



Go Programming Pattern in Kubernetes Philosophy

Harry Zhang @resouer



Contents

- **What I will talk?**

- Kubernetes basic in 1 min
- **For Kubernetes developers:**
 - The Golang programming patterns of Kubernetes (Controller, codegen etc)
 - Write your own Controller
 - gPRC based interface design in Kubernetes (CRI as example)
- **For Kubernetes users:**
 - Effective pattern of programming based on Kubernetes
- 广告 (Don't worry, it's not **that** kind of AD)

- **What I will not talk?**

- Kubernetes usage and under the hood
- Internal systems or commercial software



Kubernetes

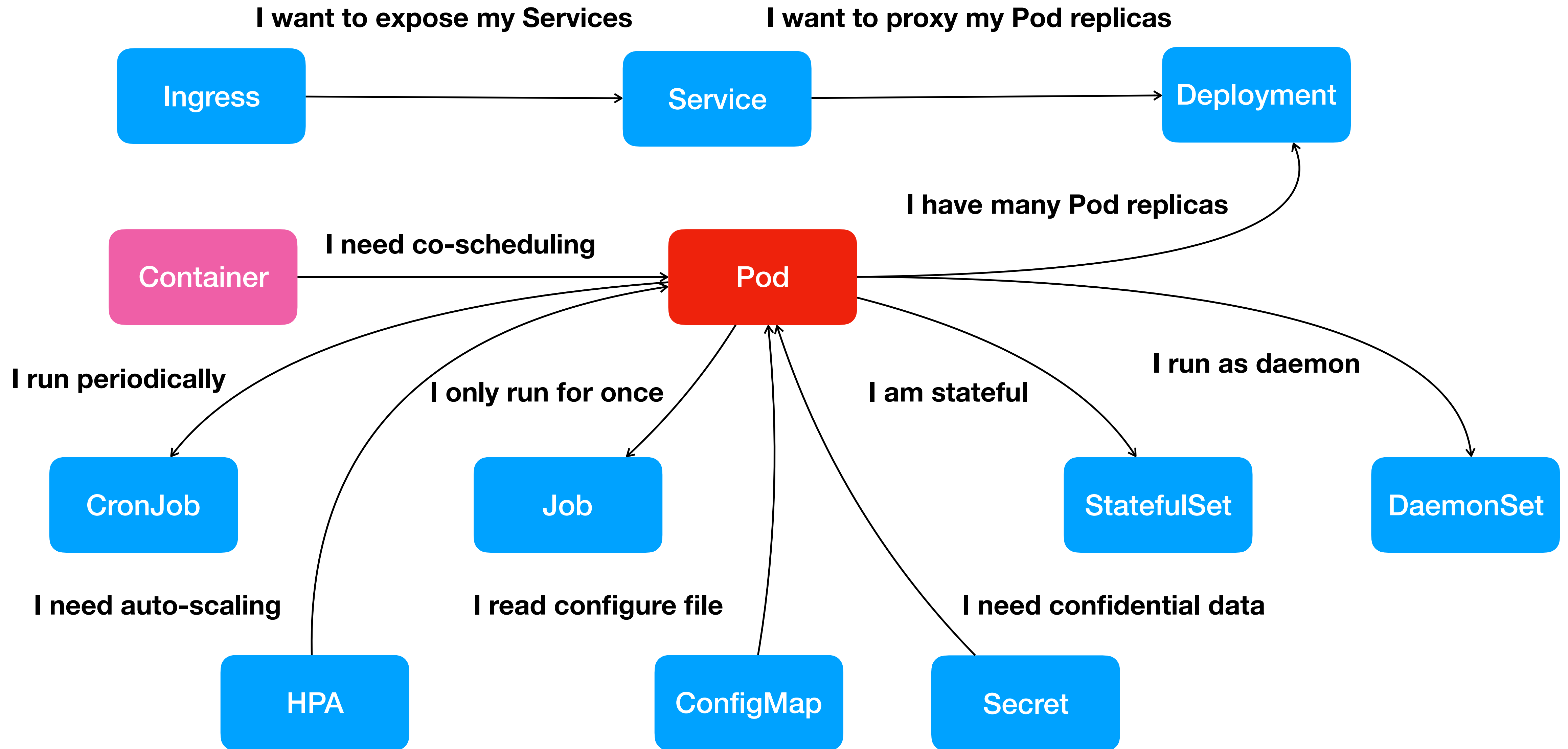
- The **container** orchestration and management project created by Google
- Successor of Google **Borg/Omega** system
- One of the **most popular** open source projects in this world
- Written by, and heavily depends on Golang



Again: Why Go?

- All about **community**
- A sad story:
 - <https://github.com/google/lmctfy>
- Now think about a C/C++ based Kubernetes?
- And, well designed **programming patterns** with powerful **extensibility**

Understand Kubernetes in 1 r



Understand Kubernetes in 2 r



- `kubectl run nginx --image=nginx:1.7.9 --replicas=3`
- `kubectl create -f deployment.yaml`
- `kubectl create -f hpa.yaml`

- **API Object Oriented Programming**

```
apiVersion: autoscaling/v2alpha1
kind: HorizontalPodAutoscaler
metadata:
  name: php-apache
  namespace: default
spec:
  scaleTargetRef:
    apiVersion: apps/v1beta1
    kind: Deployment
    name: nginx-deployment
  minReplicas: 1
  maxReplicas: 10
  metrics:
  - type: Resource
    resource:
      name: cpu
      targetAverageUtilization: 50
```

```
apiVersion: apps/v1beta1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 3
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.7.9
        ports:
        - containerPort: 80
```

Core of API “OO”

