



Module 01: Introduction

Kubernetes Workshop



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Agenda

- ★ Workshop Objectives
- ★ Workshop Agenda
- ★ Kubernetes Introduction

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EVERYONE'S EXCITED ABOUT **KUBERNETES**

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Workshop Objectives

- Getting started with Kubernetes
- Learn Kubernetes through hands-on labs
- Understand how Kubernetes works
- And most importantly, have fun with Kubernetes!



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Workshop Agenda

- Module 01: Introduction
- Module 02: Kubernetes Architecture
- Module 03: YAML & Kubectl
- Module 04: Kubernetes Basics
- Module 05: Deployments & Upgrades
- Module 06: Labels & Annotations
- Module 07: Kubernetes Networking
- Module 08: Services
- Module 09: Ingress
- Module 10: ConfigMaps & Secrets
- Module 11: Jobs & CronJobs
- Module 12: DaemonSets
- Module 13: Helm Package Manager
- Module 14: Managed Kubernetes
- Module 15: Advanced Scheduling
- Module 16: StatefulSets
- Module 17: Autoscaling
- Module 18: Kubernetes Storage
- Module 19: Kubernetes Operators
- Module 20: Summary

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Workshop Labs

The image displays two side-by-side screenshots of the GitLab web interface. The left screenshot shows the 'Groups' page for the 'kubernetes-workshop' group, which has a Group ID of 5006054. It lists six subgroups: Lab-01, Lab-02, Lab-03, Lab-04, Lab-05, and Lab-06. The right screenshot shows the details for 'Lab 03: Deploy and Upgrade a Single Service'. The 'Instructions' section contains the following steps:

- Deploy application using deployments
 - List existing deployments
 - kubectl get deployments
 - List existing pods
 - kubectl get pods
 - Inspect the Deployment definition
 - curl https://gitlab.com/sela-kubernetes-workshop/lab-03/raw/master/Frontend-deployment.yaml
 - Create the Deployment resource
 - kubectl apply -f https://gitlab.com/sela-kubernetes-workshop/lab-03/raw/master/Frontend-deployment.yaml
 - List existing deployments

<https://gitlab.com/sela-kubernetes-workshop>

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Kubernetes

Kubernetes can be many things... Its a scalable, self-healing and resilient

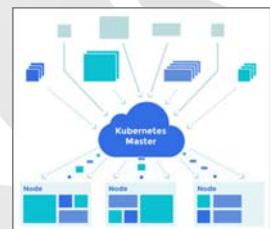
- Container orchestration engine
- Cluster management system
- Mesos, Swarm, Rancher, _____ replacement
- Microservices, CI/CD, Machine Learning platforms
- Portable "cloud"
- Kubernetes is the de facto platform for running containers today

But, It's NOT just another way to run containers...

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What is Kubernetes?

- Platform for container orchestration
- Kubernetes abstract away the underlying hardware (CPU, GPU, Mem, Disks)
- Scalable, Resilient, Self-Healing and Fault Tolerant
- Allow to run any kind of workload, on any cloud or on-prem setup
- Is responsible for maintaining the desired state
- Kubernetes encourages cattle; not pets (ephemeral)
- Individual machines don't matter
- Container isolates the app from the host



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How it works?

- Kubernetes has a declarative API.
- Apply the desired configuration to your cluster.
- Kubernetes will drive "current state" to the "desired state" eventually.
- Container crashed?
 - Restart it.
- Container unhealthy?
 - Remove from LB and Reschedule to another node.
- Container overloaded?
 - Add more replicas automatically.

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How did it all started?

- Google spawns more than **2 billion** containers per week in their data center!
- Google have developed its own tools – namely **Borg**, and **Omega** – systems that are running until now and are proven for production in massive scale
- Using all the experience gathered using those systems, three Google employees started in 2014 the **Kubernetes** project using GoLang, and was developed as OSS project from the get go
- Its first stable release (v1.0.1) was at **July 2015**
- Kubernetes is developing quickly with new features every month or two
- V1.14 was released in March 2019

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CNCF – Cloud Native Computing Foundation

- Kubernetes is the first project that graduated CNCF
 - Later came Prometheus, Envoy proxy
- The CNCF is a child entity of the Linux Foundation and operates as a vendor neutral governance group.
- CNCF is managing Kubernetes Roadmap and certifications.



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The Kubernetes Journey

- Recent surveys from from CNCF shows that over **83%** of the companies that are using containers are using **Kubernetes** (July 2018)
- It has a huge community:
 - ~46K Stars
 - ~2000 Contributors!
 - ~70000 commits
 - ~16K Forks
 - ~1000 Pending pull requests!
 - ~50000 users on Slack team

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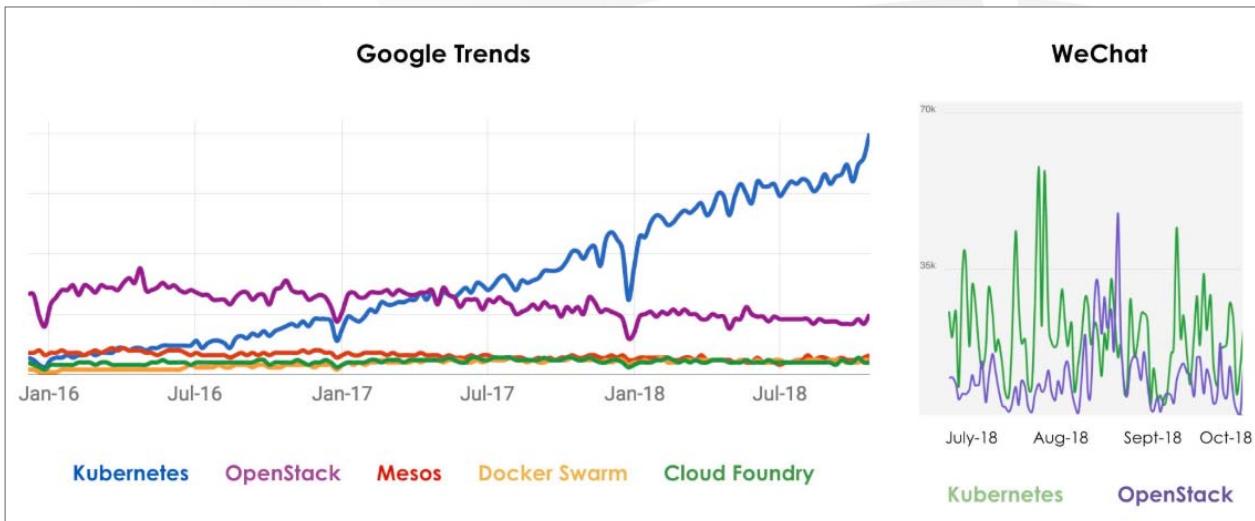
Works Everywhere

- Linux Machines
- Windows Machines
- X86, X64 architecture
- ARM Architecture – ie Raspberry Pi
- It's also possible to create mixed-architecture clusters
 - Useful for IoT scenarios



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Kubernetes in Search Trends



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Common use-cases for integrating Kubernetes

- Moving from monolithic apps to microservices
- Providing a consistent environment to various applications
- Integrating CI/CD: DevOps, GitOp and NoOps
- Management solution for containers
- Hybrid Cloud and Multi-Cloud

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Built-in Features

- Monitoring Data
- Health Checking mechanisms
- Horizontal Auto Scaling
- Service Discovery
- Rolling Deployment and Rollback
- Logging
- Application Load Balancing

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K8s biggest feature is it's huge ecosystem



Kubermatic



squash



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Questions



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Module 02: Kubernetes Architecture

Kubernetes Workshop



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Agenda

- ★ Core Concepts
- ★ High-Level components Architecture
- ★ Master Components
- ★ Worker Node Components
- ★ Putting All Together
- ★ Additional Services

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Core Concepts

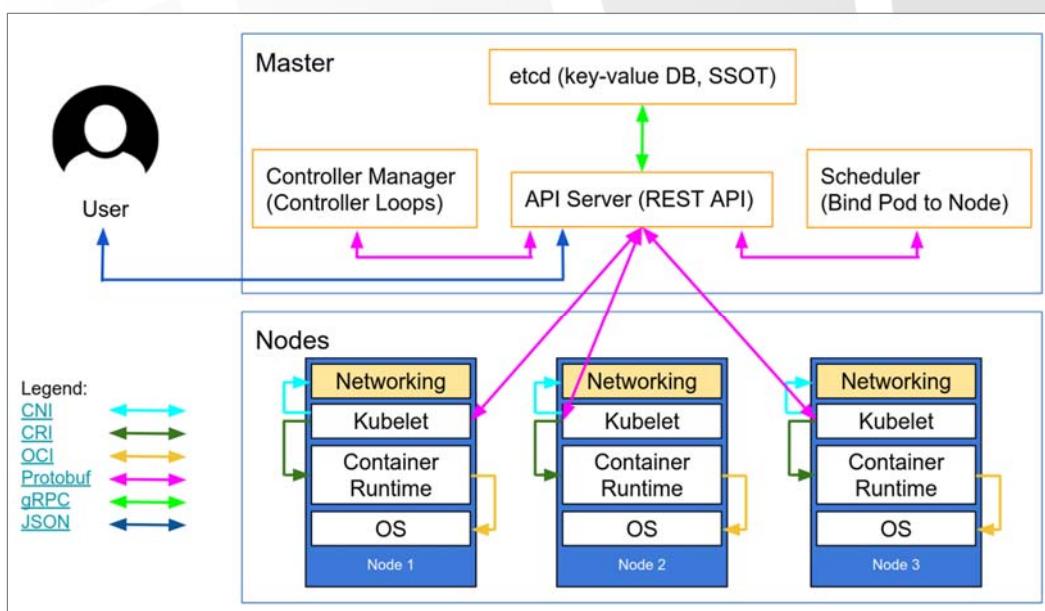
Cluster: A collection of hosts that aggregate their available resources including CPU, GPU, RAM, disks, and other devices into a usable pool.

Master: Represents a collection of components that make up the control plane of Kubernetes.

Node: A single host, physical or virtual capable of running pods. A node is managed by the master(s) using an agent.

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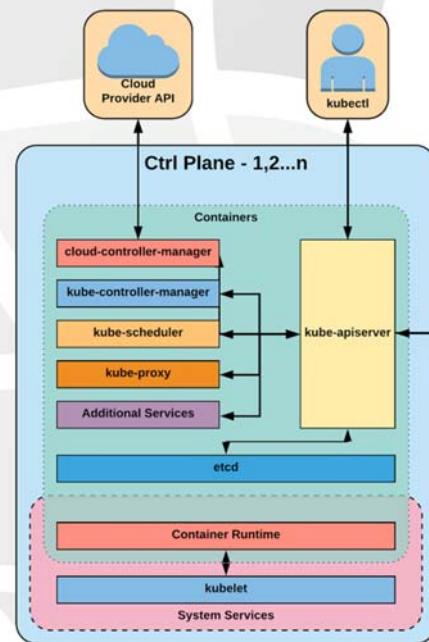
Kubernetes High-Level Components Architecture



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Master Components

- API Server
- etcd
- Controller Manager
- Kube-Scheduler



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API Server

- Provides a forward facing **REST interface** into the kubernetes control plane and datastore.
- All clients and other applications **interact** with kubernetes strictly through the API Server.
- Acts as the gatekeeper to the cluster by handling authentication and authorization, request validation, mutation, and admission control in addition to being the front-end to the backing datastore
- API server define a versioned and backward compatible interface (REST or gRPC) that enable integration with other tools

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etcd



- etcd acts as the cluster datastore.
- Purpose in relation to Kubernetes is to provide a strong, consistent and highly available key-value store for persisting cluster state.
- Stores objects and config information.
- etcd is a very-fast, high available key-value store that can be distributed among multiple nodes.
- etcd is accessible only by Kubernetes API server as it may have some sensitive information, and should not be used by other applications.

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Controller Manager

- Serves as the primary daemon that manages all core component control loops.
- Monitors the cluster state via the apiserver and steers the cluster towards the desired state
- Manages most of the Core Building Blocks in Kubernetes

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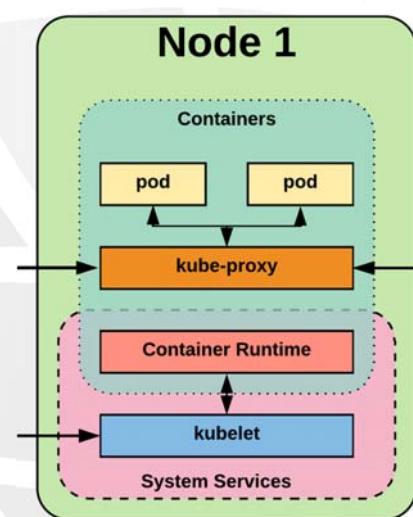
Kube-Scheduler

- Verbose policy-rich engine that evaluates workload requirements and attempts to place it on a matching resource.
- Default scheduler uses bin packing.
- Workload Requirements can include: general hardware requirements, affinity/anti-affinity, labels, and other various custom resource requirements
- The Scheduler is located on the master and responsible for making scheduling and pods distribution decisions
- Most decisions are as simple as “This **pod** should run on that **node**”

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Worker Node Components

- Kubelet
- Kube-proxy
- Container Runtime Engine



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Kubelet Service

- Kubelet is the cluster agent that is placed on every node in the cluster, and is responsible for relaying information to and from the control plane
- Kubelet communicates with the master components, and receives instructions – i.e run a pod with those containers, expose port on the node, update routing tables, etc..
- Kubelet then assumes responsibility for maintaining the state the node, and the pods that are scheduled to run on the node, as instructed by the master.

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KubeProxy Service

- Manages the network rules on each node.
- Performs connection forwarding or load balancing for Kubernetes cluster services.
- It makes sure that the networking environment is predictable and accessible and at the same time isolated.

