OPENSHIFT 4.6 ADVANCED KUBERNETES NOTES

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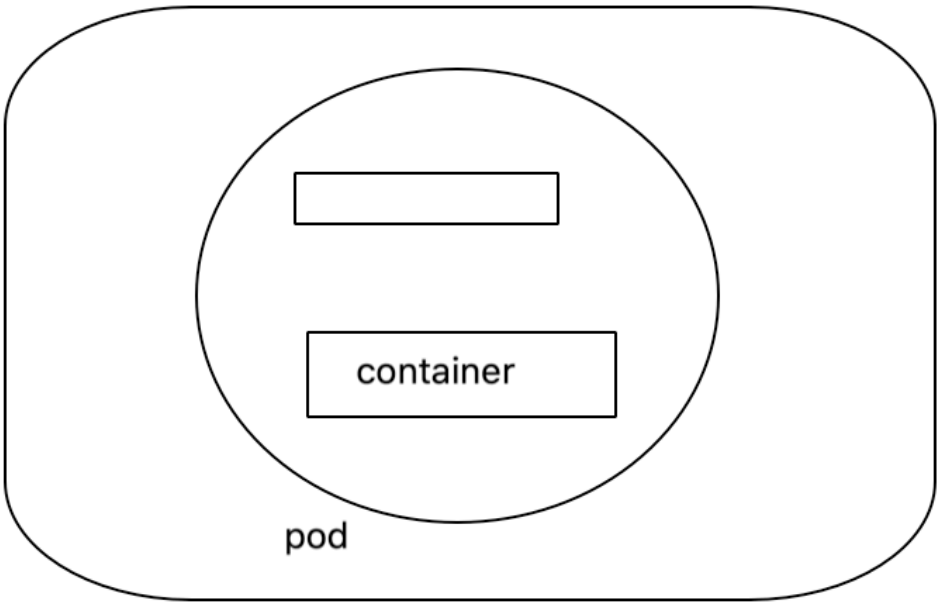
KEYWORDS

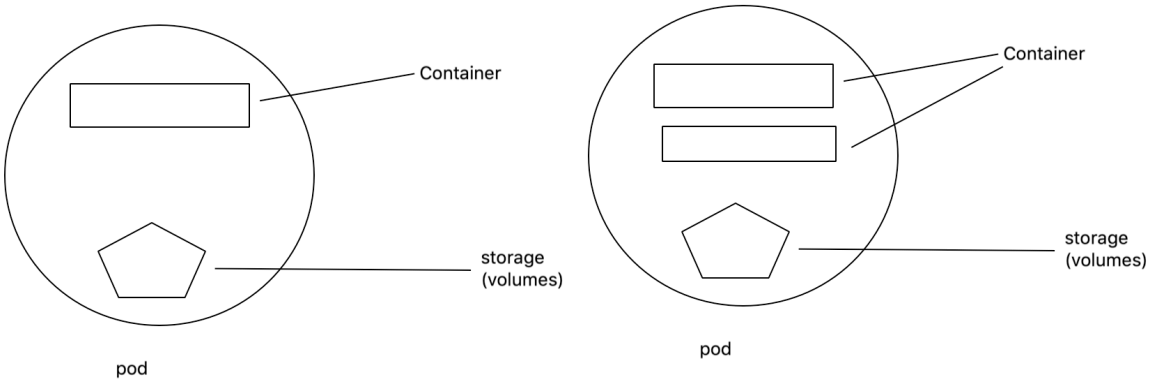
NODE
POD
CONTAINER



POD

Contains

1. Application container (s)
2. Storage resources
3. A unique network IP

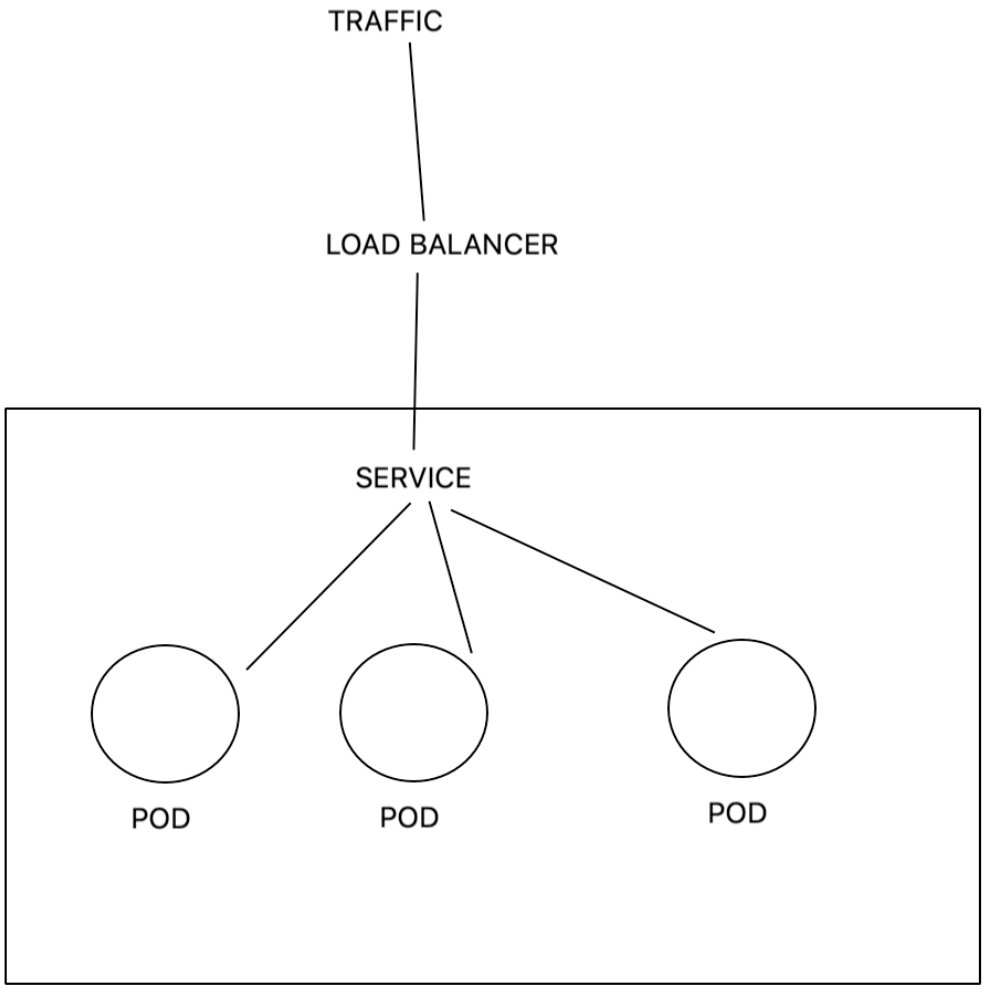


EVERY POD WILL HAVE ITS OWN IP address

Features of Kubernetes

1. Automatic bin packing
2. Service discovery and load balancing
3. Storage orchestration
4. Self- healing

SERVICE DISCOVERY AND LOAD BALANCING



STORAGE ORCHESTRATION

1. Containers running inside a pod may need to store data
2. Pods can have a storage volumes
3. Usually a single volume is shared with in all the containers in a pod

Storage system

1. Local
2. Cloud (AWS)
3. Network (NFS)

SELF HEALING

1. If container fails -it restarts container
2. If node dies - replaces and reschedule containers on other nodes
3. If container does not respond - by health check - kill container

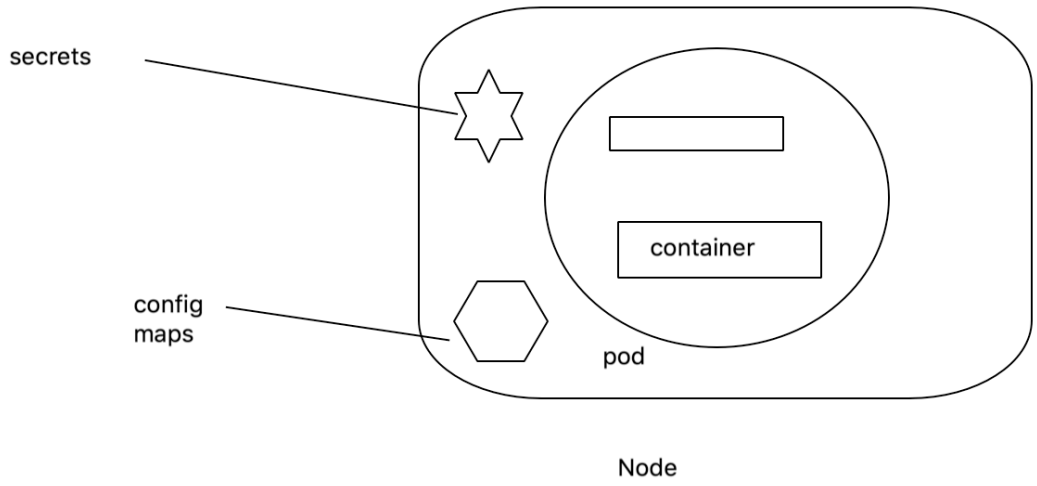
Advanced Features of Kubernetes

1. Automated rollouts and rollbacks
2. Secret and configuration management
3. Batch execution
4. Horizontal scaling

Secret and configuration management

1. Secret data like passwords and other tokens are handled using secret

2. Its a kubernetes object



Batch Execution

1. Batch jobs require an executable to run to completion
2. During job execution if any container fails or pod fails , **Job Controller** will reschedule the container pods on another node

