For this project, a Kubernetes cluster had to be set up which consists of a master and at least two worker nodes. For learning better about how Kubernetes works, I decided to deploy a simple nginx web application in three different ways: one on my local machine and other two on amazon using kops and EKS.

**Creating Kubernetes Cluster Using Minikube Locally**

Before deploying my app to the cloud, I thought about doing it in my local environment. For that I had to install a hypervisor called *hyperkit*. Once that was installed, I installed *minikube* which also installed *kubectl* (a command line tool that can talk to API Server of the Master process or node; it can interact with both minikube cluster or actual production ready cloud cluster) as a dependency. Minikube can run master and all worker processes in a single computer instead of running many virtual machines just for testing purposes.

# Starting minikube cluster using hyperkit as the hypervisor

minikube start --vm-driver=hyperkit

This command configures kubectl to use minikube cluster and also starts the master process by default as shown in the following commands.

# Viewing the master node

pawanbhatta@pawans-MBP ~ % kubectl get nodes

NAME STATUS ROLES AGE VERSION

minikube Ready control-plane,master 16m v1.20.2

# Acheiving same thing using minikube command

pawanbhatta@pawans-MBP ~ % minikube status

minikube

type: Control Plane

host: Running

kubelet: Running

apiserver: Running

kubeconfig: Configured

timeToStop: Nonexistent

Now to create the worker nodes, we proceed to use kubectl commands which works with minikube behind the hood.

#Creating my first deployment using kubectl

pawanbhatta@pawans-MBP ~ % kubectl create deployment nginx-deployment --image=nginx

Here the latest nginx image will be downloaded from docker hub and the image will be used by pod(s) to run nginx container(s). Here by default only one replica will be created.

#Viewing deployment status

pawanbhatta@pawans-MBP ~ % kubectl get deployments

NAME READY UP-TO-DATE AVAILABLE AGE

nginx-deployment 1/1 1 1 4m17s

#Viewing pods

pawanbhatta@pawans-MBP ~ % kubectl get pods

NAME READY STATUS RESTARTS AGE

nginx-deployment-84cd76b964-vldjg 1/1 Running 0 5m28s

#Viewing replicaset

pawanbhatta@pawans-MBP ~ % kubectl get replicaset

NAME DESIRED CURRENT READY AGE

nginx-deployment-84cd76b964 1 1 1 7m29s

In short, deployment manages replicaset which manages all the replica of pods. Pod is an abstraction of container. Pod can have one or more docker container running within it. However, in Kubernetes we work mostly with deployments.

#Editing the deployment.

pawanbhatta@pawans-MBP ~ % kubectl edit deployment nginx-deployment

deployment.apps/nginx-deployment edited

Here I edited the deployment configuration. Instead of default single replica, I bumped the replica number to four. All additional 3 replicas were automatically created for me as soon as the deployment configuration file was changed.

#Viewing all four replicas created

pawanbhatta@pawans-MBP ~ % kubectl get pod

NAME READY STATUS RESTARTS AGE

nginx-deployment-84cd76b964-dbczn 1/1 Running 0 4s

nginx-deployment-84cd76b964-hv86f 1/1 Running 0 4s

nginx-deployment-84cd76b964-t5jgf 1/1 Running 0 4s

nginx-deployment-84cd76b964-vldjg 1/1 Running 0 21m

However, there is better way to create/edit a deployment. That is done by creating a yaml deployment configuration file. Since the configuration file is crucial in Kubernetes let’s try to break it down.

Each configuration file has three parts:

1. Metadata: It contains name of the component. This has to be unique if we want to run a new component of the same kind.
2. Specification: All the information about the functionality or settings of a component is specified here. Attributes that can be specified here may vary according to the kind of components we want to run. For instance: if we were creating a service instead of deployment, we would have different sets of attributes being applied in specification field. One of the attributes within specification is *template* which specifies the configuration of individual pods. It contains information like which image(s) should the pod use to run the container within itself, or which port(s) should the pod be listening to.
3. Status: This is automatically generated by Kubernetes with the help of etcd (also known as the brain of Kubernetes cluster). It contains information about the current state of the deployment. It compares the current status with the desired configuration specified in the specification part of the yaml file. If they are not the same, Kubernetes will perform necessary task to make current state equal to desired state.

Below is the sample of the yaml file which when applied should run 3 replicas of nginx pods.

