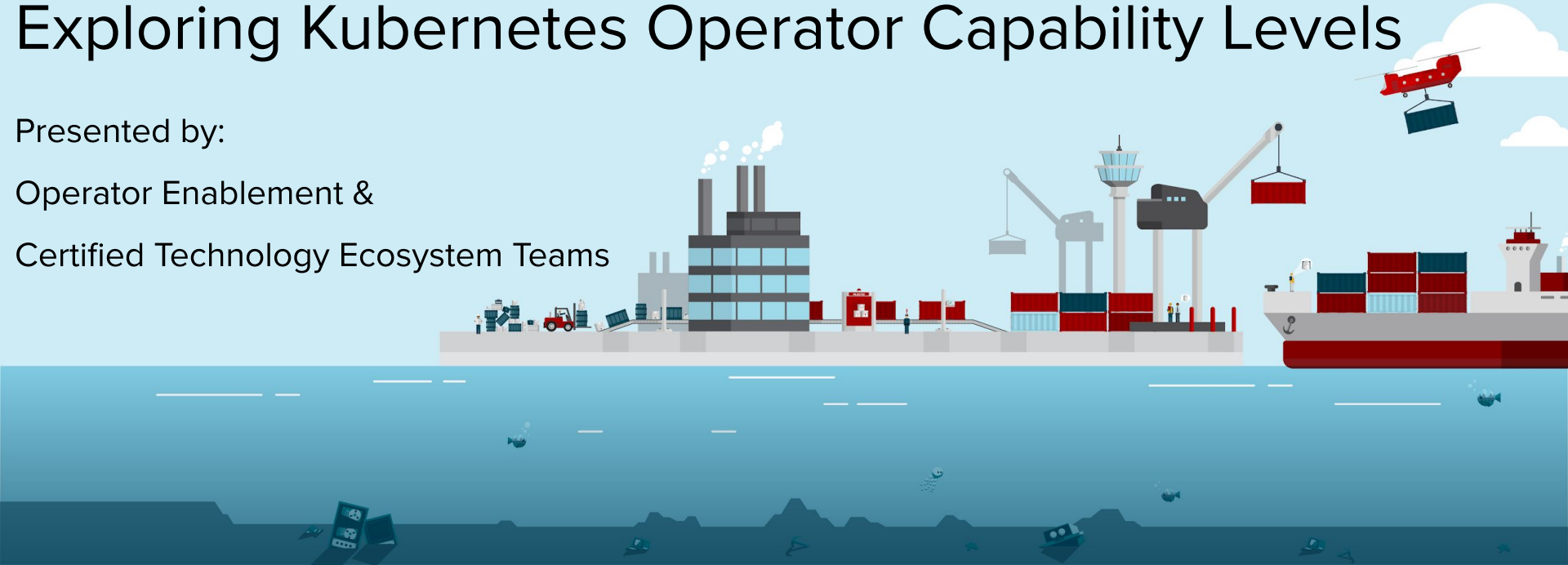
Red Hat

From Install to Auto Pilot: Exploring Kubernetes Operator Capability Levels

Presented by:

Operator Enablement &

Certified Technology Ecosystem Teams



How Many People Here Know What an Operator is?

Have Built an Operator?

Did you use Operator-SDK?

Did you get Red Hat Certified or publish to OperatorHub.io yet?

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What is an Operator?

Kubernetes Operators are the Magic Behind OpenShift 4's Automated Operations.

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try.openshift.com

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OpenShift 4 is aware of the entire infrastructure and brings the Operating System under management

OpenShift & Kubernetes

certificates & security settings

container runtime config

allowed maintenance windows

software defined networking

AUTOMATED OPERATIONS VIA OPERATORS

KUBERNETES

RHEL or RHEL CoreOS

kernel modules

device drivers

network interfaces

security groups

Nodes & Operating System

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Yeah..but what is it?

Operators

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

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Still Confused?

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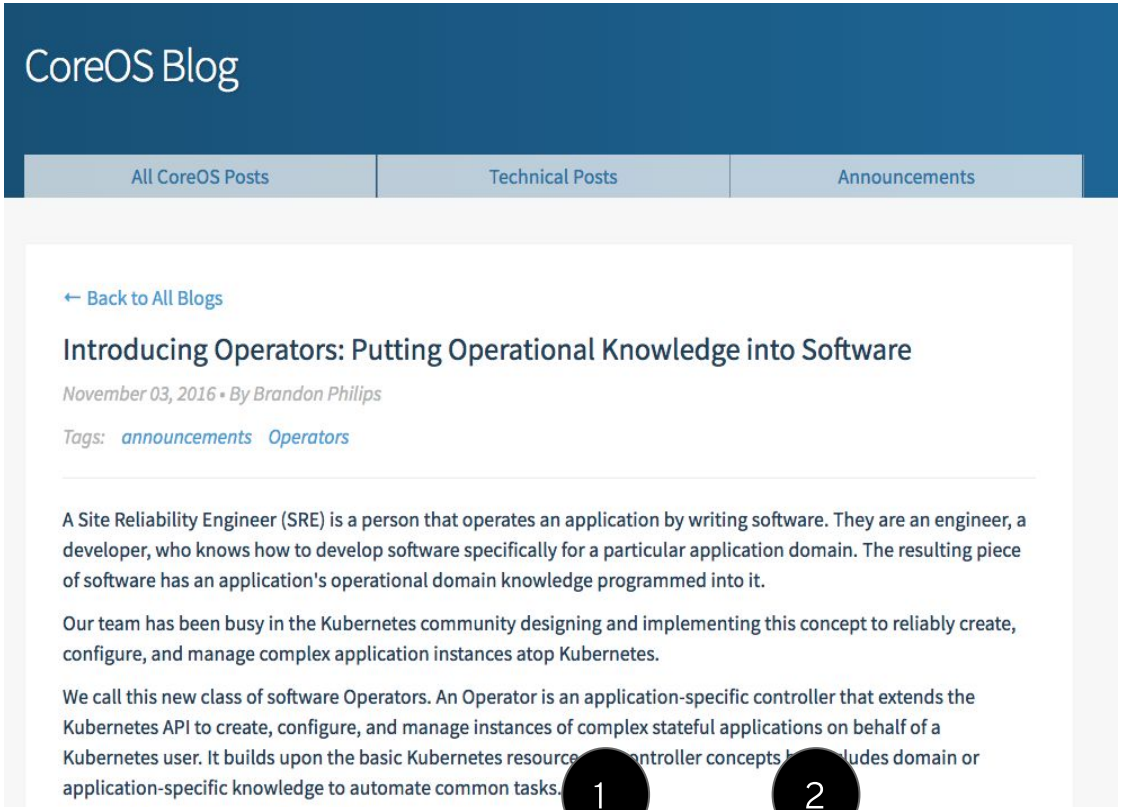
Let’s go back 3 years ago.



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

(Custom) Resource

2

Controller

3

Knowledge

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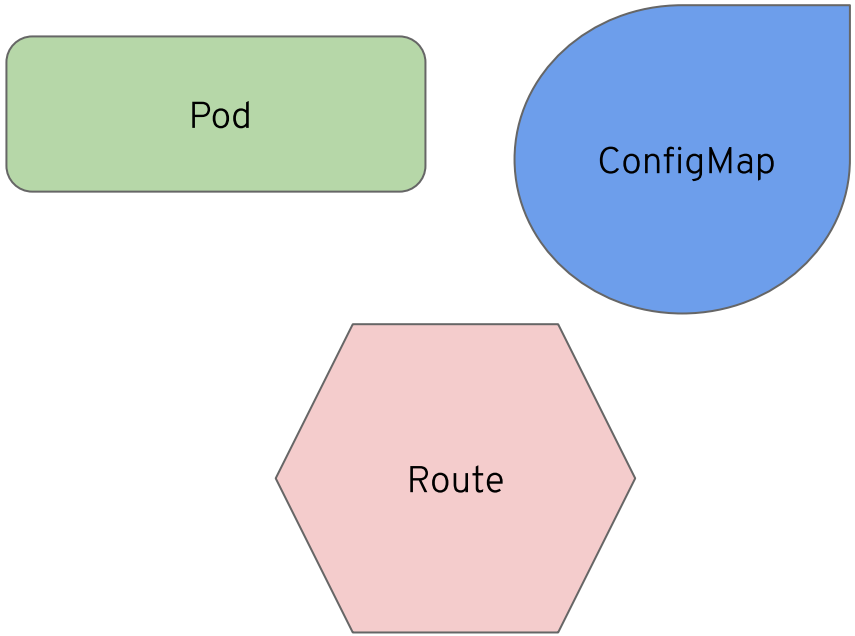
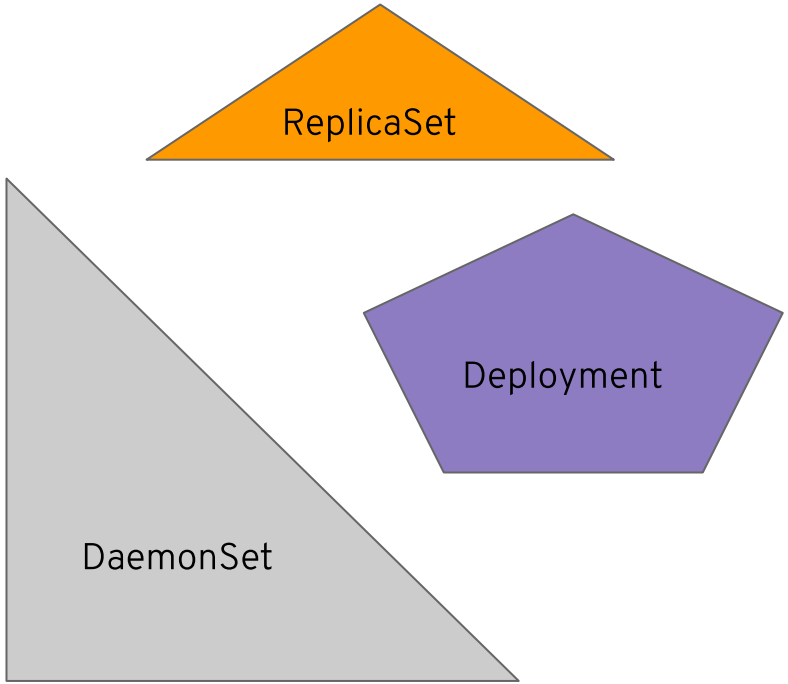
1

Resources



2

Controllers



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Domain or Application Specific Knowledge?

Installing.

Scale (properly).

Self-Heal.

Clean Up.

Update.

Backup.

Restore.

etc.

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Why do they matter to Red Hat?

