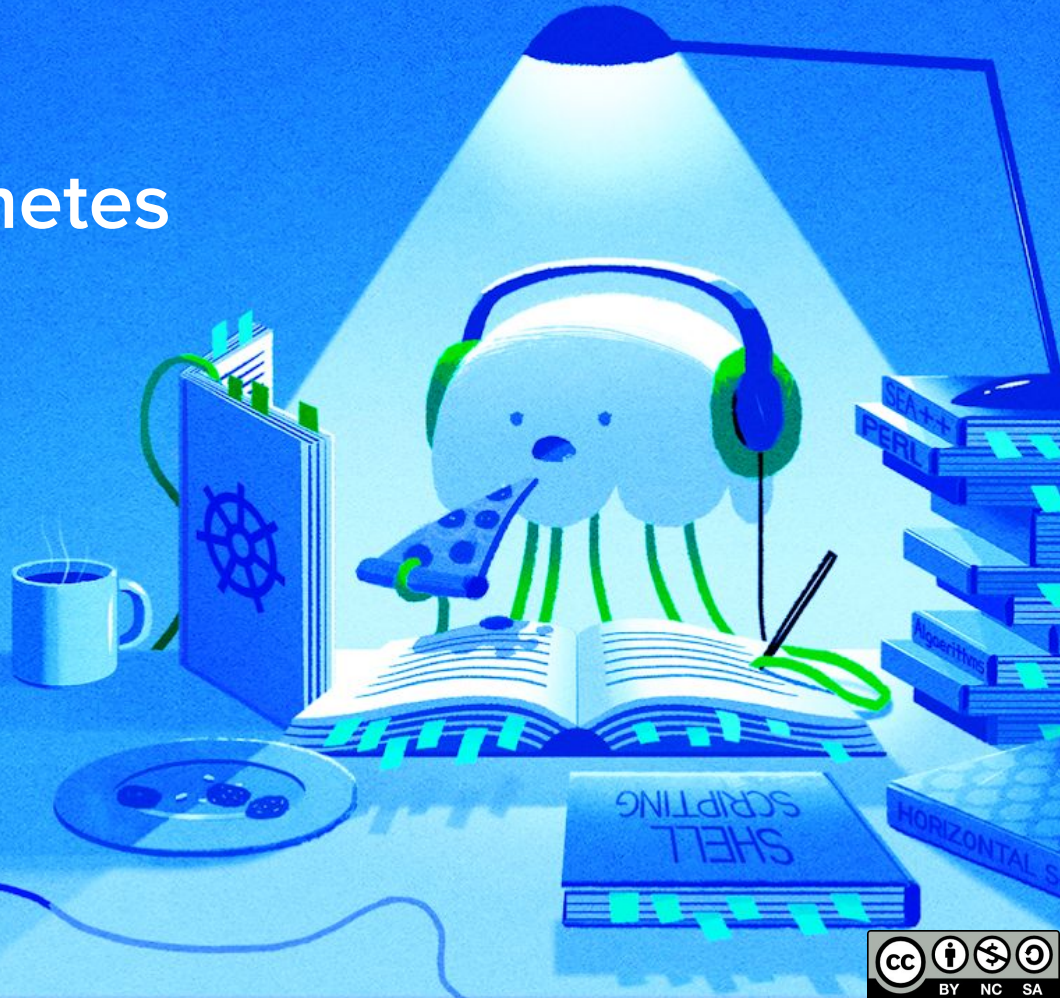
Getting Started with Containers and Kubernetes



