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kubectl Create Cluster: Production-ready Kubernetes with Cluster API 1.0

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DETROIT 2022

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Agenda

- ❑ Cluster API Introduction
- ❑ Cluster API Glossary
- ❑ How does Cluster API work?
- ❑ CRDs and Spec
- ❑ ClusterClass and Managed Topology
- ❑ Hands-on tutorials

Cluster API Introduction

Problems

- **Managing Kubernetes clusters is difficult.**

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- **Managing clusters across different cloud providers and bare metal requires infrastructure-specific knowledge.**

Problems

- Managing Kubernetes clusters is difficult.
- Kubeadm and other tools can help, but they do not manage infrastructure.
- Managing clusters across multiple types of infrastructures requires providers-specific knowledge.
- **Due to the lack of a common API interface, the experience managing Kubernetes clusters across different infrastructures is inconsistent.**

Cluster API to the rescue…

- Cluster API provides extensible APIs to create Kubernetes clusters across multiple infrastructures.

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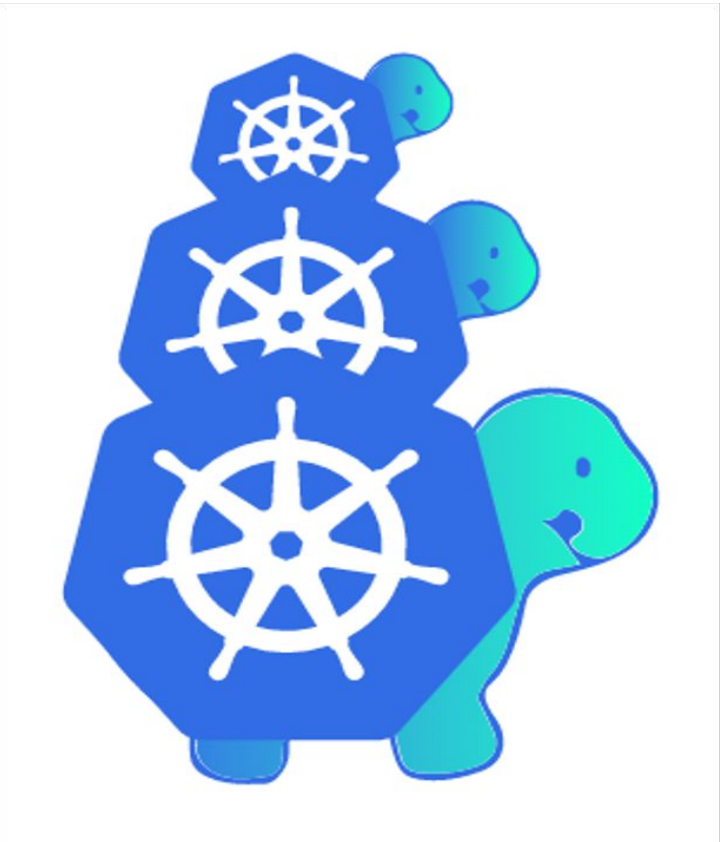
- **It has a pluggable architecture which makes it easy to onboard new infrastructure providers.**

Cluster API to the rescue…

- Cluster API provides extensible APIs to create Kubernetes clusters across multiple infrastructures.
- It not only provides declarative APIs for Kubernetes objects, but also for infrastructure components.
- It has a pluggable architecture which makes it easy to onboard new infrastructure providers.
- **A common API interface enables development of tooling to manage clusters across environments.**

What is Cluster API?

- **Cluster API is a project of the SIG Cluster Lifecycle**



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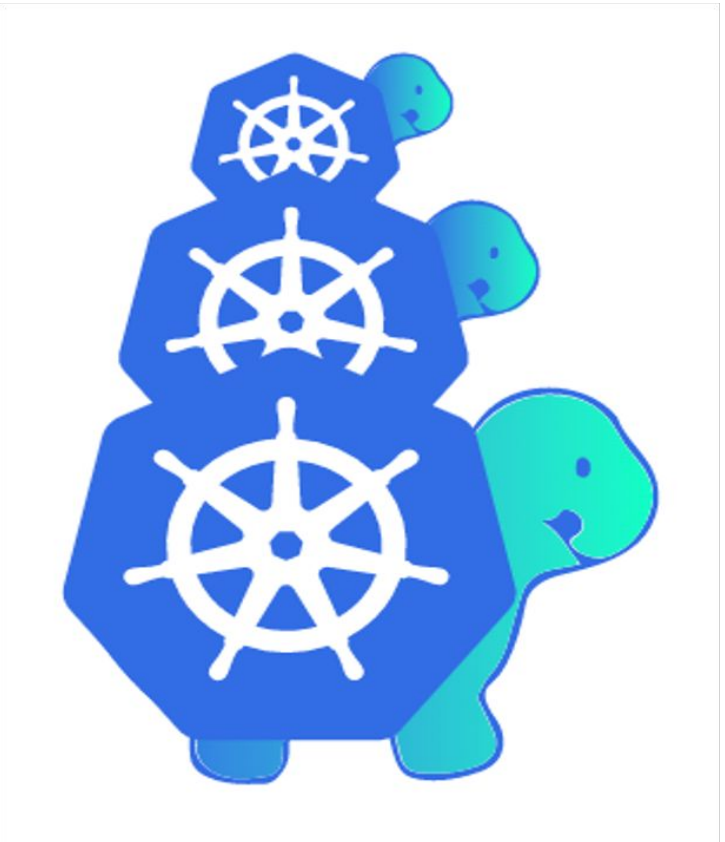
- **It uses Kubernetes to manage Kubernetes.**



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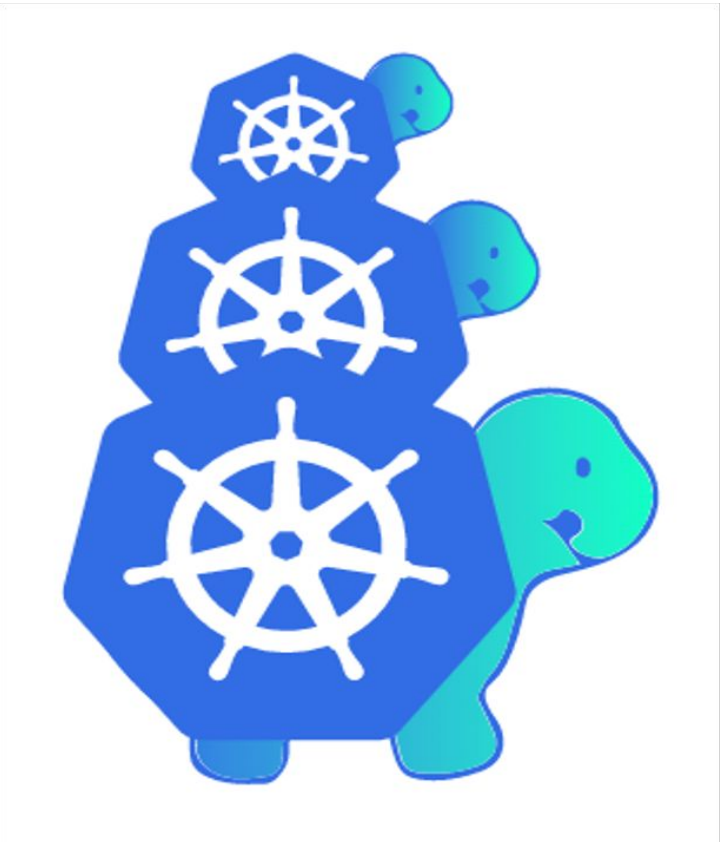
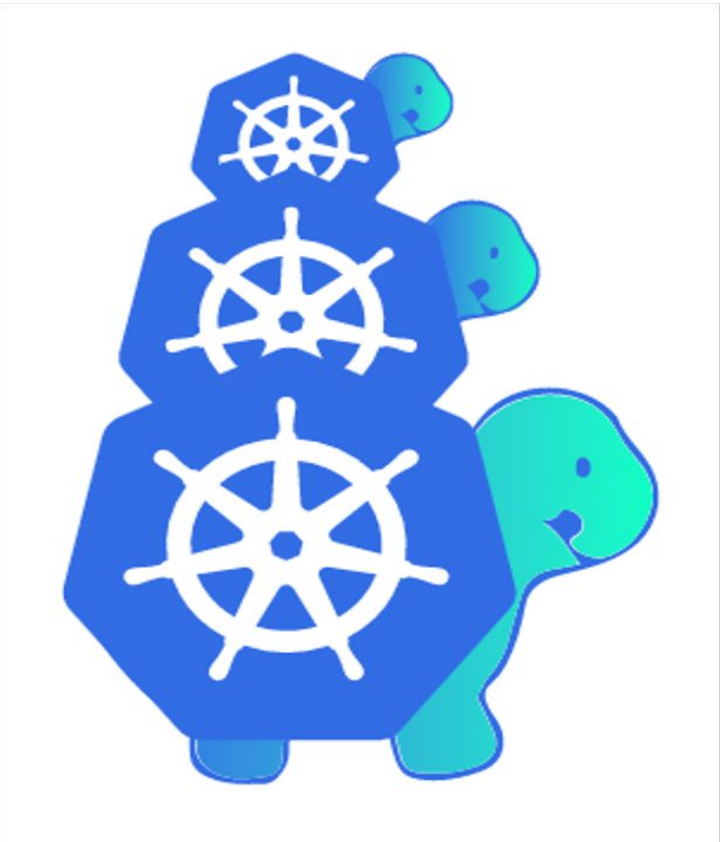
"turtles all the way down"



What is Cluster API?

- Cluster API is a project of the SIG Cluster Lifecycle.
- It uses Kubernetes to manage Kubernetes.
- **To manage Kubernetes clusters, Cluster API offers the same declarative Kubernetes-style APIs that Kubernetes itself uses to manage Deployments, Pods and everything else.**



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Cluster API Glossary

Cluster API terminology

Management cluster is a Kubernetes cluster into which the Cluster API components have been installed.

