web-$p" --template '{{range $i, $c := .spec.containers}}{{{$c.image}}}{{end}}'; echo; done
```

```
anupathak@pp-os:~/Minikube/StatefulSets$ for p in 0 1 2; do kubectl get pod "web-$p" --template '{{range $i, $c := .spec.containers}}{{{$c.image}}}{{end}}'; echo; done
gcr.io/google_containers/nginx-slim:0.8
gcr.io/google_containers/nginx-slim:0.8
gcr.io/google_containers/nginx-slim:0.8
anupathak@pp-os:~/Minikube/StatefulSets$
```

If you want to delete StatefulSets then you have two options Non-Cascading deletion and Cascading deletion.

In Non Cascading deletion, the StatefulSet's Pods are not deleted when StatefulSets is deleted.

In Cascading deletion, both the StatefulSet's Pod and StatefulSets are deleted.

Non-Cascading deleted

Open the two terminals and run the below command on the first terminal.

```
kubectl get pods -w -l app=nginx
```

```
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -w -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0    1/1     Running   0          24m
web-1    1/1     Running   0          24m
web-2    1/1     Running   0          10m
[...]
```

On the second terminal, this command will delete only StatefulSets only, not the StatefulSets pods.

```
kubectl delete statefulset web --cascade=orphan
```

```
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl delete statefulset web --cascade=orphan
statefulset.apps "web" deleted
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get sts
No resources found in default namespace.
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ [...]
```

If you go to the first terminal, you will see the pods still exist.

```
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -w -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0    1/1     Running   0          24m
web-1    1/1     Running   0          24m
web-2    1/1     Running   0          10m
web-3    1/1     Running   0          11m
web-4    1/1     Running   0          25m
web-5    1/1     Running   0          25m
web-6    1/1     Running   0          25m
[...]
```

If you try to delete any pod, you will observe that the deleted pods are not relaunching.

```
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0    1/1     Running   0          29m
web-1    1/1     Running   0          29m
web-2    1/1     Running   0          15m
[...]
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl delete pods web-0
pod "web-0" deleted
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-1    1/1     Running   0          29m
web-2    1/1     Running   0          15m
[...]
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-1    1/1     Running   0          30m
web-2    1/1     Running   0          15m
[...]
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl delete pods web-2
pod "web-2" deleted
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-1    1/1     Running   0          30m
[...]
```

Now, we have to perform the StatefulSets deletion through the Cascading method.

To do that, apply the both service and StatefulSets files.

```
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl apply -f service.yaml
service/nginx unchanged
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ 
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ 
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl apply -f StatefulSet.yaml
statefulset.apps/web created
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ 
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ [...]
```

If you see both pods are running

```
anupathak@pp-OptiPlex-5090:~/Minikube/StatefulSets$ kubectl get pods -w -l app=nginx
NAME      READY   STATUS    RESTARTS   AGE
web-0    1/1     Running   0          169s
web-1    1/1     Running   0          167s
[...]
```

Check the hostname of both pods by running the below command

```
for i in 0 1; do kubectl exec -i -t "web-$i" — curl http://localhost/; done
```

```
aaarpathak@ppp-os:~/Minikube/StatefulSets$ for i in 0 1; do kubectl exec -i -t "web-$i" -- curl http://localhost/; done
web-0
web-1
aaarpathak@ppp-os:~/Minikube/StatefulSets$ aaarpathak@ppp-os:~/Minikube/StatefulSets$
```

Cascading deleted

In this method, the StatefulSets will be deleted with StatefulSet's Pod.

```
kubectl delete statefulset web
```

```
aaarpathak@ppp-os:~/Minikube/StatefulSets$ kubectl delete statefulset web
statefulset.apps "web" deleted
aaarpathak@ppp-os:~/Minikube/StatefulSets$ aaarpathak@ppp-os:~/Minikube/StatefulSets$
```

Kubernetes DaemonSet

“A DaemonSet ensures that all (or some) Nodes run a copy of a Pod. As nodes are added to the cluster, Pods are added to them. As nodes are removed from the cluster, those Pods are garbage collected. Deleting a DaemonSet will clean up the Pods it created.” — Kubernetes DaemonSet Official Definition

Suppose you have to deploy the same pod on all nodes for monitoring. DaemonSet ensures that a specific pod runs on all nodes within the cluster.

Key Features

1. **DaemonSets Ensure Uniformly:** DaemonSets ensures that a designated pod which is used for logs and monitoring will be deployed on every node within the cluster.
2. **Perfect for Infrastructure Services:** DaemonSets are great for services that need to run on every node like networking, storage, or security agents.
3. **Scaling Automatically:** If you add more nodes, then the DaemonSets Pods will be added to new nodes automatically.
4. **Stable Hostnames:** DaemonSets provides stable hostnames which means on each node, the pod's names remain the same if the pods are rescheduled or restarted which makes it easy to reference them across the cluster.

UseCases

1. **Monitoring and Logging:** With the help of DaemonSets, we can deploy monitoring agents or log collectors to gather the information on the node. Tools like Prometheus, beats, ElasticSearch, etc can be deployed using DaemonSets to ensure complete coverage across the cluster.
2. **Security Agents:** We can deploy Security Agents like intrusion detection systems (IDS) or anti-malware software on every node to protect the cluster from threats.
3. **Custom Network Policies:** We can deploy the custom network policies or firewall rules on each node to control communication and security at the node level.
4. **Operating System Updates:** We can deploy the updates or patches at one time with the help of DaemonSets.
5. **Storage and Data Management:** Ensuring that each node has access to particular storage resources, such as local storage or network-attached storage(NAS). DaemonSets can manage storage plugins or agents to provide consistent access.

HandsOn

Initially, I created three machines of which one is a Master Node and the rest of two are Worker Nodes.

If you don't know how to set up the multi-worker nodes using kubeadm then kindly refer to my blog [Day10- Setting up a Kubernetes Cluster\(Master+Worker Node\) using kubeadm on AWS EC2 Instances\(Ubuntu 22.04\) | by Aman Pathak | DevOps.dev](#) which will take maximum 15 minutes

Let's see our Object first:

- Currently, I have three machines Only(1 Master + 2 Worker Nodes)
- We will deploy the DaemonSet Pod on two Worker Nodes.
- Once the Pods will be running on both Worker Nodes. We will create a new machine as Worker Node 3.
- Worker Node3 will join the Kubernetes cluster.
- The DaemonSet Pod will be running automatically without any intervention from our side.

This is the Entire Proof of our Hands-On. You just need to take a look. Further Step by Step, we will look into the next steps.

The screenshot shows two terminal windows side-by-side. Both windows are titled 'root@ip-172-31-80-54:/home/ubuntu' and are running the command 'kubectl get nodes'. The left window shows the initial state with three nodes: ip-172-31-84-155 (Ready, <none>, 14m), ip-172-31-85-200 (Ready, control-plane, 27m), and ip-172-31-92-125 (Ready, <none>, 14m). The right window shows the state after the DaemonSet has been applied, where all three nodes are now Ready and have the 'nginx' role. This indicates that the DaemonSet has successfully deployed its pods onto the available worker nodes.

```
root@ip-172-31-80-54:/home/ubuntu# kubectl get nodes
NAME           STATUS    ROLES      AGE   VERSION
ip-172-31-84-155   Ready    <none>    14m   v1.28.2
ip-172-31-85-200   Ready    control-plane   27m   v1.28.2
ip-172-31-92-125   Ready    <none>    14m   v1.28.2
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl apply -f daemonSets.yml
daemonset.apps/nginx-daemonset created
root@ip-172-31-85-200:/home/ubuntu/DaemonSets#
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1    Running   0          6s
nginx-daemonset-q47kk   1/1    Running   0          6s
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get nodes
NAME           STATUS    ROLES      AGE   VERSION
ip-172-31-80-56   NotReady  <none>    7s   v1.28.2
ip-172-31-84-155   Ready    <none>    15m   v1.28.2
ip-172-31-85-200   Ready    control-plane   28m   v1.28.2
ip-172-31-92-125   Ready    <none>    15m   v1.28.2
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1    Running   0          75s
nginx-daemonset-q47kk   1/1    Running   0          75s
nginx-daemonset-xrmkn  0/1    ContainerCreating   0          2s
root@ip-172-31-85-200:/home/ubuntu/DaemonSets#
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get nodes
NAME           STATUS    ROLES      AGE   VERSION
ip-172-31-80-56   Ready    <none>    20s   v1.28.2
ip-172-31-84-155   Ready    <none>    13m   v1.28.2
ip-172-31-85-200   Ready    control-plane   29m   v1.28.2
ip-172-31-92-125   Ready    <none>    15m   v1.28.2
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1    Running   0          88s
nginx-daemonset-q47kk   1/1    Running   0          88s
nginx-daemonset-xrmkn  0/1    ContainerCreating   0          15s
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1    Running   0          3m7s
nginx-daemonset-q47kk   1/1    Running   1 (50s ago)  3m7s
nginx-daemonset-xrmkn  1/1    Running   0          114s
root@ip-172-31-85-200:/home/ubuntu/DaemonSets#
```

As of now, we have only One Master Node(control plane) and Two Worker Nodes.

The screenshot shows a single terminal window titled 'root@ip-172-31-85-200:/home/ubuntu'. It is running the command 'kubectl get nodes'. The output shows three nodes: ip-172-31-84-155 (Ready, <none>, 14m), ip-172-31-85-200 (Ready, control-plane, 27m), and ip-172-31-92-125 (Ready, <none>, 14m). This confirms that the three nodes are correctly identified and assigned their respective roles.

```
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get nodes
NAME           STATUS    ROLES      AGE   VERSION
ip-172-31-84-155   Ready    <none>    14m   v1.28.2
ip-172-31-85-200   Ready    control-plane   27m   v1.28.2
ip-172-31-92-125   Ready    <none>    14m   v1.28.2
```

DaemonSet YAML file

```
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: nginx-daemonset
spec:
  selector:
    matchLabels:
      name: nginx
  template:
    metadata:
      labels:
        name: nginx
```

```

spec:
  containers:
    - name: nginx
      image: nginx:latest

```

I have deployed my daemonSet YAML file which is deployed to both Worker Nodes.

```

root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl apply -f daemonSets.yaml
daemonset.apps/nginx-daemonset created
root@ip-172-31-85-200:/home/ubuntu/DaemonSets#
root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1     Running   0          6s
nginx-daemonset-q47kk  1/1     Running   0          6s

```

Here, I have run the command to join the Kubernetes Cluster for Worker Node3.

```

root@ip-172-31-80-56:/home/ubuntu# kubeadm join 172.31.85.200:6443 --token huxx5l.burfix3grjv9964 \
--discovery-token-ca-cert-hash sha256:f3f78dc7d58793629562cd4ca80ae82e13f5697e9a7873c89d98e30c10527c2b
[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with "kubectl -n kube-system get cm kubeadm-config -o yaml"
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap...

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 noes' on the control-plane to see this node join the cluster.

```

After joining, you can see the node is getting ready to be part of the cluster.

```

root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get nodes
NAME           STATUS   ROLES      AGE   VERSION
ip-172-31-80-56  NotReady <none>    7s    v1.28.2
ip-172-31-84-155 Ready    <none>    15m   v1.28.2
ip-172-31-85-200 Ready    control-plane 28m   v1.28.2
ip-172-31-92-125 Ready    <none>    15m   v1.28.2
root@ip-172-31-85-200:/home/ubuntu/DaemonSets#

```

Here, you can see that Worker Node3 is in ready status.

```

root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get nodes
NAME           STATUS   ROLES      AGE   VERSION
ip-172-31-80-56  Ready    <none>    20s   v1.28.2
ip-172-31-84-155 Ready    <none>    15m   v1.28.2
ip-172-31-85-200 Ready    control-plane 20m   v1.28.2
ip-172-31-92-125 Ready    <none>    15m   v1.28.2
root@ip-172-31-85-200:/home/ubuntu/DaemonSets#

```

If you list all the pods, you will see there is one more started in which the container is creating without running any command.

```

root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1     Running   0          88s
nginx-daemonset-q47kk  1/1     Running   0          88s
nginx-daemonset-xrmkn  0/1     ContainerCreating   0          15s

```

Here, you can see the Pod is in running status.

```

root@ip-172-31-85-200:/home/ubuntu/DaemonSets# kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-daemonset-nbstb  1/1     Running   0          3m7s
nginx-daemonset-q47kk  1/1     Running   1 (50s ago) 3m7s
nginx-daemonset-xrmkn  1/1     Running   0          114s

```

Kubernetes Network Policies

What is Network Policy?

By default, a pod can communicate with any other pods whether it's present in any namespaces. But if you want to secure your pod by providing access to only known pods or authorized pods then Kubernetes has the richest feature known as Network Policy. Network Policy will help you to protect your pod by accessing only authorized pods. So, this way the pod's security will be enhanced.

Network Policy allows us to define the rules to communicate between the pods. With the help of Networking Policy, Kubernetes provides fine-grained controls over what traffic is allowed or denied which leads to enhancing the security and isolation of your applications.

Key Features:

Policy Rules: Network Policies consist of a set of rules in which you define how the traffic is allowed or denied. You can specify these rules by pod labels, namespaces, or particular IPs.

Pod Selectors: If you want to apply the Network Policy to the particular pod then you can use Pod Selector which will select the particular pod and apply the Network Policy on that pod.

Ingress and Egress: Network Policies allow you to define the Ingress and Egress rules. Ingress means incoming traffic on the pod from the outside whereas Egress means outgoing traffic to the internet(anywhere) from the pod itself.

Namepaces: If you want to apply your Network Policy to the group of pod which is present in the particular namespace then you can namespaceSelector which will help you to invoke the Network Policy on all pods within the particular namespace.

Priority: Network Policy also provides the priority feature in which you define the priority of the rules which helps you to get fine-grained control over the traffic rules of your application.

Use cases of Network Policy:

- **Isolation:** You can invoke the Network Policies to isolate different application components inside the Cluster. For example, you have an application with frontend and backend so you will create a namespace and apply the network policy on that namespace to make the frontend and backend application secure.
- **Microservices:** Network Policies help to make microservices architecture more secure and prevent unauthorized communications between different microservices.
- **Compliance:** For Compliance reasons, you have to follow the protocol in which only authorized pods can communicate with each other. Network policies help you to achieve this.

- **Multi-tenancy:** Network Policies make sure that it will not interfere with different tenants. So, the flow of the multi-tenant cluster will be working smoothly if anything fails on the particular tenant.
- **Application testing:** Suppose, if you are testing something of an application then, Network Policy helps to control its access to production services, reducing the risks of unintended interactions.

Hands-On Demo:

To perform the hands-on Network Policy, Kubernetes must have network plugins like Calico or Cilium. By default noop network plugin is installed that does not provide advanced or rich features of Kubernetes Networking.

In the below steps, we will install the Cilium networking plugin to perform our demo. Without any advanced networking plugin, we can't able to perform a demo.

minikube start — network-plugin=cni

```
ubuntu@ip-172-31-93-32:~$ minikube start --network-plugin=cni
minikube v1.32.0 - Ubuntu 22.04 (xen/and64)
Using the docker driver based on existing profile
Starting a new node minikube in cluster minikube
Pulling base image ...
Updating the running docker "minikube" container ...
Preparing Kubernetes v1.28.3 on Docker 24.0.7 ...
Verifying Kubernetes components...
* Using image gcr.io/k8s-minikube/storage-provisioner:v5
Enabled addons: storage-provisioner, default-storageclass
Docker kubectl is now configured to use "minikube" cluster and "default" namespace by default
ubuntu@ip-172-31-93-32:~$
```

curl -LO

<https://github.com/cilium/cilium-cli/releases/latest/download/cilium-linux-amd64.tar.gz>

```
ubuntu@ip-172-31-93-32:~$ curl -LO https://github.com/cilium/cilium-cli/releases/latest/download/cilium-linux-amd64.tar.gz
% Total    % Received % Xferd  Average Speed   Time   Time  Current
          Dload  Upload   Total   Spent    Left  Speed
0       0     0      0      0      0      0      0      0      0      0      0
100 35.5M  100 35.5M      0      0      0      0      0      0      0      0
ubuntu@ip-172-31-93-32:~$ ls
cilium-linux-amd64.tar.gz  minikube-linux-amd64
ubuntu@ip-172-31-93-32:~$
```

sudo tar xzvfC cilium-linux-amd64.tar.gz /usr/local/bin

rm cilium-linux-amd64.tar.gz

```
ubuntu@ip-172-31-93-32:~$ sudo tar xzvfC cilium-linux-amd64.tar.gz /usr/local/bin
rm cilium-linux-amd64.tar.gz
cilium
ubuntu@ip-172-31-93-32:~$
```

cilium install

```
ubuntu@ip-172-31-93-32:~$ cilium install
Auto-detected Kubernetes kind: minikube
Auto-detected host OS: Ubuntu 22.04
Auto-detected host CPU: Intel(R) Xeon(R) Gold 6232 @ 2.10GHz
Detected minikube version "1.32.0"
Using Cilium version 1.14.2
Auto-detected cluster name: minikube
Auto-detected kube-proxy has been installed
ubuntu@ip-172-31-93-32:~$
```

To validate whether your networking pod is running or not, run the below command.

kubectl get pods — namespace=kube-system -l k8s-app=cilium

```
ubuntu@ip-172-31-93-32:~$ kubectl get pods --namespace=kube-system -l k8s-app=cilium
NAME        READY   STATUS    RESTARTS   AGE
cilium-vbznd 1/1     Running   0          28s
ubuntu@ip-172-31-93-32:~$
```

Create three namespaces and deploy the nginx pod on those namespaces with service where we have to expose port 80

```

kubectl create namespace namespace-a
kubectl create deployment nginx - image=nginx - namespace namespace-a
kubectl expose deployment nginx - port=80 - namespace namespace-a
kubectl create namespace namespace-b
kubectl create deployment nginx - image=nginx - namespace namespace-b
kubectl expose deployment nginx - port=80 - namespace namespace-b
kubectl create namespace namespace-c
kubectl create deployment nginx - image=nginx - namespace namespace-c
kubectl expose deployment nginx - port=80 - namespace namespace-c

```

```

ubuntu@ip-172-31-93-32:/~$ kubectl create namespace namespace-a
namespace-a created
ubuntu@ip-172-31-93-32:/~$ kubectl create deployment nginx --image=nginx --namespace namespace-a
deployment.apps/nginx created
ubuntu@ip-172-31-93-32:/~$ kubectl expose deployment nginx --port=80 --namespace namespace-a
service/nginx exposed
ubuntu@ip-172-31-93-32:/~$ kubectl create namespace namespace-b
namespace-b created
ubuntu@ip-172-31-93-32:/~$ kubectl create deployment nginx --image=nginx --namespace namespace-b
deployment.apps/nginx created
ubuntu@ip-172-31-93-32:/~$ kubectl expose deployment nginx --port=80 --namespace namespace-b
service/nginx exposed
ubuntu@ip-172-31-93-32:/~$ kubectl create namespace namespace-c
namespace-c created
ubuntu@ip-172-31-93-32:/~$ kubectl create deployment nginx --image=nginx --namespace namespace-c
deployment.apps/nginx created
ubuntu@ip-172-31-93-32:/~$ kubectl expose deployment nginx --port=80 --namespace namespace-c
service/nginx exposed
ubuntu@ip-172-31-93-32:/~$ kubectl get pods,svc -A

```

Check whether the pods are running or not of all three namespaces.
kubectl get pods -A

```

ubuntu@ip-172-31-93-32:/~$ kubectl get pods,svc -A
NAME          NAME        READY   STATUS    RESTARTS   AGE
kube-system   clliun-operator-5d47789fc8-rf8lp  1/1     Running   0          8m6s
kube-system   pod/clliun-vbnd  1/1     Running   0          8m6s
kube-system   pod/coredns-5dd5756b8-hx1qd  1/1     Running   0          7m46s
kube-system   pod/etcd-minikube  1/1     Running   1 (10m ago)  11m
kube-system   pod/kube-apiserver-minikube  1/1     Running   1 (10m ago)  11m
kube-system   pod/kube-controller-manager-minikube  1/1     Running   1 (10m ago)  11m
kube-system   pod/kube-proxy-dkxj5  1/1     Running   1 (10m ago)  10m
kube-system   pod/kube-scheduler-minikube  1/1     Running   1 (10m ago)  11m
kube-system   pod/storage-provisioner  1/1     Running   2 (10m ago)  11m
namespace-a   pod/nginx-7854ff8877-m69p4  1/1     Running   0          41s
namespace-b   pod/nginx-7854ff8877-m69p4  1/1     Running   0          41s
namespace-c   pod/nginx-7854ff8877-gmz9k  1/1     Running   0          41s
NAME          TYPE        CLUSTER-IP      EXTERNAL-IP      PORT(S)      AGE
default       service/kubernetes  ClusterIP   <none>        443/TCP      11m
kube-system   service/hubble-peer  ClusterIP   10.96.0.1      <none>        443/TCP      8m6s
kube-system   service/kube-dns  ClusterIP   10.96.1.64     <none>        53/TCP,53/UDP,9153/TCP  11m
namespace-a   service/nginx  ClusterIP   10.96.1.64     <none>        80/TCP      41s
namespace-b   service/nginx  ClusterIP   10.107.36.122   <none>        80/TCP      41s
namespace-c   service/nginx  ClusterIP   10.110.192.6    <none>        80/TCP      41s
ubuntu@ip-172-31-93-32:/~$ kubectl get pods,svc -A

```

List the Private IPs of all three pods running from all three namespaces.
kubectl get pods -A -o wide

```

ubuntu@ip-172-31-93-32:/~$ kubectl get pods -A -o wide
NAME          NAME        READY   STATUS    RESTARTS   AGE   IP           NODE   NOMINATED-NODE   READINESS   GATES
kube-system   clliun-operator-5d47789fc8-rf8lp  1/1   Running   0          8m6s  192.168.49.2  minikube  <none>        <none>
kube-system   clliun-vbnd  1/1   Running   0          8m6s  192.168.49.2  minikube  <none>        <none>
kube-system   coredns-5dd5756b8-hx1qd  1/1   Running   0          10m  192.168.0.5   minikube  <none>        <none>
kube-system   etcd-minikube  1/1   Running   1 (10m ago)  11m  192.168.49.2  minikube  <none>        <none>
kube-system   kube-apiserver-minikube  1/1   Running   1 (10m ago)  11m  192.168.49.2  minikube  <none>        <none>
kube-system   kube-controller-manager-minikube  1/1   Running   1 (10m ago)  11m  192.168.49.2  minikube  <none>        <none>
kube-system   kube-proxy-dkxj5  1/1   Running   1 (10m ago)  10m  192.168.49.2  minikube  <none>        <none>
kube-system   kube-scheduler-minikube  1/1   Running   1 (10m ago)  11m  192.168.49.2  minikube  <none>        <none>
kube-system   storage-provisioner  1/1   Running   2 (10m ago)  11m  192.168.49.2  minikube  <none>        <none>
namespace-a   nginx-7854ff8877-rx8b8  1/1   Running   0          82s  10.0.0.15    minikube  <none>        <none>
namespace-b   nginx-7854ff8877-m69p4  1/1   Running   0          81s  10.0.0.165   minikube  <none>        <none>
namespace-c   nginx-7854ff8877-gmz9k  1/1   Running   0          81s  10.0.0.73    minikube  <none>        <none>
ubuntu@ip-172-31-93-32:/~$ kubectl get pods,svc -A

```

Now, try to access the pod of namespace-b from the namespace-a pod

kubectl -n namespace-c exec <namespace-c_pod_name> - curl <namespace-a_pod_private_ip>

kubectl -n namespace-c exec nginx-77b4fdf86c-v4qdd - curl 10.244.0.106

```

ubuntu@ip-172-31-93-32:~/Network-Policy$ kubectl -n namespace-a exec nginx-7054ff8877-rx8b8 -- curl 10.0.0.165
  % Total    % Received % Xferd  Average Speed   Time   Time  Current
  100  615  100  615    0     0  386k   0  --::--  --::--  --::-- 600k
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light dark; }
body { width: 35em; margin: 0 auto;
font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and
working. Further configuration is required.</p>
<p>For online documentation and support please refer to
<a href="http://nginx.org/">http://nginx.org/</a></p>
<p>Commercial support is available at
<a href="http://nginx.com/">nginx.com</a>.</p>
<p><em>Thank you for using nginx.</em></p>
</body>
</html>
ubuntu@ip-172-31-93-32:~/Network-Policy $ 
```

Now, try to access the pod of namespace-b from the namespace-c pod

```

ubuntu@ip-172-31-93-32:~/Network-Policy$ kubectl -n namespace-c exec nginx-7054ff8877-gmz9k -- curl 10.0.0.165
  % Total    % Received % Xferd  Average Speed   Time   Time  Current
  100  615  100  615    0     0  421k   0  --::--  --::--  --::-- 600k
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light dark; }
body { width: 35em; margin: 0 auto;
font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and
working. Further configuration is required.</p>
<p>For online documentation and support please refer to
<a href="http://nginx.org/">http://nginx.org/</a></p>
<p>Commercial support is available at
<a href="http://nginx.com/">nginx.com</a>.</p>
<p><em>Thank you for using nginx.</em></p>
</body>
</html>
ubuntu@ip-172-31-93-32:~/Network-Policy $ 
```

As you saw in the above two steps, different namespace pods are able to access the other namespace's pods which is not good DevOps practice. Let's first try to implement where the namespace-b pod can't be accessible to any other pod.

Deny All

```

apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata: [REDACTED]
name: deny-all-traffic
namespace: namespace-b
spec: [REDACTED]
podSelector: {}
policyTypes:
- Ingress
- Egress

```

Deploy the NetworkPolicy to deny all access for namespace-b

After deploying the network policy, now try to access the namespace-b pod from both namespace-a and namespace-c pod and you will see in the below snippet that you can't access the namespace-b pod which is expected.

```

ubuntu@ip-172-31-93-32:~/Network-Policy$ vim Deny-All.yaml
ubuntu@ip-172-31-93-32:~/Network-Policy$ kubectl apply -f Deny-All.yaml
networkpolicy.networking.k8s.io/deny-all-traffic created
ubuntu@ip-172-31-93-32:~/Network-Policy$ curl 10.0.0.165
% Total % Received % Xferd Average Speed Time Time Current
          Dload Upload Total Spent Left Speed
0 0 0 0 0 0 0 0 --:--:-- 0:00:06 --:--:-- 0:0C
ubuntu@ip-172-31-93-32:~/Network-Policy$ curl 10.0.0.165
% Total % Received % Xferd Average Speed Time Time Current
          Dload Upload Total Spent Left Speed
0 0 0 0 0 0 0 0 --:--:-- 0:00:49 --:--:-- 0:0C
ubuntu@ip-172-31-93-32:~/Network-Policy$ 

```

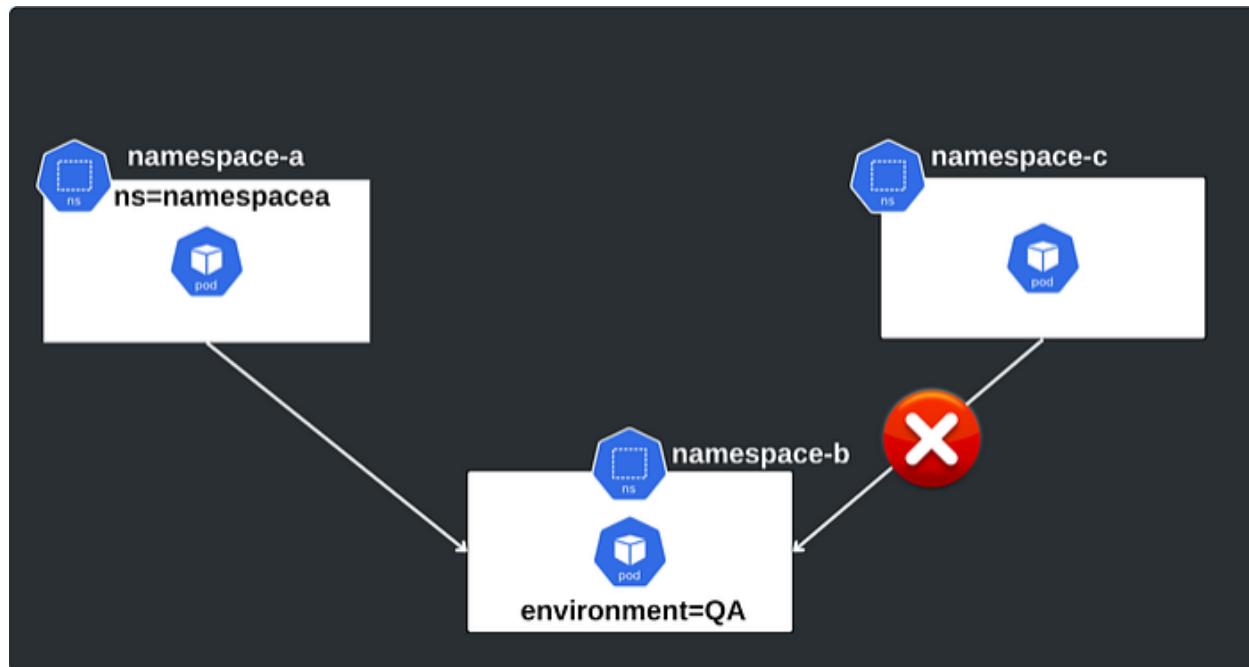
Once you delete the Network Policy, then try to access the namespace-b pod from the other pod and you will see that you can access the namespace-b pod.

```

ubuntu@ip-172-31-93-32:~/Network-Policy$ kubectl delete -f Deny-All.yaml
networkpolicy.networking.k8s.io "deny-all-traffic" deleted
ubuntu@ip-172-31-93-32:~/Network-Policy$ curl 10.0.0.165
% Total % Received % Xferd Average Speed Time Time Current
          Dload Upload Total Spent Left Speed
100 615 100 615 0 0 545k 0 --:--:-- 0:00:06 --:--:-- 600k
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and working. Further configuration is required.</p>
<p>For online documentation and support please refer to
<a href="http://nginx.org/">http://nginx.org/.<br/>
Commercial support is available at
<a href="http://nginx.com/">http://nginx.com/.</p>
<p><em>Thank you for using nginx.</em></p>
</body>
</html>
ubuntu@ip-172-31-93-32:~/Network-Policy$ 

```

Now, let's try to impose accessibility like the one below snippet where the namespace-c pod can only access the namespace-b pod. If namespace-a tries to access namespace-b pod then our goal is to prevent the access.



Add the label to all three K8s namespaces

```

kubectl label namespaces namespace-a ns=namespacea
kubectl label namespaces namespace-b ns=namespaceb

```

```
kubectl label namespaces namespace-c ns=namespacetc
```

```
ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl label namespaces namespace-a ns=namespacea
ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl label namespaces namespace-c ns=namespacetc
namespace/nspace-a labeled
namespace/nspace-b labeled
namespace/nspace-c labeled
ubuntu@ip-172-31-93-32:/~Network-Policy$ ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl get ns --show-labels
NAME        STATUS   AGE     LABELS
default     Active   22m    kubernetes.io/metadata.name=default
kube-node-lease Active   22m    kubernetes.io/metadata.name=kube-node-lease
kube-public  Active   22m    kubernetes.io/metadata.name=kube-public
kube-system  Active   22m    kubernetes.io/metadata.name=kube-system
namespace-a Active   12m    kubernetes.io/metadata.name=namespace-a,ns=namespacea
namespace-b Active   12m    kubernetes.io/metadata.name=namespace-b,ns=namespaceb
namespace-c Active   12m    kubernetes.io/metadata.name=namespace-c,ns=namespacetc
ubuntu@ip-172-31-93-32:/~Network-Policy$ 
```

Now, Our motive is that only namespace-a can be able to access the namespace-b pod whereas the namespace-c can't be able to access the namespace-b pod. Let's implement the Network Policy.

Add the label environment=QA to the namespace-b pod because there can be multiple pods running inside one namespace. So, if you have to give access to the particular pod instead of all.

```
kubectl get pods - namespace namespace-b
kubectl label - namespace namespace-b pod nginx-7854ff8877-m69p4 environment=QA
kubectl get pods - namespace namespace-b - show-labels
```

```
ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl label pod nginx-7854ff8877-m69p4 environment=QA
Error from server (NotFound): pods "nginx-7854ff8877-m69p4" not found
ubuntu@ip-172-31-93-32:/~Network-Policy$ ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl get pods --namespace namespace-b
NAME        READY   STATUS   RESTARTS   AGE
nginx-7854ff8877-m69p4   1/1   Running   0          36s
ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl label --namespace namespace-b pod nginx-7854ff8877-m69p4 environment=QA
pod/nginx-7854ff8877-m69p4 labeled
ubuntu@ip-172-31-93-32:/~Network-Policy$ ubuntu@ip-172-31-93-32:/~Network-Policy$ ubuntu@ip-172-31-93-32:/~Network-Policy$ kubectl get pods --namespace namespace-b --show-labels
NAME        READY   STATUS   RESTARTS   AGE   LABELS
nginx-7854ff8877-m69p4   1/1   Running   0          19s   app=nginx,environment=QA,pod-template-hash=7854ff8877
ubuntu@ip-172-31-93-32:/~Network-Policy$ 
```

Now, try to access namespace-b pod from namespace-a where it should be accessible.

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: nginx-ingress
  namespace: namespace-b
spec:
  podSelector:
    matchLabels:
      environment: QA
  policyTypes:
  - Ingress
  ingress:
  - from:
    - namespaceSelector:
        matchLabels:
          ns: namespacea
  kubectl apply -f Allow-namsepacea.yml
  kubectl -n namespace-a exec nginx-7854ff8877-rx8b8 - curl 10.0.0.165
```

```

ubuntu@ip-172-31-93-32:/Network-Policies$ kubectl apply -f Allow-namespaces.yaml
networkpolicy.networking.k8s.io/nginx-ingress created
ubuntu@ip-172-31-93-32:/Network-Policies$ kubectl -n namespace-a exec nginx-7854ff8877-rxb8 -- curl 10.0.0.165
  % Total    % Received % Xferd  Average Speed   Time   Time  Current
     0       0       0      0  0:00:05  0:00:05  0:00:05  600k
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light dark; }
body { width: 35em; margin: 0 auto;
font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and
working. Further configuration is required.</p>
<p><a href="http://nginx.org/">For online documentation and support please refer to</a><br/>
<a href="http://nginx.com/">Commercial support is available at</a><br/>
<a href="http://nginx.org/en/contact.html">Thank you for using nginx.</a></p>
</body>
</html>
ubuntu@ip-172-31-93-32:/Network-Policies$ 

```

Now, Let's try to access namespace-b pod from namespace-c.

kubectl -n namespace-c exec nginx-7854ff8877-gmz9k — curl 10.0.0.165

As you can see in the below snippet, namespace-c pod could not able to access namespace-b pod which is expected.

```

ubuntu@ip-172-31-93-32:/Network-Policies$ kubectl -n namespace-c exec nginx-7854ff8877-gmz9k -- curl 10.0.0.165
  % Total    % Received % Xferd  Average Speed   Time   Time  Current
     0       0       0      0  0:00:05  0:00:05  0:00:05  0

```

Kubernetes Operators

What are Operators?

Kubernetes Operator is a method for packaging or bundling, deploying, and managing the application by extending the functionality of the Kubernetes API.

The above definition is One and a half line but if you deep dive into that line you will see there are a lot of things which is followed to write this definition. Let's try to understand it.

There are two types of applications Stateless and Stateful Applications.

Stateless applications are those applications where the data or persisting data is not the priority. So, if the pods get restarted then it will lose the data but it won't bother us because we already knew that our application is Stateless.

But Stateful applications are those applications where the data is very important and we have to keep our data persistent whether its in Persistent Volume or somewhere else. But whenever the pod is replaced or restarted then the pod will lose the data which is not what we want. To get rid of the data loss, we will use Stateful Applications.

First of all, this is only one usage of the Operators. There will be more usages of the Kubernetes Operators which, we will discuss later in this blog.

Kubernetes Operators have rich features that help to deploy stateless, stateful, complex, or custom applications.

Features of Operators:

1. **Custom Resource Definitions(CRD):** With the help of Operators, you can define your CRD to extend the capability of your Kubernetes for a particular application. We will discuss CRD in a detailed way later.

Example: Prometheus is one of the finest Operators, in which there is a Custom Resource known as Prometheus which allows users to define the monitor configuration declaratively. You can specify the details like alerting rules, service monitors, etc using the custom resource.

2. **Custom Controllers:** There is no use of Custom resource if the Custom Controller is not present. Operators implement custom controllers to watch and reconcile(correct) the state of the custom resource and ensure that the desired state matches the actual state.

Example: In Native Kubernetes, etcd is one of the components that take care of the current and desired state thing and other things like stability of the Kubernetes Cluster and node failures, etc.

3. **Automated Operations:** Operators automate routine tasks which makes it easier to manage the complex applications over their lifecycle.

Example: In the MongoDB operator, if the users increase the number of replicas in the custom resource then, the Operator automatically adjusts the replicas to seamless scaling.

4. **Operational Policies:** Operators consistently enforce the operational policies to keep the environment secure across instances of application.

Example: The Vault operators enforce the security policies over HashiCorp Vault which ensures that the sensitive data will be secured.

5. **Rolling Updates and Upgrades:** Operators manage the rolling updates and upgrades of the application. So that, there will be no downtime.

Example: CockroachDB operator handles the rolling updates on the CockroachDB cluster one node at a time to follow the no downtime protocol during the upgrading hours..

6. **Integrate with Ecosystem tools:** Operators integrate with other Kubernetes tools to provide better functionality for the application.

Example: Prometheus Operator can be integrated with Grafana to provide complete monitoring.

7. **Stateful Applications:** Operators help to manage complex or stateful applications by handling tasks like data persistent, disaster recovery, scaling, etc.

Example: Apache Kafka Operator manages Kafka clusters which automates tasks such as topic creation, partition reassignment, etc.

Kubernetes is one of the best container orchestration tools because of the Operator feature. If you observe, to leverage the rich feature you have to install operators like to get the benefit of the HPA(Horizontal Pod Autoscaler) feature you need to install an operator for it, and the same for Network Policy, etc.

So, without Operators, the life of a Kubernetes DevOps guy is not very easy.

Now this is enough to get a basic understanding of Kubernetes Operators. But there are some more things that you need to know.

1. Custom Resource Definition

CRD is indeed one of the powerful features of Kubernetes, acting like a superpower that lets you define and use custom resources tailored to your specific needs. Let's put it in a scenario:

Imagine you have a fantastic application ready to roll, but Kubernetes, as amazing as it is, might not have all the necessary tools and features to handle the uniqueness of your application. Here's where CRD steps in as your superhero sidekick.

In straightforward terms, CRD allows you to create your very own resource types in Kubernetes. It's like getting a custom tool for your specific job. But, of course, there's a twist — your CRD needs the Kubernetes seal of approval. Think of it as a passport check; once

your CRD gets the nod from Kubernetes, it becomes a certified member of the Kubernetes family.

Now, here's the exciting part. Once you've crafted your CRD to match your application's needs, you can share it with the world! Just like posting your creation on a hub for others to benefit. In the Kubernetes world, this hub is known as operatorhub.io. It's a place where your CRD can shine, offering its capabilities to others who might have similar challenges.

So, in a nutshell, CRD empowers you to extend Kubernetes by creating your custom resources, and once validated, you can share your creations on operatorhub.io, contributing to the Kubernetes ecosystem and helping others tackle their unique challenges. It's like giving your application its very own set of superpowers within the Kubernetes universe!

Custom Resource Definition can be created in YAML

2. Custom Controller

Without a Custom Controller, there is no benefit to using Custom Resource Definition. Custom Controller is a dedicated created for the CRD. The main work of the Custom Controller is to meet the desired state of the custom resources with the actual state such as replicates. Also, Custom Controllers are like a watcher who watches and keep an eye on the custom resource. So, if there is any misshappening occurs then Custom Controllers fix it or take the necessary steps as part of the auto healing.

Custom Controller can be created in many languages like Go, Python, etc and there is one component client-go that is dedicated to Golang which has all the necessary tools for working with Kubernetes.

3. Custom Resource

Once the Custom Controller is deployed, you have to think or you have already prepared the roadmap for how many namespaces you have to deploy your Custom Resource. It can be deployed on multiple worker nodes as per the requirement. Custom Resource is the last step in the process of creating and deploying the Custom Resources where Custom Controller is the second and CRD is the first step.

Let's go through a sample **Custom Resource Definition**

A scenario could be managing a custom application called "AwesomeApp" that needs to maintain a specific number of replicas based on a defined metric. Here's how the CRD might look:

File: awesomeapp-crd.yaml

```
apiVersion: apiextensions.k8s.io/v1
kind: CustomResourceDefinition
metadata:
  name: awesomeapps.app.example.com
spec:
  group: app.example.com
  names:
    kind: AwesomeApp
    listKind: AwesomeAppList
```

```

plural: awesomeapps
singular: awesomeapp
scope: Namespaced
versions:
- name: v1
  served: true
  storage: true
additionalPrinterColumns:
- name: Replicas
  type: integer
  JSONPath: .spec.replicas

```

In this CRD, we define a custom resource named “AwesomeApp” belonging to the group “app.example.com.” It has a field for the number of replicas.

Let's go through a sample Custom Controller:

Now, let's create a simple Custom Controller in Go that watches for changes to our custom resource and takes action accordingly.

// File: main.go

```

package main
import (
    "context"
    "flag"
    "fmt"
    "time"
    "k8s.io/client-go/kubernetes"
    "k8s.io/client-go/tools/cache"
    "k8s.io/client-go/tools/clientcmd"
    "k8s.io/client-go/util/homedir"
    "k8s.io/client-go/util/wait"
    "k8s.io/client-go/util/workqueue"
)
func main() {
    kubeconfig, _ := getKubeconfig()
    config, err := clientcmd.BuildConfigFromFlags("", kubeconfig)
    if err != nil {
        panic(err.Error())
    }
    clientset, err := kubernetes.NewForConfig(config)
    if err != nil {
        panic(err.Error())
    }
    informer := cache.NewSharedInformer(
        cache.NewListWatchFromClient(
            clientset.AppsV1().RESTClient(),
            "awesomeapps",
            "namespace-name",
            cache.ResourceEventHandlerFuncs{
                AddFunc: func(obj interface{}) {

```

```

fmt.Println("AwesomeApp created:", obj)
// Logic to handle the creation of AwesomeApp
},
UpdateFunc: func(oldObj, newObj interface{}) {
    fmt.Println("AwesomeApp updated:", newObj)
    // Logic to handle the update of AwesomeApp
},
DeleteFunc: func(obj interface{}) {
    fmt.Println("AwesomeApp deleted:", obj)
    // Logic to handle the deletion of AwesomeApp
},
),
&v1.AwesomeApp{},
0, // no resync
cache.ResourceEventHandlerFuncs{},
)
stopCh := make(chan struct{})
defer close(stopCh)
go informer.Run(stopCh)
// Run forever
select {}
}
func getKubeconfig() (*string, error) {
home := homedir.HomeDir()
kubeconfig := flag.String("kubeconfig", home+"/.kube/config", "absolute path to the
kubeconfig file")
flag.Parse()
return kubeconfig, nil
}

```

In this simplified example:

- The controller watches for changes in AwesomeApp resources.
- When an AwesomeApp resource is created, updated, or deleted, the corresponding handler functions are invoked.
- You would extend this controller with your custom logic to manage the AwesomeApp replicas based on the specified metric.

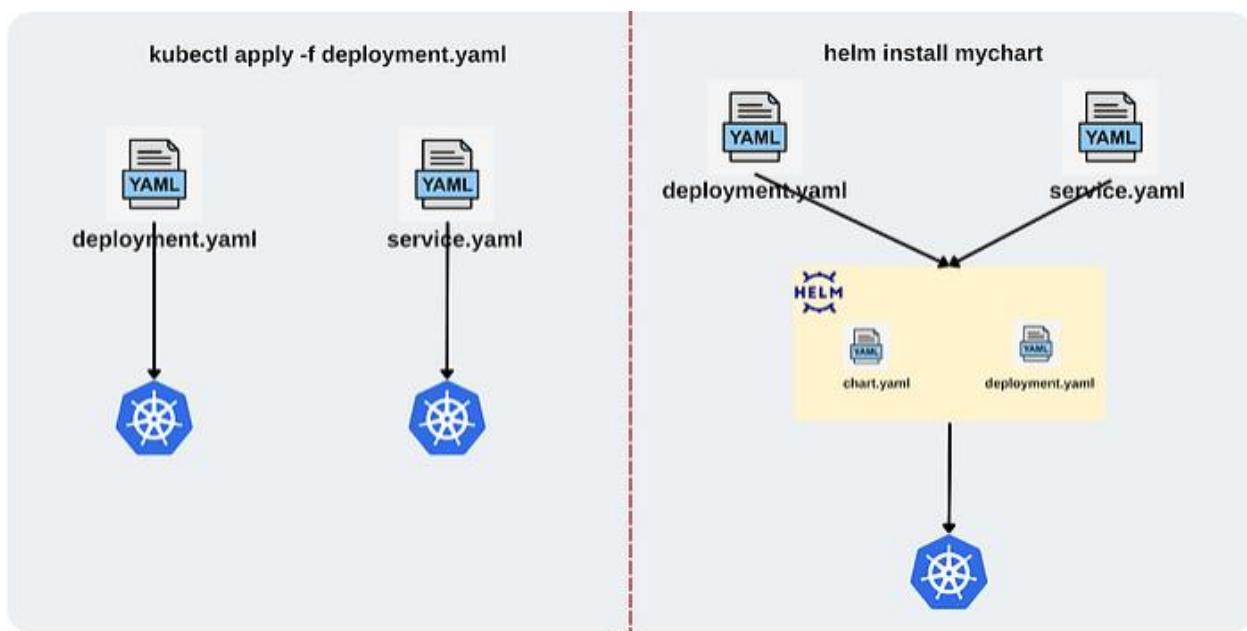
Helm & Helm Charts

Helm

Helm is a Kubernetes package manager in which the multiple numbers of YAML files such as the backend, and frontend come under one roof(helm) and deploy using helm.

