Kubernetes

An Introduction to Kubernetes and What’s New in v1.6

{code} by Dell EMC - Community Webinar

April 6, 2017

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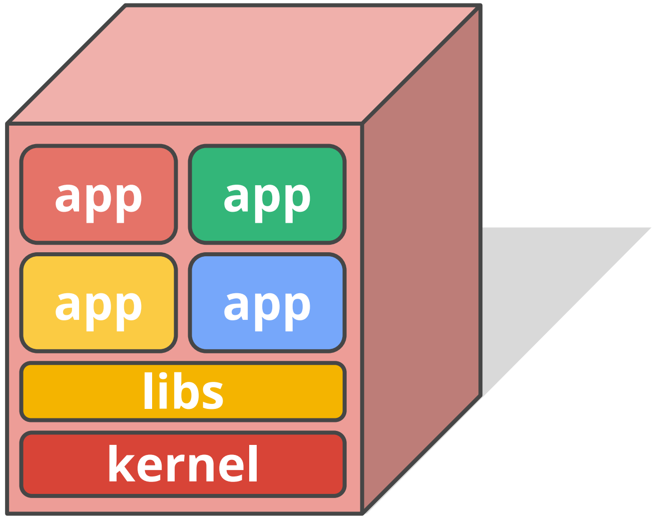
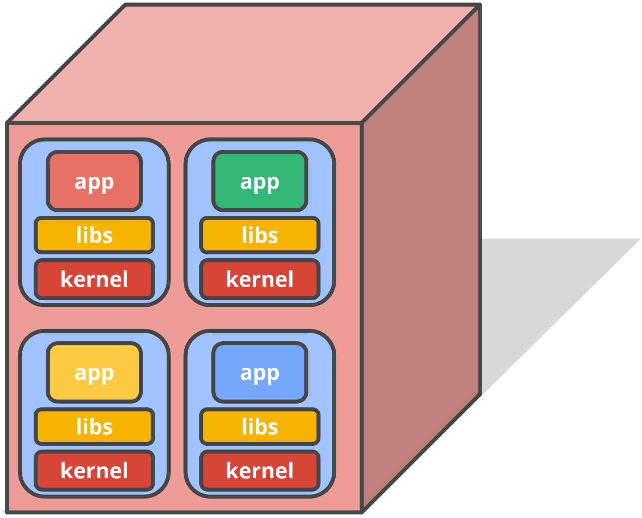
Why Containers?



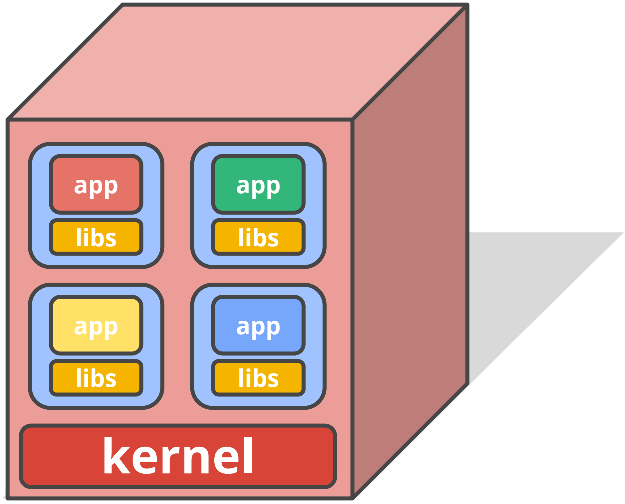
Shared Machines

- ✗ No isolation
- ✗ Shared Libraries



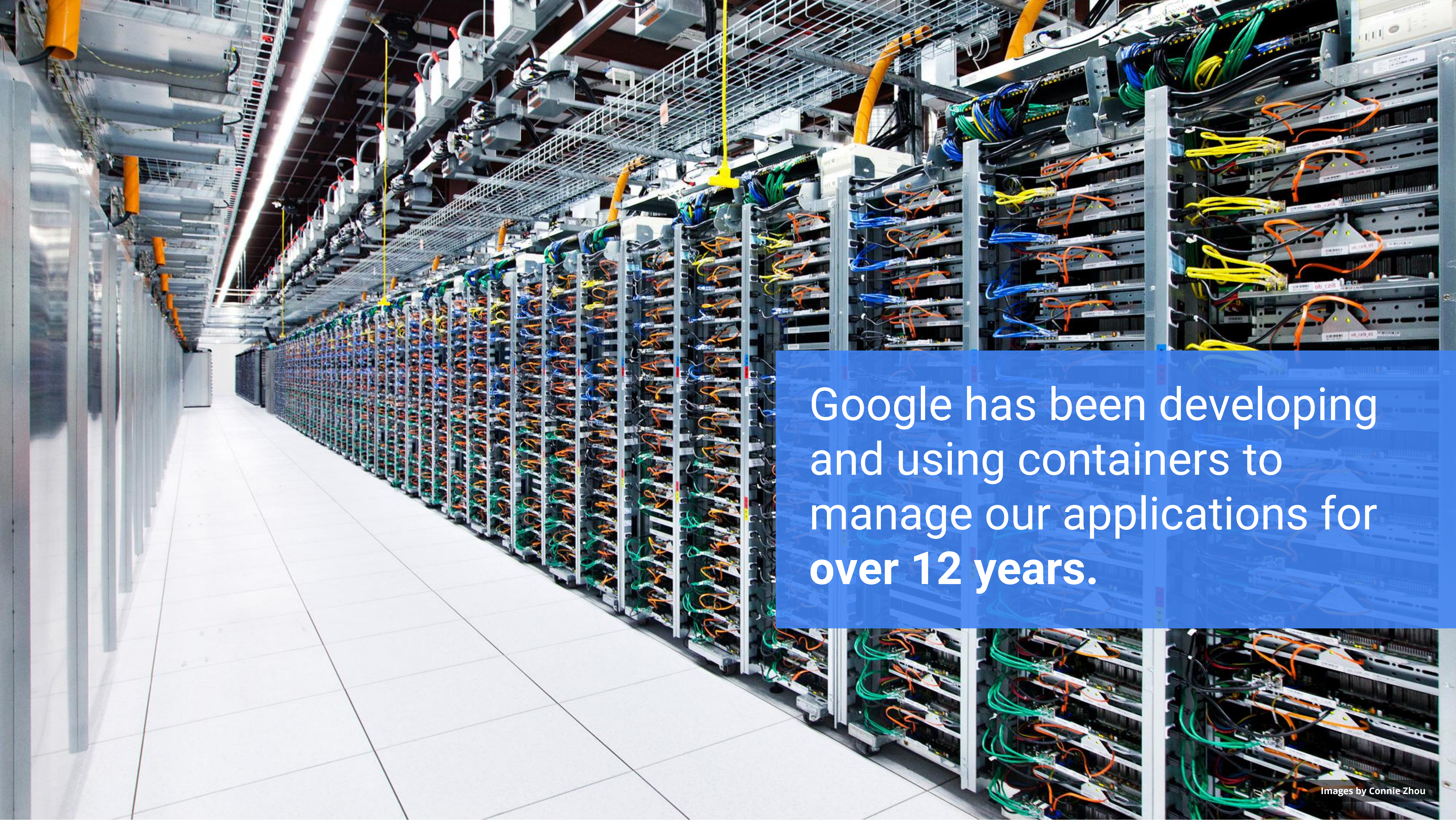
Virtual Machines

- ✓ Isolation
- ✓ No Shared Libraries
- ✗ Hard to manage
- ✗ Expensive and Inefficient



Containers

- ✓ Isolation
- ✓ No Shared Libraries
- ✓ Less overhead
- ✗ Less Dependency on Host OS



Google has been developing and using containers to manage our applications for **over 12 years.**

Images by Connie Zhou

Everything at Google runs in containers:

- Gmail, Web Search, Maps, ...
- MapReduce, batch, ...
- GFS, Colossus, ...
- Even **Google's Cloud Platform:** our VMs run in containers!

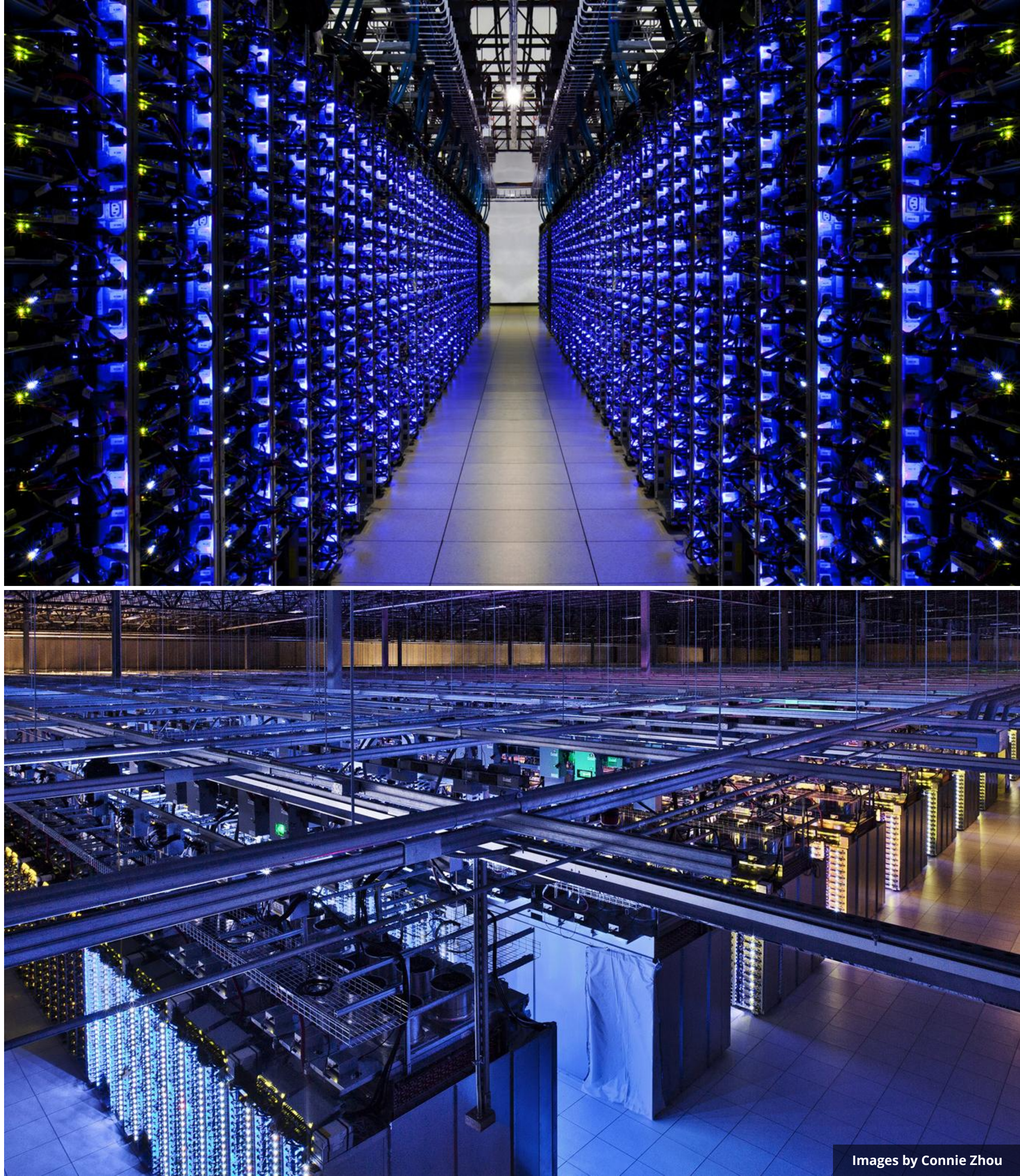
We launch over **2 billion** containers **per week**

Shipping Containers At Clyde, by Steve Gibson

Managing Containerized Applications is Different

- Deployment
- Management, monitoring
- Isolation (very complicated!)
- Updates
- Discovery
- Scaling, replication, sets

A **fundamentally different** way of managing applications requires different tooling and abstractions



Images by Connie Zhou

Kubernetes

Greek for *"Helmsman"*; also the root of the words *"governor"* and *"cybernetic"*

- Manages container clusters
- Inspired and informed by Google's experiences and internal systems
- Supports multiple cloud and bare-metal environments
- Supports multiple container runtimes
- **100% Open source**, written in Go

Manage applications, not machines

Workload Portability

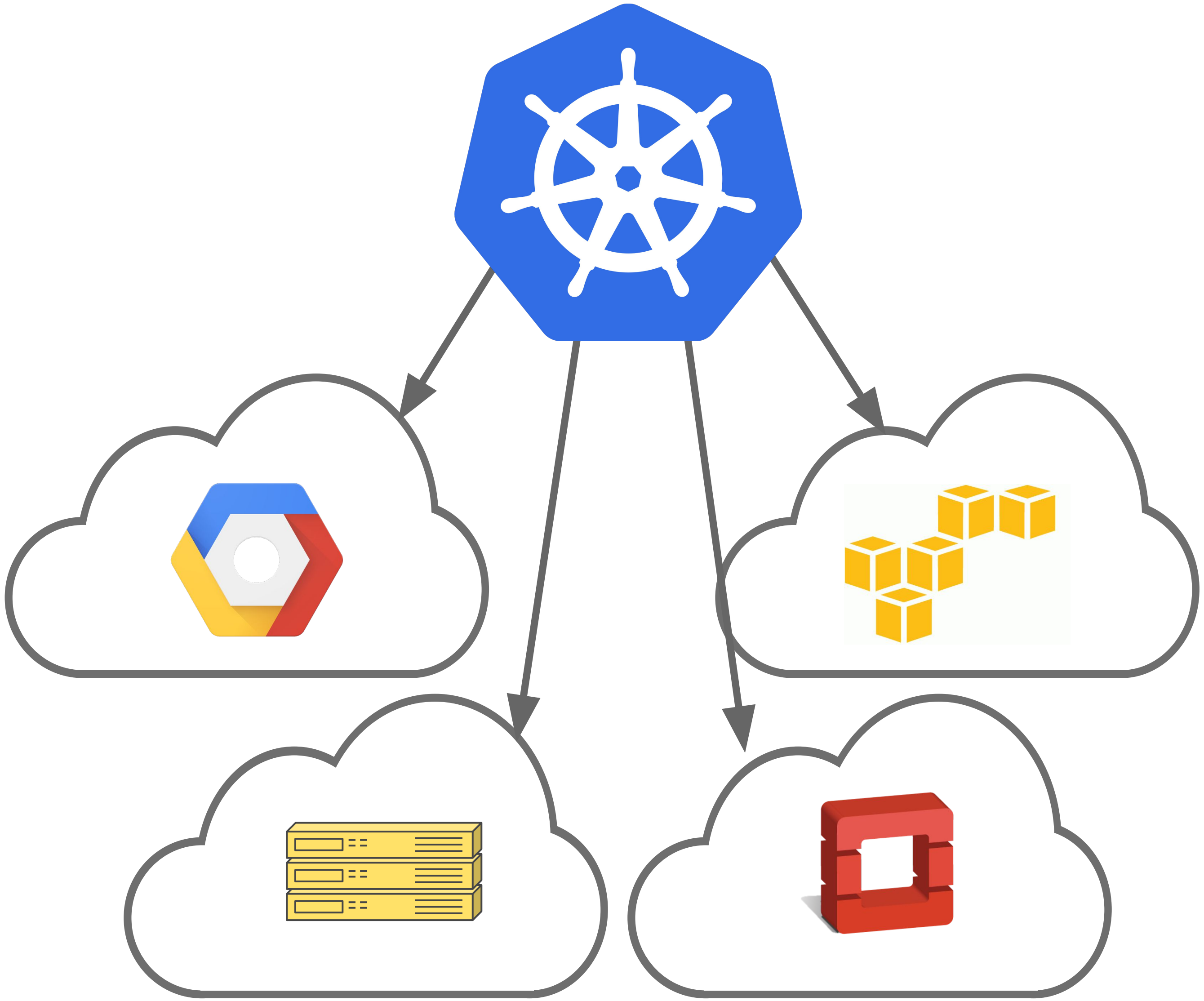
Workload portability

Goal: Avoid vendor lock-in

Runs in many environments, including “bare metal” and “your laptop”