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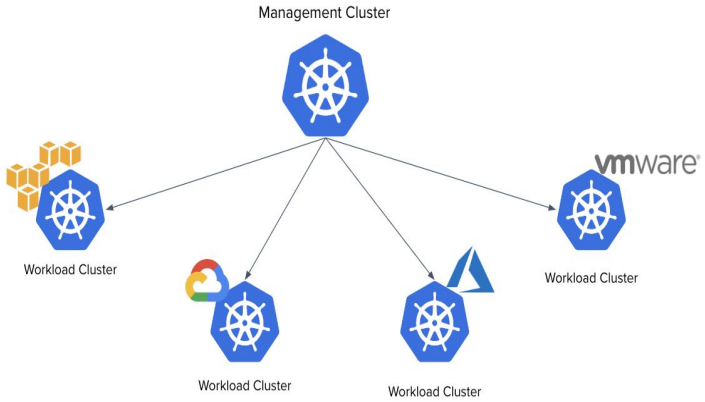


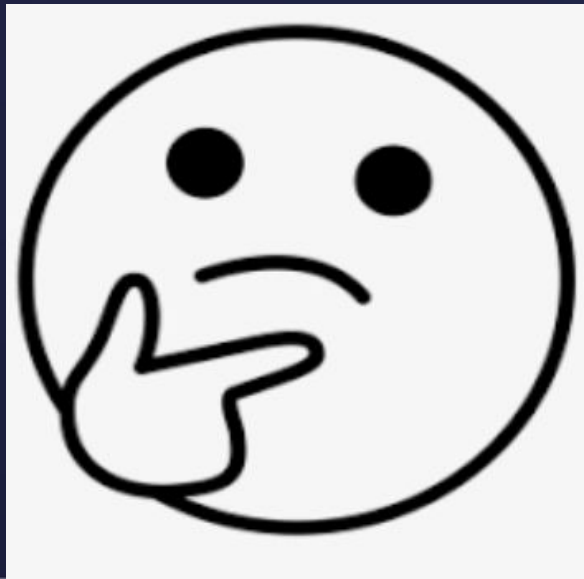
Provider: Cluster API uses the concept of a provider to interact with underlying IaaS platforms, such as AWS, Azure, vSphere, etc. Providers have abbreviations like CAPA, CAPZ and CAPV.

Cluster API terminology

Cluster lifecycle management includes:

- Creating new Kubernetes clusters.
- Managing the underlying infrastructure.
- Scaling up and down the number of nodes in the cluster.
- Upgrading clusters to another Kubernetes version.
- Deleting clusters, including the underlying infrastructure.

How does Cluster API work?



How does it work?

Overview of Kubernetes reconciliation loop and CRDs

- At the core of Kubernetes is a control loop (or reconciliation loop) that is responsible for reconciling the desired state and the actual state.

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- **“*Reconciling desired state and actual state*” simply means changing actual state to converge to the desired state.**

How does it work?

Overview of Kubernetes reconciliation loop and CRDs

- At the core of Kubernetes is a control loop (or reconciliation loop) that is responsible for reconciling the desired state and the actual state.

- "*Reconciling desired state and actual state*" simply means making the actual state look like the desired state.

- **The control loop is implemented by a controller and is fundamental to how almost everything works in Kubernetes.**

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Overview of Kubernetes reconciliation loop and CRDs

- **To add new kinds of objects to Kubernetes, we use a Custom Resource Definition (CRD).**

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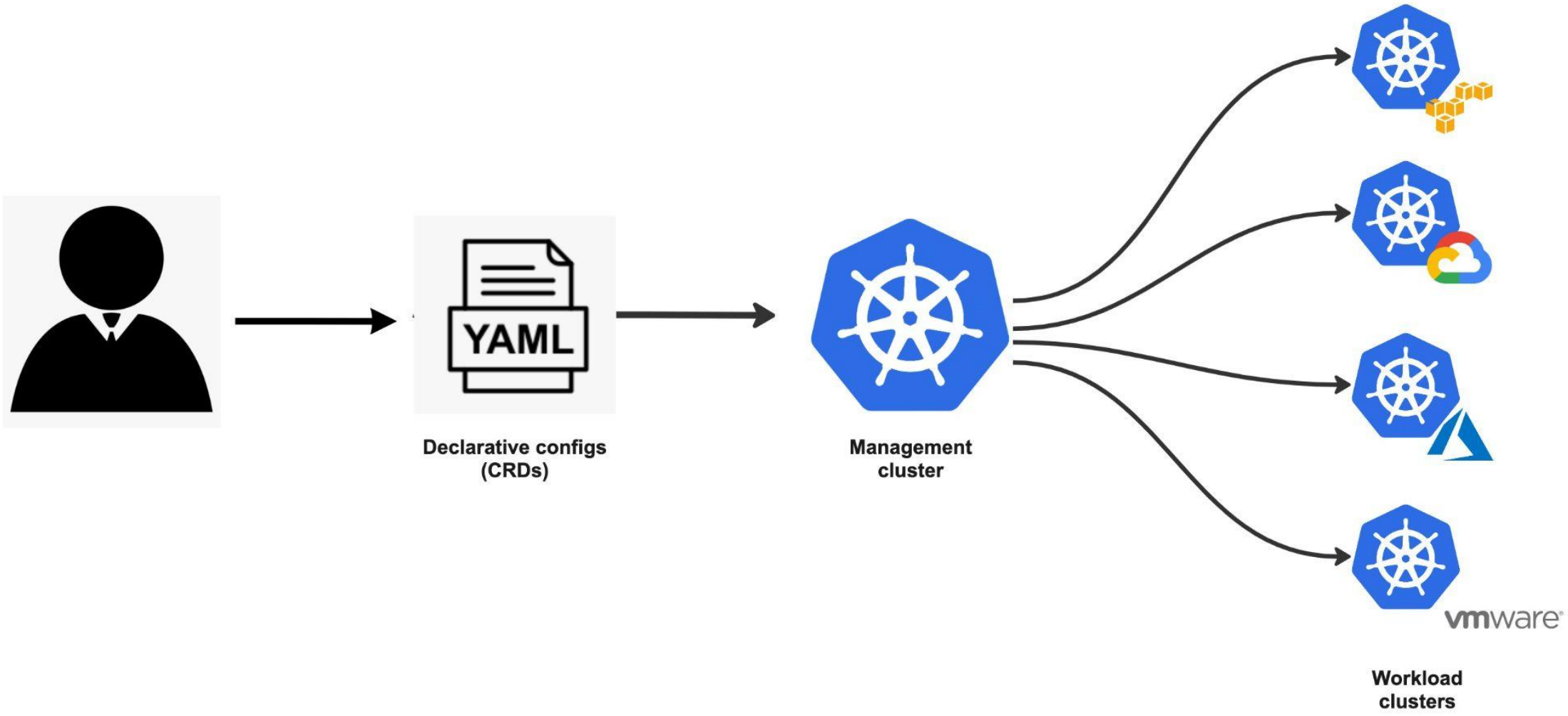
- **Each CRD needs a controller to implement the corresponding control loop.**

How does it work?

Overview of Kubernetes reconciliation loop and CRDs

- To add new kinds of objects to Kubernetes, we use a Custom Resource Definition (CRD).
- There needs to be a controller to implement the control loop for each CRD.
- **Cluster API uses CRDs and controllers to extend Kubernetes to manage the Cluster lifecycle.**

How does it work?



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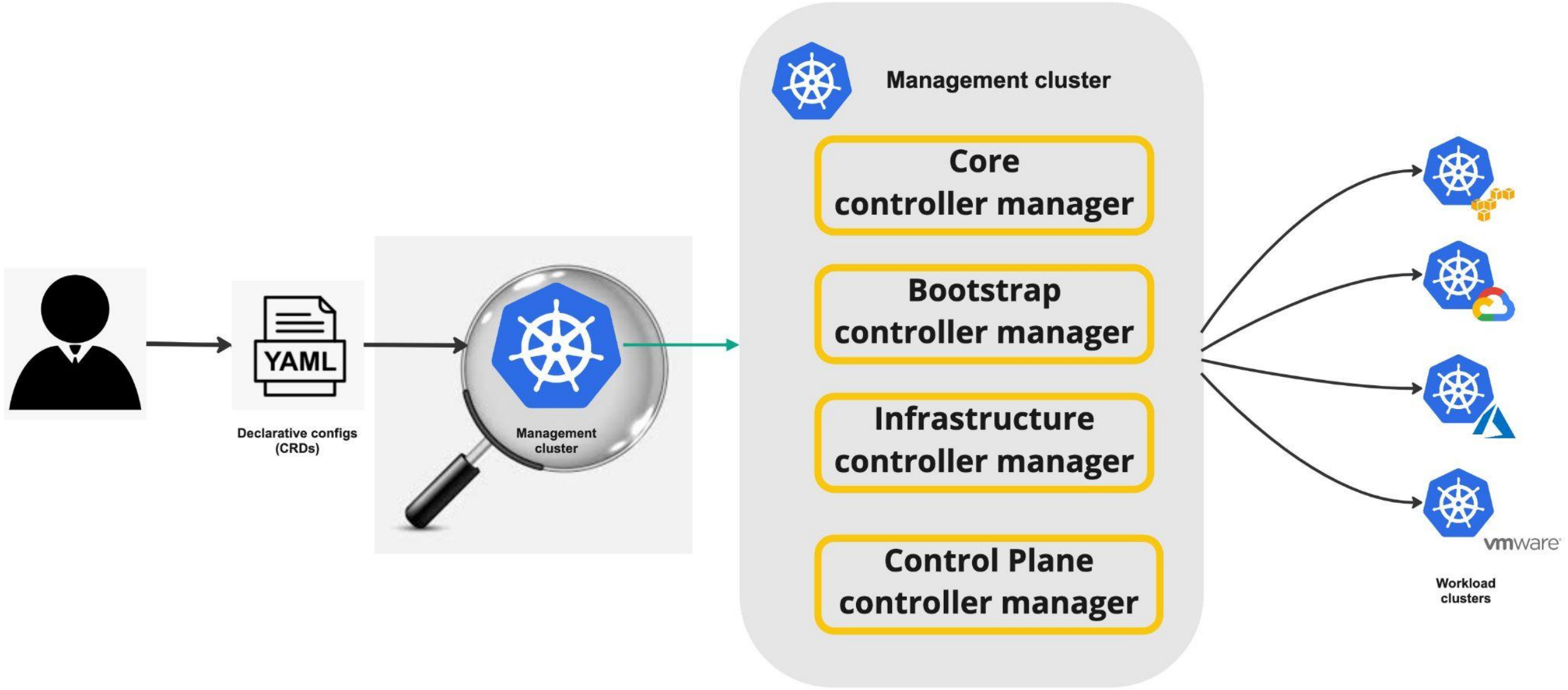