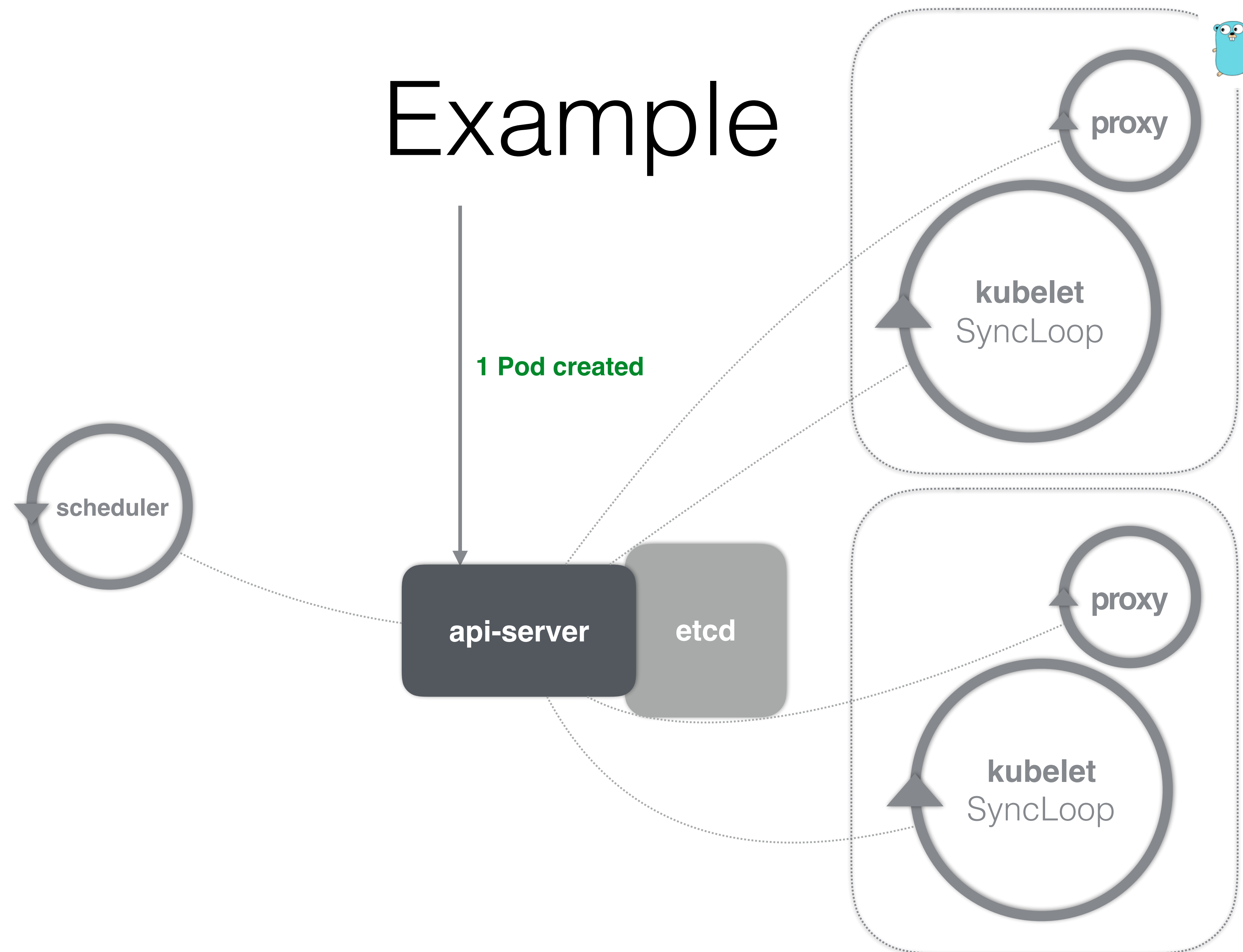


1.API objects stores in etcd

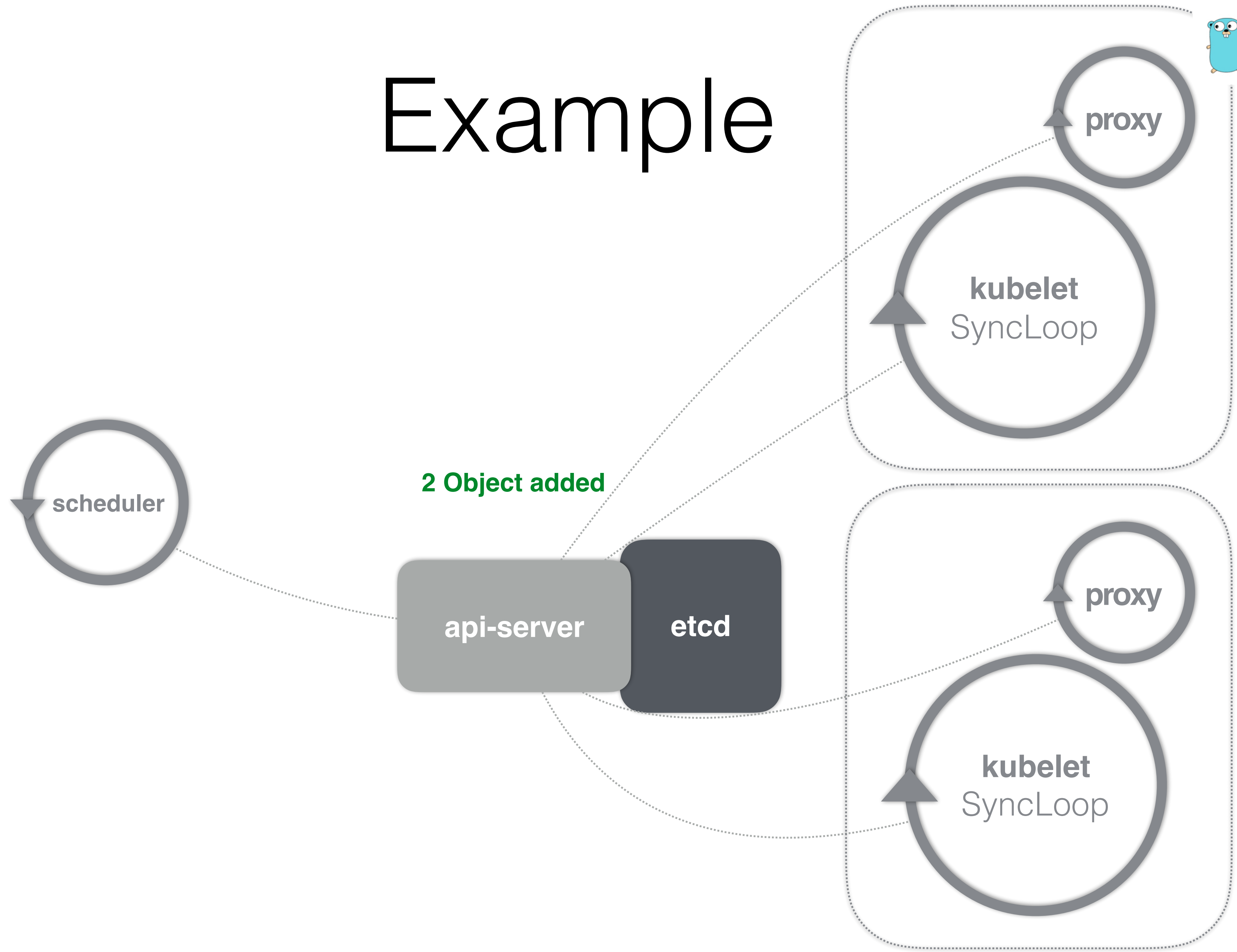
2.Control loops (Sync Loop) to reconcile API objects



