



# Kubernetes

# Kubernetes

## Course Outline

### Day 1

- Google Container Registry
- Kubernetes Architecture
- Nodes
- Pods
- Services
- Replica Sets
- Deployments
- Daemon Sets
- Resource Quotas
- Health Check
- Horizontal Pod Autoscaler
- Labels

### Day 2

- Pod Disruption Budgets
- Persistent Disks
- Persistent Volumes
- Persistent Volume Claims
- Storage Classes
- Stateful Sets
- Config Maps
- Secrets
- Ingresses
- Nginx Ingress Controller
- kube-lego



DAY I

# YAML

- stands for “YAML Ain’t Markup Language”
- is a human friendly data serialization standard for all programming language

# YAML

```
name: Courses
list:
- name: Go for Beginner
  price: 600
- name: Redis Fundamental
  price: 300
- name: RxJS for Beginner
  price: 500
```

# JSON

```
{
  "name": "Courses",
  "list": [
    {
      "name": "Go for Beginner",
      "price": 600
    },
    {
      "name": "Redis Fundamental",
      "price": 300
    },
    {
      "name": "RxJS for Beginner",
      "price": 500
    }
  ]
}
```

# Google Container Registry

<https://cloud.google.com/container-registry/>





[gcr.io](#) / [acoshift-1362](#) / [acourse](#)

Filter by name or tag

<input type="checkbox"/> Name	Tags	Virtual size	Uploaded
<input type="checkbox"/> 1f5261270fb3	7d9feb45ba5038b84856f51142e730a23fe9a3b9 latest	3.9 MB	2 days ago
<input type="checkbox"/> 6b81b1966f31	38f520dbf60aae34bb5528fd7559666e2c5f3eaf 	3.9 MB	2 days ago
<input type="checkbox"/> 4dd203deaac1	09f311488b5756981ed1f8089b225032c98d1d1d 	3.9 MB	2 days ago
<input type="checkbox"/> b6bb495787e3	049cc2b0944aba25cf2b71a7b051cc5d8a807d5c 	3.9 MB	2 days ago
<input type="checkbox"/> a1e2abf97afa	09695bdb99fcbe4114e9e120e36b3a35881c2228 	3.9 MB	4 days ago
<input type="checkbox"/> c81615a32bfb	6444528f0898dc7074b03b2155702178e0cee3a4 	3.9 MB	6 days ago
<input type="checkbox"/> 340072282343	390c17ac043b2f9881496b00430b451b49cb773a 	3.9 MB	7 days ago
<input type="checkbox"/> bf6d895e3d4f	b0b70dd5745c99969205a087b9b745c1fbdb6560 	3.9 MB	8 days ago
<input type="checkbox"/> d2d2aaa26269	5917485deaf70248110e2da0e6296e014967e1f5 	3.9 MB	8 days ago
<input type="checkbox"/> ef65e4cce15c	fe5253cdfa5a59e861fd2e61e7f77b7b7d97f1c5 	3.9 MB	9 days ago
<input type="checkbox"/> dfbc13dac286	977399a9770be959ae830da88933cd9e4884ad3f	3.9 MB	12 days ago

```
$ docker push acoshift/backend:1.0.0
```

```
$ gcloud docker -- push gcr.io/myproject/backend:1.0.0
```

```
$ docker pull acoshift/backend:1.0.0
```

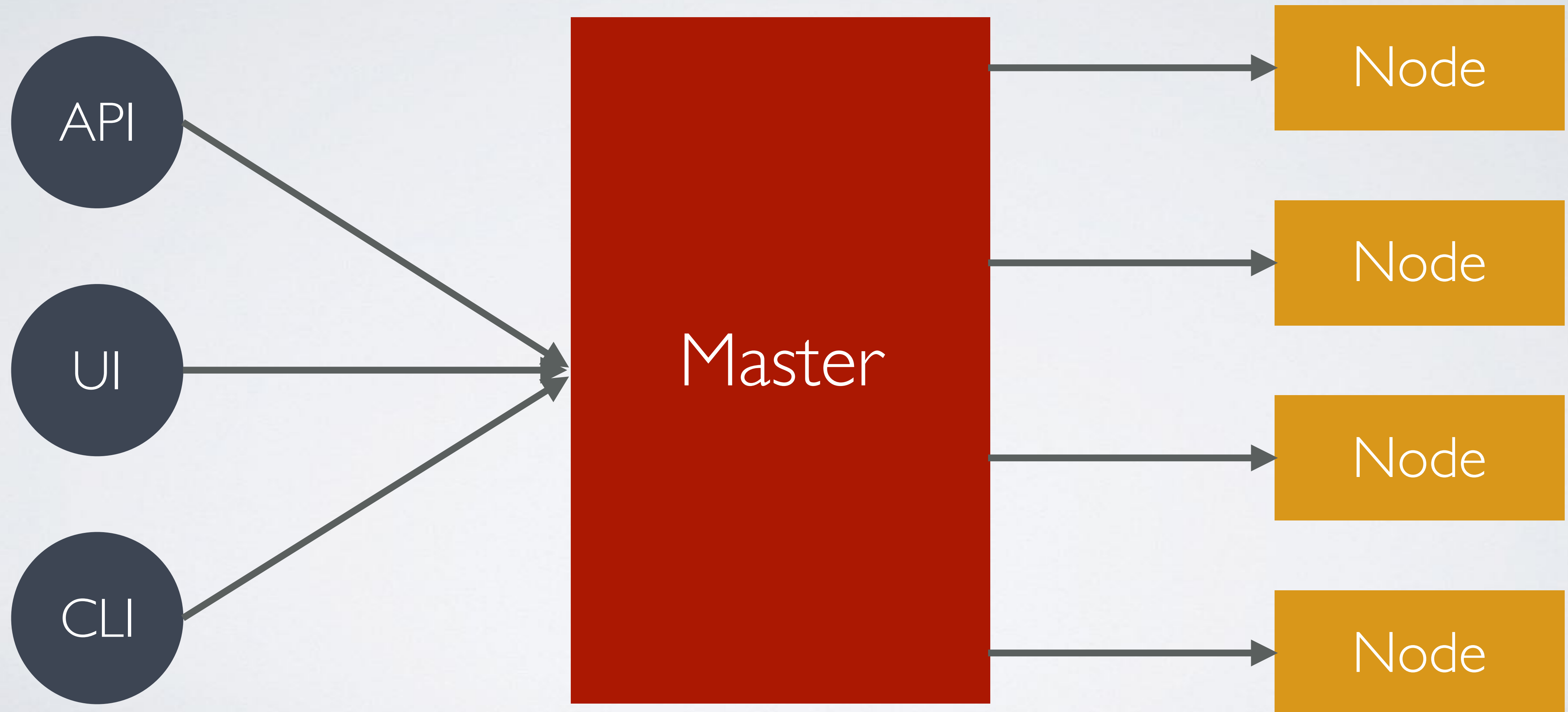
```
$ gcloud docker -- pull gcr.io/myproject/backend:1.0.0
```



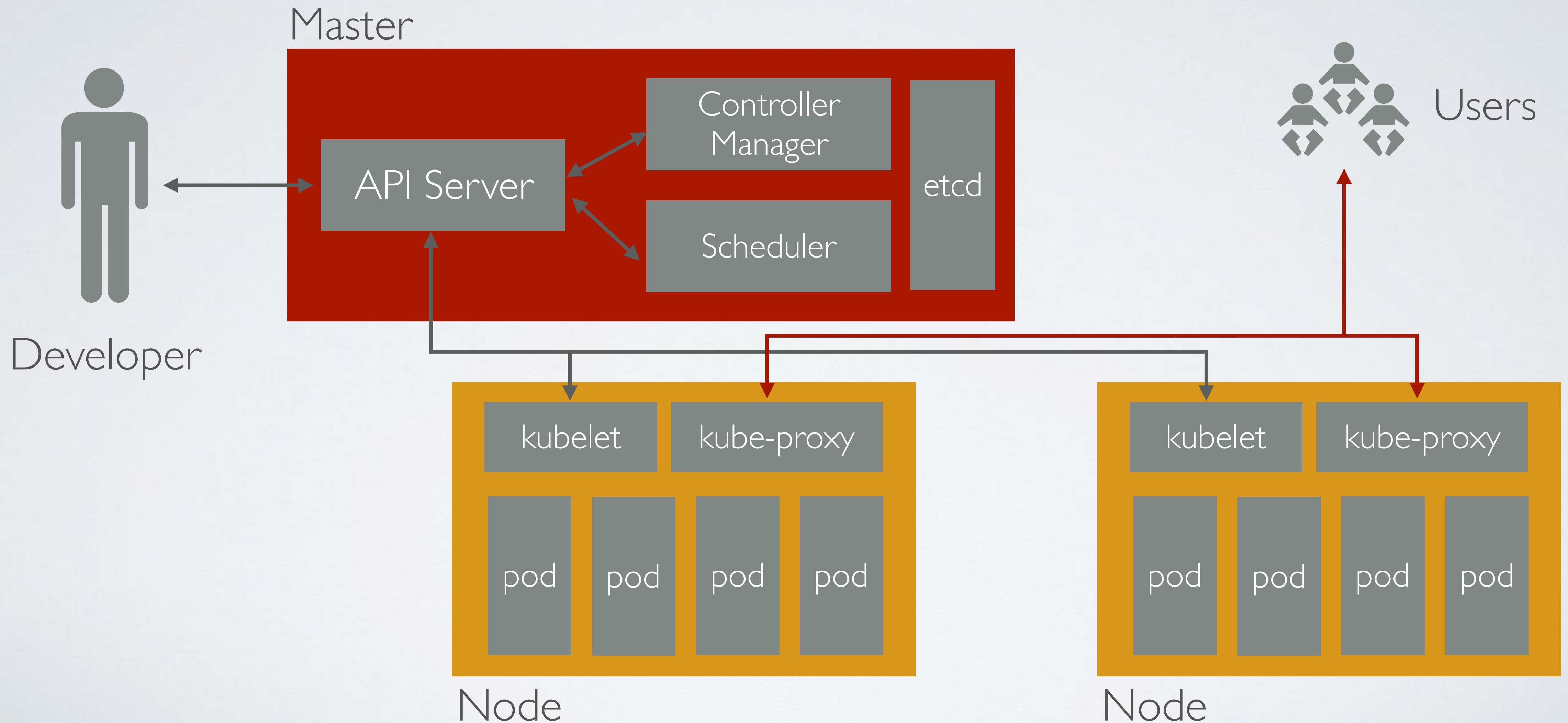
```
$ docker login -u _json_key -p "$(cat keyfile.json)" https://gcr.io
$ docker push gcr.io/myproject/backend:1.0.0
$ docker pull gcr.io/myproject/backend:1.0.0
```

[https://console.cloud.google.com/gcr/  
images/google-containers/GLOBAL](https://console.cloud.google.com/gcr/images/google-containers/GLOBAL)

# Kubernetes Architecture



# Kubernetes Architecture



# Nodes (no)

a worker machine in Kubernetes

```
$ kubectl get nodes
```

NAME	STATUS	AGE	VERSION
gke-cluster-sg-1-pool-1-3fada004-n6gj	Ready	4d	v1.7.0
gke-cluster-sg-1-pool-1-3fada004-pglr	Ready	4d	v1.7.0

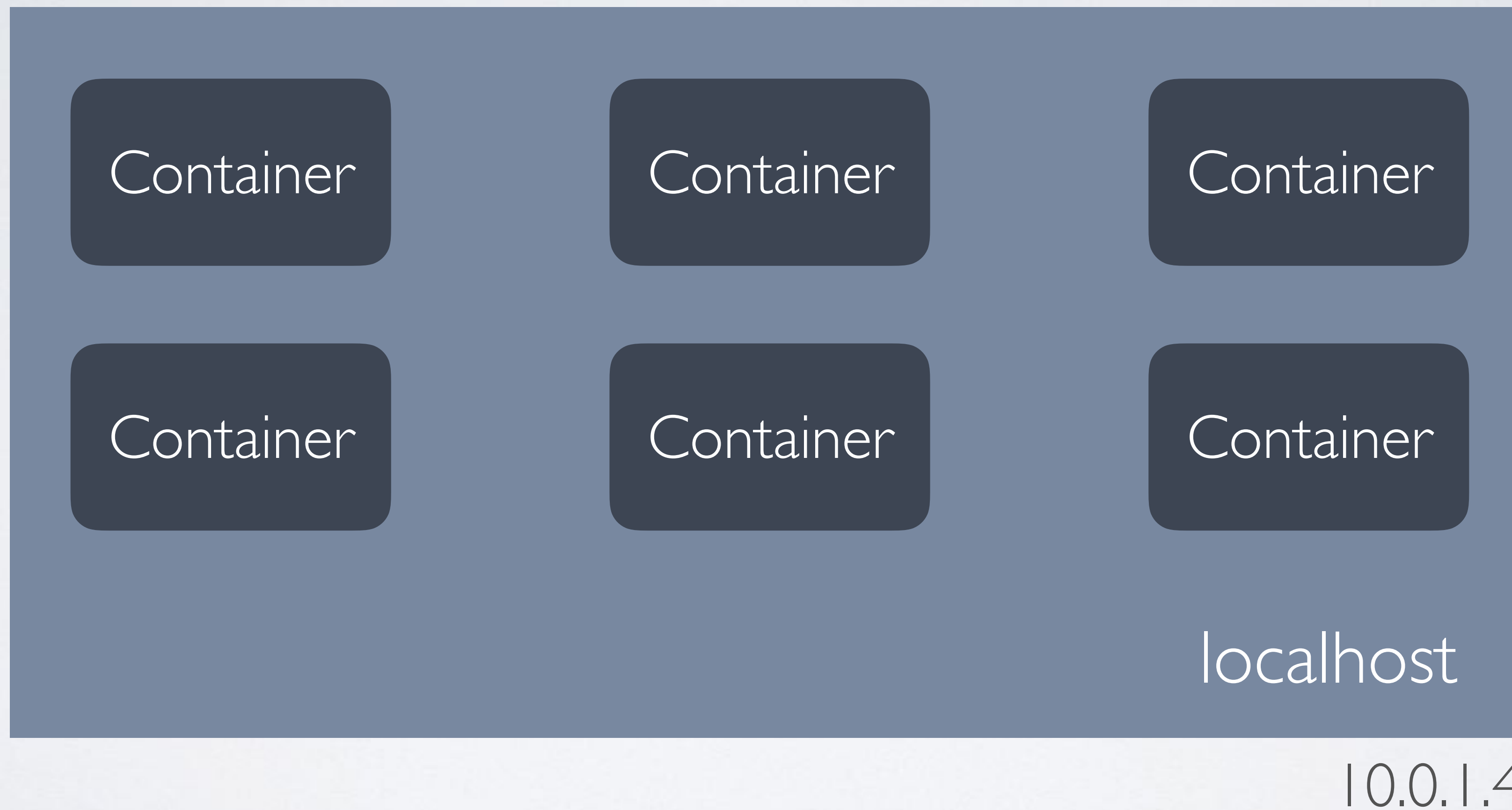
```
$ kubectl describe nodes gke-cluster-sg-1-pool-1-3fada004-n6gj
```



# Pods (po)

a group of one or more containers

# Pod



```
kind: Pod
apiVersion: v1
metadata:
  name: echoserver
spec:
  containers:
  - name: echoserver
    image: gcr.io/google-containers/echoserver:1.6
    ports:
    - containerPort: 8080
```

just additional  
information

all ports listening on  
0.0.0.0 will be accessible  
from network

```
$ kubectl create -f 01-pod.yaml  
pod "echoserver" created
```

```
$ kubectl get pods
```

NAME	READY	STATUS	RESTARTS	AGE
echoserver	1/1	Running	0	4m

```
$ kubectl port-forward echoserver 9000:8080  
Forwarding from 127.0.0.1:9000 -> 8080  
Forwarding from [::1]:9000 -> 8080
```



```
$ curl localhost:9000
Hostname: echoserver
```

```
Pod Information:
  -no pod information available-
```

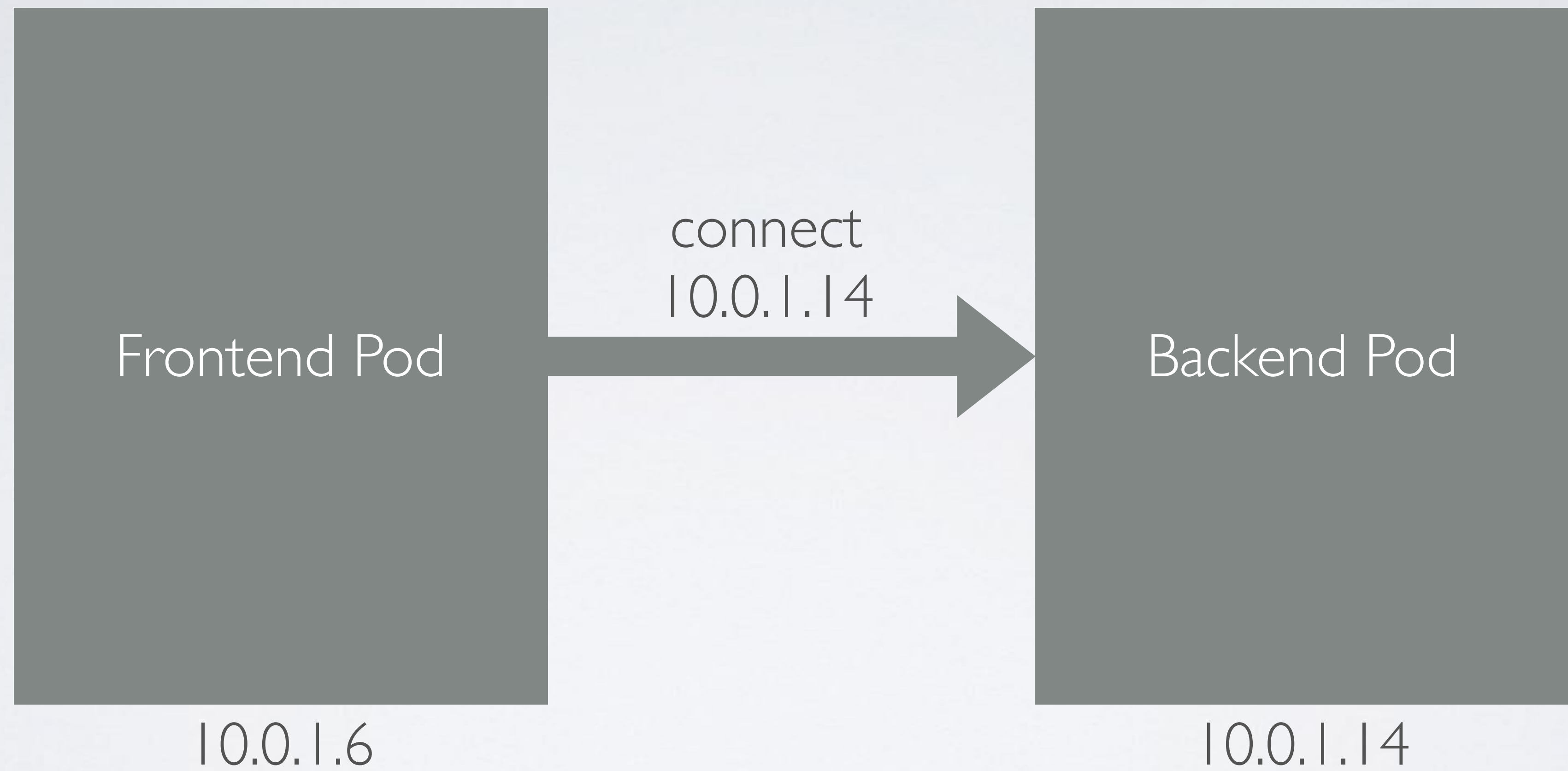
```
Server values:
  server_version=nginx: 1.13.1 - lua: 10008
```