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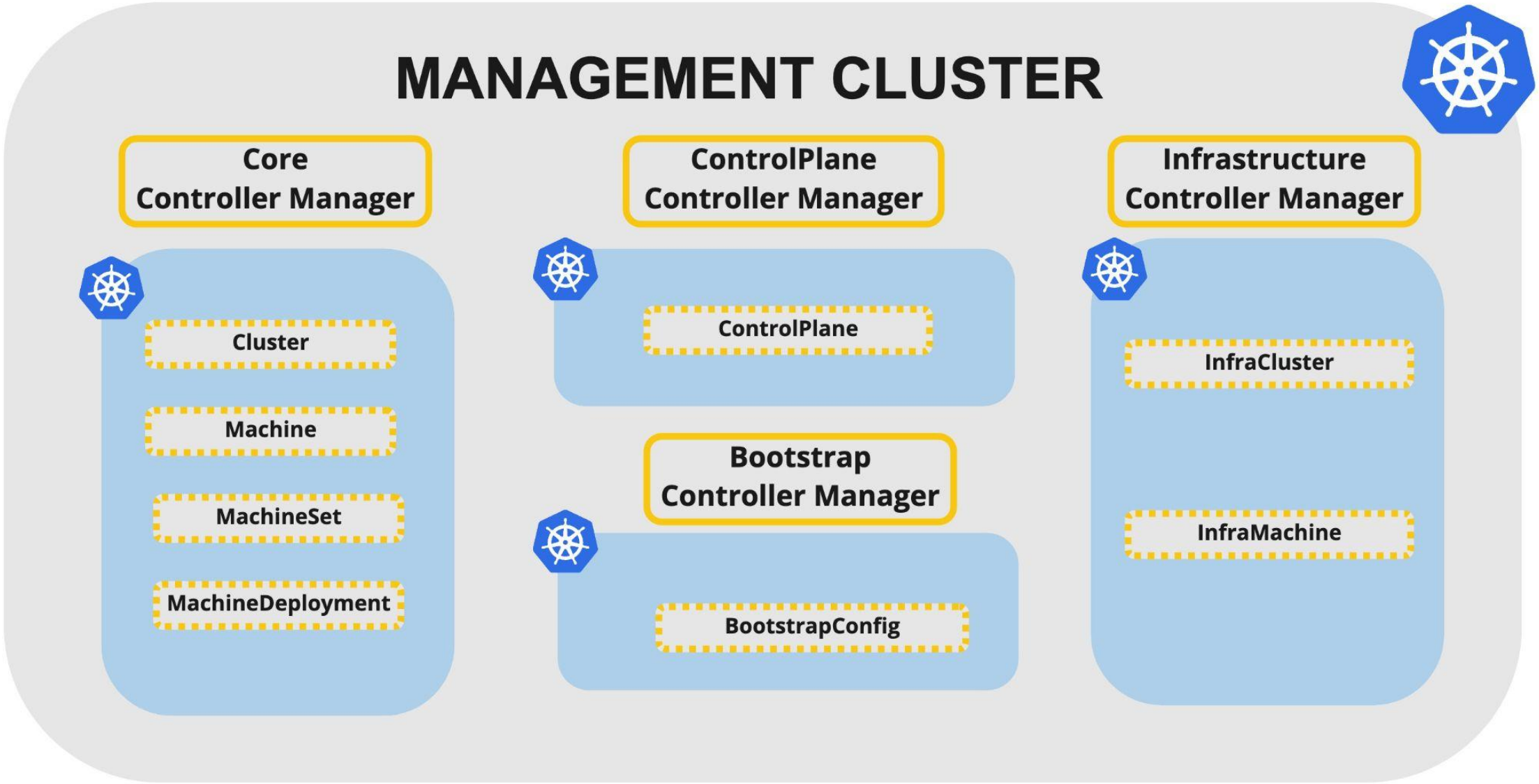

CRDs and Spec

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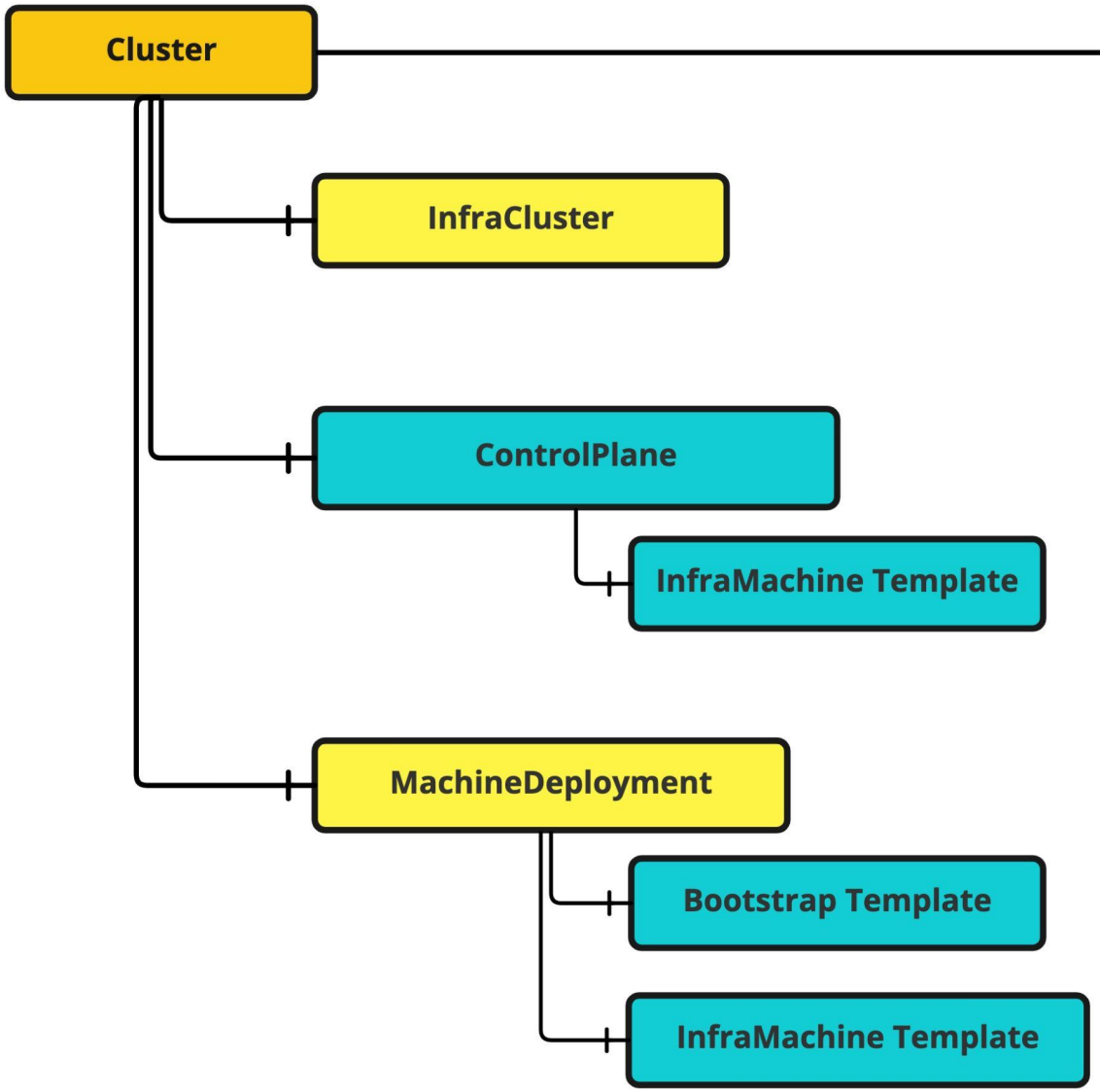


