

wide

Wednesday, April 10, 2024 5:10 PM

```
export do="--dry-run=client -o yaml"
```

```
export do="--dry-run=client -o yaml"
```

This command sets a shell variable named 'do' with the value "--dry-run=client -o yaml".

- **export:** This command is used in Unix-based systems (like Linux) to export a variable so that it becomes available to subshells and scripts executed from the current shell session.
- **do:** This is the name of the variable being created or updated. Variables in shell scripting are typically referenced by prefixing them with a dollar sign (\$). For example, to use the do variable, you would write \$do.
- **--dry-run=client -o yaml":** This is the value assigned to the do variable. It consists of two parts:
 - **--dry-run=client:** This part is used with kubectl commands and instructs kubectl to perform a dry run, which means it will simulate the operation specified (like creating or updating a resource) but won't execute it. The client argument specifies that the dry run should be done on the client side, meaning it won't contact the server.
 - **-o yaml:** This part specifies the output format for the kubectl command. It tells kubectl to format the output as YAML, which is a human-readable data serialization format commonly used in Kubernetes manifests and configurations.

Putting it all together, the `export do="--dry-run=client -o yaml"` command creates a shell variable named do with the value --dry-run=client -o yaml. This variable can then be used in kubectl commands to perform dry runs and output the results in YAML format.

1. **Dry Run for Creating Resources:** It simulates the creation without actually creating the deployment. The output, formatted as YAML, will show what the deployment would look like if created.

```
kubectl create deployment nginx --image=nginx $do
```

```
kubectl create deployment nginx --image=nginx
```

This command creates the "nginx" deployment with the nginx image on the server side.

2. **Dry Run for Updating Resources:** Here, we're updating the image of the deployment "nginx" to "nginx:latest" but using a dry run. The output in YAML format will display the

updated configuration without actually applying the update.

```
kubectl set image deployment/nginx nginx=nginx:latest $do
```

```
kubectl set image deployment/nginx nginx=nginx:latest
```

This command updates the image of the "nginx" deployment to "nginx:latest" on the server side.

3. **Dry Run for Deleting Resources:** This command deletes a pod named "mypod" but performs a dry run. The output in YAML will show what the delete operation would do without actually deleting the pod.

```
kubectl delete pod mypod $do
```

```
kubectl delete pod mypod
```

This command deletes the "mypod" pod on the server side.

4. **Dry Run for Applying Manifests:** Using kubectl apply, you can apply Kubernetes manifest files (my-manifest.yaml in this example) but perform a dry run to see what changes would be applied if you were to run the command without the dry run option.

```
kubectl apply -f my-manifest.yaml $do
```

```
kubectl apply -f my-manifest.yaml
```

This command applies the Kubernetes manifest file (my-manifest.yaml) to the server side.

5. **Get Resource Details in YAML Without Changing State:** This command retrieves details about the "nginx" deployment but uses a dry run, so it won't actually change the state of the deployment. The output will be in YAML format.

```
kubectl get deployment nginx -o yaml $do
```

```
kubectl get deployment nginx
```

This command retrieves details about the "nginx" deployment from the server side without affecting the deployment's state.

- Drag and copy
- Paste - Ctrl+Shift+V
- Kodekloud Practice labs are easy as compared to the actual exam.
- Practice kubectl explain and avoid using documentation.
- kx () and kn () alias for switching and viewing the current context.
- Make alias in starting

Topics

Wednesday, April 24, 2024 11:43 PM

Ingress

Security - clusterrole/role

Security - clusterrolebinding/rolebinding

Security - RBAC

Security - Network Policies

Security - kubeconfig

Commands

Thursday, April 25, 2024 6:42 PM

Run the command:

You can check for apiVersion of replicaset by command

kubectl api-resources | grep replicaset

OR

kubectl explain replicaset | grep VERSION for

Then run the command: **kubectl create -f /root/replicaset-definition-**

Switching Namespace

kubectl config set-context --current --namespace=<desired-namespace>

Press : (colon) and the cursor will move at the bottom left corner of the screen. Type "set number" or "set nu" and hit Enter.

:set number

Ctrl + L = To clear the screen. You can also run the "clear" command.
Ctrl + U = To clear the current line
Ctrl + A = Move pointer to the beginning
Ctrl + E = Move pointer to the end
Ctrl + K = Delete the next word on the left
Ctrl + F = To move the cursor forward word by word
Ctrl + B = To move cursor backward word by word

Scale the deployment app to 2 pods.

kubectl scale deploy app --replicas=2

kubectl logs <pod-name> -c init-myservice

-c = Name of container

Query the Kube API server using 'kubectl get all --all-namespaces -o yaml > all-deploy-services.yaml' to get all resource configurations.

how to login as a particular user in a node in k8s?

```
ssh username@node_ip
```

Cheat Sheet

Sunday, April 28, 2024 4:18 AM

Search for 'kubectl cheatsheet' and run starting two commands.

More Focus

Thursday, April 25, 2024 6:58 PM

Services

Scheduling

Logging and Monitoring

YAML

Monday, April 29, 2024 5:05 PM

List

colors:

- red
- blue
- green

Dictionary

person:

name: John Doe
age: 30
city: New York

List of Dictionary

people:

- name: John Doe
age: 30
city: New York
- name: Jane Smith
age: 25
city: Los Angeles
- name: Alex Johnson
age: 35
city: Chicago

Dictionary of List

colors:

- red:
- apple
- cherry

yellow:

- banana
- lemon

orange:

- orange
- peach

Final Thoughts

Saturday, May 25, 2024 10:52 AM

Try to read from the docs and understand each and every field- Why this field is mandatory, why this field is optional, what will happen if we don't include a particular field, what are some default values, what will happen if the sequence change.

Core Concepts

Friday, April 26, 2024 11:28 AM

- ? Create an nginx pod and list the pod with different levels of verbosity. What is verbosity? Explain the question and then give the solution in detail.

In the context of Kubernetes, verbosity refers to the level of detail or amount of information displayed in the output of a command. When you request information with higher verbosity, you typically get more detailed or comprehensive output.

For example, in the case of listing Kubernetes resources like pods, you can specify different levels of verbosity to control the amount of information displayed. This can include basic information such as names and statuses, or more detailed information like labels, annotations, IP addresses, etc.

Now, let's go through the question and then provide the solution step by step:

Question:

Create an nginx pod and list the pod with different levels of verbosity.

Solution:

Create an nginx pod named "nginx-pod" using the following YAML definition:

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

Save the above YAML definition to a file, let's say nginx-pod.yaml, and create the pod using the command:

kubectl apply -f nginx-pod.yaml

Now, list the pod "nginx-pod" with different levels of verbosity:

Basic verbosity (default):

kubectl get pod nginx-pod

This command will display basic information about the pod, such as its name, status, and age.

Medium verbosity:

kubectl get pod nginx-pod -o wide

Adding -o wide provides additional information like node name, IP address, and node selector.

High verbosity:

kubectl get pod nginx-pod -o yaml

Using -o yaml displays the full YAML definition of the pod, including all metadata, labels, annotations, and spec details.

By adjusting the verbosity level with different output options (-o flag), you can control the amount of information displayed when listing Kubernetes resources like pods.

Mocks

Monday, April 29, 2024 11:09 AM

CKA M2

- Architecture, Install, Maintenance - Service Account permission
- Architecture, Install, Maintenance - Cluster Role
- Architecture, Install, Maintenance - Cluster Role Binding
- Architecture, Install, Maintenance - Argument and Commands
- Architecture, Install, Maintenance - Find node in all cluster/namespace with the condition given, store result as "X, Y" - **JSON PATH**
- Architecture, Install, Maintenance - Creating generic secret
- Troubleshooting - Node not accessible, Pod template, Pod not running, master node comp
- Troubleshooting - Cronjob
- Troubleshooting - Daemonset for logs
- Scheduling - Resource limit CPU
- Scheduling - Resource limit Memory
- Scheduling - Create Deployment
- Storage - PV, PVC - Resize PVC
- Storage - PV, PVC - Request Storage from PV
- Service & Networking - Unable to access the application
- Service & Networking - Expose application, DNS
- Service & Networking - ClusterIP
- Service & Networking - Loadbalancer

CKA M3

- Architecture, Install, Maintenance - etcd backup restore
- Troubleshooting - Sidecar Container
- Scheduling - Rolling Update, Rollback
- Storage - PV, PVC, Sidecar Container
- Service Networking - ReplicaSet
- Service Networking - NodePort

CKA M4

- Architecture, Install, Maintenance - Save logs "INFO" and "ERROR" to a file
- Troubleshooting - Network Policy
- Scheduling - Update Image
- Service Networking - Pod DNS, Service DNS, Record Result

From experts

Monday, April 29, 2024 12:00 PM

17 questions

- 8 were straightforward that you could execute with just a couple of commands.
- 3-4 were slightly involved but the instructions are crystal clear, so if you know what to do, you shouldn't face any hassles.
- 5-6, will take up the bulk of your time.

Focus Areas

- Volumes -- PVs, PVCs, SCs
- RBAC -- know how to verify once you provision them
- **Network Policies -- my Achilles heel** (<https://github.com/ahmetb/kubernetes-network-policy-recipes>)
- Services (especially NodePorts)
- Upgrade a node to a target version
- Troubleshoot "unready" nodes
- Monitoring and logging -- easy
- **Sidecars -- struggled with this one**
- ETCD backup and restore
- Deployment scaling and recording
- Draining nodes

Practice Tips

- theory (Mumshad) twice.
- set of 10 labs (there are a total of 55) in one go.
- I repeatedly did them until I could do all the labs without having to peek into the documentation even once.
- **Mock and Lightning labs. (Wrote them 6 times each)**
- took out the time to go through the entire documentation for these aspects: RBAC, Network Policies, Upgrade, Multiple Schedulers, and Ingress.
- Nana's Kubernetes basics course (Optional)

Exam Tips

- Bookmark the Etcd documentation page
- If a question spans more than one paragraph simply skip it for now (**go for the quick wins first**)
- Always target Upgrade, and ETCD backup questions for the latter half of the exam.
- Read every question twice, the first time to know what the ask is, the second time to confirm that I hadn't missed anything (by the time you read it a second time, your mind would have formulated the complete answer :)).
- Before draining a node, get all the resources into a yaml file. In case something goes wrong, I can simply run that yaml in another node so as to keep all pods running.

- Before editing or deleting anything (pod, deployment etc) I'd take a backup,
kubectl get <resource> <resource_name> -o yaml > question-number-resource.yaml
- Copy-paste the use-context command twice, and do not hit "clear" unnecessarily. That way I'd know I am in the right context by just looking at the top of the screen.
- Ensure that I attempt all questions and in case I am not able to get a pod/deployment running successfully, then at least keep it running even in the error state (like I did for the Sidecar). **Partial credits can be the difference between a borderline pass/fail.**
- alias k=kubectl and export do="--dry-run=client -o yaml" were the only shortcuts I used.

Focus Areas

- Create roles, service, and rolebindings
- Unschedule a node and reschedule the pods
- Backup and restore ETCD
- Upgrade a cluster to a specific version
- NETWORK POLICY
- Scale deployments
- NodeSchedulers
- Pod logs
- Pod resource usage
- Persistent Volumes
- Assigning PVC to pods
- Sidecar containers
- Ingress
- Exposing deployments/ pods
- Troubleshooting nodes, pods, or network (practice all)

Exam Tips

- alias k=kubectl Lets you type "k" in place of "kubectl"
- export do="--dry-run=client -o yaml" This will let you create yaml files when you use the "kubectl run" command [ex: kubectl run nginx --image=nginx \$do > nginx.yaml].

Necessary Bookmarks

<https://kubernetes.io/docs/home/>

<https://kubernetes.io/docs/reference/generated/kubectl/kubectl-commands>

<https://kubernetes.io/docs/reference/kubectl/cheatsheet/>

<https://kubernetes.io/docs/concepts/storage/persistent-volumes/#persistent-volumes>

<https://kubernetes.io/docs/concepts/services-networking/network-policies/>

<https://kubernetes.io/docs/tasks/administer-cluster/configure-upgrade-etcd/#backing-up-an-etcd-cluster>

Command

Monday, April 29, 2024 1:24 PM

apiVersion

kubectl api-resources | grep <replicaset or object name>

Start a hazelcast pod and let the container expose port 5701

kubectl run hazelcast --image=hazelcast/hazelcast --port=5701

Start a hazelcast pod and set environment variables "DNS_DOMAIN=cluster" and "POD_NAMESPACE=default" in the container

kubectl run hazelcast --image=hazelcast/hazelcast --env="DNS_DOMAIN=cluster" --env="POD_NAMESPACE=default"

Start a hazelcast pod and set labels "app=hazelcast" and "env=prod" in the container

kubectl run hazelcast --image=hazelcast/hazelcast --labels="app=hazelcast,env=prod"

Create a service for a replicated nginx, which serves on port 80 and connects to the containers on port 8000

kubectl expose rc nginx --port=80 --target-port=8000

Create a service for a pod valid-pod, which serves on port 444 with the name "frontend"

kubectl expose pod valid-pod --port=444 --name=frontend

Create a second service based on the above service, exposing the container port 8443 as port 443 with the name "nginx-https"

```
kubectl expose service nginx --port=443 --target-port=8443 --name=nginx-https
```

Delete pods and services with label name=myLabel

```
kubectl delete pods,services -l name=myLabel
```

Delete a pod with minimal delay

```
kubectl delete pod foo --now
```

View the details of daemonset revision 3

```
kubectl rollout history daemonset/abc --revision=3
```

Mark the nginx deployment as paused

```
kubectl rollout pause deployment/nginx
```

Restart a deployment

```
kubectl rollout restart deployment/nginx
```

Resume an already paused deployment

kubectl rollout resume deployment/nginx

Set a deployment's nginx container CPU limits to "200m" and memory to "512Mi"

kubectl set resources deployment nginx -c=nginx --limits(cpu=200m,memory=512Mi)

Display only the most recent 20 lines of output in pod nginx

kubectl logs --tail=20 nginx

Approve CSR 'csr-sqgzp'

kubectl certificate approve csr-sqgzp

Deny CSR 'csr-sqgzp'

kubectl certificate deny csr-sqgzp

Update node 'foo' with a taint with key 'dedicated' and value 'special-user' and effect 'NoSchedule' # If a taint with that key and effect already exists, its value is replaced as specified

kubectl taint nodes foo dedicated=special-user:NoSchedule

Add a taint with key 'dedicated' on nodes having label mylabel=X

kubectl taint node -l myLabel=X dedicated=foo:PreferNoSchedule

Get the documentation of the resource and its fields

kubectl explain pods

open certificate

clusterplane pods as services

Common Paths

certificates

manifests

kubelet

Imp Labs

Tuesday, May 21, 2024 1:19 PM

Scheduling

- Lab 3
- Lab 4
- Lab 6

Probes

Saturday, May 25, 2024 10:42 AM

Probe = To examine

<https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-startup-probes/#define-a-liveness-command>

Flow of probes

Startup > Liveness > Readiness

1. Startup Probe:

- If configured, the startup probe runs first to check if the container's application has started successfully.
- If the startup probe fails, the container is considered not ready, and liveness and readiness probes are not initiated until the startup probe succeeds.

2. Liveness Probe:

- Once the startup probe succeeds (or if not configured), the liveness probe begins to monitor the container's health during its lifecycle.
- If the liveness probe fails, Kubernetes restarts the container to attempt recovery from an unresponsive or stuck state.

3. Readiness Probe:

- Simultaneously with the liveness probe, the readiness probe determines if the container is ready to handle incoming traffic.
- When the container is ready (passes the readiness probe), it's included in service load balancing and traffic routing.

Types of Liveness Probes

1. Define a liveness HTTP request

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: liveness
  name: liveness-http
spec:
  containers:
    - name: liveness
      image: registry.k8s.io/e2e-test-images/agnhost:2.40
      args:
        - liveness
      livenessProbe:
        httpGet:
          path: /healthz
          port: 8080
          httpHeaders:
            - name: Custom-Header
              value: Awesome
        initialDelaySeconds: 3
        periodSeconds: 3
```

This liveness probe will periodically send an HTTP GET request to the /healthz endpoint on port 8080 of the container.

The probe will send an HTTP GET request to <http://<pod-ip>:8080/healthz> with an additional header Custom-Header: Awesome. The probe does not modify the URL itself; it sends the headers along with the request to the URL specified in the path field.

Custom Headers

Custom headers in HTTP requests are additional pieces of information that can be sent along with the main request. They are used to provide extra details or instructions to the server receiving the request.

Here's an example to illustrate custom headers:

Let's say you are sending an HTTP request to a server to retrieve some data. Along with the request, you want to provide information about the type of data you're expecting or any special instructions. You can do this by adding custom headers to your request.

For instance, consider a scenario where you're requesting JSON data from a server. You can include a custom header like Accept: application/json to indicate that you prefer to receive JSON-formatted responses.

```
vbnet

GET /data HTTP/1.1
Host: example.com
Accept: application/json
```

2. Define a TCP liveness probe

```
apiVersion: v1
kind: Pod
metadata:
  name: goproxy
  labels:
    app: goproxy
spec:
  containers:
    - name: goproxy
      image: registry.k8s.io/goproxy:0.1
      ports:
        - containerPort: 8080
      readinessProbe:
        tcpSocket:
          port: 8080
        initialDelaySeconds: 15
        periodSeconds: 10
      livenessProbe:
        tcpSocket:
          port: 8080
        initialDelaySeconds: 15
        periodSeconds: 10
```

A third type of liveness probe uses a TCP socket. With this configuration, the kubelet will attempt to open a socket to your container on the specified port.

If it can establish a connection, the container is considered healthy, if it can't it is considered a failure.

This will attempt to connect to the goproxy container on port 8080.

- ★ A tcp socket is just like a path between two rooms(port) in a building.

TCP (Transmission Control Protocol): This is the set of rules they agree to follow during the conversation. It ensures that data is sent reliably and in order.

Protect slow starting containers with startup probes

```
ports:  
- name: liveness-port  
  containerPort: 8080  
  
livenessProbe:  
  httpGet:  
    path: /healthz  
    port: liveness-port  
  failureThreshold: 1  
  periodSeconds: 10  
  
startupProbe:  
  httpGet:  
    path: /healthz  
    port: liveness-port  
  failureThreshold: 30  
  periodSeconds: 10
```

In the given example, the startup probe is configured with a failureThreshold of 30 and a periodSeconds of 10, allowing a maximum of 5 minutes ($30 * 10 = 300s$) for the application to complete its startup.

Once the startup probe succeeds, the liveness probe takes over for fast response to deadlocks. If the startup probe fails to succeed within the specified time, the container is terminated according to the pod's restartPolicy.

startupProbe:

- The startupProbe waits for the failureThreshold (30 in this case) multiplied by the periodSeconds (10 seconds), which equals 300 seconds (5 minutes). This means it gives the application a maximum of 5 minutes to start successfully.
- If the startupProbe fails before this 300-second mark, it indicates that the container's application hasn't started properly, and the container is considered not ready. The liveness and readiness probes are not initiated until the startup probe succeeds.

livenessProbe:

- Once the startupProbe succeeds (i.e., the application starts within 5 minutes), the livenessProbe takes over.
- The livenessProbe then checks the container's health every 10 seconds, with a failureThreshold of 1. This means if the livenessProbe fails once (i.e., the container is found unhealthy), the container is restarted.

Readiness Probe

Readiness probes are configured similarly to liveness probes. The only difference is that you use the readinessProbe field instead of the livenessProbe field.

Services

Saturday, May 25, 2024 1:41 PM

If some set of Pods (call them "backends") provides functionality to other Pods (call them "frontends") inside your cluster, how do the frontends find out and keep track of which IP address to connect to, so that the frontend can use the backend part of the workload?

Each Service object defines a logical set of endpoints (usually these endpoints are Pods) along with a policy about how to make those pods accessible.

2 tier application

Create a pod , services files for a web application having frontend, backend and database. Take any random image, node is node01 and database should be mysql and finally give the url that we can curl to access the web application externally.

Let's create YAML files for a web application with frontend, backend, and database components, using MySQL for the database. We'll create a pod, services, and then provide the URL to access the web application externally.

yaml

 Copy code

```
apiVersion: v1
kind: Pod
metadata:
  name: web-app-pod
spec:
  containers:
    - name: frontend
      image: <frontend-image>
      ports:
        - containerPort: 80
    - name: backend
      image: <backend-image>
      ports:
        - containerPort: 8080
    - name: database
      image: mysql:5.7
  env:
    - name: MYSQL_ROOT_PASSWORD
      value: <your-root-password>
```

Services YAML (web-app-services.yaml):

yaml

 Copy code

```
apiVersion: v1
kind: Service
metadata:
  name: frontend-service
spec:
  selector:
    app: web-app
    tier: frontend
  ports:
    - protocol: TCP
      port: 80
      targetPort: 80

---
apiVersion: v1
kind: Service
metadata:
  name: backend-service
spec:
  selector:
    app: web-app
    tier: backend
  ports:
    - protocol: TCP
      port: 8080
      targetPort: 8080

---
apiVersion: v1
kind: Service
metadata:
  name: database-service
spec:
  selector:
    app: web-app
    tier: database
  ports:
    - protocol: TCP
      port: 3306
      targetPort: 3306
```

Now, apply these YAML files using `kubectl apply -f web-app-pod.yaml` and `kubectl apply -f web-app-services.yaml`.

To access the web application externally, you'll need to expose the frontend service using NodePort or LoadBalancer.
For NodePort, you can use:

bash

 Copy code

```
kubectl expose service frontend-service --type=NodePort --name=web-app-nodeport
```

After exposing the service, you can use kubectl get svc web-app-nodeport to get the NodePort allocated. Let's say it's port 32000. You can then curl to access the web application externally using:

curl <http://<node-ip>:32000>

OR

You can directly create the frontend-service as type NodePort instead of creating it as type ClusterIP and then exposing it separately.

 "Inside the cluster, services communicate with each other using their service names. For example, the frontend pod can communicate with the backend pod using backend-service as the hostname."

Does this needs to be mentioned in the service file or all services are linked with each other?

In Kubernetes, services are linked to each other through the cluster's internal DNS. This linking happens automatically based on the service names and selectors you define. You don't need to explicitly mention service names in each service file for them to communicate internally.

Here's how it works:

Service Names:

Each service is given a name when you create it, such as frontend-service, backend-service, etc. These names are used by other pods and services within the cluster to communicate with the respective services.

DNS Resolution:

Kubernetes has an internal DNS service that automatically resolves service names to their corresponding cluster IP addresses.

For example, if a pod wants to communicate with the backend-service, it can use backend-service as the hostname in its network requests.

Automatic Linking:

When pods or services need to communicate with each other, they simply use the service name as the hostname in their requests.

Kubernetes handles the routing internally, directing the traffic to the appropriate pods behind the service.

So, to answer your question, the service names don't need to be explicitly mentioned in each service file for them to communicate internally. Kubernetes automatically links services based on their names and selectors, making service-to-service communication seamless within the cluster.

Port definitions in Pods have names, and you can reference these names in the targetPort attribute of a Service.

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    app.kubernetes.io/name: proxy
spec:
  containers:
    - name: nginx
      image: nginx:stable
      ports:
        - containerPort: 80
          name: http-web-svc

---
apiVersion: v1
kind: Service
metadata:
  name: nginx-service
spec:
  selector:
    app.kubernetes.io/name: proxy
  ports:
    - name: name-of-service-port
      protocol: TCP
      port: 80
      targetPort: http-web-svc
```

Services without selectors

```
apiVersion: v1
kind: Service
metadata:
  name: my-service
spec:
  ports:
    - name: http
      protocol: TCP
      port: 80
      targetPort: 9376
```

Because this Service has no selector, the corresponding EndpointSlice (and legacy Endpoints) objects are not created automatically.

You can map the Service to the network address and port where it's running, by adding an EndpointSlice object manually. For example:

```
apiVersion: discovery.k8s.io/v1
kind: EndpointSlice
metadata:
  name: my-service-1 # by convention, use the name of the Service
                      # as a prefix for the name of the EndpointSlice
  labels:
    # You should set the "kubernetes.io/service-name" Label.
    # Set its value to match the name of the Service
    kubernetes.io/service-name: my-service
addressType: IPv4
ports:
  - name: http # should match with the name of the service port defined above
    appProtocol: http
    protocol: TCP
    port: 9376
endpoints:
  - addresses:
      - "10.4.5.6"
  - addresses:
      - "10.1.2.3"
```

You link an EndpointSlice to a Service by setting the kubernetes.io/service-name label on that EndpointSlice.

Accessing a Service without a selector works the same as if it had a selector. In the example for a Service

without a selector, traffic is routed to one of the two endpoints defined in the EndpointSlice manifest: a TCP connection to 10.1.2.3 or 10.4.5.6, on port 9376.

Endpoints

In the Kubernetes API, an Endpoints (the resource kind is plural) defines a list of network endpoints, typically referenced by a Service to define which Pods the traffic can be sent to.

in a Kubernetes Service definition file, an "endpoint" typically refers to the IP address of the pods that are targeted by the service.

When you create the "frontend-service" Service, Kubernetes automatically creates EndpointSlices to manage the endpoints (IP addresses) of the Pods that belong to the Service.

nodePort Type

```
curl <node-IP><nodeport>
curl <endpoint> where endpoint=<pod ip><targerPort>
curl <ClusterIP><port>
```

Weightage: 7%

Question No:1

**Create a new pod called web-pod with image busybox
Allow the pod to be able to set system_time**

The container should sleep for 3200 seconds

1. k run web-pod --image=busybox -- command sleep 3200 --dry-run=client -o yaml > web.yaml
2. vi web.yaml
3. Append following in yaml file

```
securityContext:  
  capabilities:  
    add: ["SYS_TIME"]
```

```
apiVersion: v1  
kind: Pod  
metadata:  
  creationTimestamp: null  
  labels:  
    run: web-pod  
    name: web-pod  
spec:  
  containers:  
    - command:  
      - sleep  
      - "3200"  
    image: busybox  
    securityContext:  
      capabilities:  
        add: ["SYS_TIME"]  
    name: web-pod  
    resources: {}  
  dnsPolicy: ClusterFirst  
  restartPolicy: Always  
status: {}
```

4. Save the file ":wq!" and then run **k apply -f web.yaml**

With Linux capabilities, you can grant certain privileges to a process without granting all the privileges of the root user. To add or remove Linux capabilities for a Container, include the capabilities field in the securityContext section of the Container manifest.

Problem

Weightage: 11%

Question No:2

Create a new deployment called myproject, with image nginx:1.16 and 1 replica. Next upgrade the deployment to version 1.17 using rolling update

Make sure that the version upgrade is recorded in the resource annotation.

By default:-

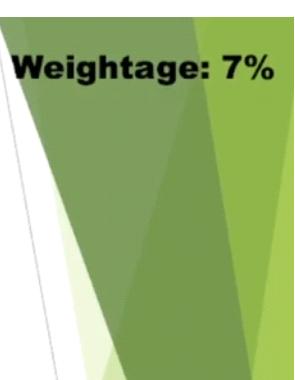
replica = 1
StrategyType = RollingUpdate

1. k create deploy myproject --image=nginx:1.16
2. k set image deployment myproject nginx=nginx:1.17 --record
k set image deployment/<name-of-deployment> <container-name>=<image-name>

Verify

1. k get deploy
2. k describe deploy <deployment name>
3. Since it's related to "Rolling Update", k rollout history deployment <deployment name>

Problem



Weightage: 7%

Question No:3

**Create a new deployment called my-deployment. Scale the deployment to 3 replicas.
Make sure desired number of pod always running.**

If no image is given, choose your own!

```
kubectl create deployment my-deployment --replicas=3 --image=busybox
```

Problem

Weightage: 4%

Question No:4

Deploy a web-nginx pod using the nginx:1.17 image with the labels set to tier=web-app.

```
k run pod web-nginx --image=nginx:1.17 --labels="tier=webapp"
```

verify

```
k get po --show-labels
```

Problem

Weightage: 4%

Question No:5

Create a static pod on node01 called static-pod with image nginx and you have to make sure that it is recreated/restarted automatically in case of any failure happens

M1 - KK

Wednesday, May 8, 2024 11:26 PM

- ? k exec example -- echo hii > /hi.txt
I ran this command. How to get inside the pod and see the hi.txt file content?

kubectl exec <pod_name> -- cat /hi.txt

- ? How to attach a bash terminal with a pod? Give me the command.

kubectl exec -it <pod_name> -- /bin/bash

This command will open a bash terminal inside the specified pod, allowing you to interact with it as if you were using a local terminal.

- ? Create a pod manifest file that runs a while loop and then sleep 1000.

```
apiVersion: v1
kind: Pod
metadata:
  name: loop-pod
spec:
  containers:
    - name: loop-container
      image: busybox
      command: ["/bin/sh", "-c"]
      args:
        - |
          while true; do
            echo "Running loop..."
            sleep 5
          done
          sleep 1000
```

The | character allows for multi-line strings in YAML, making it easier to write complex commands inside the manifest file.

OR

```
apiVersion: v1
kind: Pod
metadata:
  name: loop-pod
spec:
  containers:
    - name: loop-container
      image: busybox
      command:
        - "/bin/sh"
        - "-c"
        - |
          while true; do
            echo "Running loop..."
            sleep 5
          done
          sleep 1000
```

OR

Replace command with one line.

```
command: ["/bin/sh", "-c", "while true; do echo 'Running loop...'; sleep 5; done; sleep 1000"]
```

/bin/bash vs /bin/sh vs /bin/bsh

- /bin/bash is the Bash shell with advanced features,
- /bin/sh traditionally refers to the Bourne Shell or a POSIX-compliant shell

- `/bin/bsh` may not be a standard shell designation and could be a typo or a custom implementation.

?

how to check whether a pod ran "sleep 1000" command or not when i wrote command: ["bin/bash", "sleep 1000"] in the yaml file?

Use kubectl logs to view its logs.

However, since sleep 1000 doesn't produce any output, you **won't see** any specific logs related to that command.

If you want to verify that the sleep 1000 command was indeed executed, you can modify your pod's command to include an echo statement or create a file during the sleep period. For example:

?

how to list pod as a particular user using kubectl?

kubectl get pods --as=user1

?

How to delete forcefully a pod

kubectl delete pod <pod_name> --grace-period=0 --force

A grace period of 0 indicates that the pod should be terminated immediately without waiting for any graceful shutdown procedures to complete.

?

How to take a backup of pod before deleting it?

Use the kubectl get pod command to retrieve the configuration of the pod you want to backup. For example:

```
kubectl get pod <pod_name> -o yaml > pod_backup.yaml
```

If you ever need to recreate the pod using the backup, you can apply the backup file using **kubectl apply -f pod_backup.yaml**.

?

If there is a deployment, there must be a replicaset, right?

Yes, in Kubernetes, when you create a Deployment, it manages a ReplicaSet behind the scenes. When you create a Deployment, Kubernetes automatically creates and manages the associated ReplicaSet. The Deployment controls the ReplicaSet's behavior, such as scaling the number of replicas, updating the application, rolling back changes, and ensuring that the application runs as desired.

What is up-to-date in replicaset?

In a Kubernetes ReplicaSet, the "up-to-date" status refers to the number of pods that are currently running and match the desired state specified in the ReplicaSet's configuration.

Try to use matching names for volumes and VolumeMounts to indicate their relationship. For example, if you have a volume named data-volume, use data-volume as the name in the VolumeMount for the container that uses that volume.

Sidecar vs init-container

Sidecar

```
spec:
  containers:
    - name: app-container
      image: main-app-image
      ports:
        - containerPort: 80
    - name: logging-sidecar
      image: logging-agent-image
      volumeMounts:
        - name: logs-volume
          mountPath: /var/log/app

  volumes:
    - name: logs-volume
      emptyDir: {} # Example of an emptyDir volume for logging
```

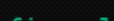


init-container

```
spec:
  containers:
    - name: app-container
      image: main-app-image
      ports:
        - containerPort: 80

  initContainers:
    - name: setup-container
      image: setup-image
      command: [sh, -c, "wget -O /app/config.ini http://config-server/config.ini"]
      volumeMounts:
        - name: config-volume
          mountPath: /app/config

  volumes:
```



```
volumes:  
  - name: config-volume  
    emptyDir: {} # Example of an emptyDir volume for configuration
```



- The sidecar container (logging-sidecar) in the first example runs alongside the main application and has a lifecycle tied to the main container.
- The init container (setup-container) in the second example runs initialization tasks before the main application starts and has a separate lifecycle from the main container.



is it necessary to run any command in init-container or sidecar container, right?

In an init container, you typically run commands or scripts to perform initialization tasks before the main application container starts.

However, if an init container's purpose is simply to wait for a resource to become available (such as a database or external service), you may not need to run any explicit command. The init container can wait using the sleep command or a specialized tool designed for waiting.

```
# Rollback to a specific revision  
kubectl rollout undo deployment/frontend --to-revision=2  
  
# Rolling restart of the "frontend" deployment  
kubectl rollout restart deployment/frontend  
  
# Rolling resume of the "frontend" deployment which is paused  
kubectl rollout resume deployment/my-deployment
```

?

Daemonsets and StatefulSet

A DaemonSet ensures that a copy of a specified pod runs on every node in the Kubernetes cluster.

Stateful Applications:

Stateful applications are software programs that store data or maintain some form of state. This means they remember information from one interaction to the next.

StatefulSet is a Kubernetes resource designed specifically for managing stateful applications. It helps in deploying and managing stateful applications within a Kubernetes cluster.

CoreDNS vs Replica

When you deploy CoreDNS in a Kubernetes cluster, you typically define the number of replicas for the CoreDNS pods. The number of replicas determines how many instances of CoreDNS are running to handle DNS requests and provide fault tolerance and scalability.

```

apiVersion: apps/v1
kind: Deployment
metadata:
  name: coredns
spec:
  replicas: 2 # Define the number of replicas
  selector:
    matchLabels:
      k8s-app: coredns
  template:
    metadata:
      labels:
        k8s-app: coredns
    spec:
      containers:
        - name: coredns
          image: coredns/coredns:1.8.4
          ports:
            - containerPort: 53
              protocol: UDP
            - containerPort: 53
              protocol: TCP

```

8080:80/tcp

- **8080: This is the host port.** It refers to the port where the service is running. When traffic comes to this port on the node, Kubernetes forwards it to the pod's targetPort.
- **80: This is the container port or targetPort.** It refers to the port on which the application or service is listening inside the pod. The traffic from the host port (8080) is forwarded to this targetPort (80) inside the pod.
- **tcp:** This specifies the protocol being used. In this case, it's TCP (Transmission Control Protocol), which is the default protocol for most network communications.

```
ports:  
  - protocol: TCP  
    port: 80  
  - protocol: UDP  
    port: 53
```

in this, what does port 80 do in TCP and 53 in UDP?

- The rule with protocol: TCP and port: 80 specifies that incoming TCP traffic on port 80 is allowed.
- The rule with protocol: UDP and port: 53 specifies that incoming UDP traffic on port 53 is allowed.

Ingress

```
apiVersion: networking.k8s.io/v1  
kind: Ingress  
metadata:  
  name: minimal-ingress  
  annotations:  
    nginx.ingress.kubernetes.io/rewrite-target: /  
spec:  
  ingressClassName: nginx-example  
  rules:  
  - http:  
    paths:  
    - path: /testpath  
      pathType: Prefix  
      backend:  
        service:  
          name: test  
          port:  
            number: 80
```

- This Ingress resource defines a routing rule for HTTP traffic where requests with the path `/testpath` (and paths prefixed with `/testpath`) are forwarded to the test service on port 80.
- **The annotation `nginx.ingress.kubernetes.io/rewrite-target: /`**: indicates that the URL should be rewritten to `/` before being sent to the backend service.
- **annotations:** Additional settings or configurations for the Ingress. In this case, it includes the annotation `nginx.ingress.kubernetes.io/rewrite-target: /`, which is specific to the NGINX Ingress Controller and specifies that the URL should be rewritten to `/` before being forwarded to the backend service.
- **pathType: Prefix**: Specifies that the path `/testpath` is a prefix match. This means that requests with paths like `/testpath/something` will also match this rule.

Docker vs VM

Docker containers share the host's OS kernel and storage resources, leading to lightweight and efficient resource utilization. On the other hand, VMs provide full OS virtualization and resource allocation, allowing them to run different OSes and provide stronger isolation but at the cost of higher resource overhead. Each approach has its advantages and is chosen based on the specific requirements of the application and the desired balance between isolation, resource efficiency, and flexibility.

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: ingress-wildcard-host
spec:
  rules:
    - host: "foo.bar.com"
      http:
        paths:
          - pathType: Prefix
            path: "/bar"
            backend:
              service:
                name: service1
                port:
                  number: 80
    - host: "*.foo.com"
      http:
        paths:
          - pathType: Prefix
            path: "/foo"
            backend:
              service:
                name: service2
                port:
                  number: 80
```

Suppose you have two backend services in your Kubernetes cluster:

- Service 1 (name: service1) handles requests for foo.bar.com/bar.
 - Service 2 (name: service2) handles requests for any subdomain of foo.com with the prefix /foo.
 - When a request comes in for foo.bar.com/bar, the Ingress routes it to service1 listening on port 80.
 - If a request comes in for any subdomain of foo.com with the prefix /foo, the Ingress routes it to service2 also listening on port 80.
-
- <http://foo.bar.com/bar>: This URL will match the first rule in the Ingress file because the host header is foo.bar.com, and the path prefix is /bar. The traffic will be forwarded to service1 on port 80.

- <http://www.test.foo.com/foo>: This URL will match the second rule in the Ingress file because the host header matches the wildcard *.foo.com, and the path prefix is /foo. The traffic will be forwarded to service2 on port 80.
- In the first rule of the Ingress YAML file you provided, the path is specified as "/bar" with a pathType of "Prefix". This means that any URL starting with "foo.bar.com/bar" will match this rule, regardless of what comes after "/bar" in the URL.

Host	Host header	Match?
*.foo.com	bar.foo.com	Matches based on shared suffix
*.foo.com	baz.bar.foo.com	No match, wildcard only covers a single DNS label
*.foo.com	foo.com	No match, wildcard only covers a single DNS label

M2 - KK

Monday, May 20, 2024 11:03 PM

For this question, please set the context to cluster1 by running:

```
kubectl config use-context cluster1
```

Create a service account called pink-sa-cka24-arch. Further create a cluster role called pink-role-cka24-arch with full permissions on all resources in the core api group under default namespace in cluster1.

Finally create a cluster role binding called pink-role-binding-cka24-arch to bind pink-role-cka24-arch cluster role with pink-sa-cka24-arch service account.

```
kubectl --context cluster1 create serviceaccount pink-sa-cka24-arch  
kubectl --context cluster1 create clusterrole pink-role-cka24-arch --resource=* --verb=*  
kubectl --context cluster1 create clusterrolebinding pink-role-binding-cka24-arch --  
clusterrole=pink-role-cka24-arch --serviceaccount=default:pink-sa-cka24-arch
```

💡 Find the node across all clusters that consumes the most **memory** and store the result to the file /opt/high_memory_node in the following format cluster_name,node_name.

The node could be in any clusters that are currently configured on the student-node.

Check out the metrics for all node across all clusters:

```
student-node ~ → kubectl top node --context cluster1 --no-headers | sort -nr -k4 | head -1  
cluster1-controlplane 124m 1% 768Mi 1%  
  
student-node ~ → kubectl top node --context cluster2 --no-headers | sort -nr -k4 | head -1  
cluster2-controlplane 79m 0% 873Mi 1%  
  
student-node ~ → kubectl top node --context cluster3 --no-headers | sort -nr -k4 | head -1  
cluster3-controlplane 78m 0% 902Mi 1%  
  
student-node ~ → kubectl top node --context cluster4 --no-headers | sort -nr -k4 | head -1  
cluster4-controlplane 78m 0% 901Mi 1%  
  
student-node ~ →
```

Using this, find the node that uses most **memory**. In this case, it is **cluster3-controlplane** on **cluster3**.

Save the result in the correct format to the file:

```
student-node ~ → echo cluster3,cluster3-controlplane > /opt/high_memory_node
```

A pod called `logger-complete-cka04-arch` has been created in the `default` namespace. Inspect this pod and save **ALL** the logs to the file `/root/logger-complete-cka04-arch` on the `student-node`.

Solution

Run the command `kubectl logs logger-complete-cka04-arch --context cluster3 > /root/logger-complete-cka04-arch` on the `student-node`.
Run the command :

```
student-node ~ ➔ kubectl logs logger-complete-cka04-arch --context cluster3 > /root/logger-complete-cka04-arch

student-node ~ ➔ head /root/logger-complete-cka04-arch
INFO: Wed Oct 19 10:50:54 UTC 2022 Logger is running
CRITICAL: Wed Oct 19 10:50:54 UTC 2022 Logger encountered errors!
SUCCESS: Wed Oct 19 10:50:54 UTC 2022 Logger re-started!
INFO: Wed Oct 19 10:50:54 UTC 2022 Logger is running
CRITICAL: Wed Oct 19 10:50:54 UTC 2022 Logger encountered errors!
SUCCESS: Wed Oct 19 10:50:54 UTC 2022 Logger re-started!
INFO: Wed Oct 19 10:50:54 UTC 2022 Logger is running

student-node ~ ➔
```

kubectl logs vs kubectl get events

```
student-node ~ ➔ kubectl get pod -l mode=exam,type=external -n spectra-1267
NAME      READY   STATUS    RESTARTS   AGE
pod-23   1/1     Running   0          9m18s
pod-21   1/1     Running   0          9m17s
```

How to logout as root user?

Run "exit"

How to logout as root user?

SU -

Change namespace

kubectl config set-context --current --namespace=<my-namespace>

How to view logs ?

View Logs of a Pod:
kubectl logs <pod-name>

View Logs of a Specific Container in a Pod:
kubectl logs <pod-name> -c <container-name>

kubectl exec with interactive Terminal:

Open an interactive terminal inside the container.

Syntax: kubectl exec -it <pod-name> [-c <container-name>] -- /bin/sh

Example: kubectl exec -it my-pod -- /bin/sh

In what order should i create - SA, role, rolebinding?

By following this order, you establish a clear hierarchy of permissions: Service Account > Role/ClusterRole > RoleBinding/ClusterRoleBinding, ensuring that pods have the necessary access levels within your Kubernetes environment.

1. kubectl create sa my-service-account
2. kubectl create clusterrole my-cluster-role --verb=get,list --resource=pods
3. kubectl create clusterrolebinding my-cluster-role-binding --clusterrole=my-cluster-role --serviceaccount=default:my-service-account

How to deploy a pod on "cluster1-controlplane" from a yaml file stored on "student-node".

Transfer the YAML file to the target node ("cluster1-controlplane"):

scp /path/to/your/pod.yaml user@cluster1-controlplane:/path/on/cluster1-controlplane/

Replace /path/to/your/pod.yaml with the actual path to your YAML file, user with your username on "cluster1-controlplane," and /path/on/cluster1-controlplane/ with the destination path on "cluster1-controlplane" where you want to store the file.

ssh user@cluster1-controlplane

kubectl apply -f /path/on/cluster1-controlplane/pod.yaml

M3 - KK

Tuesday, May 21, 2024 8:39 PM

- Under `initContainers:` → `- command: add -c` to the next line of `- sh`, so final command should look like this

```
initContainers:  
- command:  
- sh  
- -c  
- echo 'Welcome!'
```

command: ["sh", "-c", "echo 'Welcome!'"]

If you will check pod then it must be failing again but with different error this time, let's find that out

```
kubectl get event --field-selector involvedObject.name=blue-dp-cka09-trb-xxxxx
```

You will see an error something like

```
Warning Failed pod/blue-dp-cka09-trb-69dd844f76-rv9z8 Error: failed to create containerd task: failed to create shim task: OCI runtime create failed: runc create failed: u
```

Edit the deployment again

```
kubectl edit deploy blue-dp-cka09-trb
```

- Under `volumeMounts:` → `- mountPath: /etc/nginx/nginx.conf` → `name: nginx-config` add `subPath: nginx.conf` and save the changes.

Finally the pod should be in running state.

One of the nginx based pod called `cyan-pod-cka28-trb` is running under `cyan-ns-cka28-trb` namespace and it is exposed within the cluster using `cyan-svc-cka28-trb` service.

This is a `restricted` pod so a network policy called `cyan-np-cka28-trb` has been created in the same namespace to apply some restrictions on this pod.

Two other pods called `cyan-white-cka28-trb` and `cyan-black-cka28-trb` are also running in the `default` namespace.

The nginx based app running on the `cyan-pod-cka28-trb` pod is exposed internally on the default nginx port (`80`).

Expectation: This app should `only` be accessible from the `cyan-white-cka28-trb` pod.

Problem: This app is not accessible from anywhere.

Troubleshoot this issue and fix the connectivity as per the requirement listed above.

Note: You can exec into `cyan-white-cka28-trb` and `cyan-black-cka28-trb` pods and test connectivity using the `curl` utility.

You may update the network policy, but make sure it is not deleted from the `cyan-ns-cka28-trb` namespace.

Solution

Let's look into the network policy

```
kubectl edit networkpolicy cyan-np-cka28-trb -n cyan-ns-cka28-trb
```

Under `spec: → egress:` you will notice there is not `cidr:` block has been added, since there is no restrictions on `egress` traffic so we can update it as below. Further you will notice that the port used in the policy is `8080` but the app is running on default port which is `80` so let's update this as well (under `egress` and `ingress`):

- Change `port: 8080` to `port: 80`

```
- ports:  
  - port: 80  
    protocol: TCP  
  to:  
  - ipBlock:  
    cidr: 0.0.0.0/0
```

Now, lastly notice that there is no POD selector has been used in `ingress` section but this app is supposed to be accessible from `cyan-white-cka28-trb` pod under `default` namespace. So let's edit it to look like as below:

```
ingress:  
- from:  
  - namespaceSelector:  
    matchLabels:  
      kubernetes.io/metadata.name: default  
  podSelector:  
    matchLabels:  
      app: cyan-white-cka28-trb
```

Now, lastly notice that there is no POD selector has been used in `ingress` section but this app is supposed to be accessible from `cyan-white-cka28-trb` pod under `default` namespace. So let's edit it to look like as below:

```
ingress:  
- from:  
  - namespaceSelector:  
    matchLabels:  
      kubernetes.io/metadata.name: default  
  podSelector:  
    matchLabels:  
      app: cyan-white-cka28-trb
```

Now, let's try to access the app from `cyan-white-pod-cka28-trb`

```
kubectl exec -it cyan-white-cka28-trb -- sh  
curl cyan-svc-cka28-trb.cyan-ns-cka28-trb.svc.cluster.local
```

Also make sure its not accessible from the other pod(s)

```
kubectl exec -it cyan-black-cka28-trb -- sh  
curl cyan-svc-cka28-trb.cyan-ns-cka28-trb.svc.cluster.local
```

It should not work from this pod. So its looking good now.

Liveness probe

From this we can see that the Liveness probe is failing for the kube-apiserver-cluster4-controlplane pod, and we can see its trying to connect to port 6444 port but the default api port is 6443. So let's look into the kube api server manifest.

To verify if port 6444 is correct for the kube-apiserver-cluster4-controlplane pod's liveness probe or if it should be another port, you can follow these steps:

Retrieve the YAML configuration of the pod to inspect its liveness probe configuration. Use the following command:

```
kubectl get pod kube-apiserver-cluster4-controlplane -o yaml
```

In Kubernetes, **nslookup kubernetes.default** is a command used to look up the DNS records for the kubernetes.default domain.

The kubernetes.default domain is typically used for internal Kubernetes DNS resolution. It resolves to the IP addresses of Kubernetes services related to the Kubernetes control plane, such as the API server, DNS service, and others.

When you run nslookup kubernetes.default within a pod or a container in Kubernetes, it queries the DNS server configured in the pod (which is usually the Kubernetes DNS service) to resolve the IP address associated with the kubernetes.default domain. This can be useful for troubleshooting DNS-related issues or verifying connectivity to Kubernetes control plane services from within a pod or container.

```
kubectl exec -it <pod-name> -c <container-name> -- nslookup <hostname>
```

```
Now let's test if the nslookup command is working :  
  
student-node ~ ➔ kubectl exec -n dev-cka02-svcn -i -t tester-cka02-svcn -- nslookup kubernetes.default  
;; connection timed out; no servers could be reached  
command terminated with exit code 1
```

The **-it** flags are used to run the command interactively, allowing you to see the output and interact with the command if needed.

Configure Liveness, Readiness and Startup Probes

Liveness Probe:

1. Checks if the container is running properly.
2. If the liveness probe fails, Kubernetes restarts the container.
3. Used to ensure that the application within the container is functioning as expected.
4. Commonly checks for responsiveness or availability of critical services.

Readiness Probe:

1. Checks if the container is ready to serve traffic.

2. If the readiness probe fails, the pod is removed from service endpoints.
3. Ensures that the container is ready to accept incoming requests before traffic is routed to it.
4. Useful for services that require initialization or warm-up time before serving traffic.

Startup Probe:

1. Checks if the container has started successfully.
2. Designed for applications that may require additional time to start up or initialize.
3. Used during the initial startup of a container to delay readiness and liveness checks until the application is fully initialized.
4. Helps prevent premature termination of containers during startup, especially for applications with longer startup times or complex initialization processes.

★ If docker ps is not working, try crictl ps (CRI-O)

- ConfigMaps
- ClusterIP
- NodePort
- Ingress
- Deployment - rollout, history, status etc

? How to access a pod form a node using curl to check whether the service is accessible or not?

Identify Node IP Addresses:
kubectl get nodes -o wide

SSH into that node.
ssh username@<node-ip-address>

curl <http://<pod-ip>:<port>>

If controller manager and scheduler both are failed to start, which should i first resolve?

it's generally advisable to prioritize resolving the controller manager first.

- `kubectl delete pod --grace-period=0 --force --namespace <namespace-name>`

`unalias` = To delete alias

M4 - KK

Thursday, May 23, 2024 12:15 PM

```
Message: failed to create containerd task: failed to create shim task: OCI runtime create failed: runc create failed: unable to start container process: error during container init: error mounting "/var/lib/kubelet/pods/b2b93222-b8cb-496e-b286-b26b5819c8a3/volumes/kubernetes.io~configmap/nginx-config" to rootfs at "/etc/nginx/nginx.conf": mount /var/lib/kubelet/pods/b2b93222-b8cb-496e-b286-b26b5819c8a3/volumes/kubernetes.io~configmap/nginx-config:/etc/nginx/nginx.conf (via /proc/self/fd/6), flags: 0x5001: not a directory: unknown
```

```
imple-webapp:  
  Container ID: containerd://da9bd120c1151ff61a6e1719c6ae440c7799a982e94d86f69044f967b11d045a  
  Image: kodekloud/webapp-color:v2  
  Image ID: docker.io/kodekloud/webapp-color@sha256:6c204ec4f0c5b2aac1d1711fe853efee4cf97f45e3f717ee182af253243c794c  
  Port: 8080/TCP  
  Host Port: 0/TCP  
  State: Running  
  Started: Thu, 23 May 2024 11:56:52 +0000  
  Ready: True  
  Restart Count: 0  
  Environment: <none>  
  Mounts:  
    /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-69cgp (ro)
```

frontend-wl04-svc NodePort 10.96.115.14 <none> 8080:30080/TCP 6m31s

curl <http://cluster1-node01:30080>

hostport

When you define a hostPort in a pod specification, it binds the pod's container port directly to the host machine's port. This means that the pod's container port is exposed on the host machine's IP address and can be accessed directly using the host's IP and port combination.

target port (8080)
NodePort (30080)

Find the node across all clusters that consumes the most `memory`, and store the result to the file `/opt/high_memory_node` in the following format `cluster_name, node_name`.

The node could be in any clusters that are currently configured on the `student-node`.

Solution

Check out the metrics for all node across all clusters:

```
student-node ~ → kubectl top node --context cluster1 --no-headers | sort -nr -k4 | head -1
cluster1-controlplane 124m 1% 768Mi 1%
student-node ~ → kubectl top node --context cluster2 --no-headers | sort -nr -k4 | head -1
cluster2-controlplane 79m 0% 873Mi 1%
student-node ~ → kubectl top node --context cluster3 --no-headers | sort -nr -k4 | head -1
cluster3-controlplane 78m 0% 902Mi 1%
student-node ~ → kubectl top node --context cluster4 --no-headers | sort -nr -k4 | head -1
cluster4-controlplane 78m 0% 901Mi 1%
student-node ~ →
```

- **kubectl top node**: This part of the command retrieves resource usage statistics for nodes in the Kubernetes cluster.
- **--context cluster1**: This flag specifies that the command should be executed in the context of the Kubernetes cluster named "cluster1". The context determines which cluster kubectl interacts with.
- **--no-headers**: This flag tells kubectl not to include headers in the output, making it easier to process the output using command-line tools.
- **|**: The pipe operator (|) is used to pass the output of the previous command (kubectl top node) to the next command (sort).
- **sort -nr -k4**: This part of the command sorts the output numerically (-n) in reverse order (-r) based on the fourth column (-k4). In the context of kubectl top node, the fourth column typically represents **memory usage**.
- **|**: Another pipe operator (|) is used to pass the sorted output to the next command (head).
- **head -1**: Finally, head is used to display the first line of the sorted output, which corresponds to the node with the highest memory usage.

In summary, the command retrieves memory usage statistics for nodes in the "cluster1" Kubernetes cluster, sorts them based on memory usage in descending order, and then displays the node with the highest memory usage. The head -1 part ensures that only the node with the highest memory usage is shown, which is then typically redirected to a file using > or >> for storage and further analysis.

Cronjob

There is a Cronjob called orange-cron-cka10-trb which is supposed to run every two minutes (i.e 13:02, 13:04, 13:06...14:02, 14:04...and so on). This cron targets the application running inside the orange-app-cka10-trb pod to make sure the app is accessible. The application has been exposed internally as a ClusterIP service.

However, this cron is not running as per the expected schedule and is not running as intended.

Make the appropriate changes so that the cronjob runs as per the required schedule and it passes the accessibility checks every-time.

Check the cron schedule

`kubectl get cronjob`

Make sure the schedule for orange-cron-cka10-trb cronjob is set to `*/2 * * * *` if not then edit it.

★ `* * * * *`: These fields represent, in order, minutes, hours, day of month, month, and day of week. Using `*` for each field means "every value" in that field.

So, the schedule `*/2 * * * *` for a CronJob in Kubernetes means "run the job every 2 minutes, all hours, days of the month, months, and days of the week."

- `0 12 * * *` MON-FRI: This schedule runs a task every weekday (Monday to Friday) at noon (12:00).
- `*/10 * * * *`: This schedule runs a task every 10 minutes, so it executes at 00:00, 00:10, 00:20, and so forth.
- `15 * * * *`: This schedule runs a task every hour at the 15th minute, so it executes at 1:15, 2:15, 3:15, and so on.
- `0 0 * * *`: This schedule runs a task once a day at midnight (00:00), marking the start of a new day.

★ `*/10 * * * *`: Runs every 10 minutes.

★ `10 * * * *`: Runs once per hour, specifically at the 10th minute of each hour.

- ★ * */2 * * * - run every 2 hours, executing the specified command or job.
- ★ * 2 * * * - run at 2 AM every day.
- ★ * 14 * * * - run at 2 PM hour, every day.

★ 2 17 * * * - This cronjob will run every day at 5:02 PM.

Also before that look for the issues why this cron is failing

kubectl logs orange-cron-cka10-trb-xxxx

You will see some error like

curl: (6) Could not resolve host: orange-app-cka10-trb

You will notice that the curl is trying to hit orange-app-cka10-trb directly but it is supposed to hit the relevant service which is orange-svc-cka10-trb so we need to fix the curl command.

Edit the cronjob

kubectl edit cronjob orange-cron-cka10-trb

Change schedule * * * * * to */2 * * * *

Change command curl orange-app-cka10-trb to curl orange-svc-cka10-trb

Wait for 2 minutes to run again this cron and it should complete now.

```
Solution

Check the cron schedule

kubectl get cronjob

Make sure the schedule for orange-cron-cka10-trb cronjob is set to */2 * * * * if not then edit it.

Also before that look for the issues why this cron is failing

kubectl logs orange-cron-cka10-trb-xxxx

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Edit the cronjob

kubectl edit cronjob orange-cron-cka10-trb

• Change schedule * * * * * to */2 * * * *
• Change command curl orange-app-cka10-trb to curl orange-svc-cka10-trb

Wait for 2 minutes to run again this cron and it should complete now.
```

We recently deployed a DaemonSet called logs-cka26-trb under kube-system namespace in cluster2 for collecting logs from all the cluster nodes including the controlplane node. However, at this moment, the DaemonSet is not creating any pod on the controlplane node.

Troubleshoot the issue and fix it to make sure the pods are getting created on all nodes including the controlplane node.

Solution

Check the status of DaemonSet

kubectl --context2 cluster2 get ds logs-cka26-trb -n kube-system

You will find that DESIRED CURRENT READY etc have value 2 which means there are two pods that have been created. You can check the same by listing the PODs

```
kubectl --context2 cluster2 get pod -n kube-system
```

You can check on which nodes these are created on

```
kubectl --context2 cluster2 get pod <pod-name> -n kube-system -o wide
```

Under NODE you will find the node name, so we can see that it's not scheduled on the controlplane node which is because it must be missing the required tolerations. Let's edit the DaemonSet to fix the tolerations

```
kubectl --context2 cluster2 edit ds logs-cka26-trb -n kube-system
```

Under tolerations: add below given tolerations as well

```
- key: node-role.kubernetes.io/control-plane  
operator: Exists  
effect: NoSchedule
```

Wait for some time PODs should schedule on all nodes now including the controlplane node.

Solution

Check the status of DaemonSet

```
kubectl --context2 cluster2 get ds logs-cka26-trb -n kube-system
```

You will find that DESIRED CURRENT READY etc have value 2 which means there are two pods that have been created. You can check the same by listing the PODs

```
kubectl --context2 cluster2 get pod -n kube-system
```

You can check on which nodes these are created on

```
kubectl --context2 cluster2 get pod <pod-name> -n kube-system -o wide
```

Under NODE you will find the node name, so we can see that its not scheduled on the controlplane node which is because it must be missing the required tolerations. Let's edit the DaemonSet to fix the tolerations

```
kubectl --context2 cluster2 edit ds logs-cka26-trb -n kube-system
```

Under tolerations: add below given tolerations as well

```
- key: node-role.kubernetes.io/control-plane  
operator: Exists  
effect: NoSchedule
```

Wait for some time PODs should schedule on all nodes now including the controlplane node.

To schedule a DaemonSet on the control plane node with tolerations, you typically need to know the key for the toleration that matches the control plane components' taint. The key for toleration depends on how the control plane node is tainted.

You can find the taints applied to the control plane node using the following command:

```
kubectl describe node <control-plane-node-name>
```

Look for the "Taints" section in the output. It will show the key-value pairs of taints applied to the node.

For this question, please set the context to cluster1 by running:

```
kubectl config use-context cluster1
```

The deployment called trace-wl08 inside the test-wl08 namespace on cluster1 has undergone several, routine, rolling updates and rollbacks.

Inspect the revision 2 of this deployment and store the image name that was used in this revision in the /opt/trace-wl08-revision-book.txt file on the student-node.

Set the correct context: -

```
kubectl config use-context cluster1
```

List the deployments in `test-wl08` namespace as follows: -

```
kubectl get deploy -n test-wl08
```

Run the following command to check the revisions of the deployment called `trace-wl08` :-

```
kubectl rollout history deployment -n test-wl08 trace-wl08
```

Inspect the `revision 2` by using the `--revision` option: -

```
kubectl rollout history deployment -n test-wl08 trace-wl08 --revision=2
```

Under the `Containers` section, you will see the `image` name.

On the `student-node`, save that image name in the given file `/opt/trace-wl08-revision-book.txt`:

```
echo "busybox:1.35" > /opt/trace-wl08-revision-book.txt
```

When a service is set up in Kubernetes, it must have an endpoint associated with it.

Now we will check if service is correctly defined:

```
student-node ~ → kubectl describe svc external-webserver-cka03-svcn
Name:           external-webserver-cka03-svcn
Namespace:      default
...
Endpoints:     <none> # there are no endpoints for the service
...
```

As we can see there is no endpoints specified for the service, hence we won't be able to get any output. Since we can not destroy any k8s object, let's create the endpoint manually for this service as shown below:

```
student-node ~ → export IP_ADDR=$(ifconfig eth0 | grep inet | awk '{print $2}')
student-node ~ → kubectl --context cluster3 apply -f - <<EOF
apiVersion: v1
kind: Endpoints
metadata:
  # the name here should match the name of the Service
  name: external-webserver-cka03-svcn
subsets:
  - addresses:
    - ip: $IP_ADDR
    ports:
      - port: 9999
EOF
```

nslookup

Task

SECTION: SERVICE NETWORKING

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

Create a nginx pod called `nginx-resolver-cka06-svcn` using image `nginx`, expose it internally with a service called `nginx-resolver-service-cka06-svcn`.

Test that you are able to look up the service and pod names from within the cluster. Use the image: `busybox:1.28` for dns lookup. Record results in `/root/CKA/nginx.svc.cka06.svcn` and `/root/CKA/nginx.pod.cka06.svcn`

Solution

Switching to `cluster1`:

```
kubectl config use-context cluster1
```

To create a pod `nginx-resolver-cka06-svcn` and expose it internally:

```
student-node ~ → kubectl run nginx-resolver-cka06-svcn --image=nginx
student-node ~ → kubectl expose pod/nginx-resolver-cka06-svcn --name=nginx-resolver-service-cka06-svcn --port=80 --target-port=80 --type=ClusterIP
```

To create a pod `test-nslookup`. Test that you are able to look up the service and pod names from within the cluster:

```
student-node ~ → kubectl run test-nslookup --image=busybox:1.28 --rm -it --restart=Never -- nslookup nginx-resolver-service-cka06-svcn
student-node ~ → kubectl run test-nslookup --image=busybox:1.28 --rm -it --restart=Never -- nslookup nginx-resolver-service-cka06-svcn > /root/CKA/nginx.svc.cka06.svcn
```

Get the IP of the `nginx-resolver-cka06-svcn` pod and replace the dots(.) with hyphon(-) which will be used below.

```
student-node ~ → kubectl get pod nginx-resolver-cka06-svcn -o wide
student-node ~ → IP=kubectl get pod nginx-resolver-cka06-svcn -o wide --no-headers | awk '{print $6}' | tr '.' '-'
student-node ~ → kubectl run test-nslookup --image=busybox:1.28 --rm -it --restart=Never -- nslookup $IP.default.pod > /root/CKA/nginx.pod.cka06.svcn
```

- **kubectl run test-nslookup:** This part initiates the creation of a new Kubernetes pod named test-nslookup.
- **--image=busybox:1.28:** It specifies the Docker image to use for the pod. In this case, it's using the BusyBox image with version 1.28.
- **--rm:** This flag indicates that the pod should be automatically removed after it exits. It's useful for temporary or one-off pods.
- **-it:** These flags are used together to run the pod interactively and allocate a terminal. It's often used for debugging or interactive sessions with the pod.

- **--restart=Never:** This specifies that the pod should not be restarted automatically if it exits. It's set to Never to indicate that this is a one-time job or task.
- **-- nslookup nginx-resolver-service-cka06-svcn:** This part is the command to be run inside the pod. It runs the nslookup command to perform a DNS lookup for the host nginx-resolver-service-cka06-svcn. This is typically used to check DNS resolution within the Kubernetes cluster.

The `kubectl exec -it <pod-name> -- nslookup <domain-name>` command will give you DNS records for services associated with pods in the cluster, not for all services in the cluster.

The command `tr '.' '-'` is a Unix/Linux command that uses the tr utility to replace dots (.) with hyphens (-) in text input.

awk '{print \$6}': This part of the command uses awk to extract the sixth column (\$6) from the output of the previous command. In the wide format output of `kubectl get svc`, the sixth column typically contains the external IP address of the service.

Finally, the extracted external IP address is assigned to a shell variable named IP.

What is the use of external IP?

If you have services running in your Kubernetes cluster that need to be accessed from outside the cluster (for example, by users or other systems), the external IP address provides a way for external traffic to reach those services.

To access a pod using its external IP, you can follow these steps:

Get the external IP of the service:

```
kubectl get svc <svc-name> -o wide --no-headers | awk '{print $6}'
```

Use nslookup to resolve the IP address to the pod name:

```
kubectl run test-lookup --image=busybox --rm -it --restart=Never -- nslookup $IP.default.pod > /root/CKA/pod.cka06.svcn
```

`kubectl run test-lookup`: Creates a temporary pod named test-lookup.

- `--image=busybox`: Specifies the BusyBox image to use for the temporary pod.
- `--rm`: Removes the temporary pod after it exits.
- `-it`: Runs the pod in interactive mode.
- `--restart=Never`: Specifies that the pod should not be restarted automatically.
- `-- nslookup $IP.default.pod`: Runs the nslookup command inside the temporary pod to resolve the IP address (\$IP) to the pod name (\$IP.default.pod).
- `> /root/CKA/pod.cka06.svcn`: Redirects the output of nslookup to a file named pod.cka06.svcn in the specified directory (/root/CKA/).

If everything is set up correctly, the file should contain the pod name corresponding to the external IP address.

- ★ When using nslookup with Kubernetes, especially to resolve internal DNS names within the cluster, you often replace dots (.) with hyphens (-) in the domain name. This is because Kubernetes DNS uses a specific naming convention where dots are replaced by hyphens for certain DNS records.

nslookup

The primary purpose of nslookup is to perform DNS queries.

For example, if you run nslookup example.com, it might return the IP address associated with example.com

★ Kubernetes automatically creates DNS records for services within the cluster.

❓ How to get all of the dns records in a cluster using nslookup?

List Services

```
kubectl get services --all-namespaces
```

List Pods:

```
kubectl get pods --all-namespaces
```

Perform DNS Queries:

```
kubectl exec -it <pod-name> -- nslookup <service-name>.<namespace>.svc.cluster.local
```

To resolve the "Back-off restarting failed container" issue, you should:

- Check the logs of the container (`kubectl logs <pod-name> -c <container-name>`) to identify the specific error or reason for the failures.
- Review the pod's configuration, including resource requests and limits, environment variables, volume mounts, and health checks.
- Ensure that the container image is accessible and correctly specified in the pod manifest.
- Adjust resource allocations if the container is consistently exceeding its limits.
- Monitor resource utilization and performance metrics to identify any underlying issues with resource contention or bottlenecks.

OOMKilled error is caused by?

ChatGPT

The "OOMKilled" error in Kubernetes indicates that a container was terminated because it exceeded its allocated memory limits and triggered an Out Of Memory (OOM) event.

solution

Review and adjust the memory requests and limits for containers to ensure they have sufficient resources allocated.

To verify a ClusterRoleBinding in Kubernetes, you can use the following command with the `-as=<user-name>` flag:

```
kubectl get clusterrolebinding <clusterrolebinding-name> -o json -as=<user-name>
```

nslookup

```
# DNS lookup for the Service
kubectl exec busybox-test -- nslookup nginx-svc > svc-result.txt
```

1. DNS lookup for the Service ('nginx-svc'):

```
yaml
Server:  10.96.0.10
Address 1: 10.96.0.10 kube-dns.kube-system.svc.cluster.local

Name:      nginx-svc
Address 1: 10.96.0.100
```

```
# DNS lookup for the Pod
kubectl exec busybox-test -- nslookup nginx-app > pod-result.txt
```

2. DNS lookup for the Pod ('nginx-app'):

```
yaml
Server:  10.96.0.10
Address 1: 10.96.0.10 kube-dns.kube-system.svc.cluster.local

Name:      nginx-app
Address 1: 192.168.1.5
```

M5 - KK

Friday, May 24, 2024 7:04 PM

★ Poora Question Read karo complete and then solve karna start karo

A Role always sets permissions within a particular namespace; when you create a Role, you have to specify the namespace it belongs in. Roles are specific to namespaces and control access to resources within that namespace only.

ClusterRole, by contrast, is a non-namespaced resource. The resources have different names (Role and ClusterRole) because a Kubernetes object always has to be either namespaced or not namespaced; it can't be both. ClusterRoles are not bound to a namespace and can control access across the entire cluster.

★ If the resource you want to control is within a specific namespace, create a Role. If the resource needs to be controlled at the cluster level, without considering namespaces, create a ClusterRole.

? A template to create a Kubernetes pod is stored at /root/red-probe-cka12-trb.yaml on the student-node. However, using this template as-is is resulting in an error.

Fix the issue with this template and use it to create the pod. Once created, watch the pod for a minute or two to make sure its stable i.e, it's not crashing or restarting.

Make sure you do not update the args: section of the template.

LivenessProbe

```
Solution

Try to apply the template
kubectl apply -f red-probe-cka12-trb.yaml

You will see error:
error: error validating "red-probe-cka12-trb.yaml": error validating data: [ValidationError(Pod.spec.containers[0].livenessProbe.httpGet): unknown field "command" in io.k8s.api.core.v1.HTTPGetAction]

From the error you can see that the error is for liveness probe, so let's open the template to find out:
vi red-probe-cka12-trb.yaml

Under livenessProbe: you will see the type is httpGet however the rest of the options are command based so this probe should be of exec type.
• Change httpGet to exec

Try to apply the template now
kubectl apply -f red-probe-cka12-trb.yaml

Cool it worked, now let's watch the POD status, after few seconds you will notice that POD is restarting. So let's check the logs/events
kubectl get event --field-selector involvedObject.name=red-probe-cka12-trb

You will see an error like:
21s      Warning  Unhealthy  pod/red-probe-cka12-trb  Liveness probe failed: cat: can't open '/healthcheck': No such file or directory
```

So seems like Liveness probe is failing, lets look into it:

```
vi red-probe-cka12-trb.yaml
```

Notice the command `- sleep 3 ; touch /healthcheck; sleep 30;sleep 30000` it starts with a delay of `3` seconds, but the liveness probe `initialDelaySeconds` is set to `1` and `failureThreshold` is also set to `1`. Which means the POD will fail just after first attempt of liveness check which will happen just after `1` second of pod start. So to make it stable we must increase the `initialDelaySeconds` to at least `5`.

```
vi red-probe-cka12-trb.yaml
```

- Change `initialDelaySeconds` from `1` to `5` and save apply the changes.

Delete old pod:

```
kubectl delete pod red-probe-cka12-trb
```

Apply changes:

```
kubectl apply -f red-probe-cka12-trb.yaml
```

A liveness probe is a mechanism used in Kubernetes to check if a container within a pod is running correctly. If the liveness probe fails, Kubernetes restarts the container to ensure the application remains available and responsive.

- `initialDelaySeconds` provides an initial buffer period before the liveness probes start. This delay is useful to allow services or applications to initialize fully before being checked.
- `periodSeconds` determines how often the liveness probe is repeated once it starts. This interval controls the frequency of checks to ensure that the container stays healthy.
- `failureThreshold` specifies the number of consecutive failed probes required to trigger a restart. If the liveness probe fails for failureThreshold times consecutively, Kubernetes restarts the container.

The kubelet uses liveness probes to know when to restart a container.

cluster4-node01 node that belongs to cluster4 seems to be in the NotReady state. Fix the issue and make sure this node is in Ready state.

Note: You can ssh into the node using ssh cluster4-node01.\

```
SSH into the cluster4-node01 and check if kubelet service is running
```

```
ssh cluster4-node01  
systemctl status kubelet
```

You will see its inactive, so try to start it.

```
systemctl start kubelet
```

Check again the status

```
systemctl status kubelet
```

Its still failing, so let's look into some latest error logs:

```
journalctl -u kubelet --since "30 min ago" | grep 'Error:'
```

You will see some errors as below:

```
cluster4-node01 kubelet[6301]: Error: failed to construct kubelet dependencies: unable to load client CA file /etc/kubernetes/pki/CA.crt: open /etc/kubernetes/pki/CA.crt: no such file or directory
```

Check if `/etc/kubernetes/pki/CA.crt` file exists:

```
ls /etc/kubernetes/pki/
```

You will notice that the file name is `ca.crt` instead of `CA.crt` so possibly `kubelet` is looking for a wrong file. Let's fix the config:

```
vi /var/lib/kubelet/config.yaml
```

- Change clientCAFile from `/etc/kubernetes/pki/CA.crt` to `/etc/kubernetes/pki/ca.crt`

Try to start it again

```
systemctl start kubelet
```

Service should start now but there might be an error as below

```
ReportingIn
stance:""}: 'Post "https://cluster4-controlplane:6334/api/v1/namespaces/default/events": dial tcp 10.9.63.18:633
4: connect: connection refused'(may retry after sleeping)
Sep 18 09:21:47 cluster4-node01 kubelet[6803]: E0918 09:21:47.641184      6803 kubelet.go:2419] "Error getting node
" err="node \"cluster4-node01\" not found"
```

You must have noticed that its trying to connect to the `api` server on port `6334` but the default port for `kube-apiserver` is `6443`. Let's fix this:

Edit the kubelet config

```
vi /etc/kubernetes/kubelet.conf
```

- Change server

```
server: https://cluster4-controlplane:6334
```

to

```
server: https://cluster4-controlplane:6443
```

You must have noticed that it's trying to connect to the api server on port `6334` but the default port for `kube-apiserver` is `6443`.

Finally restart kubelet service

```
systemctl restart kubelet
```

Check from the `student-node` now and `cluster4-node01` should be ready now.

```
kubectl get node --context=cluster4
```

?

We have deployed a 2-tier web application on the cluster3 nodes in the canara-wl05 namespace. However, at the moment, the web app pod cannot establish a connection with the MySQL pod successfully.

You can check the status of the application from the terminal by running the curl command with the following syntax:

```
curl http://cluster3-controlplane:NODE-PORT
```

To make the application work, create a new secret called db-secret-wl05 with the following key values:-

1. DB_Host=mysql-svc-wl05
2. DB_User=root
3. DB_Password=password123

Next, configure the web application pod to load the new environment variables from the newly created secret.

Note: Check the web application again using the curl command, and the status of the application should be success.

You can SSH into the cluster3 using ssh cluster3-controlplane command.

```
Let's create a new secret called db-secret-w105 as follows: -
```

```
kubectl create secret generic db-secret-w105 -n canara-w105 --from-literal=DB_Host=mysql-svc-w105 --from-literal=DB_User=root --from-literal=DB_Password=password123
```

```
After that, configure the newly created secret to the web application pod as follows: -
```

```
---
apiVersion: v1
kind: Pod
metadata:
  labels:
    run: webapp-pod-w105
  name: webapp-pod-w105
  namespace: canara-w105
spec:
  containers:
  - image: kodekloud/simple-webapp-mysql
    name: webapp-pod-w105
    envFrom:
    - secretRef:
        name: db-secret-w105
```

```
then use the kubectl replace command: -
```

```
kubectl replace -f <FILE-NAME> --force
```

```
then use the kubectl replace command: -
```

```
kubectl replace -f <FILE-NAME> --force
```

```
In the end, make use of the curl command to check the status of the application pod. The status of the application should be success.
```

```
curl http://10.17.63.11:31020

<!doctype html>
<title>Hello from Flask</title>
<body style="background: #33b54b;"></body>
<div style="color: #e4e4e4;
  text-align: center;
  height: 90px;
  vertical-align: middle;">

  
  <h3> Successfully connected to the MySQL database.</h3>
```

```
curl http://<node-ip>:<nodeport>
```

For this question, please set the context to cluster1 by running:

```
kubectl config use-context cluster1
```

We want to deploy a python based application on the cluster using a template located at /root/olive-app-cka10-str.yaml on student-node. However, before you proceed we need to make some modifications to the

YAML file as per details given below:

The YAML should also contain a persistent volume claim with name olive-pvc-cka10-str to claim a 100Mi of storage from olive-pv-cka10-str PV.

Update the deployment to **add a sidecar container**, which can use busybox image (you might need to add a sleep command for this container to keep it running.)

Share the python-data volume with this container and mount the same at path /usr/src. Make sure this container only has read permissions on this volume.

Finally, create a pod using this YAML and make sure the POD is in Running state.

Note: Additionally, you can expose a NodePort service for the application. The service should be named olive-svc-cka10-str and expose port 5000 with a nodePort value of 32006.

However, inclusion/exclusion of this service won't affect the validation for this task.

Update olive-app-cka10-str.yaml template so that it looks like as below:

```
---
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: olive-pvc-cka10-str
spec:
  accessModes:
    - ReadWriteMany
  storageClassName: olive-stc-cka10-str
  volumeName: olive-pv-cka10-str
resources:
  requests:
    storage: 100Mi

---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: olive-app-cka10-str
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: olive-app-cka10-str
    spec:
      affinity:
        nodeAffinity:
          requiredDuringSchedulingIgnoredDuringExecution:
            nodeSelectorTerms:
              - matchExpressions:
                  - key: kubernetes.io/hostname
                    operator: In
                    values:
                      - cluster1-node01
      containers:
        - name: python
          image: poroko/flask-demo-app
          ports:
            - containerPort: 5000
          volumeMounts:
            - name: python-data
              mountPath: /usr/share/
        - name: busybox
          image: busybox
          command:
            - "bin/sh"
            - "-c"
            - "sleep 10000"
          volumeMounts:
            - name: python-data
              mountPath: "/usr/src"
              readOnly: true
      volumes:
        - name: python-data
      persistentVolumeClaim:
        claimName: olive-pvc-cka10-str
```

```

selector:
  matchLabels:
    app: olive-app-cka10-str

---
apiVersion: v1
kind: Service
metadata:
  name: olive-svc-cka10-str
spec:
  type: NodePort
  ports:
    - port: 5000
      nodePort: 32006
  selector:
    app: olive-app-cka10-str

```

Update olive-app-cka10-str.yaml template so that it looks like as below:

```

---
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: olive-pvc-cka10-str
spec:
  accessModes:
    - ReadWriteMany
  storageClassName: olive-stc-cka10-str
  volumeName: olive-pv-cka10-str
  resources:
    requests:
      storage: 100Mi

---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: olive-app-cka10-str
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: olive-app-cka10-str
    spec:
      affinity:
        nodeAffinity:
          requiredDuringSchedulingIgnoredDuringExecution:
            nodeSelectorTerms:
              - matchExpressions:
                  - key: kubernetes.io/hostname
                    operator: In
                    values:
                      - cluster1-node01
      containers:
        - name: python
          image: poroko/flask-demo-app
          ports:
            - containerPort: 5000
          volumeMounts:
            - name: python-data
              mountPath: /usr/share/
        - name: busybox
          image: busybox
          command:
            - "bin/sh"
            - "-c"
            - "sleep 10000"
          volumeMounts:
            - name: python-data
              mountPath: "/usr/src"
              readOnly: true
      volumes:
        - name: python-data
          persistentVolumeClaim:
            claimName: olive-pvc-cka10-str
  selector:
    matchLabels:
      app: olive-app-cka10-str

---
apiVersion: v1

```

```
kind: Service
metadata:
  name: olive-svc-cka10-str
spec:
  type: NodePort
  ports:
    - port: 5000
      nodePort: 32006
  selector:
    app: olive-app-cka10-str
```

- ★ In a Kubernetes YAML file, you can define multiple Kubernetes objects (such as Pods, Services, Deployments, etc.) by separating each object's configuration with triple dashes ---.

Update `olive-app-cka10-str.yaml` template so that it looks like as below:

```
---
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: olive-pvc-cka10-str
spec:
  accessModes:
    - ReadWriteMany
  storageClassName: olive-stc-cka10-str
  volumeName: olive-pv-cka10-str
  resources:
    requests:
      storage: 100Mi

---
apiVersion: apps/v1
kind: Deployment
```

```
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: olive-app-cka10-str
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: olive-app-cka10-str
    spec:
      affinity:
        nodeAffinity:
          requiredDuringSchedulingIgnoredDuringExecution:
            nodeSelectorTerms:
              - matchExpressions:
                  - key: kubernetes.io/hostname
                    operator: In
                    values:
                      - cluster1-node01
      containers:
        - name: python
          image: poroko/flask-demo-app
          ports:
            - containerPort: 5000
          volumeMounts:
            - name: python-data
              mountPath: /usr/share/
        - name: busybox
          image: busybox
          command:
            - "bin/sh"
            - "-c"
            - "sleep 10000"
          volumeMounts:
            - name: python-data
```

```

mountPath: /usr/share/
  - name: busybox
    image: busybox
    command:
      - "bin/sh"
      - "-c"
      - "sleep 10000"
  volumeMounts:
    - name: python-data
      mountPath: "/usr/src"
      readOnly: true
  volumes:
    - name: python-data
      persistentVolumeClaim:
        claimName: olive-pvc-cka10-str
  selector:
    matchLabels:
      app: olive-app-cka10-str
---
apiVersion: v1
kind: Service
metadata:
  name: olive-svc-cka10-str
spec:
  type: NodePort
  ports:
    - port: 5000
      nodePort: 32006
  selector:
    app: olive-app-cka10-str

```

Apply the template:

```
kubectl apply -f olive-app-cka10-str.yaml
```

- **containerPort**: This refers to the port on which the container inside the pod is listening. containerPort is specific to the pod's configuration
- **port**: This refers to the port exposed by the service itself.
- **targetPort**: This refers to the port to which the service will forward traffic inside the pod.

- ? John is setting up a **two tier application** stack that is supposed to be accessible using the service curlme-cka01-svcn. To test that the service is accessible, he is using a pod called curlpod-cka01-svcn. However, at the moment, he is unable to get any response from the application.

Troubleshoot and fix this issue so the application stack is accessible.

While you may delete and recreate the service curlme-cka01-svcn, please do not alter it in anyway.

- Test if the service `curlme-cka01-svcn` is accessible from pod `curlpod-cka01-svcn` or not.

```
kubectl exec curlpod-cka01-svcn -- curl curlme-cka01-svcn
.....
% Total    % Received % Xferd  Average Speed   Time   Time     Current
          Dload  Upload Total Spent   Left  Speed
0       0      0      0      0      0  0:00:10  ---:---    0
```

The command `kubectl exec <pod-name> -- curl <service-name>` is used to test whether a pod can access a service within the

Kubernetes cluster.

nslookup vs curl

You should choose curl when you want to test the accessibility of a service by sending HTTP requests to it, especially if your service communicates over HTTP/HTTPS protocols. On the other hand, choose nslookup when you want to check the DNS resolution of a service name or verify the DNS configuration in your Kubernetes environment.

- We did not get any response. Check if the service is properly configured or not.

```
kubectl describe svc curlme-cka01-svcn ''  
  
...  
Name:           curlme-cka01-svcn  
Namespace:      default  
Labels:         <none>  
Annotations:    <none>  
Selector:       run=curlme-cka01-svcn  
Type:          ClusterIP  
IP Family Policy: SingleStack  
IP Families:   IPv4  
IP:            10.109.45.180  
IPs:           10.109.45.180  
Port:          <unset>  80/TCP  
TargetPort:    80/TCP  
Endpoints:     <none>  
Session Affinity: None  
Events:        <none>
```

When you expose a application , the endpoint field of a service will represent one or more IPs based on how many services is accessing it .

So, for creating clusterIP service if i already have a pod, where can I get "port" and "targetPort" value?

- Find the ports section within the container's configuration, which will indicate the port it's listening on (targetPort).
- Choose a Port for the Service: Decide on a port (port) that you want to use to expose the service internally within the cluster.

- The service has no endpoints configured. As we can delete the resource, let's delete the service and create the service again.
- To delete the service, use the command `kubectl delete svc curlme-cka01-svcn`.
- You can create the service using imperative way or declarative way.

Using imperative command:

```
kubectl expose pod curlme-cka01-svcn --port=80
```

Using declarative manifest:

```
apiVersion: v1  
kind: Service  
metadata:  
  labels:  
    run: curlme-cka01-svcn  
  name: curlme-cka01-svcn  
spec:  
  ports:  
  - port: 80  
    protocol: TCP  
    targetPort: 80  
  selector:  
    run: curlme-cka01-svcn  
  type: ClusterIP
```

Generally containerPort and targetPort has same value.

- You can test the connection from `curlpod-cka-1-svcn` using following.

```
kubectl exec curlpod-cka01-svcn -- curl curlme-cka01-svcn
```

?

For this question, please set the context to cluster3 by running:

```
kubectl config use-context cluster3
```

Part I:

Create a ClusterIP service .i.e. service-3421-svcn in the spectra-1267 ns which should expose the pods namely pod-23 and pod-21 with port set to 8080 and targetport to 80.

Part II:

Store the pod names and their ip addresses from the spectra-1267 ns at /root/pod_ips_cka05_svcn where the output is sorted by their IP's.

Please ensure the format as shown below:

POD_NAME	IP_ADDR
pod-1	ip-1
pod-3	ip-2
pod-2	ip-3
...	

Solution

```
Switching to cluster3 :
```

```
kubectl config use-context cluster3
```

The easiest way to route traffic to a specific pod is by the use of `labels` and `selectors` . List the pods along with their labels:

```
student-node ~ → kubectl get pods --show-labels -n spectra-1267
NAME      READY   STATUS    RESTARTS   AGE     LABELS
pod-12   1/1     Running   0          5m21s   env=dev,mode=standard,type=external
pod-34   1/1     Running   0          5m20s   env=dev,mode=standard,type=internal
pod-43   1/1     Running   0          5m20s   env=prod,mode=exam,type=internal
pod-23   1/1     Running   0          5m21s   env=dev,mode=exam,type=external
pod-32   1/1     Running   0          5m20s   env=prod,mode=standard,type=internal
pod-21   1/1     Running   0          5m20s   env=prod,mode=exam,type=external
```

Looks like there are a lot of pods created to confuse us. But we are only concerned with the labels of `pod-23` and `pod-21`.

As we can see both the required pods have labels `mode=exam,type=external` in common. Let's confirm that using kubectl too:

```
student-node ~ ➔ kubectl get pod -l mode=exam,type=external -n spectra-1267
NAME      READY   STATUS    RESTARTS   AGE
pod-23   1/1     Running   0          9m18s
pod-21   1/1     Running   0          9m17s
```

Nice!! Now as we have figured out the labels, we can proceed further with the creation of the service:

```
student-node ~ ➔ kubectl create service clusterip service-3421-svcn -n spectra-1267 --tcp=8080:80 --dry-run=client -o yaml > service-3421-svcn.yaml
```

Nice!! Now as we have figured out the labels, we can proceed further with the creation of the service:

```
student-node ~ ➔ kubectl create service clusterip service-3421-svcn -n spectra-1267 --tcp=8080:80 --dry-run=client -o yaml > service-3421-svcn.yaml
```

Now modify the service definition with selectors as required before applying to k8s cluster:

```
student-node ~ ➔ cat service-3421-svcn.yaml
apiVersion: v1
kind: Service
metadata:
  creationTimestamp: null
  labels:
    app: service-3421-svcn
  name: service-3421-svcn
  namespace: spectra-1267
spec:
  ports:
  - name: 8080-80
    port: 8080
    protocol: TCP
    targetPort: 80
  selector:
    app: service-3421-svcn # delete
    mode: exam # add
    type: external # add
    type: ClusterIP
status:
  loadBalancer: {}
```

Finally let's apply the service definition:

```
student-node ~ → kubectl apply -f service-3421-svcn.yaml
service/service-3421 created

student-node ~ → k get ep service-3421-svcn -n spectra-1267
NAME           ENDPOINTS          AGE
service-3421   10.42.0.15:80,10.42.0.17:80   52s
```

To store all the pod name along with their IP's , we could use imperative command as shown below:

```
student-node ~ → kubectl get pods -n spectra-1267 -o=custom-columns='POD_NAME:metadata.name,IP_ADDR:status.podIP' --sort-by=.status.podIP
POD_NAME    IP_ADDR
pod-12      10.42.0.18
pod-23      10.42.0.19
pod-34      10.42.0.20
pod-21      10.42.0.21
...
# store the output to /root/pod_ips
student-node ~ → kubectl get pods -n spectra-1267 -o=custom-columns='POD_NAME:metadata.name,IP_ADDR:status.podIP' --sort-by=.status.podIP > /root/pod_ips_cka05_svcn
```

kubectl get ep is a command used to retrieve and display endpoint information in Kubernetes.

Create a loadbalancer service with name wear-service-cka09-svcn to expose the deployment webapp-wear-cka09-svcn application in app-space namespace.

Solution

Switch to `cluster3` :

```
kubectl config use-context cluster3
```

On student node run the command:

```
student-node ~ ➔ kubectl expose -n app-space deployment webapp-wear-cka09-svcn --type=LoadBalancer --name=wear-service-cka09-svcn --port=8080
service/wear-service-cka09-svcn exposed

student-node ~ ➔ k get svc -n app-space
NAME           TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)       AGE
wear-service-cka09-svcn   LoadBalancer   10.43.68.233   172.25.0.14   8080:32109/TCP   14s
```

?

Create a nginx pod called `nginx-resolver-cka06-svcn` using image `nginx`, expose it internally with a service called `nginx-resolver-service-cka06-svcn`.

Test that you are able to look up the service and pod names from within the cluster. Use the image: `busybox:1.28` for dns lookup. Record results in `/root/CKA/nginx.svc.cka06.svcn` and `/root/CKA/nginx.pod.cka06.svcn`

```
kubectl config use-context cluster1
```

To create a pod `nginx-resolver-cka06-svcn` and expose it internally:

```
student-node ~ ➔ kubectl run nginx-resolver-cka06-svcn --image=nginx
student-node ~ ➔ kubectl expose pod/nginx-resolver-cka06-svcn --name=nginx-resolver-service-cka06-svcn --port=80 --target-port=80 --type=ClusterIP
```

To create a pod `test-nslookup`. Test that you are able to look up the service and pod names from within the cluster:

```
student-node ~ ➔ kubectl run test-nslookup --image=busybox:1.28 --rm -it --restart=Never -- nslookup nginx-resolver-service-cka06-svcn
student-node ~ ➔ kubectl run test-nslookup --image=busybox:1.28 --rm -it --restart=Never -- nslookup nginx-resolver-service-cka06-svcn > /root/CKA/nginx.svc.cka06.svcn
```

Get the IP of the `nginx-resolver-cka06-svcn` pod and replace the dots(.) with hyphen(-) which will be used below.

```
student-node ~ ➔ kubectl get pod nginx-resolver-cka06-svcn -o wide
student-node ~ ➔ IP=$(kubectl get pod nginx-resolver-cka06-svcn -o wide --no-headers | awk '{print $6}' | tr '.' '-')
student-node ~ ➔ kubectl run test-nslookup --image=busybox:1.28 --rm -it --restart=Never -- nslookup $IP.default.pod > /root/CKA/nginx.pod.cka06.svcn
```

Administrators can impersonate other users to test their permissions using the --as option.

```
kubectl auth can-i get pods --as john -n <namespace>
```

Restart Kubelet

```
sudo systemctl restart kubelet
```

Sidecar

If I have to setup a sidecar container, do I need to put this inside a container section or init-container section?

When setting up a sidecar container in Kubernetes, you typically define it within the containers section of your Pod's YAML configuration, not in the initContainers section.

Containers Section:

- This section is used to define all the main containers that will run within your Pod.
- Sidecar containers, which are auxiliary containers that support the main application container, are specified in this section.
- Sidecar containers often share resources and network namespaces with the main application container.

Init Containers Section:

Init containers are not typically used for sidecar functionality; they are more focused on tasks that need to complete before the main application container starts.

 I have a service but it has no endpoint, what does it mean? how to create endpoint and link to those service?

If a service has no endpoints, it means that the service is not currently directing traffic to any pods.

To create endpoints and link them to a service, you need to ensure that:

- The pods targeted by the service have labels that match the service selector.
- The pods are in a ready state and able to receive traffic.
- The service definition is correctly configured to target the desired pods.

M6 -KK

Sunday, May 26, 2024 5:47 PM

Task

SECTION: ARCHITECTURE, INSTALL AND MAINTENANCE

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

We have created a service account called `green-sa-cka22-arch`, a cluster role called `green-role-cka22-arch` and a cluster role binding called `green-role-binding-cka22-arch`.

Update the permissions of this service account so that it can only get all the `namespaces` in `cluster1`.

Solution

Edit the `green-role-cka22-arch` to update permissions:

```
student-node ~ ➔ kubectl edit clusterrole green-role-cka22-arch --context cluster1
```

At the end add below code:

```
- apiGroups:
  - "*"
resources:
- namespaces
verbs:
- get
```

You can verify it as below:

```
student-node ~ ➔ kubectl auth can-i get namespaces --as=system:serviceaccount:default:green-sa-cka22-arch
yes
```

apiGroups: ["*"]: This allows the ClusterRole to apply to resources from all API groups, including both core Kubernetes resources and custom resources from any API group.

apiGroups: [""]: This restricts the ClusterRole to resources that have no API group. In Kubernetes, API groups are used to organize related resources. For example, the core Kubernetes resources like pods, services, and namespaces belong to the "" (empty string) API group, while resources like CustomResourceDefinitions (CRDs) may belong to custom API groups.

kubectl auth can-i get namespaces --as=system:serviceaccount:default:green-sa
Checks whether the service account system:serviceaccount:default:green-sa has permission to perform the get action on namespaces within the Kubernetes cluster.

For Role and RoleBinding

```
kubectl auth can-i get pods --as=system:serviceaccount:default:green-sa --namespace=default
```

Backup

Task

SECTION: TROUBLESHOOTING

For this question, please set the context to `cluster4` by running:

```
kubectl config use-context cluster4
```

The controlplane node called `cluster4-controlplane` in the `cluster4` cluster is planned for a regular maintenance. In preparation for this maintenance work, we need to take backups of this cluster. However, something is broken at the moment!

Troubleshoot the issues and take a snapshot of the `ETCD` database using the `etcdctl` utility at the location `/opt/etcd-boot-cka18-trb.db`.

Note: Make sure `etcd` listens at its default port. Also you can `SSH` to the `cluster4-controlplane` host using the `ssh cluster4-controlplane` command from the `student-node`.

Solution

SSH into `cluster4-controlplane` host.

```
ssh cluster4-controlplane
```

Let's take `etcd` backup

```
ETCDCTL_API=3 etcdctl --endpoints=https://[127.0.0.1]:2379 --cacert=/etc/kubernetes/pki/etcd/ca.crt --cert=/etc/kubernetes/pki/etcd/server.crt --key=/etc/kubernetes/pki/etcd/server.key snapshot
```

It might stuck for forever, let's see why that would happen. Try to list the PODs first

```
kubectl get pod -A
```

There might an error like

```
The connection to the server cluster4-controlplane:6443 was refused - did you specify the right host or port?
```

There seems to be some issue with the cluster so let's look into the logs

```
journalctl -u kubelet -f
```

You will see a lot of `connect: connection refused` errors but that must be because the different cluster components are not able to connect to the API server so try to filter out these logs to look more closely

```
journalctl -u kubelet -f | grep -v 'connect: connection refused'
```

You should see some errors as below

```
cluster4-controlplane kubelet[2240]: E0923 04:38:15.630925 2240 file.go:187] "Could not process manifest file" err="invalid pod: [spec.containers[0].volumeMounts[1].name: Not found: \\"etcd-cc\\"",
```

You should see some errors as below

```
cluster4-controlplane kubelet[2240]: E0923 04:38:15.630925    2240 file.go:187] "Could not process manifest file" err="invalid pod: [spec.containers[0].volumeMounts[1].name: Not found: \\"etcd-ce
```

So seems like there is some incorrect volume which `etcd` is trying to mount, let's look into the `etcd` manifest.

```
vi /etc/kubernetes/manifests/etcd.yaml
```

Search for `etcd-cert`, you will notice that the volume name is `etcd-certs` but the volume mount is trying to mount `etcd-cert` volume which is incorrect. Fix the volume mount name and save the changes. Let's restart `kubelet` service after that.

```
systemctl restart kubelet
```

Wait for few minutes to see if its good now.

```
kubectl get pod -A
```

You should be able to list the PODs now, let's try to take `etcd` backup now:

```
ETCDCTL_API=3 etcdctl --endpoints=https://[127.0.0.1]:2379 --cacert=/etc/kubernetes/pki/etcd/ca.crt --cert=/etc/kubernetes/pki/etcd/server.crt --key=/etc/kubernetes/pki/etcd/server.key snapshot
```

It should work now.

PV pvc

Task

SECTION: STORAGE

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

There is a `persistent volume` named `apple-pv-cka04-str`. Create a `persistent volume claim` named `apple-pvc-cka04-str` and request a `40Mi` of storage from `apple-pv-cka04-str` PV. The access mode should be `ReadWriteOnce` and storage class should be `manual`.

Solution

Set context to `cluster1`:

Create a yaml template as below:

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: apple-pvc-cka04-str
spec:
  volumeName: apple-pv-cka04-str
  storageClassName: manual
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 40Mi
```

Apply the template:

```
kubectl apply -f <template-file-name>.yaml
```

pv pvc

Task

SECTION: STORAGE

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

A pod definition file is created at `/root/peach-pod-cka05-str.yaml` on the `student-node`. Update this manifest file to create a persistent volume claim called `peach-pvc-cka05-str` to claim a `100Mi` of storage from `peach-pv-cka05-str` PV (this is already created). Use the access mode `ReadWriteOnce`.

Further add `peach-pvc-cka05-str` PVC to `peach-pod-cka05-str` POD and mount the volume at `/var/www/html` location. Ensure that the pod is running and the PV is bound.

Solution

Set context to `cluster1`

Update `/root/peach-pod-cka05-str.yaml` template file to create a PVC to utilise the same in POD template.

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: peach-pvc-cka05-str
spec:
  volumeName: peach-pv-cka05-str
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 100Mi
---
apiVersion: v1
kind: Pod
metadata:
  name: peach-pod-cka05-str
spec:
  containers:
  - image: nginx
    name: nginx
    volumeMounts:
    - mountPath: "/var/www/html"
      name: nginx-volume
  volumes:
  - name: nginx-volume
    persistentVolumeClaim:
      claimName: peach-pvc-cka05-str
```

Ingress

Task

SECTION: SERVICE NETWORKING

For this question, please set the context to `cluster3` by running:

```
kubectl config use-context cluster3
```

There is a deployment `nginx-deployment-cka04-svcn` in cluster3 which is exposed using service `nginx-service-cka04-svcn`.

Create an ingress resource `nginx-ingress-cka04-svcn` to load balance the incoming traffic with the following specifications:

- `pathType: Prefix` and `path: /`
- Backend Service Name: `nginx-service-cka04-svcn`
- Backend Service Port: `80`
- `ssl-redirect` is set to `false`

Now apply the ingress resource with the given requirements:

```
kubectl apply -f - << EOF
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: nginx-ingress-cka04-svcn
  annotations:
    nginx.ingress.kubernetes.io/ssl-redirect: "false"
spec:
  rules:
  - http:
      paths:
      - path: /
        pathType: Prefix
        backend:
          service:
            name: nginx-service-cka04-svcn
            port:
              number: 80
EOF
```

Check if the ingress resource was successfully created:

```
student-node ~ → kubectl get ingress
NAME           CLASS   HOSTS   ADDRESS      PORTS   AGE
nginx-ingress-cka04-svcn  <none>   *       172.25.0.10  80      13s
```

★ The port number specified is typically the port of the Service that the Ingress routes traffic to.

My original solution

```
student-node ~ ➔ cat ingress.yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: nginx-ingress-cka04-svcn
  annotations:
    nginx.ingress.kubernetes.io/ssl-redirect: "false"
spec:
  ingressClassName: nginx-example
  rules:
  - http:
    paths:
    - path: /
      pathType: Prefix
      backend:
        service:
          name: nginx-service-cka04-svcn
          port:
            number: 80
```

★ No need of ingressClassName

pv pvc

Task

SECTION: STORAGE

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

A pod definition file is created at `/root/peach-pod-cka05-str.yaml` on the `student-node`. Update this manifest file to create a persistent volume claim called `peach-pvc-cka05-str` to claim a `100Mi` of storage from `peach-pv-cka05-str` PV (this is already created). Use the access mode `ReadWriteOnce`.

Further add `peach-pvc-cka05-str` PVC to `peach-pod-cka05-str` POD and mount the volume at `/var/www/html` location. Ensure that the pod is running and the PV is bound.

Solution

Set context to `cluster1`

Update `/root/peach-pod-cka05-str.yaml` template file to create a PVC to utilise the same in POD template.

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: peach-pvc-cka05-str
spec:
  volumeName: peach-pv-cka05-str
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 100Mi
---
apiVersion: v1
kind: Pod
metadata:
  name: peach-pod-cka05-str
spec:
  containers:
    - image: nginx
      name: nginx
    volumeMounts:
      - mountPath: "/var/www/html"
        name: nginx-volume
  volumes:
    - name: nginx-volume
      persistentVolumeClaim:
        claimName: peach-pvc-cka05-str
```

Apply the template:

```
kubectl apply -f /root/peach-pod-cka05-str.yaml
```

ne

Task

SECTION: SERVICE NETWORKING

For this question, please set the context to `cluster3` by running:

```
kubectl config use-context cluster3
```

There is a deployment `nginx-deployment-cka04-svcn` in cluster3 which is exposed using service `nginx-service-cka04-svcn`.

Create an ingress resource `nginx-ingress-cka04-svcn` to load balance the incoming traffic with the following specifications:

- `pathType: Prefix` and `path: /`
- Backend Service Name: `nginx-service-cka04-svcn`
- Backend Service Port: `80`
- `ssl-redirect` is set to `false`

Now apply the ingress resource with the given requirements:

```
kubectl apply -f - << EOF
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: nginx-ingress-cka04-svcn
  annotations:
    nginx.ingress.kubernetes.io/ssl-redirect: "false"
spec:
  rules:
  - http:
      paths:
      - path: /
        pathType: Prefix
        backend:
          service:
            name: nginx-service-cka04-svcn
            port:
              number: 80
EOF
```

Check if the ingress resource was successfully created:

```
student-node ~ → kubectl get ingress
NAME           CLASS      HOSTS   ADDRESS      PORTS   AGE
nginx-ingress-cka04-svcn  <none>     *       172.25.0.10  80      13s
```

As the **ingress controller** is exposed on cluster3-controlplane using **traefik** service, we need to ssh to cluster3-controlplane first to check if the ingress resource works properly:

```
student-node ~ → ssh cluster3-controlplane
cluster3-controlplane:~# curl -I 172.25.0.11
HTTP/1.1 200 OK
...
...
```

```
curl -I <IP>
```

The `-I` option in the `curl` command sends a HEAD request to the specified IP address (or URL). This request asks the server to respond with only the HTTP headers and not the actual content of the page or resource.

Deploy

Task

SECTION: SERVICE NETWORKING

For this question, please set the context to `cluster3` by running:

```
kubectl config use-context cluster3
```

Create a `Loadbalancer` service with name `wear-service-cka09-svcn` to expose the deployment `webapp-wear-cka09-svcn` application in `app-space` namespace.

```
student-node ~ ➔ k describe deployments.apps -n app-space webapp-wear-cka09-svcn
Name:           webapp-wear-cka09-svcn
Namespace:      app-space
CreationTimestamp: Sun, 26 May 2024 12:14:00 +0000
Labels:          <none>
Annotations:    deployment.kubernetes.io/revision: 1
Selector:        app=webapp-wear-cka09-svcn
Replicas:       1 desired | 1 updated | 1 total | 1 available | 0 unavailable
StrategyType:   RollingUpdate
MinReadySeconds: 0
RollingUpdateStrategy: 25% max unavailable, 25% max surge
Pod Template:
  Labels:  app=webapp-wear-cka09-svcn
  Containers:
    simple-webapp:
      Image:      kodekloud/e-commerce:apparel
      Port:       8080/TCP
      Host Port:  0/TCP
      Environment: <none>
      Mounts:     <none>
      Volumes:    <none>
  Conditions:
    Type        Status  Reason
    ----        ----   -----
    Available   True    MinimumReplicasAvailable
    Progressing True    NewReplicaSetAvailable
    OldReplicaSets: <none>
    NewReplicaSet:  webapp-wear-cka09-svcn-764fb4667 (1/1 replicas created)
  Events:
    Type  Reason          Age   From            Message
    ----  ----           ----  ----           -----
    Normal ScalingReplicaSet 23m   deployment-controller  Scaled up replica set webapp-wear-cka09-svcn-764fb466
```

Solution

Switch to `cluster3` :

```
kubectl config use-context cluster3
```

On student node run the command:

```
student-node ~ ➔ kubectl expose -n app-space deployment webapp-wear-cka09-svcn --type=LoadBalancer --name=wear-service-cka09-svcn --port=8080
service/wear-service-cka09-svcn exposed

student-node ~ ➔ k get svc -n app-space
NAME           TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)        AGE
wear-service-cka09-svcn   LoadBalancer   10.43.68.233  172.25.0.14   8080:32109/TCP   14s
```

If incorrect PVC gets bound to a PV

- ★ If you bound incorrect pvc to a pv with "Retain" policy. You have to recreate the PV with same info and delete the prev PV.
- ★ If a user deletes a PVC in active use by a Pod, the PVC is not removed immediately. PVC removal is postponed until the PVC is no longer actively used by any Pods. Also, if an admin deletes a PV that is bound to a PVC, the PV is not removed immediately. PV removal is postponed until the PV is no longer bound to a PVC.

Commands and Arguments

```
controlplane ~ ➔ kubectl exec webapp -- sh -c "echo Hello"
Hello
controlplane ~ ➔ kubectl exec webapp -- /bin/sh -c "echo Hello"
Hello
```

In a pv , pvc question, I got "storageclass manual not found" error. Why this occur?

The error "storageclass manual not found" occurs because Kubernetes is unable to find a StorageClass named "manual" when you try to use it in your PersistentVolume (PV) or PersistentVolumeClaim (PVC) definition.

To resolve this issue, you can do one of the following:

Create a StorageClass named "manual" if it doesn't exist:

```
yaml

apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: manual
provisioner: kubernetes.io/no-provisioner
volumeBindingMode: WaitForFirstConsumer
```

Reading container logs

docker container logs

crlt logs [OPTIONS] CONTAINER_ID

Cronjob with a Service

It would be cool if a cronjob can connect to a service.

```
apiVersion: batch/v1beta1
kind: CronJob
metadata:
  name: vnc-cronjob
spec:
  schedule: "15 * * * *"
  jobTemplate:
    spec:
      metadata:
        labels:
          app: vnc-cron
    template:
      spec:
        containers:
          - name: vnc-example
            image: busybox
            args:
              - /bin/sh
              - -c
              - date; echo This would be running VNC
            ports:
              - containerPort: 5900
            restartPolicy: OnFailure
---
kind: Service
apiVersion: v1
metadata:
  name: vnc-service
spec:
  type: NodePort
  selector:
    app: vnc-cron
  ports:
    - protocol: TCP
      port: 5900
```

M7 - KK

Saturday, May 4, 2024 1:09 AM

Get the list of nodes in JSON format and store it in a file at /opt/outputs/nodes.json.

Use the command kubectl get nodes -o json > /opt/outputs/nodes.json

The service has no endpoints configured. As we can delete the resource, let's delete the service and create the service again.

To delete the service, use the command kubectl delete svc curlme-cka01-svcn.
You can create the service using imperative way or declarative way.

```
controlplane ~ ➔ kubectl get po -n kube-system -o=jsonpath='{range .items[*]}{.metadata.name}{"\n"}{end}'  
coredns-69f9c977-9kvtw  
coredns-69f9c977-rfrmt  
etcd-controlplane  
kube-apiserver-controlplane  
kube-controller-manager-controlplane  
kube-proxy-7k2jm  
kube-proxy-hx6gr  
kube-scheduler-controlplane
```

```
controlplane ~ ➔ kubectl get nodes -o=custom-columns=NODE:.metadata.name,CPU:.status.capacity.cpu  
NODE          CPU  
controlplane   36  
node01        36
```

```
controlplane ~ ➔ kubectl get pods -A -o=custom-columns=POD:.metadata.name,IP:.status.podIP --sort-by=.status.podIP
POD                               IP
coredns-69f9c977-9kvtw           10.244.0.2
coredns-69f9c977-rfrmt          10.244.0.3
nginx                            10.244.1.2
kube-flannel-ds-2pqzk           192.23.140.3
etcd-controlplane                192.23.140.3
kube-apiserver-controlplane     192.23.140.3
kube-controller-manager-controlplane 192.23.140.3
kube-proxy-hx6gr                 192.23.140.3
kube-scheduler-controlplane      192.23.140.3
kube-flannel-ds-6g4cz            192.23.140.6
kube-proxy-7k2jm                 192.23.140.6
```

Commands vs Arguments

```
controlplane ~ ➔ k exec nginx -- echo Welcome
Welcome

controlplane ~ ➔ k exec nginx -- "echo Welcome"
error: Internal error occurred: error executing command in container: failed to exec in container: failed to start exec "728983e8e69ab7708e07825841f96e9a43d30a28b72fda0ae35917d0729e3ae4": OCI runtime exec failed: exec failed: unable to start container process: exec: "echo Welcome": executable file not found in $PATH: unknown

controlplane ~ ➔ k exec nginx -- echo 'Welcome'
Welcome

controlplane ~ ➔ k exec nginx -- echo "Welcome"
Welcome

controlplane ~ ➔
```

When you specify "--command" options , whatever you enter after "--" goes under the "Command".

```
controlplane ~ ➔ k run poc --image=busybox --command -- echo Hello
pod/poc created
```

```
Containers:  
poc:  
  Container ID: containerd://  
  Image:          busybox:1.28  
  Image ID:       docker.io/busybox:  
  Port:           <none>  
  Host Port:     <none>  
  Command:  
    echo  
    Hello
```

When you **don't** specify "--command" options , whatever you enter after "--" goes under the "Args".

```
controlplane ~ ➔ k run pod --image=busybox:1.28 -- echo Hello  
pod/pod created
```

```
Containers:  
pod:  
  Container ID: containerd://  
  Image:          busybox:1.28  
  Image ID:       docker.io/busybox:  
  Port:           <none>  
  Host Port:     <none>  
  Args:  
    echo  
    Hello
```

To verify ClusterIP Service

1. `kubectl exec <pod-name> -- curl <ClusterIP-Service-Name>`
2. `kubectl exec <pod-name> -- curl <ClusterIP>:<port>`
Replace <ClusterIP> with the actual ClusterIP of your service and <port> with the port number your service is listening on.

Delete pod

```
k delete pod <pod-name> --grace-period=0
```

In Kubernetes, when you delete something like a pod or a deployment, there's also a grace period. It's the time Kubernetes gives to the program inside (like a container) to finish its tasks and exit gracefully. During this period, Kubernetes sends signals to the program, saying, "Hey, it's time to wrap up."

Now, if you use --grace-period=0 with a delete command, it's like saying, "Forget the grace period, just shut down right now!"

M8 - KK

Wednesday, May 29, 2024 12:54 PM

Weight: 8

SECTION: ARCHITECTURE, INSTALL AND MAINTENANCE

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

We have created a service account called `green-sa-cka22-arch`, a cluster role called `green-role-cka22-arch` and a cluster role binding called `green-role-binding-cka22-arch`.

Update the permissions of this service account so that it can only get all the `namespaces` in `cluster1`.

service account permissions updated?

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  creationTimestamp: "2024-05-29T06:56:54Z"
  name: green-role-cka22-arch
  resourceVersion: "4821"
  uid: 42acbcdf-3072-4852-bb93-12f45edc9bd0
rules:
- apiGroups:
  - "*"
  resources:
  - namespaces
  verbs:
  - get
...
```

I got a question in the exam which is as below

1. Create a cron job which runs every 2 minutes, ... set failures =3 and also make sure the pod terminates exactly after 8 seconds.
2. Also as a sample run one job on this cron.

not sure how to set failure and terminate (is it via command ?) and also what is the meaning on 2nd statement.

```

yaml
apiVersion: batch/v1
kind: CronJob
metadata:
  name: my-cronjob
spec:
  schedule: "*/2 * * * *"
  jobTemplate:
    spec:
      activeDeadlineSeconds: 8
      backoffLimit: 3
      template:
        spec:
          containers:
            - name: my-cronjob
              image: <your-image>
              command: ["/bin/sh"]
              args:
                - -c
                - "echo Hello from the CronJob; sleep 5"
      restartPolicy: OnFailure

```

schedule: Specifies the cron schedule for the job. In this case, "*/2 * * * *" means every two minutes.
activeDeadlineSeconds: Sets a time limit for the job to complete. If the job exceeds this limit, it will be terminated.
backoffLimit: Defines the number of retries before considering a job as failed.
container: Describes the container that the job runs, including its image, command, and arguments.
restartPolicy: Specifies the behavior when the container exits. "OnFailure" means the container will be restarted only if it fails.

?

How to verify that backup has been taken using etcdctl ? What is etcdctl snapshot status command?

```
etcdctl --endpoints=https://etcd.example.com:2379 snapshot status /path/to/etcd-snapshot.db
```

The snapshot status command will provide information about the snapshot file, such as its revision, total keys, total size, and the time it was created.

Write a json query to output the port of those services which has name <clear-cka-svc-0406>.

```
kubectl get services -o=jsonpath='{range .items[?(@.metadata.name=="clear-cka-svc-0406")]}{.spec.ports[*].port}{end}'
```

{end}: Ends the range operation.
.items[?(@.metadata.name=="clear-cka-svc-0406")]: Filters items (services) based on the name <clear-cka-svc-0406>.

For this question, please set the context to `cluster1` by running:

```
kubectl config use-context cluster1
```

Create a service account called `deploy-cka20-arch`. Further create a cluster role called `deploy-role-cka20-arch` with permissions to `get` the `deployments` in `cluster1`.

Finally create a cluster role binding called `deploy-role-binding-cka20-arch` to bind `deploy-role-cka20-arch` cluster role with `deploy-cka20-arch` service account.

Solution

Create the service account, cluster role and role binding:

```
student-node ~ ➔ kubectl --context cluster1 create serviceaccount deploy-cka20-arch
student-node ~ ➔ kubectl --context cluster1 create clusterrole deploy-role-cka20-arch --resource=deployments --verb=get
student-node ~ ➔ kubectl --context cluster1 create clusterrolebinding deploy-role-binding-cka20-arch --clusterrole=deploy-role-cka20-arch --serviceaccount=default:deploy-cka20-arch
```

You can verify it as below:

```
student-node ~ ➔ kubectl --context cluster1 auth can-i get deployments --as=system:serviceaccount:default:deploy-cka20-arch
yes
```

You might see something like as below which is not that helpful:

```
Error from server (BadRequest): container "db" in pod "db-deployment-cka05-trb-7457c469b7-zbxv6" is waiting to start: CreateContainerConfigError
```

So let's look into the kubernetes events for this pod:

```
kubectl get event --field-selector involvedObject.name=<pod-name>
```

You will see some errors as below:

```
Error: couldn't find key db in Secret default/db-cka05-trb
```

Now let's look into all secrets:

```
kubectl get secrets db-root-pass-cka05-trb -o yaml
kubectl get secrets db-user-pass-cka05-trb -o yaml
kubectl get secrets db-cka05-trb -o yaml
```

Now let's look into the deployment.

Edit the deployment

```
kubectl edit deployment db-deployment-cka05-trb -o yaml
```

You will notice that some of the keys are different what are referred in the deployment.

- Change some env keys: `db` to `database`, `db-user` to `username` and `db-password` to `password`
 - Change a secret reference: `db-user-cka05-trb` to `db-user-pass-cka05-trb`
- Finally save the changes.

Killer Doubts

Thursday, May 30, 2024 8:05 PM

nodeaffinity on pv

- ❓ I have a pv with 150Mi storage and created a PVC which requests 100Mi but still i can see that 150Mi is available to PVC, how?

Kubernetes allows PVCs to use available PVs that have more capacity than what's explicitly requested to ensure efficient resource utilization and flexibility for scaling storage needs.

- ❓ If there is a ClusterIP service - curlpod-svc and a pod - curlpod.

- If curlpod is exposed to this service, it will have an endpoint?
- You can confirm whether the app is exposed or not by - k exec curlpod -- curl curlpod-svc
- You can confirm whether the app is exposed or not by - k exec curlpod -- curl <endpoint>
- what will happen if you directly type from the node - curl curlpod-svc

Answer the above.

- If curlpod is exposed to the curlpod-svc service, it will have an endpoint. In Kubernetes, services act as a way to expose pods to other components within the cluster. When a pod is exposed via a service, Kubernetes manages the network routing so that other pods or services can communicate

with it.

- b. To confirm whether the app is exposed via the curlpod-svc service using kubectl exec, you can run the command: `kubectl exec curlpod -- curl curlpod-svc`
- c. If you know the specific endpoint of the service, you can also confirm whether the app is exposed by running: `kubectl exec curlpod -- curl <endpoint>`
Replace `<endpoint>` with the actual endpoint of the service, which can be the ClusterIP or the DNS name if applicable.
- a. It's more common to access services and pods from within the cluster using kubectl exec or similar methods rather than directly from the nodes.

To verify if a ClusterRole is bound to a ClusterRoleBinding using kubectl auth can-i, you can use the following command:

```
kubectl auth can-i get clusterrolebindings --as=system:serviceaccount:<namespace>:<serviceaccount-name>
```

Replace `<namespace>` and `<serviceaccount-name>` with the actual namespace and service account name that you want to check against.

If there is no endpoint in a service, what should i do if i already have a service - web-service, a pod web and another pod web-monitor which monitors whether this pod is bound to the service or not.

Check Service Selector:

For example, if your pods have labels `app: web`, your service YAML should have a selector like selector: `app: web`.

Check Pod Readiness:

Make sure that your pods (web and web-monitor) are running and ready.

Check Service Endpoints:

kubectl get endpoints web-service

- ★ If the ports specified in the Pod's container and the Service don't match, you typically adjust the Service's port to match the Pod's container port.
- ★ When it's mentioned that a Pod is "exposed" to a specific port, it usually refers to the Pod's targetPort. The targetPort is the port on which the application inside the Pod is listening.

How to mount configmaps, secrets, pvc all three into a single volume - web-volume in a pod ?

```
apiVersion: v1
kind: Pod
metadata:
  name: my-pod
spec:
  containers:
    - name: my-app
      image: nginx
      volumeMounts:
        - name: web-volume
          mountPath: /etc/config # Mount path in the container
  volumes:
    - name: web-volume
      projected:
        sources:
          - configMap:
              name: my-configmap
          - secret:
              name: my-secret
          - persistentVolumeClaim:
              claimName: my-pvc
```



What should i do if i have coredns but it is unable to resolve the ClusterIP haing the endpoints servicename when i enter - curl <https://<service-name>> .

1. Create a temporary Pod and try to resolve the Service's DNS name from within the cluster.
2. Check coredns pod is part of the deployment, delete the pod so that it can restart.

Service

10 / 12

Weight: 10

Expose the `hr-web-app` as service `hr-web-app-service` application on port `30082` on the nodes on the cluster.

The web application listens on port `8080`.

Name: `hr-web-app-service`

Type: `NodePort`

Endpoints: 2

Port: `8080`

NodePort: `30082`

For nodeport service
curl <nodeip>:<nodePort>

For verifying Service

Verify Service Endpoint: kubectl get endpoints service-name
Use kubectl get endpoints to verify that the Service has endpoints, which are the actual Pod IPs and ports that the Service routes traffic to.

Confirm Pod's Network Connectivity:

```
kubectl exec pod-name -- nslookup service-name
kubectl exec pod-name -- curl http://service-name:port # Replace 'port' with the actual port of the Service
```

Debug DNS Resolution:
kubectl exec pod-name -- nslookup service-name

Ensure Curl Command Syntax:
curl <http://service-name:port>

Scheduling each pod on different nodes

CNI - /opt/cni/bin

Killer

Thursday, May 30, 2024 4:50 PM

Q1

You have access to multiple clusters from your main terminal through `kubectl` contexts. Write all those context names into `/opt/course/1/contexts`.

Next write a command to display the current context into `/opt/course/1/context_default_kubectl.sh`, the command should use `kubectl`.

Finally write a second command doing the same thing into `/opt/course/1/context_default_no_kubectl.sh`, but without the use of `kubectl`.

Doubt:

- Context Names - Names Only?
Yes, Only Names.
- Write a command to display into <filename>- Should I write command or output?
Write the command.
- How to create a script file? (forgot)
`#!/bin/bash`

But this line was not mentioned in the solution.

- Without `kubectl`?

The `~/.kube/config` file is a Kubernetes configuration file used by `kubectl` and other Kubernetes command-line tools to interact with Kubernetes clusters. It contains information related to cluster, context etc. A context includes a combination of cluster, user, and namespace settings.

Solution

fastest

```
k config get-contexts # copy manually  
  
k config get-contexts -o name > /opt/course/1/contexts
```

Or using jsonpath:

```
k config view -o yaml # overview
k config view -o jsonpath=".contexts[*].name"
k config view -o jsonpath=".contexts[*].name" | tr " " "\n" # new lines
k config view -o jsonpath=".contexts[*].name" | tr " " "\n" > /opt/course/1/contexts
```

What I did:

Just printed the whole command. Just name using "-o name or manually copy"

```
k8s@terminal:~$ k config get-contexts
CURRENT   NAME      CLUSTER      AUTHINFO      NAMESPACE
*         k8s-c1-H   k8s-c1-H   k8s-c1-H   default
          k8s-c2-AC   k8s-c2-AC   k8s-c2-AC
          k8s-c3-CCC  k8s-c3-CCC  k8s-c3-CCC
k8s@terminal:~$ k config get-contexts -o name
k8s-c1-H
k8s-c2-AC
k8s-c3-CCC
```

Next create the first command:

```
# /opt/course/1/context_default_kubectl.sh
kubectl config current-context
```

```
→ sh /opt/course/1/context_default_kubectl.sh
k8s-c1-H
```

Without kubectl

And the second one:

```
# /opt/course/1/context_default_no_kubectl.sh
cat ~/.kube/config | grep current
```

 This Pod should only be scheduled on controlplane nodes. Do not add new labels to any nodes.

If we only specify a toleration the Pod can be scheduled on controlplane or worker nodes.

```
# 2.yaml
apiVersion: v1
kind: Pod
metadata:
  creationTimestamp: null
  labels:
    run: pod1
  name: pod1
```

```

# 2.yaml
apiVersion: v1
kind: Pod
metadata:
  creationTimestamp: null
  labels:
    run: pod1
    name: pod1
spec:
  containers:
    - image: httpd:2.4.41-alpine
      name: pod1-container          # change
      resources: {}
  dnsPolicy: ClusterFirst
  restartPolicy: Always
  tolerations:             # add
    - effect: NoSchedule        # add
      key: node-role.kubernetes.io/control-plane # add
  nodeSelector:             # add
    node-role.kubernetes.io/control-plane: ""  # add
status: []

```

Control plane nodes in Kubernetes typically don't have a value for taints by default.

NodeSelectors

Node has labels eg. `disktype: ssd`

```

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

```

★ Save file using - vim 4_pod1.yaml

Probe

```

# 4_pod1.yaml
apiVersion: v1
kind: Pod
metadata:
  creationTimestamp: null
  labels:
    run: ready-if-service-ready
    name: ready-if-service-ready
spec:
  containers:
    - image: nginx:1.16.1-alpine
      name: ready-if-service-ready
      resources: {}
      livenessProbe: # add from here
        exec:
          command:
            - 'true'
      readinessProbe:
        exec:
          command:
            - sh
            - -c
            - 'wget -T2 -o- http://service-am-i-ready:80' # to here
    dnsPolicy: ClusterFirst
    restartPolicy: Always
  status: {}

```

No need to mention the following fields as these are optional.

initialDelaySeconds
periodSeconds
failureThreshold

You can't mention the container name in "kubectl run command"

using get ep instead of describe svc

The already existing Service `service-am-i-ready` should now have an *Endpoint*:

```
k describe svc service-am-i-ready
k get ep # also possible
```

kubectl-cheat-sheet

Execute a bash file using: sh <filepath>

```
# /opt/course/5/find_pods.sh
kubectl get pod -A --sort-by=.metadata.creationTimestamp
```

And to execute:

```
→ sh /opt/course/5/find_pods.sh
NAMESPACE      NAME                           ...          AGE
kube-system    kube-scheduler-cluster1-controlplane1 ...
kube-system    etcd-cluster1-controlplane1        ...
kube-system    kube-apiserver-cluster1-controlplane1 ...
kube-system    kube-controller-manager-cluster1-controlplane1 ...
...
...
```

For the second command:

```
# /opt/course/5/find_pods_uid.sh
kubectl get pod -A --sort-by=.metadata.uid
```

And to execute:

```
→ sh /opt/course/5/find_pods_uid.sh
NAMESPACE      NAME                           ...          AGE
kube-system    coredns-5644d7b6d9-vwm7g ...
project-c13    c13-3cc-runner-heavy-5486d76dd4-ddvlt ...
project-hamster web-hamster-shop-849966f479-278vp ...
project-c13    c13-3cc-web-646b6c8756-qsg4b ...
```

PV PVC

In PV PVC , status should be bound. How to confirm that PVC has requested storage?

check that both have the status Bound:

```
→ k -n project-tiger get pv,pvc
NAME          CAPACITY  ... STATUS   CLAIM      ...
persistentvolume/safari-pv  2Gi       ... Bound    project-tiger/safari-pvc ...
NAME          STATUS     VOLUME   CAPACITY ...
persistentvolumeclaim/safari-pvc  Bound     safari-pv  2Gi       ...
```

AATA HUA GALAT

Deployment container mounts volume

X

Finally create a new Deployment safari in Namespace project-tiger which mounts that volume at /tmp/safari-data. The Pods of that Deployment should be of image httpd:2.4.41-alpine.

```
# 6_dep.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  creationTimestamp: null
  labels:
    app: safari
    name: safari
    namespace: project-tiger
spec:
  replicas: 1
  selector:
    matchLabels:
      app: safari
  strategy: {}
  template:
    metadata:
      creationTimestamp: null
      labels:
        app: safari
    spec:
      volumes: # add
      - name: data # add
        persistentVolumeClaim: # add
          claimName: safari-pvc # add
      containers:
      - image: httpd:2.4.41-alpine
        name: container
        volumeMounts: # add
        - name: data # add
          mountPath: /tmp/safari-data # add
```

Check "Mount" section if using volume and volumeMount.

PersistentVolumeClaims (PVCs) and Deployments do not need to be in the same namespace in Kubernetes.

7

show Pods and their containers resource usage

For the second file we might need to check the docs again:

```
→ k top pod -h
Display Resource (CPU/Memory/Storage) usage of pods.
...
Namespace in current context is ignored even if specified with --namespace.
--containers=false: If present, print usage of containers within a pod.
--no-headers=false: If present, print output without headers.
...
```

With this we can finish this task:

```
# /opt/course/7/pod.sh
kubectl top pod --containers=true
```

Check how the controlplane components kubelet, kube-apiserver, kube-scheduler, kube-controller-manager and etcd are started/installed on the controlplane node. Also find out the name of the DNS application and how it's started/installed on the controlplane node.

Choices of [TYPE] are: not-installed, process, static-pod, pod

We can see which components are controlled via systemd looking at /usr/lib/systemd directory:

This shows kubelet is controlled via systemd, but no other service named kube nor etcd.

(The kubelet could also have a different manifests directory specified via parameter --pod-manifest-path in its systemd startup config)

Static Pods

Manifest folder

pod name will be like pod-name-node-name

```
→ root@cluster1-controlplane1:~# find /etc/kubernetes/manifests/
/etc/kubernetes/manifests/
/etc/kubernetes/manifests/kube-controller-manager.yaml
/etc/kubernetes/manifests/etcd.yaml
/etc/kubernetes/manifests/kube-apiserver.yaml
/etc/kubernetes/manifests/kube-scheduler.yaml
```

```
→ root@cluster1-controlplane1:~# kubectl -n kube-system get pod -o wide | grep controlplane
coredns-5644d7b6d9-c4f68           1/1   Running   ...   cluster1-controlplane1
coredns-5644d7b6d9-t84sc          1/1   Running   ...   cluster1-controlplane1
etcd-cluster1-controlplane1        1/1   Running   ...   cluster1-controlplane1
kube-apiserver-cluster1-controlplane1 1/1   Running   ...   cluster1-controlplane1
kube-controller-manager-cluster1-controlplane1 1/1   Running   ...   cluster1-controlplane1
kube-proxy-q955p                  1/1   Running   ...   cluster1-controlplane1
kube-scheduler-cluster1-controlplane1 1/1   Running   ...   cluster1-controlplane1
weave-net-mwj47                   2/2   Running   ...   cluster1-controlplane1
```

There we see the 5 static pods, with `-cluster1-controlplane1` as suffix.

We also see that the dns application seems to be coredns,

Temporarily stop the kube-scheduler this means in a way that you can start it again afterwards.

You have to stop it.

- ★ Since, schedules is a static-pod, if you move the manifest file to some other location, it will be stopped.

Kill the Scheduler (temporarily):

```
→ root@cluster2-controlplane1:~# cd /etc/kubernetes/manifests/
→ root@cluster2-controlplane1:~# mv kube-scheduler.yaml ..
```

1. **mv**: This is the command for moving files or directories in Unix-like operating systems.
2. **kube-scheduler.yaml**: This is the name of the file you want to move.
3. **.. -** This notation refers to the parent directory of the current directory.

Manually schedule the Pod

means add a nodename in the yaml file - 9.yml

```
spec:
  nodeName: cluster2-controlplane1      # add the controlplane node name
```

The only thing a scheduler does, is that it sets the nodeName for a Pod declaration.

Let's play the scheduler

Now, the pod will be scheduled.

As we cannot kubectl apply or kubectl edit bcoz questions asks to manually schedule it , in this case we need to delete and create or replace:

As we cannot **kubectl apply** or **kubectl edit** , in this case we need to delete and create or replace:

```
k -f 9.yaml replace --force
```

RBAC

Use context: `kubectl config use-context k8s-c1-H`

Create a new *ServiceAccount* `processor` in *Namespace* `project-hamster`. Create a *Role* and *RoleBinding*, both named `processor` as well. These should allow the new *SA* to only create *Secrets* and *ConfigMaps* in that *Namespace*.

Let's talk a little about RBAC resources

A *ClusterRole|Role* defines a set of permissions and **where it is available**, in the whole cluster or just a single *Namespace*.

A *ClusterRoleBinding|RoleBinding* connects a set of permissions with an account and defines **where it is applied**, in the whole cluster or just a single *Namespace*.

Because of this there are 4 different RBAC combinations and 3 valid ones:

1. *Role + RoleBinding* (available in single *Namespace*, applied in single *Namespace*)
2. *ClusterRole + ClusterRoleBinding* (available cluster-wide, applied cluster-wide)
3. *ClusterRole + RoleBinding* (available cluster-wide, applied in single *Namespace*)
4. *Role + ClusterRoleBinding* (**NOT POSSIBLE**: available in single *Namespace*, applied cluster-wide)

```
k -n project-hamster create role processor \
--verb=create \
--resource=secret \
--resource=configmap
```

This will create a *RoleBinding* like:

```
# kubectl -n project-hamster create rolebinding processor --role processor --serviceaccount project-hamster:processor
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: processor
  namespace: project-hamster
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: processor
subjects:
- kind: ServiceAccount
  name: processor
  namespace: project-hamster
```

To test our RBAC setup we can use kubectl auth can-i:

Question 12 | Deployment on all Nodes

There should be only ever one Pod of that Deployment running on one worker node. We have two worker nodes: cluster1-node1 and cluster1-node2. Because the Deployment has three replicas the result should be that on both nodes one Pod is running. The third Pod won't be scheduled, unless a new worker node will be added. Use topologyKey: kubernetes.io/hostname for this.

There are two possible ways, one using podAntiAffinity and one using topologySpreadConstraint

Pod Affinity

The Pod affinity rule tells the scheduler to place each replica on a node that has a Pod with the label app=store. The Pod anti-affinity rule tells the scheduler never to place multiple app=web-store servers on a single node.