Types

Seq
Parallel

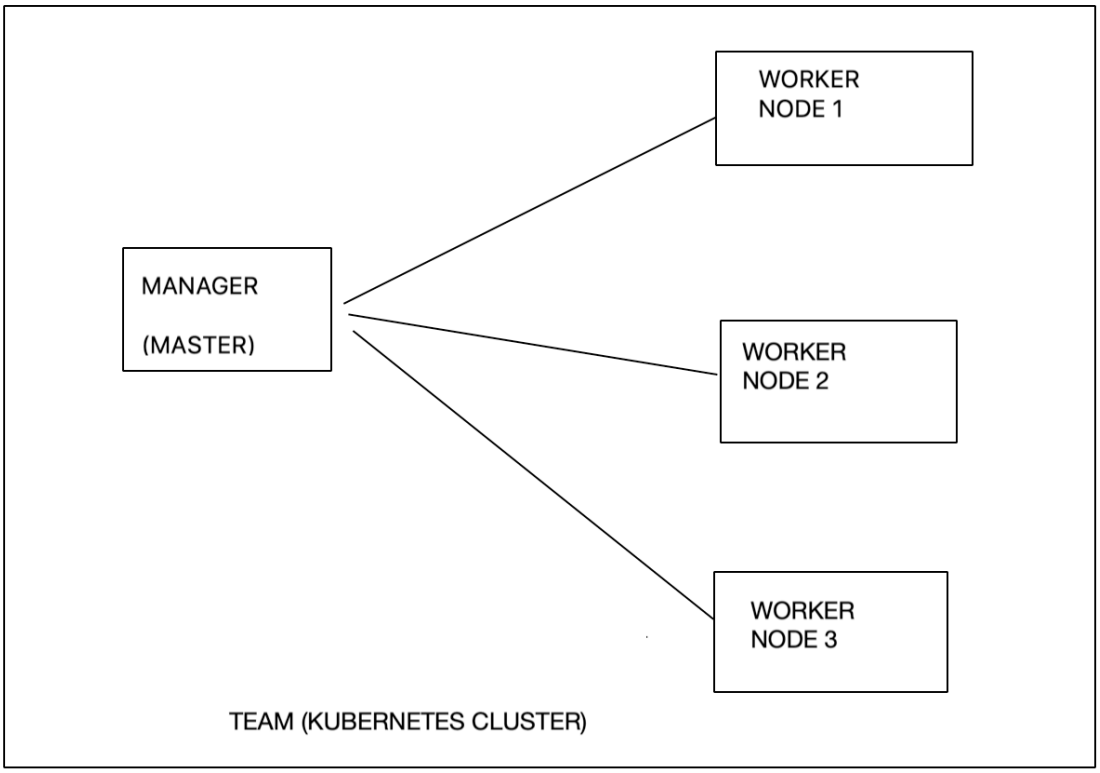
Horizontal Scaling

We can scale up and down in three ways

1. Using Commands
2. From the dashboard
3. Automatically based on CPU usage

Replication Controller
ReplicaSets

OPENSHIFT - KUBERNETES CLUSTER

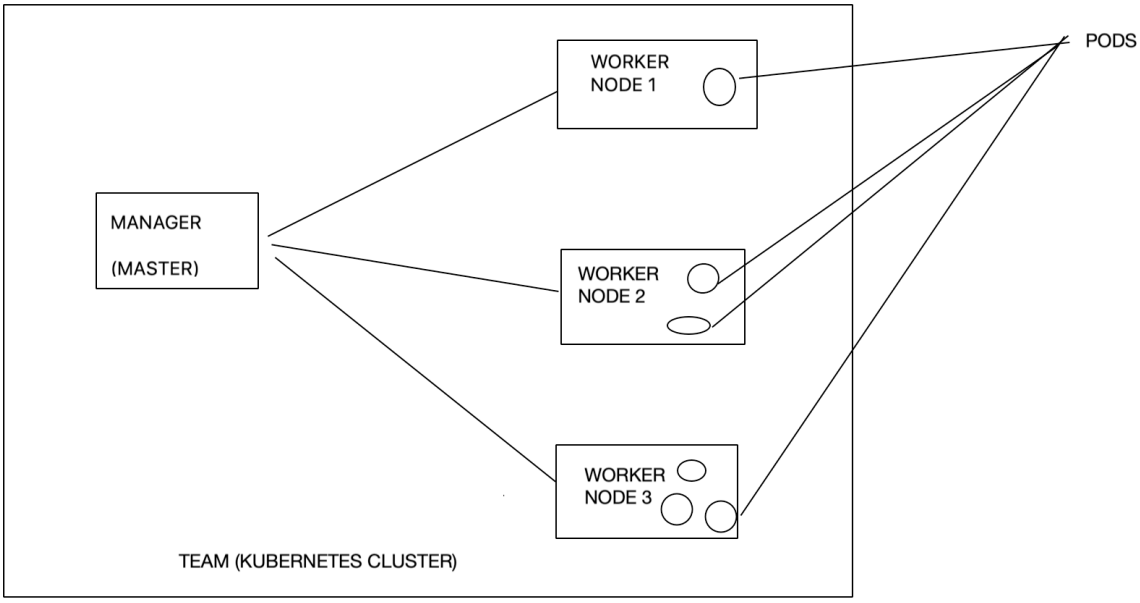


1. When you deploy kubernetes you get a cluster
2. Set of machines called nodes
3. In cluster at least one worker and one master node is required

MINIONS - WORKER NODES ARE CALLED MINIONS(IN OLD VERSION OF K8S)

THERE CAN BE MORE THAN ONE MASTER NODES IN A CLUSTER TO PROVIDE WITH FAILOVER AND HA

CAN HAVE MANY CLUSTER IN K8S



Nodes can be

Physical Machine
Virtual Machine
VM on Cloud

Kubernetes capacity

No more than - 5000 Nodes, 150000 pods, 300000 containers

No more than 100 pods per node

4 components of master node

1. API Server
2. Scheduler
3. Controller manager
4. Etcd

API SERVER

Communicate with one another applications
Front-end
Exposes api for each operations
Interact with kubernetes cluster

Control Manager

Kube Controller Manager
Cloud Controller manager

Kube controller manager

1. Node Controller - notices and responds when nodes goes down
2. Replication Controller - maintain correct count of pods

for every replication
3. EndPoints Controller - joins services and pods
4. Service Accounts and token controller - create default accounts and API access tokens for new namespaces.

