Kubernetes for Java Developers

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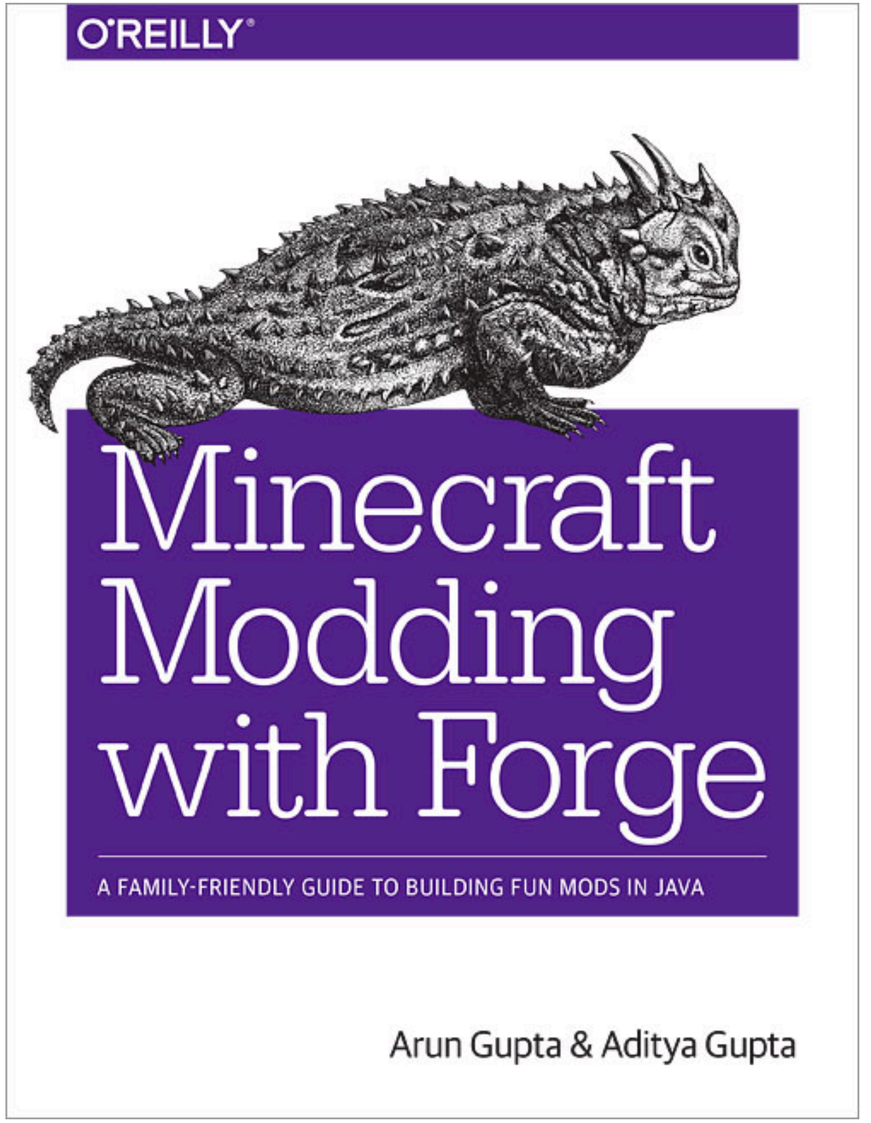
Couchbase

