



Kubernetes

In Practice







Somkiat Puisungnoen

Update Info 1 View Activity Log 10+ ...

Timeline About Friends 3,138 Photos More

When did you work at Opendream? X

... 22 Pending Items

Post Photo/Video Live Video Life Event

What's on your mind?

Public Post

Intro

Software Craftsmanship

Software Practitioner at สยามชั่นนาคุกิจ พ.ศ. 2556

Agile Practitioner and Technical at SPRINT3r

Somkiat Puisungnoen 15 mins · Bangkok · ...

Java and Bigdata



somkiat.cc

Page Messages Notifications 3 Insights Publishing Tools Settings Help ▾

somkiat.cc
@somkiat.cc

Home Posts Videos Photos

Liked Following Share ... + Add a Button



Agenda Day 1

1. Cloud Native Application
2. Kubernetes architecture
3. Key-features
4. Pods and Containers
5. Service
6. Replication Controller (RC)
7. Deployment and ReplicaSet (RS)
8. Volume



Agenda Day 2

1. Resource management
2. Horizontal Pods Autoscaler (HPA)
3. ConfigMap and Secret
4. Log and monitoring
5. Ingress network
6. Batch execution
7. Persistence storage

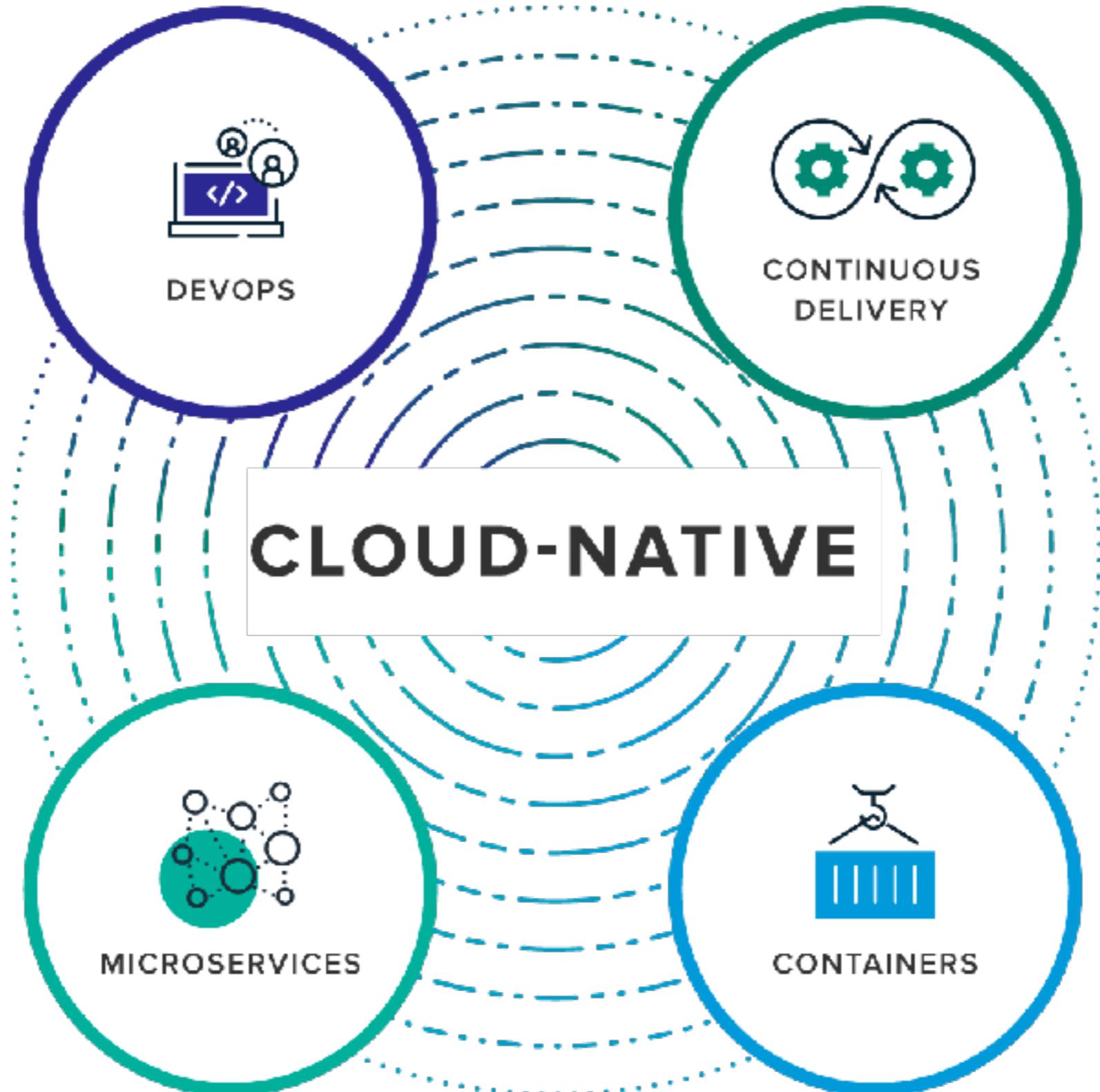


<https://github.com/up1/course-kubernetes-in-practice>



Cloud native





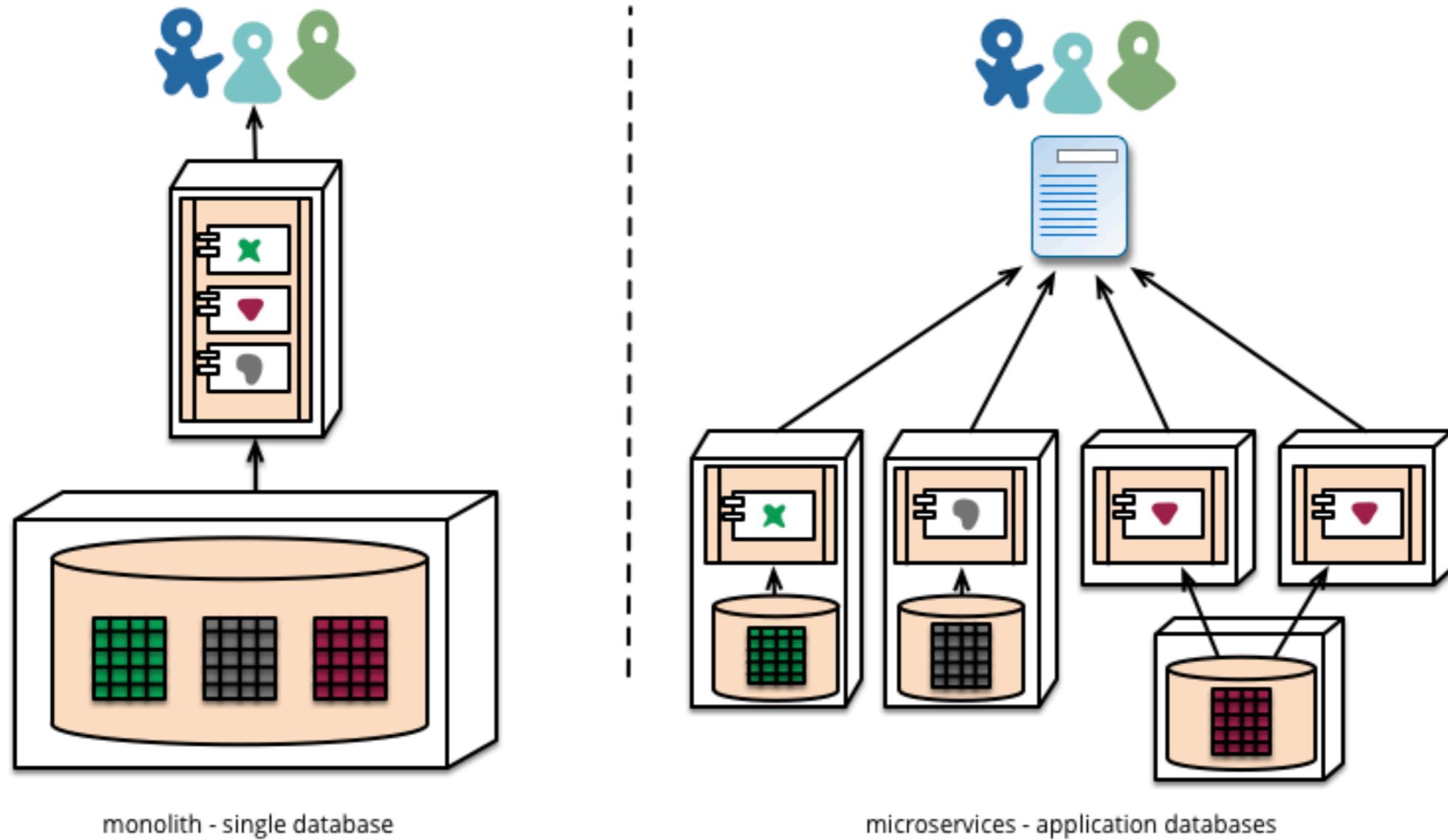
<https://pivotal.io/cloud-native>



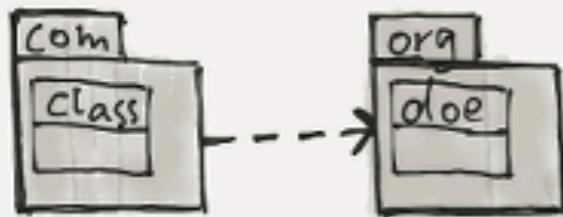
Evolution of Architecture



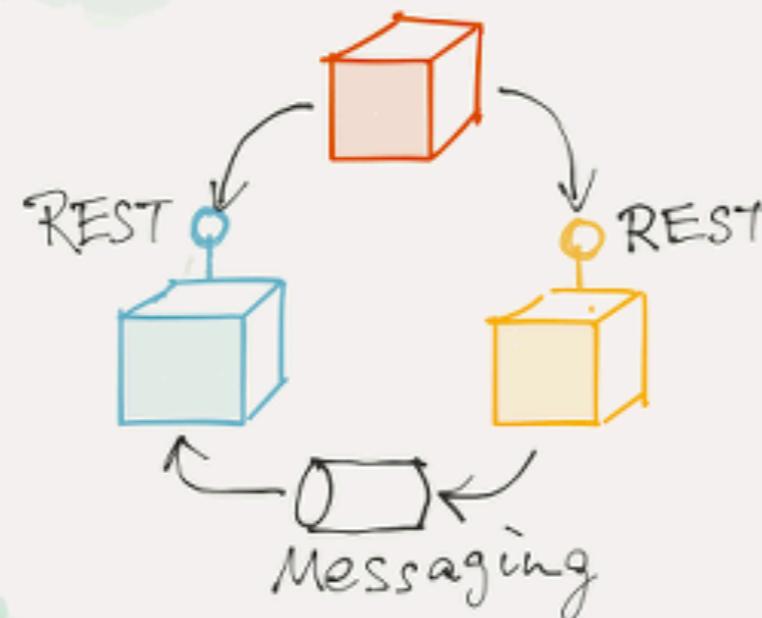
Microservices



Architecture



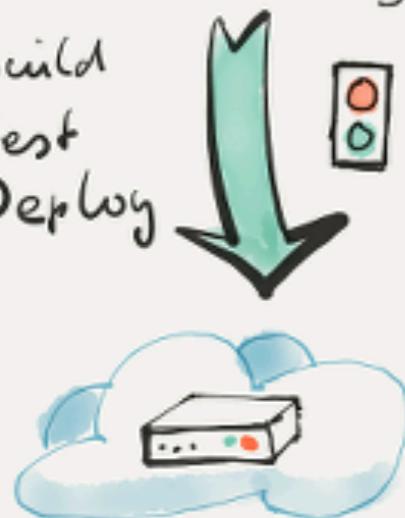
Microservices



Deployment

Continuous Delivery

`{ var i=1; }`
Build
Test
Deploy



Infrastructure

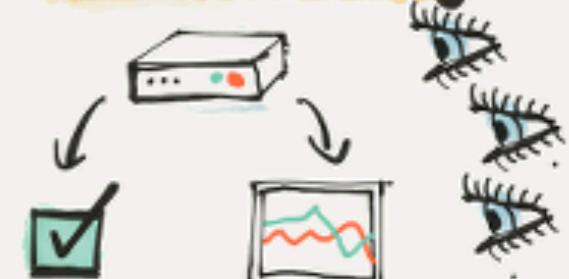


People & Teams



Communication
Collaboration

Monitoring

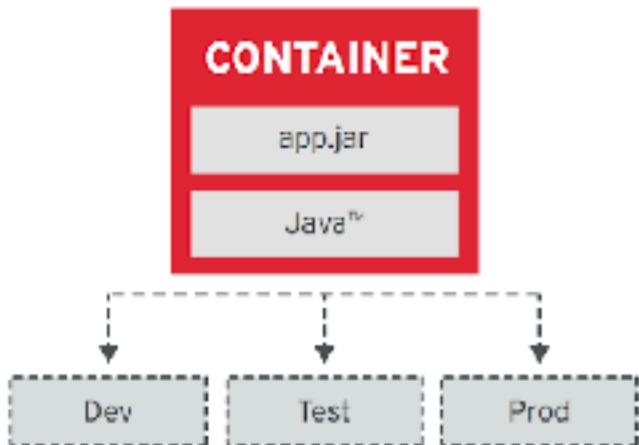


Features & Technology



Container design principle

Image Immutability Principle



High Observability Principle



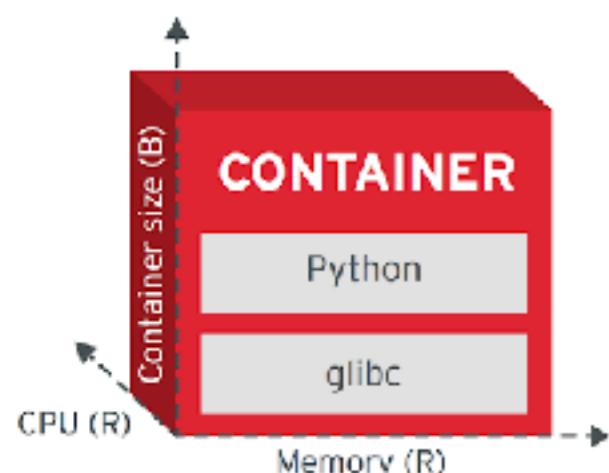
Process Disposability Principle



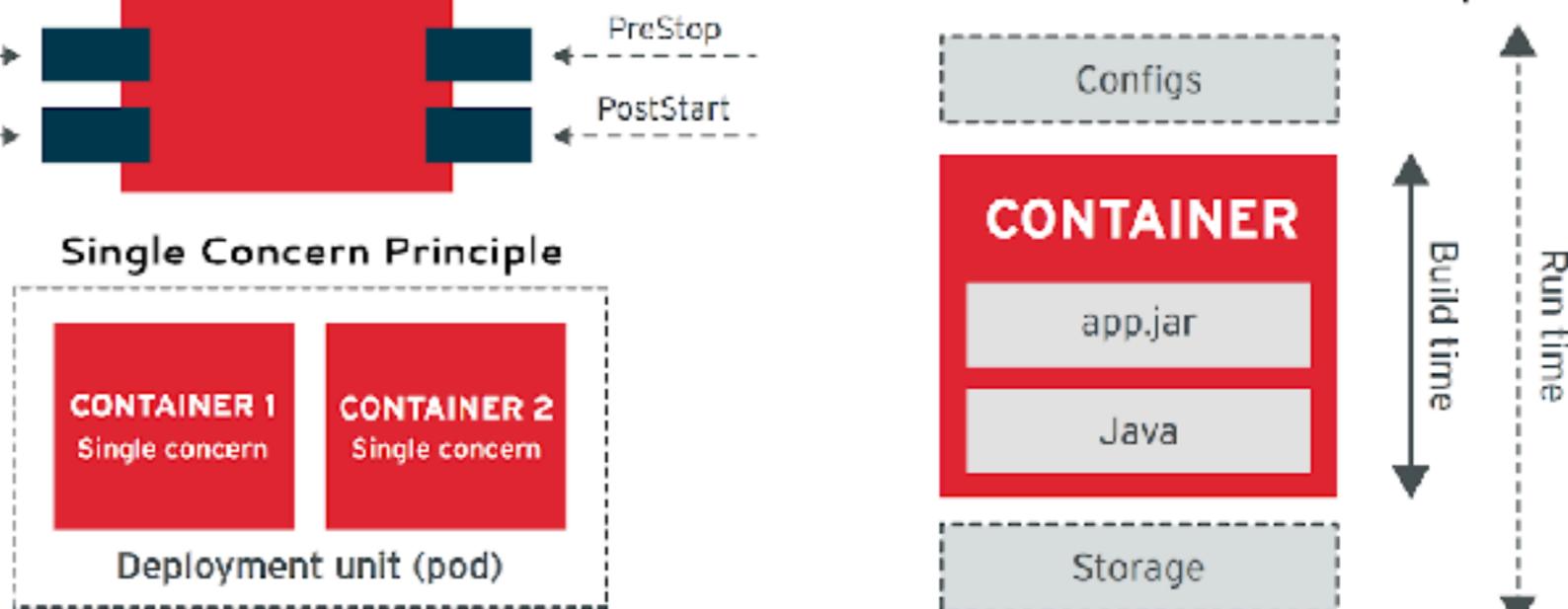
Lifecycle Conformance Principle



Runtime Confinement Principle



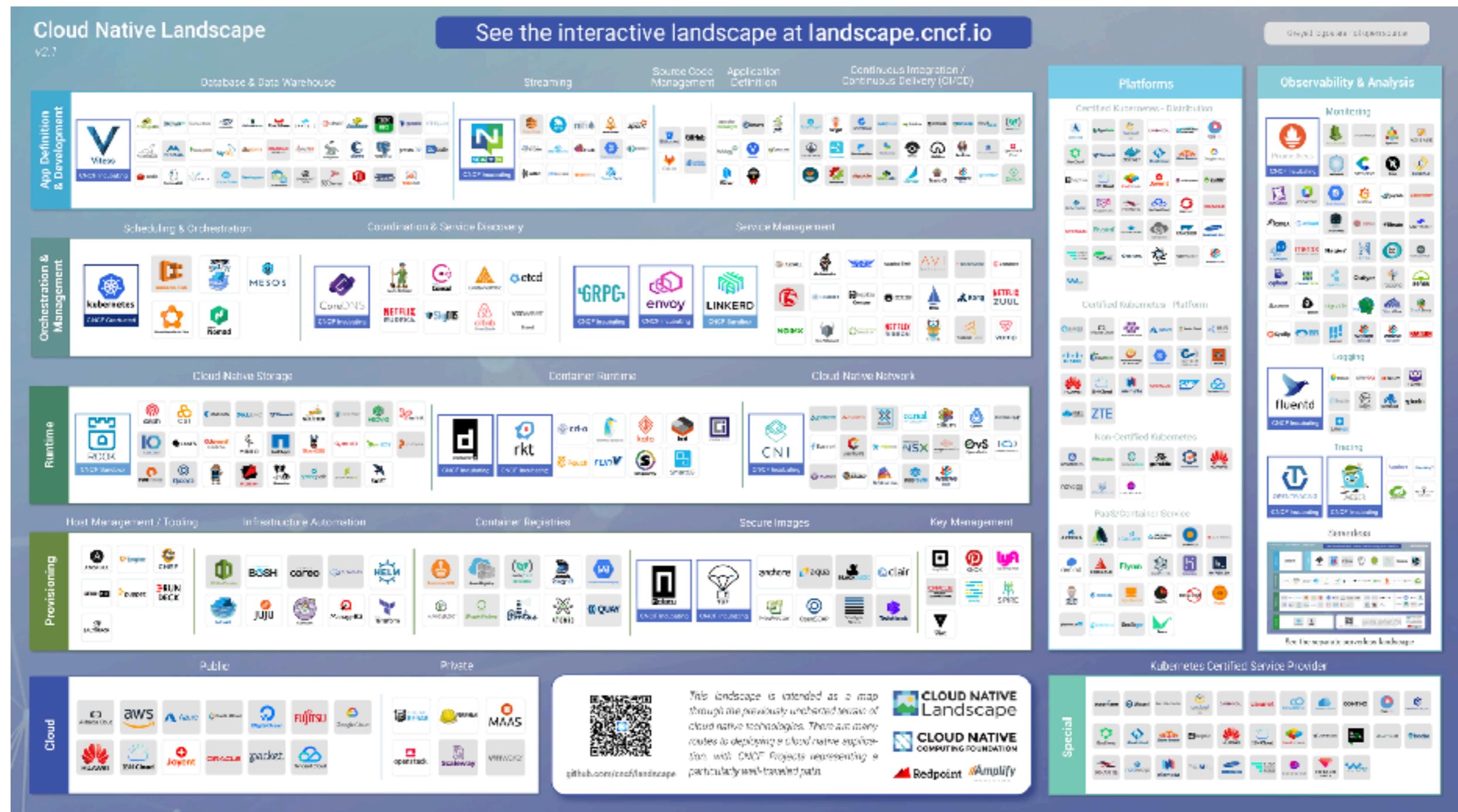
Self-Containment Principle



Single Concern Principle



Cloud native landscape



<https://github.com/cncf/landscape>



Installation



Software requirement

minkube

Kubernetes command-line tool



Starting minikube

```
$minikube start  
$minikube status
```



Version of Kubernetes

```
$kubectl get nodes -o yaml
```

```
nodeInfo:  
  architecture: amd64  
  bootID: 7c769465-27e5-4dd8-a89f-319ba1b8ef57  
  containerRuntimeVersion: docker://17.9.0  
  kernelVersion: 4.9.64  
  kubeProxyVersion: v1.9.4  
  kubeletVersion: v1.9.4  
  machineID: edffd4ca8bf24253a736ea86d2448185  
  operatingSystem: linux  
  osImage: Buildroot 2017.11  
  systemUUID: 98BAE0EF-8C9E-45DF-9AC7-F0E05806B189
```



Basic of Kubernetes



Kubernetes (k8s)