The API and the implementation are 100% open

The whole system is modular and replaceable



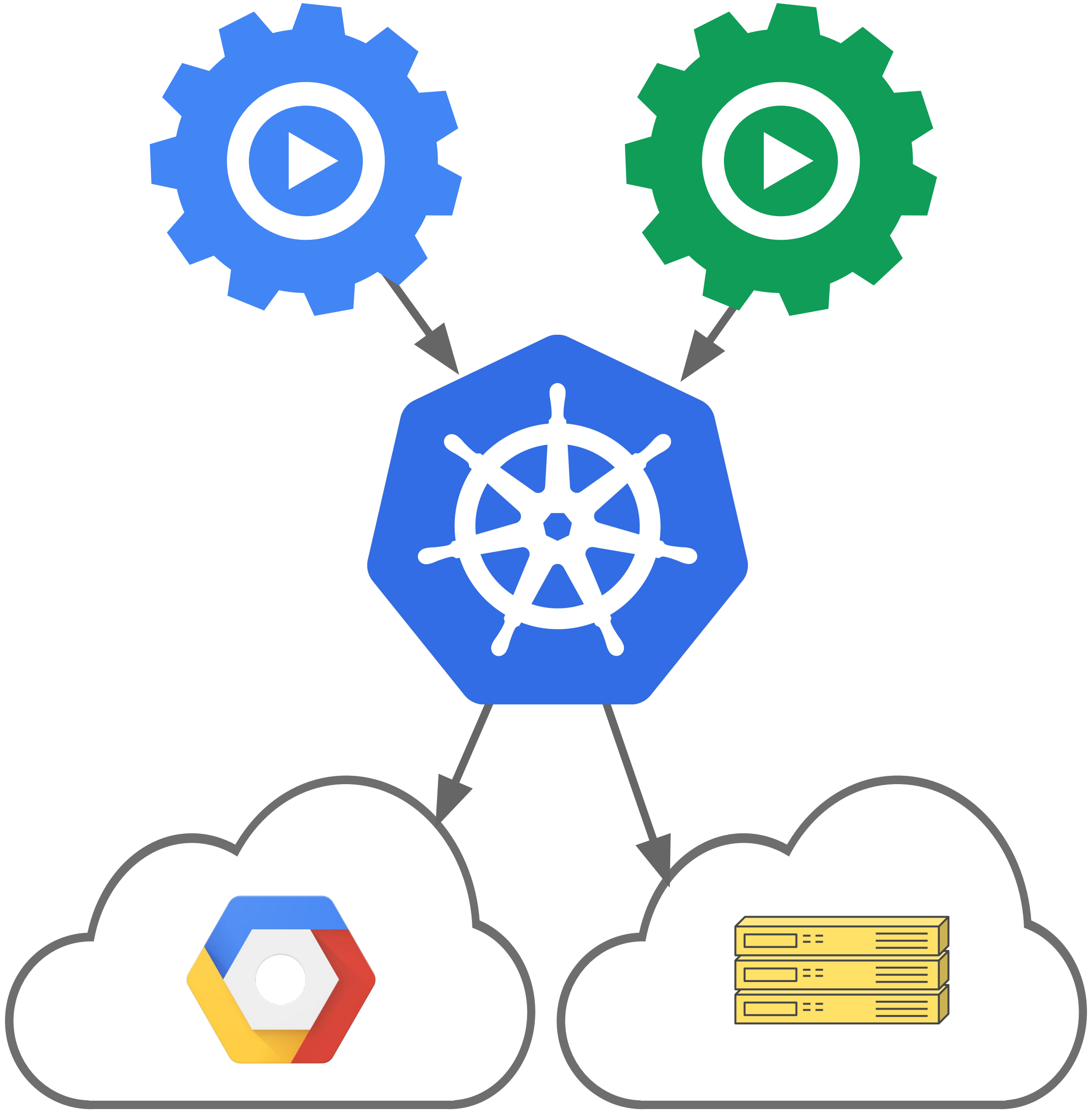
Workload portability

Goal: Write once, run anywhere*

Don’t force apps to know about concepts that are cloud-provider-specific

Examples of this:

- Network model
- Ingress
- Service load-balancers
- PersistentVolumes



** approximately*

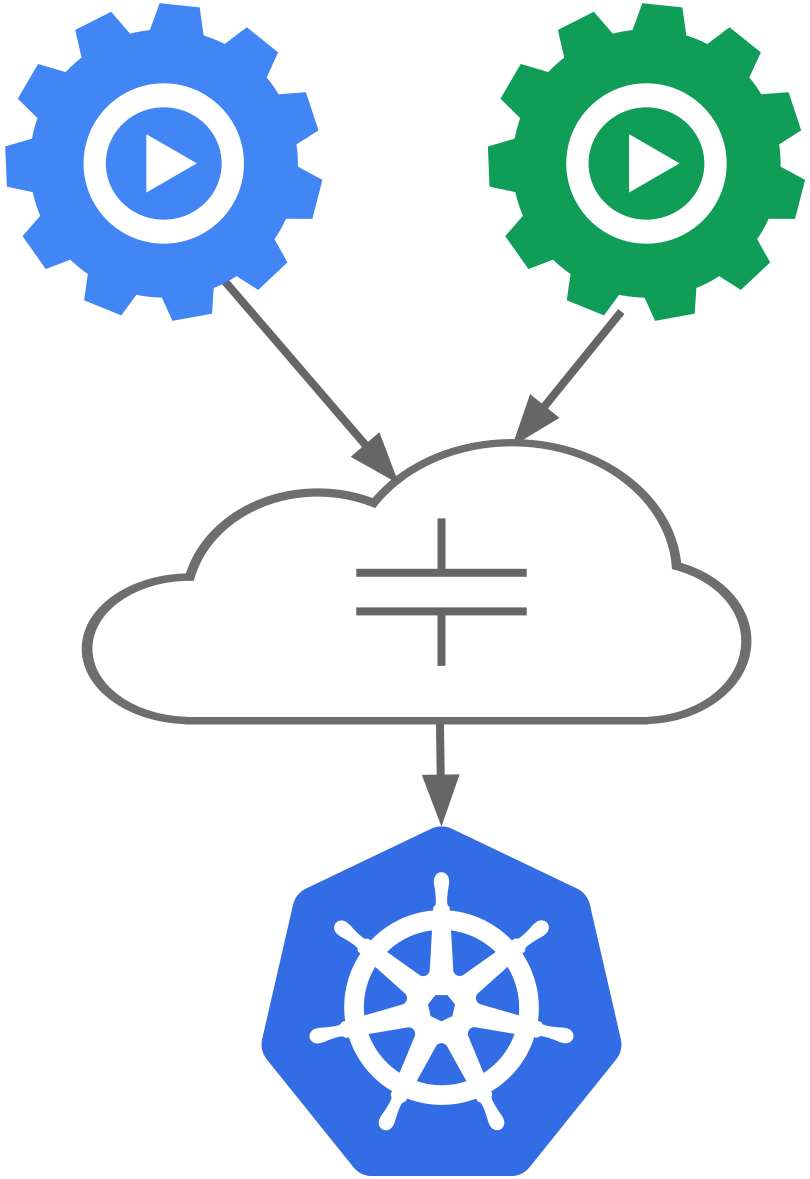
Workload portability

Goal: Avoid coupling

Don’t force apps to know about concepts that are Kubernetes-specific

Examples of this:

- Services / DNS
- Secrets / ConfigMaps
- Namespaces



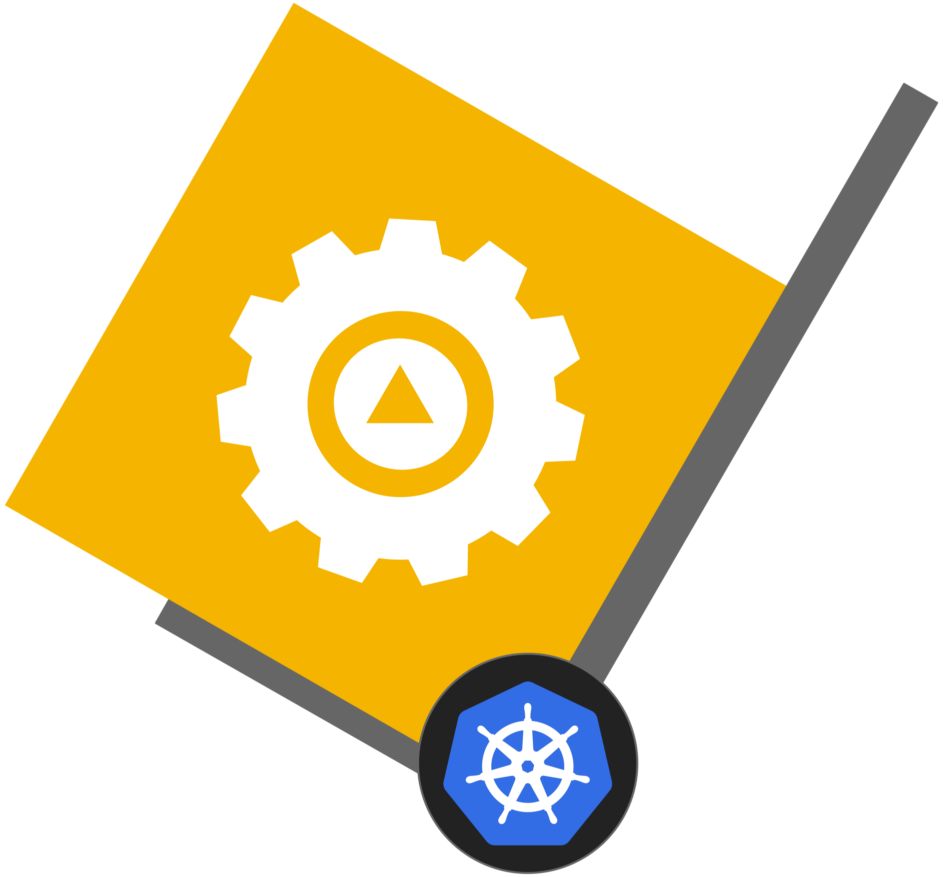
Workload portability

Result: Portability

Build your apps on-prem, lift-and-shift into cloud when you are ready

Don’t get stuck with a platform that doesn’t work for you

Put your app on wheels and move it whenever and wherever you need



Why Google Container Engine (GKE)?

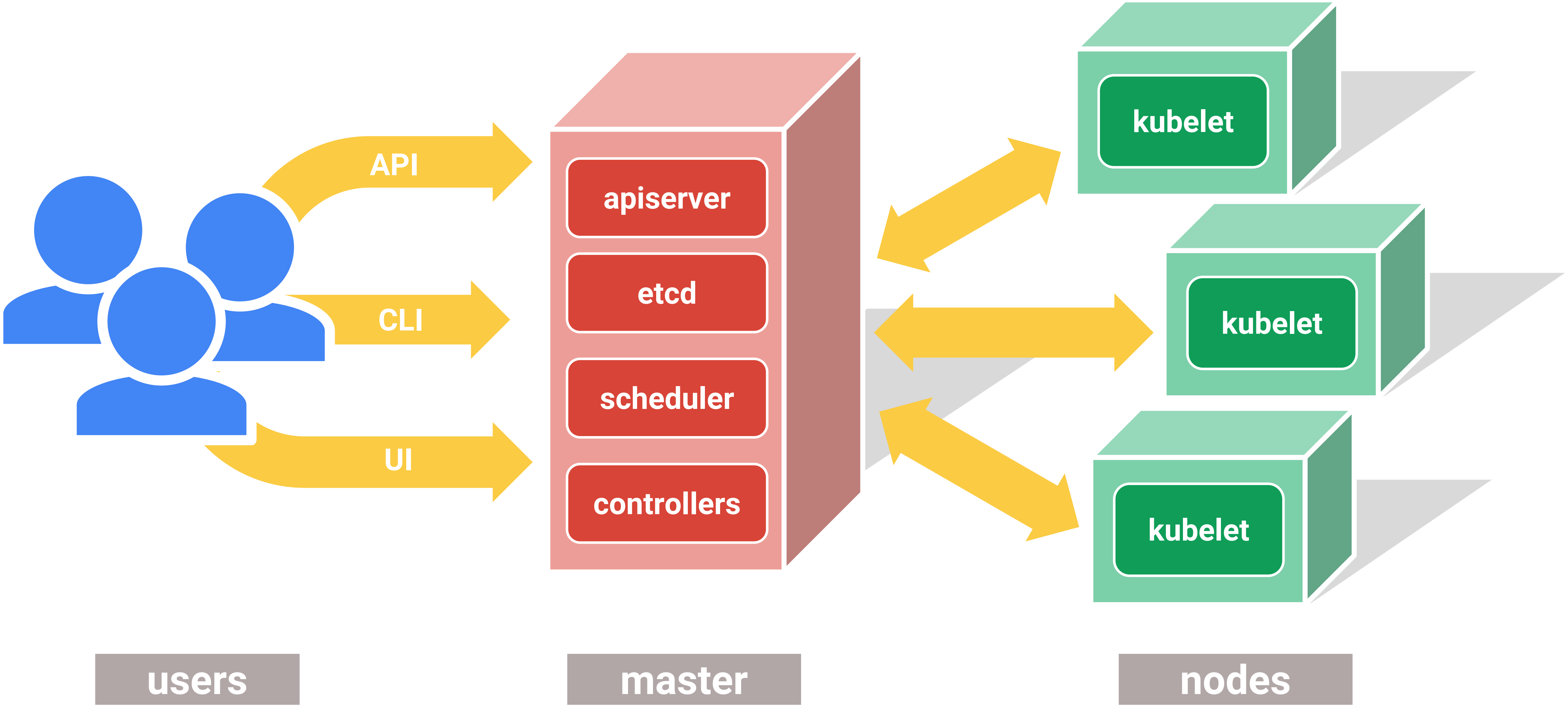
Creating/Managing the cluster:

- Choose a node OS: CoreOS, Atomic, RHEL, Debian, CentOS, Ubuntu, ...
- Provision machines: Boot VMs, install and run kube components, ...
- Configure networking: IP ranges for Pods, Services, SDN, ...
- Start cluster services: DNS, logging, monitoring, ...
- Manage nodes: kernel upgrades, OS updates, hardware failures...

