Getting Started with Kubernetes

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Couchbase

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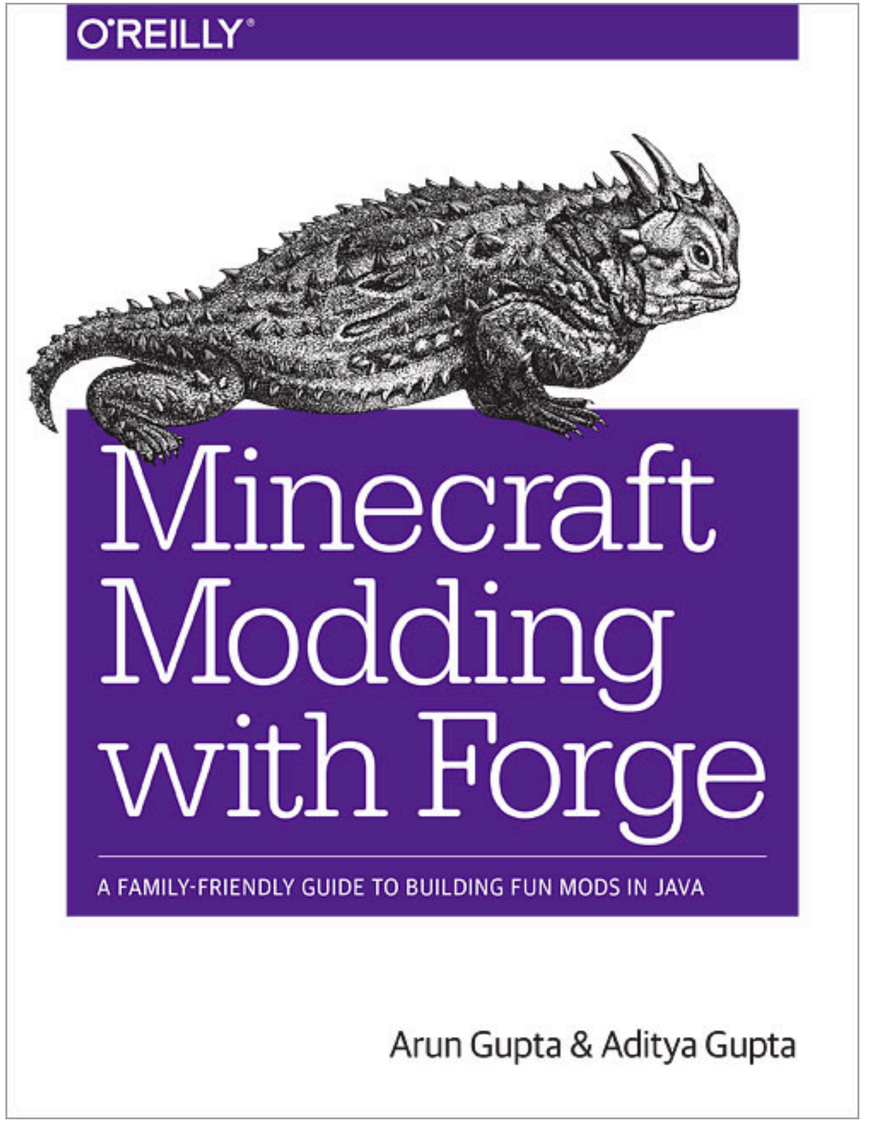

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Kubernetes

BY ARUN GUPTA

WHAT IS KUBERNETES?

Kubernetes (kubernetes.io) is an open-source orchestration system for managing containerized applications across multiple hosts, providing basic mechanisms for the deployment, maintenance, and scaling of applications.

Kubernetes, or "k8s" or "kube" for short, allows the user to declaratively specify the desired state of a cluster using high-level primitives. For example, the user may specify that they want three instances of the Couchbase server container running. Kubernetes' self-healing mechanisms, such as auto-restarting, re-scheduling, and replicating containers then converge the actual state towards the desired state.

Kubernetes supports Docker and Rocket containers. An abstraction around the containerization layer will allow for other container image formats and runtimes to be supported in the future.

KEY CONCEPTS OF KUBERNETES

POD

A Pod is the smallest deployable unit that can be created, scheduled, and managed. It's a logical collection of containers that belong to an application.

Each resource in Kubernetes is defined using a configuration file. For example, a Couchbase pod can be defined with the following `.yaml` file:

A Replication Controller creating two instances of a Couchbase pod can be defined as:

```
apiVersion: v1
kind: ReplicationController
metadata:
  name: couchbase-controller
spec:
  # Two replicas of the Pod to be created
  replicas: 2
  # Identifies the label key and value on the Pod that
  # this Replication Controller is responsible for
  managing
  selector:
    app: couchbase-rc-pod
  # 'cookie cutter' used for creating new pods when
  necessary
  template:
    metadata:
      labels:
        # label key and value on the pod.
        # These must match the selector above.
        app: couchbase-rc-pod
    spec:
      containers:
      - name: couchbase
        image: couchbase
        ports:
        - containerPort: 8091
```

SERVICE

Each Pod is assigned a unique IP address. If the Pod is inside a Replication Controller, then the pod is recreated but may be given

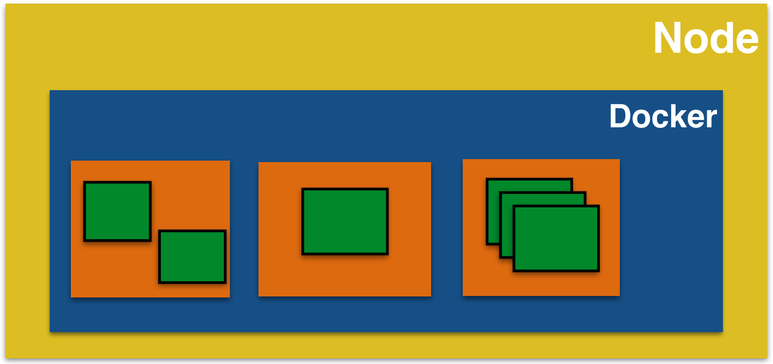
dzone.com/refcardz/kubernetes-essentials

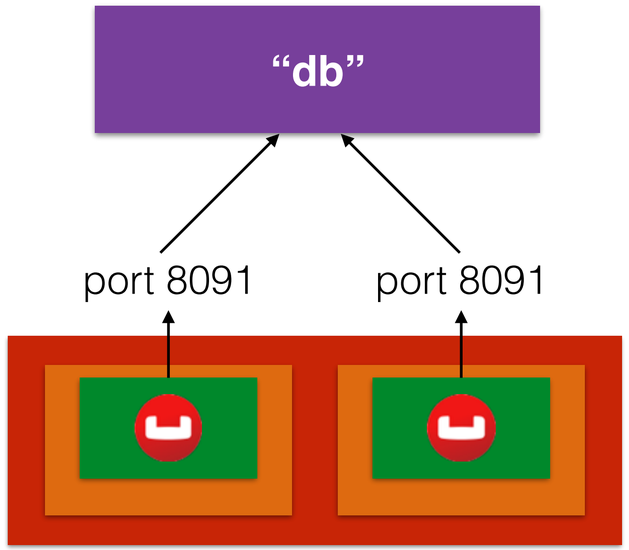
Kubernetes

- Open source orchestration system for Docker containers
- Provide declarative primitives for the “desired state”
  - Self-healing
  - Auto-restarting
  - Schedule across hosts
  - Replicating

