

Kubernetes for Newbies



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Overview

- Linux Containers
 - Quick intro / recap
 - System Containers vs. Application Containers
- Kubernetes - What is it?
- Kubernetes Pod
- Kubernetes Deployment
- Kubernetes Service
- Summary
- Future Topics



Linux Containers - Quick Intro / Recap

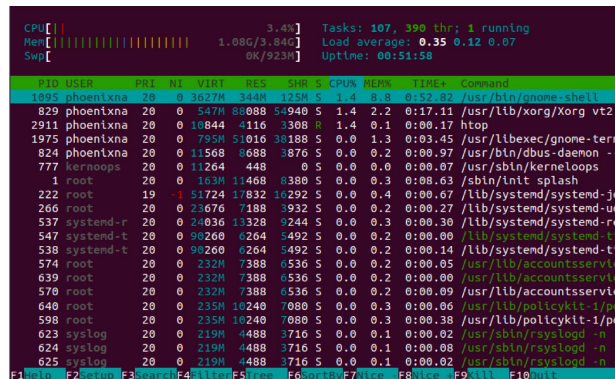
- A lightweight method for running multiple isolated applications under one Linux host
- **Feature - Portability**
 - Each container encapsulates its dependencies
 - Ensures consistent behavior across environments
- **Feature - Efficiency**
 - Containers share the host's kernel
 - Lower overhead compared to traditional virtualization
- **Feature - Scalability**
 - Containers can be spun up or shut down quickly
 - Enables rapid deployment and scaling of applications
- **Feature - Versioning / Rollback**
 - Containers support versioning
 - Facilitates easy (automatable) rollbacks



System Containers vs. Application Containers

System Containers:

- Running system-level processes and services
 - Like a mini virtual machine
- A lightweight environment for system-level tasks
- Designed to encapsulate and deploy components of the operating system
 - System daemons - systemd, cron, rsyslog, etc.
- No goal to decouple services any more than a traditional VM or bare-metal host
- Examples
 - LXC / LXK



System Containers vs. Application Containers

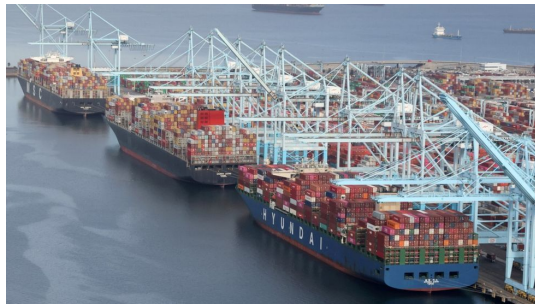
Application Containers:

- Designed to encapsulate individual applications and their dependencies
 - Fosters portability across different environments
 - Enables a microservices architecture
- Optimizes performance and scalability for the application itself
 - Avoids oversubscribing resources for more efficient use of host resources
- Examples
 - Docker
 - Containerd
 - Podman
 - CRI-O
 - Kubernetes



Containers - The Challenges

- Container runtime provides an a single host where an application can run
- Moving containerized applications from single hosts to production-worthy services requires some "extras"
- Challenges to consider:
 - Shared file systems, configurations, secrets
 - Networking across redundant hosts
 - Load balancing across instances of a service
 - Scheduling - i.e. where to provision container workload
 - Distribution - i.e how to deploy the container workload
 - etc.



Kubernetes - What is it?

- K8s = Kubernetes
- Kubernetes is Greek for helmsman or pilot
 - Following the Docker shipping metaphone
- K8s is an open-source container orchestration platform
- Automates the deployment, scaling, and management of containerized applications across a set of hosts (cluster)
- Supports load balancing, rolling updates, and application monitoring / scheduling



