Kubernetes API Overview and resources

Table of Content

Pods

Kubernetes: Pods

- The smallest unit that can be scheduled to be deployed through K8s is called a *pod*.
- Homogeneous group of containers.
- This group of containers would share storage, Linux namespaces, cgroups, IP addresses. These are co-located, hence share resources and are always scheduled together.
- Pods are not intended to live long. They are created, destroyed and re-created on demand, based on the state of the server and the service itself.

- Containers in a pod share
  - IP address and port space
  - Filesystem
  - Storage (Volumnes)
  - Labels
  - Secrets

Kubernetes: Pods

Pods Are...

- Ephemeral, disposable
- Never self-heal, and not restarted by the scheduler by itself
- Never create pods just by themselves
- Always use higher-level constructs

Kubernetes: Pod States

- **Pending** (request accepted, one or more containers are still being created)
- **Running** (Pod has been bound to a node, all of the Containers have been created. At least one Container is still running, or is in the process of starting or restarting.)
- **Succeeded** (All Containers in the Pod have terminated in success, and will not be restarted)
- **Failed** (All Containers in the Pod have terminated, and at least one container has terminated with some failure)
- **CrashLoopBackOff** (pod starting, crashing, starting again, and then crashing again.)

pod.yml

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

pod.json

```json
{
"kind":"Pod",
"apiVersion":"v1",
"metadata":{"name":"nginx","labels":{"name":"nginx"}},
"spec":{"containers":[{"name":"nginx","image":"nginx","ports":[
{"containerPort":80}]}]}
}
```

*** Delete this pod, it **won't** get re-created automatically*

```
root@ip-172-31-32-172:~/code# kubectl get pods -o wide
No resources found.
root@ip-172-31-32-172:~/code# kubectl create -f pod.json
pod/nginx created
root@ip-172-31-32-172:~/code# kubectl get pods -o wide
NAME    READY   STATUS    RESTARTS   AGE   IP           NODE                NOMINATED NODE   READINESS GATES
nginx   1/1     Running   0          7s    10.32.0.4    ip-172-31-32-172    <none>           <none>
root@ip-172-31-32-172:~/code# kubectl delete -f pod.json
pod "nginx" deleted
root@ip-172-31-32-172:~/code# kubectl get pods -o wide
No resources found.
root@ip-172-31-32-172:~/code#
```

Controllers

Controllers

- Kubernetes contains a number of higher-level abstractions called **Controllers**. Controllers build upon the basic objects, and provide additional functionality and convenience features.

They are

- **ReplicationController**
- **ReplicaSet**
- **Deployment**
- DaemonSet – used for specific purpose
- Job
- CronJob

Replication Controller

- The original form of replication in Kubernetes. Its now preferred to use Replicate Sets via a Deployment
- Ensures that a specified number of pod replicas are running at any one time. If a pod does crash, the Replication Controller replaces it.
- Allows you to scale the number of pods, and to update or delete multiple pods with a single command.

Replication Controller

```
apiVersion: v1
kind: ReplicationController
metadata:
  name: testrc
spec:
  replicas: 3
  selector:
    app: webserver
  template:
    metadata:
      name: testrc
      labels:
        app: webserver
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
```

- This file says:
  - We need to have 3 replicas of this Pod
  - The Pod has 1 container (image: nginx)
- Create the Replication controller:
  - kubectl create -f rc.yaml

Replication Controller

```
$ kubectl create -f rc.yml
replicationcontroller/testrc created
$ kubectl describe rc testrc
Name:         testrc
Namespace:    default
Selector:     app=webserver
Labels:       app=webserver
Annotations:  <none>
Replicas:     3 current / 3 desired
Pods Status:  3 Running / 0 Waiting / 0 Succeeded / 0 Failed
Pod Template:
  Labels:  app=webserver
  Containers:
   nginx:
    Image:        nginx:latest
    Port:         80/TCP
    Host Port:    0/TCP
    Environment:  <none>
    Mounts:       <none>
  Volumes:        <none>
Events:
  Type    Reason            Age   From                    Message
  ----    ------            ----  ----                    -------
  Normal  SuccessfulCreate  24s   replication-controller  Created pod: testrc-nwh7b
  Normal  SuccessfulCreate  24s   replication-controller  Created pod: testrc-mq599
  Normal  SuccessfulCreate  24s   replication-controller  Created pod: testrc-z2js6
$
```

Replica-set

Replica Set

- It is essentially the same as Replication Controller except that it has more options for selector:
  - matchLabels
  - matchExpressions
- Replica set doesn’t support rolling update, instead use deployment

Replica Set

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

- This Replica Set has the same rules as the Replication Controller in the previous slide.
- This file says:
  - We need to have 3 replicas of this Pod
  - The Pod has 1 container (image: nginx)
- Create the Replication controller:
  - kubectl create -f rs.yaml

Replica Set

```
$ kubectl create -f rs.yml
replicaset.apps/testrs created
$ kubectl describe rs testrs
Name:         testrs
Namespace:    default
Selector:     app=webserver
Labels:       <none>
Annotations:  <none>
Replicas:     3 current / 3 desired
Pods Status:  3 Running / 0 Waiting / 0 Succeeded / 0 Failed
Pod Template:
  Labels:  app=webserver
  Containers:
   nginx:
    Image:        nginx:latest
    Port:         80/TCP
    Host Port:    0/TCP
    Environment:  <none>
    Mounts:       <none>
  Volumes:        <none>
Events:
  Type    Reason            Age   From                   Message
  ----    ------            ----  ----                   -------
  Normal  SuccessfulCreate  35s   replicaset-controller  Created pod: testrs-5bgpg
  Normal  SuccessfulCreate  35s   replicaset-controller  Created pod: testrs-c775f
  Normal  SuccessfulCreate  35s   replicaset-controller  Created pod: testrs-z5rxh
$
```

Replica Set – match labels and expressions

```
  spec:
    replicas: 3
    selector:
      matchLabels:
        app: soaktestrs
```

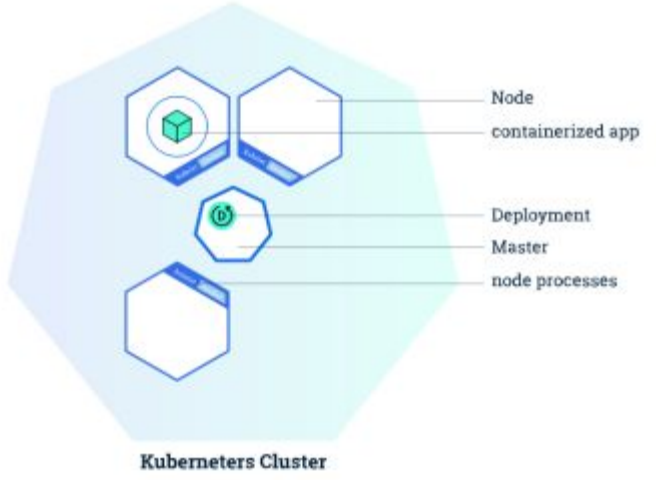
```
spec:
   replicas: 3
   selector:
     matchExpressions:
      - {key: app, operator: In, values: [soaktestrs, soaktestrs,
      - {key: teir, operator: NotIn, values: [production]}
```

Deployments

Kubernetes: Deployments

Allows you to deploy a (self-healing) instance of an application.