Kubernetes Concepts

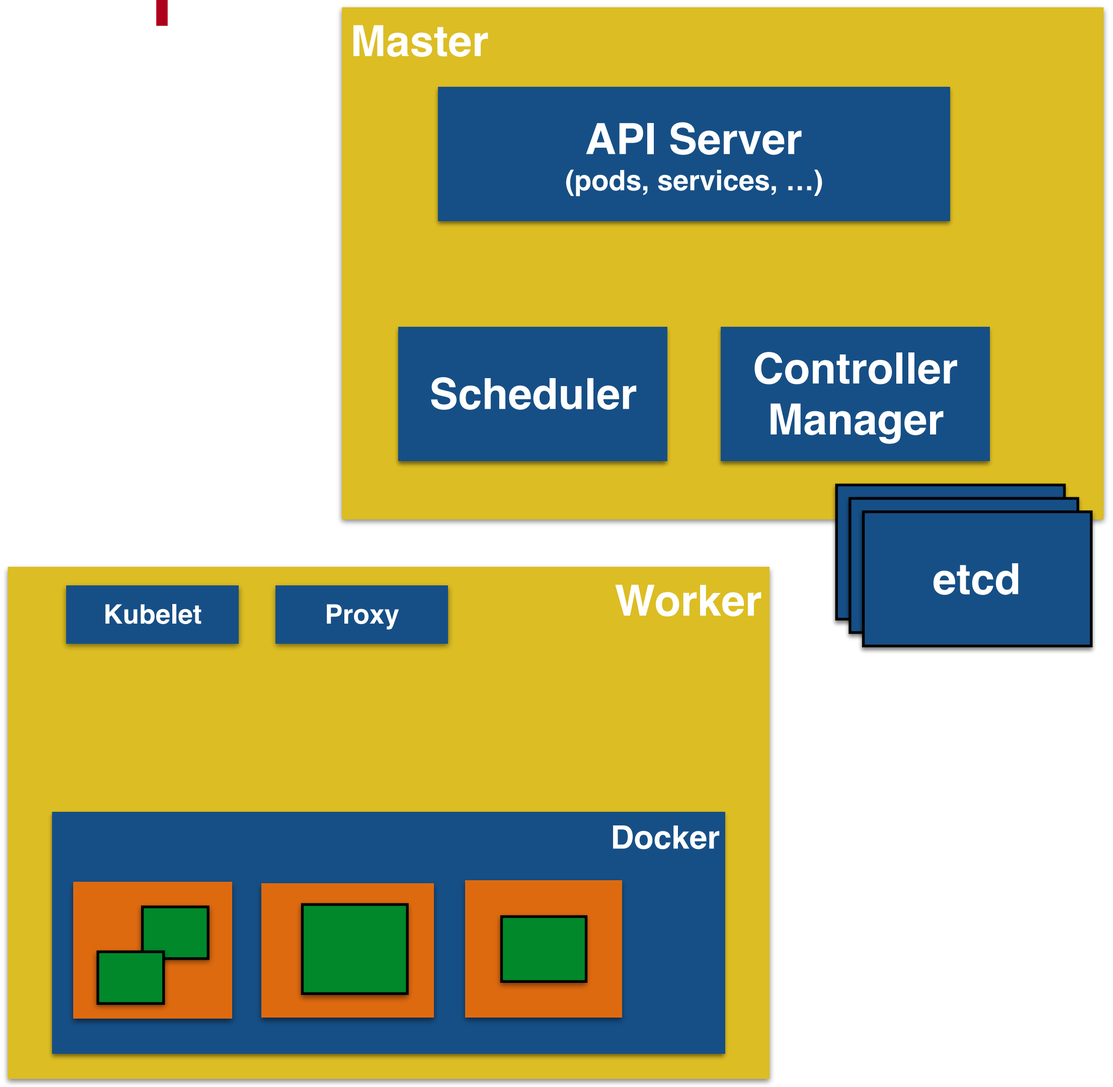
- **Pods**: colocated group of containers that share an IP, namespace, storage volume
- **Replica Set**: manages the lifecycle of pods and ensures specified number are running (next gen Replication Controller)
- **Service**: Single, stable name for a set of pods, also acts as LB
- **Label**: used to organize and select group of objects

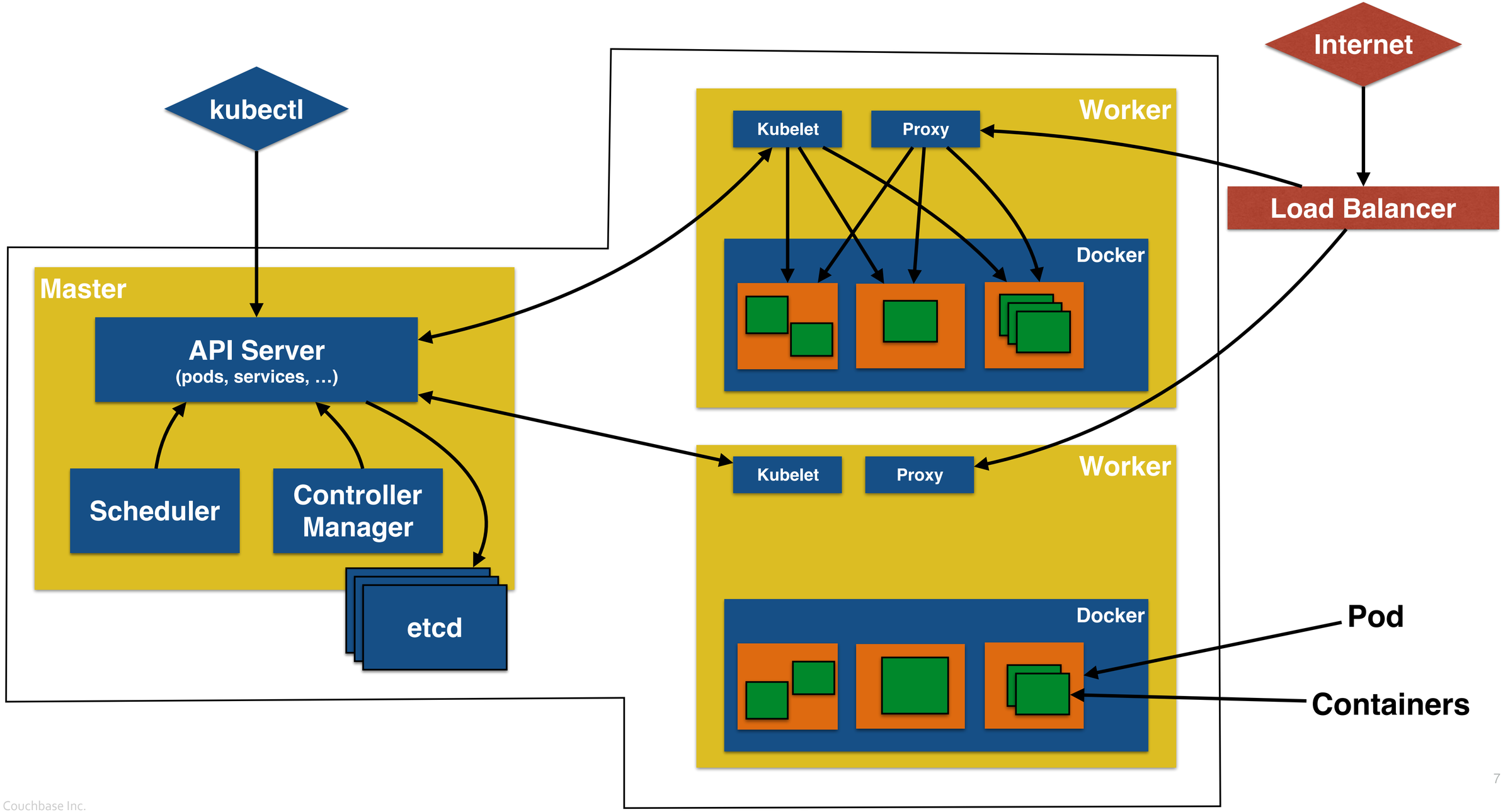




Kubernetes Components

- **Node**: Machine or VM in the cluster
- **Master**: Central control plane, provides unified view of the cluster
  - **etcd**: distributed key-value store used to persist Kubernetes system state
- **Worker**: Docker host running *kubelet* (node agent) and *proxy* services
  - Runs pods and containers
  - Monitored by *systemd* (CentOS) or *monit* (Debian)





kubectl

- Controls the Kubernetes cluster manager
- `kubectl get pods` or `minions`
- `kubectl create -f <filename>`
- `kubectl update` or `delete`
- `kubectl scale –replicas=3 rc/<name>`

Kubernetes Pod Configuration

```
1  apiVersion: v1
2  kind: Pod
3  metadata:
4    name: wildfly-pod
5    labels:
6      name: wildfly-pod
7  spec:
8    containers:
9    - name: wildfly
10     image: jboss/wildfly
11     ports:
12     - containerPort: 8080
```

Replication Controller

- Ensures that a specified number of pod "replicas" are running
  - Pod templates are cookie cutters
  - Rescheduling
  - Manual or auto-scale replicas
  - Rolling updates
- Generally wrap a pod in a RC
- Only appropriate for pods with `Restart=Always` policy (default)

Kubernetes Replication Controller Configuration

```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: wildfly-rc
spec:
  replicas: 2
  selector:
    app: wildfly-rc-pod
  template:
    metadata:
      labels:
        app: wildfly-rc-pod
    spec:
      containers:
      - name: wildfly
        image: jboss/wildfly
        ports:
        - containerPort: 8080
```

