Red Hat

Kubernetes Operator-Framework Workshop

Presented by:

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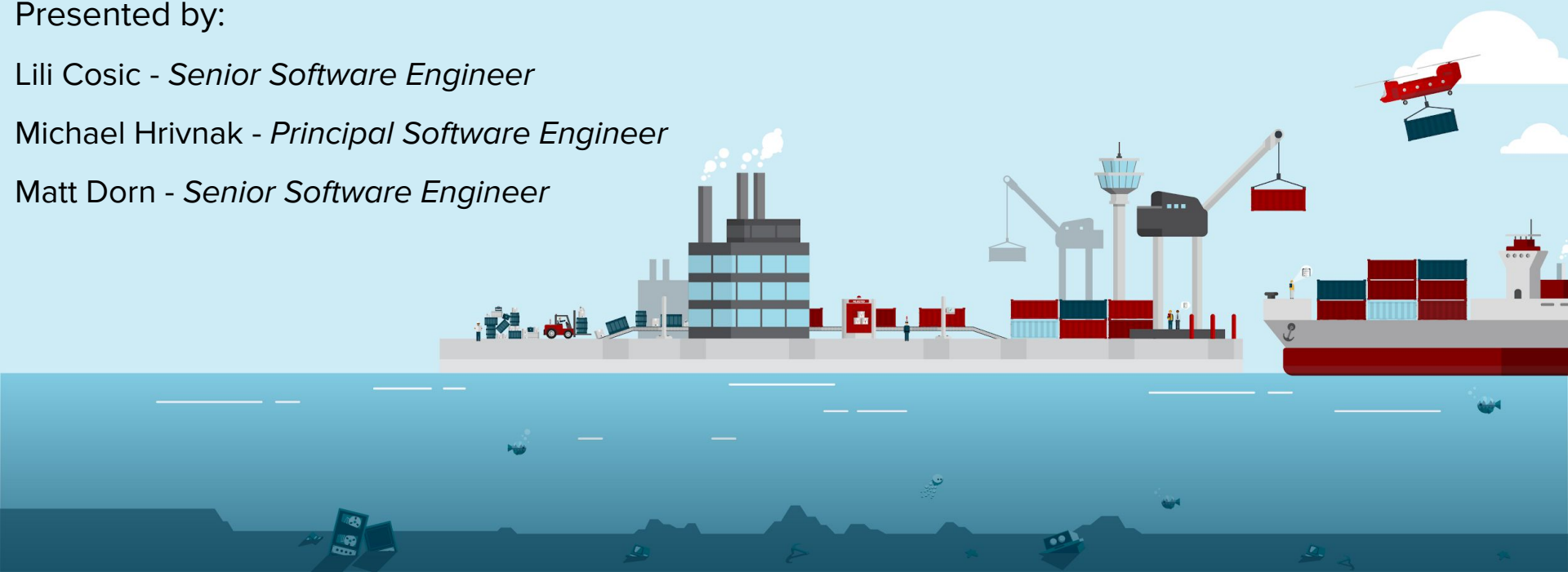

HOW MANY PEOPLE HERE USE KUBERNETES/OPENSHIFT REGULARLY?

DEVELOP IN GOLANG REGULARLY?

USE ANSIBLE REGULARLY?

ANYONE ATTEMPTED TO BUILD A CUSTOM KUBERNETES CONTROLLER FROM SCRATCH?

ANYONE TRIED THE OPERATOR-SDK, ANSIBLE-OPERATOR, OR HELM-APP OPERATOR YET?

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OUR GOAL IS TO HELP YOU
SUCCEED WITH OUR TOOLS.

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IN THIS ENTRY-LEVEL SESSION WE WILL BE EXPLORING...

OPERATOR
FRAMEWORK

Support Channels

Google Groups

https://groups.google.com/forum/#!forum/operator-framework

Kubernetes Slack (slack.kubernetes.io)

#kubernetes-operators

OpenShift Commons - Operator Framework

https://commons.openshift.org/sig/OpenshiftOperators.html

Every third Friday of the month at 12pm EST

Red Hat

Logistics

9:00am to 5:00pm

Wifi:

Password:

So...what is an Operator?