Cloud Controller manager

1. Node Controller
2. Route Controller
3. Service controller
4. Volume controller

—cloud-provider

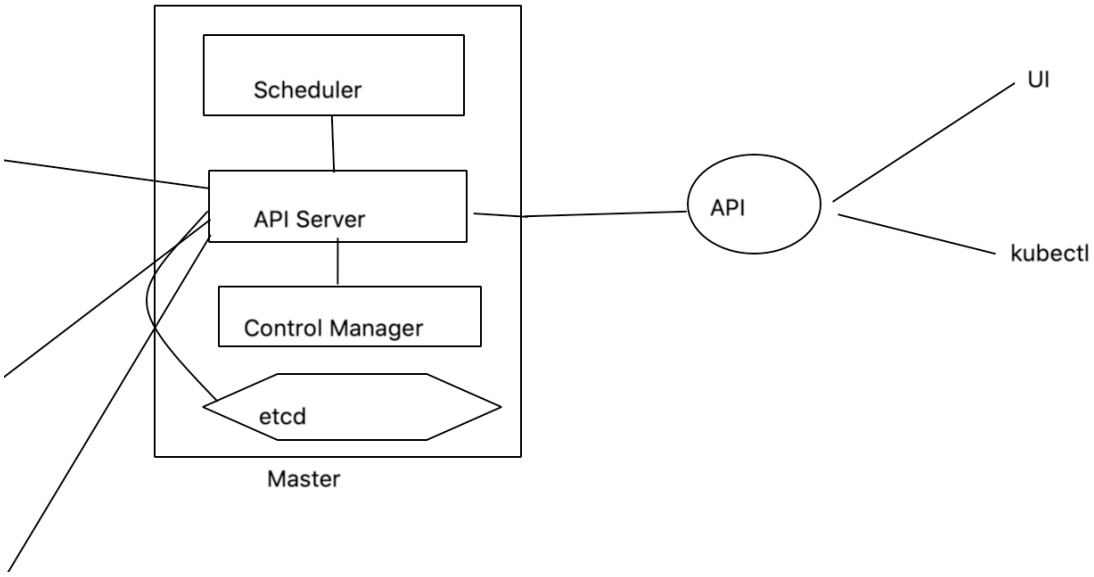
Worker Node components

1. Kubelet
2. Kube-proxy
3. Container runtime

ADDITIONAL SERVICES

Kubernetes Dashboard
Monitoring
Logging

DNS

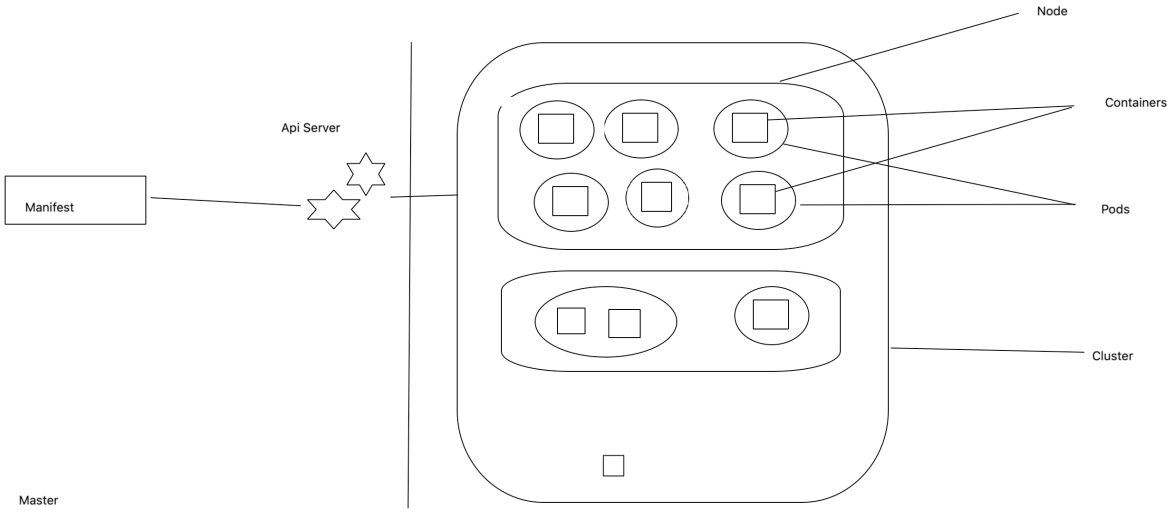


PODS

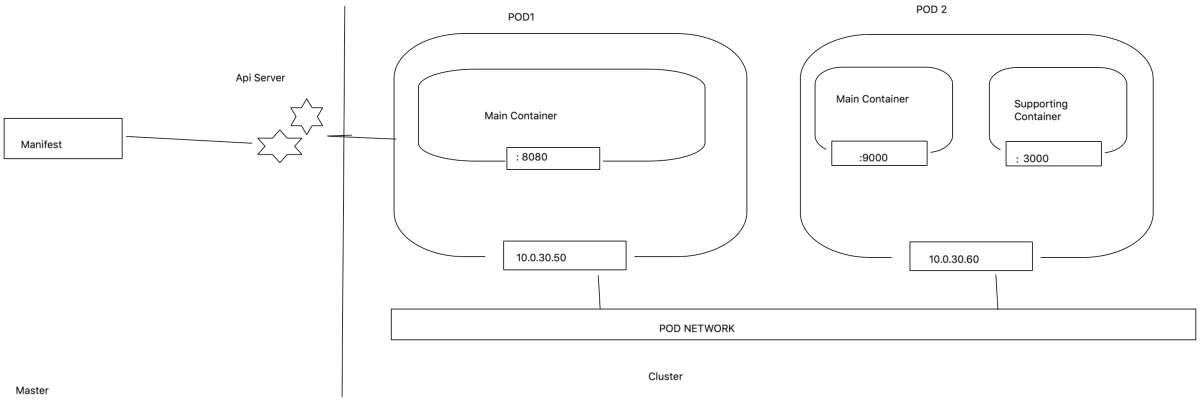
Atomic Unit of Scheduling

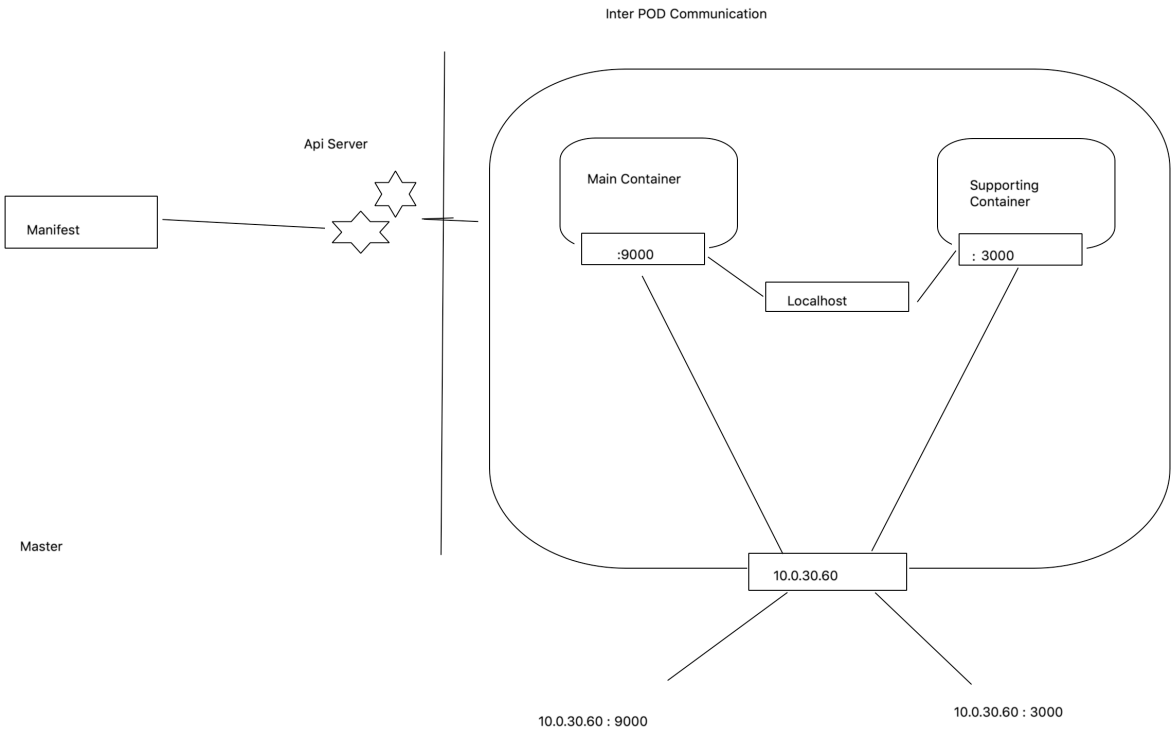
VIRTUALIZATION - VM
DOCKER - Container
KUBERNETES - Pod

POD ARCHITECTURE

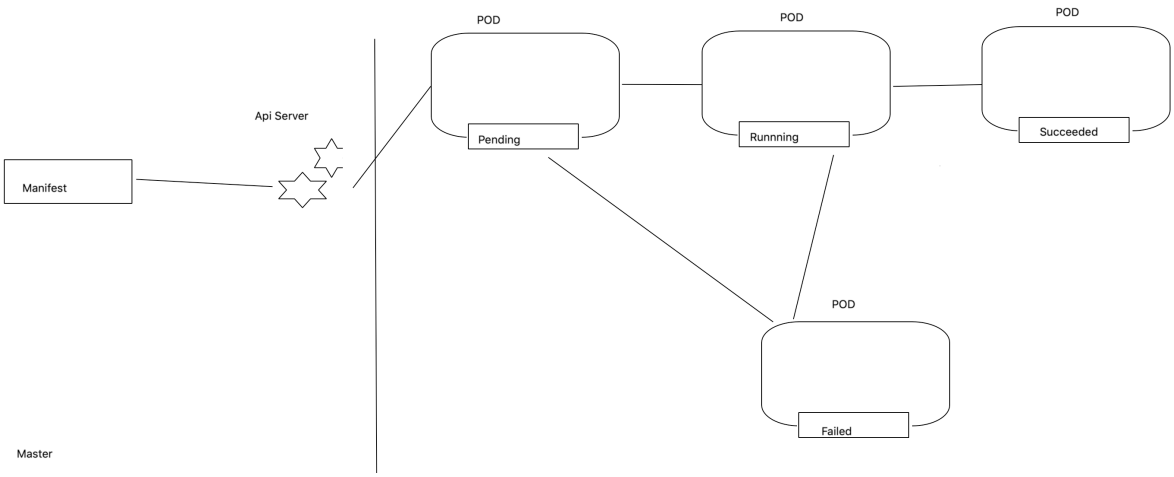


POD NETWORKING





POD LIFE CYCLE



POD DEMO

1. **Create example1.yml**

```
# nginx pod example

apiVersion: v1
kind : Pod
metadata:
    name : nginx-pod
    labels :
        app : nginx
        tier : dev

spec:
  containers :
    - name : nginx-container
      image : nginx
```

kubectl create -f example1.yml

kubectl get pod

SEE THE STATE

FIRST - PENDING
SECOND - RUNNING

Kubectl get pod -o wide

Kubectl get pod nginx-pod -o yaml

kubectl describe pod nginx-pod

Ping <ipaddress of the pod>

Kubectl exec -it nginx-pod - - /bin/sh

Kubectl delete pod nginx-pod

REPLICATION CONTROLLER

REPLICATION CONTROLLER is a service - Ensures that a specified number of pods are always running at any time

If there are excess pods - it kills and vice versa

New pod is created and launched if there is a failure or deleted or terminated.

RC and pods are associated with “labels”

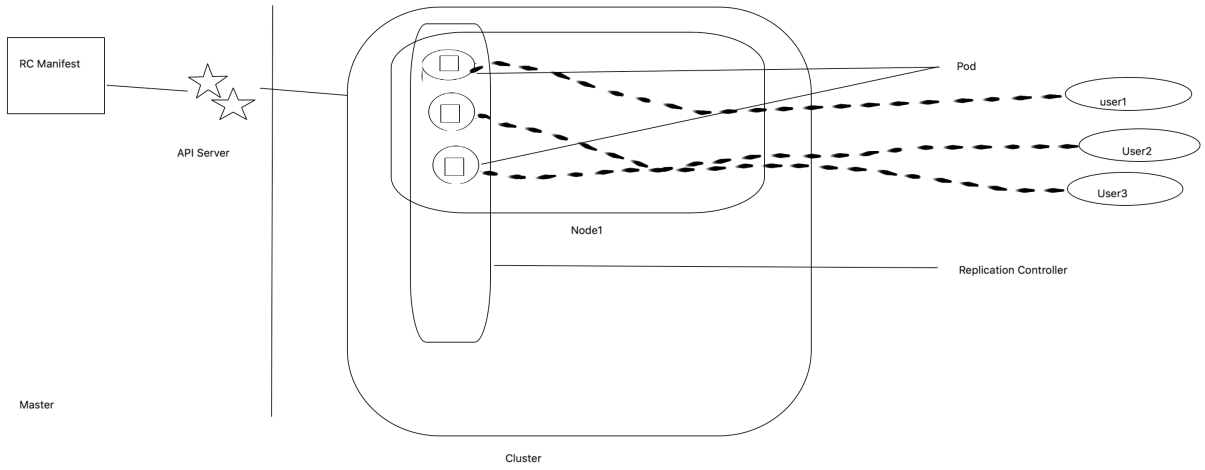
Always rc with count must be 1 then only pod is always available

Used for HA

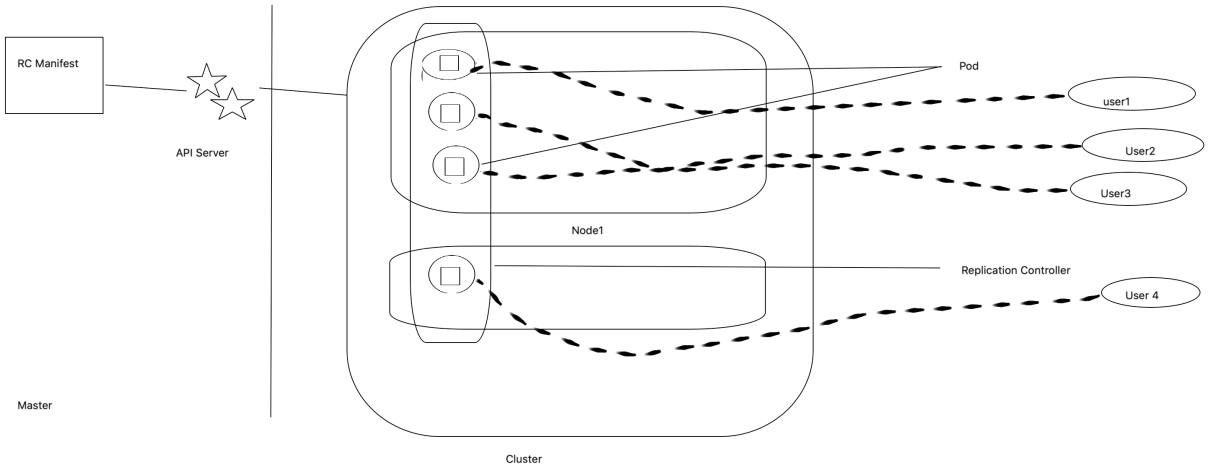
High Availability architecture

Point 1

Load Balancing



HIGH AVAILABILITY



REPLICATION CONTROLLER
REPLICA SETS

WORK WISE BOTH ARE SAME

OLD TECHNIQUE

REPLICATION CONTROLLER

Uses equality based selector

NEW TECHNIQUE

REPLICA SETS

Set based selector

DEMO

```
# nginx-rc.yml

apiVersion : v1
kind : ReplicationController
metadata :
    name : nginx-rc.yml
spec :
    replicas : 3
    selector :
```

```
    app : nginx-app
  template :
    metadata :
      name : nginx-pod
      labels :
        app : nginx-app
    spec :
      containers :
      - name : nginx-container
        image : nginx
        ports :
        - containerPort : 80
```

Commands
————————-

Kubectl create -f nginx-rc.xml

Kubectl get pods

Kubectl get po

Kubectl get po -l app=nginx-app

Kubectl describe rc nginx-rc

Kubectl get po -o wide

Kubectl get nodes

Kubectl get po -o wide

Scaling UP

Kubectl scale rc nginx-rc - - replicas=5

Kubectl get rc nginx-rc

Kubectl get po -o wide

Scale Down

Kubectl scale rc nginx-rc - - replicas=3

Kubectl get rc nginx-rc

Kubectl get po -o wide

Deletion

Kubectl delete -f nginx-rc.yml

Kubectl get rc

Kubectl get po -l app=nginx-app

REPLICA SETS

REPLICA SET - is a service - Ensures that a specified number of pods are always running at any time

If there are excess pods - it kills and vice versa

New pod is created and launched if there is a failure or deleted or terminated.

