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KUBERNETES OPERATORS

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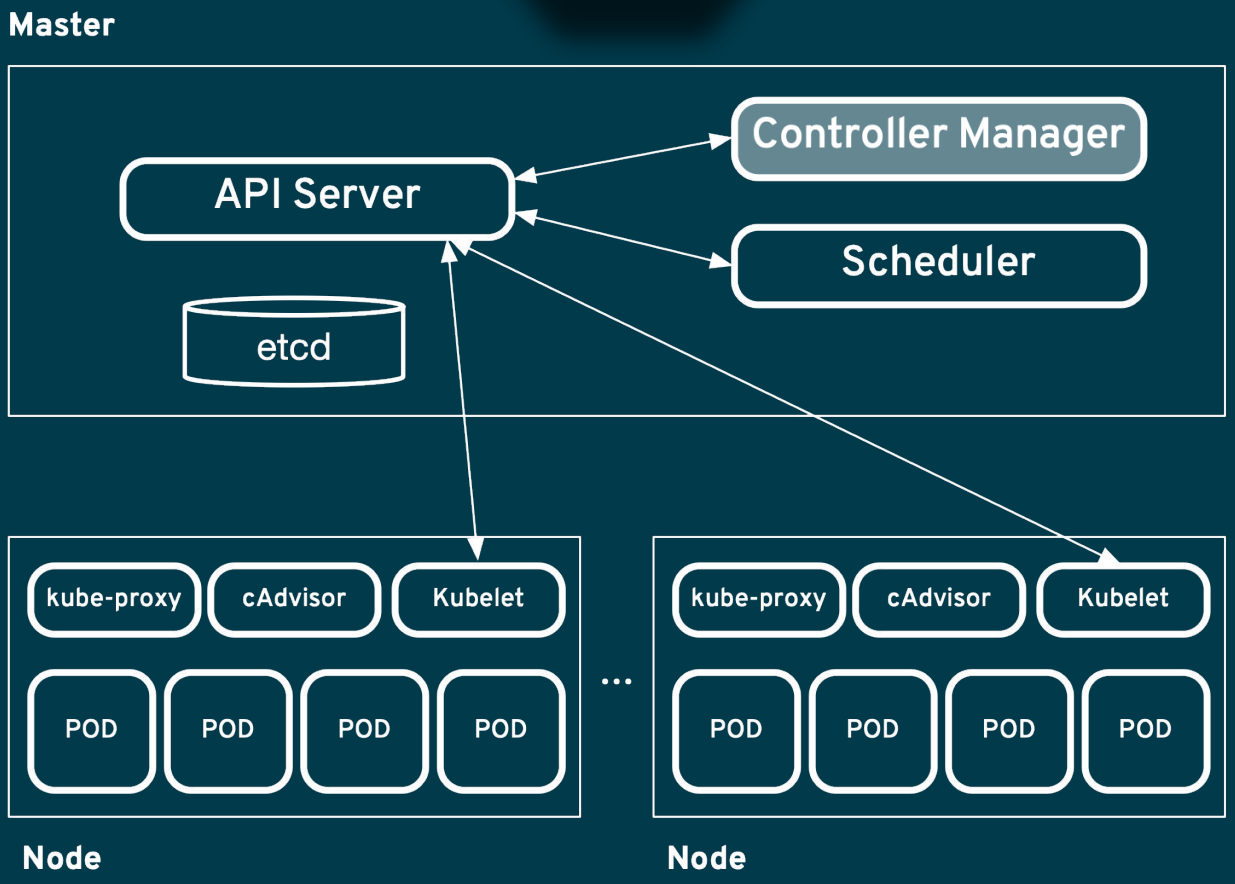
DevOpsGathering - Bochum - 2019-03-13

