Docker – Day 4

Kubernetes

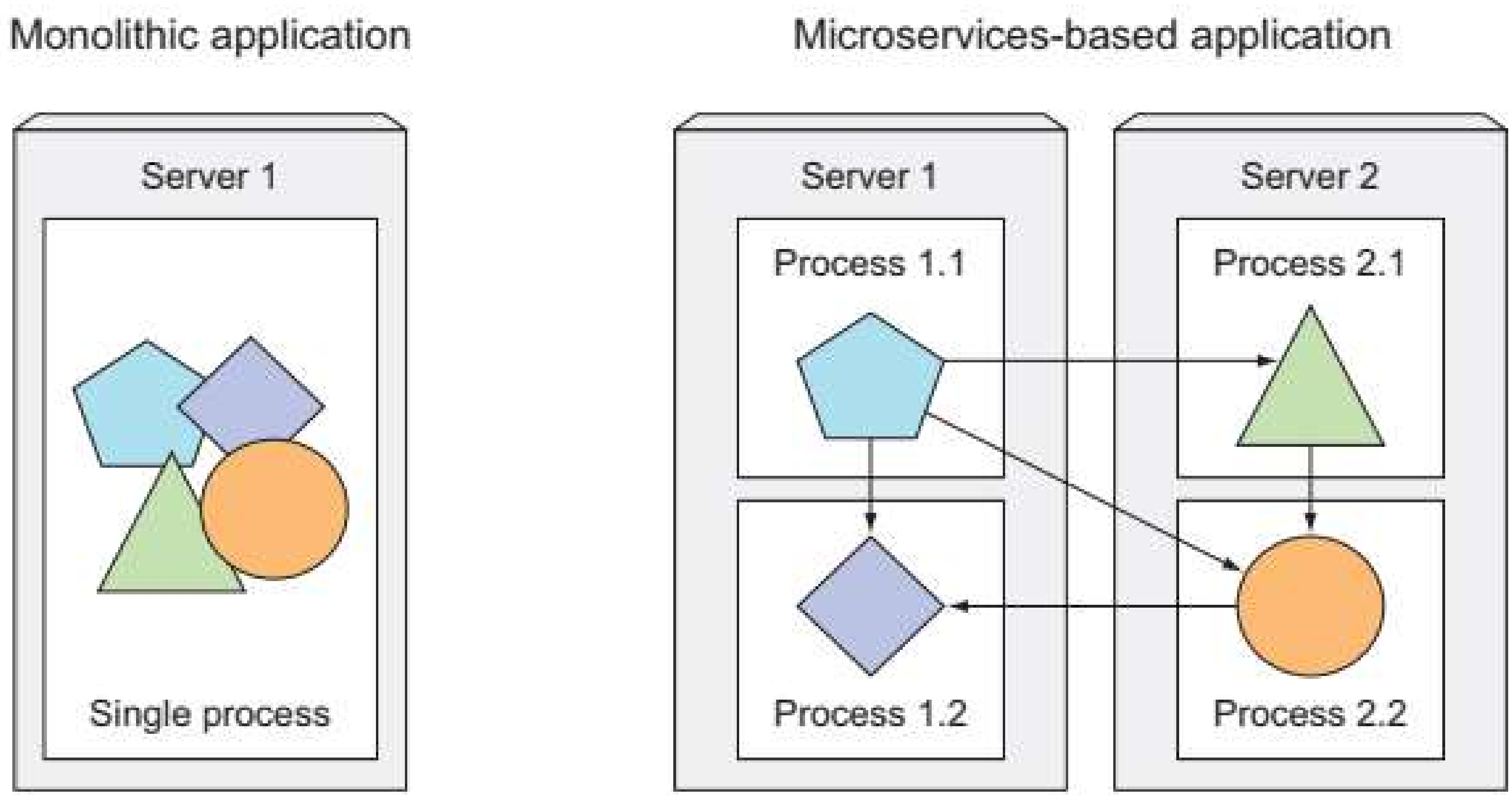
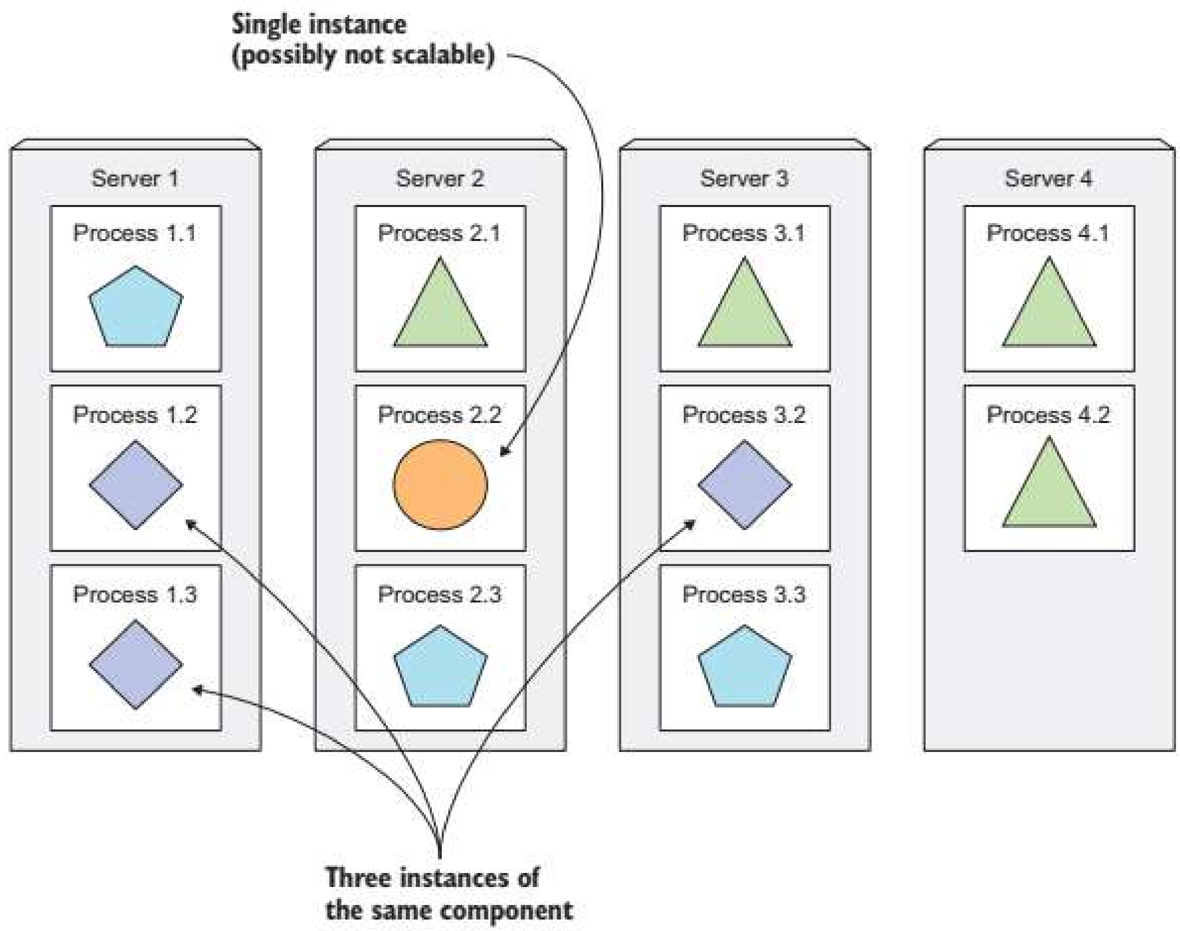
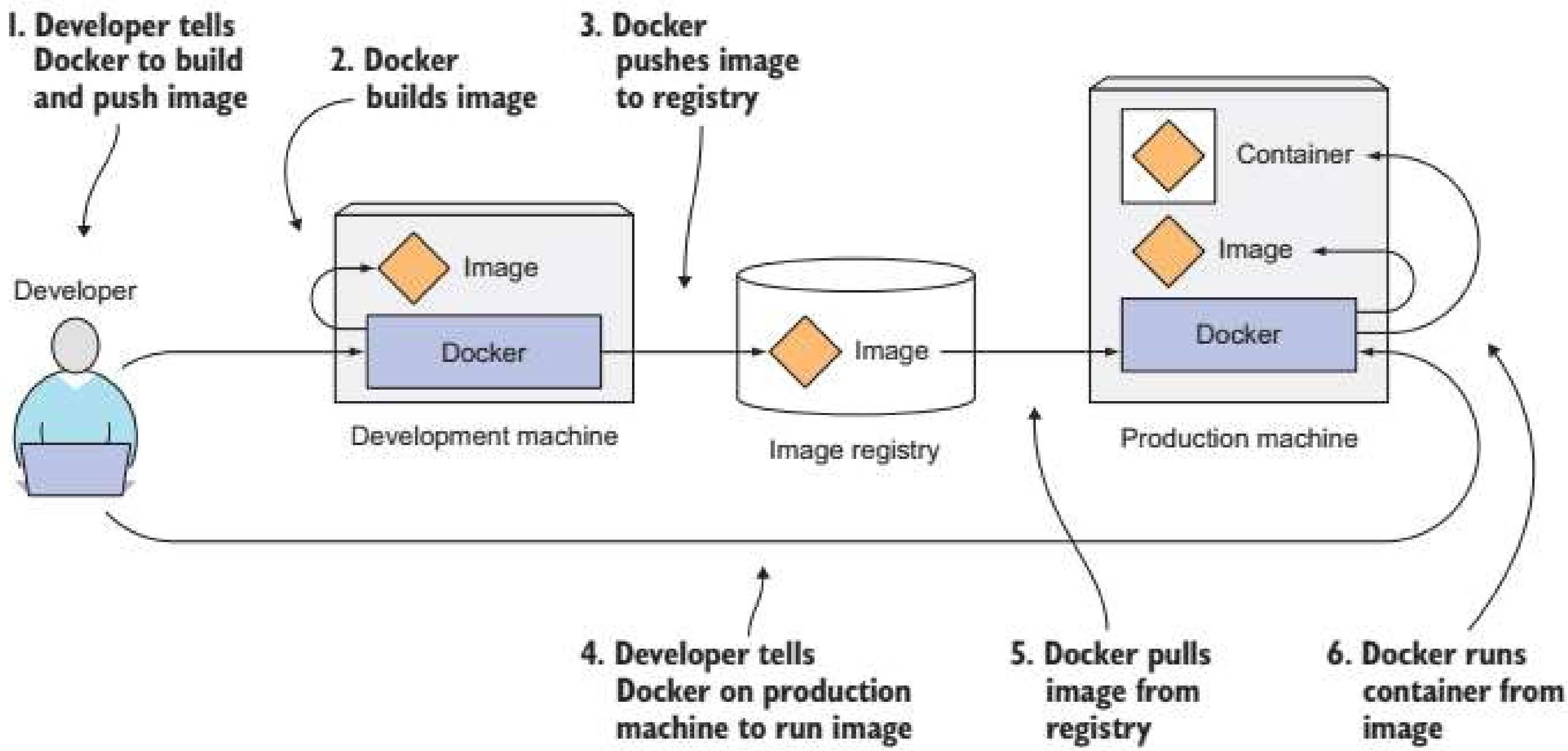
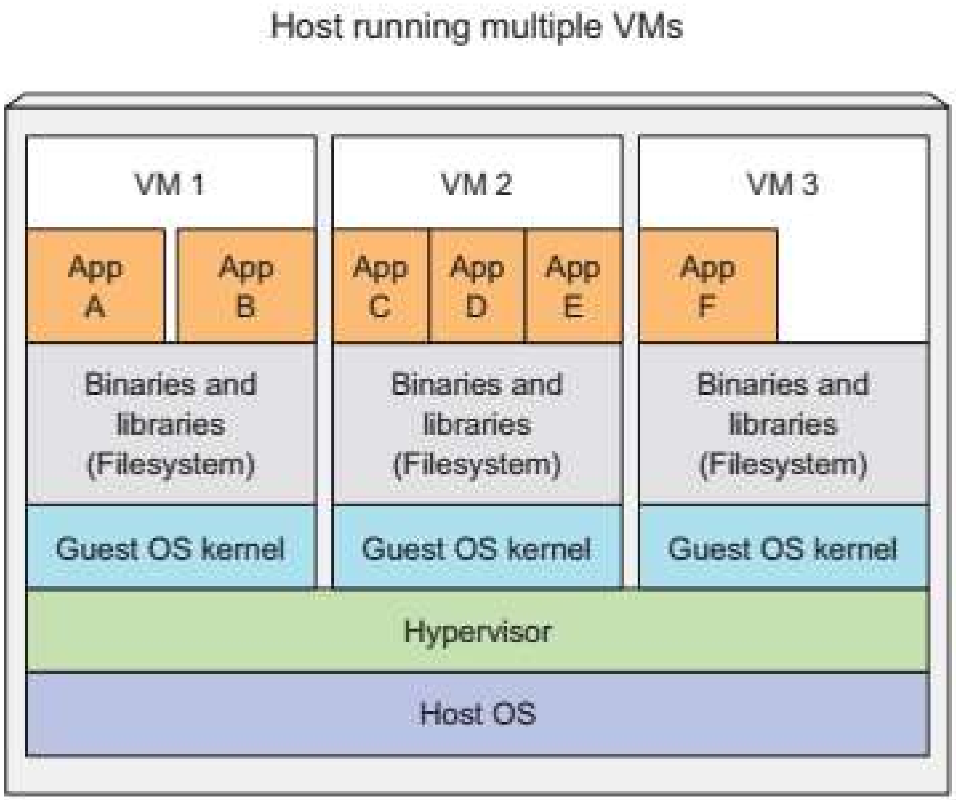


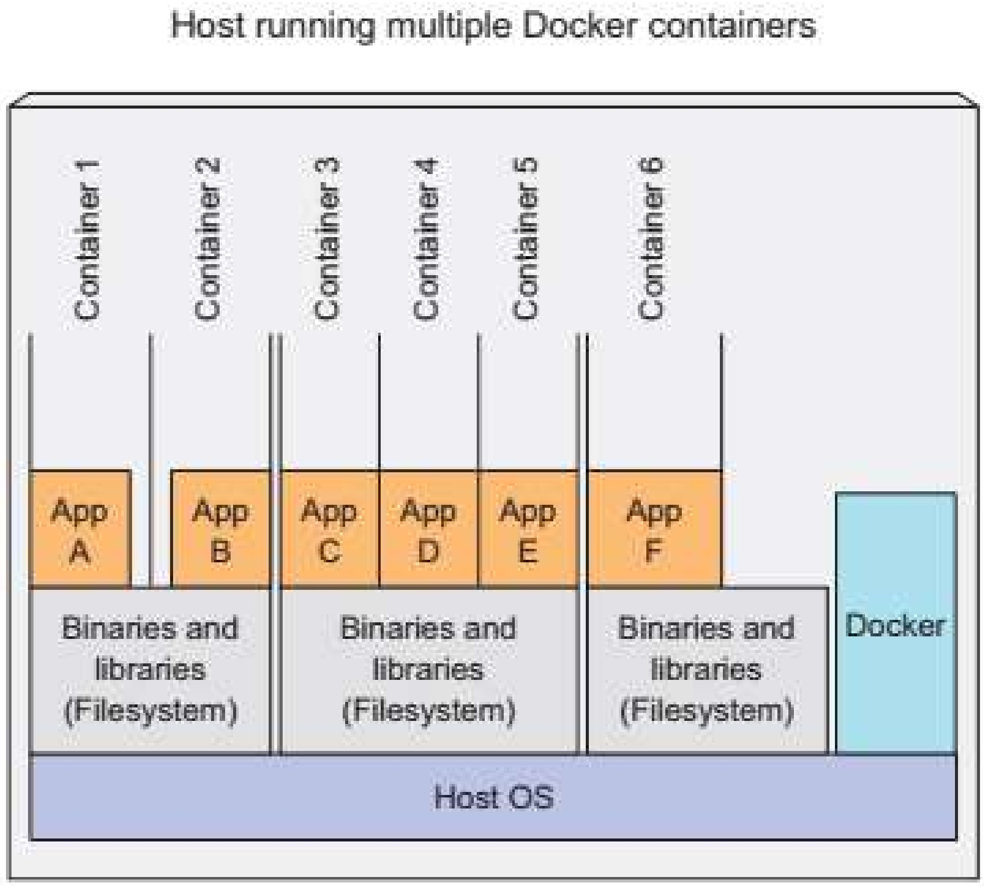
Figure 1.1 Components inside a monolithic application vs. standalone microservices