Services

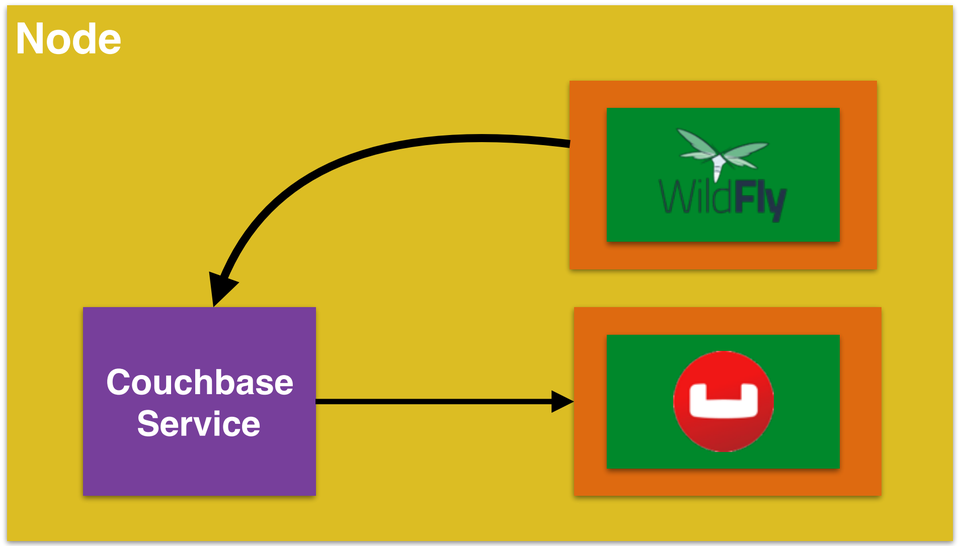
- Abstract a set of pods as a single IP and port
  - Simple TCP/UDP load balancing
- Creates environment variables in other pods or DNS resolution
- Stable endpoint for pods to reference
  - Allows list of pods to change dynamically

Kubernetes Service Configuration

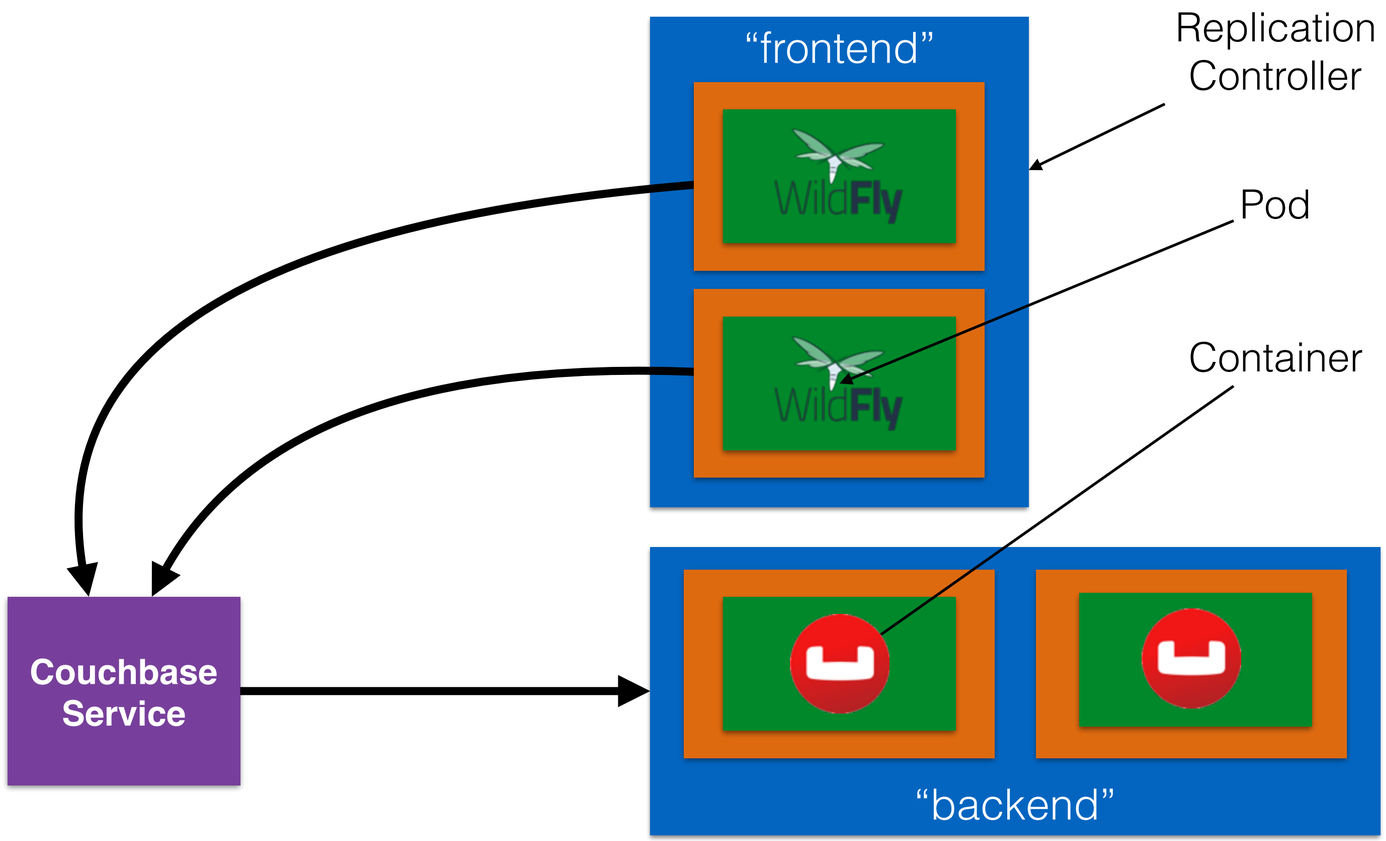
```yaml
apiVersion: v1
kind: Service
metadata:
  name: couchbase-service
spec:
  selector:
    app: couchbase-rc-pod
  ports:
    - name: admin
      port: 8091
    - name: query
      port: 8093
---
```

```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: couchbase-rc
spec:
  replicas: 2
  selector:
    app: couchbase-rc-pod
  template:
    metadata:
      labels:
        app: couchbase-rc-pod
    spec:
      containers:
      - name: couchbase
        image: couchbase
        ports:
        - containerPort: 8091
```

Couchbase Service



Service and Replication Controller



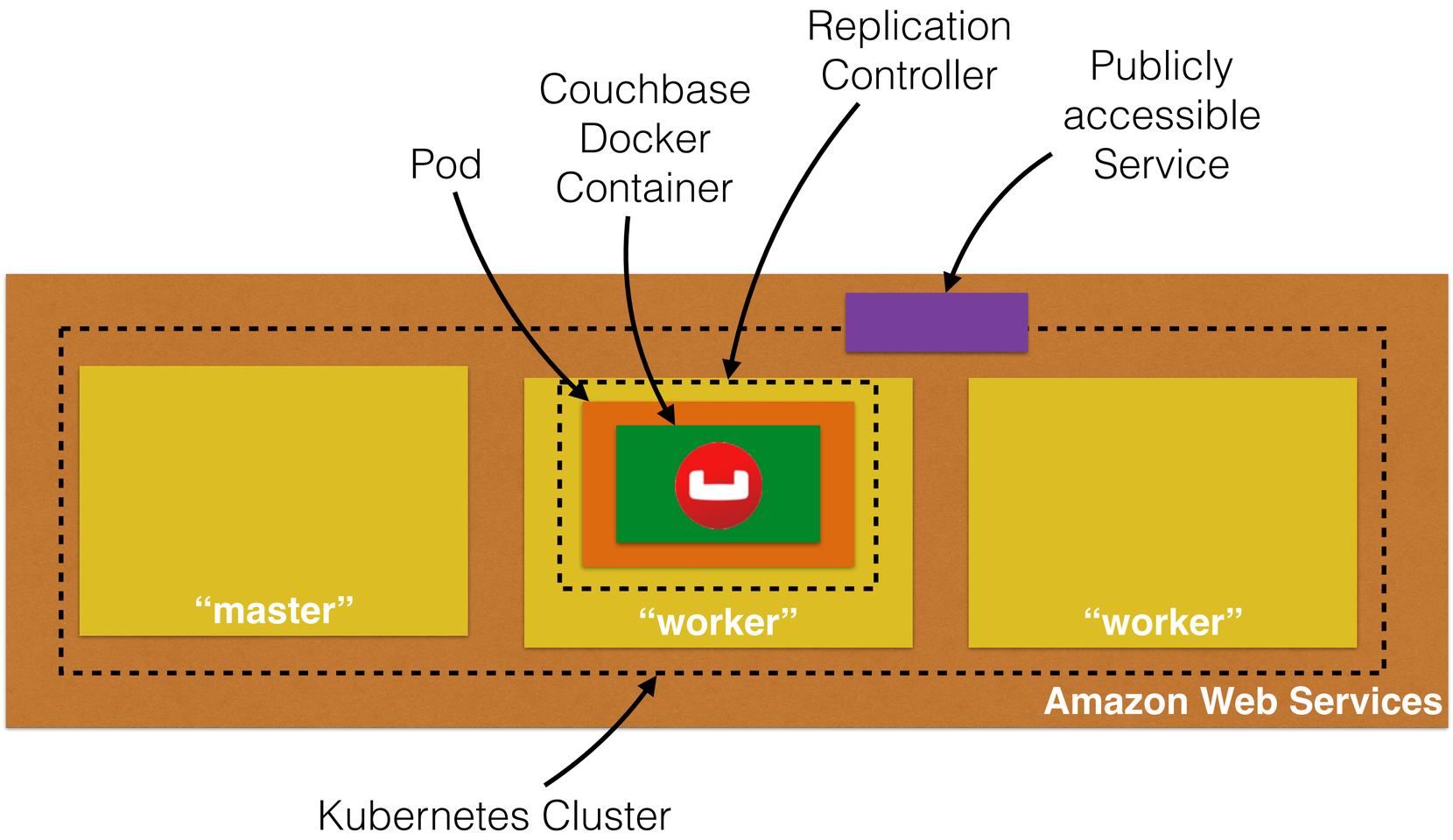
Exposing Service

- Service may be exposed outside cluster or on Internet using **`type`**
  - **`ClusterIP`** (default)
  - **`NodePort`**: A port on each node