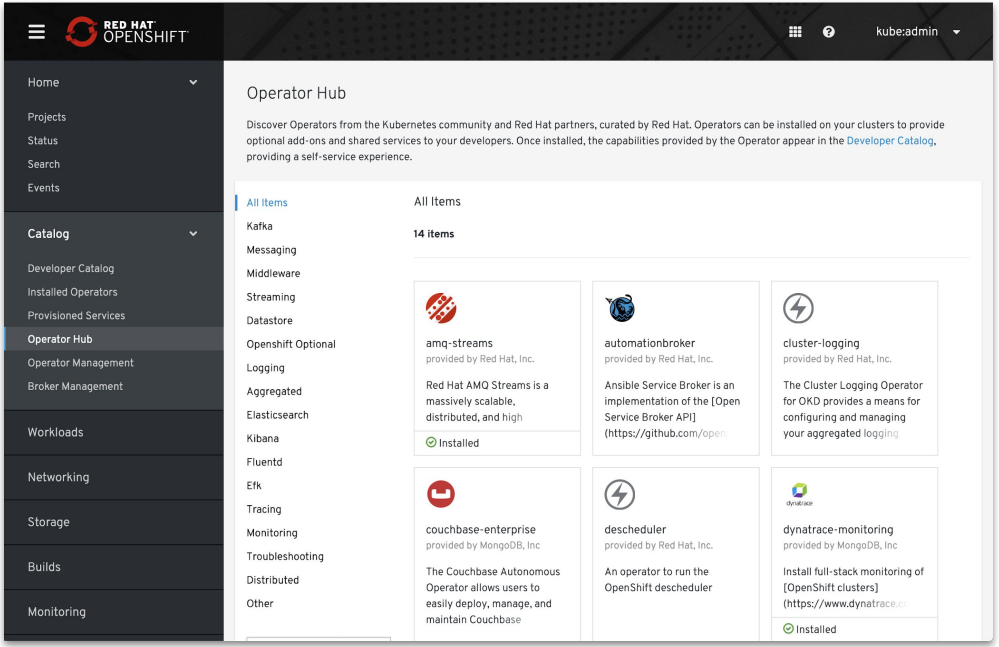
We want an “as-a-service” platform experience.

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.

OPERATORS IN OPENSHIFT

Operator Hub - Allows administrators to selectively make operators available from curated sources to users in the cluster.



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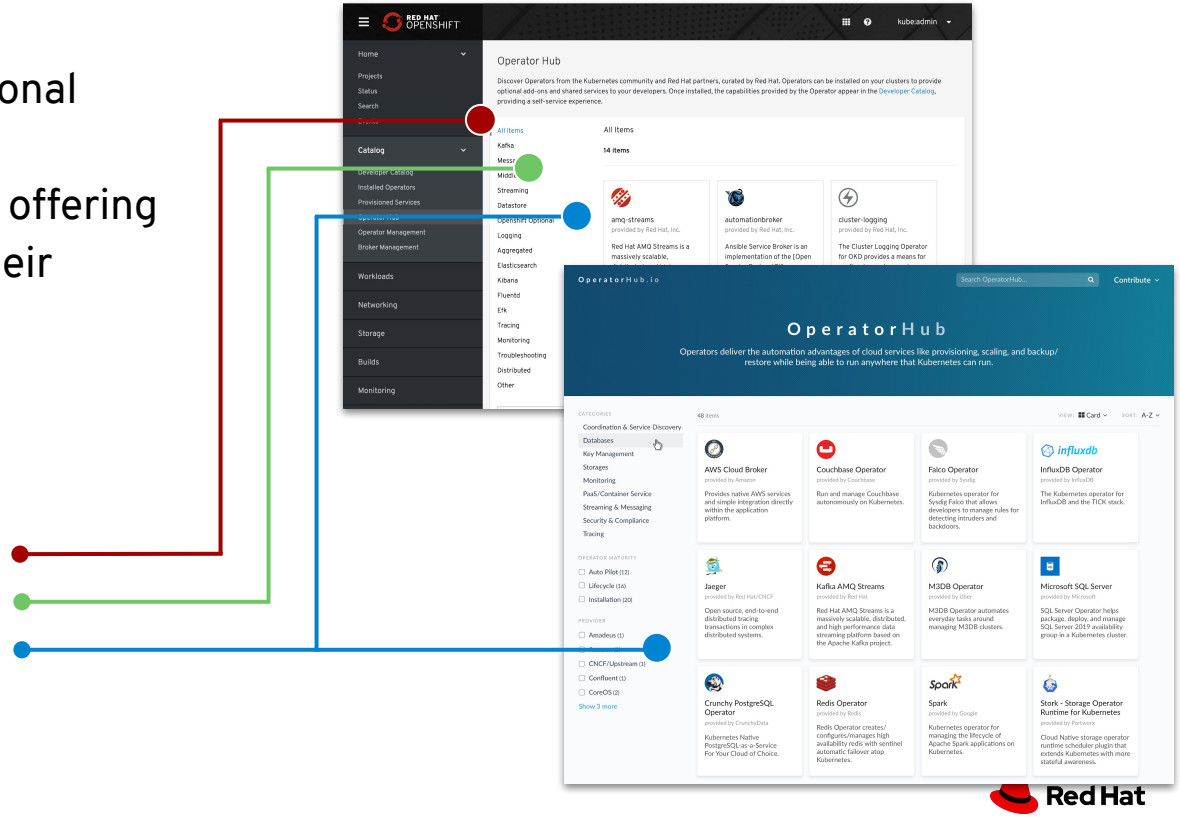
OPERATORHUB

- Accessible to admins only
- Discovery/install of all optional components and apps
- Upstream and downstream offering
- ISV partners will support their Operators

TYPES OF OPERATORS

Red Hat Products
ISV Partners
Community



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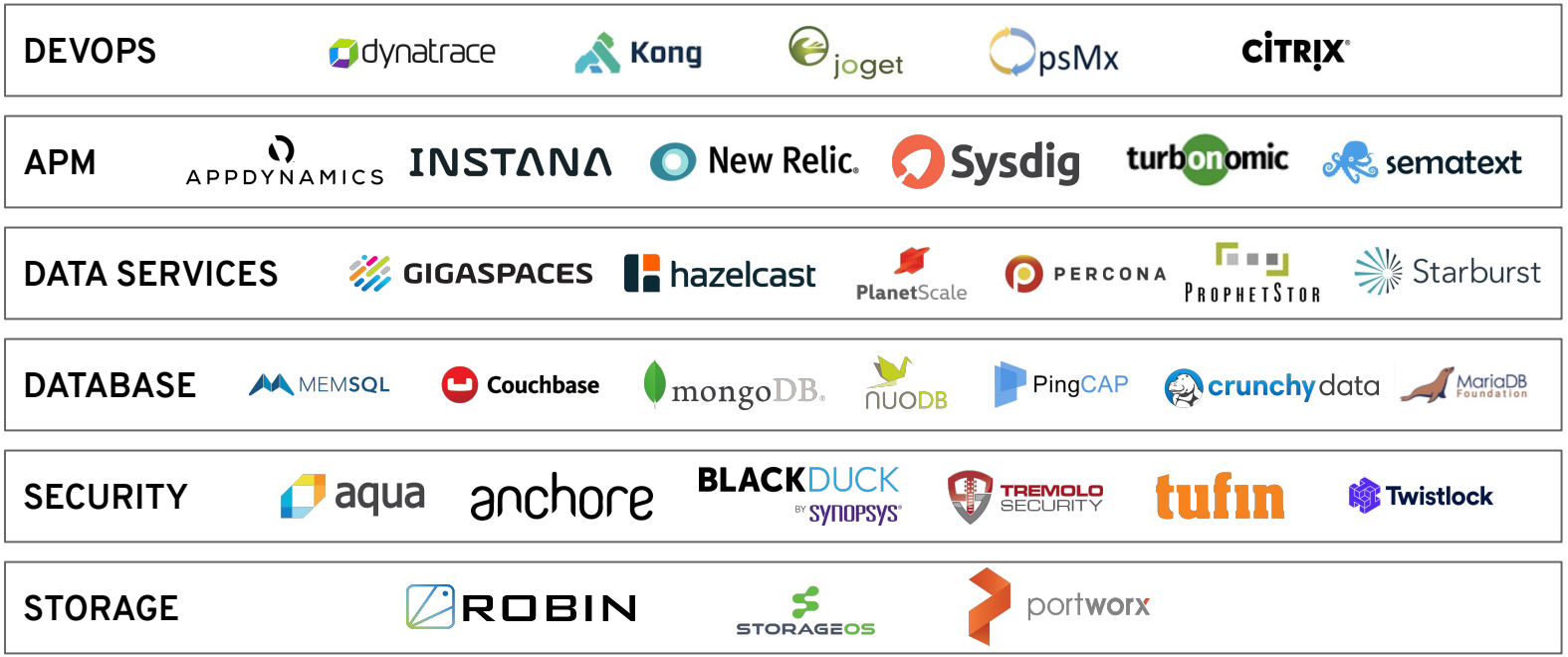
Red Hat Certified Operators



OPERATOR FRAMEWORK

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3

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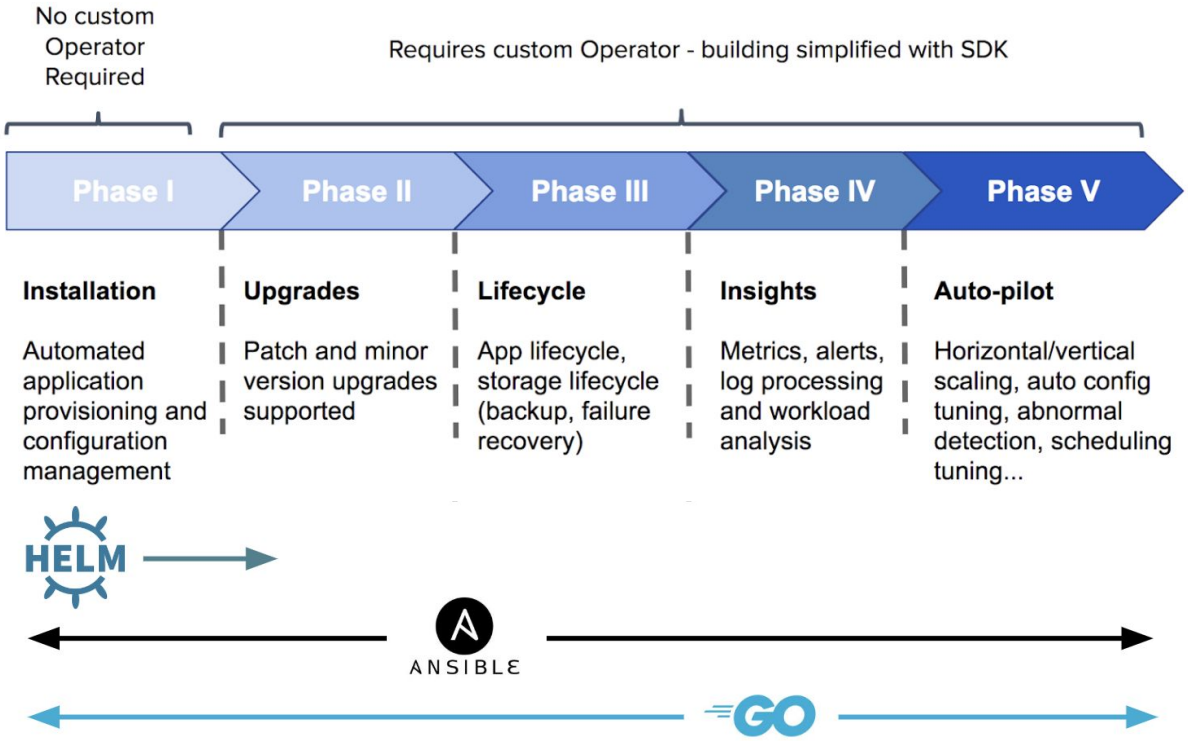
TYPES OF OPERATORS