Single instance
(possibly not scalable)
Server 1
Process 1.1
Process 1.2
Process 1.3
Server 2
Process 2.1
Process 2.2
Process 2.3
Server 3
Process 3.1
Process 3.2
Process 3.3
Server 4
Process 4.1
Process 4.2
Three instances of
the same component


1. Developer tells Docker to build and push image
2. Docker builds image
3. Docker pushes image to registry
Developer
Image
Docker
Development machine
Image
Image registry
Container
Image
Docker
Production machine
4. Developer tells Docker on production machine to run image
5. Docker pulls image from registry
6. Docker runs container from image


Host running multiple VMs
VM 1
VM 2
VM 3
App A
App B
App C
App D
App E
App F
Binaries and libraries (Filesystem)
Binaries and libraries (Filesystem)
Binaries and libraries (Filesystem)
Guest OS kernel
Guest OS kernel
Guest OS kernel
Hypervisor
Host OS


Host running multiple Docker containers
Container 1
Container 2
Container 3
Container 4
Container 5
Container 6
App A
App B
App C
App D
App E
App F
Binaries and libraries (Filesystem)
Binaries and libraries (Filesystem)
Binaries and libraries (Filesystem)
Docker
Host OS

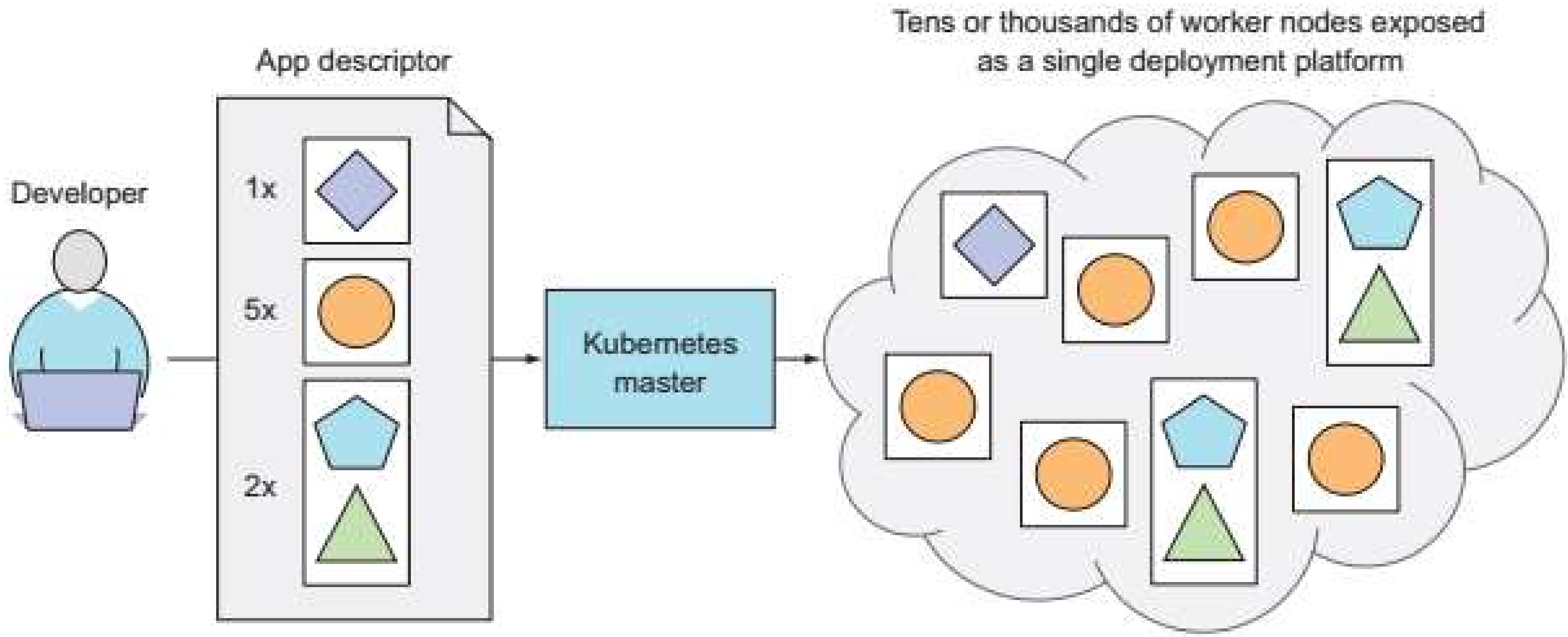


Figure 1.8 Kubernetes exposes the whole datacenter as a single deployment platform.

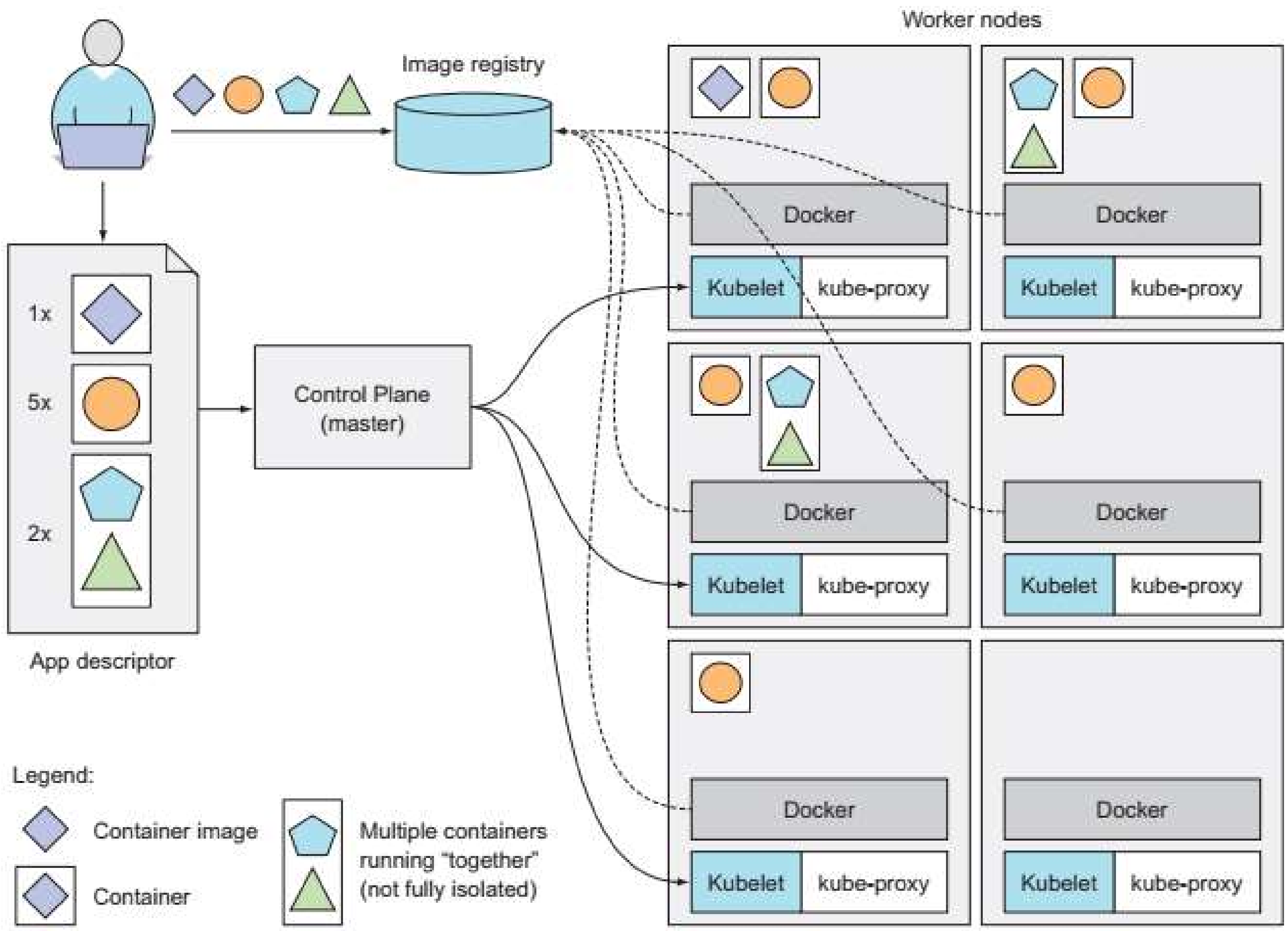


Figure 1.10 A basic overview of the Kubernetes architecture and an application running on top of it

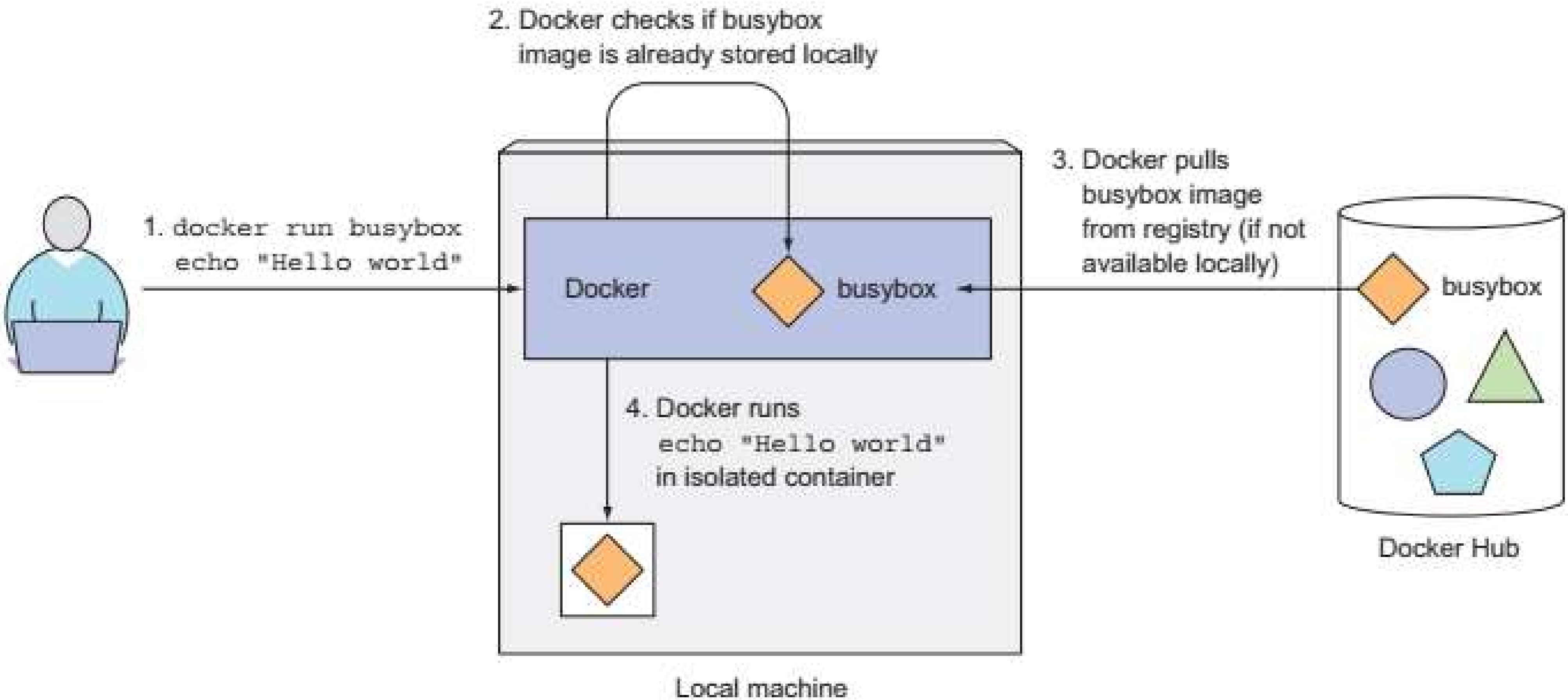


Figure 2.1 Running echo "Hello world" in a container based on the busybox container image