kubernetes

Kubernetes - History

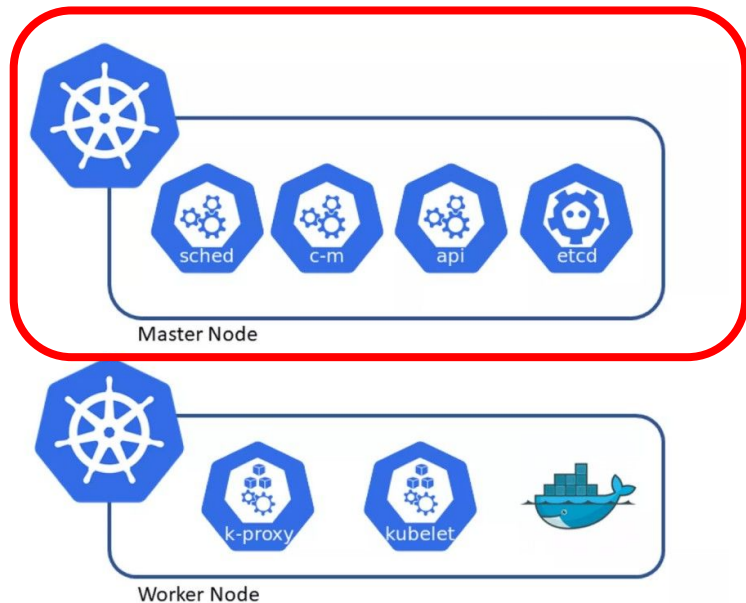
- **2003-2004 - Borg**
 - Early orchestration platform built at Google to manage container-based applications
- **2014 - Kubernetes open-sourced**
 - Google engineers open sourced K8S (based on Borg)
 - Written in the Go programming language
- **2015 - Kubernetes 1.0 released**
 - Google partners with the Linux Foundation
 - Forms the Cloud Native Computing Foundation (CNCF)
 - CNCF goes on to host many open source projects - containerd, prometheus, etcd, etc.
- **2017 - Winner of the container wars**
 - Industry rallies around K8S - Docker, Microsoft AKS, Amazon EKS, etc.
- **Today**
 - Continues to evolve with a strong community contributing to its future



Kubernetes - Architecture

Control plane (master) nodes

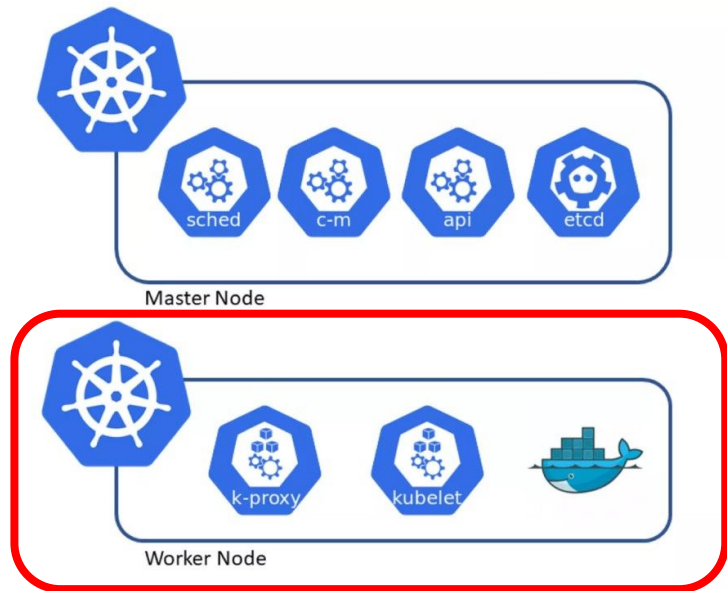
- **kube-apiserver** - Exposes Kubernetes API for cluster management.
- **kube-controller-manager** - Manages desired cluster state via controllers.
- **kube-scheduler** - Assigns Pods to nodes based on resources.
- **etcd** - Distributed key-value store for cluster data.
- ... and many more depending on your environment.



Kubernetes - Architecture

Worker nodes

- **kubelet** - Agent running on workers, executing instructions from the control plane.
- **container runtime** - Software responsible for running containers (e.g. containerd).
- **kube-proxy** - Maintains network rules and enables communication across the cluster.
- **CNI (Container Network Interface)** - Plugin enabling Pod networking across nodes.



