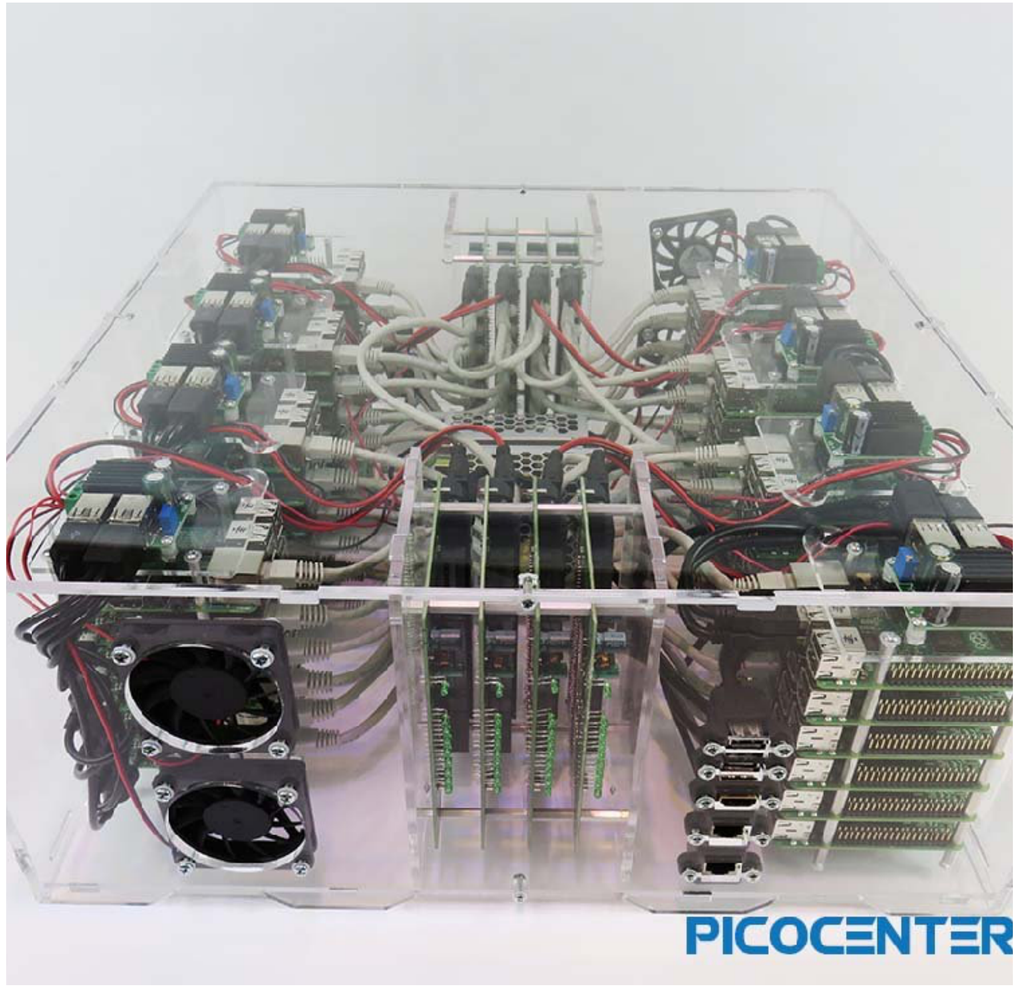
What is a cluster?

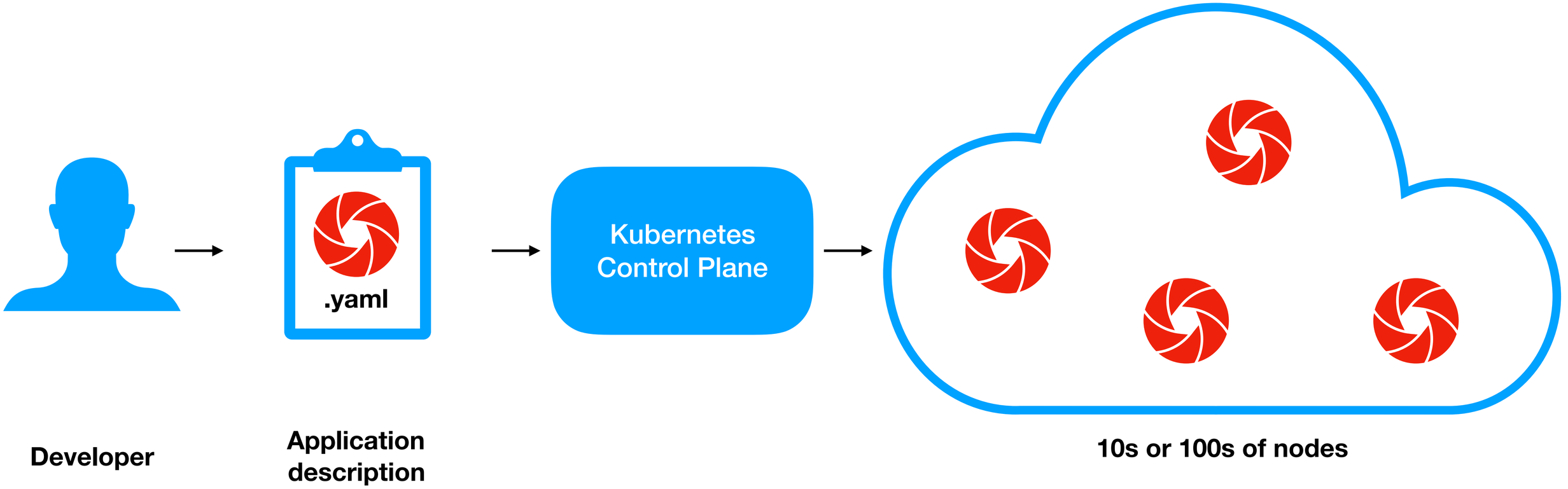
A Kubernetes cluster is a set of nodes. A node is either

- Bare iron machine
- Virtual machine

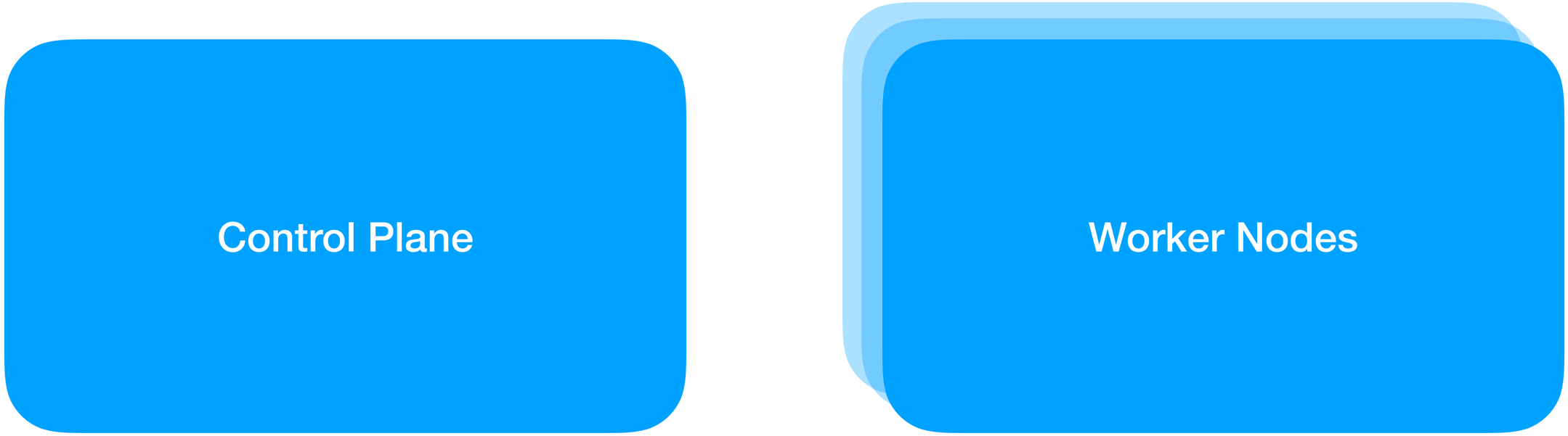


https://www.picocluster.com/

30,000 foot view



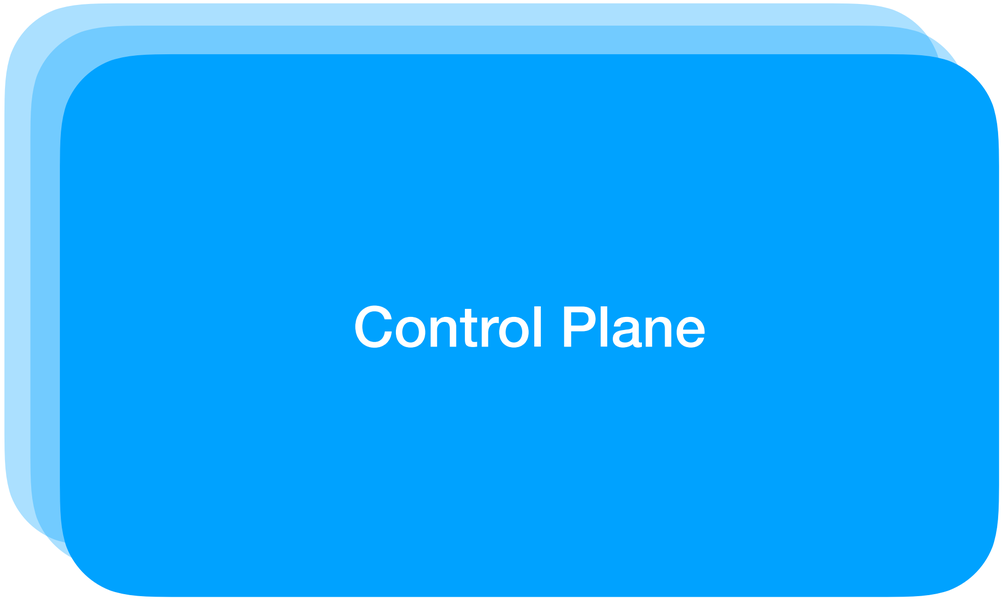
Kubernetes Architecture



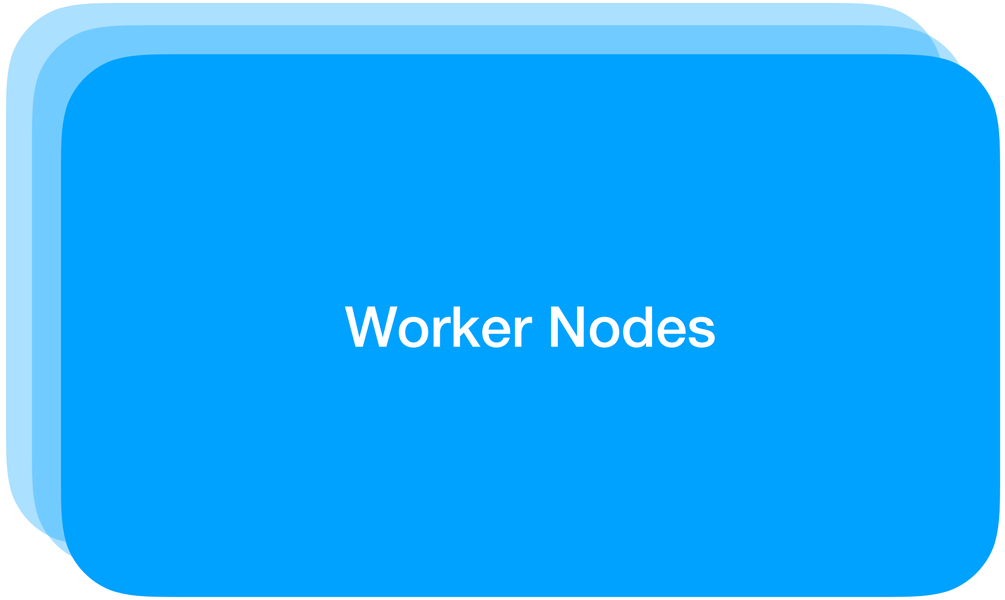
Master node(s) host the Kubernetes control plane that controls and manages the cluster

Worker nodes run the actual applications

Kubernetes Architecture



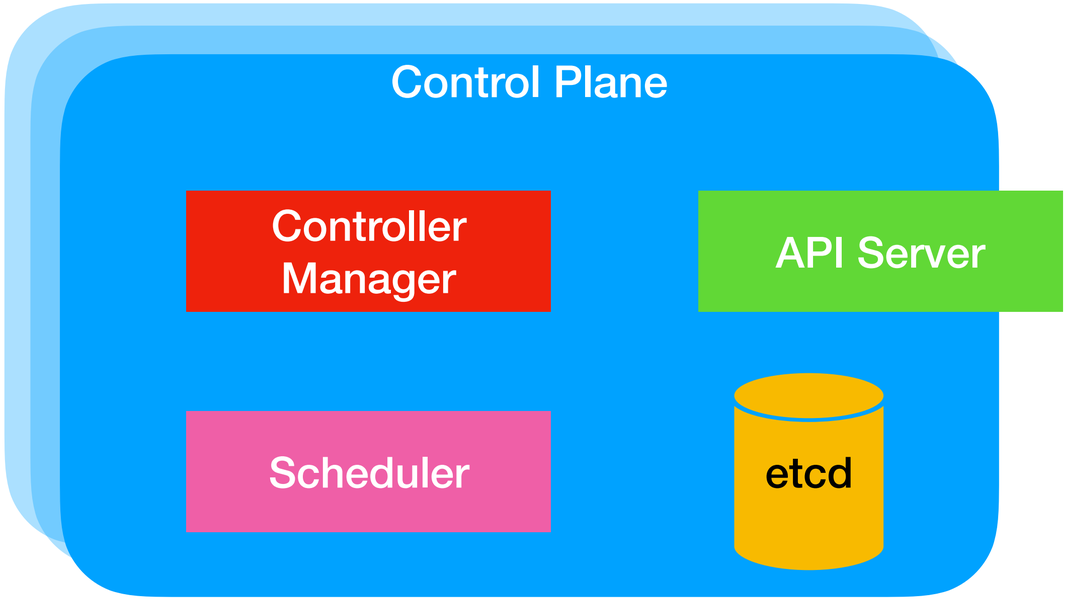
Master node(s) host the Kubernetes control plane that controls and manages the cluster



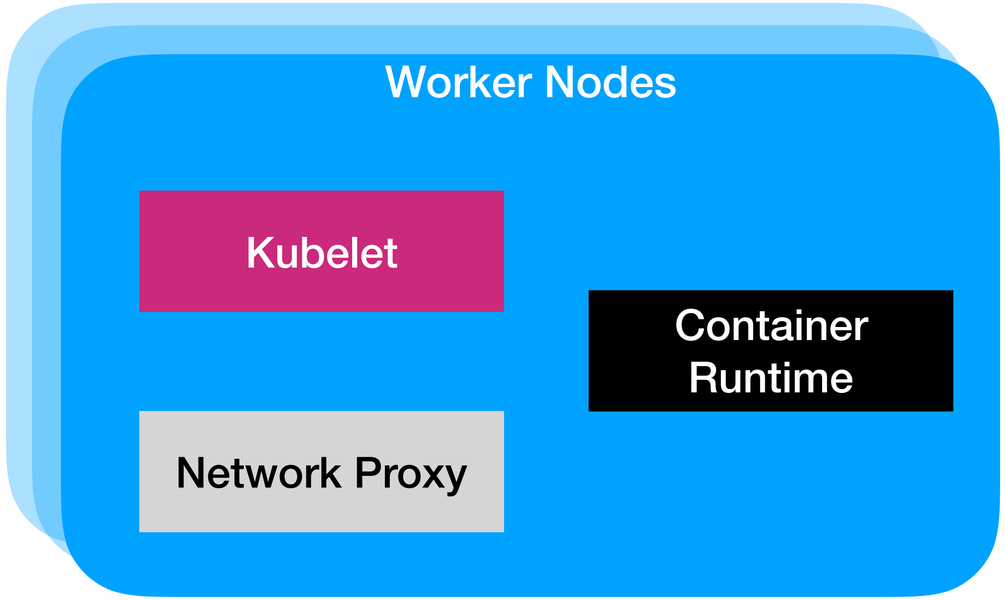
Worker nodes run the actual applications

ECLIPSE FOUNDATION

Kubernetes Architecture



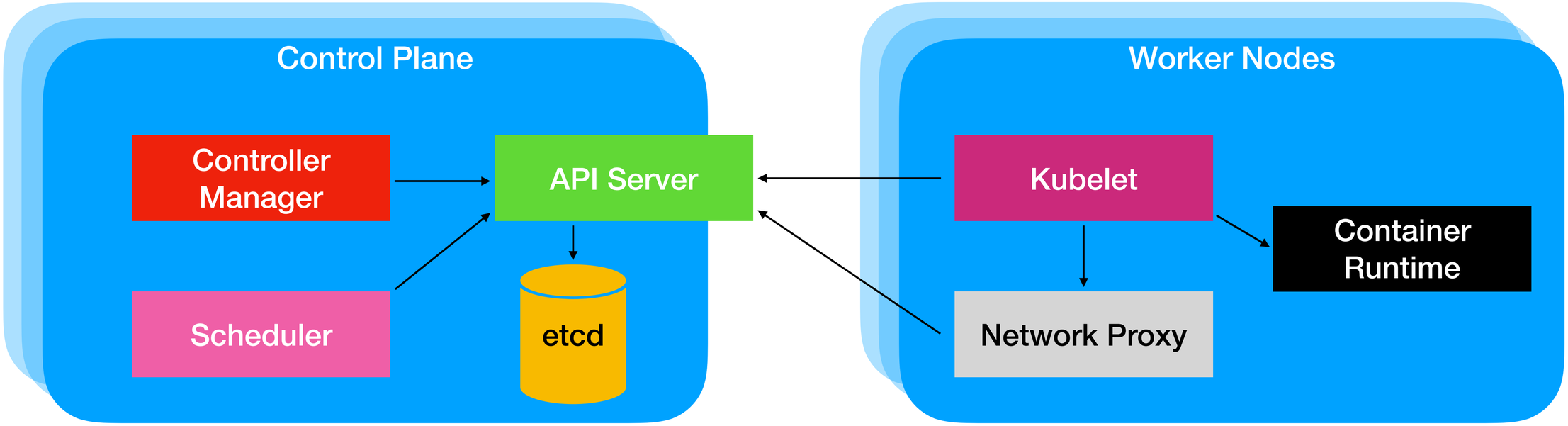
Master node(s) host the Kubernetes control plane that control and manage the cluster