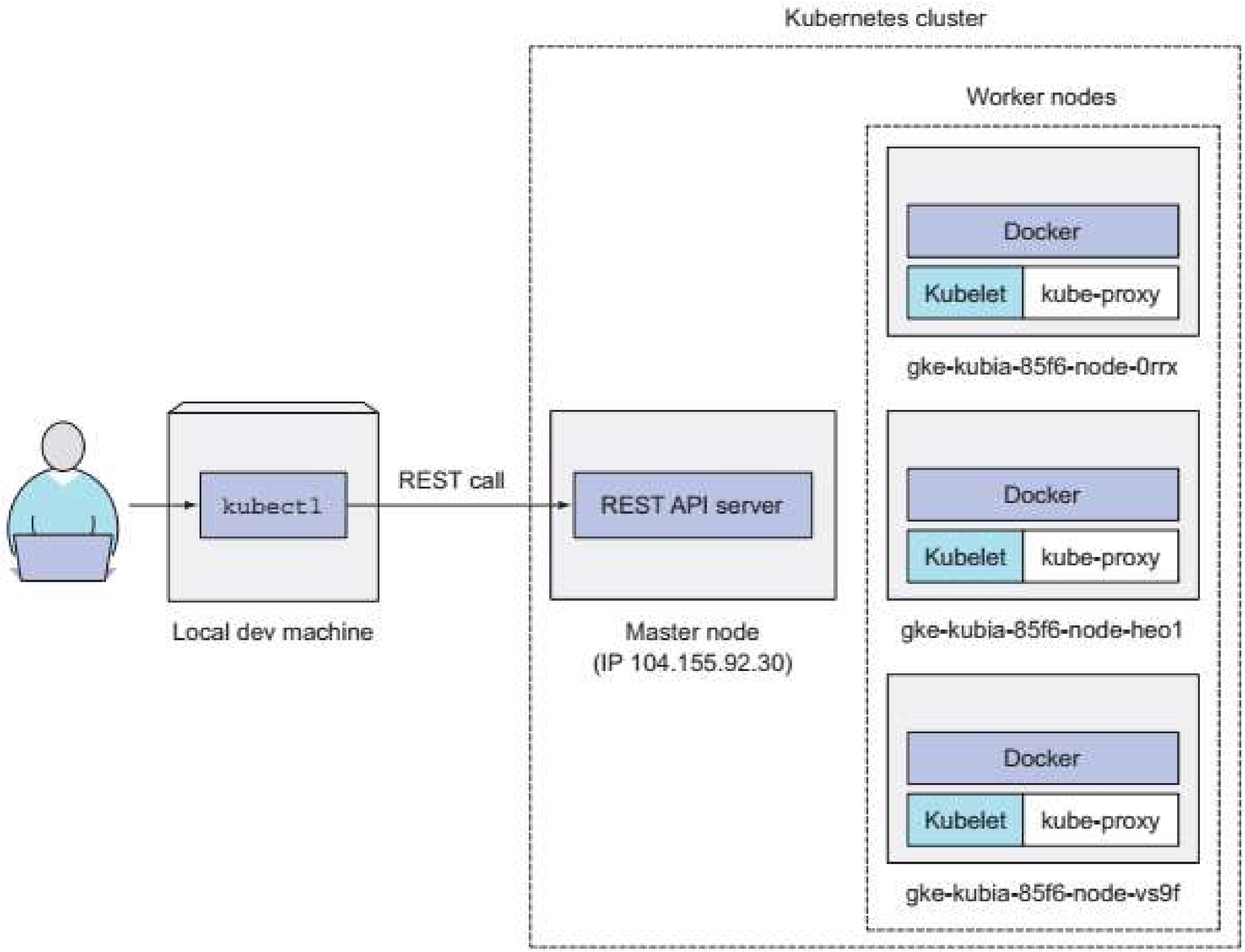


Figure 2.4 How you're interacting with your three-node Kubernetes cluster

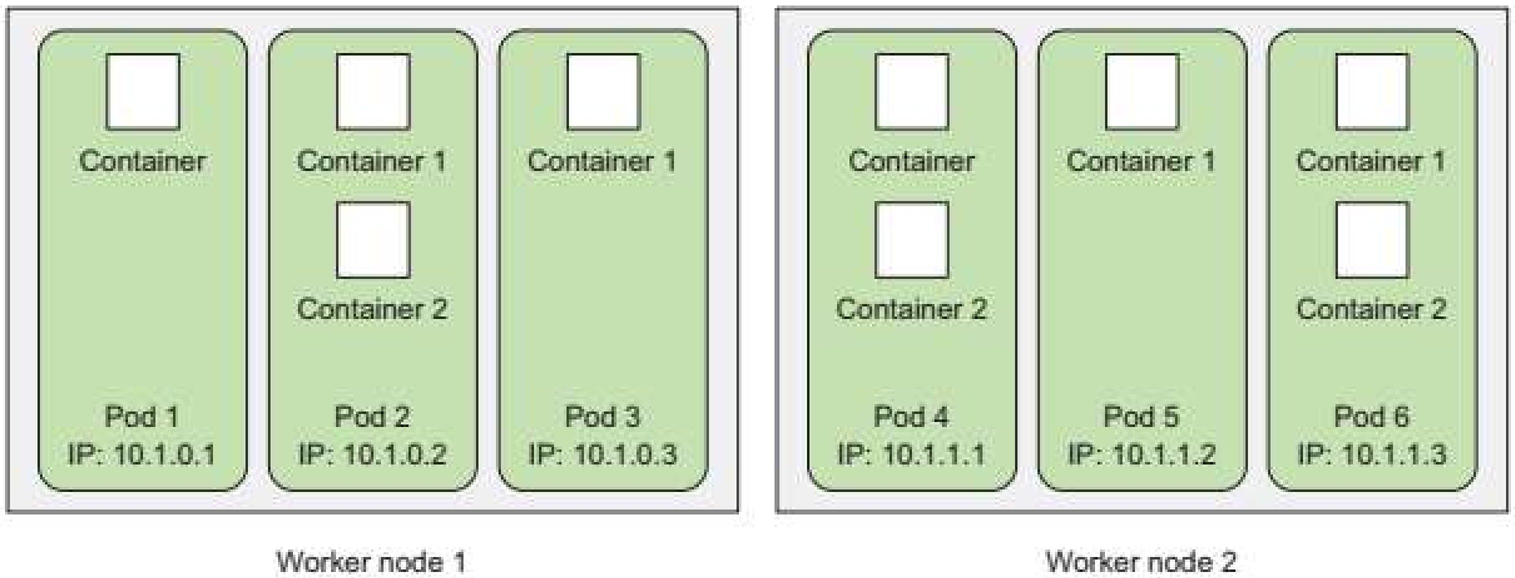


Figure 2.5 The relationship between containers, pods, and physical worker nodes

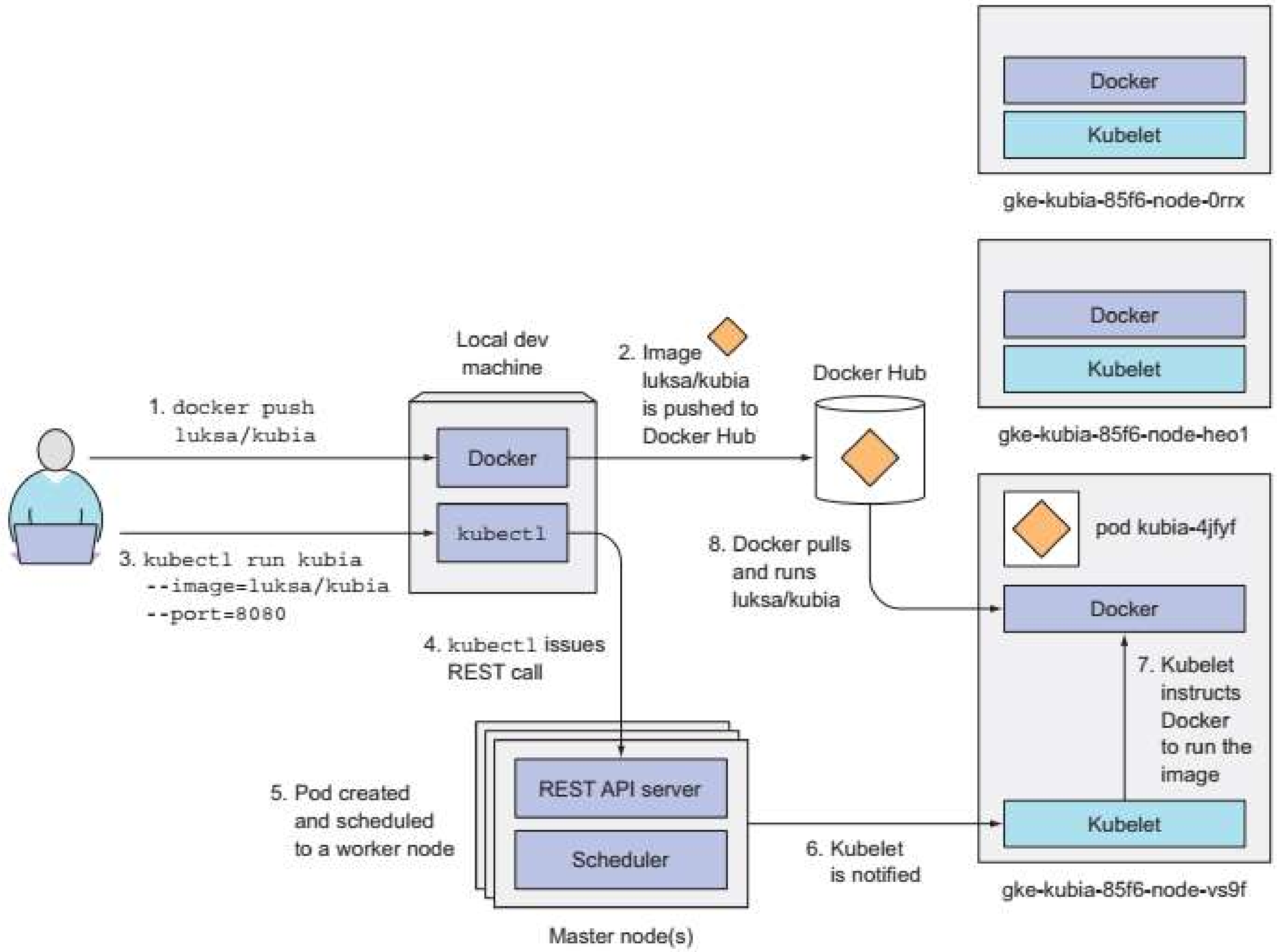


Figure 2.6 Running the `luksa/kubia` container image in Kubernetes

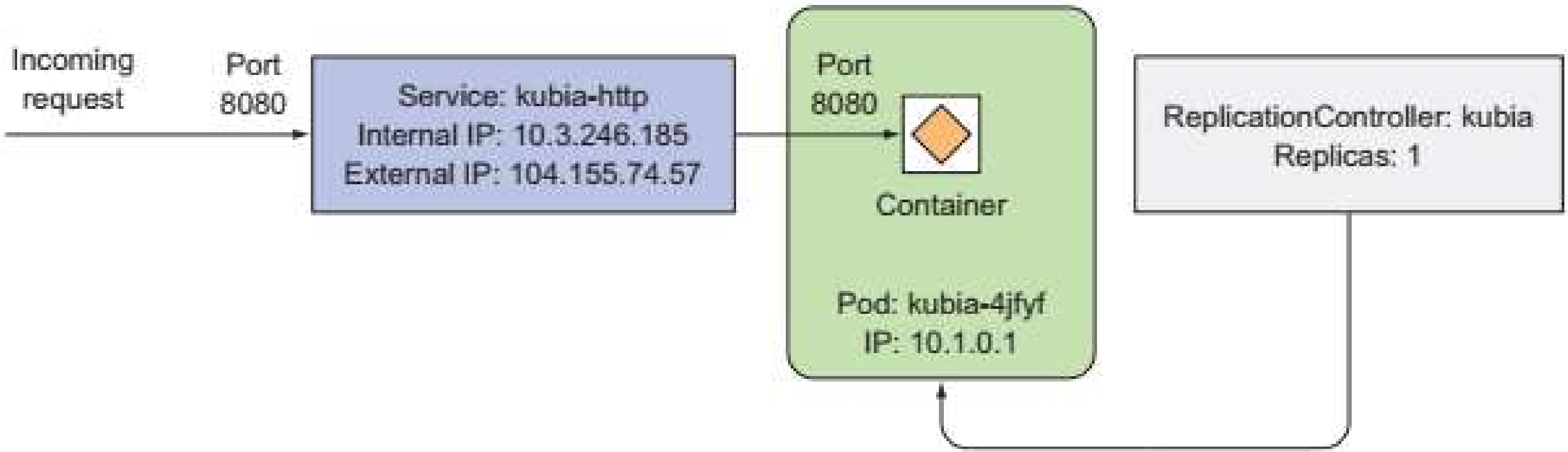


Figure 2.7 Your system consists of a ReplicationController, a Pod, and a Service.

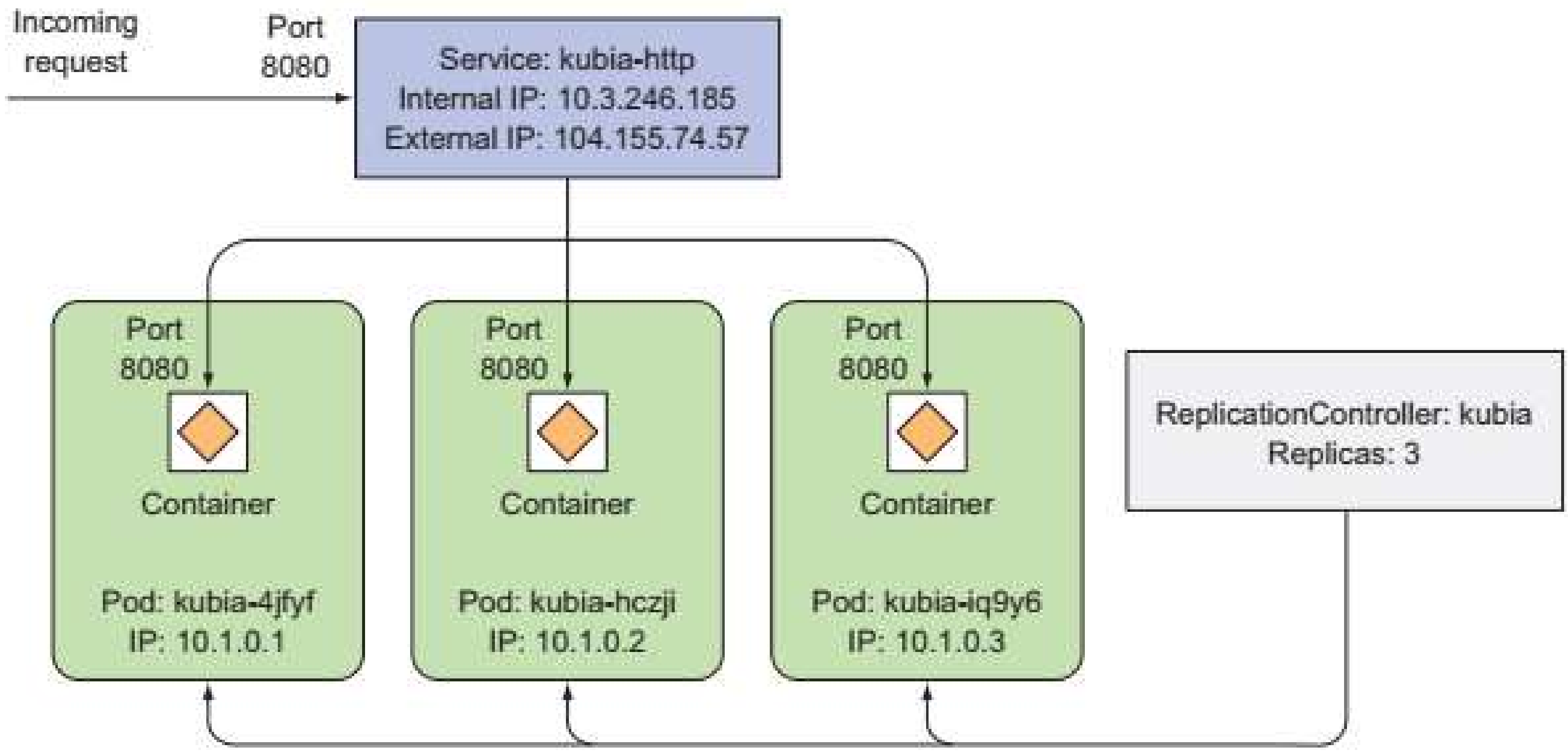


Figure 2.8 Three instances of a pod managed by the same ReplicationController and exposed through a single service IP and port.

