CLOUDNORD 2020

Kubernetes Operators:
Operating Cloud Native services at scale

Horacio Gonzalez 2020-11-19

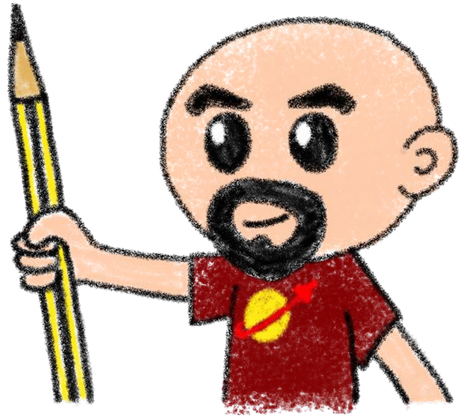
OVHcloud

SPONSORS 2020

Microsoft claranet aws AXA IPPON EXOSCALE adeo NUTANIX

Who are we?

Introducing myself and introducing ~~OVH~~ OVHcloud



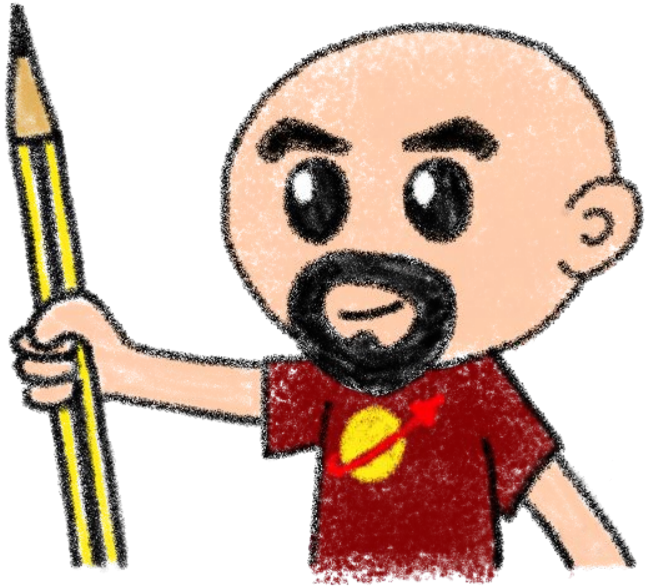
Horacio Gonzalez

@LostInBrittany

Spaniard lost in Brittany, developer, dreamer and all-around geek

OVHcloud

DevRel Leader



DevFest du
Bout du Monde

Finist
Devs

GDG Finistère

Google Developers
Experts
2019

Web Technologies
GDE
Flutter

OVHcloud: A Global Leader

200k Private cloud VMs running

1 **Dedicated IaaS Europe**

Hosting capacity : **1.3M** Physical Servers

360k Servers already deployed

Own **20Tbps** Netwok with **35 PoPs**

30 Datacenters

> **1.3M** Customers in **138** Countries

OVHcloud: 4 Universes of Products

WebCloud

Domain / Email ▽

Domain names, DNS, SSL, Redirect

Email, Open-Xchange, Exchange

Collaborative Tools, NextCloud

PaaS for Web ▽

Mutu, CloudWeb

Plesk, CPanel

PaaS with Platform.sh

Virtual servers ▽

VPS, Dedicated Server

SaaS ▽

Wordpress, Magento, Prestashop

CRM, Billing, Payment, Stats

MarketPlace

Support, Managed ▽

Support Basic

Support thought Partners

Managed services

Baremetal Cloud

Standalone, Cluster ▽

General Purpose
SuperPlan
Game
Virtualization
Storage
Database
Bigdata
HCI
AI
VDI Cloud Game
Network

T2 >20e
T3 >80e
T4 >300e
T5 >600e
12KVA /32KVA

VPS aaS ▽

pCC DC

Virtuozzo Cloud

Wholesales ▽

IT Integrators, Cloud Storage,

CDN, Database, ISV, WebHosting

High Intensive CPU/GPU,

Encrypt ▽

KMS, HSM

Encrypt (SGX, Network, Storage)

Public Cloud

Compute ▽

VM
Baremetal

K8S, IA IaaS
PaaS for DevOps

Storage ▽

File, Block, Object, Archive

Databases ▽

SQL, noSQL, Messaging,

Dashboard

Network ▽

IP FO, NAT, LB, VPN, Router,

DNS, DHCP, TCP/SSL Offload

Security ▽

IAM, MFA, Encrypt, KMS

IA, DL ▽

Standard Tools for AI, AI Studio,

IA IaaS, Hosting API AI

Bigdata, ML, Analytics

Datalake, ML, Dashboard

Hosted Private Cloud

Hosted Private Cloud ▽

VMware

SDDC, vSAN 1AZ / 2AZ
vCD, Tanzu, Horizon, DBaaS,
DRaaS

Nutanix

HCI 1AZ / 2AZ, Databases,
DRaaS, VDI

OpenStack

IAM, Compute (VM, K8S)
Stortage, Network, Databases

Storage

Ontap Select, Nutanix File
OpenIO, MinIO, CEPH
Zerto, Veeam, Atempo

AI

ElementAI, HuggingFace,
Deepopmatic, Systran,
EarthCube

Bigdata / Analitics / ML

Cloudera over S3, Dataiku,
Saagie, Tableau,

Hybrid Cloud ▽

vRack Connect, Edge-DC, Private DC

Dell, HP, Cisco, OCP, MultiCloud

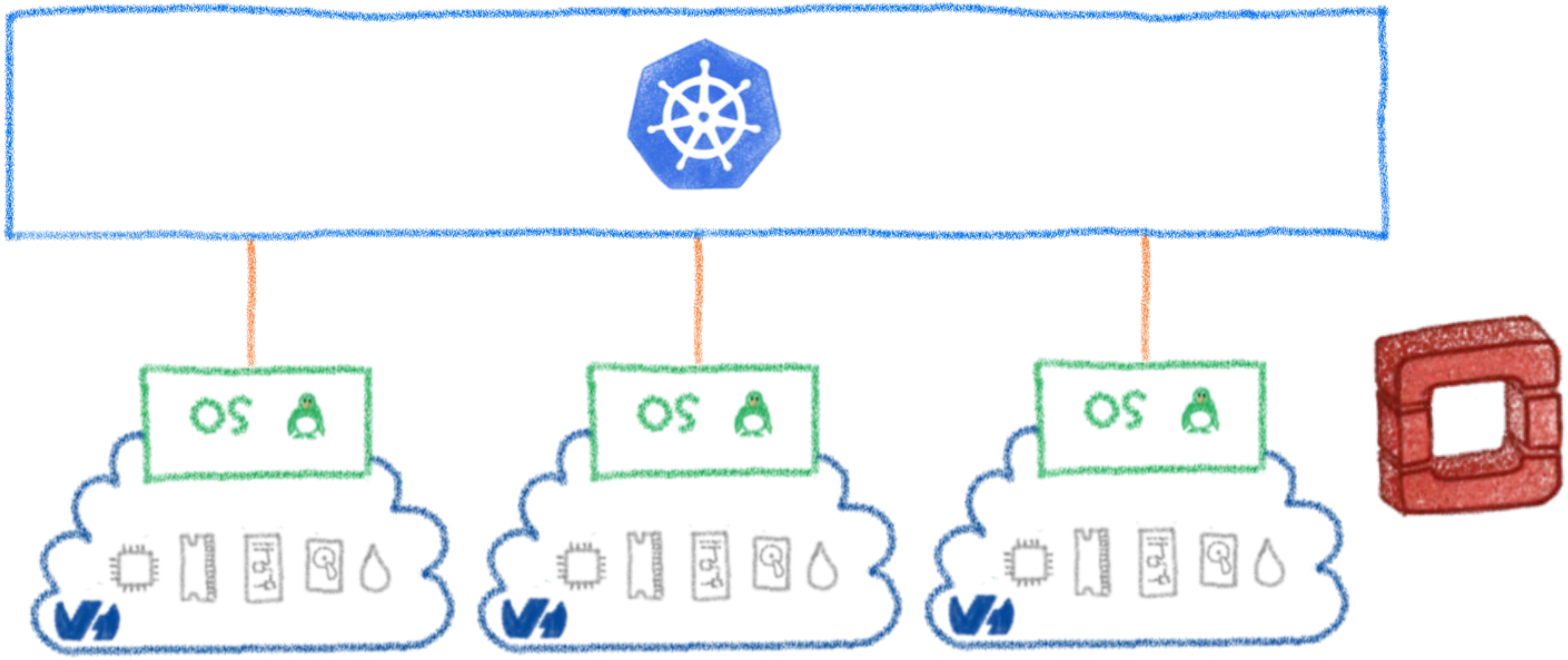
Secured Cloud ▽

GOV, FinTech, Retail, HealtCare

OVHcloud Managed Kubernetes

You use it, we operate it

Built over our Openstack based Public Cloud



Some interesting features

Developer

Fully managed, including version updates

Price / performance ratio, free masters

Large instance range... and more to come

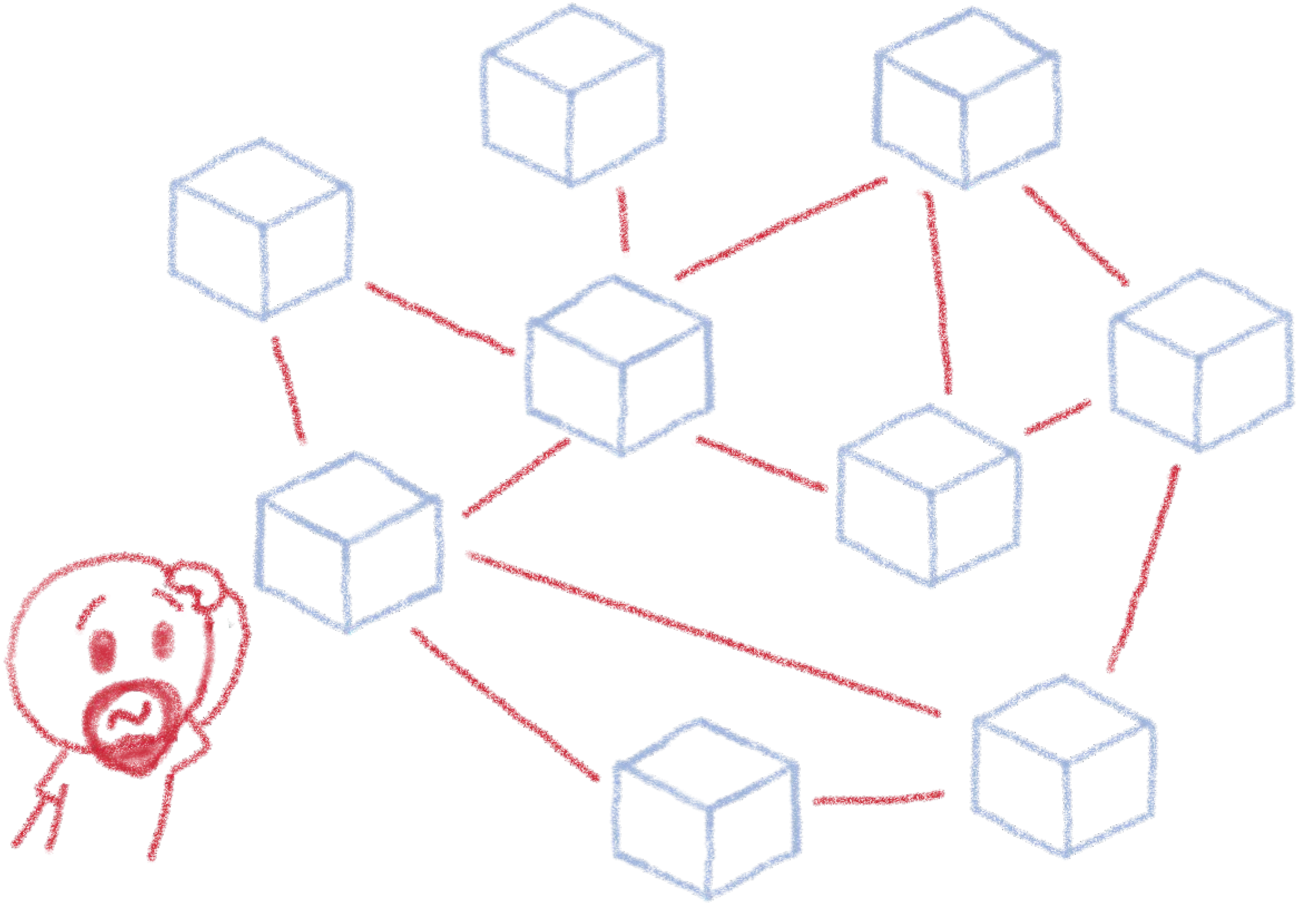
Predictible pricing

Cluster administrator

Operating Kubernetes

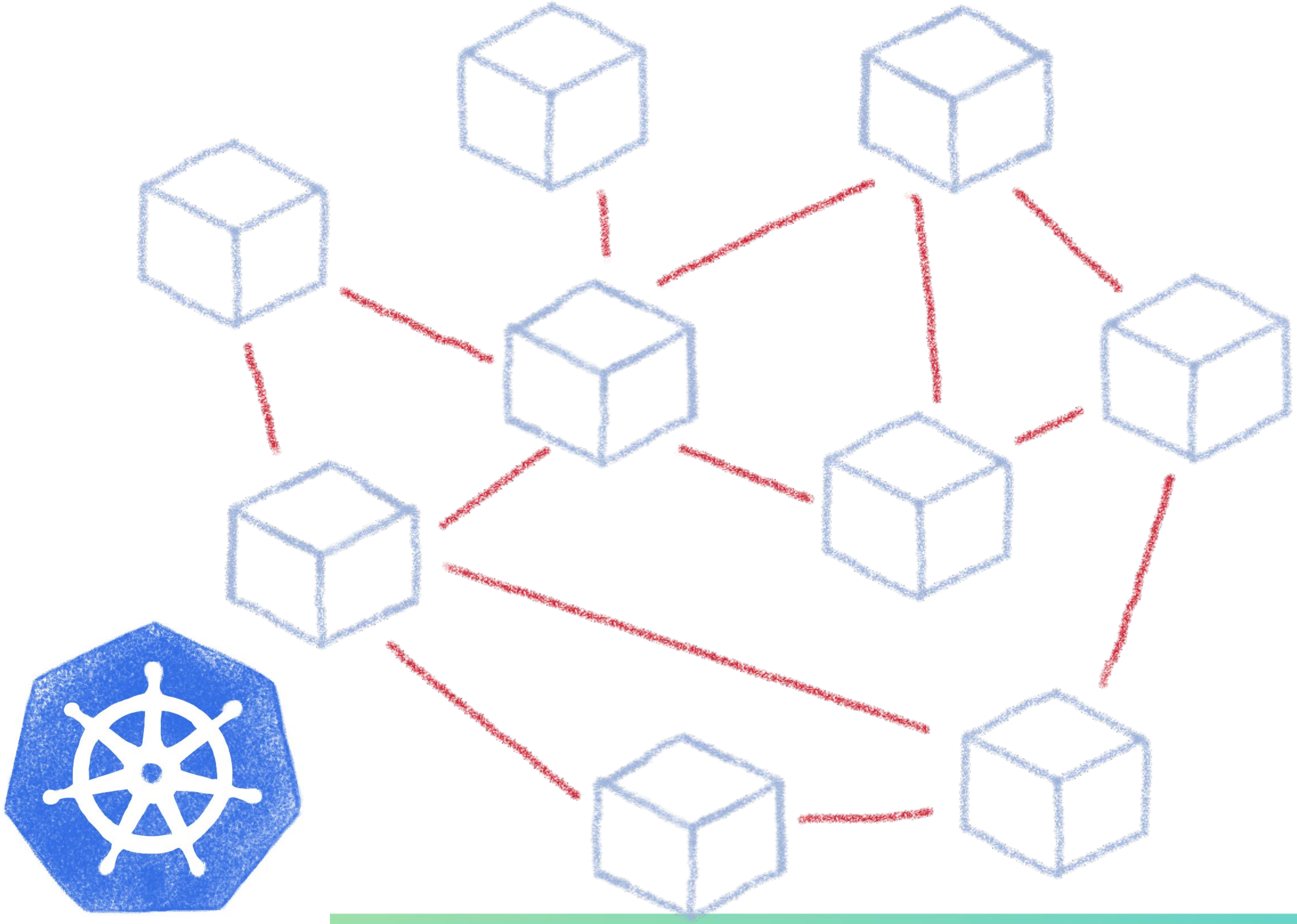
Easier said than done

Operating microservices?

