Certified Kubernetes Administrator (CKA)

Kubernetes 1.29 Edition

About the trainer

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Exam Details and Resources

Objectives, Environment, Time Management

Exam Objectives

“Perform typical responsibilities of a Kubernetes administrator.”

The certification program allows users to demonstrate their competence in a hands-on, command-line environment.

https://www.cncf.io/certification/cka/

Exam Domains & Weights

Domain	Weight
Cluster Architecture, Installation & Configuration	25%
Workloads & Scheduling	15%
Services & Networking	20%
Storage	10%
Troubleshooting	30%

The Curriculum

25% - Cluster Architecture, Installation & Configuration

- Manage role based access control (RBAC)
- Use Kubeadm to install a basic cluster
- Manage a highly-available Kubernetes cluster
- Provision underlying infrastructure to deploy a Kubernetes cluster
- Perform a version upgrade on a Kubernetes cluster using Kubeadm
- Implement etcd backup and restore

20% - Services & Networking

- Understand host networking configuration on the cluster nodes
- Understand connectivity between Pods
- Understand ClusterIP, NodePort, LoadBalancer service types and endpoints
- Know how to use Ingress controllers and Ingress resources
- Know how to configure and use CoreDNS
- Choose an appropriate container network interface plugin

30% - Troubleshooting

- Evaluate cluster and node logging
- Understand how to monitor applications
- Manage container stdout & stderr logs
- Troubleshoot application failure
- Troubleshoot cluster component failure
- Troubleshoot networking

15% - Workloads & Scheduling

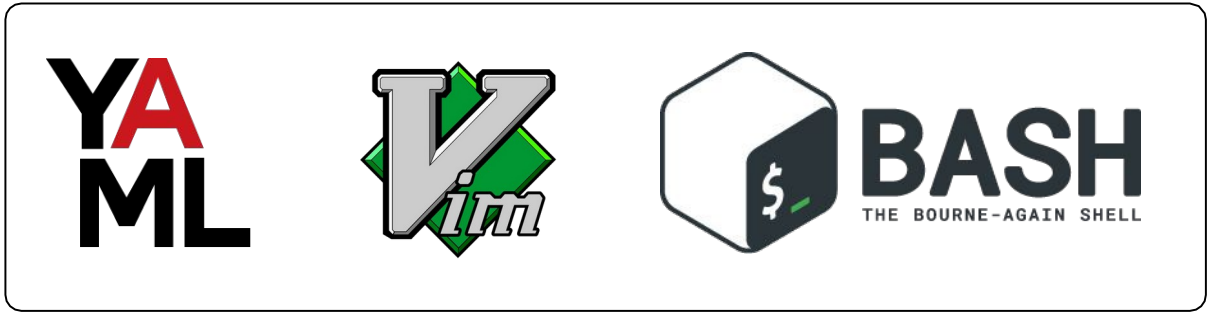
- Understand deployments and how to perform rolling update and rollbacks
- Use ConfigMaps and Secrets to configure applications
- Know how to scale applications
- Understand the primitives used to create robust, self-healing, application deployments
- Understand how resource limits can affect Pod scheduling
- Awareness of manifest management and common templating tools

10% - Storage

- Understand storage classes, persistent volumes
- Understand volume mode, access modes and reclaim policies for volumes
- Understand persistent volume claims primitive
- Know how to configure applications with persistent storage

Exam Environment

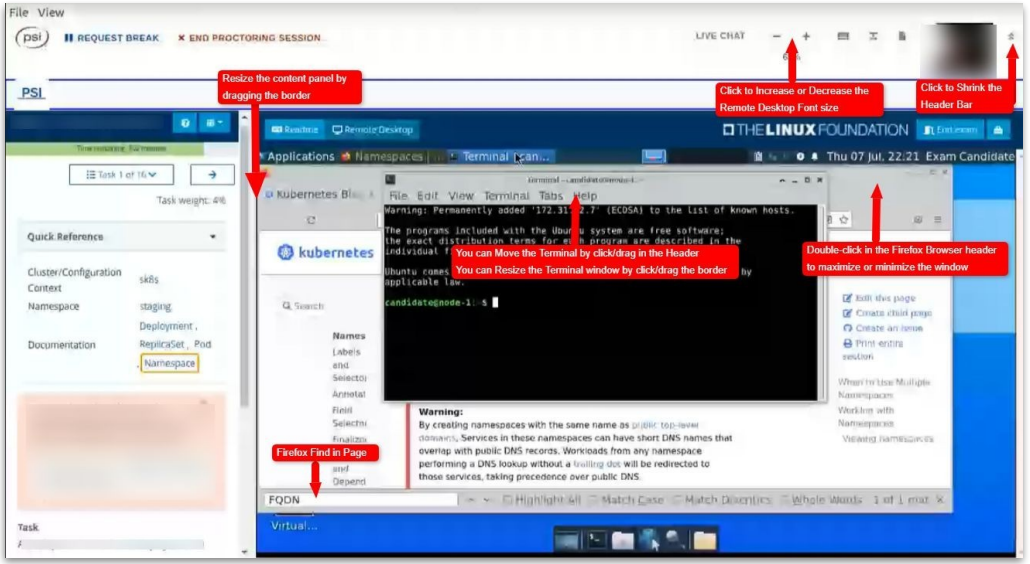
Online and proctored exam



The trinity of tooling you need to be familiar with

New PSI Exam Environment

Single monitor, no more bookmarks (announcement)



Using Kubernetes Documentation

Kubernetes docs and subdomains (see FAQ)

- Docs: https://kubernetes.io/docs
- Blog: https://kubernetes.io/blog

Setting Namespace for a Context

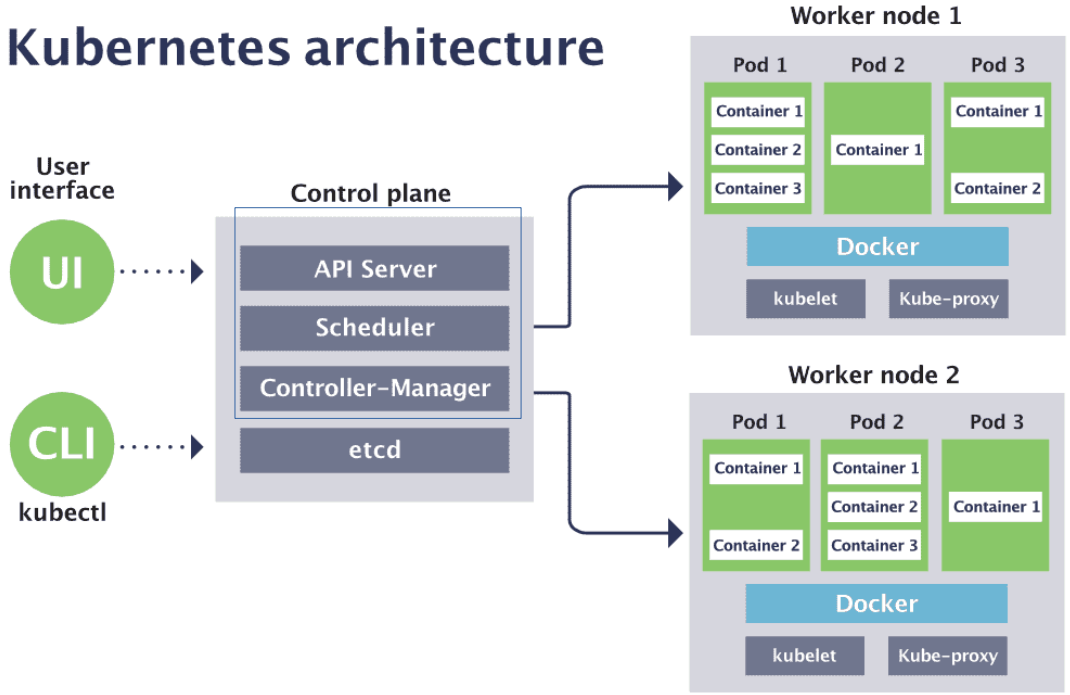
Questions will ask you to run a command on a specific cluster - Make sure to execute it!

```
$ kubectl config set-context <context-of-question>↵
  --namespace=<namespace-of-question>
$ kubectl config use-context <context-of-question>
```

Cluster Architecture, Installation & Configuration

Kubernetes architecture and components, Kubeadm, HA, etcd Backup and Restore, RBAC

Kubernetes Architecture



Control Plane components

- API Server : Expose a REST interface to Kubernetes cluster. All operations are executed programmatically by communicating with the endpoints procided by it.
- Scheduler : Responsible for assigning work to the various nodes. It keeps watch over the resource capacity.
- Controller manager : Responsible for making sure that the shared state of the cluster is operating as expected.

Worker Node components

- Kubelet : tracks the state of a pod to ensure that all the containers are running. It provides a heartbeat message every few seconds to the control plane. If a replication controller does not receive that message, the node is marked as unhealthy.

- Kube proxy : Routes traffic coming into a node from the service. It forwards requests for work to the correct containers.

ETCD

- A distributed key-value store that Kubernetes uses to share information about the overall state of a cluster.

What is Kubeadm?

Tool for creating and managing Kubernetes clusters

- Needs to be installed separately from other tools like `kubectl`.
- Deals with cluster bootstrapping but not provisioning.
- Representative use cases
  - Bootstrap a control plane node.
  - Bootstrap worker nodes and join them to the cluster.
  - Upgrade a cluster to a newer version.

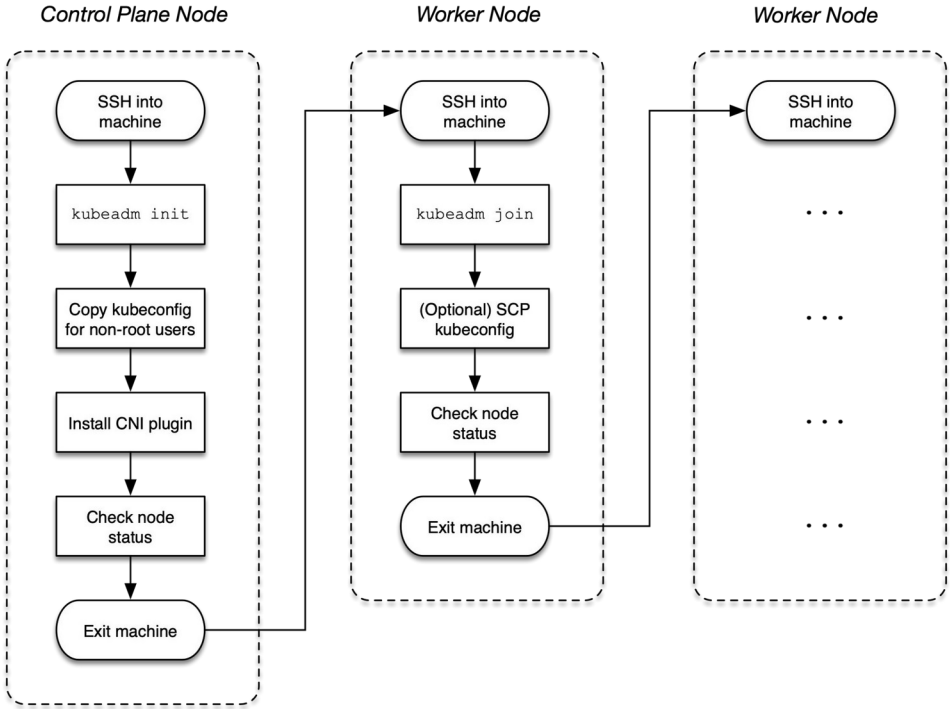
Installing a Cluster

Start with control plane, join nodes

- Initialize the control plane on node using `kubeadm init`.
- Install a Pod network add-on.
- Join worker nodes using `kubeadm join`.

Detailed installation instructions

Installing a Cluster



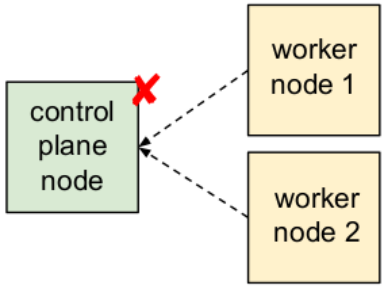
Lab 01

Creating a Cluster
with Kubeadm

Single-Control Plane Cluster

Losing the control plane node causes issues

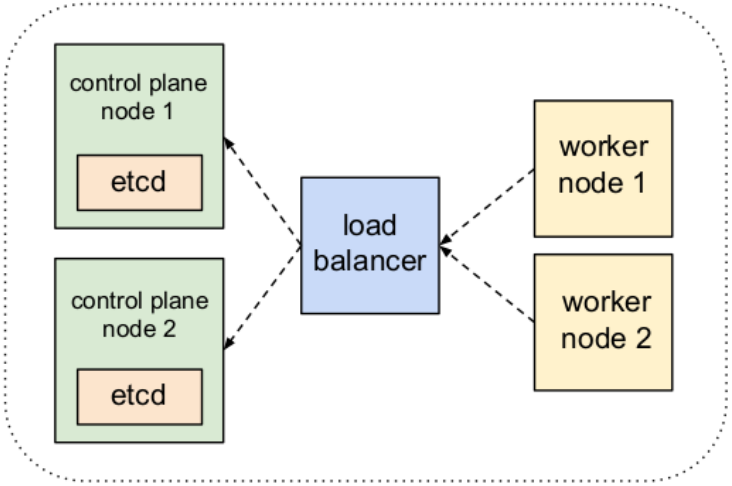
- A ReplicaSet cannot recreate failing Pod as the worker node can’t talk back to scheduler on control plane node.
- Cluster cannot be accessed externally as API server is not available anymore.



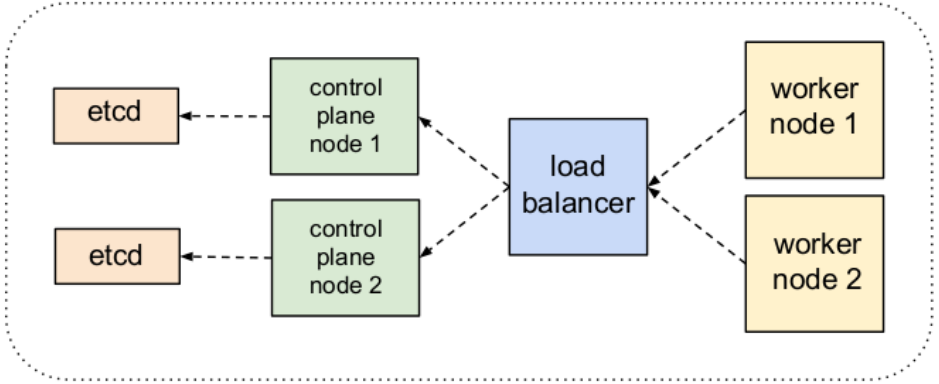
High-Availability Cluster Setup

Two configuration options available

Stacked etcd topology



External etcd topology



Detailed

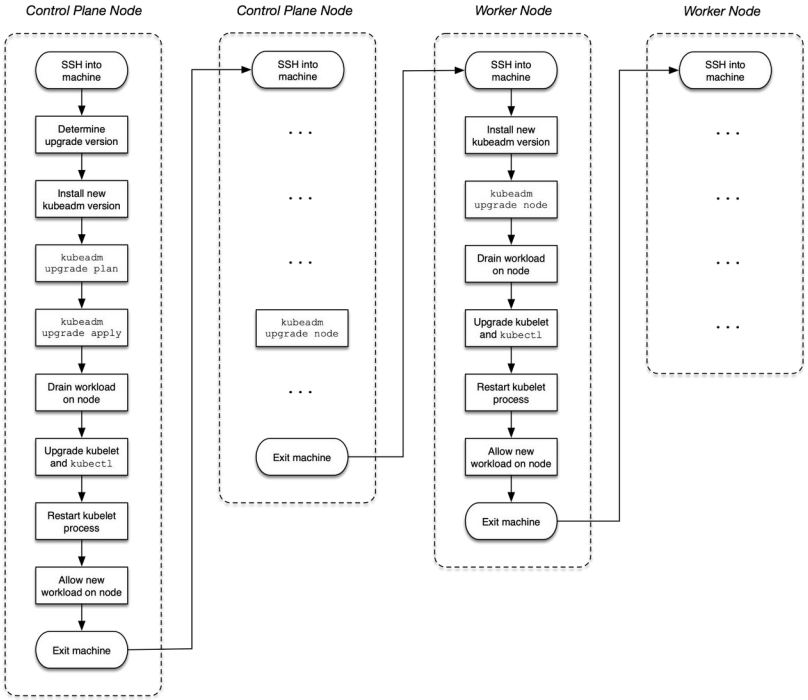
Upgrading a Cluster Version

Upgrading should be done in version increments

- Determine which version to upgrade to.
- Upgrade control plane nodes.
- Upgrade worker nodes.
- Verify the status of the cluster.