Kubernetes

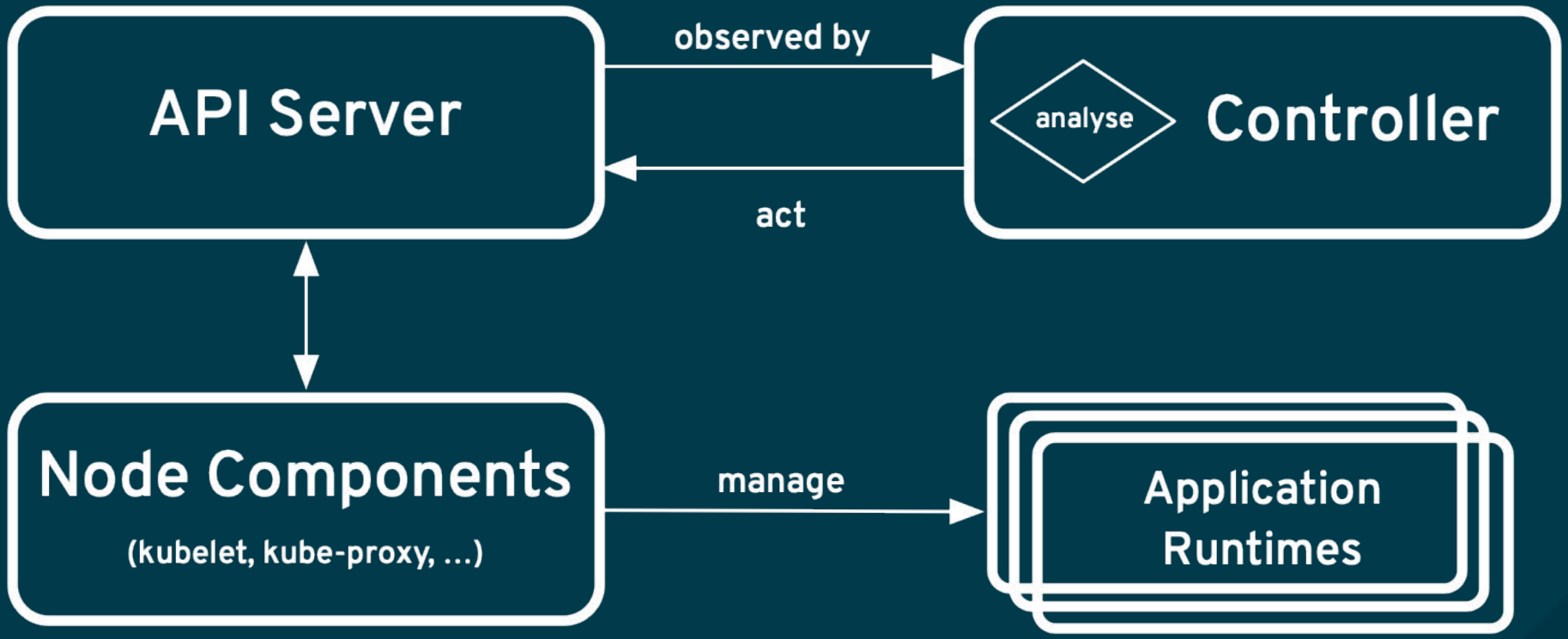


Kubernetes Controllers

- Kubernetes: Declaratige orchestration platform
- Based on resource objects for declaring target state
- Reconciliation:
  - Observe **current** state
  - Analyse and compare against **declared** state
  - Bring current state closer to declared state

Observe - Analyse - Act

Observe - Analyze - Act



Custom Controller

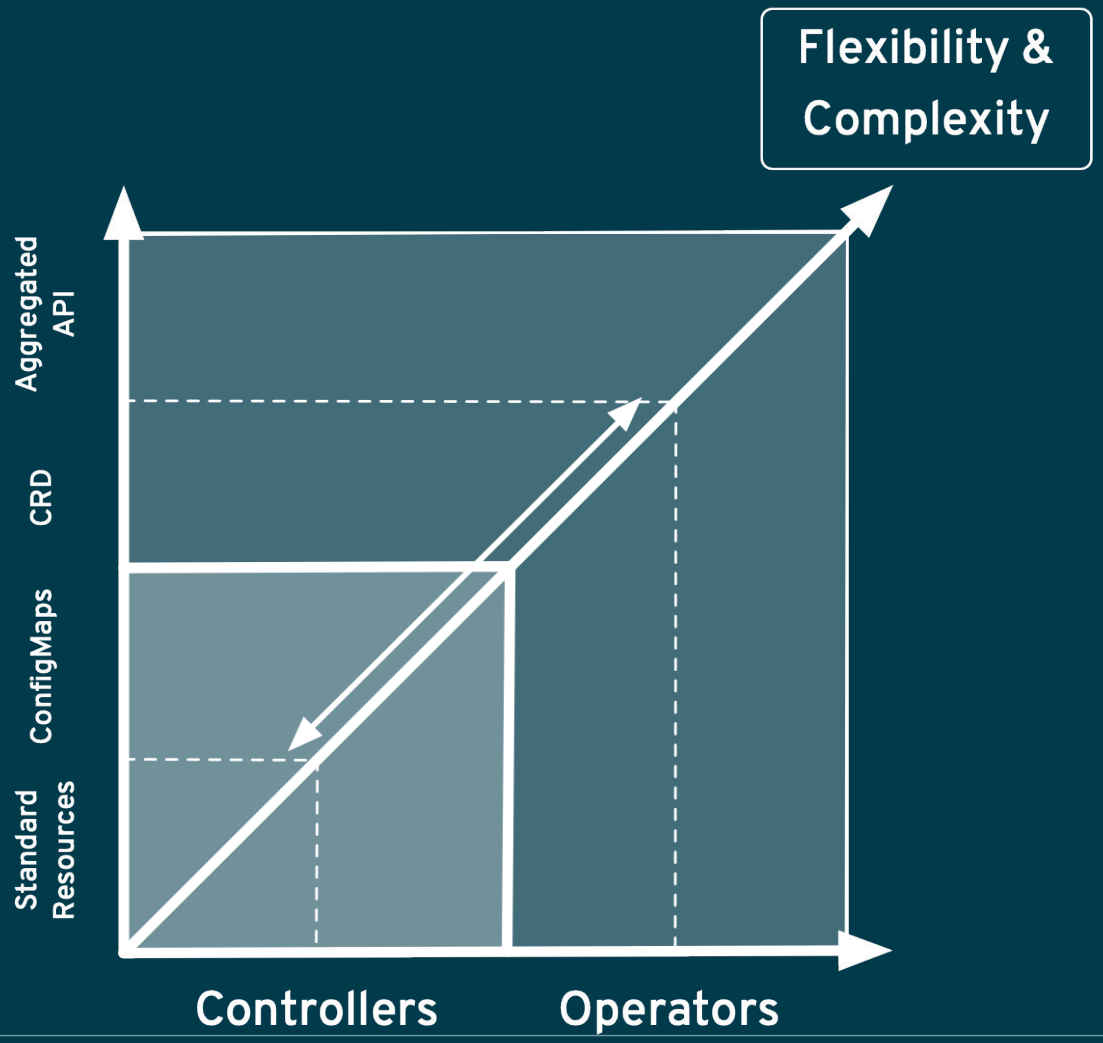
- Watches Kubernetes Resources
- Enhances platform behaviour or introduces new feautures
- Regular Kubernetes application (Deployments, Pod)
- Running permanently in the background
- Common Custom Controller triggers:
  - Labels
  - Annotations
  - ConfigMaps