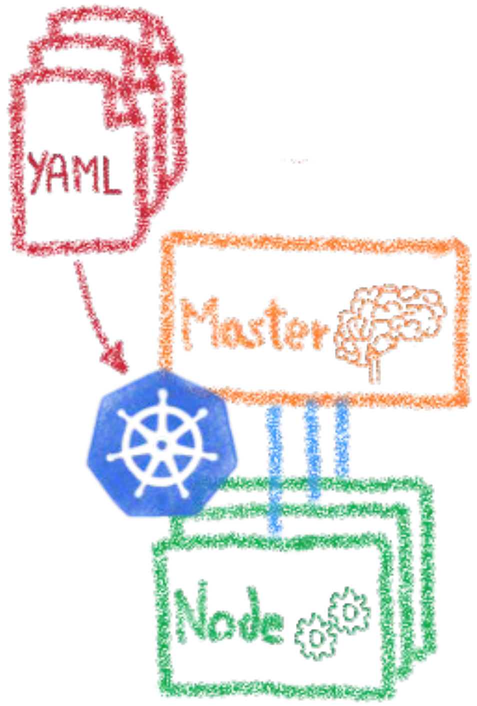


Are you sure you want to operate them by hand?

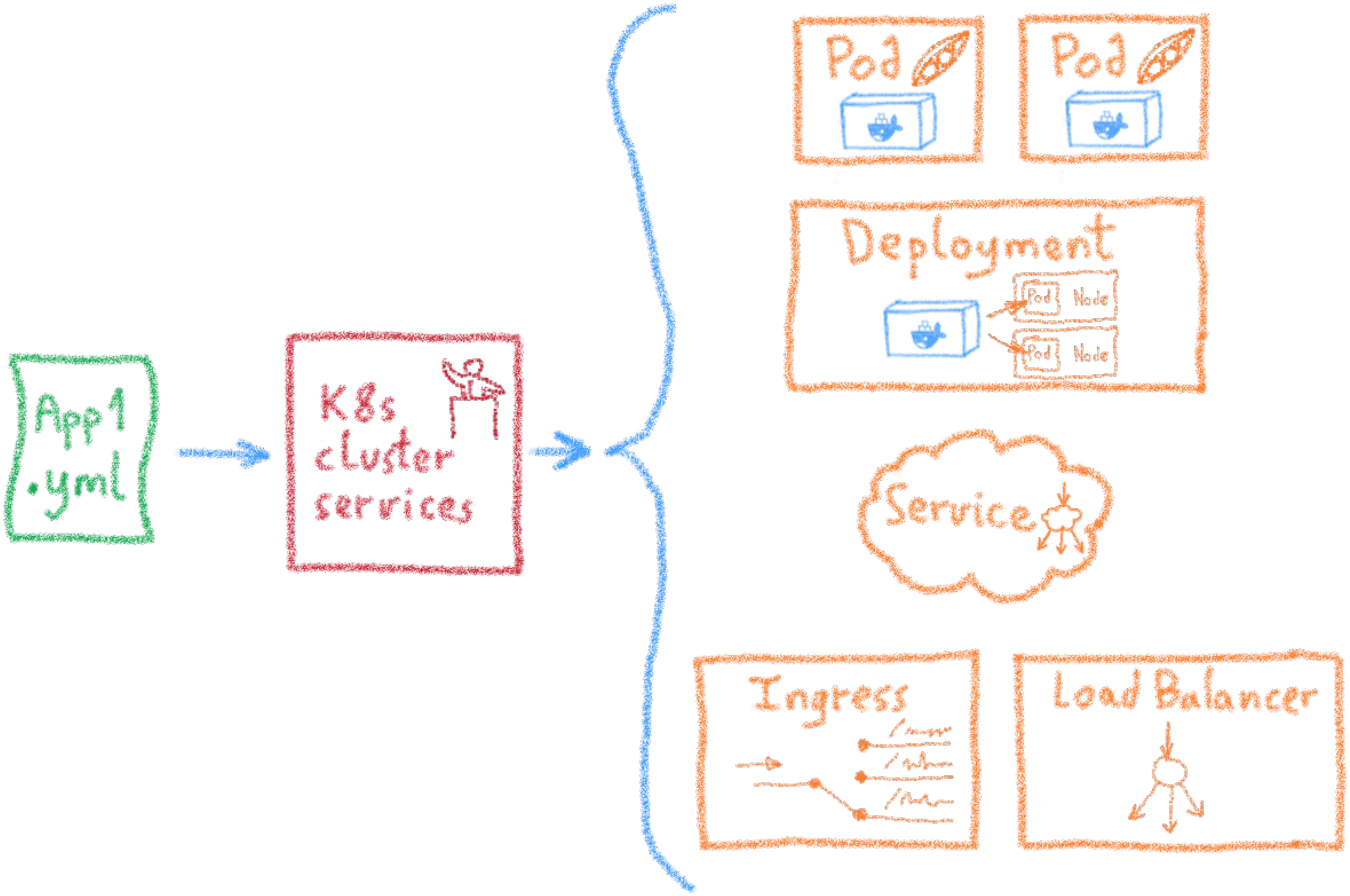
Taming microservices with Kubernetes



Declarative infrastructure



Desired State Management



Ingress

Services

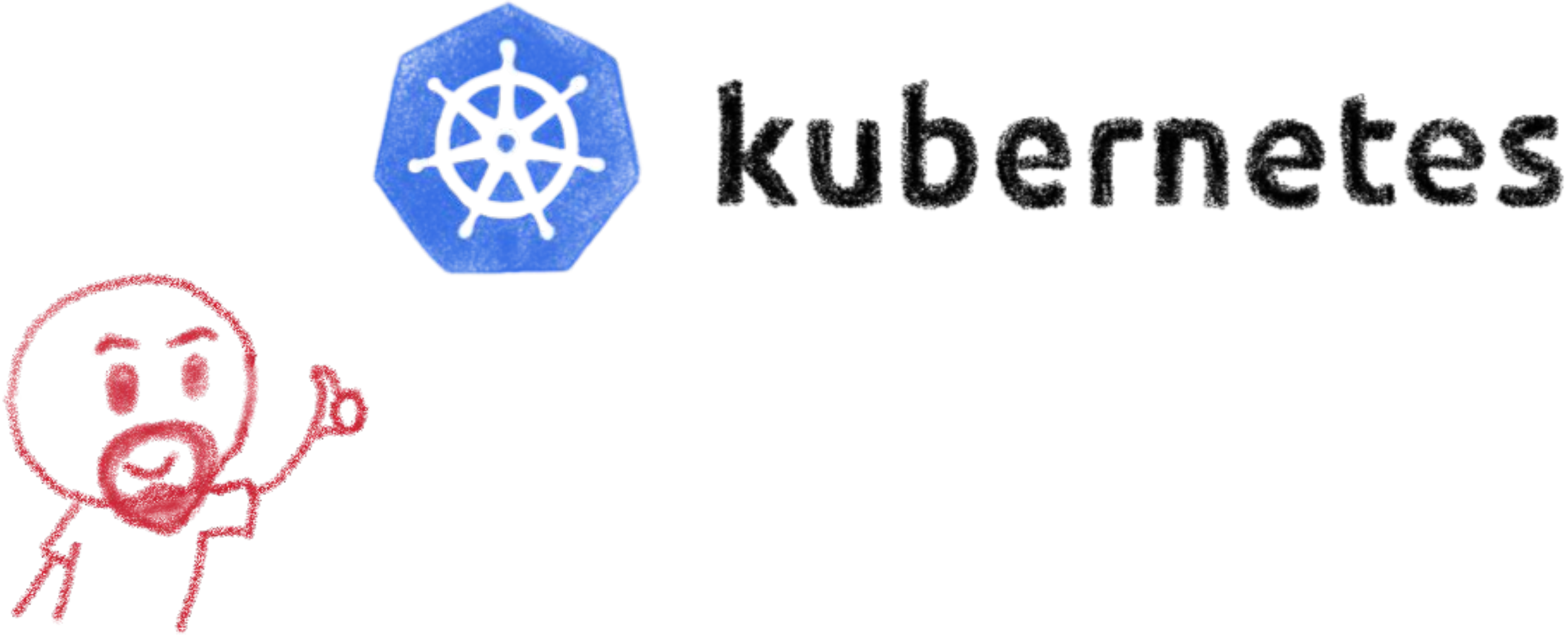
Deployments

Pods

Sidecars

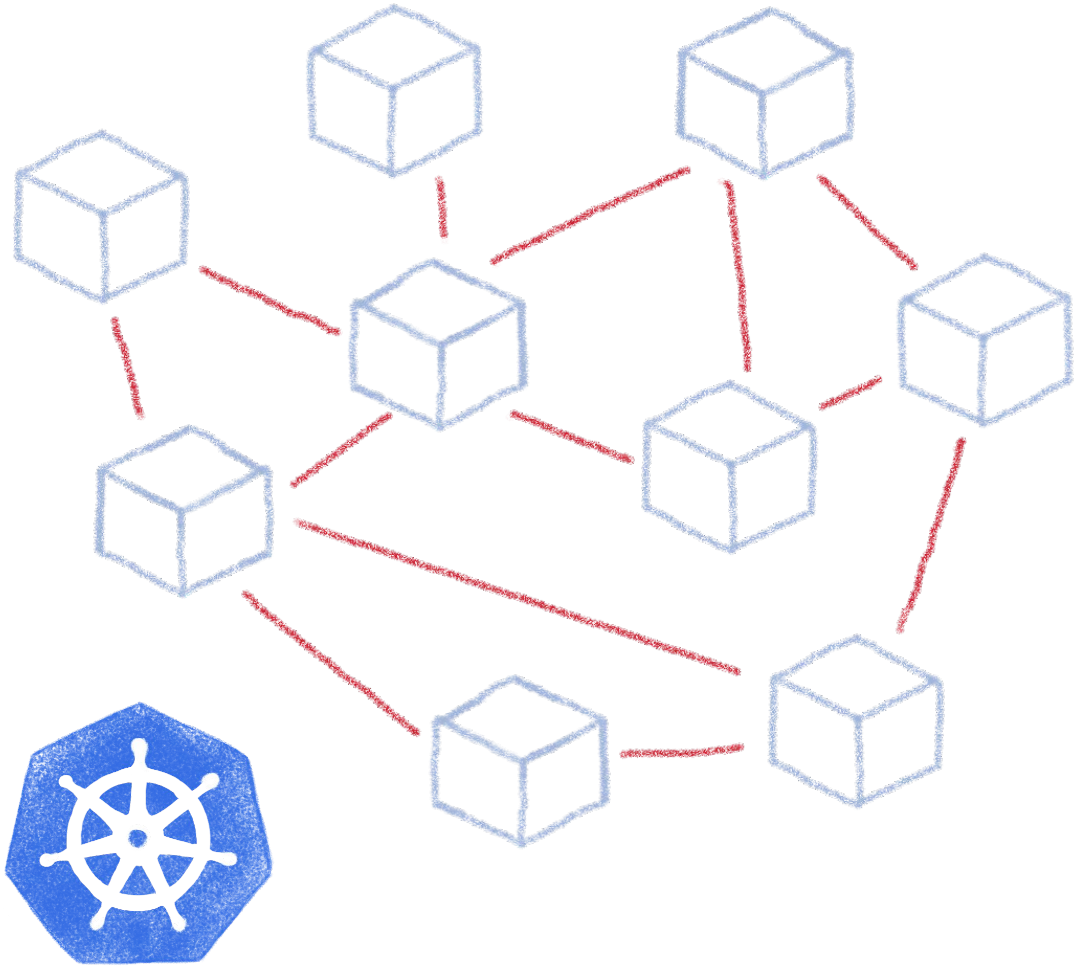
Replica Sets

Beyond a simple deployment



Everything is good now, isn't it?