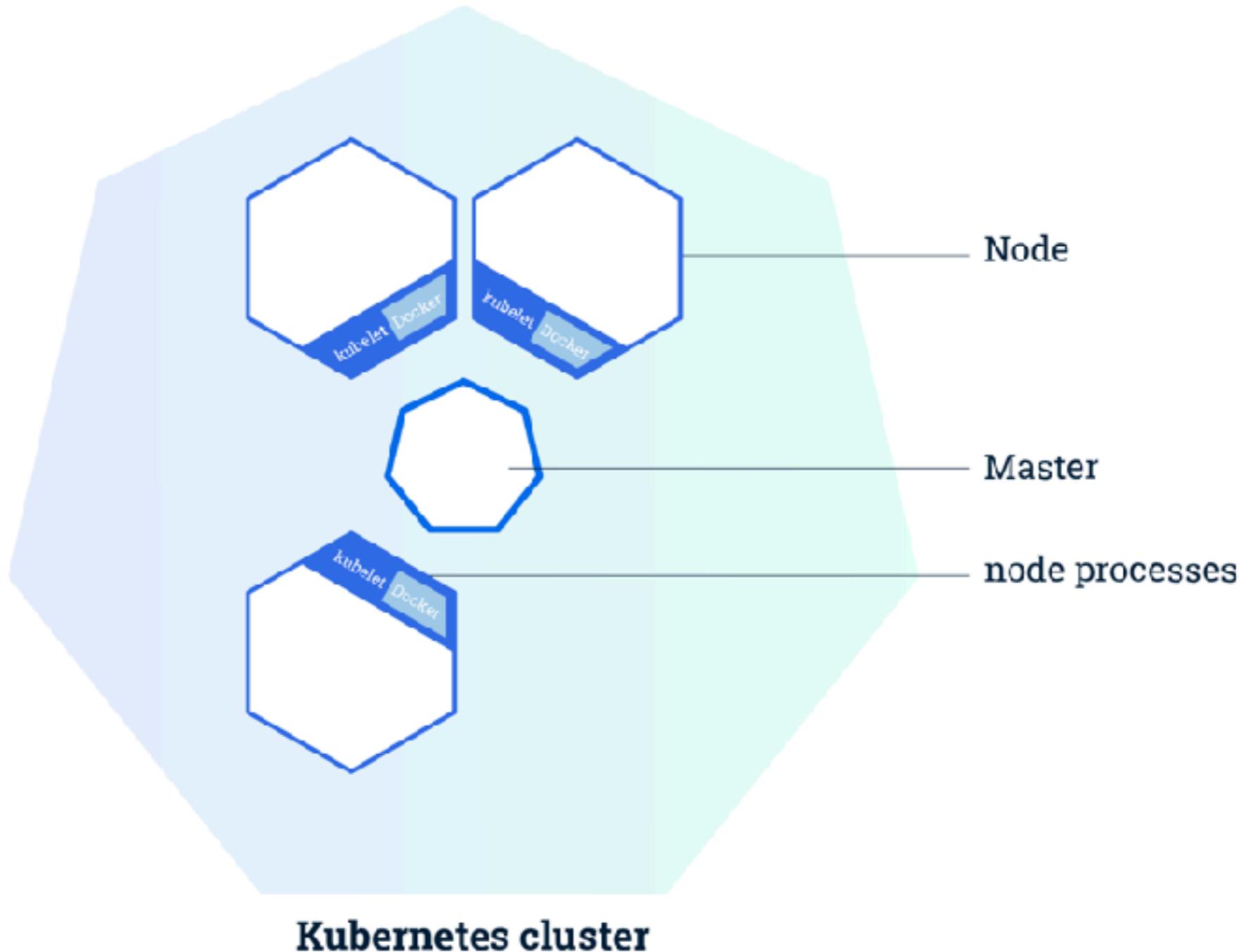
Container orchestration tool

TODO

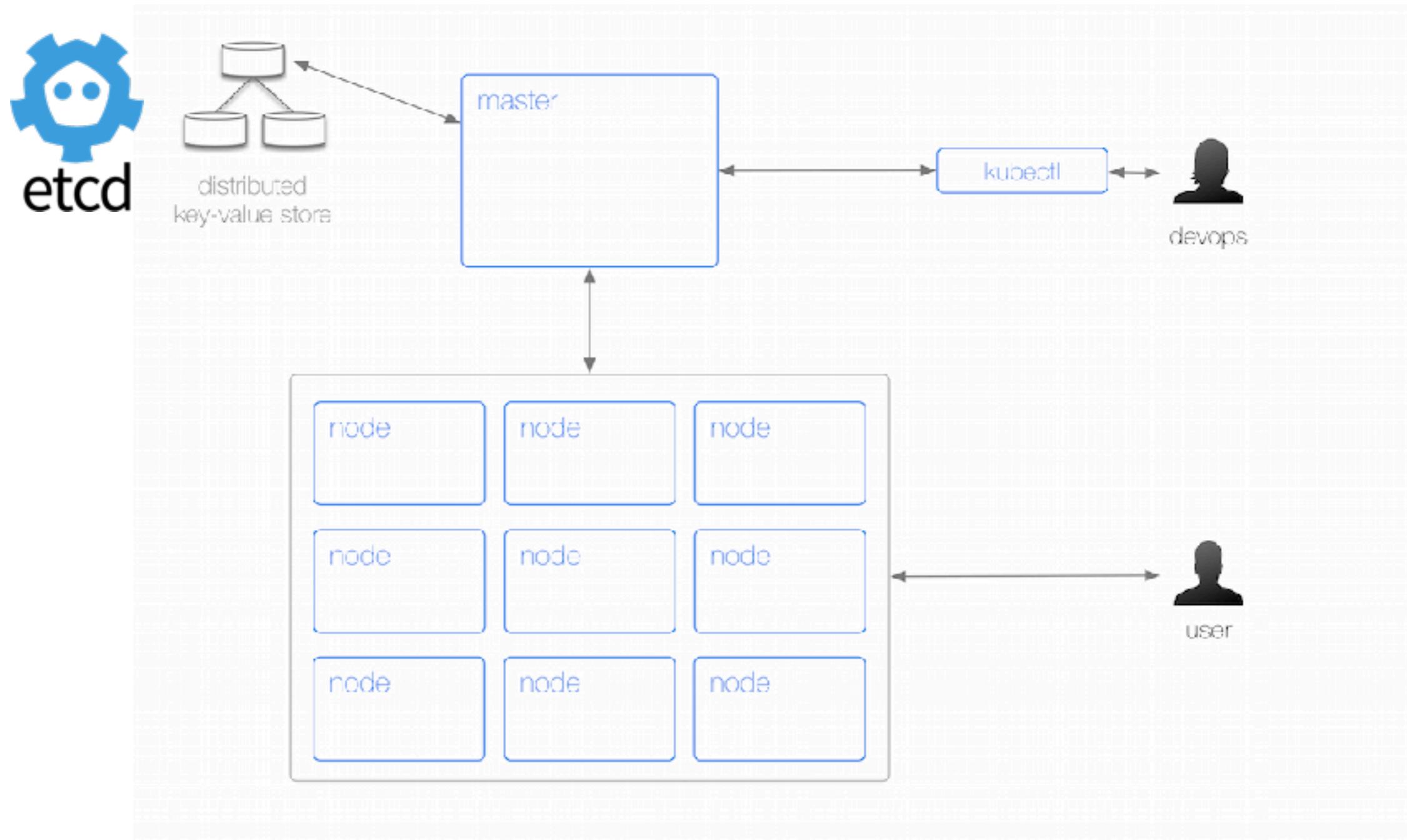
TODO



Kubernetes cluster



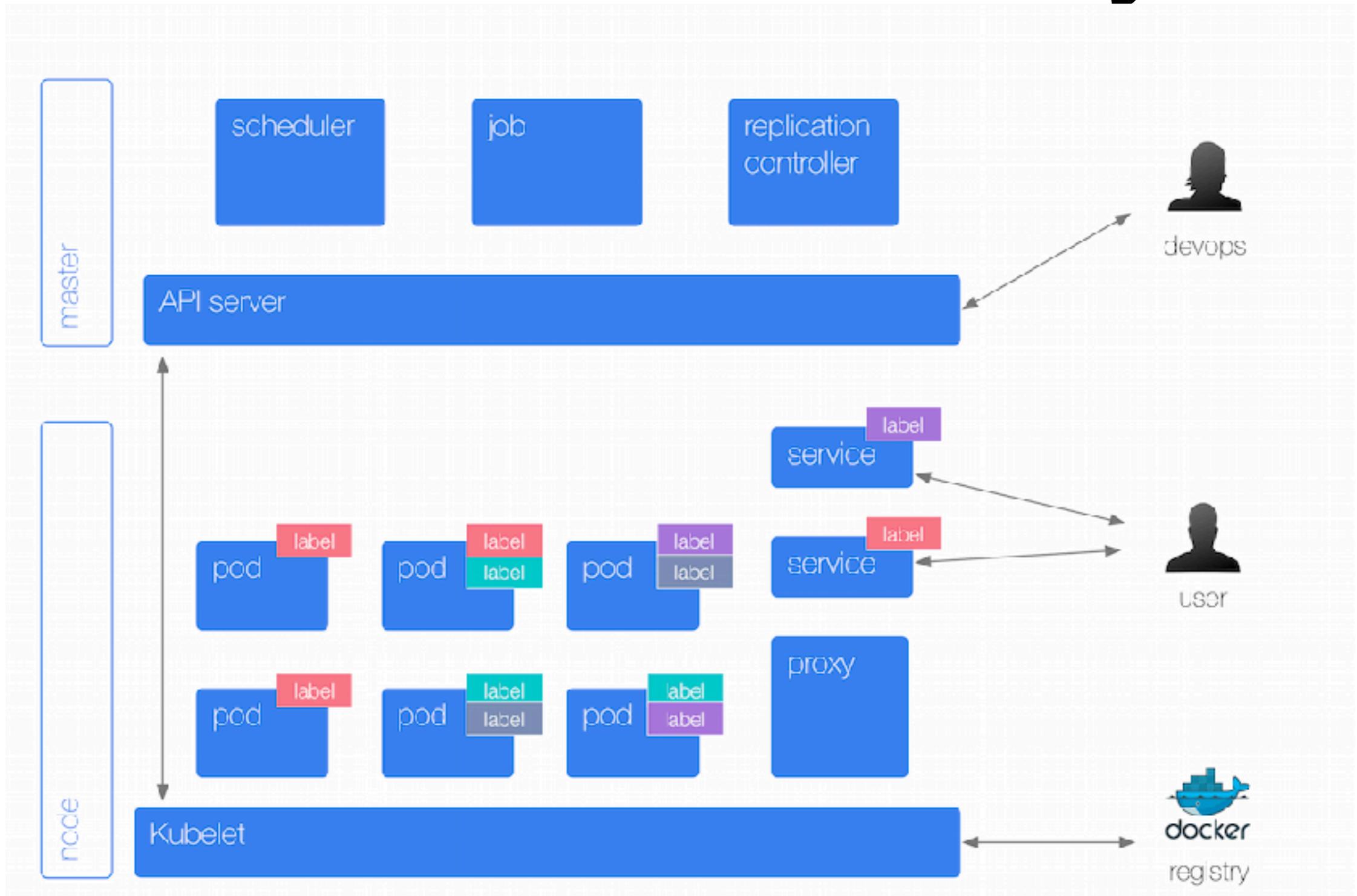
Kubernetes physical layout



<http://k8s.info/cs.html>



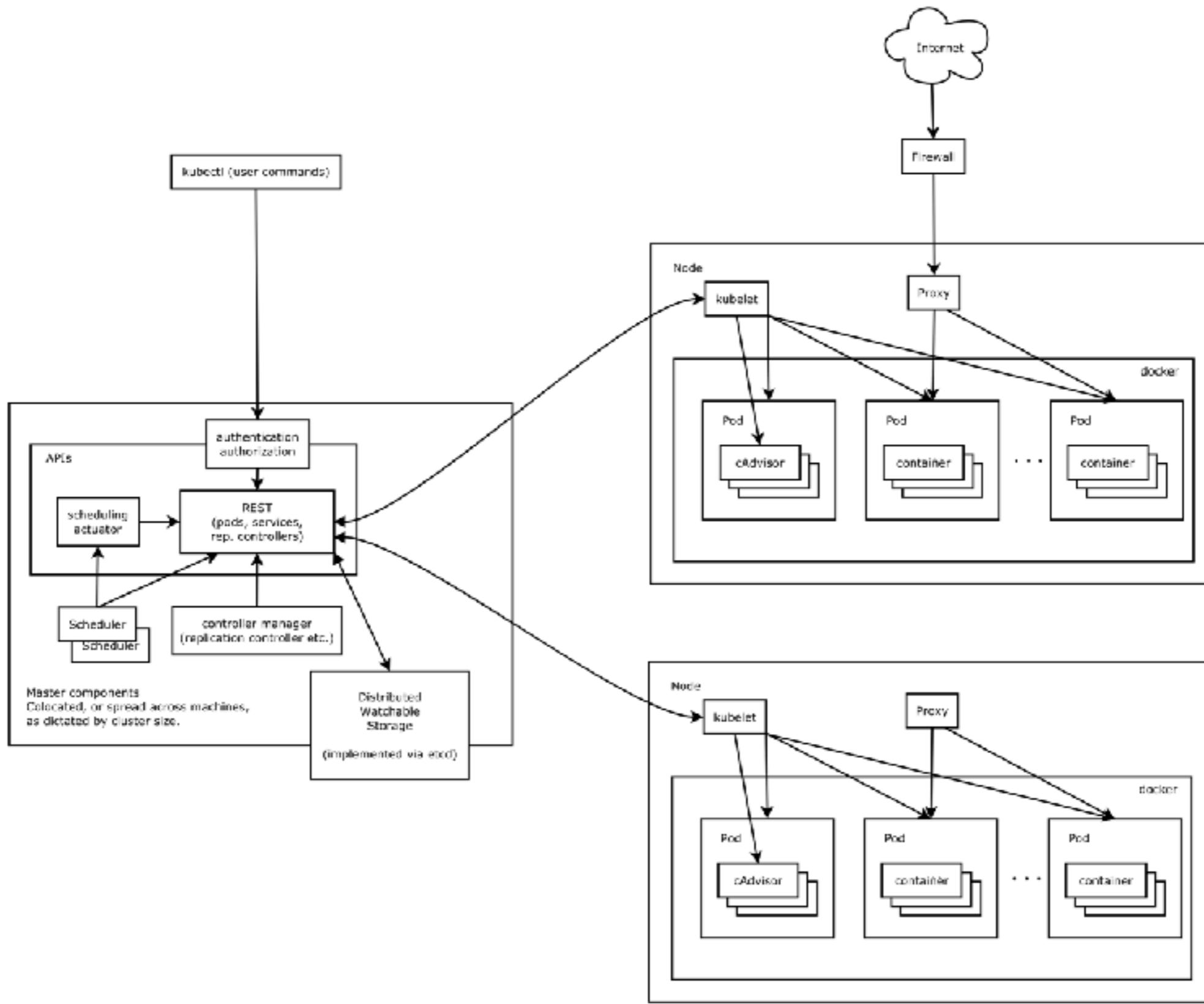
Kubernetes abstraction layout



<http://k8s.info/cs.html>



Kubernetes architecture



Hello with Kubernetes



Hello Kubernetes

Working with **kubectl** in command line
Try to run image from Docker hub

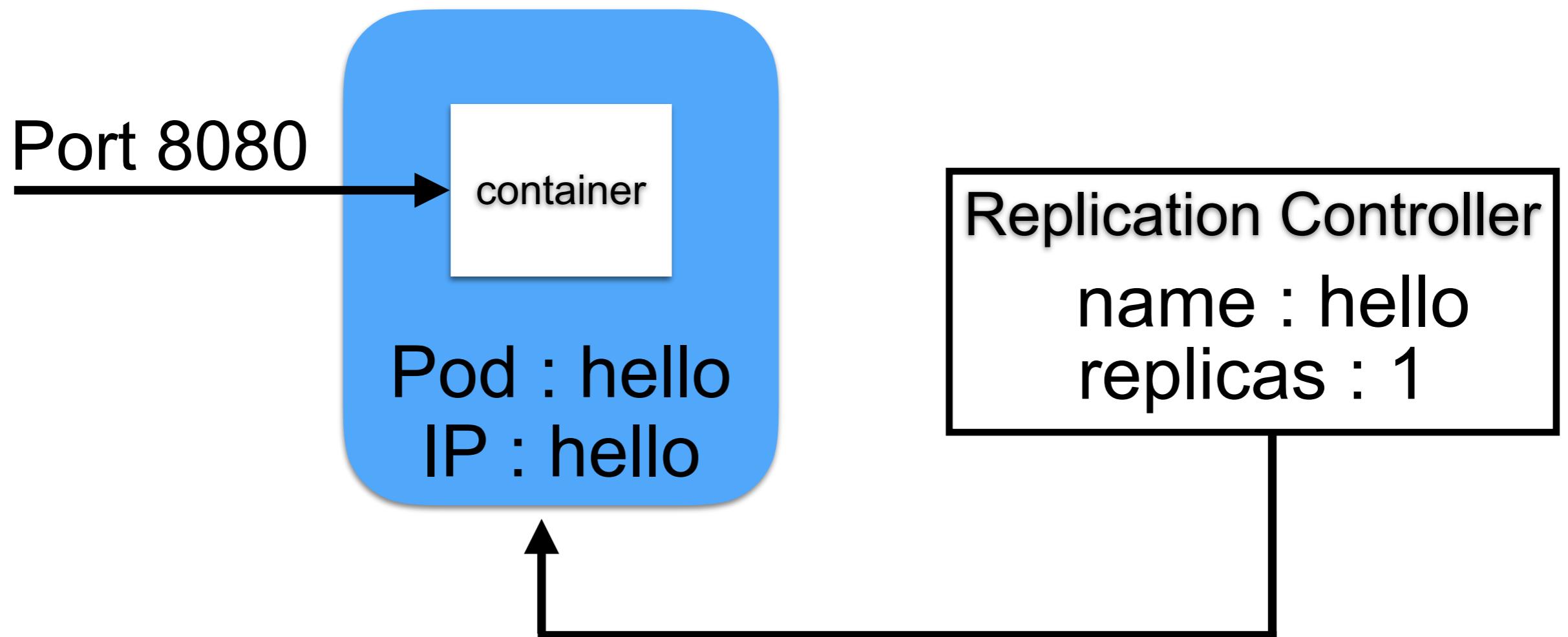


Create a container

```
$kubectl run hello --image=somkiat/hello  
--port=8080 --generator=run/v1
```



Create a container

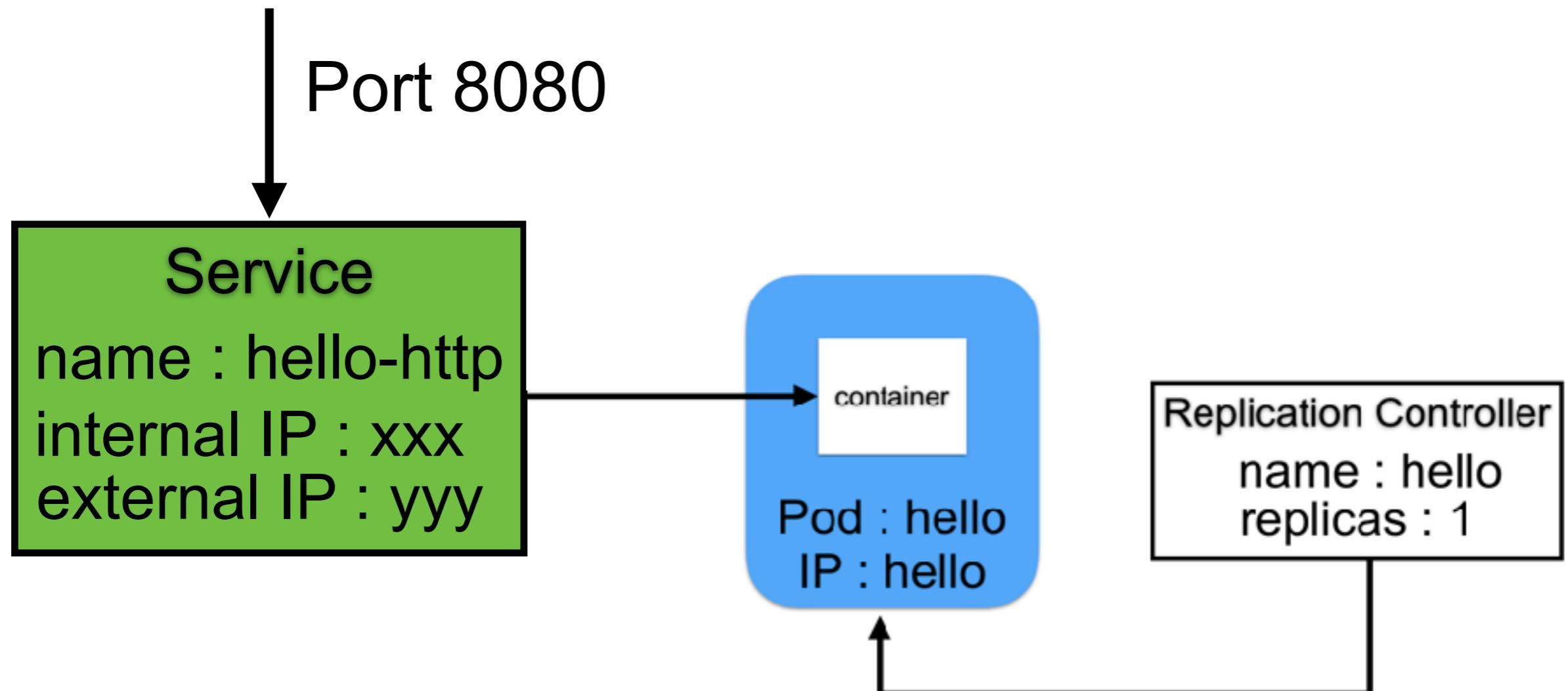


Expose RC with service

```
$kubectl expose rc hello  
--type=LoadBalancer --name hello-http
```



Expose RC with service



Access service with qinikube

```
$minikube service hello-http
```



Scaling the application

```
$ kubectl scale rc hello --replicas=3
```



List of RC

\$kubectl get rc

| NAME | DESIRED | CURRENT | READY | AGE |
|-------|---------|---------|-------|-----|
| hello | 3 | 3 | 3 | 35m |



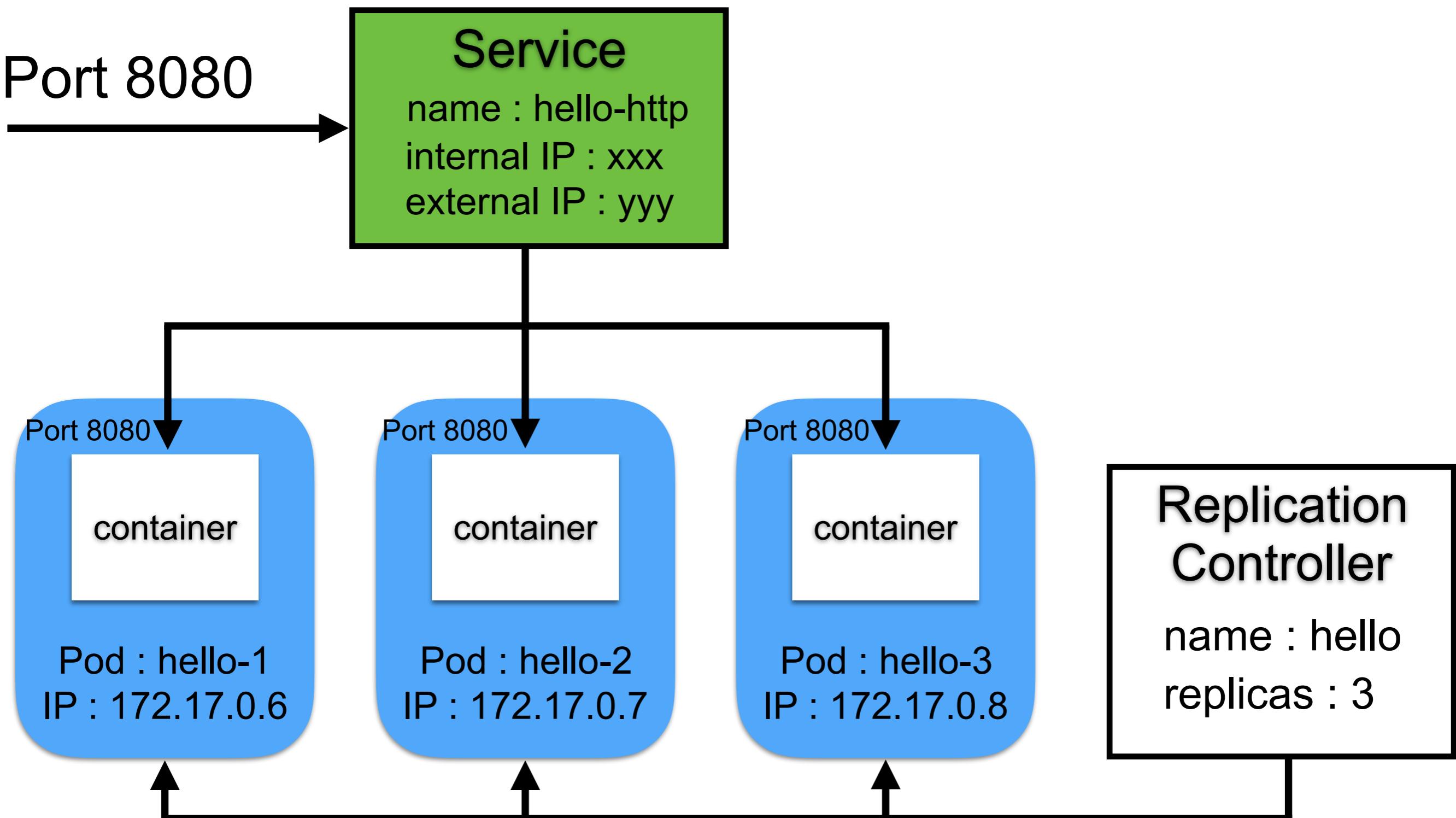
List of Pods

\$kubectl get pod -o wide

| NAME | READY | STATUS | RESTARTS | AGE | IP | NODE |
|-------------|-------|---------|----------|-----|------------|----------|
| hello-lw2p7 | 1/1 | Running | 0 | 29m | 172.17.0.8 | minikube |
| hello-pqnpz | 1/1 | Running | 0 | 36m | 172.17.0.6 | minikube |
| hello-wwsnh | 1/1 | Running | 0 | 29m | 172.17.0.7 | minikube |