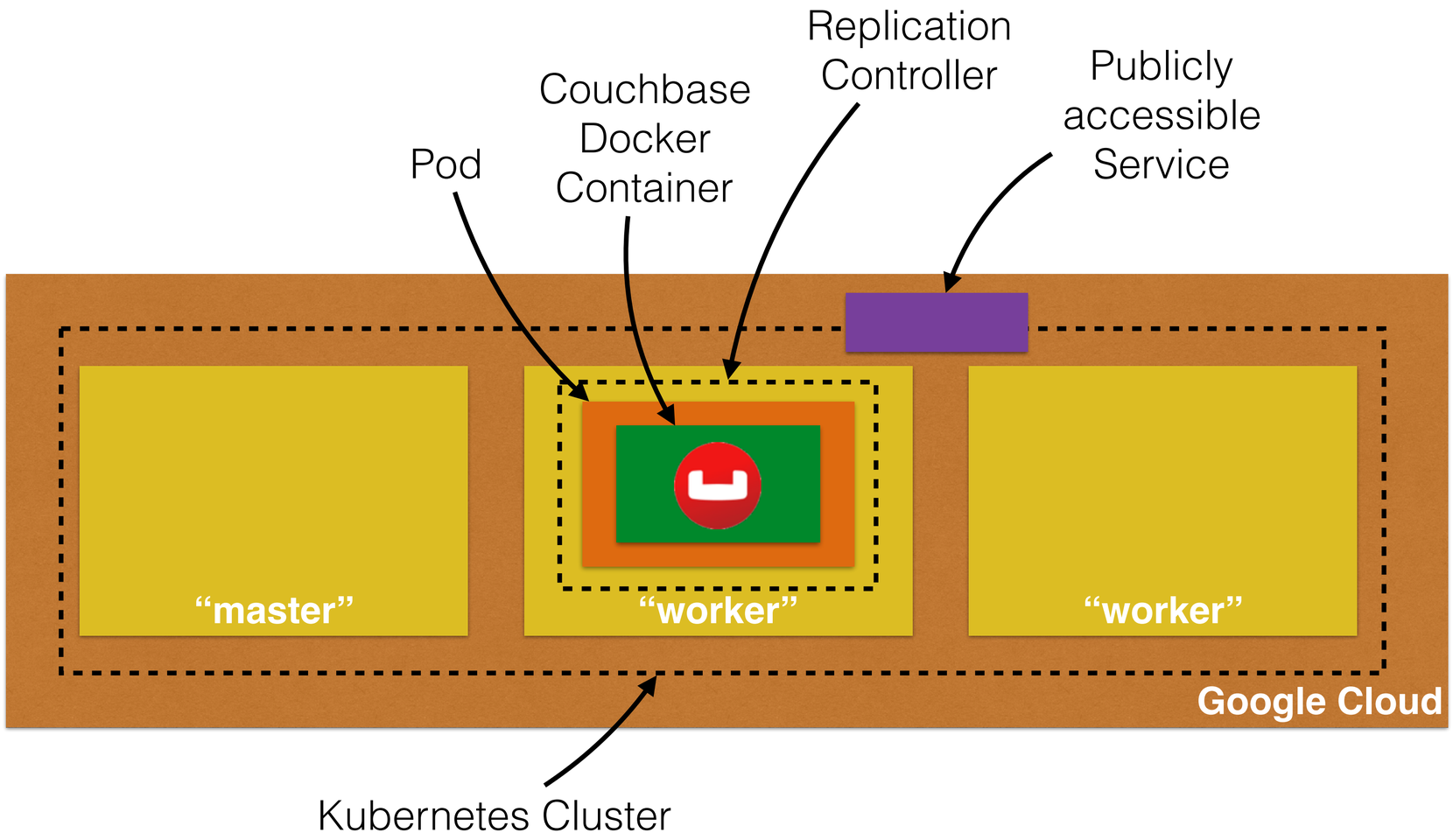
```
spec:
  type: NodePort
  ports:
  - name: admin
    port: 8091
    nodePort: 30001
  - name: query
    port: 8093
    nodePort: 30002
```

  - **`LoadBalancer`**: On cloud providers that support external LB

Exposing Service on Amazon



Exposing Service on GCE



Replica Set

- Next generation Replication Controller
- Set-based selector requirement
- Useful for Horizontal Pod Autoscaling

Replica Set Configuration

```yaml
apiVersion: extensions/v1beta1
kind: ReplicaSet
metadata:
  name: wildfly-rs
spec:
  replicas: 2
  selector:
    matchLabels:
      app: wildfly-rs-pod
    matchExpressions:
      - {key: tier, operator: In, values: ["backend"]}
      - {key: environment, operator: NotIn, values: ["dev"]}
  template:
    metadata:
      labels:
        app: wildfly-rs-pod
        tier: backend
        environment: dev
    spec:
      containers:
      - name: wildfly
        image: jboss/wildfly
        ports:
        - containerPort: 8080
```

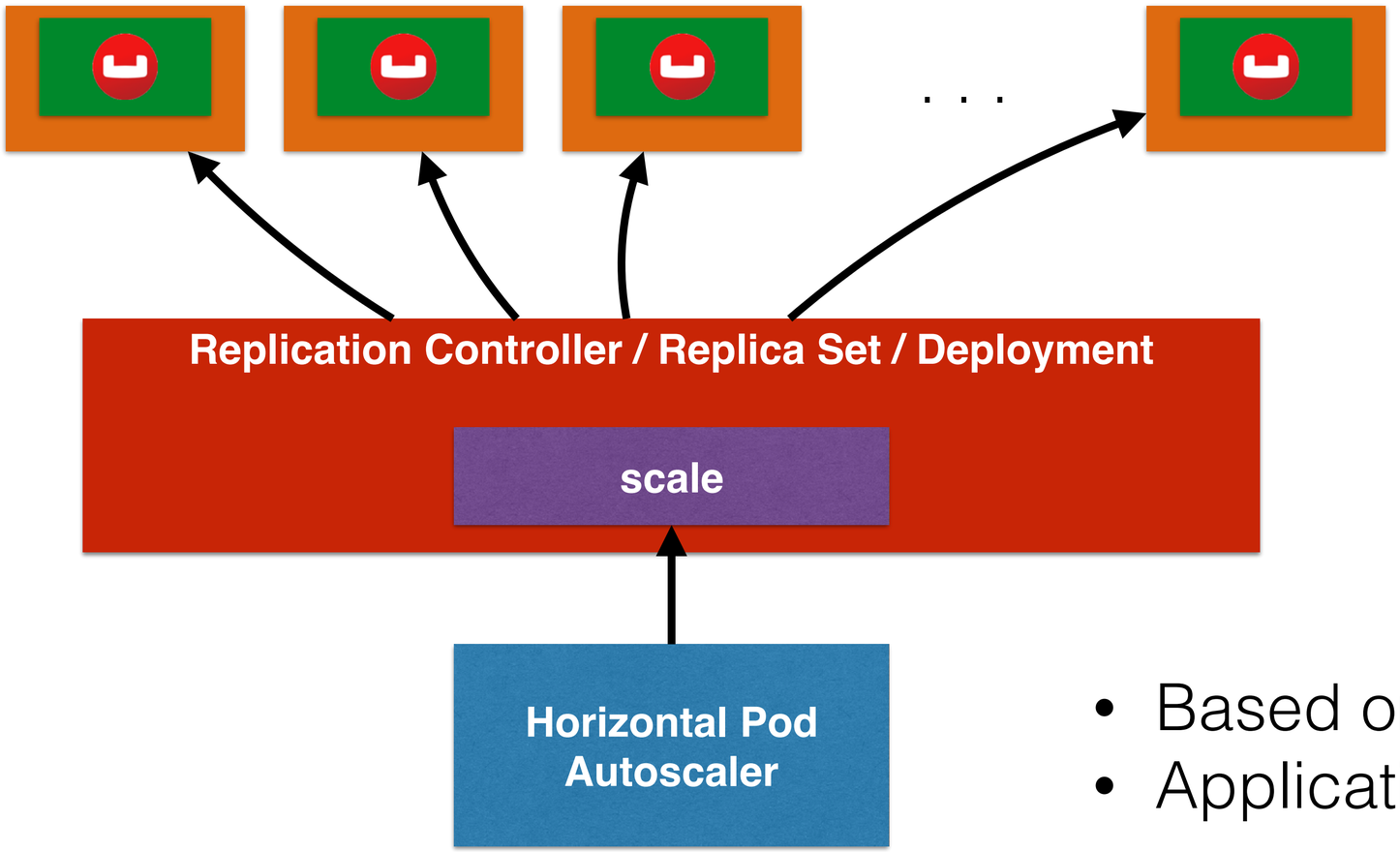
Deployment

- Declarative updates for pods and replica sets
  - For example: rolling updates
- Differences from **`kubectl`**
  - Declarative instead of imperative
  - Server-side and so is faster
  - More features, e.g. rollback to previous version