- Self Healing: Continuously monitors and replaces instances if necessary
- Provides declarative updates for Pods and Replica Sets
  - Updates actual state to desired state at a controlled rate
  - For example: Current state is 3 instances of Tomcat. Desired state is 5 instances of Tomcat -> Create 2 more instances of Tomcat



dep.yml

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

```
root@ip-172-31-68-96:~/code# kubectl create -f dep.yml
deployment.apps/nginx-deployment created
root@ip-172-31-68-96:~/code# kubectl get pods,deployments
NAME                                    READY     STATUS    RESTARTS   AGE
pod/nginx-apparmor                      1/1       Running   0          52s
pod/nginx-deployment-67594d6bf6-7jc78   1/1       Running   0          11s
pod/nginx-deployment-67594d6bf6-tf5df   1/1       Running   0          11s
pod/nginx-deployment-67594d6bf6-xzwww   1/1       Running   0          11s

NAME                                   DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
deployment.extensions/nginx-deployment   3         3         3            3           11s
root@ip-172-31-68-96:~/code#
```

Kubectl create/apply

- kubectl create -f <yaml_file>
- kubectl create -f <yaml_file_1> -f <yaml_file_2>
- kubectl create -f <json_file>
- kubectl create -f <url_name>
- kubectl create -f <directory_name>

- **kubectl create** tell the Kubernetes API what you want to create, replace or delete. It's a imperative approach and good if single person is working in the team.
- **kubectl apply** – apply changes to a live object. It's a declarative approach and good when you want to maintain versions

Lab (rc, rs, deploy)

- Exercise to create Replication Controllers, Replica Sets and Deployments and describe their functions
- Check the results and describe the objects

git clone https://github.com/abhikbanerjee/kubernetes_teach_git

cd kubernetes_teach_git/ex1/

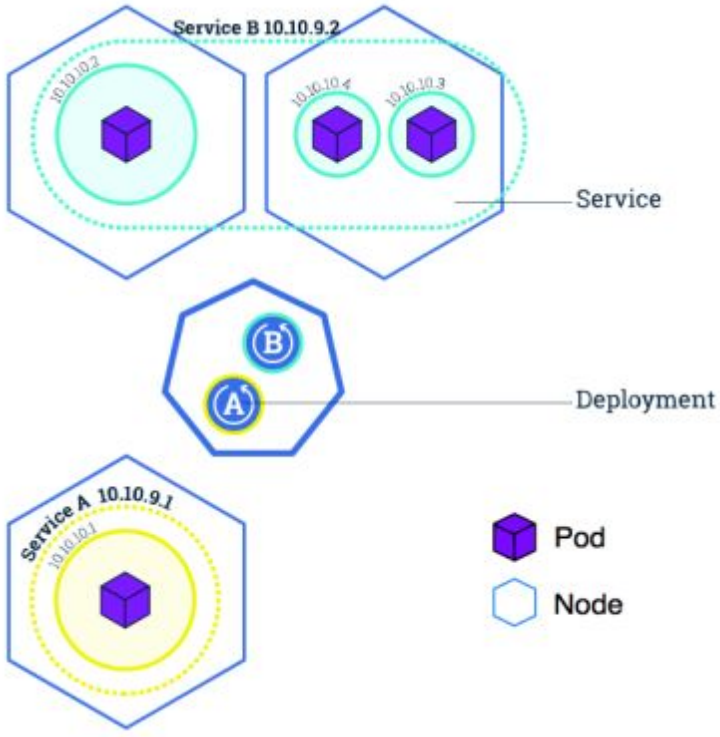
https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex1/rc_rs_deployment.md

Services

Kubernetes: Service

Abstraction regarding a set of pods which enables load balancing, traffic exposure, load balancing and service discovery.

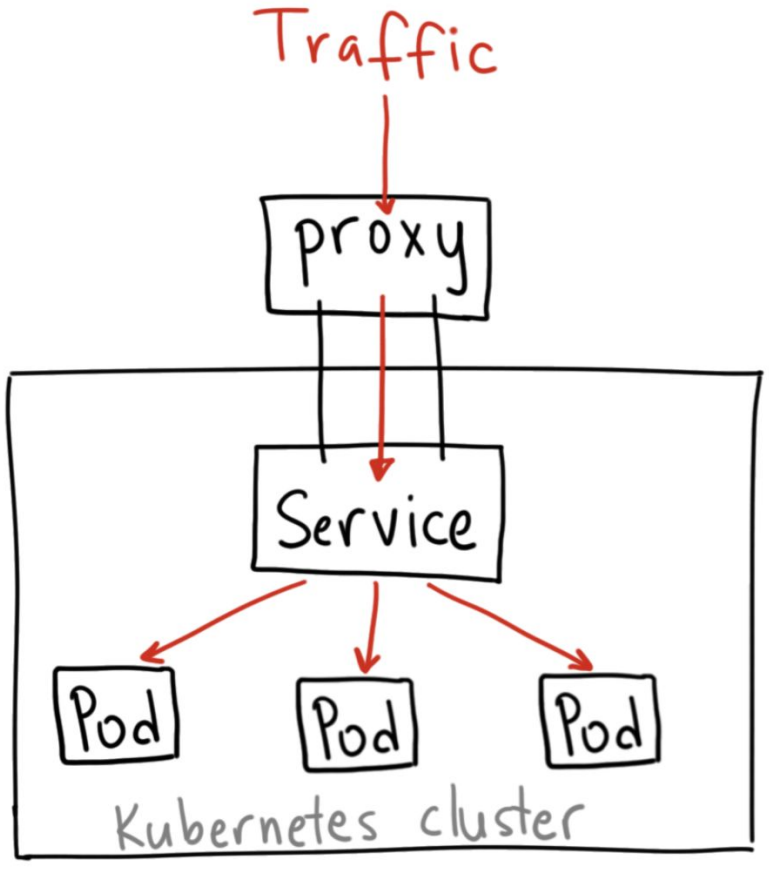
- pods to die and replicate in Kubernetes without affecting your application.
- Enable loose coupling between different Pods.
- Provides a **stable** virtual IP and port
- Services allow Pods to receive traffic.
  - Each Pod has a unique IP but those IP addresses are not exposed outside the Pod without a service.