```
spec:  
  affinity:  
    podAntiAffinity:  
      requiredDuringSchedulingIgnoredDuringExecution:  
        - labelSelector:  
            matchExpressions:  
              - key: app  
                operator: In  
                values:  
                  - web-store  
            topologyKey: "kubernetes.io/hostname"  
        podAffinity:  
          requiredDuringSchedulingIgnoredDuringExecution:  
            - labelSelector:  
                matchExpressions:  
                  - key: app  
                    operator: In  
                    values:  
                      - store  
                topologyKey: "kubernetes.io/hostname"  
      containers:  
        - name: web-app  
          image: nginx:1.16-alpine
```

When topologyKey: kubernetes.io/hostname is used in an anti-affinity rule, it ensures that Pods with the same anti-affinity labels (specified in matchExpressions) are not scheduled on nodes that share the same hostname.

```

# 12.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  creationTimestamp: null
  labels:
    id: very-important          # change
    name: deploy-important
    namespace: project-tiger     # important
spec:
  replicas: 3                      # change
  selector:
    matchLabels:
      id: very-important        # change
  strategy: {}
  template:
    metadata:
      creationTimestamp: null
      labels:
        id: very-important      # change
    spec:
      containers:
        - image: nginx:1.17.6-alpine
          name: container1         # change
          resources: {}
        - image: google/pause       # add
          name: container2         # add
      topologySpreadConstraints:      # add
        - maxSkew: 1                # add
          topologyKey: kubernetes.io/hostname # add
          whenUnsatisfiable: DoNotSchedule # add
      labelSelector:
        matchLabels:
          id: very-important      # add
status: {}

```

Question 13 | Multi Containers and Pod shared Volume

Container c1 should be of image nginx:1.17.6-alpine and have the name of the node where its Pod is running available as environment variable **MY_NODE_NAME**.

```
spec:  
  containers:  
    - image: nginx:1.17.6-alpine  
      name: c1  
      resources: {}  
      env:  
        - name: MY_NODE_NAME  
          valueFrom:  
            fieldRef:  
              fieldPath: spec.nodeName  
      volumeMounts:  
        - name: vol  
          mountPath: /vol
```

Good, then we check if container c1 has the requested node name as env variable:

```
→ k exec multi-container-playground -c c1 -- env | grep MY  
MY_NODE_NAME=cluster1-node2
```

Path is /vol

There should be a volume attached to that Pod and mounted into every container, but the volume shouldn't be persisted or shared with other Pods.

```
volumes:  
  - name: vol  
    emptyDir: {}  
status: {}
```

★ Create an emptyDir if nothing specified.

And finally we check the logging:

```
→ k logs multi-container-playground -c c3  
Sat Dec  7 16:05:10 UTC 2077  
Sat Dec  7 16:05:11 UTC 2077  
Sat Dec  7 16:05:12 UTC 2077  
Sat Dec  7 16:05:13 UTC 2077  
Sat Dec  7 16:05:14 UTC 2077  
Sat Dec  7 16:05:15 UTC 2077  
Sat Dec  7 16:05:16 UTC 2077
```

Question 14 | Find out Cluster Information

What is the Service CIDR?

What is the Service CIDR?

```
→ ssh cluster1-controlplane1
→ root@cluster1-controlplane1:~# cat /etc/kubernetes/manifests/kube-apiserver.yaml | grep range
- --service-cluster-ip-range=10.96.0.0/12
```

Which Networking (or CNI Plugin) is configured and where is its config file?

Which Networking (or CNI Plugin) is configured and where is its config file?

```
→ root@cluster1-controlplane1:~# find /etc/cni/net.d/
/etc/cni/net.d/
/etc/cni/net.d/10-weave.conflist

→ root@cluster1-controlplane1:~# cat /etc/cni/net.d/10-weave.conflist
{
    "cniVersion": "0.3.0",
    "name": "weave",
    ...
}
```

By default the kubelet looks into `/etc/cni/net.d` to discover the CNI plugins. This will be the same on every controlplane and worker nodes.

Which suffix will static pods have that run on cluster1-node1?

"-cluster1-node1"

So, pod will be like webapp-cluster1-node1

Question 15 | Cluster Event Logging

Remove containers

```
crlctl rm <container-id>
```

Write a command into /opt/course/15/cluster_events.sh which shows the latest events in the whole cluster, ordered by time (metadata.creationTimestamp).

```
# /opt/course/15/cluster_events.sh  
kubectl get events -A --sort-by=.metadata.creationTimestamp
```

Question 16 | Namespaces and Api Resources

Write the names of all namespaced Kubernetes resources (like Pod, Secret, ConfigMap...) into /opt/course/16/resources.txt.

```
k api-resources    # shows all  
k api-resources -h # help always good  
k api-resources --namespaced -o name > /opt/course/16/resources.txt
```

Find the project-* Namespace with the highest number of Roles defined in it and write its name and amount of Roles into /opt/course/16/crowded-namespace.txt.

```
→ k -n project-c13 get role --no-headers | wc -l
No resources found in project-c13 namespace.
0

→ k -n project-c14 get role --no-headers | wc -l
300

→ k -n project-hamster get role --no-headers | wc -l
No resources found in project-hamster namespace.
0

→ k -n project-snake get role --no-headers | wc -l
No resources found in project-snake namespace.
0

→ k -n project-tiger get role --no-headers | wc -l
No resources found in project-tiger namespace.
0
```

One by one

Question 17 | Find Container of Pod and check info

Write the ID of the container and the info.runtimeType into /opt/course/17/pod-container.txt

```
→ ssh cluster1-node2

→ root@cluster1-node2:~# crictl ps | grep tigers-reunite
b01edbe6f89ed    54b0995a63052    5 seconds ago    Running      tigers-reunite ...

→ root@cluster1-node2:~# crictl inspect b01edbe6f89ed | grep runtimeType
"runtimeType": "io.containerd.runc.v2",
```

crictl inspect <container-id> - to check the logs

Finally we write the container logs in the second file:

Finally we write the container logs in the second file:

```
ssh cluster1-node2 'cricl logs b01edbe6f89ed' &> /opt/course/17/pod-container.log
```

The &> in above's command redirects both the standard output and standard error.

cricl logs vs cricl inspect

Question 18 | Fix Kubelet

The procedure on tasks like these should be to check if the kubelet is running, if not start it, then check its logs and correct errors if there are some.

Always helpful to check if other clusters already have some of the components defined and running, so you can copy and use existing config files.

Read Certificates

```
openssl x509 -noout -text -in /etc/kubernetes/pki/apiserver.crt | grep Validity-A2
```

Killer - Tips

Thursday, May 30, 2024 7:14 PM

When you have to fix a component (like kubelet) in one cluster, just check how it's setup on another node in the same or even another cluster. You can copy config files over etc

Pre Setup

```
alias k=kubectl          # will already be pre-configured  
  
export do="--dry-run=client -o yaml"  # k create deploy nginx --image=nginx $do  
  
export now="--force --grace-period 0" # k delete pod x $now
```

Vim

The following settings will already be configured in your real exam environment in `~/.vimrc`. But it can never hurt to be able to type these down:

```
set tabstop=2  
set expandtab  
set shiftwidth=2
```

KK labs

Saturday, June 1, 2024 12:52 PM

Command line arguments: --color=green

args: ["--color", "green"]

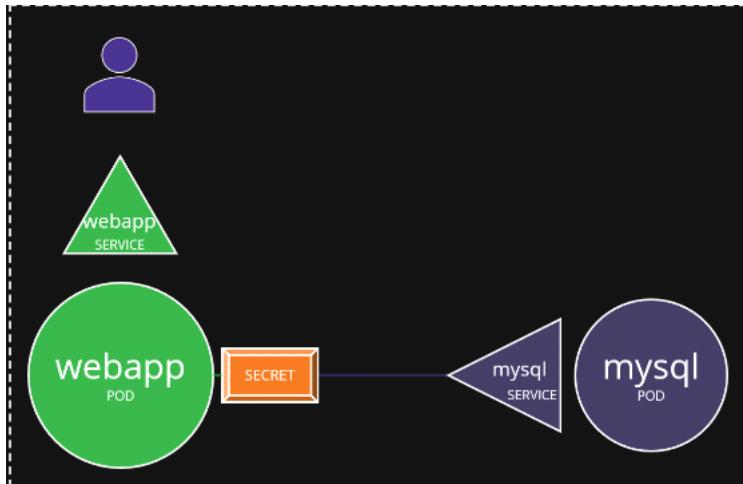
```
name@name-VirtualBox:~/green$ args:  
- "--color=green"  
-
```

How many secrets are defined in the dashboard-token secret?

```
Data  
====  
ca.crt:      570 bytes  
namespace:   7 bytes  
token:       eyJhbGciOiJSUzI1NiI  
.eyJpc3MiOiJrdWJlcms1dGVzL3Nlcn  
iJkZWZhdWx0Iiwia3VizXJuZXRIcy5p  
ybmv0ZXMuaW8vc2VydmljZWFjY291br  
3NlcnZpY2VhY2NvdW50L3NlcnZpY2Ut  
zdWIi0iJzeXN0ZW06c2VydmljZWFjY2  
xSb0dcxM4D1bvezDW7n18pI82KygQDT
```

There are three secrets - ca.crt, namespace and token.

Architecture - Check out the web application using the Webapp MySQL



```
alias kn="k config set-context --current --namespace"
```

What is the name of the Storage Class that does not support dynamic volume provisioning?

PROVISIONER = kubernetes.io/no-provisioner

WaitForFirstConsumer Mode: In this mode, a PersistentVolumeClaim (PVC) will remain unbound until a Pod that references that PVC is scheduled to a node.

Ingress vs IngressController

The host entry defines the domain name that users use to reach the application like www.google.com
What is * in Hosts?

The kube-api server stopped again! Check it out. Inspect the kube-api server logs and identify the root

cause and fix the issue.

- Run `crlctl ps -a` command to identify the kube-api server container.
 - Run `crlctl logs container-id` command to view the logs.
-
- When `kubectl` not work , run "`docker ps -a` or `crlctl ps -a`" command.
 - Then check the logs using "`crlctl logs <container-id>` , container-id of the kube-apiserver etc.

2379 is the port of etcd

Check limits also, env also.

Dumps Questions

Monday, June 3, 2024 12:34 AM

M3 - 2.0

Saturday, June 8, 2024 10:23 AM

Creating Endpoints

The web application listens on port 8080.
refers to the target port of the application.

4 June

Sunday, June 9, 2024 11:13 AM

explain

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: test-network-policy
  namespace: default
spec:
  podSelector:
    matchLabels:
      role: db
  policyTypes:
    - Ingress
    - Egress
  ingress:
    - from:
        - ipBlock:
            cidr: 172.17.0.0/16
            except:
              - 172.17.1.0/24
        - namespaceSelector:
            matchLabels:
              project: myproject
        - podSelector:
            matchLabels:
              role: frontend
  ports:
    - protocol: TCP
      port: 6379
  egress:
    - to:
        - ipBlock:
            cidr: 10.0.0.0/24
  ports:
    - protocol: TCP
      port: 5978
```

- systemctl enable --now kubelet

grep -v NoSchedule: Excludes nodes that are tainted with NoSchedule.

Here port is Service's Port, right?

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: pong
  namespace: ing-internal
spec:
  rules:
  - http:
      paths:
      - path: /hi
        pathType: Prefix
        backend:
          service:
            name: hi
            port:
              number: 5678
```

Using kubectl edit or kubectl patch expand the PersistentVolumeClaim to a capacity of 70Mi

Core Concept: Summary

Thursday, May 30, 2024 10:38 AM

?

Give an example " kubectl run nginx-pod --image=nginx --expose=80" to understand all the control plane and worker node components - apiserver, scheduler, etcd, controller manager, kubelet and kubeproxy. I want to know how these components communicate with each other to get the work done. I want to understand the workflow and anatomy.

Let's break down the command **kubectl run nginx-pod --image=nginx --expose=80** and understand how it relates to Kubernetes components and their communication:

kubectl: This is the command-line tool used to interact with the Kubernetes cluster. It communicates with the Kubernetes API server to execute commands.

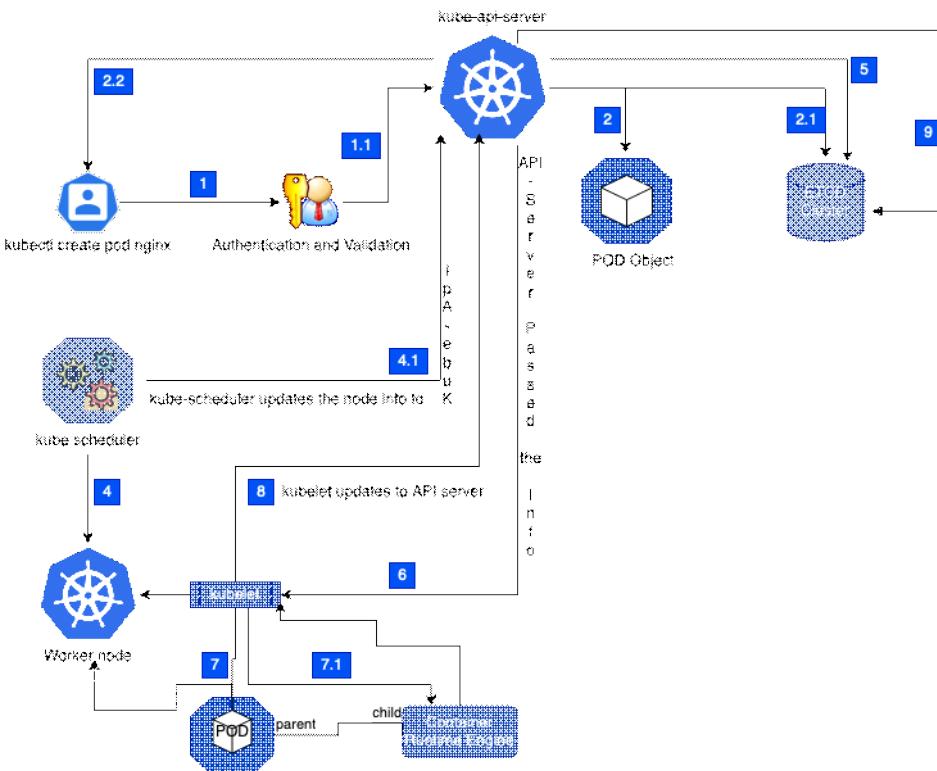
nginx-pod: This is the name of the pod that you are creating. Pods are the smallest deployable units in Kubernetes and can contain one or more containers.

--image=nginx: This flag specifies the Docker image (nginx in this case) that will be used to create the container inside the pod.

--expose=80: This flag exposes port 80 on the pod, allowing external access to services running inside the pod on that port.

Now, let's dive into how these commands interact with Kubernetes components:

1. The request is authenticated first and validated.
2. The “kube-api-server” creates a POD object, without assigning it to a node, updates the information of the newly created pod in “ETCD Cluster” and updated/shows us a message that a POD is got created.
3. The “kube-scheduler” which is continually monitoring the “kube-api-server” gets to know that a new pod is got created with no node assigned to it.
4. **The “kube-scheduler” identifies the right node** (according to pod resource requirement, pod/node affinity rules, labels & selectors etc.) to place the new POD and communicate back to the “kube-api-server” (with the information of the right node for the pod)
5. The “kube-api-server” again updates the information to the “ETCD Cluster” received from “kube-scheduler”.
6. The “kube-api-server” then passed the same information to the “kubelet” on the appropriate worker node identified by “kube-scheduler” in the 4th step.
7. **The “kubelet” then creates the pod on node** and instructs the “Container Runtime Engine” to deploy the application image/container.
8. Once done, the “kubelet” updates the information/status of the pod back to the “kube-api-server”.
9. And “kube-api-server” updates the information/data back in the “ETCD Cluster”.



Controller Manager: The controller manager component watches for changes in the cluster state, such as new pod creations. It ensures that the desired state (specified in the pod definition) matches the actual state in the cluster. For example, if a pod goes down, the controller manager ensures that a new pod is created to maintain the desired number of replicas.

Kubelet: Once the pod is scheduled onto a worker node, the kubelet on that node is responsible for managing the pod's lifecycle. It pulls the container image (nginx) from the container registry, starts the container, and monitors its health.

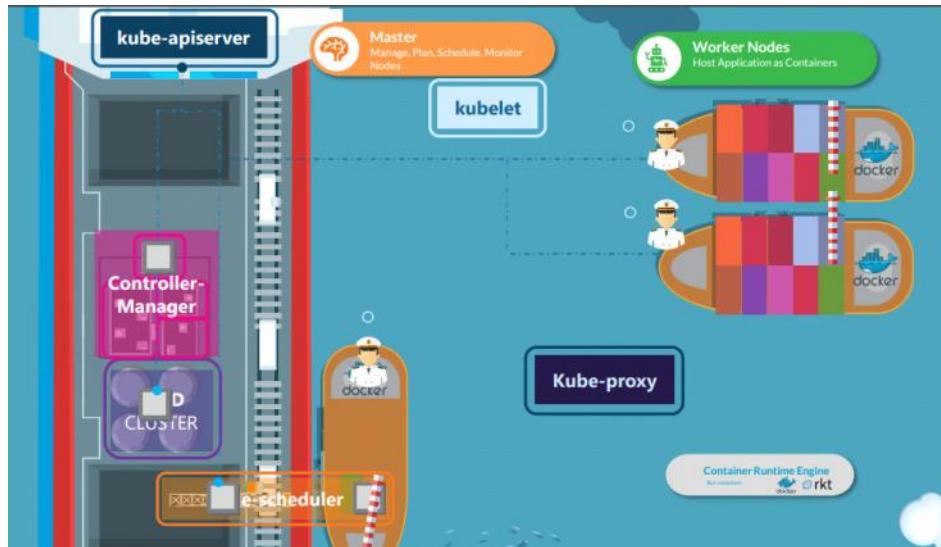
Kube Proxy: The kube proxy component running on each node is responsible for networking. In this case, when you expose port 80 (--expose=80), kube proxy sets up the necessary network rules to forward traffic from outside the cluster to the pod's port 80.

- ★ So, when a pod is created, kube-scheduler continuously monitors the kube-api server and when it finds the new pod, it assigns the pod to the right node and communicates that back to the kube-api server. The api server updates this information in the etcd cluster. The kubelet then creates the pod on the node and instructs the container runtime engine to deploy the application image. Once done, the kubelet updates the status back to the API server and the API server then updates the data back in the etcd cluster.
- ★ The scheduler is only responsible for deciding which pod goes on which node. It doesn't actually place the pod on the nodes, that's the job of the kubelet.

Kubernetes Architecture

Monday, February 19, 2024 6:26 PM

Analogy of a Cargo Shipping Operation



Cargo Ship	Worker Node
Cargo Compartments	Namespaces
Cargo	Pods, Services, Deployments, etc.
Controller Ship	Master Node
Crane Machine	kube-scheduler
Ship Captain	Kubelet
Office	Kube Controller Manager
Shipping manifests	Deployments
Handling instructions	Services

Kubernetes Architecture - Overview

Control Plane

- A control plane in Kubernetes refers to the set of components that manage the overall state of the cluster and make global decisions about the cluster (such as scheduling), as well as detecting and responding to cluster events (like starting up a new pod when a deployment's replicas field is unsatisfied).
- The control plane components run on the master node(s) of the Kubernetes cluster and include the following components: **etcd**, **kube-scheduler**, **kube-api-server**, **kube-controller-manager** and **cloud-controller-manager**(the cloud controller manager lets you link your cluster into your cloud provider's API, and separates the components that interact with that cloud platform from components that only interact with your cluster).

Node Components

- kubelet
- kube-proxy
- Container Runtime

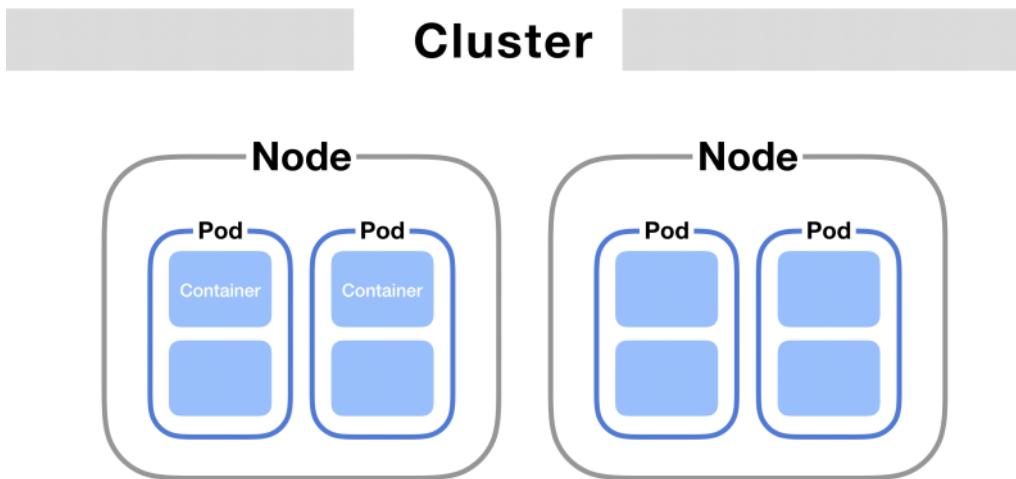
Master Node

etcd	Stores information about the cluster.
kube-scheduler	Responsible for scheduling applications or containers on nodes.
kube-apiserver	Responsible for orchestrating all operations within the cluster.
kube-controller-manager	

Worker node

kubelet	Listens for instructions from the Kube API server and manages containers
kube-proxy	It helps in enabling communication between services within the cluster.

Kubernetes Architecture - Detailed



- **Master Node (Controller Ship):**

- **API Server:** Acts as the central communication hub for all components. It receives commands (like "deploy this application" or "scale this service") and ensures that they are carried out.
- **Controller Manager:** Monitors the cluster's current state and works towards the desired state. Different controllers handle specific tasks, such as replication controller for maintaining the desired number of pod replicas.
- **etcd (Distributed Key-Value Store):** Stores the configuration data and the current state of the entire cluster. It provides a reliable way for the components to store and retrieve data.
- **Scheduler:**

- **Worker Node (Cargo Ship):**

- **Kubelet:** Acts as the cargo-ship captain, ensuring that the containers within the pod are running as expected. It communicates with the master node and starts or stops containers accordingly.
- **Container Runtime:** The software that loads and runs containers. Docker and containerd are examples. It's responsible for managing the containers on the ship.
- **Kube Proxy:** Manages network communication between pods on the same ship and ensures that external traffic reaches the appropriate containers.

★ kubelets can be present on master node as well. When ?

- **Pod (Shipping Container):**

A Pod is the smallest deployable unit in Kubernetes. It represents a group of one or more containers that share the same network namespace. Containers within a pod can easily communicate with each other.

- **Deployment (Shipping Manifest):**

A Deployment is like a shipping manifest or plan that describes how the cargo (pods) should be organized and maintained. It allows you to **declaratively** define the desired state of your application.

The example YAML provided earlier for a basic Nginx deployment specifies details like the desired number of replicas and the container image to use.

- **Service (Harbor Crane):**

A Service is like a harbor crane that provides a stable entry point for accessing the cargo (pods) within the cluster. It assigns a stable IP address and DNS name, enabling external communication.

The example YAML for a basic Nginx service defines a set of pods to route traffic to base on labels, providing a consistent way to access the application.

- **kube-scheduler (Crane Operator):**

The kube-scheduler is like the crane operator at the harbor who decides where to place each container (pod) on the available ships (worker nodes).

It considers factors like resource requirements, affinity, anti-affinity, and other constraints to make informed decisions about pod placement, optimizing the overall cluster's efficiency.

Proxy -

A proxy server refers to a server that acts as an intermediary between the request made by clients, and a particular server for some services or requests for some resources.

The proxy server prevents the identification of the client's IP address when the client makes any request to any other servers.

For Internet clients, Proxy servers also act as a shield for an internal network against the request coming from a client to access the data stored on the server. It makes the original IP address of the node remain hidden while accessing data from that server.

A **forward proxy** accepts connections from computers on a private network and forwards those requests to the public internet. It is the single point of exit for subnet users who want to access resources outside of their private network.

As the name implies, a reverse proxy is the opposite of a forward proxy. The **reverse proxy** acts as a single point of entry for external systems to access resources on a private subnet.

etcd

Monday, February 19, 2024 7:43 PM

What are key-value store?

How it is different from traditional databases?

How to quickly get started with ETCD?

How to use the client tool to operate ETCD?

etcd - It is a distributed, reliable, key-value store that is simple, secure, and fast.

key-value store

- Traditionally, databases have been in a tabular format.
- Modifying the table such as adding an extra column impacts the entire table and all of the rows in them.
- Every time a new information needs to be added, the entire table is affected and leads to a lot of empty cells. (figure)

Name	Age	Location	Salary	Grade
John Doe	45	New York	5000	
Dave Smith	34	New York	4000	
Aryan Kumar	10	New York		A
Lauren Rob	13	Bangalore		C
Lily Oliver	15	Bangalore		B

- In above table- we have
 - working individual with salary
 - student with grades
 - student can't have salary and working individual can't have grades.
 - empty cells
- A key-value store stores information in the form of documents or pages.

Key	Value
Name	Aryan Kumar
◦ Age	10
Location	New York
Grade	A

Key	Value
Name	Lauren Rob
◦ Age	13
Location	Bangalore
Grade	C

Key	Value
Name	Lily Oliver
Age	15
Location	Bangalore
Grade	B

- Each individual gets a document and all information about that individual is stored within that file
- These files can be in any format or structure and changes to one file does not affect the others.
- You can add additional details to any of these documents without having to update other similar documents.
- Key-Value Formats
 - JSON(JavaScript Object Notation) : JSON is a simpler alternative to XML.
 - YAML(YAML Ain't Markup Language)
 - XML(eXtensible Markup Language): While not as human-readable as JSON or YAML, XML is a widely used format for representing hierarchical data. It uses tags to define elements and attributes for key-value pairs. An example XML document:

```
<person>
  <name>John Doe</name>
  <age>30</age>
  <city>New York</city>
</person>
```

- INI(Initialization)- INI files use a simple and lightweight structure consisting of sections, keys, and values. Each section is enclosed in square brackets, and key-value pairs are listed within the sections. For example:

```
[section1]
key1 = value1
key2 = value2

[section2]
key3 = value3
```

- TOML(Tom's Obvious Minimal Language) - OML is a data serialization language that aims to be more readable than JSON or YAML. It uses a simple and clean syntax. One of the major differences between TOML and INI is that TOML required quote if the value is string while INI doesn't. <https://github.com/toml-lang/toml/discussions/845>. An example TOML document:

```
[owner]
name = "Tom"
dob = 1985-07-22

[database]
server = "localhost"
ports = [8000, 8001, 8002]
```

- HCL(HashiCorp Configuration Language): HCL is used by HashiCorp tools and is designed for configuration files. It uses a concise and expressive syntax. HCL is a tool-specific language intended for use with the Terraform toolset. HCL looks visually similar to JSON, with unique data structures added. An example HCL configuration:

```
server {
  name = "web-server"
  port = 8080
}
```

- **Serializing data is finding some sort of universal format that can be easily shared across different applications.**

etcd role in k8s

- The etcd data store stores information regarding the cluster such as the nodes, pods, convicts, secrets, accounts, roles, role bindings, and others.
- Every change you make to your cluster such as adding additional nodes, deploying pods or replica sets are updated in the etcd server.
- Only once it is updated in the etcd server is the change considered to be complete.
- Port 2379, which is the default port on which etcd listens.

e.g. `kubectl run nginx --image=nginx --restart=Never`

```
json

{
  "kind": "Pod",
  "apiVersion": "v1",
  "metadata": {
    "name": "nginx",
    "namespace": "default",
    "uid": "4a3f21bb-1fbb-11ee-bc8e-fa163e6c2918",
    "creationTimestamp": "2025-07-10T10:00:00Z"
  },
  "spec": {
    "containers": [
      {
        "name": "nginx",
        "image": "nginx",
        "resources": {}
      }
    ],
    "restartPolicy": "Never"
  },
  "status": {
    "phase": "Running"
  }
}
```

- This is the **database** process itself.
- It runs as a systemd service or a static pod (in /etc/kubernetes/manifests/etcd.yaml) on the **control plane node**.

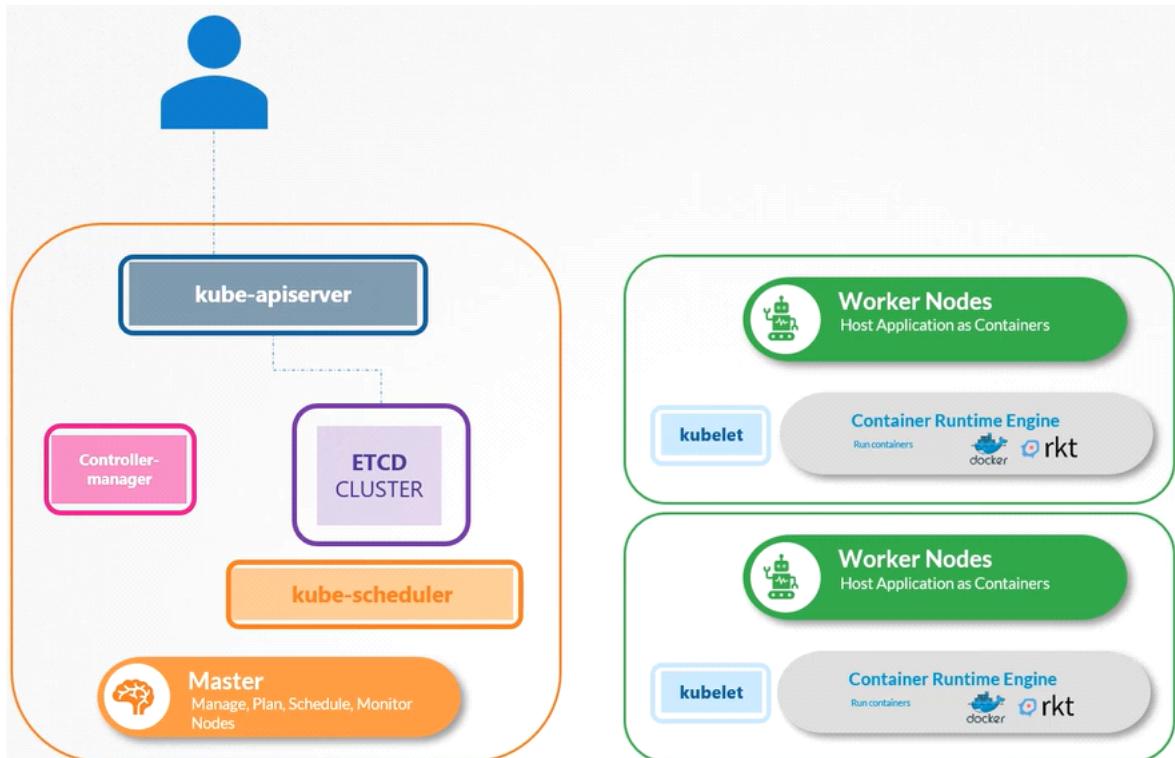
2. etcd Client

- Any component that **reads/writes data to etcd** using its **API** is an etcd client.
- In Kubernetes, the main **etcd client is the API Server**.

kube-api server

Tuesday, February 20, 2024 12:37 PM

- kube-api server is the primary management component in Kubernetes.



- When you run a kubectl command, the kubectl utility reaches to the kube-apiserver.
- The kube-api server first authenticates the request and validates it.
- It then retrieves the data from the etcd cluster and responds back with the requested information.
- **kube-api server is the only component that interacts directly with the etcd data store.**
- So, when a pod is created, kube-scheduler continuously monitors the kube-api server and when it finds the new pod, it assigns the pod to the right node and communicates that back to the kube-api server. The api server updates this information in the etcd cluster. The **kubelet then creates the pod on the node** and instructs the container runtime engine to deploy the application image. Once done, the kubelet updates the status back to the API server and the API server then updates the data back in the etcd cluster.

Kube controller Manager

Tuesday, February 20, 2024 12:38 PM

- A controller is like an office or department within the mastership.
- Each office in a mastership has its own set of responsibilities - managing containers, monitoring ships, etc.
- It's a part of Kubernetes control plane, This component is responsible for running multiple controllers that maintain the desired state of the cluster.
- All controllers are packaged into a single process known as the Kubernetes Controller Manager.

Types

Replication Controller

The Replication Controller makes sure that a specified number of identical pods are running at all times. If the actual number of pods deviates from the desired state (e.g., due to node failures or manual scaling), the Replication Controller takes corrective actions to maintain the desired count.

Node Controller

The Node Controller ensures that the worker nodes are healthy and available. If a node goes down or becomes unhealthy, the Node Controller takes corrective measures such as rescheduling the pods on healthy nodes.

Namespace Controller

The Namespace Controller is responsible for creating and managing namespaces, which provide a way to divide cluster resources among multiple users or projects. It helps keep cargo (pods) organized and isolated within their respective namespaces.

Namespaces are like separate compartments or sections within the cargo ship. Each compartment is dedicated to a specific type of cargo or a particular team/project.

Benefits of Namespaces:

Isolation: Namespaces provide isolation between different projects or teams. Cargo (resources) within one namespace is not directly aware of the cargo in other namespaces.

Resource Sharing: While isolated, namespaces allow for efficient resource sharing within the same cluster. Multiple teams can run their cargo (applications) independently in their respective compartments.

By using namespaces, Kubernetes ensures that the cargo (resources) of Company A and Company B can coexist in the same cluster without interfering with each other. Namespaces provide a way to organize and manage resources efficiently, allowing for the smooth transportation (deployment and operation) of cargo (applications) within the Kubernetes cluster (cargo ship).

Service Account & Token Controllers:

The Service Account Controller ensures that each pod has the necessary credentials to access the Kubernetes API. The Token Controller generates and refreshes tokens for service accounts, ensuring secure communication within the cluster.

Endpoint Controller

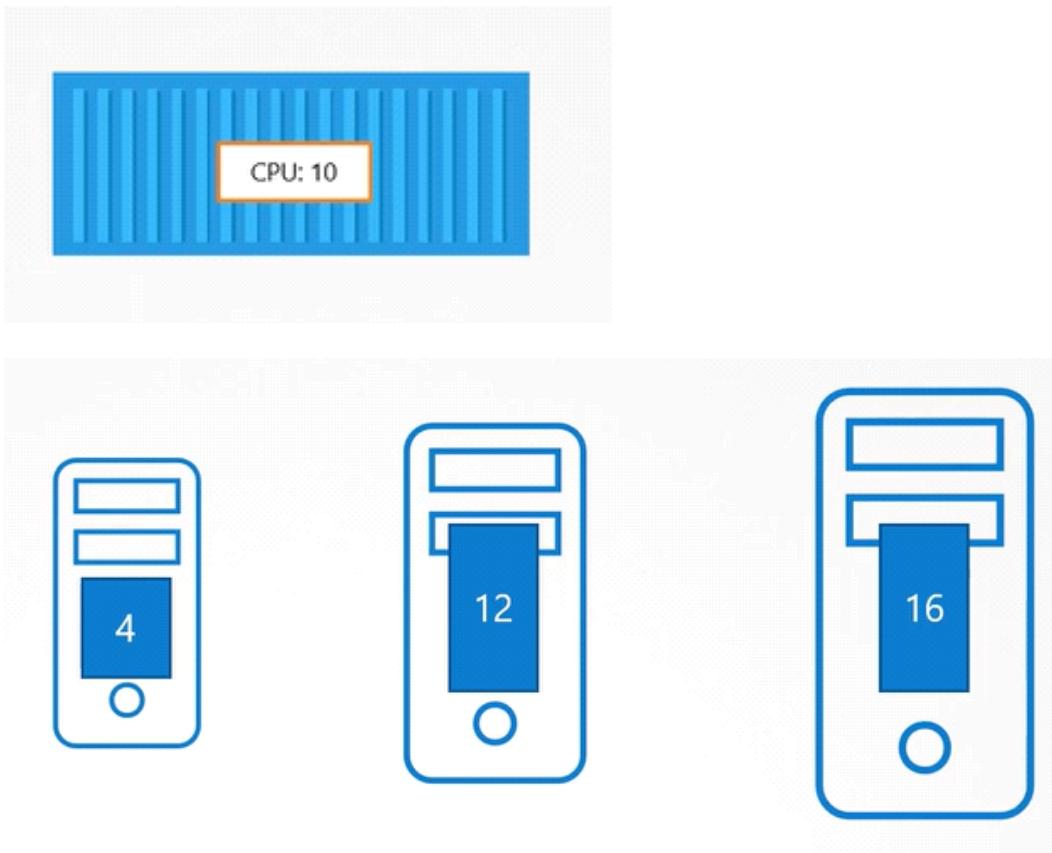
The Endpoint Controller is responsible for populating the Endpoints object, which contains information about the IP addresses and ports of pods backing a service. It ensures that cargo ships (services) can efficiently route traffic to their intended destinations (pods).

These controllers work together to ensure the smooth operation and desired state of the Kubernetes cluster, much like various controllers on a cargo ship coordinate to maintain the proper functioning and organization of the cargo. Each controller has a specific responsibility, contributing to the overall orchestration and management of containerized applications in the Kubernetes environment.

kube scheduler

Tuesday, February 20, 2024 12:38 PM

- The scheduler is only responsible for deciding which pod goes on which node. It doesn't actually place the pod on the nodes, that's the job of the **kubelet**.
- The scheduler looks at each pod and tries to find the best node for it.
- The scheduler tries to filter out the nodes that do not fit the profile for this pod. For example, the nodes that do not have sufficient CPU and memory resources requested by the pod.
- The scheduler ranks the nodes to identify the best fit for the pod. It uses a priority function to assign a score to the nodes on a scale of zero to 10. For example, the scheduler calculates the amount of resources that would be free on the nodes after placing the pod on them.



- The **best node** for scheduling a pod will have a score **closer to 10**, a higher score means higher priority.

kubelet

Tuesday, February 20, 2024 6:25 PM

- The kubelet in the Kubernetes worker node registers the node with a Kubernetes cluster.
- When it receives instructions to load a container or a pod on the node, it requests the **container runtime engine, which may be Docker**, to pull the required image and run an instance.
- The kubelet then continues to monitor the state of the pod and containers in it and reports to the kube API server on a timely basis.
- With help of kubelet a node can join the cluster and tell the cluster that it is available to run the workload.
- Kubelet talks to the control plane to get the pods list that needs to run on the node and runs the pod. It also does a health check on containers and tells the status back to API server.

Kube Proxy

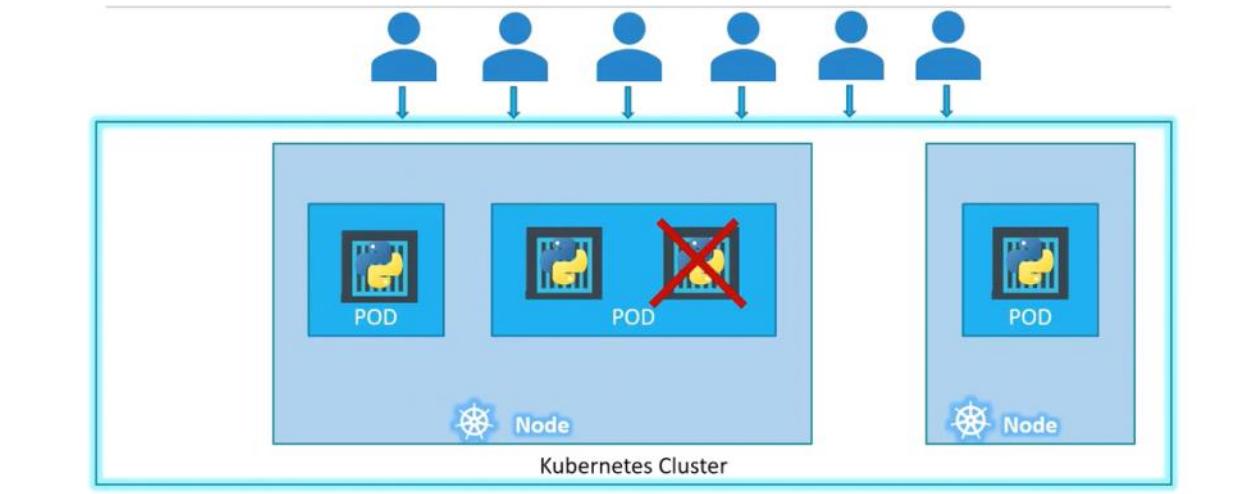
Tuesday, February 20, 2024 6:32 PM

- A pod network is an internal virtual network that expands across all the nodes in the cluster to which all the pods connect to. Through this network, they're able to communicate with each other.
- **Kube-proxy** is a process that runs on each node in the Kubernetes cluster. Its job is to look for new services, and every time a new service is created, it creates the appropriate rules on each node to forward traffic to those services to the backend pods.

Pods

Tuesday, February 20, 2024 6:49 PM

- Kubernetes does not deploy containers directly on the worker nodes.
- The containers are encapsulated into a Kubernetes object known as pods.
- A pod is a single instance of an application.
- A pod is the smallest object that you can create in Kubernetes.
- To scale up, you create new pods, and to scale down, you delete existing pods. **You do not add additional pods to an existing container to scale your application.**
- The pod has a one-to-one relationship with the containers.



? Can we put two containers in a single pod, is it a best practice? If yes, are there any criteria for which type of containers should be put in a single node?

Yes, you can put multiple containers in a single pod in Kubernetes, and it's a common practice in certain scenarios. Here are some considerations for when to use multiple containers in a single pod:

- **Co-located Components:** If two or more components of your application closely collaborate and share resources, such as sharing the same network namespace or accessing shared volumes, it can be beneficial to colocate them in a single pod. For example, **a web server and a logging agent** that need access to the same log files.
- **Sidecar Pattern:** The sidecar pattern involves deploying a helper container alongside the main application container in the same pod. **The sidecar container enhances or extends the functionality of the main container.** For instance, adding logging, monitoring, or file syncing

capabilities to the main application.

- **Shared Resources:** Containers within the same pod can share resources like network interfaces, IPC (Inter-Process Communication), and volumes. This can simplify communication and resource management between closely related components.
- **Deployment Simplicity:** Managing multiple containers as a single unit (pod) simplifies deployment and scaling. It ensures that all containers in the pod are co-located and scheduled together on the same node.

However, there are also considerations to keep in mind:

- **Resource Isolation:** Containers within the same pod share the same resources and constraints. If one container consumes excessive resources or crashes, it can affect other containers in the pod. Ensure that containers have well-defined resource limits and requirements.
- **Decomposability:** Consider the modularity and decoupling of your application components. If components can function independently and have distinct life cycles, they might be better suited as separate pods.
- **Security and Privilege:** Be cautious with sharing security contexts and privileges among containers in the same pod. Ensure that each container has appropriate access controls and permissions based on its role and responsibilities.

In conclusion, putting multiple containers in a single pod depends on factors such as application architecture, resource-sharing needs, deployment simplicity, and security considerations. Evaluate your requirements carefully and consider the trade-offs before adopting this approach.

Creating a pod using YAML in Kubernetes

```

pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
  name: myapp-pod
  labels:
    app: myapp
spec:

```

Kind	Version
POD	v1
Service	v1
ReplicaSet	apps/v1
Deployment	apps/v1

- Under metadata you can only specify name or labels or anything else that Kubernetes expects to be under metadata. You cannot add any other property as you wish under this. However, under labels, you can have any kind of key or value pairs as you see fit.

```

pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
  name: myapp-pod
  labels:
    app: myapp
    type: front-end
spec:
  containers:
    - name: nginx-container
      image: nginx

```

- "-" indicate the first item in the list.

Lab 1

Sunday, April 14, 2024 12:12 PM

Create a new pod with the nginx image.

```
kubectl run nginx --image=nginx
```

What is the image used to create the new pods?

Run the command **kubectl describe pod <pod-name>** and look under the containers section.

Which nodes are these pods placed on?

Run the command **kubectl describe pod newpods-<id>** and look at the node field.

★ Alternatively run **kubectl get pods -o wide** and check for the node the pod is placed on.

Why do you think the container agentx in pod webapp is in error?

Try to figure it out from the events section of the pod.

ImagePullBackOff

The "ImagePullBackOff" error in Kubernetes occurs when a **pod is unable to pull the specified container**

image from the container registry. This error typically indicates a problem with fetching or accessing the container image during the pod creation or deployment process.

Here are some common reasons why you might encounter the "ImagePullBackOff" error:

- Incorrect Image Name: Ensure that the container image name specified in your pod definition or deployment configuration is correct and includes the correct repository, **image name**, and **tag** (if applicable).
- Registry Authentication: If your container image is hosted in a **private registry**, make sure that Kubernetes has the necessary credentials (such as Docker Hub credentials, or a secret for other registries) to authenticate and pull the image. **You may need to create a Kubernetes secret with the registry credentials and mount it into your pod or deployment.**
- Network Issues: Check for network connectivity issues that might prevent Kubernetes from reaching the container registry. Ensure that the Kubernetes cluster has outbound **network access to the registry** where the container image is hosted.
- Image Availability: Verify that the **container image exists in the specified registry** and repository. The "ImagePullBackOff" error can occur if the image is not available or has been removed from the registry.
- Image Version or Tag: If you're using a specific image tag (e.g., version number or latest), ensure that the tag exists in the registry. Using an invalid or non-existent tag can result in the "ImagePullBackOff" error.
- Rate Limiting: Some container registries impose **rate limits on image pulls**. If you exceed the rate limit, it can lead to image pull failures and the "ImagePullBackOff" error. Check if rate limiting is affecting your image pulls.

To troubleshoot the "ImagePullBackOff" error, you can:

- Check the Kubernetes logs for more detailed error messages related to image pulling. Use **kubectl logs <pod name>** to view logs
- Verify the image name, tag, and repository in your pod or deployment configuration.
- Review the Kubernetes cluster's network connectivity and ensure it can reach the container registry.
- Verify registry authentication if you're using a private registry.
- Check for any rate-limiting issues with the container registry.

By addressing these potential issues, you can resolve the "ImagePullBackOff" error and ensure that your pods can successfully pull the required container images during deployment.

What does the READY column in the output of the kubectl get pods command indicate?

run vs apply

kubectl run:

- Purpose: Used to create and run a new Kubernetes resource, typically a pod.
- Usage: `kubectl run <name> --image=<image>`
- Example: `kubectl run nginx --image=nginx:latest`
- Resource Created: Primarily used for creating pods, although it can create other resources like jobs, deployments, etc., with specific flags (`--generator`, `--restart`, etc.).
- Recommended Use: Quick creation of single resources, such as pods for testing or debugging.

kubectl apply:

- Purpose: Used to apply configuration changes or create/update Kubernetes resources defined in YAML or JSON files.
- Usage: `kubectl apply -f <file>`
- Example: `kubectl apply -f deployment.yaml`
- Resource Created/Updated: Can create, update, or delete various Kubernetes resources (pods, deployments, services, configmaps, etc.) defined in the specified configuration file.
- Recommended Use: Managing complex configurations, applying changes across multiple resources, and maintaining desired state in a declarative manner.

In summary, kubectl run is primarily for quickly creating single resources like pods, while kubectl apply is more suitable for managing configurations, applying changes across multiple resources, and maintaining the desired state of your Kubernetes cluster.

★ You can't edit the pod definition yaml file and then run 'kubectl create' command as it will throw 'Image already exist error'. After editing the yaml file, you have to run 'kubectl apply' command.

Replication Controller

Tuesday, February 20, 2024 7:25 PM

- The Replication Controller helps us run multiple instances of a single pod in the Kubernetes cluster, thus providing high availability.
- Even if you have a single pod, the Replication Controller can help by automatically bringing up a new pod when the existing one fails.
- The Replication Controller ensures
 - that the specified number of pods are running at all times even if it's just 1 or 100.
 - Another reason we need a Replication Controller is to create multiple pods to share the load across them.

★ A ReplicaSet in Kubernetes manages multiple replicas (copies) of a single pod template, not multiple distinct pods.

? What is the limit to deploying some containers on the same node?

Are there any criteria for measurement as such?

The limit to deploy the number of containers on the same node depends on various factors such as the resources (CPU, memory, storage) available on the node, the resource requests and limits specified for each container, the workload characteristics, and the Kubernetes cluster configuration. Here are some considerations:

- **Resource Availability:** Each node in a Kubernetes cluster has a finite amount of CPU, memory, and storage available. The number of containers that can be deployed on a node depends on how much of these resources are consumed by each container and the total capacity of the node.
- **Resource Requests and Limits:** Kubernetes allows you to specify resource requests and limits for each container. **The requests define the minimum amount of resources that a container needs to run, while the limits define the maximum amount of resources that a container can use.** These specifications help the Kubernetes scheduler to make decisions about pod placement and resource allocation on nodes.
- **Workload Characteristics:** The type of workload running in the containers also influences the number of containers that can be deployed on a node. For example, CPU-intensive applications may require more CPU resources, whereas memory-intensive applications may require more memory resources.
- **Kubernetes Cluster Configuration:** The configuration of the Kubernetes cluster, including the number of nodes, their capacity, and any resource constraints or policies defined, also impacts the maximum number of containers that can be deployed.

? When we can create multiple nodes?

As for when to create multiple nodes, you typically create multiple nodes in a Kubernetes cluster to **distribute workloads**, improve fault tolerance, and **scale your applications horizontally**. Here are some scenarios when creating multiple nodes is beneficial:

- Resource Isolation: To isolate workloads and prevent resource contention, especially for applications with different resource requirements or criticality levels.
- High Availability: To ensure **high availability** of applications by distributing them across multiple nodes. This helps in minimizing downtime in case of node failures.

- Scaling: To **horizontally scale** applications by adding more nodes to handle increased workload or user demand.
- Geographical Distribution: For **deploying applications across multiple regions** or data centers to reduce latency and improve performance for users in different geographical locations.

There are no fixed criteria or measurements for determining the exact number of containers that can be deployed on a node or when to create multiple nodes. It depends on your specific application requirements, resource availability, performance goals, and the overall architecture of your Kubernetes cluster. It's important to monitor resource usage, analyze workload patterns, and scale your cluster accordingly to ensure optimal performance and resource utilization.

Replication Controller and Replica Set

A **Replica Set** is the new way of creating a replica of a pod.

- To create a replication controller

```
rc-definition.yml
apiVersion: v1
kind: ReplicationController
metadata:
  name: myapp-rc
  labels:
    app: myapp
    type: front-end
spec:
  template:
    metadata:
      name: myapp-pod
      labels:
        app: myapp
        type: front-POD
    spec:
      containers:
        - name: nginx-container
          image: nginx
```

```
pod-definition.yml
apiVersion: v1
kind: Pod
```

- To set the number of replica-

```

rc-definition.yml
apiVersion: v1
kind: ReplicationController
metadata:
  name: myapp-rc
  labels:
    app: myapp
    type: front-end
spec:
  template:
    metadata:
      name: myapp-pod
      labels:
        app: myapp
        type: front-end
    spec:
      containers:
        - name: nginx-container
          image: nginx
  replicas: 3

```

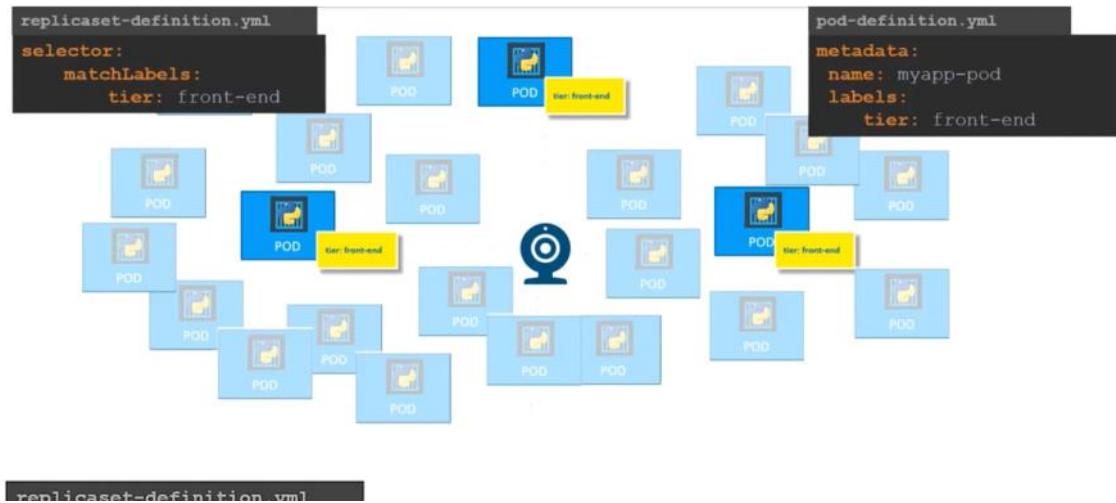
Creating a ReplicaSet

- Everything is the same as the Replication Controller except apiVersion and one new section which is a **selector**.
- The selector helps to identify what pods fall under it.

But why would you have to specify what pods fall under it if you have provided the contents of the pod definition file itself in the template?

Because we can use a replica set to monitor existing pods if you have them already created.

- ReplicaSet is a process that monitors the pod.



```
replicaset-definition.yml
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: myapp-replicaset
  labels:
    app: myapp
    type: front-end
spec:
  template:
    metadata:
      name: myapp-pod
      labels:
        app: myapp
        type: front-end
    spec:
      containers:
        - name: nginx-container
          image: nginx
    replicas: 3
  selector:
    matchLabels:
      type: front-end
```

- Selectors are crucial for controllers like ReplicaSets to identify which pods they should manage. In above pic, The type: front-end in matchLabels ensures that the ReplicaSet selects pods with the label type: front-end for management.

Lab 2

Sunday, April 14, 2024 12:39 PM

- What does 'ready' indicate in 'k get rs' command?

In the output of the **kubectl get rs** command, the "READY" column indicates the current number of replicas that are ready and available for use out of the desired number of replicas specified in the ReplicaSet's configuration.

For example, if you have a ReplicaSet with a desired replica count of 3, and the "READY" column shows "3/3," it means that all three replicas managed by the ReplicaSet are ready and available for use. If it shows "2/3," it means that two replicas are ready, but one is either still starting up or encountering an issue.

The "READY" count is important for ensuring that your application or workload has the desired level of availability based on the number of replicas configured in the ReplicaSet.

Run the command: You can check for apiVersion of replicaset by command `kubectl api-resources | grep replicaset`

`kubectl explain replicaset | grep VERSION` and correct the `apiVersion` for `ReplicaSet`.

Then run the command: `kubectl create -f /root/replicaset-definition-1.yaml`

Deleting a Replicaset

```
kubectl delete replicaset <replicaset-name>
kubectl delete -f <file-name>.yaml
```

★ Modifying a Replicaset

Run the command: `kubectl edit replicaset new-replica-set`, modify the image name, and then save the file.

Delete the previous pods to get the new ones with the correct image.

For this, run the command: `kubectl delete po <pod-name>` or `k delete po --all`

Scale the ReplicaSet to 5 PODs.

Use `kubectl scale` command or edit the replicaset using `kubectl edit replicaset`.

Run the command: `kubectl edit replicaset new-replica-set`, modify the replicas and then save the file

OR

run: `kubectl scale rs new-replica-set --replicas=5` to scale up to 5 PODs.

To check the API version you can run '`kubectl explain rs`' command.

Deployment

Thursday, February 22, 2024 6:17 PM

- Deployment is an object that provides declarative updates to applications.
 - It allows you to describe the desired state of your application's pods, and the Deployment controller changes the actual state to the desired state at a controlled rate.
 - Deployments are a key resource for managing applications in a Kubernetes cluster.
- Features and components of a Kubernetes Deployment:

- Pod Template:

A Deployment specifies the desired state through a Pod template. This template describes the characteristics of the pods that should be created, including the container image, ports, and other settings.

- Replica Sets:

Deployments use Replica Sets underneath to ensure the desired number of replicas (pod instances) are maintained. The Replica Set helps manage the scaling of pods and ensures high availability.

- Rolling Updates:

One of the powerful features of Deployments is the ability to perform rolling updates. When you want to update your application to a new version or configuration, a Deployment can manage the update process without downtime. It gradually replaces old pods with new ones, ensuring a smooth transition.

- Rollback:

If an update causes issues or if you need to revert to a previous version, Deployments support rollback functionality. You can easily roll back to a previous known good state, minimizing the impact of issues.

- Scaling:

Deployments allow you to scale your application by adjusting the number of replicas. You can scale up or down based on demand or resource availability.

- Self-healing:

If a pod or node fails, the Deployment controller automatically replaces the failed pod with a new one, ensuring the desired number of replicas is maintained.

- Declarative Configuration:

Deployments are defined using declarative YAML or JSON configuration files. **You describe the desired state, and the Deployment controller works to make the actual state match the specified state.**

- To see all the created objects at once, run the `kubectl get all` command.

```
deployment-definition.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: myapp-deployment
  labels:
    app: myapp
    type: front-end
spec:
  template:
    metadata:
      name: myapp-pod
      labels:
        app: myapp
        type: front-end
    spec:
      containers:
        - name: nginx-container
          image: nginx
replicas: 3
selector:
  matchLabels:
    type: front-end
```

lab 3

Sunday, April 14, 2024 4:05 PM

Why do you think the deployment is not ready?

Run the command: `kubectl describe pods <pod-name>` and look under the Events section.

Create deployment imperatively

```
kubectl create deployment --image=nginx nginx --replicas=4 --dry-run=client -o yaml > nginx-deployment.yaml
```

Services - NodePort

Thursday, February 22, 2024 6:31 PM

- Kubernetes 'Services' enable communication between various components within and outside of the application.
- Kubernetes 'Services' help us connect applications with other applications or users.
- 'Service' also helps in connecting the group of pods.

Kubernetes Services

- Kubernetes Services facilitate communication within and outside an application.
- They enable loose coupling between microservices.

Microservices (pods) don't need to know the exact IP of other microservices they want to talk to.
Instead, they just refer to a **Service name**, and Kubernetes **handles the routing**.

Without Services (Tight Coupling):

- Pod A must know **Pod B's exact IP** to talk to it.
- Pod IPs change when pods restart → breaks communication.

With Services (Loose Coupling):

- Pod A talks to <http://orderservice> instead of a specific Pod IP.
- Kubernetes Service acts like a **stable, load-balanced entry point** to Pod B.
- Now, **Pod A doesn't care** how many replicas Pod B has, or when they restart.

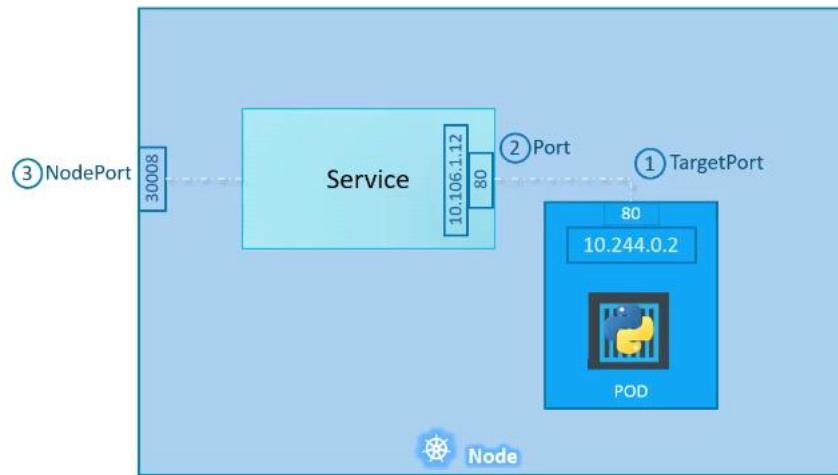
Types of Services

- ClusterIP:
 - **Description:** This is the **default** type. The clusterIP make the pod **accessible internally** to other pods by assigning an IP to it. Other pods within the same cluster can communicate with this service using the ClusterIP, but external traffic from outside the cluster cannot reach this service directly using the ClusterIP. This provides a way for pods within the cluster to interact with the

- service without exposing it to external networks.
- **Use Case:** It is used for communication between different components within the cluster. For example, if you have a frontend and backend service, the frontend can communicate with the backend using a ClusterIP service.
- **How it works:**
 - Kubernetes assigns a virtual IP (ClusterIP) to the service.
 - Internal DNS automatically resolves the service name to this IP within the cluster.
 - Traffic to the service is load-balanced across pods matching the service's selector.

- NodePort:

Most Important Diagram



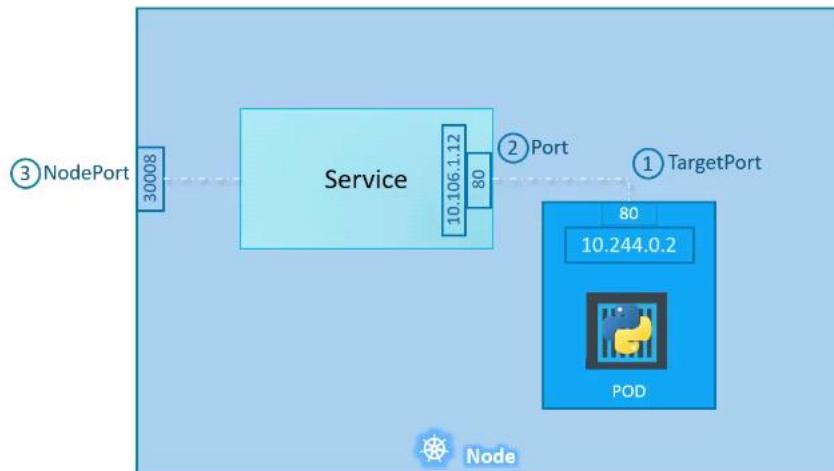
- **Description:** This type exposes the service on each node's IP at a static port. It allows external users to access the service by connecting to any node in the cluster on the specified port.
 - **Use Case:** It is commonly used when you need to expose the service to external users or systems. For example, if you have a web application, you can use NodePort to allow external users to access it
 - **How it works:**
 - In addition to a ClusterIP, **NodePort assigns a static port (e.g., 30000-32767)** on each node to the service.
 - **External traffic hitting any node's IP on the NodePort is forwarded to the ClusterIP and then to the corresponding pods.**
- LoadBalancer:
- **Description:** This type provisions an **external load balancer** (e.g., cloud load balancer) and assigns a stable external IP to the service. Traffic to this external IP is then **routed to the service's ClusterIP**.
 - **Use Case:** It is suitable for scenarios where you need external access and want to **distribute traffic across multiple nodes using a load balancer**. This type is often used in cloud environments where native load balancers are available.
 - **How it works:**
 - LoadBalancer creates an external load balancer (e.g., provided by cloud providers) and assigns an external IP to the service.
 - The load balancer distributes incoming traffic across nodes running the service based on

load balancing algorithms.

- **ExternalName:**

- Description: This type maps the service to an external DNS name. When accessed within the cluster, it resolves to the external DNS name.
- Use Case: It is used when you want to use services external to the cluster without exposing internal details. For example, you can map a service to an external database or API.
- How it works:
 - ExternalName maps the service to an external DNS name (e.g., example.com).
 - When accessed within the cluster, the service name resolves to the external DNS name, allowing pods to reach external services without exposing internal details.

How NodePort Works



Mapping Ports:

- NodePort maps a port on the node to a port on a Pod.
- External users access the application via the node's IP and the mapped port.

Creation Process:

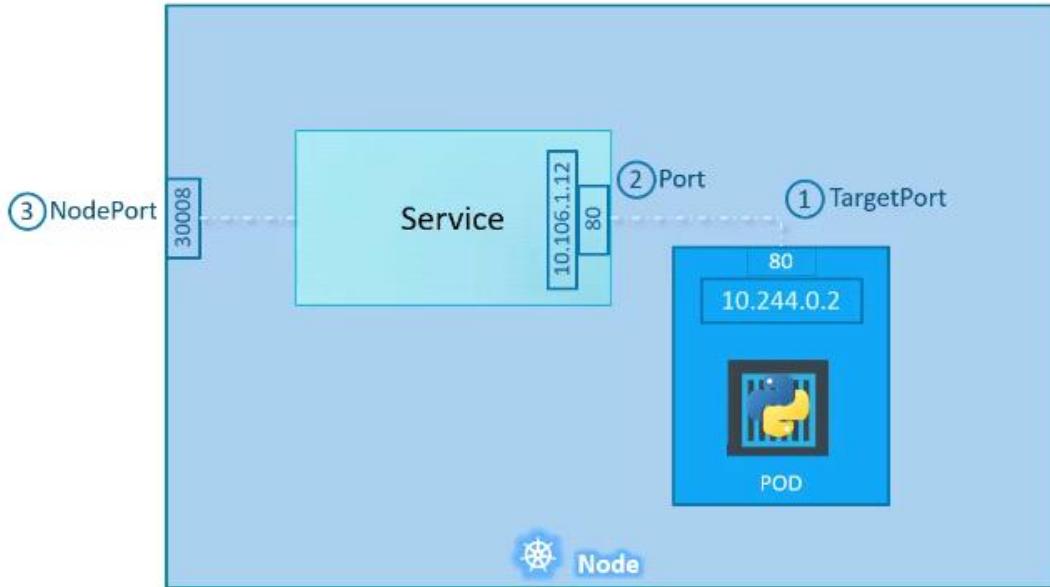
- Use a definition file (API version, kind, metadata, spec).
- Spec includes type (NodePort), ports (targetPort, port, nodePort), and selectors to link service with Pods.

Detailed Creation Steps

Definition File:

```
yaml

apiVersion: v1
kind: Service
metadata:
  name: my-nodeport-service
spec:
  type: NodePort
  ports:
    - targetPort: 80
      port: 80
      nodePort: 30008
  selector:
    app: my-app
```



```

apiVersion: v1
kind: Service
metadata: Name of the service
spec:
  type: NodePort
  ports:
    - targetPort: Port on the Pod (e.g., 80)
      port: Port on the service (e.g., 80).
      nodePort: Port on the node for external access (e.g., 30008). Node ports can only be in a valid range
                 which by default is from 30,000 to 32,767.
  
```

- ★ Out of these 3 port i.e. targetPort, port and nodePort, **only 'port' field is mandatory**.
- ★ If you don't provide a targetPort, it is assumed to be the same as port.
- ★ And if you don't provide a nodePort, a free port in the valid range between 30,000 and 32,767 is automatically allocated.

Selectors:

- Use labels and selectors to link the service to specific Pods.
- Include labels in the service definition file to identify Pods.

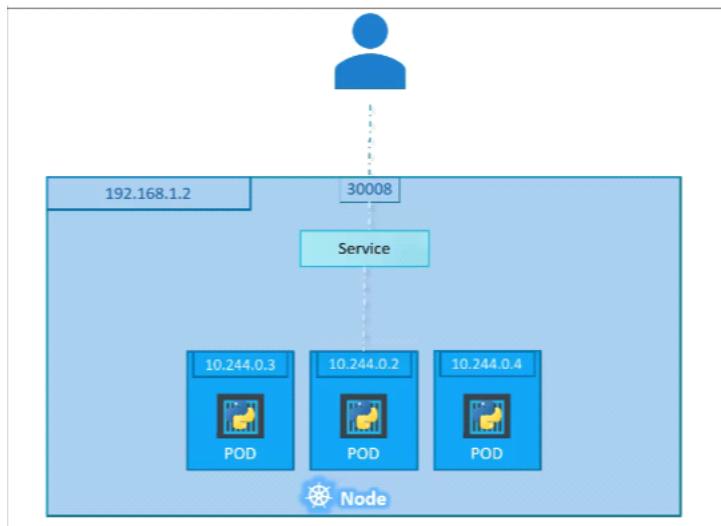
Service - NodePort

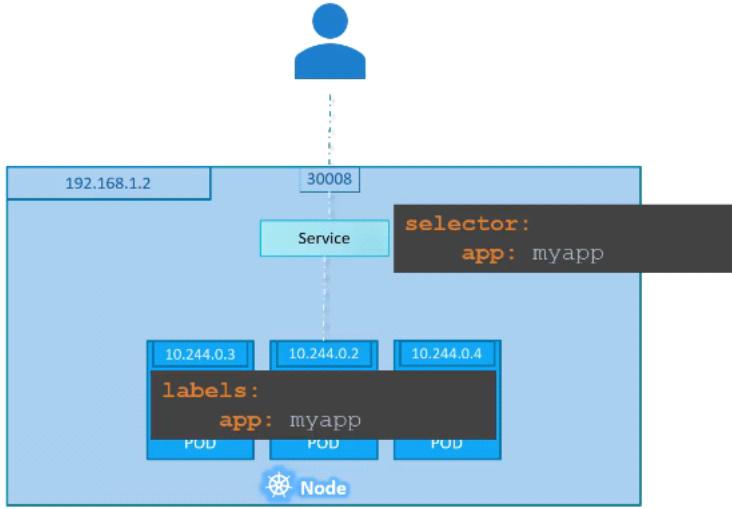
```
service-definition.yml
apiVersion: v1
kind: Service
metadata:
  name: myapp-service
spec:
  type: NodePort
  ports:
    - targetPort: 80
      port: 80
      nodePort: 30008
  selector:
    app: myapp
    type: front-end
```

```
pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
  name: myapp-pod
  labels:
    app: myapp
    type: front-end
spec:
  containers:
    - name: nginx-container
      image: nginx
```

- Move content(app, type, etc.) of label's field of pod definition file under the selector's field of service definition file.

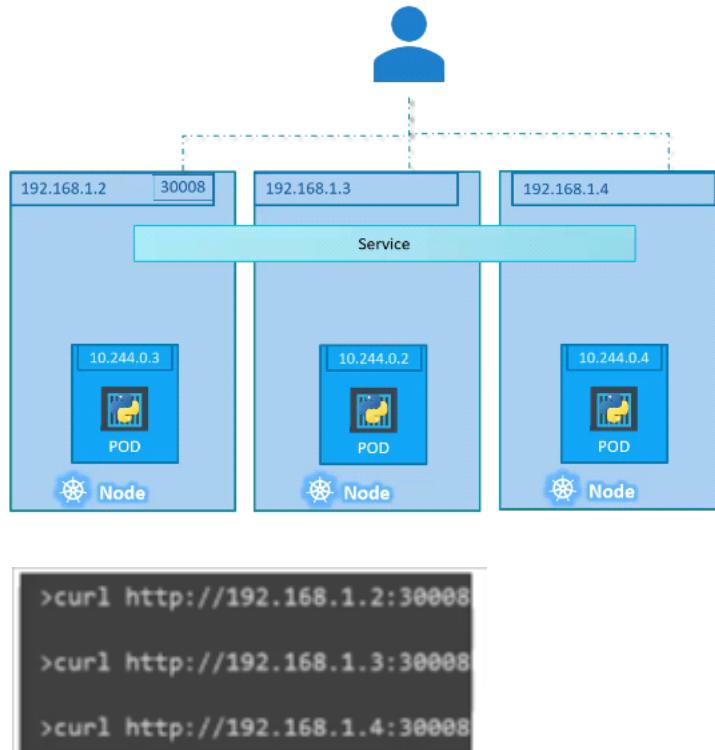
Handling Multiple Pods





- **NodePort services can handle multiple Pods with similar labels.**
- Kubernetes automatically selects all matching Pods as endpoints for the service.
- Load balancing across multiple Pods is handled internally by Kubernetes.

Handling Multiple Pods : Pods are distributed across multiple nodes



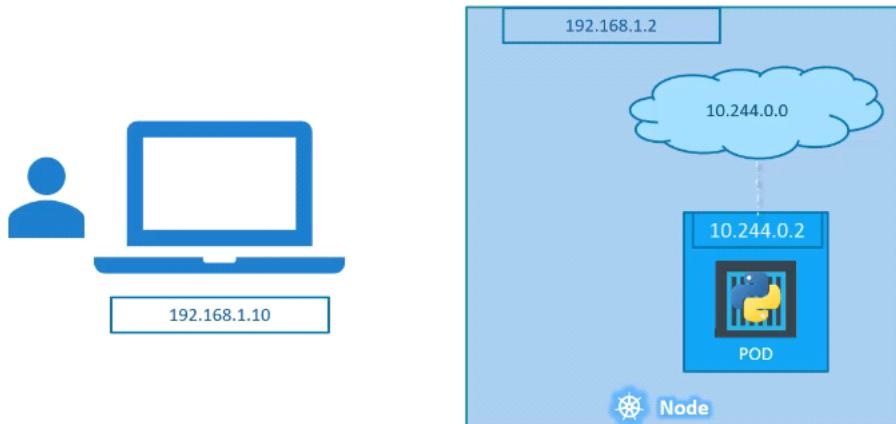
- Kubernetes automatically creates a service that spans across all the nodes in the cluster and **maps the target port to the same node port on all the nodes in the cluster**. This way you can access your application using the IP of any node in the cluster and using the same port number which in this case is 30,008.

Flexibility and Adaptability

- Kubernetes automatically updates NodePort services:
 - When Pods are added or removed.
 - Ensures continuous accessibility without manual reconfiguration.
- Supports high availability and scalability without additional configuration steps.

Summary

- NodePort services in Kubernetes provide external access to applications by mapping ports on nodes to Pods.
- They are defined in a YAML file with specifications for ports, selectors, and type.
- Kubernetes manages load balancing and updates automatically, making NodePort services flexible and adaptive.



Let's take an example in which an existing setup is given and how external access to a web application deployed on Kubernetes is achieved.

Existing Setup:

- The Kubernetes node has an IP address: 192.168.1.2.
- The laptop is on the same network so it will also have an IP address in the range 192.168.1.x which is: 192.168.1.10.
- The internal Pod network is in the range: 10.244.0.0, and a specific Pod has an IP: 10.244.0.2.
- The web application is running on the Pod with IP 10.244.0.2.

Accessing the Web Application from Laptop:

- Since the laptop and the Kubernetes node are on the same network, direct access to the Pod's IP (10.244.0.2) is not possible from the laptop due to network segregation.
- Accessing the web application requires going through the Kubernetes node.

How to access the web pages hosted on the pod?

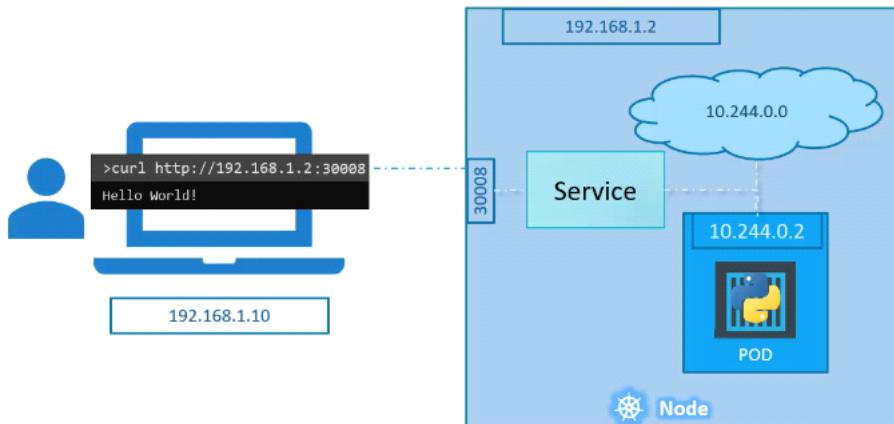
Node Access Methods: This method is from inside the Kubernetes node means we have to first SSH into the Kubernetes node and then we can access the pods.

- SSH into the Kubernetes node (192.168.1.2) and use curl to access the web application on the Pod (10.244.0.2).
- If the node has a GUI, open a browser on the node and access the web application using the internal Pod IP (<http://10.244.0.2>).

Desired Access Method:

- We need a method to access the web server directly from the laptop without SSH-ing into the Kubernetes node.

Solution - Kubernetes Service (NodePort):



- Kubernetes Service is an object just like pods, ReplicaSet, etc. A Kubernetes Service maps a port (e.g., 30008) on the node to a port on the Pod running the web application. This type of service is known as a NodePort service.
- The service listens to a port on the node (e.g., 30008) and forwards requests to the corresponding port on the Pod (port 80 where the web server is running).

Creating the NodePort Service:

- Create a NodePort service using a YAML file with specifications defining the target port, service port, and node port.
- Use labels and selectors in the service definition to link it to the Pod running the web application (e.g., using the label app: my-app).

Accessing the Web Application using NodePort:

- After creating the NodePort service, access the web application from the laptop using the Kubernetes node's IP (192.168.1.2) and the specified NodePort (e.g., 30008).
- This allows external access to the web server running on the Pod through the Kubernetes node,

providing a seamless way to interact with the application from external devices on the same network.

- ?
- What if in service definition yaml file, the port we are specifying in targetPort, port and nodeport is already in use. Explain this case with each port.

In Kubernetes, if the port specified in the service definition YAML file for targetPort, port, or nodePort is already in use, different outcomes can occur based on the specific port:

targetPort:

- This port is used to **specify the port on the pods that the service should route traffic to**.
- If the targetPort specified in the service definition YAML file is already in use by another process or service running inside the pods, Kubernetes will not be able to route traffic to the pods on that port.
- Kubernetes will typically report an error or warning during service creation or update indicating that the specified targetPort is already in use and needs to be changed.

port:

- The port in the service definition YAML file is the port that the **service listens on internally** within the cluster.
- If the specified port is already in use by another service within the cluster, Kubernetes will not be able to create or update the service.
- You'll receive an error indicating a port conflict, and you'll need to choose a different port for the service to avoid the conflict.

nodePort:

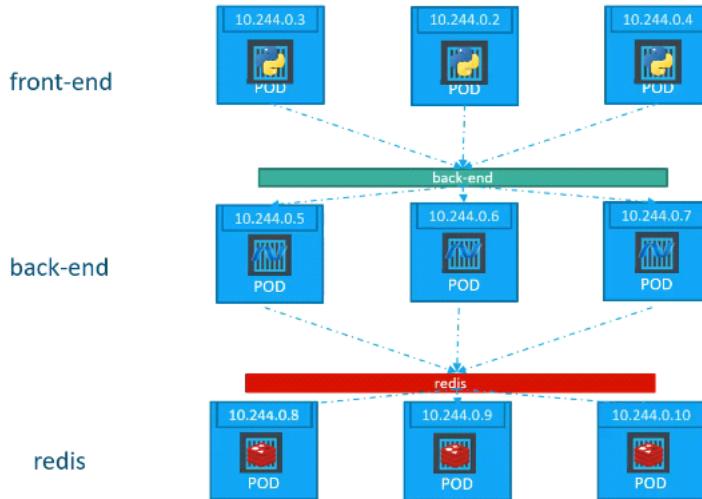
- nodePort is an **optional** field that **specifies a port on each node in the cluster to expose the service externally**.
- If the specified nodePort is already in use on any node in the cluster, Kubernetes will not be able to allocate that port for the service.
- You'll encounter an error indicating that the nodePort is already allocated and needs to be changed to an available port.

In all cases, **Kubernetes checks for port availability and ensures that ports are not double-assigned to prevent conflicts and ensure the stability and functionality of the cluster**. If a port conflict occurs, you'll need to revise the service definition YAML file and choose alternative ports that are not already in use.

Service - ClusterIP

Tuesday, April 16, 2024 12:19 AM

Overview of a Full Stack Web Application:



- A full-stack web application comprises various pods hosting different parts of the application.
- Pods can include front-end, web servers, back-end servers, key-value stores like Redis, and databases like MySQL.

Communication between Application Tiers:

- Front-end servers need to communicate with back-end servers, and back-end servers need to interact with databases and Redis services.
- Establishing connectivity between these services or tiers is crucial for seamless application functioning.

Challenges with Pod IPs:

- **Pods have dynamic IP addresses that can change due to scaling or failures.**
- Relying solely on IP addresses for internal communication is not reliable.

Role of Kubernetes Service:

- **Kubernetes Service helps group pods together and provides a single interface to access the pods in a group.**
- For example, a service created for backend pods groups them, simplifying access for other pods.

Randomized Pod Access:

- Requests sent to a service are forwarded to one of the pods under the service randomly,

ensuring load balancing and *resilience*.

Creating Services for Different Tiers:

- **Create services for each tier**, such as backend, Redis, etc., to streamline communication within the application.
- Services allow microservices-based applications to deploy effectively on Kubernetes clusters.

Cluster IP Service Type:

- Each service gets an IP and a name inside the cluster for access by other pods.
- This type of service is known as Cluster IP, providing a stable endpoint for internal communication.

Creating a Cluster IP Service:

```
service-definition.yml
apiVersion: v1
kind: Service
metadata:
  name: back-end
spec:
  type: ClusterIP
  ports:
    - targetPort: 80
      port: 80
  selector:
    app: myapp
    type: back-end
```

```
pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
  name: myapp-pod
  labels:
spec:
  containers:
    - name: nginx-container
      image: nginx
```

- Use a definition file with API version, kind (service), metadata, and spec (including type, ports, and selector).
- Specify the target port (exposed by the backend) and the port for the service (exposed for access).
- Link the service to pods using selectors, copying labels from the pod definition file.

Port: This is the port number that the Service will listen on within the cluster. Other pods or services can access the Service using this port.

TargetPort: This is the port number on which the pod's container is listening. The Service forwards incoming traffic on its own port to this targetPort of the pod, effectively routing requests to the correct container.

For example, if you have a pod running a web server listening on port 8080, and you want other pods in the cluster to access this web server through a Service, you would set:

port: 80 (the Service's port)
targetPort: 80 (the pod's container port)

This setup ensures that requests made to the Service's port 80 are forwarded to the pod's container port 8080, allowing seamless communication within the cluster.

Accessing the Service:

- Once created, the service can be accessed by other pods using the cluster IP or the service name.
- Use **kubectl create** and **kubectl get services** commands to create and check the status of the service.

Conclusion:

- Kubernetes Service Cluster IP provides a reliable and scalable way to manage communication between different parts of a microservices-based application.
- Using Cluster IP services simplifies deployment and ensures seamless interaction within the Kubernetes cluster.

?

Create a service messaging-service to expose the messaging application within the cluster on port 6379.

Use imperative commands.

```
kubectl expose pod messaging --port=6379 --name messaging-service
```

What is the purpose of ClusterIP and different endpoints that are given below?

```

controlplane ~ ➔ k describe svc -n kube-system kube-dns
Name:           kube-dns
Namespace:      kube-system
Labels:         k8s-app=kube-dns
                kubernetes.io/cluster-service=true
                kubernetes.io/name=CoreDNS
Annotations:   prometheus.io/port: 9153
                prometheus.io/scrape: true
Selector:       k8s-app=kube-dns
Type:          ClusterIP
IP Family Policy: SingleStack
IP Families:   IPv4
IP:            10.96.0.10
IPs:           10.96.0.10
Port:          dns 53/UDP
TargetPort:    53/UDP
Endpoints:    10.244.0.2:53,10.244.0.3:53
Port:          dns-tcp 53/TCP
TargetPort:    53/TCP
Endpoints:    10.244.0.2:53,10.244.0.3:53
Port:          metrics 9153/TCP
TargetPort:    9153/TCP
Endpoints:    10.244.0.2:9153,10.244.0.3:9153
Session Affinity: None
Events:        <none>

```

- **IP:** This is the IP address of the kube-dns service, but it's the ClusterIP assigned to it, not the address at which kube-dns listens. The ClusterIP is how other components within the cluster access this service.

ClusterIP: When you define a Service in Kubernetes, you can specify a clusterIP. This IP address is used by other parts of the cluster (such as other Services or Pods) to communicate with this Service. It's an internal IP address that is not exposed outside the cluster.

- **Port & TargetPort:** The Port is the service port, and TargetPort is where the pod's container receives data. Both are using the UDP protocol for DNS traffic.

The TargetPort in a Kubernetes Service configuration specifies the port on which the containers within the target pod are listening. If a pod has multiple containers, each container can listen on different ports.

In such cases, you can specify different TargetPorts for each container in the pod's Service configuration. This allows the Service to correctly route traffic to the appropriate container within the pod based on the specified ports.

In Kubernetes, two containers within the same pod cannot listen on the same TargetPort for a Service. Each container must have a unique port or set of ports that it listens on, and these ports should be mapped to different TargetPorts in the Service configuration to ensure proper routing of traffic.

- **Endpoints:** Endpoints show the backend pods that the service routes traffic to. In your case, there are two endpoints for DNS (10.244.0.2:53 and 10.244.0.3:53) and two for metrics (10.244.0.2:9153 and 10.244.0.3:9153). These endpoints represent the actual pods handling the service's functionality.

So, the kube-dns service is accessible at IP 10.96.0.10 on port 53/UDP, forwarding requests to both DNS

and metrics endpoints for load balancing and redundancy.

How a container listens from a target port of the service?

When a container listens on a specific port (known as the TargetPort), it means that the application or service inside the container is configured to accept incoming connections on that port. This configuration is typically done within the application code or the container configuration.

In the context of Kubernetes Services, the TargetPort is used to specify which port the Service should route incoming traffic to for the pods associated with that Service. When a Service receives traffic on its own port (known as the ServicePort), it forwards that traffic to the TargetPort of the pods.

For example, if you have a container running a web server inside a pod, and the web server is configured to listen on port 80 (TargetPort), you can expose this service using a Kubernetes Service with a ServicePort of 80. When external traffic hits the Service's IP and port 80, Kubernetes forwards that traffic to the pods' TargetPort 80, allowing the web server inside the container to receive and respond to requests.

The Kubernetes Service acts as a bridge between external traffic (coming from clients or other services) and the pods that provide the actual application or service.

The ServicePort is the port through which the Kubernetes Service listens for incoming traffic. When traffic arrives at this ServicePort, Kubernetes uses the Service's configuration, specifically the selector, to determine which pods should receive this traffic.

The TargetPort in the pods specifies the port on which the containers inside those pods are listening to receive this forwarded traffic. This mechanism allows Kubernetes to route traffic effectively to the appropriate containers based on their TargetPort configurations.

Does container also has their own ports? What is the criteria of having ports and which k8s objects can have port? Explain in details?

In Kubernetes, containers inside pods can indeed have their own ports. Ports are fundamental to networking and communication between different components within a Kubernetes cluster. Here's a breakdown of the criteria for having ports and which Kubernetes objects can have ports:

Containers: Containers run inside pods and are the actual units where your application code runs. Each container in Kubernetes can expose one or more ports to communicate with other containers or external services. These ports are defined in the container's configuration and are typically specified in the Dockerfile or the container runtime configuration.

Pods: Pods are the smallest deployable units in Kubernetes and can contain one or more containers. Each container inside a pod can define its own set of ports. Pods use these ports for internal communication between containers within the same pod or for exposing services to other pods or external clients.

Services: Kubernetes Services are a way to abstract and expose a set of pods as a network service. Services can have ports that define how clients can access the service.

Ingress: Kubernetes Ingress is an API object that manages external access to services in a cluster. Ingress resources can specify rules and configurations for routing external HTTP and HTTPS traffic to services based on hostnames and paths. Ingresses can define ports that the underlying services are listening on.

The criteria for having ports depend on the networking requirements of your application. If your application needs to receive incoming network requests or communicate with other services or components within the cluster, you'll define and expose ports accordingly. Ports are essential for enabling communication and networking capabilities in Kubernetes, allowing different parts of your application to interact seamlessly.

Ingress vs NodePort Service

Ingress is ideal for managing complex routing scenarios, SSL termination, and HTTP/HTTPS traffic with domain-based routing, while NodePort services are simpler and provide basic external access to services on fixed ports across all nodes in the cluster. The choice between them depends on your specific networking and external access requirements for the applications running in your Kubernetes cluster.

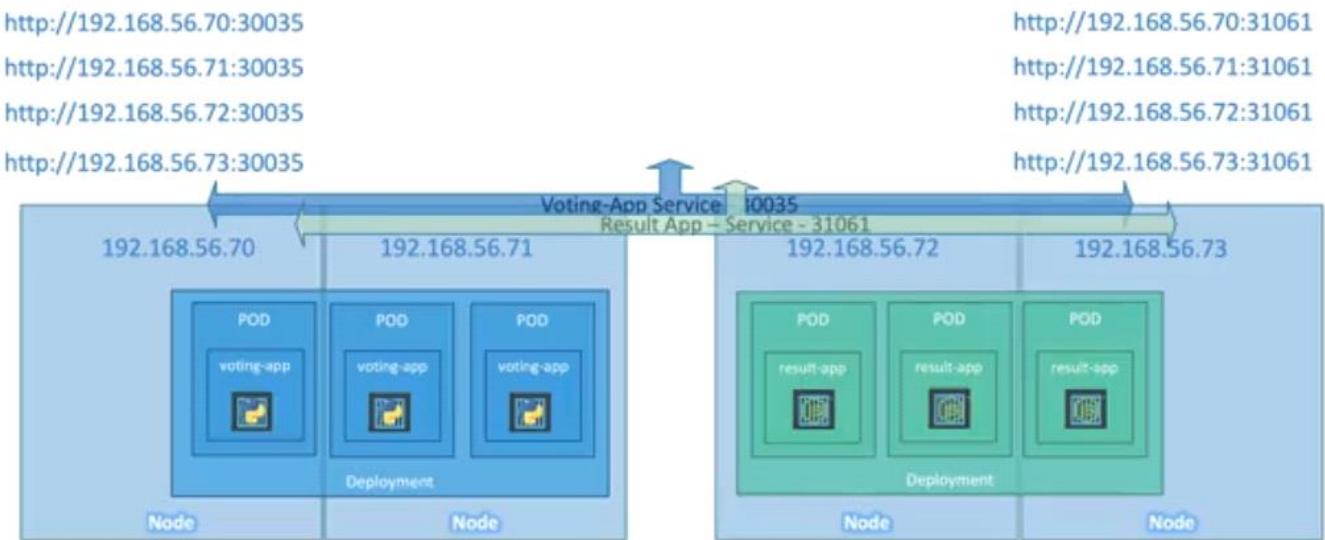
Service - LoadBalancer

Tuesday, April 16, 2024 12:37 AM

Overview of Load Balancing in Kubernetes:

- Load balancing is essential for distributing traffic across multiple instances of an application for better performance and availability.
- Kubernetes offers the LoadBalancer service type to manage load balancing effectively.

Need for Load Balancer Services:



- In Kubernetes, using services we can access both the application(voting-app and result-app) with any IP address. It means that with the IP Address 192.168.56.72(IP of one of the nodes of result-app), you can access the voting-app! But the problem is users don't want this much number of IP Addresses, it only wants a single IP Address.
- In a Kubernetes cluster, multiple instances of an application may run across different nodes.
- Load balancer services help distribute incoming traffic across these instances to optimize performance and prevent overload on any single instance.

Features of LoadBalancer Services:

- LoadBalancer services provision external load balancers in supported cloud environments - GCP, AWS and Azure.
- They automatically distribute incoming traffic across instances based on predefined algorithms.

Creating LoadBalancer Services:

```
service-definition.yaml
apiVersion: v1
kind: Service
metadata:
  name: myapp-service
spec:
  type: LoadBalancer
  ports:
    - targetPort: 80
      port: 80
      nodePort: 30008
```

- To create a LoadBalancer service, use a definition file with API version, kind (service), metadata, and spec (including type, ports, selector, and external IP).
- Specify the type as LoadBalancer and define the ports for the service.
- Use selectors to link the service to pods, ensuring proper routing of traffic.

Integration with Cloud Providers:

- LoadBalancer services integrate with cloud providers to provision and manage external load balancers.
- Cloud providers handle the configuration and scaling of load balancers based on traffic patterns.

Accessing the LoadBalancer Service:

- Once created, the LoadBalancer service assigns an external IP address for accessing the service from outside the cluster.
- Users can access the application through this external IP, which automatically distributes traffic across backend instances.

Benefits of Load Balancer Services:

- LoadBalancer services improve application scalability, resilience, and performance by evenly distributing traffic.
- They simplify the management of load balancing in a Kubernetes environment, especially in cloud deployments.

Conclusion:

- Kubernetes Service LoadBalancer plays a crucial role in optimizing application performance and availability by efficiently distributing incoming traffic.
- Integrating with cloud providers, LoadBalancer services automate load balancer provisioning and configuration, enhancing scalability and resilience.

Private IP Address

Thursday, February 22, 2024 7:51 PM

❓ Which IP Addresses Are Private?

- 10.0.0.0 to 10.255.255.255
- 172.16.0.0 to 172.31.255.255
- 192.168.0.0 to 192.168.255.255

❓ Why Private IP Addresses Are Used?

Instead of having devices inside a home or business network, each uses a public IP address, of which there's a limited supply, private IP addresses provide an entirely separate set of addresses that allow access to a network but without taking up a public IP address space.

For example, most routers in homes and businesses across the globe have the IP address of 192.168.1.1, and assign 192.168.1.2, 192.168.1.3, ... to the various devices that connect to it (using DHCP).

It doesn't matter how many routers use the 192.168.1.1 address, or how many dozens or hundreds of devices inside that network share IP addresses with users of other networks because they aren't communicating with each other directly.

Instead, the devices in a network use the router to translate requests through the public IP address, which can communicate with other public IP addresses and eventually to other local networks.

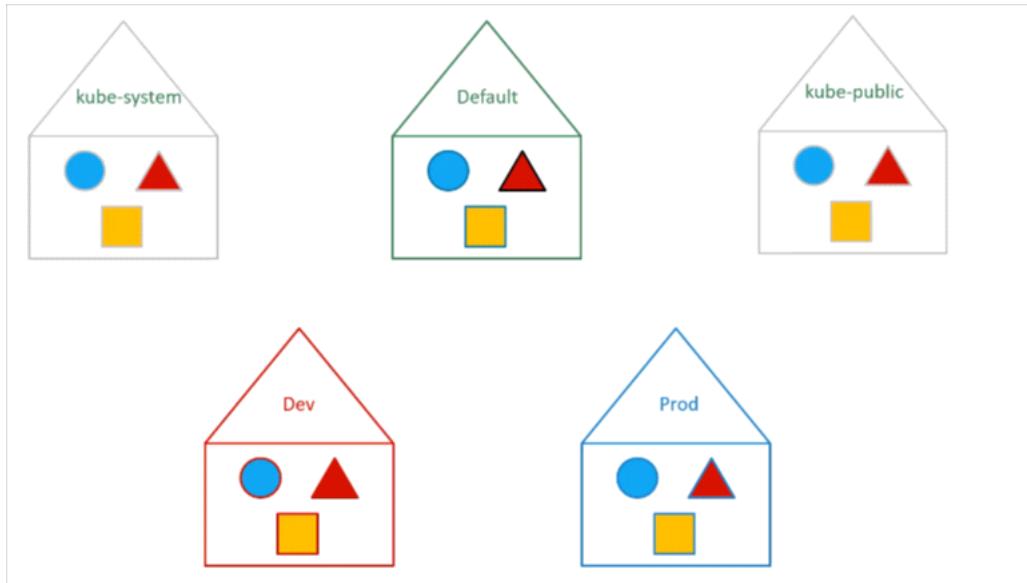
The hardware within a specific network that's using a private IP address can communicate with all the other hardware within the confines of that network but requires a **router** to communicate with devices outside the network, after which the public IP address is used for the communication.

For example, before landing on a webpage, your device (such as a computer or phone), which uses a private IP address, requested this page through a router, which has a public IP address. Once the request was made and the Webpage Server responded to deliver the page, it was downloaded to your device through a public IP address before reaching your router, after which it was handed off to your private/local address to reach your device.

Namespace

Tuesday, April 16, 2024 12:49 AM

Lecture on Kubernetes NameSpaces



Example to Explain Namespace:

- A namespace houses individual resources with unique names, providing isolation and unique identity within a cluster.

Default Namespace:

- Default Namespace is automatically created by Kubernetes at cluster setup.
- Internal Kubernetes services like networking and DNS are placed in the kube-system Namespace.
- kube-public Namespace is created for resources accessible to all users.

Purpose of Namespaces:

- Namespaces segregate resources and define access policies within a cluster.
- Useful for separating development and production environments within the same cluster.

Usage and Benefits:

- Resources within a Namespace can refer to each other directly using their names.
- Ensures resource isolation and prevents accidental modifications across environments.
- Each Namespace can have its own resource quotas, limiting resource consumption.

DNS Resolution in Namespaces:

```
mysql.connect("db-service.dev.svc.cluster.local")
```



- Services in different NameSpaces can be accessed using the format: servicename.namespace.svc.cluster.local.
- DNS entries are automatically created for services in NameSpaces.

Operational Aspects:

- Use kubectl commands with the -n or --namespace option to operate in specific NameSpaces.
- Use kubectl config to set the default NameSpace for ongoing operations.
- Switching NameSpaces using kubectl config simplifies management within a cluster.

Creating and Managing NameSpaces:

```
namespace-dev.yml
apiVersion: v1
kind: Namespace
metadata:
  name: dev
```

```
> kubectl create -f namespace-dev.yml
namespace/dev created
```

```
> kubectl create namespace dev
namespace/dev created
```

- Create a new NameSpace using a definition file or the kubectl create namespace command.
- Set resource quotas for NameSpaces to limit resource usage.

Conclusion:

- Kubernetes NameSpaces provide logical isolation and efficient resource management within a cluster.

If you want to make sure that this pod gets created in the dev environment all the time, even if you don't specify the name space in the command-line, you can move the name space definition into the pod definition file.

```
pod-definition.yml
apiVersion: v1
kind: Pod

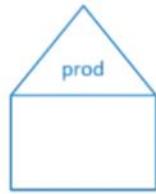
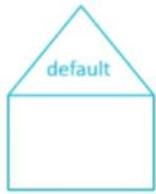
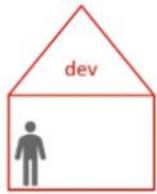
metadata:
  name: myapp-pod
  namespace: dev

labels:
  app: myapp
  type: front-end

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

But what if we want to switch to the 'dev' name space permanently,

Switch



```
> kubectl get pods --namespace=dev
```

```
> kubectl get pods
```

```
> kubectl get pods --namespace=prod
```

```
> kubectl config set-context $(kubectl config current-context) --namespace=dev
```

Resource Quota

To limit resources in a name space, create a resource quota.

To create one,

start with a definition file for resource quota,

specify the name space

for which you want to create the quota,

and then under spec, provide your limits

such as 10 pods, 10 CPU units,

10 GB byte of memory, etcetera.

```
compute-quota.yaml
apiVersion: v1
kind: ResourceQuota
metadata:
  name: compute-quota
  namespace: dev
spec:
  hard:
    pods: "10"
    requests.cpu: "4"
    requests.memory: 5Gi
    limits.cpu: "10"
    limits.memory: 10Gi
```

```
> kubectl create -f compute-quota.yaml
```

Resource Quota

Saturday, May 4, 2024 12:35 PM

Resource Quota

To limit resources in a name space, create a resource quota.

To create one, start with a definition file for resource quota, specify the name space for which you want to create the quota, and then under spec, provide your limits such as 10 pods, 10 CPU units, 10 GB byte of memory, etcetera.

```
Compute-quota.yaml
```

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: compute-quota
  namespace: dev

spec:
  hard:
    pods: "10"
    requests.cpu: "4"
    requests.memory: 5Gi
    limits.cpu: "10"
    limits.memory: 10Gi
```

```
> kubectl create -f compute-quota.yaml
```

Imperative vs Declarative

Tuesday, April 16, 2024 12:18 PM

Imperative and Declarative Commands

Kubernetes

Imperative

```
> kubectl run --image=nginx nginx  
> kubectl create deployment --image=nginx nginx  
> kubectl expose deployment nginx --port 80  
> kubectl edit deployment nginx  
> kubectl scale deployment nginx --replicas=5  
> kubectl set image deployment nginx nginx=nginx:1.18  
> kubectl create -f nginx.yaml  
> kubectl replace -f nginx.yaml  
> kubectl delete -f nginx.yaml
```

Declarative

```
> kubectl apply -f nginx.yaml
```

In CKA exam, use Imperative Commands.

- It's always recommended to run replace command after you run the 'kubectl edit' commands so that changes gets recorded.

The command `kubectl expose deployment nginx --port 80` is used to create a service in Kubernetes that exposes the deployment named "nginx" on port 80. By default, this command creates a service of type ClusterIP.

CKA Tips

Tuesday, April 16, 2024 12:33 PM

Imperative Commands with Kubectl

While you would be working mostly the declarative way - using definition files, imperative commands can help in getting one time tasks done quickly, as well as generate a definition template easily. This would help save considerable amount of time during your exams.

Before we begin, familiarize with the two options that can come in handy while working with the below commands:

- `--dry-run`: By default as soon as the command is run, the resource will be created. If you simply want to test your command , use the `--dry-run=client` option. This will not create the resource, instead, tell you whether the resource can be created and if your command is right.
- `-o yaml`: This will output the resource definition in YAML format on screen.

Use the above two in combination to generate a resource definition file quickly, that you can then modify and create resources as required, instead of creating the files from scratch.

POD

- Create an NGINX Pod

```
kubectl run nginx --image=nginx
```

- Generate POD Manifest YAML file (`-o yaml`). Don't create it(`--dry-run`)

```
kubectl run nginx --image=nginx --dry-run=client -o yaml
```

Deployment

- Create a deployment

```
kubectl create deployment --image=nginx nginx
```

- Generate Deployment YAML file (`-o yaml`). Don't create it(`--dry-run`)

```
kubectl create deployment --image=nginx nginx --dry-run=client -o yaml
```

- Generate Deployment with 4 Replicas

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

- You can also scale a deployment using the kubectl scale command.

```
kubectl scale deployment nginx --replicas=4
```

- Another way to do this is to save the YAML definition to a file and modify

```
kubectl create deployment nginx --image=nginx --dry-run=client -o yaml > nginx-deployment.yaml
```

You can then update the YAML file with the replicas or any other field before creating the deployment.

Service

- Create a Service named redis-service of type ClusterIP to expose pod redis on port 6379

```
kubectl expose pod redis --port=6379 --name redis-service --dry-run=client -o yaml
```

(This will automatically use the pod's labels as selectors)

Or

- `kubectl create service clusterip redis --tcp=6379:6379 --dry-run=client -o yaml` (This will not use the pods labels as selectors, instead it will assume selectors as app=redis. You cannot pass in selectors as an option. So it does not work very well if your pod has a different label set. So generate the file and modify the selectors before creating the service)

- Create a Service named nginx of type NodePort to expose pod nginx's port 80 on port 30080 on the nodes:

```
kubectl expose pod nginx --type=NodePort --port=80 --name=nginx-service --dry-run=client -o yaml
```

(This will automatically use the pod's labels as selectors, but you cannot specify the node port. You have to generate a definition file and then add the node port in manually before creating the service with the pod.)

Or

```
kubectl create service nodeport nginx --tcp=80:80 --node-port=30080 --dry-run=client -o yaml
```

(This will not use the pods labels as selectors)

Both the above commands have their own challenges. While one of it cannot accept a selector the other cannot accept a node port. I would recommend going with the kubectl expose command. If you need to specify a node port, generate a definition file using the same command and manually input the nodeport before creating the service.

Reference:

<https://kubernetes.io/docs/reference/generated/kubectl/kubectl-commands>

<https://kubernetes.io/docs/reference/kubectl/conventions/>

kubectl apply

Tuesday, April 16, 2024 12:35 PM

```
nginx.yaml
apiVersion: v1
kind: Pod
metadata:
  name: myapp-pod
  labels:
    app: myapp
    type: front-end-service
spec:
  containers:
    - name: nginx-container
      image: nginx:1.19

Live object configuration
{
  "apiVersion": "v1",
  "kind": "Pod",
  "metadata": {
    "annotations": {},
    "labels": {
      "run": "myapp-pod",
      "type": "front-end-service"
    },
    "name": "myapp-pod"
  },
  "spec": {
    "containers": [
      {
        "image": "nginx:1.19",
        "name": "nginx-container"
      }
    ]
  }
}

> kubectl apply -f nginx.yaml
```

Kubernetes

```
Live object configuration
apiVersion: v1
kind: Pod
metadata:
  name: myapp-pod
  labels:
    app: myapp
    type: front-end-service
spec:
  containers:
    - name: nginx-container
      image: nginx:1.19
status:
  conditions:
    - lastProbeTime: null
      status: "True"
      type: Initialized
```

The 'kubectl apply' command uses a 'Last applied Configuration' file . This command compares the all the three files - local, last applied Configuration and Live Configuration file to make the changes.

- Only when you run 'kubectl apply' command, 'last config' file is generated.
- Whether you use imperative or declarative approach, 'live config' file is created in the cluster.

Internal Process:

- kubectl apply considers local configuration, live Kubernetes object definition, and last applied configuration for decision-making.
- If the object doesn't exist, it's created with a live configuration storing status.
- YAML local configuration is converted to JSON and stored as last applied configuration.

Updating Objects:

Updates are compared between local, live, and last applied configurations.

Differences trigger updates in the live configuration.

Last applied configuration helps identify deleted or removed fields.

Usage of Last Applied Configuration:

Helps determine fields to be removed or updated in the live configuration.

Stored as an annotation named "last applied configuration" within the live object configuration on the Kubernetes cluster.

Location of Last Applied Configuration:

Stored in the live object configuration in Kubernetes as an annotation.
Only applicable when using kubectl apply, not with kubectl create or kubectl replace.

Recommendations:

Avoid mixing imperative and declarative approaches in Kubernetes object management.
kubectl apply compares all configurations for deciding changes, ensuring consistency.

Conclusion:

kubectl apply command's internal workings ensure accurate and consistent updates to Kubernetes objects.
Understanding these processes enhances effective Kubernetes cluster management.

- ★ **Saving changes to a YAML file using :wq! alone updates the local file but does not affect the cluster. Running kubectl apply after saving the changes applies those changes to the Kubernetes cluster, updating the cluster's configuration accordingly.**

lab 4

Tuesday, April 16, 2024 12:58 PM

Create a new service to access the web application using the service-definition-1.yaml file.

Name: webapp-service

Type: NodePort

targetPort: 8080

port: 8080

nodePort: 30080

selector:

name: simple-webapp

Update the `/root/service-definition-1.yaml` file as follows:

```
---  
apiVersion: v1  
kind: Service  
metadata:  
  name: webapp-service  
  namespace: default  
spec:  
  ports:  
    - nodePort: 30080  
      port: 8080  
      targetPort: 8080  
  selector:  
    name: simple-webapp  
  type: NodePort
```

Run the following command to create a `webapp-service` service as follows:

```
-  
  
kubectl apply -f /root/service-definition-1.yaml
```

Using labels in imperative commands

```
kubectl run redis -l tier=db --image=redis:alpine
```

Create a service redis-service to expose the redis application within the cluster on port 6379.

```
kubectl expose pod redis --port=6379 --name redis-service
```

Create a deployment named webapp using the image kodekloud/webapp-color with 3 replicas.

```
kubectl create deployment webapp --image=kodekloud/webapp-color --replicas=3
```

Create a new pod called custom-nginx using the nginx image and expose it on container port 8080.

```
kubectl run custom-nginx --image=nginx --port=8080
```

Create a new namespace called dev-ns.

```
kubectl create namespace dev-ns or kubectl create ns dev-ns
```

Deploy pod whe name, namespace, replica and image is given.

```
kubectl create deployment redis-deploy --image=redis --replicas=2 -n dev-ns
```

Create a pod called httpd using the image httpd:alpine in the default namespace. Next, create a service of type ClusterIP by the same name (httpd). The target port for the service should be 80.

Try to do this with as few steps as possible.

```
kubectl run httpd --image=httpd:alpine --port=80 --expose=true
```

OR

```
kubectl run httpd --image=httpd:alpine --port=80 --expose
```

Deployments and Services

Thursday, March 7, 2024 7:15 PM

When you want to deploy an application and manage its lifecycle, including version updates and maintaining availability, you use a Deployment.

When you need a consistent way to access a set of pods, or when you need to expose your application to the outside world, you use a Service.

Alias

Wednesday, March 27, 2024 2:45 PM

Default Shortcuts

pods (po)
services (svc)
replicationcontrollers (rc)
nodes (no)
events (ev)
limitranges (limits)
persistentvolumes (pv)
persistentvolumeclaims (pvc)
resourcequotas (quota)
namespaces (ns)
serviceaccounts (sa)
horizontalpodautoscalers (hpa)
endpoints (ep) or secrets.

Examples

kubectl get pods	= k get po
kubectl get deployments	= k get deploy
kubectl get services	= k get svc
kubectl get persistentvolumes	= k get pv
kubectl get persistentvolumeclaims	= k get pvc
kubectl get replicationcontrollers	= k get rc
kubectl get ingresses	= k get ing
kubectl get configmaps	= k get cm
kubectl get namespaces	= k get ns
kubectl get serviceaccounts	= k get sa

Obj and Non-obj

Sunday, April 14, 2024 12:33 PM

Here are some common kubectl commands categorized based on whether they require mentioning the Kubernetes object explicitly or not:

Commands Requiring Kubernetes Object:

- `kubectl describe <object>`: Provides detailed information about a specific Kubernetes object.
- `kubectl delete <object>`: Deletes a specific Kubernetes object.
- `kubectl get <object>`: Retrieves information about one or more Kubernetes objects.
- `kubectl edit <object>`: Allows you to modify a specific Kubernetes object by opening an editor.
- `kubectl logs <pod>`: Retrieves the logs of a specific pod.
- `kubectl exec -it <pod> -- <command>`: Executes a command inside a specific pod.

Commands Not Requiring Kubernetes Object Mention:

- `kubectl run <name> --image=<image>`: Creates and runs a new pod with the specified image.
- `kubectl create -f <file>`: Creates a Kubernetes resource (e.g., pod, deployment) based on the YAML configuration file.
- `kubectl apply -f <file>`: Applies changes to a Kubernetes resource based on the YAML configuration file.
- `kubectl version`: Displays the Kubernetes client and server versions.
- `kubectl cluster-info`: Displays cluster information.

These are just examples, and there are many kubectl commands available, each serving different purposes within a Kubernetes cluster management context.

Handy Commands

Sunday, April 14, 2024 4:57 PM

- Create an NGINX Pod

```
kubectl run nginx --image=nginx
```

- Generate POD Manifest YAML file (-o yaml). Don't create it(--dry-run)

```
kubectl run nginx --image=nginx --dry-run=client -o yaml
```

- Create a deployment

```
kubectl create deployment --image=nginx nginx
```

- Generate Deployment YAML file (-o yaml). Don't create it(--dry-run)

```
kubectl create deployment --image=nginx nginx --dry-run=client -o yaml
```

- Generate Deployment YAML file (-o yaml). Don't create it(--dry-run) and save it to a file.

```
kubectl create deployment --image=nginx nginx --dry-run=client -o yaml > nginx-deployment.yaml
```

- Make necessary changes to the file (for example, adding more replicas) and then create the deployment.

```
kubectl create -f nginx-deployment.yaml
```

OR

In k8s version 1.19+, we can specify the --replicas option to create a deployment with 4 replicas.

```
kubectl create deployment --image=nginx nginx --replicas=4 --dry-run=client -o yaml > nginx-deployment.yaml
```

Context

Thursday, April 25, 2024 12:10 AM

In Kubernetes, a "context" and a "namespace" are two distinct concepts that serve different purposes:

Context:

- A context in Kubernetes refers to a combination of a cluster, user identity, and namespace. It's essentially a way to switch between different Kubernetes clusters or configurations easily.
- The kubectl command-line tool uses contexts to determine which cluster it should interact with and which user identity to use for authentication.
- You can have multiple contexts defined, each representing a different Kubernetes cluster or configuration.
- You can view the available contexts and switch between them using the kubectl config get-contexts and kubectl config use-context commands, respectively.

Namespace:

- A namespace in Kubernetes is a way to divide cluster resources into virtual clusters. It's used to organize and isolate resources within a cluster.
- By default, Kubernetes uses the default namespace for most objects. However, you can create additional namespaces to logically separate different projects, teams, or environments.
- Resources such as pods, services, deployments, etc., belong to a namespace unless explicitly specified otherwise.
- Namespaces provide a scope for resource names and prevent naming conflicts between different projects or teams using the same cluster.

In summary, a context is used to specify which Kubernetes cluster and user identity to interact with, while a namespace is used to organize and isolate resources within a cluster.

kubeadm Installation

Monday, February 26, 2024 5:10 PM

- 1 Master Node, 2 Worker Node
-

Manual Scheduling

Monday, February 26, 2024 12:07 PM

- Every POD has a field called `nodeName` that by default is not set. Kubernetes will create this field automatically.
- The scheduler goes through all PODs and looks for those that don't have this property set. Those are the candidates for the scheduling.
- It then identifies the right node for the POD by running the scheduling algorithm.
- Once identified, it schedules the POD on the node by setting the '`nodeName`' property to the name of the node by creating the Binding object.
- If there is no scheduler to monitor and schedule a node then the pods will continue to be in a "Pending" State.
- Without a scheduler, the easiest way to schedule a POD is to simply set the `nodeName` field to the name of the node in your POD specification file while creating the POD.



What if the POD is already created and you want to assign POD to a node?

To assign existing PODs to a node is to create a `Binding object` and send a POST request to the PODs binding API. This is what the actual scheduler does.

```
apiVersion: v1
kind: Binding
metadata:
  name: nginx

target:
  apiVersion: v1
  kind: Node
  name: node02
```

- In the binding object, we specify the target node with the name of the node. Then send a POST request to the PODs binding API by setting data property in the JSON format. Here you must convert your YAML to its equivalent JSON format.

```
curl --header "Content-Type: application/json" --request POST --data
'{
  "apiVersion": "v1",
  "kind": "Binding",
  "metadata": {
    "name": "nginx"
  },
  "target": {
    "apiVersion": "v1",
    "kind": "Node",
    "name": "node02"
}
```

```

curl --header "Content-Type: application/json" --request POST --data
'{
  "apiVersion": "v1",
  "kind": "Binding",
  "metadata": {
    "name": "nginx"
  },
  "target": {
    "apiVersion": "v1",
    "kind": "Node",
    "name": "node02"
  }
}' http://$SERVER/api/v1/namespaces/default/pods/$PODNAME/binding

```

- Common HTTP methods for retrieving from and sending data to a server: -

The GET method

The GET method is used to retrieve data from the server.

The POST method

The POST method sends data to the server and creates a new resource.

The PUT method

The PUT method is most often used to update an existing resource.

The PATCH method

The PATCH method is very similar to the PUT method because it also modifies an existing resource.

The DELETE method

The DELETE method is used to delete a resource specified by its URI.

?

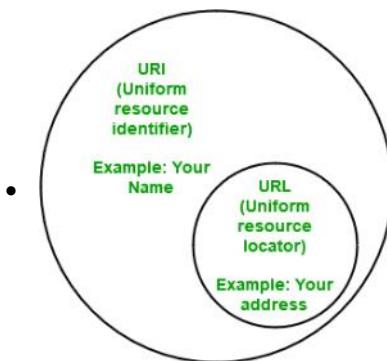
PATCH vs PUT

PATCH is used to apply partial updates to a resource, meaning that only the fields that need to be changed are sent in the request body. PUT is used to replace the entire resource with a new representation, meaning that all the fields of the resource are sent in the request body, even if they are not modified.

- URL vs URI vs URN

URI (Uniform Resource Identifier):

- A URI is a generic term that encompasses both URLs and URNs.
- It serves as a unique identifier for a resource, whether it's a web page, an image, an email address, or any other digital entity.
- Think of a URI as a nameplate that points to a specific location or identity.
- Examples of URIs:
 - URL: <https://jwt.io>
 - URN: urn:isbn:1234567890 (identifies a publication through the ISBN system) 1



URL (Uniform Resource Locator):

- A URL is a specific type of URI.
- It provides the **address or location of a resource** on the internet.
- The address (or location) of a resource specifies where it can be found. **It answers the question: "Where can I access this resource?"**
- Components of a URL:
 - Scheme: The protocol used to access the resource (e.g., HTTP, HTTPS).
 - Domain: The server hosting the resource (domain name or IP address).
 - Port: Optional protocol port for the request.
 - Path: The resource's location on the server.
 - Parameters: Optional extra information.
 - Anchor: Represents a specific part within the resource (also called a fragment).
- Example URLs:
 - jwt.io (web page)
 - auth0.com/docs/get-started (another web page)
 - identicons.dev/static/icons/mono/png/icon-access-token.png (image)
 - <mailto:yourfriend@somewhere.com> (email address)
 - <ftp://ftpserver.com/myfolder> (FTP resource) 1



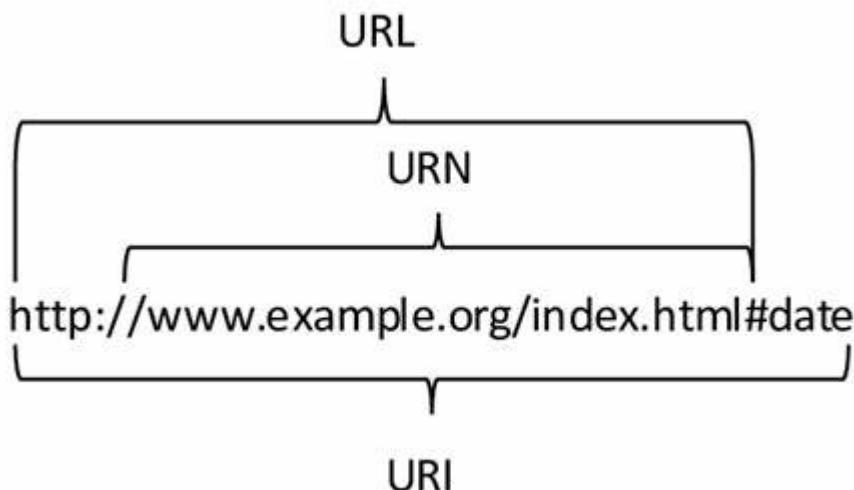
DG

URN (Uniform Resource Name):

- A URN is another subtype of URI.

- It focuses on **identifying a resource** rather than providing its location.
- The identity of a resource refers to its unique identification or name. It answers the question: “What is this resource?”
- URNs are like names, similar to how your name uniquely identifies you.
- Example URNs:
 - urn:isbn:0-486-27557-4 (identifies a publication through the ISBN system)
 - urn:ietf:rfc:2648 (an RFC issued by the IETF)
 - An email address (e.g., john.doe@example.com) serves as an identity resource. It uniquely identifies a user and provides a way to communicate with them. However, it doesn’t reveal the location or how to access the user.

In summary:



- URI is the umbrella term.
- URL specifies the location of a resource.
- URN defines a resource’s identity.
- Imagine you’re attending a conference. Your name badge (identity) displays your name and affiliation, uniquely identifying you. However, it doesn’t reveal your hotel room number (address) or session location.

lab 1

Friday, April 19, 2024 12:25 PM

- ? Why is the POD in a pending state?

If you are not able to find it using 'k describe pod <pod-name>' then inspect the environment for various Kubernetes control plane components.

Run 'k get ns'

NAME	STATUS	AGE
default	Active	9m15s
kube-flannel	Active	9m9s
kube-node-lease	Active	9m15s
kube-public	Active	9m15s
kube-system	Active	9m15s

Check the 'scheduler pod' in kube-system namespace.

NAME	READY	STATUS	RESTARTS	AGE
coredns-69f9c977-4t15r	1/1	Running	0	9m28s
coredns-69f9c977-bhd8r	1/1	Running	0	9m28s
etcd-controlplane	1/1	Running	0	9m42s
kube-apiserver-controlplane	1/1	Running	0	9m42s
kube-controller-manager-controlplane	1/1	Running	0	9m42s
kube-proxy-gs49k	1/1	Running	0	9m29s
kube-proxy-hm5p7	1/1	Running	0	8m49s

Here, you can see that the scheduler is not present.

The 'Pending' state for a pod indicates that the Kubernetes scheduler has not yet assigned the pod to a node. There are several reasons why a pod might be stuck in the 'Pending' state:

- Resource Constraints: The node may not have enough resources (CPU, memory) to accommodate the pod.
- Taints and Toleration: The node might have a taint that the pod does not tolerate, preventing it from being scheduled.
- Node Selector: The pod may have a node selector that does not match any nodes in the cluster.
- Pod Priority: If higher-priority pods are waiting to be scheduled, they might be taking precedence over this pod.
- Network Issues: Connectivity or DNS issues can also cause scheduling delays.

To diagnose the issue, you can:

- Check the events for the pod using `kubectl describe pod <pod_name> -n kube-system` to see if there are any specific error messages.
- Inspect the node's resources and taints using `kubectl describe node <node_name>` to

- ensure it has the necessary resources and is schedulable.
- Review the pod's specifications, including resource requests, tolerations, node selectors, and affinity rules, to ensure they are correct.

What are some reserved namespaces in kubernetes?

In Kubernetes, several reserved namespaces serve specific purposes and are used for system-level components, special configurations, or namespace management. Some of the reserved namespaces in Kubernetes include:

- default: This is the default namespace for objects created in Kubernetes if no namespace is specified. It's where most user-created resources reside unless explicitly placed in another namespace.
- kube-system: Reserved for system-level components of Kubernetes, such as core system services (e.g., DNS, API server) and controllers (e.g., scheduler, controller manager).
- kube-public: Contains publicly accessible resources that should be readable by all users, even those who are not authenticated.
- kube-node-lease: Used by the Kubernetes Node Lease feature, which allows nodes to periodically update their lease to indicate that they are still active.
- kube-ingress: Some Kubernetes distributions may use this namespace for Ingress controllers and related resources.
- kube-service-catalog: Used by the Kubernetes Service Catalog project, which enables service brokers to provision and manage external services.
- kube-storage-classes: Used for managing storage classes in Kubernetes clusters, especially for dynamic provisioning of storage volumes.
- kube-public-lease: Used by the Kubernetes Lease API, providing a way to claim a specific resource for exclusive access, such as a public IP address.

These namespaces are reserved to organize and manage Kubernetes resources effectively, ensuring that system components, special configurations, and certain types of resources are logically separated and managed within the cluster.

What is 'kube-system'?

kube-system is a namespace in Kubernetes that is reserved for system-level components and resources. In Kubernetes, namespaces are virtual clusters that help in organizing and partitioning resources within a cluster. The kube-system namespace is created by default during the installation of Kubernetes, and it typically contains essential system-level components that are required for the cluster to function correctly. These components include:

- CoreDNS: A DNS server that provides name resolution within the cluster.
- Etcd: A distributed key-value store used for storing cluster state information.
- Kube-apiserver: The API server component that exposes the Kubernetes API.
- Kube-controller-manager: Manages various controllers that regulate the state of the cluster.
- Kube-proxy: Manages network routing for services in the cluster.

These components are critical for the operation and management of the Kubernetes cluster itself. Placing them in the kube-system namespace helps to separate them from application workloads and provides better organization and security within the cluster.

Manually schedule the pod on node01.

Delete the existing pod first. Run the below command:

```
$ kubectl delete po nginx
```

To list and know the names of available nodes on the cluster:

```
$ kubectl get nodes
```

Add the nodeName field under the spec section in the nginx.yaml file with node01 as the value:

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
spec:
  nodeName: node01
  containers:
  - image: nginx
    name: nginx
```

Then run the command `kubectl create -f nginx.yaml` to create a pod from the definition file.

To check the status of a nginx pod and to know the node name:

```
$ kubectl get pods -o wide
```

OR

You can run 'kubectl edit pod' command.

- ★ You can just use
`kubectl get pod <your pod name> -w` or `--watch`
whenever any update/change/delete happens to the pod, you will see the update.
- ★ Adding a `-w` or `--watch` to all your `kubectl get [resource]`s command makes the result notified of each creation, modification, or deletion of that resource.
i.e `kubectl get pod [pod_name] -w` or `kubectl get nodes --watch`
- ★ You can't move a running pod to one node to another.

Selectors and Labels

Monday, February 26, 2024 11:57 PM

Labels:

Definition:

- Labels are key-value pairs attached to objects (like pods).
- They are used to organize and select subsets of objects.
- Example: environment: production, app: frontend.

Purpose:

- Facilitate grouping and categorization of resources.
- Enable better management and organization of objects.

Syntax:

Labels are applied in the metadata section of Kubernetes objects.

```
metadata:  
  labels:  
    key1: value1  
    key2: value2
```

Selectors:

- Selectors are used to filter and select a group of objects based on their labels.
- They define the criteria for identifying objects.

Types of Selectors:

- Equality-based:

Selects resources where the label key-value pair matches exactly.

```
app: frontend  
environment: production
```

- Set-based:

Allows more complex selection using operators like in, notin, exists, etc.

```
environment in (production, staging)
```

Selectors uses

Used in various Kubernetes resources like Services, Replication Controllers, Deployments, etc.
For example, selecting pods for a service based on a label.

```
apiVersion: v1
kind: Service
metadata:
  name: frontend-service
spec:
  selector:
    app: frontend
    environment: production
  ports:
    - protocol: TCP
      port: 80
      targetPort: 8080
```

lab 2

Friday, April 19, 2024 3:53 PM

- ?
- We have deployed several PODs. They are labelled with tier, env and bu. How many PODs exist in the dev environment (env)?

Use selectors to filter the output

Solution

Run - **kubectl get pods --selector env=dev --no-headers | wc -l**

or

`kubectl get pods --selector env=dev`

--no-headers=false:

When using the default or custom-column output format, don't print headers (default print headers).

Putting it all together:

- The command retrieves pod information from the Kubernetes cluster, specifically filtering pods with the label `env=dev`.
- It includes headers in the output (`--no-headers=false`), so the output will have column headers.
- The output is then passed through `wc -l`, which counts the number of lines in the output. Since each line corresponds to a pod, this effectively counts the number of pods that match the label selector. The default behavior of `wc` without options is to count lines, words, and characters in the input.

How many objects are in the prod environment including PODs, ReplicaSets and any other objects?

`kubectl get all --selector env=prod --no-headers | wc -l`

Identify the POD which is part of the prod environment, the finance BU and of frontend tier?

kubectl get all --selector env=prod,bu=finance,tier=frontend

Taints and Tolerations

Monday, February 26, 2024 11:57 PM

Taint (nodes) - Tains ko paint/spray samjho

Toleration (pods)- Pods jo us taint ko tolerate kar paaye.

- Taints and tolerations are a mechanism that allows you to ensure that pods are not placed on inappropriate nodes.
- Taints are added to nodes, while tolerations are defined in the pod specification.
- When you taint a node, it will repel all the pods except those that have a 'toleration' for that taint.
- A node can have one or many taints associated with it.

Person and Bug Analogy

Person with Taint

Bug with Toleration Level

- Taints are set on nodes.
- Tolerations are set on pods.
- Taints and tolerations are only meant to restrict nodes from accepting certain pods.
- Taints and tolerations do not tell the pods to go to the particular node. It only tells the pods

Types of Taint Effects

- NoSchedule
- PreferNoSchedule
- NoExecute

NoSchedule

- **Not allowed pods without toleration**
- The Kubernetes scheduler will only allow scheduling pods that have tolerations for the tainted nodes.
- This effect is commonly used for nodes with specific hardware or software requirements where only certain pods should be scheduled.