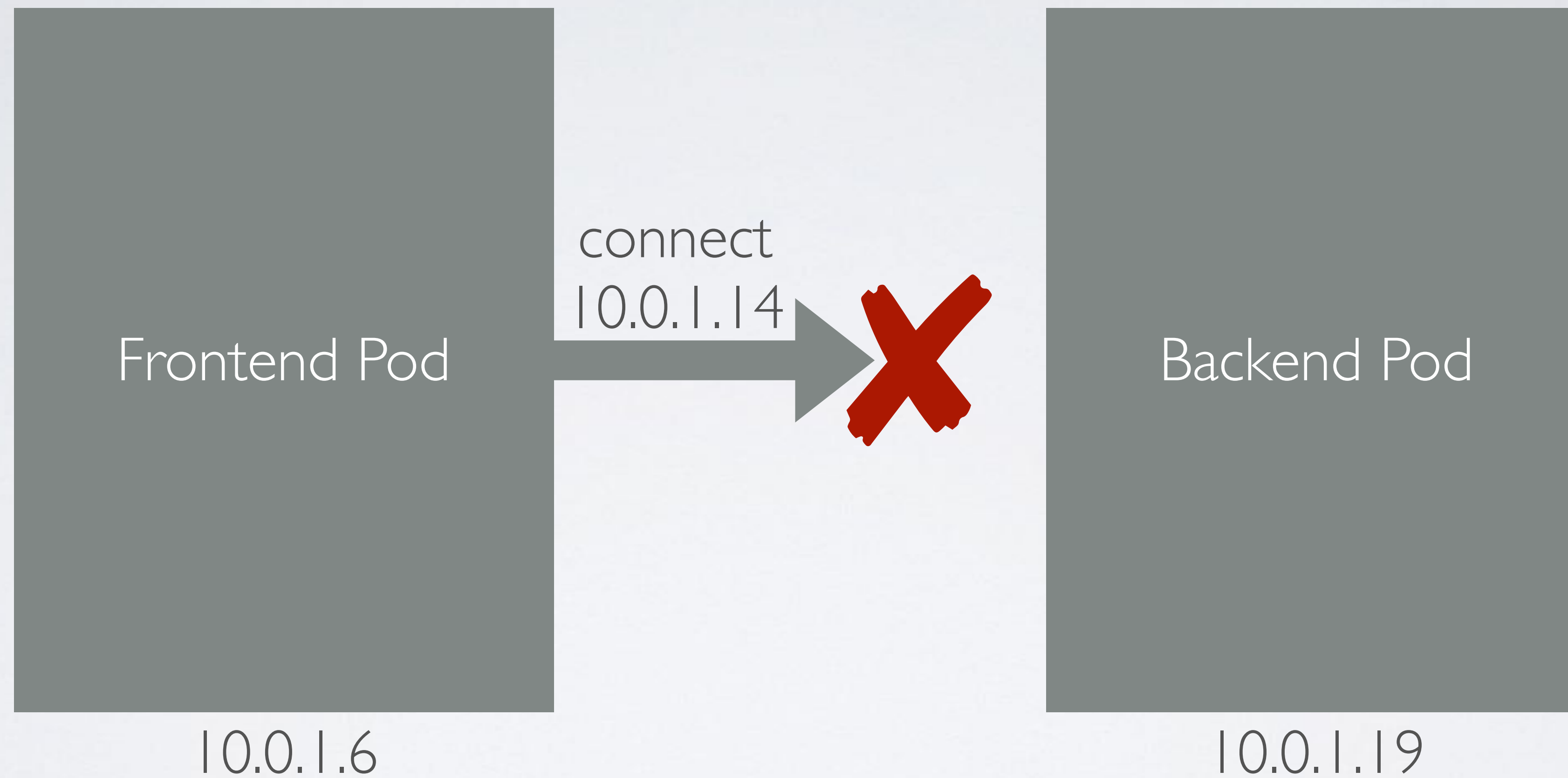
```
Request Information:
  client_address=127.0.0.1
  method=GET
  real path=/
  query=
  request_version=1.1
  request_uri=http://localhost:8080/
```

```
Request Headers:
  accept=/*/*
  host=localhost:9000
  user-agent=curl/7.51.0
```

```
Request Body:
  -no body in request-
```

```
$ kubectl delete pod echoserver  
pod "echoserver" deleted
```





# Services (svc)

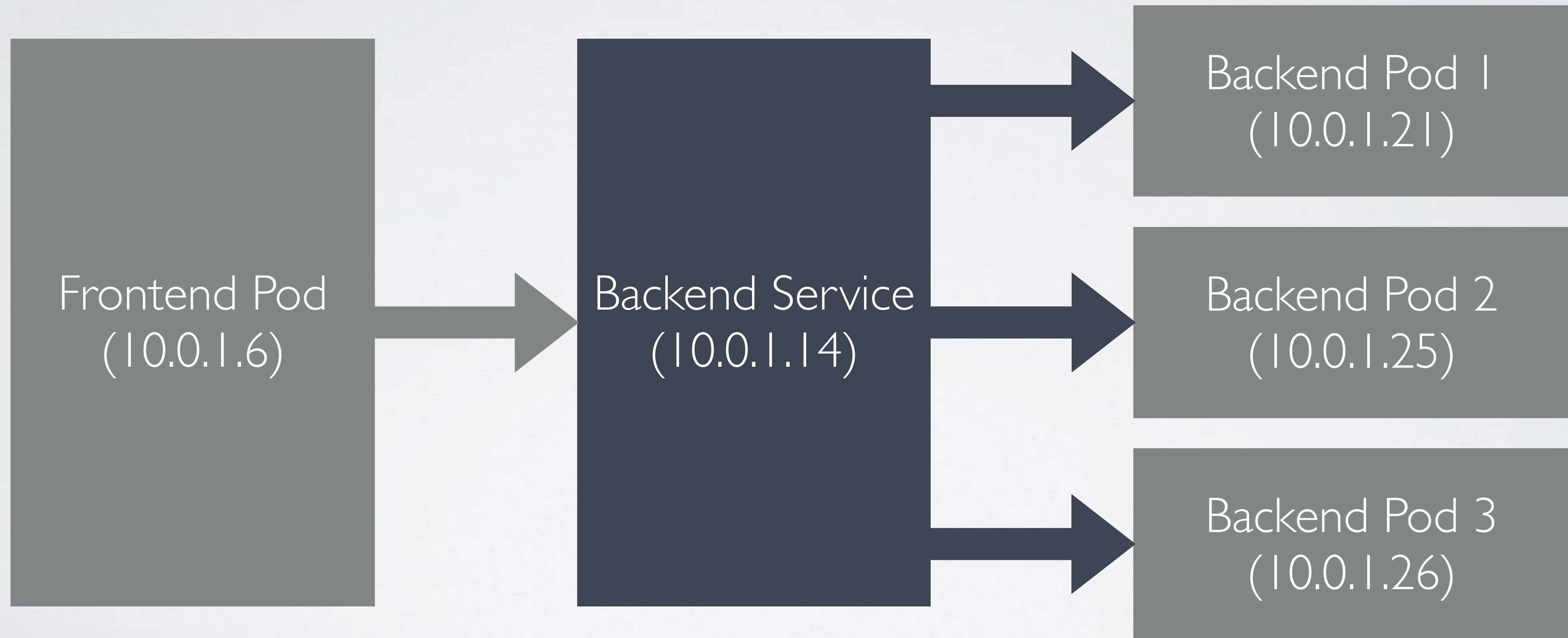
an abstraction which defines a logical set of Pods and a policy by which to access them

# Service Types

- ClusterIP
- NodePort
- LoadBalancer
- ExternalName



# ClusterIP



```
kind: Pod
apiVersion: v1
metadata:
  name: echoserver
  labels:
    app: echoserver
spec:
  containers:
  - name: echoserver
    image: gcr.io/google-containers/echoserver:1.6
    ports:
    - containerPort: 8080
```

```
kind: Service
apiVersion: v1
metadata:
  name: echoserver
spec:
  selector:
    app: echoserver
  ports:
  - port: 80
    targetPort: 8080
```

```
$ kubectl create -f 02-service.yaml  
pod "echoserver" created  
service "echoserver" created
```

```
$ kubectl get services
```

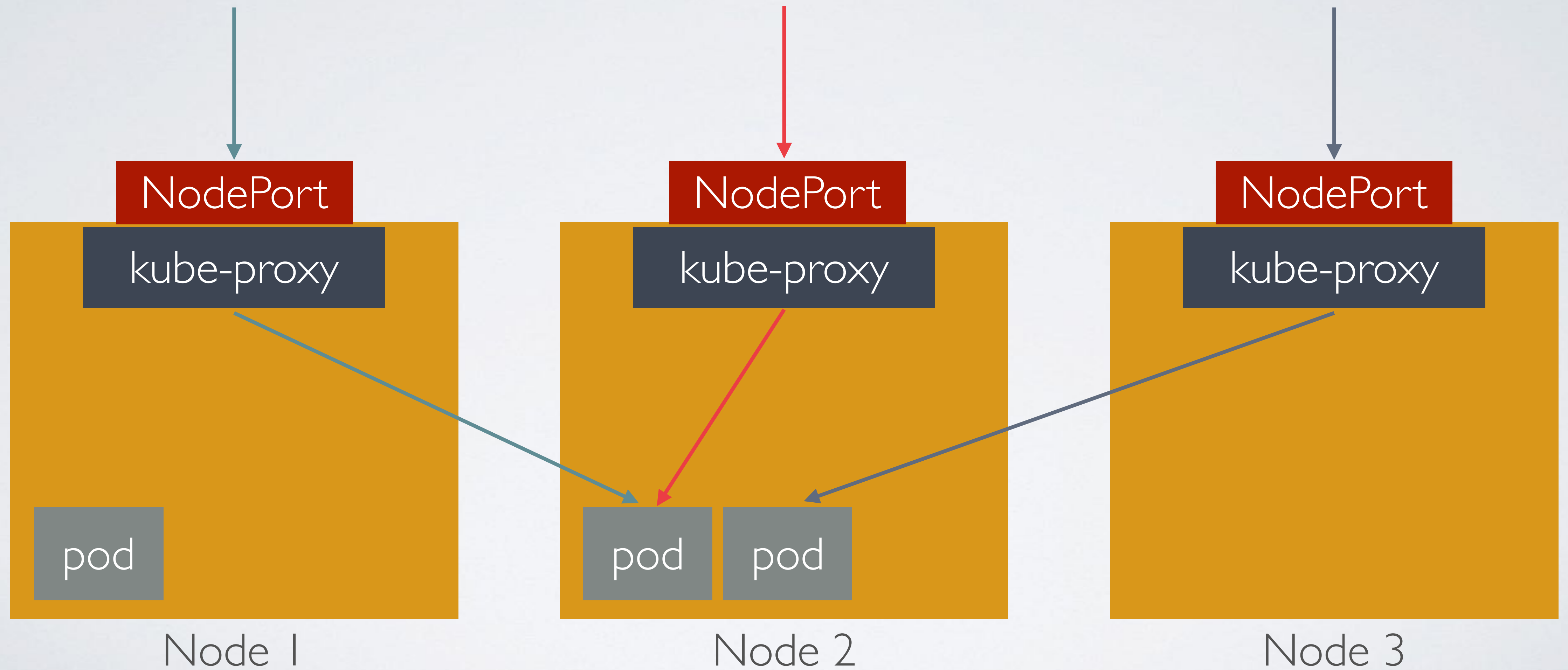
NAME	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
echoserver	10.3.248.15	<none>	80/TCP	11s

```
$ kubectl run -it --rm busybox --image=busybox  
$ wget -O- http://echoserver
```



```
$ kubectl delete -f 02-service.yaml
```

# NodePort



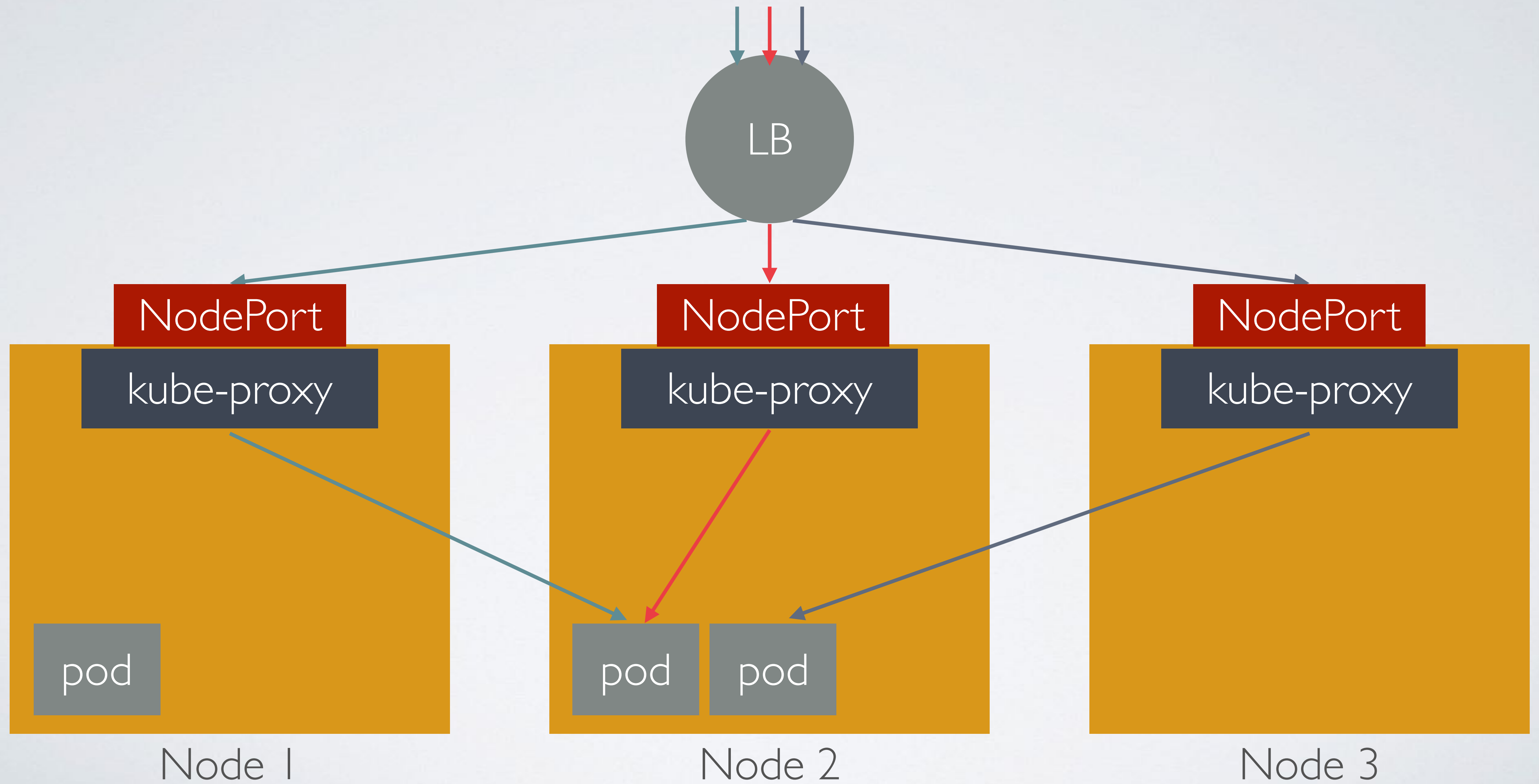
```
kind: Service
apiVersion: v1
metadata:
  name: echoserver
spec:
  type: NodePort
  selector:
    app: echoserver
  ports:
  - port: 80
    targetPort: 8080
    nodePort: 31000
```



valid port:  
30000-32767

```
$ curl http://serverIP:31000
```

# LoadBalancer



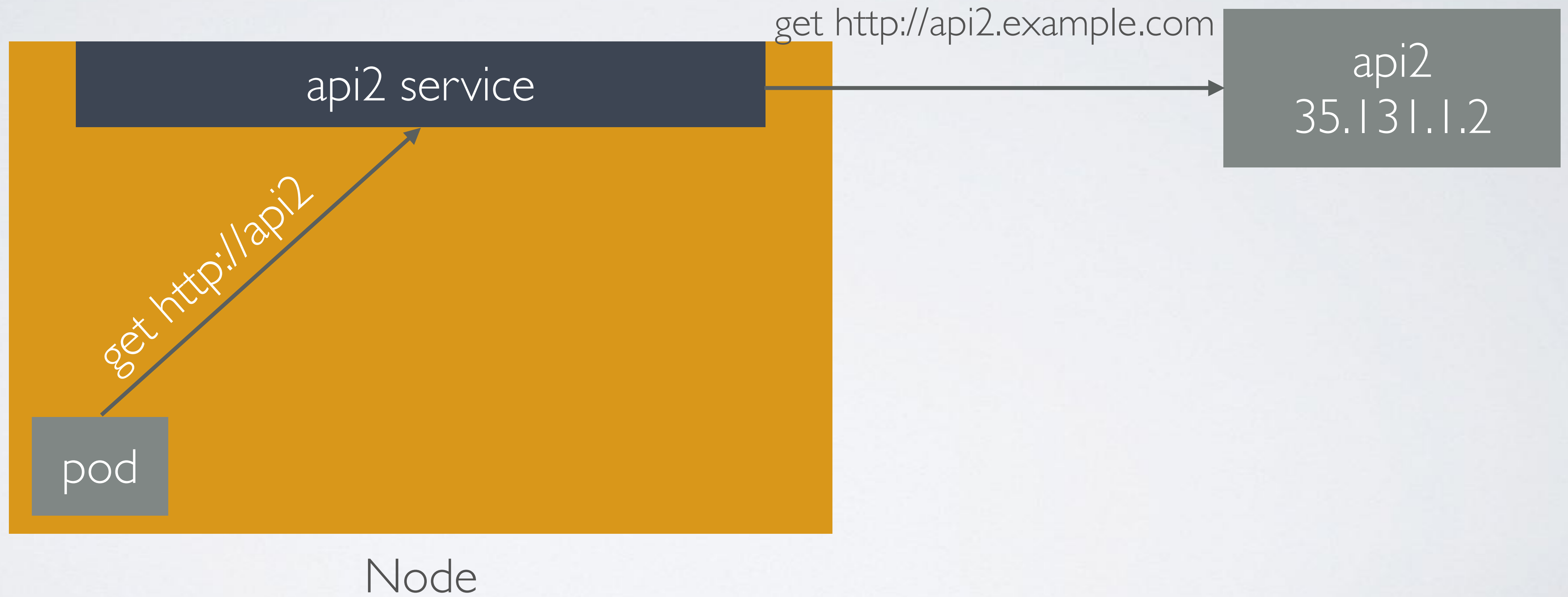
```
kind: Service
apiVersion: v1
metadata:
  name: echoserver
spec:
  type: LoadBalancer
  selector:
    app: echoserver
  ports:
  - port: 80
    targetPort: 8080
  loadBalancerIP: 35.185.1.1
```



optional static ip

```
$ curl http://loadbalcnerIP
```

# ExternalName





```
kind: Service
apiVersion: v1
metadata:
  name: google
spec:
  type: ExternalName
  externalName: google.com
```

