SYNERGETICS

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Container Orchestration using Docker & Kubernetes

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Educate | Advise | Implement | Manage

Agenda

Module 1: Working with Kubernetes (Architecture)

Module 2: Working with Kubernetes (Deployment)

Module 3: Kubernetes on Azure

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Module 1

Working with Kubernetes (Architecture)

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Kubernetes : Introduction

“Kubernetes is an open-source system for automating deployment, scaling, and management of containerized applications.”

- One of the most popular cluster management tool.
- Having Largest developer community.
- Architecture designed by Google.
- Backed by 10 years of container deployment experience

Why Kubernetes

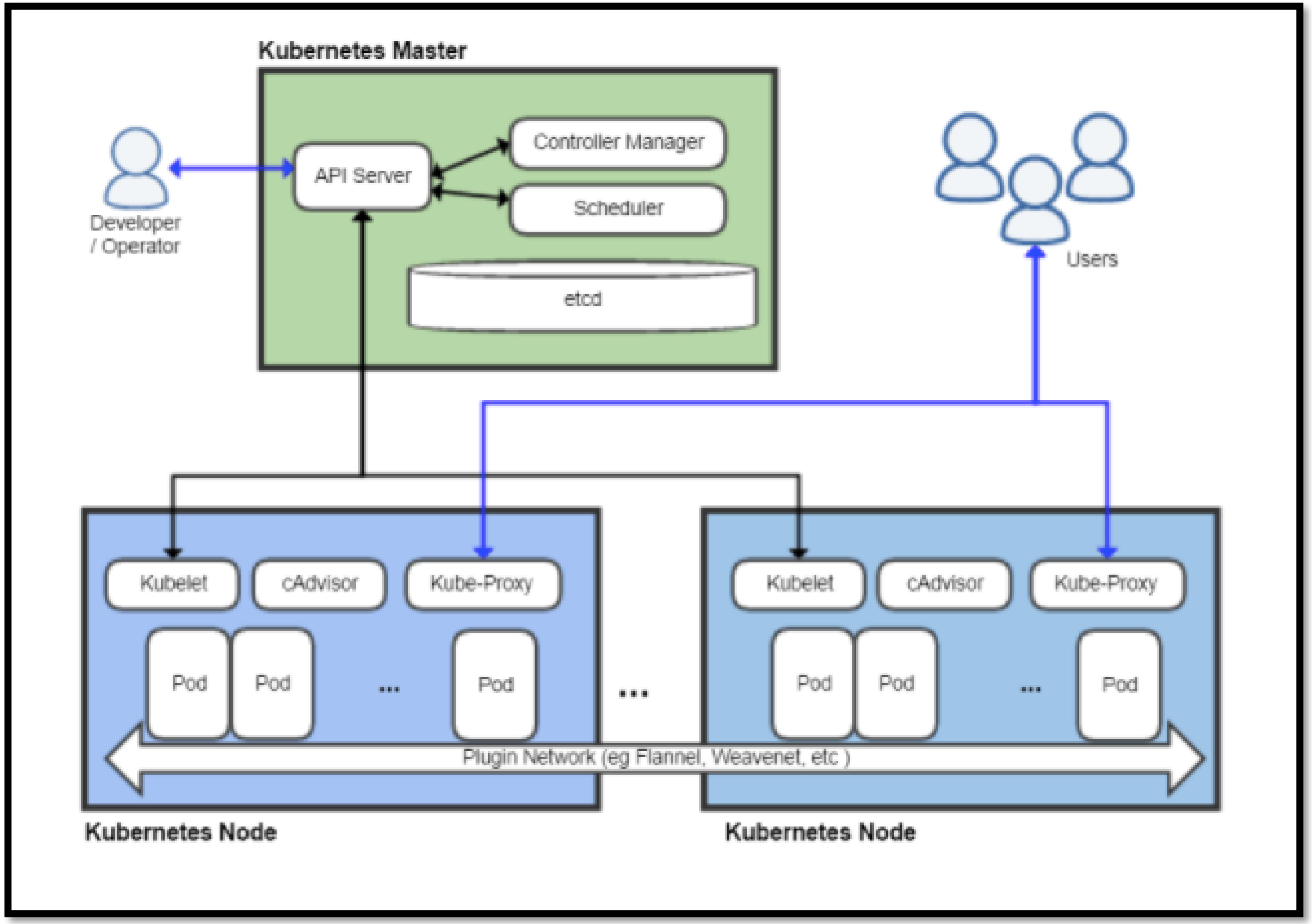
- Manage your Application, ignore the machines.
- Manage Applications
  - Where to run
  - When to Get, when to run, and when to discard
- Application Image usage
  - Image lifecycle management
  - Run image as application (containers)

What Kubernetes provide?