Example Taint:

```
yaml
```

```
kubectl taint nodes node-1 key=value:NoSchedule
```

Example Pod with Tolerance:

```
yaml
```

```
tolerations:
- key: "key"
  operator: "Equal"
  value: "value"
  effect: "NoSchedule"
```

PreferNoSchedule

- Pods that do not tolerate the taint with the effect PreferNoSchedule will avoid being scheduled on the tainted node, but it's not a strict prohibition.
- This effect is used when you want to bias the scheduler to avoid the node but not strictly enforce it.

Example Taint:

```
yaml
```

```
kubectl taint nodes node-2 key=value:PreferNoSchedule
```

Example Pod with Tolerance:

```
yaml
```

```
tolerations:
- key: "key"
  operator: "Equal"
  value: "value"
  effect: "PreferNoSchedule"
```

NoExecute

- Kubernetes will evict(forcefully remove/stop) the running pods from the nodes if the pods don't have tolerations for the tainted nodes.
- This effect is used for scenarios where you want to enforce a taint on a node and ensure that existing pods are evicted.

Example Taint:

```
yaml
```

```
kubectl taint nodes node-3 key=value:NoExecute
```

Example Pod with Tolerance:

```
yaml
```

```
tolerations:
- key: "key"
  operator: "Equal"
  value: "value"
  effect: "NoExecute"
```

- ★ Taints with NoSchedule and PreferNoSchedule effects are mainly used for controlling where pods are scheduled, while the NoExecute effect is more aggressive and is used for enforcing taints on already running pods.



The scheduler does not schedule any pods on the master node. Why?

When the Kubernetes cluster is first set up, a taint is set on the master node automatically that prevents any pods from being scheduled on this node. You can modify this but it's a best practice to not deploy application workloads on master server.

lab 3

Friday, April 19, 2024 4:13 PM

Create a taint on node01 with key of spray, value of mortein and effect of NoSchedule

kubectl taint node node01 spray=mortein:NoSchedule

- ★ The default value for an operator is Equal.

A toleration "matches" a taint if the keys are the same and the effects are the same, and:

the operator is Exists (in which case no value should be specified), or
the operator is Equal and the values should be equal.

Remove the taint on controlplane, which currently has the taint effect of NoSchedule.

1. Run - kubectl describe node controlplane
2. You'll find that in 'Taint' some value is there node-role.kubernetes.io/control-plane:NoSchedule
3. Add '-' after the value and the node will get untaint. e.g.
kubectl taint nodes controlplane node-role.kubernetes.io/control-plane:NoSchedule-

- ? If a node node01 has key=spray, value=mortein and effect=NoSchedule , how to untaint it ?

To untaint a node with a specific key-value pair and effect, such as key=spray, value=mortein, and effect=NoSchedule, you can use the kubectl taint command with the - sign followed by the taint specification. Here's how you can do it:

kubectl taint nodes node01 key-spray=value-mortein:NoSchedule-

This command removes the taint with the specified key-value pair and effect from the node named

node01. After running this command, the node will no longer have the taint that prevents scheduling of pods due to this taint.

- ★ when you want to remove a taint from a node using kubectl taint, you do not need to specify the value of the taint. Only the taint key and effect are required to identify the taint you want to remove.

kubectl taint nodes node01 key=spray:NoSchedule-

Node Selector

Tuesday, February 27, 2024 12:24 PM

- We can set the limitations on the pods so that pods run on particular nodes.
- In Node Selector we use labels and selectors to match the particular pods with nodes.
- In Node Selector we can't provide advanced expressions like - selecting all nodes except this one like that.

```
pod-definition.yml
apiVersion:
kind: Pod
metadata:
  name: myapp-pod
spec:
  containers:
    - name: data-processor
      image: data-processor
  nodeSelector:
    size: Large
```

Here 'Large' is the label.

Label Nodes

```
▶ kubectl label nodes <node-name> <label-key>=<label-value>
▶ kubectl label nodes node-1 size=Large
```

Node Affinity

Tuesday, February 27, 2024 11:34 AM

- Node affinity allows you to specify rules for pod scheduling based on the properties of the nodes.
- It enables you to control which nodes your pods are scheduled on, considering factors such as hardware specifications, geographical location, or other custom node labels.
- It also ensures that pods are hosted on particular nodes.
- You can specify multiple labels in the form of an array using Node Affinity.

```
pod-definition.yml
apiVersion:
kind:
metadata:
  name: myapp-pod
spec:
  containers:
    - name: data-processor
      image: data-processor
  affinity:
    nodeAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        nodeSelectorTerms:
          - matchExpressions:
            - key: size
              operator: In
              values:
                - Large
                - Medium
```

- Note, that there are two elements - Large and Medium in the "values".

If you want the Node to not to select a Pod with the label "Small", you can write it as:-

```
pod-definition.yml
apiVersion:
kind:
metadata:
  name: myapp-pod
spec:
  containers:
    - name: data-processor
      image: data-processor
  affinity:
    nodeAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        nodeSelectorTerms:
          - matchExpressions:
            - key: size
              operator: NotIn
              values:
                - Small
```

We can use the "NotIn" value in "the operator".

'During Scheduling' is a state where a pod does not exist and is created for the first time.

key is label.

What if the nodes with matching labels are not available?

- **RequiredDuringScheduling** - It means ki pod us node par hi place hoga jiska node affinity rule satisfy hoga agar pod ko aisa node nahi milta hai to fir pod place nahi hoga ya fir scheduled nahi hoga.

Specifies rules that must be met for a pod to be scheduled onto a node. However, if the labels on a node change at runtime in a way that would make the pod unschedulable, the pod will still continue to run on the node.

- **PreferredDuringScheduling** - It means ki pod apna best try karega ki use wo node mil jaaye jo node affinity rules ko follow kare par agar nahi milta hai to kisi bhi available node par wo pod scheduled ho jaayega. Is case me pod ki placement less important hai pod ko run karne se.

Specifies rules that attempt to match the affinity but do not enforce it. If no node meets the rules specified in the affinity, the pod will still be scheduled.

Pod States

- '**DuringExecution**' is a state where a pod is running and then a change is made to the environment that affects node affinity such as a change in labels etc.
- '**IgnoredDuringExecution**' means ki pod jo bhi placed/scheduled hai nodes par wo waise hi continue rakhenge apna execution bhale hi node affinity change ho ya na ho.
- '**RequiredDuringExecution**' means ki agar pod node affinity rule ko meet nahi kiya to usko evict kar diya jaayega. 'Evict' means ki forcefully terminate kar diya jaayega.

	DuringScheduling	DuringExecution
Type 1	Required	Ignored
Type 2	Preferred	Ignored
Type 3	Required	Required

Node Affinity Operators

In: Requires that the node has one of the specified values for the label.

```
yaml
```

```
nodeAffinity:  
  requiredDuringSchedulingIgnoredDuringExecution:  
    nodeSelectorTerms:  
      - matchExpressions:  
          - key: example.com/zone  
            operator: In  
            values:  
              - zone1  
              - zone2
```

NotIn: Requires that the node does not have any of the specified values for the label.

```
yaml
```

```
nodeAffinity:  
  requiredDuringSchedulingIgnoredDuringExecution:  
    nodeSelectorTerms:  
      - matchExpressions:  
          - key: example.com/zone  
            operator: NotIn  
            values:  
              - zone3
```

Exists: Requires that the node has a label with the specified key, regardless of the value.

```
yaml
```

```
nodeAffinity:  
  requiredDuringSchedulingIgnoredDuringExecution:  
    nodeSelectorTerms:  
      - matchExpressions:  
          - key: example.com/zone  
            operator: Exists
```

DoesNotExist: Requires that the node does not have a label with the specified key.

```
yaml
```

```
nodeAffinity:  
  requiredDuringSchedulingIgnoredDuringExecution:  
    nodeSelectorTerms:  
      - matchExpressions:  
          - key: example.com/zone  
            operator: DoesNotExist
```

Gt (Greater Than), Lt (Less Than), and Hard requirement:

These operators are not directly supported for node affinity.

Node affinity is useful for scenarios where you want to influence the scheduling of pods based on node characteristics such as CPU architecture, hardware resources, or geographic location. By using node affinity effectively, you can optimize resource utilization and enhance the performance and reliability of your Kubernetes workloads.

Taints and Tolerations vs Node Affinity

- Taints are set on nodes.
- Tolerations are set on pods.

Let's say hamara goal ye hai ki particular node par specific pod placed karna.

Taints and Tolerations se ye ho sakta hai ki ek particular tainted node particular toleration pod ko prefer kare lekin ye zaroori nahi hai ki ek particular pod particular node par hi jaaye.

Similarly, Node affinity se ye ho sakta hai ki pods jo node labels ko match kar rahe hai wo unpar hi placed honge par aisa bhi ho sakta hai ki doosre pods bhi us node par placed ho jaaye.

So:-

- Combinations of Taints/Tolerations and Node Affinity rules can be used together to completely dedicate nodes for specific pods.
- We first use taints and tolerations to prevent other pods from being placed on our nodes, and then we use node affinity to prevent our pods from being placed on their nodes.

nodeSelectorTerm vs labelSelector:

In Kubernetes, nodeSelectorTerm and labelSelector are both components used in Node Affinity, which allows you to specify rules for scheduling pods onto specific nodes based on node labels. Here's how they differ:

nodeSelectorTerm:

- Definition: nodeSelectorTerm is part of the nodeSelector field within a Node Affinity configuration.
- Purpose: It defines the criteria that must be met by a node for the pod to be scheduled on that node.
- Usage: You use nodeSelectorTerm to specify expressions that match nodes based on their labels. For example, you can say that a pod should be scheduled on nodes where region=us-east or tier=backend.

labelSelector:

- Definition: labelSelector is used to filter pods based on their labels.
- Purpose: It allows you to select pods based on the presence of specific labels.
- Usage: You use labelSelector in various Kubernetes resources, such as services or deployments, to target pods with specific labels. For instance, you might create a service that selects pods with app=web to route traffic to those pods.

In summary, nodeSelectorTerm is used in Node Affinity to define node-level criteria for pod scheduling, while labelSelector is used more broadly across Kubernetes resources to select pods based on their labels, regardless of node affinity considerations.

lab 4

Friday, April 19, 2024 7:09 PM

Apply a label color=blue to node node01

```
kubectl label node node01 color=blue
```

Create a new deployment named blue with the nginx image and 3 replicas.

```
k create deploy
```

Set Node Affinity to the deployment to place the pods on node01 only.

- Name: blue
- Replicas: 3
- Image: nginx
- NodeAffinity: requiredDuringSchedulingIgnoredDuringExecution
- Key: color
- value: blue

Update the deployment by running `kubectl edit deployment blue` and add the nodeaffinity section as follows:

```
---  
apiVersion: apps/v1  
kind: Deployment  
metadata:  
  name: blue  
spec:  
  replicas: 3  
  selector:  
    matchLabels:  
      run: nginx  
  template:  
    metadata:  
      labels:  
        run: nginx  
    spec:  
      containers:  
      - image: nginx  
        imagePullPolicy: Always  
        name: nginx  
      affinity:  
        nodeAffinity:  
          requiredDuringSchedulingIgnoredDuringExecution:  
            nodeSelectorTerms:  
            - matchExpressions:  
              - key: color  
                operator: In  
                values:  
                - blue
```

and save the file.

★ **affinity section will be put under the spec of template.**

NodeAffinity is a concept in Kubernetes that is set at the Pod level. It allows you to constrain which nodes your pod is eligible to be scheduled based on labels on the node. By using node affinity, you can influence the scheduling of pods onto specific nodes in the cluster based on node labels, ensuring that pods are placed on nodes that meet certain criteria.

? Create a new deployment named red with the nginx image and 2 replicas, and ensure it gets placed on the controlplane node only.

Use the label key - `node-role.kubernetes.io/control-plane` - which is already set on the controlplane node.

- Name: red
- Replicas: 2
- Image: nginx
- NodeAffinity: requiredDuringSchedulingIgnoredDuringExecution
- Key: `node-role.kubernetes.io/control-plane`
- Use the right operator

It is also possible that 'value' field is not given in nodeAffinity so, you can create definition file using key and operators only.

Create the file `reddeploy.yaml` file as follows:

```
---  
apiVersion: apps/v1  
kind: Deployment  
metadata:  
  name: red  
spec:  
  replicas: 2  
  selector:  
    matchLabels:  
      run: nginx  
  template:  
    metadata:  
      labels:  
        run: nginx  
    spec:  
      containers:  
      - image: nginx  
        imagePullPolicy: Always  
        name: nginx  
      affinity:  
        nodeAffinity:  
          requiredDuringSchedulingIgnoredDuringExecution:  
            nodeSelectorTerms:  
            - matchExpressions:  
              - key: node-role.kubernetes.io/control-plane  
                operator: Exists
```

Then run `kubectl create -f reddeploy.yaml`

?

I have a confusion nodeSelectorTerms

1)
`nodeAffinity:`
 `requiredDuringSchedulingIgnoredDuringExecution:`
 `nodeSelectorTerms:`

```
- matchExpressions:  
  - key: topology.kubernetes.io/zone  
    operator: In  
    values:  
      - antarctica-east1  
      - antarctica-west1
```

2)

affinity:

podAffinity:

```
requiredDuringSchedulingIgnoredDuringExecution:
```

```
- labelSelector:  
  matchExpressions:  
    - key: security  
      operator: In  
      values:  
        - S1
```

Sometimes you find nodeSelectorTerms and under that matchingExpression is there but sometimes there is no nodeSelectorTerms but labelSelector is there. Help me to clarify this doubt when should I use nodeSelectorTerms, labelSelector.

Solution

The confusion between nodeSelectorTerms and labelSelector typically arises from the context in which they are used: nodeSelectorTerms is related to node affinity, while labelSelector is related to pod affinity. Here's a breakdown to clarify when to use each:

nodeSelectorTerms with matchExpressions (Node Affinity):

- Purpose: Used to specify rules for scheduling pods onto specific nodes based on node attributes.
- Usage: When you want to ensure that pods are scheduled on nodes with certain characteristics, such as specific labels or node features.
- Example Scenario: You have nodes in different zones (e.g., "antarctica-east1" and "antarctica-west1"), and you want to schedule pods only on nodes in a particular zone.

labelSelector with matchExpressions (Pod Affinity):

- Purpose: Used to define rules for pod placement based on the presence of other pods' labels.
- Usage: When you want to influence pod scheduling based on the presence or absence of specific labels on other pods.
- Example Scenario: You have pods labeled with "security: S1," and you want to ensure that other pods are scheduled on nodes where pods with the "security: S1" label are already running.

In summary, use nodeSelectorTerms when you want to select nodes based on their attributes or labels, and use labelSelector with podAffinity when you want to influence pod scheduling based on the presence or absence of labels on other pods.

Resource Requirements of Pods

Thursday, February 29, 2024 3:29 PM

Resource Request - Minimum amount of CPU or memory requested by the container.

- To add a resource request, add a section of 'resources' and under this add 'requests'

pod-definition.yaml

```
apiVersion: v1
kind: Pod
metadata:
  name: simple-webapp-color
  labels:
    name: simple-webapp-color
spec:
  containers:
  - name: simple-webapp-color
    image: simple-webapp-color
    ports:
    - containerPort: 8080
  resources:
    requests:
      memory: "4Gi"
      cpu: 2
```

cpu: 2 means 2 virtual cpu (vCPU).

So when the scheduler gets a request to place this pod, it looks for a node that has this amount of resources available.

A scheduler decides on which node a pod goes to.

- Memory Units

1 G (Gigabyte) = 1,000,000,000 bytes

1 M (Megabyte) = 1,000,000 bytes

1 K (Kilobyte) = 1,000 bytes

1 Gi (Gibibyte) = 1,073,741,824 bytes

1 Mi (Mebibyte) = 1,048,576 bytes

1 Ki (Kibibyte) = 1,024 bytes

Gibi is pronounced as (*jii-bee*)

- What happens when a pod tries to exceed resources beyond its specific limit?

In the case of the CPU, the system throttles the CPU so that it does not go beyond the specific limit.

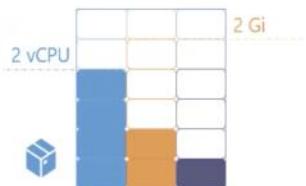
However, that is not the case with the memory. A container uses more memory resources than its limit.

So if a pod tries to consume more memory than its limit constantly, the pod will be terminated and you'll see that the pod terminated with an OOM(Out Of Memory) error in the logs.

|Resource Limits

pod-definition.yaml

```
apiVersion: v1
kind: Pod
metadata:
  name: simple-webapp-color
  labels:
    name: simple-webapp-color
spec:
  containers:
  - name: simple-webapp-color
    image: simple-webapp-color
    ports:
    - containerPort: 8080
  resources:
    requests:
      memory: "1Gi"
      cpu: 1
    limits:
      memory: "2Gi"
      cpu: 2
```



Default Configuration of Kubernetes

- By default, Kubernetes does not have a CPU or Memory limit. It means any pod can consume as much as resources as req on any node and

? In resource requirement in kubernetes, what does one count of CPU mean?
Also explain 0.1 means 100m.

In Kubernetes, the CPU resource requirement is specified in terms of CPU units, where 1 CPU unit typically corresponds to 1 virtual CPU (vCPU) on a physical CPU core. However, the exact meaning of "1 CPU" can vary depending on the underlying hardware and configuration.

When you specify CPU resources in Kubernetes, you often use decimal values like 0.1 to represent CPU units. This decimal notation is used to express fractions of a CPU, and it's based on the concept of millicores (m).

- ★ 1m is the lowest value.

Here's how it works:

1 CPU (or 1.0): This typically refers to one full vCPU or one core of a physical CPU. For example, if you set a container's CPU request to 1, it means the container can use one full CPU core.

0.1 CPU (or 100m): This notation represents one-tenth of a CPU core. The m stands for "milli" or "milliCPU," indicating a fraction of 1 CPU. So, 100m is equivalent to 0.1 CPU or one-tenth of a core.

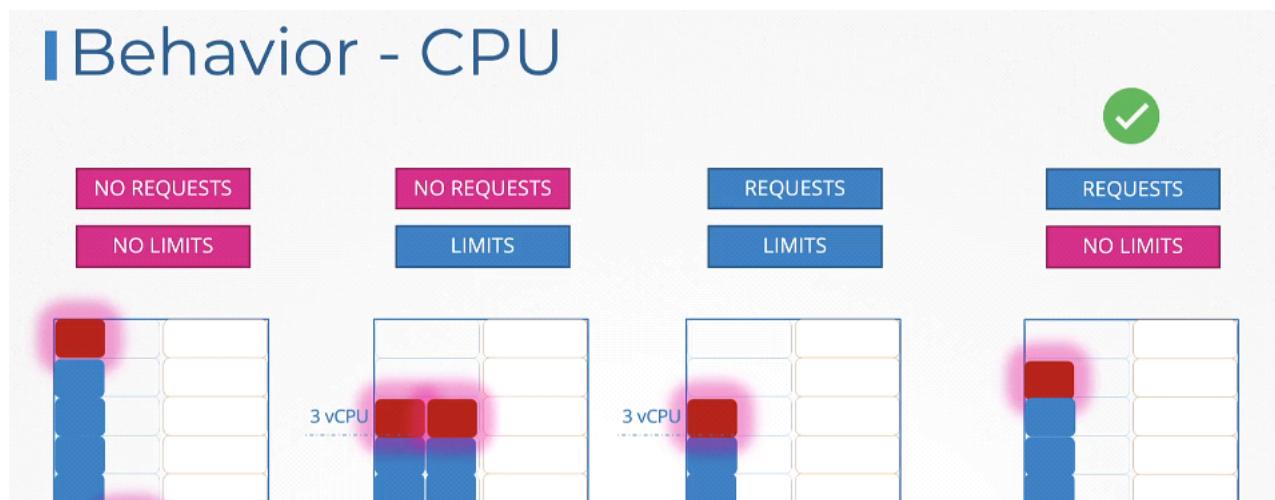
Using decimal values and millicores allows for more granular control over CPU resources. For example, you can specify resource requests like 0.5 CPU or 500m, which means half a core or 500 milliCPU. This flexibility is useful for optimizing resource allocation and scaling applications effectively within Kubernetes clusters.

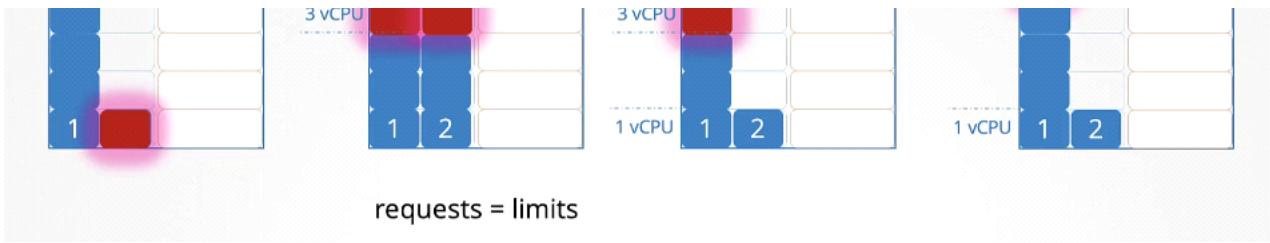
Each node ke paas CPU aur memory hota hai. Pod ko node par place hone ke liye, pod scheduler se resource request karta hai. Schedules apna best node us pod ko deta hai jo node pod ki request ko complete kare, nahi to scheduler pod ko schedule nahi karta and you'll find pod as 'pending state' when you run 'kubectl describe pod <pod-name>' command'.

CPU Behavior : How CPU Request and Limit works

Let's say there are two pods competing for resource. Without limit set, one pod can consume all the CPU Resources and prevent the second pod to consume the req resources.

- CPU Request: This specifies the minimum amount of CPU that a container needs to run. Kubernetes tries to ensure that the container gets at least this much CPU time, but it can use more if available.
- CPU Limit: This sets the maximum amount of CPU that a container is allowed to use. If the container tries to use more CPU than the limit, Kubernetes throttles its CPU usage to stay within the limit.





1. No Request, No Limit - In this case, a pod will consume all the CPU and maybe other pods won't get the CPU.
2. No Request, Limit - In this case, the limit is set but the request is not specified, kubernetes will set request = limit.
3. Request, Limit - In this case, request and limit are set, so a pod will get min CPU and the CPU within the limit. The problem with this is that if one pod requires more CPU than the limit and another pod is using CPU less than the limit then why can't we use CPU of other?
4. Request, No limit - This is the ideal Condition. You set the min CPU request but there's no limit.

Similary, Memory behaves.



- ★ Unlike CPU, we cannot throttle memory. Once memory is assigned to a pod, the only way to kind of retrieve it is to kill the pod and free up all the memory that are used by it.

Resource Availability in a Kubernetes Cluster:

- A Kubernetes cluster comprises nodes, each with its CPU and memory resources.
- Pods, the basic execution units in Kubernetes, require resources to run effectively.

Resource Requests and Limits:

- Resource Requests: These are the minimum required resources for a container to run. Kubernetes ensures that a pod gets at least the requested amount of resources.
- Resource Limits: Limits are the maximum resources a container can consume. Kubernetes prevents containers from using resources beyond the specified limits.
- These requests and limits can be set in the pod-definition file under the resources section.

CPU and Memory Units:

- CPU Units: CPU resources can be specified in fractions, such as 0.1 CPU or 100m (where 'm' stands for milli).
- One count of CPU is equivalent to one vCPU (virtual CPU).
- Memory Units: Memory resources can be specified in mebibytes (Mi), gibibytes (Gi), or gigabytes (G).
- Note the difference between G (gigabyte) and Gi (gibibyte); G refers to 1,000 megabytes, while Gi refers to 1,024 mebibytes.

Setting Resource Limits:

```
pod-definition.yaml
apiVersion: v1
kind: Pod
metadata:
  name: simple-webapp-color
  labels:
    name: simple-webapp-color
spec:
  containers:
  - name: simple-webapp-color
    image: simple-webapp-color
    ports:
      - containerPort: 8080
    resources:
      requests:
        memory: "1Gi"
        cpu: 1
      limits:
        memory: "2Gi"
        cpu: 2
```

- Setting limits is crucial to prevent containers from consuming excessive resources, which can lead to resource contention and performance issues.
- Exceeding CPU limits results in throttling, where the system limits CPU usage to the specified limit.
- Exceeding memory limits can lead to termination (OOM error) of pod, especially if a container consumes more memory than it's allocated.
- When you specify the new limits for memory and CPU like this. Now when the pod is created, Kubernetes sets new limits for the container. And remember that the limits and requests are set for each container within a pod. So if there are multiple containers, then each container can have a request or limit set for its own.

Default Configurations and Best Practices:

- By default, Kubernetes does not set CPU or memory requests/limits, allowing pods to consume resources freely.
- It's best practice to set resource requests to ensure pods have guaranteed resources for optimal performance.
- Setting resource limits prevents pods from consuming excessive resources and affecting other pods' performance.

Limit Ranges and Resource Quotas:

LimitRange

limit-range-cpu.yaml

```
apiVersion: v1
kind: LimitRange
metadata:
  name: cpu-resource-constraint
spec:
  limits:
    - default:
        cpu: 500m
      defaultRequest:
        cpu: 500m
      max:
        cpu: "1"
      min:
        cpu: 100m
      type: Container
```

limit-range-memory.yaml

```
apiVersion: v1
kind: LimitRange
metadata:
  name: memory-resource-constraint
spec:
  limits:
    - default:
        memory: 1Gi
      defaultRequest:
        memory: 1Gi
      max:
        memory: 1Gi
      min:
        memory: 500Mi
      type: Container
```

- Limit Ranges: These are used to define default values for containers that do not have specified requests/limits in the pod-definition files. This is applicable at the name space level.
- Resource Quotas: Quotas are set at the namespace level and restrict the total CPU and memory usage across all pods in that namespace.
- Quotas enforce limits on requested and consumed resources, preventing resource abuse and ensuring fair resource distribution.

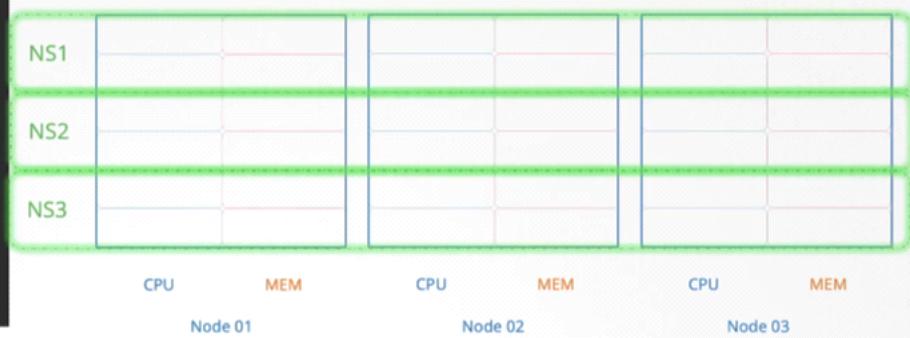
★ Note that these limits are enforced when a pod is created. So if you create or change a limit range, it does not affect existing pods. It'll only affect newer pods that are created after the limit range is created or updated.

Namespace-level Resource Management:

Resource Quotas

resource-quota.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: my-resource-quota
spec:
  hard:
    requests.cpu: 4
    requests.memory: 4Gi
    limits.cpu: 10
    limits.memory: 10Gi
```



- Resource quotas at the namespace level are essential for managing overall resource usage in a Kubernetes environment.
- Quotas help prevent individual pods or containers from monopolizing resources, leading to better cluster performance and stability.
- Limit ranges and quotas play a crucial role in resource governance and ensuring efficient resource utilization in Kubernetes clusters.
- These detailed notes provide a comprehensive understanding of resource requirements, limits, and management practices in Kubernetes, emphasizing the importance of efficient resource utilization for optimal cluster performance.

What does 'throttle' mean - You know, because unlike CPU, we cannot throttle memory.

ChatGPT

"Throttle" in the context of computing refers to the act of limiting or regulating the usage of a resource. When we say that Kubernetes throttles CPU usage, it means that Kubernetes actively manages and controls the amount of CPU resources allocated to a container, ensuring that it does not exceed the specified limits.

However, unlike CPU, memory cannot be throttled in the same way. Once a container's memory usage reaches its limit, it may experience issues like out-of-memory errors or performance degradation, as there is no mechanism to throttle memory usage in the same way CPU usage is managed.

lab 5

Saturday, April 20, 2024 5:15 PM

Another pod called elephant has been deployed in the default namespace. It fails to get to a running state. Inspect this pod and identify the Reason why it is not running.

look for 'last state'

The reason for the pod not running is `OOMKilled`. This means that the pod ran out of memory.

```
root@controlplane:~# kubectl describe pod elephant | grep -A5 State:  
  State:          Waiting  
    Reason:        CrashLoopBackOff  
  Last State:    Terminated  
    Reason:        OOMKilled  
    Exit Code:     1  
  Started:       Sun, 25 Apr 2021 15:13:07 +0000  
  Finished:      Sun, 25 Apr 2021 15:13:07 +0000  
  Ready:         False  
root@controlplane:~#
```

It's changing the status frequently so make use of the `watch` command to get the output every two seconds: -

```
root@controlplane ~ → watch kubectl get pods
```

Note: - Make use of the `CTRL + C` key to exit from the process.

`kubectl get pods --watch`

The elephant pod runs a process that consumes 15Mi of memory. Increase the limit of the elephant pod to 20Mi.

Delete and recreate the pod if required. Do not modify anything other than the required fields.

- Pod Name: elephant
- Image Name: polinux/stress
- Memory Limit: 20Mi

Solution

Run command '`kubectl edit pod <pod-name>`' command.

Then run '`kubectl replace`' command with the temporary file name.

Daemon Sets

Saturday, March 2, 2024 4:41 PM

- A DaemonSet ensures that a specific pod runs on all or some nodes in a cluster.

The screenshot shows a terminal window with two code snippets and a command:

daemon-set-definition.yaml

```
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: monitoring-daemon
spec:
  selector:
    matchLabels:
      app: monitoring-agent
  template:
    metadata:
      labels:
        app: monitoring-agent
    spec:
      containers:
        - name: monitoring-agent
          image: monitoring-agent
```

replicaset-definition.yaml

```
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: monitoring-daemon
spec:
  selector:
    matchLabels:
      app: monitoring-agent
  template:
    metadata:
      labels:
        app: monitoring-agent
    spec:
      containers:
        - name: monitoring-agent
          image: monitoring-agent
```

kubectl create -f daemon-set-definition.yaml

```
daemon-set Created
```

- The DaemonSets controller automatically handles the deployment and scaling of pods to match the desired state across the nodes. DaemonSets are commonly used for deploying system daemons and background services that should run on every node.
 - Key Characteristics of DaemonSets:
 - Pod Placement: A pod managed by a DaemonSet runs on every node in the cluster by default.
 - DaemonSets ensure that exactly one pod runs on each node to maintain the desired state.
 - Use Cases:
 - Running monitoring agents, log collectors, or networking components on every node.
 - Ensuring that specific pods are distributed across all nodes in the cluster.
- ★ kube-proxy is the component that is required by each worker node. A Daemon set can be used for that. Similarly, daemonsets can be used for networking solutions as well.**
- How daemon set do this?
Daemonsets uses 'NodeAffinity' as the default scheduler for this purpose.

```
yaml

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: your-image:tag
```

selector: Defines the pods to be managed by the DaemonSet based on labels.

template: Specifies the pod template with its metadata and container specifications.

Updating DaemonSets:

When you update a DaemonSet, it triggers updates to all the DaemonSet pods. You can update the template or other specifications, and the DaemonSet controller will automatically roll out the changes to all nodes.

Node Affinity for DaemonSets:

You can use node affinity rules to control which nodes the DaemonSet should run on. For example, you might want the DaemonSet pods to run only on nodes with specific labels.

Example with Node Affinity:

yaml

```
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: example-daemonset
spec:
  selector:
    matchLabels:
      app: example-app
  template:
    metadata:
      labels:
        app: example-app
    spec:
      affinity:
        nodeAffinity:
          requiredDuringSchedulingIgnoredDuringExecution:
            nodeSelectorTerms:
              - matchExpressions:
                  - key: example.com/zone
                    operator: In
                    values:
                      - zone1
```

In this example, the DaemonSet is set to run only on nodes with the label example.com/zone: zone1.

DaemonSets are a powerful tool for running background processes on every node in a Kubernetes cluster, and they provide a convenient way to manage such infrastructure components in a distributed environment.

- ? Ques- "kube-proxy can be deployed as DaemonSet on worker nodes". So, my question is - "A node is called a worker node because it has kube-proxy and kubelet installed on it.
- Where do these components get installed?
 - Can we install different components in different pods? Yes
 - What are pods?
 - What if a worker node has only one component and is similar to master nodes?
 - What if a worker node or master node has multiple components? e.g. 2 scheduler.
 - What are containers?

Commands

kubectl get daemonsets

kubectl describe daemonsets <daemonset-name>

lab 6

Monday, April 22, 2024 3:51 PM

How many DaemonSets are created in the cluster in all namespaces?

Check all namespaces

'kubectl get daemonset -A'

OR

'kubectl get ds -A'

? On how many nodes are the pods scheduled by the DaemonSet kube-proxy?

Creating a DaemonSet

Deploy a DaemonSet for FluentD Logging.

Use the given specifications:-

- Name: elasticsearch
- Namespace: kube-system
- Image: registry.k8s.io/fluentd-elasticsearch:1.20

1st Method

An easy way to create a DaemonSet is to first generate a YAML file for a Deployment with the command `kubectl create deployment elasticsearch --image=registry.k8s.io/fluentd-elasticsearch:1.20 -n kube-system --dry-run=client -o yaml > fluentd.yaml`. Next, remove the replicas, strategy and status fields from the YAML file using a text editor. Also, change the kind from `Deployment` to `DaemonSet`.

Finally, create the Daemonset by running `kubectl create -f fluentd.yaml`

2nd Method

Create a file `fluentd.yaml` with the content below:

```
---
apiVersion: apps/v1
kind: DaemonSet
metadata:
  labels:
    app: elasticsearch
  name: elasticsearch
  namespace: kube-system
spec:
  selector:
    matchLabels:
      app: elasticsearch
  template:
    metadata:
      labels:
        app: elasticsearch
    spec:
      containers:
        - image: registry.k8s.io/fluentd-elasticsearch:1.20
          name: fluentd-elasticsearch
```

Then run the following command: `kubectl apply -f fluentd.yaml`

Static Pods

Sunday, March 3, 2024 12:31 AM

Question - What if there is no Master Node and just a single Worker Node?

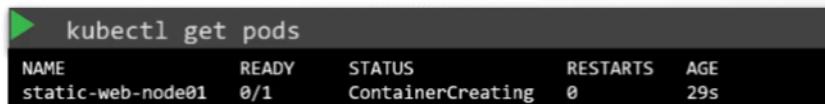
- In this case, the worker node can work independently.
- kubelet will help the worker node with this. kubelet works on the pod level and can only understand pods.
- It can manage the pods and ensure that they are alive.
- Unlike regular pods that are managed by the control plane (scheduled by a scheduler, etc.), static pods are directly created on a specific node and are not managed by the API server. They are defined on the node itself, and the kubelet on that node monitors and manages the lifecycle of these pods.

kubelet can create both types of pods - Static Pods and one from API Server both at the same time.

kube-apiserver is also aware of this so when you run 'kubectl get pods' command on the master node, static pods will also get listed.

Well, how is that happening?

When the kubelet creates a static Pod, if it is a part of a cluster, it also creates a mirror object in the kube-apiserver. What you see from the kube-apiserver is just a read-only mirror of the Pod. You can view details about the Pod, but you cannot edit or delete it like the usual Pods. You can only delete them by modifying the files from the Nodes manifest folder.



A terminal window showing the output of the 'kubectl get pods' command. The output is as follows:

NAME	READY	STATUS	RESTARTS	AGE
static-web-node01	0/1	ContainerCreating	0	29s

★ Note that the name of the Pod is automatically appended with the Node name in static pods.

How does a kubelete create a pod?

While creating a kubelet.service file, specify the path of config

Static Pods in Kubernetes are a way to run pods without the control of the Kubernetes API server. Unlike regular pods that are managed by the control plane (scheduled by a scheduler, etc.), static pods are

directly created on a specific node and are not managed by the API server. They are defined on the node itself, and the kubelet on that node monitors and manages the lifecycle of these pods.

You can use 'Static Pods' to deploy components of Nodes itself.

Static PODs	DaemonSets
Created by the Kubelet	Created by Kube-API server (DaemonSet Controller)
Deploy Control Plane components as Static Pods	Deploy Monitoring Agents, Logging Agents on nodes
	Ignored by the Kube-Scheduler

Key Characteristics of Static Pods:

- Node-Level Configuration:
Static Pods are defined on a per-node basis. Each node can have its own set of static pod definitions.
- No API Server Involvement:
The Kubernetes API server is not aware of static pods. They are not included in the control plane's desired state.
- Location of Manifests:
We know that to create a Pod, you need the details of the Pod in a Pod definition file but how do you provide the Pod definition file to the kubelet without a kube-apiserver?

You can configure the kubelet to read the Pod definition files from a directory on the server designated to store information about Pods. Place the Pod definition files in this directory. The kubelet periodically checks this directory for files, reads these files, and creates Pods on the host. Not only does it create the Pod, it can ensure that the Pod stays alive.

If the application crashes,

the kubelet attempts to restart it.

If you make a change to any of the file

within this directory, the kubelet recreates the Pod

for those changes to take effect.

If you remove a file from this directory,

the Pod is deleted automatically.

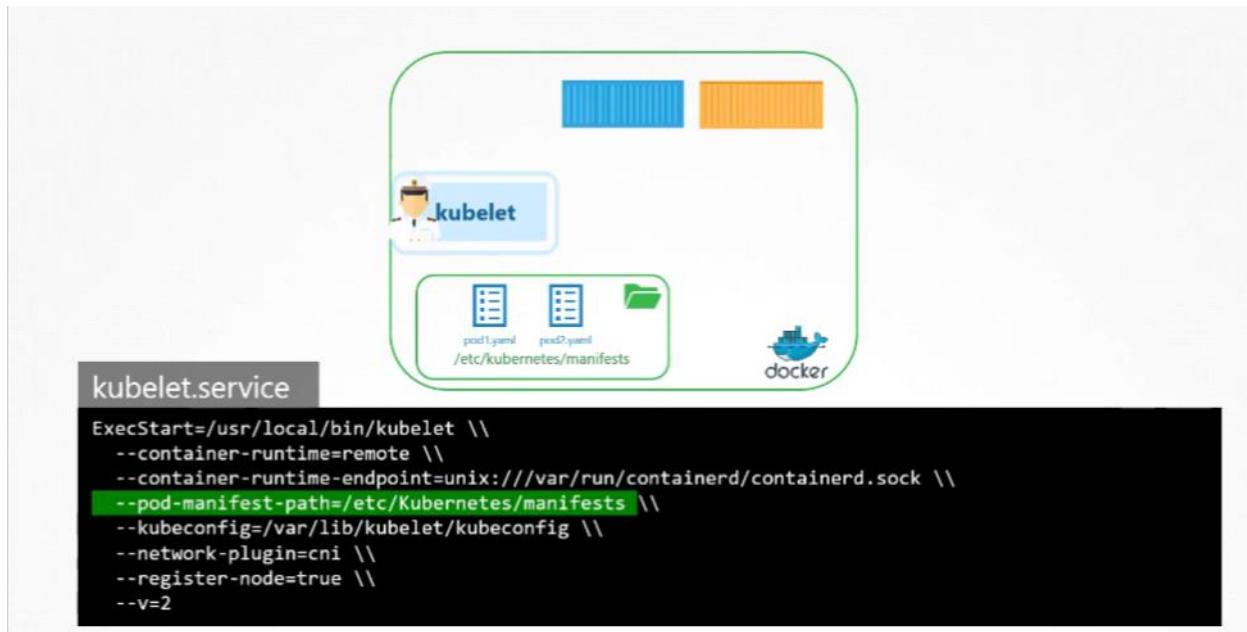
So these Pods that are created by the kubelet on its own

without the intervention from the API server

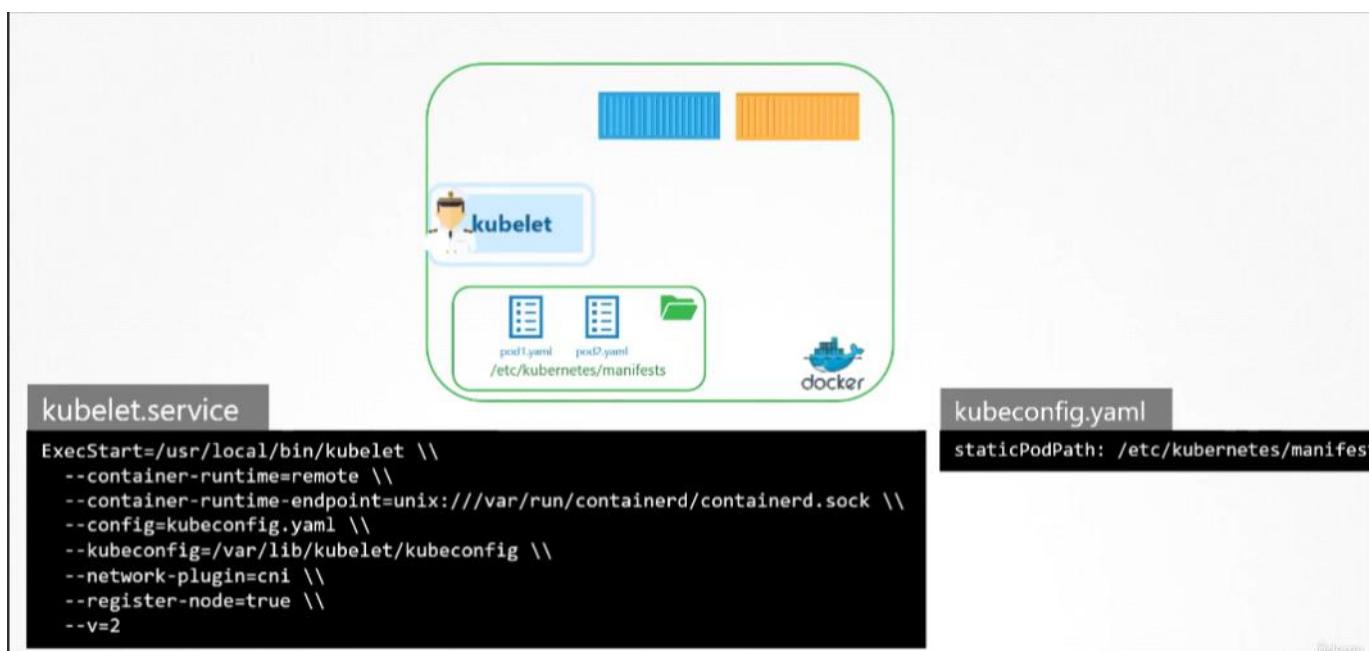
or rest of the Kubernetes cluster components

are known as static Pods.

The pod manifests for static pods are typically located in a directory monitored by the kubelet on the node, such as `/etc/kubernetes/manifests`. It could be any directory on the host and the location of that directory is passed into the kubelet as an option while running the service.



OR



There's also another way to configure this. Instead of specifying the option directly in the kubelet.service file, you

could provide a path to another config file using the config option and define the directory path as staticPodPath in that file. Clusters set up by the kube admin tool uses this approach.

Once the static Pods are created, you can view them by running the 'docker ps' command. The kubectl utility works with the kube-apiserver since we don't have an API server now, no kubectl utility, which is why we are using the docker command.

- ★ You can only create Pods this way. You cannot create replica sets or deployments or services by placing a definition file in the designated directory because that requires other cluster plane components like the replication and deployment controllers, et cetera.

- Kubelet Management:

The kubelet on each node is responsible for monitoring the specified directory and starting, updating, or stopping the static pods accordingly.

- Control Plane Ignorance:

The control plane is unaware of static pods, so features like scaling, rolling updates, or health checks are not automatically handled for static pods.

Creating Static Pods:

- Choose a node where you want to run the static Pod. In this example, it's my-node1.

```
ssh my-node1
```

- Define Manifest:

Create a pod manifest (YAML or JSON file) specifying the pod's metadata, containers, and other details.

- Place Manifest on Node:

Place the pod manifest in the directory monitored by the kubelet, often located at `/etc/kubernetes/manifests`.

- Kubelet Takes Over:

The kubelet detects the new manifest and starts the pod on the node.

- Restart the kubelet.

```
sudo systemctl restart kubelet
```

Example Static Pod Manifest:

```
yaml

apiVersion: v1
kind: Pod
metadata:
  name: static-pod
  namespace: default
spec:
  containers:
    - name: nginx
      image: nginx:latest
```

Use Cases:

- Node-Specific Services:

Since static Pods are not dependent

on the Kubernetes control plane, you can use static Pods

to deploy the control plane components itself

as Pods on a Node.

Running services on a node that should not be managed by the Kubernetes control plane.



Start by installing kubelet on all the master Nodes,

then create Pod definition files that uses docker images

of the various control plane components

such as the API server, controller, ETCD, et cetera.

Place the definition files

in the designated manifest folder,

and the kubelet takes care of deploying

the control plane components themselves

as Pods on the cluster.

This way, you don't have to download the binaries,

configure services, or worry about the services crashing.

If any of these services were to crash,

since it's a static Pod,

it'll automatically be restarted by the kubelet.

★ That's how the kube admin tool sets up a Kubernetes cluster, which is why when you list the Pods in the kube-system namespace, you see the control plane components as Pods in a cluster setup by the kube admin tool.

Considerations:

- Node Restart:
If a node restarts, static pods are automatically recreated by the kubelet based on the manifests in the monitored directory.
- Not Portable:
Static pods are tied to a specific node and are not portable across the cluster.

Static Pods provide a way to run essential system components or services directly on a node, outside the control of the Kubernetes API server. They are useful for scenarios where you need specific pods to be managed at the node level.

lab 7

Monday, April 22, 2024 10:30 PM

?

How many static pods exist in this cluster in all namespaces?

Solution

Run the command `kubectl get pods --all-namespaces` or `k get pods -A` and look for those pods with **<node-name> appended in the last**.

Here -controlplane appended in the name. e.g. `kube-apiserver-controlplane`

OR

Run '`kubectl get pod <pod-name> -n <namespace> -o yaml`' and then check for ownerReference section.

```
  startTime: <redacted>
  manager: kubelet
  operation: Update
  time: "2022-04-16T18:52:45Z"
  name: kube-apiserver-controlplane
  namespace: kube-system
  ownerReferences:
  - apiVersion: v1
    controller: true
    kind: Node
    name: controlplane
    uid: fbab9414-1ae8-4f64-bc94-456dd8569e6c
  resourceVersion: "467"
  uid: 26acf5fa-82dc-4fef-adae-e208089ce9af
spec:
  containers:
  - command:
    - kube-apiserver
    - --advertise-address=10.38.102.6
```

?

Which of the below components is NOT deployed as a static pod?

- The coredns pods are created as part of the coredns deployment and hence, it is not a static pod.
- kube-proxy is deployed as a DaemonSet and hence, it is not a static pod.

By default, static pods are created for the controlplane components and hence, they are only created in the controlplane node.

★ What is the path of the directory holding the static pod definition files?

Run the command `ps -aux | grep kubelet` and identify the config file -- `config=/var/lib/kubelet/config.yaml`. Then check in the config file for `staticPodPath`.

First identity the kubelet config file:

```
root@controlplane:~# ps -aux | grep /usr/bin/kubelet
root      3668  0.0  1.5 1933476 63076 ?        Ssl  Mar13  16:18 /usr/bin/...
root      4879  0.0  0.0 11468  1040 pts/0    S+   00:06   0:00 grep --co...
```

From the output we can see that the kubelet config file used is

`/var/lib/kubelet/config.yaml`

Next, lookup the value assigned for `staticPodPath`:

```
root@controlplane:~# grep -i staticpod /var/lib/kubelet/config.yaml
staticPodPath: /etc/kubernetes/manifests
root@controlplane:~#
```

As you can see, the path configured is the `/etc/kubernetes/manifests` directory.

OR

`cat /var/lib/kubelet/config.yaml`

Look for 'Static pod Path'

? What is the docker image used to deploy the kube-api server as a static pod?

Check the image defined in the /etc/kubernetes/manifests/kube-apiserver.yaml manifest file.

- ?
- Run the image on the static pod to use busybox:1.28.4
 - Name: static-busybox
 - Image: busybox:1.28.4

```
kubectl run --restart=Never --image=busybox:1.28.4 static-busybox --dry-run=client -o yaml --command -- sleep 1000 > /etc/kubernetes/manifests/static-busybox.yaml
```

- ★
- command will always come at the end (after the --dry-run)**

To move file to another location
cp <filename> <destination-path>

For editing the image on static pod, edit the manifest file and save the file :wq!

- ?
- We just created a new static pod named static-greenbox. Find it and delete it.

Identify which node the static pod is created on, ssh to the node and delete the pod definition file.

If you don't know the IP of the node, run the kubectl get nodes -o wide command and identify the IP.

Then, SSH to the node using that IP. For static pod manifest path look at the file /var/lib/kubelet/config.yaml on node01

1. First, let's identify the node in which the pod called **static-greenbox** is created. To do this, run:

```
root@controlplane:~# kubectl get pods --all-namespaces -o wide | grep static-greenbox
default      static-greenbox-node01              1/1      Running   6
root@controlplane:~#
```

From the result of this command, we can see that the pod is running on node01.

2. Next, SSH to **node01** and identify the path configured for static pods in this node.

Important : The path need not be `/etc/kubernetes/manifests`. Make sure to check the path configured in the kubelet configuration file.

```
root@controlplane:~# ssh node01
root@node01:~# ps -ef | grep /usr/bin/kubelet
root      4147      1  0 14:05 ?        00:00:00 /usr/bin/kubelet --k
root      4773    4733  0 14:05 pts/0    00:00:00 grep /usr/bin/kubele

root@node01:~# grep -i staticpod /var/lib/kubelet/config.yaml
staticPodPath: /etc/just-to-mess-with-you

root@node01:~#
```

Here the staticPodPath is `/etc/just-to-mess-with-you`

ps -ef vs ps -aux

The ps command is used to view information about running processes on a Unix-like system. Here's what each option means in the context of the ps command:

ps -ef: This option is used to display a full listing of all processes in the system. Here's what each flag

means:

- -e: Selects all processes.
- -f: Produces a full listing that includes additional details such as the UID, PPID, C, STIME, TTY, TIME, and CMD.

ps -aux: This option is also used to display a full listing of all processes in the system, but it has slightly different flags:

- -a: Selects all processes.
- -u: Displays processes for all users.
- -x: Includes processes not attached to a terminal.

So, the main difference between ps -ef and ps -aux is in the flags used to select and display processes. Both commands provide a comprehensive view of running processes, but they use different flags to achieve this.

```
grep -i staticpod /var/lib/kubelet/config.yaml
```

The command grep -i staticpod /var/lib/kubelet/config.yaml is used to search for the term "staticpod" case-insensitively (-i option) in the file located at /var/lib/kubelet/config.yaml. Here's what each part of the command does:

- grep: This is the command-line utility used to search text using patterns.
- -i: This option tells grep to perform a case-insensitive search, meaning it will match "staticpod" regardless of the case (e.g., StaticPod, STATICPOD, etc.).
- staticpod: This is the pattern or text string being searched for in the file.
- /var/lib/kubelet/config.yaml: This is the path to the file in which the search will be conducted. In this case, it's searching in the config.yaml file located at /var/lib/kubelet/.

When you run this command, grep will search the config.yaml file for the term "staticpod" (or any variation due to the case-insensitive option) and display any lines that contain this term.

Multiple Schedulers

Sunday, March 3, 2024 1:47 AM

- ★ "With kubeadm, all the components run as pods.

In Kubernetes, it's possible to have multiple schedulers running in a cluster. Having multiple schedulers allows for more flexibility in scheduling decisions and can be useful in specific scenarios where you want to customize scheduling behavior for certain pods or groups of pods.

Key Points about Multiple Schedulers:

- Default Scheduler:

The default scheduler in a Kubernetes cluster is the one embedded in the kube-scheduler component. It is responsible for making scheduling decisions for all pods in the cluster.

- Custom Schedulers:

Kubernetes allows you to run multiple custom schedulers alongside the default scheduler.

- Scheduling Policies:

Each scheduler can have its own scheduling policies and rules. This enables you to have different scheduling behaviors for various types of workloads.

- Pod Annotations:

To specify which scheduler should be used for a particular pod, you can add annotations to the pod definition. The annotation `scheduler.alpha.kubernetes.io/name` is used to indicate the scheduler.

Example:

```
yaml
metadata:
  annotations:
    scheduler.alpha.kubernetes.io/name: custom-scheduler
```

- Scheduling Algorithm:

Each scheduler can use its scheduling algorithm and logic. For example, a custom scheduler might consider additional factors like specific hardware requirements or specialized rules.

Steps to Use Multiple Schedulers:

- Deploy Custom Scheduler:

Deploy the custom scheduler(s) in your cluster. This can be done by running the scheduler as a separate component and ensuring it can communicate with the Kubernetes API server.

- Annotate Pods:

Annotate pods with the desired scheduler's name to indicate which scheduler should be responsible for scheduling that pod.

- Scheduler Configuration:

Configure each custom scheduler with its policies and rules. This may involve setting up affinity rules, node selection preferences, and other scheduling parameters.

Example YAML for Pod Annotation:

```
yaml
apiVersion: v1
kind: Pod
metadata:
  name: example-pod
  annotations:
    scheduler.alpha.kubernetes.io/name: custom-scheduler
spec:
  containers:
  - name: nginx
    image: nginx:latest
```

In this example, the pod is annotated with custom-scheduler as the desired scheduler.

Considerations and Best Practices:

- Careful Planning:

Plan the deployment of multiple schedulers carefully, considering the specific requirements of your workloads.

- Monitoring and Debugging:

Ensure proper monitoring and debugging capabilities for each scheduler to understand scheduling decisions and troubleshoot any issues.

- Documentation:

Document the scheduling policies and behaviors of each scheduler to make cluster management more transparent.

Having multiple schedulers in a Kubernetes cluster is an advanced feature and should be used judiciously based on specific use cases and requirements. It provides additional flexibility and customization options for workload scheduling.

Introduction to Multiple Schedulers in Kubernetes:

- Kubernetes allows deploying multiple schedulers in a cluster.
- The default scheduler evenly distributes pods across nodes based on conditions like taints, tolerations, and node affinity.

Need for Custom Schedulers:

- Sometimes, applications require custom scheduling based on specific checks or conditions not covered by the default scheduler.
- Kubernetes allows the creating and deploying custom schedulers alongside the default one.

Deploying Custom Schedulers:

- For the other schedulers, we could create a separate configuration file and set the scheduler name like this.

```
my-scheduler-2-config.yaml
apiVersion: kubescheduler.config.k8s.io/v1
kind: KubeSchedulerConfiguration
profiles:
- schedulerName: my-scheduler-2

my-scheduler-config.yaml
apiVersion: kubescheduler.config.k8s.io/v1
kind: KubeSchedulerConfiguration
profiles:
- schedulerName: my-scheduler

scheduler-config.yaml
apiVersion: kubescheduler.config.k8s.io/v1
kind: KubeSchedulerConfiguration
profiles:
- schedulerName: default-scheduler
```

Deploy Additional Scheduler

```
▶ wget https://storage.googleapis.com/kubernetes-release/release/v1.12.0/bin/linux/amd64/kube-scheduler
kube-scheduler.service
ExecStart=/usr/local/bin/kube-scheduler \\
--config=/etc/kubernetes/config/kube-scheduler.yaml
```

my-scheduler-2.service

my-scheduler-2-config.yaml

Deploy Additional Scheduler

```
▶ wget https://storage.googleapis.com/kubernetes-release/release/v1.12.0/bin/linux/amd64/kube-scheduler
```

```
kube-scheduler.service
```

```
ExecStart=/usr/local/bin/kube-scheduler \\  
--config=/etc/kubernetes/config/kube-scheduler.yaml
```

```
my-scheduler-2.service
```

```
ExecStart=/usr/local/bin/kube-scheduler \\  
--config=/etc/kubernetes/config/my-scheduler-2-config.yaml
```

```
my-scheduler.service
```

```
ExecStart=/usr/local/bin/kube-scheduler \\  
--config=/etc/kubernetes/config/my-scheduler-config.yaml
```

```
my-scheduler-2-config.yaml
```

```
apiVersion: kubescheduler.config.k8s.io/v1  
kind: KubeSchedulerConfiguration  
profiles:  
- schedulerName: my-scheduler-2
```

```
my-scheduler-config.yaml
```

```
apiVersion: kubescheduler.config.k8s.io/v1  
kind: KubeSchedulerConfiguration  
profiles:  
- schedulerName: my-scheduler
```

- Custom schedulers must have unique names to distinguish them from the default scheduler.
- Configuration files specify scheduler names and options like kubeconfig for API authentication.
- Deployment methods include running the scheduler as a service, as a pod, or as a deployment.

Running Schedulers as Pods:

```
my-custom-scheduler.yaml
```

```
apiVersion: v1  
kind: Pod  
metadata:  
  name: my-custom-scheduler  
  namespace: kube-system  
spec:  
  containers:  
    - command:  
      - kube-scheduler  
      - --address=127.0.0.1  
      - --kubeconfig=/etc/kubernetes/scheduler.conf  
      - --config=/etc/kubernetes/my-scheduler-config.yaml  
    image: k8s.gcr.io/kube-scheduler-amd64:v1.11.3  
    name: kube-scheduler
```

```
my-scheduler-config.yaml
```

```
apiVersion: kubescheduler.config.k8s.io/v1  
kind: KubeSchedulerConfiguration  
profiles:  
- schedulerName: my-scheduler  
leaderElection:  
  leaderElect: true  
  resourceNamespace: kube-system  
  resourceName: lock-object-my-scheduler
```

- Pod definitions include paths to custom configuration files (kube-scheduler conf file).
- Leader election (leader elect option) helps in high-availability setups with multiple scheduler instances on different nodes. The leader elect option is used when you have multiple copies of the scheduler running on different master nodes as a high-availability setup where you have multiple master nodes with the Kubernetes scheduler process running on both of them. If multiple copies of the same scheduler are running on different nodes, only one can be active at a time, and that's where the leader elect option helps in choosing a leader who will lead the scheduling activities.

Deploying Schedulers as Deployments:

- Deployments use images of custom schedulers and config files, with additional prerequisites like service accounts

and cluster role bindings for authentication.

- ConfigMaps can be used to pass configuration files to deployments, ensuring proper setup.

Configuring Pods for Custom Schedulers:

The screenshot illustrates the workflow for using a custom scheduler in Kubernetes:

- Initial State:** A terminal session shows the output of `kubectl get pods --namespace=kube-system`. It lists several system pods like coredns, etcd, and kube-scheduler, along with a pod named `my-custom-scheduler`.
- Pod Definition:** A separate window shows the `pod-definition.yaml` file, which defines a pod named `nginx` with a single container using the `nginx` image. The `schedulerName` field is set to `my-custom-scheduler`.
- Creation:** A terminal session runs `kubectl create -f pod-definition.yaml`.
- Final State:** Another terminal session shows the output of `kubectl get pods`. It displays the newly created pod `nginx` in the `pending` state. A green checkmark icon indicates this is a correct state for a pod being scheduled.
- Success:** A final terminal session shows the pod `nginx` has transitioned to the `running` state, with a green checkmark icon indicating success.

- Pod definition files include a new field called `schedulerName` to specify the custom scheduler to use.
- When creating pods, ensure the correct scheduler is picked; pending states may indicate configuration issues.

How do you know which scheduler picked up

scheduling a particular pod?

The screenshot shows the output of the `kubectl get events -o wide` command:

LAST SEEN	COUNT	NAME	KIND	TYPE	REASON	SOURCE	MESSAGE
9s	1	nginx.15	Pod	Normal	Scheduled	my-custom-scheduler	Successfully assigned default/nginx to node01
8s	1	nginx.15	Pod	Normal	Pulling	kubelet, node01	pulling image "nginx"
2s	1	nginx.15	Pod	Normal	Pulled	kubelet, node01	Successfully pulled image "nginx"
2s	1	nginx.15	Pod	Normal	Created	kubelet, node01	Created container
2s	1	nginx.15	Pod	Normal	Started	kubelet, node01	Started container

Now, we can view this in the events

using the `kubectl get events` command

with the `-o wide` option.

And this will list all the events in the current namespace

and look for the scheduled events

and as you can see, the source of the event

is the custom scheduler that we created.

That's the name that we gave to the custom scheduler.

And the message says that successfully assigned the image.

So that indicates that it's working.

Monitoring and Troubleshooting:

```
kubectl logs my-custom-scheduler --name-space=kube-system
I0204 09:42:25.819338      1 server.go:126] Version: v1.11.3
W0204 09:42:25.822720      1 authorization.go:47] Authorization is disabled
W0204 09:42:25.822745      1 authentication.go:55] Authentication is disabled
I0204 09:42:25.822801      1 insecure_serving.go:47] Serving healthz insecurely on 127.0.0.1:10251
I0204 09:45:14.725407      1 controller_utils.go:1025] Waiting for caches to sync for scheduler controller
I0204 09:45:14.825634      1 controller_utils.go:1032] Caches are synced for scheduler controller
I0204 09:45:14.825814      1 leaderelection.go:185] attempting to acquire leader lease kube-system/my-custom-scheduler...
I0204 09:45:14.834953      1 leaderelection.go:194] successfully acquired lease kube-system/my-custom-scheduler...
```

- Check pod events (`kubectl get events -o wide`) to see which scheduler picked up scheduling a pod.
- Logs (`kubectl logs`) of the scheduler help in diagnosing issues and ensuring proper functionality.

Conclusion:

- Custom schedulers enhance Kubernetes flexibility by allowing tailored scheduling logic for specific applications.
- Proper configuration, monitoring, and troubleshooting are essential for successful deployment and usage of custom schedulers.

lab 8

Wednesday, April 24, 2024 12:09 AM

What is the name of the POD that deploys the default kubernetes scheduler in this environment?

Run the command `kubectl get pods --namespace=kube-system`

OR

Run the command `kubectl get pods -n kube-system`

What is the image used to deploy the kubernetes scheduler?

`kubectl describe pod kube-scheduler-controlplane --namespace=kube-system`

We have already created the ServiceAccount and ClusterRoleBinding that our custom scheduler will make use of.

Checkout the following Kubernetes objects:

ServiceAccount: my-scheduler (kube-system namespace)

ClusterRoleBinding: my-scheduler-as-kube-scheduler

ClusterRoleBinding: my-scheduler-as-volume-scheduler

Run the command:

`kubectl get serviceaccount -n kube-system`

```
kubectl get clusterrolebinding
```

Let's create a configmap that the new scheduler will employ using the concept of ConfigMap as a volume.

We have already given a configMap definition file called my-scheduler-configmap.yaml at /root/ path that will create a configmap with name my-scheduler-config using the content of file /root/my-scheduler-config.yaml.

```
kubectl create -f /root/my-scheduler-configmap.yaml.
```

Deploy an additional scheduler to the cluster following the given specification.

Use the manifest file provided at /root/my-scheduler.yaml. Use the same image as used by the default kubernetes scheduler.

Name: my-scheduler

Status: Running

Correct image used?

```
---  
apiVersion: v1  
kind: Pod  
metadata:  
  labels:  
    run: my-scheduler  
  name: my-scheduler  
  namespace: kube-system  
spec:  
  serviceAccountName: my-scheduler  
  containers:  
    - command:  
        - /usr/local/bin/kube-scheduler  
        - --config=/etc/kubernetes/my-scheduler/my-scheduler-config.yaml  
      image: registry.k8s.io/kube-scheduler:v1.29.0 # changed  
      livenessProbe:  
        httpGet:  
          path: /healthz  
          port: 10259  
          scheme: HTTPS  
        initialDelaySeconds: 15  
      name: kube-second-scheduler  
      readinessProbe:  
        httpGet:  
          path: /healthz  
          port: 10259  
          scheme: HTTPS  
      resources:  
        requests:  
          cpu: '0.1'  
      securityContext:  
        privileged: false  
    volumeMounts:  
      - name: config-volume  
        mountPath: /etc/kubernetes/my-scheduler  
hostNetwork: false  
hostPID: false  
volumes:  
  - name: config-volume  
    configMap:  
      name: my-scheduler-config
```

Run kubectl create -f my-scheduler.yaml and wait sometime for the container to be in running state.

A POD definition file is given. Use it to create a POD with the new custom scheduler.

File is located at /root/nginx-pod.yaml

Uses custom scheduler

Status: Running

Set `schedulerName` property on pod specification as `my-scheduler`.

```
---
apiVersion: v1
kind: Pod
metadata:
  name: nginx
spec:
  schedulerName: my-scheduler
  containers:
    - image: nginx
      name: nginx
```

Run `kubectl create -f nginx-pod.yaml`

Monitoring Cluster Component

Monday, April 1, 2024 4:19 PM

Monitoring a Kubernetes cluster is crucial for ensuring its health, performance, and reliability. There are several tools and practices available for monitoring Kubernetes clusters. Here are some key aspects and tools for effective cluster monitoring:

What to Monitor?

- Node-level metrics: Monitor the health of individual nodes in the cluster, including resource usage (CPU, memory, disk), network metrics, and node conditions.
- Pod-level metrics: Keep an eye on the health and performance of pods. Monitor no. of pods, pod resource usage, restart counts, CPU and memory consumption by them, and any events related to pod failures.
- Cluster-Wide Metrics: Gather and analyze cluster-wide metrics, such as API server performance, etcd health, and overall cluster resource utilization.
- Service Health: Monitor the health of services within the cluster. Ensure that services are reachable, and check for any errors or latency issues.
- Logging: Collect and analyze logs from pods, nodes, and system components. Logging is crucial for troubleshooting issues and understanding the behavior of applications.
- Event Monitoring: Keep track of Kubernetes events to stay informed about changes and issues within the cluster.

Tools for Kubernetes Cluster Monitoring:

- Prometheus: Prometheus is a popular open-source monitoring and alerting toolkit. It can be used to collect metrics from various components in the Kubernetes cluster.
- Grafana: Grafana is a visualization and monitoring platform that can be integrated with Prometheus to create dashboards for monitoring Kubernetes clusters.
- Kube-state-metrics: Kube-state-metrics exposes cluster-level metrics, such as the number of pods, deployments, and other Kubernetes objects. These metrics are valuable for understanding the overall state of the cluster.
- cAdvisor: Container Advisor (cAdvisor) provides container-level performance metrics. It is integrated with the kubelet and can be used to collect detailed container metrics.
- Elastic Stack (ELK Stack): Elasticsearch, Logstash, and Kibana (ELK Stack) can be used for log aggregation, storage, and visualization. This is particularly useful for analyzing logs from various components.
- Container Runtime Monitoring: Tools like Docker stats or containerd stats provide real-time insights into the resource usage of containers.

- Heapster: It was an original project that enabled monitoring and analysis features for k8s. It's now deprecated.
- Metric Server - Lighter version of Heapster. 1 Metric server per cluster. Stores data as in-memory and not on disk so, you can't see historical data.

How metrics are generated for pods on nodes?

Kubernetes runs an agent on each node known as the kubelet, which is responsible for receiving instructions from the Kubernetes API master server and running pods on the nodes.

The kubelet also contains a sub-component known as the cAdvisor or Container Advisor. cAdvisor is responsible for retrieving performance metrics from pods and exposing them through the kubelet API to make the metrics available for the Metrics Server.

- ★ kubelet runs on each node. Kubelet is a Kubernetes agent for managing Pods. Some Pods are running on your Master nodes, too. For example, your network Pods, your etcd Pods (if you haven't provided its cluster yourself), and any other Pods that you run on your Master nodes (a node exporter, log collector, etc.) or any DaemonSet that you didn't tolerate them not to get scheduled on your Master nodes are kinds of Pods that run on your Master. So Kubernetes needs Kubelet to manage them.

Best Practices for Kubernetes Cluster Monitoring:

- Centralized Monitoring:

Use centralized monitoring tools to gather and analyze metrics and logs from different components within the cluster.

- Alerting:

Set up alerting rules to receive notifications when certain metrics exceed predefined thresholds. This helps in proactive issue resolution.

- Capacity Planning:

Monitor resource usage trends over time to plan for capacity upgrades and optimizations.

- Security Monitoring:

Implement security monitoring to detect and respond to any unusual activities or potential security threats.

- Regular Audits:

Conduct regular audits of monitoring configurations to ensure that all critical components and events are covered.

By implementing robust monitoring practices and using appropriate tools, you can gain deep insights into the health and performance of your Kubernetes cluster, enabling timely detection and resolution of issues.

How many monitoring tools are used by each cluster?

The choice of monitoring tools in a Kubernetes cluster can vary based on the specific requirements, preferences, and characteristics of the environment. Kubernetes clusters often employ multiple monitoring tools to cover different aspects of cluster health, performance, and resource utilization. Here are some commonly used categories of monitoring tools in Kubernetes, along with examples:

Container Orchestration Monitoring:

Prometheus: A widely-used open-source monitoring and alerting toolkit designed for reliability and scalability. It provides a rich set of features for monitoring containerized applications.

Logging and Event Monitoring:

Elasticsearch, Fluentd, and Kibana (EFK): A popular stack for collecting, indexing, and visualizing logs in a Kubernetes environment. Elasticsearch stores and indexes logs, Fluentd collects and forwards logs, and Kibana offers a web interface for log exploration.

Graylog: Another log management and analysis tool that can be integrated into Kubernetes clusters for centralized log processing.

Cluster Health and Resource Monitoring:

kube-state-metrics: Exposes cluster-level metrics about the state of various Kubernetes objects. It is often used in conjunction with Prometheus to monitor the health and state of the cluster.

cAdvisor (Container Advisor): Automatically discovers all containers in the machine and collects CPU, memory, file system, and network usage information. It can be integrated with monitoring solutions like Prometheus.

Alerting and Notification:

Prometheus Alertmanager: Works with Prometheus to manage alerts and notifications. It can send alerts to various channels like email, Slack, or custom webhooks based on defined rules.

Grafana: While primarily a visualization tool, Grafana can also be configured to receive alerts from Prometheus and other monitoring systems, providing a unified dashboard and alerting interface.

Tracing:

Jaeger: An open-source, end-to-end distributed tracing system. It helps in monitoring and troubleshooting the performance of applications running in a Kubernetes cluster.

Zipkin: Another distributed tracing system that can be integrated into Kubernetes for collecting and visualizing traces.

It's common for Kubernetes clusters to use a combination of these tools to ensure comprehensive monitoring coverage. The specific tools chosen may depend on factors such as the size of the cluster, the complexity of the applications, and the team's familiarity and preferences. Additionally, cloud providers may offer their monitoring solutions, further influencing the tooling choices in a Kubernetes environment.

Metric Server

Monday, April 1, 2024 4:26 PM

The Kubernetes Metric Server is a component that collects resource metrics from the Kubelet on each node, aggregates them, and makes them available to other components in the cluster. It provides a scalable and efficient way to query resource usage metrics for pods and nodes.

Key Features and Components:

- Kubelet Metrics:

Metric Server collects resource metrics such as CPU and memory usage from the Kubelet on each node. This data is then aggregated to provide cluster-wide insights.

- Resource Metrics API:

Metric Server exposes a Resource Metrics API, which allows other components, such as the Horizontal Pod Autoscaler (HPA), to query resource metrics for pods and nodes.

- Aggregated Metrics:

Metric Server aggregates resource metrics across pods and nodes, providing a comprehensive view of resource utilization within the cluster.

- No Long-Term Storage:

Metric Server is designed for real-time metrics and does not store historical data. For long-term storage and more advanced queries, additional monitoring solutions like Prometheus are often used.

Querying Metrics:

Once the MetricServer is deployed, you can use kubectl top to query resource metrics. For example:

```
bash
kubectl top pods
kubectl top nodes
```

Integration with Horizontal Pod Autoscaler (HPA):

Metric Server is commonly used in conjunction with the HPA to enable autoscaling of pods based on resource metrics. The HPA can dynamically adjust the number of replicas for a deployment based on specified resource utilization thresholds.

Important Considerations:

- Secure Communication:

Ensure that the Metric Server is configured to use secure communication, especially in production environments.

- Scaling Considerations:

Depending on the size of the cluster and workload, consider scaling the Metric Server deployment to handle the query load effectively.

- Alternative Monitoring Solutions:

Metric Server provides basic resource metrics. For more advanced monitoring, especially with historical data and custom metrics, consider using additional solutions like Prometheus.

- Compatibility:

Verify the compatibility of the Metric Server with the Kubernetes version you are using, as updates may be released to accommodate changes in the Kubernetes API.

The Metric Server is a fundamental component for obtaining resource metrics within a Kubernetes cluster. It plays a key role in enabling features like autoscaling and provides valuable insights into the overall health and performance of the cluster.

1 metric server per cluster.

Does Metric server is in-memory monitoring solution ?

ChatGPT

Yes, the Kubernetes Metric Server is an in-memory monitoring solution that collects and exposes resource usage metrics for containers and pods in a Kubernetes cluster. It's designed to provide basic cluster-wide metrics to support autoscaling of pods.

Key points about Metric Server:

In-Memory Storage:

Metric Server keeps a limited set of metrics in memory. It does not store historical data or provide advanced querying capabilities like some other monitoring solutions.

Lightweight:

Metric Server is intentionally lightweight and is focused on providing real-time metrics quickly. It is not intended to replace more comprehensive monitoring solutions like Prometheus.

Exposed Metrics:

The metrics provided by Metric Server include CPU and memory usage metrics for nodes, pods, and containers within the cluster. These metrics are essential for making scaling decisions, such as autoscaling.

Default Metrics API:

The metrics exposed by Metric Server adhere to the Kubernetes Metrics API, making it easy for other components and tools to consume and use these metrics.

Used by Horizontal Pod Autoscaler (HPA):

Metric Server is often used in conjunction with the Horizontal Pod Autoscaler (HPA). The HPA uses the metrics provided by Metric Server to automatically adjust the number of pod replicas based on observed resource usage.

Here's a simple example of how to deploy Metric Server in a Kubernetes cluster:

```
yaml

apiVersion: v1
kind: ServiceAccount
metadata:
  name: metrics-server
  namespace: kube-system

---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: metrics-server
rules:
  - apiGroups:
    - ""


```

```
rules:
  - apiGroups:
    - ""
  resources:
  - "pods"
  - "nodes"
  - "namespaces"
  verbs:
  - "list"
```

```
rules:
- apiGroups:
  - ""
    resources:
    - "pods"
    - "nodes"
    - "namespaces"
    verbs:
    - "list"
    - "get"
- nonResourceURLs:
  - "/metrics"
    verbs:
    - "get"
```

```
verbs:
- "get"

---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: metrics-server
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: metrics-server
subjects:
- kind: ServiceAccount
  name: metrics-server
  namespace: kube-system
```

```

namespace: kube-system

---

apiVersion: apps/v1
kind: Deployment
metadata:
  name: metrics-server
  namespace: kube-system
spec:
  selector:
    matchLabels:
      k8s-app: metrics-server
  template:
    metadata:
      name: metrics-server
      labels:
        k8s-app: metrics-server

```

```

spec:
  selector:
    matchLabels:
      k8s-app: metrics-server
  template:
    metadata:
      name: metrics-server
      labels:
        k8s-app: metrics-server
  spec:
    serviceAccountName: metrics-server
    containers:
      - name: metrics-server
        image: k8s.gcr.io/metrics-server-amd64:v0.5.0
        args:
          - "--cert-dir=/tmp"
          - "--secure-port=4443"
          - "--kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname"

```

This YAML configuration deploys Metric Server in the kube-system namespace. It creates the necessary RBAC roles, service account, and a deployment for Metric Server. Note that the image version (k8s.gcr.io/metrics-server-amd64:v0.5.0) may vary based on the Kubernetes version you are using.

How many metric server are present in a cluster?

ChatGPT

In a typical Kubernetes cluster, there is usually one instance of the Metric Server deployed. The Metric Server serves as a cluster-wide aggregator of resource usage metrics, collecting information about CPU and memory usage from nodes, pods, and containers.

The Metric Server is designed to be a lightweight, in-memory monitoring solution that provides real-time metrics for components like the Horizontal Pod Autoscaler (HPA) to make scaling decisions. It does not maintain historical data or offer advanced querying capabilities.

While there is typically only one Metric Server deployed in a cluster, the actual architecture and setup can vary based on factors such as the cluster size, workload characteristics, and specific requirements. In some cases, organizations may choose to deploy additional monitoring solutions like Prometheus or others to complement or replace the Metric Server for more comprehensive monitoring needs.

It's important to note that the deployment of monitoring solutions, including the Metric Server, can be tailored based on the monitoring requirements and the tools chosen by the cluster administrators.

So, if there is only one metric server is deployed in each cluster, in which nodes it gets deployed - master or worker or where does it gets installed and which memory or whose memory does it use ?

ChatGPT

The Metric Server is typically deployed in the cluster and runs as a set of containers. It is not restricted to being deployed specifically on master nodes or worker nodes; rather, it is designed to run on any node within the cluster. The Metric Server collects resource usage metrics from all nodes, pods, and containers in the cluster.

Here are some key points regarding the deployment and resource usage of the Metric Server:

Node Deployment:

Metric Server can be deployed as a set of containers within pods, and these pods are scheduled to run on nodes in the Kubernetes cluster. The deployment is not restricted to a specific node type (master or worker) but is generally deployed as a part of the cluster infrastructure.

Resource Usage:

Metric Server is a lightweight in-memory monitoring solution. It keeps a limited set of metrics in memory, focusing on providing real-time metrics for scaling decisions. It does not persistently store historical data or require large amounts of storage.

Resource Utilization:

Metric Server utilizes the resources (CPU and memory) of the nodes where its pods are scheduled. The amount of memory used by Metric Server is typically limited and configured based on the deployment specifications.

Scalability:

Since Metric Server is designed to be lightweight, it can scale horizontally with the addition of more instances to handle the monitoring needs of larger clusters. Deploying additional instances of Metric Server allows for better scalability and load distribution.

Deployment Example (Part of the YAML Configuration):

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: metrics-server
  namespace: kube-system
spec:
  selector:
    matchLabels:
      k8s-app: metrics-server
  template:
    metadata:
      name: metrics-server
      labels:
        k8s-app: metrics-server
    spec:
      serviceAccountName: metrics-server
      containers:
        - name: metrics-server
          image: k8s.gcr.io/metrics-server-amd64:v0.5.0
          args:
            - "--cert-dir=/tmp"
            - "--secure-port=4443"
            - "--kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname"
```

In this example, the Metric Server is deployed as a set of containers within a pod, and the pod is part of a deployment. The deployment is placed in the kube-system namespace. The image version (k8s.gcr.io/metrics-server-amd64:v0.5.0) may vary based on the Kubernetes version being used.

It's important to ensure that the Metric Server deployment is accessible by components such as the Horizontal Pod Autoscaler (HPA), which uses the metrics provided by Metric Server for scaling decisions.

If a cluster is just a collect of Nodes, where do Metric Server is deployed and what do you mean by deployed ?

ChatGPT

In Kubernetes, when we say a component like the Metric Server is "deployed," it means that its associated containerized application is scheduled to run within the cluster. The term "deployed" in this

context refers to the instantiation of the application on one or more nodes in the Kubernetes cluster.

Here's a breakdown of the concept of deployment in Kubernetes:

Deployment Object:

A Deployment object is a Kubernetes resource that defines a desired state for a set of pods. It acts as a declarative configuration for creating and managing pods. Deployments provide features such as rolling updates, rollbacks, and scaling.

Pods and Containers:

The Metric Server, like many other applications in Kubernetes, runs within pods. A pod is the smallest deployable unit in Kubernetes and can contain one or more containers.

Node Scheduling:

When a Deployment is created, the Kubernetes scheduler takes care of selecting nodes in the cluster where the pods associated with the deployment will run. The scheduler considers factors like resource availability, affinity, anti-affinity, and other constraints.

Containers within Pods:

Each pod created by the Metric Server Deployment contains one or more containers. In the case of the Metric Server, it is a containerized application that collects and serves metrics.

Namespace:

The Metric Server Deployment may be part of a specific namespace (logical partition within a cluster).

For example, it is common to deploy monitoring components in the kube-system namespace.

Scaling:

Deployments can be scaled horizontally by adjusting the number of desired replicas. This allows the Metric Server, or any other application, to handle varying workloads by running multiple instances of the application across different nodes.

Here's a simple example of deploying the Metric Server using a Deployment YAML configuration:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: metrics-server
  namespace: kube-system
spec:
  replicas: 1
  selector:
    matchLabels:
      app: metrics-server
  template:
    metadata:
      labels:
        app: metrics-server
    spec:
      containers:
        - name: metrics-server
          image: k8s.gcr.io/metrics-server-amd64:v0.5.0
          args:
            - "--cert-dir=/tmp"
            - "--secure-port=4443"
```

```
- "--kubernetes-preferred-address-types=InternalIP,ExternalIP,Hostname"
```

In this example:

The Metric Server Deployment is defined with one replica (replicas: 1).

The Deployment specifies the container image (image: k8s.gcr.io/metrics-server-amd64:v0.5.0) and its associated configuration.

The Metric Server is part of the kube-system namespace (namespace: kube-system).

The Kubernetes scheduler ensures that the specified number of replicas is running on nodes within the cluster, effectively deploying the Metric Server to provide metric collection services.

So, if a Metric Server is just installed in a container, it must be in a pod and the pod will be in node, right ?

Yes, that's correct. The Metric Server, like any other application in Kubernetes, is typically deployed within a pod, and that pod is scheduled to run on one or more nodes within the cluster. Let's break down the hierarchy:

Pod:

A pod is the smallest deployable unit in Kubernetes. It can contain one or more containers. In the case of the Metric Server, it is likely a single-container pod.

Node:

Nodes are the individual machines (physical or virtual) that make up the Kubernetes cluster. The pod containing the Metric Server is scheduled to run on one or more nodes.

Deployment:

The deployment is a higher-level abstraction that manages the desired state of one or more pods. It ensures that the specified number of replicas (instances) of the Metric Server pod are running. The deployment is responsible for handling updates, rollbacks, and scaling.

Here's a simplified illustration:

Kubernetes Cluster

|

|-- Node 1

| |-- Pod (Metric Server)

| | |-- Container (Metric Server)

|

|-- Node 2

| |-- Pod (Metric Server)

| | |-- Container (Metric Server)

|

|-- Node 3

```
|-- Pod (Metric Server)
|   |-- Container (Metric Server)
```

In this example, the Metric Server is deployed as a set of pods, and each pod contains a single container running the Metric Server application. These pods are scheduled to run on different nodes within the Kubernetes cluster.

The deployment configuration (like the one shown in the previous examples) specifies how many replicas of the Metric Server pod should be running, and the Kubernetes scheduler takes care of distributing these replicas across the available nodes. This allows for scalability, fault tolerance, and load distribution within the cluster.

So, by this way above k8s cluster has three 'metric server' instead of one, right ?

ChatGPT

I apologize for any confusion caused by my previous responses. In the example given, each node in the Kubernetes cluster has its own instance of the Metric Server pod. This might not be the most typical deployment scenario for the Metric Server.

In a standard Metric Server deployment, it's common to have a single instance (pod) or a small number of instances deployed within the cluster, rather than having one per node. Having a single Metric Server or a few instances provides a centralized way to collect and serve metrics for the entire cluster.

```
Kubernetes Cluster
|
|-- Node 1
|   |-- Pod (Metric Server)
|   |   |-- Container (Metric Server)
|
|-- Node 2
|   |-- Pod (Metric Server)
|   |   |-- Container (Metric Server)
|
|-- Node 3
|   |-- Pod (Metric Server)
|   |   |-- Container (Metric Server)
```

In this corrected example, there is a single instance of the Metric Server pod, and it might be scheduled to run on any of the available nodes within the cluster. This aligns more closely with the typical deployment pattern for the Metric Server, where you have a few instances serving metrics for the entire cluster.

I appreciate your understanding, and I hope this clarification helps.

Can I get information about the whole cluster , if I deploy one Metric Server on a single pod in any one

node - either master or worker?

ChatGPT

Yes, you can get information about the whole cluster by deploying a single instance of the Metric Server on a single pod. The Metric Server is designed to collect and serve metrics for the entire cluster, and it typically does not need to be deployed on every node.

Here's how it works:

Single Metric Server Instance:

You can deploy a single instance of the Metric Server using a Deployment or a similar configuration. This Metric Server pod can be scheduled to run on any node within the cluster.

Cluster-wide Metrics:

The Metric Server collects resource usage metrics (such as CPU and memory usage) from nodes, pods, and containers across the entire cluster.

Horizontal Pod Autoscaler (HPA):

The metrics collected by the Metric Server are often used by components like the Horizontal Pod Autoscaler (HPA) to make decisions about scaling the number of pod replicas based on observed resource usage.

kubectl top Command:

You can use the kubectl top command to view resource usage metrics retrieved from the Metric Server. For example:

```
kubectl top nodes  
kubectl top pods
```

This command provides real-time metrics for nodes and pods in the cluster, utilizing the data collected by the Metric Server.

Deploying a single instance of the Metric Server provides a centralized and efficient way to collect and serve metrics for the entire Kubernetes cluster. It is not necessary to deploy the Metric Server on every node, as it is designed to be a cluster-wide monitoring solution.

How Metric Server collects resource usage metrics (such as CPU and memory usage) from nodes, pods, and containers across the entire cluster while being deployed in a single node ?

I apologize for any confusion in my previous responses. To clarify, the Metric Server needs to be deployed and running on every node in the cluster to collect resource usage metrics from each node, pod, and container. Deploying a single instance of the Metric Server on a single node will not provide comprehensive metrics for the entire cluster.

Here's how the Metric Server typically works:

Pod Deployment:

The Metric Server is deployed as a set of pods within the cluster. These pods are scheduled to run on each node in the cluster.

Node Metrics:

Each instance of the Metric Server running on a node collects metrics specific to that node, such as CPU and memory usage.

Aggregated Metrics:

The Metric Server instances on all nodes aggregate their metrics, providing a comprehensive view of the resource usage across the entire cluster.

Cluster-wide View:

Users and components within the cluster can query the Metric Server to obtain cluster-wide metrics.

The Metric Server provides an API endpoint that can be queried using tools like kubectl top.

bash

```
kubectl top nodes
```

```
kubectl top pods
```

These commands retrieve aggregated metrics from all Metric Server instances, giving a holistic view of the cluster's resource usage.

In summary, deploying the Metric Server on every node is crucial for obtaining accurate and comprehensive metrics for the entire cluster. A single instance of the Metric Server will only provide metrics for the specific node on which it is deployed, and it won't give a complete picture of the entire cluster's resource utilization.

Lab 1

Tuesday, April 2, 2024 12:49 PM

Let us deploy a metrics-server to monitor the PODs and Nodes. Pull the git repository for the deployment files.

1. Download the metric server repo from GitHub

```
git clone https://github.com/kodekloudhub/kubernetes-metrics-server.git
```

This repo contains the following files:

- a. aggregated-metrics-reader.yaml
- b. metrics-server-deployment.yaml
- c. auth-delegator.yaml
- d. metrics-server-service.yaml
- e. auth-reader.yaml
- f. README.md
- g. metrics-apiservice.yaml
- h. resource-reader.yaml

2. Run the 'kubectl create -f .' command from within the downloaded repository.

The kubectl create command in Kubernetes is used to create resources defined in a YAML or JSON file. It is a powerful command-line tool that interacts with the Kubernetes API server to manage Kubernetes resources.

When you use kubectl create -f ., you are telling Kubernetes to create resources based on the YAML or JSON files present in the current directory (. represents the current directory). Let's break down what this command does in the context of the files you have in your folder:

- a. aggregated-metrics-reader.yaml
- b. metrics-server-deployment.yaml
- c. auth-delegator.yaml
- d. metrics-server-service.yaml
- e. auth-reader.yaml
- f. README.md
- g. metrics-apiservice.yaml
- h. resource-reader.yaml

Assuming that the .yaml files in your folder are Kubernetes resource manifests, running kubectl create -f . would instruct Kubernetes to create the resources defined in these YAML files.

For example, if metrics-server-deployment.yaml contains a Deployment resource definition, running kubectl create -f metrics-server-deployment.yaml would create that Deployment in your Kubernetes cluster.

The -f flag in kubectl create -f . stands for "filename" or "file," indicating that you are specifying a file or files containing resource definitions. The . after -f specifies the current directory, telling Kubernetes to look for YAML or JSON files in the current directory and create resources based on those files.

It's important to note that before running `kubectl create`, you should review the YAML files to ensure they contain the correct configurations for your Kubernetes resources.

★ The Kubernetes API server will ignore the `README.md` file when you use the `kubectl create -f .` command because it specifically looks for YAML or JSON files to create Kubernetes resources.

3. Run the '`kubectl top node`' command and wait for a valid output to get the matrices of nodes.
4. Run the '`kubectl top pod`' command and wait for a valid output to get the matrices of nodes.

CPU core = 251m. What does 'm' means ?

Application logs

Tuesday, April 2, 2024 1:12 PM

In Docker

- When you run command **docker run <name of image>** you see the logs.
- When you run the container in detached mode using **docker run -d <name-of-image>** you can't see the logs now.
- To view the logs you run **docker logs -f ecf**

-f - It is used here to view the live logs.

★ In kubernetes

When you create a pod, using -

```
kubectl create -f <yaml file>
```

Run

```
kubectl logs -f <pod-name>
```

-f - It is used here for live logs

For multiple containers running in a pod, specify container name also.

```
kubectl logs -f <pod-name> <container-name>
```

Monitoring

Sunday, March 3, 2024 5:19 PM

Node Health:

Monitor the health of individual nodes in the cluster, including resource usage (CPU, memory, disk), network metrics, and node conditions.

Pod Health:

Keep an eye on the health and performance of pods. Monitor pod resource usage, restart counts, and any events related to pod failures.

Tools for Kubernetes Cluster Monitoring:

Prometheus:

Prometheus is a popular open-source monitoring and alerting toolkit. It can be used to collect metrics from various components in the Kubernetes cluster.

Grafana:

Grafana is a visualization and monitoring platform that can be integrated with Prometheus to create dashboards for monitoring Kubernetes clusters.

Question - How many monitoring tools we use in a cluster ? or monitoring tools are used by each node?

- How Metric Server is being deployed - on a single node, on a single pod of each node?
- If it's deployed on any one node, how does it collect information from the other nodes?

Metric Server

The Kubernetes Metric Server is a component that collects resource metrics from the Kubelet on each node, aggregates them, and makes them available to other components in the cluster. It provides a scalable and efficient way to query resource usage metrics for pods and nodes.

So how are the metrics generated

for the pods on these nodes?

Kubernetes runs an agent on each node

known as the kubelet, which is responsible

for receiving instructions

from the Kubernetes API master server

and running pods on the nodes.

The kubelet also contains a sub component

known as the cAdvisor or Container Advisor.

cAdvisor is responsible

for retrieving performance metrics from pods

and exposing them through the kubelet API

to make the metrics available for the Metrics Server.

On-Disk Databases vs In-Memory Databases

On-Disk Databases

- All data stored on disk, disk I/O needed to move data into main memory when needed.
- Data is always persisted to disk.
- Traditional data structures like B-Trees designed to store tables and indices efficiently on disk.
- Virtually unlimited database size.
- Support very broad set of workloads, i.e. OLTP, data warehousing, mixed workloads, etc.

In-Memory Databases

- All data stored in main memory, no need to perform disk I/O to query or update data.
- Data is persistent or volatile depending on the in-memory database product.
- Specialized data structures and index structures assume data is always in main memory.
- Optimized for specialized workloads; i.e. communications industry-specific HLR/HSS workloads.
- Database size limited by the amount of main memory.

Logging

Sunday, March 3, 2024 6:53 PM

In docker, we use event-simulator to get the logs.

- i) docker run kodekloud/event-simulator
- ii) docker logs -f <container-id> - This gives the live logs about the container.

In k8s, we use

kubectl logs -f <pod-name>

-f options is used to stream the logs live.

- We must specify the container name while running this command because a pod-definition file can have multiple containers.

kubectl logs -f <pod-name> <container-name>

```
event-simulator.yaml
apiVersion: v1
kind: Pod
metadata:
  name: event-simulator-pod
spec:
  containers:
    - name: event-simulator
      image: kodekloud/event-simulator
    - name: image-processor
      image: some-image-processor
```

Init & Sidecar Containers

Thursday, May 23, 2024 12:16 PM

Sidecar

In Kubernetes, a sidecar container is a container that starts before the main application container and continues to run.

When setting up a sidecar container in Kubernetes, you typically define it within the containers section of your Pod's YAML configuration, not in the initContainers section.

Containers Section:

- This section is used to define all the main containers that will run within your Pod.
- Sidecar containers, which are auxiliary containers that support the main application container, are specified in this section.
- Sidecar containers often share resources and network namespaces with the main application container.

Init Containers Section:

Init containers are not typically used for sidecar functionality; they are more focused on tasks that need to complete before the main application container starts.

Sidecar containers run alongside the main application container and provide additional services such as logging, monitoring, or handling networking tasks.

Init Containers

Init containers are exactly like regular containers, except:

- Init containers always run to completion. Once an init container finishes its job, it exits, regardless of whether it succeeded or failed.
- Each init container must complete successfully before the next one starts. If an init container fails, the process stops, and Kubernetes doesn't start the main container. Only when all init containers succeed does Kubernetes start the main container.

Init Containers:

Setup Tasks: Init containers are used for tasks like preparing configuration files, initializing data, or running database migrations before the main application container starts.

Rolling Updates and Rollbacks

Sunday, March 3, 2024 7:10 PM

Deployment Strategy

- Recreate
- Rolling Updates(default)

What we can update - application version, labels, replicas?

Pod Images: You can update the container images used by your pods, which could include updating the application code, libraries, or dependencies.

ReplicaSet or Deployment Configuration: You can modify the configuration of your ReplicaSet or Deployment, such as changing the number of replicas, updating environment variables, specifying resource limits, etc.

Secrets and ConfigMaps: If your application uses Secrets or ConfigMaps to store sensitive information or configuration data, you can update these resources as part of a rolling update.

Annotations and Labels: You can add, modify, or remove annotations and labels associated with your pods, services, or other Kubernetes resources.

Resource Requests and Limits: You can adjust the resource requests (CPU and memory) and limits for your containers to optimize performance or accommodate changes in workload requirements.

Pod Affinity and Anti-Affinity Rules: If you have defined affinity or anti-affinity rules for your pods, you can update these rules to control pod placement within the cluster.

Network Policies: If you use Network Policies to control network traffic to and from your pods, you can update these policies to reflect changes in your application's networking requirements.

Service Configuration: You can update the configuration of your services, such as changing the type of service (ClusterIP, NodePort, LoadBalancer), updating service selectors, or modifying service ports.

Ingress Rules: If you use an Ingress controller to manage external access to your services, you can update Ingress rules to route traffic differently or add new routes.

Horizontal Pod Autoscaler (HPA): If you have configured an HPA for autoscaling your pods based on resource utilization metrics, you can update the HPA configuration to adjust scaling thresholds or target metrics.

update vs upgrade

?

How does a deployment perform an upgrade?

Before the rollback, the old replica set had zero pods, and the new replica set had five pods, and this is reversed after the rollback is finished.

Create	> kubectl create -f deployment-definition.yml
Get	> kubectl get deployments
Update	> kubectl apply -f deployment-definition.yml
	> kubectl set image deployment/myapp-deployment nginx=nginx:1.9.1
Status	> kubectl rollout status deployment/myapp-deployment
	> kubectl rollout history deployment/myapp-deployment
Rollback	> kubectl rollout undo deployment/myapp-deployment

Deployment Rollout:

```
> kubectl rollout status deployment/myapp-deployment
Waiting for rollout to finish: 0 of 10 updated replicas are available...
Waiting for rollout to finish: 1 of 10 updated replicas are available...
Waiting for rollout to finish: 2 of 10 updated replicas are available...
Waiting for rollout to finish: 3 of 10 updated replicas are available...
Waiting for rollout to finish: 4 of 10 updated replicas are available...
Waiting for rollout to finish: 5 of 10 updated replicas are available...
Waiting for rollout to finish: 6 of 10 updated replicas are available...
Waiting for rollout to finish: 7 of 10 updated replicas are available...
Waiting for rollout to finish: 8 of 10 updated replicas are available...
Waiting for rollout to finish: 9 of 10 updated replicas are available...
deployment "myapp-deployment" successfully rolled out

> kubectl rollout history deployment/myapp-deployment
deployments "myapp-deployment"
REVISION  CHANGE-CAUSE
1          <none>
2          kubectl apply --filename=deployment-definition.yml --record=true
```

- When you create or update something in Kubernetes (like an application), it triggers a rollout.
- Rollout means Kubernetes is making changes to your setup, like adding new features or updating existing ones. Think of it like upgrading your computer software—it's making your setup better or different.

Deployment Revision:



- Every time Kubernetes makes a change, it creates a new version called a revision.
- This helps Kubernetes keep track of what changes were made and when.
- It's like saving different versions of a document—you can go back to an older version if needed.

Deployment Strategies:

- **Recreate Strategy:** It's like tearing down an old building completely and then building a new one from scratch. This can cause **downtime** because everything is replaced at once. When you run the 'kubectl describe deployment' command here, you'll find that the old replica set was scaled down to 0 and then up.



- **Rolling Update Strategy:** It's like renovating a building floor by floor. You update one part at a time, so the whole thing keeps working while you make changes. It's the default strategy. When you run the 'kubectl describe deployment' command here, you'll find that the old replica set was scaled down one at a time and then up one at a time.



Updating Deployments:

Kubectl apply

```
> kubectl apply -f deployment-definition.yml
deployment "myapp-deployment" configured
```

```
> kubectl set image deployment/myapp-deployment \
    nginx=nginx:1.9.1
deployment "myapp-deployment" image is updated
```

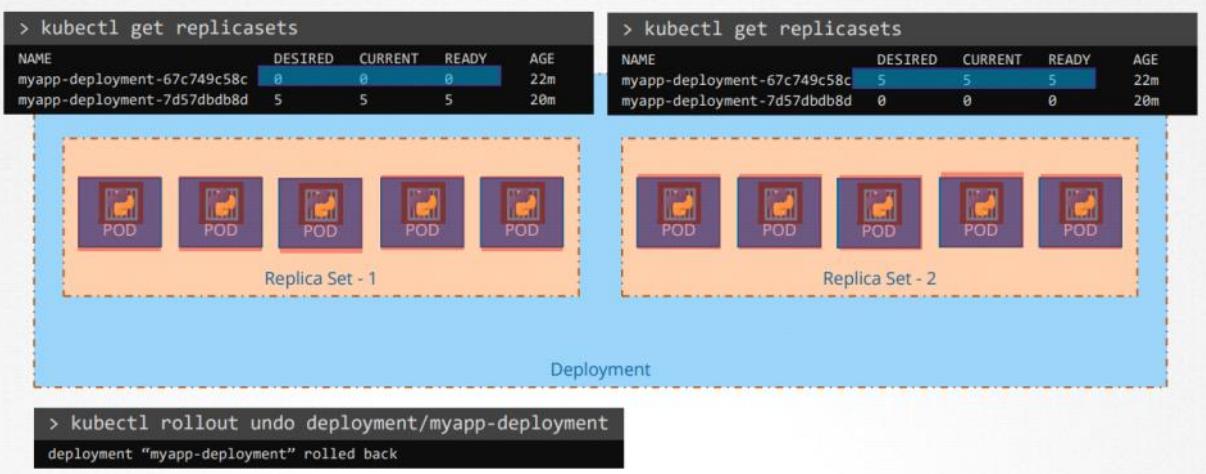
```
deployment-definition.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: myapp-deployment
  labels:
    app: myapp
    type: front-end
spec:
  template:
    metadata:
      name: myapp-pod
      labels:
        app: myapp
        type: front-end
    spec:
      containers:
        - name: nginx-container
          image: nginx:1.7.1
  replicas: 3
  selector:
    matchLabels:
      type: front-end
```

- Modify the deployment definition file and use 'kubectl apply' to apply changes and trigger a new rollout.
- Alternatively, use kubectl set image to update the image directly, but be cautious with future configuration changes.

Deployment Upgrade Process:

- When upgrading, Kubernetes creates a new replica set for the updated version while scaling down the old one gradually (rolling update strategy).
- Use 'kubectl describe deployment' to see detailed information about the deployment and upgrade events.

Rolling Back Updates:



- To undo an update, use **kubectl rollout undo deployment/<deployment-name>** followed by the deployment name.
- Kubernetes destroys pods in the new replica set and brings back older pods in the old replica set.

Key Commands Summary:

kubectl rollout status deployment/<deployment-name>:

- This command tells you the status of your rollout. It shows if your changes are still happening or if they're done.
- For example, if you're updating an app, it tells you if the update is still going on or if it's finished.
- **kubectl rollout status deployment/myapp-deployment**

kubectl rollout history deployment/<deployment-name>:

- Use this command to see a history of all the changes (revisions) made to your setup over time.
- It's like looking at a timeline of what happened, showing all the updates and when they happened.
- **kubectl rollout history deployment/myapp-deployment**

kubectl apply:

- After you make changes to your setup (like updating an app), you use this command to apply those changes.
- It's like saving your changes and telling Kubernetes to make them happen.
- **kubectl apply -f deployment.yaml**

kubectl set image:

- This command is used to change the image (like the version of your app) without editing the setup file directly.
- It's like swapping a picture in a frame without taking the frame apart—you just put a new picture inside.
- **kubectl set image deployment/myapp-deployment nginx=nginx:1.19**

kubectl describe deployment <deployment-name>:

- When you want to know more details about your setup (deployment), you use this command.
- It gives you a detailed description of what's going on, like events happening during updates.
- **kubectl describe deployment myapp-deployment**

kubectl get replica sets:

- Use this command to see all the copies (replica sets) of your setup.
- It's like checking how many copies of your document you have, each with different changes or versions.
- **kubectl get replica sets**

kubectl rollout undo:

- If something goes wrong after an update, you can use this command to undo the changes and go back to a previous version.
- It's like pressing "Undo" on your computer to revert to how things were before.
- **kubectl rollout undo deployment/myapp-deployment**

Lab 1

Tuesday, April 2, 2024 5:55 PM

Upgrade the application by setting the image on the deployment to "kodekloud/webapp-color:v2"

Identify the name of the Deployment where you want to perform the upgrade. Let's assume the Deployment is named webapp-deployment.

Use the kubectl set image command to update the image of the Deployment to kodekloud/webapp-color:v2. Here's the command:

- ★ k set image --help = To take the help.

```
kubectl set image deployment/<deployment-name> <container-name>=<Image-name>      OR  
kubectl set image deployment <deployment-name> <container-name>=<Image-name>
```

kubectl set image deployment/webapp-deployment webapp=kodekloud/webapp-color:v2

No need to run 'kubectl apply' after this command.

In this command:

- deployment/webapp-deployment specifies the Deployment you want to update.
- webapp=kodekloud/webapp-color:v2 sets the webapp container's image to kodekloud/webapp-color:v2.

Replace webapp-deployment with the actual name of your Deployment. After running this command, Kubernetes will initiate a rolling update to replace the existing pods with pods running the new image (kodekloud/webapp-color:v2). The rolling update ensures zero-downtime deployment by gradually replacing old pods with new ones.

Change the deployment strategy to Recreate from RollingUpdate. Delete and re-create the deployment if necessary. Only update the strategy type for the existing deployment.

1. To change the deployment strategy from RollingUpdate to Recreate in Kubernetes, you need to update the Deployment's YAML manifest file and then apply the changes using kubectl apply.
 - a. Edit the Deployment's YAML manifest file - vi <yaml-file>
 - i. Modify the strategy section to use Recreate instead of RollingUpdate.
 - ii. Save the changes to yaml file.
 - b. Run this command to update deployment configuration
kubectl apply -f path/to/updated-deployment.yaml

OR

2. Edit the deployment.

- i. **kubectl edit deployment frontend**
- ii. Since you don't know/have the yaml file so, output the configuration to a file, you can use shell redirection (>).
`kubectl get deployment webapp-deployment -o yaml > webapp-deployment.yaml`

? Difference between making changes using 'kubectl edit' command vs editing the YAML file and then using 'kubectl apply'.

kubectl edit deploy frontend:

Usage: This command opens the specified resource (in this case, the deployment named frontend) in the default editor set in your system (often defined by the EDITOR environment variable).

When to Use:

Quick edits: When you need to make small, immediate changes to a resource configuration without modifying the file directly.

Ad-hoc modifications: For temporary changes or testing purposes that you **don't want to persist in the actual configuration file**.

Note: Changes made with kubectl edit are applied directly to the live resource in the cluster but are not saved to a file. They are ephemeral and will not persist across cluster restarts or deployments.

Editing the Deployment File Directly:

Usage: This involves manually editing the YAML file that defines the deployment, typically using a text editor.

When to Use:

Persistent changes: When you want to make permanent modifications to the deployment's configuration that should persist across deployments and cluster restarts.

Version-controlled changes: When you want to track changes using version control systems (e.g., Git) and apply them consistently across environments.

Note: Editing files directly gives you more control over the configuration and allows for more complex modifications, but you need to manage versioning and apply changes manually.

kubectl apply Command:

Usage: This command applies the configuration from a YAML file to the cluster, creating or updating resources as needed.

When to Use:

Applying changes from files: When you have made changes to a YAML file (e.g., a deployment file) and want to apply those changes to the cluster.

Consistent deployments: When you want to ensure that the same configuration is applied consistently across multiple clusters or environments.

Configuring Application

Sunday, March 3, 2024 7:21 PM

Configuring applications comprises of understanding the following concepts:

- Configuring Command and Arguments on applications
- Configuring Environment Variables
- Configuring Secrets

Docker - Commands and Arguments

Sunday, March 3, 2024 7:21 PM

Question - When you run a 'docker run ubuntu' command and then run 'docker ps -a', you will find that the container is in 'exited' state, why is this so?

- When we ran the Ubuntu container earlier, Docker created a container from the Ubuntu image and launched the bash program.
- By default, Docker does not attach a terminal to a container when it is run and so the bash program does not find the terminal and so it exits.
- Unlike virtual machines, containers are not meant to host an operating system. Containers are meant to run a specific task or process, such as to host an instance of a web server or application server or a database, or simply to carry out some computation or analysis. Once the task is complete, the container exits.
- A container only lives as long as the process inside it is alive. If the web service inside the container is stopped or crashes, the container exits.

So who defines what process is run within the container?

CMD, which stands for command, that defines the program that will be run within the container when it starts.

RUN vs CMD vs ENTRYPOINT

<https://www.baeldung.com/ops/dockerfile-run-cmd-entrypoint>

- The run instruction executes when we are building the image.
- The run step executes at image build time, not at the container runtime.
- Docker caches the result for the run instruction if the Dockerfile didn't change.
- If we want to invalidate the cache, we need to pass the --no-cache option to the build command.

CMD

- With the cmd instruction, we can specify a **default command that executes when the container is starting**.
- cmd indeed executes every time the container starts.
- if we have more than one cmd entry in the Dockerfile, only the last cmd is invoked
- cmd is ignored if passing any arguments when starting the container.**

`CMD ["nginx", "-g", "daemon off;"]`

In this case, the CMD instruction specifies that when a container based on this image starts, it should run the NGINX command with the argument -g daemon off;. This is the default behavior unless overridden when starting the container.

However, if you want to run a different command when starting the container, such as viewing a log file, you can override the CMD using arguments in the docker run command:

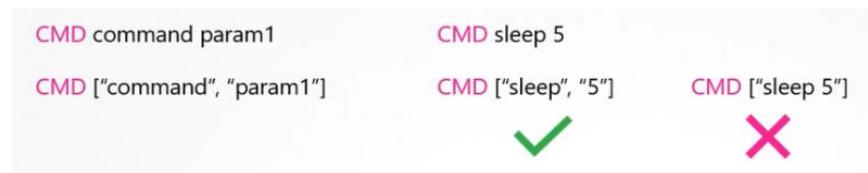
```
docker run mynginx cat /var/log/nginx/access.log
```

The cat /var/log/nginx/access.log command will finally run inside the container. This is because when you provide arguments like cat /var/log/nginx/access.log after the image name (mynginx in this case) in the docker run command, it overrides the default CMD specified in the Dockerfile.

- CMD, which stands for command, that defines the program that will be run within the container when it starts.

For the NGINX image, it is the NGINX command.

For the MySQL image, it is the MySQL D command.

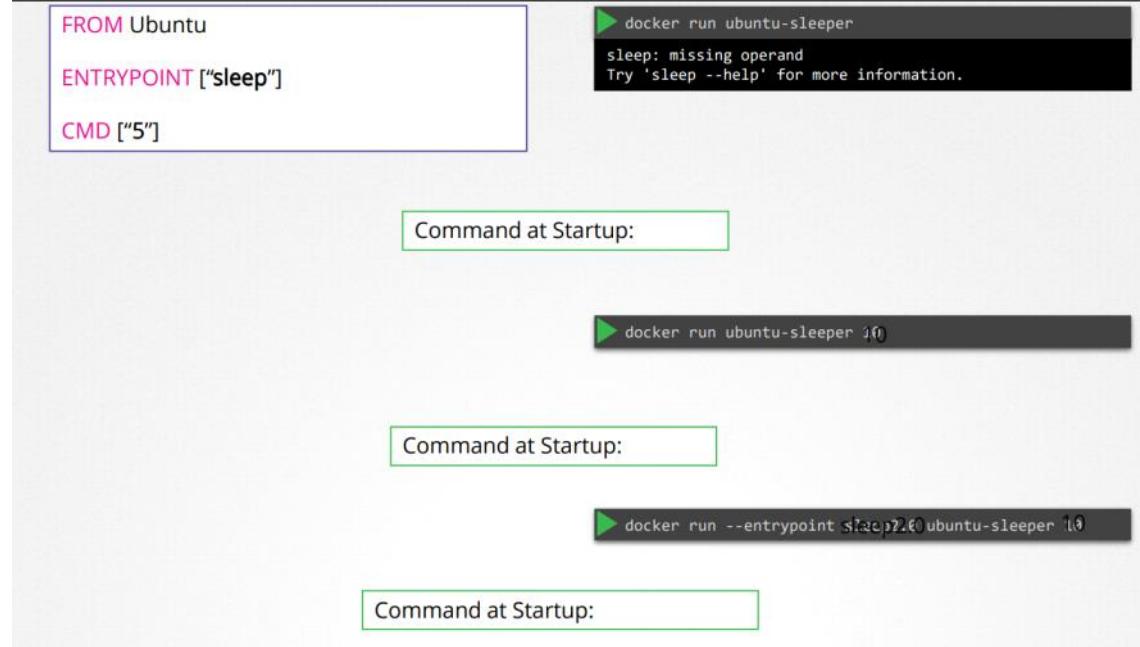


Entrypoint

- cmd is ignored if passing any arguments when starting the container.



- If you don't pass the argument in 'Entrypoint' you'll get the error. So, generally 'Entrypoint' and 'CMD' are used together.



CMD vs Entrypoint

In the case of the CMD instruction, the command line parameters passed will be replaced entirely.

Whereas in the case of the Entrypoint, the command line parameters will get appended.

The diagram illustrates the difference between `CMD` and `ENTRYPOINT`. It shows two snippets of Dockerfiles and their corresponding terminal outputs.

Snippet 1 (CMD):

```
FROM Ubuntu
CMD sleep 5
```

Output 1:

```
▶ docker run ubuntu-sleeper sleep 10
```

Output 2 (highlighted):

```
Command at Startup: sleep 10
```

Snippet 2 (ENTRYPOINT):

```
FROM Ubuntu
ENTRYPOINT ["sleep"]
```

Output 3:

```
▶ docker run ubuntu-sleeper 10
```

Output 4 (highlighted):

```
Command at Startup: sleep 10
```

If you want your dockerfile to have a default argument use `CMD` and `ENTRYPOINT` both in a JSON format.

The diagram shows a Dockerfile snippet and its execution results, demonstrating the use of `CMD` and `ENTRYPOINT` in JSON format.

Snippet:

```
FROM Ubuntu
ENTRYPOINT ["sleep"]
CMD ["5"]
```

Output 1 (highlighted):

```
▶ docker run ubuntu-sleeper
sleep: missing operand
Try 'sleep --help' for more information.
```

Output 2 (highlighted):

```
Command at Startup: sleep 5
```

Output 3:

```
▶ docker run ubuntu-sleeper 10
```

Output 4 (highlighted):

```
Command at Startup: sleep 10
```

- You can also modify entrypoint command by using `--entrypoint` flag.

```
docker run --entrypoint <new-command> <container-name> <argument>
docker run --entrypoint sleep2.0 ubuntu-sleeper 10
```

Kubernetes - Commands and Arguments

Sunday, March 3, 2024 7:21 PM

```
docker run --name ubuntu-sleeper ubuntu-sleeper 10  
docker run --name <container-name> <image-name> 10
```

Anything that is appended to the docker run command (**here 10**) will go into the **args** property of the pod definition file, in the form of an array like this.

```
pod-definition.yml  
apiVersion: v1  
kind: Pod  
metadata:  
  name: ubuntu-sleeper-pod  
spec:  
  containers:  
    - name: ubuntu-sleeper  
      image: ubuntu-sleeper  
      args: ["10"]
```

So, the argument goes into the args property but what if we override the command?

eg. docker run - --name ubuntu-sleeper --entrypoint sleep2.0 ubuntu-sleeper 10

When we override the command (replacing sleep command with sleep2.0), we have to add another field 'command' in the pod definition file.



Entrypoint is the command that runs in the starting while cmd is the default argument.

args field in the pod definition file overrides the cmd's argument of dockerfile. This is how you can override the default argument.

How to override the default instruction, say 'sleep' command to sleep2.0 command?

In docker, you will add --entrypoint sleep2.0 command in the 'docker run' command like this-

```
▶ docker run --name ubuntu-sleeper \
    --entrypoint["sleep2.0"]
    ubuntu-sleeper 10
```

In kubernets, you'll add a new field called 'command' -

```
pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
  name: ubuntu-sleeper-pod
spec:
  containers:
    - name: ubuntu-sleeper
      image: ubuntu-sleeper
      command: ["sleep2.0"]
      args: ["10"]
```

lab 2

Wednesday, April 3, 2024 3:56 PM

To view which command will be run by docker container in a pod, run

kubectl describe pod <pod-name>

Create a pod with the ubuntu image to run a container to sleep for 5000 seconds. Modify the file `ubuntu-sleeper-2.yaml`.

```
---  
apiVersion: v1  
kind: Pod  
metadata:  
  name: ubuntu-sleeper-2  
spec:  
  containers:  
    - name: ubuntu  
      image: ubuntu  
      command:  
        - "sleep"  
        - "5000"
```

or

`command: ["sleep", "5000"]`

or

```
command: [ "sleep" ]  
args: [ "5000" ]
```

The screenshot shows a terminal window titled "Terminal 1" with the following content:

```

        RestartPolicy: "Always",
        ...
    }

controlplane ~ ✘ k get po
NAME          READY   STATUS    RESTARTS   AGE
ubuntu-sleeper 1/1     Running   0          12m
ubuntu-sleeper-2 1/1     Running   0          8m14s
ubuntu-sleeper-3 1/1     Running   0          4m16s

controlplane ~ ➔ k edit pod ubuntu-sleeper-3
error: pods "ubuntu-sleeper-3" is invalid
A copy of your changes has been stored to "/tmp/kubectl-edit-2426255094.yaml"
error: Edit cancelled, no valid changes were saved.

controlplane ~ ✘ vi ubuntu-sleeper-3.yaml

controlplane ~ ➔ k edit pod ubuntu-sleeper-3
error: pods "ubuntu-sleeper-3" is invalid
A copy of your changes has been stored to "/tmp/kubectl-edit-4210034984.yaml"
error: Edit cancelled, no valid changes were saved.

controlplane ~ ✘

```

On the left side of the terminal window, there is a sidebar with the following information:

- Task**: Solution
- ⌚ 28:42**
- 5 / 10**
- Next →**
- Note:** Only make the necessary changes. Do not modify the name of the pod. Delete and recreate the pod if necessary.
- Check**
- Pod Name:** ubuntu-sleeper-3 (green checkmark)
- Command:** sleep 2000 (red X)

Inspect the two files under the directory webapp-color-2. What command is run at container startup?

In this type of question, first check the Dockerfile and then also check the pod-definition file. Entrypoint may be overridden in the pod definition.

★ Some properties you can't change by using 'kubectl edit pod <pod name>' command. You'll get error and a message that 'A copy of your changes has been stored to /tmp/abc.yaml (example). You can use

'kubectl replace --force -f /tmp/abc.yaml'

This will delete the old pod and replace the pod with new configuration.

'command' in yaml file replaces the 'entrypoint' of dockerfile and 'args' in yaml file replaces the 'cmd' in dockerfile.

So, if you have following dockerfile

ENTRYPOINT ["python", "app.py"]

```
CMD [ "--color", "red"]
```

And following yaml file

```
command [ "--color", "green"]
```

The final command that will run at the container startup will be

```
--color green
```

If you want to create a pod the pod name, image, and a command line argument have to be passed. Run command

```
kubectl run <pod-name> --image=<image-name> -- <arg1> <arg2> .....
```

example

```
kubectl run webapp-green --image=kodekloud/webapp-color -- --color green
```

the '--' is used to separate the kubectl command and the arguments.

Use 'kubectl run --help' for this purpose.

lab 3

Thursday, April 4, 2024 12:57 PM

Update the environment variable on the POD to display a green background.

Note: Delete and recreate the POD. Only make the necessary changes. Do not modify the name of the Pod.

Pod Name: webapp-color

Label Name: webapp-color

Env: APP_COLOR=green

Solution

1. Run 'kubectl edit pod webapp-color'
2. Edit the yaml file and save it (:wq!).
3. It may display an error message and the copy of changes you made will be stored to new yaml file
e.g. /tmp/lubectl-edit-123323.yaml
 - a. Run 'kubectl --force -f /tmp/lubectl-edit-123323.yaml'

- ★ The 'wq' command in Linux is used in vi or vim editor to write (save) and quit.
- ★ The 'wq!' command is used to forcefully save changes and quit, even when the file is read-only.

Secrets

Monday, March 4, 2024 5:43 PM

The diagram illustrates the creation of a Kubernetes Secret named "app-secret". It shows the secret definition with fields: DB_Host: mysql, DB_User: root, and DB_Password: paswrd. Below this, there are four command-line examples using the `kubectl create secret generic` command:

- `kubectl create secret generic <secret-name> --from-literal=<key>=<value>`
- `kubectl create secret generic \ app-secret --from-literal=DB_Host=mysql \ --from-literal=DB_User=root \ --from-literal=DB_Password=paswrd`
- `kubectl create secret generic <secret-name> --from-file=<path-to-file>`
- `kubectl create secret generic \ app-secret --from-file=app_secret.properties`

A large blue arrow labeled "1" points from the secret definition to the first command example.

- ★ Data you put in secrets must be encoded as there is no sense of storing a plain data in Secrets.

[Scroll down to view encoding secrets](#)

Question - how do you decode encoded values? Use the same base 64 command used earlier to encode it



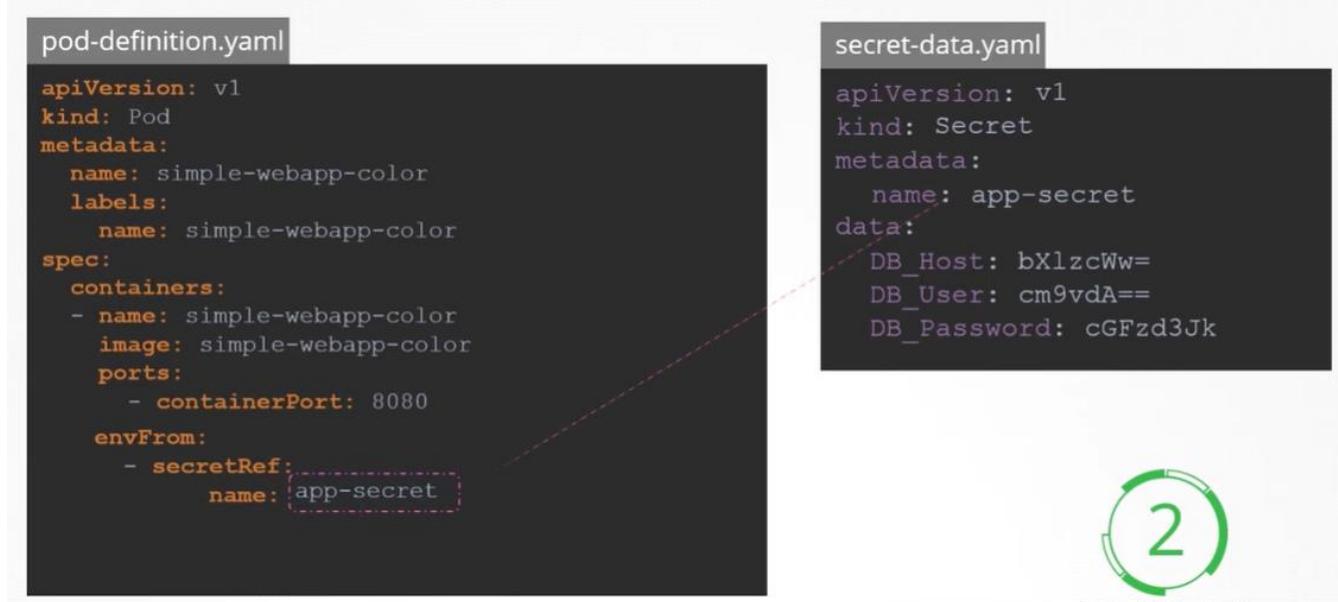
```
echo -n 'bXlzcWw=' | base64 --decode
mysql

echo -n 'cm9vdA==' | base64 --decode
root

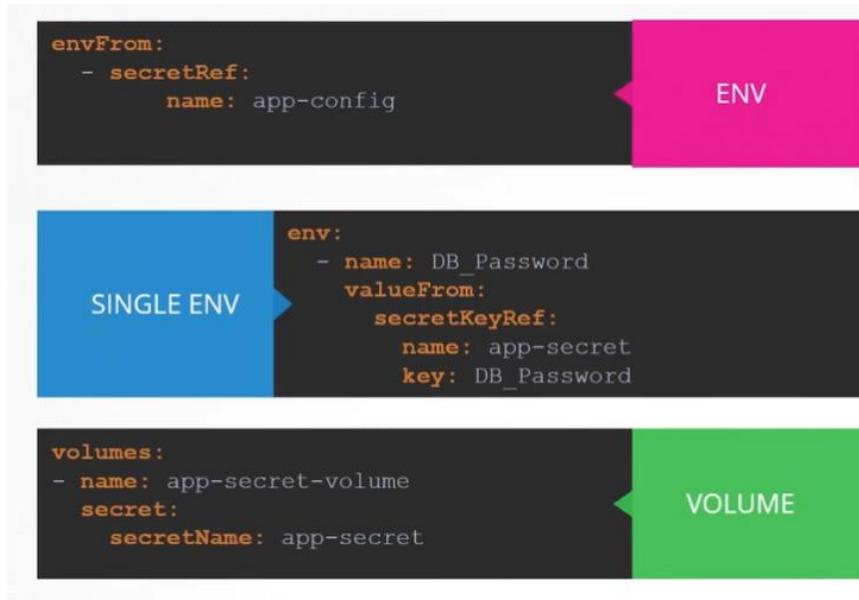
echo -n 'cGFzd3Jk' | base64 --decode
paswrd
```

The `-n` flag ensures that the generated files do not have an extra newline character at the end of the text.

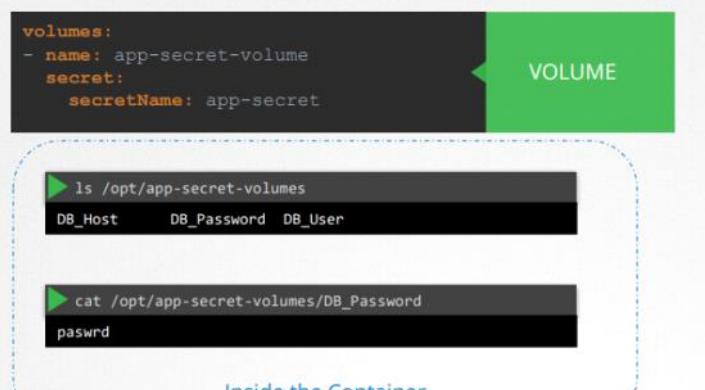
Injecting into Pods



Ways to inject into a Pod



3. Using volumes - In this, all the attributes are created as secrets and their values as the content of the file.





Secrets are not encrypted, so it is not safer in that sense. However, some best practices around using secrets make it safer. As in best practices like:

Not checking-in secret object definition files to source code repositories.

Enabling Encryption at Rest for Secrets so they are stored encrypted in ETCD.

Also the way kubernetes handles secrets. Such as:

A secret is only sent to a node if a pod on that node requires it.

Kubelet stores the secret into a tmpfs so that the secret is not written to disk storage.

Once the Pod that depends on the secret is deleted, kubelet will delete its local copy of the secret data as well.

there are other better ways of handling sensitive data like passwords in Kubernetes, such as using tools like Helm Secrets, HashiCorp Vault. I hope to make a lecture on these in the future.

Introduction to Kubernetes Secrets

Purpose of Secrets:

- Store sensitive information like passwords or keys.
- Distinct from ConfigMaps as Secrets store data in an encoded format for security.

Creating Secrets

★ Declarative ways always mean that a definition file is required to create the object while Imperative ways do not involve a definition file.

1. Imperative ways

a)

```
kubectl create secret generic <secret-name> --from-literal=<key1>=<value1> --from-literal=<key2>=<value2>
```

b)

```
kubectl create secret generic <secret-name> --from-file=<path-to-file>
```

2. Declarative ways

In the declarative approach, you first have to write the config file and the data you put inside the config file must be encoded.

step 1) Encode Data to Base64 (Linux):

```
echo -n <text-to-encode> | base64
```

```
DB_Host: mysql  
DB_User: root  
DB_Password: paswrd
```



```
DB_Host: bXlzcWw=  
DB_User: cm9vdA==  
DB_Password: cGFzd3Jk
```

```
▶ echo -n 'mysql' | base64  
bXlzcWw=
```

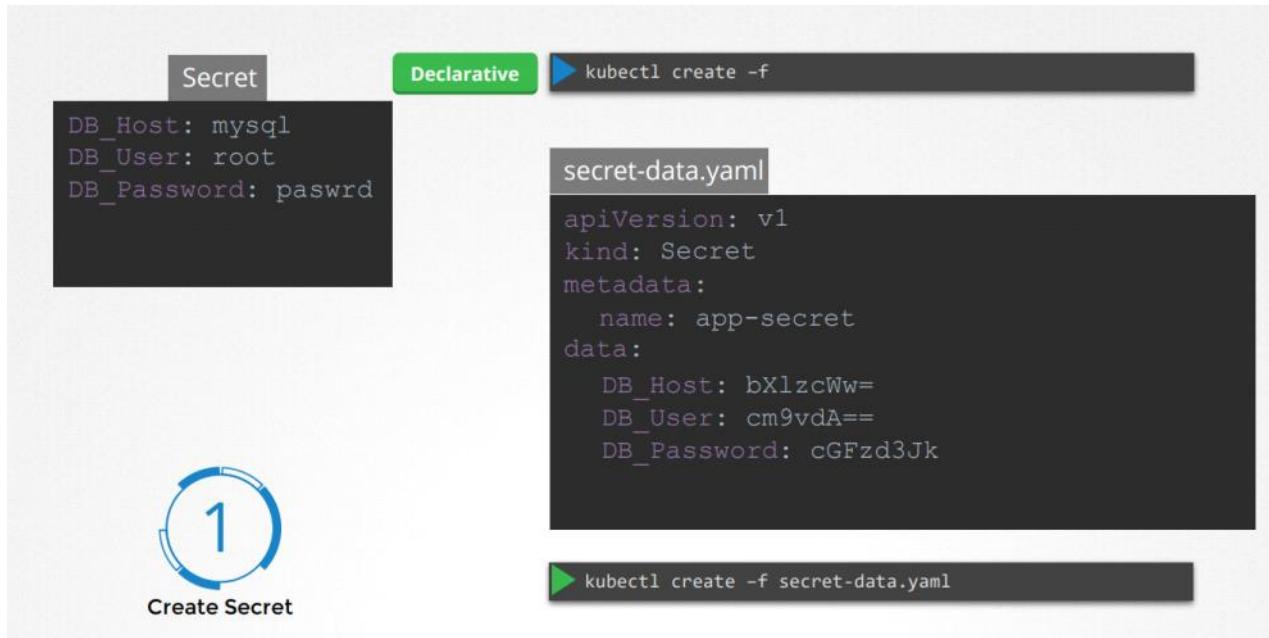
```
▶ echo -n 'root' | base64  
cm9vdA==
```

```
▶ echo -n 'paswrd' | base64  
cGFzd3Jk
```

step 2) YAML File

```
apiVersion: v1
```

```
kind: Secret
metadata:
  name: <secret-name>
data:
  <key1>: <base64-encoded-value1>
  <key2>: <base64-encoded-value2>
```



Viewing and Describing Secrets

- **Viewing Secrets:**

arduino

Copy code

```
kubectl get secrets
```

- **Describing Secrets:**

php

Copy code

```
kubectl describe secret <secret-name>
```

- **Displaying Values in YAML:**

arduino

Copy code

```
kubectl get secret <secret-name> -o yaml
```

secret file will not display literals after running "kubectl describe" command.

Using Secrets in Pods

- **Injecting Secrets into Pods:**

- Define `ENV from` property in the pod container.
- Each item in the list corresponds to a secret item.

yaml

 Copy code

```
envFrom:  
- secretRef:  
  name: <secret-name>
```

- **Alternative: Mounting Secrets as Volumes.**

Injecting into pods

Security Considerations

Encoding vs. Encryption:

- Secrets are encoded, not encrypted.

It means that anyone can look up the file that you created for secrets get the secret object and decode it. So, avoid committing secret definition files with code on github.

- etcd Encryption:

By default, data at etcd is not encrypted.

Consider enabling encryption at rest for etcd.

Use encryption configurations to specify resources.

- Access Control:

Anyone creating pods in the same namespace can access secrets. So, Configure Role-Based Access Control (RBAC) for restrictions.

- Third-Party Secret Providers:

AWS, Azure, GCP, Vault.

External providers offer enhanced security and manage secret storage.

Advanced topic covered in Certified Kubernetes Security Specialist course.

difference between kubectl secret and secret generic

kubectl secret:

This is a high-level command that can create several types of secrets, including:

docker-registry: Used for Docker registry authentication.

tls: Used for TLS/SSL certificates.

generic: Used for arbitrary key-value pairs, which is similar to kubectl create secret generic

kubectl create secret generic:

This command specifically creates a generic secret, which is a simple key-value pair secret.

It's useful for storing sensitive information like passwords, tokens, or API keys.

lab 4

Friday, April 5, 2024 11:45 AM

How many secrets are defined in the dashboard-token secret?

Run the command: kubectl describe secrets dashboard-token and look at the data field.
There are three secrets - ca.crt, namespace and token.

You may follow any one of the methods discussed in lecture to create the secret.

Secret Name: db-secret

Secret 1: DB_Host=sql01

Secret 2: DB_User=root

Secret 3: DB_Password=password123

```
k create secret generic db-secret --from-literal=DB_Host=sql01 --from-literal=DB_User=root --from-literal DB_Password=password123
```

Configure webapp-pod to load environment variables from the newly created secret.

Delete and recreate the pod if required.

Pod name: webapp-pod

Image name: kodekloud/simple-webapp-mysql

Env From: Secret=db-secret

I have tried to edit the pod using 'k edit pod' command and then it gives me the output-

```
error: pods "webapp-pod" is invalid
A copy of your changes has been stored to "/tmp/kubectl-edit-4011404577.yaml"
error: Edit cancelled, no valid changes were saved.
```

Then I ran this command -

```
k replace --force -f /tmp/kubectl-edit-4011404577.yaml
```

But it didn't update the pod, why ? It gives following error -

```
pod "webapp-pod" deleted
Error from server (BadRequest): Pod in version "v1" cannot be handled as a Pod: json: cannot unmarshal object
into Go struct field Container.spec.containers.envFrom of type []v1.EnvFromSource
```

It looks like you encountered a couple of issues while trying to edit and replace a pod in Kubernetes. Let's break down the errors and see how to resolve them:

Invalid Pod Error:

When you tried to edit the pod using kubectl edit pod, Kubernetes detected that the changes you made resulted in an invalid pod configuration. It then saved a copy of your changes to a YAML file (/tmp/kubectl-edit-4011404577.yaml) and cancelled the edit because no valid changes were detected.

Replace Pod Error:

After the edit was cancelled, you attempted to force replace the pod using kubectl replace --force -f /tmp/kubectl-edit-4011404577.yaml. However, this command failed with the error message Error from server (BadRequest): Pod in version "v1" cannot be handled as a Pod: json: cannot unmarshal object into Go struct field Container.spec.containers.envFrom of type []v1.EnvFromSource.

To address these issues:

Review the YAML File:

First, take a look at the YAML file /tmp/kubectl-edit-4011404577.yaml to understand what changes were made and why Kubernetes considered them invalid. Correct any syntax errors or invalid configurations in this file.

Apply Changes Using kubectl apply:

Instead of force replacing the pod, which can sometimes lead to unexpected errors, you can apply the changes from the edited YAML file using `kubectl apply -f /tmp/kubectl-edit-4011404577.yaml`. This command will update the pod with the corrected configuration.

Debug EnvFrom Field Error:

The error related to `envFrom` in the YAML file indicates a problem with the environment variables source configuration. Ensure that the `envFrom` field in the container specification is correctly formatted according to Kubernetes specifications. You may need to refer to the Kubernetes documentation for the correct syntax and options for defining environment variables from sources.

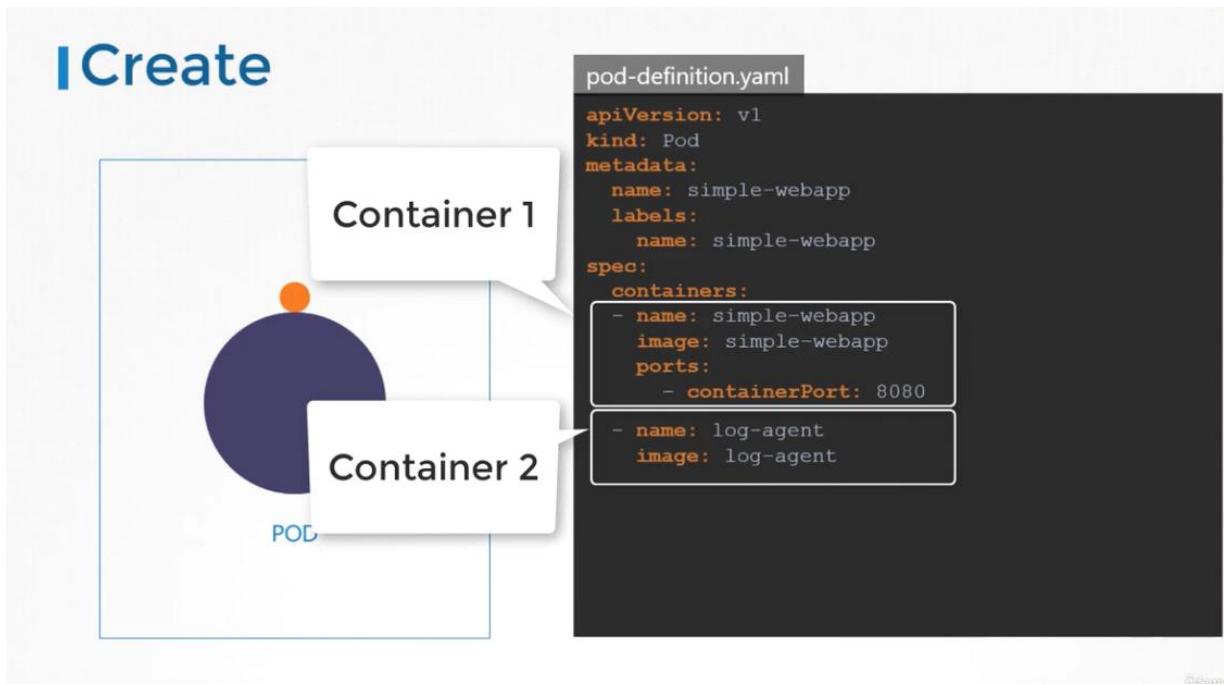
After making these adjustments, try applying the changes again using `kubectl apply -f /tmp/kubectl-edit-4011404577.yaml` and check if the pod updates successfully without errors. If you encounter any specific issues or need further assistance, please provide more details or the contents of the YAML file for a more targeted solution.