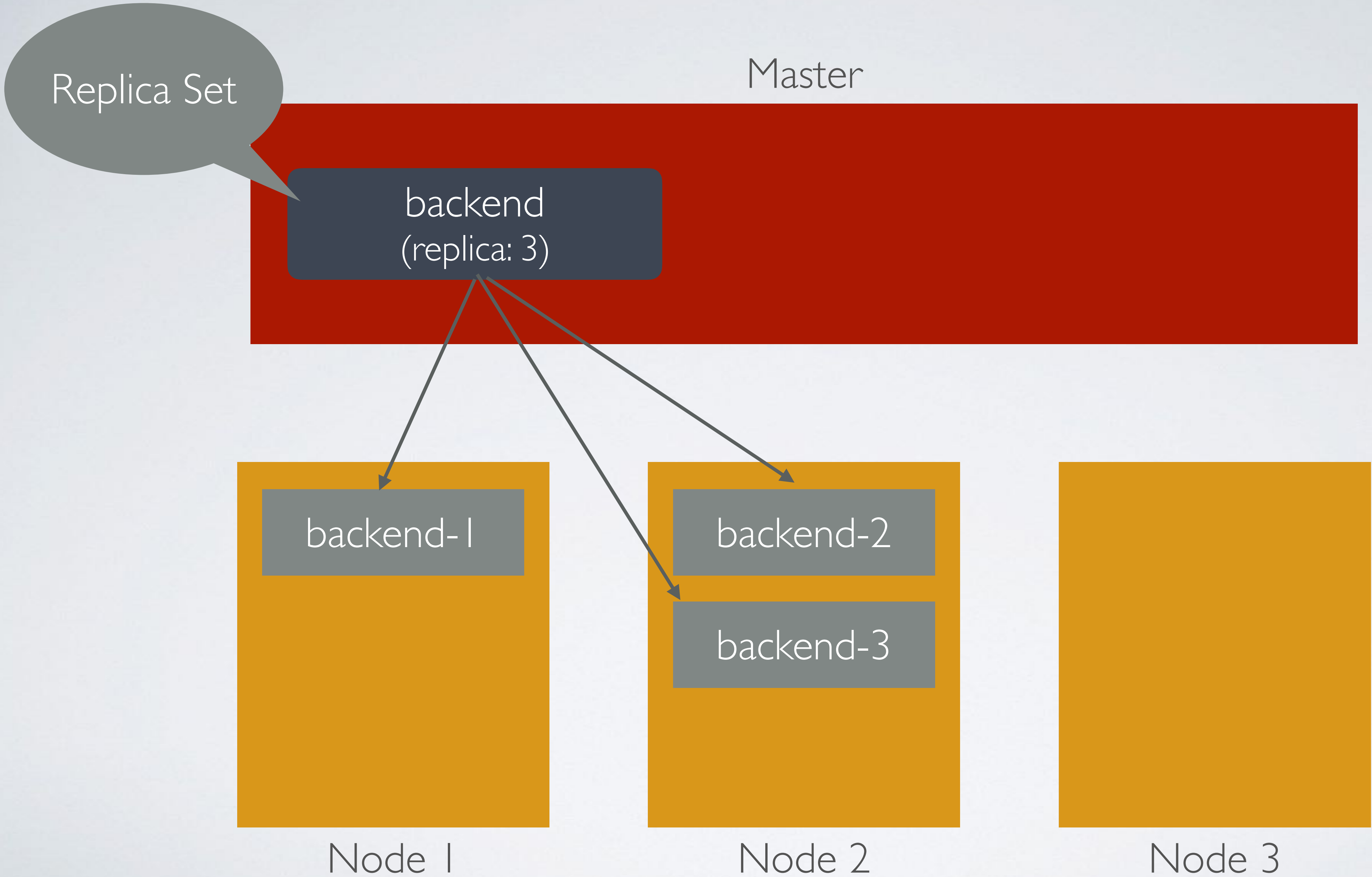
```
$ kubectl run -it --rm busybox --image=busybox  
$ wget -O- --header="Host: www.google.com" http://google
```

~~Replication Controller (rc)~~

# Replica Sets (rs)

the next-generation Replication Controller

ensures that a specified number of pod “replicas” are running at any given time



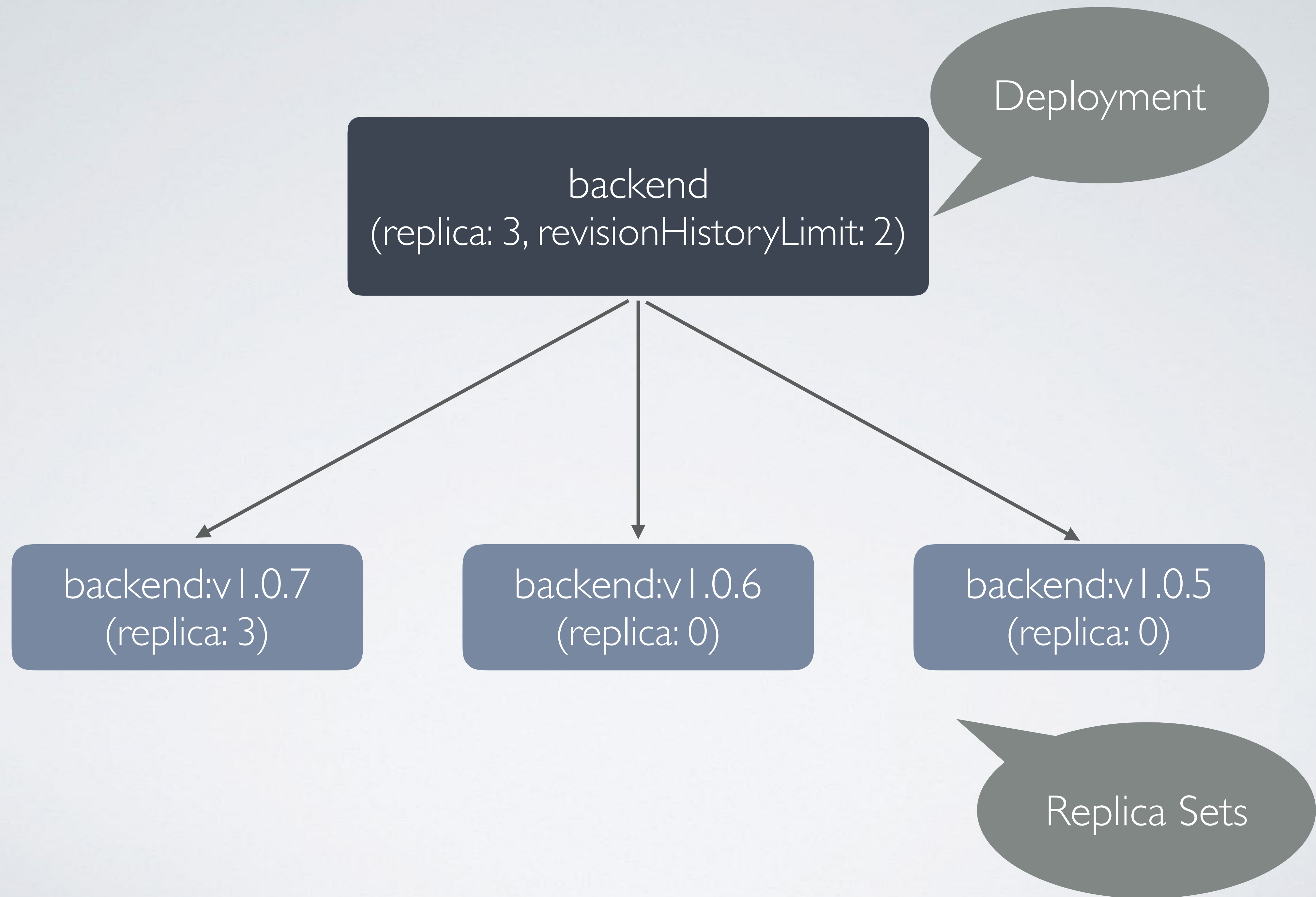
```
kind: ReplicaSet
apiVersion: extensions/v1beta1
metadata:
  name: echoserver
spec:
  replicas: 3
  template:
```

```
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.6
        ports:
        - containerPort: 8080
```

Pod

# Deployments (deploy)

provides declarative updates for Pods and ReplicaSets



```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: echoserver
spec:
  replicas: 3
  revisionHistoryLimit: 2
  template:
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.1
        ports:
        - containerPort: 8080
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxUnavailable: 1
      maxSurge: 1
```



# Strategy



Default

- RollingUpdate — updates one pod at a time
- Max Unavailable — maximum number of Pods that can be unavailable during the update process
- Max Surge — maximum number of Pods that can be created above the desired number of Pods
- Recreate — All existing Pods are killed before new ones are created

```
$ kubectl create -f 07-deployment.yaml --record=true  
deployment "echoserver" created
```

```
$ kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.2  
deployment "echoserver" image updated
```

```
$ kubectl rollout status deployment/echoserver  
Waiting for rollout to finish: 1 out of 3 new replicas have been updated...  
Waiting for rollout to finish: 1 out of 3 new replicas have been updated...  
Waiting for rollout to finish: 2 out of 3 new replicas have been updated...  
Waiting for rollout to finish: 2 out of 3 new replicas have been updated...  
Waiting for rollout to finish: 2 out of 3 new replicas have been updated...  
Waiting for rollout to finish: 1 old replicas are pending termination...  
Waiting for rollout to finish: 1 old replicas are pending termination...  
deployment "echoserver" successfully rolled out
```

```
$ kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.3  
deployment "echoserver" image updated
```

```
$ kubectl rollout history deployment/echoserver  
deployments "echoserver"
```

REVISION	CHANGE-CAUSE
1	kubectl create --filename=07-deployment.yaml --record=true
2	kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.2
3	kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.3

```
$ kubectl rollout history deployment/echoserver --revision=2
deployments "echoserver" with revision #2
Pod Template:
  Labels:      app=echoserver
              pod-template-hash=1885346732
  Annotations: kubernetes.io/change-cause=kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.2
  Containers:
    echoserver:
      Image:      gcr.io/google-containers/echoserver:1.2
      Port:      8080/TCP
      Environment:    <none>
      Mounts:         <none>
  Volumes:          <none>
```

```
$ kubectl rollout undo deployment/echoserver  
deployment "echoserver" rolled back
```

```
$ kubectl rollout history deployment/echoserver  
deployments "echoserver"
```

REVISION	CHANGE-CAUSE
1	kubectl create --filename=07-deployment.yaml --record=true
3	kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.3
4	kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.2

```
$ kubectl rollout undo deployment/echoserver --to-revision=1  
deployment "echoserver" rolled back
```

```
$ kubectl rollout history deployment/echoserver  
deployments "echoserver"
```

REVISION	CHANGE-CAUSE
3	kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.3
4	kubectl set image deployment/echoserver echoserver=gcr.io/google-containers/echoserver:1.2
5	kubectl create --filename=07-deployment.yaml --record=true

```
$ kubectl scale deployment/echoserver --replicas 6  
deployment "echoserver" scaled
```

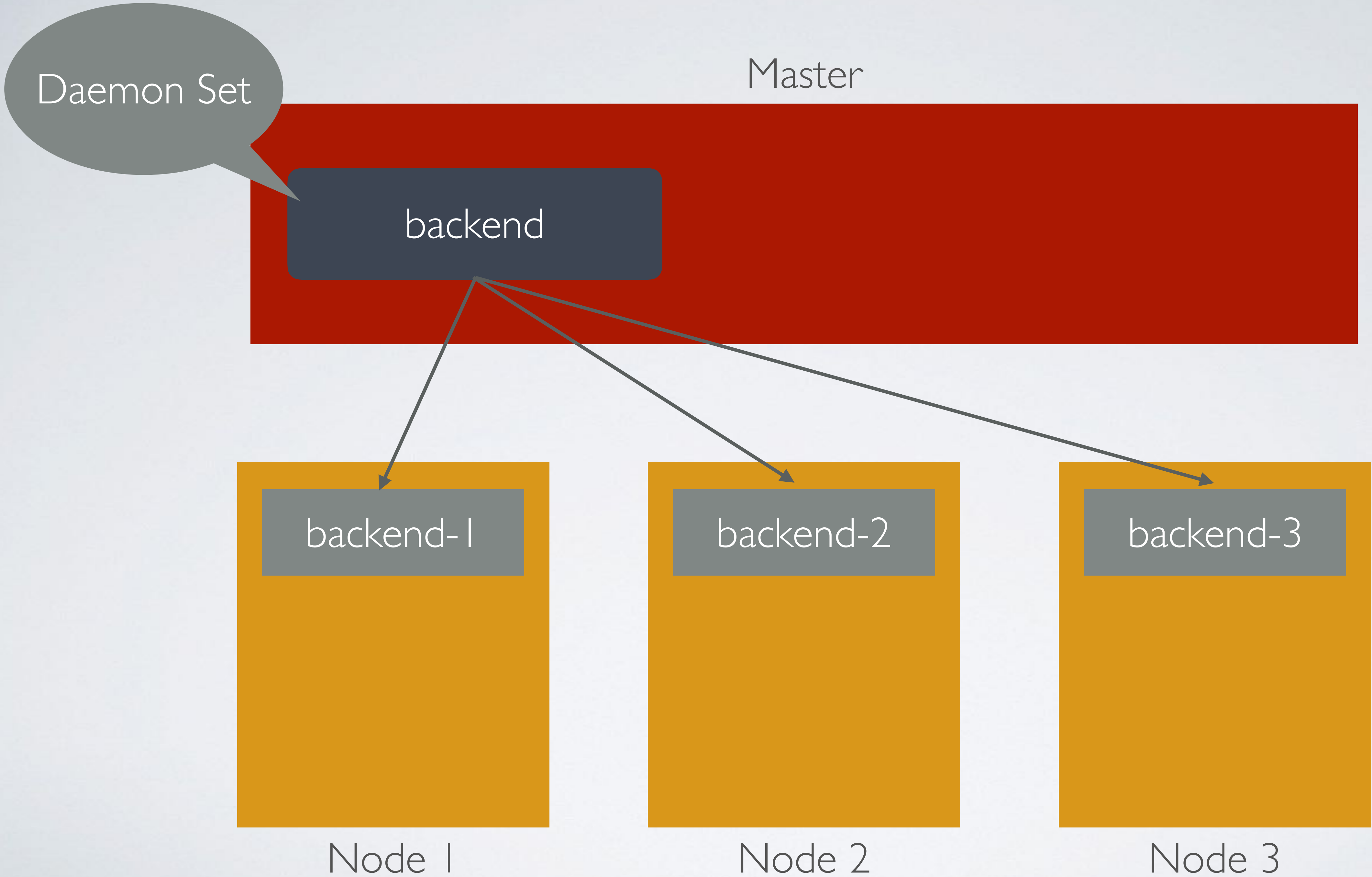
```
$ kubectl get deployment/echoserver
```

NAME	DESIRED	CURRENT	UP-TO-DATE	AVAILABLE	AGE
echoserver	6	6	6	6	11m

# Daemon Sets (ds)

ensures that all (or some) nodes run a copy of a pod





```
kind: DaemonSet
apiVersion: extensions/v1beta1
metadata:
  name: echoserver
spec:
  template:
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.6
        ports:
        - containerPort: 8080
  updateStrategy:
    type: RollingUpdate
    rollingUpdate:
      maxUnavailable: 1
```

# Strategy



Default

- OnDelete — new DaemonSet pods will only be created when you manually delete old DaemonSet pods
- RollingUpdate

# Resource Quotas (quota)

limit aggregate resource consumption

```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: echoserver
spec:
  replicas: 3
  revisionHistoryLimit: 2
  template:
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.6
        ports:
        - containerPort: 8080
        resources:
          requests:
            cpu: 200m
            memory: 300Mi
          limits:
            cpu: 1
            memory: 1Gi
```



1 CPU = 1000m

# Health Check

# Health Check

- Liveness Probes — know when to restart a Container
- Readiness Probes — don't send requests until application started