Complex deployments



Ingress

Services

Deployments

Pods

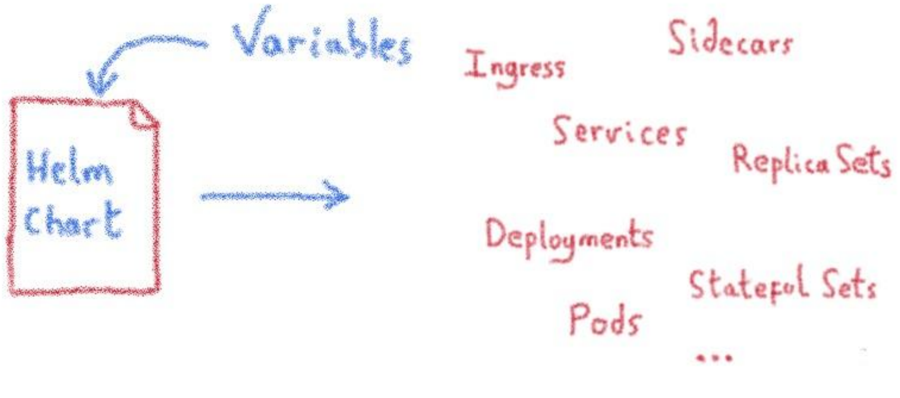
Sidecars

Replica Sets

Stateful Sets

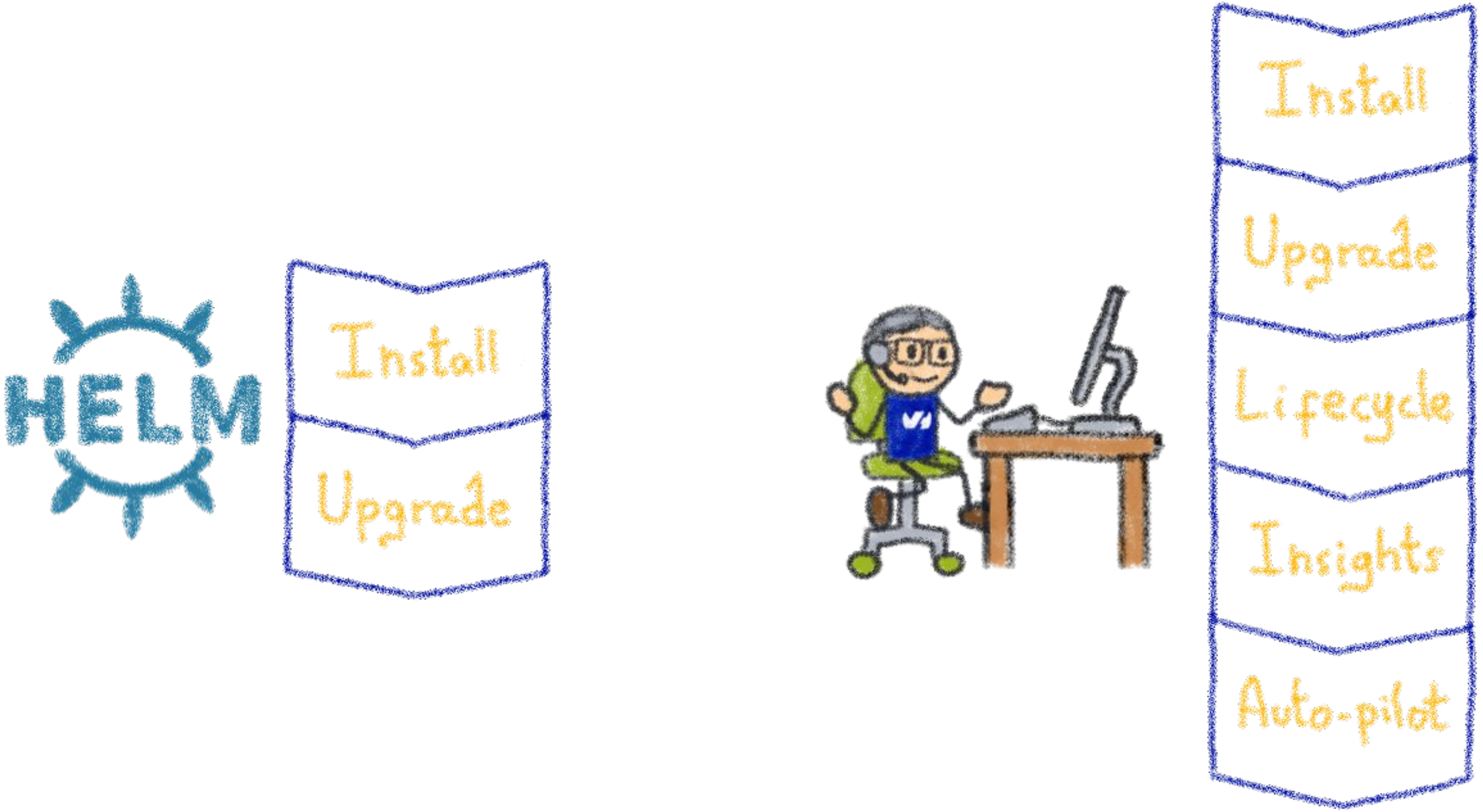
Complex deployments

A package manager for Kubernetes



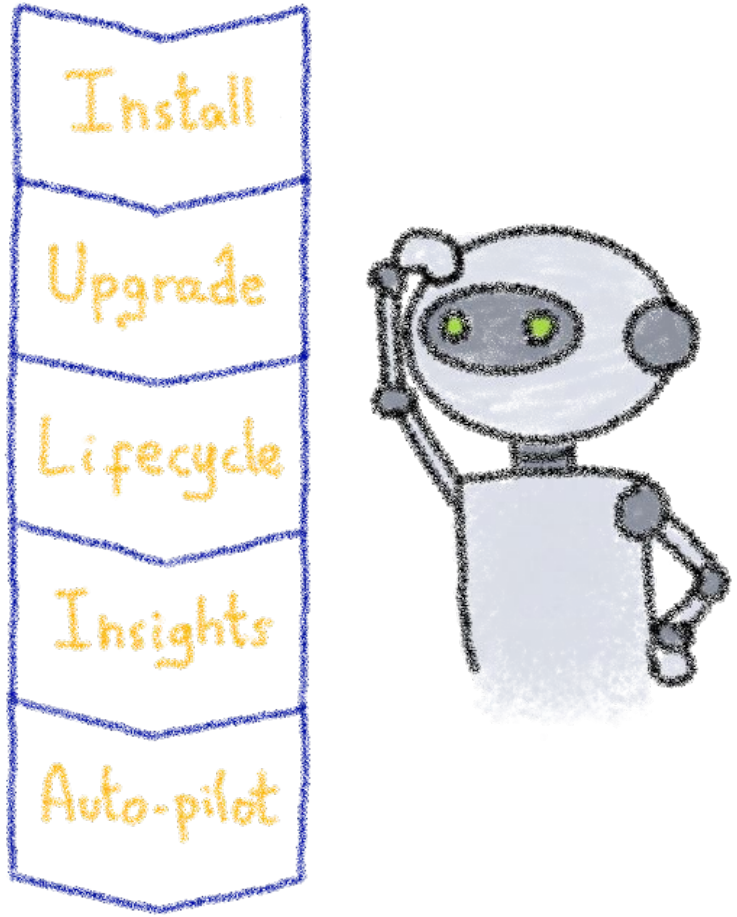
- Manage complexity
- Simple sharing
- Easy upgrades V.41 → V.42
- Easy rollbacks V.43 → V.42

Helm Charts are configuration



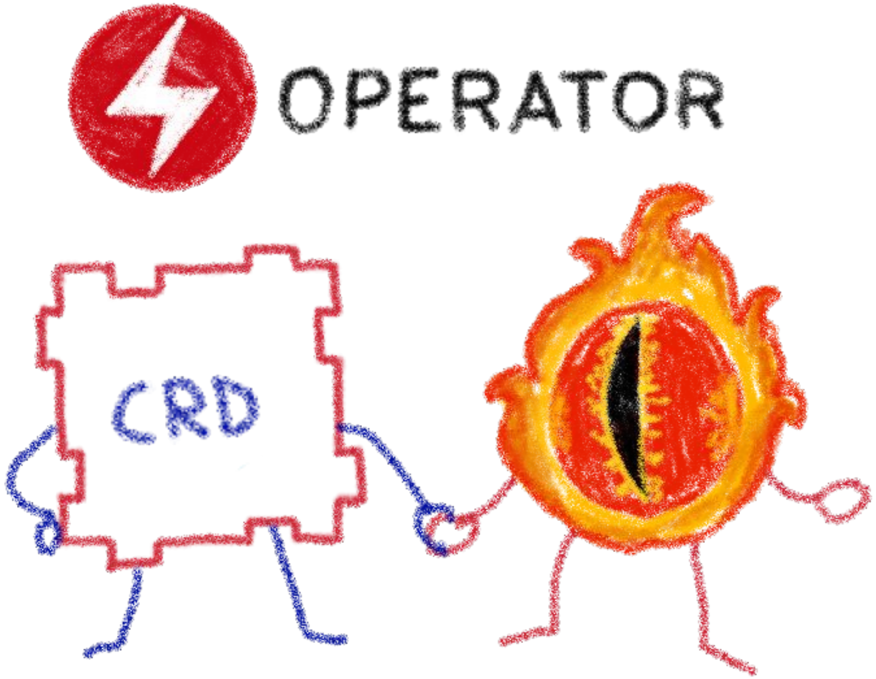
Operating is more than installs & upgrades

Kubernetes is about automation



How about automating human operators?

Building operators

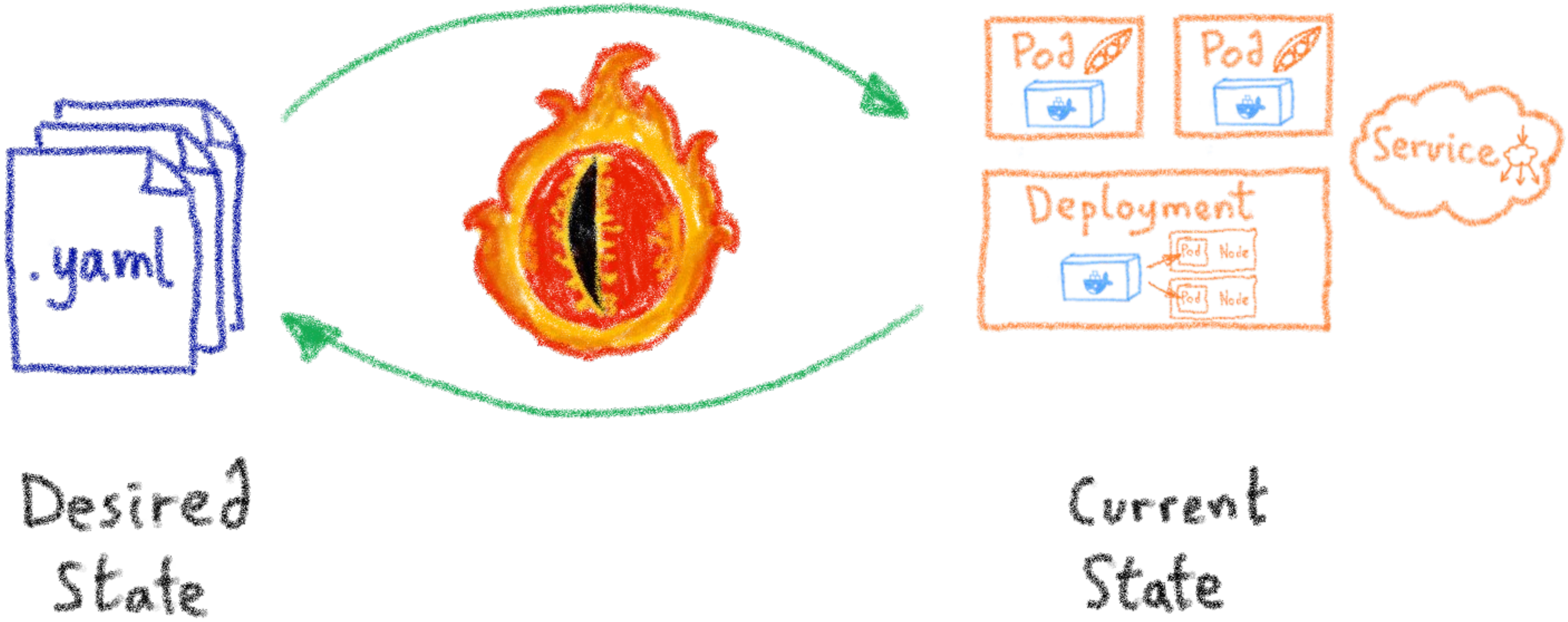


Basic K8s elements: Controllers and Custom Resources

Kubernetes Controllers

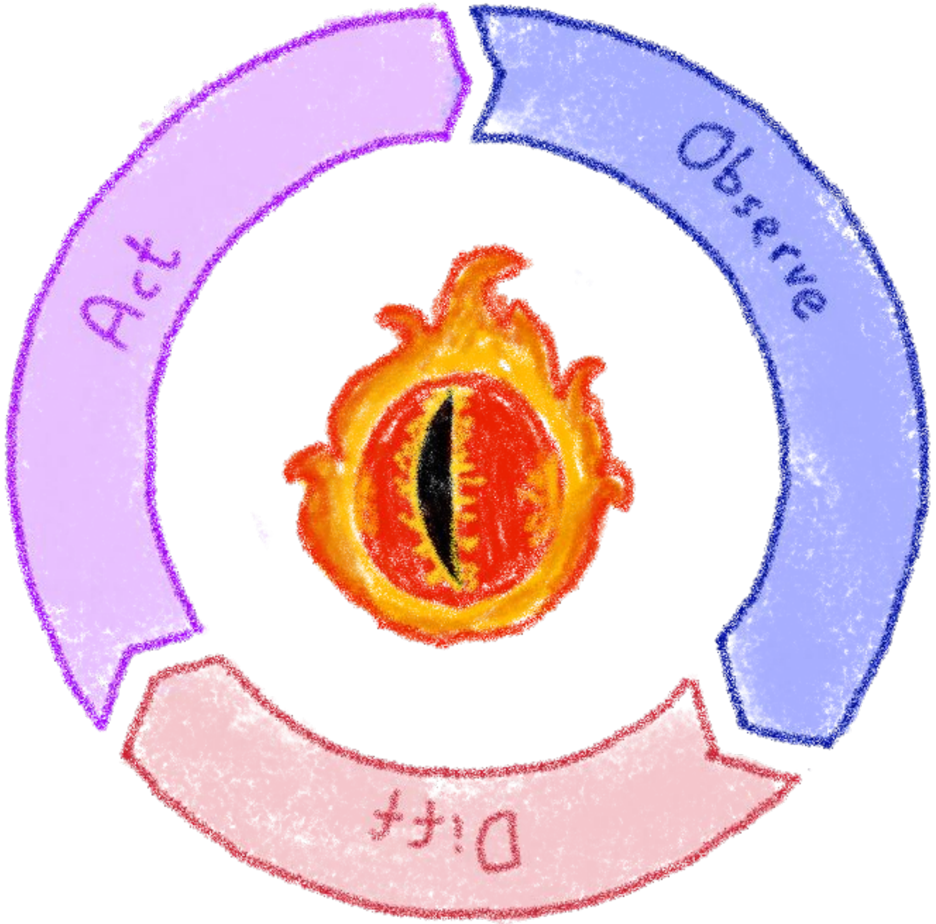
Keeping an eye on the resources

A control loop



They watch the state of the cluster,
and make or request changes where needed

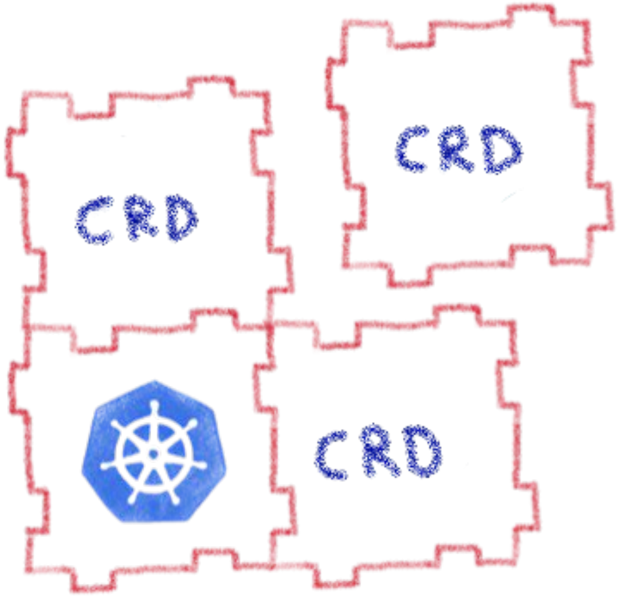
A reconcile loop



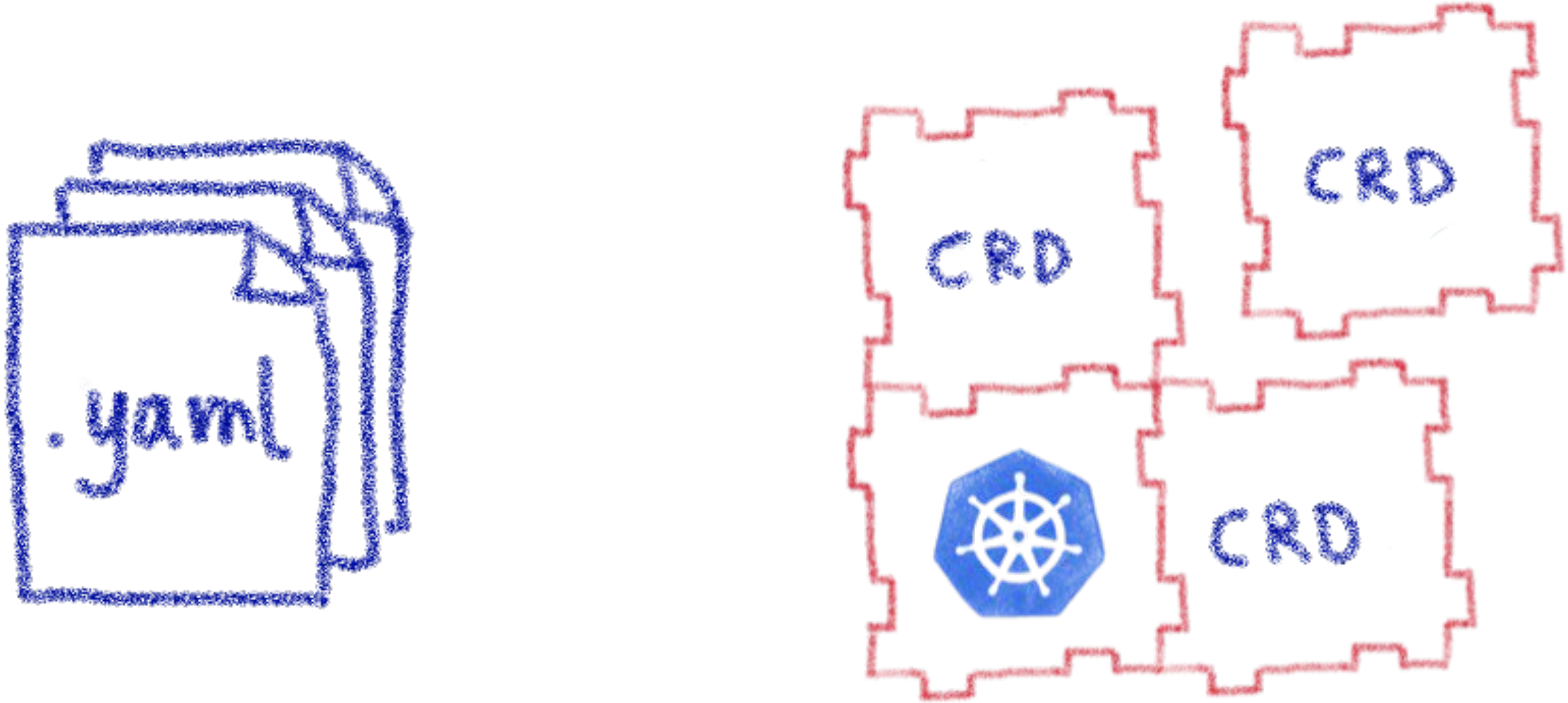
Strives to reconcile current state and desired state