Let's understand with the help of a simple example.

Suppose you have an application where frontend, backend, and database code needs to deploy on Kubernetes. Now, the task becomes hectic if you have to deploy frontend and backend codes because your application will be Stateful. For frontend, backend, and database you will have to create different YAML files and deploy them too but it will be complicated to manage. So, Helm is an open-source package manager that will help you to automate the deployment of applications for Kubernetes in the simplest way.



Let's understand again with the help of the above architecture.

Normal deployment

As you know, to deploy your code you need to write a minimum of two YAML files which is deployment and service file. Those files will be deployed with the help of the kubectl command. These files act differently from each other but you know that the files are dependent on each other.

Helm deployment

In the help deployment, all the YAML files related to the application deployment will be in the helm chart. So, if you want to deploy your application you don't need to deploy each YAML file one by one. Instead, you can just write one command helm install <your-chart-name> and it will deploy your entire application in one go. Helm is the Package manager for the Kubernetes which helps to make the deployment simple.

Benefits

- Because of the helm, the time will be saved.
- It makes the automation more smoothly
- Reduced complexity of deployments.
- Once files can be implemented in different environments. You just need to change the values according to the environmental requirements.
- Better scalability.
- Perform rollback at any time.
- Effective for applying security updates.
- Increase the speed of deployments and many more.

Hands-On

Install Helm

```
curl -fsSL -o get_helm.sh  
https://raw.githubusercontent.com/helm/helm/main/scripts/get-helm-3  
chmod 700 get_helm.sh  
./get_helm.sh  
helm version
```

```
ubuntu@ip-172-31-93-32:~$ curl -fsSL -o get_helm.sh https://raw.githubusercontent.com/helm/helm/main/scripts/get-helm-3  
ubuntu@ip-172-31-93-32:~$ chmod 700 get_helm.sh  
ubuntu@ip-172-31-93-32:~$ ./get_helm.sh  
Downloading https://get.helm.sh/helm-v3.1.1-linux-amd64.tar.gz  
Verifying checksum... Done.  
Preparing to install helm into /usr/local/bin  
helm installed into /usr/local/bin/helm  
ubuntu@ip-172-31-93-32:~$  
ubuntu@ip-172-31-93-32:~$ helm version  
version.BuildInfo{Version:"v3.13.1", GitCommit:"3547a4b5bf5edb5478ce352e18858d8a552a4110", GitTreeState:"clean", GoVersion:"go1.20.0"}  
ubuntu@ip-172-31-93-32:~$
```

To list the all repositories

```
helm list
```

```
ubuntu@ip-172-31-93-32:~$ helm list  
NAME      NAMESPACE      REVISION      UPDATED STATUS      CHART      APP VERSION  
ubuntu@ip-172-31-93-32:~$
```

Create a stable repository using the helm

```
helm repo add stable https://charts.helm.sh/stable
```

```
ubuntu@ip-172-31-93-32:~$ helm repo add stable https://charts.helm.sh/stable  
"stable" has been added to your repositories  
ubuntu@ip-172-31-93-32:~$
```

List the repo, again

```
helm repo list
```

```
ubuntu@ip-172-31-93-32:~$ helm repo list
NAME      URL
stable    https://charts.helm.sh/stable
ubuntu@ip-172-31-93-32:~$
```

To remove the repo

```
helm repo remove stable
```

```
ubuntu@ip-172-31-93-32:~$ helm repo remove stable
"stable" has been removed from your repositories
ubuntu@ip-172-31-93-32:~$
ubuntu@ip-172-31-93-32:~$ helm repo list
Error: no repositories to show
ubuntu@ip-172-31-93-32:~$
```

To create our own repo

```
helm create my-repo
```

```
ubuntu@ip-172-31-93-32:~$ helm create my-repo
Creating my-repo
ubuntu@ip-172-31-93-32:~$
ubuntu@ip-172-31-93-32:~$ ls my-repo/
Chart.yaml  charts  templates  values.yaml
ubuntu@ip-172-31-93-32:~$
```

To see the files inside the created repo

```
ubuntu@ip-172-31-93-32:~$ tree my-repo/
my-repo/
├── Chart.yaml
├── charts
│   └── templates
│       ├── NOTES.txt
│       ├── _helpers.tpl
│       ├── deployment.yaml
│       ├── hpa.yaml
│       ├── ingress.yaml
│       ├── service.yaml
│       ├── serviceaccount.yaml
│       └── tests
│           └── test-connection.yaml
└── values.yaml

3 directories, 10 files
```

Let's do a simple demo where we will host the nginx page on Kubernetes using the helm chart.

Create a chart using the command

```
helm create helloworld
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm create helloworld
Creating helloworld
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ 
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ ls
helloworld
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ 
```

The file structure should look like the below snippet.

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ tree helloworld/
helloworld/
├── charts
├── Chart.yaml
└── templates
    ├── deployment.yaml
    ├── _helpers.tpl
    ├── hpa.yaml
    ├── ingress.yaml
    ├── NOTES.txt
    ├── serviceaccount.yaml
    ├── service.yaml
    └── tests
        └── test-connection.yaml
values.yaml

3 directories, 10 files
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ 
```

Go to the Helm Chart directory helloworld and edit the values.yaml file

```
cd helloworld
```

```
vim values.yaml
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ cd helloworld/
amanpathak@pop-os:~/Learning/Kubernetes/Helm/helloworld$ 
amanpathak@pop-os:~/Learning/Kubernetes/Helm/helloworld$ vim values.yaml
amanpathak@pop-os:~/Learning/Kubernetes/Helm/helloworld$ 
```

Replace the ClusterIP with NodePort

```
41 
42 service:
43   type: NodePort
44   port: 80
45 
```

Now deploy your helm chart

To do that, you have to be present in the directory where the chart is present.

In my case, my helloworld chart is in the Helm directory. So, I have to be in the Helm directory and run the below command to install the Helm Chart.

```
helm install thehelloworld helloworld
```

```
helm install <custom-chart-release-name> <given-chart-name>
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm install thehelloworld helloworld
NAME: thehelloworld
LAST DEPLOYED: Fri Nov 24 18:49:46 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export NODE_PORT=$(kubectl get --namespace default -o jsonpath=".spec.ports[0].nodePort" services thehelloworld)
  export NODE_IP=$(kubectl get nodes --namespace default -o jsonpath=".items[0].status.addresses[0].address")
  echo http://$NODE_IP:$NODE_PORT
amanpathak@pop-os:~/Learning/Kubernetes/Helms$ 
```

Now, check the services whether your application is running or not

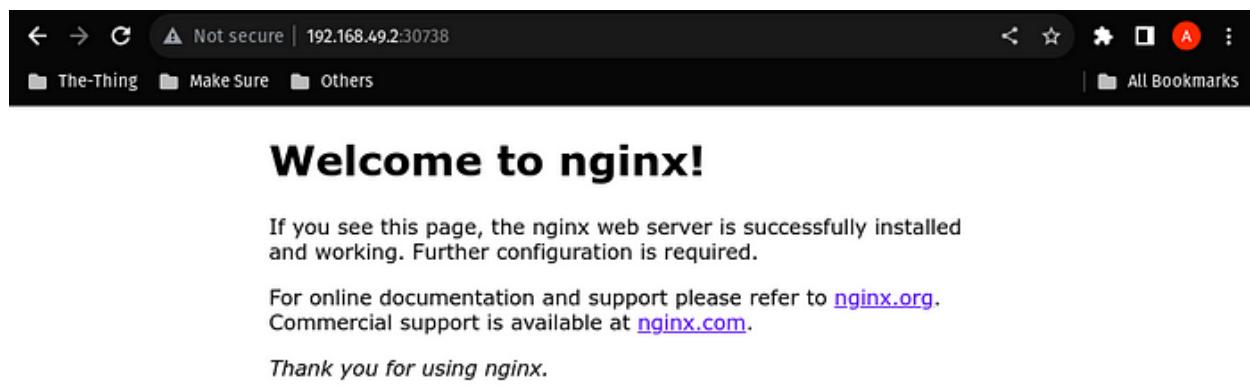
```
kubectl get svc
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ kubectl get svc
NAME      TYPE      CLUSTER-IP    EXTERNAL-IP   PORT(S)      AGE
kubernetes  ClusterIP  10.96.0.1    <none>        443/TCP     42d
thehelloworld  NodePort  10.111.180.153  <none>        80:30738/TCP  16m
amanpathak@pop-os:~/Learning/Kubernetes/Helms$ 
```

Now, access your application via browser by copying the port number(in my case 30738) with minikube private IP in starting.

To get the IP, you can simply run the command on the terminal minikube ip and use it to view the content.

As you can see in the below snippet, our application is successfully deployed with the help of Helm Chart.



If you want to see the minikube dashboard GUI then run the below command on the terminal.

```
minikube dashboard
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ minikube dashboard
🟡 Verifying dashboard health ...
🟡 Launching proxy ...
🟡 Verifying proxy health ...
⚡ Opening http://127.0.0.1:39115/api/v1/namespaces/kubernetes-dashboard/services/http:kubernetes-dashboard:/proxy/ in your default browser...
Opening in existing browser session.
```

Once you run the command, a new tab will open in your browser that will look like the below snippet.

The screenshot shows the Kubernetes Dashboard interface. On the left, a sidebar lists various cluster components: Cron Jobs, Daemon Sets, Deployments, Jobs, Pods, Replica Sets, Replication Controllers, Stateful Sets, Service, Ingresses, Ingress Classes, Services, Config and Storage, Config Maps, Persistent Volume Claims, Secrets, Storage Classes, and Cluster. The main area displays the 'Workloads' section, which includes 'Workload Status' showing three green circles labeled 'Running 1' for Deployments, Pods, and Replica Sets. Below this is a 'Deployments' table with one entry named 'thehelloworld' running on 'nginx:1.16.0'. The final section shown is 'Pods', which also lists the single pod 'thehelloworld' running on node 'minikube'.

Now, if you want to uninstall your deployment. You can simply run the below command.

```
helm uninstall thehelloworld
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm uninstall thehelloworld
release "thehelloworld" uninstalled
amanpathak@pop-os:~/Learning/Kubernetes/Helm$
```

Once you uninstall the deployment you will see nothing on your K8s dashboard because the deployment has been deleted.

This screenshot shows the same Kubernetes Dashboard interface as before, but the 'Workloads' section now displays a message: 'There is nothing to display here. You can deploy a containerized app, select other namespace or take the Dashboard Tour to learn more.' This indicates that the previously deployed 'thehelloworld' application has been successfully uninstalled.

Demo of Helm Cheat Sheets

Create the helm chart

```
helm create helloworld
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm create helloworld
Creating helloworld
amanpathak@pop-os:~/Learning/Kubernetes/Helm$
```

Create the release and deploy the helm chart

```
helm install thehelloworld helloworld
```

```
anapathak@pop-os:~/Learning/Kubernetes/Helm$ helm install thehelloworld helloworld
NAME: thehelloworld
LAST DEPLOYED: Fri Nov 24 19:40:17 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export POD_NAME=$(kubectl get pods --namespace default -l "app.kubernetes.io/name=helloworld,app.kubernetes.io/instance=thehelloworld" -o jsonpath=".items[0].metadata.name")
  export CONTAINER_PORT=$(kubectl get pod --namespace default $POD_NAME -o jsonpath=".spec.containers[0].ports[0].containerPort")
  echo "Visit http://127.0.0.1:$CONTAINER_PORT to use your application"
  kubectl --namespace default port-forward $POD_NAME 8080:$CONTAINER_PORT
anapathak@pop-os:~/Learning/Kubernetes/Helm$
```

Now, if you want 2 replicas instead of 1. So you will make the changes in the values.yaml file and replace the replica 2 with 1. But you have to redeploy the changes which will be done by the below command after doing the changes.

```
helm upgrade thehelloworld helloworld
```

```
anapathak@pop-os:~/Learning/Kubernetes/Helm$ helm upgrade thehelloworld helloworld
Release "thehelloworld" has been upgraded. Happy Helm-ing!
NAME: thehelloworld
LAST DEPLOYED: Fri Nov 24 19:42:31 2023
NAMESPACE: default
STATUS: deployed
REVISION: 2
NOTES:
1. Get the application URL by running these commands:
  export POD_NAME=$(kubectl get pods --namespace default -l "app.kubernetes.io/name=helloworld,app.kubernetes.io/instance=thehelloworld" -o jsonpath=".items[0].metadata.name")
  export CONTAINER_PORT=$(kubectl get pod --namespace default $POD_NAME -o jsonpath=".spec.containers[0].ports[0].containerPort")
  echo "Visit http://127.0.0.1:$CONTAINER_PORT to use your application"
  kubectl --namespace default port-forward $POD_NAME 8080:$CONTAINER_PORT
anapathak@pop-os:~/Learning/Kubernetes/Helm$ helm upgrade thehelloworld helloworld
NAME          READY   STATUS    RESTARTS   AGE
thehelloworld-6944bbb95f-mzht  1/1     Running   0          2m22s
thehelloworld-6944bbb95f-w6hd  1/1     Running   0          7s
anapathak@pop-os:~/Learning/Kubernetes/Helm$
```

Now, you think that you did something wrong or unexpected and you want to switch to the previous deployment. To do that, first of all, you need to know that to which revision number you have to switch.

To check the current revision use the below command.

```
helm list -a
```

```
anapathak@pop-os:~/Learning/Kubernetes/Helm$ helm list -a
NAME      NAMESPACE   REVISION      UPDATED           STATUS      CHART        APP VERSION
thehelloworld  default      2          2023-11-24 19:42:31+0530 IST  deployed  helloworld-0.1.0  1.16.0
anapathak@pop-os:~/Learning/Kubernetes/Helm$
```

Now, I want to switch to the 1 Revision number. So, I will roll back the changes by the below command.

```
helm rollback thehelloworld 1
```

```
anapathak@pop-os:~/Learning/Kubernetes/Helm$ helm rollback thehelloworld 1
Rollback was a success! Happy Helm-ing!
anapathak@pop-os:~/Learning/Kubernetes/Helm$ helm list -a
NAME      NAMESPACE   REVISION      UPDATED           STATUS      CHART        APP VERSION
thehelloworld-6944bbb95f-mzht  1/1     Running   0          7m7s
anapathak@pop-os:~/Learning/Kubernetes/Helm$
```

If you want to dry-run the chart before installation use the below command.

```
helm install thehelloworld — debug — dry-run helloworld
```

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm install thehelloworld --debug --dry-run helloworld
install.go:214: [debug] Original chart version: ""
install.go:231: [debug] CHART PATH: /home/amanpathak/Learning/Kubernetes/Helm/helloworld

NAME: thehelloworld
LAST DEPLOYED: Fri Nov 24 10:56:04 2023
NAMESPACE: default
STATUS: pending-install
REVISION: 1
USER-SUPPLIED VALUES:
{}

COMPUTED VALUES:
affinity: {}
autoscaling:
  enabled: false
  maxReplicas: 100
  minReplicas: 1
  targetCPUUtilizationPercentage: 80
fullnameOverride: ""
image:
  pullPolicy: IfNotPresent
  repository: nginx
  tag: ""
imagePullSecrets: []
ingress:
  annotations: {}
  className: -
  enabled: false
  hosts:
    - host: chart-example.local
      paths:
        - path: /
          pathType: ImplementationSpecific
  tls: []
nameOverride: ""
nodeSelector: {}
podAnnotations: {}
podLabels: {}
podSecurityContext: {}
replicaCount: 2
resources: {}
securityContext: {}
service:
  port: 80
  type: ClusterIP
serviceAccount:
```

If you want to validate your YAML files within the helm chart then, use the below command.

helm template helloworld

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm template helloworld
...
# Source: helloworld/templates/serviceaccount.yaml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: release-name-helloworld
  labels:
    helm.sh/chart: helloworld-0.1.0
    app.kubernetes.io/name: helloworld
    app.kubernetes.io/instance: release-name
    app.kubernetes.io/version: "1.16.0"
    app.kubernetes.io/managed-by: Helm
  automountServiceAccountToken: true
...
# Source: helloworld/templates/service.yaml
apiVersion: v1
kind: Service
metadata:
  name: release-name-helloworld
  labels:
    helm.sh/chart: helloworld-0.1.0
    app.kubernetes.io/name: helloworld
    app.kubernetes.io/instance: release-name
    app.kubernetes.io/version: "1.16.0"
    app.kubernetes.io/managed-by: Helm
spec:
  type: ClusterIP
  ports:
    - port: 80
      targetPort: http
      protocol: TCP
      name: http
  selector:
    app.kubernetes.io/name: helloworld
    app.kubernetes.io/instance: release-name
...
# Source: helloworld/templates/deployment.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: release-name-helloworld
  labels:
    helm.sh/chart: helloworld-0.1.0
    app.kubernetes.io/name: helloworld
    app.kubernetes.io/instance: release-name
    app.kubernetes.io/version: "1.16.0"
```

If you want to validate your Charts then use the below command.

helm lint helloworld

```
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ helm lint helloworld
--> Linting helloworld
[INFO] Chart.yaml: icon is recommended
1 chart(s) linted, 0 chart(s) failed
amanpathak@pop-os:~/Learning/Kubernetes/Helm$ 
```

If you want to delete or release the deployment then, use the below command.

```
helm uninstall thehelloworld
```

```
anupathak@pop-os:~/Learning/Kubernetes/Helm$ helm uninstall thehelloworld
release "thehelloworld" uninstalled
anupathak@pop-os:~/Learning/Kubernetes/Helm$
```

Deploy Flask Application using Helm Chart and many more features

Docker Project of Python Flask Repo-

<https://github.com/AmanPathak-DevOps/Docker-Projects/tree/master/Python-Project-for-Helm-K8s>

Kubernetes Manifest file Repo- <https://github.com/AmanPathak-DevOps/Kubernetes-files>

In the Previous Chapter, we have covered some theory and basic hands-on. But today, we will deep dive and do more hands-on.

The topics that we will cover here:

- ✓ Deploy Python Flask Application using Helm Chart
- ✓ What is Helmfile?
- ✓ Demo of Helmfile(Deploy HelmCharts using declarative method)
- ✓ Test Cases for your Helm Chart

Demonstration

Create a helm chart for the Python application by using the below command

```
helm create helm-deploy-rest-api  
ls -lart Helm-Deploy-Rest-API
```

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helm create helm-deploy-rest-api  
Creating helm-deploy-rest-api  
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ ls -lart helm-deploy-rest-api/  
total 28  
-rw-r--r-- 1 amanpathak amanpathak 2265 Nov 28 15:08 values.yaml  
-rw-r--r-- 1 amanpathak amanpathak 349 Nov 28 15:08 .helmignore  
-rw-r--r-- 1 amanpathak amanpathak 1156 Nov 28 15:08 Chart.yaml  
drwxrwxr-x 5 amanpathak amanpathak 4096 Nov 28 15:08 ..  
drwxr-xr-x 3 amanpathak amanpathak 4096 Nov 28 15:08 templates  
drwxr-xr-x 2 amanpathak amanpathak 4096 Nov 28 15:08 charts  
drwxr-xr-x 4 amanpathak amanpathak 4096 Nov 28 15:08 .  
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$
```

Comment Out the appVersion in the Chart.yaml file

```
vim helm-deploy-rest-api/Chart.yaml
```

```

14
15 # This is the chart version. This version number should be incremented each time you make changes
16 # to the chart and its templates, including the app version.
17 # Versions are expected to follow Semantic Versioning (https://semver.org/)
18 version: 0.1.0
19
20 # This is the version number of the application being deployed. This version number should be
21 # incremented each time you make changes to the application. Versions are not expected to
22 # follow Semantic Versioning. They should reflect the version the application is using.
23 # It is recommended to use it with quotes.
24 #appVersion: "1.16.0"
-
-

```

Replace the image repository with nginx

`vim helm-deploy-rest-api/values.yaml`

```

3 # Declare variables to be passed into your templates.
4
5 replicaCount: 1
6
7 image:
8   repository: avian19/python-flask-application:latest
9   pullPolicy: IfNotPresent
10  # Overrides the image tag whose default is the chart appVersion.
11  tag: ""
12
13 imagePullSecrets: []
14 nameOverride: ""

```

Replace the service type from ClusterIP to NodePort in the same values.yaml file

```

57      "      ALL
38      # readOnlyRootFilesystem: true
39      # runAsNonRoot: true
40      # runAsUser: 1000
41
42 service:
43   type: NodePort
44   port: 80
45
46 ingress:
47   enabled: false
48   className: ""
49   annotations: {}
50     # kubernetes.io/ingress.class: nginx

```

`vim helm-deploy-rest-api/templates/deployment.yaml`

Remove the appversion set and write only the image repository name

```

34       - name: {{ .Chart.Name }}
35         securityContext:
36           {{- toYaml .Values.securityContext | nindent 12 }}
37           image: "{{ .Values.image.repository }}"
38           imagePullPolicy: {{ .Values.image.pullPolicy }}
39         ports:
40           - name: http

```

In the same deployment.yaml file.

Modify the port to 9001 according to our application

```

38      imagePullPolicy: {{ .Values.image.pullPolicy }}
39      ports:
40        - name: http
41          containerPort: 9001
42          protocol: TCP
43      livenessProbe:
44        httpGet:

```

Now in the same deployment.yaml file comment out all the liveness probe and readiness probe function

```

43      #livenessProbe:
44      #httpGet:
45      #path: /
46      # port: http
47      #readinessProbe:
48      # httpGet:
49      #path: /
50      # port: http

```

Now, install your helm chart

```
helm install pythonhelm helm-deploy-rest-api/
```

```

amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helm install pythonhelm helm-deploy-rest-api/
NAME: pythonhelm
LAST DEPLOYED: Tue Nov 28 15:12:59 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export NODE_PORT=$(kubectl get --namespace default -o jsonpath=".spec.ports[0].nodePort" services pythonhelm-helm-deploy-rest-api)
  export NODE_IP=$(kubectl get nodes --namespace default -o jsonpath=".items[0].status.addresses[0].address")
  echo http://$NODE_IP:$NODE_PORT
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 

```

Now, check whether the pod is running or not

```
kubectl get pods
```

```

amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ kubectl get pods
NAME                               READY   STATUS    RESTARTS   AGE
pythonhelm-helm-deploy-rest-api-5fc585d4-c5k8n   1/1     Running   0          53m
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 

```

Check the service to get the port number

```
kubectl get svc
```

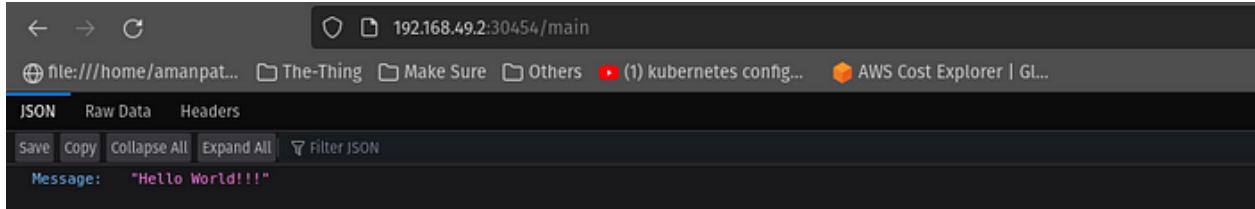
```

amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ kubectl get svc
NAME           TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
kubernetes     ClusterIP  10.96.0.1   <none>       443/TCP   45d
pythonhelm-helm-deploy-rest-api   NodePort   10.98.22.103 <none>       80:30454/TCP 55m
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 

```

Now, get the minikube ip using the minikube ip command and paste it on the browser to get the content of the application

Use the '/main' because this is our path where content is present. Otherwise, you will get errors on different paths.



You can uninstall the release for the helm chart

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helm uninstall pythonhelm
release "pythonhelm" uninstalled
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 
```

Helmfile

Earlier, we used to deploy helm charts in an imperative way. But if you want to deploy helm charts using a declarative way then we will use Helmfile. Helmfile also helps to deploy multiple charts in one go.

Demo of Helmfile

Install the file

```
wget https://github.com/roboll/helmfile/releases/download/v0.144.0/helmfile_linux_amd64
```

Rename the file name to helmfile

```
mv helmfile_linux_amd64 helmfile
```

```
amanpathak@pop-os:~/Downloads$ mv helmfile_linux_amd64 helmfile
```

Change the permissions of the helmfile

```
chmod 777 helmfile
```

```
amanpathak@pop-os:~/Downloads$ chmod 777 helmfile
amanpathak@pop-os:~/Downloads$ 
```

Now, move the helmfile to the bin folder

```
mv helmfile /usr/local/bin
```

```
amanpathak@pop-os:~/Downloads$ sudo mv helmfile /usr/local/bin
```

Validate the version by the command

```
helmfile --version
```

```
amanpathak@pop-os:~/Downloads$ helmfile --version
helmfile version v0.144.0
```

Now, We will try to deploy our previous Python application using helmfile.

```
--
```

```
releases:
- name: pythonpr
  chart: ./helm-deploy-rest-api
  installed: true
```

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ cat helmfile.yaml
---
releases:

- name: pythonpr
  chart: ./helm-deploy-rest-api
  installed: true
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 
```

Once you run the command helmfile sync, your chart will be deployed.

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helmfile sync
Building dependency release=pythonpr, chart=helm-deploy-rest-api
Affected releases are:
  Pythonpr (helm-deploy-rest-api) UPDATED

Upgrading release=pythonpr, chart=helm-deploy-rest-api
Release "pythonpr" does not exist. Installing it now.
NAME: pythonpr
LAST DEPLOYED: Tue Nov 28 17:35:28 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export NODE_PORT=$(kubectl get --namespace default -o jsonpath=".spec.ports[0].nodePort" services pythonpr-helm-deploy-rest-api)
  export NODE_IP=$(kubectl get nodes --namespace default -o jsonpath=".items[0].status.addresses[0].address")
  echo http://$NODE_IP:$NODE_PORT

Listing releases matching ^pythonpr$
pythonpr      default      1          2023-11-28 17:35:28.520188194 +0530 IST deployed      helm-deploy-rest-api-0.1.0

UPDATED RELEASES:
NAME      CHART      VERSION
pythonpr  helm-deploy-rest-api  0.1.0
```

If you want to uninstall the release then, go to the yaml file replace the true with false in the installed line, and run helm sync.

```
---
releases:

- name: pythonpr
  chart: ./helm-deploy-rest-api
  installed: false
~
```

As we run the command to uninstall the deployment the pod is terminating now.

```

amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helmfile sync
Listing releases matching '^pythonpr$'
pythonpr      default          1           2023-11-28 17:35:28.520188194 +0530 IST deployed      helm-deploy-rest-api-0.1.0

Affected releases are:
  pythonpr (. ./helm-deploy-rest-api) DELETED

Deleting pythonpr
release "pythonpr" uninstalled

DELETED RELEASES:
NAME
pythonpr
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ kubectl get pods
NAME                           READY   STATUS    RESTARTS   AGE
pythonpr-helm-deploy-rest-api-7ff6676c86-g9ldt   1/1     Terminating   0   6m23s
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 
```

Helmfile using Git repository

Suppose your charts are present on the Git repository and you want to install them. So, Helm provides you with a feature in which you don't need to clone the repo manually to deploy the chart. Instead of this, you just have to provide the git repository URL in the helmfile and helm will deploy the charts automatically.

Demo

To leverage this feature, you need to install one plugin for it. To install it just copy and paste the below command.

```
helm plugin install https://github.com/aslafy-z/helm-git — version 0.15.1
```

```

amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helm plugin install https://github.com/aslafy-z/helm-git --version 0.15.1
Installed plugin: helm-git
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ 
```

Now, add your repo accordingly in the yaml file

```

---
repositories:
  - name: helm-python
    url: git+https://github.com/AmanPathak-DevOps/Kubernetes-files@Helm?ref=master&sparse=0
releases:
  - name: pythonpr
    chart: ./helm-deploy-rest-api
    installed: false
```

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ cat helmfile.yaml
---
repositories:
  - name: helm-python
    url: git+https://github.com/AmanPathak-DevOps/Kubernetes-files@Helm?ref=master&sparse=0

releases:
  - name: pythonpr
    chart: ./helm-deploy-rest-api
    installed: true
```

Now, run the helmfile using the below command

`helmfile sync`

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ vim helmfile.yaml
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helmfile sync
Adding repo helm-python git+https://github.com/AmanPathak-DevOps/Kubernetes-files@Helm?ref=master&sparse=0
"helm-python" has been added to your repositories

Building dependency release=pythonpr, chart=helm-deploy-rest-api
Affected releases are:
  pythonpr (helm-deploy-rest-api) UPDATED

Upgrading release=pythonpr, chart=helm-deploy-rest-api
Release "pythonpr" does not exist. Installing it now.
NAME: pythonpr
LAST DEPLOYED: Tue Nov 28 17:57:30 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export NODE_PORT=$(kubectl get --namespace default -o jsonpath=".spec.ports[0].nodePort" services pythonpr-helm-deploy-rest-api)
  export NODE_IP=$(kubectl get nodes --namespace default -o jsonpath=".items[0].status.addresses[0].address")
  echo http://$NODE_IP:$NODE_PORT

Listing releases matching ^pythonpr$
pythonpr      default          1           2023-11-28 17:57:30.618835916 +0530 IST deployed      helm-deploy-rest-api-0.1.0

UPDATED RELEASES:
NAME      CHART          VERSION
pythonpr  helm-deploy-rest-api  0.1.0

amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ kubectl get pods
NAME                           READY   STATUS    RESTARTS   AGE
pythonpr-helm-deploy-rest-api-7ff6676c86-74kcs  1/1     Running   0          5s
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$
```

Install multiple charts using helmfile

You just need to add the charts in the previous helmfile below

```
---
repositories:
  - name: helm-python
    url: git+https://github.com/AmanPathak-DevOps/Kubernetes-files@Helm?ref=master&sparse=0
releases:
  - name: pythonpr
    chart: ./helm-deploy-rest-api
    installed: true
  - name: helloworld
    chart: ./helloworld
    installed: true
```

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ cat helmfile.yaml
...
repositories:
  - name: helm-python
    url: git+https://github.com/AmanPathak-DevOps/Kubernetes-files@Helm?ref=master&sparse=0
releases:
  - name: pythonpr
    chart: ./helm-deploy-rest-api
    installed: true
  - name: helloworld
    chart: ./helloworld
    installed: true
```

Now, run the command to install the charts

```
helmfile sync
```

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ helmfile sync
Adding repo helm-python git+https://github.com/AmanPathak-DevOps/Kubernetes-files@Helm?ref=master&sparse=0
"helm-python" has been added to your repositories

Building dependency release=helloworld, chart=helloworld
Building dependency release=pythonpr, chart=helm-deploy-rest-api
Affected releases are:
  helloworld [helloworld] UPDATED
  pythonpr (helm-deploy-rest-api) UPDATED

Upgrading release=helloworld, chart=helloworld
Upgrading release=pythonpr, chart=helm-deploy-rest-api
Release "pythonpr" does not exist. Installing it now.
NAME: pythonpr
LAST DEPLOYED: Tue Nov 28 10:35:10 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export NODE_PORT=$(kubectl get --namespace default -o jsonpath=".spec.ports[0].nodePort" services pythonpr-helm-deploy-rest-api)
  export NODE_IP=$(kubectl get nodes --namespace default -o jsonpath=".items[0].status.addresses[0].address")
  echo http://$NODE_IP:$NODE_PORT

Listing releases matching "pythonpr"
Release "helloworld" does not exist. Installing it now.
NAME: helloworld
LAST DEPLOYED: Tue Nov 28 10:35:10 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
1. Get the application URL by running these commands:
  export POD_NAME=$(kubectl get pods --namespace default -l "app.kubernetes.io/name=helloworld,app.kubernetes.io/instance=helloworld" -o jsonpath=".items[0].metadata.name")
  export CONTAINER_PORT=$(kubectl get pods --namespace default $POD_NAME -o jsonpath=".spec.containers[0].ports[0].containerPort")
  echo "Visit http://127.0.0.1:$CONTAINER_PORT to use your application"
  kubectl -n default port-forward $POD_NAME 8080:$CONTAINER_PORT

Listing releases matching "helloworld"
pythonpr      default      1          2023-11-28 10:35:10.002815238 +0530 IST deployed      helm-deploy-rest-api-0.1.0
helloworld     default      1          2023-11-28 10:35:10.002156284 +0530 IST deployed      helloworld-0.1.0      1.10.0

UPDATED RELEASES:
NAME        CHART      VERSION
pythonpr    helm-deploy-rest-api  0.1.0
helloworld  helloworld   0.1.0
```

Test your helm chart

Once I deploy the chart, I want to test the chart whether it's working or not.

So, you can define your test cases in the test-connection.yaml file which is presented in the tests folder of the chart itself.

```
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$ tree helm-deploy-rest-api/
helm-deploy-rest-api/
├── charts
│   └── Chart.yaml
├── templates
│   ├── deployment.yaml
│   ├── helpers.tpl
│   ├── hpa.yaml
│   ├── instance.yaml
│   ├── NOTES.txt
│   ├── serviceaccount.yaml
│   ├── service.yaml
│   └── tests
│       └── test-connection.yaml
└── values.yaml

3 directories, 10 files
amanpathak@pop-os:~/Github/Kubernetes-files/Helm$
```

As we have deployed our charts in the previous demo. So, we will test those charts.

To test the particular chart use the below command.

```
helm test <chart>
```

As you can see in the below snippet. Our helloworld chart test is succeeded.

