KUBERNETES

Kubernetes is an open-source container management tool that Automates Container Deployment, Container Scaling, and Load Balancing.

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

It Is supported by all the Clod providers.

HISTORY

Google developed an internal system called “BROG” (later names OMEGA) to deploy and manages Thousands of Google Application and services and their cluster.

In 2014, google introduced Kubernetes as an open-source platform.

Kubernetes is written in Go-lang.

Kubernetes was later donated to Cloud Native Computing Foundation (CNCF).

Cloud-native means it will develop existing features in the cloud for better purpose usage.

ONLINE PLATFROMS for K8s

Kubernetes playground.

Kubernetes with K8s.

Kubernetes with Kubernetes classroom.

CLOUD-BASED K8s SERVICES

Google Kubernetes services.

Azure Kubernetes services

Elastic Kubernetes services.

INSTALLATION TOOLS

Mini-kube

Kube-adm

KOps

CONTAINER SCALEUP PROBLEMS

Containers cannot communicate with each other.

Auto-scaling and Load balancing were not possible.

Containers had to be managed carefully.

FEATURES

Orchestration (Clustering of any number of containers running on different networks).

Auto-scaling (Vertical [Existing] - >most Preferable and Horizontal [New]) and Auto-healing.

Load balancing.

Platform Independent (Cloud/Virtual/Physical).

Fault tolerance (Node/Pod failure).

Roll back (Going back to previous version).

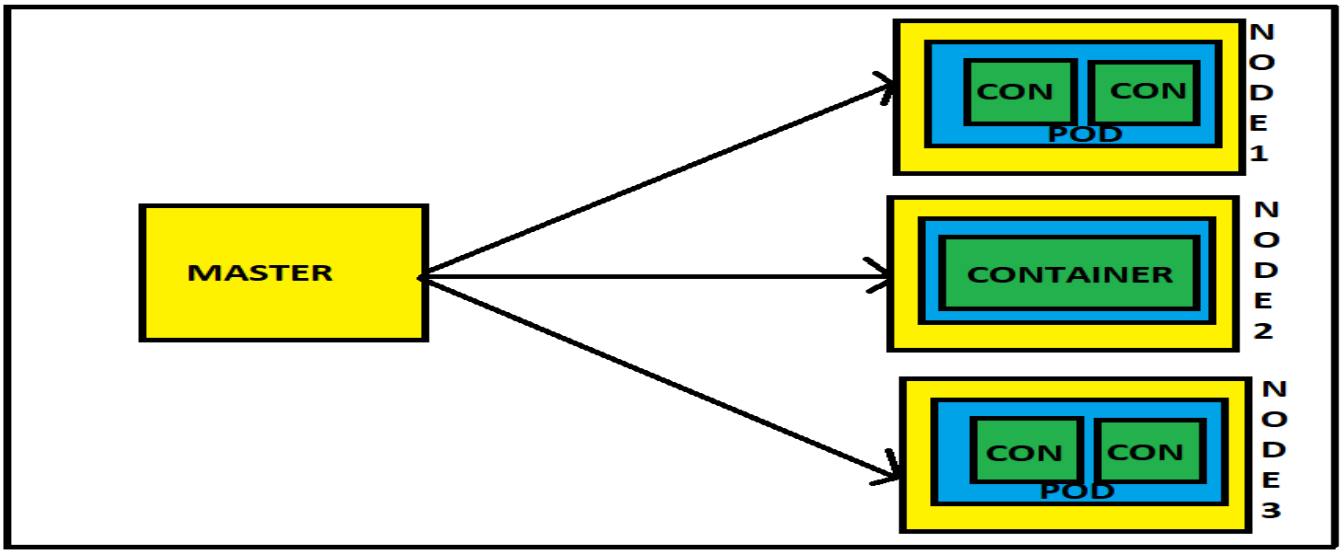
Health Monitoring of Containers. If one Container fails it will create another container.

Batch Execution (One time, Sequential, Parallel).