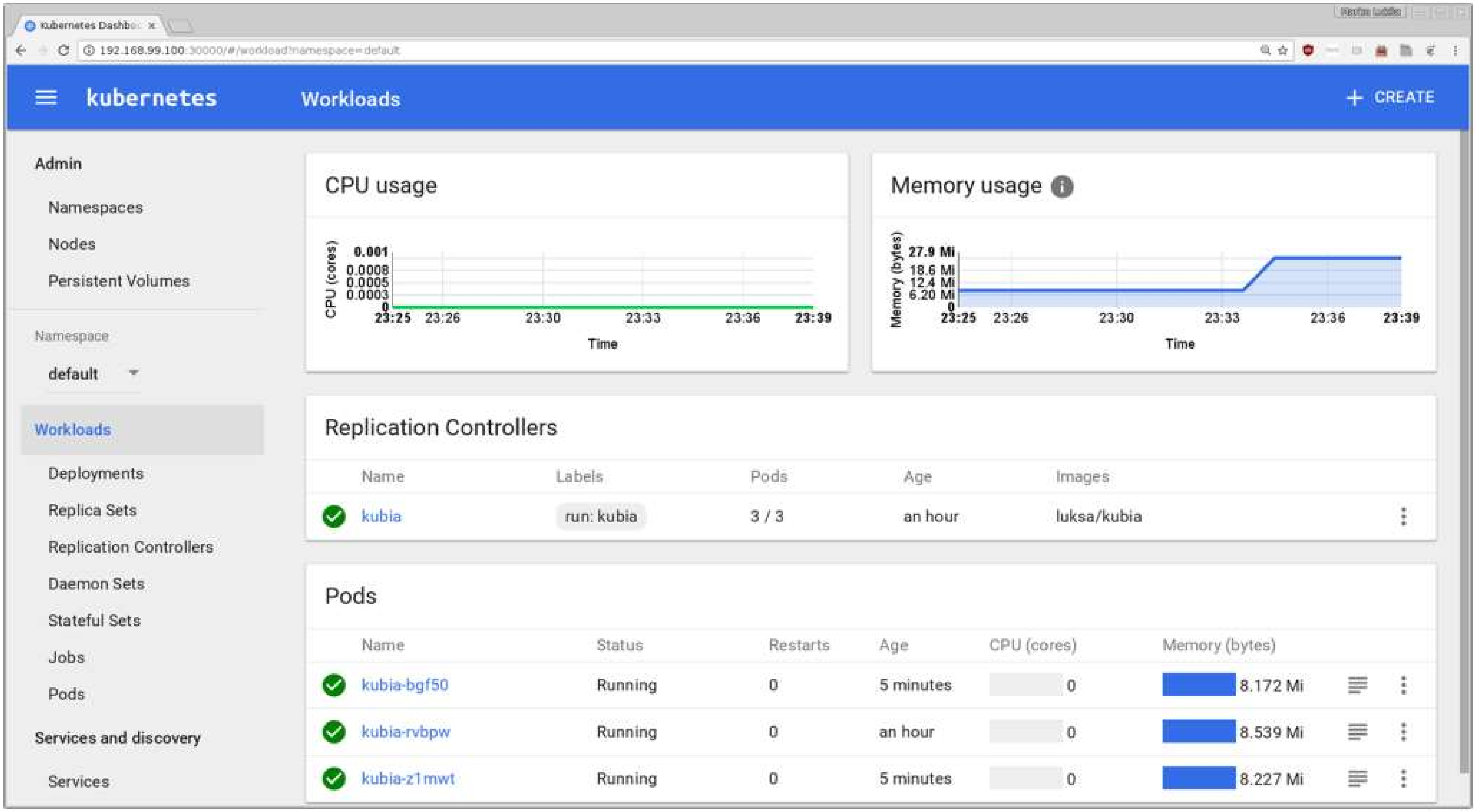


Figure 2.9 Screenshot of the Kubernetes web-based dashboard

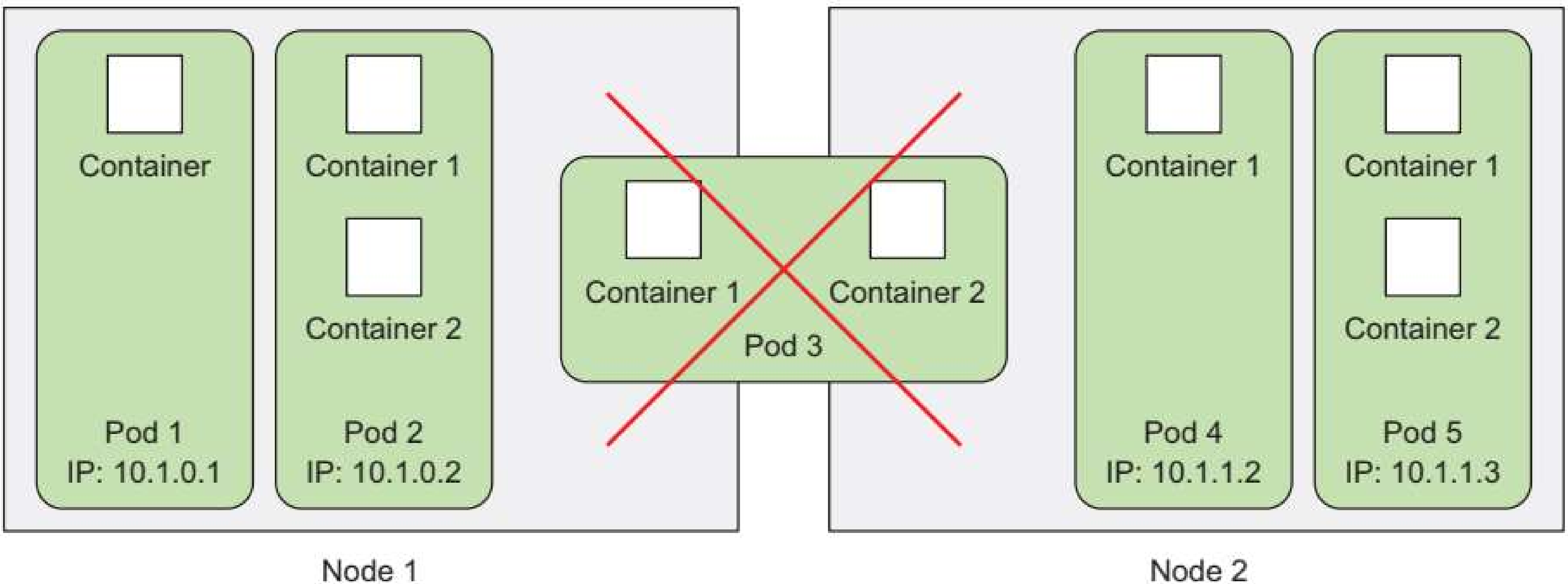


Figure 3.1 All containers of a pod run on the same node. A pod never spans two nodes.

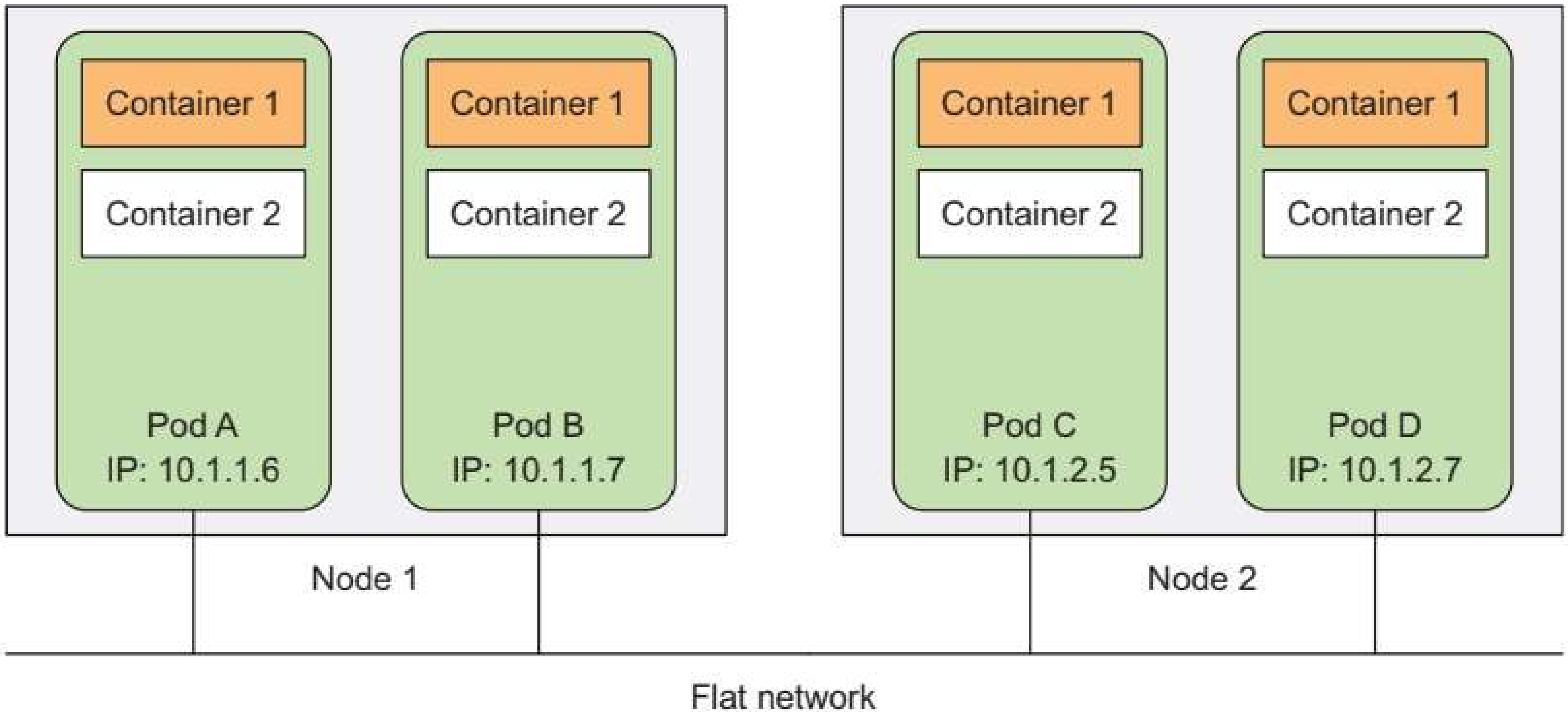


Figure 3.2 Each pod gets a routable IP address and all other pods see the pod under that IP address.

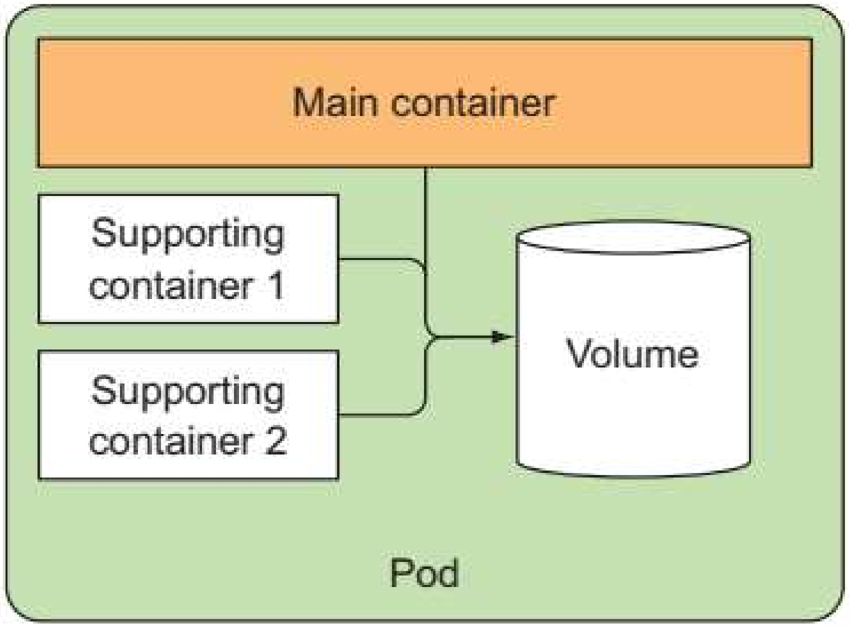
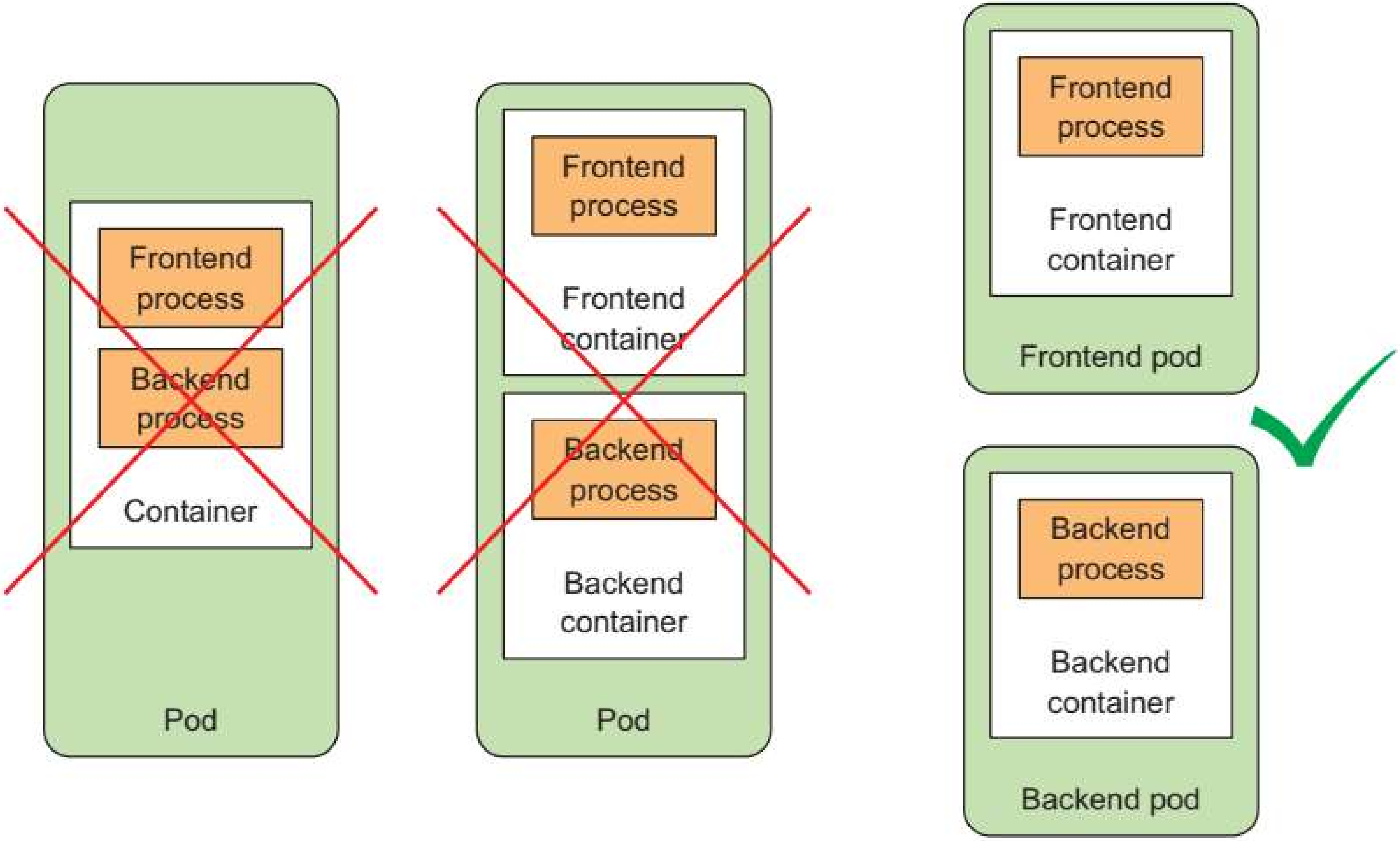


Figure 3.3 Pods should contain tightly coupled containers, usually a main container and containers that support the main one.