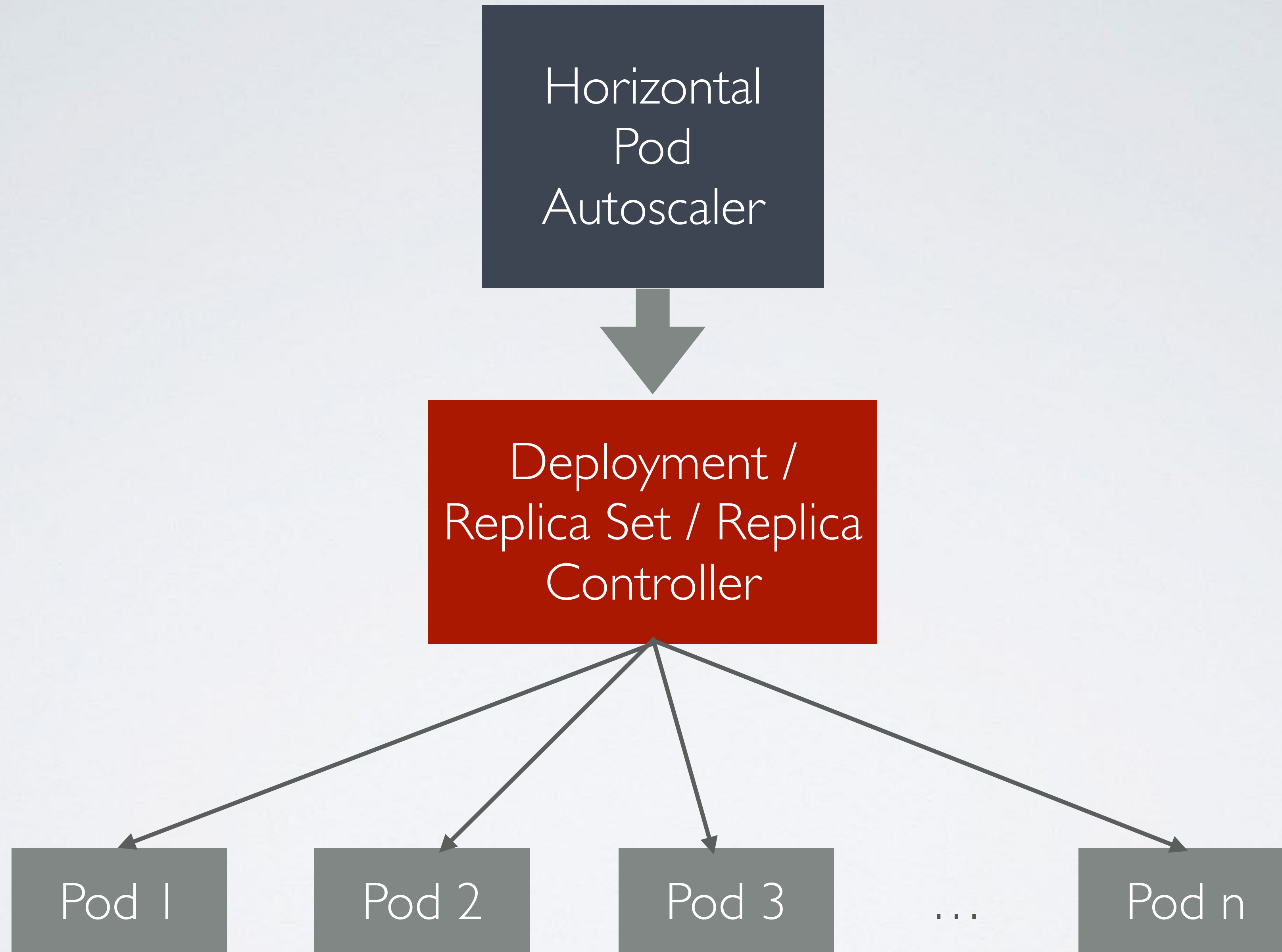


```
kind: Deployment
apiVersion: app/v1beta1
metadata:
  name: default-http-backend
spec:
  replicas: 3
  template:
    metadata:
      labels:
        app: default-http-backend
    spec:
      containers:
      - name: default-http-backend
        image: gcr.io/google-containers/defaultbackend:1.3
        ports:
        - containerPort: 8080
        readinessProbe:
          httpGet:
            path: /healthz
            port: 8080
            scheme: HTTP
          initialDelaySeconds: 30
          timeoutSeconds: 5
          periodSeconds: 10
          successThreshold: 1
          failureThreshold: 3
        livenessProbe:
          httpGet:
            path: /healthz
            port: 8080
            scheme: HTTP
          initialDelaySeconds: 30
          timeoutSeconds: 5
          periodSeconds: 10
          successThreshold: 1
          failureThreshold: 3
```



# Horizontal Pod Autoscaler (hpa)

automatically scales the number of pods in  
a replication controller, deployment or replica set



```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: hpa-example
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: hpa-example
    spec:
      containers:
      - name: hpa-example
        image: gcr.io/google-containers/hpa-example
        ports:
        - containerPort: 80
        resources:
          requests:
            cpu: 100m
```

```
apiVersion: v1
kind: Service
metadata:
  name: hpa-example
spec:
  selector:
    app: hpa-example
  ports:
    - port: 80
```

```
kind: HorizontalPodAutoscaler
apiVersion: autoscaling/v1
metadata:
  name: hpa-example
spec:
  scaleTargetRef:
    apiVersion: apps/v1beta1
    kind: Deployment
    name: hpa-example
  minReplicas: 1
  maxReplicas: 6
  targetCPUUtilizationPercentage: 50
```



50% of  
request

\$ kubectl get hpa --watch

NAME	REFERENCE	TARGETS	MINPODS	MAXPODS	REPLICAS	AGE
hpa-example	Deployment/hpa-example	0% / 50%	1	6	1	12m
hpa-example	Deployment/hpa-example	522% / 50%	1	6	1	12m
hpa-example	Deployment/hpa-example	522% / 50%	1	6	1	12m
hpa-example	Deployment/hpa-example	941% / 50%	1	6	1	13m
hpa-example	Deployment/hpa-example	941% / 50%	1	6	4	13m
hpa-example	Deployment/hpa-example	362% / 50%	1	6	4	14m
hpa-example	Deployment/hpa-example	362% / 50%	1	6	4	14m
hpa-example	Deployment/hpa-example	12% / 50%	1	6	4	15m
hpa-example	Deployment/hpa-example	12% / 50%	1	6	4	15m
hpa-example	Deployment/hpa-example	0% / 50%	1	6	4	16m

# Auto-scale Node on Container Engine

```
$ gcloud alpha container clusters update cluster-1 \  
  --enable-autoscaling \  
  --min-nodes=2 \  
  --max-nodes=6 \  
  --zone=asia-southeast1-b \  
  --node-pool=default-pool \  
  --project=acoshift-k8s
```





Name	default-pool
Current size	<input type="text" value="1"/>
Node version	1.7.0
Node image	Container-Optimized OS (cos)
Machine type	n1-standard-1 (1 vCPU, 3.75 GB memory)
Total cores	1 vCPU
Total memory	3.75 GB
Automatic node upgrades	Disabled
Automatic node repair	Disabled

Automatic node upgrades (beta) ?

Automatic node repair (beta) ?

Autoscaling (beta) ?

Minimal size

Maximal size

Preemptible nodes	Disabled
Boot disk size in GB (per node)	100
Local SSD disks (per node)	0
Instance groups	<a href="#">gke-cluster-1-default-pool-73cdab92-grp</a>

# Labels

key/value pairs that are attached to objects

```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: echoserver
  labels:
    app: echoserver
spec:
  template:
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.6
        ports:
        - containerPort: 8080
```

---

```
kind: Service
apiVersion: v1
metadata:
  name: echoserver
  labels:
    app: echoserver
spec:
  selector:
    app: echoserver
  ports:
  - port: 80
    targetPort: 8080
```

\$ kubectl get all -l app=echoserver

NAME	READY	STATUS	RESTARTS	AGE
po/echoserver-3345770719-c5q61	1/1	Running	0	10s

NAME	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
svc/echoserver	10.3.240.126	<none>	80/TCP	9s

NAME	DESIRED	CURRENT	UP-TO-DATE	AVAILABLE	AGE
deploy/echoserver	1	1	1	1	10s

NAME	DESIRED	CURRENT	READY	AGE
rs/echoserver-3345770719	1	1	1	10s

# Node Selector

```
$ kubectl label no node-3 nodeType=highmem
```

```
$ kubectl get no --show-labels
```

```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: redis
spec:
  template:
    metadata:
      labels:
        app: redis
    spec:
      containers:
      - name: redis
        image: redis:3.2.9
        ports:
        - containerPort: 6379
      nodeSelector:
        nodeType: highmem
```

```
$ kubectl label no node-3 nodeType-
```



Q&A

DAY 2

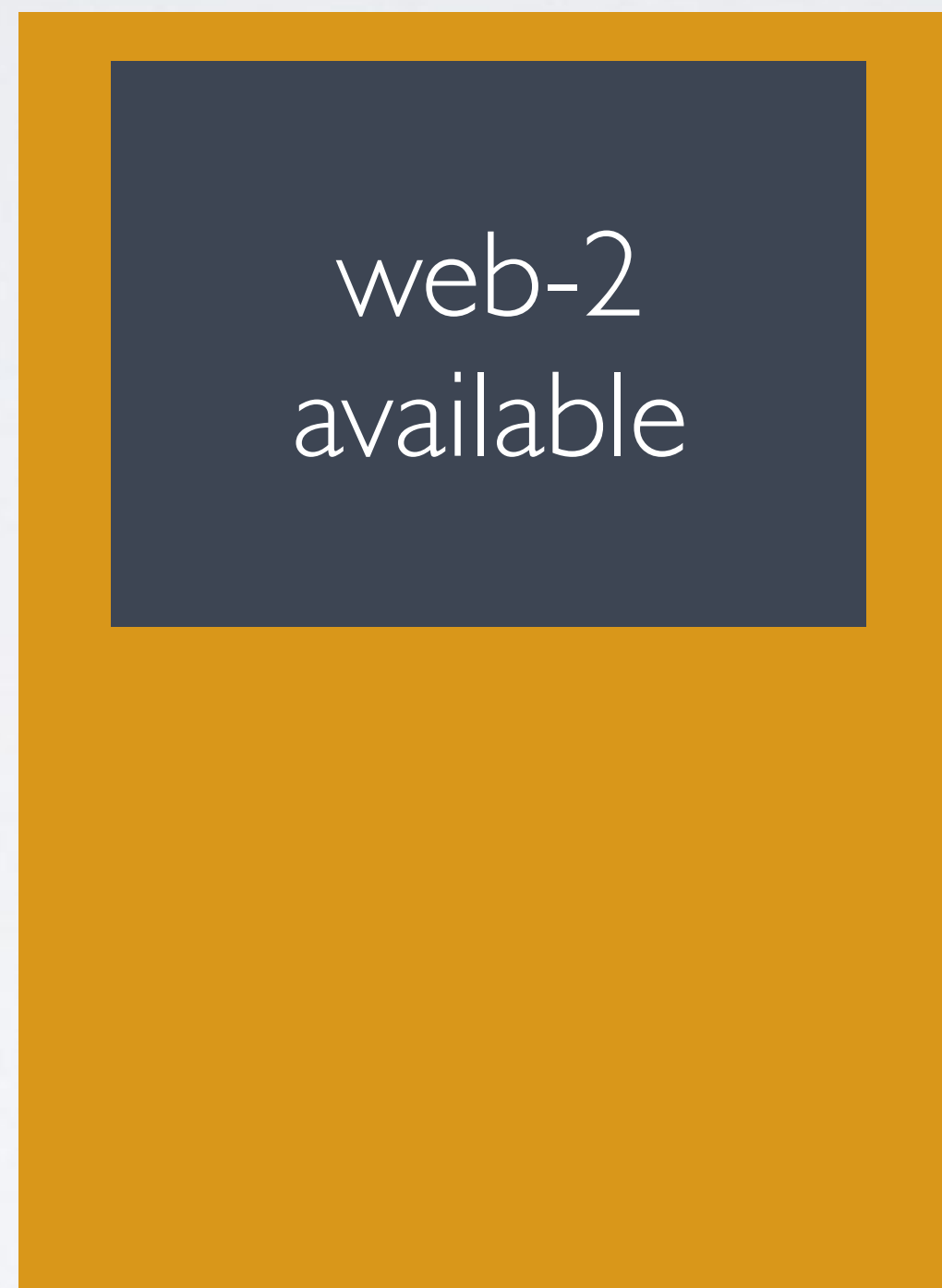
# Pod Disruption Budgets (pdb)

limits the number pods of a replicated application  
that are down simultaneously from voluntary disruptions