DEVOXX™ 4KIDS USA

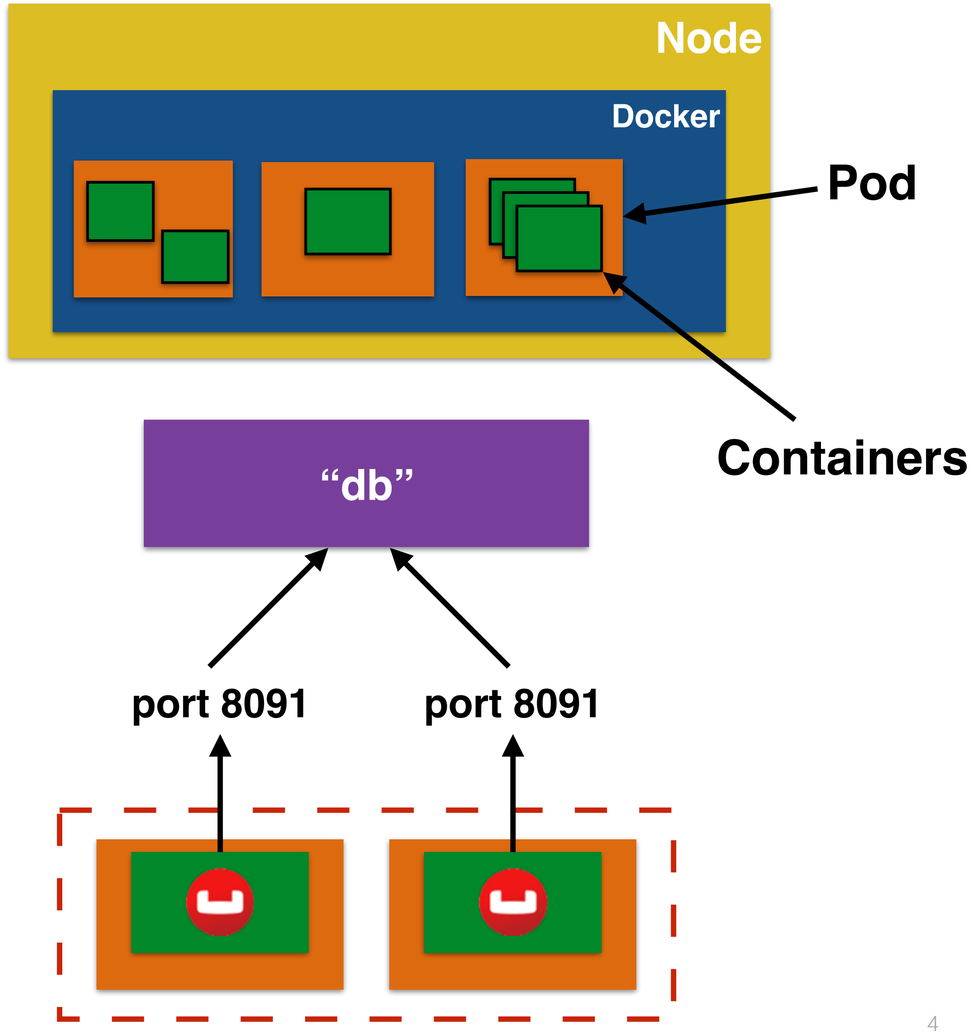


Kubernetes

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

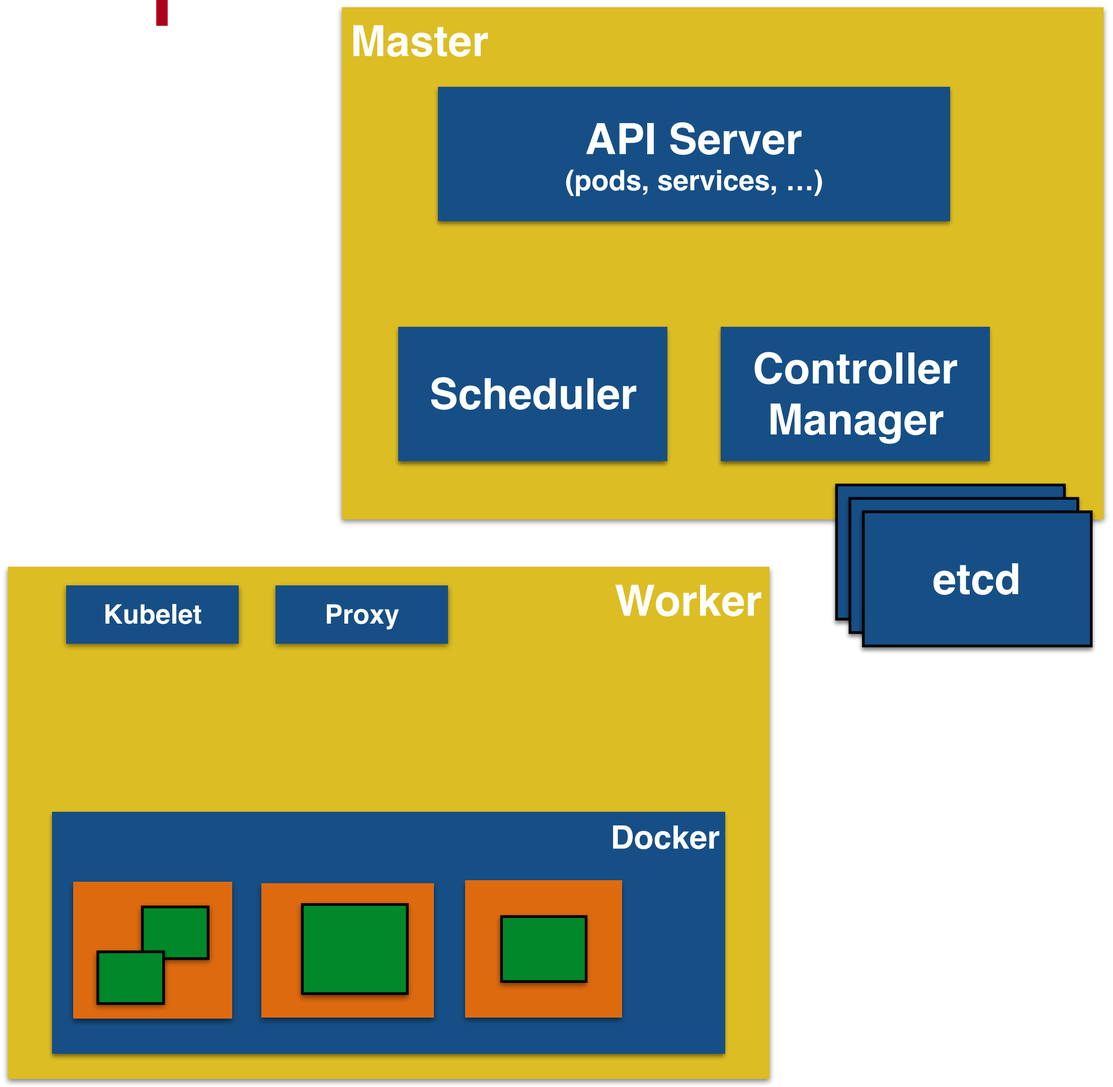
Kubernetes Concepts

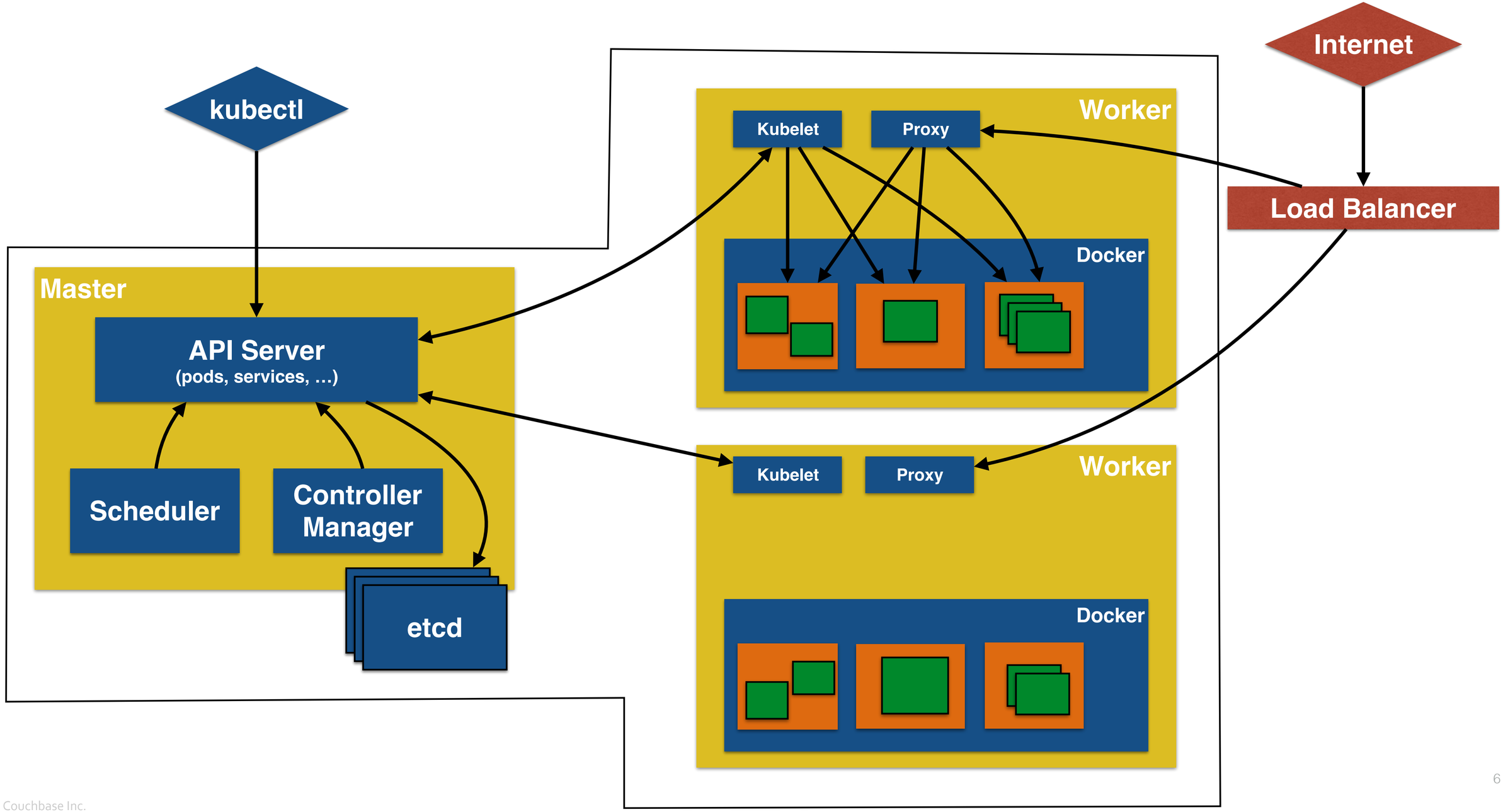
- **Pods**: colocated group of containers that share an IP, namespace, storage volume
- **Replica Set**: manages the lifecycle of pods and ensures specified number are running (next gen Replication Controller)
- **Service**: Single, stable name for a set of pods, also acts as LB
- **Label**: used to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



Kubernetes Components

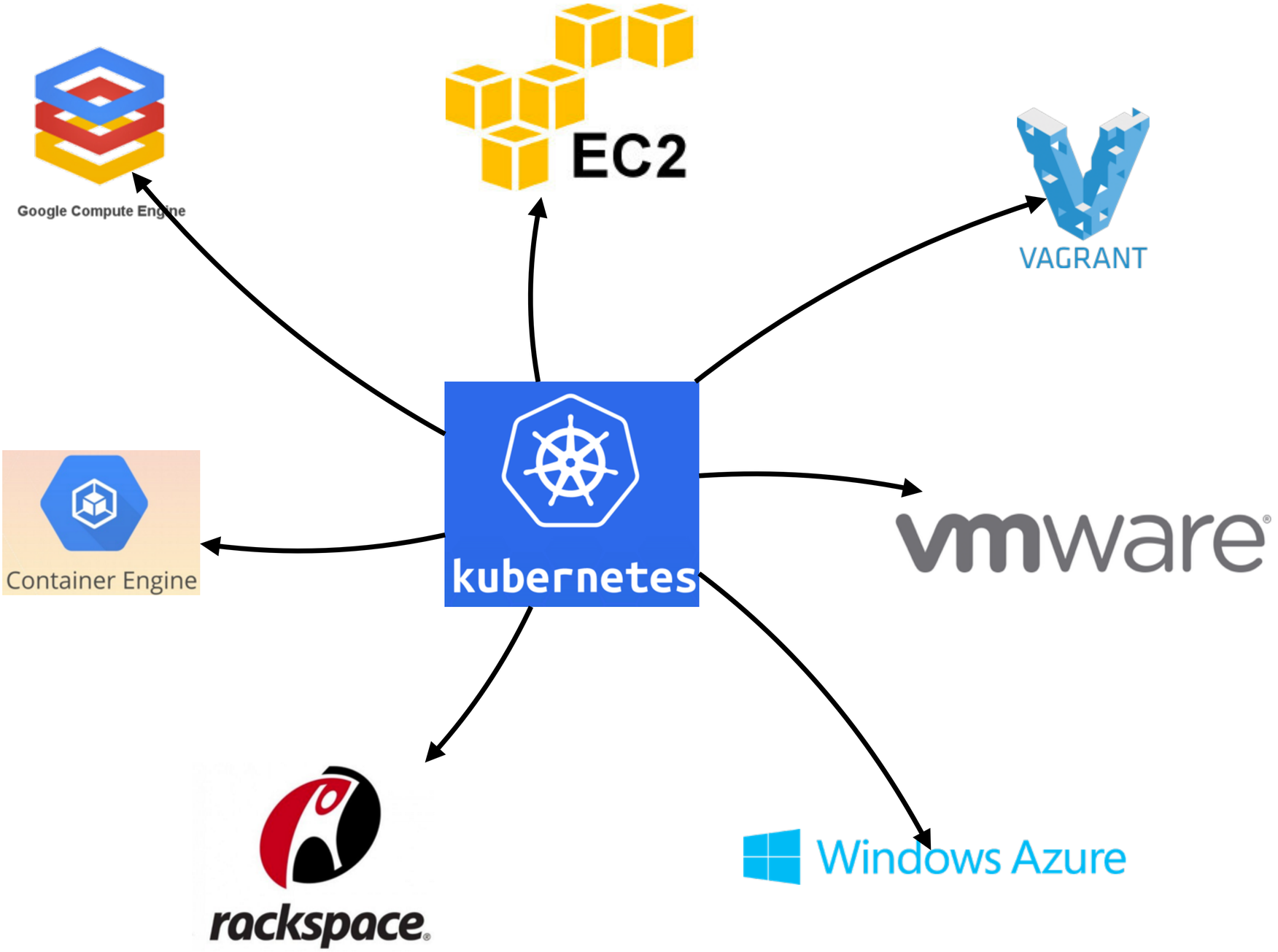
- **Node**: Machine or VM in the cluster
- **Master**: Central control plane, provides unified view of the cluster
  - **etcd**: distributed key-value store used to persist Kubernetes system state
- **Worker**: Docker host running *kubelet* (node agent) and *proxy* services
  - Runs pods and containers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



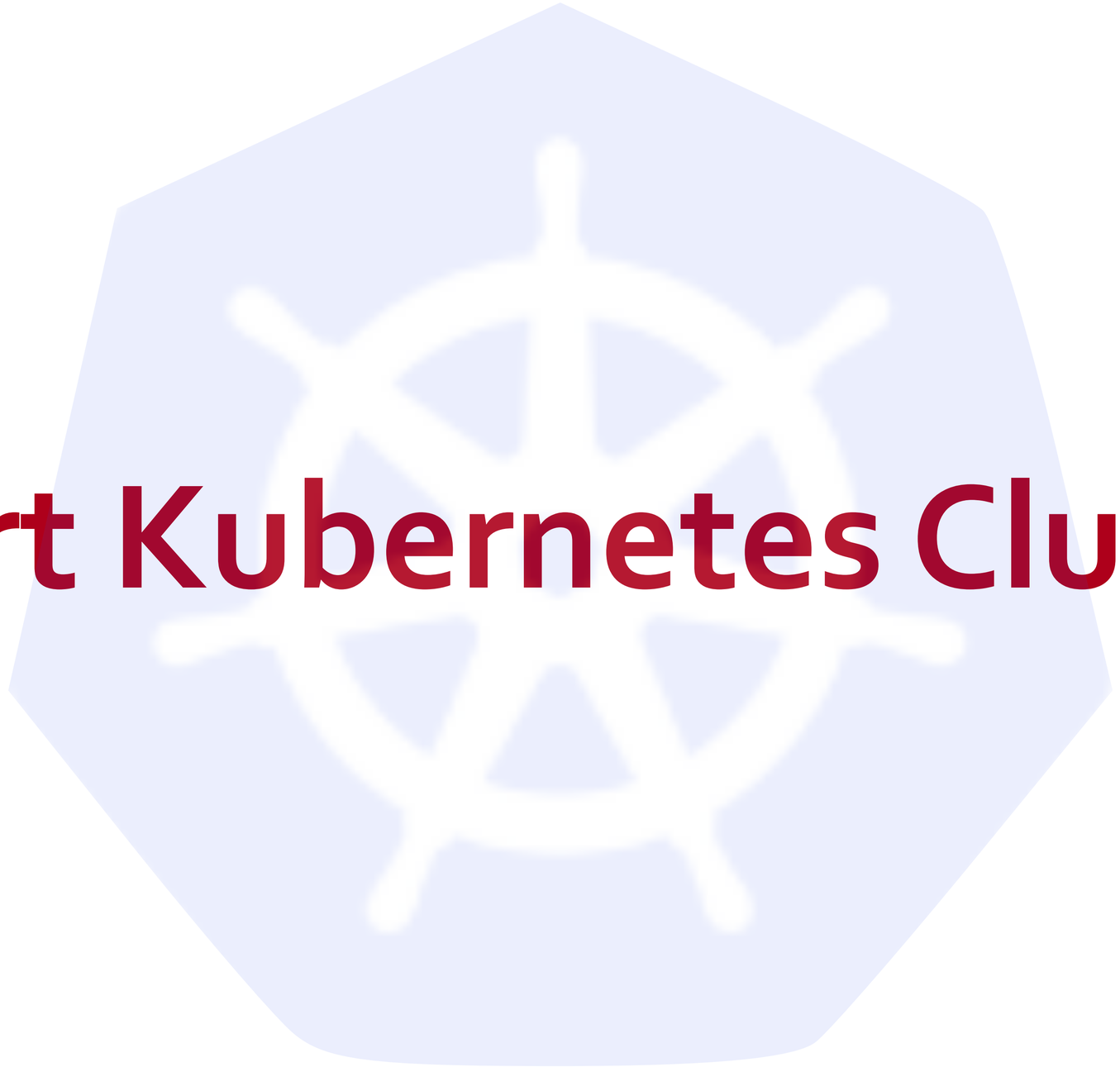


kubectl

- Controls the Kubernetes cluster manager
- CRUD Kubernetes resources
  - `create`, `get`, `describe`, `delete`, ...
  - `kubectl create -f <filename>`
- `kubectl get nodes` or `pods`
- `kubectl scale –replicas=3 rc/<name>`