Worker nodes run the actual applications

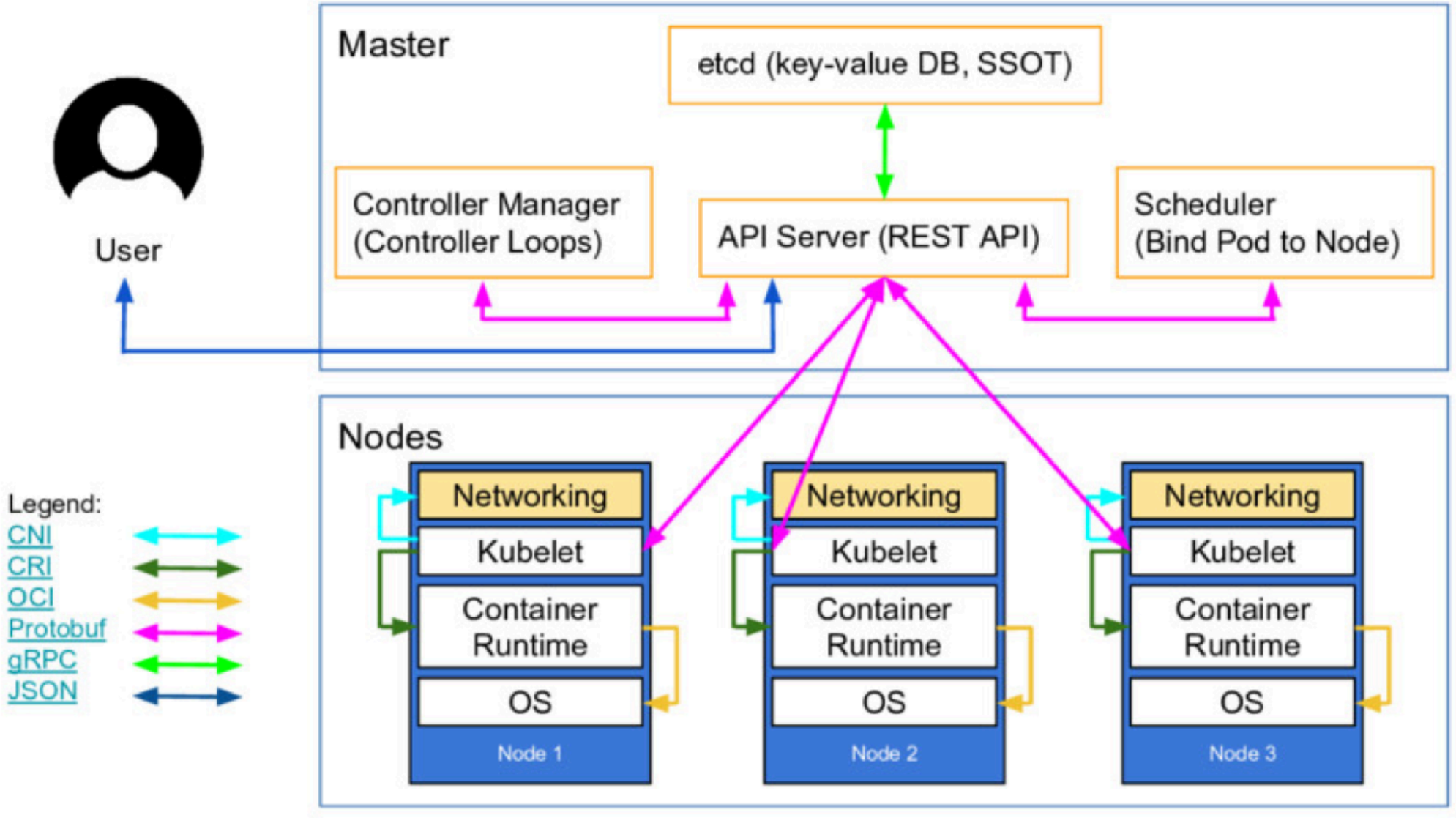
ECLIPSE FOUNDATION

Kubernetes Architecture



Master node(s) host the Kubernetes control plane that control and manage the cluster

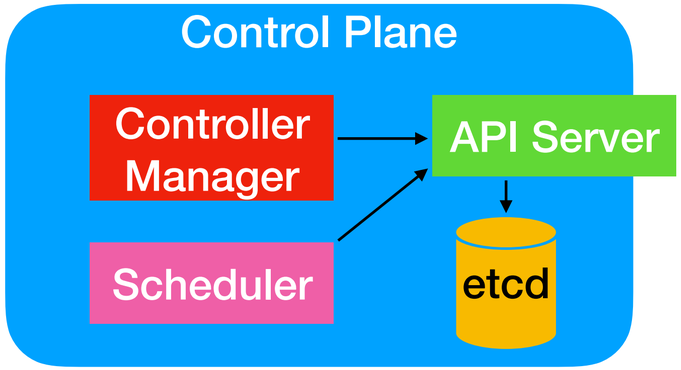
Worker nodes run the actual applications



Lucas Käldström

https://speakerdeck.com/luxas/kubeadm-cluster-creation-internals-from-self-hosting-to-upgradability-and-ha?slide=7

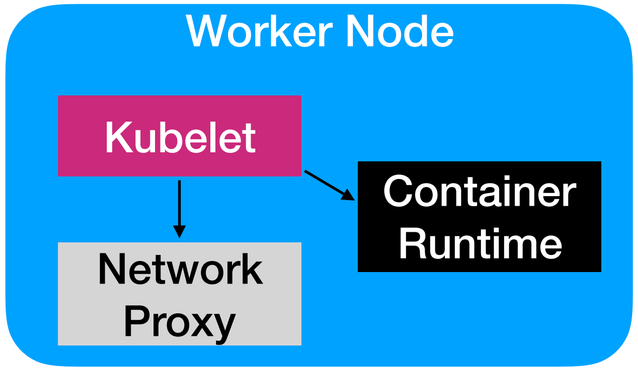
Control Plane



Multiple components that can run on a single master node or be split across multiple (master) nodes and replicated to ensure high availability:

- **API Server**: communication center for developers, sysadmin and other Kubernetes components
- **Scheduler**: assigns a worker node to each deployable component
- **Controller Manager**: performs cluster-level functions (replication, keeping track of worker nodes, handling nodes failures…)
- **etcd**: reliable distributed data store where the cluster configuration is persisted

Worker Node



Machines that run containerized applications. It runs, monitors and provides services to applications via components:

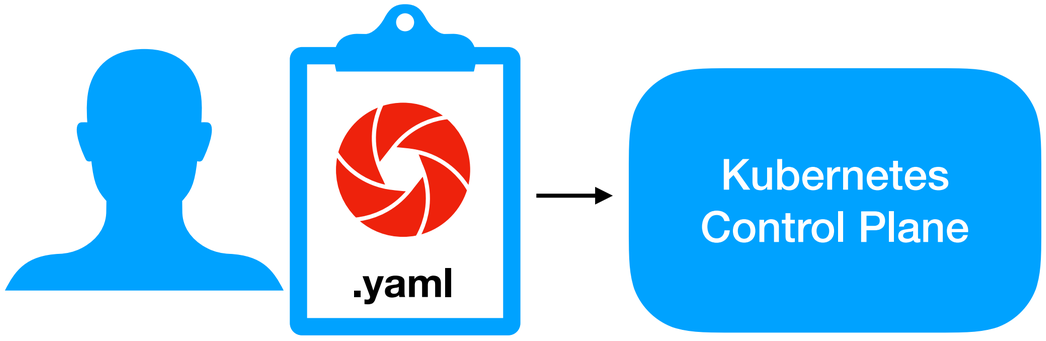
Docker, rkt, or another container runtime: runs the containers

Kubelet: talks to API server and manages containers on its node

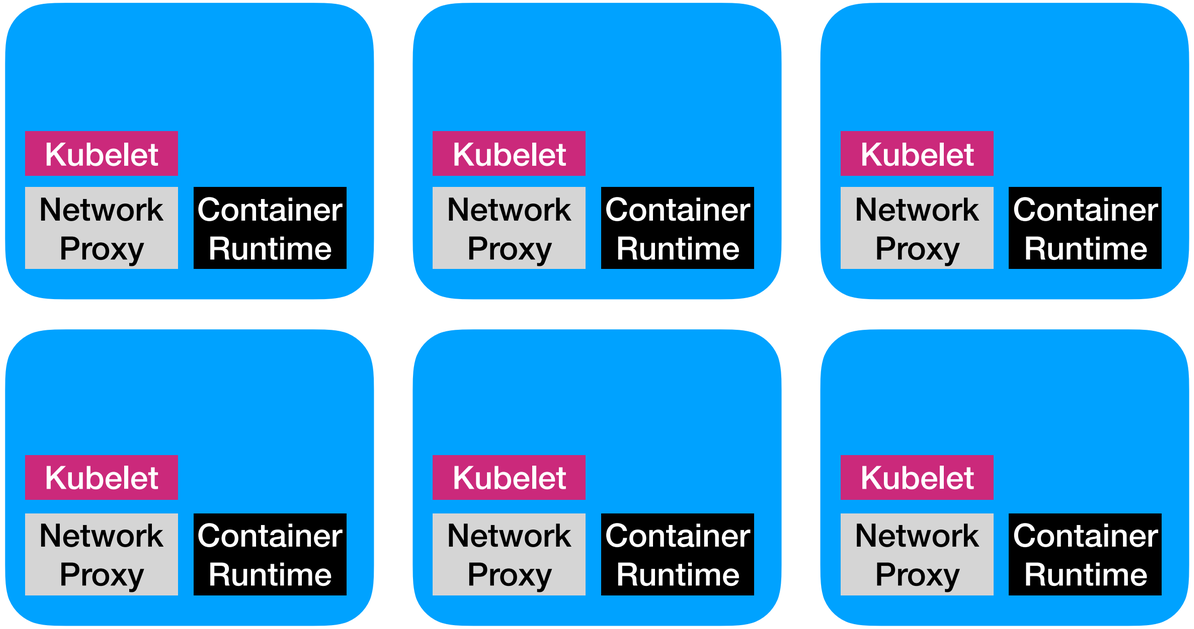
Network Proxy: load balance network traffic between application components

Running a Kubernetes application

Docker image registry
(e.g., Docker Hub)



Contains references
to Docker image(s)



Worker Nodes

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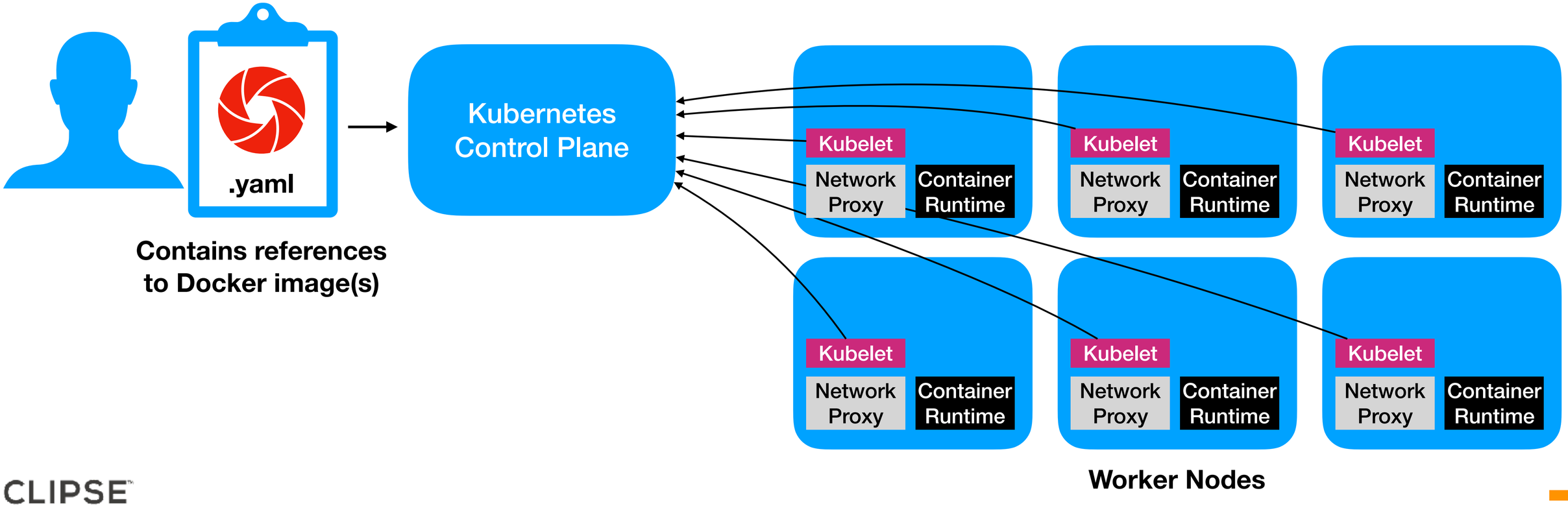
Running a Kubernetes application

Docker image registry
(e.g., Docker Hub)

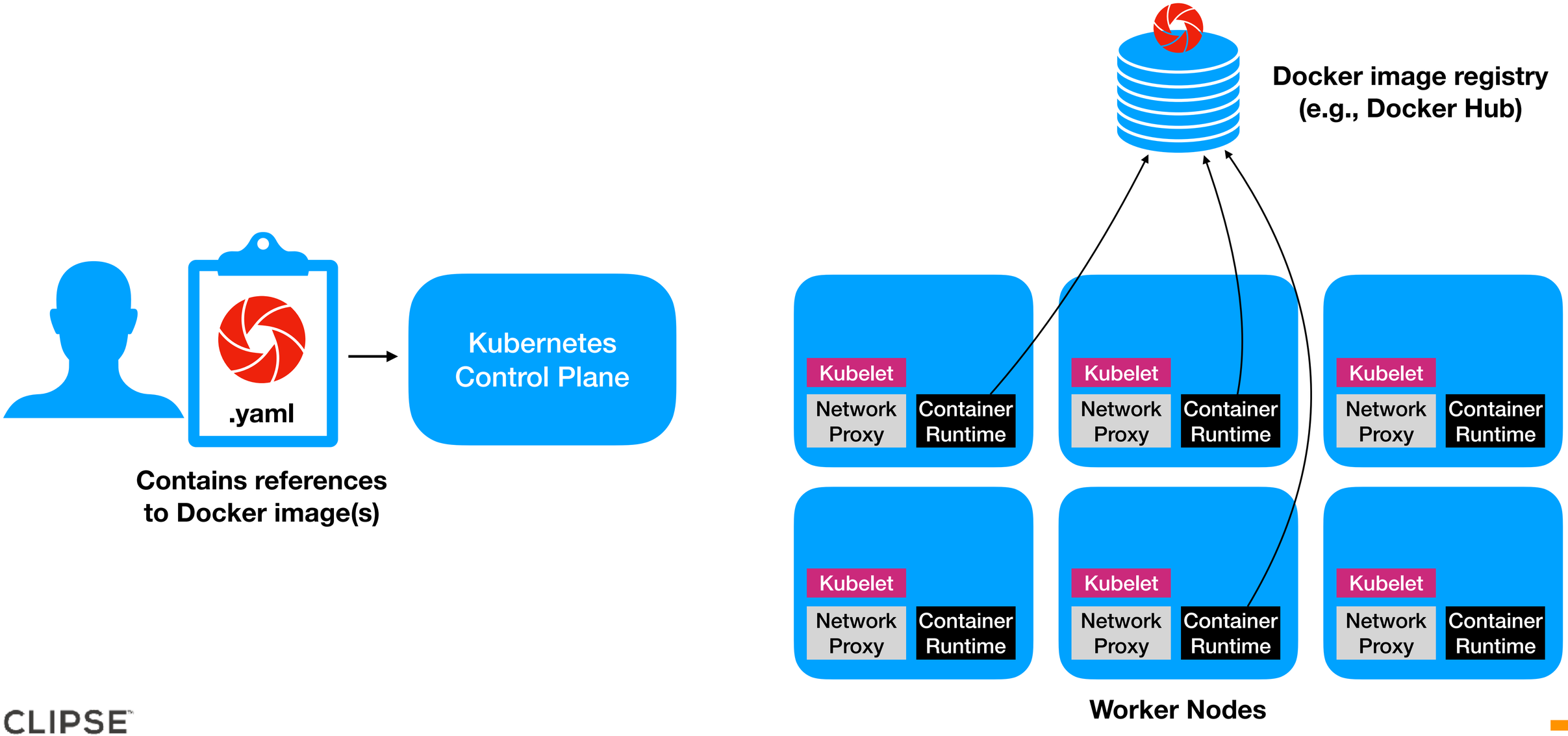


Contains references
to Docker image(s)

Worker Nodes

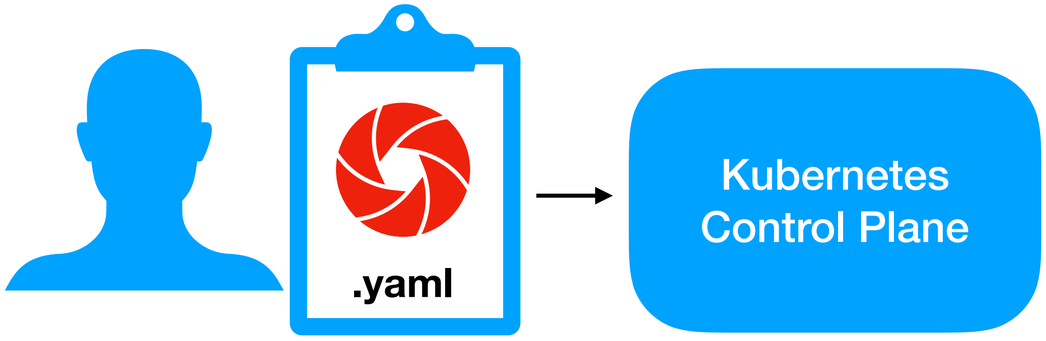
ECLIPSE FOUNDATION

Running a Kubernetes application

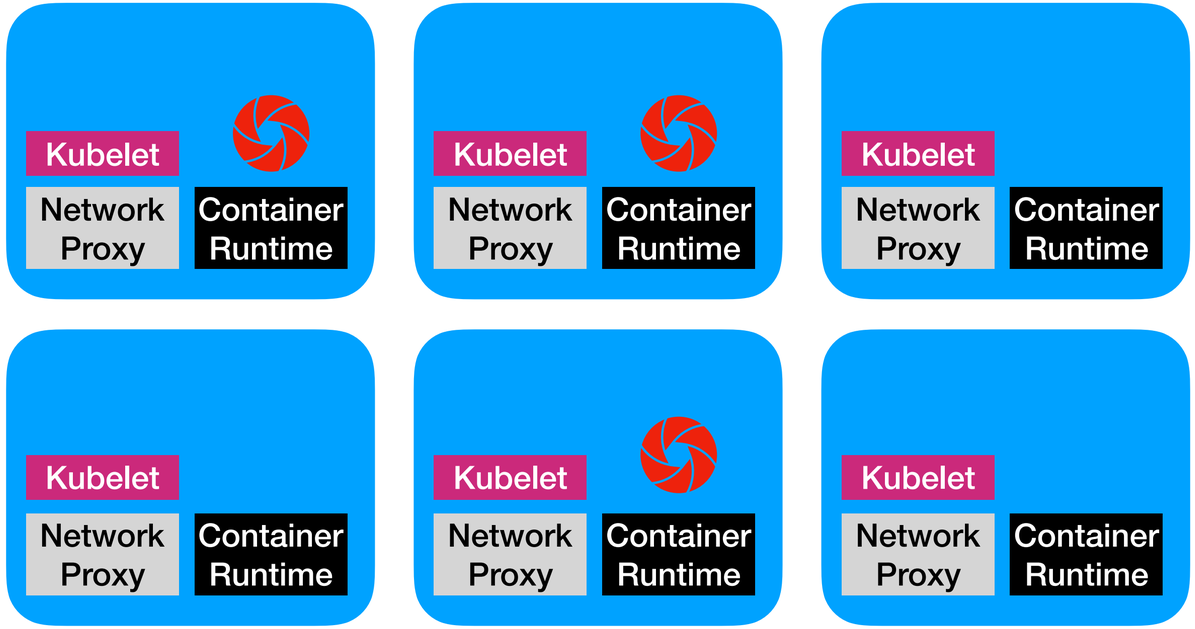


Running a Kubernetes application

Docker image registry
(e.g., Docker Hub)



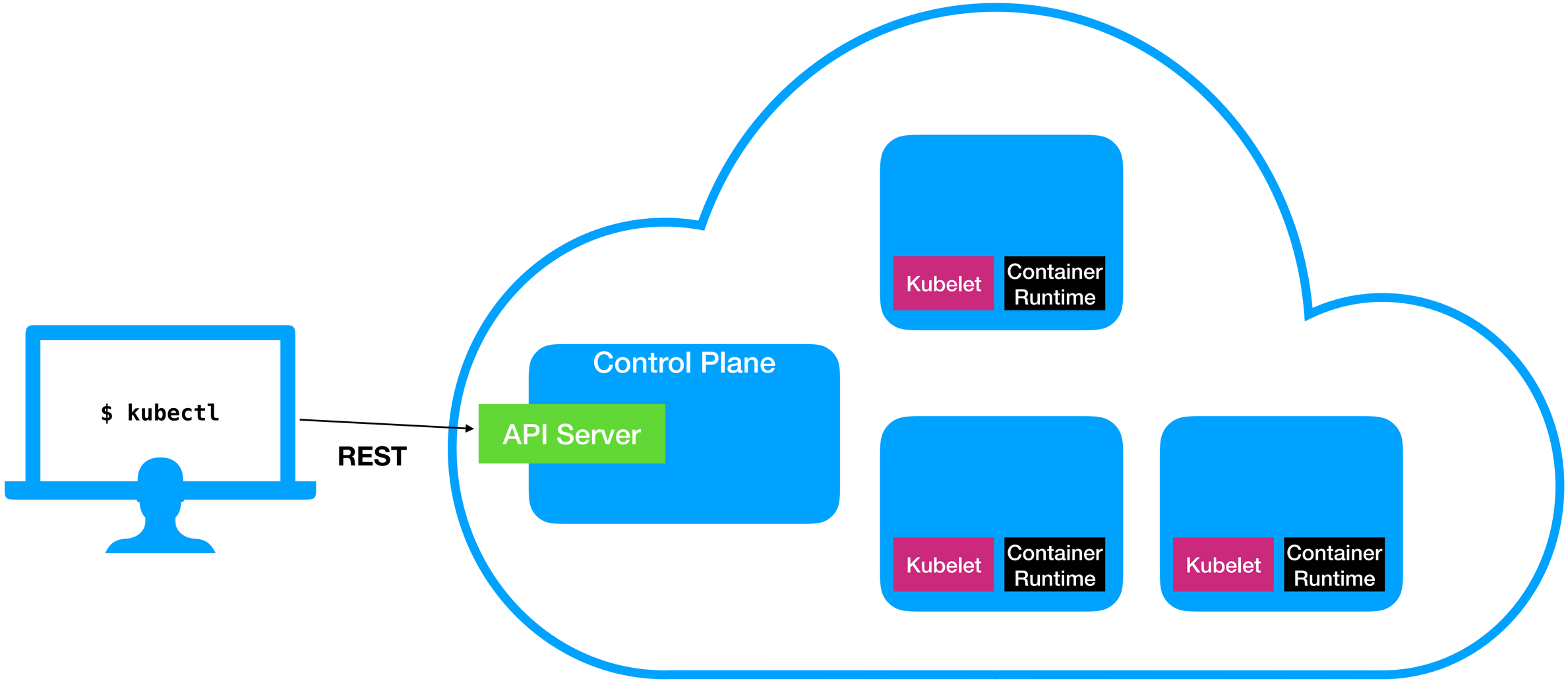
Contains references
to Docker image(s)