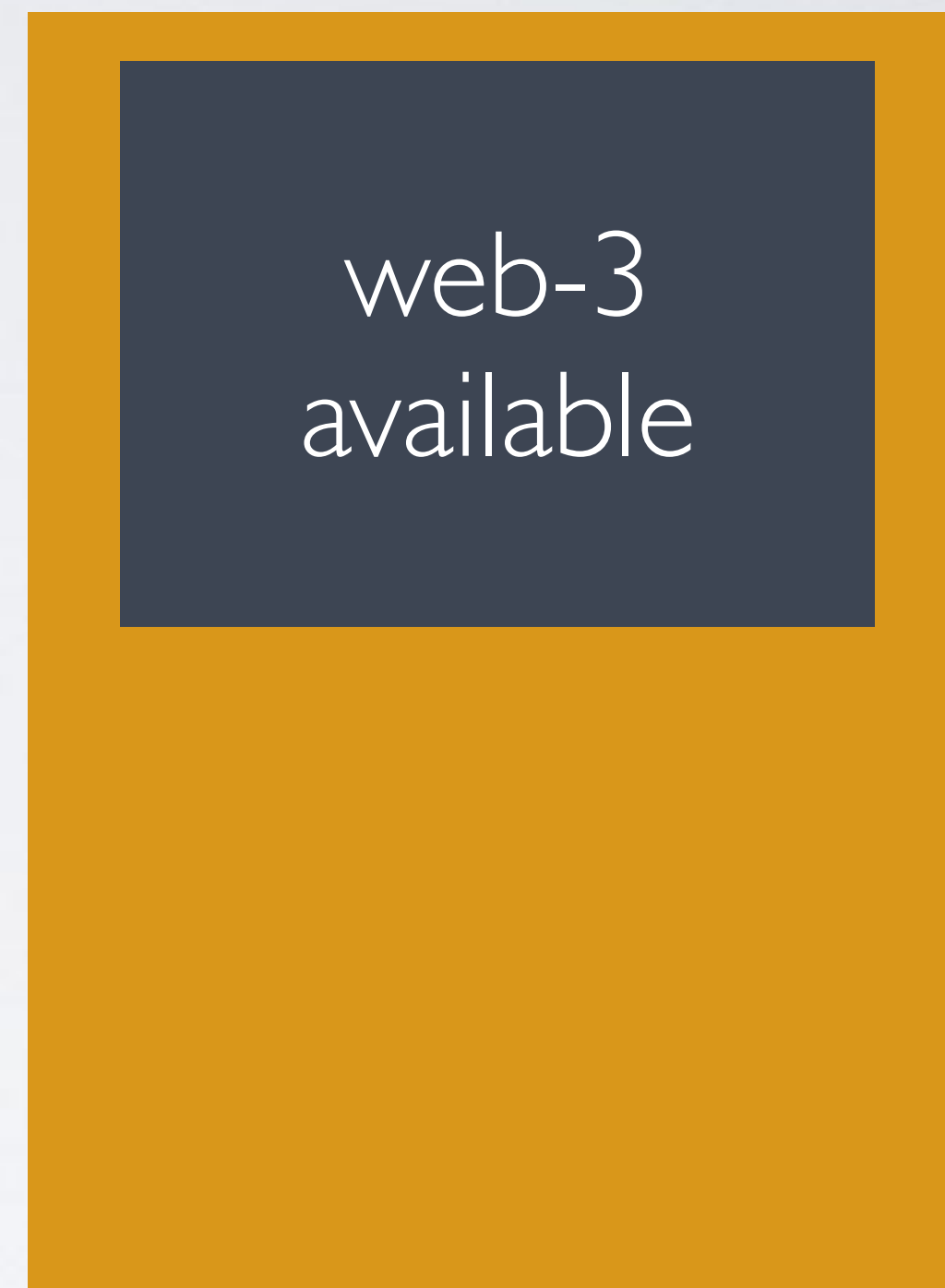
web: replicas=3, minAvailable=2



node-1



node-2

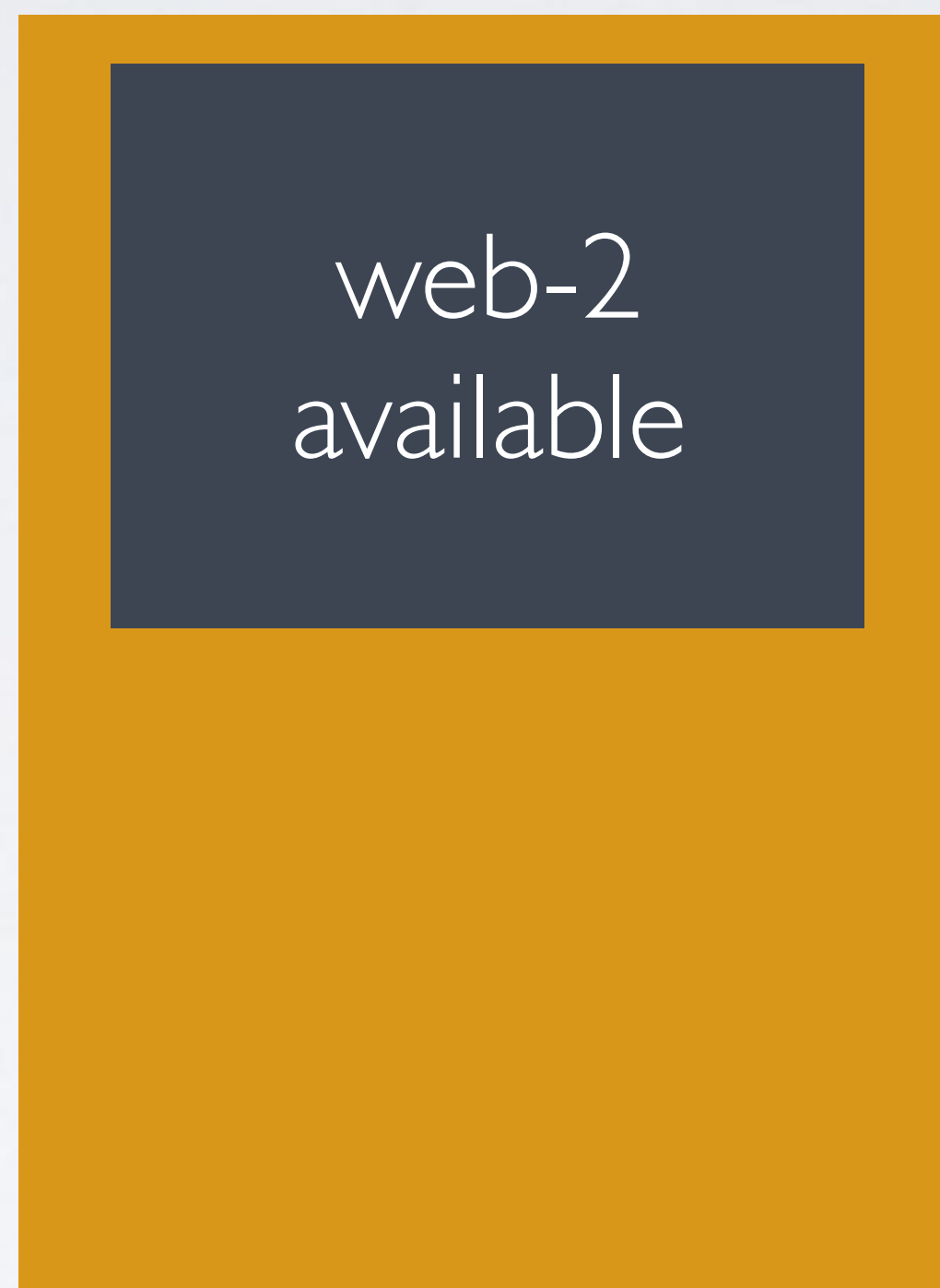


node-3

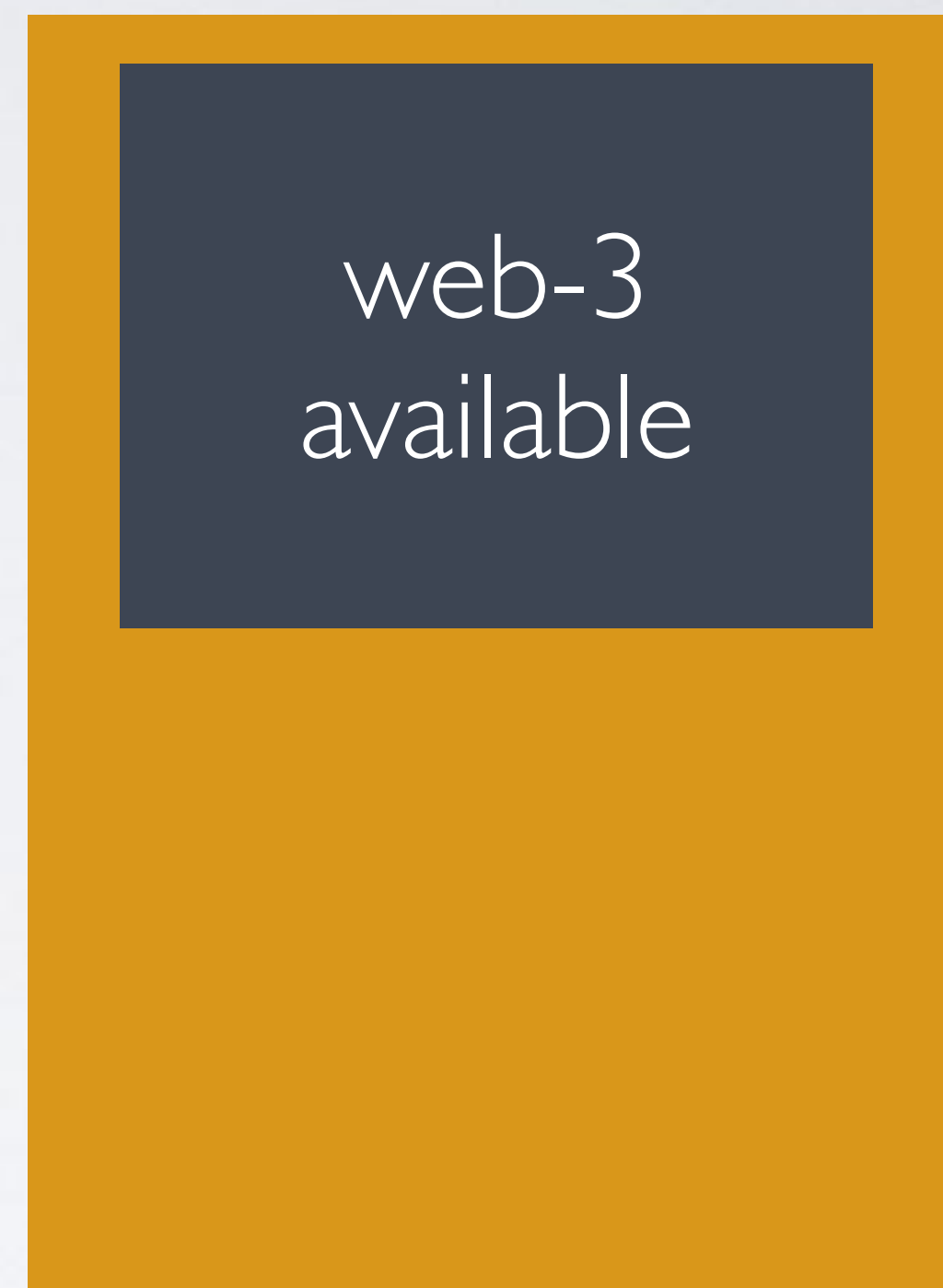
web: replicas=3, minAvailable=2



node-1  
draining

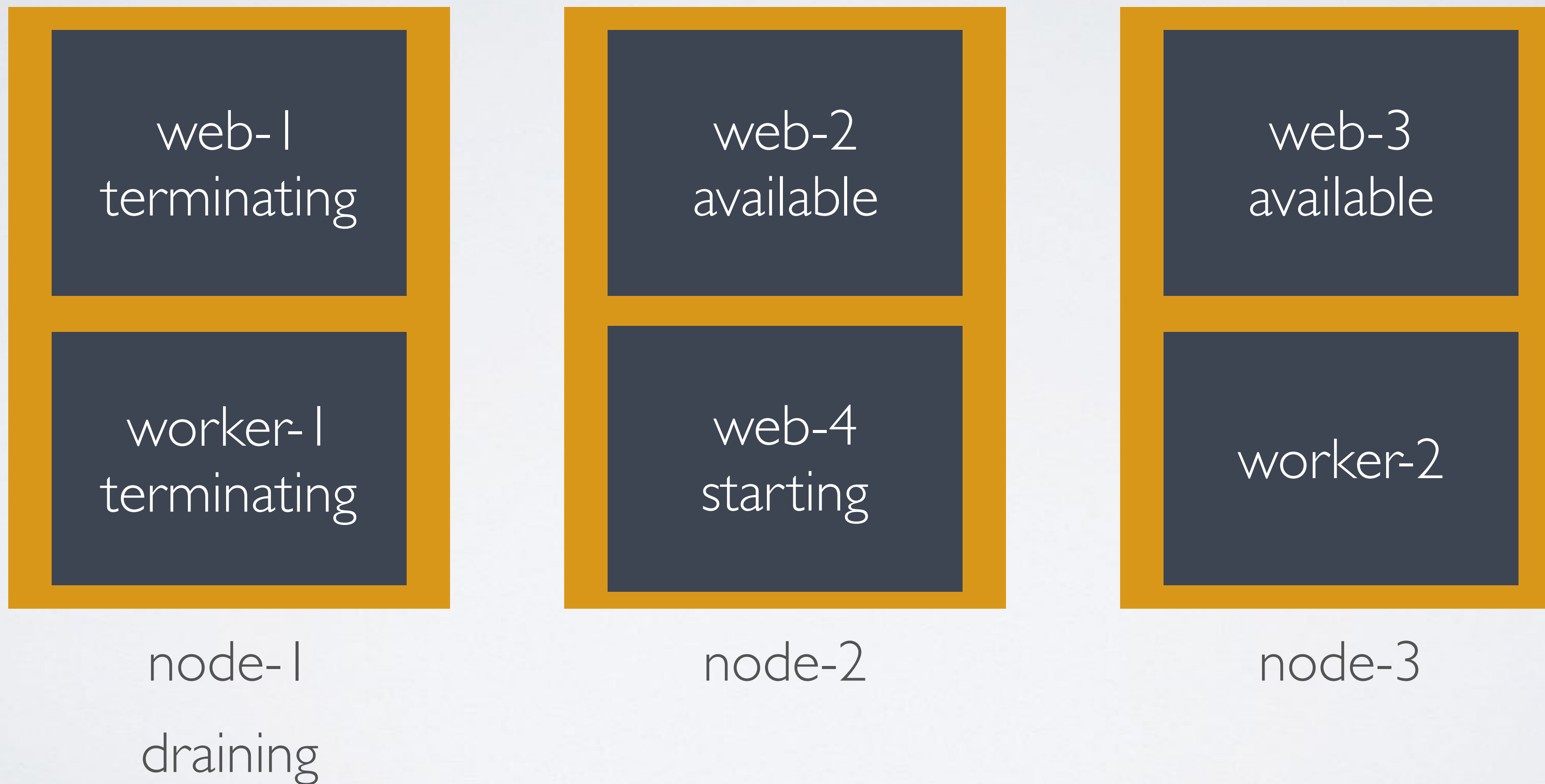


node-2



node-3

web: replicas=3, minAvailable=2



web: replicas=3, minAvailable=2



node-1  
drained



node-2



node-3

web: replicas=3, minAvailable=2



node-1  
drained



node-2



node-3



web: replicas=3, minAvailable=2



node-1  
drained



node-2  
draining



node-3

web: replicas=3, minAvailable=2

web-5  
pending



node-1  
drained



node-2  
drain blocked



node-3

# PodDisruptionBudget

- minAvailable
- maxUnavailable



percent/value

```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: echoserver
spec:
  replicas: 3
  template:
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.6
        ports:
        - containerPort: 8080
        resources:
          requests:
            cpu: 400m
```

```
kind: PodDisruptionBudget
apiVersion: policy/v1beta1
metadata:
  name: echoserver
spec:
  minAvailable: 2
  # minAvailable: 67%
  selector:
    matchLabels:
      app: echoserver
```

```
$ kubectl get no
```

NAME	STATUS	AGE	VERSION
gke-cluster-2-default-pool-75546f17-39fq	Ready	10m	v1.7.0
gke-cluster-2-default-pool-75546f17-9dc5	Ready	10m	v1.7.0
gke-cluster-2-default-pool-75546f17-xr57	Ready	10m	v1.7.0

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
echoserver-1994896057-4lk6s	1/1	Running	0	50s
echoserver-1994896057-f0rft	1/1	Running	0	51s
echoserver-1994896057-p0lpr	1/1	Running	0	42s

```
$ kubectl drain gke-cluster-2-default-pool-75546f17-39fq --force --ignore-daemonsets
node "gke-cluster-2-default-pool-75546f17-39fq" already cordoned
pod "kube-dns-autoscaler-3880103346-4qj3t" evicted
pod "kube-dns-1413379277-h96k0" evicted
node "gke-cluster-2-default-pool-75546f17-39fq" drained
```

```
$ kubectl get no
```

NAME	STATUS	AGE	VERSION
gke-cluster-2-default-pool-75546f17-39fq	Ready,SchedulingDisabled	16m	v1.7.0
gke-cluster-2-default-pool-75546f17-9dc5	Ready	16m	v1.7.0
gke-cluster-2-default-pool-75546f17-xr57	Ready	16m	v1.7.0

```
$ kubectl drain gke-cluster-2-default-pool-75546f17-9dc5 --force --ignore-daemonsets
node "gke-cluster-2-default-pool-75546f17-9dc5" already cordoned
pod "heapster-v1.4.0-2764992688-5xp57" evicted
pod "kubernetes-dashboard-1962351010-2xtq1" evicted
pod "echoserver-1994896057-f0rft" evicted
pod "l7-default-backend-2954409777-d4x3g" evicted
pod "event-exporter-v0.1.4-1771975458-s86dg" evicted
# hang
pod "echoserver-1994896057-p0lpr" evicted
node "gke-cluster-2-default-pool-75546f17-9dc5" drained
```

```
$ kubectl get no
NAME                                STATUS                                AGE      VERSION
gke-cluster-2-default-pool-75546f17-39fq  Ready,SchedulingDisabled            18m      v1.7.0
gke-cluster-2-default-pool-75546f17-9dc5  Ready,SchedulingDisabled            18m      v1.7.0
gke-cluster-2-default-pool-75546f17-xr57  Ready                               18m      v1.7.0
```

```
$ kubectl get po
NAME                                READY   STATUS    RESTARTS   AGE
echoserver-1994896057-1tg93        0/1     Pending   0           1m
echoserver-1994896057-1w5s7        1/1     Running   0           1m
echoserver-1994896057-4lk6s        1/1     Running   0           7m
```

```
$ kubectl describe po/echoserver-1994896057-1tg93
...
Events:
  FirstSeen    LastSeen    Count   From              SubObjectPath Type     Reason                  Message
  -----
  1m          1m          5    default-scheduler Warning    FailedScheduling    No nodes are available that match all of the following predicates:: Insufficient cpu (1), PodToleratesNodeTaints (1).
...
```

```
$ kubectl uncordon gke-cluster-2-default-pool-75546f17-39fq
node "gke-cluster-2-default-pool-75546f17-39fq" uncordoned
```



```
$ kubectl get no
NAME                                     STATUS                                AGE      VERSION
gke-cluster-2-default-pool-75546f17-39fq Ready                                22m      v1.7.0
gke-cluster-2-default-pool-75546f17-9dc5 Ready,SchedulingDisabled            22m      v1.7.0
gke-cluster-2-default-pool-75546f17-xr57 Ready                                22m      v1.7.0
```

```
$ kubectl get po
NAME                                READY   STATUS    RESTARTS   AGE
echoserver-1994896057-1tg93        1/1     Running   0          4m
echoserver-1994896057-1w5s7        1/1     Running   0          4m
echoserver-1994896057-4lk6s        1/1     Running   0         10m
```

```
$ kubectl uncordon gke-cluster-2-default-pool-75546f17-9dc5
node "gke-cluster-2-default-pool-75546f17-9dc5" uncordoned
```

```
$ kubectl get no
NAME                                     STATUS    AGE      VERSION
gke-cluster-2-default-pool-75546f17-39fq Ready     25m      v1.7.0
gke-cluster-2-default-pool-75546f17-9dc5 Ready     25m      v1.7.0
gke-cluster-2-default-pool-75546f17-xr57 Ready     25m      v1.7.0
```

# Persistent Disks (pd)



# Create Persistent Disk (pd) on GCP

```
$ gcloud compute disks create --size=20GB --zone=asia-southeast1-b --project=acoshift-k8s mysql-disk
Created [https://www.googleapis.com/compute/v1/projects/acoshift-k8s/zones/asia-southeast1-b/disks/mysql-disk].
```

NAME	ZONE	SIZE_GB	TYPE	STATUS
mysql-disk	asia-southeast1-b	20	pd-standard	READY

```
apiVersion: apps/v1beta1
kind: Deployment
metadata:
  name: mysql
spec:
  replicas: 1
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql
    spec:
      containers:
      - name: mysql
        env:
          - name: MYSQL_ROOT_PASSWORD
            value: mysqlpassword1234
        image: mysql:5.6.36
        imagePullPolicy: IfNotPresent
        ports:
          - containerPort: 3306
        volumeMounts:
          - mountPath: /var/lib/mysql
            name: mysql-disk
      volumes:
      - name: mysql-disk
        gcePersistentDisk:
          pdName: mysql-disk
          fsType: ext4
```

```
$ kubectl create -f 14-pv.yaml  
deployment "mysql" created
```

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
mysql-1398320157-mgf6c	1/1	Running	0	3m

```
$ kubectl port-forward mysql-1398320157-mgf6c 3306:3306
```

```
$ mysql -u root -p -h 127.0.0.1
```

```
mysql> create database db1;  
Query OK, 1 row affected (0.05 sec)
```

```
mysql> use db1;  
Database changed
```

```
mysql> create table users (  
    -> id int auto_increment,  
    -> name varchar(255) not null,  
    -> created_at timestamp not null default now(),  
    -> primary key (id)  
    -> );  
Query OK, 0 rows affected (0.08 sec)
```

```
mysql> insert into users (name) values ('acoshift'), ('user1'), ('user2');  
Query OK, 3 rows affected (0.08 sec)  
Records: 3  Duplicates: 0  Warnings: 0
```

```
mysql> select * from users;
```

id	name	created_at
1	acoshift	2017-07-15 14:46:04
2	user1	2017-07-15 14:46:04
3	user2	2017-07-15 14:46:04

```
3 rows in set (0.03 sec)
```

```
mysql> exit  
Bye
```

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
mysql-1398320157-mgf6c	1/1	Running	0	19m

```
$ kubectl delete po/mysql-1398320157-mgf6c  
pod "mysql-1398320157-mgf6c" deleted
```

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
mysql-1398320157-d0scs	0/1	ContainerCreating	0	30s

Pods



Name	Status	Restarts	Age	CPU (cores)	Memory (bytes)
------	--------	----------	-----	-------------	----------------



mysql-1398320157-d0scs

Waiting: Containe...