Detailed installation instructions

Upgrading a Cluster Version



LAB 02

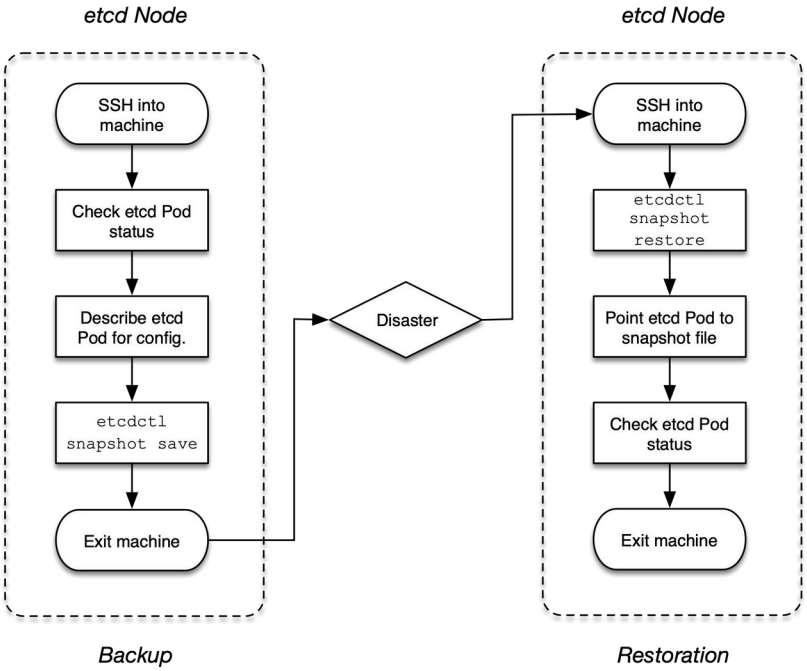
Upgrading a Cluster Version with Kubeadm

Backing up & Restoring etcd

- Create backup with `etcdctl snapshot save` command. The options `--cert`, `--cacert` and `--key` are mandatory.

- Restore backup with `etcdctl snapshot restore` command. The option `--data-dir` is mandatory. Modify the `volumes.hostPath.path` in `/etc/kubernetes/manifests/etcd.yaml` to point to directory.

Backing up & Restoring etcd

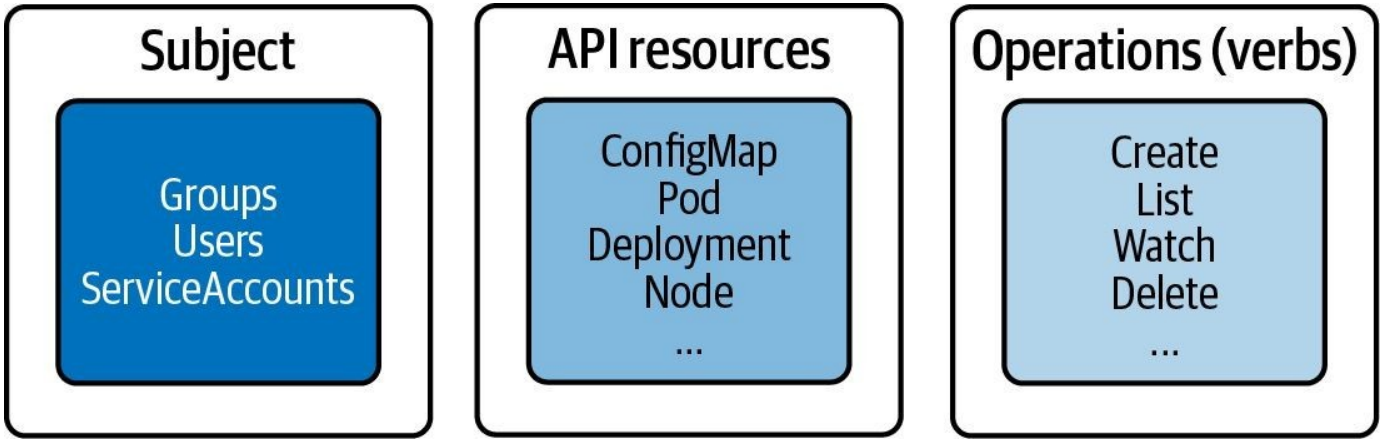


LAB 03

Backing Up and
Restoring etcd

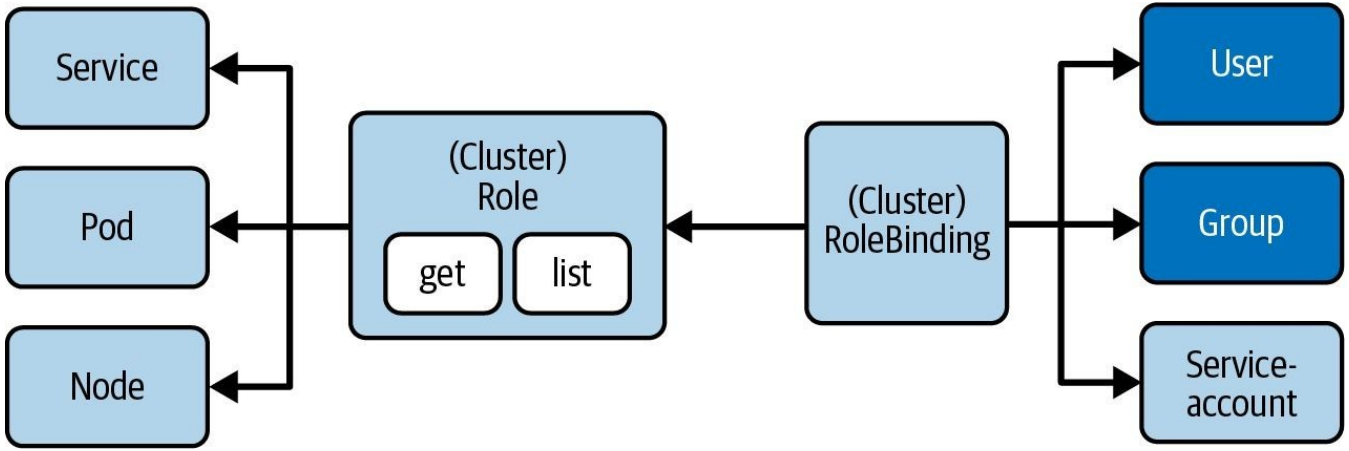
RBAC High-Level Overview

Three key elements for understanding concept



Involved RBAC Primitives

Restrict access to API resources based on user roles



Creating a Role

Defines verbs and resources in comma-separated list

```
$ kubectl create role read-only --verb=list,get,watch↵
  --resource=pods,deployments,services
role.rbac.authorization.k8s.io/read-only created
```

Resources: Primitives the operations should apply to

Operations: Only allow listing, getting, watching

Role YAML Manifest

Can define a list of rules in an array

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: pod-reader
rules:
- apiGroups: [""]
  resources: ["pods", "services"]
  verbs: ["list", "get", "watch"]

- apiGroups: ["apps"]
  resources: ["deployments"]
  verbs: ["list", "get", "watch"]
```

Resources with groups need to spelled out explicitly

Getting Role Details

Maps objects of a type to verbs

```
$ kubectl describe role read-only
Name:         read-only
Labels:       <none>
Annotations:  <none>
PolicyRule:
  Resources          Non-Resource URLs  Resource Names  Verbs
  ---------          -----------------  --------------  -----
  pods               []                 []              [list get watch]
  services           []                 []              [list get watch]
  deployments.apps   []                 []              [list get watch]
```

Creating a RoleBinding

Map subject to Role

```
$ kubectl create rolebinding read-only-binding --role=read-only↵
  --user=johndoe
rolebinding.rbac.authorization.k8s.io/read-only-binding created
```

Subject: Binds a user to the Role

Role: Reference the name of the object

RoleBinding YAML Manifest

Roles can be mapped to multiple subjects if needed

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: read-only-binding
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: read-only
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: User
  name: johndoe
```

Getting RoleBinding Details

Only shows mapping between Role and subjects

```
$ kubectl describe rolebinding read-only-binding
Name:         read-only-binding
Labels:       <none>
Annotations:  <none>
Role:
  Kind:  Role
  Name:  read-only
Subjects:
  Kind  Name     Namespace
  ----  ----     ---------
  User  johndoe
```

Cluster-wide RBAC

Apply Roles and RoleBindings across multiple namespaces

- The configuration elements are effectively the same. The only difference is the value of the `kind` attribute.
- To define a cluster-wide Role, use the imperative subcommand `clusterrole` or the kind ClusterRole in the YAML manifest.
- To define a cluster-wide RoleBinding, use the imperative subcommand `clusterrolebinding` or the kind ClusterRoleBinding in the YAML manifest.

Service Account as Subject

Usage needs to be configured in Pod

ServiceAccount YAML Manifest

Enables authentication token auto-mounting by default

```yaml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: sa-api
  namespace: k97
```

The token file will be available to any Pod that uses the Service Account at

`/var/run/secrets/kubernetes.io/serviceaccount/token`

Using Service Account in Pod

Enables authentication token auto-mounting by default

```
apiVersion: v1
kind: Pod
metadata:
  name: list-pods
  namespace: k97
spec:
  serviceAccountName: sa-api
  containers:
  - name: pods
    image: alpine/curl:3.14
    command: ['sh', '-c', 'while true; do curl -s -k -m 5 -H↵
              "Authorization: Bearer $(cat /var/run/secrets/kubernetes.io/↵
              serviceaccount/token)" https://kubernetes.default.svc.cluster.↵
              local/api/v1/namespaces/k97/pods; sleep 10; done']
```

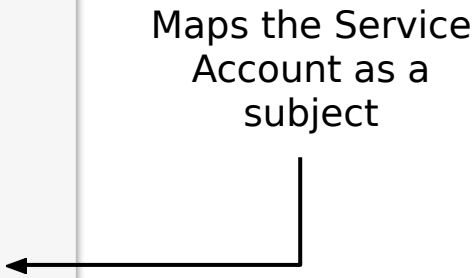
Assigned name of Service Account

List all Pods in the namespace `k97` via an API call

RoleBinding YAML Manifest

Default RBAC policies don't span beyond `kube-system`

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: serviceaccount-pod-rolebinding
  namespace: k97
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: list-pods-clusterrole
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: ServiceAccount
  name: sa-api
```



LAB 04

Regulating Access
to API Resources
with RBAC

Workloads & Scheduling

Deployments, ConfigMaps & Secrets, Health Probes, Pod Resource Limits, Node Affinity, Taints & Tolerations

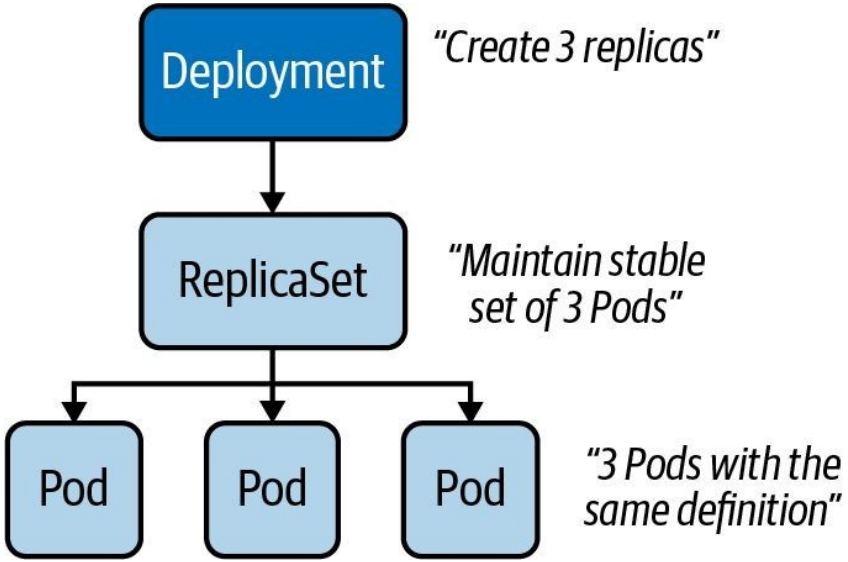
What is a Deployment?

Scaling and replication features for a set of Pods

- Controls a predefined number of Pods with the same configuration, so-called *replicas*.
- The number of replicas can be scaled up or down to fulfill load requirements.
- Updates to the replica configuration can be updated easily and is rolled out automatically.

Example Deployment

A Deployment that controls three replicas



Creating a Deployment

Creates objects for the Deployment, ReplicaSet and Pods

```
$ kubectl create deployment my-deploy --image=nginx:1.14.2 --replicas=3
deployment.apps/my-deploy created
```

The default number of replicas is 1 if the parameter wasn't provided

Deployment YAML Manifest

```
apiVersion: apps/v1
kind: Deployment
metadata:
  labels:
    app: my-deploy
  name: my-deploy
spec:
  replicas: 3
  selector:
    matchLabels:
      tier: backend
  template:
    metadata:
      labels:
        tier: backend
    spec:
      containers:
      - image:
      nginx:1.14.2
        name: nginx
```

Label selector and template label assignment have to match

Listing Deployments

ReplicaSet and Pods can be identified by name prefix

```
$ kubectl get deployments,pods,replicasets
NAME                                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/my-deploy           1/1     1            1           7m56s

NAME                                    READY   STATUS    RESTARTS   AGE
pod/my-deploy-8448c488b5-mzx5g          1/1     Running   0          7m56s