RS and pods are associated with “labels”

Always RS with count must be 1 then only pod is always available

Used for HA

REPLICA SET is Next gen replication controller

Replica set uses Set Based Selectors
Replication Controller uses Equality Based Selectors

Equality Based

Operators :
=, ==, !=

Examples

Environment = production

Tier !=frontend

Command line

Kubectl get pods -l environment=production

In manifest

Selector :
    environment : production
    tier : frontend

Supported area : services, Replication Controller

Set Based

Operators :

In, not in, exists

Examples

Environment in (production, qa, dev)
Tier not in (frontend, backend)

Command line

Kubectl get pods -l ‘environment in (production)’

In manifest

Selector :
matchExpressions :
-{key : environment, operator: in, values : [prod, qa]}
-{key : tier, operator: Not in, values : [frontend, backend]}

Supported area : Job, Deployment,Replica set and Daemon set

DEMO

```
apiVersion : apps/v1
kind : ReplicaSet
metadata :
  name : nginx-rs
spec :
  replicas : 3
  selector :
    matchLabels :
      app : nginx-app
```

```
    matchExpressions :
      - {key: tier, operator: In, values : [frontend]}

  template :
    metadata :
      name : nginx-pod
      labels :
        app : nginx-app
        tier : frontend
    spec :
      containers :
      - name : nginx-container
        image : nginx
        ports :
        - containerPort : 80
```

COMMANDS

Kubectl create -f nginx-rs.yml

Kubectl get pods

Kubectl get po -l tier=frontend

Kubectl get rs nginx-rs -o wide

Kubectl describe rs nginx-rs

Kubectl get po -o wide

Kubectl get nodes

Kubectl get po -o wide

Scaling UP

Kubectl scale rs nginx-rs - - replicas=5

Kubectl get rc nginx-rs

Kubectl get po -o wide

Scale Down

Kubectl scale rs nginx-rs - - replicas=3

Kubectl get rs nginx-rs

Kubectl get po -o wide

Deletion

Kubectl delete -f nginx-rs.yml

Kubectl get rs

Kubectl get po -l app=nginx-app

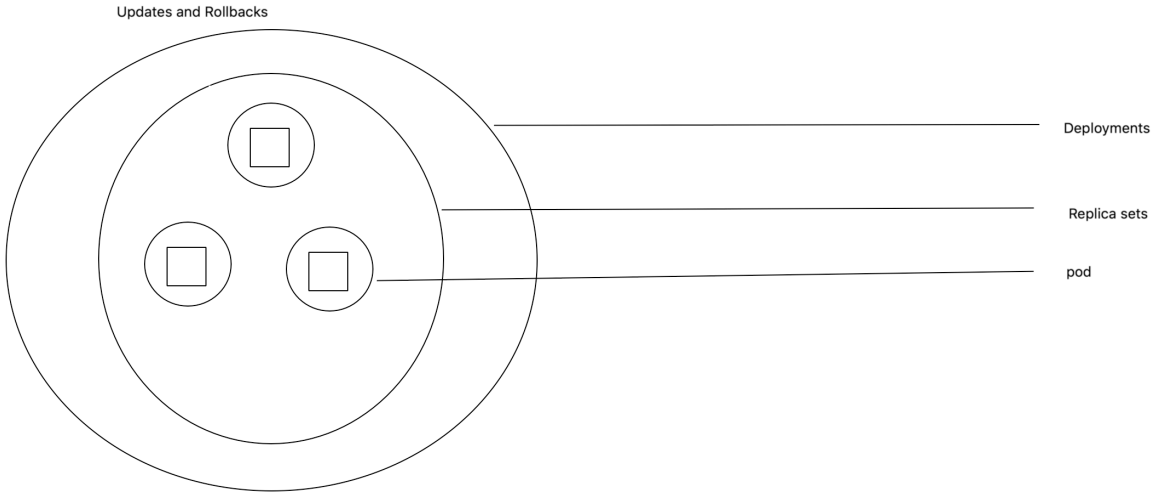
DEPLOYMENTS

SCENARIO

UPGRADE AN APPLICATION FROM V1 TO V2

Points to be addressed

1. Upgrade with zero downtime.
2. Upgrade sequentially - one after the other
3. Pause and resume upgrade process
4. Rollback upgrade to previous stable release.



Features

1. Multiple Replicas
2. Upgrade
3. Rollback
4. Scale up and down
5. Pause and resume

Deployment Algorithms

1. Recreate
2. Rolling Update (Ramped or Incremental)
3. Canary
4. Blue/Green OR Red/Black
5. A/B Deployment

DEMO

Deployment

```
apiVersion : apps/v1
kind : Deployment
metadata :
   name : nginx-deploy
   labels :
      app : nginx-app
spec :
   replicas : 3
   selector :
      matchLabels :
         app : nginx-app
   template :
      metadata :
         labels :
            app : nginx-app
      spec :
         containers :
         - name : nginx-container
           image : nginx:1.7.9
           ports :
           - containerPort : 80
```

COMMANDS

Kubectl create -f deploy.yml

Kubectl get deploy -l app=nginx-app

Kubectl get rs -l app=nginx-app

Kubectl get po -l app=nginx-app

Kubectl describe deploy nginx-deploy

DEPLOYMENT - UPDATE

kubectl set image deploy nginx-deploy nginx-container=nginx:1.9.1

kubectl edit deploy nginx-deploy

kubectl rollout status deployment/nginx-deploy

kubectl get deploy

DEPLOYMENT - ROLLBACK

kubectl set image deploy nginx-deploy nginx-container=nginx:1.91 - - record

kubectl rollout status deployment/nginx-deploy

kubectl rollout history deployment/nginx-deploy

kubectl rollout undo deployment/nginx-deploy

kubectl rollout status deployment/nginx-deploy

Scale up - deployment

kubectl scale deployment nginx-deploy - -replicas=5

kubectl get deploy

kubectl get po

Scale Down - deployment

kubectl scale deployment nginx-deploy - -replicas=1

kubectl get deploy

kubectl get po

DELETE - deployment

kubectl delete -f nginx-deploy.yml

kubectl get po -l app=nginx-app

SERVICES

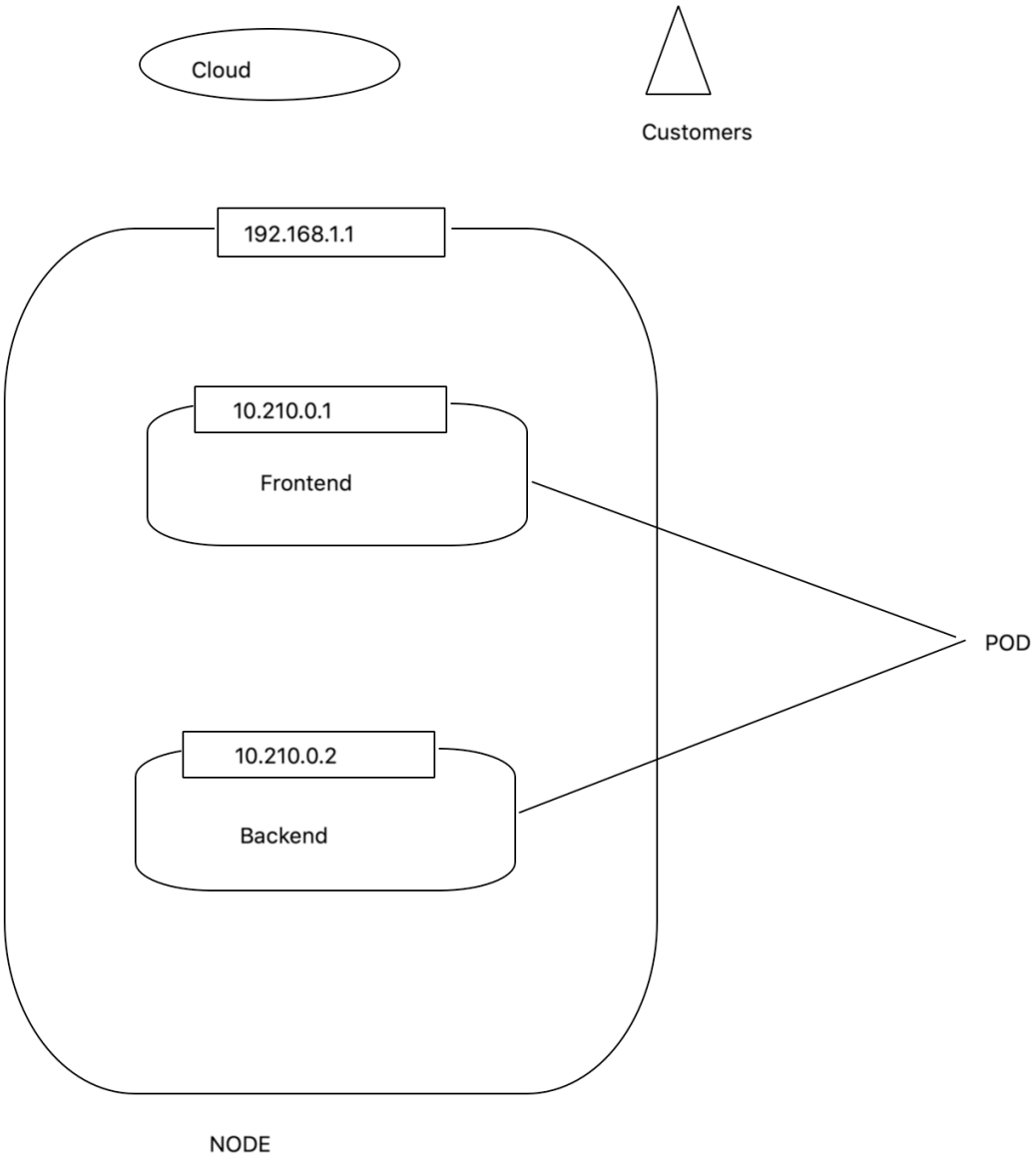
Requirement :