```
anupathak@pop-os:~/Github/Kubernetes-files/Helm$ helm list -o yaml
NAME           NAMESPACE   REVISION  UPDATED             STATUS      CHART          APP VERSION
helloworld     default     1         2023-11-28 10:35:10.002156204 +0530 IST  deployed  hello-world-0.1.0  1.16.0
pythonhelmchart default     1         2023-11-28 10:07:59.11417765 +0530 IST  failed    Helm-Delay-Rest-API-0.1.0
pythonpr        default     1         2023-11-28 10:35:10.002815238 +0530 IST  deployed  helm-deploy-rest-api-0.1.0
anupathak@pop-os:~/Github/Kubernetes-files/Helm$ helm test helloworld
NAME: helloworld
LAST DEPLOYED: Tue Nov 28 10:35:10 2023
NAMESPACE: default
STATUS: deployed
REVISION: 1
TEST SUITE: helloworld-test-connection
Last Started: Tue Nov 28 10:42:27 2023
Last Completed: Tue Nov 28 10:42:32 2023
PASSED: 1
SKIPPED: 0
Succeeded
NOTES:
1. Get the application URL by running these commands:
  export POD_NAME=$(kubectl get pods --namespace default -l "app.kubernetes.io/name=helloworld,app.kubernetes.io/instance=helloworld" -o jsonpath="{.items[0].metadata.name}")
  export CONTAINER_PORT=$(kubectl get pod --namespace default $POD_NAME -o jsonpath='{.spec.containers[0].ports[0].containerPort}')
  echo "Visit http://127.0.0.1:$CONTAINER_PORT to use your application"
  kubectl -n default port-forward $POD_NAME 8080:$CONTAINER_PORT
anupathak@pop-os:~/Github/Kubernetes-files/Helm$ []
```

AWS Elastic Kubernetes Service(EKS)

What is AWS EKS?

AWS EKS(Elastic Kubernetes Service) is a managed service that eliminates things like installation of the Kubernetes and maintaining the Kubernetes cluster.

Some basic benefits like you can focus on deployment for the applications. You don't need to think about the availability of your cluster, AWS will take care of those things.

Key features of EKS:

- **Manage Control Plane:** In EKS, the Control Plane will be managed by AWS itself.
- **Configure Node Groups:** In EKS, You can add multiple Worker Nodes according to the requirements in no time.
- **Cluster Scaling:** AWS will take care of the Cluster scaling according to your requirements whether it's upscaling or downscaling.
- **High Availability:** AWS provides high availability of your Kubernetes cluster.
- **Security:** AWS enhances the security by integrating IAM service with EKS.
- **Networking:** AWS provides better control to manage the networking stuff for your Kubernetes cluster.

If you want to read more features in a detailed way refer to the following link:

[Managed Kubernetes Service - Amazon EKS Features](#)

AWS EKS Costing

AWS will cost you 0.10\$ per hour for each cluster. If you create EC2 for Node Groups then it will cost you separately according to the instance type and the same with ECS Fargate(depends on vCPU and memory resources).

Let's Dive into the Demo!

To create EKS, we need to configure VPC and other networking things. If you are not a beginner in the cloud feel free to skip the network configuration part. But if you are new to EKS or the AWS Cloud, I would say to follow each step. So, it will help you to get a better understanding of each service that is related to AWS EKS.

Create VPC and select the desired IPv4 CIDR.

VPC > [Create VPC](#) > Create VPC

Create VPC [Info](#)

A VPC is an isolated portion of the AWS Cloud populated by AWS objects, such as Amazon EC2 instances.

VPC settings

Resources to create [Info](#)
Create only the VPC resource or the VPC and other networking resources.

VPC only **VPC and more**

Name tag [Info](#)
Create a tag with a key of 'Name' and a value that you specify.

EKS-VPC

IPv4 CIDR block [Info](#)
 IPv4 CIDR manual input IPv4 allocated IPv4 CIDR block
IPv4 CIDR
10.0.0.0/16
CIDR block size must be between /16 and /24

IPv4 CIDR block [Info](#)
 No IPv4 CIDR block IAM-allocated IPv4 CIDR block Amazon-assigned IPv4 CIDR block IPv4 CIDR owned by me

Tenancy [Info](#)
Default

Tags
A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

Key	Value - optional
<input type="text"/> Name	<input type="text"/> EKS-VPC

[Add tag](#)
You can add up to 49 more tags.

[Cancel](#) [Create VPC](#)

We need to create at least two Public Subnets to ensure high availability.

Public-Subnet1

VPC > [Subnets](#) > Create subnet

Create subnet [Info](#)

VPC

VPC ID
Create subnets in this VPC.
 vpc-0f7e11088512461c (EKS-VPC)

Associated VPC CIDRs
IPv4 CIDRs
10.0.0.0/16

Subnet settings
Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 2

Subnet name
Create a tag with a key of 'Name' and a value that you specify.
 Public-Subnet1
The name can be up to 256 characters long.

Availability Zone [Info](#)
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
 US East (Ohio) us-east-1a

IPv4 VPC CIDR block [Info](#)
Choose the IPv4 VPC CIDR block to create a subnet as.
 10.0.0.0/16

IPv4 subnet CIDR block
10.0.0.0/24
256 IPs

Tags - optional

Key	Value - optional
<input type="text"/> Name	<input type="text"/> Public-Subnet1

[Add new tag](#)
You can add up to 49 more tags.

[Remove](#)

Public Subnet2

Choose the IPv4 CIDR block to create a subnet in:
16.0.0.0/16

IPv4 subnet CIDR block
16.0.0.0/16 (256.0.0.0)

Tags - optional

Key Value - optional
Name PublicSubnet1 Remove

Add new tag
You can add 49 more tags.
Remove

Subnet 2 of 2

Subnet name
Create a tag with a key of Name and a value that you specify.
PublicSubnet2

The name can be up to 255 characters long.

Availability Zone info
Choose the zone in which your subnet will reside or let Amazon choose one for you.
US East (N. Virginia) us-east-1b

IPv4 CIDR block
Choose the IPv4 CIDR block to create a subnet in:
16.0.1.0/16

IPv4 subnet CIDR block
16.0.1.0/16 (256.0.0.0)

Tags - optional

Key Value - optional
Name PublicSubnet2 Remove

Add new tag
You can add 49 more tags.
Remove

Add new subnet

CANCEL Create subnet

We need an internet connection for our clusters and worker nodes. To do that, create an Internet Gateway.

VPC > Internet gateways > Create internet gateway

Create internet gateway [Info](#)

An internet gateway is a virtual router that connects a VPC to the internet. To create a new internet gateway specify the name for the gateway below.

Internet gateway settings

Name tag
Create a tag with a key of Name and a value that you specify.
eks-ig

Tags - optional
A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

Key Value - optional
Name eks-ig Remove

Add new tag
You can add 49 more tags.

CANCEL Create internet gateway

Now, attach the above Internet Gateway to the VPC that we created in the earlier step.

Name	Internet gateway ID	Status	VPC ID	Owner
eks-ig	igw-00cbd16fb4b26b70c	Attached	vpc-0452119f91a76c25	AWS
eks-ig	igw-047e152330c9ebd5	Detached	vpc-0452119f91a76c25	AWS

VPC > Internet gateways > Attach to VPC (igw-00cbd16fb4b26b70c) [Info](#)

Attach to VPC (igw-00cbd16fb4b26b70c)

VPC
Attach an internet gateway to a VPC to enable the VPC to communicate with the internet. Specify the VPC to attach below.

Available VPCs
Attach the internet gateway to this VPC.
vpc-0452119f91a76c25

aws Command Line Interface command

CANCEL Attach internet gateway

We need to create a route table as well for the internet access for each subnet.

Public Route table

Select the Internet Gateway in the Target.

Once you add routes, then you have to add subnets for which purpose we are creating a Public Route table.

Click on Edit subnet associations.

Select both subnets and click on Save associations.

The screenshot shows the 'Edit subnet associations' page for a specific route table. It lists 'Available subnets' (2/2) and 'Selected subnets' (1/2). The selected subnet is 'subnet-005f3aae54051621 / Public Subnet1'. A table displays subnet details: Name, Subnet ID, IPv4 CIDR, and Route table ID. The table shows two subnets: 'Public Subnet2' and 'Public Subnet1'. The 'Route table ID' column shows 'rtb-005f3aae54051621' for both.

Once you associate the subnets. You will see your subnets look like the below snippets.

The screenshot shows the 'Details' page for the route table 'rtb-005f3aae54051621 / Public-RT'. The 'Explicit subnet associations' section shows two subnets: 'Public Subnet2' and 'Public Subnet1'. The 'Subnets without explicit associations' section is empty, indicating all subnets are now associated with the route table.

Now, the EKS Cluster needs some access to the AWS Services like ec2, kms, and load balancer.

To do that, we will create an IAM Role and Policy for the EKS Cluster

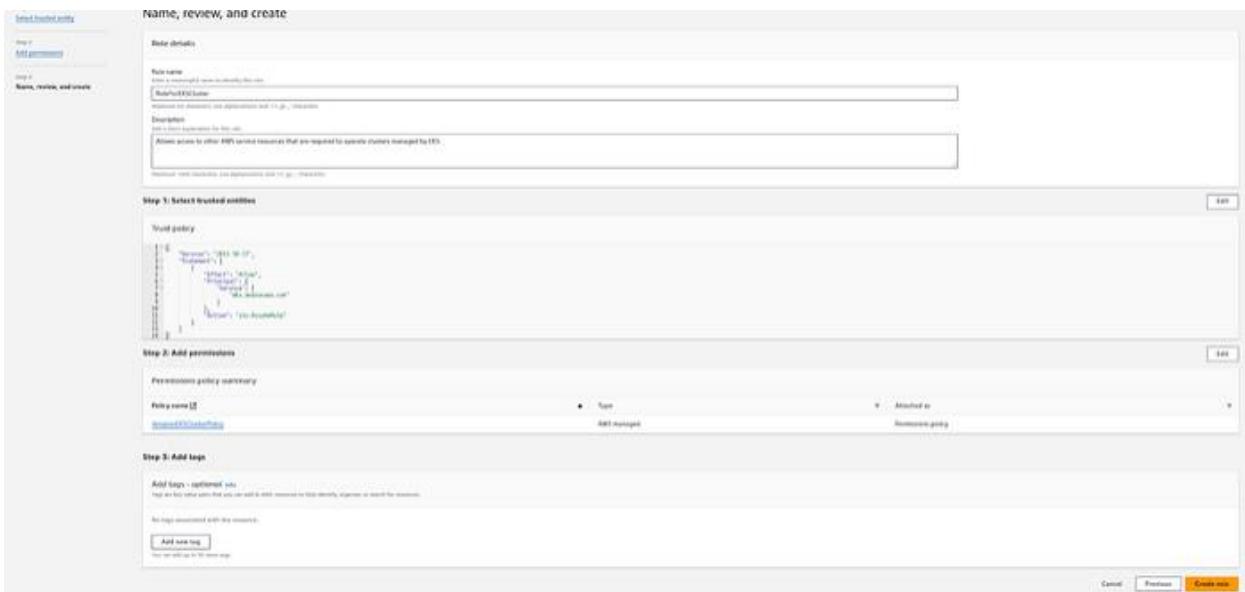
Click on AWS service as a Trusted entity type and select the EKS as Usecase and in the below options, choose EKS-Cluster.

The screenshot shows the 'Select trusted entity' step of the IAM role creation wizard. It lists four options: 'AWS Service' (selected), 'AWS account', 'SAML 2.0 Federation', and 'Custom trust policy'. Below this, it shows the 'Use case' section for 'EKS' and the 'Service or use case' dropdown set to 'EKS'.

Click on Next.

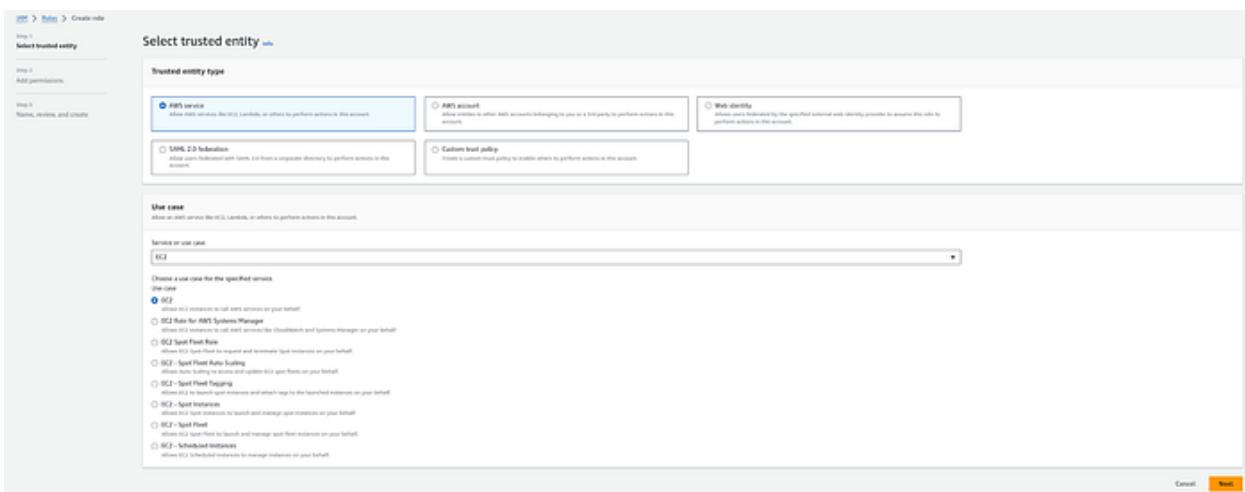


Provide the Role name



Once we created the roles for the EKS Cluster. Now, we have to create a role for the Worker Nodes which is also a necessary part.

Click on AWS service as a Trusted entity type and select the EC2 as Usecase and in the below options, choose EC2.



When you will get a popup to add the Policy for the Worker Nodes.

Select the below three policies for our Worker Nodes.

AmazonEC2ContainerRegistryReadOnly, AmazonEKS_CNI_Policy, and AmazonEKSWorkerNodePolicy

Permissions policy summary			
Policy name	Type	Attached as	
AmazonEC2ContainerRegistryReadOnly	AWS managed	Permissions policy	
AmazonEKS_CNI_Policy	AWS managed	Permissions policy	
AmazonEKSWorkerNodePolicy	AWS managed	Permissions policy	

Provide the name of the Role and click on next.

The screenshot shows the 'Create role' wizard in the AWS IAM console. It consists of three main steps:

- Step 1: Select trusted entities**: Shows a list of accounts under 'Trusted entities'. One account, 'Myself's "AWS Lambda"', is selected. Other accounts listed include 'Amazon EKS' and 'Amazon ECR'.
- Step 2: Add permissions**: Shows the 'Permissions policy summary' table with three policies selected:
 - AmazonEC2ContainerRegistryReadOnly
 - AmazonEKS_CNI_Policy
 - AmazonEKSWorkerNodePolicy
- Step 3: Add tags**: A section for adding key-value pairs to identify resources.

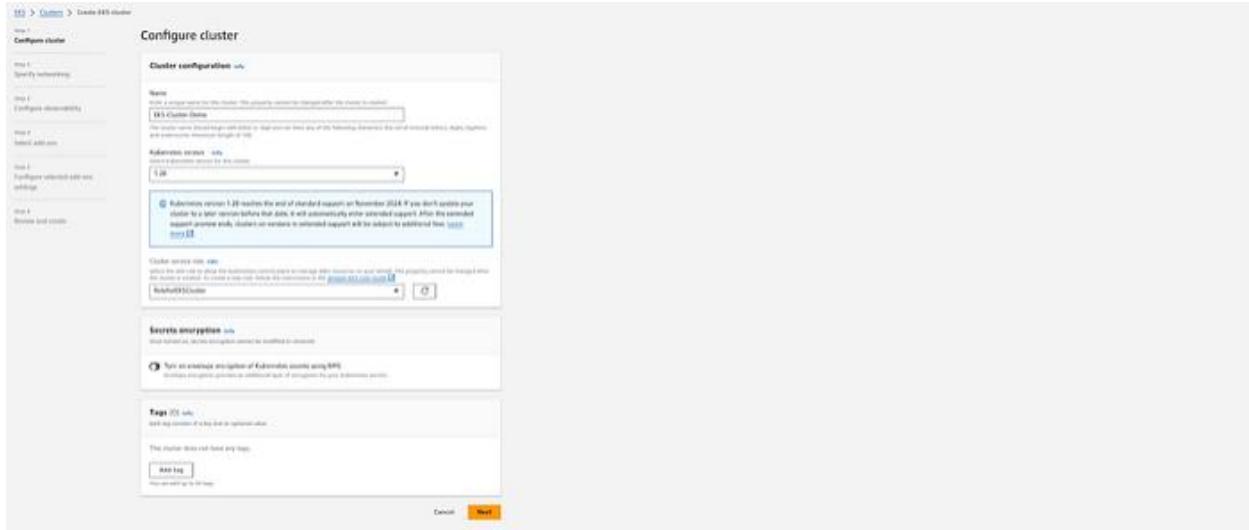
Now, Prerequisites are completed. Let's create the EKS

Navigate to the AWS EKS and click on Add cluster.

Select Create.

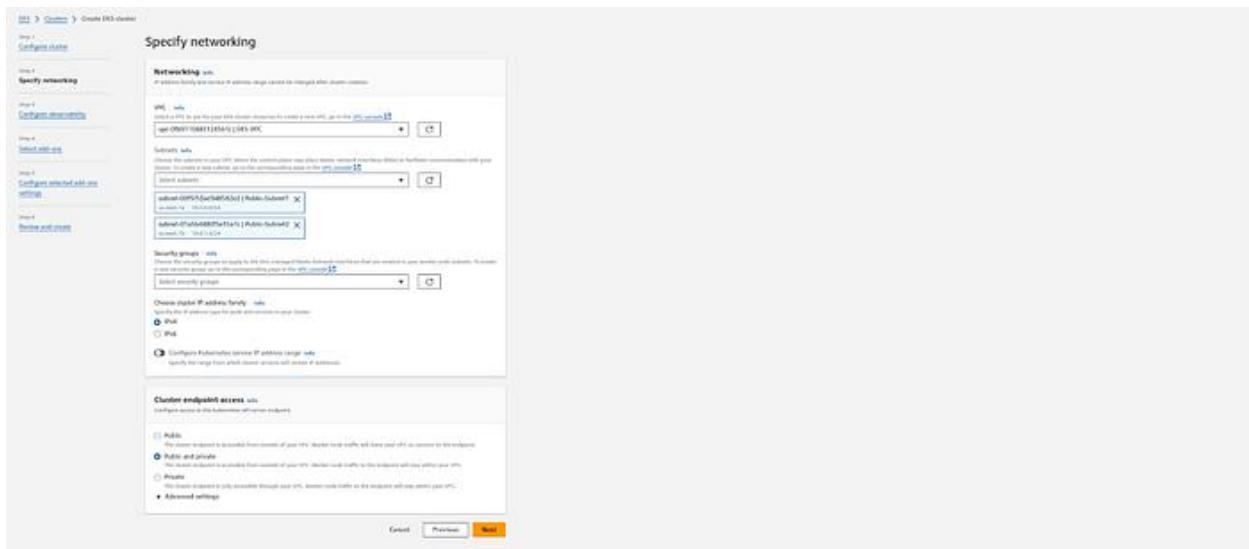
The screenshot shows the 'Clusters' page in the AWS EKS console. At the top right, there is a prominent 'Add cluster' button with a dropdown menu containing 'Create' and 'Register' options.

Provide the name of your EKS Cluster then select the Cluster role that we have created for EKS Cluster and rest of the things will be as they are and click on Next.

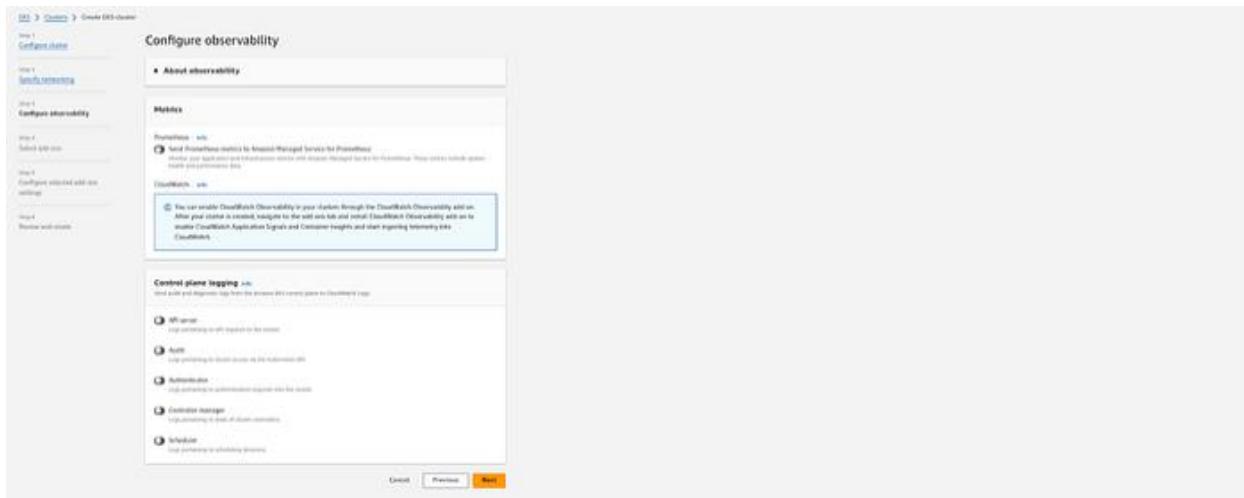


In the network configuration,

Select the vpc that we created earlier with both subnets. Apart from that, others will be as it is, and click on Next.



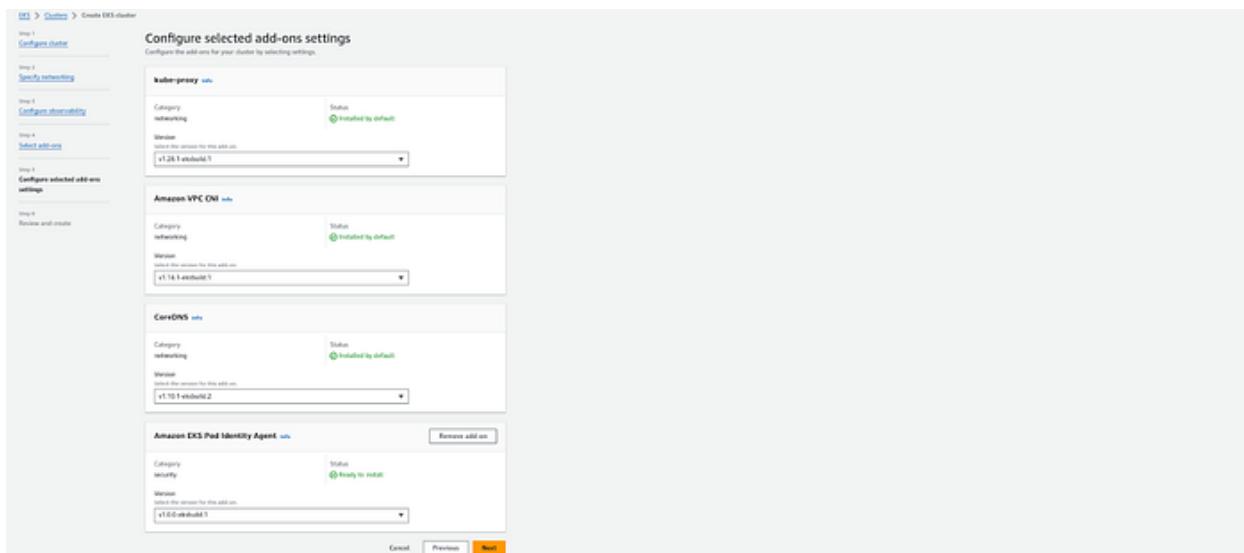
Keep the default things as it is and click on Next.



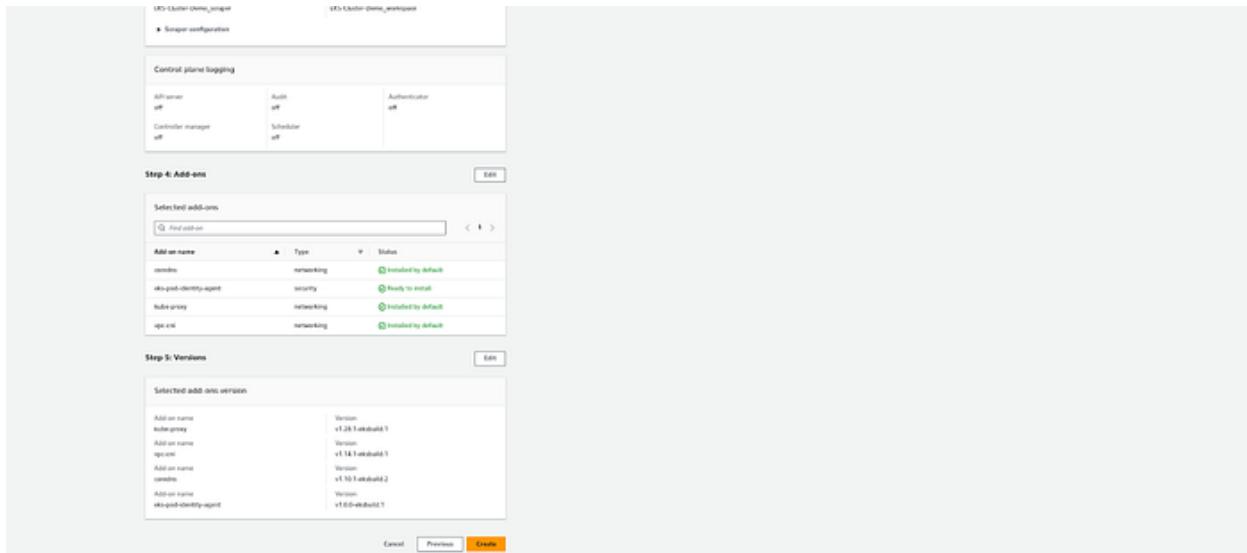
Keep the default things as it is and click on Next.



Keep the default things as it is and click on Next.



Keep the default things as it is and click on Create.



After clicking on Create, AWS will take around 4 to 5 minutes to create the EKS. Meanwhile, let's install Kubectl to work on AWS EKS.

```
curl -O
https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl
```

```
sha256sum -c kubectl.sha256
```

```
openssl sha1 -sha256 kubectl
```

```
chmod +x ./kubectl
mkdir -p $HOME/bin && cp ./kubectl $HOME/bin/kubectl && export
PATH=$HOME/bin:$PATH
echo 'export PATH=$HOME/bin:$PATH' >> ~/.bashrc
```

```
kubectl version --client
```

```
anupathak@pop-os:~$ kubectl version --client
Client Version: v1.28.3-eks-e71965b
Kustomize Version: v5.0.4-0-20230601165947-6ce0bf390ce3
anupathak@pop-os:~$
```

Install eksctl on the local machine (Optional)

```

ARCH=amd64
PLATFORM=$(uname -s)_$ARCH
curl -sLO [REDACTED]
"https://github.com/eksctl-io/eksctl/releases/latest/download/eksctl_${PLATFORM}.tar.gz"
-sL "https://github.com/eksctl-io/eksctl/releases/latest/download/eksctl_checksums.txt" | grep
$PLATFORM | sha256sum - check [REDACTED]
tar -xzf eksctl_${PLATFORM}.tar.gz -C /tmp && rm eksctl_${PLATFORM}.tar.gz
sudo mv /tmp/eksctl /usr/local/bin

```

```

ubuntu@ip-172-31-82-215:~$ ARCH=amd64
PLATFORM=$(uname -s)_$ARCH
curl -sLO "https://github.com/eksctl-io/eksctl/releases/latest/download/eksctl_${PLATFORM}.tar.gz"
curl -sL "https://github.com/eksctl-io/eksctl/releases/latest/download/eksctl_checksums.txt" | grep $PLATFORM | sha256sum --check
tar -xzf eksctl_${PLATFORM}.tar.gz -C /tmp && rm eksctl_${PLATFORM}.tar.gz
sudo mv /tmp/eksctl /usr/local/bin
eksctl_Linux_amd64.tar.gz: OK
ubuntu@ip-172-31-82-215:~$ eksctl version
0.165.0
ubuntu@ip-172-31-82-215:~$ [REDACTED]

```

Now, check the status of EKS whether it is Active or Not.

Clusters (1) <small>Info</small>		<small>C</small> <small>Delete</small> <small>Add cluster</small> ▾	
Cluster name	Status	Kubernetes version	Provider
EKS-Cluster-Demo	<small>Active</small>	1.26	EKS

Once the status of EKS is Active, run the below command.

```
aws eks update-kubeconfig — region us-east-1 — name EKS-Cluster-Demo
```

If you are getting the error which is showing below in the snippet. Then, don't worry. Let's solve it in the next step.

```

ubuntu@ip-172-31-82-215:~$ aws eks update-kubeconfig --region us-east-1 --name EKS-Cluster-Demo
Added new context arn:aws:eks:us-east-1:407622020962:cluster/EKS-Cluster-Demo to /home/ubuntu/.kube/config
ubuntu@ip-172-31-82-215:~$ 
ubuntu@ip-172-31-82-215:~$ kubectl get nodes
error: exec plugin: invalid apiVersion "client.authentication.k8s.io/v1alpha1"
ubuntu@ip-172-31-82-215:~$ [REDACTED]

```

Replace the 'alpha' with 'beta' like below snippet

```

15 users.
16 - name: arn:aws:eks:us-east-1:407622020962:cluster/EKS-Cluster-Demo
17   user:
18     exec:
19       apiVersion: client.authentication.k8s.io/v1beta1
20       args:
21         - --region
22         .

```

Now, run the command again to update the config

```
aws eks update-kubeconfig — region us-east-1 — name EKS-Cluster-Demo
```

```

amanpathak@pop-os:~$ aws eks update-kubeconfig --region us-east-1 --name EKS-Cluster-Demo
Added new context arn:aws:eks:us-east-1:407622020962:cluster/EKS-Cluster-Demo to /home/amanpathak/.kube/config
amanpathak@pop-os:~$ [REDACTED]

```

It's working

```

amanpathak@pop-os:~$ kubectl get nodes
No resources found
amanpathak@pop-os:~$ [REDACTED]

```

Trying to deploy the pod but it is in pending status because there is no worker node present where the pod can be created.

```
anapathak@pop-os:~$ kubectl create deployment nginx --image=nginx
deployment.apps/nginx created
anapathak@pop-os:~$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-7854ff8877-clhrd  0/1   Pending   0          10s
anapathak@pop-os:~$ kubectl get pods
NAME          READY   STATUS    RESTARTS   AGE
nginx-7854ff8877-clhrd  0/1   Pending   0          52s
anapathak@pop-os:~$
```

To create a worker node, Select the EKS Cluster and navigate to the Compute section.

Click on Add node group.

The screenshot shows the AWS EKS Cluster-Demo interface under the Compute tab. The Nodes tab is active, displaying a message: "No Nodes. This cluster does not have any Nodes, or you don't have permission to view them." The Node groups tab is also visible, showing a message: "No node groups. This cluster does not have any node groups. Nodes that are not part of an Amazon EKS managed node group are not shown in the AWS console." There are buttons for Edit, Delete, and Add node group.

Provide the name of your worker node and select the Worker Node role that we created earlier.

The screenshot shows the Node group configuration dialog box. It includes fields for Name (WorkerNode1), Node IAM role (EC2RoleForEKSNodes), and a note: "The selected role must not be used by a self-managed node group as this could lead to a service interruption upon managed node group deletion." A "Learn more" link is also present.

You can modify things according to your requirements. But the instance type t3.medium will be good because Kubernetes needs at least 2CPU.

Select the Subnets of the VPC that we have created above and click on Next.

Once the node is in Active status. Then, you can follow the next step.

Run the below command and you will see that our pending pod is now in running state.

kubectl get pods

```
amanpathak@pop-os:~$ kubectl get pods
NAME                  READY   STATUS    RESTARTS   AGE
nginx-7854ff8877-clhrd   1/1     Running   0          8m53s
amanpathak@pop-os:~$ 
```

Now, delete the previous, and let's try to run the static application on the nginx server with the AWS load balancer

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-app-deployment
  labels:
    app: nginx-app
spec:
  replicas: 2
  selector:
    matchLabels:
      app: nginx-app
  template:
    metadata:
      labels:
        app: nginx-app
    spec:
      containers:
        - name: nginx-container
          image: avian19/nginx-ne:latest-1.0
          ports:
            - containerPort: 80
```

`kubectl apply -f deployment.yml`

```
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$ kubectl apply -f deployment.yml
deployment.apps/nginx-app-deployment created
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$ kubectl get pods
NAME                  READY   STATUS    RESTARTS   AGE
nginx-app-deployment-d955457d5-cs4cq   1/1     Running   0          76s
nginx-app-deployment-d955457d5-jnfpd   1/1     Running   0          76s
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$ 
```

Now, host the application outside of the Kubernetes Cluster by creating a service for the nginx application and observing the load balancer dns in the EXTERNAL-IP Column.

```
apiVersion: v1
kind: Service
metadata:
  name: nginx
spec:
  selector:
    app: nginx-app
  type: LoadBalancer
  ports:
```

```
- protocol: TCP  
port: 80
```

```
kubectl apply -f svc.yaml
```

```
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$ kubectl apply -f svc.yaml  
service/nginx created  
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$ kubectl get svc  
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP  
kubernetes   ClusterIP    172.20.0.1     <none>  
nginx     LoadBalancer  172.20.22.247  a2c1c683f2b54c679e9db9c2c89994a-1570132248.us-east-1.elb.amazonaws.com  
amanpathak@pop-os:~/Github/Kubernetes-files/AWS-EKS$
```

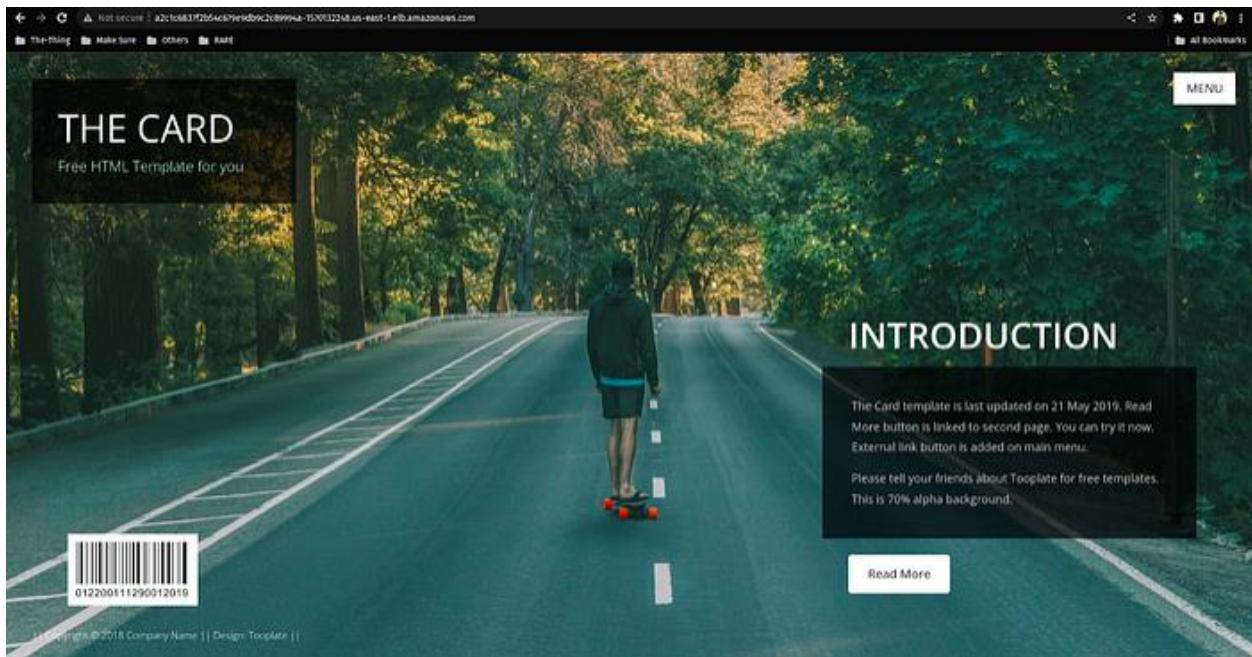
Now, navigate to AWS Console and go to the Load Balancer section.



The screenshot shows the AWS Load Balancers console. At the top, there is a header with the AWS logo and the text "Load balancers (1)". Below the header, there is a search bar labeled "Filter load balancers". A table lists one load balancer entry:

Name	DNS name	State	VPC ID	Availability Zones	Type	Date created
a2c1c683f2b54c679e9db9c2c89994a	a2c1c683f2b54c679e9db9c2c89994a-1570132248.us-east-1.elb.amazonaws.com	Active	vpc-0f001108833245...	2 Availability Zones	classic	December 5, 2023, 14:54 (JST+05:30)

Copy the Load balancer DNS then, hit on the browser and see the magic.



Azure Kubernetes Service(AKS)

What is AKS?

AKS is a managed Kubernetes Service that helps us to deploy our applications without worrying about Control Plane and other things like regular updates support, Scaling, and high availability of your cluster.

Key Features:

- **Managed Control Plane:** AKS provides a fully managed control plane. So that, you don't need to configure things like the upgradation of Kubernetes cluster, patching, and monitoring. This will help us to focus on main things like deployment of the application.
- **Scalability:** AKS provides the scalability feature in which we can scale our worker nodes according to our application traffic which will help us to achieve high availability. AKS also enables the scale-up option for the AKS Clusters.
- **Windows container support:** You can run Linux containers on the AKS, But you can run Windows containers as well which will help developers to work on Windows base applications on the Kubernetes cluster.
- **Networking Configurations:** To create AKS, networking is required. So, you can configure the networking part according to your requirements which helps you to provide fine-grained control on the Cluster networking configurations.
- **Integration with other services:** You can integrate AKS with multiple Azure services like Azure AD, Azure Policy, Azure Monitor, etc to provide solutions within the cloud for container management.
- **Multi-worker nodes:** AKS can create multiple node pools according to the application's requirements.

If you want to read more features in a detailed way refer to the below link:

<https://spot.io/resources/azure-kubernetes-service/>

Azure AKS Costing

- If you are new to AKS and want to explore the AKS service then, AKS comes under a free tier account. But the resources like computing, networking, and storage will have a cost. So use wisely. Remember, you can't autoscale the clusters or nodes under the free tier.
- Now, If you want to use AKS in your Organization It will cost you 0.10\$ per cluster per hour similar to AWS EKS Cost but the AKS cluster will be in the Standard tier. You can auto-scale your clusters and worker nodes in the Standard tier.
- There is one more tier which Premium and that will cost you 0.60\$ per cluster per hour with advanced features. You can auto-scale your clusters and worker nodes in the Standard tier.

Let's Dive into the Demo!

To create AKS, we need to configure VNet and other networking things. If you are not a beginner in the cloud feel free to skip the network configuration part. But if you are new to AKS or in the Azure Cloud, I would say to follow each step. So, it will help you to get a better understanding of each service that is related to Azure AKS.

First of all, create a separate Resource Group by clicking on Create new.

The screenshot shows the 'Create virtual network' wizard on the 'Basics' tab. In the 'Project details' section, under 'Subscription', 'Azure for Students' is selected. Under 'Resource group', a dropdown menu shows 'Cloud shell storage centrinida' and a 'Create new' option. A modal dialog box is open over the main form, titled 'Create new resource group'. It contains a 'Name' input field with 'Kits Demo' typed into it. At the bottom of the dialog are 'OK' and 'Cancel' buttons. Below the main form, there are 'Previous', 'Next', and 'Review + create' buttons, with 'Review + create' being highlighted in blue.

Provide the name of your Virtual Network and click on Next.

The screenshot shows the 'Create virtual network' wizard on the 'Basics' tab. In the 'Project details' section, under 'Subscription', 'Azure for Students' is selected. Under 'Resource group', '(New) Kits-Demo' is selected from a dropdown. In the 'Instance details' section, the 'Virtual network name' is set to 'Kits-VNet' and the 'Region' is set to '(US) East US'. A note at the bottom says 'Deploy to an edge zone'. Below the main form, there are 'Previous', 'Next', and 'Review + create' buttons, with 'Review + create' being highlighted in blue.

Now, we have to create two public subnets for the high availability of our Azure Kubernetes.

Delete the default subnet and click on Add a subnet then add two subnets with your desired IP address range and click on Next.

Configure your virtual network address space with one or more IPv4 or IPv6 address ranges. Create subnets to segment the virtual network address space into smaller ranges for use by your applications. When you deploy resources into a subnet, Azure assigns the resources an IP address from the subnet. [Learn more](#)

Add IPv4 address space

Subnets	IP address range	Size	NAT gateway
Public Subnet	10.0.1.0 - 10.0.1.255	/24 (256 addresses)	-
Public Subnet	10.0.2.0 - 10.0.2.255	/24 (256 addresses)	-

A NAT gateway is recommended for outbound internet access from subnets. Edit the subnet to add a NAT gateway. [Learn more](#)

Previous Next Review + create Give feedback

Click on Review + create to validate the error in the configurations. If there is no error feel free to click on Create.

View automation template

Basics

Subscription: Azure for Students
Resource Group: K8s-VNet
Name: K8s-VNet
Region: East US

Security

Azure Bastion: Disabled
Azure Firewall: Disabled
Azure DDoS Network Protection: Disabled

IP addresses

Address space: 10.0.0.0/16 (65,536 addresses)
Subnet: Public Subnet1 (10.0.1.0/24) (256 addresses)
Subnet: Public Subnet2 (10.0.2.0/24) (256 addresses)

Tags

Name: K8s-VNet
Name: K8s-VNet
Name: K8s-VNet
Name: K8s-VNet
Name: K8s-VNet

Previous Next Create Give feedback

Once your deployment is done, in the search field enter Kubernetes services and click on the first one.

K8s-VNet | Overview

Your deployment is complete.

Deployment name: K8s-VNet
Subscription: Azure for Students
Resource group: K8s-Demo

Deployment details:

- Inputs
- Outputs
- Template

Next steps:

- Go to resource

Services

- Kubernetes services
- Kubernetes fleet manager
- Kubernetes - Azure Arc
- App Services (preview)
- Container Instances
- Container App

Marketplace

- Azure Hadoop on AKS cluster pools (preview)
- Azure HDInsight on AKS clusters (preview)
- Azure Red Hat OpenShift clusters
- Container Apps
- Kubernetes

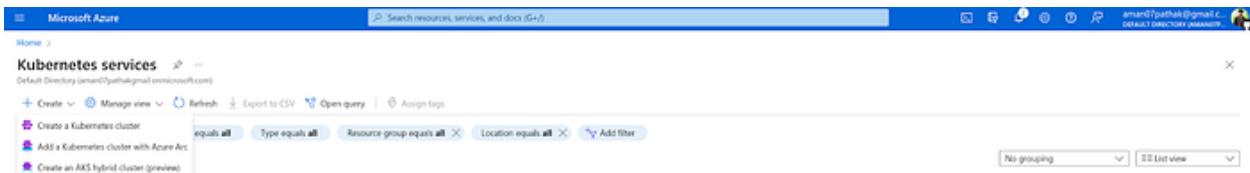
Cost management

Get notified to stay within your budget and prevent unexpected charges on your bill.
[Set up cost alerts >](#)

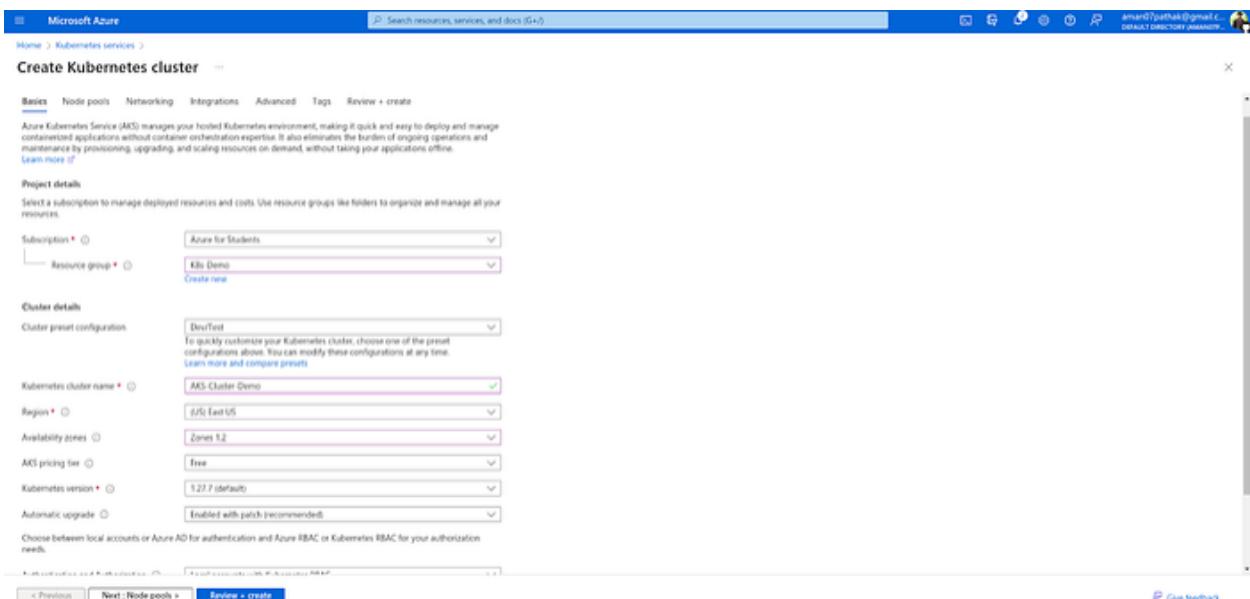
Microsoft Defender for Cloud

Secure your apps and infrastructure

Click on Create and select Create a Kubernetes cluster.



Select the Same Resource Group that we have created while creating the Virtual Network. After that, provide the name to your AKS keep the things same as shown in the below snippet, and click on Node Pools.



In the Node pools section, we have to add Worker Node. Remember one thing the default node(agentpool) is a system node. So you don't have to do anything with that node.

Click on Add node pool

Create Kubernetes cluster

Node pools

In addition to the required primary node pool configured on the Basics tab, you can also add optional node pools to handle a variety of workloads. [Learn more about node pools](#)

Name	Mode	Node size	OS SKU	Node count
agentpool	System	Standard_DS2_v2 (change)	Ubuntu	2 - 5

Enable virtual nodes

Virtual nodes allow instant scaling backed by serverless Azure Container Instances. [Learn more about virtual nodes](#)

Node pool OS disk encryption

By default, disks in AKS are encrypted at rest with Microsoft-managed keys. For additional control over encryption, you can supply your own keys using a disk encryption set backed by an Azure Key Vault. The disk encryption set will be used to encrypt the OS disks for all node pools in the cluster. [Learn more](#)

Encryption type: (Default) Encryption at rest with a platform-managed key

[Previous](#) [Next : Networking >](#) [Review + create](#) [Give feedback](#)

Provide the name to your worker node and keep the things same as shown in the below snippet such as Node size and Mode, etc.

Add a node pool

AKS-Cluster-Demo

Node pool name * workernode1

Mode * User

OS SKU * Ubuntu Linux

Availability zones None

Node size * Standard_B2s

Scale method * Manual

Node count * 1

Optional settings

Max pods per node * 110

Enable public IP per node

[Add](#) [Cancel](#)

Now, click on Networking section.

Select the kubenet as Network configuration then, keep Calico as Network policy and click on Review + Create by skipping integrations and Advanced sections.

Once the validation is passed, click on Create.

Once your deployment is complete, click on Go to resource.

Click on Connect.

You will have to run two commands that are showing on the right of the snippet to configure it on local or Cloud Shell.

But, we will configure it on our local. For that, we need to install Azure CLI and kubectl on our local machine.

To install kubectl on your local machine follow the below commands.

```
curl -O
https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl
```

```
amanspathak@pop-os:~$ curl -O https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl
% Total    % Received % Xferd  Average Speed   Time   Time  Current
          0     0      0   0:00:09  0:00:09 --:--:--  7630k
100 47.5H 100 47.5H  0     0  5943K  0  0:00:09  0:00:09 --:--:-- 7630k
amanspathak@pop-os:~$
```

```
curl -O
https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl.sha256
```

```
amanspathak@pop-os:~$ curl -O https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl.sha256
% Total    % Received % Xferd  Average Speed   Time   Time  Current
          0     0      0   0:00:01  0:00:01 --:--:--  57
100 73 100 73  0     0  57  0  0:00:01  0:00:01 --:--:--  57
amanspathak@pop-os:~$
```

```
sha256sum -c kubectl.sha256
```

```
amanspathak@pop-os:~$ sha256sum -c kubectl.sha256
kubectl: OK
amanspathak@pop-os:~$
```

```
openssl sha1 -sha256 kubectl
```

```
amanspathak@pop-os:~$ openssl sha1 -sha256 kubectl
SHA256(kubectl)= 3b9fe2effbf12a30b12739126f069fe8a7f13625e71ccb82c33ad1ea8f8092
amanspathak@pop-os:~$
```

```
chmod +x ./kubectl
mkdir -p $HOME/bin && cp ./kubectl $HOME/bin/kubectl && export
PATH=$HOME/bin:$PATH
echo 'export PATH=$HOME/bin:$PATH' >> ~/.bashrc
```

```
amanspathak@pop-os:~$ chmod +x ./kubectl
amanspathak@pop-os:~$ mkdir -p $HOME/bin && cp ./kubectl $HOME/bin/kubectl && export PATH=$HOME/bin:$PATH
amanspathak@pop-os:~$ echo 'export PATH=$HOME/bin:$PATH' >> ~/.bashrc
amanspathak@pop-os:~$
```

```
kubectl version --client
```

```
amanspathak@pop-os:~$ kubectl version --client
Client Version: v1.28.3-eks-e71965b
Kustomize Version: v5.0.4-0.20230601105947-6ce0bf390ce3
amanspathak@pop-os:~$
```

Once the kubectl is installed, you can install azurecli on your local by following the below commands.

Install Azure CLI on the local machine

```
curl -sL https://aka.ms/InstallAzureCLIDeb | sudo bash
```

```
amapathak@pop-os:~/GitHub/Kubernetes-files/AWS-EKS$ curl -sL https://aka.ms/InstallAzureCLIDeb | sudo bash
ign1 https://pkgs.jenkins.io/debian-stable binary/ InRelease
Get:2 https://pkgs.jenkins.io/debian-stable binary/ Release [2,644 B]
Get:3 https://pkgs.jenkins.io/debian-stable binary/ Release.gpg [33 B]
Hit:4 https://download.docker.com/linux/ubuntu jammy InRelease
Err:5 https://pkgs.jenkins.io/debian-stable binary/ Release.gpg
  Failed to fetch https://pkgs.jenkins.io/debian-stable binary/ Release.gpg  The public key is not available: NO_PUBKEY 58A31D57EF5975CA
Hit:5 https://dl.google.com/linux/chrome/deb Stable InRelease
Hit:7 https://apt.pop-os.org/proprietary jammy InRelease
Hit:8 https://apt.pop-os.org/releases jammy InRelease
Get:9 https://dl.winehq.org/wine-builds/ubuntu jammy InRelease [8,041 B]
Err:9 https://dl.winehq.org/wine-builds/ubuntu jammy InRelease
  The following signatures couldn't be verified because the public key is not available: NO_PUBKEY 76F1A20FF987672F
Hit:10 http://apt.pop-os.org/ubuntu jammy InRelease
Hit:11 http://packages.microsoft.com/repos/code stable InRelease
Hit:12 http://ppa.launchpadcontent.net/mhall119/yakkalibre/ubuntu jammy InRelease
Hit:13 http://apt.pop-os.org/ubuntu jammy-security InRelease
Hit:14 https://packages.microsoft.com/repos/vscode stable InRelease
Hit:15 https://ppa.launchpadcontent.net/ndrej/php/ubuntu jammy InRelease
Hit:16 http://apt.pop-os.org/ubuntu jammy-updates InRelease
Hit:17 https://packages.microsoft.com/repos/azure-cli jammy InRelease
Hit:18 https://s3.amazonaws.com/repo-deb.cyberduck.io stable InRelease
Hit:19 https://ppa.launchpadcontent.net/cubittandbook/1/gimp/ubuntu jammy InRelease
Hit:20 http://apt.pop-os.org/ubuntu jammy-backports InRelease
Reading package lists... Done
```

To install AZ CLI on other OS, you can refer to the below link

<https://learn.microsoft.com/en-us/cli/azure/install-azure-cli-linux?pivots=apt>

Now, login to your Azure Account by below command

```
az login
```

Once you run the below command, a new tab will open in your browser which will validate your account. If you have already logged into that account then, it will be automatically logged in on the terminal as well and you will see output like below snippet.

```
amapathak@pop-os:~/GitHub/Kubernetes-files/AWS-EKS$ az login
A web browser has been opened at https://login.microsoftonline.com/organizations/oauth2/v2.0/authorize. Please continue the login in the web browser. If no web browser is available or if the web browser fails to open, use device code flow with 'az login --use-device-code'.
The following tenants don't contain accessible subscriptions. Use 'az login --allow-no-subscriptions' to have tenant level access.
33bde0-d076-48dd-a03-9276eac3744c "ADU-MEN"
CloudName HomeTenantId IsDefault Name State TenantId
-----
AzureCloud aadfb5f-8b57-452e-a30c-cb195ed14fb8 True Azure for Students Enabled aadfb5f-8b57-452e-a30c-cb195ed14fb8
```

Once you log in, you can run the command that was given by Azure to connect with AKS

```
amapathak@pop-os:~/GitHub/Kubernetes-files/Azure-AKS$ az account set --subscription 60cabc20-8ca8-46a6-8fe0-b9e054e667a7
amapathak@pop-os:~/GitHub/Kubernetes-files/Azure-AKS$ amapathak@pop-os:~/GitHub/Kubernetes-files/Azure-AKS$ az aks get-credentials --resource-group K8s-Demo --name AKS-Cluster-Demo
A different object named AKS-Cluster-Demo already exists in your kubeconfig file.
Overwrite? (y/n): y
A different object named clusterUser_K8s-Demo_AKS-Cluster-Demo already exists in your kubeconfig file.
Overwrite? (y/n): y
Merged "AKS-Cluster-Demo" as current context in /home/amapathak/.kube/config
amapathak@pop-os:~/GitHub/Kubernetes-files/Azure-AKS$ 
```

Now, you can run the command to list the nodes which will help you to validate the connection as well.

```
kubectl get nodes
```

```
amapathak@pop-os:~/GitHub/Kubernetes-files/Azure-AKS$ kubectl get nodes
NAME           STATUS   ROLES   AGE   VERSION
aks-agentpool-33647681-vms00000   Ready   agent   1m    v1.27.7
aks-agentpool-33647681-vms00001   Ready   agent   1m    v1.27.7
aks-workernode1-33647681-vms00000   Ready   agent   1m    v1.27.7
amapathak@pop-os:~/GitHub/Kubernetes-files/Azure-AKS$ 
```

Now, let's try to deploy the Apache application on AKS

```
apiVersion: apps/v1
kind: Deployment
metadata:
```

```

name: apache-app-deployment
labels:
  app: apache-app
spec:
  replicas: 2
  selector:
    matchLabels:
      app: apache-app
  template:
    metadata:
      labels:
        app: apache-app
    spec:
      containers:
        - name: apache-container
          image: avian19/apache-ne:latest
          ports:
            - containerPort: 80

```

kubectl apply -f deployment.yml

```

anapathak@pop-os:~/Github/Kubernetes-files/Azure-AKS$ kubectl apply -f deployment.yml
deployment.apps/apache-app-deployment created
anapathak@pop-os:~/Github/Kubernetes-files/Azure-AKS$ kubectl get pods
NAME           READY   STATUS    RESTARTS   AGE
apache-app-deployment-5c61d8df9c-5bxcc  1/1     Running   0          6s
apache-app-deployment-5c61d8df9c-wfw0n  1/1     Running   0          6s
anapathak@pop-os:~/Github/Kubernetes-files/Azure-AKS$ 

```

Now, host the application outside of the Kubernetes Cluster by creating a service for the Apache application and observing the public in the EXTERNAL-IP Column.

```

apiVersion: v1
kind: Service
metadata:
  name: apache
spec:
  selector:
    app: apache-app
  type: LoadBalancer
  ports:
    - protocol: TCP
      port: 80

```

kubectl apply -f svc.yaml

```

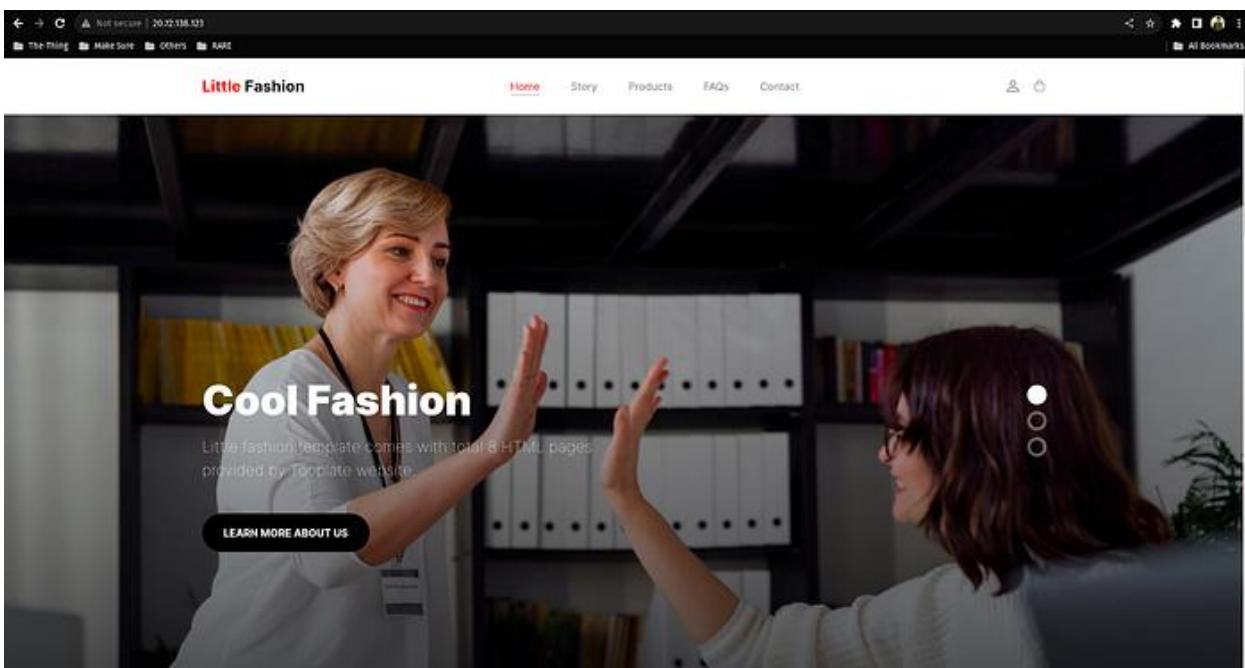
anapathak@pop-os:~/Github/Kubernetes-files/Azure-AKS$ kubectl apply -f svc.yaml
service/apache created
anapathak@pop-os:~/Github/Kubernetes-files/Azure-AKS$ kubectl get svc
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
apache   LoadBalancer   10.0.163.222  20.72.138.123  80:32299/TCP   8s
kubernetes   ClusterIP   10.0.0.1   <none>        443/TCP   39m
anapathak@pop-os:~/Github/Kubernetes-files/Azure-AKS$ 

```

As our service type is LoadBalancer, AKS created one Load Balancer which will look like the below snippet.