NAME                                          DESIRED   CURRENT   READY   AGE
replicaset.apps/my-deploy-8448c488b5          1         1         1
 7m56s
```

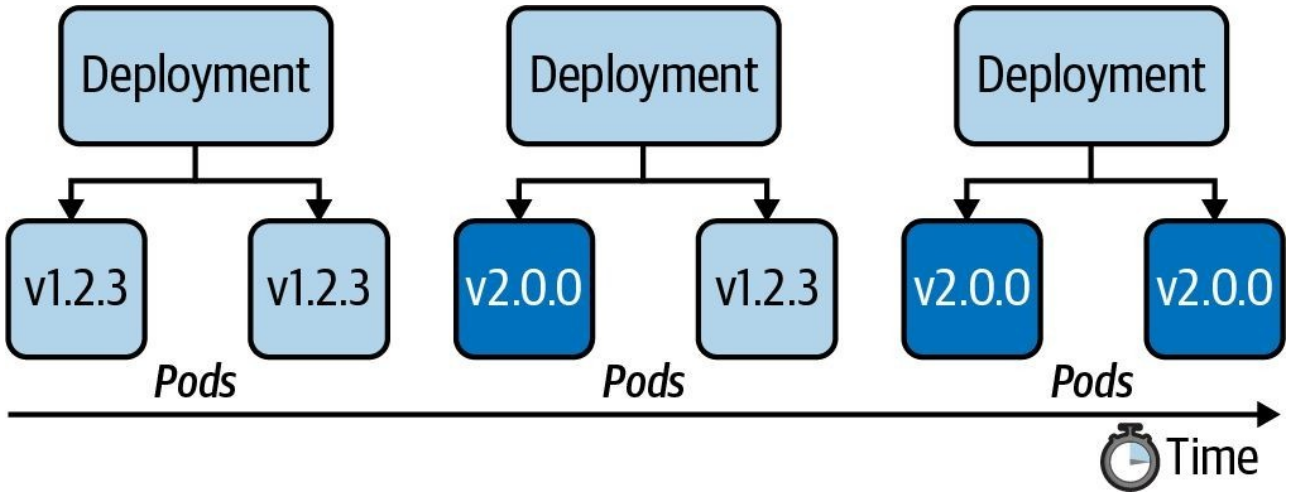
Rendering Deployment Details

Object details show relationship between parent and child

```
$ kubectl describe deployment.apps/my-deploy
Replicas:               1 desired | 1 updated | 1 total | 1 available |
                        0 unavailable
NewReplicaSet:   my-deploy-8448c488b5 (1/1 replicas created)

$ kubectl describe replicaset.apps/my-deploy-8448c488b5
Controlled By:  Deployment/my-deploy

$ kubectl describe pod/my-deploy-8448c488b5-mzx5g
Controlled By:  ReplicaSet/my-deploy-8448c488b5
```

Roll Out and Roll Back Feature

“Look ma, shiny new features. Let’s deploy them to production!”



Rolling Out a New Revision

The rollout history keeps track of changes

```
$ kubectl rollout history deployment my-deploy
deployment.apps/my-deploy  REVISION  CHANGE-
CAUSE
1          <none>

$ kubectl set image deployment my-deploy nginx=nginx:1.19.2
deployment.apps/my-deploy image updated

$ kubectl rollout history deployment my-deploy
deployment.apps/my-deploy  REVISION  CHANGE-
CAUSE
1          <none>
2          <none>
```

Changes the assigned image for Pod template

Rolling Back to Previous Revision

You can revert to any revision available in the history

```
$ kubectl rollout undo deployment my-deploy --to-revision=1
deployment.apps/my-deploy rolled back

$ kubectl rollout history deployment my-deploy
deployment.apps/my-deploy  REVISION  CHANGE-CAUSE
2          <none>
3          <none>
```

Kubernetes deduplicates a revision
if it points to the same changes

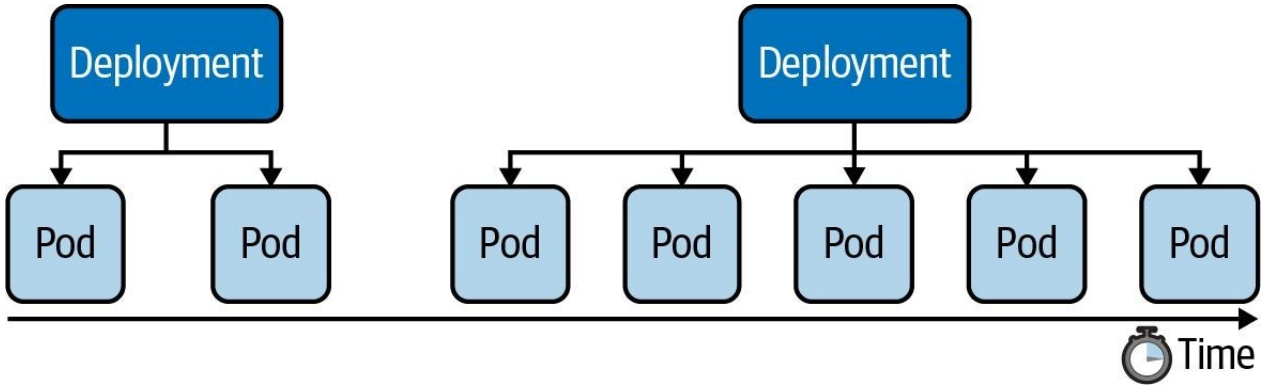
Common Deployment Strategies

Choosing the right deployment procedure depends on the needs

- *Recreate:* Terminate the old version and release the new one.
- *Ramped:* Release a new version on a rolling update fashion, one after the other.
- *Blue/green:* Release a new version alongside the old version then switch traffic.
- *Canary:* Release a new version to a subset of users, then proceed to a full rollout.

Manually Scaling a Deployment

“Load is increasing. We need to scale up the application.”



Changing the Number of Replicas

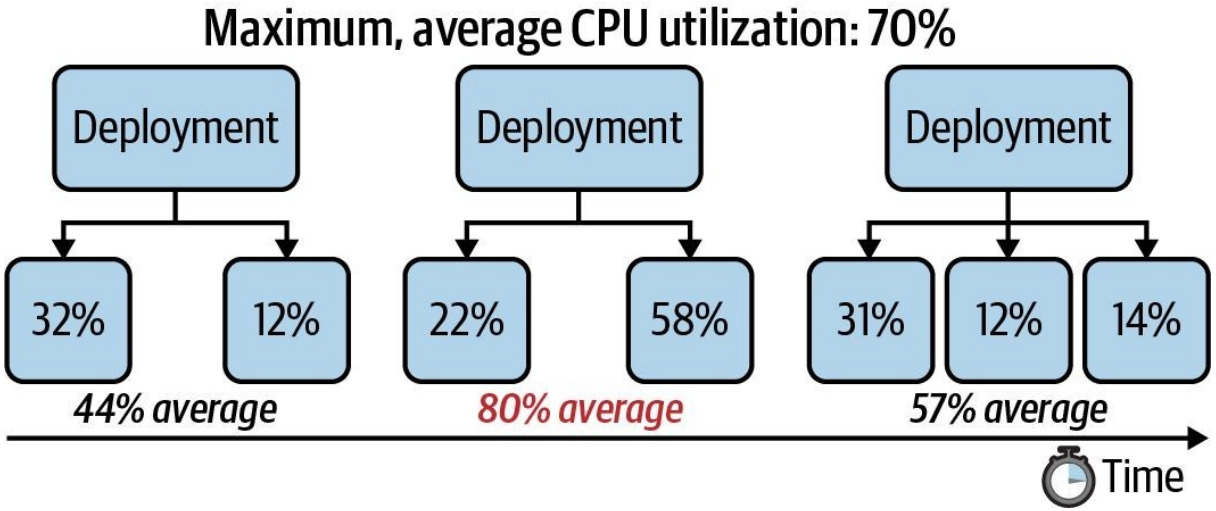
Use `scale` command or change `replicas` attribute in live object

```
$ kubectl scale deployment my-deploy --replicas=5
deployment.apps/my-deploy scaled
```

```
$ kubectl get pods
NAME                          READY   STATUS    RESTARTS   AGE
my-deploy-8448c488b5-5f5tg    1/1     Running   0          44s
my-deploy-8448c488b5-9xplx    1/1     Running   0          44s
my-deploy-8448c488b5-d8q4t    1/1     Running   0          44s
my-deploy-8448c488b5-f5kkm    1/1     Running   0          44s
my-deploy-8448c488b5-mzx5g    1/1     Running   0          3d19h
```

Autoscaling a Deployment

“Don’t make me think. Auto-scale based on CPU utilization.”



Types of Autoscalers

Decisions are made based on metrics

- *Horizontal Pod Autoscaler (HPA):* A standard feature of Kubernetes that scales the number of Pod replicas based on CPU and memory thresholds.

- *Vertical Pod Autoscaler (VPA):* Scales the CPU and memory allocation for existing Pods based on historic metrics. Supported by a cloud provider as an add-on or needs to be installed manually.

- Both autoscalers use the metrics server. You need to install the component.

Creating a HPA

The imperative command is a quick way to create the object

```
$ kubectl autoscale deployments my-deploy --cpu-percent=70 --min=2 --max=8
horizontalpodautoscaler.autoscaling/my-deploy autoscaled

 $ kubectl   get hpa my-deploy
 NAME          REFERENCE                TARGETS          MINPODS   MAXPODS   REPLICAS   AGE
 my-deploy     Deployment/my-deploy     <unknown>/70%    2         8         2          37s
```

Changes with increasing traffic

LAB 06

Performing Rolling Updates and Scaling a Deployment

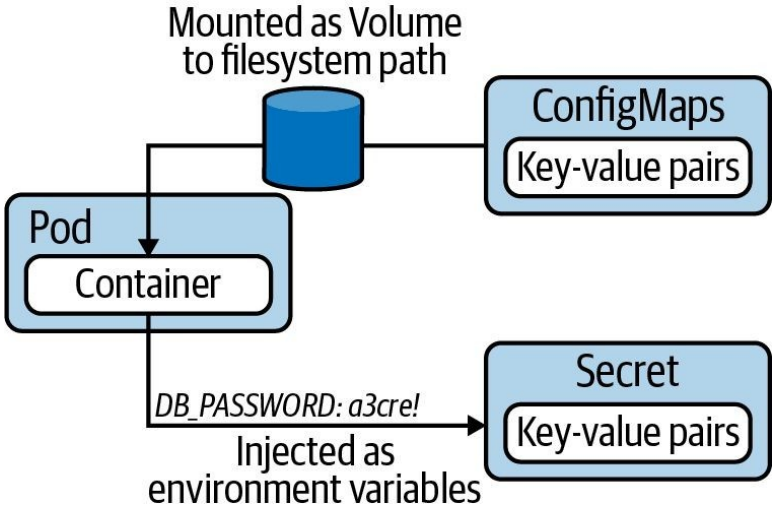
Defining Configuration Data

Control runtime behavior with centralized information

- Stored as key-value pairs in dedicated Kubernetes primitives with a lifecycle decoupled from consuming Pod.
- *ConfigMap:* Plain-text values suited for configuring application e.g. flags, or URLs.
- *Secret:* Base64-encoded values suited for storing sensitive data like passwords, API keys, or SSL certificates. Values are not encrypted!

Consuming ConfigMap & Secret

Mounting as a Volume or injecting as env. variables



ConfigMap Data Sources

Imperative command provides options for sourcing data

- `--from-literal`: Literal values, which are key-value pairs as plain text.
- `--from-env-file`: A file that contains key-value pairs and expects them to be environment variables.
- `--from-file`: A file with arbitrary contents.
- `--from-file`: A directory with one or many files.

Creating a ConfigMap

Fast, easy and flexible, can point to different sources

```
$ kubectl create configmap db-config --from-literal=db=staging
configmap/db-config created

$ kubectl create configmap db-config --from-env-file=config.env
configmap/db-config created

$ kubectl create configmap db-config --from-file=config.txt
configmap/db-config created

$ kubectl create configmap db-config --from-file=app-config
configmap/db-config created
```

ConfigMap YAML Manifest

Definition of a ConfigMap is fairly short and on point

```
apiVersion: v1

kind: ConfigMap
metadata:
  name: db-config
data:
  db: staging
  username: jdoe
```

Consuming as Env. Variables

Convenient if ConfigMap reflects the desired syntax

```
apiVersion: v1
kind: Pod
metadata:
  name: backend
spec:
  containers:
  - image: nginx
    name: backend
    envFrom:
      - configMapRef:
          name: db-config
```

```
$ kubectl exec -it nginx -- env
db=staging
username=jdoe
...
```

Consuming as a Volume

Use Volume type `configMap`

```
apiVersion: v1
kind: Pod
metadata:
  name: backend
spec:
  containers:
    - name: backend
      image: nginx
      volumeMounts:
      - name: config-volume
        mountPath: /etc/config
  volumes:
    - name: config-volume
      configMap:
        name: db-config
```

```
$ kubectl exec -it backend -- /bin/sh
# ls /etc/config
db  username

# cat /etc/config/db  staging
```

Secret Options

Imperative command: `kubectl create secret`

Option	Description
`generic`	Creates a secret from a file, directory, or literal value.
`docker-registry`	Creates a secret for use with a Docker registry.
`tls`	Creates a TLS secret.

Secret Data Sources

Imperative `generic` command provides options for sourcing data

- `--from-literal`: Literal values, which are key-value pairs as plain text.
- `--from-env-file`: A file that contains key-value pairs and expects them to be environment variables.
- `--from-file`: A file with arbitrary contents.
- `--from-file`: A directory with one or many files.

Creating a Secret

Values are base64-encoded automatically

```
$ kubectl create secret generic db-creds --from-literal=pwd=s3cre!
secret/db-creds created

$ kubectl create secret generic db-creds --from-env-file=secret.env
secret/db-creds created

$ kubectl create secret generic db-creds --from-file=id_rsa=~/.ssh/id_rsa
secret/db-creds created
```

Secret YAML Manifest

Value has to be base64-encoded manually

```
$ echo -n 's3cre!' | base64
czNjcmUh
```

```yaml
apiVersion: v1

kind: Secret

metadata:
  name: mysecret

data:
  pwd: czNjcmUh
```

Consuming as Volume

Inside of the container, values are base64-decoded

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: backend
spec:
  containers:
    - name: backend
      image: nginx
      volumeMounts:
      - name: secret-volume
        mountPath: /etc/secret
  volumes:
    - name: secret-volume
      secret:
        SecretName: mysecret
```

```
$ kubectl exec -it backend -- /bin/sh
# ls /etc/secret  pwd
# cat /etc/secret/pwd
s3cre!
```

Specialized Secret Types

The table only lists some, more in docs

Type	Description
`kubernetes.io/basic-auth`	Credentials for basic authentication
`kubernetes.io/ssh-auth`	Credentials for SSH authentication
`kubernetes.io/service-account-token`	ServiceAccount token

Plain-Text Secret Values

The `stringData` attribute allows for plain-text values

```
apiVersion: v1
kind: Secret
metadata:
  name: secret-basic-auth
type: kubernetes.io/basic-auth
stringData:
  username: admin
  password: t0p-Secret
```

LAB 07

Configuring a Pod
to Use a ConfigMap
and secret

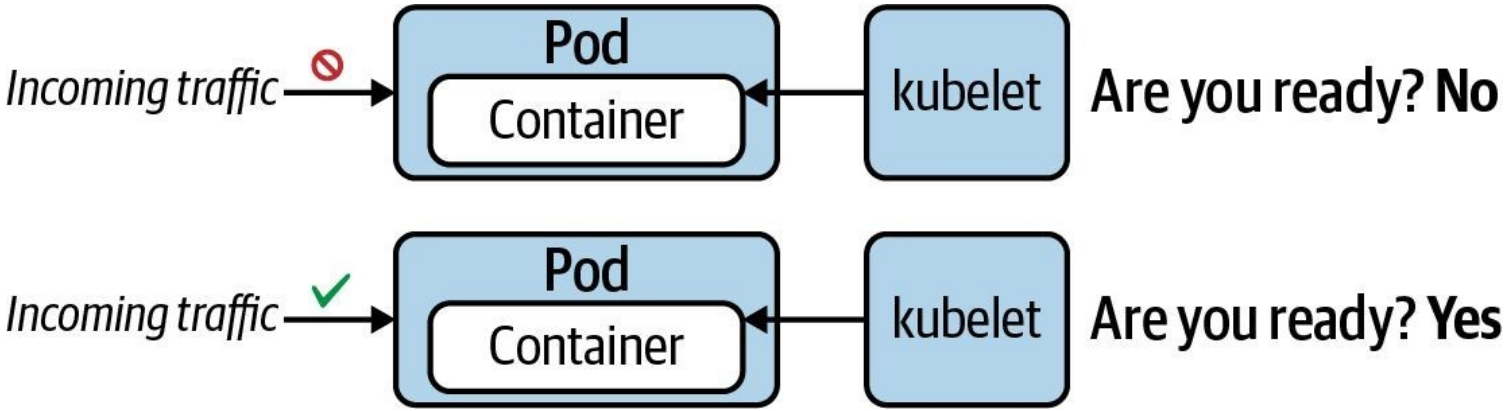
Understanding Health Probing

Runtime issues can arise, but you check for them

- Proper monitoring of applications running in production environments.
- Health probing automates the detection and correction of runtime issues.
- You can configure a container with *health probes* to execute a periodic mini-process that checks for certain conditions.

