

# 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

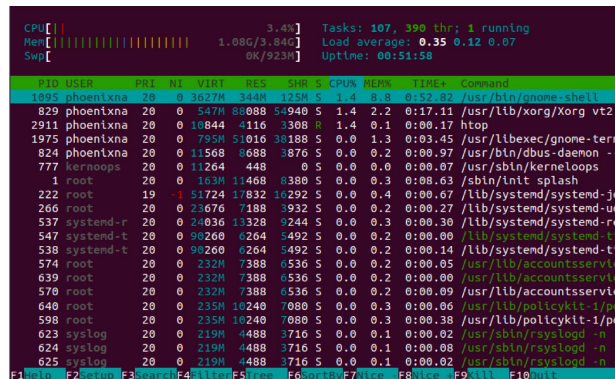
- A lightweight method for running multiple isolated applications under one Linux host
- **Feature - Portability**
  - Each container encapsulates its dependencies
  - Ensures consistent behavior across environments
- **Feature - Efficiency**
  - Containers share the host's kernel
  - Lower overhead 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 / LXDM



# System Containers vs. Application Containers

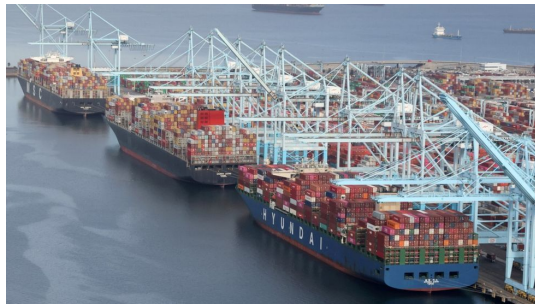
## Application Containers:

- 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
- 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

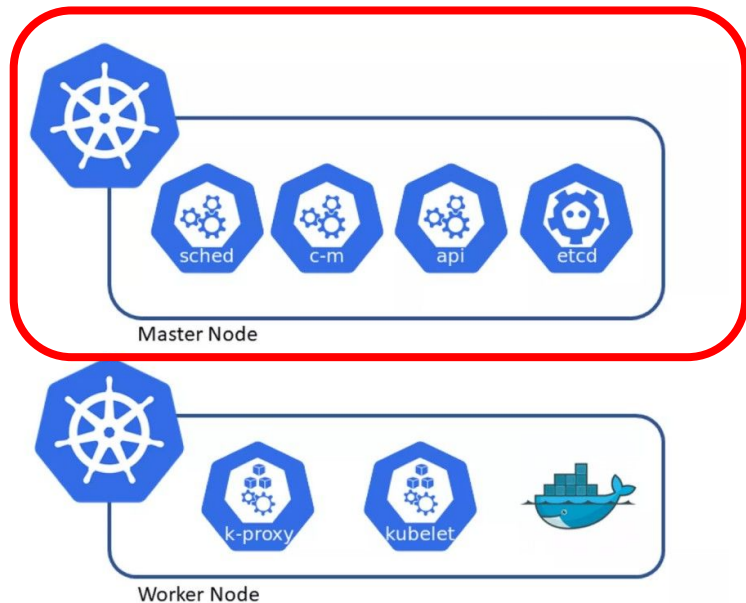
- **2003-2004 - Borg**
  - Progenitor container orchestration platform built at Google to manage many applications
- **2014 - Kubernetes open-sourced**
  - Google engineers build a new open source orchestrator based on Borg
    - Written in the Go programming language
- **2015 - Kubernetes 1.0 released**
  - In conjunction, 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

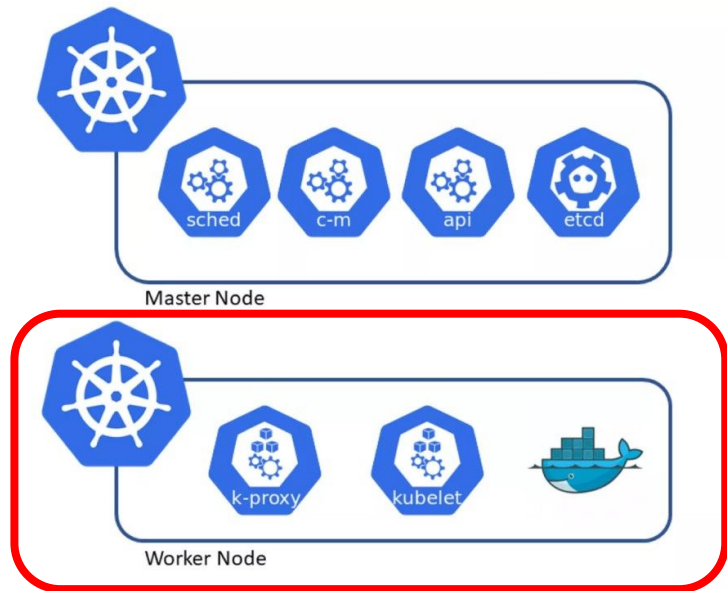
- **kube-apiserver** - Exposes Kubernetes API for cluster management.
- **kube-controller-manager** - Manages desired cluster state via controllers.
- **kube-scheduler** - Assigns Pods to nodes based on resources.
- **etcd** - Distributed key-value store for cluster data.
- ... and many more depending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

## 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: Logically partitions cluster resources.
- Isolation: Enables secure sharing of a cluster among multiple users or 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 and simplest 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 processes 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 pod nginx-deployment [-o wide] [-o yaml]
```

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

```
$ kubectl get pods
```

```
$ kubectl logs ... # using pod names discovered
```

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

# K8S Deployment

- Scalability -: Scale applications up or down by adjusting replica counts.
  - Automated 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.
- Dynamic Management - Organizes and manages pods dynamically using labels for scalability and updates.
- Communication Flexibility - Facilitates both internal cluster communication and external requests.

# Clean-up

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

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



# Summary

# 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



# Exercise 1 - ...

Setup:

\$

Try:

\$