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BY NC SA

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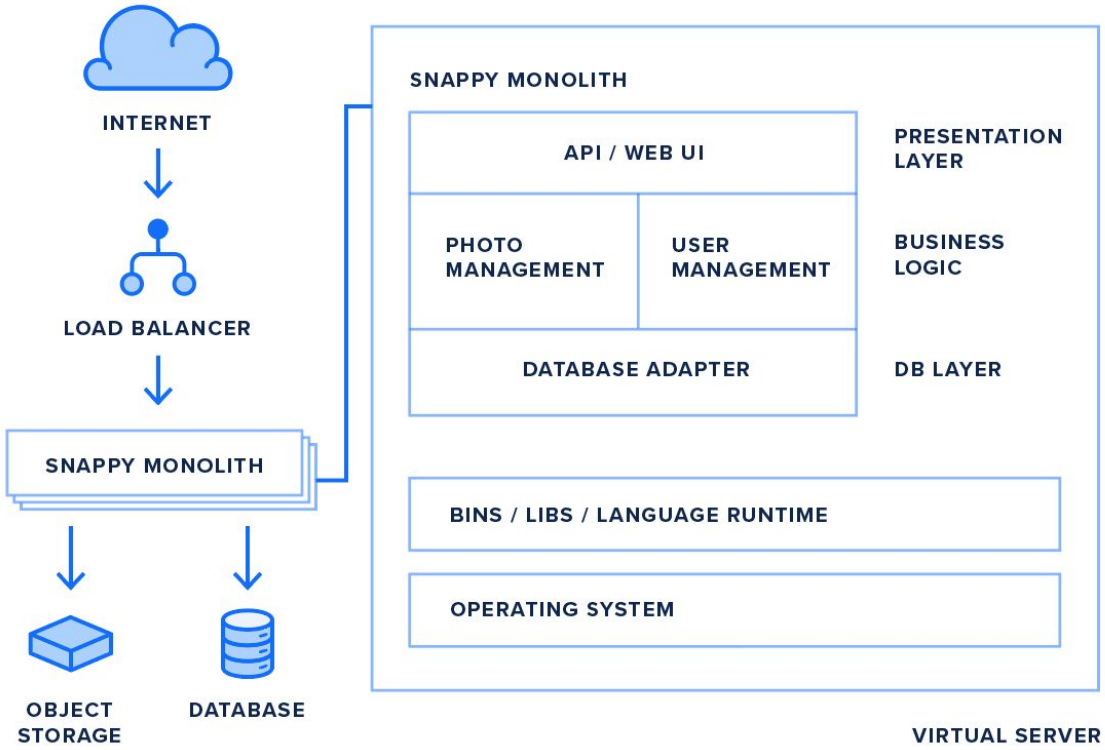
Webinar Goals

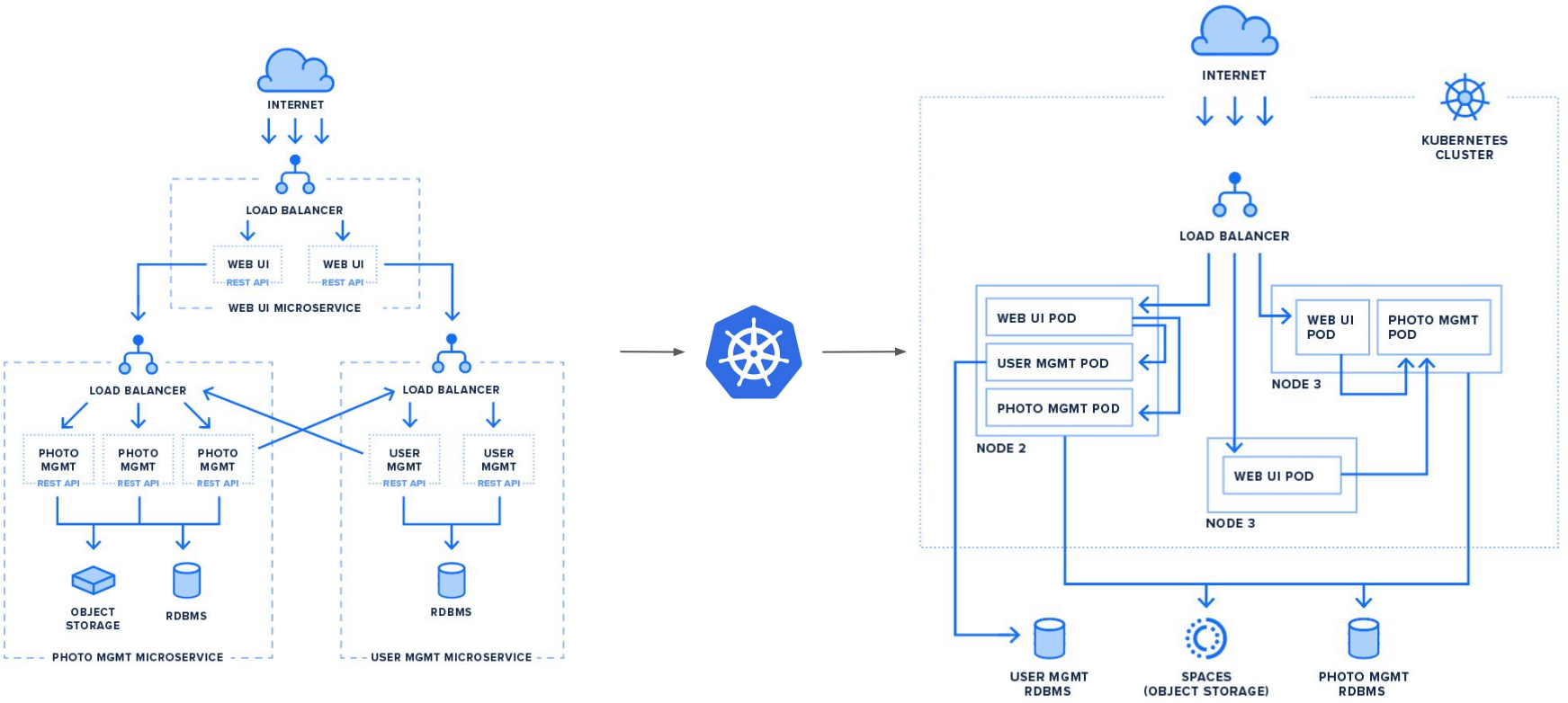
- Revisit trends in app design and deployment
- Get (more) familiar with containers
- Build a Docker container image for a demo Flask app
- Learn about Kubernetes architecture and objects
- Create and access a Kubernetes cluster
- Deploy Flask app to Kubernetes cluster
- By the end, have a load-balanced Flask app