Frontend
process
Backend
process
Container
Pod
Frontend
process
Frontend
container
Backend
process
Backend
container
Pod
Frontend
process
Frontend
container
Frontend pod
Backend
process
Backend
container
Backend pod

Listing 3.2 A basic pod manifest: kubia-manual.yaml

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: kubia-manual
spec:
  containers:
  - image: luksa/kubia
    name: kubia
    ports:
    - containerPort: 8080
      protocol: TCP
```

Descriptor conforms to version v1 of Kubernetes API

You're describing a pod.

The name of the pod

Container image to create the container from

Name of the container

The port the app is listening on

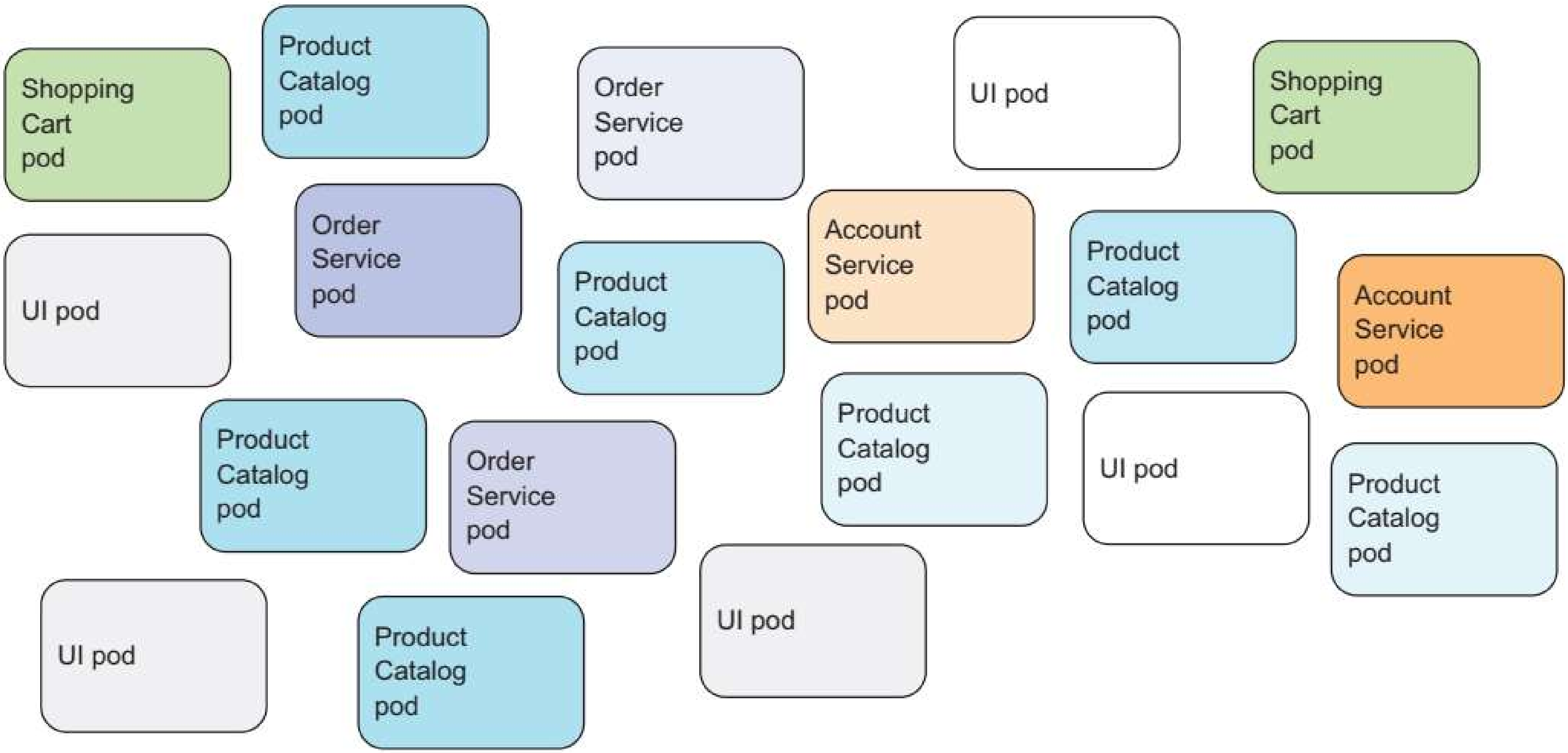


Figure 3.6 Uncategorized pods in a microservices architecture

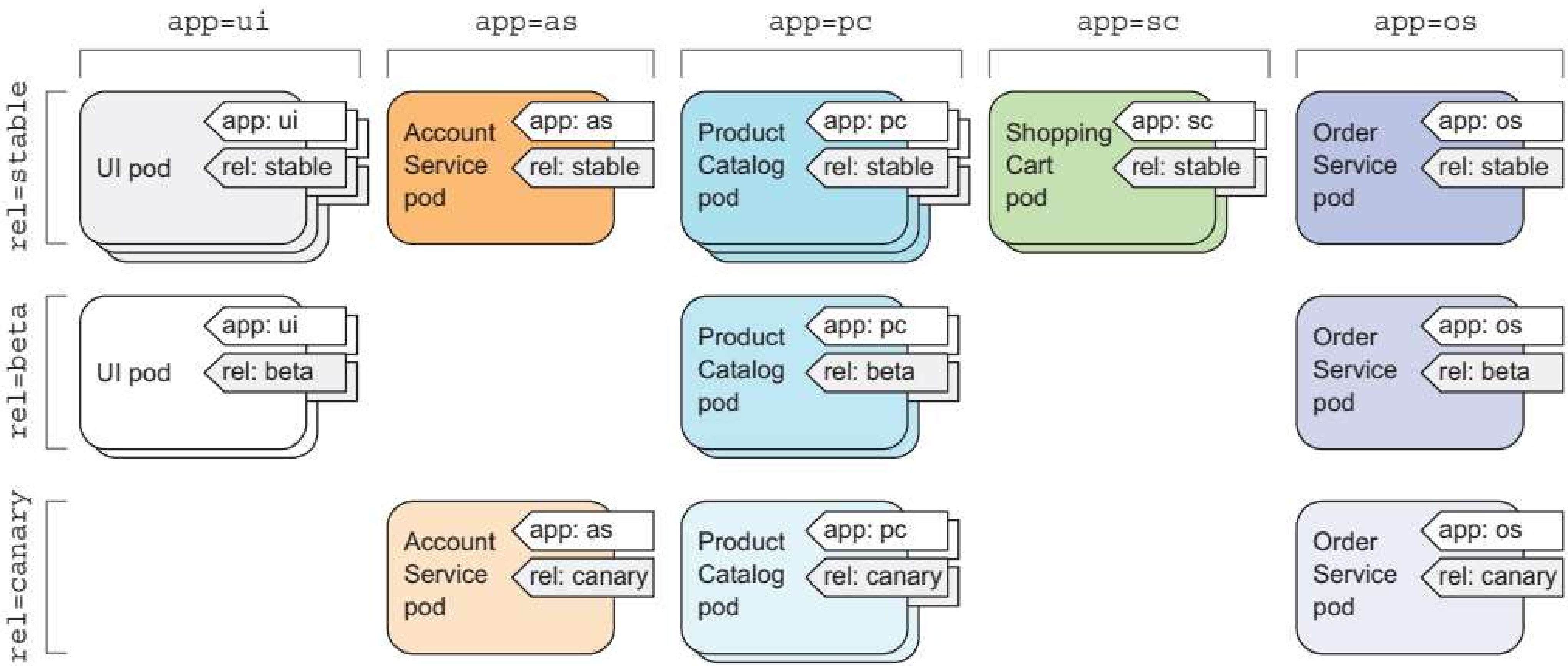


Figure 3.7 Organizing pods in a microservices architecture with pod labels

