Containerised ASP.NET Core apps with Docker and Kubernetes

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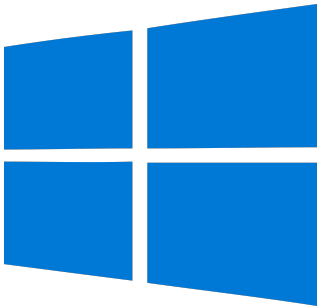
Please send talk feedback: **bit.ly/atamel**

The .NET Revolution

The world of 2014

Visual Studio

SQL Server



PowerShell

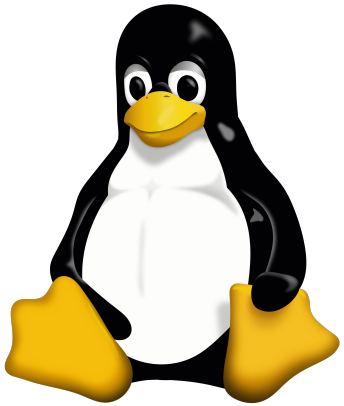
C#

ASP.NET

Eclipse

MySQL

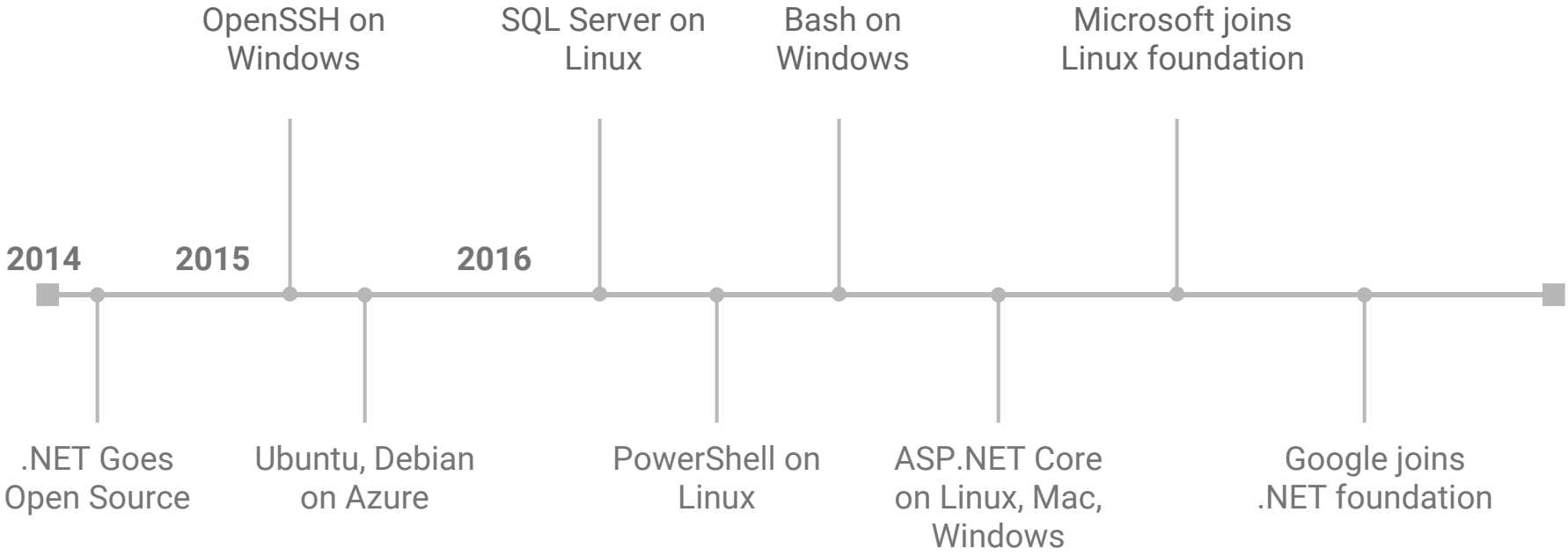
Java



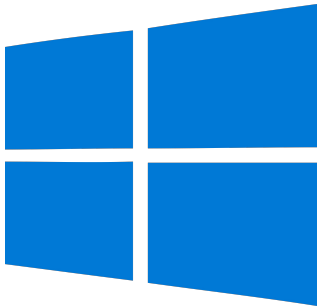
Bash

Apache

Things are changing



The convergence



SQL Server

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Bash

Visual Studio

Java

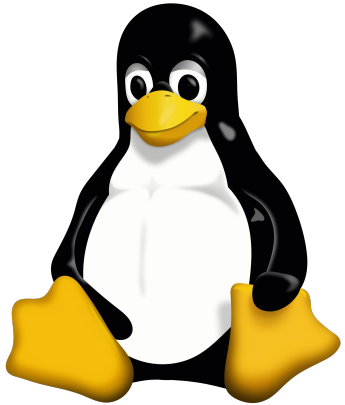
PowerShell

C#

ASP.NET

MySQL

Apache



Great time to be a .NET developer!

However, software development is HARD!

And it is not getting any easier...

In the good old days

This is all I had to care...

Life was good :-)

Image Source: Wikipedia

A lot happened since then

Internet

Databases

Web Servers

The Monolith

Mobile

App Servers

Microservices

Cloud Computing

Firewalls

Version Control

Caching

Machine Learning

Object Oriented Programming

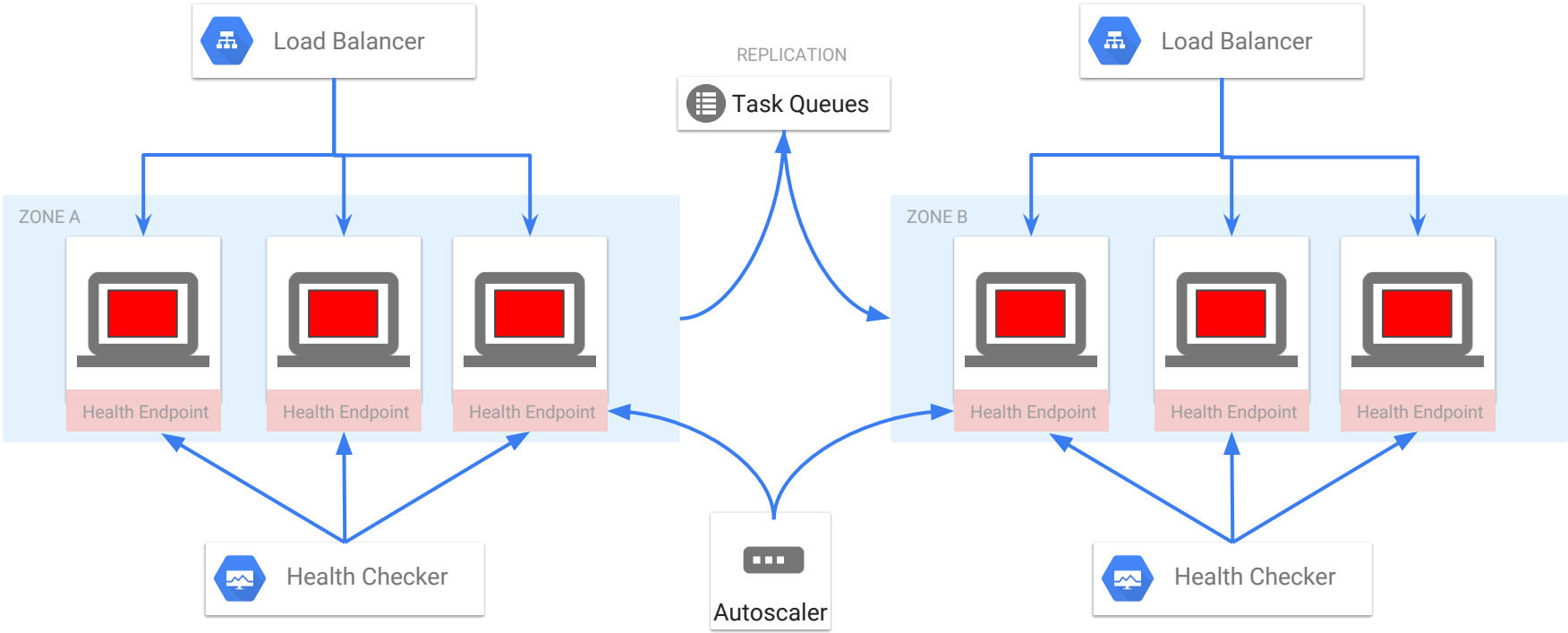
DevOps

Virtual Machines

Big Data

IoT

Nowadays


Load Balancer
REPLICATION
Task Queues
Load Balancer
ZONE A
ZONE B
Health Endpoint
Health Endpoint
Health Endpoint
Health Endpoint
Health Endpoint
Health Endpoint
Health Checker
Autoscaler
Health Checker

We haven’t even talked about

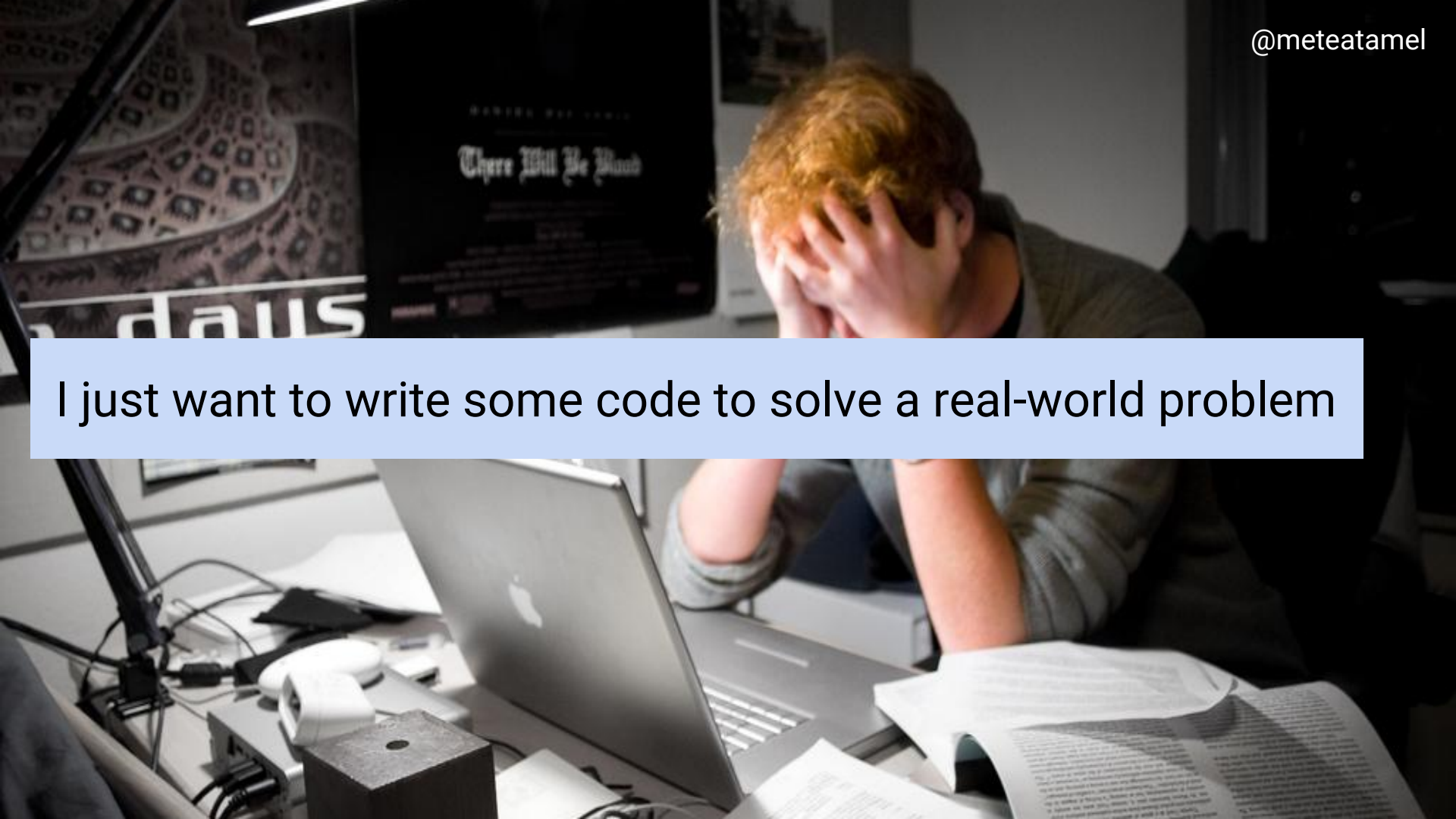
Maintaining code in **different** languages on **different** types of machines

Rolling out the **new version** of your code reliably

Rolling back to the **old version** if something goes wrong

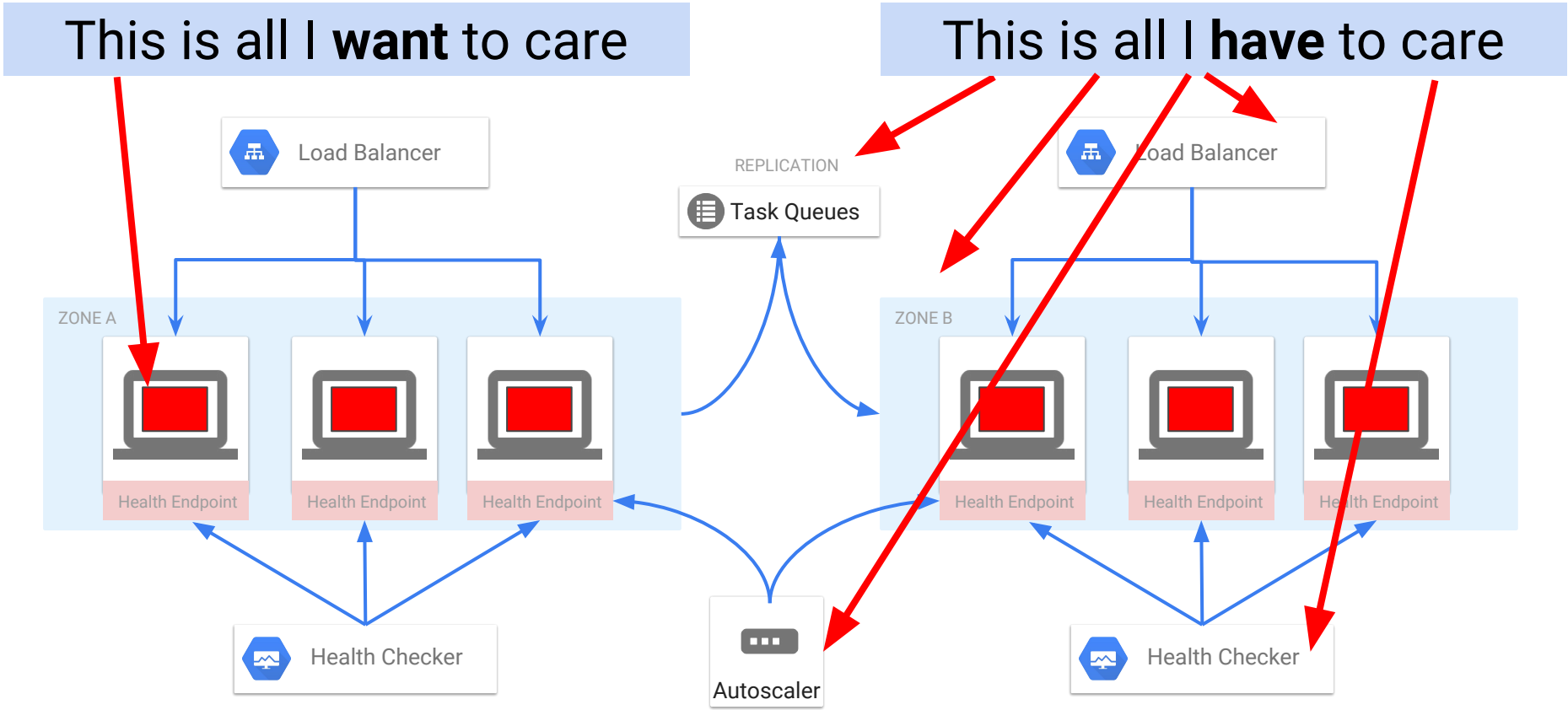
Managing **configuration** and **secrets**

