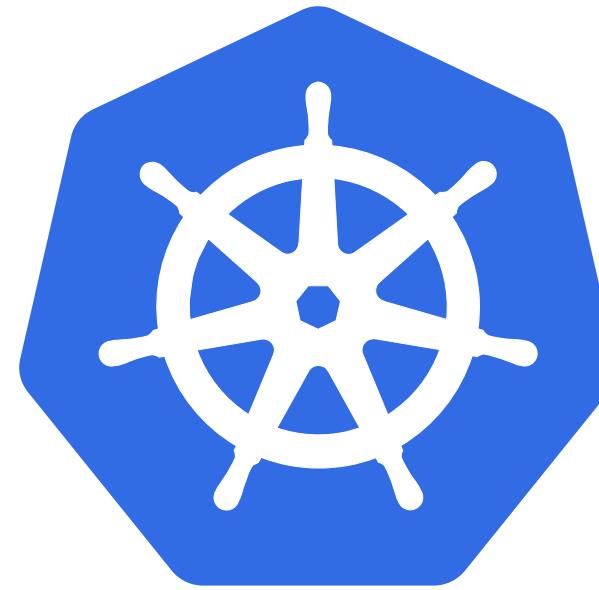
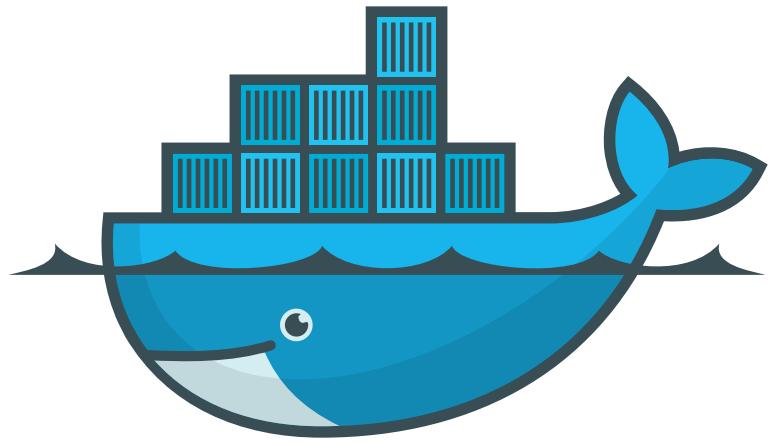


kubernetes

KUBERNETES:

K U B E R N E T E S

K 8S



WHY KUBERNETES

Earlier We used Docker Swarm as a container orchestration tool that we used to manage multiple containerized applications on our environments.

FEATURES	DOCKER SWARM	KUBERNETES
Setup	Easy	Complex
Auto Scaling	No Auto Scaling	Auto Scaling
Community	Good Community	Greater community for users like documentation, support and resources
GUI	No GUI	GUI

KUBERNETES:

IT is an open-source container orchestration platform.
It is used to automates many of the manual processes like deploying, managing, and scaling containerized applications.
Kubernetes was developed by GOOGLE using GO Language.
Google donated K8's to CNCF in 2014.
1st version was released in 2015.

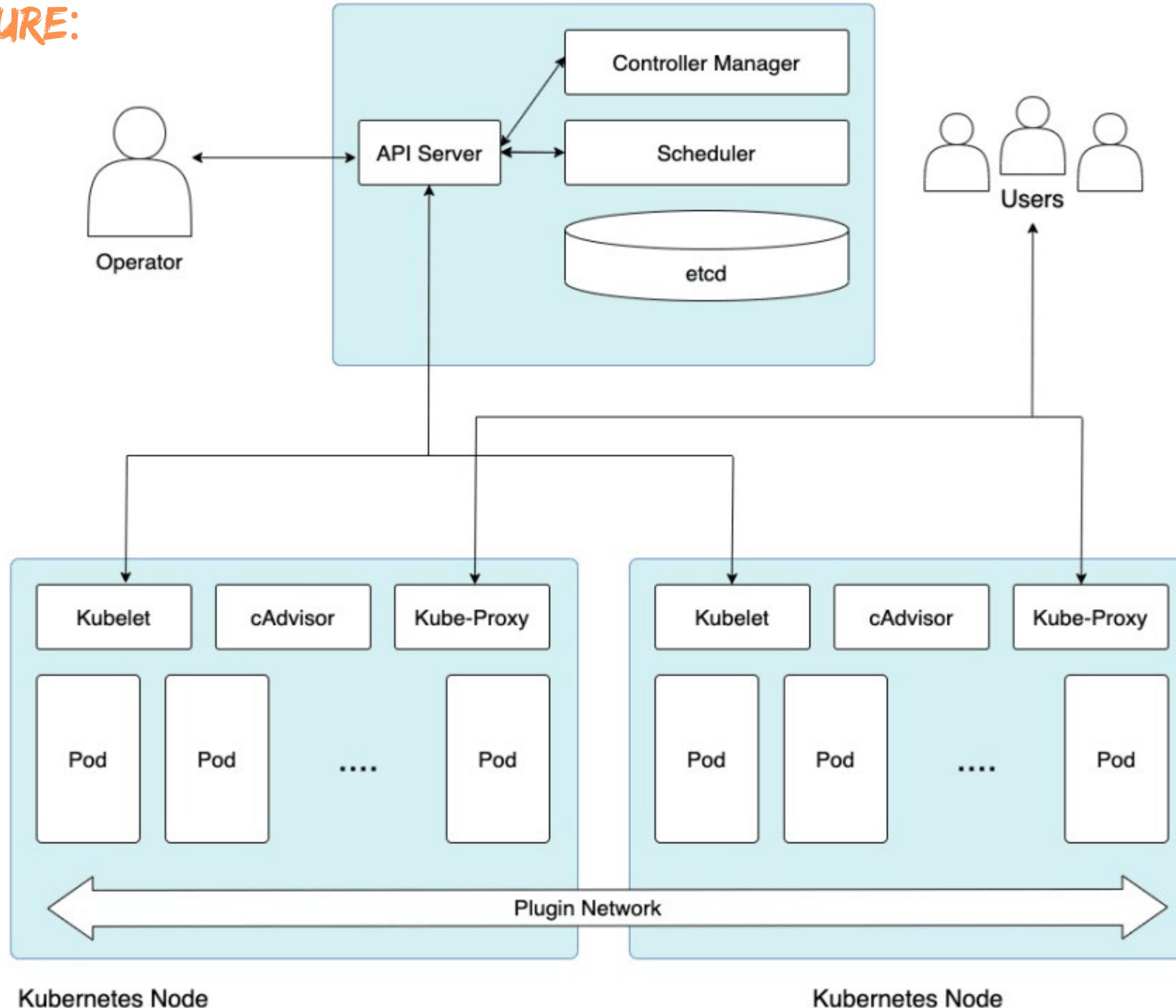
WHY KUBERNETES:

Containers are a good and easy way to bundle and run your applications. In a production environment, you need to manage the containers that run the applications and ensure that there is no downtime. In docker we used docker swarm for this. but any how docker has drawbacks!

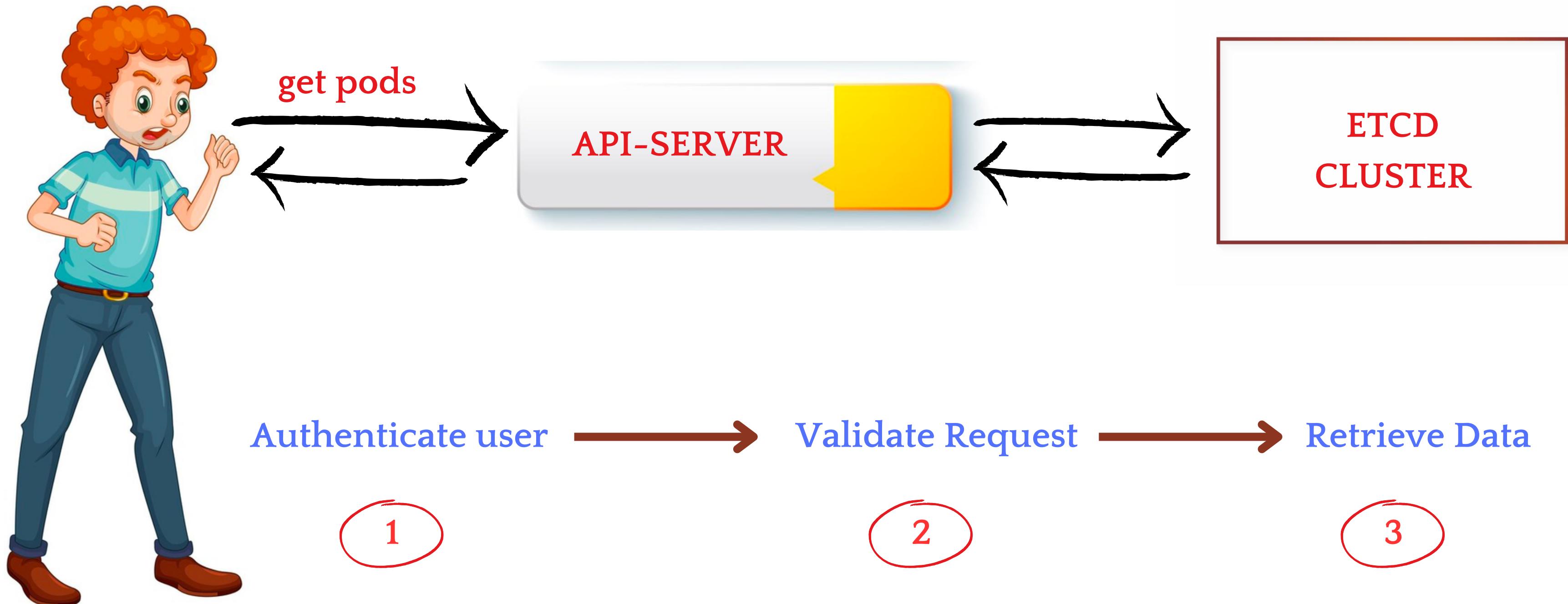
so we moved to KUBERNETES.

Kubernetes Master

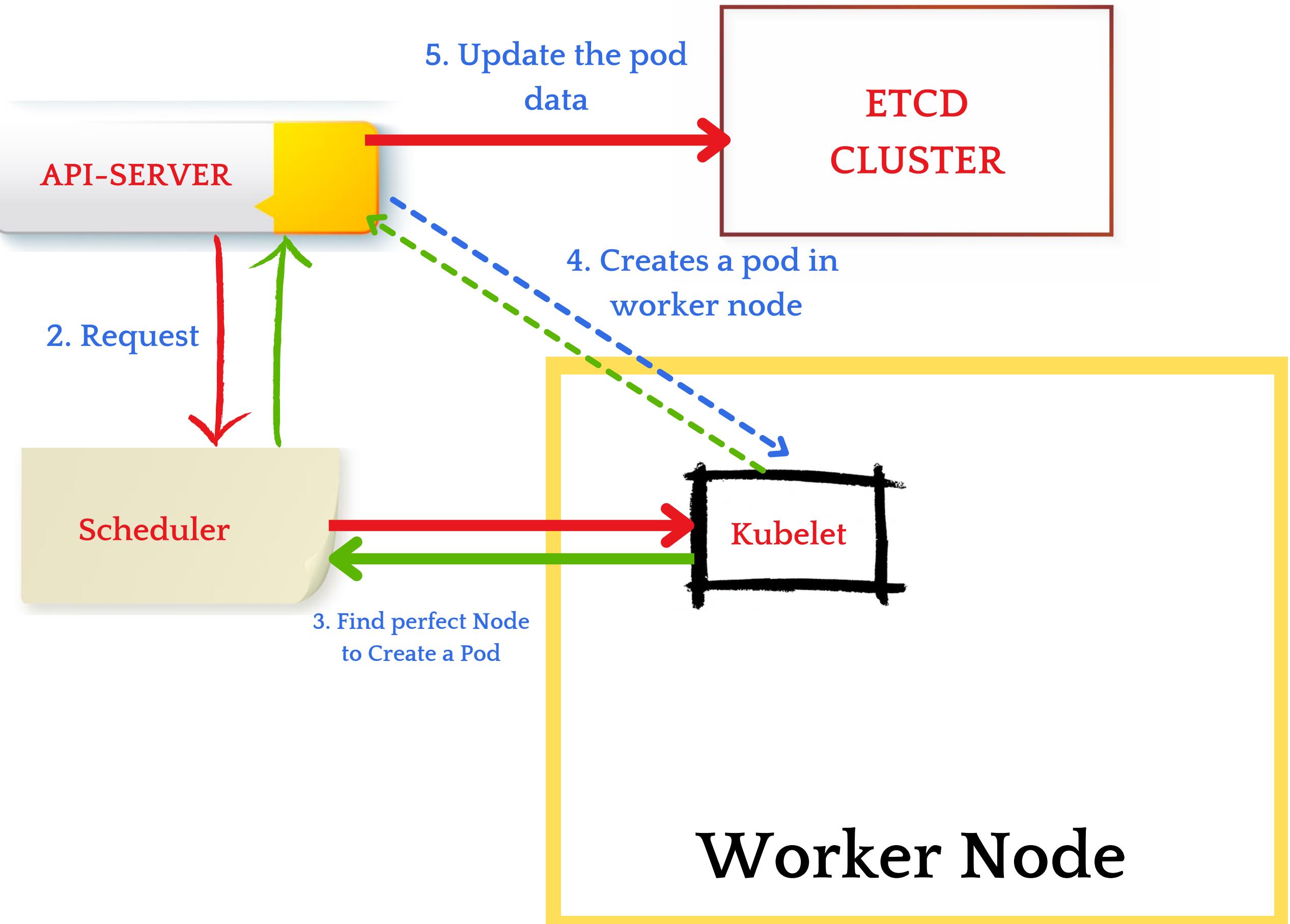
AECHITECTURE:



HOW IT WORKS:



HOW POD CREATES:



Worker Node

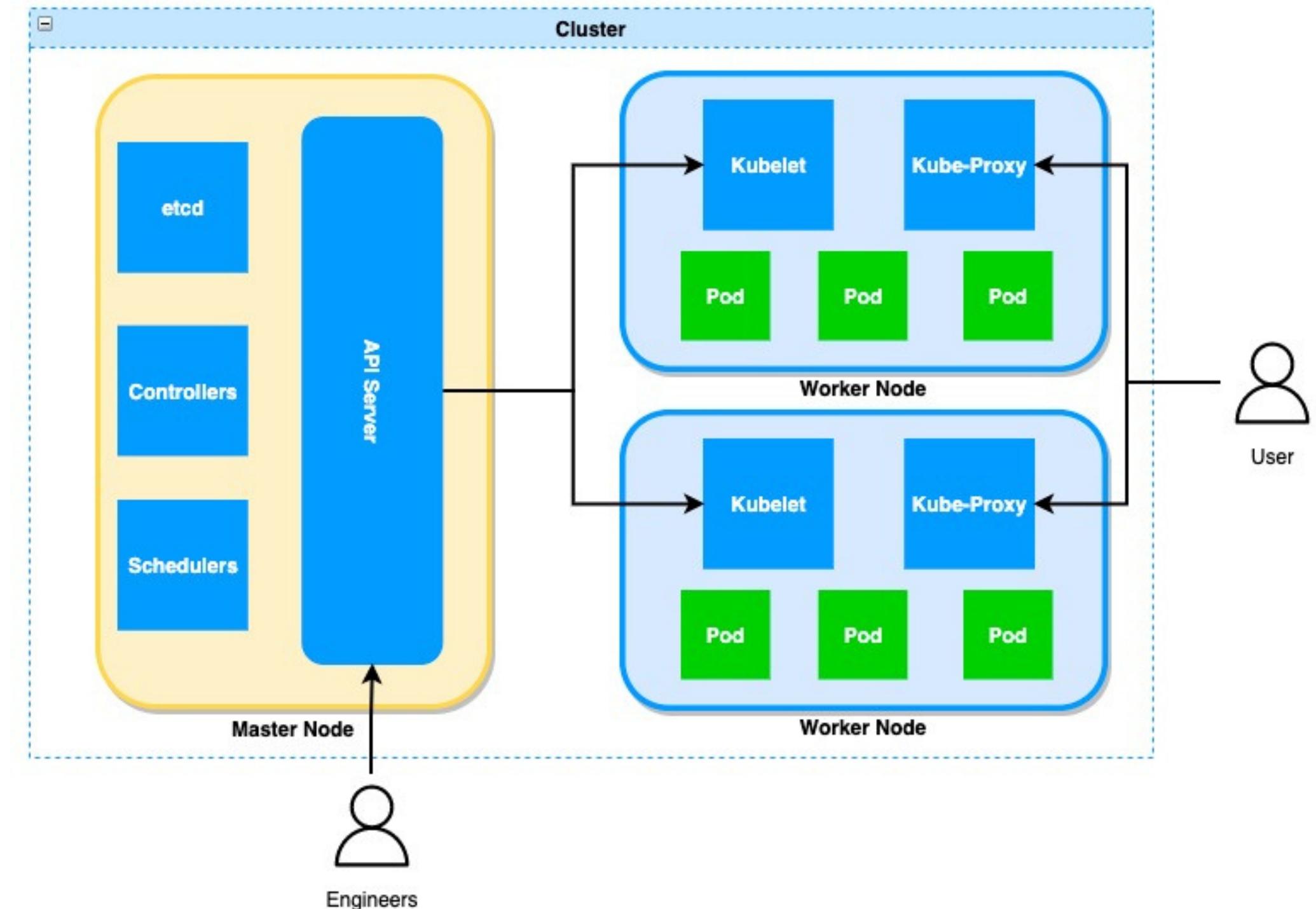
CLUSTER:

- It is a group of serversIt will have both manager and worker nodes.
- Master Node is used to assign tasks to Worker Nodes.
- Worker node will perform the task.
- we have 4 components in Master Node

- 1.API Server
- 2.ETCD
3. Controllers-manager
4. Schedulers

- we have 4 components in Worker Node.

1. Kubelet
2. Kube-Proxy
3. Pod
4. Container



API SERVER:

- It is used to accept the request from the user and store the request in ETCD.
- It is the only component that interacts with the ETCD directly

ETCD:

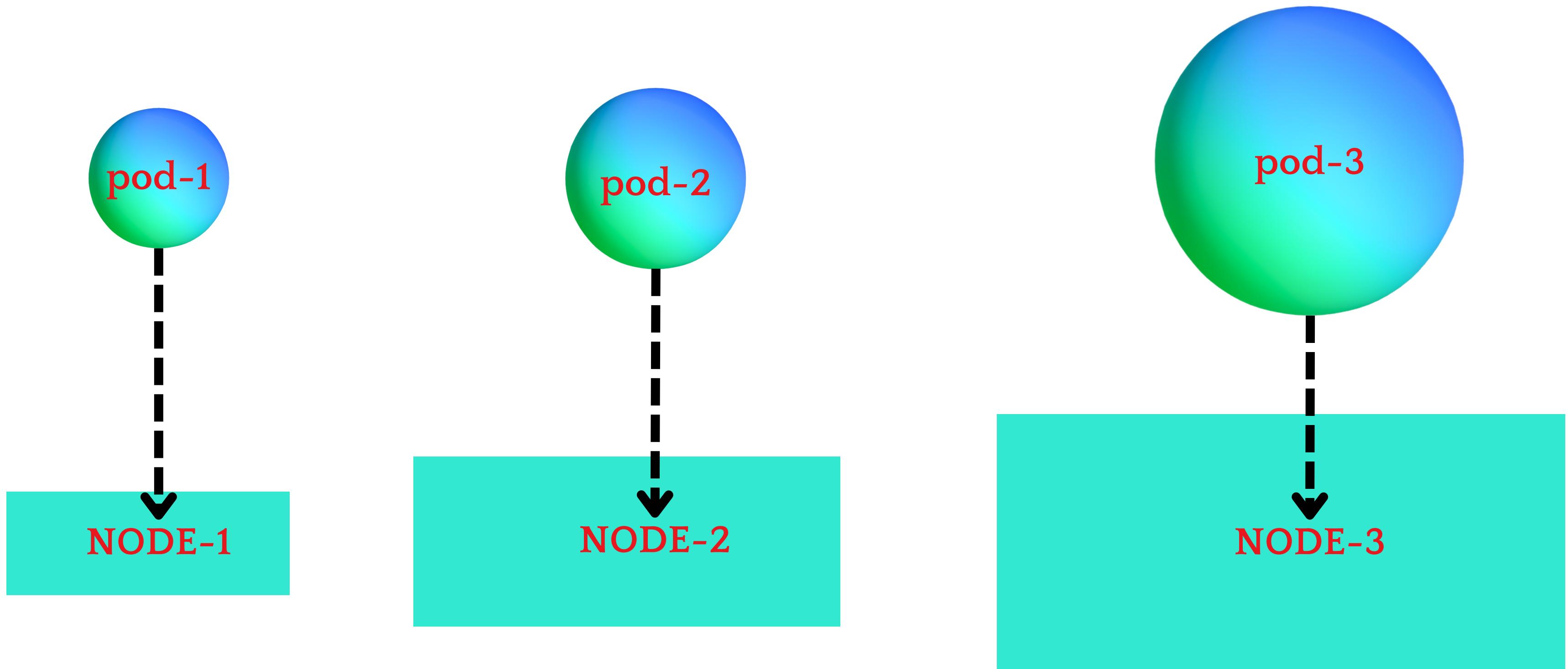
- It is like a database to our k8's
- it is used to store the requests of our cluster like pods, nodes, configs, secrets, roles etc..