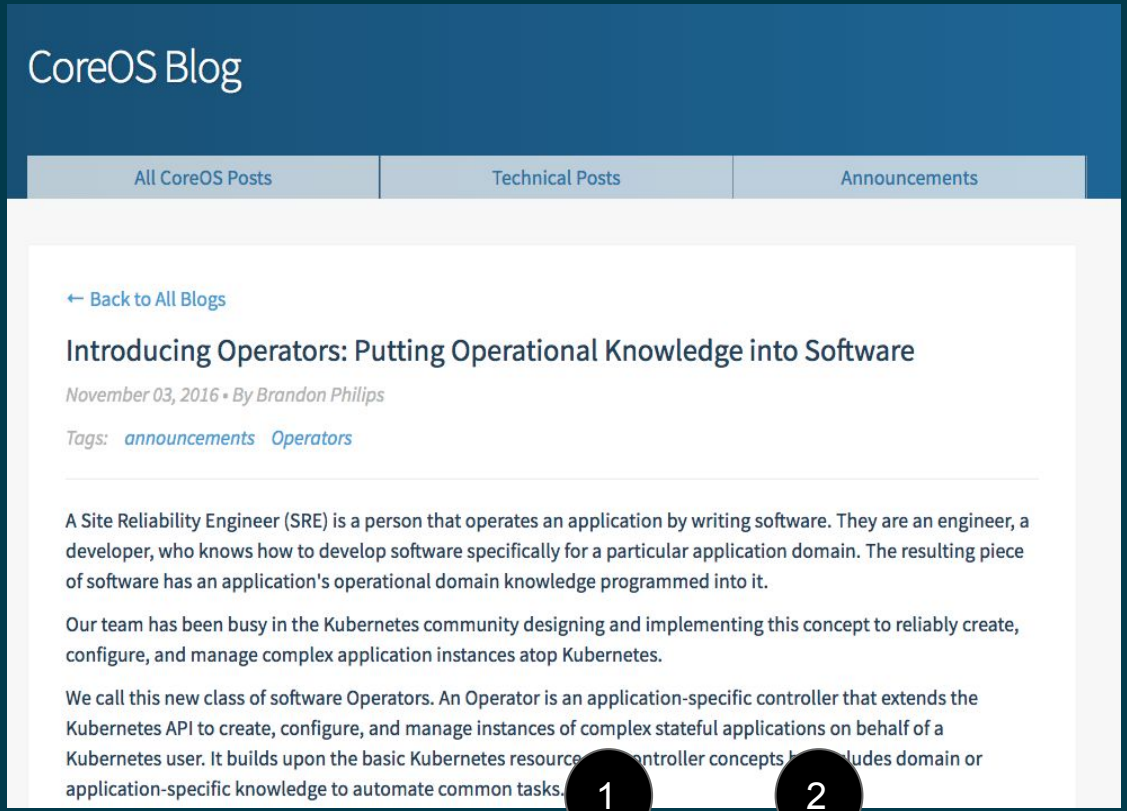
Operators

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

```
$ oc get operators

the server doesn't have a
resource type "operators"
```

LET’S GO BACK A FEW YEARS.


CoreOS Blog
All CoreOS Posts
Technical Posts
Announcements
← Back to All Blogs
Introducing Operators: Putting Operational Knowledge into Software
November 03, 2016 • By Brandon Philips
Tags: announcements Operators
A Site Reliability Engineer (SRE) is a person that operates an application by writing software. They are an engineer, a developer, who knows how to develop software specifically for a particular application domain. The resulting piece of software has an application's operational domain knowledge programmed into it.
Our team has been busy in the Kubernetes community designing and implementing this concept to reliably create, configure, and manage complex application instances atop Kubernetes.
We call this new class of software Operators. An Operator is an application-specific controller that extends the Kubernetes API to create, configure, and manage instances of complex stateful applications on behalf of a Kubernetes user. It builds upon the basic Kubernetes resource
ntroller concepts
ludes domain or
application-specific knowledge to automate common tasks.
1
2
3
It builds upon the basic Kubernetes resource and controller concepts but includes domain or application-specific knowledge to automate common tasks.

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1

Resource

2

Controller

3

Knowledge

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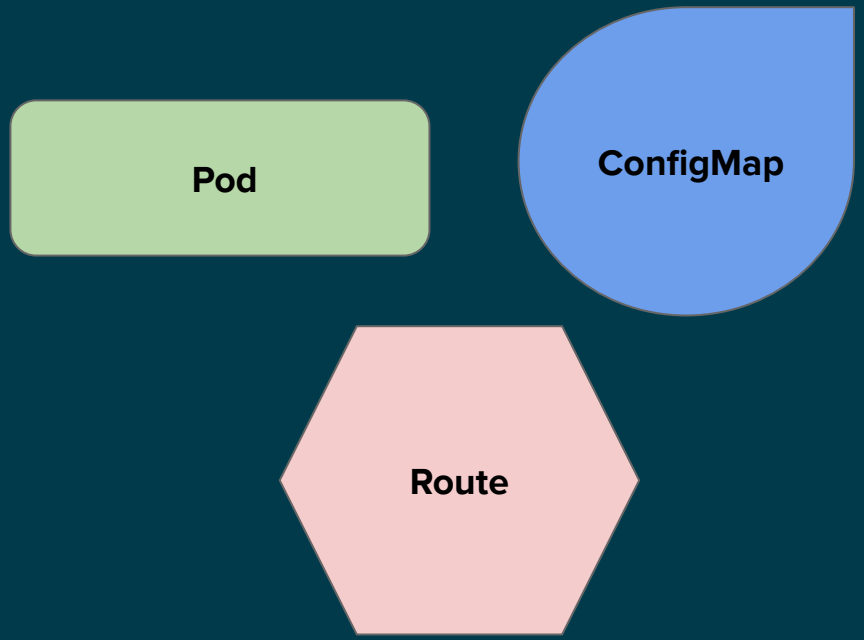
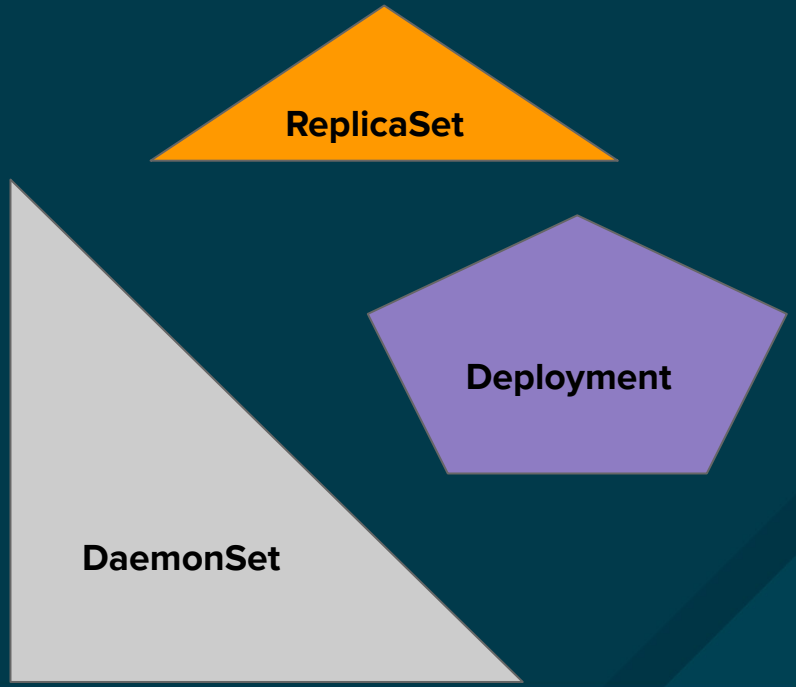
1