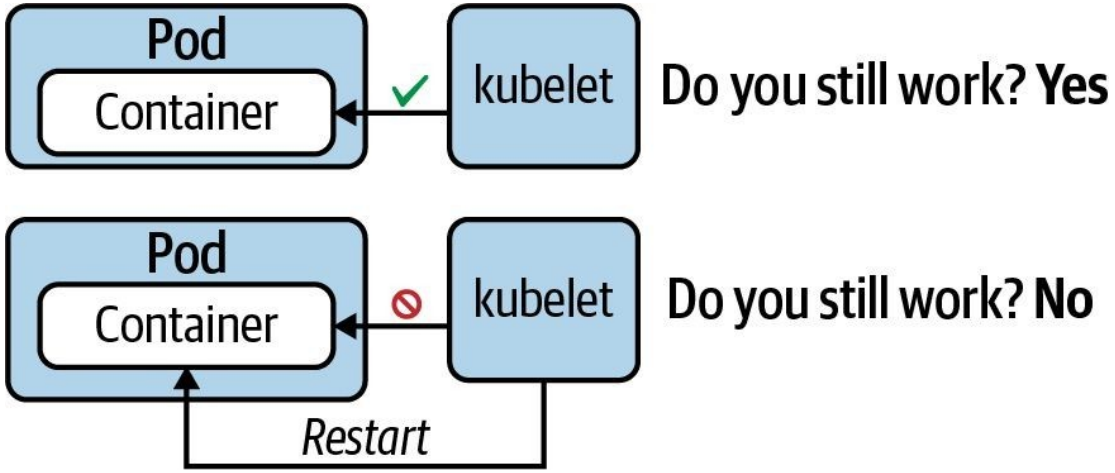
Readiness Probe

“Is application ready to serve requests?”



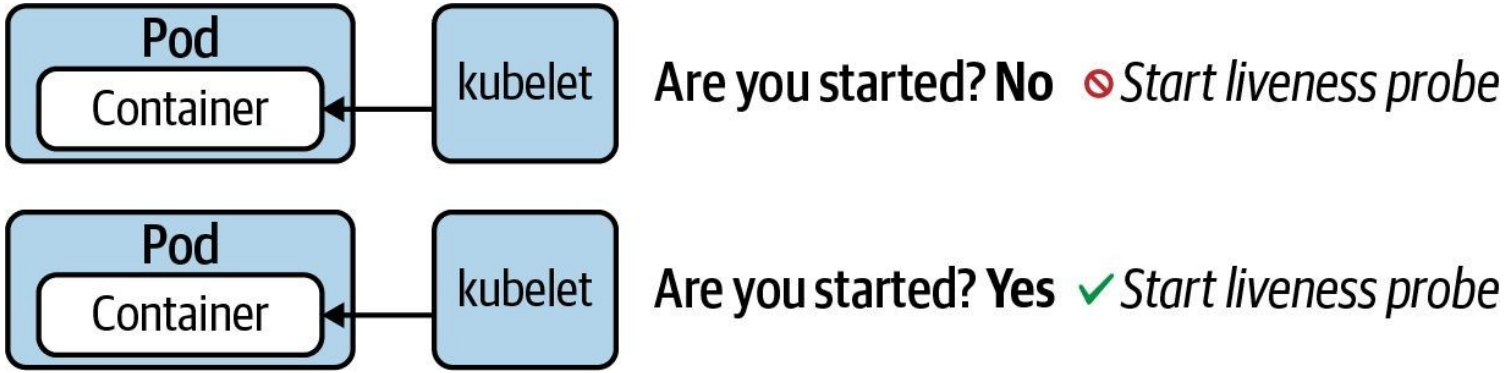
Liveness Probe

“Does the application still function without errors?”



Startup Probe

“Legacy application may need longer to start. Hold off on probing.”



Health Verification Methods

Method	Option	Description
Custom Command	`exec.command`	Executes a command inside of the container e.g. a cat command and checks its exit code. Kubernetes considers an zero exit code to be successful. A non-zero exit code indicates an error.
HTTP GET Request	`httpGet`	Sends an HTTP GET request to an endpoint exposed by the application. A HTTP response code in the range of 200 and 399 indicates success. Any other response code is regarded as an error.
TCP socket connection	`tcpSocket`	Tries to open a TCP socket connection to a port. If the connection could be established, the probing attempt was successful. The inability to connect is accounted for as an error.

Health Check Attributes

Attribute	Default Value	Description
`initialDelaySeconds`	`0`	Delay in seconds until first check is executed.
`periodSeconds`	`10`	Interval for executing a check (e.g., every 20 seconds).
`timeoutSeconds`	`1`	Maximum number of seconds until check operation times out.
`successThreshold`	`1`	Number of successful check attempts until probe is considered successful after a failure.
`failureThreshold`	`3`	Number of failures for check attempts before probe is marked failed and takes action.

Defining a Readiness Probe

HTTP probes are very helpful for web applications

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: web-app
spec:
  containers:
  - name: web-app
    image: eshop:4.6.3
    readinessProbe:
      httpGet:
        path: /
        port: 8080
      initialDelaySeconds: 5
      periodSeconds: 2
```

Successful if HTTP status code is between 200 and 399

Defining a Liveness Probe

An event log can be queried by a custom command

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: web-app
spec:
  containers:
  - name: web-app
    image: eshop:4.6.3
    livenessProbe:
      exec:
        command:
        - test `find /tmp/heartbeat.txt -mmin -1`
      initialDelaySeconds: 10
      periodSeconds: 5
```

Does the file get updated periodically by the application process?

Defining a Startup Probe

TCP socket connection if exposed by application

```
apiVersion: v1
kind: Pod
metadata:
  name: startup-pod
spec:
  containers:
  - image: httpd:2.4.46
    name: http-server
    startupProbe:
      tcpSocket:
        port: 80
      initialDelaySeconds: 3
      periodSeconds: 15
```

Tries to open a TCP socket connection to a port

LAB 08

Configuring Health Probes for a Pod

Handling Resources

It's best practice to make statement about resource consumption

- Containers can define a minimum amount of resources needed to run the application, as well as the maximum amount of resources the application is allowed to consume.
- Application developers should determine the right-sizing with load tests or at runtime by monitoring the resource consumption.
- Enforcement of resources can be constrained on a namespace-level with a ResourceQuota.

Resource Units in Kubernetes

CPU units and memory as fixed-point number or power-of-two equivalents

Kubernetes measures CPU resources in millicores and memory resources in bytes. That's why you might see resources defined as `600m` or `100Mib`.

For a deep dive on those resource units, it's worth cross-referencing the section "Resource units in Kubernetes" in the official documentation.

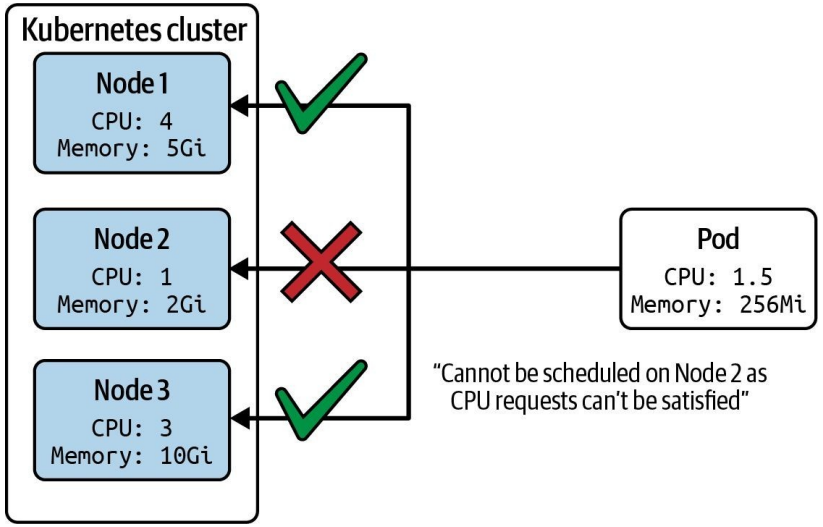
Container Resource Requests

Definition and runtime effects

- Containers can define a minimum amount of resources needed to run the application via `spec.containers[].resources.requests`.
- Resource types include CPU, memory, huge page, ephemeral storage.
- If Pod cannot be scheduled on any node due to insufficient resource availability, you may see a `PodExceedsFreeCPU` or `PodExceedsFreeMemory` status.

Example Scheduling Scenario

Node's resource capacity needs to be able to fulfill it



Resource Requests YAML Manifest

Minimum amount of resources define for a container

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: rate-limiter
spec:
  containers:
  - name: business-app
    image: bmuschko/nodejs-business-app:1.0.0
    ports:
    - containerPort: 8080
    resources:
      requests:
        memory: "256Mi"
        cpu: "1"
```

Container Resource Limits

Definition and runtime effects

- Containers can define a maximum amount of resources allowed to consumed by the application via `spec.containers[].resources.limits`.
- Resource types include CPU, memory, huge page, ephemeral storage.
- Container runtime decides how to handle situation where application exceeds allocated capacity, e.g. termination of application process.

Resource Limits YAML Manifest

Do not allow more than the allotted resource amounts

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: rate-limiter
spec:
  containers:
  - name: business-app
    image: bmuschko/nodejs-business-app:1.0.0
    ports:
    - containerPort: 8080
    resources:
      limits:
        memory: "512Mi"
        cpu: "2"
```

Pod Scheduling Details

After scheduling a Pod, you can check on runtime information

```
$ kubectl get pod rate-limiter -o yaml | grep nodeName:
  nodeName: worker-3

 $ kubectl describe node    worker-3
 ...
 Non-terminated Pods:        (3 in total)

   Namespace                    Name         CPU Requests    CPU Limits      ...
   ---------                    ----         ------------    ----------      ...
   default                   rate-limiter    1250m (62%)     0 (0%)          ...
```

What is a ResourceQuota?

Defines resource constraints per namespace

- Constraints that limit aggregate resource consumption or limit the quantity of objects that can be created.
- `requests.cpu/memory`: Across all pods in a non-terminal state, the sum of CPU/memory requests cannot exceed this value.
- `limits.cpu/memory`: Across all pods in a non-terminal state, the sum of CPU/memory limits cannot exceed this value.

ResourceQuota YAML Manifest

# of objects and limit aggregate resource consumption

```yaml
apiVersion: v1
kind: ResourceQuota
metadata:
  name: awesome-quota
  namespace: team-awesome
spec:
  hard:
    pods: 2
    requests.cpu: "1"
    requests.memory: 1024Mi
    limits.cpu: "4"
    limits.memory: 4096Mi
```

No Requests/Limits Definition

Scheduler rejects the creation of the object

```
$ kubectl create -f nginx-pod.yaml -n team-awesome
Error from server (Forbidden): error when creating "nginx-pod.yaml":
pods "nginx" is forbidden: failed quota: awesome-quota: must specify
limits.cpu,limits.memory,requests.cpu,requests.memory
```

Exceeds Requests/Limits

Scheduler rejects the creation of the object

```
$ kubectl create -f nginx-pod.yaml -n team-awesome
Error from server (Forbidden): error when creating "nginx-pod.yaml":
pods "nginx" is forbidden: exceeded quota: awesome-quota, requested:
pods=1,requests.cpu=500m,requests.memory=512Mi, used: pods=2,requests.cpu=1,
requests.memory=1024Mi, limited: pods=2,requests.cpu=1,requests.memory=1024Mi
```

Inspecting a ResourceQuota

Consumed resources and defined hard limits

```
$ kubectl describe resourcequota awesome-quota -n team-awesome
Name:             awesome-quota
Namespace:         team-awesome
Resource          Used   Hard
--------          ----   ----
limits.cpu        2      4
limits.memory     2048m  4096m
 pods             2      2
requests.cpu      1      1
requests.memory   1024m  1024m
```

LAB 09

Defining a Pod’s Resource Requirements

Node Affinity & Taints/Tolerations

Concepts with different purposes, but can go hand in hand

- **Node Affinity:** Attract Pods to a node as soft or hard requirement.
- **Taint:** Allow a node to repel a set of Pods.
- **Tolerations:** Applied to Pods to allow scheduling them to nodes with a specific taint.

Kubernetes Scheduler

`kube-scheduler` is the default scheduler for Kubernetes

```
$ kubectl get pods -n kube-system
NAME                       READY    STATUS       RESTARTS    AGE
kube-scheduler             1/1      Running      2           76d
...
```

Detailed information on node selection

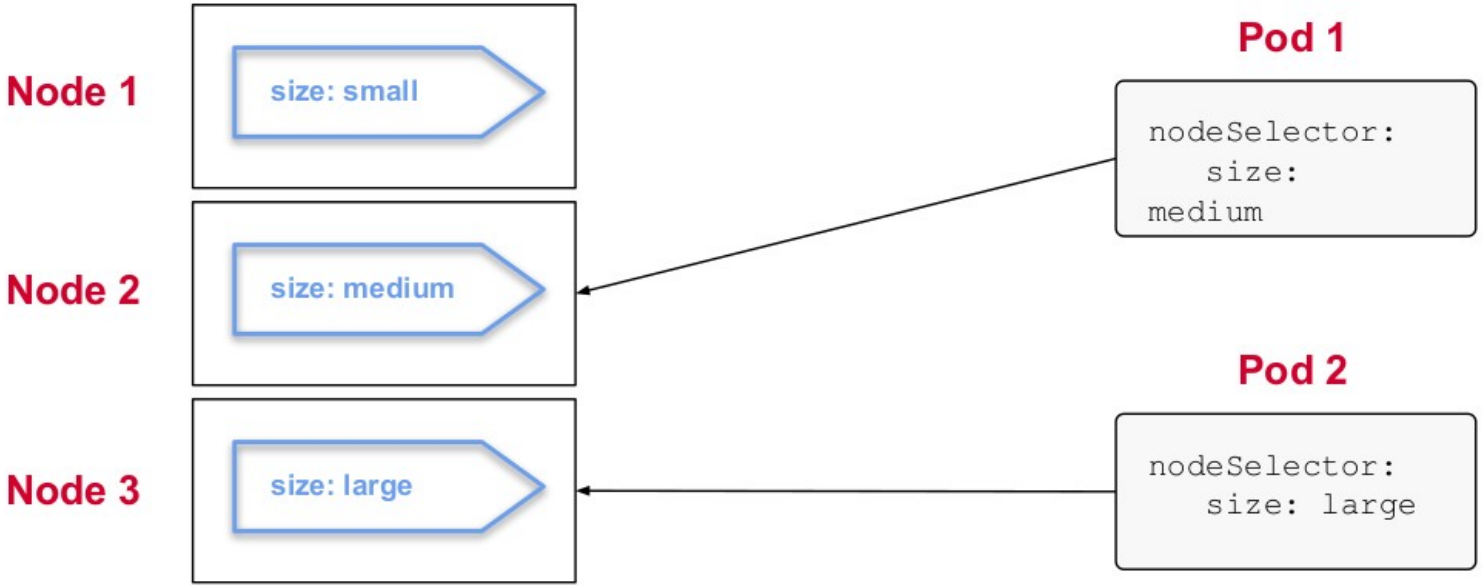
What Node Does Pod Run On?