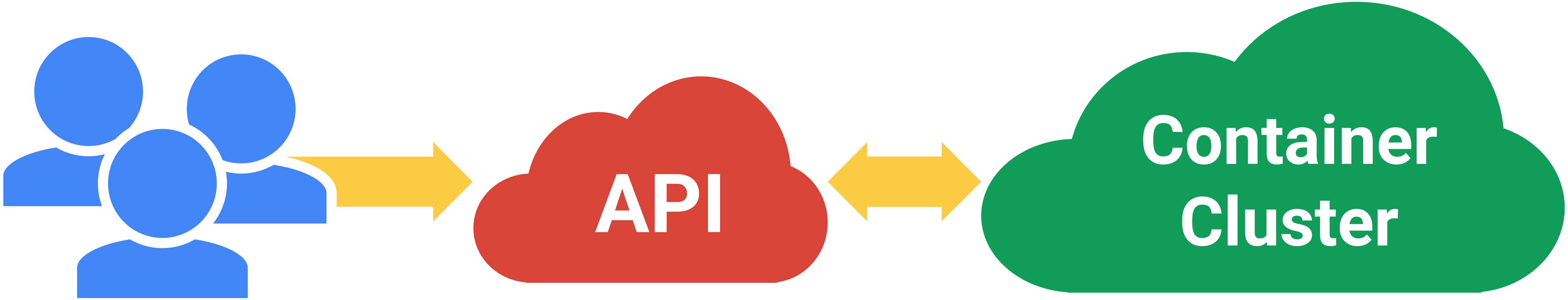
This is where **Google Container Engine (GKE)** really helps:

- One click (or command-line) cluster creation
- We manage the nodes and monitor the master control plane

The 10000 foot view



All you really care about



Pods

Pods

Small group of containers & volumes

Tightly coupled

The atom of scheduling & placement

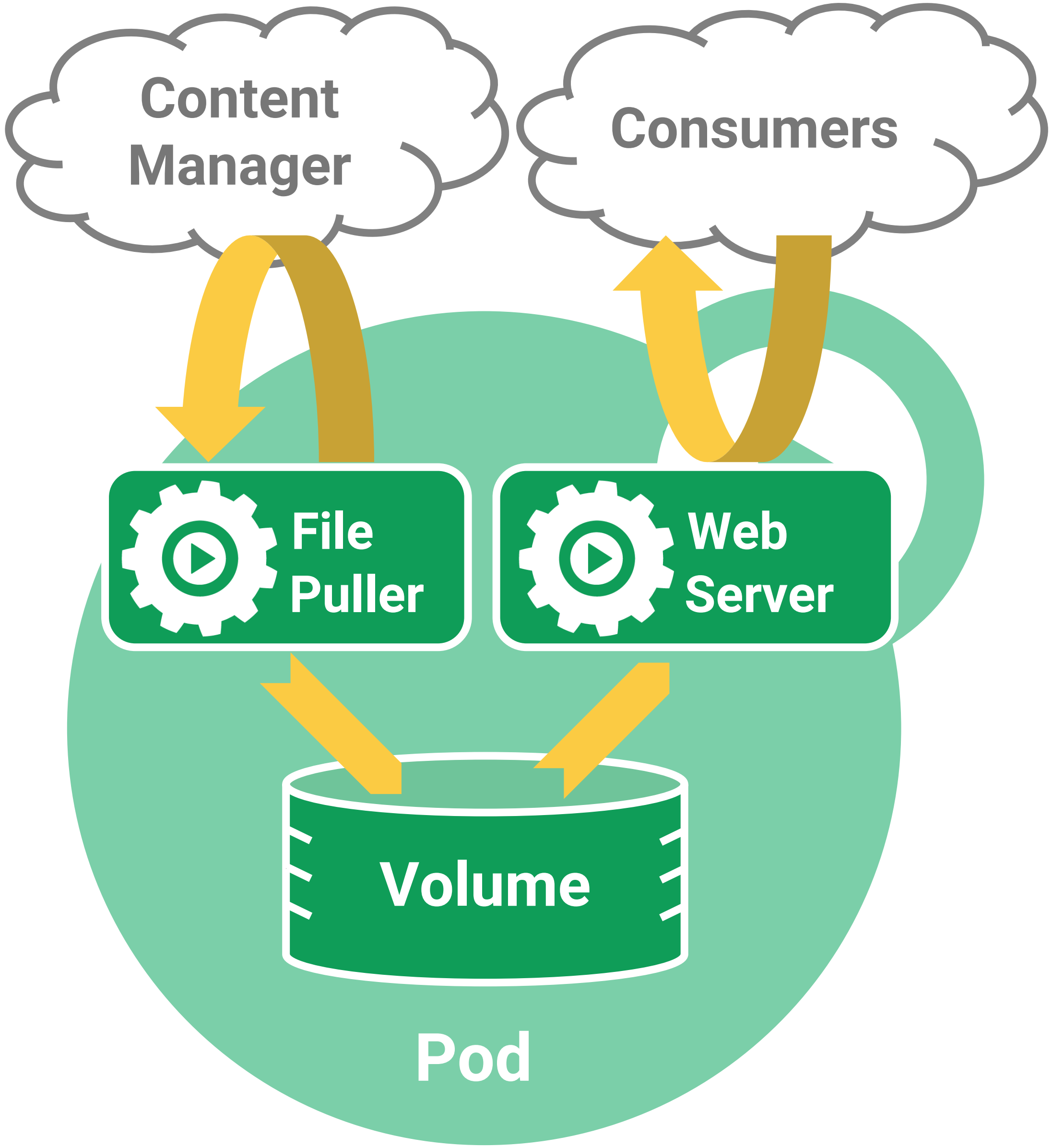
Shared namespace

- share IP address & localhost
- share IPC, etc.

Managed lifecycle

- bound to a node, restart in place
- can die, cannot be reborn with same ID

Example: data puller & web server



Replication

ReplicaSets

A simple control loop

Runs out-of-process wrt API server

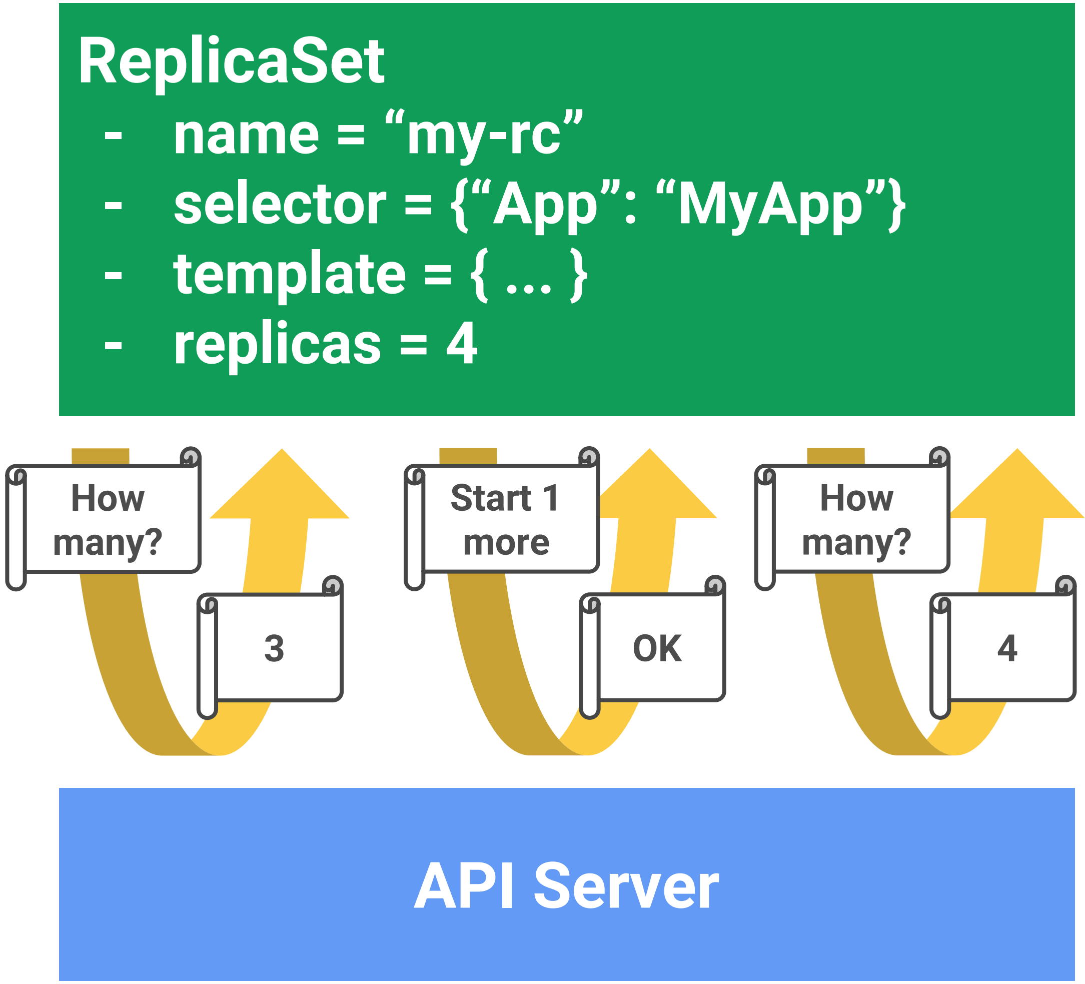
One job: ensure N copies of a pod

- grouped by a selector
- too few? start some
- too many? kill some

Layered on top of the public Pod API

Replicated pods are **fungible**

- No implied order or identity



ReplicaSet

- name = “my-rc”
- selector = {“App”: “MyApp”}
- template = { ... }
- replicas = 4