Example



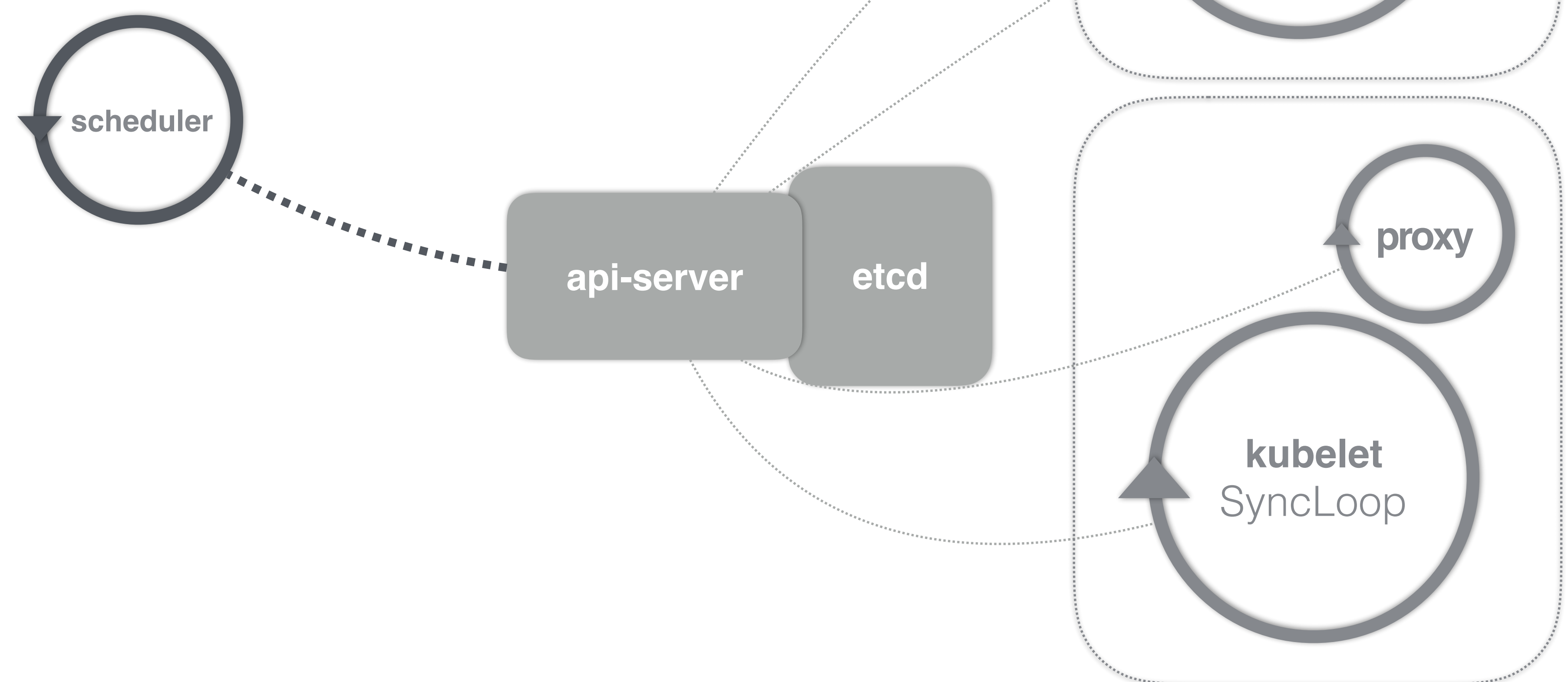
Example





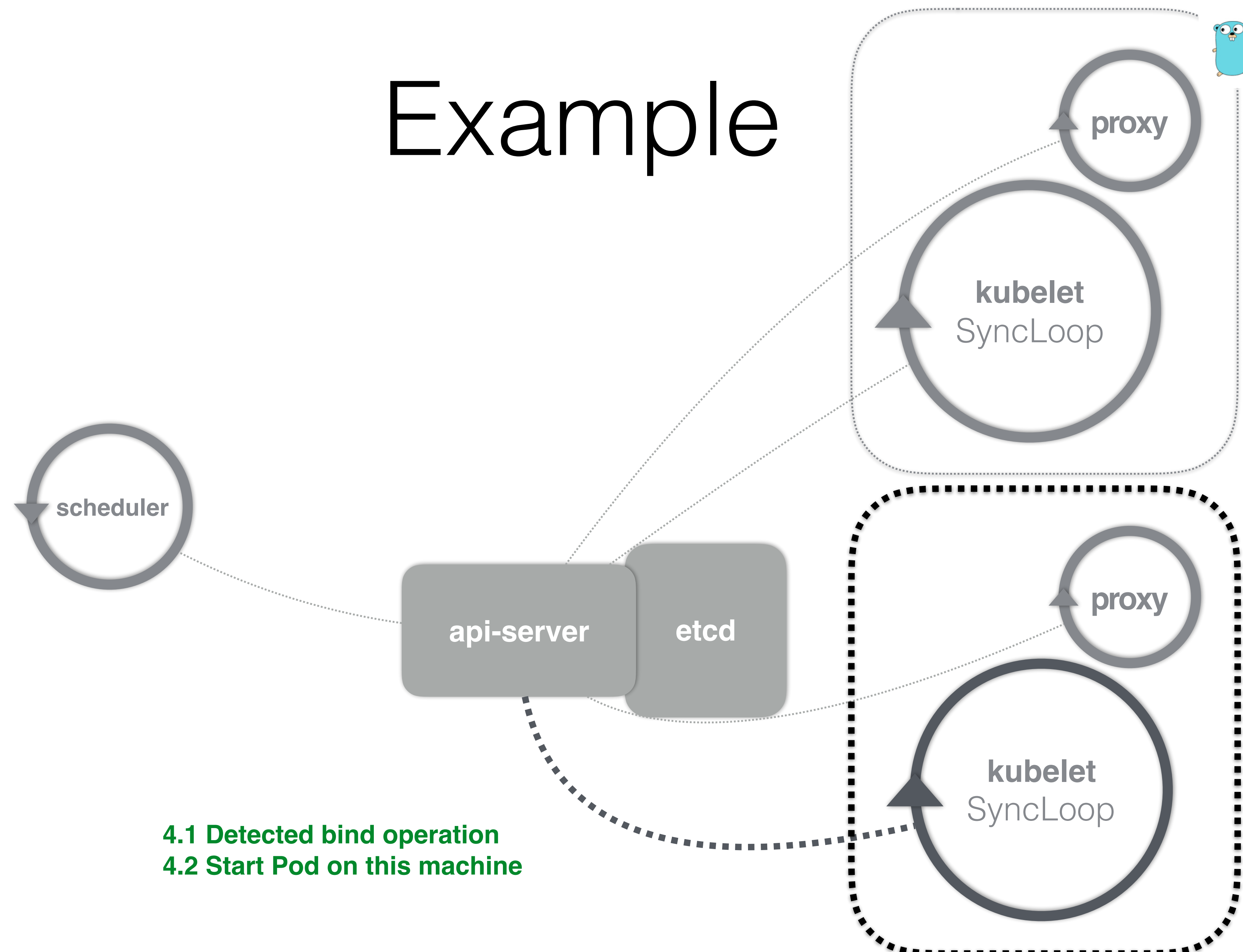
Example

3.1 New Pod detected