- High Level workload abstractions

  If container resembles **atom**, kubernetes provide **molecules**
- Storage
- Network
- Monitoring
- Scaling
- Communication

Kubernetes Architecture



Kubernetes Components

- Nodes
  - A Physical or Virtual machines on kubernets cluster.
  - Can be either a master (manager) node or worker (deployment target) node.
  - All the nodes must be in a private network
  - Master nodes must have linux based operating system.
  - Worker nodes can be either linux or windows based systems.
  - Master node need few additional components than worker nodes

Kubernetes : Master Components

- api-server
    - A Front end for kubernetes control plane.
    - Designed to scale horizontally.
- Etcd
    - Consistent & Highly available key-value store
    - Used as data store for all cluster data
- Scheduler
    - Put a pod on node!
    - Scheduling decision is based on
        - Affinity
        - Anti-affinity
        - Policy/Resource/Hardware/Software constraints
- Controller Manager
    - Responsible for following managers
        - Node controller
        - Replication controller
        - Endpoint Controller
        - Service Account and tokens controller

Kubernetes : Node (Worker) Components

- Kubelet
  - An agent that runs on each node.
- Kube-proxy
  - Enables network abstraction by maintaining network rules on the host
  - Does connection forwarding
- Container runtime
  - Container runtime either Docker or RKT
  - Any other container runtime based on runc & oci
- Add-Ons
  - Cluster DNS
  - Web-UI

Kubernetes Client tool (kubectl)

- CLI for managing kubernetes cluster
- Syntax :

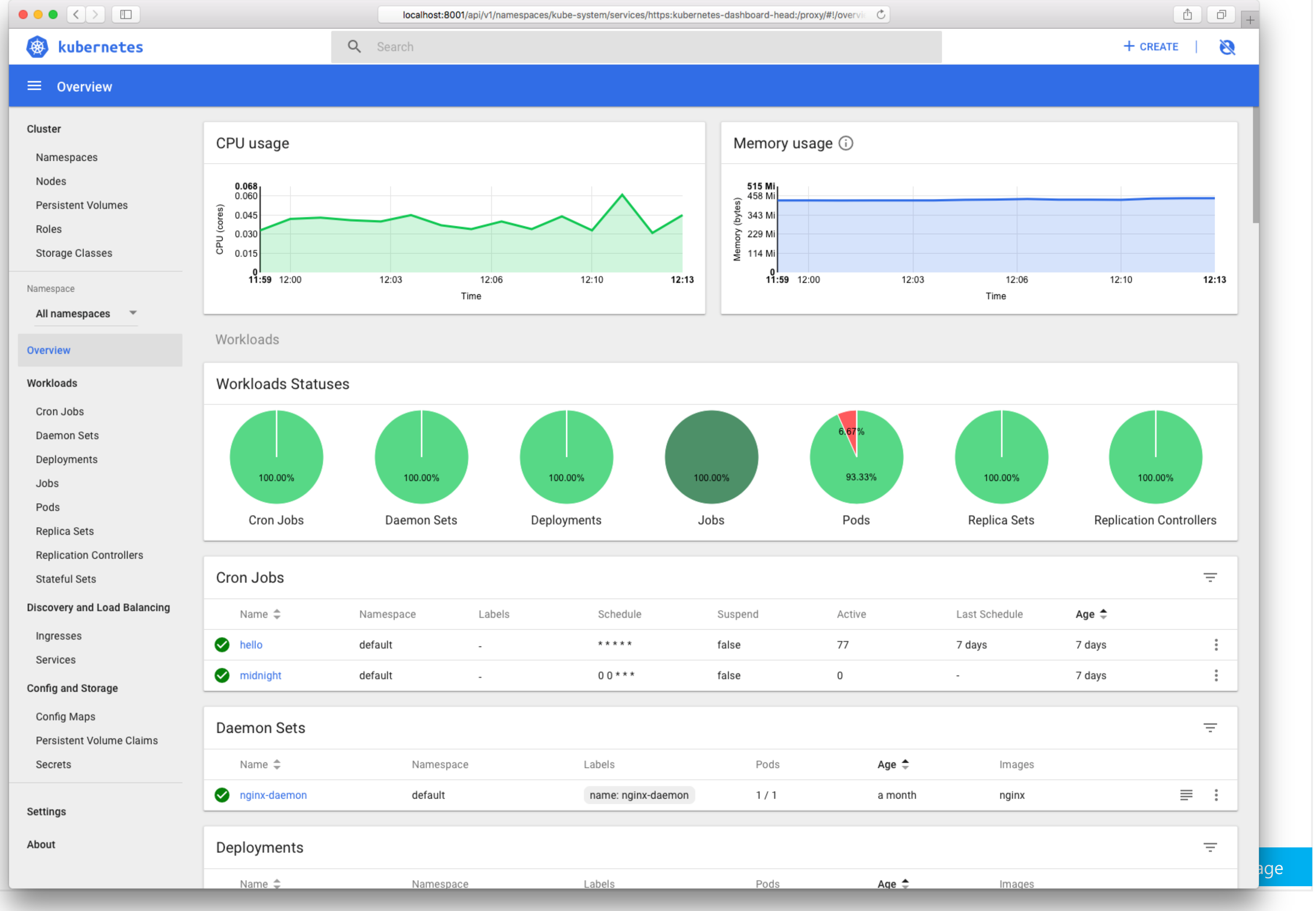
```
$ kubectl [command] [TYPE] [NAME] [flags]
```

  - Command: An operation like create, get, describe or delete
  - TYPE: A resource type like pod, service etc
    Case Sensitive, can be plural, like pods instead of pod
  - NAME: Name of resource to be operated
  - Flags: Optional flag, depends on resource type

- Example:

```
$ kubectl get pods
$ kubectl describe deployment app1
$ kubectl get pod –f mypod.yml
```

Kubernetes Dashboard [Web-UI]



Cron Jobs

	Name	Namespace	Labels	Schedule	Suspend	Active	Last Schedule	Age
✓	hello	default	-	* * * * *	false	77	7 days	7 days
✓	midnight	default	-	0 0 * * *	false	0	-	7 days

Daemon Sets

	Name	Namespace	Labels	Pods	Age	Images
✓	nginx-daemon	default	name: nginx-daemon	1 / 1	a month	nginx

Deployments

Name	Namespace	Labels	Pods	Age	Images

age

Single Host deployment for developers

- Minikube :
  A simple standalone dev cluster for anyone who wants to get started with kubernetes.
- Uses Hypervisor like Oracle VirtualBox or HyperV.
- On Linux host, hypervisor could be set to NONE.