Scaling the application



Testing

```
export SERVICE=192.168.99.100:32614
```

```
$curl http://$SERVICE  
Hello, "/" on hello-wwsnh
```

```
$curl http://$SERVICE  
Hello, "/" on hello-pqnzp
```

```
$curl http://$SERVICE  
Hello, "/" on hello-lw2p7
```



Kubernetes dashboard

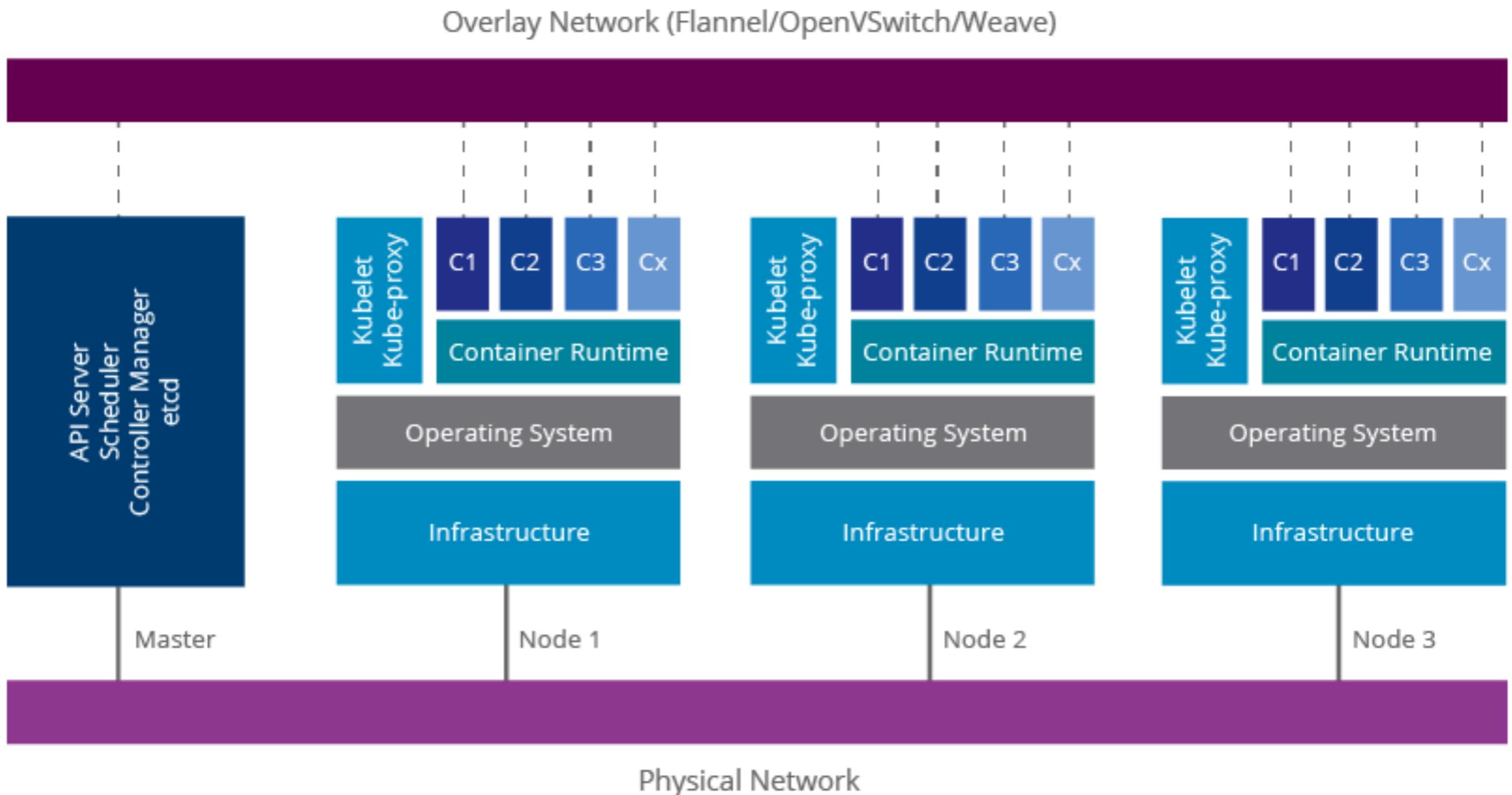
\$minikube dashboard

The screenshot shows the Kubernetes dashboard interface. At the top, there is a navigation bar with a 'kubernetes' logo, a search bar, and a '+ CREATE' button. Below the navigation bar, a blue header bar displays the text 'Overview'. On the left side, there is a sidebar under the heading 'Cluster' containing links for Namespaces, Nodes, Persistent Volumes, Roles, and Storage Classes. A dropdown menu for 'Namespaces' is open, showing 'default' as the selected option. Below the sidebar, there are two tabs: 'Overview' (which is active) and 'Workloads'. The main content area is titled 'Workloads Statuses' and contains two green circular charts, both showing '100.00%' for 'Pods' and 'Replication Controllers'. In the bottom right corner of this section, there is a small 'grid' icon. Below this, there is another table titled 'Pods' with columns for Name, Node, Status, Restarts, and Age. The table lists three pods: 'hello-lw2p7', 'hello-wwsnh', and 'hello-pqnpz', all running on the 'minikube' node.

| Name | Node | Status | Restarts | Age |
|-------------|----------|---------|----------|------------|
| hello-lw2p7 | minikube | Running | 0 | 53 minutes |
| hello-wwsnh | minikube | Running | 0 | 53 minutes |
| hello-pqnpz | minikube | Running | 0 | 59 minutes |



Kubernetes architecture



Key features



Key features

- Automatic binpacking
- Horizontal Pod Autoscaler (HPA)
- Automated rollouts and rollbacks
- Storage orchestration



Key features

Self-healing

Service discovery and Load Balancing (LB)

Secret and config management

Batch execution



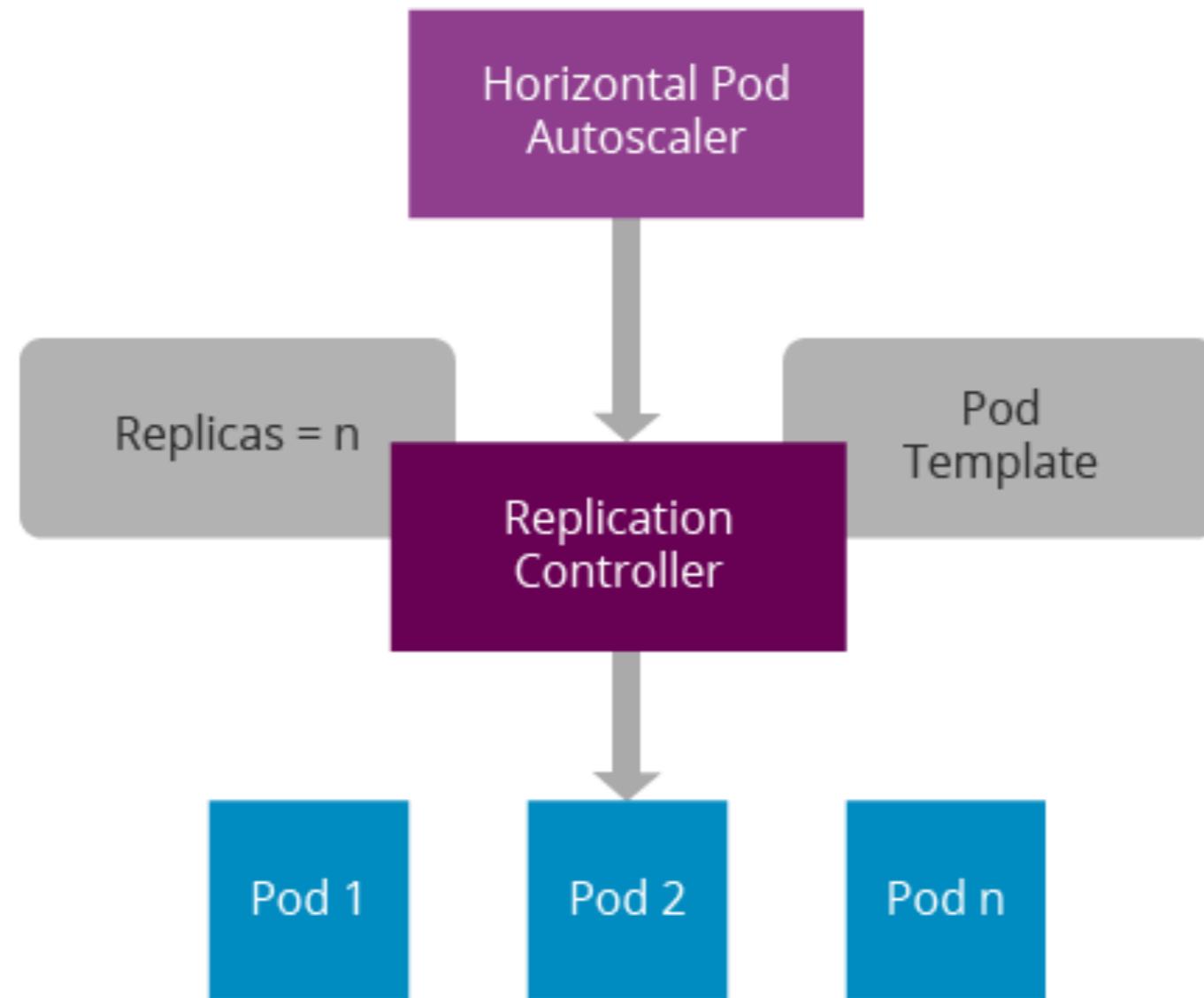
Automatic bin packing



Horizontal Pod Autoscaler



Horizontal Pod Autoscaler



Automated rollouts & rollbacks



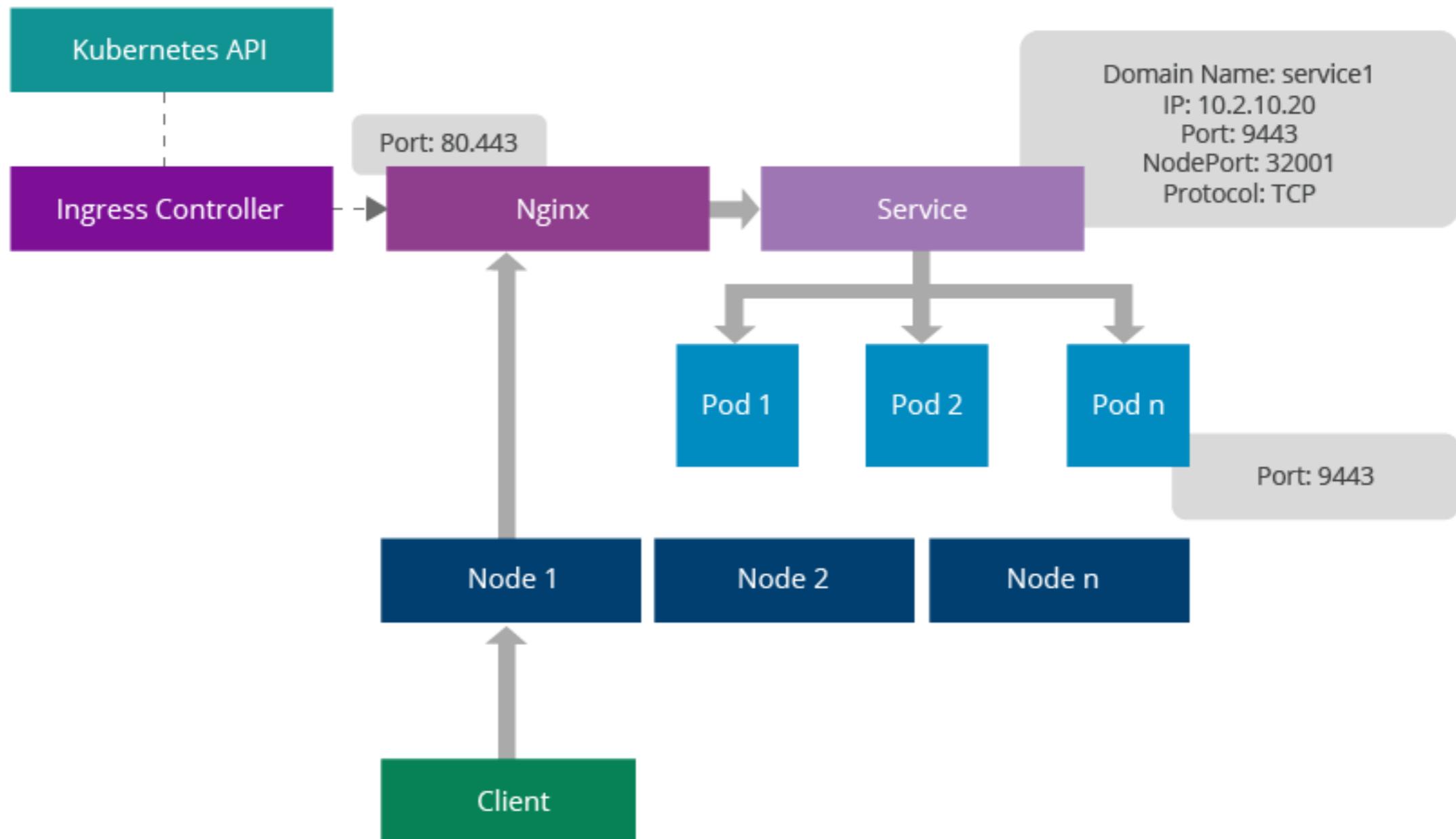
Storage orchestration



Provide well known ports for Kubernetes services



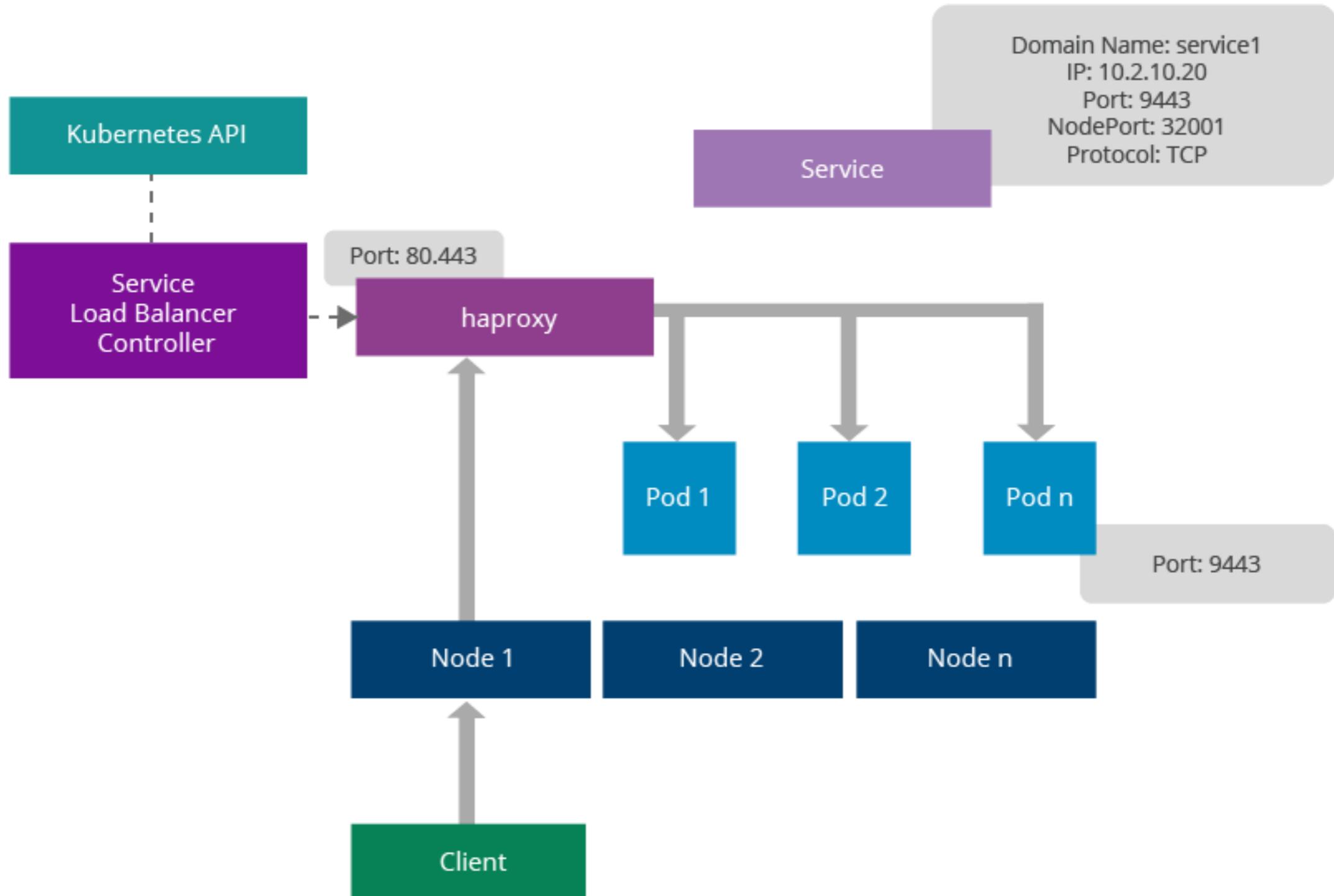
Ingress controller



Sticky session management using Service Load Balancers



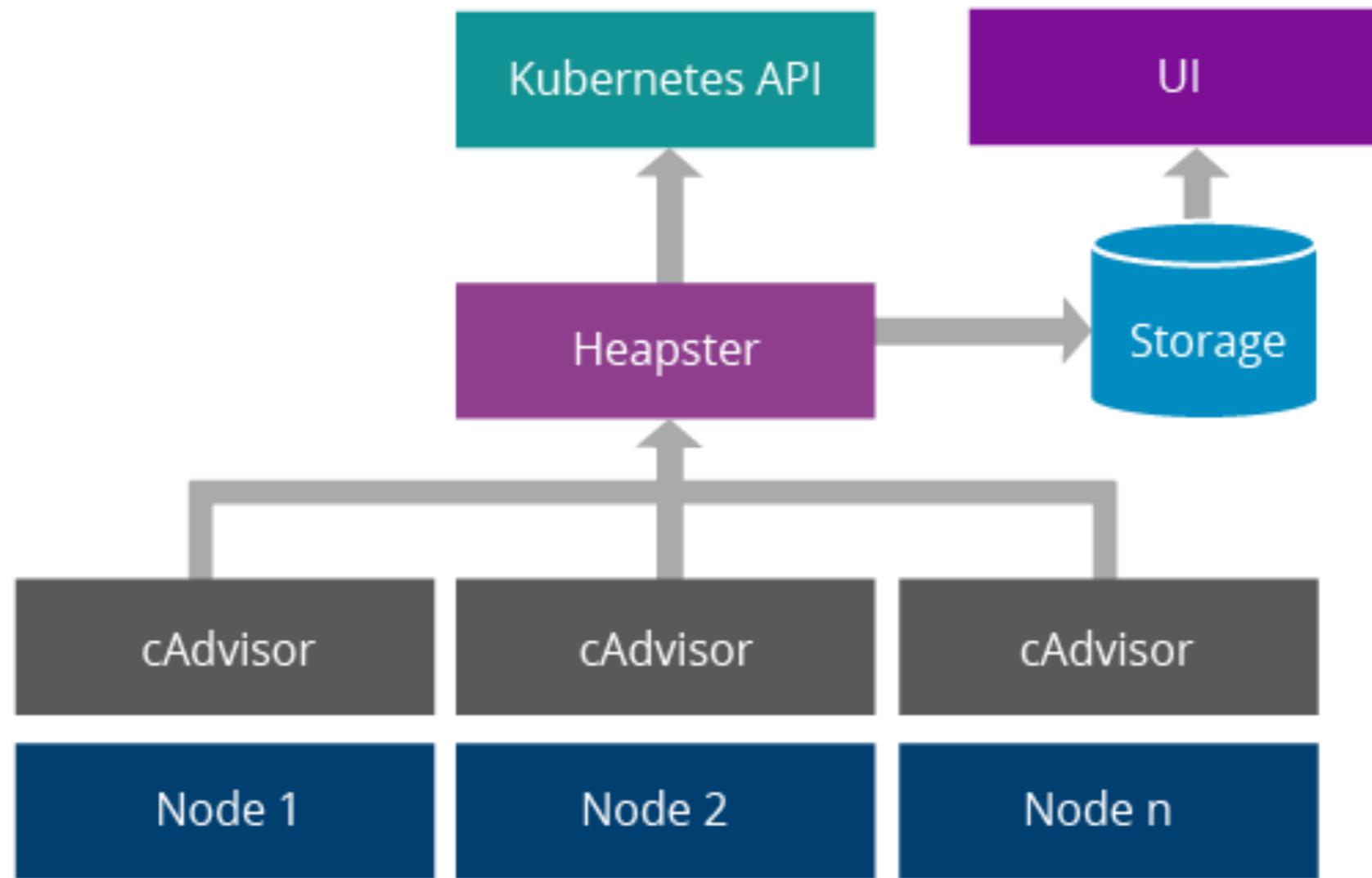
Service Load Balancer



Resource usage monitoring



Resource usage monitoring



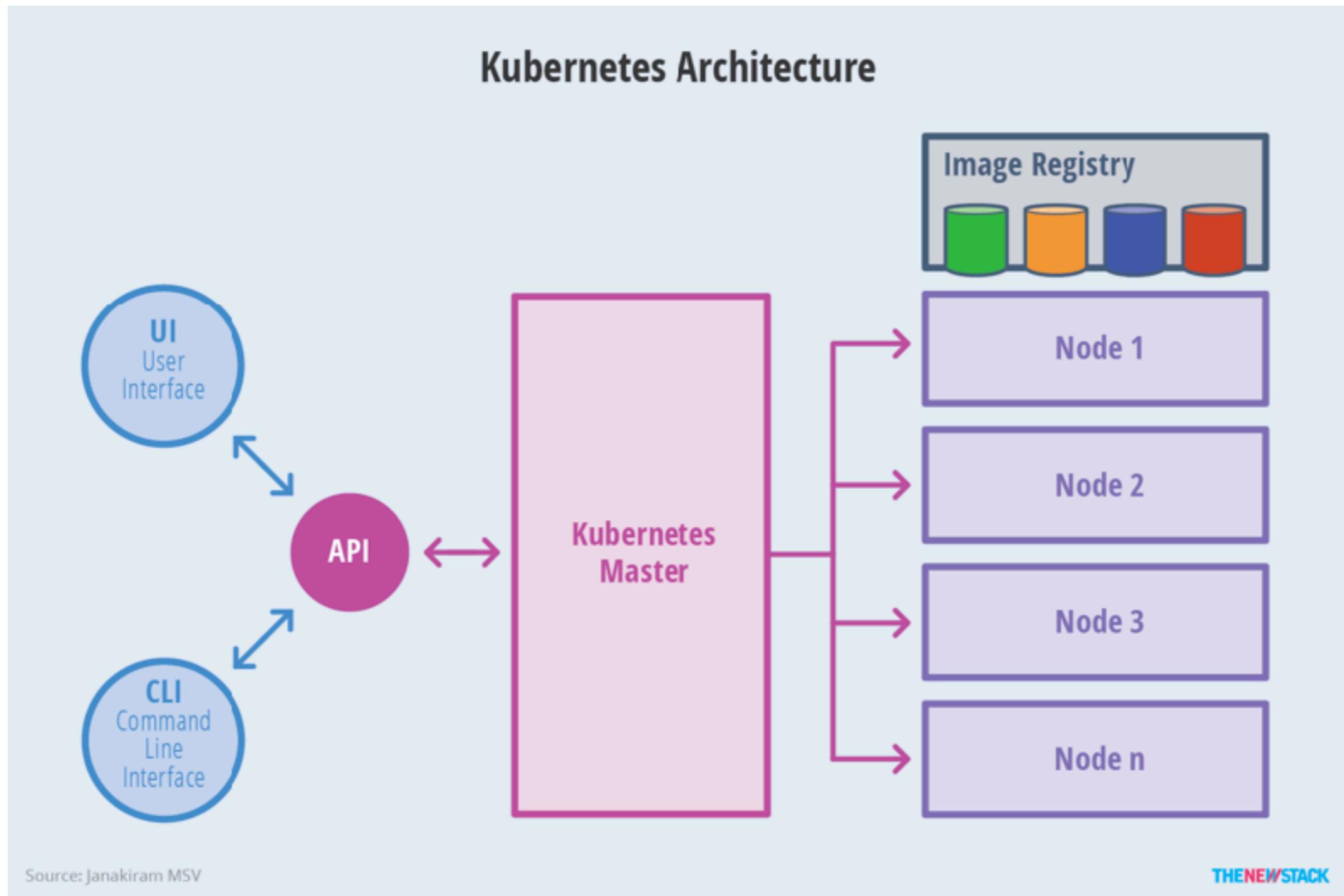
<https://github.com/kubernetes/heapster>