Worker Nodes

ECLIPSE FOUNDATION

Working with a cluster



Working with a cluster

```
$ kubectl version
Client Version: version.Info{Major:"1", Minor:"10", GitVersion:"v1.10.0",
GitCommit:"fc32d2f3698e36b93322a3465f63a14e9f0eaead", GitTreeState:"clean",
BuildDate:"2018-03-26T16:55:54Z", GoVersion:"go1.9.3", Compiler:"gc", Platform:"linux/amd64"}
Server Version: version.Info{Major:"1", Minor:"10", GitVersion:"v1.10.0",
GitCommit:"fc32d2f3698e36b93322a3465f63a14e9f0eaead", GitTreeState:"clean",
BuildDate:"2018-04-10T12:46:31Z", GoVersion:"go1.9.4", Compiler:"gc", Platform:"linux/amd64"}
```

Running a container in a Pod

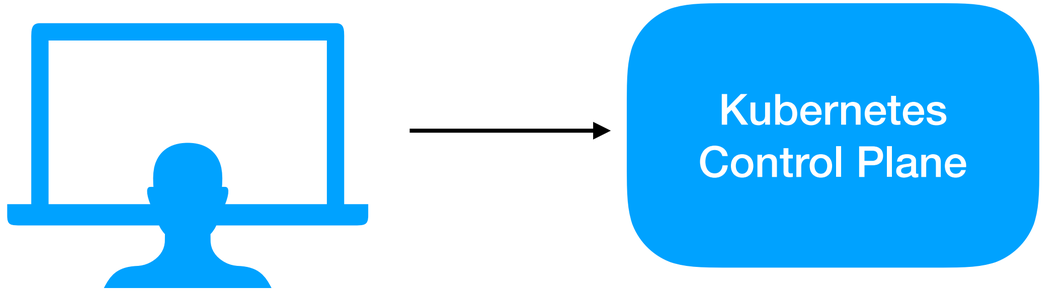
```
$ kubectl run kubernetes-bootcamp --image=gcr.io/google-samples/kubernetes-bootcamp:v1
--port=8080
deployment.apps "kubernetes-bootcamp" created

$ kubectl get deployments
NAME                  DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
kubernetes-bootcamp   1         1         1            1           35s
```

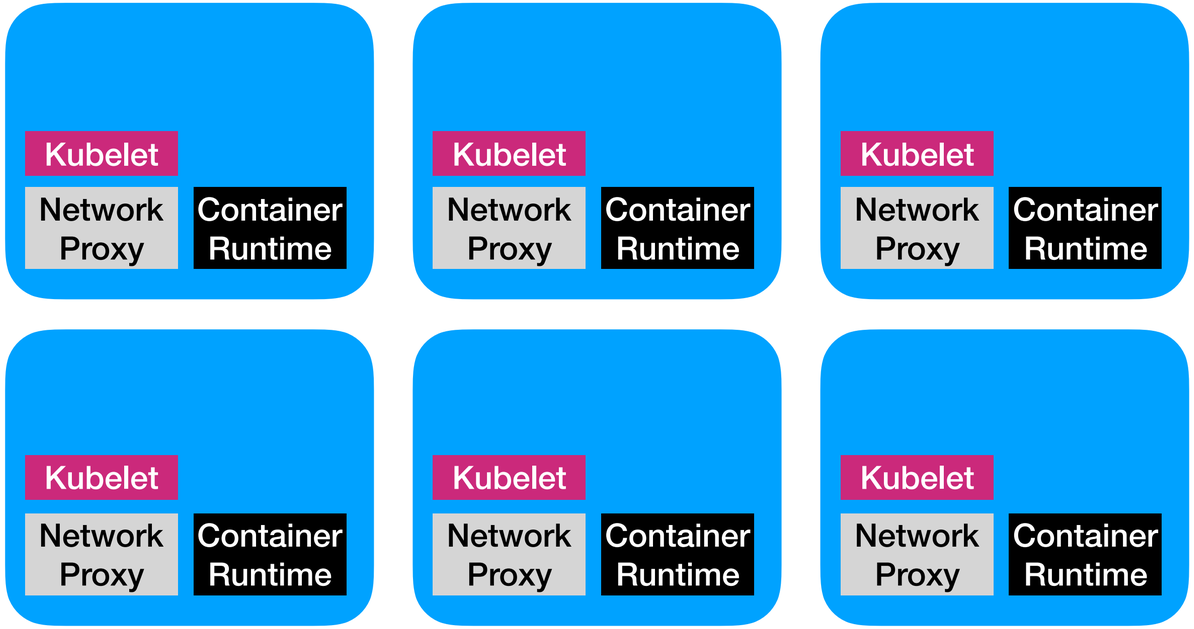
ECLIPSE FOUNDATION

Behind the scene

Docker image registry
(e.g., Docker Hub)



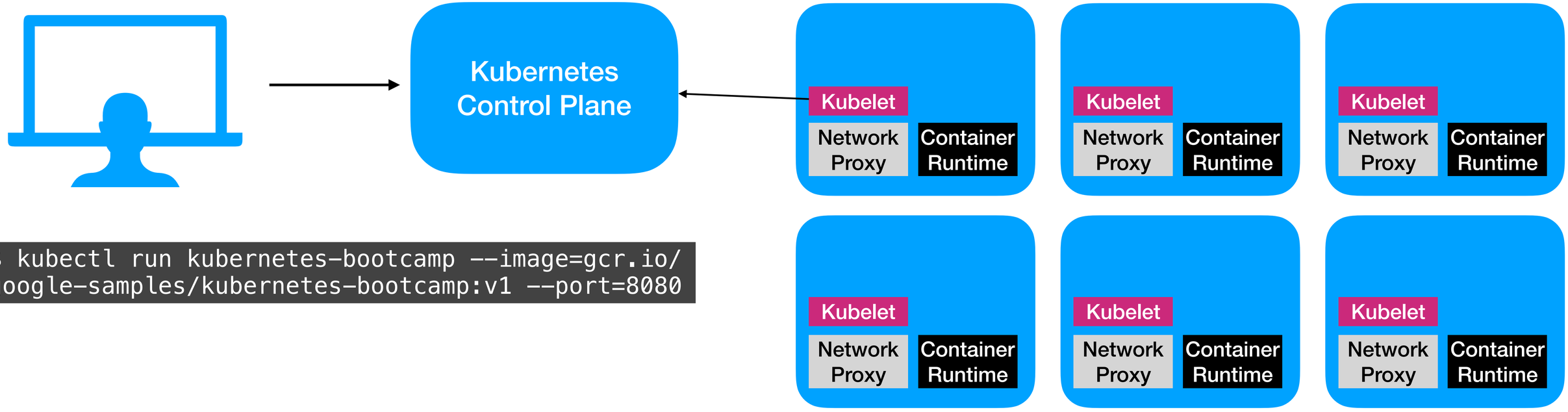

```
$ kubectl run kubernetes-bootcamp --image=gcr.io/
google-samples/kubernetes-bootcamp:v1 --port=8080
```



ECLIPSE FOUNDATION

Behind the scene

Docker image registry (e.g., Docker Hub)

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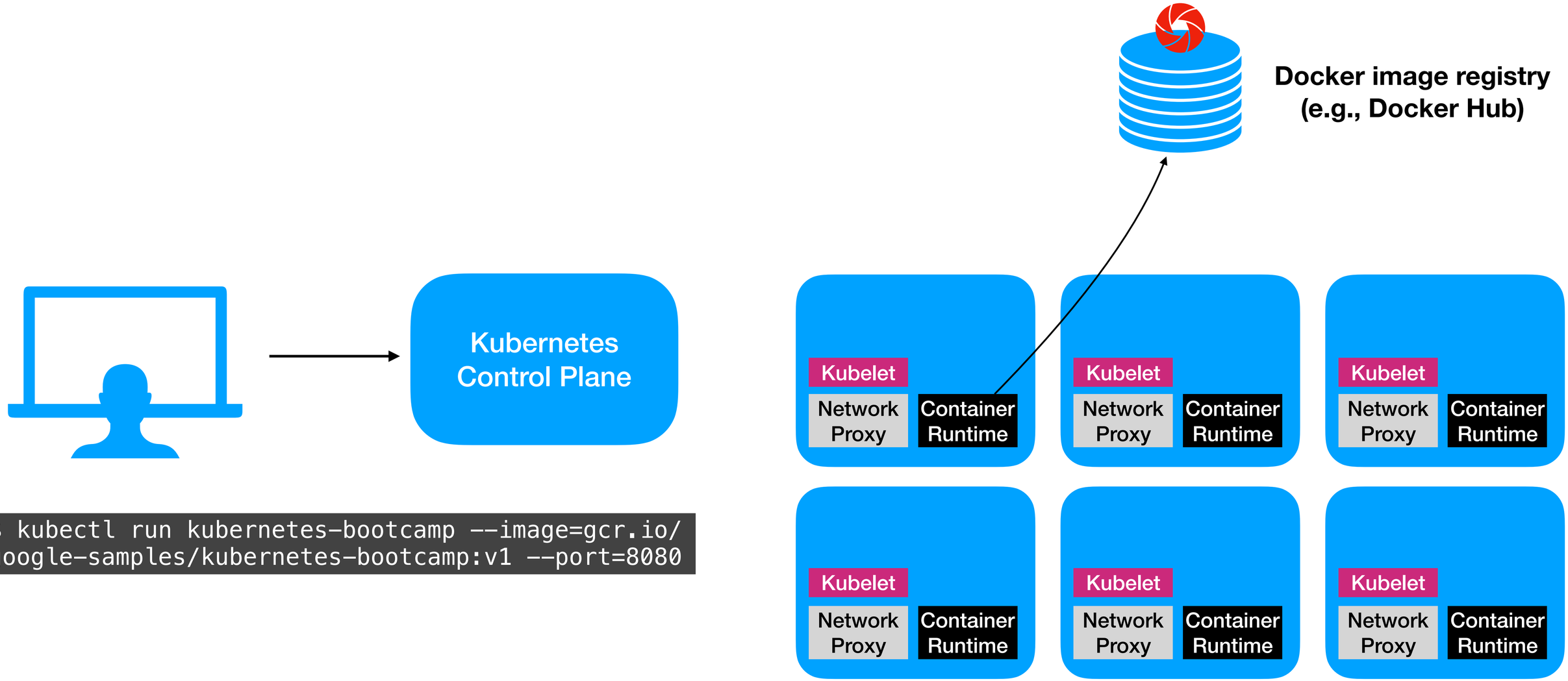
```

ECLIPSE FOUNDATION

Behind the scene

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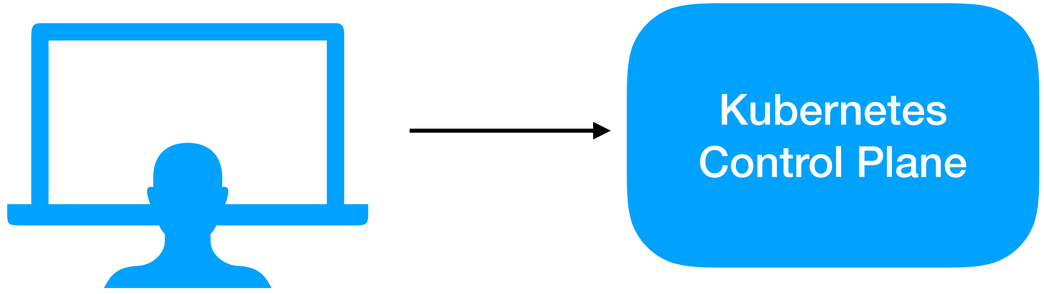
Behind the scene

Docker image registry (e.g., Docker Hub)

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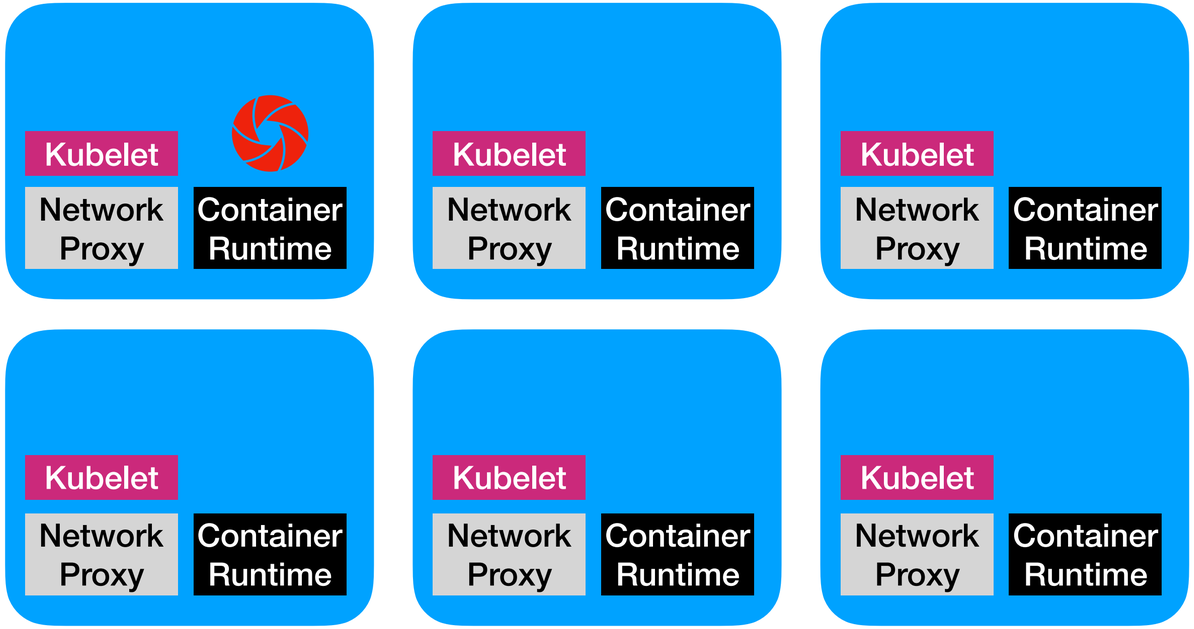


ECLIPSE FOUNDATION

Behind the scene

```
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
    name: kubernetes-bootcamp
spec:
    replicas: 1
    selector:
        matchLabels:
            run: kubernetes-bootcamp
    template:
        metadata:
            labels:
                run: kubernetes-bootcamp
        spec:
            containers:
            - image: gcr.io/google-samples/kubernetes-bootcamp:v1
              name: kubernetes-bootcamp
              ports:
              - containerPort: 8080
```

ECLIPSE FOUNDATION

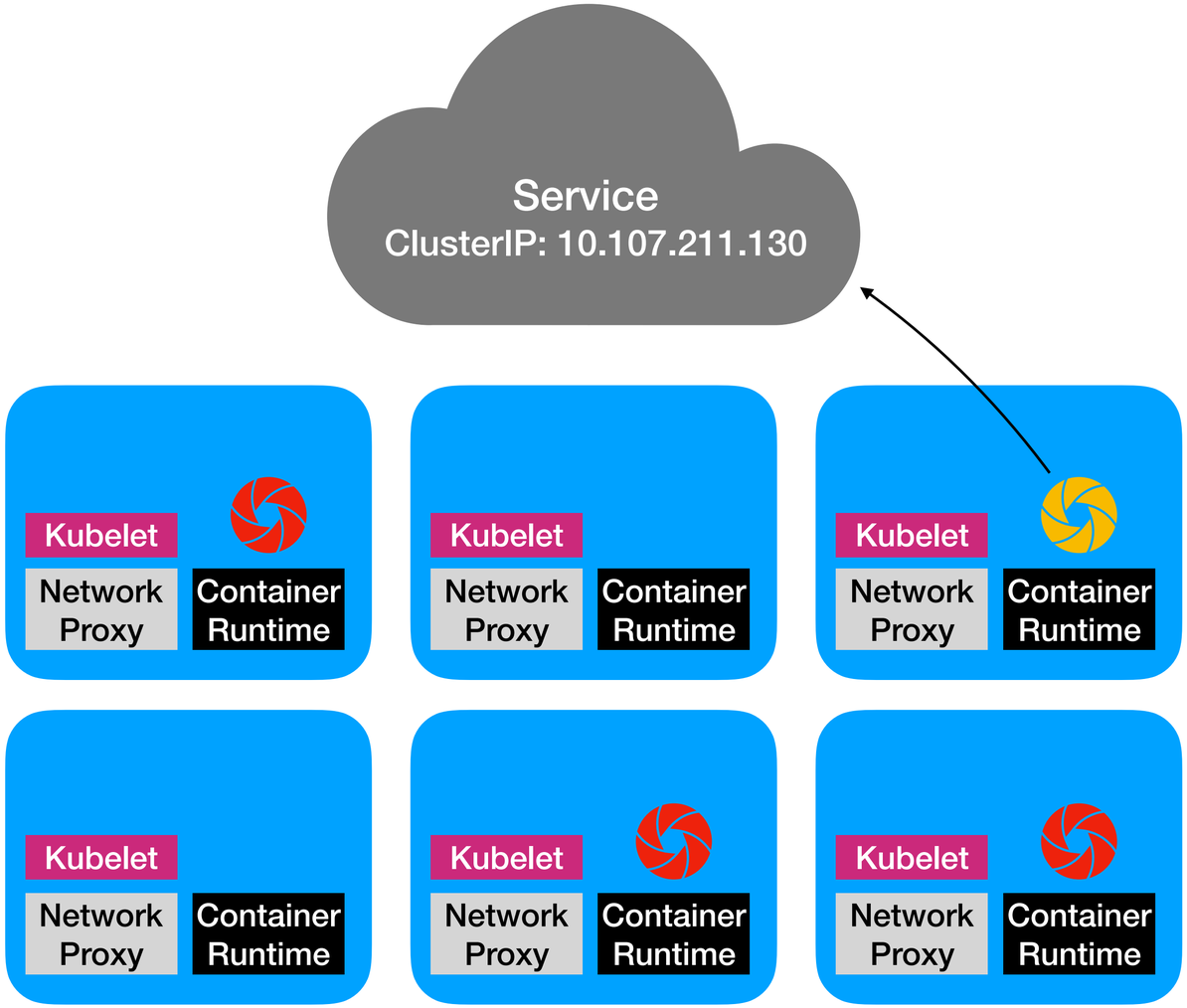
Exposing the container

```
$ kubectl expose deployment/kubernetes-bootcamp --type="NodePort" --port 8080
service "kubernetes-bootcamp" exposed