Custom Resource Definitions

Extending Kubernetes API



Extending Kubernetes API

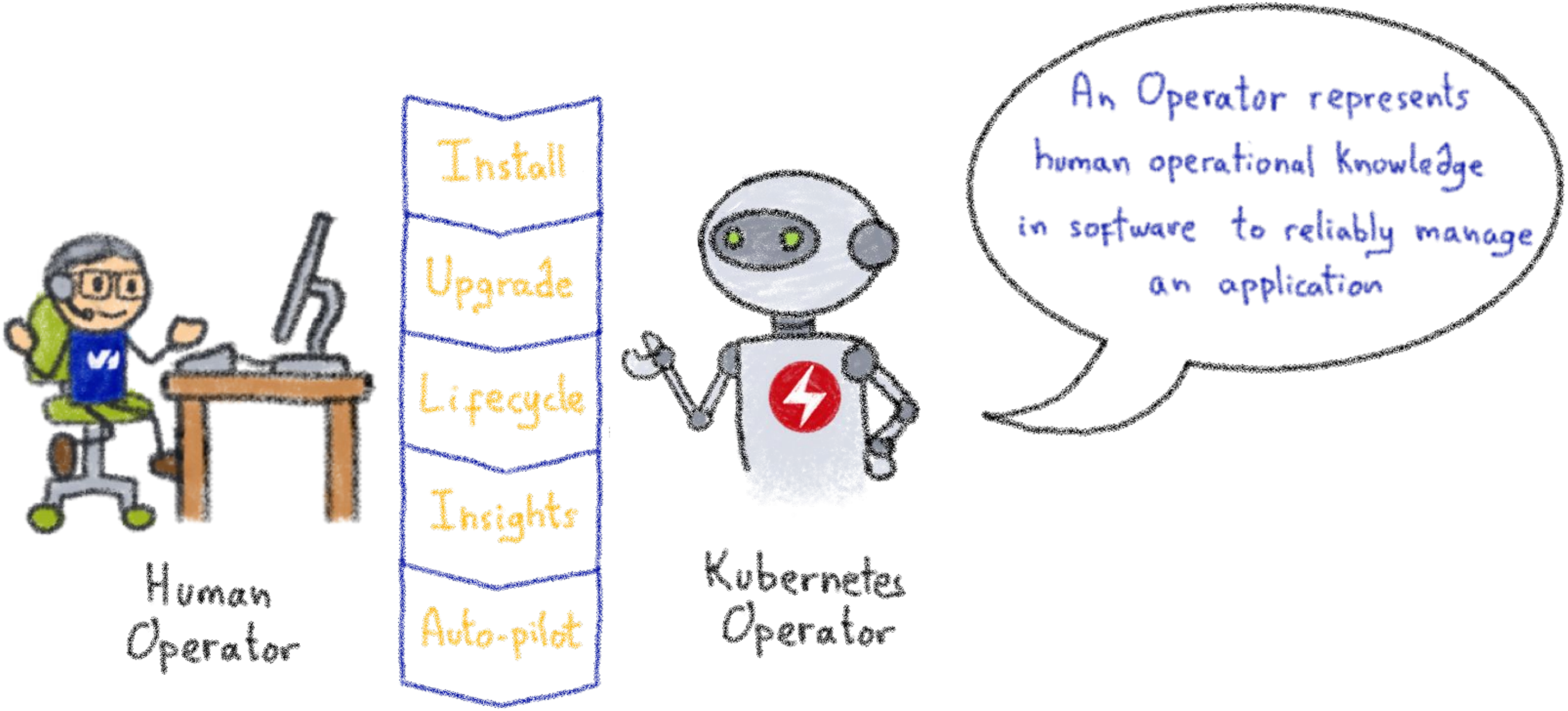


By defining new types of resources

Kubernetes Operator

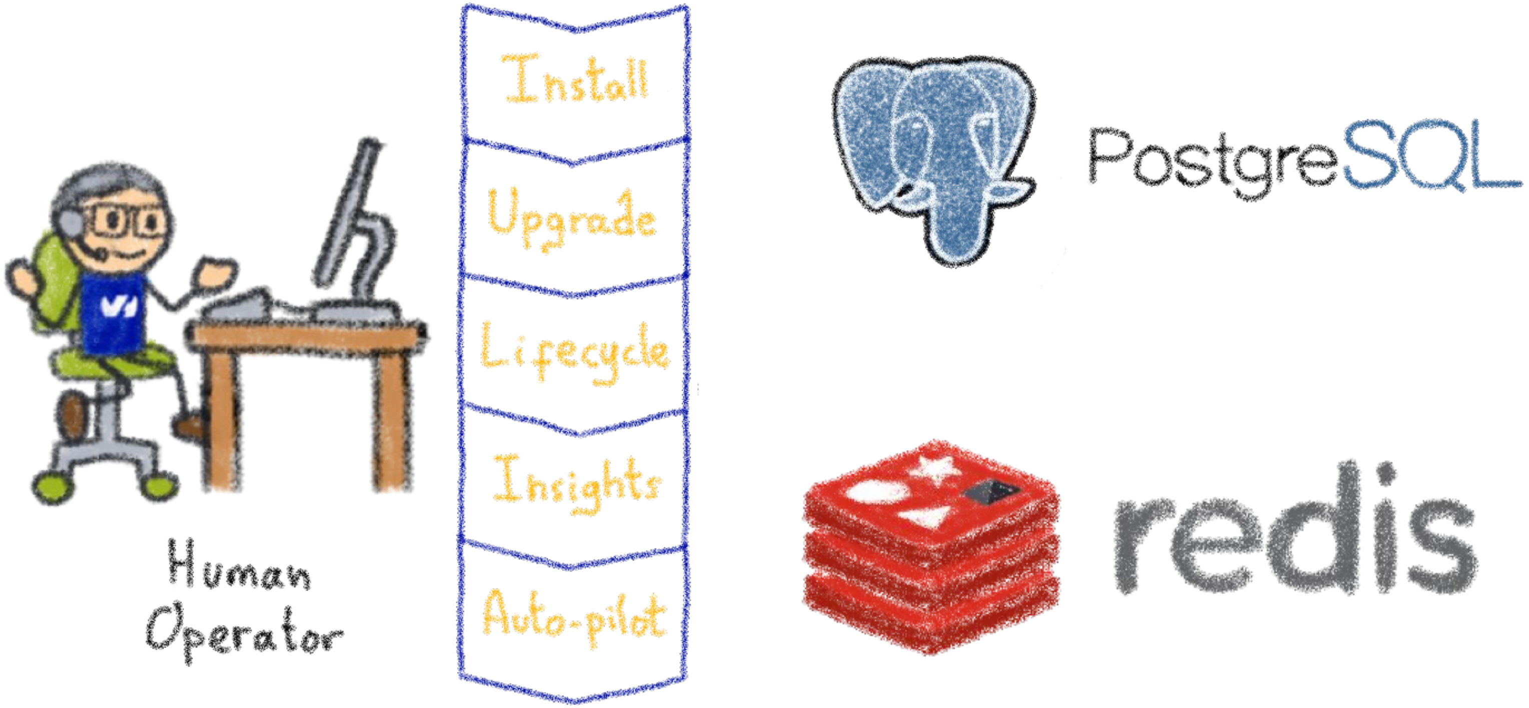
Automating operations

What's a Kubernetes Operator?



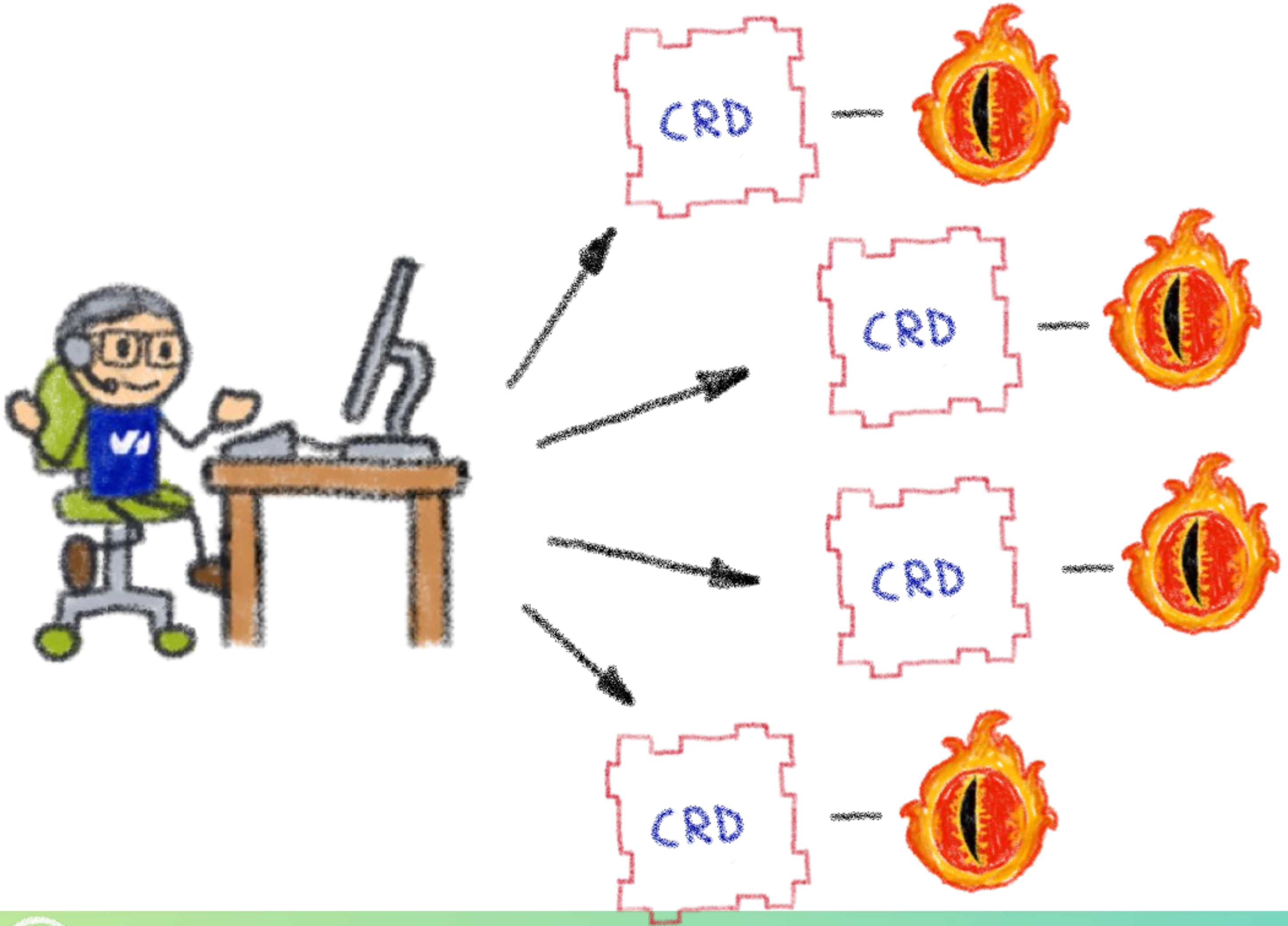
An Operator represents human operational knowledge in software to reliably manage an application

Example: databases



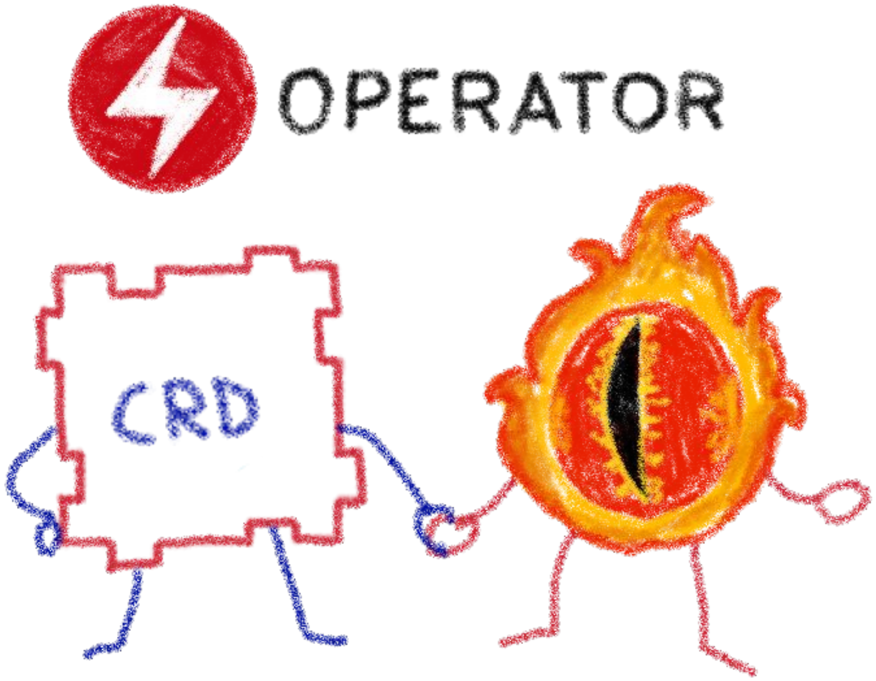
Things like adding an instance to a pool,
doing a backup, sharding...

Knowledge encoded in CRDs and Controllers



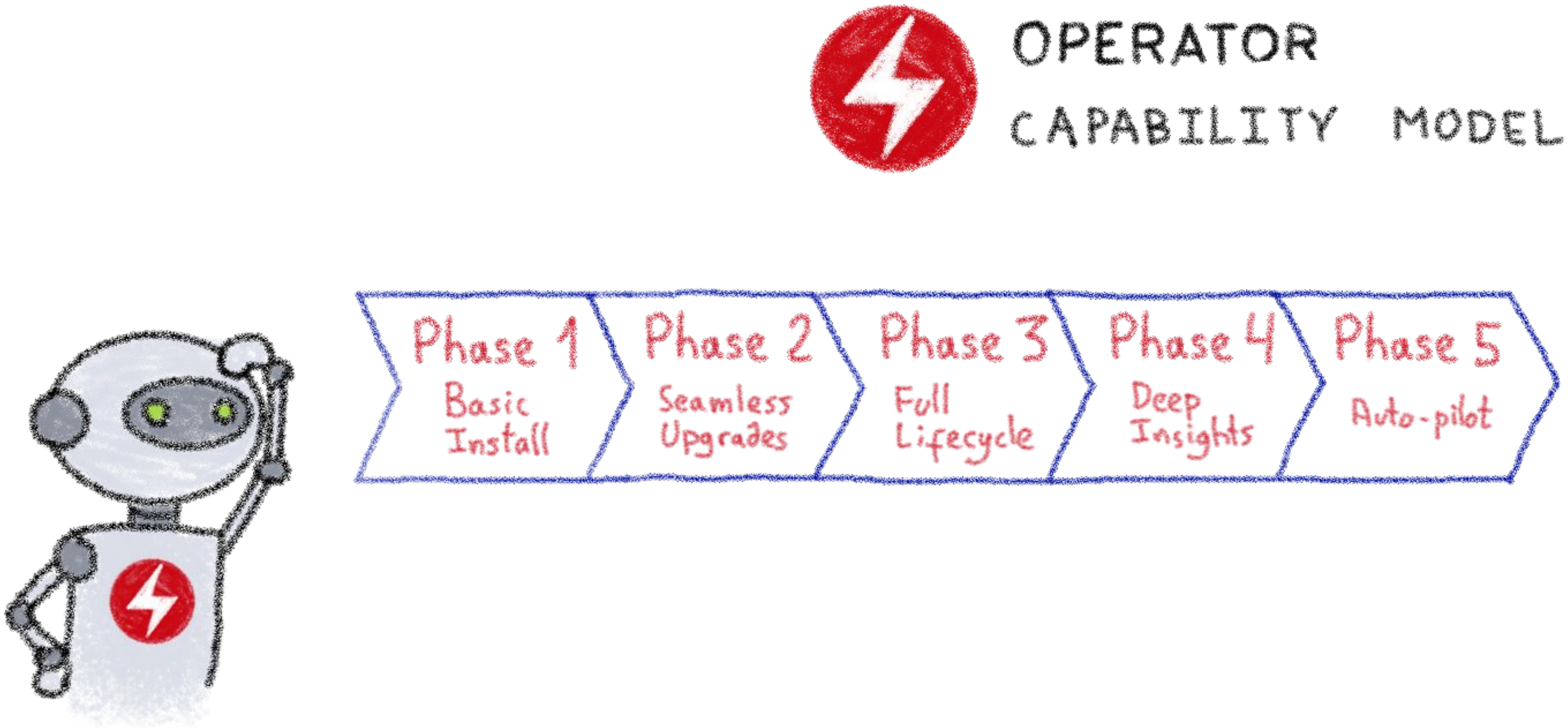
Encapsulating business logic in CRDs & Controllers