```
# Please edit the object below. Lines beginning with a '#' will be ignored,
# and an empty file will abort the edit. If an error occurs while saving this
# file will be
# reopened with the relevant failures.
#
# pods "webapp-pod" was not valid:
# * patch: Invalid value: "map[spec:map[])": cannot restore slice from map
#
apiVersion: v1
kind: Pod
metadata:
  labels:
    name: webapp-pod
  name: webapp-pod
  namespace: default
spec:
  containers:
  - image: kodekloud/simple-webapp-mysql
    imagePullPolicy: Always
    name: webapp
    envFrom:
      -secretRef:
        name: db-secret
```

```
---  
apiVersion: v1  
kind: Pod  
metadata:  
  labels:  
    name: webapp-pod  
    name: webapp-pod  
  namespace: default  
spec:  
  containers:  
    - image: kodekloud/simple-webapp-mysql  
      imagePullPolicy: Always  
      name: webapp  
      envFrom:  
        - secretRef:  
            name: db-secret
```

Multi Container Pods

Monday, March 4, 2024 6:12 PM



Introduction to Multi-Container Pods

Microservices Architecture:

- Decoupling monolithic applications into microservices.
- Development and deployment of independent, small, and reusable code.

Scaling and Modification:

- Microservices help to enable scaling up, down, and modifying individual services independently.

Need for Multi-Container Pods

Service Collaboration:

- Sometimes multiple instances need to work together e.g. web servers and logging services.
- These are useful when you want different instances (e.g. web servers and logging services) to be developed and deployed independently but you don't want a single instance having all the codes of a web server and logging services merged.

Characteristics of Multi-Container Pods

Shared Lifecycle:

- Since these instances are built and destroyed together, they have the same lifecycle.

Shared Network Space:

- Containers can refer to each other using "localhost."
 - In a multi-container pod, each container shares the same network namespace. This means they can communicate with each other using localhost and the respective ports they expose.
 - For example, if Container A and Container B are in the same pod, Container A can communicate with Container B by addressing it as localhost:port_number, where port_number is the port exposed by Container B.

Shared Storage Volumes:

- Access to the same storage volumes.
 - Kubernetes allows you to mount shared volumes into multiple containers within the same pod. These volumes are accessible to all containers in the pod.
 - This enables containers within the pod to share and access the same data or files, facilitating data sharing and collaboration between them.
 - For instance, if Container A and Container B both mount a shared volume named "shared-data," any data written to or read from this volume by Container A will be accessible to Container B and vice versa.
- Simplifies data sharing between containers.
 - By having access to the same storage volumes and being able to communicate with each other via localhost, multi-container pods simplify the process of sharing data and collaborating on tasks.
 - Containers can easily exchange information and work together on a common goal without needing to establish complex networking configurations or external communication channels.

Creating Multi-Container Pods

1. Pod Definition File:

- The container section under spec is an array.
- Allows the inclusion of multiple containers within a single pod.

Example: Adding a Log Agent Container

pod-definition.yaml

```
apiVersion: v1
kind: Pod
metadata:
  name: simple-webapp
  labels:
    name: simple-webapp
spec:
  containers:
    - name: simple-webapp
      image: simple-webapp
      ports:
        - containerPort: 8080
    - name: log-agent
      image: log-agent
```

```
spec:
  containers:
    - name: web-server
      image: web-server-image
      ports:
        - containerPort: 80
    - name: log-agent
      image: log-agent-image
```

lab 5

Wednesday, April 10, 2024 2:23 PM

- ?
- If the pod goes into the crashloopbackoff then add the command sleep 1000 in the lemon container.

crashloopbackoff -

Name: yellow
Container 1 Name: lemon
Container 1 Image: busybox
Container 2 Name: gold
Container 2 Image: redis

Solution manifest file to create a multi-container pod called `yellow` as follows:

```
apiVersion: v1
kind: Pod
metadata:
  name: yellow
spec:
  containers:
    - name: lemon
      image: busybox
      command:
        - sleep
        - "1000"

    - name: gold
      image: redis
```

Run

```
k run yellow --image=busybox --dry-run=client -o yaml ? multi-pod.yaml
```

Run

```
k create -f multi-pod.yaml
```

Sidecar container -

The application outputs logs to the file /log/app.log. View the logs and try to identify the user having issues with Login.

Inspect the log file inside the pod.

```
kubectl -n elastic-stack exec -it app -- cat /log/app.log
```

or run

```
k log -f <pod-name>
```

for particular namespace 2, run -

```
k logs <pod-name> -n <namespace>
```

To get pods in particular namespace (e.g. elastic-stack)

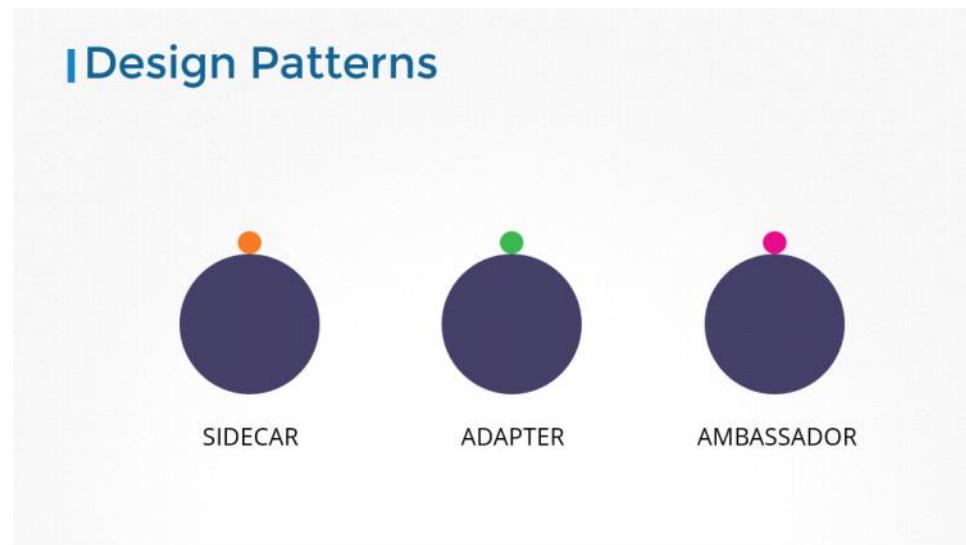
```
k get pods -n elastic-stack
```

Kibana UI

Types of multicontainers

Wednesday, April 10, 2024 6:54 PM

Not for CKA



InitContainers

Monday, March 4, 2024 6:16 PM

In a multi-container pod, each container is expected to run a process that stays alive as long as the POD's lifecycle. For example in the multi-container pod that we talked about earlier that has a web application and logging agent, both the containers are expected to stay alive at all times. The process running in the log agent container is expected to stay alive as long as the web application is running. If any of them fail, the POD restarts.

But at times you may want to run a process that runs to completion in a container. For example, a process that pulls a code or binary from a repository that will be used by the main web application. That is a task that will be run only one time when the pod is first created. Or a process that waits for an external service or database to be up before the actual application starts. That's where initContainers comes in.

An initContainer is configured in a pod like all other containers, except that it is specified inside a initContainers section, like this:

```
1 | apiVersion: v1
2 | kind: Pod
3 | metadata:
4 |   name: myapp-pod
5 |   labels:
6 |     app: myapp
7 | spec:
8 |   containers:
9 |     - name: myapp-container
10 |       image: busybox:1.28
11 |       command: ['sh', '-c', 'echo The app is running! && sleep 3600']
12 |   initContainers:
13 |     - name: init-myservice
14 |       image: busybox
15 |       command: ['sh', '-c', 'git clone <some-repository-that-will-be-used-
by-application> ; done;']
```

- ★ When a POD is first created the initContainer is run, and the process in the initContainer must run to a completion before the real container hosting the application starts.

You can configure multiple such initContainers as well, like how we did for multi-containers pod. In that case, each init container is run one at a time in sequential order.

If any of the initContainers fail to complete, Kubernetes restarts the Pod repeatedly until the Init Container succeeds.

```
1 apiVersion: v1
2 kind: Pod
3 metadata:
4   name: myapp-pod
5   labels:
6     app: myapp
7 spec:
8   containers:
9     - name: myapp-container
10    image: busybox:1.28
11    command: ['sh', '-c', 'echo The app is running! && sleep 3600']
12   initContainers:
13     - name: init-myservice
14       image: busybox:1.28
15       command: ['sh', '-c', 'until nslookup myservice; do echo waiting for
myservice; sleep 2; done;']
16     - name: init-mydb
17       image: busybox:1.28
18       command: ['sh', '-c', 'until nslookup mydb; do echo waiting for
mydb; sleep 2; done;']
```

lab 6

Thursday, April 4, 2024 3:36 PM

initcontainers

containers:

```
- name: myapp-container
  image: busybox:1.28
  command: ['sh', '-c', 'echo The app is running! && sleep 3600']
```

initContainers:

```
- name: init-myservice
  image: busybox:1.28
  command: ['sh', '-c', '20']
```

Regular Container:

Name: myapp-container

Image: busybox:1.28

Command: The command specified here (['sh', '-c', 'echo The app is running! && sleep 3600']) will be executed when this container starts. It echoes "The app is running!" and then sleeps for 3600 seconds (1 hour).

Init Container:

Name: init-myservice

Image: busybox:1.28

Command: The command specified (['sh', '-c', '20']) will be executed when this init container starts. However, the command sh -c 20 is incomplete and doesn't have a valid shell command. It seems to be missing an actual command or script to execute.

k describe pod - To describe all pod at once

Update the pod red to use an initContainer that uses the busybox image and sleeps for 20 seconds

Delete and re-create the pod if necessary. But make sure no other configurations change.

Pod: red

initContainer Configured Correctly

```
apiVersion: v1
kind: Pod
metadata:
  name: red
  namespace: default
spec:
  containers:
    - command:
        - sh
        - -c
        - echo The app is running! && sleep 3600
      image: busybox:1.28
      name: red-container
    initContainers:
      - image: busybox
        name: red-initcontainer
        command:
          - "sleep"
          - "20"
```

In Linux shell scripting, the **-c flag is used with the sh or bash command to specify a command string that should be executed.**

A new application orange is deployed. There is something wrong with it. Identify and fix the issue.

Once fixed, wait for the application to run before checking solution.

- There is a typo in the command used by the initContainer. To fix this, first get the pod definition file by running `kubectl get pod orange -o yaml > /root/orange.yaml`.
- Next, edit the command and fix the typo.
- Then, delete the old pod by running `kubectl delete pod orange`
- Finally, create the pod again by running `kubectl create -f /root/orange.yaml`

```
k logs <pod-name> -c <name-of-container>
```

The command **kubectl logs <pod-name> -c init-myservice** is used in Kubernetes to retrieve the logs of a specific container within a pod. Here's a breakdown of the command:

- **kubectl logs**: This is the main command for retrieving logs in Kubernetes.
- **<pod-name>**: Replace this with the actual name of the pod from which you want to fetch logs. The logs will be fetched from one of the containers within this pod.
- **-c init-myservice**: This part specifies the name of the container whose logs you want to retrieve. In this case, init-myservice is the name of the container.

So, when you run `kubectl logs <pod-name> -c init-myservice`, Kubernetes will fetch and display the logs generated by the container named init-myservice within the specified pod. This is useful for troubleshooting or monitoring specific components within a pod that has multiple containers.

Self-healing apps

Wednesday, April 10, 2024 7:43 PM

Not For CKA

Self-Healing Applications

Kubernetes supports self-healing applications through ReplicaSets and Replication Controllers. The replication controller helps ensure that a POD is re-created automatically when the application within the POD crashes. It helps in ensuring enough replicas of the application are running at all times.

Kubernetes provides additional support to check the health of applications running within PODs and take necessary actions through Liveness and Readiness Probes. However, these are not required for the CKA exam and as such they are not covered here. These are topics for the Certified Kubernetes Application Developers (CKAD) exam and are covered in the CKAD course.

Imperative Commands

Tuesday, May 21, 2024 4:23 PM

Rolling Update Deployment:

```
kubectl set image deployment/<deployment-name> <container-name>=<new-image> --record  
kubectl set image deployment/<deployment-name> <container-name>=<new-image>
```

Rollback Deployment:

```
kubectl rollout undo deployment/<deployment-name>
```

Rollout History:

```
kubectl rollout history deployment/<deployment-name>
```

Rollout Status:

```
kubectl rollout status deployment/<deployment-name>
```

Note - rollout history is used to view past revisions and changes in a deployment, while rollout status is used to monitor the current status and progress of a deployment's rollout.

Set Image for Deployment:

```
kubectl set image deployment/<deployment-name> <container-name>=<new-image>
```

Scale Deployment:

```
kubectl scale deployment/<deployment-name> --replicas=<number>
```

To resume a paused deployment:

```
kubectl rollout resume deployment <deployment-name>
```

Update Secrets:

```
kubectl create secret generic <secret-name> --from-literal=<key>=<value>  
kubectl create secret generic <secret-name> --from-file=<path/to/file>
```

View Secrets:

```
kubectl get secrets  
kubectl describe secret <secret-name>
```

Delete Secrets:

```
kubectl delete secret <secret-name>
```

Create ReplicaSet:

```
kubectl create replicaset --replicas=<number> --template=<pod-template.yaml>
```

View ReplicaSets:

```
kubectl get replicaset
```

Scale ReplicaSet:

```
kubectl scale replicaset/<replicaset-name> --replicas=<number>
```

Update Image in ReplicaSet:

```
kubectl set image replicaset/<replicaset-name> <container-name>=<new-image>
```

Rolling Update in ReplicaSet:

```
kubectl set image replicaset/<replicaset-name> <container-name>=<new-image> --reco
```

Environment Variables & CM

Sunday, March 3, 2024 7:32 PM

Use env property in a pod-definition file.

'env' is an array.

Run command

```
docker run -e APP_COLOR=pink simple-webapp-color
```

```
pod-definition.yaml
apiVersion: v1
kind: Pod
metadata:
  name: simple-webapp-color
spec:
  containers:
    - name: simple-webapp-color
      image: simple-webapp-color
      ports:
        - containerPort: 8080
  env:
    - name: APP COLOR
      value: pink
```

Types of Environment Variables

- a. Plain key value
- b. ConfigMaps
- c. Secrets

```
env:  
  - name: APP_COLOR  
    value: pink
```

```
env:  
  - name: APP_COLOR  
    valueFrom:  
      configMapKeyRef:
```

```
env:  
  - name: APP_COLOR  
    valueFrom:  
      secretKeyRef:
```

ConfigMaps

- When you have many pod definition files, it will become difficult to manage the environment data stored within the query's files.
- We can take this information out of the pod definition file and manage it centrally using configuration maps.
- **ConfigMaps are used to pass configuration data in the form of key-value pairs in Kubernetes.**
- When a pod is created, inject the config map into the pod so the key-value pairs are available as environment variables for the application hosted inside the container in the pod.
- ConfigMaps can be used to store users, passwords etc.
- So, there are two phases - Create ConfigMap and Inject ConfigMap into Pods.

Create ConfigMap

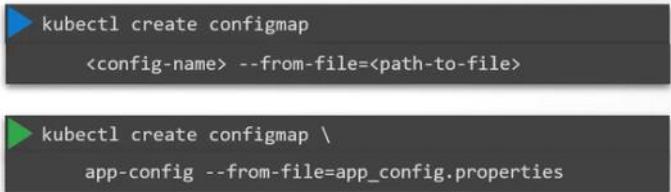
Ways to create a ConfigMap file

1. Imperative Way - Without using a configMap definition file.

- a. Using '--from-literal'



- b. Using '--from-file'



2. Declarative Way - By using config-map definition file using 'kubectl create -f'



- View ConfigMap using

```
kubectl get configmaps
```

- View ConfigMap using

```
kubectl describe configmaps
```

Inject ConfigMap into Pods

To inject ConfigMaps into a pod, add a new field 'envFrom' in the pod definition file. It's a list and mentions the name of ConfigMap(not the YAML file).

Create the pod using - 'kubectl create -f pod-definition.yaml' file.

ConfigMap in Pods

pod-definition.yaml

```
apiVersion: v1
kind: Pod
metadata:
  name: simple-webapp-color
  labels:
    name: simple-webapp-color
spec:
  containers:
  - name: simple-webapp-color
    image: simple-webapp-color
    ports:
      - containerPort: 8080
    envFrom:
      - configMapRef:
          name: app-config
```

config-map.yaml

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: app-config
data:
  APP_COLOR: blue
  APP_MODE: dev
```

Ways to Inject configMaps into the Pods

ConfigMap in Pods

```
envFrom:
```

```
- configMapRef:  
    name: app-config
```

ENV

SINGLE ENV

```
env:
```

```
- name: APP_COLOR  
  valueFrom:  
    configMapKeyRef:  
      name: app-config  
      key: APP_COLOR
```

VOLUME

```
volumes:
```

```
- name: app-config-volume  
  configMap:  
    name: app-config
```

k get cm

```
sh -c
```

Thursday, May 23, 2024 12:45 PM

command: ['sh', '-c', 'echo "logging" > /opt/logs.txt']:

This command uses the shell (sh) to execute a command that writes the string "logging" to a file named logs.txt located in the /opt directory. The > symbol redirects the output to the file, overwriting its contents if the file already exists.

command: ['sh', '-c', 'tail -F /opt/logs.txt']:

This command again uses the shell (sh) to execute a command that tails (displays) the contents of the logs.txt file located in the /opt directory. The -F option tells tail to follow the file, displaying new lines as they are appended to the file.

command: ['sh', '-c', 'while true; do echo "logging" >> /opt/logs.txt; sleep 1; done']:

This command uses the shell (sh) to execute a loop (while true) that continuously appends the string "logging" to the logs.txt file located in the /opt directory. After appending, it sleeps for 1 second (sleep 1) before repeating the process.

The kubectl logs -f <pod-name> | grep ERROR >> /logs/error/<pod-name> command does the following:

kubectl logs -f <pod-name>: This command retrieves the logs of the specified pod (<pod-name>) and uses the -f flag to follow the log stream in real-time.

|: The pipe operator (|) is used to pass the output of the kubectl logs command to the next command.

grep ERROR: This command filters the log stream, searching for lines that contain the word "ERROR".

>> /logs/error/<pod-name>: This part redirects (appends) the filtered output containing "ERROR" lines to a file named <pod-name> located in the /logs/error directory.

> (greater than symbol): This symbol is used to redirect output to a file, and it will overwrite the contents of the file if it already exists. For example:

>> (double greater than symbol): This symbol is used to **append** output to a file, preserving the existing content of the file. For example:

OS Upgrade

Monday, March 4, 2024 6:32 PM



Scenario:

- Node maintenance for tasks like software upgrades or applying patches.
- Examining options available for handling node maintenance.

Impact on Pods when a Node Goes Down

1. Pod Accessibility:

- Pods on the downed node become inaccessible.
- Impact on users depends on pod deployment methods.

2. Replica Sets:

- Replicas help maintain service availability.
- If one replica is down, others serve the application.

3. Kubernetes Response:

- When the node backs online immediately, the kubelet process starts, and kubelet restarts pods.
- Node down for more than **five minutes**: Pods terminated and considered dead.
- **Pod-eviction-timeout**: It's a time up to which Kubernetes waits for a pod to come back online. The default is set to five minutes by the controller manager. So, master nodes wait for 5 minutes before considering the node dead.
- When the node comes back online after the pod-eviction timeout, it comes up blank without any pod scheduled on it.

Handling Node Maintenance Safely

1. Quick Upgrade and Reboot:

Use when - If node downtime is short, replicas are available, and the node returns within five minutes.

- Pods are restarted automatically.

2. Draining the Node:

- Use this method when you are not sure that pod will be back.
- In this, move the workloads of the pod(e.g. Pod1) to other nodes in the cluster before maintenance of the pod(Pod1).
- When you drain a node, the pods running on that node are gracefully terminated, allowing them to complete ongoing tasks and close connections properly before being recreated on another available node. This ensures that services running in those pods experience minimal disruption during the migration process.
- `kubectl drain <node-name>`: This command terminates the pod and marks the node as 'unschedulable'.
- Now you can reboot the first node.
- When the node comes back it's still 'unschedulable', you have to 'uncordon' the node so that the pods can be scheduled on it again.

★ When a node is "cordoned," it means that it's marked as unavailable for new pod scheduling. This could be because the node is undergoing maintenance or is experiencing issues.

★ If you're performing an OS upgrade on a node (let's say node1) in Kubernetes and you've drained the node successfully, ensuring that all pods (like pod1 and pod2) are scheduled on another node (like node2), you don't need to manually move the pods back to node1 after the upgrade and reboot.

After the node (node1) is upgraded and rebooted, it will join the cluster again. Kubernetes' scheduling mechanism will then decide where to place new pods or pods that were previously running on node1 but had to move due to the drain operation. If any of the pods were deleted or new pods are created, Kubernetes will consider node1 as a potential candidate for scheduling those pods, especially if it's back online and ready to receive workloads.

In summary, you don't have to manually move the pods back to node1 after the upgrade and reboot. Kubernetes will manage the pod scheduling based on the current cluster state and node availability.

Process:

- Drain the node on which you want to make an OS upgrade. The 'drain' command cordons the node or makes it unschedulable.
- Make OS upgrade
- Uncordon the node to make it schedulable.

Managing Node Status

1. Uncordoning the Node:

- After maintenance, `kubectl uncordon <node-name>`: Allows pods to be scheduled on the node again.

2. Cordon Command:

- `kubectl cordon <node-name>`: Marks the node unschedulable without terminating or moving pods.
- Useful when you want to prevent new pods from being scheduled on a node.

Best Practices

- Drain the node if significant maintenance is required.

- Use kubectl cordon to prevent new pods on nodes without terminating existing ones.

Commands

kubectl drain, kubectl cordon, kubectl uncordon.

- ❓ Is it possible for a ReplicaSet to reschedule a pod on another node if the original node goes down?

Yes, a ReplicaSet can reschedule a pod on another node if the original node goes down. When a node becomes unavailable, Kubernetes detects this and uses the ReplicaSet's configuration, specifically the pod's replicas count, to ensure that the desired number of pods are running. If a pod on the unavailable node needs to be replaced to meet the desired replicas count, Kubernetes will schedule a new pod on an available node to maintain the desired state defined by the ReplicaSet.

- Schedule = uncordon
- Unschedule = cordon
- **Drain:** When you drain a node, the pods running on it are safely stopped, letting them finish their tasks and end connections correctly before moving them to another node. This helps keep services in those pods running smoothly with little interruption during the move.
- **Cordon:** Marks a node unschedulable, preventing new pods from being scheduled onto it, but existing pods continue running.

lab 1

Friday, April 12, 2024 4:03 PM

- ?
- How many applications do you see hosted on the cluster?

Run: 'kubectl get deployments' and count the **number of deployments**

Which nodes are the applications hosted on?

Run the command kubectl get pods -o wide and get the list of nodes the pods are placed on

- ?
- We need to take node01 out for maintenance. Empty the node of all applications and mark it unschedulable.

Run the command 'kubectl drain node01'

If you get the error like - DaemonSet-managed Pods, then use ' --ignore-daemonsets'

Run the command kubectl drain node01 --ignore-daemonsets

- ★
- 'drain' command will not work when

Run: kubectl get pods -o wide and you will see that there is a single pod scheduled on node01 which is not part of a replicaset.

The drain command will not work in this case. To forcefully drain the node we now have to use the --force flag.

deleting Pods that declare no controller:

Okay, so usually we don't expect applications to be deployed on the control plane because it usually has a taint, of some sort.

? cannot delete pods not managed by ReplicationController, Replicaset, Job etc.

Configure the node node01 to be schedulable again.

Run the command `kubectl uncordon node01`

What would happen to hr-app if node01 is drained forcefully?

OR

What would happen to an app(hr-app) which is not a part of replicaset, if node01 is drained forcefully?

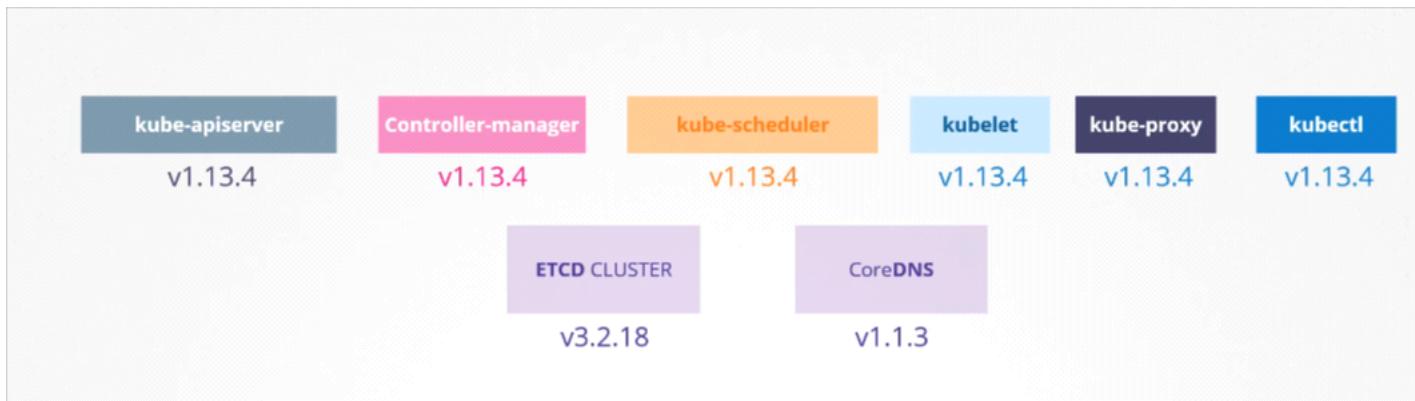
A forceful drain of the node will delete any pod that is not part of a replicaset. So, we lost hr-app forever.

Do not drain node01, instead use the kubectl cordon node01 command. This will ensure that no new pods are scheduled on this node and the existing pods will not be affected by this operation.

Kubernetes Version

Monday, March 4, 2024 11:07 PM

Run 'k get nodes', the version written under the 'VERSION' is the version of Kubernetes.

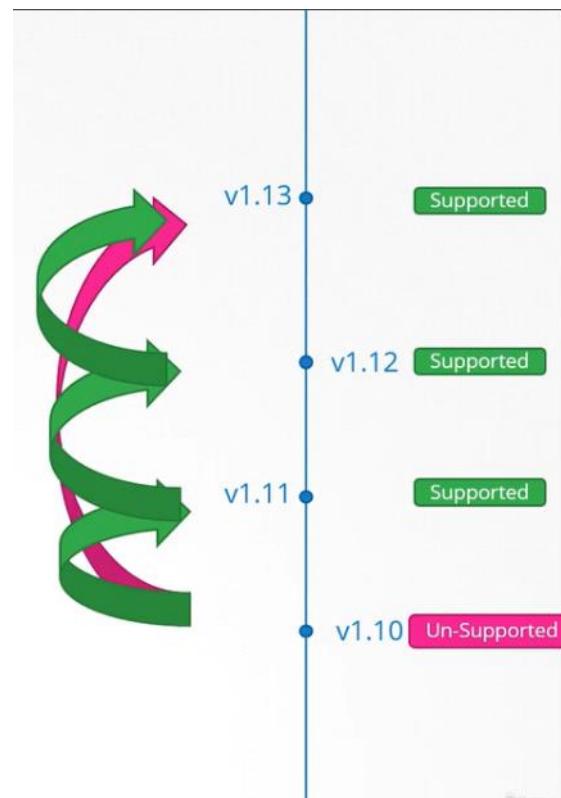


Control plane components have same version.

Components other than that such as etcd Cluster and CoreDNS have their own versions.

Cluster Upgrade Process

Monday, March 4, 2024 6:48 PM



first, a master node is upgraded and then the worker nodes,

- ★ The cordon command is used to temporarily disable scheduling new pods on a node, while allowing existing pods to continue running until they complete.

The uncordon enables the scheduling of new pods onto a previously drained or cordoned node.

kubeadm - upgrade

```
▶ apt-get upgrade -y kubeadm=1.12.0-00
```

```
▶ kubeadm upgrade apply v1.12.0
```

...

[upgrade/successful] SUCCESS! Your cluster was upgraded to "v1.12.0". Enjoy!

[upgrade/kubelet] Now that your control plane is upgraded, please proceed with upgrading your kubelets if you haven't already done so.

```
▶ kubectl get nodes
```

NAME	STATUS	ROLES	AGE	VERSION
master	Ready	master	1d	v1.11.3
node-1	Ready	<none>	1d	v1.11.3
node-2	Ready	<none>	1d	v1.11.3

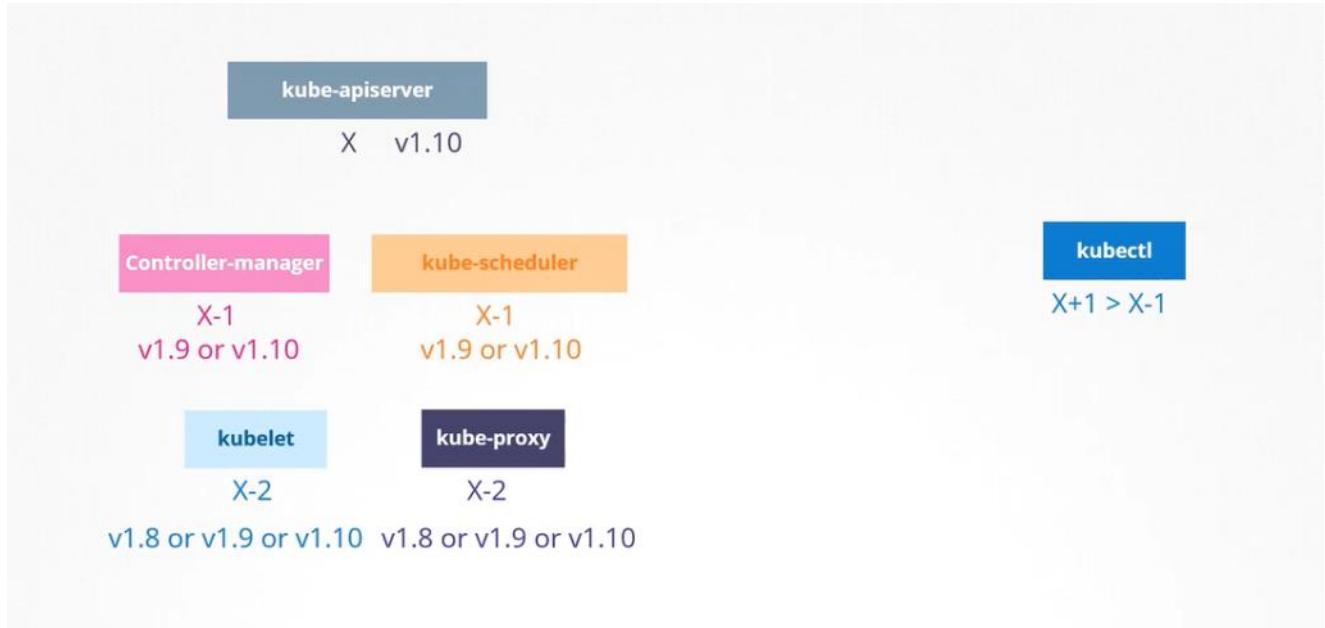
```
▶ apt-get upgrade -y kubelet=1.12.0-00
```

```
▶ systemctl restart kubelet
```

Objective: Understand the Kubernetes cluster upgrade process.

Control Plane Components Versioning

1. Component Versions:



- Different components can have different release versions.
- kube-apiserver is the primary component. Since the kube-apiserver is the primary component in the control plane, and that is the component that all other components talk to, **none of the other components should ever be at a version higher than the kube-apiserver.**
- kube-controller-manager and kube-scheduler can be at x-1.
- kubelet and kube-proxy can be at x-2.

2. kubectl Versioning:

- It can be one version higher than the kube-apiserver, same, or one version lower than the kube-apiserver. e.g. if kube-apiserver is at 1.10, kubectl can be at 1.11, 1.10 or 1.9.
- Permissible skew in versions.
- Allows live upgrades, component by component.

Upgrade Timing and Versions

1. Kubernetes Version Support:

- Kubernetes supports up to the recent three minor versions. (minor means - In v1.10 , 10 is the minor version)
- Example: With the release of version 1.13, versions 1.13, 1.12, and 1.11 are supported.

2. Upgrade Strategy:

- Upgrade one minor version at a time.
- e.g., 1.10 to 1.11, then 1.11 to 1.12.

Upgrade Process Steps

1. First, the Master Nodes are Upgraded:

- Upgrade control plane components (kube-apiserver, scheduler, controller-managers).
- There is no impact on worker nodes or applications while master node is being upgraded.
- While the master node is being upgraded, control plane components face temporary downtime.
- You can't access the cluster using kubectl or other kubernetes API, can't deploy new applications or delete or modify existing ones and controller-manager will also fail so if a pod will fail, the new pod won't be automatically created.

2. Then, the Worker Nodes are Upgraded:

- Strategies:
 - Upgrade all nodes at once but application will face downtime in this.
 - Upgrade one node at a time. In this, once the first node is upgraded, the workload move to the other nodes and similarly for other nodes.
 - Add new nodes with the latest software version. Move the workload of a node to the new node and then delete the old node.
- Use kubectl drain to move workloads before node upgrade
- Upgrade kubeadm and kubelet packages on worker nodes.
- Update node configuration with kubeadm tool.
- Restart kubelet service.
- Use kubectl uncordon to mark the node as schedulable.
- Pods may not immediately return to the upgraded node.

Upgrade Commands with kubeadm

1. Upgrade Planning:

- Run 'kubeadm upgrade plan' to get information on the current and latest versions such as

```
▶ kubeadm upgrade plan
[preflight] Running pre-flight checks.
[upgrade] Making sure the cluster is healthy:
[upgrade/config] Making sure the configuration is correct:
[upgrade] Fetching available versions to upgrade to
[upgrade/versions] Cluster version: v1.11.8
[upgrade/versions] kubeadm version: v1.11.3
[upgrade/versions] Latest stable version: v1.13.4
[upgrade/versions] Latest version in the v1.11 series: v1.11.8
```

- Controlplane components version and latest version available

Upgrade to the latest stable version:		
COMPONENT	CURRENT	AVAILABLE
API Server	v1.11.8	v1.13.4
Controller Manager	v1.11.8	v1.13.4
Scheduler	v1.11.8	v1.13.4
Kube Proxy	v1.11.8	v1.13.4
CoreDNS	1.1.3	1.1.3
Etcd	3.2.18	N/A

2. Upgrade Execution:

- ★ • Upgrade kubeadm tool to the next version. You must upgrade the kubeadm tool itself before you can upgrade the cluster. kubeadm tool also follows the same version as that of kubernetes.
- Execute 'kubeadm upgrade apply <version-name> e.g. v1.12.0>' to upgrade the control plane components.
- ★ • After running the 'kubeadm upgrade apply <version-name>' command, you need to manually upgrade kubelet versions on each node because **kubeadm does not install or upgrade kubelets.**

Example: Upgrade from 1.11 to 1.13:

Upgrade first to 1.12, then to 1.13.

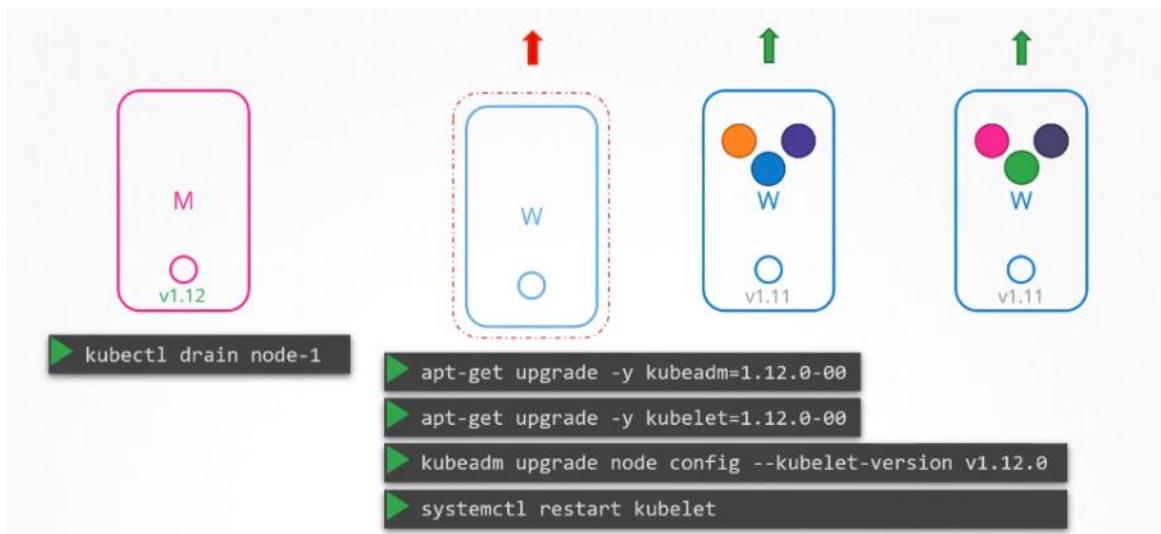
- First upgrade the kubeadm to v1.12
- Then upgrade the control plane components to v1.12
- Upgrade kubelet on master node(if master node has kubelet) and then restarts the kubelet.

```
apt-get upgrade -y kubeadm=1.12.0-00
kubeadm upgrade apply v1.12.0
...
[upgrade/successful] SUCCESS! Your cluster was upgraded to "v1.12.0". Enjoy!
[upgrade/kubelet] Now that your control plane is upgraded, please proceed with upgrading your kubelets if you haven't already done so.

kubectl get nodes
NAME      STATUS    ROLES      AGE      VERSION
master    Ready     master     1d       v1.11.3
node-1   Ready     <none>    1d       v1.11.3
node-2   Ready     <none>    1d       v1.11.3

apt-get upgrade -y kubelet=1.12.0-00
systemctl restart kubelet
```

- After upgrading the master node, we will upgrade the worker node.
- Then run 'kubectl drain <node-name>' command. The kubectl drain command lets you safely terminate all the pods from a node and reschedules them on the other nodes. It also cordons the node and marks it unschedulable. That way, no new pods are scheduled on it.
- Then upgrade the kubeadm and kubelet package on the worker nodes as we did on the master node.



- Then run 'systemctl restart kubelet' command.

Now if I do a kubectl get node, you're gonna see something interesting. You're gonna see that it still points to version 1.28.0.

Well, why is that? I thought we just upgraded, it says we've successfully upgraded.

Well keep in mind when you do a kubectl get node, and you see the version column here, this version column, it pulls the

version that your kubelet is running.

So our kubelet, remember, based off the kubeadm plan command, it needs to be upgraded manually afterwards, after kubeadm is run.

So this version is just getting pulled from whatever version your kubelet is running, so that's why it still says version 1.28.0.

Once we upgrade kubelet, it'll then point to 1.29.3. But let's go back to the documentation and let's go ahead and see the next steps. So after we run the kubeadm upgrade apply,

- Finally run, 'kubectl uncordon <node-name>' to make that node schedulable as 'kubectl drain' command made the node unschedulable.

★ The kubectl get nodes command displays the version of the kubelets running on each node, not the version of the API server it self, which is why it still shows the master node at version 1.11 after upgrading the kubelet to version 1.12. The kubelet is primarily responsible for managing containers on a node. It is a worker node component.

```
bash

# Upgrade kubeadm tool
apt-get install kubeadm=1.12.x-00

# Upgrade control plane components
kubeadm upgrade apply v1.12.x

# Upgrade kubelet on master (if applicable)
apt-get install kubelet=1.12.x-00
systemctl restart kubelet

# Upgrade kubelet on worker nodes
apt-get install kubelet=1.12.x-00
systemctl restart kubelet

# Uncordon the node
kubectl uncordon <node-name>
```



Best Practices

Considerations:

- Choose an upgrade strategy based on downtime tolerance.
- Plan for potential pod rescheduling delays.

Conclusion

- Control plane components upgrade first.
- Worker nodes upgrade next, ensuring minimal impact on applications.
- Strategies: All at once, one at a time, or adding new nodes.

Demo - Upgrading Kubernetes Cluster

Saturday, April 13, 2024 12:41 AM

Example - We are upgrading our cluster from v1.28 to v1.29

To upgrade your cluster, you'll perform the following steps:

Identify Your Distribution:

- Check which Linux distribution your servers are using, as the commands may vary slightly. You can do this by running `cat /etc/*release*` to see your distribution details.

```
All rights reserved

controlplane ~ ➔ kubectl get node
NAME      STATUS   ROLES      AGE     VERSION
controlplane   Ready    control-plane   98m    v1.28.0
node01       Ready    <none>    98m    v1.28.0

I
controlplane ~ ➔ cat /etc/*release*
DISTRIB_ID=Ubuntu
DISTRIB_RELEASE=20.04
DISTRIB_CODENAME=focal
DISTRIB_DESCRIPTION="Ubuntu 20.04.6 LTS"
NAME="Ubuntu"
VERSION="20.04.6 LTS (Focal Fossa)"
ID=ubuntu
ID_LIKE=debian
PRETTY_NAME="Ubuntu 20.04.6 LTS"
VERSION_ID="20.04"
HOME_URL="https://www.ubuntu.com/"
SUPPORT_URL="https://help.ubuntu.com/"
BUG_REPORT_URL="https://bugs.launchpad.net/ubuntu/"
PRIVACY_POLICY_URL="https://www.ubuntu.com/legal/terms-and-policies/privacy-policy"
VERSION_CODENAME=focal
UBUNTU_CODENAME=focal

controlplane ~ ➔
```

Update Package Repository:

- Replace the old package repository definition with the new one that corresponds to the version you're upgrading to. Run the command provided in the documentation, making sure to specify the correct minor version.

```
echo "deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] https://pkgs.k8s.io/core:/stable:/v1.29/deb/ /" | sudo tee /etc/apt/sources.list.d/kubernetes.list
```

```
curl -fsSL https://pkgs.k8s.io/core:/stable:/v1.29/deb/Release.key | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-apt-keyring.gpg
```

Download Signing Key:

- Download the public signing key for the Kubernetes package repositories using the command provided in the documentation. Again, ensure you specify the version you're upgrading to.

Update Package List:

- Run apt-get update to update the package list with the new repositories.

Determine Upgrade Version:

- Use apt-cache madison kubeadm to see the available versions for upgrading. Select the latest version within the desired minor release.

Determine which version to upgrade to

Find the latest patch release for Kubernetes 1.29 using the OS package manager:

Ubuntu, Debian or HypriotOS CentOS, RHEL or Fedora

```
# Find the Latest 1.29 version in the list.
# It should look like 1.29.x-*, where x is the latest patch.
sudo apt update
sudo apt-cache madison kubeadm
```

Upgrade kubeadm:

- Use the command apt-get install -y kubeadm=<version> to upgrade kubeadm to the selected version.
For the first control plane node

1. Upgrade kubeadm:

Ubuntu, Debian or HypriotOS CentOS, RHEL or Fedora

```
# replace x in 1.29.x-* with the latest patch version
sudo apt-mark unhold kubeadm && \
sudo apt-get update && sudo apt-get install -y kubeadm='1.29.x-*' && \
sudo apt-mark hold kubeadm
```

- Run 'kubeadm version' to verify.

Check Upgrade Plan:

- Run sudo kubeadm upgrade plan to verify the upgrade plan and check for any compatibility issues.

3. Verify the upgrade plan:

-

```
sudo kubeadm upgrade plan
```

Apply Upgrade:

- Execute `sudo kubeadm upgrade apply v<version>` to apply the upgrade to your cluster. This will upgrade the control plane components automatically.

Upgrade kubelet:

- After upgrading kubeadm, you'll need to manually upgrade the kubelet process on each control plane node. Drain the nodes, upgrade kubelet, restart kubelet, and then uncordon the node to resume scheduling pods.
- **We have to manually upgrade kubelet, Because kubelet is not running in a pod, so we have to upgrade it ourselves.**

Upgrade Worker Nodes:

- Repeat the process for upgrading worker nodes by upgrading kubeadm, running '`sudo kubeadm upgrade node`', draining the node, upgrading kubelet, restarting kubelet, and uncording the node.
- Run '`sudo kubeadm upgrade node`' instead of '`kubeadm upgrade apply`'

Repeat for Each Node:

- If you have multiple nodes, repeat the upgrade steps for each node until your entire cluster is upgraded to the desired version.

★ To ssh into the worker node, run '`ssh <node-name>`

? What is controlplane node?

A control plane node, also known as a master node, is responsible for managing the Kubernetes cluster's control plane components, such as the API server, controller manager, scheduler, and etcd. It acts as the central management hub for the cluster.

? Does every command runs on controlplane node such as `kubectl get pods`, `kubectl create -f pod.yaml`?

Not every command runs on the control plane node. Commands like `kubectl get pods`, `kubectl create -f`

`pod.yaml`, and other `kubectl` commands are client-side commands that interact with the Kubernetes API server, which is typically hosted on the control plane node. These commands can be run from any machine that has `kubectl` configured to connect to the cluster, not necessarily from the control plane node itself.

?

Do we need to ssh into worker node to run any command on it like 'sudo apt update'?

You do not need to SSH into a worker node to run Kubernetes-related commands like `kubectl` commands. These commands are executed from the client machine where `kubectl` is installed and configured.

?

Can we ssh into the master node also, if yes how, if no then why we don't ssh into contolplane?

You can SSH into the master node if necessary, but it's generally not recommended or necessary for routine management tasks in Kubernetes. Instead, you interact with the cluster using `kubectl` or other Kubernetes client tools from your local machine or a dedicated management node. SSHing into the control plane node is typically reserved for advanced troubleshooting or administrative tasks that cannot be performed through standard Kubernetes management tools.

?

When do we need to ssh into the worker node?

You typically need to SSH into a worker node in Kubernetes for specific troubleshooting or administrative tasks that cannot be accomplished through standard Kubernetes management tools like `kubectl`. Here are some scenarios when you might need to SSH into a worker node:

Troubleshooting Pods: If a pod is not behaving as expected or encountering issues that cannot be diagnosed through `kubectl` commands or logs, you might SSH into the worker node hosting that pod to inspect the pod's logs or check its environment directly.

Node-Level Debugging: Sometimes, you may need to investigate node-level issues such as networking problems, disk utilization, or other system-level issues that impact pods running on that node.

Software Installation/Configuration: Installing additional software or configuring system-level settings on a specific worker node may require SSH access to that node.

Node Maintenance: During node maintenance tasks such as upgrading the operating system, kernel, or other node-specific components, you might SSH into the node to perform these tasks.

Container Runtimes: If you are using container runtimes other than the default (e.g., Docker), you might need to SSH into the worker node to manage or troubleshoot the container runtime directly.

Security Audits and Monitoring: In some cases, for security audits or performance monitoring purposes, you may SSH into worker nodes to gather specific metrics or perform security checks.

It's important to note that SSHing into worker nodes should be done cautiously and only by authorized personnel, as direct access to nodes can potentially disrupt cluster operations if not handled carefully. It's generally recommended to perform routine management and monitoring tasks through Kubernetes APIs and tools like `kubectl` whenever possible.

lab 2

Saturday, April 13, 2024 1:18 PM

- ? How many nodes can host workloads in this cluster?

Check the taints on both controlplane and node01. If none exists, then both nodes can host workloads.

By running the `kubectl describe node` command, we can see that neither nodes have taints.

```
root@controlplane:~# kubectl describe nodes controlplane | grep -i taint
Taints:          <none>
root@controlplane:~#
root@controlplane:~# kubectl describe nodes node01 | grep -i taint
Taints:          <none>
root@controlplane:~#
```

This means that both nodes have the ability to schedule workloads on them.

- ? How many applications are hosted on the cluster?

Run the below command and count the number of deployments:

```
root@controlplane:~# kubectl get deployments.apps
NAME    READY   UP-TO-DATE   AVAILABLE   AGE
blue    5/5     5           5           119s
root@controlplane:~#
```

We have 1 deployment called blue

- ? You are tasked to upgrade the cluster. Users accessing the applications must not be impacted, and you cannot provision new VMs. What strategy would you use to upgrade the cluster?

Upgrade one node at a time

- ? What is the latest version available for an upgrade with the current version of the kubeadm tool installed?

Run the **kubeadm upgrade plan** command

```
[upgrade/versions] Target version: v1.28.9
[upgrade/versions] Latest version in the v1.28 series: v1.28.9

Components that must be upgraded manually after you have upgraded
them via 'kubeadm upgrade apply':
COMPONENT      CURRENT        TARGET
kubelet        2 x v1.28.0    v1.28.9
```

1.28.9

Upgrade the controlplane components to exact version v1.29.0

Solution

Upgrade the kubeadm tool (if not already), then the controlplane components, and finally the kubelet.

Practice referring to the Kubernetes documentation page.

To seamlessly transition from Kubernetes v1.28 to v1.29 and gain access to the packages specific to the desired Kubernetes minor version, follow these essential steps during the upgrade process. This ensures that your environment is appropriately configured and aligned with the features and improvements introduced in Kubernetes v1.29.

On the `controlplane` node:

Use any text editor you prefer to open the file that defines the Kubernetes apt repository.

```
vim /etc/apt/sources.list.d/kubernetes.list
```

Update the version in the URL to the next available minor release, i.e v1.29.

```
deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] https://pkgs
```

After making changes, save the file and exit from your text editor.

Proceed with the next instruction.

```
root@controlplane:~# apt update  
root@controlplane:~# apt-cache madison kubeadm
```

After making changes, save the file and exit from your text editor.

Proceed with the next instruction.

```
root@controlplane:~# apt update  
root@controlplane:~# apt-cache madison kubeadm
```

Based on the version information displayed by `apt-cache madison`, it indicates that for Kubernetes version `1.29.0`, the available package version is `1.29.0-1.1`. Therefore, to install kubeadm for Kubernetes `v1.29.0`, use the following command:

```
root@controlplane:~# apt-get install kubeadm=1.29.0-1.1
```

Run the following command to upgrade the Kubernetes cluster.

```
root@controlplane:~# kubeadm upgrade plan v1.29.0  
root@controlplane:~# kubeadm upgrade apply v1.29.0
```

Note that the above steps can take a few minutes to complete.

Now, upgrade the version and restart Kubelet. Also, mark the node (in this case, the "controlplane" node) as schedulable.

```
root@controlplane:~# apt-get install kubelet=1.29.0-1.1  
root@controlplane:~# systemctl daemon-reload  
root@controlplane:~# systemctl restart kubelet  
root@controlplane:~# kubectl uncordon controlplane
```

Next is the worker node. Drain the worker node of the workloads and mark it UnSchedulable

```
kubectl drain node01 --ignore-daemonsets
```

ssh into the node01.

On the `node01` node, run the following commands:

If you are on the `controlplane` node, run `ssh node01` to log in to the `node01`.

Use any text editor you prefer to open the file that defines the Kubernetes apt repository.

```
vim /etc/apt/sources.list.d/kubernetes.list
```

Update the version in the URL to the next available minor release, i.e v1.29.

```
deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] https://pkgs.k8s.io/core:/stable:/v1.29/deb/ /
```

```
vim /etc/apt/sources.list.d/kubernetes.list
```

```
deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg]
https://pkgs.k8s.io/core:/stable:/v1.29/deb/ /
```

After making changes, save the file and exit from your text editor.
Proceed with the next instruction.

```
root@node01:~# apt update  
root@node01:~# apt-cache madison kubeadm
```

Based on the version information displayed by `apt-cache madison`, it indicates that for Kubernetes version `1.29.0`, the available package version is `1.29.0-1.1`. Therefore, to install kubeadm for Kubernetes `v1.29.0`, use the following command:

```
root@node01:~# apt-get install kubeadm=1.29.0-1.1  
# Upgrade the node  
root@node01:~# kubeadm upgrade node
```

Now, upgrade the version and restart Kubelet.

```
root@node01:~# apt-get install kubelet=1.29.0-1.1  
root@node01:~# systemctl daemon-reload  
root@node01:~# systemctl restart kubelet
```

Type `exit` or `logout` or enter `CTRL + d` to go back to the `controlplane` node.

Type exit or logout or enter CTRL + d to go back to the controlplane node

What is the current version of the cluster?

kubectl get nodes and look at the VERSION

Backup and Restore

Monday, March 4, 2024 6:59 PM

Backup Considerations

1. Backup Candidates:

- etcd cluster: Stores all cluster-related information.
- Resource Configurations: Definition files for deploying pod, deployment, and services.
- Persistent Storage:

Resource Configurations Backup

A. Declarative Approach:

- Store all object definition files such as pod-definition files in source code repositories like github.
- In this way, it will be easily reusable and shareable.

B. Imperative Approach:

- Query the Kube API server using '`kubectl get all --all-namespaces -o yaml > all-deploy-services.yaml`' to get all resource configurations.
- Save the configurations for all objects as a copy.
- Use tools like Ark (Velero) for automated backups of kubernetes cluster using kubernetes API.

etcd Backup

1. etcd Snapshot:

- etcd stores information about the cluster state. So, instead of backing up 'resource config', you can directly back up 'etcd cluster'.
★ • etcd cluster is hosted on master node.
• While configuring etcd, we specified a location where all the data would be stored, the data directory. That is the directory that can be configured to be backed up by your backup tool.

```
etc.service
ExecStart=/usr/local/bin/etcd \
--name ${ETCD_NAME} \
--cert-file=/etc/etcd/kubernetes.pem \
--key-file=/etc/etcd/kubernetes-key.pem \
--peer-cert-file=/etc/etcd/kubernetes.pem \
--peer-key-file=/etc/etcd/kubernetes-key.pem \
--trusted-ca-file=/etc/etcd/ca.pem \
--peer-trusted-ca-file=/etc/etcd/ca.pem \
--peer-client-cert-auth \
--client-cert-auth \
--initial-advertise-peer-urls https://${INTERNAL_IP}:2380 \
--listen-peer-urls https://${INTERNAL_IP}:2380 \
--listen-client-urls https://${INTERNAL_IP}:2379,http://${INTERNAL_IP}:2379 \
--advertise-client-urls https://${INTERNAL_IP}:2379 \
--initial-cluster-token etcd-cluster-0 \
--initial-cluster controller-0=https://${CONTROLLER0_IP}:2380 \
--initial-cluster-state new \
--data-dir=/var/lib/etcd
```

- Backup the etcd server or use its built-in snapshot solution.
- Take a snapshot using **etcdctl snapshot save <snapshot-name>**.

```
▶ ETCCTL_API=3 etcdctl \
    snapshot save snapshot.db
```

You can view the status of backup using 'etcdctl snapshot status <snapshot-name> e.g. snapshot.db>

```
▶ ETCCTL_API=3 etcdctl \
    snapshot status snapshot.db
+-----+-----+-----+-----+
| HASH | REVISION | TOTAL KEYS | TOTAL SIZE |
+-----+-----+-----+-----+
| e63b3fc5 | 473353 | 875 | 4.1 MB |
+-----+-----+-----+-----+
```

Restore Process

- Stop the Kube API server service. Run 'service kube-apiserver stop'.
- Run 'etcdctl snapshot restore' command with the path to the backup file. When etcd restores from a backup, it initializes a new cluster configuration and configures the members of etcd as new members to a new cluster. This is to prevent a new member from accidentally joining an existing cluster.

Restore - ETCD



ETCD Cluster

```
▶ ETCCTL_API=3 etcdctl \
  snapshot restore snapshot.db \
  --data-dir /var/lib/etcd-from-backup
```

I | mvcc: restore compact to 475629

```
▶ ETCCTL_API=3 etcdctl \
  snapshot save snapshot.db
```

```
▶ ls
snapshot.db
```

```
▶ service kube-apiserver stop
Service kube-apiserver stopped
```

etcd.service

```
ExecStart=/usr/local/bin/etcd \
--name ${ETCD_NAME} \
--cert-file=/etc/etcd/kubernetes.pem \
--key-file=/etc/etcd/kubernetes-key.pem \
--peer-cert-file=/etc/etcd/kubernetes.pem \
--peer-key-file=/etc/etcd/kubernetes-key.pem \
--trusted-ca-file=/etc/etcd/ca.pem \
--peer-trusted-ca-file=/etc/etcd/ca.pem \
--peer-client-cert-auth \
--client-cert-auth \
--initial-advertise-peer-urls https:// ${INTERNAL_IP}
--listen-peer-urls https:// ${INTERNAL_IP}:2380 \
--listen-client-urls https:// ${INTERNAL_IP}:2379,https:// ${INTERNAL_IP}:2379
--advertise-client-urls https:// ${INTERNAL_IP}:2379 \
--initial-cluster-token etcd-cluster-0 \
--initial-cluster controller-0=https:// ${CONTROLLER0}:2380 \
--initial-cluster-state new \
--data-dir=/var/lib/etcd-from-backup
```

"etcdctl snapshot restore snapshot.db --data-dir /var/lib/etcd-from-backup"

The etcdctl snapshot restore command is used to restore an etcd snapshot from a file. Here's a breakdown of the command you provided:

- **etcdctl:** This is the command-line tool for interacting with etcd, a distributed key-value store used by Kubernetes for storing cluster state.
- **snapshot restore:** This subcommand is used to restore an etcd snapshot.
- **snapshot.db:** This is the name of the snapshot file that you want to restore. Replace snapshot.db with the actual filename of your etcd snapshot.
- **--data-dir /var/lib/etcd-from-backup:** This flag specifies the directory where the restored data will be stored. Replace /var/lib/etcd-from-backup with the desired directory path on your system.

In summary, the etcdctl snapshot restore command restores an etcd snapshot from a specified file (snapshot.db) and stores the restored data in the specified data directory (/var/lib/etcd-from-backup). This command is useful for recovering etcd data from backups in case of data loss or corruption.

- Configure the etcd configuration file to use the new data directory (--data-dir).
- Reload the service demon and restart etcd service.

```
▶ systemctl daemon-reload
```

```
▶ service etcd restart
```

- Start the Kube API server service - run 'service kube-apiserver start'.

3. Authentication and Endpoint Configuration:

- Specify certificate files for authentication.

- Specify the etcd cluster endpoint and certificate details.

```
▶ ETCDCCTL_API=3 etcdctl \
    snapshot save snapshot.db \
    --endpoints=https://127.0.0.1:2379 \
    --cacert=/etc/etcd/ca.crt \
    --cert=/etc/etcd/etcd-server.crt \
    --key=/etc/etcd/etcd-server.key
```

4. Considerations:

- The restore process creates a new cluster configuration to prevent accidental joining of an existing cluster.
- Specify the necessary certificate files for authentication.

★ If you're using a managed Kubernetes environment, then, at times, you may not even access to the etcd cluster.

In that case, backup by querying the Kube API server is probably the better way.

Backup Methods Comparison

1. etcd Backup:

- Directly backup etcd data directory or use etcdctl snapshot.
- Requires access to etcd cluster.
- Useful for fine-grained control.

2. Kube API Server Query:

- Query and save resource configurations using kubectl.
- Suitable for managed Kubernetes environments.
- Backup by querying the API server without direct etcd access.

etcdctl

Wednesday, April 24, 2024 12:11 PM

etcdctl is a command line client for etcd.

In all our Kubernetes Hands-on labs, the ETCD key-value database is deployed as a static pod on the master. The version used is v3.

To make use of etcdctl for tasks such as backup and restore, make sure that you set the ETCDCTL_API to 3. You can do this by exporting the variable ETCDCTL_API before using the etcdctl client. This can be done as follows:

```
export ETCDCTL_API=3
```

On the Master Node:

```
master $ export ETCDCTL_API=3
master $ etcdctl version
etcdctl version: 3.3.13
API version: 3.3
master $
```

To see all the options for a specific sub-command, make use of the -h or --help flag. For example, if you want to take a snapshot of etcd, use:

'etcdctl snapshot save -h' and keep a note of the mandatory global options.

Since our ETCD database is TLS-Enabled, the following options are mandatory:

--cacert	verify certificates of TLS-enabled secure servers using this CA bundle
--cert	identify secure client using this TLS certificate file
--endpoints=[127.0.0.1:2379]	This is the default as ETCD is running on master node and exposed on localhost 2379.

--key	identify secure client using this TLS key file
-------	--

Similarly use the help option for snapshot restore to see all available options for restoring the backup.

```
etcdctl snapshot restore -h
```

For a detailed explanation on how to make use of the etcdctl command line tool and work with the -h flags, check out the solution video for the Backup and Restore Lab.

```
apt-get install etcd-client
```

lab 3

Wednesday, April 24, 2024 12:14 PM

What is the version of ETCD running on the cluster?

Look at the ETCD Logs using the command **kubectl logs etcd-controlplane -n kube-system**

OR

check the image used by the ETCD pod: **kubectl describe pod etcd-controlplane -n kube-system**

The screenshot shows a terminal window with three tabs: 'Task', 'Hint', and 'Solution'. The 'Solution' tab is selected. The terminal output is as follows:

```
Look at the ETCD Logs using the command kubectl logs etcd-controlplane -n kube-system or check the image used by the ETCD pod: kubectl describe pod etcd-controlplane -n kube-system

root@controlplane:~# kubectl -n kube-system logs etcd-controlplane | grep -i 'etcd-version'
"caller":"embed/etcd.go:306","msg":"starting an etcd server","etcd-version":"3.5.7","git-sha":"215b53cf3"

root@controlplane:~# kubectl -n kube-system describe pod etcd-controlplane | grep Image:
    Image:      registry.k8s.io/etcd:3.5.7-0
root@controlplane:~#
```

? At what address can you reach the ETCD cluster from the controlplane node?

Use the command **kubectl describe pod etcd-controlplane -n kube-system** and look for **--listen-client-urls**.

? What is the difference between "IP" and "listen-client-urls"

IP: 192.19.119.9
--listen-client-urls=https://127.0.0.1:2379,https://192.19.119.9:2379

"IP" refers to the actual IP address of the system, which in this case is 192.19.119.9. On the other hand, --listen-client-urls is a configuration option for etcd, a distributed key-value store, specifying the URLs clients can use to connect to the etcd server.

The --listen-client-urls option specifies the URLs where the etcd server listens for client connections. In your example, it indicates that the etcd server is configured to listen for client connections on two URLs:

<https://127.0.0.1:2379>: This URL is for clients connecting from the local machine (localhost).

<https://192.19.119.9:2379>: This URL is for clients connecting from the external IP address 192.19.119.9.

So, "IP" refers to the specific IP address of the system, --listen-client-urls defines the URLs through which clients can access the etcd server, including both the local loopback address (127.0.0.1) and the external IP address (192.19.119.9).

Where is the ETCD server certificate file located?

Check the ETCD pod configuration with the command: `kubectl describe pod etcd-controlplane -n kube-system` and look for the value for `--cert-file`:

```
root@controlplane:~# kubectl -n kube-system describe pod etcd-controlplane | grep '--cert-file'
--cert-file=/etc/kubernetes/pki/etcd/server.crt
root@controlplane:~#
```

The master node in our cluster is planned for a regular maintenance reboot tonight. While we do not anticipate anything to go wrong, we are required to take the necessary backups. Take a snapshot of the ETCD database using the built-in snapshot functionality.

Solution

Use the etcdctl snapshot save command. You will have to use additional flags to connect to the ETCD server.

- `--endpoints`: Optional Flag, points to the address where ETCD is running (127.0.0.1:2379)
- `--cacert`: Mandatory Flag (Absolute Path to the CA certificate file)
- `--cert`: Mandatory Flag (Absolute Path to the Server certificate file)
- `--key`: Mandatory Flag (Absolute Path to the Key file)

/etc/kubernetes/pki/etcd

Run the command:

```
root@controlplane:~# ETCDCTL_API=3 etcdctl --endpoints=https://[127.0.0.1]:2379 \
--cacert=/etc/kubernetes/pki/etcd/ca.crt \
--cert=/etc/kubernetes/pki/etcd/server.crt \
--key=/etc/kubernetes/pki/etcd/server.key \
snapshot save /opt/snapshot-pre-boot.db

Snapshot saved at /opt/snapshot-pre-boot.db
root@controlplane:~#
```

You may also refer the solution [here](#)

? I want to take backup of etcd , which ip should i choose or I can choose anyone - --listen-client-urls=https://127.0.0.1:2379,https://192.20.125.8:2379

You can choose either IP address (127.0.0.1 or 192.20.125.8) from the --listen-client-urls option for taking the backup of etcd. Both IPs are valid and can be used for this purpose.

kubernetes service

Restore

Restore the original state of the cluster using the backup file.

The data-dir parameter in an etcd manifest file specifies the directory where etcd stores its data.

First Restore the snapshot:

```
root@controlplane:~# ETCDCTL_API=3 etcdctl --data-dir /var/lib/etcd-from-backup \
snapshot restore /opt/snapshot-pre-boot.db

2022-03-25 09:19:27.175043 I | mvcc: restore compact to 2552
2022-03-25 09:19:27.266709 I | etcdserver/membership: added member 8e9e05c52164694d [http://localhost:2380] to
root@controlplane:~#
```

Note: In this case, we are restoring the snapshot to a different directory but in the same server where we took the backup (**the controlplane node**) As a result, the only required option for the restore command is the `--data-dir`.

Next, update the `/etc/kubernetes/manifests/etcd.yaml`:

We have now restored the etcd snapshot to a new path on the controlplane - `/var/lib/etcd-from-backup`, so, the only change to be made in the YAML file, is to change the hostPath for the volume called `etcd-data` from old directory (`/var/lib/etcd`) to the new directory (`/var/lib/etcd-from-backup`).

```
volumes:
- hostPath:
  path: /var/lib/etcd-from-backup
  type: DirectoryOrCreate
  name: etcd-data
```

With this change, `/var/lib/etcd` on the container points to `/var/lib/etcd-from-backup` on the `controlplane` (which is what we want).

When this file is updated, the `ETCD` pod is automatically re-created as this is a static pod placed under the `/etc/kubernetes/manifests` directory.

Note 1: As the ETCD pod has changed it will automatically restart, and also `kube-controller-manager` and `kube-scheduler`. Wait 1-2 to mins for this pods to restart. You can run the command: `watch "crictl ps | grep etcd"` to see when the ETCD pod is restarted.

Note 2: If the etcd pod is not getting `Ready 1/1`, then restart it by `kubectl delete pod -n kube-system etcd-controlplane` and wait 1 minute.

We need to choose a different data-dir to restore the backup. So, we write `--data-dir /var/lib/etcd-from-backup`.

Note 1: As the ETCD pod has changed it will automatically restart, and also `kube-controller-manager` and `kube-scheduler`. Wait 1-2 to mins for this pods to restart. You can run the command: `watch "crictl ps | grep etcd"` to see when the ETCD pod is restarted.

Note 2: If the etcd pod is not getting `Ready 1/1`, then restart it by `kubectl delete pod -n kube-system etcd-controlplane` and wait 1 minute.

Note 3: This is the simplest way to make sure that ETCD uses the restored data after the ETCD pod is recreated. You don't have to change anything else.

If you do change `--data-dir` to `/var/lib/etcd-from-backup` in the ETCD YAML file, make sure that the `volumeMounts` for `etcd-data` is updated as well, with the `mountPath` pointing to `/var/lib/etcd-from-backup`
(THIS COMPLETE STEP IS OPTIONAL AND NEED NOT BE DONE FOR COMPLETING THE RESTORE)

If you do change `--data-dir` to `/var/lib/etcd-from-backup` in the ETCD YAML file, make sure that the `volumeMounts` for `etcd-data` is updated as well, with the `mountPath` pointing to `/var/lib/etcd-from-backup`

The `data-dir` parameter in the `etcd` configuration specifies the directory where `etcd` stores its data. This is a configuration setting within `etcd` itself.

On the other hand, `volumeMounts` in Kubernetes are used to mount volumes from a Kubernetes Volume into the container. This is how Kubernetes manages storage for containers.

When you change the `data-dir` in the `etcd` configuration to a different location like `/var/lib/etcd-from-backup`, you also need to ensure that Kubernetes mounts this directory correctly into the `etcd` container using `volumeMounts`. This is because Kubernetes manages the storage for containers and needs to ensure that the container has access to the specified directory.

In summary, `data-dir` is a configuration setting within `etcd` itself, while `volumeMounts` are used by Kubernetes to provide storage to containers. When you change the `data-dir` location, you also need to update the `volumeMounts` to ensure that Kubernetes mounts the correct directory into the container.

If `<data-dir-location>` is the same folder as before, delete it and stop the `etcd` process before restoring the cluster. Otherwise, change `etcd` configuration and restart the `etcd` process after restoration to have it use the new data directory.

```
ps aux | grep etcd
kill <etcd-process-PID>
```

lab 4

Thursday, May 2, 2024 10:20 AM

MOST IMPORTANT TIPS

When taking a backup where the etcd server is present in the same cluster, using --listen-client-url as the endpoint is suitable because it allows etcd to listen on specific client URLs for incoming connections within the cluster.

On the other hand, when the etcd server is external, using --advertise-client-url as the endpoint is appropriate. This option allows etcd to advertise a specific client URL for external communication, ensuring that it communicates externally using the designated IP address or network interface.

Context

- If you work with multiple Kubernetes clusters, contexts help you switch between these environments.
- Each context represents a distinct Kubernetes environment. Switching contexts allows you to isolate and organize your work based on different clusters, ensuring that your actions and commands are directed to the correct environment.
- Context switching helps prevent accidental changes or operations on the wrong cluster.
- When you switch the context to cluster 1, all subsequent commands and operations you perform will be related to cluster 1 only. This includes actions like viewing nodes, deploying applications, inspecting resources, and managing configurations.

To explore the clusters accessible from the student-node, you can use the following command:

```
kubectl config view
```

How many clusters are defined in the kubeconfig on the student-node?

```
k config view
student-node ~ ➔ k config view
apiVersion: v1
clusters:
- cluster:
  certificate-authority-data: DATA+OMITTED
  server: https://cluster1-controlplane:6443
  name: cluster1
- cluster:
  certificate-authority-data: DATA+OMITTED
  server: https://192.6.18.11:6443
  name: cluster2
contexts:
```

Answer: 2 - Cluster1 and Cluster2

How many nodes (both controlplane and worker) are part of cluster1?

Switch to cluster1 - kubectl config use-context cluster1
kubectl get nodes

What is the name of the controlplane node in cluster2?

kubectl config use-context cluster2
kubectl get node

You can SSH to all the nodes (of both clusters) from the student-node.

```
ssh <name-of-node>
ssh cluster1-controlplane
```

To get back to the student node, use the logout or exit command, or, hit Control +D

It's possible to SSH from one node to another in different clusters, it requires proper networking, security configurations, permissions, and access controls to be in place.

How is ETCD configured for cluster1?

```
kubectl config use-context cluster1
kubectl get pods -n kube-system | grep etcd
```

You will notice that etcd is running as a pod.

In cluster1, when you look at the pods running in the kube-system area, you'll see that **etcd**, which is responsible for storing cluster data, **runs as a pod**. This setup is known as a **Stacked ETCD Topology**, where etcd's data storage system is placed on top of the cluster formed by the nodes managed by kubeadm, which handles control plane components like scheduling and management.

It's like having a storage layer (etcd) stacked on top of the infrastructure layer (nodes and control plane) to manage and store data effectively within the Kubernetes environment.

OR

```
kubectl describe pod <kube-apiserver> -n kube-system
```

If etcd-server is present with local host IP (127. something), it means it's **Stacked ETCD Topology**.

What if there is no etcd pod running in the cluster?

1. ssh into the control plane of the cluster and search for etcd manifest file.

```
ssh <controlplane-node-name>
ls /etc/kubernetes/manifests/ | grep -i etcd
```

2. If you still don't find anything means etcd is not running as a Stacked ETCD Topology.
Let's look for if etcd is set up as External etcd

However, if you inspect the process on the controlplane for cluster2, you will see that that the process for the kube-apiserver is referencing an external etcd datastore:

```
ssh <controlplane-node-name>
ps -ef | grep etcd
```

3. ssh <controlplane-node-name>

```
kubectl describe pod <kube-apiserver-name> -n kube-system
```

If etcd-server is present with separate IP (192. something), it means it's **External ETCD Topology** bcoz etcd-server points to some file in local such as /etc/kubernetes/pki/etcd/<>.

- External etcd refers to running the etcd data store service separately from the Kubernetes cluster.
- Etcd is deployed as its own service or cluster, independent of the Kubernetes control plane components.
- Kubernetes control plane components (like kube-apiserver, kube-controller-manager, kube-scheduler) communicate with the external etcd service to store and retrieve cluster state information.

ps -ef and ps -aux

The ps command in Linux is used to display information about running processes.

- -e: Selects all processes.
- -f: Produces a full-format listing, providing more details like UID, PID, PPID, C, STIME, TTY, TIME, and CMD.

- -a: Selects all processes.
- -u: Displays processes belonging to the specified user or all users.
- -x: Includes processes without a controlling terminal.

IP of external etcd

```
ssh <controlplane-node-name>
ps -ef | grep etcd
```

What is the default data directory used for ETCD datastore used in cluster1?

```
kubectl config use-context cluster1
```

```
kubectl -n kube-system describe pod <etcd-pod-name> | grep data-dir
```

What is the default data directory used for ETCD datastore used in cluster2?

Remember, this cluster uses an External ETCD topology.

ssh into the external etcd using its IP or name

```
ssh etcd-server
ps -ef | grep -i etcd
```

-i` or `--ignore-case`: Ignores case distinctions in patterns and input data.

How many nodes are part of the ETCD cluster that etcd-server is a part of?

member list command

- To run etcdctl command, first set the version name.
- SSH to the etcd server using ssh **etcd-server** and then run **ps -ef | grep -i etcd**
- **Here you can** find the information that you need to pass to the etcdctl command like endpoint, cacert etc.
 - endpoint = look for listen-client-url (eg . 127.0.0.1:2379 in output of above command, listen-client-url because we need info from etcd)
 - cacert = look for trusted-ca-file
 - cert = look for cert-file
 - key = look for key-file

```
ETCDCTL_API=3 etcdctl --endpoints 10.2.0.9:2379 --cert=/etc/kubernetes/pki/etcd/server.crt --key=/etc/kubernetes/pki/etcd/server.key --cacert=/etc/kubernetes/pki/etcd/ca.crt member list
```

Take a backup of etcd on cluster1 and save it on the student-node at the path /opt/cluster1.db

- kubectl config use-context cluster1
- Next, inspect the endpoints and certificates used by the etcd pod. We will make use of these to take the backup.
kubectl describe pods -n kube-system etcd-cluster1-controlplane | grep pki
- SSH to the controlplane node of cluster1 and then take the backup using the endpoints and

certificates we identified above:

endpoint= advertise-client-url

```
ETCDCTL_API=3 etcdctl --endpoints=https://10.1.220.8:2379 --
cacert=/etc/kubernetes/pki/etcd/ca.crt
--cert=/etc/kubernetes/pki/etcd/server.crt
--key=/etc/kubernetes/pki/etcd/server.key
snapshot save /opt/cluster1.db
```

- endpoint =look for advertised-client-url

- cacert= look for trusted-ca-file
- cert = look for cert-file
- key = look for key-file

- Finally, copy the backup to the student-node. To do this, go back to the student-node and use scp as shown below:

```
ssh student-node
scp cluster1-controlplane:/opt/cluster1.db /opt
```

SCP - Secure Copy Protocol, used to move files to and from remote machines.

- verify using ls /opt command in the student-node.

Advertised Client URL vs Listen Client URL for --endpoint

- advertise-client-url - Specifies the URL that the etcd server advertises to clients for API access
- listen-client-url (192, 127) - Defines the IP addresses and ports that the etcd server listens on for client connections.
- listen-metric-url - Sets the URL for exposing metrics and statistics related to etcd's performance and health.

"client" refers to any program or system that interacts with the etcd server, such as applications or other components within the Kubernetes cluster.

★ When you want to access data from the etcd server, you typically use the listen-client-urls because these are the URLs where the etcd server is listening for incoming client requests. These URLs are usually internal to the cluster or network.

On the other hand, when you want to expose the etcd server to clients outside of its immediate environment, you use the advertise-client-url. This URL is what clients outside the cluster or network use to connect to the etcd server.

For security purposes, the cacert (Certificate Authority certificate), cert (server certificate), and key (private key associated with the server's certificate) remain the same in both cases. They ensure secure communication and authentication between the etcd server and its clients, regardless of whether they are internal or external.

Restore backup for cluster 2 stored at /opt/cluster2.db. Use this snapshot to carry out a restore on cluster2 to a new path /var/lib/etcd-data-new

1. Send the file to etcd-server from cluster2

```
scp /opt/cluster2.db etcd-server:/root
★ scp <location of backup db> <name of server>:<location of path of this server>
```

2. ssh to etcd-server and confirm
ssh etcd-server
cd ~
ls

3. ETCDCTL_API=3 etcdctl snapshot restore <location of backup eg. /root/cluster2.db> --data-dir

<where you want to restore>

```
ETCDCTL_API=3 etcdctl snapshot restore /root/cluster2.db --data-dir /var/lib/etcd-data-new
```

4. Verify and change the owner to etcd of it's root user

```
ls -la
```

```
if it's root then,  
chown -R etcd:etcd etcd-data-new/
```

Again verify if user is etcd or not

5. Change the configuration on etcd

```
vi /etc/systemd/system/etcd.service
```

Change the --data-dir to change it to new folder which is --data-dir-new (As given in question that carry out restore to a new path)

6. systemctl daemon-reload

7. systemctl restart etcd

8. Verify using "systemctl status etcd", if it's running or not

9. Delete controller-manager and scheduler from cluster 2

```
kubectl delete pod <controller-manager> <scheduler> -n kube-system
```

It will again come back and start running

Ssh back to master node
systemctl restart kubelet

scp

scp <jo copy karna hai> <jaha par paste karna hai>

scp /opt/cluster2.db etcd-server:/root

The scp command is used for securely copying files between a local host and a remote host or between two remote hosts. Here's a breakdown of the command you provided:

- **scp**: This is the command itself, indicating that you're using Secure Copy to transfer files.
- **/opt/cluster2.db**: This is the file you want to copy. It's located in the /opt directory on your local host.
- **etcd-server:/root**: This is the destination for the file. You're specifying a remote host named etcd-server, and you want to copy the file to the /root directory on that remote host.

So, the overall command **scp /opt/cluster2.db etcd-server:/root** means "Copy the file cluster2.db from my local host's /opt directory to the /root directory on the remote host named etcd-server, using Secure Copy (scp) for the transfer."

scp cluster1-controlplane:/opt/cluster1.db /opt

The command you provided copies the file cluster1.db from the directory /opt on the cluster1-controlplane server to the local directory /opt. Here's a breakdown of the command:

scp: The command used for secure copy.

- cluster1-controlplane: The hostname or IP address of the remote server from which the file is being copied.
- ./opt/cluster1.db: The path to the file cluster1.db on the remote server.
- ./opt: The destination directory on the local machine where the file will be copied.

After running this command, the file cluster1.db from the remote server will be copied to the /opt directory on your local machine.

Upgrading

Monday, May 6, 2024 3:19 AM

1.29.16

Major = 1

Minor - 29

Patch = 16

Upgrading Controlplane Nodes

1. We will be upgrading the controlplane node first. Drain the controlplane node of workloads and mark it UnSchedulable

k drain controlplane --ignore-daemonsets

Verify using "k get pods" and make sure that all the controlplane nodes are now on other node (node01)

2. Check the Linux distro

cat /etc/*release*

UBUNTU

3. Now open the kubernetes doc, select the appropriate version e.g. Upgrading cluster from v1.19.0 to v1.20.0

4. Since, the distro is Ubuntu, Select only "Ubuntu Command"

```
apt update  
apt-cache madison kubeadm
```

5. Upgrade kubeadm. Select the latest version which is just greater than the current version. e.g. If current version is 1.29.16 then select 1.30.9-0 (latest patch of next major version)

```
sudo apt-mark unhold kubeadm && \  
sudo apt-get update && sudo apt-get install -y kubeadm='1.30.9-0' && \  
sudo apt-mark hold kubeadm
```

6. Verify that the download works and has the expected version:

kubeadm version

7. Verify the upgrade plan:

```
sudo kubeadm upgrade plan
```

Run the command "kubeadm upgrade apply v1.30.9 that will appear as output to above command.
Press "y"

8. Choose a version to upgrade to, and run the appropriate command. For example:

```
# replace x=9 with the patch version you picked for this upgrade
```

```
sudo kubeadm upgrade apply v1.30.9
```

Press "y"

9. Upgrade kubelet and kubectl

```
sudo apt-mark unhold kubelet kubectl && \
sudo apt-get update && sudo apt-get install -y kubelet='1.30.9-0' kubectl='1.30.9-0' && \
sudo apt-mark hold kubelet kubectl
```

10. Restart the kubelet:

```
sudo systemctl daemon-reload
sudo systemctl restart kubelet
```

11. kubectl uncordon controlplane

Worker Node

1. k drain node01 --ignore-daemonsets - Run this on Master node as kubectl runs on master node only.
2. ssh node01
3. Upgrade kubeadm

```
sudo apt-mark unhold kubeadm && \
sudo apt-get update && sudo apt-get install -y kubeadm=1.20.0-0 && \
sudo apt-mark hold kubeadm
```

4. Verify that the download works and has the expected version:

```
kubeadm version
```

5. Verify the upgrade plan:

```
sudo kubeadm upgrade plan
```

6. Upgrade the kubelet and kubectl:

```
sudo apt-mark unhold kubelet kubectl && \
sudo apt-get update && sudo apt-get install -y kubelet=1.20.0-0 kubectl=1.20.0-0 && \
sudo apt-mark hold kubelet kubectl
```

```
sudo systemctl daemon-reload
sudo systemctl restart kubelet
```

7. exit

```
k get nodes
```

8. k uncordon node01 --ignore-daemonsets

```
k get nodes
```

?

Why we need to unhold kubelet kubectl and kubeadm and then holdwhile upgrading, explain in short.

```
sudo apt-mark unhold kubeadm && \
sudo apt-get update && sudo apt-get install -y kubeadm=1.20.0-0 && \
sudo apt-mark hold kubeadm
```

```
sudo apt-mark unhold kubelet kubectl && \
sudo apt-get update && sudo apt-get install -y kubelet=1.20.0-0 kubectl=1.20.0-0 && \
sudo apt-mark hold kubelet kubectl
```

what does hold and unhold means?

In Kubernetes upgrades, you often need to hold (prevent updates) or unhold (allow updates) specific components like kubeadm, kubelet, and kubectl to ensure a smooth upgrade process.

- Hold: When you hold a package, it prevents the package manager from automatically updating that package. This is useful during upgrades to ensure that specific versions of critical components remain unchanged until the upgrade process is complete.
- Unhold: Conversely, when you unhold a package, it allows the package manager to update that package. This is necessary when you want to upgrade specific components to newer versions as part of the upgrade process.

In the provided commands:

- `sudo apt-mark unhold kubeadm && ... && sudo apt-mark hold kubeadm`: Unholds kubeadm to allow updating to version 1.20.0-0, performs the update, and then holds it again to prevent further automatic updates.
- `sudo apt-mark unhold kubelet kubectl && ... && sudo apt-mark hold kubelet kubectl`: Unholds kubelet and kubectl, updates them to version 1.20.0-0, and then holds them again to maintain version stability.

These commands ensure that during the upgrade process, the specified components are updated to the desired versions without interference from automatic updates that could disrupt the upgrade.

Imp Topics

Monday, May 6, 2024 1:02 PM

Volume
pV
pVC
hostPath
emptyDir
hostPath
secret
configMaps

Docker Storage

Monday, March 4, 2024 11:08 PM

Bind Mount vs Volumes

Bind Mount:

- This refers to mounting a specific directory from the host machine into a container. It allows the container to access and modify the host's files directly.

Volume:

- In Docker, a volume is a preferred method for persisting data generated by and used by Docker containers. It's a managed filesystem that's part of Docker's storage system, isolated from the host filesystem but accessible by containers.
- Docker volumes are stored on the host but are managed and accessed to isolate them from direct host filesystem access, ensuring containerized applications can interact with data securely and independently.
- Docker manages volumes, making them easier to use and maintain than manually managing bind mounts.

Bind Mount

Bind mounts will mount a file or directory onto your container from your host machine, which you can then reference via its absolute path.

- To use bind mounts, the file or directory does not need to exist on your Docker host already. If it doesn't exist, it will be created on demand.
- Bind mounts rely on the host machine's filesystem having a specific directory structure available. You must explicitly create a path to the file or folder to place the storage.

Another important piece of information about bind mounts is that they give access to sensitive files. According to the Docker docs, you can change the host filesystem through processes running in a container. This includes creating, modifying, and deleting system files and directories, which can have pretty severe security implications. It could even impact non-Docker processes.

When you use a volume, a new directory is created within Docker's storage directory on the host machine, and Docker manages that directory's contents.

Bind Mounts:

A bind mount allows you to link a specific folder or file from the host machine to a specific path within a container. With bind mounts, the data is directly shared between the host and the container.

Usage:

```
docker run -v /host/path:/container/path myimage
```

Here, changes made in /host/path on the host are immediately reflected in /container/path in the container, and vice versa.

Docker Volumes:

Docker volumes, on the other hand, are managed by Docker and provide a higher level of abstraction. They are intended for sharing and persisting data between containers. Docker volumes create a dedicated folder within the Docker data directory on the host machine.

Usage:

```
docker volume create my_volume  
docker run -v my_volume:/container/path myimage
```

Here, Docker creates a volume named my_volume within its data directory, and the data in /container/path within the container is stored in that volume.

In summary:

Bind Mounts: Directly link a host folder or file to a container path. Changes are immediately reflected on both sides.

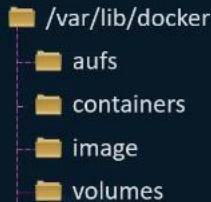
Docker Volumes: Managed by Docker, providing a more abstracted way to handle data. Volumes have their own lifecycle and can be easily shared between containers. They are stored within the Docker data directory on the host.

Both bind mounts and Docker volumes serve different use cases, and the choice between them depends on factors like persistence, ease of management, and the specific requirements of your application.

Overview of Docker File System Structure

Default Docker Data Location:

File system



- Docker stores data in **/var/lib/docker/**.
- The filepath `/var/lib/docker/` is a common location where Docker stores its data on the Docker host. This filepath is specific to Linux-based systems where Docker is running directly on the host machine.
- For windows it's `C:\Users\<your_username>\AppData\Local\Docker`
- Subfolders include containers, images, volumes, etc.
- Files related to containers are stored under the 'container' folder and files related to images are stored under the 'image' folder.
- Any volumes created by docker are stored under the volumes folder.

Docker Layered Architecture

Layered Architecture:



- Docker builds images in a layered architecture.
- Each instruction in Dockerfile creates a new layer.
- Layers store changes from the previous layer.
- Advantages: Faster image builds, efficient disk space usage.

Image Layers and Copy-on-Write Mechanism

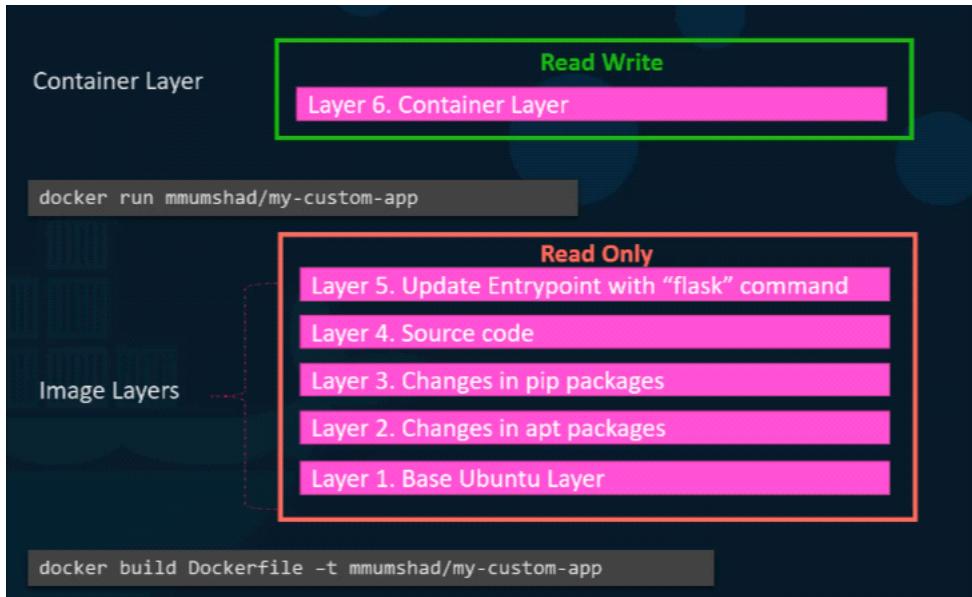


Image Layers:

- Image layers are read-only and created during image build.
- Each layer represents changes made by a Dockerfile instruction.
- Docker utilizes a copy-on-write mechanism for file modifications.
- Future modifications create a copy in a read-write layer.

Container Writeable Layer:

- Containers create a new writeable layer on top of the image layer.
- Stores data generated by the container (e.g., log files, temporary files).
- The life of this layer is as long as container is alive. When container gets destroyed, this layer and all of the changes stored in it are also destroyed.

★ The same image layer is shared by all containers created using this image.

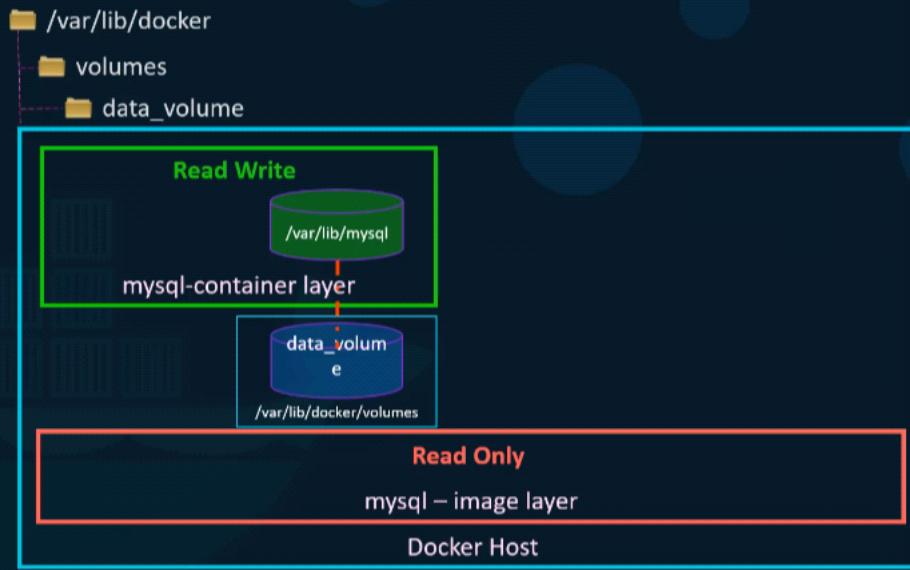
Persistent Data with Volumes

volumes

```
docker volume create data_volume
```

```
docker run -v data_volume:/var/lib/mysql mysql
```

```
docker run -v data_volume2:/var/lib/mysql mysql
```



Docker Volumes:

- Create volumes using 'docker volume create <volume-name>'. It creates a folder inside the '`/var/lib/docker/volumes`'
- Mount volumes to containers using -v or --mount options. To mount this volume to a container's directory run 'docker run -v <volume-name>:<directory-inside-the-container> <image-name>
 - docker run: This part of the command instructs Docker to run a new container based on the specified image.
 - -v `data_volume:/var/lib/mysql`: This option creates and mounts a volume named `data_volume` and links it to the directory `/var/lib/mysql` within the container. `/var/lib/mysql` is the default location where MySQL stores data. This volume is used to store the MySQL database files persistently, separate from the container's filesystem. If the `data_volume` does not exist, Docker creates it automatically.
 - mysql: This specifies the Docker image to use for running the container. In this case, it's the official MySQL image available on Docker Hub.

When you run this command, Docker performs the following actions:

- Checks if the `data_volume` Docker volume exists. If not, it creates it.
 - Creates a new container based on the MySQL image.
 - Mounts the `data_volume` to the container's `/var/lib/mysql` directory, ensuring that MySQL data files are stored in the volume.
 - Starts the MySQL service within the container, allowing you to interact with the MySQL database.
-
- This is called Volume mounting. Volume data persists even if the container is destroyed.

Volume Mounting Types:

- Volume Mounting: Mounts a volume from the volumes directory.
 - Bind Mounting: Mounts a directory from any location on the Docker host.
- ```
docker run -v /data/mysql:/var/lib/mysql mysql
```
- Use -v for volume mounting and --mount for more verbose options.

Volume Mounting Commands:

- docker volume create <volume-name>: Creates a volume.
- docker run -v <volume-name>:<container-path> <image>: Volume mounting.
- docker run -v /host/path:/container/path <image>: Bind mounting.

Bind Mounting:

- Mounts a directory from the Docker host into the container.
- Example: docker run -v /data/mysql:/var/lib/mysql mysql

Volume Creation during Container Run:

If a specified volume doesn't exist, Docker creates it automatically.

New Syntax for Volume Mounting:

Use --mount option for more explicit and verbose syntax.

- ★ Always use --mount for mounting the data volumes with type,source and target options.

```
docker run -v /data/mysql:/var/lib/mysql mysql
```

```
docker run \
--mount type=bind,source=/data/mysql,target=/var/lib/mysql mysql
```

source = location on my host

target = location on my container

- ★ All these operations maintaining the layered architecture, creating a writeable layer, moving files across layers to enable copy and write, etc. are done by storage drivers.
- ★ Volumes are not handled by 'Storage Drivers', volumes are handled by 'Volume Driver Plugins'. The default volume driver plugin is local. The local volume plugin helps create a volume on the Docker host and store its data under the var/lib/docker/volumes directory.

## Docker Storage Drivers

Storage Drivers:

- Responsible for implementing Docker's file system and layered architecture.
- Common storage drivers include AUFS, VFS, ZFS, device mapper, overlay, and overlay2.
- Docker automatically selects the best available driver based on the OS. e.g Ubuntu uses AUFS

## Performance Characteristics:

- Different storage drivers offer varied performance and stability.
- Selection depends on the underlying operating system and application needs.

# Storage Drivers

Monday, March 4, 2024 11:10 PM



- When you run a Docker container you can choose to use a specific volume driver such as the REX-Ray EBS to provision a volume from Amazon EBS. This will create a container and attach a volume from the AWS Cloud. When the container exits, your data is safe in the cloud.

# Volume Drivers

Monday, March 4, 2024 11:10 PM

```
▶ docker run -it \
--name mysql
--volume-driver rexray/ebs
--mount src=ebs-vol,target=/var/lib/mysql
mysql
```

# CSI

Tuesday, April 2, 2024 12:04 AM

## Container Storage Interface (CSI)

### Background:

- Kubernetes initially used Docker as the sole container runtime engine.
- The introduction of other runtimes (e.g., RKT, CRI-O) prompted the need for a standardized interface that's when CRI was developed.
- Container Runtime Interface (CRI): It is a standard that defines how an orchestration solution(e.g. Kubernetes ) would communicate with container runtimes(e.g. Docker).

### Need for Container Storage Interface (CSI)

- Diverse Storage Solutions:
  - Kubernetes requires flexibility in supporting various storage solutions.
  - Docker was embedded within Kubernetes, limiting compatibility.
  - The introduction of multiple storage options necessitated a standardized interface.

## Container Storage Interface (CSI)

### Purpose:

- **Standardizes how orchestration solutions interact with container runtimes.**
- Allows the development of storage drivers for diverse storage solutions.
- Eliminates the need to modify Kubernetes source code for each storage solution.

### Universal Standard:

- Not Kubernetes-specific; intended as a universal standard.
- Enables any container orchestration tool to work with any storage vendor with a supported CSI plugin.

### Adoption:

- Embraced by Kubernetes, Cloud Foundry, and Mesos.
- Widely adopted by various storage vendors, each providing their own CSI drivers.
- CSI Workflow and Architecture

### CSI Architecture:

- Defines Remote Procedure Calls (RPCs) to be implemented by storage drivers.
- Orchestrator (e.g., Kubernetes) calls specific RPCs, and storage drivers handle requests.

### Example RPCs:

- Create Volume RPC: Orchestrator requests volume creation, passing details like volume name.
- Delete Volume RPC: Orchestrator requests volume deletion, and storage driver decommissions the volume.

Specification Details:

- CSI specification on GitHub details RPC parameters, expected responses, and error codes.

## Conclusion and Resources

Universal Compatibility:

- CSI enables interoperability between container orchestrators and storage vendors.
- Kubernetes can integrate seamlessly with various storage solutions using CSI.

Resources:

- Explore the CSI specification on GitHub for in-depth details.
- Learn more about specific CSI drivers provided by different storage vendors.

The Container Storage Interface (CSI) is a crucial component in the world of container orchestration, especially in platforms like Kubernetes. Here's a breakdown of what CSI is and how it works:

Why CSI Exists:

- Diversification of Container Runtimes: Initially, Kubernetes heavily relied on Docker as its container runtime. However, with the emergence of other runtimes like RKT and CRI-O, there was a need to standardize how Kubernetes interacts with these runtimes.
- Avoiding Code Embeddedness: CSI was introduced to prevent Kubernetes from embedding specific code for each storage solution directly into its source code. This decoupling allows for better flexibility and easier integration of new storage solutions without modifying the core Kubernetes codebase.

CSI and Standardization:

- Container Runtime Interface (CRI): Similar to CRI for runtimes and CNI for networking, CSI provides a standard interface for storage systems to integrate with Kubernetes. It defines how Kubernetes communicates with storage solutions.
- Universal Compatibility: CSI is designed to be a universal standard, not limited to Kubernetes alone. It enables any container orchestration tool to work seamlessly with any storage vendor that supports the CSI standard.

## How CSI Works:

- **RPCs (Remote Procedure Calls):** CSI defines a set of RPCs that container orchestrators like Kubernetes use to interact with storage systems. These RPCs include operations like creating volumes, attaching volumes to pods, resizing volumes, etc.
- **Responsibilities:** When Kubernetes needs to perform storage-related tasks (like creating or deleting volumes), it calls the appropriate RPCs defined by CSI. The storage driver, which implements these RPCs, then handles the requests and interacts with the underlying storage infrastructure.

## Key Concepts:

- **Flexibility:** CSI allows storage vendors to develop their own drivers (CSI plugins) that conform to the CSI standards. This enables a wide range of storage solutions to be used with Kubernetes.
- **Interoperability:** Kubernetes, Cloud Foundry, Mesos, and other container orchestration platforms that support CSI can seamlessly integrate with storage vendors' solutions via CSI plugins.

## Practical Implementation:

- **Usage in Kubernetes:** When Kubernetes needs to provision or manage storage resources, it interacts with the appropriate CSI plugins using the defined RPCs.
- **CSI Specification:** The details of how CSI works, including RPC definitions, parameter passing, error handling, etc., are documented in the CSI specification. This specification is publicly available on GitHub for reference and implementation.

In essence, CSI streamlines the integration of diverse storage solutions with Kubernetes and other container orchestration platforms, fostering compatibility, flexibility, and ease of management for storage-related tasks in containerized environments.

## Volumes in K8s

Monday, March 4, 2024 11:22 PM

### Volumes

#### Persistent Volumes



```
pv-definition.yaml
apiVersion: v1
kind: PersistentVolume
metadata:
 name: pv-vol1
spec:
 accessModes:
 - ReadWriteOnce
 capacity:
 storage: 1Gi
 awsElasticBlockStore:
 volumeID: <volume-id>
 fsType: ext4

▶ kubectl create -f pv-definition.yaml

▶ kubectl get persistentvolume
NAME CAPACITY ACCESS MODES RECLAIM POLICY STATUS CLAIM STORAGECLASS REASON AGE
pv-vol1 1Gi RWO Retain Available 3m
```

Persistent Volume (PV)

#### Modes

|               |
|---------------|
| ReadOnlyMany  |
| ReadWriteOnce |
| ReadWriteMany |

## Introduction to Volumes in Kubernetes

Transient(lasting only for a short time, ephemeral) Nature of Containers:

- Docker containers are ephemeral(designed for short-lived tasks).
- Data within Docker containers is also temporary and gets deleted with the container.

Volumes in Docker:

- **To persist data beyond the container's lifespan, volumes are attached.**
- Data processed or generated by a container is stored in a volume to retain it permanently.

- Volumes help retain data even after the associated container is deleted.

## Implementation in Kubernetes

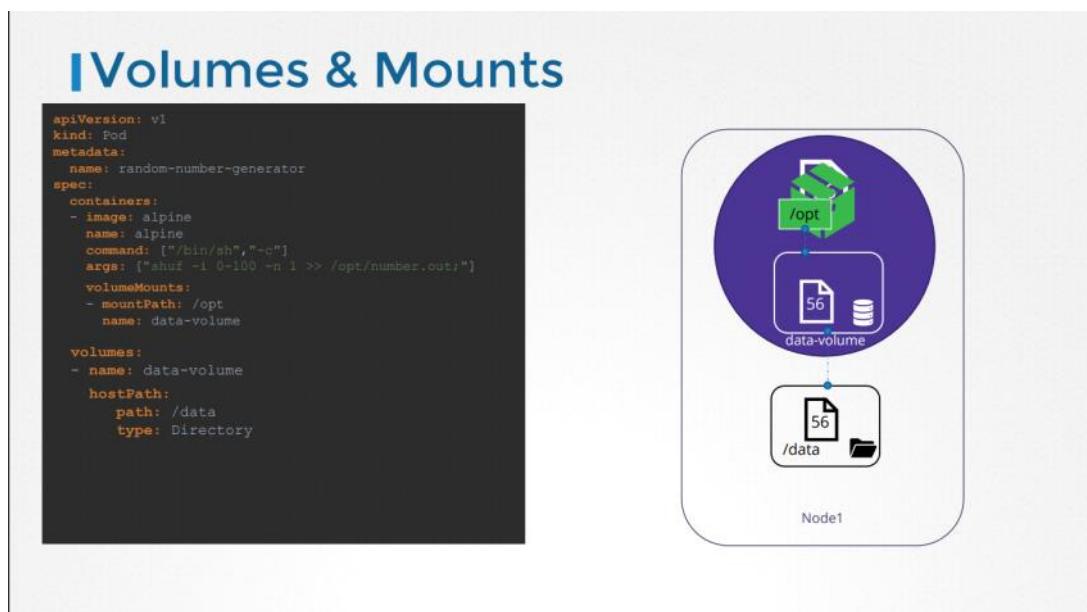
Transient Pods in Kubernetes:

- **Pods in Kubernetes share a similar transient nature.**
- When a pod processes data and is deleted, the processed data within the pod is also lost.

Using Volumes in Kubernetes:

- Similar to Docker, Kubernetes uses volumes to persist data beyond pod lifetimes.
- Volume attached to a pod stores data, ensuring its persistence even after the pod deletion.

Example Implementation:

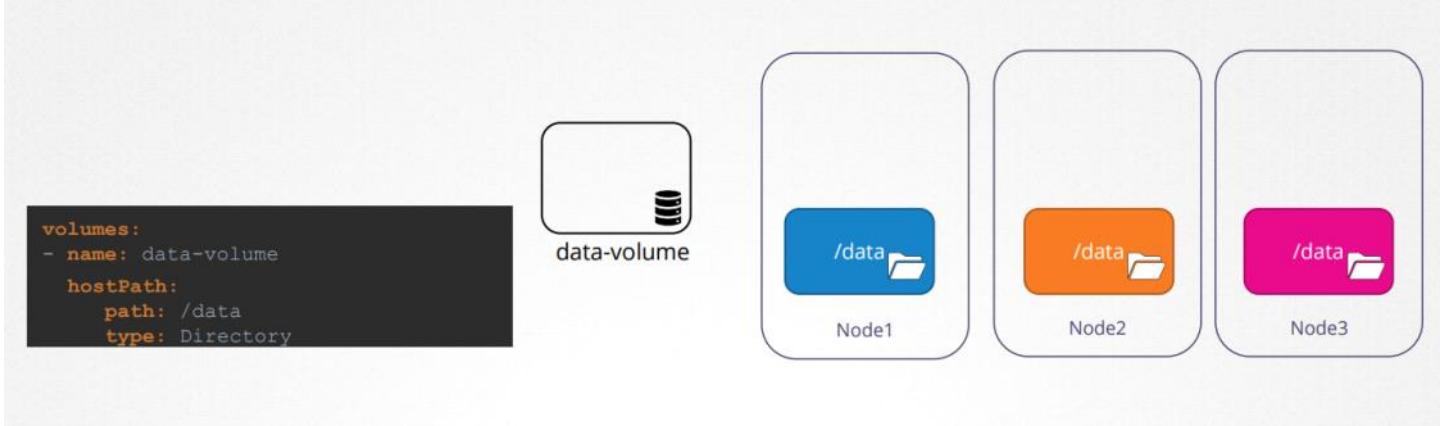


- In the above example, In a single-node Kubernetes cluster, a pod generates a random number(command and args mentioned) and writes it to `/opt/number.out`.
- A volume is created with host path configuration, specifying the `'/data'` directory on the host as storage.
- Volume is mounted to the `'/opt'` directory inside the pod.
- This ensures that the random number is stored in the `'/data'` directory on the host, persisting even after pod deletion.

## Volume Storage Options in Kubernetes

### hostPath





- Directly configures a directory on the host node as storage for the volume.
- **It works fine in a single-node cluster but is not recommended for multi-node clusters** because the pods would use the /data directory on all the nodes, and expect all of them to be the same and have the same data. Since they're on different servers, they're not the same.

Considerations for Multi-Node Clusters:

- The host path option is not recommended for multi-node clusters due to inconsistencies across nodes.
- Different nodes may have distinct /data directories; external storage solutions are more suitable.

## Storage Solutions in Kubernetes

Kubernetes-Compatible Storage Solutions:

- Kubernetes supports various storage solutions for volumes.
- Examples include NFS, ClusterFS, Flocker, Fiber Channel, Ceph FS, ScaleIO, and public cloud solutions like AWS EBS, Azure Disk, and Google's Persistent Disk.

Configuration Example:

```

volumes:
- name: data-volume
 awsElasticBlockStore:
 volumeID: <volume-id>
 fsType: ext4

```

- To use AWS Elastic Block Store (EBS) as volume storage:
  - Replace the host path field with the AWS EBS field.
  - Include volume ID and file system type for EBS configuration.

Explain this:-

```

spec:
 containers:
 - image: registry.k8s.io/test-webserver
 name: test-container
 volumeMounts:

```

```
- mountPath: /cache
 name: cache-volume
volumes:
- name: cache-volume
 emptyDir:
 sizeLimit: 500Mi
```

It means that this kubernetes host has a volume which name is "cache-volume" of type emptydir and 500Mi size limit and this volume is mounted to the container at /cache and the name of mount is also "cache-volume" (volume mount name can be different).

## hostPath vs emptyDir

- With hostPath, you mount a directory from the host node's filesystem into a Pod.
- The directory specified in hostPath is accessible to the Pod, but it's tied to the specific node where the Pod is scheduled.
- It works fine in a single-node cluster

emptyDir:

- emptyDir is a temporary storage volume
- It's created empty when the Pod starts, and it's unique to that Pod.
- The data in an emptyDir volume persists as long as the Pod is running on the node. If the Pod is deleted or rescheduled to another node, the data in emptyDir is lost.
- It's useful for sharing files between containers in the same Pod or for storing temporary data that's only needed during the Pod's lifecycle.

# Persistent Volumes

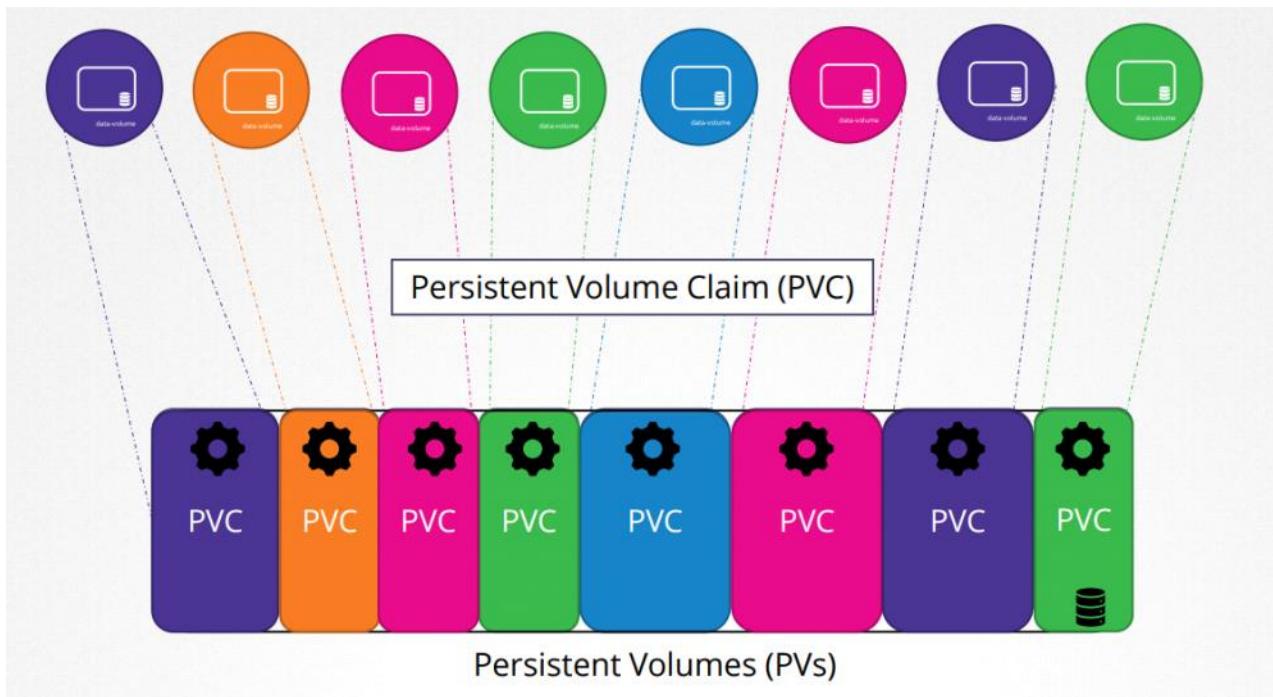
Tuesday, April 2, 2024 12:07 AM

## Introduction to Persistent Volumes (PVs)

Context from Previous Lecture:

- In the single node cluster, volumes were configured within pod definition files.
- For large environments, when you want to deploy a pod you have to edit the pod definition file each time for the storage and it will be a difficult task.

Centralized Storage Management:



- **Persistent Volumes (PVs)** provide a cluster-wide pool of storage configured by an administrator.
- PVs allow administrators to manage storage centrally and enable the users to select storage from this pool for their pods using PVC.

## Creating a Persistent Volume (PV)

PV Definition Template:

### pv-definition.yaml

```
apiVersion: v1
kind: PersistentVolume
metadata:
 name: pv-voll
spec:
 accessModes:
 - ReadWriteOnce
 capacity:
 storage: 1Gi
 hostPath:
 path: /tmp/data
```

### pv-definition.yaml

```
apiVersion: v1
kind: PersistentVolume
metadata:
 name: pv-voll
spec:
 accessModes:
 - ReadWriteOnce
 capacity:
 storage: 1Gi
 awsElasticBlockStore:
 volumeID: <volume-id>
 fsType: ext4
```

ReadOnlyMany

ReadWriteOnce

ReadWriteMany

```
kubectl create -f pv-definition.yaml
```

```
kubectl get persistentvolume
```

| NAME    | CAPACITY | ACCESS MODES | RECLAIM POLICY | STATUS    | CLAIM | STORAGECLASS | REASON | AGE |
|---------|----------|--------------|----------------|-----------|-------|--------------|--------|-----|
| pv-voll | 1Gi      | RWO          | Retain         | Available |       |              |        | 3m  |

Persistent Volume (PV)

- Start with a base template and update the API version - "v1".
- Set the kind to "PersistentVolume" and assign a name, e.g., "pv-voll"

### Specifying Access Modes:

- Define access modes to determine how a volume should be mounted on hosts.
- Access modes include ReadOnlyMany, ReadWriteOnce, or ReadWriteMany.

**ReadOnlyMany (ROX):** **Multiple Pods can read from the volume concurrently**, but they cannot write to it. This mode is suitable for scenarios where multiple Pods need read-only access to the same data, such as sharing configuration files or static content.

**ReadWriteOnce (RWO):** The volume can be mounted as read-write by a single Pod. **It allows one Pod to read from and write to the volume exclusively**. This mode is commonly used for scenarios where a single Pod requires read-write access to persistent data, such as databases or applications that need to write to files.

**ReadWriteMany (RWX): Multiple Pods can read from and write to the volume concurrently.** This mode allows for shared read-write access among multiple Pods. It is typically used for scenarios like shared storage or file sharing where multiple Pods need to read from and write to the same volume simultaneously.

#### Setting Capacity:

- Specify the amount of storage to be reserved for the persistent volume.
- Example: Set capacity to 1 GB.

#### Volume Type:

- The initial example uses the hostPath option (not recommended for production).
- For production, replace hostPath with supported storage solutions like AWS Elastic Block Store.

#### Creating and Listing Persistent Volumes:

- Use 'kubectl create' command to create the persistent volume.
- Use 'kubectl get persistentvolume' command to list created volumes.

## Transition to Supported Storage Solutions

#### Caution on hostPath:

- The **hostPath option uses storage from the node's local directory** and is not suitable for production environments.

#### Exploring Other Storage Solutions:

- Replace hostPath with supported storage solutions seen in previous lectures (e.g., AWS Elastic Block Store).

# Persistent Volume Claims(PVC)

Tuesday, March 5, 2024 12:32 PM

- Administrator Creates Persistent Volumes
- User creates Persistent Volumes Claims (PVCs)
- There is a one-to-one relationship between PV and PVC.

Persistent Volume Claim is bound to the Persistent Volume based on pvc-definition and pv-definition config file resp.

```
pvc-definition.yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
 name: myclaim
spec:
 accessModes:
 - ReadWriteOnce
 resources:
 requests:
 storage: 500Mi

▶ kubectl get persistentvolumeclaim
NAME STATUS VOLUME CAPACITY ACCESS MODES
myclaim Pending
```

```
▶ kubectl create -f pvc-definition.yaml
```

```
pvc-definition.yaml
```

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
 name: myclaim
spec:
 accessModes:
 - ReadWriteOnce
 resources:
 requests:
 storage: 500Mi
```

```
pv-definition.yaml
```

```
apiVersion: v1
kind: PersistentVolume
metadata:
 name: pv-vol1
spec:
 accessModes:
 - ReadWriteOnce
 capacity:
 storage: 1Gi
 awsElasticBlockStore:
 volumeID: <volume-id>
 fsType: ext4
```

```
▶ kubectl create -f pvc-definition.yaml
```

?

Do, PV and PVC must have same access modes in kubernetes storage?

Here's how the matching works:

If a PVC requests a specific access mode (e.g., RWO), Kubernetes will try to find a PV with a compatible access mode (e.g., RWO) and sufficient capacity.

If no PV with an exact match is found, Kubernetes may still bind the PVC to a PV with a different access mode if that mode is compatible with the PVC's requirements and no exact match is available.

It's essential to understand the implications of access modes:

If a PVC requests RWO access and gets bound to a PV with RWX access, the PVC will still function but may not fully utilize the RWX capability.

If a PVC requests RWX access and no PV with RWX is available, the PVC will remain unbound until a suitable PV becomes available.

So, while matching access modes can ensure optimal utilization, Kubernetes can handle variations in access modes based on compatibility and availability.

?

What happens to the underlying persistent volume when we delete the persistent volume claims?

- By default, it is set to retain. This means the persistent volume **will remain until it is manually deleted** by the administrator. It is not available for reuse by any other claims.

**persistentVolumeReclaimPolicy:** Retain

- PV can also be deleted automatically as soon as PVC gets deleted for this set .

**persistentVolumeReclaimPolicy:** Delete

- PV can also be recycled, in this case, **data in data volumes will be securely erased or cleaned before making it available to other claims.**

**persistentVolumeReclaimPolicy:** Recycle

## Overview of Persistent Volume Claims (PVCs)

Relationship with Persistent Volumes (PVs):

- Administrator Role: Creates Persistent Volumes (PVs).
- User Role: Creates Persistent Volume Claims (PVCs) to use storage from PVs.
- PVCs bind to PVs based on request criteria and properties.

Binding Process:

- Binding associates a PVC with a single PV.
- Kubernetes matches PV to PVC based on request criteria (capacity, access modes, etc.).
- Labels and selectors can be used for specific bindings if there are multiple matches.

Capacity Matching:

- Smaller PVC may bind to a larger PV if other criteria match and no better options are available.
- One-to-one relationship: No other claims can utilize the remaining capacity in the volume.

Pending State:

- If no available volumes match a claim's criteria, the PV Claim remains in a pending state.
- It automatically binds when suitable volumes become available.

## Creating a Persistent Volume Claim (PVC)

PVC Definition Template:

- Start with a blank template.
- Set API version to v1 and kind to "persistent volume claim."
- Name the claim (e.g., "My Claim").

Specifying Access Modes and Resources:

- Set access modes (e.g., ReadWriteOnce).
- Specify requested resources, such as 500 megabytes.

Creating and Viewing PVCs:

- Use 'kubectl create' to create the PVC.
- Use 'kubectl get persistentvolumeclaim' to view created PVCs.

## Binding and Deletion

Binding Process Execution:

- When the PVC is created, Kubernetes looks for matching PVs based on criteria.
- Example: PVC in a pending state gets bound to a PV due to matching access modes and available capacity.

Deleting a PVC:

- Use '**kubectl delete persistentvolumeclaim <pvc-name>**' to delete a PVC.
- The administrator can configure the behavior of the underlying PV when a PVC is deleted.

Options for Deletion:

- Retain (Default): PV remains until manually deleted by the administrator.
- Delete: PV is automatically deleted when the PVC is deleted.
- Recycle: Data in the PV is scrubbed before making it available to other claims.

?

**To bind a PV to a pod, you must create a PVC, right?**

Yes, that's correct. In Kubernetes, to bind a Persistent Volume (PV) to a Pod, you typically follow these steps:

- **Create a Persistent Volume (PV):** This involves defining a PV resource in Kubernetes, which represents a piece of storage in the cluster. PVs can be provisioned statically by an administrator or dynamically by a storage class.
- **Create a Persistent Volume Claim (PVC):** A Persistent Volume Claim is a request for storage by a Pod. When you create a PVC, **you specify the storage requirements such as access mode, storage class, and size based on PV's spec.**
- **Bind the PVC to the Pod:** Once a PVC is created, Kubernetes tries to find a suitable PV that matches the PVC's requirements. If a matching PV is available and not already bound to another PVC, Kubernetes binds the PVC to the PV.
- **Mount the PVC in the Pod:** In the Pod's manifest file, you specify the PVC as a volume and mount it into the desired path within the Pod's containers. This allows the Pod to access the storage provided by the PVC, which is backed by the PV.

# Using PVCs in Pods

Thursday, April 11, 2024 6:01 PM

PV is for whole cluster but you can also use it for a particular pod.

Once you create a PVC use it in a POD definition file by specifying the PVC Claim name under the persistentVolumeClaim section in the volumes section like this:

```
1 | apiVersion: v1
2 | kind: Pod
3 | metadata:
4 | name: mypod
5 | spec:
6 | containers:
7 | - name: myfrontend
8 | image: nginx
9 | volumeMounts:
10 | - mountPath: "/var/www/html"
11 | name: mypd
12 | volumes:
13 | - name: mypd
14 | persistentVolumeClaim:
15 | claimName: myclaim
```

The same is true for ReplicaSets or Deployments. Add this to the pod template section of a Deployment on ReplicaSet.

# lab 1

Thursday, April 11, 2024 6:05 PM

The application stores logs at location /log/app.log. View the logs.

You can exec in to the container and open the file:

```
kubectl exec webapp -- cat /log/app.log
```

The command kubectl exec webapp -- cat /log/app.log is used to execute a command inside a running Kubernetes pod named "webapp" and display the contents of a log file named "app.log" located at the path "/log/app.log" within that pod. Here's a breakdown of the command:

**kubectl exec:** This is the Kubernetes command-line tool used to execute commands inside a container running in a pod.

**webapp:** This is the name of the pod where the command will be executed. You replace "webapp" with the actual name of your pod.

**--:** This is a separator used to distinguish between the kubectl command and the command that will be executed inside the pod.

**cat /log/app.log:** This is the command that will be executed inside the "webapp" pod. It uses the cat command to display the contents of the "app.log" file located at the path "/log/app.log" within the pod.

When you run this command, Kubernetes performs the following actions:

- Locates the pod named "webapp" in the cluster.
- Executes the cat /log/app.log command inside the container running in the "webapp" pod.
- Streams the output of the cat /log/app.log command back to your terminal, displaying the contents of the "app.log" file.

? Configure a volume to store these logs at /var/log/webapp on the host.  
Use the spec provided below.

Name: webapp

Image Name: kodekloud/event-simulator

Volume HostPath: /var/log/webapp

Volume Mount: /log

## Solution

- First delete the existing pod by running the following command: - kubectl delete po webapp
- then use the below manifest file to create a webapp pod with given properties as follows:

```

apiVersion: v1
kind: Pod
metadata:
 name: webapp
spec:
 containers:
 - name: event-simulator
 image: kodekloud/event-simulator
 env:
 - name: LOG_HANDLERS
 value: file
 volumeMounts:
 - mountPath: /log
 name: log-volume

 volumes:
 - name: log-volume
 hostPath:
 # directory location on host
 path: /var/log/webapp
 # this field is optional
 type: Directory

```

- Then run the command kubectl create -f <file-name>.yaml to create a pod.

## Hint

- Use the command kubectl get po webapp -o yaml > webapp.yaml and add the given properties under the spec.volumes and spec.containers.volumeMounts.

OR

- Use the command kubectl run to create a new pod and use the flag --dry-run=client -o yaml to generate the manifest file.
- In the manifest file add spec.volumes and spec.containers.volumeMounts property.
- After that, run the following command to create a pod called webapp: -

```
kubectl replace -f webapp.yaml --force
```

kubectl replace -f: - It will remove the existing resource and will replace it with the new one from the given manifest file.

- ?
- Create a Persistent Volume with the given specification.

Volume Name: pv-log  
Storage: 100Mi  
Access Modes: ReadWriteMany  
Host Path: /pv/log  
Reclaim Policy: Retain

## Solution

Use the following manifest file to create a pv-log persistent volume:

```
apiVersion: v1
kind: PersistentVolume
metadata:
 name: pv-log
spec:
 persistentVolumeReclaimPolicy: Retain
 accessModes:
 - ReadWriteMany
 capacity:
 storage: 100Mi
 hostPath:
 path: /pv/log
```

Then run the command `kubectl create -f <file-name>.yaml` to create a PV from manifest file.

Let us claim some of that storage for our application. Create a Persistent Volume Claim with the given specification.

Volume Name: claim-log-1

Storage Request: 50Mi

Access Modes: ReadWriteOnce

Solution manifest file to create a `claim-log-1` PVC with given properties as follows:

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
 name: claim-log-1
spec:
 accessModes:
 - ReadWriteOnce
 resources:
 requests:
 storage: 50Mi
```

Then run `kubectl create -f <file-name>.yaml` to create a PVC from the manifest file.