SCHEDULER:

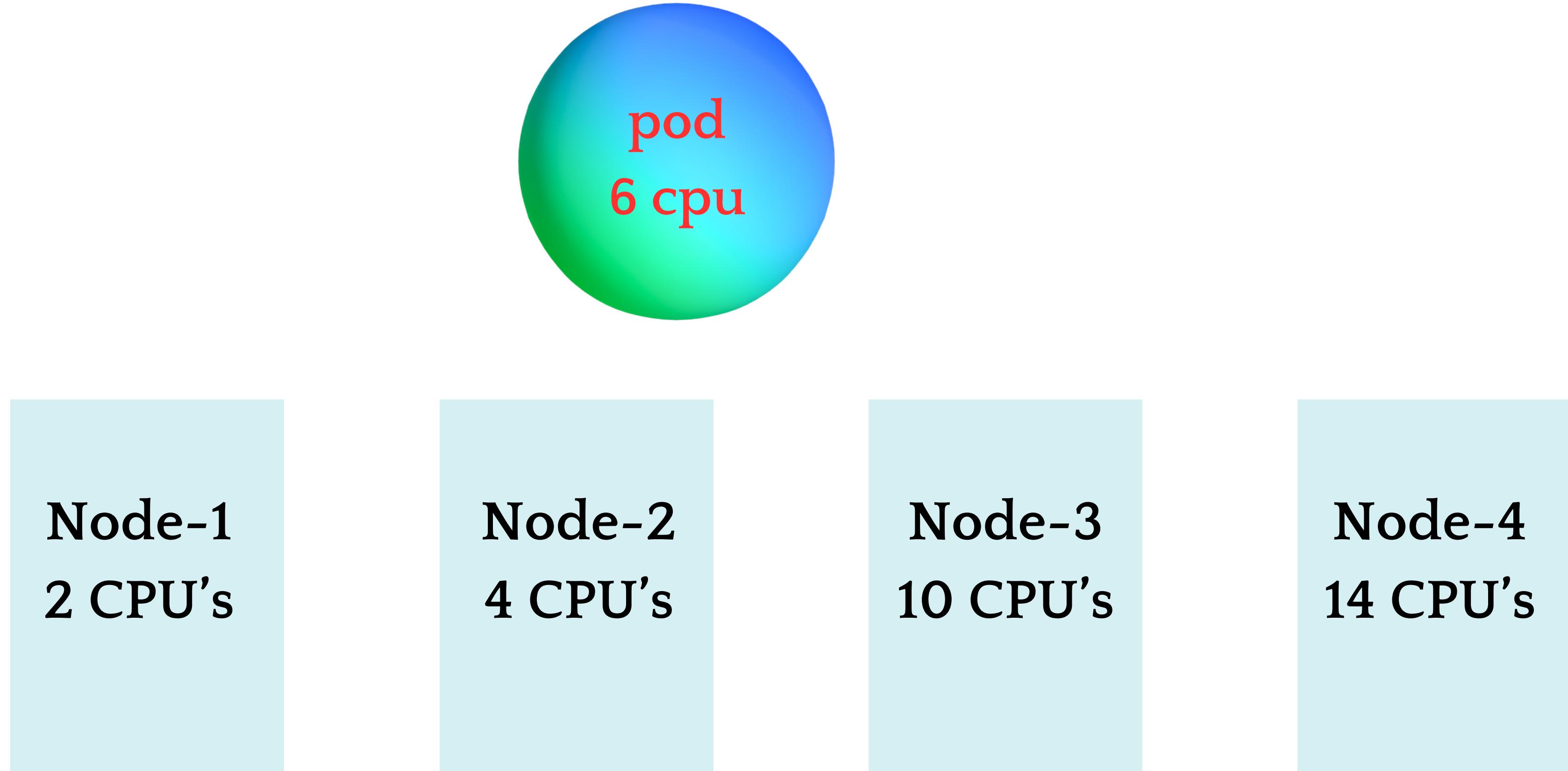
- It is used to search pending tasks which are present in ETCD.
- If any pending task found in ETCD, it will schedule in worker node.
- It will decide in which worker node our task should gets executed.
- It will decide by communication with the kubelet in worker node
- Scheduler always monitor API-Server
- The scheduler is a crucial component responsible for assigning pods to nodes
- This will ensure that pods are scheduled on suitable nodes that meet their resource requirements and constraints

HOW SCHEDULER DECIDES

The scheduler is going to decide to put the right pod in right node based on Size, Memory, CPU etc..

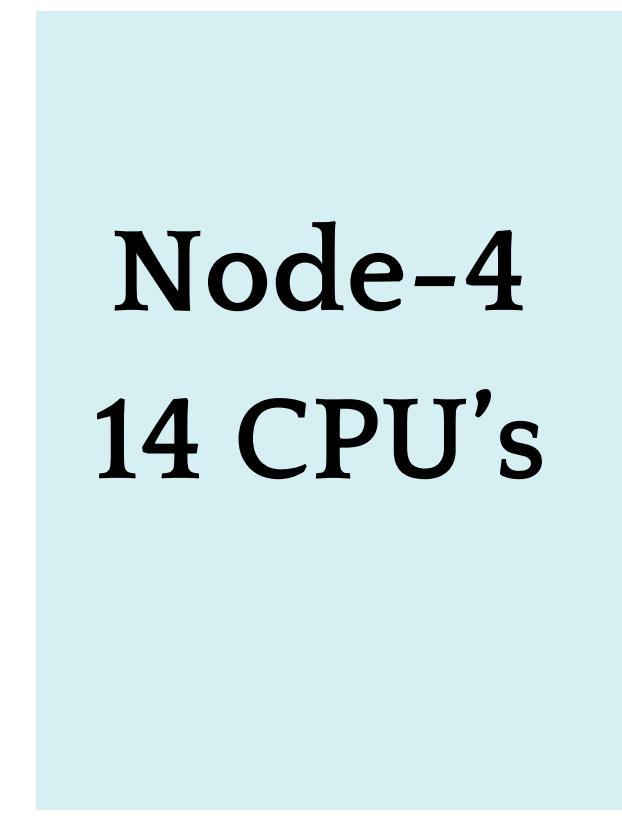
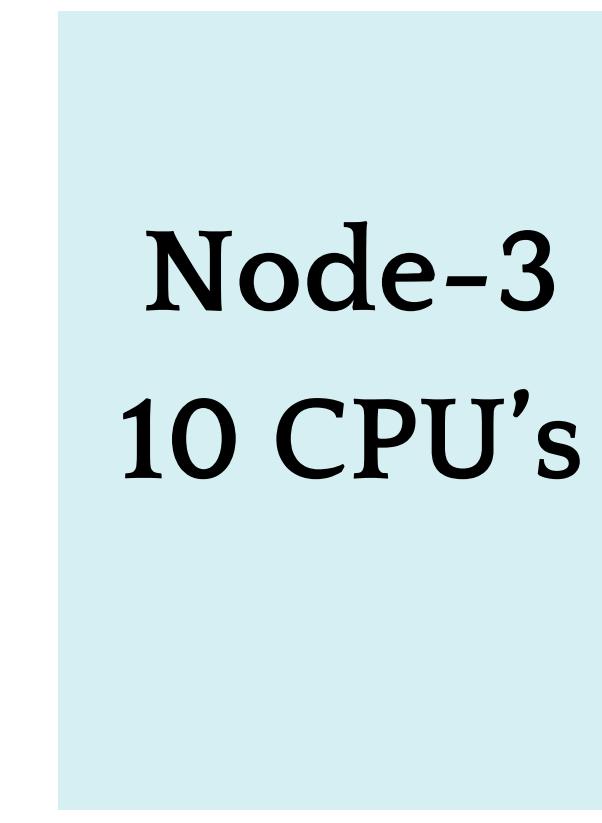
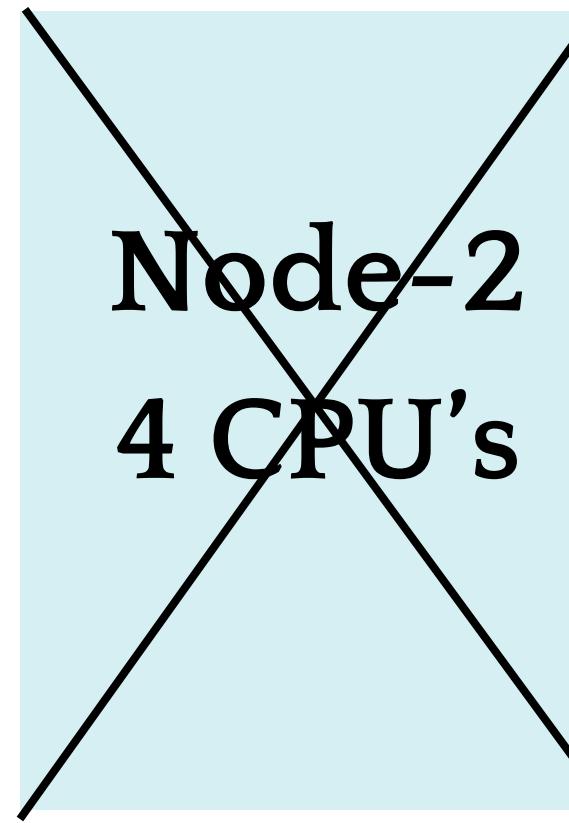
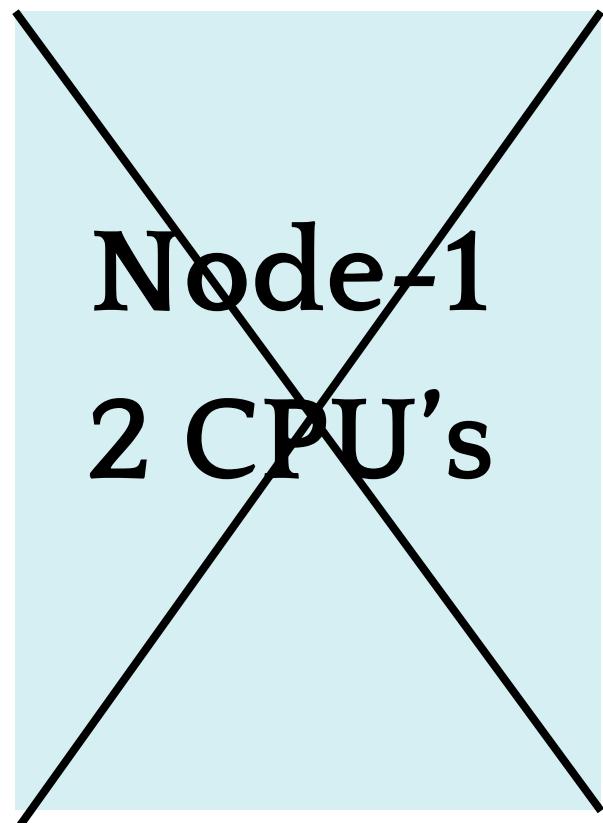


Just assume that we have 1 pod and 4 nodes just like the below image



Lets see How its decides

It Eliminates Node-1 & Node-2 because Node contains less CPU than pod

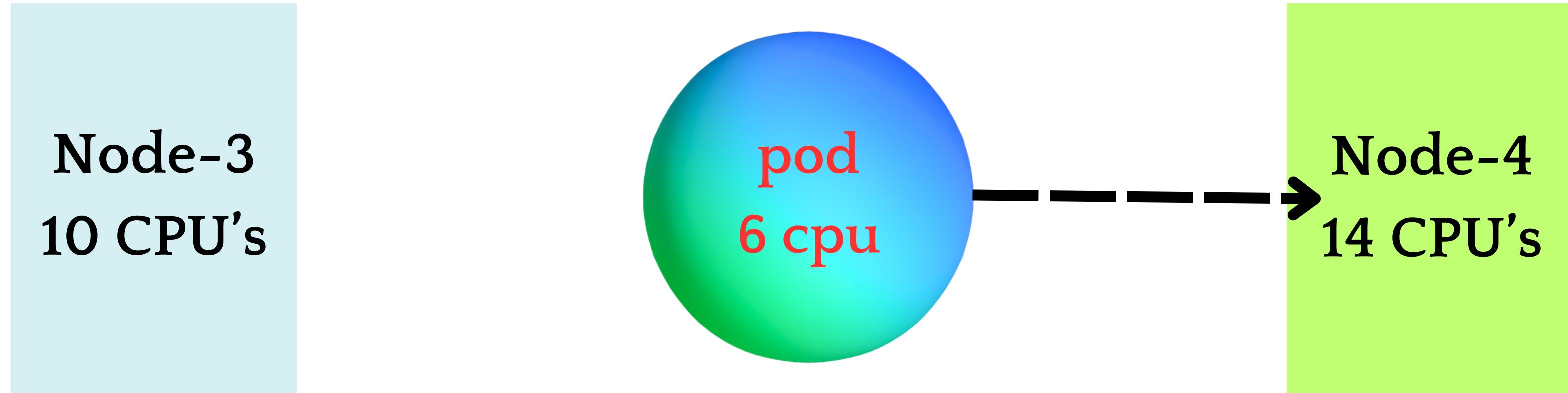


In the rest of these 2 nodes, scheduler decides based on CPU

Ex: If scheduler places the pod on Node-3 then Node-3 contains only 2 CPU's only

If scheduler places the pod on Node-4 then Node-4 contains only 4 CPU's.

So scheduler selects Node-4 to place a pod.



Not only CPU it selects based on different parameters like

- Resource Requirement limits
- Taints & Tolerations
- Node selector

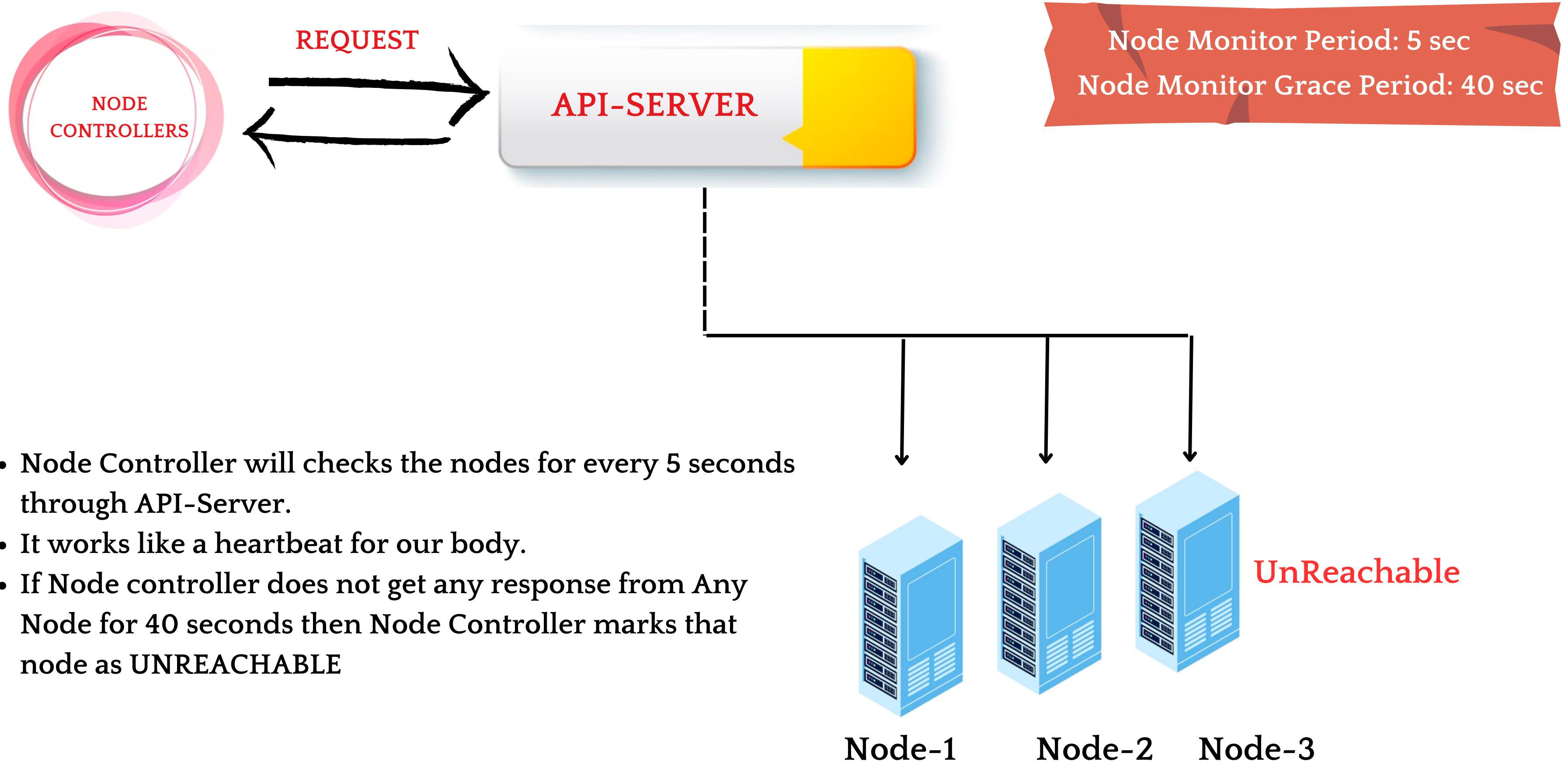
- Scheduler will do the following tasks
 - a. Pod Creation
 - b. Pod scheduling
 - c. Selecting Node
 - d. Pod Running
 - e. Kubelet Action

CONTROLLERS:

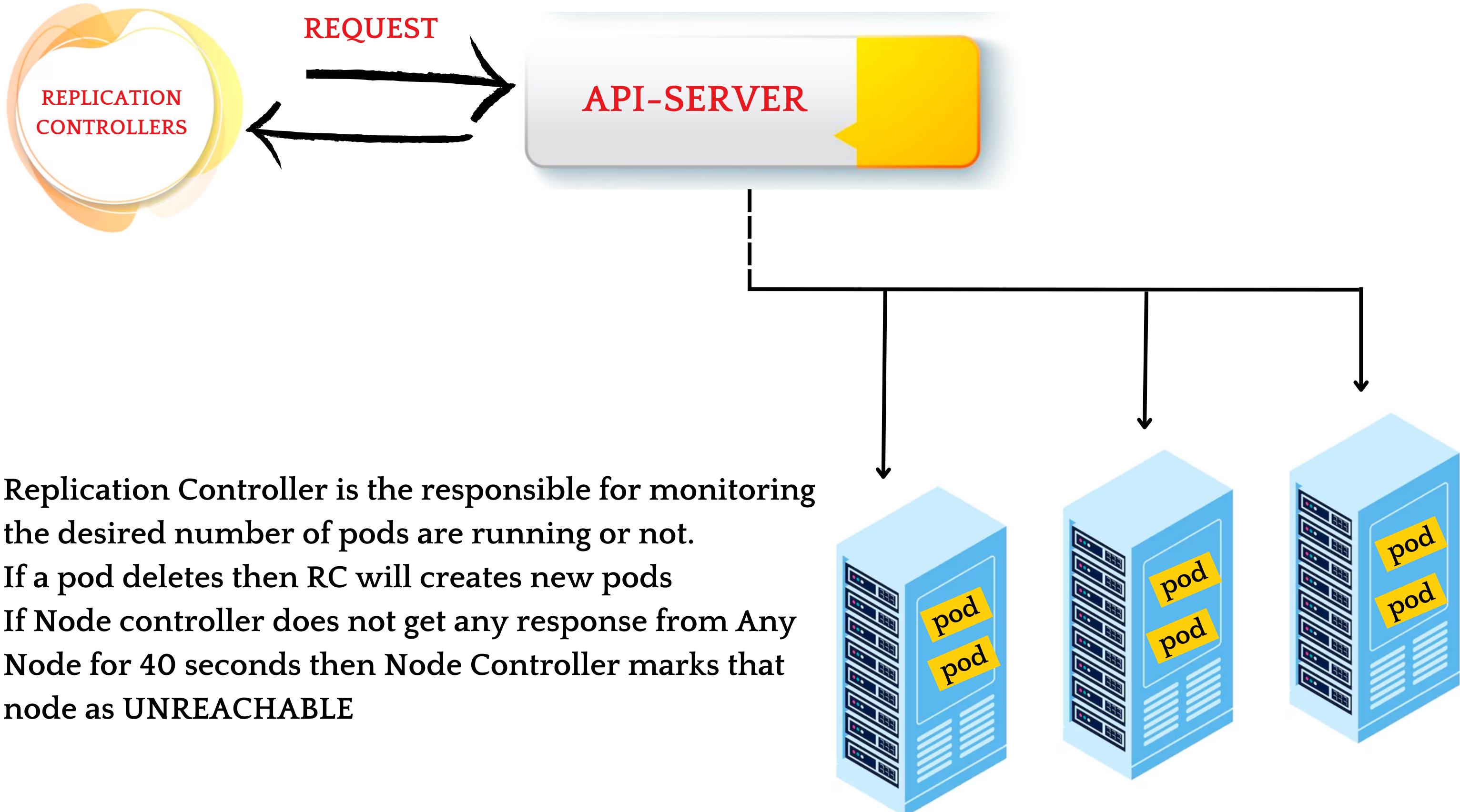
The controller Manager collects the data/information from the API Server of the Kubernetes cluster like the desired state of the cluster and then decides what to do by sending the instructions to the API Server.

- Controller will do the following tasks
 - a. Replication Controller
 - b. Node Controller
 - c. Service Controller

HOW NODE CONTROLLER WORKS:



HOW REPLICATION CONTROLLER WORKS:



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

KUBE-PROXY

- kube-proxy contains all the network configuration of the entire cluster such as pod IP, Services, Deployments etc..
- It takes care of the load balancing and routing which comes under networking configuration.

POD: A group of one or more containers.

CONTAINER:

- It is a virtual machine which does not have any OS.
- it is used to run the applications in worker nodes.

KUBERNETES CLUSTER SETUP:

There are multiple ways to setup kubernetes cluster.

1. SELF MANAGER K8'S CLUSTER

- a. mini kube (single node cluster)
- b. kubeadm(multi node cluster)
- c. KOPS

2. CLOUD MANAGED K8'S CLUSTER

- a. AWS EKS
- b. AZURE AKS
- c. GCP GKS
- d. IBM IKE

MINIKUBE:

It is a tool used to setup single node cluster on K8's.

It contains API Servers, ETCD database and container runtime

It helps you to containerized applications.

It is used for development, testing, and experimentation purposes on local.