Operators

> An **Operator is a** Kubernetes **Controller** that understands **two domains**: Kubernetes and something else. By combining knowledge of both areas, it can **automate tasks** that usually require a human operator that understands both domains.
>
> — *Jimmy Zelinskie*
> https://github.com/kubeflow/tf-operator/issues/300#issuecomment-357527937

- Operator **IS-A** Controller
- Custom domain modelled as **Custom Resource Definition**
- Semantically: Operator automates operational tasks and is codified knowledge
- Technically: Operator = Controller + CRD
- CoreOS pioneered the Operator movement

Controller Operator Spectrum



Custom Resource Definition

```
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata:
  name: prometheuses.monitoring.coreos.com
spec:
  group: monitoring.coreos.com
  names:
    kind: Prometheus
    plural: prometheuses
  scope: Namespaced
  version: v1
  validation:
    openAPIV3Schema: ....
```

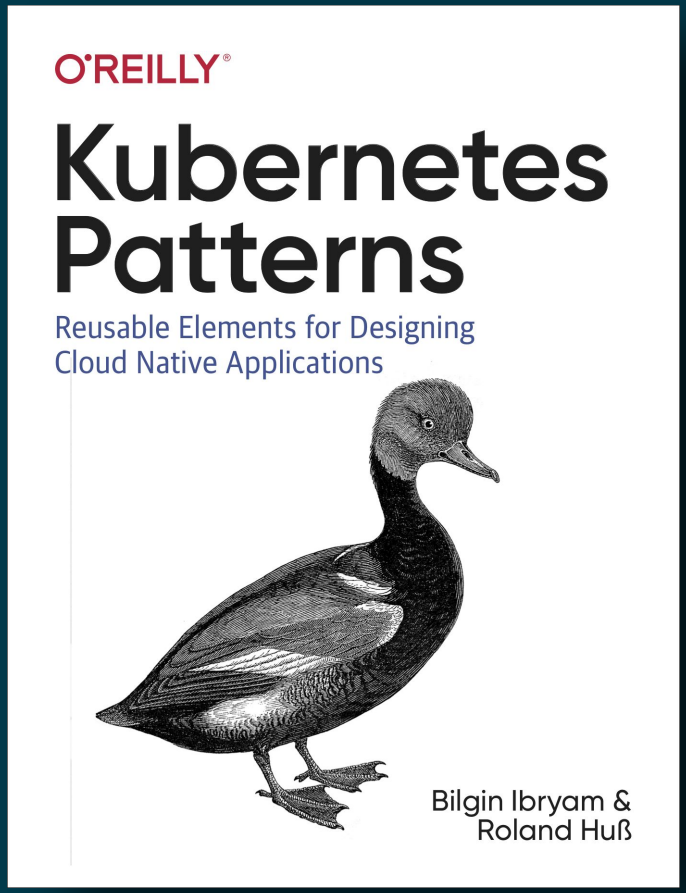
Custom Resource

```
apiVersion: monitoring.coreos.com/v1
kind: Prometheus
metadata:
  name: prometheus
spec:
  serviceMonitorSelector:
    matchLabels:
      team: frontend
  resources:
    requests:
      memory: 400Mi
status:
  phase: Installed
```

CRD Classification

- **Installation CRDs**
  - Installing and operating applications
  - Backup and Restore
  - Monitoring and self-healing
  - Example: `Prometheus` for installing Prometheus & components
- **Application CRDs**
  - Application specific domain concepts
  - Example: `ServiceMonitor` for registering Kubernetes service to be scraped by Prometheus