ClusterIP Service

Cluster IP

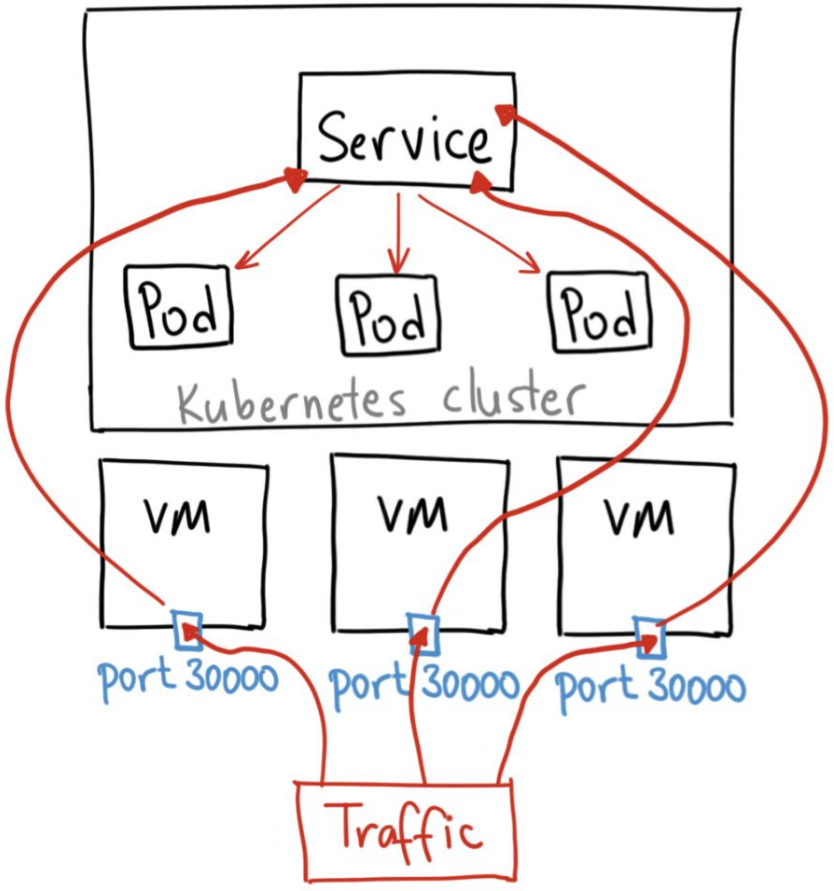
- Expose the service on a cluster-internal IP
- Default Kubernetes Service
- Using this makes the service only reachable from within the cluster (no external access)
- Access through proxy



NodePort Service

NodePort

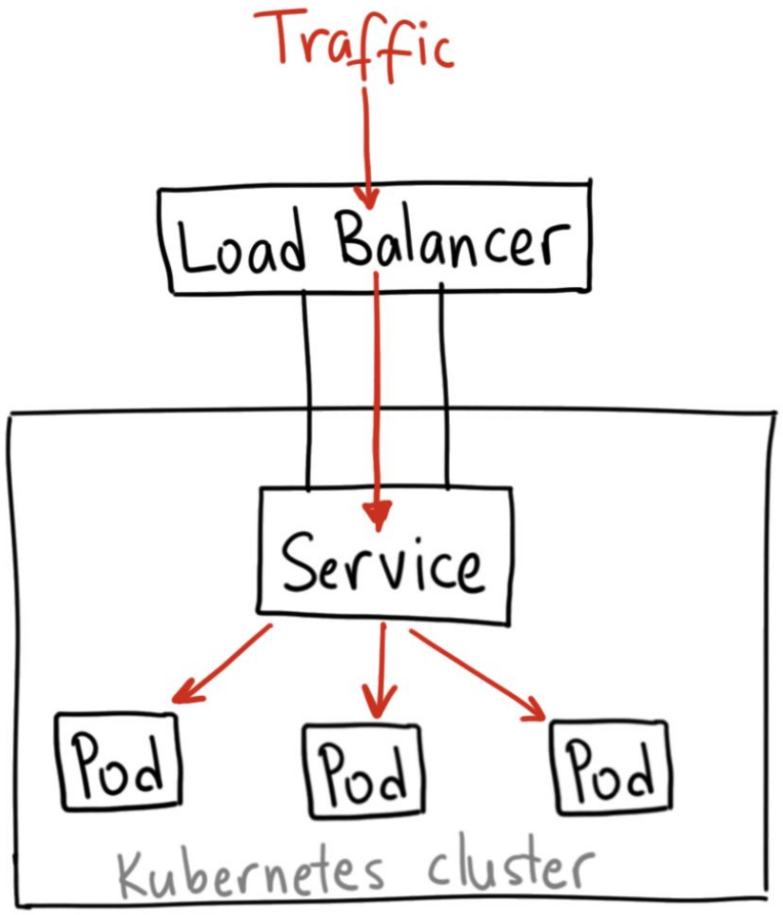
- Opens a specific port on all the Nodes (the VMs)
- Traffic that is sent to this port is forwarded to the service.
- One service per port, only use ports 30000–32767



LoadBalancer Service

Load Balancer

- Spin up a Network Load Balancer that provides a single IP address that will forward all traffic to your service



** kubernetes does not offer an implementation of network load-balancers for bare metal clusters.
The implementations of Network LB that Kubernetes does ship with are all glue code that calls out to various cloud platforms (GCP, AWS, Azure…). If you're not running on a supported cloud platform; LoadBalancer will remain in the "pending" state indefinitely when created.

```
root@ip-172-31-68-96:~# kubectl get svc
NAME         TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
kubernetes   ClusterIP   10.96.0.1    <none>        443/TCP   37m
root@ip-172-31-68-96:~#
root@ip-172-31-68-96:~# kubectl expose deployment nginx-deployment
--type=LoadBalancer --name=nginx-service
service/nginx-service exposed
root@ip-172-31-68-96:~#
root@ip-172-31-68-96:~# kubectl get svc
NAME            TYPE           CLUSTER-IP     EXTERNAL-IP   PORT(S)        AGE
kubernetes      ClusterIP      10.96.0.1      <none>        443/TCP        37m
nginx-service   LoadBalancer   10.102.89.83   <pending>     80:31095/TCP   3s
root@ip-172-31-68-96:~#
```

Lab (Services)

- For all the concepts discussed until now
- Create pods, Services, Deployments
- Various ways to use the create command

We already have the git repo cloned in our machines.

$$ cd to the ex2

https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex2/pod_deploy_service.md

Kubernetes Popular commands

- **kubectl get** - list resources about a target.
  - kubectl get services, kubectl get pods
- **kubectl describe** - show basic information about a resource
  - kubectl describe pods my-pod
- **kubectl logs** - print the logs from a container in a pod. Extremely useful
  - kubectl logs my-pod
- **kubectl exec** - execute a command on a container in a pod
- **Kubectl top** – resource consumption of nodes and pods – but this requires Heapster

Storage

Kubernetes: Volumes

On-disk files in a container are the simplest place for an application to write data, but this approach has drawbacks. The files are lost when the container crashes or stops for any other reason. Furthermore, files within a container are inaccessible to other containers running in the same Pod. The Kubernetes Volume abstraction addresses both of these issues.

- A directory accessible to all containers in a pod
- Volumes out live containers that run within a pod
- May be passed between pods
- Data is preserved across container restarts

Kubernetes: Persistent Volume

Persistent storage in a cluster

- Separate from **PersistentVolumeClaim**, which is a request for storage.
- May be created ahead of time in a static manner for use by a cluster
- May be created dynamically from available, unclaimed resources
- May be freed and passed from user to user so care should be taken to delete contents when done with use

Kubernetes: Persistent Volumes

PV: Storage in the cluster that has been provisioned by an administrator (static or dynamic) and is independent of any individual pod that uses the PV.