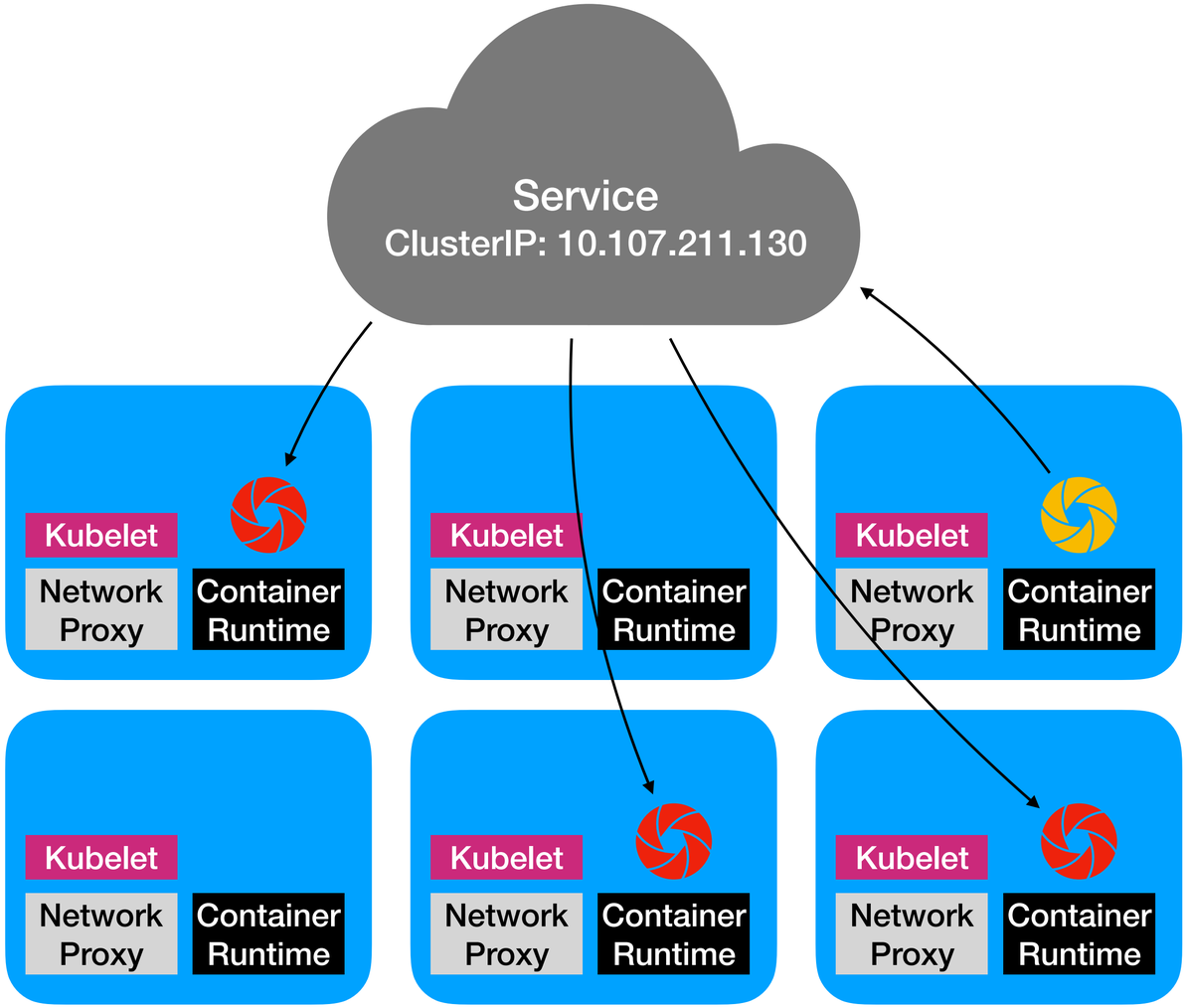
$ kubectl get services
NAME                  TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)          AGE
kubernetes-bootcamp   NodePort    10.107.211.130   <none>        8080:32437/TCP   46s
$ kubectl describe services/kubernetes-bootcamp
Name:                     kubernetes-bootcamp
Namespace:                default
Labels:                   run=kubernetes-bootcamp
Annotations:              <none>
Selector:                 run=kubernetes-bootcamp
Type:                     NodePort
IP:                       10.107.211.130
Port:                     <unset>  8080/TCP
TargetPort:               8080/TCP
NodePort:                 <unset>  32437/TCP
Endpoints:                172.18.0.4:8080
Session Affinity:         None
External Traffic Policy:  Cluster
Events:                   <none>
```

ECLIPSE FOUNDATION

Exposing the container



Exposing the container



Scaling the application

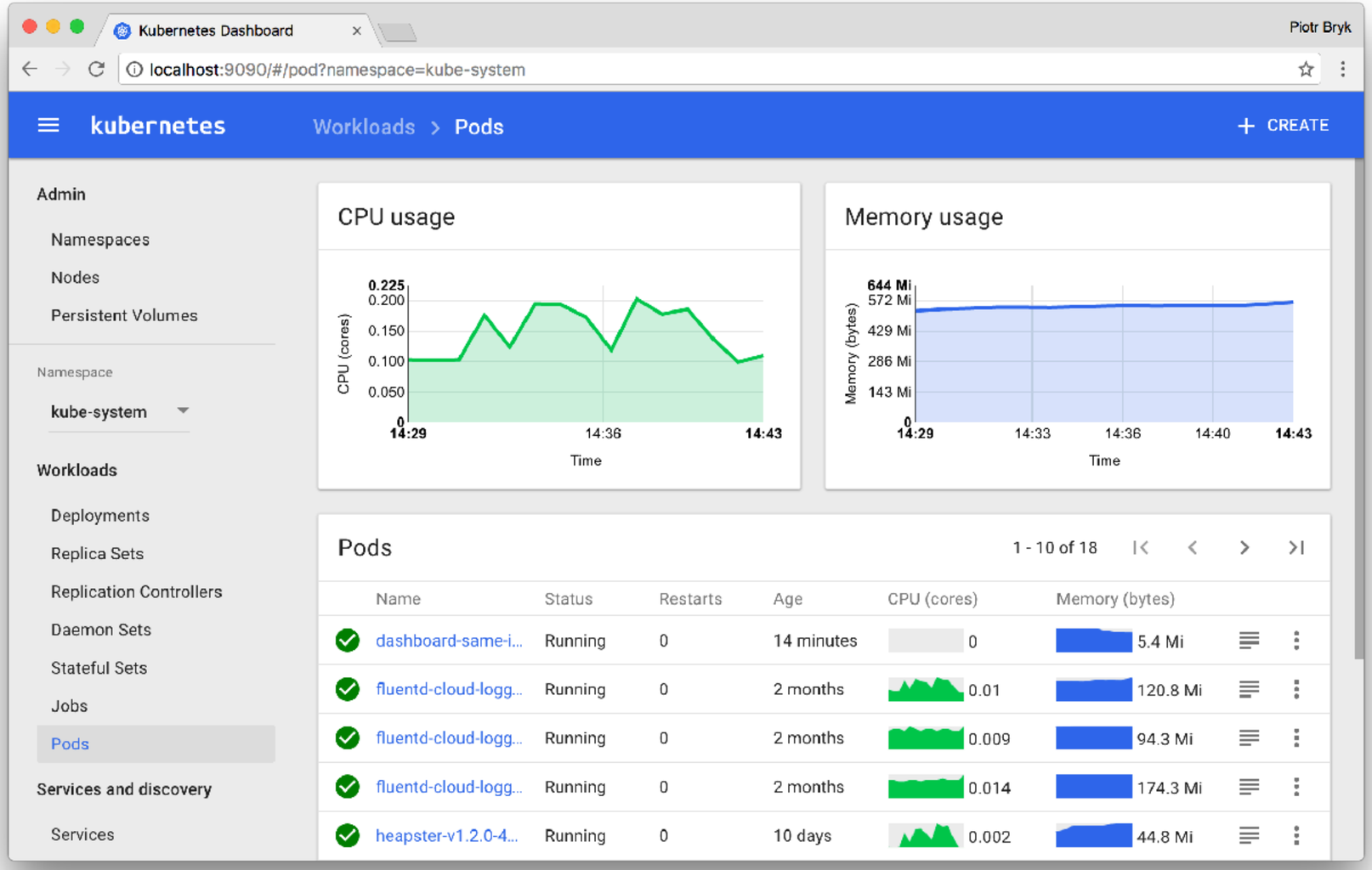
```
$ kubectl get deployments
NAME                  DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
kubernetes-bootcamp   1         1         1            0           3s
$ kubectl get pods
NAME                                   READY     STATUS    RESTARTS   AGE
kubernetes-bootcamp-5c69669756-k9b6g   1/1       Running   0          50s

$ kubectl scale deployments/kubernetes-bootcamp --replicas=4
deployment.extensions "kubernetes-bootcamp" scaled

$ kubectl get deployments
NAME                  DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
kubernetes-bootcamp   4         4         4            4           25s
$ kubectl get pods
NAME                                   READY     STATUS    RESTARTS   AGE
kubernetes-bootcamp-5c69669756-7bhhj   1/1       Running   0          28s
kubernetes-bootcamp-5c69669756-bz49n   1/1       Running   0          28s
kubernetes-bootcamp-5c69669756-gvcrr   1/1       Running   0          28s
kubernetes-bootcamp-5c69669756-k9b6g   1/1       Running   0          50s
```

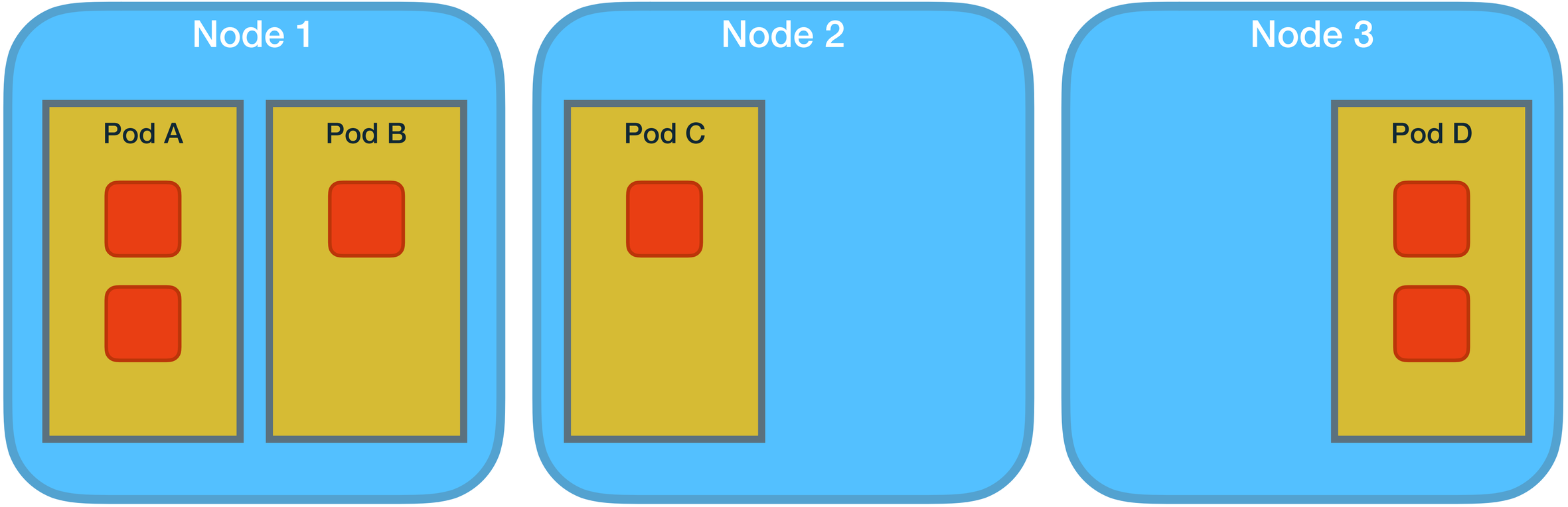
ECLIPSE FOUNDATION

Dashboard



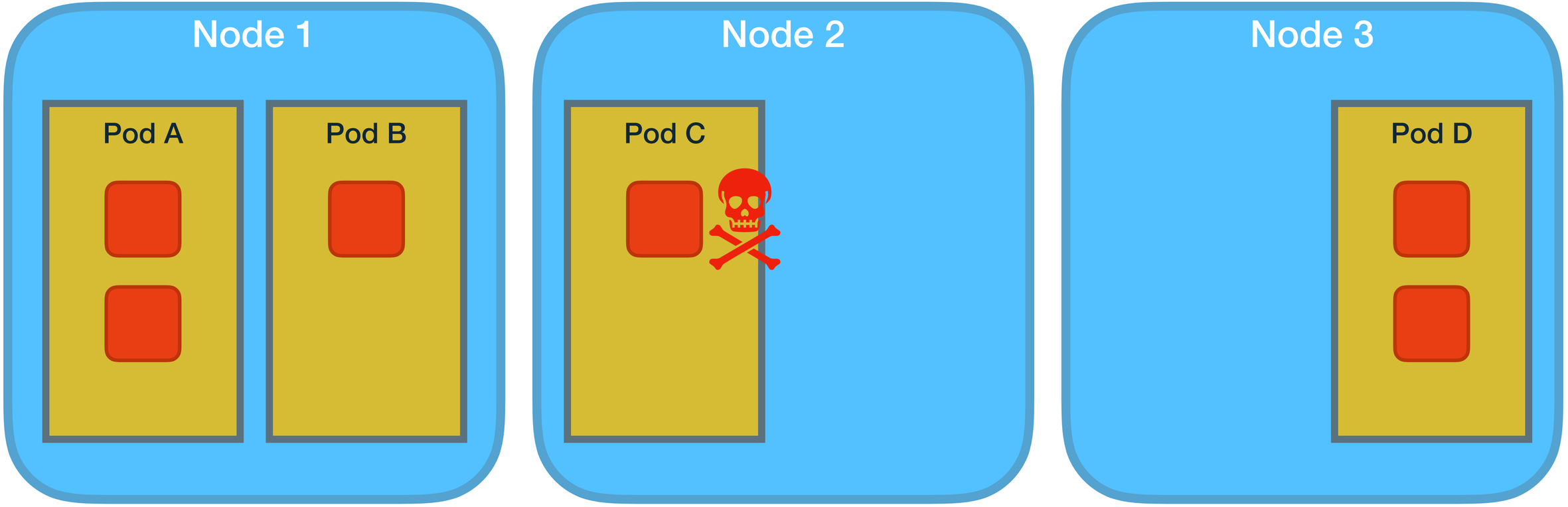
Kubernetes Concepts

Concept #1 — Pod

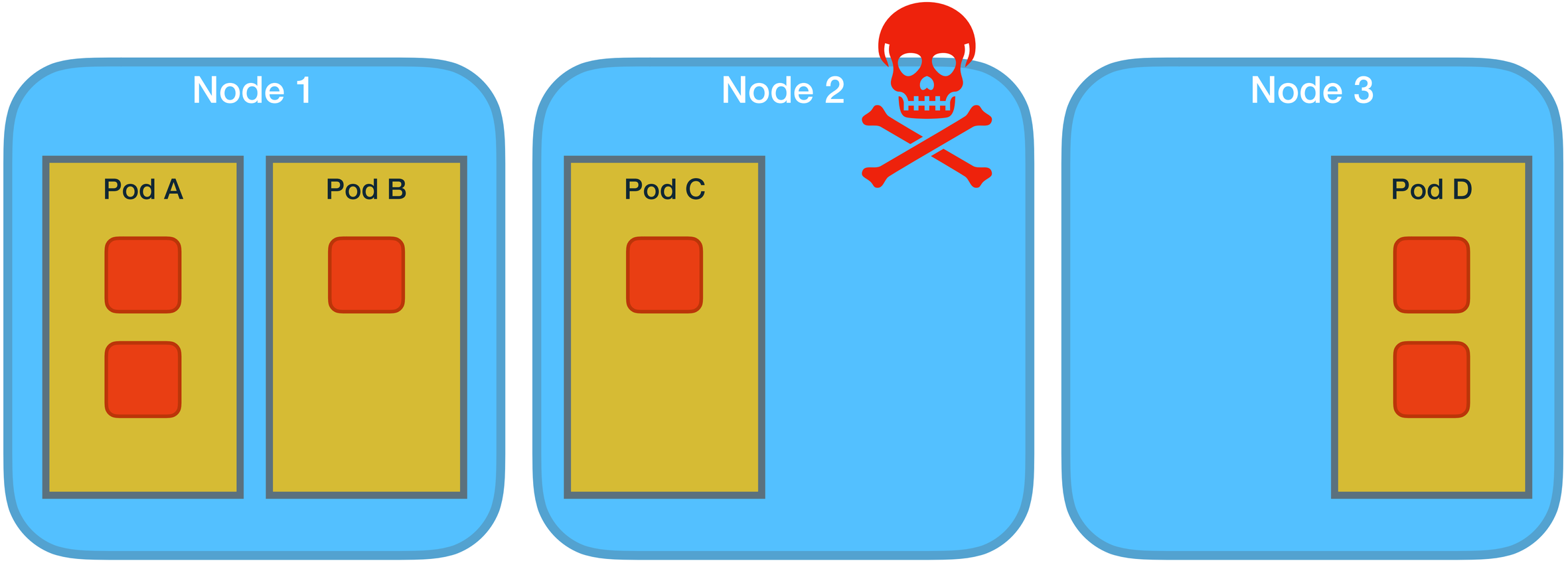


ECLIPSE FOUNDATION

Concept #1 — Pod



Concept #1 — Pod



Concept #1 — Pod

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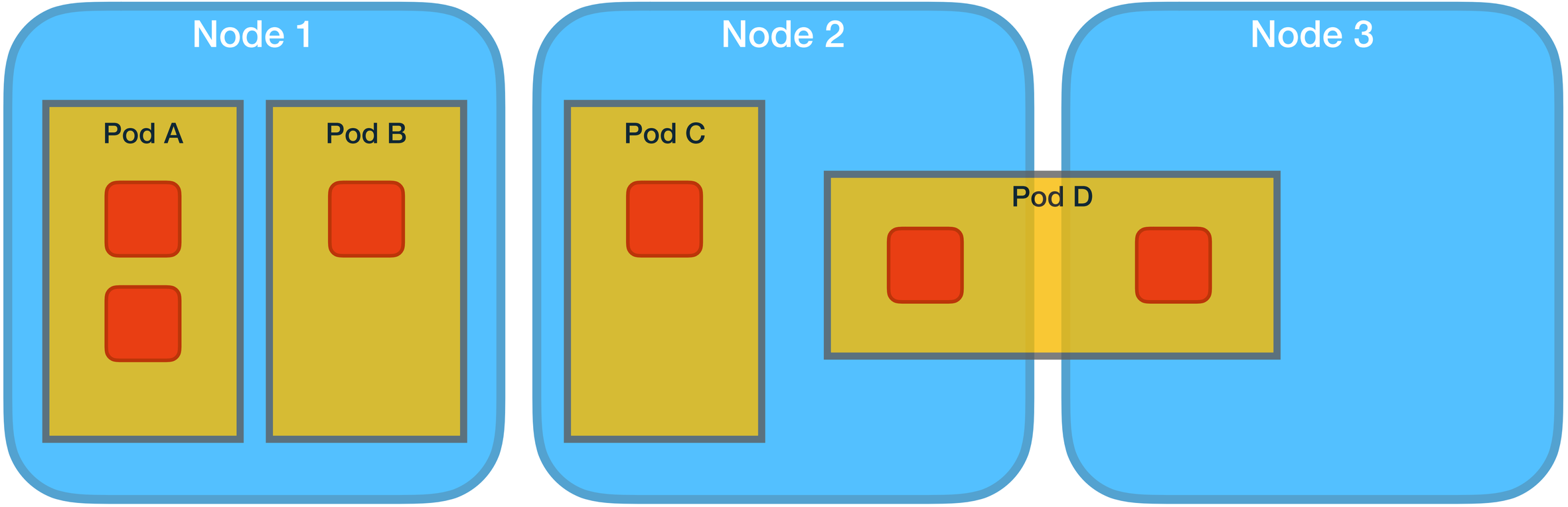
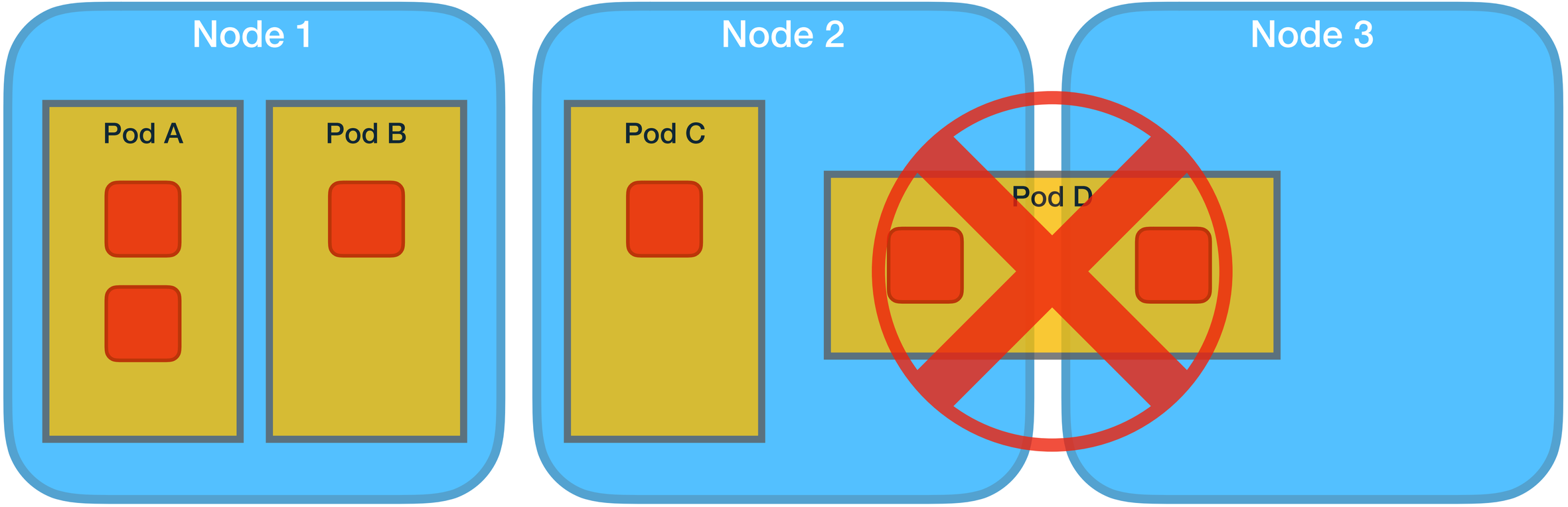
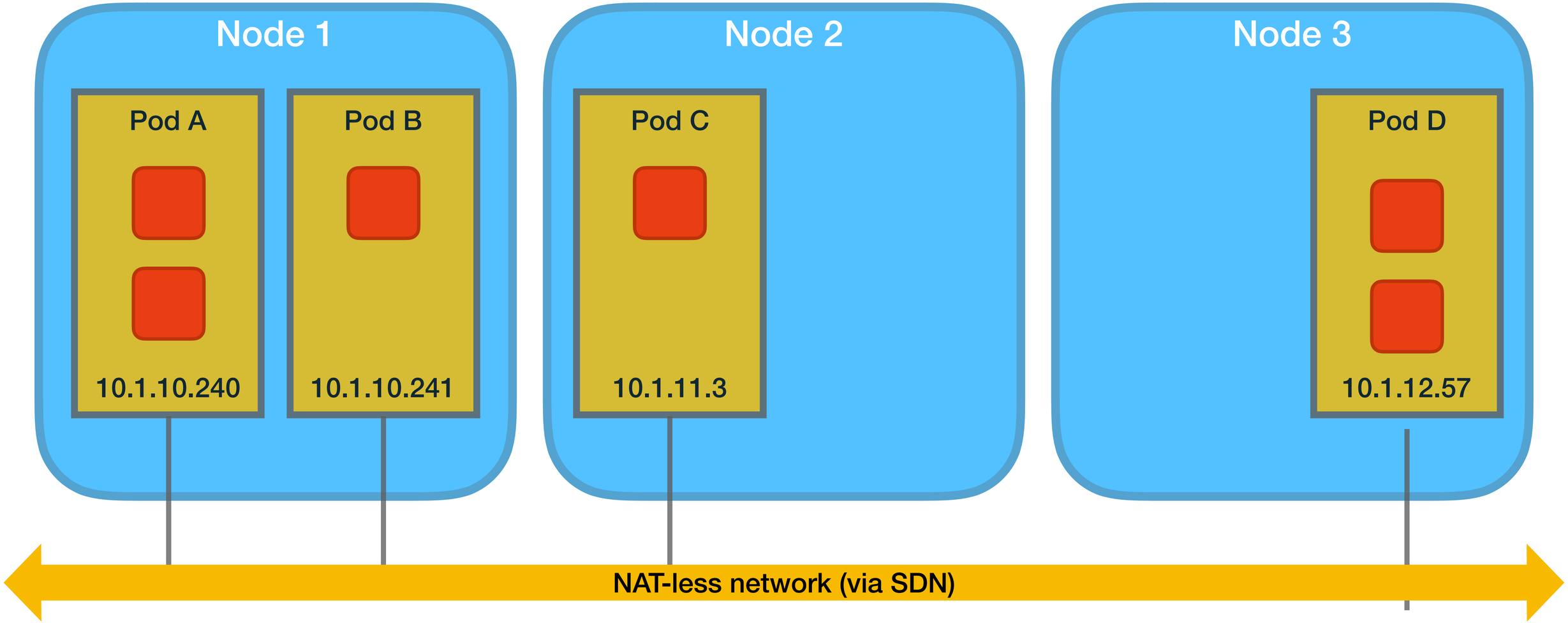


ECLIPSE FOUNDATION

Concept #1 — Pod



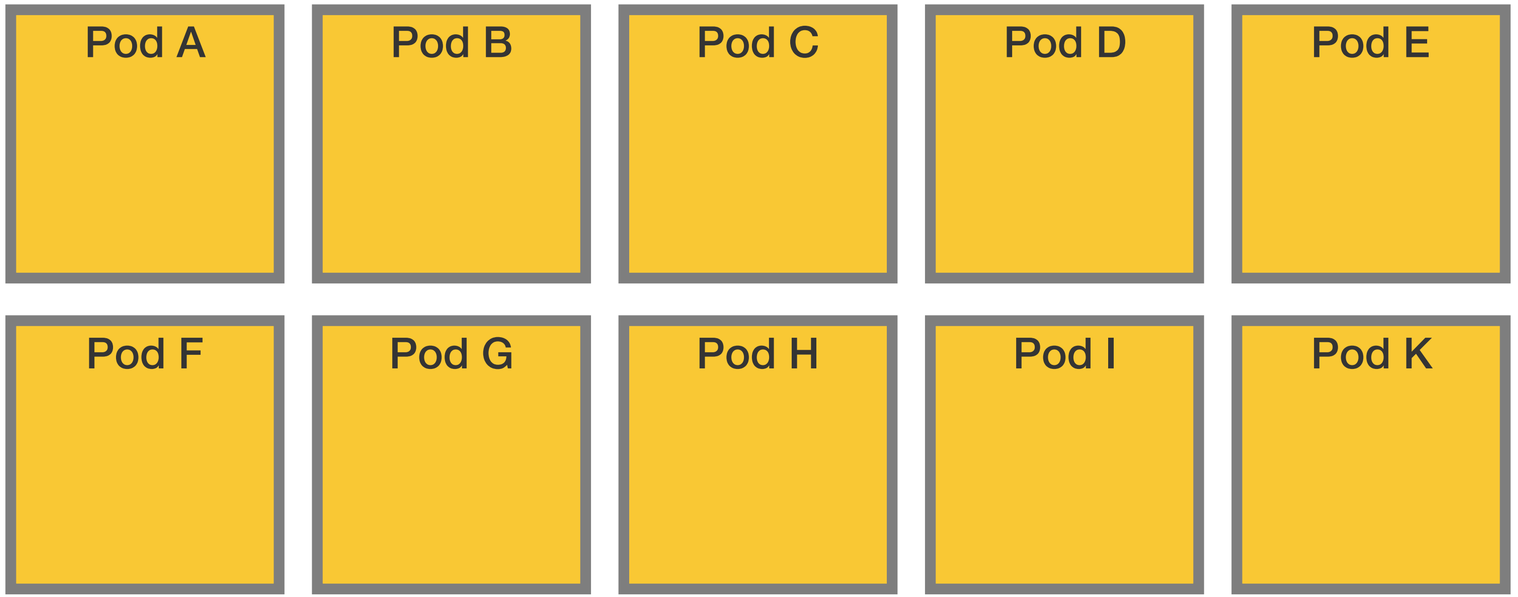
Concept #1 — Pod



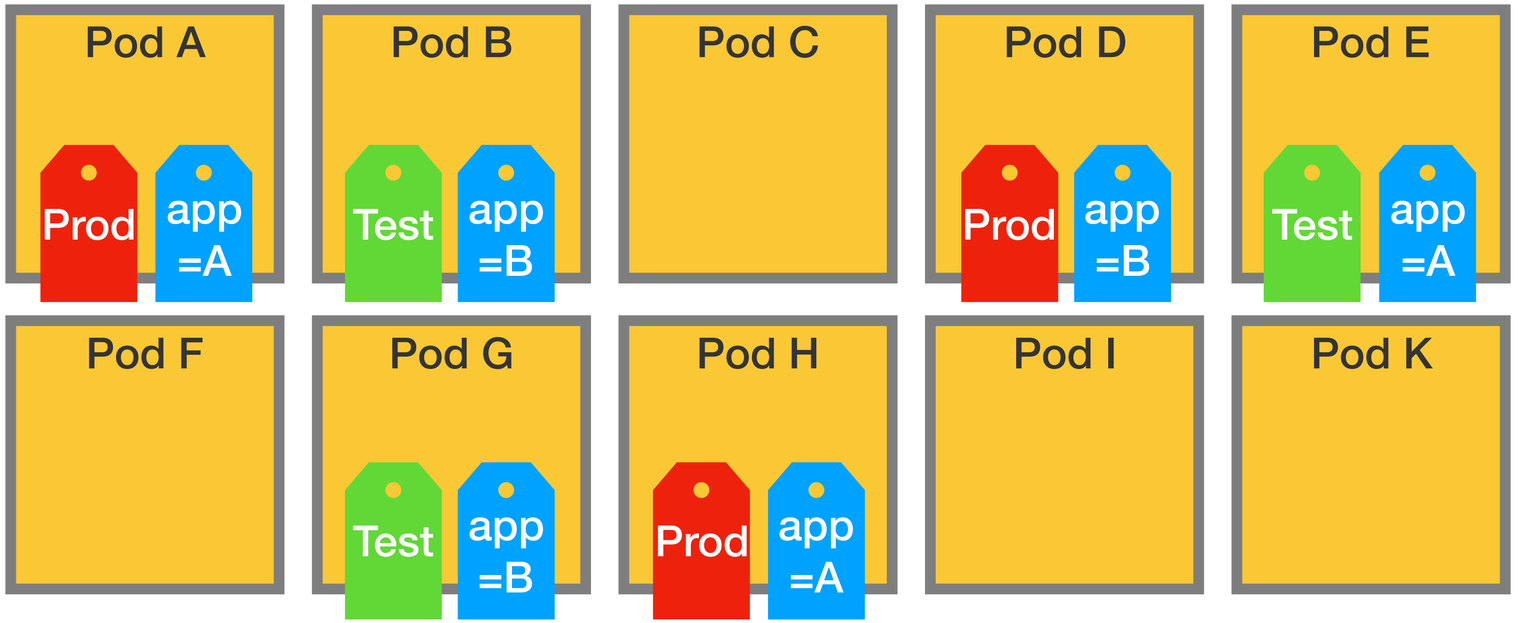
Concept #1 — Pod