https://get.k8s.io/



Start Kubernetes Cluster

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
```

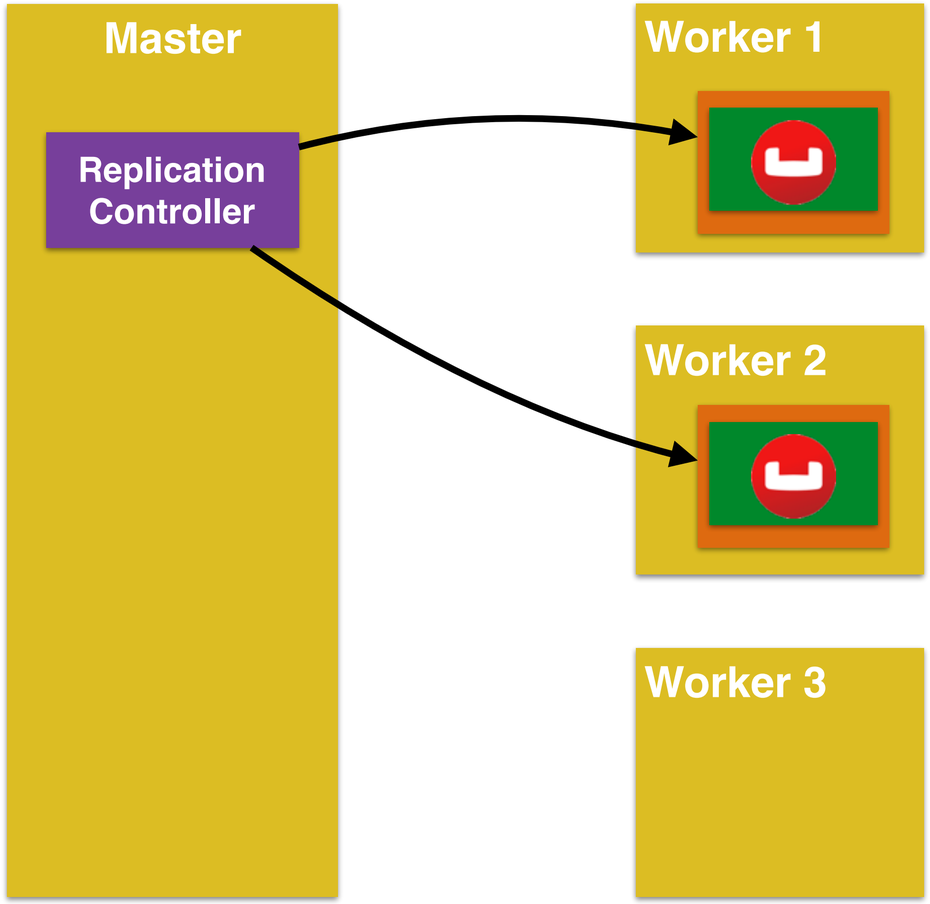
Replication Controller

- 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)

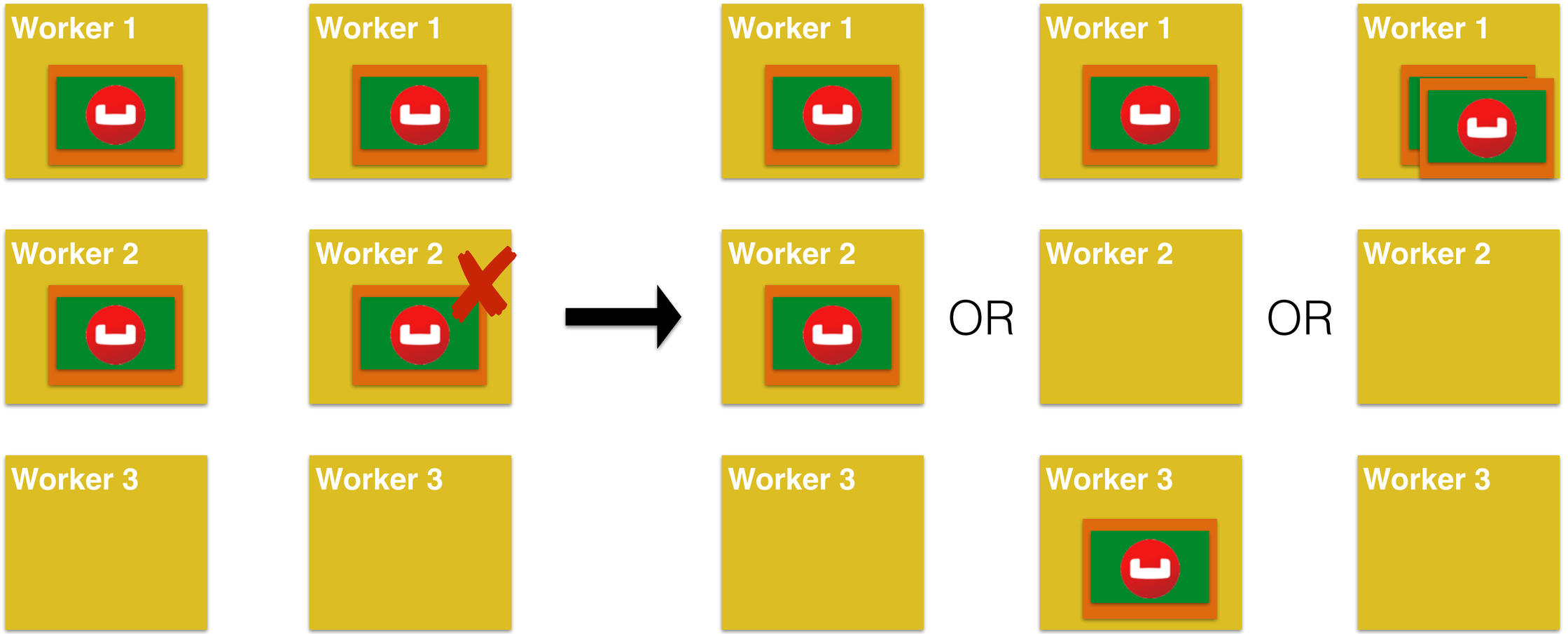
Kubernetes Replication Controller Configuration