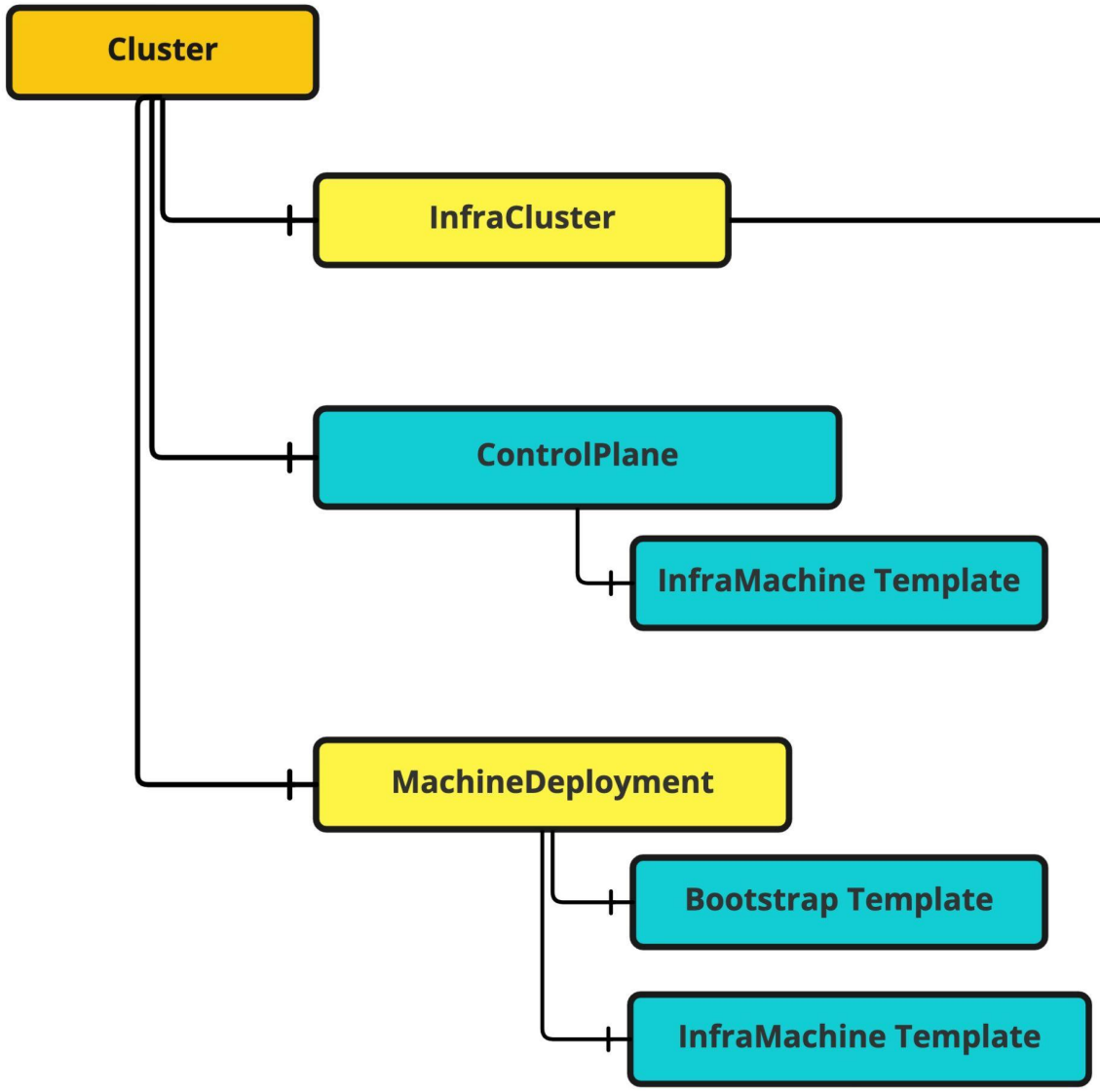
Cluster

Cluster-wide configuration.

Generic networking concepts like Pod and Service IP ranges or DNS domain.

```yaml
apiVersion: cluster.x-k8s.io/v1beta1
kind: Cluster
metadata:
  name: example
  namespace: default
spec:
  clusterNetwork:
    pods:
      cidrBlocks:
      - 192.168.0.0/16
  controlPlaneRef:
    . . .
  infrastructureRef:
    . . .
  topology: # This is an experimental feature
    class: example-class
    version: v1.23.0
    controlPlane:
      replicas: 1
    workers:
      machineDeployments:
      - class: "example-worker"
        name: "md-0"
        replicas: 1
```

CRDs and Spec



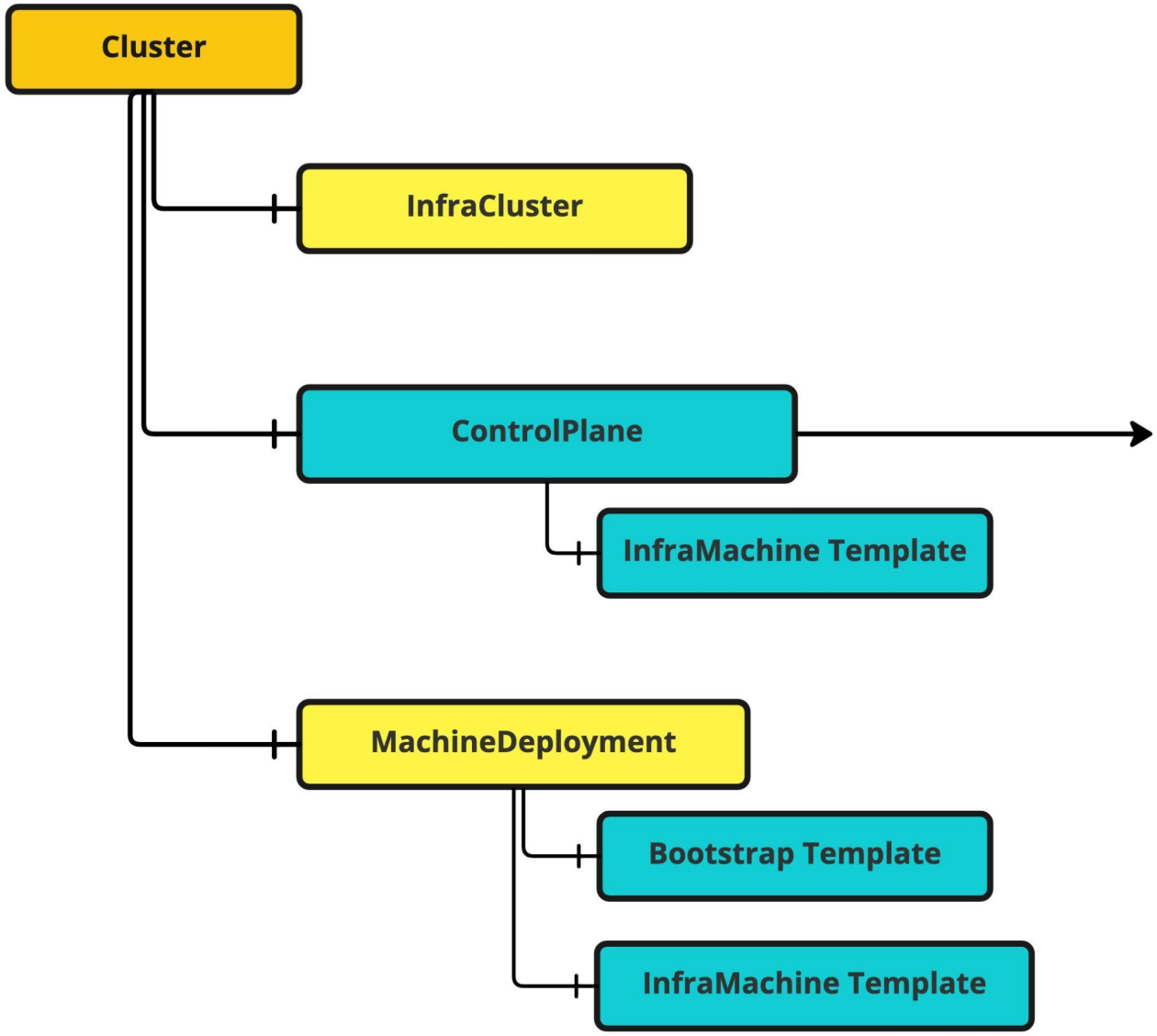
InfraCluster

Example: AWSCluster, AzureCluster, DockerCluster, etc.

Provider-specific cluster configuration.

```yaml
apiVersion: infrastructure.cluster.x-k8s.io/v1beta1
kind: AWSCluster
metadata:
  name: example
  namespace: default
spec:
  region: us-west-2
  sshKeyName: example
```

CRDs and Spec



ControlPlane

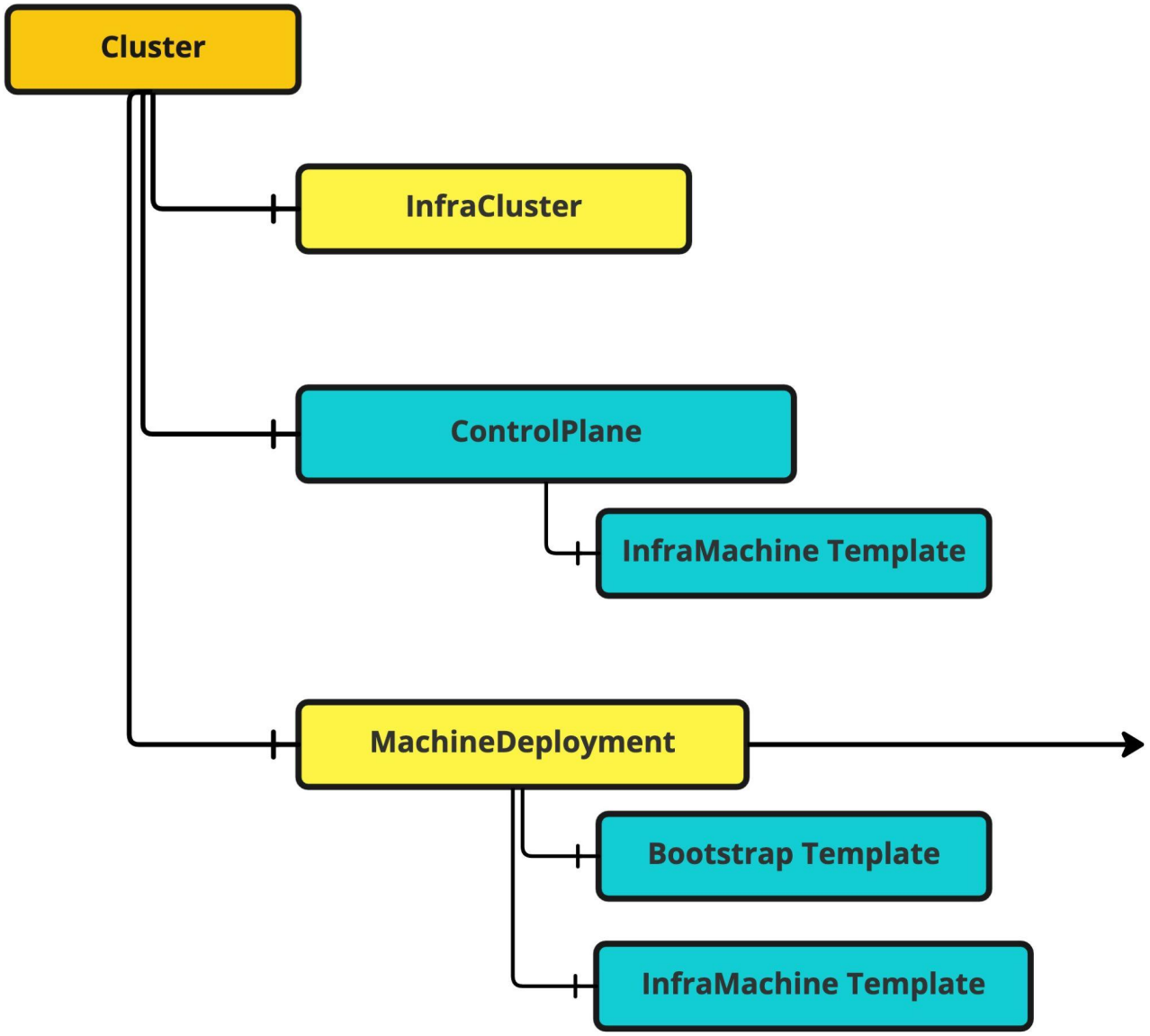
Example: KubeadmControlPlane, EKS, AKS, etc.