```
apiVersion: v1
kind: Pod
metadata:
  name: ecf-k8s-101
spec:
  containers:
  - image: nginx
    name: static-nginx
    ports:
    - containerPort: 8080
      protocol: TCP
```

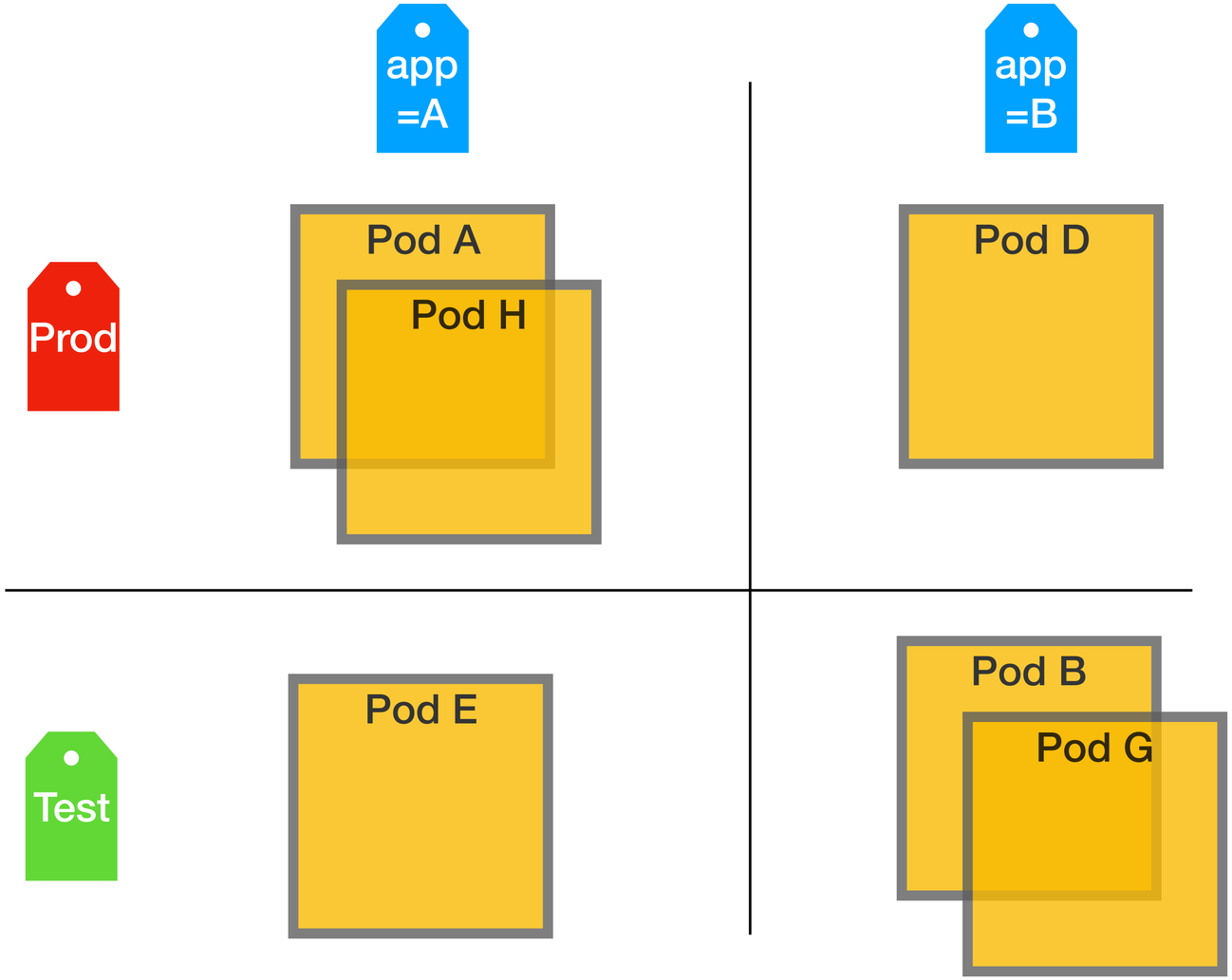
Concept #2 — Labels



Concept #2 — Labels



Concept #2 — Labels



Concept #3 — Namespaces

- They are not Linux namespace (used by container runtimes to isolate containers)
- Separate resources into non-overlapping groups
- Can define permissions on namespaces
- Can even limit the amount of computational resources available
- Network policies use namespaces to isolate pods

custom-ns.yaml

```
apiVersion: v1
kind: Namespace
metadata:
  name: custom-ns
```

```
$ kubectl create -f custom-ns.yaml
Namespace “custom-ns” created

$ kubectl create namespace custom-ns
namespace "custom-ns" created
```

ECLIPSE FOUNDATION

Concept #4 — ReplicaSet

Ensures that a specified number of pod replicas are running at any given time.

```
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: frontend
  labels:
    app: guestbook
    tier: frontend
spec:
  replicas: 3
  selector:
    matchLabels:
      tier: frontend
 template:
    metadata:
      labels:
        app: guestbook
        tier: frontend
    spec:
      containers:
      - name: php-redis
        image: gcr.io/google_samples/gb-frontend:v3
        resources:
          requests:
            cpu: 100m
            memory: 100Mi
        ports:
        - containerPort: 80
```

ECLIPSE FOUNDATION

Concept #5 — DaemonSet

- A DaemonSet ensures that all (or some) Nodes run a copy of a Pod.
- As nodes are added to the cluster, Pods are added to them.
- As nodes are removed from the cluster, those Pods are garbage collected.

```
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: fluentd-elasticsearch
  namespace: kube-system
  labels:
    k8s-app: fluentd-logging
spec:
  selector:
    matchLabels:
      name: fluentd-elasticsearch
  template:
    metadata:
      labels:
        name: fluentd-elasticsearch
    spec:
      tolerations:
      - key: node-role.kubernetes.io/master
        effect: NoSchedule
      containers:
      - name: fluentd-elasticsearch
        image: k8s.gcr.io/fluentd-elasticsearch:1.20
        resources:
          limits:
            memory: 200Mi
          requests:
            cpu: 100m
            memory: 200Mi
```

ECLIPSE FOUNDATION

Concept #6 — Job and CronJob

- A job creates one or more pods and ensures that a specified number of them successfully terminate.
- As pods successfully complete, the job tracks the successful completions. When a specified number of successful completions is reached, the job itself is complete. Deleting a Job will cleanup the pods it created.