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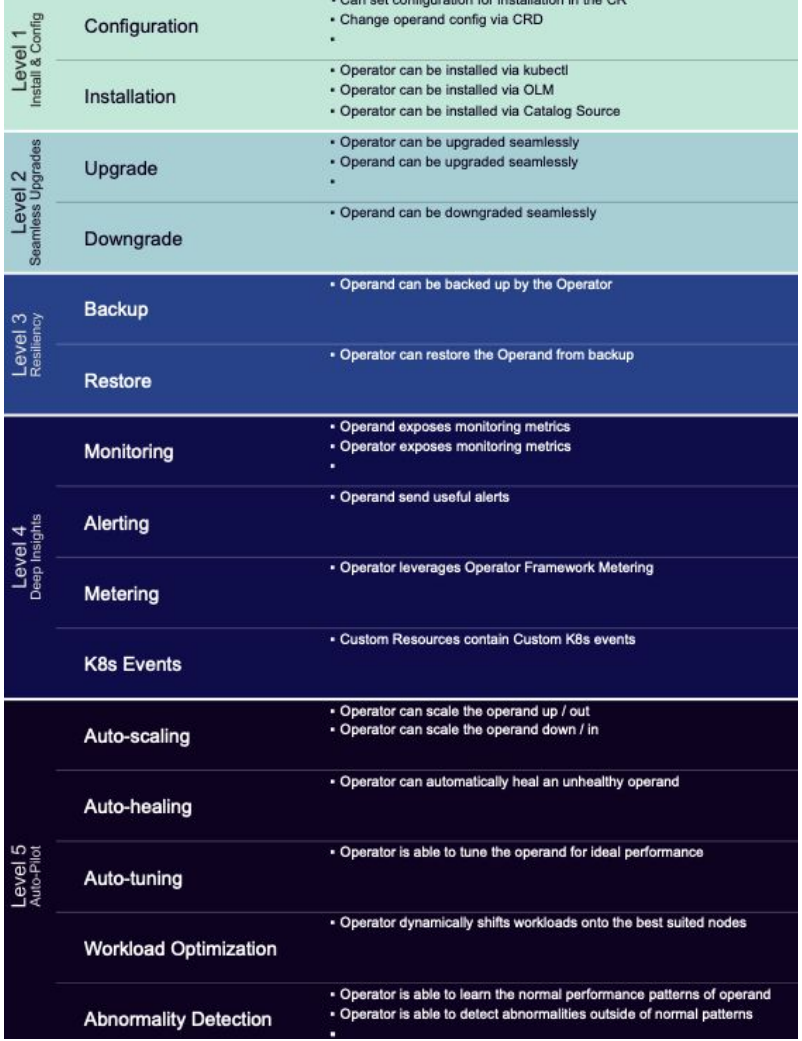
Level 1
Install & Config
Configuration
• Change operand config via CRD
Installation
• Operator can be installed via kubectl
• Operator can be installed via OLM
• Operator can be installed via Catalog Source
Level 2
Seamless Upgrades
Upgrade
• Operator can be upgraded seamlessly
• Operand can be upgraded seamlessly
Downgrade
• Operand can be downgraded seamlessly
Level 3
Resiliency
Backup
• Operand can be backed up by the Operator
Restore
• Operator can restore the Operand from backup
Level 4
Deep Insights
Monitoring
• Operand exposes monitoring metrics
• Operator exposes monitoring metrics
Alerting
• Operand send useful alerts
Metering
• Operator leverages Operator Framework Metering
K8s Events
• Custom Resources contain Custom K8s events
Level 5
Auto-Pilot
Auto-scaling
• Operator can scale the operand up / out
• Operator can scale the operand down / in
Auto-healing
• Operator can automatically heal an unhealthy operand
Auto-tuning
• Operator is able to tune the operand for ideal performance
Workload Optimization
• Operator dynamically shifts workloads onto the best suited nodes
Abnormality Detection
• Operator is able to learn the normal performance patterns of operand
• Operator is able to detect abnormalities outside of normal patterns

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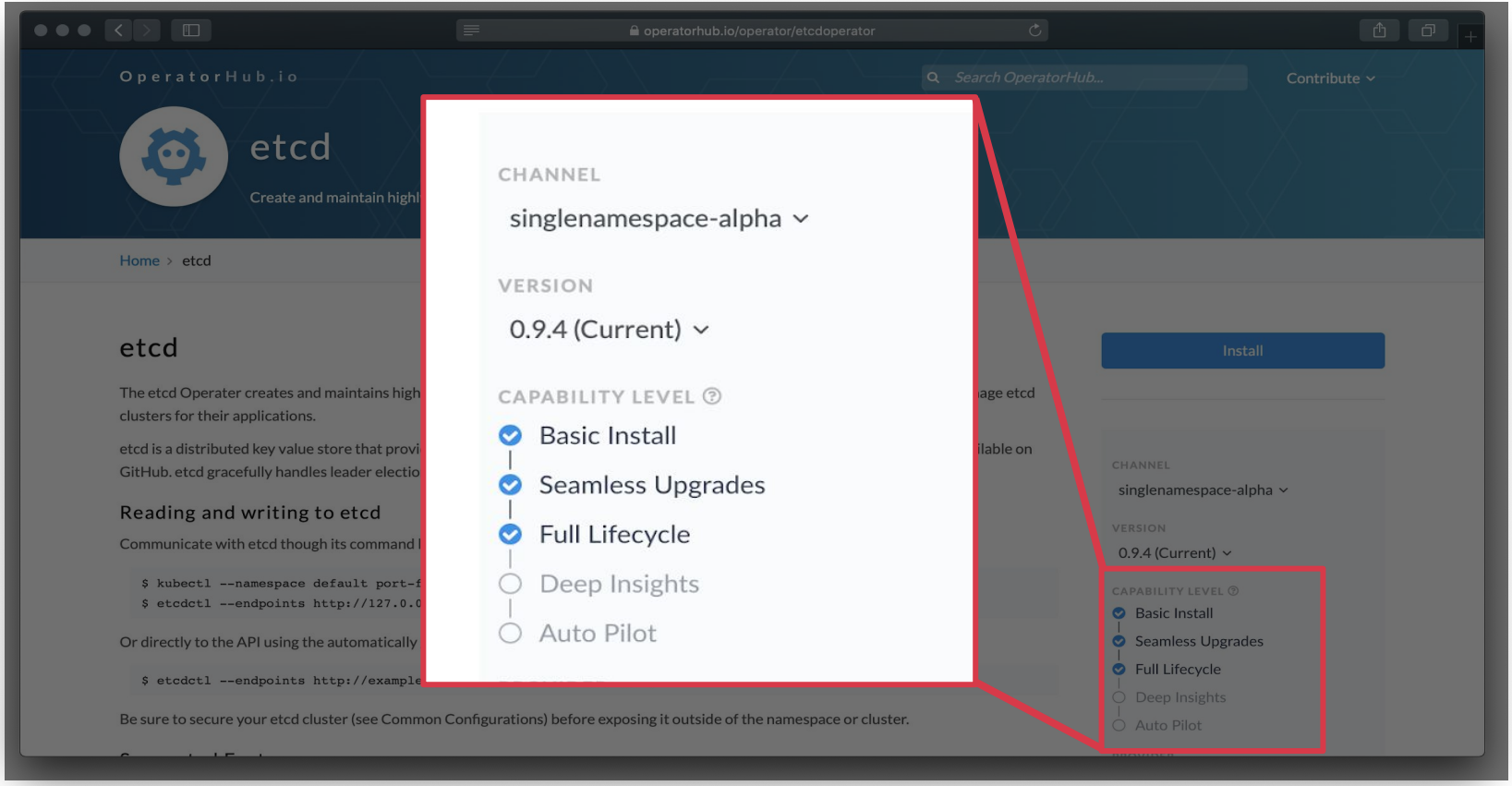
operatorhub.io/operator/etcdoperator
OperatorHub.io
Search OperatorHub...
Contribute
etcd
Create and maintain high
Home > etcd
etcd
The etcd Operater creates and maintains high
clusters for their applications.
etcd is a distributed key value store that provi
GitHub. etcd gracefully handles leader electio
Reading and writing to etcd
Communicate with etcd though its command l
$ kubectl --namespace default port-f
$ etcdctl --endpoints http://127.0.0
Or directly to the API using the automatically
$ etcdctl --endpoints http://example
Be sure to secure your etcd cluster (see Common Configurations) before exposing it outside of the namespace or cluster.
CHANNEL
singlenamespace-alpha
VERSION
0.9.4 (Current)
CAPABILITY LEVEL
Basic Install
Seamless Upgrades
Full Lifecycle
Deep Insights
Auto Pilot
Install
CHANNEL
singlenamespace-alpha
VERSION
0.9.4 (Current)
CAPABILITY LEVEL
Basic Install
Seamless Upgrades
Full Lifecycle
Deep Insights
Auto Pilot

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Let’s Explore!

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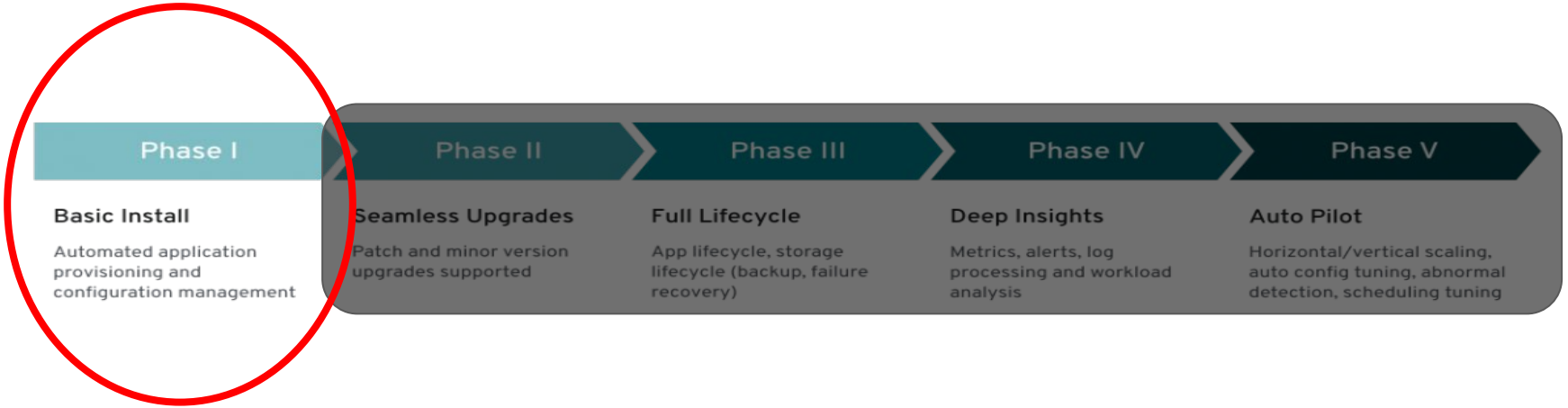
Level 1: Basic Install



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We all know installing is pretty simple in the Kubernetes world.

You may currently install non-Operator Kubernetes Applications via...

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```
kubectl apply -f namespace.yaml
kubectl apply -f networkpolicy.yaml
kubectl apply -f serviceaccount.yaml
kubectl apply -f role.yaml
kubectl apply -f rolebinding.yaml
kubectl apply -f configmap1.yaml
kubectl apply -f configmap2.yaml
kubectl apply -f secret1.yaml
kubectl apply -f secret2.yaml
kubectl apply -f deployment.yaml
```

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```
helm install -f myvalues.yaml ./redis
```

Red Hat

```
oc process -f my-rails-postgresql --param-file=postgres.env
```

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How do you install an Operator?

Installing an Operator

4

Step 1: Apply the CRD(s).

Step 2: Apply a Service Account and RBAC.

Step 3: Apply the controller via a Deployment.

Step 4: Apply the CR(s).