Deployment Configuration

```
1  apiVersion: extensions/v1beta1
2  kind: Deployment
3  metadata:
4    name: wildfly-deployment
5  spec:
6    replicas: 3
7    template:
8      metadata:
9        labels:
10         app: wildfly
11     spec:
12       containers:
13       - name: wildfly
14         image: jboss/wildfly
15         ports:
16         - containerPort: 8080
```

Horizontal Pod Autoscaling



- Based on observed CPU utilization
- Application provided metrics (health)

Horizontal Pod Autoscaling

- Typical usage
  - `kubectl autoscale deployment | rc | rs --min=<PODS> --max=<PODS> –cpu-percent=<CPU>`
- Autoscale a deployment with number of pods between 2 and 10
  - `kubectl autoscale deployment db --min=2 --max=10`
- Autoscale a Replication with maximum number of pods 5, target CPU utilization of 80%
  - `kubectl autoscale rc --max=5 --cpu-percent=80`

HPA Configuration

Volumes

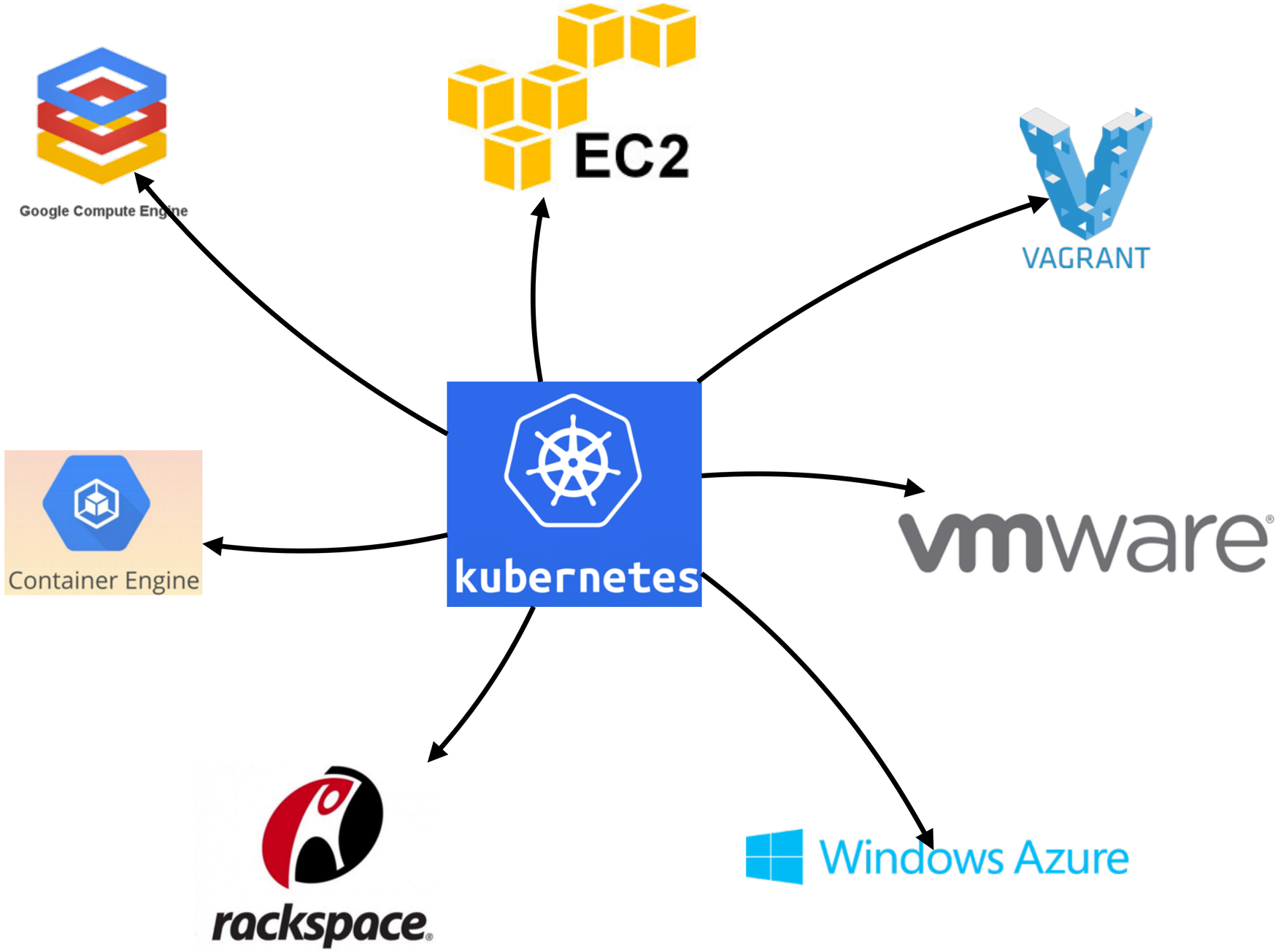
- Directory accessible to the containers in a pod
- Volume outlives any containers in a pod
- Common types
  - `hostPath`
  - `nfs`
  - `awsElasticBlockStore`
  - `gcePersistentDisk`

Volume Configuration

```
1  apiVersion: v1
2  kind: Pod
3  metadata:
4    name: couchbase-pod
5    labels:
6      name: couchbase-pod
7  spec:
8    containers:
9    - name: couchbase
10     image: arungupta/couchbase-oreilly:k8s
11     ports:
12     - containerPort: 8091
13     volumeMounts:
14     - mountPath: /var/couchbase/lib
15       name: couchbase-data
16   volumes:
17   - name: couchbase-data
18     hostPath:
19       path: /opt/data
```

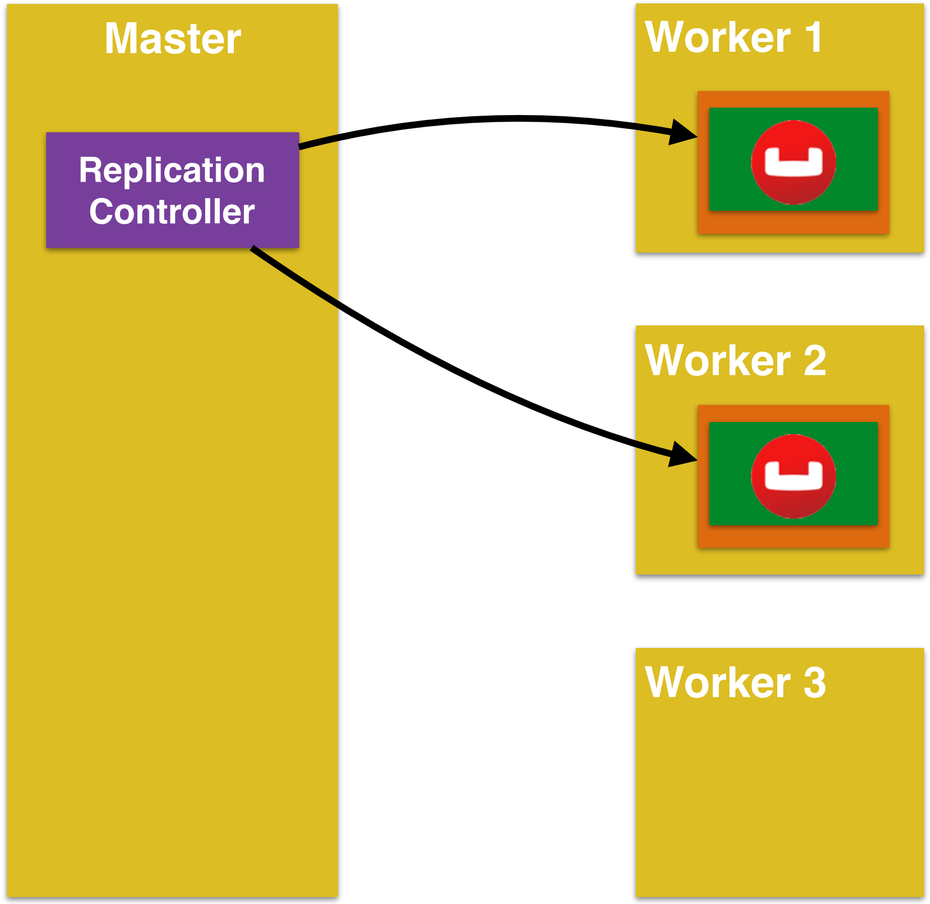
Namespace

- Namespace allows to partition resources into a logical group
- Each namespace provides:
  - **scope** for resources to avoid collisions
  - **policies** to ensure appropriate authority to trusted users
  - **constraints** for resource consumption