App Modernization & Microservices

The Monolith



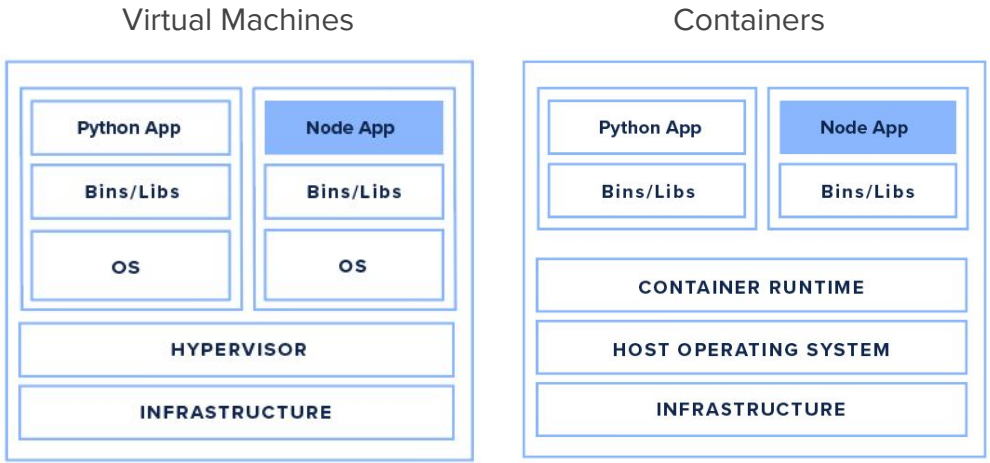
Breaking the Monolith



Revisiting Containers

What is a Container?

- VMs vs. Containers
- Container features
  - Lightweight
  - Portable
  - Isolated



Container Ecosystem

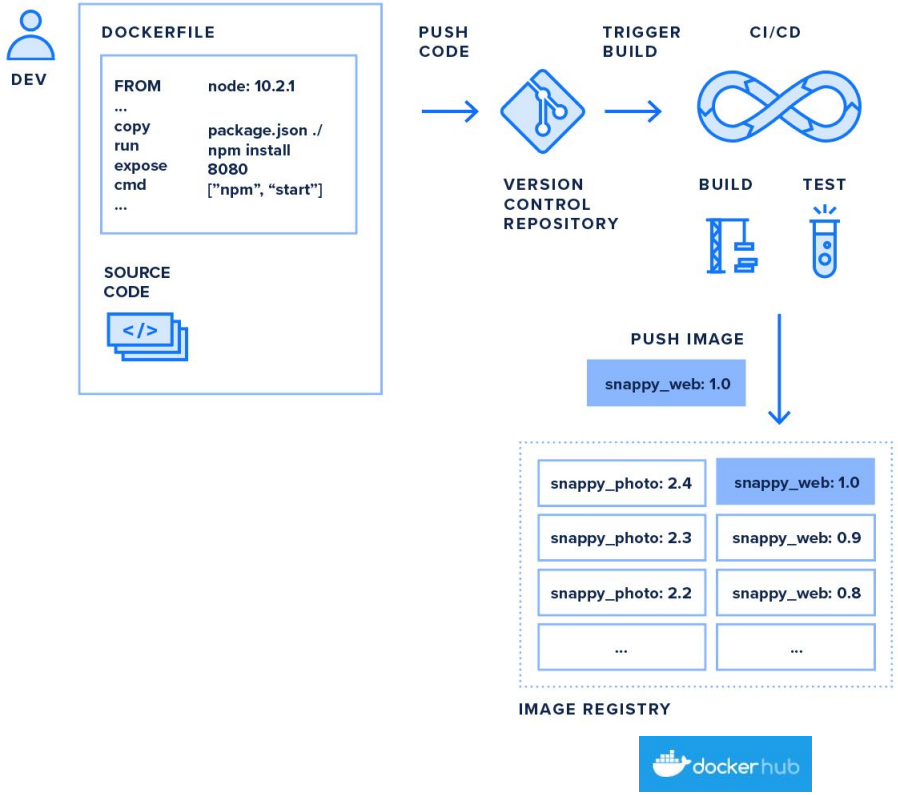
- Container Images
- Containers
- Container Runtime