System architecture



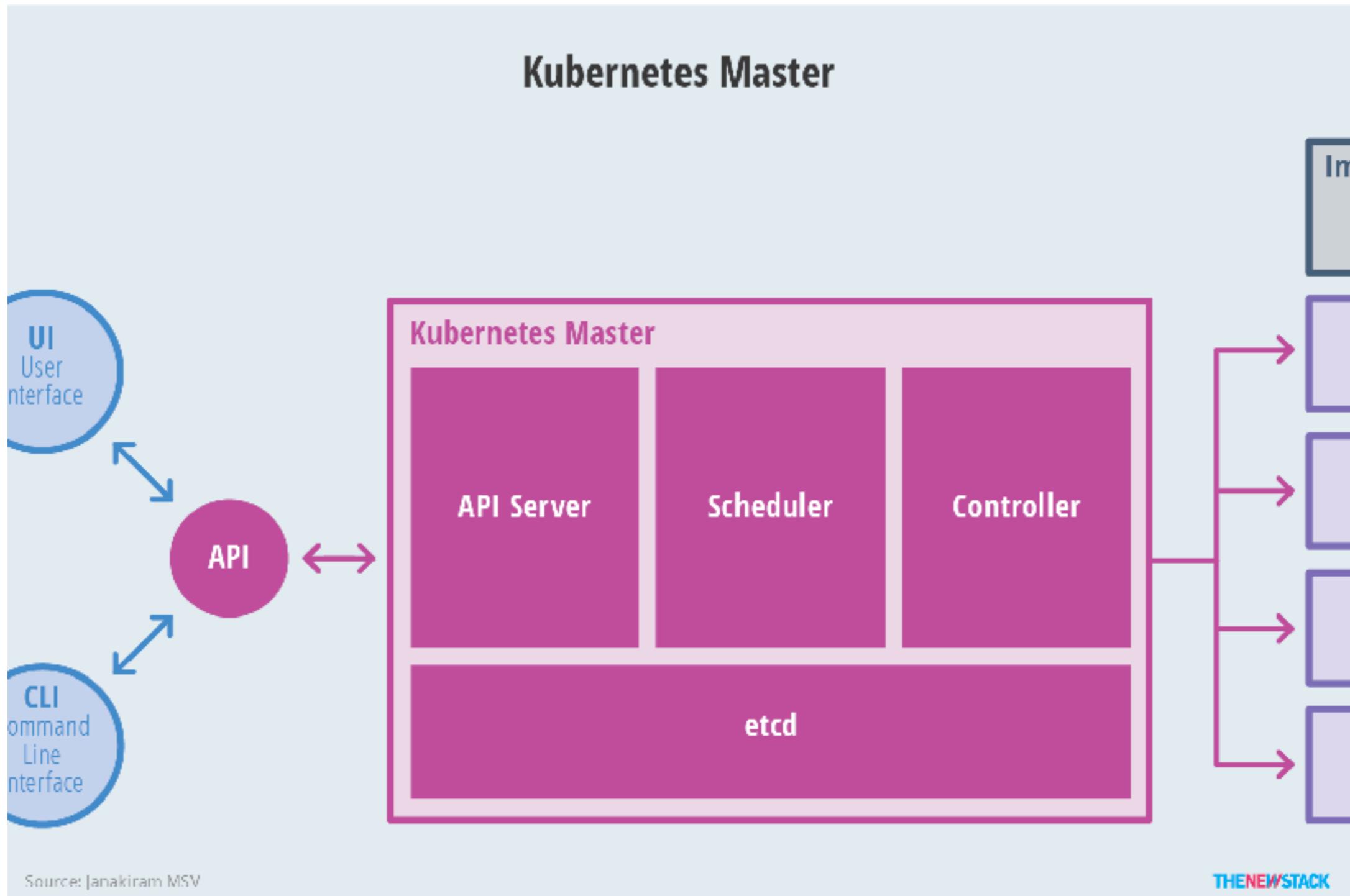
System architecture



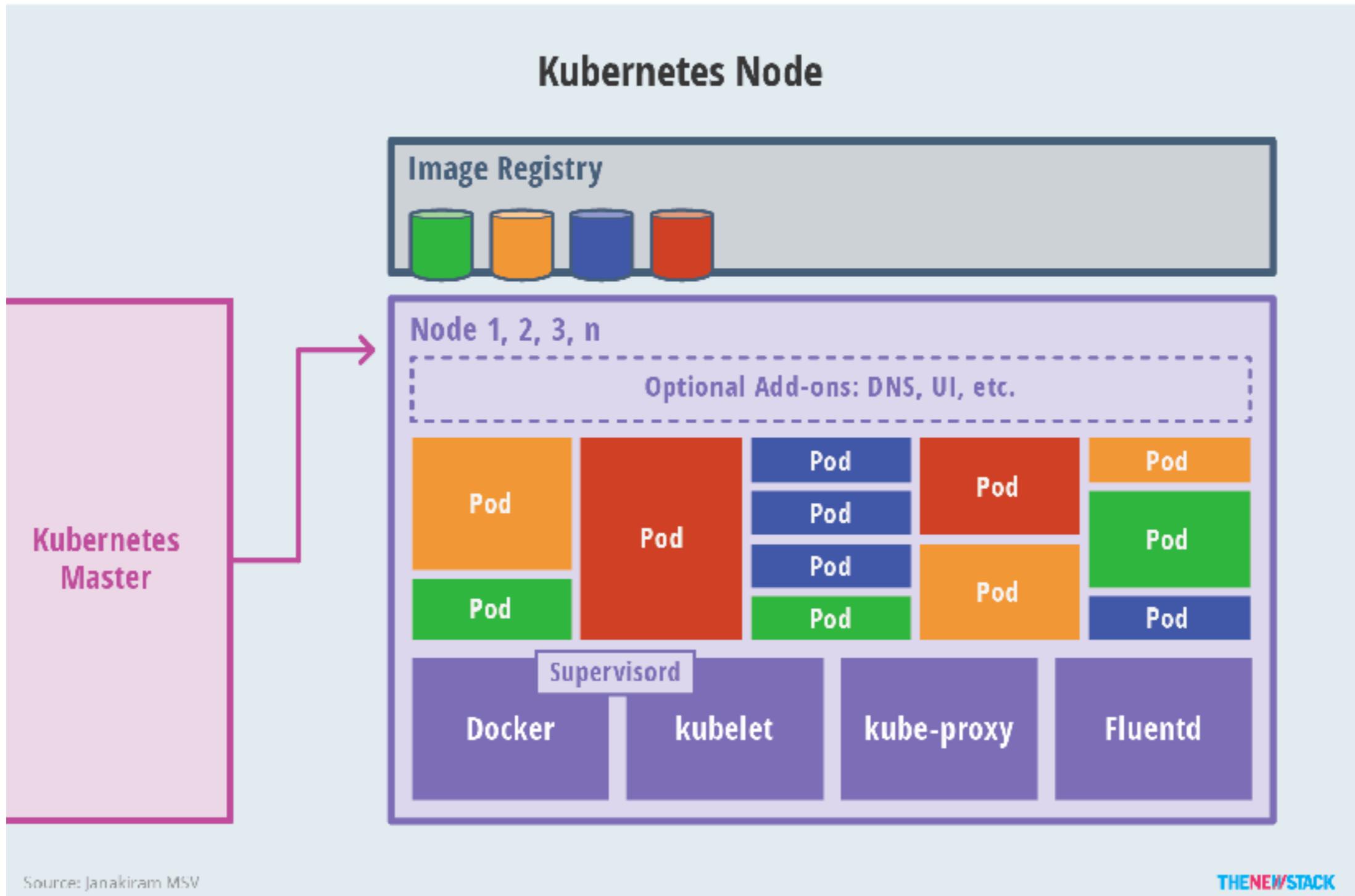
<https://thenewstack.io/kubernetes-an-overview/>



Master



Node



<https://thenewstack.io/kubernetes-an-overview/>



Core concepts of Kubernetes



Core concepts

Pods vs containers

Services

Replication Controllers

Deployments

ConfigMap and Secret

Volumes

StatefulSets

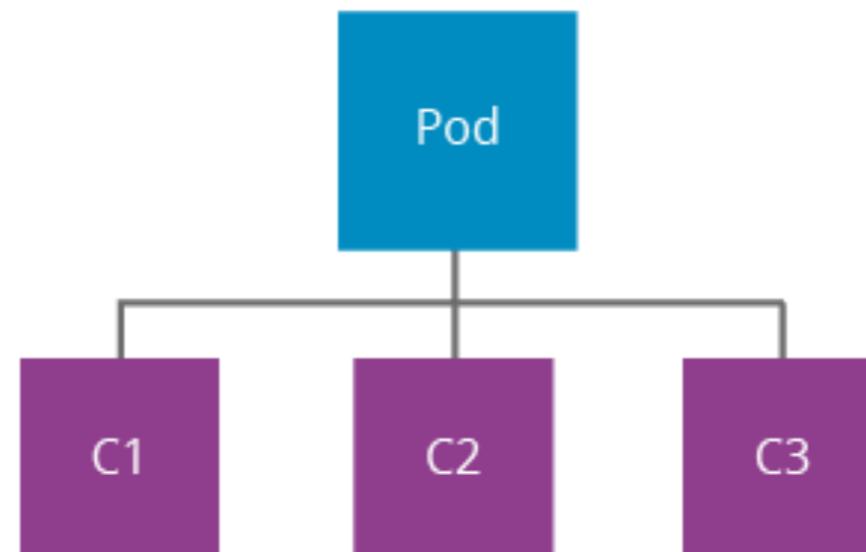


Pods vs containers



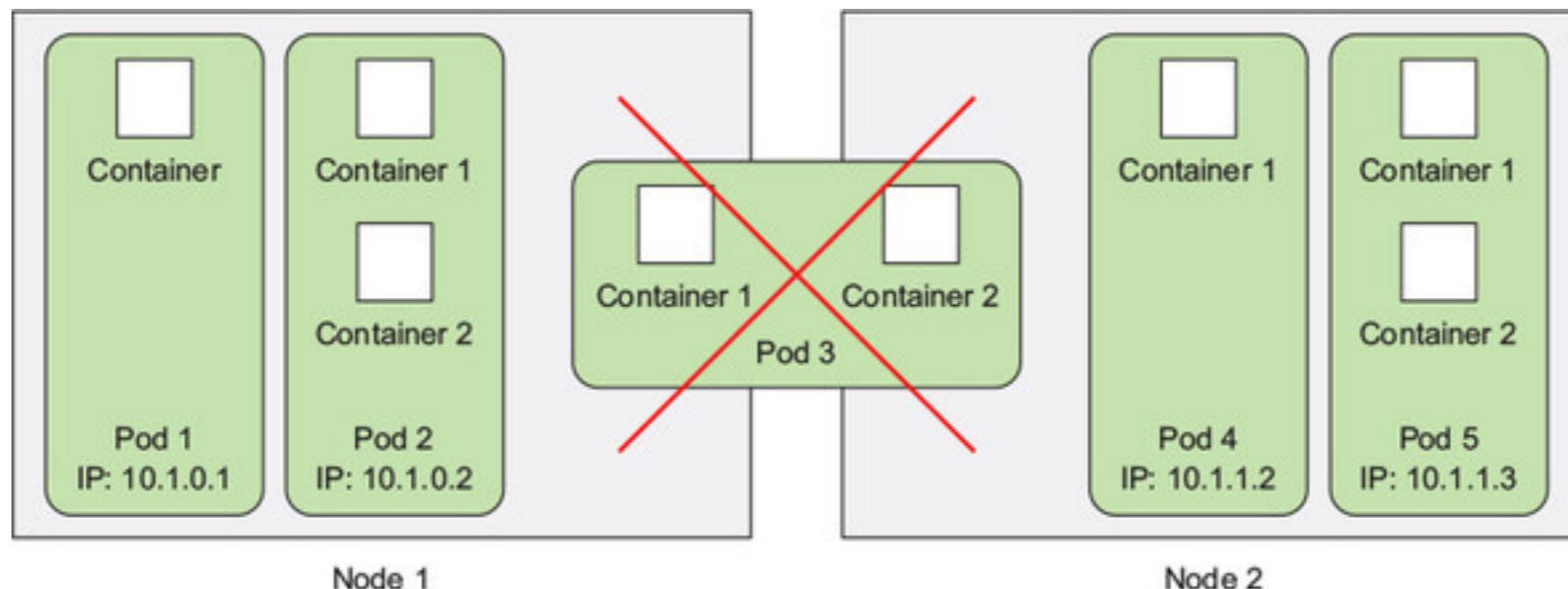
Pods

Small group of co-located containers
Optionally shared volume between containers
Basic deployment unit in Kubernetes



Pods

1 pods = 1 container
1 pods = N containers



All containers in same Pods

Share process ID

Share network interface

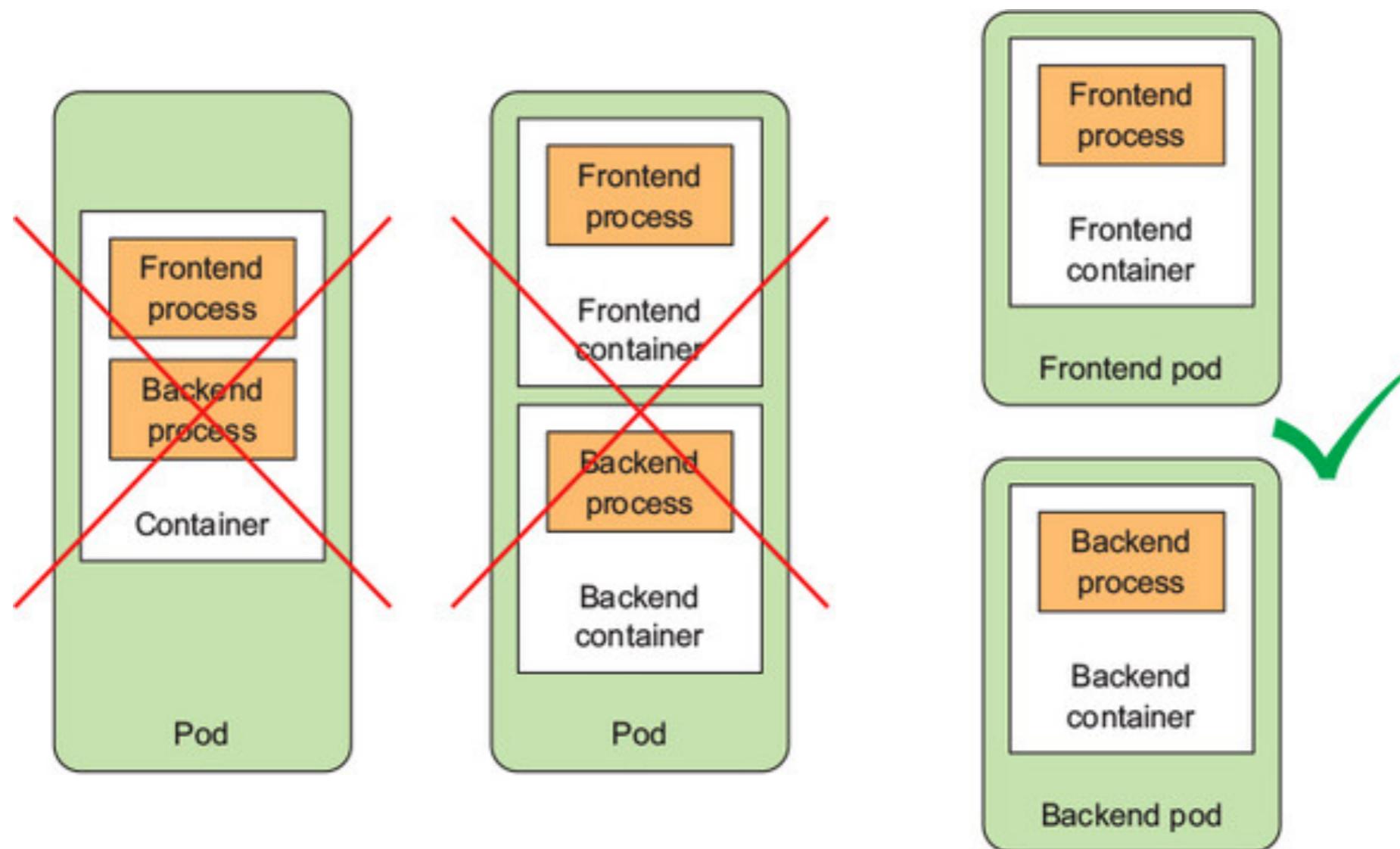
Share Hostname/IP/Port

Share Unix Time Sharing (UTS)



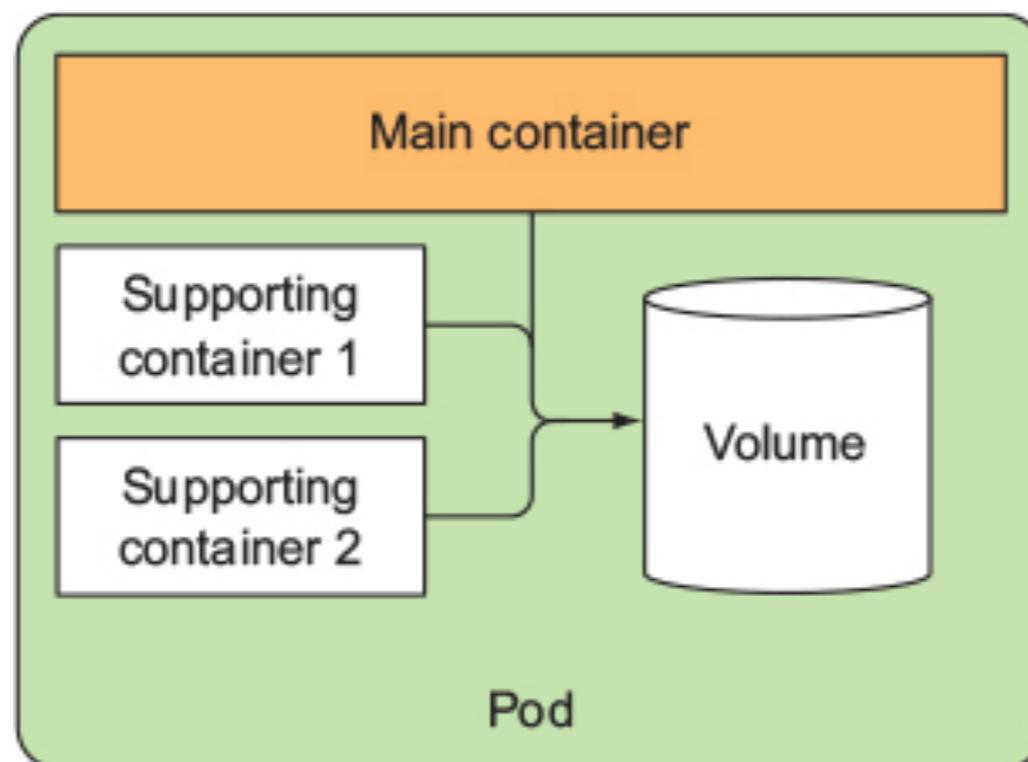
Organize container across Pods

Split multi-tiers app into multiple pods

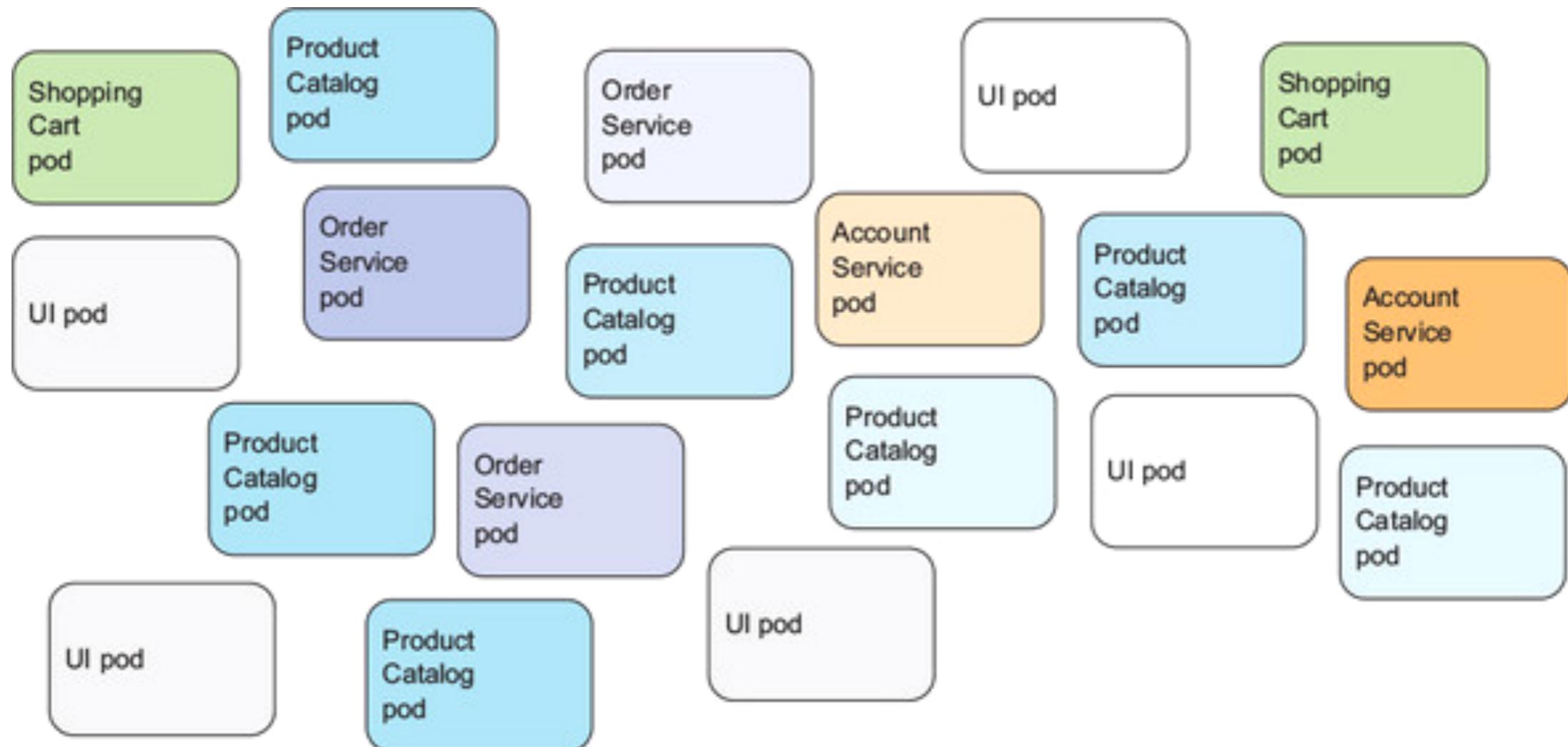


Organize container across Pods

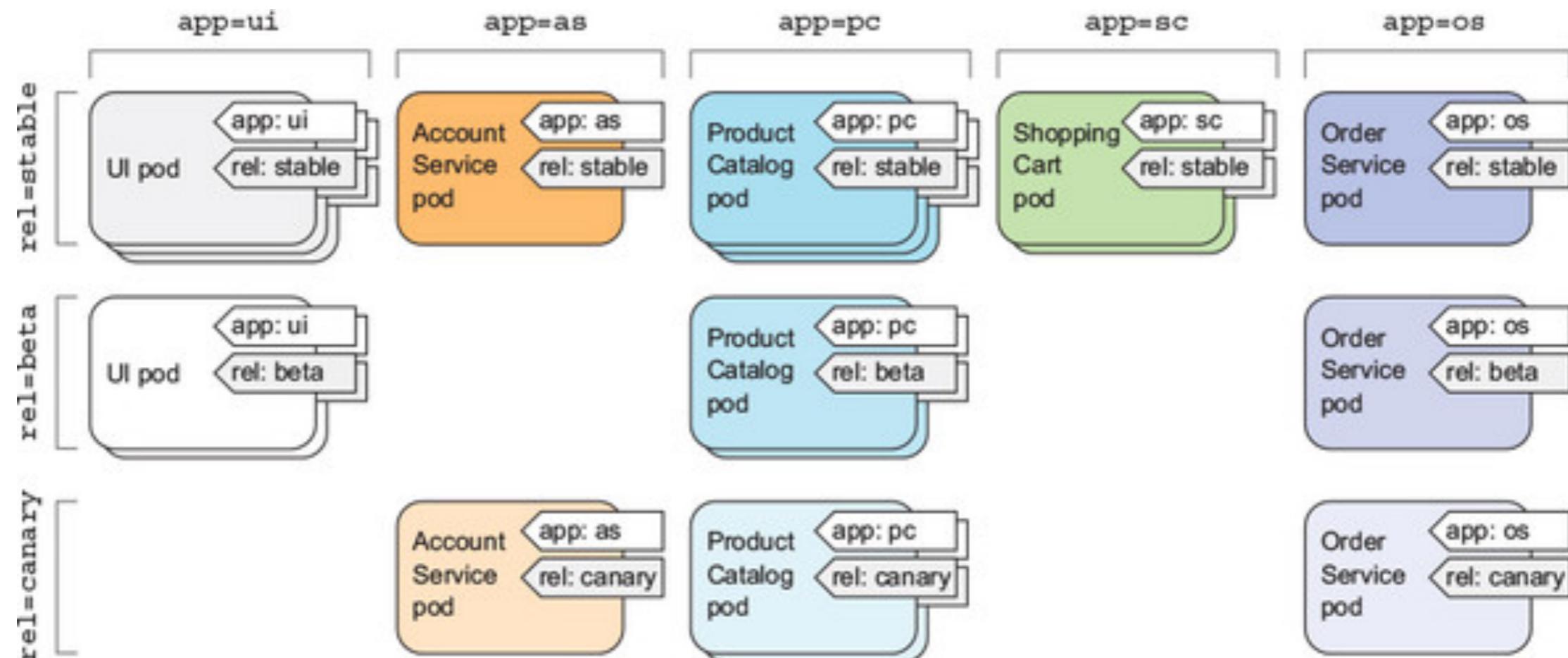
When to use multiple containers in a pods