?

Why is the claim not bound to the available Persistent Volume?

Run the command: `kubectl get pv,pvc` and look under the Access Modes section.  
**The Access Modes set on the PV and the PVC do not match.**

Update the Access Mode on the claim to bind it to the PV.  
Delete and recreate the claim-log-1.

Volume Name: claim-log-1

Storage Request: 50Mi

PVol: pv-log

Status: Bound

To delete the existing pvc:

```
$ kubectl delete pvc claim-log-1
```

Solution manifest file to create a `claim-log-1` PVC  
with correct `Access Modes` as follows:

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
 name: claim-log-1
spec:
 accessModes:
 - ReadWriteMany
 resources:
 requests:
 storage: 50Mi
```

Then run `kubectl create -f <file-name>.yaml`

```
kubectl edit pvc claim-log-1
```

? Does name of volume mount and volume need to be same ?

```
apiVersion: v1
kind: Pod
metadata:
 name: webapp
spec:
 containers:
 - name: event-simulator
 image: kodekloud/event-simulator
 env:
 - name: LOG_HANDLERS
 value: file
 volumeMounts:
 - mountPath: /log
 name: log-volume
```

```
volumes:
- name: log-volume
 hostPath:
 # directory location on host
 path: /var/log/webapp
 # this field is optional
 type: Directory
```

No, the name of the volume mount (log-volume in this example) and the name of the volume itself (log-volume) do not need to be the same in Kubernetes. The name specified in the volumeMounts section (name: log-volume) is used to reference the volume defined in the volumes section. It's a way to associate a specific volume definition with a mount point within a container.

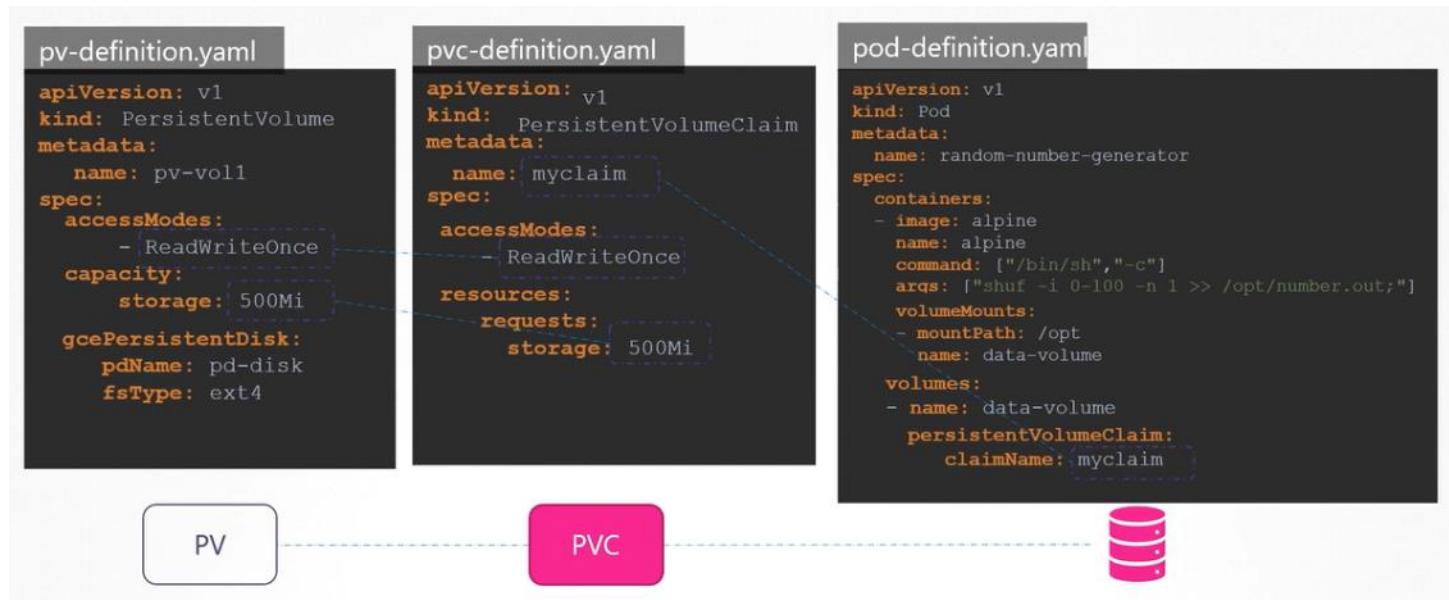
In the provided YAML snippet:

name: log-volume under volumeMounts is the name used to refer to the volume within the container where it will be mounted.  
name: log-volume under volumes is the name of the actual volume definition that specifies the volume type and its properties.  
Using different names for the volume mount and the volume itself is common and allows for clarity and flexibility in managing volumes within Kubernetes pods.

# Storage Classes

Tuesday, March 5, 2024 12:46 PM

## Static Provisioning



## Dynamic Provisioning

'storageClassName' section is added in pvc-definition file.





```

sc-definition.yaml
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
 name: google-storage
provisioner: kubernetes.io/gce-pd
parameters:
 type: pd-standard [pd-standard | pd-ssd]
 replication-type: none [none | regional-pd]

```

parameters section depends on the type of provisioner you are using.

You can create your own classes.



## Introduction to Storage Classes

Background:

- Previous lectures covered static provisioning of Persistent Volumes (PVs) and Claims (PVCs).
- Static provisioning involves manually creating disks on cloud providers before defining PVs.

Dynamic Provisioning:

- Desire for automatic provisioning of volumes when applications require them.
- Achieved through Storage Classes for dynamic provisioning of volumes.

Yes, in dynamic provisioning with storage classes in Kubernetes, both Persistent Volumes (PVs) and Persistent Volume Claims (PVCs) are created automatically as needed.

## Static and Dynamic Provisioning

Static Provisioning:

- Definition: Static provisioning involves pre-allocating storage resources (Persistent Volumes or PVs) in the Kubernetes cluster before they are needed by applications.
- Process: In static provisioning, a cluster administrator manually creates PVs and defines their properties (storage type, capacity, access modes, etc.) based on the available storage resources in the cluster.
- Usage: These pre-created PVs are then made available for consumption by applications through Persistent Volume Claims (PVCs). When an application (Pod) requests storage via a PVC, it binds to a pre-existing PV that meets its requirements.

## Dynamic Provisioning:

- Definition: Dynamic provisioning involves creating storage resources (PVs) automatically in response to application demands, without the need for manual intervention by administrators.
- Process: In dynamic provisioning, storage classes are defined in Kubernetes that specify how to provision storage dynamically. When an application requests storage via a PVC and specifies a storage class, Kubernetes automatically creates a PV that matches the criteria defined in the storage class.
- Usage: Dynamic provisioning simplifies storage management as administrators do not need to pre-provision PVs. Storage resources are created on-demand, which optimizes resource utilization and scalability.

## Comparison:

- Static provisioning requires administrators to manually create and manage PVs, which can be time-consuming and less flexible.
- Dynamic provisioning automates the process of creating PVs based on application demands, improving agility and resource utilization.
- Static provisioning is suitable for environments where storage requirements are known in advance and stable.
- Dynamic provisioning is beneficial for dynamic environments with varying storage needs and allows for efficient resource allocation.

Overall, dynamic provisioning is a more flexible and automated approach to managing storage in Kubernetes, while static provisioning provides more control but requires manual management of storage resources.

- ★ Static provisioning means setting aside storage spaces beforehand, like reserving parking spots in a parking lot. These spots are fixed and ready to use when needed.

Dynamic provisioning is like having a smart parking system that creates parking spots automatically when cars arrive. The system figures out where to put the cars without you having to reserve specific spots in advance.

## Creating a Storage Class

With storage classes, you can define a provisioner, such as Google Storage, that can automatically provision storage on Google Cloud and attach that to pods when a claim is made. That's called dynamic provisioning of volumes.

## Storage Class Definition:

- Create a Storage Class object(`sc-definition.yaml` with `apiVersion storage.k8s.io/v1`).
- Specify a name and set the provisioner (e.g., `kubernetes.io/gce-pd` for Google Cloud).

## Eliminating PV Definitions:

- With Storage Class, PV definitions are no longer required.
- PVs and associated storage are created automatically when the Storage Class is created.

## PVC with Storage Class

PVC Reference to Storage Class:

- For the PVC to use the storage class, In the PVC definition, specify the Storage Class name associated with dynamic provisioning.

Dynamic Provisioning Workflow:

- When a PVC is created, the associated Storage Class uses the provisioner to:
  - Provision a new disk on the cloud provider (e.g., Google Cloud).
  - Create a Persistent Volume automatically.
  - Bind the PVC to the dynamically created volume.

★ Dynamic Provision still creates a PV but the 'user' don't need to manually create PV anymore.

## Storage Class Provisioners

Examples of Provisioners:

- Different cloud providers and storage systems have specific provisioners (e.g., kubernetes.io/gce-pd, kubernetes.io/aws-ebs).
- Provisioners are responsible for creating disks and PVs.

Provisioner Parameters:

- Provisioners may accept additional parameters specific to the storage system.
- Examples include disk type, replication mode, etc.

## Use Cases and Customization

Flexibility of Storage Classes:

- Multiple Storage Classes can be created, each using different types of disks.
- Allows creating different classes of service (e.g., silver, gold, platinum).

Parameter Customization:

- Parameters passed to provisioners depend on the storage system.
- Example: For Google Persistent Disk, specifying disk type (standard, SSD) and replication mode (none, regional PD).

## Conclusion and Implications

### Purpose of Storage Classes:

- Enables dynamic provisioning of volumes based on predefined classes.
- Simplifies PVC creation without the need for PV definitions.

### Flexibility and Management:

- Offers flexibility to choose different types of storage based on application requirements.
- Management of different classes of service becomes more straightforward.

# lab 2

Tuesday, March 5, 2024 12:44 PM

- ?
- What is the name of the Storage Class that does not support dynamic volume provisioning?

Look for the storage class name that uses no-provisioner

| NAME                      | PROVISIONER                   | RECLAIMPOLICY | VOLUMEBINDINGMODE    | ALLOW |
|---------------------------|-------------------------------|---------------|----------------------|-------|
| VOLUMEEXPANSION           | rancher.io/local-path         | Delete        | WaitForFirstConsumer | false |
| local-path (default)      | rancher.io/local-path         | Delete        | WaitForFirstConsumer | false |
| local-storage             | kubernetes.io/no-provisioner  | Delete        | WaitForFirstConsumer | false |
| portworx-io-priority-high | kubernetes.io/portworx-volume | Delete        | Immediate            | false |
| 6s                        |                               |               |                      |       |

Answer - local-storage

- ?
- Create a new PersistentVolumeClaim by the name of local-pvc that should bind to the volume local-pv.

PVC: local-pvc

Correct Access Mode?

Correct StorageClass Used?

PVC requests volume size = 500Mi?

Hint - Inspect the pv local-pv for the specs.

Use the below YAML file to create the PersistentVolumeClaim **local-pvc**:

```

kind: PersistentVolumeClaim
apiVersion: v1
metadata:
 name: local-pvc
spec:
 accessModes:
 - ReadWriteOnce
 storageClassName: local-storage
 resources:
 requests:
 storage: 500Mi
```

- ? Why is the PVC in a pending state despite making a valid request to claim the volume called local-pv?

Hint - Inspect the PVC events.

WaitForFirstConsumer

- ? Create a new pod called nginx with the image nginx:alpine. The Pod should make use of the PVC local-pvc and mount the volume at the path /var/www/html.

The PV local-pv should be in a bound state.

Solution manifest file to create a pod called **nginx** is as follows:

```

apiVersion: v1
kind: Pod
metadata:
 name: nginx
 labels:
 name: nginx
spec:
 containers:
 - name: nginx
 image: nginx:alpine
 volumeMounts:
 - name: local-persistent-storage
 mountPath: /var/www/html
 volumes:
 - name: local-persistent-storage
 persistentVolumeClaim:
 claimName: local-pvc
```

Create a new Storage Class called delayed-volume-sc that makes use of the below specs:

provisioner: kubernetes.io/no-provisioner

volumeBindingMode: WaitForFirstConsumer

# Volume Binding Mode

Friday, April 12, 2024 12:05 PM

Immediate - The Immediate mode indicates that volume binding and dynamic provisioning occur once the PersistentVolumeClaim is created.

WaitForFirstConsumer - This will delay the binding and provisioning of a PersistentVolume until a Pod using the PersistentVolumeClaim is created.

# Commands

Friday, April 12, 2024 12:21 PM

k get sc

# Doubts

Friday, April 12, 2024 12:32 PM

A Persistent Volume (PV) is created at the cluster level, usually by a cluster administrator or someone with the necessary permissions. The PV represents a piece of storage in the cluster that can be used by applications.

A Persistent Volume Claim (PVC) is then created by a user or a workload that needs storage. The PVC requests storage with specific requirements like access mode, size, and storage class. The PVC binds to an available PV that meets its requirements, essentially claiming storage from the pool of PVs.

Finally, a Pod can use this PVC as a volume by referencing the PVC's name in its volume definition. This allows the Pod to access and use the storage provided by the PV that the PVC is bound to.

## PV is created at cluster level means?

When we say a Persistent Volume (PV) is created at the cluster level, it means that the PV is managed by the Kubernetes cluster itself rather than being specific to a particular namespace or workload.

Here's what "created at the cluster level" implies:

- Cluster Scope: PVs are resources that exist at the cluster level, meaning they are available for use by any workload or namespace within the cluster.
- Admin Responsibility: Creating and managing PVs typically falls under the responsibility of a cluster administrator. The admin sets up the storage systems, defines the PVs, and makes them available for use.
- Shared Resources: PVs are shared resources that can be claimed by Persistent Volume Claims (PVCs) from any namespace. This allows multiple workloads across different namespaces to access and use the same PV if needed.
- Storage Abstraction: PVs abstract the details of underlying storage systems from the workloads using them. Workloads request storage through PVCs based on their requirements, and Kubernetes handles the provisioning and mapping to the appropriate PV.

In summary, PVs being created at the cluster level means they are part of the shared infrastructure of the Kubernetes cluster, accessible and usable by multiple workloads across namespaces.

## PV is a storage so it must be present on particular node, right?

Not exactly. A Persistent Volume (PV) in Kubernetes represents a piece of storage that is provisioned by an administrator. It's important to understand that a PV is an abstracted resource that represents storage available to the cluster, but it doesn't necessarily reside on a specific node like other Kubernetes resources such as pods.

Here are some key points to clarify:

- **Location Agnostic:** PVs are location-agnostic in the sense that they are not tied to a specific node in the cluster. They represent storage that can be provided by various types of storage systems like NFS, local disks, cloud storage, etc.
- **Provisioned by Administrator:** PVs are provisioned by cluster administrators and made available for consumption by Persistent Volume Claims (PVCs), which are requests for storage by pods.
- **Decoupled from Nodes:** Unlike pods, which are scheduled and run on specific nodes in the cluster, PVs are independent of nodes. They are more akin to a pool of storage resources that pods can claim and use as needed.
- **Dynamic Provisioning:** While a cluster administrator can pre-provision PVs, Kubernetes also supports dynamic provisioning where PVs are automatically created based on PVC requests. In this case, the actual storage backend might be provisioned dynamically by external storage providers.

So, to sum up, PVs are not tied to specific nodes but represent abstracted storage resources that can be dynamically provisioned and used by pods across the cluster as needed.

# Imperative Commands

Monday, May 6, 2024 3:06 PM

```
kubectl create pv <pv-name> --capacity=<storage-size> --access-mode=<access-mode> --hostPath=<path-on-host>
```

```
kubectl create pvc <pvc-name> --namespace=<namespace> --storage-class=<storage-class> --volume-name=<pv-name> --access-mode=<access-mode> --resources=requests.storage=<storage-size>
```

```
kubectl create storageclass <storage-class-name> --provisioner=<provisioner-name> --parameters=<parameters>
```

```
kubectl run <statefulset-name> --image=<image-name> --replicas=<replica-count> --requests=<pvc-requests> --labels=<labels>
```

StatefulSets are a type of workload object similar to Deployments. StatefulSets provide guarantees about the ordering and uniqueness of pod names, stable network identities (hostname and DNS), and persistent storage volumes (PersistentVolumeClaims).

Deployments are suitable for stateless applications with interchangeable pods, while StatefulSets are designed for stateful applications that require stable identities, ordered deployment, and persistent storage. Choose the appropriate workload object based on the nature and requirements of your application.

In a StatefulSet:

1. Each pod has a stable and predictable identity, which is maintained across restarts and rescheduling.
2. Pods are deployed in a specific order, ensuring that each pod is started only after the previous one has been fully deployed and is ready.
3. Persistent storage volumes can be associated with each pod, allowing them to maintain state even if they are rescheduled or restarted.

# VolumeAttachment

Sunday, December 8, 2024 10:15 AM

VolumeAttachment objects are non-namespaced.

From <<https://kubernetes.io/docs/reference/kubernetes-api/config-and-storage-resources/volume-attachment-v1/>>



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Listen

A volume attachment is a Kubernetes object that indicates the intent to attach or detach a volume from a specific node:

- **Purpose**

Ensures that the required storage is mounted to the desired node for applications that need persistent data storage

- **How it works**

When a PersistentVolume (PV) is created and bound to a Persistent Volume Claim (PVC), the k8s storage controller creates a VolumeAttachment. The storage driver on the node is then notified and mounts the volume to its host.

## When Do You Need to Know About VolumeAttachments?

### 1. Troubleshooting Storage Issues:

- If a pod cannot access its volume, checking VolumeAttachment objects can help diagnose attachment/detachment problems.

## 2. Custom CSI Drivers:

- Developers creating custom CSI drivers may need to handle VolumeAttachment objects.

## 3. Dynamic Volume Provisioning:

- Understanding VolumeAttachment is useful when working with dynamic storage environments, especially with advanced features like snapshots or cloning.

## Volume Mode

Kubernetes supports two volumeModes of PersistentVolumes: Filesystem and Block.

Explain the three types of storage - Block , Object and Files in layman's term.

Here's a simple explanation of the three types of storage—**Block**, **Object**, and **File**—with relatable examples to help you understand the differences:

### 1. Block Storage

- **What It Is:** Think of block storage like **Lego blocks**. Data is broken into fixed-sized blocks, and each block has a unique identifier. Applications access these blocks directly, assemble them, and manage how the data is organized.
- **Example:** Imagine writing a book, but instead of storing it as a single document, each page is stored separately. You, as the author, need to remember where each page is stored to put them together when needed.
- **Common Uses:**
  - Databases (e.g., MySQL, PostgreSQL).
  - Virtual machines (VMs) and operating systems.
- **Key Features:**
  - High performance and low latency.
  - Requires the application or system to manage the structure (e.g., filesystem).

### 2. Object Storage

- **What It Is:** Object storage is like a **cloud photo album**. Each piece of data (an object) is stored with metadata and a unique identifier, but there's no hierarchical structure like folders.

- **Example:** You upload photos to a cloud service (like Google Photos). The service doesn't care about "folders"; instead, it organizes your photos based on metadata like date or location.
- **Common Uses:**
  - Backup and archival storage.
  - Storing large, unstructured data (images, videos, logs).
  - Cloud storage (e.g., AWS S3, Azure Blob).
- **Key Features:**
  - Highly scalable.
  - Ideal for unstructured data and analytics.

### 3. File Storage

- **What It Is:** File storage is like a **traditional filing cabinet**. Data is stored as files in folders, organized hierarchically, and accessed using paths (e.g., /home/user/documents).
- **Example:** On your laptop, you save documents, images, and videos in specific folders. You open these files by navigating through folders.
- **Common Uses:**
  - Home directories and shared drives.
  - Applications that need hierarchical data organization (e.g., logs).
- **Key Features:**
  - Familiar and easy to use.
  - Less scalable for massive amounts of data compared to object storage.

#### Summary Comparison Table:

| Feature   | Block Storage     | Object Storage             | File Storage                 |
|-----------|-------------------|----------------------------|------------------------------|
| Structure | Fixed-size blocks | Flat objects with metadata | Hierarchical (folders/files) |
| Access    | Raw, low-level    | API-based (e.g., S3)       | File system (e.g., NFS)      |
| Use Cases | Databases, VMs    | Backups, unstructured data | Logs, shared folders         |

# Security Primitives

Friday, March 15, 2024 11:58 AM

Primitive mtlb ki basic/ unsophisticated ( less complex)

Secure host ke some main features/property:-

1. Root access disabled hona chahiye
2. Password based authentication disable hona chahiye only SSH key based authentication should be made available.

? Why password based authentication should be disabled?

Disabling password-based authentication enhances security by reducing the risk of brute-force attacks, password guessing, and password theft. Instead, using more secure authentication methods like SSH keys or certificates provides stronger protection against unauthorized access to systems and data.

We need to secure kube-apiserver first kyonki saare major kaam ye hi kar raha cluster par. We interact kube-apiserver with kubectl commands. So, this is the first line of defence.

## Authentication(Pramanit) vs Authorization

- Who can access is Authentication.
- What can they do is Authorization.

So, kon kon access kar sakta hai , jisko authentication hogा wahi.

Koi kya kya access kar sakta hai wo uske liye authorized hona chahiye.

Kubernets ko secure karne ke liye 2 decisions lene padte hai . Who can access the cluster( authentication) and what they can do(authorization).

Authentication in Kubernetes - There are different way jis se ki hum apiserver ko authenticate kar sakte hai.

1. Files - Username and Passwords
2. Files - Username and Tokens
3. Certificates
4. External Authentication providers - LDAP
5. Service Accounts - For machines

#### Tokens vs passwords vs certificates

Token: A token is a piece of data that represents a user's authentication credentials. It can be used to access specific resources or perform certain actions on behalf of the user. Tokens are often used in authentication mechanisms like OAuth, where they grant limited access without exposing the actual password.

Password: A password is a secret string of characters that a user uses to verify their identity and gain access to a system, account, or resource. Passwords are typically kept confidential and should be chosen carefully to ensure security.

Certificate: A certificate is a digital document that verifies the identity of an entity, such as a website, server, or person. It contains information like the entity's public key, expiration date, and issuer. Certificates are used in SSL/TLS protocols to establish secure communication channels over the internet.

In summary, tokens are used for authentication and access control, passwords are secret credentials for user authentication, and certificates are digital documents used for verifying identities in secure communications.

#### Authorization in Kubernets

Authorization can be implemented using

RBAC Authorization  
ABAC Authorization

## Node Authorization

### Webhook Mode

All communication between the various components of master and worker node is secured using TLS encryption.

- ? How communication between the application is get secured?

By default, all pods can access the all other pods within the cluster. So, you can secure this communication using Network Policies.

# Authentication

Sunday, March 17, 2024 9:53 AM

## Types of accounts

1. User accounts - Admin, developers etc.
2. Service accounts - 3rd party apps.

Kubernetes does not manage user accounts and relies on external source like files with user details, certificates or 3rd party identity service like LDAP to manage users. So you can't create users or list number of users by running a command.

**Kubernetes can create and manage service accounts.**

## Two types of users :-

1. Admin - access the clusters for administrative tasks.
2. Developers - access the clusters to test/deploy applications.

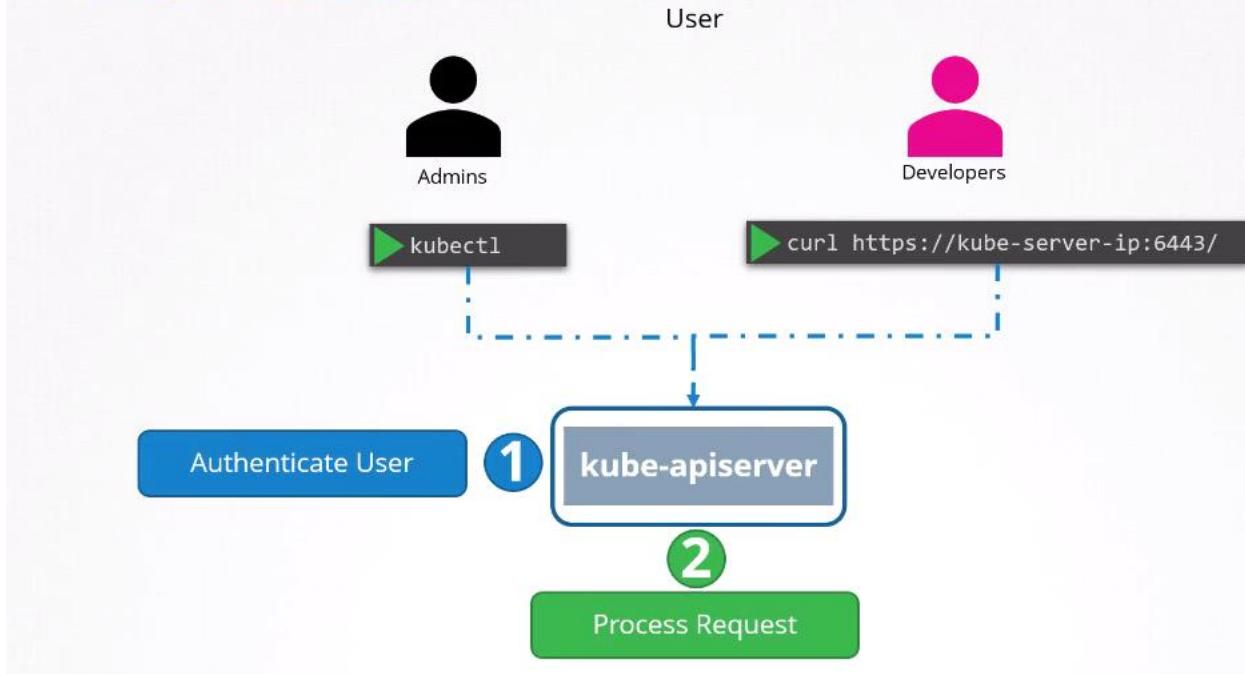
A user can access the cluster through

1. kubectl
2. API

All user access is managed by the kube-apiservers.

Steps followed by kube-apiserver to provide authentication.

# Accounts



1. The kube-apiserver first authenticates the request (via kubectl or API) of user.
2. Process the requests.

? How does kube-apiserver authenticates?

There are following mechanisms

1. A static file with list of username and passwords.
2. A static file with list of username and tokens
3. Certificates
4. Identity Services - eg. LDAP, Kerberos.

A static Password file

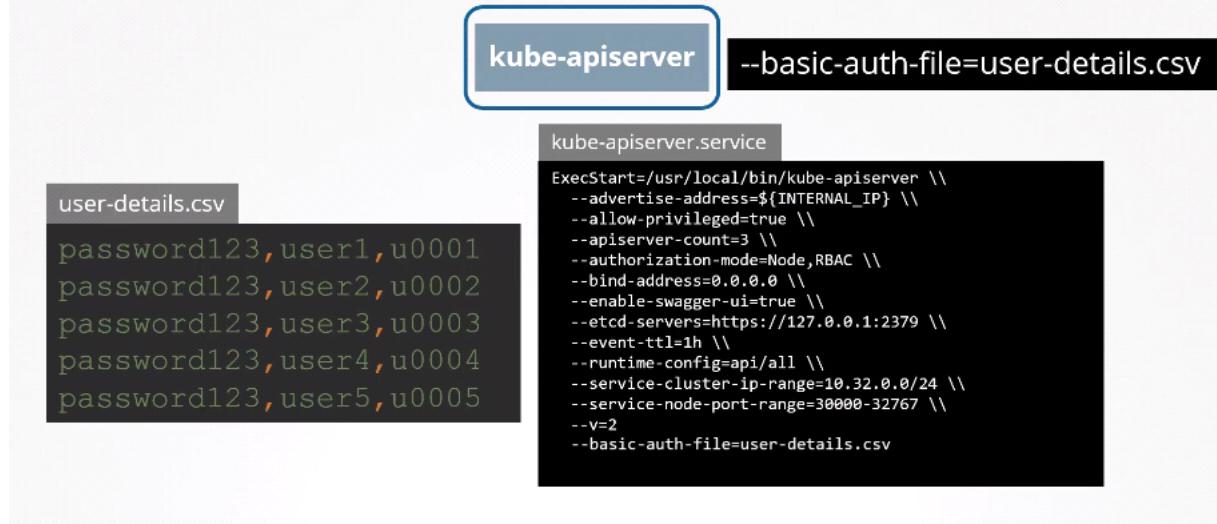
## Auth Mechanisms - Basic

kube-apiserver

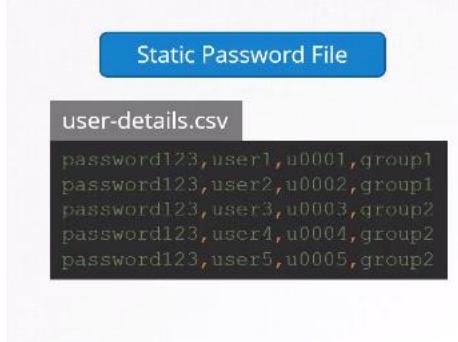
--basic-auth-file=user-details.csv

kube-apiserver.service

# Auth Mechanisms - Basic



- To make a static password file( say user-details.csv), create a csv file with 3 columns- passwords, username and user-id
- You can also add 4th column for assigning group to a user.



- Now, In kube-apiserver.service file, append following line:-  
--basic-auth-file=user-details.csv
- Restart the kube-apiserver

★ If you have setup your cluster using the kubeadm tool, then you must update the kube-apiserver pod definition file with '--basic-auth-file=user-details.csv', the kubeadm tool will automatically restart the kubeapi-server.

# Kube-api Server Configuration

kube-apiserver.service

```
ExecStart=/usr/local/bin/kube-apiserver \
--advertise-address=${INTERNAL_IP} \
--allow-privileged=true \
--apiserver-count=3 \
--authorization-mode=Node,RBAC \
--bind-address=0.0.0.0 \
--enable-swagger-ui=true \
--etcd-servers=https://127.0.0.1:2379 \
--event-ttl=1h \
--runtime-config=api/all \
--service-cluster-ip-range=10.32.0.0/24 \
--service-node-port-range=30000-32767 \
--v=2 \
--basic-auth-file=user-details.csv
```

/etc/kubernetes/manifests/kube-apiserver.yaml

```
apiVersion: v1
kind: Pod
metadata:
 creationTimestamp: null
 name: kube-apiserver
 namespace: kube-system
spec:
 containers:
 - command:
 - kube-apiserver
 - --authorization-mode=Node,RBAC
 - --advertise-address=172.17.0.107
 - --allow-privileged=true
 - --enable-admission-plugins=NodeRestriction
 - --enable-bootstrap-token-auth=true
 - --basic-auth-file=user-details.csv
 image: k8s.gcr.io/kube-apiserver-amd64:v1.11.3
 name: kube-apiserver
```

Note: Showing fewer options for simplicity

See

- ★ To authenticate using basic credentials while accessing the api server

```
curl -v -k https://master-node-ip:6443/api/v1/pods -u "user1:password123"
```

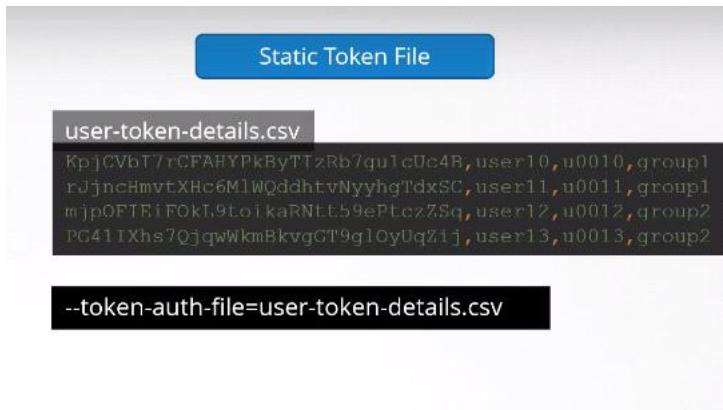
```
{
 "kind": "PodList",
 "apiVersion": "v1",
 "metadata": {
 "selfLink": "/api/v1/pods",
 "resourceVersion": "3594"
 },
 "items": [
 {
 "metadata": {
 "name": "nginx-64f497f8fd-krkg6",
 "generateName": "nginx-64f497f8fd-",
 "namespace": "default",
 "selfLink": "/api/v1/namespaces/default/pods/nginx-64f497f8fd-krkg6",
 "uid": "77dd7dfb-2914-11e9-b468-0242ac11006b",
 "resourceVersion": "3569",
 "creationTimestamp": "2019-02-05T07:05:49Z",
 "labels": {
 "pod-template-hash": "2090539498",
 "run": "nginx"
 }
 }
 }
]
}
```

A static token file

- Similar to password file, password column will be replaced by the tokens.
- For token files we add '--token-auth-file=<csv file name>.

Static Token File

user-token-details.csv



Authentication using static files is not recommended.

# TLS

Sunday, March 17, 2024 11:40 AM

What are TLS Certificates?

How does Kubernetes use Certificates?

How to generate them?

How to configure them?

How to view them?

How to troubleshoot issues related to Certificates

A certificate is used to guarantee trust between two parties (like a user and a server). The Certificate guarantees that the communication between the two parties is encrypted and the server is authenticated (server is who it says it is).

- Encryption is important because plain data can easily be understood by a hacker. So, data must be encrypted with encryption keys.

Q How encryption is done?

- There is an encryption key which is a combination of random numbers and alphabets, this is basically added to your data.
- Now your data is encrypted. If the attacker gets the data still he can't do anything with the data.
- Now, the server also needs a key to decrypt the data.
- If the key is passed to the server through the same network it's **Symmetric encryption**. In this, the same key is used for encryption and decryption. Since, the key is passed through the same network, there is a risk of interception.

User: John  
Password: Pass123

XCVB: DKSJD  
LKJSDFK: XZKJSDLF

How to mitigate this risk?

**Asymmetric encryption**

Is asymmetric encryption used? We use a pair of keys - private key and public key (public lock samjhao ise).

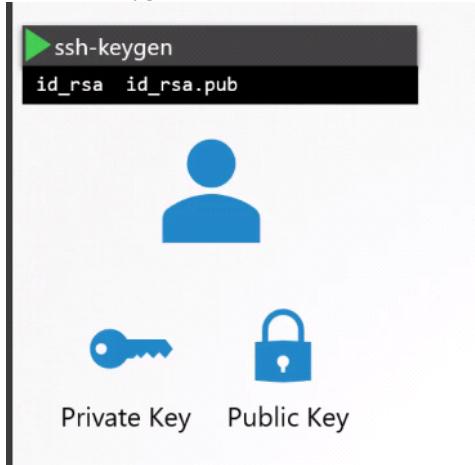
How asymmetric encryption is done?

Private key user ke paas hai aur public key ( ya fir public lock samjho to zyada clear hogा) kisi ke paas bhi ho sakti hai.

Ab public lock se ab kuch bhi lock(encrypt) kar sakte ho usko open(decrypt) karne ke liye private key lagegi. So, it must be with you and not shared with anyone else.

How to generate assymetric keys ?

Run ssh-keygen command

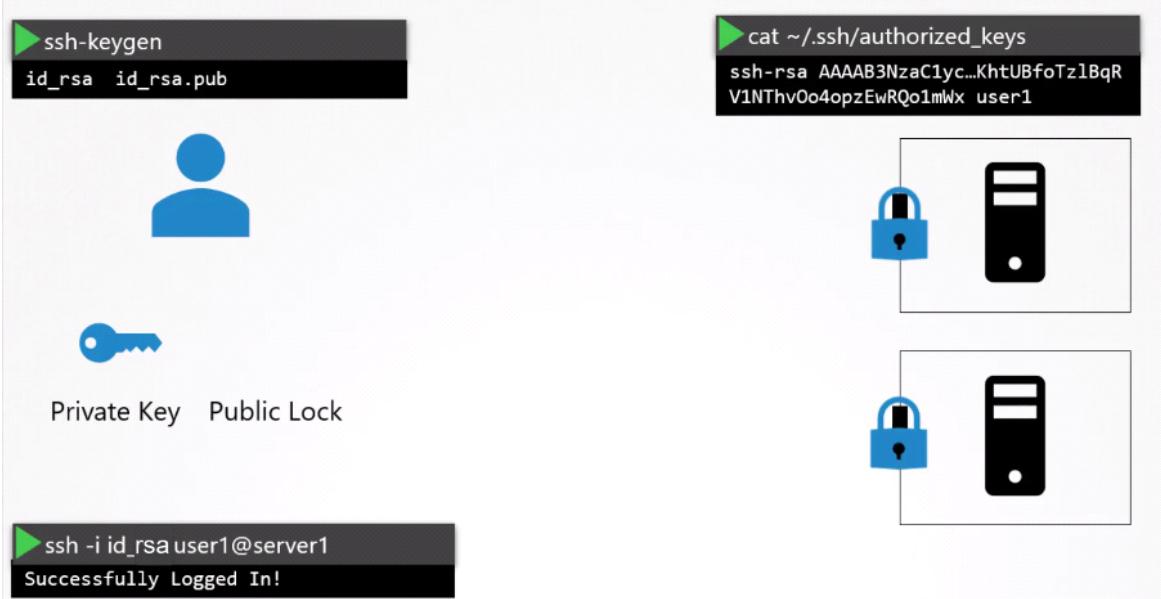


Private key - id\_rsa

Public key - id\_rsa.pub

Using public key or public lock, you lock the access to the server. Since it is public, it can be viewed using cat command.





Now, you can open this lock with the private key you have.

For multiple server, use same public lock and then ssh into it using the private key.

#### Multiple server, Multiple User case

You(root user) can create a separate public and private key for each user for accessing then the server.

- ★ We can use asymmetric encryption for symmetric encryption by securely transferring the private key to the web server (other party).

The process of securely transferring the symmetric key from the client to the server involves asymmetric encryption. Here's how it typically works:



1. The server generates a pair of asymmetric keys: a public key and a private key.
2. The server sends its public key to the client.
3. The client uses the server's public key to encrypt the symmetric key.
4. The encrypted symmetric key is sent from the client to the server.
5. The server uses its private key to decrypt the symmetric key.

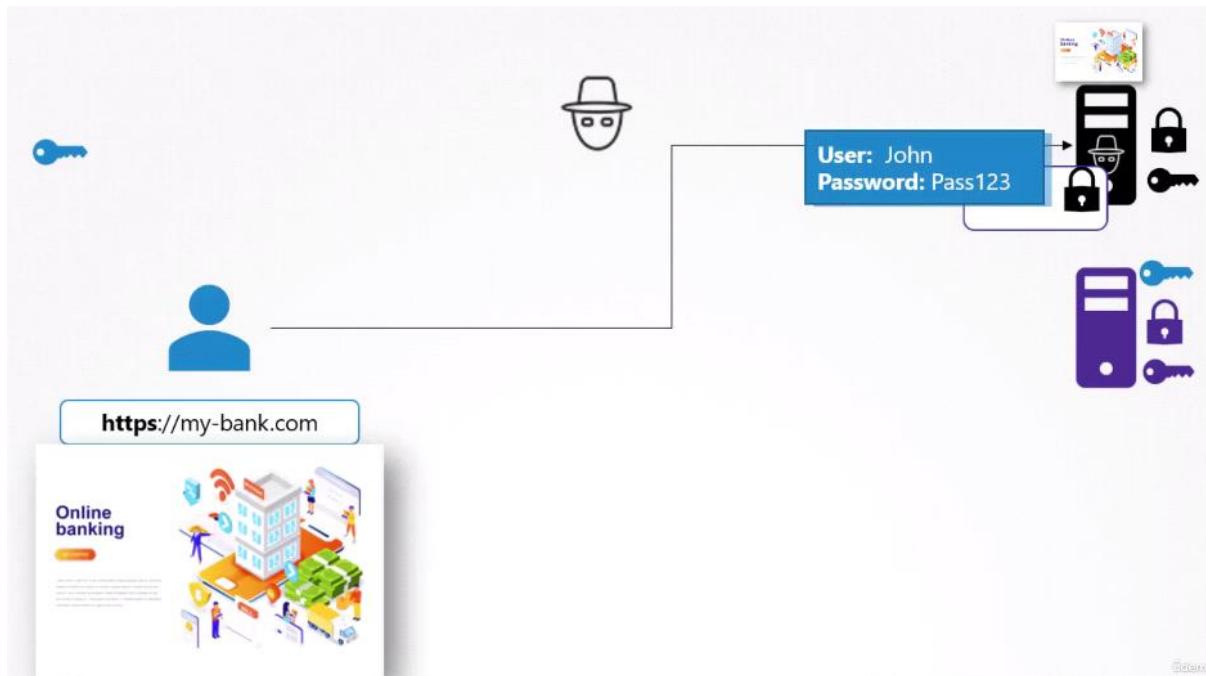
This process ensures that even if someone intercepts the encrypted symmetric key during transmission, they cannot decrypt it without the server's private key. Thus, it helps maintain the confidentiality and integrity of the symmetric key during transfer.

#### sshgen vs openssl rsa

If you need to generate SSH keys for SSH authentication, you would use `ssh-keygen`. On the other hand, if you need to generate RSA private keys for other purposes, such as SSL/TLS certificates, digital signatures, or encryption, you would use `openssl genrsa`.

#### How does hacker fools you?

Hacker also uses the same encryption method but the hacker creates the similar website and somehow redirects the route to his own server.



How do you(user) can know that the public key received from the server is legitimate and from the real bank server?

That's why the server not only sends the key but also sends the **certificates** with it.

What info does a certificate contain?

```

Certificate:
Data:
 Serial Number: 420327018966204255
 Signature Algorithm: sha256WithRSAEncryption
 Issuer: CN=kubernetes
 Validity
 Not After : Feb 9 13:41:28 2020 GMT
 Subject: CN=my-bank.com
X509v3 Subject Alternative Name:
 DNS:mybank.com, DNS:i-bank.com,
 DNS:we-bank.com,
Subject Public Key Info:
 00:b9:b0:55:24:fb:a4:ef:77:73:
 7c:9b

```

What if hacker also create the similar certificate?

In certificate there is a **digital signature** which specifies who signs the certificate. A certificate created by the hacker will have digital signatures signed by himself.

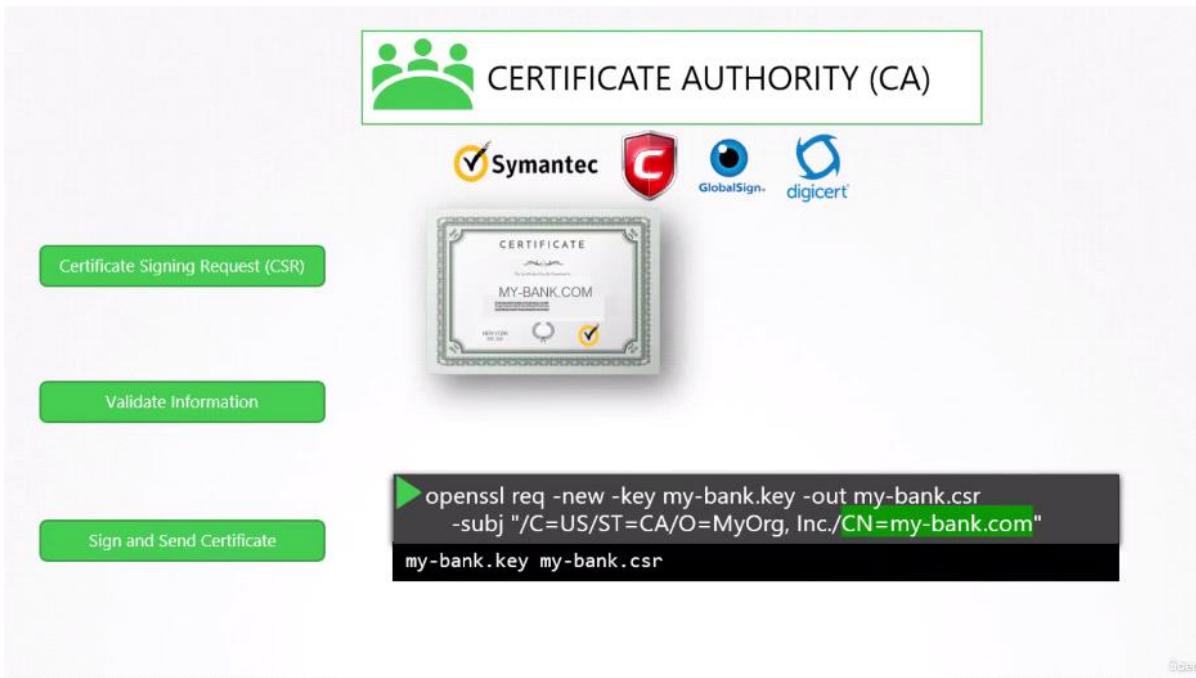
★ your browser helps you in validation of these certificates.

What are some Certificate Authority(CA) that signs your certificates and make it legitimate?

Digicert  
Symantec etc.

How your certificate gets signed by CA?

1. You generate a CSR by mentioning your domain name and the key (private key).
2. CA verifies the details
3. If valid, CA signs and sends the certificate back to you.



The "key" refers to the private key that will be used for the digital signature. When you generate a CSR, you provide the following information:

**Domain Name:** This is the domain name for which you are requesting the TLS certificate. For example, `example.com`.

**Private Key:** This is the private key that corresponds to the public key for which you are requesting a certificate. The private key is used for generating the digital signature in the CSR.

Here's a brief overview of the steps involved in generating a CSR for a TLS certificate:

**Generate a private key:** You can use tools like `openssl genrsa` to generate an RSA private key.

**Generate a CSR:** Use the private key and your domain name to generate a CSR. This CSR includes information like your organization details, common name (domain name), and the public key.

corresponding to the private key.

Submit the CSR: Once you have the CSR, you can submit it to a Certificate Authority (CA) to obtain a signed TLS certificate.

The private key is crucial in this process because it is used to create the digital signature within the CSR, which verifies the authenticity of the certificate request.

How does browser knows that the certificate is signed by legitimate CA and not fake CA (eg. A certificate not signed by Symantec but by a company who claims that it's Symantec) ?

CA also has their own public key and private key.

The CAs use their private keys to sign the certificates.

The public keys of all the CAs are shared to the browsers.

The browser uses the public key of the CA to validate that the certificate was actually signed by the CA themselves.

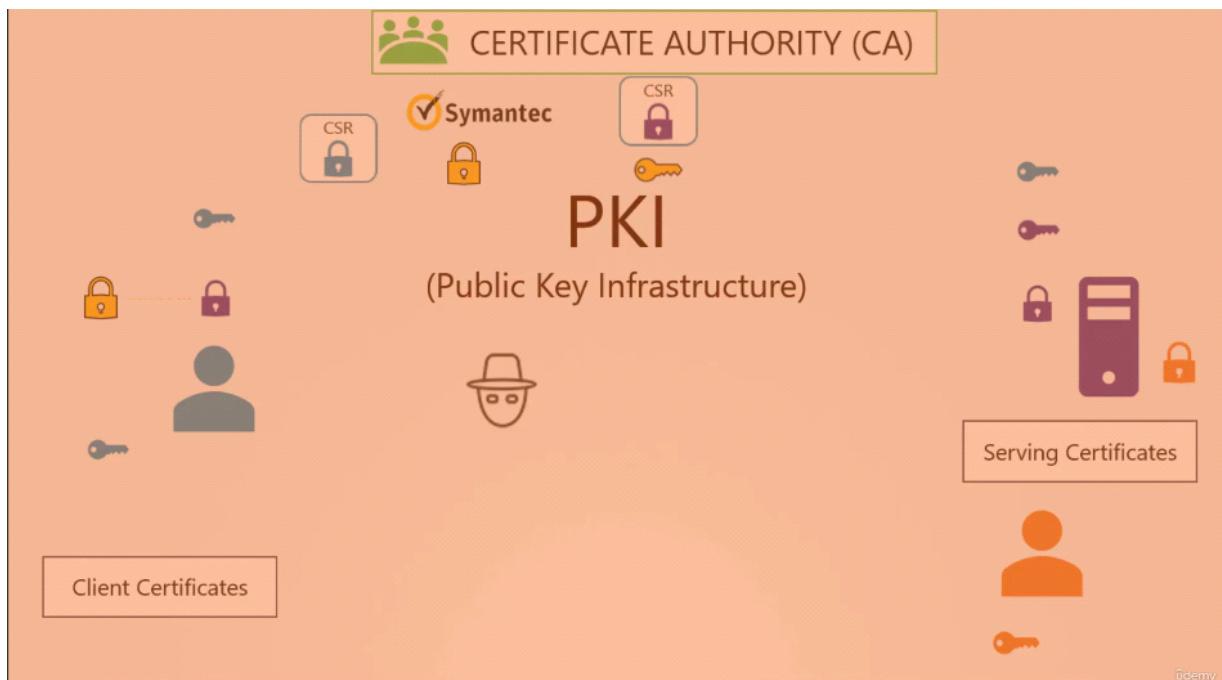


You can also have private CA for the private website (such as payroll websites for HPE employee only). In this case, public key is shared to all the employees web browser.

How server knows that the user is legitimate and not the hacker?

in such case, server can request a certificate from the client and so the client must generate a pair of keys and a signed certificate from a valid CA. The client then sends the certificate to the server for it to verify that the client is who they say they are. A normal user no need to generate it manually.

PKI



- ★ Private key is used for decryption and public for encryption but vice versa can also be used. You just can't use same key for encryption and decryption both.

### Certificate (Public Key)

They have following extensions - .crt, .pem

eg.

server.crt

server.pem

client.crt

## Private Key

They have following extensions - .key, .key.pem

eg.

server.key  
server-key.pem  
client.key  
client-key.pem

- ★ Agar key ke extension me ".key" aa raha to wo private hai baaki sab public key hai.

# TLS - Kubernetes

Sunday, March 17, 2024 11:02 PM

Three types of TLS certificates:-

1. Server certificates configured on the servers. e.g. public and private key generated by servers.
2. Root certificate configured on the CA servers. e.g. public and private key generated by CA.
3. Client certificates configured on the clients. e.g. public and private key generated by clients.

In kubernetes, there are two requirements:-

1. User/Client who is accessing the cluster to establish a secure connection - Requires a Client Certificate
2. Communication between all the components within the k8s cluster also needs to be secured - Requires a Server Certificate

Kubernetes Components and Certificates requires by them

Server Components

1. kube-apiserver - The apiserver exposes an HTTPS service that other components, as well as external users, use to manage the Kubernetes cluster. It has certificate and a key(private).



★ .crt extension is used for certificates.

The kube-apiserver makes its API accessible and available for use by other components, tools, and users within the Kubernetes cluster. This means that clients can send requests to the kube-apiserver to perform operations or retrieve information about the cluster's state.

**Protocol:** By using HTTPS, the kube-apiserver ensures that all communications between clients and the API server are encrypted and secure. This is crucial for protecting sensitive information such as authentication tokens, configuration details, and resource data exchanged during API interactions.

**Endpoints:** The kube-apiserver exposes specific endpoints (URLs) through which clients can access different parts of the Kubernetes API. For example, there are endpoints for managing pods, services,

namespaces, deployments, and more. Clients send HTTP/HTTPS requests to these endpoints to perform CRUD (Create, Read, Update, Delete) operations on Kubernetes resources.

**Authentication and Authorization:** The kube-apiserver enforces authentication and authorization mechanisms to control access to its API. Clients must provide valid credentials (such as tokens, certificates, or API keys) to authenticate themselves before they can make API requests. Additionally, the kube-apiserver applies RBAC (Role-Based Access Control) policies to authorize clients based on their roles and permissions.

**API Objects:** The API exposed by kube-apiserver consists of various API objects, such as Pods, Services, Deployments, ConfigMaps, Secrets, and more. Each API object represents a specific resource or configuration within the Kubernetes cluster. Clients interact with these API objects by sending API requests (e.g., creating a new pod, updating a service, deleting a deployment).

In summary, the kube-apiserver exposes its API via an HTTPS service to provide a secure and standardized way for clients, tools, and users to interact with the Kubernetes cluster. This includes accessing and managing resources, querying cluster state, monitoring health, and performing administrative tasks through well-defined endpoints and secure communication channels.

2. Another server is etcd server. The etcd server stores all information about the cluster. So, it also has a certificate and private key.



3. Other server component in the cluster is kubelet component that is present on the worker nodes. It also has a certificate and a private key. They also expose an HTTPS API endpoint that the kube-apiserver talks to to interact with the worker nodes.

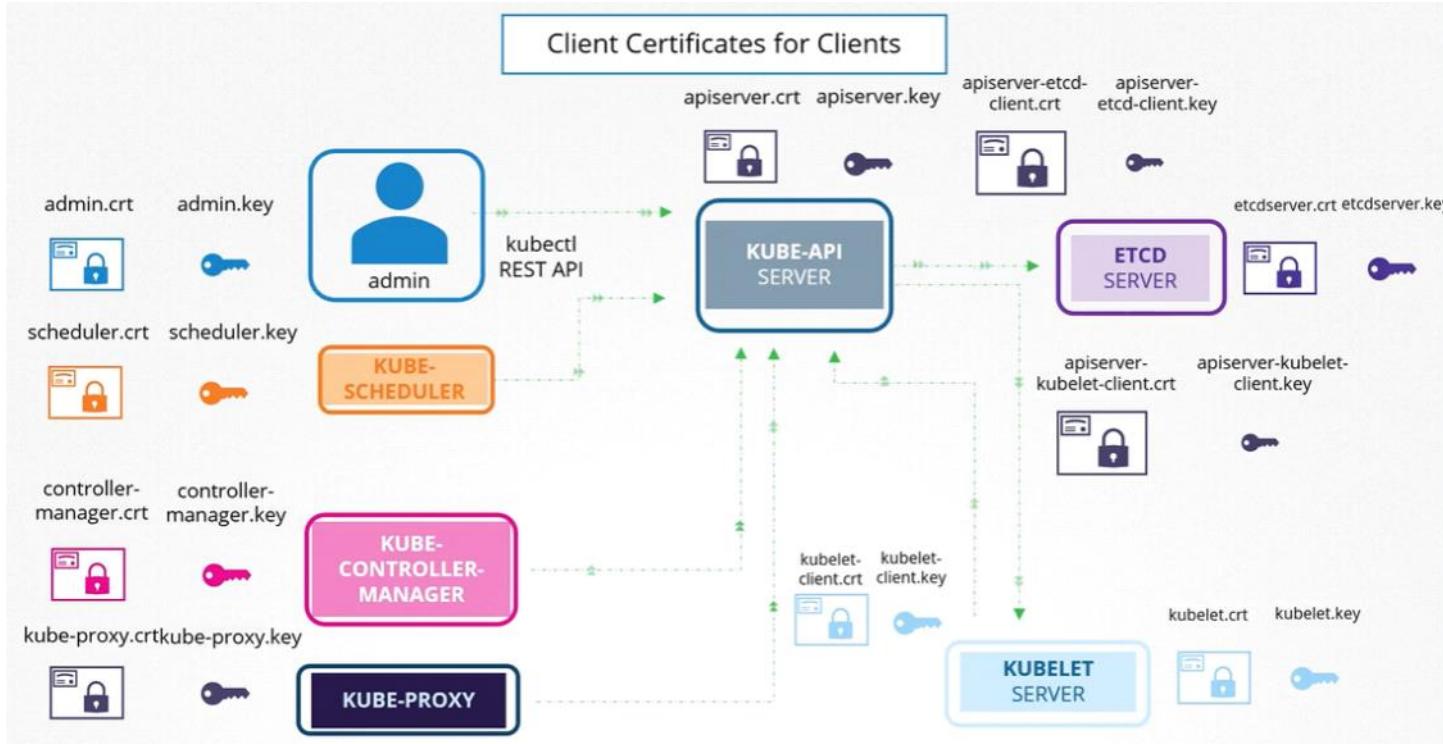


**Client components - Components that access the server components.** Client certificates are used by clients to connect to the server. (Kabhi kabhi server ko kisi doosre server se communicate karna padta hai. Jisme request bhejne wala client ban jaata hai aur use client certificate ya fir server ka original certificate use karna padta hai.)

1. Admin
2. Kube-scheduler
3. kube-controller-manager
4. kube-proxy
5. The servers also communicate amongst them as well. For example, the kube-apiserver communicates with the etcd server. In fact, of all the components, the kube-apiserver is the only server that talks to the etcd server.

For etcd server, the kube-apiserver is a client, so it needs to authenticate. kube-apiserver can use its own server keys and certificates for this purpose or it can generate separate key and certificate.

6. kube-apiserver also talks to the kubelet server on each of the individual nodes. That's how it monitors the worker nodes for this. It can also generate its new certificate and key or can use its original ones.



kubernetes requires you to have atleast one CA, you can have multiple.

? What are the basic property of any server? Does it need to be have an API ?

It depends on the server's purpose and functionality whether it will have an API or not:

**APIs for Service Interaction:** Servers that provide services to clients often have APIs (Application Programming Interfaces) to define how clients can interact with and access those services. APIs establish protocols, data formats, and endpoints for communication between clients and the server, enabling seamless integration and interoperability.

**APIs for Management and Control:** Servers used in infrastructure management, cloud computing, or software platforms may have APIs for management, automation, and orchestration tasks. These APIs allow administrators, developers, or external systems to programmatically control server configurations, deploy applications, monitor performance, and manage resources.

**Non-API Servers:** Not all servers necessarily expose APIs. For example, some servers may function primarily as data storage systems (e.g., file servers, database servers) without exposing public APIs for external clients. However, internal components or administrative tools may still use APIs for managing and interacting with these servers.

Server Properties:-

Servers, in a general computing context, refer to systems or software that provide services or resources to client devices or applications over a network. The basic properties of any server include:

**Service Provision:** A server is designed to provide specific services or resources to clients. These services can range from hosting websites, serving files, handling email communications, providing database access, running applications, managing network traffic, and more.

**Network Connectivity:** Servers are typically connected to a network, either locally within an organization's infrastructure or globally over the internet. They use protocols like TCP/IP to communicate with clients and other servers, allowing data exchange and service delivery.

**Resource Management:** Servers manage resources such as CPU processing power, memory, storage, network bandwidth, and I/O operations efficiently to handle client requests and deliver services effectively. Resource allocation and optimization are key functions of server management.

**Concurrency:** Servers often support concurrent connections from multiple clients simultaneously. They use mechanisms like multithreading, multiprocessing, or asynchronous I/O to handle concurrent requests efficiently and maintain responsiveness.

**Security:** Servers implement security measures to protect against unauthorized access, data breaches, and malicious activities. This includes authentication mechanisms, encryption for data in transit and at rest, access control policies, firewalls, intrusion detection systems, and regular security updates.

**Reliability and Availability:** Servers are expected to be reliable and available for clients whenever needed. They employ redundancy, failover mechanisms, backup strategies, and monitoring tools to ensure high availability and minimize downtime.

# TLS - Certificate Creation in K8s

Monday, March 18, 2024 3:20 PM

There are different tools, but we will use 'openssl'.

Steps to generate CA Certificate

1. Generate the private key
2. CSR - Generate the certificate signing request(CSR). The CSR has all the certificate details but no digital signature. It has following components:-
  - a. Private key
  - b. Common Name(CN) field
3. Sign Certificate - We sign the certificate using the "openssl x509" and by specifying the certificate signing request, we generated in the previous command. Since this is for the CA itself it is self-signed by the CA using its own private key that it generated in the first step.



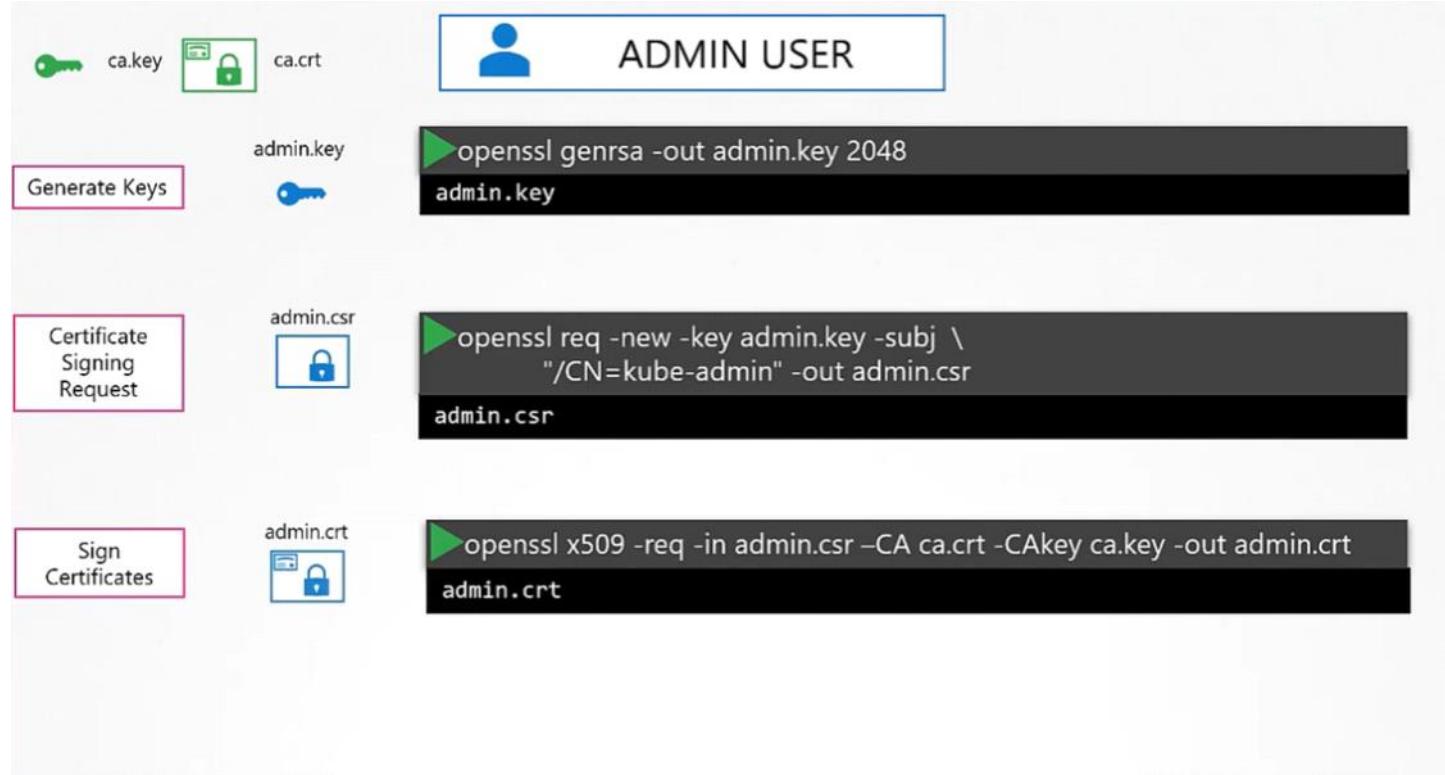
★ For all other certificates, we use CA key pairs to sign them.

Steps to generate Client Certificate

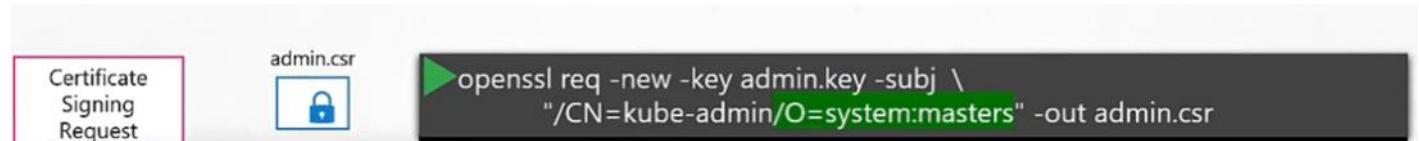
For Admin user

1. Generate the private key
2. Generate the certificate signing request(CSR).
3. Sign Certificate - Sign the certificate with the CA certificate and CA private key. The name of the output(admin-client) certificate is admin.crt. This admin.crt certificate will be used by the admin user to authenticate to Kubernetes cluster.

This process is similar to creating a username(certificate) and password(key) for new user but it's more secure.



Specify the group name with /O=system:masters in CSR step to specify that this is for admin user.



For basic user

1. ?

We follow the same process to generate client certificates for all other components that access the Kube API server.

## Steps to generate certificate for Kube Scheduler

- ★ Since kube scheduler is the part of control plane i.e. system component. So, the name of its certificate will have prefix "system". For e.g. "system:kube-scheduler". Similarly, kube-controller-manager is also the part of control plane so name of its certificate will also start from prefix "system".

## Client Certificates

admin  
user  
kube-scheduler  
kube-controller-manager  
kube-proxy



We can use admin certificates in REST API call instead of a username and password.

```
curl https://kube-apiserver:6443/api/v1/pods \
--key admin.key --cert admin.crt
--cacert ca.crt
```

{  
  "kind": "PodList",  
  "apiVersion": "v1",  
  "metadata": {

```
▶ curl https://kube-apiserver:6443/api/v1/pods \
 --key admin.key --cert admin.crt
 --cacert ca.crt
{
 "kind": "PodList",
 "apiVersion": "v1",
 "metadata": {
 "selflink": "/api/v1/pods",
 },
 "items": []
}
```

We can also make a kube-config.yaml file instead of making a REST API Call.

```
kube-config.yaml
apiVersion: v1
clusters:
- cluster:
 certificate-authority: ca.crt
 server: https://kube-apiserver:6443
 name: kubernetes
kind: Config
users:
- name: kubernetes-admin
 user:
 client-certificate: admin.crt
 client-key: admin.key
```

Remember in the prerequisite lecture we mentioned that

for clients to validate the certificates sent by the server

and vice versa, they all need a copy

of the certificate authorities public certificate.

The one that we said is already installed within

the user's browsers in case of a web application.

Similarly in Kubernetes for these various components

to verify each other, they all need a copy

of the CA's root certificate.

So whenever you configure a server

or a client with certificates,

you will need to specify the CA root certificate as well

## Server Side Certificates

kube-apiserver

Name of certificate can be kube-api server, kubernetes, kubernetes.default, kubernetes.default.svc, kubernetes.default.svc.cluster.local or the IP address of the host running the Kube API server or the pod running it.

So all those certificates having above names will be able to establish a valid connection

How to generate kube-apiserver certificate.

1. Generate key

```
▶ openssl genrsa -out apiserver.key 2048
apiserver.key
```

2. Generate CSR. To add all the above alternative names, add these names to OpenSSL Config file (openssl.cnf) and then pass this config file as an open in CSR step.

```
openssl.cnf
[req]
req_extensions = v3_req
distinguished_name = req_distinguished_name
[v3_req]
basicConstraints = CA:FALSE
keyUsage = nonRepudiation,
subjectAltName = @alt_names
[alt_names]
DNS.1 = kubernetes
DNS.2 = kubernetes.default
DNS.3 = kubernetes.default.svc
DNS.4 = kubernetes.default.svc.cluster.local
IP.1 = 10.96.0.1
IP.2 = 172.17.0.87
```

3. Sign the certificate using CA key

```
▶ openssl x509 -req -in apiserver.csr \
-CA ca.crt -CAkey ca.key -out apiserver.crt
apiserver.crt
```

etcd-cluster

- ★ Client certificates are used by the kube-apiserver while communicating as a client to the etcd and kubelet servers.

```
ExecStart=/usr/local/bin/kube-apiserver \
--advertise-address=${INTERNAL_IP} \
--allow-privileged=true \
--apiserver-count=3 \
--authorization-mode=Node,RBAC \
--bind-address=0.0.0.0 \
--enable-swagger-ui=true \
--etcd-cafile=/var/lib/kubernetes/ca.pem \
--etcd-certfile=/var/lib/kubernetes/apiserver-etcd-client.crt \
--etcd-keyfile=/var/lib/kubernetes/apiserver-etcd-client.key \
--etcd-servers=https://127.0.0.1:2379 \
--event-ttl=1h \
--kubelet-certificate-authority=/var/lib/kubernetes/ca.pem \
--kubelet-client-certificate=/var/lib/kubernetes/apiserver-kubelet-client.crt \
--kubelet-client-key=/var/lib/kubernetes/apiserver-kubelet-client.key \
--kubelet-https=true \
--runtime-config=api/all \
--service-account-key-file=/var/lib/kubernetes/service-account.pem \
--service-cluster-ip-range=10.32.0.0/24 \
--service-node-port-range=30000-32767 \
--client-ca-file=/var/lib/kubernetes/ca.pem \\"
```

```
--service-account-key-file=/var/lib/kubernetes/service-account.pem \\
--service-cluster-ip-range=10.32.0.0/24 \\
--service-node-port-range=30000-32767 \\
--client-ca-file=/var/lib/kubernetes/ca.pem \\
--tls-cert-file=/var/lib/kubernetes/apiserver.crt \\
--tls-private-key-file=/var/lib/kubernetes/apiserver.key \\
--v=2
```

To specify the keys and certificates for communication between the Kubernetes API server, etcd, and kubelet servers, you typically configure them in the Kubernetes API server's executable or service configuration file. Here's a breakdown of how you would specify these certificates and keys:

#### CA File:

The Certificate Authority (CA) file is used to verify the certificates presented by clients connecting to the API server, etcd, and kubelet servers. It's crucial to remember that every component needs the CA certificate to verify its clients.

You specify the CA file in the Kubernetes API server's configuration using the --client-ca-file flag or equivalent in the configuration file.

#### API Server Certificates:

Next, you specify the API server certificates under the TLS certificate options. These certificates include the server's public key certificate and private key.

The API server's TLS configuration includes options like --tls-cert-file for the server certificate file and --tls-private-key-file for the server's private key file.

#### Client Certificates for API Server:

The API server also needs client certificates to authenticate itself when connecting to the etcd server. These client certificates include the client's public key certificate and private key.

Specify the client certificates for the API server in the configuration using options like --etcd-cert-file for the client certificate file and --etcd-key-file for the client's private key file. Additionally, specify the CA file using --etcd-cafile to verify the etcd server's certificate.

#### Kubelet Client Certificates:

Finally, if the API server communicates with kubelet servers using client certificates, you would also specify these client certificates in the configuration. This ensures secure communication between the API server and kubelet servers.

Use options like --kubelet-client-certificate for the kubelet client certificate file and --kubelet-client-key for the kubelet client's private key file.

kubelet server

1. It's an https API server that runs on each node and responsible for managing the nodes.
2. kubelet certificates are named after the name of nodes with syntax - "system:node:<node-name>" system because

# View Certification Details

Tuesday, March 19, 2024 12:17 PM

To get the details of each certificate for a health check, you need to know how the cluster was set up. There are 2 methods to set up a cluster - The Hard way and Kubeadm.

1. In the hard way, you generate each certificate by yourself.
2. Using kubeadm tool, certificates are generated automatically.

**While you deploy all the components as native services on the nodes in the hard way, the Kubeadm tool deploys these as pods.**

When deploying a Kubernetes cluster manually or using automation tools like Kubeadm, there are different approaches to how the cluster components are deployed and managed. The line "While you deploy all the components as native services on the nodes in the hard way, the Kubeadm tool deploys these as pods" refers to these different deployment methods:

Deploying Components as Native Services (The Hard Way):

1. In the "hard way" method of deploying Kubernetes, administrators manually install and configure each component (such as kube-apiserver, kube-scheduler, kube-controller-manager, and kubelet) as native services directly on the nodes in the cluster.
2. Each component runs as a system service on the host operating system of the node, managed by systemd or another service manager.

Kubeadm Tool Deployment (Using Pods):

1. Kubeadm is a popular tool for bootstrapping and managing Kubernetes clusters. When using Kubeadm, the deployment approach is different.
2. Kubeadm deploys Kubernetes components as pods running in the cluster itself. Instead of installing system services on the nodes directly, Kubeadm creates and manages Kubernetes objects (such as Deployments, Pods, Services) to run and manage the cluster components.
3. For example, the kube-apiserver, kube-scheduler, kube-controller-manager, and other components are deployed as pods running within the Kubernetes cluster, managed by the Kubernetes control plane.

Key Differences:

Management Level:

The "hard way" involves managing components at the system service level on each node's operating system, while Kubeadm manages components at the Kubernetes object level within the cluster itself.

Deployment Abstraction:

Kubeadm abstracts the deployment process by creating and managing Kubernetes resources (like Deployments) for the cluster components, providing a higher level of automation and easier management compared to manual service installation.

Flexibility and Consistency:

Kubeadm provides a standardized and consistent way to deploy and manage Kubernetes clusters, ensuring that components

are deployed uniformly across nodes. This reduces the chances of configuration errors and simplifies cluster management. Pod Lifecycle Management:

With Kubeadm's pod-based deployment approach, Kubernetes handles the lifecycle of cluster components, including scaling, rolling updates, and self-healing mechanisms, providing more robustness and reliability.

In summary, while manual deployment (the hard way) involves installing Kubernetes components as system services on nodes directly, Kubeadm automates and abstracts this process by deploying components as pods within the Kubernetes cluster itself, offering a more efficient and manageable deployment method.

| kubeadm        |                  |                  |         |           |              |        |            |
|----------------|------------------|------------------|---------|-----------|--------------|--------|------------|
| Component      | Type             | Certificate Path | CN Name | ALT Names | Organization | Issuer | Expiration |
| kube-apiserver | Server           |                  |         |           |              |        |            |
| kube-apiserver | Server           |                  |         |           |              |        |            |
| kube-apiserver | Server           |                  |         |           |              |        |            |
| kube-apiserver | Client (Kubelet) |                  |         |           |              |        |            |
| kube-apiserver | Client (Kubelet) |                  |         |           |              |        |            |
| kube-apiserver | Client (Etcd)    |                  |         |           |              |        |            |
| kube-apiserver | Client (Etcd)    |                  |         |           |              |        |            |
| kube-apiserver | Client (Etcd)    |                  |         |           |              |        |            |

If your cluster is setup using kubeadm

To get the details of certificate files

```
▶ cat /etc/kubernetes/manifests/kube-apiserver.yaml
spec:
 containers:
 - command:
 - kube-apiserver
 - --authorization-mode=Node,RBAC
 - --advertise-address=172.17.0.32
 - --allow-privileged=true
 - --client-ca-file=/etc/kubernetes/pki/ca.crt
 - --disable-admission-plugins=PersistentVolumeLabel
 - --enable-admission-plugins=NodeRestriction
 - --enable-bootstrap-token-auth=true
 - --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt
 - --etcd-certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt
 - --etcd-keyfile=/etc/kubernetes/pki/apiserver-etcd-client.key
 - --etcd-servers=https://127.0.0.1:2379
 - --insecure-port=0
 - --kubelet-client-certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt
 - --kubelet-client-key=/etc/kubernetes/pki/apiserver-kubelet-client.key
 - --kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname
 - --proxy-client-cert-file=/etc/kubernetes/pki/front-proxy-client.crt
 - --proxy-client-key-file=/etc/kubernetes/pki/front-proxy-client.key
 - --secure-port=6443
 - --service-account-key-file=/etc/kubernetes/pki/sa.pub
 - --service-cluster-ip-range=10.96.0.0/12
 - --tls-cert-file=/etc/kubernetes/pki/apiserver.crt
 - --tls-private-key-file=/etc/kubernetes/pki/apiserver.key
```

```
--service-account-key-file=/etc/kubernetes/pki/sa.key
- --service-cluster-ip-range=10.96.0.0/12
- --tls-cert-file=/etc/kubernetes/pki/apiserver.crt
- --tls-private-key-file=/etc/kubernetes/pki/apiserver.key
```

To view details about each certificate, e.g. apiserver.cert

```
openssl x509 -in <> -text -noout
/etc/kubernetes/pki/apiserver.crt
```

```
openssl x509 -in /etc/kubernetes/pki/apiserver.crt -text -noout
Certificate:
Data:
 Version: 3 (0x2)
 Serial Number: 3147495682089747350 (0x2bae26a58f090396)
 Signature Algorithm: sha256WithRSAEncryption
 Issuer: CN=kubernetes
 Validity
 Not Before: Feb 11 05:39:19 2019 GMT
 Not After : Feb 11 05:39:20 2020 GMT
Subject: CN=kube-apiserver
Subject Public Key Info:
 Public Key Algorithm: rsaEncryption
 Public-Key: (2048 bit)
 Modulus:
 00:d9:69:38:80:68:3b:b7:2e:9e:25:00:e8:fd:01:
 Exponent: 65537 (0x10001)
X509v3 extensions:
 X509v3 Key Usage: critical
 Digital Signature, Key Encipherment
 X509v3 Extended Key Usage:
 TLS Web Server Authentication
X509v3 Subject Alternative Name:
 DNS:master, DNS:kubernetes, DNS:kubernetes.default,
 DNS:kubernetes.default.svc, DNS:kubernetes.default.svc.cluster.local, IP
 Address:10.96.0.1, IP Address:172.17.0.27
```

Name of certificate - Subject: CN = <name of certificate>

Expiry - 'Not After' section

## kubeadm

| Certificate Path                                                                                                                   | CN Name                                     | ALT Names                                                                                                                              | Organization   | Issuer     | Expiration           |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|----------------|------------|----------------------|
| /etc/kubernetes/pki/apiserver.crt<br>/etc/kubernetes/pki/apiserver.key                                                             | kube-apiserver                              | DNS:master<br>DNS:kubernetes<br>DNS:kubernetes.default<br>DNS:kubernetes.default.svc<br>IP Address:10.96.0.1<br>IP Address:172.17.0.27 |                | kubernetes | Feb 11 05:39:20 2020 |
| /etc/kubernetes/pki/ca.crt<br>/etc/kubernetes/pki/apiserver-kubelet-client.crt<br>/etc/kubernetes/pki/apiserver-kubelet-client.key | kubernetes<br>kube-apiserver-kubelet-client |                                                                                                                                        | system:masters | kubernetes | Feb 8 05:39:19 2029  |
| /etc/kubernetes/pki/apiserver-etcd-client.crt<br>/etc/kubernetes/pki/apiserver-etcd-client.key                                     | kube-apiserver-etcd-client                  |                                                                                                                                        | system:masters | self       | Feb 11 05:39:22 2020 |
| /etc/kubernetes/pki/etcd/ca.crt                                                                                                    | kubernetes                                  |                                                                                                                                        |                | kubernetes | Feb 8 05:39:21 2017  |

## View logs

### Hard Way

## Inspect Service Logs

```
▶ journalctl -u etcd.service -l
2019-02-13 02:53:28.144631 I | etcdmain: etcd Version: 3.2.18
2019-02-13 02:53:28.144680 I | etcdmain: Git SHA: eddf599c6
2019-02-13 02:53:28.144684 I | etcdmain: Go Version: go1.8.7
2019-02-13 02:53:28.144688 I | etcdmain: Go OS/Arch: linux/amd64
2019-02-13 02:53:28.144692 I | etcdmain: setting maximum number of CPUs to 4, total number of available CPUs is 4
2019-02-13 02:53:28.144734 N | etcdmain: the server is already initialized as member before, starting as etcd
member...
2019-02-13 02:53:28.146625 I | etcdserver: name = master
2019-02-13 02:53:28.146637 I | etcdserver: data dir = /var/lib/etcd
2019-02-13 02:53:28.146642 I | etcdserver: member dir = /var/lib/etcd/member
2019-02-13 02:53:28.146645 I | etcdserver: heartbeat = 100ms
2019-02-13 02:53:28.146648 I | etcdserver: election = 1000ms
2019-02-13 02:53:28.146651 I | etcdserver: snapshot count = 10000
2019-02-13 02:53:28.146677 I | etcdserver: advertise client URLs = 2019-02-13 02:53:28.185353 I | etcdserver/api:
enabled capabilities for version 3.2
2019-02-13 02:53:28.185588 I | embed: ClientTLS: cert = /etc/kubernetes/pki/etcd/server.crt, key =
/etc/kubernetes/pki/etcd/server.key, ca = , trusted-ca = /etc/kubernetes/pki/etcd/old-ca.crt, client-cert-auth =
true
2019-02-13 02:53:30.080017 I | embed: ready to serve client requests
2019-02-13 02:53:30.080130 I | etcdserver: published {Name:master ClientURLs:[https://127.0.0.1:2379]} to cluster
c9be114fc2da2776
2019-02-13 02:53:30.080281 I | embed: serving client requests on 127.0.0.1:2379
WARNING: 2019/02/13 02:53:30 Failed to dial 127.0.0.1:2379: connection error: desc = "transport: authentication
handshake failed: remote error: tls: bad certificate"; please retry.
```

## kubeadm

# View Logs

```
▶ kubectl logs etcd-master

2019-02-13 02:53:28.144631 I | etcdmain: etcd Version: 3.2.18
2019-02-13 02:53:28.144680 I | etcdmain: Git SHA: eddf599c6
2019-02-13 02:53:28.144684 I | etcdmain: Go Version: go1.8.7
2019-02-13 02:53:28.144688 I | etcdmain: Go OS/Arch: linux/amd64
2019-02-13 02:53:28.144692 I | etcdmain: setting maximum number of CPUs to 4, total number of available CPUs is 4
2019-02-13 02:53:28.144734 N | etcdmain: the server is already initialized as member before, starting as etcd
member...
2019-02-13 02:53:28.146625 I | etcdserver: name = master
2019-02-13 02:53:28.146637 I | etcdserver: data dir = /var/lib/etcd
2019-02-13 02:53:28.146642 I | etcdserver: member dir = /var/lib/etcd/member
2019-02-13 02:53:28.146645 I | etcdserver: heartbeat = 100ms
2019-02-13 02:53:28.146648 I | etcdserver: election = 1000ms
2019-02-13 02:53:28.146651 I | etcdserver: snapshot count = 10000
2019-02-13 02:53:28.146677 I | etcdserver: advertise client URLs = 2019-02-13 02:53:28.185353 I | etcdserver/api:
enabled capabilities for version 3.2
2019-02-13 02:53:28.185588 I | embed: ClientTLS: cert = /etc/kubernetes/pki/etcd/server.crt, key =
/etc/kubernetes/pki/etcd/server.key, ca = , trusted-ca = /etc/kubernetes/pki/etcd/old-ca.crt, client-cert-auth =
true
2019-02-13 02:53:30.080017 I | embed: ready to serve client requests
2019-02-13 02:53:30.080130 I | etcdserver: published {Name:master ClientURLs:[https://127.0.0.1:2379]} to cluster
c9be114fc2da2776
2019-02-13 02:53:30.080281 I | embed: serving client requests on 127.0.0.1:2379
WARNING: 2019/02/13 02:53:30 Failed to dial 127.0.0.1:2379: connection error: desc = "transport: authentication
handshake failed: remote error: tls: bad certificate"; please retry.
```

★ If kube-apiserver or etcd cluster is down, then kubectl will won't work. In that case, you can use docker commands.

First, list all the containers using 'docker ps -a' command and then run 'docker logs <container id>'.

To perform a health check of certificates in a Kubernetes cluster provisioned by Kubeadm, you can follow these steps:

#### Identify Certificate Files:

- Look for the kube-apiserver definition file in the /etc/kubernetes/manifests folder. This file contains information about the certificates used by the API server.
- Identify the certificate files used for each purpose (e.g., API server certificate, client certificates, CA certificate) and note down their paths and names.

#### Decode Certificate Details:

- Use the **openssl x509** command to decode each certificate file and view its details.
- Start with the API server certificate file and examine the subject section to ensure it's named correctly (e.g., kube-apiserver).
- Check the alternate names section to verify all relevant alternate names are present.
- Review the validity section to identify the expiration date and issuer (CA) of the certificate.

#### Check Certificate Requirements:

- Ensure that each certificate has the correct names, alternate names, organization details, and is issued by the correct CA (e.g., Kubernetes CA for certificates in a Kubeadm setup).
- Check that certificates are not expired and meet the requirements outlined in the Kubernetes documentation.

#### View Logs for Issues:

- If you encounter issues with certificates, start by looking at logs.
- For clusters set up manually with native services, use the operating system's logging functionality to view service logs.
- For clusters provisioned with Kubeadm, where components are deployed as pods, use kubectl logs command followed by the pod name to view logs. If core components like API server or etcd are down, you may need to use Docker commands (**docker ps -a** and **docker logs <container-ID>**) to fetch logs.

By following these steps, you can perform a health check of certificates in a Kubernetes cluster and ensure that they are correctly configured, valid, and meeting the necessary requirements for secure communication within the cluster.

# lab 1

Sunday, May 5, 2024 5:28 PM

Identify the certificate file used for the kube-api server.

- Run the command cat /etc/kubernetes/manifests/kube-apiserver.yaml
- look for the line --tls-cert-file.

```
controlplane /etc/kubernetes/manifests → cat kube-apiserver.yaml | grep apiserver
 kubeadm.kubernetes.io/kube-apiserver.advertise-address.endpoint: 192.17.113.3:6443
 component: kube-apiserver
 name: kube-apiserver
 - kube-apiserver
 - --etcd-certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt
 - --etcd-keyfile=/etc/kubernetes/pki/apiserver-etcd-client.key
 - --kubelet-client-certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt
 - --kubelet-client-key=/etc/kubernetes/pki/apiserver-kubelet-client.key
 - --tls-cert-file=/etc/kubernetes/pki/apiserver.crt
 - --tls-private-key-file=/etc/kubernetes/pki/apiserver.key
 image: registry.k8s.io/kube-apiserver:v1.29.0
 name: kube-apiserver
```

apiserver.crt

Identify the Certificate file used to authenticate kube-apiserver as a client to ETCD Server.

Run the command cat /etc/kubernetes/manifests/kube-apiserver.yaml and look for value of etcd-certfile flag.

```
controlplane /etc/kubernetes/manifests → cat kube-apiserver.yaml | grep etcd
 - --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt
 - --etcd-certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt
 - --etcd-keyfile=/etc/kubernetes/pki/apiserver-etcd-client.key
 - --etcd-servers=https://127.0.0.1:2379
```

Identify the key used to authenticate kubeapi-server to the kubelet server.

```
controlplane /etc/kubernetes/manifests → cat kube-apiserver.yaml | grep kubelet
 - --kubelet-client-certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt
 - --kubelet-client-key=/etc/kubernetes/pki/apiserver-kubelet-client.key
 - --kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname
```

--kubelet-client-key=/etc/kubernetes/pki/apiserver-kubelet-client.key

Identify the ETCD Server Certificate used to host ETCD server.

Look for cert-file option in the file /etc/kubernetes/manifests/etcd.yaml.

```
--cert-file=/etc/kubernetes/pki/etcd/server.crt
```

```
controlplane /etc/kubernetes/manifests → cat etcd.yaml | grep etcd
 kubeadm.kubernetes.io/etcd.advertise-client-urls: https://192.17.113.3:2379
 component: etcd
 name: etcd
 - etcd
 - --cert-file=/etc/kubernetes/pki/etcd/server.crt
 - --data-dir=/var/lib/etcd
 - --key-file=/etc/kubernetes/pki/etcd/server.key
 - --peer-cert-file=/etc/kubernetes/pki/etcd/peer.crt
 - --peer-key-file=/etc/kubernetes/pki/etcd/peer.key
 - --peer-trusted-ca-file=/etc/kubernetes/pki/etcd/ca.crt
 - --trusted-ca-file=/etc/kubernetes/pki/etcd/ca.crt
```

Identify the ETCD Server CA Root Certificate used to serve ETCD Server.

ETCD can have its own CA. So this may be a different CA certificate than the one used by kube-api server.

Look for CA Certificate (trusted-ca-file) in file /etc/kubernetes/manifests/etcd.yaml

```
controlplane /etc/kubernetes/manifests → cat etcd.yaml | grep etcd
 kubeadm.kubernetes.io/etcd.advertise-client-urls: https://192.17.113.3:2379
 component: etcd
 name: etcd
 - etcd
 - --cert-file=/etc/kubernetes/pki/etcd/server.crt
 - --data-dir=/var/lib/etcd
 - --key-file=/etc/kubernetes/pki/etcd/server.key
 - --peer-cert-file=/etc/kubernetes/pki/etcd/peer.crt
 - --peer-key-file=/etc/kubernetes/pki/etcd/peer.key
 - --peer-trusted-ca-file=/etc/kubernetes/pki/etcd/ca.crt
 - --trusted-ca-file=/etc/kubernetes/pki/etcd/ca.crt
 image: registry.k8s.io/etcd:3.5.10-0
 name: etcd
```

What is the Common Name (CN) configured on the Kube API Server Certificate?

OpenSSL Syntax: openssl x509 -in file-path.crt -text -noout

Run the command openssl x509 -in /etc/kubernetes/pki/apiserver.crt -text and look for Subject CN.

```
controlplane /etc/kubernetes/manifests ➔ cat kube-apiserver.yaml | grep cert
- --etcd-certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt
- --kubelet-client-certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt
- --proxy-client-cert-file=/etc/kubernetes/pki/front-proxy-client.crt
- [+]tls cert_file=/etc/kubernetes/pki/apiserver.crt
```

```
controlplane /etc/kubernetes/manifests ➔ openssl x509 -in /etc/kubernetes/pki/apiserver.crt -text -no
out
Certificate:
Data:
 Version: 3 (0x2)
 Serial Number: 3479745051933187810 (0x304a89b031669ee2)
 Signature Algorithm: sha256WithRSAEncryption
 Issuer: CN = kubernetes
 Validity
 Not Before: May 5 11:48:31 2024 GMT
 Not After : May 5 11:53:31 2025 GMT
 Subject: CN = kube-apiserver
 Subject Public Key Info:
 Public Key Algorithm: rsaEncryption
 Public-Key: (2048 bit)
 Modulus:
```

The Subject field specifies the entity to which the certificate applies or the entity it represents.

Here, CN=kubernetes indicates that the certificate is intended for use within the Kubernetes cluster itself, possibly for authentication, secure communication, or other internal operations.

What is the name of the CA who issued the Kube API Server Certificate?

```
controlplane /etc/kubernetes/manifests ➔ openssl x509 -in /etc/kubernetes/pki/apiserver.crt -text -no
out
Certificate:
Data:
 Version: 3 (0x2)
 Serial Number: 3479745051933187810 (0x304a89b031669ee2)
 Signature Algorithm: sha256WithRSAEncryption
 Issuer: CN = kubernetes
 Validity
```

The Issuer field indicates the entity that issued or signed the certificate.

In this case, CN=kubernetes suggests that the certificate was self-signed by the Kubernetes cluster itself.

Which of the below alternate names is not configured on the Kube API Server Certificate?

```
B7:68:46:E8:05:C9:FB:6A:FC:9B:BD:94:26:5D:78:72:8D:71:5F:50
X509v3 Subject Alternative Name:
DNS:controlplane, DNS:kubernetes, DNS:kubernetes.default, DNS:kubernetes.default.svc,
DNS:kubernetes.default.svc.cluster.local, IP Address:10.96.0.1, IP Address:192.17.113.3
Signature Algorithm: sha256WithRSAEncryption
Signature Value:
```

What is the Common Name (CN) configured on the **ETCD Server certificate**?

```
cat etcd.yaml | grep crt
--cert-file=/etc/kubernetes/pki/etcd/server.crt
openssl x509 -in /etc/kubernetes/pki/etcd/ca.crt -text -noout
```

Search for :  
Subject :  
CN = controlplane

Run the command `openssl x509 -in /etc/kubernetes/pki/apiserver.crt -text` and check on the Expiry date.

Validity  
Not Before: May 5 11:48:31 2024 GMT  
Not After : May 5 11:53:31 2025 GMT

How long, from the issued date, is the **Root CA Certificate** valid for?

File: /etc/kubernetes/pki/ca.crt

```
controlplane /etc/kubernetes/manifests → cat kube-apiserver.yaml | grep ca
 - --client-ca-file=/etc/kubernetes/pki/ca.crt
 - --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt
 - --kubelet-client-certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt
 - --requestheader-client-ca-file=/etc/kubernetes/pki/front-proxy-ca.crt
 - --service-account-issuer=https://kubernetes.default.svc.cluster.local
```

Kubectl suddenly stops responding to your commands. Check it out! Someone recently modified the /etc/kubernetes/manifests/etc.yaml file

kubectl stop responding means no kubectl command will work now.  
Use "docker ps" or "crlctl ps"

Kubectl suddenly stops responding to your commands. Check it out! Someone recently modified the /etc/kubernetes/manifests/etc.yaml file

You are asked to investigate and fix the issue. Once you fix the issue wait for some time for kubectl to respond. Check the logs of the ETCD container.

```
The certificate file used here is incorrect. It is set to /etc/kubernetes/pki/etcd/server-certificate.crt which does not exist. As we saw in the previous questions the correct path should be /etc/kubernetes/pki/etcd/server.crt.

root@controlplane:~# ls -l /etc/kubernetes/pki/etcd/server* | grep .crt
-rw-r--r-- 1 root root 1188 May 20 00:41 /etc/kubernetes/pki/etcd/server.crt
root@controlplane:~#
```

Update the YAML file with the correct certificate path and wait for the ETCD pod to be recreated. wait for the kube-apiserver to get to a Ready state.

NOTE: It may take a few minutes for the kubectl commands to work again so please be patient.

The kube-api server stopped again! Check it out. Inspect the kube-api server logs and identify the root cause and fix the issue.

- Run crictl ps -a command to identify the kube-api server container.
- Run crictl logs container-id command to view the logs.

```
If we inspect the kube-apiserver container on the controlplane, we can see that it is frequently exiting.

root@controlplane:~# crictl ps -a | grep kube-apiserver
1fb242855cff8 529872250cccd About a minute ago Exited kube-apiserver 3 ed2174865a416 kube-apiserver-controlplane

If we now inspect the logs of this exited container, we would see the following errors:

root@controlplane:~# crictl logs -v tail -2 1fb242855cff8
W0916 14:19:44.771928 1 clientconn.go:1311] [core] grpc: addrConn.createTransport failed to connect to {127.0.0.1:2379 127.0.0.1 <nil> 0 <nil>}. Err: connection error: desc = "transport: authentication handshake failed: x509: certificate signed by unknown authority". Reconnecting...
E0916 14:19:48.689383 1 run.go:74] [core] "command failed" err="context deadline exceeded"

This indicates an issue with the ETCD CA certificate used by the kube-apiserver. Correct it to use the file /etc/kubernetes/pki/etcd/ca.crt. Once the YAML file has been saved, wait for the kube-apiserver pod to be ready. This can take a couple of minutes.
```

# Certificates API

Tuesday, March 19, 2024 2:42 PM

## Certificate Generation and Signing Process:

1. An administrator sets up a CA (Certificate Authority) server and generates a pair of key and certificate files for various components in the cluster.
2. When a new administrator joins the team, he/she generates her own private key and creates a certificate signing request (CSR), which she sends to the existing administrator.
3. The existing administrator takes the CSR to the CA server, signs it using the CA server's private key and root certificate, and generates a signed certificate for the new administrator.

## Certificate Expiry and Rotation:

1. Certificates have a validity period, and when they expire, the same process of generating a new CSR and getting it signed by the CA server is followed.
2. This ensures that certificates are regularly rotated and remain valid for secure communication.

## CA Server and Location:

1. The CA server is essentially a pair of key and certificate files used to sign certificates for the Kubernetes environment.
2. These files need to be securely stored on a server, often referred to as the CA server, which should be kept in a safe and secure environment.

## Kubernetes Master Node as CA Server:

1. In some setups, the CA key and certificate files are placed on the Kubernetes master node itself, making it act as the CA server.
2. Tools like Kubeadm also create a CA pair of files and store them on the master node for certificate signing purposes.

## Certificates API in Kubernetes:

1. Kubernetes provides a built-in Certificates API that allows users to send certificate signing requests directly to Kubernetes through an API call.
2. Administrators can create a Certificate Signing Request(CSR) object in Kubernetes to review and approve certificate signing requests easily using kubectl commands.
3. The Controller Manager in the Kubernetes control plane, specifically the CSR-Approving and CSR-Signing controllers, handles certificate-related operations, including signing certificates and approving CSR requests.

## Controller Manager Configuration:

The Controller Manager's service configuration includes options to specify the CA server's root certificate and private key, which are required for signing certificates.

## Certificate Extraction and Sharing:

1. Once a certificate is signed by Kubernetes, it can be extracted and shared with the user.
2. The certificate can be viewed in YAML format, and to decode it from base64 encoding, the base64 utility's decode option can be used.
3. Overall, the Controller Manager plays a crucial role in managing certificate-related operations in

Kubernetes, including signing certificates, approving CSR requests, and ensuring secure communication within the cluster. The Certificates API provides a convenient way to automate certificate management processes, such as signing requests and certificate rotation.

## CSR

1. User first creates a key

```
▶ openssl genrsa -out jane.key 2048
jane.key
```

2. A user then generates a certificate signing request using the key with her name on it, then sends the request to the administrator.

```
▶ openssl req -new -key jane.key -subj "/CN=jane" -out jane.csr
jane.csr

-----BEGIN CERTIFICATE REQUEST-----
MIICWDCAUACAQAwEzERMA8GA1UEAwIBmV3LXVzZXIwggEiMA0GCSqGSIb3DQE
B
AQUAA4IBDwAwggEKAoIBAQD00WJW+DXsAJSIrjpNo5vRIpInzg+6xc9+UWvkKi0
Lfc27t+1eNnON5Muq99NevmMEOnrDUO/thyVqP2w2XNIDRxjYf40FbmD+5zWlyCK
9w0BAQsFAAOCAQEAS9i56C1uxTuf5BBYSU7QFHuzalNxAdYsaORRQNmH2wHqGi4
hOK4a2zyNy14400ijyaD6tUW8DSxkr8BLK8kg3srEtJq15rLzy9LRVrsJghD4gY
P9NL+aDRSxROVSqBaB2nleYpm5c3TF53lesNSNMLQ2++RMnjDQJ7juPEic8/dhk
Wr2EUM6UawzykrdhImwTv2m1MY0R+DntViYie+0H9/YElt+FSGjh5LSYUvI1Dqiy
413E/y3ql71WfAcuH3OsVpUuNQISMdQs0qWCsbe56CCSDhPGZIpUbnKUpAwka+8E
vwQ07jG+hpknxmuFaeXxglkodLaJ7ju/TDIcw==
-----END CERTIFICATE REQUEST-----
```

The administrator takes a key and creates a CertificateSigningRequest object.

The CertificateSigningRequest object is created like any other Kubernetes object, using a manifest file with the usual fields but you don't specify it as plain text. Instead, it must be encoded using the base64 command.

```
jane.csr

-----BEGIN CERTIFICATE REQUEST-----
MIICWDCAUACAQAwEzERMA8GA1UEAwIBmV3LXVzZXIwggEiMA0GCSqGSIb3DQE
B
AQUAA4IBDwAwggEKAoIBAQD00WJW+DXsAJSIrjpNo5vRIpInzg+6xc9+UWvkKi0
Lfc27t+1eNnON5Muq99NevmMEOnrDUO/thyVqP2w2XNIDRxjYf40FbmD+5zWlyCK
9w0BAQsFAAOCAQEAS9i56C1uxTuf5BBYSU7QFHuzalNxAdYsaORRQNmH2wHqGi4
hOK4a2zyNy14400ijyaD6tUW8DSxkr8BLK8kg3srEtJq15rLzy9LRVrsJghD4gY
P9NL+aDRSxROVSqBaB2nleYpm5c3TF53lesNSNMLQ2++RMnjDQJ7juPEic8/dhk
Wr2EUM6UawzykrdhImwTv2m1MY0R+DntViYie+0H9/YElt+FSGjh5LSYUvI1Dqiy
413E/y3ql71WfAcuH3OsVpUuNQISMdQs0qWCsbe56CCSDhPGZIpUbnKUpAwka+8E
vwQ07jG+hpknxmuFaeXxglkodLaJ7ju/TDIcw==
-----END CERTIFICATE REQUEST-----
```

```
cat jane.csr | base64
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURSBDRVFRVNULS0
tLS0KTUlJQ1dEQ0NBVUFQVFb0v6RVJNQThHQTFVRU
F3d0libVYzTFhWeIpYSXdnZ0VpTUEwR0NTcUdTSWIzR
FFFQgpBUVVBQTRJQkR3QXdnZ0VLQW9JQkFRRE8wV0pX
K0RYC0FKU01yanB0bzV2UklCcGxuemcrNnhj0StVnd
rS2kwCkxmQzI3dCsxZUVuT041TXVxOT10ZXztTUVPbn
J
```

```
jane-csr.yaml
```

```
apiVersion: certificates.k8s.io/v1
kind: CertificateSigningRequest
metadata:
 name: jane
spec:
 expirationSeconds: 600 #seconds
 usages:
 - digital signature
 - key encipherment
 - server auth
 request:
 LS0tLS1CRUdJTiBDRVJUSUZJQ0FURSBDRV
 FVRVNULS0tLS0KTU1JQ1dEQ0NBVUFDVFB
 d0V6RVJNQThHQTFVRUF3d0libVYzTFhWe1
 pYSXdnZ0VpTUEwR0NTcUdTSWIzRFFFQgpB
 UVVBQTRJQkR3QXdnZ0VLQW9JQkFRRE8wV0
 pXK0RYc0FKU0lyanBObzV2UklCcGxuemcr
 NnhjOStVVndrS2kwCkxmQzI3dCsxZUVuT0
 41TXVxOTl0ZXztTUVPbnJ
```

Get list of CSR request

```
▶ kubectl get csr
```

| NAME | AGE | SIGNERNAME                          | REQUESTOR         | REQUESTEDDURATION | CONDITION |
|------|-----|-------------------------------------|-------------------|-------------------|-----------|
| jane | 10m | kubernetes.io/kube-apiserver-client | admin@example.com | 10m               | Pending   |

Signing the CSR

```
▶ kubectl certificate approve jane
```

```
jane approved!
```

View the certificate

You must also decrypt the certificate using - 'base64 --decoded'.

```
▶ kubectl get csr jane -o yaml
```

```
apiVersion: certificates.k8s.io/v1
kind: CertificateSigningRequest
metadata:
 creationTimestamp: 2019-02-13T16:36:43Z
 name: new-user
spec:
```

```
▶ echo "LS0...Qo=" | base64 --decode
```

```
-----BEGIN CERTIFICATE-----
MIICWDCCAUACAQAwEzERMA8GA1UEAwIBmV3LXVzZXIWgg
AQUAA4IBDwAwggEKAoIBAQDO0WJW+DXsAJSIrjpNo5vRIB
Lfc27t+1eEnON5Muq99NevmMEOnrDUO/thyVqP2w2XNIDR
y3BihhB93MJ70ql3UTvZ8TELqyaDknR1/jv/SxgXkok0AB
-----END CERTIFICATE-----
```

```
▶ kubectl get csr jane -o yaml
```

```
apiVersion: certificates.k8s.io/v1
kind: CertificateSigningRequest
metadata:
 creationTimestamp: 2019-02-13T16:36:43Z
 name: new-user
spec:
 groups:
 - system:masters
 - system:authenticated
 expirationSeconds: 600
 usages:
 - digital signature
 - key encipherment
 - server auth
 username: kubernetes-admin
 status:
 certificate:
 LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSURDakNDQwZLz0F3SUJBz0lVRmwy
 Q2wxYXoxawI5M3JNVisreFRYQUowU3dnndRRWUpLbipJaHzjTkFRRUwKQlFBd0ZURVRN
 QkVHQTFVRUF4TUthM1ZpWhKdVpYUmjekFlRncweE9UQX1NVE14TmpNeU1EQmFGd1dn
 Y0ZFeDl2ajNuSXY3eFdDS1NIRm5sU041c0t5Z0VxUkwzTFM5V29GelhHZDdWCmlEZ2FO
 MVVRMFBXTVhjN09FVnVjSwc1Yk4weEVHTkVwRUStdU1BNLZWeHVjs1h6aG9ldDY0MED1
 MGU0YXFkWIKWmVMbjBvRTFCY3dod2xic0I1ND0KLS0tLS1FTk0gQ0VSVElGSUNBVEUt
 LS0tLQo=
 conditions:
 - lastUpdateTime: 2019-02-13T16:37:21Z
 message: This CSR was approved by kubectl certificate approve.
 reason: KubectlApprove
 type: Approved
```

```
▶ echo "LS0...Qo=" | base64 --decode
```

```
-----BEGIN CERTIFICATE-----
MIICWDCCAUACAQAwEzERMA8GA1UEAwIBmV3LXVzZXIWgg
AQUAA4IBDwAwggEKAoIBAQD00WJW+DXsAJSIrjpNo5vRIB
LFC27t+1eEnON5Muq99NevmMEOnrDUO/thyVqP2w2XNIDR
y3BihhB93MJ70ql3UTvZ8TELqyaDknR1/jv/SxgXkok0AB
IF5nxAttMvkDPQ7NbeZRG43b+QW1VGR/z6DWOfJnbfezot
EcCXAwqChjBLkz2BHP4J89D6Xb8k39pu6jpyngV6uP0tI
j2qEL+hZEWkkFz80lNNtyT5LxMqENDCnIgwC4GZiRGbrAg
9w0BAQsFAAOCAQEAS9iS6C1uxTuf5BBYSU7QFQHUza1NxA
h0K4a2zyNyijyaD6tUW8DSxkr8BLK8Kg3srREtJql
P9NL+aDRSxROVSqBaB2nWeYpM5cJ5TF53lesNSNMLQ2++R
Wr2EUM6UawzykrdHImwTv2m1MY0R+DntV1Yie+0H9/YElt
4l3E/y3qL71WfAcuH3OsVpUUUnQISMdQs0qWCsbE56CC5Dh
vwQ07jG+hpknxmuFAeXxgUwodALaJ7ju/TDIcw==
```

```
-----END CERTIFICATE-----
```

- ★ All the certificate related operations are carried out by the Controller Manager. It has controllers in it called as CSR-Approving, CSR-signing, et cetera. They're responsible for carrying out these specific tasks.



To get the info about CA cert and keys

```
▶ cat /etc/kubernetes/manifests/kube-controller-manager.yaml
```

```
spec:
 containers:
 - command:
 - kube-controller-manager
 - --address=127.0.0.1
 - --cluster-signing-cert-file=/etc/kubernetes/pki/ca.crt
 - --cluster-signing-key-file=/etc/kubernetes/pki/ca.key
 - --controllers=*,bootstrapsigner,tokencleaner
 - --kubeconfig=/etc/kubernetes/controller-manager.conf
 - --leader-elect=true
 - --root-ca-file=/etc/kubernetes/pki/ca.crt
 - --service-account-private-key-file=/etc/kubernetes/pki/sa.key
 - --use-service-account-credentials=true
```

# kubeconfig

Tuesday, March 19, 2024 3:49 PM

## How to retrieve information about the pods from kube-apiserver?

By making REST API call

```
▶ curl https://my-kube-playground:6443/api/v1/pods \
 --key admin.key
 --cert admin.crt
 --cacert ca.crt
```

The command you provided is using the curl tool to interact with the Kubernetes API server. Let's break down each part of the command:

1. curl: curl is a command-line tool used to transfer data to or from a server using various protocols such as HTTP, HTTPS, FTP, etc. In this case, it's being used to send an HTTPS request to the Kubernetes API server.
2. <https://my-kube-playground:6443/api/v1/pods>: This part of the command specifies the URL endpoint of the Kubernetes API server. It's trying to access the /api/v1/pods endpoint, which typically provides information about pods in the Kubernetes cluster. <https://my-kube-playground:6443> is the URL of the Kubernetes API server, where my-kube-playground is the hostname or IP address of the server, and 6443 is the default port for the Kubernetes API server.
3. --key admin.key: This option specifies the path to the client certificate private key file (admin.key) to use for authentication when connecting to the Kubernetes API server. This key is used to prove the identity of the client (in this case, curl acting on behalf of a user or application).
4. --cert admin.crt: This option specifies the path to the client certificate file (admin.crt) to use for authentication. The certificate contains the public key corresponding to the private key specified with --key. Together, the certificate and private key authenticate the client to the server.
5. --cacert ca.crt: This option specifies the path to the CA certificate file (ca.crt) used to verify the authenticity of the Kubernetes API server's certificate. The CA certificate is used to establish a secure connection (HTTPS) and ensure that the server's certificate is signed by a trusted authority.

In summary, the curl command is making an HTTPS request to the Kubernetes API server to retrieve information about pods (/api/v1/pods endpoint). It's authenticating itself using a client certificate and key (admin.crt and admin.key) and verifying the server's certificate using the CA certificate (ca.crt) to establish a secure and trusted connection with the API server.

By kubectl, we can write same command as

```
▶ kubectl get pods
 --server my-kube-playground:6443
 --client-key admin.key
 --client-certificate admin.crt
 --certificate-authority ca.crt
```

No resources found.

To write this much words in a command is time consuming, so we create a config file for it.

```
▶ kubectl get pods
--kubeconfig config

No resources found.
```

This config file can be found under the HOME directory.

```
$HOME/.kube/config
KubeConfig File

--server my-kube-playground:6443
--client-key admin.key
--client-certificate admin.crt
--certificate-authority ca.crt
```

#### Format of a KubeConfig file

Is KubeConfig file me hum last waale cluster par focus kar rahe to sirf us cluster aur uske respective Contexts and Users ki details hai. Isi tarah baaki ke bhi cluster-context-user ka bana sakte hai.

# KubeConfig File

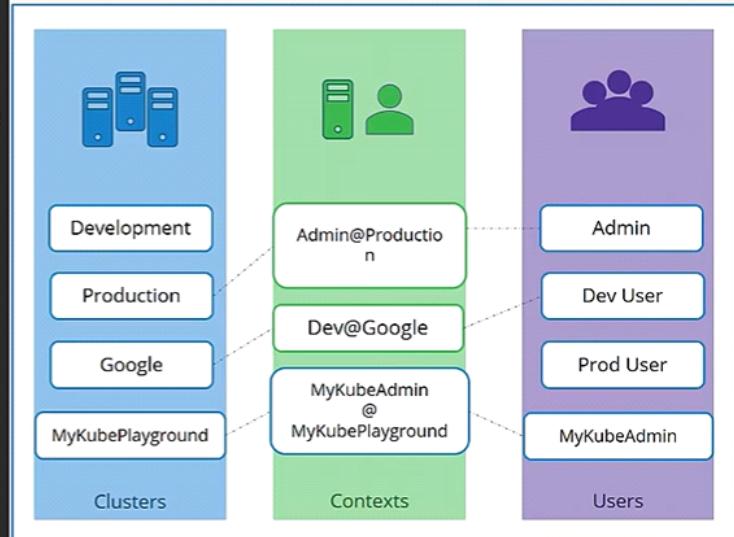
```
apiVersion: v1
kind: Config

clusters:
- name: my-kube-playground
 cluster:
 certificate-authority: ca.crt
 server: https://my-kube-playground:6443

contexts:
- name: my-kube-admin@my-kube-playground
 context:
 cluster: my-kube-playground
 user: my-kube-admin

users:
- name: my-kube-admin
 user:
 client-certificate: admin.crt
 client-key: admin.key
```

\$HOME/.kube/config



Saare cluster ka details add karne ke baad kubeconfig file will somewhat look like this par details hidden hai...idea ke liye -

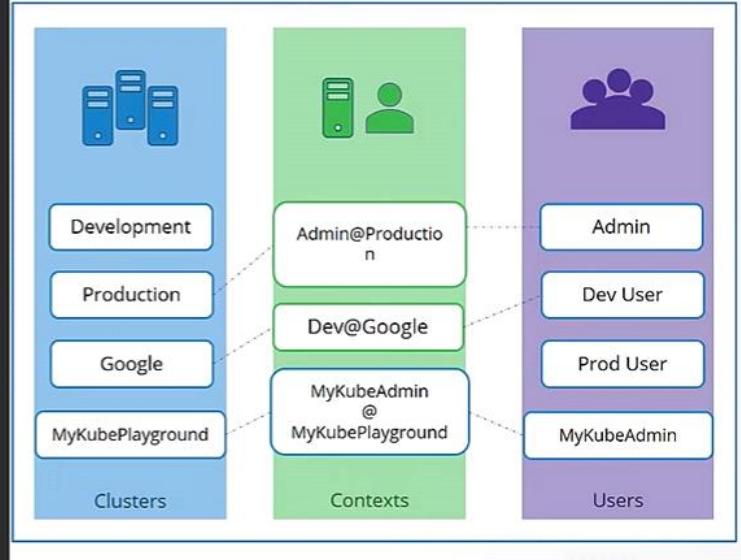
```
apiVersion: v1
kind: Config
current-context: dev-user@google

clusters:
- name: my-kube-playground (values hidden...)
- name: development
- name: production
- name: google

contexts:
- name: my-kube-admin@my-kube-playground
- name: dev-user@google
- name: prod-user@production

users:
- name: my-kube-admin
- name: admin
- name: dev-user
- name: prod-user
```

\$HOME/.kube/config



- ? How does kubectl will know ki kis context ko use karn ahai by default ?  
For this purpose, we will add another section 'current-context' in the kube-configuration file.
- ? How to view default kubeconfig file?

We can also do this using kubectl command as well

```
kubectl config view --kubeconfig=my-custom-config
apiVersion: v1
kind: Config
current-context: my-kube-admin@my-kube-playground

clusters:
- name: my-kube-playground
- name: development
- name: production

contexts:
- name: my-kube-admin@my-kube-playground
- Name: prod-user@production

users:
- name: my-kube-admin
- name: prod-user
```

To view the default kubeconfig file being used

```
kubectl config view
apiVersion: v1
kind: Config
current-context: kubernetes-admin@kubernetes

clusters:
- cluster:
 certificate-authority-data: REDACTED
 server: https://172.17.0.5:6443
 name: kubernetes

contexts:
- context:
 cluster: kubernetes
 user: kubernetes-admin
 name: kubernetes-admin@kubernetes

users:
- name: kubernetes-admin
 user:
 client-certificate-data: REDACTED
 client-key-data: REDACTED
```

? how to change the default kube-config file, let's say dev to prod?

```
kubectl config view
```

```
apiVersion: v1

kind: Config
current-context: my-kube-admin@my-kube-playground

clusters:
- name: my-kube-playground
- name: development
- name: production

contexts:
- name: my-kube-admin@my-kube-playground
- Name: prod-user@production

users:
- name: my-kube-admin
- name: prod-user
```

```
kubectl config use-context prod-user@production
```

```
apiVersion: v1

kind: Config
current-context: prod-user@production

clusters:
- name: my-kube-playground
- name: development
- name: production

contexts:
- name: my-kube-admin@my-kube-playground
- Name: prod-user@production

users:
- name: my-kube-admin
- name: prod-user
```

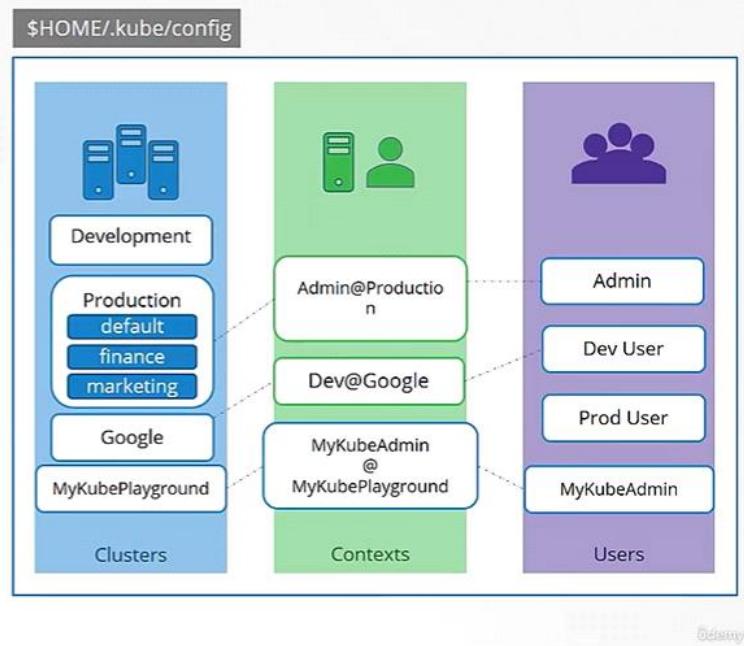
We can also specify particular namespaces in the kubeconfig file as well by adding another section 'namespace'.

```
apiVersion: v1
kind: Config

clusters:
- name: production
 cluster:
 certificate-authority: ca.crt
 server: https://172.17.0.51:6443

contexts:
- name: admin@production
 context:
 cluster: production
 user: admin
 namespace: finance

users:
- name: admin
 user:
 client-certificate: admin.crt
 client-key: admin.key
```



### Try to use full path for the certificate files

```
apiVersion: v1
kind: Config

clusters:
- name: production
 cluster:
 certificate-authority: /etc/kubernetes/pki/ca.crt
 server: https://172.17.0.51:6443

contexts:
- name: admin@production
 context:
 cluster: production
 user: admin
 namespace: finance

users:
- name: admin
 user:
 client-certificate: /etc/kubernetes/pki/users/admin.crt
 client-key: /etc/kubernetes/pki/users/admin.key
```

Methods to specify the certificate credentials.

1st

use certificate-authority-data field and pass the content of the certificate by encoding with the base64.

# Certificates in KubeConfig

```
apiVersion: v1
kind: Config

clusters:
- name: production
 cluster:
 certificate-authority: /etc/kubernetes/pki/ca.crt

 certificate-authority-data: LS0tLS1CRUdJTiBDRVJU
 SUZJQ0FURSBSRVFVRVNULS0tLS0KTU1J
 Q1dEQ0NBVUFQVFBD0V6RVJNQThHQTfV
 RUF3d0libVYzTFhWeIpYSXdnZ0VpTUEw
 R0NTcUdTSWIzRFFFQgpBUVVBQTRJQkR3
 QXdNz0VLQW9JQkFRRE8wV0pXK0RYc0FK
 U0lyanB0bzV2Uk1CcGxuemcrNnhj0StV
 VndrS2kwCkxmQzI3dCsxZUVuT041TXVx
 OTl0ZXZtTUVPbnJ
```

```
-----BEGIN CERTIFICATE-----
MIICWDCCAUACQAwEzERMA8GA1UEAwIBmV3LXVzZXIWggEiMA0G
AQAA4IBDwAwggEKAoIBAQD00WJW+DXsAJSlrjpNo5vRIBpInzg+e
Lfc27t+1eInONSMuq99NevmMEOnrDUO/thyVqP2w2XNIDRxjYyF46
y3B1hB93M7Q13UTvZ8TELqyaDknR1/jv/SxgXkok@ABUTpWMx4
IF5nxAttMWkDPQ7NbZRG43b+QW1VGR/z6DWOfJnbfezoAydGL1
EcCXAwgQChjBLk28HPR4J89D6xbk39pu6jpyngV6uP0tIb0zpQnV
j2qEL+hZEWkkFz801NNtyT5LxMqENDCnIgwC4GZiRGbrAgMBAAGgA
9w0BAQsfAACQEA9i56CluxTuf5BBYSU7QFHuzalNxAdysaORf
hOK4a2zyNyI4400ijyaD6tUW8DSxkr8BLK8Kg3srREtJq15rLZYI
P9NL+aDRSXROVSqBaB2nWeYpMScJ5TF531esNSMML02++RMnjDQJ7
Wr2EU6UawzykrdHImwTv2mlMY0R+DNTv1Yie+0H9/YElt+FSGjhE
413E/y3qL71WfAcuH3OsVpUUnQISMdQs0qWcsbE56CC5dPGZiP0t
vW087jG+hpknxmuFAexXgUwodAlaJ7ju/TDICw==
-----END CERTIFICATE-----
```

```
▶ cat ca.crt | base64
```

```
LS0tLS1CRUdJTiBDRVJUSUZJQ0FURSBSRVFVRVN
tLS0KTU1JQ1dEQ0NBVUFQVFBD0V6RVJNQThHQT
F3d0libVYzTFhWeIpYSXdnZ0VpTUEwR0NTcUdTS
FFFQgpBUVVBQTRJQkR3QXdnZ0VLQW9JQkFRRE8w
K0RYc0FKU0lyanB0bzV2Uk1CcGxuemcrNnhj0StV
rS2kwCkxmQzI3dCsxZUVuT041TXVxOTl0ZXZtTU
J
```

To decode the content use

```
▶ echo "LS0...bnJ" | base64 --decode
```

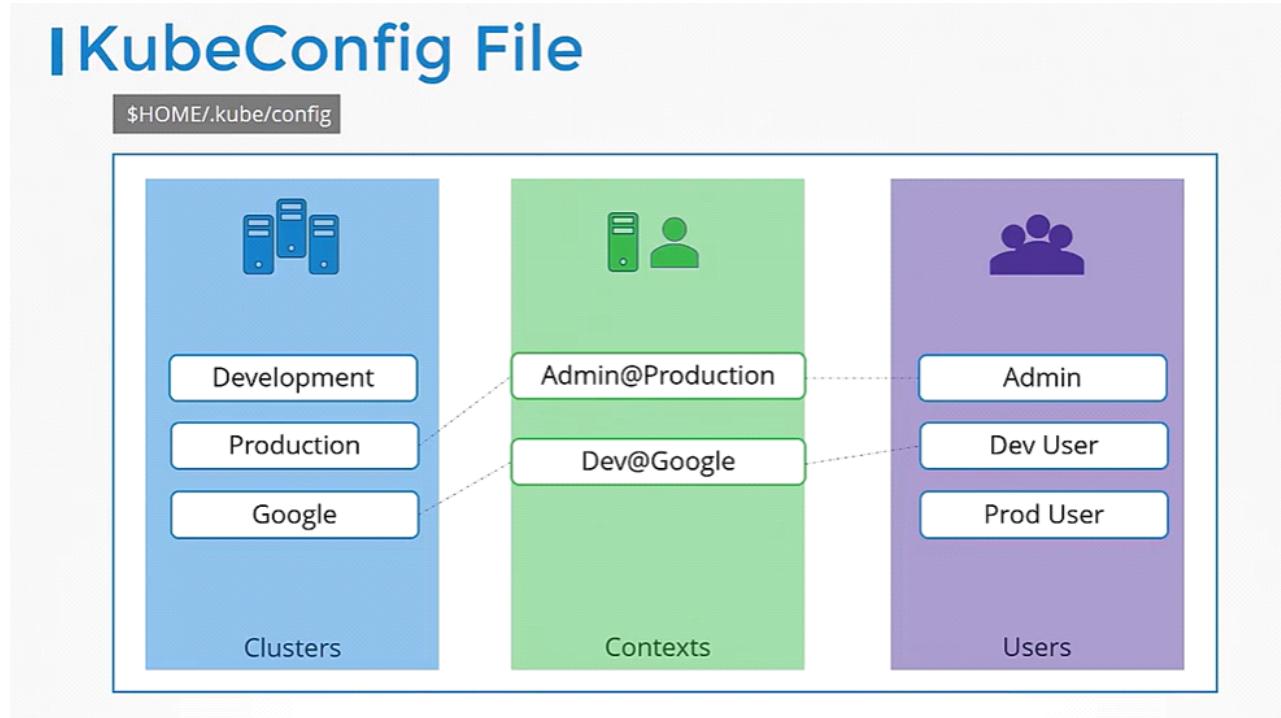
how to manage authentication and access to Kubernetes clusters using configuration files called kubeconfig

Purpose of Kubeconfig:

Kubeconfig is a configuration file used by kubectl and other Kubernetes command-line tools to manage access to Kubernetes clusters.

It contains information such as server addresses, user credentials, and cluster contexts.

Structure of Kubeconfig:



1. Kubeconfig files have three main sections: clusters, users, and contexts.
2. Clusters: Defines various Kubernetes clusters that you need access to, specifying server addresses and CA certificates.  
Multiple clusters because some for dev, some for prod etc.
3. Users: Specifies user accounts (e.g., admin, dev, prod) with credentials (client certificate, client key) to access clusters.
4. Contexts: Links clusters and users together, defining which user account will be used to access which cluster.

★ Now using this, you define which existing users with their respective privileges can access which cluster. You are not creating a new user nor configuring the user access so that's why you need not to use any user or server certificate in each and every kubectl command you run.

In below KubeConfig file,

```
$HOME/.kube/config
```

### KubeConfig File

```
--server my-kube-playground:6443
--client-key admin.key
--client-certificate admin.crt
--certificate-authority ca.crt
```

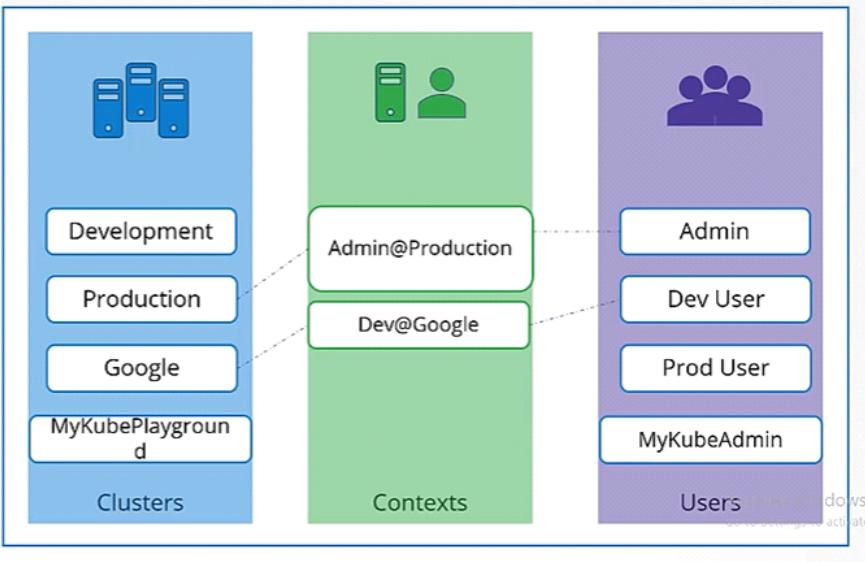
- --server my-kube-playground :6443 - The server specifications will go into the Clusters.  
- --client-key admin.key - Goes into the users section  
- --client-certificate admin.crt - Goes into the users section  
--certificate-authority ca.crt - Goes into the clusters section

You then create a context

that specifies to use the my kube admin user

to access the my kube playground cluster.