Following volumes are supported by Kubernetes:

GCEPersistentDisk ; AWSElasticBlockStore

AzureFile ; AzureDisk

FC (Fibre Channel) ; FlexVolume

Flocker ; NFS

iSCSI ; RBD (Ceph Block Device)

CephFS ; Cinder (OpenStack block storage)

Glusterfs ; VsphereVolume

Portworx Volumes ; ScaleIO Volumes

StorageOS

Example: Persistent Volumes

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: pv0003
spec:
  capacity:
    storage: 5Gi
  volumeMode: Filesystem
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Recycle
  mountOptions:
    - hard
    - nfsvers=4.1
  nfs:
    path: /tmp
    server: 172.17.0.2
```

Kubernetes: Persistent Volume Claims

- PVC: Request for a storage by a user, it is similar to pod and it can request specific size and access modes (e.g., can be mounted once read/write or many times read-only).

Example: Persistent Volume Claim

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: user-service-war-pv-claim
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
```

Example: Deployment using PVC

```
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: userservice
spec:
  replicas: 1
  template:
    ……
    spec:
      containers:
      ……
        volumeMounts:
        - mountPath: /usr/local/tomcat/webapps/user-service-1.0.war
          name: user-service-war
      volumes:
      - name: user-service-war
        persistentVolumeClaim:
          claimName: user-service-war-pv-claim
```

Lab (Volume, PV, PVC)

- create pods,PV and PVC
- Experiment with creating end to end application, mount volume, read from shared pod
- Fix a bug

cd to ex6
6.1 Exercise of Volume
https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex6/create_volumes.md

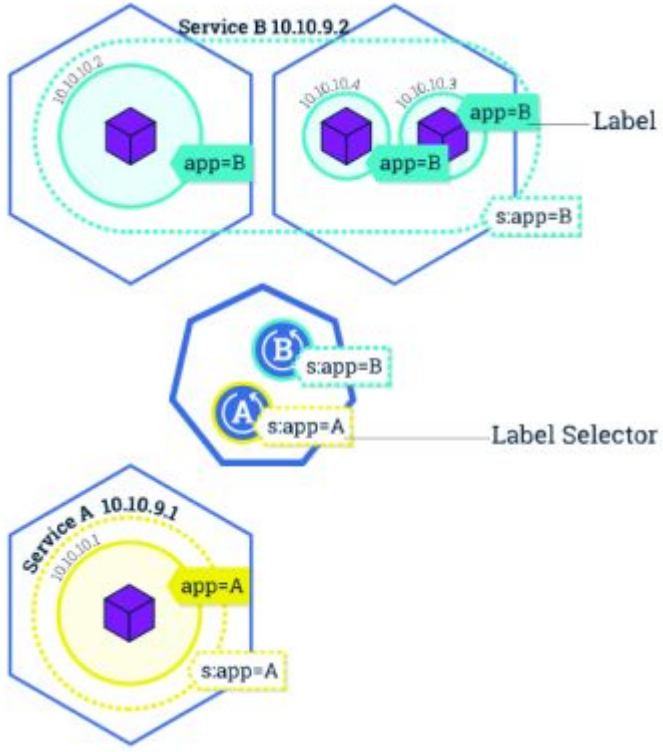
6.2 Exercise on PV, PVC
https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex6/create_pv.md

Labels

Kubernetes: Label

Key/Value pairs that can be attached to objects to enable a variety of use cases.

- Designate objects for specific environments such as development, test and production
- Set versions to objects
- Set roles or other arbitrary information to classify objects
- Can be added or modified at any time



$ kubectl get pod –l name=<label>

```
peter@Azure:~$ kubectl run nginx --image nginx --port 80
deployment "nginx" created
peter@Azure:~$ kubectl get pods
NAME                     READY     STATUS    RESTARTS   AGE
nginx-158599303-04h8d    1/1       Running   0          4s
peter@Azure:~$ kubectl label pods nginx-158599303-04h8d new-label=awesome
pod "nginx-158599303-04h8d" labeled
peter@Azure:~$ kubectl get pods -l new-label=else
No resources found.
peter@Azure:~$ kubectl get pods -l new-label=awesome
NAME                     READY     STATUS    RESTARTS   AGE
nginx-158599303-04h8d    1/1       Running   0          3m
peter@Azure:~$ kubectl get pods --show-labels
NAME                     READY     STATUS    RESTARTS   AGE       LABELS
nginx-158599303-04h8d    1/1       Running   0          3m        new-label=awesome,pod-template-hash=158599303,run=nginx
```

Note: Best mechanism to organize Kubernetes objects

- labels can be used to provide logical structure
- divide by teams, or by environments, or versions
- $ kubectl create -f helloworld-pod-with-labels.yml
- $ kubectl get po --show-labels

Lab (Kubernetes Labels)

- Create a series of pods with different labels
- Query the pods based on various labels
- Delete pods based on certain selectors

We have already pulled the git repo

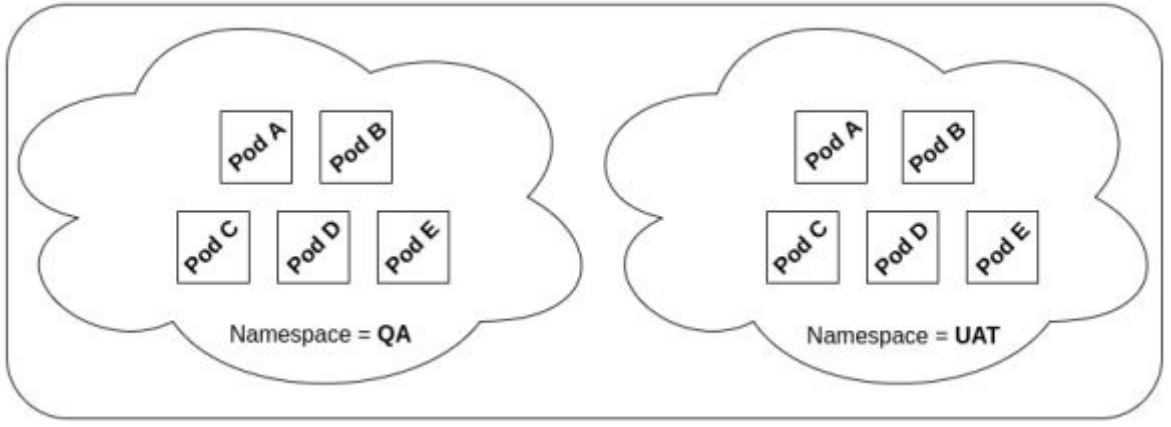
Now cd to ex3

https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex3/label_usage.md

Namespaces

Kubernetes: Namespace

- Resources are segmented within namespaces
  - Sandbox per developer for example
- Pods will route dns to default (own) namespace
- The same app could run independently in different namespaces
- Namespaces create an excellent mechanism to subdivide resources and provide isolation. This enables using a cluster for multiple projects or multiple teams