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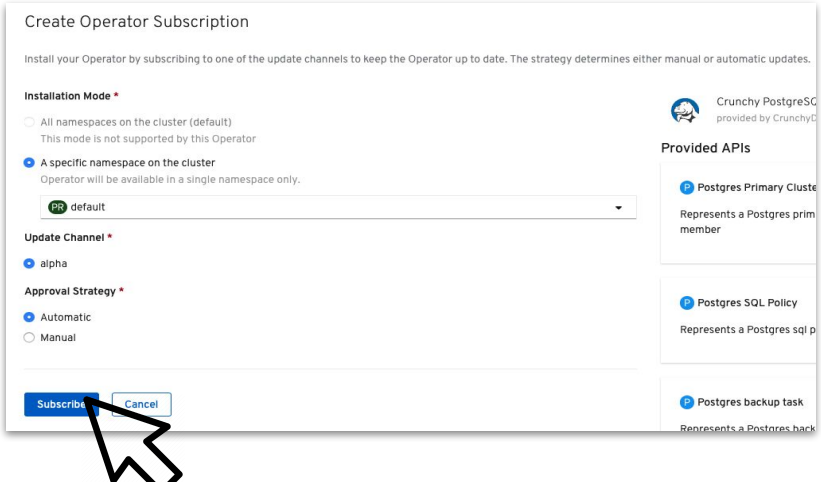
Installing an Operator via OLM



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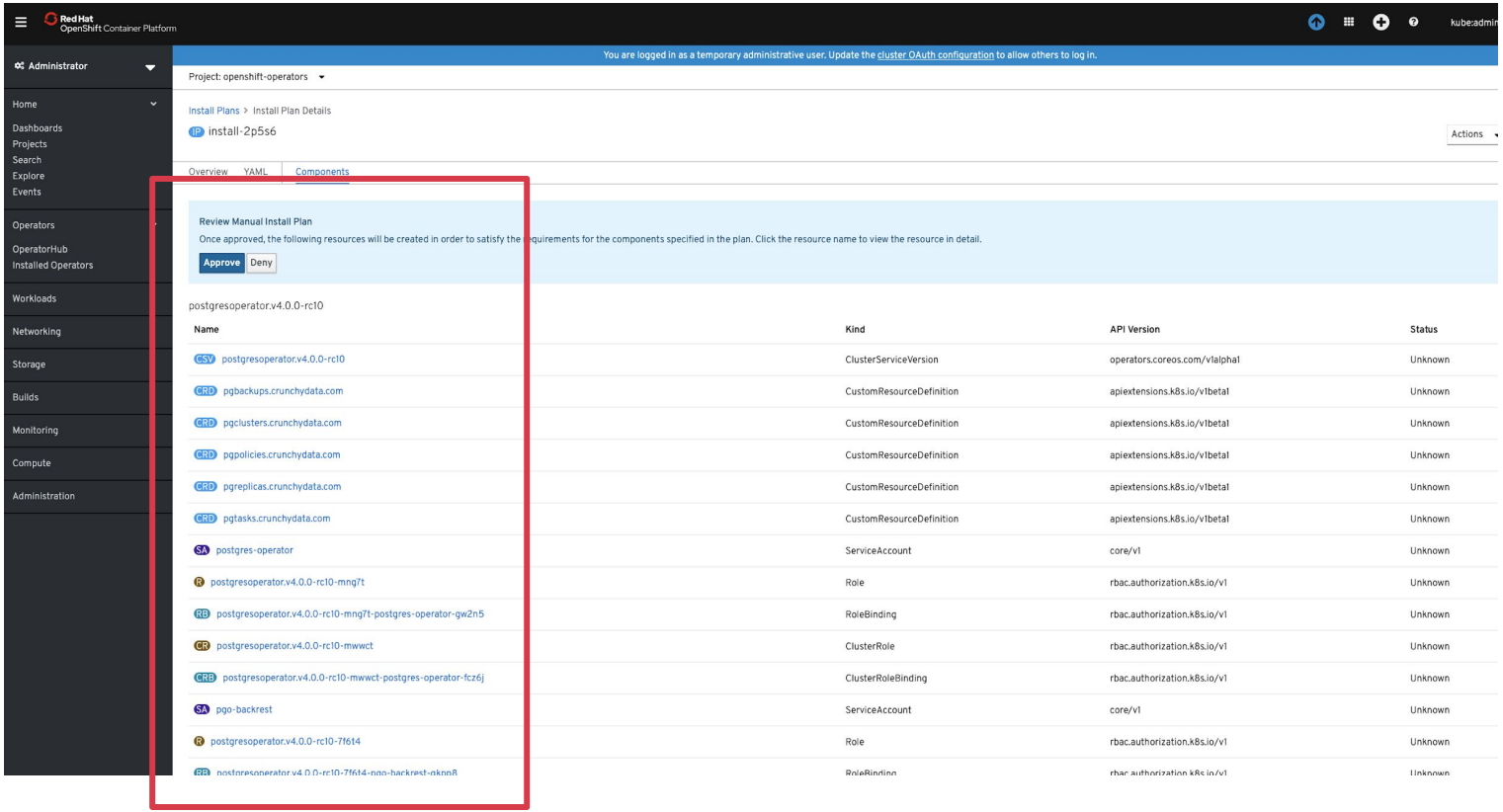
Review Resources Before Installing



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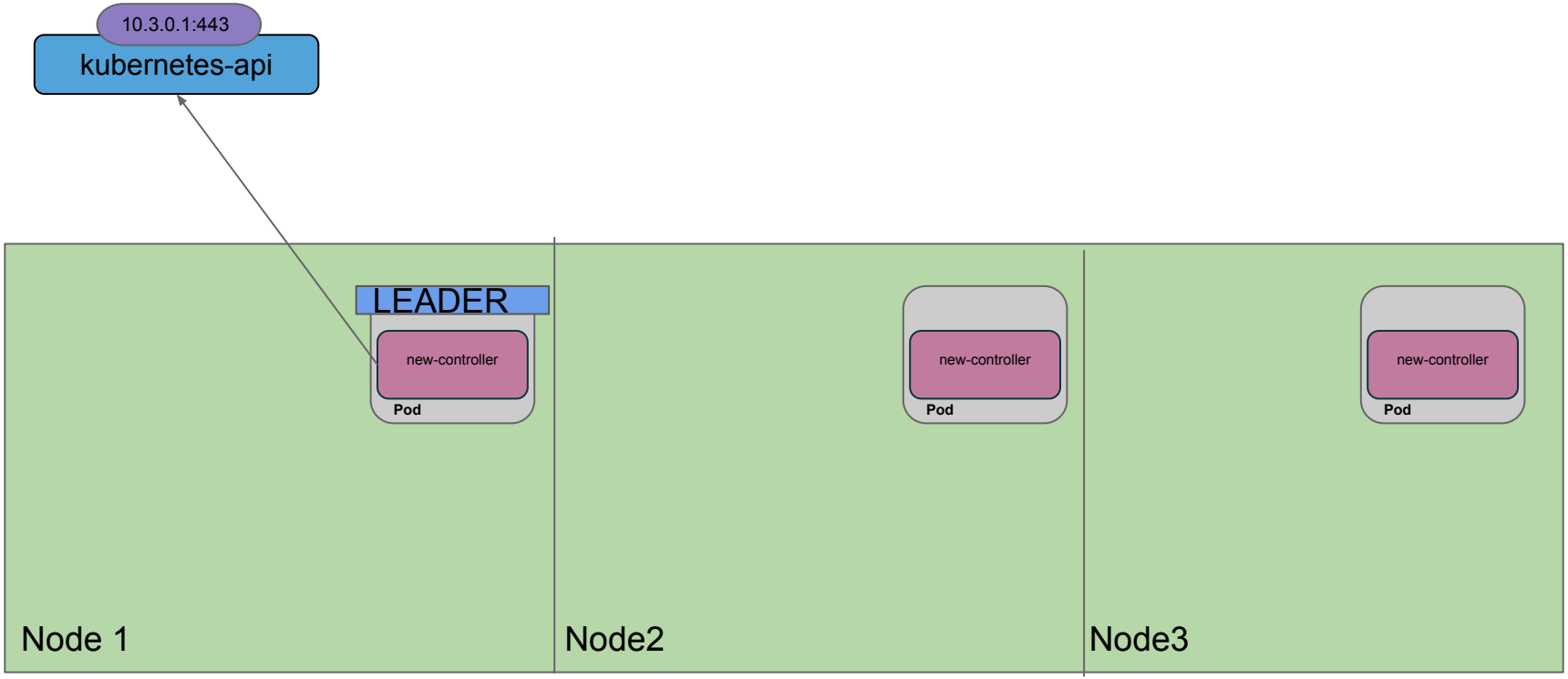
CRD and Controller are Applied



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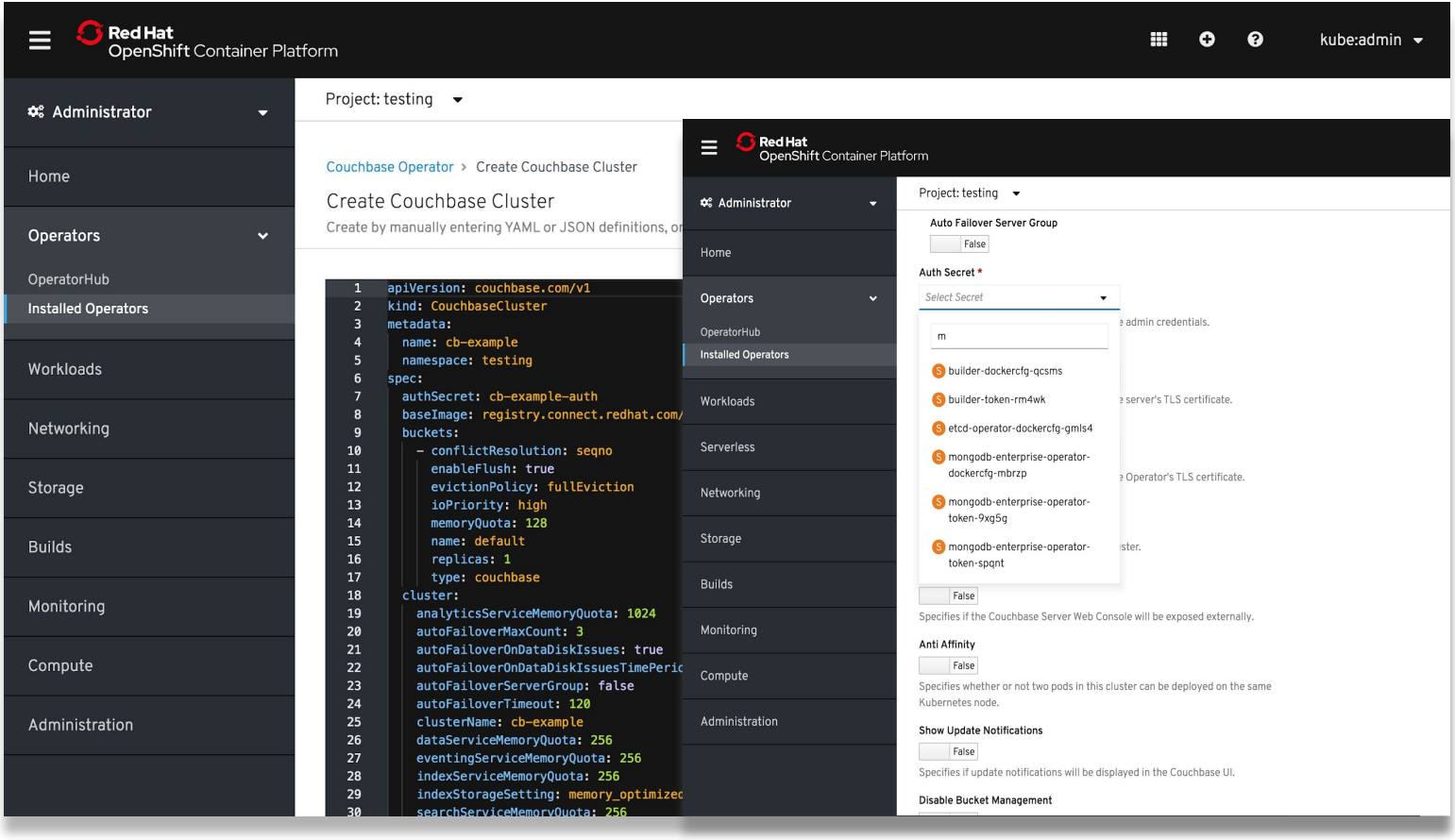
Create the CR(s)