Custom Controllers for Custom Resources



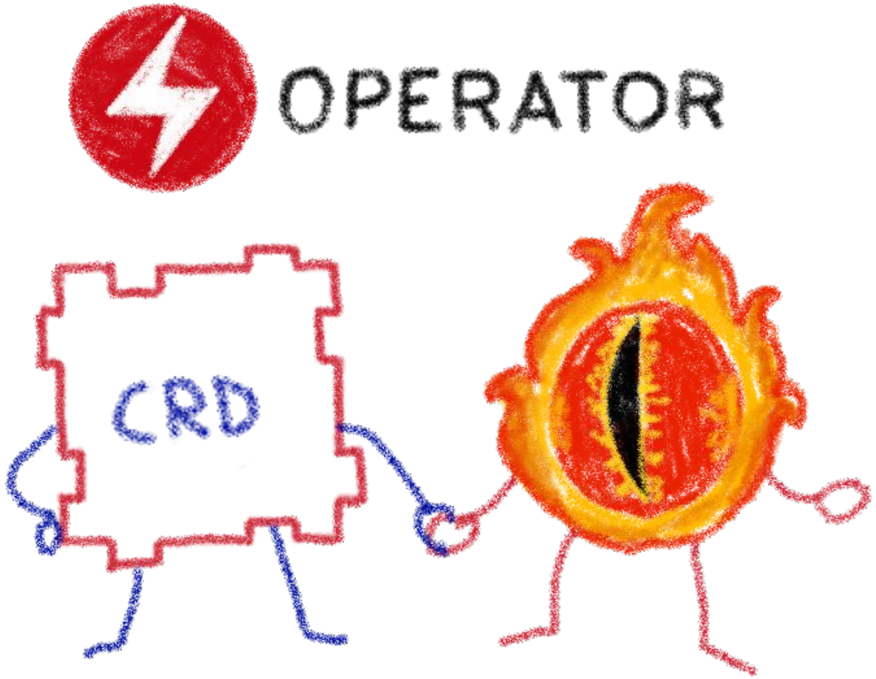
Operators implement and manage Custom Resources using custom reconciliation logic

Operator Capability Model



Gauging the operator maturity

How to write an Operator



1- Create a new project

2- Write the CRDs to define new resource APIs

3- Specify resources to watch

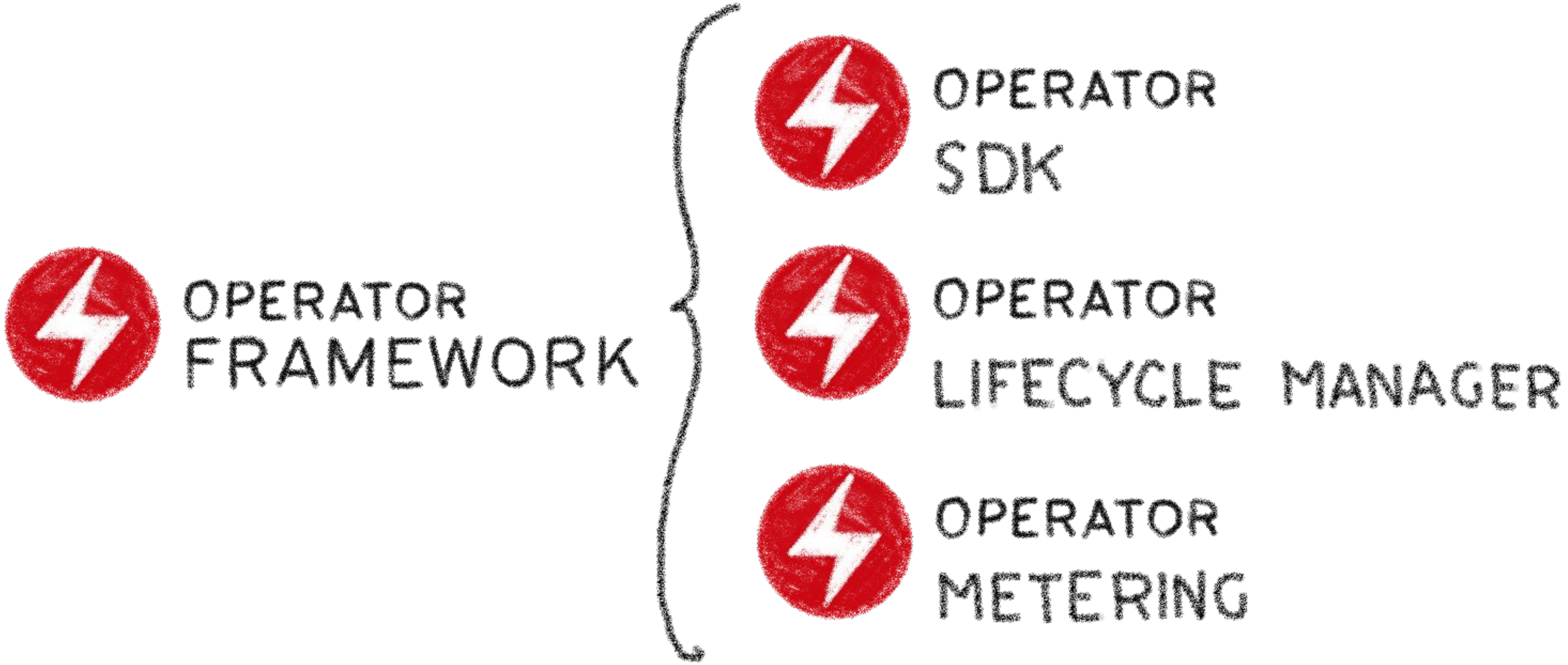
4- Define the reconciliation logic in the Controllers

5- Build the Operator

Kubebuilder

SDK for building Kubernetes APIs using CRDs

The Operator Framework



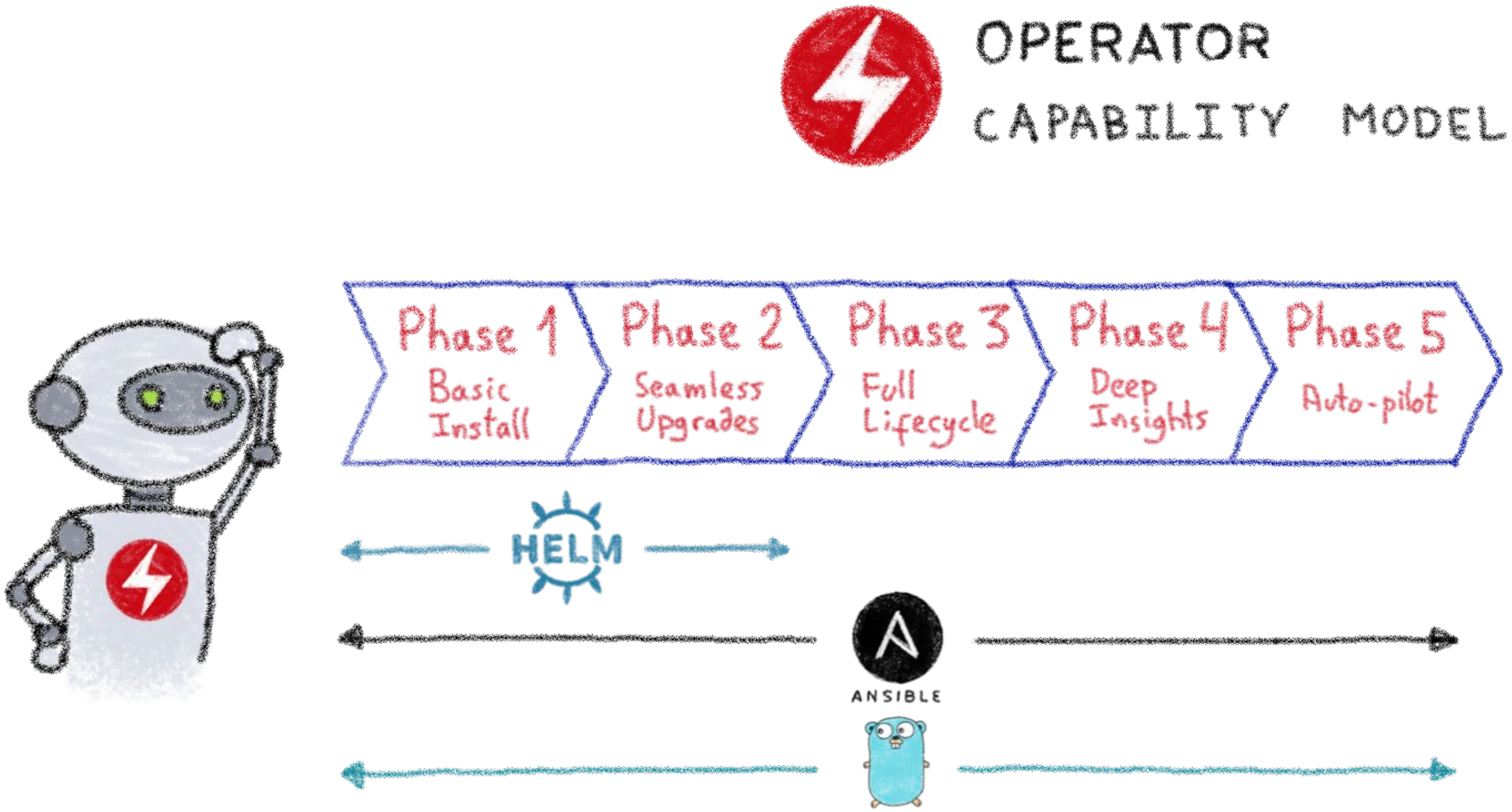
Open source framework to accelerate the development of an Operator

Operator SDK

OPERATOR SDK
BUILD
TEST
ITERATE
HELM
ANSIBLE

Three different ways to build an Operator

Operator SDK and Capability Model



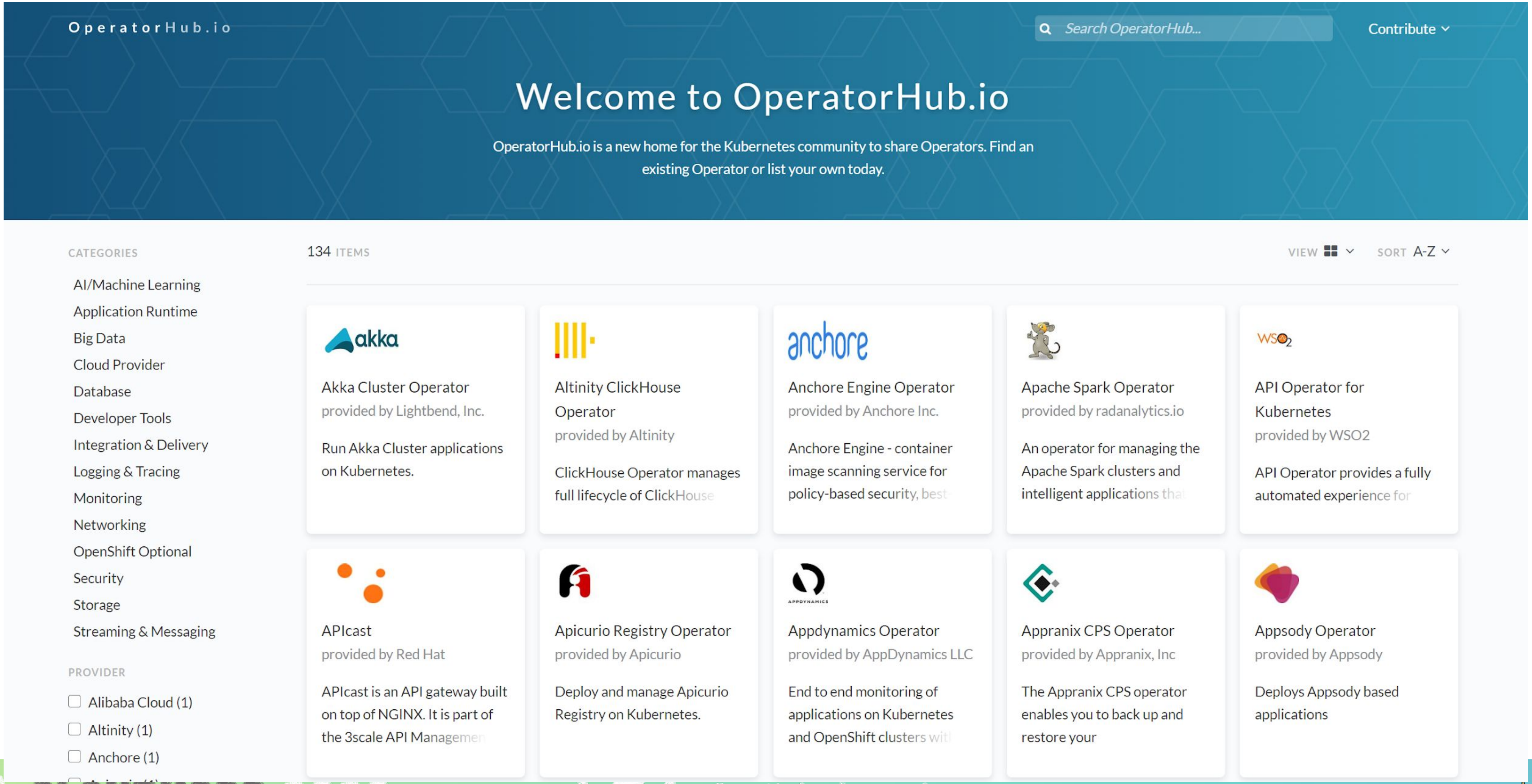
Operator Lifecycle Manager

INSTALL

MANAGE

UPDATE

OperatorHub.io



OperatorHub.io

Search OperatorHub...

Contribute

Welcome to OperatorHub.io

OperatorHub.io is a new home for the Kubernetes community to share Operators. Find an existing Operator or list your own today.

CATEGORIES

- AI/Machine Learning
- Application Runtime
- Big Data
- Cloud Provider
- Database
- Developer Tools
- Integration & Delivery
- Logging & Tracing
- Monitoring
- Networking
- OpenShift Optional
- Security
- Storage
- Streaming & Messaging

PROVIDER

- □ Alibaba Cloud (1)
- □ Altinity (1)
- □ Anchore (1)

134 ITEMS

VIEW

SORT A-Z

Akka Cluster Operator
provided by Lightbend, Inc.
Run Akka Cluster applications on Kubernetes.

Altinity ClickHouse Operator
provided by Altinity
ClickHouse Operator manages full lifecycle of ClickHouse

Anchore Engine Operator
provided by Anchore Inc.
Anchore Engine - container image scanning service for policy-based security, best

Apache Spark Operator
provided by radanalytics.io
An operator for managing the Apache Spark clusters and intelligent applications tha

API Operator for Kubernetes
provided by WSO2
API Operator provides a fully automated experience for

APIcast
provided by Red Hat
APIcast is an API gateway built on top of NGINX. It is part of the 3scale API Managemen

Apicurio Registry Operator
provided by Apicurio
Deploy and manage Apicurio Registry on Kubernetes.