Resources



2

Controllers



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Domain or Application Specific Knowledge?

Installing.

Scale (properly).

Update.

Backup.

Restore.

Self-Heal.

Clean Up.

etc.

An “Operator” takes advantage of what Kubernetes does best...

```
$ oc proxy
```

```
$ curl localhost:8001
```

```
$ curl http://localhost:8001/api/v1/ | jq .resources[].name
"bindings"
"componentstatuses"
"configmaps"
"endpoints"
"events"
"limitranges"
"namespaces"
"namespaces/finalize"
"namespaces/status"
"nodes"
"nodes/proxy"
"nodes/status"
"persistentvolumeclaims"
"persistentvolumeclaims/status"
"persistentvolumes"
"persistentvolumes/status"
"Pods"
 ...
```

```
$ kubectl get configmaps

$ kubectl get endpoints

$ kubectl get namespaces
```

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```
$ kubectl get pod kube-dns-1187388186-rr1jb -n kube-system -o yaml
```

```
(curl -XGET ../api/v1/namespaces/kube-system/pods/kube-dns-1187388186-rr1jb)
```

```
apiVersion: v1
kind: Pod
metadata:
  name: kube-dns-1187388186-rr1jb
  namespace: kube-system
  ownerReferences:...
Spec:
  Containers:
    name: kubedns
    image: gcr.io/google_containers/k8s-dns-kube-dns-amd64:1.14.4
```

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Operators take advantage of
Custom Resource Definitions.
...Formerly known as Third Party Resources (TPRs)

CRDs allow us to **extend** the Kubernetes API.

Let’s extend the Kubernetes API by creating our very own object/resource via CRDs.

Create the CRD

```
$ cat my-new-crd.yaml
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata:
  name: mysql.db.example.com
Spec:
  group: db.example.com
  version: v1
  scope: Namespaced
  names:
    plural: mysqls
    singular: mysql
    kind: MySql
    shortNames:
    - ms

$ kubectl create -f my-new-crd.yaml
```

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Let’s first verify the creation of the CRD object/resource.

Verify CRD Creation via CLI

```
$ kubectl get crd
```

```
NAME                          KIND
mysql.db.example.com    CustomResourceDefinition.v1beta1.apiextensions.k8s.io
```

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Verify CRD Creation via API

```
curl -XGET localhost:8001/apis/apiextensions.k8s.io/v1beta1/customresourcedefinitions
```

```
{
  "kind": "CustomResourceDefinitionList",
  "apiVersion": "apiextensions.k8s.io/v1beta1",
  "metadata": {
    "selfLink": "/apis/apiextensions.k8s.io/v1beta1/customresourcedefinitions",
    "resourceVersion": "229273"
  },
  "items": [
   {
        "metadata": {
          "name": "mysql.db.example.com",
          "selfLink":
"/apis/apiextensions.k8s.io/v1beta1/customresourcedefinitions/mysql.db.example.c
          "uid": "8e4d17df-b085-11e7-9176-080027b424ef",
          "resourceVersion": "228836",
          "creationTimestamp": "2017-10-14T02:15:32Z"
        },
....
```

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Let’s now actually verify our new **mysql** resource/object!

Verify New **Database** Resource via CLI

```
$ kubectl get mysql
```

```
No resources found.
```

Verify New **Database** Resource via API

```
curl -XGET localhost:8001/apis/db.example.com/v1/namespaces/default/mysqls
```


```
{
  "apiVersion": "db.example.com/v1",
  "items": [],
  "kind": "MySqlList",
  "metadata": {
    "resourceVersion": "240591",
    "selfLink": "/apis/stable.example.com/v1/namespaces/default/mysqls"
  }
}
```

Let’s create a new **database** object.

Create a new **mysql** object

```
$ cat new-mysql-object.yaml
```

```
apiVersion: "db.example.com/v1"
kind: MySql
metadata:
  name: wordpress
spec:
  user: wp
  password: secret
  foo: bar
```