0

41 seconds

-

-



AttachVolume.Attach failed for volume "mysql-disk" : googleapi: Error 400: The disk resource 'projects/acoshift-k8s/zones/asia-southeast1-b/disks/mysql-disk' is already being used by 'projects/acoshift-k8s/zones/asia-southeast1-b/instances/gke-cluster-1-default-pool-73cdab92-hhk2'

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
mysql-1398320157-d0scs	1/1	Running	0	6m

```
$ kubectl port-forward mysql-1398320157-d0scs 3306:3306
```

```
Forwarding from 127.0.0.1:3306 -> 3306
```

```
Forwarding from [::1]:3306 -> 3306
```

```
$ mysql -u root -p -h 127.0.0.1
```

```
mysql> use db1;  
Database changed
```

```
mysql> select * from users;
```

id	name	created_at
1	acosshift	2017-07-15 14:46:04
2	user1	2017-07-15 14:46:04
3	user2	2017-07-15 14:46:04

```
3 rows in set (0.04 sec)
```

```
mysql> exit  
Bye
```

```
$ kubectl delete -f 14-pd.yaml  
deployment "mysql" deleted
```

```
$ gcloud compute disks delete --zone=asia-southeast1-b --project=acoshift-k8s mysql-disk  
The following disks will be deleted:  
- [mysql-disk] in [asia-southeast1-b]
```

```
Do you want to continue (Y/n)? Y
```

```
Deleted [https://www.googleapis.com/compute/v1/projects/acoshift-k8s/zones/asia-southeast1-b/disks/mysql-disk].
```



# Persistent Volumes (pv)

a piece of storage in the cluster that has been provisioned  
by an administrator

# Persistent Volume Claims (pvc)

a request for storage by a user

# Storage Classes

a way for administrators to describe the “classes” of storage they offer

# Provisioning

- Static
- Dynamic

```
$ kubectl get storageclass
```

NAME	TYPE
standard (default)	kubernetes.io/gce-pd

```
$ kubectl describe storageclass standard
```

Name: standard

IsDefaultClass: Yes

Annotations: storageclass.beta.kubernetes.io/is-default-class=true

Provisioner: kubernetes.io/gce-pd

Parameters: type=pd-standard

Events: <none>

```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: ssd
provisioner: kubernetes.io/gce-pd
parameters:
  # type: pd-standard
  type: pd-ssd
  zone: asia-southeast1-b
```

```
$ kubectl create -f 15-storageclass.yaml  
storageclass "ssd" created
```

```
$ kubectl get storageclass
```

NAME	TYPE
ssd	kubernetes.io/gce-pd
standard (default)	kubernetes.io/gce-pd

# Access Modes

- `ReadWriteOnce` — the volume can be mounted as read-write by a single node
- `ReadOnlyMany` — the volume can be mounted read-only by many nodes
- `ReadWriteMany` — the volume can be mounted as read-write by many nodes

Volume Plugin	ReadWriteOnce	ReadOnlyMany	ReadWriteMany
AWSElasticBlockStore	✓	-	-
AzureFile	✓	✓	✓
AzureDisk	✓	-	-
CephFS	✓	✓	✓
Cinder	✓	-	-
FC	✓	✓	-
FlexVolume	✓	✓	-
Flocker	✓	-	-
GCEPersistentDisk	✓	✓	-
Glusterfs	✓	✓	✓
HostPath	✓	-	-
iSCSI	✓	✓	-
PhotonPersistentDisk	✓	-	-
Quobyte	✓	✓	✓
NFS	✓	✓	✓
RBD	✓	✓	-
VsphereVolume	✓	-	-
PortworxVolume	✓	-	✓
ScaleIO	✓	✓	-
StorageOS	✓	-	-

<https://kubernetes.io/docs/concepts/storage/persistent-volumes/>



# Reclaim Policy

- Retain

Default for static  
provisioning

- Recycle

Default for dynamic  
provisioning

- Delete



```
kind: PersistentVolume
apiVersion: v1
metadata:
  name: disk-1
  annotations:
    volume.beta.kubernetes.io/mount-options: discard
spec:
  storageClassName: standard
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  gcePersistentDisk:
    fsType: ext4
    pdName: disk-1
```

```
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: mysql-pvc
spec:
  storageClassName: standard
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 5Gi
```

```
$ gcloud compute disks create --size=10GB --zone=asia-southeast1-b --project=acoshift-k8s disk-1
Created [https://www.googleapis.com/compute/v1/projects/acoshift-k8s/zones/asia-southeast1-b/disks/disk-1].
```

NAME	ZONE	SIZE_GB	TYPE	STATUS
disk-1	asia-southeast1-b	10	pd-standard	READY

```
$ kubectl create -f 16-pv.yaml
persistentvolume "disk-1" created
```

```
$ kubectl get pv
```

NAME	CAPACITY	ACCESSMODES	RECLAIMPOLICY	STATUS	CLAIM	STORAGECLASS	REASON	AGE
disk-1	10Gi	RWO	Retain	Available				12s

```
$ kubectl create -f 16-pvc.yaml
persistentvolumeclaim "mysql-pvc" created
```

```
$ kubectl get pv
```

NAME	CAPACITY	ACCESSMODES	RECLAIMPOLICY	STATUS	CLAIM	STORAGECLASS	REASON	AGE
disk-1	10Gi	RWO	Retain	Bound	default/mysql-pvc	standard		1m

```
$ kubectl get pvc
```

NAME	STATUS	VOLUME	CAPACITY	ACCESSMODES	STORAGECLASS	AGE
mysql-pvc	Bound	disk-1	10Gi	RWO	standard	34s

```
apiVersion: apps/v1beta1
kind: Deployment
metadata:
  name: mysql
spec:
  replicas: 1
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql
    spec:
      containers:
      - name: mysql
        env:
          - name: MYSQL_ROOT_PASSWORD
            value: mysqlpassword1234
        image: mysql:5.6.36
        imagePullPolicy: IfNotPresent
        ports:
          - containerPort: 3306
        volumeMounts:
          - mountPath: /var/lib/mysql
            name: mysql-disk
      volumes:
      - name: mysql-disk
        persistentVolumeClaim:
          claimName: mysql-pvc
```

```
$ kubectl create -f 16-mysql.yaml  
deployment "mysql" created
```

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
mysql-68058648-d3m8l	1/1	Running	0	48s

```
$ kubectl delete po/mysql-68058648-d3m8l  
pod "mysql-68058648-d3m8l" deleted
```

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
mysql-68058648-rsqk1	1/1	Running	0	4s

```
$ kubectl delete deploy/mysql pvc/mysql-pvc pv/disk-1  
deployment "mysql" deleted  
persistentvolumeclaim "mysql-pvc" deleted  
persistentvolume "disk-1" deleted
```

```
$ gcloud compute disks delete --zone=asia-southeast1-b --project=acoshift-k8s disk-1  
The following disks will be deleted:  
- [disk-1] in [asia-southeast1-b]
```

```
Do you want to continue (Y/n)? Y
```

```
Deleted [https://www.googleapis.com/compute/v1/projects/acoshift-k8s/zones/asia-southeast1-b/disks/disk-1].
```

# Stateful Sets

provides guarantees about the ordering of deployment and scaling



# Stateful Sets

- Stable, unique network identifier
- Stable, persistent storage
- Ordered, graceful deployment and scaling
- Ordered, graceful deletion and termination
- Ordered, automated rolling updates



```
$ kubectl create -f https://raw.githubusercontent.com/cockroachdb/cockroach/master/cloud/kubernetes/cockroachdb-statefulset.yaml
service "cockroachdb-public" created
service "cockroachdb" created
poddisruptionbudget "cockroachdb-budget" created
statefulset "cockroachdb" created
```

```
$ kubectl get po
```

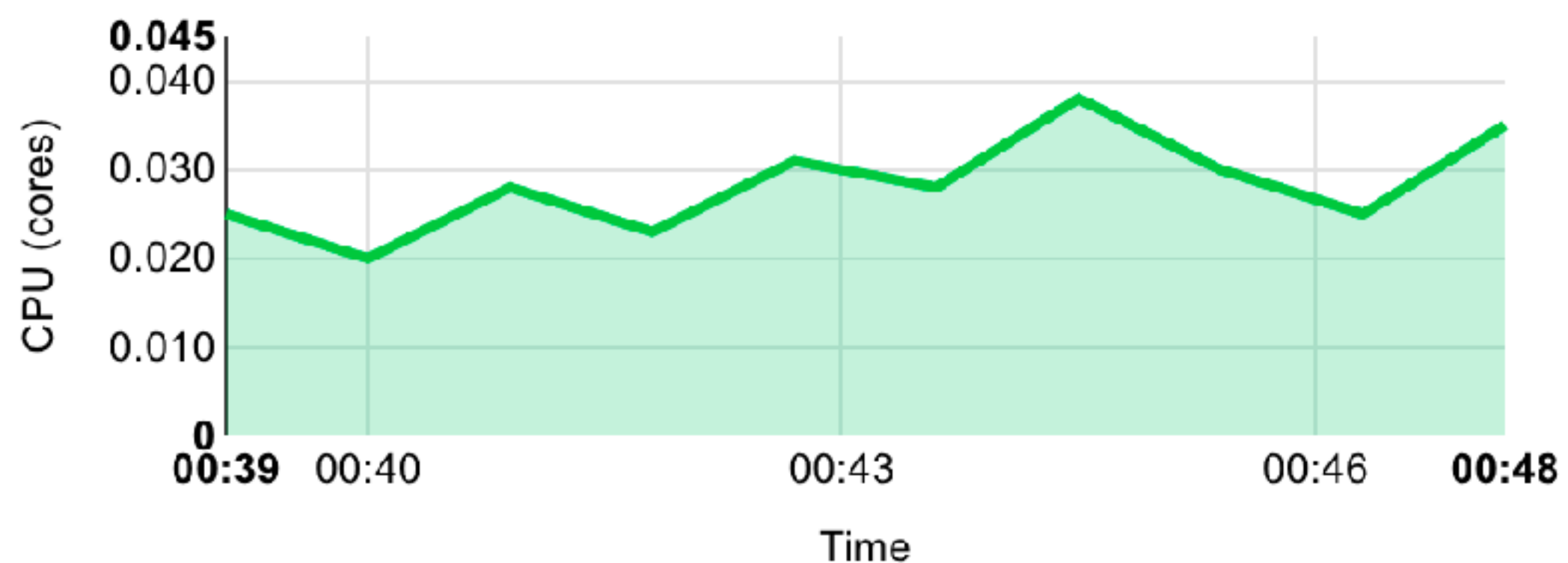
NAME	READY	STATUS	RESTARTS	AGE
cockroachdb-0	1/1	Running	0	10m
cockroachdb-1	1/1	Running	0	9m
cockroachdb-2	1/1	Running	0	8m

```
$ kubectl port-forward cockroachdb-0 8080
```

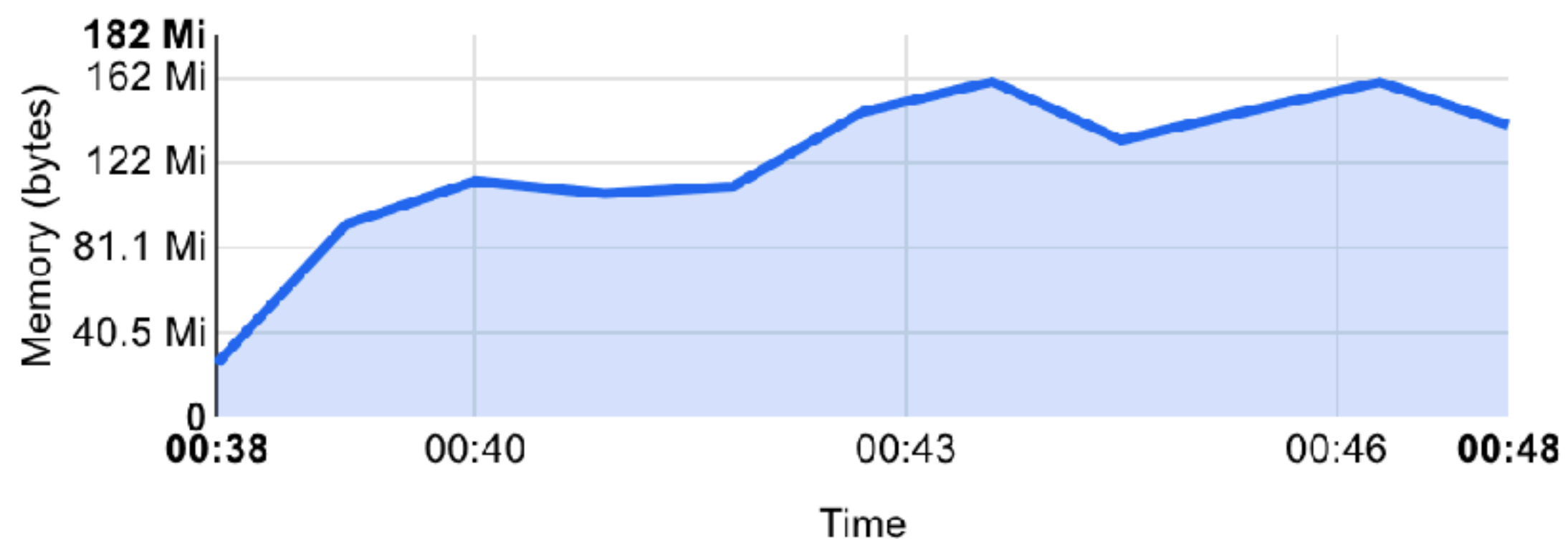
# Live Nodes

ID ▼	ADDRESS ▼	UPTIME ▼	BYTES ▼	REPLICAS ▼	MEM USAGE ▼	LOGS
1	<ul style="list-style-type: none"><li>cockroachdb-0.cockroachdb.default.svc.cluster.local:26257</li></ul>	10 minutes	3.2 MiB	10	95.6 MiB	<a href="#">Logs</a>
2	<ul style="list-style-type: none"><li>cockroachdb-1.cockroachdb.default.svc.cluster.local:26257</li></ul>	9 minutes	3.3 MiB	10	71.5 MiB	<a href="#">Logs</a>
3	<ul style="list-style-type: none"><li>cockroachdb-2.cockroachdb.default.svc.cluster.local:26257</li></ul>	9 minutes	3.3 MiB	10	70.4 MiB	<a href="#">Logs</a>







## CPU usage



## Memory usage i



## Pods ≡

Name <span>⬆</span>	Status <span>⬆</span>	Restarts	Age <span>⬆</span>	CPU (cores)	Memory (bytes)		
✓ cockroachdb-4	Running	0	52 seconds	-	-	≡	⋮
✓ cockroachdb-3	Running	0	a minute	-	-	≡	⋮
✓ cockroachdb-2	Running	0	11 minutes	 0.009	 35.863 Mi	≡	⋮
✓ cockroachdb-1	Running	0	11 minutes	 0.011	 37.871 Mi	≡	⋮
✓ cockroachdb-0	Running	0	13 minutes	 0.015	 65.488 Mi	≡	⋮

# Live Nodes

ID ▾	ADDRESS ▾	UPTIME ▾	BYTES ▾	REPLICAS ▾	MEM USAGE ▾	LOGS
1	<ul style="list-style-type: none"><li>cockroachdb-0.cockroachdb.default.svc.cluster.local:26257</li></ul>	12 minutes	4.2 MiB	6	101.6 MiB	<a href="#">Logs</a>
2	<ul style="list-style-type: none"><li>cockroachdb-1.cockroachdb.default.svc.cluster.local:26257</li></ul>	11 minutes	84.4 KiB	7	73.5 MiB	<a href="#">Logs</a>
3	<ul style="list-style-type: none"><li>cockroachdb-2.cockroachdb.default.svc.cluster.local:26257</li></ul>	11 minutes	111.2 KiB	6	73.6 MiB	<a href="#">Logs</a>
4	<ul style="list-style-type: none"><li>cockroachdb-3.cockroachdb.default.svc.cluster.local:26257</li></ul>	a minute	4.1 MiB	5	60.4 MiB	<a href="#">Logs</a>
5	<ul style="list-style-type: none"><li>cockroachdb-4.cockroachdb.default.svc.cluster.local:26257</li></ul>	a minute	4.1 MiB	6	60.5 MiB	<a href="#">Logs</a>

```
$ kubectl run -it --rm cockroach-client --image=cockroachdb/cockroach --restart=Never --command -- ./cockroach sql --host cockroachdb-public --insecure
```

```
root@cockroachdb-public:26257/> create database db1;
CREATE DATABASE
```

```
root@cockroachdb-public:26257/> set database = db1;
SET
```

```
root@cockroachdb-public:26257/db1> create table users (
    -> id serial,
    -> name string not null default '',
    -> created_at timestamp not null default now(),
    -> primary key (id)
    -> );
```

CREATE TABLE

```
root@cockroachdb-public:26257/db1> insert into users (name) values ('acoshift'), ('user1'), ('user2');
INSERT 3
```

```
root@cockroachdb-public:26257/db1> select * from users;
```

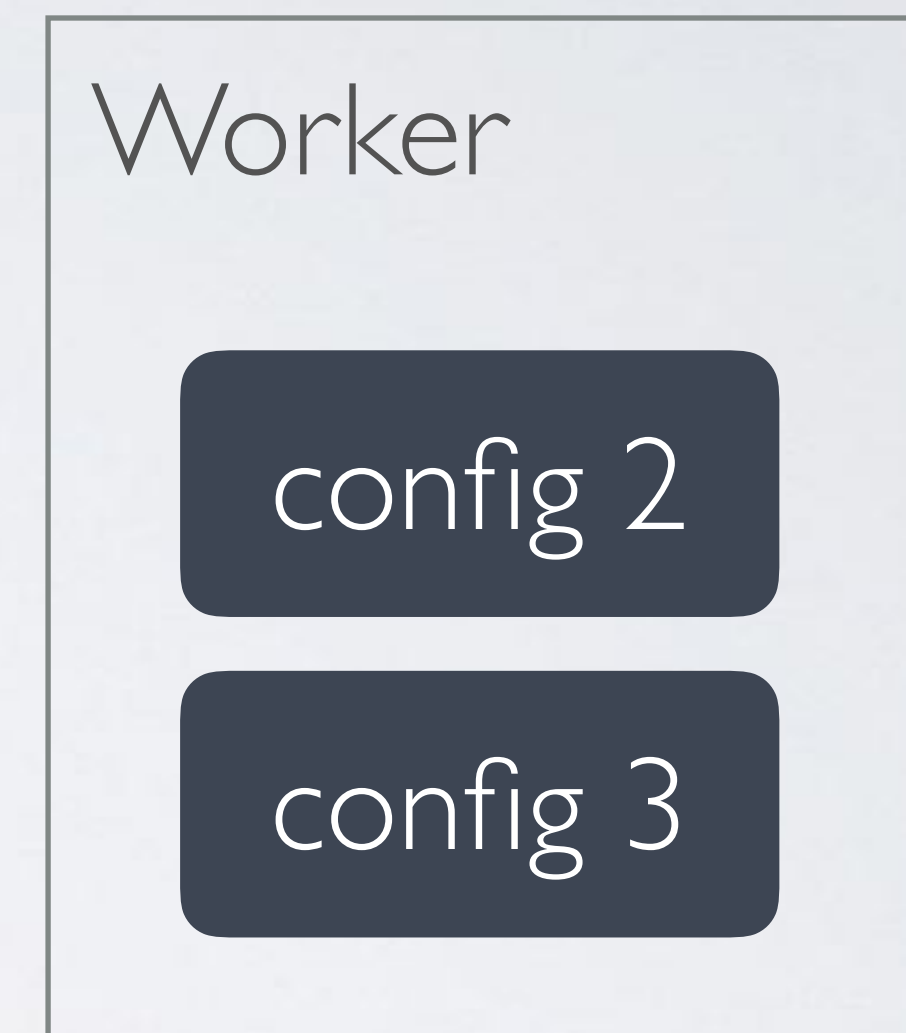
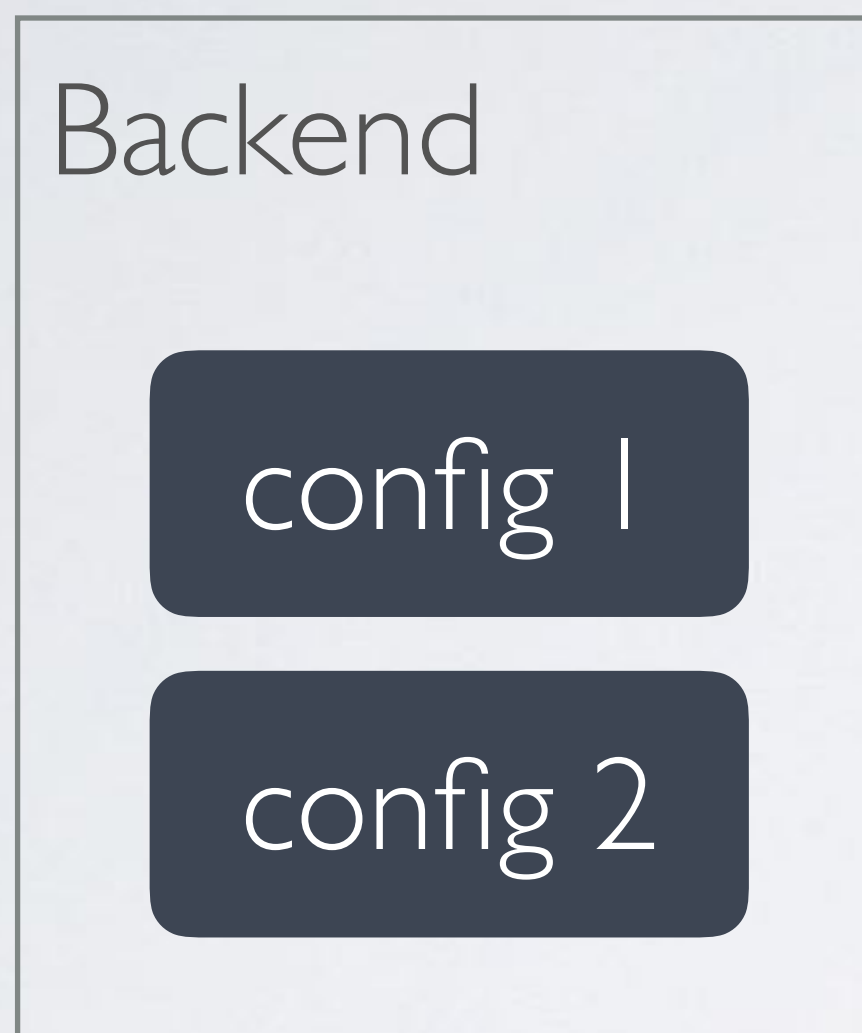
id	name	created_at
262376372306051076	acoshift	2017-07-15 17:55:14.366042+00:00
262376372306247684	user1	2017-07-15 17:55:14.366042+00:00
262376372306345988	user2	2017-07-15 17:55:14.366042+00:00