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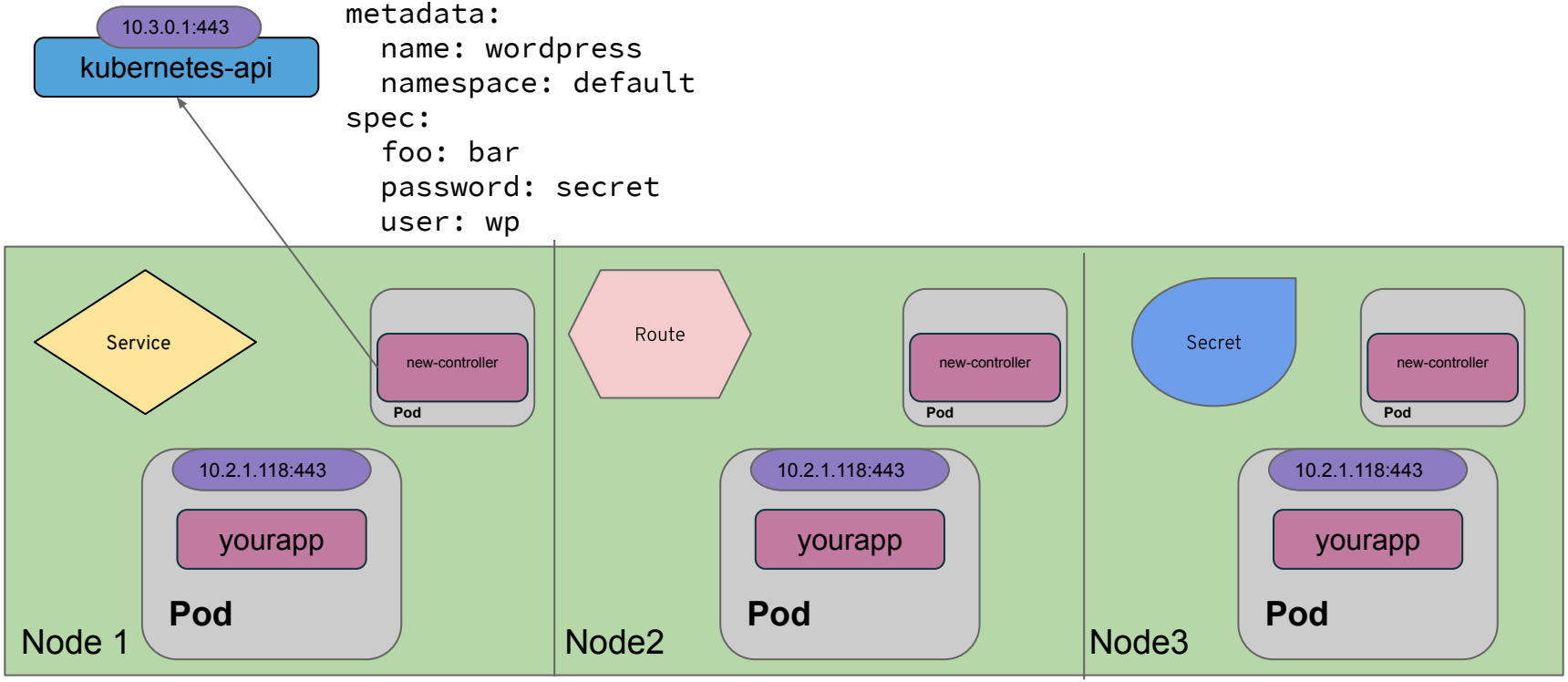
CR is Applied

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



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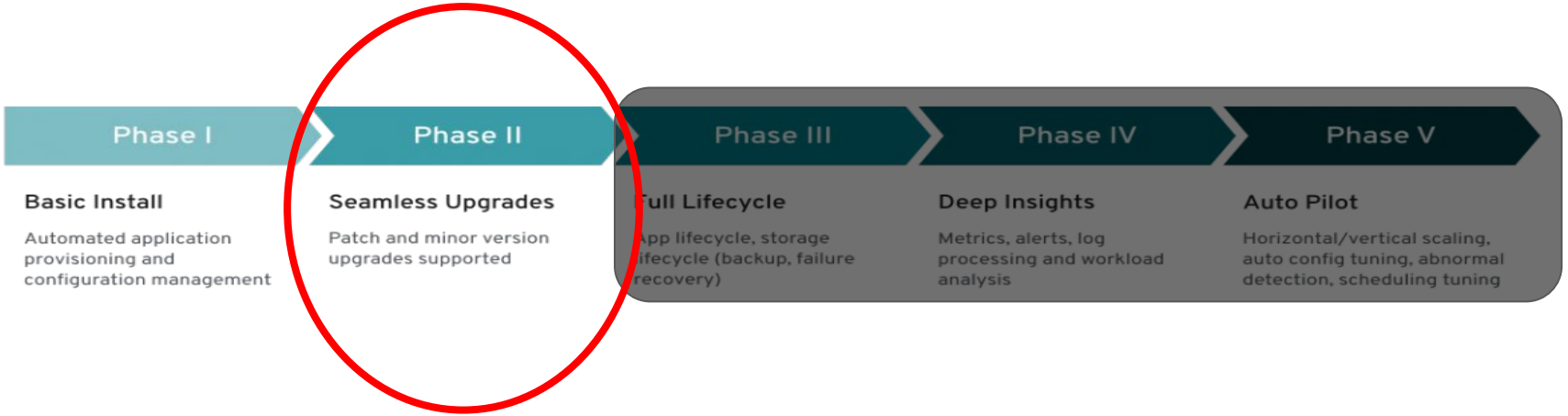
Level 2: Seamless Upgrades



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Operator Upgrades

3

Upgrading the Controller.

Upgrading the Operand.

Upgrading the CRD version/schema.

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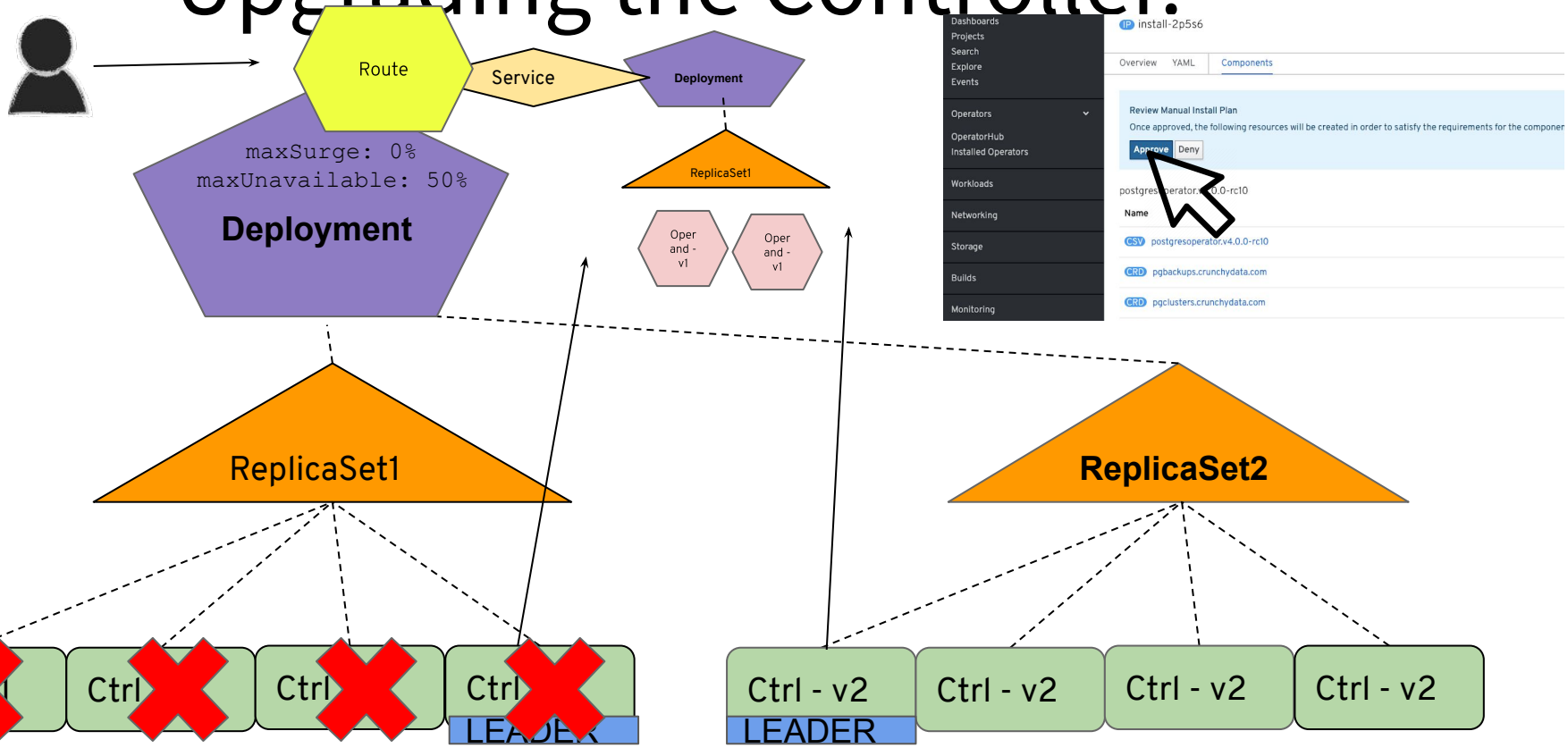
Upgrading the Controller.