Replicas for the desired number of control plane Machines.

Version for the target Kubernetes version of the control plane Machines.

```yaml
apiVersion: controlplane.cluster.x-k8s.io/v1beta1
kind: KubeadmControlPlane
metadata:
  name: example-control-plane
  namespace: default
spec:
  kubeadmConfigSpec:
    clusterConfiguration:
      . . .
    initConfiguration:
      . . .
    joinConfiguration:
      . . .
 machineTemplate:
    infrastructureRef:
      apiVersion: infrastructure.cluster.x-k8s.io/v1beta1
      kind: AWSMachineTemplate
      name: example-control-plane
  replicas: 1
  version: v1.23.0
```

CRDs and Spec



MachineDeployment

Declarative management of worker nodes of the Kubernetes cluster.

Replicas for the desired number of Machines.

Version for the target Kubernetes version of the Machines.

```yaml
apiVersion: cluster.x-k8s.io/v1beta1
kind: MachineDeployment
metadata:
  name: example-md-0
  namespace: default
spec:
  clusterName: example
  replicas: 0
  selector:
    matchLabels: null
  template:
    spec:
      bootstrap:
        configRef:
          apiVersion: bootstrap.cluster.x-k8s.io/v1beta1
          kind: KubeadmConfigTemplate
          name: example-md-0
      clusterName: example
      infrastructureRef:
        apiVersion: infrastructure.cluster.x-k8s.io/v1beta1
        kind: AWSMachineTemplate
        name: example-md-0
      version: v1.23.0
```

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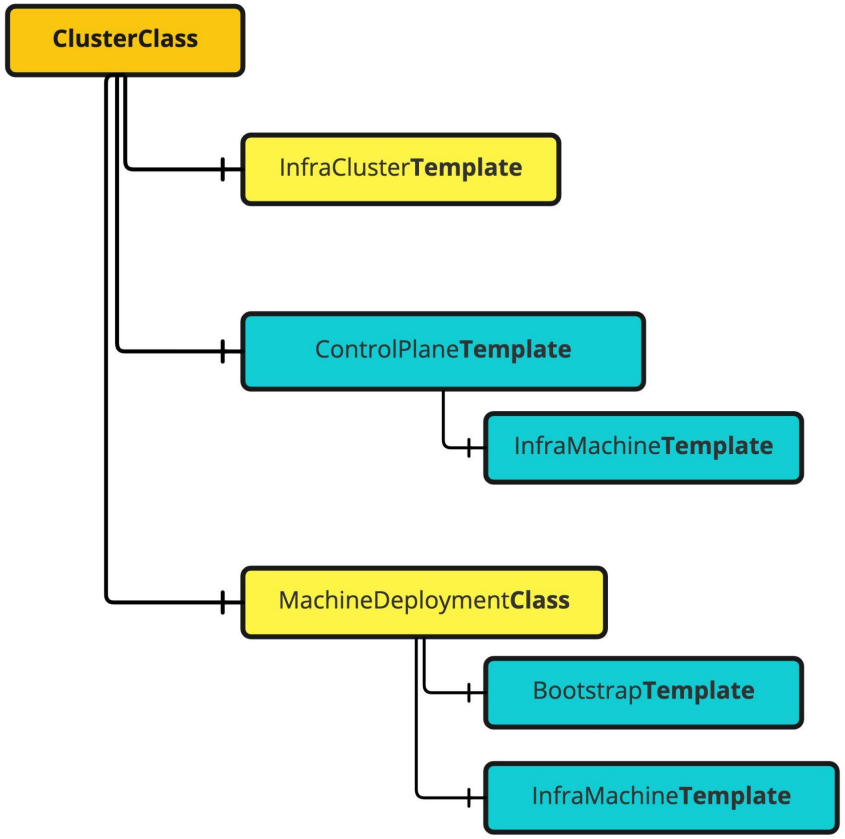
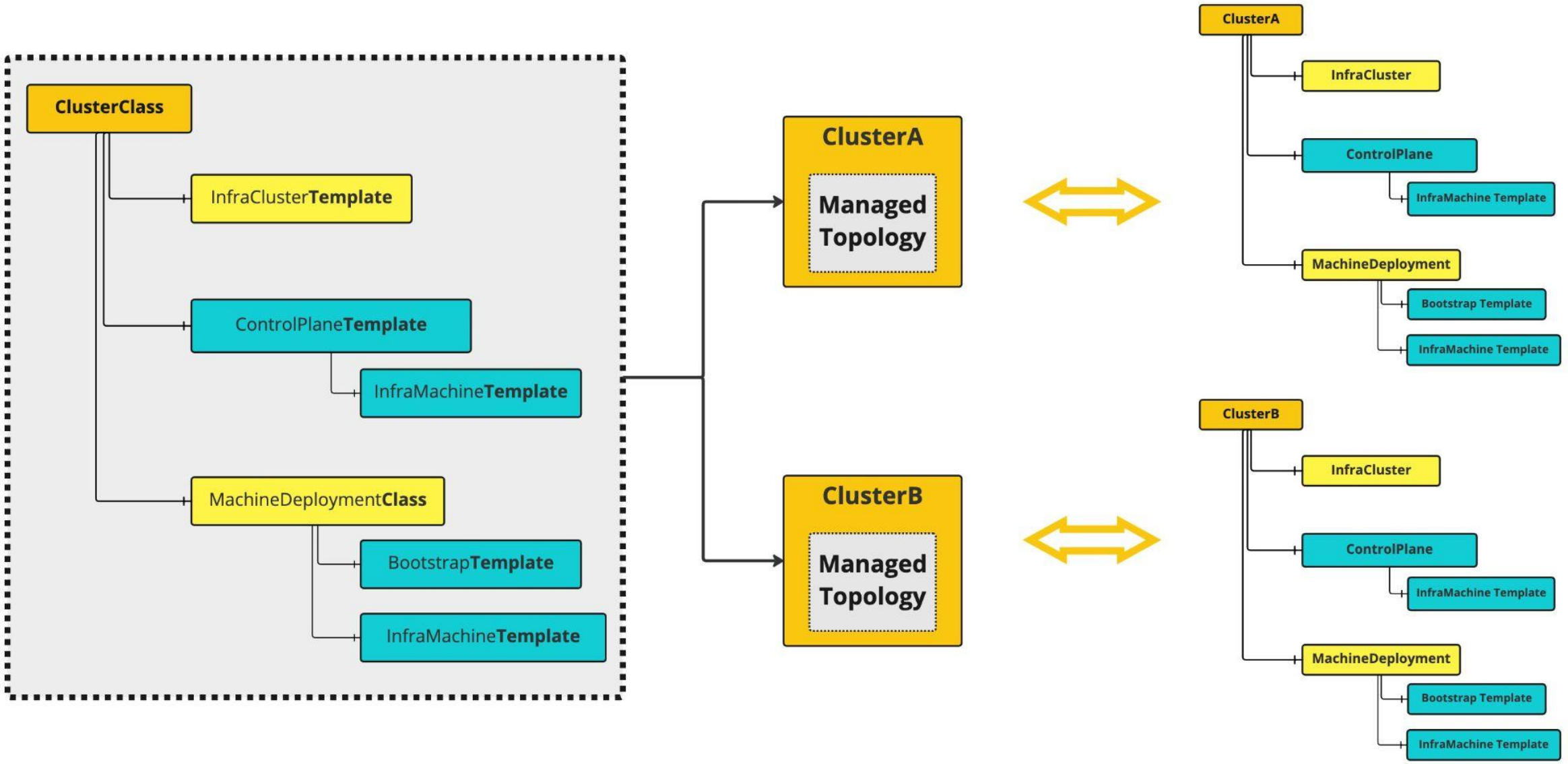
ClusterClass and Managed Topologies

ClusterClass and Managed Topologies

ClusterClass is a collection of templates that define a topology (control plane and MachineDeployments) to be used to continuously reconcile one or more Clusters.