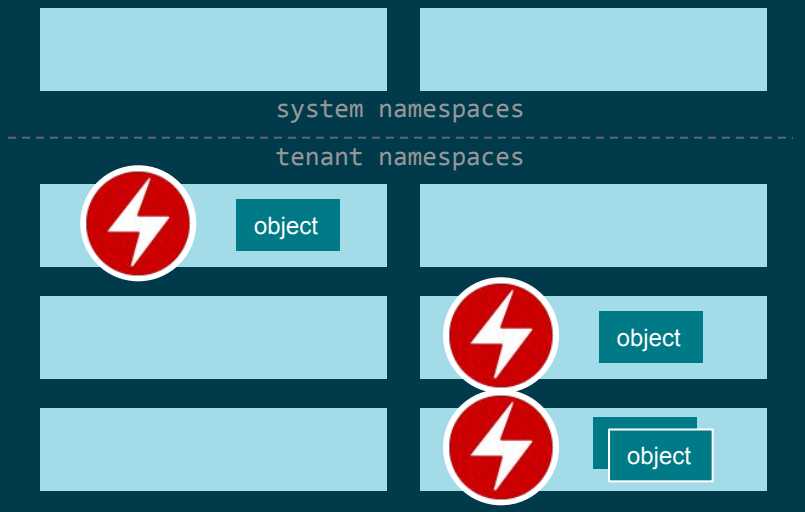
KUBERNETES PATTERNS



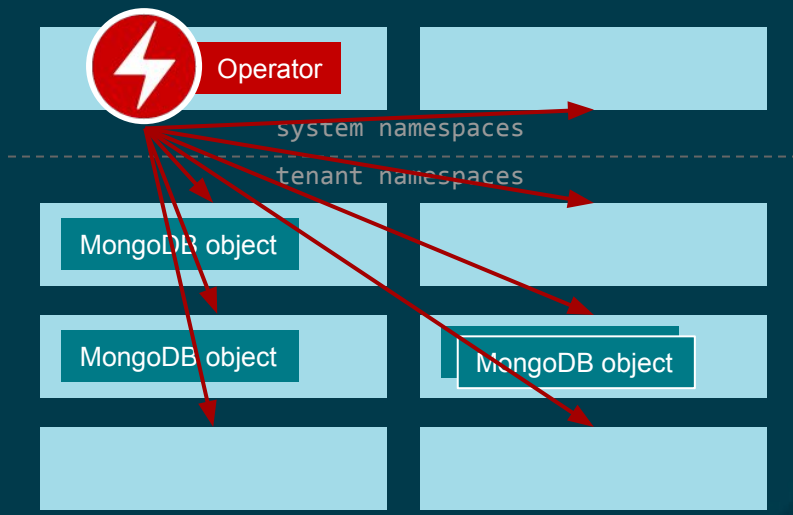
https://kubernetes-patterns.io

Operator Installation Options

One Operator per Namespace



One Operator watching all Namespaces



https://github.com/operator-framework/awesome-operators

README.md

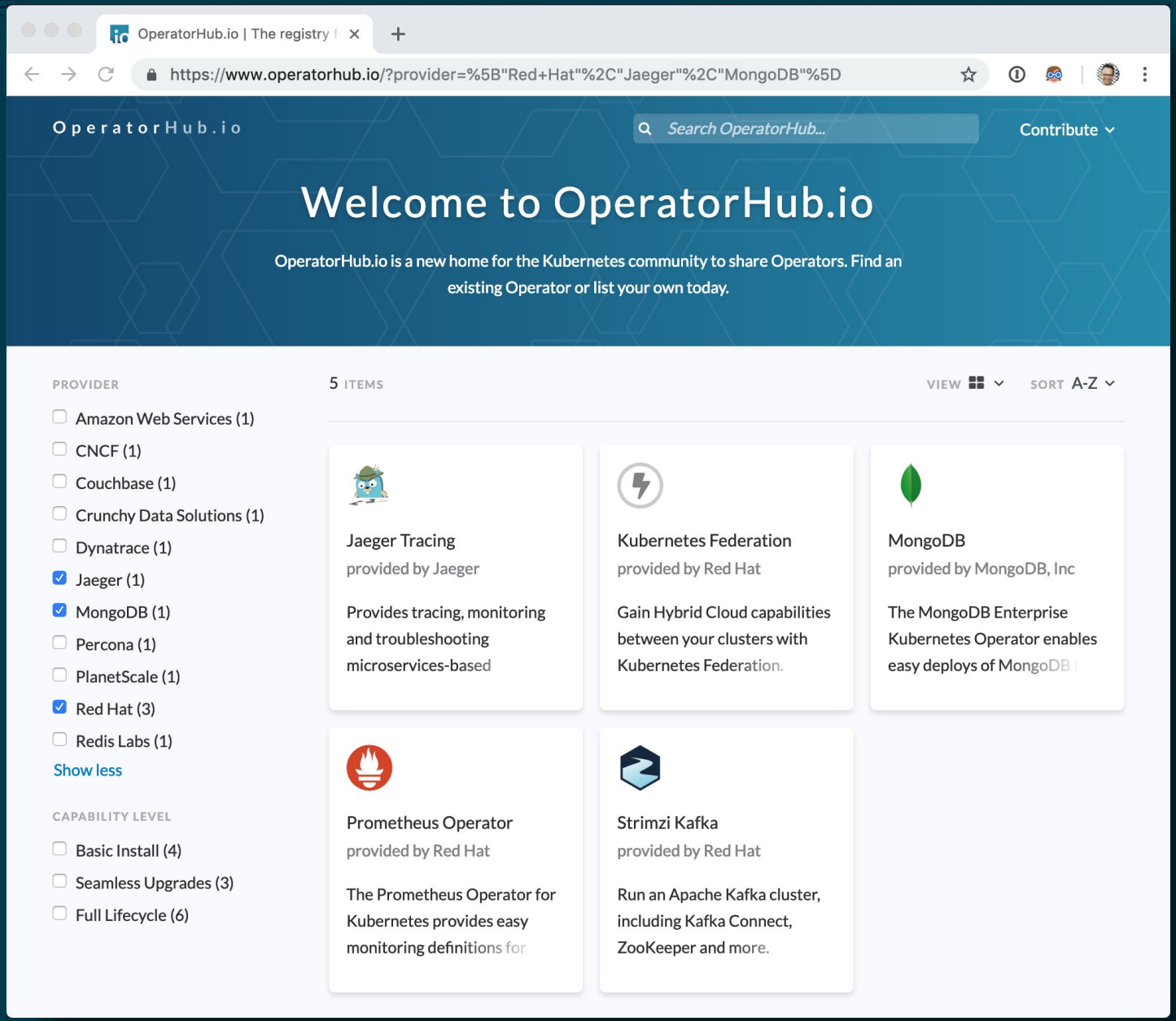
Awesome Operators in the Wild