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Container Runtime Engine

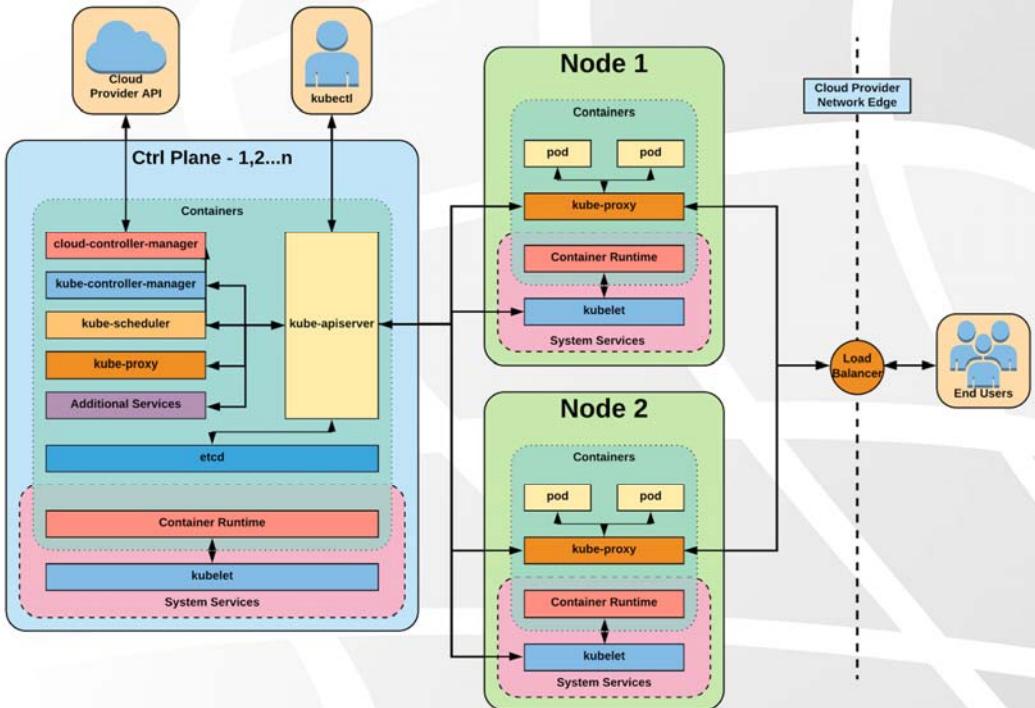
- A container runtime is a CRI (Container Runtime Interface) compatible application that executes and manages containers.
 - Containerd (docker)
 - Cri-o
 - Rkt
 - Kata (formerly clear and hyper)
 - Virtlet (VM CRI compatible runtime)

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Additional Services (Optional)

- **cloud-controller-manager**
 - Daemon that provides cloud-provider specific knowledge and integration capability into the core control loop of Kubernetes
- **Cluster DNS**
 - Provides Cluster Wide DNS for Kubernetes Services
- **Metrics API Server**
 - Provides metrics for use with other Kubernetes Components.

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Questions



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Module 03: YAML & Kubectl

Kubernetes Workshop



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Agenda

- ★ YAML
- ★ Kubectl
- ★ Lab 01: Setting Up Your Workstation

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YAML

- Stands for **Yet Another Markup Language**, or **YAML Ain't Markup Language** (depending who you ask)
- Is a human-readable text-based format for specifying configuration-type information
- Fortunately, there are only two types of structures you need to know about in YAML:
 - Lists
 - Maps

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YAML - Maps

- Maps let you associate name-value pairs

```
---
```

```
apiVersion: v1
kind: Pod
```

YAML

```
{
  "apiVersion": "v1",
  "kind": "Pod"
}
```

JSON

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YAML - Lists

- Lists are literally a sequence of objects

```
args:  
  - sleep  
  - "1000"  
  - message  
  - "Bring back Firefly!"
```

YAML

```
{  
  "args": ["sleep", "1000", "message", "Bring back Firefly!"]  
}
```

JSON

Kubernetes ❤️ YAML

```
apiVersion: v1  
kind: Pod  
metadata:  
  namespace: default  
  name: sample-pod  
spec:  
  containers:  
    - image: nginx  
      name: container-name
```

```
apiVersion: apps/v1beta2  
kind: ReplicaSet  
metadata:  
  name: nginx  
  annotations:  
    description: "nginx frontend"  
  labels:  
    app: nginx  
    tier: frontend  
spec:  
  replicas: 3  
  selector:  
    matchLabels:  
      app: nginx  
      tier: frontend  
  template:  
    metadata:  
      labels:  
        app: nginx  
        tier: frontend  
    spec:  
      containers:  
        - name: nginx  
          image: nginx:latest  
          ports:  
            - containerPort: 80
```

```
apiVersion: apps/v1beta2  
kind: Deployment  
metadata:  
  name: nginx  
  annotations:  
    description: "nginx frontend"  
  labels:  
    app: nginx  
    tier: frontend  
spec:  
  replicas: 3  
  minReadySeconds: 10  
  strategy:  
    type: RollingUpdate  
    rollingUpdate:  
      maxSurge: 5  
      maxUnavailable: 2  
  selector:  
    matchLabels:  
      app: nginx  
      tier: frontend  
  template:  
    metadata:  
      labels:  
        app: nginx  
        tier: frontend  
    spec:  
      containers:  
        - name: nginx  
          image: nginx:latest  
          ports:  
            - containerPort: 80
```

```
kind: Service  
apiVersion: v1  
metadata:  
  name: nginx  
spec:  
  type: ClusterIP  
  selector:  
    app: nginx  
  ports:  
    - protocol: TCP  
      port: 80  
      targetPort: 80
```

Kubectl

- Kubectl is a command line interface for running commands against Kubernetes clusters
- Allow for listing and querying objects, creating and modifying objects, port-forwarding, accessing logs, ssh to containers, etc...
- Since 1.13 supports plugins as well

Everything you do in Kubernetes, you do with kubectl

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Kubectl

```
$ kubectl <command> <resource> [arguments] [-n <namespace>]
```

```
$ kubectl get pods
```

```
$ kubectl get svc -n dev
```

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

```
$ kubectl edit svc <service-name>
```

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

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Kubectl

| Kubernetes Cheat Sheet | | |
|--|--|---|
| What is Kubernetes? Kubernetes is a platform for managing containerized workloads. Kubernetes orchestrates computing, networking and storage to provide a seamless portability across infrastructure providers. | | |
| Viewing Resource Information | | |
| Nodes | Deployments | ReplicaSets |
| \$ kubectl get no \$ kubectl get no -o wide \$ kubectl describe no \$ kubectl get no -o yaml \$ kubectl get node --selector=[label_name] \$ kubectl get nodes -o jsonpath='{.items[*].status.addresses[?(@.type=="ExternalIP")].address}' \$ kubectl top node [node_name] | \$ kubectl get deploy \$ kubectl describe deploy \$ kubectl get deploy -o wide \$ kubectl get deploy -o yaml | \$ kubectl get rs \$ kubectl describe rs \$ kubectl get rs -o wide \$ kubectl get rs -o yaml |
| Pods | Services | Roles |
| \$ kubectl get po \$ kubectl get po -o wide \$ kubectl describe po \$ kubectl get po --show-labels \$ kubectl get -l app=nginx \$ kubectl get po -o yaml \$ kubectl get pod [pod_name] -o yaml --export \$ kubectl get pod [pod_name] -o yaml --export > nameoffile.yaml \$ kubectl get pods --field-selector status.phase=Running | \$ kubectl get svc \$ kubectl describe svc \$ kubectl get svc -o wide \$ kubectl get svc -o yaml \$ kubectl get svc --show-labels | \$ kubectl get roles --all-namespaces \$ kubectl get roles --all-namespaces -o yaml |
| Namespaces | DaemonSets | Secrets |
| \$ kubectl get ns \$ kubectl get ns -o yaml \$ kubectl describe ns | \$ kubectl get ds \$ kubectl get ds --all-namespaces \$ kubectl describe ds [daemonset_name] -n [namespace_name] \$ kubectl get ds [ds_name] -n [ns_name] -o yaml | \$ kubectl get secrets \$ kubectl get secrets --all-namespaces \$ kubectl get secrets -o yaml |
| | Events | ConfigMaps |
| | \$ kubectl get events \$ kubectl get events -n kube-system \$ kubectl get events -w | \$ kubectl get cm \$ kubectl get cm --all-namespaces \$ kubectl get cm --all-namespaces -o yaml |
| | Logs | Ingress |
| | \$ kubectl logs [pod_name] \$ kubectl logs --since=1h [pod_name] \$ kubectl logs --tail=20 [pod_name] \$ kubectl logs -f -c [container_name] [pod_name] \$ kubectl logs [pod_name] > pod.log | \$ kubectl get ing \$ kubectl get ing --all-namespaces |
| | Service Accounts | PersistentVolume |
| | \$ kubectl get sa \$ kubectl get sa -o yaml \$ kubectl get serviceaccounts default -o yaml > ./sa.yaml \$ kubectl replace serviceaccount default -f ./sa.yaml | \$ kubectl get pv \$ kubectl describe pv |
| | | PersistentVolumeClaim |
| | | \$ kubectl get pvc \$ kubectl describe pvc |



<http://linuxacademy.com>

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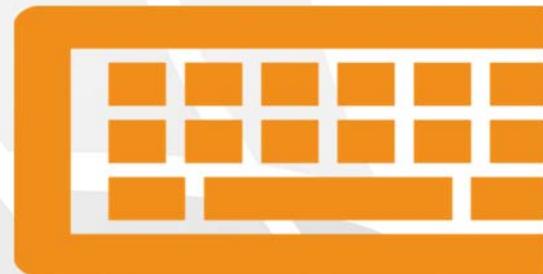
Questions



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Lab 01: Setting Up Your Workstation

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-01>

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Module 04: Kubernetes Basics

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Agenda

- ★ Kubernetes Building Blocks
- ★ Namespaces
- ★ Pods
- ★ Replication Sets
- ★ Lab 02: Creating Our First Pod

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Kubernetes Building Blocks

- Namespace
- Pod
- ReplicaSet
- Deployment
- Services
- Ingress
- ConfigMaps
- Secrets
- Jobs
- CronJobs
- DaemonSet
- StatefulSet
- Volumes
- PersistentVolumes
- PersistentVolumeClaims
- StorageClasses

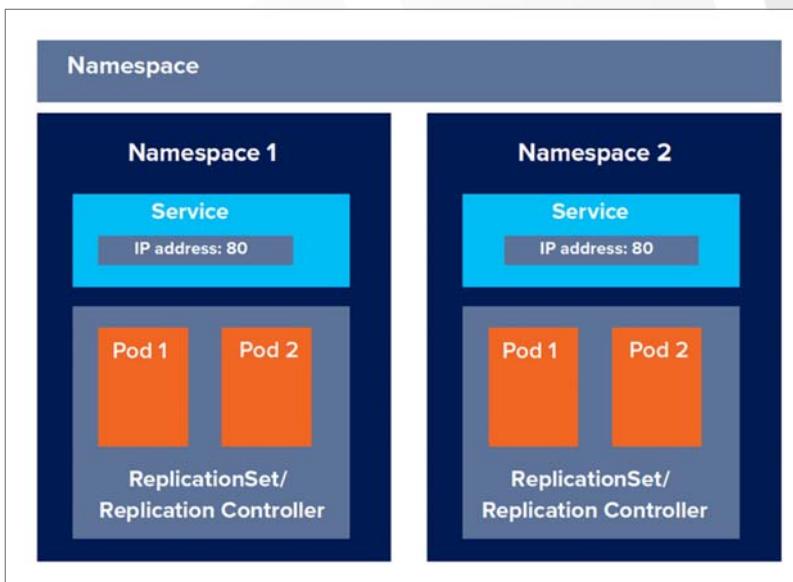
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Namespace

- A Namespace is a logical isolation method, and most Kubernetes objects are scoped in a Namespace
- A Namespace often used to group logically similar workloads, and enforce different policies
- Namespaces can also allow multi-tenancy
 - For example, Namespace per environment (dev, prod), Namespace per Team or a developer, Namespace per PR, etc..
 - Role-Based Access Control (RBAC) can be used to limit specific access to resources or namespaces.

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Namespace



```
● ● ●  
apiVersion: v1  
kind: Namespace  
metadata:  
  name: dev  
  labels:  
    name: development
```

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Default Namespaces

- **default:** The default namespace for any object without a namespace.
- **kube-system:** Acts as the home for objects and resources created by Kubernetes itself.
- **kube-public:** A special namespace; readable by all users that is reserved for cluster bootstrapping and configuration.

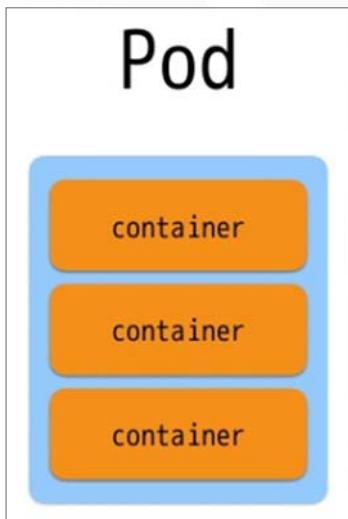
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Pod

- A Pod is the most basic, atomically deployable unit in Kubernetes
- A Pod is ephemeral – once terminated, it will be reclaimed
- A Pod consists of one or many co-located containers
- A Pod represent a single instance of an application
- The Containers in a Pod share a loopback network interface, and can share mounted folders
- Containers in a Pod cannot use the same network port within the Pod
- Each Pod has its own, uniquely assigned internal IP address

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Pod



A black terminal window with three colored dots (red, yellow, green) at the top. The window contains the following YAML code:

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    name: nginx
spec:
  containers:
  - name: nginx
    image: nginx
    ports:
    - containerPort: 80
```

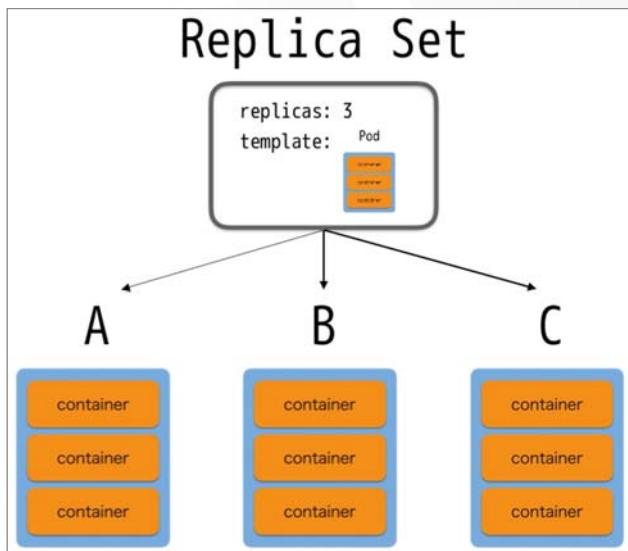
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ReplicaSet

- ReplicaSet ensures that a specified number of Pod replicas are running at any given time.
- If there are more Pods than defined in the 'replicas' field – The ReplicaSet kills them
- If there are less Pods than defined in the 'replicas' field – The ReplicaSet creates them

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ReplicaSet



```
apiVersion: v1
kind: ReplicationSet
metadata:
  name: nginx
spec:
  replicas: 3
  selector:
    app: nginx
  template:
    metadata:
      name: nginx
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: nginx
          ports:
            - containerPort: 80
```

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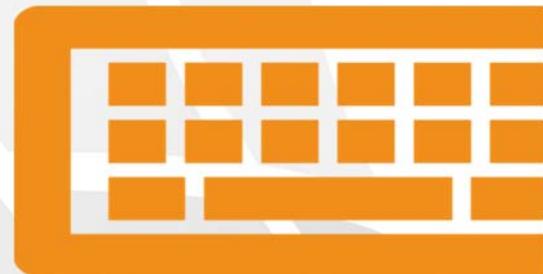
Questions



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Lab 02: Creating and scaling your first pod

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-02>

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Module 05: Deployments & Upgrades

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Agenda

- ★ Deployments
- ★ Rolling Upgrades
- ★ Lab 03: Deploy and Upgrade a Single Service

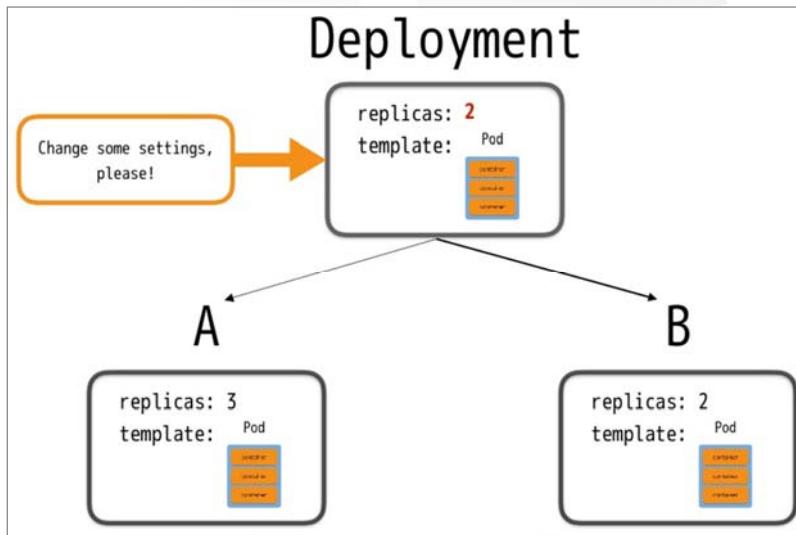
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Deployment

- Deployments hold ReplicaSets (one for each version) and adds Upgrade Strategy
- When a Deployment is updated, Kubernetes will perform a rolling upgrade of the Pods running on the cluster.
- Rolling Upgrades actually creates new ReplicaSets, with the updated container image, continually replacing replicas from the old ReplicaSet.
- After Rolling Upgrade is done, the old ReplicaSet kept alive (with zero replicas) for easy rollback.

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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:1.15.4
      ports:
        - containerPort: 80
```

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Deployment

- **revisionHistoryLimit:** The number of previous iterations of the Deployment to retain.
- **strategy:** Describes the method of updating the Pods based on the **type**. Valid options are **Recreate** or **RollingUpdate**.
 - **Recreate:** All existing Pods are killed before the new ones are created.
 - **RollingUpdate:** Cycles through updating the Pods according to the parameters: **maxSurge** and **maxUnavailable**.