Minikube architecture

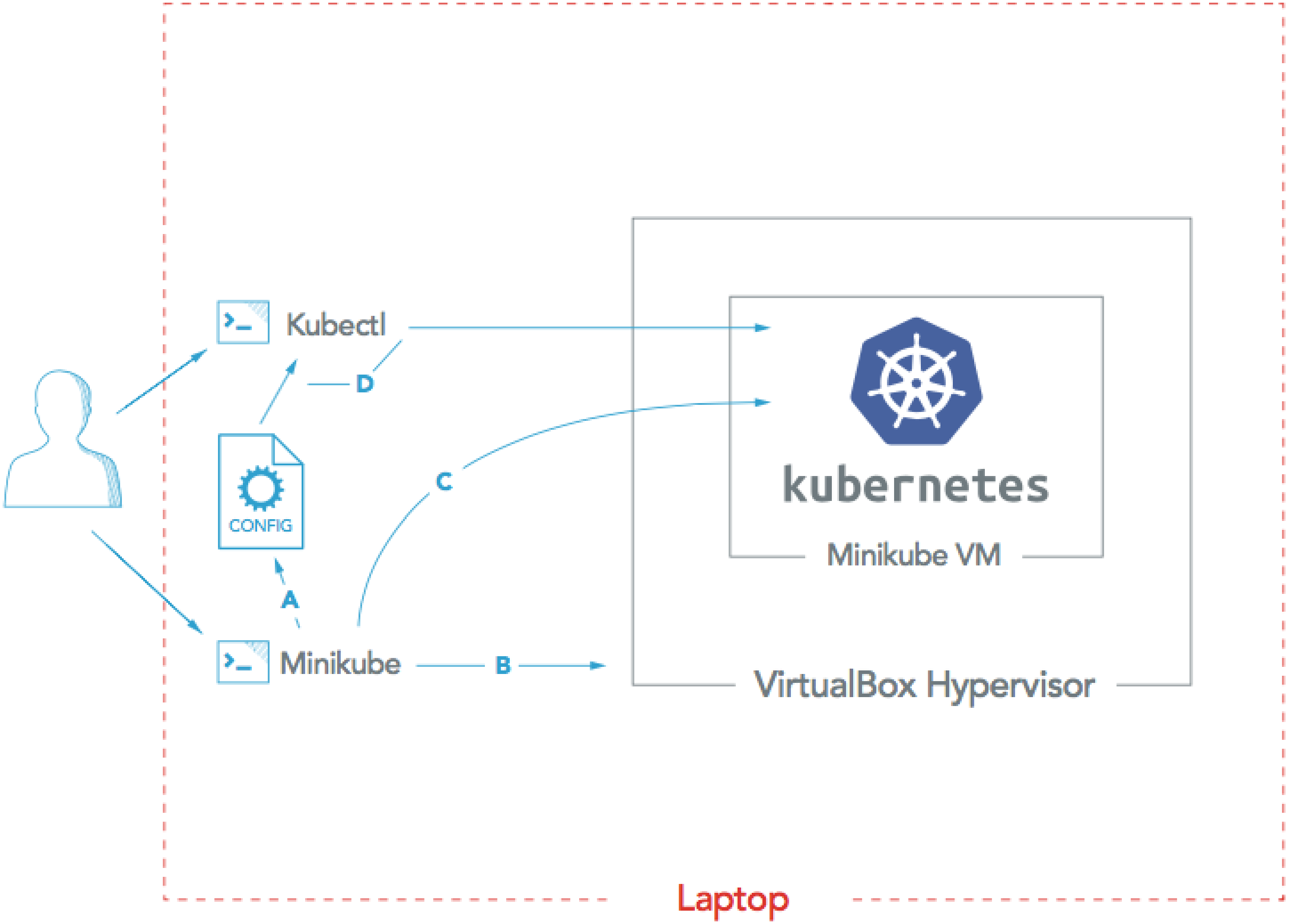
- Entire cluster as single VM
- Host system as user workstation
- Use kubectl to access cluster

- Simple commands:

```
$ minikube start –vm-driver hyperv
     --hyperv-virtual-switch=“Swit

$ minikube delete

$ minikube dashboard
```



A: Minikube generates kubeconfig file
B: Minikube creates Minikube VM

C: Minikube sets up Kubernetes in Minikube VM
D: Kubectl uses kubeconfig to work with Kubernetes

Multi Host deployments

- Ideal for production like environments
- Provides High availability [by multiple master nodes]
- Load balance workload across multiple worker nodes
- Secure & reliable cluster experience
- Minikube is ideal only for first time users to learn kubernetes
- Kubernetes provide following options
  - On cload (By vendors like Microsoft Azure, AWS, Google)
  - On Premise (Using kubeadm)

kubeadm

- Kubeadm is tool to bootstrap kubernetes cluster (either on premise or on cloud)
- Uses Signed certificates for secure communication across cluster.
- Most common operations
  - Kubeadm init (bootstrap a cluster from Master node)
  - Kubeadm join (Join existing cluster from Worker node)
- System requirement
  - One or more machines running Debian or RedHat based linux
  - 2 GB or more RAM per machine
  - 2 or more CPUs per machine
  - Full network connectivity between all machines (Private/Public Network)