Managing **scripts** that need to run on each machine



I just want to write some code to solve a real-world problem

The reality


This is all I **want** to care
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Health Endpoint
Health Endpoint
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Health Endpoint
Health Endpoint
Health Checker
Autoscaler
Health Checker

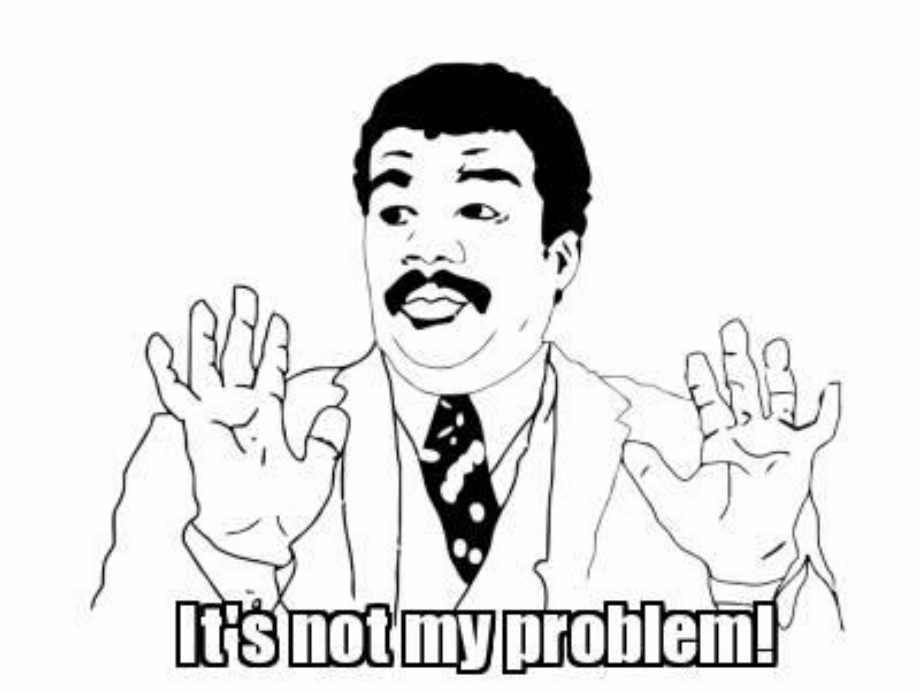
Writing code to solve problems is still fun!

Running that code in production is very hard

What do we do?

In the good old days

Write your code, pass it to QA for testing, let operations team run it...



Nowadays, it is your problem

What do we do?

You can write your code in **any** language and run **anywhere** exactly the **same** way

Your app is optimally deployed **somewhere** and managed by **someone.** It just works!

There are no machines. All resources are **automatically** provisioned on demand

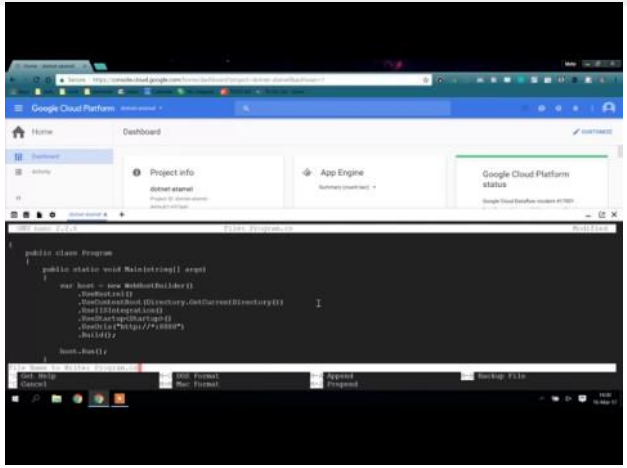
Docker + Kubernetes + Cloud

Write your code in any language and run it anywhere exactly the same way
⇒ Containers (eg. Docker, Rkt)

Your app is optimally deployed and managed
⇒ Container Management Platforms (eg. Kubernetes, Docker Swarm, Mesos)

All the resources needed for your app is automatically provisioned per demand
⇒ Cloud Providers (eg. Google Cloud, AWS, Azure)

Demo: Simple Microservice



Containers

What is a container?

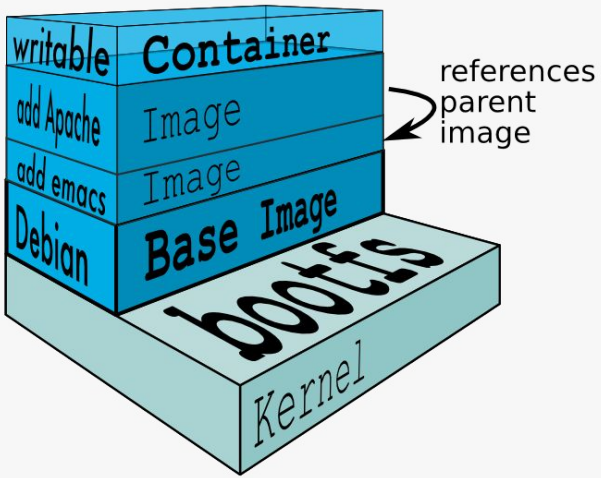
Docker

rkt

A **lightweight** way to virtualize applications

Linux (or Windows) processes

Lightweight	Easily deployable
Hermetically sealed	Introspectable
Isolated	Composable



Why containers?

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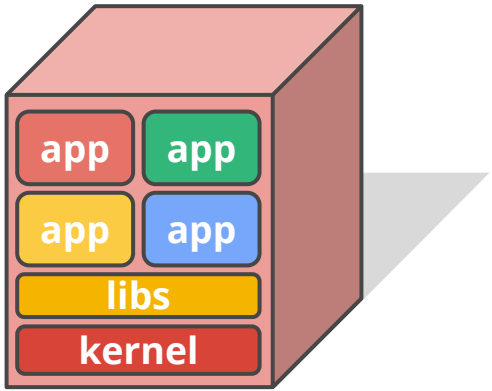
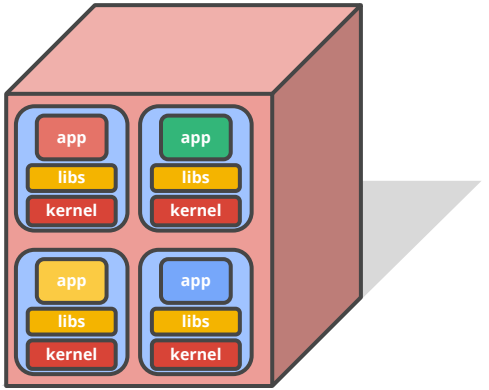


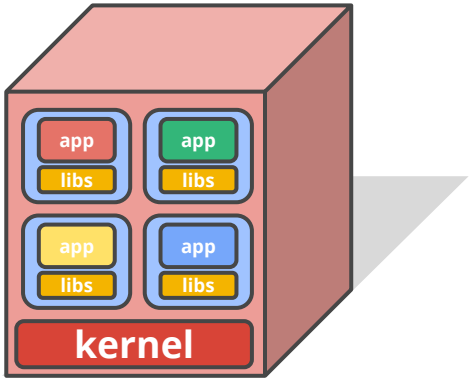
Physical Machine

- ✗ No isolation
- ✗ Common libs
- ✗ Highly coupled Apps & OS



Virtual Machines

- ✓ Isolation
- ✓ No Common Libs
- ✗ Expensive and Inefficient
- ✗ Hard to manage



Containers

- ✓ Isolation
- ✓ No Common Libs
- ✓ Less overhead
- ✗ Less Dependency on Host OS

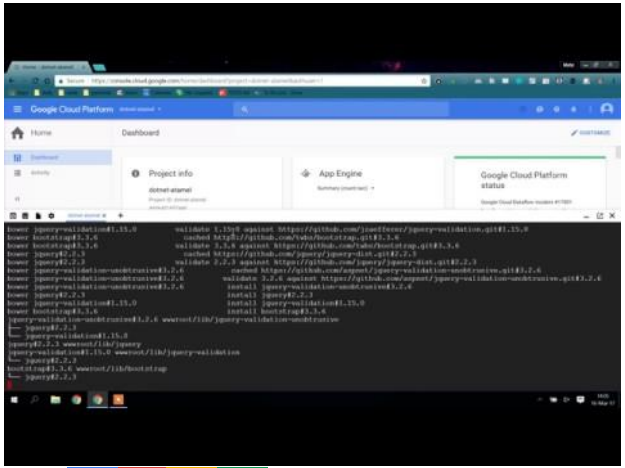

@meteatamel
Google has been developing and using containers to manage our applications for **over 12 years.**
Images by Connie Zhou

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**

Demo: Containerised Microservice



Containers not enough

Containers help to create a lightweight and consistent environment for apps

But you still need to answer these questions:

- Who takes care of **redundancy**?
- Who takes care of **resiliency**?
- Who **scales up/down** your app?
- Who and how a **new version** of your app gets deployed?
- Who rolls back to a **previous version** if something goes wrong?
- Etc. etc. etc.

Kubernetes

Kubernetes

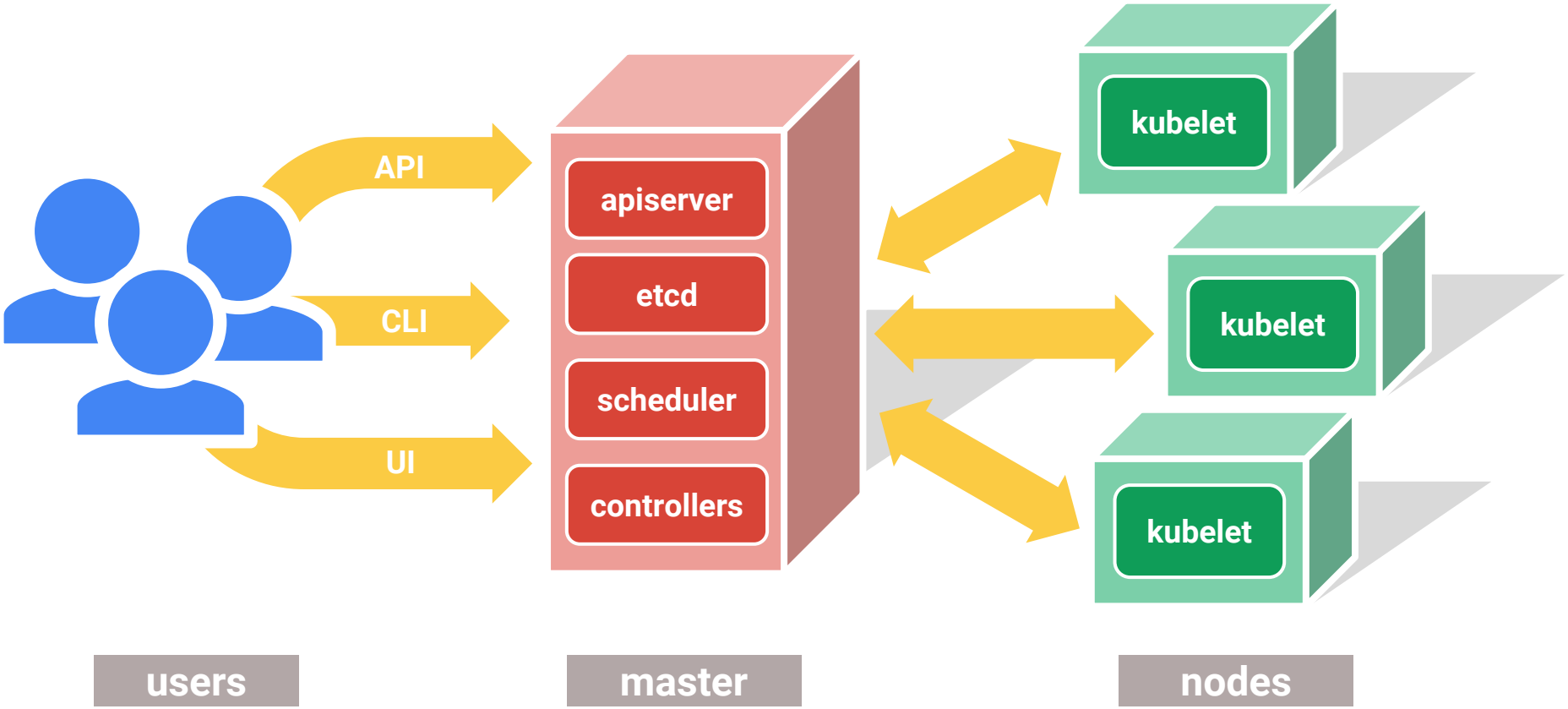
Greek for *“Helmsman”*; also the root of the words *“governor”* and *“cybernetic”*

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

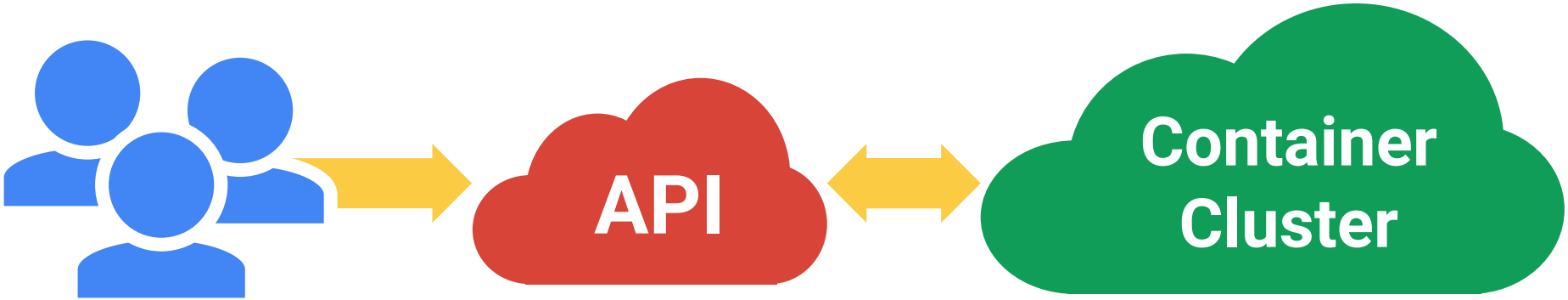
Manage applications, not machines

The 10000 foot view

@meteatamel



All you really care about



Container clusters: A story in two parts

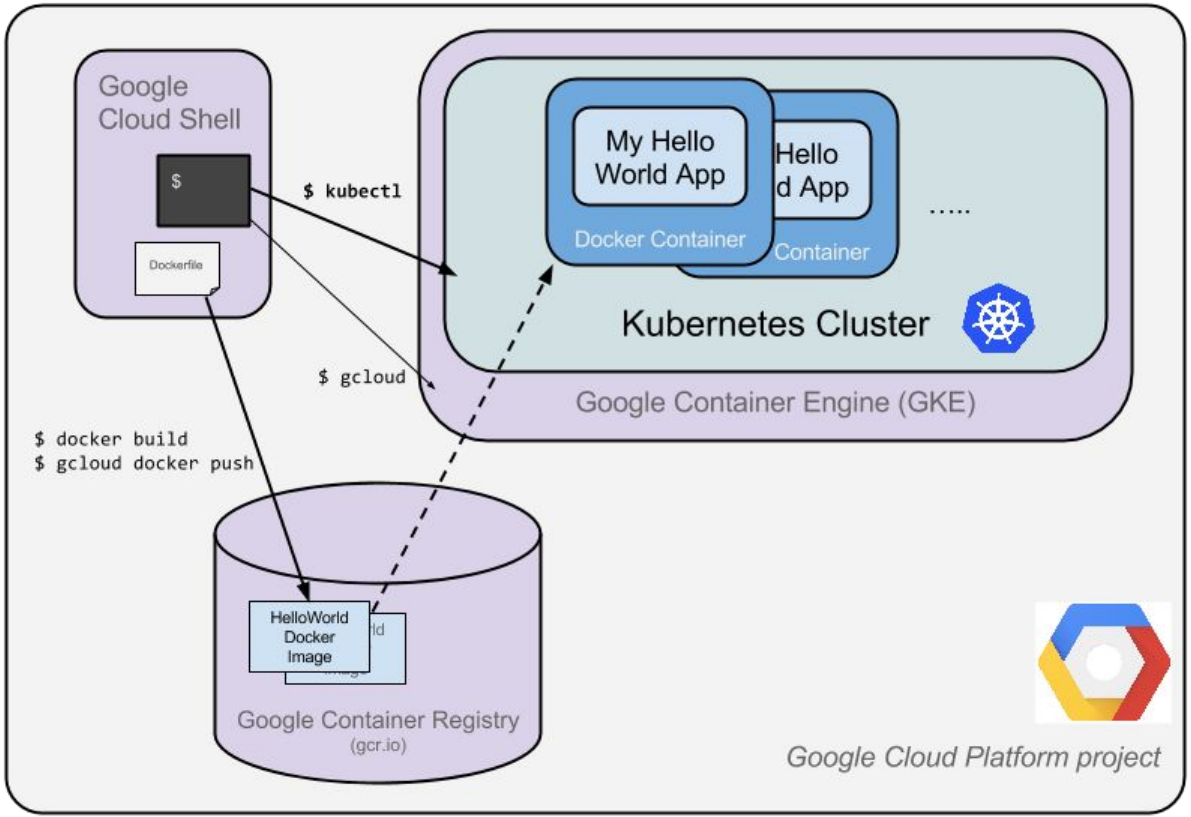
1. Setting up the cluster

- Choose a cloud: GCE, AWS, Azure, Rackspace, on-premises, ...
- 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...