Rolling Update

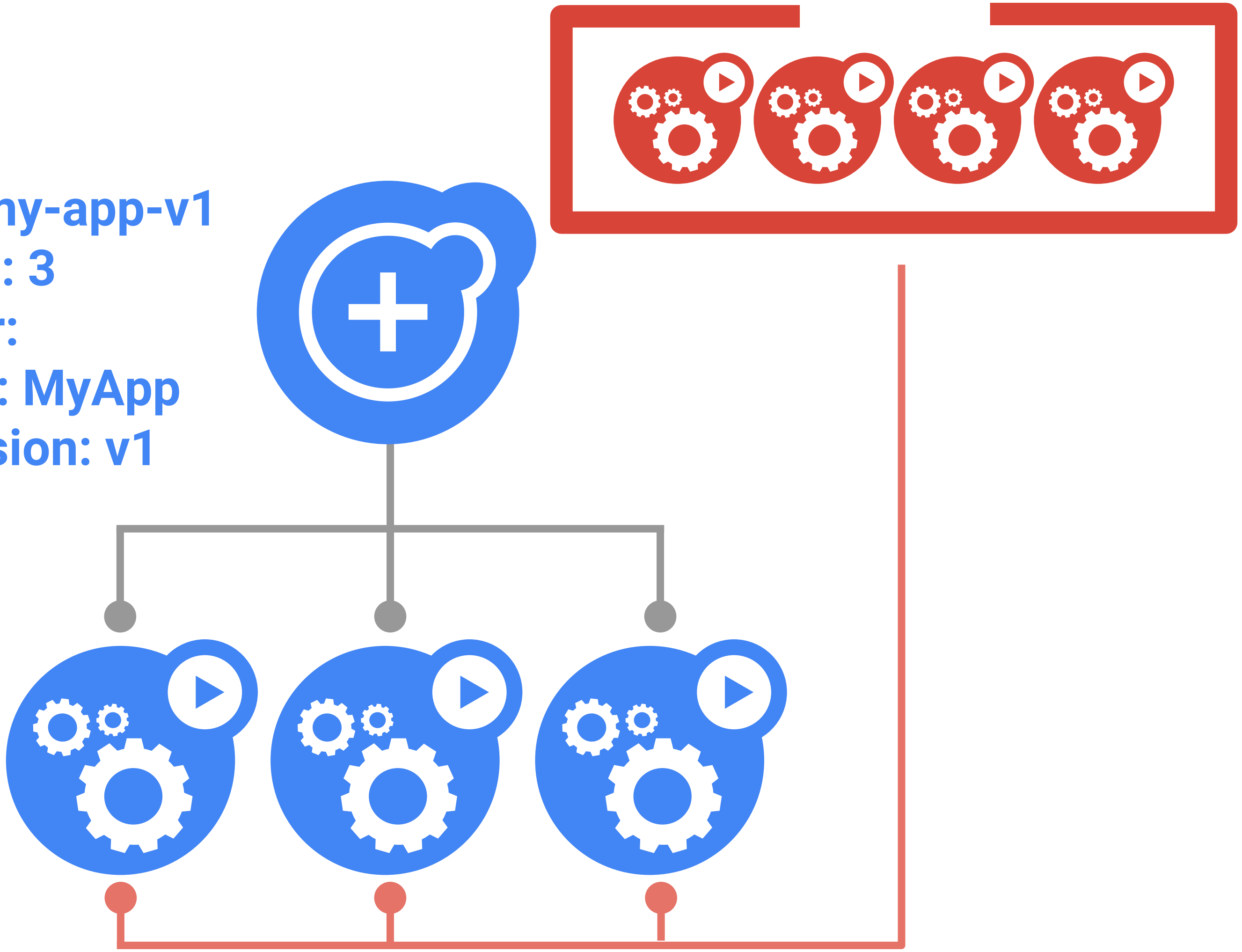
Rolling Update

Service

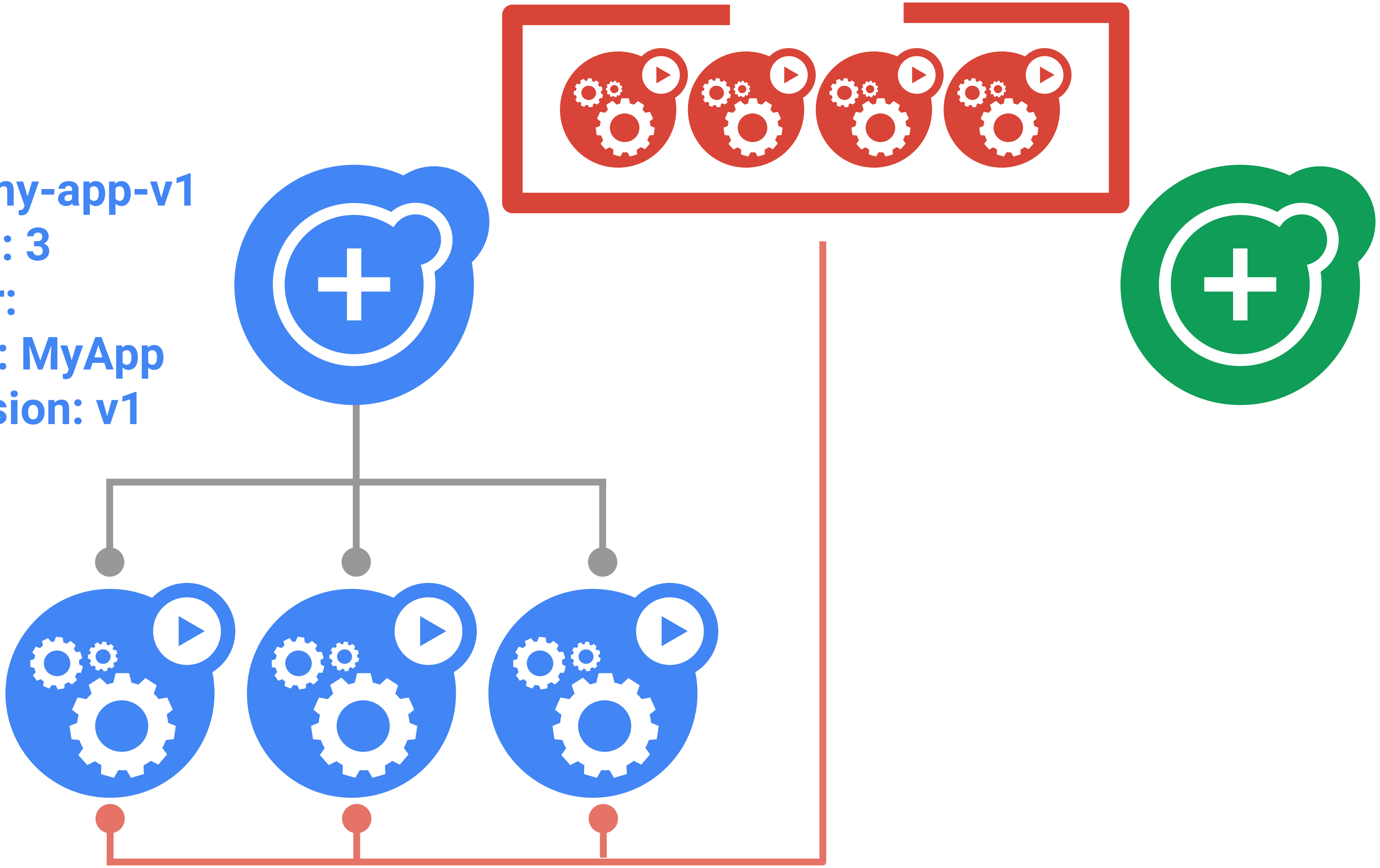
- app: MyApp

ReplicaSet

- name: my-app-v1
- replicas: 3
- selector:
  - app: MyApp
  - version: v1



Rolling Update



Service

- app: MyApp

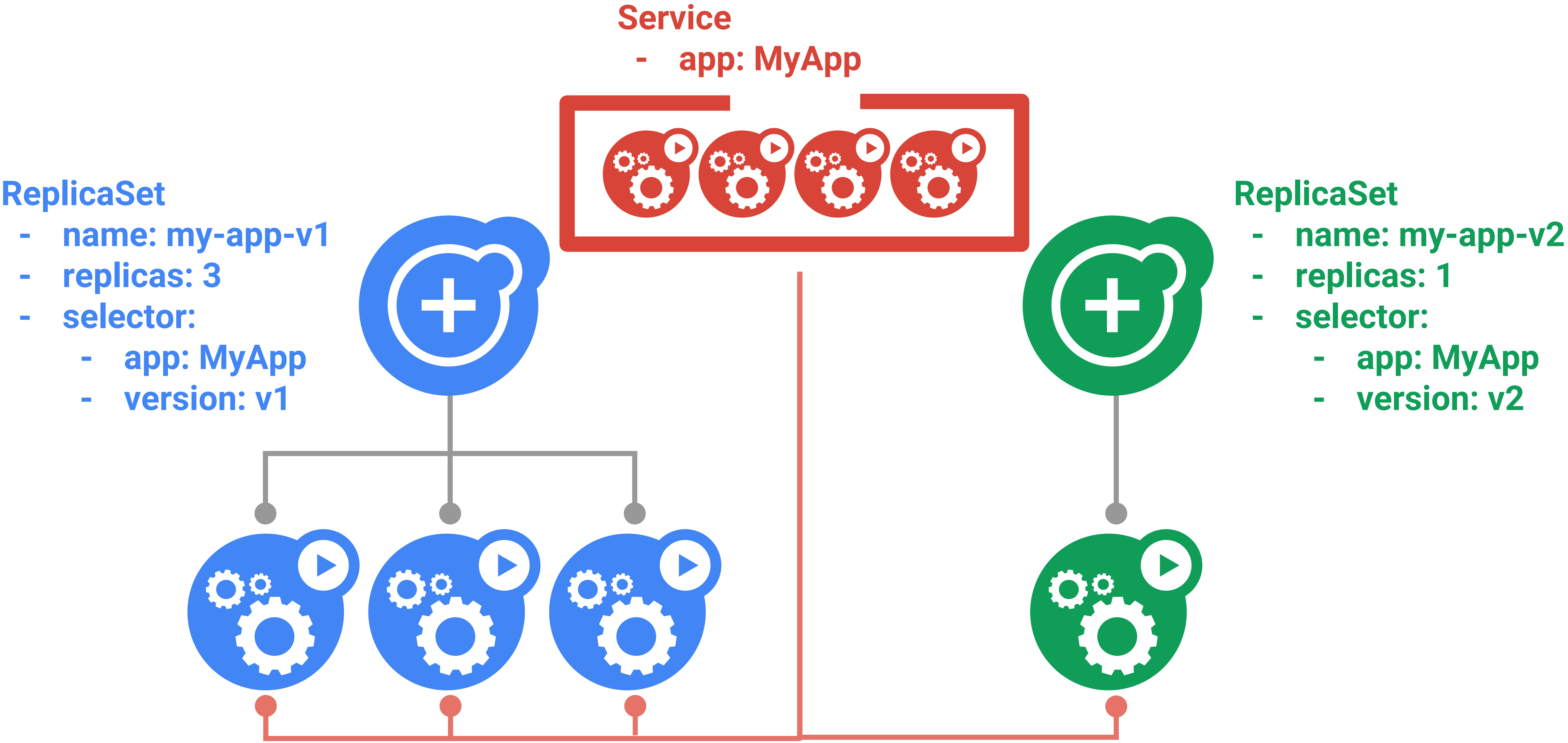
ReplicaSet

- name: my-app-v1
- replicas: 3
- selector:
  - app: MyApp
  - version: v1

ReplicaSet

- name: my-app-v2
- replicas: 0
- selector:
  - app: MyApp
  - version: v2

Rolling Update



Service

- app: MyApp

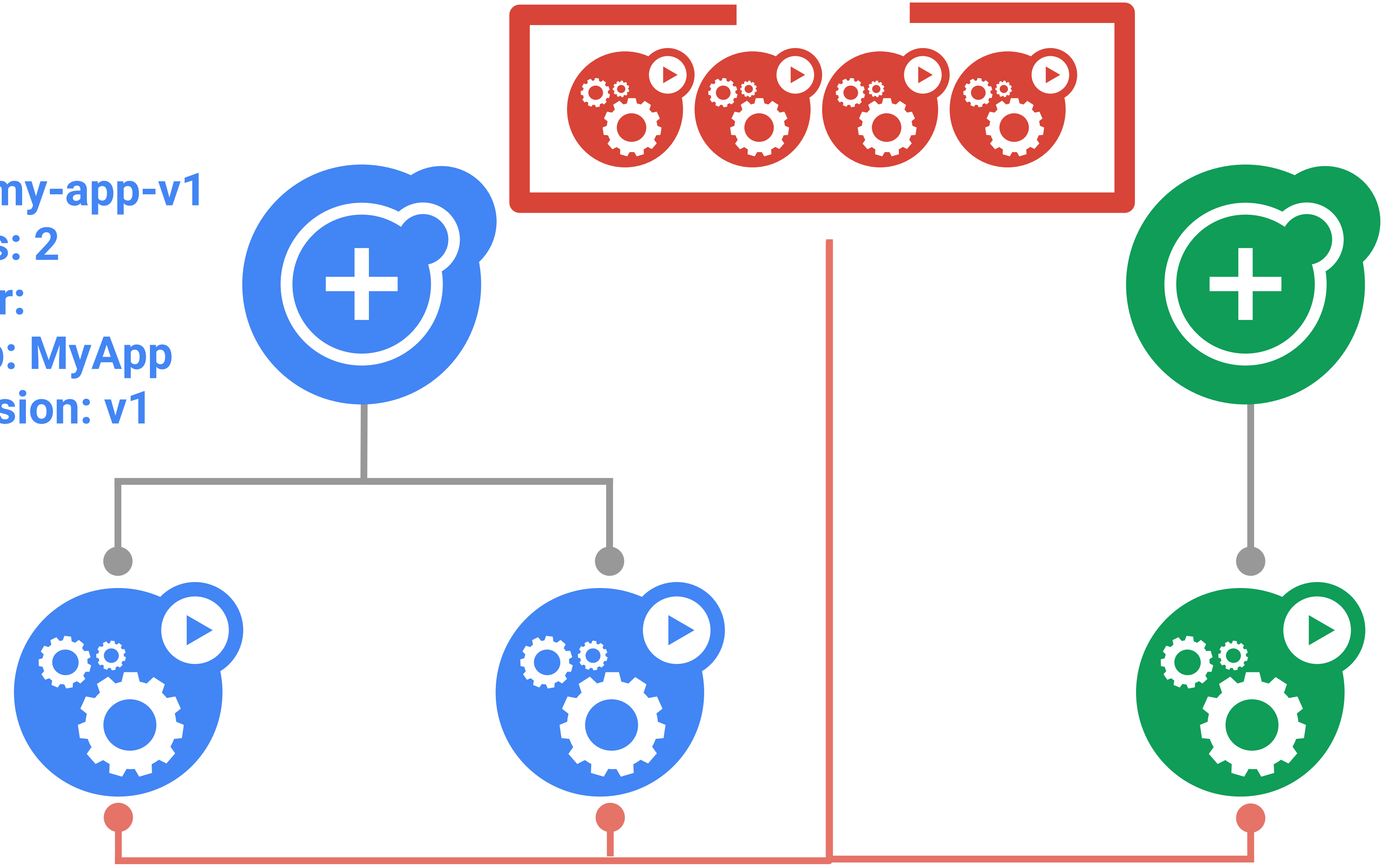
ReplicaSet

- name: my-app-v1
- replicas: 3
- selector:
  - app: MyApp
  - version: v1

ReplicaSet

- name: my-app-v2
- replicas: 1
- selector:
  - app: MyApp
  - version: v2

Rolling Update



Service

- app: MyApp

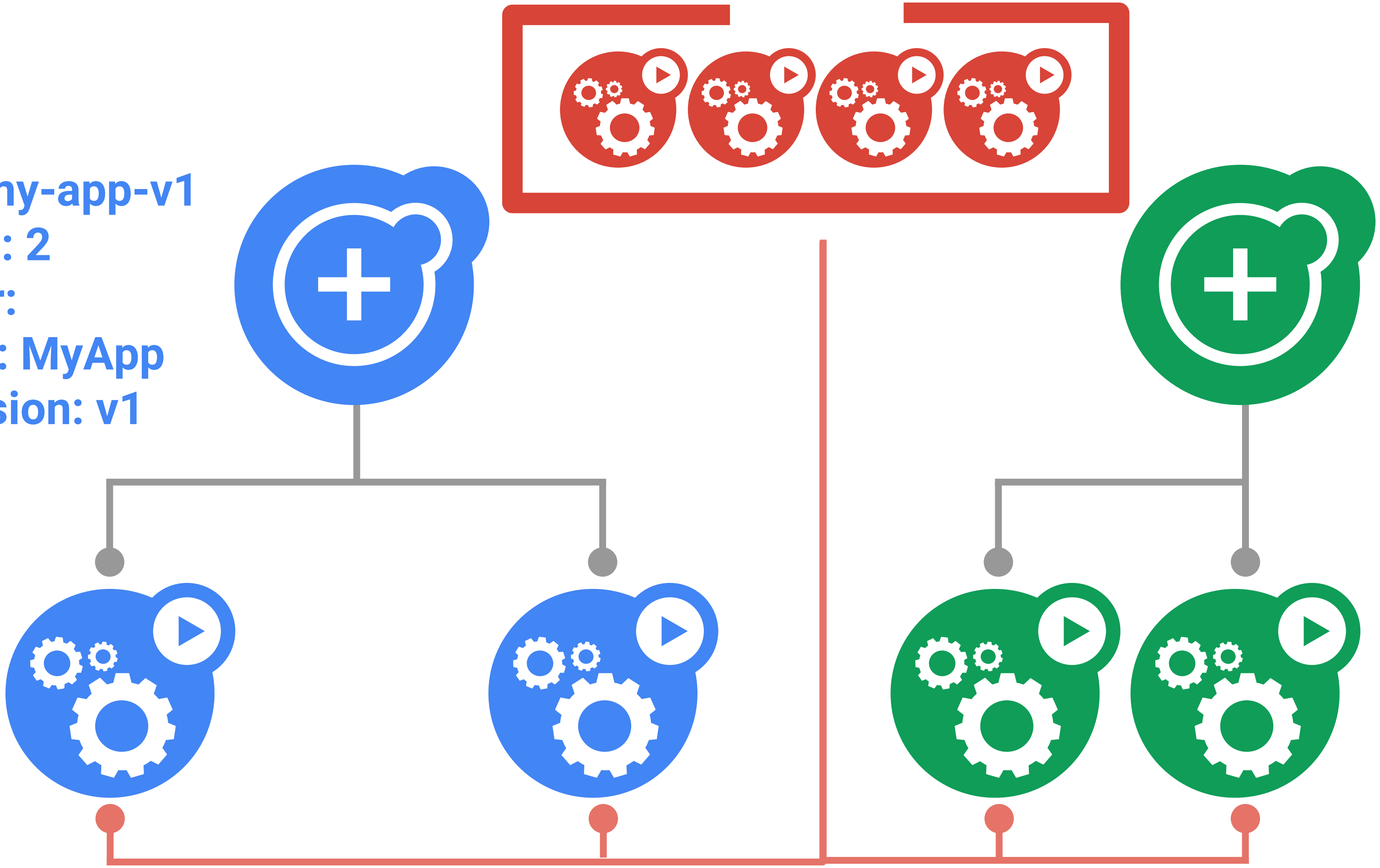
ReplicaSet

- name: my-app-v1
- replicas: 2
- selector:
  - app: MyApp
  - version: v1

ReplicaSet

- name: my-app-v2
- replicas: 1
- selector:
  - app: MyApp
  - version: v2

Rolling Update

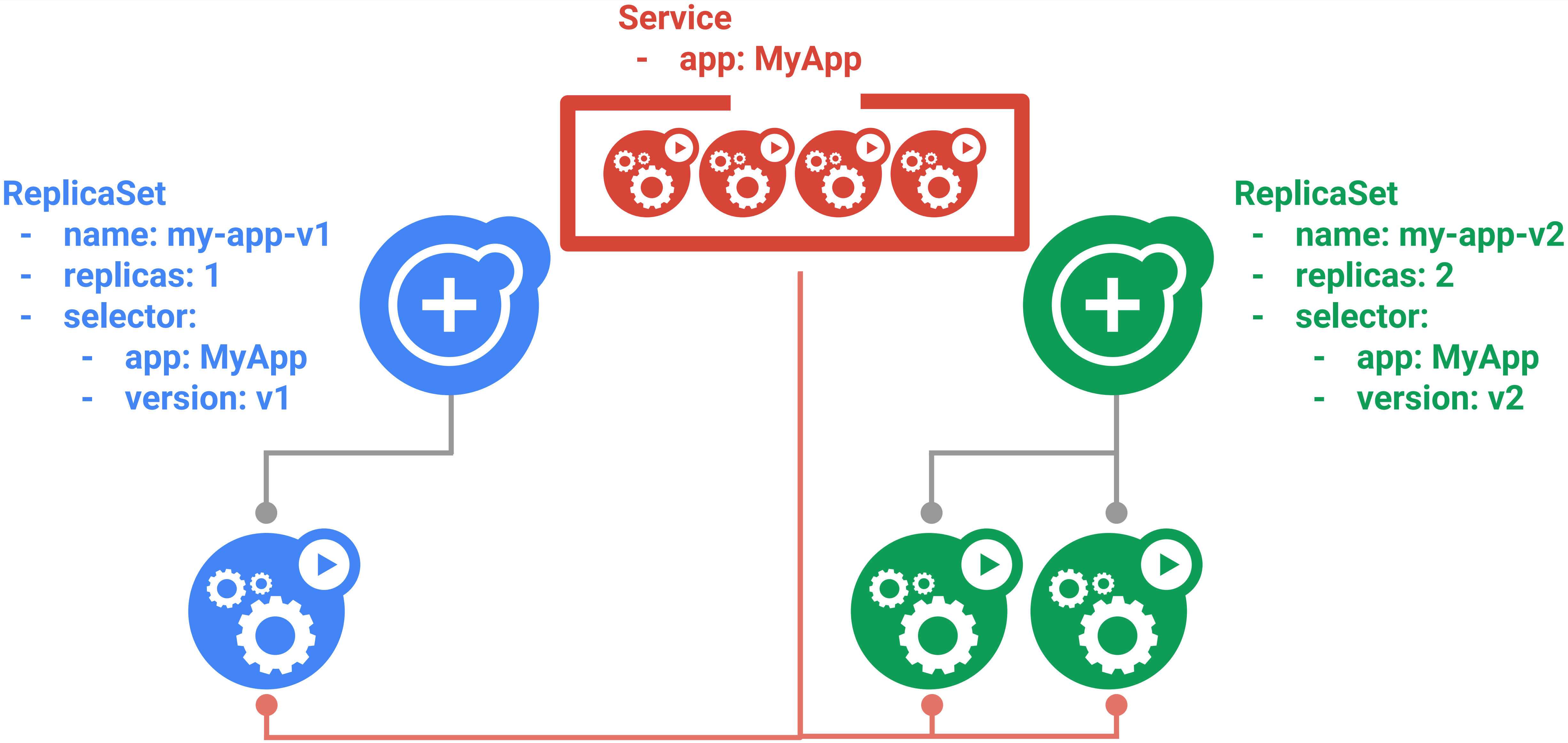


Service
- app: MyApp

ReplicaSet
- name: my-app-v1
- replicas: 2
- selector:
    - app: MyApp
    - version: v1