Kubernetes: Namespace

- $ kubectl get po,deploy,svc,rs --all-namespaces
- $ kubectl create -f <pod_config> -n <namespace_name>
- $ kubectl get po -o wide
- $ kubectl get po -o wide -n <namespace_name>
- $ kubectl delete po simple_pod
- $ kubectl delete po simple_pod -n <namespace_name>

```
peter@Azure:~$ kubectl get ns
NAME          STATUS    AGE
default       Active    23d
kube-public   Active    23d
kube-system   Active    23d
peter@Azure:~$ kubectl create -f https://raw.githubusercontent.com/mhausenblas/kbe/master/specs/ns/ns.yaml
W1006 13:59:41.630630     134 factory_object_mapping.go:423] Failed to download OpenAPI (the server could not find the requested resource), falling back to swagger
namespace "test" created
peter@Azure:~$ kubectl get ns
NAME          STATUS    AGE
default       Active    23d
kube-public   Active    23d
kube-system   Active    23d
test          Active    19s
peter@Azure:~$ kubectl create --namespace=test -f https://raw.githubusercontent.com/mhausenblas/kbe/master/specs/ns/pod.yaml
W1006 14:00:18.027941     145 factory_object_mapping.go:423] Failed to download OpenAPI (the server could not find the requested resource), falling back to swagger
pod "podintest" created
peter@Azure:~$ kubectl get pods --namespace=test
NAME         READY     STATUS              RESTARTS   AGE
podintest    0/1       ContainerCreating   0          11s
```

Segregating context using Namespaces

- Create namespaces “dev” and “prod”
- kubectl config view (get the user)
- kubectl config current-context
- kubectl config set-context dev --namespace=dev --cluster=<current-context> --user=<user>
- kubectl config set-context prod --namespace=prod --cluster=<current-context> --user=<user>
- kubectl config get-contexts
- kubectl config use-context dev

  ## do something
- kubectl config use-context prod

  ## do something

Lab (Namespace)

- Create a namespace
- check various objects in different namespaces
- Can create or delete objects from a specific namespace

cd to ex12

https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex12/namespaces.md

Secrets

Kubernetes: Secrets

- Kubernetes secret objects let you store and manage sensitive information, such as passwords, OAuth tokens, and ssh keys.
- Using secret to store this information is safer and more flexible than putting it verbatim in a container image or Pod Lifecycle definition.

Create Secrets – using “kubectl create secret”

- Create files with the content:

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

  echo -n '1f3wr8sdfssf' > ./password.txt

- Creating secrets from the file:

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

From file

$ kubectl create secret generic **test-secret** --from-literal=username='my-app' --from-literal=password='39528$vdg7Jb'

From literal

Create Secrets – manually Using YAML

- Creating base64 encoded Secrets:

```
$ echo -n 'admin' | base64
    YWRtaW4=
$ echo -n '1f2d1e2e67df' | base64
    MWYyZDFlMmU2N2Rm
```

secret.yaml

```
apiVersion: v1
kind: Secret
metadata:
  name: mysecret
type: Opaque
data:
  username: YWRtaW4=
  password: MWYyZDFlMmU2N2Rm
```

Creating secrets from the YAML file:

kubectl create -f ./secret.yaml

Retrieve values of secrets:

kubectl get secret mysecret -o yaml

Using Secrets

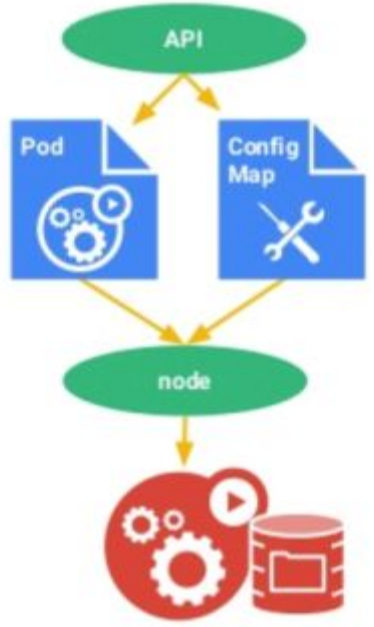
$ kubectl create secret generic **mysql** --from-literal=password=12345

```
spec:
  containers:
    - image: mysql:5.6
      name: mysql
      env:
        - name: MYSQL_ROOT_PASSWORD
          valueFrom:
            secretKeyRef:
              name: mysql
              key: password
```

ConfigMap

Kubernetes: Configmap

A set of key-value pairs that serve as configuration data for pods. They solve the problem of how to pass config data such as environment variables to pods.



Config maps are commonly composed of:

- Command line arguments
- Environment variables
- Files in a volume

Config maps function similar to secrets, but values are stored as strings and are more readily readable.

$ kubectl create -f etcd-config.yml

```
apiVersion: extensions
kind: ConfigMap
metadata:
  name: etcd-env-config
data:
  discovery_url: http://etcd-discovery:2379
  etcdctl_peers: http://etcd:2379
```

Kubernetes: Config Map

```
root@ip-172-31-68-96:~# kubectl create configmap test-config --from-literal=key1=config1 --from-literal=key2=config2
configmap/test-config created
root@ip-172-31-68-96:~# kubectl get configmap
NAME          DATA      AGE
my-config     2         1m
test-config   2         7s
root@ip-172-31-68-96:~#
root@ip-172-31-68-96:~# kubectl describe configmap/test-config
Name:         test-config
Namespace:    default
Labels:       <none>
Annotations:  <none>

Data
====
key1:
----
config1
key2:
----
config2
Events:  <none>
root@ip-172-31-68-96:~#
```

Kubernetes: Config Map

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: test-cm
  labels:
    name: test-cm
data:
  key1: value1
  key2: value2
```