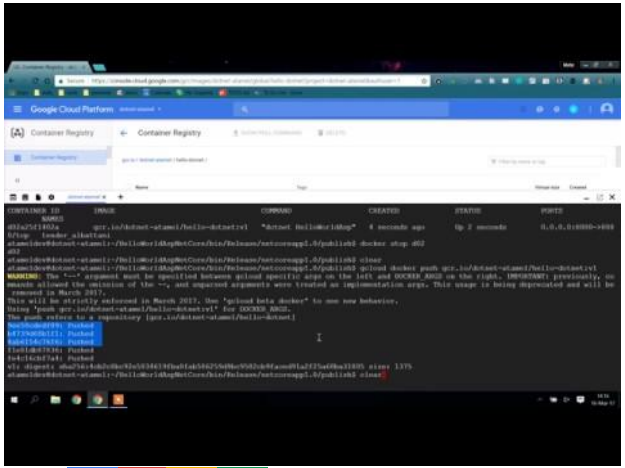
Not the easy or fun part, but unavoidable

This is where things like **Google Container Engine (GKE)** really help

Kubernetes cluster on GKE



Demo: Create Kubernetes cluster



2. Using the cluster

- Run Pods & Containers
- Replica Sets
- Services
- Volumes

This is the fun part!

A distinct set of problems from cluster setup and management

Don’t make developers deal with cluster administration!

Accelerate development by focusing on the applications, not the cluster

Kubernetes Building Blocks

Kubernetes Terminology

Deployment

Pod

Volume

Label

Selector

ReplicaSet

Liveness Probe

Readiness Probe

Service

DaemonSet

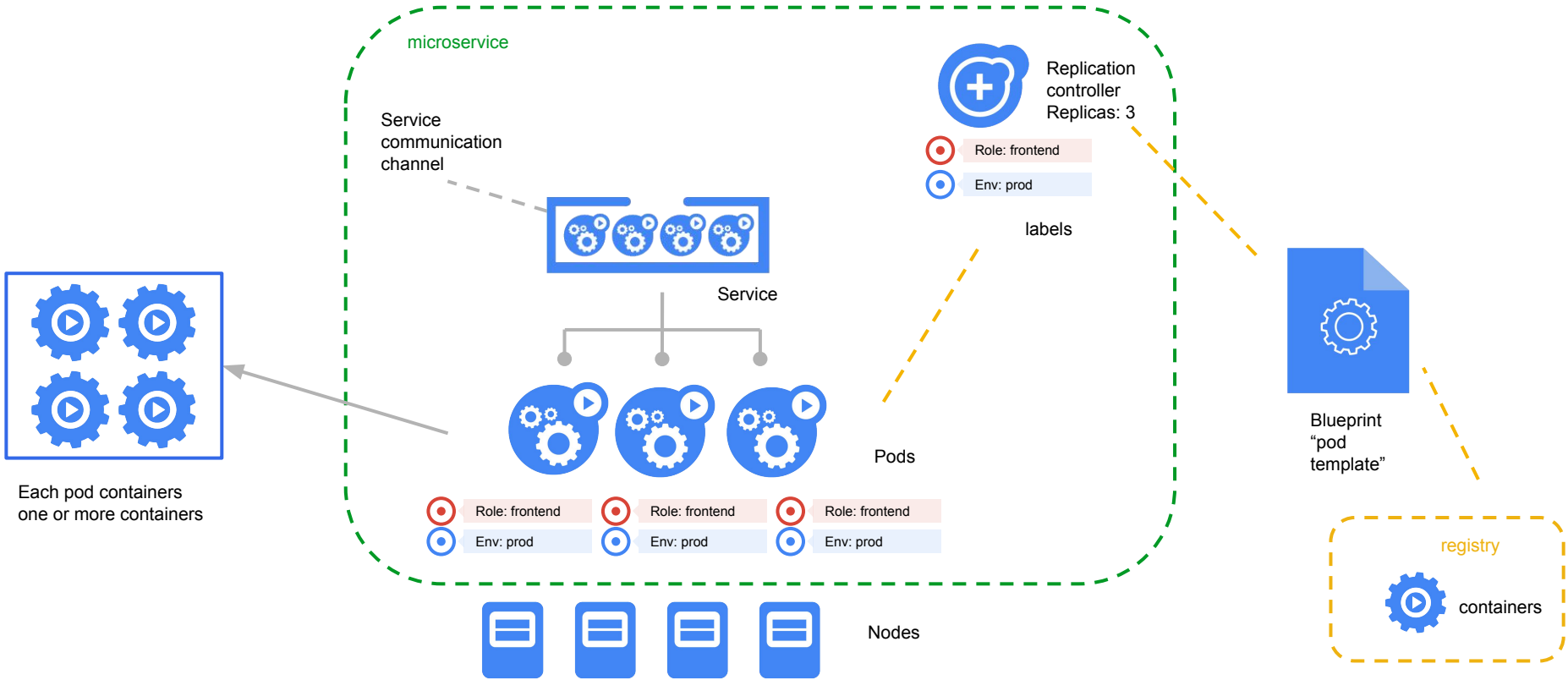
Job

StatefulSet

ConfigMap

Secret

Container cluster



Deployments

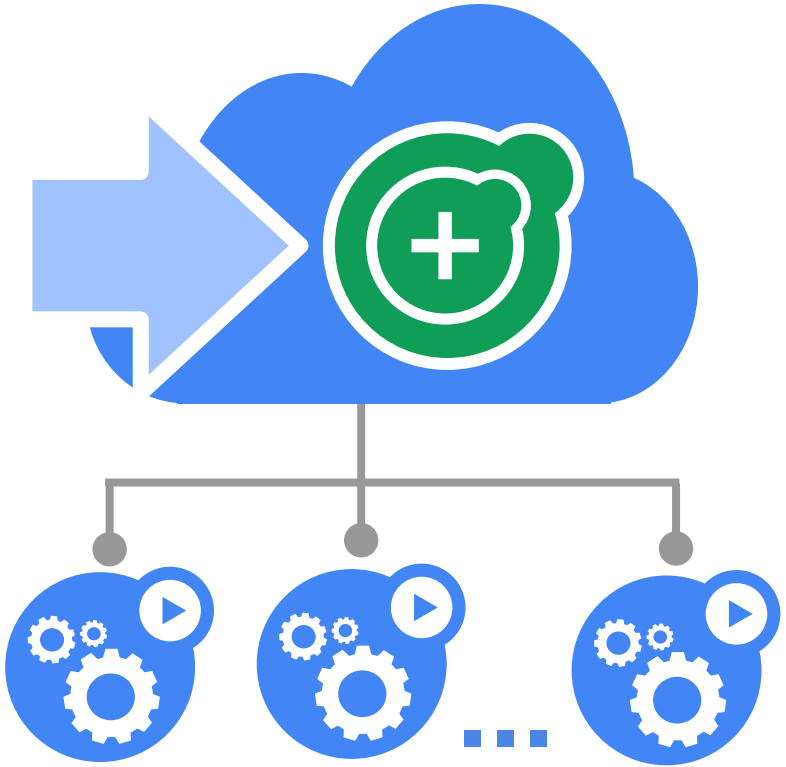
Deployments

A Deployment provides declarative updates for Pods and Replica Sets

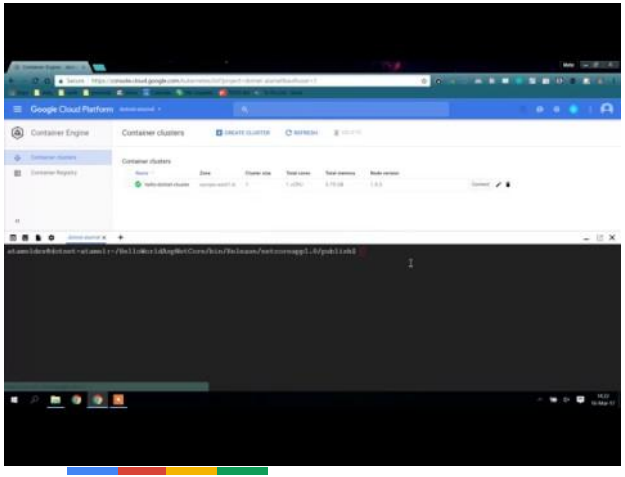
Describe the desired state and the Deployment controller will change the actual state to the desired state at a controlled rate for you.

Deployment manages replica changes for you

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



Demo: Create Deployment



Kubernetes Terminology

Deployment

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StatefulSet

ConfigMap

Secret

Pods and Volumes

Pods

Small group of containers & volumes

Tightly coupled

The atom of scheduling & placement

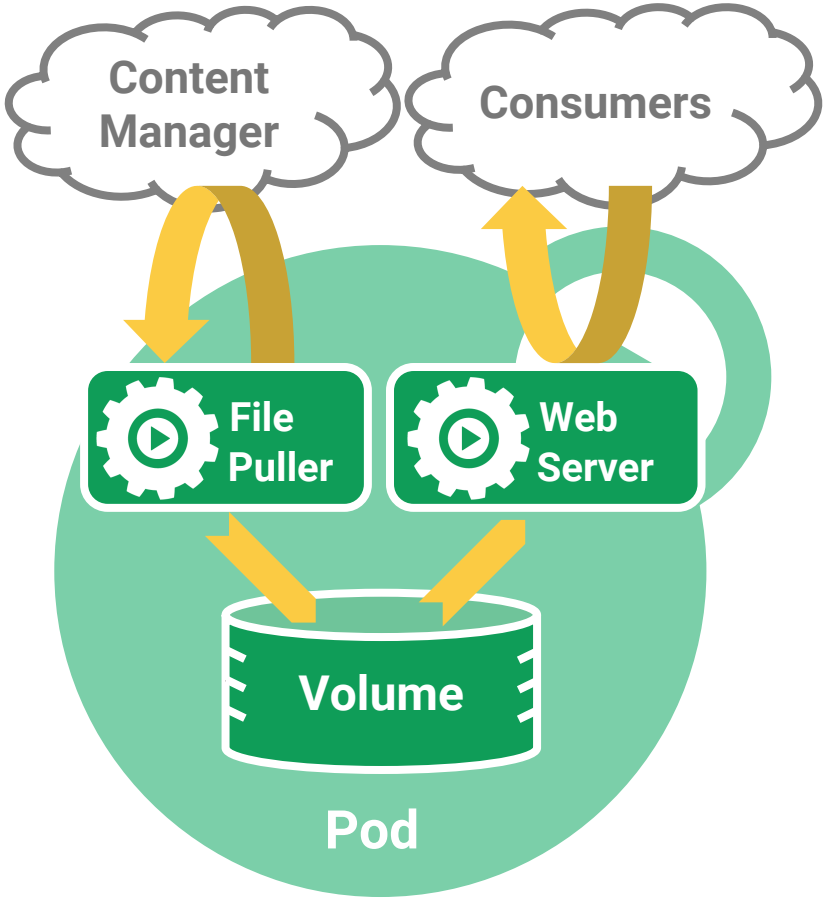
Shared namespace

- 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



Volumes

Pod-scoped storage

Support many types of volume plugins

- Empty dir (and tmpfs)
- Host path
- Git repository
- GCE Persistent Disk
- AWS Elastic Block Store
- Azure File Storage
- iSCSI
- Flocker
- NFS
- vSphere
- GlusterFS
- Ceph File and RBD
- Cinder
- FibreChannel
- Secret, ConfigMap, DownwardAPI
- Flex (exec a binary)
- ...

Kubernetes Terminology

Deployment

Pod

Volume

Label

Selector

ReplicaSet

Liveness Probe

Readiness Probe

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DaemonSet

Job

StatefulSet

ConfigMap

Secret

Labels & Selectors

Labels

Arbitrary metadata

Attached to any API object

Generally represent **identity**

Queryable by **selectors**

- think SQL '*select ... where ...*'

The **only** grouping mechanism

- pods under a ReplicationController
- pods in a Service
- capabilities of a node (constraints)