Here Master and worker runs on same machine

It is a platform Independent.

By default it will create one node only.

Installing Minikube is simple compared to other tools.

NOTE: But we dont implement this in real-time

MINIKUBE SETUP:

REQUIREMENTS:

- 2 CPUs or more
- 2GB of free memory
- 20GB of free disk space
- Internet connection
- Container or virtual machine manager, such as:
Docker.

UPDATE SERVER:

1 apt update -y

2 apt upgrade -y

INSTALL DOCKER:

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

4 sudo curl -fsSL https://get.docker.com -o get-docker.sh

sudo sh get-docker.sh

INSTALL MINIKUBE:

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

6 sudo mv minikube-linux-amd64 /usr/local/bin/minikube

7 sudo chmod +x /usr/local/bin/minikube

8 sudo minikube version

INSTALL KUBECTL:

9 sudo curl -LO "https://dl.k8s.io/release/\$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl"

10 sudo curl -LO "https://dl.k8s.io/\$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl.sha256"

11 sudo echo "\$(cat kubectl.sha256) kubectl" | sha256sum --check

12 sudo install -o root -g root -m 0755 kubectl /usr/local/bin/kubectl

13 sudo kubectl version --client

14 sudo kubectl version --client --output=yaml

15 sudo minikube start --driver=docker --force

KUBECTL:

- kubectl is the CLI which is used to interact with a Kubernetes cluster.
- We can create, manage pods, services, deployments, and other resources
- We can also monitoring, troubleshooting, scaling and updating the pods.
- To perform these tasks it communicates with the Kubernetes API server.
- It has many options and commands, to work on.
- The configuration of kubectl is in the \$HOME/.kube directory.
- The latest version is 1.29

SYNTAX:

kubectl [command] [TYPE] [NAME] [flags]

kubectl api-resources : to list all api resources

Lets start working on kubernetes!

Note:

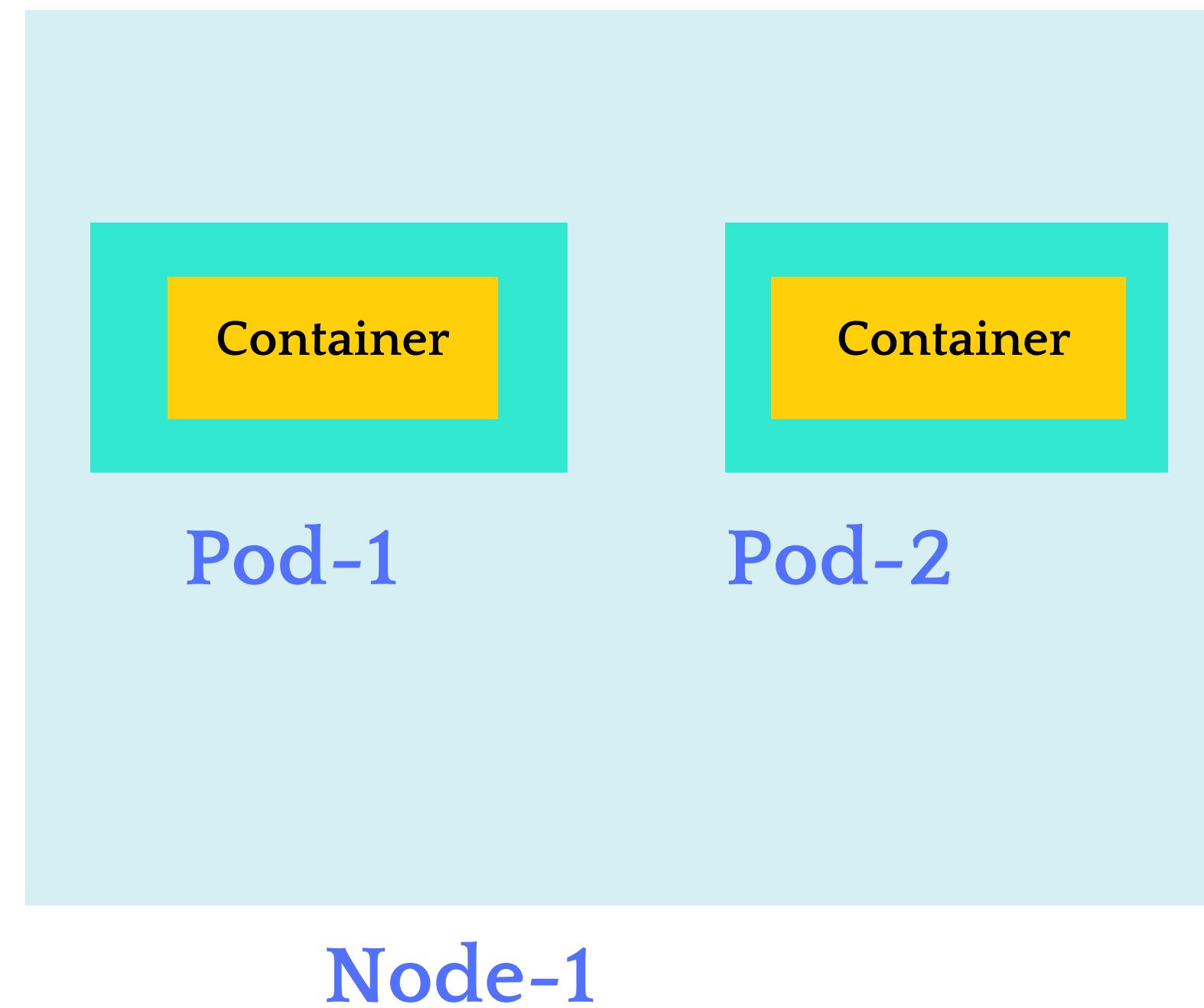
Kubernetes will not deploy the containers directly on worker nodes.
Kubernetes has a object called POD which contains containers.

Lets learn about PODS

POD:

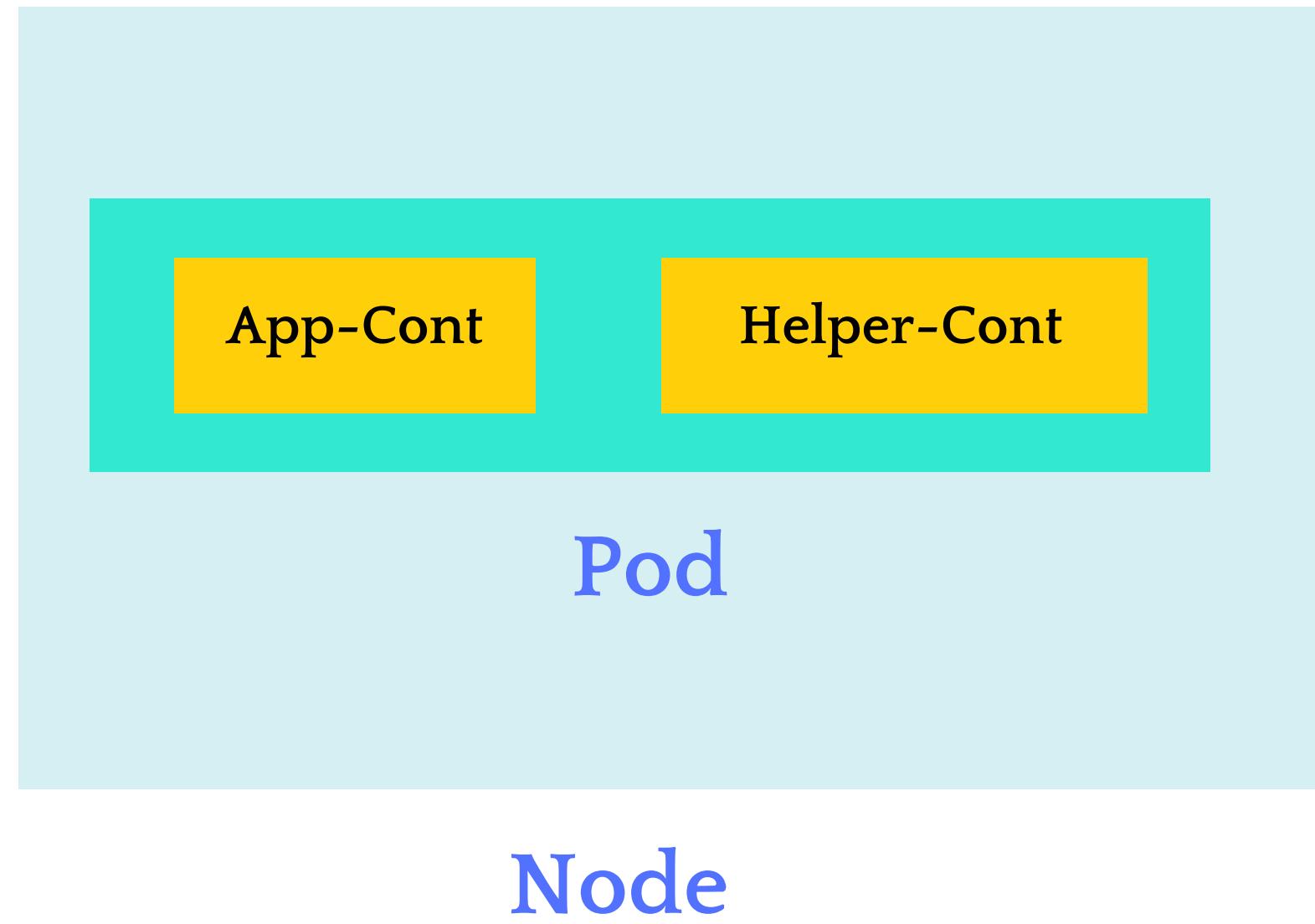
- It is a smallest object that we can create in K8's.
- It is a group of containers.
- Pod acts like a single instance for our application.
- Pods are ephemeral (short living objects)
- Mostly we can use single container inside a pod but if we required, we can create multiple containers inside a same pod.
- when we create a pod, containers inside pods can share the same network namespace, and can share the same storage volumes .
- While creating pod, we must specify the image, along with any necessary configuration and resource limits.
- K8's cannot communicate with containers, they can communicate with only pods.
- We can create this pod in two ways,
 - 1. Imperative(command)
 - 2. Declarative (Manifest file)

SINGLE CONTAINER POD



Basically, each pods needs only one container. But sometimes we need 2 containers in one pod.

MULTI CONTAINER POD



Helper containers are additional containers included in a pod to perform some tasks that support the primary container which are running in the pod.

How Helper container works:

- A helper container is used to collect the logs from the primary container.
- Helper containers can be used to run monitoring and metrics collection agents from the main application container.
- Helper containers can assist in syncing files or data between containers in a pod. For example, a pod might have a main application container and a helper container responsible for syncing configuration files or other shared resources.
- Security-related tasks, such as handling secrets, encryption, or authentication, can be done by helper container.

POD CREATION:

IMPERATIVE:

The imperative way uses kubectl command to create pod.

This method is useful for quickly creating and modifying the pods.

SYNTAX: `kubectl run pod_name --image=image_name`

COMMAND: *kubectl run pod-1 --image=nginx*

kubectl : command line tool run : action

pod-1 : name of pod

nginx : name of image

KUBECTL:

DECLARATIVE:

The Declarative way we need to create a Manifest file in YAML Extension.

This file contains the desired state of a Pod.

It takes care of creating, updating, or deleting the resources.

This manifest file need to follow the yaml indentation.

YAML file consist of KEY-VALUE Pair.

Here we use create or apply command to execute the Manifest file.

SYNTAX: kubectl create/apply -f file_name

CREATE: if you are creating the object for first time we use create only.

APPLY: if we change any thing on files and changes need to apply the resources.

MANIFEST FILE:

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
spec:
  containers:
  - name: nginx
    image: nginx:1.14.2
  ports:
  - containerPort: 80
```

apiVersion: This is the version of API from Kubernetes which is used to create objects.

kind: defines the object that we are creating.

metadata: data about the object like names, labels etc ...

spec: It is the specifications of the object

COMMANDS:

- To get all the pods: **kubectl get pods (or) kubectl get pod (or) kubectl get po**
- To delete a pod: **kubectl delete pod pod_name**
- To get IP of a pod: **kubectl get po pod_name -o wide**
- To get IP of all pods: **kubectl get po -o wide**
- To get all details of a pod: **kubectl describe pod podname**
- To get all details of all pods: **kubectl describe po**
- To get the pod details in YAML format: **kubectl get pod pod-1 -o yaml**
- To get the pod details in JSON format: **kubectl get pod pod-1 -o json**
- To enter into a pod: **kubectl exec -it pod_name -c cont_name bash**
- To get the logging info of our pod: **kubectl logs pod_name**
- To get the logs of containers inside the pod: **kubectl logs pod_name -c cont-name**

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.

Label-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. Node selector is used to choose the node to apply a particular command.

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.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
  labels:
    env: testing
    department: DevOps
spec:
  containers:
    - name: containers1
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo This is our Pod; sleep 5 ; done"]
```

To see the list of pods with labels: **kubectl get pods --show-labels**

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

kubectl get pods -l env=testing

kubectl get pods -l department!=DevOps

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(=).

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.

`kubectl label pods Pod_name Location=India`

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.

Lets list all those pods that have an env label with value for either testing or development.

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

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)'

We can also delete the pods as per the label.

Let's deleted all those pods that don't have the Chinda value for the location key in the Label.

kubectl delete pod -l Location!=China

WE DEPLOYED THE POD



LETS ACCESS OUR APPLICATION



I CANT ABLE TO ACCESS MY APPLICATION

The reason why we are not able to access the application: In Kubernetes, if you want to access the application we have to expose our pod. To Expose these pods we use Kubernetes services.

KUBERNETES SERVICES

- Service is a method for exposing Pods in your cluster.
- Each Pod gets its own IP address But we need to access from IP of the Node..
- If you want to access pod from inside we use Cluster-IP.
- If the service is of type NodePort or LoadBalancer, it can also be accessed from outside the cluster.
- It enables the pods to be decoupled from the network topology, which makes it easier to manage and scale applications

TYPES:

- CLUSTER-IP
- NODE PORT
- LOAD BALANCER
- EXTERNAL NAME

TYPES OF SERVICES

- **ClusterIP:** A ClusterIP service provides a stable IP address and DNS name for pods within a cluster. This type of service is only accessible within the cluster and is not exposed externally.
- **NodePort:** A NodePort service provides a way to expose a service on a static port on each node in the cluster. This type of service is accessible both within the cluster and externally, using the node's IP address and the NodePort.
- **LoadBalancer:** A LoadBalancer service provides a way to expose a service externally, using a cloud provider's load balancer. This type of service is typically used when an application needs to handle high traffic loads and requires automatic scaling and load balancing capabilities.
- **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.

COMPONENTS OF SERVICES

A service is defined using a Kubernetes manifest file that describes its properties and specifications. Some of the key properties of a service include:

- Selector: A label selector that defines the set of pods that the service will route traffic to.
- Port: The port number on which the service will listen for incoming traffic.
- TargetPort: The port number on which the pods are listening for traffic.
- Type: The type of the service, such as ClusterIP, NodePort, LoadBalancer, or ExternalName.

CLUSTER-IP:

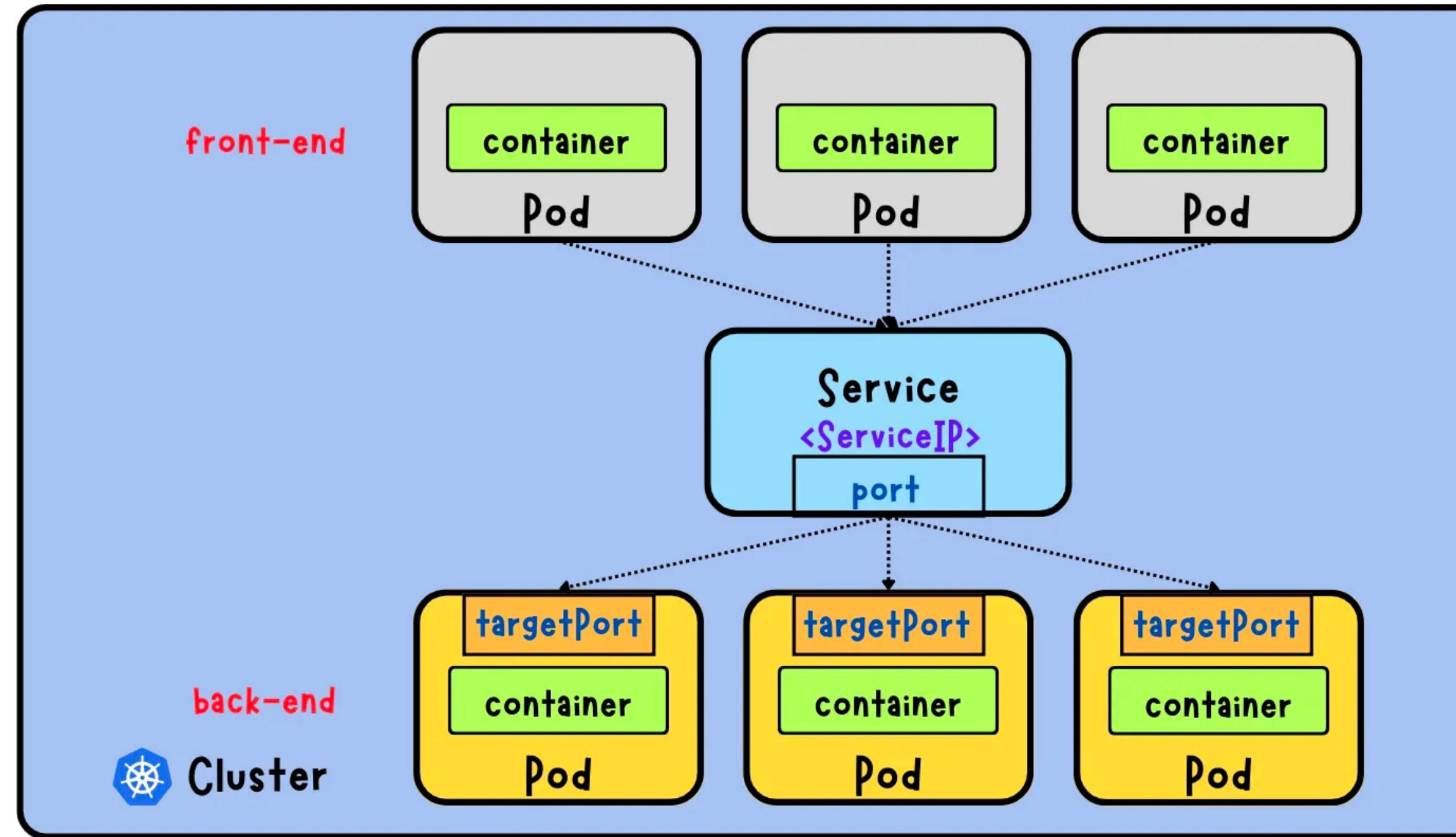
```
apiVersion: v1
kind: Pod
metadata:
  name: frontend
  labels:
    app: swiggy
spec:
  containers:
    - name: cont1
      image: rahamshaik/tic-tac-toe-1:latest
      ports:
        - containerPort: 80
```

- To deploy the application we create a container, which stores inside the pod.
- After container is created we will be not able to access the application.
- Because we cannot access the pods and ports from the cluster.
- To Avoid this we are creating the Services.

```
---  
apiVersion: v1  
kind: Service  
metadata:  
  name: frontend  
spec:  
  type: ClusterIP  
  selector:  
    app: swiggy  
ports:  
  - port: 80  
    targetPort: 80
```

- In this code we are exposing the application. here we use clusterip service
- By using this we can access application inside the cluster only.
- But if we want to access the application from outside we need to use nodeport.
- ClusterIP will assign one ip for service to access the pod.
- Just Replace *ClusterIP*=*NodePort*
- kubectl apply -f filename.yml

Three Types of Services: ClusterIP



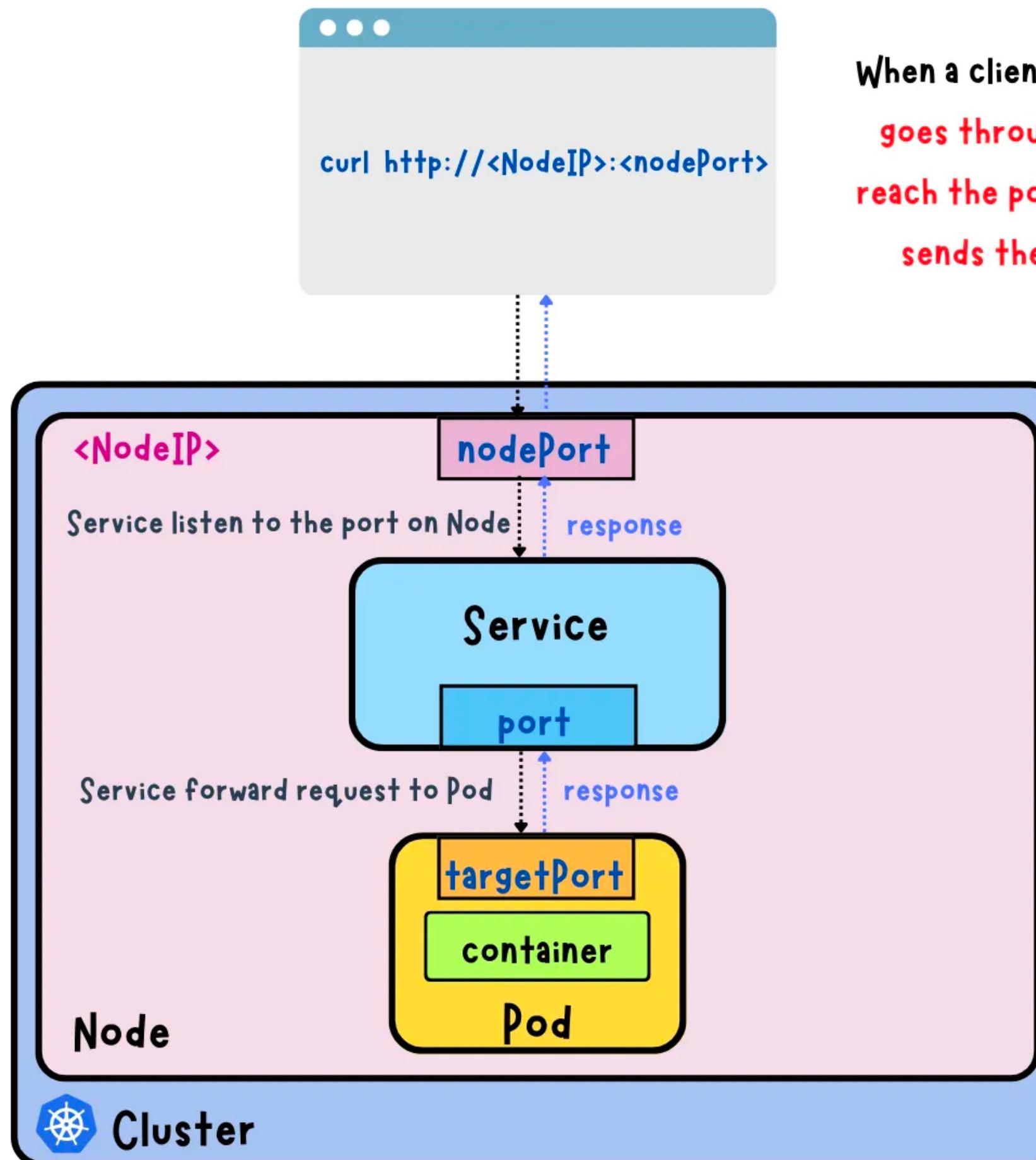
port: port on Service

targetPort: port on Pod (destination)

```
---  
apiVersion: v1  
kind: Service  
metadata:  
  name: frontend  
spec:  
  type: NodePort  
  selector:  
    app: swiggy  
  ports:  
    - port: 80  
      targetPort: 80  
      nodePort: 30001
```