ReplicaSet
- name: my-app-v2
- replicas: 2
- selector:
    - app: MyApp
    - version: v2

Rolling Update

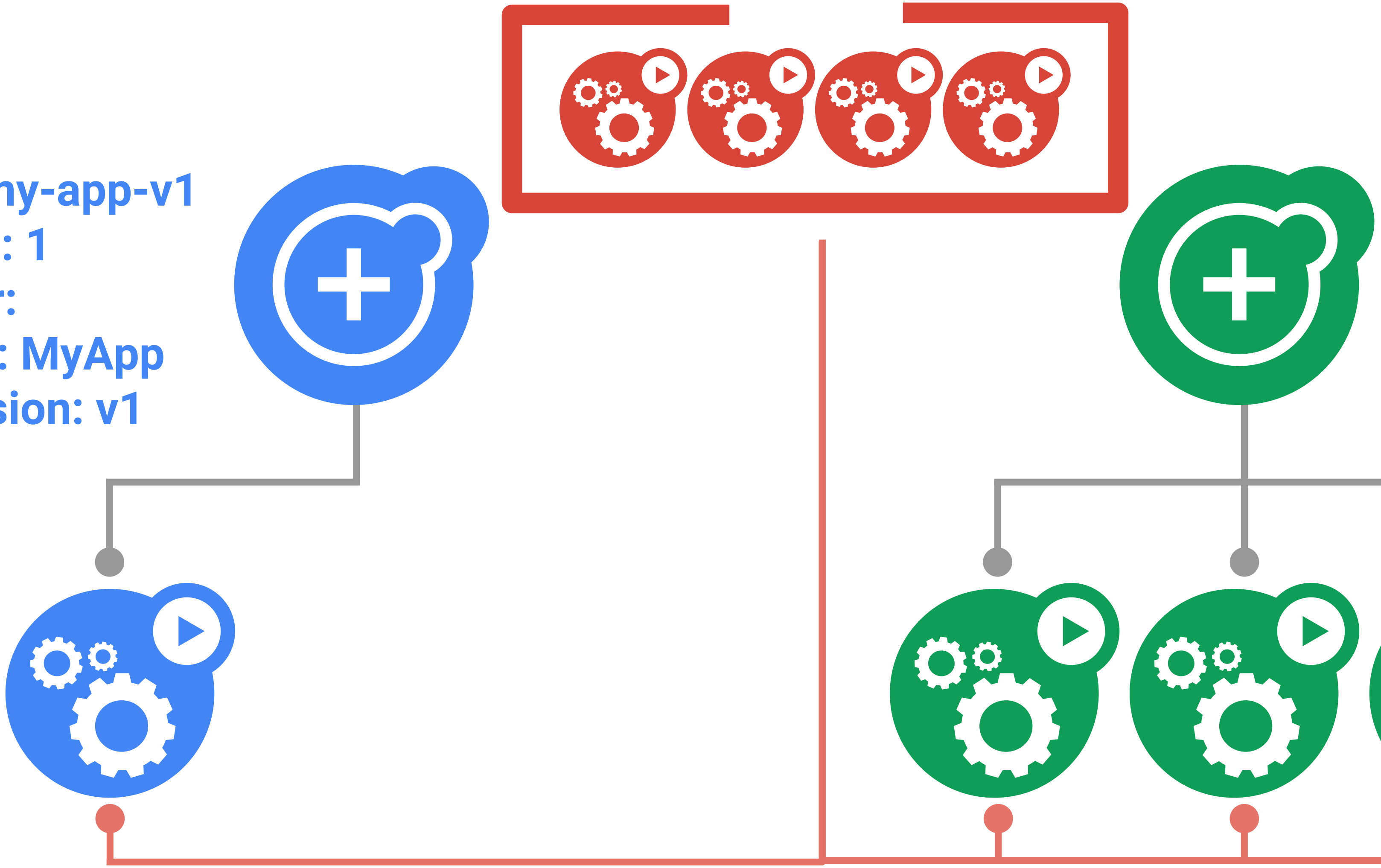


Service
- app: MyApp

ReplicaSet
- name: my-app-v1
- replicas: 1
- selector:
  - app: MyApp
  - version: v1

ReplicaSet
- name: my-app-v2
- replicas: 2
- selector:
  - app: MyApp
  - version: v2

Rolling Update

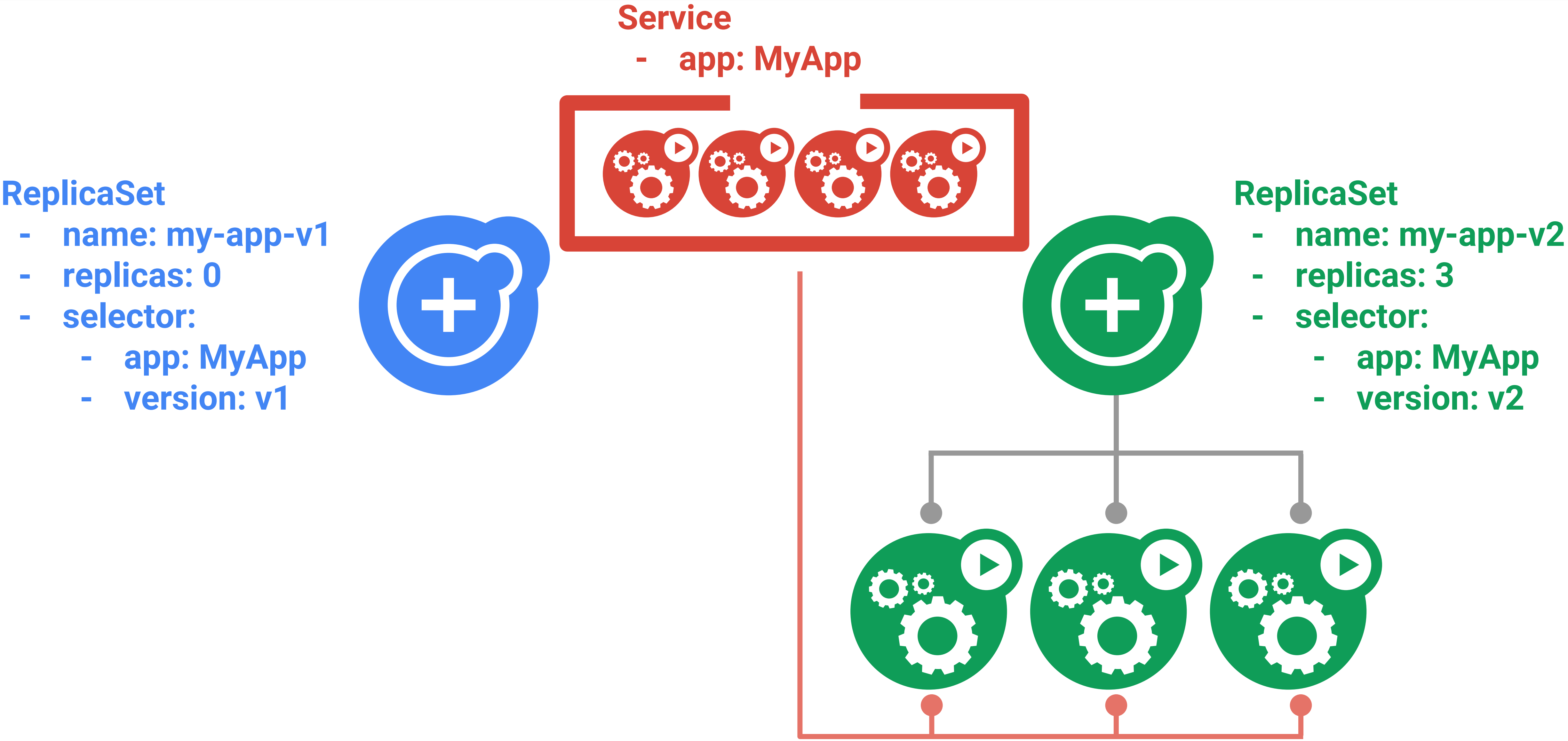


Service
- app: MyApp

ReplicaSet
- name: my-app-v1
- replicas: 1
- selector:
  - app: MyApp
  - version: v1

ReplicaSet
- name: my-app-v2
- replicas: 3
- selector:
  - app: MyApp
  - version: v2

Rolling Update



Service

- app: MyApp

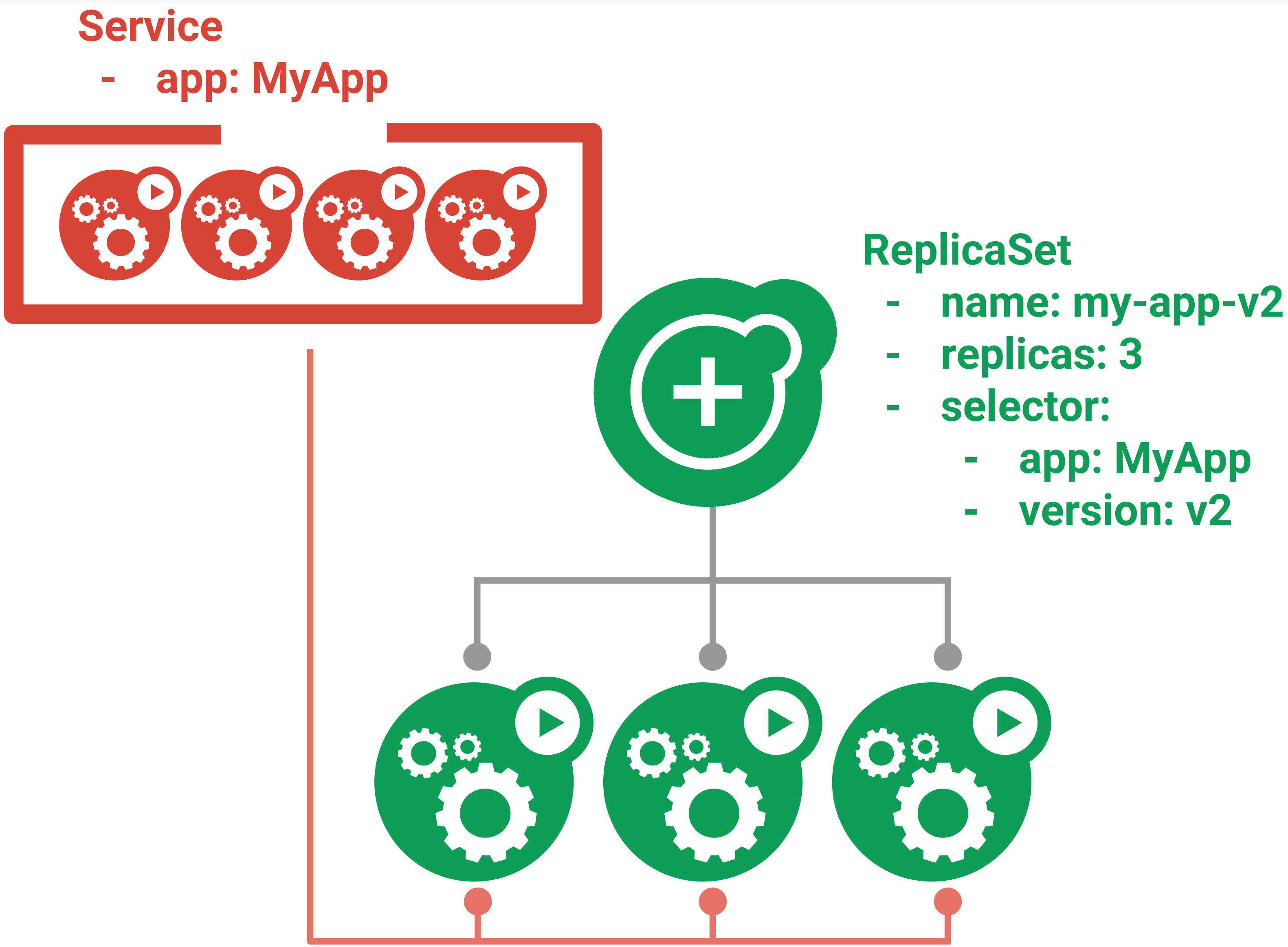
ReplicaSet

- name: my-app-v1
- replicas: 0
- selector:
    - app: MyApp
    - version: v1

ReplicaSet

- name: my-app-v2
- replicas: 3
- selector:
    - app: MyApp
    - version: v2

Rolling Update



Service
- app: MyApp

ReplicaSet
- name: my-app-v2
- replicas: 3
- selector:
  - app: MyApp
  - version: v2

Deployments

Deployments

Updates-as-a-service

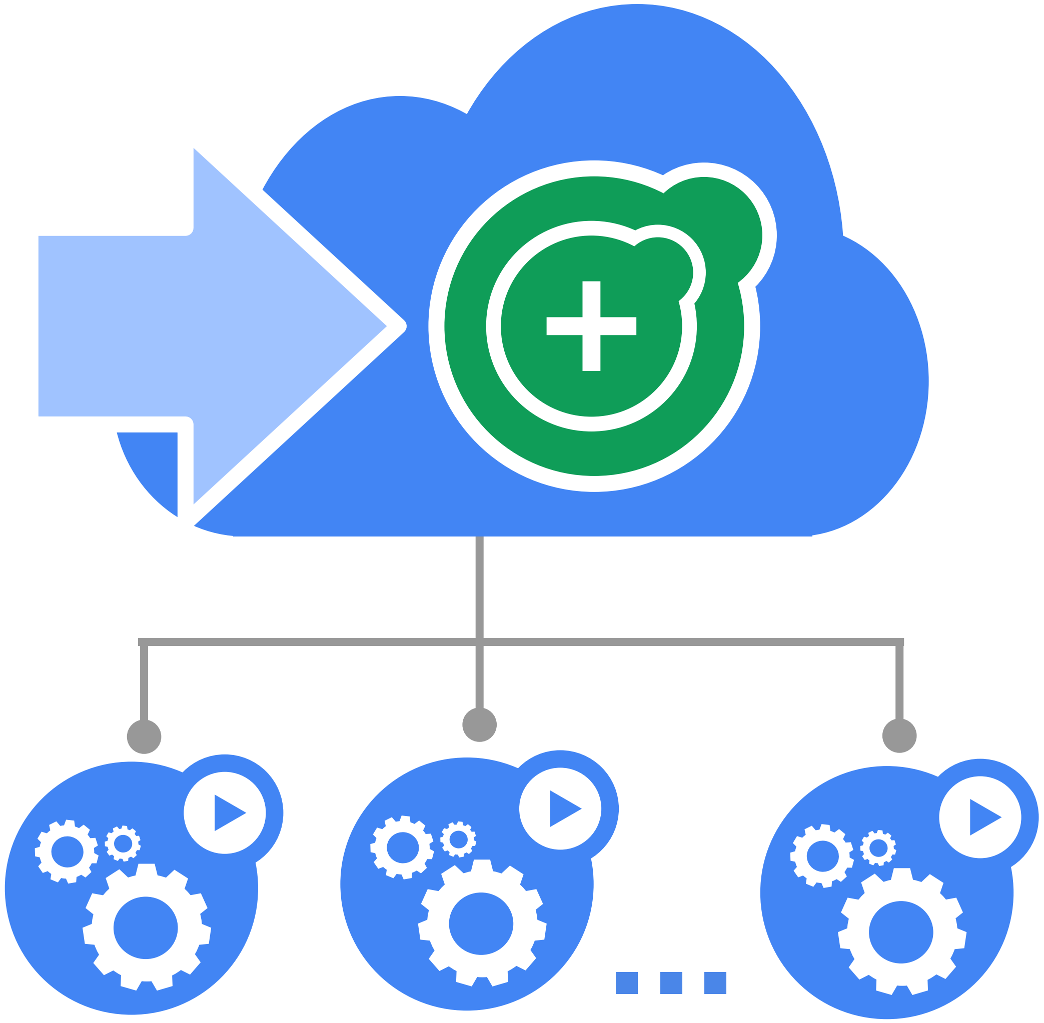
- Rolling update is imperative, client-side

Deployment manages replica changes for you

- stable object name
- updates are configurable, done server-side
- `kubectl edit` or `kubectl apply`

Aggregates stats

Can have multiple updates in flight



Deployment Demo

DaemonSets

Problem: how to run a Pod on every node?