Selectors

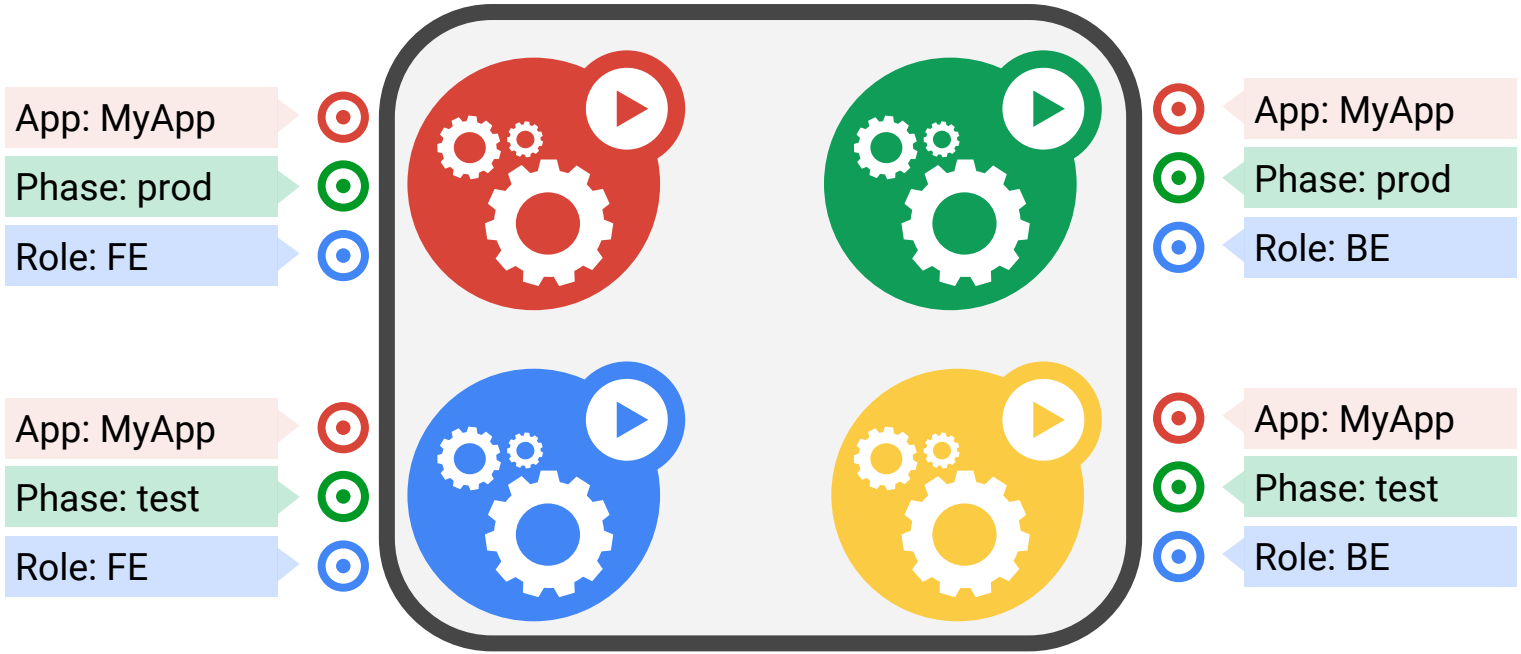
App: MyApp
Phase: prod
Role: FE

App: MyApp
Phase: prod
Role: BE

App: MyApp
Phase: test
Role: FE

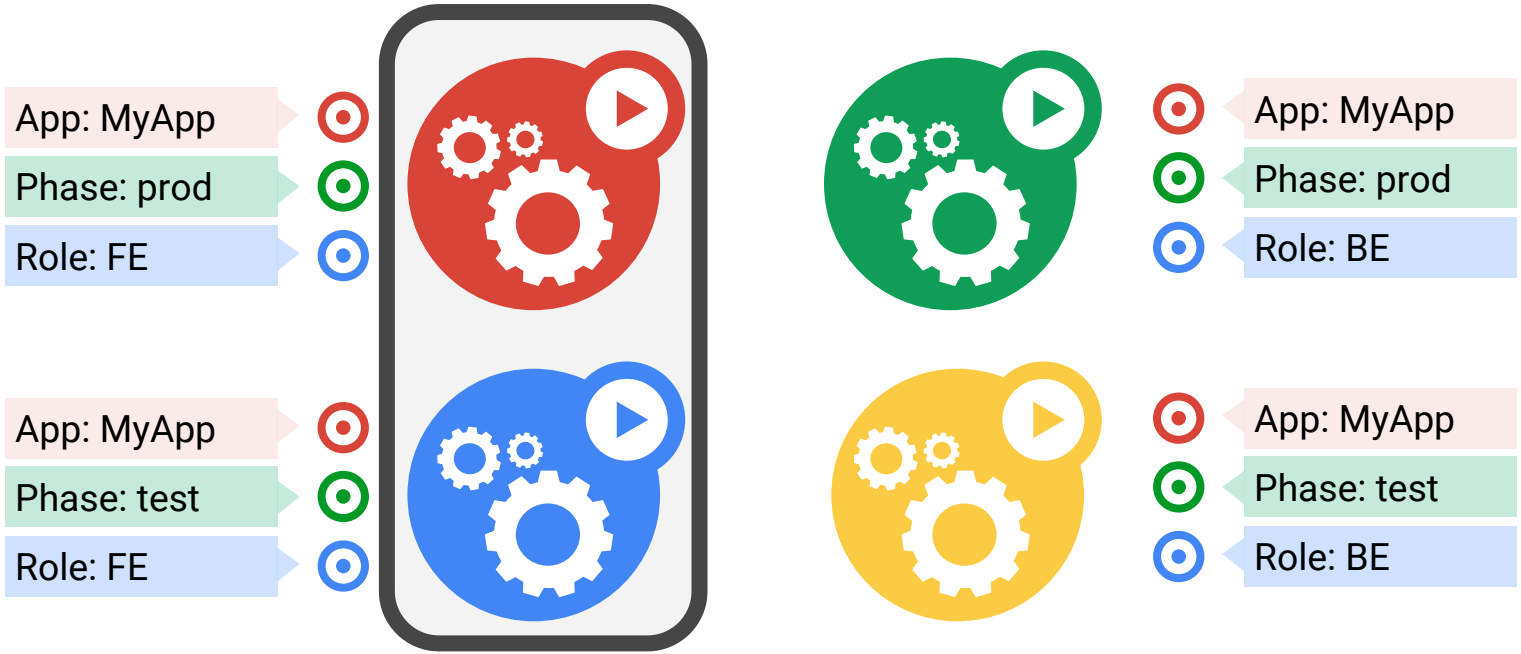
App: MyApp
Phase: test
Role: BE

Selectors



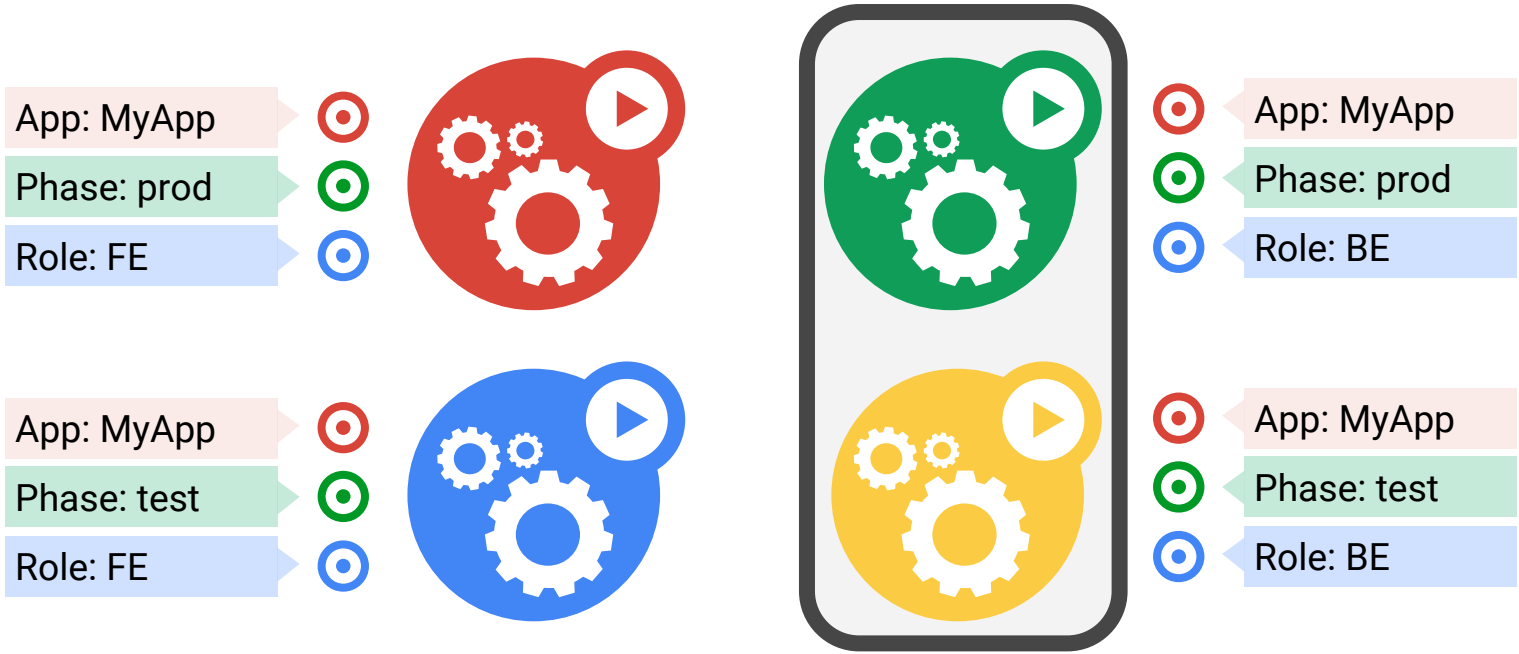
App = MyApp

Selectors



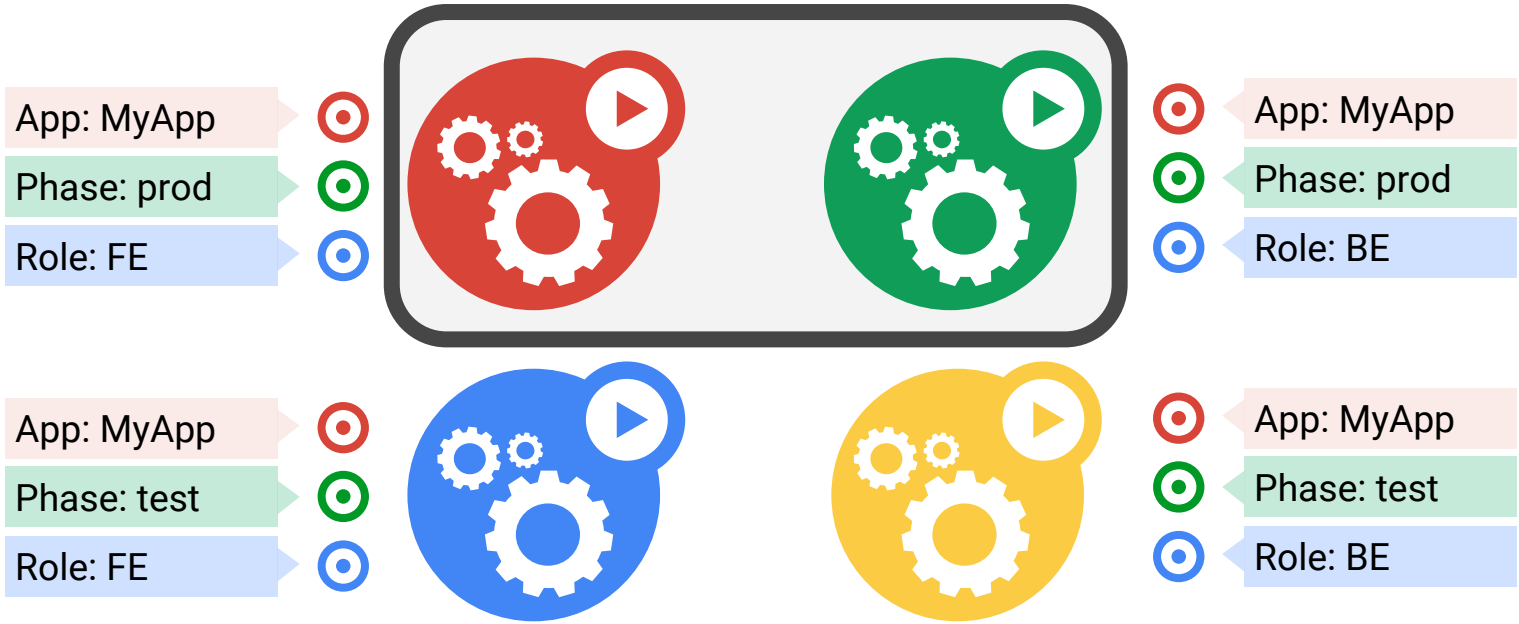
App = MyApp, Role = FE

Selectors



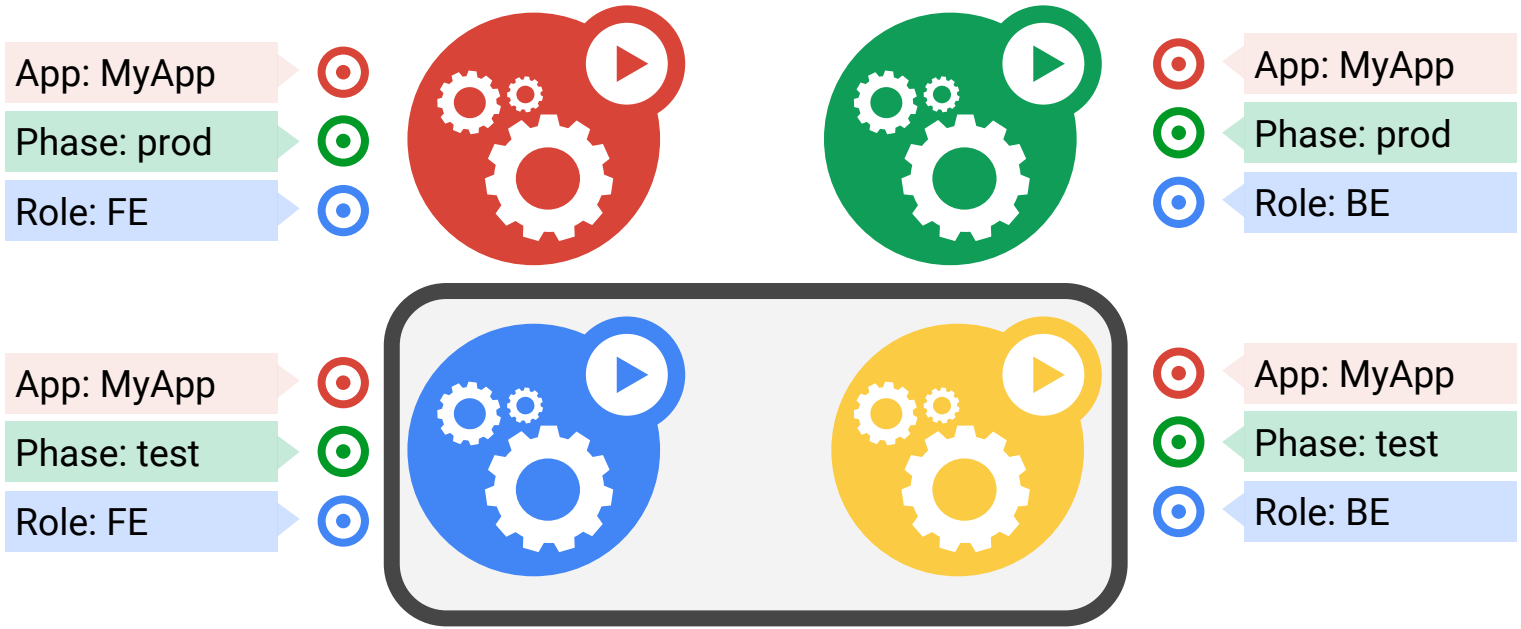
App = MyApp, Role = BE

Selectors



App = MyApp, Phase = prod

Selectors



App = MyApp, Phase = test

Kubernetes Terminology

Deployment	ReplicaSet	DaemonSet
Pod	Liveness Probe	Job
Volume	Readiness Probe	StatefulSet
Label	Service	ConfigMap
Selector		Secret