```
$ kubectl create -f new-mysql-object.yaml
```

Let’s verify the creation of the **mysql** object.

Verify **database** object via CLI

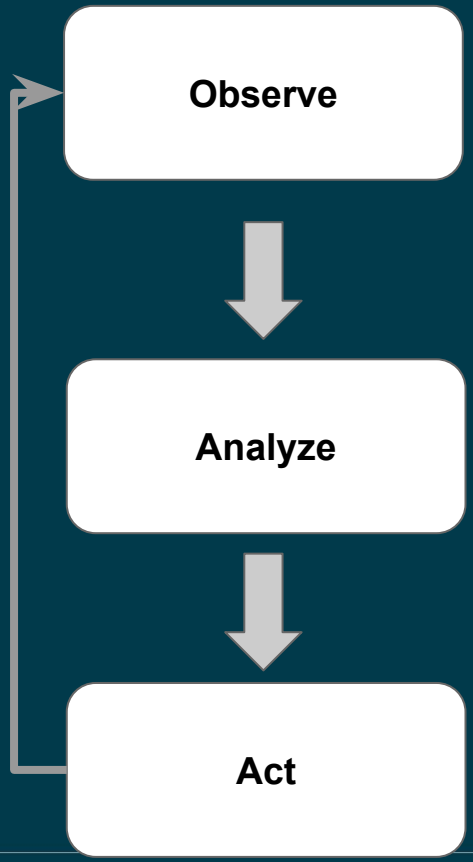
```
$ kubectl get mysql
NAME        AGE
wordpress   5s
```

```
$ kubectl get mysql wordpress -o yaml
```

```
apiVersion: db.example.com/v1
kind: MySql
metadata:
  clusterName: ""
  creationTimestamp: 2017-10-14T03:23:26Z
  deletionGracePeriodSeconds: null
  deletionTimestamp: null
  name: wordpress
  namespace: default
  resourceVersion: "238701"
  selfLink: /apis/db.example.com/v1/namespaces/default/mysqls/wordpress
  uid: 0afd1584-b08f-11e7-9176-080027b424ef
spec:
  foo: bar
  password: secret
  user: wp
```

A Custom Resource needs a controller
to **ACT**
upon its presence.

Kubernetes Controllers



Current state of the cluster.

Compare current state to desired state.

Perform all the actions necessary to make current state meet desired state.

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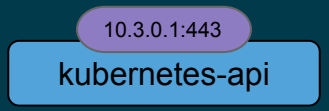
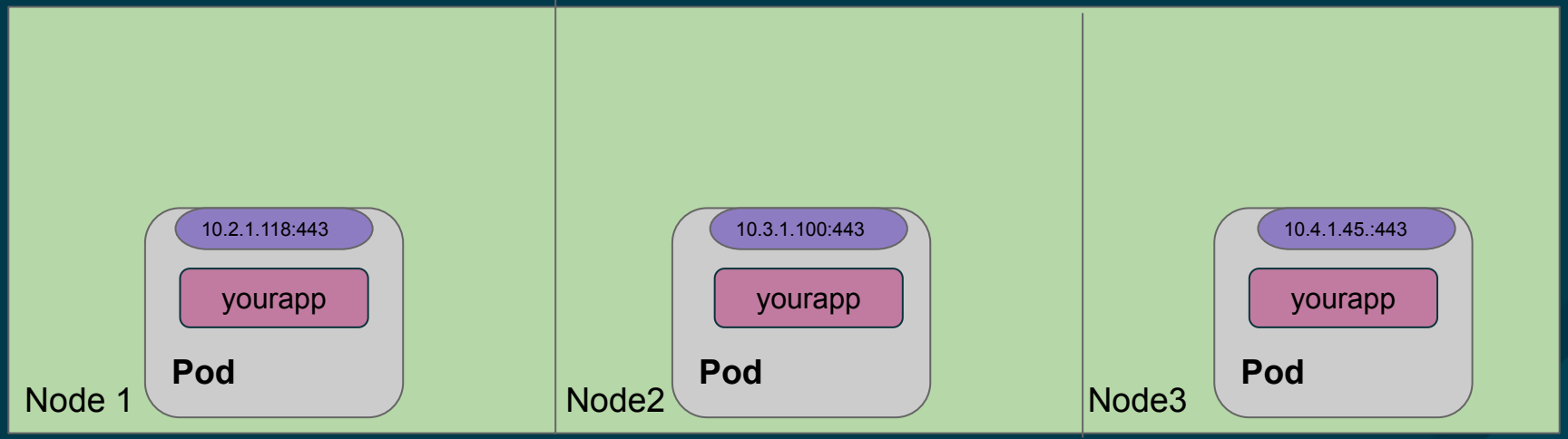
....and all is quiet..