docker

cri-o

containerd

- Container Registries



Example: Containerized Flask App

App Code (`cat app/app.py`**)**

```
from flask import Flask
app = Flask(__name__)

@app.route('/')
def hello_world():
    return 'Hello, World!'

if __name__ == "__main__":
    app.run(debug=True,host='0.0.0.0')
```

Example: Containerized Flask App

Dockerfile (`cat app/Dockerfile`**)**

```
FROM python:3-alpine

WORKDIR /app

COPY requirements.txt .
RUN pip install -r requirements.txt

COPY . .

EXPOSE 5000

CMD ["python", "app.py"]
```

- Build & tag image
  - `docker build -t flask:v0 .`
  - `docker images`
- Run container / test
  - `docker run -p 5000:5000 flask:v0`
  - `docker ps`
  - `curl http://localhost:5000`

Container Clusters

Container Clusters

- What if we have 10s, 100s, 1000s of running containers on multiple VMs?
- How to deploy, scale, restart, manage all of these containers?
- What problems do they solve?
  - Management
    - Metrics
    - Health checks
    - Security
  - Abstraction of hardware
  - Networking
  - Scheduling
  - Scaling
  - Deployment
    - Rollbacks
    - Zero-downtime / blue-green
  - Service discovery

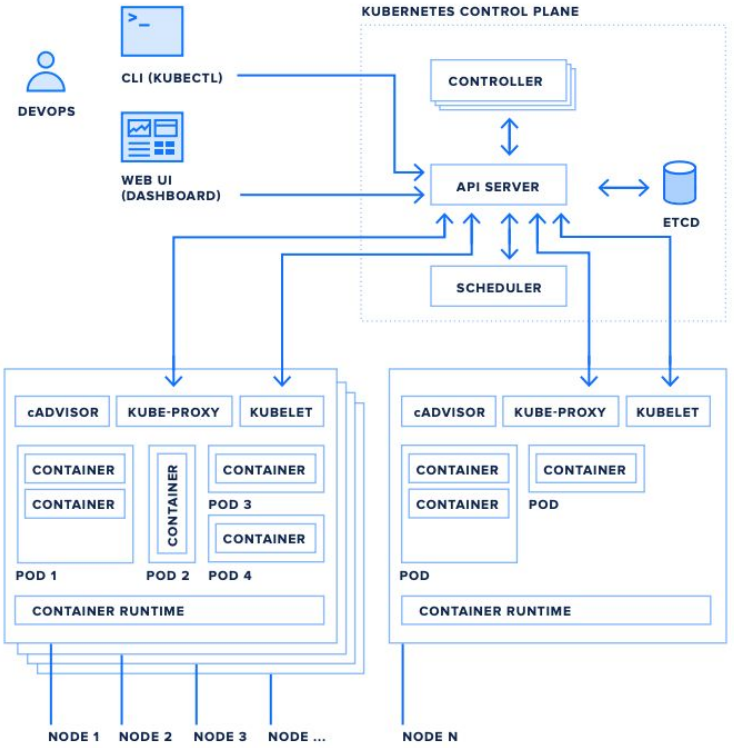
A Brief Kubernetes History

- “K8s”
- Evolved out of Borg (Google’s internal container cluster)
- Open sourced ~2014
- Grew in popularity, open source velocity increased
- Now the most popular container cluster (most cloud platforms have some sort of managed K8s offering)
- Features added regularly and frequently
- Cloud Native / CNCF - Kubernetes, Prometheus, Fluentd