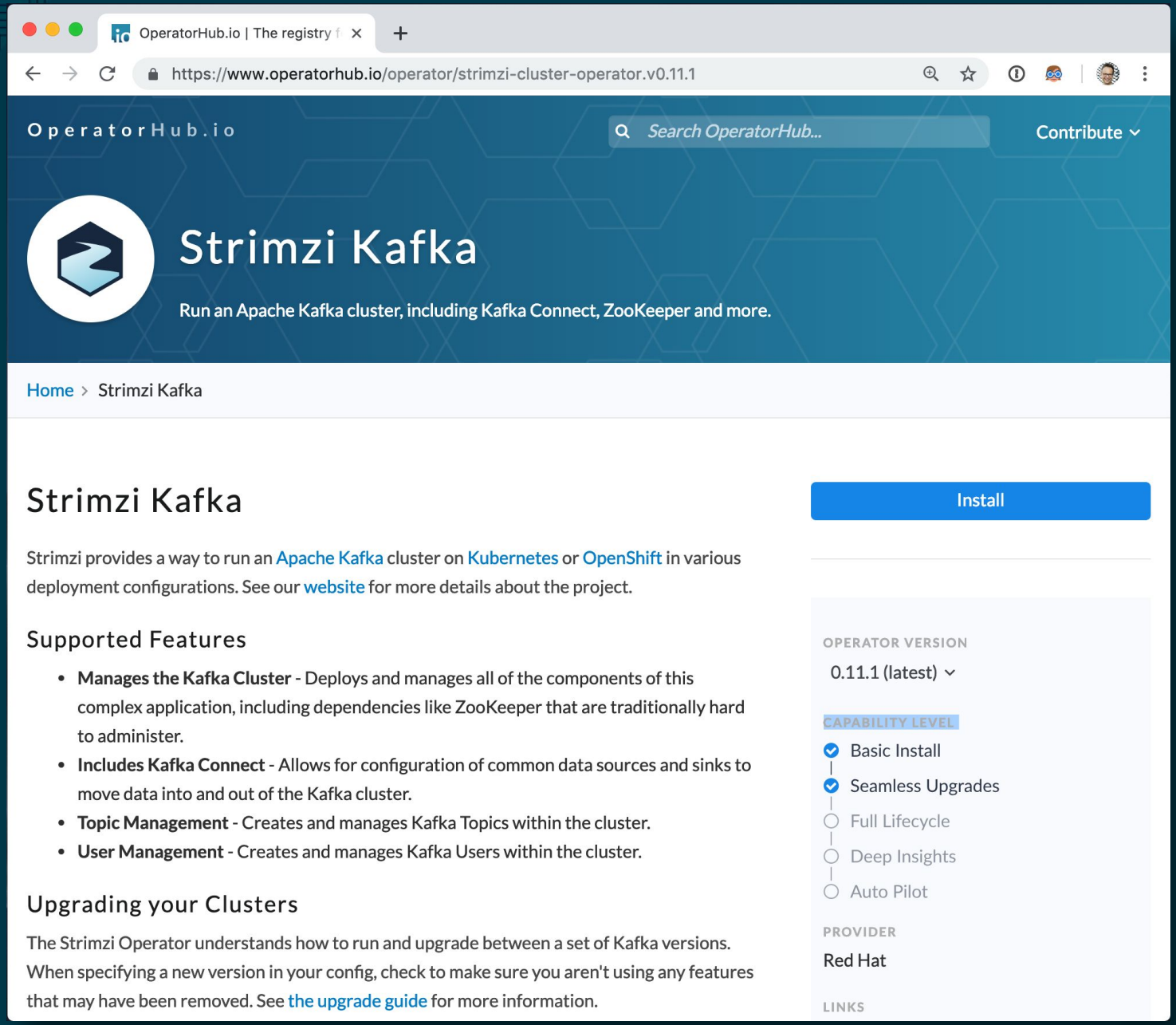
Operators are Kubernetes native applications. We define native as being both managed using the Kubernetes APIs via kubectl and ran on Kubernetes as containers. Operators take advantage of Kubernetes's extensibility to deliver the automation advantages of cloud services like provisioning, scaling, and backup/restore while being able to run anywhere that Kubernetes can run.