```
apiVersion: v1
  kind: Pod
  metadata:
    name: pod-with-cm
  spec:
    containers:
      - name: test-container
        image: k8s.gcr.io/busybox
        command: [ "/bin/sh", "-c", "env" ]
        env:
          - name: SPECIAL_LEVEL_KEY
            valueFrom:
              configMapKeyRef:
                name: test-cm
                key: key1
    restartPolicy: Never
```

Lab (Config Maps)

- Create a deployment which uses hard coded value for log-level
- Create a Config Map
- Use the Config map inside a deployment

cd to ex14

https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex14/configmap.md

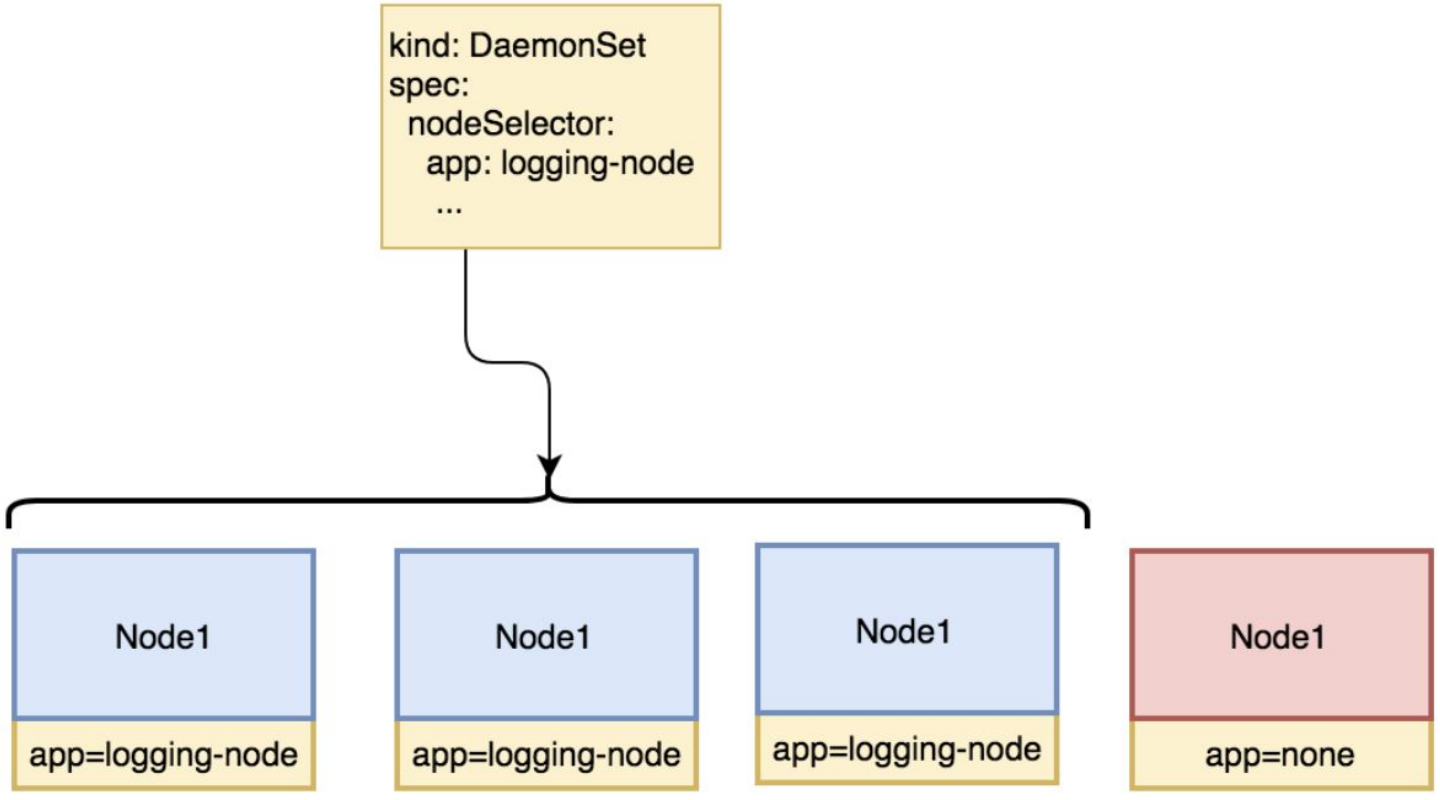
Daemonset

Kubernetes: DaemonSet

A ***DaemonSet*** ensures that all (or some) Nodes run a copy of a Pod. As nodes are added to the cluster, Pods are added to them. As nodes are removed from the cluster, those Pods are garbage collected. Deleting a DaemonSet will clean up the Pods it created.

- Usually used for pods meant for Monitoring or collecting logs

Kubernetes: DaemonSet



DaemonSet example

```
apiVersion: extensions/v1beta1
kind: DaemonSet
metadata:
  name: logging
spec:
  template:
    metadata:
      labels:
        app: logging-app
    spec:
      nodeSelector:
        app: logging-node
      containers:
        - name: webserver
          image: nginx
          ports:
          - containerPort: 80
```

- Looks like pod

How to assign labels to nodes?

If node exists

kubectl label nodes <node-name> <label-key>=<label-value>

While provisioning

--node-labels <label-key>=<label-value>

Jobs

Kubernetes: Jobs

Jobs - Create pods and ensures that a specified number of them successfully terminate. As pods successfully complete, the *job* tracks the successful completions.

Get all pods for a job

pods=$(kubectl get pods --selector=<label-key=value> --output=jsonpath='{.items[*].metadata.name}')

Useful spec for a job

Pod may fail due to low resource or a process exits with non-zero code, in that case:

spec.restartPolicy: can be **Never**; or **onFailure**

spec.BackOffLimit: set number of re-tries, in case restartPolicy is onFailure

spec.activeDeadlineSeconds: kills a job after specified time

Kubernetes: Cron Jobs

- Creates Job objects on a time-based schedule
- One Cron Job object is like one line of a *crontab* (cron table) file
- It runs a job periodically on a given schedule

What if Cron misses scheduling (say, due to limited resource) ?

>> Number of schedules missed in (now - last scheduled time)

>> If {startingDeadlineSeconds} is set; Number of schedules missed in (now - startingDeadlineSeconds)

If there are more than 100 missed schedules, then it logs error

Lab (Jobs and Cron Jobs)

- Create Job and check the logs
- Create a Cron Job,
- Edit the Cron Job

cd to ex9

https://github.com/abhikbanerjee/kubernetes_teach_git/blob/master/ex9/cronjob.md

How to assign pods to nodes

Kubernetes: Assigning Pods to Nodes

You can constrain a pod to only be able to run on particular nodes or to prefer to run on particular nodes. There are several ways to do this, and the recommended approaches all use label selectors to make the selection.

- *nodeSelector* is the simplest recommended form of node selection constraint.
- *nodeSelector* is a field of PodSpec. It specifies a map of key-value pairs. For the pod to be eligible to run on a node, the node must have each of the indicated key-value pairs as labels (it can have additional labels as well). The most common usage is one key-value pair.

Kubernetes: nodeSelector Example

Step1: Label the nodes
kubectl label nodes <node-name> <label-key>=<label-value>

Step2: Assign the Pod creation on node with label ‘disktype’ and value ‘ssd’
kubectl create -f pod-nginx.yaml

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    env: test
spec:
  containers:
  - name: nginx
    image: nginx
    imagePullPolicy: IfNotPresent
  nodeSelector:
    disktype: ssd
```

```yaml
spec:
  affinity:
    nodeAffinity:
      nodeSelectorTerms:
      - matchExpressions:
        - key: kubernetes.io/e2e-az-name
          operator: In
          values:
          - e2e-az1
          - e2e-az2
```

Pod Priority and pre-emption

Kubernetes: Pod Priority

- Pods can have priority. Priority indicates the importance of a Pod relative to other Pods. **If a Pod cannot be scheduled, the scheduler tries to pre-empt (evict) lower priority Pods to make scheduling of the pending Pod possible.**

Kubernetes: Pod Priority

Set the priority for pod scheduling but cannot ask never to kill a pod

Example PriorityClass

```yaml
apiVersion: scheduling.k8s.io/v1alpha1
kind: PriorityClass
metadata:
  name: high-priority
value: 1000000
globalDefault: false
description: "This priority class should be used for XYZ service pods only."
```