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Module 2

Working with kubernetes (Deployment)

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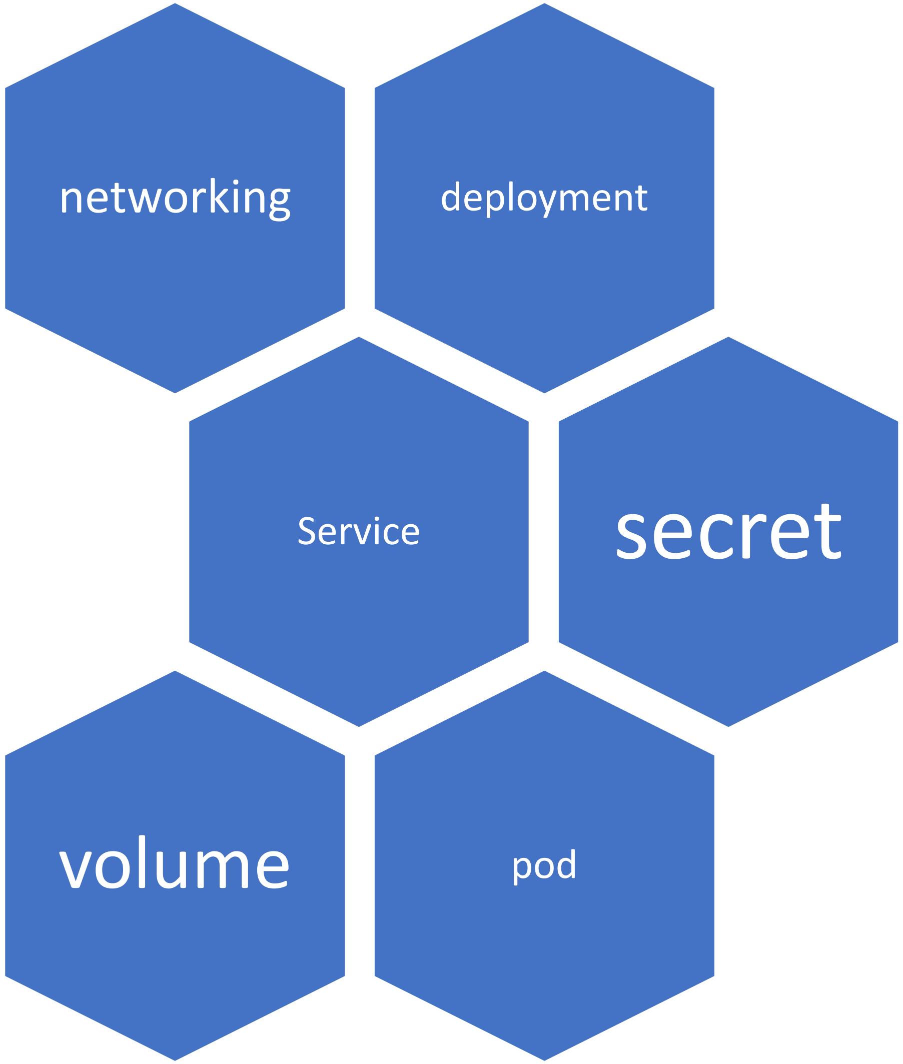
Kubernetes Concepts