Organize pods with Labels

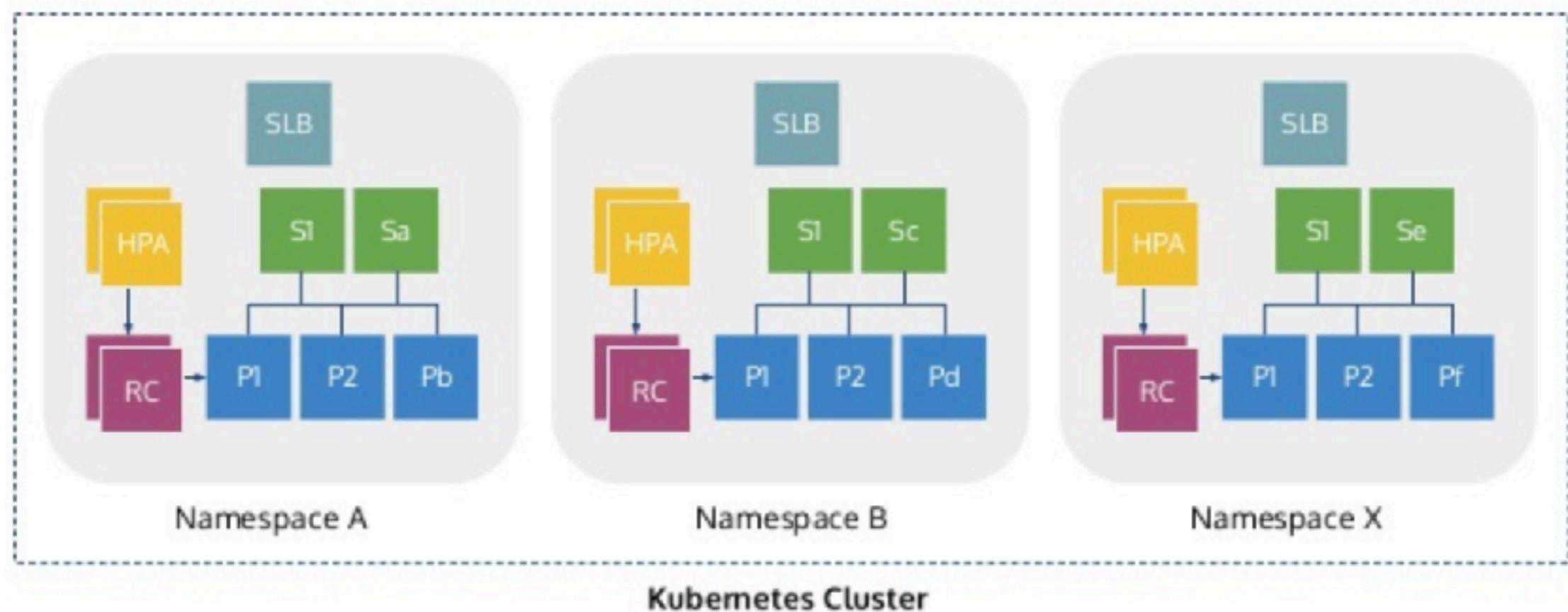


Organize pods with Labels



Pods namespaces

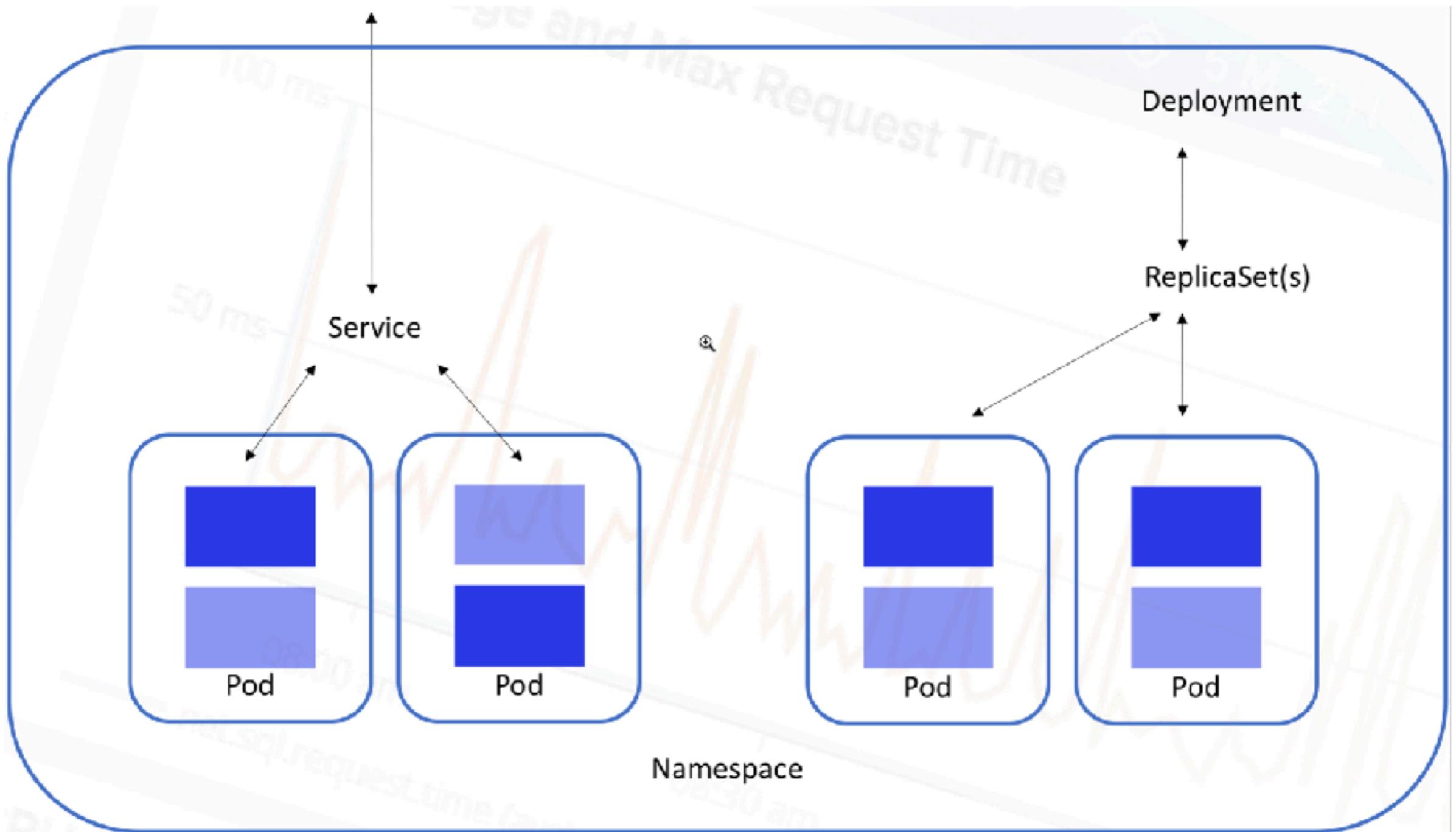
Allow different teams to use the same cluster



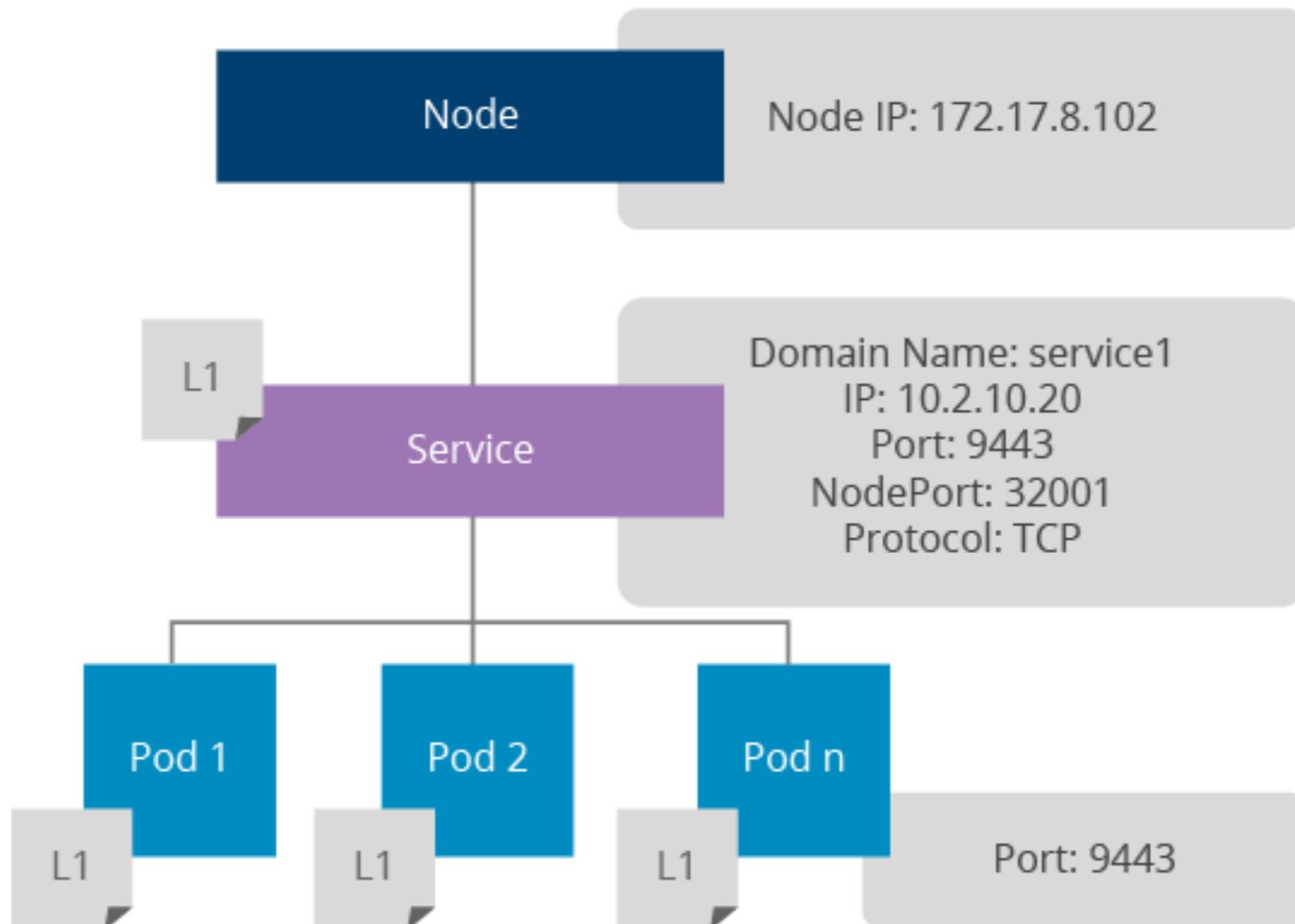
Services discovery and Load balancing



Services



Services

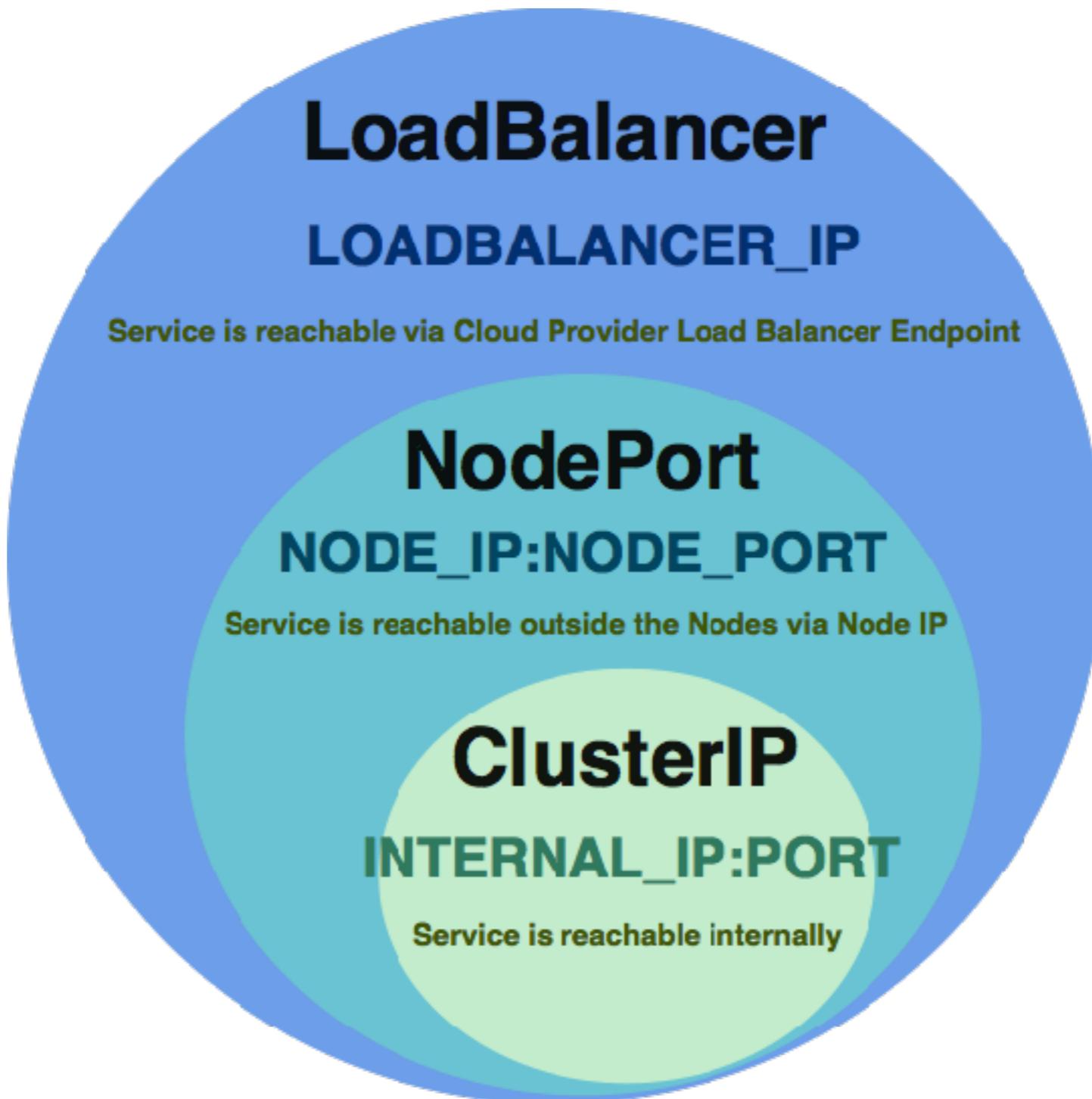


Services

- Independent from Pods
- Abstraction layer of Pods
- Provide load balance
- Expose access Pods/Load balance
- Find Pods by label selector



3 types of services



Workshop :: Pods & Services

1 container per Pods

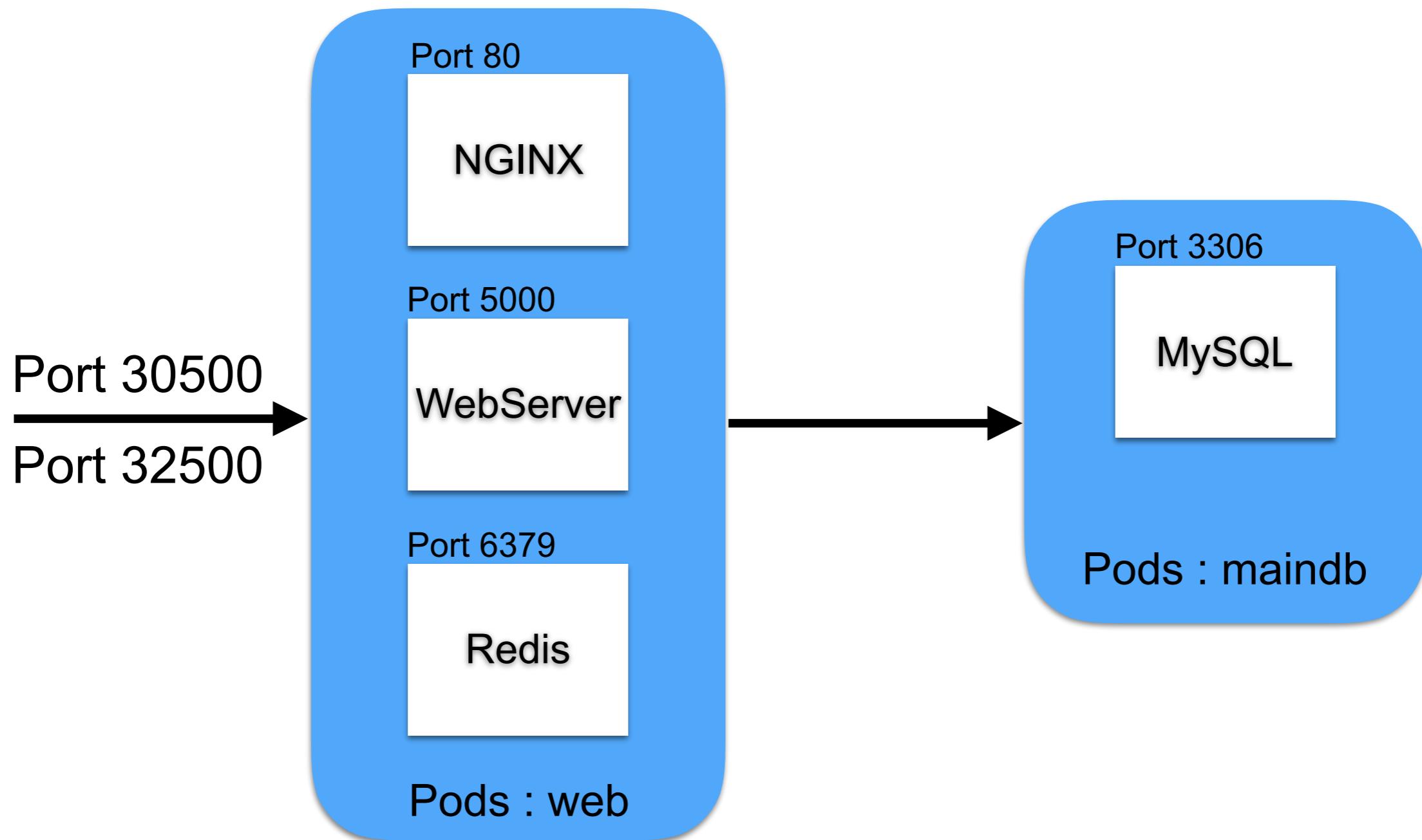


Workshop :: Pods & Services

N container per Pods



Workshop



Replication Controller (RC)



Replication Controller

Create and maintain Pods

Keep copy of Pods by design

Maintain on cluster level

Auto-healing if Pods crash with any reason

Ensure Pods is up and run with desired number



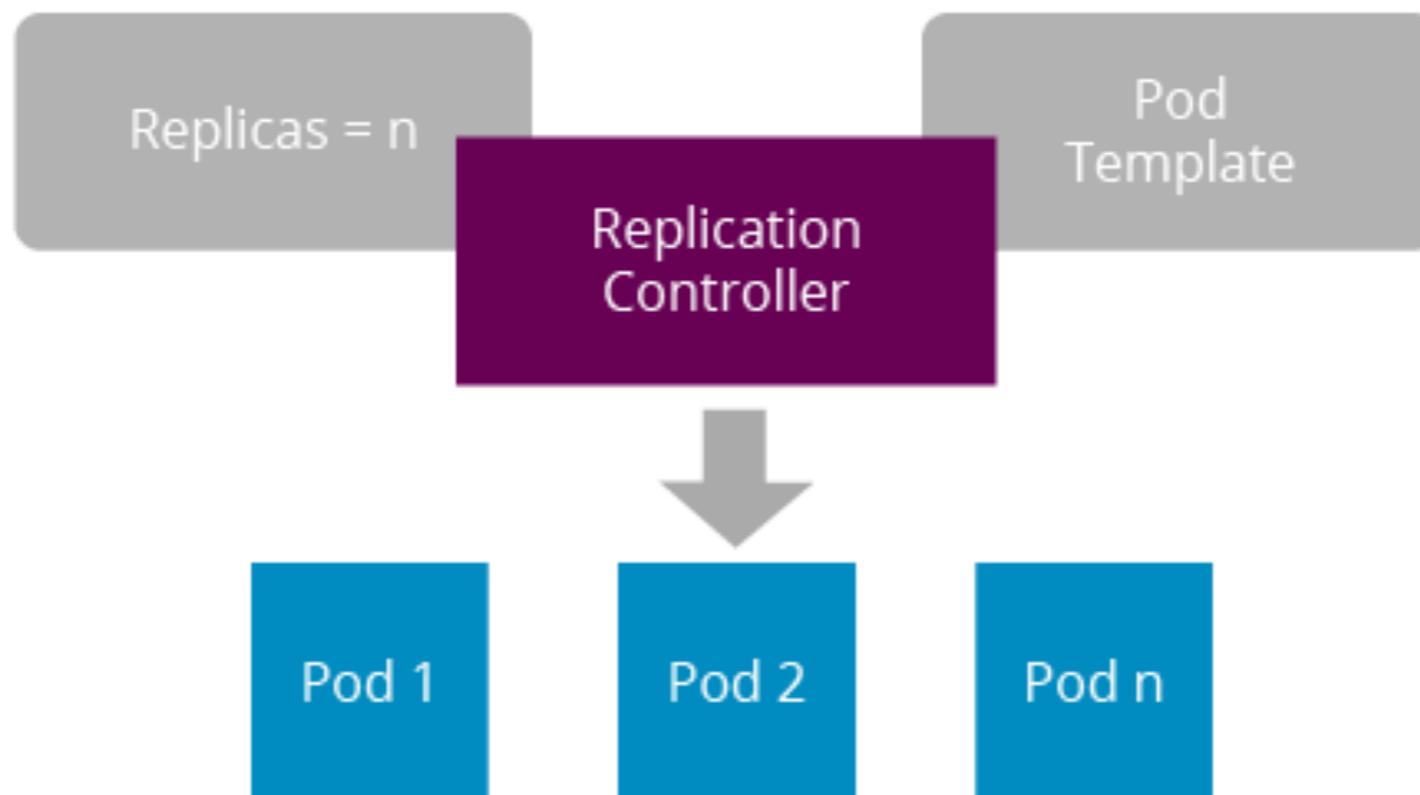
Replication Controller

Running based on label type
Equality-based requirement

```
selector:  
  name: web  
  version: "1.0"  
  module: WebServer  
  environment: development
```