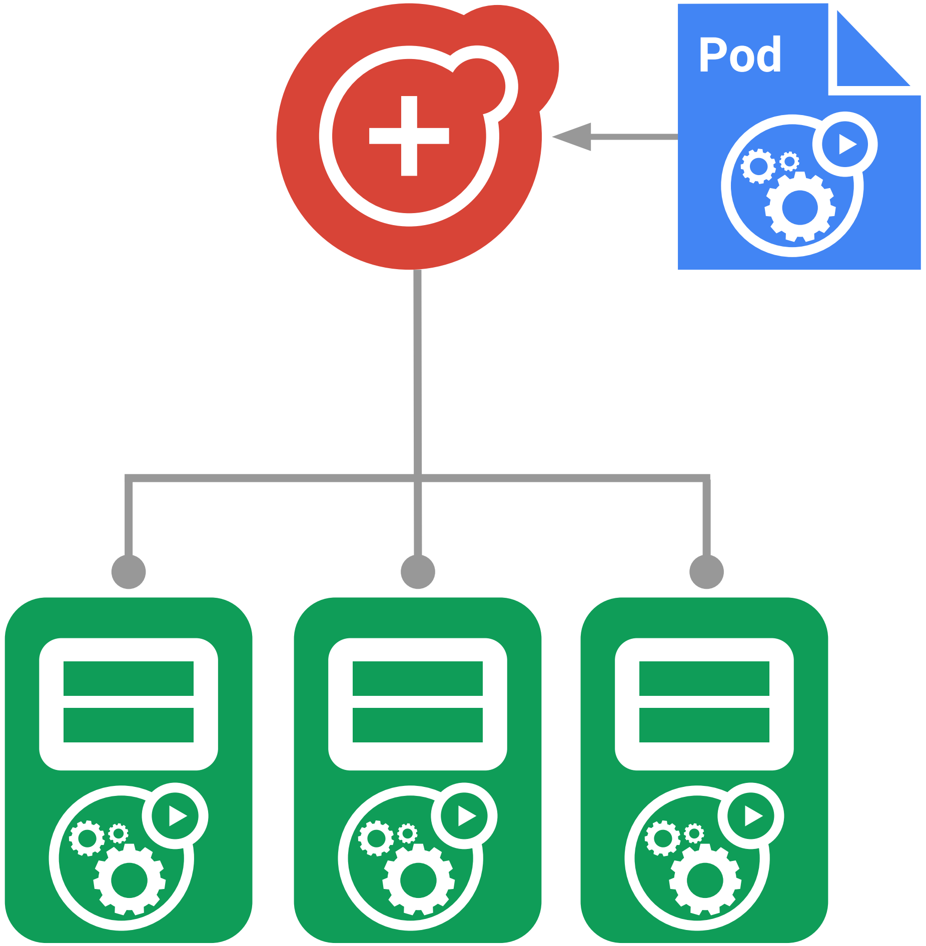
- or a subset of nodes

Similar to ReplicaSet

- principle: do one thing, don't overload

"Which nodes?" is a selector

Use familiar tools and patterns



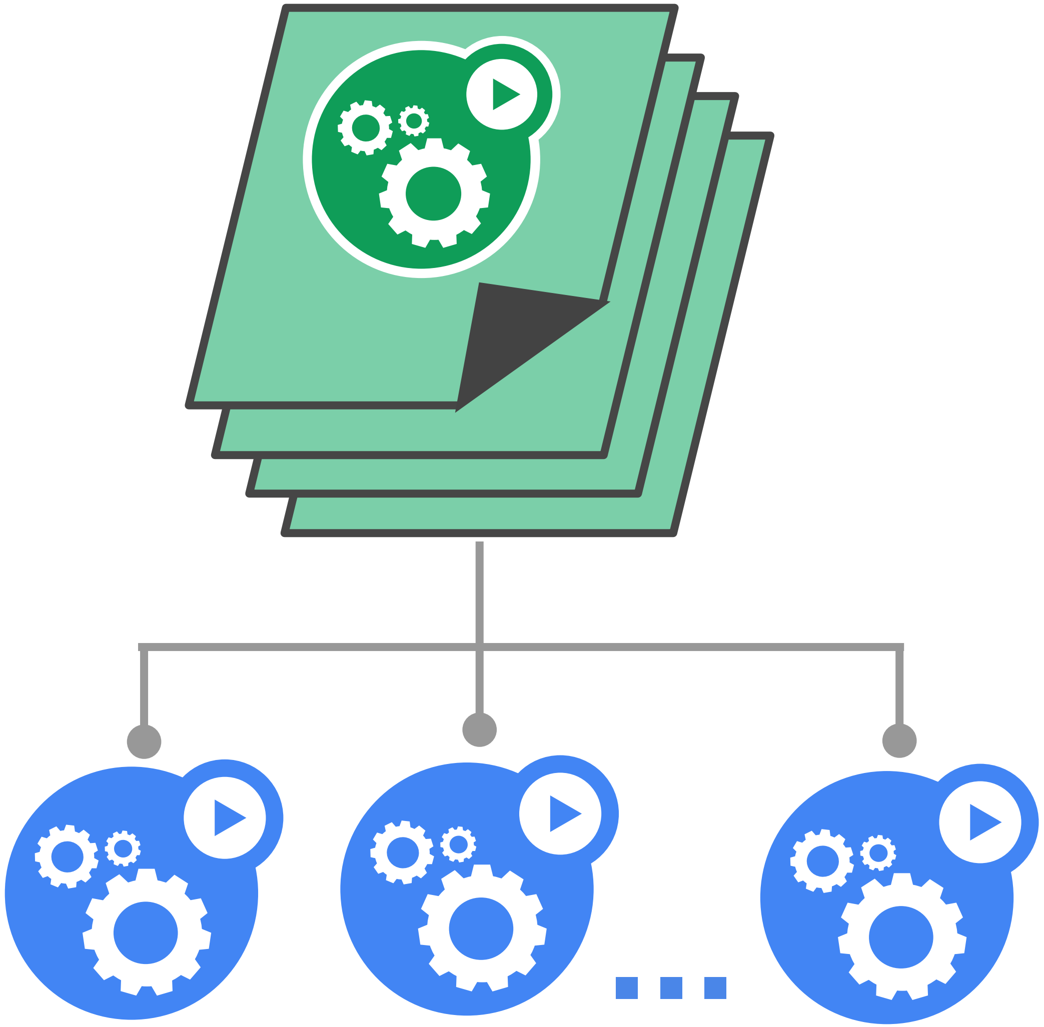
Jobs

Run-to-completion, as opposed to run-forever

- Express parallelism vs. required completions
- Workflow: restart on failure
- Build/test: don’t restart on failure

Aggregates success/failure counts

Built for batch and big-data work



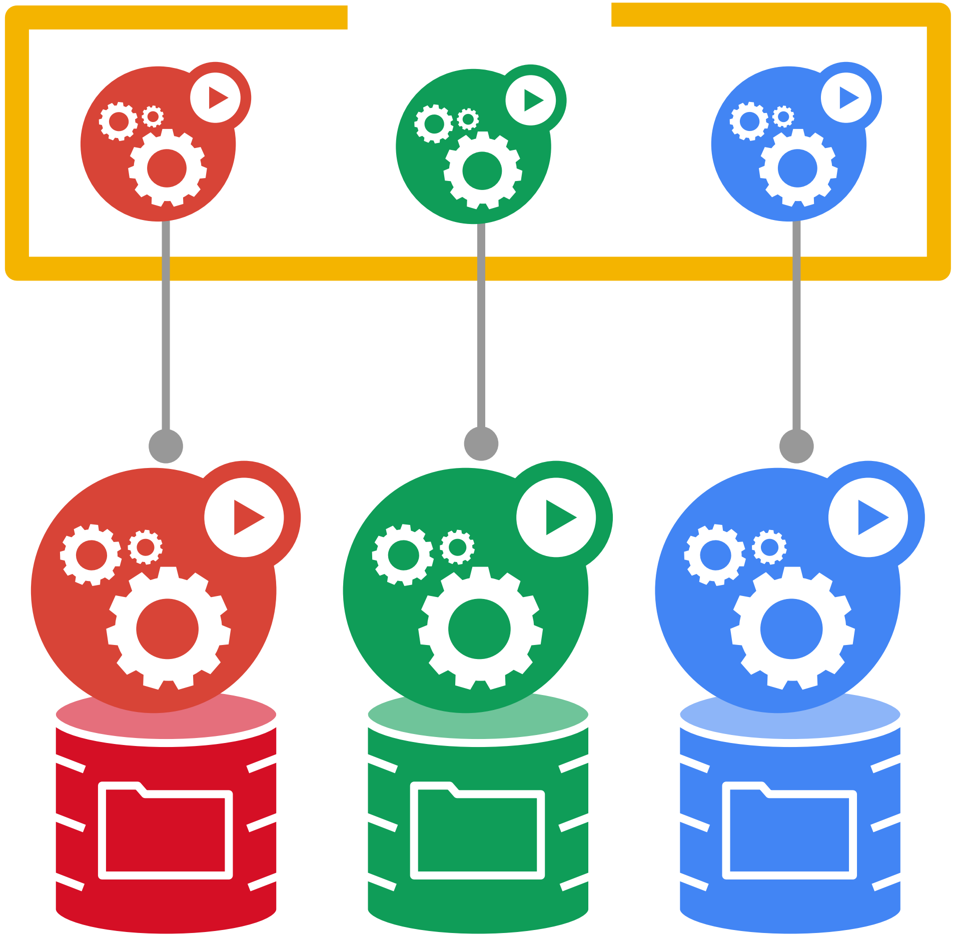
StatefulSets

Goal: enable clustered software on Kubernetes

- mysql, redis, zookeeper, ...

Clustered apps need “identity” and sequencing guarantees

- stable hostname, available in DNS
- an ordinal index
- stable storage: linked to the ordinal & hostname
- discovery of peers for quorum
- startup/teardown ordering



Secrets

Goal: grant a pod access to a secured *something*

- don't put secrets in the container image!

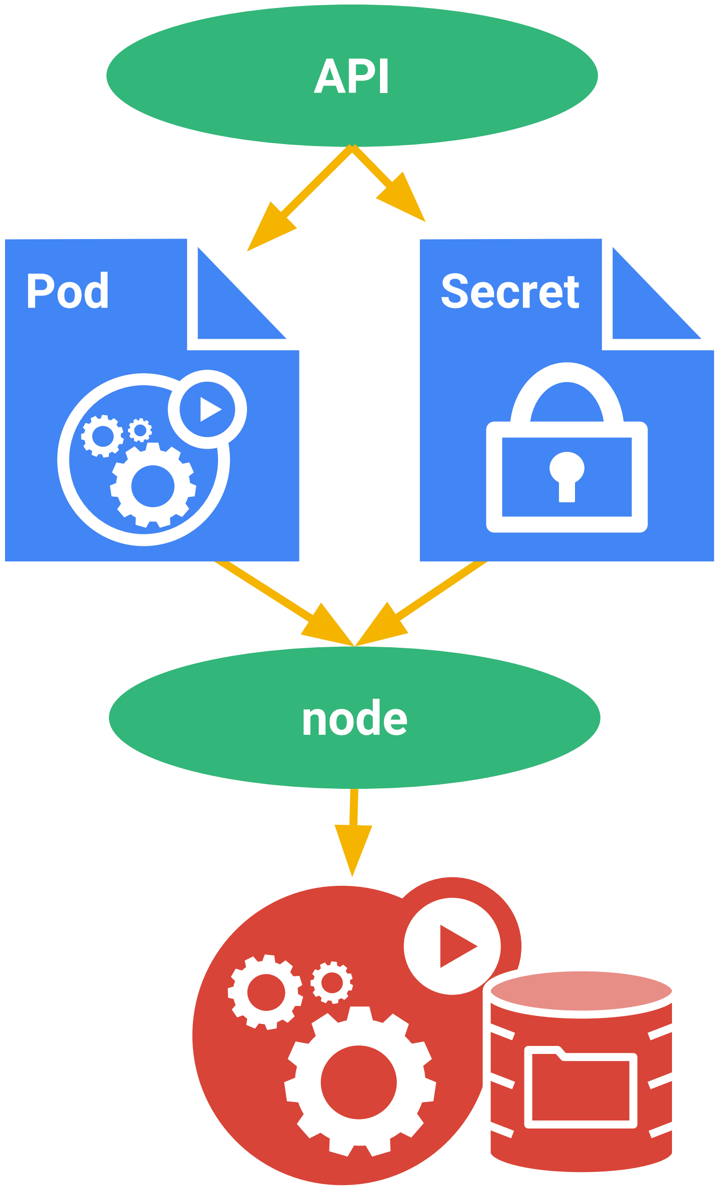
12-factor says config comes from the environment

- Kubernetes is the environment

Manage secrets via the Kubernetes API

Inject secrets as virtual volumes into your Pods

- late-binding, tmpfs - never touches disk
- also available as env vars



Introducing Kubernetes 1.6

Kubernetes 1.6

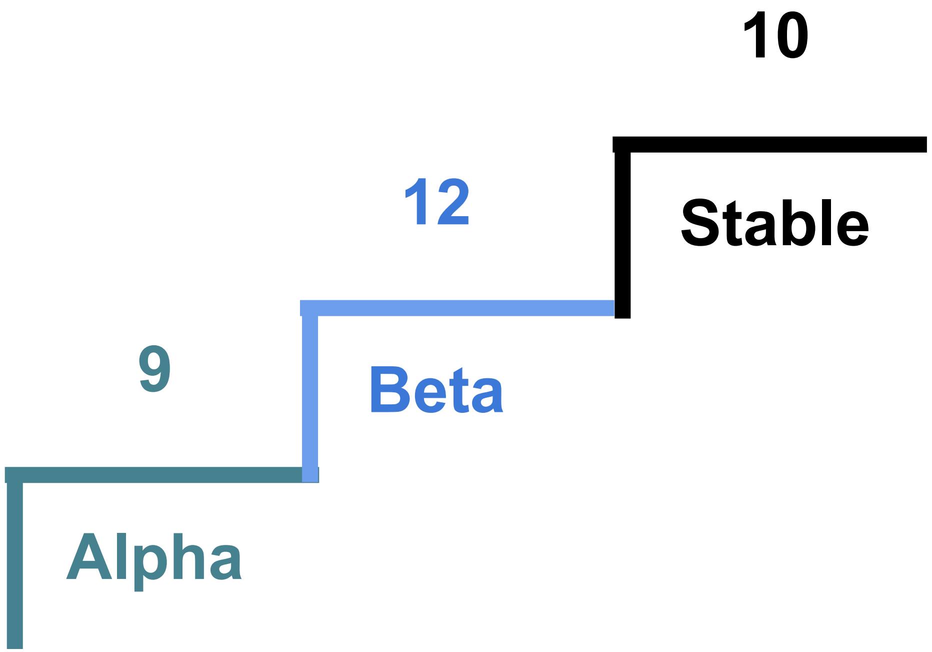
Introducing Kubernetes 1.6

Release theme: Multi-workload, Multi-team Large clusters

- 5000 node clusters
- Role Based Access Control
- Controlled scheduling
- StorageClasses

Released: March 28, 2017

- Release Lead: Dan Gillespie (CoreOS)



9

Alpha

12

Beta

10

Stable

Kubernetes 1.6 - Scale

5000 nodes!