# Deployment configuration yaml file

apiVersion: apps/v1

kind: Deployment

metadata:

name: nginx-deployment2

labels:

app: nginx

spec:

replicas: 3

selector:

matchLabels:

app: nginx

template:

metadata:

labels:

app: nginx

spec:

containers:

- name: nginx

image: nginx:1.14.2

ports:

- containerPort: 80

#Creating yet another deployment using new yaml file

pawanbhatta@pawans-MBP CloudComputing % kubectl apply -f nginx-deployment.yaml

deployment.apps/nginx-deployment2 created

#Viewing all deployments created so far

pawanbhatta@pawans-MBP CloudComputing % kubectl get deployments

NAME READY UP-TO-DATE AVAILABLE AGE

nginx-deployment 4/4 4 4 12h

nginx-deployment2 3/3 3 3 42s

#Service configuration yaml file

apiVersion: v1

kind: Service

metadata:

name: nginx-service

spec:

selector:

app: nginx

ports:

- protocol: TCP

port: 80

targetPort: 8080

#Creating service that forwards requests to all the related pods

pawanbhatta@pawans-MBP CloudComputing % kubectl apply -f nginx-service.yaml

service/nginx-service created

#Viwing all running srrvices

pawanbhatta@pawans-MBP CloudComputing % kubectl get service

NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE

kubernetes ClusterIP 10.96.0.1 <none> 443/TCP 13h

nginx-service ClusterIP 10.97.69.24 <none> 80/TCP 2m54s

#Checking if service is forwarding requests to all the related pod instances

pawanbhatta@pawans-MBP CloudComputing % kubectl describe service nginx-service

Name: nginx-service

Namespace: default

Labels: <none>

Annotations: <none>

Selector: app=nginx

Type: ClusterIP

IP: 10.97.69.24

Port: <unset> 80/TCP

TargetPort: 8080/TCP

Endpoints: 172.17.0.7:8080,172.17.0.8:8080,172.17.0.9:8080

Session Affinity: None

Events: <none>

#Verifying the IP address of the pods

pawanbhatta@pawans-MBP CloudComputing % kubectl get pod -o wide

NAME READY STATUS RESTARTS AGE IP NODE NOMINATED NODE READINESS GATES

nginx-deployment2-66b6c48dd5-6q5fk 1/1 Running 0 59m 172.17.0.8 minikube <none> <none>

nginx-deployment2-66b6c48dd5-hjbc6 1/1 Running 0 59m 172.17.0.9 minikube <none> <none>

nginx-deployment2-66b6c48dd5-wsxh6 1/1 Running 0 59m 172.17.0.7 minikube <none> <none>

Endpoints attribute of the nginx-service contains three private IP addresses where each of the pods that we created are listening to which verifies that we have successfully connected our service to all related pods.

Deleting deployments and services that was created was done by following kubectl commands.

#Deleting deployment and service

pawanbhatta@pawans-MBP CloudComputing % kubectl delete -f nginx-deployment.yaml

deployment.apps "nginx-deployment2" deleted

pawanbhatta@pawans-MBP CloudComputing % kubectl delete -f nginx-service.yaml

service "nginx-service" deleted

pawanbhatta@pawans-MBP CloudComputing % kubectl delete deployment nginx-deployment

deployment.apps "nginx-deployment" deleted

**Creating Kubernetes Cluster on AWS using Kops:**

First step in creating Kubernetes cluster from scratch is to create a new IAM Role:

I gave following permission to the new role: AmazonEC2FullAccess, IAMFullAccess, AmazonS3FullAccess, AmazonVPCFullAccess, AmazonRoute53FullAccess.

Then I created a new EC2 instance and assigned the role I created above to the instance.

I installed kops and kubectl in the machine after I sshed into it.

#Installing kops

curl -LO https://storage.googleapis.com/kubernetes-release/release/v1.18.0/bin/linux/amd64/kubectl

chmod +x ./kubectl

sudo mv ./kubectl /usr/local/bin/kubectl

#Installing kubectl

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

Since kops needs a “store” to store configuration information of the cluster, we create a S3 bucket for that purpose.

#Creating S3 bucket for the kubernetes state store

aws s3api create-bucket --bucket k8-kops-bukcet-coding-rant

#Creating env variable pointing to the place where our bucket is located

export KOPS\_STATE\_STORE=s3://k8-kops-bucket-coding-rant

#Naming the cluster

export NAME=coding-rant.k8s.local

#A three-master and five-worker node cluster, with master nodes spread across different Availability Zones, can be created using the following command:

kops create cluster --name $NAME --zones us-west-2a,us-west-2b,us-west-2c --authorization RBAC --master-size t2.micro --node-size t2.micro --yes

Now for the final part, kops delete command was used to delete the entire cluster which means all the EC2 instances that the kops created will automatically be terminated.

#Deleting the cluster

kops delete cluster --name=coding-rant.k8s.local --yes

**Creating Kubernetes Cluster on AWS with EKS:**

EKS provides fully managed Kubernetes control plane. Instead of having to create and configure the master node, we can now focus on creating and managing worker node only. However, there is lots of configuration to set up before we can create a cluster in EKS. To help us, there is a command line tool called EksCtl which will make all the tedious configuration task easy for us.