Replication Controller



Scale up replicas of RC

```
$kubectl scale <option>  
--replicas=<number>  
<type or name>
```

```
bash-3.2$ kubectl get rc  
NAME      DESIRED   CURRENT   READY      AGE  
hello     5          5          5          15m  
bash-3.2$ kubectl get pods  
NAME        READY   STATUS    RESTARTS   AGE  
hello-jptv7  1/1     Running   0          43s  
hello-kdbsc  1/1     Running   0          43s  
hello-rn545  1/1     Running   0          15m  
hello-w6t5q  1/1     Running   0          43s  
hello-x6x8k  1/1     Running   0          43s
```



Detail of RC

\$kubectl describe rc <name>

Containers:

hello:
 Image: somkiat/hello:latest
 Port: 8080/TCP
 Host Port: 0/TCP
 Environment: <none>
 Mounts: <none>
 Volumes: <none>

Events:

| Type | Reason | Age | From | Message |
|--------|------------------|-----|------------------------|--------------------------|
| Normal | SuccessfulCreate | 16m | replication-controller | Created pod: hello-rn545 |
| Normal | SuccessfulCreate | 16m | replication-controller | Created pod: hello-pfwnj |
| Normal | SuccessfulCreate | 16m | replication-controller | Created pod: hello-jfqfl |
| Normal | SuccessfulCreate | 13m | replication-controller | Created pod: hello-6pfqm |
| Normal | SuccessfulCreate | 11m | replication-controller | Created pod: hello-l4lqc |
| Normal | SuccessfulCreate | 11m | replication-controller | Created pod: hello-pfgr2 |
| Normal | SuccessfulDelete | 9m | replication-controller | Deleted pod: hello-l4lqc |
| Normal | SuccessfulDelete | 9m | replication-controller | Deleted pod: hello-pfwnj |
| Normal | SuccessfulDelete | 9m | replication-controller | Deleted pod: hello-6pfqm |
| Normal | SuccessfulDelete | 9m | replication-controller | Deleted pod: hello-pfgr2 |
| Normal | SuccessfulCreate | 2m | replication-controller | Created pod: hello-kdbsc |
| Normal | SuccessfulCreate | 2m | replication-controller | Created pod: hello-jptv7 |
| Normal | SuccessfulCreate | 2m | replication-controller | Created pod: hello-x6x8k |

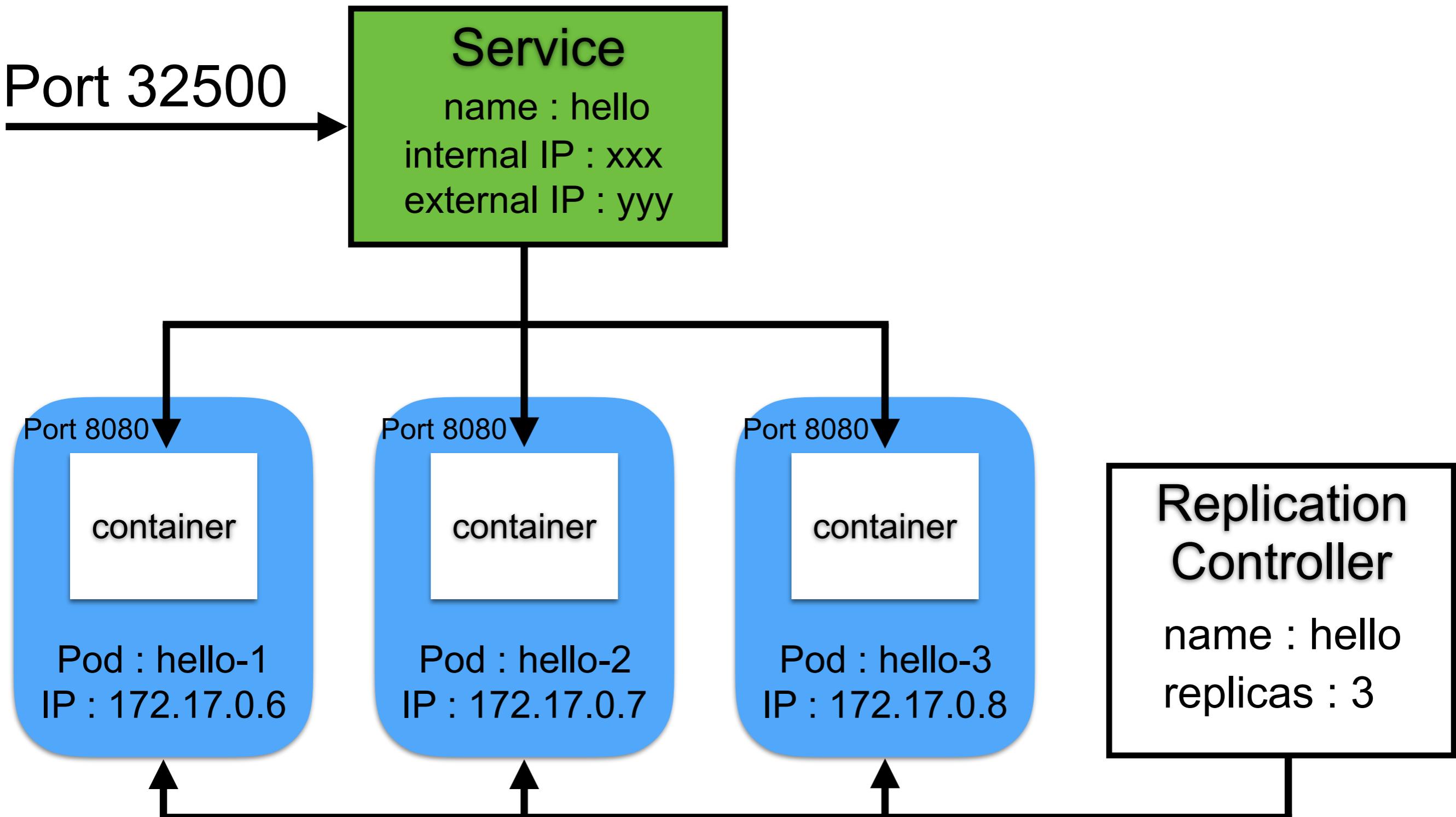


Workshop

Replication Controller



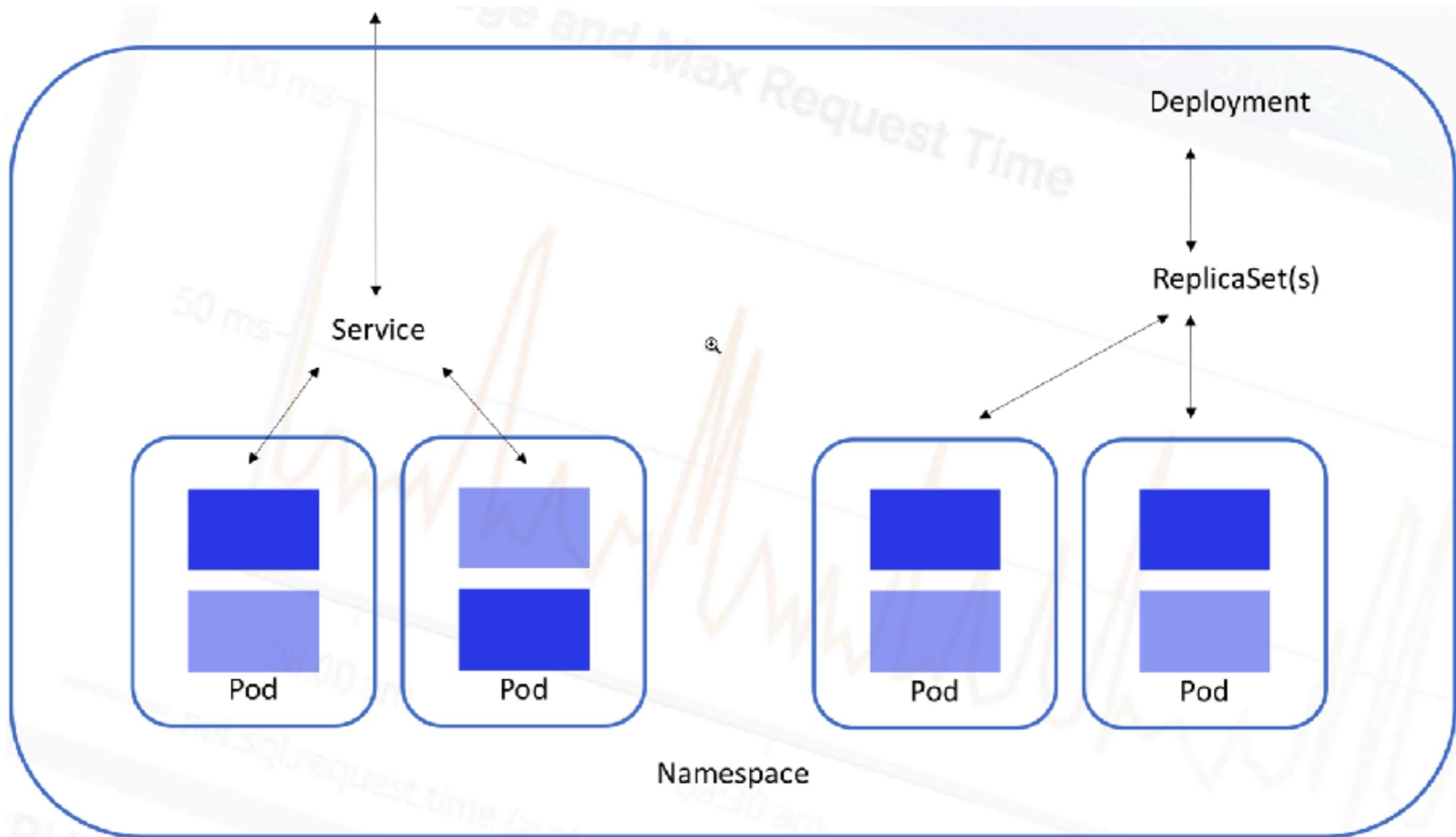
Scaling the application



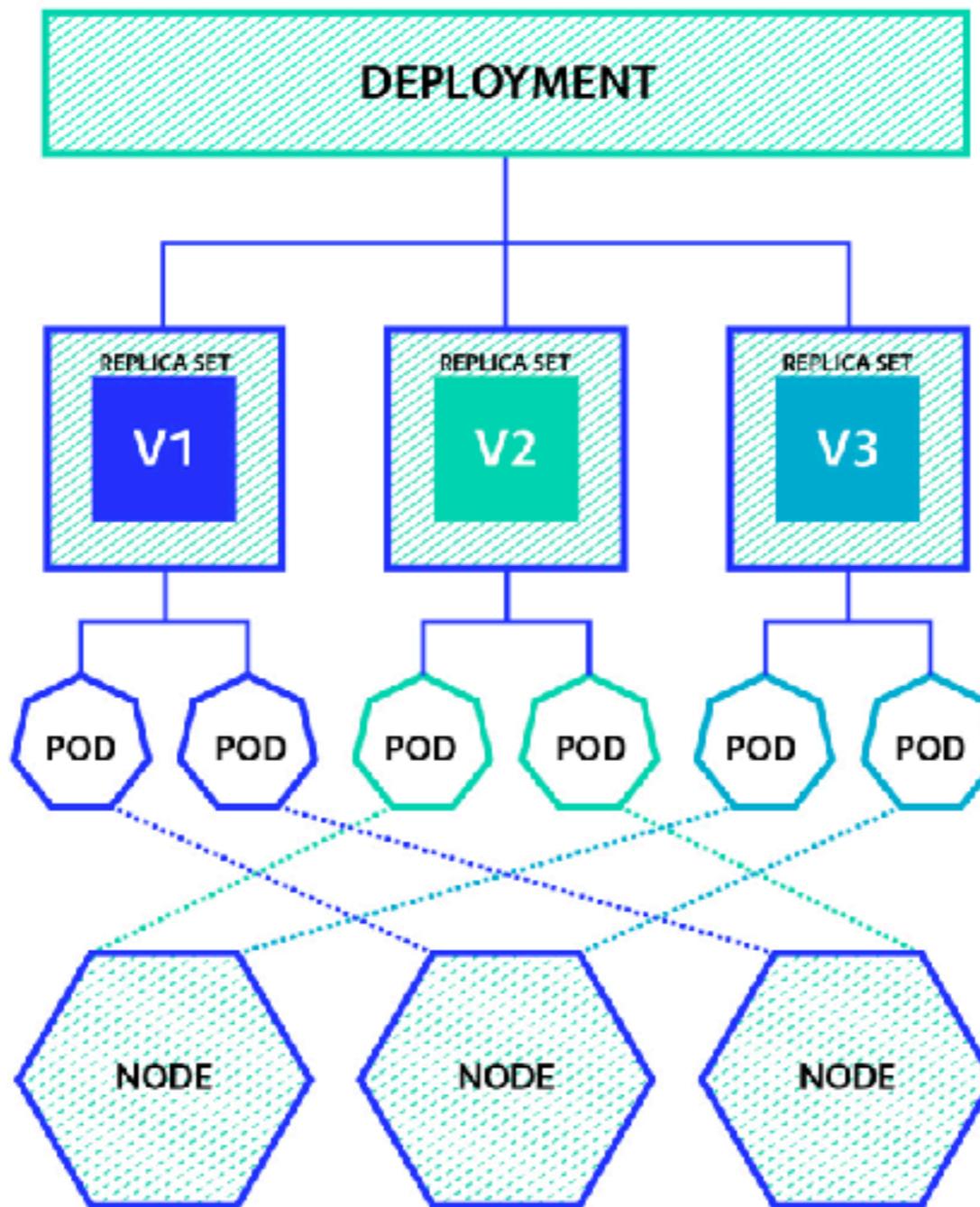
Deployment and ReplicaSet (RS)



Deployment and ReplicaSet



Deployment and ReplicaSet



<https://thenewstack.io/kubernetes-deployments-work/>



Deployment and RS

Next-generation of RC

Provide function to maintain versioning of Pods

Update new version (Rollout)

Revert to old version (Rollback)

Scale a deployment

Pause process

Resume process



New version from Deployment

Create new RS

Start to scale as desired

Scale down existing RS to 0

Delete existing RS



Deployment/RS vs RC

RS more dynamic than RC

RS support label with methods:

Equality-based requirement

Set-based requirement



Rollout strategy

Set online

Edit online

Modify YAML file and apply



Set online

```
$kubectl set image deployment/hello  
hello=somkiat/hello:v2
```

```
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: 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: 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 old replicas are pending termination...  
Waiting for rollout to finish: 1 old replicas are pending termination...  
Waiting for rollout to finish: 1 old replicas are pending termination...  
deployment "hello" successfully rolled out
```



Edit online

\$kubectl edit deployment hello

```
# Please edit the object below. Lines beginning with a '#' will be ignored,
# and an empty file will abort the edit. If an error occurs while saving this file,
# it will be reopened with the relevant failures.
#
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  annotations:
    deployment.kubernetes.io/revision: "6"
    kubectl.kubernetes.io/last-applied-configuration: |
      {"apiVersion":"apps/v1","kind":"Deployment","metadata":{"annotations":{}},
      "namespace":"default","spec":{"replicas":3,"revisionHistoryLimit":1,"selector":{"matchLabels":{"app":"web"}}, "template":{"metadata":{"labels":{"app":"web"}}, "spec":{"containers":[{"image":"nginx:1.13.6-alpine", "ports":[{"containerPort":8080, "protocol":"TCP"}]}]}}}
  creationTimestamp: 2018-04-01T17:17:51Z
  generation: 10
  labels:
    app: web
  name: hello
  namespace: default
  resourceVersion: "33405"
  selfLink: /apis/extensions/v1beta1/namespaces/default/deployments/hello
  uid: 9b773859-35d0-11e8-9d36-0800275c6c60
```



Modify YAML file and apply

```
$kubectl apply -f hello_deployment.yml
```



Show history of rollout

```
$kubectl rollout history deployment/hello
```

```
deployments "hello"
REVISION  CHANGE-CAUSE
2          <none>
3          <none>
4          <none>
```

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello
  labels:
    app: web
spec:
  replicas: 3
  revisionHistoryLimit: 1
  selector:
    matchLabels:
      app: web
```

spec.revisionHistory = 2 (default)
spec.revisionHistory = 0 (clean all)



Try to rollback to revision

```
$kubectl rollout undo deployment/hello --to-revision=2
```



Try to scale a deployment

\$kubectl scale deployment hello --replicas=5

```
bash-3.2$ kubectl scale deployment hello --replicas=3
deployment.extensions "hello" scaled
```

```
bash-3.2$ kubectl get deployment -o wide
```

| NAME | DESIRED | CURRENT | UP-TO-DATE | AVAILABLE | AGE | CONTAINERS | IMAGES | SELECTOR |
|-------|---------|---------|------------|-----------|-----|------------|---------------|----------|
| hello | 3 | 3 | 3 | 3 | 21m | hello | somkiat/hello | app=web |

```
bash-3.2$ kubectl scale deployment hello --replicas=5
deployment.extensions "hello" scaled
```

```
bash-3.2$ kubectl get deployment -o wide
```

| NAME | DESIRED | CURRENT | UP-TO-DATE | AVAILABLE | AGE | CONTAINERS | IMAGES | SELECTOR |
|-------|---------|---------|------------|-----------|-----|------------|---------------|----------|
| hello | 5 | 5 | 5 | 5 | 21m | hello | somkiat/hello | app=web |

```
bash-3.2$ kubectl scale deployment hello --replicas=1
deployment.extensions "hello" scaled
```

```
bash-3.2$ kubectl get deployment -o wide
```

| NAME | DESIRED | CURRENT | UP-TO-DATE | AVAILABLE | AGE | CONTAINERS | IMAGES | SELECTOR |
|-------|---------|---------|------------|-----------|-----|------------|---------------|----------|
| hello | 1 | 1 | 1 | 1 | 21m | hello | somkiat/hello | app=web |



Pause and resume rollout