networking

deployment

Service

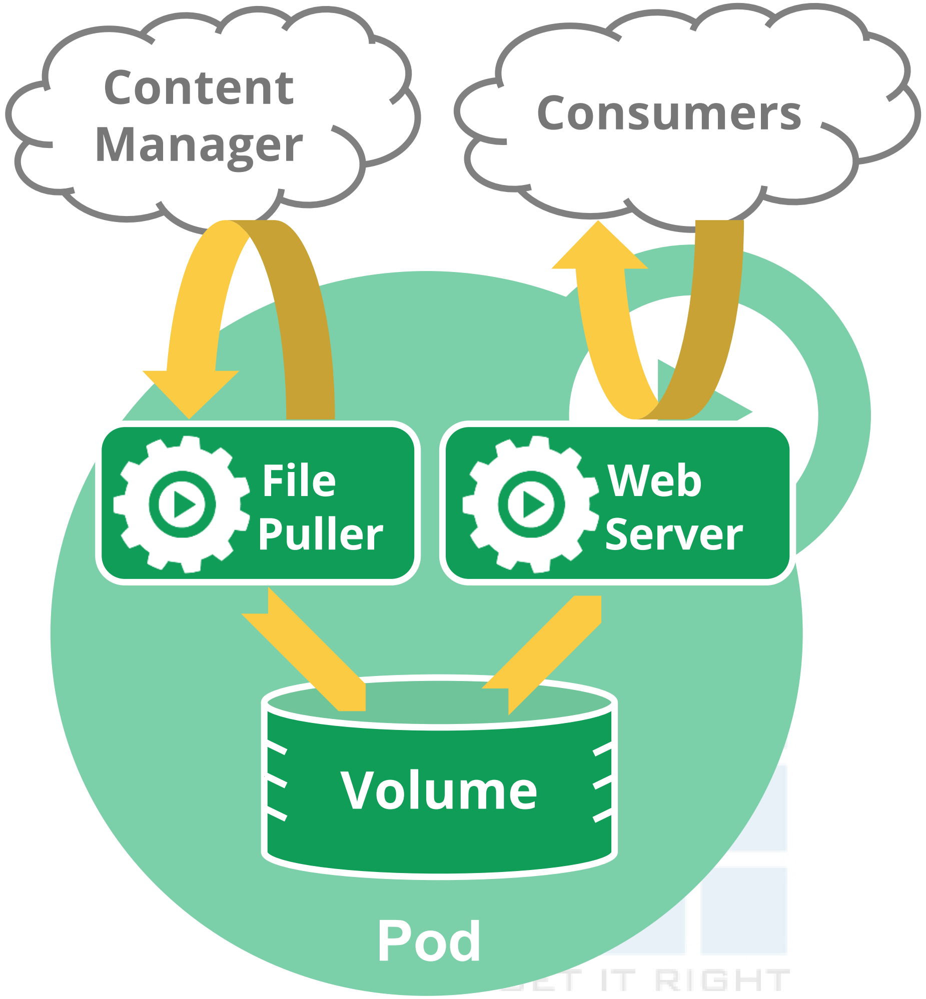
secret

volume

pod

Kubernetes Concepts : pods

- Smallest deployable unit for kubernetes.
- Ephemeral, disposable entities (ref cattle vs pets)
- May contain one or more container
- Deployed / destroyed / scaled as single unit
- All containers in a pod are sharing resources [Storage, Compute & Network]
- All container in a pod are tightly coupled.



Kubernetes Concepts : pods

Phase	Description
Pending	Waiting for image downloading, not all containers ready yet.
Running	Pod deployed to a node, either all containers started or one is starting (images downloaded in pending phase)
Succeeded	All Containers in the Pod have terminated in success, and will not be restarted.
Failed	All Containers in the Pod have terminated, and at least one Container has terminated in failure. That is, the Container either exited with non-zero status or was terminated by the system.
Unknown	For some reason the state of the Pod could not be obtained, typically due to an error in communicating with the host of the Pod.

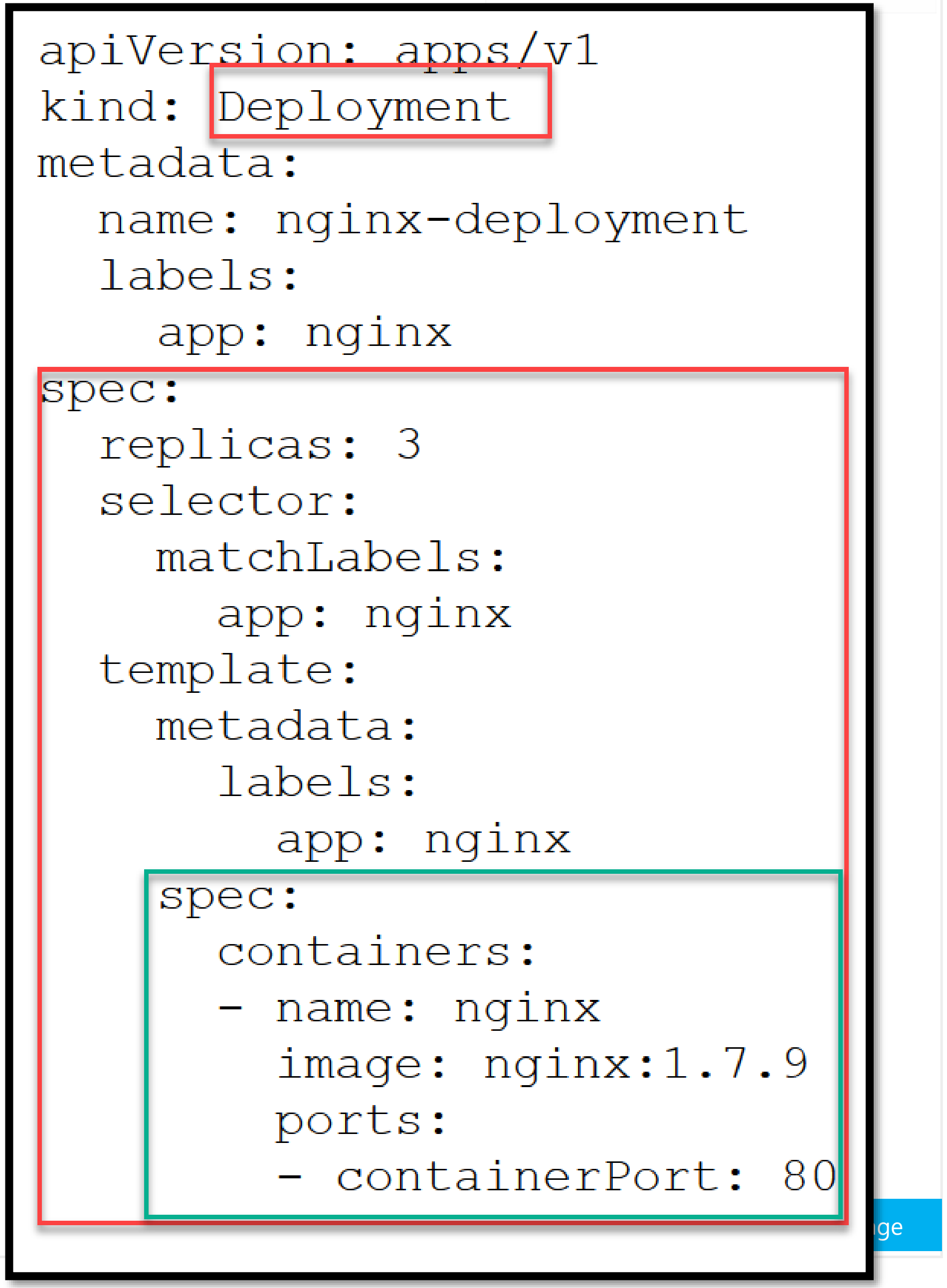
Kubernetes Concepts : ReplicaSet

- A ReplicaSet ensures specified number of pod replicas
- A Replication controller makes sure that “Desired” replica count matches with “Actual” replica count for given ReplicaSet.