Once Pod is scheduled, the node is assigned automatically

```
$ kubectl    get nodes

NAME           STATUS      ROLES       AGE              VERSION
kube-node1     Ready       master      204d             v1.19.2


$ kubectl get pod app -o yaml | grep nodeName:
  nodeName: kube-node1
```

Node Selection Constraint

Define a label selector in Pod's spec that matches node label



Node Selection Constraint

Add labels to nodes

```
$ kubectl label nodes minikube size=medium
node/minikube labeled

$ kubectl get nodes --show-labels
NAME           STATUS   ROLES    AGE    VERSION   LABELS
...
minikube-m02   Ready    master   204d   v1.19.2    ...size=medium
minikube-m03   Ready    master   204d   v1.19.2    ...
minikube-m04   Ready    master   204d   v1.19.2    ...
```

Node Selection Constraint

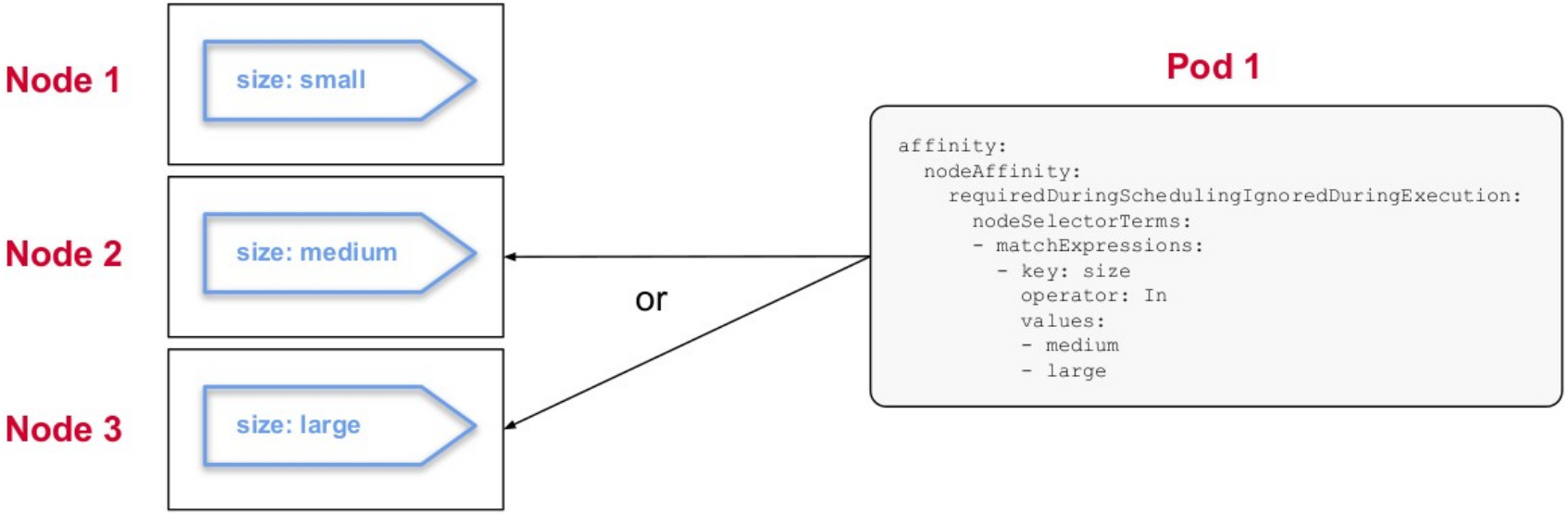
Define the `nodeSelector` attribute upon Pod creation

```
apiVersion: v1
kind: Pod
metadata:
  name: app
spec:
  containers:
  - image: nginx
    name: nginx
  restartPolicy: Never
  nodeSelector:
    size: medium
```

Can't have multiple keys with the same value as the underlying data structure is a map

Node Affinity

Similar to `nodeSelector` but more flexible and powerful

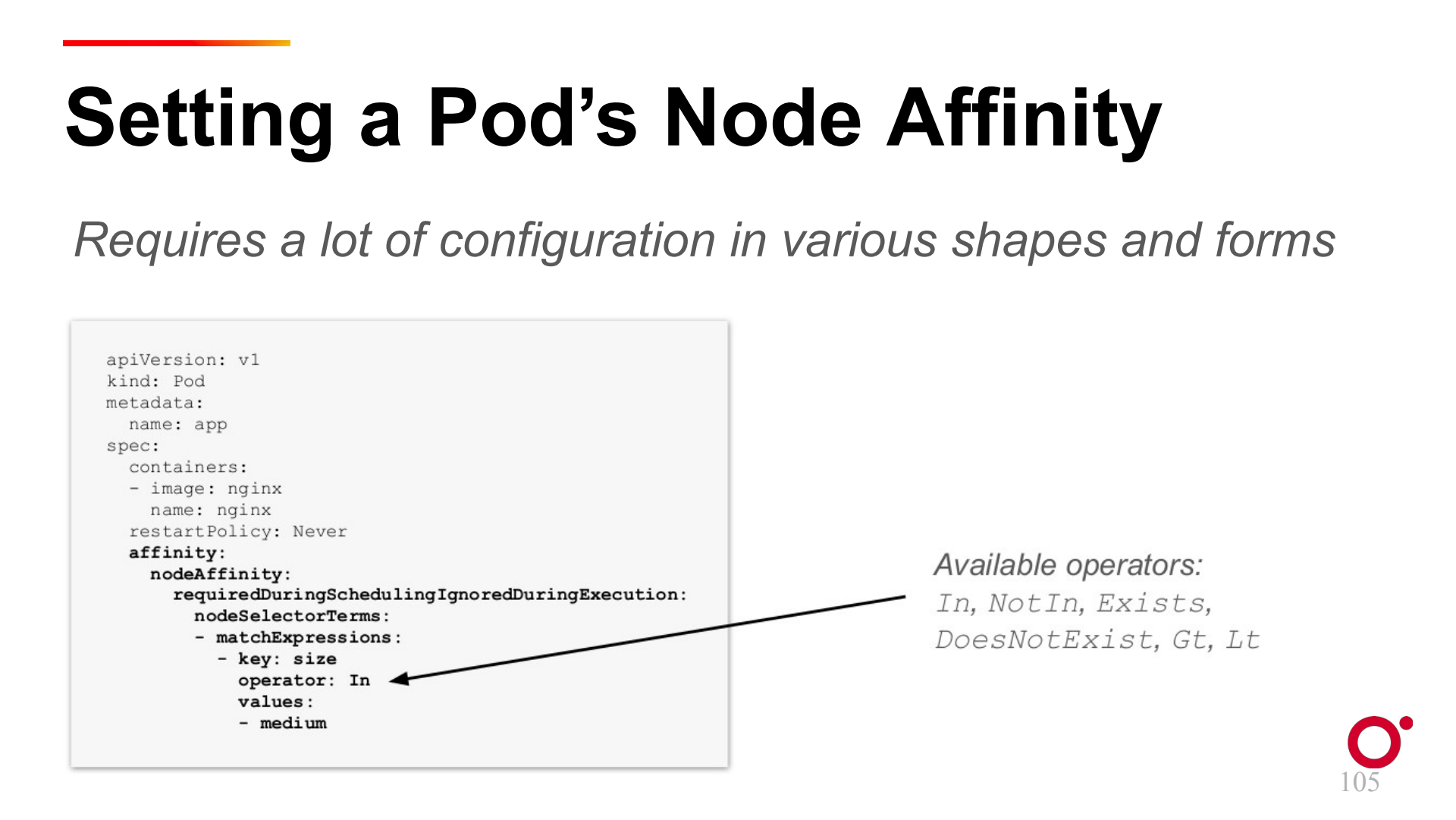


Setting a Pod's Node Affinity

Requires a lot of configuration in various shapes and forms

```
apiVersion: v1
kind: Pod
metadata:
  name: app
spec:
  containers:
  - image: nginx
    name: nginx
  restartPolicy: Never
  affinity:
    nodeAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        nodeSelectorTerms:
        - matchExpressions:
          - key: size
            operator: In
            values:
            - medium
```

Available operators:
In, NotIn, Exists, DoesNotExist, Gt, Lt



Node Affinity Types

Currently two types, potentially more in the future

Type	Description
`requiredDuringSchedulingIgnoredDuringExecution`	Rules that must be met for a Pod to be scheduled onto a node.
`preferredDuringSchedulingIgnoredDuringExecution`	Rules that specify preferences that the scheduler will try to enforce but will not guarantee.

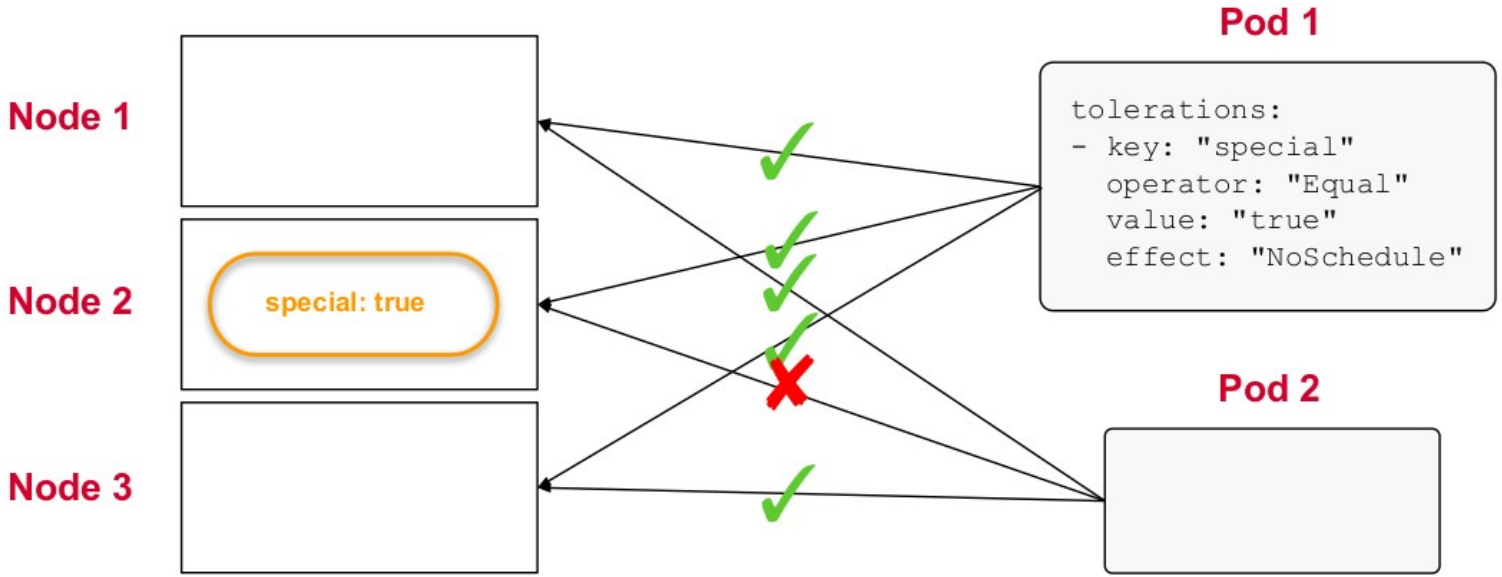
`*IgnoredDuringExecution` means that changes to the affinity of a running Pod does not have an effect

LAB 10

Scheduling a Pod
on Specific Nodes

Taints and Tolerations

A Pod that doesn't have specific toleration is repelled



Setting a Node Taint

Add taint to nodes

```
$ kubectl taint nodes kube-control-plane special=true:NoSchedule
node/kube-control-plane tainted

$ kubectl get nodes kube-control-plane -o yaml | grep -C 3 taints:
...
spec:
  taints:
  - effect: NoSchedule
    key: special
    value: "true"
```

Taint Effects

Needs to be provided to node and Pod

Effect	Description
`NoSchedule`	Unless a Pod has matching toleration, it won't be be scheduled on the node.
`PreferNoSchedule`	Try not to place a Pod that does not tolerate the taint on the node, but it is not required.
`NoExecute`	Evict Pod from node if already running on it. No future scheduling on the node.

Setting a Pod's Toleration

Requires a lot of configuration in various shapes and forms

```
apiVersion: v1
kind: Pod
metadata:
  name: app
spec:
  containers:
  - image: nginx
    name: nginx
  restartPolicy: Never
  tolerations:
  - key: "special"
    operator: "Equal"
    value: "true"
    effect: "NoSchedule"
```

Available operators:
Equal, Exists

LAB 11

Configuring a Node
to Only Accept
Specific Pods

Services & Networking

Inter-Pod Communication, Service Types, Ingress, CoreDNS, CNI plugins

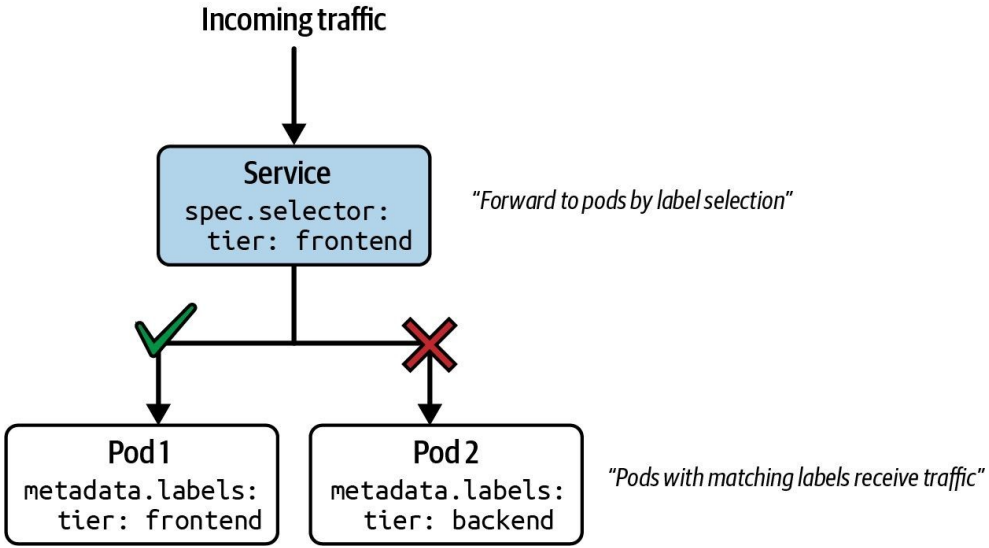
What is a Service?

Discoverable networking capability for Pods

- A Pod’s IP address is not considered stable over time. A Pod restart leases a new IP address.
- Building a microservices architecture on Kubernetes requires network interfaces stable over time.
- A Service provides discoverable names and load balancing to a set of Pods.

Request Routing

"How does a service decide which Pod to forward the request to?"



Different Types of Services

Type	Behavior
`ClusterIP`	Exposes the service on a cluster-internal IP. Only reachable from within the cluster.
`NodePort`	Exposes the service on each node's IP at a static port. Accessible from outside of the cluster.
`LoadBalancer`	Exposes the service externally using a cloud provider’s load balancer.