CLOUD NATIVE
COMPUTING FOUNDATION

Kubernetes Architecture

- Client-Server architecture
  - Server: Control Plane
  - Clients: Nodes



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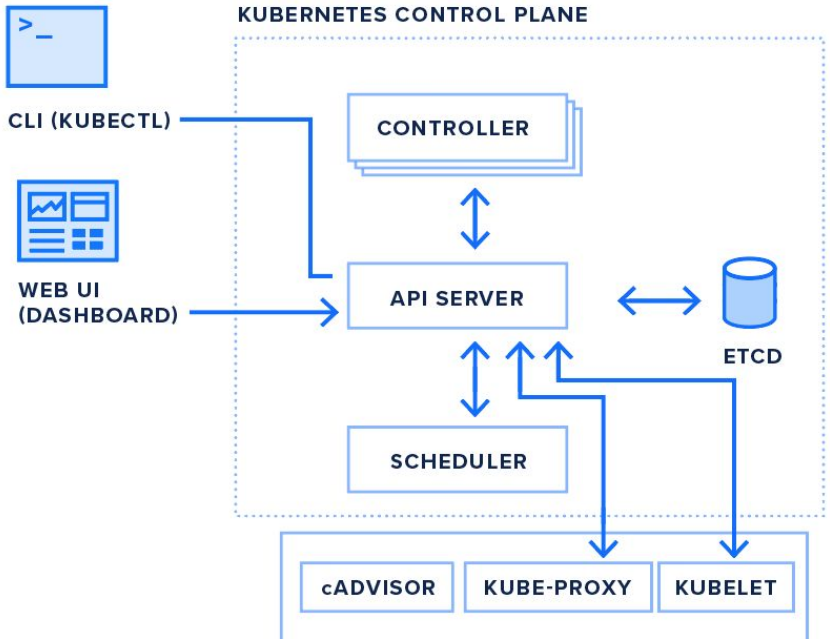
Kubernetes Architecture - Server

- Control Plane
  - API server
  - Scheduler
  - Controllers
    - Kubernetes
    - Cloud
  - Etcd



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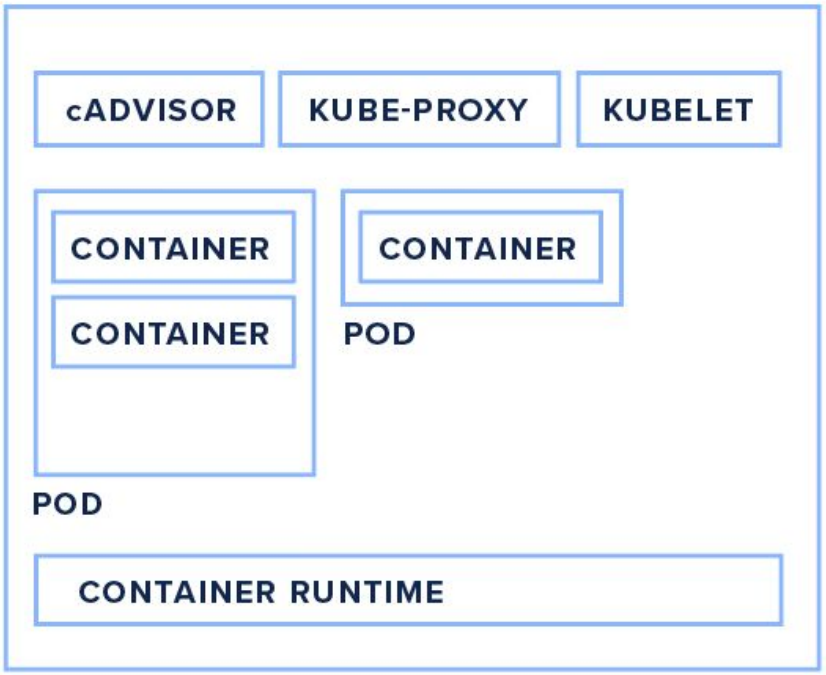
Kubernetes Architecture - Clients

- Nodes
  - Kubelet
  - Kube-proxy
  - cAdvisor
  - Container runtime



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How do I interact with a Kubernetes cluster?

- REST API
  - Can use curl, client libraries, etc.
- Kubectl
  - Command-line tool to interact with control plane
  - Abstracts away multiple REST API calls
  - Provides “get” “create” “delete” “describe”, etc. functionality
  - Filtering results
- Set up kubectl
  - `cp k8s_config_file ~/.kube/config`
  - May need to create this directory, depending on your OS
  - `kubectl cluster-info`

Kubernetes Objects: Pods and Workloads

Pods

- Fundamental Kubernetes work unit
- Can run one or more containers
  - Why more than one?
- Pod containers share resources
  - Storage
  - Network (localhost)
  - Always run on the same Node