```
$HOME/.kube/config
```



Creating Kubeconfig:

1. Create a kubeconfig file in YAML format with API version v1 and kind config.
2. Add entries for clusters, users, and contexts, specifying server addresses, client certificates, keys, and context names.

Usage of Kubeconfig:

1. Use kubectl commands with the --kubeconfig option to specify the kubeconfig file.

2. By default, kubectl looks for a file named config under the .kube directory in the user's home directory.
3. Specify the default context in the kubeconfig file using the current-context field.

#### Managing Kubeconfig:

1. Use kubectl config view to view the current kubeconfig file, contexts, and users.
2. Update the current context using kubectl config use-context to switch between different user accounts or clusters.
3. You can specify namespaces within contexts to switch to specific namespaces automatically.

#### Certificate Handling in Kubeconfig:

1. Specify paths to certificate files (e.g., CA certificate) in the kubeconfig file.
2. Alternatively, use the certificate-authority-data field to provide the contents of the certificate in Base64 encoded format directly in the kubeconfig file.
3. Overall, kubeconfig files provide a structured way to manage authentication and access to Kubernetes clusters, allowing users to switch between different clusters, user accounts, and namespaces easily without specifying credentials in every kubectl command.

# API Groups

Tuesday, March 19, 2024 8:17 PM

## Kubernetes API Overview:

The Kubernetes API is a key component that allows users to interact with the Kubernetes cluster, perform operations, and manage resources.

Operations like checking the cluster version or getting a list of pods are done through the Kubernetes API server.

## API Groups and Resources:

The Kubernetes API is grouped into multiple categories based on functionality, such as version, health, metrics, logs, etc.

The APIs related to cluster functionality are categorized into two main groups:

**Core Group:** Contains core functionality like namespaces, pods, replication controllers, nodes, services, etc.

**Named Group:** Organizes newer features and functionalities into separate groups like apps, extensions, networking, storage, authentication, and authorization.

## API Group Hierarchy:

Within each API group, there are specific resources (e.g., deployments, replica sets, network policies) that represent Kubernetes objects.

Each resource has associated actions or "verbs" that define operations you can perform on them, such as listing, getting, creating, updating, deleting, and watching resources.

## Accessing API Groups:

You can view available API groups and resources by accessing the Kubernetes API server directly or through kubectl.

Accessing the API server without authentication will restrict access to certain APIs, such as the version API.

Use authentication mechanisms like certificates and credentials to authenticate and access the API server securely.

## Kubectl Proxy:

kubectl proxy is a command that starts a proxy service locally, allowing you to access the Kubernetes API server securely without specifying credentials in each request.

The proxy service uses credentials and certificates from your kubeconfig file to forward requests to the API server.

## Key Takeaways:

Understanding API groups and resources helps in organizing and managing Kubernetes objects effectively.

API groups and resources are used in conjunction with authentication and authorization mechanisms to control access to cluster resources.

Differentiate between kubectl proxy used for API server access and kube-proxy used for pod and service connectivity within the cluster.

In the next section on authorization, you'll learn how to use these API groups and resources to define access control policies for users and groups within Kubernetes clusters.

# Authorization

Wednesday, March 20, 2024 10:49 AM

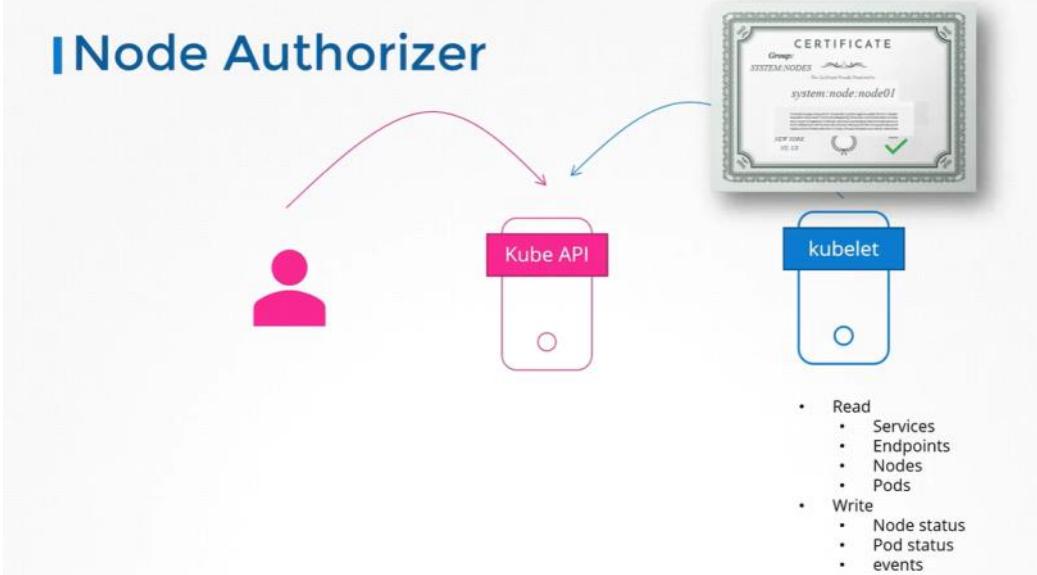
## 1. Need for Authorization:

- Authorization is essential to control access within the Kubernetes cluster, especially when multiple users or entities access the cluster with varying levels of privileges.
- Different users or applications should have specific permissions tailored to their roles and responsibilities. e.g. The Developer doesn't need to delete the node or modify any configuration in the cluster, Service accounts should be granted the least access, etc.

The image shows a 3x3 grid of terminal windows. Each window contains a command and its output. The columns represent different user types: Admins (black icon), Developers (pink icon), and Bots (robot icon). The rows represent different kubectl commands: get pods, get nodes, and delete node.

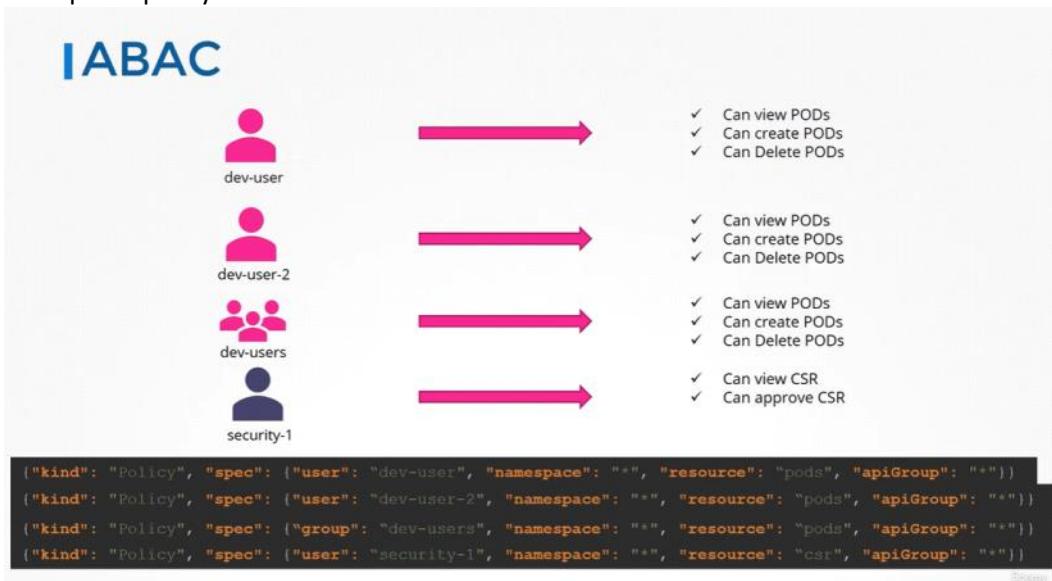
| User Type  | Command                      | Output                                                                                                        |
|------------|------------------------------|---------------------------------------------------------------------------------------------------------------|
| Admins     | kubectl get pods             | NAME READY STATUS AGE RESTARTS<br>nginx 1/1 Running 0 53s                                                     |
| Admins     | kubectl get nodes            | NAME STATUS ROLES AGE VERSION<br>worker-1 Ready <none> 5d21h v1.13.0<br>worker-2 Ready <none> 5d21h v1.13.0   |
| Admins     | kubectl delete node worker-2 | Node worker-2 Deleted!                                                                                        |
| Developers | kubectl get pods             | NAME READY STATUS AGE RESTARTS<br>nginx 1/1 Running 0 53s                                                     |
| Developers | kubectl get nodes            | NAME STATUS ROLES AGE VERSION<br>worker-1 Ready <none> 5d21h v1.13.0<br>worker-2 Ready <none> 5d21h v1.13.0   |
| Developers | kubectl delete node worker-2 | Error from server (Forbidden): nodes "worker-2" is forbidden: User "developer" cannot delete resource "nodes" |
| Bots       | kubectl get pods             | Error from server (Forbidden): pods is forbidden: User "Bot-1" cannot list "pods"                             |
| Bots       | kubectl get nodes            | Error from server (Forbidden): nodes is forbidden: User "Bot-1" cannot get "nodes"                            |
| Bots       | kubectl delete node worker   | Error from server (Forbidden): nodes "worker-2" is forbidden: User "Bot-1" cannot delete resource "nodes"     |

- We also want to restrict the users to their namespaces alone.
- Authorization Mechanisms in Kubernetes:
  - Node Authorizer: kubelet is used to read information from the kube-apiserver and also reports to the apiserver about node status etc. These requests are handled by the node authorizer.

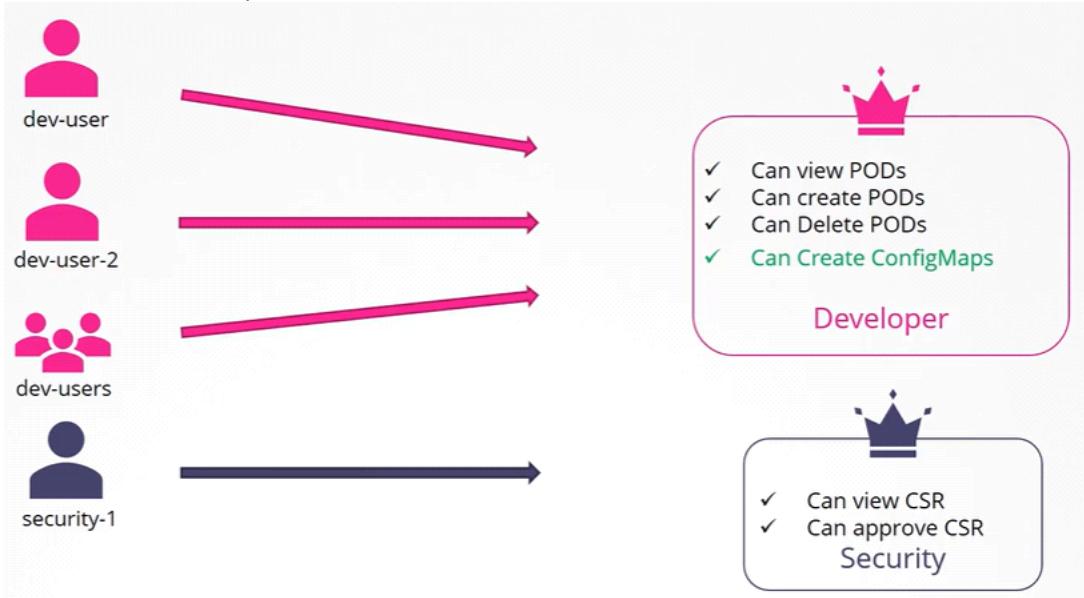


- Attribute-Based Authorization: Associates users or groups of users with specific permissions defined in policy files. It's manual and can be cumbersome to manage.

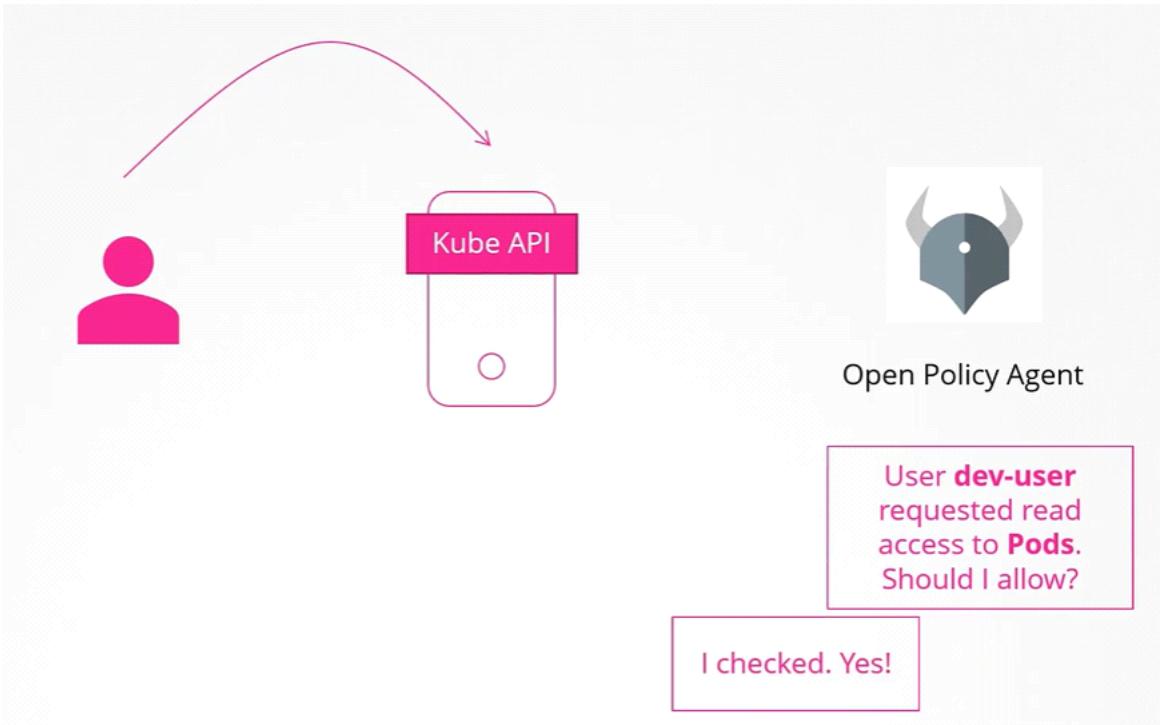
Example of policy files:-



- Role-Based Access Control (RBAC): In this, we create a role with a set of permissions and then associate the user with the role. Offers a more structured approach by defining roles with associated permissions. Users or groups are then associated with these roles. Modifications to roles reflect instantly across associated users.



- Webhook or External Authorization (e.g., Open Policy Agent): Allows outsourcing authorization decisions to external tools like Open Policy Agent. Kubernetes makes API calls to external agents to determine access permissions.



## 2. Authorization Modes:

- Always Allow and Always Deny- Two additional modes where requests are either always allowed or always denied without undergoing authorization checks.
- These modes are configured using the --authorization-mode option on the Kube API Server where AlwaysAllow is default option.
- Multiple modes can be configured in a comma-separated list. Requests are processed sequentially through each mode until a decision is reached. ( Node -> RBAC -> Webhook)

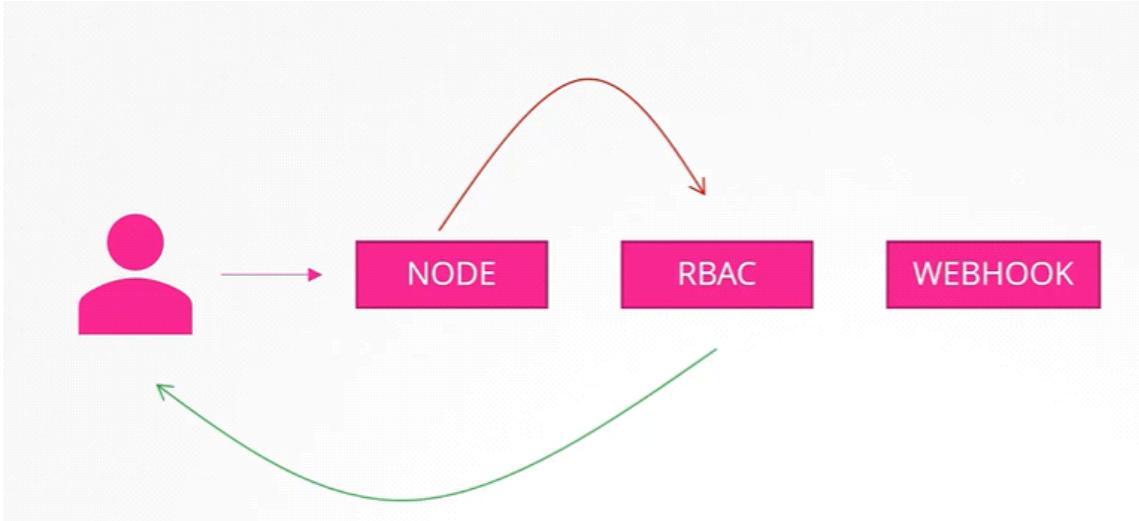
|             |      |      |      |         |            |
|-------------|------|------|------|---------|------------|
| AlwaysAllow | NODE | ABAC | RBAC | WEBHOOK | AlwaysDeny |
|-------------|------|------|------|---------|------------|

```

ExecStart=/usr/local/bin/kube-apiserver \
--advertise-address=${INTERNAL_IP} \
--allow-privileged=true \
--apiserver-count=3 \
--authorization-mode=Node,RBAC,Webhook \
--bind-address=0.0.0.0 \
--enable-swagger-ui=true \
--etcd-cafile=/var/lib/kubernetes/ca.pem \
--etcd-certfile=/var/lib/kubernetes/apiserver-etcd-client.crt \
--etcd-keyfile=/var/lib/kubernetes/apiserver-etcd-client.key \
--etcd-servers=https://127.0.0.1:2379 \
--event-ttl=1h \
--kubelet-certificate-authority=/var/lib/kubernetes/ca.pem \
--kubelet-client-certificate=/var/lib/kubernetes/apiserver-etcd-client.crt \
--kubelet-client-key=/var/lib/kubernetes/apiserver-etcd-client.key \
--service-node-port-range=30000-32767 \
--client-ca-file=/var/lib/kubernetes/ca.pem \
--tls-cert-file=/var/lib/kubernetes/apiserver.crt \
--tls-private-key-file=/var/lib/kubernetes/apiserver.key \
--v=2

```

- When a request is received, it goes through each configured authorization mode in the specified order.
- If a mode denies the request, it moves to the next mode in the chain.
- Once a mode approves the request, further checks are skipped, and the user or entity is granted permission.



So, suppose --authorization-mode = Node, RBAC, Webhook. Then, if 'Node' denies the request it moves to the RBAC. If the user gets permission from the RBAC then the next mode in the chain i.e. 'Webhook'

### 3. Default Authorization Mode:

- If no authorization mode is specified, Kubernetes defaults to Always Allow, which permits all requests without authorization checks.

### 4. Future Topics:

- The lecture hints at discussing Role-Based Access Control (RBAC) in more detail in upcoming lectures.
- Role-Based Access Control provides a structured and manageable way to define and manage access permissions within the Kubernetes cluster.

Overall, understanding authorization mechanisms in Kubernetes is crucial for maintaining security and ensuring that users and applications have appropriate levels of access and permissions within the cluster.

# RBAC

Thursday, March 21, 2024 1:00 PM

## Creating a Role:

- Create a role object by defining a role definition file.
- Set the apiVersion to rbac.authorization.k8s.io/v1 and the kind to Role.
- Specify the rules for the role, including apiGroups, resources, and verbs (actions).
- For example, a role named developer might have rules allowing actions like list, get, create, and delete on resources like pods and config maps.

```
developer-role.yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
 name: developer
rules:
- apiGroups: []
 resources: ["pods"]
 verbs: ["list", "get", "create", "update", "delete"]
- apiGroups: []
 resources: ["ConfigMap"]
 verbs: ["create"]
```

- Create the role using kubectl create -f <role-definition-file-name.yaml>.

```
▶ kubectl create -f developer-role.yaml
```

## Creating a Role Binding:

- Create a role-binding object to link a user or group to a role. After creating the role this is the next step.
- Set the API version to rbac.authorization.k8s.io/v1 and the kind to RoleBinding.
- In 'Subject' section, we define the user details.
- In roleRef section, we define the role we created.
- Use this command to create the role-binding

```
▶ kubectl create -f devuser-developer-binding.yaml
```

## Namespaces and Scope:

Roles and role bindings are scoped within namespaces.

Specify the namespace in the metadata of the definition files if you want to limit access to resources within a specific namespace.

## Viewing and Managing Roles:

- Use kubectl commands like kubectl get roles to list created roles and kubectl describe role <role-name> to view details about a specific role.

```
▶ kubectl get roles
NAME AGE
developer 4s

▶ kubectl get rolebindings
NAME AGE
devuser-developer-binding 24s

▶ kubectl describe role developer
Name: developer
Labels: <none>
Annotations: <none>
PolicyRule:
 Resources Non-Resource URLs Resource Names Verbs
 ----- ----- ----- -----
 ConfigMap [] [] [create]
 pods [] [] [get watch list create delete]
```

- Similarly, use kubectl get rolebindings to list role bindings and kubectl describe rolebinding <role-binding-name> to view details about a specific role binding.

```
▶ kubectl describe rolebinding devuser-developer-binding
Name: devuser-developer-binding
Labels: <none>
Annotations: <none>
Role:
 Kind: Role
 Name: developer
Subjects:
 Kind Name Namespace
 ---- -- --
 User dev-user
```

### Testing Access Permissions:

Users can check their access permissions using kubectl auth can-i command followed by the action and resource.

```
▶ kubectl auth can-i create deployments
yes

▶ kubectl auth can-i delete nodes
no
```

Administrators can impersonate other users to test their permissions using the --as option.

```
▶ kubectl auth can-i create deployments --as dev-user
no
```

```
▶ kubectl auth can-i create pods --as dev-user
yes
```

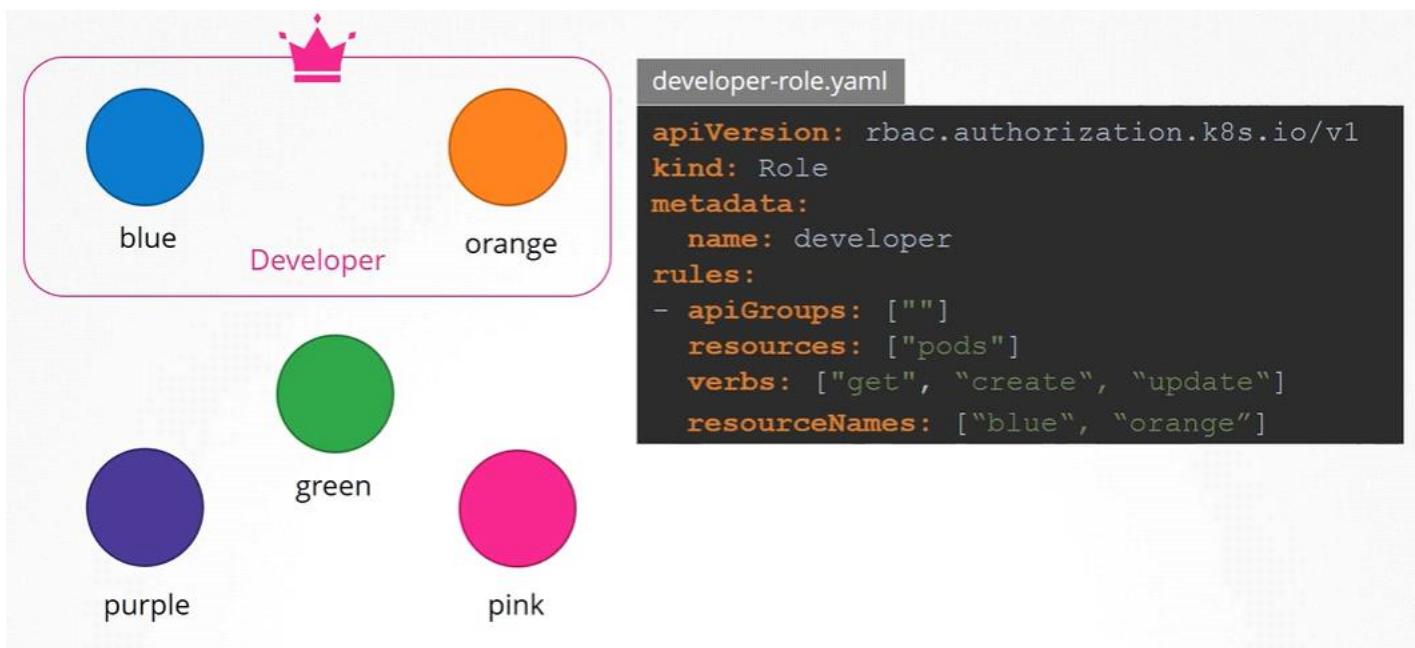
```
▶ kubectl auth can-i create pods --as dev-user --namespace test
no
```

#### Resource Names in Permissions:

RBAC allows specifying access to specific resources by name.

For example, you can grant access to certain pods within a namespace by specifying their names in the resource names field of the rule.

For example, you have five pods in the namespace and you wanna give access to a user to pods, but not all pods. You can restrict access to the blue and orange pod alone by adding a resource names field to the rule.



# lab 4

Monday, April 29, 2024 11:08 PM

- ?
- Inspect the environment and identify the authorization modes configured on the cluster.

Use the command **kubectl describe pod kube-apiserver-controlplane -n kube-system** and look for --authorization-mode.

**OR**

**cat /etc/kubernetes/manifests/kube-apiserver.yaml** and look for --authorization-mode.

OR

**ps -aux | grep authorization**

--authorization-mode=Node,RBAC

The --authorization-mode=Node,RBAC flag in Kubernetes indicates the authorization modes enabled for the kube-apiserver. Specifically:

**Node:** Allows nodes in the cluster to perform actions based on their identity without further authentication. For example, a node may need permission to access certain resources or perform specific operations within the cluster.  
**RBAC (Role-Based Access Control):** Enables fine-grained access control based on roles and permissions assigned to users, groups, or service accounts. It allows administrators to define who can access what resources and what actions they can perform.

How many roles exist in the default namespace?

**kubectl get roles**

- ?
- How many roles exist in all namespaces together?

**k get roles -A**

- ? What are the resources the kube-proxy role in the kube-system namespace is given access to?
- ? What actions can the kube-proxy role perform on configmaps?

```
k describe role kube-proxy -n kube-system
```

- ★ No. of lines count

```
k get roles --no-header | wc -l
```

Which account is the kube-proxy role assigned to?

```
kubectl describe rolebinding kube-proxy -n kube-system
```

```
controlplane ~ ➔ kubectl describe rolebinding kube-proxy -n kube-system
Name: kube-proxy
Labels: <none>
Annotations: <none>
Role:
 Kind: Role
 Name: kube-proxy
Subjects:
 Kind Name Namespace
 ---- --- -----
 Group system:bootstrappers:kubeadm:default-node-token
```

Group system:boot.....token

A user dev-user is created. User's details have been added to the kubeconfig file. Inspect the permissions granted to the user. Check if the user can list pods in the default namespace.

- ★ Use the **--as dev-user** option with kubectl to run commands as the dev-user.

Create the necessary roles and role bindings required for the dev-user to create, list and delete pods in the default namespace.

Use the given spec:

Role: developer

Role Resources: pods

Role Actions: list

Role Actions: create

Role Actions: delete

RoleBinding: dev-user-binding

RoleBinding: Bound to dev-user

To create a Role:-

```
kubectl create role developer --namespace=default --verb=list,create,delete --resource=pods
```

To create a RoleBinding:-

```
kubectl create rolebinding dev-user-binding --namespace=default --role=developer --user=dev-user
```

A set of new roles and role-bindings are created in the blue namespace for the dev-user. However, the dev-user is unable to get details of the dark-blue-app pod in the blue namespace. Investigate and fix the issue.

Run the command: **kubectl edit role developer -n blue** and correct the resourceNames field. You don't have to delete the role.

Add a new rule in the existing role developer to grant the dev-user permissions to create deployments in the blue namespace.

Remember to add api group "apps".

Older file

```
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
 creationTimestamp: "2024-04-29T17:36:19Z"
 name: developer
 namespace: blue
 resourceVersion: "4598"
 uid: 2f4bc280-26db-4525-ab54-dfe2f1772e8e
rules:
- apiGroups:
 - ""
 resourceNames:
 - blue-app
 - dark-blue-app
 resources:
 - pods
 - deployments
 verbs:
 - get
 - watch
 - create
 - delete
```

Make changes in it to look like this

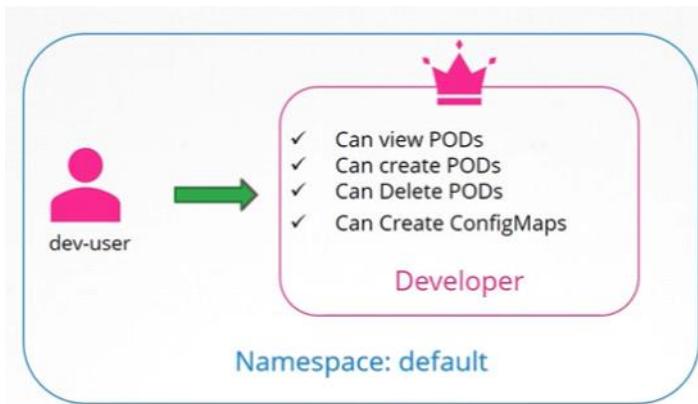
```
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
 name: developer
 namespace: blue
rules:
- apiGroups:
 - apps
 resourceNames:
 - dark-blue-app
 resources:
 - pods
 verbs:
 - get
 - watch
 - create
 - delete
- apiGroups:
 - apps
 resources:
 - deployments
 verbs:
 - create
```

A new rule is created from the apiGroups. For deployment, the apiGroups is "apps".

# Cluster Roles and Cluster Role Binding(CKA)

Thursday, March 21, 2024 1:33 PM

- ★ Roles and role-binding are **Namespaced** means they are created within a namespace and if you don't specify they are created in the default namespace.

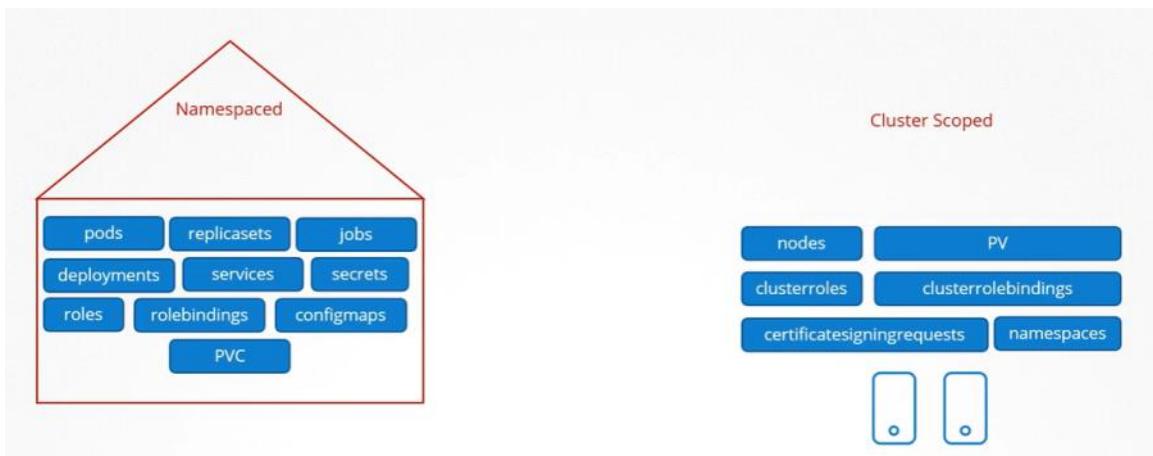


- ? Namespaces are used to isolate or group pods, deployments, and services but what about nodes?

Nodes in Kubernetes are not isolated or grouped using namespaces like pods, deployments, and services. Namespaces are primarily used for logical grouping and isolation of resources at the pod and service level. Nodes, on the other hand, are physical or virtual machines that form the underlying infrastructure for running Kubernetes workloads. They are part of the cluster's infrastructure and are managed collectively rather than being isolated or grouped within namespaces.

## Namespaced vs. Cluster-Scoped Resources:

Resources are categorized as namespaced and cluster-scoped resources.



- Namespaced resources like pods, secrets, roles, rolebindings, replicasets, deployments, and services are created within namespaces and are specific to that namespace.
- Cluster-scoped resources, like nodes and persistent volumes, are not associated with any namespace and are accessible across the entire cluster.

To get the list of all the namespaced resources run:-

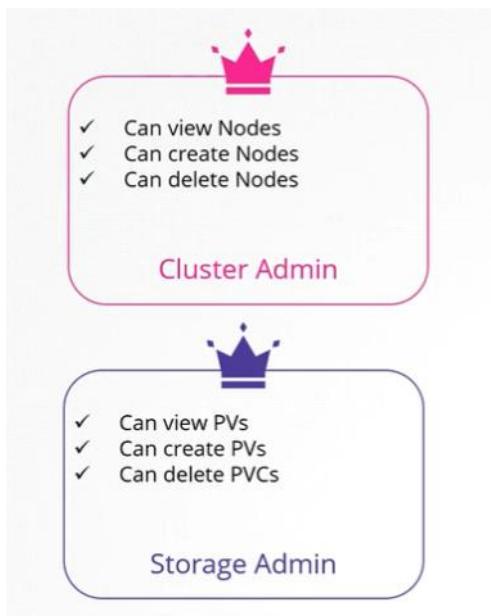
```
▶ kubectl api-resources --namespaced=true
```

To get the list of all the thecluster-scoped resources, run:-

```
▶ kubectl api-resources --namespaced=false
```

## Understanding Cluster Roles and Cluster Role Bindings:

- Cluster roles are similar to roles but are used for cluster-scoped resources.
- For example, a cluster-admin role can be created to manage nodes, and a storage admin role can be created to manage persistent volumes.



```
▶ kubectl create -f cluster-admin-role.yaml
```

- Create a cluster role definition file with the kind set to ClusterRole and specify the rules for accessing cluster-wide resources.

```
cluster-admin-role.yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
 name: cluster-administrator
rules:
- apiGroups: []
 resources: ["nodes"]
 verbs: ["list", "get", "create", "delete"]
```

- Create a cluster role binding object to link users or groups to cluster roles. This is done using the ClusterRoleBinding kind.

A ClusterRoleBinding in Kubernetes binds a ClusterRole to a set of subjects (users, groups, or service accounts) across the entire cluster. It grants permissions defined in the ClusterRole to the subjects, allowing them to perform actions on cluster-wide resources. This is used for managing access control at a cluster level rather than within a specific namespace.

Creating Cluster Roles and Cluster Role Bindings:

```
cluster-admin-role-binding.yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
 name: cluster-admin-role-binding
subjects:
- kind: User
 name: cluster-admin
 apiGroup: rbac.authorization.k8s.io
roleRef:
 kind: ClusterRole
 name: cluster-administrator
 apiGroup: rbac.authorization.k8s.io
```

- Define rules in the cluster role definition file to grant permissions for cluster-wide resources such as nodes.
- Create a cluster role binding object to associate users or groups with cluster roles using the kubectl create command.

```
▶ kubectl create -f cluster-admin-role-binding.yaml
```

Usage of Cluster Roles for Namespaced Resources:

- While cluster roles are primarily for cluster-wide resources, they can also be used for namespaced resources.
- When a cluster role is used for namespaced resources, it grants access to those resources across all namespaces in the cluster.

Earlier, when we created a role to authorize a user to access pod, the user had access to pods in a particular namespace alone.

With cluster roles, when you authorize a user to access the pods, [the user gets access to all pods across the cluster.](#)

Default Cluster Roles in Kubernetes:

- Kubernetes sets up default cluster roles when the cluster is first deployed.
- These default roles can be explored and utilized for managing access to various resources in the cluster.

# lab 5

Tuesday, April 30, 2024 11:02 AM

How many ClusterRoles do you see defined in the cluster?

**k get clusterroles --no-headers | wc -l**

How many ClusterRoleBindings exist on the cluster?

**k get clusterrolebinding --no-headers | wc -l**

What namespace is the cluster-admin clusterrole part of?

ClusterRole is a non-namespaced resource.

You can check via the **kubectl api-resources --namespaced=false** command.

So the correct answer would be Cluster Roles are cluster wide and not part of any namespace

So cluster roles and cluster role bindings are not namespaced.

So they're not specific to any namespace.

So cluster roles are cluster wide and not part of any namespace.

What user/groups are the cluster-admin role bound to?

(The ClusterRoleBinding for the role is with the same name.)

**kubectl describe clusterrolebinding cluster-admin**

What level of permission does the cluster-admin role grant?

kubectl describe clusterrole cluster-admin

[ \* ] = Perform any action on any resource in the cluster

A new user michelle joined the team. She will be focusing on the nodes in the cluster. Create the required ClusterRoles and ClusterRoleBindings so she gets access to the nodes.

Create clusterrole

kubectl create clusterrole node-reader --verb=get,watch,list,create,delete --resource=nodes

create clusterrolebinding

kubectl create clusterrolebinding node-reader --clusterrole=node-reader --user=michelle

Run "kubectl get nodes --as michelle" to verify.,

## Verbs

get: Allows reading/viewing resources.

watch: Allows monitoring changes to resources in real-time.

list: Allows listing multiple resources.

create: Allows creating new resources.

delete: Allows deleting existing resources.

## Role vs. ClusterRole:

Role: Applies permissions within a namespace, governing access to resources within that namespace.

ClusterRole: Applies permissions cluster-wide, governing access to resources across all namespaces.

## RoleBinding vs. ClusterRoleBinding:

RoleBinding: Binds a Role to a user, group, or service account within a specific namespace.

ClusterRoleBinding: Binds a ClusterRole to a user, group, or service account across the entire cluster,

allowing broader permissions.

# Service Accounts(CKA)

Thursday, March 21, 2024 11:32 AM

In Kubernetes, service accounts are a way to give your applications or services within the cluster an identity and permissions to interact with other parts of the Kubernetes system. They help in managing access control and authentication for applications running in the cluster.

Here's a detailed explanation in simple terms:

1. Identity for Applications: Just like people have identities (like usernames) to access systems, applications running in Kubernetes need identities too. **Service accounts provide these identities to applications within the cluster.**
2. Permissions Management: Service accounts also come with permissions attached. These permissions determine what actions an application can perform within the Kubernetes environment. For example, a service account might be allowed to create or delete pods, but not modify cluster-wide settings.
3. Secure Communication: When an application needs to communicate with other parts of the Kubernetes system, such as accessing the API server or interacting with other pods, it does so using its service account credentials. This helps in ensuring secure communication within the cluster.
4. Multiple Service Accounts: You can create multiple service accounts based on the specific needs of your applications. For example, you might have one service account for a frontend application and another for a backend service, each with different permissions.
5. Controlled Access: By using service accounts, you can control access to resources and actions within your Kubernetes cluster. This adds a layer of security by ensuring that applications only have access to what they need and nothing more.  
Overall, service accounts in Kubernetes play a crucial role in managing identities, permissions, and secure communication for applications running within the cluster, contributing to better security and control over your Kubernetes environment.

User Accounts vs. Service Accounts:

- User accounts are used by humans for tasks like administration(admin) or application deployment(developer).
- Service accounts are used by machines or applications to interact with the Kubernetes cluster, such as monitoring tools or automated deployment tools like Jenkins.

### Creating a Service Account:

To create a service account, use the kubectl create serviceaccount command followed by the account name, such as kubectl create serviceaccount <service-account-name>.

```
▶ kubectl create serviceaccount dashboard-sa
serviceaccount "dashboard-sa" created
```

to view service accounts

```
▶ kubectl get serviceaccount
NAME SECRETS AGE
default 1 218d
dashboard-sa 1 4d
```

Service accounts automatically generate a token, which is stored as a secret object named after the service account.

```
▶ kubectl describe serviceaccount dashboard-sa
Name: dashboard-sa
Namespace: default
Labels: <none>
Annotations: <none>
Image pull secrets: <none>
Mountable secrets: dashboard-sa-token-kbbdm
Tokens: dashboard-sa-token-kbbdm
Events: <none>
```

The service account token is what must be used by the external application while authenticating to the Kubernetes API.

### Token Management for Service Accounts:

- The service account token is stored as a secret object and can be viewed using kubectl describe secret.
- This token is used for authentication when making REST calls to the Kubernetes API, such as in a custom dashboard application.

### Automatic Mounting of Tokens:

- By default, Kubernetes automatically mounts the default service account and its token to pods

- unless specified otherwise in the pod definition.
- The token is mounted as a volume inside the pod at /var/run/secrets/kubernetes.io/serviceaccount.

- ★ For every namespace in Kubernetes, a service account named default is automatically created.

Changes in Kubernetes Versions 1.22 and 1.24:

In Kubernetes version 1.22, the TokenRequestAPI was introduced to provision service account tokens securely and scalably.

Tokens generated through the TokenRequestAPI are audience-bound, time-bound, and object-bound, improving security and scalability.

Starting from version 1.24, service accounts no longer automatically create secret objects with non-expiring tokens. Instead, tokens are generated on-demand using the TokenRequestAPI.

If needed, non-expiring tokens can still be created manually by creating a secret object associated with the service account.

Best Practices for Token Management:

The TokenRequestAPI is recommended over manually creating service account token secrets, as it provides more secure tokens with bounded lifetimes.

Service account token secrets should only be created if the TokenRequestAPI cannot be used, and the security exposure of persisting non-expiring tokens is acceptable.

The lecture emphasizes the importance of understanding the changes in token management for service accounts in Kubernetes versions 1.22 and 1.24 and highlights best practices for secure token management.

# lab 6

Tuesday, April 30, 2024 12:26 PM

How many Service Accounts exist in the default namespace?

**k get sa --no-headers | wc -l**

What is the secret token used by the default service account?

**k describe sa default**

Tokens: <none>

What type of account does the Dashboard application use to query the Kubernetes API?

Error Message - pods is forbidden: User "system:serviceaccount:default:default" cannot list resource "pods" in API group "" in the namespace "default"

As evident from the error in the web-dashboard UI, the pod makes use of a service account to query the Kubernetes API.

Run "k describe po <webapplication-pod>

```
controlplane ~ ➔ k describe po
Name: web-dashboard-74cbcd9494-kscmd
Namespace: default
Priority: 0
Service Account: default
```

Which account does the Dashboard application use to query the Kubernetes API?

Error Message - pods is forbidden: User "system:serviceaccount:default:default" cannot list resource "pods" in API group "" in the namespace "default"

Again, the name of the Service Account is displayed in the error message on the dashboard. The deployment makes use of the default service account which we inspected earlier.

Run "k describe po <webapplication-pod>

```
controlplane ~ ➔ k describe po
Name: web-dashboard-74cbcd9494-kscmd
Namespace: default
Priority: 0
Service Account: default
```

At what location is the ServiceAccount credentials available within the pod?

k describe po

Check the "Mounts" under the "web-dashboard" inside the "Containers"

```
controlplane ~ ➔ k describe po
Name: web-dashboard-74cbcd9494-kscmd
Namespace: default
Priority: 0
Service Account: default
Node: controlplane/192.11.124.8
Start Time: Tue, 30 Apr 2024 06:58:07 +0000
Labels: name=web-dashboard
 pod-template-hash=74cbcd9494
Annotations: <none>
Status: Running
IP: 10.42.0.9
IPs:
 IP: 10.42.0.9
Controlled By: ReplicaSet/web-dashboard-74cbcd9494
Containers:
 web-dashboard:
 Container ID: containerd://24ddfaa559efa9e196e3bb3d9114ee4b9eed170bfe8d4da464606
 Image: gcr.io/kodekloud/customimage/my-kubernetes-dashboard
 Image ID: gcr.io/kodekloud/customimage/my-kubernetes-dashboard@sha256:7d70ab
 Port: 8080/TCP
 Host Port: 0/TCP
 State: Running
 Started: Tue, 30 Apr 2024 06:58:13 +0000
 Ready: True
 Restart Count: 0
 Environment:
 PYTHONUNBUFFERED: 1
 Mounts:
 /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-t9kks (ro)
Conditions:
```

The application needs a ServiceAccount with the Right permissions to be created to authenticate to Kubernetes. The default ServiceAccount has limited access. Create a new ServiceAccount named dashboard-sa.

1. k create sa dashboard-sa
2. Add additional permissions for the newly created dashboard-sa account using RBAC. ( /var/rbac)
3. Create an authorization token for the newly created service account, copy the generated token and paste it into the token field of the UI.

To do this, run **kubectl create token dashboard-sa** for the dashboard-sa service account, copy the token and paste it in the UI.

4. You shouldn't have to copy and paste the token each time. The Dashboard application is programmed to read token from the secret mount location. Edit he

Use the **kubectl edit** command for the deployment and specify the **serviceAccountName** field inside the pod spec.

```
apiVersion: apps/v1
kind: Deployment
metadata:
 name: web-dashboard
 namespace: default
spec:
 replicas: 1
 selector:
 matchLabels:
 name: web-dashboard
 strategy:
 rollingUpdate:
 maxSurge: 25%
 maxUnavailable: 25%
 type: RollingUpdate
 template:
 metadata:
 creationTimestamp: null
 labels:
 name: web-dashboard
 spec:
 serviceAccountName: dashboard-sa
 containers:
 - image: gcr.io/kodekloud/customimage/my-kubernetes-dashboard
 imagePullPolicy: Always
 name: web-dashboard
 ports:
 - containerPort: 8080
 protocol: TCP
```

OR

Make use of the kubectl set command. Run the following command to use the newly created service account: - **kubectl set serviceaccount deploy/web-dashboard dashboard-sa**

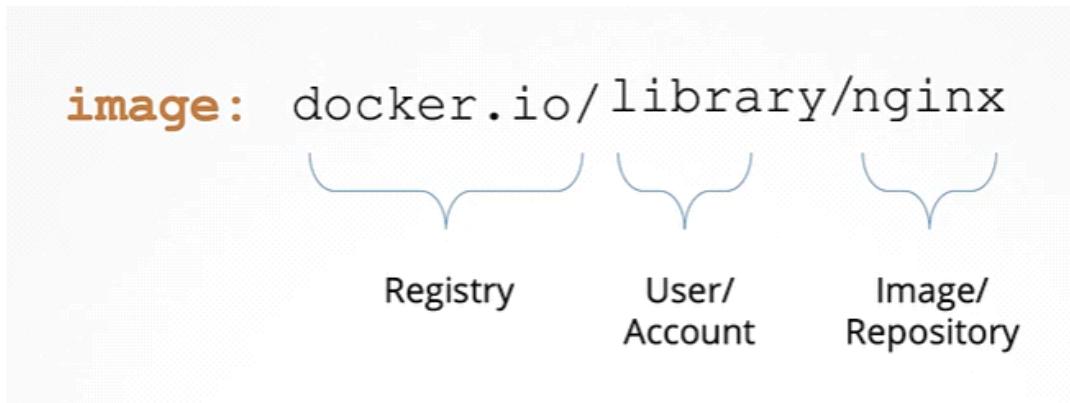


# Image Security

Thursday, March 21, 2024 2:53 PM

## Image Naming Convention:

- Images in Kubernetes follow Docker's image naming convention.
- The image name consists of the repository name (e.g., Nginx), which can include a user or account name (e.g., library/Nginx).
- 'library' is the name of the default account where the docker's official images are stored. If you don't specify the account name, automatically it's the library.



## Default Registry:

If no location is specified, images are assumed to be pulled from Docker's default registry, Docker Hub (docker.io).

## Public vs. Private Registries:

Public registries like Docker Hub and Google's registry (gcr.io) host publicly accessible images. For private applications or in-house images, hosting them on an internal private registry or using cloud providers' private registries (e.g., AWS, Azure, GCP) is recommended. Private repositories on these registries can be accessed using credentials.

## Using Private Images in Kubernetes:

1. To run a container using a private image, log into your private registry using docker login and input your credentials.
2. Replace the image name in the pod definition file with the full path to the image in the private registry.
3. Implementing Authentication in Kubernetes:

```
▶ docker login private-registry.io
```

```
▶ docker run private-registry.io/apps/internal-app
```

```
nginx-pod.yaml
```

```
apiVersion: v1
kind: Pod
metadata:
 name: nginx-pod
spec:
 containers:
 - name: nginx
 image: private-registry.io/apps/internal-app
 imagePullSecrets:
 - name: regcred
```

```
▶ kubectl create secret docker-registry regcred \
 --docker-server= private-registry.io \
 --docker-username= registry-user \
 --docker-password= registry-password \
 --docker-email= registry-user@org.com
```

4. Create a secret object (regcred) with Docker credentials using **kubectl create secret docker-registry**.
5. Specify the registry server name, username, password, and email address in the secret.
6. In the pod definition file, specify the secret under the `imagePullSecrets` section to provide credentials to the kubelets on worker nodes for pulling private images.
7. Configure the deployment to use credentials from the new secret to pull images from the private registry

```
apiVersion: v1
kind: Pod
metadata:
 name: private-reg
spec:
 containers:
 - name: private-reg-container
 image: <your-private-image>
 imagePullSecrets:
 - name: regcred
```

```
imagePullSecrets:
- name: <name-of-secret>
```

- 8.

# lab

Tuesday, May 7, 2024 6:13 PM

What secret type must we choose for docker registry?  
docker-registry

|                 |                                                                |
|-----------------|----------------------------------------------------------------|
| docker-registry | Create a secret for use with a Docker registry                 |
| generic         | Create a secret from a local file, directory, or literal value |
| tls             | Create a TLS secret                                            |

We decided to use a modified version of the application from an internal private registry. Update the image of the deployment to use a new image from **myprivateregistry.com:5000**

- k edit deploy
- Previous image - nginx:alpine
- Replace the image with **image: myprivateregistry.com:5000/nginx:alpine**

Pod will not run and will show "ImagePullBackOff" error because we don't have any secret with credentials to access the above registry.

# Docker - Security

Thursday, March 21, 2024 4:48 PM

## Container Isolation with Namespaces:

- Containers in Docker are not completely isolated from the host but share the same kernel. Containers are isolated using namespaces in Linux. The host has a namespace and the containers have their own namespace. All the processes run by the containers are run on the host itself but in their own namespace.
- Isolation is achieved using namespaces in Linux, where each container has its own namespace, including processes.
- Processes in containers are visible only within their namespace and cannot see processes outside of it.

## User Security:

- By default, Docker runs processes within containers as the root user.
- To run processes as a different user
  - you can use the user option in the Docker run command

```
ps aux
USER PID %CPU %MEM VSZ RSS TTY STAT START TIME COMMAND
root 1 0.0 0.0 4528 828 ? Ss 03:06 0:00 sleep 3600
```

```
docker run --user=1000 ubuntu sleep 3600
```

```
ps aux
USER PID %CPU %MEM VSZ RSS TTY STAT START TIME COMMAND
1000 1 0.0 0.0 4528 828 ? Ss 03:06 0:00 sleep 3600
```

- or set it in the Docker image itself using the USER instruction during image creation.

```
Dockerfile
FROM ubuntu
USER 1000
```

## Root User in Containers:

The root user within a Docker container is not the same as the root user on the host. Docker implements security features using Linux capabilities to limit the abilities of the root user within the container. Docker runs containers with a limited set of capabilities by default to prevent unauthorized access or system disruption.

## Linux Capabilities:

Linux capabilities control and limit what actions a user or process can perform on a system.

```
▶ docker run --cap-add MAC_ADMIN ubuntu
```

```
▶ docker run --cap-drop KILL ubuntu
```

Docker restricts containers' capabilities by default but allows users to add or drop capabilities using the cap add and cap drop options in the Docker run command.

The privileged flag can be used to run containers with all privileges enabled, although this is discouraged for security reasons.

```
▶ docker run --privileged ubuntu
```

Understanding these security concepts in Docker is crucial for managing security contexts effectively in Kubernetes, especially when dealing with containers and their access permissions within a cluster environment.

# Security Contexts

Thursday, March 21, 2024 5:31 PM

## Configuring Security Settings:

- In Kubernetes, security settings can be configured at either the container level or the Pod level.
- If configured at the Pod level, the settings apply to all containers within that Pod.
- Settings configured at the container level override those at the Pod level.

## Setting Security Context in Pod Definition:

To configure security context at the container level, add a field called `securityContext` under the `spec` section of the Pod definition file.

```
apiVersion: v1
kind: Pod
metadata:
 name: web-pod
spec:
 securityContext:
 runAsUser: 1000

 containers:
 - name: ubuntu
 image: ubuntu
 command: ["sleep", "3600"]
```

Use the `runAsUser` option within `securityContext` to set the user ID for the Pod or container.

```
apiVersion: v1
kind: Pod
metadata:
 name: web-pod
spec:
 containers:
 - name: ubuntu
 image: ubuntu
 command: ["sleep", "3600"]
 securityContext:
 runAsUser: 1000
 capabilities:
 add: ["MAC_ADMIN"]
```

capabilities are only supported at the container level and not at the pod level.

Adding Linux Capabilities:

To add Linux capabilities, use the capabilities option within securityContext.

Specify a list of capabilities to add to the Pod or container.

By configuring security contexts effectively, you can enhance the security of your Kubernetes environment, control access permissions, and mitigate potential security risks. Practice with coding exercises to gain hands-on experience in viewing, configuring, and troubleshooting issues related to security contexts in Kubernetes.

# lab 8

Tuesday, May 7, 2024 7:11 PM

What is the user used to execute the sleep process within the ubuntu-sleeper pod?

Run the command: **kubectl exec ubuntu-sleeper -- whoami** and check the user that is running the container.

Edit the pod ubuntu-sleeper to run the sleep process with user ID 1010.

To delete the existing `ubuntu-sleeper` pod:

```
kubectl delete po ubuntu-sleeper
```

After that apply solution manifest file to run as user `1010` as follows:

```

apiVersion: v1
kind: Pod
metadata:
 name: ubuntu-sleeper
 namespace: default
spec:
 securityContext:
 runAsUser: 1010
 containers:
 - command:
 - sleep
 - "4800"
 image: ubuntu
 name: ubuntu-sleeper
```

Then run the command `kubectl apply -f <file-name>.yaml` to create a resource.

NOTE: TO delete the pod faster, you can run `kubectl delete pod ubuntu-sleeper -- force`. This can be done for any pod in the lab or the actual exam. It is not recommended to run this in Production, so keep a note of that.

With what user sidecar container starts

```
apiVersion: v1
kind: Pod
metadata:
 name: multi-pod
spec:
 securityContext:
 runAsUser: 1001
 containers:
 - image: ubuntu
 name: web
 command: ["sleep", "5000"]
 securityContext:
 runAsUser: 1002

 - image: ubuntu
 name: sidecar
 command: ["sleep", "5000"]
```

solution - 1001

Update pod ubuntu-sleeper to run as Root user and with the SYS\_TIME capability.

To delete the existing pod:

```
kubectl delete po ubuntu-sleeper
```

After that apply solution manifest file to add capabilities in `ubuntu-sleeper` pod:

```

apiVersion: v1
kind: Pod
metadata:
 name: ubuntu-sleeper
 namespace: default
spec:
 containers:
 - command:
 - sleep
 - "4800"
 image: ubuntu
 name: ubuntu-sleeper
 securityContext:
 capabilities:
 add: ["SYS_TIME"]
```

then run the command `kubectl apply -f <file-name>.yaml` to create a pod from given definition file.

Now update the pod to also make use of the NET\_ADMIN capability.

Note: Only make the necessary changes. Do not modify the name of the pod.

To delete the existing pod:

```
kubectl delete po ubuntu-sleeper
```

After that apply solution manifest file to add capabilities in `ubuntu-sleeper` pod:

```

apiVersion: v1
kind: Pod
metadata:
 name: ubuntu-sleeper
 namespace: default
spec:
 containers:
 - command:
 - sleep
 - "4800"
 image: ubuntu
 name: ubuntu-sleeper
 securityContext:
 capabilities:
 add: ["SYS_TIME", "NET_ADMIN"]
```

then run the command `kubectl apply -f <file-name>.yaml` to create a pod from given definition file.

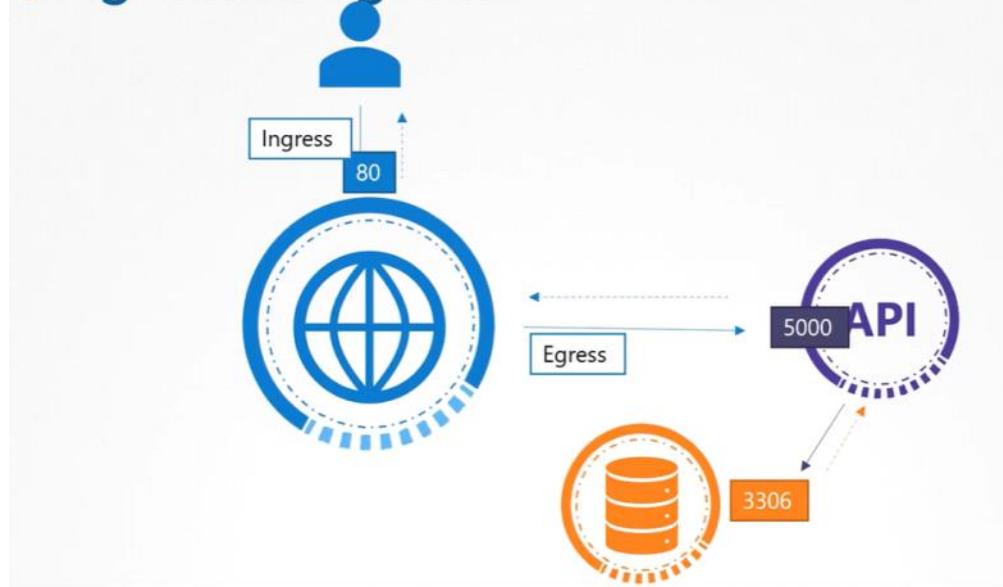
# Network Policies

Thursday, March 21, 2024 5:40 PM

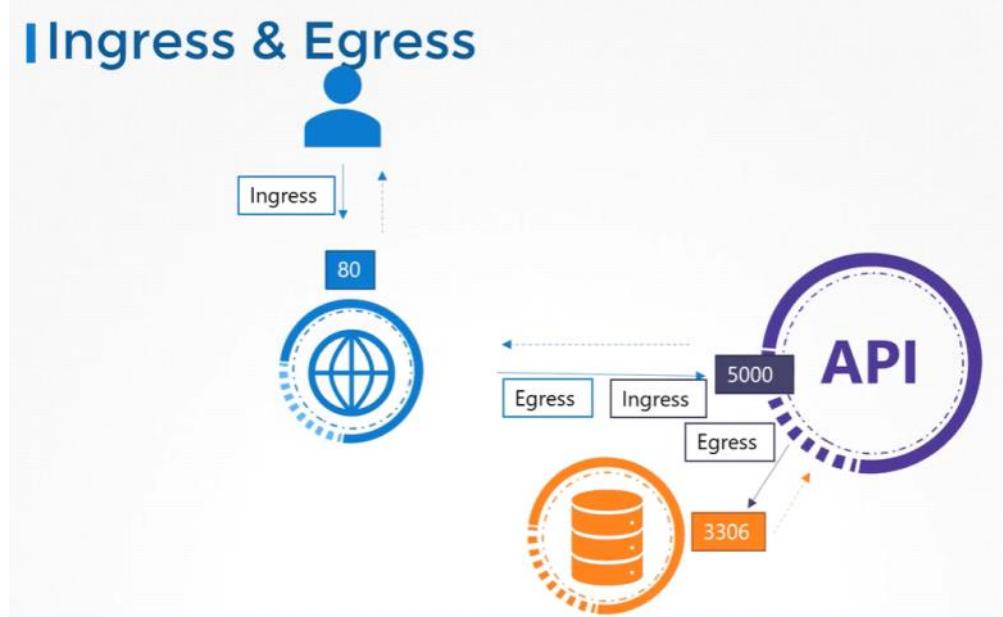
## Traffic Flow Basics:

- Let's take an example in which data traffic in an application flows from users to web servers(blue), API servers(purple), and database servers(orange).
- Ingress traffic refers to incoming traffic, while egress traffic refers to outgoing traffic.

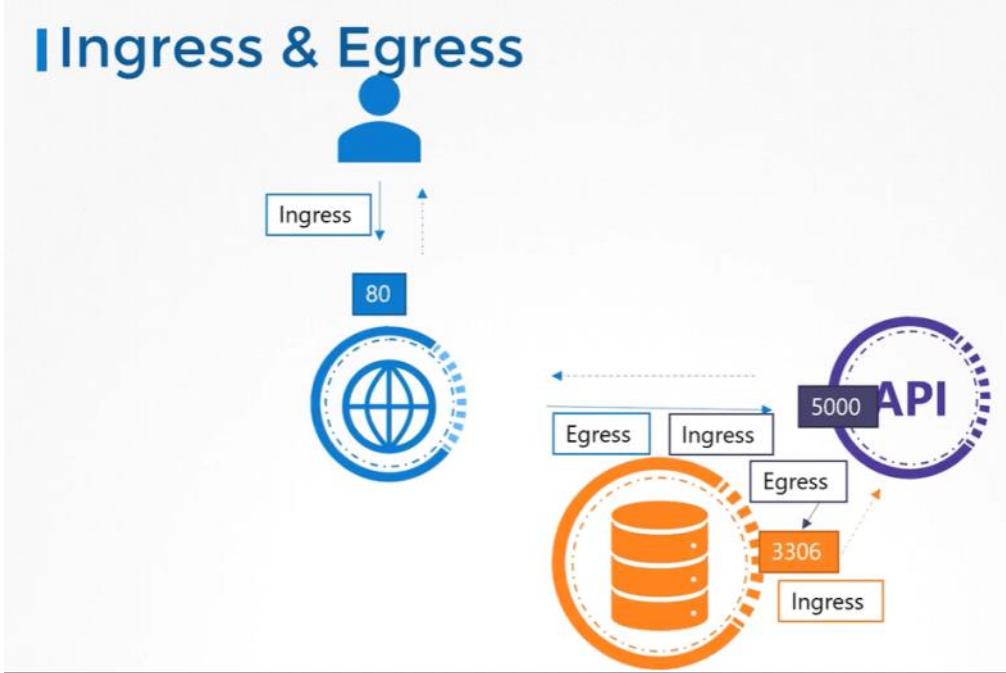
## Ingress & Egress



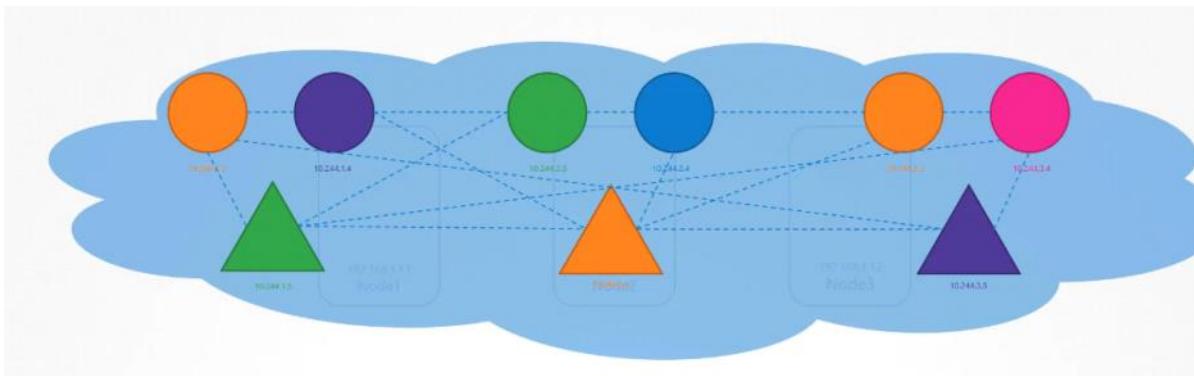
## Ingress & Egress



## Ingress & Egress



### Kubernetes Networking Basics:



- Kubernetes clusters consist of nodes hosting pods and services, each with its own IP address.
- Pods within the cluster can communicate with each other **by default** due to the virtual private network setup.

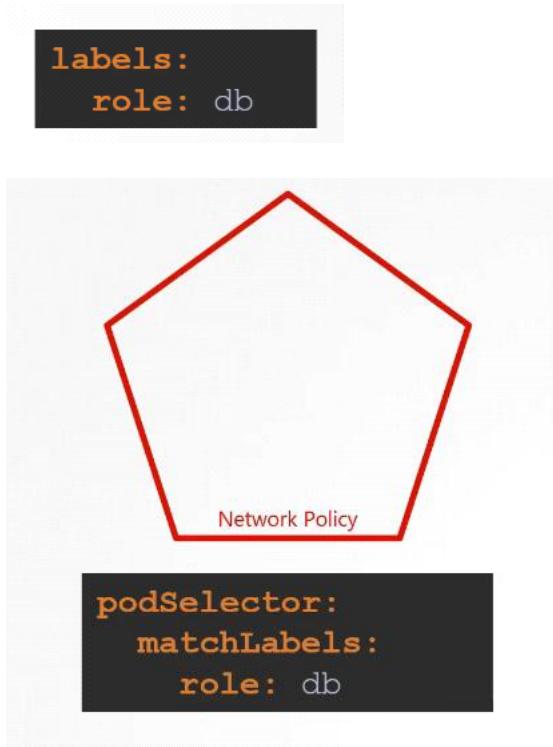
### Network Policies in Kubernetes:

- **Network policies allow you to control and restrict traffic flow between pods( you don't want the frontend to connect directly with the database for security reasons).**
- You can define ingress and egress rules within a network policy to specify allowed traffic paths.
- **Network policies are created as Kubernetes objects and linked to pods using labels and selectors.**
- Policy types (ingress, egress, or both) determine the direction of traffic isolation.

### Creating Network Policies:

- To create a network policy, define the API version, kind, metadata, and spec in the object definition file.

- Specify the pod selector to apply the policy to specific pods and define ingress or egress rules accordingly.
- Run the kubectl create command to create and enforce the network policy.



```

policyTypes:
- Ingress
ingress:
- from:
 - podSelector:
 matchLabels:
 name: api-pod
ports:
- protocol: TCP
 port: 3306

```

Supported Network Solutions:

- Not all network solutions in Kubernetes support network policies.
- Supported solutions include Cube Router, Calico, Romana, and WaveNet.
- Check the documentation of your network solution to verify support for network policies.

Enforcement of Network Policies:

- Network policies are enforced by the network solution implemented in the Kubernetes cluster.

- Even if a network solution does not support network policies, you can still create them, but they won't be enforced.

#### Solutions that Support Network Policies:

- Kube-router
- Calico
- Romana
- Weave-net

#### Solutions that DO NOT Support Network Policies:

- Flannel

```

apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
 name: db-policy
spec:
 podSelector:
 matchLabels:
 role: db
 policyTypes:
 - Ingress
 ingress:
 - from:
 - podSelector:
 matchLabels:
 name: api-pod
 ports:
 - protocol: TCP
 port: 3306

```

Run "k create -f policy-definition.yaml" to create the policy.

★ For an egress or ingress isolation to take place, note that you have to add them under the policy types as seen here.

Otherwise, there is no isolation.

# Developing Network Policies

Thursday, March 21, 2024 5:53 PM

Requirements and Focus:

- The goal is to protect the database pod by allowing access only from the API pod on port 3306.
- Other pods (like the web pod) and their ports are not of concern in this scenario.

Initial Blockage and Policy Association:

- Start by blocking all traffic to and from the database pod using a network policy associated with the DB pod label.
- Create a network policy with an ingress rule to allow traffic from the API pod to the DB pod on port 3306.

Understanding Policy Types:

- Ingress rules allow incoming traffic, while egress rules govern outgoing traffic.
- In this case, ingress rules are needed to allow traffic from the API pod to the database pod.

? **Do you need a separate rule for the results to go back to the API pod?**

**No, because once you allow incoming traffic, the response or reply to that traffic is allowed back automatically. We don't need a separate rule for that.**

Selectors for Traffic Control:

- Use pod selectors to allow traffic from specific pods (e.g., API pod) based on their labels.
- Namespace selectors can restrict traffic to specific namespaces.
- IP block selectors enable defining traffic from specific IP addresses or ranges.

```

apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
 name: db-policy
spec:
 podSelector:
 matchLabels:
 role: db

 policyTypes:
 - Ingress

 ingress:
 - from:
 - podSelector:
 matchLabels:
 name: api-pod
 ports:
 - protocol: TCP
 port: 3306

```

- The from field defines the source of traffic
- pod selector provide the labels of the API(source of traffic) pod
- The ports field defines what port on the database pod is the traffic allowed to go to.

So when deciding on what type of rule is to be created, you only need to be concerned about the direction in which the request originates.

## **Handling Multiple Scenarios:**

Deal with scenarios where multiple API pods with the same labels exist in different namespaces.  
Adjust network policies to allow traffic from specific API pods in designated namespaces.

```

apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
 name: db-policy
spec:
 podSelector:
 matchLabels:
 role: db
 policyTypes:
 - Ingress
 ingress:
 - from:
 - podSelector:
 matchLabels:
 name: api-pod
 namespaceSelector:
 matchLabels:
 name: prod
 ports:
 - protocol: TCP
 port: 3306

```

**namespaceSelector** : We add a new selector called the namespace selector property along with the pod selector property. Under this, we use match labels again to provide a label set on the namespace.

```

spec:
 podSelector:
 matchLabels:
 role: db
 policyTypes:
 - Ingress
 ingress:
 - from:
 - podSelector:
 matchLabels:
 name: api-pod
 namespaceSelector:
 matchLabels:
 name: prod
 - ipBlock:
 cidr: 192.168.5.10/32
 ports:
 - protocol: TCP
 port: 3306

```

We could configure a network policy to allow traffic originating from certain IP addresses such as IP of backup server which is not the part of the cluster using **ipBlock**.

?

**What if you only have the namespace selector and not the pod selector like this?**

In this case, all pods within the specified namespace will be allowed to reach the database pod.

★ traffic from any source either meets pod selector criteria or ipBlock criteria.

1. podSelector - to select pods by labels.
2. namespaceSelector - to select namespaces by labels
3. ipBlock selector - to select IP address ranges.

```
ingress:
- from:
 - podSelector:
 matchLabels:
 name: api-pod
 namespaceSelector:
 matchLabels:
 name: prod
 - ipBlock:
 cidr: 192.168.5.10/32
```

Here are two rules, and any one of them needs to be followed:-

1. podSelector
2. ipBlock

Any two of them needs to be true.

Here podSelector and nameSelector both needs to be true or followed.

```
ingress:
- from:
 - podSelector:
 matchLabels:
 name: api-pod
 - namespaceSelector:
 matchLabels:
 name: prod
- ipBlock:
 cidr: 192.168.5.10/32
```

Here, three rules are there bcoz we have added "**dash**" in front of namespaceSelector and any one of them needs to be followed:-

1. podSelector
2. namespaceSelector
3. ipBlock

Any two of them needs to be true.

Here podSelector and nameSelector both needs to be true or followed.

### Egress Rules for Outgoing Traffic:

- Include egress rules in network policies to control outgoing traffic from pods.
- Specify destinations using selectors (pod, namespace, or IP block) and ports for egress traffic.
- instead of **from**, we now have **to section** under egress.
- Under to, we could use any of the selectors such as a pod, a namespace, or an ipBlock selector.
- port to which the request are to be sent

```
spec:
 podSelector:
 matchLabels:
 role: db

 policyTypes:
 - Ingress
 - Egress
 ingress:
 - from:
 - podSelector:
 matchLabels:
 name: api-pod
 ports:
 - protocol: TCP
 port: 3306

 egress:
 - to:
 - ipBlock:
 cidr: 192.168.5.10/32
 ports:
 - protocol: TCP
 port: 80
```

# lab 9

Tuesday, April 30, 2024 4:53 PM

How many network policies do you see in the environment?

**k get networkpolicy**

**OR**

**k get networkpol**

Pod on which network policy is applied

**k describe networkpolicy**

- ? Create a network policy to allow traffic from the Internal application only to the payroll-service and db-service. Also, ensure that you allow egress traffic to DNS ports TCP and UDP (port 53) to enable DNS resolution from the internal pod.

Solution manifest file for a network policy **internal-policy** as follows:

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
 name: internal-policy
 namespace: default
spec:
 podSelector:
 matchLabels:
 name: internal
 policyTypes:
 - Egress
 - Ingress
 ingress:
 - {}
 egress:
 - to:
 - podSelector:
 matchLabels:
```

```
- to:
 - podSelector:
 matchLabels:
 name: mysql
 ports:
 - protocol: TCP
 port: 3306

- to:
 - podSelector:
 matchLabels:
 name: payroll
 ports:
 - protocol: TCP
 port: 8080

- ports:
 - port: 53
 protocol: UDP
 - port: 53
 protocol: TCP
```

OR

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
 name: internal-policy
 namespace: default
spec:
 podSelector:
 matchLabels:
 name: internal
 policyTypes:
 - Egress
 egress:
 - to:
 - podSelector:
 matchLabels:
 name: payroll
 ports:
 - protocol: TCP
 port: 8080

 - to:
 - podSelector:
 matchLabels:
 name: mysql
 ports:
 - protocol: TCP
 port: 3306
```

Then mention the TCP and UDP ports.

Note: We have also allowed Egress traffic to TCP and UDP port. This has been added to ensure that the internal DNS resolution works from the internal pod.

**Remember: The kube-dns service is exposed on port 53:**

```
root@controlplane:~> kubectl get svc -n kube-system
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
kube-dns ClusterIP 10.96.0.10 <none> 53/UDP,53/TCP,9153/TCP 18m
```

```
root@controlplane:~>
```

Calico

Wednesday, June 4, 2025 12:36 PM

# Networking - Basics

Wednesday, March 6, 2024 7:28 PM

## LAN

- A "local network" or "LAN" is a network that is limited to a specific geographic area, such as a home, office, or campus.
- Devices within a LAN can communicate with each other directly without the need for routing through the internet. Ethernet is a common technology used to connect devices within a LAN.
- Local Area Networks (LANs) typically use private IP addresses as defined by the Internet Assigned Numbers Authority (IANA).
- Private IP addresses are reserved for use within private networks and are not routable over the public internet.
- This helps in preventing conflicts with public IP addresses and adds an extra layer of security to internal networks.

The commonly used private IP address ranges, defined in RFC 1918, are:

- 10.0.0.0 to 10.255.255.255 (10.0.0.0/8)
- 172.16.0.0 to 172.31.255.255 (172.16.0.0/12)
- 192.168.0.0 to 192.168.255.255 (192.168.0.0/16)

Devices within a LAN are assigned IP addresses from these private address ranges. When a device in a private network needs to communicate with the internet, a Network Address Translation (NAT) device or router translates the private IP address of the device into a public IP address before the data is sent over the internet. This allows multiple devices within the private network to share a single public IP address.

Using private IP addresses within LANs helps in managing address space, ensures privacy and security, and avoids conflicts with globally routable IP addresses on the internet.

When should we use IP 172.16.0.0/12 and 192.168.0.0/16

## Ethernet:

**Ethernet is a widely used technology for connecting computers and other devices in a local area network (LAN).** It defines the physical and data link layer specifications for wired communication in a network. In simpler terms, Ethernet is like the language that devices use to communicate with each other over a wired connection, typically using copper cables or fiber optics.

Ethernet allows multiple devices, such as computers, printers, and servers, to connect to a network and share information. It's a fundamental technology in networking and is used in both home and enterprise environments.

### eth0:

The term "eth0" refers to a specific network interface on a device, particularly in the context of Linux-based operating systems. The "eth" part stands for Ethernet, and the "0" indicates the first Ethernet interface on the system. Linux systems often have multiple network interfaces, and each one is assigned a name like eth0, eth1, etc.

Now, let's put it into a real-world example:

Imagine you have a small office with several computers and a server. To connect them all, you set up an Ethernet network. Each computer and the server has a network interface card (NIC) that allows them to communicate over the Ethernet network. In this scenario, eth0 on each device represents the first Ethernet interface through which they connect to the local network.

So, eth0 is like the designated "port" on a computer that is plugged into the overall office Ethernet network. It's the entry point for data to come in or go out, facilitating communication between devices within the local network.

### **Is it necessary that ethernet must be wired?**

No, Ethernet does not have to be wired exclusively. While traditional Ethernet connections often involve physical cables, there are wireless variations of Ethernet technology known as Wi-Fi or Wireless Ethernet.

#### **Wired Ethernet:**

This is the traditional form of Ethernet where devices are connected using physical cables, typically copper or fiber optic. This type of connection is reliable and can provide high-speed data transfer rates. It's commonly used in homes, offices, and data centers to establish stable and fast local area networks (LANs).

#### **Wireless Ethernet (Wi-Fi):**

Wi-Fi, or Wireless Fidelity, is a wireless extension of Ethernet. It enables devices to connect to a network without the need for physical cables. Instead, Wi-Fi uses radio waves to transmit data between devices and a wireless router or access point. This is convenient for mobile devices like laptops, smartphones, and tablets, allowing them to connect to the internet or local network without being tethered by cables.

In summary, while traditional Ethernet involves wired connections, Wireless Ethernet or Wi-Fi is a wireless alternative that provides flexibility and mobility. Both types of connections serve the purpose of facilitating communication between devices in a network, but the choice between wired and wireless depends on factors such as the specific requirements of the network, the devices being used, and considerations for convenience and mobility.

### **Switch**

A switch is a fundamental networking device that operates at the data link layer (Layer 2) of the OSI

(Open Systems Interconnection) model. Its primary function is to connect multiple devices within a local area network (LAN) and intelligently forward data between them. Unlike a hub, which broadcasts data to all connected devices, a switch makes more efficient use of network bandwidth by selectively forwarding data only to the device that needs it.

Let's break down the key features and functions of a switch in more detail:

#### Frame Switching:

A switch operates by examining the data link layer (Layer 2) Ethernet frames. Each frame contains the source and destination MAC (Media Access Control) addresses.

The switch builds a MAC address table (also known as a forwarding table or content addressable memory - CAM table) to associate MAC addresses with the physical ports on the switch.

#### MAC Address Table:

The MAC address table helps the switch make forwarding decisions. When a device sends data to another device, the switch checks its MAC address table to determine the appropriate port to send the data to.

#### Port-Based Connectivity:

Switches provide multiple ports to connect devices like computers, printers, servers, or other switches in a network.

Each port on a switch operates as an independent collision domain, meaning that devices connected to different ports can transmit data simultaneously without causing collisions.

#### Traffic Isolation and Efficiency:

Unlike hubs, switches create micro-segments within a network, isolating traffic between devices. This minimizes collisions and enhances overall network efficiency.

Switches use full-duplex communication, allowing data to be transmitted and received simultaneously on a port.

#### Broadcast and Multicast Handling:

Switches forward broadcast frames to all connected devices, ensuring that devices receive important network information.

Multicast frames are selectively forwarded to only those ports where devices have expressed interest in the multicast group.

#### VLAN Support:

Virtual LANs (VLANs) can be configured on a switch to logically segment a network. VLANs allow devices in different physical locations to be grouped together in the same logical network.

#### Managed vs. Unmanaged Switches:

Managed switches offer additional features such as VLAN configuration, Quality of Service (QoS) settings, port mirroring, and more. These switches are configurable and provide greater control over network traffic.

Unmanaged switches, on the other hand, operate with default settings and are generally simpler to set

up. They are suitable for basic connectivity without advanced configuration needs.

#### Example Scenario:

Imagine an office network with computers, printers, and a file server. A switch connects these devices, intelligently forwarding data between them based on MAC addresses. If Computer A wants to communicate with the file server, the switch uses its MAC address table to send the data only to the port where the file server is connected, minimizing unnecessary network traffic. This efficient communication is a key advantage of using switches in a network.

#### VETH Pairs, Pipe, Virtual Cable

#### NAT - IP Masquerade

port : 8080:80

The first number before the colon (8080) represents the port on the host machine, while the number after the colon (80) represents the port inside the container.

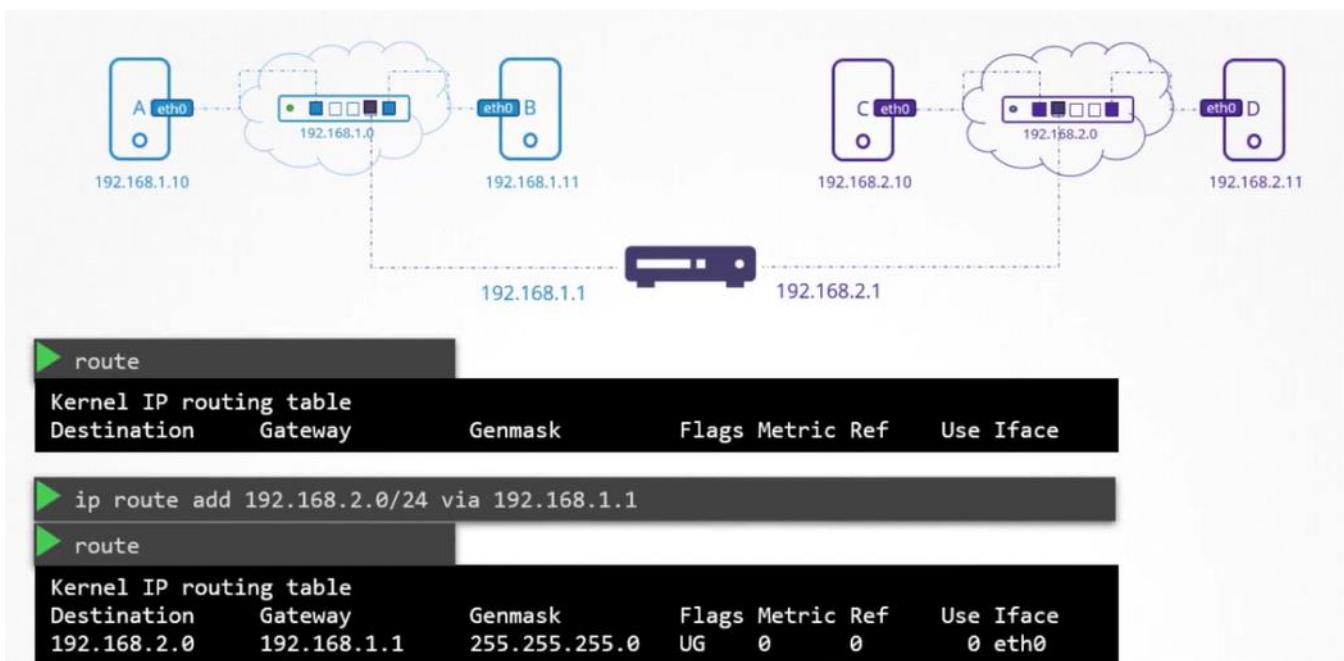
You can remember it as :

**host:container**

# Switching Routing

Tuesday, March 5, 2024 12:35 PM

- To enable device B to reach device C, run the 'ip route add' command with the network address of 192.168.2.0 via gateway 192.168.1.1
- The router helps to connect two networks. It's an intelligent device.
- A router connecting two networks, let's say network A (192.168.1.0/24) and network B (192.168.2.0/24), typically has at least two IP addresses assigned to itself which is 192.168.1.1 for Network A and 192.168.2.1 for Network B.
- If the network was a room, the gateway is a door to the outside world to the other networks or the internet. The systems need to know where that door is to go through that. Run the 'route' command, if it displays empty information means your system will not be able to reach the other system on another network. It can only reach other systems within the same network.



- To configure a gateway on system B to reach the systems on network 2.0, run the IP route add command and specify that you can reach the 192.168.2.0 network through the door or gateway at 192.168.1.1.

If system C needs to send a packet to system B, then you need to add a route on system C's routing table to access the network at 192.168.1.0 through the network configured with the IP address 192.168.2.1

```
▶ ip route add 192.168.1.0/24 via 192.168.2.1
▶ route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
192.168.1.0 192.168.2.1 255.255.255.0 UG 0 0 0 eth0
```

0.0.0.0 - A 0.0.0.0 entry in the gateway field indicates that you don't need a gateway.

?

Is it true that if a router connects two networks say A(192.168.1.0) and B(192.168.2.0) then the router has two IP Addresses assigned to itself? Explain.

Yes, a router indeed connects two networks, let's say network A (192.168.1.0/24) and network B (192.168.2.0/24), typically has at least two IP addresses assigned to itself. Let's break down why:

#### Interface IP Addresses:

- Network A Interface: The router's interface connected to network A would have an IP address within the range of network A, such as 192.168.1.1.
- Network B Interface: Similarly, the router's interface connected to network B would have an IP address within the range of network B, such as 192.168.2.1.

#### Routing Between Networks:

- The router acts as a gateway between network A and network B. When devices in network A want to communicate with devices in network B, they send packets to the router's IP address on network A (192.168.1.1).
- The router then forwards these packets to the appropriate interface connected to network B (192.168.2.1), allowing communication between the two networks.

#### Routing Table Entries:

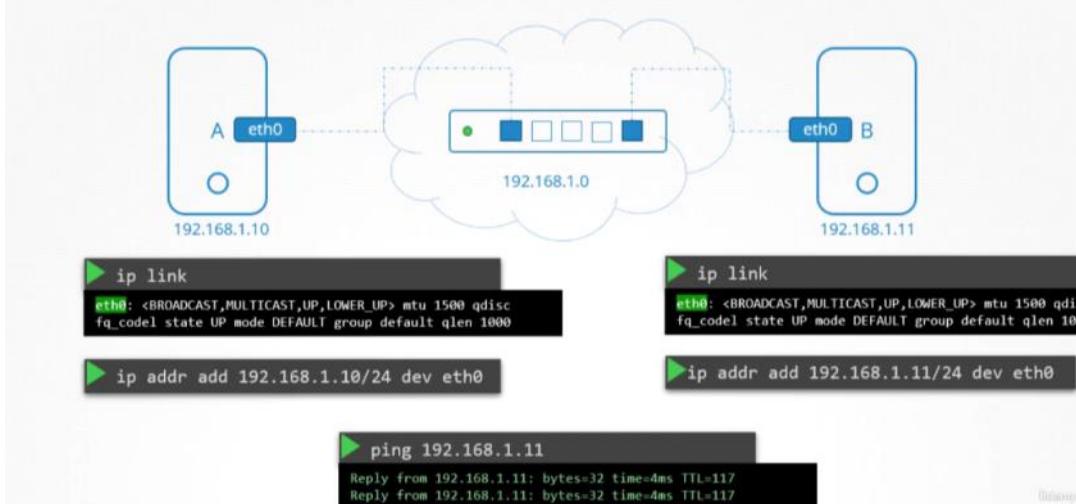
- The router's routing table contains entries that specify which interface to use for forwarding packets to specific destinations. For example, it may have a route entry like:
- Destination: 192.168.2.0/24 (Network B)
- Next Hop: 192.168.2.1 (Router's interface for network B)

#### NAT and External IP:

In addition to the interface IPs, routers often have an external IP address assigned by the Internet Service Provider (ISP). This external IP is used for communication outside of the local network, and Network Address Translation (NAT) is used to map internal IP addresses to the external IP when communicating over the internet.

So, while the router may have multiple IP addresses assigned to its interfaces for internal network communication (like between A and B), it also typically has an external IP for communication with devices outside its local networks, achieved through NAT.

# ISwitching



Network Address = A Network Address is a logical or physical address that uniquely identifies a host or a machine in a telecommunication network.

In IP Address, 196.32.216.9, Starting 192.32.216 represents the network and 9 represents the host. The first three bytes of an IP address in Class C(192.0.0.0 to 223.255.255.0) represent the network and the last byte specifies the host in the network. e.g. In IP Address, 196.32.216.9, Starting 192.32.216 represents the network and 9 represents the host.

Class C is generally used for LAN.

## Concept of a Network:

- Two computers (A and B) need a 'switch' to create a network. The switch creates a network containing the systems( A and B).
- Switch enables the communication within the network.
- Each host requires an interface (physical or virtual) to connect itself to a switch.

## Viewing Interfaces:

- Use 'ip link' command to see available interfaces.
- Example: ip link show eth0 for details on interface eth0.

## Assigning IP Addresses

### Setting IP Addresses:

- Use 'ip addr' command to assign IP addresses to the system e.g. A and B on the same network.
- Example: ip addr add 192.168.1.5/24 dev eth0.

## Communication within a Network

Switch:

- A switch enables communication within a network. To enable communication between two different networks, we use 'routers'.
- Hosts in the same network can send and receive packets.

## Networks and Routers

Introduction to Routers:

- Two separate networks (e.g., 192.168.1.0, 192.168.2.0) are connected using routers.
- Routers are devices with multiple network ports.
- A router is a computer and a networking device that forwards data packets between computer networks.
- Three main functions of a router include data packet routing, network address filtering, and acting as an intermediary between networks.

Router IPs:

- Since it connects to the two separate networks, it gets two IPs assigned, one on each network.
- Router gets an IP on each connected network (e.g., 192.168.1.1, 192.168.2.1).

## Routing Configuration

Routing Basics:

- When system B tries to send a packet to system C, how does it know where the router is on the network to send the packet through?

Systems need a gateway or route to reach other networks. If a network is a room, a gateway is a door for the outside world, to the other network. The systems need to know where that door is to go through that.

- View routing table with 'route -s' command.

Default Gateway:

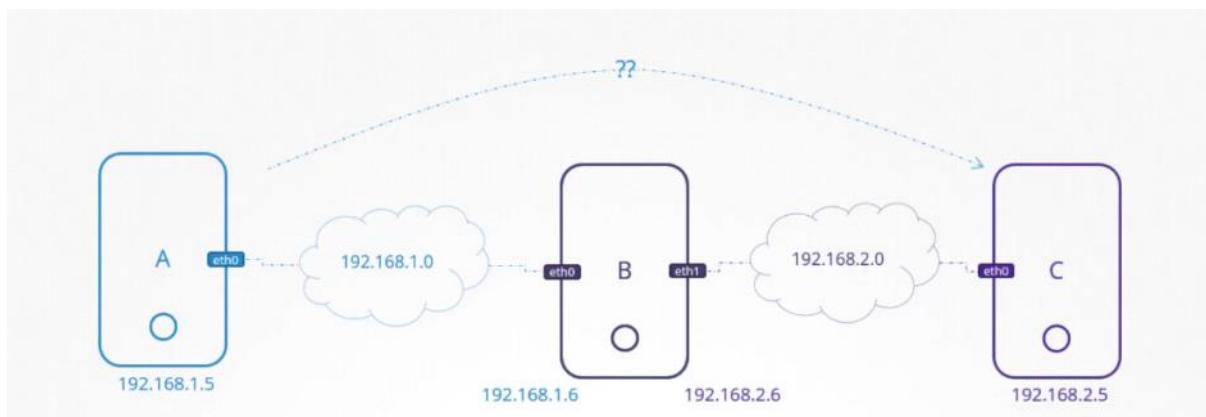
```
route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default 192.168.2.1 0.0.0.0 UG 0 0 0 eth0
0.0.0.0 192.168.2.1 0.0.0.0 UG 0 0 0 eth0
```

- For any network that you don't know a route to, you can use the router as the default gateway.
- Default gateway is set to the router's IP Address.
- Instead of default, you can also write **0.0.0.0**
- Run **ip route add default via 192.168.1.1**.
- Run **ip route add default via 192.168.2.1**
- Since your router is connected to two separate networks (192.168.1.0 and 192.168.2.0), you'll

need to configure two default gateways, each corresponding to the respective network segment.

- Configure default gateway for reaching networks outside the current network using **ip route add default** command.
  - Example: **ip route add 192.168.2.0/24 via 192.168.1.1**, To configure a gateway on system B to reach the systems on network 2.0. **This has to be configured on all the systems.**
  - For example, if the system C is to send a packet to system B, then you need to add a route on system C's routing table to access the network at 1.0 through the router configured with the IP address 2.1.

## Linux as a Router



How do we get A to talk to C?

- We need to tell host A that the door or gateway to network two is through host B. And we do that by adding a routing table entry. We add a route to access network 192.168.2 via the gateway 192.168.1.6.  
**▶ ip route add 192.168.2.0/24 via 192.168.1.6**
- Similarly, we need to add an entry into host C's routing table so that C can send packets to A.  
**▶ ip route add 192.168.1.0/24 via 192.168.2.6**
- But we still don't get any response back. **By default, in Linux, packets are not forwarded from one interface to the next.** For example, packets received on eth0 on host B are not forwarded to elsewhere through eth1.

Setting Up Linux as a Router:

- For routing between networks, enable packet forwarding. Whether a host can forward packets between interfaces is governed by a setting in a file, run **cat /proc/sys/net/ipv4/ip\_forward**. By default, the value in this file is set to **0, meaning no forward**.
- Set this to 1 by running **echo 1 > /proc/sys/net/ipv4/ip\_forward**.
- Now, ping command will run ( **ping 192.168.2.5** )
- Also, set value in **/etc/sysctl.conf** to 1 to persist these changes because changes made using these commands(**ip route, ip addr**) are only valid till a restart.

```
/etc/sysctl.conf
...
net.ipv4.ip_forward = 1
...
```

## Practical Commands

- ip link - List and modify interfaces.
- ip addr - View assigned IP addresses.
- ip addr add - Set IP addresses on interfaces.
- ip route or route - View routing table.
- ip route add - Add entries to the routing table.

## Practical Application

### Setting Up Linux as a Router:

- Connect hosts A, B, and C on different networks.
- Use routing tables to enable communication.
- Configure Linux as a router to forward packets.

# Commands

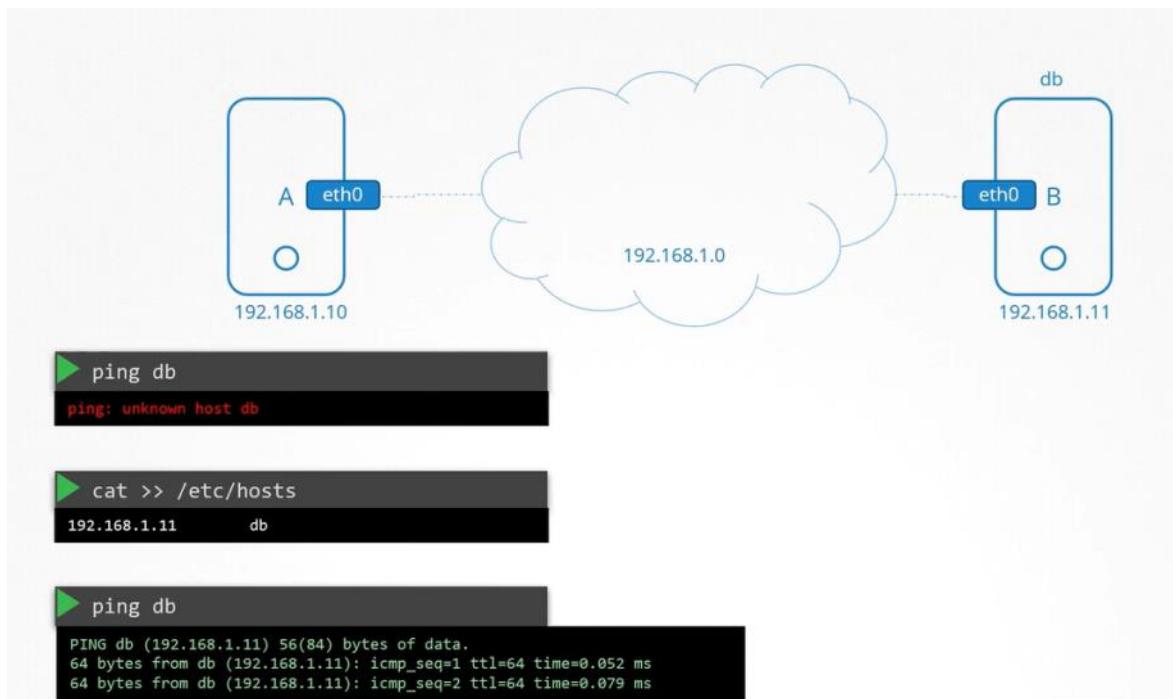
Tuesday, March 5, 2024 3:06 PM

- ip link** - see available interfaces.
- ip link show <interface-name>** - detailed info of an interface
- ip addr** - To see the IP addresses assigned to those interfaces.
- ip addr add 192.168.1.5/24 dev eth0** - assign IP address to the system on same network.
- route**
- ip route add**
- cat /proc/sys/net/ipv4/ip\_forward** - To check ip forwarding is enabled on a host

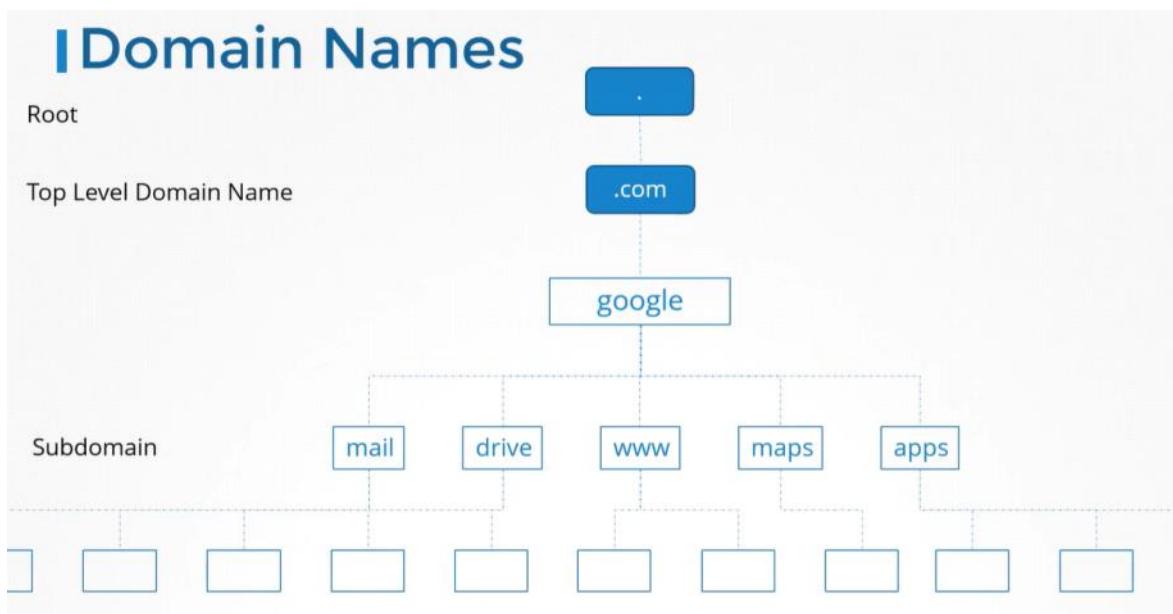
# DNS

Tuesday, March 5, 2024 3:26 PM

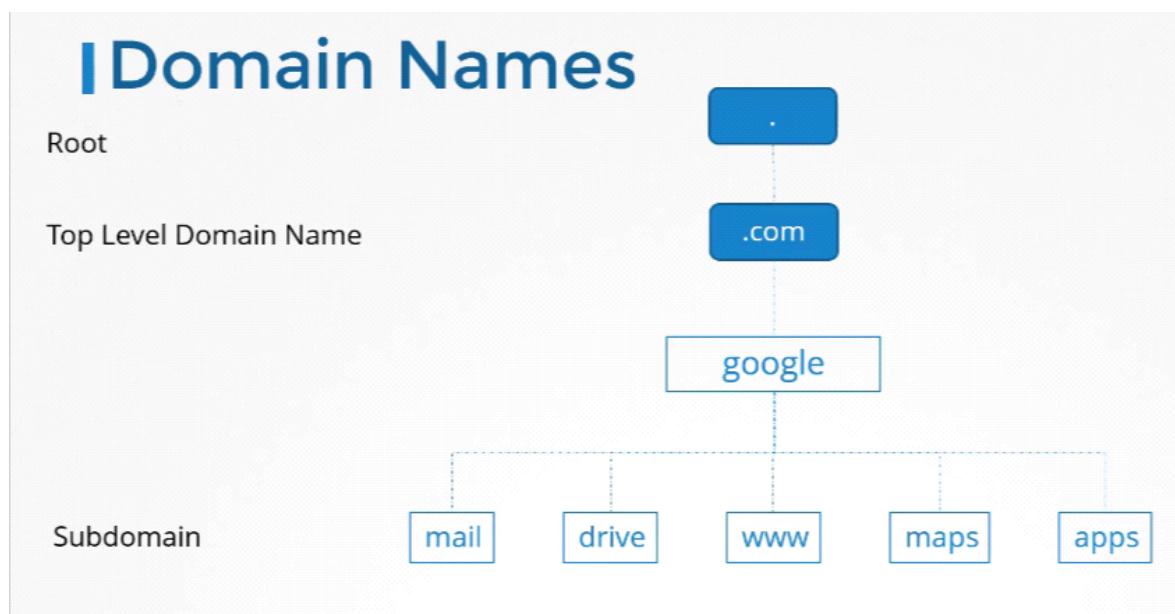
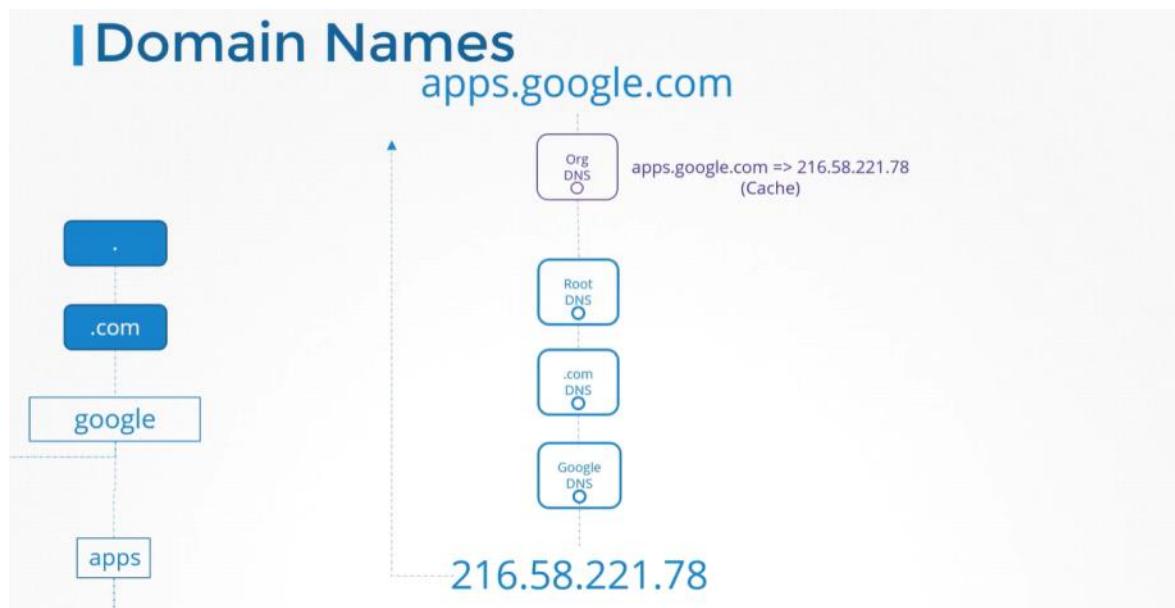
- You know that system B has database services on it. So instead of having to remember the IP address of system B, you decide to give it a name db.
- If you try to ping db now, you would see that host A is unaware of a host named db.
- So, how to tell system A that when you mention 'db' it means ip address 192.168.1.11



- You can do that by adding an entry into the **/etc/hosts** file on system A. Mention the IP address and the name you want your host to see system B has. DNS first looks at local **/etc/hosts** file and then look at nameserver. This is defined in **/etc/nsswitch.conf** file.

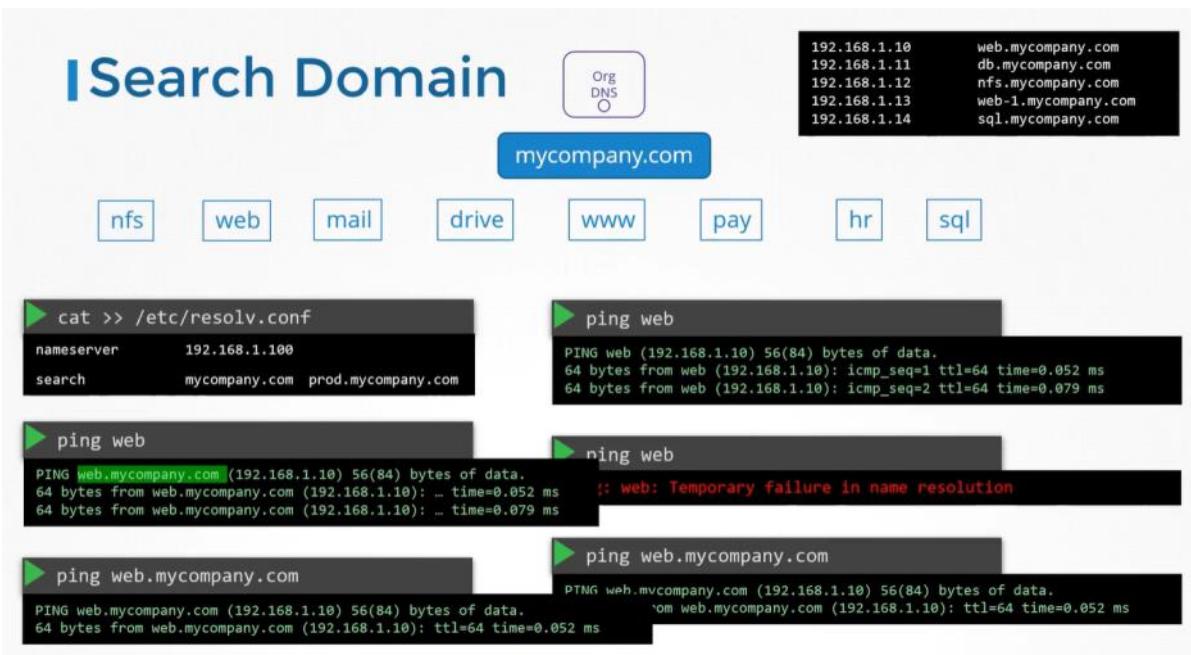


Your organization DNS caches the IP to fasten the process.



Search Domain





When you want to write only 'ping web' instead of 'ping web.mycompany.com' then put the 'mycompany.com' in **/etc/resolv.conf** file.

## Record Type

|       |                 |                                         |
|-------|-----------------|-----------------------------------------|
| A     | web-server      | 192.168.1.1                             |
| AAAA  | web-server      | 2001:0db8:85a3:0000:0000:8a2e:0370:7334 |
| CNAME | food.web-server | eat.web-server, hungry.web-server       |

## Ping alternatives

- nslookup** - Looks for IP in DNS server only and not in /etc/host. e.g. nslookup [www.google.com](http://www.google.com)
- dig** - results more details . e.g. dig [www.google.com](http://www.google.com)

## Introduction to DNS Concepts

Initial Scenario:

Two computers (A and B) on the same network.

IP addresses: A (192.168.1.10) and B (192.168.1.11).

Ping Using IP:

- Pinging one computer from the other using IP addresses.

## **Mapping Names in /etc/hosts**

Creating Host Entry:

- Assigning a name "db" to system B (192.168.1.11) in /etc/hosts on system A.

Name Resolution:

- System A can now ping "db" instead of using the IP.

### **/etc/hosts Limitation:**

- No verification of actual system name.
- Example: Fooling system A by mapping system B as "Google."

## **Introduction to DNS Server**

Single DNS Server:

- Transition from /etc/hosts to a central DNS server.
- DNS server manages entries for multiple hosts.

DNS Server Configuration:

**DNS server IP (192.168.1.100) specified in /etc/resolv.conf.**

## **DNS Server Setup**

resolv.conf Entry:

# DNS



- Adding DNS server entry: nameserver 192.168.1.100. The nameserver entry in the /etc/resolv.conf file specifies the DNS server that the system should use for domain name resolution.

Centralized Management:

- DNS server manages host-to-IP mapping centrally.
- Simplifies changes and avoids manual updates on each host.

## Local /etc/hosts vs. DNS Server

The main difference between a local /etc/hosts file and a DNS server lies in how they resolve domain names to IP addresses:

Local /etc/hosts file:

- This file is present on your computer or server.
- It maps domain names to IP addresses locally on that machine.
- When you access a domain name, your computer checks this file first before querying a DNS server.
- It's useful for defining custom mappings or for bypassing DNS lookup for specific domains.

DNS Server:

- A DNS (Domain Name System) server is a network service that translates domain names into IP addresses globally.
- DNS servers maintain a distributed database containing domain name records (like A records for IPv4 addresses or AAAA records for IPv6 addresses).
- When you access a domain name, your computer queries a DNS server to resolve the domain name to its corresponding IP address.
- DNS servers are hierarchical, with different levels (root servers, top-level domain servers, authoritative servers) handling different parts of the domain name resolution process.

In summary, the local /etc/hosts file is specific to a single machine and provides immediate IP address resolution, while a DNS server is a network service that resolves domain names globally across the internet.

## Resolving External Sites

**External Site Resolution:**

Adding public DNS server (e.g., 8.8.8.8) to resolve external sites.

**DNS Forwarding:**

Configuring DNS server to forward unknown host queries to the public DNS server.

## **DNS Hierarchy and Domains**

**Domain Naming:**

Understanding domain names (e.g., [www.google.com](http://www.google.com)).

Top-level domains (.com, .net, .edu, .org).

**Subdomains:**

Exploring subdomains (e.g., maps.google.com, drive.google.com).

Configuring Search Domain

**Search Domain Entry:**

Configuring search domain in /etc/resolv.conf for automatic domain append.

Example: search mycompany.com.

**Multiple Search Domains:**

Adding multiple search domains for comprehensive search.

## **DNS Record Types**

**DNS Record Types:**

A (IPv4) and AAAA (IPv6) records.

CNAME records for aliasing.

Introduction to more record types.

Testing DNS Resolution

**Testing Tools:**

Beyond ping: Introduction to nslookup and dig for testing DNS resolution.

**Introduction to DNS:**

- DNS (Domain Name System) is like the internet's phonebook. It translates domain names (like google.com) into IP addresses (like 192.168.1.1) that computers understand.
- Commands such as ping use DNS to resolve hostnames to IP addresses and vice versa.

**Hosts File Usage:**

- The /etc/hosts file on Linux systems is a simple text file that maps hostnames to IP addresses

locally.

- For example, adding 192.168.1.11 db in /etc/hosts allows you to refer to db instead of the IP address 192.168.1.11 within the same system.

#### Name Resolution:

- Hosts trust entries in the /etc/hosts file without verifying the actual existence of hostnames.
- You can even map non-existent hostnames to IPs in /etc/hosts, and the system will trust it.

#### DNS Server Implementation:

- DNS servers handle hostname-to-IP mappings for an entire network.
- By specifying the DNS server's IP in /etc/resolv.conf, systems can resolve hostnames across the network.
- Suppose you have to provision a test server for your own needs. You don't think others would need to resolve the server by its name, so it may not be added to the DNS server. In that case, you can add an entry into your host /etc/hosts file to resolve this server.

#### Dual Entry Handling:

- When a hostname exists both in the local /etc/hosts file and in DNS, the local entry takes precedence.
- This behavior can be modified by changing the order in /etc/nsswitch.conf.

#### External DNS Resolution:

- For external websites, DNS servers or public DNS services like Google's 8.8.8.8 are used for resolution.
- /etc/resolv.conf can be edited to include external DNS servers for resolving internet addresses.

#### Domain Names and Structure:

- Domain names follow a hierarchical structure, with the top-level domain (TLD) at the end (e.g., .com, .org, .net).
- Subdomains help organize services under a domain (e.g., maps.google.com).

#### Internal DNS Setup:

- Organizations use internal DNS servers for resolving internal hostnames.
- Adding search domains in /etc/resolv.conf allows systems to resolve internal hostnames without specifying the full domain name.

#### DNS Record Types:

- DNS servers store different types of records, such as A records for IPv4 addresses, AAAA records for IPv6 addresses, and CNAME records for aliases.
- Mapping one name to another name is called CNAME records.
- It stores IP to host names. That's known as A records.
- Storing IPv6 to host names is known as AAAA records.

#### DNS Testing Tools:

- Tools like nslookup and dig help troubleshoot DNS issues by querying DNS servers directly.
- These tools are essential for diagnosing DNS resolution problems.

# CoreDNS

Saturday, April 27, 2024 12:03 AM

## How to configure a host as a DNS server.

We are given a server dedicated as the DNS server, and a set of IPs to configure as entries in the server. There are many DNS server solutions out there, in this lecture we will focus on a particular one – CoreDNS.

So how do you get coredns?

- CoreDNS binaries can be downloaded from their Github releases page or as a docker image. Let's go the traditional route.
- Download the binary using curl or wget.
- And extract it. You get the coredns executable.



```
▶ wget https://github.com/coredns/coredns/releases/download/v1.4.0/coredns_1.4.0_linux_amd64.tgz
coredns_1.4.0_linux_amd64.tgz

▶ tar -xvf coredns_1.4.0_linux_amd64.tgz
coredns

▶ ./coredns
. :53
2019-03-04T10:46:13.756Z [INFO] CoreDNS-1.4.0
2019-03-04T10:46:13.756Z [INFO] linux/amd64, go1.12,
8dcc7fc
CoreDNS-1.4.0
linux/amd64, go1.12, 8dcc7fc
```

|              |          |
|--------------|----------|
| 192.168.1.10 | web      |
| 192.168.1.11 | db       |
| 192.168.1.20 | web      |
| 192.168.1.21 | db-1     |
| 192.168.1.22 | nfs-1    |
| 192.168.1.30 | web-1    |
| 192.168.1.31 | db-2     |
| 192.168.1.32 | nfs-2    |
| 192.168.1.40 | web-2    |
| 192.168.1.41 | sql      |
| 192.168.1.42 | web-5    |
| 192.168.1.50 | web-test |
| 192.168.1.61 | db-prod  |
| 192.168.1.52 | nfs-4    |
| 192.168.1.60 | web-3    |
| 192.168.1.61 | db-test  |
| 192.168.1.62 | nfs-prod |

Run the executable to start a DNS server. It by default listens on port 53, which is the default port for a DNS server.

Now we haven't specified the IP to hostname mappings. For that you need to provide some configurations. There are multiple ways to do that. We will look at one.

1. First we put all of the entries into the DNS servers /etc/hosts file.
2. And then we configure CoreDNS to use that file. CoreDNS loads its configuration from a file

named Corefile.

Here is a simple configuration that instructs CoreDNS to fetch the IP to hostname mappings from the file /etc/hosts. When the DNS server is run, it now picks the IPs and names from the /etc/hosts file on the server.

The diagram illustrates the setup of a CoreDNS instance. It features three terminal windows and a separate icon. The first terminal window shows the command to edit the /etc/hosts file, which contains a list of IP-to-hostname mappings. The second terminal window shows the creation of a Corefile that specifies to read the hosts file. The third terminal window shows the execution of the CoreDNS binary, which starts the DNS service on port 53. To the right, a blue rounded rectangle contains the word "DNS" above a small blue circle, representing the running service.

```
cat > /etc/hosts
192.168.1.10 web
192.168.1.11 db
192.168.1.20 web
192.168.1.21 db-1
192.168.1.22 nfs-1
192.168.1.30 web-1
192.168.1.31 db-2
192.168.1.32 nfs-2
192.168.1.40 web-2
192.168.1.41 sql
192.168.1.42 web-5
192.168.1.50 web-test
192.168.1.61 db-prod
192.168.1.52 nfs-4
192.168.1.60 web-3
192.168.1.61 db-test
192.168.1.62 nfs-prod

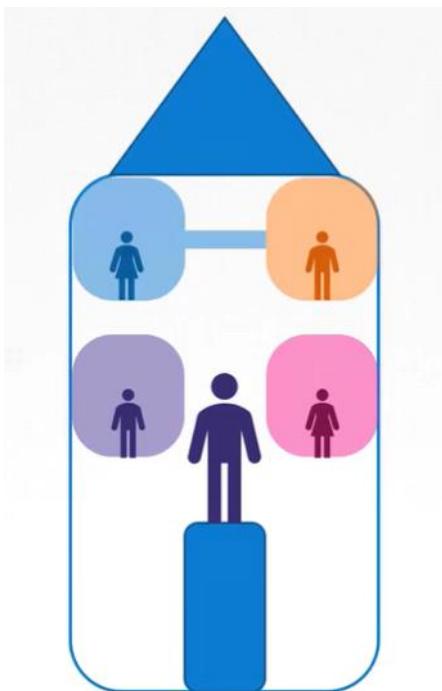
cat > Corefile
.
{
 hosts /etc/hosts
}

./coredns
.:53
2019-03-04T10:46:13.756Z [INFO] CoreDNS-1.4.0
2019-03-04T10:46:13.756Z [INFO] linux/amd64, go1.12,
8dcc7fc
CoreDNS-1.4.0
linux/amd64, go1.12, 8dcc7fc
```

# Network Namespaces

Tuesday, March 5, 2024 7:13 PM

- Network namespaces are used by containers like Docker to implement network isolation.
- Namespaces are just like rooms in your house that you assign to each of your children.
- The room helps in providing privacy to each child. Each child can only see what's within his or her room, they cannot see what happens outside their room. As far as they're concerned, they're the only person living in the house. However, as a parent, you have visibility into all the rooms in the house, as well as other areas of the house. If you wish, you can establish connectivity between two rooms in the house. When you create a container, you want to make it isolated.



## Routing Table and ARP Table

ARP Table (Address Resolution Protocol Table):

- **Function:** The ARP table is used to map IP addresses to MAC (Media Access Control) addresses on a local network segment.
- **How it works:** When a device wants to communicate with another device on the same local network, it uses ARP to find the MAC address associated with the destination IP address. This mapping is stored in the ARP table.
- **Content:** The ARP table contains entries that typically include the IP address of devices on the local network and their corresponding MAC addresses.

Routing Table:

- **Function:** The routing table is used by routers and networking devices to determine the best path for

**forwarding packets to their destination across networks.**

- **How it works:** When a device receives a packet, it consults the routing table to decide where to send the packet next based on the destination IP address. The routing table contains information about network paths, gateways, and next-hop routers.
- **Content:** The routing table contains entries that specify network destinations, associated gateway addresses, and routing metrics (like hop count or cost) used to determine the optimal path for packet delivery.

Key Differences:

- **Scope:** The ARP table operates at the data link layer (Layer 2) and is specific to a local network segment, while the routing table operates at the network layer (Layer 3) and encompasses routing decisions across multiple networks.
- **Purpose:** ARP resolves IP addresses to MAC addresses for local communication, whereas the routing table determines the best path for packets to traverse across interconnected networks.
- **Content:** ARP entries include IP-to-MAC mappings, while routing table entries include network destinations, gateways, and routing metrics.

In summary, the ARP table helps devices on a local network communicate by mapping IP addresses to MAC addresses, while the routing table assists routers in making decisions about how to forward packets between different networks.

## Loopback and eth0 interface - uses and difference

The Loopback and eth0 interfaces are two distinct network interfaces commonly found in computer systems, each serving different purposes:

Loopback Interface:

- **Purpose:** The Loopback interface, often denoted as lo, is a **virtual network interface that allows a device to communicate with itself**. It is used for local testing and diagnostic purposes.
- **IP Address:** The Loopback interface is typically assigned the IP address 127.0.0.1, also known as the loopback address.
- **Uses:**
- Testing network services on the local machine without involving actual network hardware.
- Accessing local network services like web servers, databases, or APIs for development and debugging.
- Verifying network functionality without relying on external networks.
- **Example:** When you access "localhost" on your web browser, it points to the loopback interface.

eth0 Interface (Ethernet Interface 0):

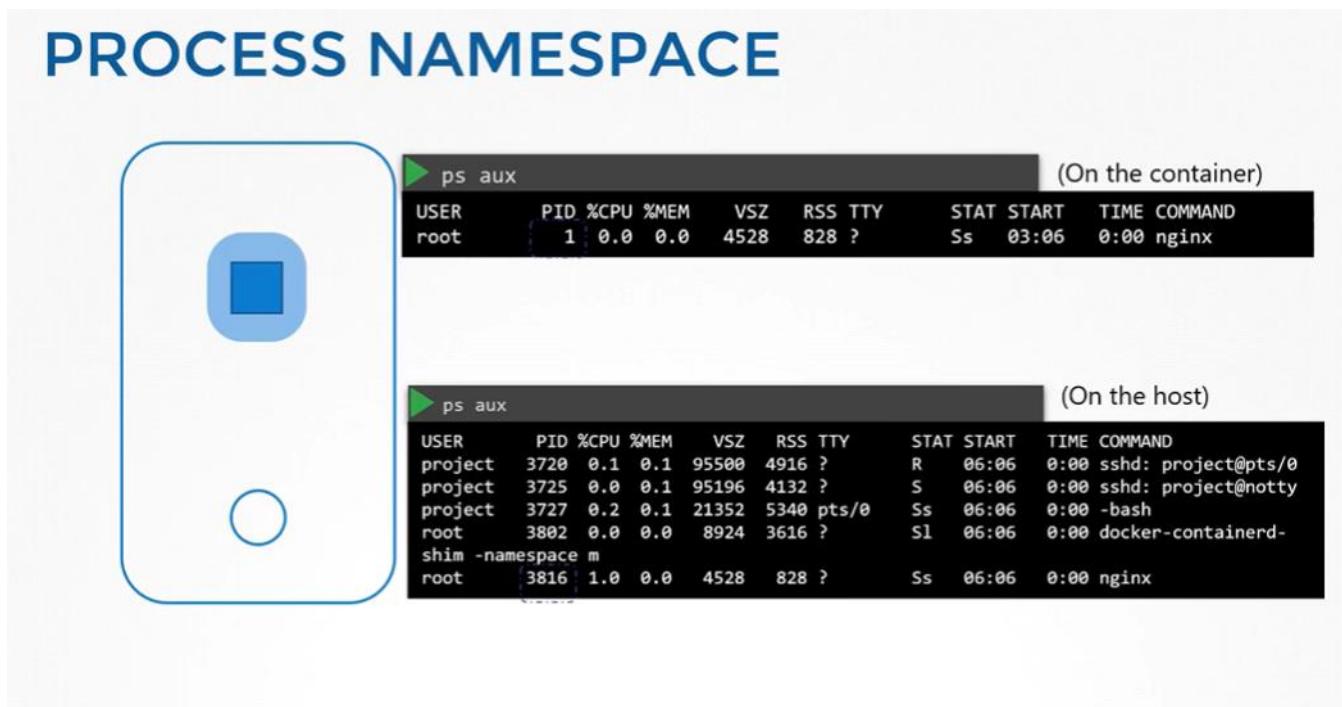
- **Purpose:** **The eth0 interface is a physical or virtual network interface that connects a device to an Ethernet network.** It is used for communication with other devices on the network, including local and remote systems.
- **IP Address:** The eth0 interface is assigned an IP address that allows it to communicate over the network. This IP address is typically provided by a DHCP server or configured manually.
- **Uses:**
- Connecting the device to a local network or the internet.
- Sending and receiving network traffic to communicate with other devices, such as servers, routers, or other computers.
- Enabling services and applications to access resources over the network.
- **Example:** A computer connected to a router via an Ethernet cable would use the eth0 interface for network communication.

Difference:

- Nature: The Loopback interface is virtual and internal to the device, allowing it to communicate with itself, while the eth0 interface can be physical (e.g., Ethernet cable) or virtual (e.g., VPN interface) and connects the device to external networks.
- Purpose: Loopback is primarily used for local testing and internal communication, whereas eth0 facilitates communication with external devices and networks.
- IP Addressing: Loopback uses the loopback address 127.0.0.1 by default, while eth0 is assigned an IP address for network communication, often obtained from a DHCP server or manually configured.

In summary, the Loopback interface is for internal testing and self-communication within a device, while the eth0 interface is for external network communication, allowing devices to connect to and communicate with other devices and systems over Ethernet networks.

## Process Namespace



- When you list the processes from within the container. You see a single process with a process ID of 1. When you list the same processes as a root user from the underlying host, you see all the other processes, along with the process running inside the container, this time with a different process ID. It's the same process running with different process IDs inside and outside the container. That's how namespaces work.

## **Overview of Network Namespaces**

Analogy with House Rooms:

- Likening host to a house and namespaces to rooms.
- Namespace provides privacy and isolation for processes.

### Namespace Implementation

Container Isolation:

- Containers isolated using namespaces.
- Processes within a container only see their own processes.

Parental Visibility:

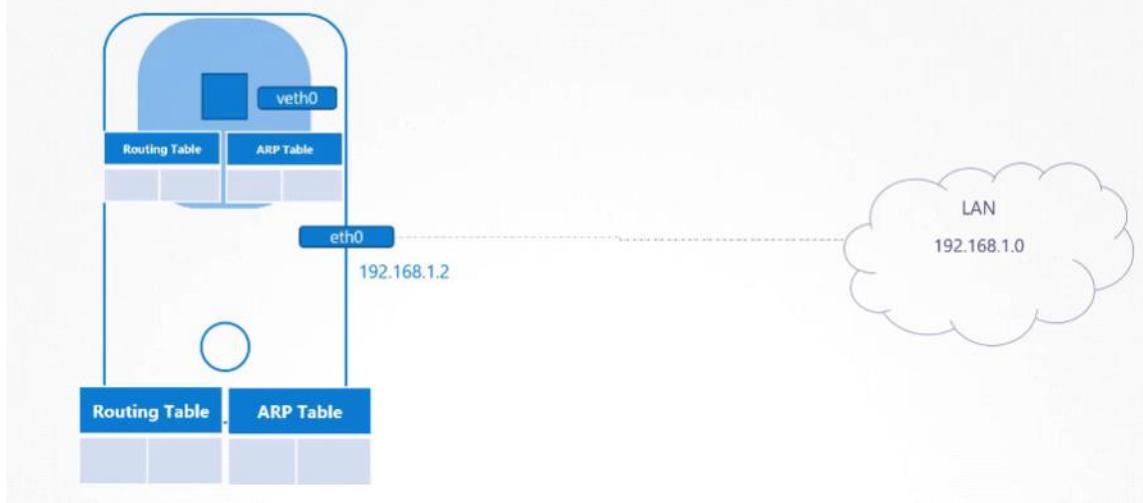
- Parent (host) has visibility into all namespaces and processes.
- Parent can establish connectivity between namespaces.

Demonstration:

- Example with a container having a single process (PID 1).
- Different PIDs for the same process inside and outside the container.

### Network Namespace for Networking Isolation

# NETWORK NAMESPACE



Host Networking:

- Host has its own network interfaces, routing, and ARP tables.
- Objective is to seal these details from the container means that the goal is to prevent the container from accessing or being aware of the networking details of the host system.

In simpler terms, when you create a container, you want to make sure that it operates within its isolated networking environment without being able to see or interfere with the networking configurations (such as interfaces, routing rules, and ARP tables) of the host machine. This isolation helps in maintaining security and ensures that containers operate independently without affecting or being affected by the host's networking setup.

Creating Network Namespace:

- **ip netns add <network-namespace-name>** command to create network namespaces.
- **ip netns list** command to list existing network namespaces.



Namespace-Specific Commands

Viewing Interfaces within Namespace:

- **ip link** command is used to view the interface.

- **ip netns exec <namespace-name> ip link** command to execute commands within a namespace. You can also use **ip -n <namespace-name>**

Namespace Isolation:

- Namespace limits visibility of host interfaces.
- Demonstration of restricted interface view within a namespace.