```
apiVersion: db.example.com/v1
kind: MySql
metadata:
  clusterName: ""
  creationTimestamp: 2017-10-14T03:47:21Z
  deletionGracePeriodSeconds: null
  deletionTimestamp: null
  name: wordpress
  namespace: default
  resourceVersion: "242282"
  selfLink: /apis/db.example.com/v1/namespaces/default/mysqls/wordpress
  uid: 6228add3-b092-11e7-9176-080027b424ef
spec:
  foo: bar
  password: secret
  user: wp
```



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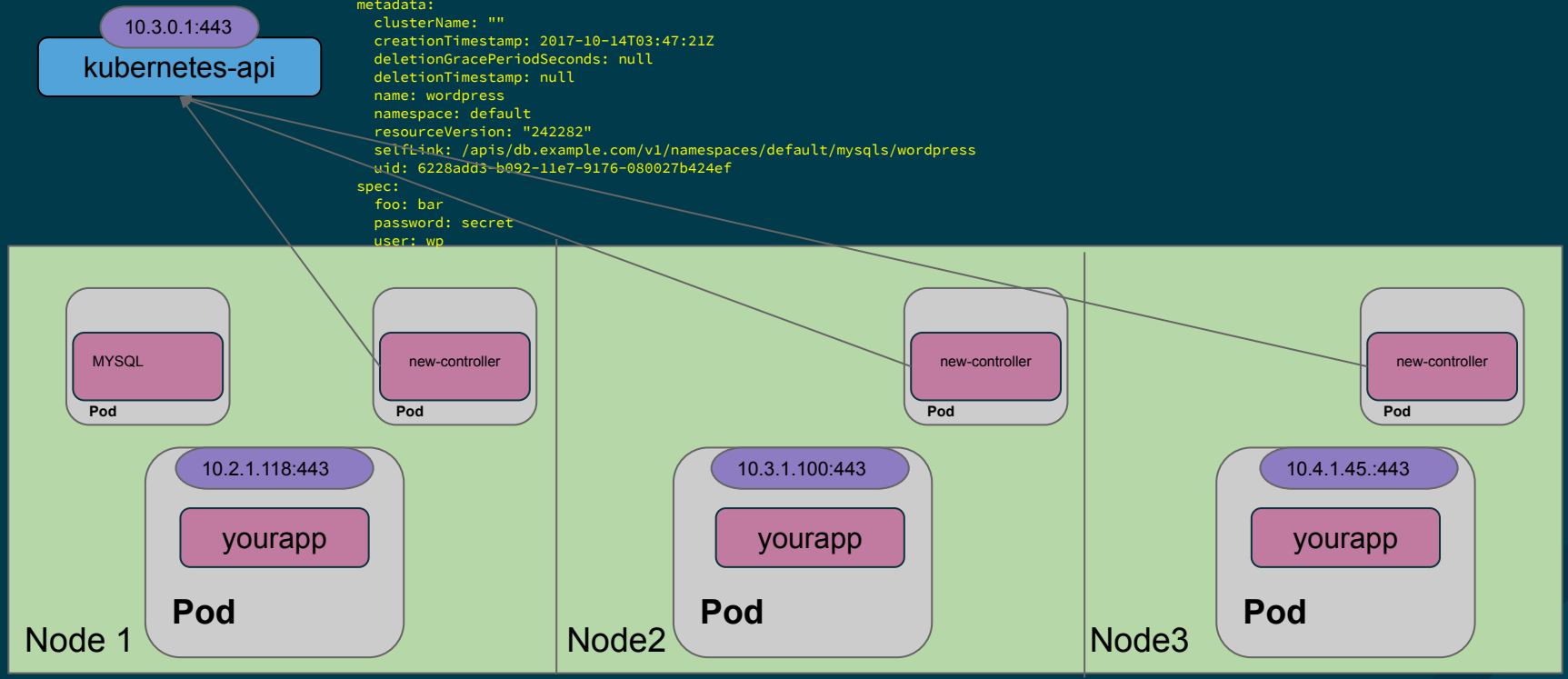
We need a custom controller to notice the new **database** object and **ACT**!