ClusterClass and Managed Topologies



Hands on

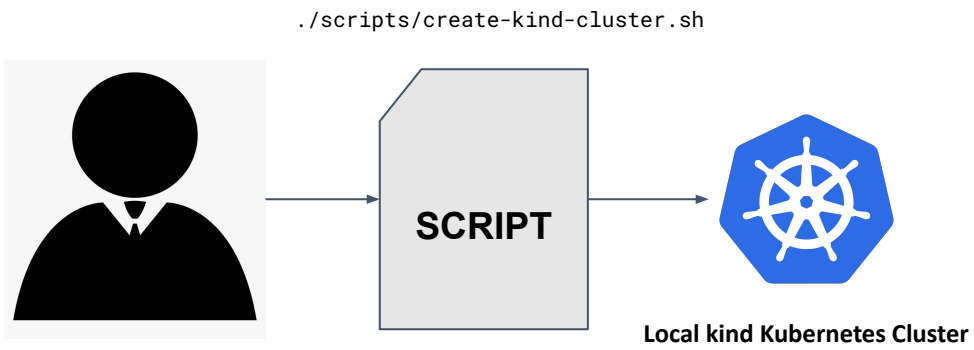
Prerequisites

Instructions can be found in Prerequisites at **github.com/ykakarap/kubecon-na-22-capi-lab**

- Install Docker, kubectl, kind, clusterctl and helm
- Clone the tutorial repository
- Pre-download container images
- Verification

Create a local cluster

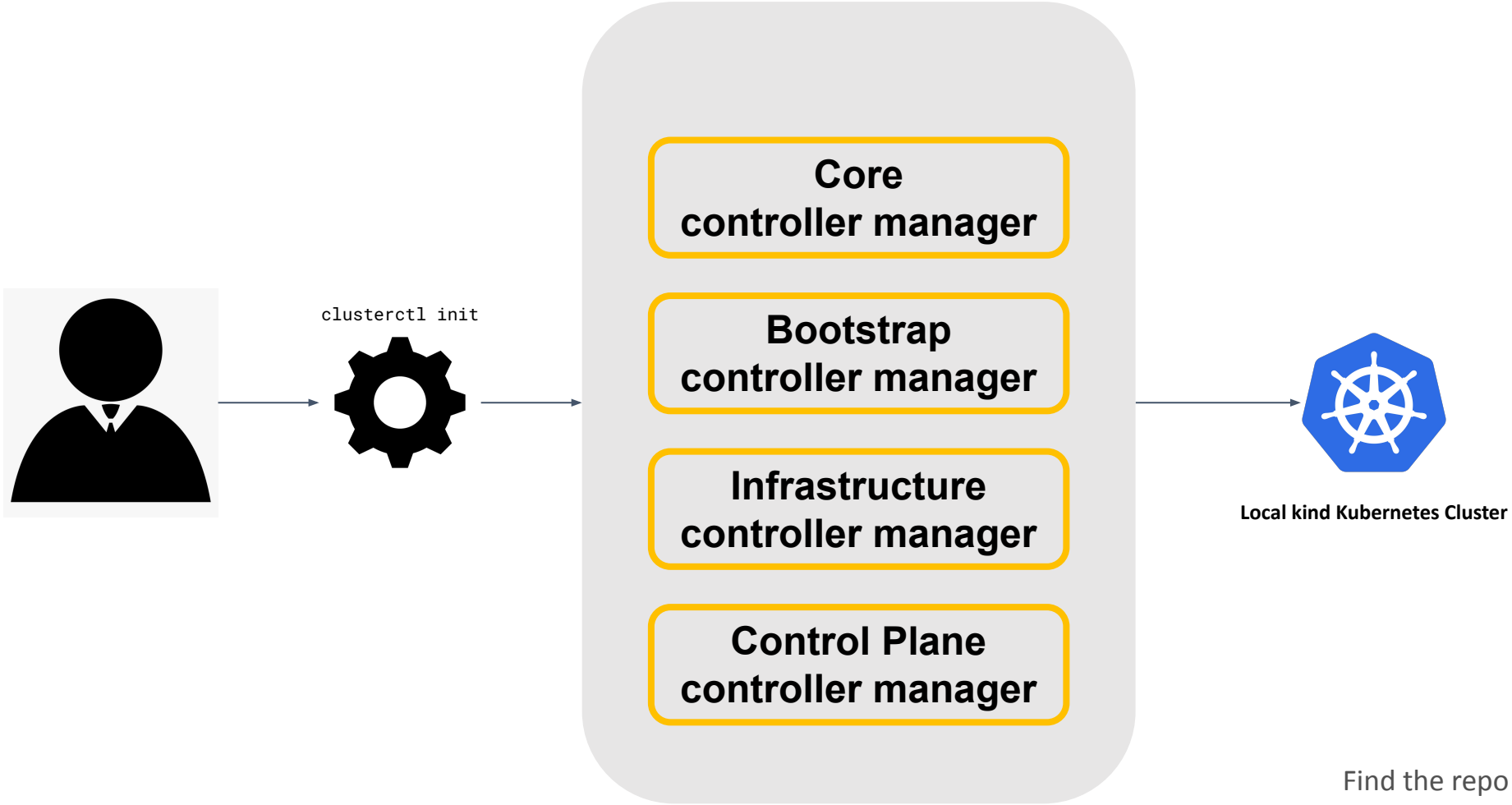
Step 1: Use kind to create a local Kubernetes cluster.



Find the repo at:
github.com/ykakarap/kubecon-na-22-capi-lab

Create a management cluster

Step 2: Use clusterctl to install the management cluster components on your local cluster.



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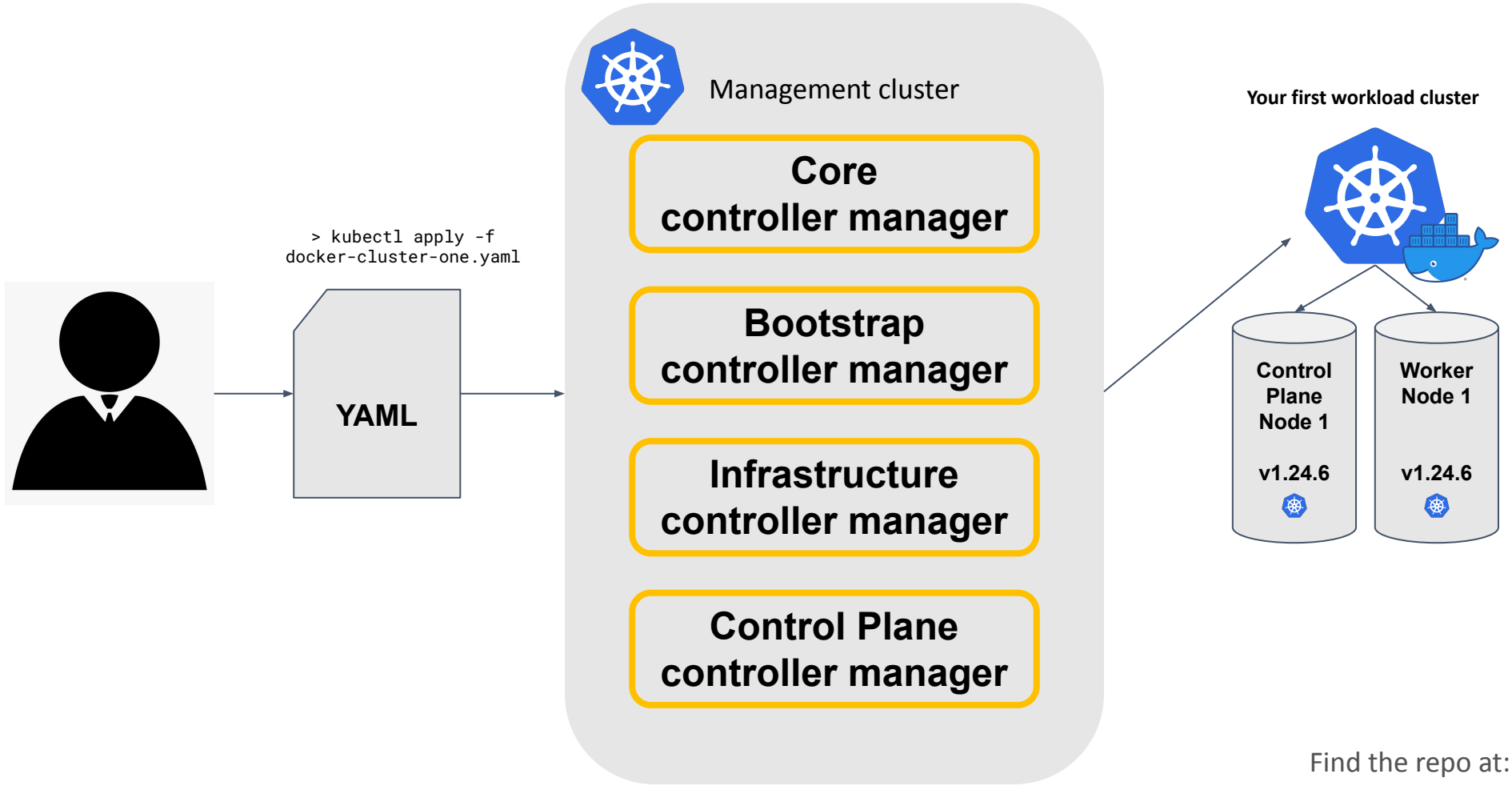
Your first workload cluster

Step 3: Create your first workload cluster using kubectl apply.