The screenshot shows two side-by-side Azure portal pages. The left page is titled 'Load balancing | Load Balancer' under 'Load Balancing Services'. It lists 'Load Balancer' as the selected item in a navigation menu. The right page is titled 'kubernetes | Load balancer' under 'Kubernetes'. It also lists 'Load balancer' as the selected item. Both pages have search bars at the top and show various configuration options like 'Activity log', 'Tag', 'Diagnose and solve problems', 'Settings', and 'Frontend IP configuration'. The right page has a detailed 'Essentials' section with fields such as 'Resource group': 'dev_k8s_demo_my-cluster-demo-eus01', 'Location': 'East US', 'Subscription': 'Azure for Developers', 'Subresource ID': 'k8scluster01-4ca1-4bad-8fa0-09ef54ef67a7', 'SKU': 'Standard', 'Tag (id): Name: AKS-Cluster-Demo', 'Backend pool': '2 backend pools', 'Load balancing rule': 'a0a7ae031f1144745b8849d375a7e-TCP-80 (Ip:32299)', 'Health probe': 'a0a7ae031f1144745b8849d375a7e-TCP-80 (Ip:32299)', 'NAT rules': '0 inbound', 'Tier': 'Standard', and 'Region': 'Regional'. A note at the bottom says 'Configure high availability and scalability for your applications'.

Now, copy the EXTERNAL-IP that we get by running the list svc command in the previous step hit on the browser, and see the magic.



Google Kubernetes Engine (GKE)

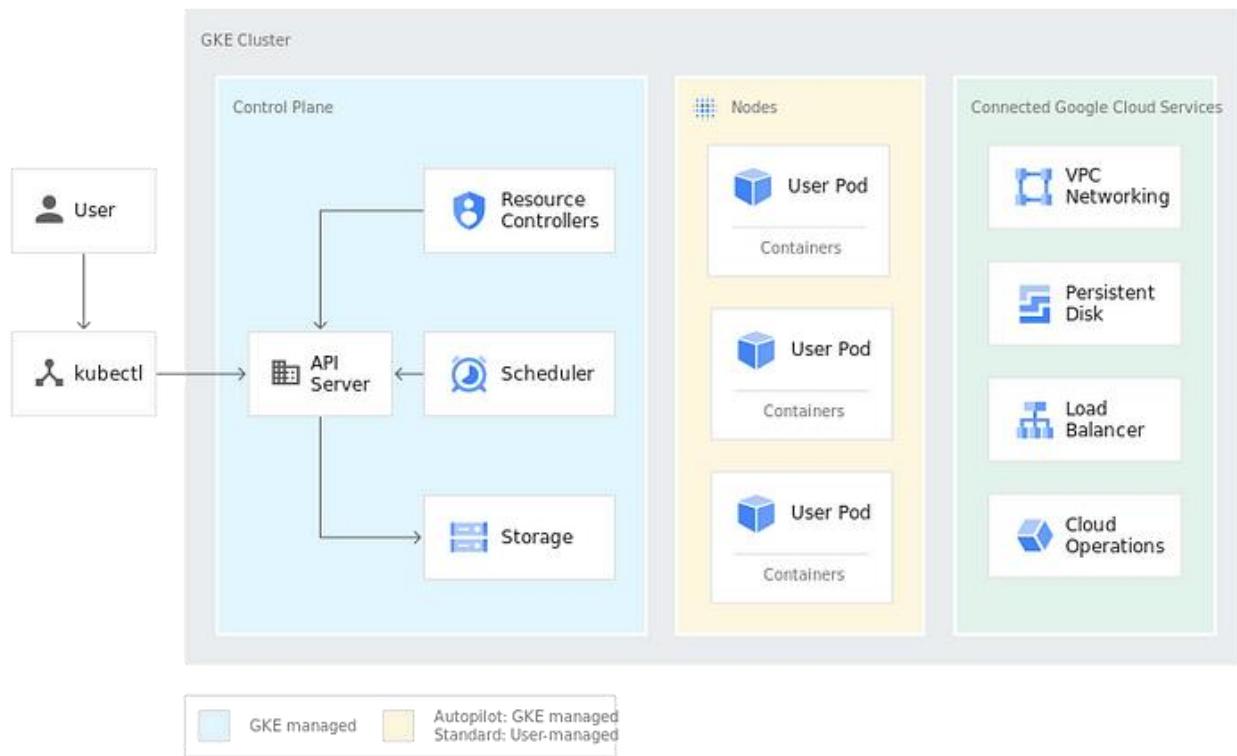
What is GKE?

GKE stands for Google Kubernetes Engine which is a managed Kubernetes service to deploy your application easily without worrying about Control Plane, Scaling, or updating to your Kubernetes Cluster.

One of the main advantages of GKE is that Kubernetes is developed by Google itself.

Key Features:

- **Multi-Versions:** GKE has the most available versions as Kubernetes developed Google itself.
- **Auto Upgrades:** The Control Plane and nodes will be automatically updated.
- **Auto Health Repair:** GKE provides automatic health repair for the nodes.
- **Security Enhancement:** GKE provides Containerized Optimised OS which will help you to enhance the security of your nodes.
- **Monitoring:** GKE provides monitoring support by integrating the monitoring services with GKE itself.
- **Scalability:** GKE provides scalability to your Kubernetes Clusters and Nodes according to the requirements.
- **Multi-Cloud Support:** You can run your applications anywhere without interruption using GKE on Google GKE, Azure AKS, or AWS EKS.



Let's Dive into the Demo!

If you have never created Kubernetes Cluster on Google Cloud before then, you have to enable it first to use it.

Click on Enable.

The screenshot shows the Google Cloud Platform interface for enabling the Kubernetes Engine API. The top navigation bar includes 'Google Cloud' and 'My Project 42933'. Below the navigation is a 'Product details' section for the 'Kubernetes Engine API'.

Kubernetes Engine API
 Google Kubernetes Engine
 Build and manage container-based applications, powered by the open source Kubernetes technology.

ENABLE TRY THIS API!

OVERVIEW DOCUMENTATION RELATED PRODUCTS

Overview
 Build and manage container-based applications, powered by the open source Kubernetes technology.

Additional details
 Type: [Service API](#)
 Last product update: 7/22/22
 Category: [Compute & Google Kubernetes API](#)
 Service name: [container.googleapis.com](#)

Tutorials and documentation
[Learn more](#)

Terms of Service
 By using this product you agree to the terms and conditions of the following license: [Google Cloud Platform](#).

Click on CREATE

The screenshot shows the Google Cloud Kubernetes Engine dashboard. The top navigation bar includes 'My Project 42953', a search bar, and various navigation links like 'ONBOARDING', 'OPERATIONS', and 'LEARN'. The main area is titled 'Kubernetes clusters' and features a prominent 'CREATE' button. A modal window titled 'Run your business critical workloads faster, safer, and easier at enterprise scale' is open, providing information about GKE Enterprise and its benefits. Below the modal, there are tabs for 'OVERVIEW', 'OBSERVABILITY', and 'COST OPTIMIZATION', along with a filter and status table.

Now, we will create the Standard Kubernetes Cluster. To do that, click on SWITCH TO STANDARD CLUSTER.

The screenshot shows the 'Create an Autopilot cluster' wizard. The current step is 'Cluster basics', which requires setting up basics for your cluster, networking, and advanced settings. The 'Name' field is set to 'autopilot-cluster-1'. The 'Region' dropdown is set to 'us-central1'. A note indicates that the region cannot be changed once the cluster is created. The right side of the screen shows a preview of the cluster configuration.

Provide the name to your cluster name and select the location type according to your credits remaining in the Google Cloud. Also, specify the node locations and click to expand default-pool which is showing on the left.

The screenshot shows the 'Create a Kubernetes cluster' wizard. The current step is 'Cluster basics', which includes options for 'NODE POOLS', 'default-pool', and 'CLUSTER'. The 'default-pool' section is expanded, showing fields for 'Name' (set to 'gke-cluster-name'), 'Location type' (set to 'Regional'), and 'Region' (set to 'us-central1'). A note states that the region cannot be changed once the cluster is created. The right side of the screen shows estimated monthly costs and a preview of the cluster configuration.

Select the configuration as given in the below screenshot to reduce some costs.

The screenshot shows the 'Configure node settings' section of the Google Cloud Platform interface. On the left, a sidebar lists 'Cluster basics', 'NODE POOLS', and 'default pool' (with 'Nodes' selected). The main area displays 'Machine configuration' settings. Under 'Image type', it is set to 'Ubuntu with container (Ubuntu containerized)'. A note states: 'The default Linux node image for newly created clusters and node pools with versions 1.28.3-gke.5100000 or later is Container-optimized OS with containerized (also the recommended runtime). Since Dockerfile is being deprecated by Kubernetes project, GKE will incorporate Docker-ready images [link], so we recommend that you migrate to containerized node images [link] as soon as possible.' Below this, 'Machine type' is set to 'e2-medium (2 vCPU, 8 GB memory)'. The 'vCPU' section shows '0.252 vCPU (1 shared core)' and 'Memory' shows '1 GB'. On the right, the 'Estimated monthly cost' is listed as '\$95.84' with a note: 'That's about \$0.13 per hour'. A 'SHOW COST BREAKDOWN' link is also present.

Provide the Root disk size of 15 GB because it will be sufficient according to our demonstration.

This screenshot shows the continuation of the configuration process. In the 'Machine type' section, the 'e2-medium' machine type is selected. In the 'Root disk type' dropdown, 'Balanced persistent disk' is chosen. The 'Root disk size (GB)' is explicitly set to '15'. Other options like 'Boot disk encryption' and 'Enable nodes on spot VMs' are shown but not selected.

Click on the Networking and provide configurations as given below.

Node networking

These node networking settings will be used when new nodes are created using this node pool.

The cluster settings specify a maximum of 510 pods per node, but you can override that setting at the node pool level.

Maximum pods per node: 256
Must fit pod address range per node /23

Network tags: Network tag

The cluster settings specify a default cluster level pod address range, but you can override that setting at the node pool level.

Automatically create secondary ranges: Pod secondary CIDR range: Pod secondary CIDR range

Node Networks: [Edit](#)

[ADD A NODE NETWORK](#)

Estimated monthly cost [PREVIEWS](#)
\$95.84
That's about \$0.13 per hour
Pricing is based on the resources you use, management fees, discounts and credits. [Learn more](#)

[SHOW COST BREAKDOWN](#)

CREATE CANCEL Equivalent: REST or COMMAND LINE

We don't need to modify anything in Security and other things. So you can skip it and click on CREATE.

Node security

These node security settings will be used when new nodes are created using this node pool.

Identity details: Specify the default identity for new auto-provisioned node pools using a service account or custom scopes. To improve security, we recommend creating and using a minimally privileged service account. [Learn more](#)

Service account: Compute Engine default service account

The service account is used to call Google Cloud APIs.

Access scopes: Access scopes are permanent. Select the type and level of API access to grant the VM. [Learn more](#)

Allow default access: Allow access to Compute Engine, Storage and Service Management, write access to Logging and Monitoring, and restrictive access to Service Control.

Allow full access in all Cloud APIs: Allow full access to all Cloud APIs.

Set access for each API: Set access for each API.

Enable sandbox with gvisor: [Learn more](#)

Shielded options: [Edit](#)

Enable integrity monitoring: [Learn more](#)

Enable secure boot: [Learn more](#)

Enable Confidential GKE Nodes: When enabled, Confidential GKE Nodes encrypts your nodes, and all of the workloads running on them, in-use. [Learn more](#)

Estimated monthly cost [PREVIEWS](#)
\$95.84
That's about \$0.13 per hour
Pricing is based on the resources you use, management fees, discounts and credits. [Learn more](#)

[SHOW COST BREAKDOWN](#)

CREATE CANCEL Equivalent: REST or COMMAND LINE

After clicking on CREATE. GCP will take some time to create the Kubernetes Cluster.

Kubernetes Engine Kubernetes clusters [CREATE](#) [DEPLOY](#) [REFRESH](#) [Search](#)

[ONBOARDING](#) [NEW](#) [OPERATIONS](#) [LEARN](#)

OVERVIEW								
Status	Name	Location	Number of nodes	Total vCPUs	Total memory	Notifications	Labels	⋮
<input type="checkbox"/>	gke-cluster-demo	us-central1	3	6	3 GB	=	=	⋮

Once your Kubernetes Cluster is ready, then click on CONNECT.

You will get a command to configure it on your local machine. But there are two prerequisites that you have to follow which first is to configure gcloud-cli and install kubectl on your local machine. Let's do this.

```
sudo apt-get update
sudo apt-get install apt-transport-https ca-certificates gnupg curl sudo
curl https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg - dearmor -o
/usr/share/keyrings/cloud.google.gpg |
echo "deb [signed-by=/usr/share/keyrings/cloud.google.gpg]
https://packages.cloud.google.com/apt cloud-sdk main" | sudo tee -a
/etc/apt/sources.list.d/google-cloud-sdk.list
```

```
anapathak@pop-os:~$ echo "deb [signed-by=/usr/share/keyrings/cloud.google.gpg] https://packages.cloud.google.com/apt cloud-sdk main" | sudo tee -a /etc/apt/sources.list.d/google-cloud-sdk.list
```

Update your local machine and install Google Cloud cli

```
sudo apt-get update && sudo apt-get install google-cloud-cli
```

```
anapathak@pop-os:~$ sudo apt-get install google-cloud-cli
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Suggested packages:
  google-cloud-cli-app-engine-java google-cloud-app-engine-python google-cloud-cli-pubsub-emulator google-cloud-cli-bigtable-emulator google-cloud-cli-datastore-emulator kubectl
The following NEW packages will be installed:
  google-cloud-cli
0 upgraded, 1 newly installed, 0 to remove and 5 not upgraded,
Need to get 104 MB of archives.
After this operation, 104 MB of additional disk space will be used.
Get:1 http://apt.googleapis.com/apt cloud-sdk/main amd64 google-cloud-cli amd64 456.0.0-0 [104 MB]
Fetched 104 MB in 11s (9,137 kB/s)
Selecting previously unselected package google-cloud-cli.
(Reading database ... 454232 files and directories currently installed.)
Preparing to unpack .../google-cloud-cli_456.0.0-0_amd64.deb ...
Unpacking google-cloud-cli (456.0.0-0) ...
Setting up google-cloud-cli (456.0.0-0) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
```

After installing gcloud cli, now we have to configure it with our account. To do that, run the below command and it will open your browser and select your main GCP account.

```
gcloud init
```

```
anupathak@pop-os:~$ gcloud init
Welcome! This command will take you through the configuration of gcloud.
Your current configuration has been set to: [default]
You can skip diagnostics next time by using the following flag:
  gcloud init --skip-diagnostics
Network diagnostic detects and fixes local network connection issues.
  Checking network connection...done.
  Reachability Check passed.
  Network diagnostic passed (1/1 checks passed).
You must log in to continue. Would you like to log in (Y/n)? Y
Your browser has been opened to visit:
  https://accounts.google.com/o/oauth2/auth?response_type=code&client_id=32555946559.apps.googleusercontent.com&redirect_uri=http%3A%2F%2localhost%3A8085%2F&scope=openid+https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fcloud-platform+https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fappengine.admin+https%3A%2F%2Fwww.googleapis.com%2Faccounts.readonly&state=112HSKhVYrI0GsxXXAnqErxmngKprB&access_type=offline&code_challenge=qYnZvJKenkvfIdspL6xlvBlj40t-kOjZFS4wY-B15Xg&code_challenge_method=s256
```

Now, you need one plugin to complete the configuration.

```
gcloud components install gke-gcloud-auth-plugin
```

```
anupathak@pop-os:~$ sudo apt-get install google-cloud-sdk-gke-gcloud-auth-plugin
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  google-cloud-sdk-gke-gcloud-auth-plugin
0 upgraded, 1 newly installed, 0 to remove and 5 not upgraded.
Need to get 3,214 kB of archives.
After this operation, 11.2 MB of additional disk space will be used.
Get:1 https://packages.cloud.google.com/apt cloud-sdk/main amd64 google-cloud-sdk-gke-gcloud-auth-plugin amd64 456.0.0-0 [3,214 kB]
Fetched 3,214 kB in 7s (468 kB/s)
Selecting previously unselected package google-cloud-sdk-gke-gcloud-auth-plugin.
(Reading database ... 493089 files and directories currently installed.)
Preparing to unpack .../google-cloud-sdk-gke-gcloud-auth-plugin_456.0.0-0_amd64.deb ...
Unpacking google-cloud-sdk-gke-gcloud-auth-plugin (456.0.0-0) ...
Setting up google-cloud-sdk-gke-gcloud-auth-plugin (456.0.0-0) ...
```

After configuring Google Cloud CLI our first prerequisite is completed.

Now, we have to install kubectl which is mandatory to perform the commands on the Google Kubernetes Cluster.

To install kubectl on your local machine follow the below commands.

```
curl -O
https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl
```

```
anupathak@pop-os:~$ curl -O https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl
  % Total    % Received % Xferd  Average Speed   Time   Time  Current
  100  47.5M  100  47.5M    0     0  5043k      0:00:09  0:00:09  ====== 7630k
anupathak@pop-os:~$
```

```
curl -O
https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl.sha256
```

```
anupathak@pop-os:~$ curl -O https://s3.us-west-2.amazonaws.com/amazon-eks/1.28.3/2023-11-14/bin/linux/amd64/kubectl.sha256
  % Total    % Received % Xferd  Average Speed   Time   Time  Current
  100    73  100    73    0     0  57      0:00:01  0:00:01  ====== 57
anupathak@pop-os:~$
```

```
sha256sum -c kubectl.sha256
```

```
anupathak@pop-os:~$ sha256sum -c kubectl.sha256
kubectl: OK
anupathak@pop-os:~$
```

```
openssl sha1 -sha256 kubectl
```

```
anupathak@pop-os:~$ openssl sha1 -sha256 kubectl
SHA2-256(kubectl)= 3b9fe2effbf12a30b12739126f069fe8a7f13625e71ccb82c33ad1ea8f8092
anupathak@pop-os:~$
```

```
chmod +x ./kubectl
```

```
mkdir -p $HOME/bin && cp ./kubectl $HOME/bin/kubectl && export PATH=$HOME/bin:$PATH  
echo 'export PATH=$HOME/bin:$PATH' >> ~/.bashrc
```

```
anupathak@pop-os:~$ chmod +x ./kubectl  
anupathak@pop-os:~$ mkdir -p $HOME/bin && cp ./kubectl $HOME/bin/kubectl && export PATH=$HOME/bin:$PATH  
anupathak@pop-os:~$ echo 'export PATH=$HOME/bin:$PATH' >> ~/.bashrc  
anupathak@pop-os:~$
```

kubectl version --client

```
anupathak@pop-os:~$ kubectl version --client  
Client Version: v1.28.3-eks-e71965b  
Kustomize Version: v5.0.4-0.202306091105947-6ce0bf399ce3  
anupathak@pop-os:~$
```

Now, copy the command that is given by GCP to connect to the Kubernetes Cluster and paste it into your local machine.

```
anupathak@pop-os:~/GitHub/Kubernetes-files/Google-GKE$ gcloud container clusters get-credentials gke-cluster-demo --region us-central1 --project level-footing-398711  
Fetching cluster endpoint and auth data.  
kubeconfig entry generated for gke-cluster-demo.  
anupathak@pop-os:~/GitHub/Kubernetes-files/Google-GKE$
```

To validate whether your cluster is working or not, list the nodes.

kubectl get nodes

```
anupathak@pop-os:~/GitHub/Kubernetes-files/Google-GKE$ kubectl get nodes  
NAME STATUS ROLES AGE VERSION  
gke-gke-cluster-demo-default-pool-e5419887-jzsx Ready <none> 5m43s v1.28.3-gke.1203001  
gke-gke-cluster-demo-default-pool-e5419887-9zrv Ready <none> 5m24s v1.28.3-gke.1203001  
gke-gke-cluster-demo-default-pool-e5419887-jhw5 Ready <none> 5m12s v1.28.3-gke.1203001  
anupathak@pop-os:~/GitHub/Kubernetes-files/Google-GKE$
```

Now, let's try to run the static application on nginx server with a GCP load balancer

```
apiVersion: apps/v1  
kind: Deployment  
metadata:  
  name: nginx-app-deployment  
  labels:  
    app: nginx-app  
spec:  
  replicas: 2  
  selector:  
    matchLabels:  
      app: nginx-app  
  template:  
    metadata:  
      labels:  
        app: nginx-app  
    spec:  
      containers:  
      - name: nginx-container  
        image: avian19/nginx-ne:latest-1.0  
      ports:  
      - containerPort: 80
```

kubectl apply -f deployment.yml

```

amarpathak@pop-os:~/Github/Kubernetes-files/Google-GKE$ kubectl apply -f deployment.yaml
deployment.apps/nginx-app-deployment created
amarpathak@pop-os:~/Github/Kubernetes-files/Google-GKE$ kubectl get deploy
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
nginx-app-deployment   2/2     2           2           11s
amarpathak@pop-os:~/Github/Kubernetes-files/Google-GKE$ kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
nginx-app-deployment-d055457d5-chmbx  1/1     Running   0          16s
nginx-app-deployment-d055457d5-poww9  1/1     Running   0          16s
amarpathak@pop-os:~/Github/Kubernetes-files/Google-GKE$ 

```

Now, host the application outside of the Kubernetes Cluster by creating a service for the nginx application and observe the Public IP in the EXTERNAL-IP Column.

```

apiVersion: v1
kind: Service
metadata: []
name: nginx
spec: []
selector:
  app: nginx-app
type: LoadBalancer
ports:
- protocol: TCP
  port: 80

```

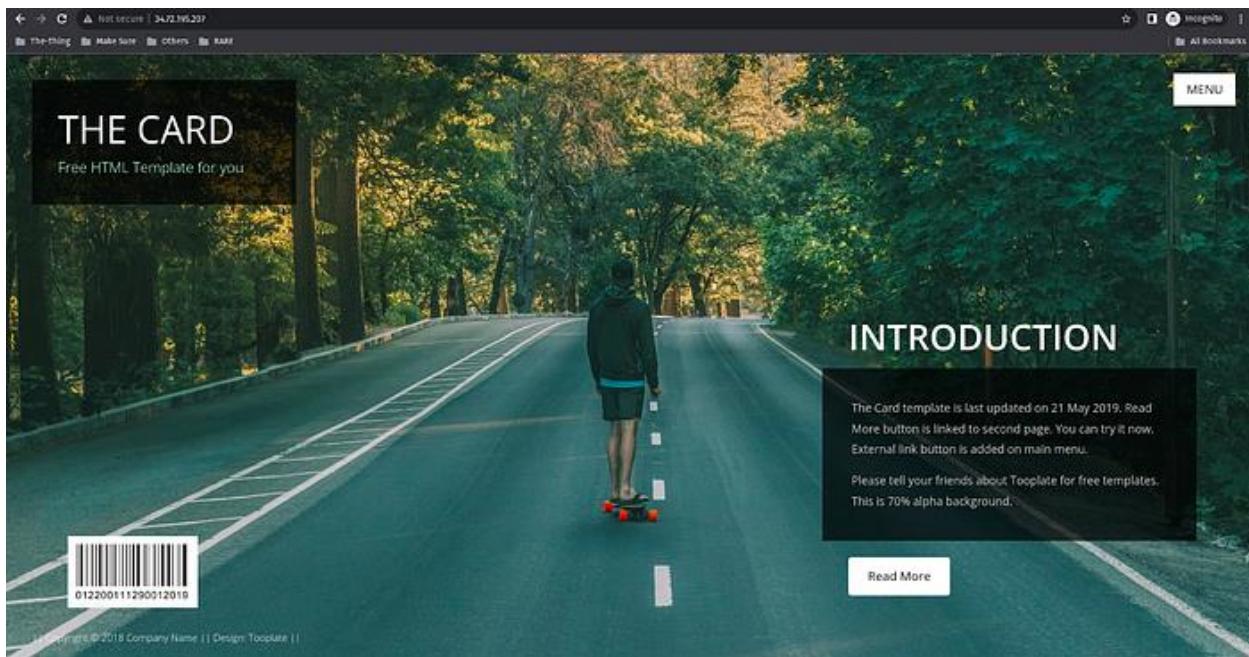
`kubectl apply -f svc.yaml`

```

amarpathak@pop-os:~/Github/Kubernetes-Tiles/Google-GKE$ kubectl apply -f svc.yaml
service/nginx created
amarpathak@pop-os:~/Github/Kubernetes-Tiles/Google-GKE$ kubectl get svc
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
kubernetes   ClusterIP  10.120.0.1   <none>        443/TCP   11m
nginx   LoadBalancer  10.120.4.246  <pending>    80:32595/TCP   9s
amarpathak@pop-os:~/Github/Kubernetes-Tiles/Google-GKE$ kubectl get svc
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
kubernetes   ClusterIP  10.120.0.1   <none>        443/TCP   12m
nginx   LoadBalancer  10.120.4.246  34.72.195.207  80:32595/TCP   72s
amarpathak@pop-os:~/Github/Kubernetes-Tiles/Google-GKE$ 

```

Copy the Public IP and paste it into your favorite browser and see the magic.



You can also decrease the number of nodes that are running in the below screenshot.

The screenshot shows the Google Cloud Compute Engine interface. In the left sidebar, 'Virtual machines' is selected, and 'VM instances' is chosen. The main area displays a table of VM instances. One instance is highlighted with a green checkmark. The columns include Status, Name, Zone, Recommendations, In use by, Internal IP, External IP, and a more options menu. A search bar at the top right contains the text 'gke'. On the right side of the screen, there is a 'LEARN' section with several cards, one of which is titled 'Create a website or application'.

After going to the Cluster, click on default-pool which is showing under Node Pools.

The screenshot shows the Google Cloud Kubernetes Engine interface. In the left sidebar, 'Clusters' is selected. The main area shows the 'gke-cluster-demo' cluster details. Under the 'NODES' tab, it lists a single node pool named 'default-pool' with 3 nodes. Below that, the 'Nodes' tab lists three individual nodes, each with status 'Ready' and specific resource details like CPU and memory usage.

Click on edit

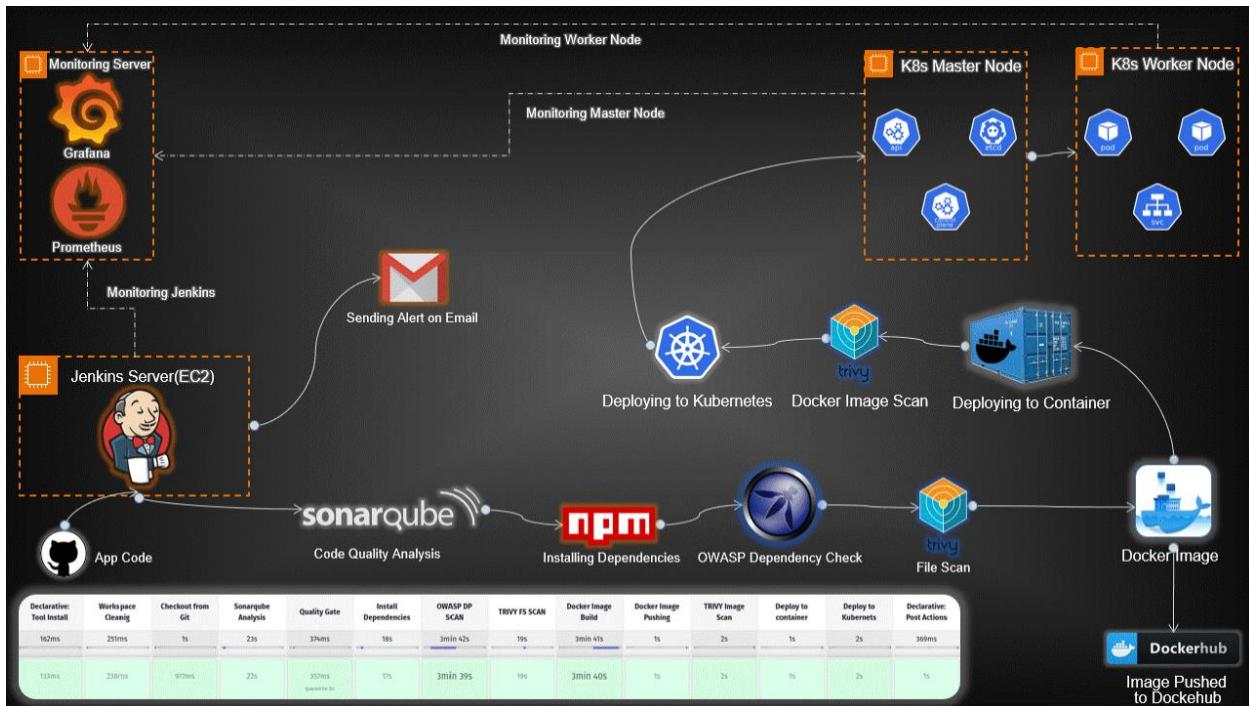
The screenshot shows the 'Node pool details' page for the 'default-pool' of the 'gke-cluster-demo' cluster. The 'EDIT' button is visible at the top. The page displays configuration details such as the number of nodes (3), autoscaling settings (Off), and node zones (us-central1-a). It also lists node-level configurations like image type, machine type, and storage settings.

Replace 3 with the 1 to reduce the nodes then scroll down and click on Save.

Once you Save the configurations, then you will see the VM Instances will be deleted.

Don't worry your application will still running

End-to-End DevSecOps Kubernetes Project



Introduction:

In today's rapidly evolving tech landscape, deploying applications using Kubernetes has become a crucial aspect of modern software development. This guide provides a detailed walkthrough for setting up an end-to-end Kubernetes project, covering everything from infrastructure provisioning to application deployment and monitoring.

Prerequisites:

Before diving into the implementation, ensure you have the following in place:

- Basic understanding of Kubernetes concepts.
- Access to AWS or any other cloud provider for server instances.
- A TMDB API key for accessing movie databases in your Netflix Clone application.
- DockerHub account for pushing and pulling Docker images.
- Gmail account for email notifications.
- Jenkins, Kubernetes, Docker, and necessary plugins installed.

High-Level Overview:

- Infrastructure Setup:** Provisioned servers for Jenkins, Monitoring, and Kubernetes nodes.
- Toolchain Integration:** Integrated essential tools like Jenkins, SonarQube, Trivy, Prometheus, Grafana, and OWASP Dependency-Check.
- Continuous Integration/Continuous Deployment (CI/CD):** Automated workflows with Jenkins pipelines for code analysis, building Docker images, and deploying applications on Kubernetes.
- Security Scanning:** Implemented Trivy and OWASP Dependency-Check to scan for vulnerabilities in code and Docker images.
- Monitoring and Visualization:** Set up Prometheus and Grafana for real-time monitoring and visualization of both hardware and application metrics.
- Email Notifications:** Configured Jenkins for email alerts based on pipeline results.

You will get the Jenkinsfile and Kubernetes Manifest files along with the Dockerfile. Feel free to modify it accordingly

Project GitHub Repo-

<https://github.com/AmanPathak-DevOps/Netflix-Clone-K8S-End-to-End-Project>

We need four servers for our today's Project

Jenkins Server- On this Server, Jenkins will be installed with some other tools such as sonarqube(docker container), trivy, and kubectl.

Monitoring Server- This Server will be used for Monitoring where we will use Prometheus, Node Exporter, and Grafana.

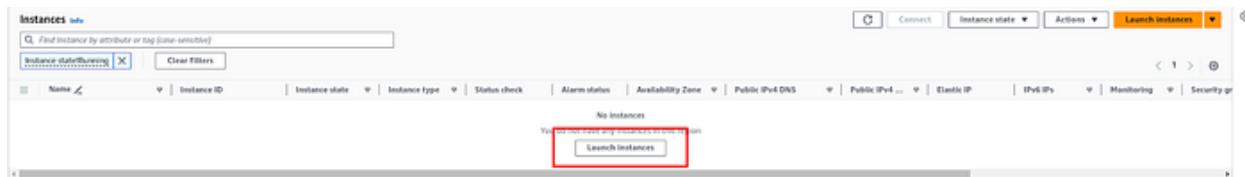
Kubernetes Master Server- This Server will be used as the Kubernetes Master Cluster Node which will deploy the applications on worker nodes.

Kubernetes Worker Server- This Server will be used as the Kubernetes Worker Node on which the application will be deployed by the master node.

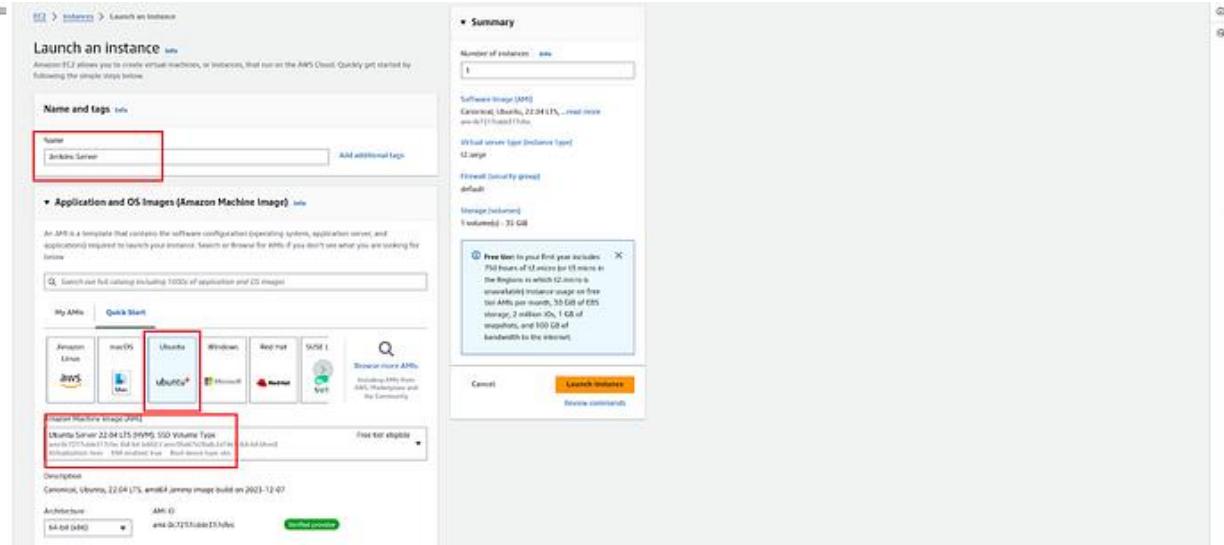
Let's create the following instances.

Jenkins Server

Click on Launch Instances.

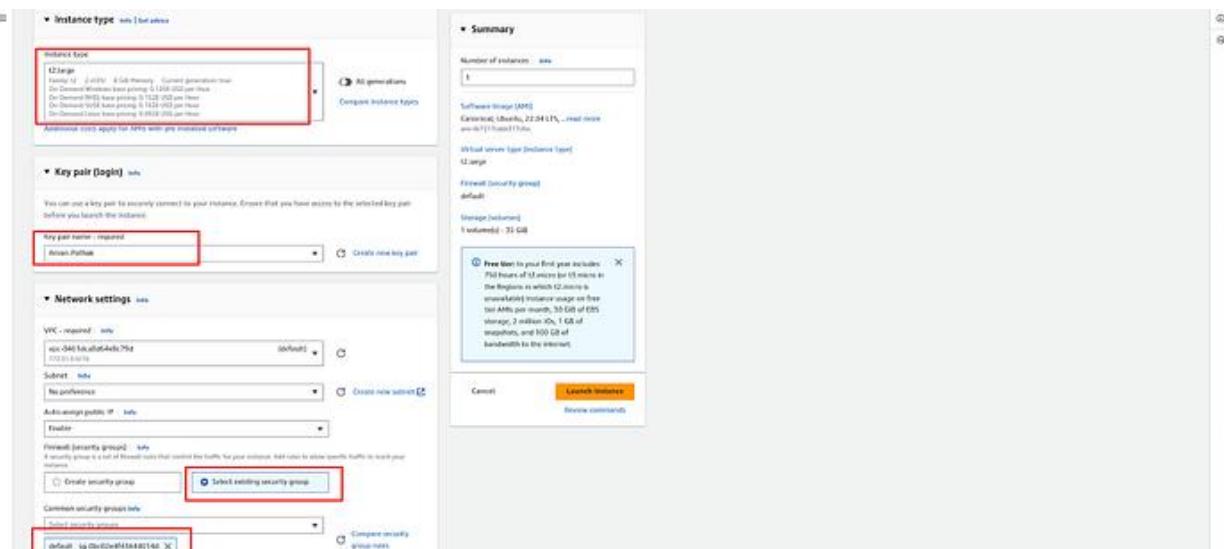


Provide the name of your Jenkins instance, and select the Ubuntu OS 22.04 version.

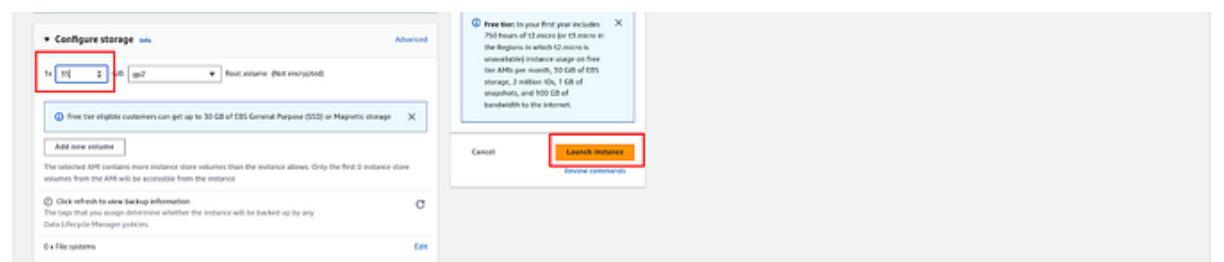


We need to configure multiple things on the Jenkins instance. So, select the t2.large instance type, provide the key or you can create if you want.

Keep the networking things as it is. But make sure to open all inbound and outbound traffic in the selected security groups.

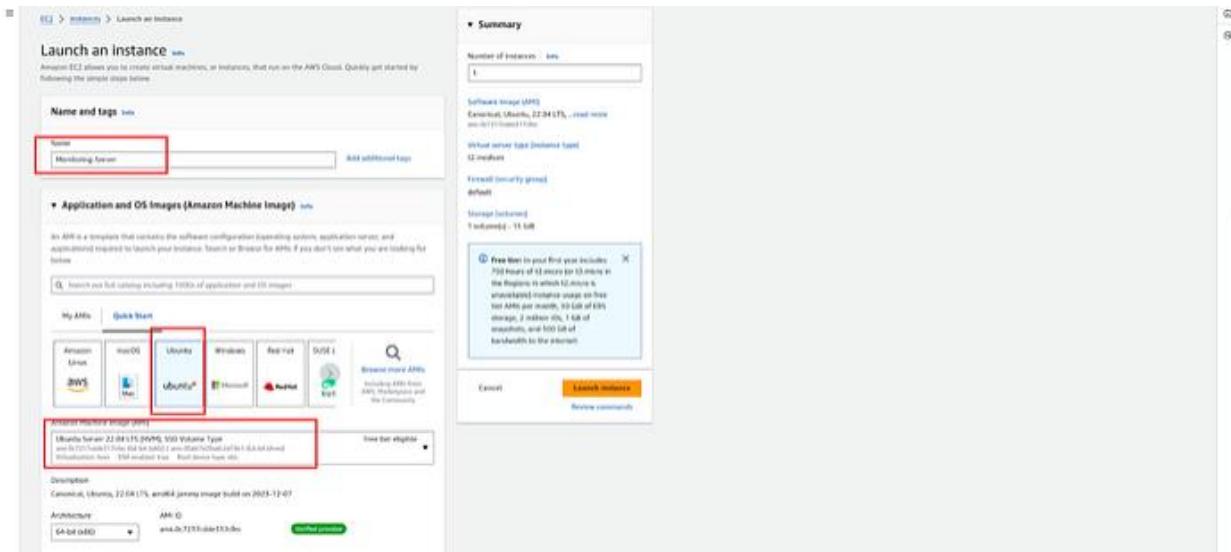


Increase the storage capacity for Jenkins Instance from 8GB to 35GB and click on Launch Instance.