Creating a Service

Ensure that Pod labels and Service label selector match

```
$ kubectl run echoserver --image=k8s.gcr.io/echoserver:1.10 --restart=Never↵
  --port=8080
  pod/echoserver created

  $ kubectl create service clusterip echoserver --tcp=80:8080
  service/echoserver created

  $ kubectl run echoserver --image=k8s.gcr.io/echoserver:1.10 --restart=Never↵
  --port=8080 --expose
  service/echoserver created
  pod/echoserver created
```

Shortcut for creating a Pod + Service

Service YAML Manifest

Defines containers and their images running in them

```yaml
apiVersion: v1
kind: Service
metadata:
  name: echoserver
spec:
  type: ClusterIP
  selector:
    app: echoserver
  ports:
  - port: 80
    targetPort: 8080
```

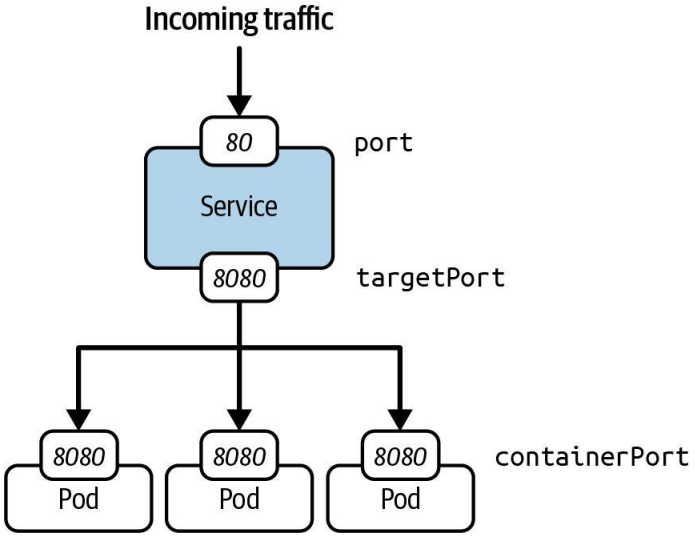
Service type

Label selection for Pods

Mapping of incoming to outgoing port

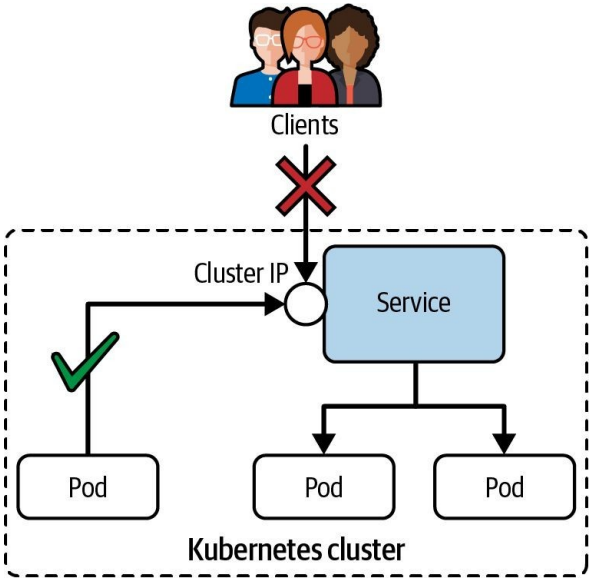
Port Mapping

“How to map the service port to the container port in Pod?”



ClusterIP Service Type

Only reachable from within the cluster, e.g. another Pod



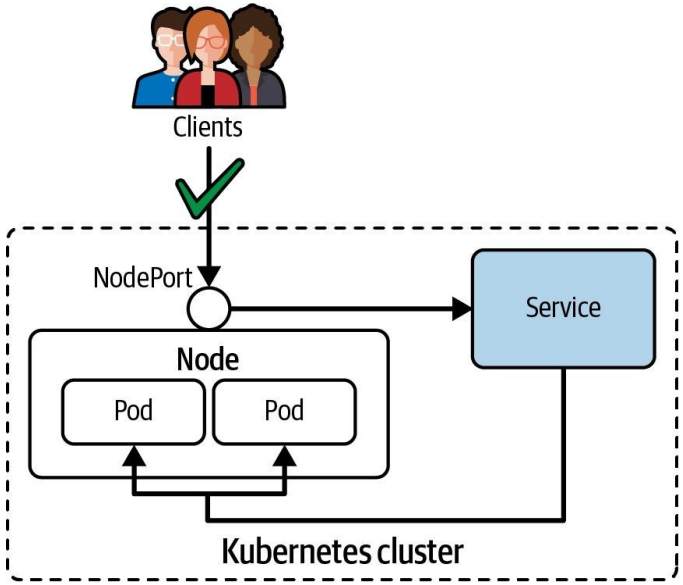
Accessing a ClusterIP Service

Use the combination of cluster IP and incoming service port

```
$ kubectl get pod,service
NAME              READY   STATUS    RESTARTS   AGE
pod/echoserver    1/1     Running   0          23s

NAME                 TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)    AGE
service/echoserver   ClusterIP   10.96.254.0    <none>        5005/TCP   8s

$ kubectl run tmp --image=busybox --restart=Never -it --rm↵
  -- wget 10.96.254.0:5005
  Connecting to 10.96.254.0:5005 (10.96.254.0:5005)
  ...
```

NodePort Service Type

Can be resolved from outside of the Kubernetes cluster



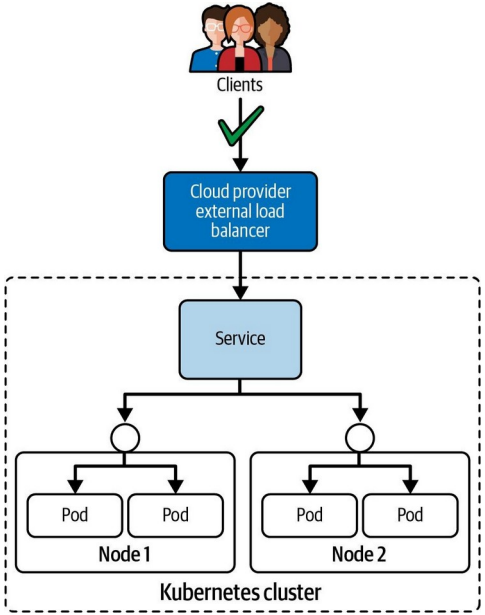
Accessing a NodePort Service

Use the combination of node IP and statically-assigned port

```
$ kubectl get pod,service
NAME              READY    STATUS    RESTARTS   AGE
pod/echoserver    1/1      Running   0          23s

NAME                  TYPE       CLUSTER-IP    EXTERNAL-IP   PORT(S)          AGE
service/echoserver    NodePort   10.96.254.0   <none>        5005:30158/TCP   8s
```

LoadBalancer Service Type

Routes traffic from existing, external load balancer to Service



Accessing a LoadBalancer Service

Use the combination of node IP and statically-assigned port

```
$ kubectl get pod,service
NAME              READY    STATUS     RESTARTS    AGE
pod/echoserver    1/1      Running    0           23s

NAME                  TYPE           CLUSTER-IP      EXTERNAL-IP      PORT(S)          AGE
service/echoserver    LoadBalancer   10.109.76.157   10.109.76.157    5005:30642/TCP   5s

$ wget 10.109.76.157:5005
Connecting to 10.109.76.157:5005... connected.
...
```

LAB 12

Routing traffic to Pods from Inside and Outside of a Cluster

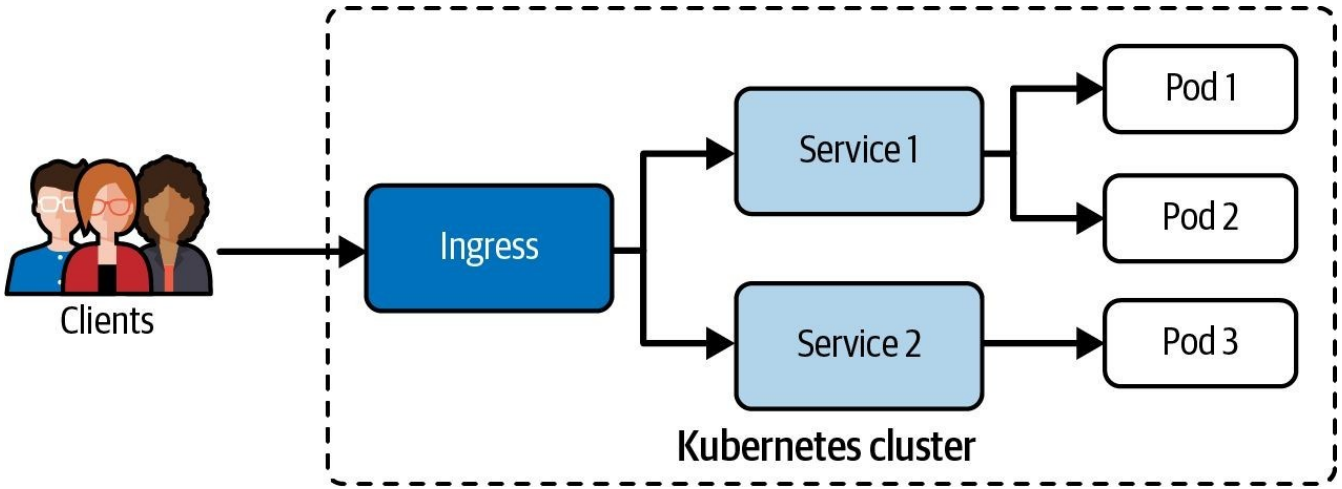
What is an Ingress?

Route HTTP(S) traffic from the outside of cluster to Service

- It’s not a specific Service type, nor should it be confused with the Service type `LoadBalancer`.
- Defines rules for mapping URL context path to Service object.
- An Ingress cannot work without an Ingress controller. The Ingress controller evaluates the collection of rules defined by an Ingress that determine traffic routing.

Ingress Traffic Routing

Can involve one or many Services as backend



Creating an Ingress

The rule definition requires intricate knowledge of syntax

```
$ kubectl create ingress corellian↵
  --rule="star-alliance.com/corellian/api=corellian:8080"
ingress.networking.k8s.io/corellian created
```

Ingress YAML Manifest

The host definition is optional

```yaml
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: corellian
spec:
  rules:
  - host: star-alliance.com
    http:
      paths:
      - backend:
          service:
            name: corellian
            port:
              number: 8080
        path: /corellian/api
        pathType: Exact
```

Ingress Rules

Traffic routing is controlled by rules defined on Ingress resource

- Optional host. If no host is defined, then all inbound HTTP traffic is handled.
- A list of paths e.g. `/testpath`.
- The backend, a combination of Service name and port.

Path Types

Incoming URLs match based on type

	Rule	*Request*
Exact	`/foo`	`/foo` ✓ `/bar` ✗
Prefix	`/foo`	`/foo, /foo/` ✓ `/bar` ✗

Accessing an Ingress

Use host name and context path

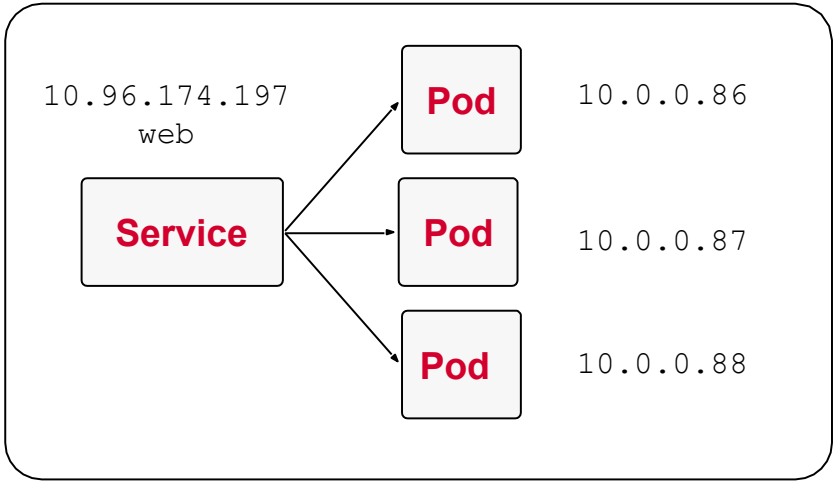
```
$ wget star-alliance.com/corellian/api/ --timeout=5 --tries=1
Resolving star-alliance.com (star-alliance.com)... 192.168.64.15
Connecting to star-alliance.com (star-alliance.com)|192.168.64.15|:80... connected.
...
```

LAB 13

Defining and Using an Ingress

DNS for Services

Kubernetes DNS service creates record for Service

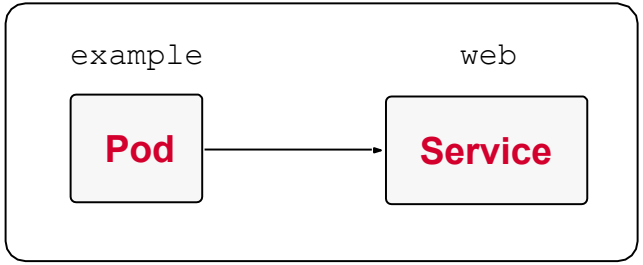


Kubernetes DNS Service

Hostname	IP Address
web	10.96.174.197

Resolving a Service by DNS

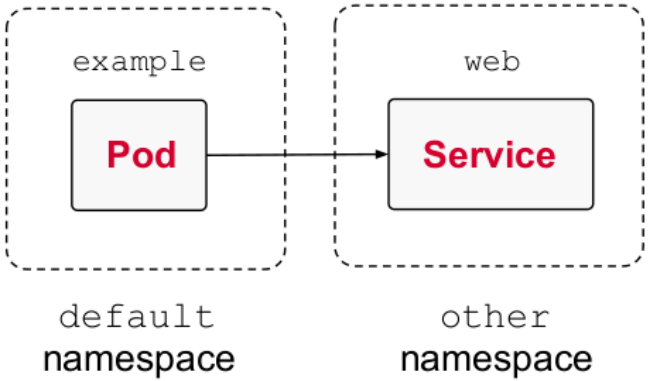
Resolve by hostname within the same namespace




```
$ curl http://web
Hello World
```

Resolving a Service by DNS

Resolve by namespace, type, root domain from another namespace




```
$ curl http://web.other
Hello World

$ curl http://web.other.svc
Hello World

$ curl http://web.other.svc.cluster.local
Hello World
```

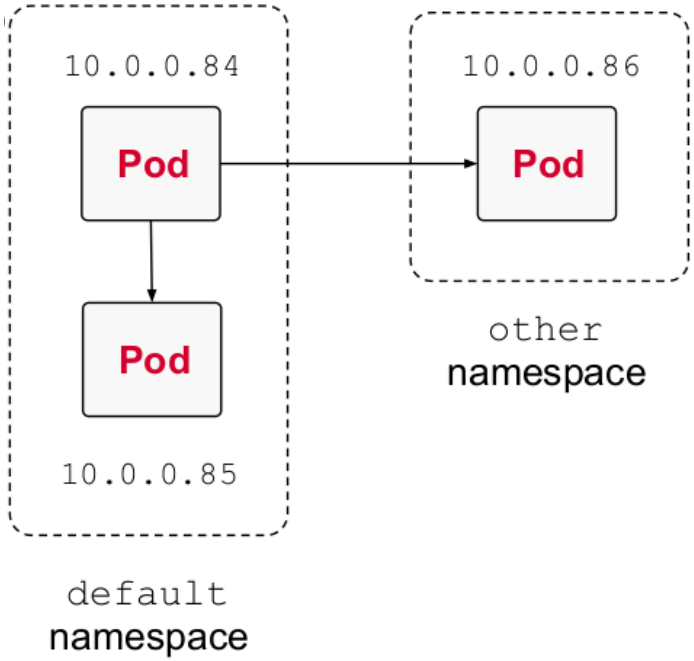
Namespace

Type

Root Domain

Resolving a Pod by DNS

DNS records are not created by default, resolve by IP a




```
$ curl 10.0.0.85
Hello World

$ curl 10.0.0.86
Hello World
```