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    env: test
spec:
  containers:
  - name: nginx
    image: nginx
    imagePullPolicy: IfNotPresent
  priorityClassName: high-priority
```

Pod Pre-emption

- When Pods are created, they go to a queue and wait to be scheduled. The scheduler picks a Pod from the queue and tries to schedule it on a Node. If no Node is found that satisfies all the specified requirements of the Pod, pre-emption logic is triggered for the pending Pod.

Node Taints

Kubernetes: Node taints

- Node Taints is a property of pods that repel them to a set of nodes

- Taints ensure that pods are not scheduled onto inappropriate nodes. One or more taints are applied to a node; this marks that the node should not accept any pods that do not tolerate the taints.

Adding and removing a taint to node

- Tainting a node named ‘node1’

  kubectl taint nodes node1 key=value:NoSchedule

  - Taint effect NoSchedule means no Pod will be able to schedule onto node1

- Removing taint of the node ‘node1’

  kubectl taint nodes node1 key=value:NoSchedule-

Kubernetes: Node role

- A node role is just a label with the format:
  - ***node-role.kubernetes.io/<role>***
- It can be added using ***kubectl label*** command

Recall how to add a label:
kubectl label nodes <node-name> <label-key>=<label-value>

- Adding a role to node
  - ***kubectl label test.node.test.com node-role.kubernetes.io/worker***

- Removing a role from node
  - ***kubectl label test.node.test.com node-role.kubernetes.io/worker-***

Resource quotas

Kubernetes: Resource Quotas

- When several users or teams share a cluster with a fixed number of nodes, there is a concern that one team could use more than its fair share of resources.
- Resource quotas are a tool for administrators to address this concern.
- It is defined by "**ResourceQuota**" object. It provides constraints that **limit aggregate resource consumption per namespace.**

Kubernetes: Compute Resource Quotas

Resource Name	Description
`cpu`	Across all pods in a non-terminal state, the sum of CPU requests cannot exceed this value.
`limits.cpu`	Across all pods in a non-terminal state, the sum of CPU limits cannot exceed this value.
`limits.memory`	Across all pods in a non-terminal state, the sum of memory limits cannot exceed this value.
`memory`	Across all pods in a non-terminal state, the sum of memory requests cannot exceed this value.
`requests.cpu`	Across all pods in a non-terminal state, the sum of CPU requests cannot exceed this value.
`requests.memory`	Across all pods in a non-terminal state, the sum of memory requests cannot exceed this value.

Kubernetes: Storage Resource Quotas

Resource Name	Description
`requests.storage`	Across all persistent volume claims, the sum of storage requests cannot exceed this value.
`persistentvolumeclaims`	The total number of persistent volume claims that can exist in the namespace.
`<storage-class-name>.storageclass.storage.k8s.io/requests.storage`	Across all persistent volume claims associated with the storage-class-name, the sum of storage requests cannot exceed this value.
`<storage-class-name>.storageclass.storage.k8s.io/persistentvolumeclaims`	Across all persistent volume claims associated with the storage-class-name, the total number of persistent volume claims that can exist in the namespace.

Kubernetes: Object Count Quotas

- `count/persistentvolumeclaims`
- `count/services`
- `count/secrets`
- `count/configmaps`
- `count/replicationcontrollers`
- `count/deployments.apps`
- `count/replicasets.apps`
- `count/statefulsets.apps`
- `count/jobs.batch`
- `count/cronjobs.batch`
- `count/deployments.extensions`

Kubernetes: Resource Quotas Example

cpu_memory_quota.yml

```yaml
apiVersion: v1
kind: ResourceQuota
metadata:
  name: pods-medium
spec:
  hard:
    cpu: "10"
    memory: 20Gi
    pods: "10"
  scopeSelector:
    matchExpressions:
    - operator : In
      scopeName: PriorityClass
      values: ["medium"]
```

compute_quota.yml

```yaml
apiVersion: v1
kind: ResourceQuota
metadata:
  name: compute-resources
spec:
  hard:
    pods: "4"
    requests.cpu: "1"
    requests.memory: 1Gi
    limits.cpu: "2"
    limits.memory: 2Gi
```

Kubernetes: Limit Resource by Pods

pod.yml

```yaml
apiVersion: v1
kind: Pod
spec:
  containers:
  - name: db
    …
    resources:
      requests:
        memory: "64Mi"
        cpu: "250m"
      limits:
        memory: "128Mi"
        cpu: "500m"
  - name: wp
    …
    resources:
      requests:
        memory: "64Mi"
        cpu: "250m"
      limits:
        memory: "128Mi"
        cpu: "500m"
```

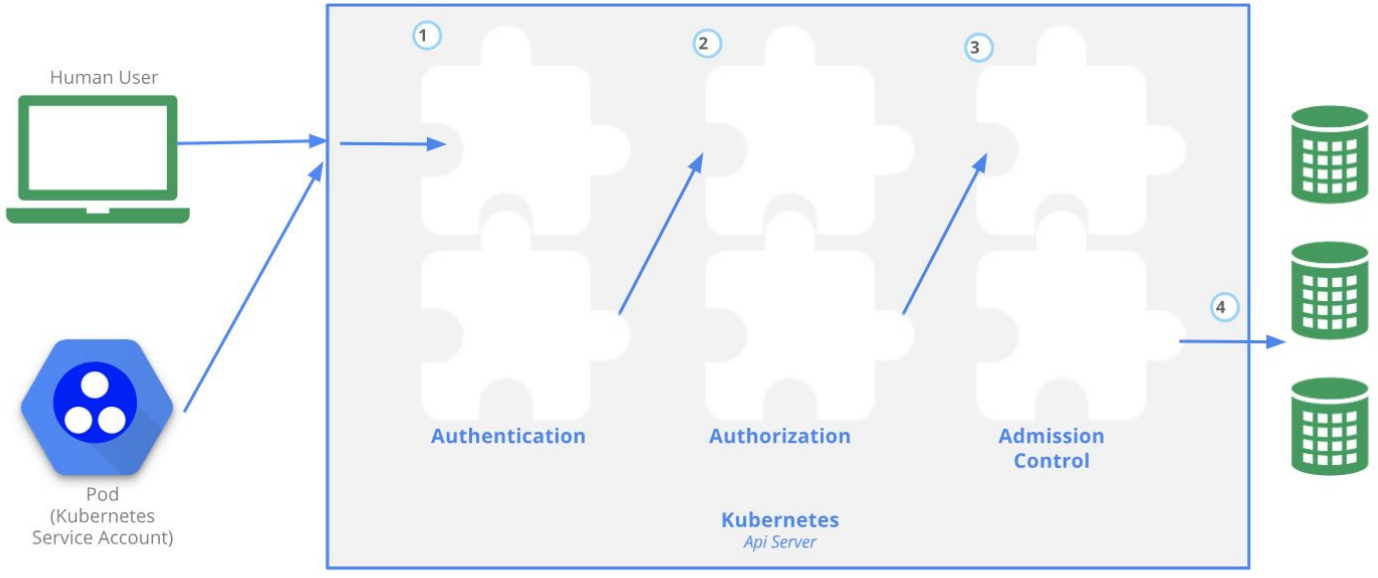
Kubernetes Authentication and Access Control

Control Access to APIs

Human users and K8s service accounts can be authorized for API access.

When a request reaches the API, it goes through 3 stages.

1. Authentication
2. Authorization
3. Admission Control



Step 1: Authentication

HTTP request is passed to the authenticator to authenticate the user.

Type of authenticator (set by cluster admin):

- client certificate ($USER/.kube/config contains root certificate for api-server certificate)
- password
- plain token
- bootstrap token

* If the admin sets multiple, this step checks all and grants access even if one is passed.

Status:

- **pass**: the user is authenticated as "username", and this "username" is available to subsequent steps.
- **fail**: 401 code

Step 2: Authorization

After successful authentication, the HTTP request is authorized for existing "**policies**"

HTTP request contains {"**username**", "requested action", "objects getting affected"}

Type of authorizers (set by cluster admin):

- **RBAC** – Role based access control
- **ABAC** – Attribute based access control

RBAC and ABAC allows the cluster-admin to dynamically configure policies through the Kubernetes API to grant restricted access.

* If the admin sets multiple, this step checks all and grants access even if one is passed.

RBAC (Role based Access Control)

Role – are additive rules with set of permissions. (no "deny" rules)

API group: rbac.authorization.k8s.io

Enable api-server with: --authorization-mode=RBAC

Type of Roles:

1. **Role** – within a namespace
2. **ClusterRole** – within the cluster

Role