Minikube Prep



Note - Assumes container runtime installed (e.g. Docker)

Install minikube

```
$ curl -LO \  
https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64  
  
$ sudo install minikube-linux-amd64 /usr/local/bin/minikube
```

Install kubectl

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

Minikube Init



Start Cluster

```
$ minikube start --nodes 2 -p newbie-demo
```

```
$ minikube status -p newbie-demo
```

```
$ minikube ssh -p newbie-demo -n newbie-demo # control plan
```

```
$ minikube ssh -p newbie-demo -n newbie-demo-m02 # worker
```

Nodes Provisioned

```
$ kubectl get nodes
```

```
$ kubectl describe nodes
```

Namespaces

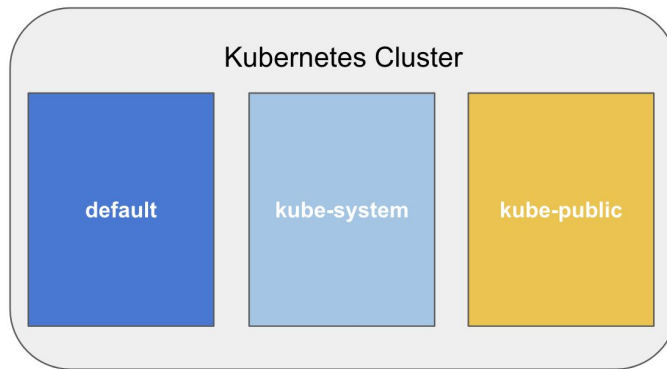
- **Resource Partitioning** - Divides cluster resources into logical groups.
- **Isolation** - Securely share cluster with multiple teams.

Create a namespace:

```
$ kubectl create namespace newbie-ns
```

```
$ kubectl get namespace
```

```
$ kubectl describe namespace
```



Namespace: kube-system

- **System Components** - Dedicated namespace for essential system components and infrastructure services.
- **Critical Operations** - Hosts management components (schedulers, controllers, network plugins, etc.) essential for cluster operations.
- **Isolation** - Helps isolate critical system components from user workloads, enhancing security and maintainability.

```
$ kubectl get namespace kube-system
```

```
$ kubectl describe namespace kube-system
```



Run a K8S Pod

Create a Pod imperatively

```
$ kubectl run nginx-pod --image=nginx:latest --restart=Never
```

```
$ kubectl delete pod nginx-pod
```

Create a Pod declaratively

```
$ kubectl apply -f k8s/nginx-pod.yaml
```



Take a Look at the Pod

```
$ kubectl get pod nginx-pod [-o wide] [-o yaml]
```

```
$ kubectl describe pod nginx-pod
```

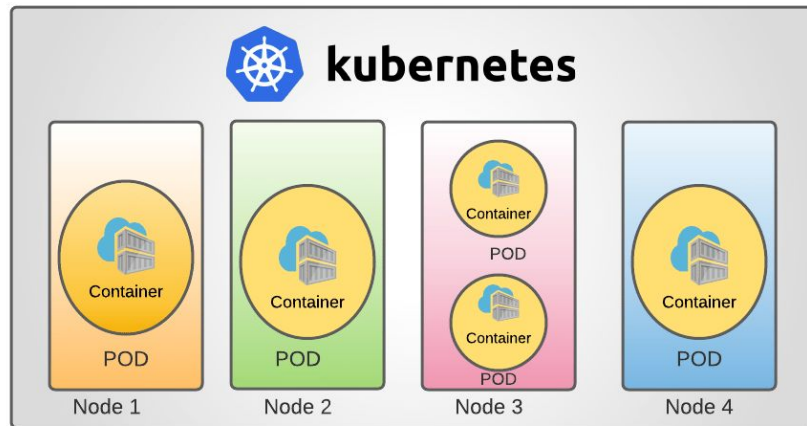
```
$ kubectl logs nginx-pod
```

```
$ kubectl exec -it nginx-pod - /bin/bash
```

```
    $ curl inside the container
```