```
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
```

Concept #7 — Service

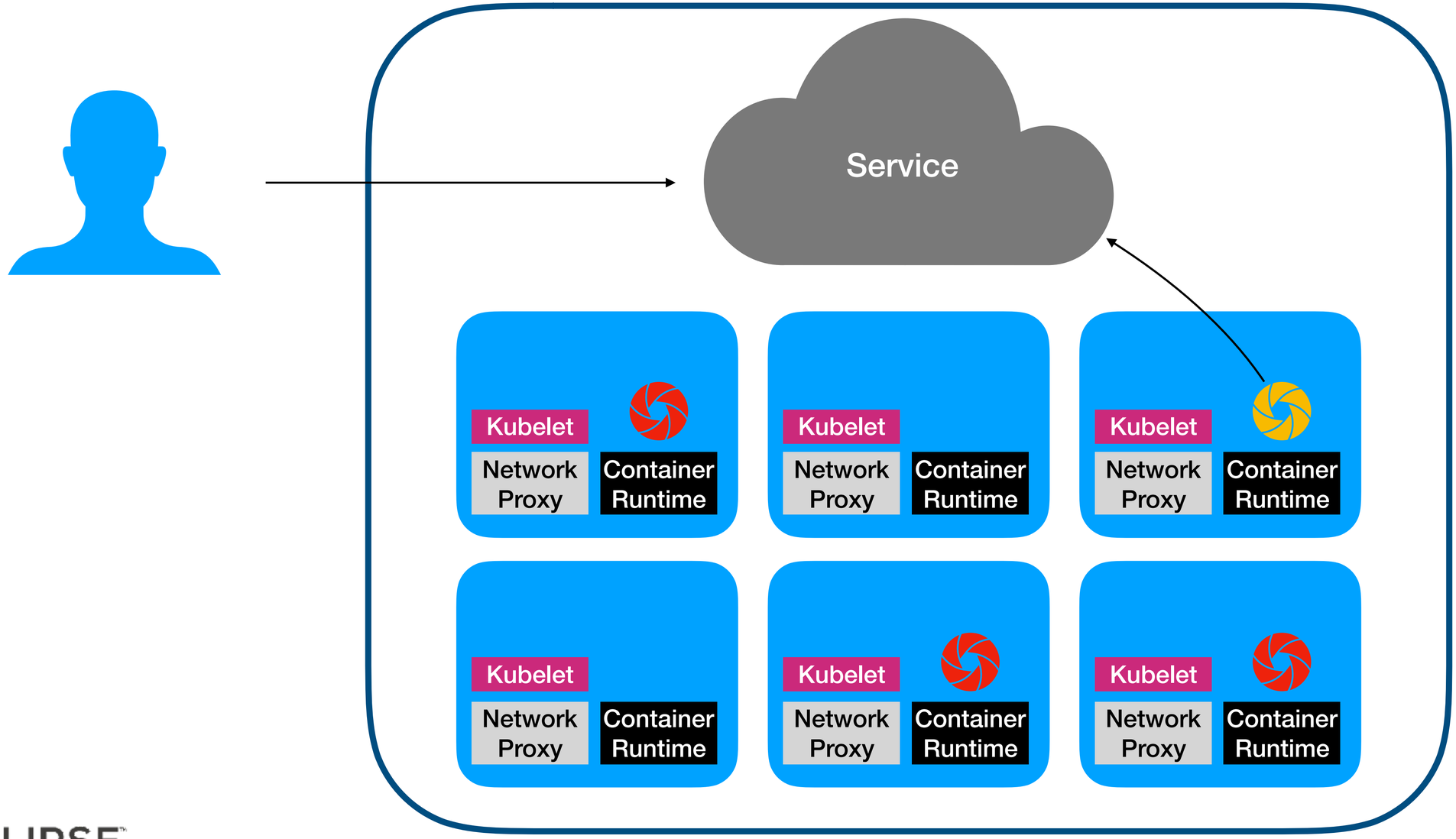
- A service is a stable address for a pod (or a bunch of pods)
  - ClusterIP: cluster-private IP
  - NodePort: ClusterIP + any node IP on specific port (thus available to the "outside" of the cluster)
  - LoadBalancer: NodePort + load balancer frontend (provided by the cloud provider).
  - Ingress: kind of reverse proxy in front of the cluster

```
apiVersion: v1
kind: Service
metadata:
  name: my-nginx
  labels:
    run: my-nginx
spec:
  ports:
  - port: 80
    protocol: TCP
  selector:
    run: my-nginx
```

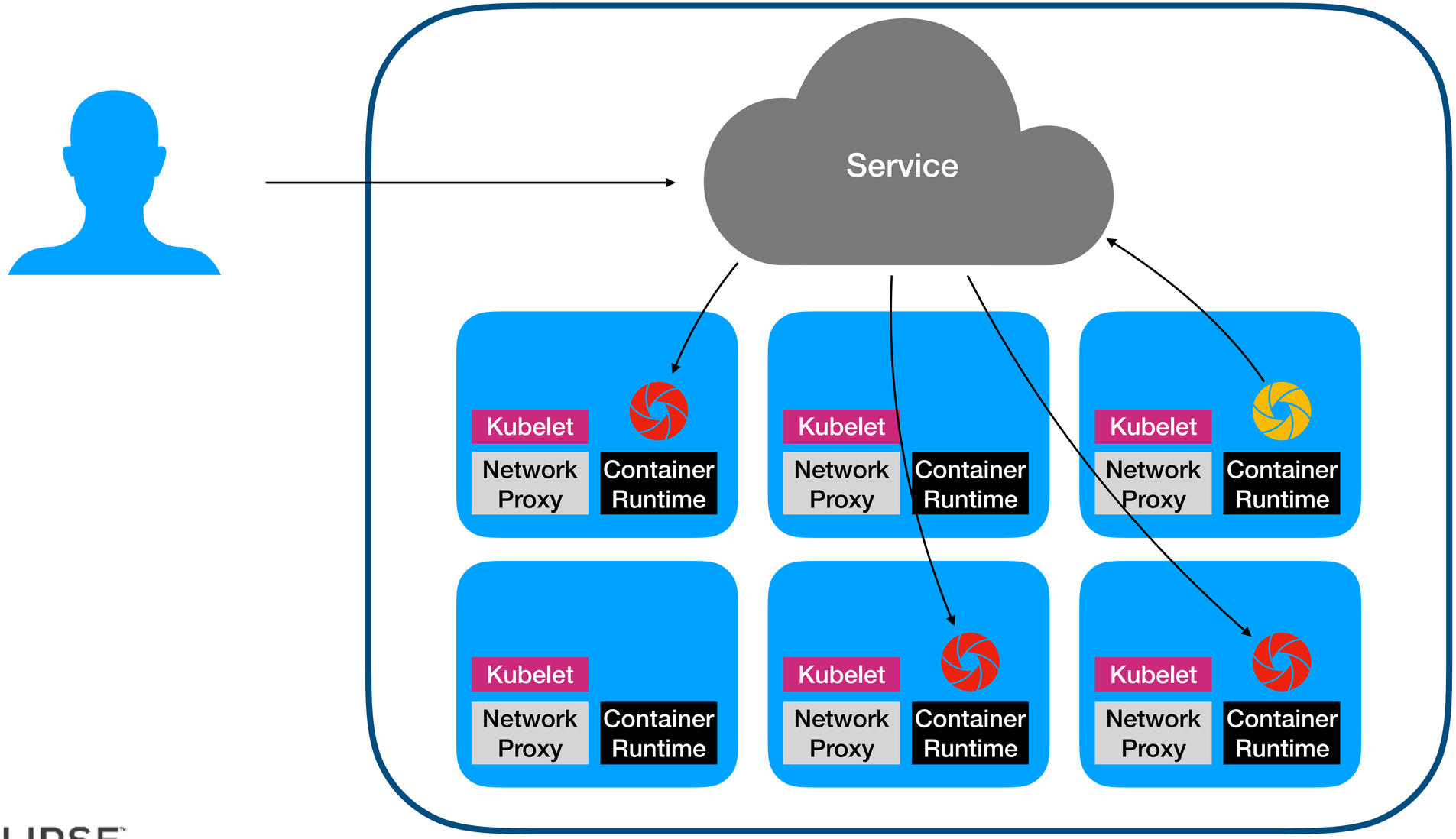
```
$ kubectl get svc my-nginx
NAME       CLUSTER-IP     EXTERNAL-IP   PORT(S)
my-nginx   10.0.162.149   <none>        80/TCP
```

ECLIPSE FOUNDATION

Concept #7 — Service



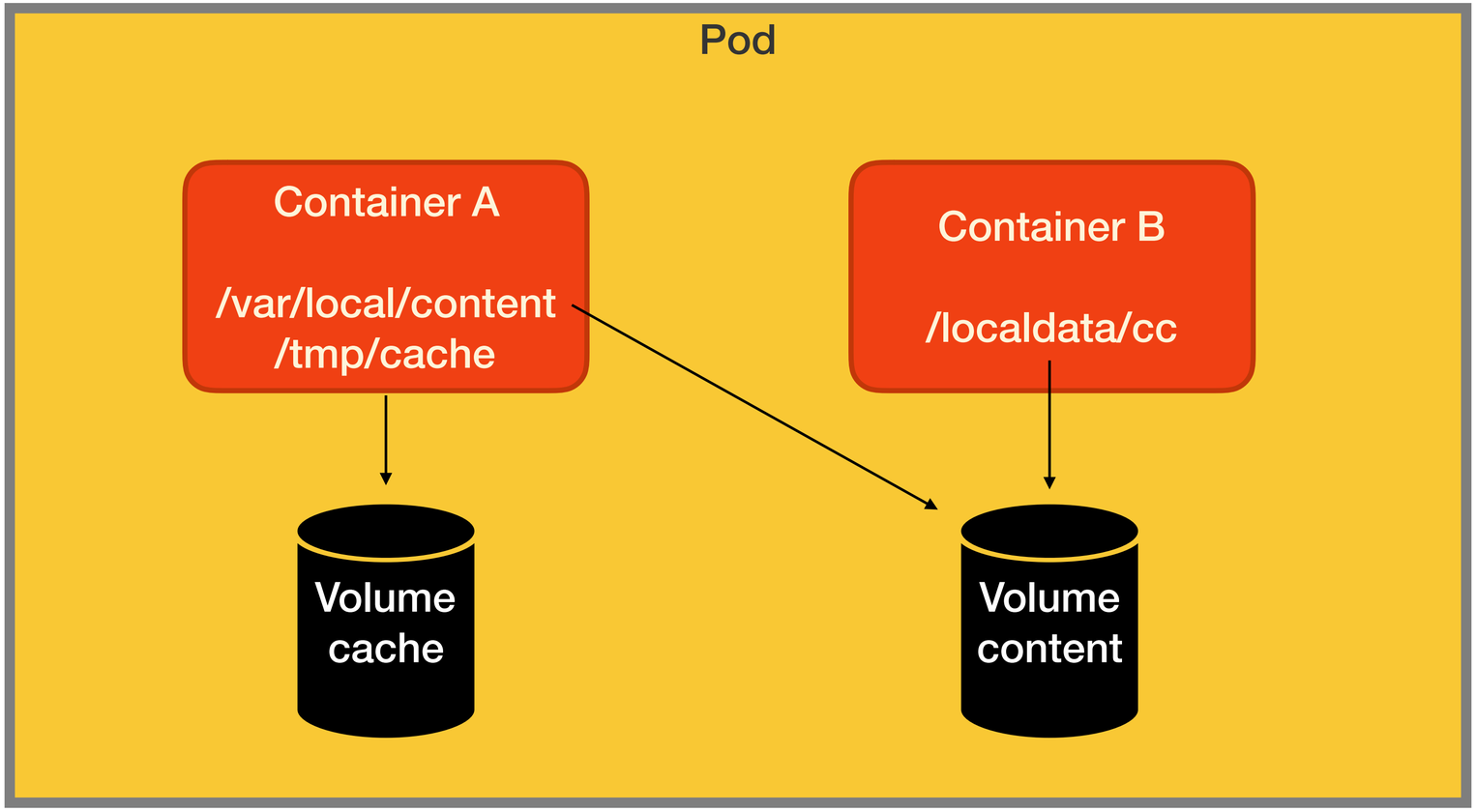
Concept #7 — Service



Concept #7 — Service

- Service Discovery
  - Via environment variables. Each pod is initialized with environments variables for each service available at that moment (e.g. MY-NGINX_SERVICE_HOST=10.0.162.149 and MY-NGINX_SERVICE_PORT=80)
  - Via DNS. The control plane runs a DNS server and modify each container's /etc/resolve.conf to use it. Each service gets a DNS entry in the form <service_name>.<namespace>.<cluster_domain_suffix> (e.g.,my-ginx.default.svc.eclipsefnd-cluster1.local).
  - Access to external resources is also possible via Endpoints

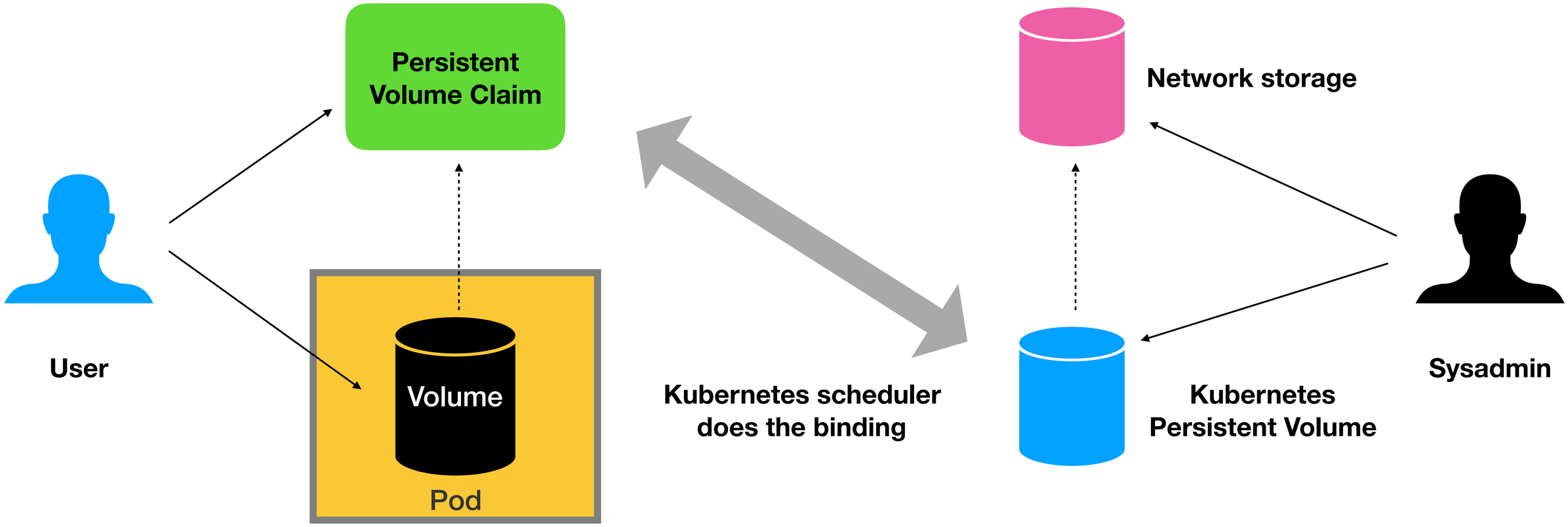
Concept #8 — Volumes



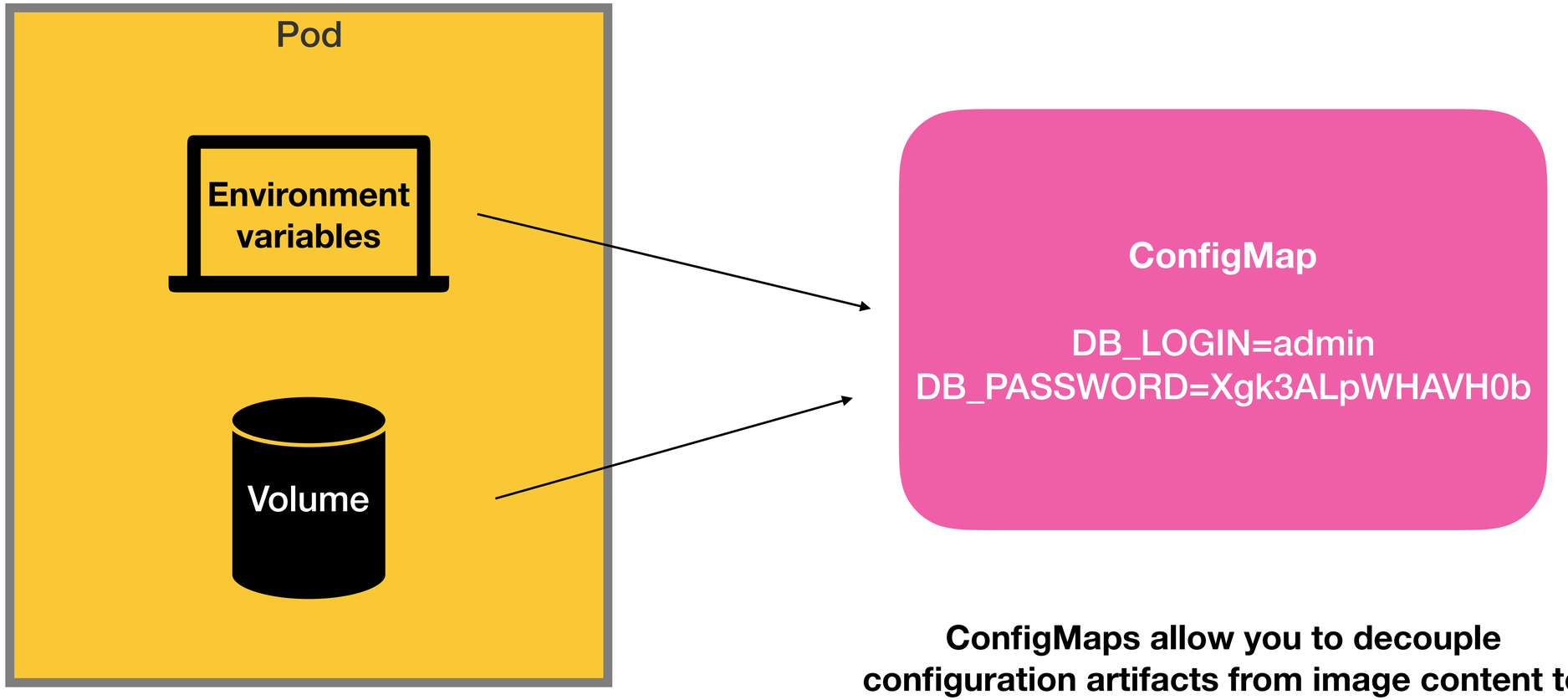
Concept #8 — Volumes

- Empty directory used for storing transient data (lifecycle is tied to its pod).
- Worker node's filesystem path (hostPath).
- Git repository
- Cloud provider-specific storage (Google Compute Engine Persistent Disk, Amazon Web Services Elastic Block Store Volume, Microsoft Azure Disk Volume.
- Various network storage (nfs, cinder, cephfs, iscsi, flocker, glusterfs, ...)
- Volumes used to expose certain Kubernetes resources and cluster information to the pod (configMap, secret, downwardAPI)
- persistentVolumeClaim A way to use a pre- or dynamically provisioned persistent storage.

Concept #8 — Volumes

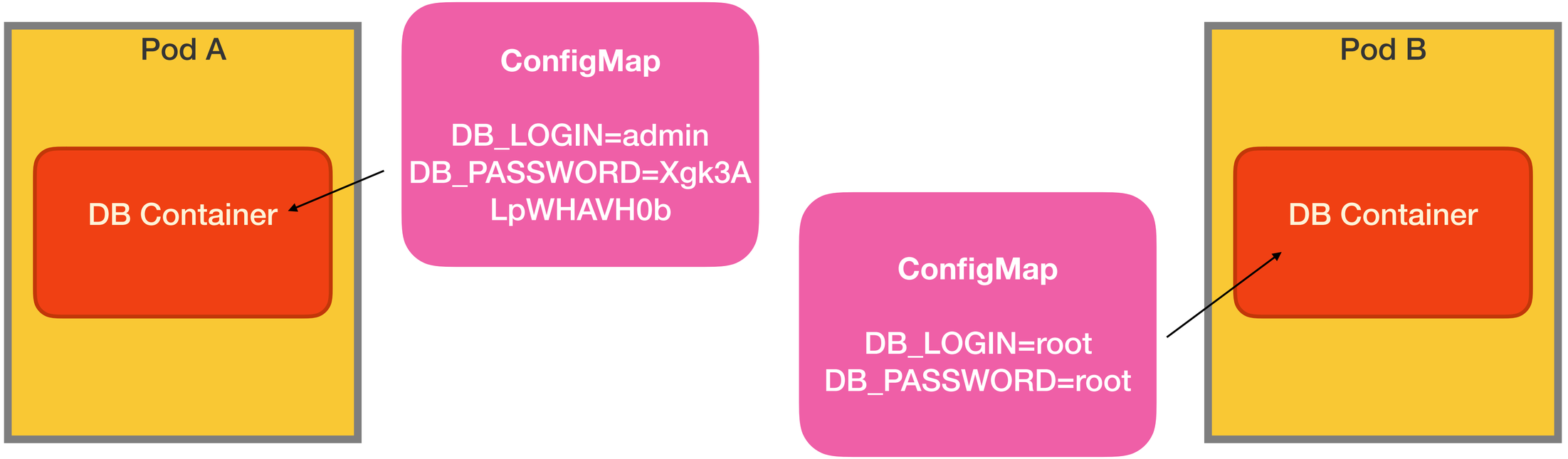


Concept #9 — ConfigsMap & Secret



ConfigMaps allow you to decouple configuration artifacts from image content to keep containerized applications portable

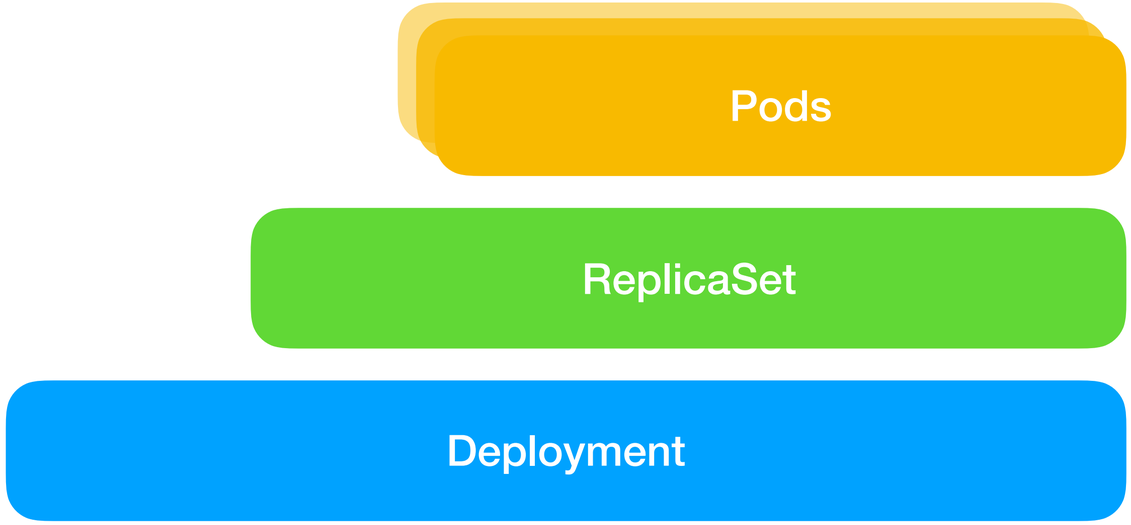
Concept #9 — ConfigsMap & Secret



Concept #9 — ConfigsMap & Secret

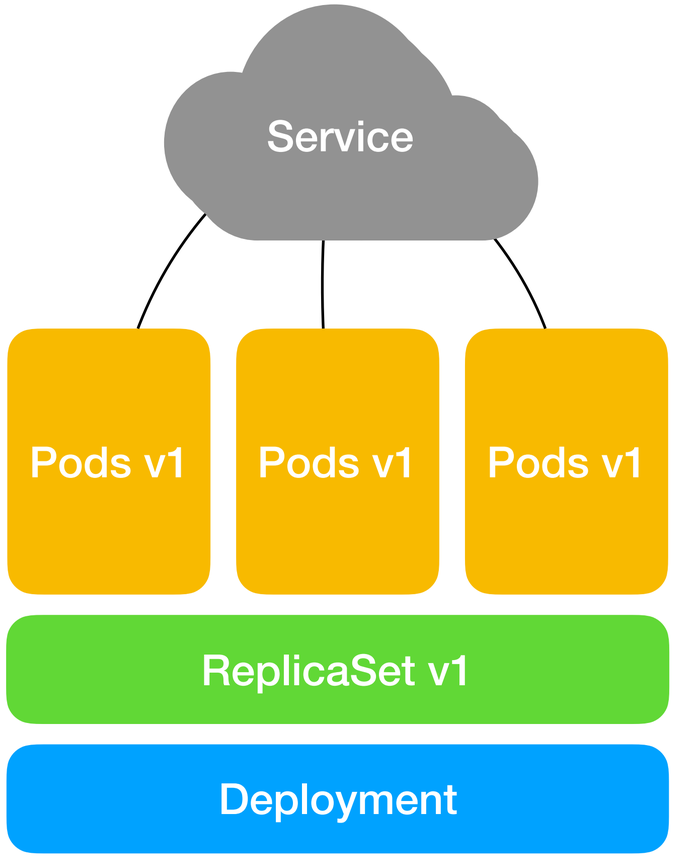
- Secrets are much like ConfigMaps but to store certs, password, etc.
- Kubernetes makes sure each Secret is only distributed to the nodes that run the pods that need access to the Secret.
- Secrets are always stored in memory (tmpfs) on the nodes and never written to physical storage.
- Secrets are stored encrypted in etcd

Concept #10 — Deployment

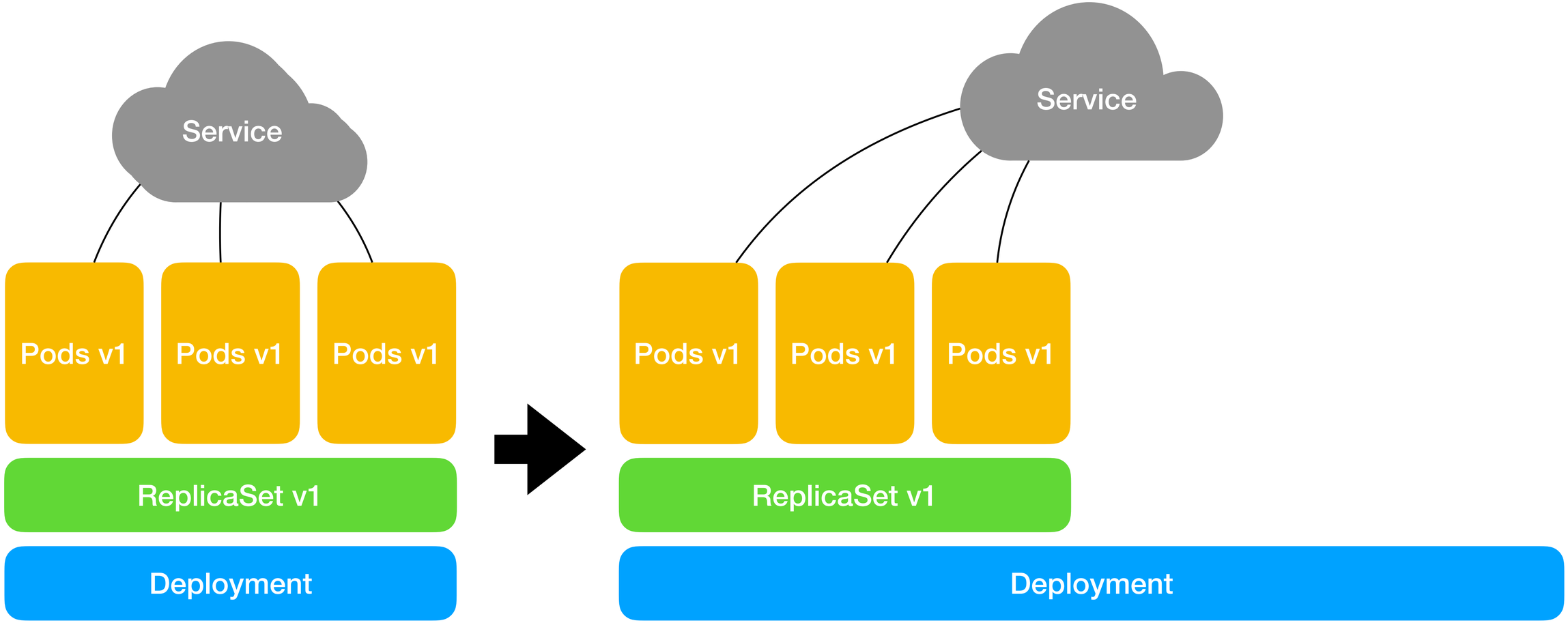