```yaml
# role for accessing pods in default namespace
kind: Role
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  namespace: default
  name: pod-reader
rules:
- apiGroups: [""] # "" is core API group
  resources: ["pods"]
  verbs: ["get", "watch", "list"]
```

```yaml
# role using resourceNames
rules:
- apiGroups: [""]
  resources: ["configmaps"]
  resourceNames: ["my-configmap"]
  verbs: ["update", "get"]
```

```yaml
# The above role won't be able to access pod logs # {pod = namespaced resource}, {logs = is not}
rules:
- apiGroups: [""]
  resources: ["pods", "pods/log"]
  verbs: ["get", "list"]
```

Check all endpoints
$ kubectl proxy &
$ curl localhost:8001

```yaml
# role for a non-resource endpoint
rules:
- nonResourceURLs: ["/healthz", "/healthz/*"]
  verbs: ["get", "post"]
```

RoleBinding

RoleBinding – refer subjects (users, groups, or service accounts) to a role

```yaml
# A role binding allows "Mary" to read
# pods in the "default" namespace
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: read-pods
  namespace: default
subjects:
- kind: User
  name: Mary  # case sensitive
  apiGroup: rbac.authorization.k8s.io
roleRef:
  kind: Role
  name: pod-reader
  apiGroup: rbac.authorization.k8s.io
```

```yaml
# binding for a group
subjects:
- kind: Group
  name: "frontend-admins"

# default service account in the kube-system namespace
subjects:
- kind: ServiceAccount
  name: default
  namespace: kube-system


# binding for all service accounts in the "qa" namespace
subjects:
- kind: Group
  name: system:serviceaccounts:qa
```

Question – why need namespace for a RoleBinding when it is already scoped and defined in a Role?

Answer – A RoleBinding may also refer a ClusterRole to grant the permissions to namespaced resources defined in the ClusterRole within the RoleBinding's namespace.

E.g. for a ClusterRole that reads secrets in all namespace, if you define a RoleBinding (with namespace=n1) referring to the ClusterRole, the user will read secrets in the namespace=n1 only not in all namespace (which was the scope of ClusterRole)

ClusterRole

ClusterRole = Roles defined for the entire cluster

ClusterRole = Role + cluster resources (like nodes) + non-resource (like /healtz) + not limited to one namespace

```yaml
# ClusterRole to read secrets across all namespace
kind: ClusterRole
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  # no "namespace", ClusterRoles are not namespaced
  name: secret-reader
rules:
- apiGroups: [""]
  resources: ["secrets"]
  verbs: ["get", "watch", "list"]
```

ClusterRole Binding

ClusterRoleBinding – refer subjects (users, groups, or service accounts) to a ClusterRole

```
# This cluster role binding allows anyone in the "manager" group to read secrets in any namespace.
kind: ClusterRoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: read-secrets-global
subjects:
- kind: Group
  name: manager # Name is case sensitive
  apiGroup: rbac.authorization.k8s.io
roleRef:
  kind: ClusterRole
  name: secret-reader
  apiGroup: rbac.authorization.k8s.io
```

ABAC (Attribute based Access Control)

Defines an access control paradigm whereby access rights are granted to users through the use of policies which combine attributes together
API group: abac.authorization.k8s.io

Enable api-server with: --authorization-mode=ABAC

Provide api-server with access file: --authorization-policy-file=SOME_FILENAME

Each line in the policy file is the policy JSON object

ABAC Policies

```
# John has read-only access to pods in 'developer' namespace
{
  "apiVersion": "abac.authorization.kubernetes.io/v1beta1",
  "kind": "Policy",
  "spec": {
    "user": "john200",
    "namespace": "developer",
    "resource": "pods",
    "readonly": true
  }
}
```

ServiceAccount: is identified by "system:serviceaccount:<namespace>:<serviceaccountname>"

```
# default service account (in the kube-system namespace) full privilege to the API
{
  "apiVersion": "abac.authorization.kubernetes.io/v1beta1",
  "kind": "Policy",
  "spec": {
    "user": "system:serviceaccount:kube-system:default",
    "namespace": "*",
    "resource": "*",
    "apiGroup": "*"
  }
}
```

Step 3: Admission Control

Checks if the user requesting for a write operation has the necessary permission to bring the change in the K8s resource. Thus, happens prior to persistence of the object.

Enable: kube-apiserver --enable-admission-plugins=NamespaceLifecycle,LimitRanger

Plugins enabled by default: NamespaceLifecycle, ServiceAccount, PersistentVolumeClaimResize, DefaultStorageClass, ResourceQuota, Priority

* Many advanced features in Kubernetes require an admission controller to be enabled in order to properly support the feature.

Service Accounts

-- Provides an **identity for processes that runs in a Pod**

Human users are authenticated by the api-server as a particular User account.

Processes in containers inside pods are authenticated by the api-server as a particular Service account.

When a pod is created;

spec.serviceAccountName mentions the ServiceAccount, "default" is auto assigned.

The API permissions of the service account is defined in the **authorization policy** (RBAC or ABAC) as discussed earlier.

Service Accounts – Tokens

```
# create a service account named acc1
apiVersion: v1
kind: ServiceAccount
metadata:
  name: acc1
```

```
# create a pod using acc1 service account
apiVersion: v1
kind: Pod
metadata:
  name: my-pod
spec:
  serviceAccountName: acc1
```

auto-create token

```
secrets:
- name: acc1-token-bvbk5
```

```
# manually created token and use for a service account
apiVersion: v1
kind: Secret
metadata:
  name: acc1-secret
  annotations:
    kubernetes.io/service-account.name: acc1
type: kubernetes.io/service-account-token
```

Service Accounts – ImagePullSecret

Case: Provide specific access to serviceaccounts (in turn pods) to pull images from multiple docker registries

- Create a ImagePullSecret

$ kubectl create secret docker-registry myregistrykey
--docker-server=DOCKER_REGISTRY_SERVER --docker-username=DOCKER_USER
--docker-password=DOCKER_PASSWORD --docker-email=DOCKER_EMAIL

- Change the service account to use the above ImagePullSecret

$ kubectl patch serviceaccount **default** -p '{"imagePullSecrets": [{"name": "myregistrykey"}]}'

** Now the pod using the serviceaccount "default" will use the secret to pull images from the specific docker registry*

Service Accounts – Pod creation

Case: What happens with ServiceAccount when a Pod is created

- If the pod does not have a ServiceAccount set, it sets the ServiceAccount to **default**.
- It ensures that the ServiceAccount referenced by the pod exists, and otherwise rejects it.
- If the pod does not contain any ImagePullSecrets, then ImagePullSecrets of the ServiceAccount are added to the pod.
- It adds a volume to the pod which contains a token for API access.
- It adds a volumeSource to each container of the pod mounted at /var/run/secrets/kubernetes.io/serviceaccount
  - We have seen this in one of the exercises where two containers in the same pod trying to share volumes – was authenticated by serviceaccount secret that was auto-created