```
$kubectl rollout pause deployment/hello  
$kubectl rollout resume deployment/hello
```



Workshop

Deployment/RS

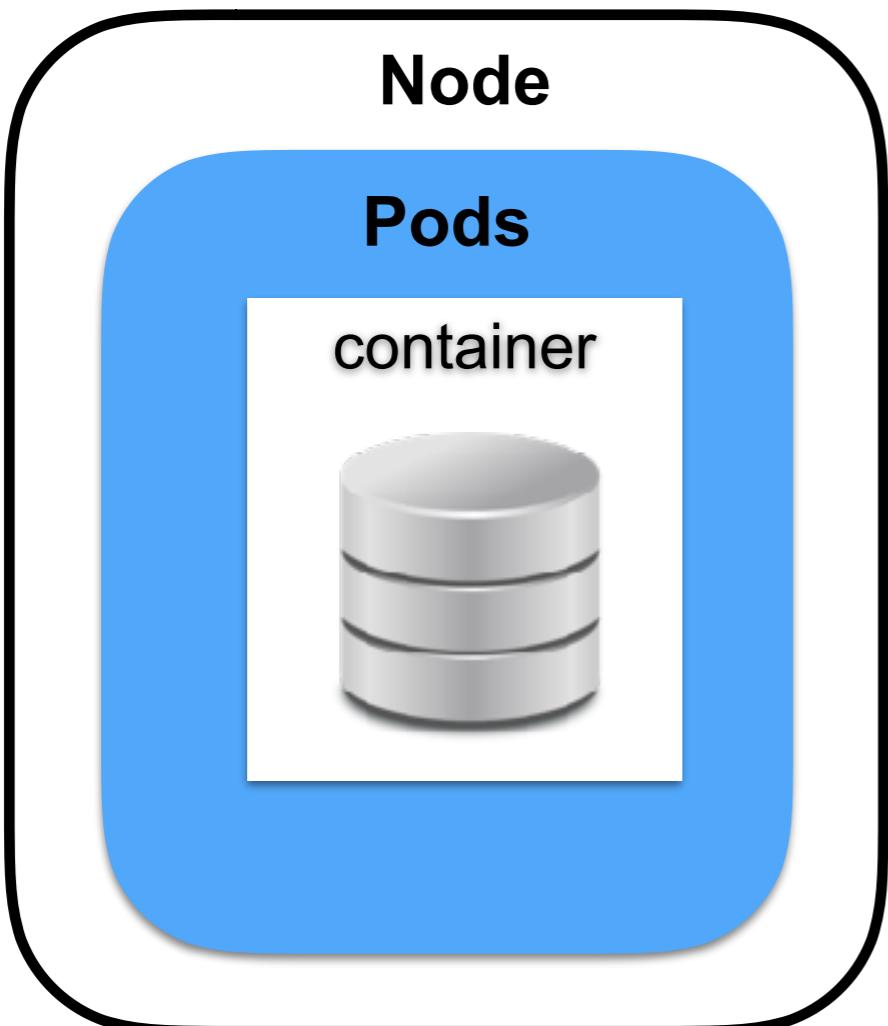


Volume

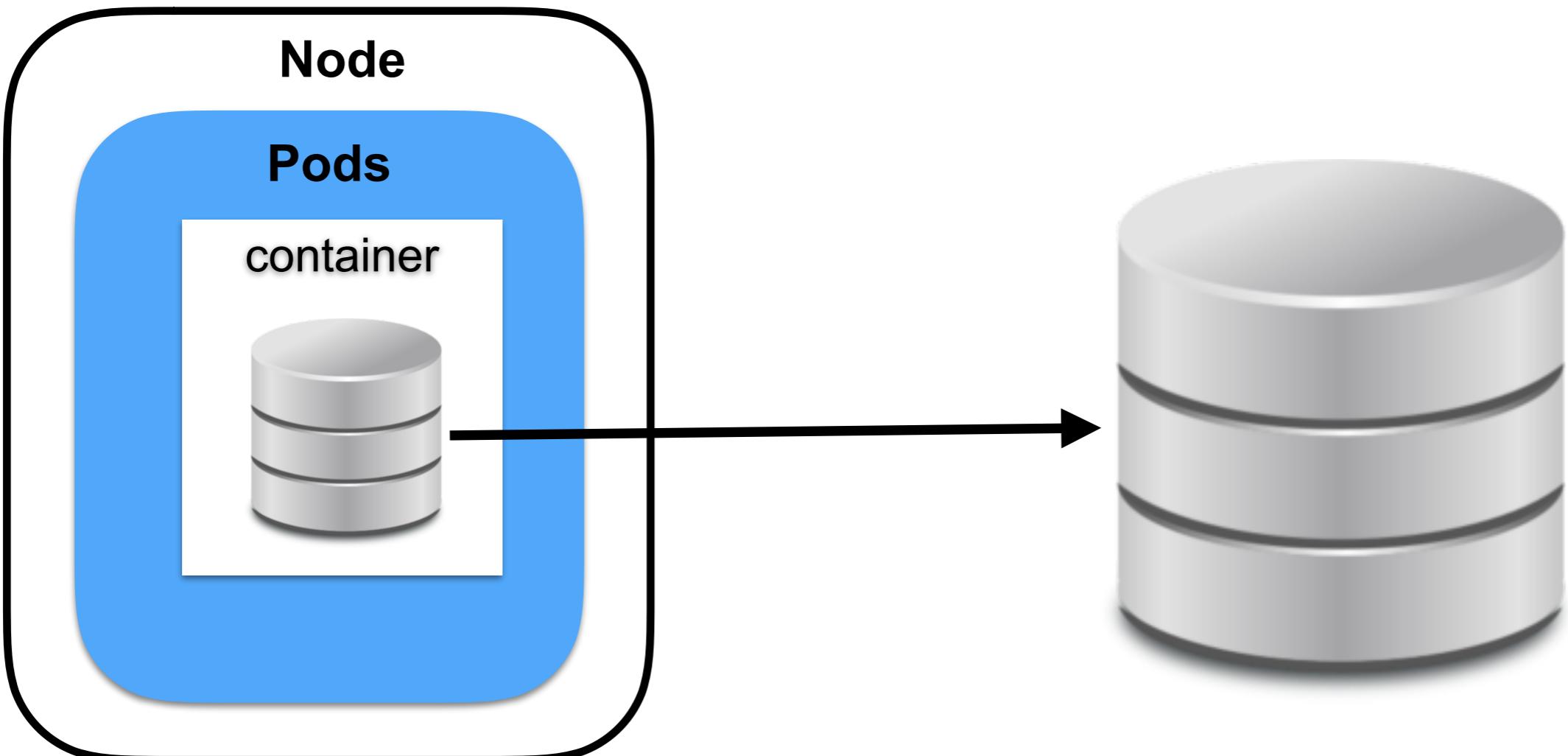
<https://kubernetes.io/docs/concepts/storage/volumes/#resources>



Volume



Volume



Volume

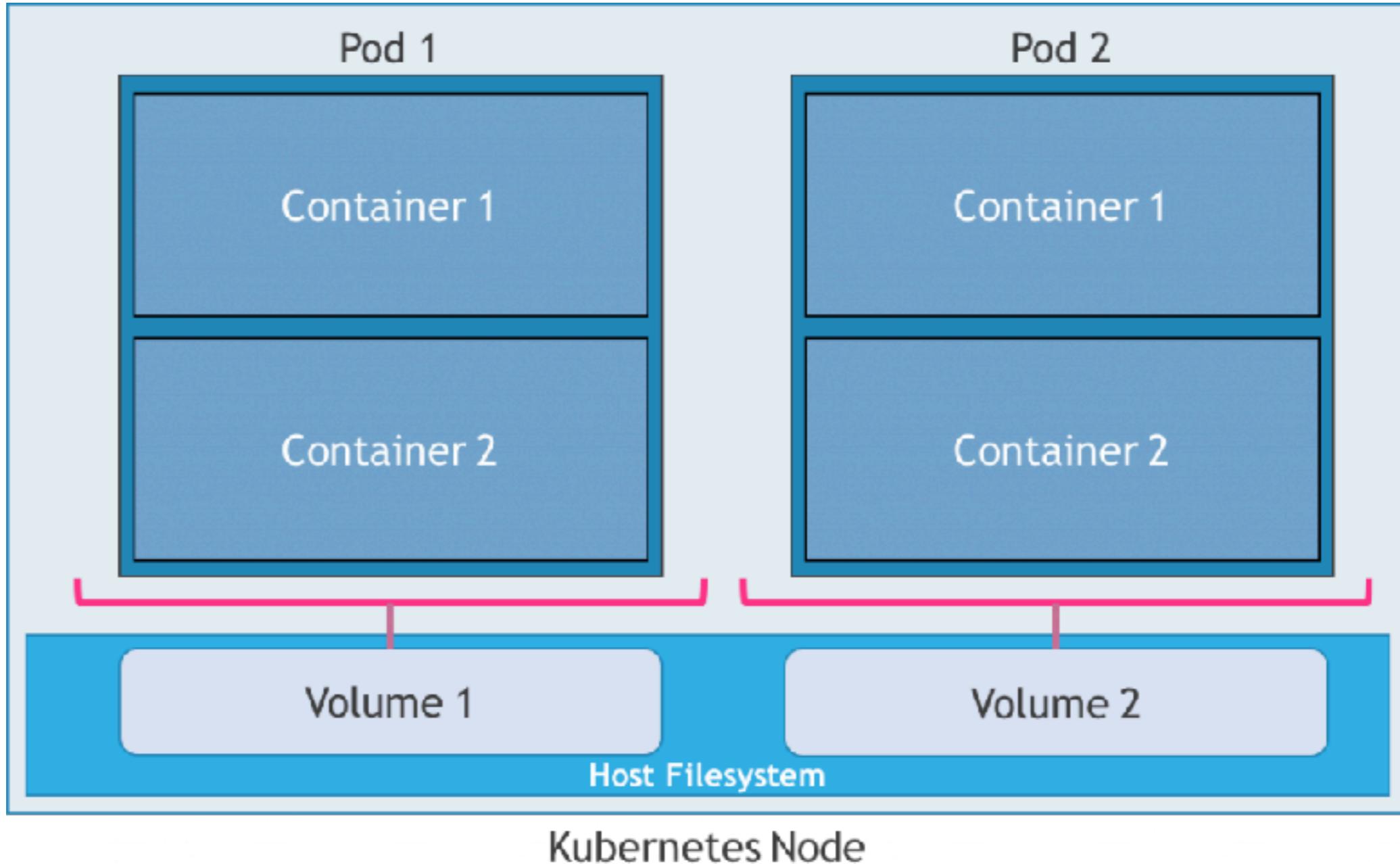
Containers in the same Pods share storage
(EmptyDir)

- Read and write for all containers in Pods
- Container crash not effect to this storage
- When Pods is deleted then Empty will deleted

Data of Pods/container is **ephemeral**
all data may loss when Pods is restarted



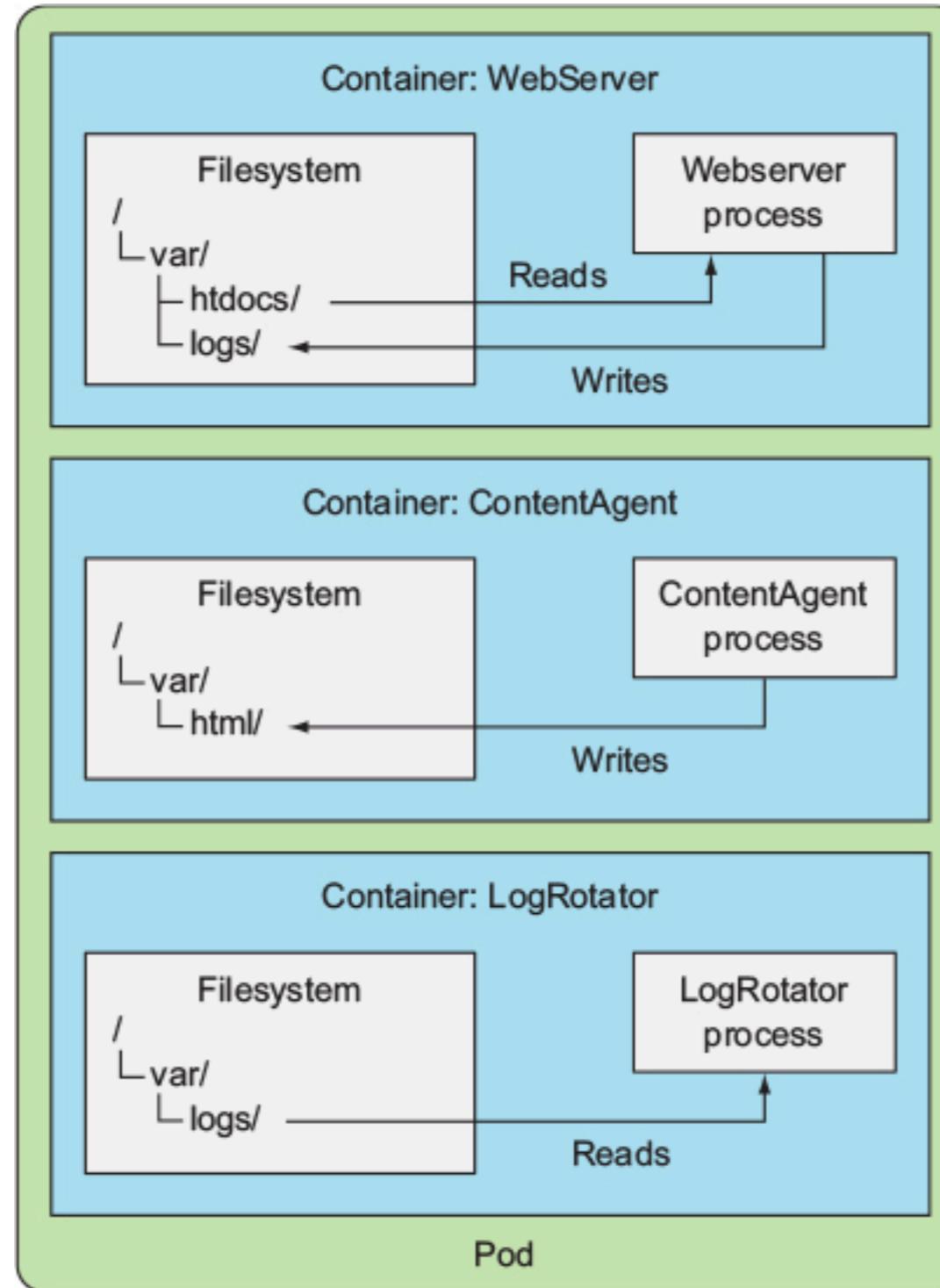
Containers shared volume



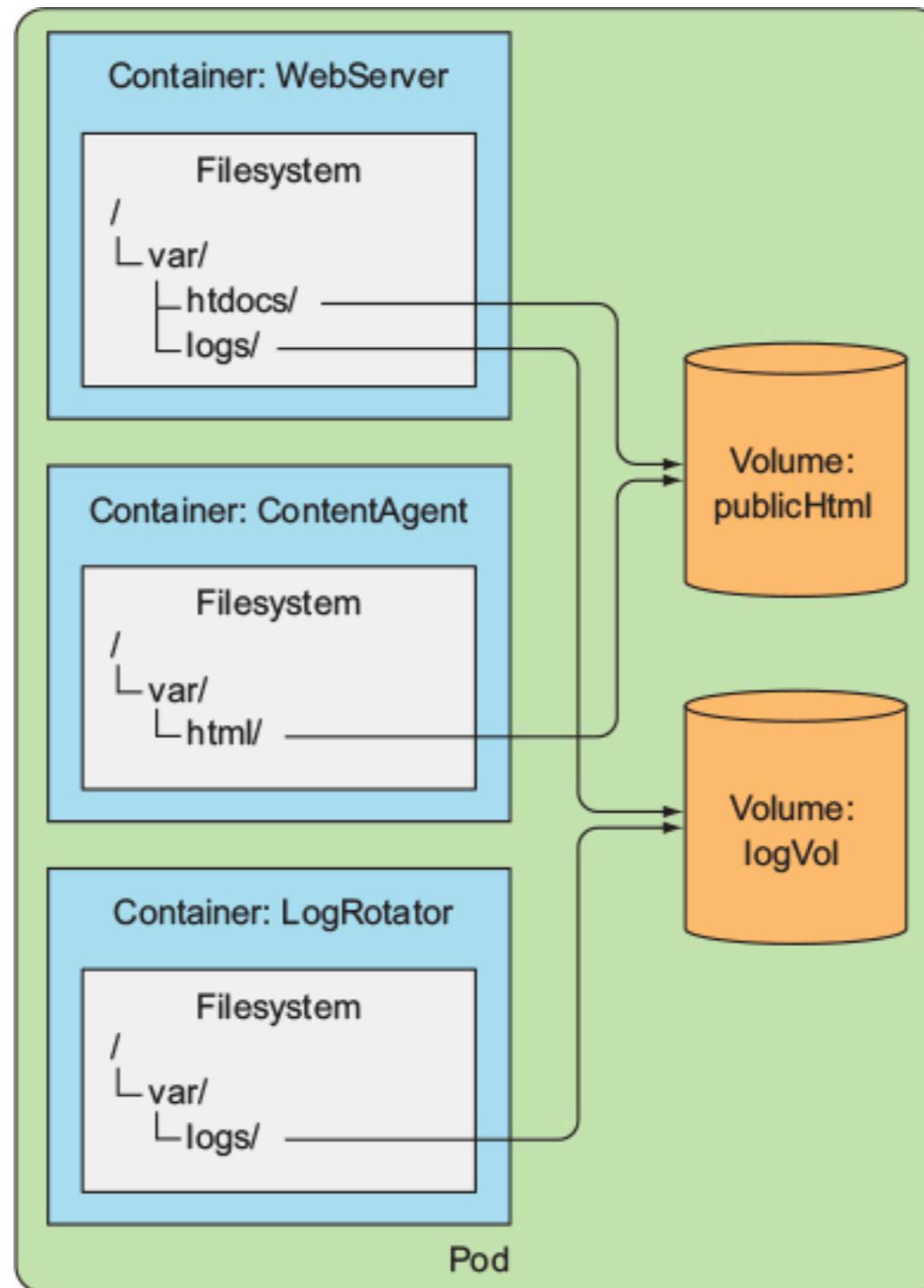
<https://thenewstack.io/strategies-running-stateful-applications-kubernetes-volumes/>



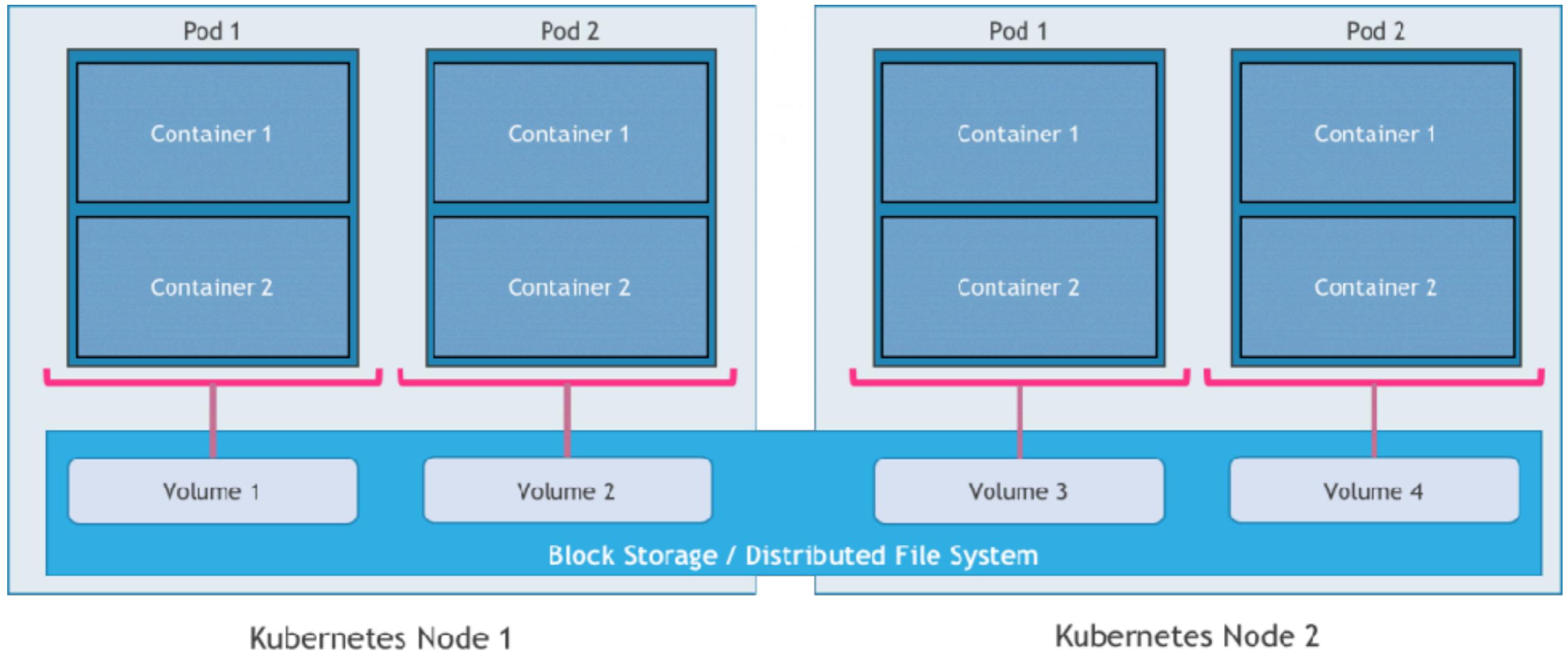
Without shared storage



Containers shared volume



Nodes shared volume



<https://thenewstack.io/strategies-running-stateful-applications-kubernetes-volumes/>



Volume on Kubernetes

**EmptyDir
hostPath
gitRepo
NFS**

icePersistentDisk

Flocker

Persistent Volume Claim (PVC)

configMap, secret

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



Kubernetes volumes

EmptyDir

HostPath

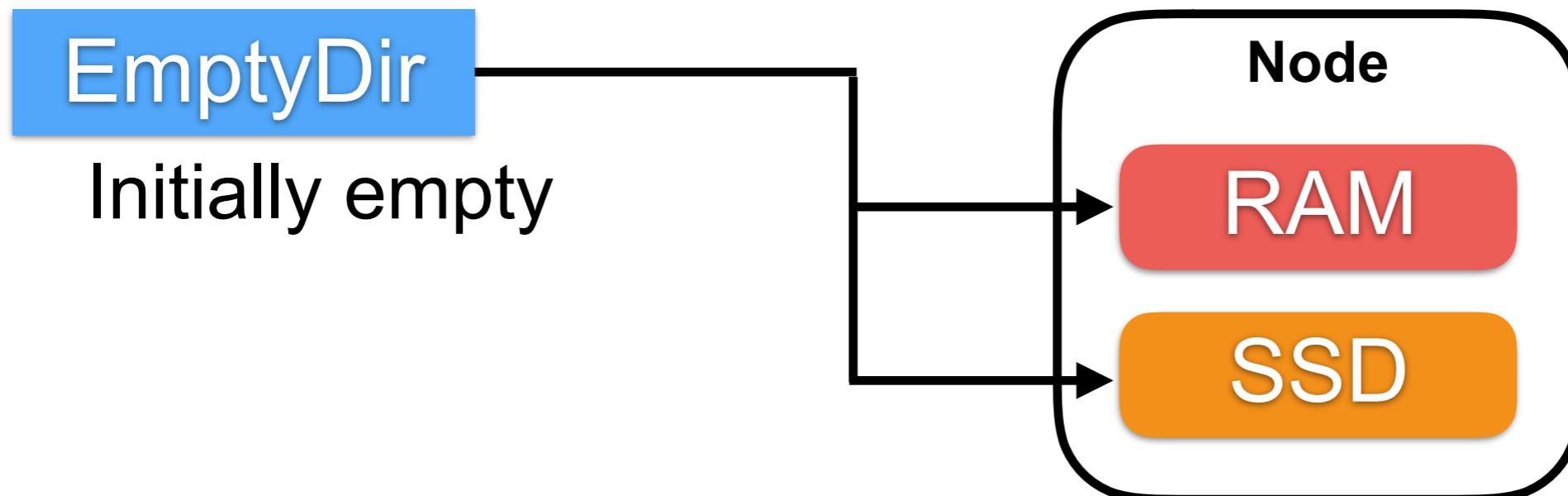
NFS

Cloud Volume

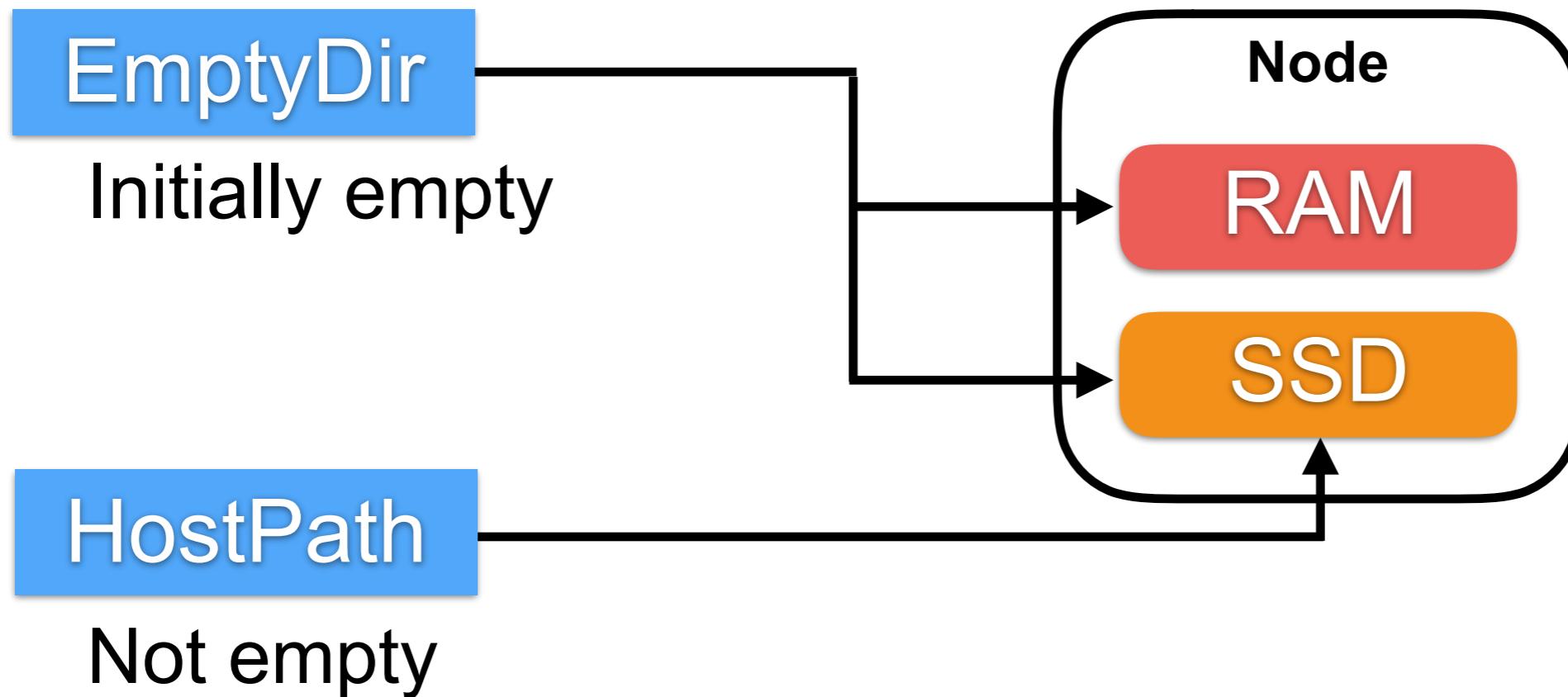
Persistent Volume Claim



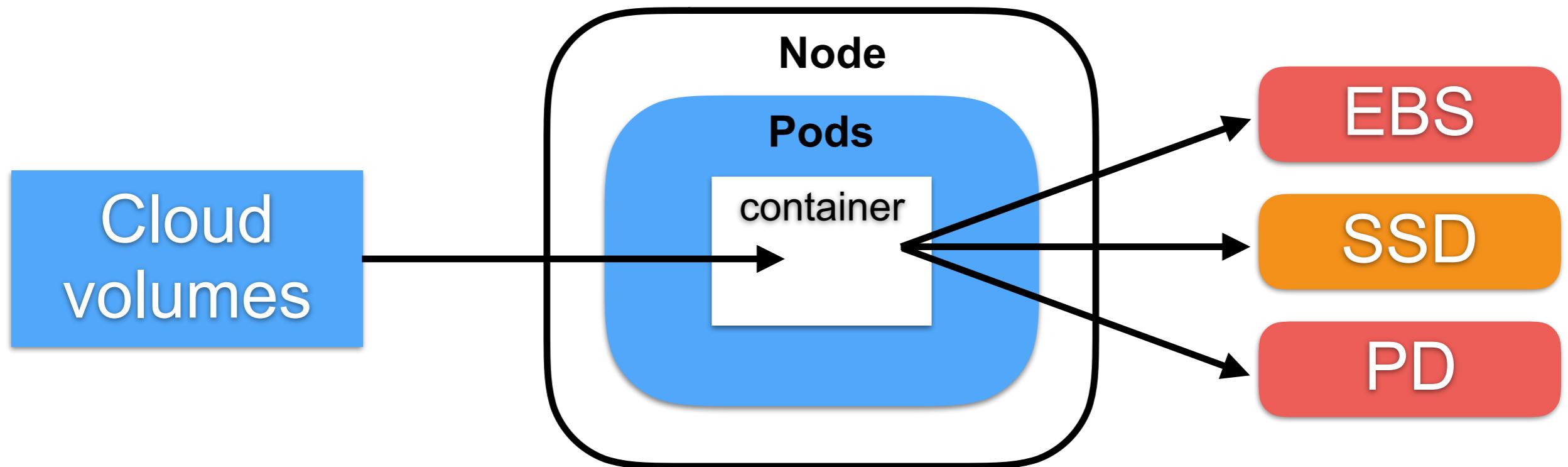
Kubernetes volumes



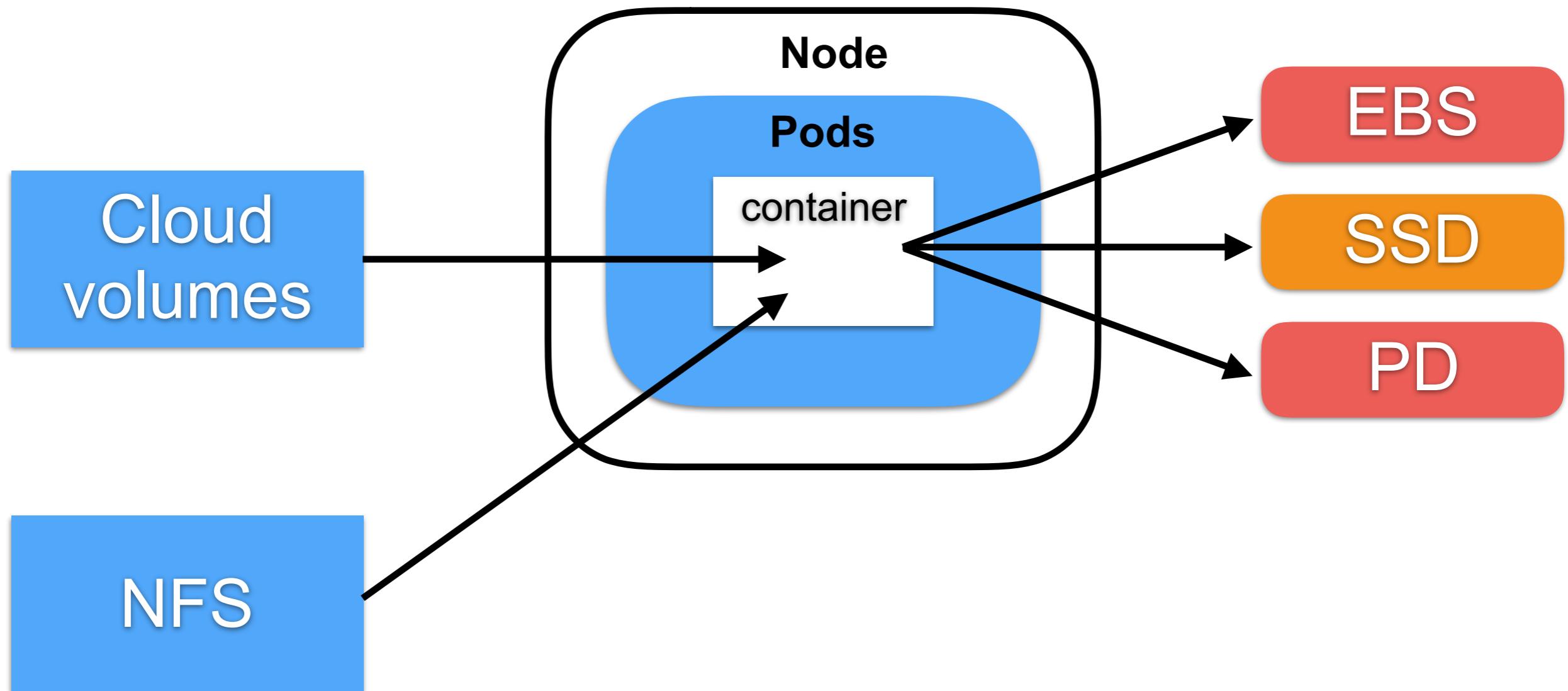
Kubernetes volumes



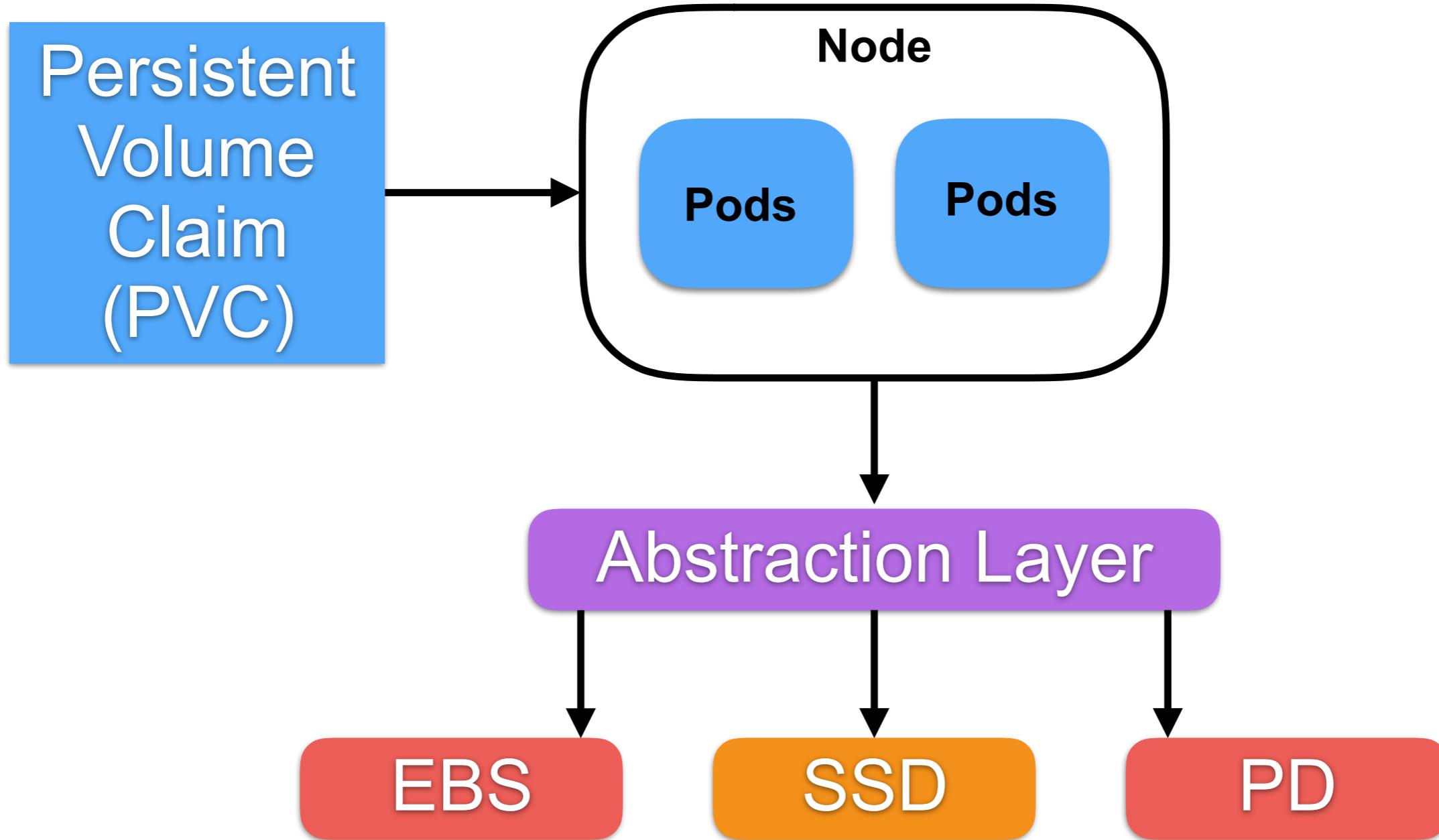
Kubernetes volumes



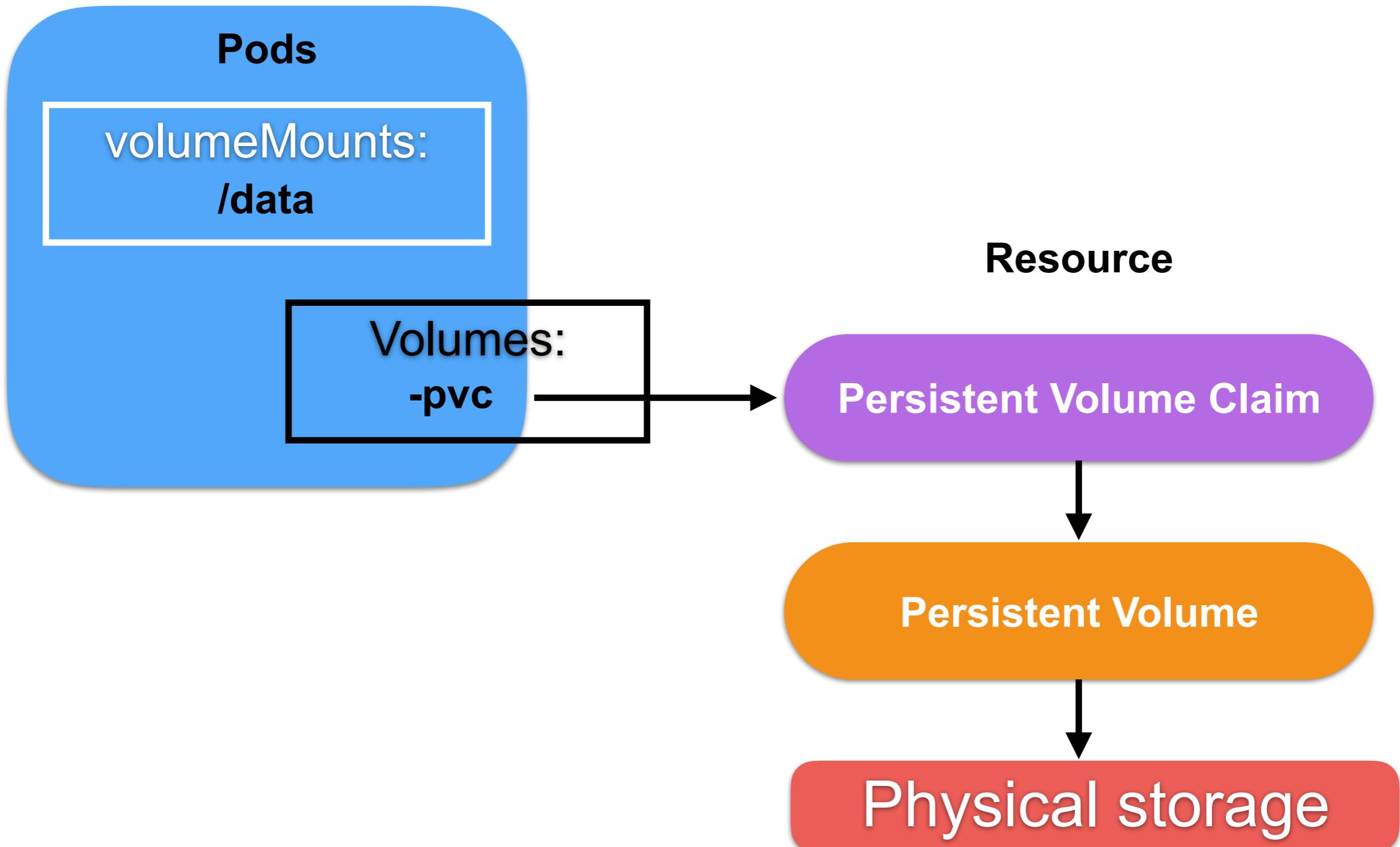
Kubernetes volumes



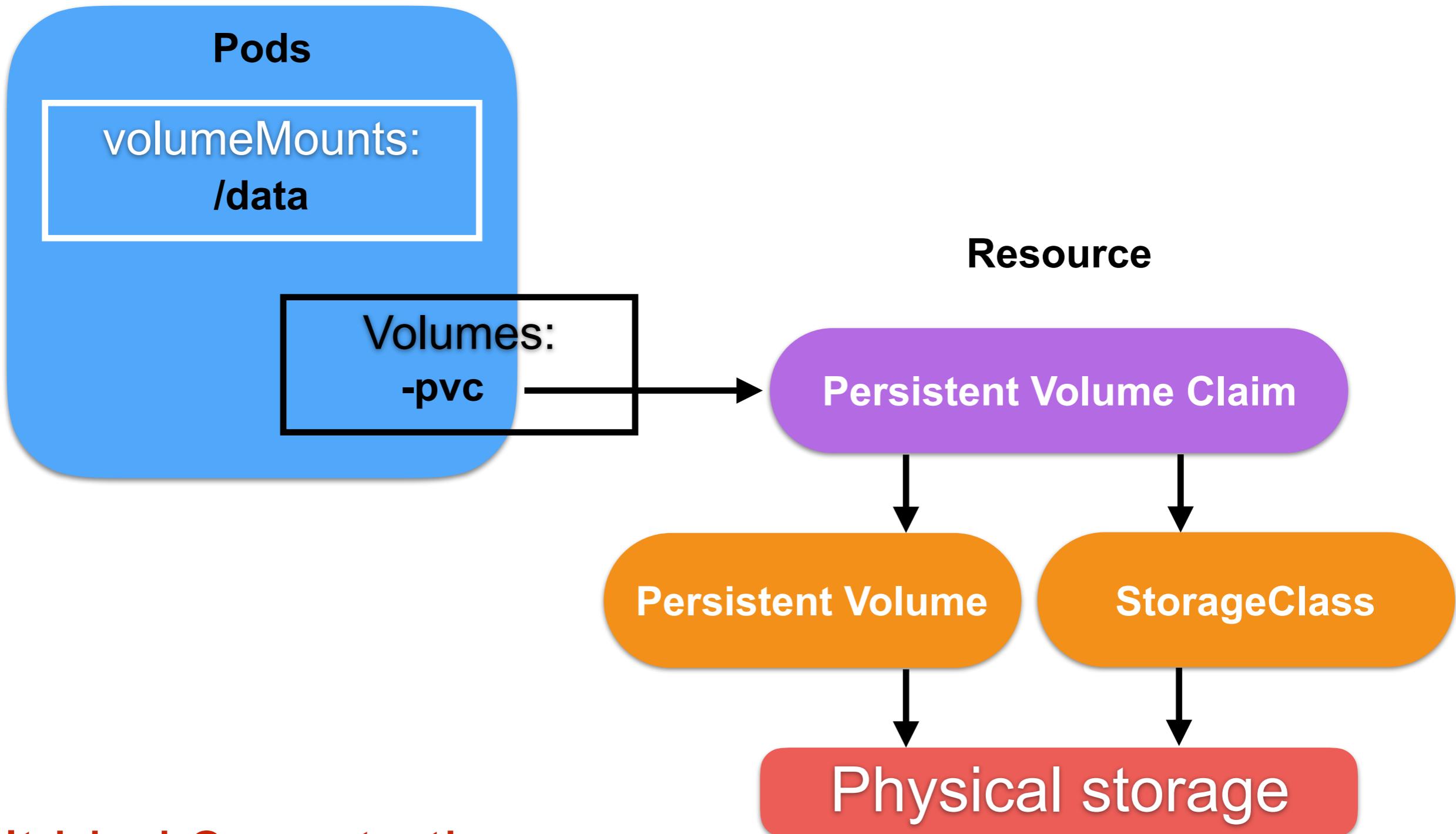
Kubernetes volumes



Persistent volume



Persistent volume



Can't bind 2 pvc to the same pv.



EmptyDir

Shares volume/storage in same Pods