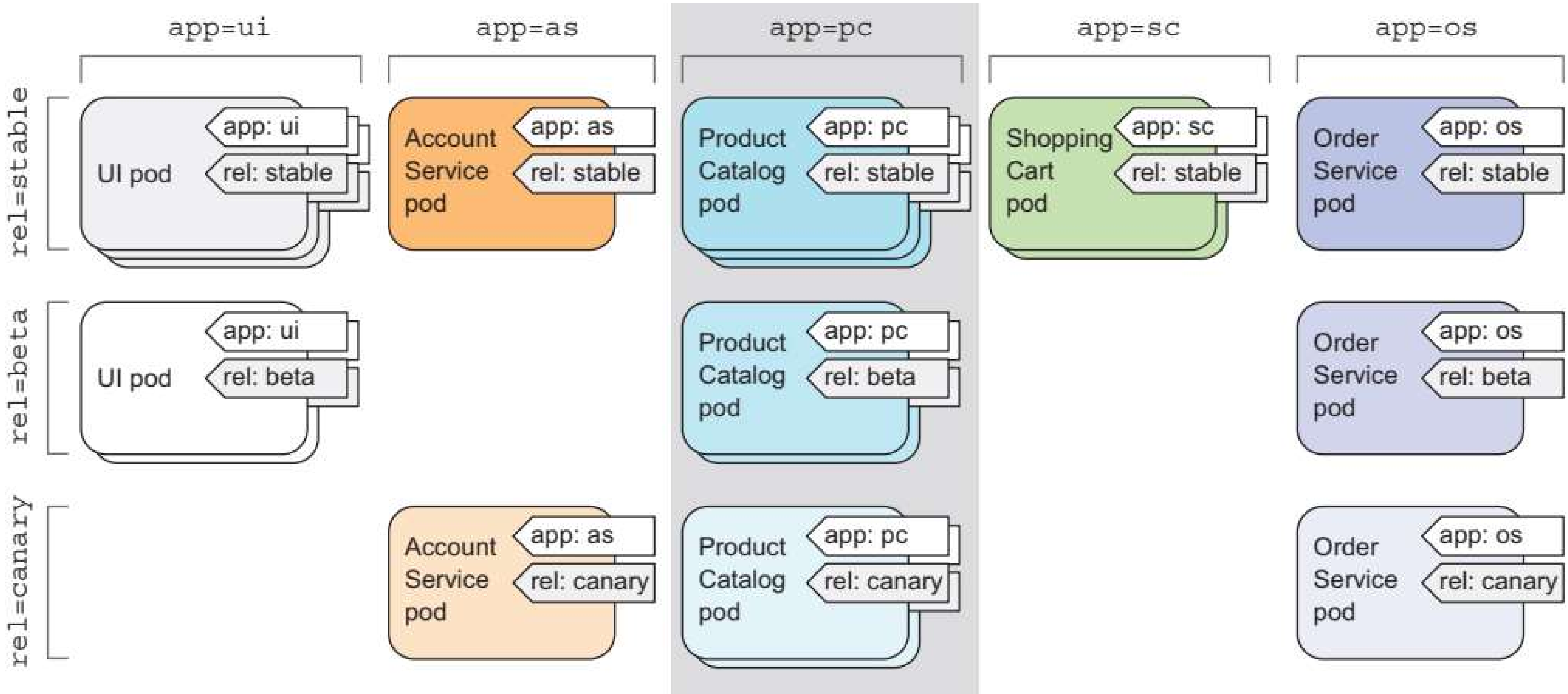


Figure 3.8 Selecting the product catalog microservice pods using the “app=pc” label selector

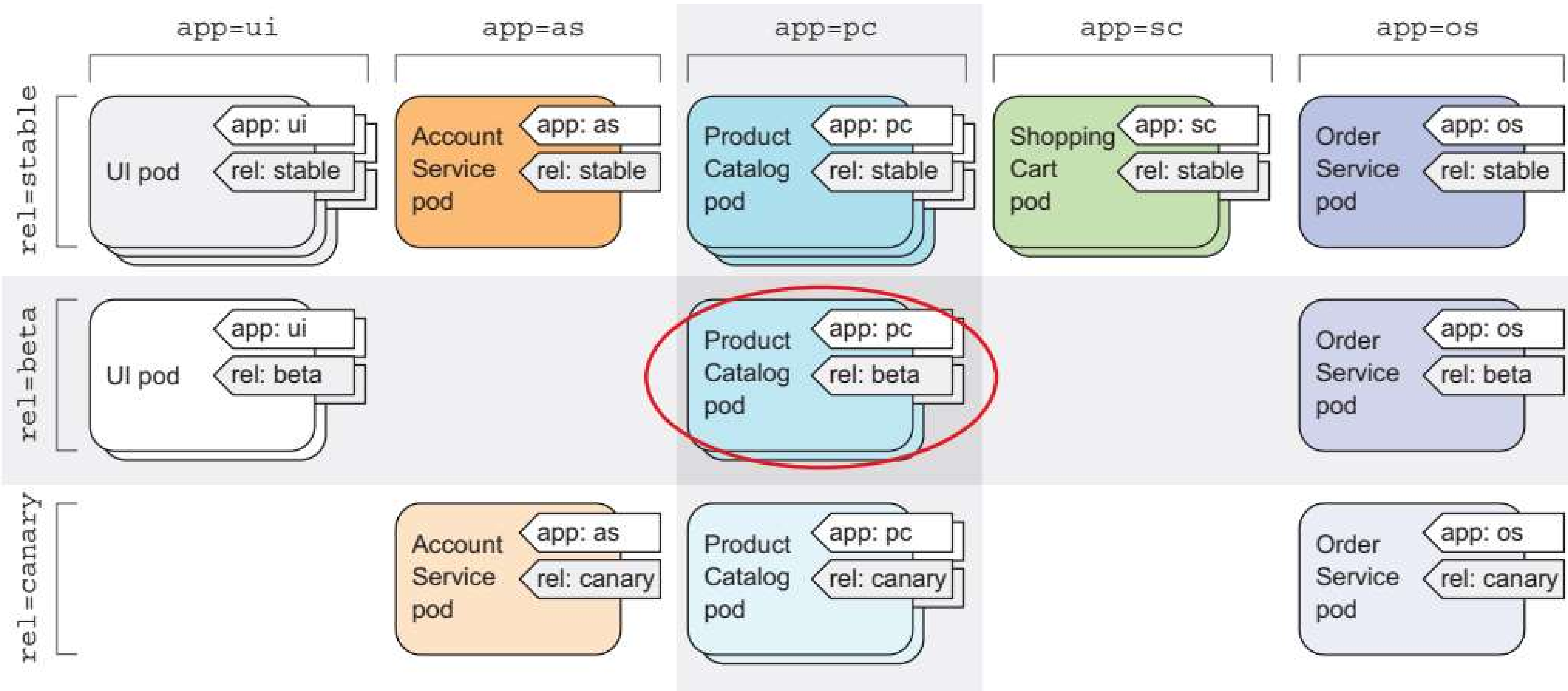


Figure 3.9 Selecting pods with multiple label selectors

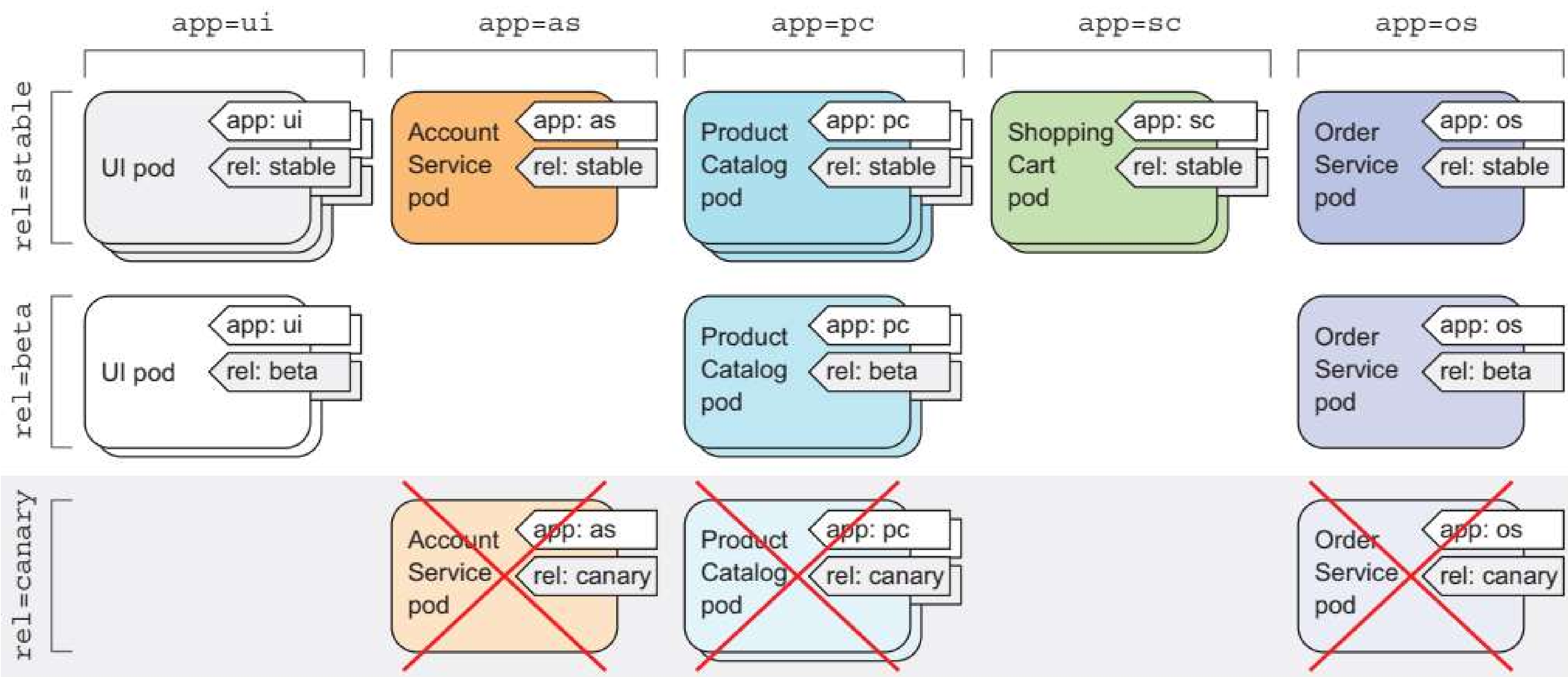


Figure 3.10 Selecting and deleting all canary pods through the `rel=canary` label selector

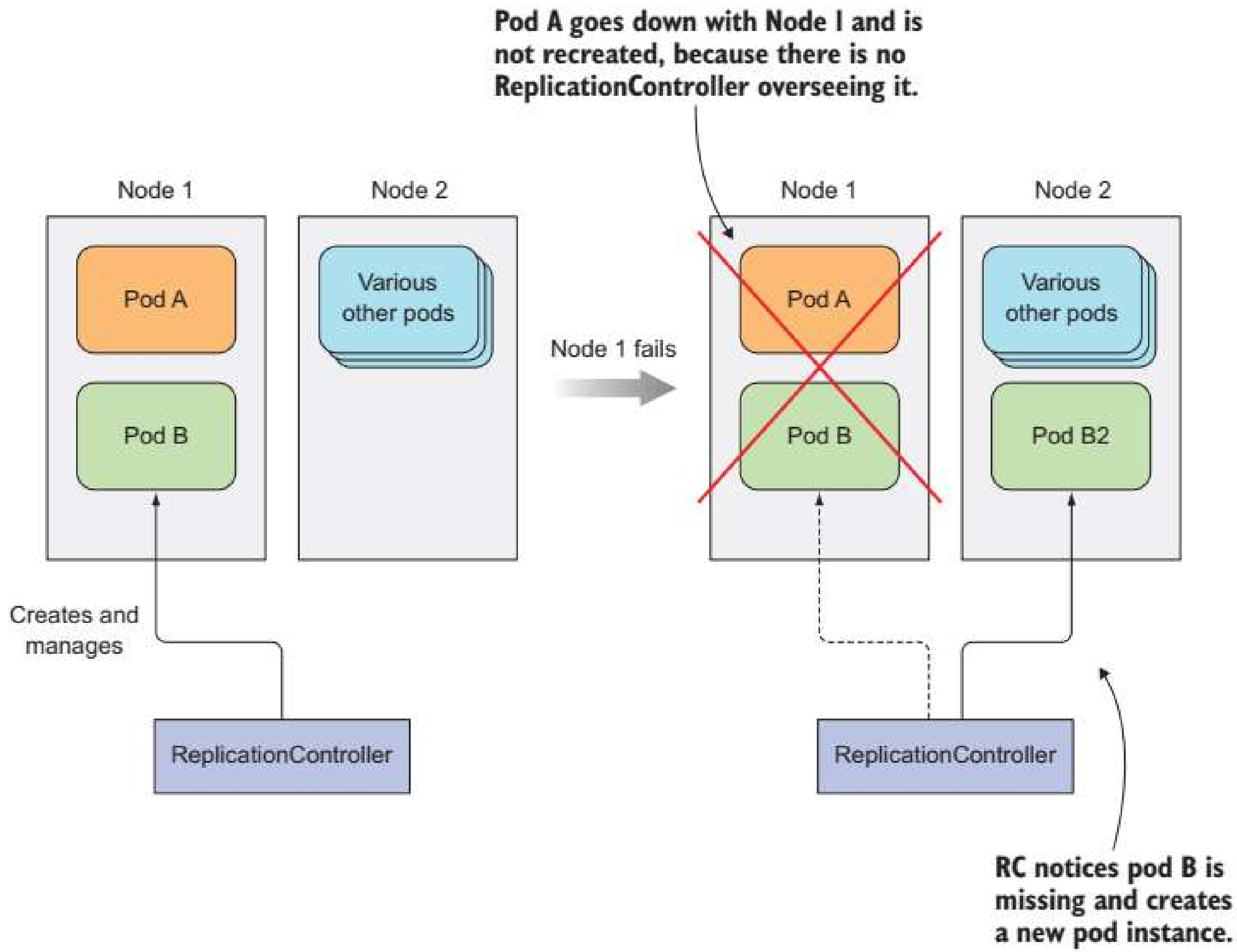


Figure 4.1 When a node fails, only pods backed by a ReplicationController are recreated.

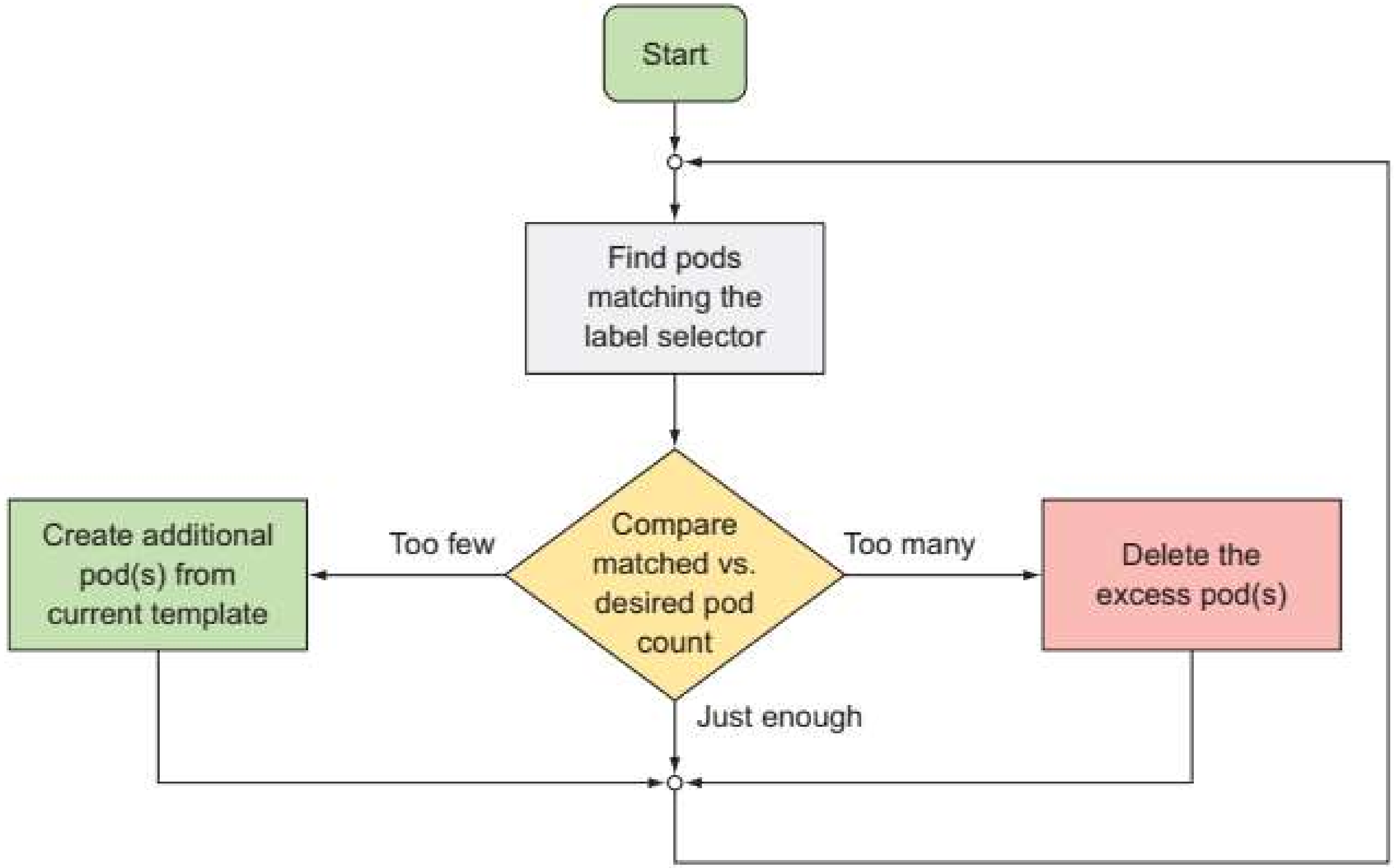


Figure 4.2 A ReplicationController's reconciliation loop

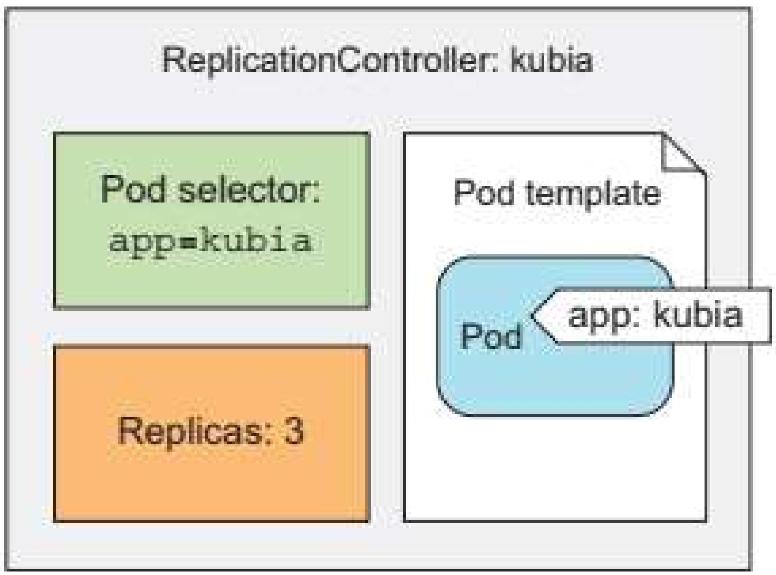


Figure 4.3 The three key parts of a ReplicationController (pod selector, replica count, and pod template)

Listing 4.4 A YAML definition of a ReplicationController: kubia-rc.yaml