```

ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc state UNKNOWN mode DEFAULT group default qlen 1000
 link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc state UP mode DEFAULT group default qlen 1000
 link/ether 02:42:ac:11:00:08 brd ff:ff:ff:ff:ff:ff

ip netns exec red ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc state UNKNOWN mode DEFAULT group default qlen 1000
 link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00

```

| Address     | Hwtype | Hwaddress         | Flags Mask | Iface |
|-------------|--------|-------------------|------------|-------|
| 172.17.0.21 | ether  | 02:42:ac:11:00:15 | C          | eth0  |
| 172.16.0.8  | ether  | 06:fe:d3:b5:59:65 | C          | eth0  |
| _gateway    | ether  | 02:42:d3:7a:84:8e | C          | eth0  |
| host01      | ether  | 02:42:ac:11:00:1c | C          | eth0  |

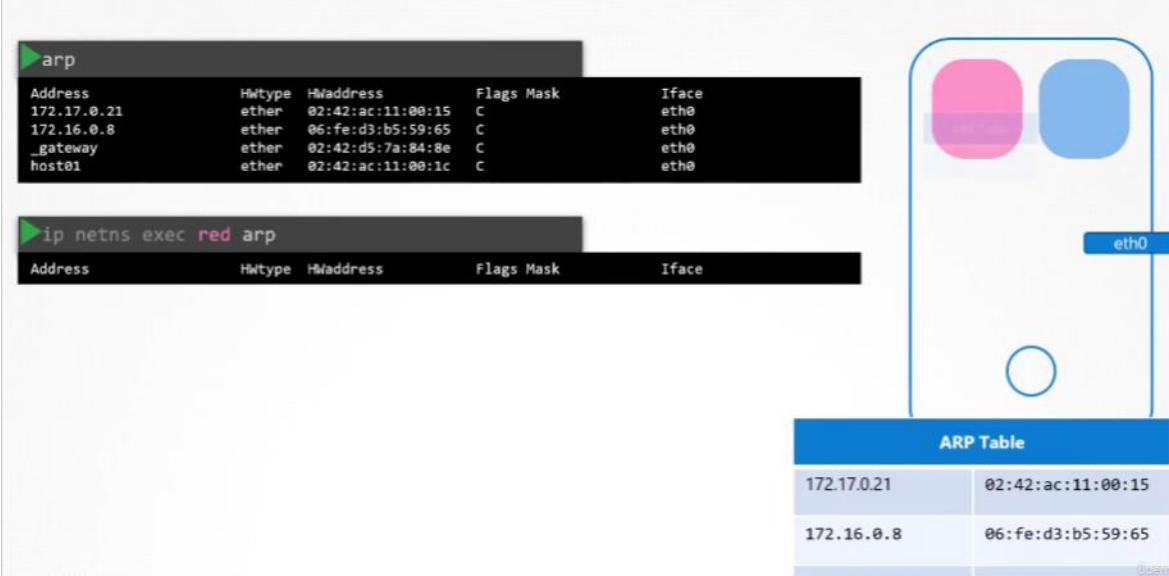
  

| ARP Table   |                   |
|-------------|-------------------|
| 172.17.0.21 | 02:42:ac:11:00:15 |
| 172.16.0.8  | 06:fe:d3:b5:59:65 |

When you run arp command inside the pod, you'll not find the entries and same for routing tables.

Each namespace has its own ARP table, which is separate from the host system's ARP table. Similarly, each namespace has its own routing table, which is isolated from the host's routing table. When you run commands inside a namespace, you are operating within the context of that namespace's network stack.

- **Network Namespace:** The ip netns exec command allows you to execute commands within a specific network namespace. When you run ip netns exec red arp, you're querying the ARP table of the "red" namespace, not the host's ARP table.
- **Routing Context:** Similarly, the routing tables (ip route) inside a namespace are specific to that namespace. Routes configured within the namespace are independent of routes in other namespaces or the host's routing table.



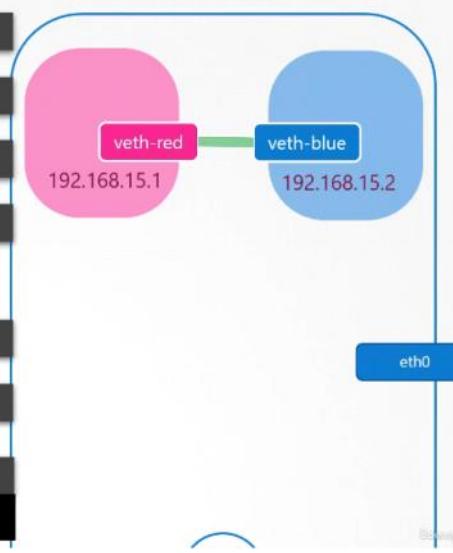
## Interconnecting Namespaces

Creating Virtual Ethernet Pair:

```

ip link add veth-red type veth peer name veth-blue
ip link set veth-red netns red
ip link set veth-blue netns blue
ip -n red addr add 192.168.15.1 dev veth-red
ip -n blue addr add 192.168.15.2 dev veth-blue
ip -n red link set veth-red up
ip -n blue link set veth-blue up
ip netns exec red ping 192.168.15.2
PING 192.168.15.2 (192.168.15.2) 56(84) bytes of data.
64 bytes from 192.168.15.2: icmp_seq=1 ttl=64 time=0.026 ms

```



## Creation of virtual cable pair (veth) or pipe for connecting namespaces.

### ip link add veth-red type veth peer name veth-blue:

- This command creates a virtual Ethernet pair consisting of two interfaces: veth-red and veth-blue.
- These interfaces are connected as a pair, where data sent through one end (e.g., veth-red) appears on the other end (veth-blue).

### ip link set veth-red netns red:

- This command moves the veth-red interface into the network namespace named "red".
- Network namespaces provide isolated network stacks, so moving an interface into a namespace isolates it from the rest of the system.

### ip link set veth-blue netns blue:

- Similarly, this command moves the veth-blue interface into the network namespace named "blue".

### ip -n red addr add 192.168.15.1 dev veth-red:

- Within the "red" namespace (-n red), this command assigns the IP address 192.168.15.1 to the veth-red interface.

**ip -n blue addr add 192.168.15.2 dev veth-blue:**

- Similarly, within the "blue" namespace, this command assigns the IP address 192.168.15.2 to the veth-blue interface.

**ip -n red link set veth-red up:**

- This command brings the veth-red interface up within the "red" namespace, enabling it to send and receive network traffic.

**ip -n blue link set veth-blue up:**

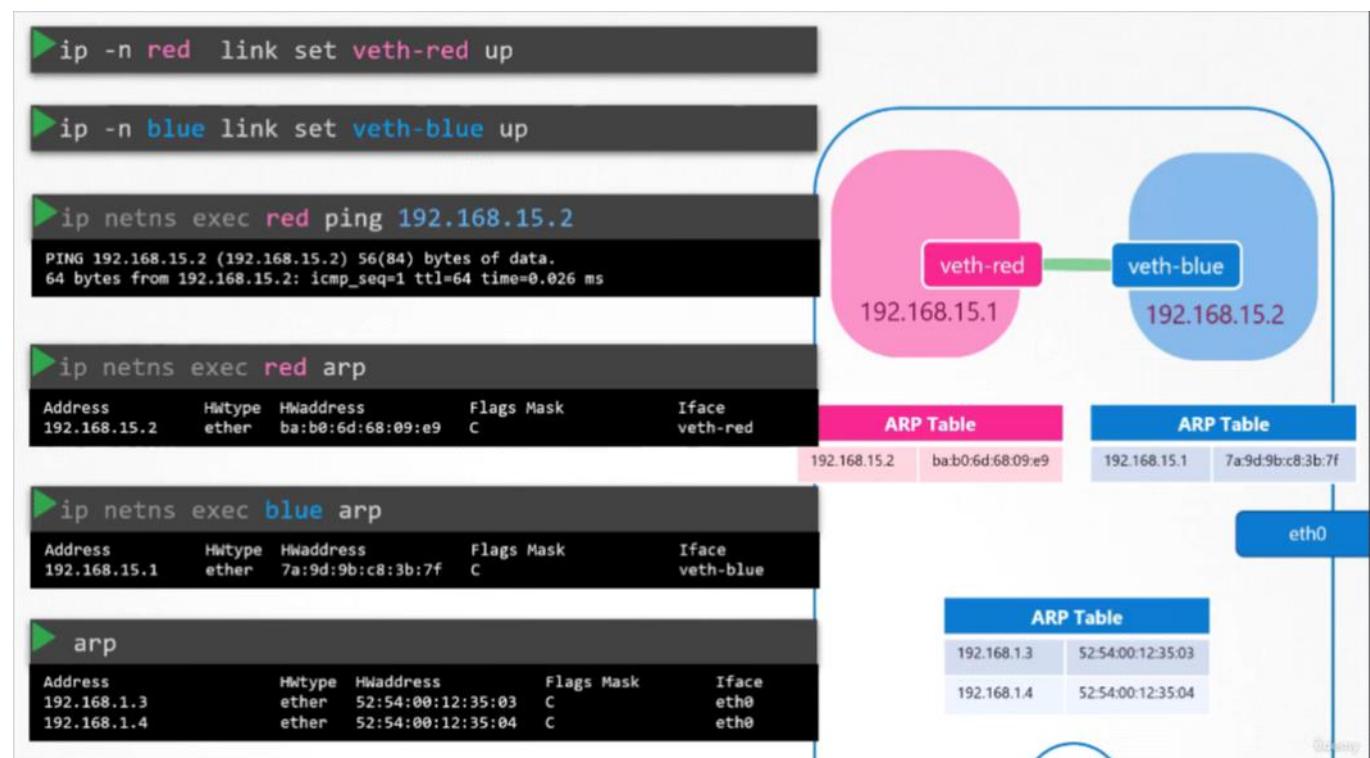
- Likewise, this command brings the veth-blue interface up within the "blue" namespace.

After executing these commands, you'll have a virtual Ethernet pair (veth-red and veth-blue) connecting the "red" and "blue" network namespaces, each with its own IP address (192.168.15.1 and 192.168.15.2, respectively), allowing communication between processes in these isolated namespaces as if they were connected by a physical network cable.

Establishing Connectivity:

- Assigning IP addresses within namespaces.
- Demonstration of ping between namespaces.

Now checking the arp table in red and blue namespace and in host



## How to connect to multiple namespaces using Linux Bridge ?

To create a virtual network, you need a virtual switch. So you create a virtual switch within our host, and connect the namespaces to it.

- To create an internal bridge network, we add a new interface to the host using the `ip link add` command with the type set to bridge. We will name it Vnet0.

```
▶ ip link add v-net-0 type bridge
```

- It's just another interface like eth0 which you can see in `ip link` command.

```
▶ ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN
 mode DEFAULT group default qlen 1000
 link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP mode DEFAULT group default qlen 1000
 link/ether 02:0d:31:14:c7:a7 brd ff:ff:ff:ff:ff:ff
6: v-net-0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN
 mode DEFAULT group default qlen 1000
 link/ether 06:9d:69:52:6f:61 brd ff:ff:ff:ff:ff:ff
```

- v-net-0 is down so you have to turn it up.

```
▶ ip link set dev v-net-0 up
```

- For namespaces, this interface is like a switch that it can connect to. For host, it's an interface.
- Delete the previous cable between red and blue.

```
▶ ip -n red link del veth-red
```

- Let us now create new cables to connect the namespaces to the bridge.

Run the `ip link add` command and create a pair with veth-red on one end, and the other end will be named veth-red-br as it connects to the bridge network.

```
▶ ip link add veth-red type veth peer name veth-red-br
```



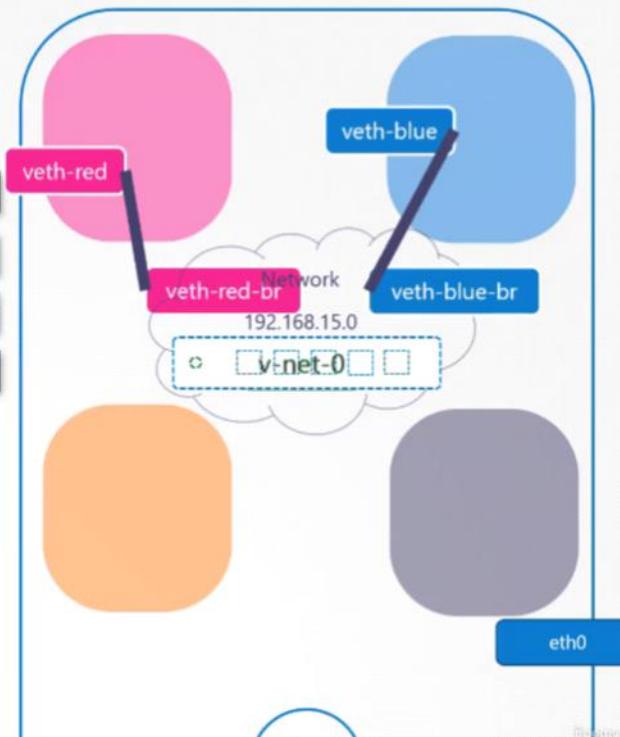
```
▶ ip link add veth-blue type veth peer name veth-blue-br
```



- To attach one end of this host interface to the red namespace, run the `ip link set veth-red netns red` command. To attach the other end to the bridge network, run the `ip link set` command on the veth-red-br and specify the master for it.

# LINUX BRIDGE

```
▶ ip link set veth-red netns red
▶ ip link set veth-red-br master v-net-0
▶ ip link set veth-blue netns blue
▶ ip link set veth-blue-br master v-net-0
```

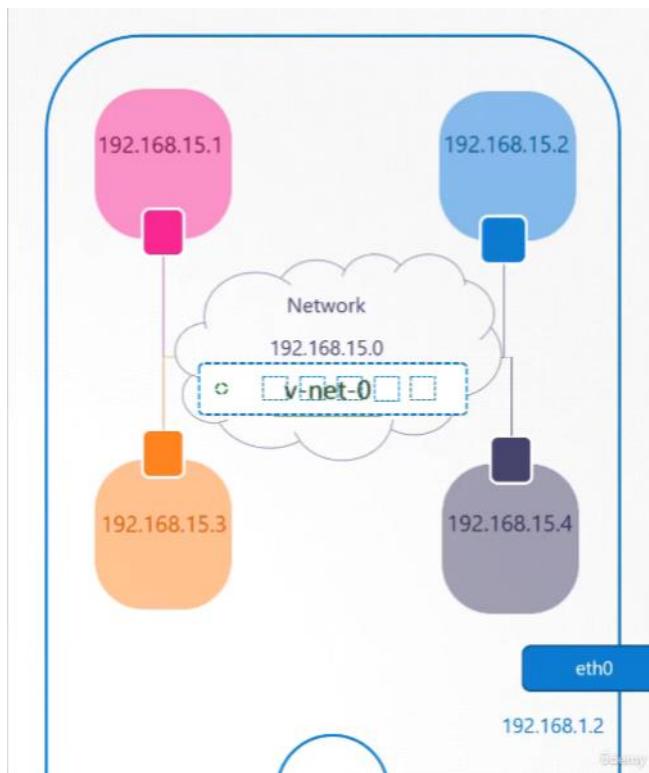


- Let us now set ip addresses

for these links and turn them up.

```
▶ ip -n red addr add 192.168.15.1 dev veth-red
▶ ip -n blue addr add 192.168.15.2 dev veth-blue
▶ ip -n red link set veth-red up
▶ ip -n blue link set veth-blue up
```

- ★ we assigned our host the IP 192.168.1.2 from my host.



# Networking Docker

Wednesday, March 6, 2024 7:42 PM

## Type of network in Docker

### None

- The "none" network mode in Docker means that the container does not have networking capabilities.

### Host

- In the "host" network mode, the container shares the network namespace with the host system.
- Containers in this mode can access services running on the host using localhost or the host's IP address.

### Bridge

- The "bridge" network mode is Docker's default networking mode.
- Containers connected to a bridge network can communicate with each other and with the host system.
- Docker creates a virtual bridge network interface on the host, and each container connected to the bridge gets its own IP address within the bridge subnet.
- This mode is commonly used for multi-container applications where containers need to communicate over a private network.

**Explain "bridge network is like an interface to the host but a switch to the namespaces or containers within the host."**

In Docker, the concept of a "bridge network" is essential for managing communication between containers and between containers and the host. The description "a bridge network is like an interface to the host but a switch to the namespaces or containers within the host" helps illustrate how this network operates.

Let's break down the components of this description:

### Bridge Network:

In Docker, a bridge network is a default network driver used to connect containers on the same host. Each host running Docker has its own bridge network. This network operates at the link layer (Layer 2 of the OSI model) and facilitates communication between containers.

### Interface to the Host:

The bridge network acts as an "interface to the host" in the sense that it provides a connection point for communication between containers and the host machine. Containers connected to the bridge network can communicate with the host and with each other using this shared network.

### Switch to the Namespaces or Containers within the Host:

The bridge network also acts as a "switch" within the namespaces or containers on the host. Each container connected to the bridge network is like a "port" on the virtual switch. When containers communicate with each other, the bridge

network functions as a switch, allowing them to exchange data directly within the host.

Containers attached to the bridge network can communicate seamlessly as if they were connected to the same local network switch.

Note - The primary function of a switch is to connect multiple devices within a local area network (LAN) and intelligently forward data between them. Unlike a hub, which broadcasts data to all connected devices, a switch makes more efficient use of network bandwidth by selectively forwarding data only to the device that needs it.

interface in a network - an interface refers to a point of connection between two different entities, allowing them to communicate and exchange information.

Network interfaces specifically pertain to the point at which a device connects to a network. A network interface can be associated with a physical port on a device, such as an **Ethernet port**, or a logical interface in the case of virtualized environments.

### **How does Docker attach the container, or its network namespace, to the bridge network?**

Docker attaches a container to the bridge network by creating a virtual Ethernet pair and connecting one end to the container's network namespace and the other end to the bridge network.

Container Creation:

When you create a Docker container, Docker creates a network namespace for that container. A network namespace is an isolated networking environment where the container's network interfaces, routes, and firewall rules are managed.

Bridge Network:

- Docker uses a bridge network by default to provide connectivity between containers on the same host.
- The bridge network acts as a virtual switch, allowing containers to communicate with each other and with the host system.

Virtual Ethernet Pair:

- To connect the container to the bridge network, Docker creates a virtual Ethernet pair.
- One end of this pair is placed inside the container's network namespace as a network interface (e.g., eth0).
- The other end of the pair is added to the bridge network on the host system.

Connection Establishment:

Docker configures the virtual Ethernet pair such that traffic from the container's network interface is

forwarded to the bridge network, enabling communication with other containers and the host.

In essence, Docker leverages virtual networking mechanisms like the bridge network and virtual Ethernet pairs to connect containers to networks, facilitating communication between containers and with external networks.

# CNI - Container Networking Interface

Thursday, March 7, 2024 12:13 PM

## Bridge Program



When Rocket or Kubernetes creates a new container, they call the Bridge Program and pass the container ID and namespace to get networking configured for that container.

```
bridge add <cid> <namespace>
```

[Day 32/40 - Kubernetes Networking Explained | Container Network Interface \(CNI\) With @kubesimplify](#)

- ?
- What if you wanted to create such a program for yourself, maybe for a new networking type?
- ?
- If you were doing so, what arguments and commands should it support?
- ?
- How do you make sure the program you create will work currently with these run times?
- ?
- How do you know that container run times like Kubernetes or Rocket will invoke your program correctly?

That's where we need some standards defined. A standard that defines how a program should look, how container run times will invoke them so that everyone can adhere to a single set of standards and develop solutions that work across run times. That's where container network interface comes in.



## CONTAINER NETWORK INTERFACE

- Container Runtime must create network namespace
- Identify network the container must attach to
- Container Runtime to invoke Network Plugin (bridge) when container is ADDED.
- Container Runtime to invoke Network Plugin (bridge) when container is DELETED.
- JSON format of the Network Configuration



- Must support command line arguments ADD/DEL/CHECK
- Must support parameters container id, network ns etc..
- Must manage IP Address assignment to PODs
- Must Return results in a specific format

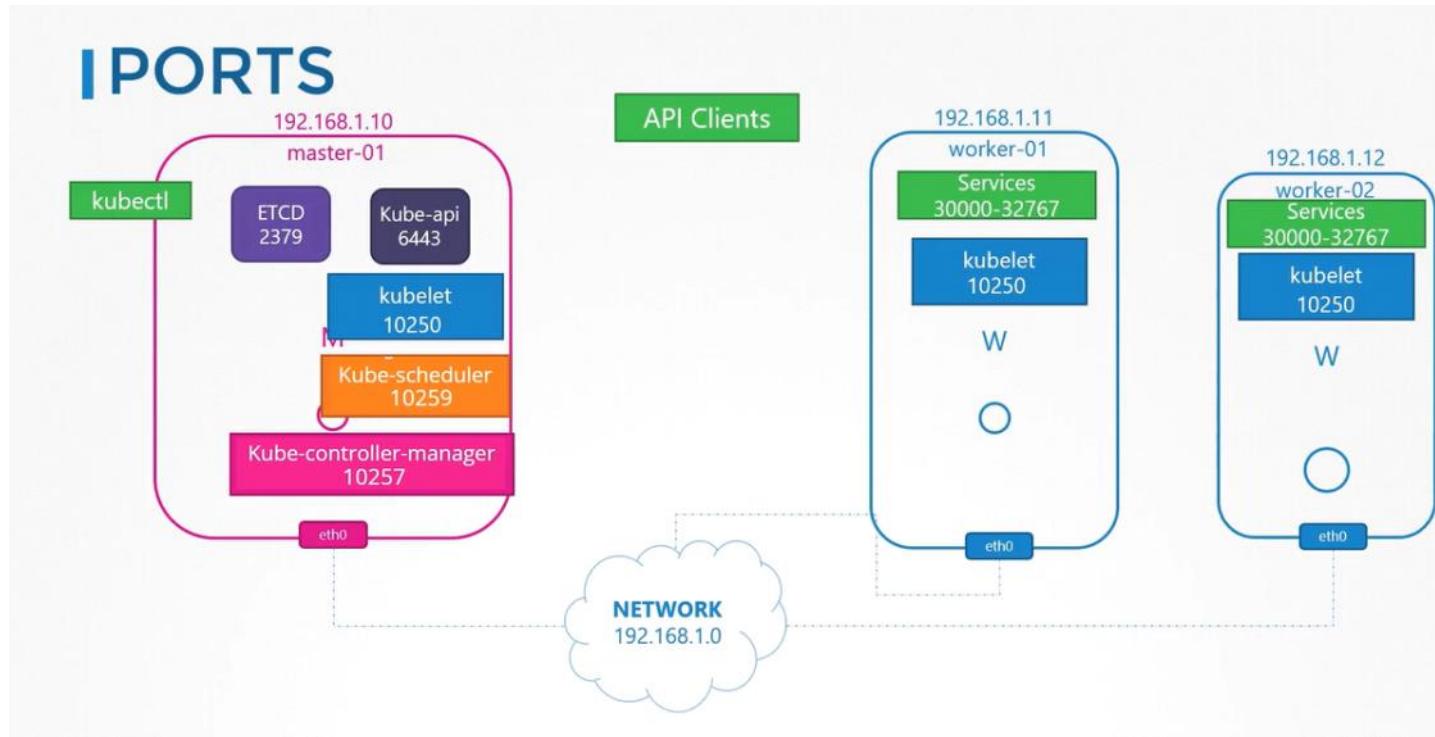


1. The CNI is a set of standards that define how programs should be developed to solve networking challenges
2. in a container runtime environments.
3. The programs are referred to as plugins.
4. In this case, Bridge program that we have been referring to is a plugin for CNI.
5. CNI defines how the plugin should be developed and how container run times should invoke them.
6. CNI defines a set of responsibilities for container run times and plugins.
7. For container run times, CNI specifies that it is responsible
8. for creating a network name space for each container.
9. It should then identify the networks the container must attach to, container run time must then invoke the plugin when a container is created using the add command and also invoke the plugin when the container is deleted using the del command.
10. It also specifies how to configure a network plugin on the container runtime environment using a JSON file.

# Cluster Networking

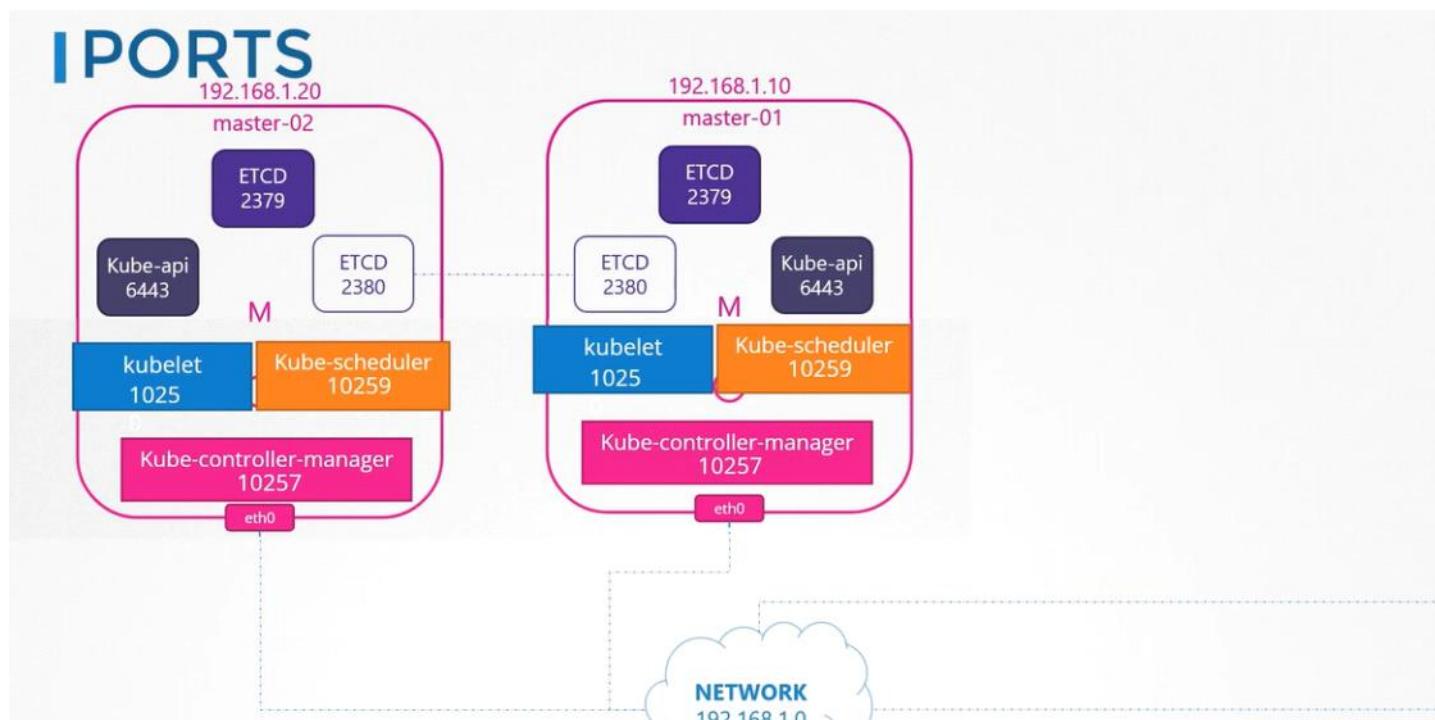
Thursday, March 7, 2024 1:02 PM

## Ports



- ★ kubelets can be present on master node as well.

If you have multiple master nodes, than port 2380 should also be open so that etcd clients can communicate with each other.





## I COMMANDS

```
▶ ip link
```

```
▶ ip addr
```

```
▶ ip addr add 192.168.1.10/24 dev eth0
```

```
▶ ip route
```

```
▶ ip route add 192.168.1.0/24 via 192.168.2.1
```

```
▶ route
```

```
▶ cat /proc/sys/net/ipv4/ip_forward
```

```
1
```

```
▶ arp
```

```
▶ netstat -plnt
```

A Kubernetes cluster comprises master and worker nodes, and each node must be equipped with at least one network interface. These interfaces should have configured IP addresses. It's crucial to assign unique hostnames and MAC addresses to each node, especially if VMs were created by cloning from existing ones.

Certain ports need to be opened to facilitate communication among various components in the control plane. Here's a breakdown of the relevant ports:

**Master Node:**

Accepts connections on port 6443 for the API server. This port is accessed by kube control tool, external users, and other control plane components.

Kubelets on both master and worker nodes listen on port 10250.

**Master Node (Additional Ports):**

Kube Scheduler requires port 10259 to be open.

Kube Controller Manager requires port 10257 to be open.

**Worker Nodes:**

Expose services for external access on ports 30000 to 32767.

**ETCD Server:**

Listens on port 2379. If multiple master nodes are present, these ports need to be open on all master nodes, and an additional port, 2380, should be open for ETCD clients to communicate with each other. It's essential to be aware of these ports when setting up networking for nodes, configuring firewalls, IP table rules, or network security groups in cloud environments like GCP, Azure, or AWS. If any networking issues arise, checking these ports can be a valuable step in the investigation.

The Kubernetes documentation page also provides information on the list of ports to be opened. Consider these details when configuring your cluster's networking to ensure smooth communication between components.

In the upcoming practice session, you'll explore the networking setup in an existing environment. Familiarize yourself with commands to view information about interfaces, IPs, hostnames, ports, etc. This exercise aims to help you become more comfortable with the environment, paving the way for more complex exercises in the future.

# lab 1

Thursday, April 25, 2024 12:04 PM

?

What is the network interface configured for cluster connectivity on the controlplane node?

Run the ip a / ip link command and identify the interface.

```
Run: kubectl get nodes -o wide to see the IP address assigned to the controlplane node.

controlplane:~# kubectl get nodes controlplane -o wide
NAME STATUS ROLES AGE VERSION INTERNAL-IP EXTERNAL-IP OS-IMAGE KERNEL-VER
controlplane Ready control-plane 7m v1.29.0 192.23.97.3 <none> Ubuntu 22.04.3 LTS 5.4.0-11

controlplane:~#
```

In this case, the internal IP address used for node to node communication is 192.23.97.3 .

**Important Note :** The result above is just an example, the node IP address will vary for each lab.

Next, find the network interface to which this IP is assigned by making use of the ip a command:

```
controlplane:~# ip a | grep -B2 192.23.97.3
25556: eth0@if25557: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1450 qdisc noqueue state UP group default
 link/ether 02:42:c0:17:61:03 brd ff:ff:ff:ff:ff:ff link-netnsid 0
 inet 192.23.97.3/24 brd 192.23.97.255 scope global eth0
 controlplane:~#
```

Here you can see that the interface associated with this IP is eth0 on the host.

The command ip a | grep -B2 192.23.97.3 is used to find network interface information related to the IP address 192.23.97.3 using the ip command and filtering the output with grep. Here's a breakdown of each part of the command:

- ip a: This command is used to display network interface information on a Linux system. It shows details such as IP addresses, network interfaces, and their status.
- |: This is a pipe operator that takes the output of the ip a command and passes it as input to the next command (grep in this case).
- grep -B2 192.23.97.3: The grep command is used for pattern matching in text. In this context:
  - **-B2: This option tells grep to display the two lines of context before the matched line. In other words, it shows the line with the IP address and two lines before it.**
  - 192.23.97.3: This is the IP address being searched for in the output of ip a.

So, when you run ip a | grep -B2 192.23.97.3, the command will search the output of ip a for the IP address 192.23.97.3 and display that line along with two lines of context before it, which often includes information about the network interface associated with that IP address.

So, eth0 is is the network interface configured for cluster connectivity on the controlplane node.

## -A and -B flag

You can use the -A option to display lines after the context. So if you want to display two lines after the context (similar to -B2 which displays two lines before the context), you can use -A2 like this:

```
ip a | grep -A2 192.23.97.3
```

This command will search for the IP address 192.23.97.3 in the output of ip a and display that line along with two lines after it, providing additional context related to the network interface associated with that IP address.

If you want to display both lines before and after the context when using grep, you can combine the -B (lines before) and -A (lines after) options. Here's how you can do it:

```
ip a | grep -B2 -A2 192.23.97.3
```

This command will display two lines before and two lines after the line containing 192.23.97.3 in the output of ip a.

### ip a vs ip link

When you run ip a, it shows detailed information about all network interfaces, including their IP addresses, MAC addresses, state (UP/DOWN), and associated network information.

#### ❓ What is the MAC address of the interface on the controlplane node?

Since eth0 is the network interface configured for cluster connectivity on the controlplane node.  
(from above question)

Run the command: ip link show eth0

The command ip link show eth0 is used to display information about the network interface named eth0. Here's what each part of the command does:

- ip: This is the command-line utility for managing networking in Linux.
- link: This subcommand is used to manage network interfaces.
- show: This option is used to display information about the specified network interface.
- eth0: This specifies the network interface for which you want to display information. In this case, it's eth0.

When you run this command, it will show details about the eth0 network interface, such as its status, MAC address, MTU (Maximum Transmission Unit), and other configuration settings.

link/ether 02:42:c0:0c:b9:03: This is the MAC (Media Access Control) address of the interface, uniquely identifying it on the network.

#### ❓ What is the MAC address assigned to node01?

SSH to the node01 node and run the command: ip link show eth0.

| NAME         | STATUS | ROLES         | AGE | VERSION | INTERNAL-IP  | EXTERNAL-IP | OS-IMAGE           | KERNEL-VERSION | CONTAINER-RUNTIME   |
|--------------|--------|---------------|-----|---------|--------------|-------------|--------------------|----------------|---------------------|
| controlplane | Ready  | control-plane | 17m | v1.29.0 | 192.10.255.6 | <none>      | Ubuntu 22.04.3 LTS | 5.4.0-1106-gcp | containerd://1.6.26 |
| node01       | Ready  | <none>        | 16m | v1.29.0 | 192.10.255.9 | <none>      | Ubuntu 22.04.3 LTS | 5.4.0-1106-gcp | containerd://1.6.26 |

```
controlplane ~ ➔ k get no -o wide
```

```
controlplane ~ ➔ ip a | grep -A2 -B2 192.10.255.9
```

```
controlplane ~ ✘ ip a | grep 192.10.255.9
```

I am currently in controlplane node and looking for worker's node (node 01) IP from the control plane so I am not getting the desired output.

So, I have to ssh into the node01 and rerun the above command and then you can find the MAC addresses.

To exit from worker node, run 'exit' command.

## Master Node and Worker Node in a cluster

In a typical Kubernetes cluster, the node named "**controlplane**" is often configured as the master node, while "**node01**" is usually a worker node. The master node hosts the control plane components such as the API server, scheduler, controller manager, and etcd. It manages the cluster's state and coordinates tasks on worker nodes.

On the other hand, worker nodes like "**node01**" are where the actual application workloads run. They receive instructions from the master node and execute tasks like running containers, pods, and managing networking for applications.

So, in your cluster, "controlplane" is likely the master node, and "node01" is a worker node.

- ?
- We use Containerd as our container runtime. What is the interface/bridge created by Containerd on the controlplane node?

Run ip address show type bridge

What is the state of the interface cni0?

Run 'ip link' command

OR

Run 'ip link show cni0'

?

If you were to ping google from the controlplane node, which route does it take?

OR

?

What is the IP address of the Default Gateway?

Run the command: ip route show default and look at for default gateway.

## ip route command

The ip route command is used in Linux systems to display and manipulate the IP routing table.

Here are some common options and explanations for the ip route command:

Displaying Routing Table:

- ip route show: Displays the IP routing table, including destination networks, gateway addresses, and interface names.

Adding a Route:

- ip route add: Adds a new route to the routing table. For example:  
ip route add <destination\_network> via <gateway\_address> dev <interface\_name>

Deleting a Route:

- ip route del: Deletes a route from the routing table. For example:  
ip route del <destination\_network> via <gateway\_address> dev <interface\_name>

Routing Table Filters:

- ip route show table <table\_number>: Displays routes from a specific routing table.
- ip route show default: Displays the default route.
- ip route show cache: Displays the routing cache.

Other Options:

- ip route get <destination\_ip>: Shows the route a packet would take to reach a specific destination IP.
- ip route flush: Flushes all routes from the routing table.
- ip route help: Displays the help information for the ip route command.

These are some basic examples of how the ip route command can be used to manage IP routing in Linux.

What is the port the kube-scheduler is listening on in the controlplane node?

Here is a sample result of using the `netstat` command and searching for the scheduler process:

```
root@controlplane:~# netstat -nplt | grep scheduler
tcp 0 0 127.0.0.1:10259 0.0.0.0:*
 LISTEN 3665/kube-scheduler
root@controlplane:~#
```

We can see that the kube-scheduler process binds to the port `10259` on the `controlplane` node.

I ran 'k describe pod kube-scheduler-controlplane -n kube-system' command and look for 'port' option and it shows 'none'.

But in the solution is mentions - Use the command: `netstat -nplt`

Where I am wrong, explain in simple language ?

In Kubernetes, the kube-scheduler is not directly exposed with a specific port that you can find by using the `kubectl describe pod` command. When you run that command, it shows information about the pod itself, such as its configuration and status, but it doesn't display details about the port the kube-scheduler listens on.

To find out the port that the kube-scheduler is listening on, you need to look at the network configuration of the control plane node where the kube-scheduler pod is running. The `netstat -nplt` command is used to list all listening ports on a Linux system.

Here's a breakdown of what you're doing:

- **`kubectl describe pod kube-scheduler-controlplane -n kube-system`:** This command gives you information about the kube-scheduler pod, but it won't directly show you the port it's listening on.
- **`netstat -nplt`:** This command lists all listening TCP ports on the control plane node. By running this command on the control plane node, you can see which port the kube-scheduler process is listening on.

So, you're not wrong; you just need to use the correct command (`netstat -nplt`) to get the information about the listening port of the kube-scheduler process on the control plane node.

-i = Ignores, case for matching

**netstat -nplt**

- `netstat` stands for network statistics.
- The netstat command is used in Linux to display network-related information.
- It provides various network statistics, such as network connections, routing tables, interface statistics, masquerade connections, and multicast memberships.
- The information provided by netstat can be helpful in troubleshooting network issues, monitoring network activity, and understanding the network configuration of a system.
- **This(netstat) is useful if you want to know which ports the kube-scheduler process is using at the host level, outside of Kubernetes.**

### -nplt

- **-n:** This option tells netstat to **show numerical addresses** instead of resolving them to hostnames. It displays IP addresses and port numbers as numbers, which can be helpful for scripting or when you don't need hostname resolution.
- **-p:** This option is used to **display the PID (Process ID)** and the name of the program or process associated with each network connection or listening port. It shows which program is using a particular network resource.
- **-l:** This option instructs netstat to **only display listening sockets**, i.e., ports on which a service or process is actively listening for incoming connections. Listening sockets are essential for services like web servers, databases, and other network services to accept incoming requests.
- **-t:** This option filters the output to **only show TCP connections** and listening ports. TCP (Transmission Control Protocol) is a connection-oriented protocol used for reliable data transmission over networks.

So, when you combine these options into netstat -nplt, you're asking netstat to display

- numerical addresses (-n)
- show the associated process with each port (-p)
- list only listening sockets (-l)
- focus on TCP connections and listening ports (-t).

This command is commonly used for network troubleshooting and monitoring to identify which processes are listening on which TCP ports on your system.

 when to use netstat and when to look for ports using 'kubectl describe pod' command?

When you're working with Kubernetes clusters, especially in troubleshooting or inspecting networking aspects, there are different commands and tools you use depending on what information you need and where you need to gather it from.

- **netstat:** This is a command-line tool used for inspecting network-related information on a host machine, such as listening ports, active connections, and network interfaces. When you run netstat -nplt, you're asking the host machine directly to show you all listening TCP ports (-t for TCP) along with their associated processes (-p) in numeric format (-n). This command gives you insights into which processes are listening on which ports on the host machine.
- **kubectl describe pod:** This is a Kubernetes command used to get detailed information about Kubernetes objects, including pods. When you run kubectl describe pod kube-scheduler-controlplane -n kube-system, you're asking Kubernetes to describe the specified pod (kube-scheduler-controlplane in the kube-system namespace). This command provides you with details about the pod itself within the Kubernetes environment, such as its status, events, labels, and other metadata managed by Kubernetes.

Now, let's relate these commands to your scenario:

#### netstat Command:

When you run netstat -nplt, you're checking the host machine (which could be your control plane node) to see if the kube-scheduler process is listening on any specific ports directly on the host machine itself. This is useful if you want to know which ports the kube-scheduler process is using at the host level, outside of Kubernetes.

- kubectl describe Command: When you run kubectl describe pod kube-scheduler-controlplane -n kube-system, you're querying Kubernetes to get detailed information about the kube-scheduler pod specifically running within your Kubernetes cluster.
- This command is used to understand the status, configuration, and other Kubernetes-related details of the kube-scheduler pod managed by Kubernetes.

In summary, netstat is for host-level network diagnostics outside of Kubernetes, while kubectl describe is for Kubernetes-specific information about pods and other resources managed by Kubernetes within the cluster.

 Notice that ETCD is listening on two ports. Which of these have more client connections established?

Correct! That's because 2379 is the port of ETCD to which all control plane components connect to. 2380 is only for etcd peer-to-peer connectivity. When you have multiple controlplane nodes. In this case we don't.

Here is a sample result:

```
root@controlplane:~# netstat -anp | grep etcd | grep 2380 | wc -l
1
root@controlplane:~#
root@controlplane:~#
root@controlplane:~# netstat -anp | grep etcd | grep 2379 | wc -l
81
root@controlplane:~#
```

**Important Note** The count you see in this example may change for your lab, so make sure to check for yourself.

#### wc -l

The wc -l command is used to count the number of lines in a file or output. The -l option specifically tells the wc (word count) command to count lines. So, when you run wc -l, it will count the lines in the input provided to it and display the count. For example, if you run wc -l file.txt, it will count the lines in the file named file.txt.

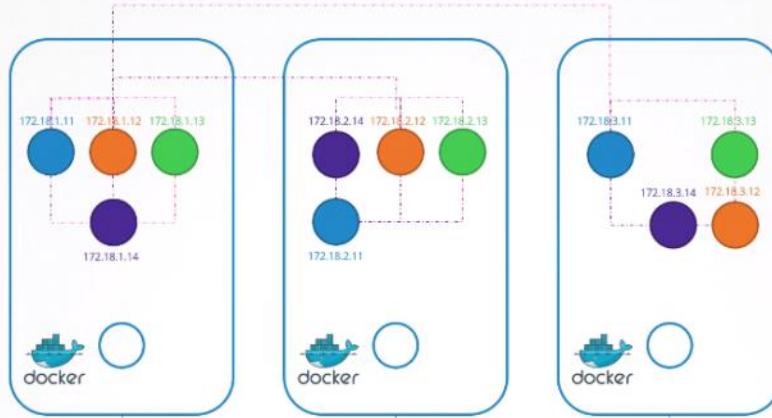
# Pod Networking

Thursday, March 7, 2024 3:08 PM

Github - Saiyam - Networking

## Networking Model

- Every POD should have an IP Address
- Every POD should be able to communicate with every other POD in the same node.
- Every POD should be able to communicate with every other POD on other nodes without NAT.



# Networking Model

```
▶ ip link add v-net-0 type bridge
```

```
▶ ip link set dev v-net-0 up
```

- ❑ Every POD should have an IP Address
- ❑ Every POD should be on the same node.
- ❑ Every POD should be able to communicate with every other POD on other nodes without NAT.

```
▶ ip link add veth-red type veth peer name veth-red-br
```

```
▶ ip link set veth-red netns red
```

```
▶ ip -n red addr add 192.168.15.1 dev veth-red
```

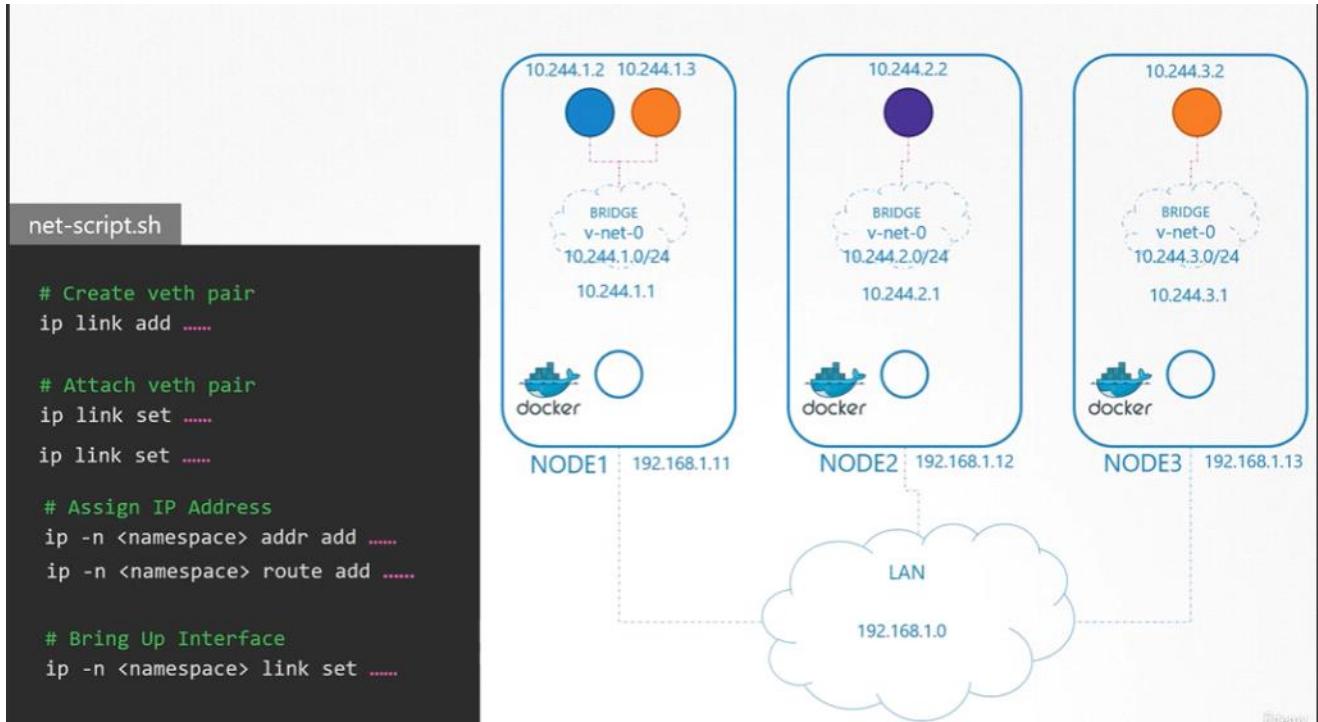
```
▶ ip -n red link set veth-red up
```

```
▶ ip link set veth-red-br master v-net-0
```

```
▶ ip netns exec blue ip route add 192.168.1.0/24 via 192.168.15.5
```

```
▶ iptables -t nat -A POSTROUTING -s 192.168.15.0/24 -j MASQUERADE
```





### Pod Networking Challenges:

- Kubernetes doesn't come with a built-in solution for pod networking.
- Users are expected to implement a networking solution to address challenges related to pods, their addresses, communication, and service access.

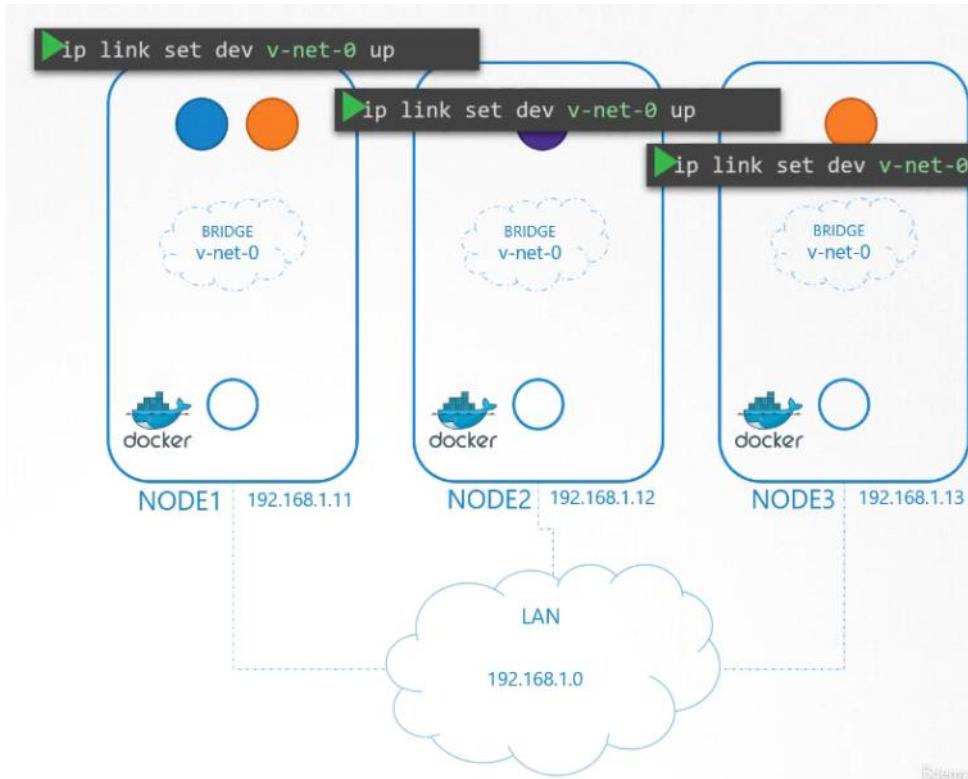
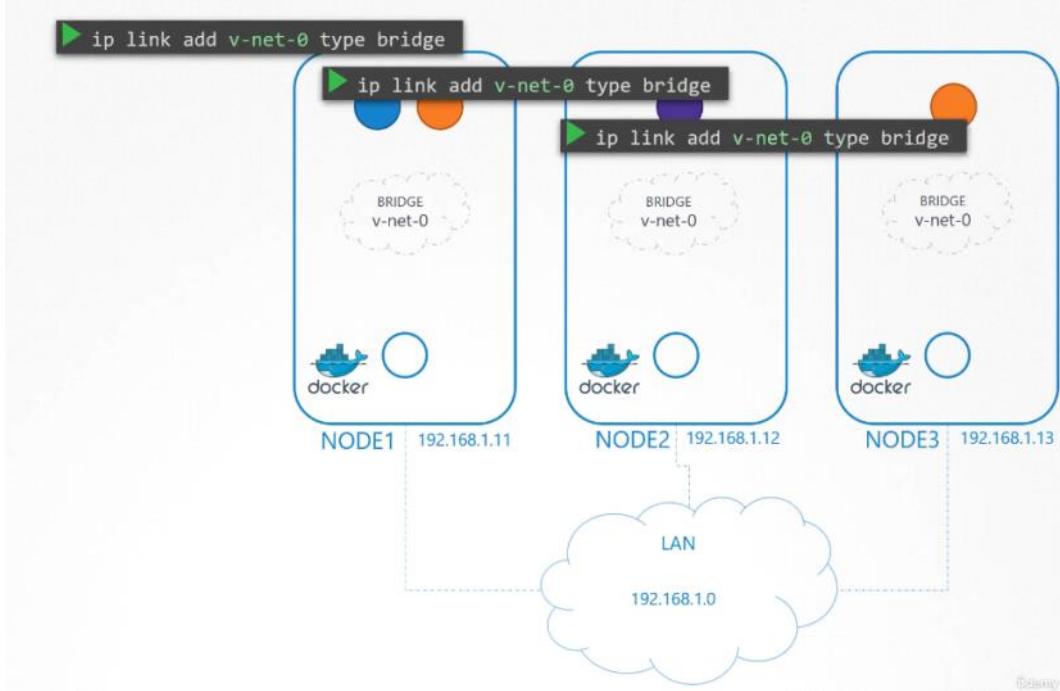
### Pod Networking Requirements:

- Kubernetes expects each pod to have a unique IP address.
- Pods should be able to communicate within the same node and across nodes using these IP addresses.
- No specific IP range or subnet is mandated; it's up to the user to implement a solution that automatically assigns IPs and establishes connectivity.

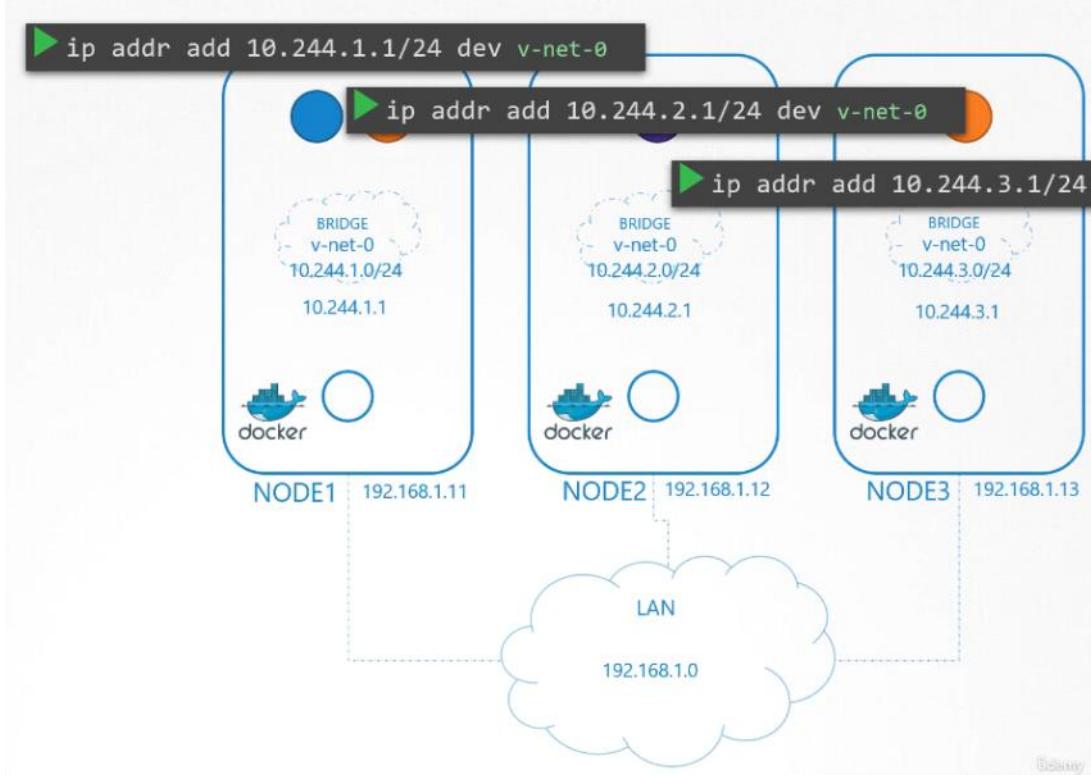
### Solution 1:

**Phase 1 - The pods all get their own unique IP address and are able to communicate with each other on their own nodes.**

- The nodes are part of an external network, so their IP addresses will be in the LAN range. In this case, the LAN has IP addresses in the range of 192.168.1.0, so the nodes will have IP addresses in the range of 192.168.1.11-13.



- Next step, when containers are created, Kubernetes creates network name spaces for them. To enable communication between them, we attach these namespaces to a bridge network, bridge networks are created within nodes to attach namespaces. So we create a bridge network on each node and then bring them up.
- Next, we will assign IP address to the bridge networks. Choose any private address range.



- The next step will be performed for each container, so it's better to write a script file and run in each container.
  - a. First, Attach a container to the network, we need a pipe or a virtual network cable. Use **ip link add** command.
  - b. Then, Attach one end to the container and another end to the bridge using the **ip link set** command. We then assign IP address using the ip addr command and add a route to the default gateway.
  - c. Finally, we bring up the interface.
  - d. We then run the above script for 2nd container with its information.

```
net-script.sh

Create veth pair
ip link add

Attach veth pair
ip link set
ip link set

Assign IP Address
ip -n <namespace> addr add
ip -n <namespace> route add

Bring Up Interface
ip -n <namespace> link set
```

**Phase 2 - The next part is to enable them to reach other pods on other nodes.**

- As of now, The blue pod has no idea where is the purple pod as purple pod is on different node with a private IP address.

```
▶ bluepod$ ping 10.244.2.2
```

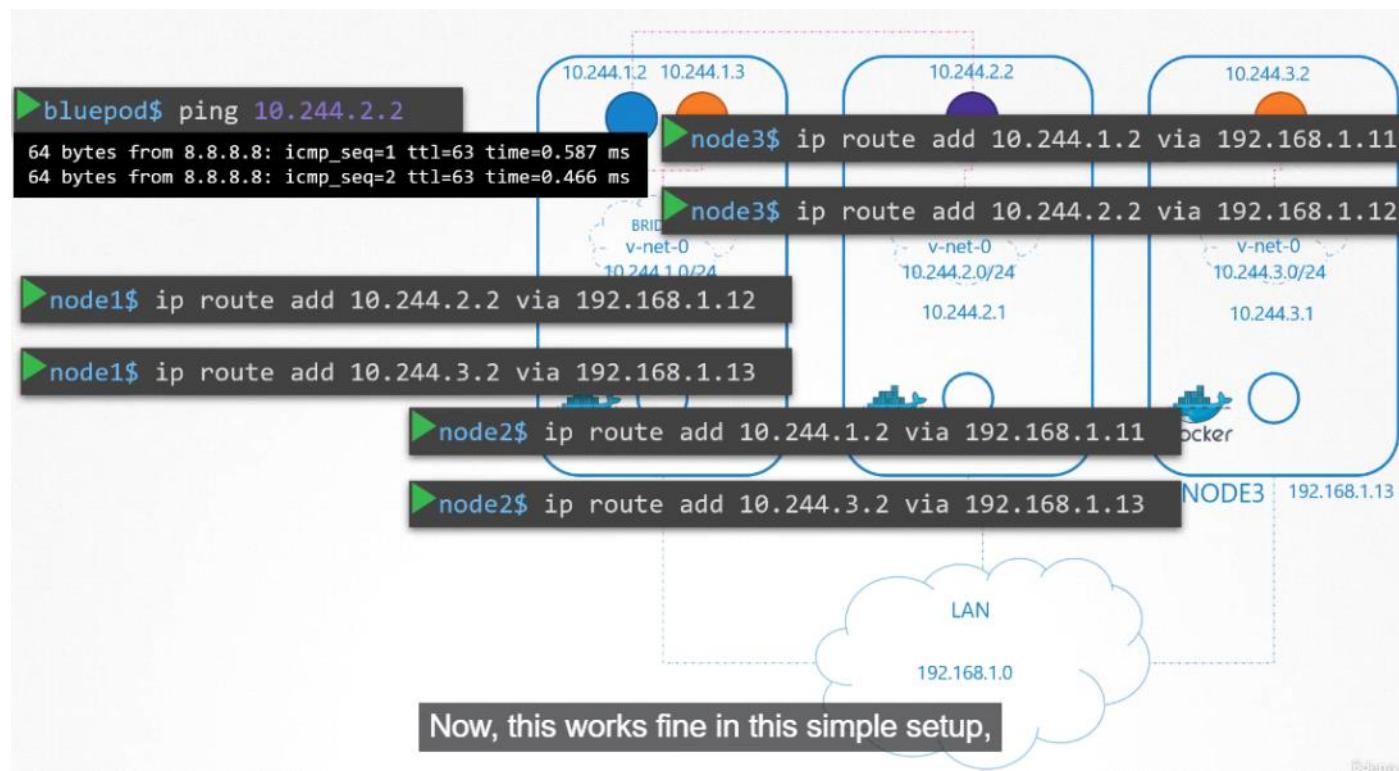
Connect: Network is unreachable

- Add a route to node1's routing table to route traffic to 10.244.2.2 where the node2's IP at 192.168.1.12.

```
▶ node1$ ip route add 10.244.2.2 via 192.168.1.12
```

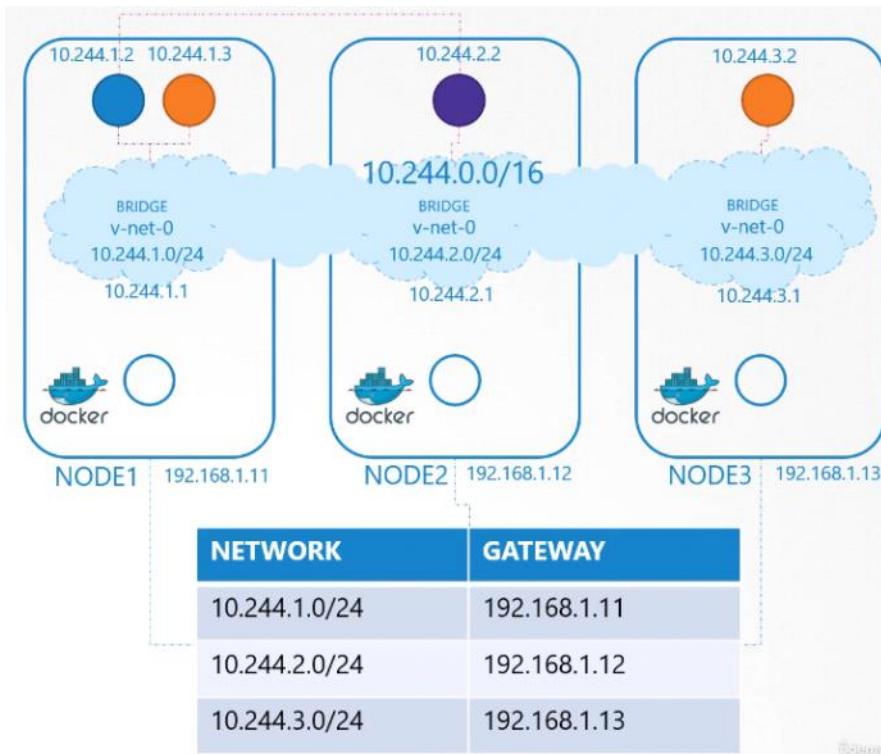
- Once the route is added the blue pod is able to ping.

Similarly we configure route on all the hosts(pods) to all the other hosts with this information.



Since you've already configured Phase 1, where pods on the same node can communicate with each other using their unique IP addresses, you don't need to add a route from the purple pod to both the orange and blue pods. You just need to ensure that the routing within each node is correctly set up so that pods on the same node can communicate internally without additional routing configurations between them.

## Solution 2



#### Using a Router for Routing:

- Instead of configuring routes individually on each server, it's better to set up routing on a router if you have one in your network.
- You can make all hosts use the router as their default gateway, making it easier to manage routes for different networks in the router's routing table.
- The router is related to the cluster, not to individual nodes. It's responsible for routing packets between nodes within the cluster and also between the cluster and external networks, such as the internet or other network segments.

#### Creating a Single Large Network with a Router:

- By setting up routing on a router, the individual virtual networks with addresses like 10.244.1.0/24 on each node can be combined into a single large network with the address 10.244.0.0/16.
- In the case of 10.244.1.0/24, the first 24 bits are dedicated to the network, leaving 8 bits for host addresses, which allows for 254 host addresses in that network.
- A /16 subnet mask means that the first 16 bits are used for the network, providing a significantly larger address space for host addresses compared to a /24 subnet.

#### Automating Steps with Scripts:

- Initially, manual steps were performed to prepare the environment, including setting up bridge networks and routing tables.
- A script was created to automate the process of connecting containers to the network, which was executed manually for each container.

### Automating Script Execution with CNI:

- To avoid manual execution in large environments with many containers being created frequently, the Container Network Interface (CNI) comes into play.
- CNI tells Kubernetes how to run a script automatically whenever a container is created, simplifying the process and ensuring consistency.

```
net-script.sh
ADD)
Create veth pair
Attach veth pair
Assign IP Address
Bring Up Interface
ip -n <namespace> link set

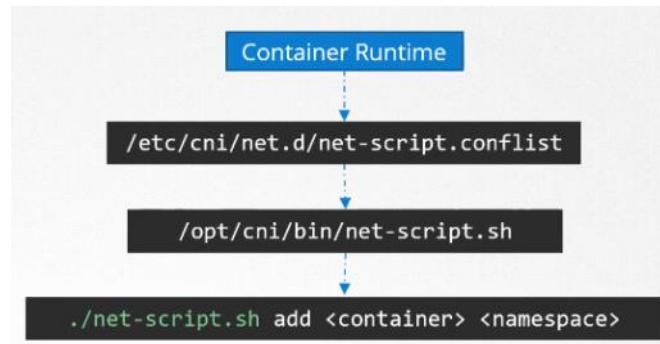
DEL)
Delete veth pair
ip link del
```

### Modifying the Script for CNI:

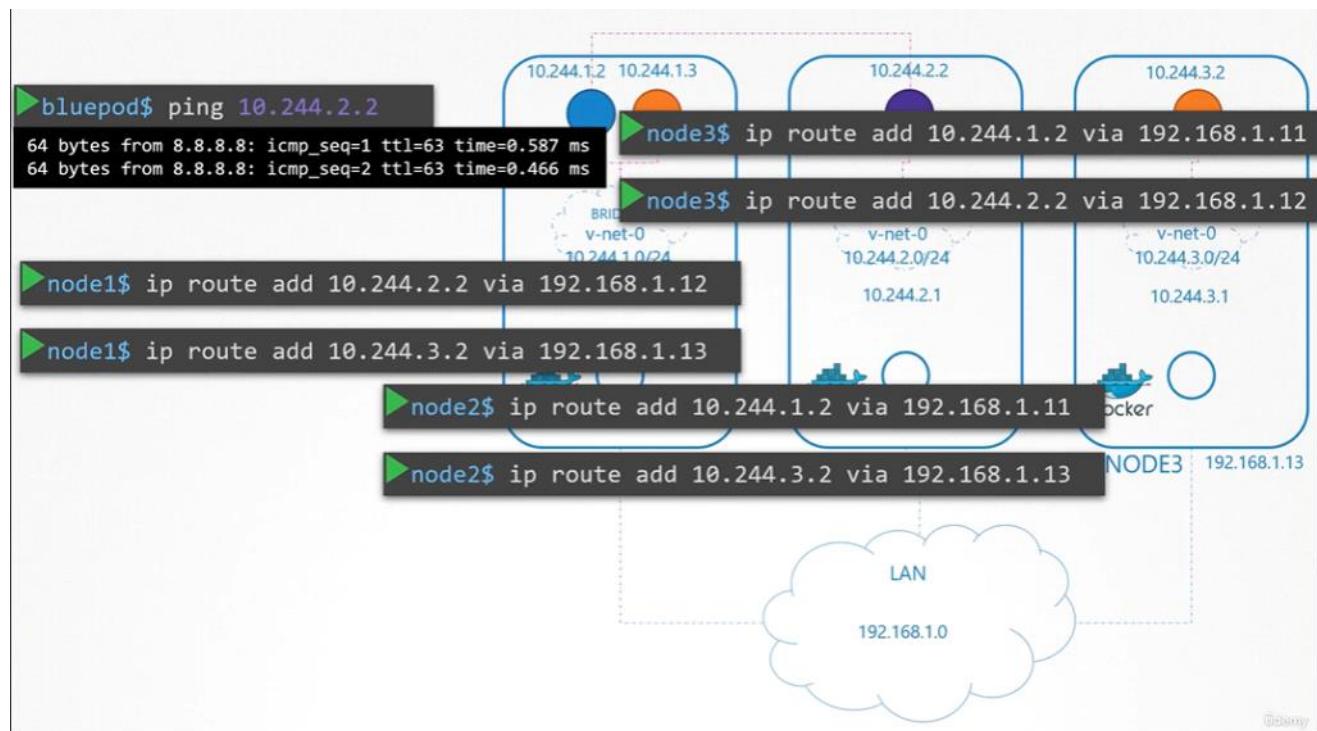
- The script needs to be modified to meet CNI standards, including an "add" section to add a container to the network and a "delete" section to remove container interfaces and to free the IP addresses when a container is deleted.

### Container Runtime and CNI Execution:

- The container runtime on each node is responsible for creating containers.
- Whenever a container is created, the container runtime looks at the CNI configuration passed as a command line argument when it was run and identifies our script's name.
- It then looks in the CNIs bin directory to find our script and then executes the script with the add command and the name and namespace ID of the container, and then our script takes care of the rest.



How does this commands work ..i mean how we can connect two networks 10.22.2.2 via 192.168.1.12



X



## CONTAINER NETWORK INTERFACE (CNI)

net-script.sh

```
ADD)
Create veth pair
Attach veth pair
Assign IP Address
Bring Up Interface
ip -n <namespace> link set

DEL)
Delete veth pair
ip link del
```

Container Runtime

/etc/cni/net.d/net-script.conflist

/opt/cni/bin/net-script.sh

./net-script.sh add <container> <namespace>

Octoby

# CNI - Kubernetes

Thursday, March 7, 2024 6:14 PM



**CONTAINER NETWORK INTERFACE**

- ✓ Container Runtime must create network namespace
- ✓ Identify network the container must attach to
- ✓ Container Runtime to invoke Network Plugin (bridge) when container is ADDED.
- ✓ Container Runtime to invoke Network Plugin (bridge) when container is DELETED.
- ✓ JSON format of the Network Configuration

Container Runtime = Kubernetes, Mesos, CRI-O

CNI stands for Container Network Interface. It's like a middleman that helps containers in a Kubernetes cluster connect to the network. When a container is created, CNI tells Kubernetes how to run a script automatically that sets up the container's network connection. This makes it easier to manage networking for containers and ensures they can communicate with each other and with external networks as needed.

?

**Where do we specify the CNI plugins for k8s to be used?**

The CNI plugin is configured in the kubelet service on each node in the cluster.

kubelet because kubelet is the one responsible for creating containers and then kubelet invokes the appropriate network plugin.

# Configuring CNI

```
kubelet.service
ExecStart=/usr/local/bin/kubelet \\
--config=/var/lib/kubelet/kubelet-config.yaml \\
--container-runtime=remote \\
--container-runtime-endpoint=unix:///var/run/containerd/containerd.sock \\
--image-pull-progress-deadline=2m \\
--kubeconfig=/var/lib/kubelet/kubeconfig \\
--network-plugin=cni \\
--cni-bin-dir=/opt/cni/bin \\
--cni-conf-dir=/etc/cni/net.d \\
--register-node=true \\
--v=2
```

or

## View kubelet options

```
ps -aux | grep kubelet
root 2095 1.8 2.4 960676 98788 ? Ssl 02:32 0:36 /usr/bin/kubelet --bootstrap-
kubeconfig=/etc/kubernetes/bootstrap-kubelet.conf --kubeconfig=/etc/kubernetes/kubelet.conf --
config=/var/lib/kubelet/config.yaml --cgroup-driver=cgroupfs --cni-bin-dir=/opt/cni/bin --cni-
conf-dir=/etc/cni/net.d --network-plugin=cni
```

- ps: Short for "process status," it's a command used to view information about processes.
- -aux: Options that modify the output of the ps command:
  - a: Shows information about all users' processes.
  - u: Displays a detailed output, including the user who owns each process.
  - x: Includes processes that are not attached to a terminal.

CNI bin directory has all the plugins as executables.

```
ls /opt/cni/bin
bridge dhcp flannel host-local ipvlan loopback macvlan portmap ptp sample tuning
vlan weave-ipam weave-net weave-plugin-2.2.1
```

CNI config directory has a set of configuration files. This is where kubelet looks to find out which plugin needs to be used.

```
ls /etc/cni/net.d
10-bridge.conf
```

If there are multiple files here it will choose the one in alphabetical order.

```
▶ ls /etc/cni/net.d
10-bridge.conf

▶ cat /etc/cni/net.d/10-bridge.conf
{
 "cniVersion": "0.2.0",
 "name": "mynet",
 "type": "bridge",
 "bridge": "cni0",
 "isGateway": true,
 "ipMasq": true,
 "ipam": {
 "type": "host-local",
 "subnet": "10.22.0.0/16",
 "routes": [
 { "dst": "0.0.0.0/0" }
]
 }
}
```

This file contains the information such as

|                                   |                                                                                                                                                |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Name (Name)                       | The name of the CNI plugin, in this case, "MyNet."                                                                                             |
| Type (Type)                       | Specifies the type of network configuration, such as "bridge" for a bridged network.                                                           |
| Gateway (IS Gateway)              | Defines whether the bridge network should have an IP address assigned to it to act as a gateway for network traffic.                           |
| IP Masquerade (IP Masquerade)     | Determines if a NAT (Network Address Translation) rule should be added for IP masquerading, allowing internal IPs to access external networks. |
| IPAM (IPAM Section):              | IP Address Management configuration, specifying the subnet or range of IP addresses assigned to pods and any necessary routes.                 |
| Type Host Local (Type host local) | Indicates that IP addresses are managed locally on the host system, as opposed to being managed remotely by a DHCP server.                     |
| Type DSCP (Type DSCP)             | An alternative type that can be set to configure an external DHCP server for managing IP addresses.                                            |

## Masquerade

Masquerade means false

What is IP Masquerading?

IP masquerading, also known as Network Address Translation (NAT), is a technique used to allow devices with private IP addresses to access the internet or other external networks using a single public IP address. It's commonly used in home and small office networks to share a single internet connection among multiple devices.

How Does IP Masquerading Work?

Imagine you have a small office network with several computers and devices (e.g., laptops, smartphones, printers) connected to a router. Each device on the network is assigned a private IP address from a reserved range, such as 192.168.1.0/24. The router, which connects the local network to the internet, has a public IP address assigned by the internet service provider (ISP).

Internal Communication:

Devices within the local network communicate with each other using their private IP addresses (e.g., 192.168.1.2, 192.168.1.3).

Accessing External Networks:

When a device on the local network wants to access the internet or communicate with a server on an external network (e.g., a website), it sends a request.

The request includes the device's private IP address as the source IP address.

IP Masquerading Process:

The router, which supports IP masquerading, intercepts the outgoing request from the device.

It replaces the source IP address in the request with its own public IP address (assigned by the ISP).

The router then forwards the modified request to the external network.

Response Handling:

When the external network sends a response back to the router's public IP address, the router remembers which device within the local network made the original request.

It receives the response and performs the reverse operation, replacing its public IP address with the corresponding private IP address of the device.

The router forwards the response to the correct device within the local network based on its internal routing table.

Example:

Device Request:

A laptop (IP address: 192.168.1.2) on the local network wants to access a website (e.g., [www.example.com](http://www.example.com)).

IP Masquerading Action:

The laptop sends a request with its private IP address (192.168.1.2) to the router.

The router, using IP masquerading, replaces the source IP address with its public IP address (e.g., 203.0.113.1) and forwards the request to the website.

Website Response:

The website responds to the router's public IP address (203.0.113.1) with the requested web page.

The router receives the response, replaces its public IP address with the laptop's private IP address (192.168.1.2), and forwards the response to the laptop.

Result:

The laptop successfully accesses the website and receives the web page.

The external network only sees communication coming from the router's public IP address, maintaining the privacy of devices within the local network.

In summary, IP masquerading allows devices with private IP addresses to communicate with external networks using a shared public IP address, managed by a router or gateway device. It facilitates internet access and communication for devices within local networks while maintaining security and privacy.

Port forwarding, VPN, Proxy Servers are the other alternatives for Masquerading.

# CNI Weave

Thursday, March 7, 2024 6:44 PM

Weaveworks - Weave CNI Plugin

Install using -

```
kubectl apply -f https://github.com/weaveworks/weave/releases/download/v2.8.1/weave-daemonset-k8s.yaml
```

How do we deploy Weave on a Kubernetes cluster?

- The Weave CNI plugin is deployed on a cluster, it deploys an agent or service on each node.
- Weave and Weave Peers can be deployed as services or daemons on each node in the cluster manually.
- If Kubernetes is set up already, then an easier way to do that is to deploy it as pods in the cluster.

## Weaveworks

Weaveworks is CNI (Container Network Interface) plugin.

Problems:

In larger environments with hundreds of nodes in a cluster and hundreds of pods on each node, It is not practical to have so many entries on the routing table.

Weaveworks Weave CNI Solution:

- Weaveworks Weave CNI plugin is THE solution FOR ABOVE PROBLEM.
- It deploys an agent or service on each node in the Kubernetes cluster.
- These agents communicate with each other, exchanging information about nodes, networks, and pods.
- Each agent has information about the entire cluster setup, so agents have information about pods of other nodes and IP of those pods.

- Weave creates its own bridge on the nodes and names at Weave, then assigns IP address to each network.

#### Weave Encapsulation and Routing:

- What path a packet takes to reach its destination depends on the route configured on the container. Weave makes sure that pods get the correct route configured to reach the agent, and the agent then takes care of other pods.
- Weave ensures that pods get the correct route configured to reach the agent.
- When a packet is sent from one pod to another on a different node, Weave intercepts the packet, encapsulates it into a new one with new source and destination information, and routes it across the network.

#### Deployment of Weave on Kubernetes:

- Weave and Weave Peers can be deployed as services or daemons on each node manually. Alternatively, if Kubernetes cluster is setup already, they can be deployed as pods using a simple kubectl apply command.
- The Weave peers are deployed as a daemon set, ensuring that one pod of the given kind is deployed on all nodes in the cluster.

#### Troubleshooting and Logs:

- For troubleshooting purposes, the lecture suggests using the kubectl logs command to view the logs of Weave peers deployed as pods on each node.

#### Deployment with kubeadm and Weave Plugin:

- If the Kubernetes cluster is set up with the Kubeadm tool and the Weave plugin, Weave peers can be observed as pods deployed on each node.

## lab 2

Thursday, April 25, 2024 12:19 PM

- ?
- Inspect the kubelet service and identify the container runtime endpoint value is set for Kubernetes.

Run

```
ps -aux | grep kubelet
```

and search for container runtime endpoint field in the last.

What is container runtime endpoint ?

- ?
- What is the path configured with all binaries of CNI supported plugins?

So all of the plug-ins are going to be stored in /opt/cni/bin.

- ?
- What is the CNI plugin configured to be used on this kubernetes cluster?

Run the command:

```
ls /etc/cni/net.d/ and identify the name of the plugin.
```

- ? What binary executable file will be run by kubelet after a container and its associated namespace are created?

Look at the type field in file /etc/cni/net.d/10-flannel.conflist.

```
controlplane /opt/cni/bin → cat /etc/cni/net.d/10-flannel.conflist
{
 "name": "cbr0",
 "cniVersion": "0.3.1",
 "plugins": [
 {
 "type": "flannel",
 "delegate": {
 "hairpinMode": true,
 "isDefaultGateway": true
 }
 },
 {
 "type": "portmap",
 "capabilities": {
 "portMappings": true
 }
 }
]
}
```

type : flannel

# lab 3

Saturday, May 11, 2024 12:15 PM

k logs = Use this for viewing the logs when container is running

wget vs curl

## Deploy a weave-net networking solution to the cluster.

1. go to "Installaing Addons" on the k8s doc.
2. download the yaml file using wget
3. You can directly run kubectl apply -f <yaml file> but if "--cluster-cidr" option is set on the kube-proxy, make sure it mache the IPALLOC\_RANGE given to Weave Net.
  - a. Check the kube-proxy using "kubectl get pods -n kube-system" and then "kubectl describe <kube-proxy-pod>".
  - b. Check for config

```
Port: <none>
Host Port: <none>
Command:
 /usr/local/bin/kube-proxy
 --config=/var/lib/kube-proxy/config.conf
 --hostname-override=$(NODE_NAME)
State: Running
Started: Thu, 27 Apr 2023 13:22:12 -0400
```

config path is set to /var/lib/kube-proxy/config.conf

```
NODE_NAME: (v1:spec.nodeName)
Mounts:
 /lib/modules from lib-modules (ro)
 /run/xtables.lock from xtables-lock (rw)
 /var/lib/kube-proxy from kube-proxy (rw)
 /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-hbsc9 (ro)
Conditions:
```

Check the mount section to locate the /var/lib/kube-proxy , found that it comes from kube-proxy volume.

```
Volumes:
 kube-proxy:
 Type: ConfigMap (a volume populated by a ConfigMap)
 Name: kube-proxy
 Optional: false
```

Found that kube-proxy volume is a ConfigMap.

Run "kubectl get cm -n kube-system" to verify.

Run "kubectl describe cm kube-proxy -n kube-system"

```
kubeconfig: /var/lib/kube-proxy/kubeconfig.conf
qps: 0
clusterCIDR: 10.244.0.0/16
configSyncPeriod: 0s
conntrack:
 maxPerCore: null
```

c. clusterCIDR is configured and set to 10.244.0.0/16

4. Vim into the yaml file for weave and add an option as following in container section.

```
containers:
- name: weave
 env:
 - name: IPALLOC_RANGE
 value: 10.0.0.0/16
```

```
containers:
- name: weave
 command:
 - /home/weave/launch.sh
 env:
 - name: IPALLOC_RANGE
 value: 10.244.0.0/16
 - name: INIT_CONTAINER
```

5. Save the file.

6. Run "kubectl apply -f <yaml-file>.

# IPAM

Thursday, March 7, 2024 6:59 PM

How are the virtual bridge networks in the nodes assigned an IP subnet and how are the pods assigned an IP?

- CNI says, it is the responsibility of the CNI plugin the network solution provider to take care of assigning IP's to the containers.

## Solution 1

CNI comes with two built-in plug-ins to which you can outsource the task of making sure that we don't assign any duplicate IP's and manage it properly.

e.g. host\_local() plugin

```
Invoke IPAM host-local plugin
ip = get_free_ip_from_host_local()

Assign IP Address
ip -n <namespace> addr add
ip -n <namespace> route add
```

- We need to invoke that plugin in the script file.

## Solution 2

- to support different kinds of plugins we can make our script dynamic using IPAM(IP Address Management)
- The CNI configuration file has a section called IPAM in which we can specify the type of plugin to be used, the subnet and route to be used.

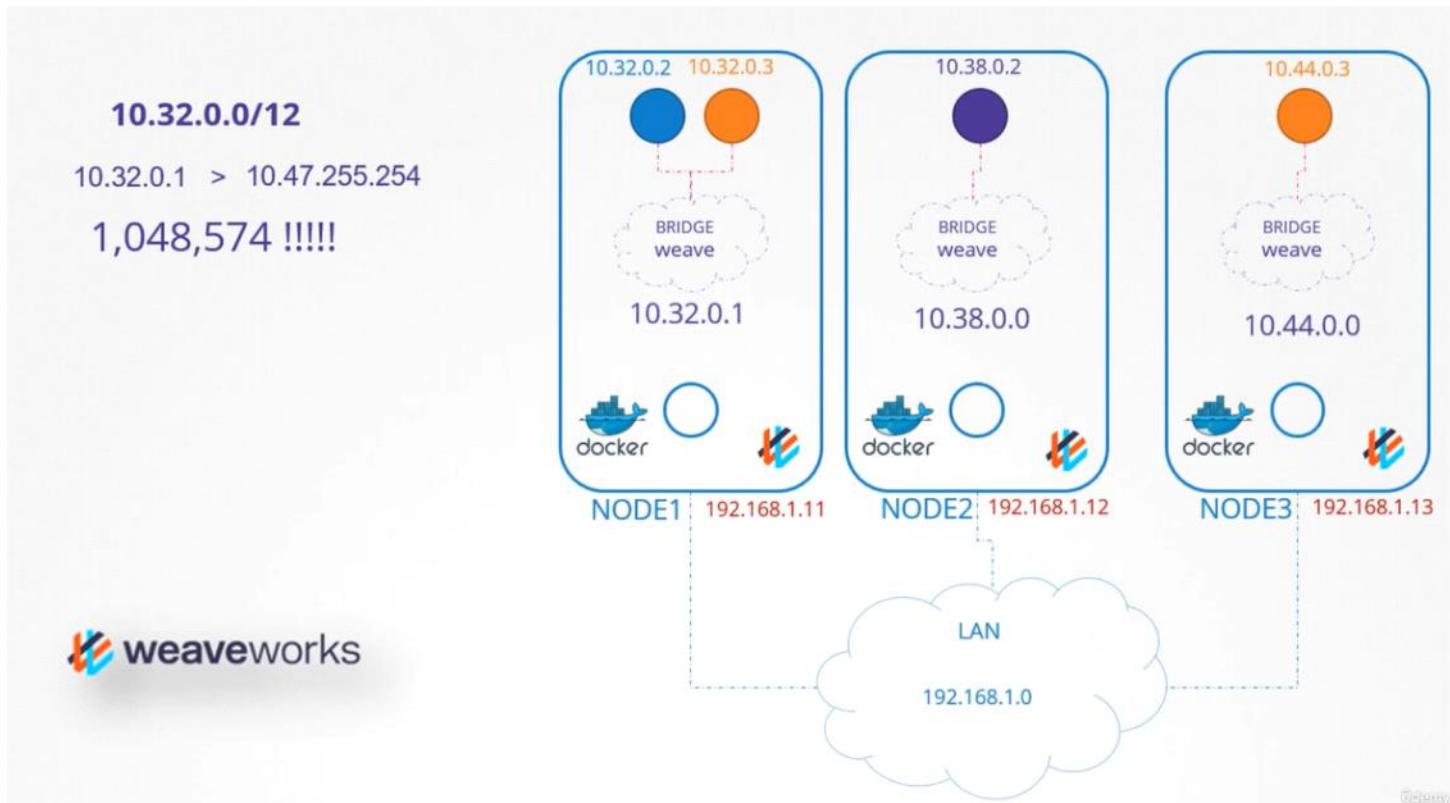


## CONTAINER NETWORK INTERFACE (CNI)

DHCP    host-local

```
▶ cat /etc/cni/net.d/net-script.conf
{
 "cniVersion": "0.2.0",
 "name": "mynet",
 "type": "net-script",
 "bridge": "cni0",
 "isGateway": true,
 "ipMasq": true,
 "ipam": {
 "type": "host-local",
 "subnet": "10.244.0.0/16",
 "routes": [
 { "dst": "0.0.0.0/0" }
]
 }
}
```

- Weave, by default, allocates the IP range 10.32.0.0/12 for the entire network.
- That gives the network IP's from range 10.32.0.1 to 10.47.255.254.
- From this range, the peers decide to split the IP addresses equally between them and assigns one portion to each node.



Responsibility for IP Address Assignment:

According to CNI (Container Network Interface) standards, the responsibility for assigning IP addresses to containers lies with the CNI plugin, which is the network solution provider.

Managing IP Addresses in CNI Plugins:

The lecture refers to the basic plugin created earlier, where IP addresses were assigned within the plugin. The instructor emphasizes the importance of managing IP addresses properly to avoid duplicates. Storing the list of IPs in a file on each host is suggested.

Built-in IPAM Plugins in CNI:

CNI comes with two built-in IPAM (IP Address Management) plugins, and one of them is the host local plugin. This plugin follows the approach of managing IP addresses locally on each host. It is the responsibility of the script to invoke the IPAM plugin, and the CNI configuration file includes an IPAM section specifying the type of plugin, subnet, and route.

Dynamic Scripting and Plugin Invocation:

Instead of hard-coding the use of a specific IPAM plugin like host local in the script, the lecture suggests making the script dynamic to support different plugins. The details of the IPAM plugin can be read from the CNI configuration file, making the script adaptable to various network solution providers.

#### Weaveworks IP Address Management:

The lecture provides insights into how Weaveworks manages IP addresses. Weave, by default, allocates the IP range 10.32.0.0/12 for the entire network, offering a million IPs for pods. Peers split the IP addresses equally between them, and pods on each node receive IP addresses from this range. These ranges are configurable during the deployment of the Weave plugin.

#### Configurability of IP Ranges in Weave:

Weave allows the configuration of IP ranges with additional options during plugin deployment, offering flexibility in defining the IP address space for the network.

The learners are encouraged to explore IPAM in the Weave CNI plugin through practice tests. Overall, the lecture provides insights into how IP addresses are managed within Kubernetes, with a focus on flexibility, configurability, and the role of CNI plugins in the process.

# lab 4

Friday, May 17, 2024 11:33 PM

- ? What is the Networking Solution used by this cluster?

Check the config file located at /etc/cni/net.d/

**cat /etc/cni/net.d/10.weave.conf**

view under the plugin section.

- ? How many weave agents/peers are deployed in this cluster?

Run the command kubectl get pods -n kube-system and count weave pods

- ? Identify the name of the bridge network/interface created by weave on each node.

The bridge network/interface created by Weave on each node typically has a name that starts with "weave" followed by a unique identifier. For example, it might be named something like "weave-abc123" where "abc123" is a unique identifier generated by Weave.

To ensure that the "weave" interface you see when running the "ip add" command is indeed the bridge network created by Weave and not any other interface, you can follow these steps:

Check Interface Details:

Run the command ip add or ip a to list all network interfaces on the node.

Look for an interface with a name starting with "weave" (e.g., weave-abc123).

## Verify Type:

Once you identify the "weave" interface, check its type using the command `ip link show weave-abc123`. The output should indicate that it is a "bridge" type interface, confirming that it is indeed the bridge network created by Weave.

## Look for Weave-Specific Details:

Weave may also add specific details or labels to the interface name or description that indicate it is associated with Weave's networking solution.

For example, the interface description might mention "Weave" or include specific Weave-related information.

By examining the interface details, type, and any specific identifiers or labels associated with it, you can confidently identify the "weave" interface as the bridge network created by Weave on the node.

## ★ **nodeName**

Adding a `nodeName` section in the "spec" of a Kubernetes pod's configuration will ensure that the pod is deployed on a specific node.

```
apiVersion: v1
kind: Pod
metadata:
 name: my-pod
spec:
 nodeName: specific-node
 containers:
 - name: my-container
 image: nginx
```

## ★ **Gateway**

- A gateway is a network device or software component that serves as an entry point or exit point between different networks.
- It facilitates communication between devices on one network and devices on another network,

- such as connecting a local network to the internet
- It directs traffic between networks, handles routing decisions, and enables devices to communicate across network boundaries.

In networking terminologies, the term "gateway" refers to both the concept of a network gateway and an actual IP address that serves as the gateway for a network.

When we refer to the "default gateway" in networking, we usually refer to an IP address that represents the device or point through which network traffic exits the local network to reach external networks.

This IP address is assigned to a specific networking device, such as a router or firewall, within a network. The gateway IP address is configured on this device, indicating that it serves as the gateway for that network.

Example:

Consider a small office network with multiple computers, printers, and a router serving as the gateway to the internet:

- The gateway device (router) has a public IP address assigned by the ISP and a private IP address within the local network.
- Devices within the office network have private IP addresses (e.g., 192.168.1.0/24) assigned by the router.
- When a computer in the office network accesses a website on the internet, the gateway (router) forwards the request, translates the source IP address of the request to its public IP address using NAT, and routes the response back to the requesting computer.

## Switch

switch is a networking device that connects multiple devices within the local network

When a computer in the office network wants to communicate with another device in the same network (e.g., send a file to a printer), it sends data packets addressed to the destination device's IP address.

The switch receives these data packets and uses its internal logic to forward the packets only to the port where the destination device is connected. This ensures that the data reaches the intended device and not all devices on the network.

Switches use MAC addresses (Media Access Control addresses) to determine the physical addresses of devices connected to each of their ports.

? What is the default gateway configured on the PODs scheduled on node01?

"Suppose I have created a busybox container running busybox pod. Why do I need to run **kubectl exec busybox -- ip route** to check the default gateway. What happen if I run **ip route** command

*directly on the node and not inside the pod, explain in short."*

When you run **kubectl exec busybox -- ip route** inside a pod (such as the busybox pod), it shows the routing table specific to that pod, including the default gateway used by the pod to route traffic outside the cluster.

If you run the **ip route** command directly on the node (outside the pod), you will see the routing table for the entire node, including routes for all pods running on that node. However, you won't see the specific default gateway used by an individual pod. The routing table at the node level provides information about how traffic is routed for all pods on that node, but it doesn't isolate the routing information for a single pod like the kubectl exec busybox -- ip route command does within the pod itself.

```
controlplane /etc/cni/net.d → kubectl exec busybox -- ip route
default via 10.244.192.0 dev eth0
10.244.0.0/16 dev eth0 scope link src 10.244.192.1
```

- ?
- What is the pod IP range configured by weave?

```
run kubectl get pods -n kube-syste
run kubectl logs <any-weave-pod-name> command
search for ipalloc-range option
```

# OSI Model

Sunday, May 19, 2024 12:41 PM

## **Application Layer (Layer 7):**

- The application layer provides network services directly to user applications. It enables communication and interaction between software applications and the network.
- Protocols and services at this layer include HTTP (Hypertext Transfer Protocol), FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), and DNS (Domain Name System), among others.
- For example, web browsers, email clients, and file transfer applications operate at the application layer to communicate over the network.

## **Presentation Layer (Layer 6):**

- The presentation layer is responsible for data translation, encryption, and decryption to ensure that data sent by one device can be understood by the receiving device.
- It formats data in a way that applications can interpret and handles data encryption and decryption for secure communication.
- For instance, the presentation layer may encrypt sensitive data before transmission and decrypt it upon reception.

## **Session Layer (Layer 5):**

- The session layer manages and establishes communication sessions between devices. It handles the coordination of data exchange and manages dialogues between applications.
- For example, when a user opens a web browser (client) and connects to a web server (server), the session layer establishes and manages the communication session between the client and server.

## **Transport Layer (Layer 4):**

- At the transport layer, data packets are indeed processed using protocols like TCP/IP or UDP.
- TCP/IP: Provides acknowledgment (ACK) to the sender, confirming that data packets have been received.
- UDP: Does not provide acknowledgment.

## **Network Layer (Layer 3):**

- After processing at the transport layer, the data is divided into packets and sent to specific routers based on the destination address.
- Routers receive these packets and use routing tables to determine the best path for forwarding the packets to their intended destinations.

## **Data Link Layer (Layer 2):**

- Upon reaching the routers, data packets are forwarded to switches, not directly to devices.
- Switches use MAC addresses to forward data packets to the specific devices connected to them,

- ensuring efficient data transfer within the local network.
- Switches do not assign private IP addresses; instead, devices connected to the switch have their private IP addresses assigned either manually or through DHCP (Dynamic Host Configuration Protocol).

### **Physical Layer (Layer 1):**

- Hubs and repeaters are devices that operate at the physical layer of the OSI model.
- Hubs are simple devices that broadcast data to all connected devices, while repeaters amplify and regenerate signals to extend the network's reach.
- However, modern networks typically use switches instead of hubs for better performance and efficiency.

### **Data Transmission Example:**

This example illustrates how data travels through each layer of the OSI model in an office network environment, from the sender's computer to the receiver's computer, utilizing devices, protocols, and data encapsulation at each layer.

- A user in the office sends an email attachment to a colleague.
- The user's computer (sender) at Layer 7 (Application Layer) uses SMTP to compose and send the email.
- The email message is encapsulated into a TCP segment at Layer 4 (Transport Layer) with appropriate port numbers.
- The TCP segment is further encapsulated into an IP packet at Layer 3 (Network Layer) with source and destination IP addresses.
- The IP packet is encapsulated into a data-link frame at Layer 2 (Data Link Layer) with source and destination MAC addresses.
- The data-link frame is transmitted over the physical medium (Ethernet cable) at Layer 1 (Physical Layer) using electrical signals.
- The receiving computer (receiver) receives the electrical signals and processes them through the layers in reverse order (Layer 1 to Layer 7) to extract the email attachment.

## **a simplified way to look at it!**

In networking, data is indeed divided into smaller units (such as packets or frames) for efficient transmission across networks. Each unit contains essential information, including where it needs to be sent (destination address) and where it came from (source address). This information is added at different layers of the OSI model as the data traverses through the network.

Here's a breakdown of how data is handled as it travels through the OSI layers:

### **Data Division:**

Data is divided into smaller units (e.g., packets, frames, segments) at the transport layer (Layer 4) or data link layer (Layer 2), depending on the protocol used (TCP, UDP, Ethernet, etc.).

Each unit contains a portion of the original data along with header information specifying its destination and source.

### **Header Information:**

Header information is added to each unit at different OSI layers:

At the network layer (Layer 3), IP addresses are added to packets, indicating the destination and source devices on different networks.

At the data link layer (Layer 2), MAC addresses are added to frames, specifying the physical addresses of devices within the same network.

### **Transmission:**

The data units (packets or frames) are transmitted over the network medium, such as Ethernet cables or wireless signals, at the physical layer (Layer 1).

### **Routing and Switching:**

Routers at the network layer (Layer 3) route packets between networks based on IP addresses, ensuring they reach their intended destinations across different networks.

Switches at the data link layer (Layer 2) forward frames within the same network based on MAC addresses, optimizing data transfer within the local network.

### **Reception and Processing:**

When data units reach their destinations, they are received and processed by the receiving devices.

Each device processes the data units through the OSI layers in reverse order, extracting header information and reassembling the original data from the smaller units.

So, in essence, data is divided, encapsulated with routing information, transmitted across networks,

received at the destination, and then reassembled to deliver the complete information to the recipient.

Each layer of the OSI model plays a crucial role in this process, ensuring efficient and reliable communication across networks.

# Service Networking

Thursday, March 7, 2024 7:09 PM

- ★ Every Kubernetes node runs a kubelet process, which is responsible for creating pods. It then invokes the CNI plugin to configure networking for that pod.



**How services get the IP addresses?**

**How are they made available across all the nodes in the cluster?**

**How is the service made available to external users through a port on each node?**

**Who is doing that and how and where do we see it?**

Introduction to Services:

- Services is a way to facilitate communication between pods.
- Instead of pods directly communicating, services act as an intermediary.

Types of Services:

- ClusterIP services are accessible from all pods within the cluster, irrespective of the nodes they are on.
- NodePort services, in addition to being accessible from within the cluster, expose the application on a port on all nodes, making it accessible externally.

Service Object Creation:

- When a service object is created in Kubernetes, it is assigned an IP address from a predefined range.
- kube-proxy, running on each node, creates forwarding rules based on these service IPs to redirect traffic to the appropriate pods.

kube-proxy Component:

- kube-proxy is described as a component running on each node, responsible for watching changes in the cluster related to services through kube-apiserver.
- It dynamically creates forwarding rules based on the service IPs, ensuring proper routing of traffic to the associated pods.

Unlike pods, services are not created on each node or assigned to each node.  
Services are a cluster-wide concept.

With services, nothing like that exists.

There are no processes or namespaces or interfaces for a service. It's just a virtual object.

Within the container's network namespace, there are virtual interfaces (veth pairs) associated with each container. These interfaces connect the container's network namespace to the pod's network namespace, enabling network communication.

? Does each namespace have its own interface?

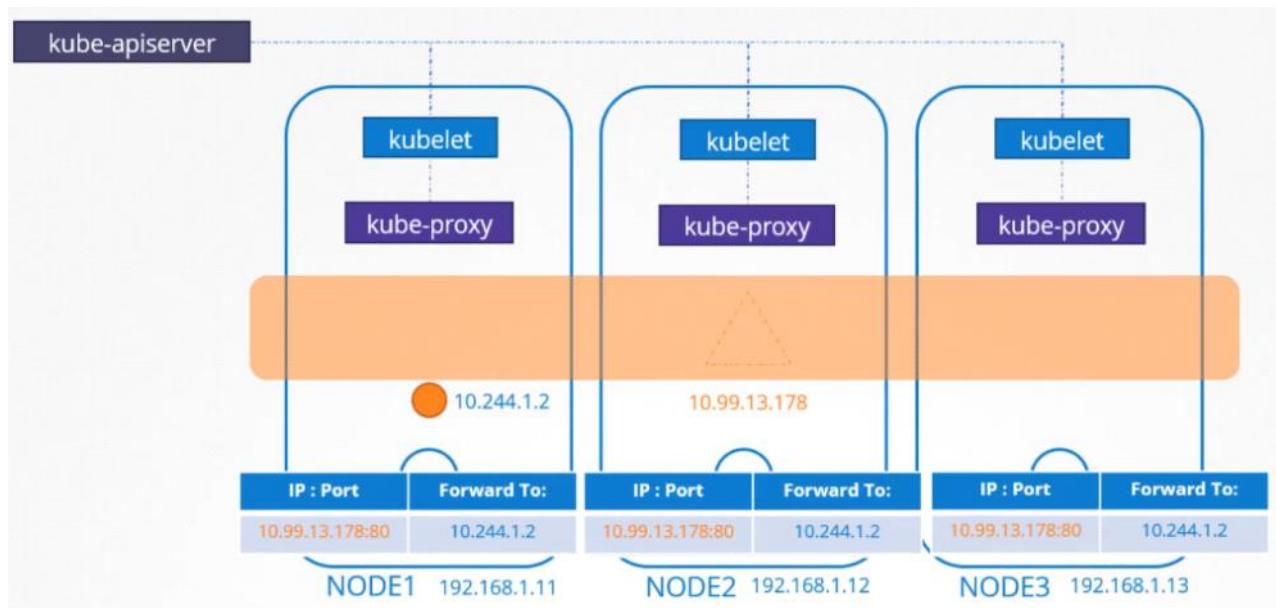
Yes, each container's network namespace has its own virtual network interface. These interfaces are part of the container's isolated network environment and help manage network communication within the container.

? Does IP relate to the container or interface?

The IP address is typically related to the container's virtual interface within its network namespace. Each container gets its IP address assigned to its network interface, allowing it to communicate within the pod and with other containers or external networks.

Service IP Allocation:

- Services get their IP addresses assigned from a specified range, and kube-proxy creates forwarding rules accordingly.
- Any traffic coming to the IP of the services go to the IP of the pod.



kube-proxy Proxy Modes:

kube-proxy supports different proxy modes, including userspace and iptables.

The default and most common option is iptables.

The proxy mode can be set using the proxy mode option, while configuring the kube-proxy service.

```
kube-proxy --proxy-mode [userspace | iptables | ipvs] ...
```

## How iptables are configured by kube-proxy and how you can view them on the nodes ?

A pod is created and it has IP - 10.244.1.2

```
kubectl get pods -o wide
```

| NAME | READY | STATUS  | RESTARTS | AGE | IP         | NODE   |
|------|-------|---------|----------|-----|------------|--------|
| db   | 1/1   | Running | 0        | 14h | 10.244.1.2 | node-1 |

10.244.1.2

We create a service of that cluster IP to make this pod available within the cluster. It has IP 10.103.132.104. This range is specified in the Kube API server's option called service-cluster-ip-range, which is by default set to 10.0.0.0/24.

```
kubectl get service
```

| NAME       | TYPE      | CLUSTER-IP     | PORT(S)  | AGE |
|------------|-----------|----------------|----------|-----|
| db-service | ClusterIP | 10.103.132.104 | 3306/TCP | 12h |

```
kube-api-server --service-cluster-ip-range ipNet (Default: 10.0.0.0/24)
```

In our case, service-cluster-ip-range is 10.96.0.0/12. That gives my services IP anywhere from 10.96.0.0 to 10.111.255.255.

```
ps aux | grep kube-api-server
```

```
kube-apiserver --authorization-mode=Node,RBAC --service-cluster-ip-
range=10.96.0.0/12
```

- The subnet mask /12 indicates that the first 12 bits of the IP address are fixed, leaving  $32 - 12 = 20$  bits for variable addresses.

Also, when pod networking is set up, I provided a pod network CIDR range of 10.244.0.0/16, which gives my pods IP addresses from 10.244.0.0 to 10.244.255.255.

| Object   | IP Range                    |
|----------|-----------------------------|
| Pod      | 10.244.0.0 - 10.244.255.255 |
| Services | 10.96.0.0 - 10.111.255.255  |

There shouldn't be a case where a pod and a service are assigned the same IP address. Both of these should have their own dedicated range of IPs to work with.

So, In our case

| Object   | IP             |
|----------|----------------|
| Pod      | 10.244.1.2     |
| Services | 10.103.132.104 |

You can see the rules created by kube-proxy in the IP table's NAT table output.

```
▶ iptables -L -t nat | grep db-service
KUBE-SVC-XA50GUC7YRH0S3PU tcp -- anywhere 10.103.132.104 /* default/db-service: cluster IP */ tcp dpt:3306
DNAT tcp -- anywhere anywhere /* default/db-service: */ tcp to:10.244.1.2:3306
KUBE-SEP-JBWCWHHQ57V2WN7 all -- anywhere anywhere /* default/db-service: */
```

This rules mean any traffic going to the IP address 10.103.132.104 on port 3306, which is the IP of the service, should have its destination address changed to 10.244.1.2 and port 3306, which is the IP of the pod.

You can also see kube-proxy create these entries in the kube-proxy logs itself. In the logs, you will find what proxier it uses. In this case, it's iptables, and then adds an entry when it added a new service for the database.

```
▶ cat /var/log/kube-proxy.log
I0307 04:29:29.883941 1 server_others.go:140] Using iptables Proxier.
I0307 04:29:29.912037 1 server_others.go:174] Tearing down inactive rules.
I0307 04:29:30.027360 1 server.go:448] Version: v1.11.8
I0307 04:29:30.049773 1 conntrack.go:98] Set sysctl 'net/netfilter/nf_conntrack_max' to 131072
I0307 04:29:30.049945 1 conntrack.go:52] Setting nf_conntrack_max to 131072
I0307 04:29:30.050701 1 conntrack.go:83] Setting conntrack hashsize to 32768
I0307 04:29:30.050701 1 proxier.go:294] Adding new service "default/db-service:3306" at 10.103.132.104:3306/TCP
```

The configuration of the service clusterIP range in the Kube API server. This range is used for assigning IP addresses to services.

#### Overlap Prevention:

It emphasizes the importance of ensuring that the IP ranges specified for pod networks and service networks do not overlap to avoid conflicts.

#### NodePort Service Configuration:

For NodePort services, kube-proxy creates iptables rules to forward external traffic on a specific port to the corresponding backend pods.

#### kube-proxy Logs:

The kube-proxy logs are mentioned as a source where entries related to service creation and iptables rule additions can be found. The location of these logs may vary depending on the installation.

The lecture concludes with a comprehensive overview of service networking in Kubernetes, providing insights into how services are dynamically managed and how kube-proxy plays a crucial role in enabling seamless communication between pods.

# lab 5

Wednesday, May 15, 2024 12:55 PM

# DNS in K8s

Monday, May 20, 2024 4:25 PM

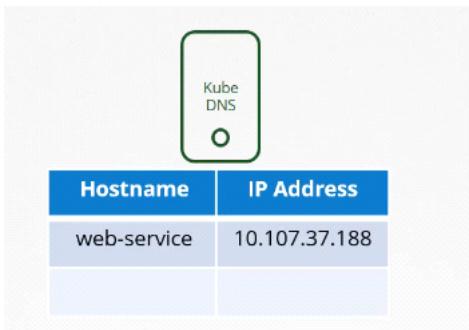
## DNS in Kubernetes Overview:

- DNS (Domain Name System) in Kubernetes is responsible for resolving names to IP addresses within the cluster.
- It helps pods and services communicate with each other using human-readable names instead of IP addresses.

## Kubernetes DNS Setup:

- Kubernetes sets up a built-in DNS server automatically when you create a cluster.
- This DNS server maps service names to IP addresses and assists in internal communication within the cluster.

## Service DNS Records:



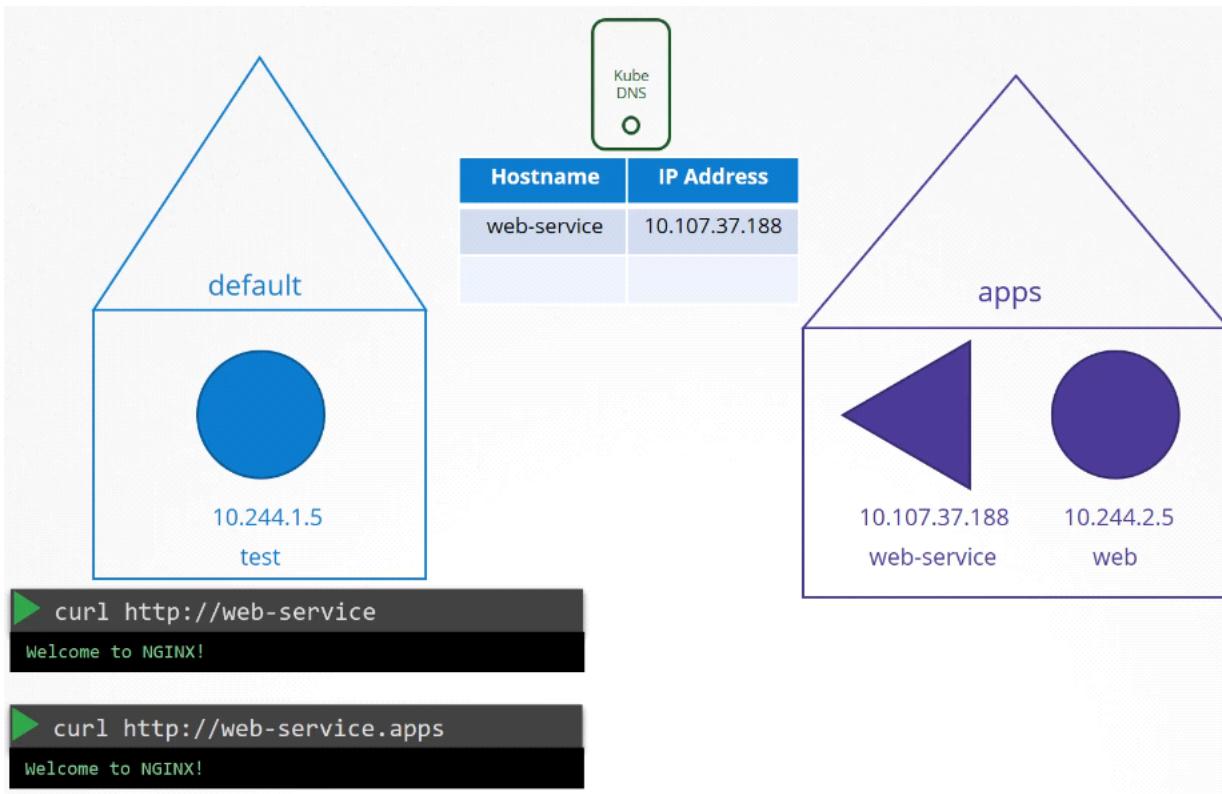
A diagram showing the Kube DNS interface. At the top, there is a green rounded rectangle containing the text "Kube DNS". Below it is a table with two columns: "Hostname" and "IP Address". There is one row in the table with the data: "web-service" in the Hostname column and "10.107.37.188" in the IP Address column.

| Hostname    | IP Address    |
|-------------|---------------|
| web-service | 10.107.37.188 |
|             |               |

- When a service is created, Kubernetes DNS creates a record mapping the service name to its IP address.
- Services within the same namespace can be reached using just their service names (e.g., Web-Service).

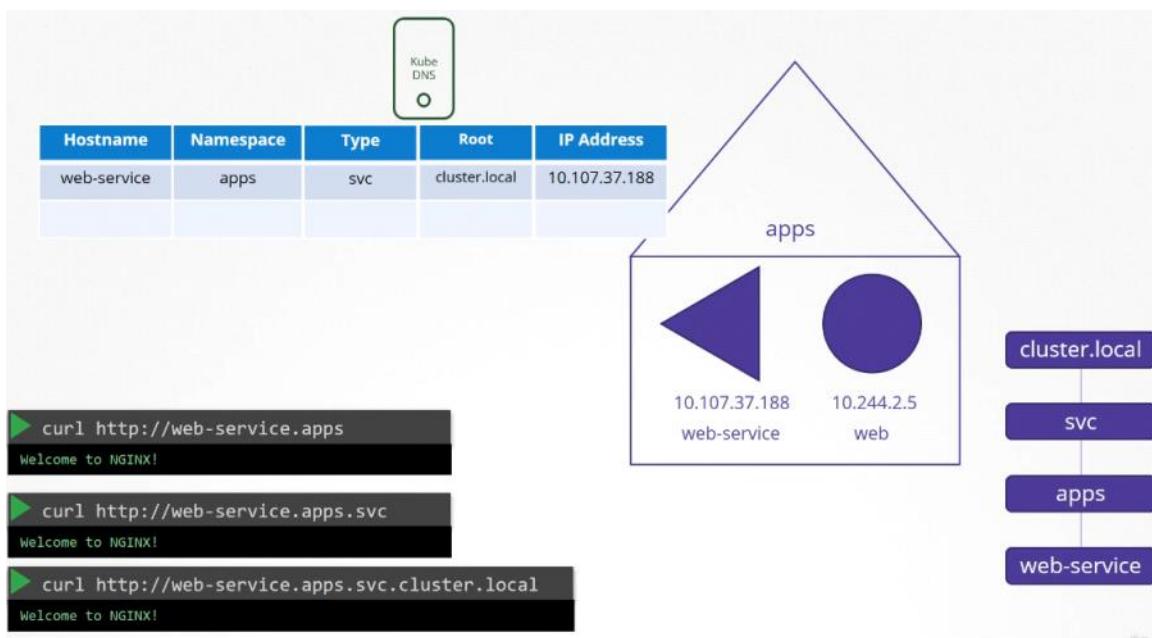
Let's assume the web service was in a separate namespace named Apps.

Then to refer to it from the default namespace you would have to say web-service.apps



#### Namespace and Subdomains:

- Each namespace in Kubernetes has its subdomain created by the DNS server.
- Services and pods within a namespace are grouped under this subdomain.
- All services are further grouped under the 'SVC' subdomain for easy access.
- Finally, all the services and pods are grouped, into a root domain for the cluster, which is set to `cluster.local` by default.

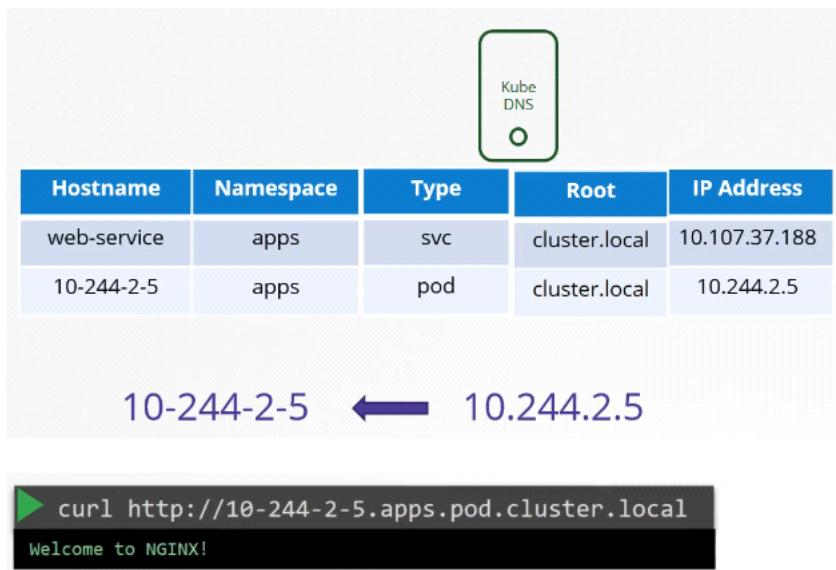


### Fully Qualified Domain Names (FQDN):

- Services can be accessed using fully qualified domain names (FQDN) like webservice.apps.svc.cluster.local.
- FQDNs provide a complete hierarchy for reaching services within the cluster.

### Pod DNS Records:

- DNS records for pods are not created by default but can be enabled explicitly.
- Pods are assigned names based on their IP addresses, with dots replaced by dashes.
- These pod names are added to the DNS server for internal resolution within the cluster.
- The name space remains the same and type is set to pod.
- The route domain is always cluster.local



### Conclusion:

DNS in Kubernetes simplifies communication by allowing services and pods to be accessed using meaningful names.

It organizes resources within namespaces and provides a structured approach to internal networking. This overview should cover the essential concepts of DNS in Kubernetes without delving into complex technical details.

# CoreDNS in K8s

Monday, May 20, 2024 4:26 PM

## CoreDNS Overview:

- CoreDNS is a DNS server used in Kubernetes clusters to resolve names to IP addresses within the cluster.
- It replaces the older kube-dns as the recommended DNS server from Kubernetes version 1.12 onward.

## CoreDNS Setup:

- CoreDNS is deployed as a pod in the kube-system namespace within the Kubernetes cluster.
- It is set up as a replica set of 2 for redundancy, ensuring reliability.



- For pods, it forms host names by replacing dots with dashes in the IP address of the pod unlike services.
- Every time a new pod is created, we add a record in the DNS server for that pod so that other pods can access the new pod and configure the etc/resolv.conf file in the pod to point to the DNS server so that the new pod can resolve other pods in the cluster.

## Corefile Configuration:

- CoreDNS requires a configuration file called Corefile, located at `etc/coredns/Corefile`, which contains plugins and settings.
- Plugins in CoreDNS handle various tasks like error handling, health reporting, and DNS resolution for Kubernetes.
- The plugin that makes CoreDNS work with Kubernetes is the Kubernetes plug-in. That is where the top level domain name of the cluster is set. In this case, `cluster.local`.

pods - The pods option you can under kubernetes is what is responsible for creating a record for pods in the cluster.

```
▶ cat /etc/coredns/Corefile
.:53 {
 errors
 health
 kubernetes cluster.local in-addr.arpa ip6.arpa {
 pods insecure
 upstream
 fallthrough in-addr.arpa ip6.arpa
 }
 prometheus :9153
 proxy . /etc/resolv.conf
 cache 30
 reload
}
```

- Any record that the DNS server can solve, for example, say a pod tries to reach [www.google.com](http://www.google.com), it is forwarded to the nameserver specified in the CoreDNS pods `etc/resolv.conf`.
- This core file is passed in to the pod as a ConfigMap object.

```
▶ kubectl get configmap -n kube-system
NAME DATA AGE
coredns 1 168d
```

## Kubernetes Plugin:

- The Kubernetes plugin in CoreDNS configures the top-level domain name for the cluster (e.g., `cluster.local`).
- It can be configured to create DNS records for pods in the cluster, converting IPs into dash-separated names.

We now have the CoreDNS pod up and running

using the appropriate Kubernetes plugin.

It watches the Kubernetes cluster for new pods or services,

and every time a pod or a service is created,

it adds a record for it in its database.

#### DNS Resolution in Pods:

- Pods are configured to use CoreDNS as the DNS server automatically by Kubernetes.

What address do the pods use to reach the DNS server?

- The CoreDNS service (named KubeDNS by default) is created to make CoreDNS accessible to other components in the cluster. The IP address of this service

is configured as the name server on pods.

The DNS configurations on pods

are done by Kubernetes automatically by kubelet.

#### DNS Lookup:

- Pods can resolve other pods and services using simplified names (e.g., web-service) or fully qualified domain names (FQDNs).
- The resolv.conf file in pods includes search entries for service domains, enabling easy DNS lookup for services.

#### Conclusion:

- CoreDNS simplifies DNS resolution within Kubernetes clusters, allowing pods and services to communicate using meaningful names.
- It automatically manages DNS configurations for pods and services, ensuring efficient internal networking.

This summary should cover the essential concepts of CoreDNS in Kubernetes without going into complex technical details.

# CoreDNS Corefile

Tuesday, June 3, 2025 5:12 PM

## Day 31/40 - Understanding CoreDNS In Kubernetes

CoreDNS is the DNS server used in Kubernetes to resolve service and pod names. It uses a config file called Corefile to decide how to handle DNS queries. Each **plugin** in the Corefile handles a specific task.

It's a DNS Server.

It's deployed as deployment - coredns and also has a service called - kubedns.  
it is present in kube-system namespace.

Suppose you are running an nginx server.

If you exec into that pod and run cat /etc/resolve.conf. You will get the ClusterIP of the kube-dns Service as the nameserver.

```
Master-->k get svc -n=kube-system
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
kube-dns ClusterIP 10.96.0.10 <none> 53/UDP,53/TCP,9153/TCP 13d
Master-->k exec -it nginx -- bash
root@nginx:/# cat /etc/resolv.conf
search default.svc.cluster.local svc.cluster.local cluster.local ec2.internal
nameserver 10.96.0.10
options ndots:5
root@nginx:/#
```

search entry in /etc/resolve.conf

If we were not using the coredns, we have to put entry in the /etc/hosts file by exec into the pod.

If we are not using coredns, a pod-nginx wanted to connect with pod-nginx-1 then, the IP of pod-nginx-1 must be there in /etc/hosts file in pod-nginx.

But if we have 100 pods, this will be a tedious task so, we use coredns.

coredns Configmap

<https://kubernetes.io/docs/tasks/administer-cluster/dns-custom-nameservers/>

```

apiVersion: v1
kind: ConfigMap
metadata:
 name: coredns
 namespace: kube-system
data:
 Corefile: |
 .:53 {
 errors
 health {
 Lameduck 5s
 }
 ready
 kubernetes cluster.local in-addr.arpa ip6.arpa {
 pods insecure
 fallthrough in-addr.arpa ip6.arpa
 ttl 30
 }
 prometheus :9153
 forward . /etc/resolv.conf
 cache 30
 Loop
 reload
 Loadbalance
 }
}

```

The Corefile configuration includes the following [plugins](#) of CoreDNS:

What each plugin does:

.:53

- **Dot .**: The root DNS zone, which means this configuration applies to all DNS queries.
- **Port 53**: The default port for DNS queries.

#### errors

- Enables logging of DNS errors to standard output.
- Useful for **debugging** and **troubleshooting** DNS resolution failures.

### **health { lameduck 5s }**

- Exposes a health endpoint at /health, usually at <http://localhost:8080/health>.
- Kubernetes can probe this to see if CoreDNS is healthy.
- lameduck 5s: When CoreDNS is shutting down, it delays shutdown for 5 seconds, allowing existing connections to complete.

💡 Example use: This helps during rolling updates to prevent dropping DNS queries in flight.

### **ready**

- Adds a readiness endpoint at /ready.
- Kubernetes uses this to determine if CoreDNS is **ready to receive traffic**.
- If this endpoint fails, Kubernetes will not send DNS traffic to that CoreDNS pod.

### **kubernetes cluster.local in-addr.arpa ip6.arpa { ... }**

This block configures CoreDNS to **resolve Kubernetes service and pod names**.

### **cluster.local**

- This is the **default domain suffix** for services in Kubernetes.
- E.g., a service called mysql in namespace dev becomes: mysql.dev.svc.cluster.local

### **in-addr.arpa, ip6.arpa**

- These are **reverse DNS zones** used for:
  - in-addr.arpa: IPv4 address lookups.
  - ip6.arpa: IPv6 address lookups.

### **pods insecure:**

Allows CoreDNS to resolve pod names directly (based on IPs), without strict validation. Needed in some setups to allow pod-to-pod DNS resolution.

### **fallthrough in-addr.arpa ip6.arpa:**

If CoreDNS doesn't find an answer in these zones, it continues to the next plugin (forward, etc.).

**ttl 30:**

The **Time To Live** (TTL) for DNS records — the duration clients can cache the DNS response (30 seconds here).

### **prometheus :9153**

- Exposes metrics (like number of queries, errors, response times) for Prometheus to scrape.
- Helps in monitoring DNS performance and behavior.

### **forward . /etc/resolv.conf**

- If CoreDNS can't resolve a domain using the Kubernetes plugin, it **forwards** the query to an upstream DNS server.
- . = all unmatched queries.
- /etc/resolv.conf usually contains the default nameservers of your host or cloud provider (e.g., Google DNS, AWS DNS, etc.).

### **cache 30**

- Caches successful DNS responses for 30 seconds.
- Reduces load on upstream DNS servers and speeds up repeat queries.

### **loop**

- Detects and prevents **infinite loops** in DNS resolution (e.g., forwarding from one CoreDNS pod to another in a cycle).
-  Protects against misconfigurations.

### **reload**

- Automatically reloads the Corefile when it changes (no need to restart the CoreDNS pod).
- Handy for applying config updates dynamically.

### **loadbalance**

- Randomizes the order of A or AAAA records in DNS responses.
- This helps **distribute traffic across multiple pod IPs** for the same service (basic round-robin).

## What is Reverse DNS?

Reverse DNS (rDNS) is the opposite of **forward DNS**.

- **Forward DNS:** You give a **domain name**, and DNS returns an **IP address**.
  - Example: google.com → 142.250.195.78
- **Reverse DNS:** You give an **IP address**, and DNS returns the **domain name**.
  - Example: 142.250.195.78 → del03s24-in-f14.1e100.net

# Ingress

Wednesday, May 1, 2024 12:25 AM

## Instructor's Introduction to Ingress in Kubernetes:

Purpose: Discusses the difference between services and ingress in Kubernetes and when to use each.

Scenario: Deploying an application for an online store on Kubernetes.

Service Types Used:

- Cluster IP service for MySQL database accessibility within the cluster.
- Node Port service to make the application available externally on a high port (port greater than 30,000 e.g., 38080).
- Scaling: Increasing pod replicas to handle increased traffic.
- External Access Setup: Configuring DNS server to point to node IPs and using a proxy server to map port 80 to 38080.

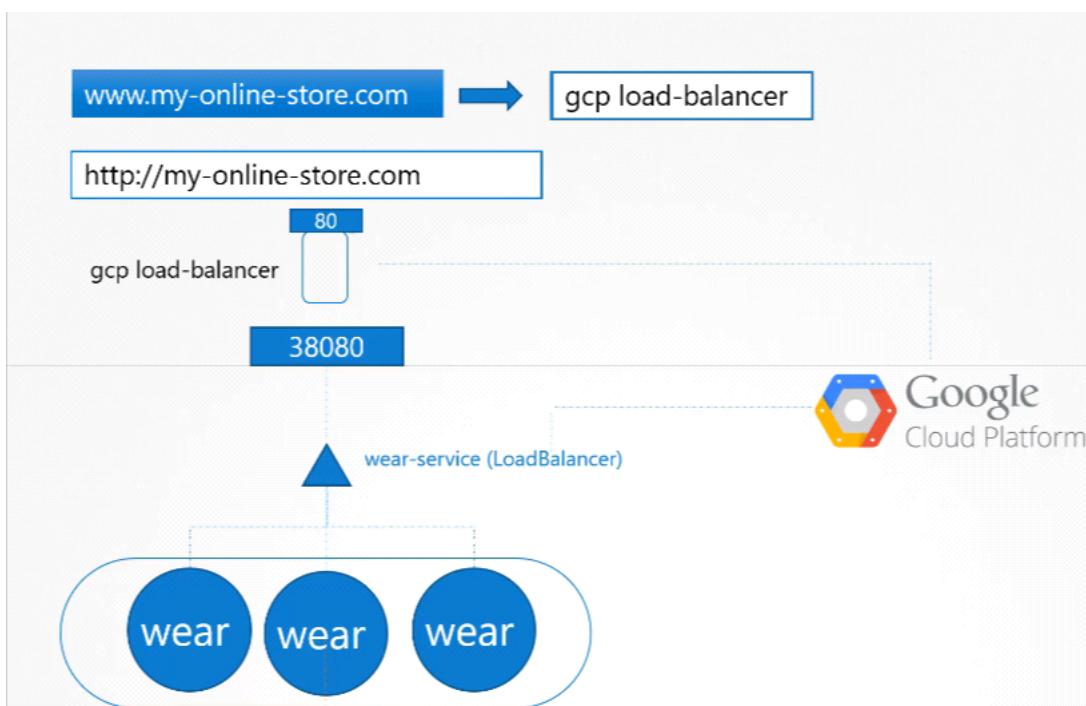
Proxy Server

A proxy server acts as an intermediary between client devices and servers, forwarding requests and responses. In Kubernetes with Ingress, a proxy server like Nginx or HAProxy can route incoming requests based on rules defined in the Ingress configuration. For example, if an Ingress rule directs traffic from port 80 to port 38080 on nodes, the proxy server will receive requests on port 80 and forward them to the specified port 38080 on the appropriate nodes based on routing rules. This setup allows for centralized traffic management and routing in a Kubernetes cluster.



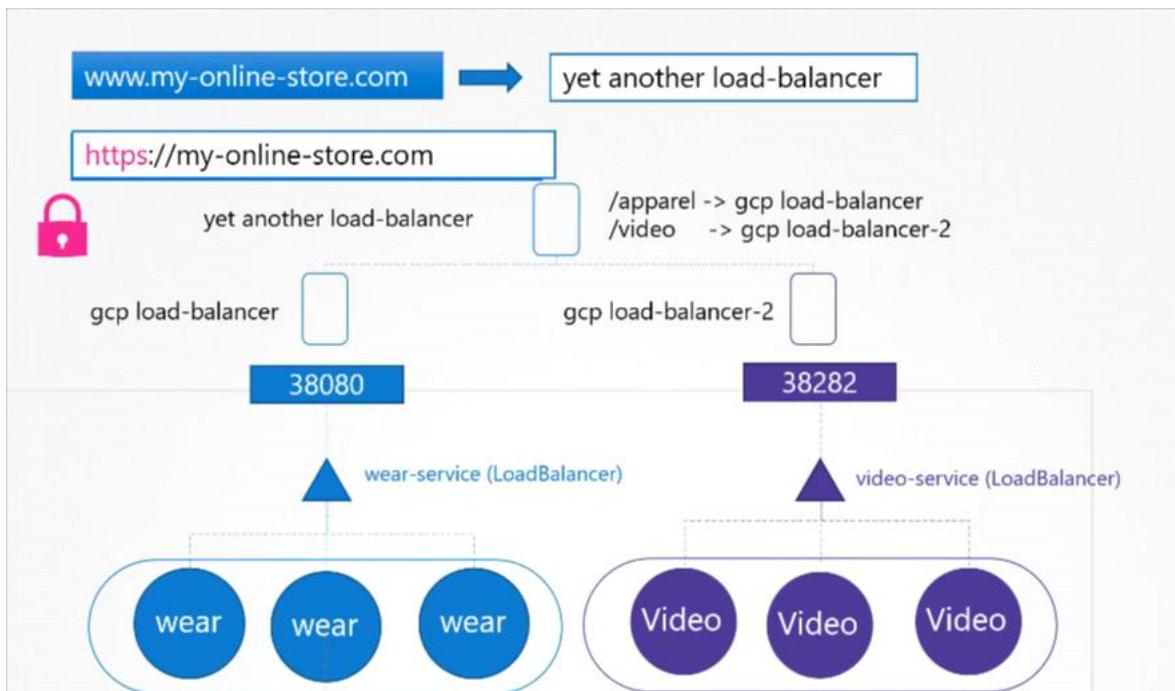
When users visit `myonlinestore.com`, their requests go to port 80, which is the standard HTTP port. However, since Kubernetes services can only allocate high-numbered ports (greater than 30,000) for NodePorts, an additional layer is introduced—a proxy server. This proxy server acts as an intermediary between the users and your cluster. It listens for incoming requests on port 80 and forwards them to port 38080 on your nodes, where your application is running. By pointing the DNS to this proxy server, users can access your application by simply visiting `myonlinestore.com` without specifying a port number. This is the case when your application is hosted on-prem in your data center.

#### Public Cloud Environment (Google Cloud Platform):



- Using Load Balancer service type instead of Node Port for external access.
- When you do that, Kubernetes would still do everything that it has to do for a node port, which is to provision a high port for the service. But in addition to that, Kubernetes also sends a request to Google Cloud Platform to provision a network load balancer for the service.
- Google Cloud Platform automatically provisions a network load balancer configured to route traffic to the service ports on all the nodes and return its information to Kubernetes.
- Load Balancers provide a single, stable external IP address that users can access your application with. This simplifies DNS management and provides a consistent interface for users. In this case, we set the DNS to point to this IP and users access the application using the URL `myonlinestore.com`.

#### Adding New Services:



- For adding a new service such as a video streaming service, deploy it as a separate deployment within the same cluster and loadBalancer service.
- Now, the new load balancer has its own IP.
- Now, you have to direct traffic between each of these load balancers based on the URL that the users type in. For this you need another oroxy or load balancer that can redirect traffic based on URLs to different services.
- ★ • Every time you introduce a new service, you have to reconfigure the load balancer.

Enable SSL:

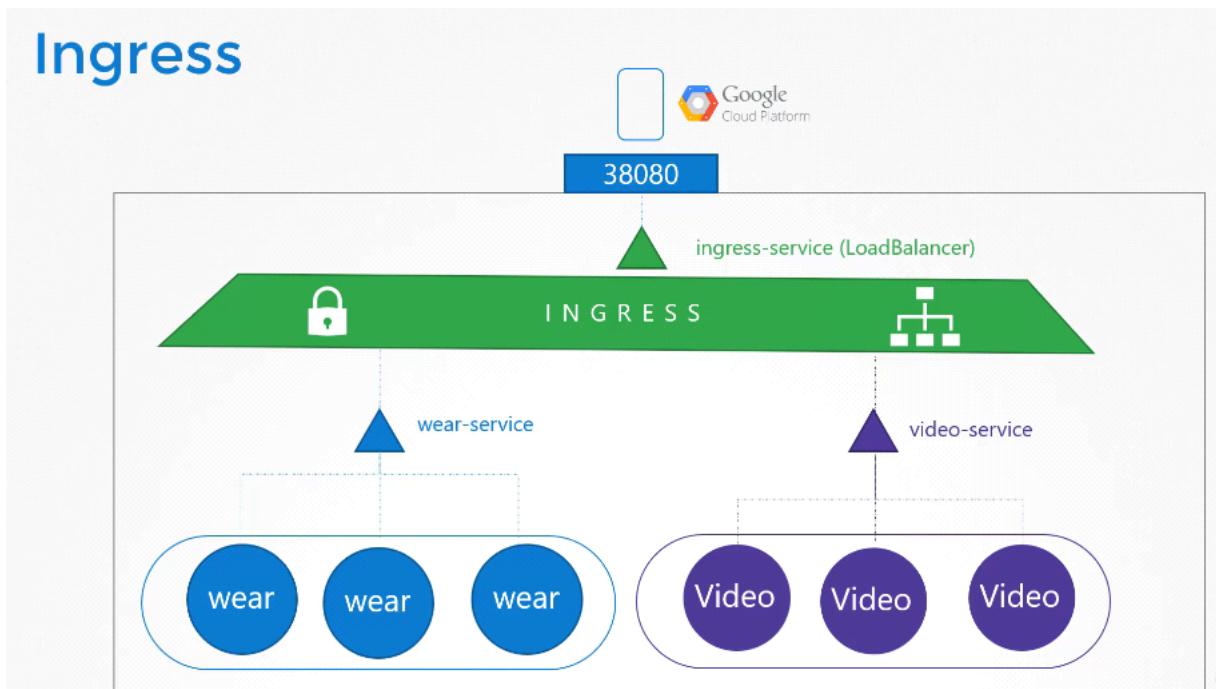
- Enable ssl so that user can access the application at https.
- It can be done at different levels, either at the application level itself or at the load balancer or proxy server level.
- This can become complex as the application load increases.

Need for Ingress:

- To manage all of that within the Kubernetes cluster and have all that configuration as just another Kubernetes definition file that lives along with the rest of your application deployment files.
- Simplifying external access and SSL configuration.
- Managing configurations within the Kubernetes cluster.

## Ingress Overview:

# Ingress



Ingress helps your users access your application using a single externally accessible URL that you can configure to route to different services within your cluster based on the URL path while implementing SSL security as well.

- Functionality: Acts as a layer seven load balancer within Kubernetes.
- Configuration: Can be configured just like other Kubernetes object.
- Kubernetes doesn't have ingress controller by default.
- Supported Solutions (Ingress Controllers):
  - GCE(Google Cloud Platform)
  - nginx
  - Contour
  - HA Proxy
  - Traefik
  - Istio
- Need to publish as a nodePort or with Cloud Native load balancer.
- You can perform load balancing authentications, ssl and URL-based routing at a single place, ingress controller.

## ingress controller

An ingress controller is a Kubernetes component responsible for managing incoming traffic to services within the cluster. It acts as an entry point and directs traffic based on rules defined in ingress resources

- Load balancers distribute traffic across servers at the network layer (Layer 4), focusing on IP addresses and ports.
- Nginx servers can act as both web servers and load balancers, handling HTTP requests and distributing traffic based on HTTP protocols at both Layer 4 and Layer 7.
- Ingress controllers are specific to Kubernetes and manage external access to services within the cluster at Layer 7, understanding HTTP/HTTPS traffic and using rules defined in ingress resources.
- The ingress controllers are not just another load balancer or N-G-I-N-X server. The load balancer components are just a part of it. The ingress controllers have additional intelligence built into them to monitor the Kubernetes cluster for new definitions or ingress resources and configure the N-G-I-N-X server accordingly.

An N-G-I-N-X controller is deployed as just another deployment in Kubernetes.

## Ingress Resources

Ingress resources in Kubernetes are objects that define how incoming HTTP and HTTPS traffic should be routed to services within the cluster. They act as configuration rules for an ingress controller to manage external access to services.

### **Layer 4 vs Layer 7 Load Balancer**

Layer 4 Load Balancer:

- Imagine your data is like a parcel being delivered.
- A layer 4 load balancer checks only the address label (IP address and port numbers) on the parcel.
- It decides which delivery truck (server) should handle the parcel based on this information.
- It's like a sorting machine that looks at the destination and sends the parcel to the right truck.
- However, it doesn't understand what's inside the parcel or what type of item it is.

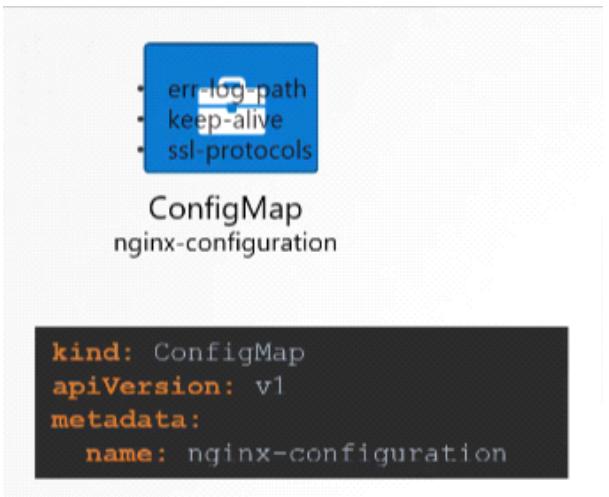
Layer 7 Load Balancer:

- Now, think of your data as a letter with content inside.
- A layer 7 load balancer opens the letter and reads the contents (like the URL or specific data).
- Based on what it reads, it decides which department or person (server) should handle the letter.
- It's like a smart assistant who knows what's in each letter and sends it to the right person or department based on its content.
- This type of load balancer can make more informed decisions because it understands the data itself, not just the destination address.

### **Deploying nginx Ingress Controller:**

- Deployed just like a Kubernetes deployment.
- Configuration includes defining a config map for nginx settings and a service for external access.
- Within the image the nginx program is stored at location /nginx-ingress-controller.
- If you have worked with N-G-I-N-X before, you know that it has a set of configuration options such as the path to store the logs, keep a live threshold, SSL settings, session timeouts, et cetera. In order to decouple these configuration data from the N-G-I-N-X controller image, you must create a config map object and pass that in. Now remember, the config map object need not have any entries at this point.

A blank object will do, but creating one makes it easy for you to modify a configuration setting in the future.



- You must also pass in two environment variables that carry the **pod's name(POD\_NAME)** and **namespace(POD\_NAMESPACE)** it is deployed to.
- specify the ports used by the ingress controller, which happens to be 80 and 443.
- We then need a service to expose the ingress controller to the external world.