Object Representation CoreDNS

Recommended Kubernetes DNS server implementation

```
$ kubectl   get pods -n kube-system
NAME                          READY    STATUS         RESTARTS      AGE
coredns-f9fd979d6-skk6w       1/1      Running        2             67d

$ kubectl get services -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     195d
```

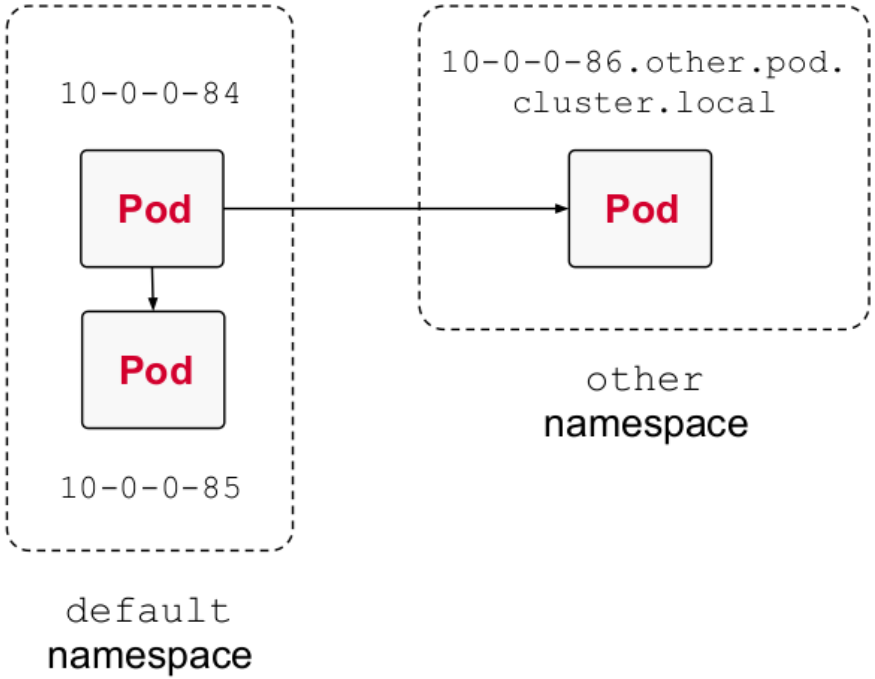
Configuring CoreDNS

Sets root domain and enables DNS for Pods

```
$ kubectl describe configmap coredns -n kube-system
...
Data
====
Corefile:
------
.:53 {
    ...
    kubernetes cluster.local in-addr.arpa ip6.arpa {
        pods insecure
        fallthrough in-addr.arpa ip6.arpa  ttl 30
    }
    ...
}
```

Resolving a Pod by DNS

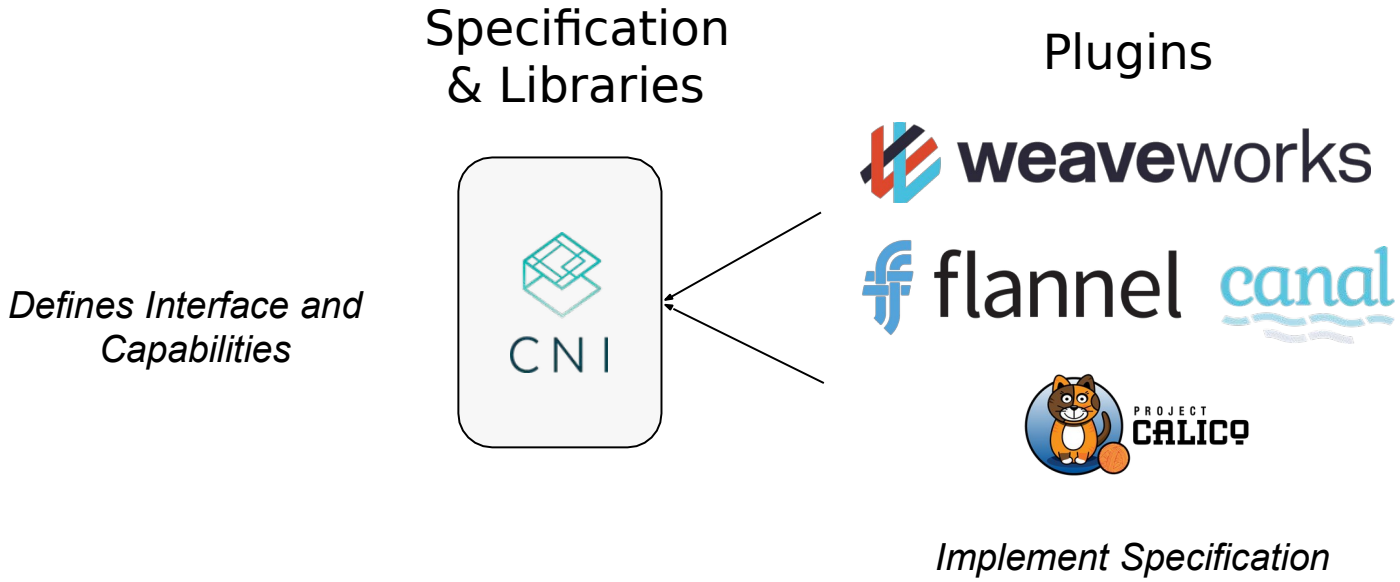
DNS records are not created by default, resolve by IP




```
$ curl 10-0-0-85
Hello World

$ curl
10-0-0-86.other.pod.cluster
.local
Hello World
```

Understanding CNI

Kubernetes uses CNI for Pod networking



Choosing a CNI Plugin

Direct installation instructions only available for Weave Net

List of plugins:

https://kubernetes.io/docs/concepts/cluster-administration/addons/

Installation instructions for Weave Net:

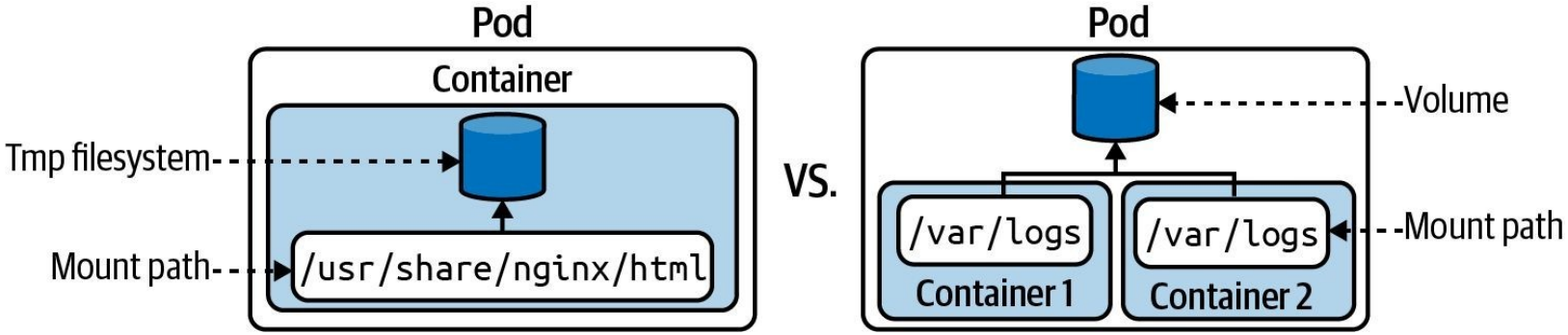
https://kubernetes.io/docs/setup/production-environment/tools/kubeadm/high-availability/#steps-for-the-first-control-plane-node

Storage

Volumes, Volume Configuration Options, PersistentVolumes with Static & Dynamic Binding

Understanding Volumes

By default, a container manages files in a temporary file system



Types of Volumes

Type	Description
`emptyDir`	Empty directory in Pod. Only persisted for the lifespan of a Pod.
`hostPath`	File or directory from the host node's filesystem into your Pod.
`configMap, secret`	Provides a way to inject configuration data and secrets into Pods.
`nfs`	An existing NFS (Network File System) share to be mounted into your Pod. Preserves data after Pod restart.
Cloud provider solutions	Provider-specific implementation for AWS, GCE or Azure.

Defining and Mounting a Volume

Provide type and assign mount path per container

```
apiVersion: v1
kind: Pod
metadata:
  name: my-container
spec:
  volumes:
  - name: logs-volume
    emptyDir: {}
  containers:
  - image: nginx
    name: my-container
    volumeMounts:
    - mountPath: /var/logs
      name: logs-volume
```

Define Volume name and type

Specify mount path in container

Using a Volume

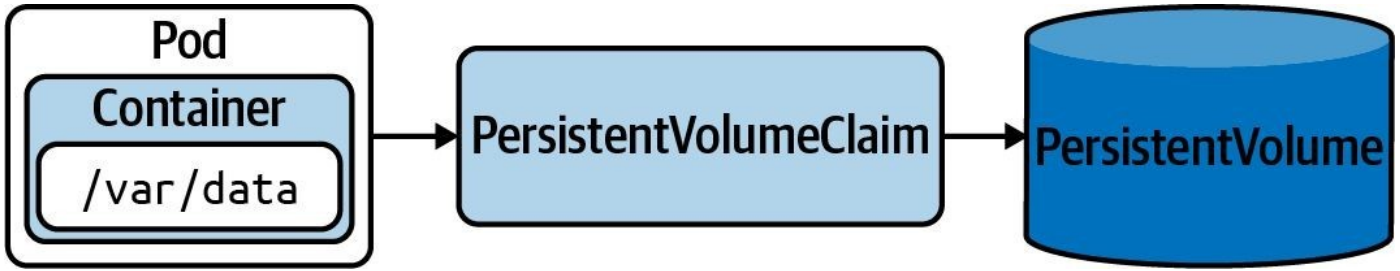
New files can be created in mounted path of Volume

```
$ kubectl create -f pod-with-vol.yaml
pod/my-container created

$ kubectl exec -it my-container -- /bin/sh
# cd /var/logs
# pwd
/var/logs
# touch app-logs.txt
 # ls
app-logs.txt
```

Mount path became accessible in container

Understanding PersistentVolumes

Persist data that outlives a Pod, node, or cluster restart



Static vs. Dynamic Provisioning

PersistentVolume object is created manually or automatically

- *Static:* Storage device needs to be created first. The PersistentVolume object references the storage device and needs to be created manually.
- *Dynamic:* The PersistentVolumeClaim object references a storage class. The PersistentVolume object is created automatically.
- *Storage Class:* Object that knows how to provision a storage device with specific performance requirements.

Defining a PersistentVolume

Define storage capacity, access mode, and host path

```
apiVersion: v1
kind: PersistentVolume
Metadata:
  name: db-pv
spec:
  capacity:
    storage: 1Gi
  accessModes:
  - ReadWriteOnce
  hostPath:
    path: /data/db
```

Access Mode & Reclaim Policy

Configuration options for PersistentVolume

Access Mode

Type	Description
`ReadWriteOnce`	Read-write access by a single node.
`ReadOnlyMany`	Read-only access by many nodes.
`ReadWriteMany`	Read-write access by many nodes.

Reclaim Policy

Type	Description
`Retain`	Default. When PVC is deleted, PV is “released” and can be reclaimed.
`Delete`	Deletion removes PV and associated storage.
`Recycle`	Deprecated. Use dynamic binding instead.

Creating the PersistentVolume

Listing the object show many of its configuration options

```
$ kubectl create -f db-pv.yaml
persistentvolume/db-pv created

$ kubectl get pv   db-pv
NAME    CAPACITY    ACCESS   MODE     RECLAIM POLICY     STATUS      ...
db-pv   1Gi         RWO      S        Retain             Available   ...
```

The object hasn’t been consumed by a claim yet

Defining a Claim

Will use a PersistentVolume based on resource request

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: db-pvc
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 256Mi
  storageClassName: ""
```

Assign an empty storage class name to use a statically-created PersistentVolume

Creating the PersistentVolumeClaim

Listing the object show many of its configuration options

```
$ kubectl create -f db-pvc.yaml
persistentvolumeclaim/db-pvc created

$ kubectl get pvc db-pvc
NAME      STATUS   VOLUME   CAPACITY   ACCESS MODES   STORAGECLASS   AGE
db-pvc    Bound    pvc      512m       RWO            standard       7s
```

Binding to the PersistentVolume object was successful

Mounting a Claim in a Pod

Use Volume type `persistentVolumeClaim`

```
apiVersion: v1
kind: Pod
metadata:
  name: app-consuming-pvc
spec:
  volumes:
    - name: app-storage
      persistentVolumeClaim:
        claimName: db-pvc
  containers:
  - image: alpine
    ...
    volumeMounts:
      - mountPath: "/mnt/data"
        name: app-storage
```

Reference the Volume by claim name

Creating the Pod

The Volume is now listed in Pod details

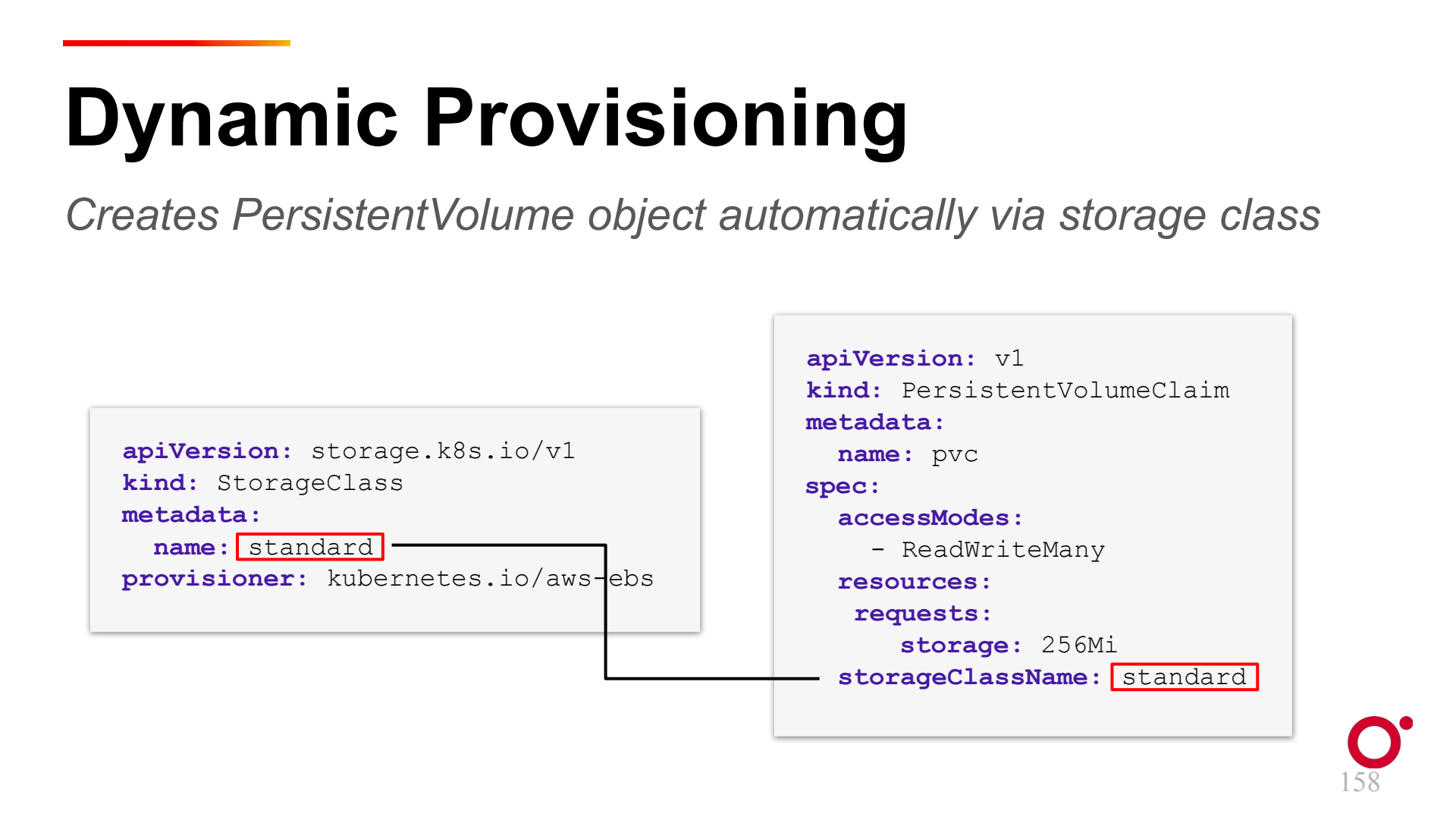
```
$ kubectl create -f app-consuming-pvc.yaml
pod/app-consuming-pvc created