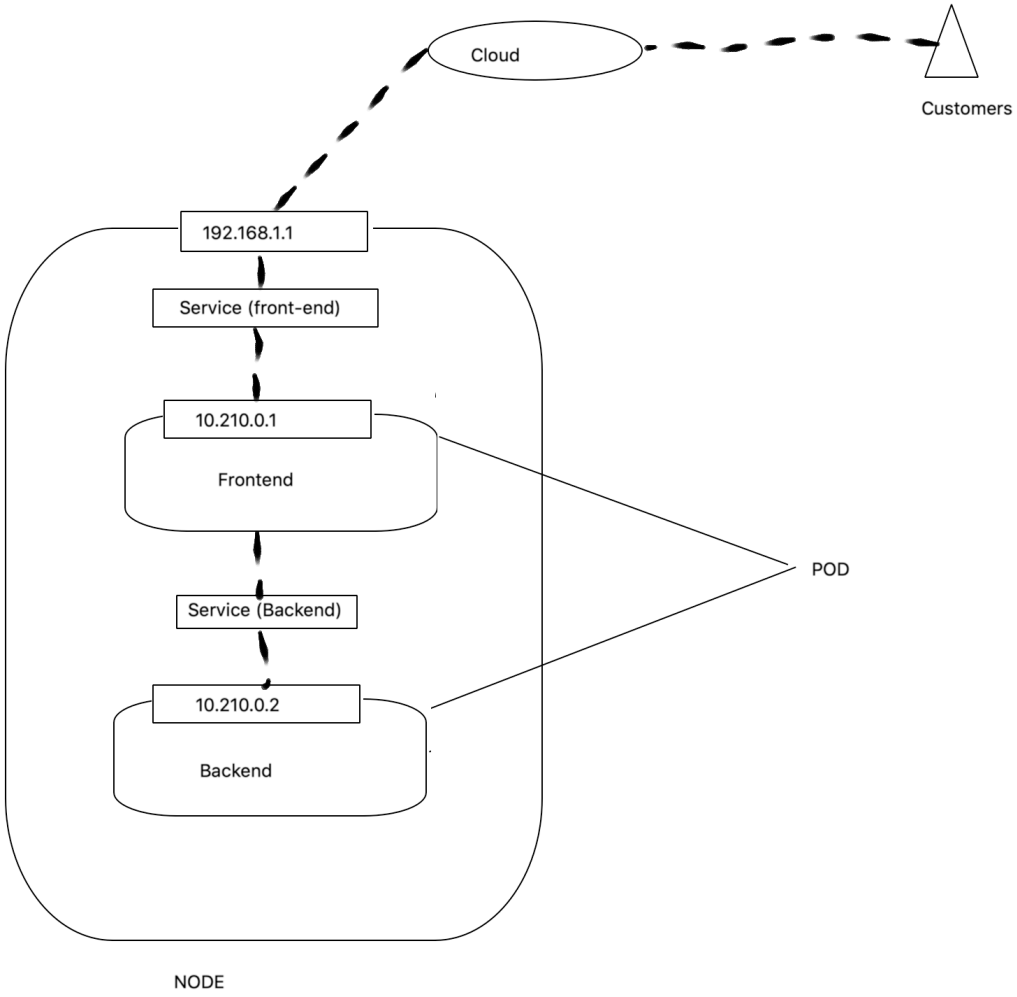
Deploy web application

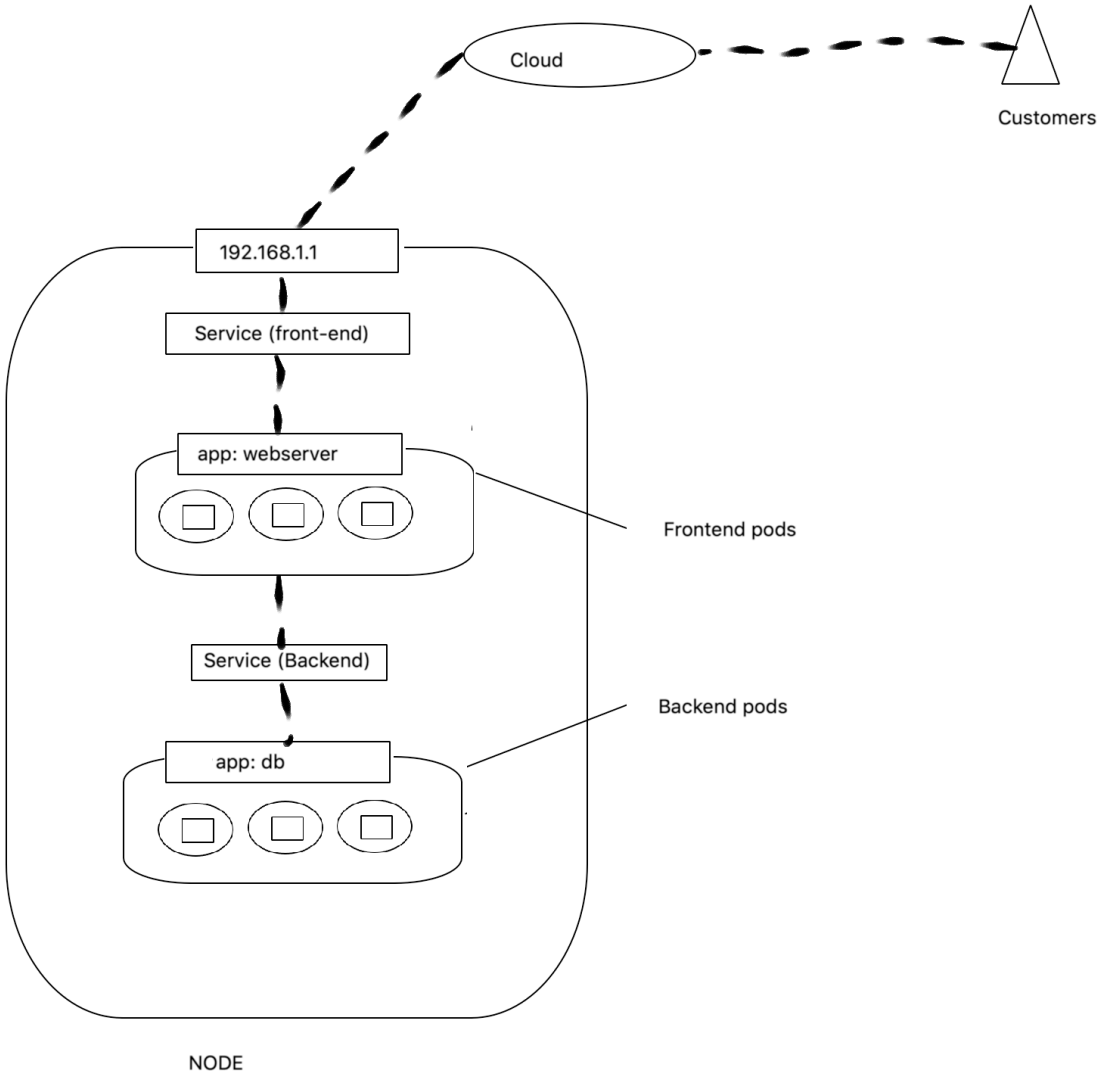
Steps :

1. Front end application is a web app - how to expose to outside world ?

2. How to connect to backend service ?
3. When Pod dies How to resolve IP changes when system creates new POD?

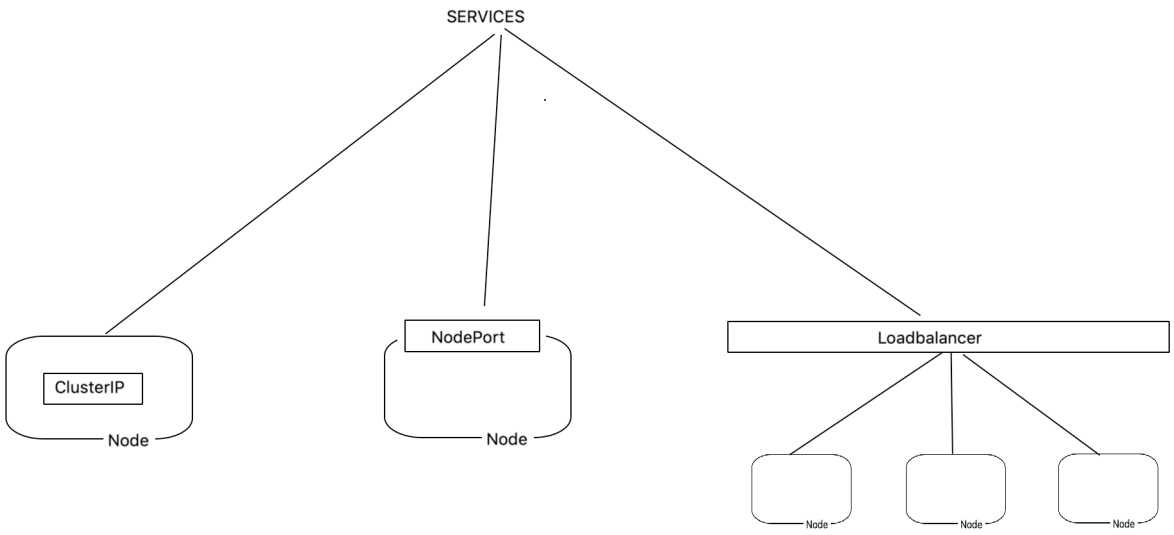



Cloud
Customers
192.168.1.1
Service (front-end)
10.210.0.1
Frontend
POD
Service (Backend)
10.210.0.2
Backend
NODE