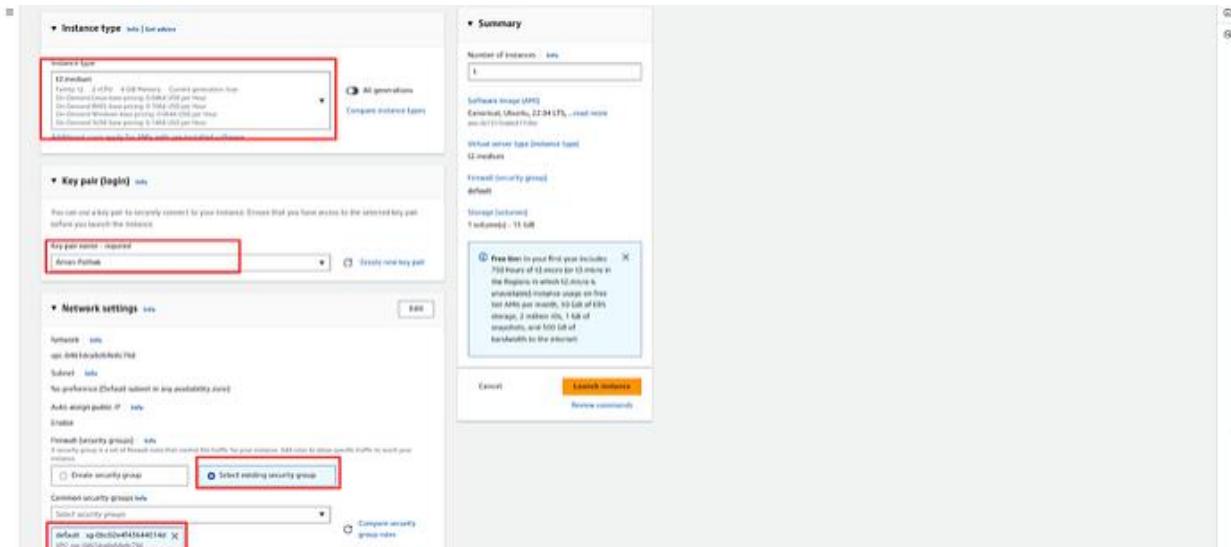
Monitoring Server

Provide the name of your Monitoring Instance, and select the Ubuntu 22.04 OS.

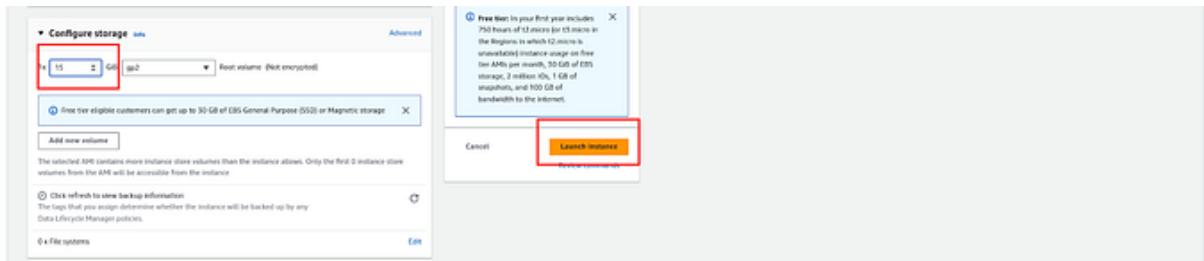


We need to configure the monitoring tools on this instance which needs a minimum of 4GB RAM. So, select the t2.medium instance type, provide the key or you can create if you want.

Keep the networking things as it is. But make sure to open all inbound and outbound traffic in the selected security groups.



Increase the storage capacity for Jenkins Instance from 8GB to 15GB and click on Launch Instance.

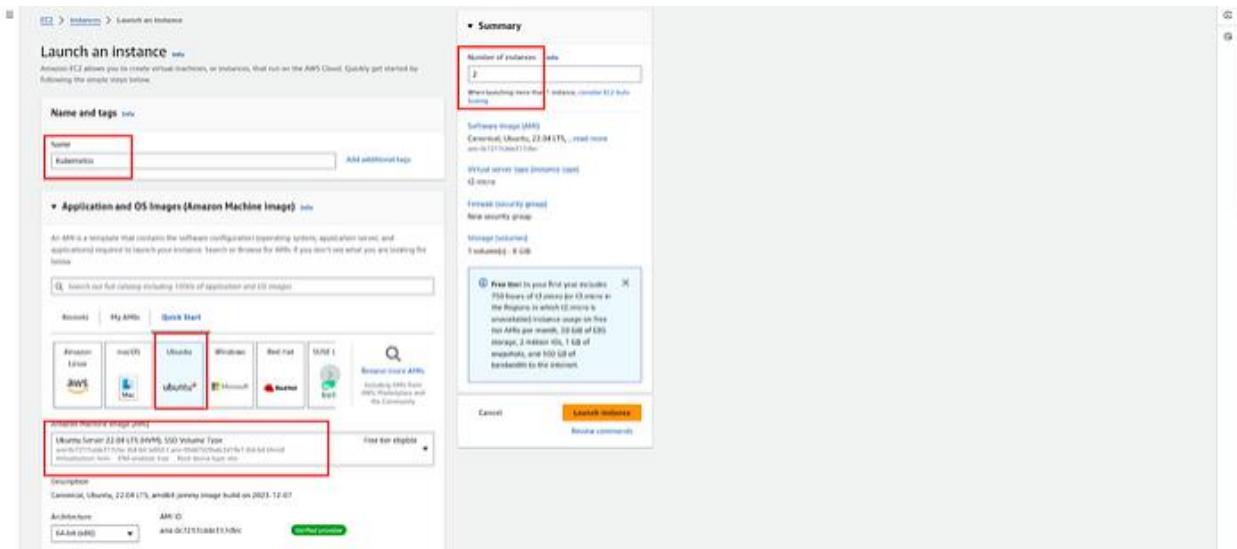


Kubernetes Master & Worker Node

We have to create two Kubernetes Nodes which need at least 2 CPUs.

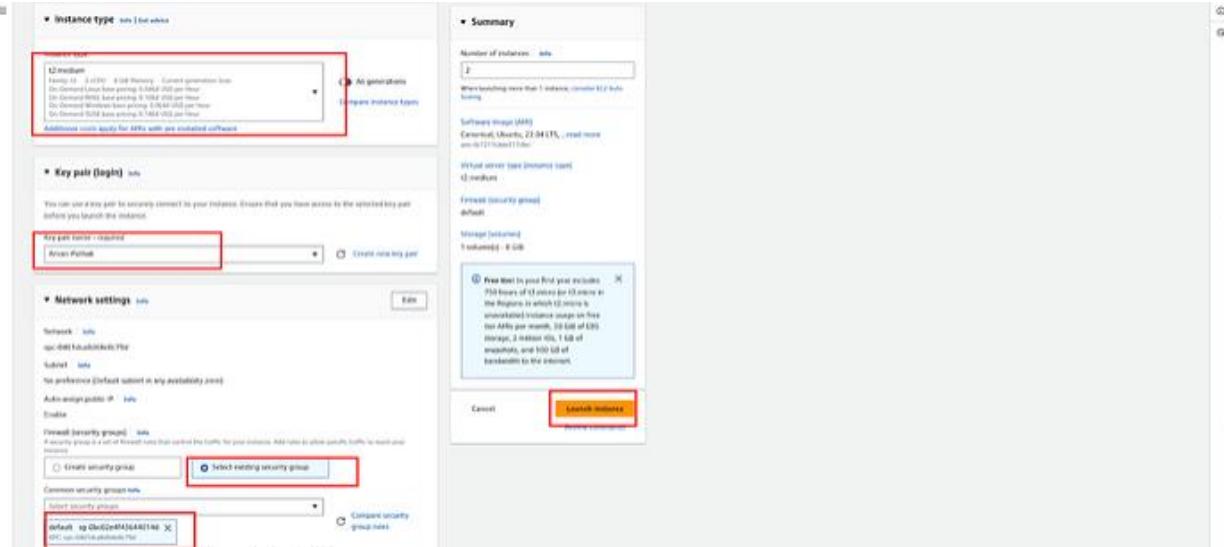
Provide the name of your Kubernetes Master Instance, and select the Ubuntu 22.04 OS.

In the Number of Instances, replace 1 with 2 because we need two Kubernetes Nodes.



Select the t2.medium instance type, provide the key or you can create if you want.

Keep the networking things as it is. But make sure to open all inbound and outbound traffic in the selected security groups then keep the rest of the things as it is and click on Launch Instance.



Rename the Kubernetes Servers and all four servers will look like the below snippet.

Instances (4) Info									
Filter instance by attribute or tag [view selected] Actions Launch instances									
Instance state = running Clear filters									
Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv6 —	Elastic IP
Kubernetes-Master	i-0027513f0f0a02123	Running	t2.medium	bootstrapping	No alarms	us-east-1e	ec2-52-31-122-68.compute-1.amazonaws.com	52.31.122.68	-
Kubernetes-Worker	i-01450d0464397ef5d5b	Running	t2.medium	bootstrapping	No alarms	us-east-1e	ec2-50-99-64-57.compute-1.amazonaws.com	50.99.64.57	-
Jenkins-Server	i-0aa005980f319887	Running	t2.large	✓/2 checks passed	No alarms	us-east-1e	ec2-54-207-155-151.compute-1.amazonaws.com	54.207.155.151	-
Monitoring-Server	i-0522db81e5e6522d	Running	t2.medium	bootstrapping	No alarms	us-east-1e	ec2-54-163-127-65.compute-1.amazonaws.com	54.163.127.65	-

Log in to the Jenkins Server

```
mangat@akipop-03:~$ ssh -i "Aman-Pataki.pem" ubuntu@ec2-34-207-155-151.compute-1.amazonaws.com
The authenticity of host 'ec2-34-207-155-151.compute-1.amazonaws.com (34.207.155.151)' can't be established.
ED25519 key fingerprint is SHA256:V0NhjWvN5edodnH7f3RppScvdMf1I2Fj3DpLE43Ic.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-34-207-155-151.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-1017-aws x86_64)

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

System information as of Wed Dec 27 13:57:18 UTC 2023

System load: 0.16015625 Processes: 105
Usage of /: 4.6% of 33.7468 Users logged in: 0
Memory usage: 2% IPv4 address for eth0: 172.31.59.9
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

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-59-9:~$
```

Download Open JDK and Jenkins

```
# Intalling Java
sudo apt update -y
sudo apt install openjdk-11-jre -y
java --version
# Installing Jenkins
curl -fsSL https://pkg.jenkins.io/debian/jenkins.io-2023.key | sudo tee \
```

```
/usr/share/keyrings/jenkins-keyring.asc > /dev/null
echo deb [signed-by=/usr/share/keyrings/jenkins-keyring.asc] \
https://pkg.jenkins.io/debian binary/ | sudo tee \
/etc/apt/sources.list.d/jenkins.list > /dev/null
sudo apt-get update -y
sudo apt-get install jenkins -y
```

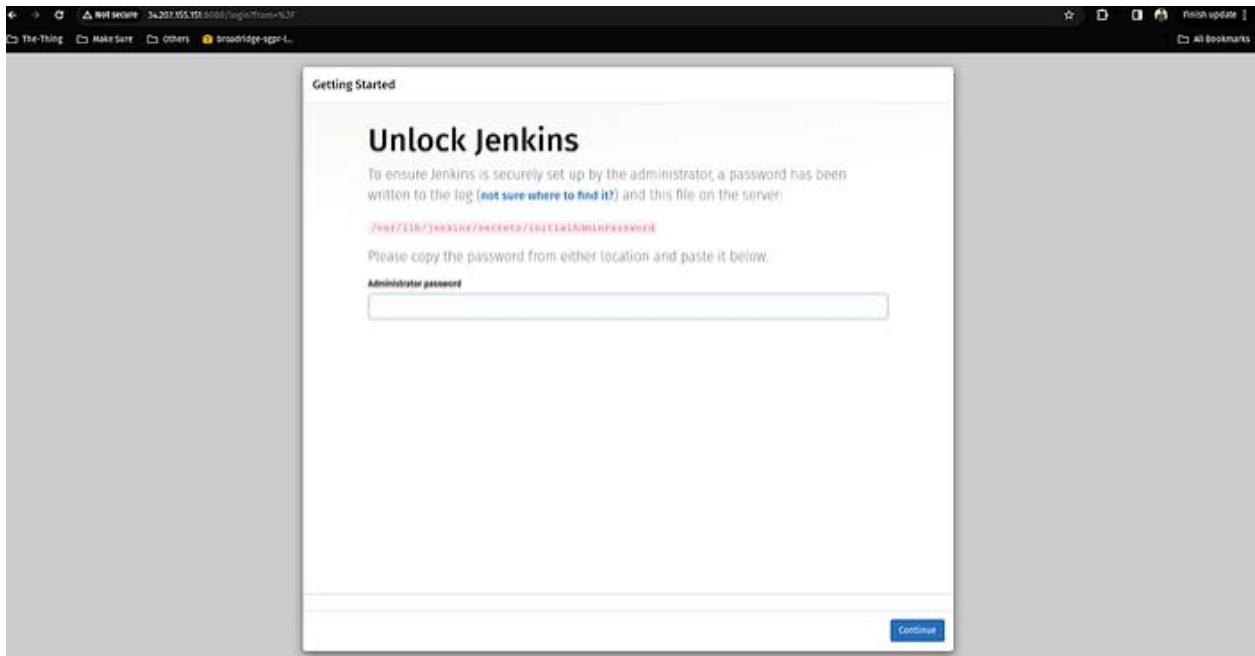
```
ubuntu@ip-172-31-59-9:~$ sudo apt update -y
sudo apt install openjdk-11-jre -y
java --version
# Installing Jenkins
curl -fsSL https://pkg.jenkins.io/debian/jenkins.io-2023.key | sudo tee \
/usr/share/keyrings/jenkins-keyring.gpg > /dev/null
echo deb [signed-by=/usr/share/keyrings/jenkins-keyring.gpg] \
https://pkg.jenkins.io/debian binary/ | sudo tee \
/etc/apt/sources.list.d/jenkins.list > /dev/null
sudo apt-get update -y
sudo apt-get install jenkins -y
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates InRelease [110 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-security InRelease [109 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [14.1 MB]
Get:5 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe Translation-en [5652 kB]
Get:7 http://security.ubuntu.com/ubuntu jammy-security/main amd64 Packages [1051 kB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 c-n-f Metadata [286 kB]
Get:9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 Packages [217 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse Translation-en [112 kB]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/multiverse amd64 c-n-f Metadata [372 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [263 kB]
Get:13 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/main Translation-en [269 kB]
Get:14 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted amd64 Packages [1250 kB]
Get:15 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/restricted Translation-en [203 kB]
Get:16 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [1020 kB]
Get:17 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe Translation-en [226 kB]
Get:18 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 c-n-f Metadata [22.1 kB]
Get:19 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 Packages [41.5 kB]
Get:20 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 c-n-f Metadata [168 kB]
Get:21 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe amd64 c-n-f Metadata [472 kB]
Get:22 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/main amd64 Packages [41.7 kB]
Get:23 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/main Translation-en [10.5 kB]
Get:24 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/main amd64 c-n-f Metadata [388 kB]
Get:25 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/restricted amd64 c-n-f Metadata [116 kB]
Get:26 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe amd64 Packages [24.3 kB]
Get:27 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe Translation-en [16.5 kB]
Get:28 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/universe amd64 c-n-f Metadata [644 kB]
Get:29 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports/multiverse amd64 c-n-f Metadata [116 kB]
Get:30 http://security.ubuntu.com/ubuntu jammy-security/main Translation-en [208 kB]
```

Check the status of the Jenkins server

```
ubuntu@ip-172-31-59-9:~$ systemctl status jenkins.service
● jenkins.service - Jenkins Continous Integration Server
   Loaded: loaded (/lib/systemd/system/jenkins.service; enabled; vendor preset: enabled)
     Active: active (running) since Wed 2023-12-27 14:01:16 UTC; 1min ago
       Main PID: 4896 (java)
         Tasks: 49 (limit: 9498)
        Memory: 2.2G
          CPU: 53.266s
        CGroup: /system.slice/jenkins.service
                 └─ 4896 /usr/bin/java -Djava.awt.headless=true -jar /usr/share/java/jenkins.war --webroot=/var/cache/jenkins/war --httpPort=8080

Dec 27 14:00:54 ip-172-31-59-9 jenkins[4896]: 5c267e0c42134562ad3b5a4c263784f2
Dec 27 14:00:54 ip-172-31-59-9 jenkins[4896]: This may also be found at: /var/lib/jenkins/secrets/initialAdminPassword
Dec 27 14:00:54 ip-172-31-59-9 jenkins[4896]: ****
Dec 27 14:00:54 ip-172-31-59-9 jenkins[4896]: ****
Dec 27 14:00:54 ip-172-31-59-9 jenkins[4896]: ****
Dec 27 14:01:16 ip-172-31-59-9 jenkins[4896]: 2023-12-27 14:01:16.166+0000 [id=29]      INFO  jenkins.InitReactorRunners$1onAttained: Completed initialization
Dec 27 14:01:16 ip-172-31-59-9 jenkins[4896]: 2023-12-27 14:01:16.192+0000 [id=21]      INFO  hudson.lifecycle.Lifecycle#onReady: Jenkins is fully up and running
Dec 27 14:01:16 ip-172-31-59-9 systemd[1]: Started Jenkins Continous Integration Server.
Dec 27 14:01:16 ip-172-31-59-9 jenkins[4896]: 2023-12-27 14:01:16.294+0000 [id=4]      INFO  h.m.DownloadService$Downloadable#load: Obtained the updated data file for hudson.tasks.
Dec 27 14:01:16 ip-172-31-59-9 jenkins[4896]: 2023-12-27 14:01:16.295+0000 [id=47]      INFO  hudson.util.Retrigger.start: Performed the action check updates server successfully at the
Lines 1-20/20 [END]
```

Copy your Jenkins Server Public IP and paste it into your favorite browser with port number 8080.



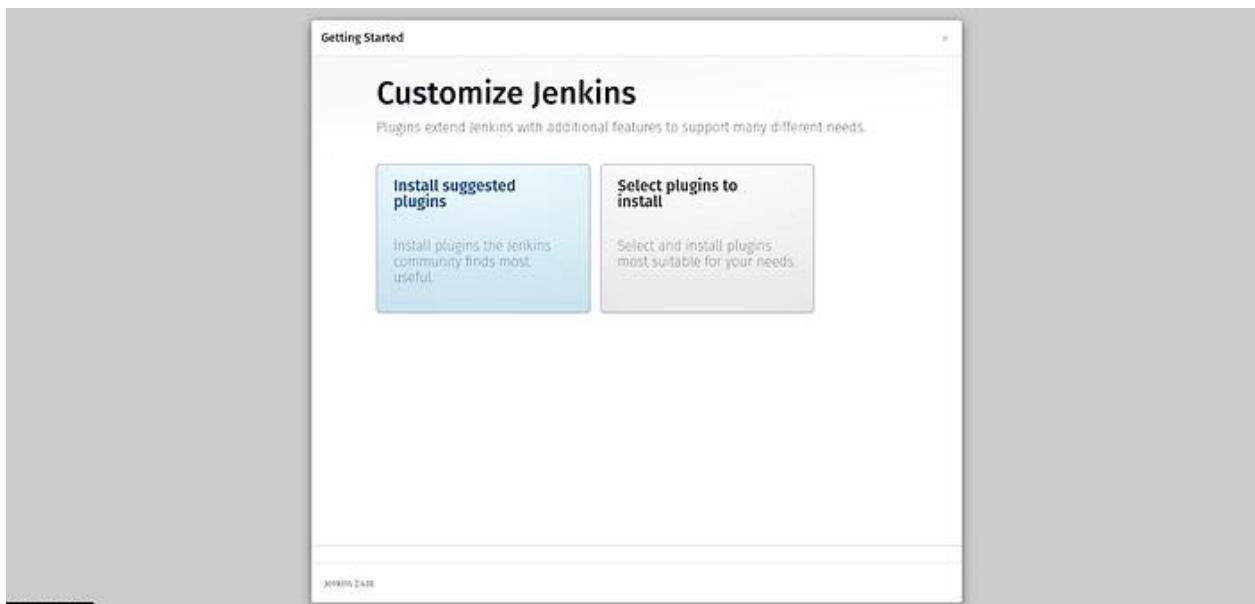
Run the command on your Jenkins server

```
sudo cat /var/lib/jenkins/secrets/initialAdminPassword
```

Copy the output and paste it into your above snippet text field and click on Continue.

```
ubuntu@ip-172-31-59-9:~$ sudo cat /var/lib/jenkins/secrets/initialAdminPassword
5c267e0c42134562ad3b5b4c263784f2
ubuntu@ip-172-31-59-9:~$ []
```

Click on the Install suggested plugins



Click on the Skip and continue as admin

Getting Started

Create First Admin User

Username

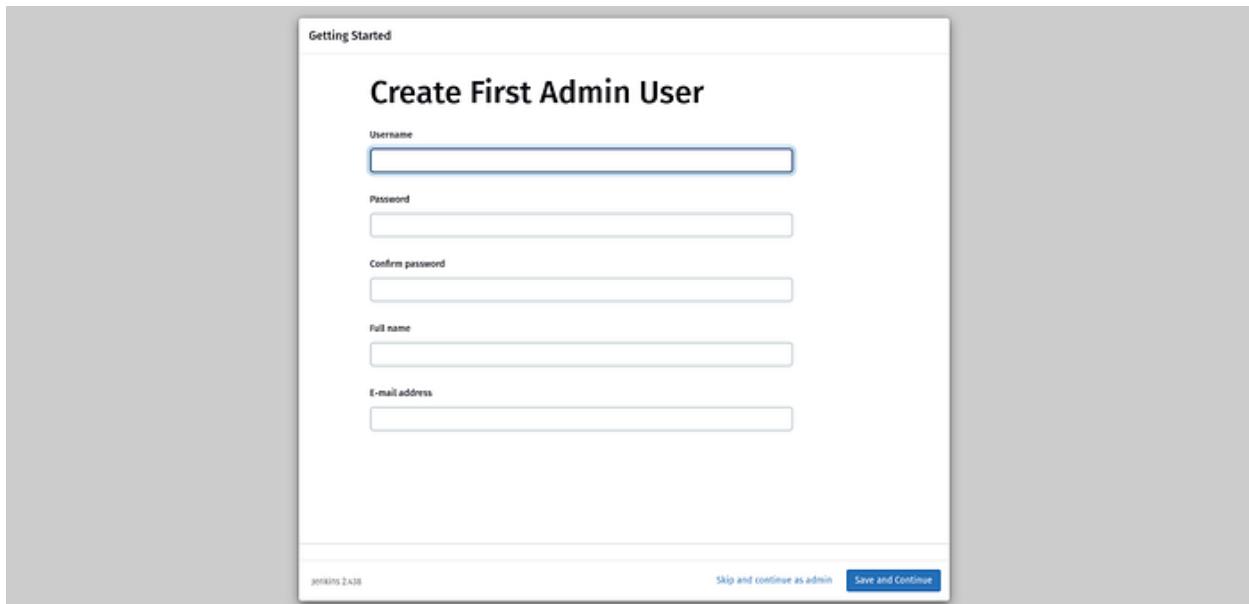
Password

Confirm password

Full name

E-mail address

JENKINS ZAAB Skip and continue as admin Save and Continue



Click on Save and Finish

Getting Started

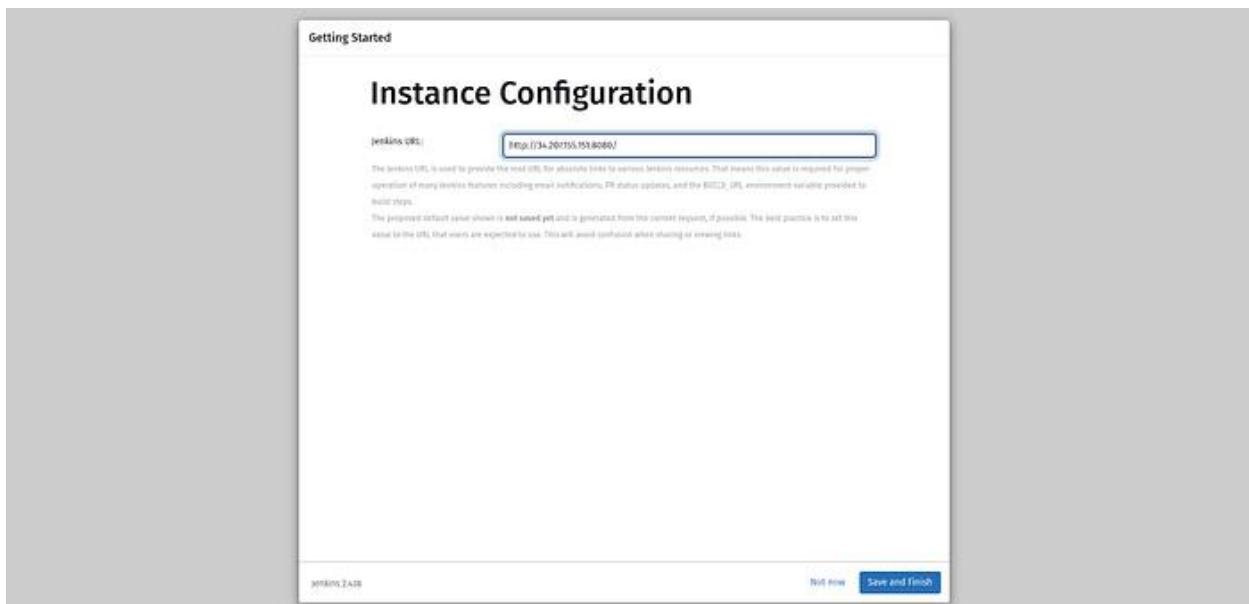
Instance Configuration

(jenkins URL)

The Jenkins URL is used to provide the root URL for absolute links to various Jenkins resources. This means this value is required for proper operation of many Jenkins features including email notifications, PR status options, and the BUILDS URL environment variable provided to build steps.

The proposed default server URL is not saved yet and is generated from the current request, if possible. The best practice is to set this value to the URL that users are expected to use. This will avoid confusion when sharing or viewing links.

JENKINS ZAAB Not now Save and Finish



Install Docker and configure on the Jenkins Server

```
sudo apt update  
sudo apt install docker.io -y  
sudo usermod -aG docker jenkins  
sudo usermod -aG docker ubuntu  
sudo systemctl restart docker  
sudo chmod 777 /var/run/docker.sock
```

```

ubuntu@ip-172-31-59-9:~$ sudo apt update
sudo apt install docker.io
sudo su -
sudo usermod -gG docker jenkins
sudo usermod -gG docker ubuntu
systemctl restart docker
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
Ign:4 https://pkgs.jenkins.io/debian binary/ InRelease
Hit:5 https://pkgs.jenkins.io/debian binary/ Release
Hit:6 http://security.ubuntu.com/ubuntu jammy-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
26 packages can be upgraded. Run 'apt list --upgradable' to see them.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
bridge-utils contained dns-root-data dnsmasq-base pigz runc ubuntu-fan
Suggested packages:
laptopd aufs-tools cgroups-mount | cgroup-lite debootstrap docker-doc rimse zfs-fuse | zfsutils
These packages will be installed:
bridge-utils contained dns-root-data dnsmasq-base docker.io pigz runc ubuntu-fan
0 upgraded, 8 newly installed, 0 to remove and 26 not upgraded.
Need to get 69.7 MB of archives.

```

Install Sonarqube on your Jenkins Server

We will use a docker container for Sonarqube

```
docker run -d --name sonar -p 9000:9000 sonarqube:its-community
```

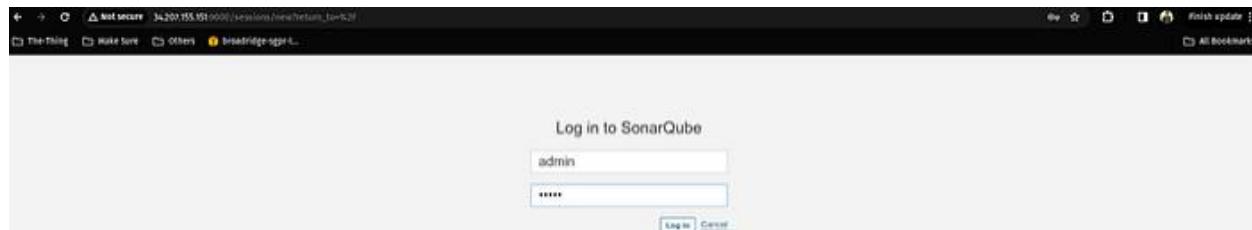
```

ubuntu@ip-172-31-59-9:~$ docker run -d --name sonar -p 9000:9000 sonarqube:its-community
unable to find image 'sonarqube:its-community' locally
its-community: Pulling from library/sonarqube
3dd1b1f9be59: Pull complete
0f83b805bdd: Pull complete
e7ee05cb0e6: Pull complete
51526e7965d8: Pull complete
ffccdc76c160: Pull complete
9d141c5b0e5b: Pull complete
b99511b2efef: Pull complete
Digest: sha256:61f0a07052cd205e4581a5b269bdeaf65832830d62b+06e419ea2elf
Status: Downloaded newer image for sonarqube:its-community
889013945455dbdb6714716459336e053a1497798898408a0ca9847e0de1fdcc
ubuntu@ip-172-31-59-9:~$ 

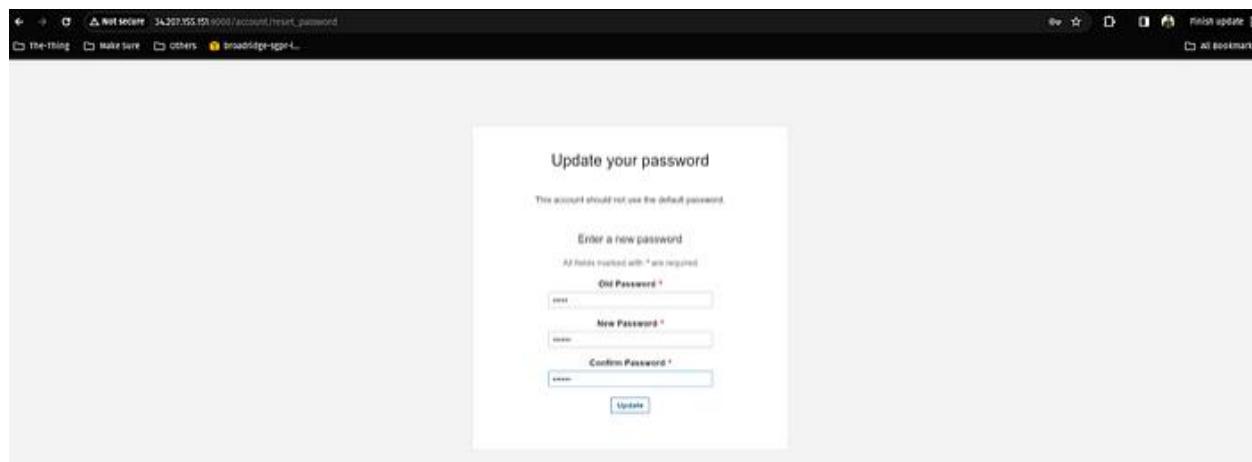
```

Now, copy your Public IP of Jenkins Server and add 9000 Port on your browser.

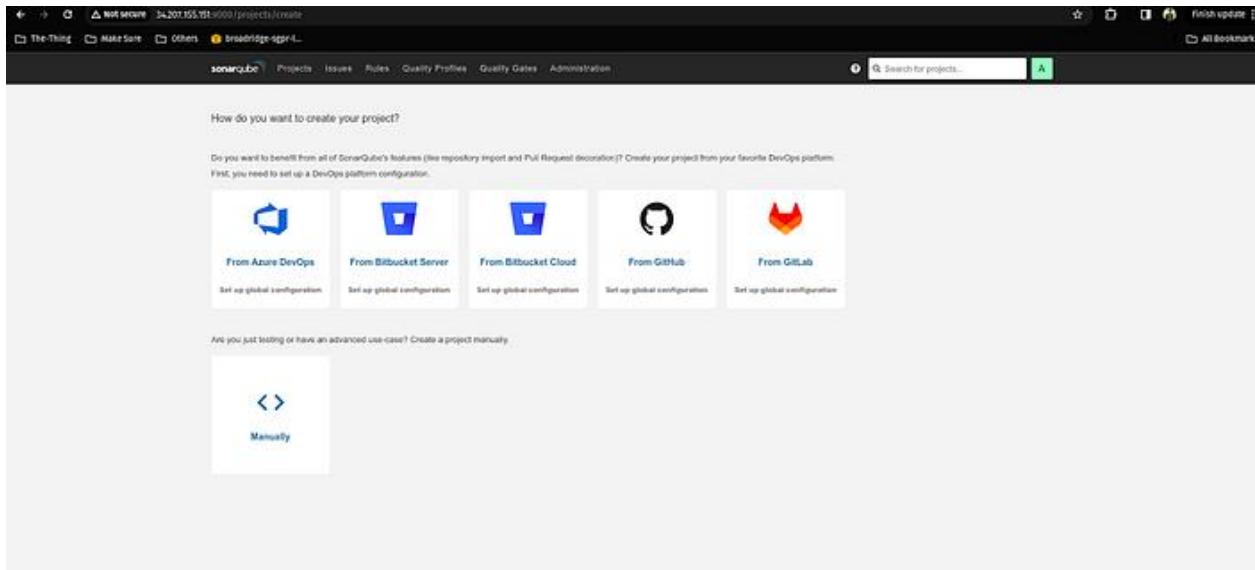
The username and password will be admin



Reset the password and click on Update



You will see your Sonarqube Server in the below snippet.



Install the Trivy tool on the Jenkins Server

```
sudo apt-get install wget apt-transport-https gnupg lsb-release
wget -qO - https://aquasecurity.github.io/trivy-repo/deb/public.key | sudo apt-key add -
deb https://aquasecurity.github.io/trivy-repo/deb $(lsb_release -sc) main | sudo tee -a
/etc/apt/sources.list.d/trivy.list
sudo apt-get update
sudo apt-get install trivy
```

```
ubuntu@172-31-59-91:~$ sudo apt-get install wget apt-transport-https gnupg lsb-release
wget -qO - https://aquasecurity.github.io/trivy-repo/deb/public.key | sudo apt-key add -
deb https://aquasecurity.github.io/trivy-repo/deb $(lsb_release -sc) main | sudo tee -a /etc/apt/sources.list.d/trivy.list
sudo apt-get update
sudo apt-get install trivy
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
lsb-release is already the newest version (11.1.ubuntu4).
lsb-release set to manually installed.
wget is already the newest version (1.21.2-2ubuntu1).
apt is already the newest version (2.4.11-1ubuntu0.1).
gnupg is already the newest version (2.2.27-3ubuntu2.1).
gnupg set to manually installed.
The following NEW packages will be installed:
  apt-transport-https
0 upgraded, 1 newly installed, 0 to remove and 26 not upgraded.
Need to get 1510 B of archives.
After this operation, 170 kB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 https://mirr0r.com/1.4.25/archive.ubuntu.com/ubuntu jammy-updates/universe amd64 apt-transport-https all 2.4.11 [1510 B]
Fetched 1510 B in 0s (990.5 kB/s)
Selecting previously unselected package apt-transport-https.
(Reading database ... 66852 files and directories currently installed.)
Preparing to unpack .../apt-transport-https_2.4.11_all.deb ...
Unpacking apt-transport-https (2.4.11) ...
Setting up apt-transport-https (2.4.11) ...
Scanning processes...
Scanning linux images...
```

Install and Configure the Prometheus, Node Exporter, and Grafana on the Monitoring Server

Login to the Monitoring Server

```
manapatnak@pop-01:~$ ssh -i "Aman-Pathak.pem" ubuntu@ec2-54-152-127-65.compute-1.amazonaws.com
The authenticity of host 'ec2-54-152-127-65.compute-1.amazonaws.com (54.152.127.65)' can't be established.
ED25519 key fingerprint is SHA256:st/AMW46dab0/VlVnJ3duC1mWdv5NWI2Rui0WicIBo.
It is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-54-152-127-65.compute-1.amazonaws.com' (ED25519) to the list of known hosts.

You are now connected to the server as user "ubuntu". To run a command as administrator (user "root"), use "sudo <command>".

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

System information as of Wed Dec 27 15:13:05 UTC 2023

System load: 0.0          Processes:           105
Usage of /: 10.8% of 14.36GB  Users logged in:      0
Memory usage: 5%          IPv4 address for eth0: 172.31.52.7
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

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-52-7:~
```

Create Prometheus user

```
sudo useradd \
- system \
- no-create-home \
- shell /bin/false prometheus
```

```
ubuntu@ip-172-31-52-7:~$ sudo useradd prometheus  
    --system %  
    --no-create-home %  
    --shell /bin/false prometheus  
ubuntu@ip-172-31-52-7:~$ [ ]
```

Download the Prometheus file on the Monitoring Server

```
wget https://github.com/prometheus/prometheus/releases/download/v2.49.0-rc.1/prometheus-2.49.0-rc.1.linux-amd64.tar.gz
```

Untar the Prometheus downloaded package

```
tar -xvf prometheus-2.49.0-rc.1.linux-amd64.tar.gz
```

```
ubuntu@ip-172-31-52-7:~$ tar -xvf prometheus-2.49.0-rc.1.linux-amd64.tar.gz
prometheus-2.49.0-rc.1.linux-amd64/
prometheus-2.49.0-rc.1.linux-amd64/LICENSE
prometheus-2.49.0-rc.1.linux-amd64/NOTICE
prometheus-2.49.0-rc.1.linux-amd64/prometheus
prometheus-2.49.0-rc.1.linux-amd64/prometheus/
prometheus-2.49.0-rc.1.linux-amd64/prometheus-overview.html
prometheus-2.49.0-rc.1.linux-amd64/prometheus/node-cpu.html
prometheus-2.49.0-rc.1.linux-amd64/prometheus/node.html
prometheus-2.49.0-rc.1.linux-amd64/prometheus/prometheus.html
prometheus-2.49.0-rc.1.linux-amd64/prometheus/index.html.example
prometheus-2.49.0-rc.1.linux-amd64/prometheus/node-overview.html
prometheus-2.49.0-rc.1.linux-amd64/prometheus/node-disk.html
prometheus-2.49.0-rc.1.linux-amd64/prometheus/prometheus.yml
prometheus-2.49.0-rc.1.linux-amd64/promtool
prometheus-2.49.0-rc.1.linux-amd64/console_libraries/
prometheus-2.49.0-rc.1.linux-amd64/console_libraries/menu.lib
prometheus-2.49.0-rc.1.linux-amd64/console_libraries/prom.lib
ubuntu@ip-172-31-52-7:~$
```

Create two directories /data and /etc/prometheus to configure the Prometheus

```
sudo mkdir -p /data /etc/prometheus
```

Now, enter into the prometheus package file that you have untar in the earlier step.

```
cd prometheus-2.49.0-rc.1.linux-amd64/
```

```
ubuntu@ip-172-31-52-7:~$ sudo mkdir -p /data /etc/prometheus
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ cd prometheus-2.49.0-rc.1.linux-amd64/
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ ls
LICENSE NOTICE console_libraries consoles prometheus prometheus.yml promtool
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ 
```

Move the prometheus and promtool files package in /usr/local/bin

```
sudo mv prometheus promtool /usr/local/bin/
```

```
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ ls
LICENSE NOTICE console_libraries consoles prometheus prometheus.yml promtool
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ sudo mv prometheus promtool /usr/local/bin/
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ 
```

Move the console and console_libraries and prometheus.yml in the /etc/prometheus

```
sudo mv consoles console_libraries/ prometheus.yml /etc/prometheus/
```

```
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ sudo mv consoles console_libraries/ prometheus.yml /etc/prometheus/
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ 
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ ls /etc/prometheus/
console_libraries consoles prometheus.yml
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ 
```

Provide the permissions to prometheus user

```
sudo chown -R prometheus:prometheus /etc/prometheus/ /data/
```

```
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ sudo chown -R prometheus:prometheus /etc/prometheus/ /data/
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ 
```

Check and validate the Prometheus

```
prometheus --version
```

```
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ prometheus --version
prometheus, version 2.49.0-rc.1 (branch: HEAD, revision: 1e306056a6716366c74dbde6fc160fe5fd1fcda)
  build user:        root@23ee6cc14eb
  build date:       20231220-09:30:04
  go version:      go1.21.5
  platform:        linux/amd64
  tags:             netgo,builtinAssets,stringlabels
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ 
```

Create a systemd configuration file for prometheus

Edit the file /etc/systemd/system/prometheus.service

```
sudo vim /etc/systemd/system/prometheus.service
```

and paste the below configurations in your prometheus.service configuration file and save it

```
[Unit]
Description=Prometheus
Wants=network-online.target
After=network-online.target
StartLimitIntervalSec=500
StartLimitBurst=5
[Service]
User=prometheus
Group=prometheus
Type=simple
Restart=on-failure
RestartSec=5s
ExecStart=/usr/local/bin/prometheus \
- config.file=/etc/prometheus/prometheus.yml \
- storage.tsdb.path=/data \
- web.console.templates=/etc/prometheus/consoles \
- web.console.libraries=/etc/prometheus/console_libraries \
- web.listen-address=0.0.0.0:9090 \
- web.enable-lifecycle
[Install]
WantedBy=multi-user.target
```

```
[Unit]
Description=Prometheus
Wants=network-online.target
After=network-online.target
StartLimitIntervalSec=500
StartLimitBurst=5
[Service]
User=prometheus
Group=prometheus
Type=simple
Restart=on-failure
RestartSec=5s
ExecStart=/usr/local/bin/prometheus \
- config.file=/etc/prometheus/prometheus.yml \
- storage.tsdb.path=/data \
- web.console.templates=/etc/prometheus/consoles \
- web.console.libraries=/etc/prometheus/console_libraries \
- web.listen-address=0.0.0.0:9090 \
- web.enable-lifecycle
[Install]
WantedBy=multi-user.target
```

Once you write the systemd configuration file for Prometheus, then enable it and start the Prometheus service.

```
sudo systemctl enable prometheus.service
sudo systemctl start prometheus.service
systemctl status prometheus.service
```

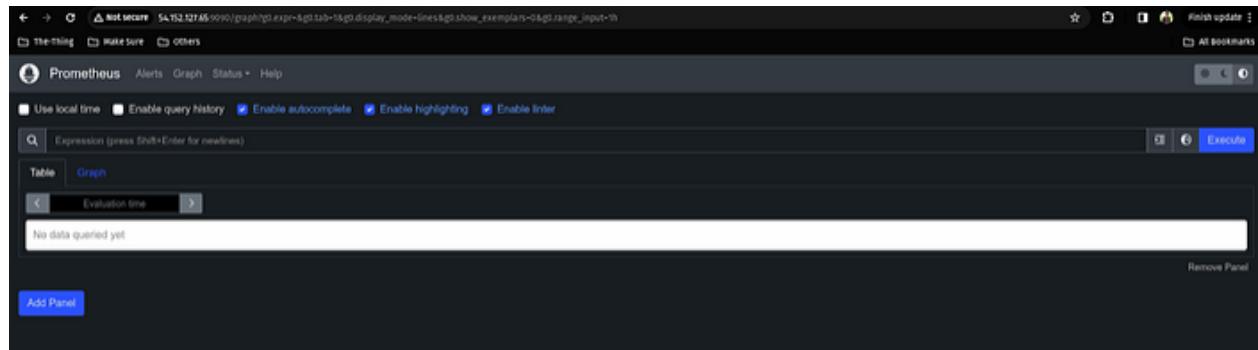
```

ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ sudo systemctl enable prometheus.service
Created symlink /etc/systemd/system/multi-user.target.wants/prometheus.service → /etc/systemd/system/prometheus.service.
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ sudo systemctl start prometheus.service
ubuntu@ip-172-31-52-7:~/prometheus-2.49.0-rc.1.linux-amd64$ sudo systemctl status prometheus.service
● prometheus.service - Prometheus
   Loaded: loaded (/etc/systemd/system/prometheus.service; enabled; vendor preset: enabled)
     Active: active (running) since Wed 2023-12-27 15:39:56 UTC; 5s ago
       Main PID: 1793 (prometheus)
         Tasks: 7 (limit: 4667)
        Memory: 15.8M
          CPU: 67ms
        CGroup: /system.slice/prometheus.service
               └─1793 /usr/local/bin/prometheus --config.file=/etc/prometheus/prometheus.yml --storage.tsdb.path=/data --web.console.templates=/etc/prometheus/consoles --web.console.libraries=

Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.662Z caller=head.go:687 level=info component=t+sd msg="On-disk memory mappable chunks replay completed" duration=3.35µs
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.662Z caller=head.go:695 level=info component=t+sd msg="Replaying WAL, this may take a while"
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.662Z caller=head.go:766 level=info component=t+sd msg="WAL segment loaded" segment=0 maxSegment=0
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.662Z caller=head.go:893 level=info component=t+sd msg="WAL replay completed" checkpoint.replay_duration=34.161us vol=1
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.662Z caller=main.go:1060 level=info fs_type=EXT4-SUPER_MAGIC
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.662Z caller=main.go:1245 level=info msg="Load balancer configuration file" filename=/etc/prometheus/prometheus.yml
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.670Z caller=main.go:1282 level=info msg="Completed loading of configuration file" filename=/etc/prometheus/prometheus.yml
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.670Z caller=main.go:1024 level=info msg="Server is ready to receive web requests."
Dec 27 15:39:56 ip-172-31-52-7 prometheus[1793]: ts=2023-12-27T15:39:56.670Z caller=manager.go:146 level=info component="rule manager" msg="Starting rule manager..."