```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
```

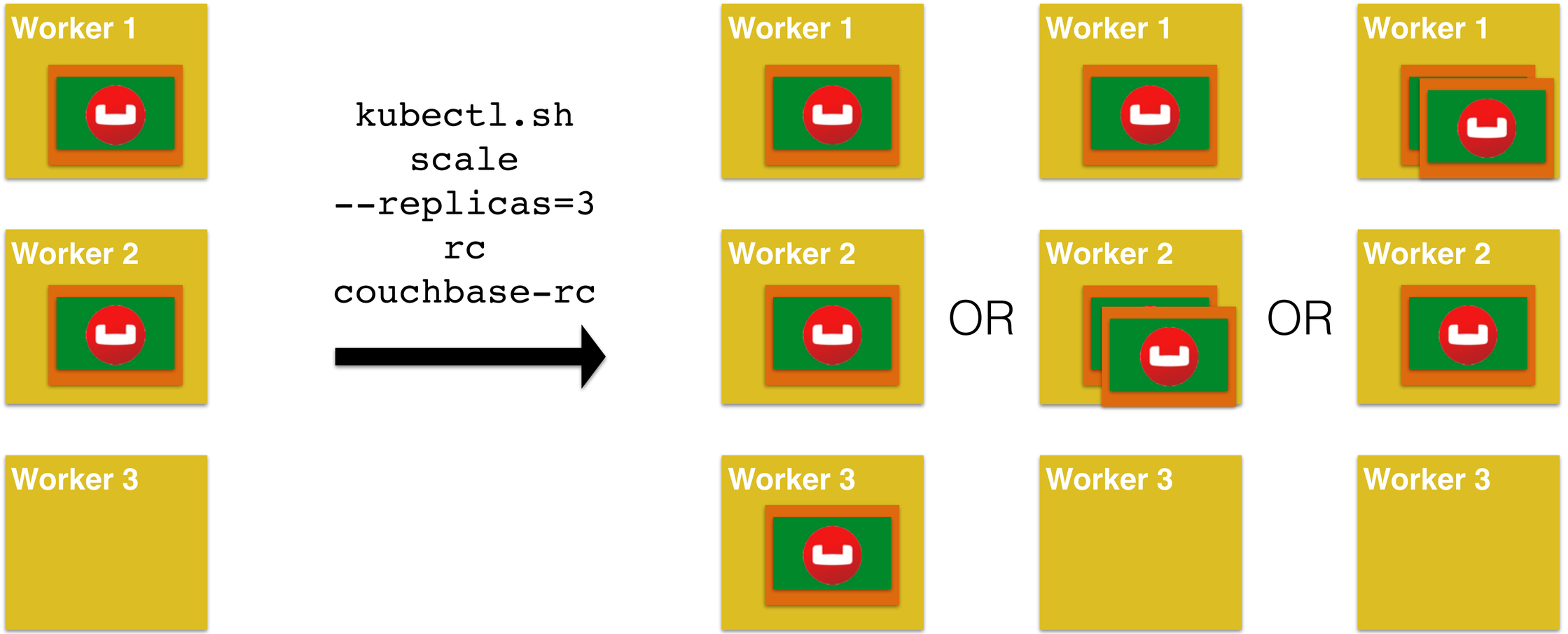
Replication Controller



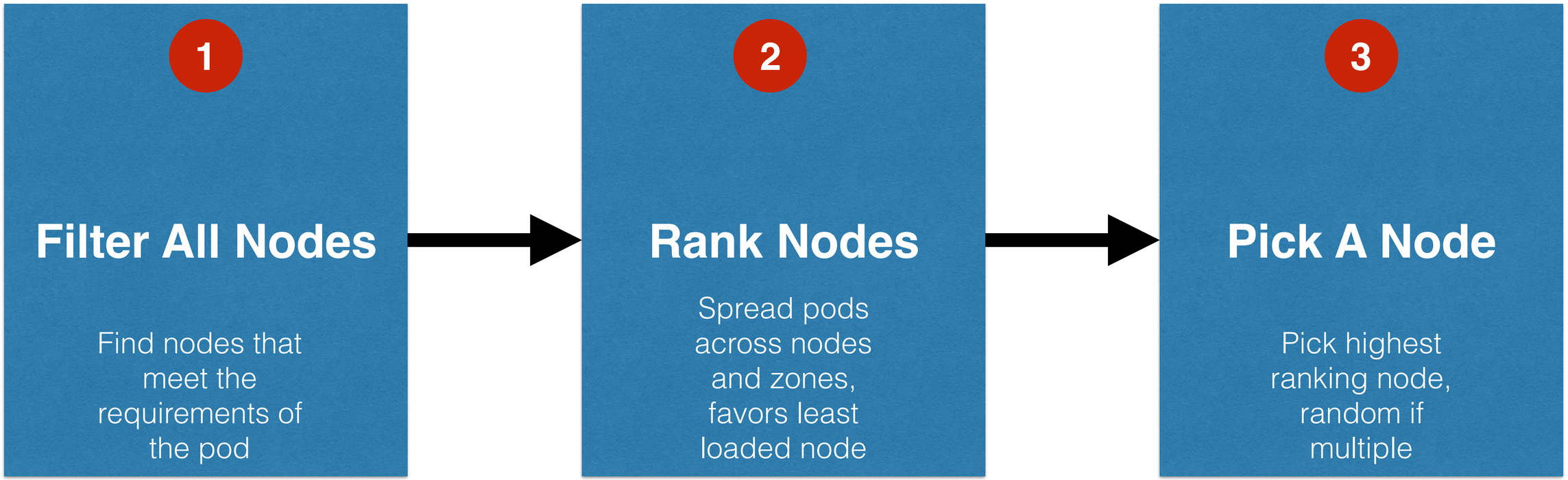
RC: “Actual” vs “Desired” State



RC: Scale Pods



Kubernetes Scheduling Algorithm



Replica Set

- Next generation Replication Controller
- Set-based selector requirement
  - Expression: **`key`**, **`operator`**, **`value`**
  - Operators: **`In`**, **`NotIn`**, **`Exists`**, **`DoesNotExist`**
- Generally created with **`Deployment`**
- Enables **`Horizontal Pod Autoscaling`**

Replica Set Configuration

```
1  apiVersion: extensions/v1beta1
2  kind: ReplicaSet
3  metadata:
4    name: wildfly-rs
5  spec:
6    replicas: 2
7    selector:
8      matchLabels:
9        app: wildfly-rs-pod
10     matchExpressions:
11       - {key: tier, operator: In, values: ["backend"]}
12       - {key: environment, operator: NotIn, values: ["dev"]}
13   template:
14     metadata:
15       labels:
16         app: wildfly-rs-pod
17         tier: backend
18         environment: dev
19     spec:
20       containers:
21       - name: wildfly
22         image: jboss/wildfly
23         ports:
24         - containerPort: 8080
```

Services

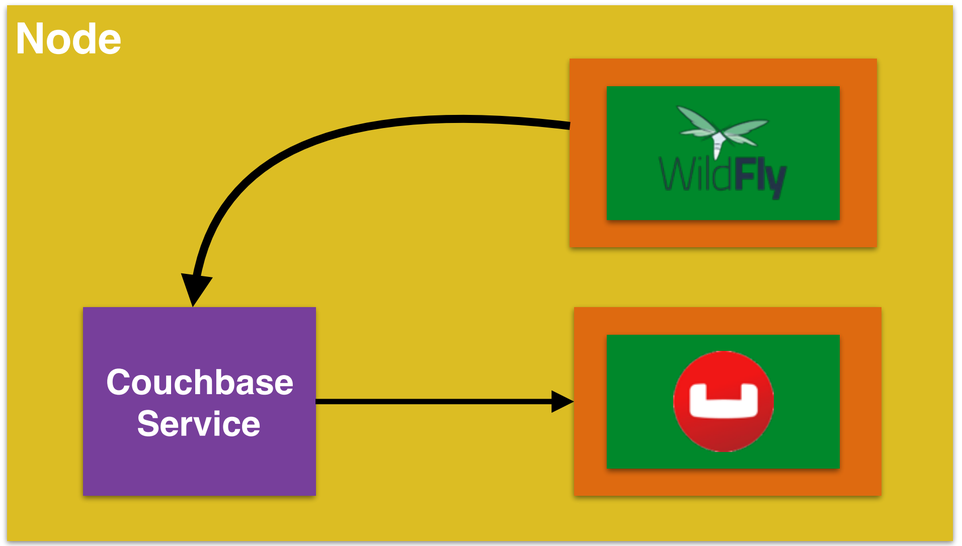
- Abstract a set of pods as a single IP and port
  - Simple TCP/UDP load balancing
- Creates environment variables in other pods or DNS resolution
- Stable endpoint for pods to reference
  - Allows list of pods to change dynamically

Kubernetes Service Configuration

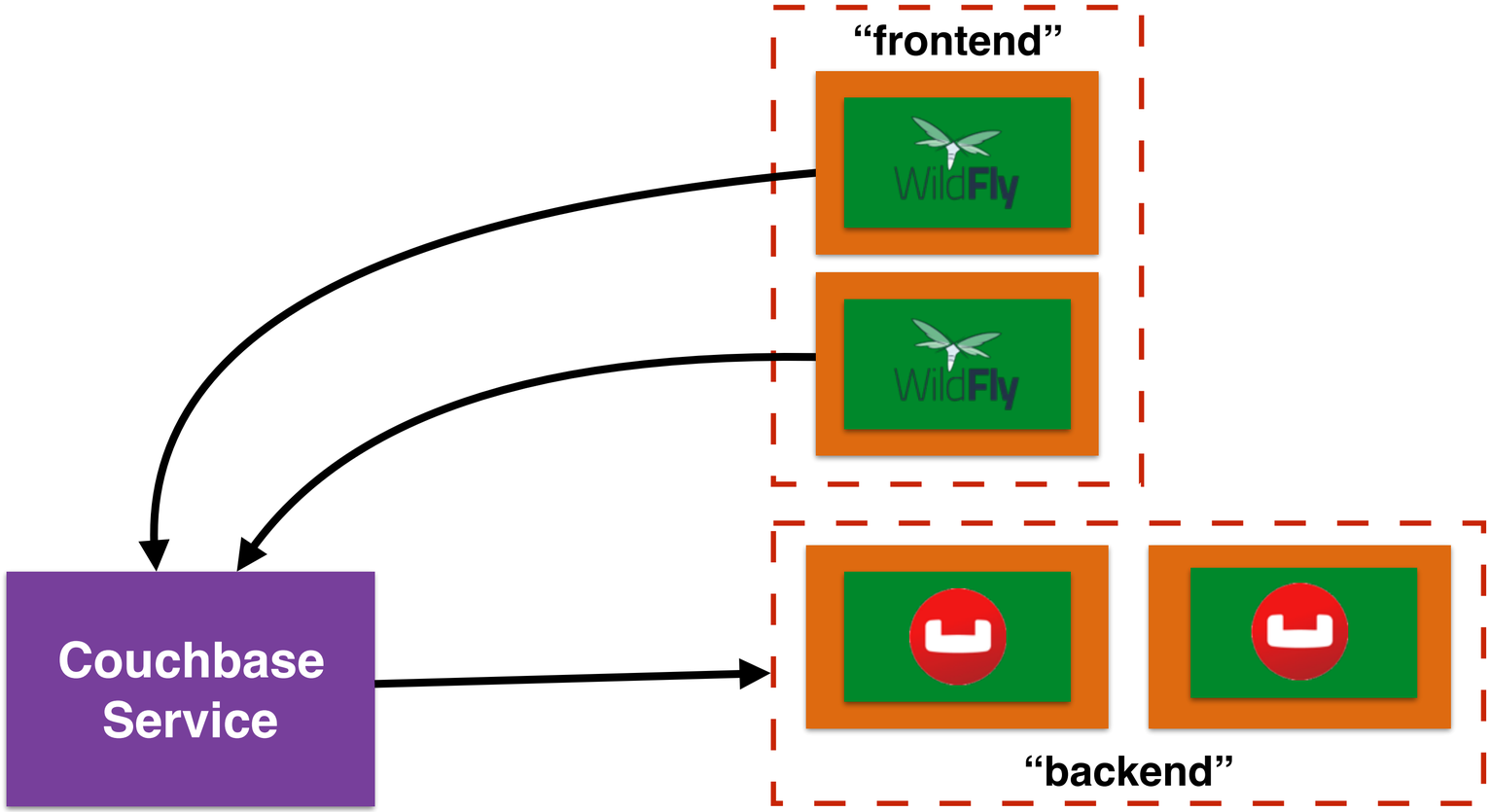
```yaml
apiVersion: v1
kind: Service
metadata:
  name: couchbase-service
spec:
  selector:
    app: couchbase-rc-pod
  ports:
    - name: admin
      port: 8091
    - name: query
      port: 8093
---
```