#installing eksctl

brew install weaveworks/tap/eksctl

**TASK 1: Launching Kubernetes Cluster:**

First step before creating a EKS cluster is to create our own VPC where we need at least four subnets (2 private and 2 public). We need to make sure to associate our private subnets to routing table that connects to NAT while we need to associate the public subnets to internet gateway directly.

#Creating the cluster using eksctl

pawanbhatta@pawans-MBP CloudComputing % eksctl create cluster \

--name coding-rant-cluster-v1 \

--version 1.17 \

--region us-east-1 \

--nodegroup-name coding-rant-nodes \

--node-type t2.micro \

--nodes 2 \

Now we can view our worker nodes using kubectl commands.

#Viewing the newly created worker nodes

pawanbhatta@pawans-MBP CloudComputing % kubectl get nodes

NAME STATUS ROLES AGE VERSION

ip-192-168-59-48.ec2.internal Ready <none> 50m v1.17.12-eks-7684af

ip-192-168-8-160.ec2.internal Ready <none> 50m v1.17.12-eks-7684af

**TASK 2: Deploying contenarized application**

Now we can deploy the application of our choice into the cluster. For testing purposes, I am going to deploy nginx container using following kubectl command.

#Deploying nginx web server in the cluster

pawanbhatta@pawans-MBP CloudComputing % kubectl create deployment nginx-deployment --image=nginx

#Getting all running containers

pawanbhatta@pawans-MBP CloudComputing % kubectl get pods

NAME READY STATUS RESTARTS AGE

nginx-deployment-ddd976fc7-n87hs 1/1 Running 0 14m

**TASK 3: Scaling the pod to more container instances:**

To scale the pod to more container instances, we will have to edit the deployment yaml file. For that we will use the following command:

#Opening the deployment yaml file

pawanbhatta@pawans-MBP ~ % kubectl edit deployments

Then I bumped the replicas to 2 so that out nginx web server was running 2 instances or containers across two nodes in the cluster.

However, another easy way to run multiple replicas of same container would be to create a deployment yaml file.

# Deployment configuration yaml file

apiVersion: apps/v1

kind: Deployment

metadata:

name: nginx-deployment2

labels:

app: nginx

spec:

replicas: 2

selector:

matchLabels:

app: nginx

template:

metadata:

labels:

app: nginx

spec:

containers:

- name: nginx

image: nginx:1.14.2

ports:

- containerPort: 80

#Deploying using yaml config file that has multiple instance of the web server

pawanbhatta@pawans-MBP CloudComputing % kubectl apply -f nginx-deployment.yaml

deployment.apps/nginx-deployment2 created

#Viewing all container that are running

pawanbhatta@pawans-MBP CloudComputing % kubectl get pods

NAME READY STATUS RESTARTS AGE

nginx-deployment2-574b87c764-4pwgh 1/1 Running 0 2m9s

nginx-deployment2-574b87c764-mjxmw 1/1 Running 0 2m9s

**TASK 4: Updating the application with a new software version**

Since we mentioned image version in the deployment yaml file, we can simply change the configuration yaml file to reflect the version of the nginx image we would like to run. Our updated yaml deployment file would look something like this:

# Deployment configuration yaml file

apiVersion: apps/v1

kind: Deployment

metadata:

name: nginx-deployment2

labels:

app: nginx

spec:

replicas: 2

selector:

matchLabels:

app: nginx

template:

metadata:

labels:

app: nginx

spec:

containers:

- name: nginx

image: nginx:1.19.8

ports:

- containerPort: 80

#Applying software update

pawanbhatta@pawans-MBP CloudComputing % kubectl apply -f nginx-deployment.yaml

deployment.apps/nginx-deployment2 configured

#Previous pods are now replaced with the new version

pawanbhatta@pawans-MBP CloudComputing % kubectl get pods

NAME READY STATUS RESTARTS AGE

nginx-deployment2-54898b49d5-vp6rf 1/1 Running 0 25s

nginx-deployment2-54898b49d5-vzp6t 1/1 Running 0 25s

**TASK 5: Deleting the application and stopping the Kubernetes cluster**

We can delete the application that is running in the cluster with kubectl commands.

#Deleting the application

pawanbhatta@pawans-MBP CloudComputing % kubectl delete -f nginx-deployment.yaml

deployment.apps "nginx-deployment2" deleted

#No application running in the cluster

pawanbhatta@pawans-MBP CloudComputing % kubectl get pods

No resources found in default namespace.

Now we can stop the whole cluster by using eksctl commands. All the EC2 instances, VPC, subnets and elastic IP address allocated while creating the cluster will be automatically be deleted.

#Deleting the cluster

pawanbhatta@pawans-MBP CloudComputing % eksctl delete cluster --name coding-rant-cluster-v1