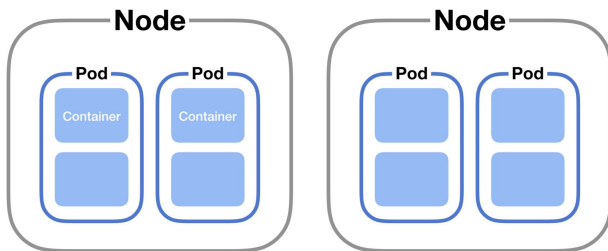
```
$ docker ps    # check the containers
```

```
$ kubectl port-forward nginx-pod 8080:80
```



K8S Pod

- **Basic Unit** -The smallest unit in the Kubernetes object model
- **Isolation** - Pod processes and resource allocations are segregated
 - Helps secure Pod interactions with the rest of the cluster
 - Caps resources at the Pod level to protect other workloads in the cluster
- **Shared Resources** - Containers within a Pod share the same IP and ports
 - Enables easy communication over the localhost
- **Lifespan** - Pods can have a short lifespan
 - Easily created, terminated, and replaced based on the application's requirements.



Run a K8S Deployment

```
# Create a deployment imperatively
```

```
$ kubectl create deployment nginx-deployment --image=nginx:latest
```

```
$ kubectl scale deployment  nginx-deployment -replicas=3
```

```
$ kubectl delete deployment nginx-deployment
```

```
# Create a deployment declaratively
```

```
$ kubectl apply -f k8s/nginx-deployment.yaml
```



Take a Look at the Deployment

```
$ kubectl get deployment nginx-deployment [-o wide] [-o yaml]
```

```
$ kubectl describe deployment nginx-deployment
```

```
$ kubectl get replicaset nginx-deployment
```

```
$ kubectl get pods # look at pods supporting this deployment
```

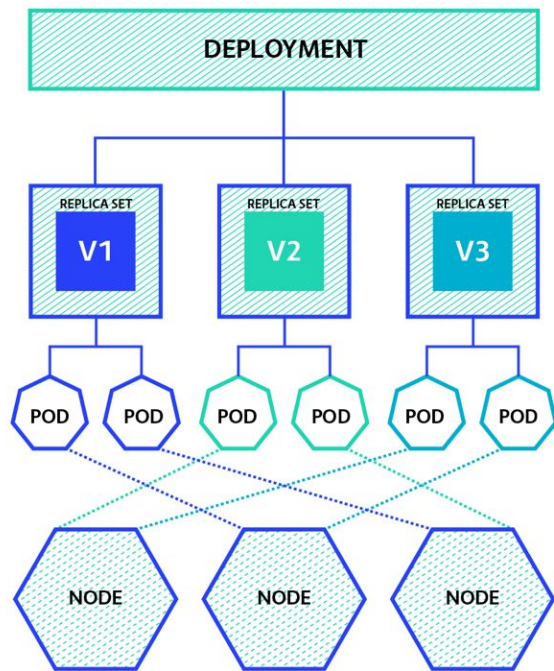
```
$ kubectl logs <pod-name> # use pod names discovered
```

```
$ docker ps # check the containers
```



K8S Deployment

- **Scalability** - Scale applications up or down by adjusting replica counts.
- **Load Balancing** - Built-in load balancing for even distribution of traffic.
- **Self-Healing** - Health checks and automatic replacement of unhealthy pods for high reliability.
- **Rolling Updates** - Updates without downtime, with quick rollback options.
- ... this is where K8S value starts to show.