3.2 Bind Pod to a node





Example

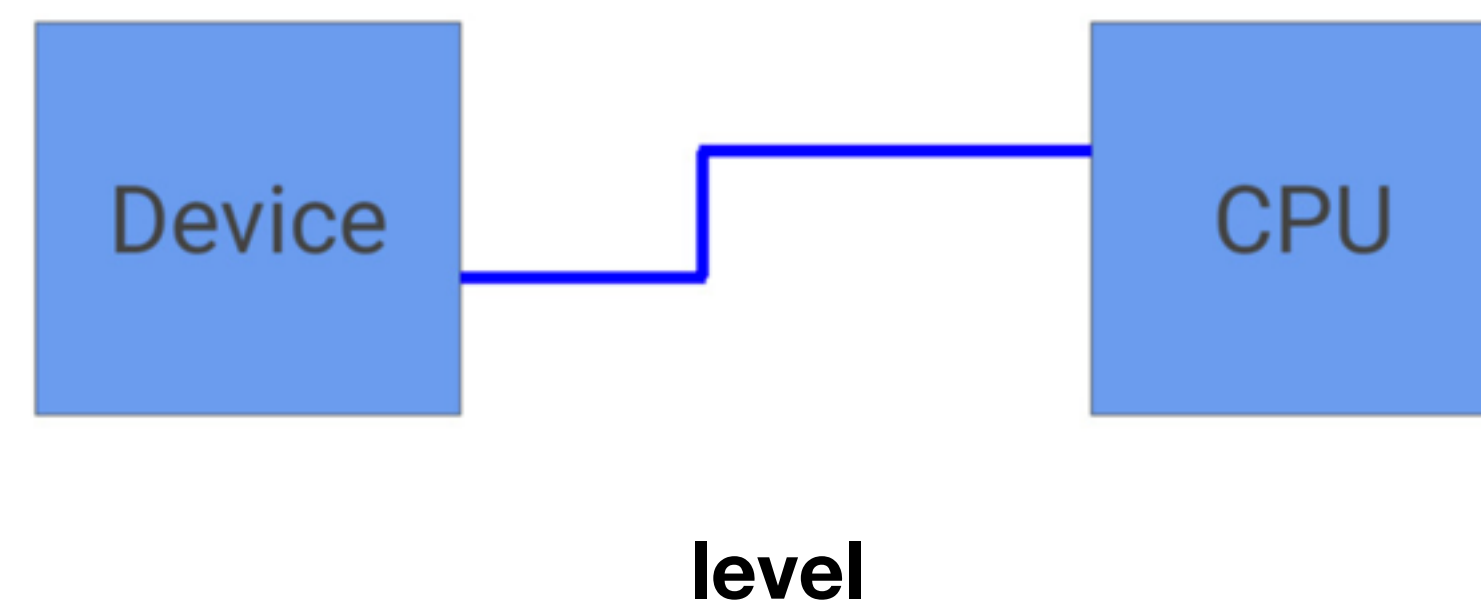
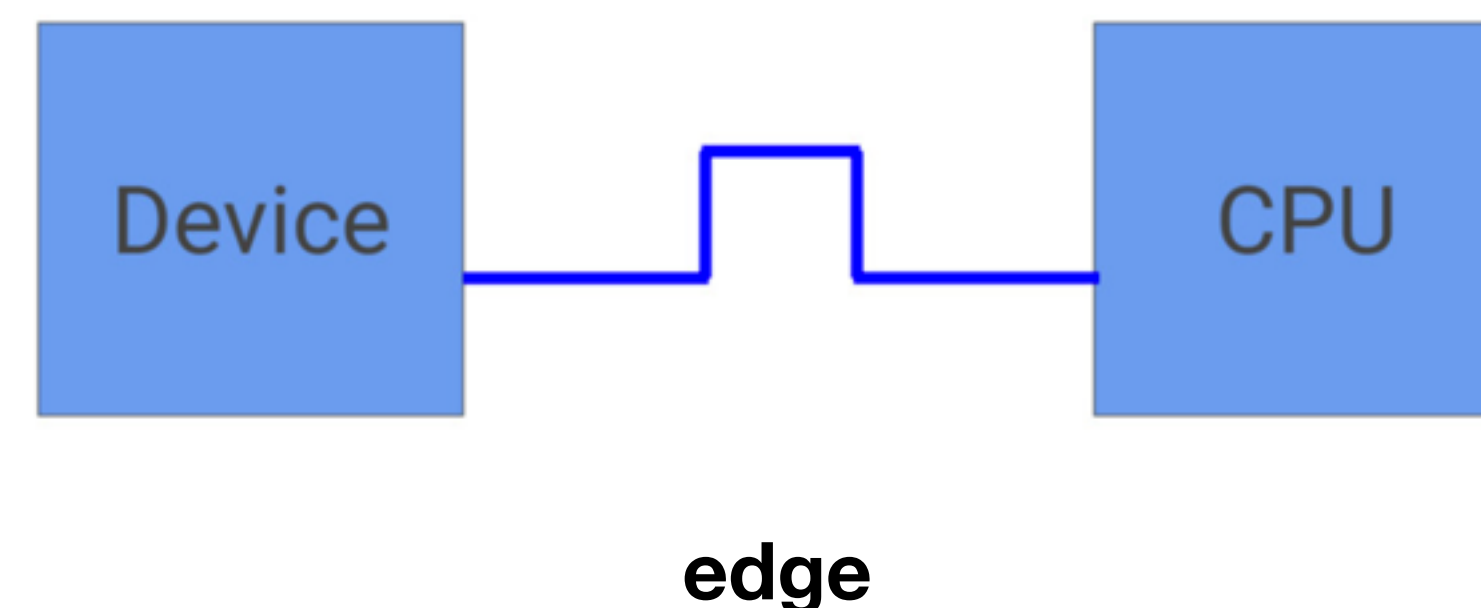