Resiliency & Redundancy

ReplicaSets*

A simple control loop

Runs out-of-process wrt API server

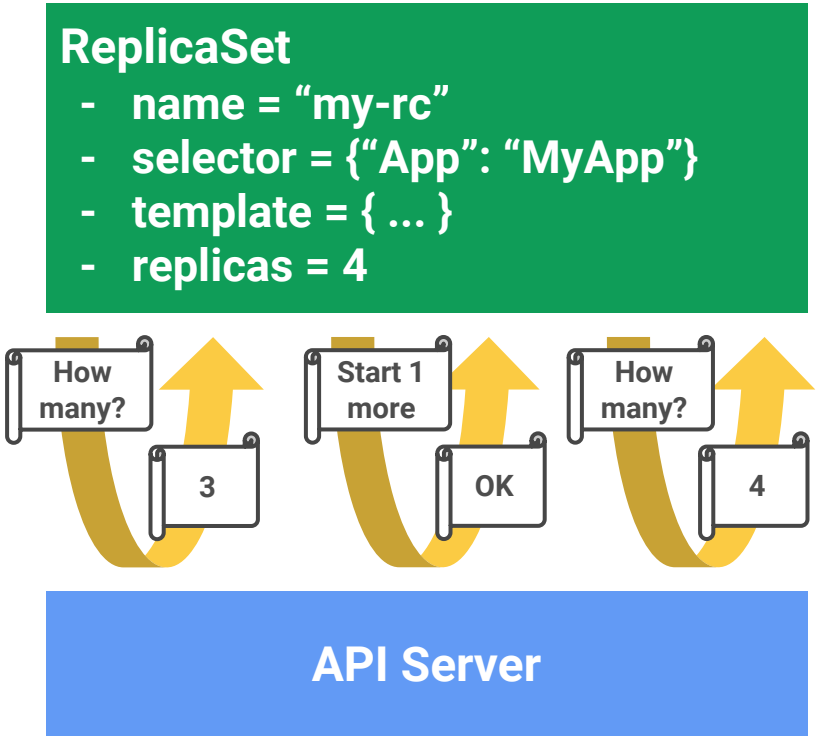
One job: ensure N copies of a pod

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

Layered on top of the public Pod API

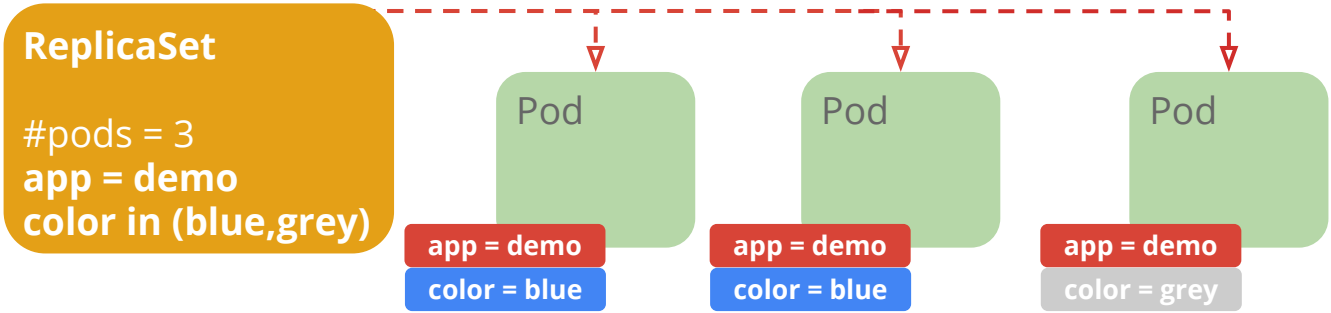
Replicated pods are **fungible**

- No implied order or identity



* The evolution of ReplicationControllers

ReplicaSets



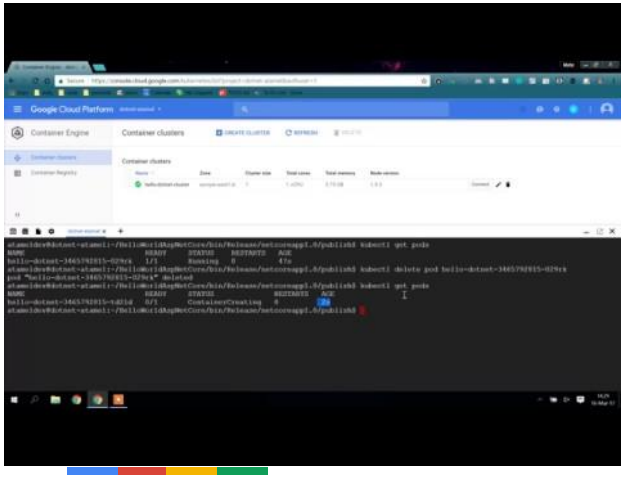
Behavior

- Keeps Pods running
- Gives direct control of Pod #s
- Grouped by Label Selector

Benefits

- ➔ Recreates Pods, maintains desired state
- ➔ Fine-grained control for scaling
- ➔ Standard grouping semantics

Demo: ReplicaSets



Kubernetes Health Checks

Health Check Philosophy

It’s **your** responsibility to let Kubernetes know whether your app is healthy or not!

Liveness Probes

Liveness Probes make sure your application is running

```
livenessProbe:
  # an http probe
  httpGet:
    path: /healthz
    port: 8080
  initialDelaySeconds: 15   # wait 15 seconds after pod is started to check for health
  timeoutSeconds: 1         # wait 1 second for a response to health check
```

Readiness Probes

Readiness probes make sure your application is ready to serve traffic

```
readinessProbe:
  # an http probe
  httpGet:
    path: /readiness
    port: 8080
  initialDelaySeconds: 20  # wait 20 seconds after pod is started to check for health
  timeoutSeconds: 5        # wait 5 second for a response to health check
```

Kubernetes Terminology

Deployment	**ReplicaSet**	DaemonSet
Pod	**Liveness Probe**	Job
Volume	**Readiness Probe**	StatefulSet
Label	Service	ConfigMap
Selector		Secret

Services

Services

A logical grouping of pods that perform the same function (the Service's endpoints)

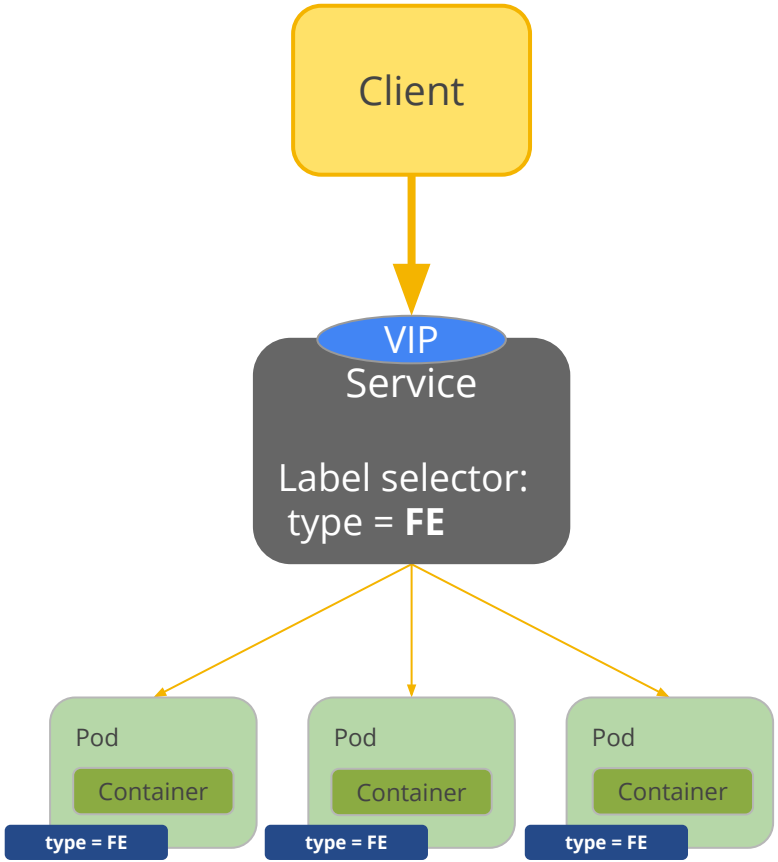
- grouped by label selector

Load balances incoming requests across constituent pods

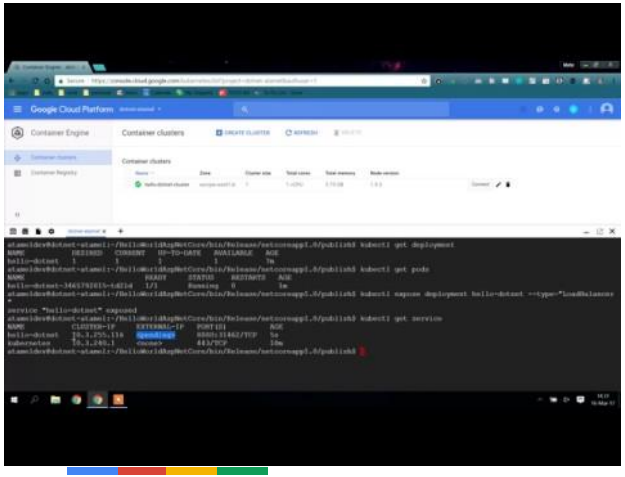
Choice of pod is random but supports session affinity (ClientIP)

Gets a **stable** virtual IP and port

- also a DNS name

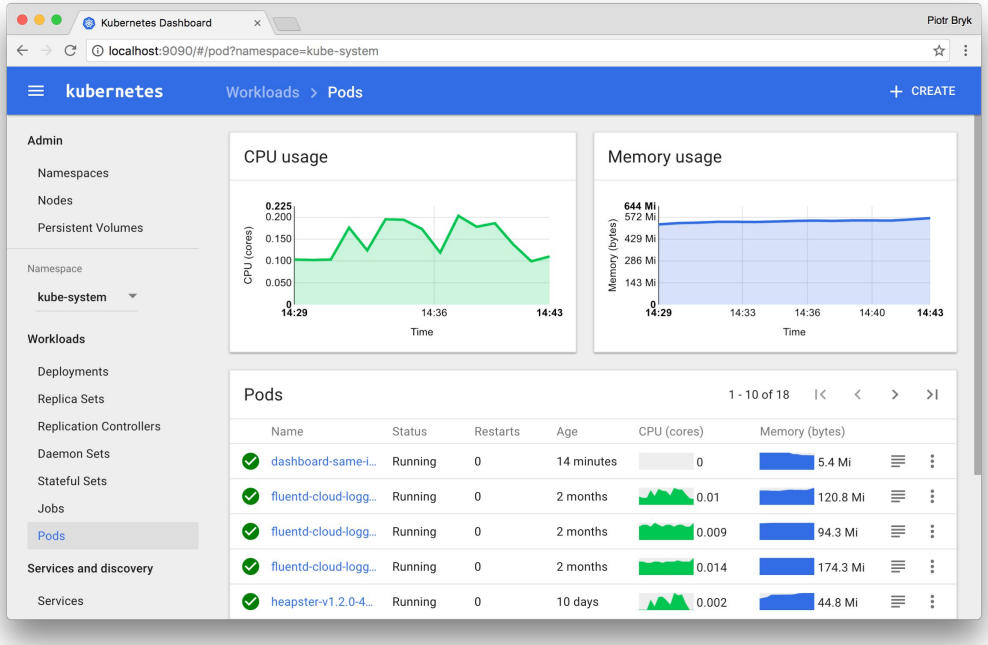


Demo: Services

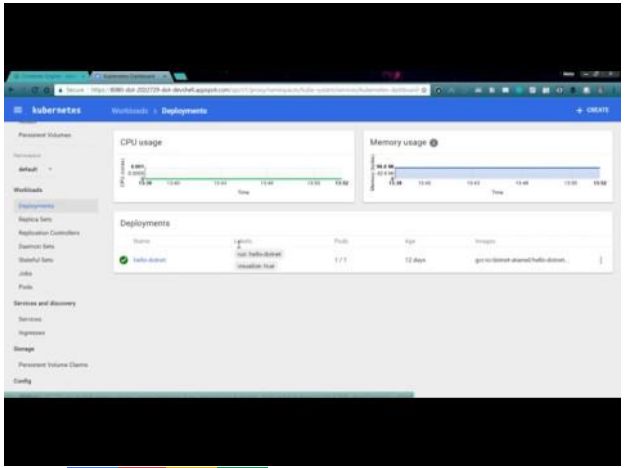


Kubernetes Dashboard

A general purpose, web-based UI to view/manage Kubernetes clusters



Demo: Kubernetes Dashboard



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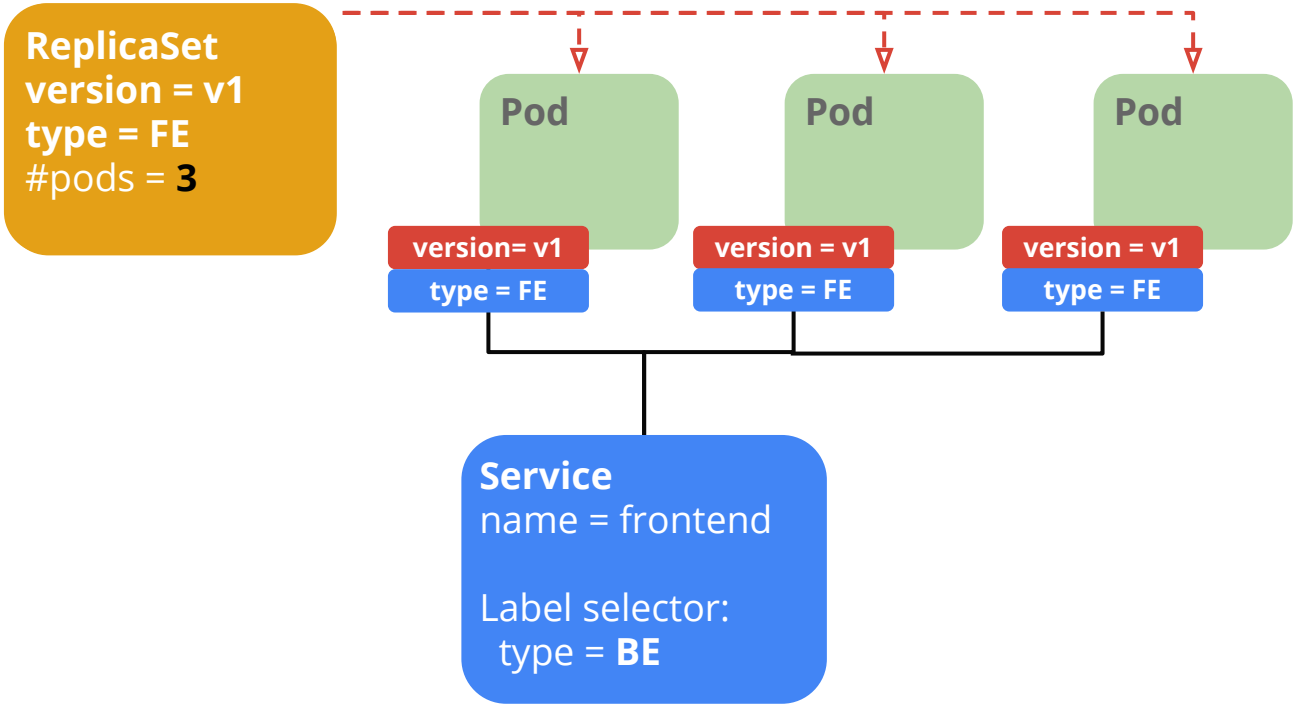
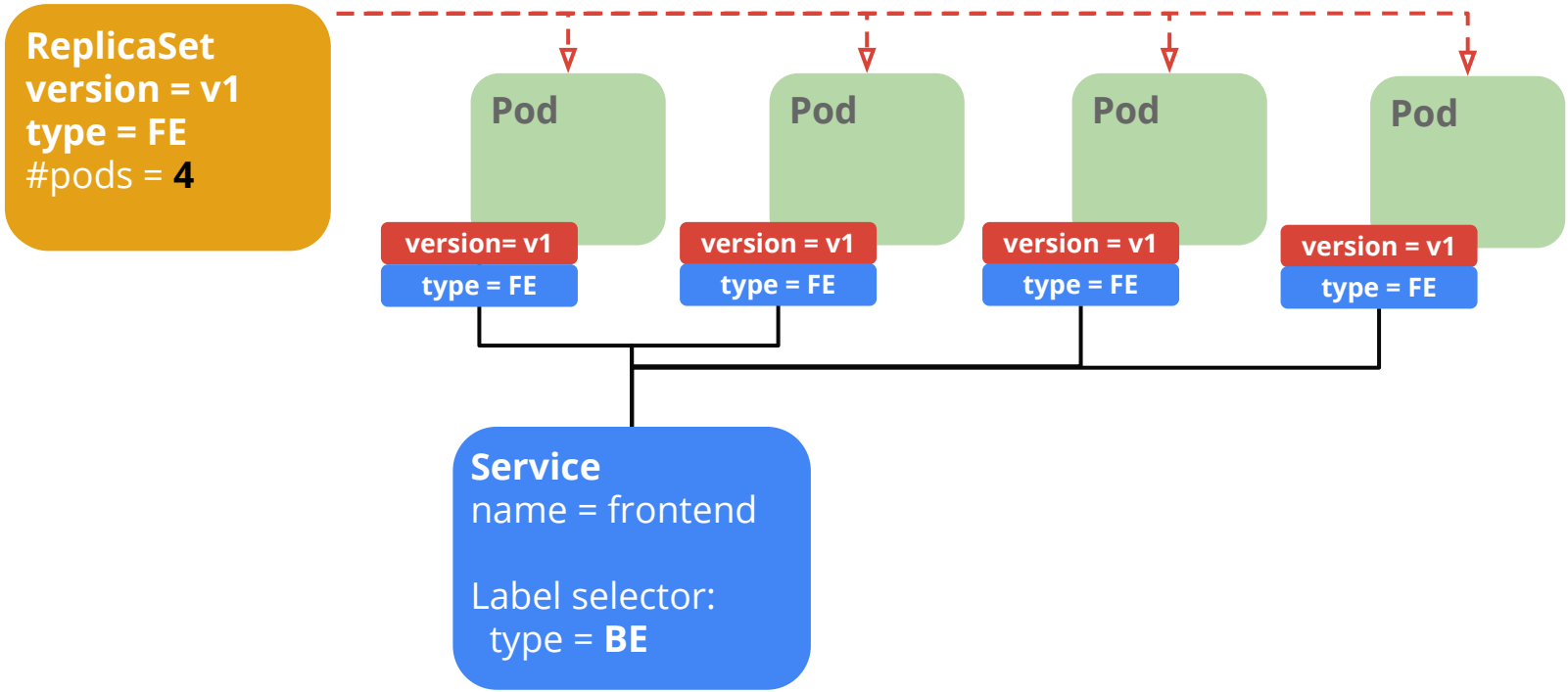
Scaling