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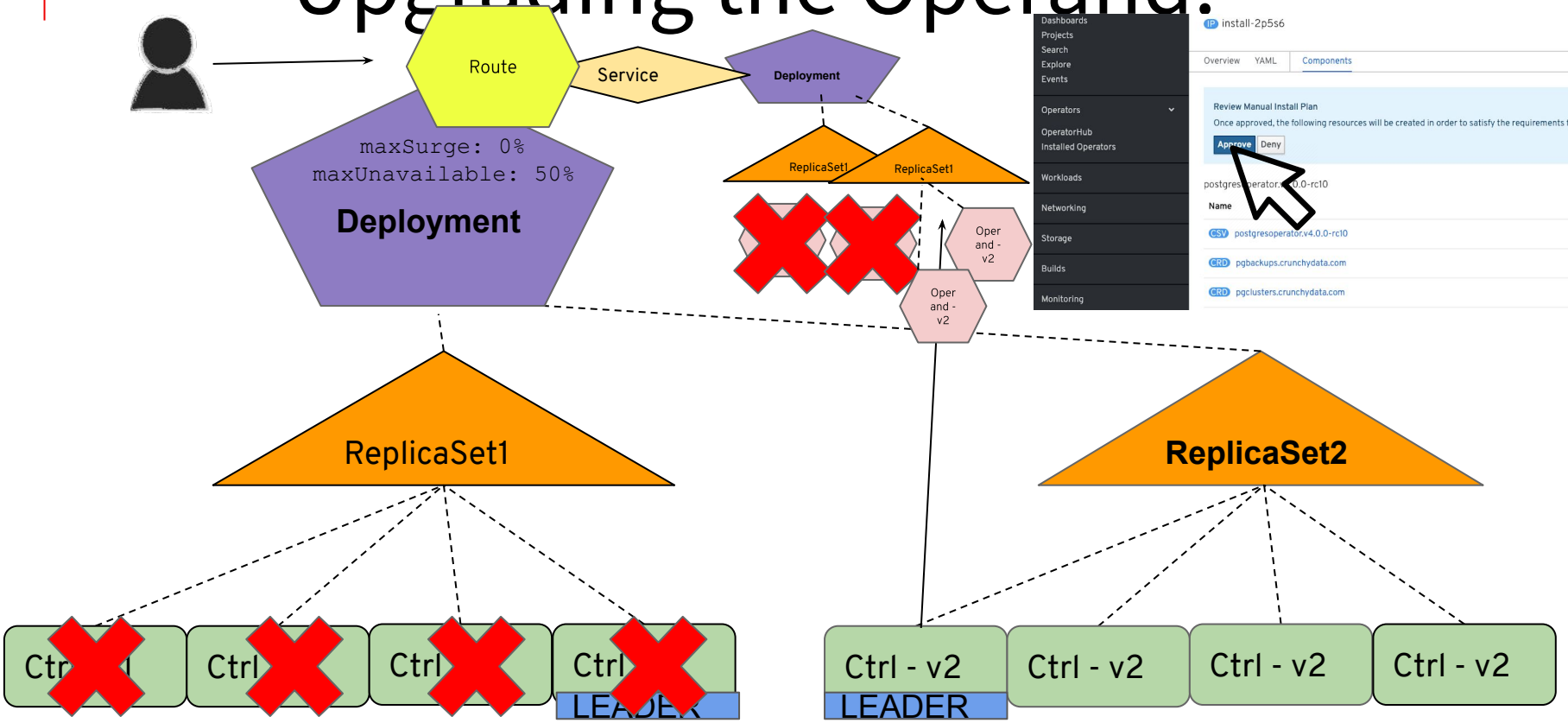
Upgrading the Operand.



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Upgrading the CRD

```
apiVersion: stable.example.com/v1alpha1
kind: CronTab
metadata:
  name: cr1
  namespace: default
spec:
  hostPort: localhost:8080
```

```
apiVersion: stable.example.com/v1alpha2
kind: CronTab
metadata:
  name: cr1
  namespace: default
spec:
  host: localhost
  port: 8080
```

```
Kind: CustomResourceDefinition
metadata:
  name: crontabs.stable.example.com
spec:
  group: stable.example.com
  versions:
  - name: v1alpha1
    served: true
    storage: true
  scope: Namespaced
  names:
    plural: crontabs
    singular: crontab
    kind: CronTab
    shortNames:
    - ct
  validation:
    openAPIV3Schema:
      type: object
      properties:
        spec:
          type: object
          properties:
            hostPort:
              type: string
```

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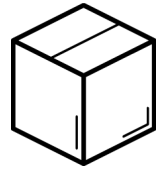
Upgrading the CRD

OPERATOR LIFECYCLE MANAGER

metadata



package

```
 Kind: CustomResourceDefinition
metadata:
  name: crontabs.stable.example.com
spec:
...
  - name: v1alpha1
    served: true
    storage: true
  scope: Namespaced
  names:
    plural: crontabs
    singular: crontab
    kind: CronTab
    shortNames:
    - ct
  - name: v1alpha2
    served: true
    storage: true
    schema:
      openAPIV3Schema:
        type: object
        properties:
          spec:
            type: object
            properties:
              host:
                type: string
              port:
                type: string
```

/apis/stable.example.com/v1alpha2/namespaces/default/crontabs/cr1

Webhook

Ctrl - v2

```
apiVersion:
stable.example.com/v1alpha2
kind: CronTab
metadata:
  name: cr1
  namespace: default
spec:
  host: localhost
  port: 8080
```

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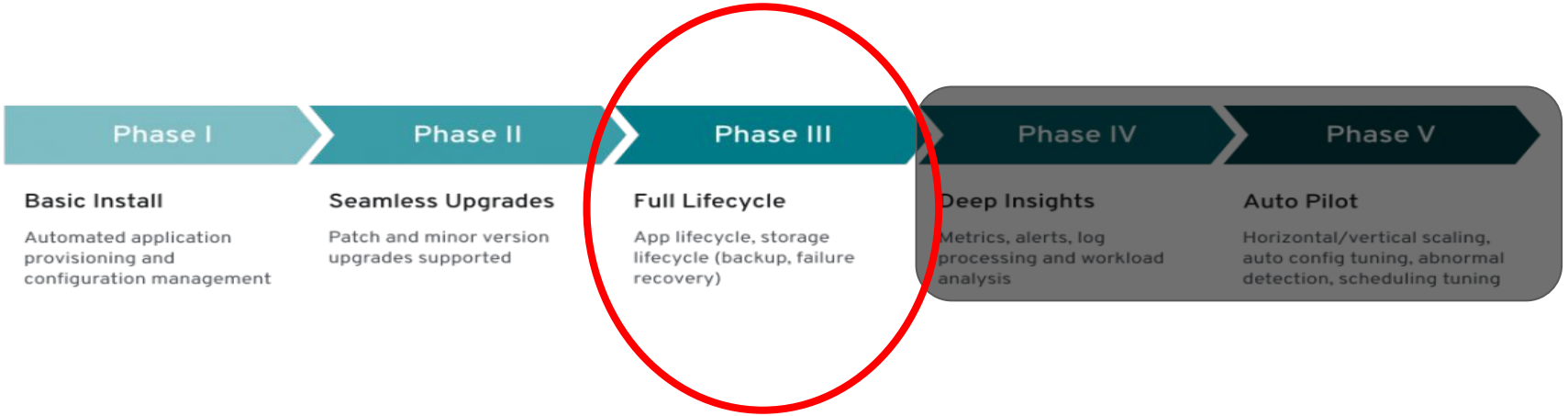
Level 3: Full Lifecycle (Backup & Restore)



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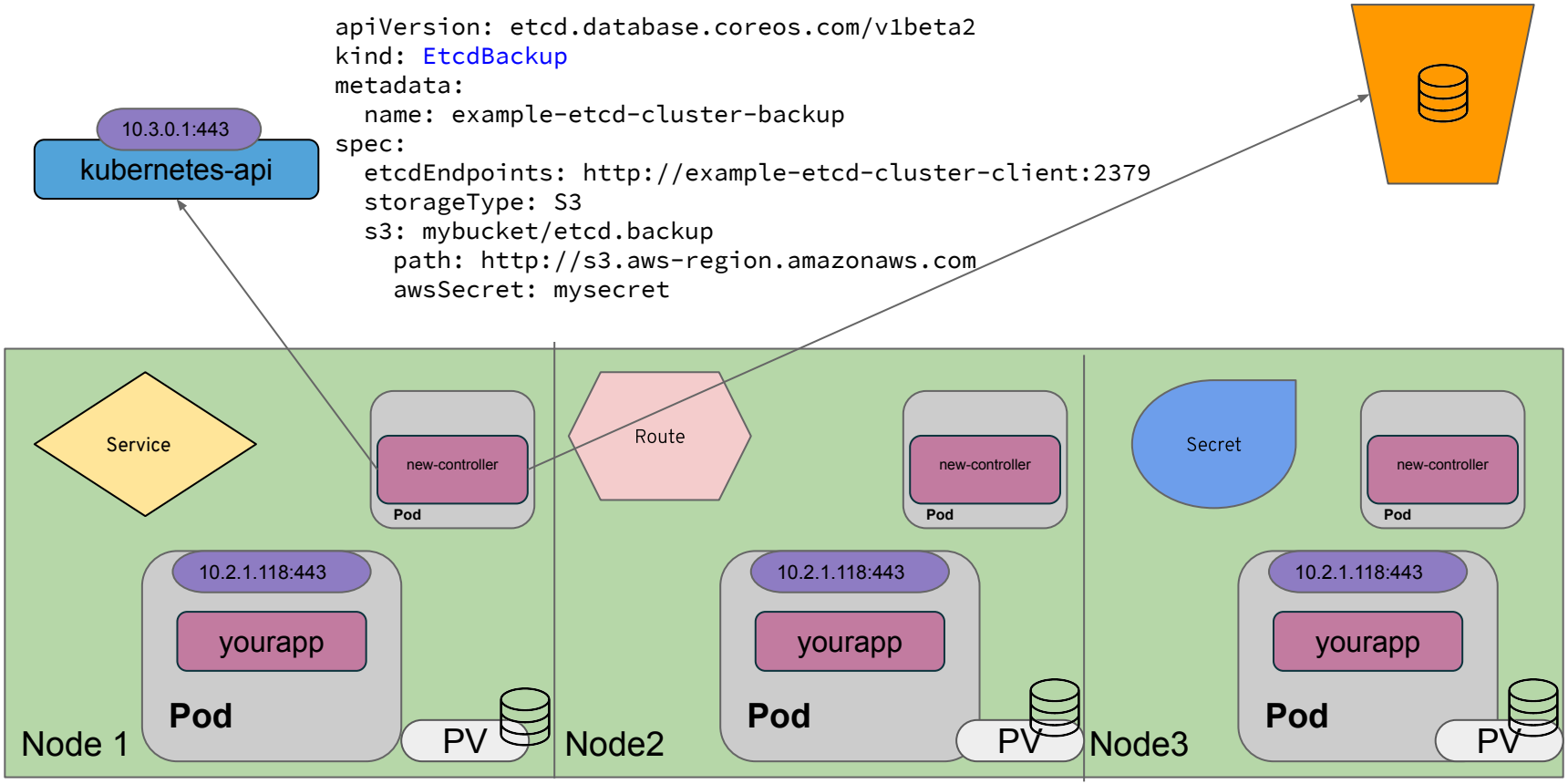
Operator Backup

```
apiVersion: etcd.database.coreos.com/v1beta2
kind: EtcdBackup
metadata:
  name: example-etcd-cluster-backup
spec:
  etcdEndpoints: http://example-etcd-cluster-client:2379
  storageType: S3
  s3: mybucket/etcd.backup
    path: http://s3.aws-region.amazonaws.com
    awsSecret: mysecret
```