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: deploy-example
spec:
  replicas: 3
  revisionHistoryLimit: 3
  selector:
    matchLabels:
      app: nginx
      env: prod
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 1
      maxUnavailable: 0
  template:
    <pod template>
```

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RollingUpdate Deployment

- Updating pod template generates a new ReplicaSet revision.

R1 pod-template-hash:

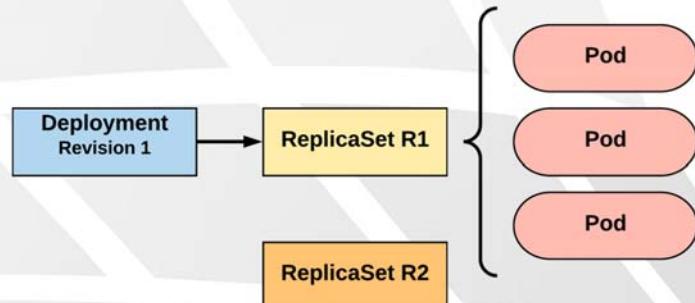
676677fff

R2 pod-template-hash:

54f7ff7d6d

```
$ kubectl get replicaset
NAME      DESIRED  CURRENT  READY  AGE
mydep-676677fff  3        3        3     5h
```

```
$ kubectl get pods
NAME      READY  STATUS  RESTARTS  AGE
mydep-676677fff-9r2zn  1/1   Running  0       5h
mydep-676677fff-hsfz9  1/1   Running  0       5h
mydep-676677fff-sjxhf  1/1   Running  0       5h
```



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RollingUpdate Deployment

- New **ReplicaSet** is initially scaled up based on **maxSurge**

R1 pod-template-hash:

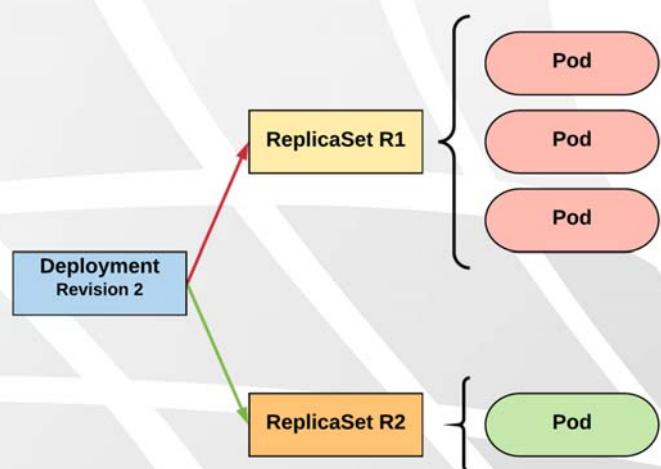
676677fff

R2 pod-template-hash:

54f7ff7d6d

```
$ kubectl get replicaset
NAME      DESIRED  CURRENT  READY  AGE
mydep-54f7ff7d6d  1        1        1     5s
mydep-676677fff  2        3        3     5h
```

```
$ kubectl get pods
NAME      READY  STATUS  RESTARTS  AGE
mydep-54f7ff7d6d-9gvll  1/1   Running  0       2s
mydep-676677fff-9r2zn  1/1   Running  0       5h
mydep-676677fff-hsfz9  1/1   Running  0       5h
mydep-676677fff-sjxhf  1/1   Running  0       5h
```



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RollingUpdate Deployment

- Phase out of old Pods managed by **maxSurge** and **maxUnavailable**.

R1 pod-template-hash:

676677fff

R2 pod-template-hash:

54f7ff7d6d

\$ kubectl get replicaset

| NAME | DESIRED | CURRENT | READY | AGE |
|------------------|---------|---------|-------|-----|
| mydep-54f7ff7d6d | 2 | 2 | 2 | 8s |
| mydep-6766777fff | 2 | 2 | 2 | 5h |

\$ kubectl get pods

| NAME | READY | STATUS | RESTARTS | AGE |
|------------------------|-------|---------|----------|-----|
| mydep-54f7ff7d6d-9gvll | 1/1 | Running | 0 | 5s |
| mydep-54f7ff7d6d-cqv1q | 1/1 | Running | 0 | 2s |
| mydep-6766777fff-9r2zn | 1/1 | Running | 0 | 5h |
| mydep-6766777fff-hsfz9 | 1/1 | Running | 0 | 5h |

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RollingUpdate Deployment

- Phase out of old Pods managed by **maxSurge** and **maxUnavailable**

R1 pod-template-hash:

676677fff

R2 pod-template-hash:

54f7ff7d6d

\$ kubectl get replicaset

| NAME | DESIRED | CURRENT | READY | AGE |
|------------------|---------|---------|-------|-----|
| mydep-54f7ff7d6d | 3 | 3 | 3 | 10s |
| mydep-6766777fff | 0 | 1 | 1 | 5h |

\$ kubectl get pods

| NAME | READY | STATUS | RESTARTS | AGE |
|------------------------|-------|---------|----------|-----|
| mydep-54f7ff7d6d-9gvll | 1/1 | Running | 0 | 7s |
| mydep-54f7ff7d6d-cqv1q | 1/1 | Running | 0 | 5s |
| mydep-54f7ff7d6d-gccr6 | 1/1 | Running | 0 | 2s |
| mydep-6766777fff-9r2zn | 1/1 | Running | 0 | 5h |

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RollingUpdate Deployment

- Phase out of old Pods managed by **maxSurge** and **maxUnavailable**

R1 pod-template-hash:

676677fff

R2 pod-template-hash:

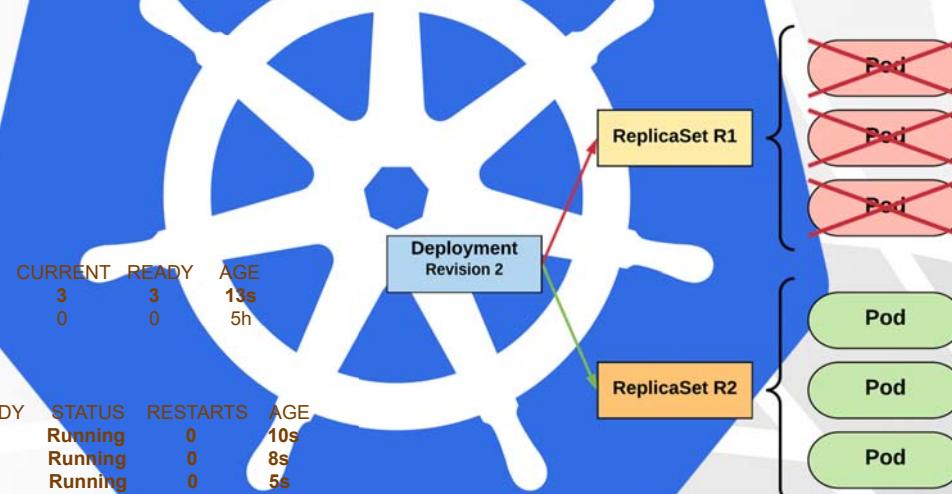
54f7ff7d6d

\$ kubectl get replicaset

| NAME | DESIRED | CURRENT | READY | AGE |
|------------------|---------|---------|-------|-----|
| mydep-54f7ff7d6d | 3 | 3 | 3 | 13s |
| mydep-6766777fff | 0 | 0 | 0 | 5h |

\$ kubectl get pods

| NAME | READY | STATUS | RESTARTS | AGE |
|------------------------|-------|---------|----------|-----|
| mydep-54f7ff7d6d-9gvll | 1/1 | Running | 0 | 10s |
| mydep-54f7ff7d6d-cqv1q | 1/1 | Running | 0 | 8s |
| mydep-54f7ff7d6d-gccr6 | 1/1 | Running | 0 | 5s |



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RollingUpdate Deployment

- Updated to new deployment revision completed.

R1 pod-template-hash:

676677fff

R2 pod-template-hash:

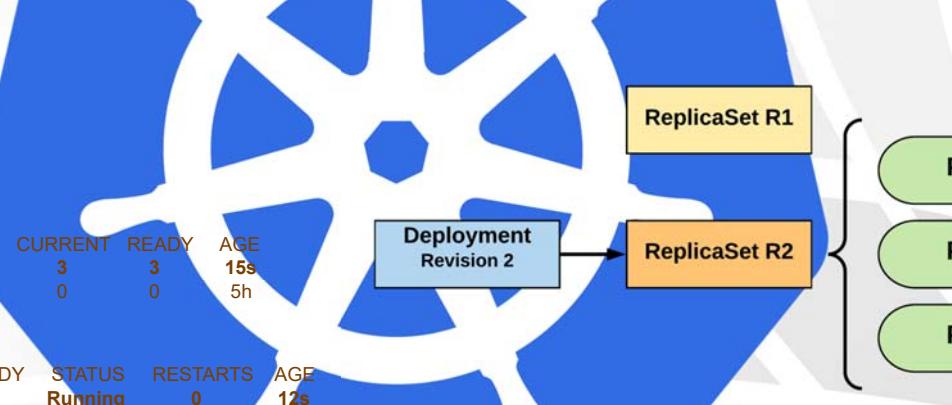
54f7ff7d6d

\$ kubectl get replicaset

| NAME | DESIRED | CURRENT | READY | AGE |
|------------------|---------|---------|-------|-----|
| mydep-54f7ff7d6d | 3 | 3 | 3 | 15s |
| mydep-6766777fff | 0 | 0 | 0 | 5h |

\$ kubectl get pods

| NAME | READY | STATUS | RESTARTS | AGE |
|------------------------|-------|---------|----------|-----|
| mydep-54f7ff7d6d-9gvll | 1/1 | Running | 0 | 12s |
| mydep-54f7ff7d6d-cqv1q | 1/1 | Running | 0 | 10s |
| mydep-54f7ff7d6d-gccr6 | 1/1 | Running | 0 | 7s |



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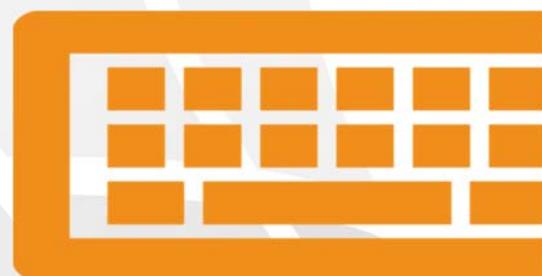
Questions



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Lab 03: Deploy and Upgrade a Single Service

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-03>

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Module 06: Labels & Annotations

Kubernetes Workshop



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Agenda

- ★ Labels
- ★ Annotations
- ★ Selectors

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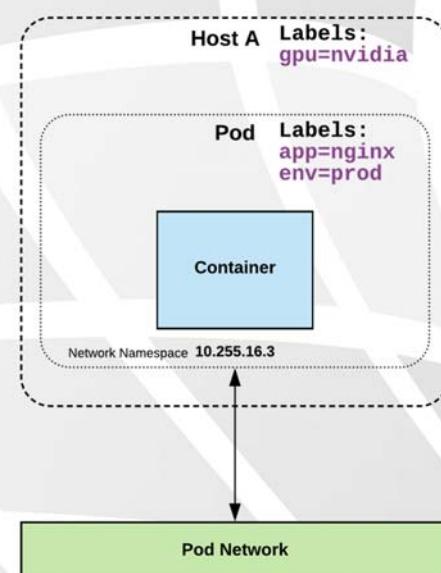
Labels

- A label is a semantic tag that can be attached to Kubernetes objects to mark them as a part of a group.
- Services use labels to understand the backend pods they should route requests to.

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Label Example

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-label-example
  labels:
    app: nginx
    env: prod
spec:
  containers:
  - name: nginx
    image: nginx:stable-alpine
    ports:
    - containerPort: 80
```



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Annotations

- Annotations are a similar mechanism that allows you to attach arbitrary key-value information to an object.
- Annotations are a way of adding rich metadata to an object that is not helpful for selection purposes.

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Annotation Example

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: dev-dispatcher-ingress
  namespace: dev
  annotations:
    # Annotations for Nginx ingress controller:
    ingress.kubernetes.io/ssl-redirect: "false"
    ingress.kubernetes.io/rewrite-target: /
spec:
  rules:
  - host: devcluster
    http:
      paths:
      - path: /dispatcher
        backend:
          serviceName: dispatcher-service
          servicePort: 80
```

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-deployment
  annotations:
    description: "my description"
spec:
  replicas: 2
  template:
    metadata:
      labels:
        app: my-app
    spec:
      containers:
      - image: my-app:1.7.9
        ports:
        - containerPort: 80
```

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Selectors

- **Selectors** use labels to filter or select objects, and are used throughout Kubernetes.
- **Equality based** selectors allow for simple filtering (`=`, `==`, or `!=`)
- **Set-based** selectors are supported on a limited subset of objects. However, they provide a method of filtering on a set of values, and supports multiple operators including: `in`, `notin`, and `exist`.