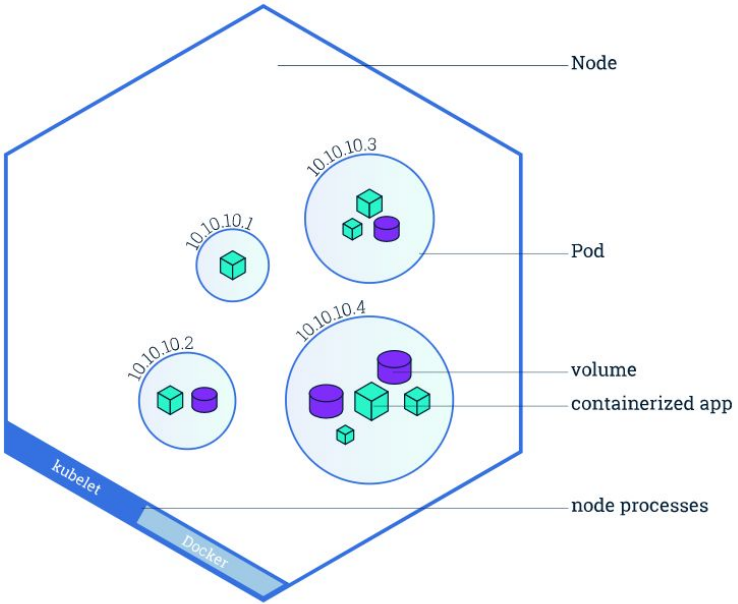


Image Attribution: [K8s Official Docs]

Pod Manifest Example

Pod Manifest (`cat k8s/flask-pod.yaml`)

```
apiVersion: v1
kind: Pod
metadata:
  name: flask-pod
  labels:
    app: flask-helloworld
spec:
  containers:
  - name: flask
    image: hjdo/flask-helloworld:latest
    ports:
    - containerPort: 5000
```

- Deploy the Flask Pod
  - `kubectl apply -f flask_pod.yaml`
- Check that it's up
  - `kubectl get pod`
- Forward a local port into the cluster so that we can access it
  - `kubectl port-forward pods/flask-pod 5000:5000`
  - `curl http://localhost:5000`
- Delete the Pod
  - `kubectl delete pod flask-pod`

Deployments

- How to manage multiple Pods?
  - ReplicaSets
- Higher-level object that “contains” the Pod object
- Pod management
  - Deployment
  - Scaling
  - Updates

Deployment example

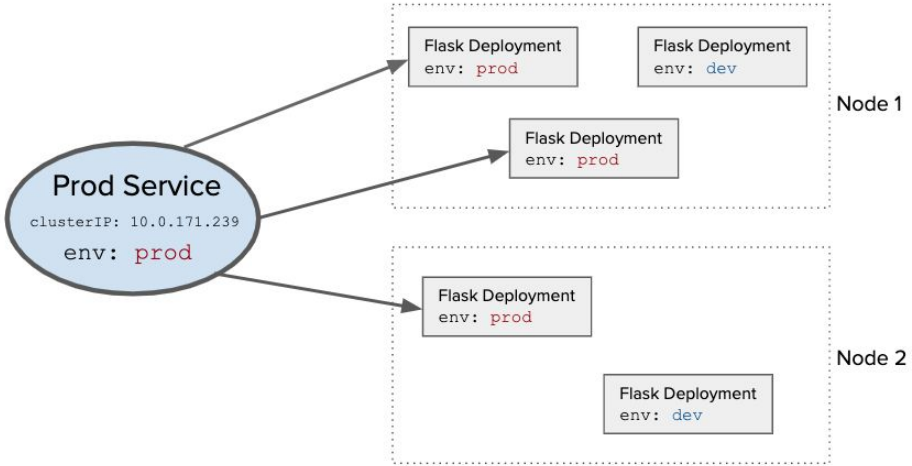
Deployment Manifest (`cat k8s/flask-deployment.yaml` **)**