Kubernetes Concepts : deployment

- A Desired State of Services, Pods, ReplicaSet etc.
- Can be written using YAML or JSON syntax
- Comparable to “docker-compose.yml” used in day 1
- Even deployments initiated by kubectl command are internally stored as YAML files.

- The sample deployment named “nginx-deployment”



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

Kubernetes Concepts : service

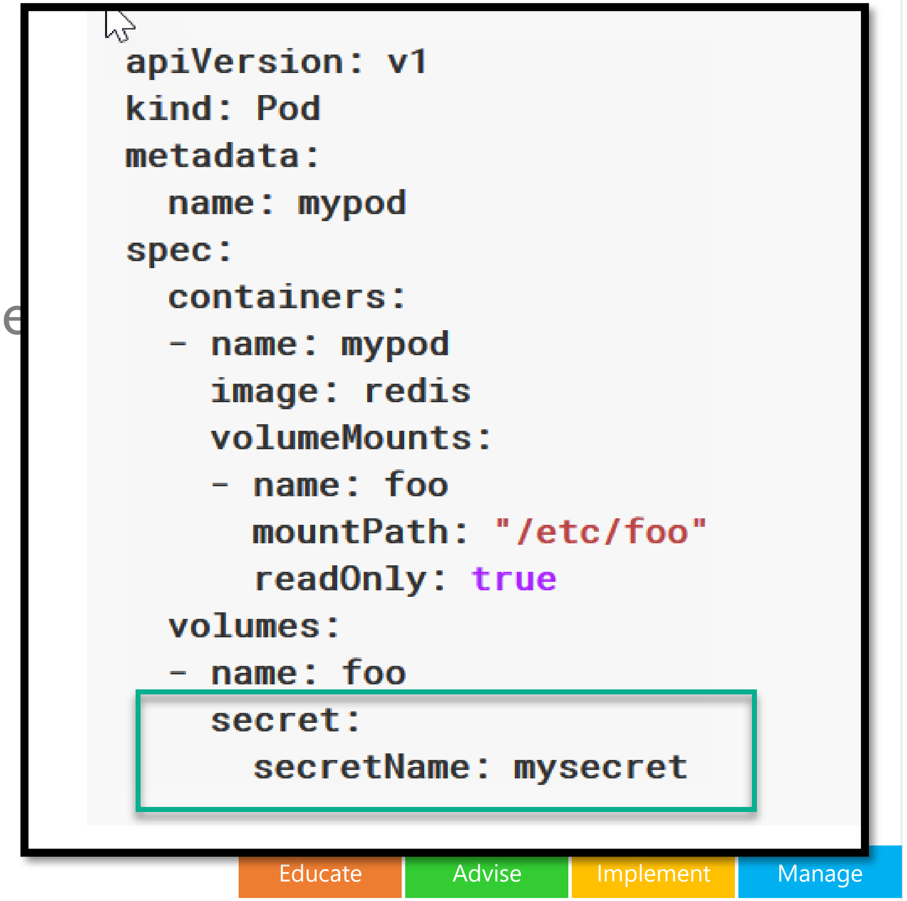
- An abstraction which defines logical set of pods and policy to access them.
- Services establish a single endpoint for collection of replicated pods, distributing inbound traffic based on label selectors.
- In kubernetes modelling language they represent a "Load Balancer".
- Pods and Services exists independently, have disjoint lifecycle.
- Supports both tcp & udp protocols (default: tcp)
- Kubernetes assigns VIP to service.
- Kubernetes DNS scheduler should assign a DNS label to each service.
  - Eg: service named "db" can be accessed by other services by name "db"

Kubernetes Concepts : Secrets

- Intended to hold sensitive information like passwords, Oauth tokens or SSH keys
- Kubectl has few command to manage secrets

```
$ kubectl get secrets
$ kubectl create secret
```

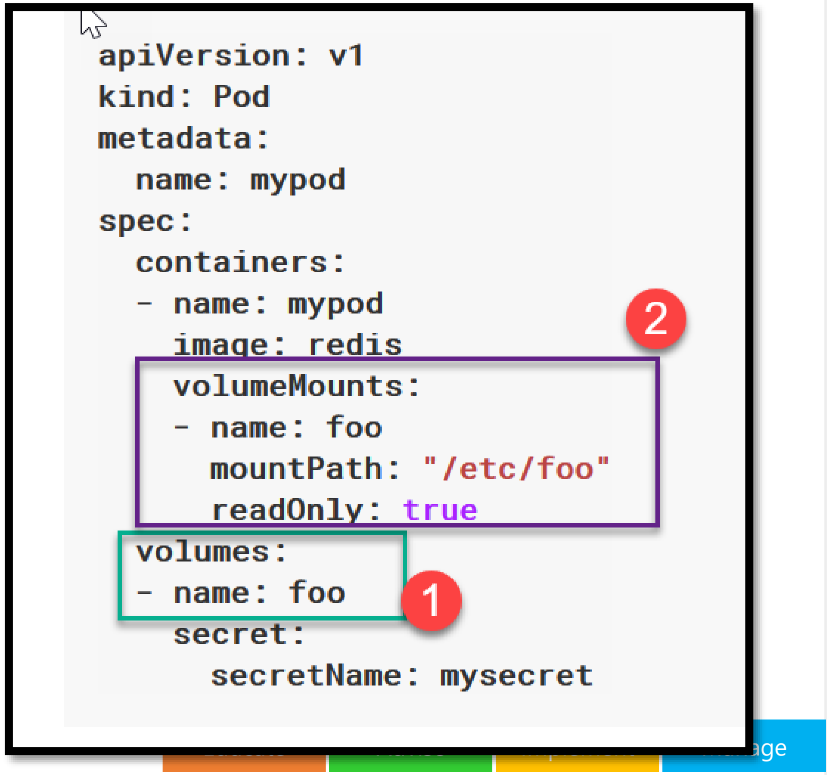
A reference to secret can be added to deployment [yaml] file