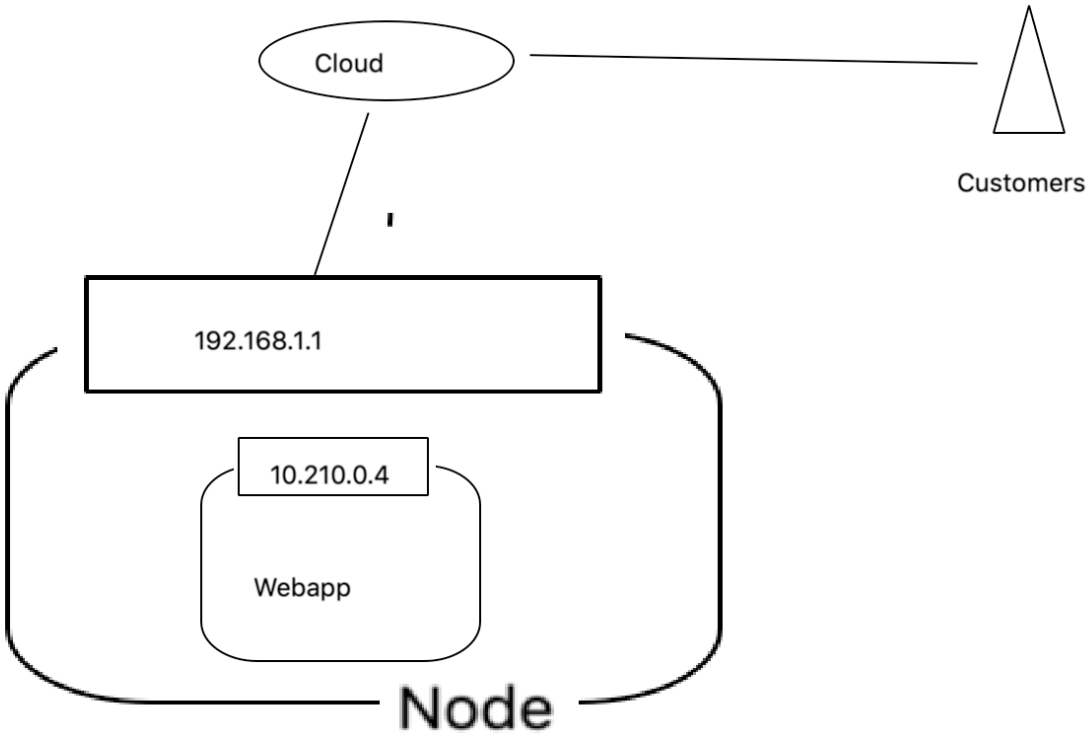


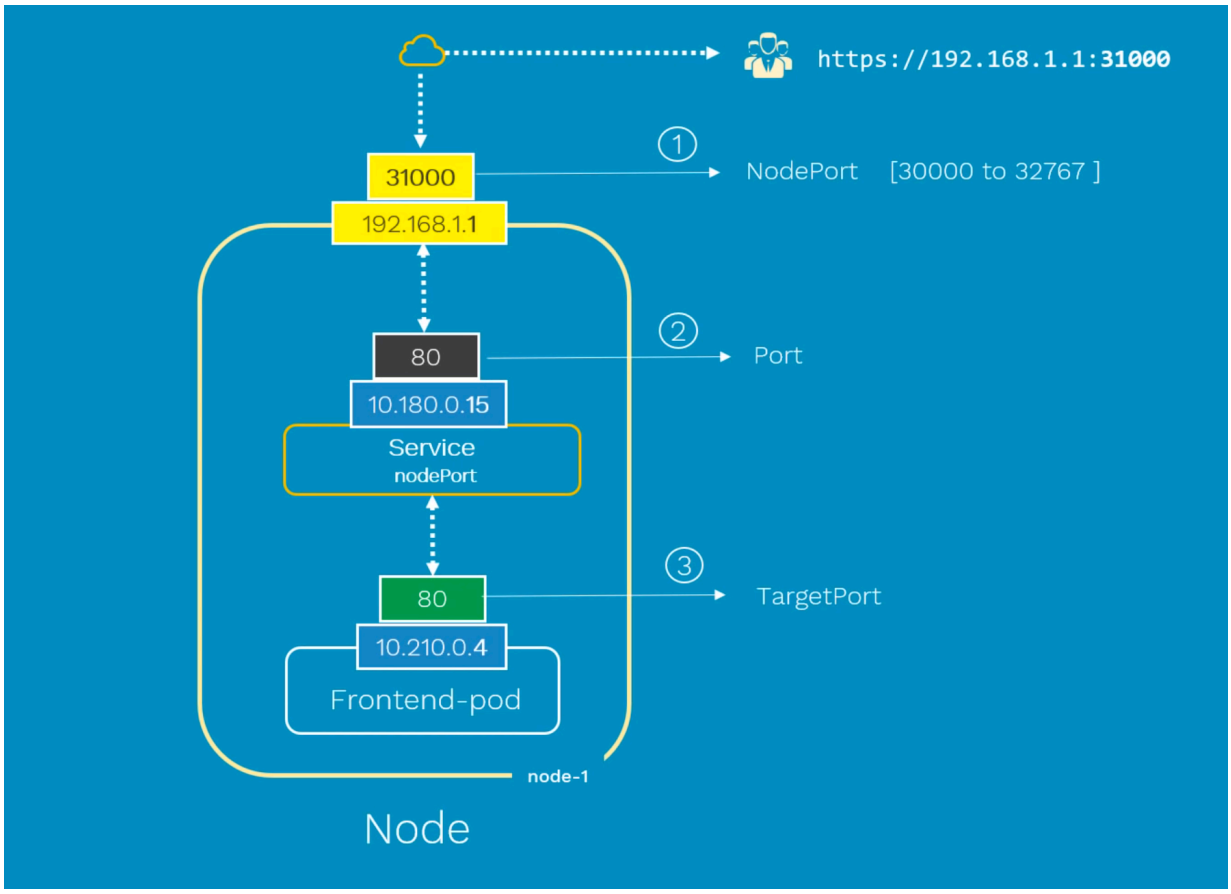
Types of Services

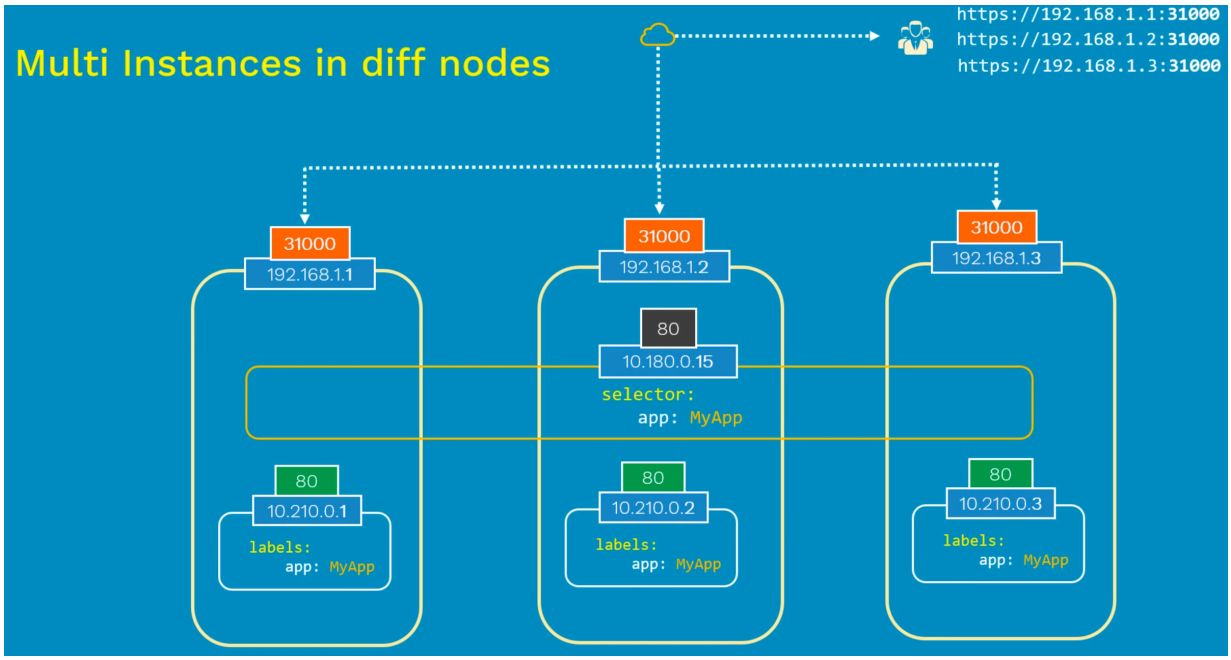
1. Cluster IP
2. NodePort
3. LoadBalancer


SERVICES
ClusterIP
Node
NodePort
Node
Loadbalancer
Node
Node
Node

NODEPORT


Cloud
Customers
192.168.1.1
10.210.0.4
Webapp
Node


https://192.168.1.1:31000
1
NodePort [30000 to 32767]
31000
192.168.1.1
2
Port
80
10.180.0.15
Service
nodePort
3
TargetPort
80
10.210.0.4
Frontend-pod
node-1
Node


Multi Instances in diff nodes
https://192.168.1.1:31000
https://192.168.1.2:31000
https://192.168.1.3:31000
31000
192.168.1.1
31000
192.168.1.2
31000
192.168.1.3
80
10.180.0.15
selector:
app: MyApp
80
10.210.0.1
labels:
app: MyApp
80
10.210.0.2
labels:
app: MyApp
80
10.210.0.3
labels:
app: MyApp

DEMO

Node Port Code

nginx-deploy.yml

```
apiVersion : apps/v1
kind : Deployment
metadata :
    name : nginx-deployment
    labels :
        app : nginx-app
spec :
    replicas : 1
    selector :
        matchLabels :
            app : nginx-app
    template :
        metadata :
            labels :
                app : nginx-app
        spec :
            containers :
            - name : nginx-containers
              image : nginx:1.7.9
```

```
        ports :
        - containerPort : 80
```

Node Port Service

nginx-svc.yml

```
apiVersion : v1
kind : Service
metadata :
   name : my-service
   labels :
      app : nginx-app
spec :
   selector :
      app : nginx-app
   type : NodePort
   ports :
   - nodePort : 31000
     port : 80
     targetPort : 80
```

Commands

kubectl create -f nginx-deploy.yml

kubectl create -f nginx-svc.yml

kubectl get service -l app=nginx-app

kubectl get po -o wide

kubectl describe svc my-service

(Only for google cloud) - gcloud compute instances list

Z

$. kubectl get po -o wide

NAME READY STATUS RESTARTS AGE IP NODE NOMINATED NODE READINESS GATES
nginx-deployment-786888db66-xk7xx 1/1 Running 0 2m28s 10.244.1.3 node01 <none> <none>

controlplane $ curl http://10.244.1.3:80

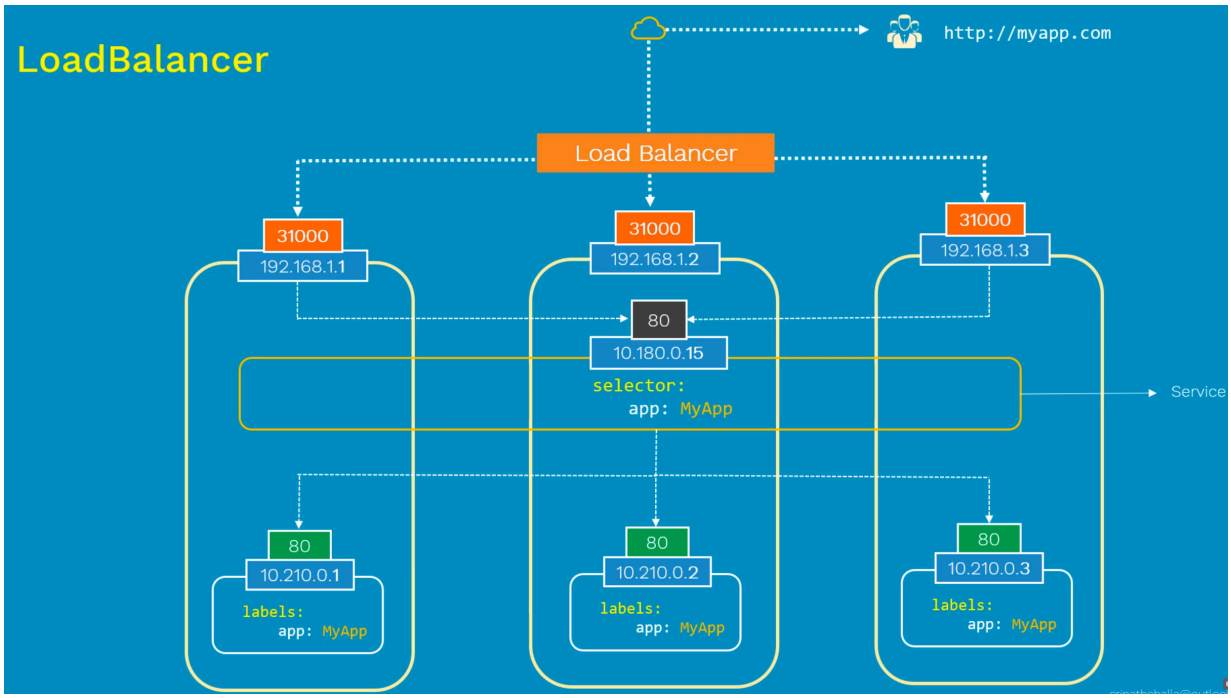
Curl http://NODEIPADDRESS:31000

Curl http://clusterip:port (configured in the manifest, you can use any number)

Able to see the html page from container

kubectl delete svc my-service

LOADBALANCER



Demo

nginx-deploy.yml

```
apiVersion : apps/v1
kind : Deployment
metadata :
    name : nginx-deployment
    labels :
        app : nginx-app
spec :
    replicas : 1
    selector :
        matchLabels :
```

```
        app : nginx-app
  template :
    metadata :
      labels :
        app : nginx-app
    spec :
      containers :
      - name : nginx-containers
        image : nginx:1.7.9
        ports :
        - containerPort : 80
```