4.1 Detected bind operation
4.2 Start Pod on this machine



Pattern 1: Controller

- Control everything by **Controller**
- **Level driven, not edge driven**





Controller

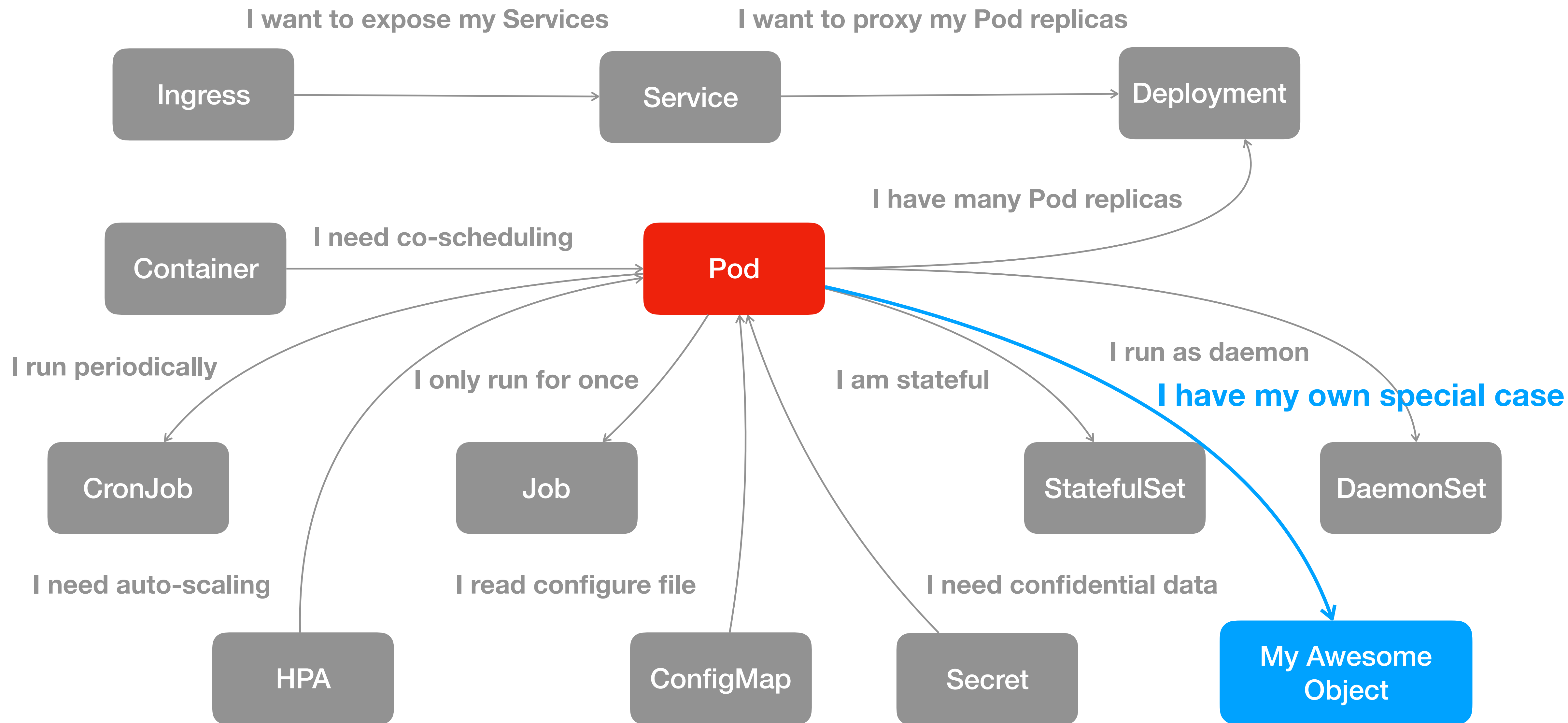
- The heart of Kubernetes orchestrator
 - drives the cluster state based on the changes to the API objects

- **Write your own controller!**

```
for {  
    desired := getDesiredState()  
    current := getCurrentState()  
    makeChanges(desired, current)  
}
```



Why DIY?



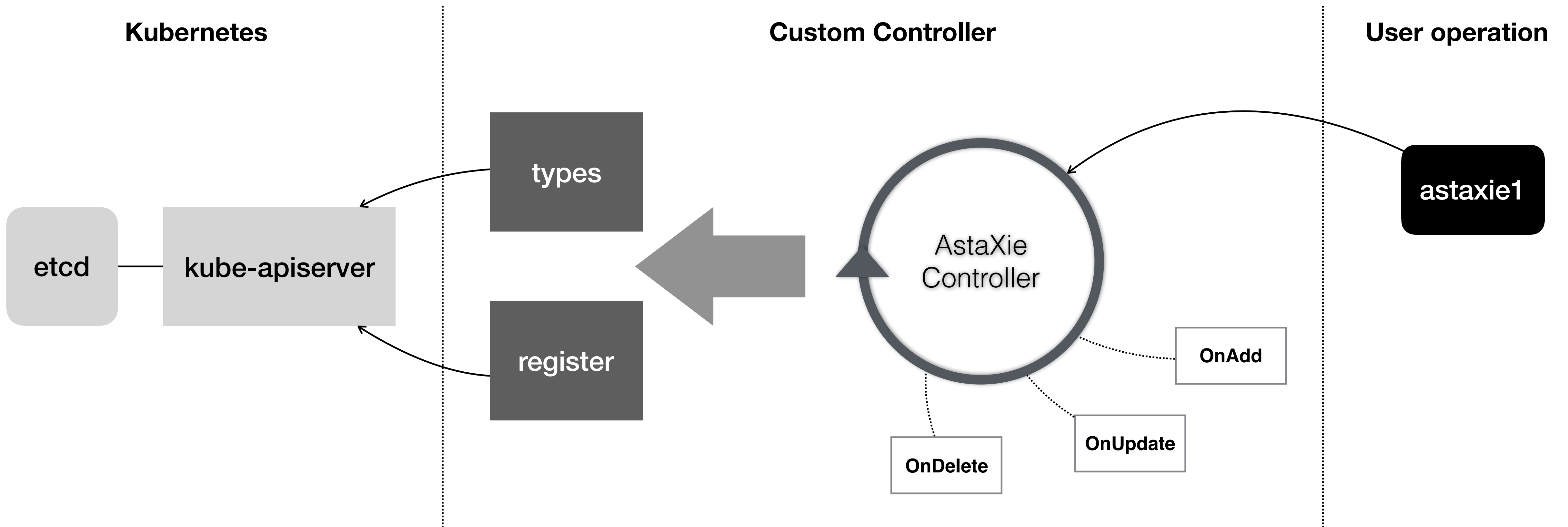


Demo

- I want to have a **Asta Xie** object into k8s API
- I want a controller to handle **add/update/delete** of all Asta Xie instances

```
$ kubectl get astaxie  
  
NAME          KIND  
astaxie1      AstaXie.v1.cr.client-go.k8s.io
```

My AstaXie Object & Control





A Real World Example

- I want to have a **Network** object into k8s API
- I want a controller to handle **add/update/delete** of all Network instances
 - onAdd: create Neutron network
 - onDelete: delete Neutron network
 - onUpdate: update Network object status
- https://github.com/openstack/stackube/blob/master/pkg/network-controller/network_controller.go