```
- image: nginx:alpine
  name: web-server
  volumeMounts:
    - name: html
      mountPath: /usr/share/nginx/html
      readOnly: true
  ports:
    - containerPort: 80
      protocol: TCP

  volumes:
    - name: html
      emptyDir:
        medium: Memory
```



HostPath

Mount file/dir from host to Pods

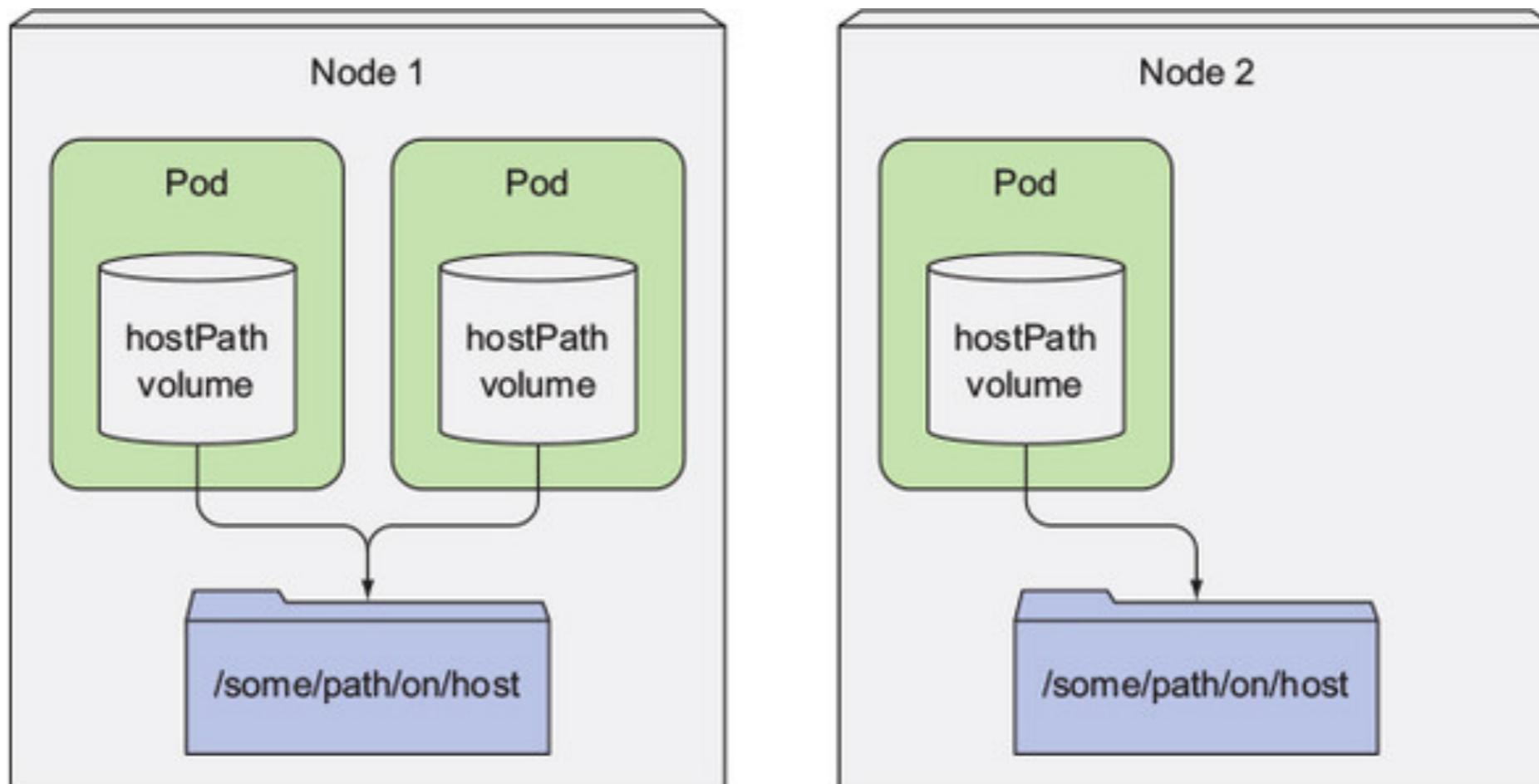
Use when Pods need data from host

Some hostPath need permission for access

Resource scheduling can't check readiness



HostPath



HostPath

Keep data of MongoDB on worker node

```
spec:  
  volumes:  
    - name: mongodb-data  
      hostPath:  
        path: /tmp/mongodb  
  containers:  
    - image: mongo  
      name: mongodb  
  volumeMounts:  
    - name: mongodb-data  
      mountPath: /data/db
```



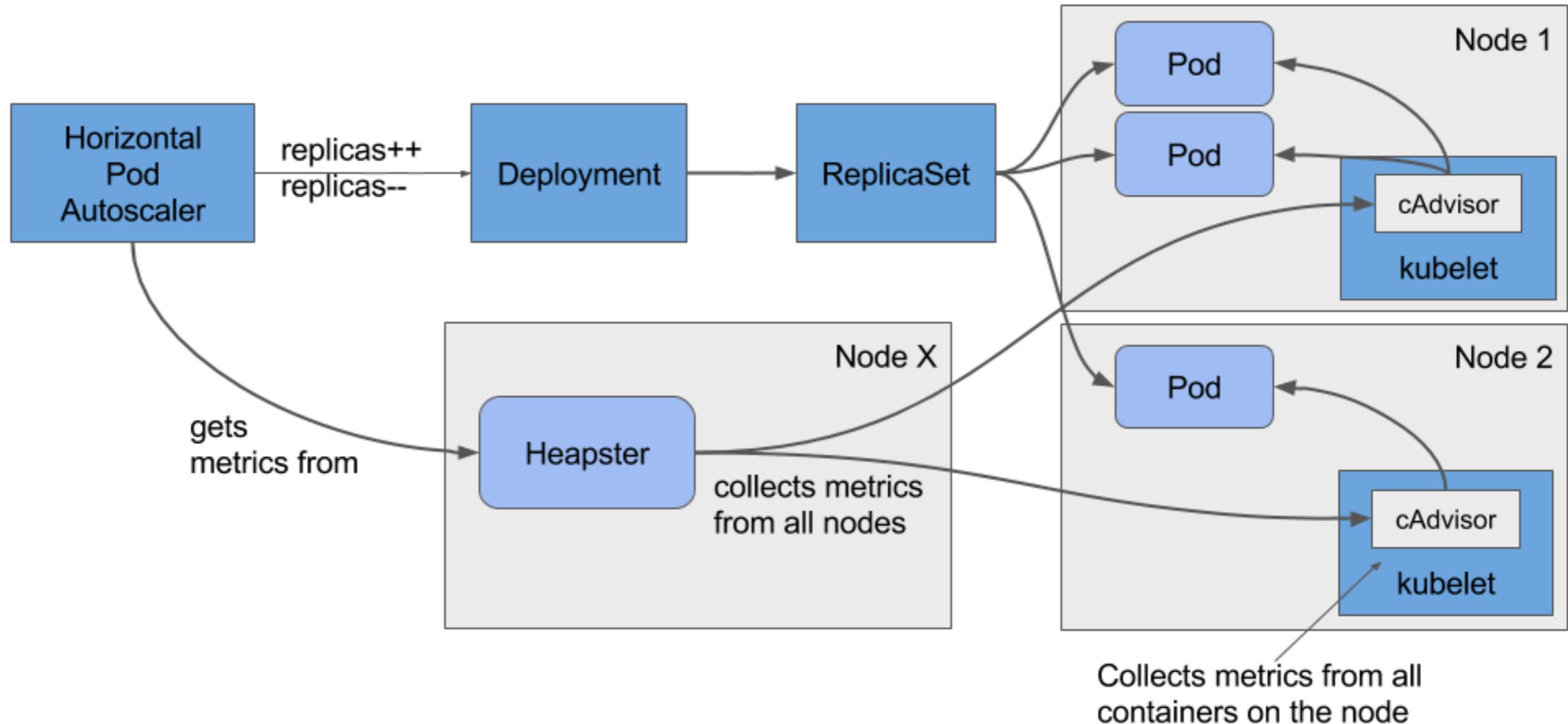
Workshop Volume



Horizontal Pods Autoscaler (HPA)



Components of autoscaling



Workshop HPA