$ kubectl describe pod app-consuming-pvc
...
Volumes:
  app-storage:
    Type:       PersistentVolumeClaim (a reference to a
                PersistentVolumeClaim in the same namespace)
    ClaimName:  db-pvc
    ReadOnly:   false
...
```

Dynamic Provisioning

Creates PersistentVolume object automatically via storage class

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: standard
provisioner: kubernetes.io/aws-ebs
```

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: pvc
spec:
  accessModes:
    - ReadWriteMany
  resources:
   requests:
      storage: 256Mi
  storageClassName: standard
```



LAB 14

Creating a
Persistent Volume

Troubleshooting

Cluster/Node Logging, Monitoring Applications, Identifying and Fixing Application, Cluster, and Networking Issues

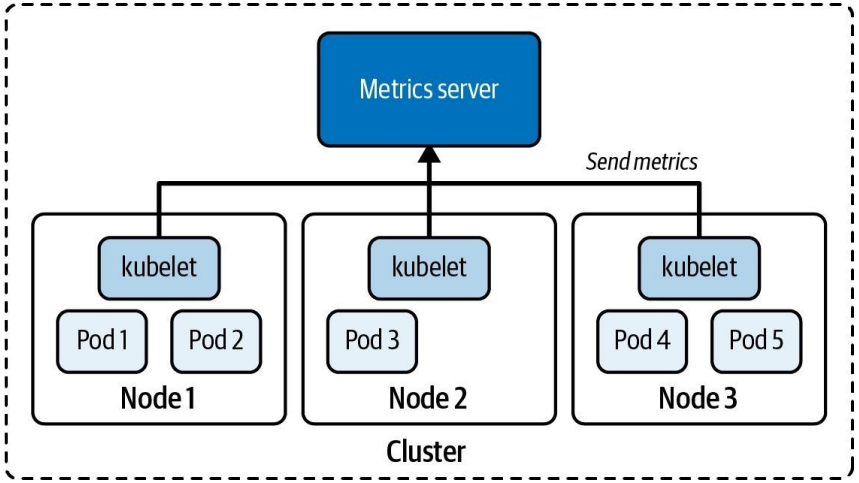
Monitoring Kubernetes

What metrics are of interest?

- Number of nodes in the cluster.
- Health status of nodes.
- Node performance metrics like CPU, memory, disk space, network.
- Pod-level performance metrics like CPU, memory consumption.

Metrics Server

Cluster-wide metrics aggregator



Installing the Metrics Server

```
$ kubectl apply -f
https://github.com/kubernetes-sigs/metrics-server/releases/latest/download/
components.yaml
```

Using the Metrics Server

The `kubectl top` command can query nodes and Pods

```
$ kubectl top nodes
NAME       CPU(cores)   CPU%   MEMORY(bytes)   MEMORY%
minikube   283m         14%    1262Mi          32%
```

```
$ kubectl top pod frontend
NAME       CPU(cores)   MEMORY(bytes)
frontend   0m           2Mi
```

Accessing Container Logs

Simply use the `kubectl logs` command

```
$ kubectl logs hazelcast
...
May 25, 2020 3:36:26 PM com.hazelcast.core.LifecycleService
INFO: [10.1.0.46]:5701 [dev] [4.0.1] [10.1.0.46]:5701 is STARTED
```

Use the command line option `-f, --follow` to stream the logs

Accessing Container Logs

Specify container name for multi-container Pods

```
$ kubectl logs hazelcast -c app
...
May 25, 2020 3:36:26 PM com.hazelcast.core.LifecycleService
INFO: [10.1.0.46]:5701 [dev] [4.0.1] [10.1.0.46]:5701 is STARTED
```

Use the command line option `-c` or `--container`

Official Troubleshooting Docs

Detailed advice and help during exam

- Troubleshooting applications
- Troubleshooting cluster

Troubleshooting Services

Check Service type and call endpoint

```
$ kubectl get service nginx
NAME    TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)          AGE
nginx   NodePort    10.105.201.83   <none>        80:30184/TCP     3h
```

```
$ curl http://nginx:30184
curl: (6) Could not resolve host: nginx
```

✘ Connectivity issue

Troubleshooting Services

Ensure correct label selection

```
$ kubectl describe service myapp
Name:              myapp
Namespace:         default
Labels:            app=myapp
Annotations:       <none>
Selector:          app=myapp
Type:              ClusterIP
IP:                10.102.22.26
Port:              80/TCP
TargetPort:        80/TCP
Endpoints:         10.0.0.115:80
Session Affinity:  None
Events:            <none>
```

```
$ kubectl describe pod myapp

Name:          myapp
...
Labels:        app=myapp
...
```

✓ Matching labels

Troubleshooting Pods

Check the status first - is it running?

```
$ kubectl get pods
NAME    READY    STATUS     RESTARTS    AGE
myapp   1/1      Running    0           12m
```

✓ Healthy status

Troubleshooting Pods

Check the event log - does it indicate issues?

```
$ kubectl describe pod myapp
...
Events:
  Type     Reason       Age                    From                Message
  ----     ------       ----                   ----                -------
  Normal   Scheduled    <unknown>              default-scheduler   Successfully assigned default/secret-pod to minikube
  Warning  FailedMount  3m15s                  kubelet, minikube   Unable to attach or mount volumes: unmounted volumes=[mysecret], unattached volumes=[default-token-bf8rh mysecret]: timed out waiting for the condition
  Warning  FailedMount  68s (x10 over 5m18s)   kubelet, minikube   MountVolume.SetUp failed for volume "mysecret" : secret "mysecret" not found
  ...
```

✘ Failed mount

Troubleshooting Pods

Check the container logs - do you see anything suspicious?

```
$ kubectl logs myapp
...
2019-03-05 10:57:51.112     DEBUG  Receiving order
2019-03-05 10:57:51.112     INFO   Processing payment with ID 345993
2019-03-05 10:57:51.112     ERROR  Can't connect to payment system
```

✘Connectivity issues

Use the command line option `--previous` to gets the logs from the previous instantiation of a container after a restart

LAB 15

Troubleshooting an Issue for an Application

Troubleshooting Control Plane

Check the status of the cluster nodes first - are they

```
$ kubectl get nodes
NAME VERSION     STATUS        ROLES         AGE

master  v1.22.3  Ready         master        198d

worker-1 v1.22.3 Ready         <none>        198d

worker-2 v1.22.3 Ready         <none>        198d
```

✓ Healthy status

Troubleshooting Control Plane

Check the status of control plane Pods - do they indicate issues?

```
$ kubectl get po -n kube-system
NAME                          READY   STATUS             RESTARTS   AGE
kube-apiserver                1/1     Running            49         70d
kube-controller-manager       1/1     CashLoopBackoff    2          70d
kube-proxy-mpgd9              1/1     Running            2          70d
kube-scheduler-minikube       1/1     Running            2          70d
```

✘Failing controller manager Pod

Troubleshooting Control Plane

Check the logs of API server Pod

```
$ kubectl get pods -n kube-system
NAME                               READY   STATUS             RESTARTS   AGE
kube-apiserver-minikube            1/1     Running            49         70d
kube-controller-manager-minikube   1/1     CashLoopBackoff    2          70d
kube-proxy-mpgd9                   1/1     Running            2          70d
kube-scheduler-minikube            1/1     Running            2          70d
```

✘ Failing controller manager Pod

LAB 16

Troubleshooting an Issue with the Control Plane

Troubleshooting Worker Nodes

Check the status of the worker nodes - are they ready?

```
$ kubectl get nodes
NAME        STATUS      ROLES    AGE    VERSION
master      Ready       master   198d   v1.22.3
worker-1    Ready       <none>   198d   v1.22.3
worker-2    NotReady    <none>   198d   v1.22.3
worker-3    Ready       <none>   198d   v1.22.3
```

✘ Issue with the node `worker-2`

Troubleshooting Worker Nodes

Based on conditions check CPU, memory, processes, disk space

```
$ top
Processes: 568 total, 2 running, 566 sleeping, 2382 threads
15:30:40
Load Avg: 1.96, 1.80, 1.68  CPU usage: 2.49% user, 1.83% sys,
95.66% idle
SharedLibs: 706M resident, 108M data, 196M linkedit.
MemRegions: 192925 total, 6808M resident, 312M private, 5106M
shared. PhysMem: 33G used (4319M wired), 31G unused.
VM: 3461G vsize, 2315M framework vsize, 0(0) swapins, 0(0)
swapouts.
Networks: packets: 6818487/8719M in, 2169040/361M out. Disks:
1305228/17G read, 1354811/32G written.
```

✓ Sufficient memory

```
$ df -h
Filesystem       Size   Used  Avail Capacity iused
ifree %iused  Mounted on
/dev/disk1s1s1  1.8Ti   14Gi   1.6Ti     1%  567557
19538461203    0%   /
devfs           187Ki  187Ki    0Bi   100%     648
0  100%   /dev
/dev/disk1s5    1.8Ti   20Ki  1.6Ti     1%       0
19539028760    0%   /System/Volumes/VM
/dev/disk1s3    1.8Ti  282Mi  1.6Ti     1%     799
19539027961    0%   /System/Volumes/Preboot
/dev/disk1s6    1.8Ti  520Ki  1.6Ti     1%      16
19539028744    0%   /System/Volumes/Update
/dev/disk1s2    1.8Ti  172Gi  1.6Ti    10% 1071918
19537956842    0%   /System/Volumes/Data
map auto_home     0Bi    0Bi    0Bi   100%       0
0  100%   /System/Volumes/Data/home
```

✓ Available disk space

Troubleshooting Worker Nodes

Check Kubelet status

```
$ systemctl status kubelet.service
● 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 Thu 2021-01-21 22:59:54 UTC; 22min ago
     Docs: https://kubernetes.io/docs/home/
 Main PID: 6171 (kubelet)
    Tasks: 16 (limit: 1151)
   CGroup: /system.slice/kubelet.service
           └─6171 /usr/bin/kubelet --bootstrap-kubeconfig=/etc/kubernetes/bootstrap-kubelet.conf
--kubeconfig=/etc/kub
```

✓ Kubelet active

Troubleshooting Worker Nodes

View and inspect systemd logs

```
$ journalctl -u kubelet.service
Jan 22 15:51:25 kube-worker-1 systemd[1]: Started kubelet: The Kubernetes Node Agent.
Jan 22 15:51:25 kube-worker-1 systemd[1]: kubelet.service: Current command vanished from the
unit file, execution of the command list won't be resumed.
Jan 22 15:51:25 kube-worker-1 systemd[1]: Stopping kubelet: The Kubernetes Node Agent...
Jan 22 15:51:25 kube-worker-1 systemd[1]: Stopped kubelet: The Kubernetes Node Agent.
Jan 22 15:51:25 kube-worker-1 systemd[1]: Started kubelet: The Kubernetes Node Agent.
Jan 22 15:51:25 kube-worker-1 kubelet[4330]: F0122 15:51:25.656116    4330 server.go:198] failed
to load Kubelet config file /var/lib/kubelet/config.yaml, error failed to read kubelet config
file "/var/lib/kubelet/config
...
```

✘ Failed to read config file

Troubleshooting Worker Nodes

Check certificate on node

```
$ openssl x509 -in /var/lib/kubelet/pki/kubelet.crt -text
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number: 2 (0x2)
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: CN = kube-worker-1-ca@1611330698
        Validity
            Not Before: Jan 22 14:51:38 2021 GMT
            Not After : Jan 22 14:51:38 2022 GMT
        Subject: CN = kube-worker-1@1611330698
...
```

✓ Certificate issued by correct CA and not expired

LAB 17

Troubleshooting an Issue with the Worker Node

Network Policies

Purpose, Rules, Best Practices

What is a Network Policy?

Firewall rules for Pod-to-Pod communication

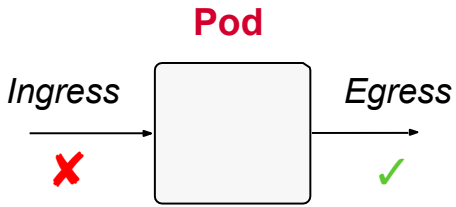
- Communication between Pods in the same cluster is unrestricted. You can use the Pod's IP address to communicate with it.
- Network policies implement the principle of least privilege. Only allow communicate is needed to fulfill requirement of architecture.
- You can disallow and allow network communication with fine-grained rules.

Example Network Policies

“Network Policies control traffic from and to the Pod”

Network Policy Rules

Which Pod does the rule apply to?



Which direction of traffic?

Who is allowed?

Deny All Policy YAML Manifest

Start with default deny policy and then allow traffic

```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: default-deny-all
spec:
  podSelector: {}
  policyTypes:
  - Ingress
  - Egress
```

Allow Policy YAML Manifest

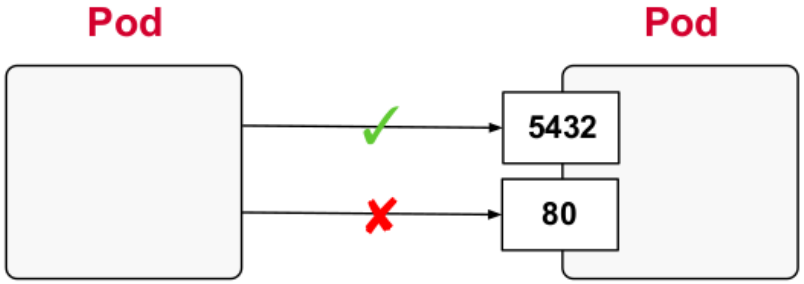
`kubectl` doesn't provide an imperative command

```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: api-allow
spec:
  podSelector:
    matchLabels:
      app: payment-processor
      role: api
  ingress:
  - from:
    - podSelector:
        matchLabels:
          app: coffeeshop
```

Selects the labels of Pods the rule should apply to

Only defines rules for incoming traffic

Restricting Access to Ports



By default all ports are open

```
...
ingress:
- from:
  - podSelector:
      matchLabels:
        tier: backend
  ports:
  - protocol: TCP
    port: 5432
...
```

LAB 18

Restricting Access
to and from a Pod

Thank you