Pattern 2: Gode Generator



- **client-gen:** generate typed Kubernetes AP client for type
 - client.Pod.Get().Resource(...).Do()
- **conversion-gen:** seamless upgrades between API versions
 - apiVersion: k8s.io/v1alpha1 -> apiVersion: k8s.io/v1beta1
- **deepcopy-gen:** deepcopy
 - go get k8s.io/kubernetes/vendor/k8s.io/kube-gen/cmd/deepcopy-gen
 - deepcopy-gen -i ./pkg/apis/v1
- **defaulter-gen:** set default values for fields
- **go-to-protobuf:** generate protobuf messages for your types
- **informer-gen:** generate informers that can be used to watch for updates to your types
- **openapi-gen:** generate openapi compatible API documentation

```
func autoConvert_api_Affinity_To_v1_Affinity(in *api.Affinity, out *v1.Affinity, s conversion.Scope)
out.NodeAffinity = (*v1.NodeAffinity)(unsafe.Pointer(in.NodeAffinity))
out.PodAffinity = (*v1.PodAffinity)(unsafe.Pointer(in.PodAffinity))
out.PodAntiAffinity = (*v1.PodAntiAffinity)(unsafe.Pointer(in.PodAntiAffinity))
return nil
}
```

```
1 // Deployment enables declarative updates for Pods and ReplicaSets.
2 message Deployment {
3   // Standard object metadata.
4   // +optional
5   optional k8s.io.apimachinery.pkg.apis.meta.v1.ObjectMeta metadata = 1;
6
7   // Specification of the desired behavior of the Deployment.
8   // +optional
9   optional DeploymentSpec spec = 2;
10
11  // Most recently observed status of the Deployment.
12  // +optional
13  optional DeploymentStatus status = 3;
14 }
15
```

```
└─ pkg
  └─ apis
    └─ navigator
  └─ client
    └─ clientset_generated
    └─ informers_generated
    └─ listers_generated
```



More Reference

- github.com/kubernetes/gengo
- github.com/kubernetes/kubernetes/tree/master/cmd/libs/go2idl

Pattern 3: gRPC based Interface



- **Decouple** Kubernetes from external dependencies
- kubelet -> **gRPC** -> dockershim -> dockerd
- **go2idl**: gogoprotobuf based protobuf gen

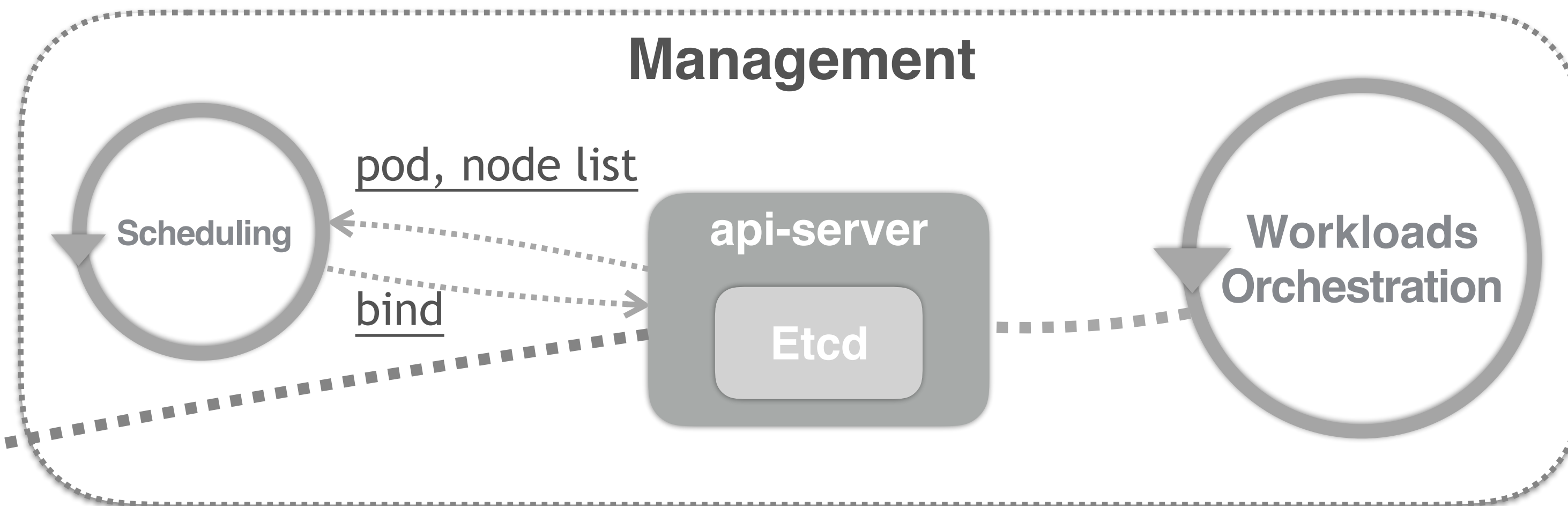
```
// PodSandboxManager contains basic operations for sandbox.
type PodSandboxManager interface {
    Create(config *PodSandboxConfig) (string, error)
    Delete(id string) (string, error)
    List(filter PodSandboxFilter) []PodSandboxListItem
    Status(id string) PodSandboxStatus
}

// ContainerRuntime contains basic operations for containers.
type ContainerRuntime interface {
    Create(config *ContainerConfig, sandboxConfig *PodSandboxConfig, PodSandboxID string) (string, error)
    Start(id string) error
    Stop(id string, timeout int) error
    Remove(id string) error
    List(filter ContainerFilter) ([]ContainerListItem, error)
    Status(id string) (ContainerStatus, error)
    Exec(id string, cmd []string, streamOpts StreamOptions) error
}

// ImageService contains image-related operations.
type ImageService interface {
    List() ([]Image, error)
    Pull(image ImageSpec, auth AuthConfig) error
    Remove(image ImageSpec) error
    Status(image ImageSpec) (Image, error)
    Metrics(image ImageSpec) (ImageMetrics, error)
}

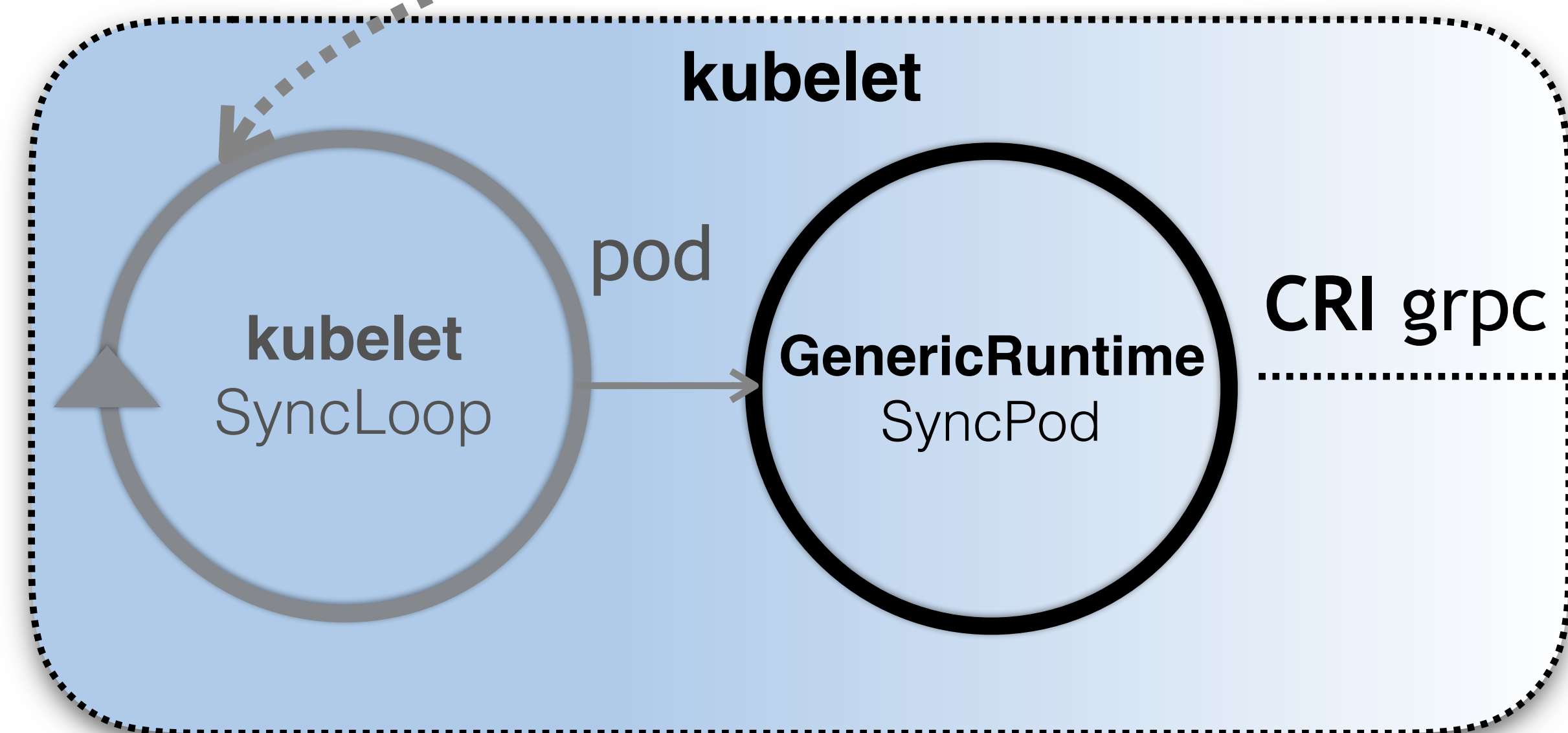
type ContainerMetricsGetter interface {
    ContainerMetrics(id string) (ContainerMetrics, error)
}
```