```

Once the Prometheus service is up and running then, copy the public IP of your Monitoring Server and paste it into your favorite browser with a 9090 port.



Now, we have to install a node exporter to visualize the machine or hardware level data such as CPU, RAM, etc on our Grafana dashboard.

To do that, we have to create a user for it.

```

sudo useradd \
- system \
- no-create-home \
- shell /bin/false node_exporter

```

```

ubuntu@ip-172-31-52-7:~$ sudo useradd \
--system \
--no-create-home \
--shell /bin/false node_exporter
ubuntu@ip-172-31-52-7:~$ 

```

Download the node exporter package

```

wget
https://github.com/prometheus/node_exporter/releases/download/v1.7.0/node_exporter-1.7.0.linux-amd64.tar.gz

```

```

ubuntu@ip-172-31-52-7:~$ wget https://github.com/prometheus/prometheus/releases/download/v2.49.0-rc.1/prometheus-2.49.0-rc.1.linux-amd64.tar.gz
--2023-12-27 15:15:08-- https://github.com/prometheus/prometheus/releases/download/v2.49.0-rc.1/prometheus-2.49.0-rc.1.linux-amd64.tar.gz
Resolving github.com (github.com)... 140.82.114.3
Connecting to github.com (github.com)|140.82.114.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 9731690 (9.3Mi) [application/octet-stream]
Location: https://objects.githubusercontent.com/github-production-release-asset-2e65be/6838921/7b134043-d3ed-4b37-bbe2-789435ef95837X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4C5VENH5AN2F20231227T151508ZGX-Amz-Expires=38000X-Amz-Signature=7957799c6ed6d7313c180d174fe0ba164630b03d19b8bf8f5d90a7973c28731736X-Amz-SignedHeaders=host&actor_id=0&key_id=6838921&response-content-disposition=attachment%3Bfilename%3Dprometheus-2.49.0-rc.1.linux-amd64.tar.gz&response-content-type=application%2Foctet-stream [following]
--2023-12-27 15:15:08-- https://objects.githubusercontent.com/github-production-release-asset-2e65be/6838921/7b134043-d3ed-4b37-bbe2-789435ef95837X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4C5VENH5AN2F20231227T151508ZGX-Amz-Expires=38000X-Amz-Signature=7957799c6ed6d7313c180d174fe0ba164630b03d19b8bf8f5d90a7973c28731736X-Amz-SignedHeaders=host&actor_id=0&key_id=6838921&response-content-disposition=attachment%3Bfilename%3Dprometheus-2.49.0-rc.1.linux-amd64.tar.gz&response-content-type=application%2Foctet-stream
Resolving objects.githubusercontent.com (objects.githubusercontent.com)... 185.199.109.133, 185.199.109.133, 185.199.110.133, ...
Connecting to objects.githubusercontent.com (objects.githubusercontent.com)|185.199.109.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 9731690 (9.3Mi) [application/octet-stream]
Saving to: 'prometheus-2.49.0-rc.1.linux-amd64.tar.gz'

prometheus-2.49.0-rc.1.linux-amd64.tar.gz      100%[=====]  92.66M   131MB/s   in 0.7s

2023-12-27 15:15:09 (131 MB/s) - 'prometheus-2.49.0-rc.1.linux-amd64.tar.gz' saved [97161690/97161690]

ubuntu@ip-172-31-52-7:~$ ls
prometheus-2.49.0-rc.1.linux-amd64.tar.gz
ubuntu@ip-172-31-52-7:~$ 
```

Untar the node exporter package file and move the node_exporter directory to the /usr/local/bin directory

```

tar -xvf node_exporter-1.7.0.linux-amd64.tar.gz
sudo mv node_exporter-1.7.0.linux-amd64/node_exporter /usr/local/bin/ 
```

```

ubuntu@ip-172-31-52-7:~$ tar -xvf node_exporter-1.7.0.linux-amd64.tar.gz
node_exporter-1.7.0.linux-amd64/
node_exporter-1.7.0.linux-amd64/LICENSE
node_exporter-1.7.0.linux-amd64/node_exporter
node_exporter-1.7.0.linux-amd64/NOTICE
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ sudo mv node_exporter-1.7.0.linux-amd64/node_exporter /usr/local/bin/
ubuntu@ip-172-31-52-7:~$ 
```

Validate the version of the node exporter

```

node_exporter --version 
```

```

ubuntu@ip-172-31-52-7:~$ node_exporter --version
node_exporter, version 1.7.0 (branch: HEAD, revision: 7333465abf9efbe81876393bb57e6fadb9466041b)
  build user:        root@03591b902f6d8
  build date:       20231112-23:53:35
  go version:      go1.21.4
  platform:        linux/amd64
  tags:             netgo osusergo static_build
ubuntu@ip-172-31-52-7:~$ 
```

Create the systemd configuration file for node exporter.

Edit the file

```

sudo vim /etc/systemd/system/node_exporter.service 
```

Copy the below configurations and paste them into the /etc/systemd/system/node_exporter.service file.

```

[Unit]
Description=Node Exporter
Wants=network-online.target
After=network-online.target
StartLimitIntervalSec=500
StartLimitBurst=5
[Service]
User=node_exporter
Group=node_exporter
Type=simple
Restart=on-failure
RestartSec=5s
ExecStart=/usr/local/bin/node_exporter \
- collector.logind
[Install]
WantedBy=multi-user.target 
```

```
[Unit]
Description=Node Exporter
Wants=network-online.target
After=network-online.target
StartLimitIntervalSec=500
StartLimitBurst=5

[Service]
User=node_exporter
Group=node_exporter
Type=simple
Restart=on-failure
RestartSec=5
ExecStart=/usr/local/bin/node_exporter \
--collector.logind

[Install]
WantedBy=multi-user.target

```

Enable the node exporter systemd configuration file and start it.

```
sudo systemctl enable node_exporter
sudo systemctl enable node_exporter
systemctl status node_exporter.service
```

```
ubuntu@ip-172-31-52-7:~$ sudo systemctl enable node_exporter
Created symlink /etc/systemd/system/multi-user.target.wants/node_exporter.service → /etc/systemd/system/node_exporter.service.

ubuntu@ip-172-31-52-7:~$ sudo systemctl start node_exporter.service
ubuntu@ip-172-31-52-7:~$ sudo systemctl status node_exporter.service
● node_exporter.service - Node Exporter
   Loaded: loaded (/etc/systemd/system/node_exporter.service; enabled; vendor preset: enabled)
     Active: active (running) since Wed 2023-12-27 15:53:27 UTC; 10s ago
       Main PID: 1987 (node_exporter)
         Tasks: 5 (limit: 4667)
        Memory: 2.4M
          CPU: 9ms
        CGroup: /system.slice/node_exporter.service
               └─ 1987 /usr/local/bin/node_exporter --collector.logind

Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=thermal_zone
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=timex
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=timenex
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=udp_queues
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=uname
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=version
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=xfs
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.699Z caller=node_exporter.go:117 level=info collector=rfs
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.700Z caller=tls_config.go:274 level=info msg="Listening on" address=[::]:9100
Dec 27 15:53:27 ip-172-31-52-7 node_exporter[1987]: ts=2023-12-27T15:53:27.700Z caller=tls_config.go:277 level=info msg="TLS is disabled." http=false address=[::]:9100
ubuntu@ip-172-31-52-7:~$
```

Now, we have to add a node exporter to our Prometheus target section. So, we will be able to monitor our server.

edit the file

```
sudo vim /etc/prometheus/prometheus.yml
```

Copy the content in the file

```
- job_name: "node_exporter"
  static_configs:
    - targets: ["localhost:9100"]
```

```
# my global config
global:
  scrape_interval: 15s # Set the scrape interval to every 15 seconds. Default is every 1 minute.
  evaluation_interval: 15s # Evaluate rules every 15 seconds. The default is every 1 minute.
  # scrape_timeout is set to the global default (10s).

# Alertmanager configuration
alerting:
  alertmanagers:
    - static_configs:
      - targets:
        - alertmanager:9093

# Load rules once and periodically evaluate them according to the global 'evaluation_interval'.
rule_files:
  # - "first.rules.yaml"
  # - "second.rules.yaml"

# A scrape configuration containing exactly one endpoint to scrape:
# Here it's Prometheus itself.
scrape_configs:
  # The job name is added as a label 'job=<job_name>' to any timeseries scraped from this config.
  # job_name: "prometheus"

  # metrics_path defaults to '/metrics'
  # scheme defaults to 'http'.

  static_configs:
    targets: ["localhost:9090"]

  - job_name: "node_exporter"
    static_configs:
      - targets: ["localhost:9100"]
```

After saving the file, validate the changes that you have made using promtool.

```
promtool check config /etc/prometheus/prometheus.yml
```

```
ubuntu@ip-172-31-52-7:~$ promtool check config /etc/prometheus/prometheus.yml
Checking /etc/prometheus/prometheus.yml
SUCCESS: /etc/prometheus/prometheus.yml is valid prometheus config file syntax
ubuntu@ip-172-31-52-7:~$
```

If your changes have been validated then, push the changes to the Prometheus server.

```
curl -X POST http://localhost:9090/-/reload
```

```
ubuntu@ip-172-31-52-7:~$ curl -X POST http://localhost:9090/-/reload
ubuntu@ip-172-31-52-7:~$
```

Now, go to your Prometheus server and this time, you will see one more target section as node_exporter which should be up and running.

The screenshot shows the Prometheus Targets page. At the top, there are tabs for 'All', 'Unhealthy', and 'Collapse All'. A search bar is present with the placeholder 'Filter by endpoint or labels'. Below the tabs, there are two sections: 'node_exporter (1/1 up)' and 'prometheus (1/1 up)'. Each section has a table with columns: Endpoint, State, Labels, Last Scrape, Scrape Duration, and Error. In the 'node_exporter' section, the endpoint is 'http://localhost:9100/metrics', state is 'UP', labels include 'instance="localhost:9100"', 'job="node_exporter"', and last scrape was 8.326s ago. In the 'prometheus' section, the endpoint is 'http://localhost:9090/metrics', state is 'UP', labels include 'instance="localhost:9090"', 'job="prometheus"', and last scrape was 7.56s ago. There are also small buttons for 'Edit' and 'View' next to each table entry.

Now, install the Grafana tool to visualize all the data that is coming with the help of Prometheus.

```
sudo apt-get install -y apt-transport-https software-properties-common wget
sudo mkdir -p /etc/apt/keyrings/
wget -q -O - https://apt.grafana.com/gpg.key | gpg - dearmor | sudo tee
/etc/apt/keyrings/grafana.gpg > /dev/null
echo "deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com stable main" |
sudo tee -a /etc/apt/sources.list.d/grafana.list
echo "deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com beta main" |
sudo tee -a /etc/apt/sources.list.d/grafana.list
sudo apt-get update
```

```

ubuntu@ip-172-31-52-7:~$ sudo apt-get install -y apt-transport-https software-properties-common wget
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Note: selecting 'apt' instead of 'apt-transport-https'.
wget is already the newest version (1.23.2-2ubuntu1).
apt is set to manually installed.
apt is already the newest version (2.4.11).
apt set to manually installed.
software-properties-common is already the newest version (0.99.22.8).
software-properties-common set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ sudo mkdir -p /etc/apt/keyrings/
wget -O https://apt.grafana.com/gpg.key | gpg --dearmor | sudo tee /etc/apt/keyrings/grafana.gpg > /dev/null
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ echo "deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com stable main" | sudo tee -a /etc/apt/sources.list.d/grafana.list
deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com stable main
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ echo "deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com beta main" | sudo tee -a /etc/apt/sources.list.d/grafana.list
deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com beta main
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ echo "deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com jammy main" | sudo tee -a /etc/apt/sources.list.d/grafana.list
deb [signed-by=/etc/apt/keyrings/grafana.gpg] https://apt.grafana.com jammy main
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ # Updates the list of available packages
sudo apt-get update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-stable InRelease [5984 B]
Get:6 https://apt.grafana.com beta InRelease [5976 B]
Get:7 https://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 Packages [14.1 MB]
Get:8 https://apt.grafana.com stable/main amd64 Packages [184 kB]
Err:9 https://apt.grafana.com beta InRelease

```

Install the Grafana

```
sudo apt-get install grafana
```

```

ubuntu@ip-172-31-52-7:~# Installs the latest OSS release;
sudo apt-get install grafana
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  fontconfig-config fonts-dejavu-core libfontconfig1
The following NEW packages will be installed:
  fontconfig-config fonts-dejavu-core libfontconfig1
0 upgraded, 5 newly installed, 0 to remove and 26 not upgraded.
Need to get 305 MB of archives.
After this operation, 388 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 fonts-dejavu-core all 2.37-2build1 [1641 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 fontconfig-config all 2.13.1-4.2ubuntu5 [29.1 kB]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/main amd64 libfontconfig1 amd64 2.13.1-4.2ubuntu5 [131 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-dejavu-core 1.2.2-4 [407 kB]
Get:5 https://apt.grafana.com stable/main amd64 grafana amd64 10.2.3 [104 kB]
Fetched 105 MB in 3s (36.6 MB/s)
Selecting previously unselected package fonts-dejavu-core.
(Reading database ... 64799 files and directories currently installed.)

```

Enable and start the Grafana Service

```
sudo systemctl enable grafana-server.service
```

```
sudo systemctl start grafana-server.service
```

```
sudo systemctl status grafana-server.service
```

```

ubuntu@ip-172-31-52-7:~$ sudo systemctl enable grafana-server.service
Synchronizing state of grafana-server.service with SysV service script with /lib/systemd/systemd-sysv-install.
Executing: /lib/systemd/systemd-sysv-install enable grafana-server
Created symlink /etc/systemd/system/multi-user.target.wants/grafana-server.service → /lib/systemd/system/grafana-server.service.
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ sudo systemctl start grafana-server.service
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ sudo systemctl status grafana-server.service
● grafana-server.service - Grafana Instance
   Loaded: loaded (/lib/systemd/system/grafana-server.service; enabled; vendor preset: enabled)
     Active: active (running) since Wed 2023-12-27 16:07:44 UTC; 5s ago
       Docs: http://docs.grafana.org
      Main PID: 2034 (grafana)
        Tasks: 6 (limit: 4667)
         Memory: 1.4GiB
            CPU: 1.472s
           CGroup: /system.slice/grafana-server.service
               └─2034 /usr/share/grafana/bin/grafana server --config=/etc/grafana/grafana.ini --pidfile=/run/grafana/grafana-server.pid --packaging=deb cfg=default.paths.logs=/var/log/grafana

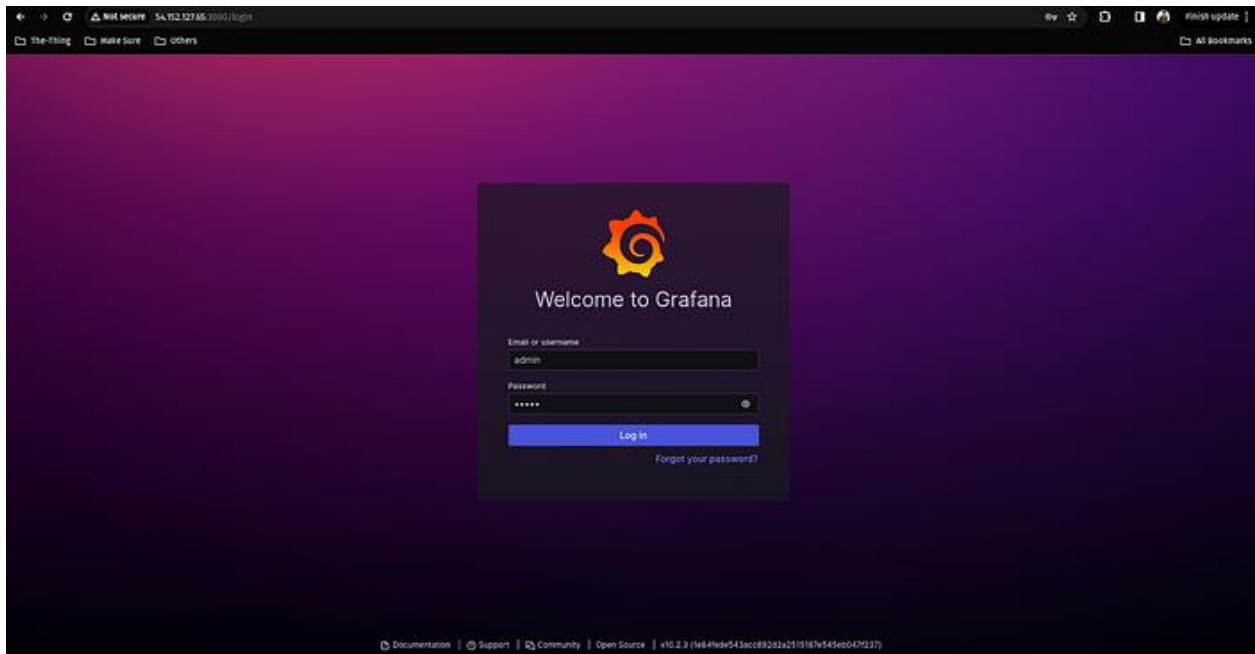
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.056951952 level=info msg="Migration successfully executed" id="Update uid column values in playlist" duration=1µs
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.057256192 level=info msg="Executing migration" id="Add index for uid in playlist"
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.058422938 level=info msg="Migration successfully executed" id="Add index for uid in playlist" duration=1µs
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.064784082 level=info msg="Executing migration" id="update group index for alert rules"
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.071421089 level=info msg="Migration successfully executed" id="update group index for alert rules" duration=1µs
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.071421089 level=info msg="Executing migration" id="update group index for alert rules" duration=1µs
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.071752122 level=info msg="Migration successfully executed" id="managed Folder permissions alert actions"
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.0774581092 level=info msg="Executing migration" id="admin only folder/dashboard permission"
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.0779015372 level=info msg="Migration successfully executed" id="admin only folder/dashboard permission" duration=1µs
Dec 27 16:07:50 ip-172-31-52-7 grafana[2034]: logger=migrator t=2023-12-27T16:07:50.08835639432 level=info msg="Executing migration" id="add action column to seed_assignment"

```

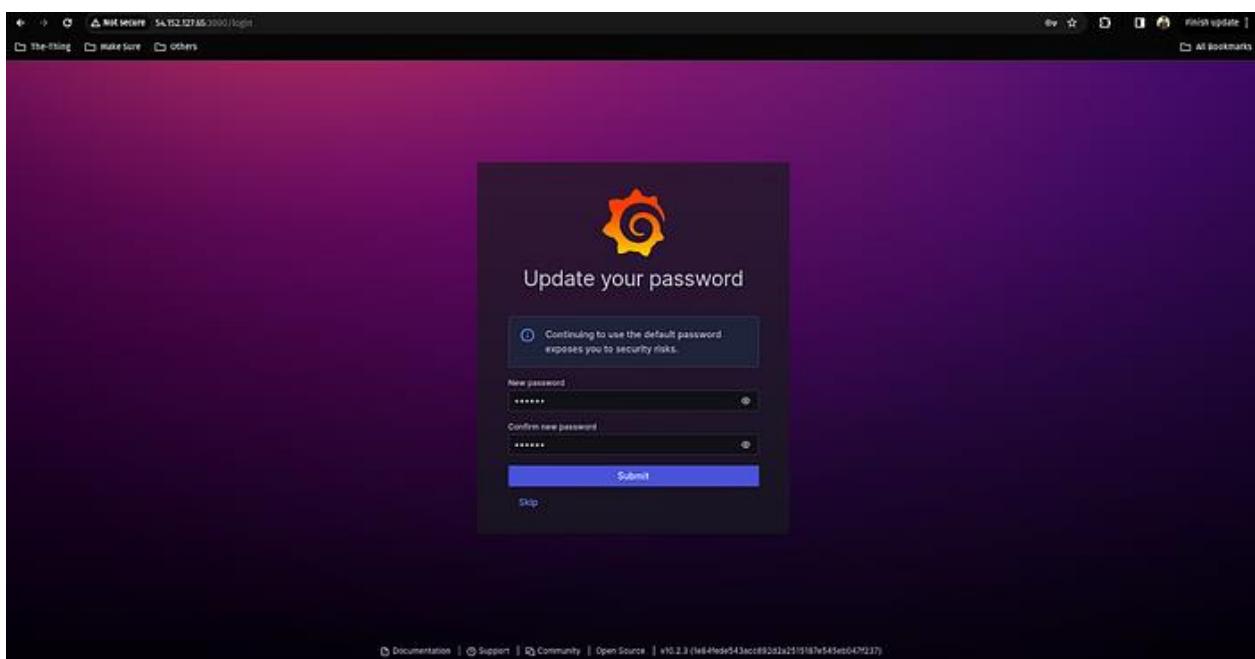
(lines 1-21/21 (END))

To access the Grafana dashboard, copy the public IP address of the Monitoring Server and paste it into your favorite browser with port 3000

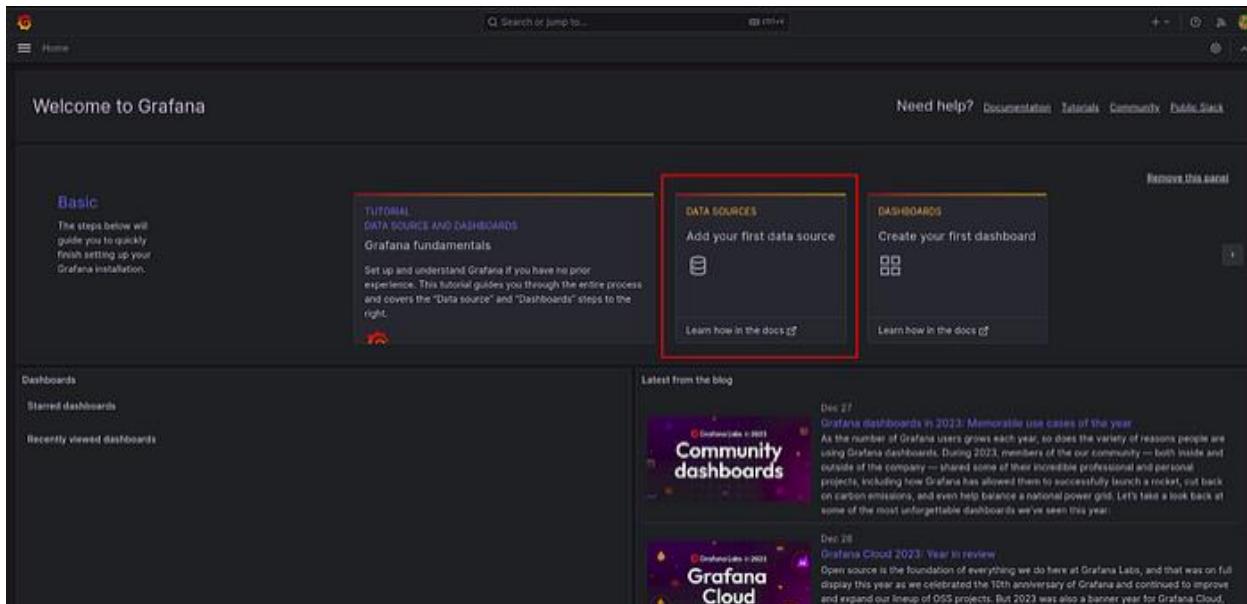
username and password will be admin



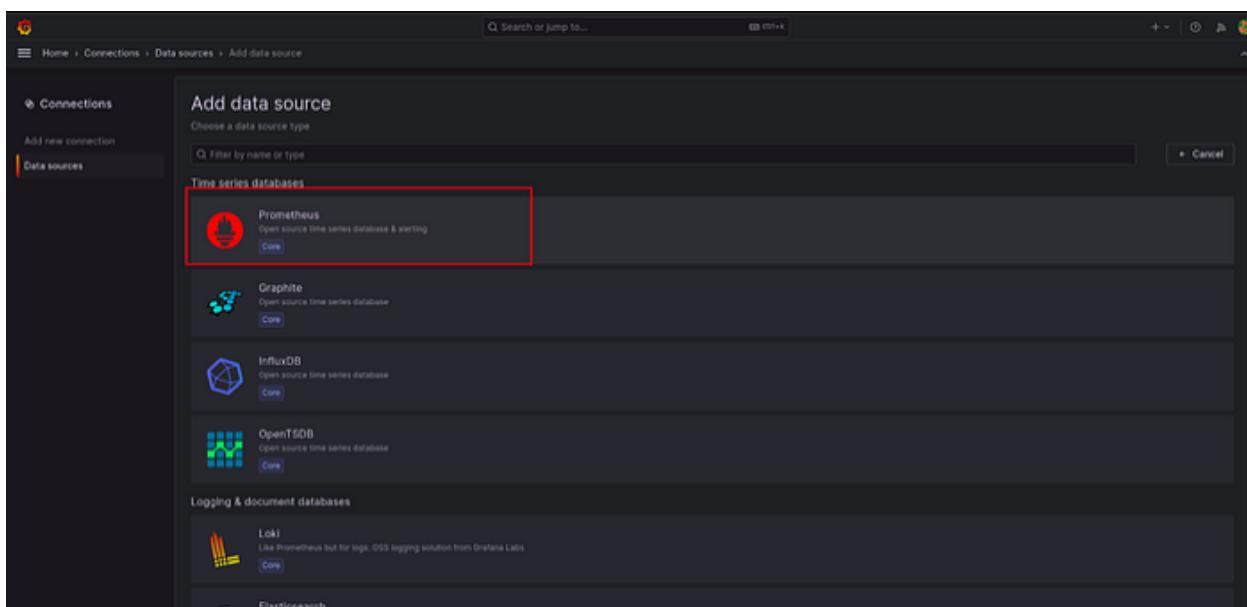
Reset the password



Click on Data sources



Select the Prometheus



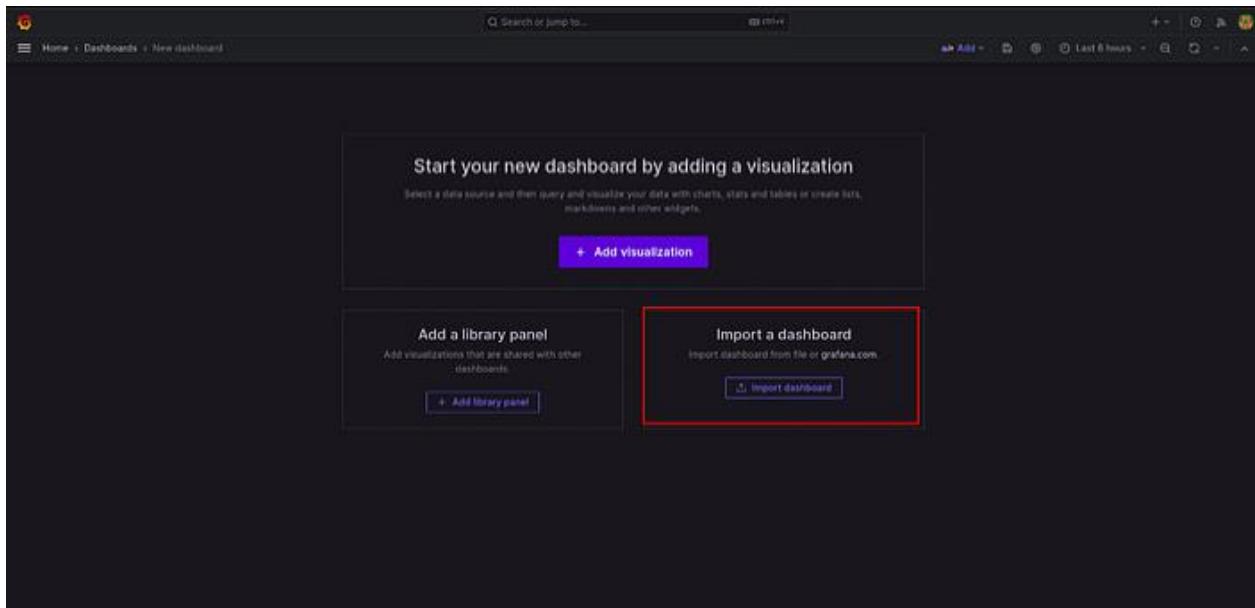
Provide the Monitoring Server Public IP with port 9090 to monitor the Monitoring Server.

The screenshot shows the 'Data sources' section of the Grafana interface. A data source named 'prometheus' is selected. The 'Settings' tab is active. A message box at the top says 'Configure your Prometheus data source below' or skip it. The 'Name' field is set to 'prometheus'. The 'Prometheus server URL' field is set to 'http://54.12.127.65:9090'. The 'Default' button is selected.

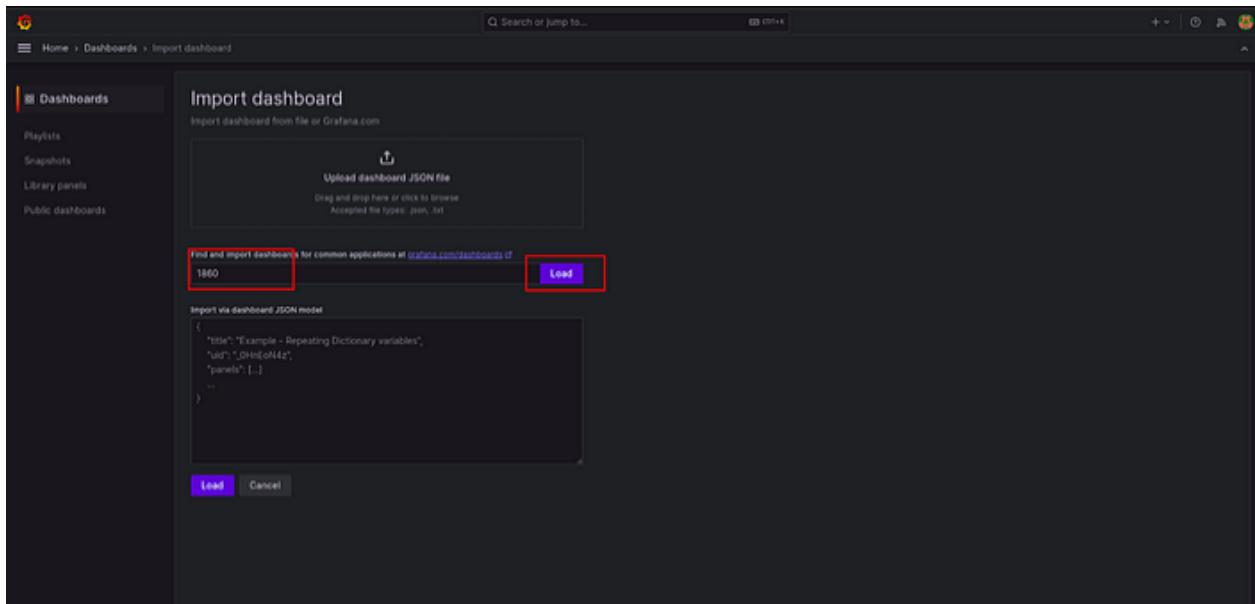
Click on Save and test.

The screenshot shows the 'Settings' tab for the 'prometheus' data source. It includes sections for 'Query editor', 'Performance', and 'Other'. The 'HTTP method' is set to 'POST'. At the bottom, there are 'Delete' and 'Save & test' buttons, with 'Save & test' highlighted by a red box.

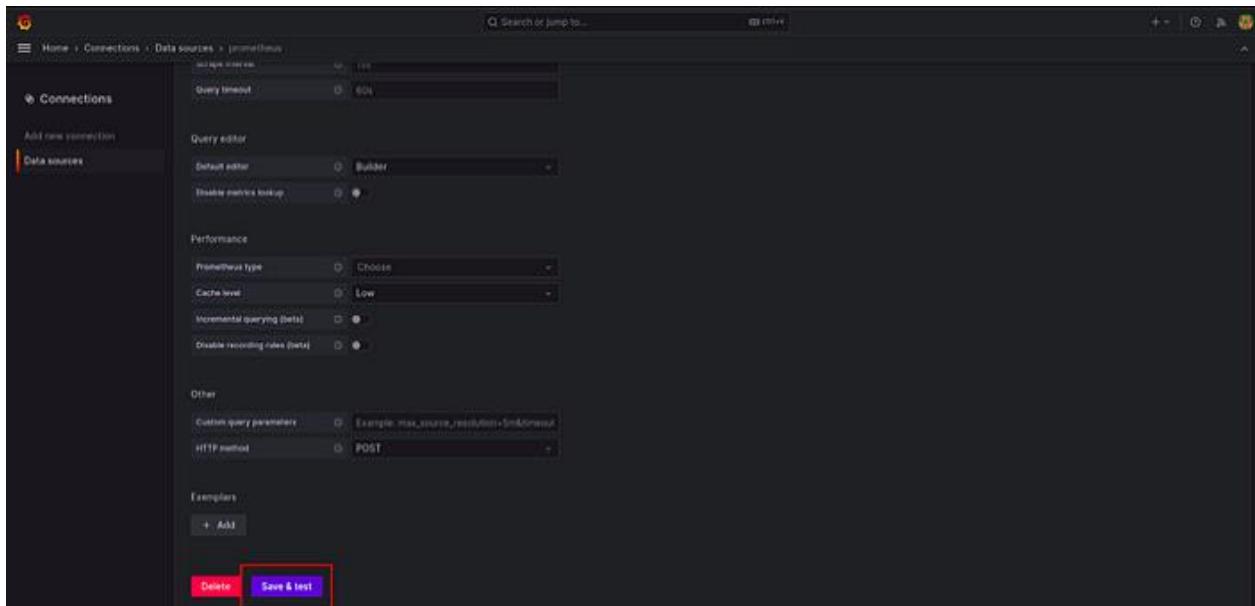
Go to the dashboard section of Grafana and click on the Import dashboard.



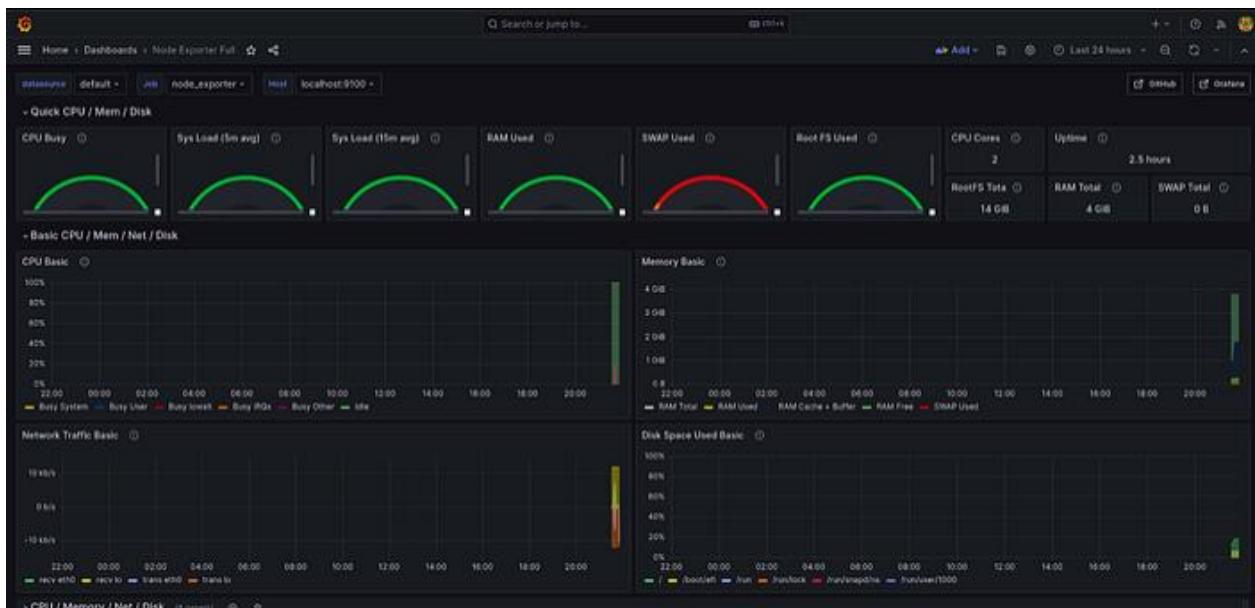
Add 1860 for the node exporter dashboard and click on Load.



Then, select the Prometheus from the drop down menu and click on Import



The dashboard will look like this



Now, we have to monitor our Jenkins Server as well.

For that, we need to install the Prometheus metric plugin on our Jenkins.

Go to Manage Jenkins -> Plugin search for Prometheus metrics install it and restart your Jenkins.

The screenshot shows the Jenkins Plugins page. A search bar at the top right contains the text 'Prometheus'. Below it, a table lists three plugins:

- Prometheus Metrics** (2.6.2): Jenkins Prometheus Plugin expose an endpoint (/prometheus) with metrics where a Prometheus Server can scrape. Released 5 days 0 hr ago.
- Cortex Metrics** (1.0.1): Adds the ability to publish run results to Cortex directly using the Prometheus push endpoint. Released 2 yr 9 mo ago.
- Otel agent host metrics monitoring** (1.1.3): monitoring observability. This plugin allows monitoring of Jenkins agents by deploying Prometheus node exporters and Otel collectors to them and linking to a Grafana dashboard displaying those gathered metrics. Released 5 mo 20 days ago.

A sidebar on the left shows navigation links: Dashboard, Manage Jenkins, Plugins, Updates, Available plugins (selected), Installed plugins, Advanced settings, and Download progress.

Edit the /etc/prometheus/prometheus.yml file

```
sudo vim /etc/prometheus/prometheus.yml
```

```
- job_name: "jenkins"
  static_configs:
    - targets: ["<jenkins-server-public-ip>:8080"]
```

```
# my global config
global:
  scrape_interval: 15s # Set the scrape interval to every 15 seconds. Default is every 1 minute.
  evaluation_interval: 15s # Evaluate rules every 15 seconds. The default is every 1 minute.
  # scrape_timeout is set to the global default (10s).

# Alertmanager configuration
alerting:
  alertmanagers:
    - static_configs:
      - targets:
          - alertmanager:9093

# Load rules once and periodically evaluate them according to the global 'evaluation_interval'.
rule_files:
  - "first_rules.yml"
  - "second_rules.yml"

# A scrape configuration containing exactly one endpoint to scrape.
# Here we're scrape Prometheus itself.
scrape_configs:
  - job_name: "prometheus"
    # The job name is added as a label 'job=<job_name>' to any timeseries scraped from this config.
    - job_name: "prometheus"

    # metrics_path defaults to '/metrics'
    # scheme defaults to 'http'.

    static_configs:
      - targets: ["localhost:9090"]
    - job_name: "node_exporter"
      static_configs:
        - targets: ["localhost:9100"]

    - job_name: "jenkins"
      static_configs:
        - targets: [<jenkins-server-public-ip>:8080"]
```

-- INSERT --

Once you add the Jenkins job, validate the Prometheus config file whether it is correct or not by running the below command.

```
promtool check config /etc/prometheus/prometheus.yml
```

Now, push the new changes on the Prometheus server

```
curl -X POST http://localhost:9090/-/reload
```

```
ubuntu@ip-172-31-52-7:~$ sudo vim /etc/prometheus/prometheus.yml
ubuntu@ip-172-31-52-7:~$ promtool check config /etc/prometheus/prometheus.yml
Checking /etc/prometheus/prometheus.yml
SUCCESS: /etc/prometheus/prometheus.yml is valid prometheus config file syntax

ubuntu@ip-172-31-52-7:~$ curl -X POST http://localhost:9090/-/reload
ubuntu@ip-172-31-52-7:~$
```

Copy the public IP of your Monitoring Server and paste on your favorite browser with a 9090 port with /target. You will see the targets that you have added in the /etc/prometheus/prometheus.yml file.

The screenshot shows the Prometheus Targets page. At the top, there are tabs for 'All', 'Unhealthy', and 'Collapse All'. A search bar labeled 'Filter by endpoint or labels' is present. Below the table, there are three status indicators: 'Unknown' (yellow), 'Unhealthy' (red), and 'Healthy' (green). The table lists three targets:

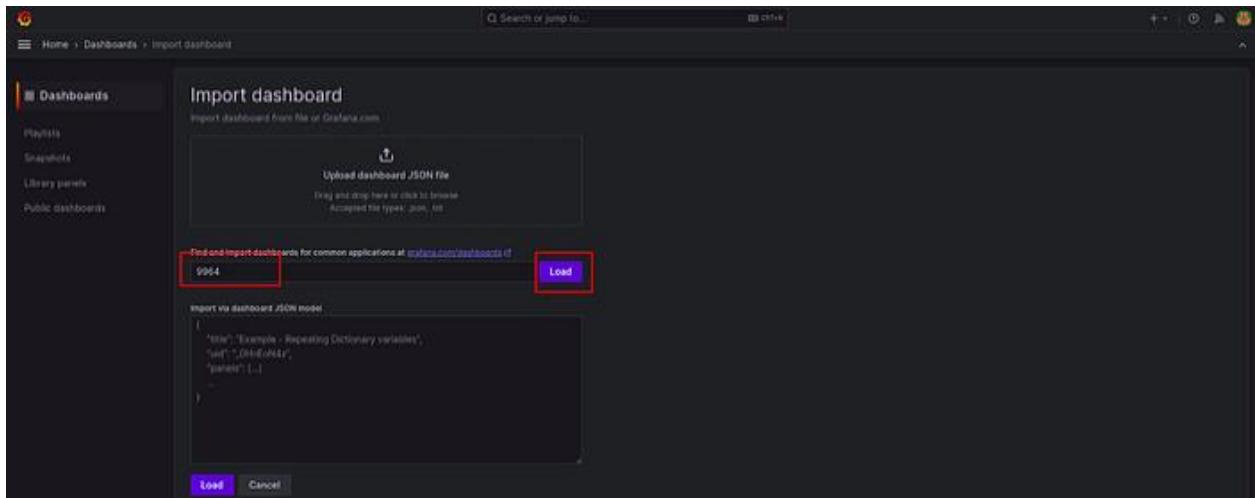
Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
http://192.168.1.11:8080/prometheus	OK	jenkins["192.168.1.11:8080"]	13.958s ago	23.806ms	
node_exporter (1/1 up)	OK	node_exporter["192.168.1.11:9100"]	9.720s ago	15.258ms	
prometheus (1/1 up)	OK	prometheus["192.168.1.11:9090"]	8.450s ago	5.688ms	

To add the Jenkins Dashboard on your Grafana server.

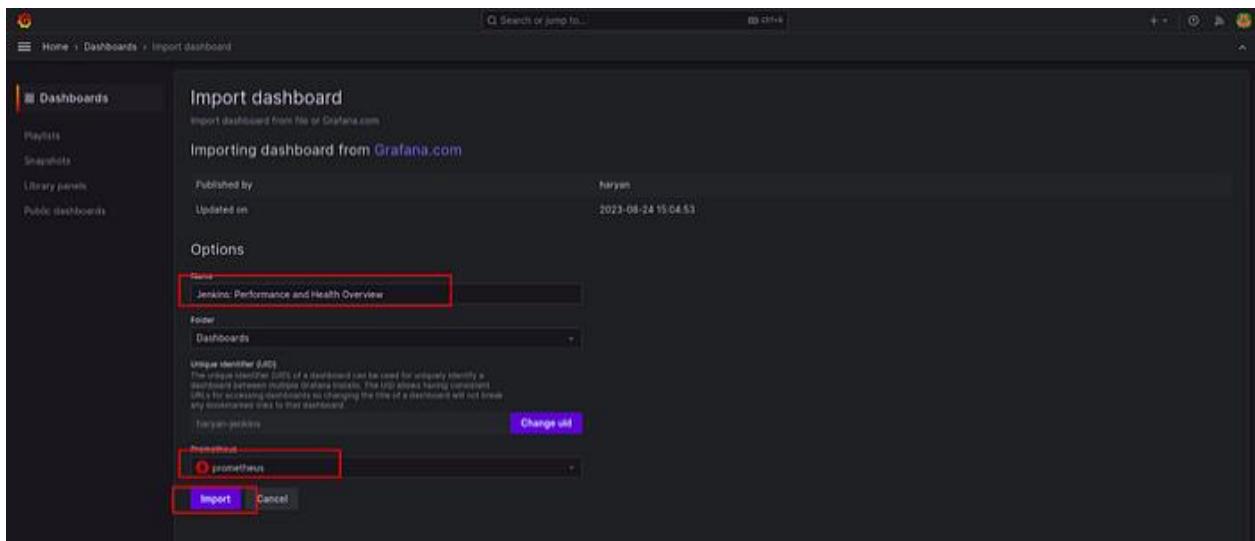
Click on New -> Import.

The screenshot shows the Grafana Dashboards page. On the right side, there is a 'New' button and an 'Import' button, both highlighted with red boxes. The main area displays a list of dashboards with a search bar and filter options.