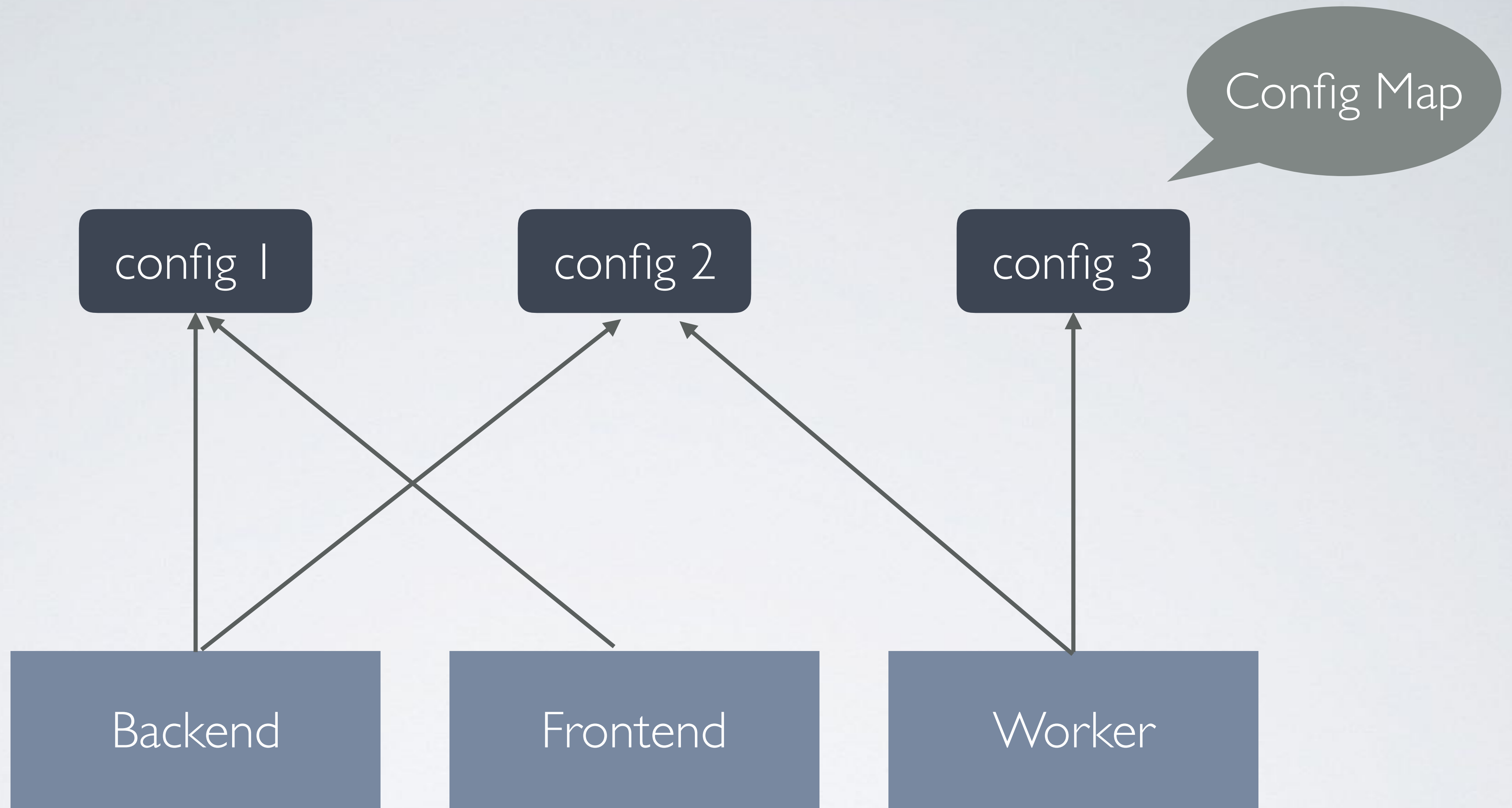
(3 rows)



# Config Maps (cm)

decouple configuration artifacts from image content  
to keep containerized applications portable







```
kind: ConfigMap
apiVersion: v1
metadata:
  name: redis-config
data:
  redis.conf: |
    databases 1
    save ""
    appendonly no
    maxmemory 2mb
    maxmemory-policy allkeys-lru
```

```
---
kind: Service
apiVersion: v1
metadata:
  name: redis
spec:
  selector:
    app: redis
  ports:
  - port: 6379
```

```
kind: StatefulSet
apiVersion: apps/v1beta1
metadata:
  name: redis
spec:
  serviceName: redis
  replicas: 1
  template:
    metadata:
      labels:
        app: redis
    spec:
      containers:
      - name: redis
        image: redis:3.2.9
        ports:
        - containerPort: 6379
        volumeMounts:
        - mountPath: /usr/local/etc/redis
          name: config
        command:
        - redis-server
        - /usr/local/etc/redis/redis.conf
      volumes:
      - name: config
        configMap:
          name: redis-config
          items:
          - key: redis.conf
            path: redis.conf
```

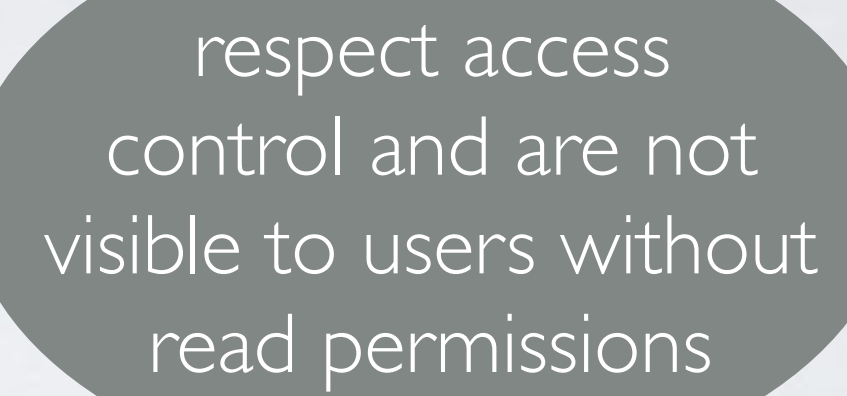
```
$ kubectl create -f 21-cm.yaml  
configmap "redis-config" created  
service "redis" created  
statefulset "redis" created
```

```
$ kubectl run -it --rm redis-client --image=redis --restart=Never --command -- bash  
root@redis-client:/data# redis-cli -h redis
```

```
redis:6379> config get save  
1) "save"  
2) ""
```

# Secrets

hold sensitive information



respect access  
control and are not  
visible to users without  
read permissions

```
$ echo -n "testuser" | base64
```

```
dGVzdHVzZXI=
```

```
$ echo -n "testpassword" | base64
```

```
dGVzdHBhc3N3b3Jk
```

```
apiVersion: v1
kind: Secret
metadata:
  name: backend-secret
data:
  username: dGVzdHVzZXI=
  password: dGVzdHBhc3N3b3Jk
```

```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: nginx
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: gcr.io/google-containers/nginx-slim:0.8
        ports:
        - containerPort: 80
        volumeMounts:
        - name: www
          mountPath: /usr/share/nginx/html
      volumes:
      - name: www
        secret:
          secretName: backend-secret
          defaultMode: 0666
```

```
$ kubectl create -f 22-secret.yaml
```

```
$ kubectl get po
```

NAME	READY	STATUS	RESTARTS	AGE
nginx-1183500012-cjcpq	1/1	Running	0	15s

```
$ kubectl port-forward nginx-1183500012-cjcpq 8080:80
```

```
$ curl localhost:8080/username  
testuser
```

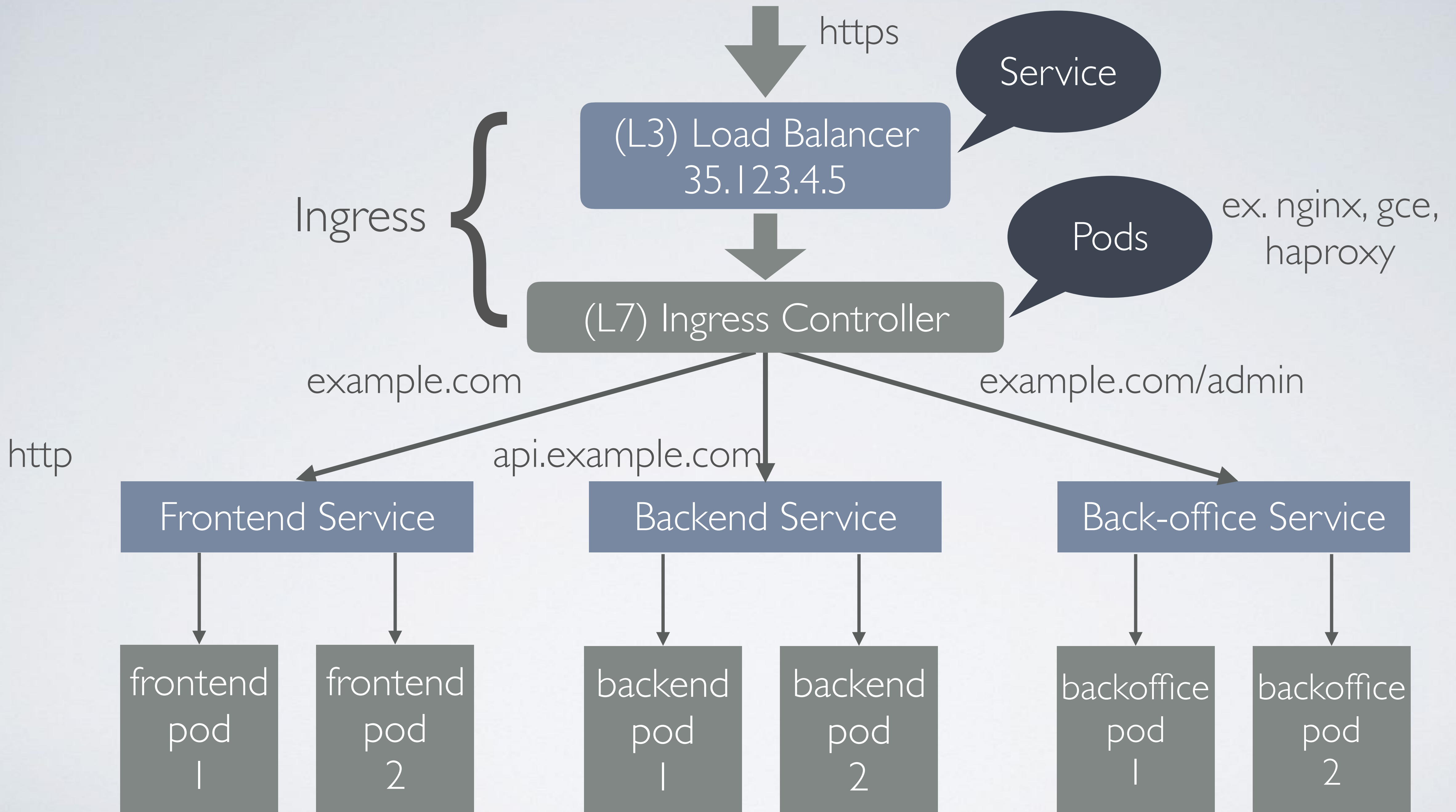
```
$ curl localhost:8080/password  
testpassword
```





# Ingresses (ing)

a collection of rules that allow inbound connections to reach the cluster services



```
kind: Deployment
apiVersion: apps/v1beta1
metadata:
  name: echoserver
spec:
  replicas: 3
  template:
    metadata:
      labels:
        app: echoserver
    spec:
      containers:
      - name: echoserver
        image: gcr.io/google-containers/echoserver:1.6
        ports:
        - containerPort: 8080
```

```
apiVersion: v1
kind: Service
metadata:
  name: echoserver
spec:
  ports:
  - port: 80
    targetPort: 8080
  selector:
    app: echoserver
```

```
apiVersion: apps/v1beta1
kind: Deployment
metadata:
  name: default-http-backend
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: default-http-backend
    spec:
      containers:
      - name: default-http-backend
        image: gcr.io/google-containers/defaultbackend:1.0
        livenessProbe:
          httpGet:
            path: /healthz
            port: 8080
            scheme: HTTP
          initialDelaySeconds: 30
          timeoutSeconds: 5
        ports:
        - containerPort: 8080
        resources:
          limits:
            cpu: 10m
            memory: 20Mi
          requests:
            cpu: 10m
            memory: 20Mi
```

```
apiVersion: v1
kind: Service
metadata:
  name: default-http-backend
spec:
  ports:
  - port: 80
    targetPort: 8080
  selector:
    app: default-http-backend
```

# Nginx Ingress Controller

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: nginx-config
data:
  client-max-body-size: 20m
  hsts: "false"
  keep-alive: "30"
  proxy-body-size: 20m
  server-tokens: "false"
  use-gzip: "true"
```

```
apiVersion: v1
kind: Service
metadata:
  name: nginx-ingress
spec:
  type: LoadBalancer
  selector:
    app: nginx-ingress
  ports:
    - name: http
      port: 80
    - name: https
      port: 443
```