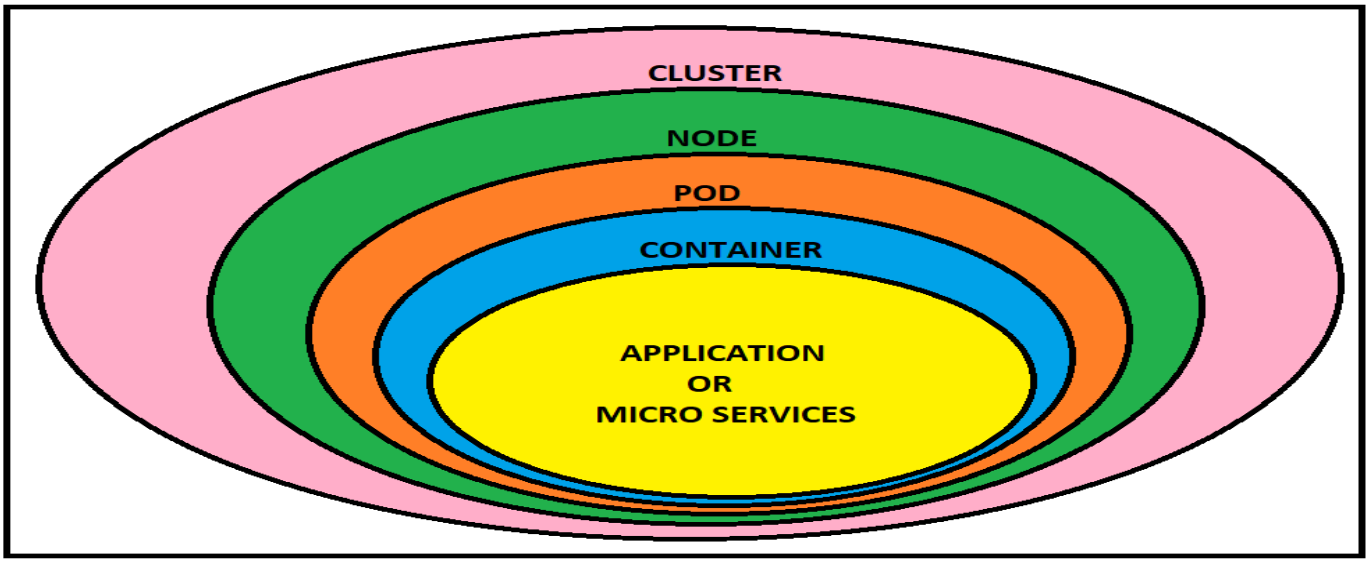
Scripts in K8s is called Manifest, which is in form of Json or YAML.