(30 Pods/Node → 150,000 Pods)

etcd

CoreOS

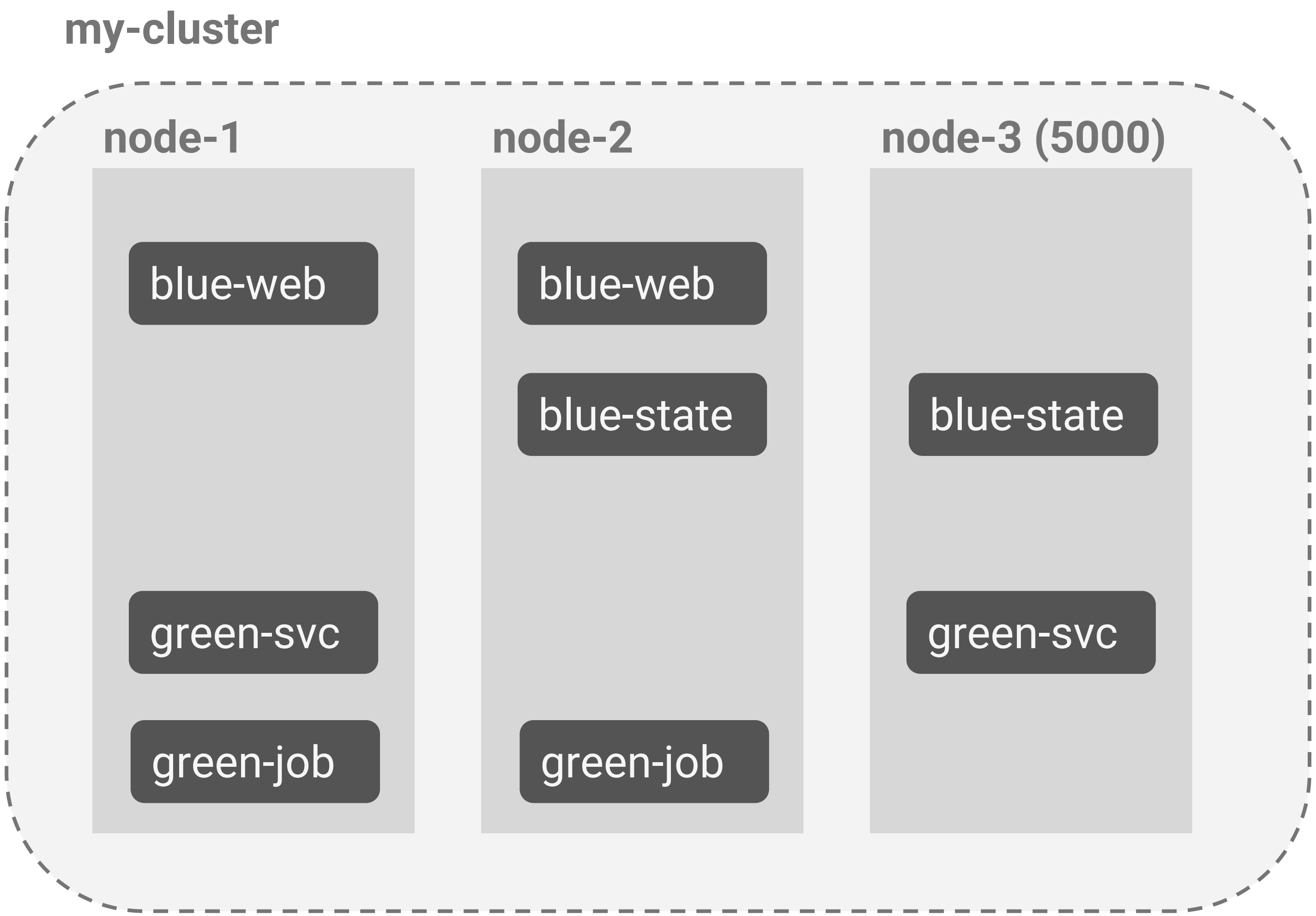
Kubernetes 1.6 - RBAC

Without fine-grained Access:

- Authorization at cluster level
- All pods have same authorization

Without controlled scheduling:

- Lack flexibility for multi-workload



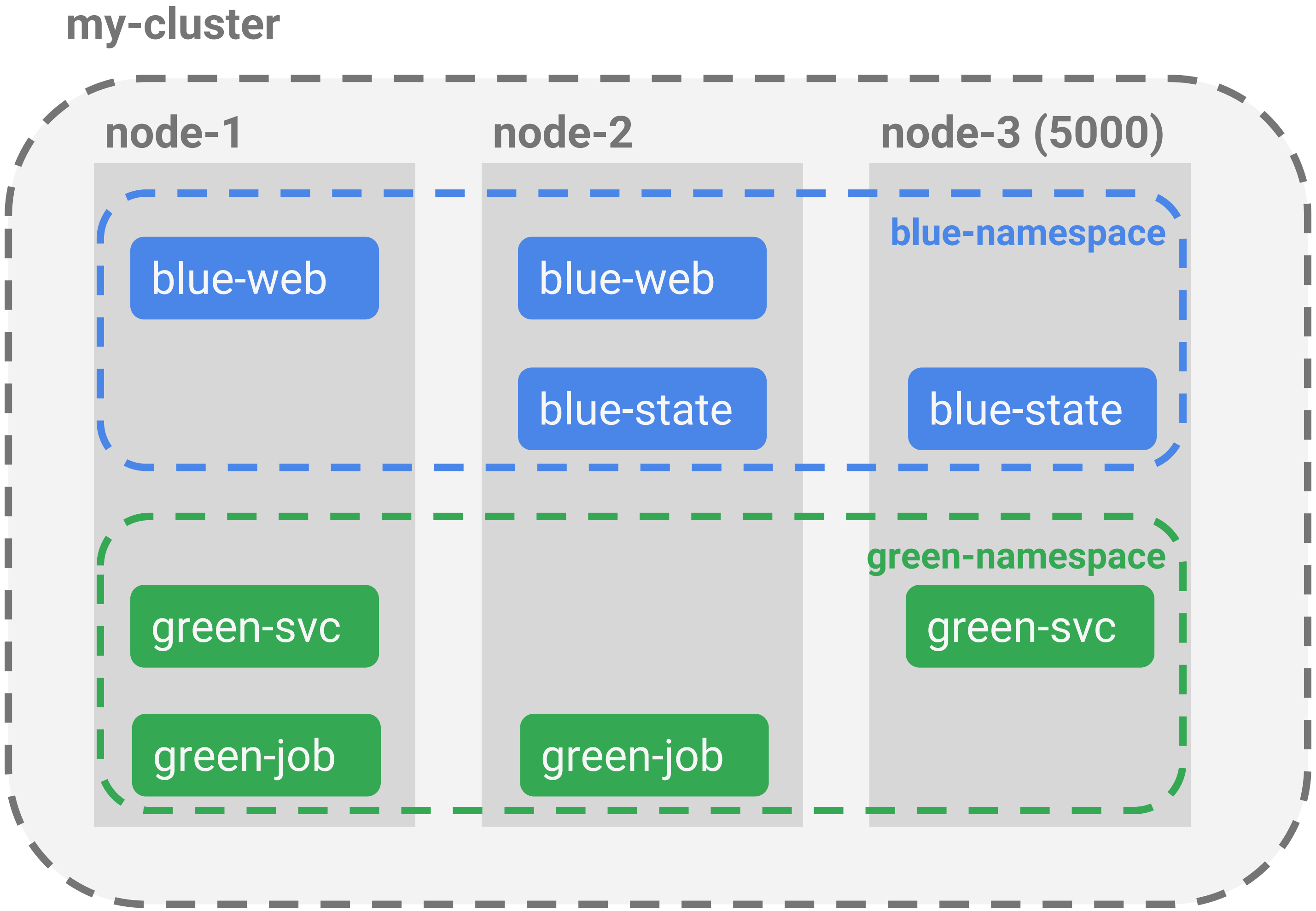
Kubernetes 1.6 - RBAC

Introducing RBAC:

- Per-namespace/ resource, role, action

Examples:

- **Alice** can list **Eng** services, but not **HR**
- **Bob** can create Pods in **Test** namespace, but not in **Prod**
- **Scheduler** can read **Pods** but not **Secrets**



Kubernetes 1.6 - Controlled Scheduling

Introducing 3 new Features

- Node/Pod-level affinity/anti-affinity
- Taints/Tolerations/Forgiveness
- Custom schedulers
    - Users can write their own scheduler!

Kubernetes 1.6 - Controlled Scheduling

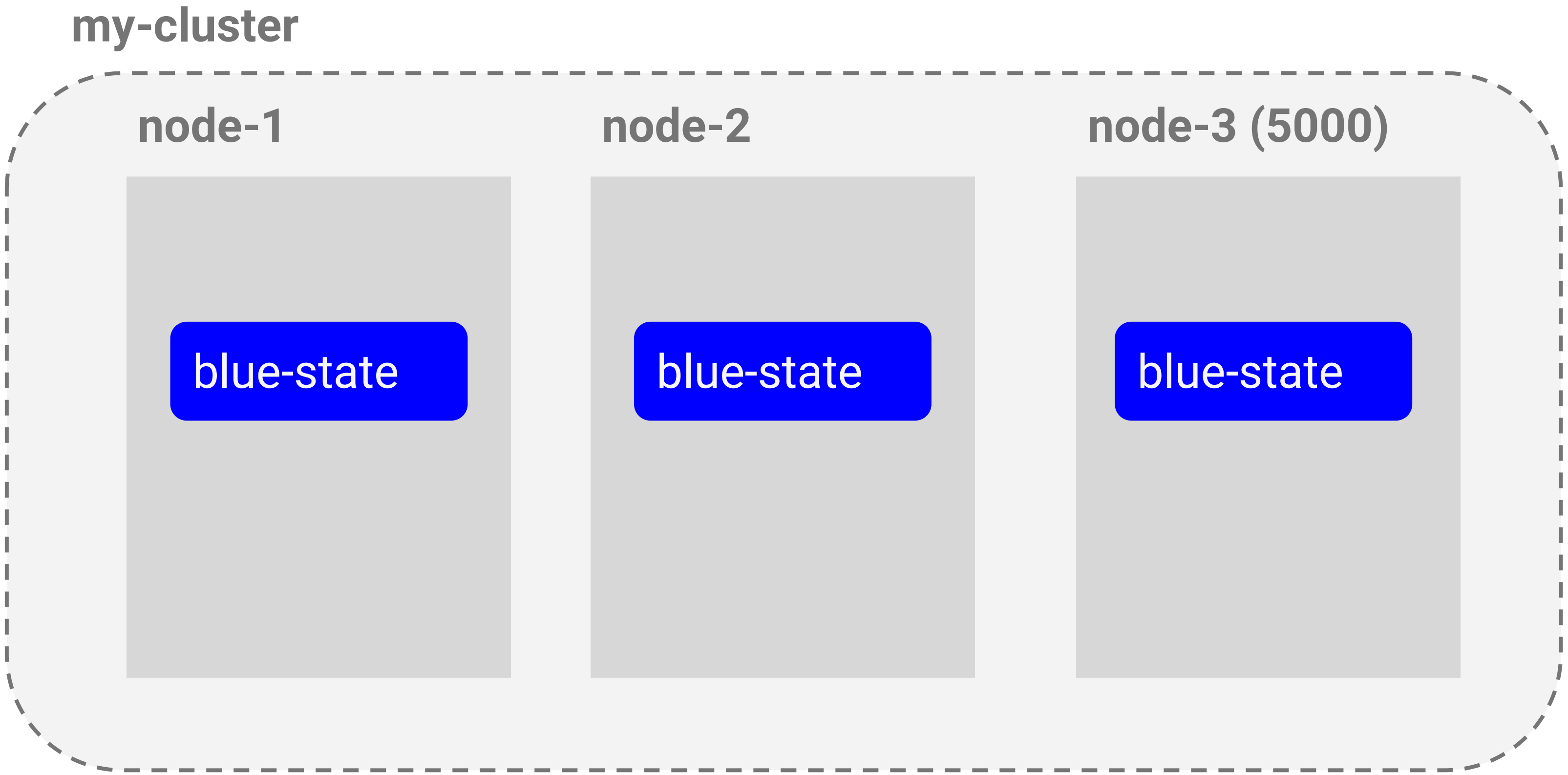
Example: Quorum-Based Stateful App (pod anti-affinity)

Pod (blue-state)

```
pod anti-affinity:
labelSelector:
   key: name
   operator: Equal
   value: blue-state
topologyKey: hostname
```

PodDisruptionBudget

```
 minAvailable: 2
 selector: blue-state
```



Kubernetes 1.6 - Controlled Scheduling

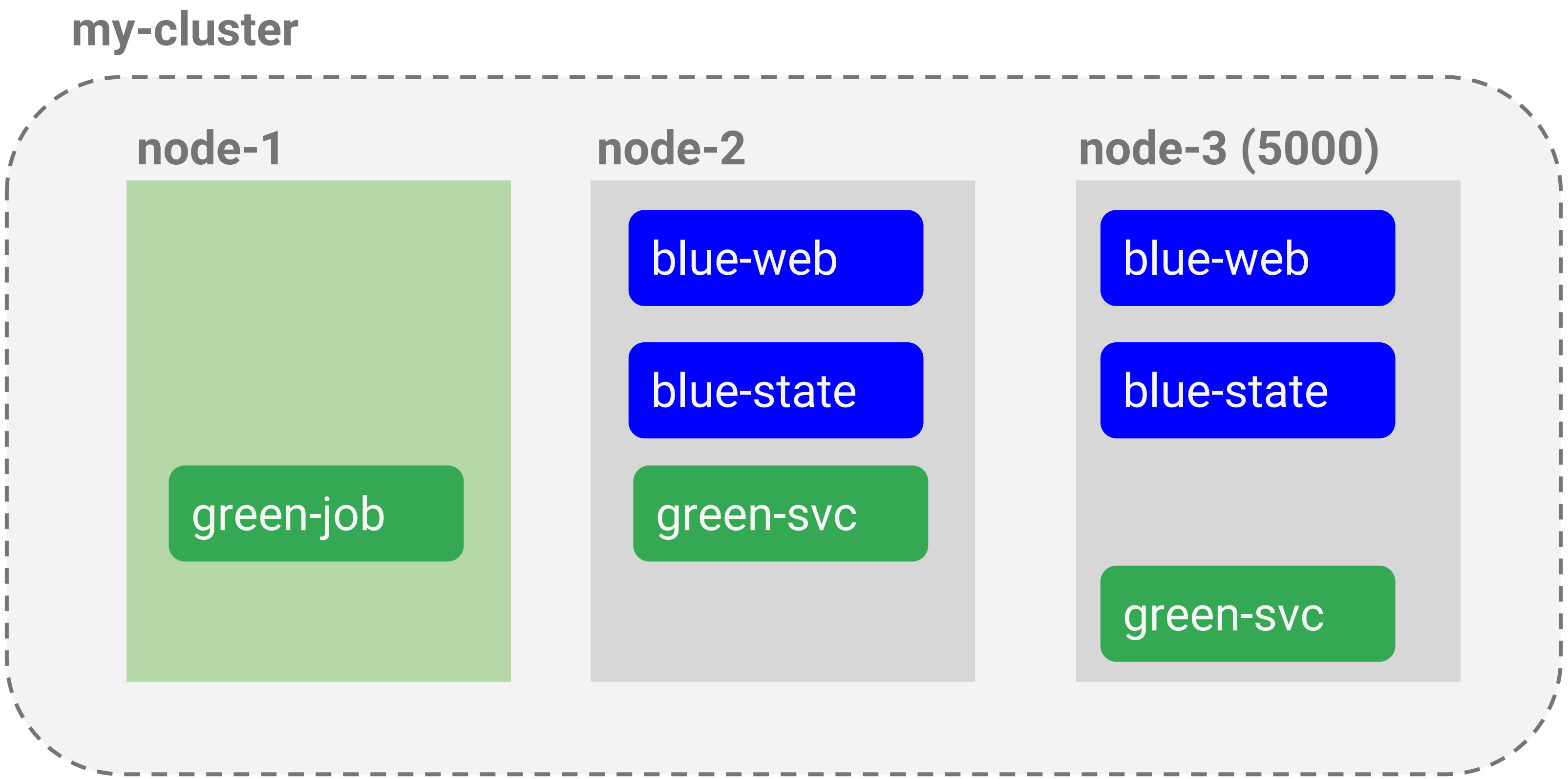
Example: Dedicated Nodes (taints/tolerations)