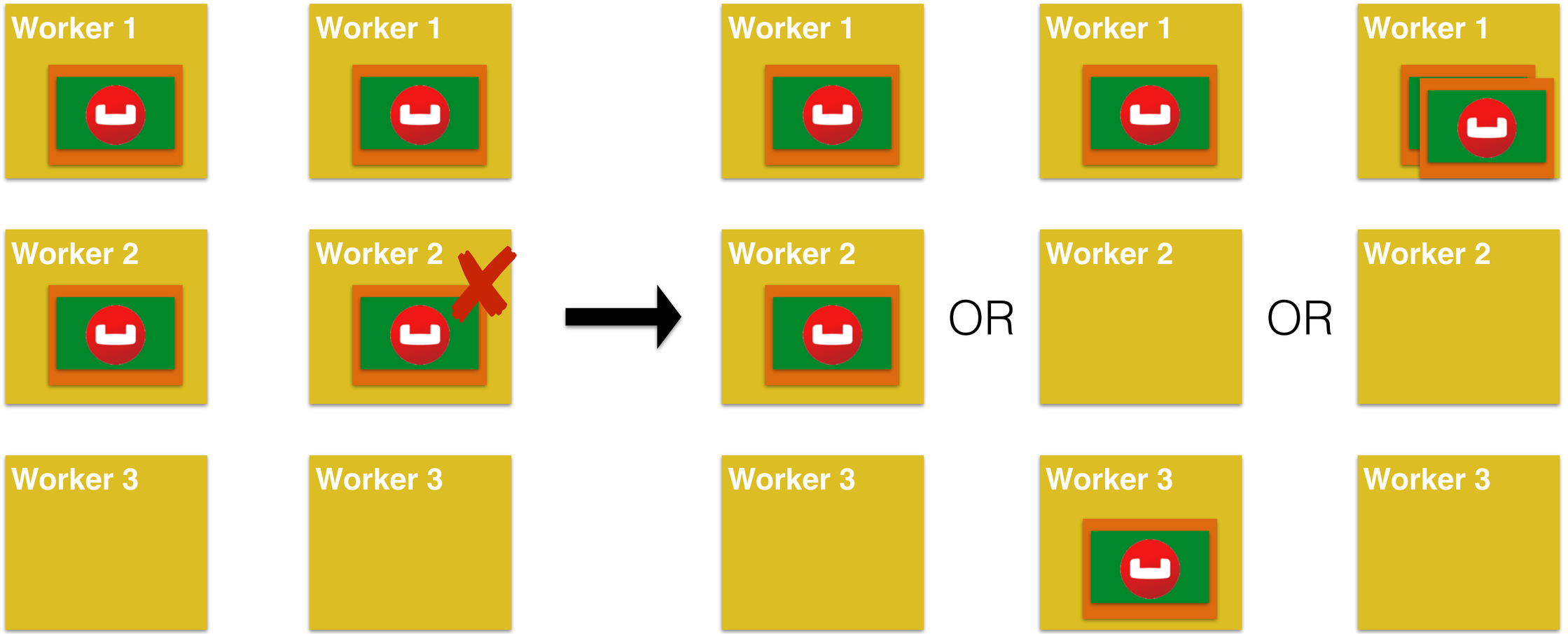


https://get.k8s.io/

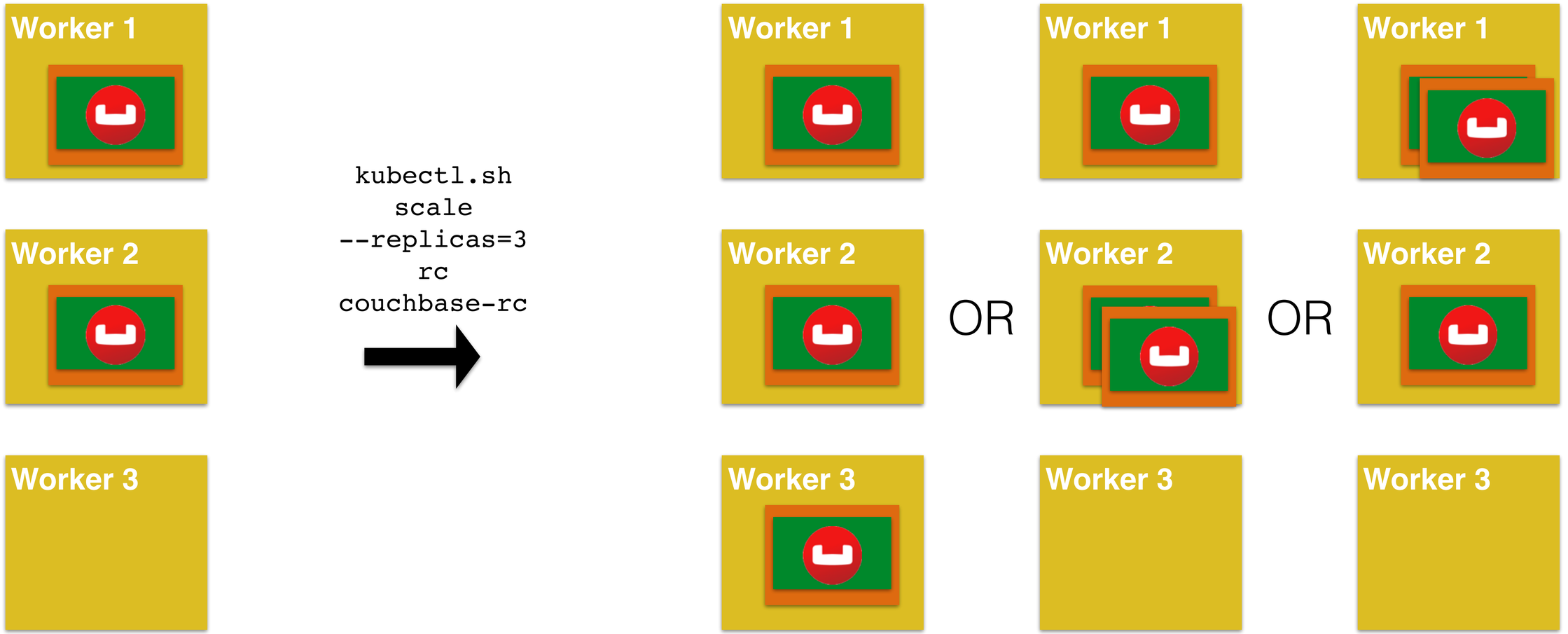
Replication Controller



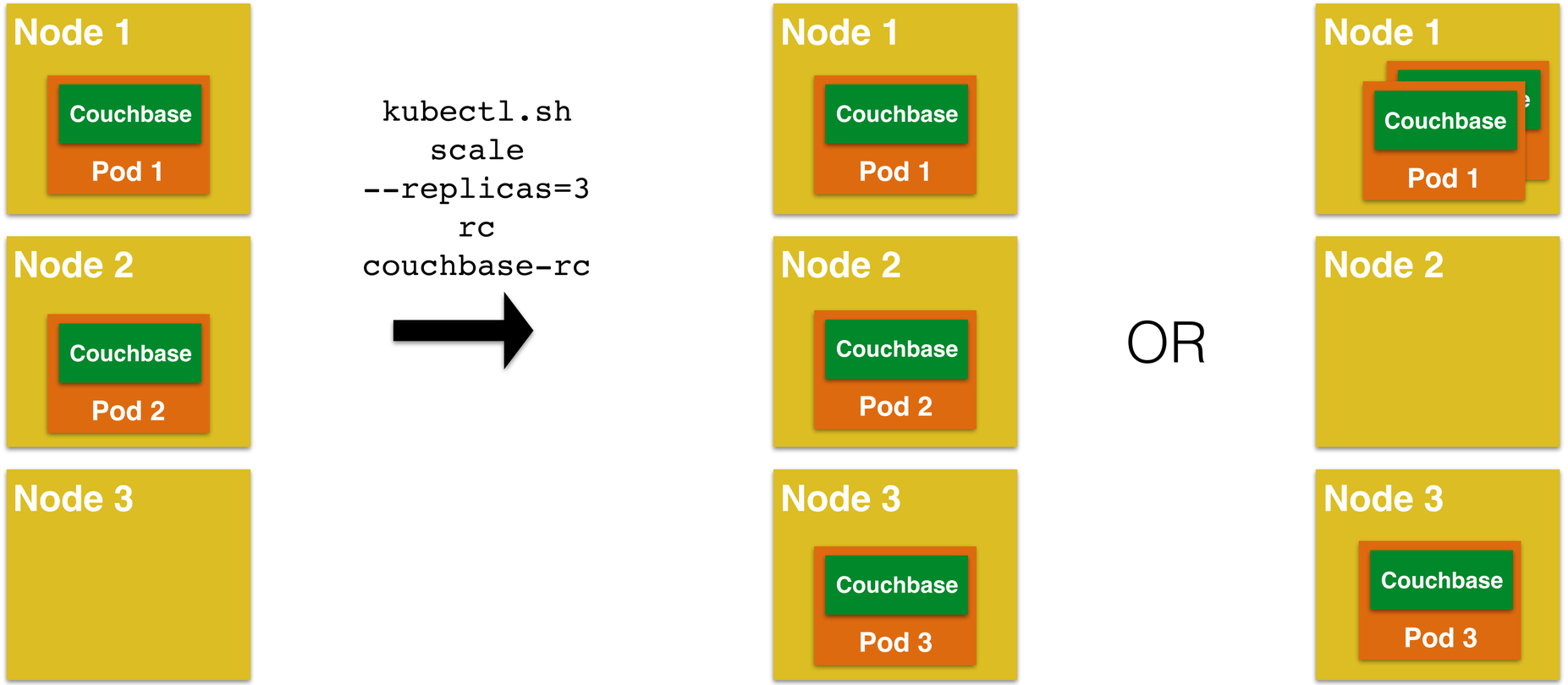
RC: “Actual” vs “Desired” State



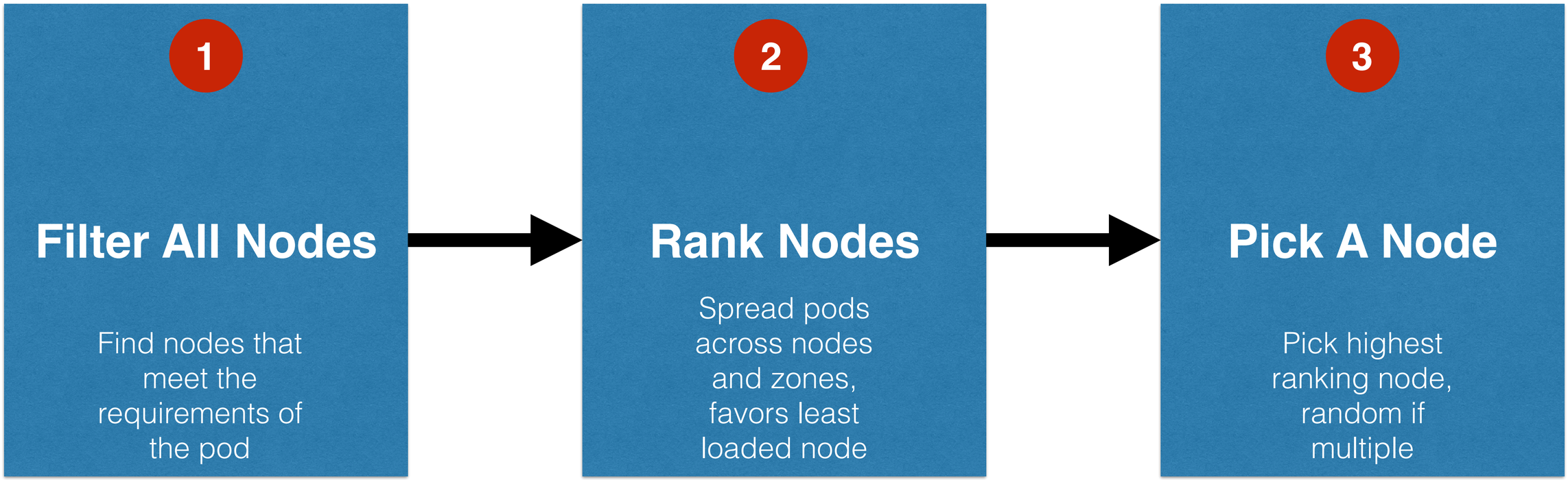
RC: Scale Pods



Replication Controller: Scaling

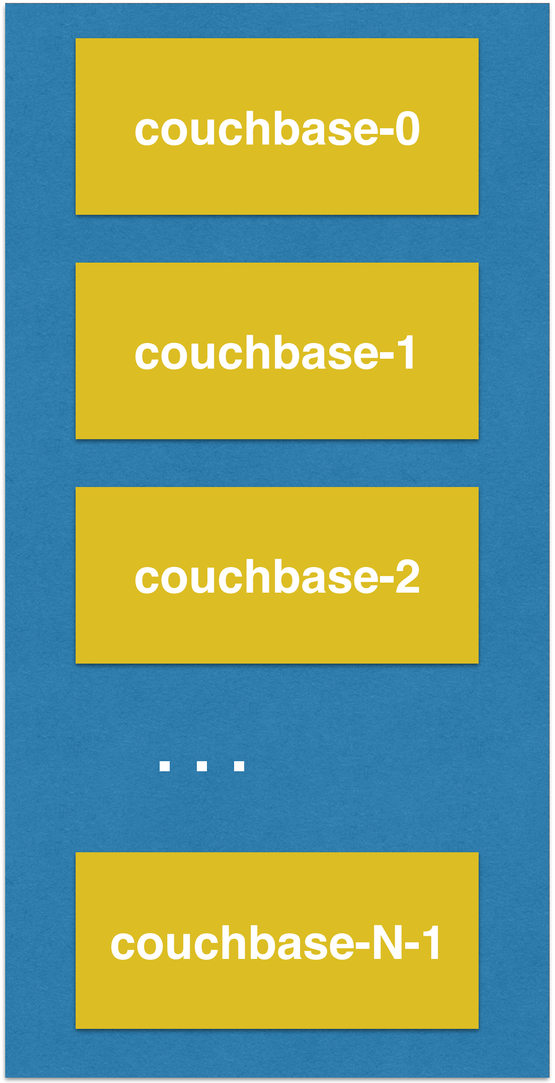


Kubernetes Scheduling Algorithm