- In this code we are exposed the application from anywhere (inside & outside)
- We need to Give public ip of node where pod is running.
- Node Port Range= 30000 - 32767
- here i haе defined port number as 30001
- if we dont specify the port it will assign automatically.
- kubectl apply -f filename.yml.
- NodePort expose service on a static port on each node.
- NodePort services are typically used for smaller applications with a lower traffic volume.
- To avoid this we are using the LoadBalancer service.
- Just Replace *NodePort=LoadBalancer*

Three Types of Services: NodePort



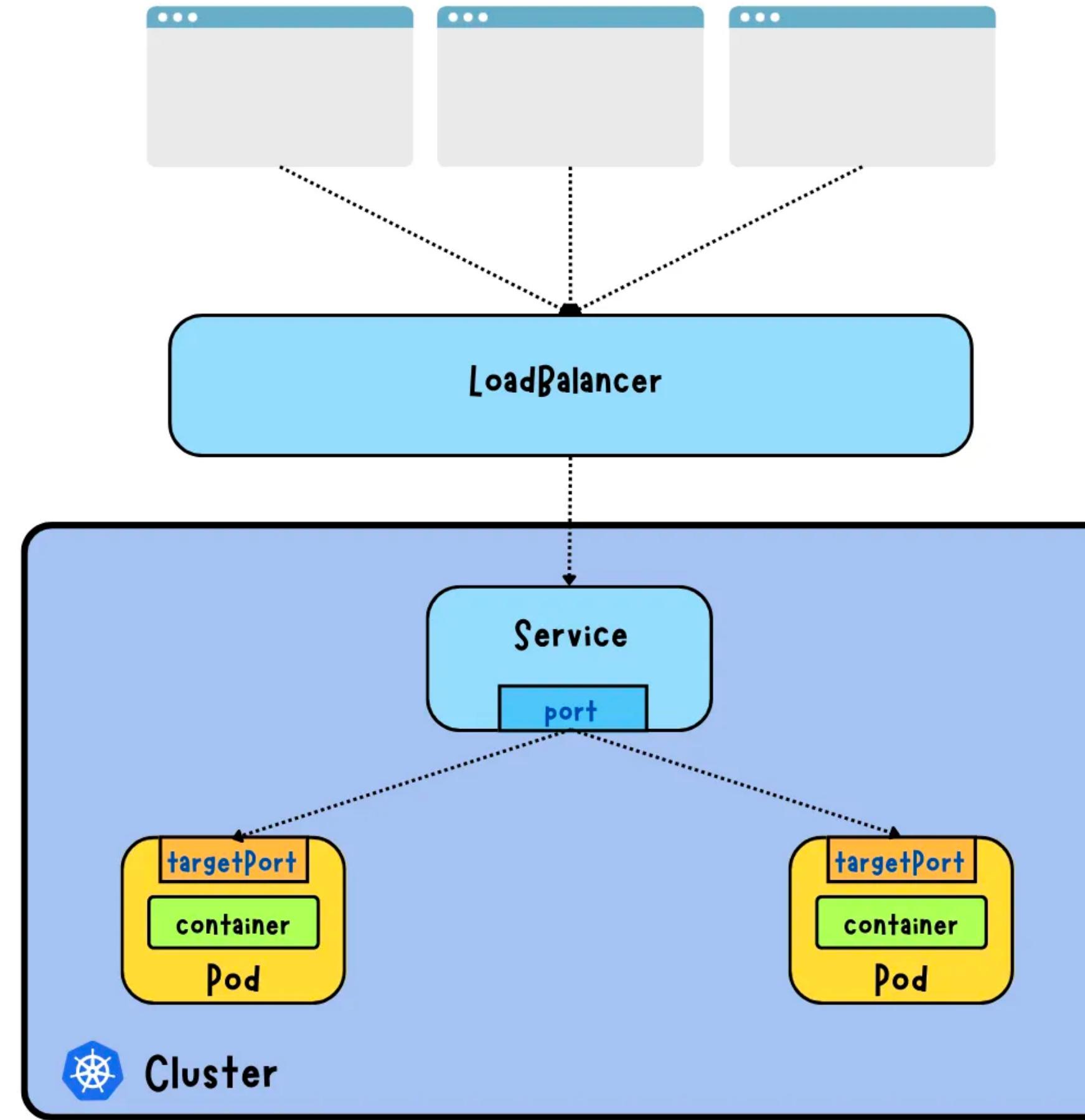
When a client sends a **request** to a **NodePort** service, it goes through the **NodePort**, **Port**, and **TargetPort** to reach the **pod**. The pod then processes the **request** and sends the **response** back through the same ports.

nodePort: port on **Node**
port: port on **Service**
targetPort: port on **Pod (destination)**

```
apiVersion: v1
kind: Service
metadata:
  name: frontend
spec:
  type: LoadBalancer
  selector:
    app: swiggy
  ports:
    - port: 80
      targetPort: 80
```

- In LoadBalaner we can expose application externally with the help of Cloud Provider LoadBalancer.
- it is used when an application needs to handle high traffic loads and requires automatic scaling and load balancing capabilities.
- After the LoadBalancer service is created, the cloud provider will created the Load Balancer.
- This IP address can be used by clients outside the cluster to access the service.
- The LoadBalancer service also automatically distributes incoming traffic across the pods that match the selector defined in the YAML manifest.
- access : publicip:port and LB url
- <http://aodce056441c04035918de4bfb5bff97-40528368.us-east-1.elb.amazonaws.com/>

Three Types of Services: LoadBalancer



ExternalName:

```
apiVersion: v1
kind: Service
metadata:
  name: k8-service
  namespace: dev
spec:
  type: ExternalName
  externalName: k8.learning.com
```

COMMANDS FOR SERVICES:

1. Creates a new service based on the YAML file

```
kubectl create -f filename
```

2. Create a ClusterIP service

```
kubectl create service clusterip <service-name> --tcp=<port>:<targetPort>
```

3. Create a NodePort service

```
kubectl create service nodeport <service-name> --tcp=<port>:<targetPort>  
--node-port=<nodePort>
```

4. Create a LoadBalancer service

```
kubectl create service loadbalancer <service-name> --tcp=<port>:<targetPort>
```

5. Create a service for a pod

```
kubectl expose pod <pod-name> --name=<service-name> \  
--port=<port> --target-port=<targetPort> --type=<service-type>
```

6. Create a service for a deployment

```
kubectl expose deployment <deployment-name> --name=<service-name> \  
--port=<port> --target-port=<targetPort> --type=<service-type>
```

7. Retrieve a list of services that have been created

```
kubectl get services
```

8. Retrieve detailed information about a specific service

```
kubectl describe services <service-name>
```

THE DRAWBACK

In the above both methods we can be able to create a pod
but what if we delete the pod ?

once you delete the pod we cannot able to access the pod,
so it will create a lot of difficulty in Real time

NOTE: Self healing is not Available here.

To overcome this on we use some Kubernetes components called RC, RS,
DEPLOYMENTS, DAEMON SETS, etc ...

REPLICAS IN KUBERNETES:

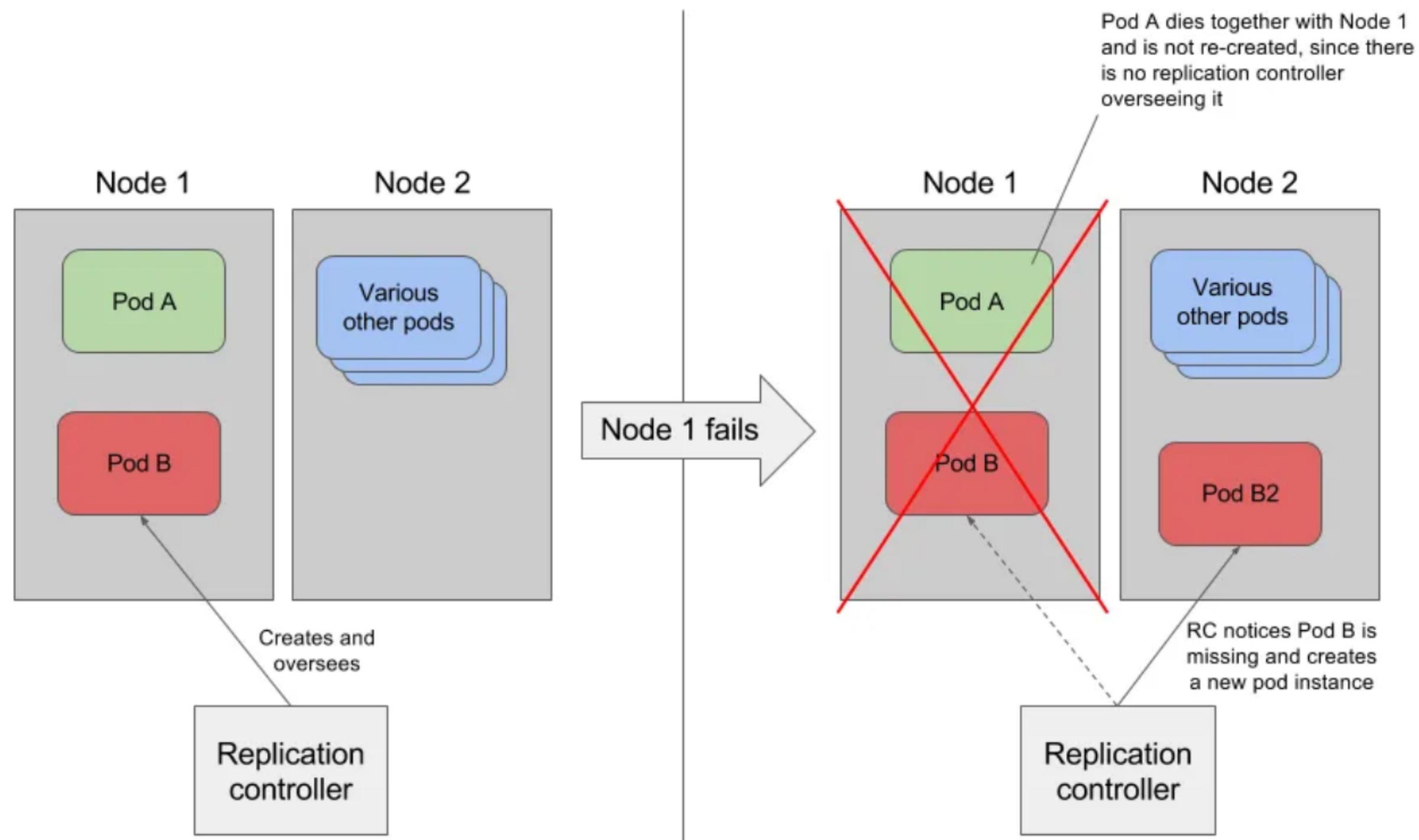
- Before Kubernetes, other tools did not provide important and customized features like scaling and replication.
- When Kubernetes was introduced, replication and scaling were the premium features that increased the popularity of this container orchestration tool.
- Replication means that if the pod's 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.

REPLICATION CONTROLLER:

- Replication controller can run specific number of pods as per our requirement.
- It is the responsible for managing the pod lifecycle
- It will make sure that always pods are up and running.
- If there are too many pods, RC will terminates the extra pods.
- If there are too less RC will create new pods.
- This Replication controller will have self-healing capability, that means automatically it will creates.
- If a pod is failed, terminated or deleted then new pod will get created automatically. Replication Controllers use labels to identify the pods that they are managing.
- We need to specifies the desired number of replicas in YAML file.

REPLICATION CONTROLLER:



```
apiVersion: v1
kind: ReplicationController
metadata:
  name: my-replicationcontroller
spec:
  replicas: 3
  selector:
    app: my-app
  template:
    metadata:
      labels:
        app: my-app
  spec:
    containers:
      - name: my-container
        image: my-image:latest
        ports:
          - containerPort: 80
```

SELECTOR: It select the resources based on labels. Labels are key value pairs.

This will helps to pass a command to the pods with label app=nginx

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

TO EXECUTE

TO GET

TO DESCRIBE

TO SCALE UP

TO SCALE DOWN

TO DELETE REPLICA CONTROLLER

: `kubectl create -f file_name.yml`

: `kubectl get rc`

: `kubectl describe rc/nginx`

: `kubectl scale rc rc_name --replicas 5`

: `kubectl scale rc rc_name --replicas 2` (*drops from 5 to 2*)

: `kubectl delete rc rc_name`

IF WE DELETE RC, PODS ARE ALSO GETS DELETED, BUT IF WE DON'T WANT TO DELETE PODS, WE WANT TO DELETE ONLY REPLICA SETS THEN

`kubectl delete rc rc_name --cascade=orphan`

`kubectl get rc rc_name`

`kubectl get pod`

Now we deleted the RC but still pods are present, if we want to assign this pods to another RC use the same selector which we used on the RC last file.

THE DRAWBACK

RC used only equality based selector

ex: env=prod

here we can assign only one value (equality based selector)

We are not using these RC in recent times, because RC is replaced by RS(Replica Set)

REPLICASET:

- it is nothing but group of identical pods. If one pod crashes automatically replica sets gives one more pod immediately.
- it uses labels to identify the pods
- Difference between RC and RS is selector and it offers more advanced functionality.
- The key difference is that the replication controller only supports ***equality-based selectors*** whereas the replica set supports ***set-based selectors***.
- it monitors the number of replicas of a pod running in a cluster and creating or deleting new pods.
- It also provides better control over the scaling of the pod.
- A ReplicaSet identifies new Pods to acquire by using its selector.
- we can provide multiple values to same key.
- ex: env in (prod,test)

```
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: my-replicaset
spec:
  replicas: 3
  selector:
    matchLabels:
      app: my-app
  template:
    metadata:
      labels:
        app: my-app
  spec:
    containers:
      - name: my-container
        image: my-image:latest
        ports:
          - containerPort: 80
```

- Replicas: Number of pod copies we need to create
- Matchelabel: label we want to match with pods
- Template: This is the template of pod.
- Note: give apiVersion: apps/v1 on top
- Labels : mandatory to create RS (if u have 100 pods in a cluster we can inform which pods we need to take care by using labels) if u labeled some pods a raham then all the pods with label raham will be managed.

```
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"]
```

COMMANDS:

TO EXECUTE

: `kubectl create -f replicaset-nginx.yaml`

TO LIST

: `kubectl get replicaset/rs`

TO GET INFO

: `kubectl get rs -o wide`

TO GET IN YAML

: `kubectl get rs -o yaml`

TO GET ALL RESOURCES : `kubectl get all`

Now delete a pod and do list now it will be created automatically

TO DELETE A POD

: `Kubectl delete po pod_name`

TO DELETE RS

: `kubectl delete rs`

TO SHOW LABELS OF RS

: `Kubectl get po -show-labels`

TO SHOW POD IN YAML

: `Kubectl get pod -o yaml`

THE DRAWBACK

Here Replica set is an lower level object which focus on maintaining desired number of replica pods.

To manage this replica set we need a higher-level object called deployment which provide additional functionality like rolling updates and roll backs.

Deployments use ReplicaSets under the hood to manage the actual pods that run the application.

DEPLOYMENT:

- It has features of Replicaset and some other extra features like updating and rollbacks to a particular version.
- The best part of Deployment is we can do it without downtime.
- you can update the container image or configuration of the application.
- Deployments also provide features such as versioning, which allows you to track the history of changes to the application.
- It has a pause feature, which allows you to temporarily suspend updates to the application
- Scaling can be done manually or automatically based on metrics such as CPU utilization or requests per second.
- Deployment will create ReplicaSet, ReplicaSet will create Pods.
- If you delete Deployment, it will delete ReplicaSet and then ReplicaSet will delete Pods.

```
apiVersion: apps/v1
kind: Deployment
metadata:
  labels:
    run: nginx
  name: nginx-deploy
spec:
  replicas: 2
  selector:
    matchLabels:
      run: nginx
  template:
    metadata:
      labels:
        run: nginx
  spec:
    containers:
    - image: nginx
      name: nginx
```

- Replicas: Number of pod copies we need to create
- Matchlabel: label we want to match with pods
- Template: This is the template of pod.
- Labels : mandatory to create RS (if u have 100 pods in a cluster we can inform which pods we need to take care by using labels) if u labeled some pods a raham then all the pods with label raham will be managed.

MANIFEST FILE:

To create a replica set : `kubectl create -f replicaset-nginx.yaml`

To see a deployment : `kubectl get deployment/deploy`

To see full details of deployment : `kubectl get deploy -o wide`

To view in YAML format : `kubectl get deploy -o yaml`

To get all info : `kubectl describe deploy`

COMMAND TO CREATE DEPLOYMENT:

`kubectl create deployment deployment-name --image=image-name --replicas=4`

Now delete a pod and do list now it will be created automatically

To delete a pod: `Kubectl delete po pod_name`

To check logs : `kubectl logs pod_name`

To delete a deployment : `kubectl delete deploy deploy_name`

When you inspect the Deployments in your cluster, the following fields are displayed:

- **NAME** lists the names of the Deployments in the namespace.
- **READY** displays how many replicas of the application are available to your users. It follows the pattern ready/desired.
- **UP-TO-DATE** displays the number of replicas that have been updated to achieve the desired state.
- **AVAILABLE** displays how many replicas of the application are available to your users.
- **AGE** displays the amount of time that the application has been running.

UPDATING A DEPLOYMENT:

update the container image:

kubectl set image deployment/deployment-name my-container=image-name

or

kubectl edit deployment/deployment-name

To roll back:

kubectl rollout status deployment/deployment-name

To check the status:

kubectl rollout status deployment/deployment-name

To get the history:

kubectl rollout history deployment/deployment-name

To rollback specific version:

kubectl rollout undo deployment/deployment-name --to-revision=number

PAUSE/UNPAUSE A DEPLOYMENT:

To pause a pod in deployment:

kubectl rollout pause deployment/deployment-name

To un-pause a pod in deployment:

kubectl rollout resume deployment/deployment-name

DEPLOYMENT SCALING:

Lets assume we have 3 pods, if i want to scale it to 10 pods (**manual scaling**)

`kubectl scale deployment/nginx-deployment --replicas=10`

Assume we have HPA(**Horizontal POD Auto-scaling**) enabled in cluster.

So if we want to give the min and max count of replicas

`kubectl autoscale deployment/nginx-deployment --min=10 --max=15`

Now if we want to assign cpu limit for it

`kubectl autoscale deployment/nginx-deployment --min=10 --max=15 --cpu-percent=80`

Manual scaling means we can define the replicas (`--replicas=5`)

HPA automatically scale the replicas based on cpu metrics

DEPLOYMENT SCALING:

Now run kubectl get rs : you will get the new deployment.

kubectl get pod

You see that the number of old replicas is 3, and new replicas is 0.

Next time you want to update these Pods, you only need to update the Deployment's Pod template again.

While updating pods, 75% will be available and 25% will be unavailable during updates

Lets assume, if we have 4 pods, while trying to update them atleast 3 of them are available and 1 should be updated in the mean time.

DAEMON-SET:

- It is used to run a copy a pod to each worker node.
- It is used to perform some tasks like monitoring, Log collection etc.. that need to run on every node of the cluster.
- A DaemonSet ensures that all eligible nodes run a copy of a Pod
- When you create daemon set k8s schedules one copy of pod in each node.
- If we added new node it will copy the pod automatically to new node.
- If I remove on node from cluster the pod in that node also removed.
- Deleting a DaemonSet will clean up the Pods it created.
- Daemon-set does not contains replicas, because bydefault it will create only 1 pod in each node.
- Daemon sets will not used for deployments on real-time, it is only to schedule pods.

```
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: example-daemonset
spec:
  selector:
    matchLabels:
      app: example-app
  template:
    metadata:
      labels:
        app: example-app
    spec:
      containers:
      - name: example-container
        image: nginx:latest
```

NAMESPACE:

- Namespaces are used to group the components like pods, services, and deployments.
- This can be useful for separating environments, such as development, staging, and production, or for separating different teams or applications.
- In real-time all the frontend pods are mapped to one namespace and backend pods are mapped to another namespace.
- It represents the cluster inside the cluster.
- You can have multiple namespaces within one Kubernetes cluster, and they are all logically isolated from one another.
- Namespaces provide a logical separation of cluster resources between multiple users, teams, projects, and even customers.