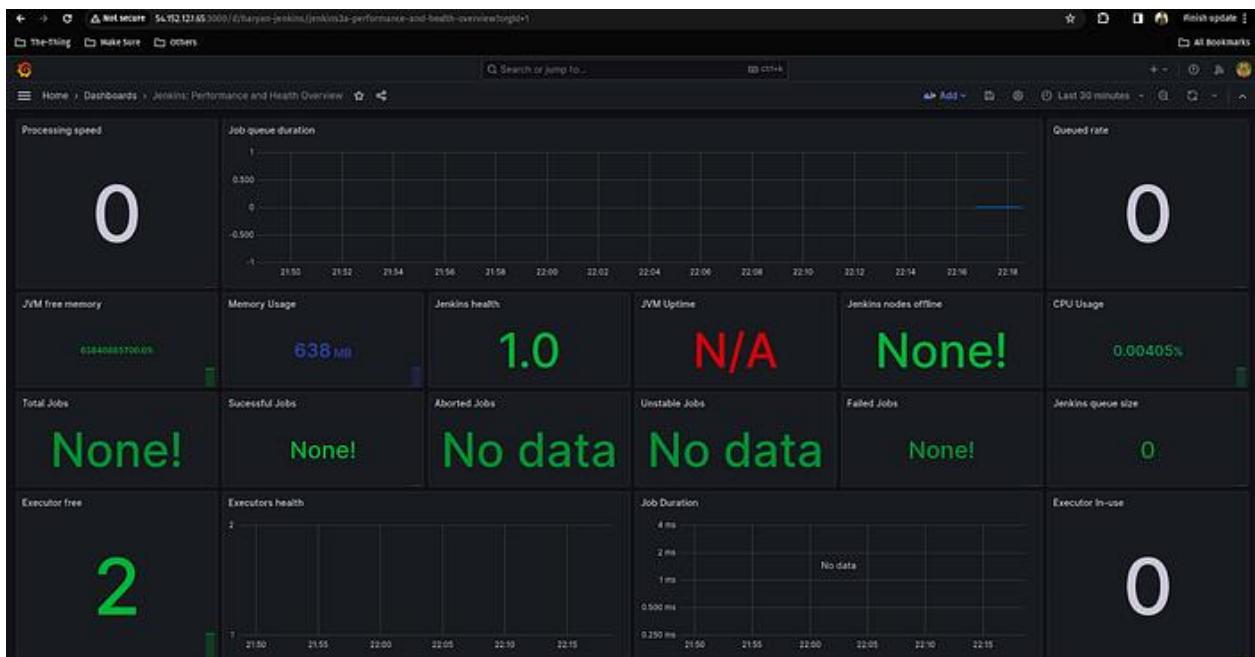
Provide the 9964 to Load the dashboard.



Select the default Prometheus from the drop-down menu and click on Import.



You will see your Jenkins Monitoring dashboard in the below snippet.



Now, we have to integrate Email Alert. So, if our Jenkins pipeline will succeed or fail we will get a notification alert on our email.

To do that, we need to install the Jenkins Plugin, whose name is Email Extension Template.

Manage Jenkins -> Plugins and install the Email Extension Template plugin.

After installing the plugin, go to your email ID and click on Manage account and you will see what looks like the below snippet.

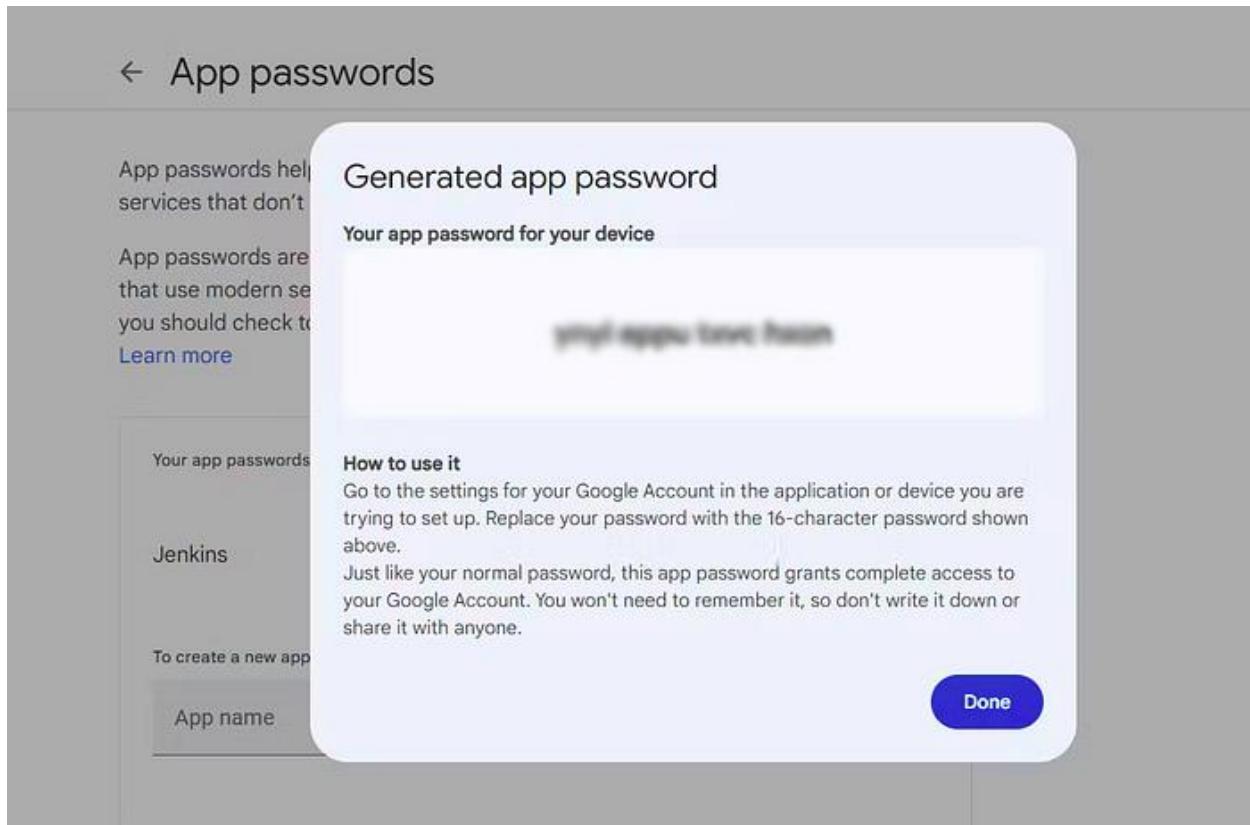
In the Security section, search for App passwords and click on it.

The screenshot shows the Google Account interface under the 'Security' tab. A search bar at the top has 'app' typed into it. Below the search bar, there are three results: 'Your connections to third-party apps & services', 'App passwords', and 'Web & App Activity'. The 'App passwords' result is highlighted with a red box. To the right of the search results, there is a 'Recent security activity' section listing three items: 'NoiseFit: Health & Fitness was given account access' (Dec 21 - Maharashtra, India), 'CRED was given account access' (Dec 20 - Maharashtra, India), and 'New sign-in on OnePlus Nord2 5G' (Dec 20 - Maharashtra, India). A 'See details' link is located below this section.

Gmail will prompt you for the password. Provide the password then you have to provide the name of your app where you are integrating email service.

The screenshot shows the 'App passwords' page under the 'Security' tab. It includes a brief description of what app passwords are and a note about their security. A 'Learn more' link is provided. Below this, a message states 'You don't have any app passwords.' There is a text input field labeled 'App name' containing 'Jenkins'. A 'Create' button is located at the bottom right of the input field.

You will get your password below. Copy the password and keep it secure somewhere.



Add your email ID and the password that you have generated in the previous step.

Go to Manage Jenkins -> Credentials.

Click on (global).

The screenshot shows the Jenkins "Credentials" page under "Manage Jenkins > Credentials". A single global credential entry is listed: "System" (Kind) with the ID "(global)".

Click on Add credentials

The screenshot shows the Jenkins "Global credentials (unrestricted)" page under "Manage Jenkins > Credentials > System". A table header is visible with columns for ID, Name, Kind, and Description. A note at the bottom of the table says: "This credential domain is empty. How about [adding some credentials?](#)"

Select the Username with password in Kind.

Provide your mail ID and generated password then provide the ID as mail to call both credentials.

The screenshot shows the Jenkins 'New credentials' configuration page. The 'Kind' dropdown is set to 'Username with password'. The 'Scope' dropdown is set to 'Global (Jenkins, nodes, items, all child items, etc.)'. The 'Username' field contains 'username' and has a red box around it. The 'Password' field contains 'password' and has a red box around it. The 'ID' field contains 'mail' and has a red box around it. The 'Description' field is empty. A blue 'Create' button is at the bottom.

You can see we have added the credentials for the mail.

Global credentials (unrestricted)				+ Add Credentials
ID	Name	Kind	Description	
mail	username@gmail.com/*****	Username with password		

Now, we have to configure our mail for the alerts.

Go to Jenkins -> Manage Jenkins -> System

Search for Extend E-mail Notification.

Provide the smtp.gmail.com in the SMTP server and 465 in the SMTP port.

Extended E-mail Notification

SMTP Server: smtp.gmail.com

SMTP Port: 465

Credentials: username@gmail.com:password

Advanced: Use SSL (selected), Use TLS, Use STARTTLS

Default user e-mail suffix:

Default Content type: HTML (text/html)

Save

Then, On the same page Search for Extend E-mail Notification.

Provide the smtp.gmail.com in the SMTP server and 465 in the SMTP port.

Select Use SMTP Authentication and provide the Gmail ID and its password in the Username and password.

To validate whether Jenkins can send the emails to you or not, check the Test configuration by sending a test e-mail.

E-mail Notification

SMTP server: smtp.gmail.com

Default user e-mail suffix:

Advanced: Use SMTP Authentication (selected)

User Name: username@gmail.com

Password: (Masked)

Port: 465

Reply-to Address:

Character:

UTF-8

Test configuration by sending test e-mail

Save

You can see below for the reference.

Test email #1 Inbox

 address not configured yet <aman07pathak@gmail.com>
to me ▾

This is test email #1 sent from Jenkins

Reply

Forward



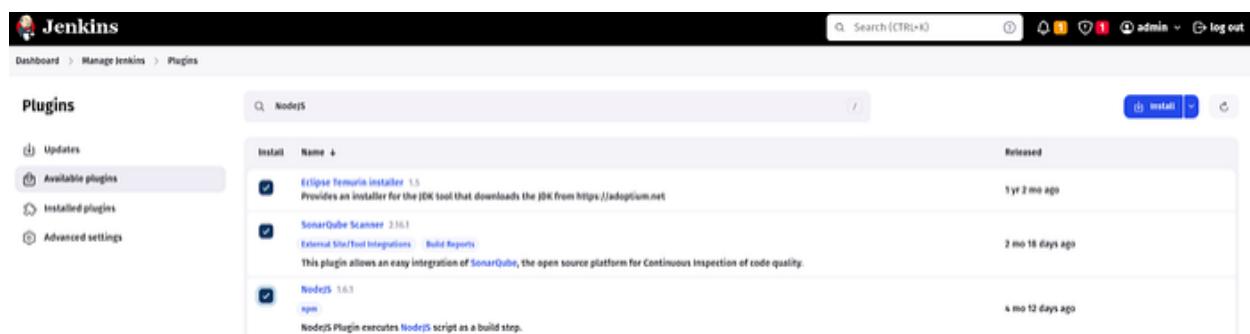
Now, we will set up our Jenkins Pipeline. But there are some plugins required to work with them.

Download the following plugins

Eclipse Temurin installer

SonarQube Scanner

NodeJS



The screenshot shows the Jenkins Plugins page. The search bar at the top contains 'NodeJS'. On the left, a sidebar has 'Available plugins' selected. The main area lists three plugins:

Install	Name	Released
<input checked="" type="checkbox"/>	Eclipse Temurin installer 1.5	1 yr 2 mo ago
<input checked="" type="checkbox"/>	SonarQube Scanner 2.16.1	2 mo 18 days ago
<input checked="" type="checkbox"/>	NodeJS 1.6.1	4 mo 12 days ago

Now, configure the plugins

Go to Manage Jenkins -> Tools

Click on Add JDK and provide the following things below



The screenshot shows the 'Add JDK' dialog. It has a 'Name' field containing 'jdk' and a checked 'Install automatically' checkbox. Under 'Install from adoptium.net', the 'Version' dropdown is set to 'JDK 21+25'. There is also an 'Add installer' button.

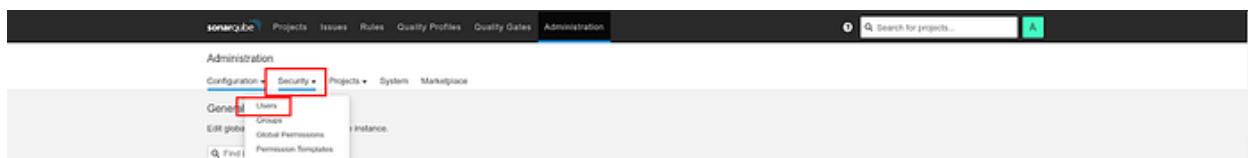
Click on Add NodeJS and provide the following things below



Now, we will configure Sonarqube

To access the sonarqube, copy the Jenkins Server public IP with port number 9000

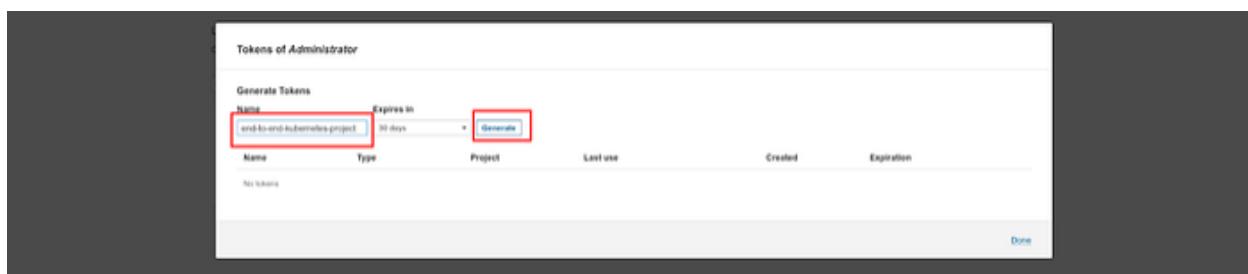
Then, click Security and click on Users.



Click on the highlighted blue box on the right to generate the token.



Now provide the name of your token and click on Generate.



Copy the generated token and keep it somewhere.

The screenshot shows the 'Tokens of Administrator' page. At the top, there's a 'Generate Tokens' section with fields for 'Name' (left empty) and 'Expires in' (set to '30 days'). A 'Generate' button is present. Below this, a message states: 'New token "end-to-end-kubernetes-project" has been created. Make sure you copy it now; you won't be able to see it again!'. A 'Copy' button is next to the token ID: 'sonar-kf29be5c3114813446e95a4f3d80014d5fc13eb'. A table lists tokens: 'end-to-end-kubernetes...' (User, Never used, Created: December 27, 2023, Expiration: January 26, 2024). A 'Revoke' button is shown for this row. At the bottom right is a 'Done' button.

Now, add the token to your Jenkins credentials

Go to Manage Jenkins -> Credentials.

Select the Secret text in Kind.

Provide your token then provide the ID as sonar-token to call the credentials.

The screenshot shows the 'New credentials' page under 'Manage Jenkins > Credentials > System > Global credentials (unrestricted)'. A 'Secret text' credential is being added. The form fields are: 'Scope' (Global Jenkins, nodes, items, all child items, etc), 'Name' (sonar), 'ID' (sonar-token), and 'Description' (SonarQube). The 'Secret text' field contains the token 'sonar-kf29be5c3114813446e95a4f3d80014d5fc13eb'. A 'Create' button is at the bottom.

Go to Manage Jenkins -> System

Click on Add Sonarqube

The screenshot shows the 'SonarQube servers' configuration page. It includes sections for 'Environment variables' (unchecked), 'SonarQube installations' (List of SonarQube installations), and an 'Add SonarQube' button.

Provide the name sonar-server with the Server URL and select the credentials that we have added.

SonarQube servers

If checked, job administrators will be able to inject a SonarQube server configuration as environment variables in the build.

Environment variables

SonarQube installations

List of SonarQube installations

Name
sonar-server

Server URL
Default is http://localhost:9000
http://192.168.1.10:9000

Server authentication token
SonarQube authentication token. Mandatory when anonymous access is disabled.
sonar-admin

+ Add +

Advanced ▾

Go to Manage Jenkins -> Tools

Find Sonarqube Scanner and click on Add

SonarQube Scanner installations

Add SonarQube Scanner

Provide the name sonar-server and select the latest version of Sonarqube.

SonarQube Scanner

Name
sonar-server

Install automatically

Install from Maven Central

Version
SonarQube Scanner 5.0.13096

Add installer ▾

To create a webhook, click on Configuration and select Webhooks.

Administration

Configuration Security Projects System Marketplace

General Settings Encryption Webhooks Individual users Create User

Click on Create.

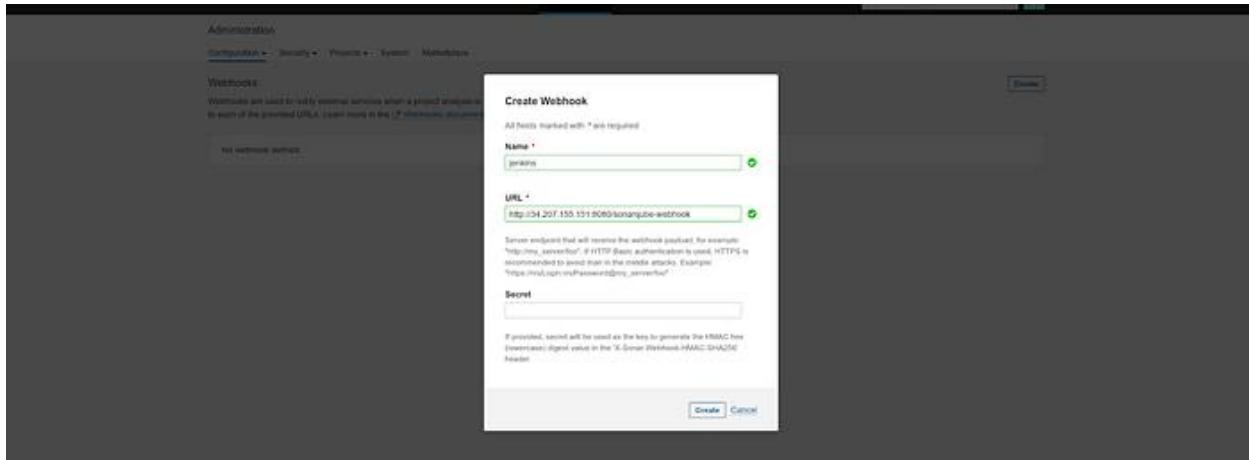
Administration

Configuration Security Projects System Marketplace

Webhooks

Webhooks are used to notify external services when a project analysis is done. An HTTP POST request including a JSON payload is sent to each of the provided URLs. Learn more in the [Webhooks documentation](#).

Provide the name and Jenkins URL like below and click on Create.



The Webhook will be showing the below snippet.



To create a project, click on Manually.



Provide the name of your project and click on Set up.

sonarqube Projects Issues Rules Quality Profiles Quality Gates Administration

Q Netflix

Create a project

All fields marked with * are required

Project display name *
netflix

Up to 250 characters. Some scanners might override the value you provide.

Project key *
netflix

The project key is a unique identifier for your project. It may contain up to 400 characters. Allowed characters are alphanumeric, “_” (underscores), “-” (hyphens) and “.” (periods), with at least one non-digit.

Main branch name *
master

The name of your project's default branch [Learn More](#)

Get Up

Embedded database should be used for evaluation purposes only
The embedded database will not scale. It will not support upgrading to newer versions of SonarQube, and there is no support for migrating your data out of it.

SonarQube™ technology is powered by SonarSource SA.

Project Settings | Project Information

Get the most out of SonarQube!
Take advantage of the whole ecosystem by using SonarLint, a free IDE plugin that helps you find and fix issues earlier in your workflow. Connect SonarLint to SonarQube to sync rule sets and issue states.

Learn More | Dismiss

Select the existing token and click on continue.

sonarqube Projects Issues Rules Quality Profiles Quality Gates Administration

Q Netflix master

Overview Issues Security Hotspots Measures Code Activity Project Settings | Project Information

Analyze your project

We initialized your project on SonarQube, now it's up to you to launch analyses!

Provide a token

Generate a project token
 Use existing token

Existing token value <http://fQW9eHc31Mdf1ad6fP6d67aa4436d3f7c1>

This token is used to identify you when an analysis is performed. If it has been compromised, you can revoke it at any point in time in your user account.

Continue

Run analysis on your project

Embedded database should be used for evaluation purposes only
The embedded database will not scale. It will not support upgrading to newer versions of SonarQube, and there is no support for migrating your data out of it.

SonarQube™ technology is powered by SonarSource SA.

Project Settings | Project Information

Get the most out of SonarQube!
Take advantage of the whole ecosystem by using SonarLint, a free IDE plugin that helps you find and fix issues earlier in your workflow. Connect SonarLint to SonarQube to sync rule sets and issue states.

Learn More | Dismiss

Select the Other as your build and Linux as OS.

Now, we will create the Jenkins Pipeline

Click on Create item.

Provide the name of your Jenkins Pipeline and select Pipeline.

Currently, we are just creating a pipeline for Sonarqube analysis of the code, quality gate for Sonarqube, and installing the dependencies.

In the post-build, we have added email alerts for the success or failure of the pipeline.

```
pipeline{
    agent any
    tools{
        jdk 'jdk'
        nodejs 'nodejs'
    }
    environment {
        SCANNER_HOME=tool 'sonar-server'
    }
    stages {
        stage('Workspace Cleaning'){
            steps{
                cleanWs()
            }
        }
        stage('Checkout from Git'){
            steps{
                git branch: 'master', url:
                'https://github.com/AmanPathak-DevOps/Netflix-Clone-K8S-End-to-End-Project.git'
            }
        }
        stage('SonarQube Analysis'){
            steps{
                withSonarQubeEnv('SonarQube') {
                    sh ""$SCANNER_HOME/bin/sonar \
Dsonar.projectKey=Netflix \
"""
                }
            }
        }
        stage('Deployment'){
            steps {
                script {
                    wait()
                }
            }
        }
        stage('Post-Build'){
            steps {
                sh "rm -rf .sonar"
            }
        }
    }
    post {
        always{
            emaile{
                subject: "${currentBuild.number} - ${currentBuild.result}"
            }
        }
    }
}
```

```

body: "Project: ${env.JOB_NAME}<br/>" +
    "Build Number: ${env.BUILD_NUMBER}<br/>" +
    "URL: ${env.BUILD_URL}<br/>",
to: 'aman07pathak@gmail.com',
attachmentsPattern: 'trivyfs.txt,trivyimage.txt'
}
}
}

```

The screenshot shows the Jenkins Pipeline configuration page. The pipeline is named 'sonarqube'. The pipeline script is as follows:

```

pipeline {
    agent any
    stages {
        stage('SonarQube Analysis') {
            steps {
                sh 'mvn sonar:sonar -Dsonar.host.url="http://sonarqube:9000"'
            }
        }
        stage('Artifact Upload') {
            steps {
                sh 'mvn clean package -DskipTests'
            }
        }
        stage('Deploy to Docker') {
            steps {
                sh 'docker build -t sonarqube-project:0.0.1 .'
            }
        }
    }
}

```

At the bottom, there are 'Save' and 'Apply' buttons.

Click on build pipeline and after getting the success of the pipeline.

You will see the Sonarqube code quality analysis which will look like the below snippet.

The screenshot shows the SonarQube interface for the 'Netflix' project. The analysis status is 'Passed'. Key metrics shown are:

- Bugs: 0
- Vulnerabilities: 0
- Hotspots Reviewed: 0.0%
- Code Smells: 18
- Coverage: 0.0%
- Duplications: 0.0%
- Lines: 3.2k

Now, we have to add one more tool for our application named OWASP Dependency-check.

Go to Manage Jenkins -> Plugins

Search for OWASP Dependency-Check and install it.

The screenshot shows the Jenkins Manage Jenkins > Plugins page. The search bar is set to 'OWASP'. The 'Available plugins' section lists the 'OWASP Dependency-Check' plugin, which is version 5.4.3 and was released 3 months and 18 days ago. The plugin description states: 'This plug-in can independently execute a Dependency-Check analysis and visualize results. Dependency-Check is a utility that identifies project dependencies and checks if there are any known, publicly disclosed, vulnerabilities.' There is a green 'Install' button next to the plugin entry.

After installing, make sure to configure the OWASP.

Provide the name select the latest version of OWASP and click on Save.



Now, add the OWASP dependency check stage in the Jenkins pipeline and click on Save.

```
stage('OWASP DP SCAN') {
    steps {
        dependencyCheck additionalArguments: '--scan ./ --disableYarnAudit
--disableNodeAudit', odcInstallation: 'owasp-dp-check'
        dependencyCheckPublisher pattern: '**/dependency-check-report.xml'
    }
}
stage('TRIVY FS SCAN') {
    steps {
        sh "trivy fs . > trivyfs.txt"
    }
}
```



Now, click on Build Now.

The screenshot shows the Jenkins Pipeline interface for the Netflix project. On the left, there's a sidebar with options like Status, Changes, Build Now, Configure, Delete Pipeline, Full Stage View, SonarQube, Rename, and Pipeline Syntax. The main area has tabs for Status and Netflix. Under Netflix, there's a 'Stage View' section showing a timeline of stages: Declarative: Tool Install (223ms), clean workspace (512ms), Checkout from Git (1s), SonarQube Analysis (29s), quality gate (530ms), Install Dependencies (16s), OWASP DP SCAN (16min 45s), TRIVY FS SCAN (21s), and Declarative: Post Actions (14ms). Below this is a 'SonarQube Quality Gate' section. A 'Dependency-Check Trend' chart is also present.

Once your pipeline is successful. Then, scroll down and you will see a dependency check. Click on it and you will see the output like the below snippet.

The screenshot shows the 'Dependency-Check Results' page within the Jenkins Pipeline interface. It includes a 'Dependency-Check Results' header, a 'Severity Distribution' chart, and a table of vulnerabilities:

File Name	Vulnerability	Severity	Weakness
postcss:8.4.18	CvF-2023-44210	Medium	CWE-794
vite:3.2.2	CvF-2023-34092	High	CWE-796

Now, we have to build our Docker Image and push it to DockerHub

To do that, we need to configure the following things.

Go to Manage Jenkins -> Credentials

Add Docker Credentials to your Jenkins

The screenshot shows the Jenkins Global credentials (unrestricted) page. It lists two credentials: 'mail' (Username with password) and 'sonar-token' (Secret text). The 'mail' entry has a red asterisk next to its name, indicating it is required. The 'Description' column for both entries is empty. There are edit icons next to each entry.

ID	Name	Kind	Description
mail	aman0pathak@gmail.com/*****	Username with password	
sonar-token	sonar-token	Secret text	sonar-token

Add your credentials and click on Create.

The screenshot shows the Jenkins New credentials page. The 'Kind' dropdown is set to 'Username with password'. The 'Scope' dropdown is set to 'Global (Jenkins, nodes, items, all child items, etc.)'. The 'Username' field contains 'aviant9'. The 'Password' field is empty. The 'ID' field contains 'docker'. The 'Description' field is empty. A 'Create' button is at the bottom.

Install the following Docker plugins on your Jenkins

Docker
Docker Commons
Docker Pipeline
Docker API
docker-build-step

The screenshot shows the Jenkins Plugins page. The left sidebar has tabs for Updates, Available plugins (which is selected), Installed plugins, and Advanced settings. A search bar at the top right contains the text 'Docker'. Below it, a table lists available plugins:

Install	Name	Released
<input checked="" type="checkbox"/>	Docker 1.5	3 mo 24 days ago
<input checked="" type="checkbox"/>	Docker Commons 4.3.0-rc.10_6a_6a_f0_29	3 mo 29 days ago
<input checked="" type="checkbox"/>	Docker Pipeline 572.v950f58993841	4 mo 18 days ago
<input checked="" type="checkbox"/>	Docker API 1.3.4-84.v91d9_5edc6a2c	29 days ago
<input checked="" type="checkbox"/>	docker-build-step 2.10	2 mo 24 days ago
<input type="checkbox"/>	CloudBees Docker Build and Publish 1.4.0	1 yr 4 mo ago

A yellow callout box highlights the Docker API plugin, stating: "This plugin is up for adoption! We are looking for new maintainers. Visit our [Adopt a Plugin](#) initiative for more information."

Restart your Jenkins

The screenshot shows the Jenkins Plugins page with the Download progress tab selected. The left sidebar includes tabs for Updates, Available plugins, Installed plugins, Advanced settings, and Download progress (selected). A large orange progress bar at the top indicates the download is complete. Below it, the 'Download progress' section is titled 'Preparation' and lists several items with green checkmarks indicating success:

- Checking internet connectivity
- Checking update center connectivity
- Success

Cloud Statistics shows 100% success. The Docker API plugin is listed with a status of 'Running'.

At the bottom, there are two links: 'Go back to the top page' and 'Restart Jenkins when installation is complete and no jobs are running' (with a checked checkbox).

Configure the tool in Jenkins

Go to Manage Jenkins -> Tools and provide the below details.

Dashboard > Manage Jenkins > Tools

Dependency-Check installations Edited

Docker installations

ADD DOCKER

Docker

Name: docker

Install automatically

Download from docker.com

Docker version: latest

Add Installer

Add Docker

Save **Apply**

Jenkins 2.138

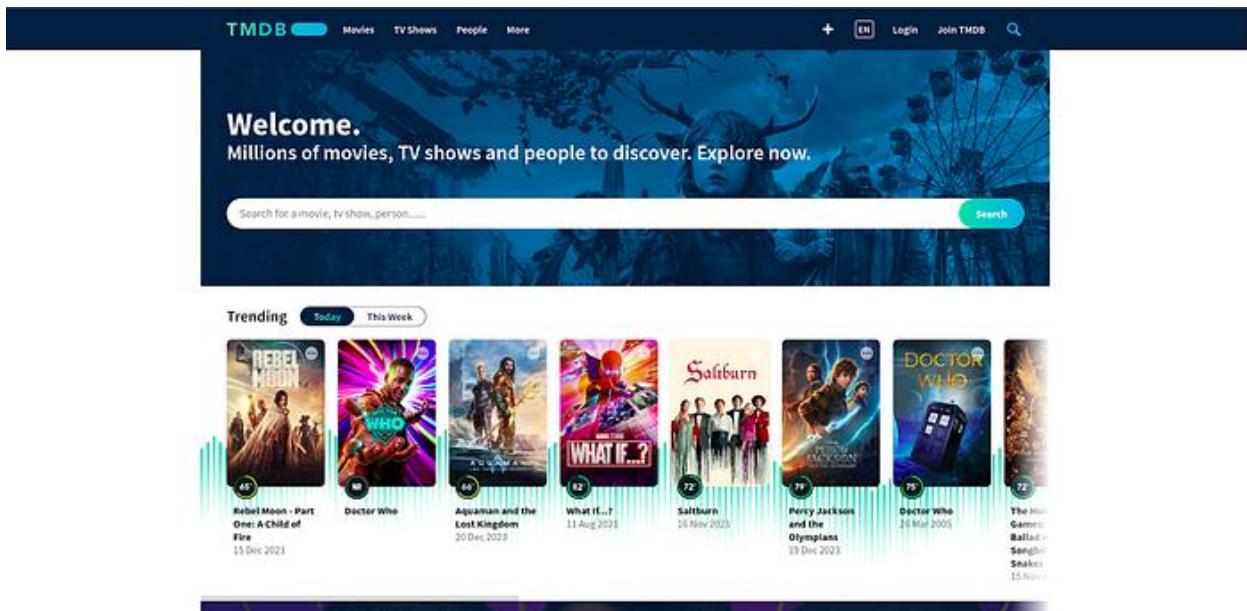
Our application is Netflix Clone. So we need some movie databases on our application.

For that, we have one application that will provide the API. So, we can use the API to get the movies on our application.

TMDB is one of them

Go to this link <https://www.themoviedb.org/>

Click on Join TMDB



Enter the details and click on SignUp

Benefits of being a member

- ✓ Find something to watch on your subscribed streaming services
- ✓ Log the movies and TV shows you have watched
- ✓ Keep track of your favourite movies and TV shows and get recommendations from them
- ✓ Build and maintain a personal watchlist
- ✓ Build custom mixed lists (movies and TV)
- ✓ Take part in movie and TV discussions
- ✓ Contribute to, and improve the information in our database

Sign up for an account

Signing up for an account is free and easy. Fill out the form below to get started. JavaScript is required to continue.

Username: aman21

Password (6 characters minimum):

Password Confirm:

Email: myemailid@gmail.com

By clicking the "Sign up" button below, I certify that I have read and agree to the TMDB terms of use and privacy policy.

[Sign Up](#) [Cancel](#)

THE MOVIE DB

[JOIN THE COMMUNITY](#)

THE BASICS

- About TMDB
- Contact Us
- Support Forums
- API
- System Status

GET INVOLVED

- Contribution Bible
- Add New Movie
- Add New TV Show

COMMUNITY

- Guidelines
- Discussions
- Leaderboard

LEGAL

- Terms of Use
- API Terms of Use
- Privacy Policy
- DMCA Policy

Once you sign up, you will get a confirmation email on your account. Confirm it.

Log in to your TMDB account and go to the settings.

Welcome.
Millions of movies, TV shows and people to discover. Explore now.

Search for a movie, TV show, person.....

Trending [Today](#) [This Week](#)

Rebel Moon - Part One: A Child of Fire 15 Dec 2023	Doctor Who	Aquaman and the Lost Kingdom 20 Dec 2023	What If...? 11 Aug 2021	Soulburn 15 Nov 2023	Perseus and the Olympians 13 Dec 2023	Doctor Who 26 Nov 2023	The War Games Ballad 4 Sangily Snakes 15 Nov 2
---	------------	---	----------------------------	-------------------------	--	---------------------------	---

<https://www.themoviedb.org/settings/account>

Go to the API section.

The screenshot shows the TMDB account settings interface. On the left, a sidebar menu under 'Settings' includes 'Edit Profile', 'Account Settings' (which is currently selected), 'Streaming Services', 'Notification Settings', 'Blocked Users', 'Import List', 'Sharing Settings', 'Sessions', 'API', and 'Delete Account'. The main content area is titled 'Account Settings' and contains the following fields:

- Default Language: English (en-GB)
- Fallback Language: None (Don't Fallback)
- Country: India
- Timezone: Auto detect? (checkbox checked) Asia - Kabul
- Include Adult Items in Search?: No
- Filter Profanity?: Yes
- Enable Keyboard Shortcuts?: Yes

A 'Save' button is located at the bottom of the form.

Click on Create to generate API

The screenshot shows the TMDB API overview page. On the left, a sidebar menu under 'Settings' includes 'Edit Profile', 'Account Settings', 'Streaming Services', 'Notification Settings', 'Blocked Users', 'Import List', 'Sharing Settings', 'Sessions', and 'API' (which is currently selected). The main content area has tabs for 'API', 'Overview', and 'Create' (which is highlighted with a red box).

TMDb offers a powerful API service that is free to use as long as you properly attribute us as the source of the data and/or images you use. You can find the logos for attribution [here](#).

Documentation

Our primary documentation is located at [developer.themoviedb.org](#).

Support

If you have questions or comments about the information covered here, please create a post on our [support forums](#).

Request an API Key

To generate a new API key, click [here](#).

Select Developer.

The screenshot shows the TMDB API creation page. On the left, a sidebar menu under 'Settings' includes 'Edit Profile', 'Account Settings', 'Streaming Services', 'Notification Settings', 'Blocked Users', 'Import List', and 'API' (which is currently selected). The main content area has tabs for 'API', 'Overview', and 'Create' (which is highlighted with a red box).

What type of API key do you wish to register?

Developer

- You are an individual
- Your project is still in development
- Your project is non profit
- Your project is ad supported

Professional

- You represent a company
- Your project is for profit (not ad supported)
- You are an OEM or hardware vendor

Accept the Terms & Conditions.

12. General Terms

- 1. Relationship of the Parties.** Notwithstanding any provision hereof, for all purposes of the Terms of Use, you and TMDB shall be and act independently and not as partner, joint venturer, agent, employee or employer of the other. You shall not have any authority to assume or create any obligation for or on behalf of TMDB, express or implied, and you shall not attempt to bind TMDB to any contract.
- 2. Invalidity of Specific Terms.** If any provision of the Terms of Use is found by a court of competent jurisdiction to be invalid, the parties nevertheless agree that the other provisions of this agreement will remain in full force and effect and the court should endeavor to give effect to the parties' intentions as reflected in the invalid provision.
- 3. Location of Lawsuit and Choice of Law.** THE TERMS OF USE AND THE RELATIONSHIP BETWEEN YOU AND TMDB SHALL BE GOVERNED BY THE LAWS OF THE STATE OF CALIFORNIA WITHOUT REGARD TO ITS CONFLICT OF LAW PROVISIONS. YOU AND TMDB AGREE TO SUBMIT TO THE PERSONAL JURISDICTION OF THE COURTS LOCATED WITHIN THE COUNTY OF SAN MATEO, CALIFORNIA.
- 4. No Waiver of Rights by TMDB.** TMDB's failure to exercise or enforce any right or provision of the Terms of Use shall not constitute a waiver of such right or provision.
- 5. No Transfer.** The rights and obligations of these Terms of Use is personal to you and may not be transferred by you, either voluntarily or by operation of law.
- 6. Notice.** Any notice to be sent to you under these Terms of Use may be sent via email, post, or any other reasonable means, at the contact information provided by you to TMDB from time to time. It is your obligation to insure that this information is current.

Miscellaneous. The section headings and subheadings contained in this agreement are included for convenience only, and shall not limit or otherwise affect the terms of the Terms of Use. Any construction or interpretation to be made of the Terms of Use shall not be construed against the drafter. The Terms of Use constitute the entire agreement between TMDB and you with respect to the subject matter hereof.

This Agreement was last updated on: July 28, 2014.

Cancel

Accept

ow

Provide the basic details and click on Submit.

Sharing Settings

Sessions

API

Delete Account

First Name

Last Name

Email Address

Phone Number (no parenthesis or dashes)

Address 1

City

Zip Code

Submit

India

After clicking on Submit. You will get your API. Copy the API and keep it somewhere.

The screenshot shows the TMDB API Overview page. On the left, there's a sidebar with 'Settings' and 'API' selected. The main area has tabs for 'Overview', 'Details', 'Sessions', 'Stats', and 'Regenerate Key'. Below the tabs, it says 'TMDb offers a powerful API service that is free to use as long as you properly attribute us as the source of the data and/or images you use. You can find the logos for attribution [here](#)'. It also links to 'Documentation' at [Developer.theMovieDB.org](#) and 'Support' forums. Under 'API Details', it says 'If you'd like to edit the details of your app, [click here](#)'. The 'API Key' section contains a redacted API key value: '6b1f4e589c20195d123907bd7800c'. Below it is a large block of encoded API key data.

Now, we have to configure our Docker images where we will build our image with the help of new code and then, push it to DockerHub.

After pushing the image, we will scan our DockerHub Image to find the vulnerabilities in the image.

Make sure to replace the API with your API and if you are pushing Dockerfile on your Dockerhub account then, replace my username of the Dockerhub with yours.

The screenshot shows the Netflix CI Pipeline configuration screen. The 'Pipeline' tab is selected. In the 'Script' editor, there is a red box highlighting the Docker build command. The command is as follows:

```

script:
  - docker build --tag sadmin902/tmdb:latest .
  - docker tag sadmin902/tmdb:latest sadmin902/tmdb:latest
  - docker push sadmin902/tmdb:latest
  - docker push sadmin902/tmdb:latest

```

Click on Build

Jenkins

Dashboard > Netflix >

Status: Green Netflix

[Changes](#)

[Build Now](#)

[Configure](#)

[Delete Pipeline](#)

[Full Stage View](#)

[SonarQube](#)

[Rename](#)

[Pipeline Syntax](#)

[Add description](#)

[Disable Project](#)

Dependency-Check Trend

— Unassigned — Low — Medium — High — Critical

Stage View

Declarative: Tool Install	Clean workspace	Checkout from Git	SonarQube Analysis	quality gate	Install Dependencies	OWASP DP Scan	TRIVY FS SCAN	Declarative: Post Actions
22ms	51ms	1s	2ms	530ms	16s	16min 45s	2ms	74ms
156ms	530ms	1s	22s	335ms (passed for all)	20s	11min 54s	2ms	85ms
290ms	494ms	1s	27s	725ms (passed for all)	12s	21min 36s	2ms	263ms

SonarQube Quality Gate

As you can see Our Pipeline is successful.

Jenkins

Dashboard > Netflix >

Status: Green Netflix

[Changes](#)

[Build Now](#)

[Configure](#)

[Delete Pipeline](#)

[Full Stage View](#)

[SonarQube](#)

[Rename](#)

[Pipeline Syntax](#)

[Add description](#)

[Disable Project](#)

Dependency-Check Trend

— Unassigned — Low — Medium — High — Critical

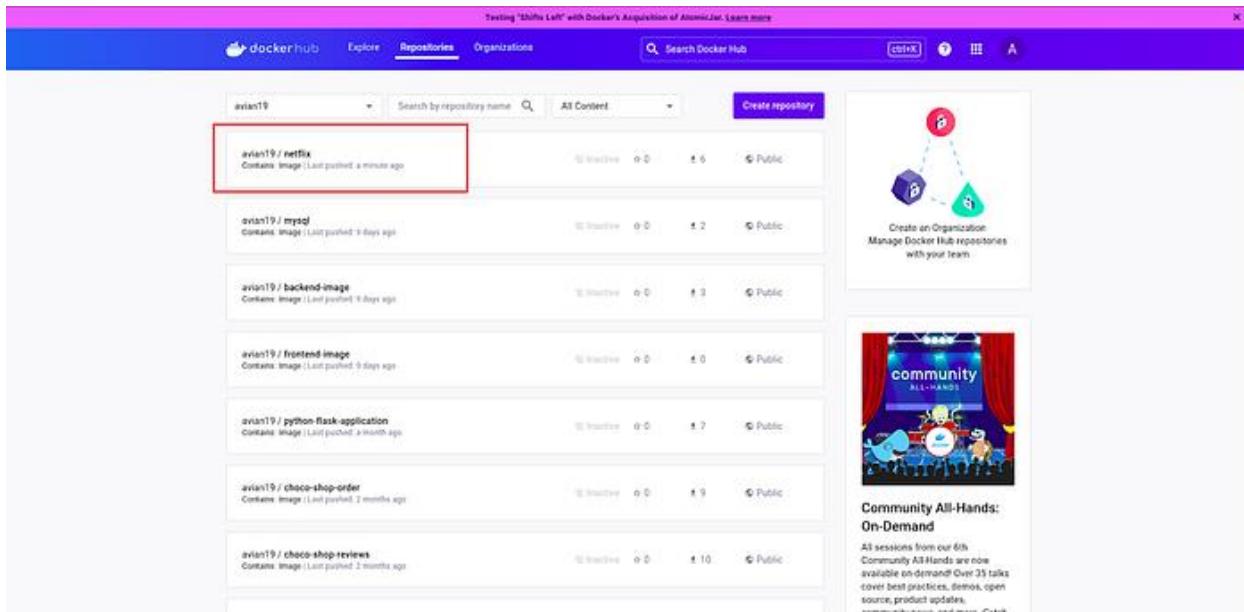
Stage View

Declarative: Tool Install	Clean workspace	Checkout from Git	SonarQube Analysis	quality gate	Install Dependencies	OWASP DP Scan	TRIVY FS SCAN	Docker Build & Push	TRIVY	Declarative: Post Actions
17ms	33ms	1s	20s	394ms	18s	3min 23s	16s	52s	840ms	152ms
324ms	645ms	3s	22s	428ms (passed for all)	53s	3min 42s	19s	4min 18s	3s	100ms
123ms	258ms	960ms	20s	326ms (passed for all)	19s	3min 5s	150ms	83ms	83ms	397ms
130ms	252ms	986ms	20s	388ms (passed for all)	19s	3min 31s	19s	328ms	44ms	92ms

Now, validate whether the docker image has been pushed to DockerHub or not.

Log in to your Dockerhub account.

As you can see in the below screenshot, Our Docker image is present on Docker Hub.



Now, we have to deploy our application using Kubernetes.