Scaling


ReplicaSet
version = v1
type = FE
#pods = 3
Pod
Pod
Pod
version= v1
type = FE
version = v1
type = FE
version = v1
type = FE
Service
name = frontend
Label selector:
type = BE

Scaling


ReplicaSet
version = v1
type = FE
#pods = 4
Pod
Pod
Pod
Pod
version= v1
type = FE
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version = v1
type = FE
version = v1
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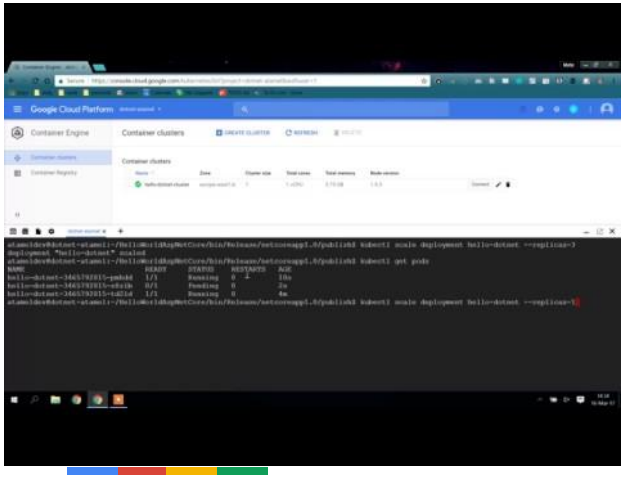
Service
name = frontend
Label selector:
type = BE

Demo: Scaling

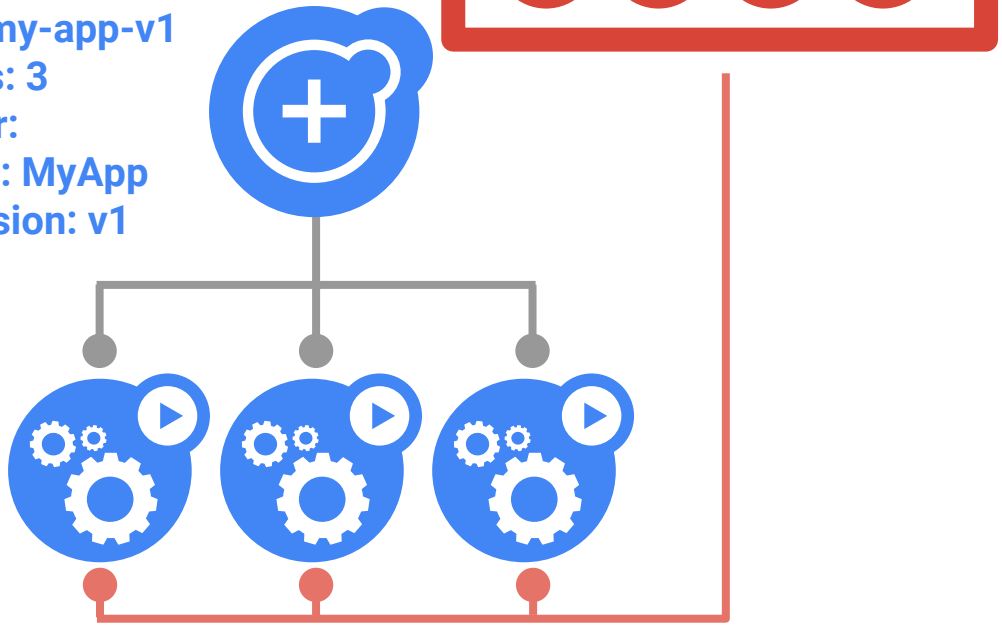


Rolling Update

Rolling Update

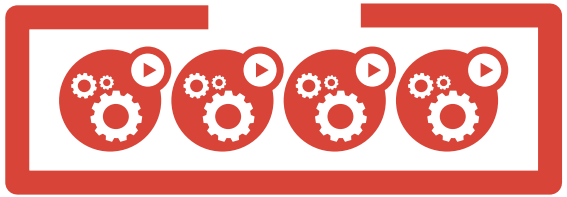
Service
- app: MyApp

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

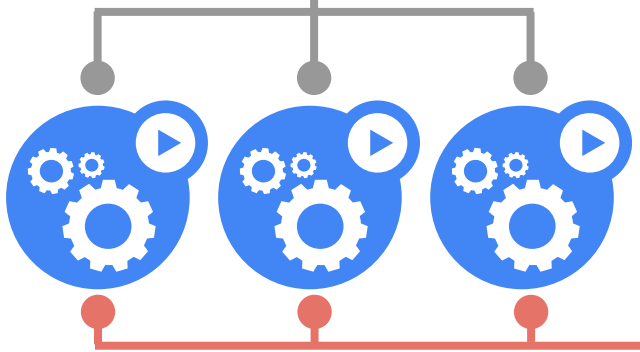


Rolling Update

Service
- app: MyApp

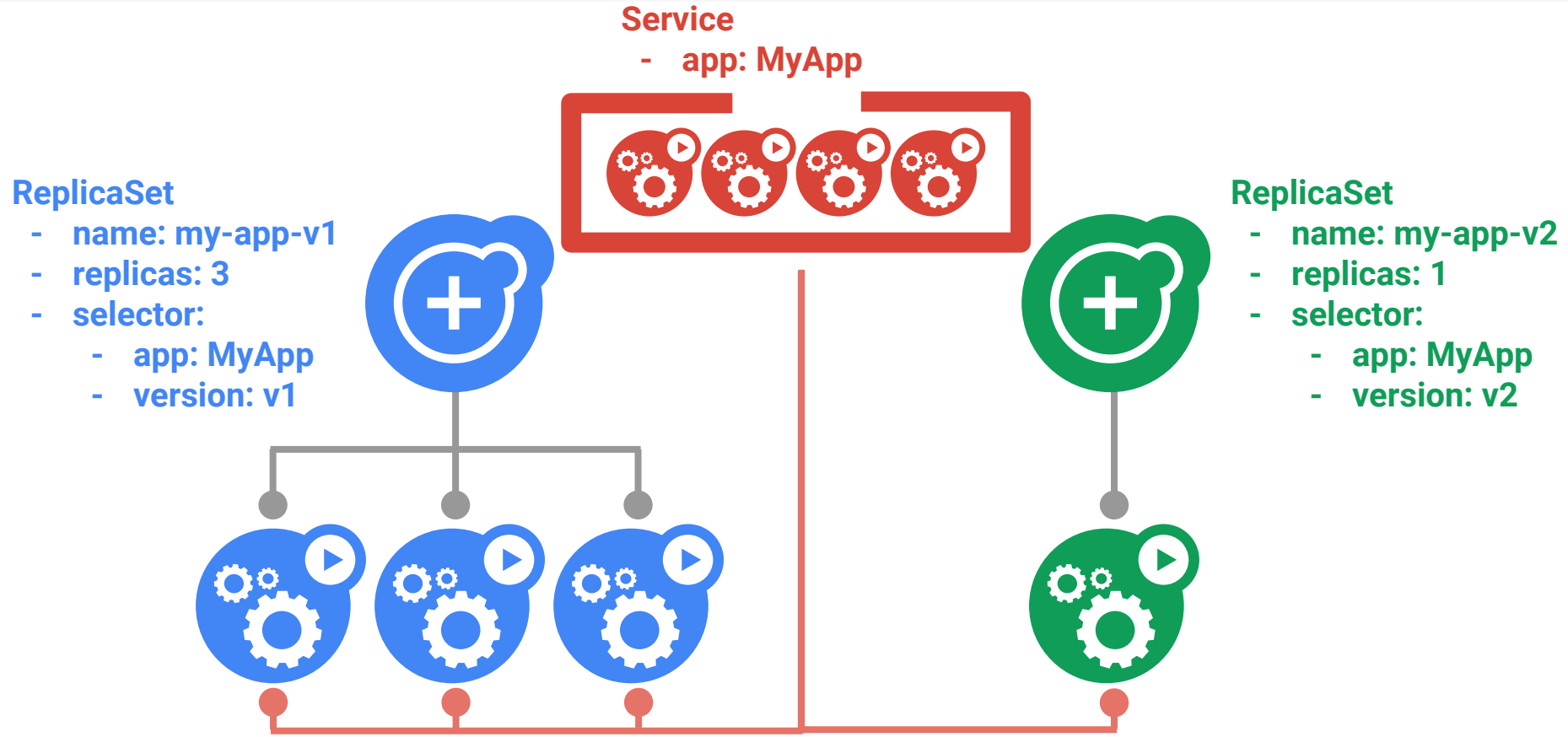


ReplicaSet
- name: my-app-v1
- replicas: 3
- selector:
  - app: MyApp
  - version: v1



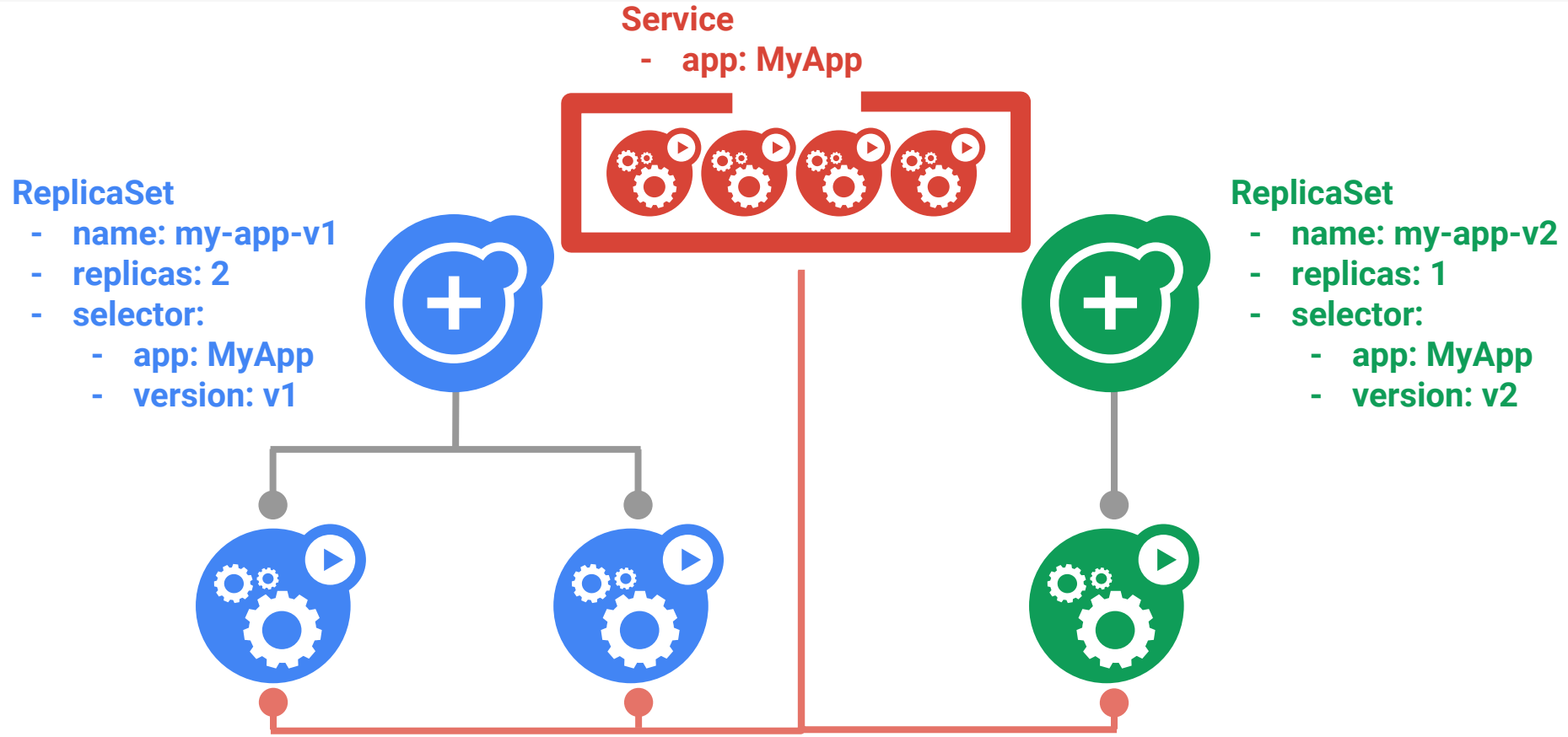
ReplicaSet
- name: my-app-v2
- replicas: 0
- selector:
  - app: MyApp
  - version: v2