Appdynamics Operator
provided by AppDynamics LLC
End to end monitoring of applications on Kubernetes and OpenShift clusters wit

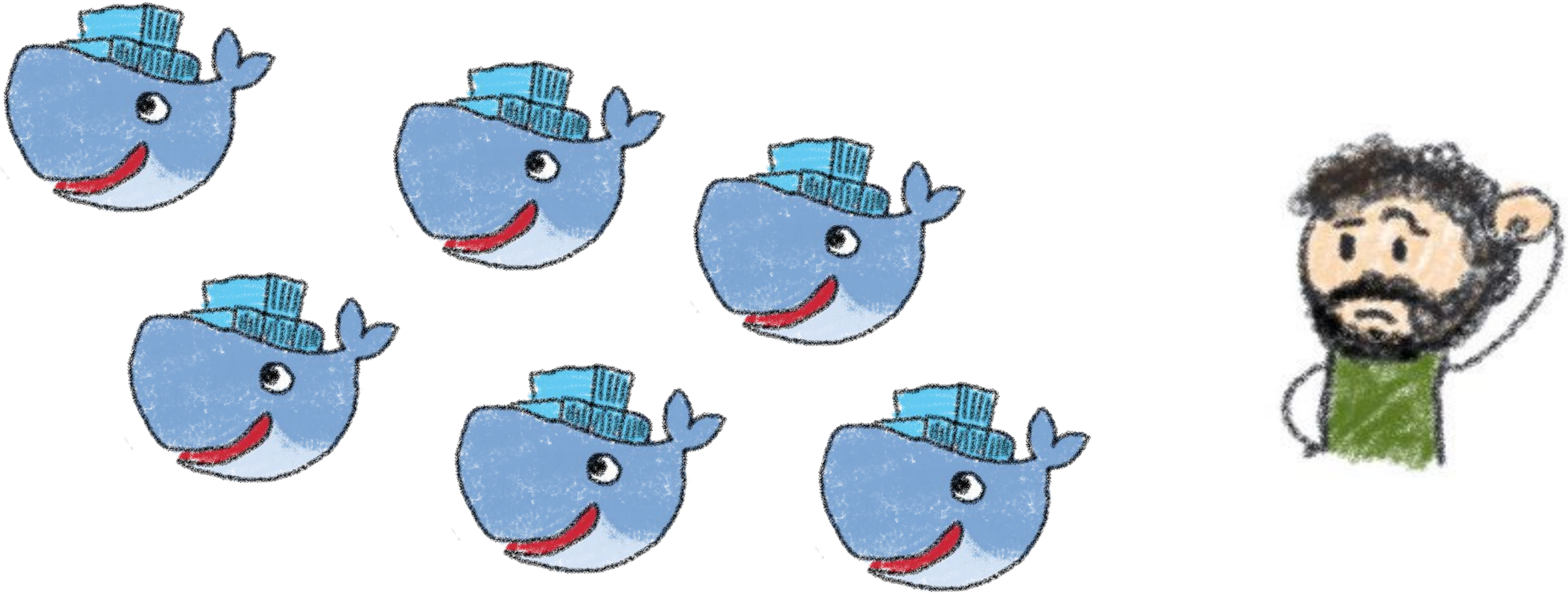
Apprantix CPS Operator
provided by Appranix, Inc
The Appranix CPS operator enables you to back up and restore your

Appsody Operator
provided by Appsody
Deploys Appsody based applications

Harbor Operator

Managing private registries at scale

We wanted to build a new product



OVHcloud Managed Private Registry

Looking at the Open Source world

Two main alternatives around Docker Registry

Harbor has more community traction

HARBOR

★ Star	11.5k

Fork	3.1k

CLOUD NATIVE
COMPUTING FOUNDATION

HELM

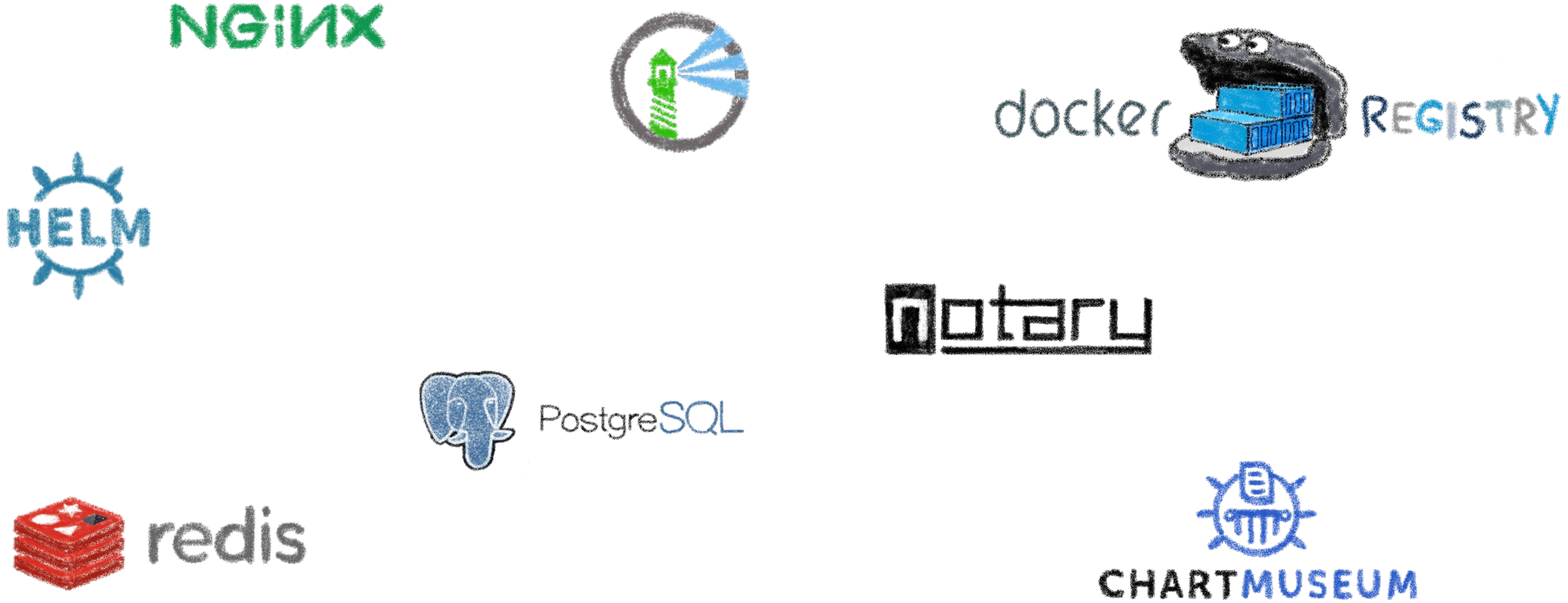
Portus

★ Star	2.6k

Fork	454

Two main alternatives

Harbor has lots of components



But it has a Helm Chart

It should be easy to install, isn't it?

```
$ helm install harbor
```

What about configuration?

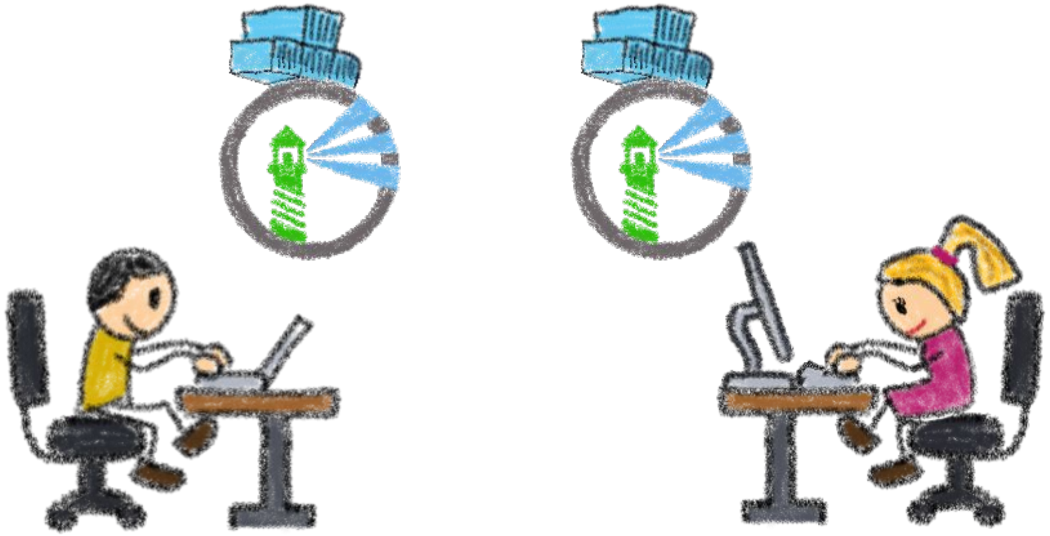
Installing a 200 GB K8s volume?

Nginx pods for routing requests?

One DB instance per customer?

Managing pods all around the cluster?

We wanted a Managed Private Registry



One Harbor instance per customer

One-click deployment, API

Shared tooling, isolated data

Ingress controller

redis

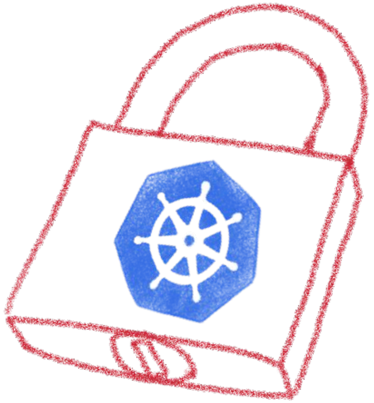
PostgreSQL

Object Storage

} as a Service

Reusing existing services

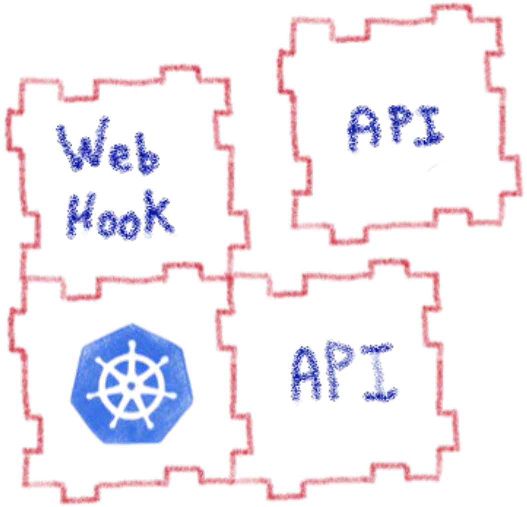
Using the platform



RBAC

Security policies

API inputs validation



Modularity & Extensibility

APIception

Webhooks

Kubernetes tooling to the rescue

Let's automate it

docker REGISTRY
notary
CHARTMUSEUM
HELM
PostgreSQL
Web Hook
API
API
redis

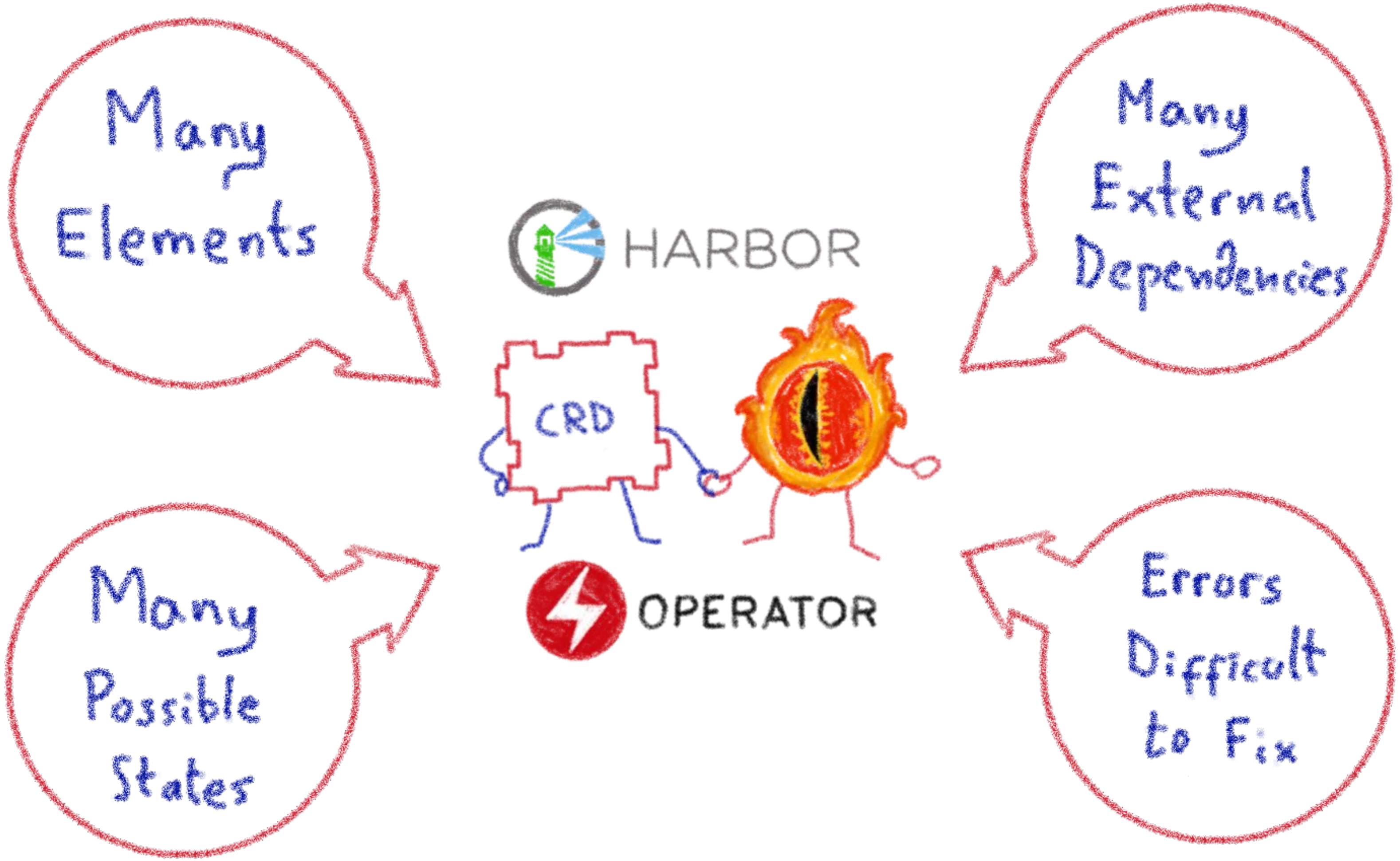
We needed an operator… and there wasn't any

Working with the community

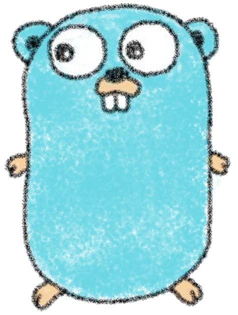
We need an Operator for HARBOR, we are coding it. Interested?
Oh yeah! We would love it!