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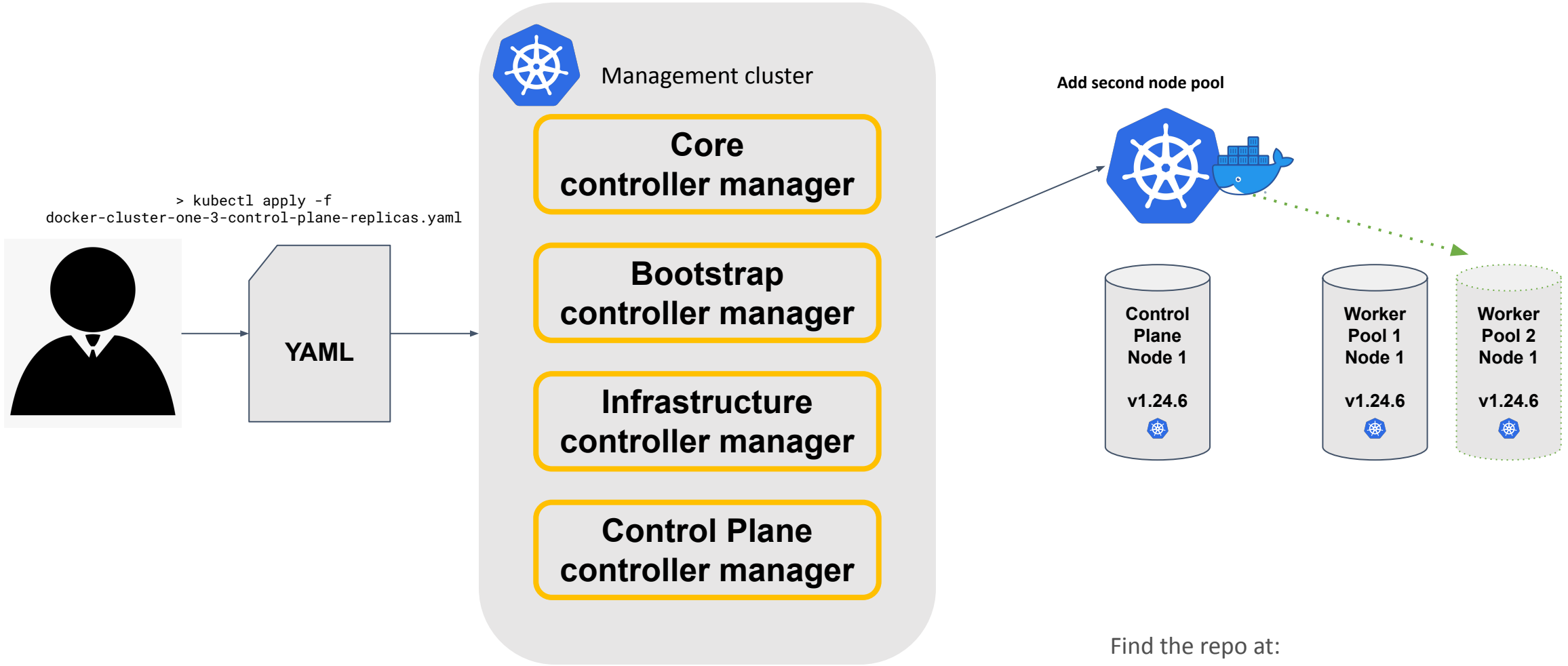
Changing the Cluster topology: add pool



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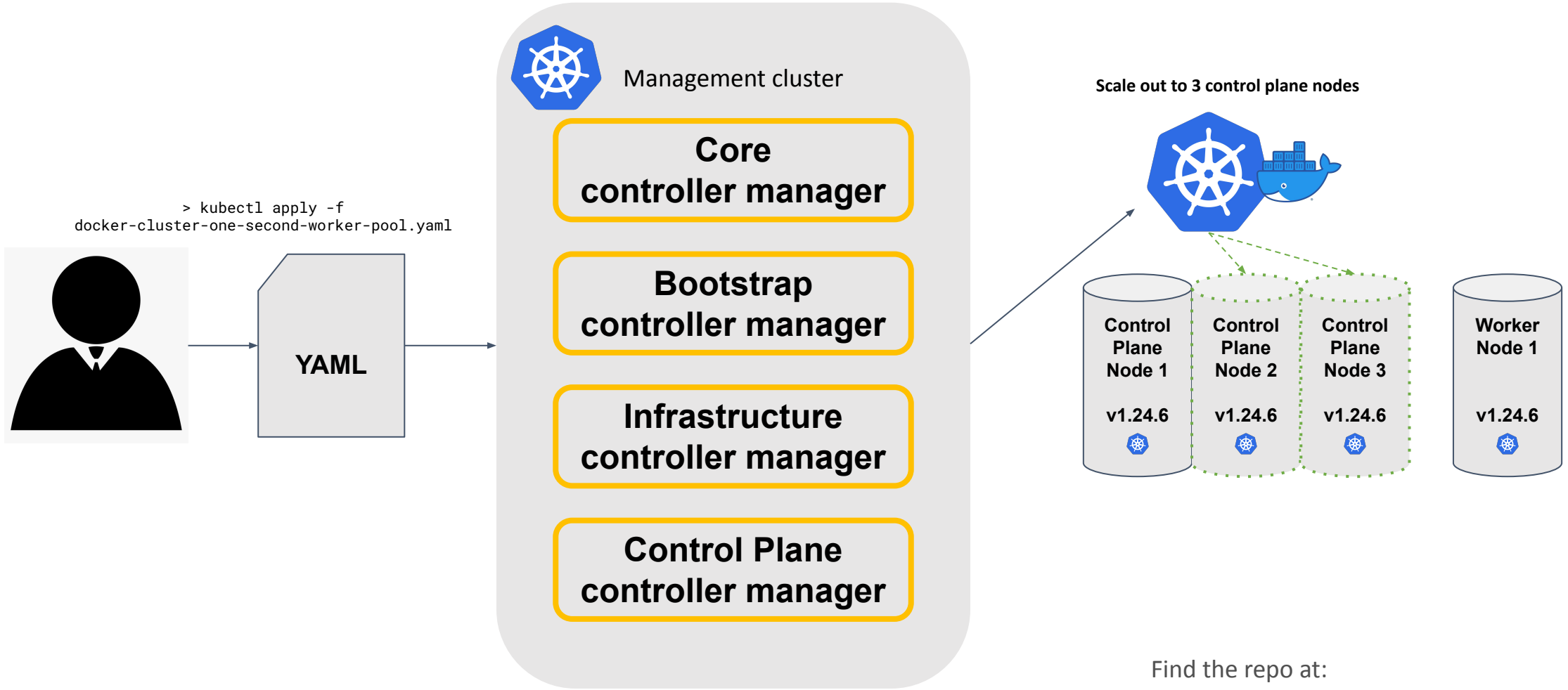
Changing the Cluster topology: scale



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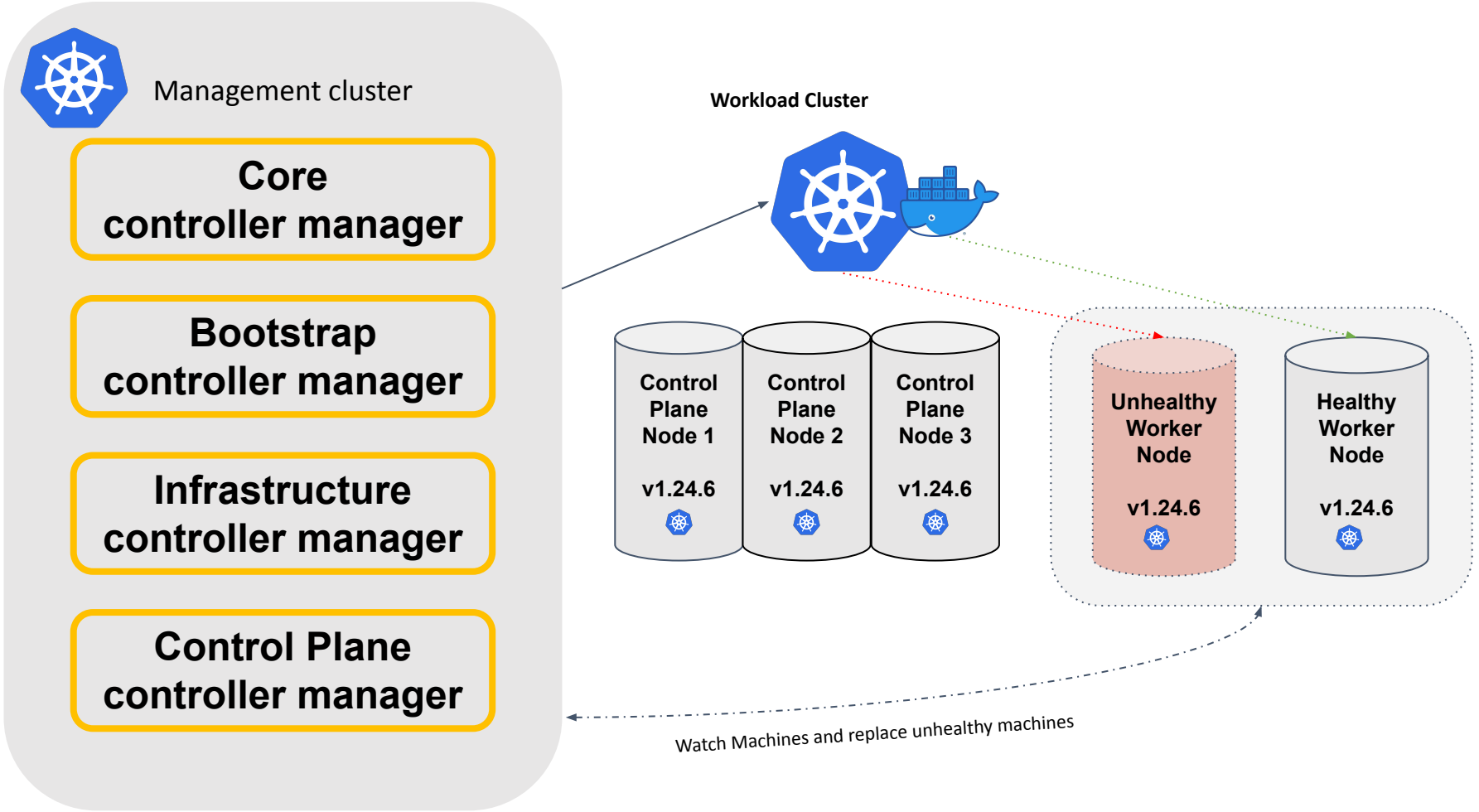
MachineHealthChecks and Machine Remediation