```

apiVersion: v1
kind: Service
metadata:
 name: nginx-ingress
spec:
 type: NodePort
 ports:
 - port: 80
 targetPort: 80
 protocol: TCP
 name: http
 - port: 443
 targetPort: 443
 protocol: TCP
 name: https
 selector:
 name: nginx-ingress

```

- Since the Ingress controller interacts with the Kubernetes API to manage and configure Ingress resources, it requires a service account to authenticate and authorize its API requests securely.

```
apiVersion: v1
kind: ServiceAccount
metadata:
 name: nginx-ingress-serviceaccount
```

Roles

ClusterRoles

RoleBindings

## Final manifest file

```
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
 name: nginx-ingress-controller
spec:
 replicas: 1
 selector:
 matchLabels:
 name: nginx-ingress
 template:
 metadata:
 labels:
 name: nginx-ingress
 spec:
 containers:
 - name: nginx-ingress-controller
 image: quay.io/kubernetes-ingress-
 controller/nginx-ingress-controller:0.21.0
 args:
 - /nginx-ingress-controller
 - --configmap=$(POD_NAMESPACE)/nginx-configuration
```

```
 - name: nginx-ingress-controller
 image: quay.io/kubernetes-ingress-
 controller/nginx-ingress-controller:0.21.0
 args:
 - /nginx-ingress-controller
 - --configmap=$(POD_NAMESPACE)/nginx-configuration
 env:
 - name: POD_NAME
 valueFrom:
 fieldRef:
 fieldPath: metadata.name
 - name: POD_NAMESPACE
 valueFrom:
 fieldRef:
 fieldPath: metadata.namespace
 ports:
 - name: http
 containerPort: 80
 - name: https
 containerPort: 443
```

To create an Ingress controller, we need to deploy the Nginx Ingress image, expose it with a service, configure it using a ConfigMap, and ensure a service account with appropriate permissions for accessing these objects.

## Creating Ingress Resources:

- Purpose: Routing traffic based on URL paths or host names.
- Configuration: Defined in ingress resources using Kubernetes definition files.

```
Ingress-wear.yaml
```

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
 name: ingress-wear
spec:
 backend:
 serviceName: wear-service
 servicePort: 80
```

```
▶ kubectl create -f Ingress-wear.yaml
ingress.extensions/ingress-wear created
```

```
▶ kubectl get ingress
NAME HOSTS ADDRESS PORTS
ingress-wear * 80 2s
```

The backend section defines

where the traffic will be routed to.

So if it's a single backend,

then you don't really have any rules.

You can simply specify the service name

and port of the backend wear service.

Routing Methods:

- Based on URL paths. ([www.abcd.com](http://www.abcd.com), [www.abcd.com/login](http://www.abcd.com/login), [www.abcd.com/signin](http://www.abcd.com/signin))
- Based on domain names or host names (login.abcd.com, signin.abcd.com )

Ingress Resource - Rules

have rules at the top

for each host or domain name,

and within each rule you have different paths

to route traffic based on the URL.

In Ingress, rules define how incoming requests should be routed to different backend services based on certain criteria like host, path, or header values. Here are some examples:

**Routing by Host:** You can specify different backend services based on the host header in the HTTP request. For instance:

Host: [www.example.com](http://www.example.com) -> Service A

Host: api.example.com -> Service B

**Path-Based Routing:** Routing can also be based on the URL path. For example:

Path: /app1 -> Service X

Path: /app2 -> Service Y

**Combination of Host and Path:** You can combine host and path rules for more granular routing:

Host: app.example.com, Path: /users -> Service A

Host: app.example.com, Path: /products -> Service B

**TLS Termination:** Ingress can handle TLS termination, directing HTTPS traffic to different backend services based on host or path.

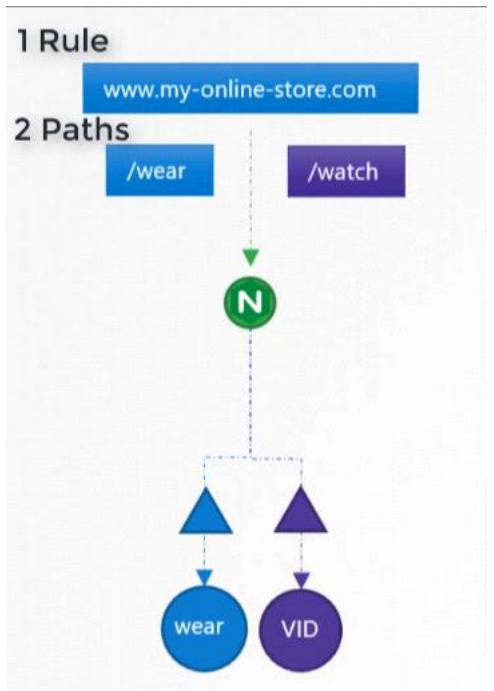
These rules allow you to manage traffic routing effectively, directing requests to appropriate backend services based on various criteria defined in the Ingress configuration.

Example Configurations:

- Routing traffic to different services based on URL paths.
- Splitting traffic based on domain names with rules and backend specifications.
- Default Backend: Configuring a default backend for unmatched URLs.

Creating ingress resource

for path based



```

apiVersion: extensions/v1beta1
kind: Ingress
metadata:
 name: ingress-wear-watch
spec:
 rules:
 - http:
 paths:
 - path: /wear
 backend:
 serviceName: wear-service
 servicePort: 80
 - path: /watch
 backend:
 serviceName: watch-service
 servicePort: 80

```

above version is old.

```

apiVersion: extensions/v1beta1 apiVersion: networking.k8s.io/v1
kind: Ingress kind: Ingress
metadata: metadata:
 name: ingress-wear-watch name: ingress-wear-watch
spec: spec:
 rules: rules:
 - http: - http:
 paths: paths:
 - path: /wear - path: /wear
 backend: pathType: Prefix
 serviceName: wear-service backend:
 servicePort: 80 service:
 name: wear-service
 port: port:
 number: 80
 - path: /watch - path: /watch
 backend: pathType: Prefix
 serviceName: watch-service backend:
 servicePort: 80 service:
 name: watch-service
 port: port:
 number: 80

```

### Latest Version

run "k create -f <>".

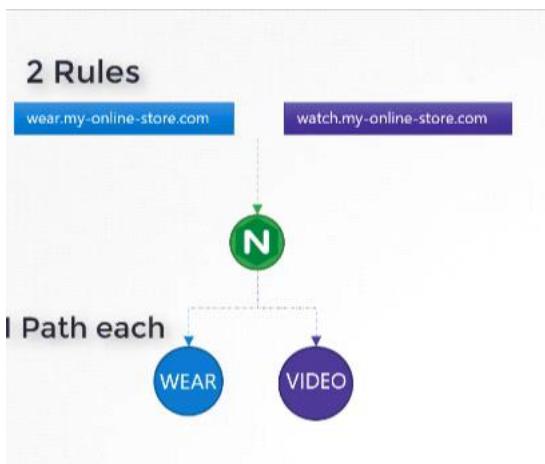
## Imperative Way

Now, in k8s version 1.20+ we can create an Ingress resource from the imperative way like this:-

Format - **kubectl create ingress <ingress-name> --rule="host/path=service:port"**

Example - `kubectl create ingress ingress-test --rule="wear.my-online-store.com/wear*=wear-service:80"`

for host/domain



```
Ingress-wear-watch.yaml
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
 name: ingress-wear-watch
spec:
 rules:
 - host: wear.my-online-store.com
 http:
 paths:
 - backend:
 serviceName: wear-service
 servicePort: 80
 - host: watch.my-online-store.com
 http:
 paths:
 - backend:
 serviceName: watch-service
 servicePort: 80
```

The rewrite option in Ingress allows you to modify the URL path of incoming requests before routing them to backend services. This is useful for scenarios where the backend service expects a different URL structure than what the client sends.

```
1 apiVersion: extensions/v1beta1
2 kind: Ingress
3 metadata:
4 name: test-ingress
5 namespace: critical-space
6 annotations:
7 nginx.ingress.kubernetes.io/rewrite-target: /
8 spec:
9 rules:
10 - http:
11 paths:
12 - path: /pay
13 backend:
14 serviceName: pay-service
15 servicePort: 8282
```

This rewrites the URL by replacing whatever is under rules->http->paths->path which happens to be /pay in this case with the value in rewrite-target. This works just like a search and replace function.

For example: replace(path, rewrite-target)  
In our case: replace("/path","/")

## **Services vs Ingress**

Services are for basic internal networking and load balancing, while Ingress manages external access and more complex routing, especially for HTTP/HTTPS traffic. Use Services for internal cluster needs and Ingress for external access and advanced routing.

Services and Ingress are both Kubernetes resources used for networking, but they serve different purposes and are used in different scenarios:

### **Services:**

- Purpose: Services expose applications running in a Kubernetes cluster to other parts of the cluster or to external users.
- Functionality: They provide basic load balancing and routing based on selectors (such as labels) to direct traffic to pods.
- Types:
  - ClusterIP (internal only)
  - NodePort (exposes on a specific port on each node)
  - LoadBalancer (integrates with cloud providers' load balancers)
  - ExternalName (maps a service to an external endpoint)
- Use Cases: Use Services when you need to expose applications internally within the cluster or when you want basic load balancing for your application.

### **Ingress:**

- Purpose: Ingress is used for managing external access to services in a Kubernetes cluster.
- Functionality: It provides more advanced routing and traffic rules based on hostnames, paths, and TLS termination. Ingress controllers are responsible for implementing these rules.
- Types: Ingress resource (defines routing rules), Ingress Controller (actual implementation that processes Ingress rules and manages traffic).
- Use Cases: Use Ingress when you have multiple services exposed through different paths or hostnames and need more advanced routing capabilities. It's particularly useful for HTTP/HTTPS traffic and managing external access to services.

In summary, use Services for basic internal networking and load balancing within the cluster. Use Ingress for managing external access, routing traffic based on rules, and handling more complex scenarios like HTTPS termination and path-based routing.

## lab 6

Saturday, May 11, 2024 12:15 PM

Identify the DNS solution implemented in this cluster.

Run the command: **kubectl get pods -n kube-system** and look for the DNS pods.

| NAME                                 | READY | STATUS  | RESTARTS | AGE   |
|--------------------------------------|-------|---------|----------|-------|
| coredns-69f9c977-2x5fl               | 1/1   | Running | 0        | 3m20s |
| coredns-69f9c977-w5jn5               | 1/1   | Running | 0        | 3m20s |
| etcd-controlplane                    | 1/1   | Running | 0        | 3m33s |
| kube-apiserver-controlplane          | 1/1   | Running | 0        | 3m33s |
| kube-controller-manager-controlplane | 1/1   | Running | 0        | 3m35s |
| kube-proxy-gycds                     | 1/1   | Running | 0        | 3m21s |
| kube-scheduler-controlplane          | 1/1   | Running | 0        | 3m33s |

What is the name of the service created for accessing CoreDNS?

| controlplane ~ ➔ k get svc -n kube-system |           |            |             |                        |       |
|-------------------------------------------|-----------|------------|-------------|------------------------|-------|
| NAME                                      | TYPE      | CLUSTER-IP | EXTERNAL-IP | PORT(S)                | AGE   |
| kube-dns                                  | ClusterIP | 10.96.0.10 | <none>      | 53/UDP,53/TCP,9153/TCP | 6m22s |

❓ What is the IP of the CoreDNS server that should be configured on PODs to resolve services?

Run the command: **kubectl get service -n kube-system** and look for cluster IP value.

| controlplane ~ ➔ k get svc -n kube-system kube-dns |           |            |             |                        |  |     |
|----------------------------------------------------|-----------|------------|-------------|------------------------|--|-----|
| NAME                                               | TYPE      | CLUSTER-IP | EXTERNAL-IP | PORT(S)                |  | AGE |
| kube-dns                                           | ClusterIP | 10.96.0.10 | <none>      | 53/UDP,53/TCP,9153/TCP |  | 13m |

❓ What is the purpose of ClusterIP and different endpoints that are given below?

| controlplane ~ ➔ k describe svc -n kube-system kube-dns |                                                                                      |
|---------------------------------------------------------|--------------------------------------------------------------------------------------|
| Name:                                                   | kube-dns                                                                             |
| Namespace:                                              | kube-system                                                                          |
| Labels:                                                 | k8s-app=kube-dns<br>kubernetes.io/cluster-service=true<br>kubernetes.io/name=CoreDNS |
| Annotations:                                            | prometheus.io/port: 9153<br>prometheus.io/scrape: true                               |
| Selector:                                               | k8s-app=kube-dns                                                                     |
| Type:                                                   | ClusterIP                                                                            |
| IP Family Policy:                                       | SingleStack                                                                          |
| IP Families:                                            | IPv4                                                                                 |
| IP:                                                     | 10.96.0.10                                                                           |
| IPs:                                                    | 10.96.0.10                                                                           |
| Port:                                                   | dns 53/UDP                                                                           |
| TargetPort:                                             | 53/UDP                                                                               |
| Endpoints:                                              | 10.244.0.2:53,10.244.0.3:53                                                          |
| Port:                                                   | dns-tcp 53/TCP                                                                       |
| TargetPort:                                             | 53/TCP                                                                               |
| Endpoints:                                              | 10.244.0.2:53,10.244.0.3:53                                                          |
| Port:                                                   | metrics 9153/TCP                                                                     |
| TargetPort:                                             | 9153/TCP                                                                             |
| Endpoints:                                              | 10.244.0.2:9153,10.244.0.3:9153                                                      |
| Session Affinity:                                       | None                                                                                 |
| Events:                                                 | <none>                                                                               |

- **IP:** This is the IP address of the kube-dns service, but it's the ClusterIP assigned to it, not the address at which kube-dns listens. The ClusterIP is how other components within the cluster access this service.
- **Port & TargetPort:** The Port is the service port, and TargetPort is where the pod's container receives data. Both are using the UDP protocol for DNS traffic.

The TargetPort in a Kubernetes Service configuration specifies the port on which the containers within the target pod are listening. If a pod has multiple containers, each container can listen on different ports.

In such cases, you can specify different TargetPorts for each container in the pod's Service configuration. This allows the Service to correctly route traffic to the appropriate container within the pod based on the specified ports.

In Kubernetes, two containers within the same pod cannot listen on the same TargetPort for a Service. Each container must have a unique port or set of ports that it listens on, and these ports should be mapped to different TargetPorts in the Service configuration to ensure proper routing of traffic.

- **Endpoints:** You're on the right track. Endpoints show the backend pods that the service routes traffic to. In your case, there are two endpoints for DNS (10.244.0.2:53 and 10.244.0.3:53) and two for metrics (10.244.0.2:9153 and 10.244.0.3:9153). These endpoints represent the actual pods handling the service's functionality.

So, the kube-dns service is accessible at IP 10.96.0.10 on port 53/UDP, forwarding requests to both DNS and metrics endpoints for load balancing and redundancy.

### How a container listens from a target port of the service?

When a container listens on a specific port (known as the TargetPort), it means that the application or service inside the container is configured to accept incoming connections on that port. This configuration is typically done within the application code or the container configuration.

In the context of Kubernetes Services, the TargetPort is used to specify which port the Service should route incoming traffic to for the pods associated with that Service. When a Service receives traffic on its own port (known as the ServicePort), it forwards that traffic to the TargetPort of the pods.

For example, if you have a container running a web server inside a pod, and the web server is configured to listen on port 80 (TargetPort), you can expose this service using a Kubernetes Service with a ServicePort of 80. When external traffic hits the Service's IP and port 80, Kubernetes forwards that traffic to the pods' TargetPort 80, allowing the web server inside the container to receive and respond to requests.

The Kubernetes Service acts as a bridge between external traffic (coming from clients or other services) and the pods that provide the actual application or service.

The ServicePort is the port through which the Kubernetes Service listens for incoming traffic. When traffic arrives at this ServicePort, Kubernetes uses the Service's configuration, specifically the selector, to determine which pods should receive this traffic.

The TargetPort in the pods specifies the port on which the containers inside those pods are listening to receive this forwarded traffic. This mechanism allows Kubernetes to route traffic effectively to the appropriate containers based on their TargetPort configurations.

?

**Does container also has their own ports? What is the criteria of having ports and which k8s objects can have port? Explain in details?**

In Kubernetes, containers inside pods can indeed have their own ports. Ports are fundamental to networking and communication between different components within a Kubernetes cluster. Here's a breakdown of the criteria for having ports and which Kubernetes objects can have ports:

**Containers:** Containers run inside pods and are the actual units where your application code runs. Each container in Kubernetes can expose one or more ports to communicate with other containers or external services. These ports are defined in the container's configuration and are typically specified in the Dockerfile or the container runtime configuration.

**Pods:** Pods are the smallest deployable units in Kubernetes and can contain one or more containers.

Each container inside a pod can define its own set of ports. Pods use these ports for internal communication between containers within the same pod or for exposing services to other pods or external clients.

**Services:** Kubernetes Services are a way to abstract and expose a set of pods as a network service. Services can have ports that define how clients can access the service.

**Ingress:** Kubernetes Ingress is an API object that manages external access to services in a cluster. Ingress resources can specify rules and configurations for routing external HTTP and HTTPS traffic to services based on hostnames and paths. Ingresses can define ports that the underlying services are listening on.

The criteria for having ports depend on the networking requirements of your application. If your application needs to receive incoming network requests or communicate with other services or components within the cluster, you'll define and expose ports accordingly. Ports are essential for enabling communication and networking capabilities in Kubernetes, allowing different parts of your application to interact seamlessly.

## **Ingress vs NodePort Service**

Ingress is ideal for managing complex routing scenarios, SSL termination, and HTTP/HTTPS traffic with domain-based routing, while NodePort services are simpler and provide basic external access to services on fixed ports across all nodes in the cluster. The choice between them depends on your specific networking and external access requirements for the applications running in your Kubernetes cluster.

# Application Failure

Saturday, April 27, 2024 1:10 PM

## Problem

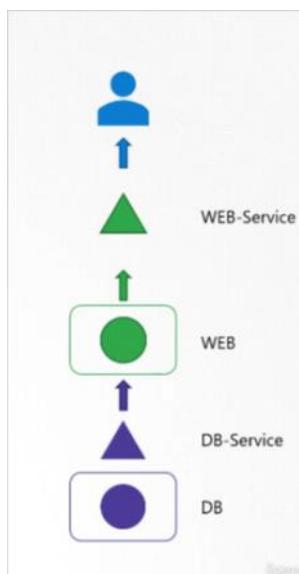
Application Structure Example: The user is unable to access the application.

**Two-Tier Application:** Consists of a web server and a database server.

Database Pod: Hosts the database application and serves the web servers via a database service.  
Web Pod: Hosts the web server and serves users via the web service.

## Solution

Initial Steps:



- Mapping or Charting: It is recommended to create a map or chart of the application configuration.
- Choosing Start Point: Depending on the issue's familiarity, start troubleshooting from either end of the application map.
- **Check every object and link**

### Application Front End Troubleshooting:

- Accessibility Check: Test accessibility using standard methods like **curl** on the node port's IP.

```
curl http://web-service-ip:node-port
curl: (7) Failed to connect to web-service-ip port node-port: Connection timed out
```

- Service Check: Verify if the service has discovered endpoints for the web pod.
- Service-Pod Selector Comparison: Ensure selectors on the service match those on the pod.



## Pod State Analysis:

- Pod Status: Verify if the pod is running and check the number of restarts.

```

 ➜ kubectl get pod
 NAME READY STATUS RESTARTS AGE
 Web 1/1 Running 5 50m

```

- Event Checking: Use the **kubectl describe** to inspect events related to the pod.

```

 ➜ kubectl describe pod web
 ...
 Events:
 Type Reason Age From Message
 ---- ----- -- -- --
 Normal Scheduled 52m default-scheduler Successfully assigned webapp-mysql to worker-1
 Normal Pulling 52m kubelet, worker-1 pulling image "simple-webapp-mysql"
 Normal Pulled 52m kubelet, worker-1 Successfully pulled image "simple-webapp-mysql"
 Normal Created 52m kubelet, worker-1 Created container
 Normal Started 52m kubelet, worker-1 Started container

```

- Log Analysis: Check application logs using **kubectl logs** to identify any failures or issues.

```

 ➜ kubectl logs web
 10.32.0.1 - - [01/Apr/2019 12:51:55] "GET / HTTP/1.1" 200 -
 10.32.0.1 - - [01/Apr/2019 12:51:55] "GET /static/img/success.jpg HTTP/1.1" 200 -
 10.32.0.1 - - [01/Apr/2019 12:51:55] "GET /favicon.ico HTTP/1.1" 404 -
 10.32.0.1 - - [01/Apr/2019 12:51:57] "GET / HTTP/1.1" 200 -
 10.32.0.1 - - [01/Apr/2019 12:51:57] "GET / HTTP/1.1" 200 -
 10.32.0.1 - - [01/Apr/2019 12:51:58] "GET / HTTP/1.1" 200 -
 10.32.0.1 - - [01/Apr/2019 12:51:58] "GET / HTTP/1.1" 200 -

```

★ If the pod is restarting due to a failure, then the logs in the current version of the pod that's running the current version of the container may not reflect why it failed the last time.

1. Run '**kubectl logs web -f**' option to watch logs.  
OR
2. Run '**kubectl logs web -f --previous**' option to view logs of previous pods.

## Database Troubleshooting:

- DB Service Check: Verify the status of the DB service and ensure endpoint discovery.
- DB Pod Analysis: Inspect DB pod logs for database-related errors or issues.

★ Follow 'Troubleshooting Application' on kubernetes docs.

## Accessing the Application

### 1. Using Endpoint

In Kubernetes, an endpoint in a service refers to the combination of the IP address of the pod associated with that service and the target port of the container within that pod.

```
controlplane ~ ➔ k describe svc -n alpha
Name: web-service
Namespace: alpha
Labels: <none>
Annotations: <none>
Selector: name=webapp-mysql
Type: NodePort
IP Family Policy: SingleStack
IP Families: IPv4
IP: 10.43.180.233
IPs: 10.43.180.233
Port: <unset> 8080/TCP
TargetPort: 8080/TCP
NodePort: <unset> 30081/TCP
Endpoints: 10.42.0.10:8080
Session Affinity: None
External Traffic Policy: Cluster
Events: <none>
```

```
controlplane ~ ➔ k get pods -o wide
NAME READY STATUS RESTARTS AGE IP NODE NOMINATED NODE READINESS GATES
webapp-mysql-b68bb6bc8-r8j7s 1/1 Running 0 16m 10.42.0.10 controlplane <none> <none>
mysql 1/1 Running 0 16m 10.42.0.9 controlplane <none> <none>
```

curl <http://<endpoint-of-app-service>>

When to use: When accessing the application within the cluster.

### 2. Using localhost and NodePort

curl <http://localhost:30081>

When to use: Testing the application locally on the node running the application.

### 3. Using NodeIP and Nodeport

curl <http://<NodeIP>:<NodePort>>

When to use: When accessing the application from outside the cluster.

### 4. ns lookup - creating a temporary pod

Running nslookup in a temporary pod to get the service name, which can be used to access the application.

```
controlplane ~ ➔ k run testpod --image=busybox:1.28 --rm -it --restart=Never -- nslookup web-service
Server: 10.43.0.10
Address 1: 10.43.0.10 kube-dns.kube-system.svc.cluster.local

Name: web-service
Address 1: 10.43.180.233 web-service.alpha.svc.cluster.local
pod "testpod" deleted
```

This will give the service name

When to use: To resolve the service name for accessing the application.

## 5. nslookup

You can use the externalIP of the service to directly access it from within the cluster using nslookup.

The command you provided will resolve the externalIP of the service to its DNS name, which can be useful for testing and verifying connectivity within the cluster.

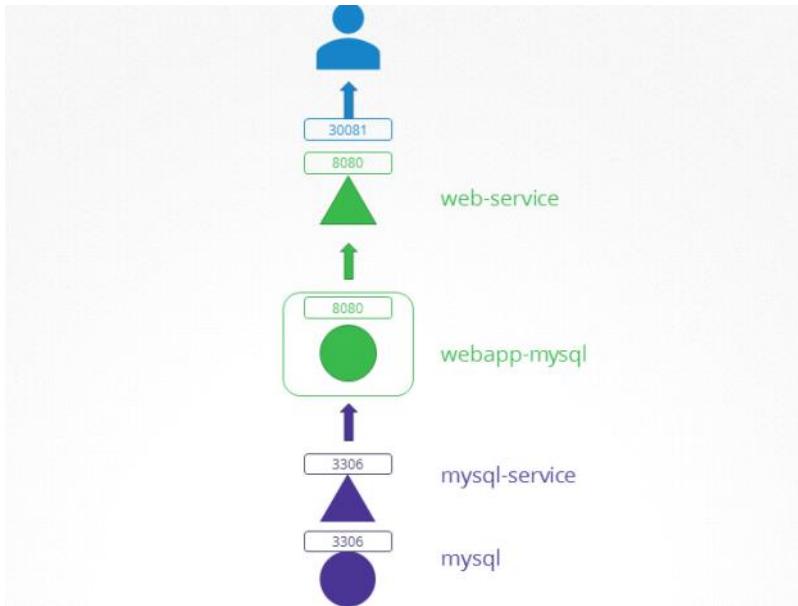
```
k run testpod --image=busybox:1.28 --rm -it --restart=never -- nslookup 10.12.244.10
```

# lab 1

Saturday, April 27, 2024 1:30 PM

## Troubleshooting Test 1

A simple 2 tier application is deployed in the alpha namespace. It must display a green web page on success. Click on the App tab at the top of your terminal to view your application. It is currently failed. Troubleshoot and fix the issue.



The "Name does not resolve" error typically occurs when your application or client is unable to resolve the hostname of the SQL server.

★ Switched Namespace to "alpha"

`kubectl config set-context --current --namespace=<desired-namespace>`

❓ How to know a pod is a deployment?

To determine if a given pod is deployed using a Deployment or created directly, you can inspect the pod's metadata. Here are a few steps you can follow:

Get Pod Information: Use the `kubectl describe pod <pod_name>` command to get detailed information about the pod.

**Check Owner References:** Look for the "Owner References" section in the pod description. If the pod is managed by a Deployment, you should see an owner reference indicating the Deployment's name and controller type.

**Identify Controller Type:** The controller type mentioned in the owner reference will indicate if the pod is part of a Deployment (controller type: Deployment) or created directly without a controller managing it.

In Kubernetes, the "Controller: true" attribute under the "Owner References" section of a resource's metadata indicates that the resource is managed by a controller. Controllers are

responsible for ensuring that the desired state of a resource matches its actual state, reconciling any differences as needed.

```
yaml
Owner References:
 Kind: Deployment
 Name: my-deployment
 Controller: true
```

This indicates that the pod is managed by a Deployment named "my-deployment."

On the other hand, if the pod is created directly without a controller, you may not see any owner references related to a Deployment or other controllers.

- ?
- To access the application, do a curl and then do a local host because it's accessible on the node port and the port is 30081.

Command-

curl <http://localhost:30081>

k get svc

Output

web-service NodePort 10.43.105.145 <none> 8080:30081/TCP 32m

### What is the relation between localhost and nodeport?

When you access a service using localhost and a specific port (e.g., <http://localhost:30081>), it typically means that you are trying to reach a service running on the same machine (localhost) through a specific port (30081).

In Kubernetes, a NodePort service exposes your service on a specific port on each node in the cluster. When you use localhost and the NodePort, it works as follows:

- NodePort Assignment: In your case, the service web-service has been assigned a NodePort of 30081. This means that the service is accessible on port 30081 on every node in your Kubernetes cluster.
- Localhost in the Cluster: When you use localhost in the context of a pod or a container running inside a Kubernetes cluster, it refers to the local network interface of that pod/container, not the actual host machine where the cluster is running.
- Accessing NodePort Services: To access a NodePort service from within the cluster, you typically use the cluster's internal DNS or service name, not localhost. For example, if your service is named web-service, you might access it from another pod using <http://web-service:30081>.
- Using Localhost: If you're accessing the service from outside the cluster, on the machine where Kubernetes is running, you can use localhost because the NodePort is bound to the host's IP address and is accessible locally.

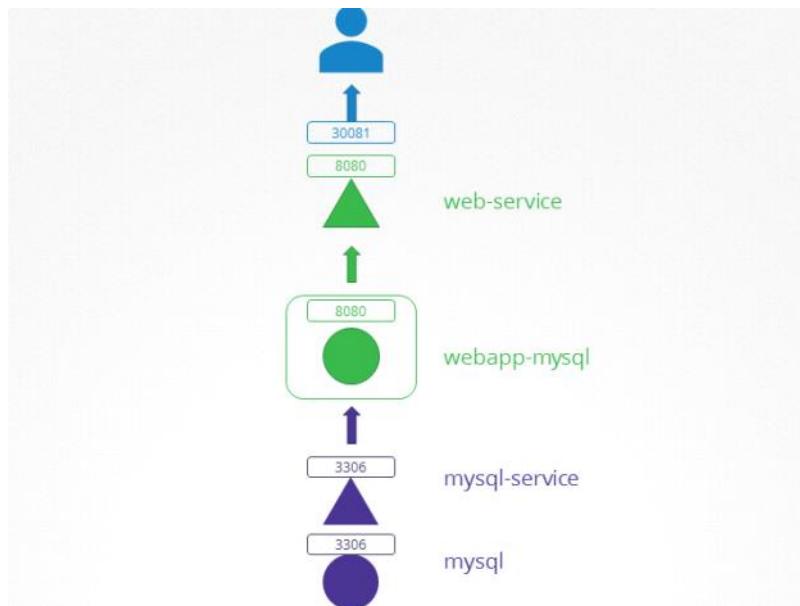
So, in summary, the relation between localhost and NodePort is that localhost refers to the local network interface of the machine or pod/container, and NodePort exposes a service on a specific port on each node in the Kubernetes cluster, making it accessible locally on the host machine using localhost.

## Solution

1. curl <http://localhost:30081>  
Accessed the web application successfully
2. Run 'kubectl get deploy', found that web application is deployed as deployment and sql is deployed as a pod.
3. When you run , '**kubectl describe pod webapp-mysql**' you'll find that "DB\_Host : mysql-service" while the name of the service for mysql is just "mysql"( **k get svc**). It's also mentioned in the diagram.
4. Change the name of svc from "mysql" to "mysql-service"(DB\_Host) using '**k edit svc mysql**'.
5. Save the changes using wq!
6. k replace --force -f /tmp/kubectl-edit-1427405591.yaml

## Troubleshooting Test 2:

The same 2 tier application is deployed in the beta namespace. It must display a green web page on success. Click on the App tab at the top of your terminal to view your application. It is currently failed. Troubleshoot and fix the issue.



**Environment Variables:** DB\_Host=mysql-service; DB\_Database=Not Set; DB\_User=root;  
DB\_Password=paswrd; 2003: Can't connect to MySQL server on 'mysql-service:3306' (111 Connection refused)

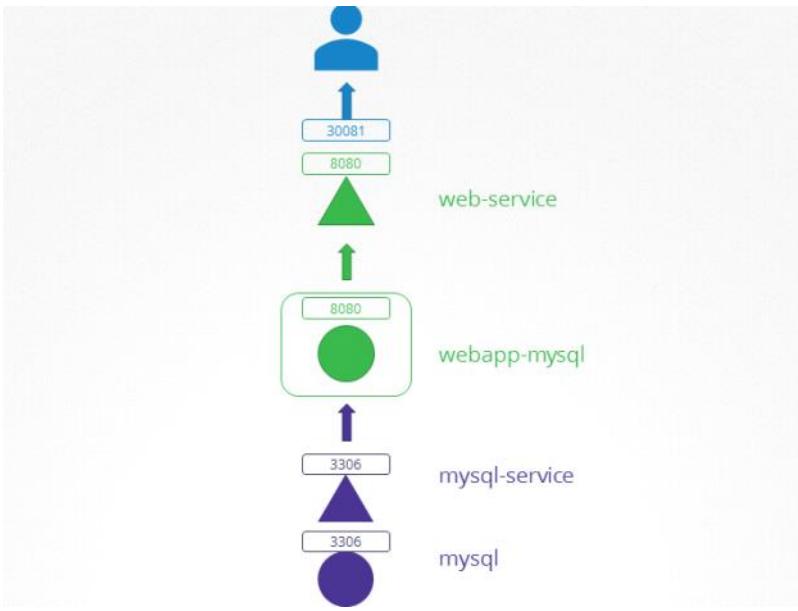
Since you are unable to access the application, look for endpoints, port, targetport and nodeport.

## Solution

1. Switch context to beta - k config set-context --current --namespace=beta
2. curl <http://localhost:30081> - Since website opens but unable to load the result means there is problem in service - mysql-service or pod - mysql.
3. Run "**kubectl describe svc mysql-service**" and "k get pods -o wide".  
IP address of both should be same(**Endpoint in service should be same as IP of pod**), labels and selectors should be same.
4. You'll find that port(**kubectl describe svc mysql-service**) is not matching as that given in diagram.  
Also - **By default `targetPort` is set to the same value as the `port` field.**
5. Edit the service using "kubectl edit svc mysql-service"
6. Save the changes using wq!
7. k replace --force -f /tmp/kubectl-edit-1427405591.yaml

## Troubleshooting Test 3:

The same 2 tier application is deployed in the gamma namespace. It must display a green web page on success. Click on the App tab at the top of your terminal to view your application. It is currently failed or unresponsive. Troubleshoot and fix the issue.



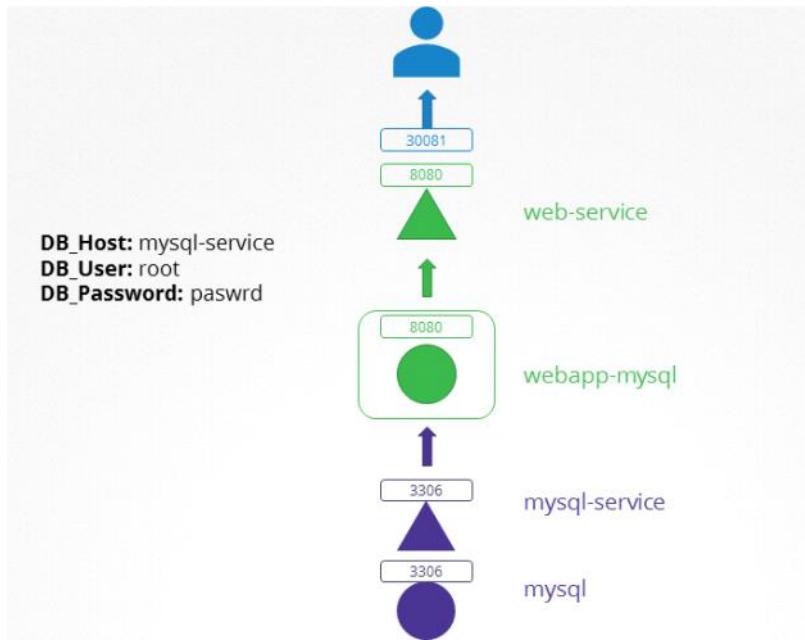
Environment Variables: DB\_Host=mysql-service; DB\_Database=Not Set; DB\_User=root;  
DB\_Password=paswrd; 2003: Can't connect to MySQL server on 'mysql-service:3306' (111 Connection refused)

1. k get pods - 0 restarts, Running
2. k get svc - ports and IP are there
3. The port of the web-service should be in the URL. For example 8080:30081/TCP is the port in the service then 30081 should be in the URL
4. k describe deploy - DB\_Host is same as the service name for db (DB\_Host: mysql-service)
5. Check labels for webpods - kubectl describe pod and kubectl describe svc  
Seems good
6. Check labels for database- kubectl describe pod and kubectl describe svc  
**Labels don't match.** Also, Let's check the endpoint, **k describe mysql service** and here you have no endpoints.
7. Edit the service file
8. Save it

#### Troubleshooting Test 4:

The same 2 tier application is deployed in the delta namespace. It must display a green web page on success. Click on the App tab at the top of your terminal to view your application. It is currently failed.

Troubleshoot and fix the issue.



Environment Variables: DB\_Host=mysql-service; DB\_Database=Not Set; DB\_User(sql-user);  
DB\_Password=paswrd; 1045 (28000): Access denied for user 'sql-user'@'10.42.0.16' (using password:  
YES)

1. Run 'k describe deploy' command and you'll find that DB\_USER is not matching with given username.
2. k edit deploy
3. save

## Troubleshooting Test 5

Environment Variables: DB\_Host=mysql-service; DB\_Database=Not Set; DB\_User(sql-user);  
DB\_Password=paswrd; 1045 (28000): Access denied for user 'sql-user'@'10.42.0.18' (using password: YES)  
From webapp-mysql-785cd8f94-nrvr2!

If you inspect the environment variable called `MYSQL_ROOT_PASSWORD`, you will notice that the value is incorrect as compared to the architecture diagram: -

```
root@controlplane:~# kubectl -n epsilon describe pod mysql | grep MYSQL_ROOT_PASSWORD
 MYSQL_ROOT_PASSWORD: passwooooorrddd
root@controlplane:~#
```

Correct this by deleting and recreating the `mysql` pod with the correct environment variable as follows: -

```
spec:
 containers:
 - env:
 - name: MYSQL_ROOT_PASSWORD
 value: paswrd
```

Also edit the `webapp-mysql` deployment and make sure that the `DB_User` environment variable is set to `root` as follows: -

```
spec:
 containers:
 - env:
 - name: DB_Host
 value: mysql-service
 - name: DB_User
 value: root
 - name: DB_Password
 value: paswrd
```

Once the objects are recreated, and you should be able to access the application.

For User Password related questions, you should also check '[ConfigMaps](#)' if issue is not resolved.

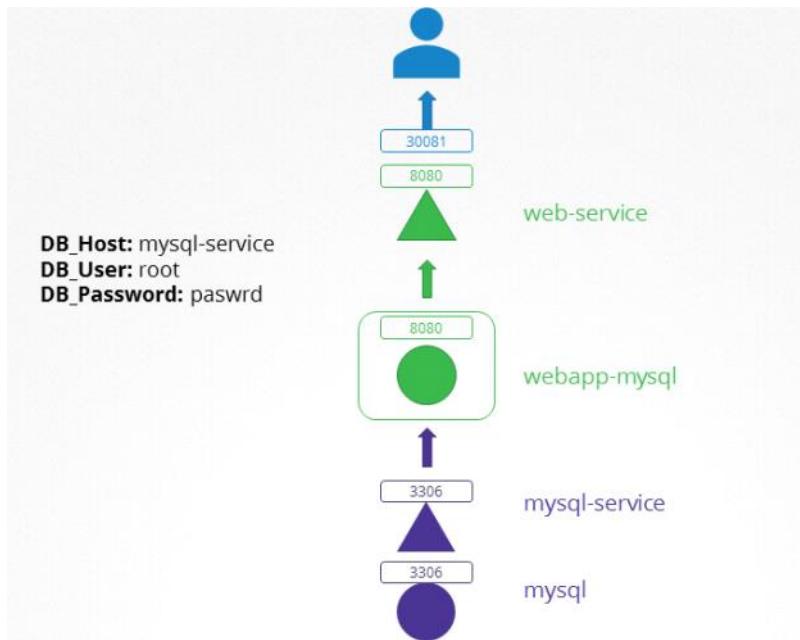
- ❓ if the `DB_USER=root` and `DB_PASSWORD=paswrd` in the deployment file, what will be the value of `MYSQL_ROOT_PASSWORD` in the pod?

The value of `MYSQL_ROOT_PASSWORD` in the pod would be set to the value specified in the `DB_PASSWORD` field of your deployment file, which is `paswrd`.

In Kubernetes deployments, environment variables defined in the deployment configuration are typically used to set corresponding environment variables inside the pods during runtime. Therefore, `DB_PASSWORD=paswrd` in your deployment file would be translated to `MYSQL_ROOT_PASSWORD=paswrd` inside the pod.

## Troubleshooting Test 6:

The same 2 tier application is deployed in the zeta namespace. It must display a green web page on success. Click on the App tab at the top of your terminal to view your application. It is currently failed. Troubleshoot and fix the issue.



502 Bad Gateway

There are a few things wrong in this setup:

1. If you inspect the `web-service`, you will see that the `nodePort` used is incorrect. This service should be exposed on port `30081` and NOT `30088`.

```
root@controlplane:~# kubectl -n zeta get svc web-service
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
web-service NodePort 10.102.190.212 <none> 8080:30088/TCP 3m1s
root@controlplane:~#
```

To correct this, delete the service and recreate it using the below YAML file:

```
apiVersion: v1
kind: Service
metadata:
 name: web-service
 namespace: zeta
spec:
 ports:
 - nodePort: 30081
 port: 8080
 targetPort: 8080
 selector:
 name: webapp-mysql
 type: NodePort
```

2. Also edit the `webapp-mysql` deployment and make sure that the `DB_User` environment variable is set to `root` as follows:-

```
spec:
 containers:
 - env:
 - name: DB_Host
 value: mysql-service
 - name: DB_User
 value: root
 - name: DB_Password
 value: paswrd
```

3. The `DB_Password` used by the `mysql` pod is incorrect. Delete the current pod and recreate with the correct environment variable as per the snippet below:-

```
spec:
 containers:
 - env:
 - name: MYSQL_ROOT_PASSWORD
 value: paswrd
```

Once the objects are recreated, and you should be able to access the application.

?

For making changes in the environment variable, should i make changes to pod definition file or deployment file ?

You should make changes to the `Deployment` file if you want to modify environment variables. The Deployment file defines the desired state of your application, including its environment variables. When you make changes to the Deployment file and apply those changes using `kubectl apply`, Kubernetes will update the corresponding Pods according to the new configuration specified in the Deployment.

?

Values realted to db-host, password and user is stored in deployment or pod ?

Values related to db-host, password, and user are typically stored in the Deployment or a ConfigMap in Kubernetes. Storing sensitive information like passwords in the Deployment directly is not recommended due to security concerns. Instead, you can use Kubernetes secrets to manage sensitive data securely.

?

Explain each field and also explain what port number should be written where

Port: <unset> 8080/TCP  
TargetPort: 8080/TCP  
NodePort: <unset> 30081/TCP  
Endpoints: 10.42.0.14:8080

?

Explain each field and also explain what port number should be written where

Port: <unset> 8080/TCP  
TargetPort: 8080/TCP  
NodePort: <unset> 30081/TCP  
Endpoints: 10.42.0.14:8080

Sure, let's break down each field in the context of a Kubernetes Service definition:

- Port: This field specifies the port number on which the service will be exposed within the Kubernetes cluster. In your example, the port is

<unset>, which means that Kubernetes will automatically assign a port number. However, typically you would specify a port number here. For example, Port: 8080 would mean the service is exposed on port 8080 internally.

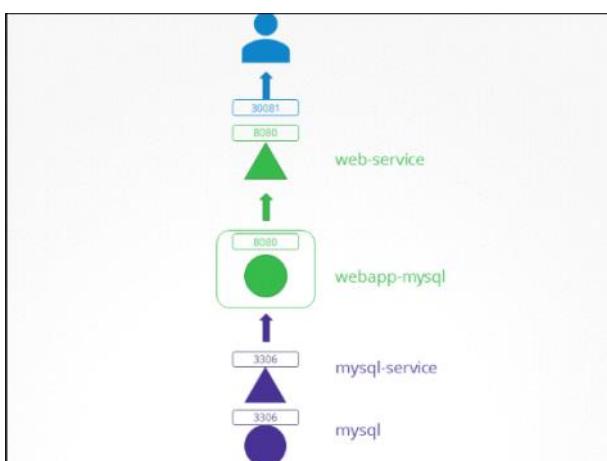
- TargetPort: This field specifies the port number on which the backend pods are listening. When a request is made to the service port (specified in the Port field), Kubernetes forwards the traffic to the pods' TargetPort. In your case, TargetPort: 8080 indicates that the pods are listening on port 8080 for incoming traffic from the service.
- NodePort: This field specifies the port number on which the service is exposed on each node in the cluster. It is used for accessing the service from outside the cluster (typically for development or testing purposes). In your example, NodePort: <unset> means Kubernetes will assign a NodePort automatically. However, NodePort: 30081 would specify that the service is accessible on port 30081 on each node.
- Endpoints: This field shows the IP address and port of the backend pods that the service is routing traffic to. In your case, Endpoints: 10.42.0.14:8080 indicates that the service is forwarding traffic to a pod with IP address 10.42.0.14 on port 8080.

To summarize, in a typical setup where you want to expose a service:

- Port should be set to the port number where the service will be accessible internally within the cluster.
- TargetPort should be set to the port number on which the backend pods are listening for traffic from the service.
- NodePort is optional and is used if you want to expose the service on a specific port on each node externally.
- Endpoints show the IP and port of the pods to which the service forwards traffic.

In your case, if you want to set specific port numbers:

- Port: 8080
- TargetPort: 8080
- NodePort: 30081 (if you want to expose the service externally on port 30081)
- Endpoints: 10.42.0.14:8080 (IP and port of the pod where the service is routing traffic)



For the database pod (mysql-service), the `MYSQL_ROOT_PASSWORD` environment variable is mandatory.

For the web application pod, the `DB_Host`, `DB_User`, and `DB_Password` environment variables are

required to establish a connection with the MySQL database.

It's common practice but not mandatory for MYSQL\_ROOT\_PASSWORD and DB\_Password to have the same value if your web application needs root-level access to the database.

For the MySQL database, you would typically use ClusterIP to expose it internally within the cluster.

- ★ targetPort: The port on which MySQL is listening inside the mysql pod (e.g., 3306). **The targetPort will not be that of webapp-service pod.**

# Control Plane Failures

Sunday, April 28, 2024 2:32 AM

1. Check Node status - Ready
2. Check pod status - Running

```
▶ kubectl get nodes
NAME STATUS ROLES AGE VERSION
worker-1 Ready <none> 8d v1.13.0
worker-2 Ready <none> 8d v1.13.0
```

```
▶ kubectl get pods
NAME READY STATUS RESTARTS AGE
mysql 1/1 Running 0 113m
webapp-mysql 1/1 Running 0 113m
```

3. If controlplane components

- a. Deployed as pod using tool like kubeadm, then pod in the kube-system namespace should be running

```
▶ kubectl get pods -n kube-system
NAME READY STATUS RESTARTS AGE
coredns-78fcdf6894-5dntv 1/1 Running 0 1h
coredns-78fcdf6894-knpzl 1/1 Running 0 1h
etcd-master 1/1 Running 0 1h
kube-apiserver-master 1/1 Running 0 1h
kube-controller-manager 1/1 Running 0 1h
kube-proxy-fvbppj 1/1 Running 0 1h
kube-proxy-v5r2t 1/1 Running 0 1h
kube-scheduler-master 1/1 Running 0 1h
weave-net-7kd52 2/2 Running 1 1h
weave-net-jtl5m 2/2 Running 1 1h
```

- a. Deployed as a service , check the status of services

on master node

```

▶ service kube-apiserver status
● kube-apiserver.service - Kubernetes API Server
 Loaded: loaded (/etc/systemd/system/kube-apiserver.service; enabled; vendor preset: enabled)
 Active: active (running) since Wed 2019-03-20 07:57:25 UTC; 1 weeks 1 days ago
 Docs: https://github.com/kubernetes/kubernetes
 Main PID: 15767 (kube-apiserver)
 Tasks: 13 (limit: 2362)

▶ service kube-controller-manager status
● kube-controller-manager.service - Kubernetes Controller Manager
 Loaded: loaded (/etc/systemd/system/kube-controller-manager.service; enabled; vendor preset: enabled)
 Active: active (running) since Wed 2019-03-20 07:57:25 UTC; 1 weeks 1 days ago
 Docs: https://github.com/kubernetes/kubernetes
 Main PID: 15771 (kube-controller)
 Tasks: 10 (limit: 2362)

▶ service kube-scheduler status
● kube-scheduler.service - Kubernetes Scheduler
 Loaded: loaded (/etc/systemd/system/kube-scheduler.service; enabled; vendor preset: enabled)
 Active: active (running) since Fri 2019-03-29 01:45:32 UTC; 11min ago
 Docs: https://github.com/kubernetes/kubernetes
 Main PID: 28390 (kube-scheduler)
 Tasks: 10 (limit: 2362)

```

on worker node

```

▶ service kubelet status
● kubelet.service - Kubernetes Kubelet
 Loaded: loaded (/etc/systemd/system/kubelet.service; enabled; vendor preset: enabled)
 Active: active (running) since Wed 2019-03-20 14:22:06 UTC; 1 weeks 1 days ago
 Docs: https://github.com/kubernetes/kubernetes
 Main PID: 1281 (kubelet)
 Tasks: 24 (limit: 1152)

▶ service kube-proxy status
● kube-proxy.service - Kubernetes Kube Proxy
 Loaded: loaded (/etc/systemd/system/kube-proxy.service; enabled; vendor preset: enabled)
 Active: active (running) since Wed 2019-03-20 14:21:54 UTC; 1 weeks 1 days ago
 Docs: https://github.com/kubernetes/kubernetes
 Main PID: 794 (kube-proxy)
 Tasks: 7 (limit: 1152)

```

4. Check the logs
  - a. if controlplane components are deployed as pod

```

▶ kubectl logs kube-apiserver-master -n kube-system
I0401 13:45:38.190735 1 server.go:703] external host was not specified, using 172.17.0.117
I0401 13:45:38.194290 1 server.go:145] Version: v1.11.3
I0401 13:45:38.819705 1 plugins.go:158] Loaded 8 mutating admission controller(s) successfully in the following order:
Namespacelifecycle,limitRanger,ServiceAccount,NodeRestriction,Priority,DefaultTolerationSeconds,DefaultStorageClass,MutatingAdmissionWebhook.
I0401 13:45:38.819741 1 plugins.go:161] Loaded 6 validating admission controller(s) successfully in the following order:
LimitRanger,ServiceAccount,Priority,PersistentVolumeClaimResize,ValidatingAdmissionWebhook,ResourceQuota.
I0401 13:45:38.821372 1 plugins.go:158] Loaded 8 mutating admission controller(s) successfully in the following order:
Namespacelifecycle,limitRanger,ServiceAccount,Priority,DefaultTolerationSeconds,DefaultStorageClass,MutatingAdmissionWebhook.
I0401 13:45:38.821410 1 plugins.go:161] Loaded 6 validating admission controller(s) successfully in the following order:
LimitRanger,ServiceAccount,Priority,PersistentVolumeClaimResize,ValidatingAdmissionWebhook,ResourceQuota.
I0401 13:45:38.985453 1 master.go:234] Using reconciler: lease
W0401 13:45:40.900380 1 genericapiserver.go:319] Skipping API batch/v2alpha1 because it has no resources.
W0401 13:45:41.370677 1 genericapiserver.go:319] Skipping API rbac.authorization.k8s.io/v1alpha1 because it has no resources.
W0401 13:45:41.381736 1 genericapiserver.go:319] Skipping API scheduling.k8s.io/v1alpha1 because it has no resources.

```

- b. If controlplane components are deployed as services, view logs using any logging solution

```
▶ sudo journalctl -u kube-apiserver
Mar 20 07:57:25 master-1 systemd[1]: Started Kubernetes API Server.
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.553377 15767 flags.go:33] FLAG: --address="127.0.0.1"
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558273 15767 flags.go:33] FLAG: --admission-control={}
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558325 15767 flags.go:33] FLAG: --admission-control-config-file=""
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558339 15767 flags.go:33] FLAG: --advertise-address="192.168.5.11"
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558353 15767 flags.go:33] FLAG: --allow-privileged=true
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558365 15767 flags.go:33] FLAG: --alsologtostderr=false
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558413 15767 flags.go:33] FLAG: --anonymous-auth=true
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558425 15767 flags.go:33] FLAG: --api-audiences=[]
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558442 15767 flags.go:33] FLAG: --apiserver-count=3
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558454 15767 flags.go:33] FLAG: --audit-dynamic-configuration=false
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558464 15767 flags.go:33] FLAG: --audit-log-batch-buffer-size=10000
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558474 15767 flags.go:33] FLAG: --audit-log-batch-max-size=1
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558484 15767 flags.go:33] FLAG: --audit-log-batch-max-wait=0s
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558495 15767 flags.go:33] FLAG: --audit-log-batch-throttle-burst=0
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558514 15767 flags.go:33] FLAG: --audit-log-batch-throttle-enable=false
Mar 20 07:57:25 master-1 kube-apiserver[15767]: I0320 07:57:25.558528 15767 flags.go:33] FLAG: --audit-log-format=json
```

## Kubernetes Docu - Troubleshooting Clusters

# lab 2

Sunday, April 28, 2024 2:41 AM

The cluster is broken. We tried deploying an application but it's not working. Troubleshoot and fix the issue.

Run the command: `kubectl get pods -n kube-system` and check the status of `kube-scheduler` pod.  
We need to check the `kube-scheduler` manifest file to fix the issue.

The `command` run by the scheduler pod is incorrect. Here is a snippet of the YAML file.

```
spec:
 containers:
 - command:
 - kube-scheduler
 - --authentication-kubeconfig=/etc/kubernetes/scheduler.conf
 - --authorization-kubeconfig=/etc/kubernetes/scheduler.conf
 - --bind-address=127.0.0.1
 - --kubeconfig=/etc/kubernetes/scheduler.conf
 - --leader-elect=true

```

Once this is corrected, the scheduler pod will be recreated.

- if a pod is not assigned to a node, then there's something with the 'scheduler'

`k get po -n kube-system`

- read the events section. Make the changes in manifest file directly as we know that the kube-scheduler is a static pod.
- Run `cat /etc/kubernetes/manifests` and then open `kube-scheduler.yaml` file.
- Make changes and save it(:wq!).

★ Static Pods are pods that are created and managed by a kubelet on a node, rather than by the Kubernetes API server. When the kubelet on a node detects a static pod manifest file in a specific directory, it creates a pod from the manifest file and manages the pod's lifecycle.

Static Pods are useful in situations where you need to run a pod on a node that is not part of a Kubernetes cluster or when you want to run a pod without relying on the Kubernetes API server.

**Kubernetes comes with several Static Pods that are configured by default. These include:**

- **kube-apiserver:** The API server for the Kubernetes control plane.
- **kube-controller-manager:** The controller manager that runs various controllers in the Kubernetes control plane.
- **kube-scheduler:** The component that schedules pods to run on nodes.

## Problem 2

Scale the deployment app to 2 pods.

Run - `kubectl scale deploy app --replicas=2`

## Problem 3

Even though the deployment was scaled to 2, the number of PODs does not seem to increase. Investigate and fix the issue. Inspect the component responsible for managing deployments and replicaset.

The job of making available the required set of replicas is of the controller manager. Check controller manager pods.

- 1) Run `kubectl describe pod kube-controller-manager-controlplane -n kube-system`
- 2) Check the events section.
- 3) If you have not found anything then check the logs
- 4) Run `kubectl logs kube-controller-manager-controlplane -n kube-system`
- 5) Here, in this problem found that somefile is missing or name is incorrect, try to look for same in doc and correct it.

- 6) Since, controller-manager is also a pod. The manifest file will be under "/etc/kubernetes/manifests"
- 7) Edit it and save it(:wq!).

1. Run k get deploy. found that 2/3 is Ready.
2. Run k get po -n kube-system. I found that the error is in the kube-controller-manager pod.
3. Run the k describe command. Didn't find anything related to an error in the "Event" section.
4. Run the k logs command. Found an error related to "Unable to load client ca file <filename>". It means there is a problem related to volume mount.
5. cat <filename>, it's present.
6. So we know that the way that the kube control manager or any other control plane component is set up is that the certificate files are on the control plane on the host. And then we use volumes to mount these directories i.e. <filename> within the same directory within the controller manager.
  - Control Plane Components: In Kubernetes, the control plane consists of several components responsible for managing the cluster. These components include the kube-apiserver, kube-scheduler, kube-controller-manager, etc.
  - Certificate Files: These components often require secure communication using certificates. For example, the kube-apiserver uses certificates for secure communication with other cluster components and users.
  - Storage of Certificate Files: The certificate files (like server certificates, client certificates, etc.) are stored on the control plane host machine. This ensures that they are securely managed and accessible to the control plane components.
  - Using Volumes: Kubernetes uses volumes to manage persistent data in pods. In this context, volumes are used to mount directories containing certificate files from the host machine into the pods running the control plane components.
  - Mounting Directories: By mounting these directories within the pods, the control plane components can access the required certificate files. This setup ensures that the components have the necessary security credentials for secure communication and operation within the Kubernetes cluster.

In summary, the explanation outlines how Kubernetes manages certificate files for control plane components by storing them on the host machine and using volumes to make them accessible within the pods where the components run.

7. Since, controller manager is also a static pod, open its manifest file.
8. go to volumeMount section

```

 timeoutSeconds: 15
volumeMounts:
- mountPath: /etc/ssl/certs
 name: ca-certs
 readOnly: true
- mountPath: /etc/ca-certificates
 name: etc-ca-certificates
 readOnly: true
- mountPath: /usr/libexec/kubernetes/kubelet-plugins/volume/exec
 name: flexvolume-dir
- mountPath: /etc/kubernetes/pki
 name: k8s-certs
 readOnly: true
- mountPath: /etc/kubernetes/controller-manager.conf
 name: kubeconfig
 readOnly: true
- mountPath: /usr/local/share/ca-certificates
 name: usr-local-share-ca-certificates
 readOnly: true
- mountPath: /usr/share/ca-certificates
 name: usr-share-ca-certificates
 readOnly: true

```

9. Find the mountPath mentioned in the error, the name of volume is k8s-certs.
10. Now, search for the "k8s-certs" volume in this yaml file.

```

volumes:
- hostPath:
 path: /etc/ssl/certs
 type: DirectoryOrCreate
 name: ca-certs
- hostPath:
 path: /etc/ca-certificates
 type: DirectoryOrCreate
 name: etc-ca-certificates
- hostPath:
 path: /usr/libexec/kubernetes/kubelet-plugins/volume/exec
 type: DirectoryOrCreate
 name: flexvolume-dir
- hostPath:
 path: /etc/kubernetes/WRONC-PKI-DIRECTORY
 type: DirectoryOrCreate
 name: k8s-certs
- hostPath:
 path: /etc/kubernetes/controller-manager.conf
 type: FileOrCreate
 name: kubeconfig
- hostPath:
 path: /usr/local/share/ca-certificates
 type: DirectoryOrCreate
 name: usr-local-share-ca-certificates
- hostPath:
 path: /usr/share/ca-certificates
 type: DirectoryOrCreate
 name: usr-share-ca-certificates

```

11. Here the path mentioned is wrong

```

 name: flexvolume-dir
 hostPath:
 path: /etc/kubernetes/WRONC-PKI-DIRECTORY
 type: DirectoryOrCreate
 name: k8s-certs
- hostPath:

```

12. replace it with /etc/kubernetes/pki as mentioned in the error.
13. Save the file (:wq!)
14. wait for pod to complete it

# Worker Node Failure

Sunday, April 28, 2024 4:22 PM

1. Check nodes - Nodes are Ready or NotReady
2. If NotReady, run **kubectl describe node <node-name>**
3. Each node has a set of conditions that can point us in a direction as to why a node might have failed. Depending on the **Status**, they are either set to true or false or unknown.
  - o When the node is out of disc space, the **OutOfDisk** flag is set to **true**.
  - o When a node is out of memory, the **MemoryPressure** flag is set to **true**.
  - o When the disc capacity is low, the **DiskPressure** flag is set to **true**.
  - o Similarly, when there are too many processes, the **PIDPressure** flag is set to **true**.
  - o And finally, if the node as a whole is healthy, the **Ready** flag is set to **true**.
4. When a worker node stops communicating with the master, maybe due to a crash, these statuses are set to unknown. Check the **LastHeartbeatTime** field to find out the time when the node might have crashed. In such cases, proceed to check the status of the node itself.

```
kubectl get nodes
NAME STATUS ROLES AGE VERSION
worker-1 Ready <none> 8d v1.13.0
worker-2 NotReady <none> 8d v1.13.0

kubectl describe node worker-1
Conditions:
 Type Status LastHeartbeatTime Reason Message
 ---- ---- ----
 OutOfDisk False Mon, 01 Apr 2019 14:30:33 +0000 KubeletHasSufficientDisk kubelet has sufficient disk space available
 MemoryPressure False Mon, 01 Apr 2019 14:30:33 +0000 KubeletHasSufficientMemory kubelet has sufficient memory available
 DiskPressure False Mon, 01 Apr 2019 14:30:33 +0000 KubeletHasNoDiskPressure kubelet has no disk pressure
 PIDPressure False Mon, 01 Apr 2019 14:30:33 +0000 KubeletHasSufficientPID kubelet has sufficient PID available
 Ready True Mon, 01 Apr 2019 14:30:33 +0000 KubeletReady kubelet is posting ready status. AppArmor enabled

kubectl describe node worker-1
Conditions:
 Type Status LastHeartbeatTime Reason Message
 ---- ---- ----
 OutOfDisk Unknown Mon, 01 Apr 2019 14:20:20 +0000 NodeStatusUnknown Kubelet stopped posting node status.
 MemoryPressure Unknown Mon, 01 Apr 2019 14:20:20 +0000 NodeStatusUnknown Kubelet stopped posting node status.
 DiskPressure Unknown Mon, 01 Apr 2019 14:20:20 +0000 NodeStatusUnknown Kubelet stopped posting node status.
 PIDPressure False Mon, 01 Apr 2019 14:20:20 +0000 KubeletHasSufficientPID kubelet has sufficient PID available
 Ready Unknown Mon, 01 Apr 2019 14:20:20 +0000 NodeStatusUnknown Kubelet stopped posting node status.
```

If the node is online at all or is crashed. If it's crashed, bring it back up.

Check for possible CPU, memory and disc space on the nodes.

```
▶ top
top - 14:43:56 up 3 days, 19:02, 1 user, load average: 0.35, 0.29, 0.21
Tasks: 112 total, 1 running, 72 sleeping, 0 stopped, 0 zombie
%Cpu(s): 3.9 us, 1.7 sy, 0.1 ni, 94.3 id, 0.0 wa, 0.0 hi, 0.1 si, 0.0 st
KiB Mem : 1009112 total, 74144 free, 736688 used, 198360 buff/cache
KiB Swap: 0 total, 0 free, 0 used. 129244 avail Mem

PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
 34 root 20 0 0 0 0 S 5.9 0.0 0:13.14 kswapd0
28826 999 20 0 1361320 383208 3596 S 5.9 38.0 0:46.95 mysqld
 1 root 20 0 78260 5924 3192 S 0.0 0.6 0:21.88 systemd
 2 root 20 0 0 0 0 S 0.0 0.0 0:00.02 kthreadd
 4 root 20 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/0:0H

▶ df -h
Filesystem Size Used Avail Use% Mounted on
udev 481M 0 481M 0% /dev
tmpfs 99M 1000K 98M 1% /run
/dev/sda1 9.7G 5.3G 4.5G 55% /
tmpfs 493M 0 493M 0% /dev/shm
tmpfs 5.0M 0 5.0M 0% /run/lock
tmpfs 493M 0 493M 0% /sys/fs/cgroup
tmpfs 99M 0 99M 0% /run/user/1000
```

Check the status of the kubelet.

Check the kubelet logs for possible issues.

```
▶ service kubelet status
● kubelet.service - Kubernetes Kubelet
 Loaded: loaded (/etc/systemd/system/kubelet.service; enabled; vendor preset: enabled)
 Active: active (running) since Wed 2019-03-20 14:22:06 UTC; 1 weeks 1 days ago
 Docs: https://github.com/kubernetes/kubernetes
 Main PID: 1281 (kubelet)
 Tasks: 24 (limit: 1152)

▶ sudo journalctl -u kubelet
-- Logs begin at Wed 2019-03-20 05:39:37 UTC, end at Mon 2019-04-01 14:42:42 UTC. --
Mar 20 08:12:59 worker-1 systemd[1]: Started Kubernetes Kubelet.
Mar 20 08:12:59 worker-1 kubelet[18962]: Flag --tts-cert-file has been deprecated, This parameter should be set via the config file specified by the Kubelet
Mar 20 08:12:59 worker-1 kubelet[18962]: Flag --tts-private-key-file has been deprecated, This parameter should be set via the config file specified by the
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.915179 18962 flags.go:33] FLAG: --address="0.0.0.0"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.918149 18962 flags.go:33] FLAG: --allow-privileged="true"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.918339 18962 flags.go:33] FLAG: --allowed-unsafe-systlcs="[]"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.918502 18962 flags.go:33] FLAG: --alsologtostderr="false"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.918648 18962 flags.go:33] FLAG: --anonymous-auth="true"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.918841 18962 flags.go:33] FLAG: --application-metrics-count-limit="100"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.918974 18962 flags.go:33] FLAG: --authentication-token-webhook="false"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.919096 18962 flags.go:33] FLAG: --authentication-token-webhook-cache-ttl="2m0s"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.919299 18962 flags.go:33] FLAG: --authorization-mode="AlwaysAllow"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.919466 18962 flags.go:33] FLAG: --authorization-webhook-cache-authorized-ttl="5m0s"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.919598 18962 flags.go:33] FLAG: --authorization-webhook-cache-unauthorized-ttl="30s"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.919791 18962 flags.go:33] FLAG: --azure-container-registry-config=""
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.919971 18962 flags.go:33] FLAG: --boot-id-file="/proc/sys/kernel/random/boot_id"
Mar 20 08:12:59 worker-1 kubelet[18962]: I0320 08:12:59.920102 18962 flags.go:33] FLAG: --bootstrap-checkpoint-path=""
```

Check the kubelet certificates. Ensure they're not expired, and they're part of the right group, and that the certificates are issued by the right CA.

```
openssl x509 -in /var/lib/kubelet/worker-1.crt -text

Certificate:
Data:
 Version: 3 (0x2)
 Serial Number:
 ff:e0:23:9d:fc:78:03:35
 Signature Algorithm: sha256WithRSAEncryption
 Issuer: CN = KUBERNETES-CA
 Validity
 Not Before: Mar 20 08:09:29 2019 GMT
 Not After : Apr 19 08:09:29 2019 GMT
 Subject: CN = system:node:worker-1, O = system:nodes
 Subject Public Key Info:
 Public Key Algorithm: rsaEncryption
 Public-Key: (2048 bit)
 Modulus:
 00:b4:28:0c:60:71:41:06:14:46:d9:97:58:2d:fe:
 a9:c7:6d:51:c1:c9:b9:5e:e6:e4:02:d3:e3:71:
 58:a1:60:fe:cb:e7:9b:4b:86:04:67:b5:4f:da:d6:
 6c:08:3f:57:e9:70:59:57:48:6a:ce:e5:d4:f3:6e:
 b2:fa:8a:18:7e:21:60:35:8f:44:f7:a9:39:57:16:
 4f:4e:1e:b1:a3:77:32:c2:ef:d1:38:b4:82:20:8f:
 11:0e:79:c4:d1:9b:f6:82:c4:88:84:84:68:d5:c3:
 e2:15:a0:ce:23:3c:8d:9c:b8:dd:fc:3a:cd:42:ae:
 5e:1b:80:2d:1b:e5:5d:1b:c1:fb:be:a3:9e:82:ff:
 a1:27:c8:b6:0f:3c:cb:11:f9:1a:9b:d2:39:92:0e:
 47:45:b8:8f:98:13:c6:4d:6a:18:75:a4:01:6f:73:
 f6:f8:7f:eb:5d:59:94:46:d8:da:37:75:cf:27:0b:
 39:7f:48:20:c5:fd:c7:a7:ce:22:9a:33:4a:38:1d:
 95:ef:00:bd:fe:47:22:42:44:99:77:5a:c4:97:bb:
 37:93:7c:33:64:f4:b8:3a:53:8c:f4:10:db:7f:5f:
 2b:89:18:d6:0e:68:51:34:29:b1:f1:61:6b:4b:c6:
 0:73:20:76:5:85:10:00:50:5b:1:51:95:65:2b:
```

# lab 3

Sunday, April 28, 2024 5:23 PM

Fix the broken cluster

Fix node01

If you are in controlplane(masternode), switch to node01(workernode).

Step1. Check the status of services on the nodes.

- **systemctl status kubelet**

OR

- **service kubelet status**

Step2. Check the service logs using **journalctl -u kubelet**.

Step1: Check the status of the nodes:

```
controlplane:~> kubectl get nodes
NAME STATUS ROLES AGE VERSION
controlplane Ready control-plane 19m v1.27.0
node01 NotReady <none> 19m v1.27.0

controlplane:~>
```

Step 2: SSH to `node01` and check the status of the container runtime (`containerd`, in this case) and the `kubelet` service.

```
root@node01:~> systemctl status containerd
● containerd.service - containerd container runtime
 Loaded: loaded (/lib/systemd/system/containerd.service; enabled; vendor preset: enabled)
 Active: active (running) since Tue 2023-05-30 12:45:03 EDT; 20min ago
 Docs: https://containerd.io
 Main PID: 995 (containerd)
 Tasks: 108
 Memory: 146.8M
 CPU: 0.000 CPU(s)
 CGroup: /system.slice/containerd.service
 └─ 995 /usr/bin/containerd

root@node01:~>
root@node01:~> systemctl status kubelet
● kubelet.service - kubelet: The Kubernetes Node Agent
 Loaded: loaded (/lib/systemd/system/kubelet.service; enabled; vendor preset: enabled)
 Drop-In: /etc/systemd/system/kubelet.service.d
 └─ 10-kubeadm.conf
 Active: inactive (dead) since Tue 2023-05-30 12:47:30 EDT; 18min ago
 Docs: https://kubernetes.io/docs/home/
 Process: 1978 ExecStart=/usr/bin/kubelet $KUBELET_KUBECONFIG_ARGS $KUBELET_CONFIG_ARGS $KUBELET_KUBEADM_ARGS $KUBELET_EXTRA_ARGS (code=exit
 Main PID: 1978 (code=exited, status=0/SUCCESS)
```

Step3. If it's stopped then start the stopped services. As we haven't found anything after running "kubectl describe" and "journalctl -u kubelet" commands.

Alternatively, run the command:

```
ssh node01 "service kubelet start"
```

or

```
systemctl start kubelet
```

Since the `kubelet` is not running, attempt to start it by running the following command:

```
root@node01:~> systemctl start kubelet

root@node01:~> systemctl status kubelet
● kubelet.service - kubelet: The Kubernetes Node Agent
 Loaded: loaded (/lib/systemd/system/kubelet.service; enabled; vendor preset: enabled)
 Drop-In: /etc/systemd/system/kubelet.service.d
 └─10-kubeadm.conf
 Active: active (running) since Tue 2023-05-30 13:06:47 EDT; 6s ago
 Docs: https://kubernetes.io/docs/home/
 Main PID: 4313 (kubelet)
 Tasks: 15 (limit: 77091)
 Memory: 31.4M
 CPU: 0.000 CPU(s) since start
 CGroup: /system.slice/kubelet.service
```

`node01` should go back to ready state now.

## Problem 2

Fix the broken cluster

Solution

1. Run `k get nodes` command to check "Ready"
2. Run `k describe node` command to check events
3. ssh `node01`
4. Run service `kubelet` status. Found it's activating but exited.
5. Try restarting it using `service kubelet start`. It doesn't activate.
6. Check the log using `journalctl -u kubelet`. Check the logs and found that a filepath is wrong.
7. `Kubelet manifests files are found at /var/lib/kubelet/config.yaml. Edit it and save it.`  
`kubelet config file are found at /etc/kubernetes/kubelet.conf.`

Kubelet Manifest Files

- Location: `/var/lib/kubelet/config.yaml`
- Purpose: This file contains configuration settings for the kubelet, the primary node agent that runs on each node. The settings in this file control various aspects of the kubelet's behavior, such as how it manages pods, interacts with the container runtime, and other operational parameters.

### Kubelet Config File

- Location: /etc/kubernetes/kubelet.conf
- Purpose: This file typically contains the kubelet's configuration information used to connect to the Kubernetes API server. It includes settings such as the kubelet's API endpoint, authentication credentials, and TLS settings.

8. Run service kubelet restart.

`kubelet` has stopped running on `node01` again. Since this is a systemd managed system, we can check the `kubelet` log by running `journalctl` command. Here is a snippet showing the error with `kubelet`:

```
journalctl -u kubelet

[...]
node01 kubelet[4554]: E0530 13:08:20.141826 4554 run.go:74] "command failed" err="failed to construct kubelet dependencies: unable to load client
[...]
```

There appears to be a mistake path used for the CA certificate in the `kubelet` configuration.

This can be corrected by updating the file `/var/lib/kubelet/config.yaml` as follows: -

```
x509:
 clientCAFile: /etc/kubernetes/pki/WRONC-CA-FILE.crt
```

Update the CA certificate file `WRONC-CA-FILE.crt` to `ca.crt`.

Once this is fixed, restart the `kubelet` service, (like we did in the previous question) and `node01` should return back to a working state.

## Problem 3

1. After running `journalctl -u kubelet`, go to the end.
2. Start reading logs from backwards.
3. Here you can see "Unable to register node and you can see the control plane and dial TCP 10.54.130.2:6553 connection refused." So this seems to be the error that's causing the remaining errors. And if you look at it, it says connection refused to this. And this is basically for the control plane that we have. And it looks like this port number is incorrect because we know that the **control plane port number is 6443 and not 6553**.
4. `vi /etc/kubernetes/kubelet.conf` file and change the port number.

**What is the difference between `/etc/kubernetes/kubelet.conf` file and `/var/lib/kubelet/config.yaml`?**

You would typically check `kubelet.conf` for kubelet-specific configuration errors or connectivity issues,

while **config.yaml** is checked for node-specific configurations affecting pod behavior and static pod management.

The kubelet.conf file and the config.yaml file in Kubernetes serve different purposes and are checked in different troubleshooting scenarios:

#### kubelet.conf (kubelet configuration file):

- Location: Usually found at /etc/kubernetes/kubelet.conf.
- Purpose: This file contains the configuration settings for the kubelet, which is responsible for managing the pods on a node.
- When to Check:
- Configuration Errors: If there are issues related to the configuration of the kubelet, such as incorrect API server endpoints, authentication settings, or TLS configurations.
- Node Connectivity: If there are connectivity issues between the kubelet and the API server, checking the kubelet configuration can help identify misconfigurations.
- Authentication and Authorization: Issues related to authentication and authorization of kubelet requests may require checking this configuration file.

#### config.yaml (kubelet manifest file):

- Location: Typically located at /var/lib/kubelet/config.yaml.
- Purpose: This file is part of the kubelet's manifest files and includes configurations for the kubelet itself, like static pod manifests, node labels, and pod eviction policies.
- When to Check:
- Pod Eviction and Scheduling: If there are issues with pod scheduling or pod evictions on the node, checking the kubelet's manifest file can provide insights into the node's configurations affecting pod behavior.
- Node-Specific Configurations: Settings specific to the node, such as node labels or taints, are defined in this file. If these settings need adjustment or if there are issues related to them, checking this file is necessary.
- Static Pods: If there are static pods managed by the kubelet on the node, their configurations are defined in this file.

# Network

Sunday, April 28, 2024 11:11 PM

# kubectl not working

Friday, May 24, 2024 6:15 PM

Sometimes , kubectl is not working. In that case how can we work using docker or crictl commands?

If kubectl is not working, you can still interact with containers in a Kubernetes cluster using Docker commands or crictl commands (if your cluster uses CRI-O or containerd as the container runtime). Here's how you can work with Docker or crictl in such situations:

## **Using Docker Commands:**

List Pods: You can list the pods running in the cluster using Docker:

```
docker ps -a | grep kube-*
```

Inspect Containers: You can inspect specific containers using Docker:

```
docker inspect <container-id>
```

View Logs: You can view logs of a container using Docker:

```
docker logs <container-id>
```

Execute Commands: You can execute commands inside a container using Docker:

```
docker exec -it <container-id> <command>
```

Replace <container-id> with the actual ID of the container you want to interact with.

## **Using crictl Commands:**

If your cluster uses CRI-O or containerd, you can use crictl commands to interact with containers. Here are some common crictl commands:

List Containers:

```
crictl ps
```

Inspect Container:

```
crictl inspect <container-id>
```

View Logs:

```
crictl logs <container-id>
```

Execute Commands:

```
cricl exec -it <container-id> <command>
```

Replace <container-id> with the actual ID of the container you want to interact with.

Keep in mind that using Docker or crictl directly bypasses the Kubernetes API and may not provide all the functionalities and features available through kubectl. It's recommended to use kubectl whenever possible for managing and interacting with Kubernetes resources.

# JSON

Friday, May 3, 2024 11:23 AM

You don't learn to walk by following rules. You learn by doing, and falling over.

For any given data, you apply a query and get the result. Similarly, for JSON data, you apply JSON PATH Query and get the result.

- Everything inside a curly braces is a dictionary in JSON.

The diagram illustrates a JSON object on the left and its resulting output on the right after applying a query. The JSON object contains a 'car' key with a value of an object. This object has 'color' and 'price' keys. A green box highlights the entire object under 'car'. The resulting output on the right shows the 'car' key followed by a green arrow pointing to a box containing 'color: blue' and 'price: \$20,000'.

```
{ "car": { "color": "blue", "price": "$20,000" }}
```

```
car:
 color: blue
 price: $20,000
```

- Everything inside a Square brace is a List in JSON. Elements are separated by commas.

The diagram illustrates a JSON object on the left and its resulting output on the right after applying a query. The JSON object contains a 'car' key with a value of an object. This object has 'color', 'price', and 'wheels' keys. The 'wheels' key has a value of a list containing four objects, each with 'model' and 'location' keys. A green box highlights the entire list under 'wheels'. The resulting output on the right shows the 'car' key followed by a green arrow pointing to a box containing the expanded list elements.

```
{ "car": { "color": "blue", "price": "$20,000", "wheels": [{ "model": "X345ERT", "location": "front-right" }, { "model": "X345ERT", "location": "front-left" }, { "model": "X345ERT", "location": "rear-right" }, { "model": "X345ERT", "location": "rear-right" }] }
```

```
car:
 color: blue
 price: $20,000
 wheels:
 - model: X345ERT
 location: front-right
 - model: X345ERT
 location: front-left
 - model: X345ERT
 location: rear-right
 - model: X345ERT
 location: rear-right
```

# | Root element

|                                                                                                               | QUERY                           | RESULT                                              |
|---------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------------------------------|
| <pre>[{"car": {"color": "blue", "price": "\$20,000"}, "bus": {"color": "white", "price": "\$120,000"}}]</pre> | Get car details<br>\$.car       | {<br>"color": "blue",<br>"price": "\$20,000"<br>}   |
|                                                                                                               | Get bus details<br>\$.bus       | {<br>"color": "white",<br>"price": "\$120,000"<br>} |
|                                                                                                               | Get car's color<br>\$.car.color | "blue"                                              |
|                                                                                                               | Get bus's price<br>\$.bus.price | "\$120,000"                                         |

The top level dictionary which has no name is known as root element of a JSON Document, denoted by \$.

| DATA                                                                                                                         | QUERY                                    | RESULT                                                        |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------------------------------------------------------|
| <pre>{ "vehicles": { "car": {"color": "blue", "price": "\$20,000"}, "bus": {"color": "white", "price": "\$120,000"} }}</pre> | Get car details<br>\$.vehicles.car       | [<br>{<br>"color": "blue",<br>"price": "\$20,000"<br>}<br>]   |
|                                                                                                                              | Get bus details<br>\$.vehicles.bus       | [<br>{<br>"color": "white",<br>"price": "\$120,000"<br>}<br>] |
|                                                                                                                              | Get car's color<br>\$.vehicles.car.color | [<br>"blue"<br>]                                              |
|                                                                                                                              | Get bus's price<br>\$.vehicles.bus.price | [<br>"\$120,000"<br>]                                         |

Note: The output of a JSON PATH Query is within a pair of square brackets.

## List

```
[
0 "car",
1 "bus",
2 "truck",
3 "bike"
]
```

Get the 1<sup>st</sup> element

```
$[0]
```

```
["car"]
```

Get the 4<sup>th</sup> element

```
$[3]
```

```
["bike"]
```

Get the 1<sup>st</sup> and 4<sup>th</sup> element

```
$[0,3]
```

```
["car", "bike"]
```

## Dictionary and List

```
{
 "car": {
 "color": "blue",
 "price": "$20,000",
 "wheels": [
 {
 "model": "X345ERT",
 "location": "front-right"
 },
 {
 "model": "X346GRX",
 "location": "front-left"
 },
 {
 "model": "X236DEM",
 "location": "rear-right"
 },
 {
 "model": "X987XMV",
 "location": "rear-right"
 }
]
 }
}
```

Get the model of the 2<sup>nd</sup> wheel

```
$.car.wheels[1].model
```

```
"X346GRX"
```

## Criteria

notin = not in

```

[
 12,
 43,
 23,
 12,
 56,
 43,
 93,
 32,
 45,
 63,
 27,
 8,
 78
]

Get all numbers greater than 40
${[Check if each item in the array > 40]}

Check if => ? ()

${[?(each item in the list > 40)]}

each item in the list => @

${[?(@ > 40)]}

@ == 40 @ in [40,43,45]
@ != 40 @ nin [40,43,45]

```

```

[
 43,
 56,
 43,
 93,
 45,
 63,
 78
]

```

**Question - Give the model number of wheels having location = "rear-right".**

| DATA                                                                                                                                                                                                                                                                                                                                                                                                                     | QUERY                                                                   | RESULT                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------|
| <pre>{   "car": {     "color": "blue",     "price": "\$20,000",     "wheels": [       {         "model": "X345ERT",         "location": "front-right"       },       {         "model": "X236DEM",         "location": "rear-right"       },       {         "model": "X346GRX",         "location": "front-left"       },       {         "model": "X987XMV",         "location": "rear-left"       }     ]   } }</pre> | <pre>Get the model of the rear-right wheel \$.car.wheels[2].model</pre> | <pre>\$.car.wheels[?( @.location == "rear-right" )].model  "X236DEM"</pre> |

# Problems

Friday, May 3, 2024 4:01 PM

```
alpine-host ~ ➔ cat q1.json
{
 "property1": "value1",
 "property2": "value2"
}
alpine-host ~ ➔ cat q1.json | jpath $.property1
[
 "value1"
]
```

```
echo "cat q1.json | jpath $.property1" > answer2.sh
```

# JSON - k8s

Saturday, May 4, 2024 12:15 AM

kube-apiserver return the result of kubectl query in a JSON format and converts the data into human readable format. While converting the data to human readable format, some information gets lost, To save this loss of information, we can use JSON Path.

## How to JSON PATH in KubeCtl?

- Identify the **kubectl** command
- Familiarize with **JSON** output
- Form the **JSON PATH** query  

'\$' not mandatory. Kubectl adds it
- Use the **JSON PATH** query with **kubectl** command

```
▶ kubectl get nodes -o json
```

```
▶ kubectl get pods -o json
```

```
{
 "apiVersion": "v1",
 "kind": "List",
 "items": [
 {
 "apiVersion": "v1",
 "kind": "Pod",
 "metadata": {
 "name": "nginx-5557945097-gznjp",
 },
 "spec": {
 "containers": [
 {
 "image": "nginx:alpine",
 "name": "nginx"
 }
]
 },
 "nodeName": "node01"
 }
]
}
```

```
▶ kubectl get pods -o=jsonpath='{ .items[0].spec.containers[0].image }'
```

# I JSON PATH Examples

```
▶ kubectl get nodes -o=jsonpath='{.items[*].metadata.name}'
master node01
```

```
{
 "apiVersion": "v1",
 "items": [
 {
 "apiVersion": "v1",
 "kind": "Node",
 "metadata": {
 "name": "master"
 },
 "status": {
 "capacity": {
 "cpu": "4"
 },
 "nodeInfo": {
 "architecture": "amd64",
 "operatingSystem": "linux"
 }
 }
 },
 {
 "apiVersion": "v1",
 "kind": "Node",
 "metadata": {
 "name": "node01"
 },
 "status": {
 "capacity": {
 "cpu": "4"
 },
 "nodeInfo": {
 "architecture": "amd64",
 "operatingSystem": "linux"
 }
 }
 }
],
 "kind": "List",
 "version": "v1"
}
```

Udemy

# I JSON PATH Examples

```
▶ kubectl get nodes -o=jsonpath='{.items[*].metadata.name}'
master node01
```

```
▶ kubectl get nodes -o=jsonpath='{.items[*].status.nodeInfo.architecture}'
amd64 amd64
```

```
{
 "apiVersion": "v1",
 "items": [
 {
 "apiVersion": "v1",
 "kind": "Node",
 "metadata": {
 "name": "master"
 },
 "status": {
 "capacity": {
 "cpu": "4"
 },
 "nodeInfo": {
 "architecture": "amd64",
 "operatingSystem": "linux"
 }
 }
 },
 {
 "apiVersion": "v1",
 "kind": "Node",
 "metadata": {
 "name": "node01"
 },
 "status": {
 "capacity": {
 "cpu": "4"
 },
 "nodeInfo": {
 "architecture": "amd64",
 "operatingSystem": "linux"
 }
 }
 }
],
 "kind": "List",
 "version": "v1"
}
```

Udemy

# I JSON PATH Examples

# I JSON PATH Examples

```
▶ kubectl get nodes -o=jsonpath='{.items[*].metadata.name}'
master node01

▶ kubectl get nodes -o=jsonpath='{.items[*].status.nodeInfo.architecture}'
amd64 amd64

▶ kubectl get nodes -o=jsonpath='{.items[*].status.capacity.cpu}'
4 4
```

```
{
 "apiVersion": "v1",
 "items": [
 {
 "apiVersion": "v1",
 "kind": "Node",
 "metadata": {
 "name": "master"
 },
 "status": {
 "capacity": {
 "cpu": "4"
 },
 "nodeInfo": {
 "architecture": "amd64",
 "operatingSystem": "linux",
 }
 }
 },
 {
 "apiVersion": "v1",
 "kind": "Node",
 "metadata": {
 "name": "node01",
 },
 "status": {
 "capacity": {
 "cpu": "4",
 },
 "nodeInfo": {
 "architecture": "amd64",
 "operatingSystem": "linux",
 }
 }
 }
],
 "kind": "list",
}
```

Üdemis

You can also merge these commands.

# I JSON PATH Examples

```
▶ kubectl get nodes -o=jsonpath='{.items[*].metadata.name}'
master node01

▶ kubectl get nodes -o=jsonpath='{.items[*].status.nodeInfo.architecture}'
amd64 amd64

▶ kubectl get nodes -o=jsonpath='{.items[*].status.capacity.cpu}'
4 4

▶ kubectl get nodes -o=jsonpath='{.items[*].metadata.name}{.items[*].status.capacity.cpu}'
master node01 4 4
```

\n - New Line  
\t - Tab

We have added a new line so that CPU capacity starts from the new line.,

```
▶ kubectl get nodes -o=jsonpath='{.items[*].metadata.name}{"\n"}{.items[*].status.capacity.cpu}'
```

```
master node01
4 4
```

But we want some different format like following

```
master 4
node01 4
```

Fig 1

## Range

Range is just like "for-each", it traverse through each element.

For above example

```
▶ kubectl get nodes -o=jsonpath=
'{range .items[*]}{.metadata.name} {"\t"} {.status.capacity.cpu} {"\n"}{end}'
```

## Column Name

```
▶ kubectl get nodes -o=custom-columns=NODE:.metadata.name,CPU:.status.capacity.cpu
```

```
NODE CPU
master 4
node01 4
```

## Sort

```
▶ kubectl get nodes --sort-by=.metadata.name
```

| NAME   | STATUS | ROLES  | AGE | VERSION |
|--------|--------|--------|-----|---------|
| master | Ready  | master | 5m  | v1.11.3 |
| node01 | Ready  | <none> | 5m  | v1.11.3 |

```
▶ kubectl get nodes --sort-by=.status.capacity.cpu
```

| NAME   | STATUS | ROLES  | AGE | VERSION |
|--------|--------|--------|-----|---------|
| master | Ready  | master | 5m  | v1.11.3 |
| node01 | Ready  | <none> | 5m  | v1.11.3 |

# lab

Saturday, May 4, 2024 1:09 AM

Get the list of nodes in JSON format and store it in a file at /opt/outputs/nodes.json.

Use the command `kubectl get nodes -o json > /opt/outputs/nodes.json`

Use JSON PATH query to fetch node names and store them in /opt/outputs/node\_names.txt.

Use the command

`kubectl get nodes -o=jsonpath='{.items[*].metadata.name}' > /opt/outputs/node_names.txt`

```
controlplane ~ ➔ kubectl get po -n kube-system -o=jsonpath='{range .items[*]}{.metadata.name}{"\n"}{end}'
coredns-69f9c977-9kvtw
coredns-69f9c977-rfrmt
etcd-controlplane
kube-apiserver-controlplane
kube-controller-manager-controlplane
kube-proxy-7k2jm
kube-proxy-hx6gr
kube-scheduler-controlplane
```

```
controlplane ~ ➔ kubectl get nodes -o=custom-columns=NODE:.metadata.name,CPU:.status.capacity.cpu
NODE CPU
controlplane 36
node01 36
```

```
controlplane ~ ➔ kubectl get pods -A -o=custom-columns=POD:.metadata.name,IP:.status.podIP --sort-by=.status.podIP
POD IP
coredns-69f9c977-9kvtw 10.244.0.2
coredns-69f9c977-rfrmt 10.244.0.3
nginx 10.244.1.2
kube-flannel-ds-2pqzk 192.23.140.3
etcd-controlplane 192.23.140.3
kube-apiserver-controlplane 192.23.140.3
kube-controller-manager-controlplane 192.23.140.3
kube-proxy-hx6gr 192.23.140.3
kube-scheduler-controlplane 192.23.140.3
kube-flannel-ds-6g4cz 192.23.140.6
kube-proxy-7k2jm 192.23.140.6
```

# Additional Pages

Sunday, April 14, 2024 11:58 AM

Below sections are addition

# Rolling Updates and Rollbacks

Sunday, March 3, 2024 7:10 PM

## Deployment Strategy

- Recreate
- Rolling Updates(deafult)

What we can update - application version, labels, replicas ?

update vs upgrade

how how a deployment performs an upgrade

Before the rollback, the first replica set had zero pods,

and new replica set had five pods,

and this is reversed after the rollback is finished.

|          |                                                                                                                                               |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Create   | <pre>&gt; kubectl create -f deployment-definition.yml</pre>                                                                                   |
| Get      | <pre>&gt; kubectl get deployments</pre>                                                                                                       |
| Update   | <pre>&gt; kubectl apply -f deployment-definition.yml</pre><br><pre>&gt; kubectl set image deployment/myapp-deployment nginx=nginx:1.9.1</pre> |
| Status   | <pre>&gt; kubectl rollout status deployment/myapp-deployment</pre><br><pre>&gt; kubectl rollout history deployment/myapp-deployment</pre>     |
| Rollback | <pre>&gt; kubectl rollout undo deployment/myapp-deployment</pre>                                                                              |

# Configuring Application

Sunday, March 3, 2024 7:21 PM

Configuring applications comprises of understanding the following concepts:

- Configuring Command and Arguments on applications
- Configuring Environment Variables
- Configuring Secrets

# Commands and Arguments- Docker

Sunday, March 3, 2024 7:21 PM

Question - When you run a 'docker run ubuntu' command and then run 'docker ps -a', you will find that the container is in 'exited' state, why is this so?

When we ran the Ubuntu container earlier,

Docker created a container from the Ubuntu image

and launched the bash program.

By default, Docker does not attach a terminal

to a container when it is run.

And so the bash program does not find the terminal

and so it exits.

- Unlike virtual machines,

containers are not meant to host an operating system.

Containers are meant to run a specific task

or process, such as to host an instance

of a web server or application server or a database,

or simply to carry out some computation or analysis.

Once the task is complete, the container exits.

- A container only lives as long as the process

inside it is alive.

If the web service inside the container is stopped

or crashes, the container exits.

So who defines what process is run

within the container?

CMD,

which stands for command, that defines the program

that will be run within the container when it starts.

## RUN vs CMD vs ENTRYPOINT

<https://www.baeldung.com/ops/dockerfile-run-cmd-entrypoint>

- The run instruction executes when we build the image.
- the run step executes at image build time, not at the container runtime.
- Docker caches the result for the run instruction if the Dockerfile didn't change.  
If we want to invalidate the cache, we need to pass the –no-cache option to the build command.

## CMD

- With the cmd instruction, we can specify a default command that executes when the container is starting.

- cmd indeed executes every time the container starts.
- if we have more than one cmd entry in the Dockerfile, only the last cmd is invoked
- This time the cmd specified in the Dockerfile is ignored. That's because we have specified arguments to the docker run command.

\$ docker run myimage cat log.txt

- cmd is ignored if passing any arguments when starting the container.
- CMD,

which stands for command, that defines the program

that will be run within the container when it starts.

For the NGINX image, it is the NGINX command.

For the MySQL image, it is the MySQL D command.

|                                                                                   |                                                                                     |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <code>CMD command param1</code>                                                   | <code>CMD sleep 5</code>                                                            |
| <code>CMD ["command", "param1"]</code>                                            | <code>CMD ["sleep", "5"]</code>                                                     |
|  |  |

### Entrypoint

- cmd is ignored if passing any arguments when starting the container.

### CMD vs Entrypoint

In case of the CMD instruction,

the command line parameters passed

will get replaced entirely.

Whereas in case of entry point,

the command line parameters will get appended.

```
FROM Ubuntu
```

```
CMD sleep 5
```

```
▶ docker run ubuntu-sleeper sleep 10
```

Command at Startup: sleep 10

```
FROM Ubuntu
```

```
ENTRYPOINT ["sleep"]
```

```
▶ docker run ubuntu-sleeper 10
```

Command at Startup: sleep 10

If you want your dockerfile have a default argument use CMD and ENTRYPOINT both and in a JSON format.

```
FROM Ubuntu
```

```
ENTRYPOINT ["sleep"]
```

```
CMD ["5"]
```

```
▶ docker run ubuntu-sleeper
```

```
sleep: missing operand
Try 'sleep --help' for more information.
```

Command at Startup: sleep 5

```
▶ docker run ubuntu-sleeper 10
```

Command at Startup: sleep 10

- You can also modify entrypoint command by using --entrypoint flag.

```
docker run --entrypoint <new-command> <container-name> <argument>
docker run --entrypoint sleep2.ø ubuntu-sleeper 10
```

# Commands and Arguments- Kubernetes

Sunday, March 3, 2024 7:21 PM

```
docker run --name ubuntu-sleeper ubuntu-sleeper 10
docker run --name <container-name> <image-name> 10
```

Anything that is appended to the docker run command

will go into the args property of the pod definition file,

in the form of an array like this.

```
pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
 name: ubuntu-sleeper-pod
spec:
 containers:
 - name: ubuntu-sleeper
 image: ubuntu-sleeper
 args: ["10"]
```

So, argument goes into the args property but what if we override the command?

eg. docker run - -name ubuntu-sleeper \ - -entrypoint sleep2.0 ubuntu-sleeper 10

```
pod-definition.yml
apiVersion: v1
kind: Pod
metadata:
 name: ubuntu-sleeper-pod
spec:
 containers:
 - name: ubuntu-sleeper
 image: ubuntu-sleeper
 command: ["sleep2.0"]
 args: ["10"]
```

# Environment Variables

Sunday, March 3, 2024 7:32 PM

use env property in a pod-definition file . 'env' is an array.

```
pod-definition.yaml
apiVersion: v1
kind: Pod
metadata:
 name: simple-webapp-color
spec:
 containers:
 - name: simple-webapp-color
 image: simple-webapp-color
 ports:
 - containerPort: 8080
 env:
 - name: APP_COLOR
 value: pink
```

## Types

```
env:
 - name: APP_COLOR
 value: pink
```

```
env:
 - name: APP_COLOR
 valueFrom:
 configMapKeyRef:
```

```
env:
 - name: APP_COLOR
 valueFrom:
 secretKeyRef:
```

## ConfigMaps

- When you have a lot of pod definition files, it

will become difficult to manage the environment data stored within the query's files.

- We can take this information out of the pod definition file

and manage it centrally using configuration maps.

- Config maps are used to pass configuration data

in the form of key value pairs in Kubernetes.

- When a pod is created, inject the config map into the pod

so the key value pairs are available

as environment variables

for the application hosted inside the container

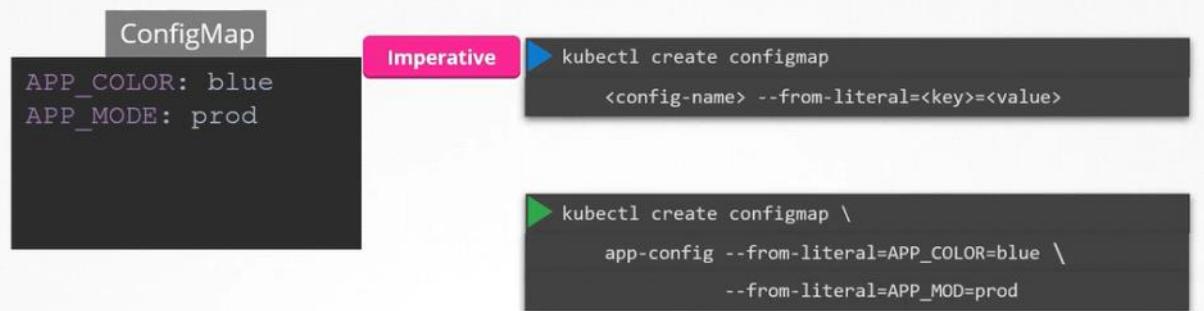
in the pod.

- ConfigMaps can be used to store user, password etc.
- So, there are two phases - Create ConfigMap and Inject ConfigMap into Pods.

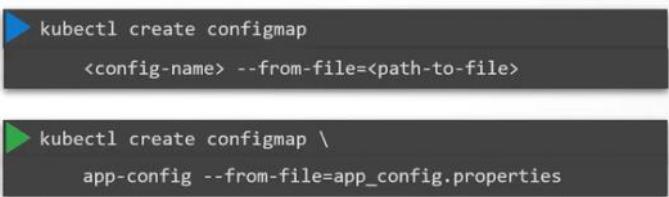
## Create ConfigMap

Ways to create a ConfigMap file

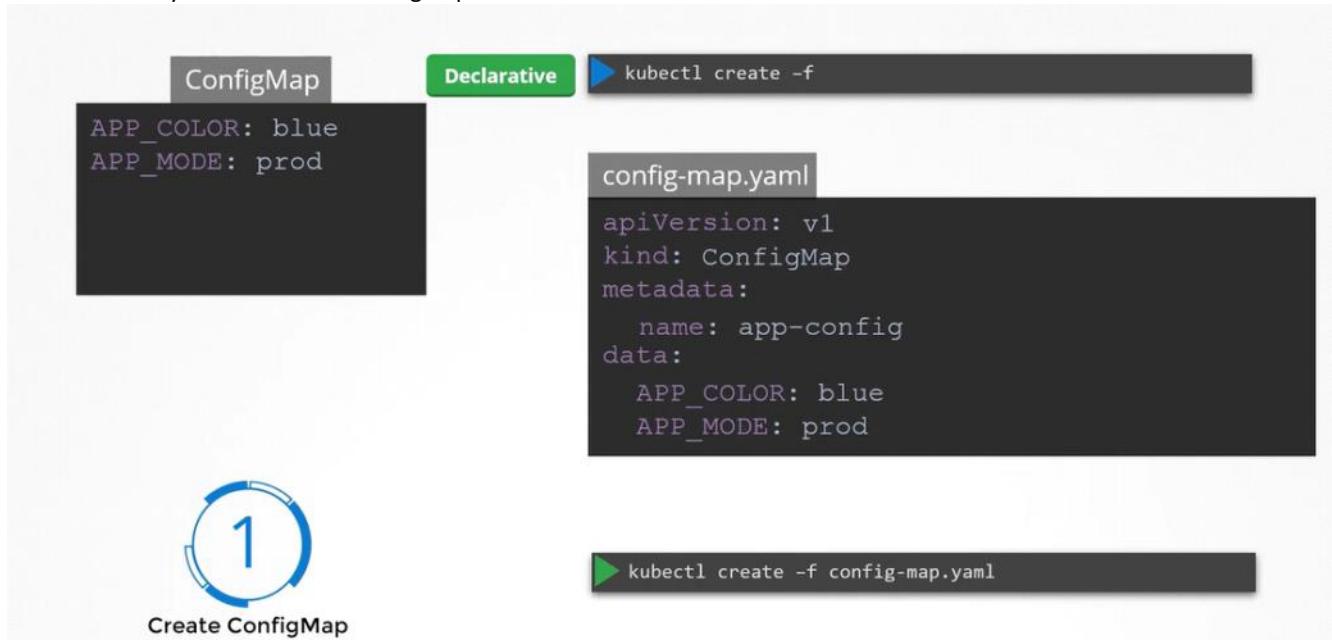
1. Imperative Way - Without using a configMap definition file.
  - a. Using --from-literal



- b. Using --from-file



## 2. Declarative Way - kubectl create configmap



### Inject ConfigMap into Pods

## | ConfigMap in Pods

pod-definition.yaml

```
apiVersion: v1
kind: Pod
metadata:
 name: simple-webapp-color
 labels:
 name: simple-webapp-color
spec:
 containers:
 - name: simple-webapp-color
 image: simple-webapp-color
 ports:
 - containerPort: 8080
 envFrom:
```

config-map.yaml

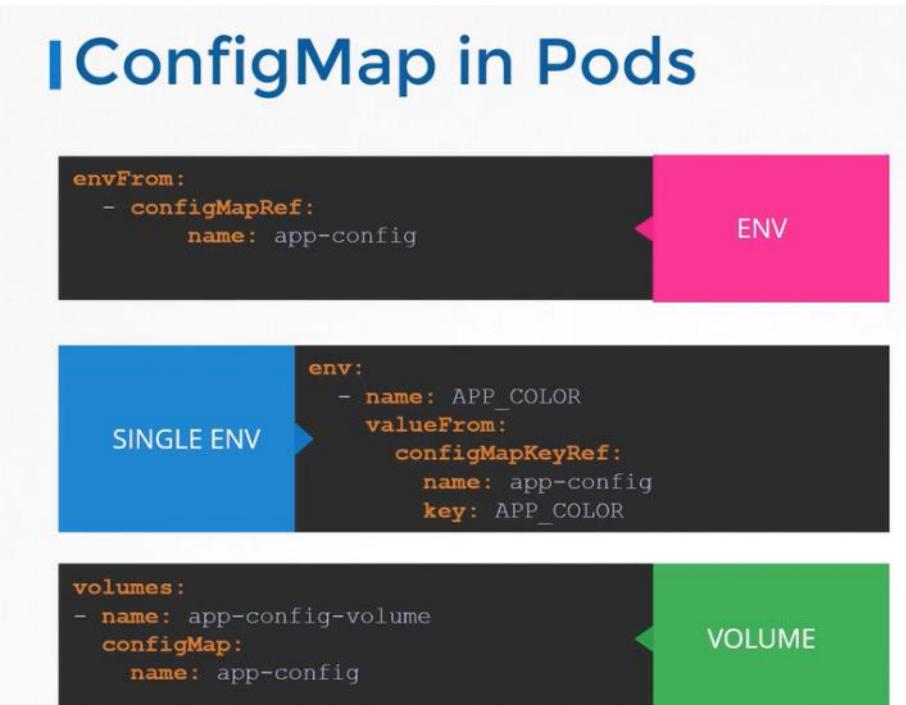
```
apiVersion: v1
kind: ConfigMap
metadata:
 name: app-c
data:
 APP_COLOR: b
 APP_MODE: p
```



```
image: simple-webapp-color
ports:
- containerPort: 8080
envFrom:
- configMapRef:
 name: app-config
```

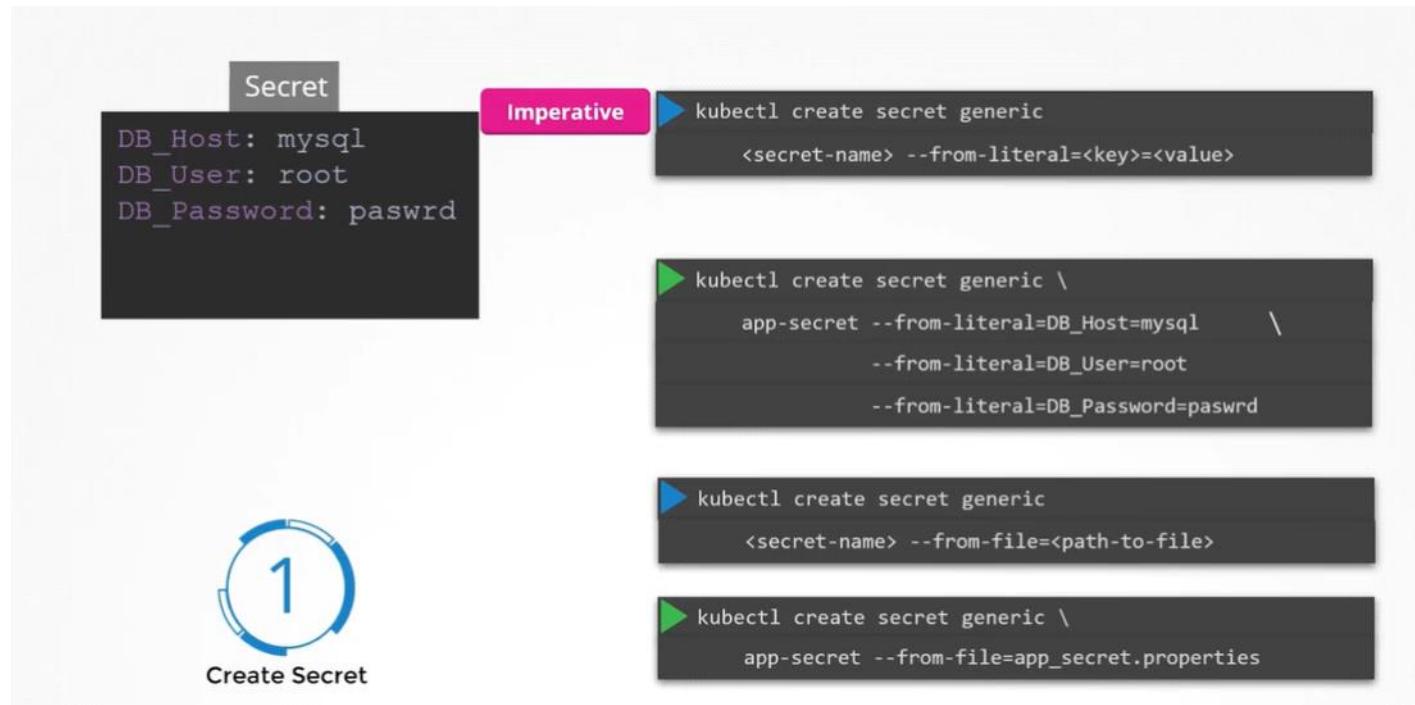


#### Ways to Inject configMaps into the Pods



# Secrets

Monday, March 4, 2024 5:43 PM

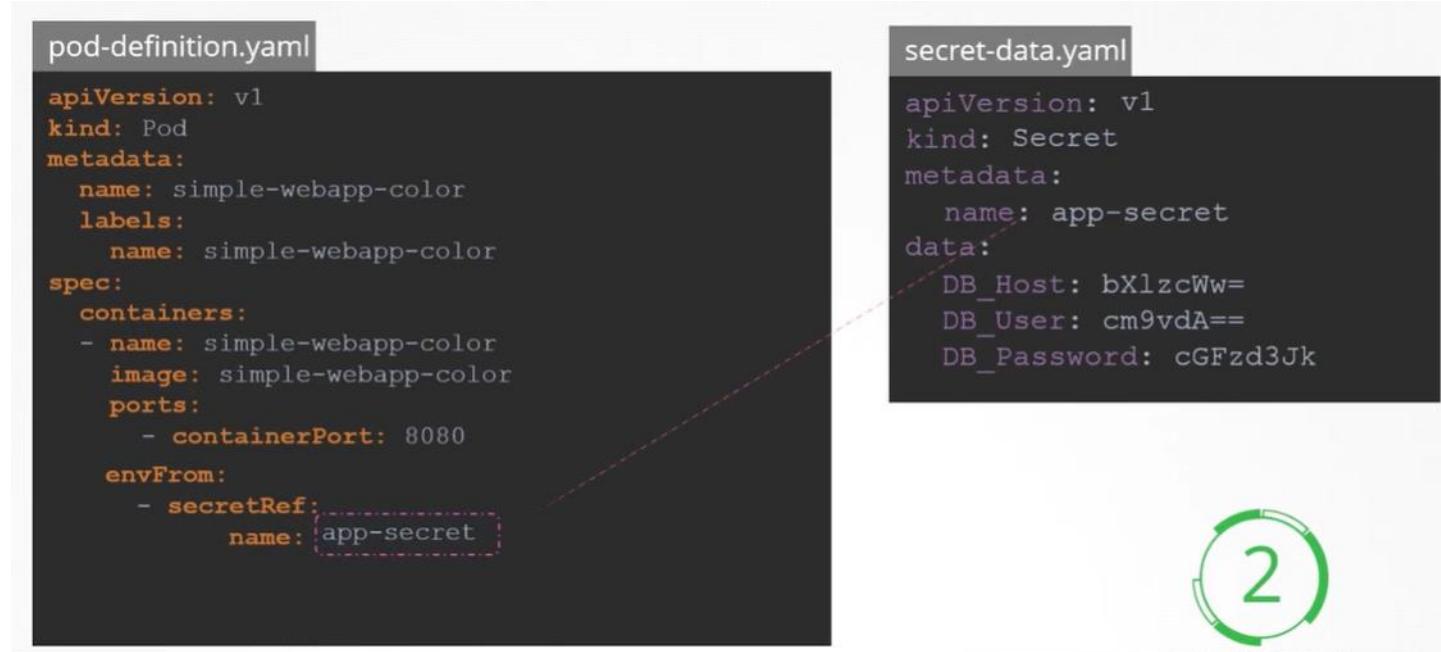


- ★ Data you put in secrets must be encoded as there is no sense of storing a plain data in Secrets.

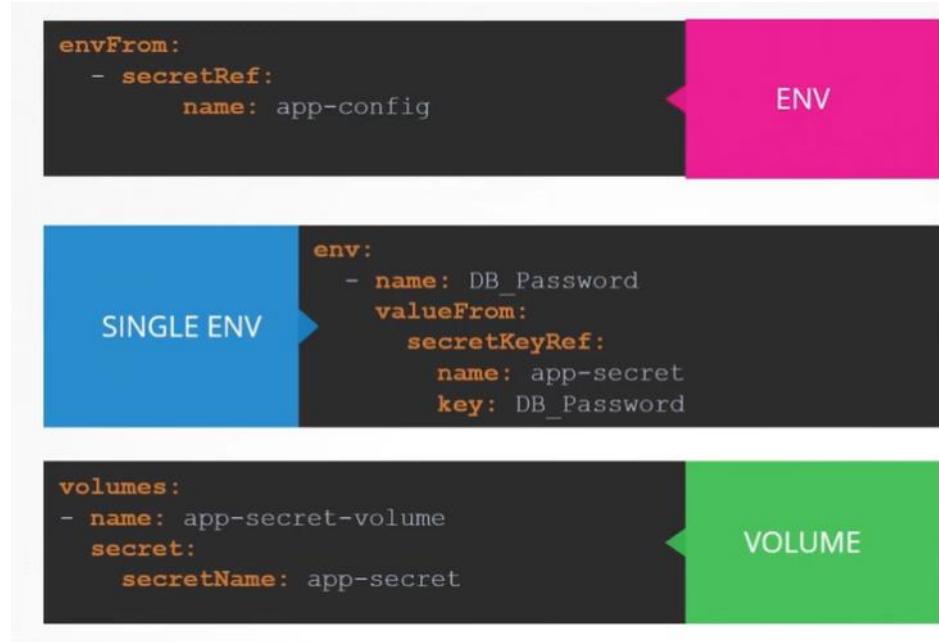
Question - how do you decode encoded values? Use the same base 64 command used earlier to encode it



## Injecting into Pods



## Ways to inject into a Pod



Secrets are not encrypted, so it is not safer in that sense. However, some best practices around using secrets make it safer. As in best practices like:

Not checking-in secret object definition files to source code repositories.

Enabling Encryption at Rest for Secrets so they are stored encrypted in ETCD.

Also the way kubernetes handles secrets. Such as:

A secret is only sent to a node if a pod on that node requires it.

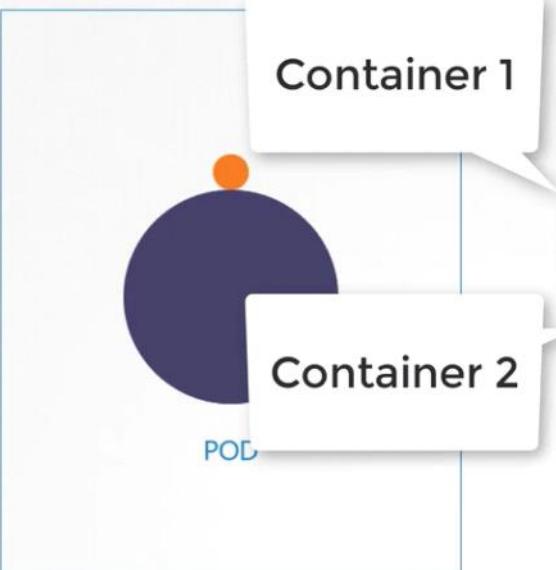
Kubelet stores the secret into a tmpfs so that the secret is not written to disk storage.

Once the Pod that depends on the secret is deleted, kubelet will delete its local copy of the secret data as well.

there are other better ways of handling sensitive data like passwords in Kubernetes, such as using tools like Helm Secrets, HashiCorp Vault. I hope to make a lecture on these in the future.

# Multi Container Pods

Monday, March 4, 2024 6:12 PM



The diagram shows a central blue circle labeled "POD". Inside the "POD" circle are two smaller circles: one labeled "Container 1" and another labeled "Container 2". An orange dot is positioned above the "Container 1" circle.

pod-definition.yaml

```
apiVersion: v1
kind: Pod
metadata:
 name: simple-webapp
 labels:
 name: simple-webapp
spec:
 containers:
 - name: simple-webapp
 image: simple-webapp
 ports:
 - containerPort: 8080
 - name: log-agent
 image: log-agent
```

# InitContainers

Monday, March 4, 2024 6:16 PM

In a multi-container pod, each container is expected to run a process that stays alive as long as the POD's lifecycle. For example in the multi-container pod that we talked about earlier that has a web application and logging agent, both the containers are expected to stay alive at all times. The process running in the log agent container is expected to stay alive as long as the web application is running. If any of them fails, the POD restarts.

But at times you may want to run a process that runs to completion in a container. For example a process that pulls a code or binary from a repository that will be used by the main web application. That is a task that will be run only one time when the pod is first created. Or a process that waits for an external service or database to be up before the actual application starts. That's where initContainers comes in.

An initContainer is configured in a pod like all other containers, except that it is specified inside a initContainers section, like this:

```
1 | apiVersion: v1
2 | kind: Pod
3 | metadata:
4 | name: myapp-pod
5 | labels:
6 | app: myapp
7 | spec:
8 | containers:
9 | - name: myapp-container
10 | image: busybox:1.28
11 | command: ['sh', '-c', 'echo The app is running! && sleep 3600']
12 | initContainers:
13 | - name: init-myservice
14 | image: busybox
15 | command: ['sh', '-c', 'git clone <some-repository-that-will-be-used-
by-application> ; done;']
```

When a POD is first created the initContainer is run, and the process in the initContainer must run to a completion before the real container hosting the application starts.

You can configure multiple such initContainers as well, like how we did for multi-containers pod. In that case each init container is run one at a time in sequential order.

If any of the initContainers fail to complete, Kubernetes restarts the Pod repeatedly until the Init Container succeeds.

```
1 apiVersion: v1
2 kind: Pod
3 metadata:
4 name: myapp-pod
5 labels:
6 app: myapp
7 spec:
8 containers:
9 - name: myapp-container
10 image: busybox:1.28
11 command: ['sh', '-c', 'echo The app is running! && sleep 3600']
12 initContainers:
13 - name: init-myservice
14 image: busybox:1.28
15 command: ['sh', '-c', 'until nslookup myservice; do echo waiting for
myservice; sleep 2; done;']
16 - name: init-mydb
17 image: busybox:1.28
18 command: ['sh', '-c', 'until nslookup mydb; do echo waiting for
mydb; sleep 2; done;']
```

# Statefulsets and Deployment

Friday, June 27, 2025 11:47 AM

StatefulSets use sequential ordinal numbers (like 0, 1, 2) for pod names, while Deployments use a random hash for pod names, because StatefulSets are designed for stateful applications that require predictable, stable identities and ordered deployment and scaling, unlike Deployments which are for stateless applications where pods are interchangeable.

Here's a more detailed explanation:

StatefulSets and Pod Identity:

- **Unique and Stable Identities:**

StatefulSets guarantee that each pod has a unique and stable network identity, meaning the pod's name and hostname remain consistent even if the pod is recreated.

- **Ordered Deployment and Scaling:**

StatefulSets deploy and scale pods in a specific order (e.g., 0, 1, 2) and also delete them in reverse order, which is crucial for applications like databases that require a specific order for data consistency.

- **Persistent Storage:**

StatefulSets are typically used with persistent storage, and the stable pod identities ensure that each pod reconnects to its designated persistent volume after recreation, maintaining its state.

- **Headless Services:**

StatefulSets often use headless services, which provide direct access to individual pods by their stable identities, rather than load balancing traffic across all pods.

Deployments and Pod Identity:

- **Interchangeable Pods:**

Deployments treat pods as interchangeable, meaning the order of creation and deletion doesn't matter, and pods can be recreated with new identities.

- **Random Hash in Pod Names:**

Deployments append a random hash to the pod name to ensure uniqueness within the ReplicaSet, but these identities are not meant to be persistent across pod recreation.

Why the Difference?

- **Stateless vs. Stateful:**

Deployments are designed for stateless applications where pods can be easily replaced without affecting the overall application state. StatefulSets are designed for stateful applications where pod identity and persistent storage are critical.

- **Data Consistency:**

The stable identities and ordered scaling in StatefulSets are essential for maintaining data consistency and integrity in stateful applications, such as databases or distributed systems.

- **Example:**

Imagine a database deployed using a StatefulSet. If a pod is recreated, it needs to reconnect to the same persistent volume to access its data. The ordinal number in the pod name (e.g., db-0, db-1) helps ensure this persistent connection. If Deployments were used, the random hash in the pod name could lead to the pod connecting to the wrong volume, resulting in data loss.

For a StatefulSet with  $n$  replicas, when Pods are being deployed, they are created sequentially, ordered from  $\{0..n-1\}$ .

As mentioned in the [StatefulSets](#) concept, the Pods in a StatefulSet have a sticky, unique identity. This identity is based on a unique ordinal index that is assigned to each Pod by the StatefulSet [controller](#). The Pods' names take the form <statefulset name>-<ordinal index>. Since the web StatefulSet has two replicas, it creates two Pods, web-0 and web-1

As with [StatefulSet creation](#), the StatefulSet controller created each Pod sequentially with respect to its ordinal index, and it waited for each Pod's predecessor to be Running and Ready before launching the subsequent Pod. So, first it will spin pod web-0 then web-1 and so on.

Similarly, If you scaled down a statefulset, The control plane deleted one Pod at a time, in reverse order with respect to its ordinal index, and it waited for each Pod to be completely shut down before deleting the next one. So, first web-4 will be terminated then web-3 and so on.

## **StatefulSets vs Deployments**

StatefulSets are designed for stateful applications, offering features like stable network identities, persistent storage, and ordered deployments that Deployments lack.

Deployments are better suited for stateless applications, where pod identity and order are not critical.

The key properties of StatefulSets that make them suitable for stateful applications include:

- **Stable, Unique Network Identities:**

Each Pod in a StatefulSet has a unique, persistent network identity (hostname) that remains consistent even if the Pod restarts or moves to a different node. This is crucial for applications that rely on stable network connections, like databases with master-slave replication.

### **Ordered, Controlled Deployment and Scaling:**

StatefulSets provide an ordered, predictable deployment and scaling mechanism. Pods are created and deleted one at a time, in a sequential manner, and scaled up or down in a similar way. This controlled approach is vital for maintaining data consistency and avoiding conflicts in stateful applications.

- **Persistent Storage:**

StatefulSets are designed to work with PersistentVolumes, ensuring that data persists even if a Pod fails or is rescheduled. This is essential for applications that require persistent storage for their state, such as databases or message queues.

Why StatefulSets are preferred over Deployments for Stateful Applications:

- **Stateless vs. Stateful:**

Deployments are primarily designed for stateless applications, where Pods are interchangeable and their identities are not important. Stateful applications, on the other hand, rely on persistent identities, storage, and ordered scaling, which are not provided by Deployments.

- **Interchangeable Pods:**

Deployments treat Pods as interchangeable, meaning that any Pod can be replaced by another without affecting the application's functionality. This is not acceptable for stateful applications where each Pod

has a specific role and data associated with it.

- **Lack of Ordering:**

Deployments do not guarantee the order of Pod creation or deletion. This can lead to issues in stateful applications, especially during scaling or rolling updates, where data consistency and availability need to be maintained.

- **No Persistent Storage:**

Deployments do not inherently handle persistent storage. While you can attach a PersistentVolumeClaim to a Deployment, it's not a built-in feature as it is with StatefulSets.

Why the StatefulSets use sequential ordinal numbers for pod names, while Deployments use a random hash?

The StatefulSets are designed for stateful applications. A stateful application is one that **remembers things between restarts**.

The sequential order helps in the following ways-

1. Pods are created in statefulsets in order (0 to N) and deleted in reverse order. So, a StatefulSet named 'web' will first create a pod web-0 then web-1 and so on based on replica size and for deletion, last replica will delete first, say web-4 then web-3 and so on.
2. Some applications require to start the pod in specific order. Examples-
  - a. pod-1 must wait for pod-0 to spin up.
  - b. Applications like Zookeeper require ordered setup (initial leader election)
3. Pod names are not random. So, you get stable DNS Names. e.g.  
e.g. web-0.web-0-service.test.svc.cluster.local  
In Deployment, pod has random hex code, so DNS names are not consistent.
4. In a StatefulSet, each pod automatically gets its own dedicated PVC, and Kubernetes manages the binding based on the pod's index.. e.g. web-0 pod uses pvc data-web-0. In the Deployment, replaced pods may not get the same pvc or there is a chance of data loss. Also, the pod web-0 can be different than web-1 as both can have different pvc and can be meant for different purposes.

**Why do StatefulSets use sequential pod names while Deployments use random hashes?**

# Minikube

Monday, March 4, 2024 1:11 AM

1. First, Open 'Docker Desktop'.
2. Run 'minikube start' command.

context not found

Unable to resolve the current Docker CLI context "default": context  
"default": context not found: open C:\Users\srivasva\.docker\contexts\meta  
\37a8eec1ce19687d132fe29051dca629d164e2c4958ba141d5f4133a33f0688f\meta.json: The system  
cannot find the path specified.

# Kubernetes Installation - Using kubeadm

Wednesday, February 28, 2024 6:46 PM