```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.7.9
        ports:
        - containerPort: 80
```

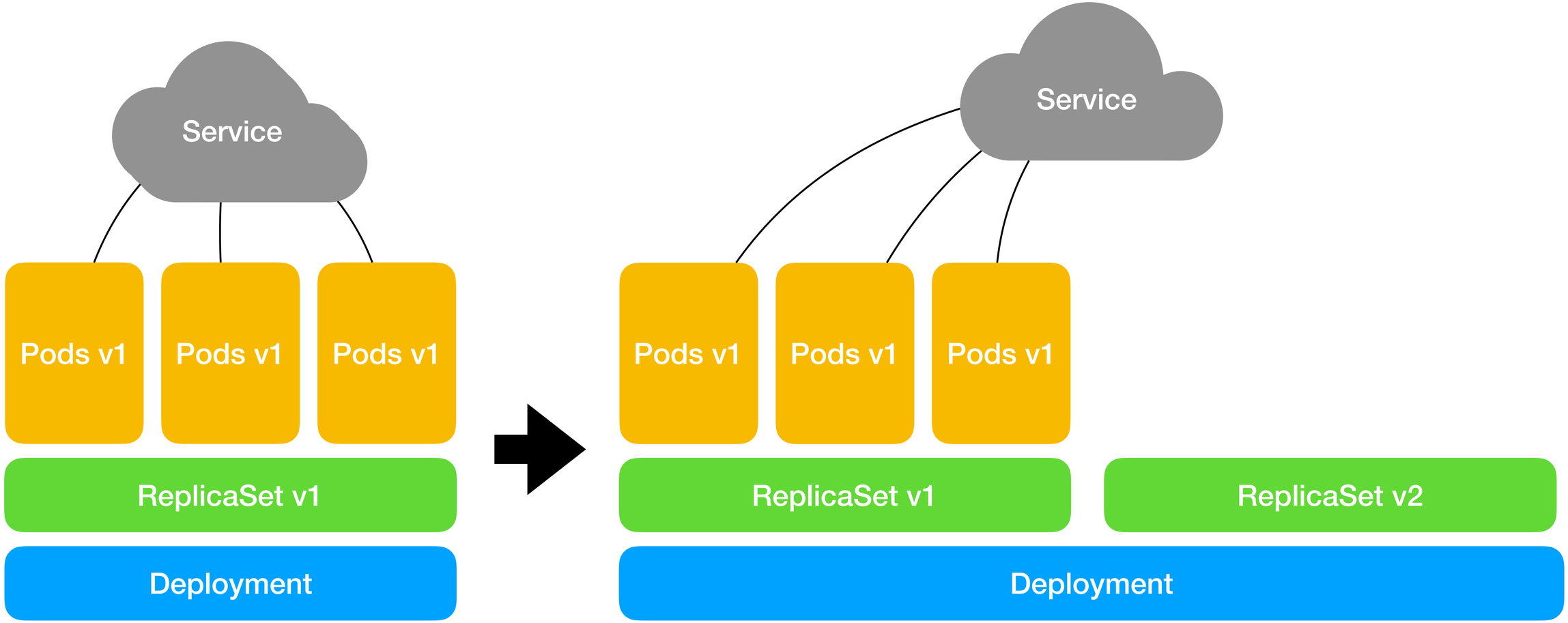
Concept #10 — Deployment



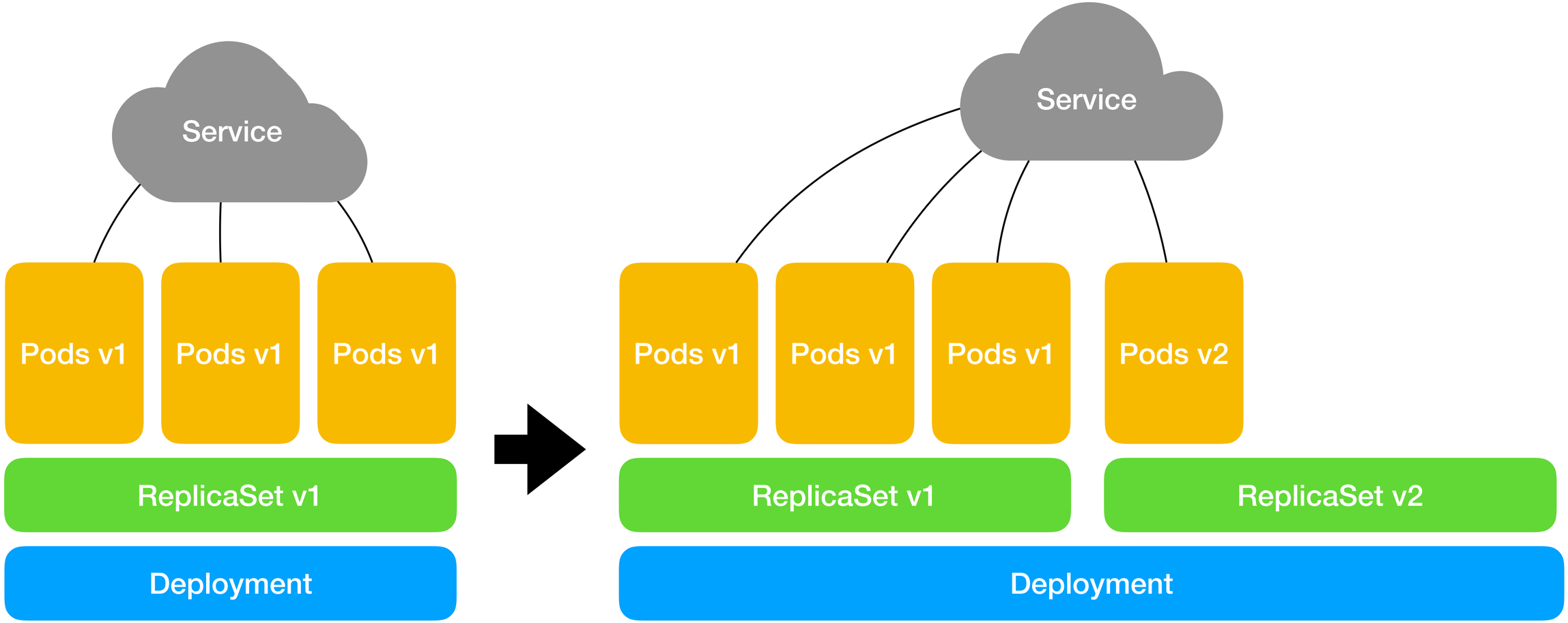
Concept #10 — Deployment



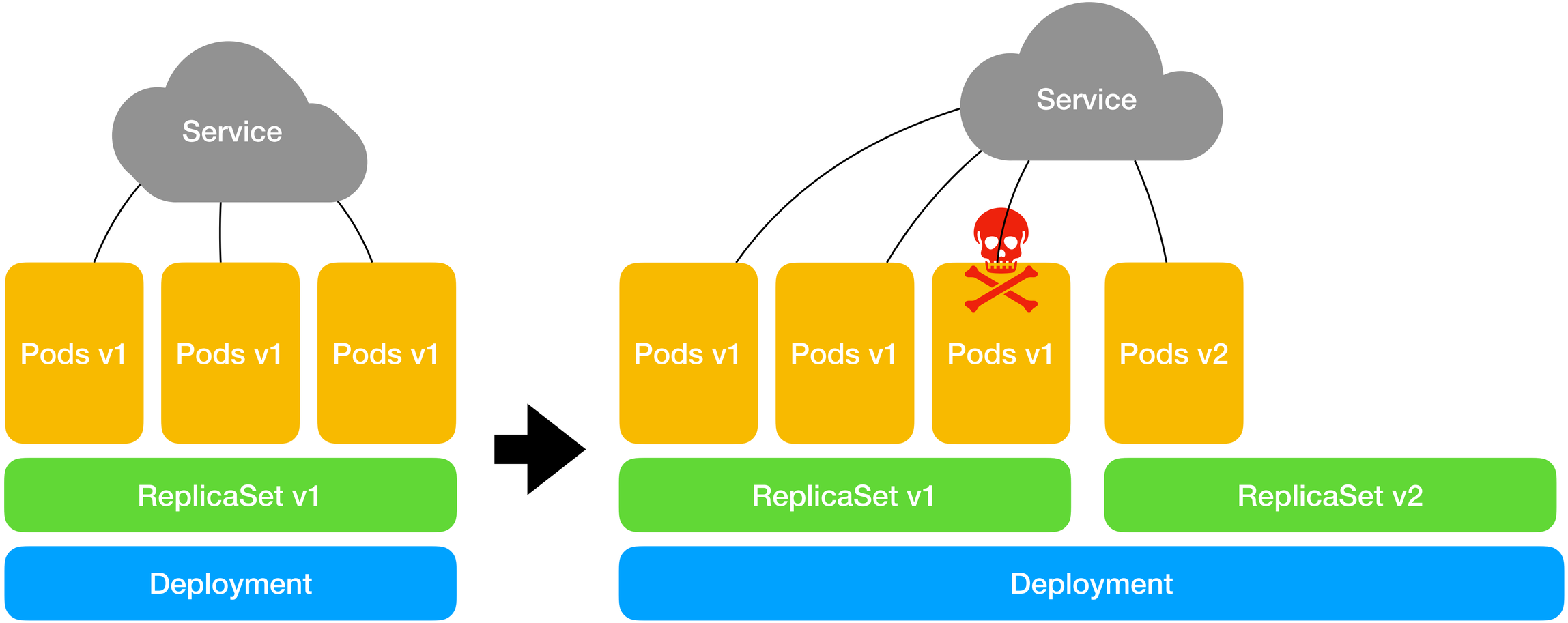
Concept #10 — Deployment



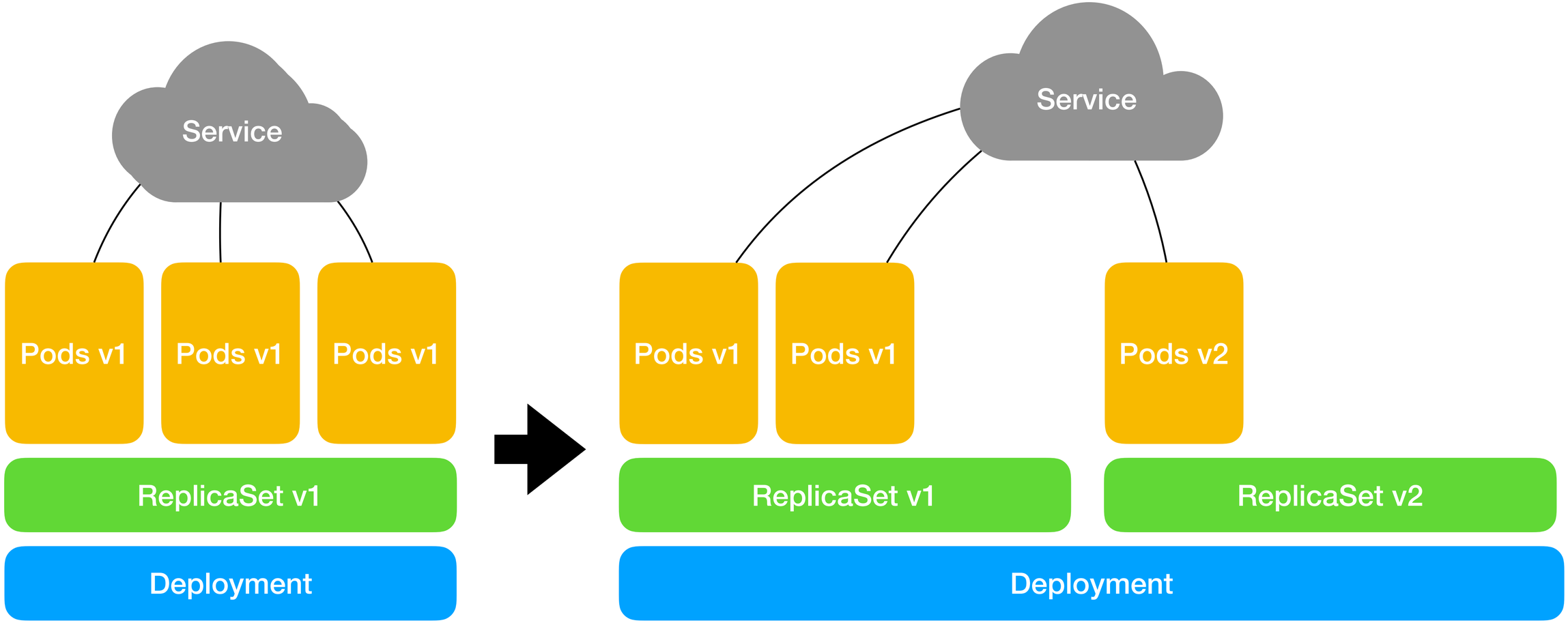
Concept #10 — Deployment



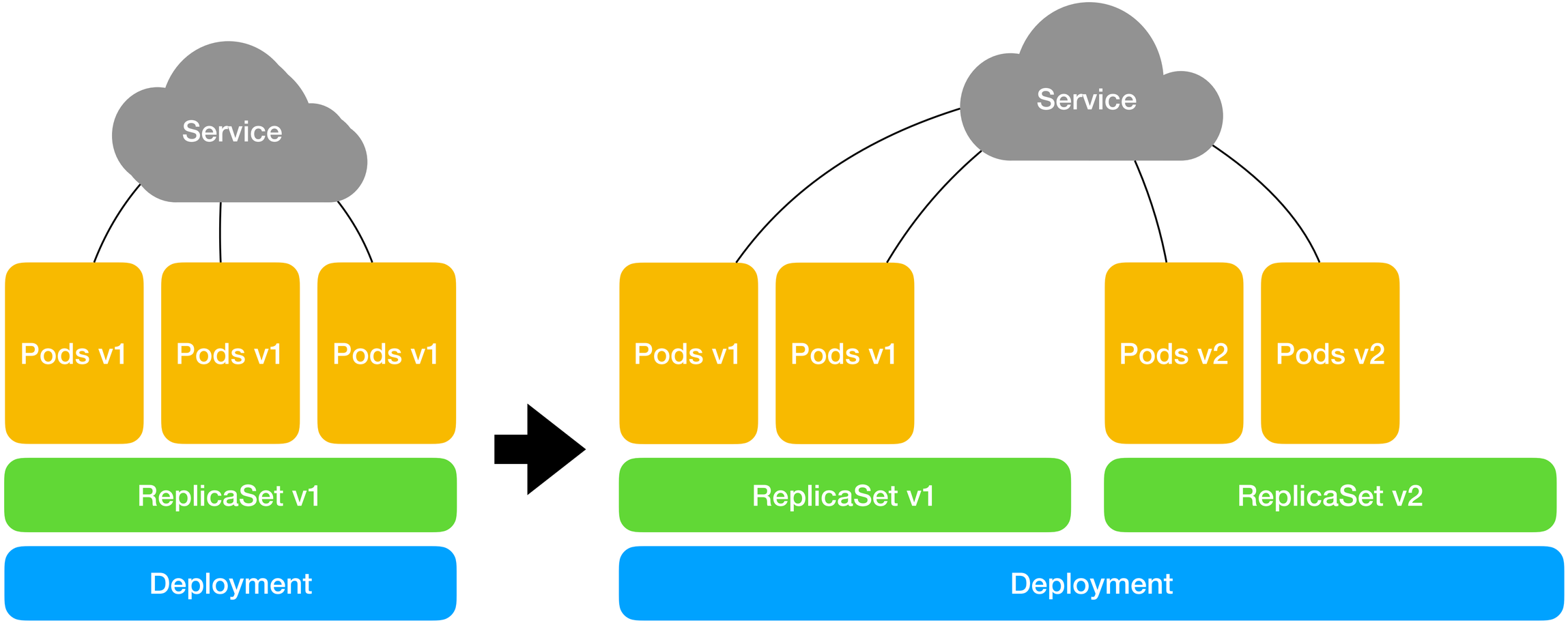
Concept #10 — Deployment