- Within the same Namespace, Pod to Pod communication.
- Namespaces provide a logical separation between the environments (Dev, QA, Test, and Prod) with many users, or projects.
- Namespaces are only hidden from each other but are not fully isolated from each other.
- One service in a Namespace can talk to another service in another Namespace if the target and sources are used with the full name which includes service/object name followed by Namespace.
- The name of resources within one namespace must be unique.
- When you delete a namespace all the resources will gets deleted.

- **kubectl get namespaces** : To get the name space
- **Default** : when we create resources like pod, service, deployments all will gets stored in default namespace
- ***kube-public*** : The namespace for resources that are publicly available by all.
- ***kube-system***: The namespace for objects created by the Kubernetes system.
- ***kube-node-lease***: It is used for the lease objects associated with each node that improves the performance of the node heartbeats as the cluster scales

COMMANDS:

- `kubectl get ns` : *used to get namespaces*
- `kubectl create ns mustafa` : *used to create new namespace*
- `kubectl config set-context --current --namespace=mustafa` : *to check to namespace*
- `kubectl config view --minify | grep namespace` : *to verify the name space.*

CREATE A POD IN NS (IMPERATIVE):

1. **Create a namespace** - `kubectl create namespace mustafa`

2. **create a pod in ns** - `kubectl run nginx --image=nginx --namespace mustafa`

(or)

`kubectl run nginx --image=nginx -n development`

3. **To check the pods:** `kubectl get pod -n mustafa`

(or)

`kubectl get pod --namespace mustafa`

CREATE A POD IN NS (DECLARATIVE):

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: mustafa
~
```

When you delete a namespace all the resources will gets deleted.

kubectl get pods -n mustafa :

used to get pods from namespace

kubectl describe pod nginx -n development :*describe a pod in namespace*

kubectl delete pod nginx -n development : *delete a pod in namespace*

POD FILE

```
---  
apiVersion: v1  
kind: Pod  
metadata:  
  name: frontendnew  
  labels:  
    app: swiggy  
  namespace: mustafa  
spec:  
  containers:  
    - name: cont1  
      image: rahamshaik/cycle:latest  
      ports:  
        - containerPort: 80
```

NODEPORT FILE

```
---  
apiVersion: v1  
kind: Service  
metadata:  
  name: frontendnew  
  namespace: mustafa  
spec:  
  type: NodePort  
  selector:  
    app: swiggy  
  ports:  
    - port: 80  
      targetPort: 80  
      nodePort: 30003
```

Before going to deploy this file we need to create mustafa namespace.
Here i just mentioned namespace in normal manifest file

CONFIG MAPS:

- ConfigMap is used to store the configuration data in key-value pairs within Kubernetes.
- But the data should be non confidential data.
- 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
- So we can set the configuration of data of application separately
- But it does not provider security and encryption. If we want to provide encryption use secrets in Kubernetes.
- Limit of config map data in only 1 MB (we cannot store more than that)
- But if we want to store a large amount of data in config maps we have to mount a volume or use a separate database or file service.

USE CASES IN CONFIG MAPS:

- **Configure application settings:** By using this config maps, we can store the configuration data that helps to run our application like database connections and environment variables
- **Configuring a pod or container:** It is used to send a configuration data to a pod or container at runtime like CLI or files.
- **Sharing configuration data across multiple resources:** By using this configuration data multiple resources can access, such as a common configuration file for different pods or services.
- **We can store the data:** By using this config maps, we can store the data like IP address, URL's and DNS etc...

SOME POINTS ABOUT CONFIGMAPS:

- 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.

Creating ConfigMap from literal:

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.

```
kubectl create cm my-first-cm --from-literal=Course=DevOps --from-literal=Cloud=AWS --from-literal=Trainer=Mustafa
```

To get Config Maps: `kubectl get cm`

To describe: `kubectl describe configmap/configmap-name`

To delete: `kubectl delete configmap/configmap`

CREATE A CONFIG-MAPS FROM FILE:

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

cat config-map-data.txt

Name=Mustafa

Course=Python

Duration=60 days

command to create config map: `kubectl create cm cm-name --from-file=filename`

To descibe: `kubectl describe configmap/configmap-name`

To delete: `kubectl delete configmap/configmap`

CREATE A CONFIG-MAPS FROM ENV FILE:

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.

cat one.env

Tool=Kubernetes

Topic=Config Maps

Course=DevOps

command to create config map: `kubectl create cm cm-name --from-env-file=one.env`

To descibe: `kubectl describe configmap/one.env`

To delete: `kubectl delete configmap/one.env`

CREATE A FOLDER FOR CONFIG-MAPS:

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.

mkdir folder1

cat folder1/file1.txt

key1=value1

key2=23

cat folder2/file2.txt

key1=value1

key2=23

command to create config map:

kubectl create cm mummy --from-file=folder1/

CREATE A YAML FOR CONFIG-MAPS:

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.

command to create config map: `kubectl create -f one.yml`

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: my-config
data:
  DATABASE_URL: "mysql://db.example.com:3306/mydb"
  API_KEY: "your-api-key"
```

Injecting CM into the pod with specific key pairs:

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

Create a file for pod and execute it
Inside the pod.yml we have to declare any value from our configmap

After creating the pod, enter into the pod using
kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **env**
That will print the list of environments.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
  env:
    - name: FirstValue
      valueFrom:
        configMapKeyRef:
          key: Name
          name: babu
```

POD.YML

kubectl apply -f pod.yml

Injecting multiple CMs with specific and multiple values:

Lets add multiple key pairs from different files.

Create a file for pod and execute it

Inside the pod.yml we have to declare any value from any configmaps

After creating the pod, enter into the pod using

kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **env**

That will print the list of environments.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
      env:
        - name: FirstValue
          valueFrom:
            configMapKeyRef:
              key: Name
              name: Config-Map-1
        - name: SecondValue
          valueFrom:
            configMapKeyRef:
              key: Course
              name: Config-Map-2
        - name: ThirdValue
          valueFrom:
            configMapKeyRef:
              key: Duration
              name: Config-Map-3
```

Injecting the environment file cm's to pod:

Create a file for pod and execute it
Inside the pod.yml we have to declare a configmap name which was created with env file

After creating the pod, enter into the pod using
kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **env**
That will print the list of environments.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: firstcontainer
  envFrom:
    - configMapRef:
        name: my-cm-env
```

POD.YML

kubectl apply -f pod.yml

Injecting cm in the pod with the entire proper file:

Create a file for pod and execute it

Inside the pod.yml we have to declare a configmap name which was created with normal file

After creating the pod, enter into the pod using

kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **ls**

You will find a folder called env-values.

In side the folder you will get file names as keys open the file using **cat** then we will get labels

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
  volumeMounts:
    - name: my-volume
      mountPath: "/env-values"
      readOnly: true
  volumes:
    - name: my-volume
  configMap:
    name: my-cm-1
```

POD.YML
kubectl apply -f pod.yml

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

This concept also will works as same as previous topic. But Inside the pod we can declare the filenames by our own inside the env-values folder.

After creating the pod, enter into the pod using
kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **ls**
You will find a folder called env-values.

In side the folder you will get file names as file1 and file2.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
      volumeMounts:
        - name: test
          mountPath: "/env-values"
          readOnly: true
  volumes:
    - name: test
  configMap:
    name: babu
    items:
      - key: Name
        path: "file1"
      - key: Occupation
        path: "file2"
```

POD.YML
kubectl apply -f pod.yml

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.
- After creating the `Secrets`, applications need to use the credentials or database credentials which will be done by injecting with the pods.

Creating Secret from literal:

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.

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

`kubectl create secret generic my-secret --from-literal=username=sm7243`

To get Config Maps: `kubectl get secret`

To descibe: `kubectl describe secret/my-secret`

To Get in yaml : `kubectl get secret my-secret -o yaml`

To delete: `kubectl delete secret/my-secret`

Secrets from file:

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

```
cat first.conf
```

```
username=sm7234
```

```
password=admin@123
```

```
kubectl create secret generic secret-from-file --from-file=first.conf
```

To get Config Maps: `kubectl get secret`

To descibe: `kubectl describe secret/secret-from-file`

To Get in yaml : `kubectl get secret secret-from-file -o yaml`

To delete: `kubectl delete secret/secret-from-file`

Secrets from env-file:

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.

cat mustafa.env

Name=mustafa

Place=Hyderabad

Compamy=TCS

kubectl create secret generic secret-from-env --from-env-file=mustafa.env

To get secrets: kubectl get secret

To descibe: kubectl describe secret/secret-from-env

To Get in yaml : kubectl get secret secret-from-env -o yaml

To delete: kubectl delete secret/secret-from-env

CREATE A FOLDER FOR SECRETS:

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.

mkdir folder1

cat folder1/file1.txt

Name=Mustafa

Place=Hyderabad=23

cat folder2/file2.txt

database=mysql

password=mypassword

command to create secret:

kubectl create secret generic secret-from-folder --from-file=folder1/

To Get in yaml : kubectl get secret secret-from-env -o yaml

Injecting Secret with a pod for a particular key pairs:

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

Create a file for pod and execute it
Inside the pod.yml we have to declare any value from our secret

After creating the pod, enter into the pod using
kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **env**
That will print the list of environments.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
    env:
      - name: value-1
        valueFrom:
          secretKeyRef:
            key: username
            name: my-secret
```

POD.YML

kubectl apply -f pod.yml

Injecting the environment file secrets to pod:

Create a file for pod and execute it

Inside the pod.yml we have to declare a secret name which was created with env file

After creating the pod, enter into the pod using
kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **ls**
You will find a folder called secret-values.

In side the folder you will get file names as keys
open the file using **cat** then we will get labels

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
      volumeMounts:
        - name: my-volume
          mountPath: "/secrets-values"
  volumes:
    - name: my-volume
      secret:
        secretName: secret-from-env
```

POD.YML

kubectl apply -f pod.yml

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

This concept also will works as same as previous topic. But Inside the pod we can declare the filenames by our own inside the env-values folder.

After creating the pod, enter into the pod using
kubectl exec -it pod_name /bin/bash

Once you entered into pod give a command **ls**
You will find a folder called secret-values.

In side the folder you will get file names as file1 and file2.

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - image: nginx
      name: cont-1
      volumeMounts:
        - name: test
          mountPath: "/secrets-values"
  volumes:
    - name: test
  secret:
    secretName: secret-from-env
  items:
    - key: Company
      path: "file1"
    - key: Name
      path: "file2"
```

POD.YML
kubectl apply -f pod.yml

There are 2 possible ways to store the data in config maps

DATA	BINARY DATA
<ul style="list-style-type: none">• Stores data in plain text• used to store configuration, script and other text based data• Encoded in UFT-8 format• Decoding is not necessary	<ul style="list-style-type: none">• Stores data in binary data• stores non-text data like images, videos or binary files• Encoded in BASE-64 format• Here you need to decode data from BASE-64 format before using

KUBERNETES JOBS:

It is a resource that is used to achieve a particular work like backup script and, once the work is completed the pod will becomes to Completed state.

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.

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 130"]
      restartPolicy: Never
```

job.yml

kubectl create -f job.yml

By executing the above file, it will creates the job and job will automatically creates pod.
check the list of pods and job

1. kubectl get po
2. kubectl get jobs

Inside the pod, the container will gets updated and it will sleep for 130 seconds,
After 130 seconds then the pod will gets deleted.

To execute the multiple commands, use the below manifest file

```
apiVersion: batch/v1
kind: Job
metadata:
  name: testjob
spec:
  template:
    metadata:
      name: testjob
    spec:
      containers:
        - image: ubuntu
          name: container1
          command: ["/bin/sh", "-c"]
          args:
            - |
              sudo apt update -y
              touch kops.pdf
              mkdir mustafa
              sleep 90
restartPolicy: Never
```

This pod will creates the file and folder and
after 90 seconds the pod will gets deleted.

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 10 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
```

The above manifest file will creates 3 pods and it will execute the commands. activeDeadlineSeconds are used to terminate the pods after 10 seconds. After 30 seconds all the pods will gets deleted.

```

root@ip-172-31-47-75:~/manifests# kubectl get po
NAME        READY   STATUS            RESTARTS   AGE
testjob-7mlc2  0/1    ContainerCreating  0          2s
testjob-h7dc9  0/1    ContainerCreating  0          2s
testjob-t468v  0/1    ContainerCreating  0          2s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME        READY   STATUS            RESTARTS   AGE
testjob-7mlc2  0/1    ContainerCreating  0          5s
testjob-h7dc9  0/1    ContainerCreating  0          5s
testjob-t468v  1/1    Running           0          5s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME        READY   STATUS            RESTARTS   AGE
testjob-7mlc2  1/1    Running           0          7s
testjob-h7dc9  1/1    Running           0          7s
testjob-t468v  1/1    Running           0          7s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME        READY   STATUS            RESTARTS   AGE
testjob-7mlc2  1/1    Terminating      0          10s
testjob-h7dc9  1/1    Terminating      0          10s
testjob-t468v  1/1    Terminating      0          10s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME        READY   STATUS            RESTARTS   AGE
testjob-7mlc2  1/1    Terminating      0          16s
testjob-h7dc9  1/1    Terminating      0          16s
testjob-t468v  1/1    Terminating      0          16s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME        READY   STATUS            RESTARTS   AGE
testjob-7mlc2  1/1    Terminating      0          18s
testjob-h7dc9  1/1    Terminating      0          18s
testjob-t468v  1/1    Terminating      0          18s
root@ip-172-31-47-75:~/manifests# kubectl get po
No resources found in default namespace.
root@ip-172-31-47-75:~/manifests#

```

As we can observe the logs here, when i run the manifest file in first 2 seconds the pods are in creating state.

After 7 seconds the pods are in running state.

After 10 seconds the pods are in terminating state

After 40 seconds all the pods will automatically deleted.

Even the pods are deleted, jobs will be present.

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
```

The above manifest file for every one minute new pod will gets creates and it will execute the commands. After 30 seconds pods will gets deleted. After 1 min new pod created.

```

root@ip-172-31-47-75:~/manifests# kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
testjob-28322313-w7fjl  1/1     Running   0          6s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
testjob-28322313-w7fjl  0/1     Completed  0          48s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
testjob-28322313-w7fjl  0/1     Completed  0          90s
testjob-28322314-4xznd  1/1     Running   0          30s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
testjob-28322313-w7fjl  0/1     Completed  0          2m2s
testjob-28322314-4xznd  0/1     Completed  0          62s
testjob-28322315-bcjqt  0/1     ContainerCreating  0          2s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
testjob-28322313-w7fjl  0/1     Completed  0          2m11s
testjob-28322314-4xznd  0/1     Completed  0          71s
testjob-28322315-bcjqt  1/1     Running   0          11s
root@ip-172-31-47-75:~/manifests# kubectl get po
NAME          READY   STATUS    RESTARTS   AGE
testjob-28322313-w7fjl  0/1     Completed  0          3m29s
testjob-28322314-4xznd  0/1     Completed  0          2m29s
testjob-28322315-bcjqt  0/1     Completed  0          89s
testjob-28322316-bxrrb  1/1     Running   0          29s
root@ip-172-31-47-75:~/manifests# █