DOCKER SWARM VS K8s

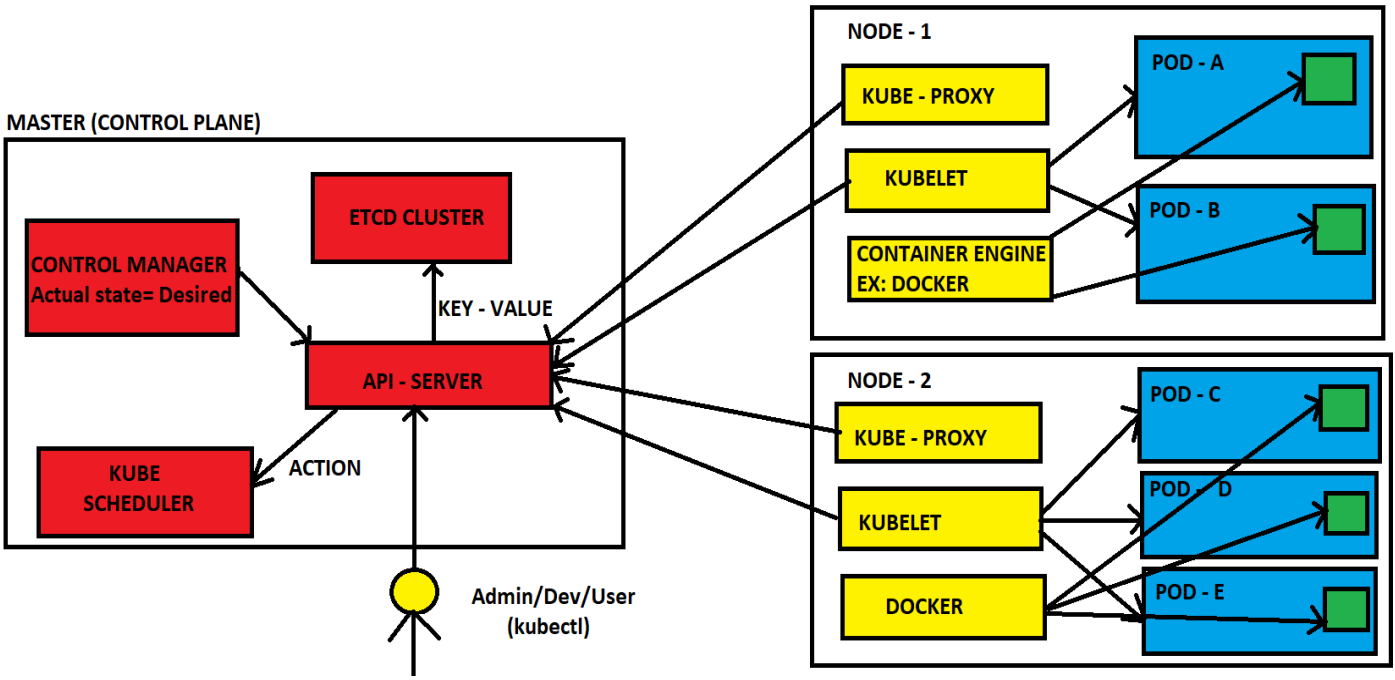
Parameters	Docker Swarm	Kubernetes
Scaling	No Autoscaling	Auto-scaling
Load balancing	Does auto load balancing	Manually configure your load balancing settings
Storage volume sharing	Shares storage volumes with any other container	Shares storage volumes between multiple containers inside the same Pod
Use of logining and monitoring tool	Use 3rd party tool like ELK	Provide an in-built tool for logging and monitoring.
Installation	Easy & fast	Complicated & time-consuming
GUI	GUI not available	GUI is available
Scalability	Scaling up is faster than K8S, but cluster strength not as robust	Scaling up is slow compared to Swarm, but guarantees stronger cluster state Load balancing requires manual service configuration
Load Balancing	Provides a built-in load balancing technique	Process scheduling to maintain services while updating
Updates & Rollbacks Data Volumes Logging & Monitoring	Progressive updates and service health monitoring.	Only shared with containers in same Pod Inbuilt logging & monitoring tools.



CLUSTER



ARCHITECTURE



Master components

- **API Server:** Exposes the API.
- **ETCD Cluster:** Key-value stores all cluster data. (Can be run on the same server as a master node or on a dedicated cluster.)
- **Kube-scheduler:** Schedules new pods on worker nodes.
- **Kube-controller-manager:** Runs the controllers.
- **Cloud-controller-manager:** Talks to cloud providers.

Node components

- **Kube-proxy:** Keeps network rules like Addressing IP to Pods.
- **Kubelet:** Agent that ensures containers in a pod are running.
- **Container engine:** Maintains the containers like Docker, Rocket etc.

Pod: A group of one or more containers.
Service: An abstraction that defines a logical set of pods as well as the policy for accessing them.
Volume: An abstraction that lets us persist data. (This is necessary because containers are ephemeral—meaning data is deleted when the container is deleted.)
Namespace: A segment of the cluster dedicated to a certain purpose, for example a certain project or team of developers.
Replica-Set (RS): Ensures that desired amount of pod is what's running.
Deployment: Offers declarative updates for pods an RS.
Stateful-Set: A workload API object that manages stateful applications, such as databases.
Daemon-Set: Ensures that all or some worker nodes run a copy of a pod. This is useful for daemon applications like fluentd.

Job: Creates one or more pods, runs a certain task(s) to completion, then deletes the pod(s).

WORKING WITH K8s

We create Manifest (.yml) format.

Apply this to the Cluster (to Master) to bring into the desired state.