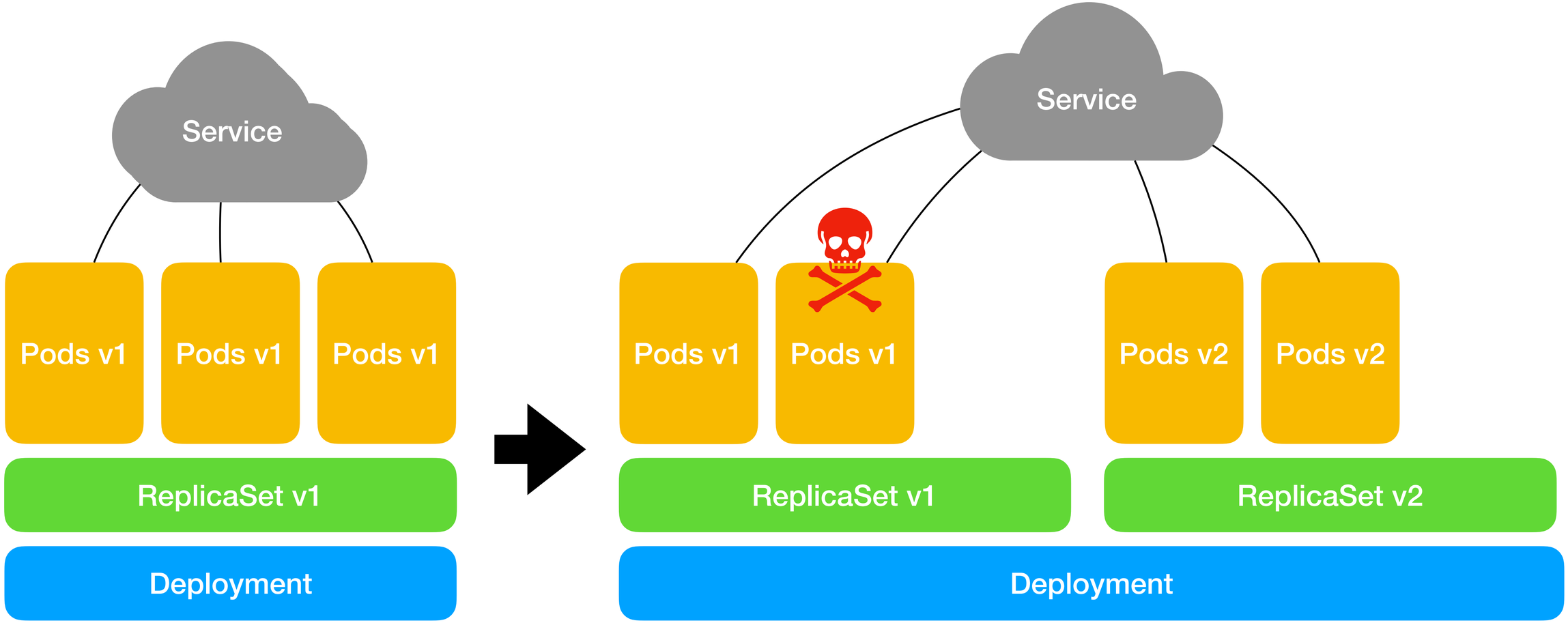
Concept #10 — Deployment



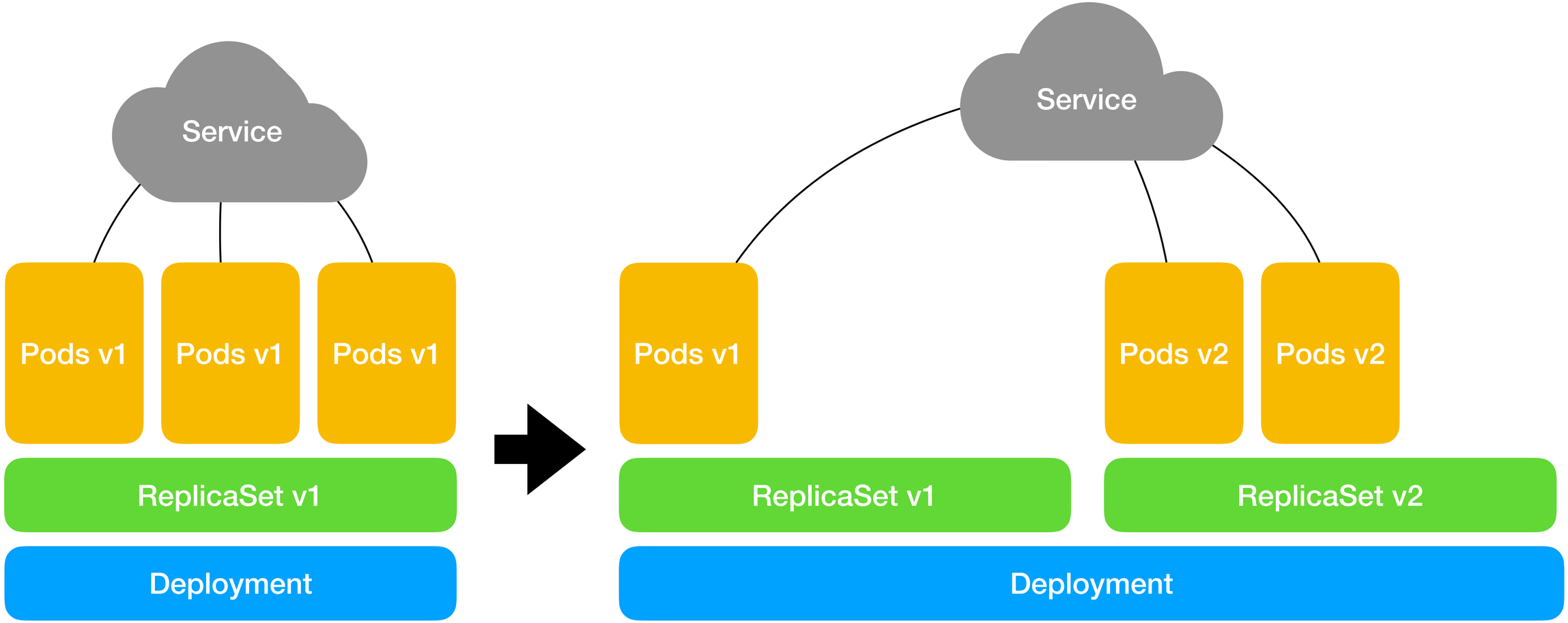
Concept #10 — Deployment



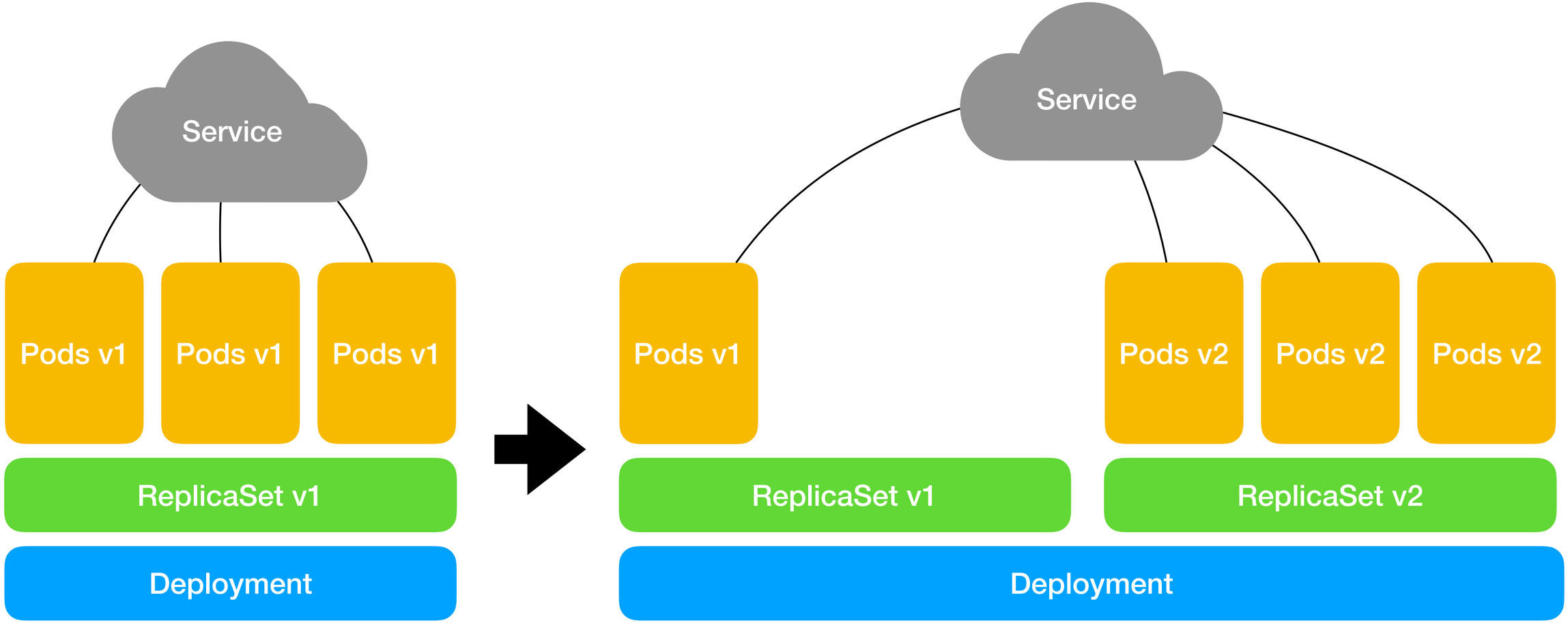
Concept #10 — Deployment



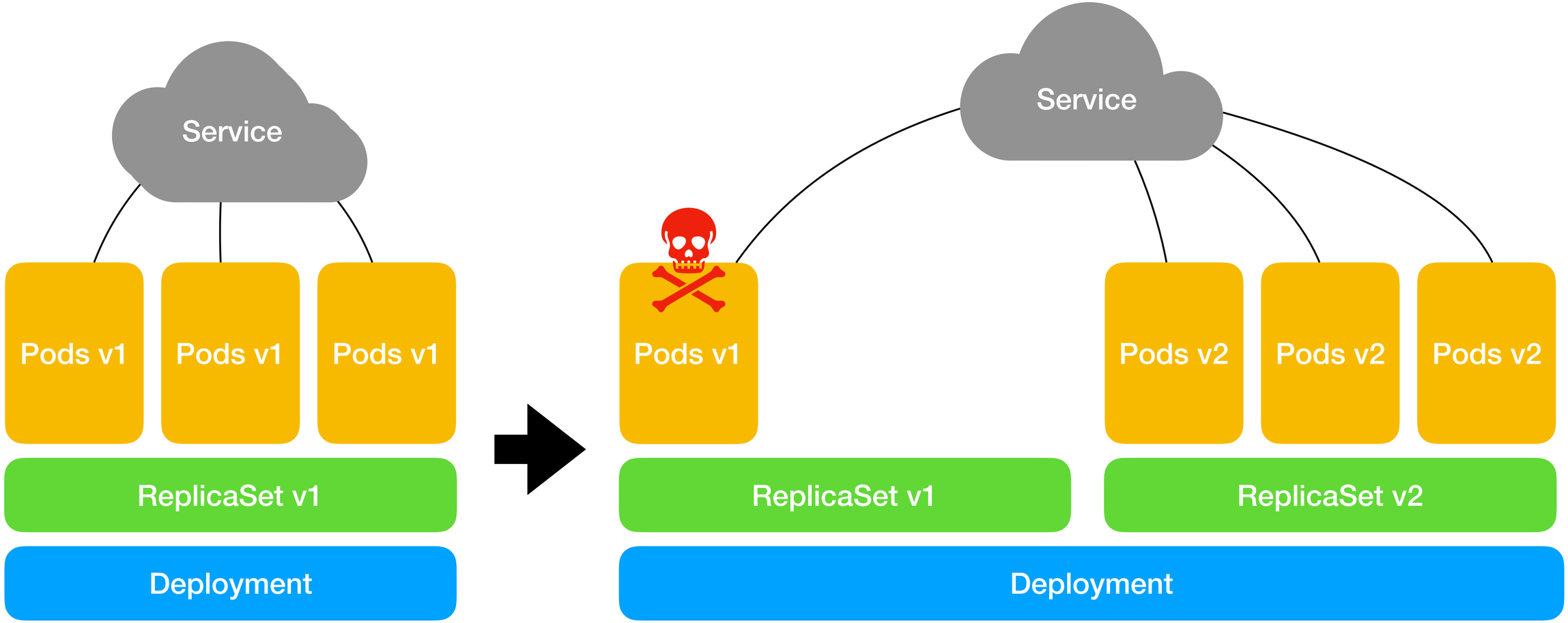
Concept #10 — Deployment



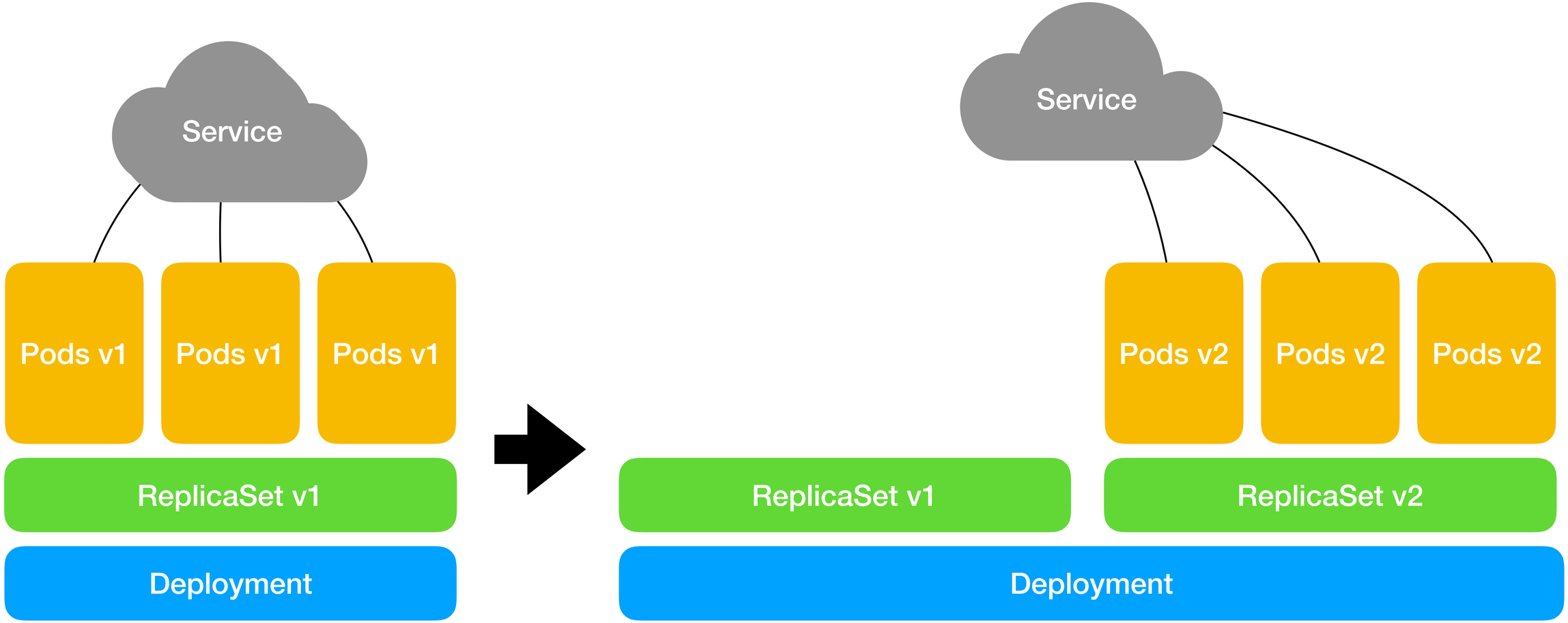
Concept #10 — Deployment



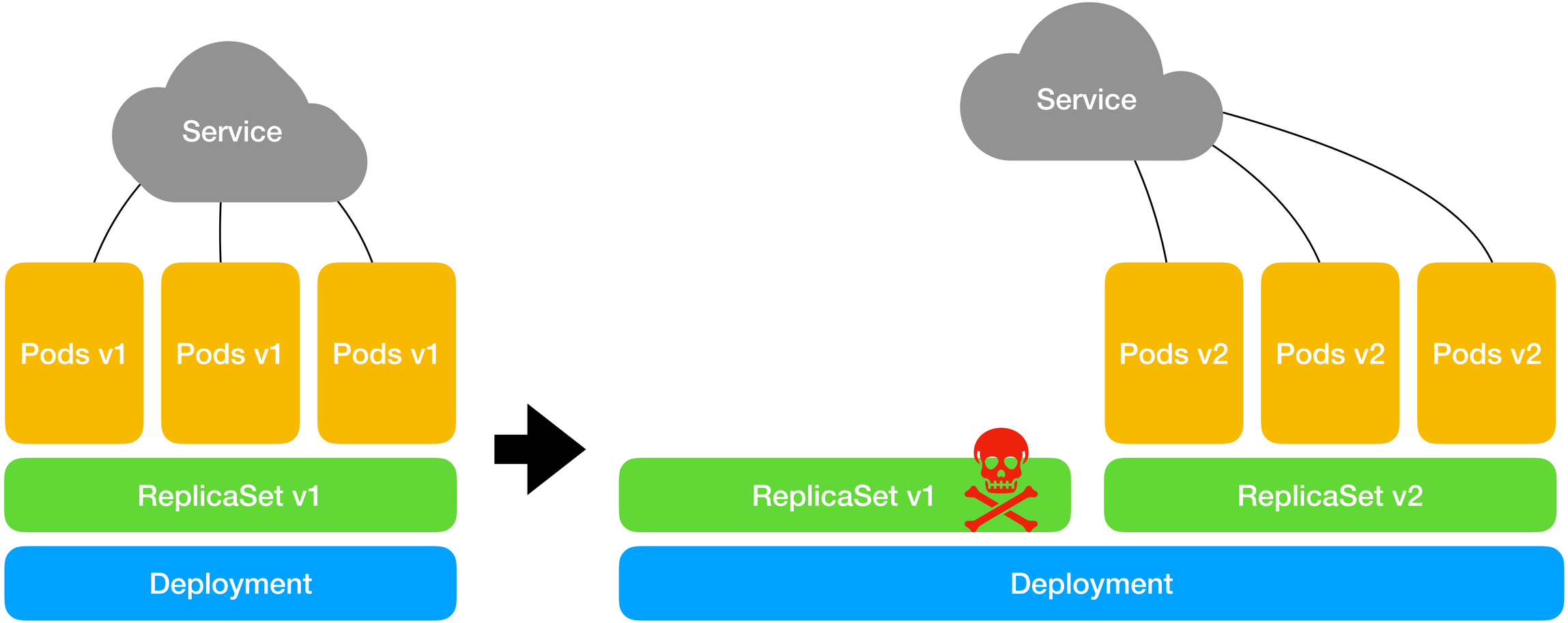
Concept #10 — Deployment



Concept #10 — Deployment



Concept #10 — Deployment



Concept #10 — Deployment