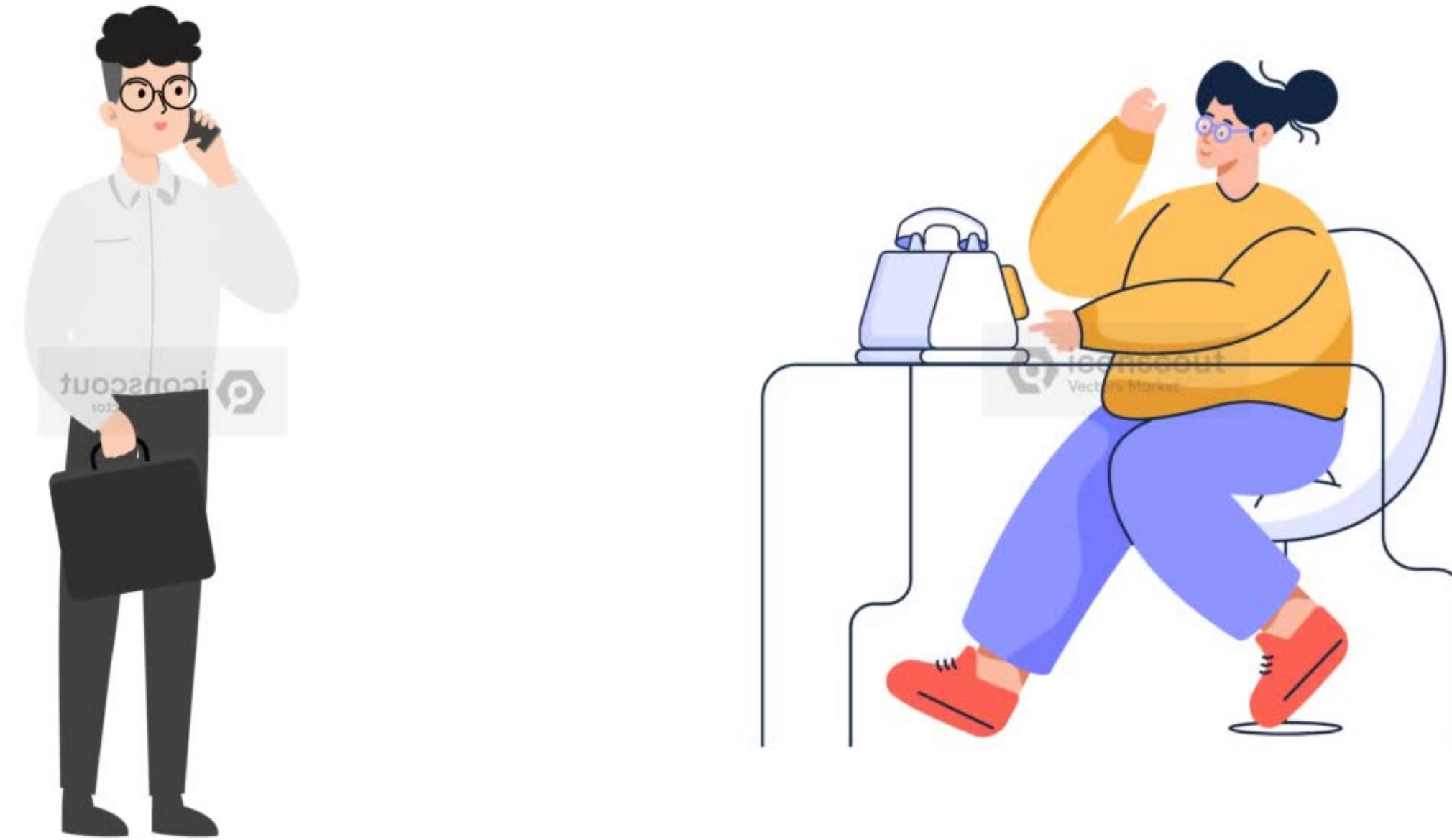
```

As we can observe the logs here, when i run the manifest file one pod is created.

After 30 seconds the pods completes it work

After 60 seconds the new pod will gets created automatically.

STATELESS APPLICATION



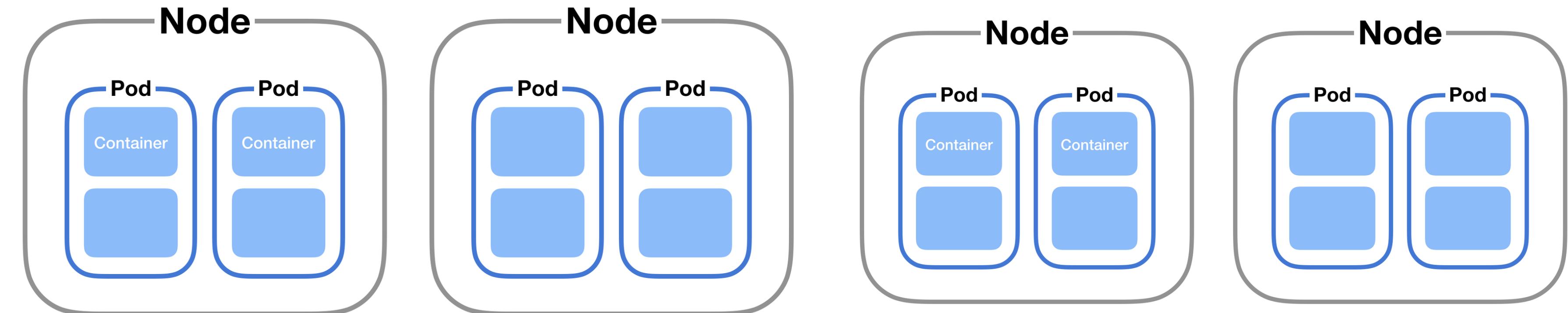
Last night i had a call with mobile customer care, and i explained my issue with her and requested to resolve the issue. She asked to stay on call for some time. Meanwhile the call was dropped due to network issues



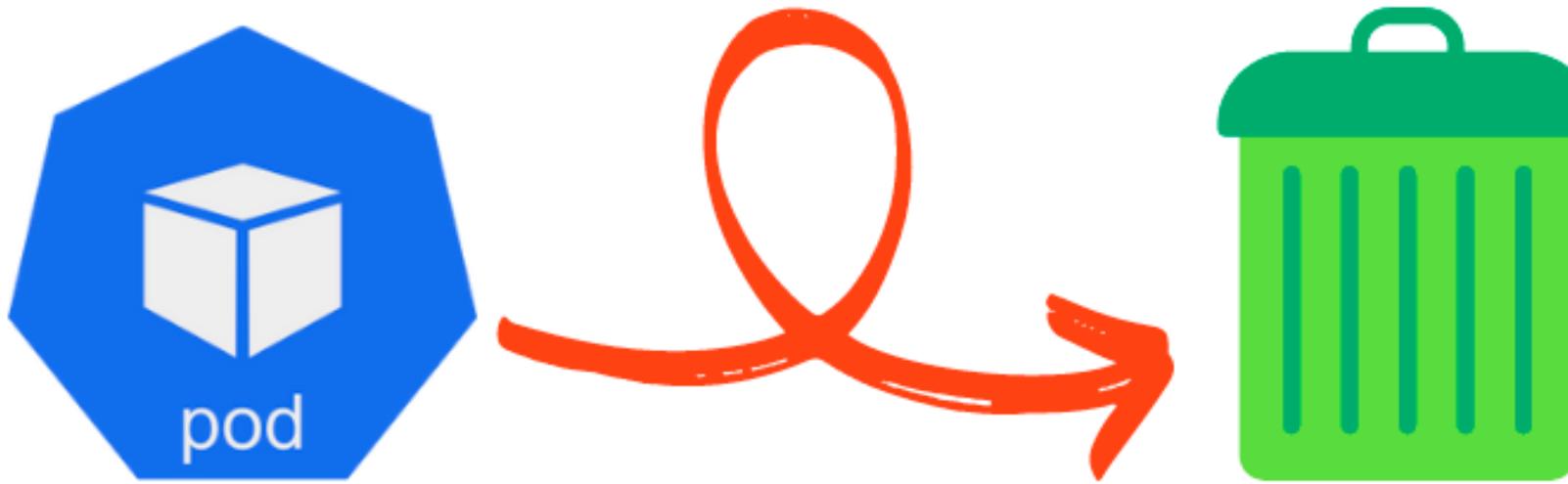
Again i called to same number, but this time another person pick the call. He don't know what the conversation we had with the first person. Again i had to repeat the details of my problem to the second person, though it is an inconvenience but it still works out

Kubernetes Deployment suits perfectly here. Let's assume you deployed your stateless application as a Deployment with 10 Pod replicas running in multiple worker nodes.

Cluster



If one of those Pods running in a particular worker node got terminated due to some issue



The ReplicaSet Controller takes care of replacing the bad Pod with a new healthy Pod either on the same node or on a different node.

Here replicaSet's will only take care of those 10 pods are running in the cluster or not.

It doesn't take care of in which worker node they are running!

If pod 1 got terminated from node 1, then new pod will gets replaced on either node 2 or node 1 or anywhere in the cluster.

This is possible because, the stateless application Pod 1 hasn't stored any data on worker node 1, hence can be easily replaced by new pod running on a different worker node 2

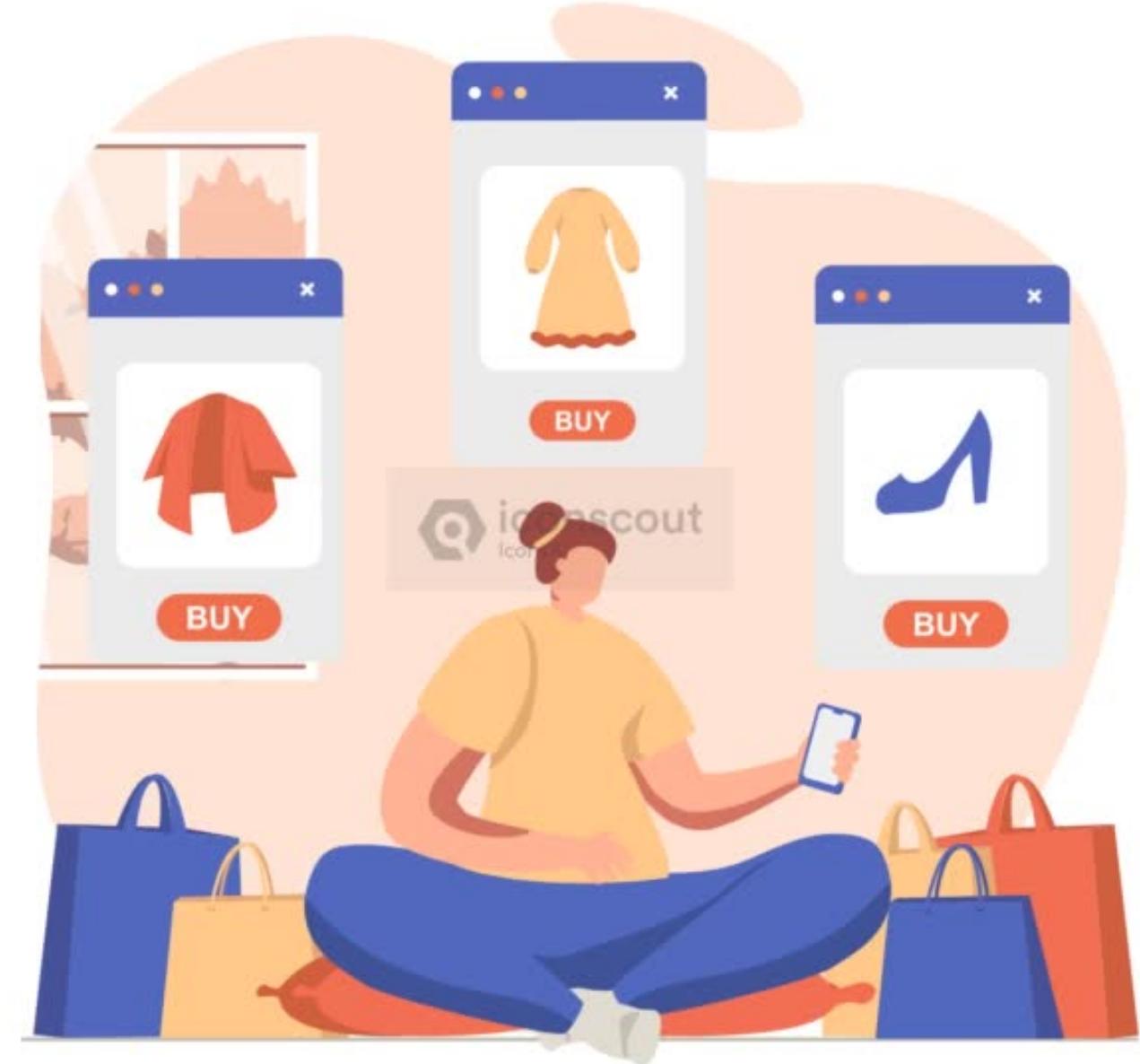
If the pod is not storing the data then we called it as **STATELESS**

STATELESS APPLICATION:

- It can't store the data permanently.
- The word STATELESS means no past data.
- It depends on non-persistent data means data is removed when Pod, Node or Cluster is stopped.
- Non-persistent mainly used for logging info (ex: system log, container log etc..)
- In order to avoid this problem, we are using stateful application.
- A stateless application can be deployed as a set of identical replicas, and each replica can handle incoming requests independently without the need to coordinate with other replicas.



Let's say you want to order some products in Amazon, you added some products to your shopping cart. After you added the book(s) to your shopping cart, If forgot to switch off the stove in kitchen and you closed the web browser hurry.



Well, you can anytime re-login to amazon portal and resume from where you left last time, as the amazon portal will ensure all items added to the Shopping cart are persisted in database.

Technically, if Amazon is using a ShoppingCart that runs in a Pod,
When i added some products on my cart that will stores on one pod and after some
time when i resumed back to the amazon portal that will shows all the products
from the different pod.

The interesting thing to understand here is, the StatefulSet Controller managed to
bind the exact same Persistent Volume to two Shopping Cart Pods associated to
that customer at two different point of time.

STATEFUL APPLICATION:

- Stateful applications are applications that store data and keep tracking it.

Example of stateful applications:

- All RDS databases (MySQL, SQL)
- Elastic search, Kafka , Mongo DB, Redis etc...
- Any applicaiton that stores data

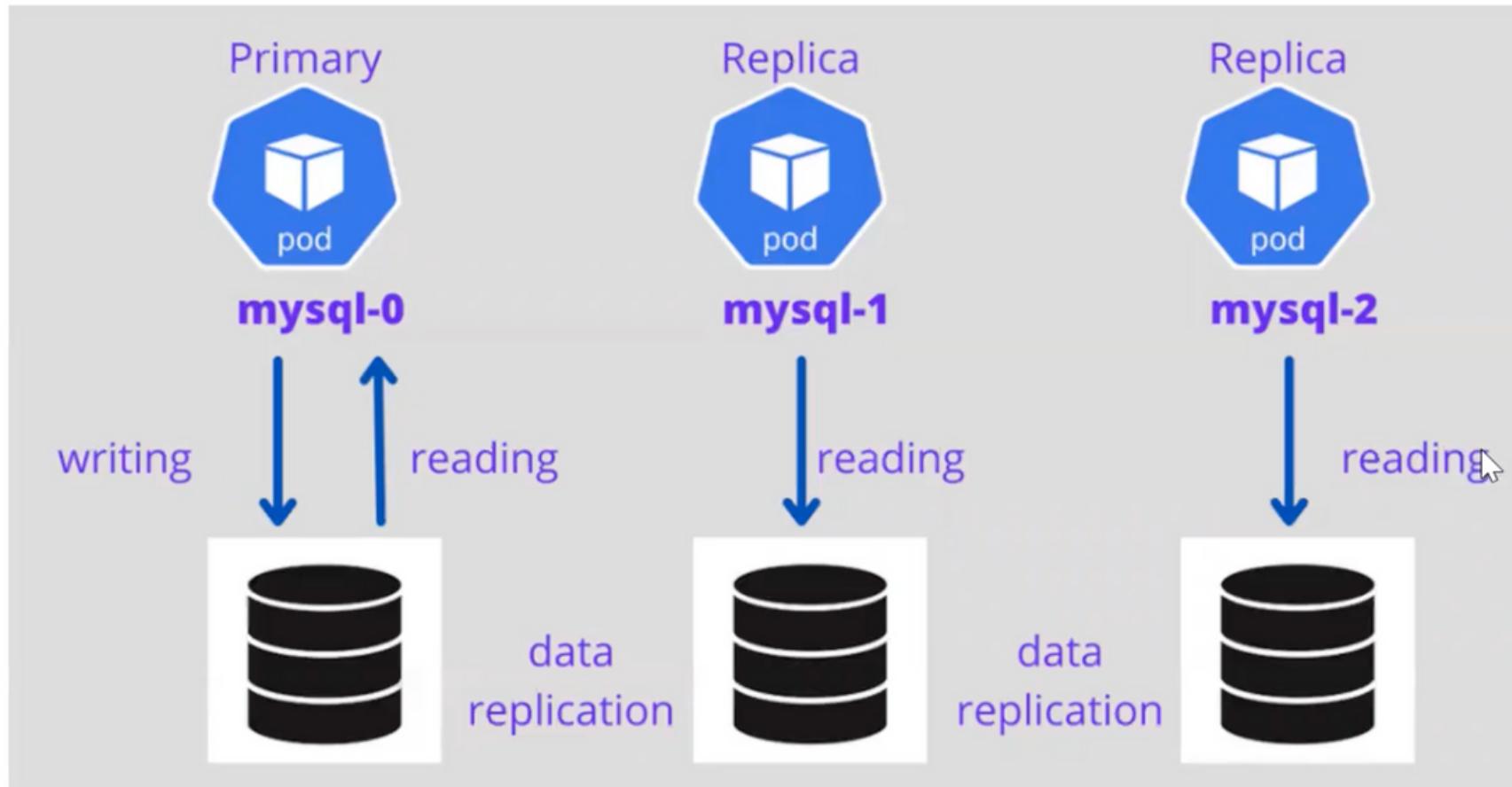
To get the code for stateful application use this link:

<https://github.com/devops0014/k8s-stateful-set-application.git>

STATEFUL SET

- A StatefulSet is the Kubernetes controller used to run the stateful application as containers (Pods) in the Kubernetes cluster.
- StatefulSets assign a sticky identity—an orginal number starting from zero-to each Pod instead of assigning random IDs for each replica Pod.
- A new Pod is created by cloning the previous Pod's data. If the previous Pod is in the pending state, then the new Pod will not be created.
- If you delete a Pod, it will delete the Pod in reverse order, not in random order.

StatefulSet



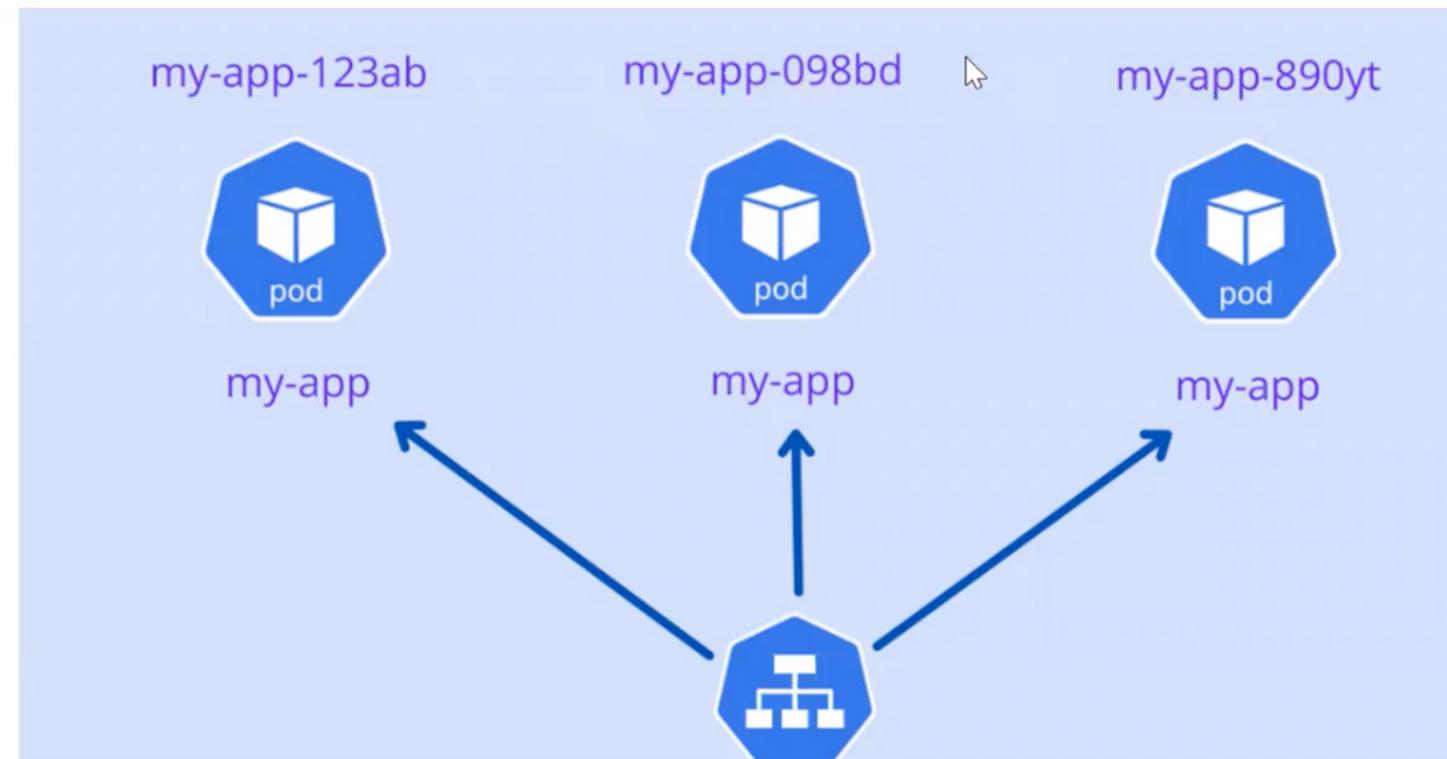
- Lets assume we deployed 3 replicas in a node,
- 1st pod is primary pod, remaining pods are secondary pods.
- Primary pod is having both read and write access
- But secondary pod is having only read access
- If we insert some data in primary pod, we can access the data from any pod i.e.. pod will share the data each other

DEPLOYMENT VS STATEFUL SET

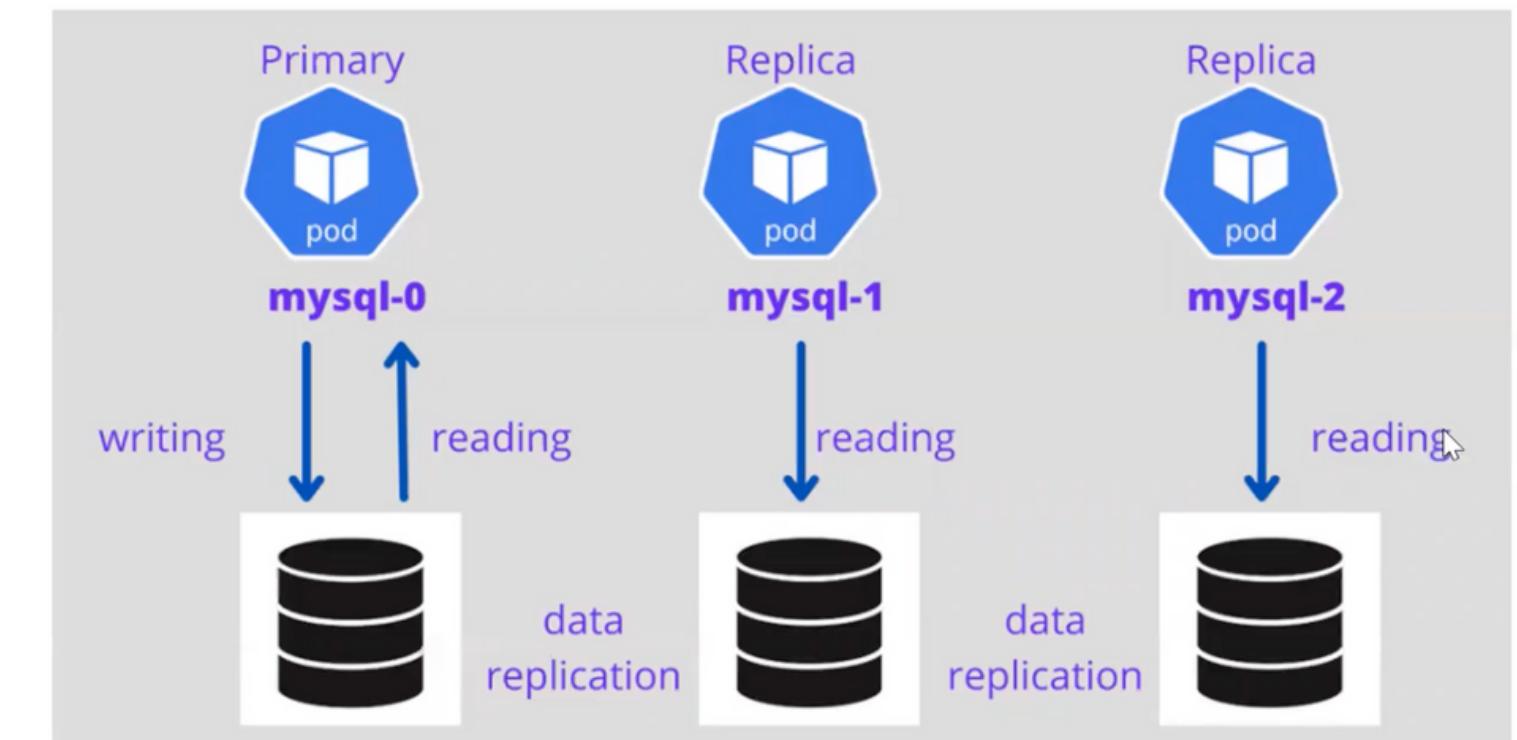
deployment cannot give the numbers or index for resources
but the stateful set will give the sticky identities called index numbers

when we delete pods in stateful set last pod will be deleted first
and primary pod deletes last

Deployment



StatefulSet



DEPLOYMENT

- It will create POD's with random ID's
- Scale down the POD's in random ID's
- POD's are stateless POD's
- We use this for application deployment

STATEFUL SET

- It will create POD's with sticky ID's
- Scale down the POD's in reverse order
- POD's are stateful POD's
- We use this for database deployment

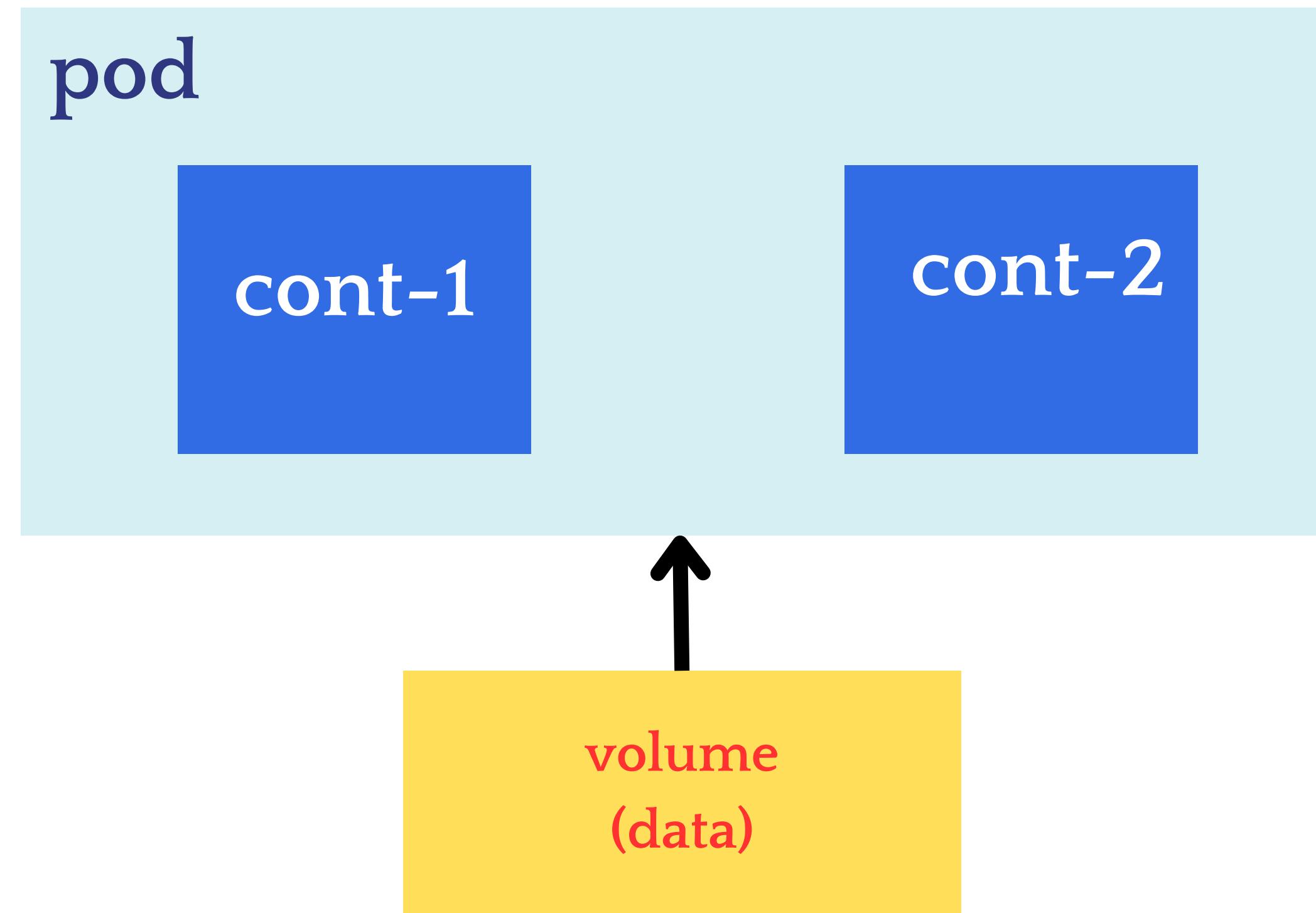
K8'S VOLUME AND LIVENESS PROBES:

Basically these K8's will works on short living data. So lets unveil the power of volumes like EmptyDir, HostPath, PV & PVC.

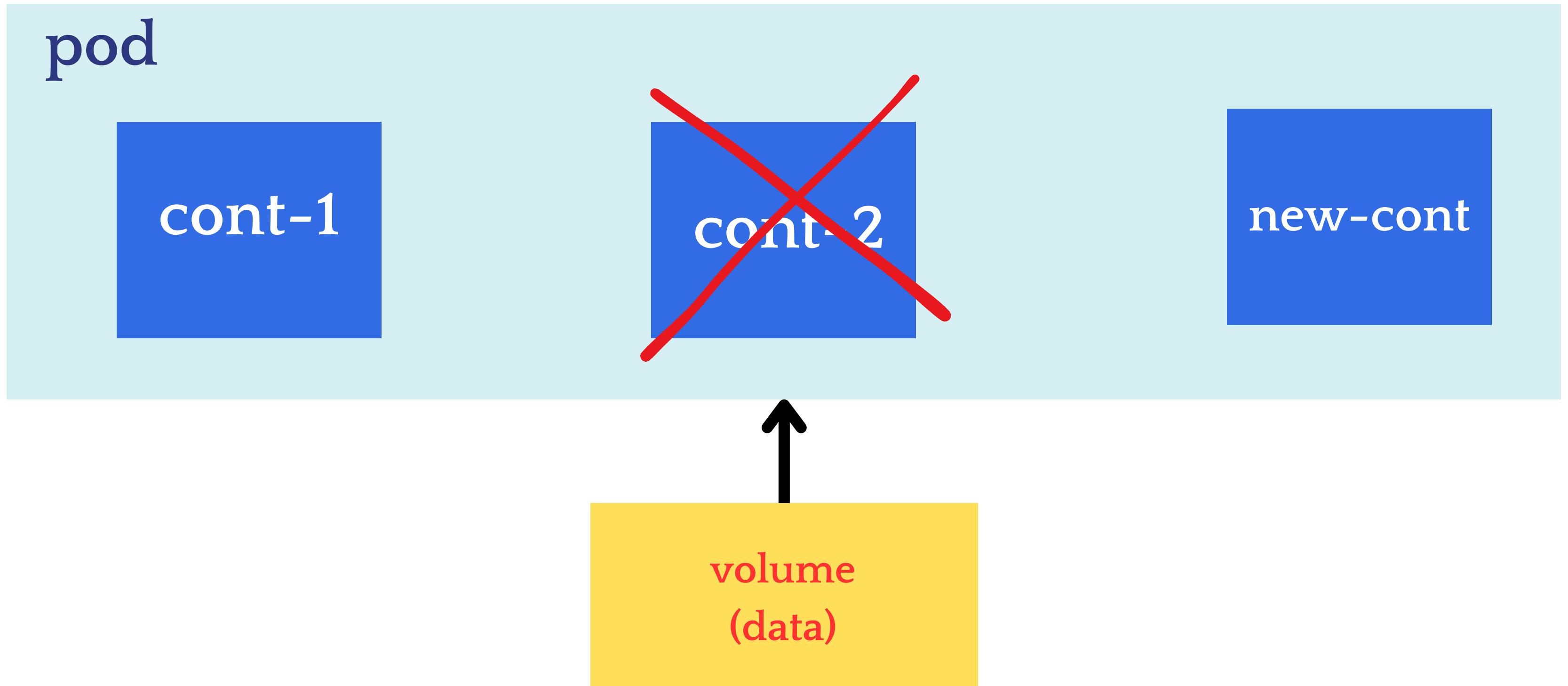
The data is a very important thing for an application. In K8's, data is kept for a short time in the applications in the pods/containers. By default the data will no longer available. To overcome this we will use Kubernetes Volumes.

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

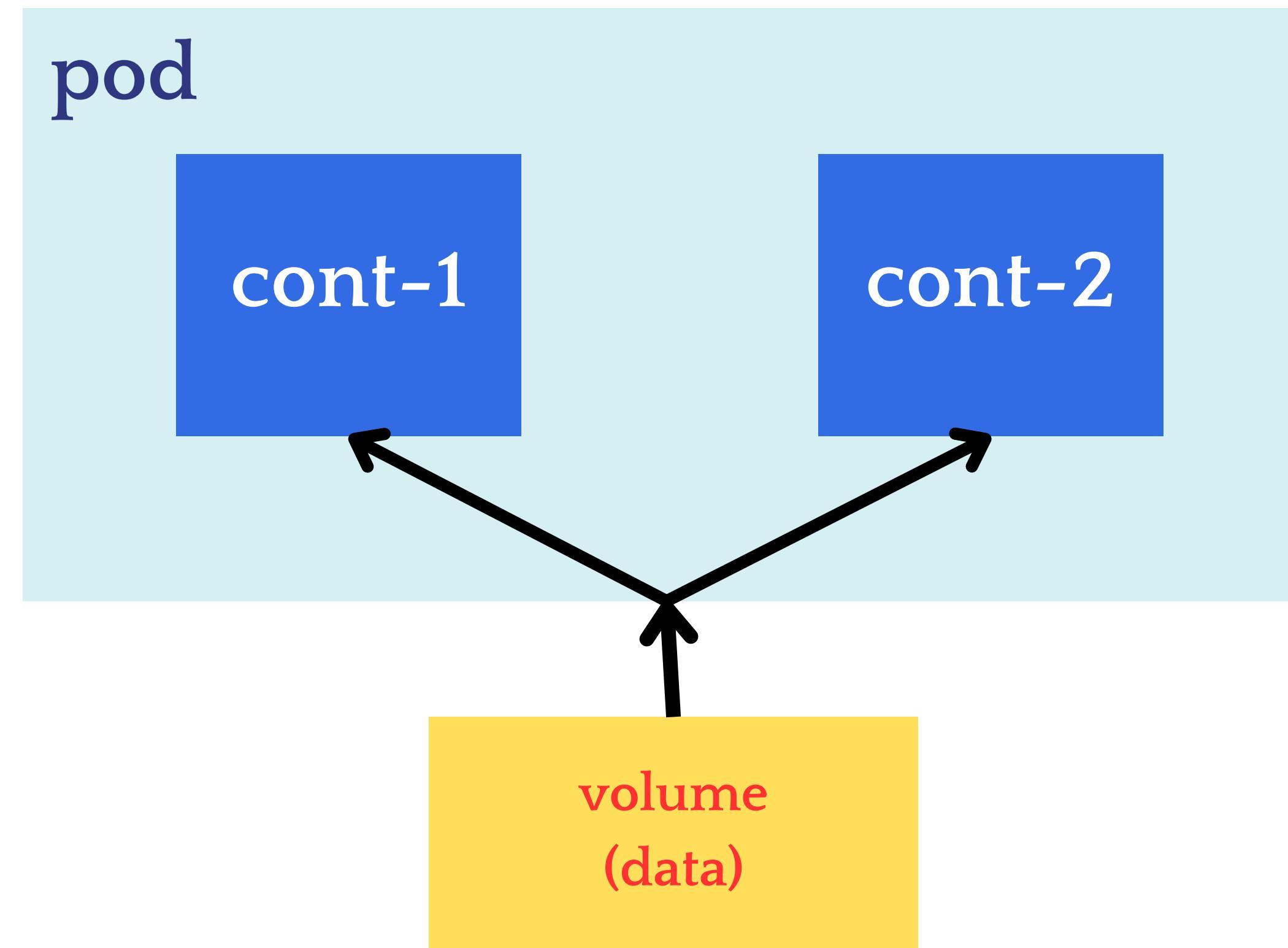
- The volumes reside inside the Pod which stores the data of all containers in that pod.



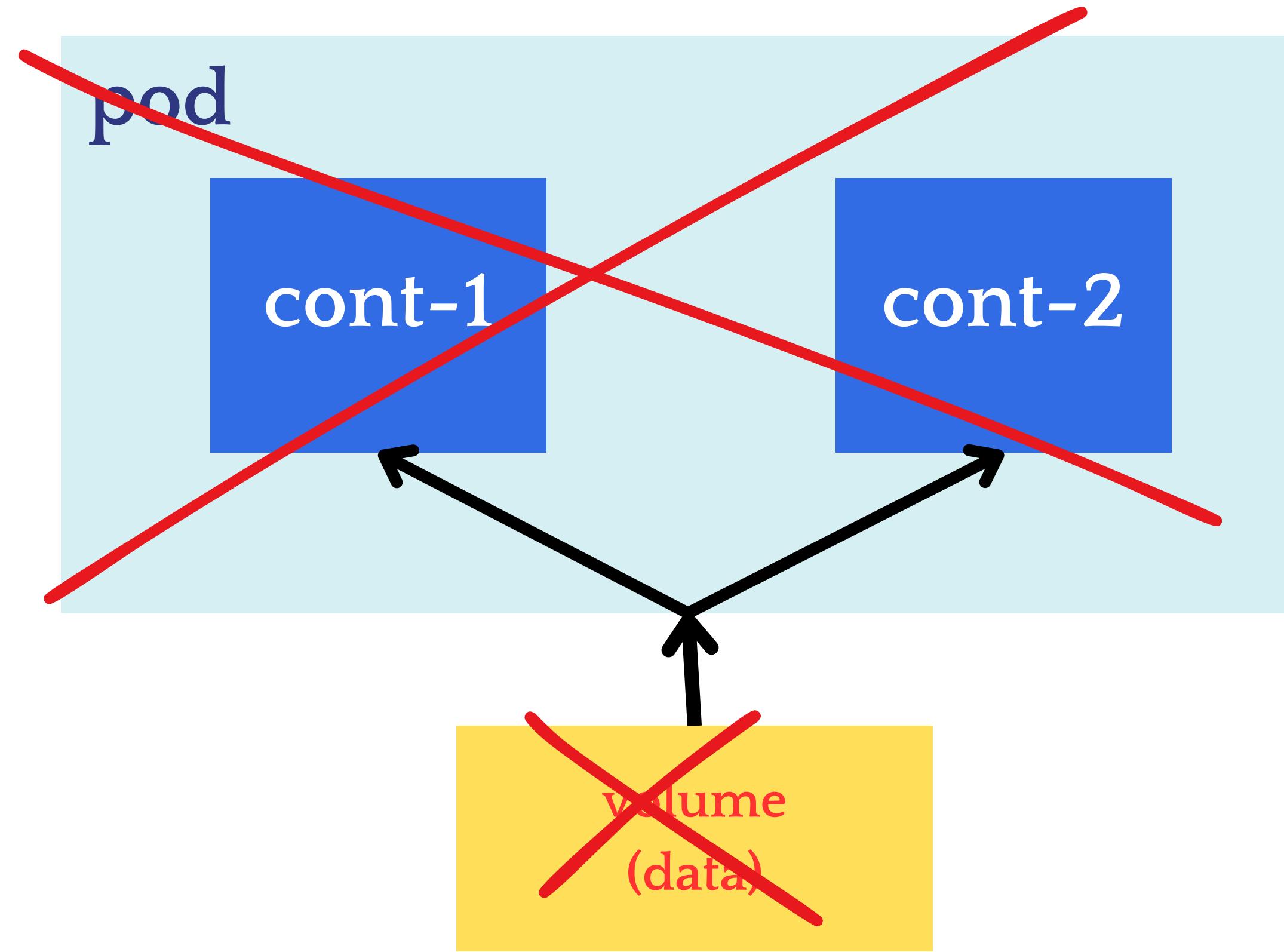
- If the container gets deleted, then the data will persist and it will be available for the new container which was created recently.



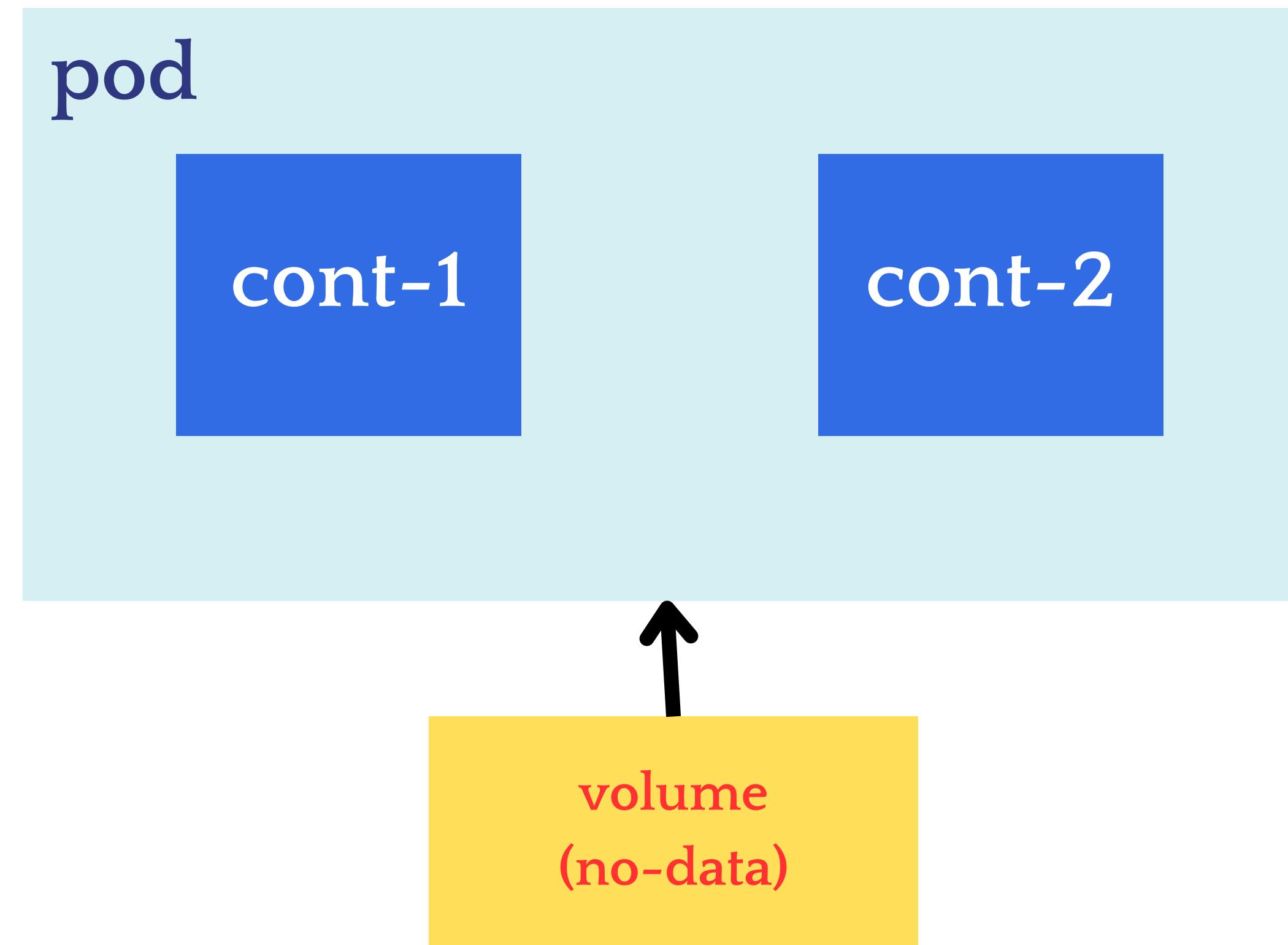
- Multiple containers within a pod can share one volume because the volume is attached to the pod.



- 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.



Types of volumes:

1. EmptyDir
2. HostPath
3. Persistent Volume
4. Persistent Volume Claim(PVC)

1. EMPTY DIR:

- This volume is used to share the data 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.

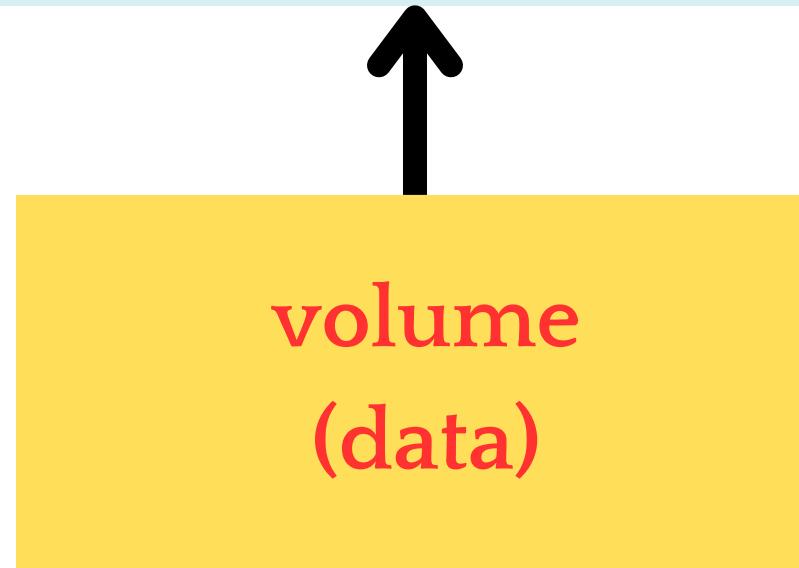
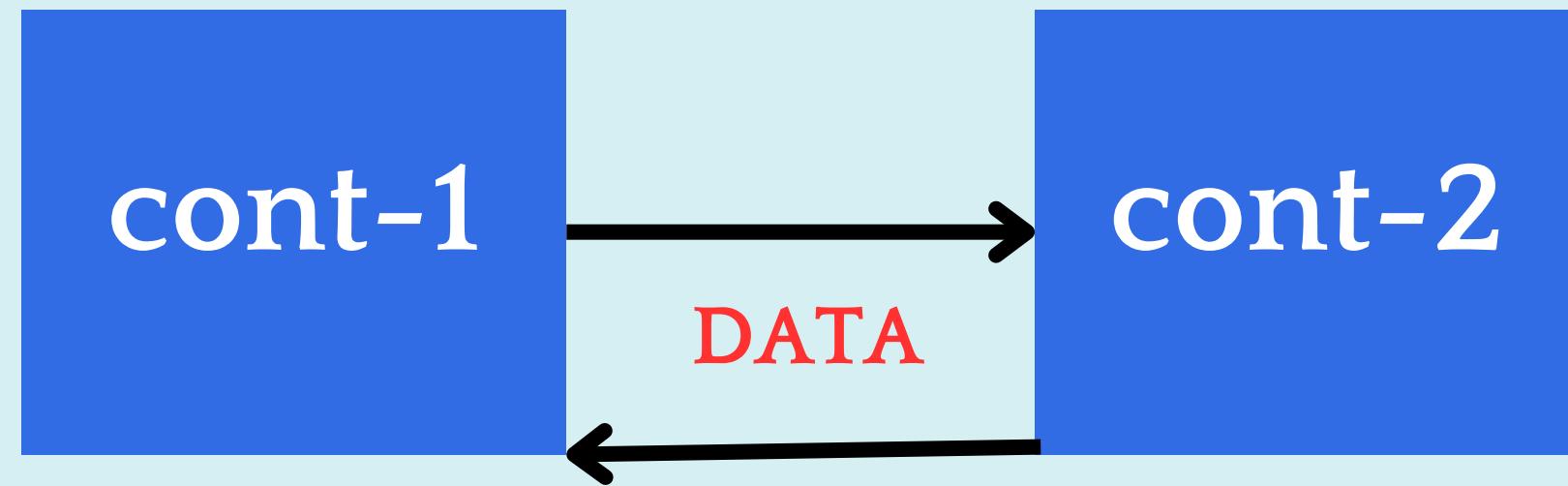
```
apiVersion: v1
kind: Pod
metadata:
  name: pod-1
spec:
  containers:
    - name: container1
      image: ubuntu
      command: ["/bin/bash", "-c", "while true; do echo Welcome to DevOps classes; sleep 5 ; done"]
      volumeMounts:
        - name: myvolume
          mountPath: "/tmp/container1"
    - name: container2
      image: centos
      command: ["/bin/bash", "-c", "while true; do echo This is Kubernetes classes; sleep 5 ; done"]
      volumeMounts:
        - name: myvolume
          mountPath: "/tmp/container2"
  volumes:
    - name: myvolume
      emptyDir: {}
```

In the above file, it will creates 2 containers inside a pod. if you create a file in any container, then the file will be available on both the containers.

docker exec -it pod-1 -c container1 /bin/bash

By using the above command create a file in cont-1 and it will be available on cont-2 as well

Pod



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).

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

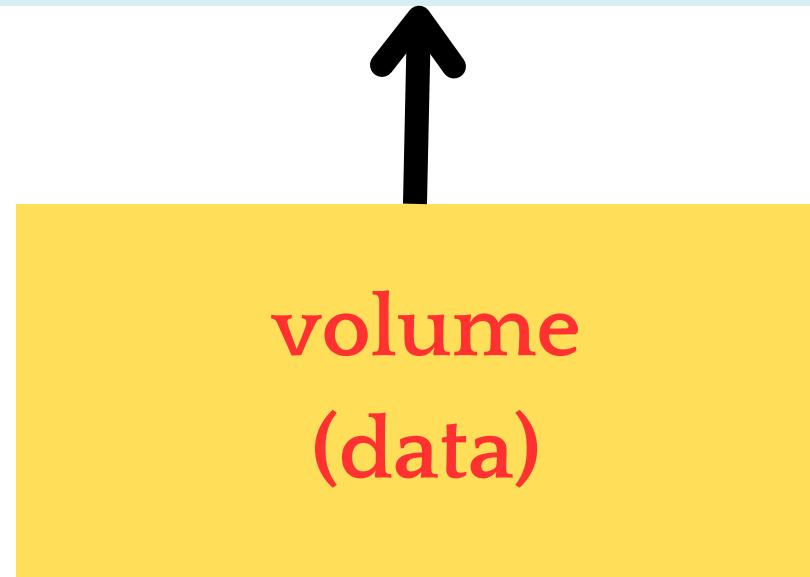
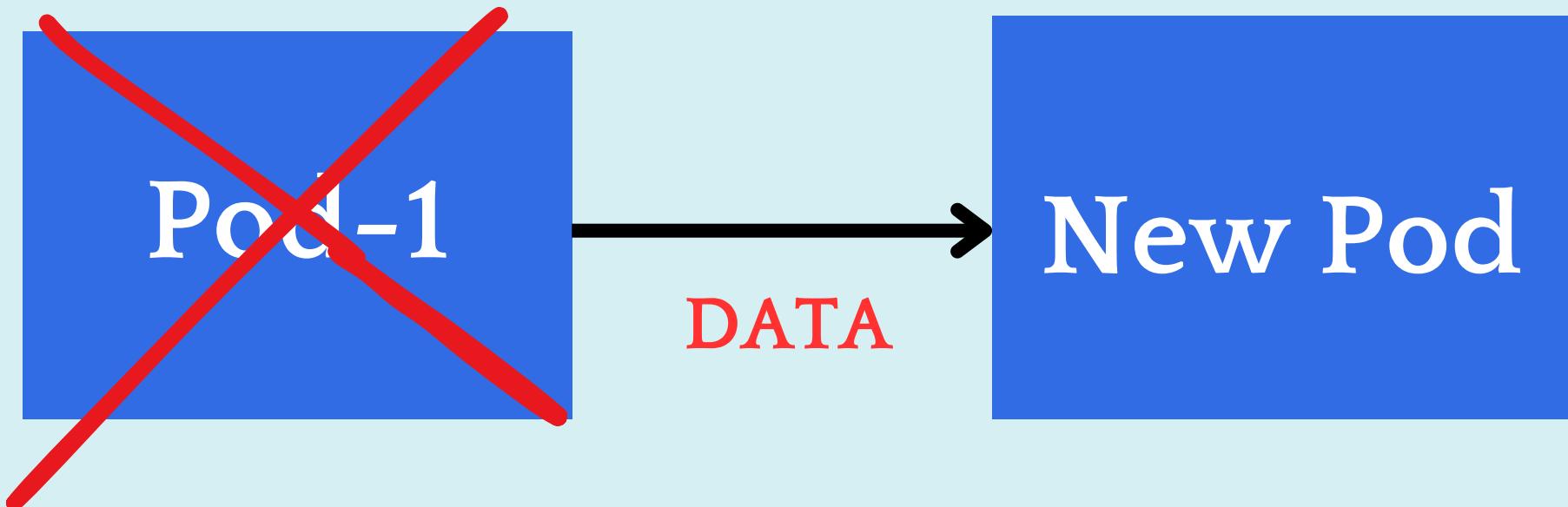
In the above file, it will creates a pod. if you create a file in container, by using the command

docker exec -it pod-1 -c container1 /bin/bash

file will gets created. Now even if you delete the pod then another pods will gets created with same data.

Because we are using HostPath which creates local volume in our host machine.

Host



PERSISTENT VOLUME:

- Persistent means always available.
- 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.
- PVs are independent of the pod lifecycle, which means they can exist even if no pod is using them.
- With the help of Persistent Volume, the data will be stored on a central location such as EBS, Azure Disks, etc.

PERSISTENT VOLUME:

- 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.
- In K8S, a PV is a piece of storage in the cluster that has been provisioned by an administrator.
- If you want to use Persistent Volume, then you have to claim that volume with the help of the manifest YAML file.
- When a pod requests storage via a PVC, K8S will search for a suitable PV to satisfy the request.
- If a PV is found that matches the request, the PV is bound to the PVC and the pod can use the storage.
- If no suitable PV is found, K8S then PVC will remain unbound (pending).

PERSISTENT VOLUME CLAIM:

- 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.
- After bounding is done to pod you can mount it as a volume. The pod specifies the amount and type of storage it needs, and the cluster provisions a persistent volume that matches the request. If its not matches then it will be in pending state.

FACTS ABOUT EBS:

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

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 is visible, containing fields for Volume type (set to 'General Purpose SSD (gp2)'), Size (set to 20 GiB), IOPS (set to 100 / 3000), Throughput (set to Not applicable), Availability Zone (set to 'us-east-1c'), and Encryption (unchecked). Below this, the 'Tags - optional' section shows no tags associated with the resource, with an 'Add tag' button available. At the bottom, there are 'Cancel' and 'Create volume' buttons, with 'Create volume' being highlighted in orange.

Now, copy the volume ID and paste it into the PV YML file

PV file:

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: myebsvol
spec:
  capacity:
    storage: 1Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Recycle
  awsElasticBlockStore:
    volumeID: vol-0a0232b56c59cc682
    fsType: ext4
```