Pod run on the node, which is controlled by the master.

ROLE OF MASTER

K8s Cluster contains Running containers or Physical/VM/cloud instance/all mix.

It designates on or more of these as master and all others as Workers or Nodes.

Master is going to run set of all K8s processes. These processes will ensure smooth functioning of cluster. This process is called as “control plane”.

Can be multi-master for high Availability.

Master runs control plane to run the cluster smoothly.

COMPONENTS OF CONTROL PLANE

KUBE-API SERVER (For all Communications)

It is front end of the Control Plane.

It will directly interact with the user (I.e we apply .yml or json manifest to kube-Apiserver).

This kube-Apiserver is directly meant to scale Automatically as per load.

ETCD:

- It is nothing but the Data base which Stores Meta data and status of cluster.

It is consistent and high available store (Key - Value store).

Source of touch for Cluster state (information about the state of Cluster).

FEATURES

Fully replicated: Entire state is available on every node in the cluster.

Secure: Implements Automatic TLS with operational Client-Certificate Authentication.

Fast: Benchmarked t 10,000 writes per second.

KUBE-SCHEDULER

When user makes a request for creation and management of pods, Kube-scheduler is going to take the action on those requests, Handles pod creation and Management.

Kube-scheduler match/assign any node to create and run pod.

A scheduler watches for newly created pods that have no node assigned for every pod that the scheduler discovers, it becomes responsible for finding best node for that pod to run on.

It gets the information for hardware configuration from configuration files and schedules the pods on the nodes Accordingly.

CONTROL MANAGER

Makes sure actual state of cluster matches to the desired state.

Two possible choices for Control manager

1. If K8s on cloud, then it will be Cloud-Controller-Manager.
2. If K8s on non-cloud, then it will be Kube-Controller-Manager.

Components on master that runs Controller.

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

Route-controller: For setting up network, routes on your cloud.

Service-controller: For load balancers on your cloud against services of type Load Balancers.

Volume-controller: For Creating, attaching and mounting volumes and interacting with the cloud provider to Orchestrate Volume.

NODE COMPONENTS

KUBELET

It Is nothing but Agent running on the Node.

Listens to the Kubernetes Master (Ex: Pod creation request).

Uses the port :10255 (can be changeable).

Sends Successful/Fail reports to the Master.

CONTAINER ENGINE

- It can be Docker, Rocket or any other.

Works with Kubelet.

Pulling images.

Start/Stop the Containers.

Exposing Containers on ports specified in the Manifest.

KUBE-PROXY

Assigns IP to each pod.

It is required to assign IP addresses to Pods (Dynamic IP).

It runs on each node & this will make sure that each pod will gets its unique IP address.

All the three components Kubelet, Kube-Proxy and Container engine Is collectively called as Node.

POD

Smallest unit of the Kubernetes.

It is a group of one or more containers that are deployed together on the same Host.

A cluster is a group of nodes.

A cluster has atleast one master node and one worker node.

In Kubernetes, control unit is the pod, not containers.

Consistent of one or more Tightly coupled containers.

Pod runs on node, which is controlled by master.

Kubernetes only knows about Pods (it does not know about individual container).

Cannot start container without a Pod.

One Pod usually contain only one container.

MULTI CONTAINER PODS

Share access to memory space.

Connect to each other using localhost. <container port>

Share access to the same Volume.

Containers with in the pods are deployed in an all-or-nothing manner.

Entire pod is hosted on the same node (scheduler will decide about which node).

LIMITATIONS

By default, no Auto-scaling or LB we need to do it Manually.

POD Crashes, Solution for that is Higher level K8s Objects but, we need to add these.

Higher level K8s Objects

Replication-set: Scaling and Healing.

Deployment: Versioning and Roll back.

Service: Static (Non-Ephemeral) IP and Networking.

Volume: Non-Ephemeral Storage.

IMPORTANT NOTATIONS

Kubectl	:	Single Cloud.
Kubeadm	:	On-Premises.
Kubefed	:	Federated (Hybrid cloud).