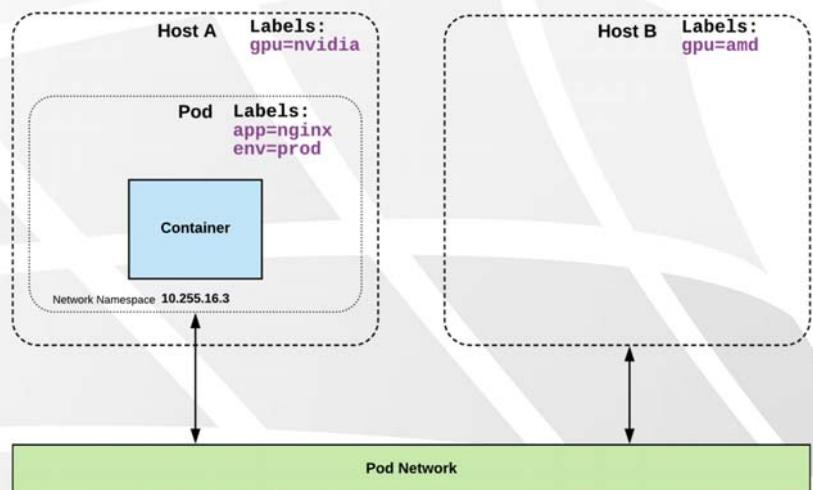
```
selector:  
matchLabels:  
gpu: nvidia
```

```
selector:  
matchExpressions:  
- key: gpu  
operator: in  
values: ["nvidia"]
```

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Selector Example

```
apiVersion: v1  
kind: Pod  
metadata:  
  name: pod-label-example  
  labels:  
    app: nginx  
    env: prod  
spec:  
  containers:  
  - name: nginx  
    image: nginx:stable-alpine  
    ports:  
    - containerPort: 80  
  nodeSelector:  
    gpu: nvidia
```



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Questions



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Module 07: Kubernetes Networking

Kubernetes Workshop



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Agenda

- ★ Kubernetes Networking Introduction
- ★ Container Network Interface (CNI)
- ★ CNI Plugins
- ★ Fundamental Networking Rules
- ★ Networking patterns

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Kubernetes Networking

- **Pod Network**
 - Cluster-wide network used for pod-to-pod communication managed by a CNI (Container Network Interface) plugin.
- **Service Network**
 - Cluster-wide range of Virtual IPs managed by kube-proxy for service discovery.

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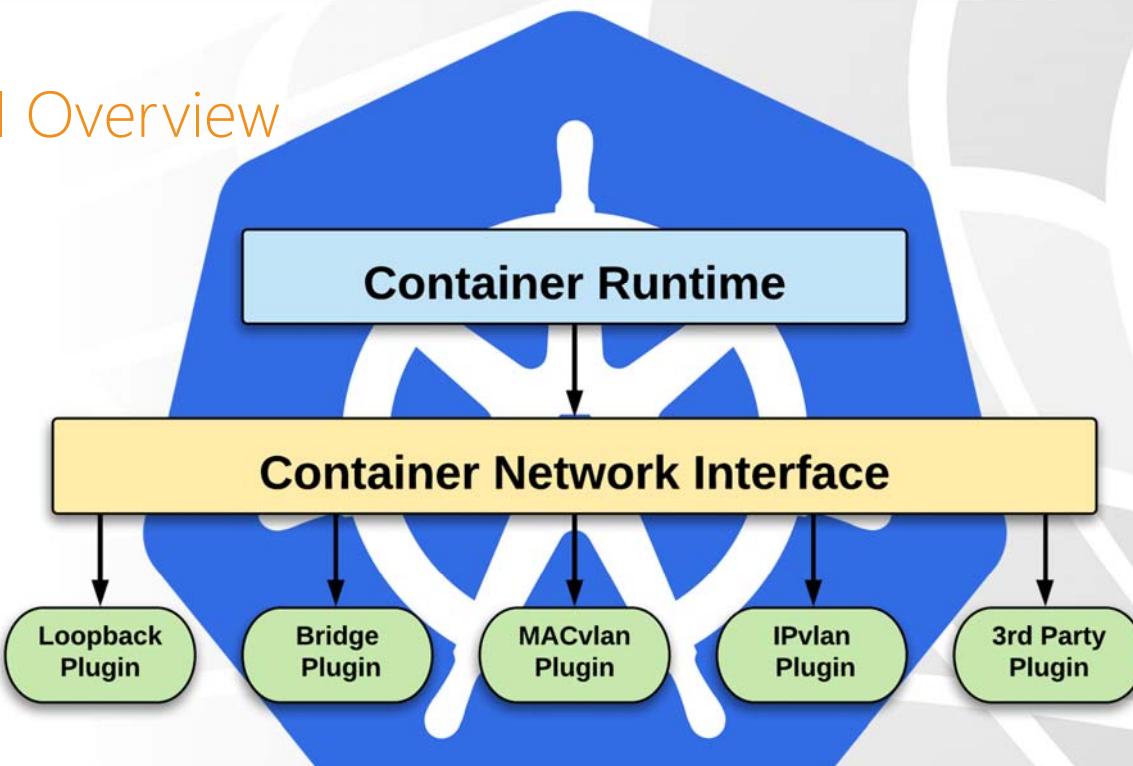
Container Network Interface (CNI)

- Pod networking within Kubernetes is plumbed via the Container Network Interface (CNI).
- Functions as an interface between the container runtime and a network implementation plugin.
- CNCF Project
- Uses a simple JSON Schema.



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CNI Overview



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CNI Plugins

- Amazon ECS
- Calico
- Cillium
- Contiv
- Contrail
- Flannel



- GCE
- kube-router
- Multus
- OpenVSwitch
- Romana
- Weave



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Fundamental Networking Rules

- All containers within a pod can communicate with each other.
- All Pods can communicate with all other Pods without NAT.
- All nodes can communicate with all Pods (and vice-versa) without NAT.
- The IP that a Pod sees itself as is the same IP that others see it as.

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Networking patterns

- **Container-to-Container**

- Containers within a pod exist within the same network namespace and share an IP.
- Enables intrapod communication over localhost.

- **Pod-to-Pod**

- Allocated cluster unique IP for the duration of its life cycle.
- Pods themselves are fundamentally ephemeral.

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Networking patterns

- **Pod-to-Service**

- Managed by kube-proxy and given a persistent cluster unique IP
- Exists beyond a Pod's lifecycle.

- **External-to-Service**

- Handled by kube-proxy.
- Works in cooperation with a cloud provider or other external entity (LB)

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Module 08: Services

Kubernetes Workshop



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Agenda

- ★ Services Introduction
- ★ Service Types – ClusterIP
- ★ Service Types – NodePort
- ★ Service Types – LoadBalancer
- ★ Service Types – ExternalName
- ★ Lab 04: Creating a Load Balancer Service

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Services

- A Service exposes one or more Pods via a stable, consistent, internal IP address
- It also exposes a hierarchical DNS name for cluster-internal communication

```
{service}.{namespace}.svc.cluster.local -> nginx.dev.svc.cluster.local
```
- The Service selects Pods based on a label, key-value selector – 'app=nginx'

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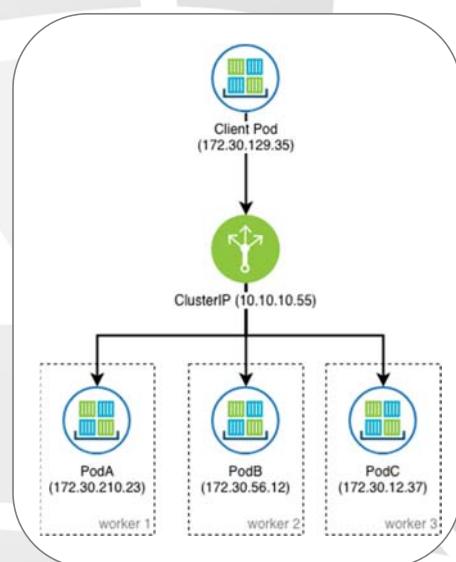
Services

- A Service may expose multiple ports in various protocols – UDP, TCP, HTTP or HTTPS
- A Service is using Round-Robin algorithm to Load Balance traffic to the Pods
- There are several Service Types, depending on the environment we are running the cluster on

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Service Types - ClusterIP

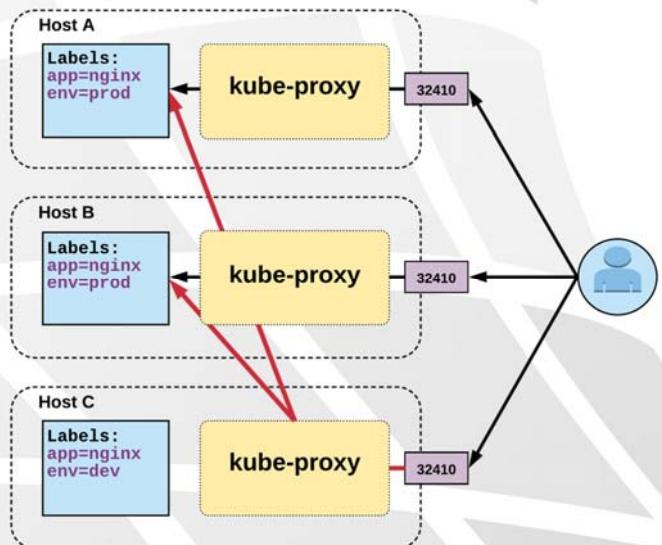
- Exposes the service on a cluster-internal IP
- Choosing this value makes the service only reachable from within the cluster
- This is the default ServiceType



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Service Types - NodePort

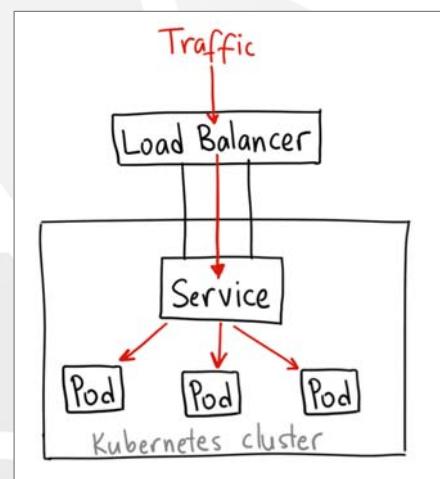
- Exposes the service on each Node's IP at a static port (the NodePort)
- A ClusterIP service, to which the NodePort service will route, is automatically created
- Ports being used are between 30000-32767



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Service Types - LoadBalancer

- Exposes the service externally using a cloud provider's load balancer
- NodePort and ClusterIP services, to which the external load balancer will route, are automatically created.



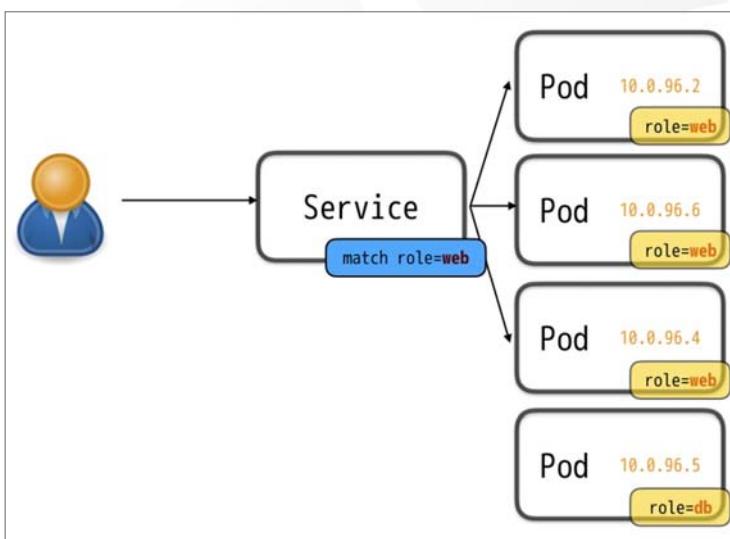
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Service Types - ExternalName

- Is used to reference endpoints OUTSIDE the cluster
- It creates an internal CNAME DNS entry that aliases another
- Maps the service to the contents of the externalName field (e.g. foo.bar.example.com), by returning a CNAME record with its value

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Simple Service



```
apiVersion: v1
kind: Service
metadata:
  name: nginx-service
  labels:
    app: nginx-service
spec:
  ports:
  - port: 80
    targetPort: 4000
  type: NodePort
  selector:
    app: nginx
```

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Syntax

```
apiVersion: apps/v1
kind: Service
apiVersion: v1
metadata:
  name: my-service
spec:
  selector:
    app: MyApp
  ports:
  - protocol: TCP
    port: 80
    targetPort: 9376
```

```
apiVersion: v1
kind: Service
apiVersion: v1
metadata:
  name: my-service
spec:
  selector:
    app: MyApp
  ports:
  - protocol: TCP
    port: 80
    targetPort: 9376
    loadBalancerIP: 78.11.24.19
  type: LoadBalancer
```

```
apiVersion: apps/v1
kind: Service
apiVersion: v1
metadata:
  name: my-service
  namespace: prod
spec:
  type: ExternalName
  externalName: my.database.example.com
```

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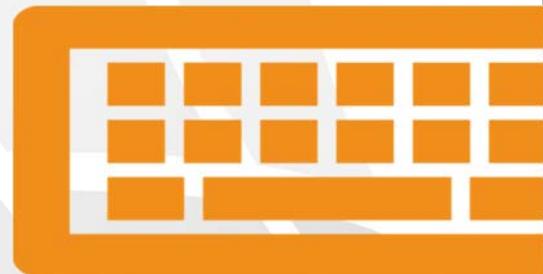
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Lab 04: Creating a Load Balancer Service

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-04>

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Module 09: Ingress

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Agenda

- ★ Introduction to Ingress
- ★ Ingress Controllers
- ★ Lab 05: Deploying applications using Ingress

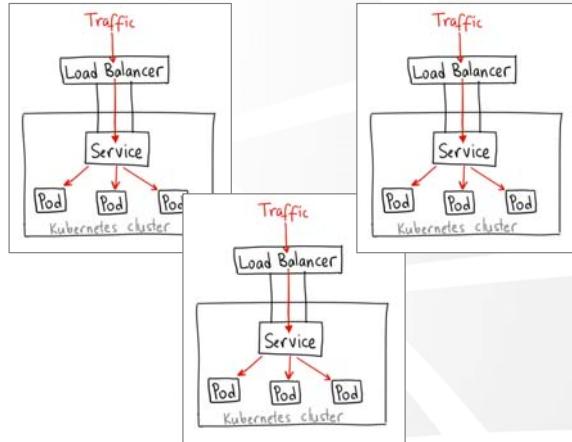
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Ingress

- An API object that manages external access to the services in a cluster, typically HTTP/S
- Ingress can provide L7 load balancing, SSL termination and name-based virtual hosting
- Support installing a Certificate for HTTPS workloads
- Can use 'Host' header, or route (/service) for smart routing
- Combined with Namespaces, can be leveraged to create a smart, multi environment, multi-purpose cluster

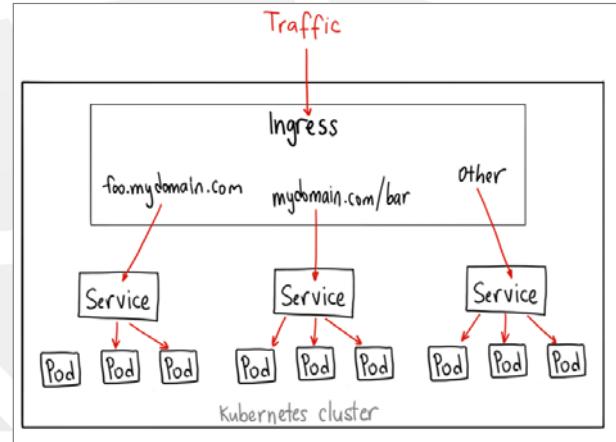
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Why Ingress?