taint:

```
  key: dedicated
  value: green-job
  effect: NoSchedule
```

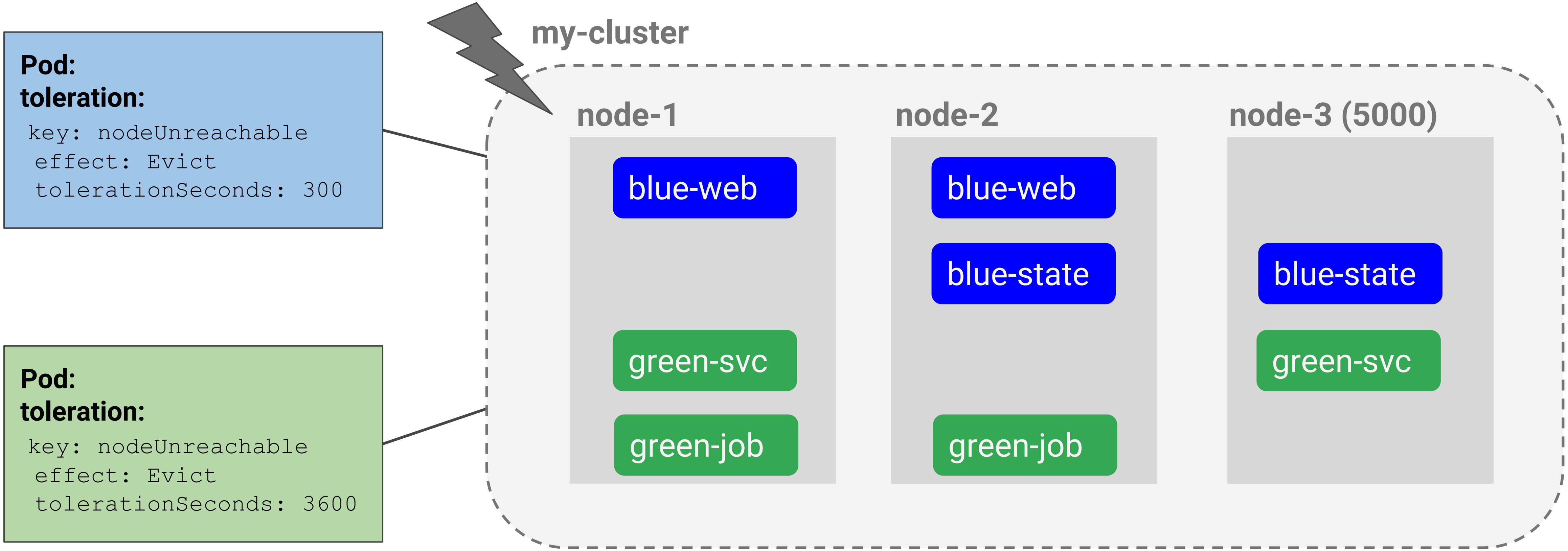
Pod (Green)

```
toleration:
    key: dedicated
    value: green-job
    effect: NoSchedule
```



Kubernetes 1.6 - Controlled Scheduling

Example: Forgiveness (t = 0s)



Pod:
toleration:

```
key: nodeUnreachable
 effect: Evict
 tolerationSeconds: 300
```

Pod:
toleration:

```
key: nodeUnreachable
 effect: Evict
 tolerationSeconds: 3600
```

Kubernetes 1.6 - Controlled Scheduling

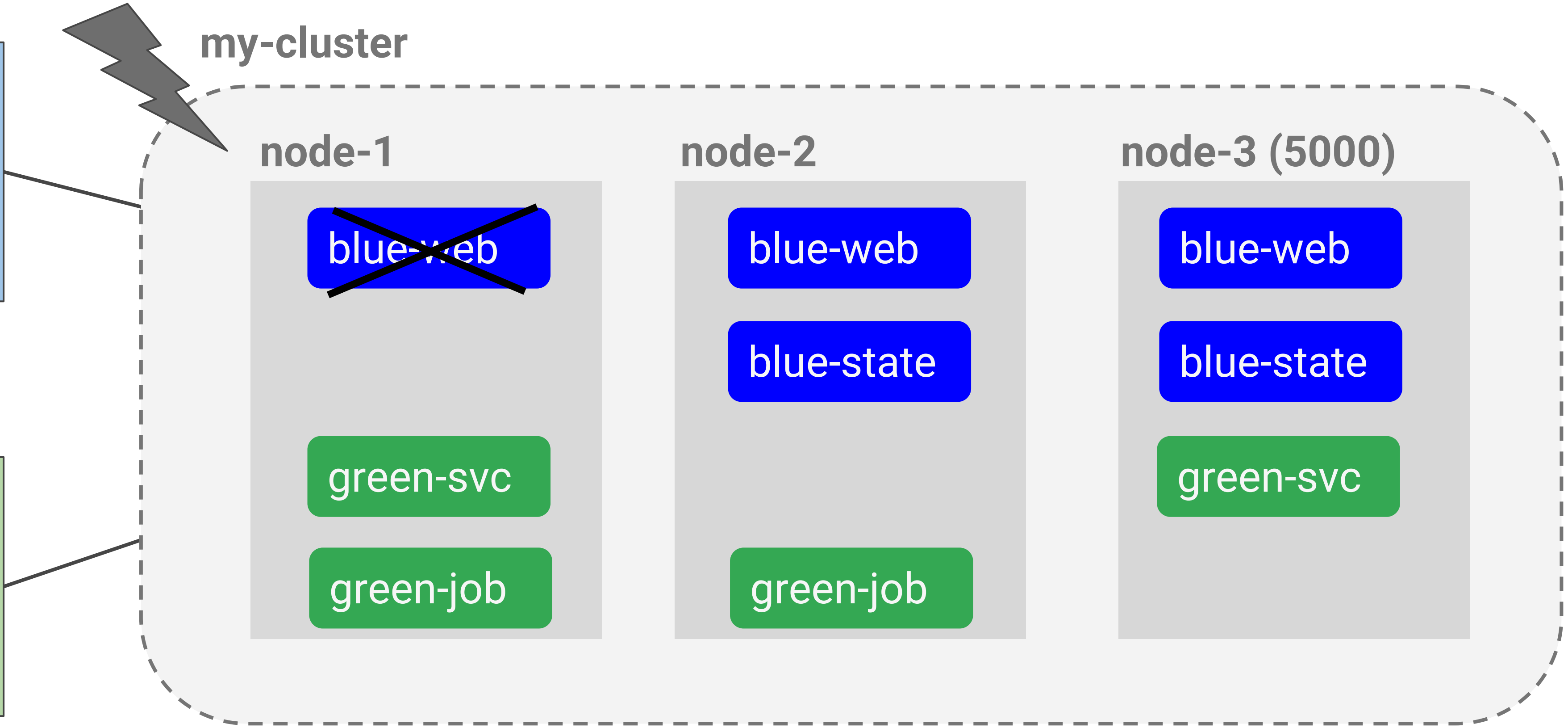
Example: Forgiveness (t = 300s)

Pod:
toleration:

```
 key: nodeUnreachable
  effect: Evict
  tolerationSeconds: 300
```

Pod:
toleration:

```
 key: nodeUnreachable
  effect: Evict
  tolerationSeconds: 3600
```



my-cluster

node-1

~~blue-web~~

green-svc

green-job

node-2

blue-web

blue-state

green-job

node-3 (5000)

blue-web

blue-state

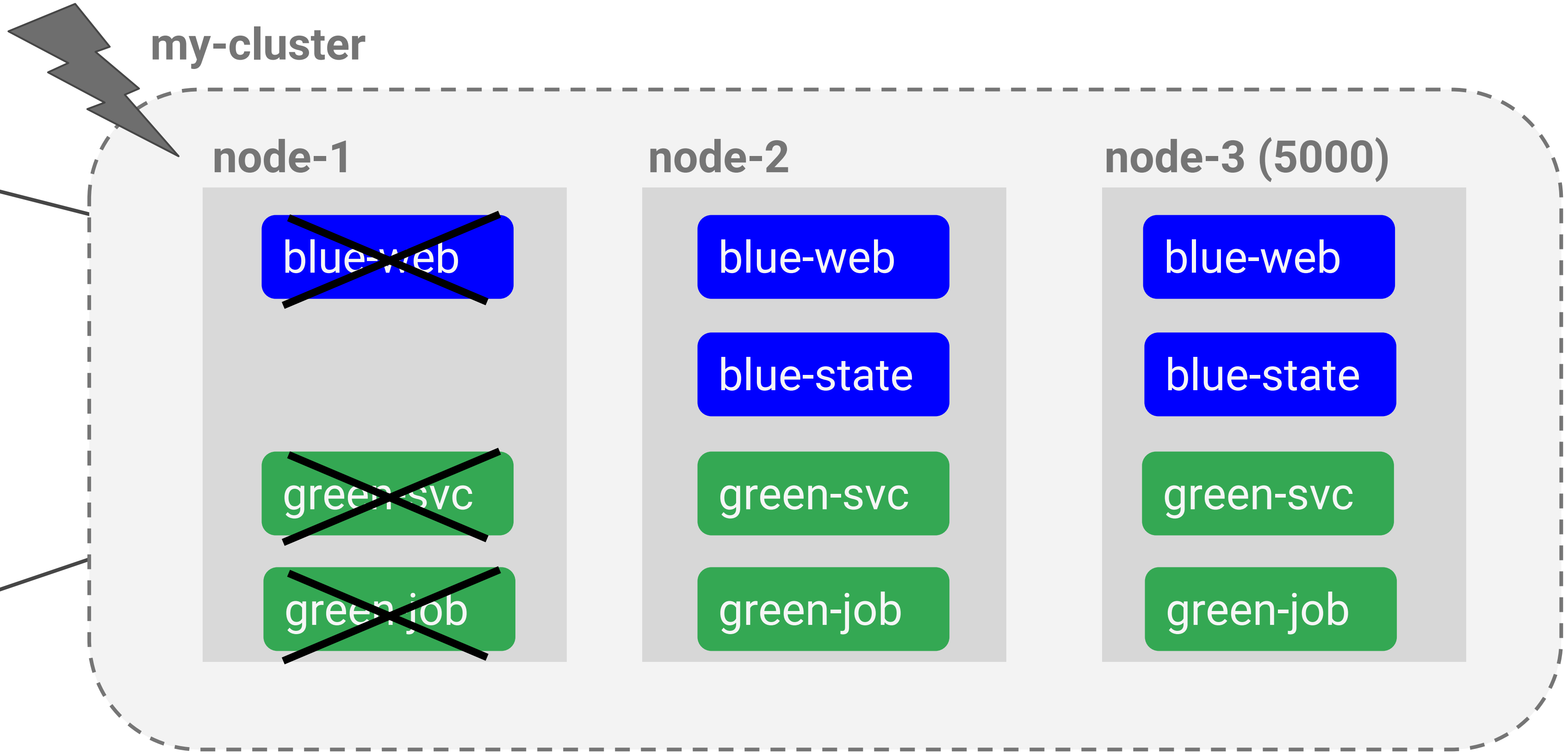
green-svc

Kubernetes 1.6 - Controlled Scheduling

Example: Forgiveness (t = 3600s)

Pod:
toleration:

```
 key: nodeUnreachable
  effect: Evict
  tolerationSeconds: 300
```



Pod:
toleration:

```
 key: nodeUnreachable
  effect: Evict
  tolerationSeconds: 3600
```

Kubernetes 1.6 - StorageClasses

Additional storage capabilities

- Support for user-written/run dynamic PV provisioners.

Pre-installed default storage classes in 1.6:

- Google Cloud (GCE/GKE) - GCE PD
- Amazon AWS - gp2 EBS volume
- Azure - Azure Disk
- vSphere - vSphere volume
- Openstack - Cinder Volume

Supported Storage

Persistent

- GCE Persistent Disk
- AWS Elastic Block Store
- Azure File Storage
- Azure Data Disk
- iSCSI
- Flocker
- NFS
- vSphere
- GlusterFS
- Ceph File and RBD
- Cinder
- Quobyte Volume
- FibreChannel
- VMware Photon PD
- Portworx
- Dell EMC ScaleIO

Ephemeral

- Empty dir (and tmpfs)
- Expose Kubernetes API
  - Secret
  - ConfigMap
  - DownwardAPI

Other

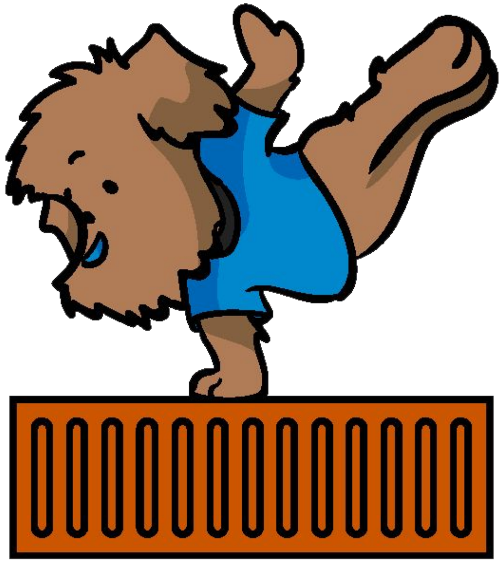
- Flex (exec a binary)
- Host path

Future

- Local Storage

Flex and FlexREX

- REX-Ray is a container storage orchestration engine created by {code} by Dell EMC
- REX-Ray provides an adapter script called FlexREX which integrates with the FlexVolume plug-in to interact with the storage system
  - Allows pods to consume data stored on volumes that are orchestrated by REX-Ray
  - Use any REX-Ray supported storage platform
    - GCE PD & CSB, AWS EBS & EFS, Digital Ocean, FittedCloud, Microsoft Azure, Oracle VirtualBox, Red Hat Ceph, S3FS and Dell EMC ScaleIO



Read more at rexray.codedellemc.com

Out-of-Tree Volume Drivers

Container Storage Interface (CSI)

- **Goal**: provide an industry wide standard for plugging storage systems into all major container orchestration (CO) systems
  - Write your volume driver once, run it anywhere
  - Working with Mesos, Cloud Foundry, and Docker
- **Goal:** Volume drivers no longer need to live in-tree
  - Can download the appropriate volume plugin when needed

Thank You!

Please visit kubernetes.io to learn more and get involved!

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