To do that, we need to install kubectl on the Jenkins server.

```
sudo apt update
sudo apt install curl
curl -LO https://dl.k8s.io/release/$(curl -L -s
https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl
sudo install -o root -g root -m 0755 kubectl /usr/local/bin/kubectl
kubectl version --client
```

```
ubuntu@ip-172-31-59-9:~$ sudo apt update
sudo apt install curl
curl -LO https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl
sudo install -o root -g root -m 0755 kubectl /usr/local/bin/kubectl
kubectl version --client
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Hit:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu jammy-backports InRelease
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Hit:5 http://security.ubuntu.com/ubuntu jammy-security InRelease
Ign:6 https://pkg.jenkins.io/debian binary/ InRelease
Hit:7 https://pkg.jenkins.io/debian binary/ Release
Fetched 229 kB in 1s (304 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
7 packages can be upgraded. Run 'apt list --upgradable' to see them.
Hit:8 https://acusecurity.github.io/trivy-repo/deb/dists/jammy/InRelease: Key is stored in legacy trusted.gpg keyring (/etc/apt/trusted.gpg), see the DEPRECATION section in apt-key(8) for details.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
curl is already the newest version (7.81.0-1ubuntu1.15).
curl set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 7 not upgraded.
% Total    % Received % Xferd  Average Speed   Time   Current
          Dl/Updted  Total  Spent   Left  Speed
100  13B  100  13B    0     0  1132  0  *--:--:--:--:--:--  114B
100 47.4K  100 47.4K   0     0  76.0M  0  *--:--:--:--:--:--  76.0M
Client Version: v1.29.0
Kustomize Version: v5.0.4-0.20230601165947-6ce0bf390ce3
ubuntu@ip-172-31-59-9:~$ 
ubuntu@ip-172-31-59-9:~$ kubectl --version
error: unknown flag: --version
See 'kubectl --help' for usage.
ubuntu@ip-172-31-59-9:~$ kubectl version
Client Version: v1.29.0
Kustomize Version: v5.0.4-0.20230601165947-6ce0bf390ce3
Error from server (Forbidden): <html><head><meta http-equiv='refresh' content='1;url=/login?from=%2Fversion%3D02s'></script id='redirect' data-redirect-url='/%2Fversion%3D02s' src="/static/f25a94ce/scripts/redirect.js"></script></head><body style='background-color:white; color:white;'>
Authentication required
<!-->
<br>
</body></html>
ubuntu@ip-172-31-59-9:~$ 
```

As you know, we have two Kubernetes Nodes of which one is the Master and the other one is the Worker Node.

Login to your both Kubernetes Master and Worker Nodes

Master Node

```
aswapatnak@pop-ss:~/Downloads$ ssh -i "Aman-Patnak.pem" ubuntu@ec2-52-91-122-66.compute-1.amazonaws.com
The authenticity of host 'ec2-52-91-122-66.compute-1.amazonaws.com (64:ff9b::345b:7a42)' can't be established.
ED25519 key fingerprint is SHA256:0x6219e219e33f3fcy1510810011jyMKE9UtttabGE+0.
This key is not known by any other name
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-52-91-122-66.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-1017-aws x86_64)

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

System information as of Thu Dec 28 06:11:01 UTC 2023

System load: 0.0      Processes:          106
Usage of /: 23.5% of 7.57GB   Users logged in:  0
Memory usage: 5%          IPv4 address for eth0: 172.31.59.154
Swap usage:  0%

* Ubuntu Pro delivers the most comprehensive open source security and
  compliance features.

  https://ubuntu.com/aws/pro

Expanded Security Maintenance for Applications is not enabled.

26 updates can be applied immediately.
19 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

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

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-59-154:~$ 
```

Worker Node

```
aswapatnak@pop-ss:~/Downloads$ ssh -i "Aman-Patnak.pem" ubuntu@ec2-3-90-84-57.compute-1.amazonaws.com
The authenticity of host 'ec2-3-90-84-57.compute-1.amazonaws.com (64:f19b::35b:5439)' can't be established.
ED25519 key fingerprint is SHA256:whmyzvXN0d5hruzu5grS/fI6qszxV6cApaaobs.
This key is not known by any other name
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ec2-3-90-84-57.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-1017-aws x86_64)

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

System information as of Thu Dec 28 06:11:50 UTC 2023

System load: 0.000976125  Processes:          105
Usage of /: 23.5% of 7.57GB   Users logged in:  0
Memory usage: 5%          IPv4 address for eth0: 172.31.52.140
Swap usage:  0%

* Ubuntu Pro delivers the most comprehensive open source security and
  compliance features.

  https://ubuntu.com/aws/pro

Expanded Security Maintenance for Applications is not enabled.

26 updates can be applied immediately.
19 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

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

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-52-140:~$ 
```

Add the hostname to your Kubernetes master node
sudo hostnamectl set-hostname K8s-Master

```
ubuntu@ip-172-31-59-154:~$ sudo hostnamectl set-hostname K8s-Master
ubuntu@ip-172-31-59-154:~$ 
```

Add the hostname to your Kubernetes worker node
sudo hostnamectl set-hostname K8s-Worker

```
ubuntu@ip-172-31-52-140:~$ sudo hostnamectl set-hostname K8s-Worker
ubuntu@ip-172-31-52-140:~$ 
```

Run the below commands on the both Master and worker Nodes.

```
sudo su
swapoff -a; sed -i '/swap/d' /etc/fstab
cat <<EOF | sudo tee /etc/modules-load.d/k8s.conf
overlay
br_netfilter
EOF
sudo modprobe overlay
sudo modprobe br_netfilter
# sysctl params required by setup, params persist across reboots
cat <<EOF | sudo tee /etc/sysctl.d/k8s.conf
net.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
EOF
# Apply sysctl params without reboot
sudo sysctl -system
apt update
sudo apt-get install -y apt-transport-https ca-certificates curl
curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg - dearmor -o
/etc/apt/keyrings/kubernetes-archive-keyring.gpg
echo "deb [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg]
https://apt.kubernetes.io/ kubernetes-xenial main" | sudo tee
/etc/apt/sources.list.d/kubernetes.list
apt update
apt-get install -y kubelet kubeadm kubectl kubernetes-cni
apt install docker.io -y
sudo mkdir /etc/containerd
sudo sh -c "containerd config default > /etc/containerd/config.toml"
sudo sed -i 's/ SystemdCgroup = false/ SystemdCgroup = true/' /etc/containerd/config.toml
systemctl restart containerd.service
systemctl restart kubelet.service
systemctl enable kubelet.service
Now, run the following commands Only on the Master Node, and then you will get the
command that is highlighted in the below snippet.
kubeadm config images pull
kubeadm init
```

```
[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] 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". This can take up to 4m0s
[apiserver] All control-plane components are healthy after 11.00265 seconds
[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 k8s-master as control-plane by adding the labels: [node-role.kubernetes.io/control-plane]
[mark-control-plane] Marking the node k8s-master as control-plane by adding the taints [node-role.kubernetes.io/control-plane:NoSchedule]
[bootstrap-token] Using token: deg9nl.y34go2ziii0fu8c1
[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 roles to allow the controller manager to post to /api/v1/nodes/:node/status in order for nodes to get long term certificate credentials
[bootstrap-token] Configured RBAC rules to allow the controller manager to 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!

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 172.31.59.154:6443 --token deg9nl.y34go2ziii0fu8c1 \
--discovery-token-ca-cert-hash sha256:e93c56bd59b175b81845a671a82ffd1839e42272d922f9c43ca8d8f6d145ce02
root@K8s-Master:/home/ubuntu#
```

Exit from the root user and run the below commands

```
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-172-31-59-154:~$ mkdir -p $HOME/.kube
sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
sudo chown $(id -u):$(id -g) $HOME/.kube/config
ubuntu@ip-172-31-59-154:~$ ls .kube/
config
ubuntu@ip-172-31-59-154:~$
```

Run on the Worker Node

Run the below command as a root user

```
kubeadm join 172.31.59.154:6443 - token deg9nl.y34go2ziii0fu8c1 \
-discovery-token-ca-cert-hash \
sha256:e93c56bd59b175b81845a671a82ffd1839e42272d922f9c43ca8d8f6d145ce02
```

```
root@K8s-Worker:/home/ubuntu# kubeadm join 172.31.59.154:6443 --token deg9nl.y34go2ziii0fu8c1 \
--discovery-token-ca-cert-hash sha256:e93c56bd59b175b81845a671a82ffd1839e42272d922f9c43ca8d8f6d145ce02
[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] Writing the config file with 'kubectl -n kube-system get cm kubeadm-config -o yaml'
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap...

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.
root@K8s-Worker:/home/ubuntu#
```

Both nodes are not ready because the network plugin is not installed on the master node

```
ubuntu@K8s-Master:~$ kubectl get nodes
NAME      STATUS    ROLES   AGE     VERSION
k8s-master NotReady control-plane 9m30s   v1.28.2
k8s-worker NotReady <none>    56s    v1.28.2
ubuntu@K8s-Master:~$
```

Only on the Master Node

Run the below command to install the network plugin on the Master node

```
kubectl apply -f
```

```
https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
```

```
ubuntu@K8s-Master:~$ kubectl apply -f https://raw.githubusercontent.com/projectcalico/calico/v3.25.0/manifests/calico.yaml
poddisruptionbudget.policy/calico-kube-controllers created
serviceaccount/calico-node created
serviceaccount/calico-node created
configmap/calico-config created
customresourcedefinition.apiextensions.k8s.io/bgpconfigurations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/bgppeers.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/blockaffinities.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/clusterautostatuses.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/clusterinformations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/felixconfigurations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/globalnetworkpolicies.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/globalnetworksets.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/hostendpoints.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamblocks.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamconfigs.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamleases.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/ipamrouters.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/preservations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/kubecontrollersconfigurations.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/networkpolicies.crd.projectcalico.org created
customresourcedefinition.apiextensions.k8s.io/networksets.crd.projectcalico.org created
clusterrole.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrole.rbac.authorization.k8s.io/calico-node created
clusterrolebinding.rbac.authorization.k8s.io/calico-kube-controllers created
clusterrolebinding.rbac.authorization.k8s.io/calico-node created
sa/sa-net-apps/calico-node created
deployment.apps/calico-kube-controllers created
ubuntu@K8s-Master:~$ [ ]
```

Both nodes are ready.

```
ubuntu@K8s-Master:~$ kubectl get nodes
NAME      STATUS    ROLES   AGE     VERSION
k8s-master Ready     control-plane   2m      v1.28.2
k8s-worker Ready     <none>    2m22s   v1.28.2
ubuntu@K8s-Master:~$ [ ]
```

Install the following Kubernetes Plugins on your Jenkins

Kubernetes

Kubernetes Credentials

Kubernetes Client API

Kubernetes CLI

Kubernetes Credential Provider

Plugin	Version	Last Updated
Kubernetes Client API	6.8.1-224.v0380f(a_4d0_10_)	4 mo 0 days ago
Kubernetes Credentials	0.11	4 mo 0 days ago
Kubernetes	1.151.46fa_109_00_4c9	19 days ago
Kubernetes CLI	1.32.3	3 mo 29 days ago
Kubernetes Credentials Provider	1.258.v9994ff923a_a_e	2 mo 10 days ago
Kubernetes Pipeline :: DevOps Steps	1.6	4 yr 11 mo ago
Google Kubernetes Engine	0.629.v265a_dc219_a_6c	8 days 1 hr ago

Now, we will set Kubernetes Monitoring for both Master and worker Nodes

Run the below command on both Kubernetes Nodes

```
sudo useradd \
--system \
--no-create-home \
--shell /bin/false prometheus
```

```
ubuntu@k8s-Master:~$ sudo useradd \
--system \
--no-create-home \
--shell /bin/false node_exporter
ubuntu@k8s-Master:~$
```

Download the node exporter package on both Kubernetes Nodes and Untar the node exporter package file and move the node_exporter directory to the /usr/local/bin directory
wget

```
https://github.com/prometheus/node_exporter/releases/download/v1.7.0/node_exporter-1.7.0.linux-amd64.tar.gz
```

```
tar -xvf node_exporter-1.7.0.linux-amd64.tar.gz
sudo mv node_exporter-1.7.0.linux-amd64/node_exporter /usr/local/bin/
```

```
ubuntu@k8s-Master:~$ wget https://github.com/prometheus/node_exporter/releases/download/v1.7.0/node_exporter-1.7.0.linux-amd64.tar.gz
--2023-12-28 10:24:31-- https://github.com/prometheus/node_exporter/releases/download/v1.7.0/node_exporter-1.7.0.linux-amd64.tar.gz
Resolving github.com (github.com)... 149.82.114.3
Connecting to github.com (github.com)|149.82.114.3|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://objects.githubusercontent.com/github-production-release-asset-2e65be/9524057/01323270-6ecb-47ea-813f-52e2a89cdc647X-Amz-Algorithm=AWS4-HMAC-SHA256X-Amz-Credential=AKIAINJYAX4C5VEM53AV2F202312282Fpus-east-1%2F53%2Faws4 requestId=X-Amz-Date=20231228T022352ZX-Amz-Expires=3006X-Amz-Signature=6fbe0d31f4bf27847c4b26939fe7929439c3bda4750bbde92c385a46f7c6146X-Amz-SignedHeaders=host&actor_id=0&key_id=0&repo_id=9524057&response-content-disposition=attachment%3Bfilename%3Dnode_exporter-1.7.0.linux-amd64.tar.gz&response-content-type=application%2Foctet-stream [following]
--2023-12-28 10:24:31-- https://objects.githubusercontent.com/github-production-release-asset-2e65be/9524057/01323270-6ecb-47ea-813f-52e2a89cdc647X-Amz-Algorithm=AWS4-HMAC-SHA256X-Amz-Credential=AKIAINJYAX4C5VEM53AV2F202312282Fpus-east-1%2F53%2Faws4 requestId=X-Amz-Date=20231228T022352ZX-Amz-Expires=3006X-Amz-Signature=6fbe0d31f4bf27847c4b26939fe7929439c3bda4750bbde92c385a46f7c6146X-Amz-SignedHeaders=host&actor_id=0&key_id=0&repo_id=9524057&response-content-disposition=attachment%3Bfilename%3Dnode_exporter-1.7.0.linux-amd64.tar.gz&response-content-type=application%2Foctet-stream
Resolving objects.githubusercontent.com (objects.githubusercontent.com)... 185.199.110.133, 185.199.111.133, 185.199.168.133...
Connecting to objects.githubusercontent.com (objects.githubusercontent.com)|185.199.110.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10419253 (9.0M) [application/octet-stream]
Saving to 'node_exporter-1.7.0.linux-amd64.tar.gz'

node_exporter-1.7.0.linux-amd64.tar.gz          100%[=====]  9.94M  --.KB/s   in 0.87s

2023-12-28 10:24:31 (143 MB/s) - 'node_exporter-1.7.0.linux-amd64.tar.gz' saved [10419253/10419253]

ubuntu@k8s-Master:~$ ls
node_exporter-1.7.0.linux-amd64.tar.gz
ubuntu@k8s-Master:~$ ubuntu@k8s-Master:~$ tar -xvf node_exporter-1.7.0.linux-amd64.tar.gz
node_exporter-1.7.0.linux-amd64/
node_exporter-1.7.0.linux-amd64/LICENSE
node_exporter-1.7.0.linux-amd64/node_exporter
node_exporter-1.7.0.linux-amd64/NOTICE
ubuntu@k8s-Master:~$ ubuntu@k8s-Master:~$ sudo mv node_exporter-1.7.0.linux-amd64/node_exporter /usr/local/bin/
ubuntu@k8s-Master:~$
```

Create the systemd configuration file for node exporter.

Edit the file

```
sudo vim /etc/systemd/system/node_exporter.service
```

Copy the below configurations and paste them into the /etc/systemd/system/node_exporter.service file.

```
[Unit]
Description=Node Exporter
Wants=network-online.target
After=network-online.target
StartLimitIntervalSec=500
StartLimitBurst=5
[Service]
User=node_exporter
Group=node_exporter
Type=simple
Restart=on-failure
RestartSec=5s
ExecStart=/usr/local/bin/node_exporter \
- collector.logind
[Install]
WantedBy=multi-user.target
```

```
[Unit]
Description=Node Exporter
Wants=network-online.target
After=network-online.target
StartLimitIntervalSec=500
StartLimitBurst=5
[Service]
User=node_exporter
Group=node_exporter
Type=simple
Restart=on-failure
RestartSec=5s
ExecStart=/usr/local/bin/node_exporter \
- collector.logind
[Install]
WantedBy=multi-user.target
```

Enable the node exporter systemd configuration file and start it.

```
sudo systemctl enable node_exporter
sudo systemctl enable node_exporter
systemctl status node_exporter.service
```

```
ubuntu@K8s-Master:~$ sudo vim /etc/systemd/system/node_exporter.service
ubuntu@K8s-Master:~$ sudo systemctl enable node_exporter
Created symlink /etc/systemd/system/multi-user.target.wants/node_exporter.service → /etc/systemd/system/node_exporter.service.
ubuntu@K8s-Master:~$ sudo systemctl start node_exporter
ubuntu@K8s-Master:~$ sudo systemctl status node_exporter
● node_exporter.service - Node Exporter
   Loaded: loaded (/etc/systemd/system/node_exporter.service; enabled; vendor preset: enabled)
     Active: active (running) since Thu 2023-12-28 10:26:31 UTC; 8s ago
       Tasks: 5 (limit: 4667)
      Memory: 2.0M
        CPU: 9ms
       CGroup: /system.slice/node_exporter.service
               └─node_exporter -> /usr/local/bin/node_exporter -c /etc/node_exporter -c /etc/node_exporter --collector.logind

Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.014Z caller=node_exporter.go:117 level=info collector=thermal_zone
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.014Z caller=node_exporter.go:117 level=info collector=rttime
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.014Z caller=node_exporter.go:117 level=info collector=rtlatency
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.014Z caller=node_exporter.go:117 level=info collector=udp_queues
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.015Z caller=node_exporter.go:117 level=info collector=uname
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.015Z caller=node_exporter.go:117 level=info collector=runtimes
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.015Z caller=node_exporter.go:117 level=info collector=rss
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.015Z caller=node_exporter.go:117 level=info collector=tls
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.015Z caller=tls config.go:274 level=info msg="Listening on" address=[::]:9100
Dec 28 10:26:31 K8s-Master node_exporter[133987]: ts=2023-12-28T10:26:31.016Z caller=tls config.go:277 level=info msg="TLS is disabled." http2=false address=[::]:9100
ubuntu@K8s-Master:~$
```

Now, we have to add a node exporter to our Prometheus target section. So, we will be able to monitor both Kubernetes Servers.

edit the file

```
sudo vim /etc/prometheus/prometheus.yml
```

Add both job names(Master & Worker nodes) with their respective public.

```
# my global config
Global:
  scrape_interval: 15s # Set the scrape interval to every 15 seconds. Default is every 1 minute.
  evaluation_interval: 15s # Evaluate rules every 15 seconds. The default is every 1 minute.
  # scrape_timeout is set to the global default (30s).

# Alertmanager configuration
alerting:
  alertmanagers:
    - static_configs:
      - targets:
          # = alertmanager:9093

# Load rules once and periodically evaluate them according to the global 'evaluation_interval'.
rule_files:
  # - "first_rules.yml"
  # - "second_rules.yml"

# A scrape configuration containing exactly one endpoint to scrape:
# Here we're scrape Prometheus itself.
scrape_configs:
  # The job name is added as a label 'job=<job_name>' to any timeseries scraped from this config.
  # job_name: 'prometheus'

  # metrics_path defaults to '/metrics'
  # scheme defaults to 'http'.

  static_configs:
    - targets: ["localhost:9090"]

    - job_name: "node_exporter"
      static_configs:
        - targets: ["localhost:9100"]

    - job_name: "jenkins"
      metrics_path: "/prometheus"
      static_configs:
        - targets: ["34.207.155.151:8080"]

    - job_name: node_export_masterK8s
      static_configs:
        - targets: ["52.91.122.66:9100"]

    - job_name: node_export_workerK8s
      static_configs:
        - targets: ["3.90.84.57:9100"]

  
```

1,1 All

After saving the file, validate the changes that you have made using promtool.

```
promtool check config /etc/prometheus/prometheus.yml
```

If your changes have been validated then, push the changes to the Prometheus server.

```
curl -X POST http://localhost:9090/-/reload
```

```
ubuntu@ip-172-31-52-7:~$ vim /etc/prometheus/prometheus.yml
ubuntu@ip-172-31-52-7:~$ promtool check config /etc/prometheus/prometheus.yml
Checking /etc/prometheus/prometheus.yml
SUCCESS: /etc/prometheus/prometheus.yml is valid prometheus config file syntax
ubuntu@ip-172-31-52-7:~$ 
ubuntu@ip-172-31-52-7:~$ ubuntu@ip-172-31-52-7:~$ curl -X POST http://localhost:9090/-/reload
ubuntu@ip-172-31-52-7:~$ [ ]
```

As you know, Jenkins will deploy our application on the Kubernetes Cluster. To do that, Jenkins must have the access keys or something to connect with the master node.

To do that copy the content inside .kube/config on Kubernetes Master node.

```
cat .kube/config
```

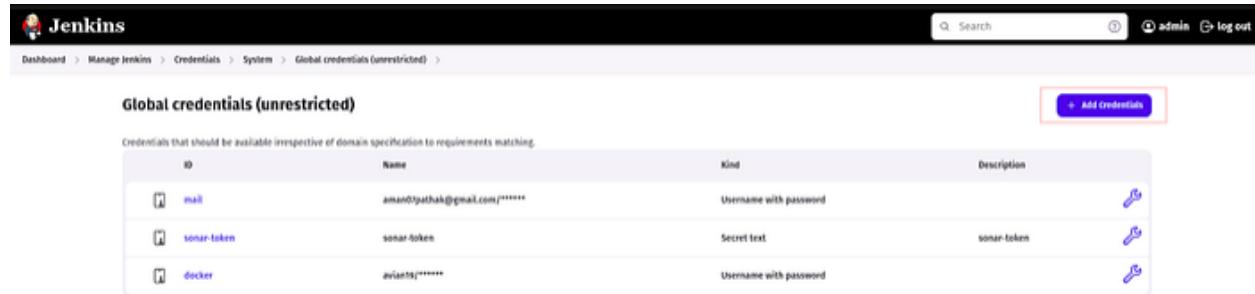
Save the file with the .txt extension.

```
*Untitled Document 1 secret.txt

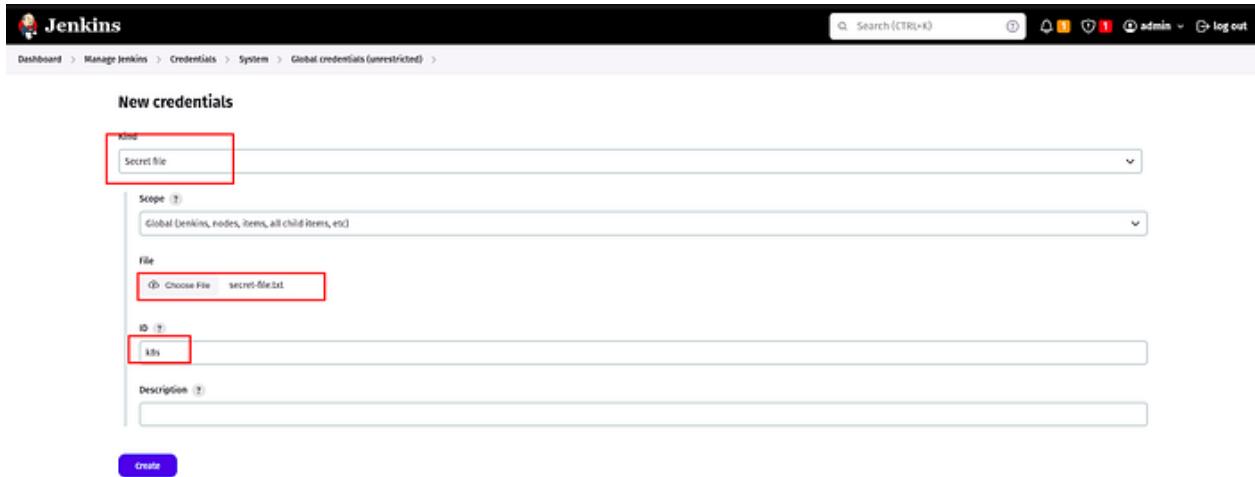
#apiVersion: v1
clusters:
- cluster:
  - certificate-authority-data:
    LS0tLS1CRUdBRUZJb3U2ZjB0b3I5b1CkL3J5URVEND0mYzHfZ3U2bZt2f1sQ9F1t1BwJ0b3RFFZSk1vWk1odmN0QyFTE2RQXgVEVtUJFRIExY0NQZtNS2EzWtLwP2tWt506N0QyGz85TxFeU3qZ360akVStkRmUz3Mqpkv5TwYy683qkTR0RFZhTUJveA
    server: https://172.31.59.154:5443
  name: kubernetes
contexts:
- context:
  - cluster: kubernetes
  - user: kubernetes-admin
  name: kubernetes-admin@kubernetes
current-context: kubernetes-admin@kubernetes
kind: config
preferences: {}
users:
- name: kubernetes-admin
user:
- client-certificate-data:
LS0tLS1CRUdBRUZJb3U2ZjB0b3I5b1CkL3J5URVEND0mYzHfZ3U2bZt2f1sQ9F1t1BwJ0b3RFFZSk1vWk1odmN0QyFTE2RQXgVEVtUJFRIExY0NQZtNS2EzWtLwP2tWt506N0QyGz85TxFeU3qZ360akVStkRmUz3Mqpkv5TwYy683qkTR0RFZhTUJveA
- client-key-data:
LS0tLS1CRUdBRUZJb3U2ZjB0b3I5b1CkL3J5URVEND0mYzHfZ3U2bZt2f1sQ9F1t1BwJ0b3RFFZSk1vWk1odmN0QyFTE2RQXgVEVtUJFRIExY0NQZtNS2EzWtLwP2tWt506N0QyGz85TxFeU3qZ360akVStkRmUz3Mqpkv5TwYy683qkTR0RFZhTUJveA
- client-key-data:
LS0tLS1CRUdBRUZJb3U2ZjB0b3I5b1CkL3J5URVEND0mYzHfZ3U2bZt2f1sQ9F1t1BwJ0b3RFFZSk1vWk1odmN0QyFTE2RQXgVEVtUJFRIExY0NQZtNS2EzWtLwP2tWt506N0QyGz85TxFeU3qZ360akVStkRmUz3Mqpkv5TwYy683qkTR0RFZhTUJveA
```

Now, add the Secret file in Jenkins Credentials.

Click on Add credentials.



Select the Secret file and provide the Secret file that you have saved earlier enter the ID k8s then click on Create.



Now, Add the deploy to the Kubernetes stage in your Jenkins pipeline.

```
stage('Deploy to Kubernetes'){
    steps{
        script{
            dir('Kubernetes') {
                withKubeConfig(caCertificate: "", clusterName: "", contextName: "",
                credentialsId: 'k8s', namespace: "", restrictKubeConfigAccess: false, serverUrl: "") {
                    sh 'kubectl apply -f deployment.yml'
                    sh 'kubectl apply -f service.yml'
                    sh 'kubectl get svc'
                    sh 'kubectl get all'
                }
            }
        }
    }
}
```

```

    def dependenciesCheckAdditionalParameters = '--use-strictVariables --allowUnknownVariablesWithValues --allowUnresolvedVariables --allowUnresolvedDependencies --allowUnresolvedProperties --allowUnresolvedAttachments'
    def dependencyCheckReportPath = 'dependency-check-report.html'

    stages {
        stage('Pre-Sync') {
            steps {
                sh "git pull"
                sh "mvn clean package"
            }
        }
        stage('Docker Build & Push') {
            steps {
                sh "mvn clean package -DskipTests -Dmaven.jenkins.dockerImage=dockerfile-build -Dmaven.jenkins.dockerImageBuild=dockerfile-build -Dmaven.jenkins.dockerImagePush=dockerfile-push"
            }
        }
        stage('Deploy to Kubernetes') {
            steps {
                sh "curl -s http://$K8S_NODE_IP:$PORT/ | grep 'Welcome to Netflix!'"
            }
        }
        post {
            success {
                emailableAttachments true
                body "Deployment successful.  
Cluster IP: $K8S_NODE_IP  
Port: $PORT  
URL: http://$K8S_NODE_IP:$PORT/  
Attachment details: https://$K8S_NODE_IP:$PORT/images.txt"
            }
        }
    }
}

```

Save **Apply**

Click on Build Now

You will see that our Application has been deployed successfully on Kubernetes.

Stage	Result	Duration	Start Time	End Time
Average Image Size	Passed	~1m	2023-06-20T10:00:00Z	2023-06-20T10:01:00Z
Dockerfile Build	Passed	~1m	2023-06-20T10:01:00Z	2023-06-20T10:02:00Z
Workspace Cleaning	Passed	~1m	2023-06-20T10:02:00Z	2023-06-20T10:03:00Z
Checked-in to Git	Passed	~1m	2023-06-20T10:03:00Z	2023-06-20T10:04:00Z
SonarQube Analysis	Passed	~1m	2023-06-20T10:04:00Z	2023-06-20T10:05:00Z
Quality Gate	Passed	~1m	2023-06-20T10:05:00Z	2023-06-20T10:06:00Z
Install Dependencies	Passed	~1m	2023-06-20T10:06:00Z	2023-06-20T10:07:00Z
CRANAP API Scan	Passed	~1m	2023-06-20T10:07:00Z	2023-06-20T10:08:00Z
TRIVIUS SCAN	Passed	~1m	2023-06-20T10:08:00Z	2023-06-20T10:09:00Z
Docker Image Build	Passed	~1m	2023-06-20T10:09:00Z	2023-06-20T10:10:00Z
Docker Image Pushing	Passed	~1m	2023-06-20T10:10:00Z	2023-06-20T10:11:00Z
Docker Image Tag	Passed	~1m	2023-06-20T10:11:00Z	2023-06-20T10:12:00Z
Deploy to container	Passed	~1m	2023-06-20T10:12:00Z	2023-06-20T10:13:00Z
Deploy to Kubernetes	Passed	~1m	2023-06-20T10:13:00Z	2023-06-20T10:14:00Z
Dockerfile Post Actions	Passed	~1m	2023-06-20T10:14:00Z	2023-06-20T10:15:00Z

Dependency Check Trend

SonarQube Quality Gate

Permalinks

You can validate whether your pods are running or not from your Kubernetes master node.

```

ubuntu@K8s-Master:~$ kubectl get pods
NAME           READY   STATUS    RESTARTS   AGE
netflix-app-57d8656b5-8nk48   1/1    Running   0          3m8s
netflix-app-57d8656b5-jrxid   1/1    Running   0          3m18s
ubuntu@K8s-Master:~$ kubectl describe pod netflix-app-57d8656b5-8nk48
Name:         netflix-app-57d8656b5-8nk48
Namespace:    default
Priority:    default
Service Account: default
Mode:        pods
Start Time:  Thu, 28 Dec 2023 11:20:42 +0000
Labels:      app=netflix-app
Annotations: pod-template-sha=37d8656b5
            cni.projectcalico.org/containerID: a9672b032090f378010de0d6f21639896de39517074775c2b14ae5708e870c9
            cni.projectcalico.org/podIP: 192.168.254.140/32
            cni.projectcalico.org/podIPs: 192.168.254.140/32
Status:      Running
IP:          192.168.254.140
IPs:         192.168.254.140
Controlled By: Replicaset/netflix-app-57d8656b5
Containers:
  netflix-app:
    Container ID:  containerd://9ddaa1d5e50e3f95f9979ee70b0ff3f0b2371201a82db6c17f8ac6af3af91a7f
    Image:        avanij9/netflix:latest

```

Also, you can check the Console logs for the earlier results.

```

Dashboard > Netflix > #0
deployment.apps/netflix-app configured
[Pipeline] in
+ kubectl apply -f service.yaml
service/netflix-app unchanged
[Pipeline] in
+ kubectl get svc
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
kubernetes   ClusterIP  10.96.0.1    <none>       443/TCP   3m18s
netflix-app   NodePort   10.109.178.85  <none>       80:32000/TCP   2m8s
[Pipeline] in
+ kubectl get all
NAME           READY   STATUS    RESTARTS   AGE
pod/netflix-app-57d8656b5-8nk48   0/1    ContainerCreating   0          1s
pod/netflix-app-98846c99d-qphwz   1/1    Running   0          11s
pod/netflix-app-98846c99d-qyqj9   1/1    Running   0          11s
NAME           TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
service/kubeapiserver   ClusterIP  10.96.0.1    <none>       443/TCP   50m3s
service/netflix-app   NodePort   10.109.178.85  <none>       80:32000/TCP   2m8s
NAME           READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/netflix-app   2/2    1           2           2m8s
NAME           DESIRED   CURRENT   READY   AGE
replicaset.apps/netflix-app-57d8656b5   1        1        1        1s
replicaset.apps/netflix-app-7474458c59   0        0        0        24s
replicaset.apps/netflix-app-96846c99d   2        2        2        11s
[Pipeline] in
[Kubernetes-CLI] kubectl configuration cleaned up
[Pipeline] // withSubunitTesting

```

We got the email that our pipeline was successful.

'SUCCESS' [Inbox](#)

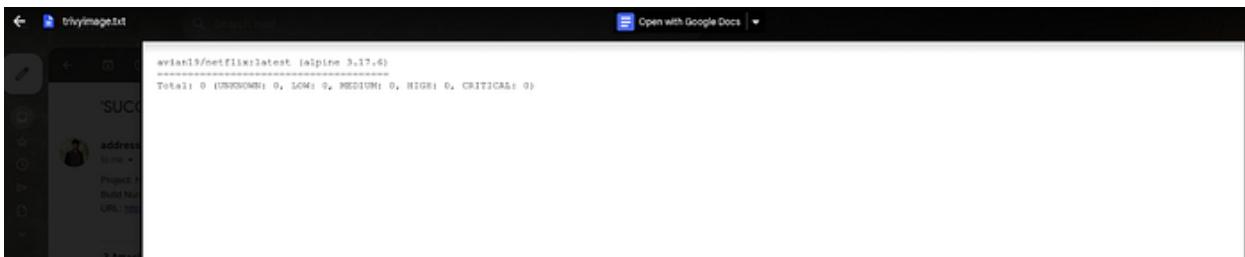
 address not configured yet <aman07pathak@gmail.com>
to me 
Project: Netflix
Build Number: 31
URL: <http://34.207.155.151:8080/job/Netflix/31/>

3 Attachments • Scanned by Gmail 



We get the trivyfs.txt file which contains the vulnerabilities.

Also, we got the vulnerabilities for our Docker Image.

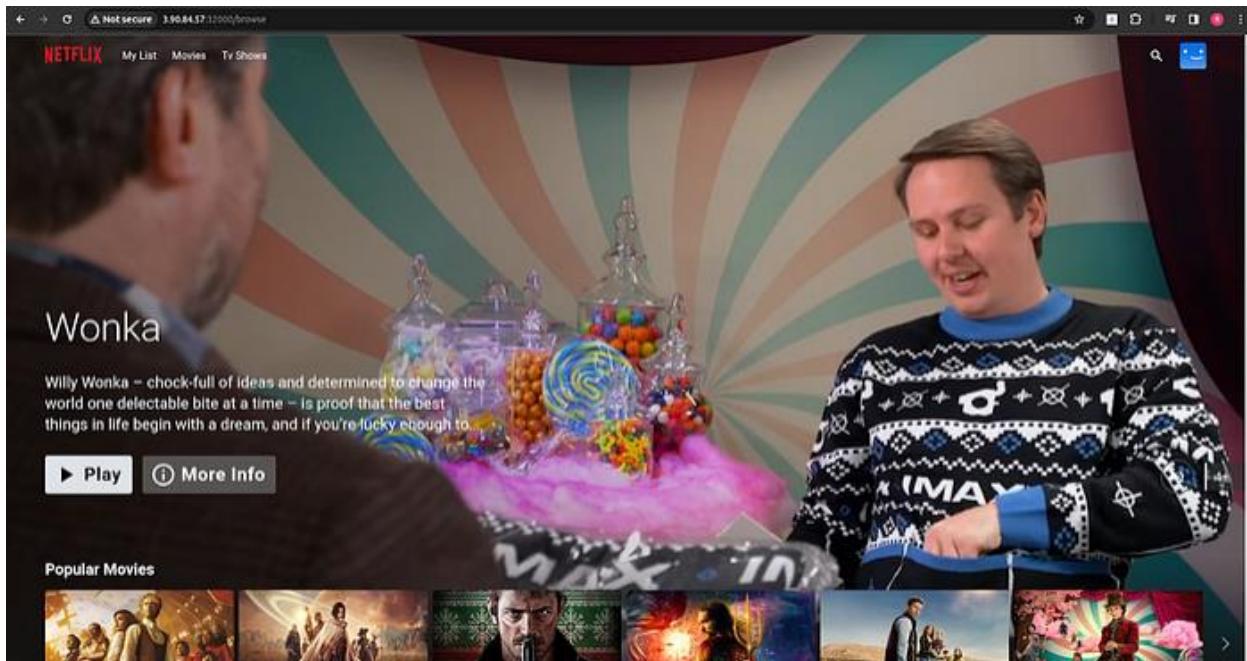


Jenkins sent the console logs by email.

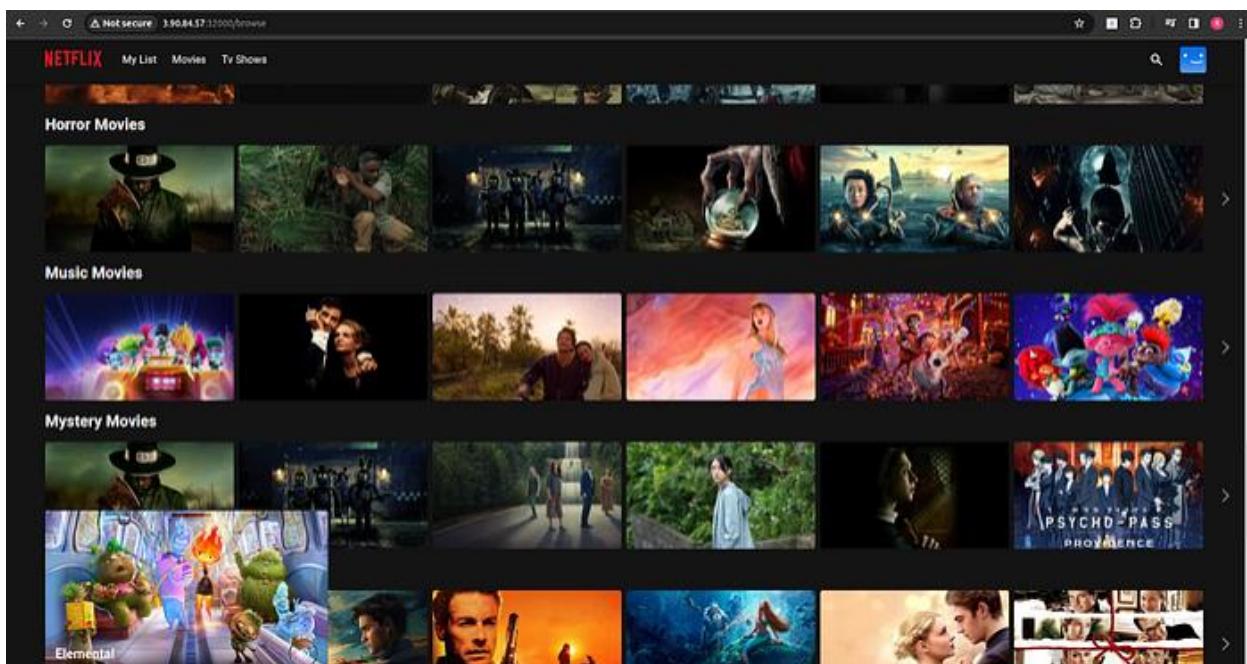


If you want to access your Netflix Clone Application.

Copy the Public IP of Worker Node and paste it on your favorite browser with port 32000 and see the magic.

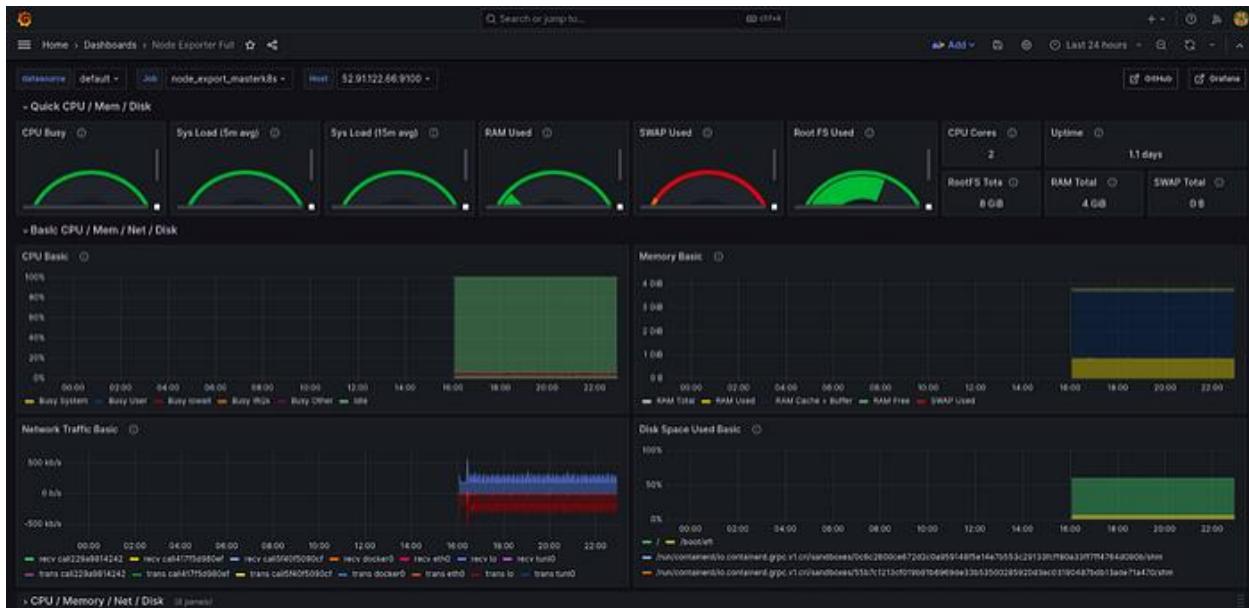


Another Snippet of our Netflix Clone application.

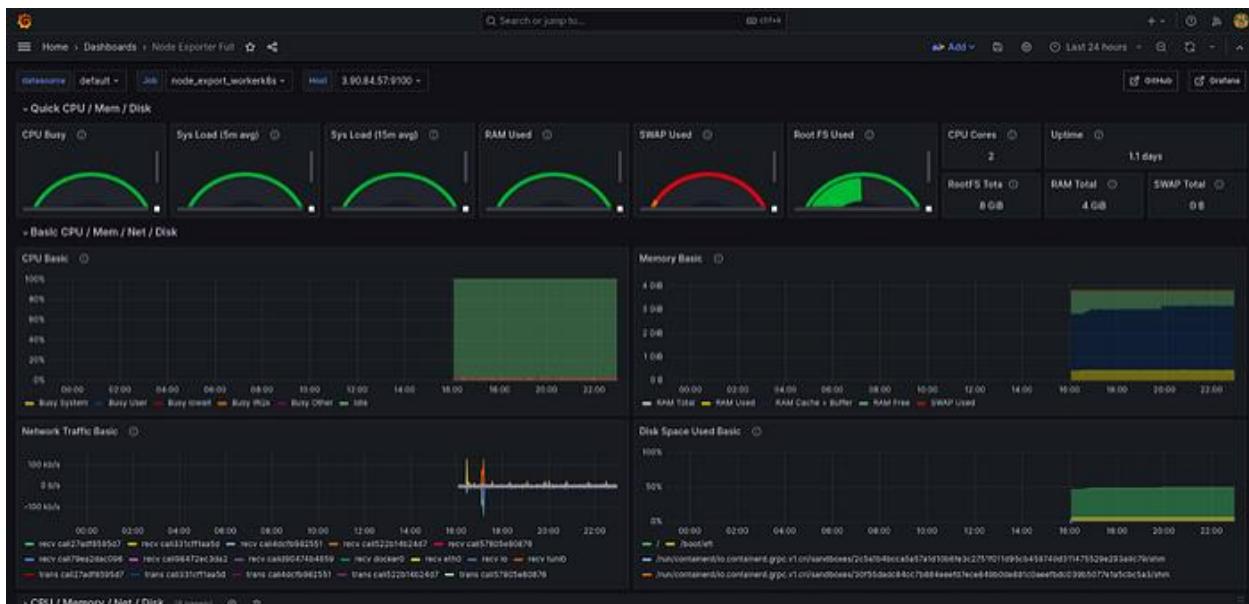


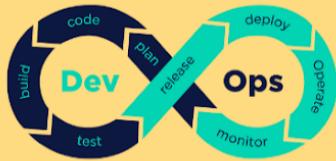
Go to the Grafana Dashboard and select Node Exporter.

You will see the real-time hardware specs of your Kubernetes master node.



You will see the real-time hardware specs of your Kubernetes worker node.





to the learners

thank you!

from aman pathak