Harbor community also needed the operator

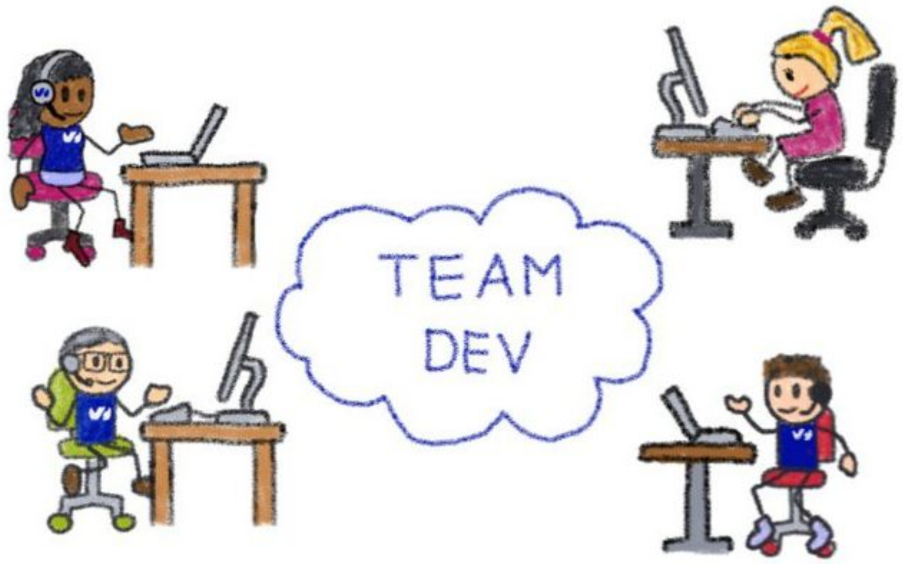
The challenge: reconciliation loop



The Harbor Operator



Written in Go



7 Components
- Config Map
- Secrets
- Ingress
- Certificates
- Deployments
- Services

1 CRD & 1 Controller

kubebuilder

OPENTRACING

Uses other operators for specific tasks (e.g. Cert Manager)

It's Open Source

Donated by OVHcloud

to the

CLOUD NATIVE
COMPUTING FOUNDATION

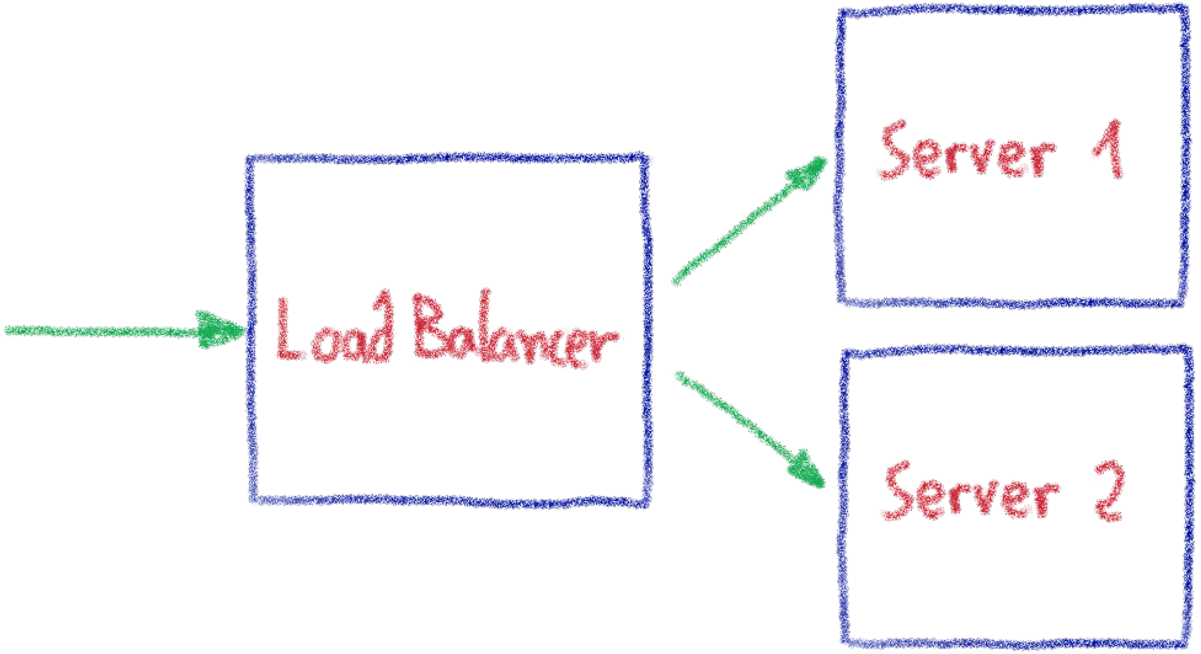
https://github.com/goharbor/harbor-operator

LoadBalancer Operator

A managed LoadBalancer at scale

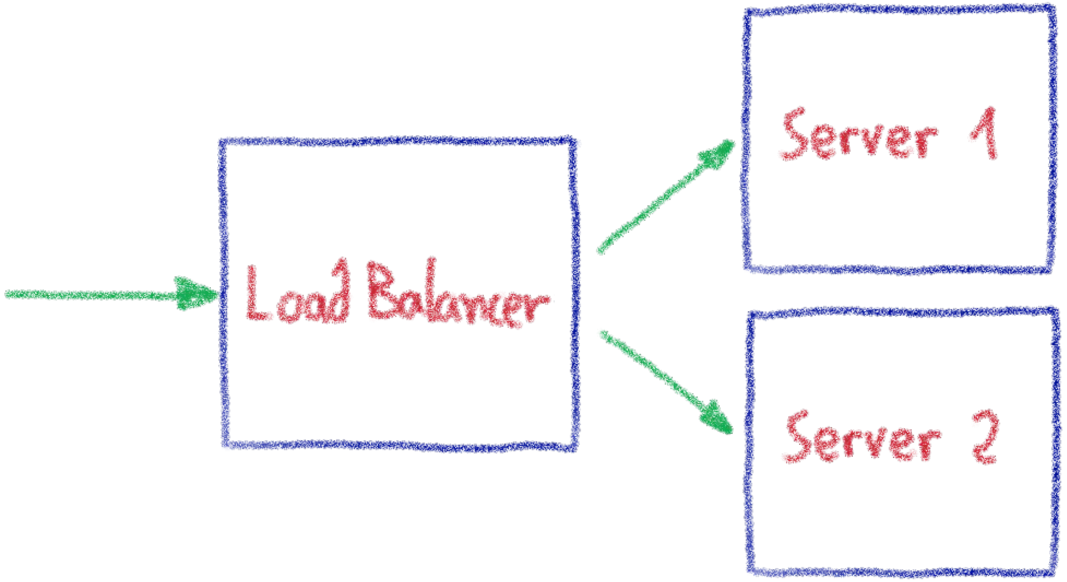
HAPROXY

Load Balancer: a critical cog



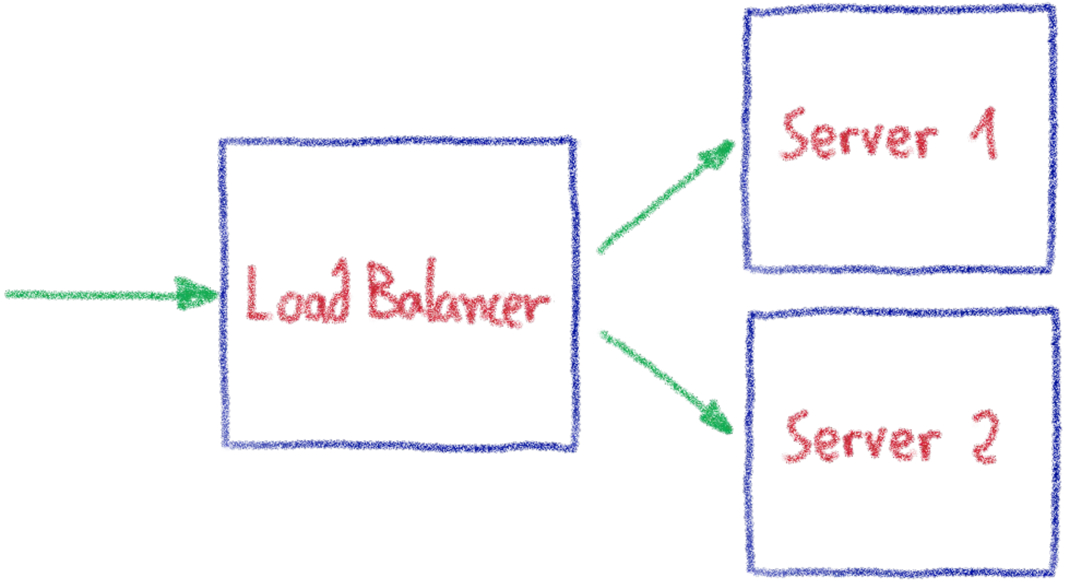
Cornerstone of any Cloud Provider's infrastructure

Our legacy Load Balancer stack



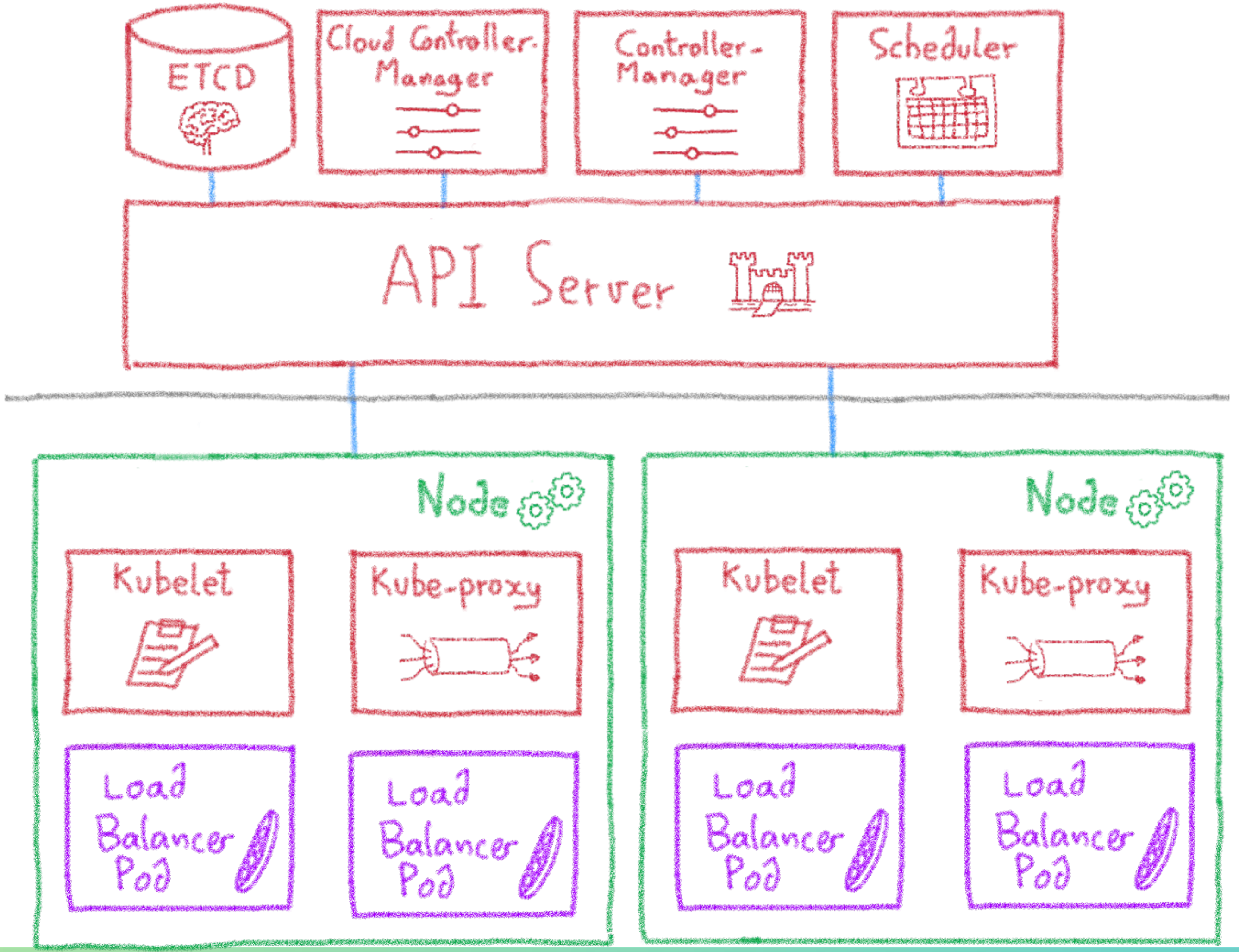
- Excellent performances
  - Built on bare metal servers + BGP
  - Custom made servers tuned for network traffic
- Carry the TLS termination
  - SSL / LetsEncrypt
- Not cloud ready
  - Piloted by configuration files
  - Long configuration loading time
- Custom made hardware
  - Slower to build
  - Needs to be deployed on 30 datacenters

Our needs for a new Load Balancer

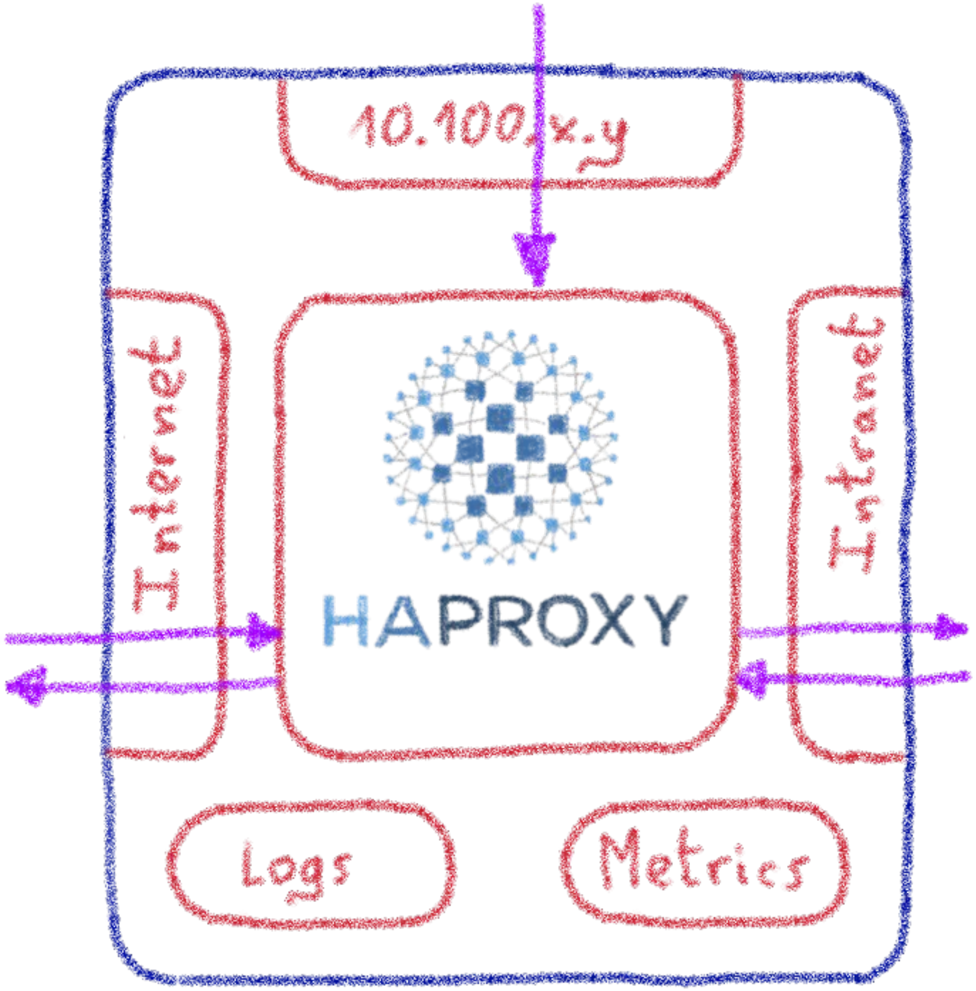


- Supporting mass update
- Quickly reconfigurable
- Available anywhere quickly
- Easily operable
- Integrated into our Public Cloud

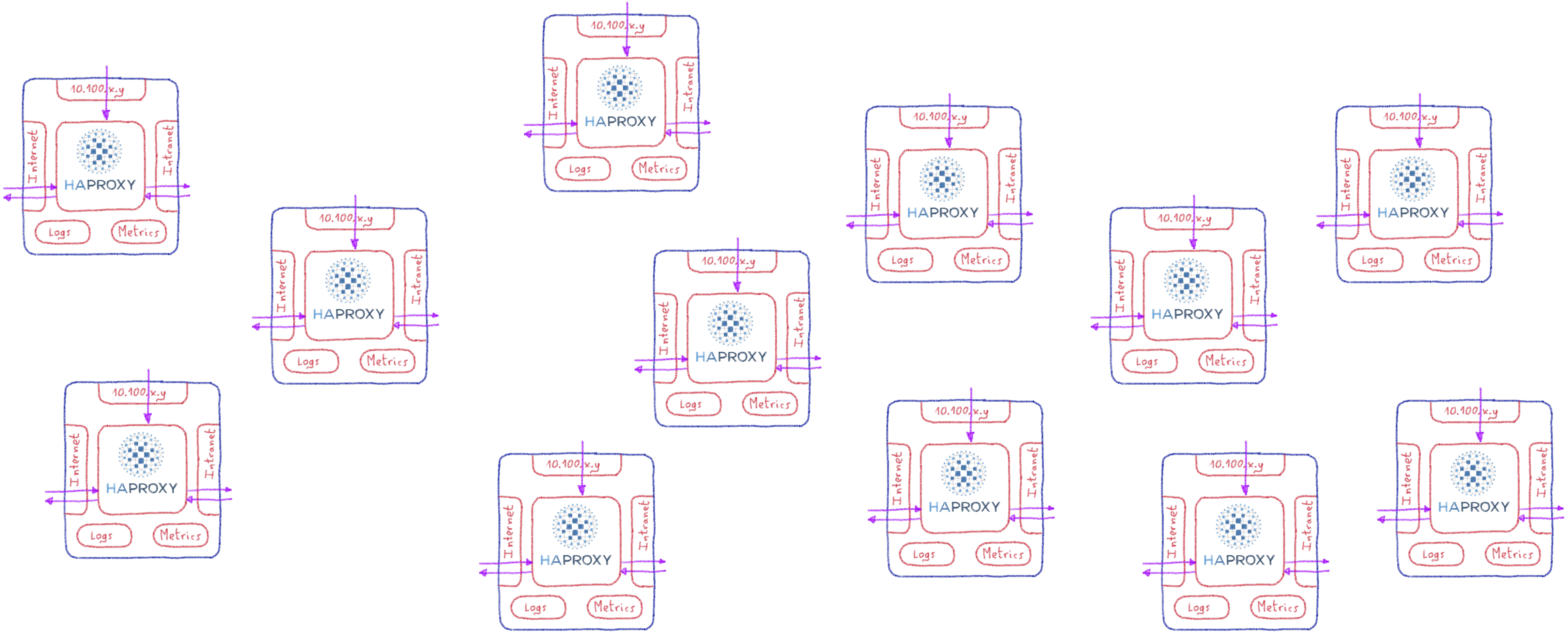
Building it on Kubernetes



A Load Balancer in a pod



Orchestrating one million LBs...