Load Balancer Services

VS



Ingress

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Ingress Example

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: dev-dispatcher-ingress
  namespace: dev
  annotations:
    # Annotations for Nginx ingress controller:
    ingress.kubernetes.io/ssl-redirect: "false"
    ingress.kubernetes.io/rewrite-target: /
spec:
  rules:
  - host: devcluster
    http:
      paths:
      - path: /dispatcher
        backend:
          serviceName: dispatcher-service
          servicePort: 80
```

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: tls-example-ingress
  spec:
    tls:
    - hosts:
      - sslexample.foo.com
      secretName: testsecret-tls
    rules:
    - host: sslexample.foo.com
      http:
        paths:
        - path: /
          backend:
            serviceName: service1
            servicePort: 80
```

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Ingress Controller

- In order for the ingress resource to work, the cluster must have an ingress controller running.
- There are many to choose from, and they are mostly compatible with other
- Multiple Ingress Controllers can be deployed on a single cluster
- Ingress Controllers opens ports 80 and 443 (HTTP/S)
- Rules are applied to incoming requests, and if a request is not matched, return 404 (Not Found) using a customizable default http service.

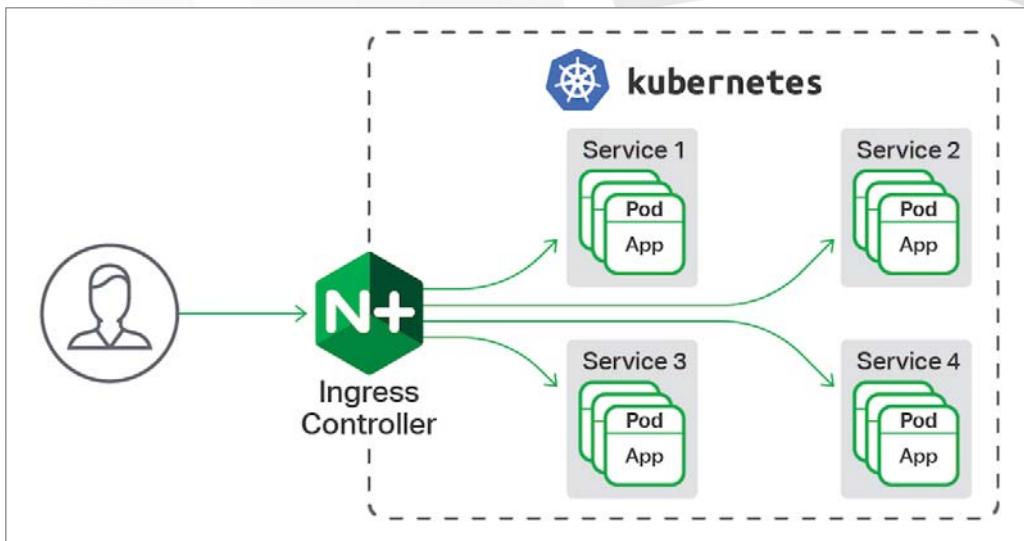
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Various Ingress Controllers Available

- Ambassador
- HAProxy
- Kong
- Traefik
- Gloo
- Contour (based on Envoy)
- Nginx (most popular and maintained by Kubernetes Community)
 - Although most popular and wide-support, there are better for specific scenarios
 - A commercial offering also available - Nginx+

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Ingress Overview



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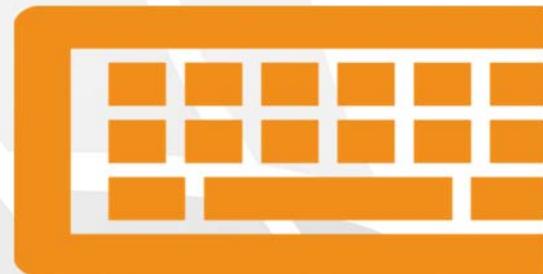
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Lab 05: Deploying applications using Ingress

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-05>

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Module 10: ConfigMaps & Secrets

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Agenda

- ★ ConfigMaps
- ★ ConfigMaps – As Environment Variables
- ★ ConfigMaps – As Volumes
- ★ Secrets
- ★ Lab 06: Using ConfigMaps and Secrets

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ConfigMaps

- ConfigMaps allow you to decouple configuration artifacts from image content to keep containerized applications portable
- Frequently used to inject configuration files and environment variables into containers
- ConfigMaps can be created by using YAML files, or load it from files



```
kubectl create configmap app-config --from-file=test.config
```

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ConfigMaps – Mapped as Environment Variable

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: env-config
  namespace: default
data:
  log_level: INFO
```

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: k8s.gcr.io/busybox
      command: [ "/bin/sh", "-c", "env" ]
    env:
      - name: LOG_LEVEL
        valueFrom:
          configMapKeyRef:
            name: env-config
            key: log_level
```

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ConfigMaps – Mapped as a Volume

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config
  namespace: default
data:
  special.level: very
  special.type: charm
```

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: k8s.gcr.io/busybox
      command: [ "/bin/sh", "-c",
                 "cat /etc/config/keys" ]
    volumeMounts:
      - name: config-volume
        mountPath: /etc/config
  volumes:
    - name: config-volume
      configMap:
        name: special-config
        items:
          - key: special.level
            path: keys
```

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Secrets

- Very similar to ConfigMaps primitive, meant to deal with sensitive data
- There are three types of secrets:
 - Docker-registry - a secret for use with a Docker registry
 - Generic - a secret from a local file, directory or literal value
 - TLS - a TLS secret (certificates)
- As ConfigMaps, can be created from the CLI, or YAML files.
- And can be mounted as Environment Variables or Volumes.

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Secrets

```
apiVersion: v1
kind: Secret
metadata:
  name: test-secret
data:
  username: bXktYXBw
  password: Mzk1MjgkdmRnN0pi
```

```
apiVersion: v1
kind: Pod
metadata:
  name: secret-test-pod
spec:
  containers:
    - name: test-container
      image: nginx
      volumeMounts:
        - name: secret-volume
          mountPath: /etc/secret-volume
  volumes:
    - name: secret-volume
      secret:
        secretName: test-secret
```

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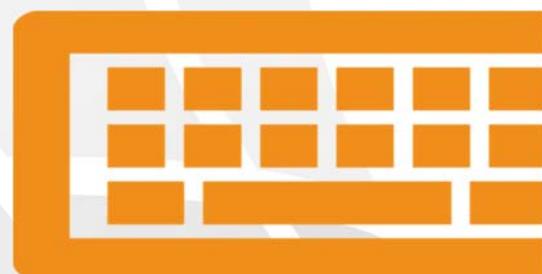
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Lab 06: Using ConfigMaps and Secrets

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-06>

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Module 11: Jobs & CronJobs

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Agenda

- ★ Jobs
- ★ CronJobs
- ★ Lab 07: Running Jobs and CronJobs

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Jobs and Cron Jobs

- A job creates one or more pods and ensures that a specified number of them successfully terminate
- Jobs are useful if you need to perform one-off or batch processing instead of running a continuous service.
- Queue Processing, and Build Jobs are first class candidate for being a Job
- CronJobs can be used to schedule a job to execute in the future or on a regular, recurring basis
- CronJobs mostly being used for maintenance tasks (re-indexing, generate a nightly report, Cleanups, etc..)

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Jobs and Cron Jobs

```
apiVersion: batch/v1
kind: Job
metadata:
  name: pi
spec:
  template:
    spec:
      containers:
        - name: pi
          image: perl
          command: ["perl", "-Mbignum=bpi",
                    "-wle", "print bpi(2000)"]
        restartPolicy: Never
  backoffLimit: 4
```

```
apiVersion: batch/v1beta1
kind: CronJob
metadata:
  name: hello
spec:
  schedule: "*/1 * * * *"
  jobTemplate:
    spec:
      template:
        spec:
          containers:
            - name: hello
              image: busybox
              args:
                - /bin/sh
                - -c
                - date; echo Hello from the Kubernetes cluster
        restartPolicy: OnFailure
```

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Job - Settings

- **backoffLimit:** The number of failures before the job itself is considered failed.
- **completions:** The total number of successful completions desired.
- **parallelism:** How many instances of the pod can be run concurrently.
- **restartPolicy:** Jobs only support a restartPolicy of type Never or OnFailure.

```
apiVersion: batch/v1
kind: Job
metadata:
  name: job-example
spec:
  backoffLimit: 4
  completions: 4
  parallelism: 2
  template:
    spec:
      restartPolicy: Never
<pod-template>
```

CronJob - Settings

- **schedule:** The cron schedule for the job.
- **successfulJobHistoryLimit:** The number of successful jobs to retain.
- **failedJobHistoryLimit:** The number of failed jobs to retain.

```
apiVersion: batch/v1beta1
kind: CronJob
metadata:
  name: cronjob-example
spec:
  schedule: "*/1 * * * *"
  successfulJobsHistoryLimit: 3
  failedJobsHistoryLimit: 1
  jobTemplate:
    spec:
      completions: 4
      parallelism: 2
      template:
        <pod template>
```

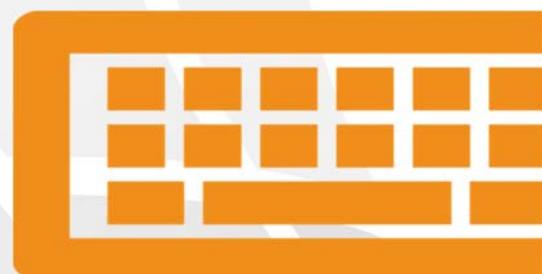
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Lab 07: Running Jobs and CronJobs

Lab



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Module 12: DaemonSets

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Agenda

- ★ DaemonSets
- ★ Lab 08: Running Pods as DaemonSets

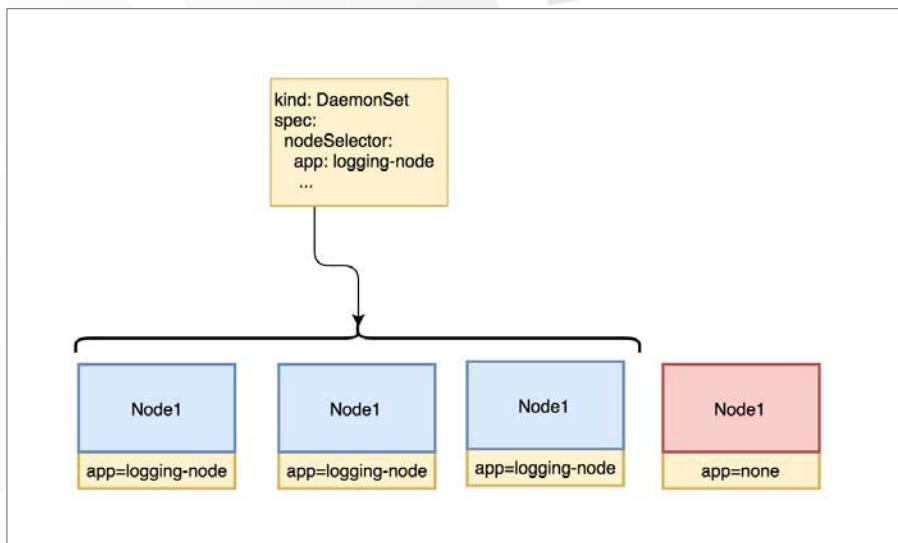
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DaemonSets

- A DaemonSet ensures that all (or some) Nodes run a copy of a Pod
- No more than one instance per node
- Very useful for daemon tools
 - Cluster storage daemon
 - Log collection daemon – fluentd, logstash
 - Monitoring daemon
- Kube-proxy is a DaemonSet

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DaemonSets



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DaemonSets Example

```
apiVersion: extensions/v1beta1
kind: DaemonSet
metadata:
  name: logging
spec:
  template:
    metadata:
      labels:
        app: logging-app
    spec:
      nodeSelector:
        app: logging-node
      containers:
        - name: webserver
          image: nginx
          ports:
            - containerPort: 80
```

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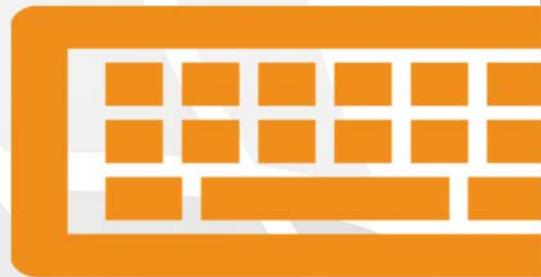
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Lab 08: Running Pods as DaemonSets

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Module 13: Helm Package Manager

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Agenda

- ★ What is Helm?
- ★ Helm Concepts
- ★ Helm Architecture
- ★ Tiller
- ★ Helm CLI
- ★ Using Helm Charts
- ★ Lab 09: Deploying Applications using Helm

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What is Helm?