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

Kubernetes Concepts : Volumes

- A Persistent data store for containers
- A container restart results in creating “clean container” (data in Writable layer lost!)
- Volumes can persist data between services or pods (containers sharing single pod)
- Deep down, Its just a directory made accessible to one or more containers / pods.
- Kubernetes supports following volumes
    - azureDisk
    - azureFile
    - Cephfs
    - Csi



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

Kubernetes Concepts: Networking

- Networking in kubernetes cluster is different than that of docker
  - Highly coupled Container to Container communication inside a pod. (use localhost)
  - Pod to Pod communication (Pods have IP address)
  - Pod to service communication (Services have VIP)
  - External to Service

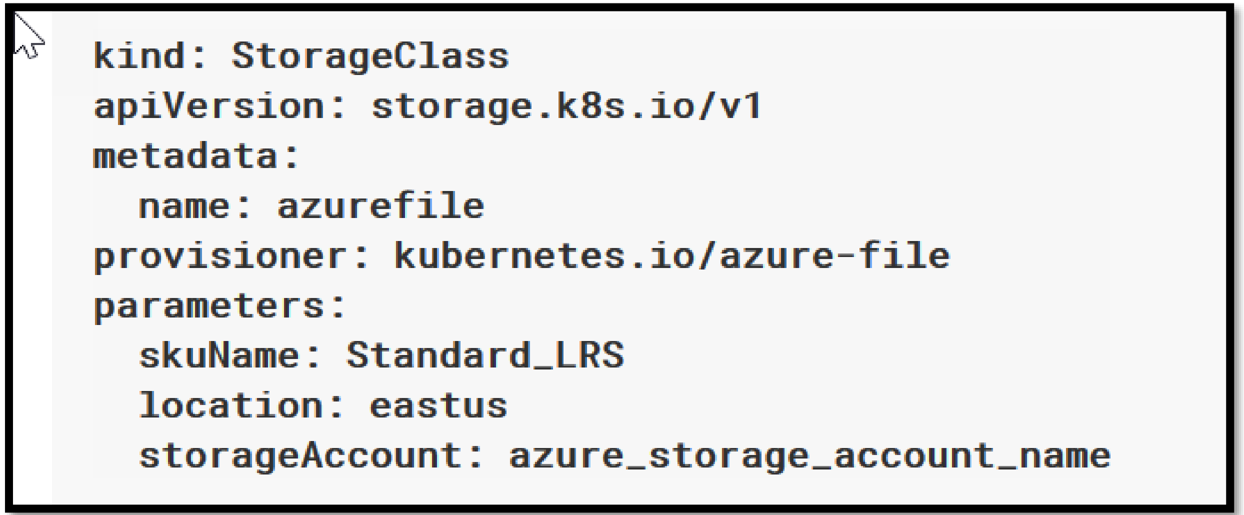
- Implementations
  - ACI
  - Cilium
  - Contiv
  - Flannel
  - Weave Net

Demos

- Demo : Deploying a sample application on kubernetes cluster

Advanced Concepts

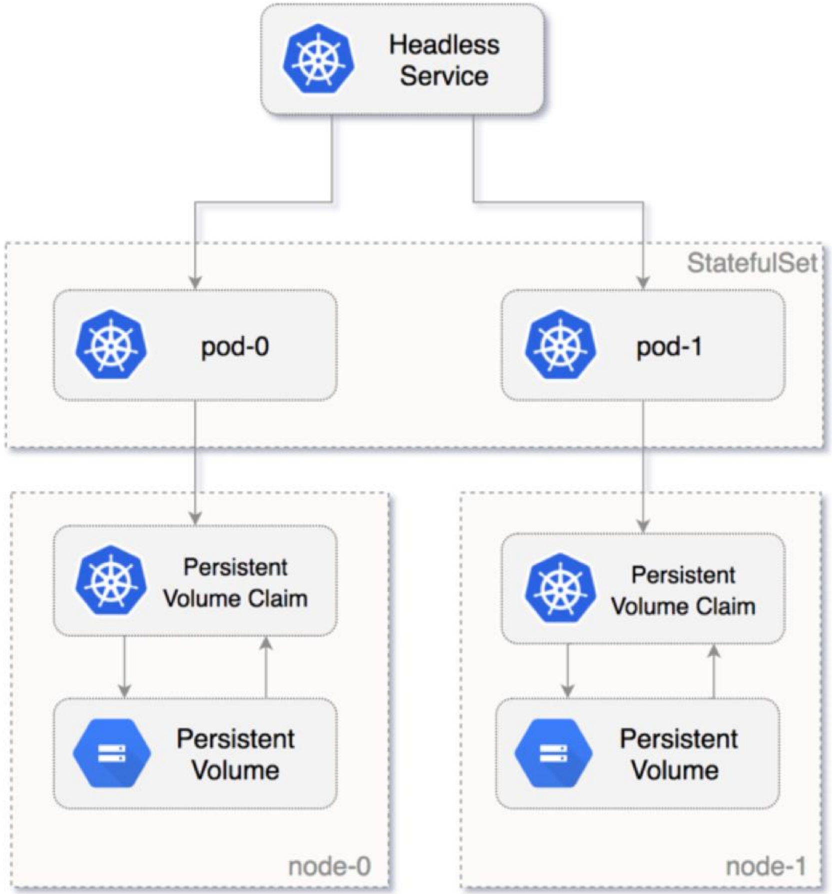
- Storage
  - Volumes
  - Persistent Volumes : Independent of pods, services or deployments
  - Storage classes (Used with Persistent Volumes)
- Compute
  - Pods can optionally define amount of resources like CPU or MEMORY
- Security
  - A Pod security policy (cluster level resource)
  - Can be managed by admission control plugin



```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: azurefile
provisioner: kubernetes.io/azure-file
parameters:
  skuName: Standard_LRS
  location: eastus
  storageAccount: azure_storage_account_name
```