Pet Set

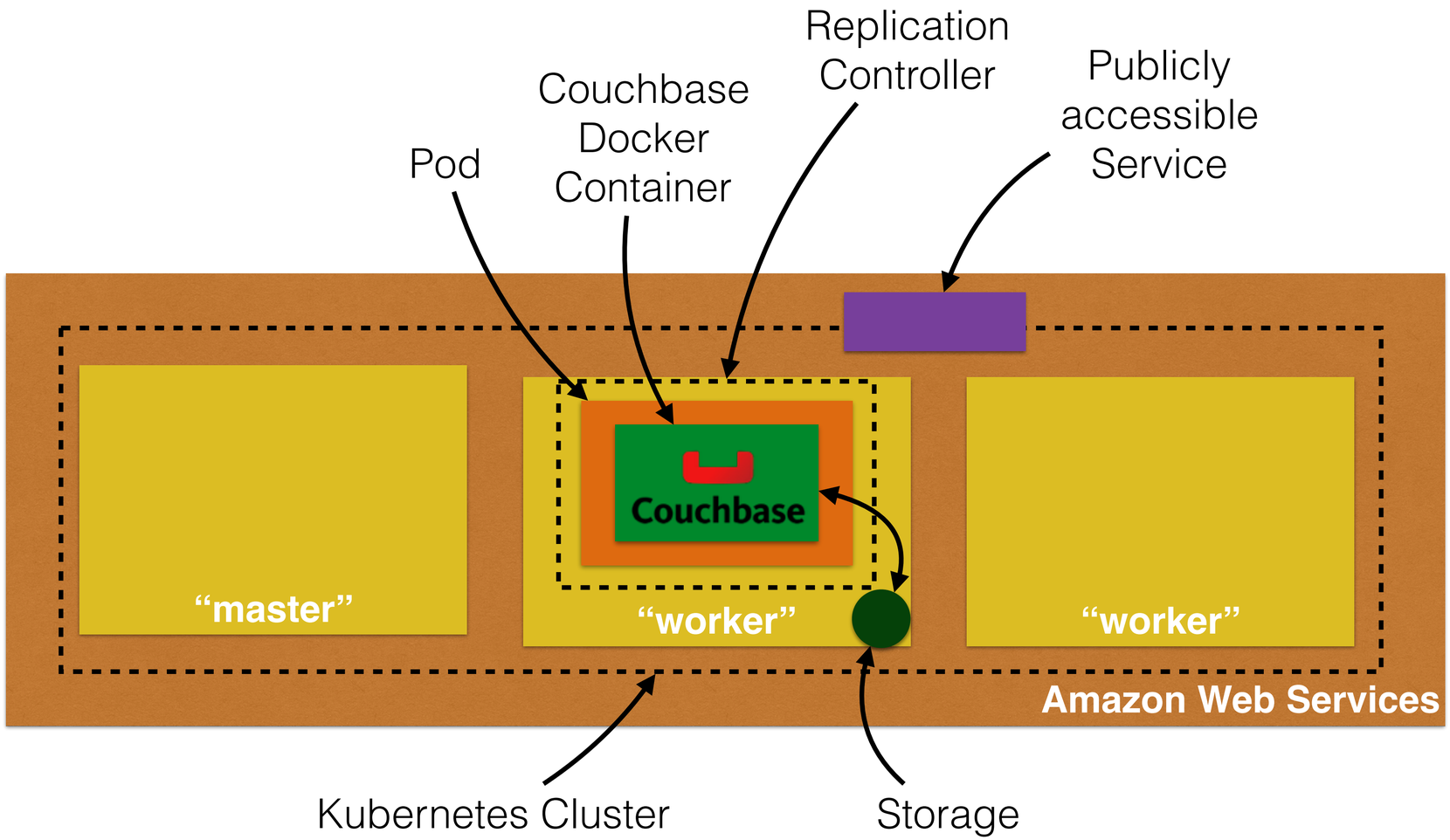
- Alpha resource introduced in 1.3
- Stateful pods
- PetSet has 0..N-1 Pets
- Each Pet has a deterministic name, and a unique identity
  - Identity = stable hostname, ordinal index, stable storage linked to ordinal & hostname
- Each Pet has at most one pod
- Each Pet Set has at most one Pet with a given identity