```
apiVersion: db.example.com/v1
kind: MySql
metadata:
  clusterName: ""
  creationTimestamp: 2017-10-14T03:47:21Z
  deletionGracePeriodSeconds: null
  deletionTimestamp: null
  name: wordpress
  namespace: default
  resourceVersion: "242282"
  selfLink: /apis/db.example.com/v1/namespaces/default/mysqls/wordpress
  uid: 6228add3-b092-11e7-9176-080027b424ef
spec:
  foo: bar
  password: secret
  user: wp
```



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ACT?

CREATE.

READ.

UPDATE.

DELETE.

But that’s probably not enough..

Server startup/shutdown
Mastering the mysqladmin administrative client
Using the mysql interactive client
User account maintenance
Log file maintenance
Database backup/copying
Hardware tuning
Multiple server setups
Software updates and upgrades
File system security
Server security
Repair and maintenance
Crash recovery
Preventive maintenance
Understanding the mysqld server daemon
Performance analysis
Choosing what else to install (e.g. Apache, Perl +modules, PHP)
Which version of MySQL (stable, developer, source, binary)
Creating a user acccount for the mysql user and group
Download and unpack a distribution
Compile source code and install (or rpm)
Initialize the data directory and grant tables with mysql_install_db
Starting the server
Installing Perl DBI support
Installing PHP
Installing Apache
Obtaining and installing the samp_db sample database

Securing a new MySQL installation
Running mysqld as an unprivileged user
Methods of starting the server
Invoking mysqld directly
Invoking safe_mysqld
Invoking mysql.server
Specifying startup options
Checking tables at startup
Shutting down the server
Regaining control of the server if you can’t connect
Creating new users and granting privileges
Determining who can connect from where
Who should have what privileges?
Administrator privileges
Revoking privileges
Removing users
deciding/finding the Data Directory’s location
Structure of the Data Directory
How mysqld provides access to data
Running multiple servers on a single Data Directory
Database representation
Table representation (form, data and index files)
OS constraints on DB and table names
Data Directory structure and performance, resources, security
MySQL status files (.pid, .err, .log, etc)
Relocating Data Directory contents

Creating new users and granting privileges
Determining who can connect from where
Who should have what privileges?
Administrator privileges
Revoking privileges
Removing users
Methods: mysqldump vs. direct copying
Backup policies
Scheduled cycles
Update logging
Consistent and comprehensible file-naming
Backing up the backup files
Off-site / off-system backups
Backing up an entire database with mysqldump
Compressed backup files
Backing up individual tables
Using mysqldump to transfer databases to another server
mysqldump options (flush-logs, lock-tables, quick, opt)
Direct copying methods
Database replication (live and off-line copying)
Recovering an entire database
Recovering grant tables
Recovering from mysqldump vs. tar/cpio files
Using update logs to replay post-backup queries
Editing update logs to avoid replaying erroneous queries
Recovering individual tables
Default parameters

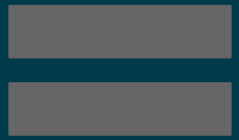
To recap...

Custom Resource Definitions (CRD)

~~Third Party Resources (TPR)~~

Custom Controller

Your Knowledge!



Operators!

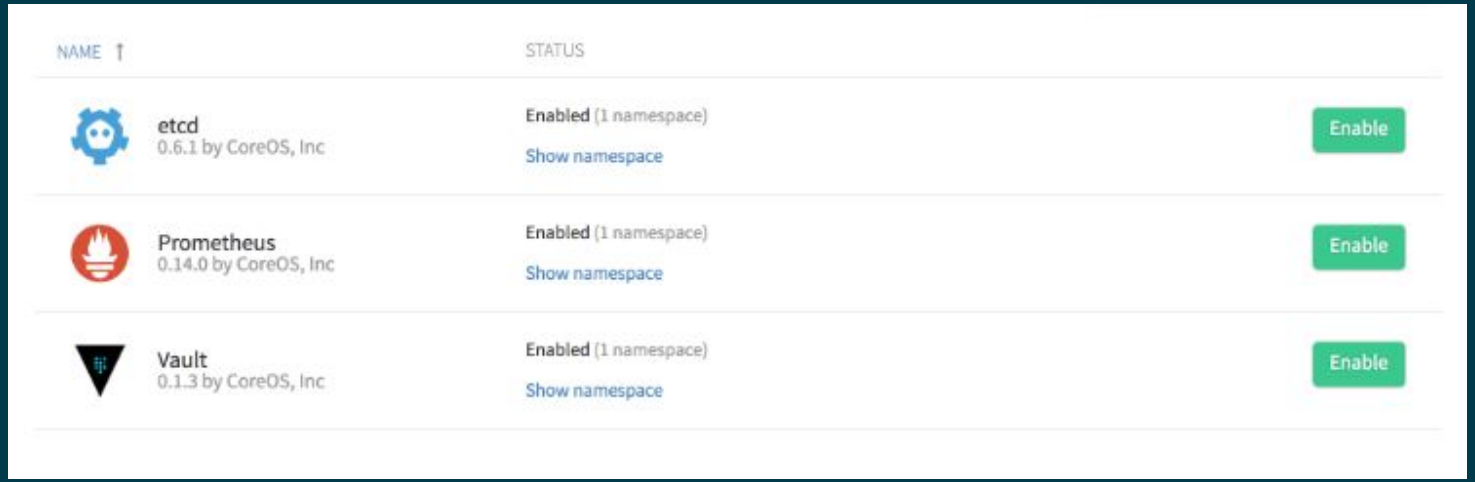
Why do Operators matter?

We want an “as-a-service” platform experience!

Build an ecosystem of software on Kubernetes that can be as easy, safe, and reliable to use and operate as a Cloud Service.

Low-touch, remotely managed, one-click-updates.

Operator Examples



Super easy to deploy an Operator in a Kubernetes environment.

Create the CRD

```
$ cat etcd-cluster-crd.yaml
```

```
apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata:
  name:
etcdclusters.etcd.database.coreos.com
spec:
  group: etcd.database.coreos.com
  names:
    kind: EtcdCluster
    listKind: EtcdClusterList
    plural: etcdclusters
    shortNames:
    - etcdclus
    - etcd
    singular: etcdcluster
  scope: Namespaced
  version: v1beta2
  versions:
  - name: v1beta2
    served: true
    storage: true
```

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Deploy etcd Operator

```
$ cat etcd-operator.yaml
```

```
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: etcd-operator
spec:
  replicas: 1
  template:
    metadata:
      labels:
        name: etcd-operator
    spec:
      containers:
      - name: etcd-operator
        image: quay.io/coreos/etcd-operator:v0.9.2
        command:
        - etcd-operator
        # Uncomment to act for resources in all namespaces. More information in doc/clusterwide.md
        #- -cluster-wide
        env:
        - name: MY_POD_NAMESPACE
          valueFrom:
            fieldRef:
              fieldPath: metadata.namespace
        - name: MY_POD_NAME
          valueFrom:
            fieldRef:
              fieldPath: metadata.name
```

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Deploy etcd Operator