```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: kubia
spec:
  replicas: 3
  selector:
    app: kubia
  template:
    metadata:
      labels:
        app: kubia
    spec:
      containers:
      - name: kubia
        image: luksa/kubia
        ports:
        - containerPort: 8080
```

- This manifest defines a ReplicationController (RC)
- The name of this ReplicationController
- The desired number of pod instances
- The pod selector determining what pods the RC is operating on
- The pod template for creating new pods

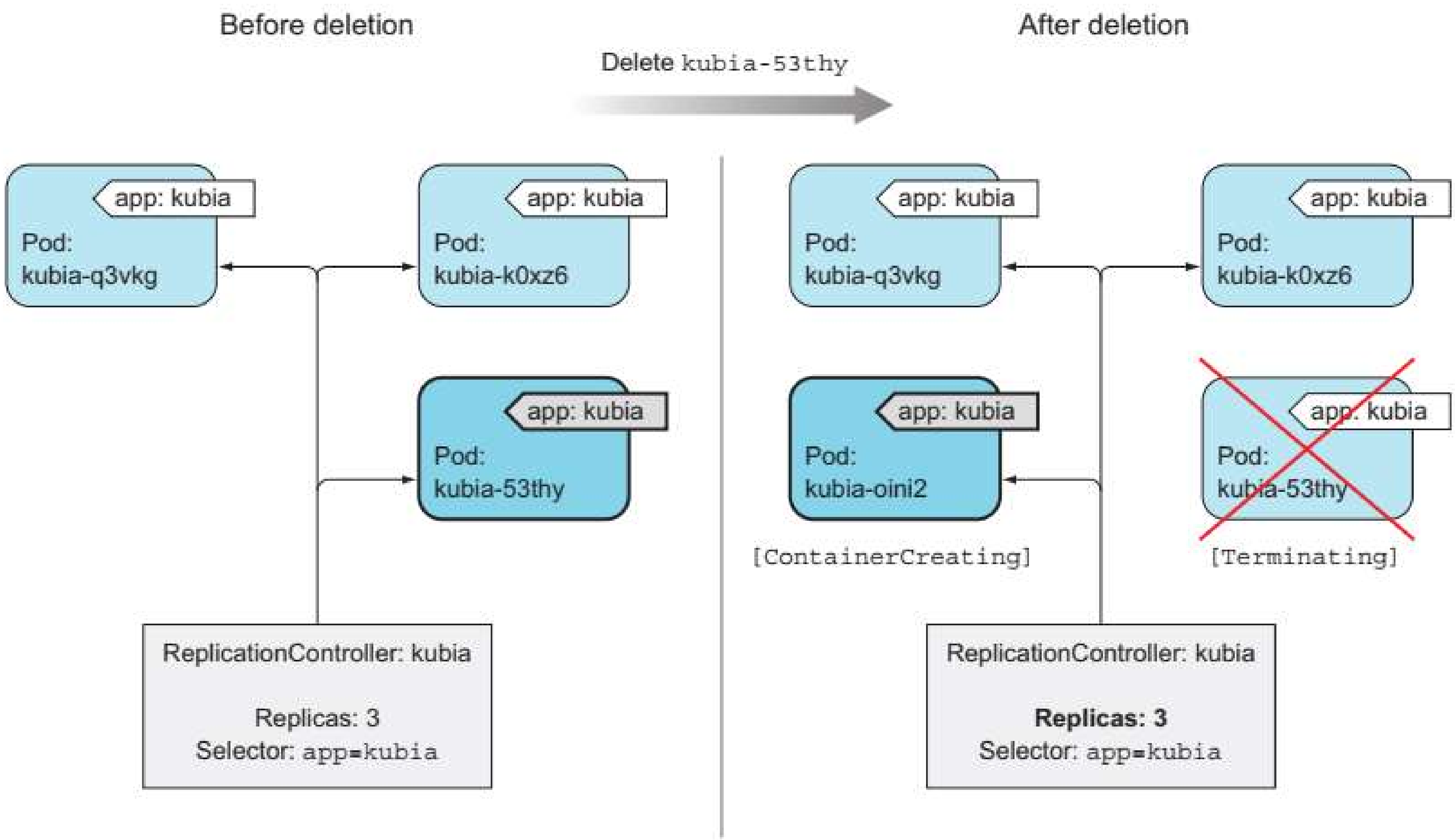


Figure 4.4 If a pod disappears, the ReplicationController sees too few pods and creates a new replacement pod.

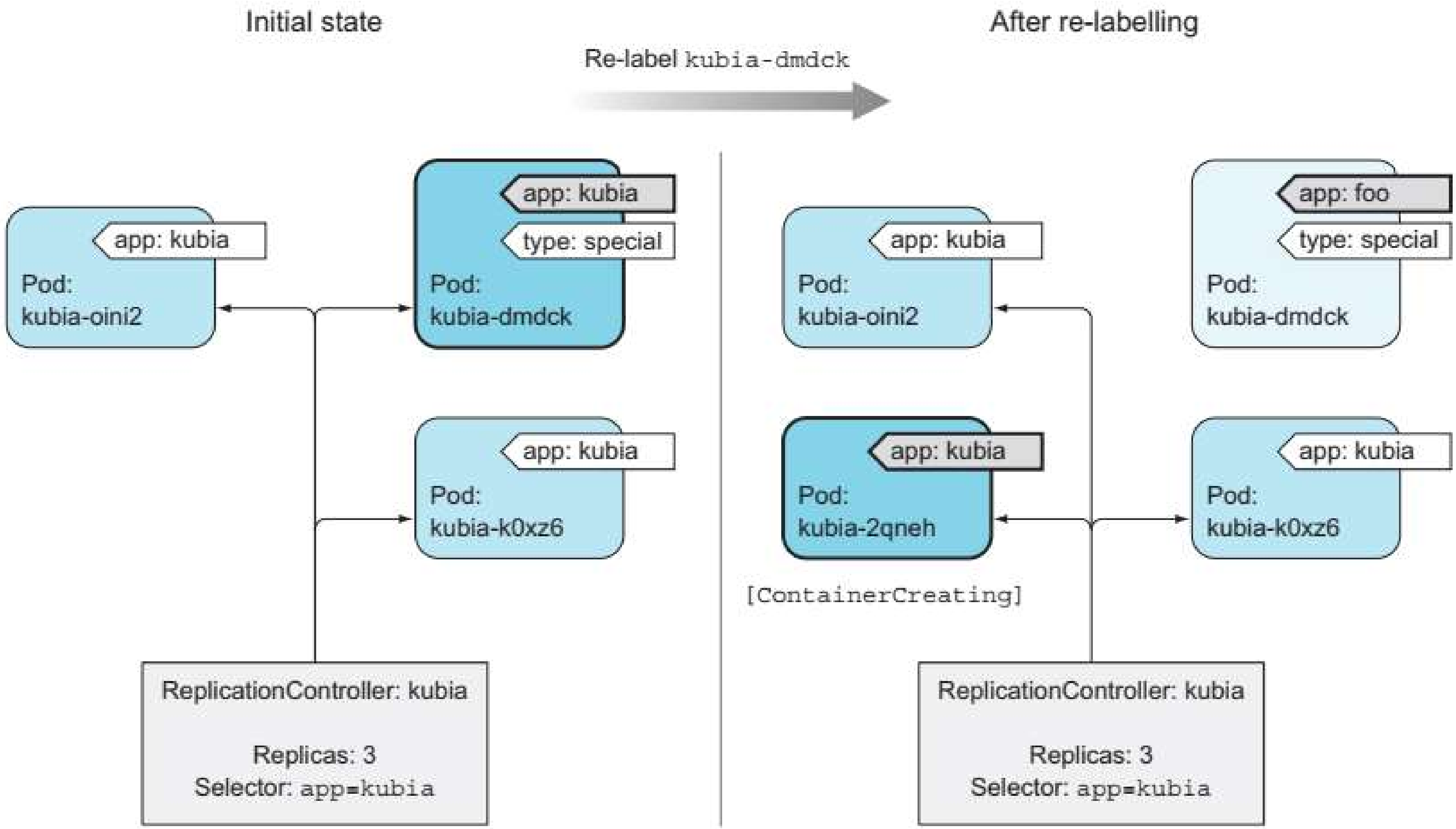


Figure 4.5 Removing a pod from the scope of a ReplicationController by changing its labels

Services

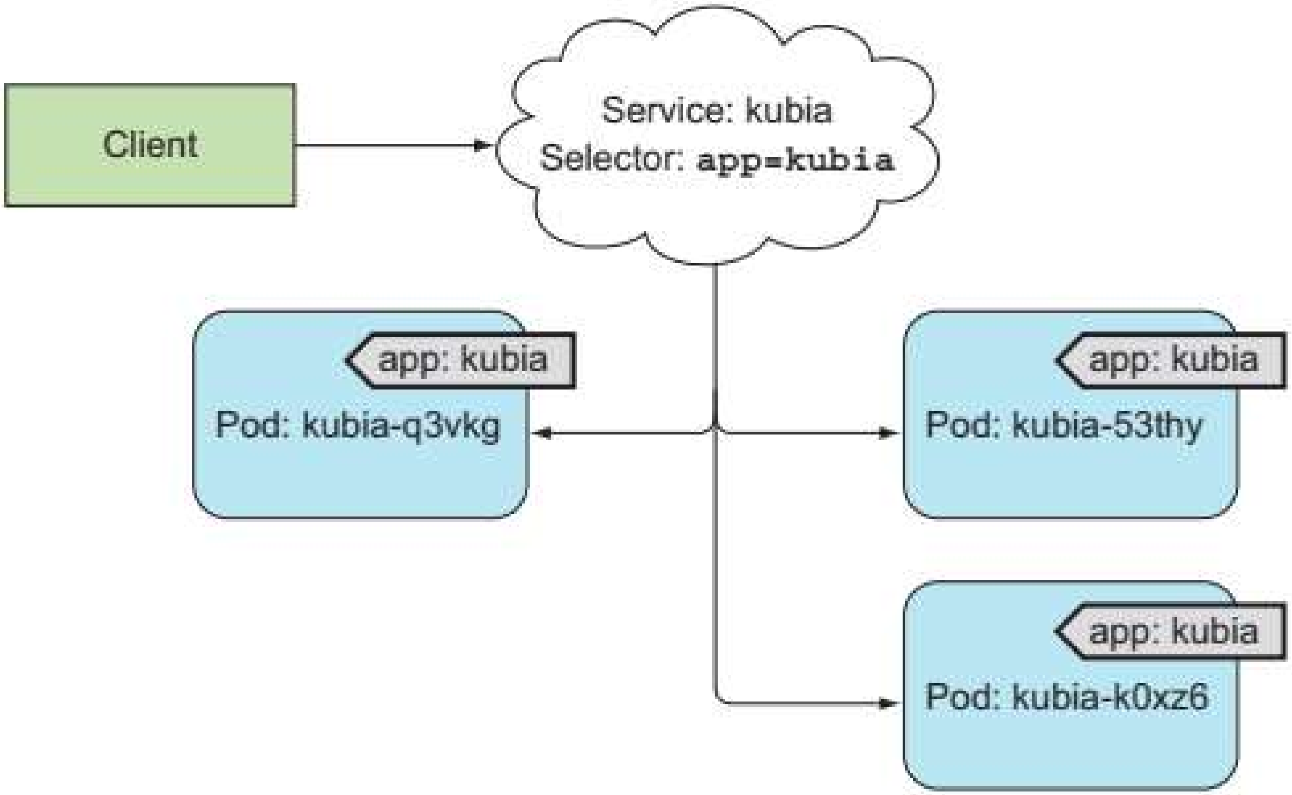


Figure 5.2 Label selectors determine which pods belong to the Service.

Listing 5.1 A definition of a service: kubia-svc.yaml

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

The port this service will be available on

The container port the service will forward to

All pods with the app=kubia label will be part of this service.

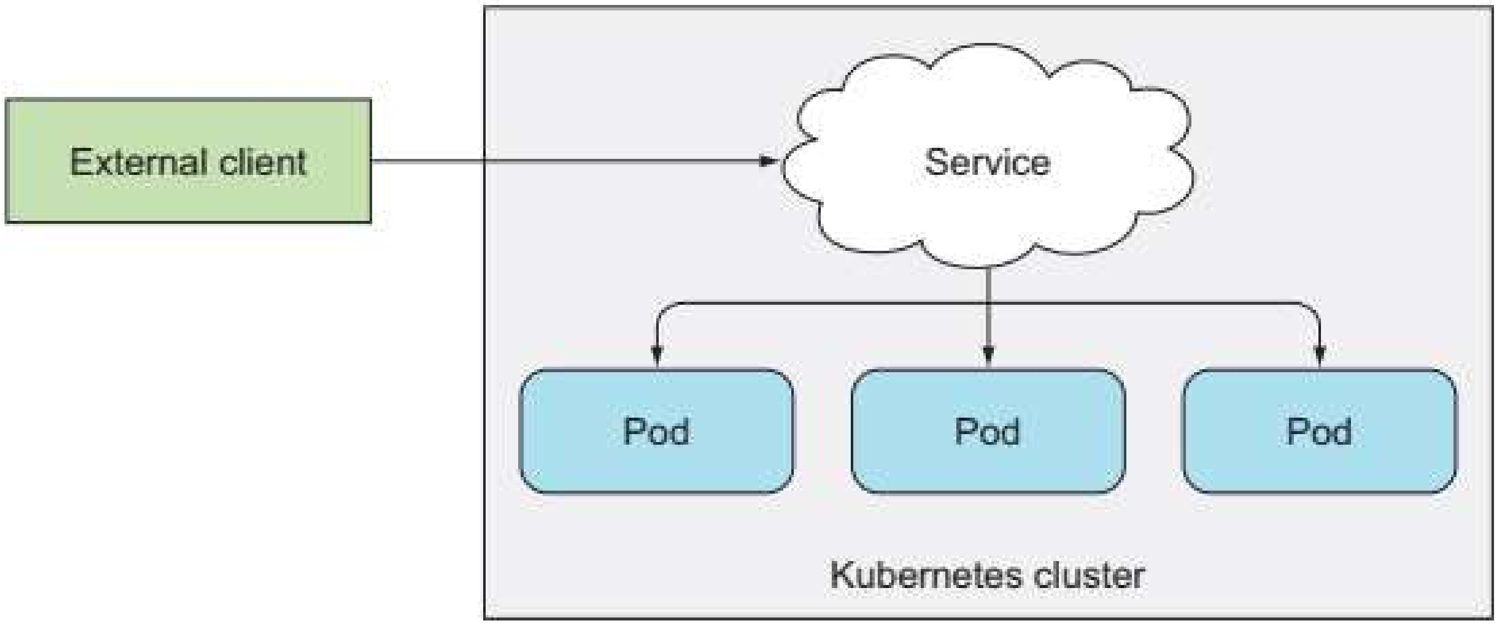
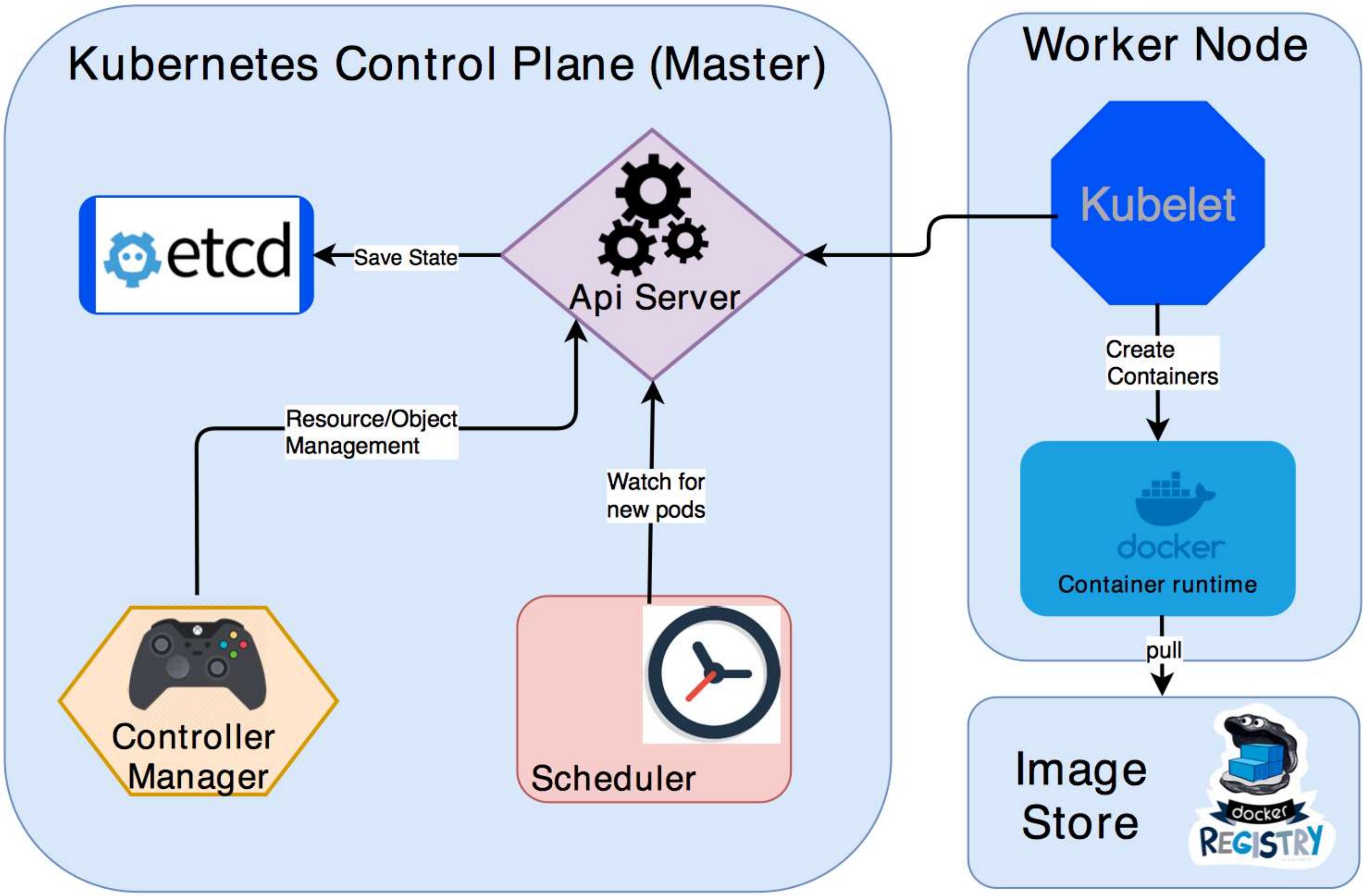


Figure 5.5 Exposing a service to external clients

Kubernetes Architecture



Kubernetes Architecture

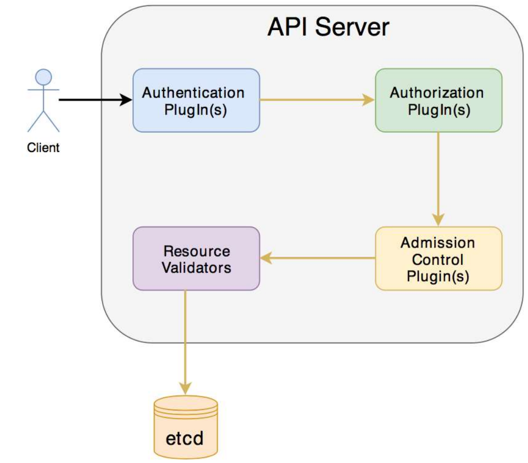
- A Kubernetes cluster consists of two main components:
    - Master (Control Plane)
    - Worker Nodes.
- Master has following components. These components are responsible for maintaining the state of the cluster:
    - etcd distributed key value store.
    - API Server.
    - Controller Manager
    - Scheduler
- Every worker node consists of the following components.
- These components are responsible for deploying and running the application containers.
    - Kubelet
    - Container Runtime (Docker)

Master Components

- etcd:
  - Stores the cluster status and metadata.
  - A distributed key value store
  - Provides reliable way of storing data across a cluster of machines.
  - API Server directly talk to etcd store.
  - K8s stores all its data under /registry directory in etcd.
- Api Server:
  - The central place for all other components.
  - Api Server will take care about validating the object before saving the information to etcd.
  - The client for the Api Server can be either kubectl (command line tool) or a Rest Api client.

Master Components

- Api Server:
  - Several plugin's are invoked by Api Server before creating/deleting/updating the object in etcd.
- Scheduler:
  - Allocate what node the pods needs to be created
- Controller Manager:
  - Make sure the actual state of the system converges towards the desired state.
  - Watch the API Server for changes to resources/objects and perform necessary actions like create/update/delete of the resource.



Worker Node components

- Kubelet
  - The agent that runs on each node in the cluster.
  - Monitors the Api Server for Pods
  - Start the pod's containers by instructing to docker runtime.
  - Monitors the status of running containers and reports to api server
  - Also do health checks for the container and restart if needed.
- Docker