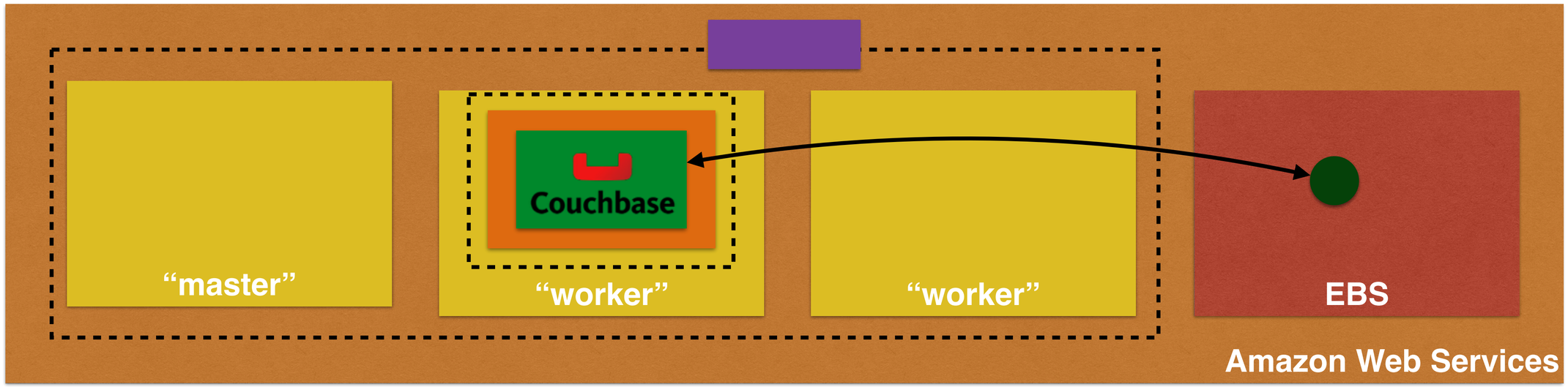
Health Checks

- Restarts Pod, if wrapped in RC
- Application-level health checks
  - HTTP
  - Container Exec
  - TCP Socket
- Health checks performed by Kubelet

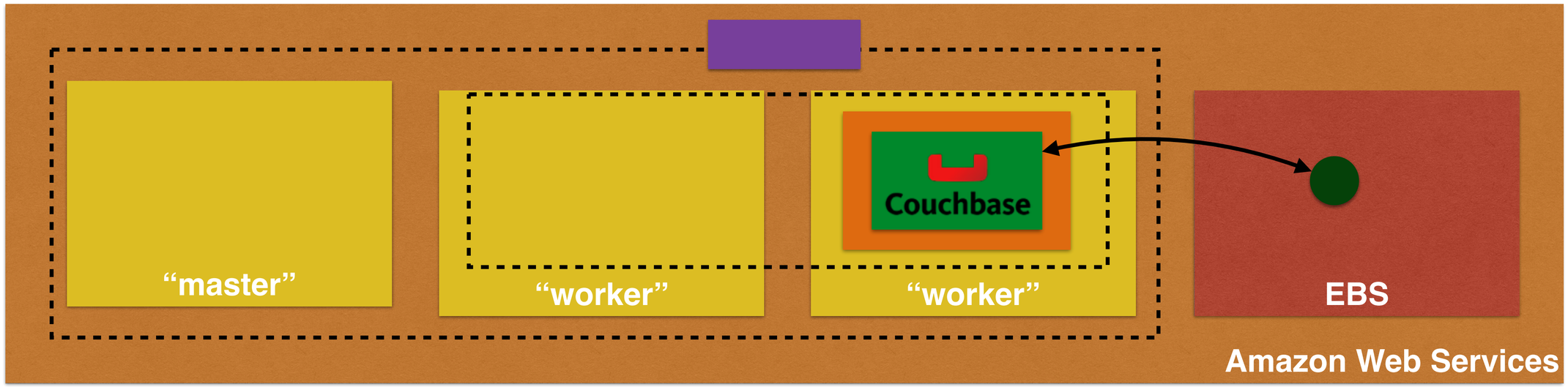
Stateful Containers



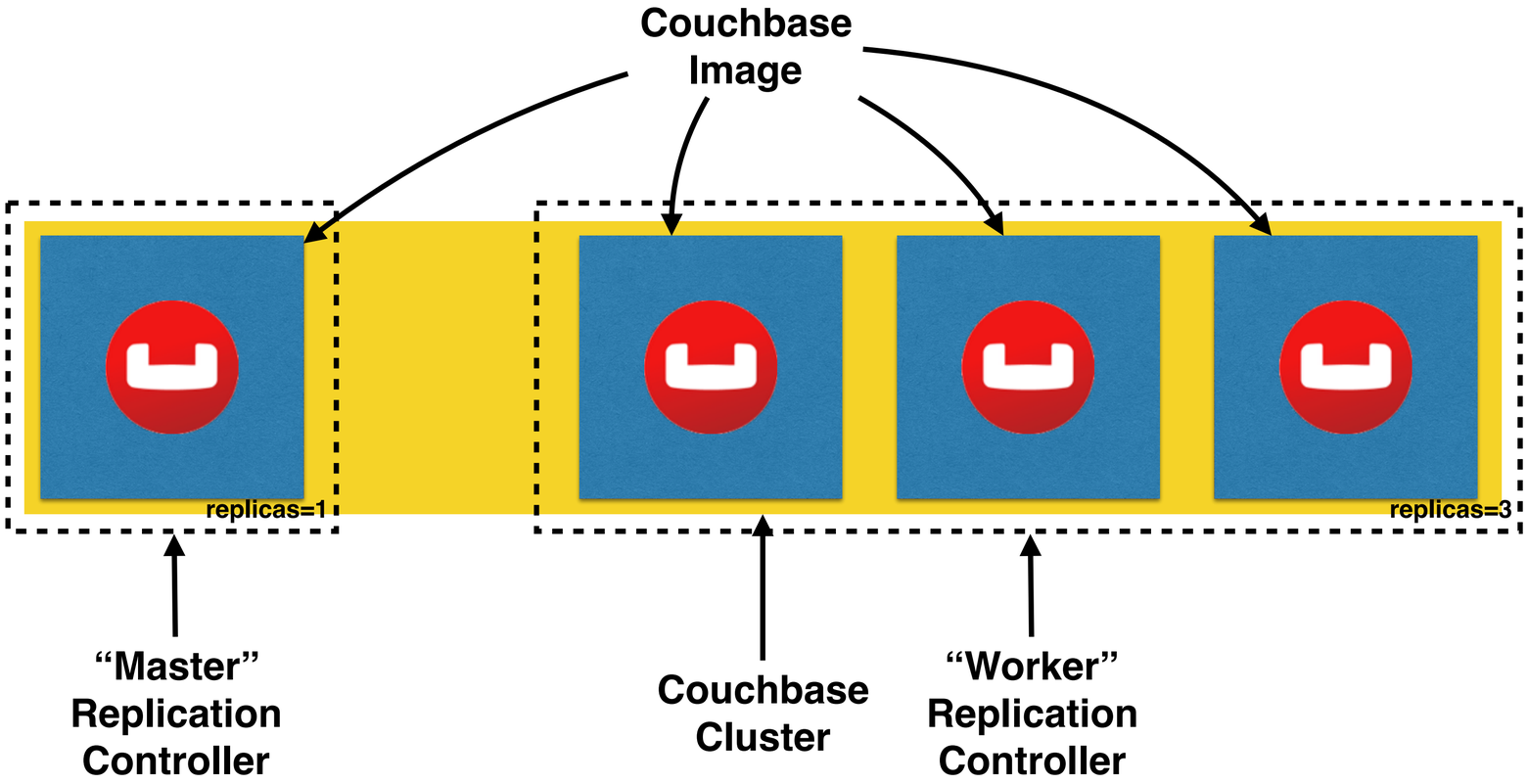
Stateful Containers



Stateful Containers



Couchbase Cluster on Kubernetes



Rolling Update

Kubernetes and Maven

- fabric8-maven-plugin

References

- github.com/javaee-samples/docker-java
- kubernetes.io
- Containers recipe: couchbase.com/containers