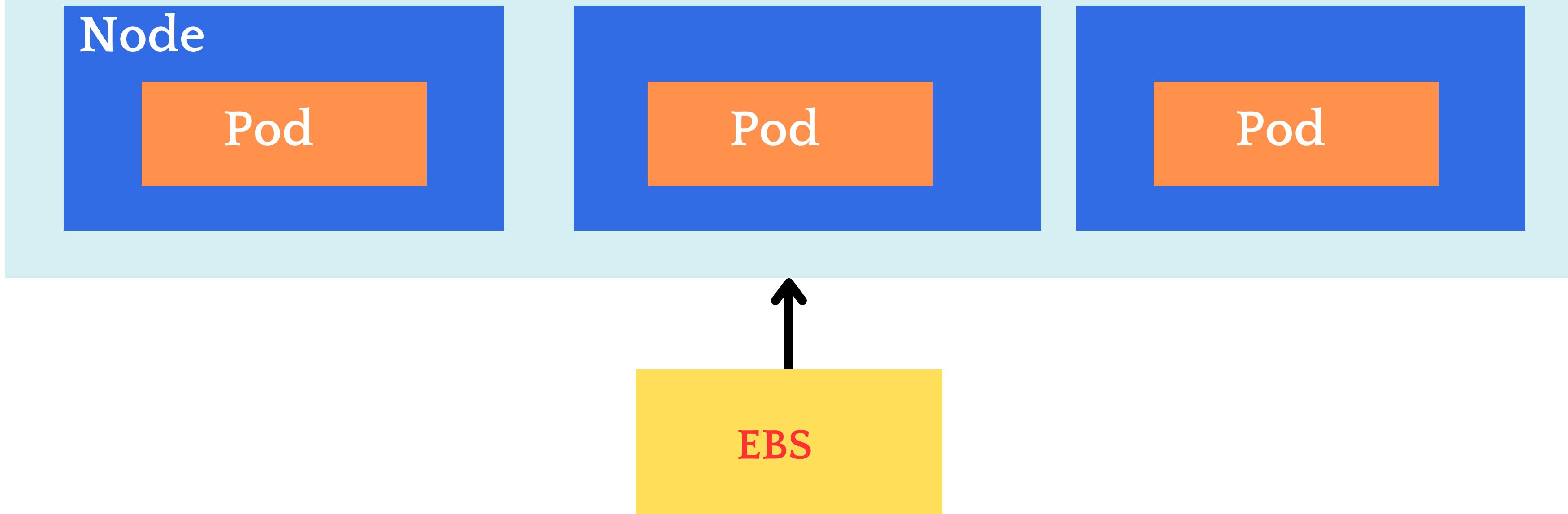
PVC file:

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: myebsvolclaim
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
```

```
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
```

we have logged in to the created container (**kubectl exec -it pod_name -c shell /bin/bash**) and created one file with some text.

Cluster



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.

vim pvc.yml

vim pv.yml

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: my-pv
spec:
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  awsElasticBlockStore:
    volumeID: vol-oe5bdf9400dbb7b57
    fsType: ext4
```

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: my-pvc
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 10Gi
```

kubectl apply -f pv.yml
kubectl apply -f pvc.yml
kubectl get pv,pvc

vim deploy.yml

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

```
kubectl apply -f deploy.yml
kubectl get deploy
kubectl get rs
kubectl get po
```

```
kubectl exec pvdeploy-86c99cf54d-d8rj4 -it -- /bin/bash
cd /tmp/persistent/
ls
vim raham
exit
```

now delete the pod and new pod will created then in that pod you will see the same content.

Access Modes

access modes determine how many pods can access a Persistent Volume (PV) or a Persistent Volume Claim (PVC) simultaneously. There are several access modes that can be set on a PV or PVC, including:

- **ReadWriteOnce**: This access mode allows a single pod to read and write to the PV or PVC. This is the most common access mode, and it's appropriate for use cases where a single pod needs exclusive access to the storage.
- **ReadOnlyMany**: This access mode allows multiple pods to read from the PV or PVC, but does not allow any of them to write to it. This access mode is useful for cases where many pods need to read the same data, such as when serving a read-only database.
- **ReadWriteMany**: This access mode allows multiple pods to read and write to the PV or PVC simultaneously. This mode is appropriate for use cases where many pods need to read and write to the same data, such as a distributed file system.
- **Execute**: This access mode allows the pod to execute the data on the PV or PVC but not read or write to it. This mode is useful for use cases where the data is meant to be executed by the pods only, such as application code.

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.

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

- Once you create a pod, then describe this pod using **kubectl describe pod pod-name**
- After that enter into the pod **kubectl exec -it pod_name -c cont_name /bin/bash**
- Check the file is created or not using **cat /tmp/healthy**
- Now check the health status **echo \$?** If it returns 0 then application is running into the container.
- 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.
- 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.

KUBERNETES INGRESS:

- Ingress helps to expose the HTTP and HTTPS routes from outside of the cluster.
- Ingress supports
 - Path-based
 - Host-based routing
- Ingress supports Load balancing and SSL termination.
- 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.

WHY DO WE USE INGRESS BECAUSE THE LOAD BALANCER SUPPORTS THE SAME THING?

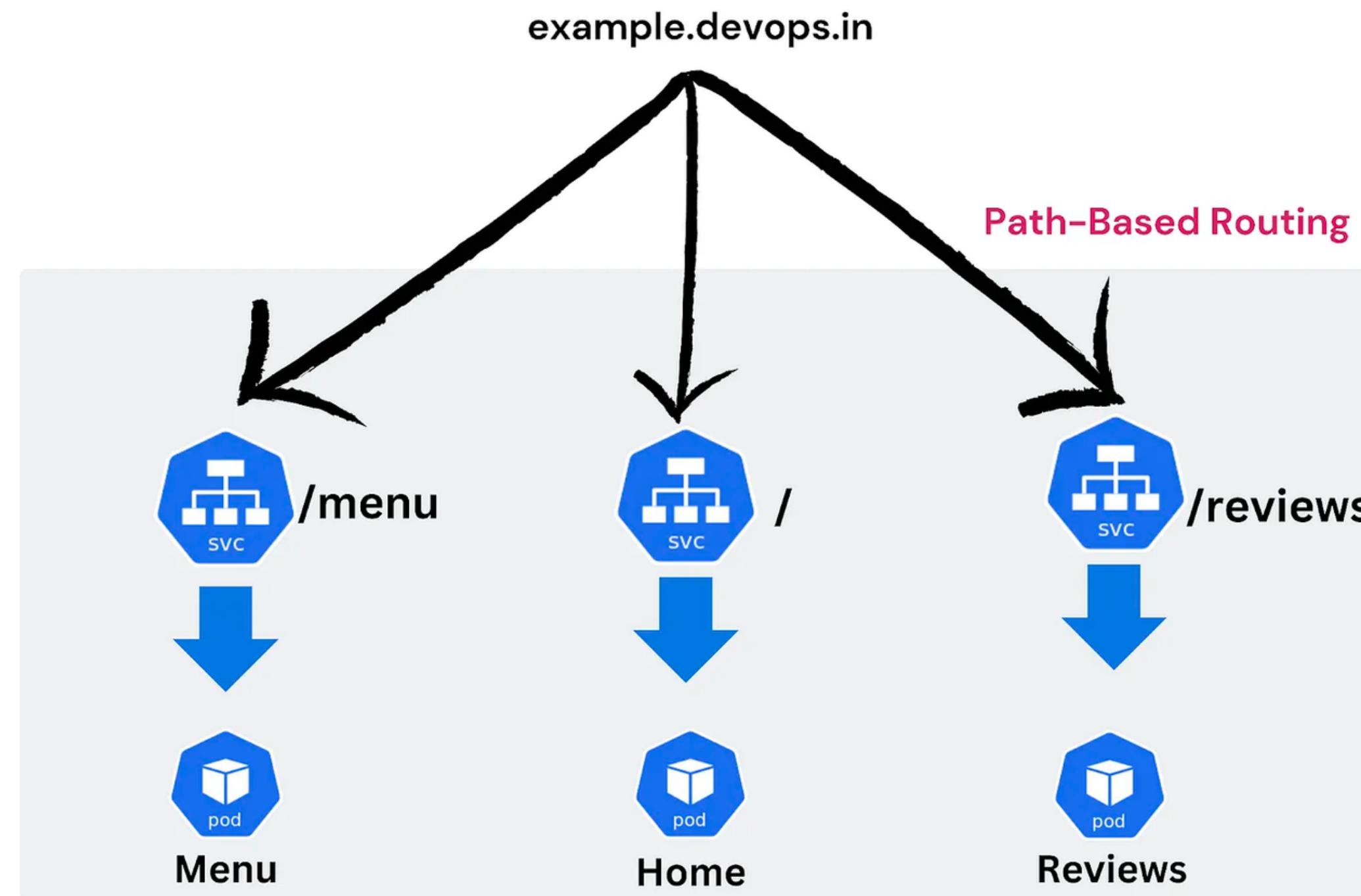
- Ingress is used to manage the external traffic to the services within the cluster which provides features like host-based routing, path-based routing, SSL termination, and more. Where a Load balancer is used to manage the traffic but the load balancer does not provide the fine-grained access control like Ingress.

Example:

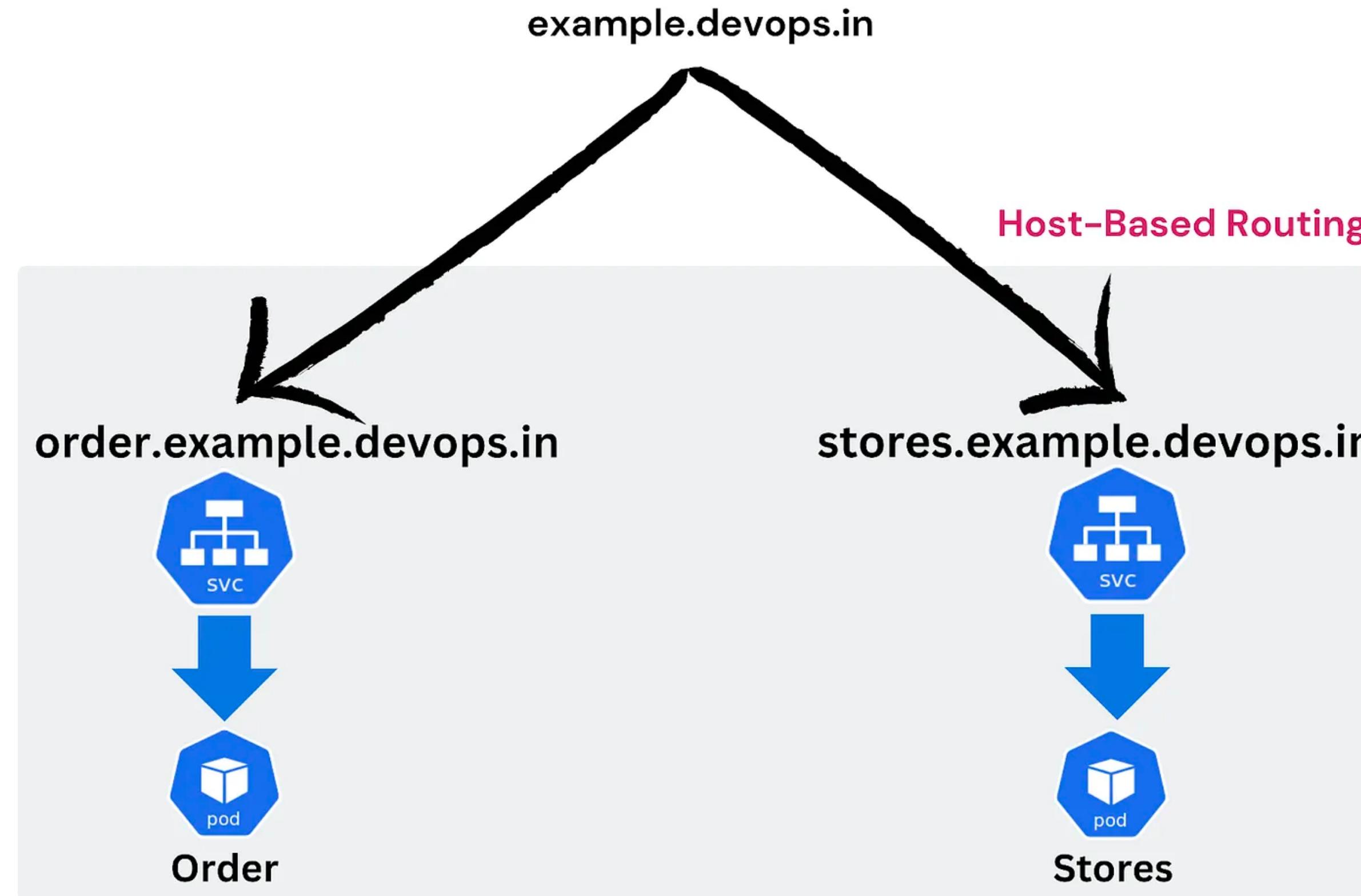
- Suppose you have multiple Kubernetes services running on your cluster and each service serves a different application such as example.com/app1 and example.com/app2. With the help of Ingress, you can achieve this. However, the Load Balancer routes the traffic based on the ports and can't handle the 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 install ingress, firstly we have to install nginx ingress controller:

command: `kubectl create -f https://raw.githubusercontent.com/kubernetes/ingress-nginx/controller-v1.2.1/deploy/static/provider/cloud/deploy.yaml`

Once we install ingress controller, we have to deploy 2 applications.

github url: <https://github.com/mustafaprojectsindevops/kubernetes/tree/master/ingress>

After executing all the files, use `kubectl get ing` to get ingress. After 30 seconds it will provide one load balancer dns.

access those applications using dns/nginx and dns/httpd. So the traffic will route into both the applications as per the routing

one.yaml

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: one
spec:
  replicas: 2
  selector:
    matchLabels:
      app: swiggy
  template:
    metadata:
      labels:
        app: swiggy
  spec:
    containers:
      - name: cont-1
        image: nginx
      ports:
        - containerPort: 80
      env:
        - name: TITLE
          value: "NGINX APP1"
---
apiVersion: v1
kind: Service
metadata:
  name: nginx
spec:
  type: NodePort
  ports:
    - port: 80
  selector:
    app: swiggy
```

two.yaml

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: two
spec:
  replicas: 2
  selector:
    matchLabels:
      app: zomato
  template:
    metadata:
      labels:
        app: zomato
  spec:
    containers:
      - name: cont-2
        image: httpd
      ports:
        - containerPort: 80
      env:
        - name: TITLE
          value: "APACHE APP2"
---
apiVersion: v1
kind: Service
metadata:
  name: httpd
spec:
  type: NodePort
  ports:
    - port: 80
  selector:
    app: zomato
```

ingress.yaml

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: k8s-ingress
  annotations:
    nginx.ingress.kubernetes.io/ssl-redirect: "false"
    nginx.ingress.kubernetes.io/use-regex: "true"
    nginx.ingress.kubernetes.io/rewrite-target: /$2
spec:
  ingressClassName: nginx
  rules:
    - http:
        paths:
          - path: /nginx(/|$)(.*)
            pathType: Prefix
            backend:
              service:
                name: nginx
                port:
                  number: 80
          - path: /httpd(/|$)(.*)
            pathType: Prefix
            backend:
              service:
                name: httpd
                port:
                  number: 80
        - path: /(.*)
          pathType: Prefix
          backend:
            service:
              name: nginx
              port:
                number: 80
```


FINAL PROJECT:

- CREATE A CLUSTER IN KOPS WITH 1 MASTER & 2 WORKERS
- CREATE A NAME SPACE
- CREATE A DEPLOYMENT WITHIN THE NAMESPACE
- INCREASE THE REPLICAS
- EXPOSE IT USING NODE PORT
- ACCESS THE APPLICATION