```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



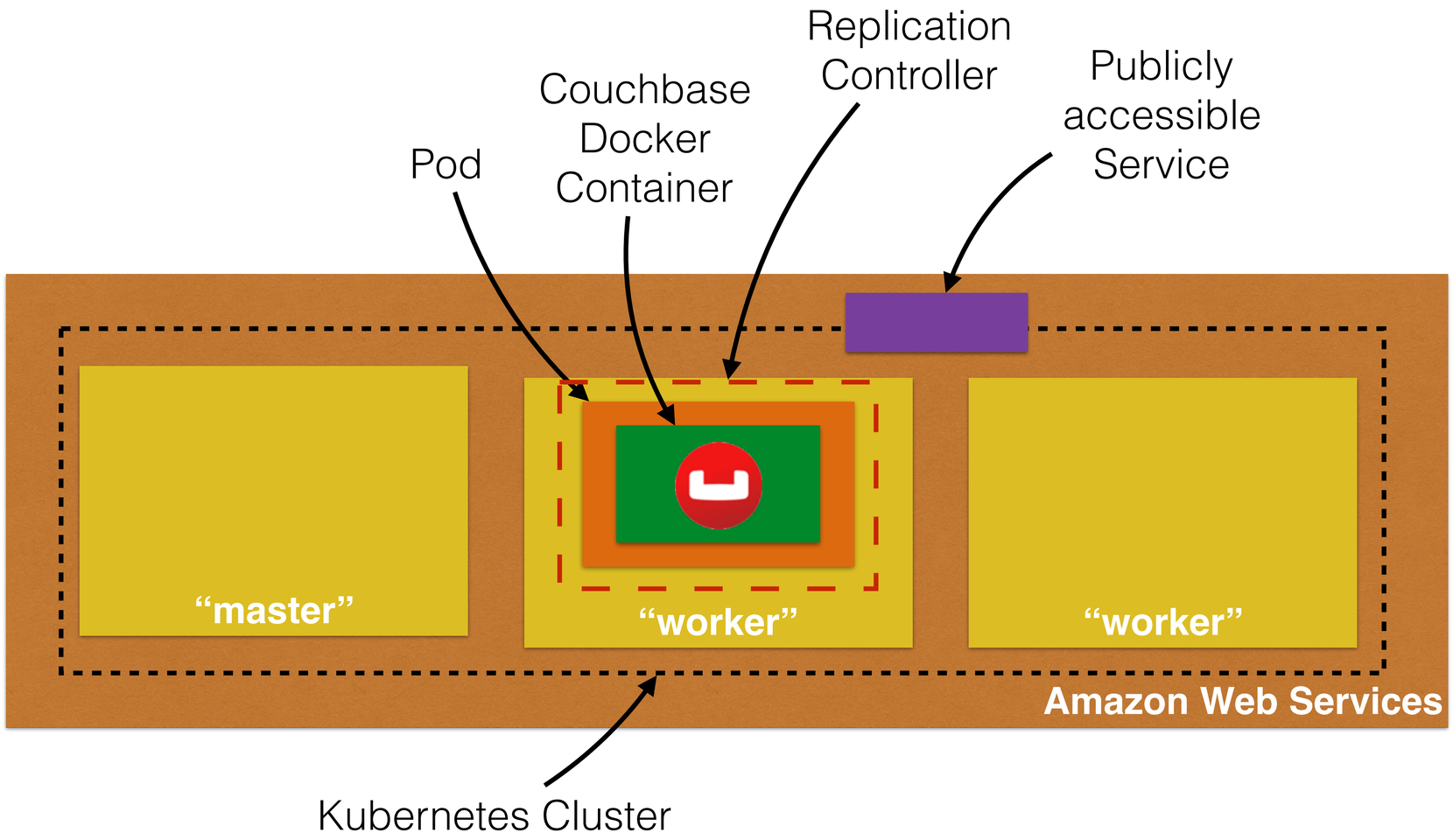
Exposing Service

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

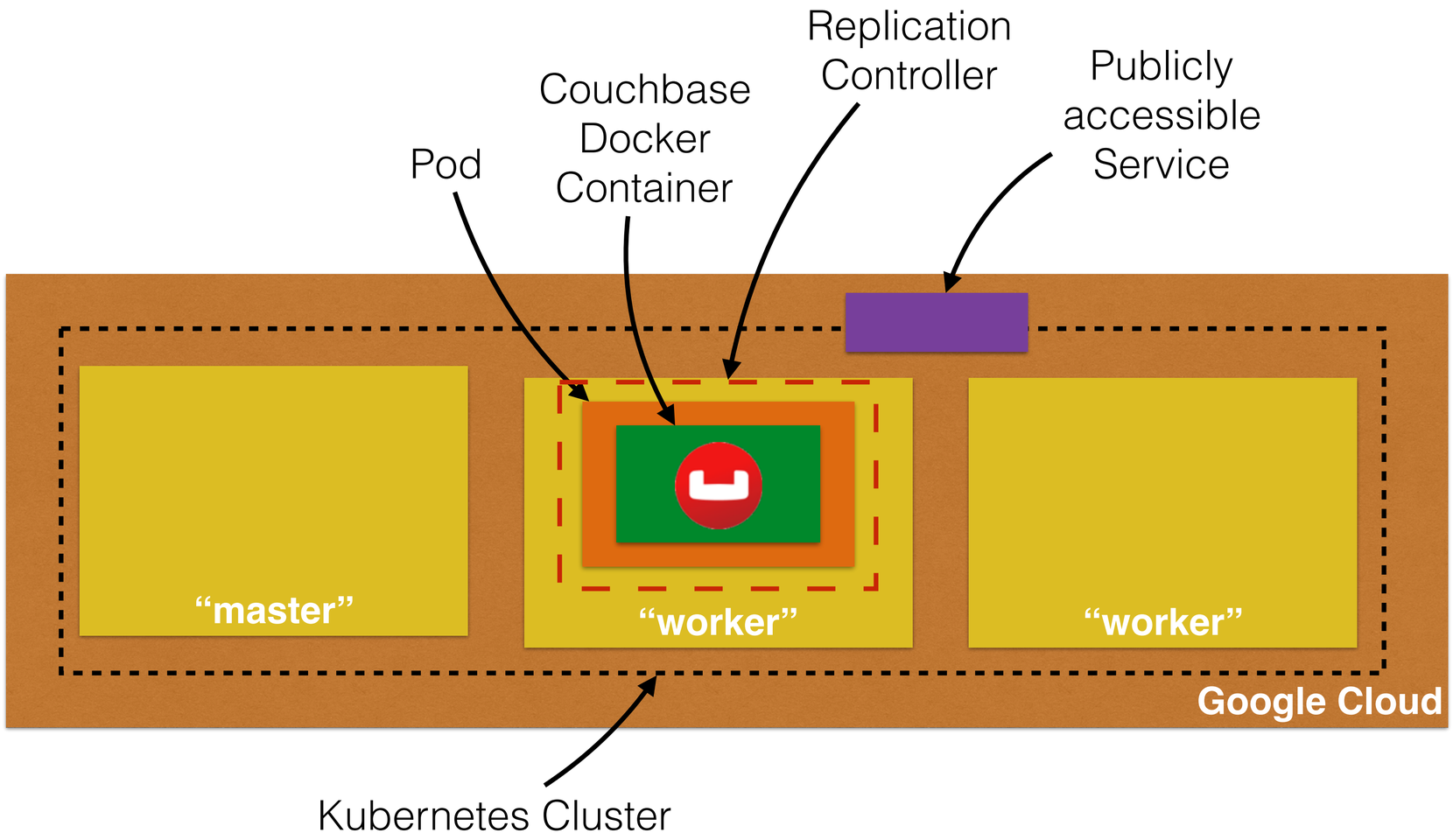
```
spec:
  type: NodePort
  ports:
  - name: admin
    port: 8091
    nodePort: 30001
  - name: query
    port: 8093
    nodePort: 30002
```