Rolling Update

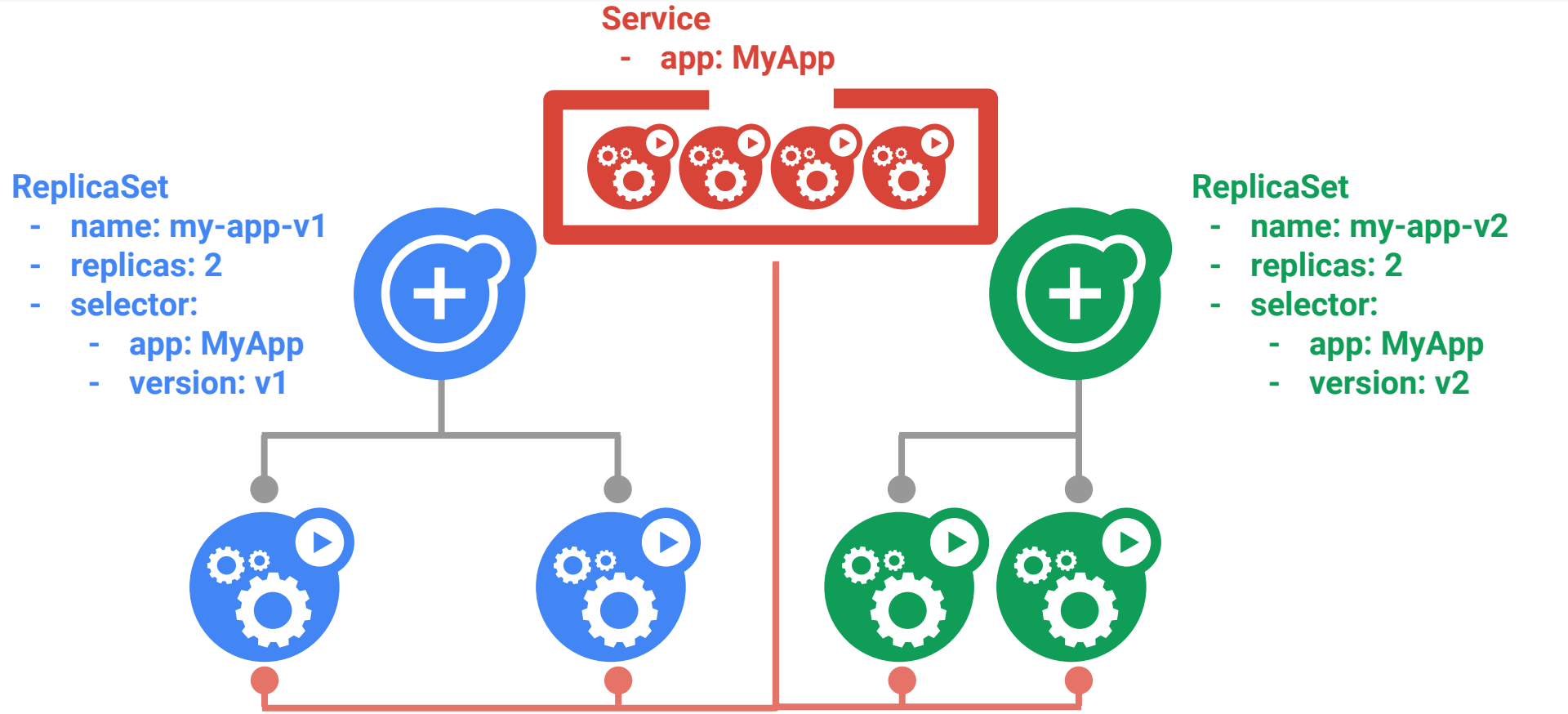


Rolling Update

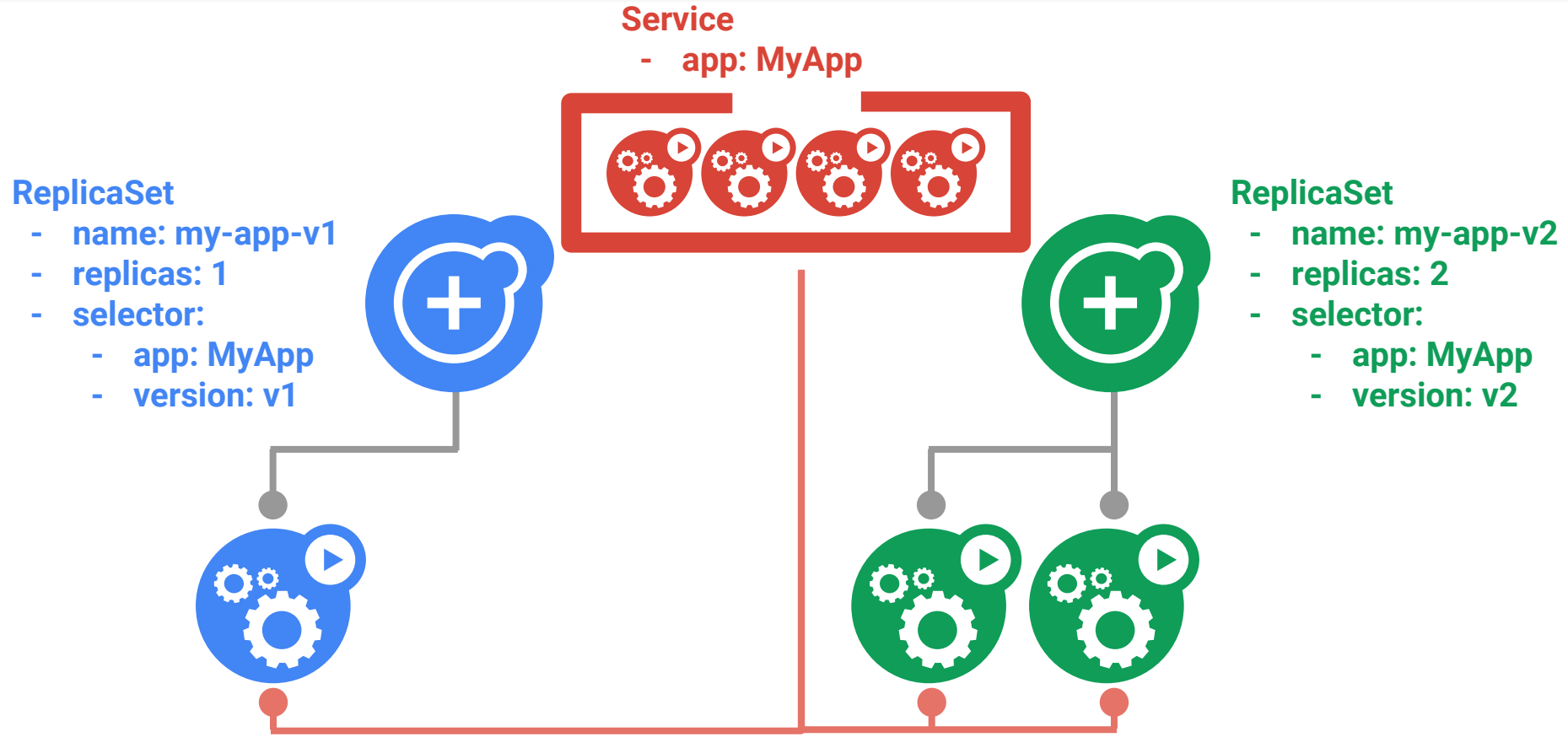
@meteatamel



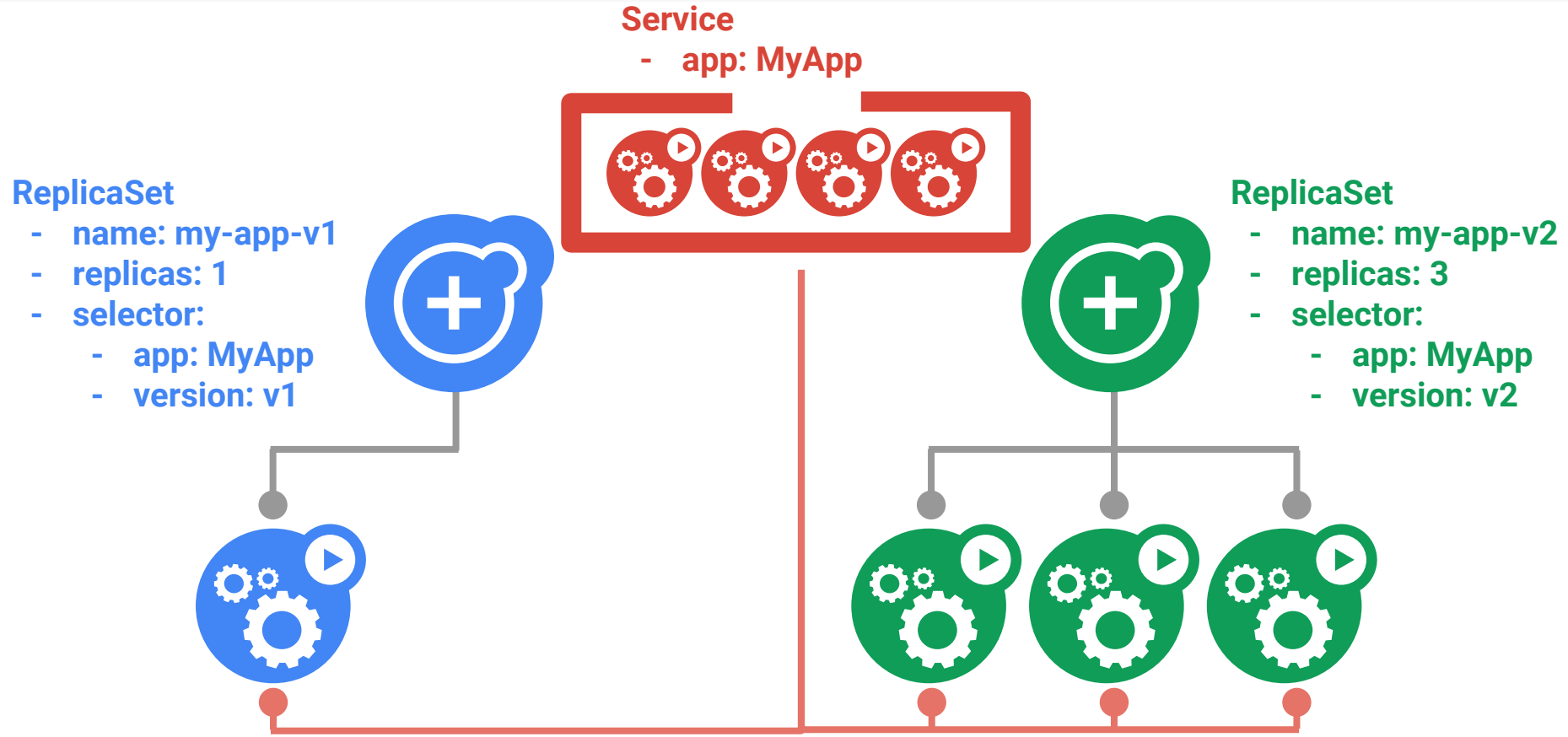
Rolling Update



Rolling Update



Rolling Update

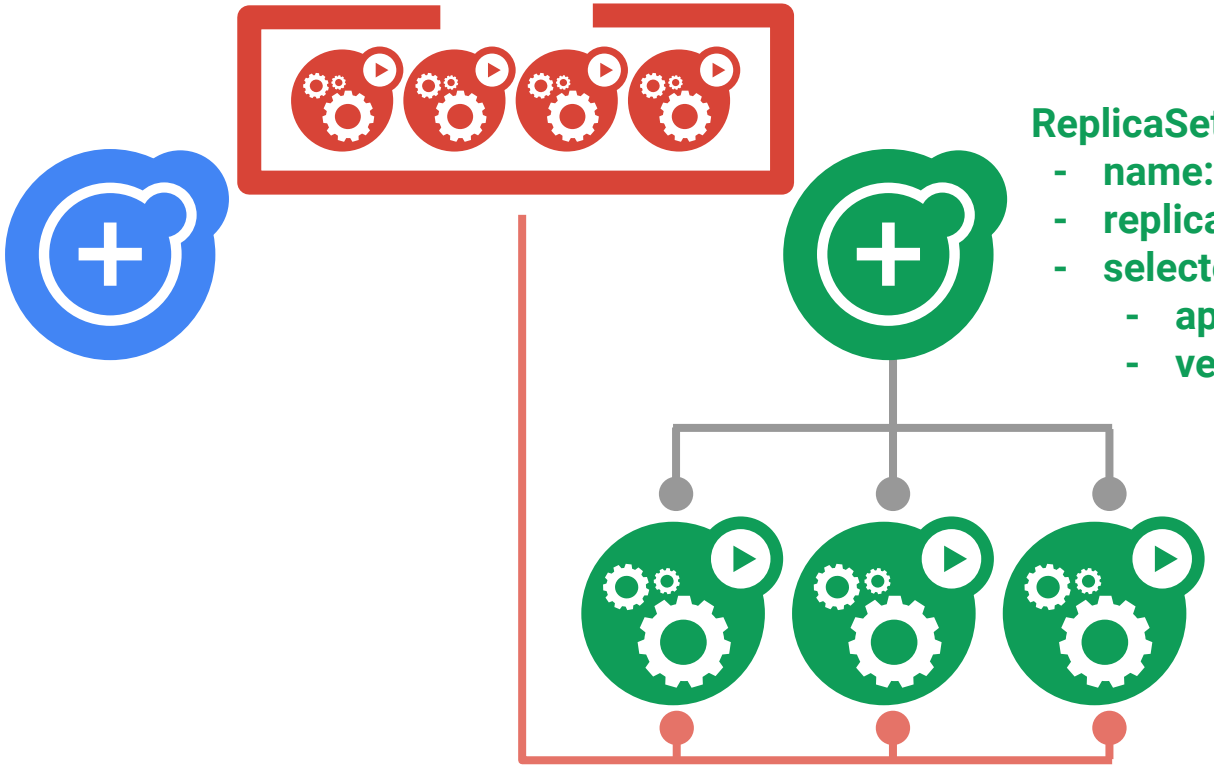


Rolling Update

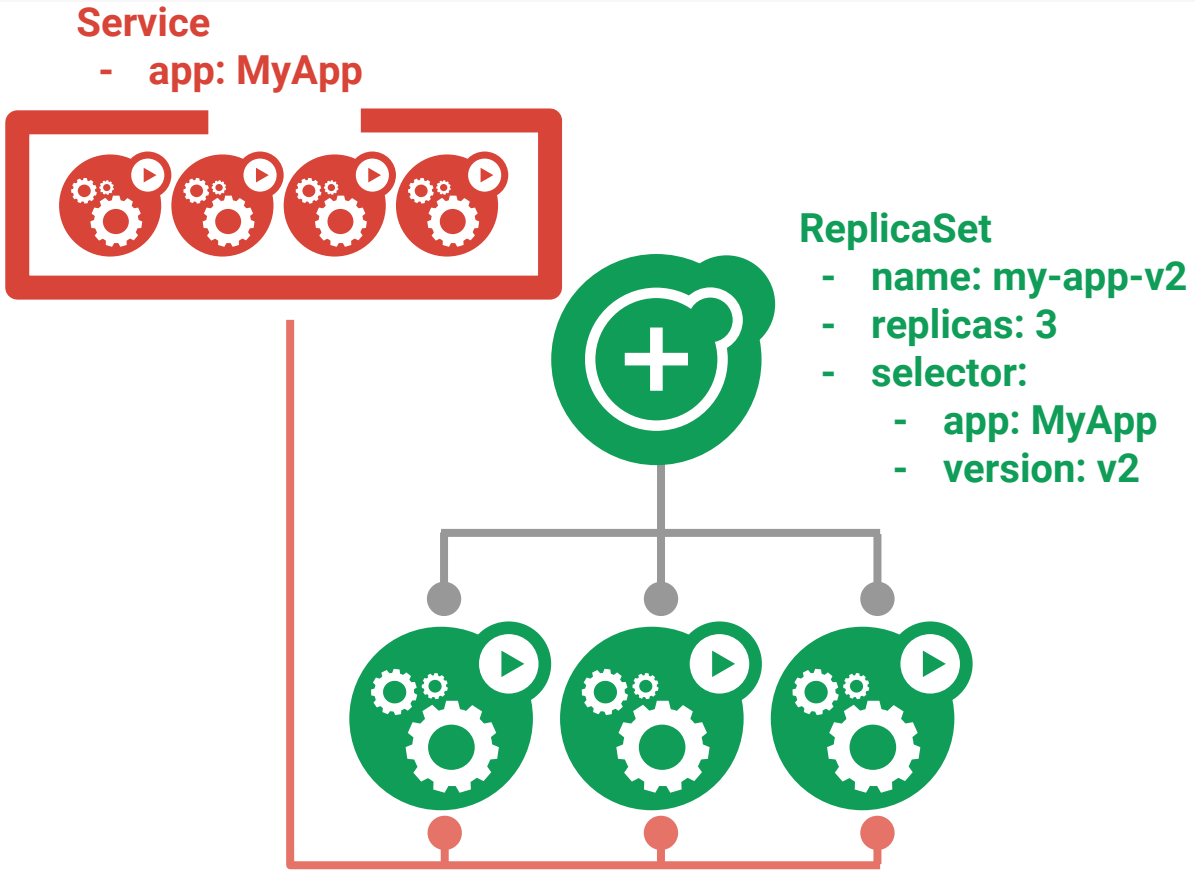
Service
- app: MyApp

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

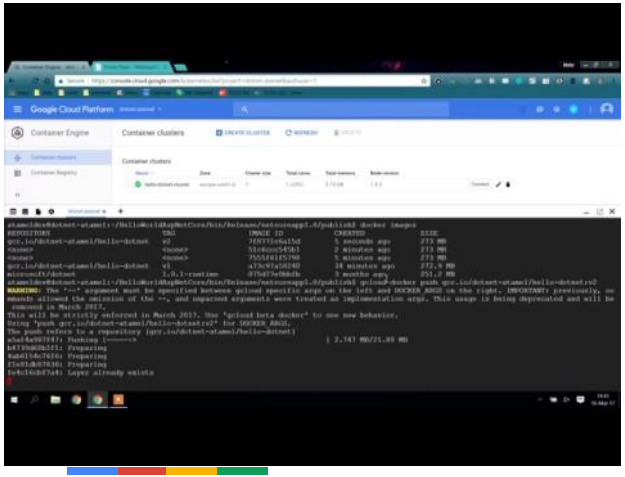
ReplicaSet
- name: my-app-v2
- replicas: 3
- selector:
  - app: MyApp
  - version: v2