CRI



pod

CRI Spec



Sandbox

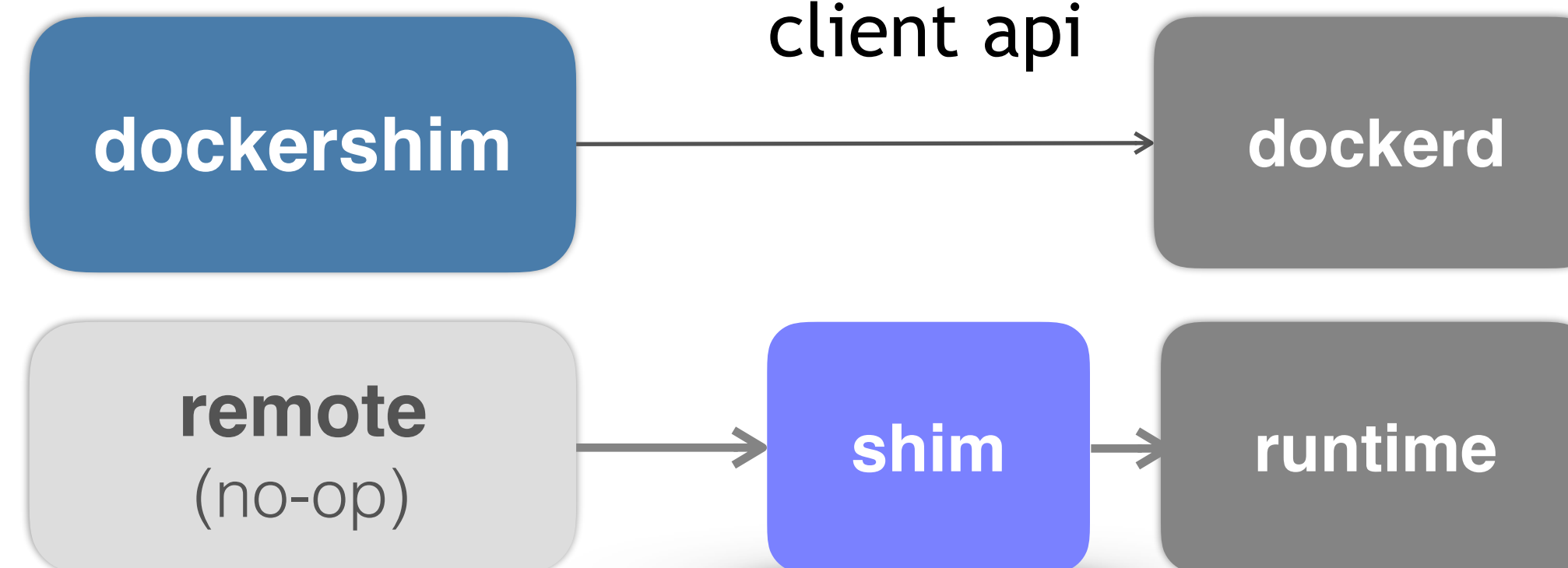
Create
Delete
List

Container

Create
Start
Exec

Image

Pull
List





Deployment

- `yum install -y kubelet kubeadm kubectl`
- `sed -i '2 i\Environment="KUBELET_EXTRA_ARGS=--container-runtime=remote --container-runtime-endpoint=/var/run/xxx.sock --feature-gates=AllAlpha=true"' /etc/systemd/system/kubelet.service.d/10-kubeadm.conf`
- `kubeadm init`
- `kubeadm join --token $token ${master_ip:port}`
- **Done!**

But that's only one part ...