MINI KUBE:

Minikube creates a single node cluster inside a VM or Cloud Instance. It is good for beginners to learn Kubernetes since you don't have to create a master and worker node to create a cluster and
we can practice basic Kubernetes functions and can also install the Kubernetes dashboard on it.

PRE-REQUISTES

Minimum 2 CPU's or more

Minimum 2GB of free memory

Minimum 20GB of free disk space

Internet connection

Container or virtual machine manager, such as: Docker, Hyperkit, Hyper-V, KVM, Parallels, Podman, VirtualBox, or VMware Fusion/Workstation

KUBECTL INSTALLATION:

sudo apt update -y

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

kubectl version

DOCKER INSTALLATION:

sudo apt-get install docker.io -y

sudo systemctl status docker

sudo usermod -aG docker $USER && newgrp docker

MINIKUBE INSTALLATION:

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

chmod +x minikube

sudo mv minikube /usr/local/bin/

minikube version

sudo minikube start --vm-driver=none

X Exiting due to GUEST_MISSING_CONNTRACK: Sorry, Kubernetes 1.22.3 requires conntrack to be installed in root's path

sudo apt-get install -y conntrack

minikube start --vm-driver=none

minikube status

kubectl cluster-info

kubectl get events

kubectl config view

kubectl run hello-minikube --image=gcr.io/google_containers/echoserver:1.4 --port=8080

kubectl get pods

DEPLOYING AN APP

kubectl create deployment hello-node --image=k8s.gcr.io/echoserver:1.4

kubectl get deployment

kubectl expose deployment hello-node --type=NodePort --port=8080

kubectl get svc

curl -v public-ip:32548

minikube ip

curl -v private-ip:32548

http://private-ip:32548/

kubectl delete service hello-node

kubectl delete deployment hello-node

minikube stop

minikube delete

KUBECTL:

It is the Kubernetes command-line tool.

It can communicate with a Kubernetes cluster's control plane, using the Kubernetes API.

It allows you to run commands against Kubernetes clusters.

You can use kubectl to deploy applications, inspect and manage cluster resources, and view logs.

The configuration file is located on .kube directory.

SYNTAX:
kubectl [command] [TYPE] [NAME] [flags]

Command: Operation you want to do (create, delete, get, describe)
TYPE: Specifies the resource type, it Is case sensitive.
NAME: Specifies the resource Name, it Is case sensitive.

REPLICASET:

it is nothing but Group of pods

if one pod is delete, terminated or failed then it will create another one.

It will maintain a stable set of replica Pods running at any given time.
It is the enhance version of Replication controller.
We can create multiple pods to share the load among them by using the replicaset.
It can balance the load even the pod is on different node.
If number of users increasing we can increate replica sets.

Replication Controller

Replication Controller is one of the key features of Kubernetes, which is responsible for managing the pod lifecycle. It is responsible for ensuring that the specified number of pod replicas are running at any point in time. It is used in times when one wants to make sure that the specified number of pods or at least one pod is running. It has the capability to bring up or down the specified no of pods.

Replication Controller	ReplicaSet
Replication Controller only supports equality-based selector. It's being replaced by Replica Sets	Replica Set supports the new set-based selector.
Example: environment = production	Example: environment in (prod, test)
This selects all resources with key equal to environment and value equals to production	This selects all resources with key equal to environment and value equals to prod or test

KIND:
POD, SERVICE -- > V1 & REPLICASET, DEPLOYMENT -- > apps/v1

WORKING:
It has features of Replicaset and some other extra features like updating and rollbacking to a particular version we want without downtime*.

here application will reside on pod to manage and update& manage that pod we used deployment

DEPLOYMENT:

A *Deployment* provides declarative updates for Pods and ReplicaSets.

You describe a *desired state* in a Deployment, and the Deployment Controller changes the actual state to the desired state at a controlled rate. You can define Deployments to create new ReplicaSets,

We can roll out changes and Rollback the changes if need.
When we create a deployment it will create 1 replica by default .
It will make sure that only few pods are down while others are updating.
By default atleast 25% pods are available and up if we want we can change.
Can track the history of versoon which had been made.