```
$ kubectl create -f etcd-operator.yaml
```

```
$ kubectl get pods
```

```
NAMESPACE     NAME                              READY     STATUS    RESTARTS   AGE
default       etcd-operator-67666dc65f-xwfvq    1/1       Running   0          1s
```

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View the etcdCluster Custom Resource

```
$ cat etcd-instance.yaml
```

```
apiVersion: "etcd.database.coreos.com/v1beta2"
kind: "EtcdCluster"
metadata:
  name: "example-etcd-cluster"
spec:
  size: 3
  version: "3.2.13"
```

Deploy etcdCluster

```
$ kubectl create -f etcd-instance.yaml

$ kubectl get etcdcluster
```

NAMESPACE	NAME	AGE
default	myetcdcluster	1s

How do you create your own Operator?

Life before the Operator SDK...

If only it were a simple as….

Resources

```
type MyCustomResourceDefinition struct
{
 // API obj kind & schema version
 metav1.TypeMeta
 // Standard object metadata (optional)
 Metadata api.ObjectMeta
 // Describe how the resource appears
 Spec v1beta1.CustomResourceDefinitionSpec
 // State of the CRD
 Status CustomResourceDefinitionStatus
}
```

Controllers

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

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Custom Operators require many building blocks and boilerplate code.

...research/download tools to interact with the API.

Kubernetes Client Libraries

Officially-supported Kubernetes client libraries

The following client libraries are officially maintained by Kubernetes SIG API Machinery.

Language	Client Library	Sample Programs
Go	github.com/kubernetes/client-go/	browse
Python	github.com/kubernetes-client/python/	browse
Java	github.com/kubernetes-client/java	browse
dotnet	github.com/kubernetes-client/csharp	browse
JavaScript	github.com/kubernetes-client/javascript	browse

Community-maintained client libraries

The following Kubernetes API client libraries are provided and maintained by their authors, not the Kubernetes team.

Language	Client Library
Clojure	github.com/yanatan16/clj-kubernetes-api
Go	github.com/ericchiang/k8s
Java (OSGi)	bitbucket.org/amdatulabs/amdatu-kubernetes
Java (Fabric8, OSGi)	github.com/fabric8io/kubernetes-client
Lisp	github.com/brendandburns/cl-k8s