- Helm is a **Package Manager** for Kubernetes
 - Package multiple K8s resources into a single logical deployment unit
 - But it's not just a Package Manager
- Helm is also a **Deployment Management** for kubernetes
 - Do a repeatable deployment
 - Manage dependencies and multiple configurations
 - Update, rollback and test application deployments

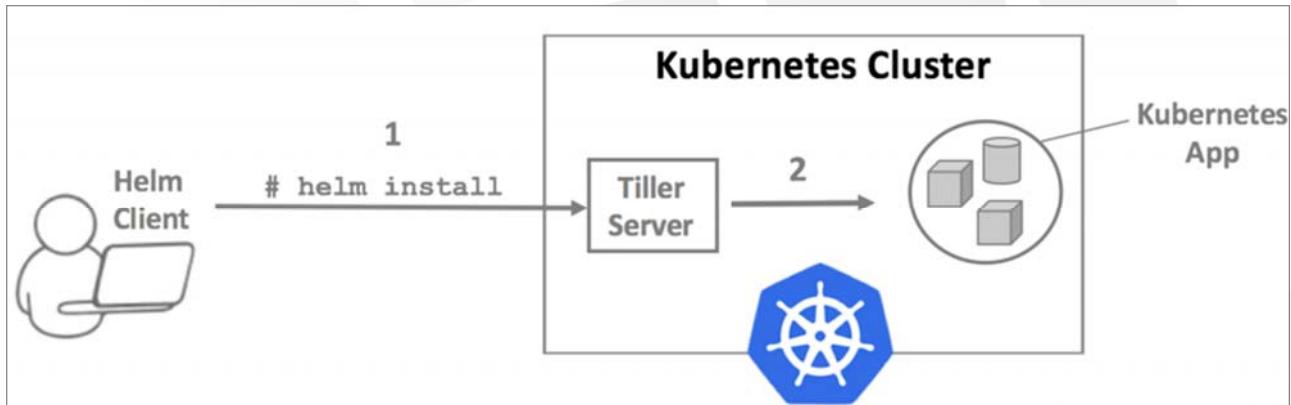
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Helm Concepts

- **Chart:** a package; bundle of Kubernetes resources
- **Release:** a chart instance is loaded into Kubernetes
 - Same chart can be installed several times into the same cluster; each will have its own Release
- **Repository:** a repository of published charts
- **Template:** a K8s configuration file mixed with go/Sprig template

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Helm Architecture



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Tiller

- Tiller is the in-cluster component of Helm.
- It interacts directly with the Kubernetes API server to install, upgrade, query, and remove Kubernetes resources.
- It also stores the objects that represent releases.
- Installing is easy
 - Download and Install Helm locally on your machine
 - run 'helm init' against a Kubernetes cluster
 - Tiller is installed

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Helm CLI

| | |
|----------------------|---|
| helm init | Set up Helm on the cluster |
| helm install/upgrade | Install or upgrade a chart |
| helm get/status/list | Find out information about running charts |
| helm search | Search charts in a repository |
| helm create | Create a new chart |
| helm template | Render chart templates locally |

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Using Helm Charts

- Installing Helm on a cluster is easy
 - \$ helm init
- And then, start deploying charts:

```
helm install --name dev-db --set mongodbRootPassword=rootpass,mongodbUsername=dev-user  
,mongodbPassword=RzTLPvBxLK526KM5E6eGuUHFpYFAGPxwWg==,mongodbDatabase=dev,  
service.type=LoadBalancer stable/mongodb
```

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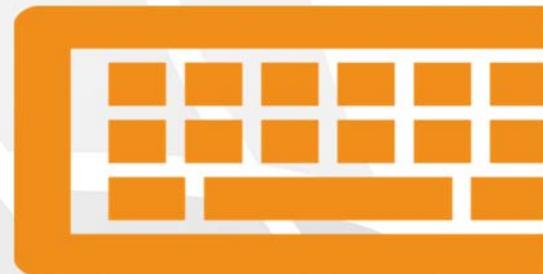
Questions



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Lab 09: Deploying Prometheus using Helm

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-09>

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Module 14: Managed Offerings

Kubernetes Workshop



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Agenda

- ★ Local Development Kubernetes
- ★ Kubernetes on Google Cloud Platform (GKE)
- ★ Kubernetes on Amazon Web Services (EKS)
- ★ Kubernetes on Microsoft Azure (AKS)
- ★ Kubernetes On-Premise using Kubeadm and Kubespray
- ★ Other Kubernetes Distributions

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Local Development Kubernetes

- **Minikube**
 - Minikube is a tool that makes it easy to run Kubernetes locally.
 - Minikube runs a single-node Kubernetes cluster inside a VM on your laptop for users looking to try out Kubernetes or develop with it day-to-day.
- **Docker for Desktop (with Kubernetes Inside)**
 - Easiest method to create local Kubernetes cluster
 - Just check the box next to “Enable Kubernetes” and you’ll have a single node cluster

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Azure Kubernetes Service (AKS)

- Fully managed Kubernetes cluster
- Set up master and nodes
- One-Click scale and upgrade operations
- Built-in secured dashboard
- Support Block and CIFS volumes on Azure
- Support for GPU workloads
- Fully integrated with Azure Monitor and Log Analytics
- Pay only for the worker nodes (no fee for the masters)
- Also, fully integrated with Azure DevOps



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Amazon Elastic Kubernetes Service (EKS)

- Fully managed Kubernetes cluster
- Set up master without the nodes
- There's a nice tool by weave - 'eksctl' that help with that
- One-Click scale and upgrade operations
- Support EBS volumes on AWS
- Support for GPU workloads
- Fully integrated with Cloud Watch
- 150\$ a month per cluster (not including the nodes)



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Google Kubernetes Service (GKE)

- Fully managed Kubernetes cluster
- Set up master and nodes
- One-Click scale and upgrade operations
- Support GCE Persistent Disks volumes on GCP
- Support for GPU workloads
- Support Preemptible machines out-of-the-box
- Fully integrated with Stackdriver
- Pay only for the worker nodes (no fee for the masters)
- The fastest deployment and scale



Google Cloud Platform



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Kubernetes On Premise

- On prem is much harder
 - Consider Provisioning, Load balancing, upgrades, etc
- Two leading approaches:
 - Kubeadm
 - The best way to install and operate vanilla Kubernetes On-Prem
 - HA is always a challenge
 - Kubespray
 - Ansible and 'old' provisioning approach. still very popular.

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Module 15: Advanced Scheduling

Kubernetes Workshop



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Agenda

- ★ Requests & Limits
- ★ Taints & Tolerations
- ★ Affinity & Anti-Affinity

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Requests & Limits

- Limits and requests for CPU resources are measured in cpu units. One cpu, in Kubernetes, is equivalent to:
 - 1 AWS/GCP/Azure/IBM vCPU
 - 1 Hyperthread on a bare-metal Intel processor with Hyperthreading
- Limits and requests for Memory resources are measured in bytes
 - E, P, T, G, M, K or Ei, Pi, Ti, Gi, Mi, Ki
 - 128974848, 129e6, 129M, 123Mi are roughly the same

```
apiVersion: v1
kind: Pod
metadata:
  name: frontend
spec:
  containers:
    - name: db
      image: mysql
      env:
        - name: MYSQL_ROOT_PASSWORD
          value: "password"
      resources:
        requests:
          memory: "64Mi"
          cpu: "250m"
        limits:
          memory: "128Mi"
          cpu: "500m"
    - name: wp
      image: wordpress
      resources:
        requests:
          memory: "64Mi"
          cpu: "250m"
        limits:
          memory: "128Mi"
          cpu: "500m"
```

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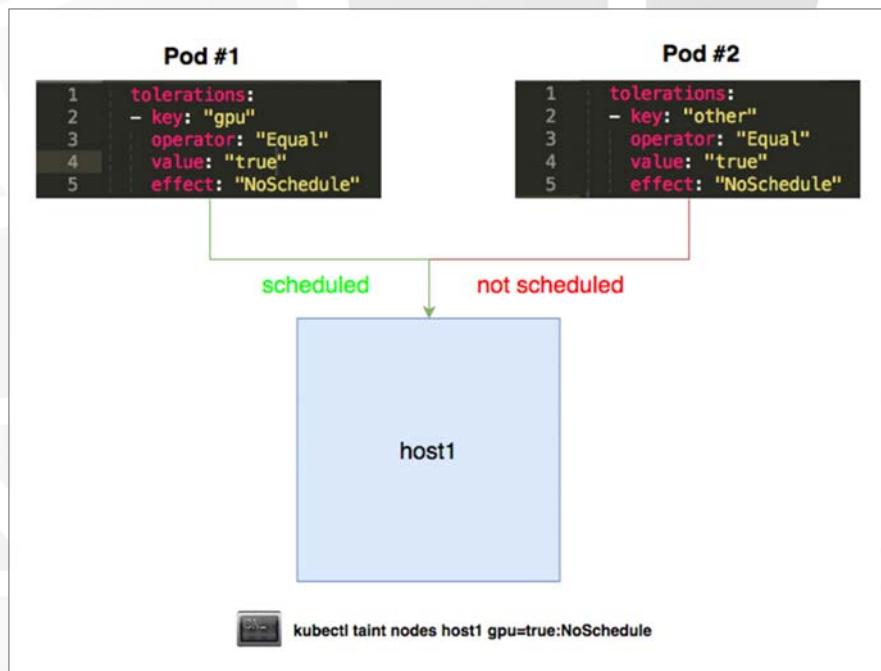
Taints & Tolerations

- Allows users to mark a node (taint the node) so that no pods can be scheduled to it, unless a pod explicitly tolerates the taint.
- The format of a taint is `<key>=<value>:<effect>`
- Effects can be `NoSchedule` or `No Execute`

```
apiVersion: v1
kind: Pod
metadata:
  name: pod-2
labels:
  security: s1
spec:
  containers:
    - name: bear
      image: supergiantkirk/animals:bear
  tolerations:
    - key: "key1"
      operator: "Equal"
      value: "value1"
      effect: "NoExecute"
      tolerationSeconds: 3600
```

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Example



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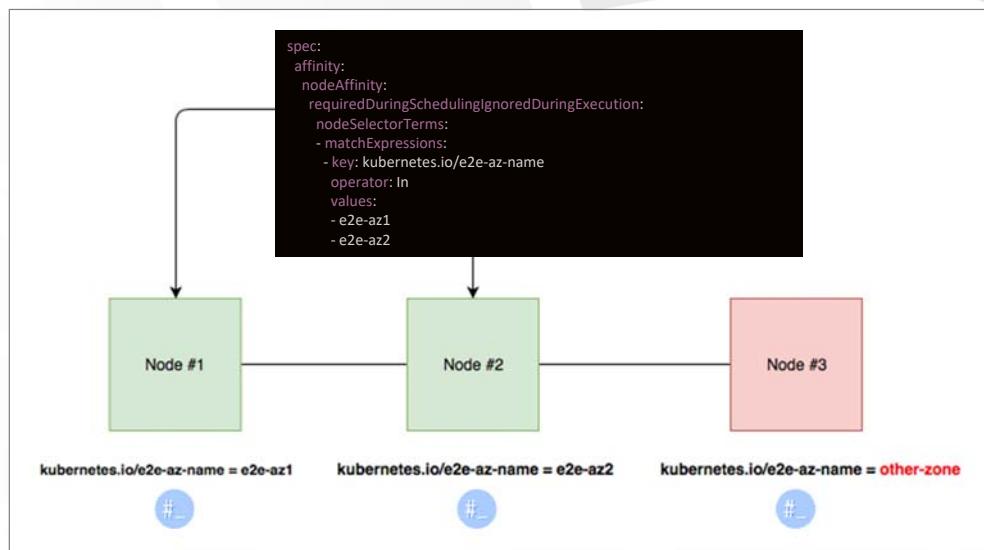
Affinity & Anti-Affinity

- Pod affinity and anti-affinity allows placing pods to nodes as a function of the labels of other pods.

```
apiVersion: v1
kind: Pod
metadata:
  name: with-pod-affinity
spec:
  affinity:
    podAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        - labelSelector:
            matchExpressions:
              - key: app
                operator: In
                values:
                  - web-store
      topologyKey: kubernetes.io/hostname
  containers:
    - name: with-pod-affinity
      image: nginx:1.12-alpine
```

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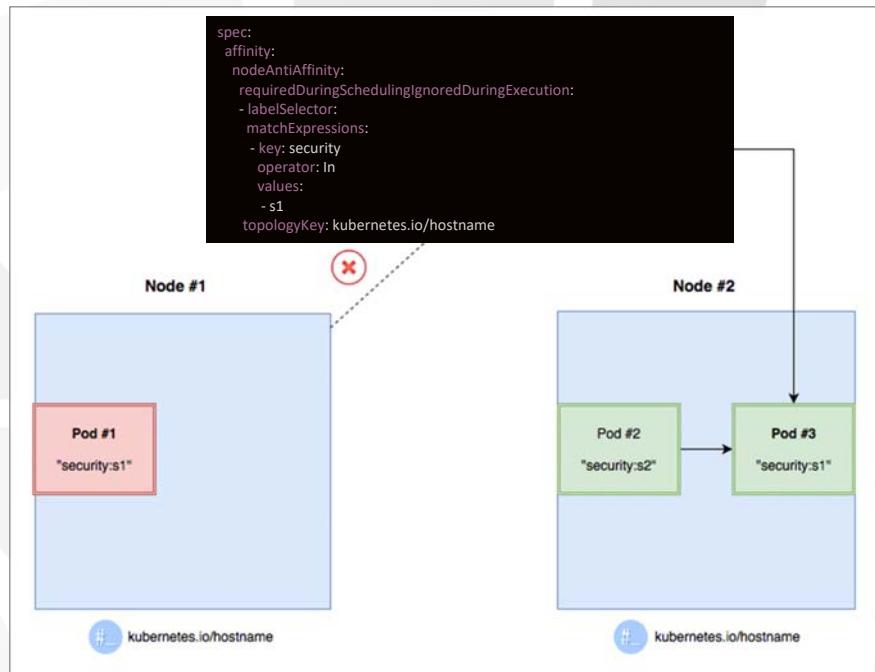
Affinity



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Anti-Affinity

The second Pod won't be scheduled to any node that has a Pod with a label "security:s1"



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Module 16: Autoscaling

Kubernetes Workshop



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Agenda

- ★ Scaling pods horizontally
- ★ Scaling pods vertically
- ★ Scaling cluster horizontally
- ★ Lab 10: Configuring Autoscaling

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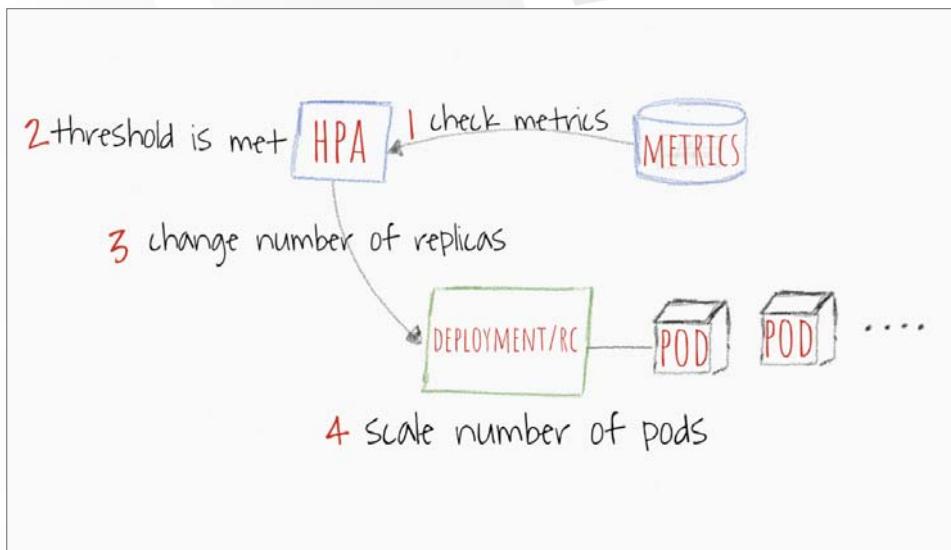
Horizontal Pod Autoscaler

- Horizontal Pod Autoscaler automatically scales the number of pods in a replication controller, deployment or replica set based on observed CPU utilization
- or, with beta support, on some other, application-provided metrics
- Uses Kubernetes Metrics Server to gather stats

```
kubectl autoscale deployment nginx --cpu-percent=50 --min=1 --max=10
```

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Horizontal Pod Autoscaler



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Horizontal Pod Autoscaler

```
apiVersion: autoscaling/v2beta1
kind: HorizontalPodAutoscaler
metadata:
  name: php-apache
  namespace: default
spec:
  scaleTargetRef:
    apiVersion: apps/v1
    kind: Deployment
    name: php-apache
  minReplicas: 1
  maxReplicas: 10
  metrics:
  - type: Resource
    resource:
      name: cpu
    target:
      type: AverageUtilization
      averageUtilization: 50
  - type: Pods
    pods:
      metric:
        name: packets-per-second
    targetAverageValue: 1k
```

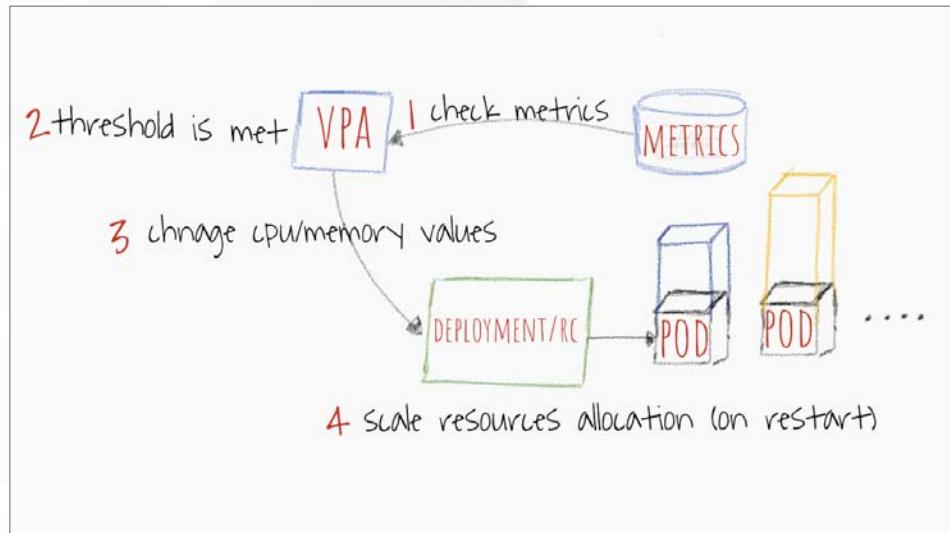
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Vertical Pod Autoscaler

- Vertical Pod Autoscaler (VPA) frees the users from necessity of setting up-to-date resource requests for the containers in their pods.
- When configured, it will set the requests automatically based on usage and thus allow proper scheduling onto nodes so that appropriate resource amount is available for each pod.
- It can both down-scale pods that are over-requesting resources, and also up-scale pods that are under-requesting resources based on their usage over time.