This list is built by the community. Have you built or are you using an Operator that is not listed? Please send a pull request and we will add that Operator to the list.

If you want to start building an Operator, you should definitely look into the Operator SDK.

App Name	Github	Description
Aerospike	travelaudience/aerospike-operator	Aerospike is a NoSQL distributed database. This Operator manages Aerospike clusters atop Kubernetes, automating their creation and administration.
Airflow	GoogleCloudPlatform/airflow-operator	A Kubernetes operator to manage Apache Airflow.
Android SDK	aerogear/android-sdk-operator	A Kubernetes operator to manage android sdk packages syncronization in a persistent volume.
ArangoDB	arangodb/kube-arangodb	ArangoDB Kubernetes Operator - Start ArangoDB on Kubernetes in 5min.
Velero	heptio/velero	Velero (formerly Ark) is a utility for managing disaster recovery, this operator manages the backup and restoration of cluster components (pv,pvc,deployments, etc.) to aid in disaster recovery.
AWS	giantswarm/aws-operator	Manages Kubernetes clusters running on Amazon Web Services
AWS Services	awslabs/aws-service-operator	Manages AWS services that are used by your applications running in Kubernetes.
Camel-k	apache/camel-k	Lightweight integration framework built from Apache Camel that runs natively on Kubernetes
Cassandra #1	instaclustr/cassandra-operator	Kubernetes operator for Apache Cassandra.
Cassandra #2	vgkowski/cassandra-operator	Kubernetes operator for cassandra clusters automation.


OperatorHub.io | The registry
https://www.operatorhub.io/?provider=%5B"Red+Hat"%2C"Jaeger"%2C"MongoDB"%5D
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.
PROVIDER
Amazon Web Services (1)
CNCF (1)
Couchbase (1)
Crunchy Data Solutions (1)
Dynatrace (1)
Jaeger (1)
MongoDB (1)
Percona (1)
PlanetScale (1)
Red Hat (3)
Redis Labs (1)
Show less
CAPABILITY LEVEL
Basic Install (4)
Seamless Upgrades (3)
Full Lifecycle (6)
5 ITEMS
VIEW
SORT A-Z
Jaeger Tracing
provided by Jaeger
Provides tracing, monitoring and troubleshooting microservices-based
Kubernetes Federation
provided by Red Hat
Gain Hybrid Cloud capabilities between your clusters with Kubernetes Federation.
MongoDB
provided by MongoDB, Inc
The MongoDB Enterprise Kubernetes Operator enables easy deploys of MongoDB
Prometheus Operator
provided by Red Hat
The Prometheus Operator for Kubernetes provides easy monitoring definitions for
Strimzi Kafka
provided by Red Hat
Run an Apache Kafka cluster, including Kafka Connect, ZooKeeper and more.


OperatorHub.io | The registry
https://www.operatorhub.io/operator/strimzi-cluster-operator.v0.11.1
OperatorHub.io
Search OperatorHub...
Contribute
Strimzi Kafka
Run an Apache Kafka cluster, including Kafka Connect, ZooKeeper and more.
Home > Strimzi Kafka
Strimzi Kafka
Install
Strimzi provides a way to run an Apache Kafka cluster on Kubernetes or OpenShift in various deployment configurations. See our website for more details about the project.
Supported Features
Manages the Kafka Cluster - Deploys and manages all of the components of this complex application, including dependencies like ZooKeeper that are traditionally hard to administer.
Includes Kafka Connect - Allows for configuration of common data sources and sinks to move data into and out of the Kafka cluster.
Topic Management - Creates and manages Kafka Topics within the cluster.
User Management - Creates and manages Kafka Users within the cluster.
Upgrading your Clusters
The Strimzi Operator understands how to run and upgrade between a set of Kafka versions. When specifying a new version in your config, check to make sure you aren't using any features that may have been removed. See the upgrade guide for more information.
OPERATOR VERSION
0.11.1 (latest)
CAPABILITY LEVEL
Basic Install
Seamless Upgrades
Full Lifecycle
Deep Insights
Auto Pilot
PROVIDER
Red Hat
LINKS