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

Exposing Service on Amazon



Exposing Service on Google Cloud

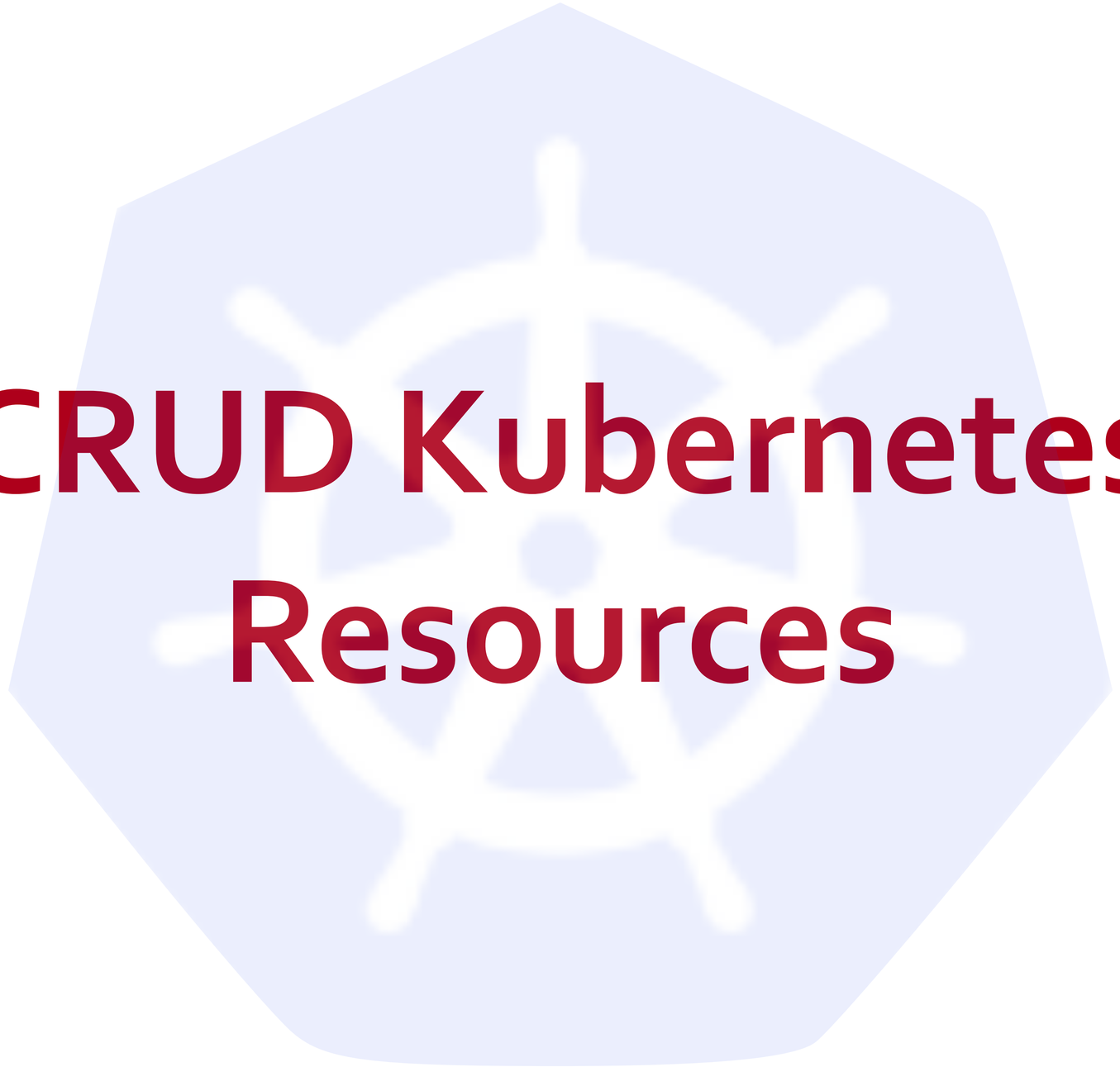


Deployment

- 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

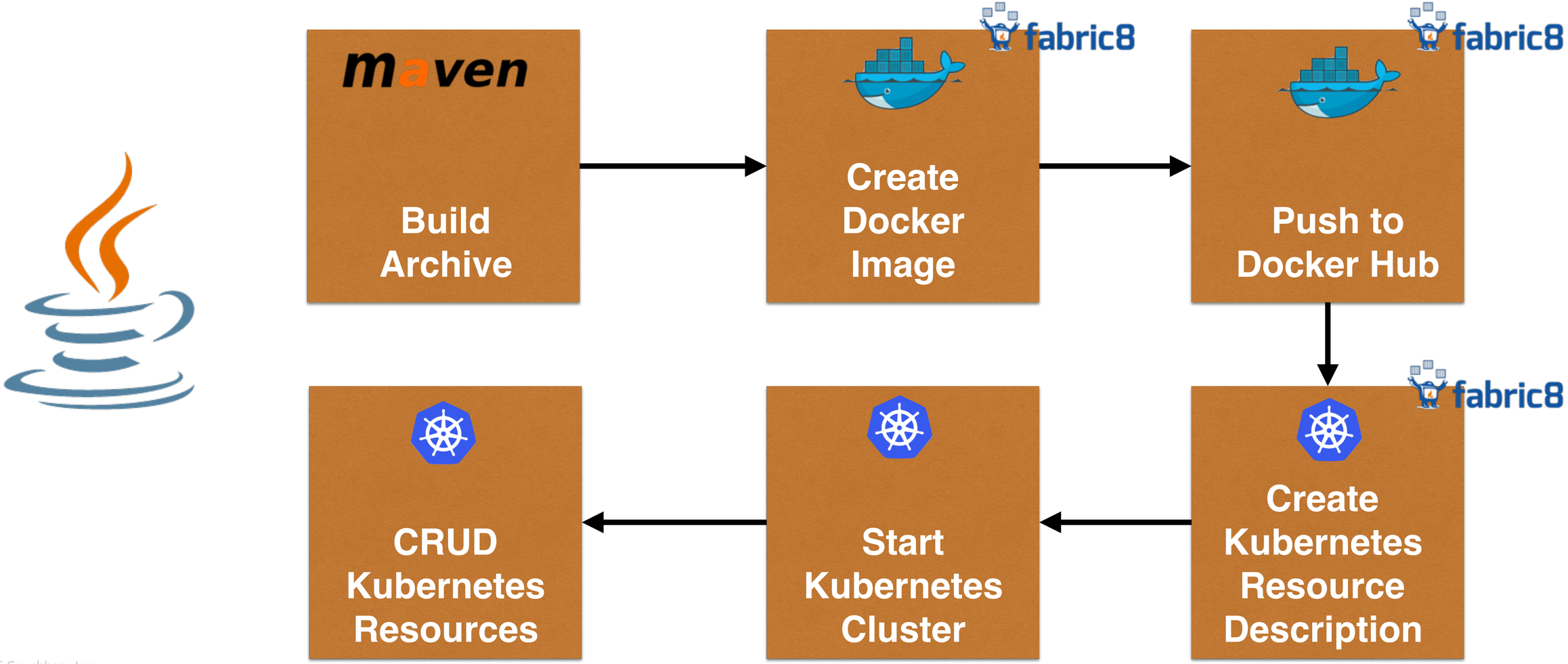
Deployment Configuration

```
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
```

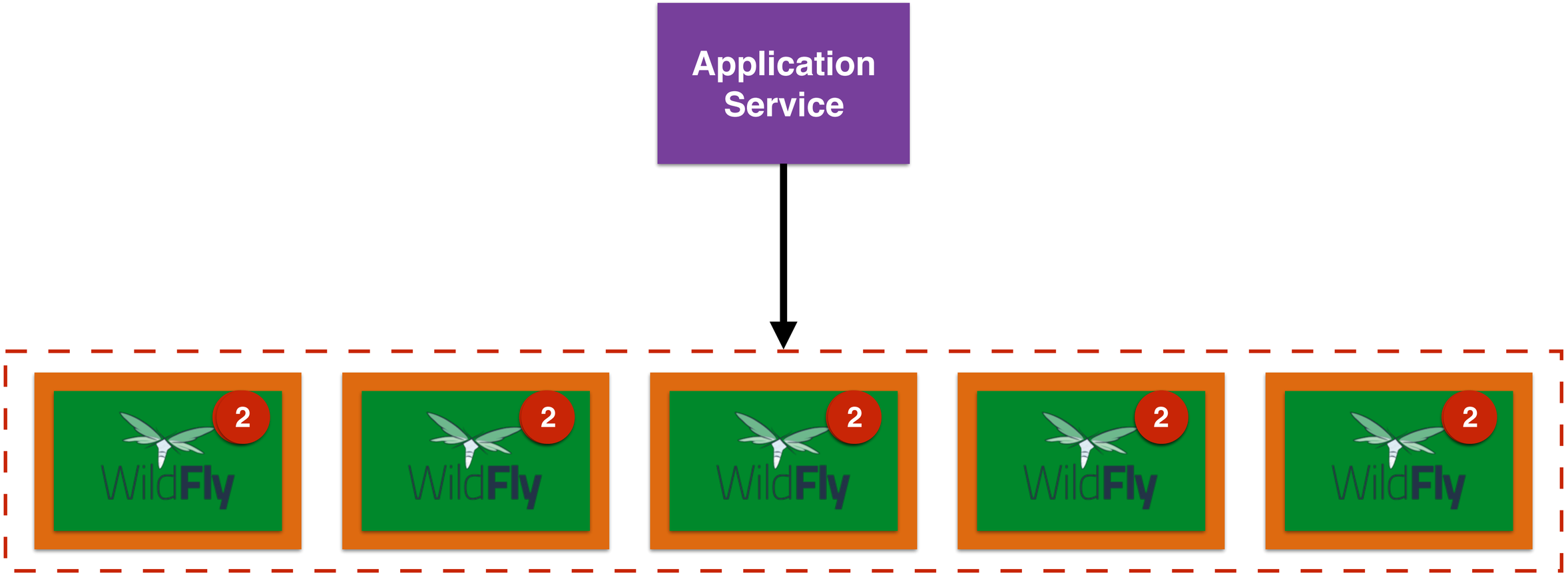


CRUD Kubernetes Resources

Kubernetes and Java Developers



Rolling Updates



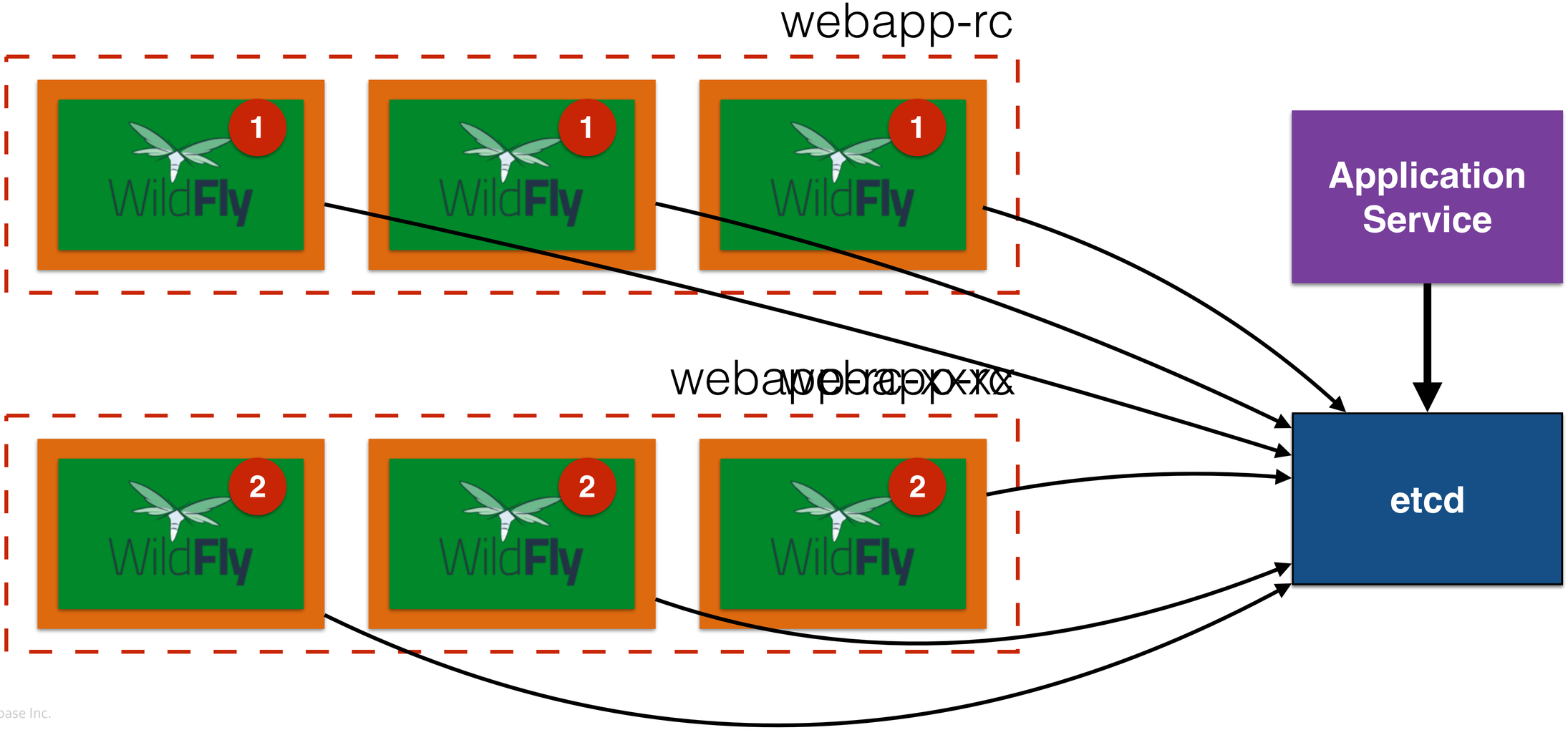
Rolling Updates - Replication Controller