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Vertical Pod Autoscaler



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Vertical Pod Autoscaler

```
apiVersion: "autoscaling.k8s.io/v1beta2"
kind: VerticalPodAutoscaler
metadata:
  name: hamster-vpa
spec:
  targetRef:
    apiVersion: "extensions/v1beta1"
    kind: Deployment
    name: hamster
```

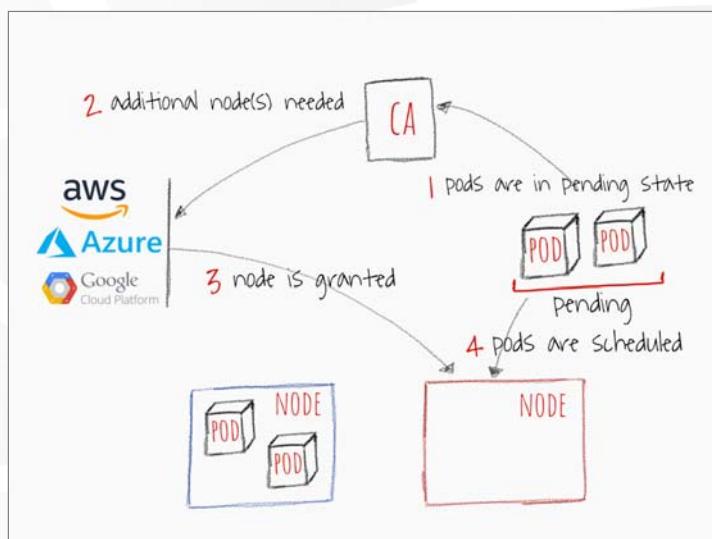
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Cluster Auto-Scaler

- Cluster Autoscaler is a tool that automatically adjusts the size of the Kubernetes cluster when one of the following conditions is true:
 - there are pods that failed to run in the cluster due to insufficient resources
 - there are nodes in the cluster that have been underutilized for an extended period of time and their pods can be placed on other existing nodes.
- Supported on GCP, AWS, Azure, Alibaba Cloud

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Cluster Auto-Scaler



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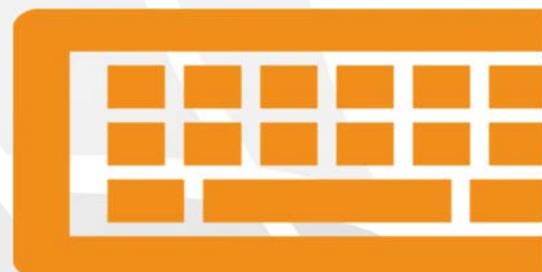
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Lab 10: Configuring Autoscaling

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-10>

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Module 17: Kubernetes Storage

Kubernetes Workshop



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Agenda

- ★ Introduction
- ★ Volumes
- ★ PersistentVolumes
- ★ PersistentVolumeClaims
- ★ StorageClasses

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Storage

- Pods by themselves are useful, but many workloads require exchanging data between containers, or persisting some form of data.
- For this we have:
 - Volumes
 - PersistentVolumes
 - PersistentVolumeClaims
 - StorageClasses

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Volumes

- Storage that is tied to the Pod's Lifecycle
- A pod can have one or more types of volumes attached to it.
- Can be consumed by any of the containers within the pod.
- Survive Pod restarts; however their durability beyond that is dependent on the Volume Type.

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Volume Types

- awsElasticBlockStore
- azureDisk
- azureFile
- cephfs
- configMap
- csi
- downwardAPI
- emptyDir
- fc (fibre channel)
- flocker
- gcePersistentDisk
- gitRepo
- glusterfs
- hostPath
- iscsi
- local
- nfs
- persistentVolumeClaim
- projected
- portworxVolume
- quobyte
- rbd
- scaleIO
- secret
- storageos
- vsphereVolume

 Persistent Volume Supported

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Volumes

- **volumes:** A list of volume objects to be attached to the Pod. Every object within the list must have it's own unique **name**.
- **volumeMounts:** A container specific list referencing the Pod volumes by **name**, along with their desired **mountPath**.

```
apiVersion: v1
kind: Pod
metadata:
  name: volume-example
spec:
  containers:
    - name: nginx
      image: nginx:stable-alpine
      volumeMounts:
        - name: html
          mountPath: /usr/share/nginx/html
          readOnly: true
    - name: content
      image: alpine:latest
      command: ["/bin/sh", "-c"]
      args:
        - while true; do
            date >> /html/index.html;
            sleep 5;
          done
      volumeMounts:
        - name: html
          mountPath: /html
  volumes:
    - name: html
      emptyDir: {}
```

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Persistent Volumes

- A **PersistentVolume** (PV) represents a storage resource.
- PVs are a **cluster wide resource** linked to a backing storage provider: NFS, GCEPersistentDisk, EBS etc.
- Generally provisioned by an administrator
- Their lifecycle is handled independently from a pod
- **CANNOT** be attached to a Pod directly. Relies on a **PersistentVolumeClaim**

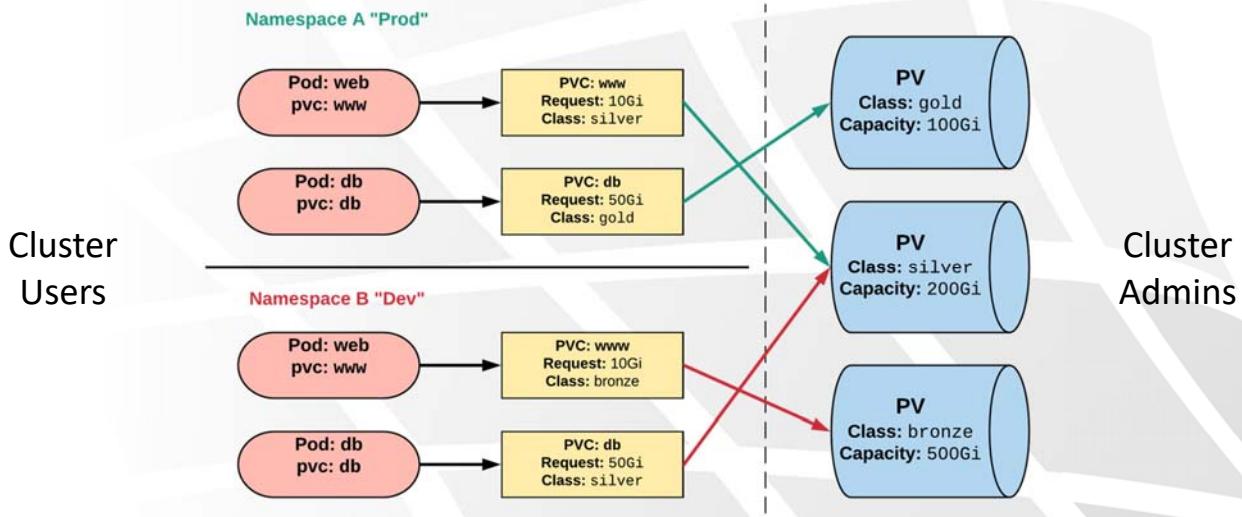
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PersistentVolumeClaims

- A **PersistentVolumeClaim** (PVC) is a **namespaced** request for storage.
- Satisfies a set of requirements instead of mapping to a storage resource directly.
- Ensures that an application's 'claim' for storage is portable across numerous backends or providers.

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Persistent Volumes and Claims



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PersistentVolume

- capacity.storage:** The total amount of available storage.
- volumeMode:** The type of volume, this can be either **Filesystem** or **Block**.
- accessModes:** A list of the supported methods of accessing the volume.
Options include:
 - ReadWriteOnce**
 - ReadOnlyMany**
 - ReadWriteMany**

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: nfsserver
spec:
  capacity:
    storage: 50Gi
  volumeMode: Filesystem
  accessModes:
    - ReadWriteOnce
    - ReadWriteMany
  persistentVolumeReclaimPolicy: Delete
  storageClassName: slow
  mountOptions:
    - hard
    - nfsvers=4.1
  nfs:
    path: /exports
    server: 172.22.0.42
```

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PersistentVolume

- **persistentVolumeReclaimPolicy:** The behaviour for PVC's that have been deleted. Options include:
 - **Retain** - manual clean-up
 - **Delete** - storage asset deleted by provider.
- **storageClassName:** Optional name of the storage class that PVC's can reference. If provided, **ONLY** PVC's referencing the name consume use it.
- **mountOptions:** Optional mount options for the PV.

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: nfsserver
spec:
  capacity:
    storage: 50Gi
  volumeMode: Filesystem
  accessModes:
    - ReadWriteOnce
    - ReadWriteMany
  persistentVolumeReclaimPolicy: Delete
  storageClassName: slow
  mountOptions:
    - hard
    - nfsvers=4.1
  nfs:
    path: /exports
    server: 172.22.0.42
```

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PersistentVolumeClaim

- **accessModes:** The selected method of accessing the storage. This **MUST** be a subset of what is defined on the target PV or Storage Class.
 - **ReadWriteOnce**
 - **ReadOnlyMany**
 - **ReadWriteMany**
- **resources.requests.storage:** The desired amount of storage for the claim
- **storageClassName:** The name of the desired Storage Class

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: pvc-sc-example
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
  storageClassName: slow
```

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PVs and PVCs with Selectors

```
kind: PersistentVolume
apiVersion: v1
metadata:
  name: pv-selector-example
  labels:
    type: hostpath
spec:
  capacity:
    storage: 2Gi
  accessModes:
    - ReadWriteMany
  hostPath:
    path: "/mnt/data"
```

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: pvc-selector-example
spec:
  accessModes:
    - ReadWriteMany
  resources:
    requests:
      storage: 1Gi
  selector:
    matchLabels:
      type: hostpath
```

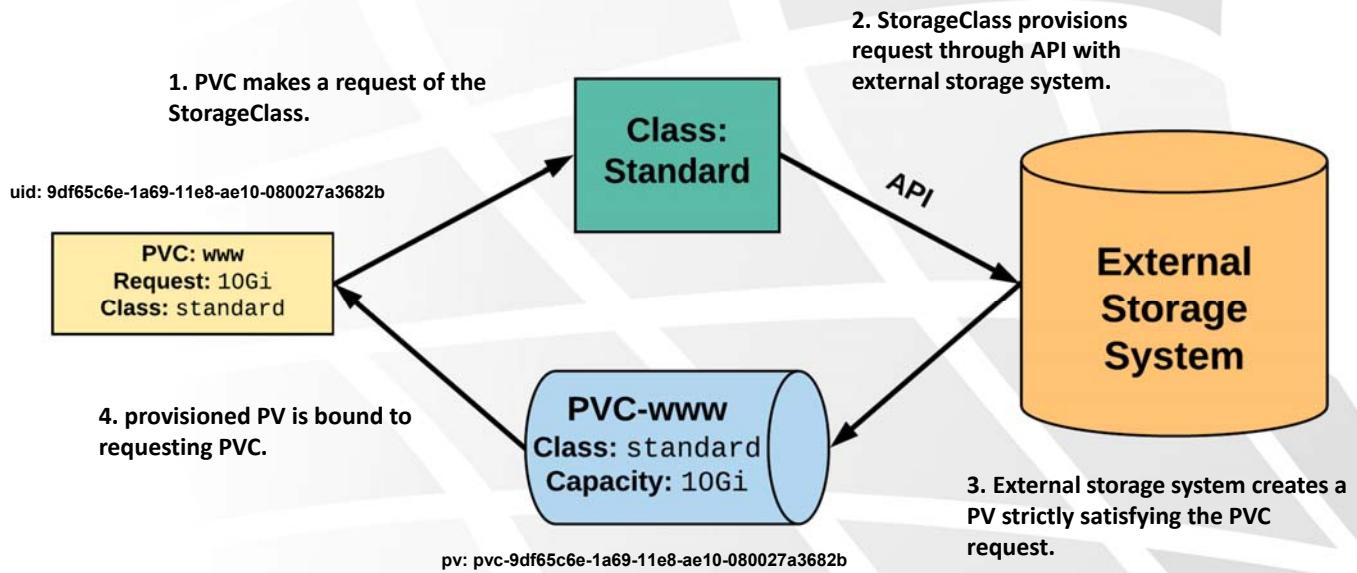
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StorageClass

- Storage classes are an abstraction on top of an external storage resource (PV)
- Work hand-in-hand with the external storage system to enable **dynamic provisioning** of storage
- Eliminates the need for the cluster admin to pre-provision a PV

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StorageClass



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StorageClass

- provisioner:** Defines the '*driver*' to be used for provisioning of the external storage.
- parameters:** A hash of the various configuration parameters for the provisioner.
- reclaimPolicy:** The behaviour for the backing storage when the PVC is deleted.
 - Retain** - manual clean-up
 - Delete** - storage asset deleted by provider

```
● ○ ●  
kind: StorageClass  
apiVersion: storage.k8s.io/v1  
metadata:  
  name: standard  
  provisioner: kubernetes.io/gce-pd  
parameters:  
  type: pd-standard  
  zones: us-central1-a, us-central1-b  
reclaimPolicy: Delete
```

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Available StorageClasses

- [AWSElasticBlockStore](#)
- [AzureFile](#)
- [AzureDisk](#)
- CephFS
- [Cinder](#)
- FC
- [Flocker](#)
- [GCEPersistentDisk](#)
- Glusterfs
- iSCSI
- [Quobyte](#)
- NFS
- [RBD](#)
- [VsphereVolume](#)
- [PortworxVolume](#)
- [ScaleIO](#)
- [StorageOS](#)
- Local



Internal Provisioner

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Questions



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Module 18: StatefulSets

Kubernetes Workshop



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Agenda

- ★ StatefulSets
- ★ Lab 11: Working with StatefulSets

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StatefulSets

- StatefulSet is the workload API object used to manage stateful applications
- Manages the deployment and scaling of a set of Pods , and provides guarantees about the ordering and uniqueness of these Pods.
- StatefulSets are valuable for applications that require one or more of the following.
 - Stable, unique network identifiers.
 - Stable, persistent storage.
 - Ordered, graceful deployment and scaling.
 - Ordered, automated rolling updates.