  - Container runtime used by Kubelet for spinning up Containers

Other components

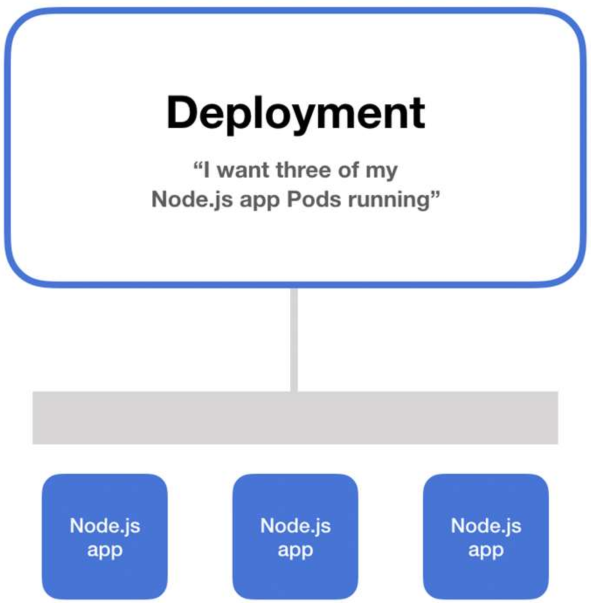
- Nodes:
  - Machine on which Kubernetes is installed.
  - This is where containers inside the pods will be launched by Kubernetes.
- Master Node:
  - Responsible for managing the cluster
  - A Kubernetes cluster also contains one or more master nodes that run the Kubernetes control plane
- Pod
  - Smallest deployable unit that can be managed by Kubernetes.
  - A logical group of one or more containers that share the same IP address

Kubernetes namespaces

- Provide for a scope of Kubernetes resource, carving up your cluster in smaller units
  - $ kubectl get ns
  - $ kubectl describe ns default
  - $kubectl create namespace test

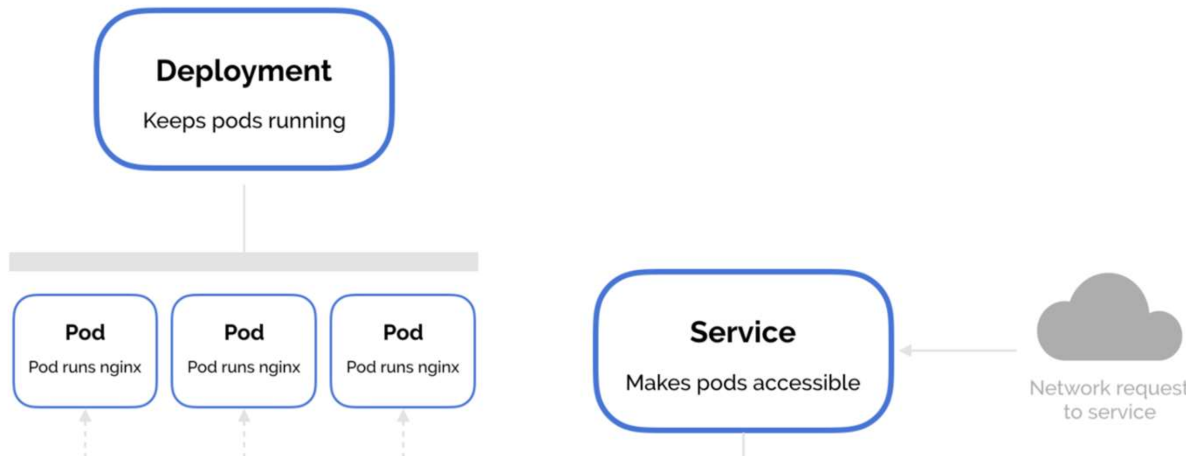
Kubernetes deployment

- Everyone running applications on Kubernetes cluster uses a deployment.
- It's what you use to scale, roll out, and roll back versions of your applications.
- With a deployment, you tell Kubernetes how many copies of a Pod you want running. The deployment takes care of everything else.



Deployment vs service

- A deployment is used to keep a set of pods running by creating pods from a template.
- A service is used to allow network access to a set of pods.
- To access a Deployment with one or many PODs, you need a Kubernetes Service endpoint mapped to the deployment using labels and selectors.



Installation - Online

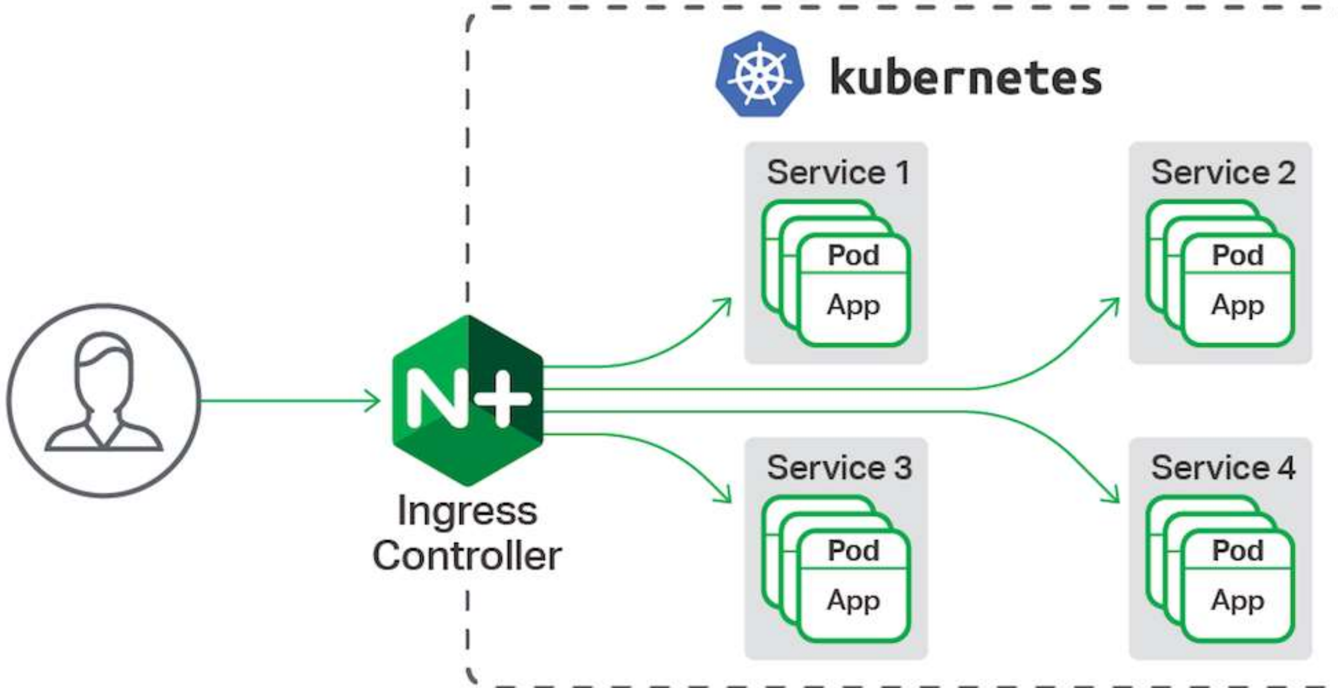
- https://labs.play-with-k8s.com

Service and Ingress

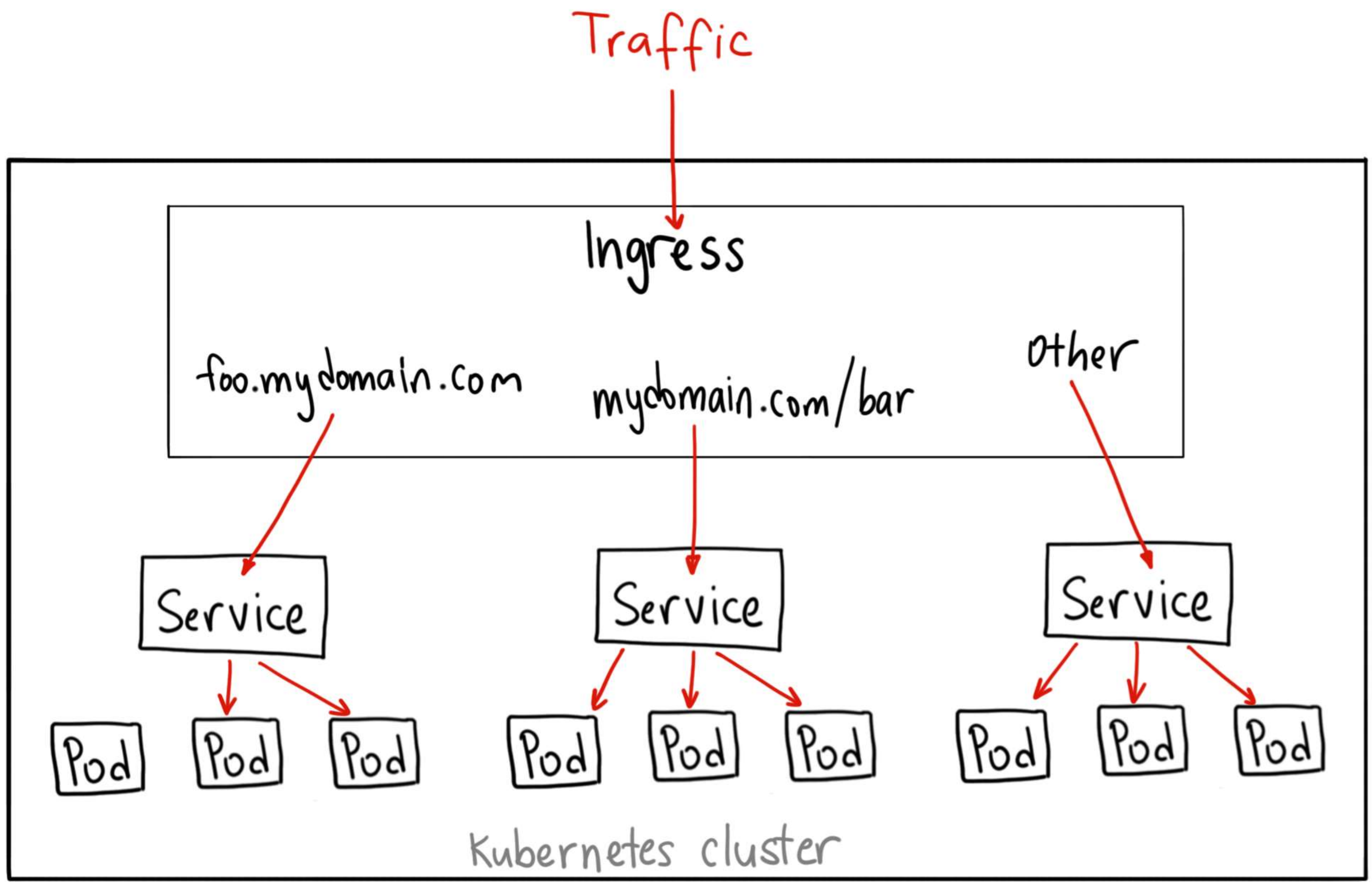
- To consume your deployment, you will need to create ingress rules that expose your deployment to the external world.
- Kubernetes Ingress is a resource to add rules for routing traffic from external sources to the services in the kubernetes cluster
- To configure ingress rules in your Kubernetes cluster, first, you will need an ingress controller.
- We will create NGINX ingress controller.
    - kubectl apply -f https://raw.githubusercontent.com/kubernetes/ingress-nginx/master/deploy/static/mandatory.yaml
    - kubectl apply -f https://raw.githubusercontent.com/kubernetes/ingress-nginx/master/deploy/static/provider/cloud-generic.yaml

Service and Ingress

- To confirm:
  - kubectl get pods -n ingress-nginx



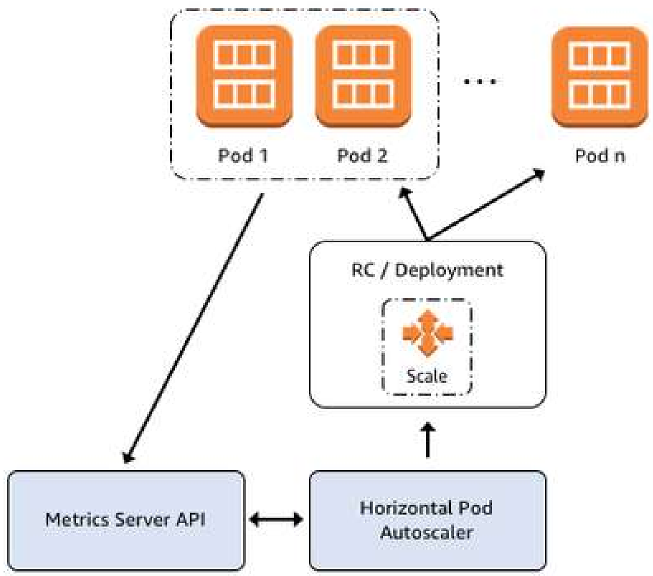
Service and Ingress

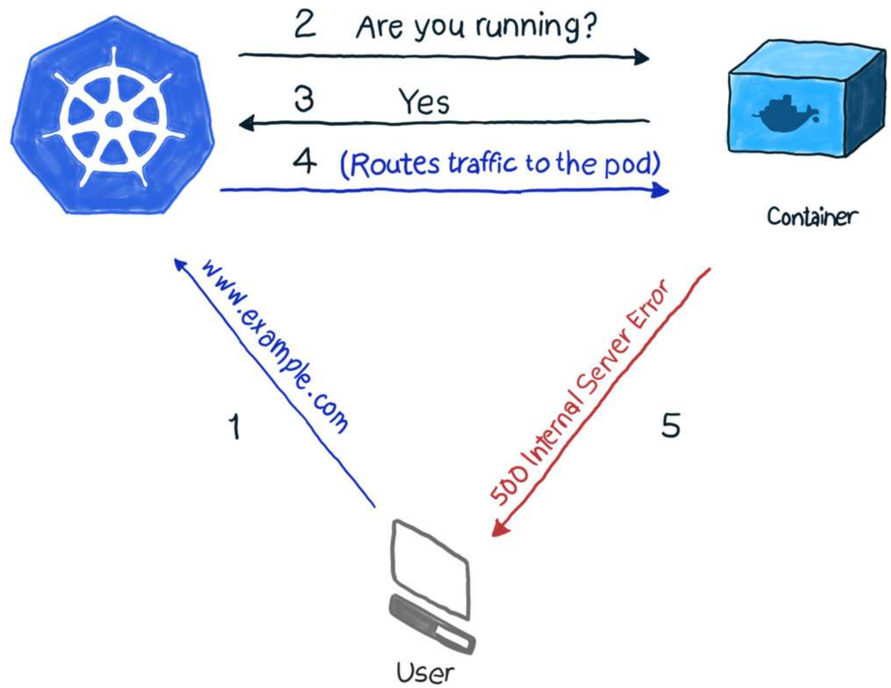


Scaling Kubernetes

- Cluster scaling, sometimes called infrastructure-level scaling,
  - Refers to the (automated) process of adding or removing worker nodes based on cluster Utilization
- Application-level scaling, sometimes called pod scaling,
  - Refers to the (automated) process of manipulating pod characteristics based on a variety of metrics
    - CPU utilization
    - HTTP requests served per second etc
  - Two kinds of podlevel scalers exist
    - Horizontal Pod Autoscalers (HPAs), which increase or decrease the number of pod replicas depending on certain metrics.
    - Vertical Pod Autoscalers (VPAs), which increase or decrease the resource requirements of containers running in a pod.

Scaling Kubernetes




2 Are you running?
3 Yes
4 (Routes traffic to the pod)
Container
www.example.com
1
500 Internal Server Error
5
User

Thanks