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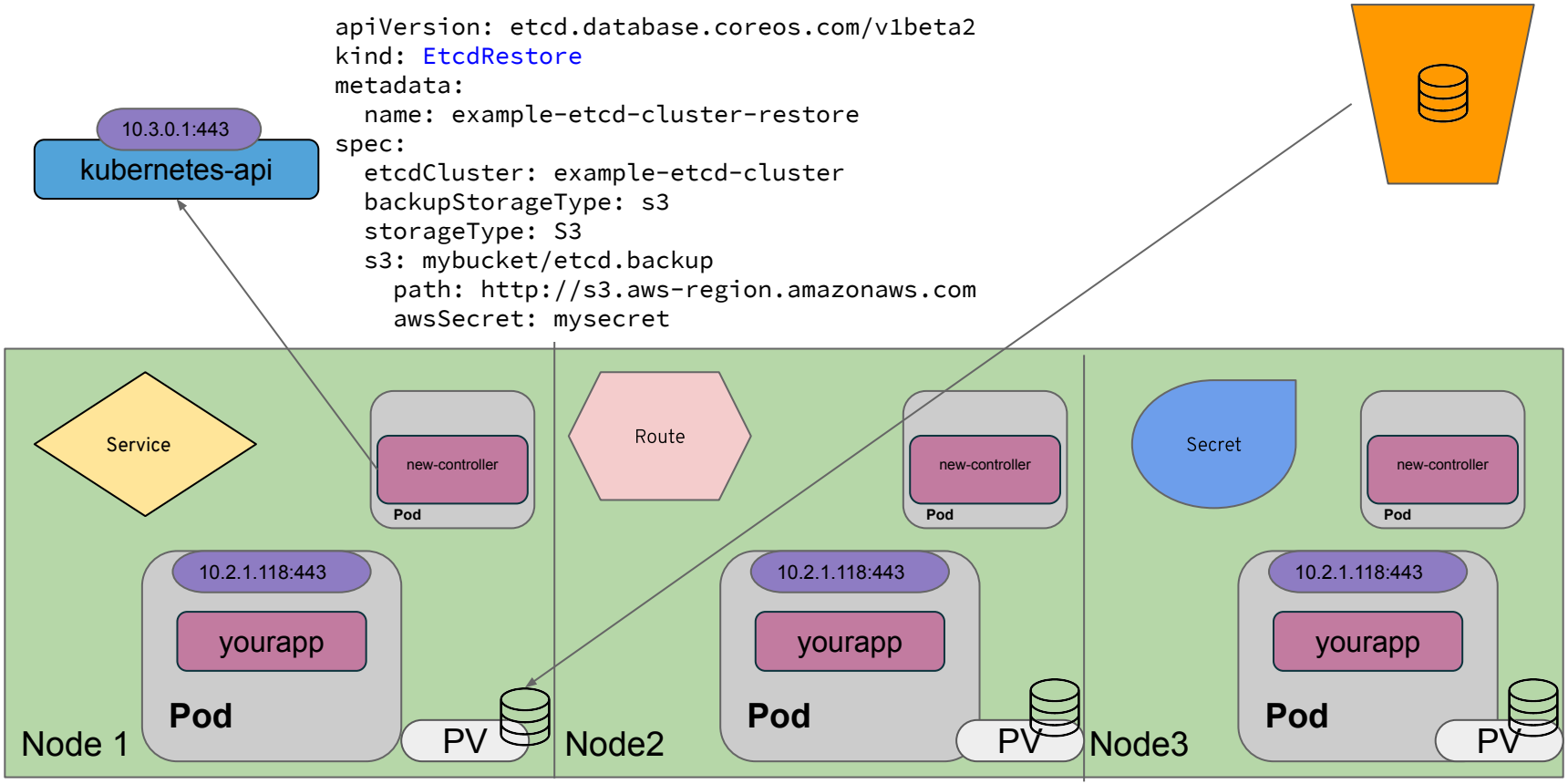
Operator Restore

```
apiVersion: etcd.database.coreos.com/v1beta2
kind: EtcdRestore
metadata:
  name: example-etcd-cluster-restore
spec:
  etcdCluster: example-etcd-cluster
  backupStorageType: s3
  storageType: S3
  s3: mybucket/etcd.backup
    path: http://s3.aws-region.amazonaws.com
    awsSecret: mysecret
```



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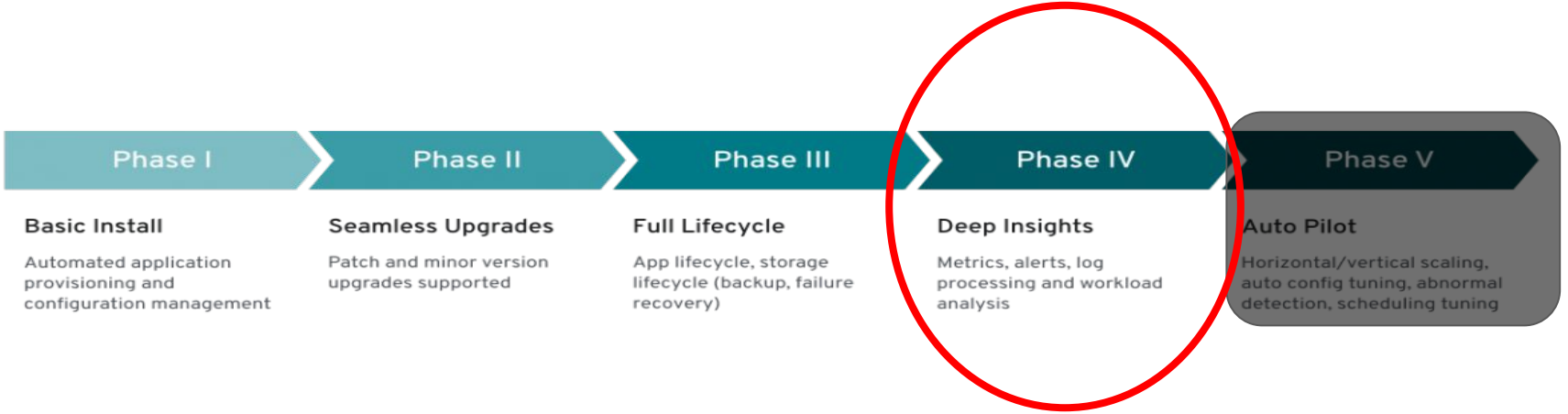
Level 4: Deep Insights



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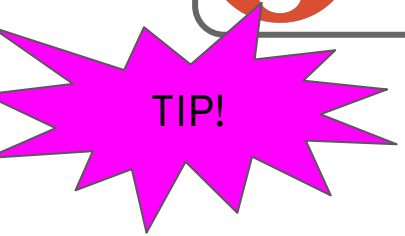
Deep Insights = Observability

Observability = Metrics, Logs, Kubernetes Events, Tracing, Profiling, etc.

Level 4: Metrics!



Always register a Prometheus `/metrics` endpoint for your Operator and Operand.

Operator-SDK does this for you and will automatically give you some default metrics including kube-state-metrics (8383/metrics)

Operator-SDK will expose that endpoint via a Service and allows you to easily create a ServiceMonitor for Prometheus Operator.

You should be utilizing the Prometheus client library to instrument your application with metrics specific to your application. Check out the Prometheus docs.

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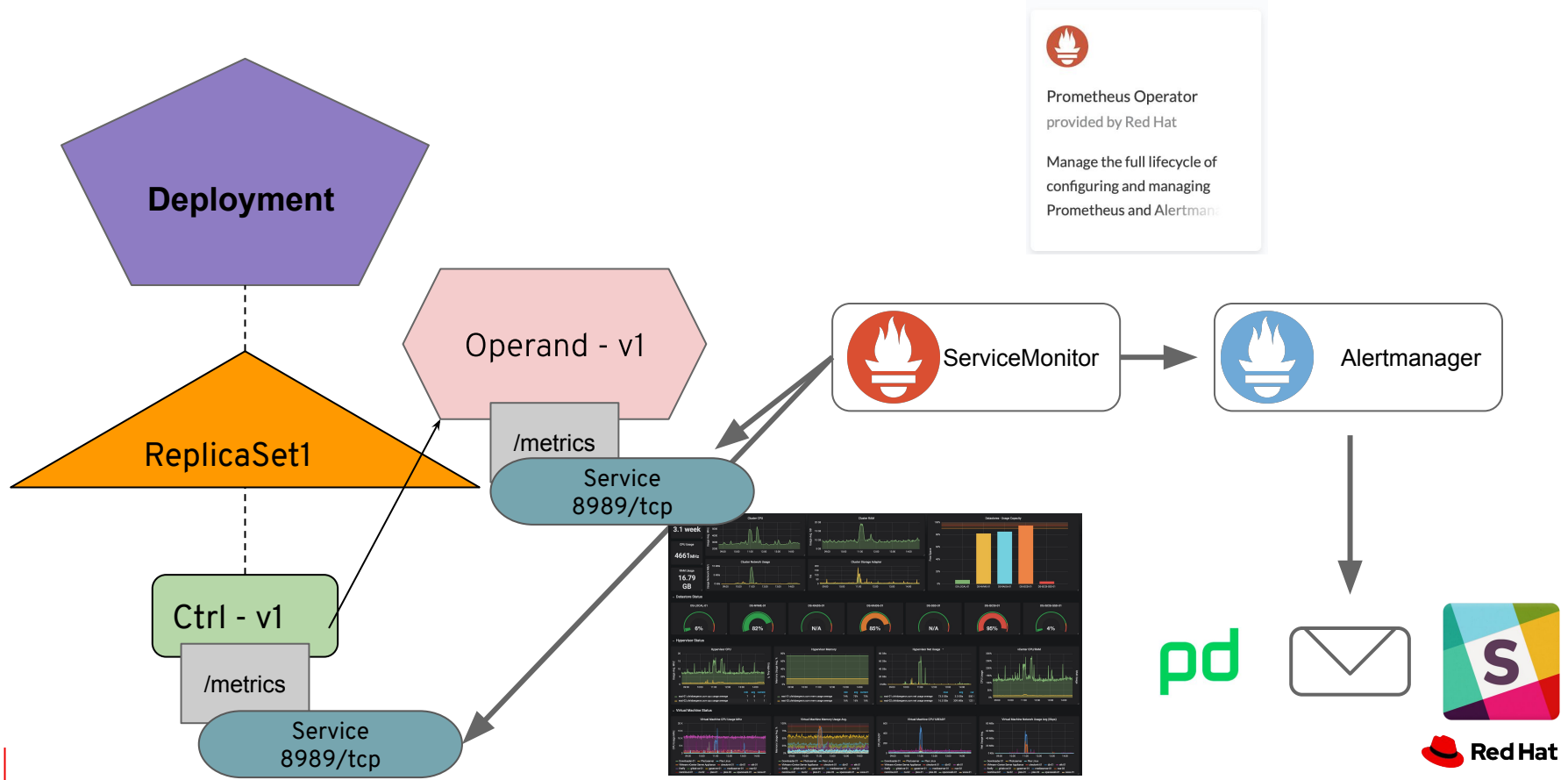
Operator and Operand Metric Endpoints



```
oc describe mycr example
.
.
.
.
.
Events:  <none>
```

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oc describe etcdcluster example

```
Events:
  Type    Reason             Age   From                          Message
  ----    ------             ----  ----                          -------
  Normal  New Member Added  38s   etcd-operator-594fbd565f-r59nh  New member example-p2knrr94d5 added to
cluster
  Normal  New Member Added  22s   etcd-operator-594fbd565f-r59nh  New member example-kx2k2hhft9 added to
cluster
  Normal  New Member Added  6s    etcd-operator-594fbd565f-r59nh  New member example-b2nxkck495 added to
cluster
```

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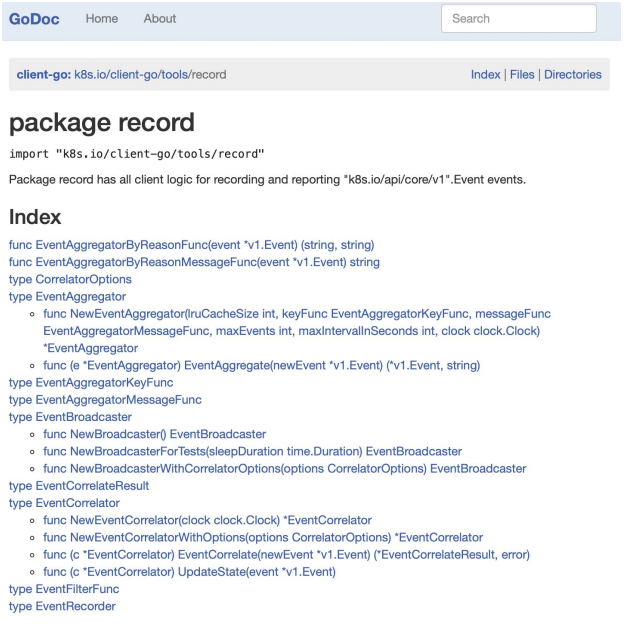
Packages to Write Events

operator-sdk ---------->


GoDoc Home About Search

client-go: k8s.io/client-go/tools/record Index | Files | Directories

package record

```
import "k8s.io/client-go/tools/record"
```

Package record has all client logic for recording and reporting "k8s.io/api/core/v1".Event events.