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: flask-dep
  labels:
    app: flask-helloworld
spec:
  replicas: 2
  selector:
    matchLabels:
      app: flask-helloworld
  template:
    metadata:
      labels:
        app: flask-helloworld
    spec:
      containers:
      - name: flask
        image: hjdo/flask-helloworld:latest
        ports:
        - containerPort: 5000
```

- Roll out the Flask Deployment
  - `kubectl apply -f flask-deployment.yaml`
- Check that it's up
  - `kubectl get deploy`
  - `kubectl get pods`
- Forward a local port into the cluster so that we can access it
  - `kubectl port-forward deployment/flask-dep 5000:5000`
  - `curl http://localhost:5000`

Services: Exposing your apps to the outside world

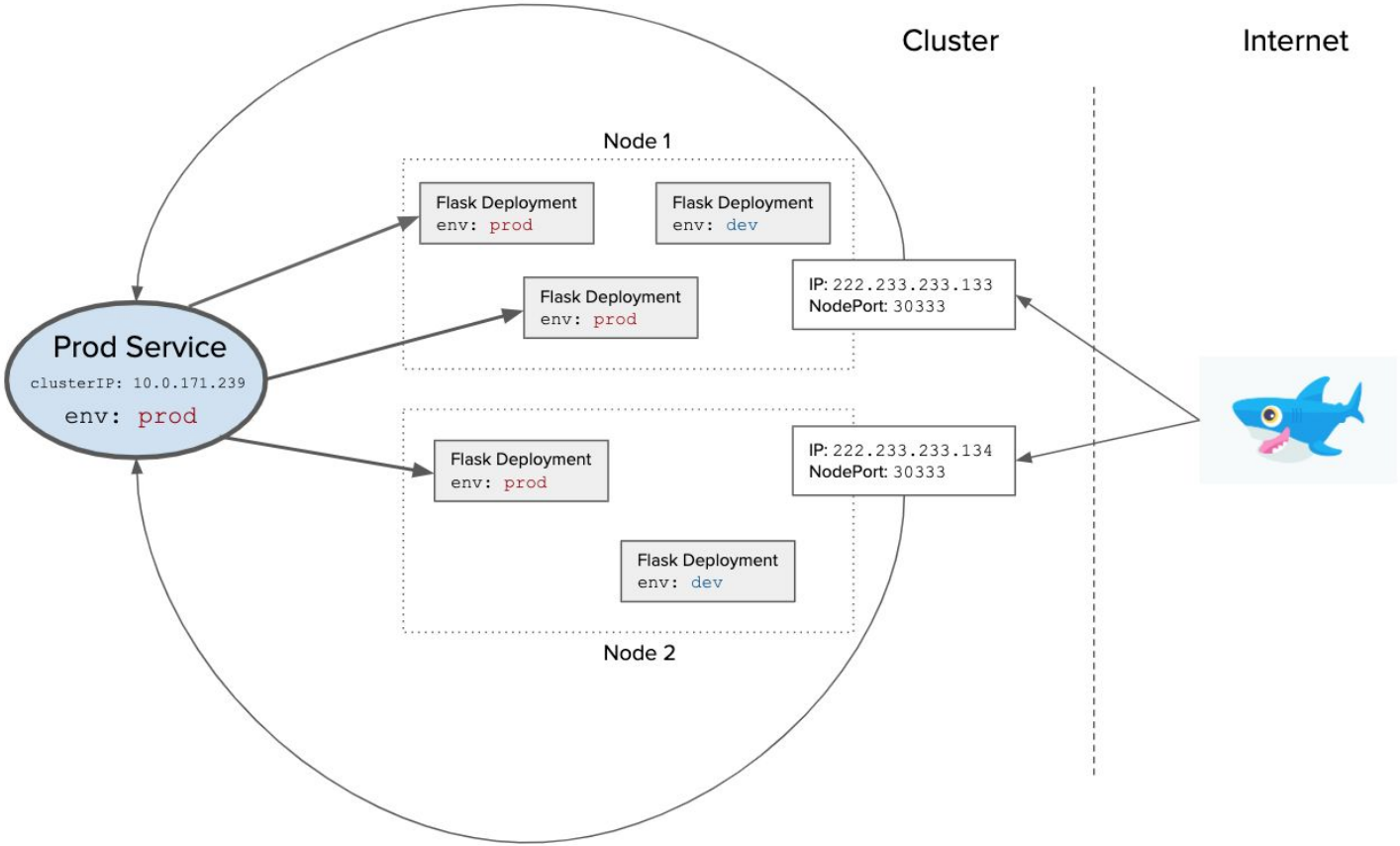
- By default, every Pod will be assigned an ephemeral cluster-internal IP address
- If you have a set of Pod replicas (Deployment), how to create a stable endpoint?
- Services: Abstraction to expose an app as a *service* (think microservices)
- Load balancing traffic
    - Routing to “healthy” / “available” Pods



Service Types

- ClusterIP
  - Creates an internal IP address that Pods can use to reach this Service
- NodePort
  - Expose the service on each Node's IP at a static port ("NodePort") - think externally
- LoadBalancer
  - Create an external (cloud provider) LoadBalancer
  - Will routes requests to Nodeport & ClusterIP services

NodePort Service



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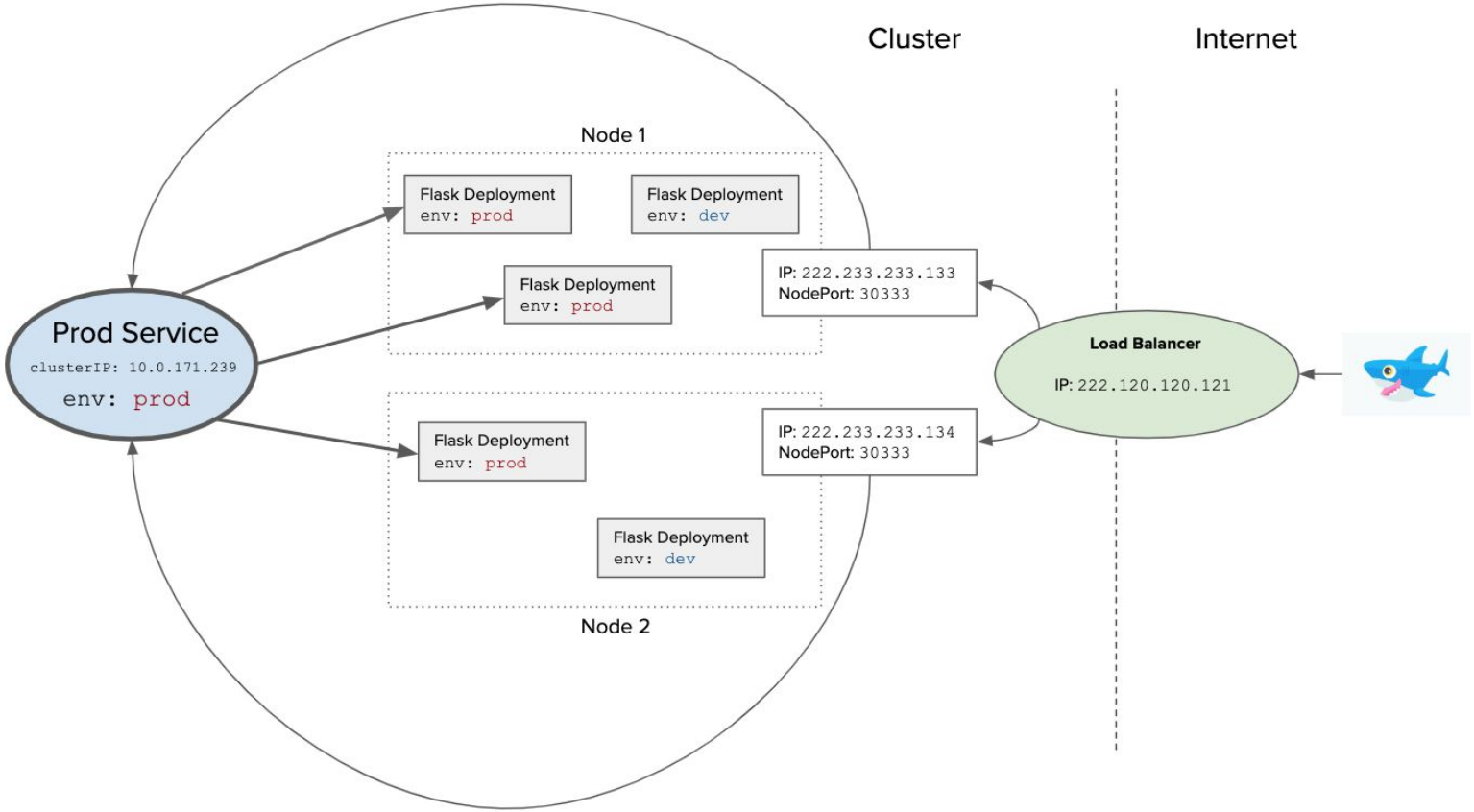
LoadBalancer Service



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Example: Flask App LoadBalancer Service

Service Manifest (`cat k8s/flask-service.yaml` **)**