You can try below **command** instead of writing service file

kubectl create -f nginx-deploy.yml

kubectl expose deploy nginx-deployment —name=nginx-service —port=80 —target-port=80 —type=LoadBalancer

Load Balancer Service

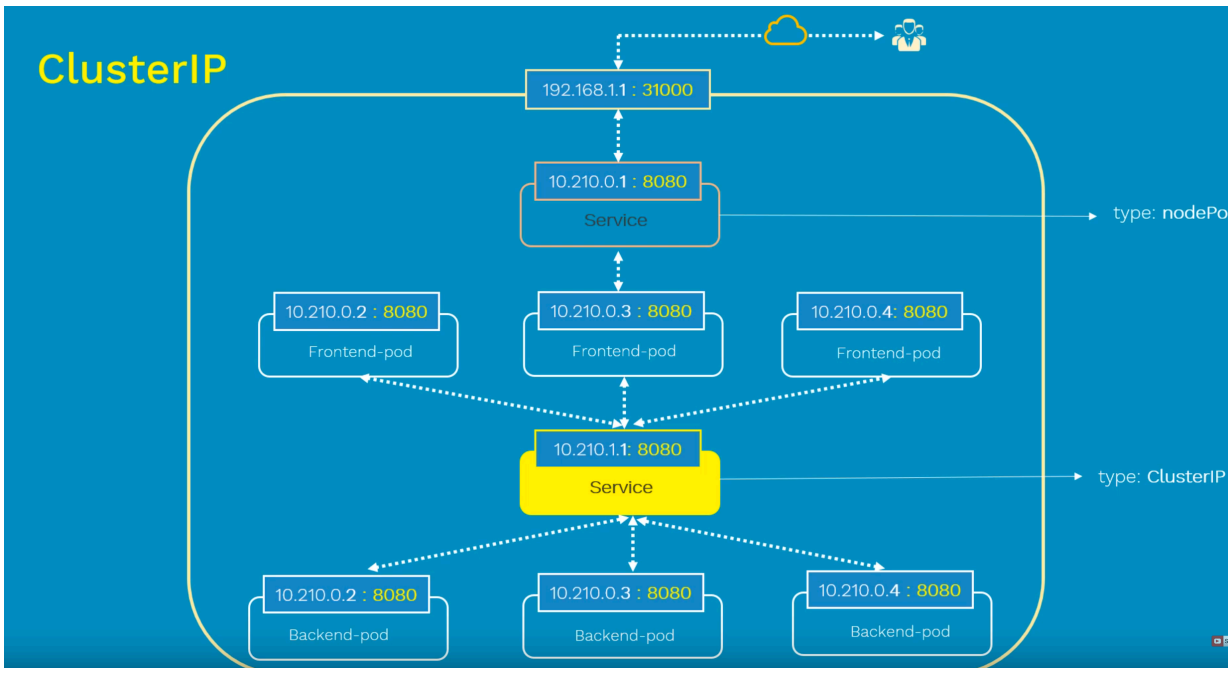
apiVersion : v1

```
kind : Service
metadata :
    name : my-service
    labels :
        app : nginx-app
spec :
    selector :
        app : nginx-app
    type : LoadBalancer
    ports :
    - nodePort : 31000
      port : 80
      targetPort : 80
```

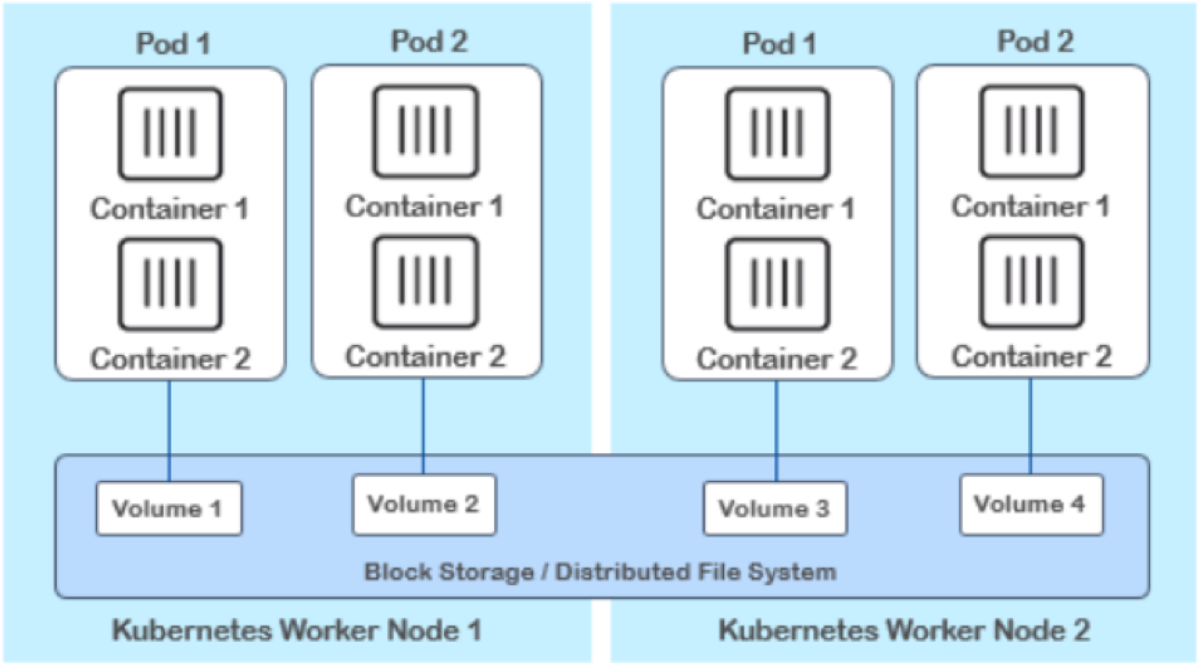
COMMANDS

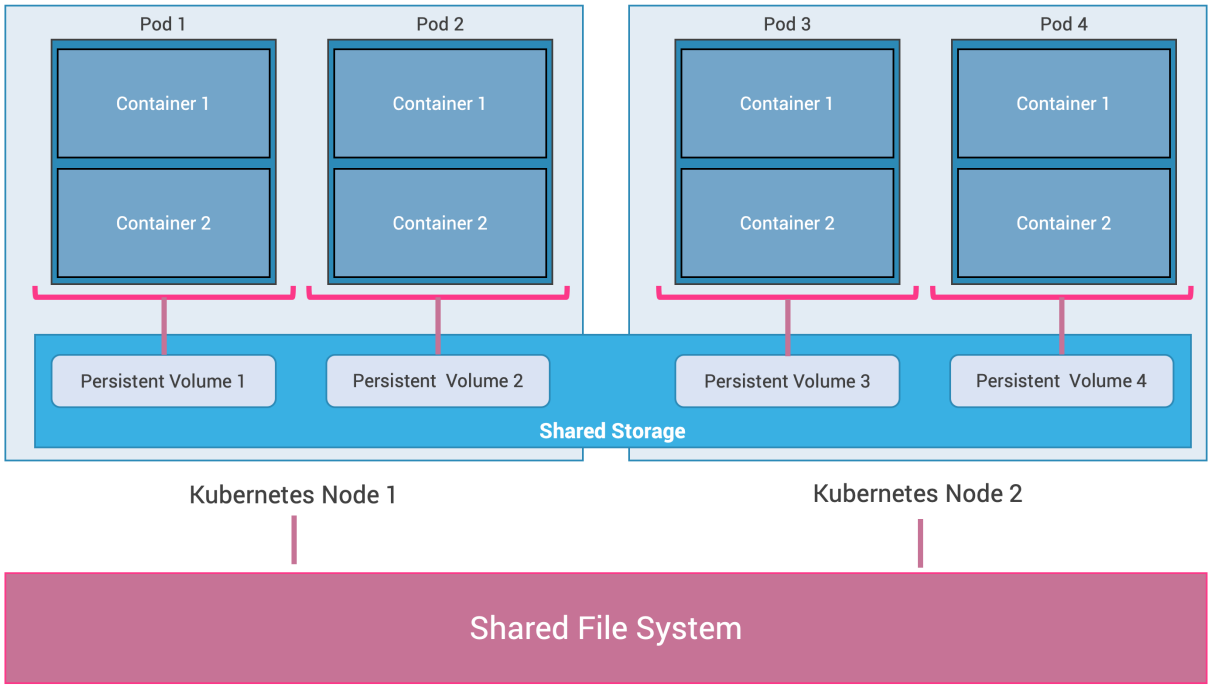
```
kubectl create -f nginx-lb-svc.yml

kubectl describe service my-service

kubectl describe service my-service | grep Load

kubectl delete svc my-service
```

CLUSTERIP



Kubernetes Volumes





Storage Types

1. Block
2. NAS
3. Object Storage
4. Google Cloud Disk
5. Cloud disks

6. AWS disks
7. Azure disk
8. FC - Fibre channel
9. RBP (ceph clock disk)
10. iSCi
11. GlusterFS
12. Azure FIle
13. VSphere volume
14. HostPath
15. ParkWorx Volumes
16. ScaleIO Volumes
17. Storage OS
18. Quobyte Volumes
19. Cinder (Openstack block Storage)
20. Flex Volume

For consistent storages - Kubernetes solution is Persistent Volumes (PV & PVC)

PV - Persistent Volumes
PVC - Persistent Volume Claims

Categories of Storage

1. Block Storage
2. NFS
3. Object Storage

Persistent volumes

Abstract details of how storage is provided from and how it is consumed.