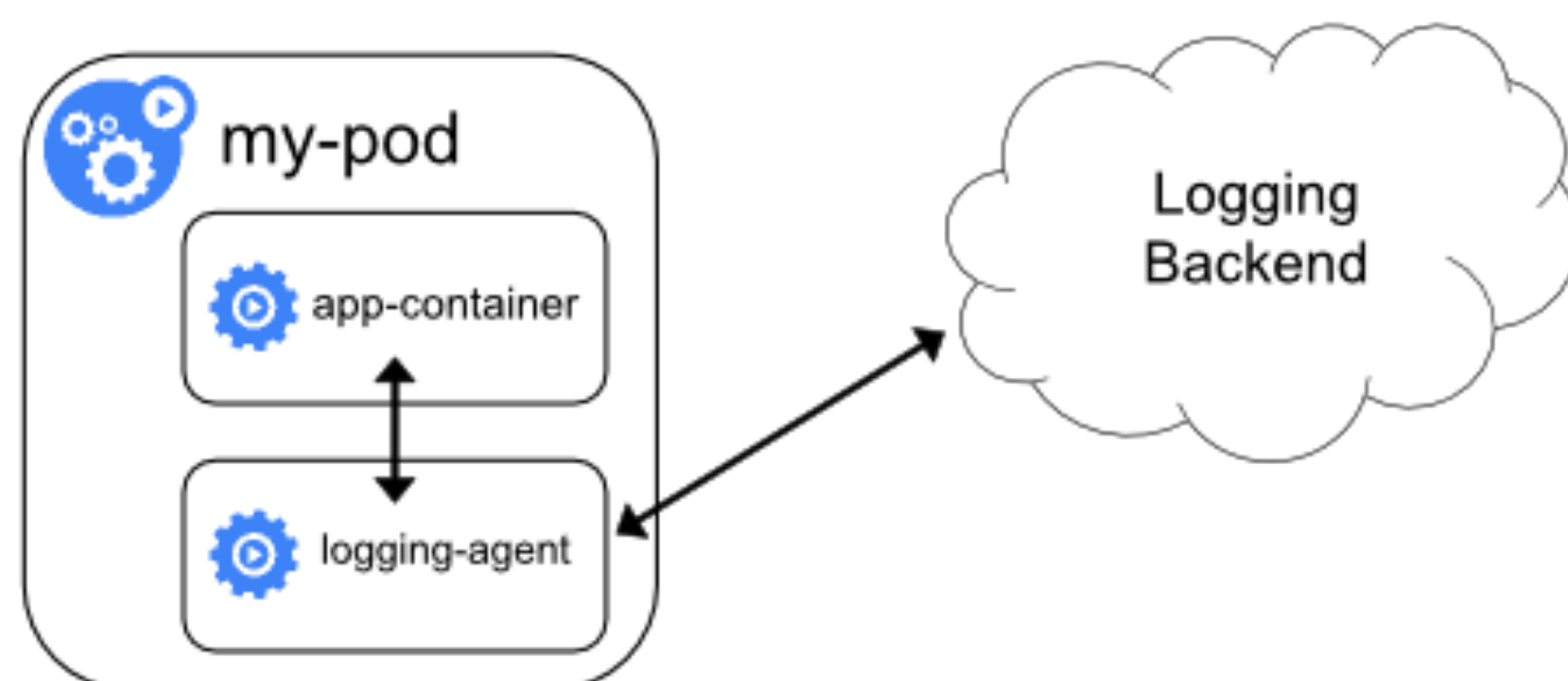


- **Kubernetes** is also about **design pattern** in **container** world
 - decoupling containers
 - re-use images
 - well-designed architecture for your container workloads
- **“How can I build distributed micro-services with container?”**



Programming Pattern

- Sidecar



```
apiVersion: v1
kind: Pod
metadata:
  name: test-app
spec:
  containers:
  - name: app-container
    image: gcr.io/google_containers/testapp:v1
    volumeMounts:
    - name: varlog
      mountPath: /var/log
  - name: logging-agent
    image: gcr.io/google_containers/fluentd:1.30
    env:
    - name: FLUENTD_ARGS
      value: -c /etc/fluentd-config/fluentd.conf
    volumeMounts:
    - name: varlog
      mountPath: /var/log
    - name: config-volume
      mountPath: /etc/fluentd-config
  volumes:
  - name: varlog
    emptyDir: {}
  - name: config-volume
    configMap:
      name: fluentd-config
```

Programming Pattern



- InitContainer

```
apiVersion: v1
kind: Pod
metadata:
  name: init-demo
spec:
  containers:
  - name: nginx
    image: nginx
    ports:
    - containerPort: 80
    volumeMounts:
    - name: workdir
      mountPath: /usr/share/nginx/html
  # These containers are run during pod initialization
  initContainers:
  - name: install
    image: busybox
    command:
    - wget
    - "-O"
    - "/work-dir/index.html"
    - http://kubernetes.io
    volumeMounts:
    - name: workdir
      mountPath: "/work-dir"
  dnsPolicy: Default
  volumes:
  - name: workdir
    emptyDir: {}
```



Programming Pattern

- **Initializer**

```
apiVersion: apps/v1beta1
kind: Deployment
metadata:
  annotations:
    "initializer.kubernetes.io/logging-agent": "true"
  name: helloworld-with-annotation
spec:
  replicas: 1
  template:
    metadata:
      name: helloworld-with-annotation
    spec:
      containers:
        - name: helloworld
          image: gcr.io/hightowerlabs/helloworld:0.0.1
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: logging-agent-initializer
data:
  config: |
    - name: logging-agent
      image: gcr.io/google_containers/fluentd:1.30
      env:
        - name: FLUENTD_ARGS
          value: -c /etc/fluentd-config/fluentd.conf
      volumeMounts:
        - name: varlog
          mountPath: /var/log
        - name: config-volume
          mountPath: /etc/fluentd-config
      volumes:
        - name: varlog
          emptyDir: {}
        - name: config-volume
          configMap:
            name: fluentd-config
```

Automatically Inject



Summary

1. How Kubernetes is using Golang?

1. What is Kubernetes and how it works (1 mins)

2. The heart of Kubernetes orchestration: **Controller**

3. Write **your own Controller** with CRD

4. code gen for deep copy, API conversion, API doc, encoding/decoding etc

5. gRPC based interface (**e.g. CRI**)

2. How we can do better to use Kubernetes?

1. **Programming Patterns** in Kubernetes

1. this is the main difference of Kubernetes with others

2. think about why everyone loves Borg

Come and Join, Gophers!



jessie frazelle ✓

@jessfraz

A superhero with supervillain tendencies.
Keyser Söze of containers. Googler.
Gopher. Opinions entirely my own.
contained.af lkml.wtf



Jaana B. Dogan · ·

@rakyll

Programmer. Working on the Go programming language at Google. Author of many; maintainer of none.

📍 California, USA

github.com/rakyll



Kris Nova

@Kris__Nova

Lesbian ♀ Transwoman ♀ Gopher ♡
K8s ⚙️ Emacs 🐞 Queen of Prussia -
Scorpio INTJ - Open DMs - My...

Following

广告时间



END

Harry Zhang @resouer