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StatefulSets

```
apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: web
spec:
  selector:
    matchLabels:
      app: nginx # has to match .spec.template.metadata.labels
  serviceName: "nginx"
  replicas: 3 # by default is 1
  template:
    metadata:
      labels:
        app: nginx # has to match .spec.selector.matchLabels
    spec:
      terminationGracePeriodSeconds: 10
      containers:
        - name: nginx
          image: k8s.gcr.io/nginx-slim:0.8
          ports:
            - containerPort: 80
              name: web
            volumeMounts:
              - name: www
                mountPath: /usr/share/nginx/html
      volumeClaimTemplates:
        - metadata:
            name: www
          spec:
            accessModes: [ "ReadWriteOnce" ]
            storageClassName: "my-storage-class"
            resources:
              requests:
                storage: 1Gi
```

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Deployment and Scaling Guarantees

- For a StatefulSet with N replicas, when Pods are being deployed, they are created sequentially, in order from {0..N-1}.
- When Pods are being deleted, they are terminated in reverse order, from {N-1..0}.
- Before a scaling operation is applied to a Pod, all of its predecessors must be Running and Ready.
- Before a Pod is terminated, all of its successors must be completely shutdown.

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Updating Strategies

- **OnDelete:** does not automatically delete and recreate Pods when the object's configuration is changed. Instead, you must manually delete the old Pods to cause the controller to create updated Pods.
- **RollingUpdate:** automatically deletes and recreates Pods when the object's configuration is changed. New Pods must be in Running and Ready states before their predecessors are deleted. With this strategy, changing the Pod specification automatically triggers a rollout. This is the default update strategy for StatefulSets.

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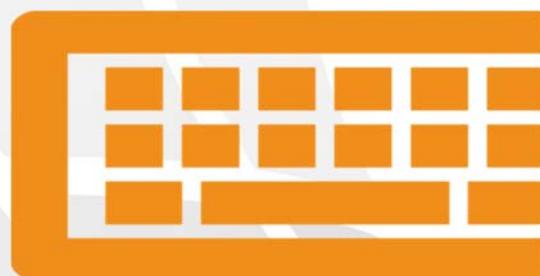
Questions



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Lab 11: Working with StatefulSets

Lab



<https://gitlab.com/sela-kubernetes-workshop/lab-11>

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Module 19: Microservices Architecture

Kubernetes Workshop



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Agenda

- ★ Microservices Architecture

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Microservices Architecture



Microservices architecture is a distinctive method of developing software systems in a modular way.

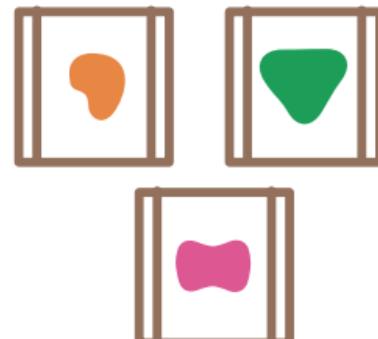
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Monolith



Puts all its functionality into a single service

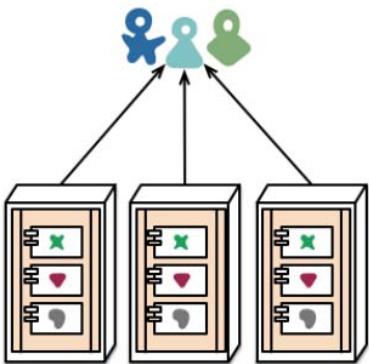
Microservices



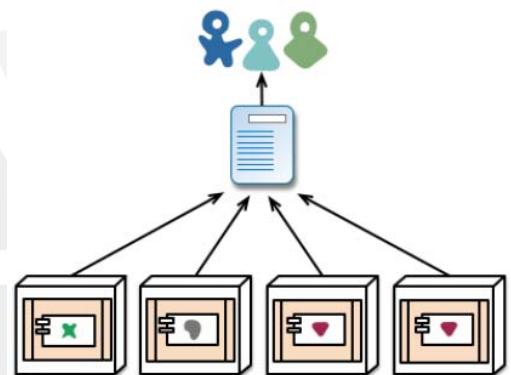
Puts each element of functionality into a separate service

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Monolith



Microservices

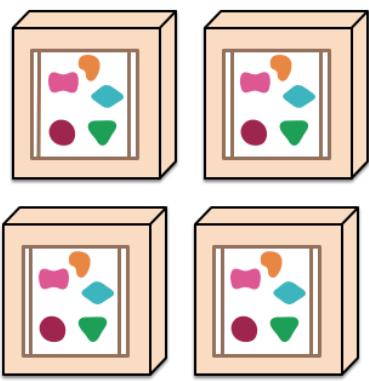


Multiple modules in the same process

Modules running in different processes

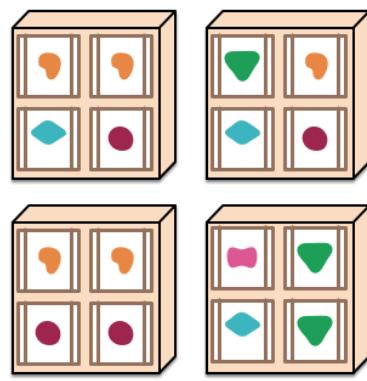
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Monolith



Scale by replicating the monolith on multiple servers

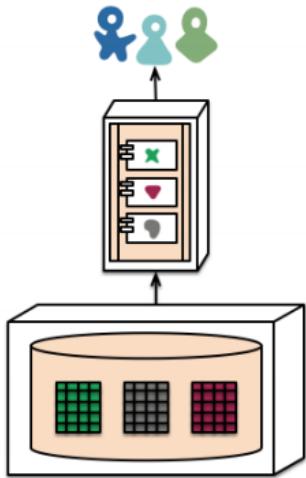
Microservices



Scale by distributing the services across servers (by demand)

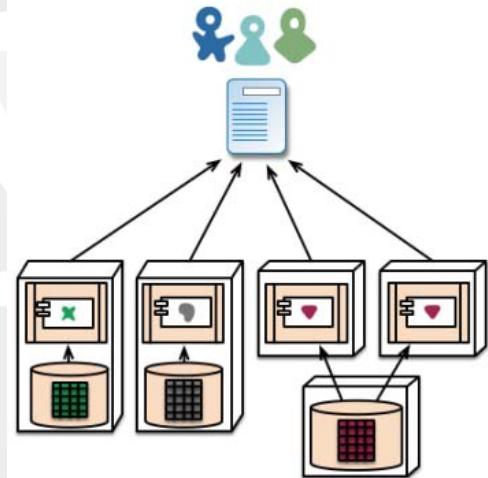
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Monolith



Single Database

Microservices



Applications Database

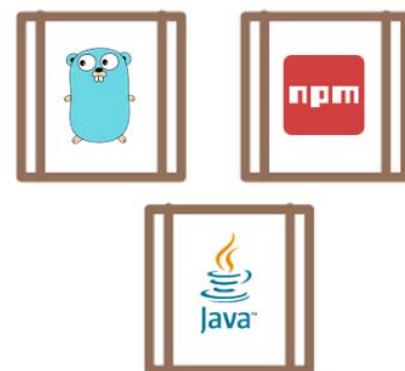
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Monolith



Single language/technology

Microservices



Multiple languages and technologies

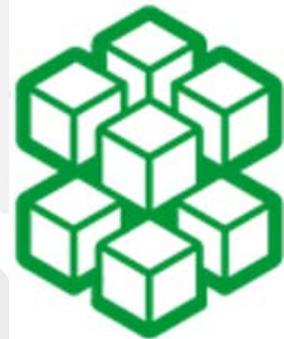
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Monolith



Do everything

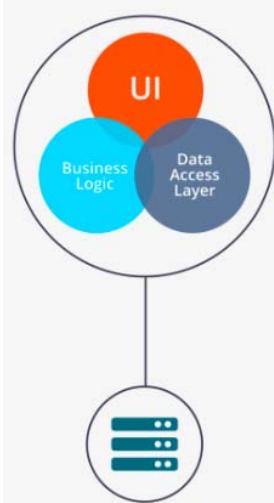
Microservices



Do one thing well

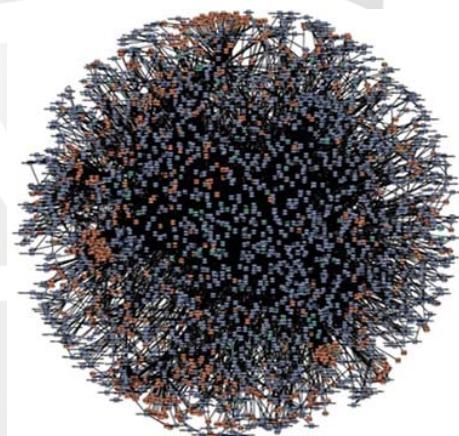
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Monolith



Simple Application Architecture

Microservices



Cognitive Complexity

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Monolith



Single (long) CI/CD pipeline

Microservices



Multiple (short) CI/CD pipelines

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Monolith

(Advantages)

- Simple to develop
- Simple to deploy
- Simple to scale
- Data consistency
- Only one app to monitor
- Only one app to operate
- Modules communicate by memory (fast)

Microservices

(Advantages)

- Deployability
- Reliability
- Availability
- Scalability
- Modifiability
- Decentralized data
- Freedom in technology
- Management

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Monolith (Drawbacks)

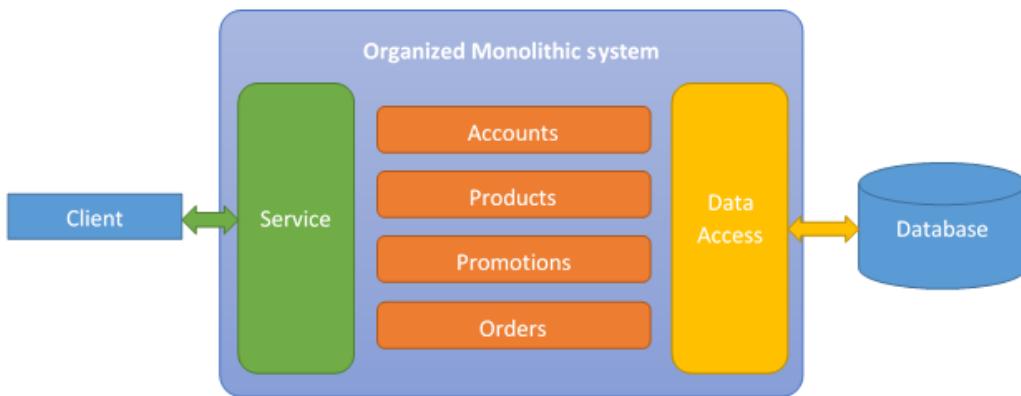
- Large codebase intimidate developers
- Difficult development scaling
- Modularity breaks over time
- Heavy CI/CD pipelines
- Small changes require the build/deploy of the entire app
- Long term technology stacks
- Difficult feature rollbacks

Microservices (Drawbacks)

- Complexity
- Operations overhead
- Require closely monitoring
- Data consistency
- Testing is a lot more difficult
- Debug challenges
- Inter-service communications
- Failure tolerant

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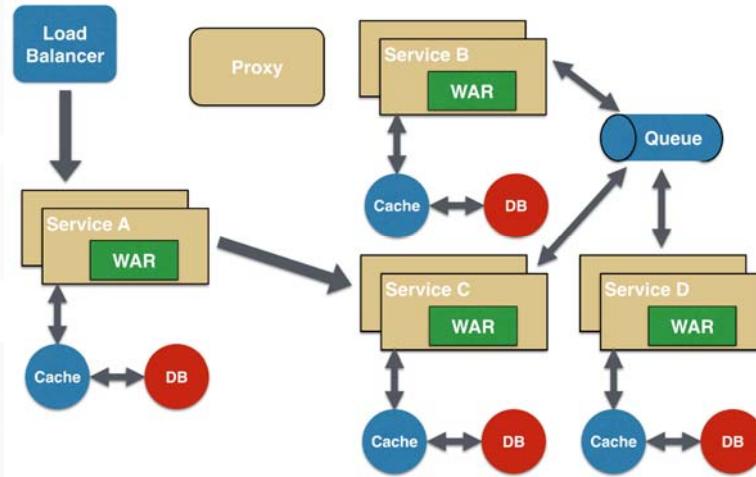
Monolith architecture is NOT an anti-pattern



But, it will not be the best solution if you grow enough

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Microservices Architecture is Great!

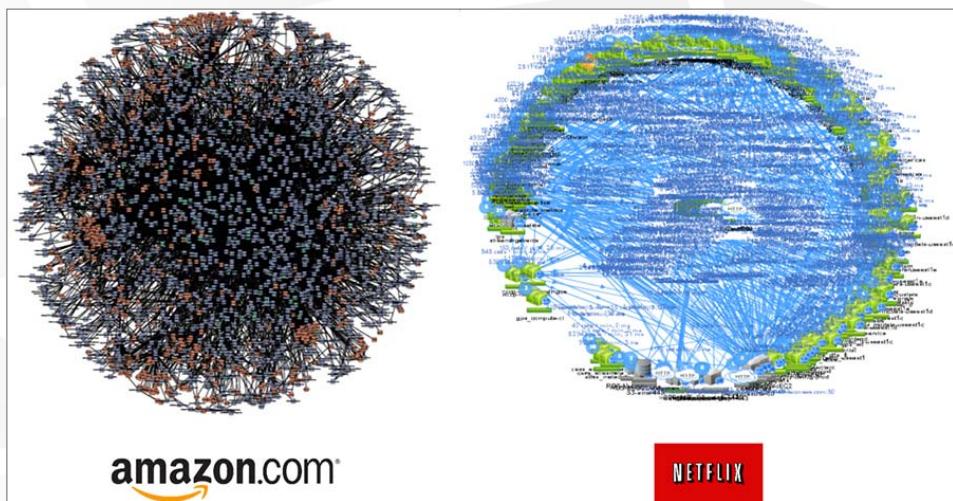


But, microservices without the right DevOps = **CHAOS**

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Who is using Microservices?

- Netflix
- eBay
- Amazon
- Twitter
- PayPal
- Uber
- Groupon



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With simplicity, comes complexity

- How to deploy or update services with zero-downtime?
- How to A/B test the application?
- How to handle network failures?
- How to manage security between services?
- How to handle timeouts? Retries?
- How to rate limit? Add quotas?
- Telemetry, Logging, Monitoring?
- What about Polyglot, Legacy systems?
- Different Tech Stacks

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Questions



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