Node.js (TypeScript)	github.com/Goyoo/node-k8s-client

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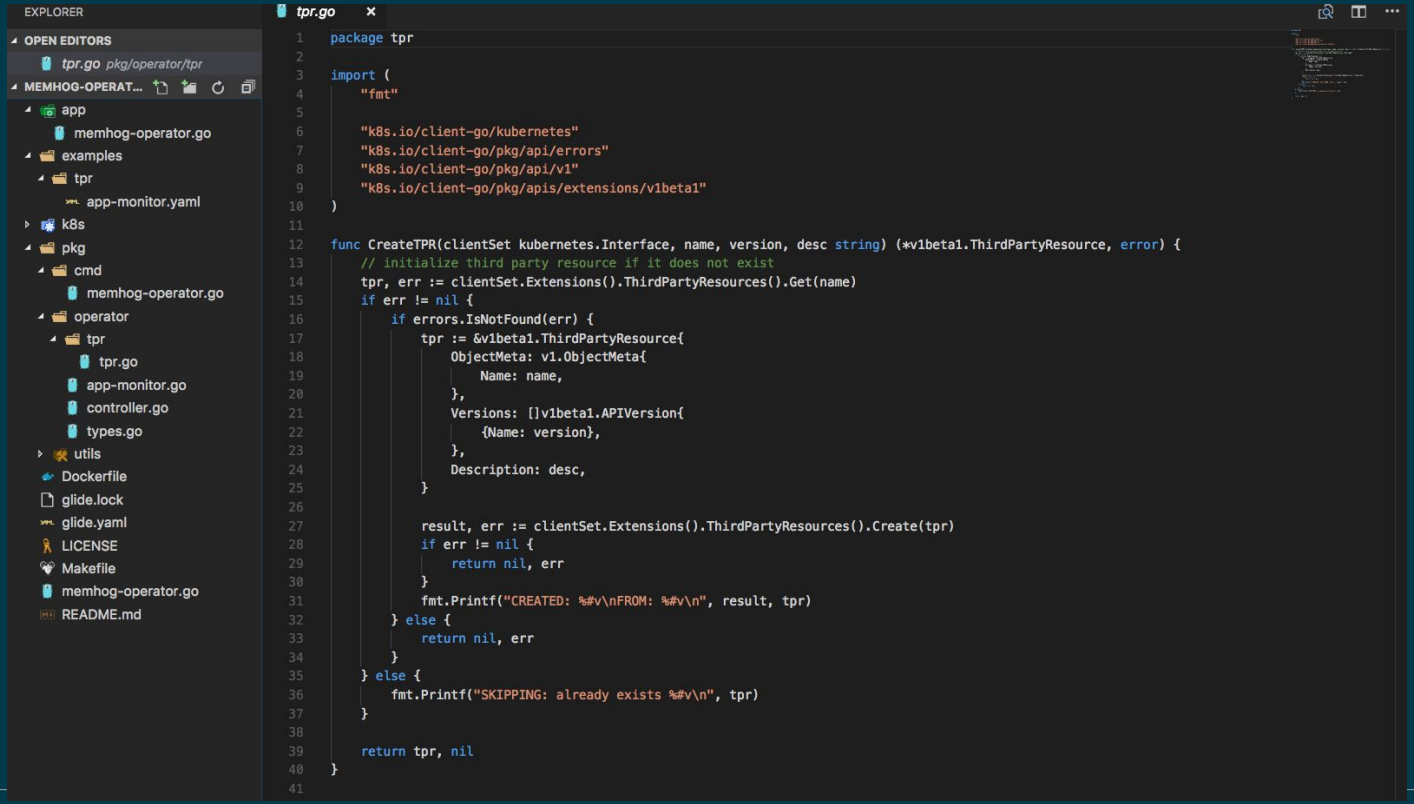
Knowledge of informers/shared informers for object cache and event handling.

Communicating desired state/actual state via annotations.

Tracking kube-related resources.

Test scaffolding & repo organization.

Custom Operator Source



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We need an easier way to **create** Operators.

We need an easier way to **manage** Operators.

Operator Framework

The Operator Framework is an open source toolkit to manage Kubernetes native applications, called Operators, in an effective, automated, and scalable way.

https://operatorhub.io/ Verified

Repositories 24 People 59 Teams 2

Pinned repositories

operator-sdk

SDK for building Kubernetes applications. Provides high level APIs, useful abstractions, and project scaffolding.

Go ★ 1.8k 404

operator-lifecycle-manager

A management framework for extending Kubernetes with Operators

Go ★ 332 141

operator-metering

Operator metering is responsible for collecting metrics and other information about what's happening in a Kubernetes cluster, and providing a way to create reports on the collected data.

Go ★ 165 37

Find a repository... Type: All Language: All New

community-operators

The canonical source for Kubernetes Operators that appear on OperatorHub.io, OpenShift Container Platform and OKD.

Shell ★ 120 149 Updated 6 hours ago

operator-metering

Top languages

Go Java Shell JavaScript Python

Most used topics

Manage

kubernetes operator

Red Hat

Operator-SDK

3

ANSIBLE

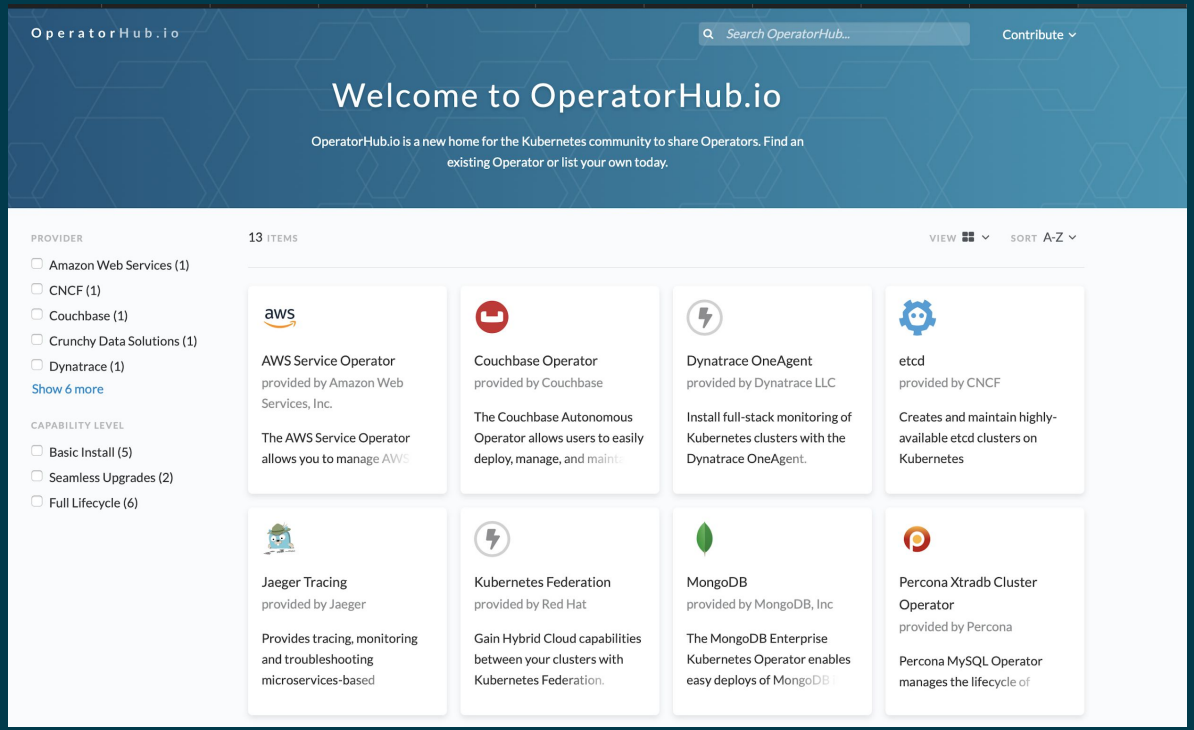
Operator Lifecycle Manager (OLM)

Enable cluster admins to manage Operators on any Kubernetes cluster (dependency management).

Operator Metering

Record historical cluster usage and generate usage reports showing usage breakdowns by pod or namespace over arbitrary time periods.

OperatorHub.io



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Follow Along with Us!

workshop.coreostrain.me

username: operator
password: coreostrainme

Katacoda!

https://learn.openshift.com/training/operatorframework