```
apiVersion: v1
kind: Service
metadata:
  name: flask-svc
  labels:
    app: flask-helloworld
spec:
  type: LoadBalancer
  ports:
  - port: 80
    targetPort: 5000
    protocol: TCP
  selector:
    app: flask-helloworld
```

- Deploy the Flask LoadBalancer Service
  - `kubectl apply -f flask-service.yaml`
- Check that it's up (may have to wait for external IP)
  - `kubectl get svc`
  - `curl loadbalancer_external_ip`
- Get external IPs of Nodes (for NodePort services)
  - `kubectl get node -o wide`

Storage & Volumes (briefly)

- Volumes
  - Tied to the lifecycle of the Pod that requests it
  - Can be used to share data between containers in a Pod
- Persistent Volumes & PVCs
  - Abstraction that allows operators to separate storage provisioning from consumption
  - For example:
    - A PV could be a 10Gi DO block storage disk made available to the cluster
    - The PVC (defined in the workload manifest) states that this particular app needs a 10Gi disk.

More K8s Features...

- Resource requests & limits
- Autoscaling
- Node affinity, taints, tolerations
- Dashboard
- Metrics-server
- ...

Where to go from here?

- Kubernetes For Fullstack Developers Curriculum
- Kubernetes White Paper
- DigitalOcean Kubernetes Community Tutorials
- Kubernetes Official Documentation
- Kubernetes GitHub Project
- https://github.com/derailed/k9s

Any questions?

Thank you!