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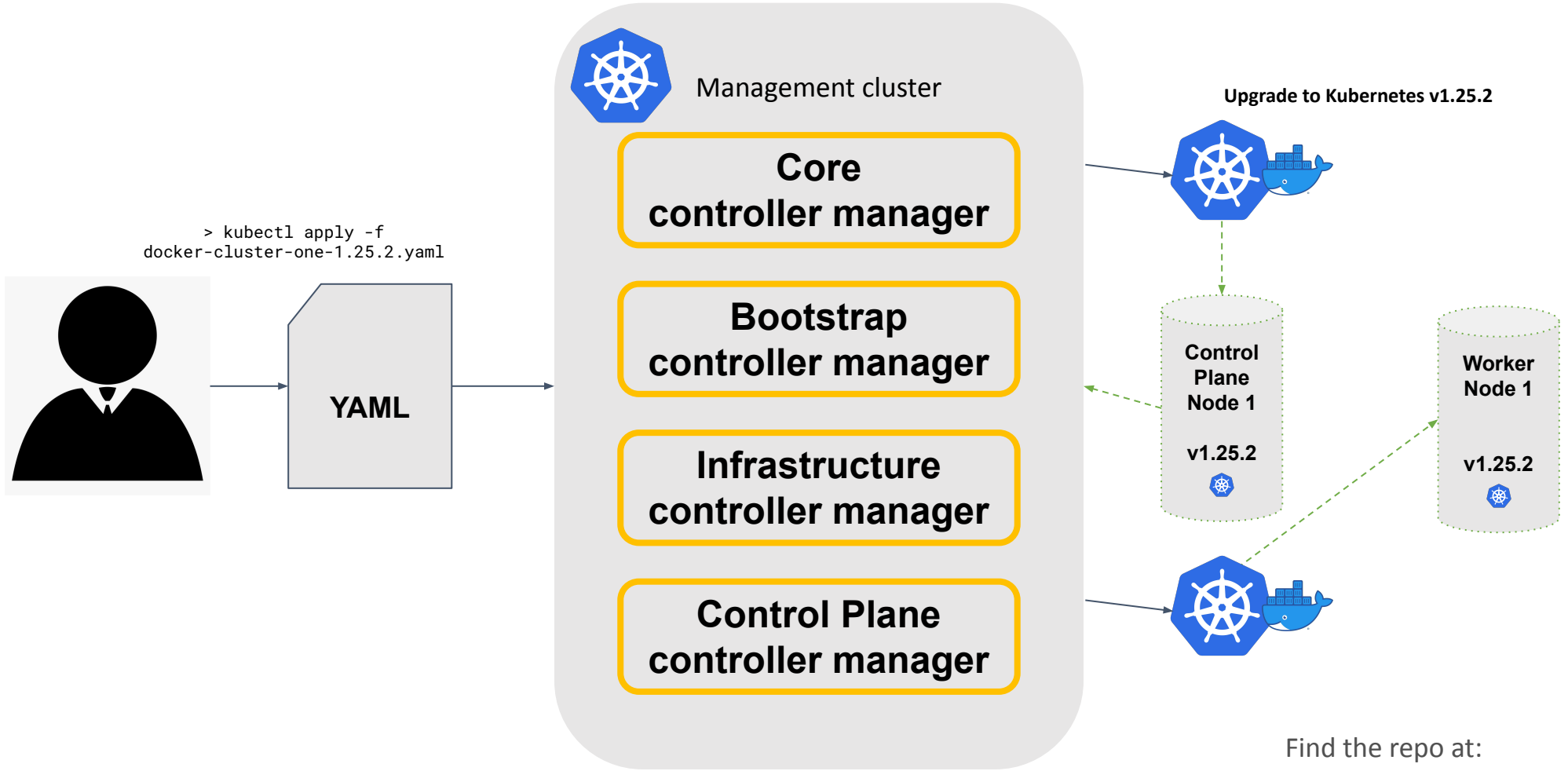
Upgrading Kubernetes Version



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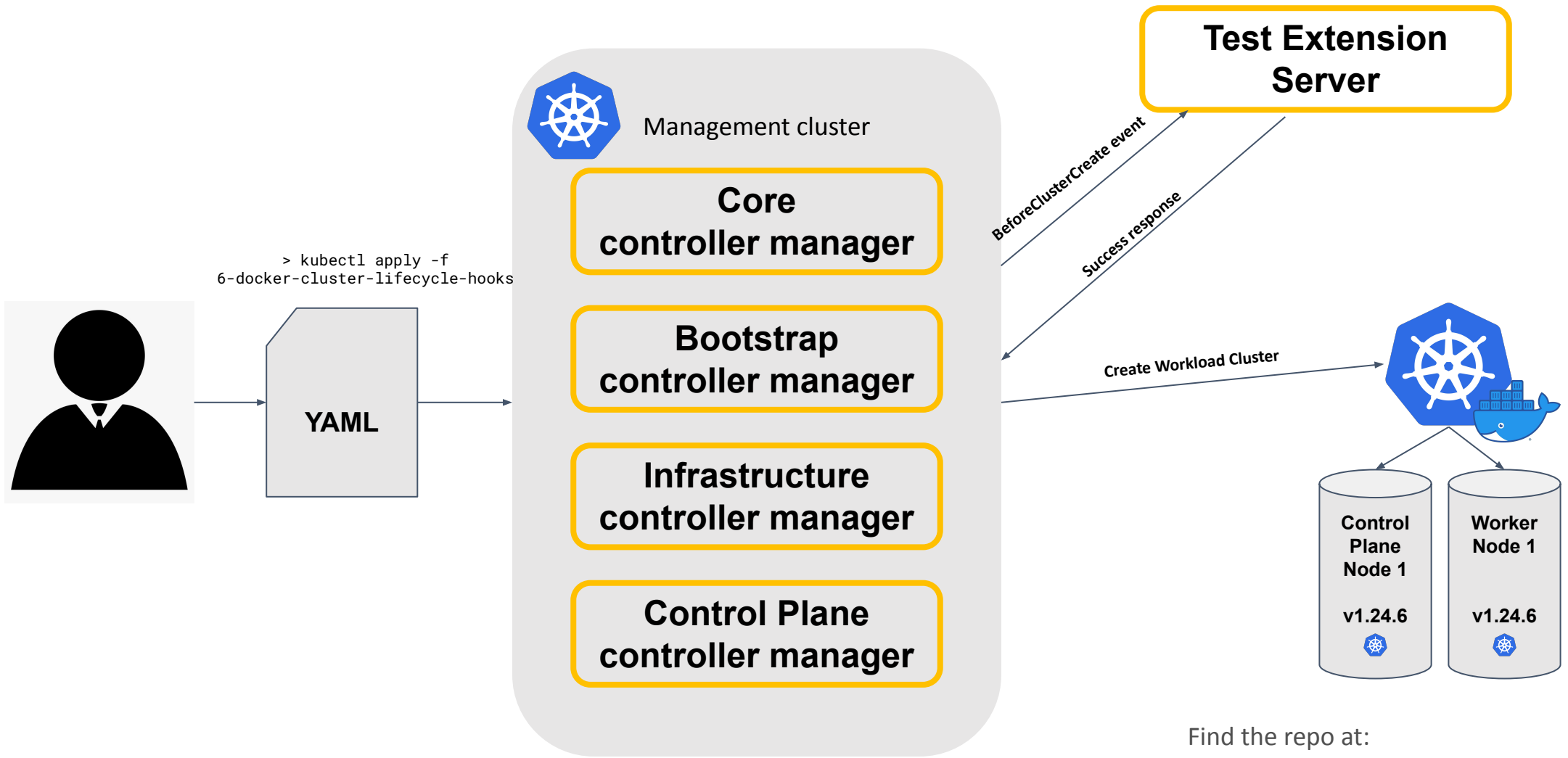
Cluster Lifecycle Hooks



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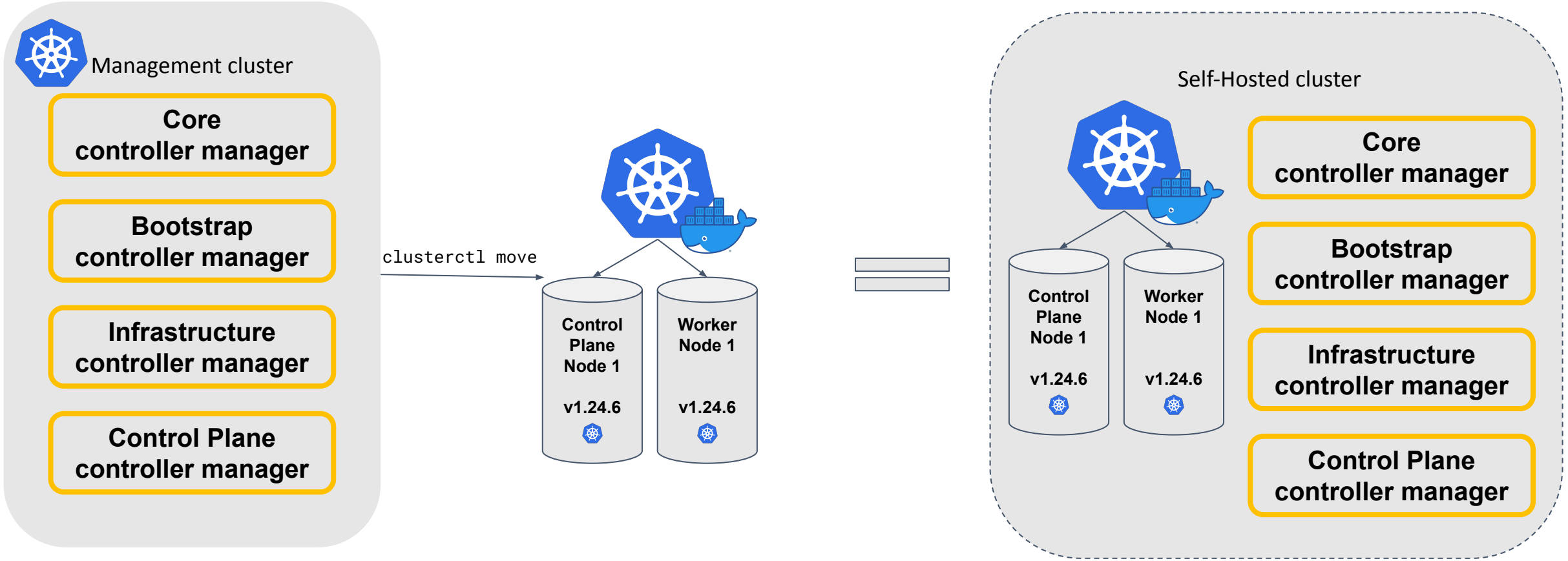
Self-Hosted



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