Operator Development

- Operator can be implemented in any language
- Frameworks:
  - Operator Framework (Golang, Helm, Ansible)
    - https://github.com/operator-framework
  - Kubebuilder (Golang)
    - https://github.com/kubernetes-sigs/kubebuilder
  - Metacontroller (Language agnostic)
    - https://metacontroller.app/
  - jvm-operators (Java, Groovy, Kotlin, ...)
    - https://github.com/jvm-operators

Kubebuilder

- https://github.com/kubernetes-sigs/kubebuilder
- Scaffolding for Golang based Operators
- Mutliple CRDs within one project
- Works directly with Kubernetes API

Metacontroller

- https://metacontroller.app/
-

jvm-controllers

- https://github.com/jvm-operators
- Toolkit for creating Kubernetes and OpenShift in JVM languages
- Supports CRD and ConfigMaps for lifecycle management
- Callback based API called on CRD lifecyle events
- Plan: Switching to a Quarkus based architecture for creating native operators

Operator Framework

For Builders:

- Easily **create** operators on Kubernetes via a common method
- Provide standardized set of **tools** to build consistent operators

For Consumers:

- Consume of cloud-native applications more **secure** and **easier**
- Keep installed operators **up to date** for security reasons and app lifecycle management

Operator Framework

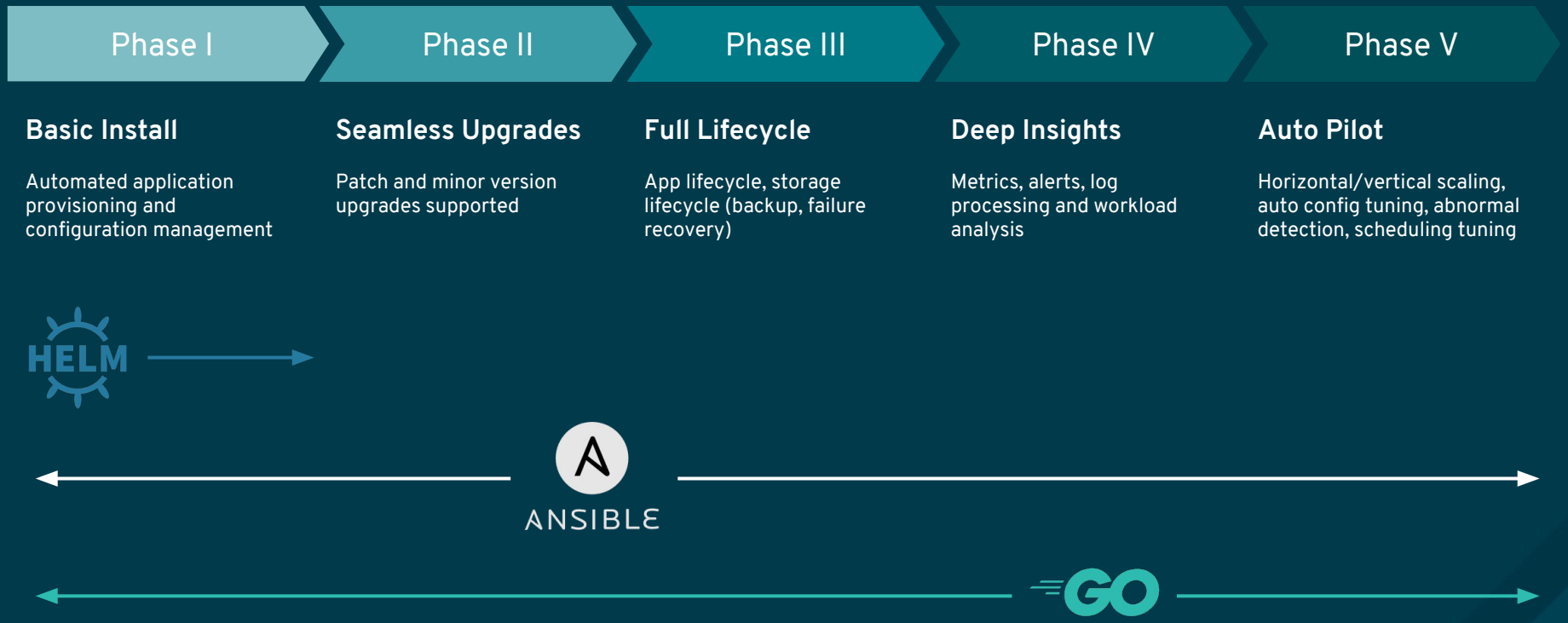
OPERATOR SDK	OPERATOR LIFECYCLE MANAGER	OPERATOR METERING
Build Operators	Install, update, and manage Operators	Operator usage reporting

https://github.com/operator-framework

Operator SDK

- Framework and Tookit for creating Operators
- Skaffolding of a project skeleton
- Scorecard check
- Uses controller-runtime under the hood
  - https://github.com/kubernetes-sigs/controller-runtime
- Modes
  - Golang
  - Ansible
  - Helm