- `kubectl rolling-update webapp-rc -f webapp-rc2.json`
- `kubectl rolling-update webapp-rc --image=arungupta/wildfly-app:2`

```
Created webapp-rc-5a11f15230716f6026c407eb9c1a60ca
Scaling up webapp-rc-5a11f15230716f6026c407eb9c1a60ca from 0 to 2, scaling down
webapp-rc from 2 to 0 (keep 2 pods available, don't exceed 3 pods)
Scaling webapp-rc-5a11f15230716f6026c407eb9c1a60ca up to 1
Scaling webapp-rc down to 1
Scaling webapp-rc-5a11f15230716f6026c407eb9c1a60ca up to 2
Scaling webapp-rc down to 0
Update succeeded. Deleting old controller: webapp-rc
Renaming webapp-rc-5a11f15230716f6026c407eb9c1a60ca to webapp-rc
replicationcontroller "webapp-rc" rolling updated
```

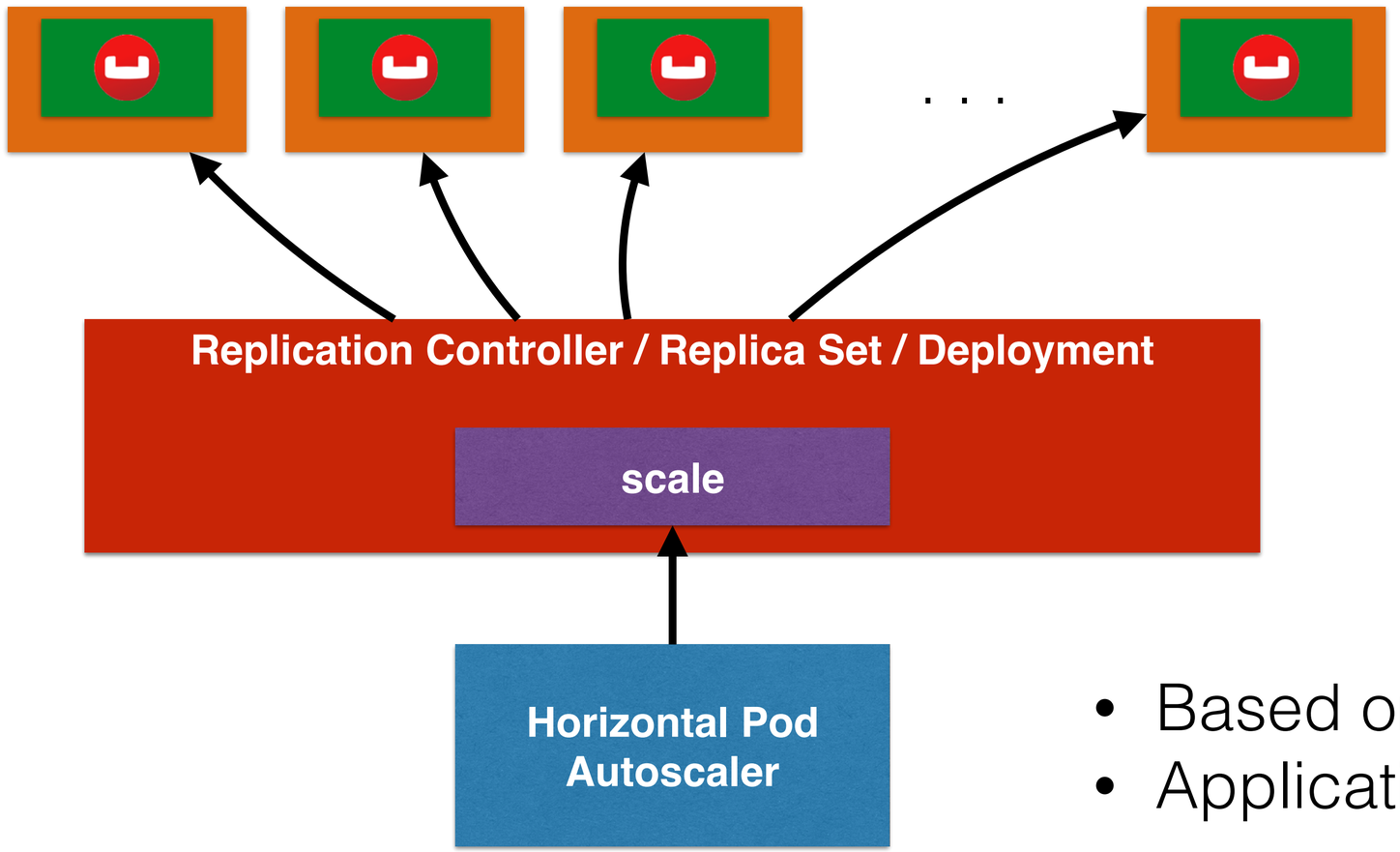

https://github.com/arun-gupta/kubernetes-java-sample/tree/master/rolling-update

Rolling Updates



https://github.com/arun-gupta/kubernetes-java-sample/tree/master/rolling-update

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

```
1  apiVersion: autoscaling/v1
2  kind: HorizontalPodAutoscaler
3  metadata:
4    name: wildfly-scaler
5  spec:
6    scaleTargetRef:
7      kind: ReplicaSet
8      name: wildfly-rs
9    minReplicas: 3
10   maxReplicas: 10
11   targetCPUUtilizationPercentage: 50
```

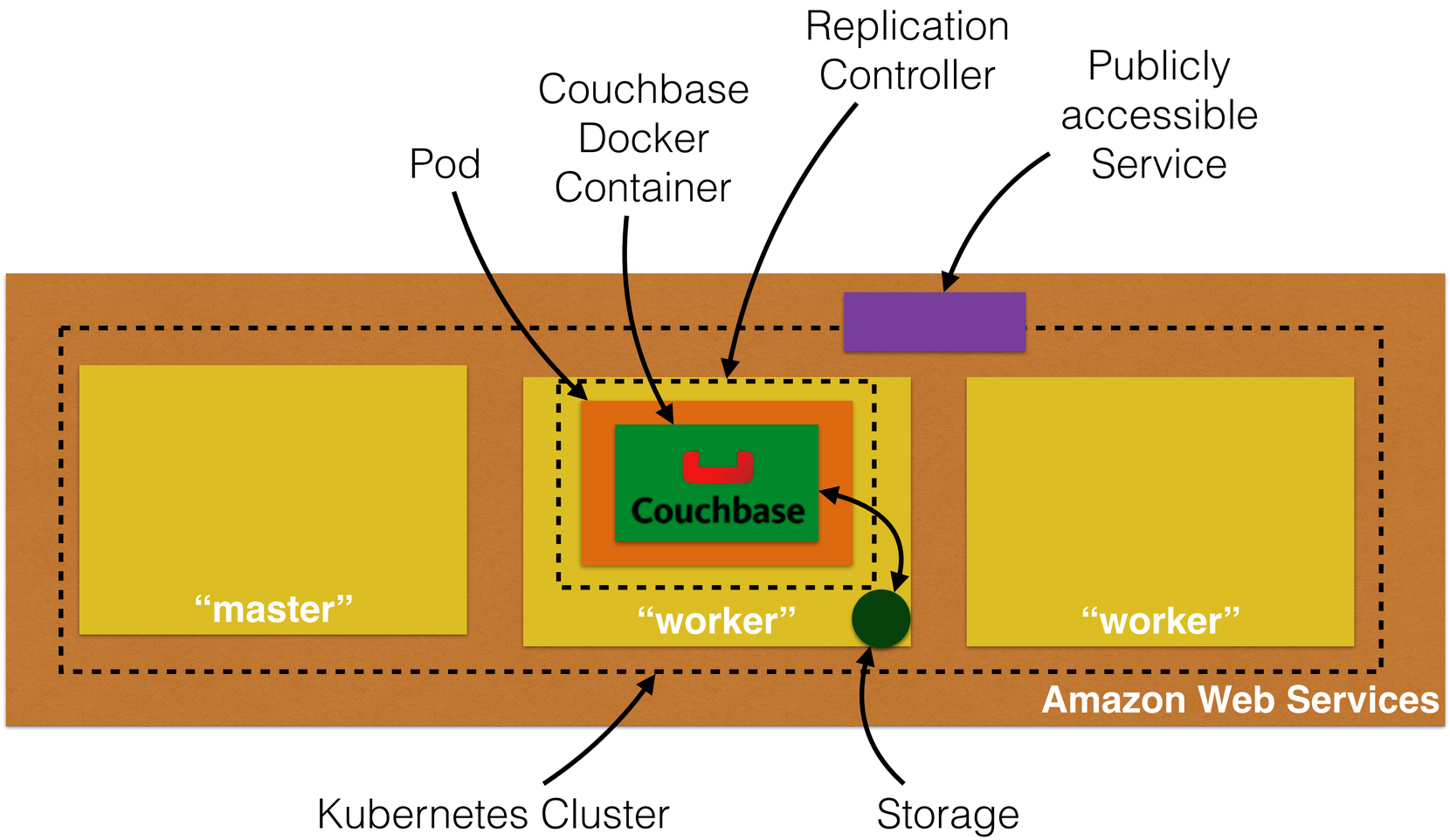
Volumes

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

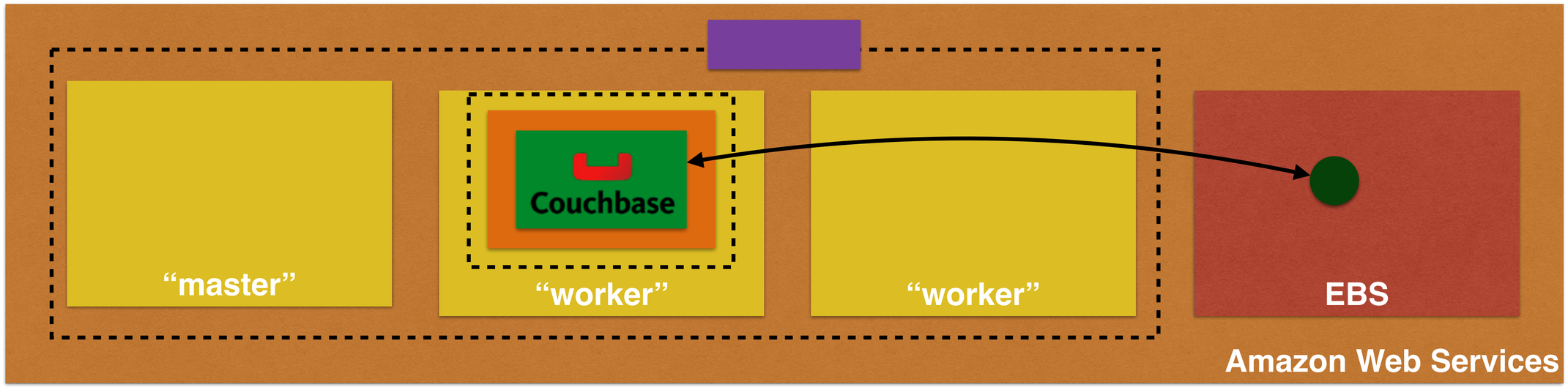
Volume Configuration

```
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
```