Index

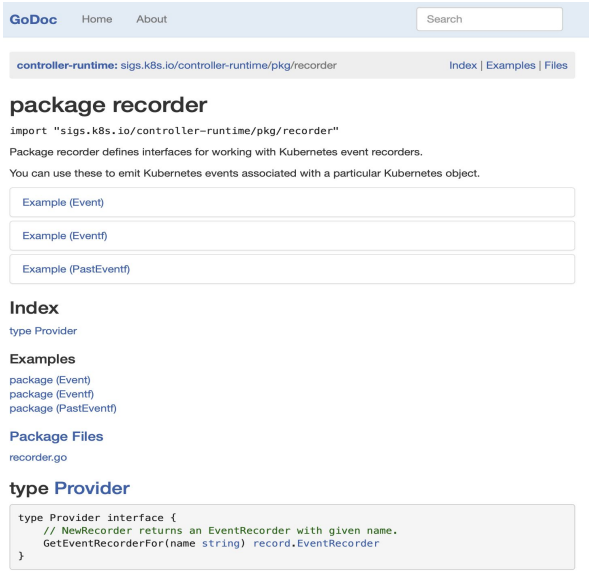
func EventAggregatorByReasonFunc(event *v1.Event) (string, string)
func EventAggregatorByReasonMessageFunc(event *v1.Event) string
type CorrelatorOptions
type EventAggregator
- func NewEventAggregator(lruCacheSize int, keyFunc EventAggregatorKeyFunc, messageFunc EventAggregatorMessageFunc, maxEvents int, maxIntervalInSeconds int, clock clock.Clock) *EventAggregator
- func (e *EventAggregator) EventAggregate(newEvent *v1.Event) (*v1.Event, string)

type EventAggregatorKeyFunc
type EventAggregatorMessageFunc
type EventBroadcaster
- func NewBroadcaster() EventBroadcaster
- func NewBroadcasterForTests(sleepDuration time.Duration) EventBroadcaster
- func NewBroadcasterWithCorrelatorOptions(options CorrelatorOptions) EventBroadcaster

type EventCorrelateResult
type EventCorrelator
- func NewEventCorrelator(clock clock.Clock) *EventCorrelator
- func NewEventCorrelatorWithOptions(options CorrelatorOptions) *EventCorrelator
- func (c *EventCorrelator) EventCorrelate(newEvent *v1.Event) (*EventCorrelateResult, error)
- func (c *EventCorrelator) UpdateState(event *v1.Event)

type EventFilterFunc
type EventRecorder

<-------- client-go


GoDoc Home About Search

controller-runtime: sigs.k8s.io/controller-runtime/pkg/recorder Index | Examples | Files

package recorder

```
import "sigs.k8s.io/controller-runtime/pkg/recorder"
```

Package recorder defines interfaces for working with Kubernetes event recorders.

You can use these to emit Kubernetes events associated with a particular Kubernetes object.

Example (Event)

Example (Eventf)

Example (PastEventf)

Index

type Provider

Examples

package (Event)
package (Eventf)
package (PastEventf)

Package Files

recorder.go

type Provider

```
type Provider interface {
    // NewRecorder returns an EventRecorder with given name.
    GetEventRecorderFor(name string) record.EventRecorder
}
```

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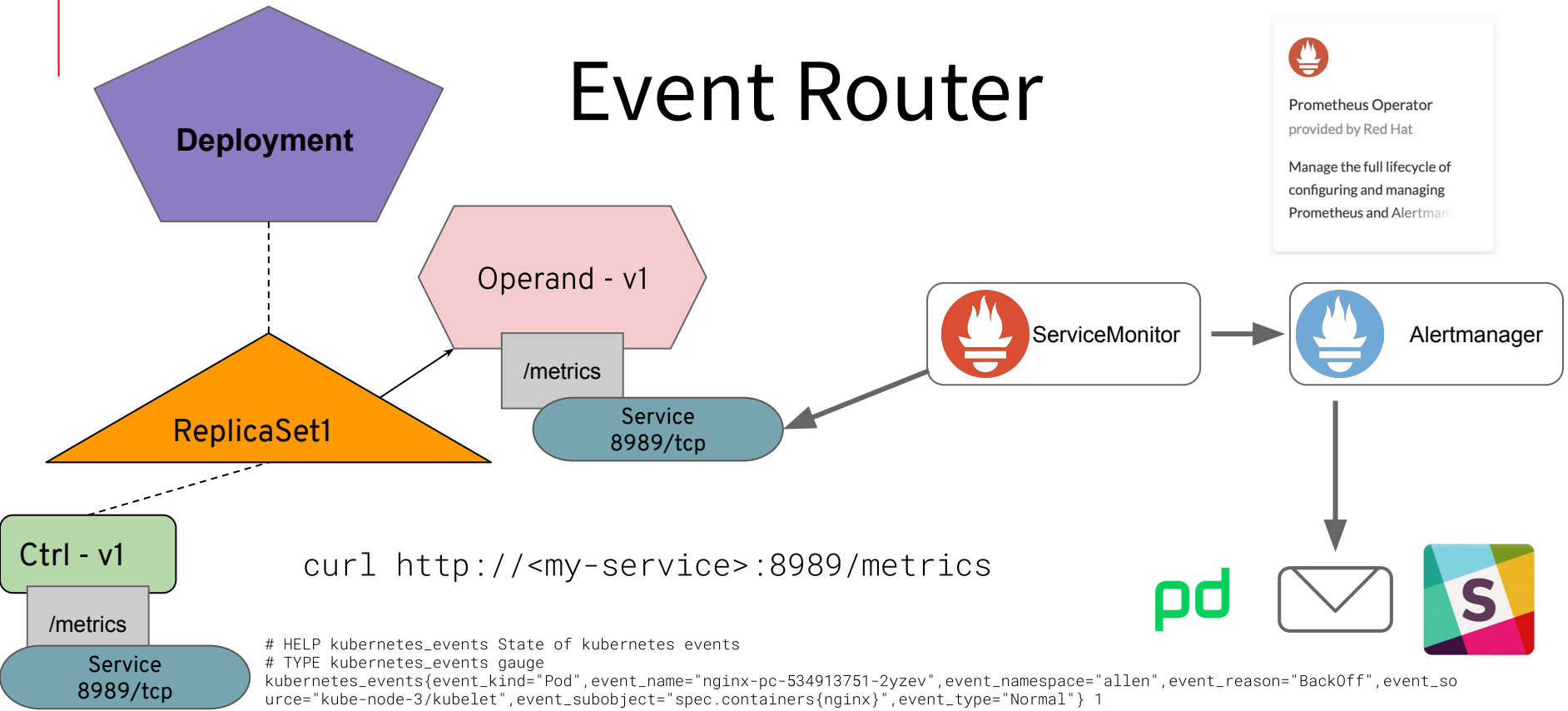
Event Router




```
curl http://<my-service>:8989/metrics
```

```
# HELP kubernetes_events State of kubernetes events
# TYPE kubernetes_events gauge
kubernetes_events{event_kind="Pod",event_name="nginx-pc-534913751-2yzev",event_namespace="allen",event_reason="BackOff",event_source="kube-node-3/kubelet",event_subobject="spec.containers{nginx}",event_type="Normal"} 1
kubernetes_events{event_kind="Pod",event_name="nginx-pc-534913751-2yzev",event_namespace="allen",event_reason="Failed",event_source="kube-node-3/kubelet",event_subobject="spec.containers{nginx}",event_type="Warning"} 0
kubernetes_events{event_kind="Pod",event_name="nginx-pc-534913751-2yzev",event_namespace="allen",event_reason="FailedSync_ErrImagePull",event_source="kube-node-3/kubelet",event_subobject="",event_type="Warning"} 0
```

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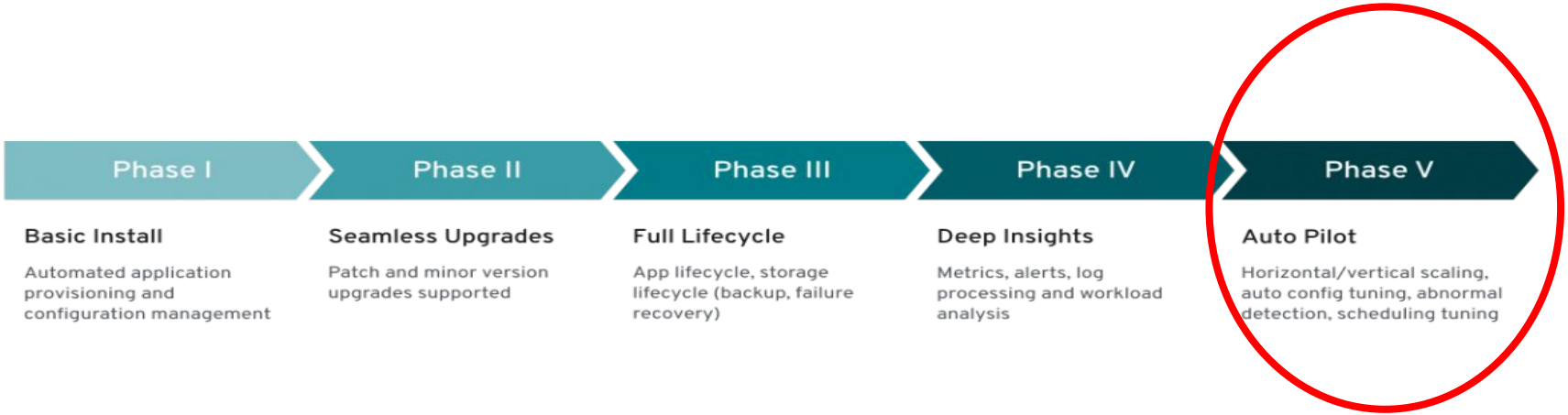
Level 5: AutoPilot



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Level 5: AutoPilot!!!

- **AUTO-SCALE**
  - Operator can scale the Operand based of:
    - CPU/Memory (Horizontal Pod Autoscaler, Vertical Pod Autoscaler)
    - # of schedulable nodes/cores (Cluster Proportional Autoscaler)
    - Custom Metrics (HPA + Prometheus Adapter)
- **AUTO-HEAL**
  - Operator runs a series of health checks and customized resolutions against operand (beyond the native liveness/readiness probes).
- **AUTO-TUNE**
  - Query metrics-server and Prometheus to tune Operand for ideal performance.

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THANK YOU!

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