Operator Maturity Model



DEMO

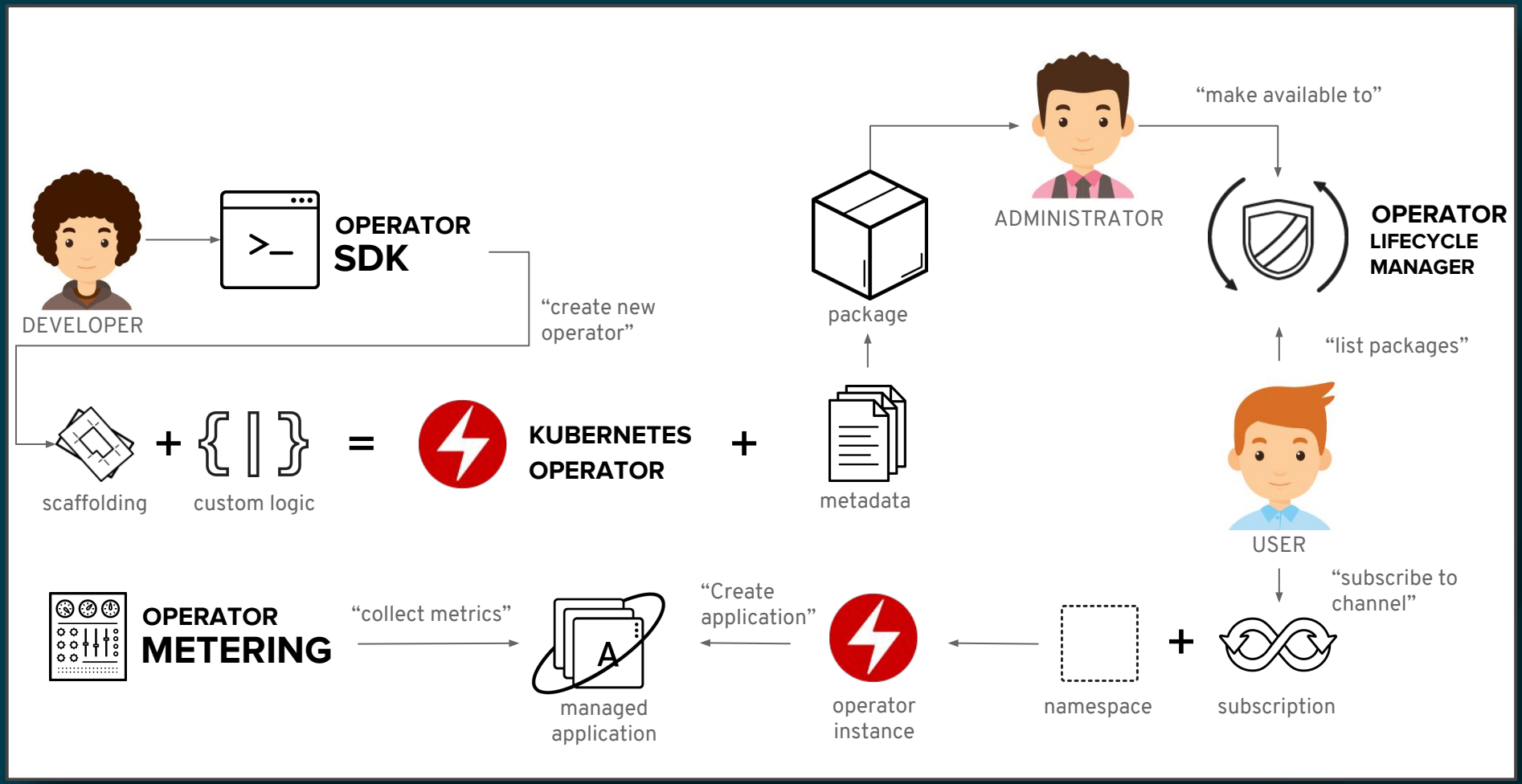
Operation Lifecycle Manager (OLM)

- OLM: Operators for managing lifecycle or Operators
- “Operator Operator”
- Main components:
  - **olm-operator**: Managing operator deployments
  - **catalog-operator**: Managing subscriptions to channels
  - OperatorGroups for implementing multi-tenancy of operartors
- Installs packages from OperatorHub.io
- Included OOTB in OpenShift 4
- Main CRD: `ClusterServiceVersion`

ClusterServiceVersion

- Metadata (name, description, version, links, labels, icon, ...)
- Operator Installation
  - Type: Deployment
    - Set of service accounts / required permissions
    - Set of deployments
- CRDs
  - Type
  - Owned - managed by this service
  - Required - must exist in the cluster for this service to run
  - Resources - a list of resources that the Operator interacts with
  - Descriptors - annotate CRD spec and status fields to provide semantic information

Operator Framework Summary



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THANK YOU

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