`kubectl apply -f lb` is not an option!

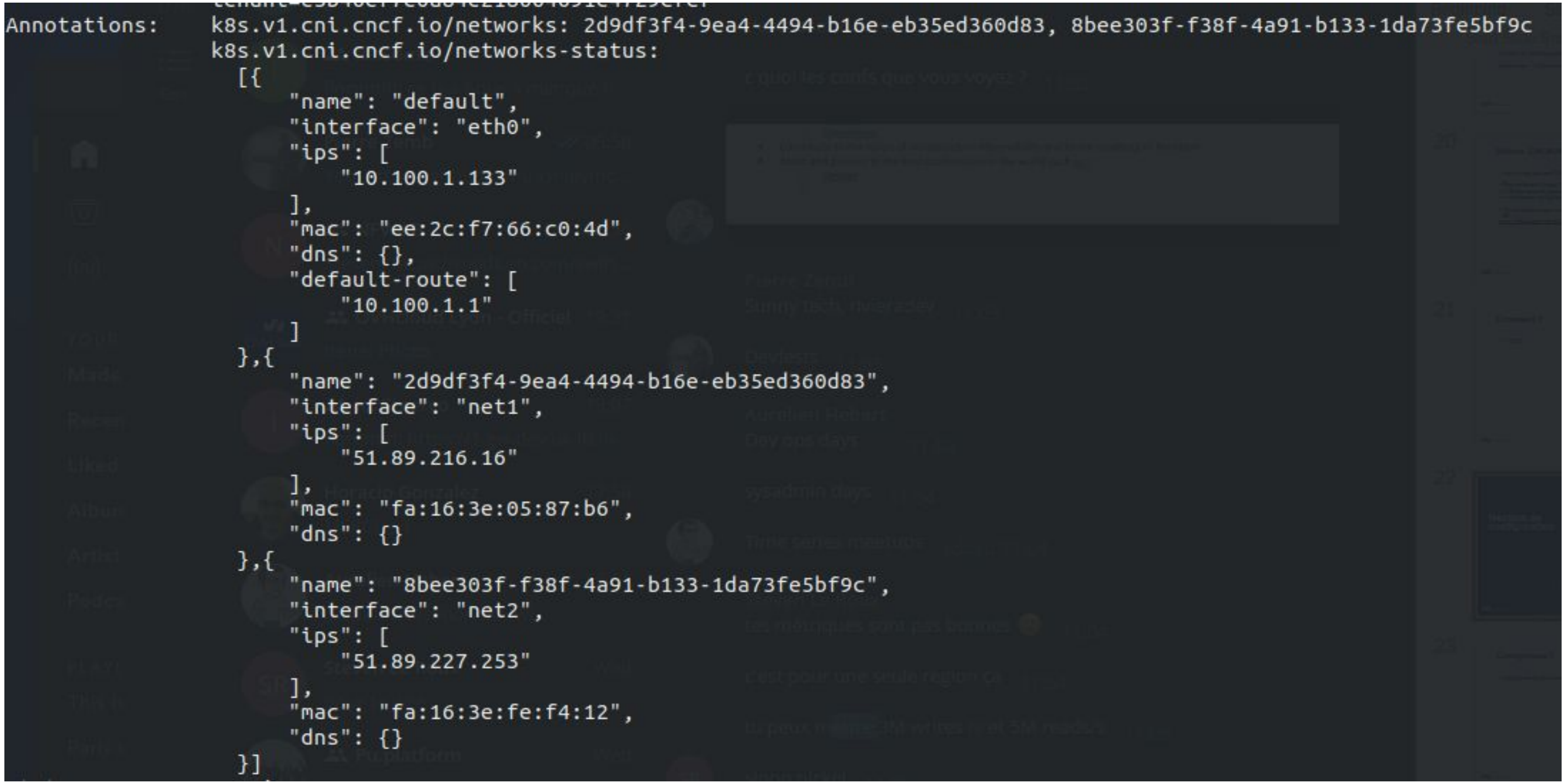
We needed an Operator

Network: multus-cni

Attaching multiple network interfaces to pods:

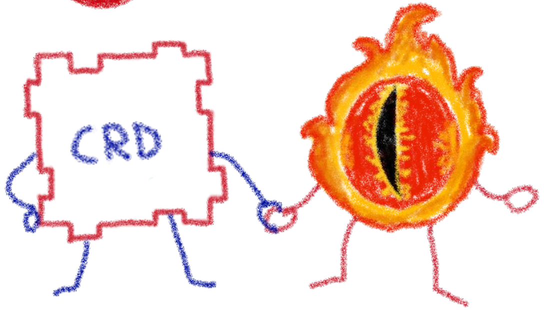
Bridge + Host-local

Adding network interfaces on the fly



```
Annotations:    k8s.v1.cni.cncf.io/networks: 2d9df3f4-9ea4-4494-b16e-eb35ed360d83, 8bee303f-f38f-4a91-b133-1da73fe5bf9c
                k8s.v1.cni.cncf.io/networks-status:
                  [{
                      "name": "default",
                      "interface": "eth0",
                      "ips": [
                          "10.100.1.133"
                      ],
                      "mac": "ee:2c:f7:66:c0:4d",
                      "dns": {},
                      "default-route": [
                          "10.100.1.1"
                      ]
                  },{
                      "name": "2d9df3f4-9ea4-4494-b16e-eb35ed360d83",
                      "interface": "net1",
                      "ips": [
                          "51.89.216.16"
                      ],
                      "mac": "fa:16:3e:05:87:b6",
                      "dns": {}
                  },{
                      "name": "8bee303f-f38f-4a91-b133-1da73fe5bf9c",
                      "interface": "net2",
                      "ips": [
                          "51.89.227.253"
                      ],
                      "mac": "fa:16:3e:fe:f4:12",
                      "dns": {}
                  }]
```

OPERATOR

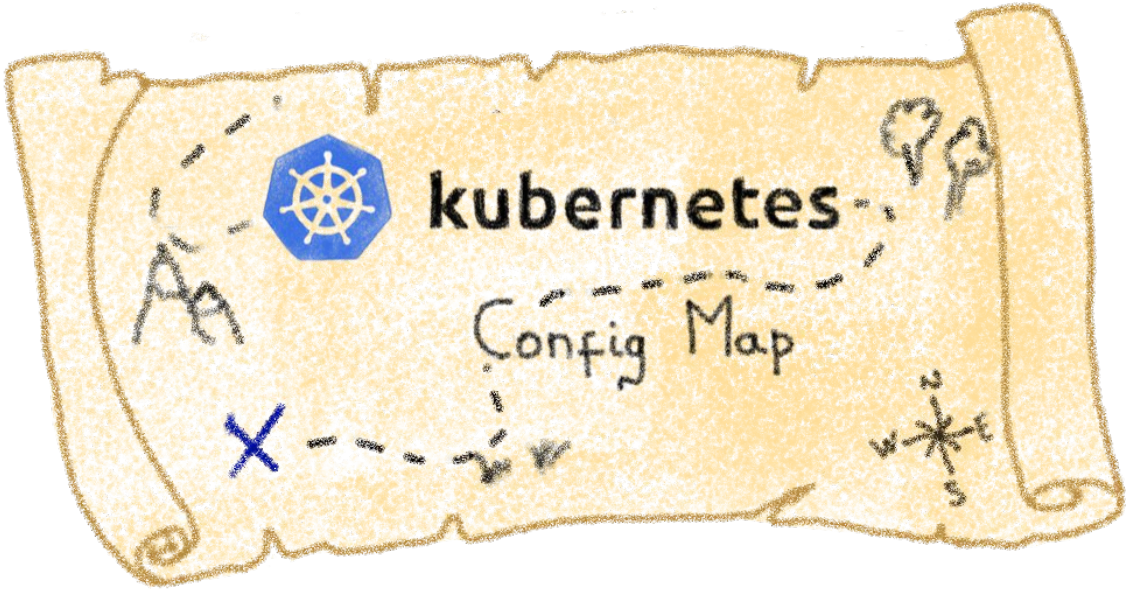


HAPROXY

MULTUS

Using annotations to add interfaces to pod

Config management



Using Config Map

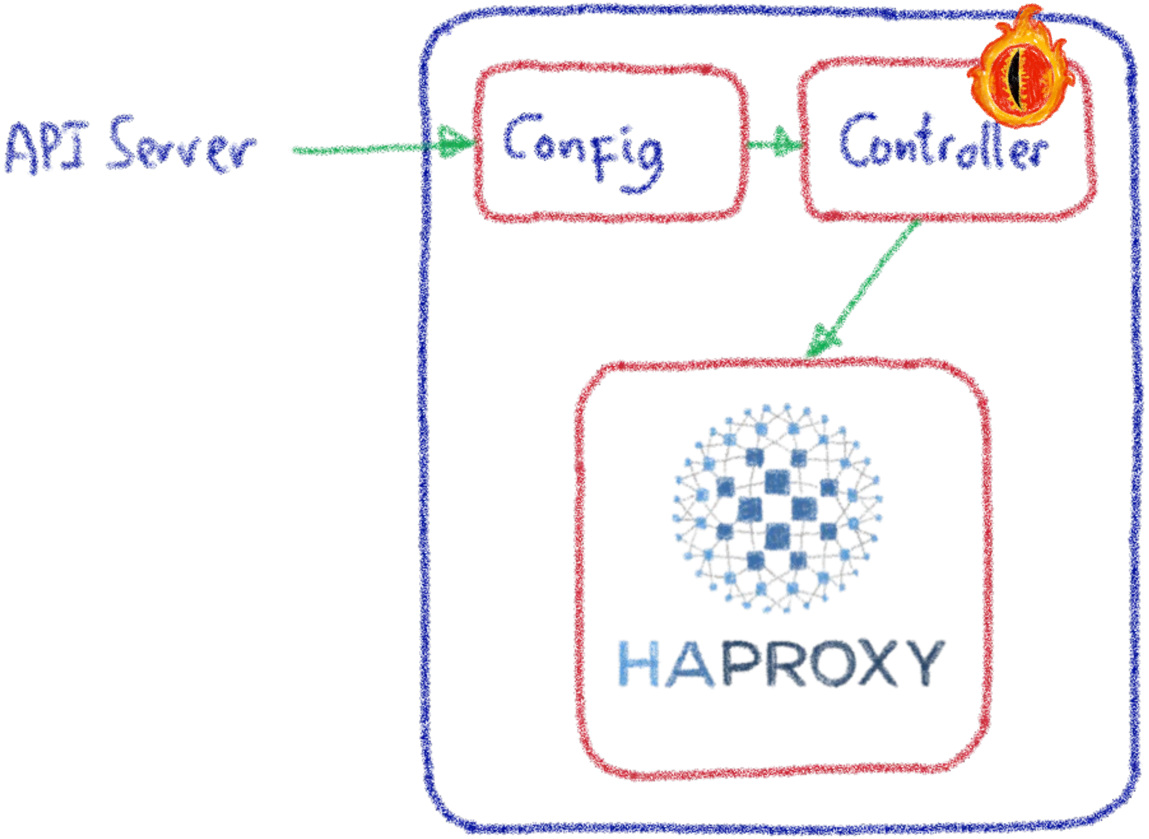
How to detect a change on Config Map files?

Watch + Trigger?

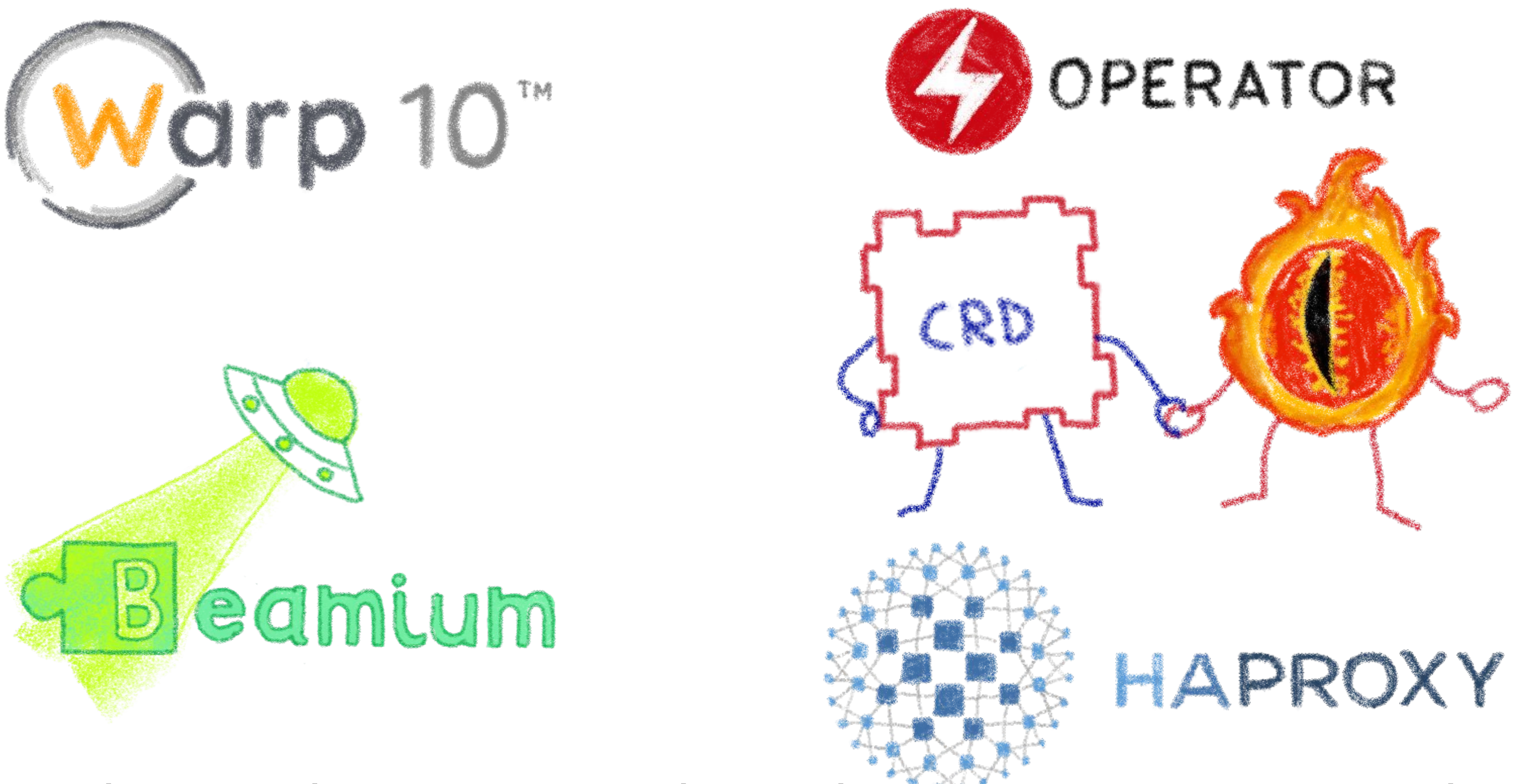
More information on Config Map working

`martensson.io/go-fsnotify-and-kubernetes-configmaps`

A Controller to watch and trigger



Observability



Tried Prometheus Operator, limited to one container per pod
Switched to Warp 10 with Beamium Operator

That's all, folks!

Thank you all!