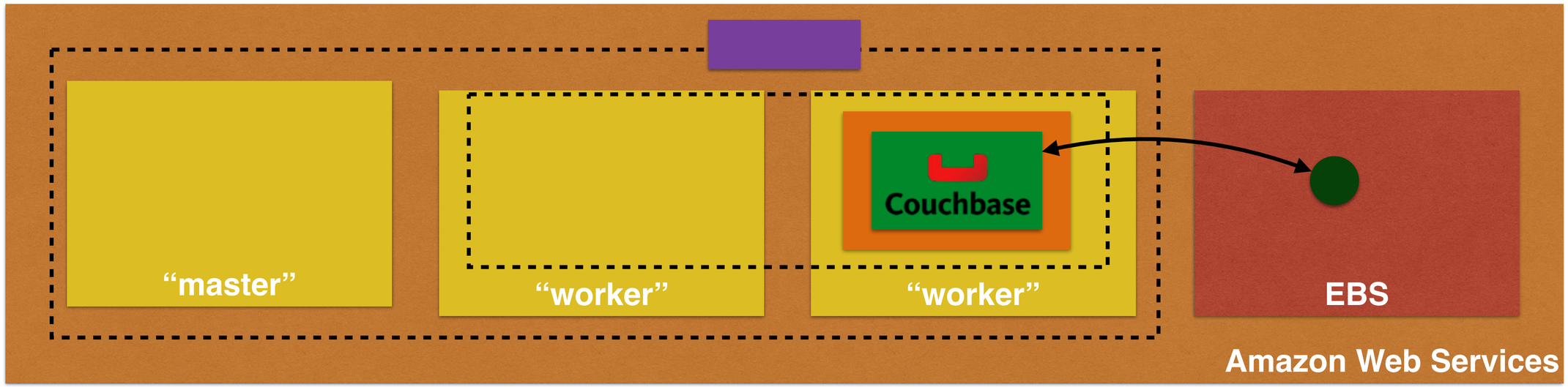
Stateful Containers



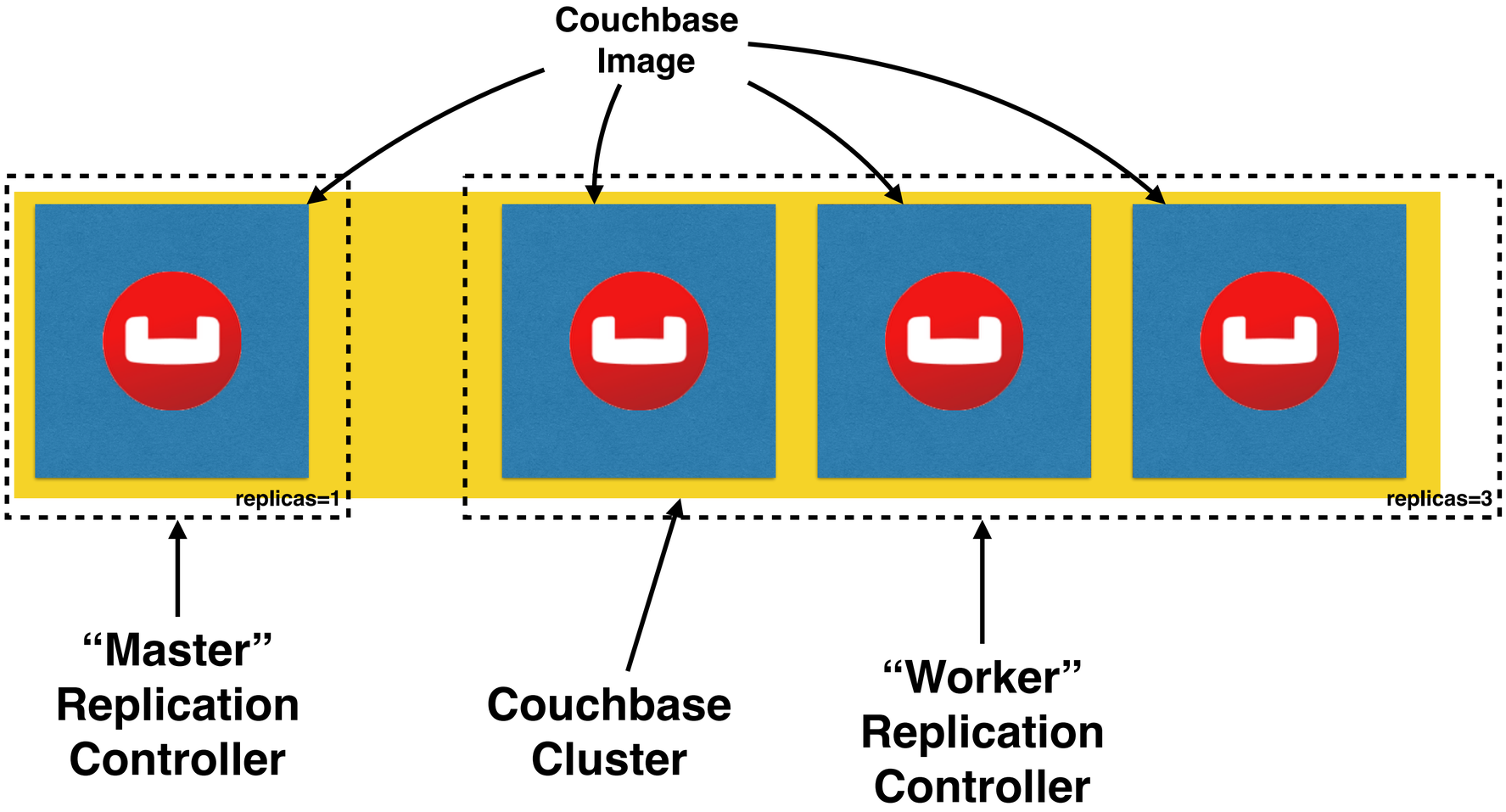
Stateful Containers



Stateful Containers



Couchbase Cluster on Kubernetes

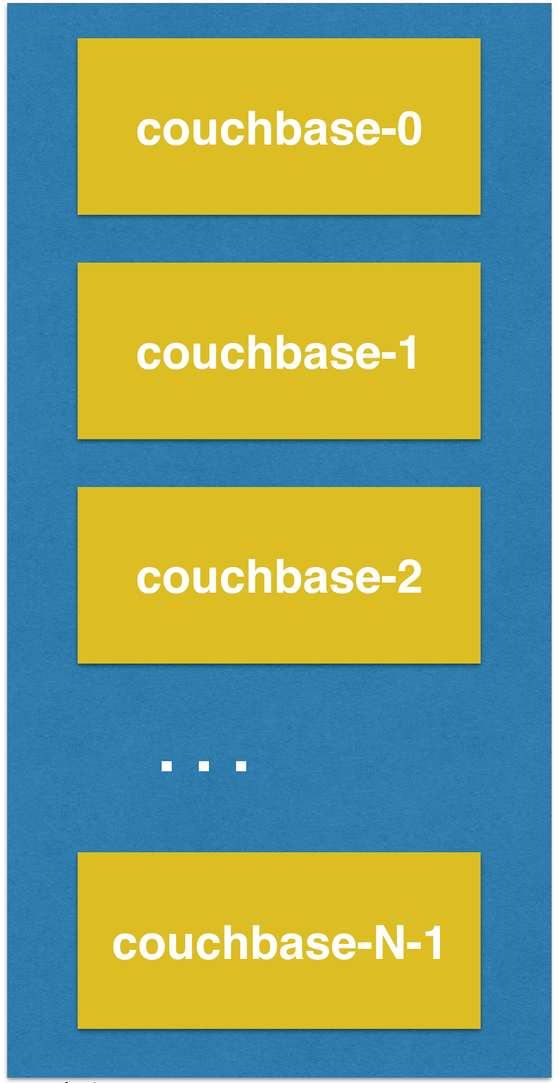


https://github.com/arun-gupta/couchbase-kubernetes/tree/master/cluster

http://blog.kubernetes.io/2016/08/create-couchbase-cluster-using-kubernetes.html

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
  - 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



https://github.com/arun-gupta/couchbase-kubernetes/tree/master/cluster-petset

Multitenancy - 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

Multitenancy - Resource Quota

Multitenancy - Limit

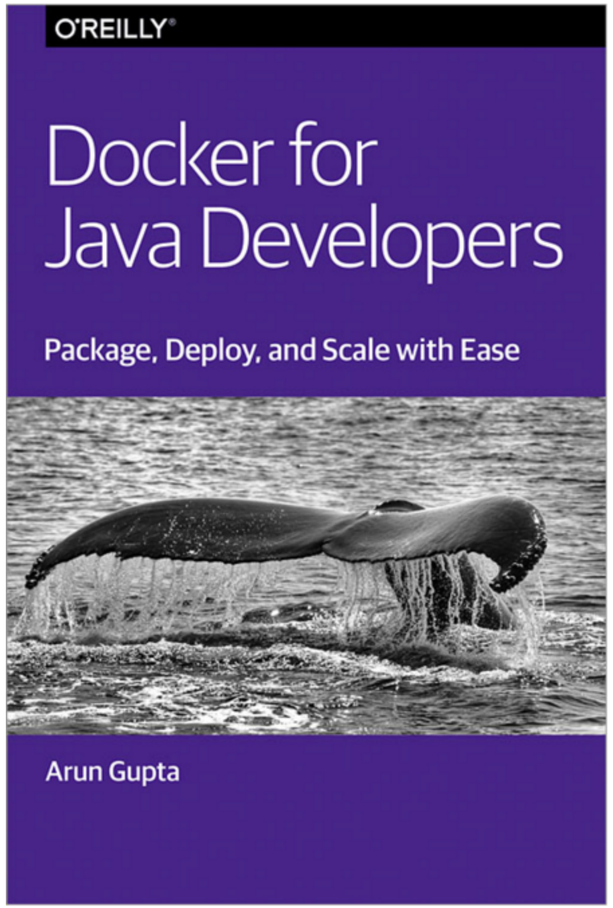
Batch Jobs

http://kubernetes.io/docs/user-guide/jobs/

Health Checks

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

bit.ly/dockerjava



bit.ly/kubejava

References

- github.com/arun-gupta/kubernetes-java-sample
- kubernetes.io
- Containers recipe: couchbase.com/containers