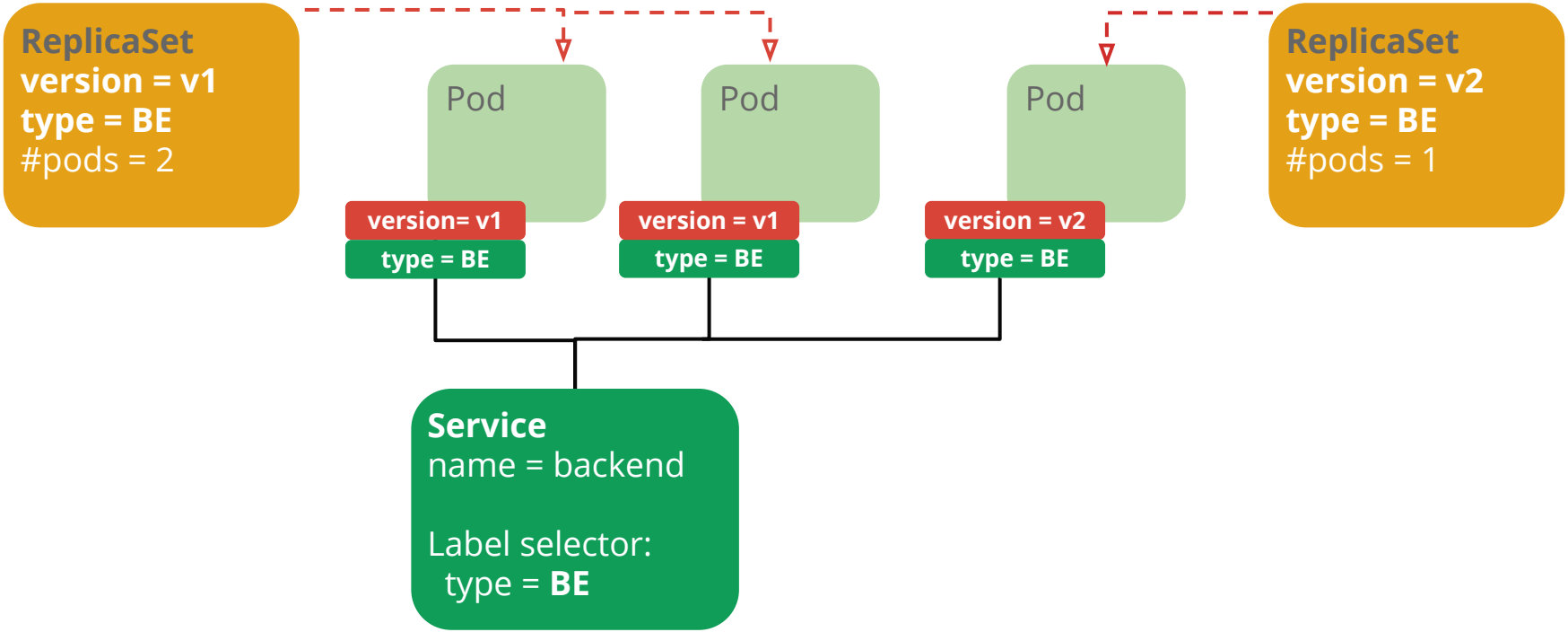
Rolling Update



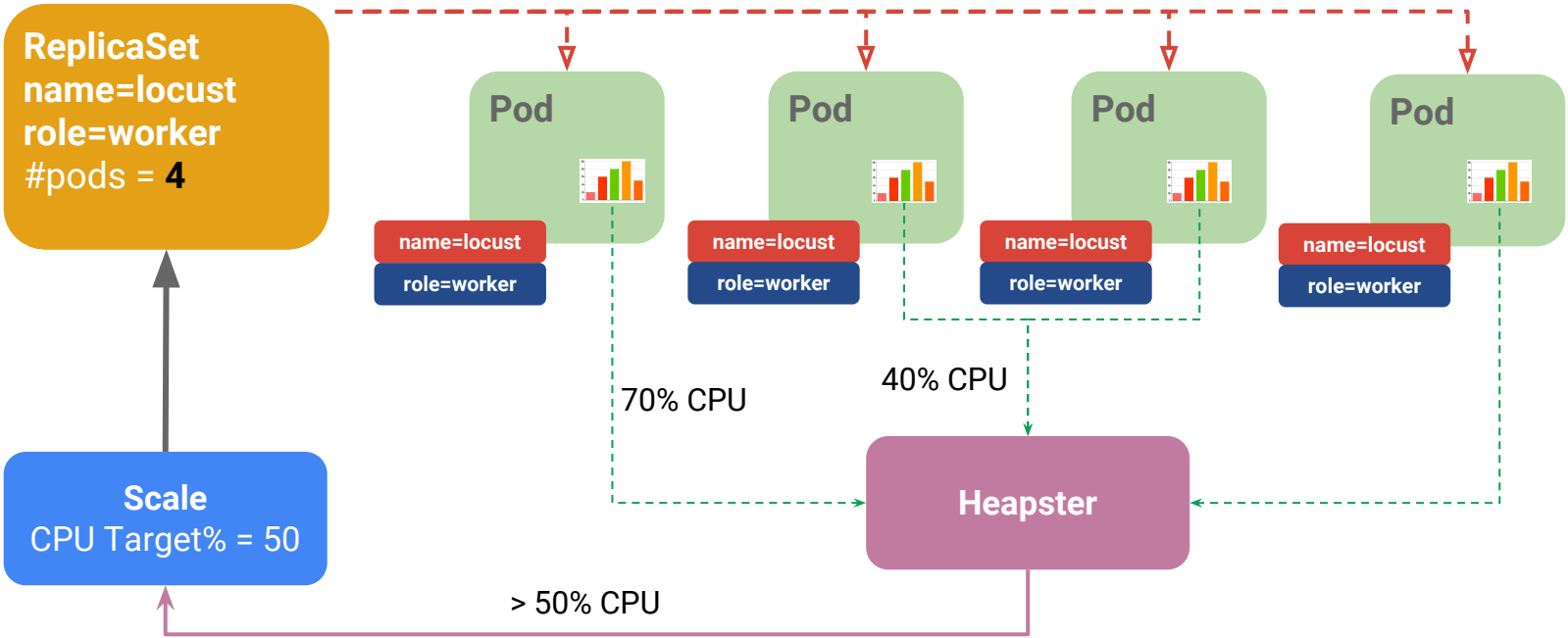
Demo: Rolling Update



Canary Deployments



Autoscaling



DaemonSets

DaemonSets

Problem: how to run a Pod on every node?

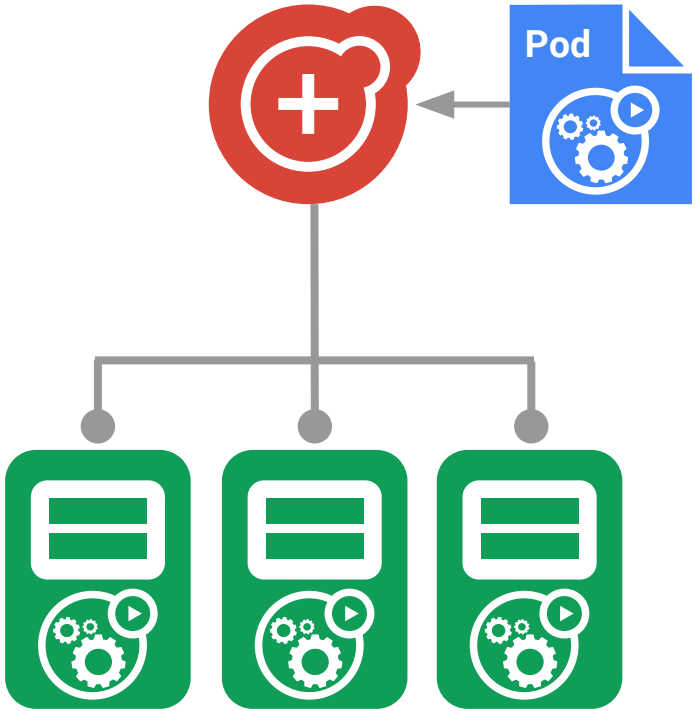
- or a subset of nodes

Similar to ReplicaSet

- principle: do one thing, don't overload

"Which nodes?" is a selector

Use familiar tools and patterns



Jobs

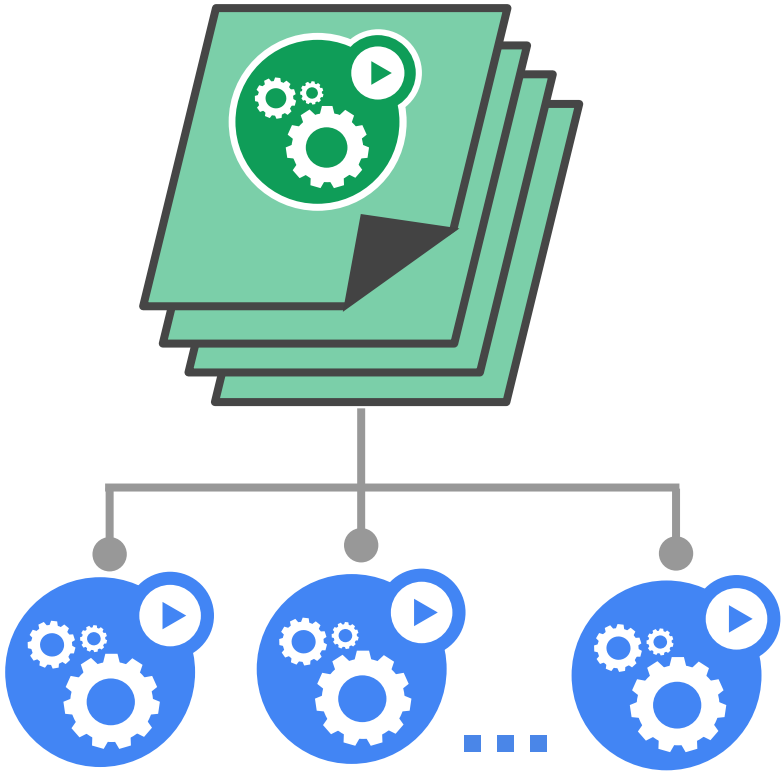
Jobs

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

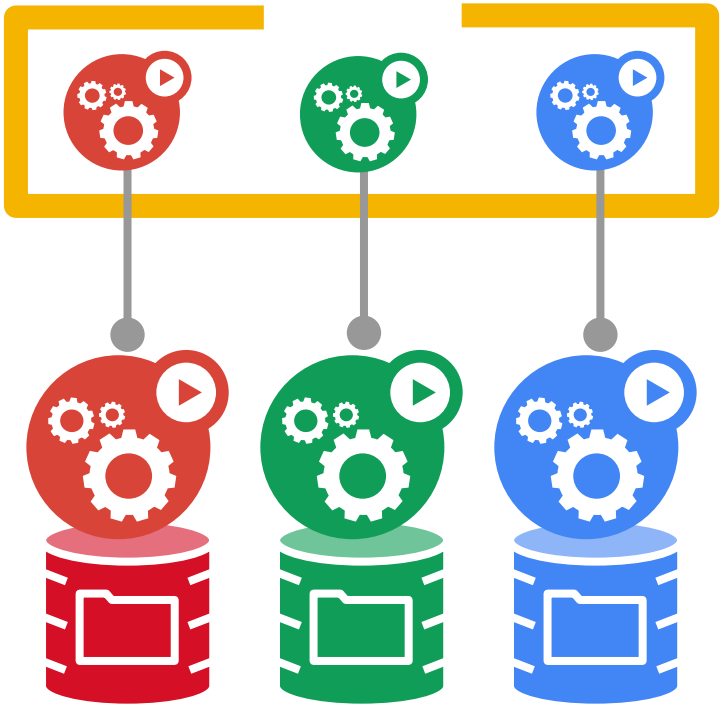
StatefulSets

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



ConfigMaps

ConfigMaps

Goal: manage app configuration

- ...without making overly-brittle container images

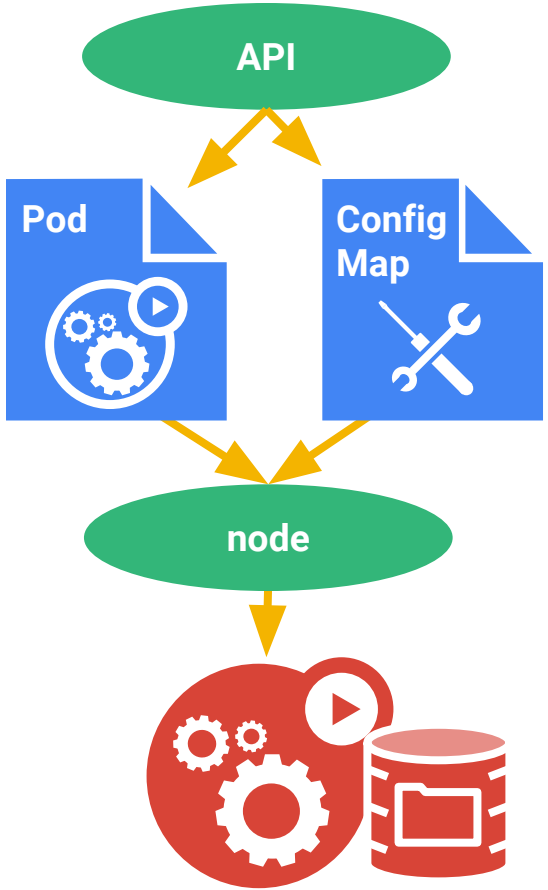
12-factor says config comes from the environment

- Kubernetes is the environment

Manage config via the Kubernetes API

Inject config as a virtual volume into your Pods

- late-binding, live-updated (atomic)
- also available as env vars



Secrets

Secrets

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

- don't put secrets in the container image!

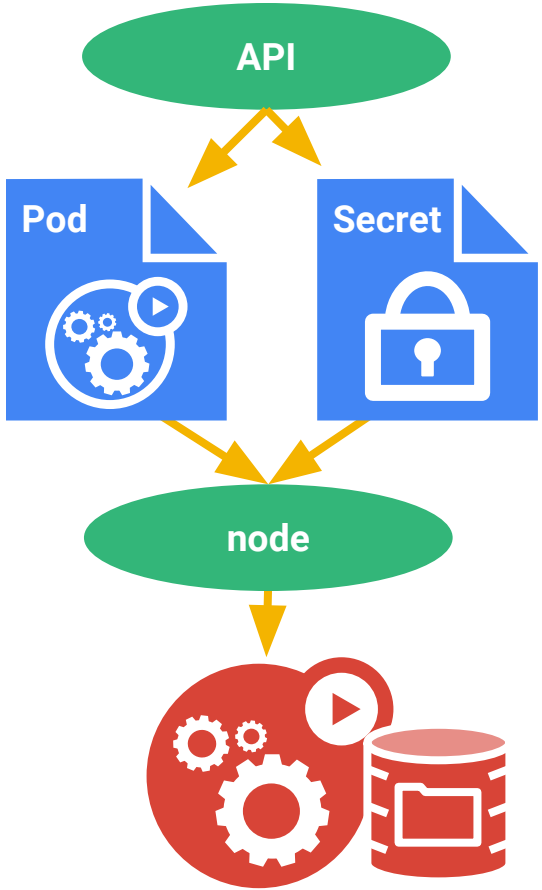
12-factor says config comes from the environment

- 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



Kubernetes Terminology

Deployment

Pod

Volume

Label

Selector

ReplicaSet

Liveness Probe

Readiness Probe

Service

DaemonSet

Job

StatefulSet

ConfigMap

Secret

There is more!

Thank You

Send talk feedback
bit.ly/atamel

kubernetes.io
cloud.google.com/container-engine

Mete Atamel
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atamel@google.com
meteatamel.wordpress.com