PV - place of storage in cluster

PVC - request for storage

Life Cycle of PV

1. Provisioning
2. Binding
3. Using
4. Reclaiming

Provisioning

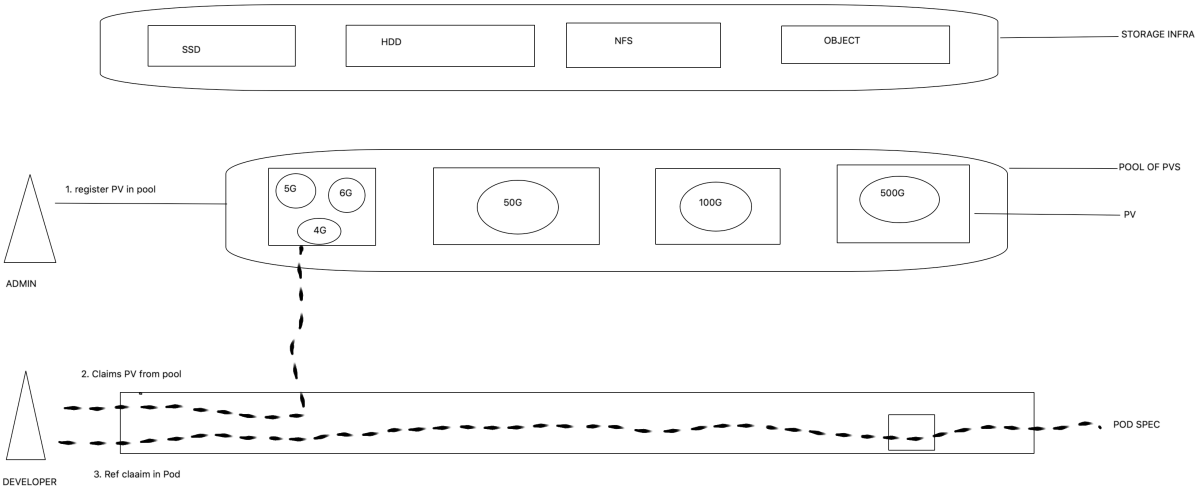
2 type

Static
Dynamic

Static - PV need to be created before PVC

Dynamic - PV is created at same time of PVC

STATIC PERSISTENT VOLUME



DYNAMIC PERSISTENT VOLUME

emptyDir

Creates empty directory, first created when a pod is assigned to a Node.
Stay as long as pod is running
Once pod is removed from a node, emptyDir is deleted forever

Example : Temp Folder

Used like Temporary space

DEMO

```
# volume example
# emptyDir demo

apiVersion : v1
kind : pod
metadata :
   name : test-ed
spec :
   containers :
   - image : nginx
     name : test-container
     volumeMounts :
     - name : cache-volume
       mountPath : /cache
   volumes :
   - name : cache-volume
     emptyDir : {}
```

Commands

Kubectl create -f test-ed.yml

Kubectl get po

kubectl exec test-ed df /cache

kubectl describe pod test-ed

Kubectl delete po test-ed

HOSTPATH

1. Mounts a file or folder from the host nodes file system in to the pod
2. Remains even after the pod is terminated
3. Similar to docker volumes
4. Use when required
5. If you have host issues then there will be problem in hostpath

DEMO

```
# volume example 2
# hostpath demo

apiVersion : v1
kind : Pod
metadata :
   name : redis-hostpath
spec :
   containers :
   - image : redis
     name : redis-container
     volumeMounts :
     - name : test-vol
       mountPath : /test-mnt
   volumes :
   - name : test-vol
     hostPath :
       path : /test-vol
```

Commands

```
kubectl create -f hostpath-volume.yml

kubectl get po

kubectl exec redis-hostpath df /test-mnt
```

kubectl describe pod redis-hostpath

AFTER SUCCESSFUL RUN

PODS ARE CREATED IN NODE 01
SO FIND FOLDER CALLED /test-vol

Mounted to .test-mnt as mentioned in manifest

STEP 2

Node 1 prompt
———————

cd /test-vol

echo “from host” > from-host.txt

cat from-host.txt

On Control-pane (master)
————————————

kubectl exec redis-hostpath cat /test-mnt/from-host.txt

Step 3

On Control-pane (master)

master $ kubectl exec redis-hostpath -it -- /bin/sh

cd /test-mnt

ls
from-host.txt

echo “from POD" > from-pod.txt

echo "from POD" > from-pod.txt

cat from-pod.txt
from POD

Node 1 prompt

cd /test-vol

ls -l

Step 4

Kubectl delete po redis-hostpath

Kubectl get po

Ensure pods are deleted

(Observation)

In node 1
ls /test-vol

Folder still exists

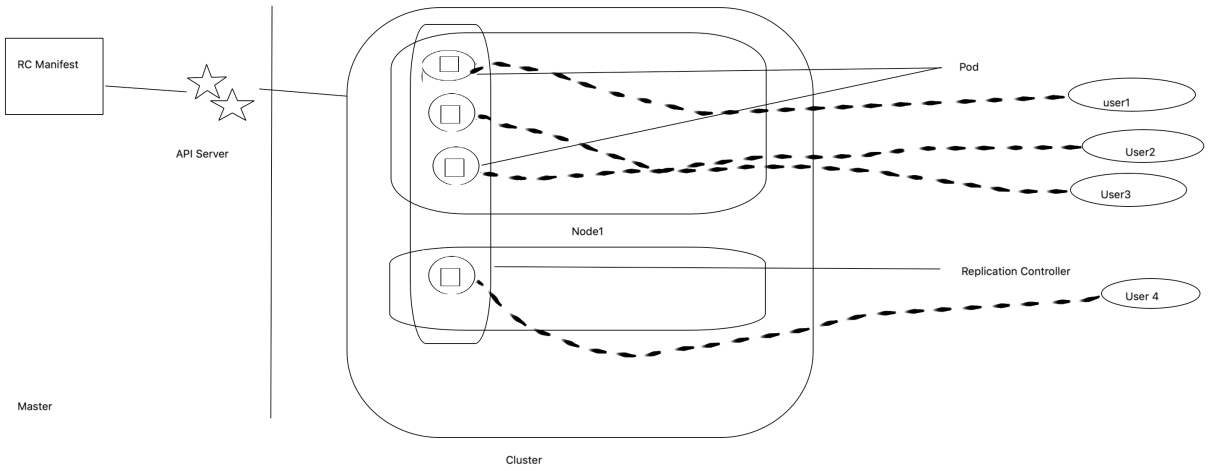
This is an advantage of host path

DaemonSets

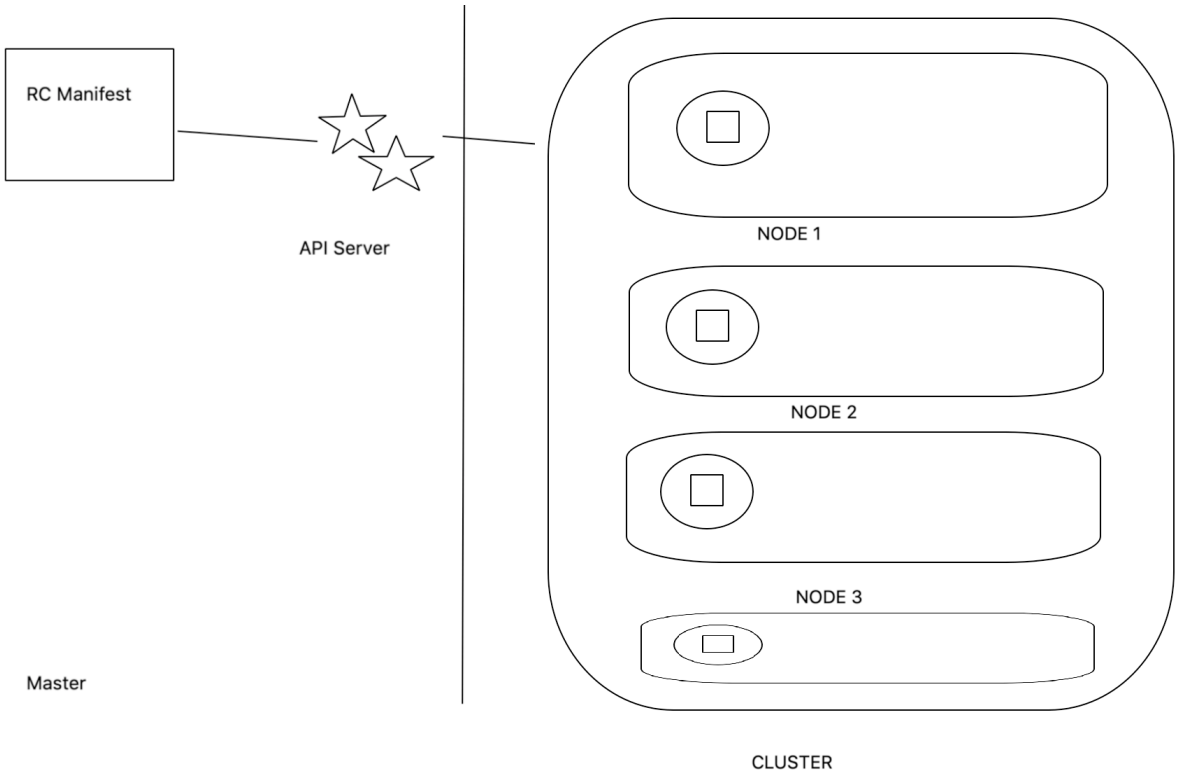
One Pod on each node

Subset of nodes inside cluster

ReplicaSet



DaemonSet



If pod to be increased then it uses or creates new nodes

If not required it will delete pod and respected node

Advantages

1. It ensures all nodes run a copy of a pod
2. As node is added to the cluster, pod is added
3. As node is removed from the cluster those pods are GC
4. Deleting daemon set will clean up the pods it created

Some Use cases of daemon

Node monitoring daemons - collects
Log collection daemons -fluentd

Kubectl log <instance name>

ELK and EFK stacks

DEMO

fluentd

```
apiVersion : apps/v1

kind : DaemonSet
metadata :
  name : fluentd-ds
spec :
  template :
    metadata :
      labels :
        name : fluentd
    spec :
      containers :
      - name : fluentd
        image : gcr.io/google-containers/fluentd-
elasticsearch:1.20
  selector :
    matchLabels :
      name : fluentd
```

Commands

```
kubectl get no

kubectl create -f daemonset.yml

kubectl get po -o wide

kubectl get ds
```

kubectl describe ds fluentd-ds

kubectl delete ds fluentd-ds

SECRETS

1. Small amount of sensitive data like passwords, tokens, key etc.
2. Reduce risk of exposing sensitive data
3. Created outside the pod
4. Stored inside etc DB
5. Size not more than 1 MB
6. Used in volumes or env variables
7. Sent only to target nodes

Can create secrets in two ways

1. Kubectl
2. Manually

DEMO

Kubectl way of creation

echo -n 'admin' > ./username.txt

echo -n '1f2dsfjkf82kd92f' > ./password.txt

ls

kubectl create secret generic db-user-pass --from-file=./username.txt --from-file=./password.txt

kubectl describe secrets db-user-pass

Manual

Step 1

echo -n 'admin' | base64

YWRtaW4=

echo -n 'efhejfhekjh9382938' | base64

ZWZoZWpmaGVramg5MzgyOTM4

Step 2

```
# secrets.yml

apiVersion : v1
kind : Secret
metadata :
   name : mysecret
type : Opaque
data :
   username : YWRtaW4=
   password : ZWZoZWpmaGVramg5MzgyOTM4
```

COMMANDS

```
kubectl create -f secrets.yml
```

```
kubectl get secrets mysecret -o yaml
```

(Find username and password)

```
echo 'YWRtaW4=' | base64 --decode
```

```
echo 'ZWZoZWpmaGVramg5MzgyOTM4' | base64 --
decode
```

STEP 3

CONSUME SECRETS IN PODS

1. Volumes
2. Env variables

```
# Use created secret in POD creation
#mysecret-pod.yml

apiVersion : v1
kind : Pod
metadata :
   name : mypod
spec :
   containers :
   - name : mypod
     image : redis
     volumeMounts :
     - name : foo
       mountPath : "/etc/foo"
       readOnly : true
   volumes :
```

```
  - name : foo
    secret :
      secretName : mysecret
```

Commands

kubectl create -f mysecret-pod.yml

kubectl get po

kubectl exec mypod ls /etc/foo

kubectl exec mypod cat /etc/foo/password

kubectl exec mypod cat /etc/foo/username