```
apiVersion: apps/v1beta1
kind: Deployment
metadata:
  name: nginx-ingress
spec:
  replicas: 1
  template:
    metadata:
      labels:
        app: nginx-ingress
    spec:
      containers:
      - name: nginx-ingress-controller
        image: gcr.io/google-containers/nginx-ingress-controller:0.9.0-beta.10
        imagePullPolicy: Always
        ports:
        - containerPort: 80
        - containerPort: 443
        env:
        - name: POD_NAME
          valueFrom:
            fieldRef:
              apiVersion: v1
              fieldPath: metadata.name
        - name: POD_NAMESPACE
          valueFrom:
            fieldRef:
              apiVersion: v1
              fieldPath: metadata.namespace
        args:
        - /nginx-ingress-controller
        - --default-backend-service=$(POD_NAMESPACE)/default-http-backend
        - --configmap=$(POD_NAMESPACE)/nginx-config
        - --publish-service=$(POD_NAMESPACE)/nginx-ingress
```

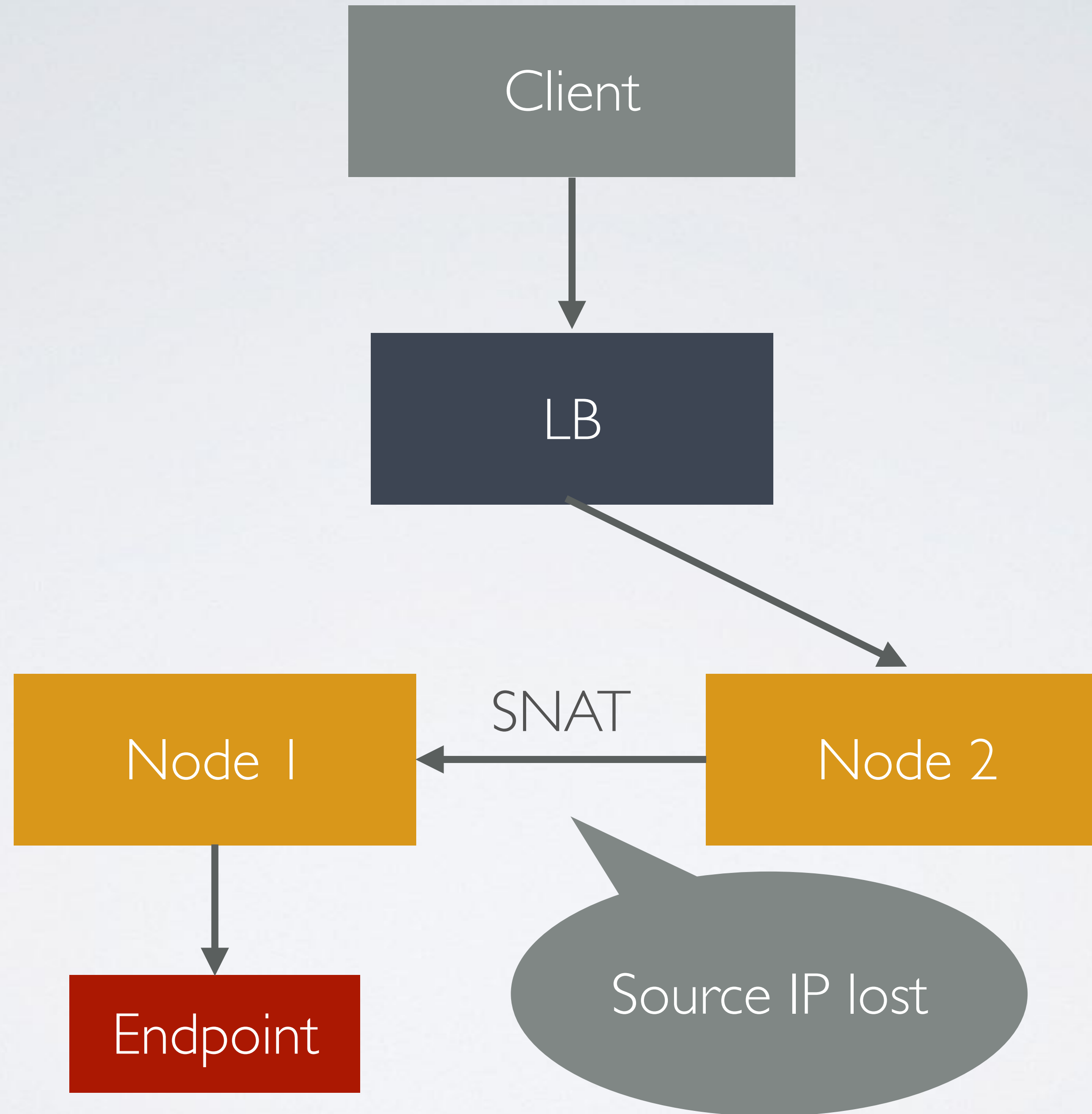
```
livenessProbe:
  failureThreshold: 3
  httpGet:
    path: /healthz
    port: 10254
    scheme: HTTP
  initialDelaySeconds: 10
  periodSeconds: 10
  successThreshold: 1
  timeoutSeconds: 5
readinessProbe:
  failureThreshold: 3
  httpGet:
    path: /healthz
    port: 10254
    scheme: HTTP
  periodSeconds: 10
  successThreshold: 1
  timeoutSeconds: 1
```

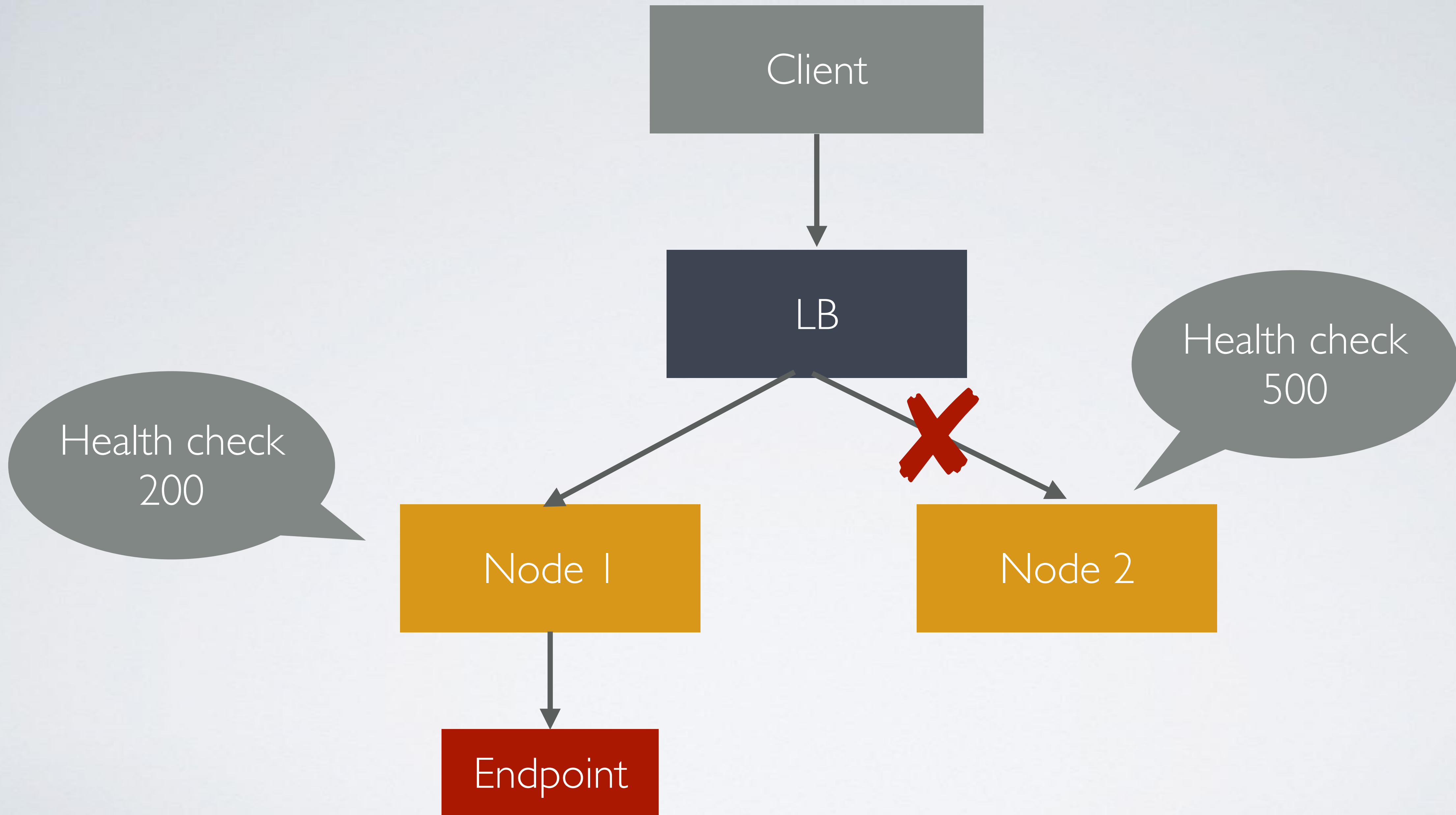


Ingress

```
kind: Ingress
apiVersion: extensions/v1beta1
metadata:
  name: nginx-ingress
  annotations:
    kubernetes.io/ingress.class: nginx
spec:
  rules:
    - host: echoserver.acoshift.com
      http:
        paths:
          - path: /
            backend:
              serviceName: echoserver
              servicePort: 80
    - host: echoserver.acoshift.me
      http:
        paths:
          - path: /
            backend:
              serviceName: echoserver
              servicePort: 80
  tls:
    - secretName: echoserver-acoshift-com-tls
      hosts:
        - echoserver.acoshift.com
```

Source IP



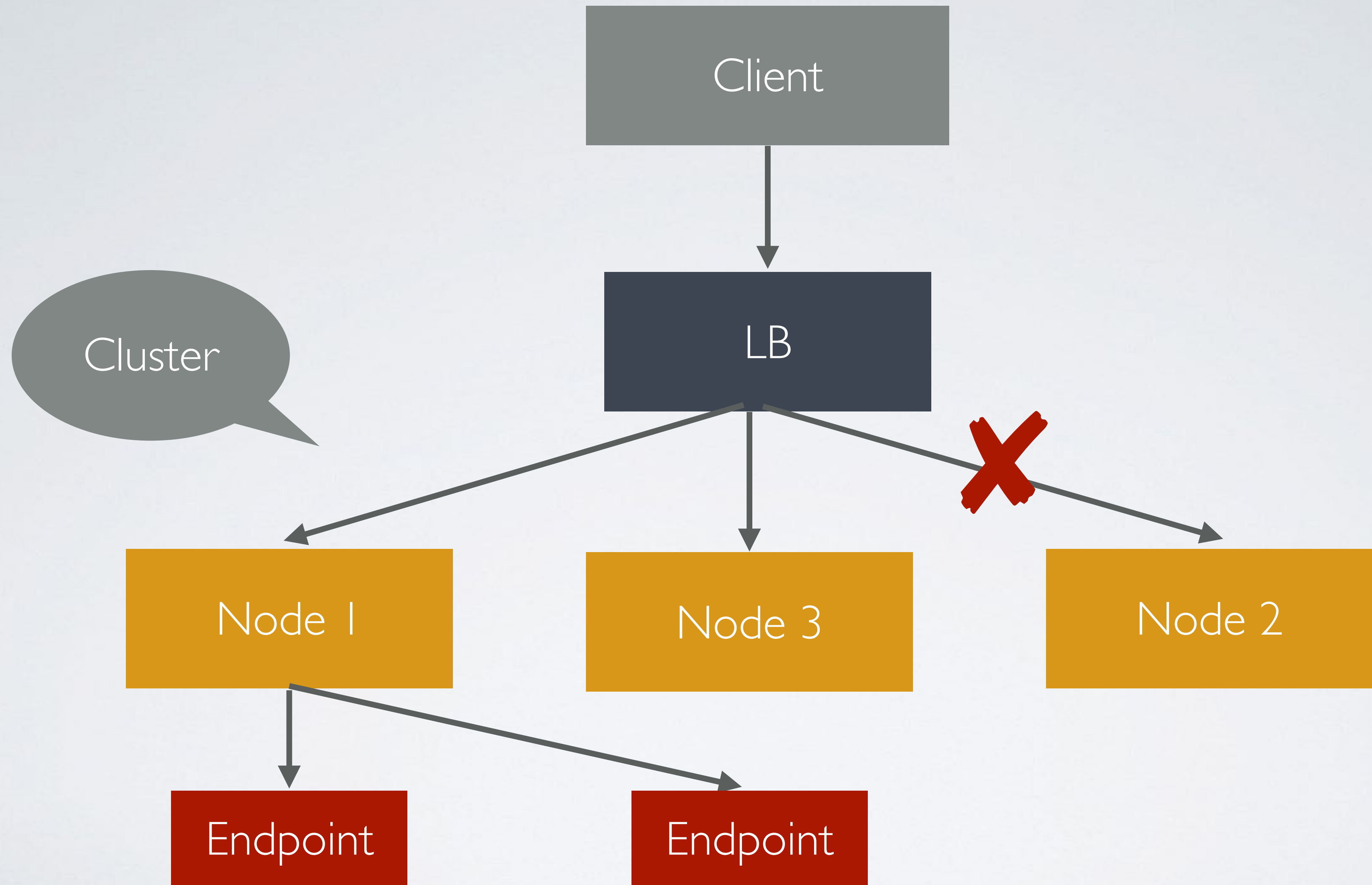


# Source IP Type

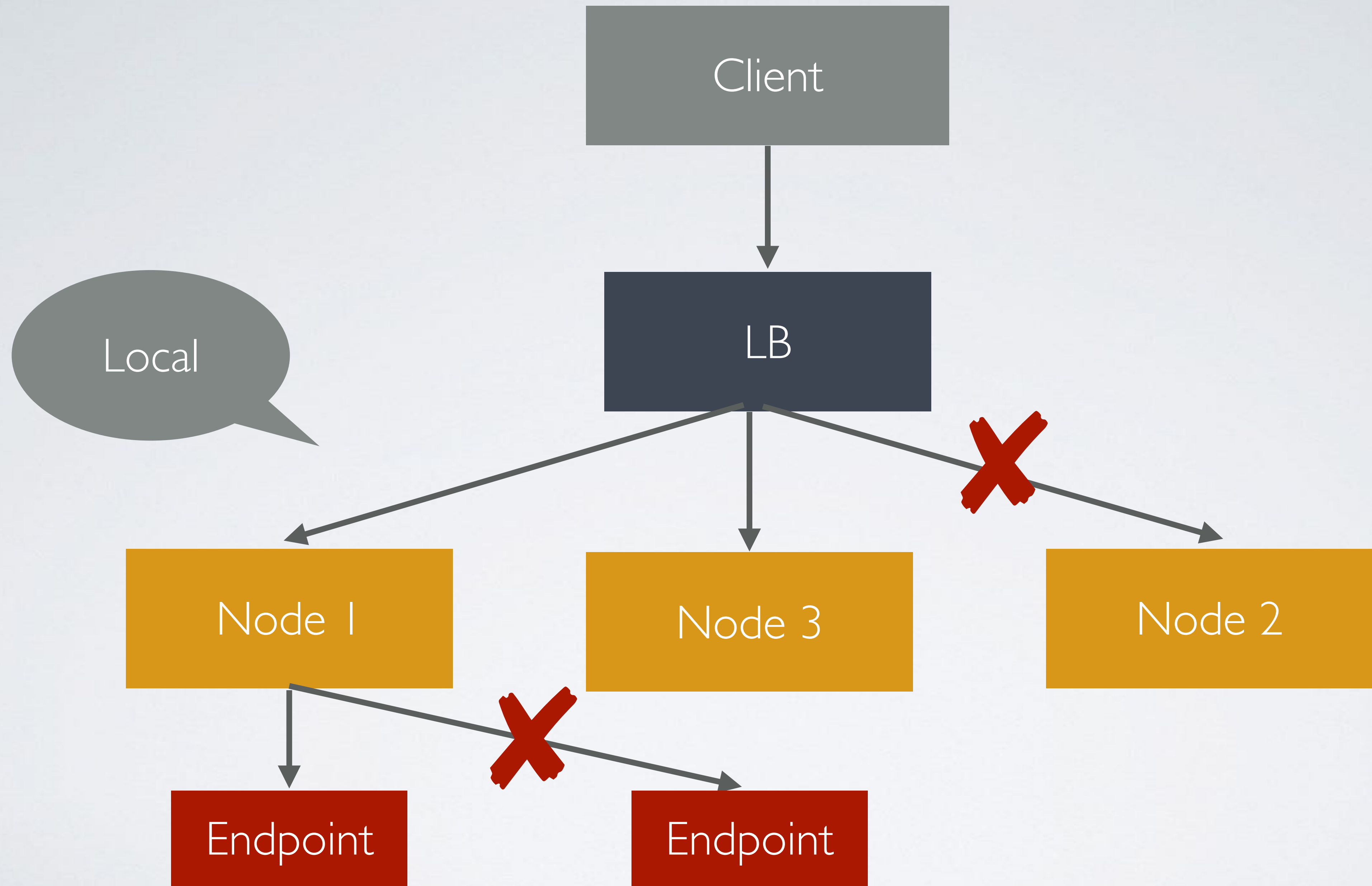
- Cluster
- Local



Default










```
kind: Service
apiVersion: v1
metadata:
  name: nginx-ingress
spec:
  type: LoadBalancer
  externalTrafficPolicy: Local
  selector:
    app: nginx-ingress
...
```



 **a46023bb4699311e7a0bf42010a94002**

Frontend

Protocol ^	IP:Port
TCP	35.187.231.192:80-443

Backend

Name: **a46023bb4699311e7a0bf42010a94002**    Region: **asia-southeast1**    Session affinity: **None**    Health check: **a46023bb4699311e7a0bf42010a94002**

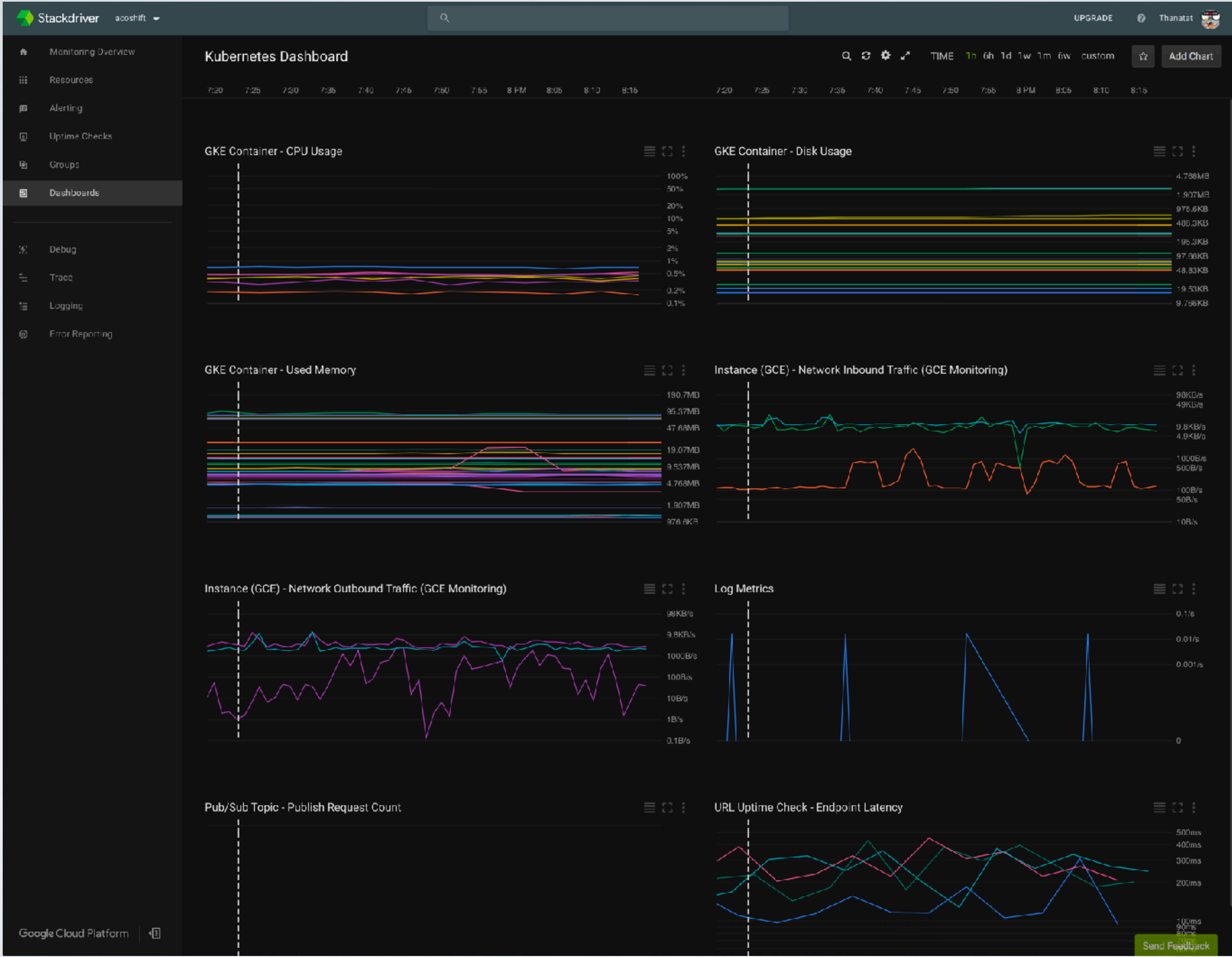
Instances ^	35.187.231.192
gke-cluster-1-default-pool-73cdab92-hhk2	
gke-cluster-1-default-pool-73cdab92-k7np	

# kube-lego

automatically requests certificates for Kubernetes Ingress resources from Let's Encrypt

# Google Stackdriver

Monitoring, logging, and diagnostics for applications on Cloud Platform and AWS





Q&A