Advanced Concepts

- Stateful Sets
  - Targeted for Stateful applications
  - Ordered Pod creation
  - Stable network identity to each pod
  - Uses PersistentVolumeClaims



Advanced Concepts

- Scaling (Manual / Automatic)
  - Kubernetes uses “ReplicaSet” to ensure desired number of instances.
  - Manual scaling requires updating “replicas” property.
  - Auto (Horizontal) scaling can created using “kubectl” command

```
$ kubectl autoscale rs app1rs --min=2 --max=5 --cpu-percent=80
```

Advanced Concepts

Rolling Update

- Update a service without an outage.
- Its works by
  - Creating a new replication controller with the updated configuration.
  - Increasing/decreasing the replica count on the new and old controllers until the correct number of replicas is reached.
  - Deleting the original replication controller.

  - Example:

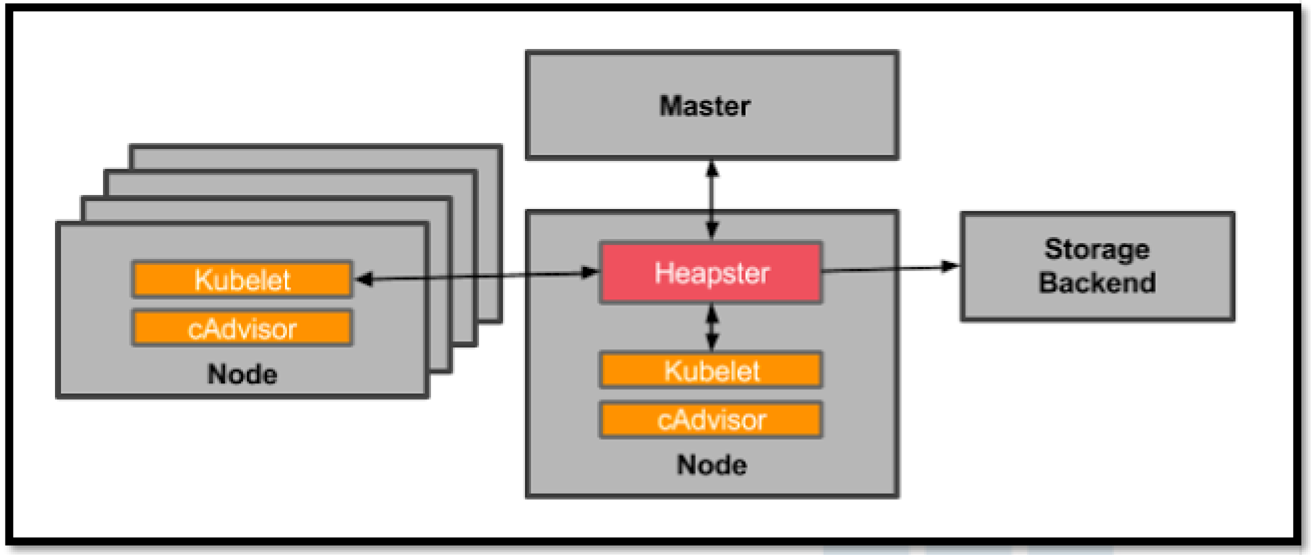
```
$ kubectl rolling-update NAME [NEW_NAME] --image=IMAGE:TAG
```

Advanced Concept

Monitoring (Infrastructure & Applications)

- Kubernetes dashboard provides basic monitoring
- Addon called “Heapster” can provide monitoring for entire cluster
- Uses cAdvisor

Container resource monitoring (native to docker)



Advanced Concepts

Disaster Recovery

- etcd is a backing store for entire cluster data.
- All data is stored as JSON objects
- Always have a backup plan for etcd
- Run etcd as cluster of odd numbers
- Restore etcd data into new cluster

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Module 08

Kubernetes on Azure

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Azure Kubernetes Services (AKS)

- Azure has provided an alternative to ACS which uses “Kubernetes”.
- Easier to setup than ACS
- AKS is a managed service with a hosted Kubernetes control plane
- Has been certified as Kubernetes conformant.
- Is compliant with SOC, ISO, and PCI DSS.
- Differs from ACS in
  - Uses “Managed Disks” for all nodes
  - Currently support only one agent pool

Hands On

- HOL 1: Deploying an AKS Cluster and accessing via kubectl in host system.
- HOL 2 : Deploying a sample application to AKS

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End Note

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Q/A

Thank You

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