Run a K8S Service



```
# Expose the deployment imperatively
```

```
kubectl expose deployment nginx-deployment \  
  
    -name=nginx-service --port=80 --type=NodePort
```

```
kubectl delete service nginx-service
```

```
# Expose the deployment declaratively
```

```
kubectl apply -f k8s/nginx-service.yaml
```

Take a Look at the Service

```
$ kubectl get service nginx-service
```

```
$ kubectl describe service nginx-service
```

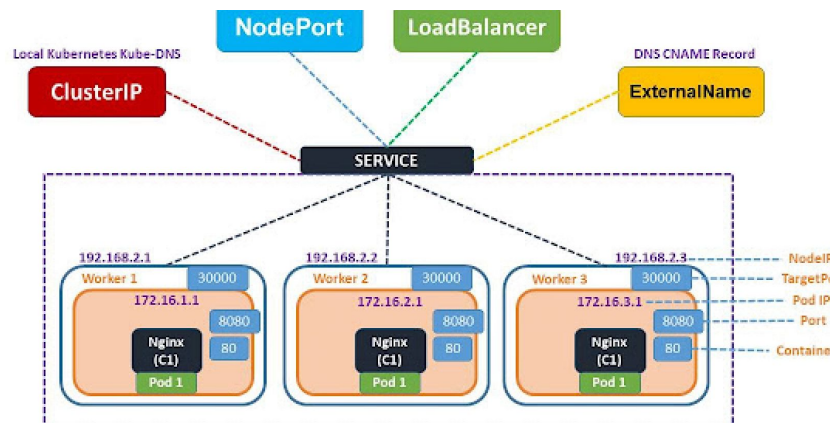
```
$ kubectl get endpoints nginx-service
```

```
$ NODE_IP=$(kubectl get nodes -o
jsonpath='{.items[0].status.addresses[0].address}')
```

```
$ NODE_PORT=$(kubectl get service nginx-service -o
jsonpath='{.spec.ports[0].nodePort}')
```

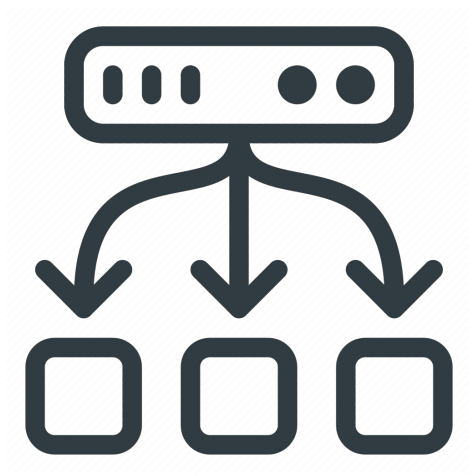
```
$ curl $NODE IP:$NODE PORT
```

```
$ kubectl logs <pod-name>
```



K8S Service

- **Load Balancing** - Efficiently distributes incoming traffic among pods.
- **Service Discovery** - Provides a stable endpoint for communicating with pods.
- **Communication Flexibility** - Facilitates both internal cluster and external requests.



Clean-up

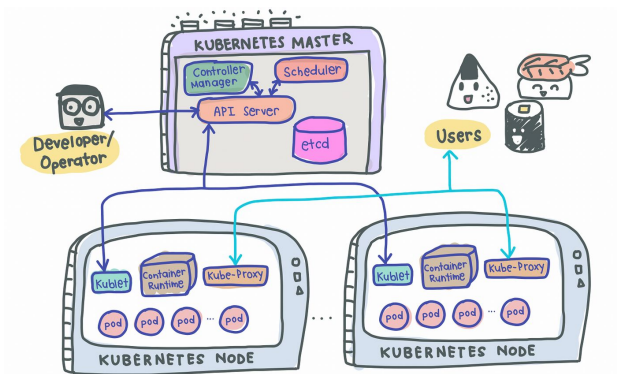
```
$ minikube delete -p newbie-demo
```

```
$ minikube status -p newbie-demo
```



Summary

- Kubernetes is a container orchestration platform
- Organizes machines into clusters
 - Optimizing resource usage and ensures high availability
- Streamlines scaling and updates with easy declarative configuration
- Automates deployment and management of containerized apps



Possible Future Discussions

- Orchestration
 - Hashicorp Nomad
 - K8S ConfigMaps, Secrets, Persistent Volumes
 - K8S Ingress, Gateway
- Monitoring
 - Prometheus / Grafana
 - ELK / EFK
- Messaging
 - RabbitMQ / ActiveMQ
- Data Pipelines
 - Airflow / Dagster
- Other ideas welcome!



Backup Slides

