Introducing KUDO

Kubernetes Operators - The Easy Way

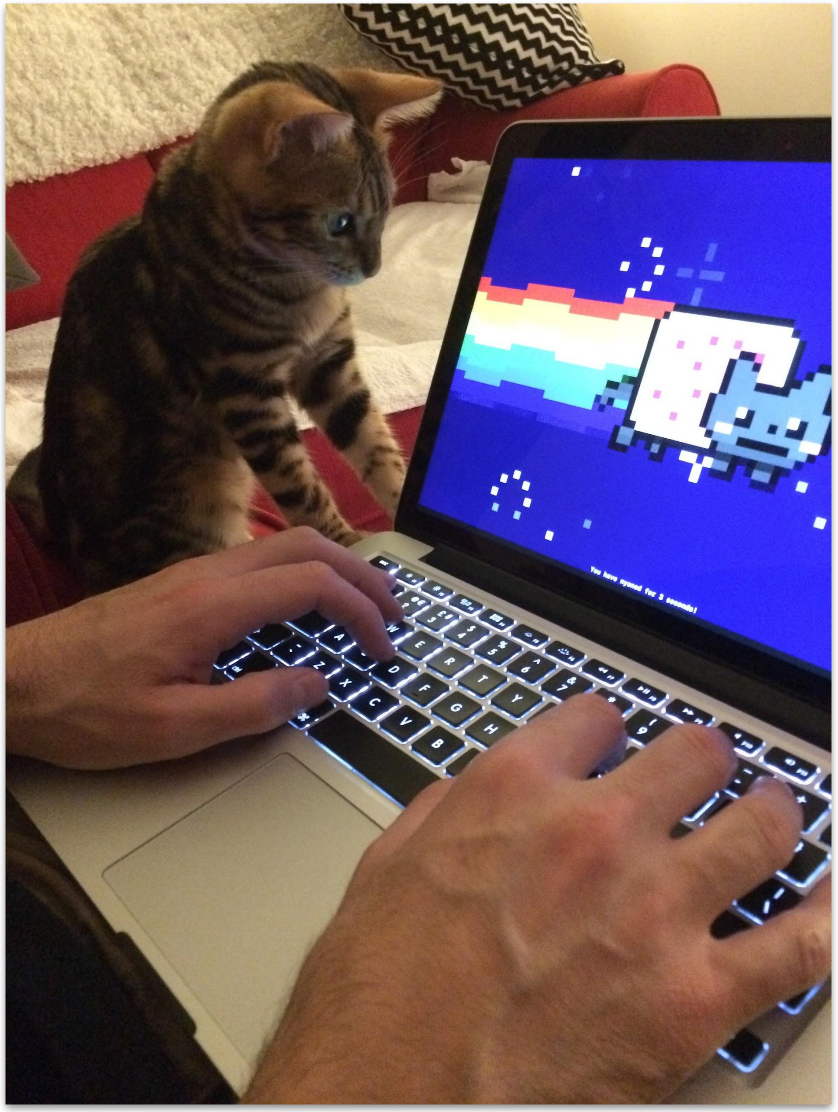
Nick Jones, D2iQ

$ whoami

Nick Jones

- Community Engineering Lead @ D2iQ
- Building stuff with open source software for ~20 years
- Ops, Dev and Dev/Ops
- Relatively new to Kubernetes
- … but not new to Ops
- Likes cats

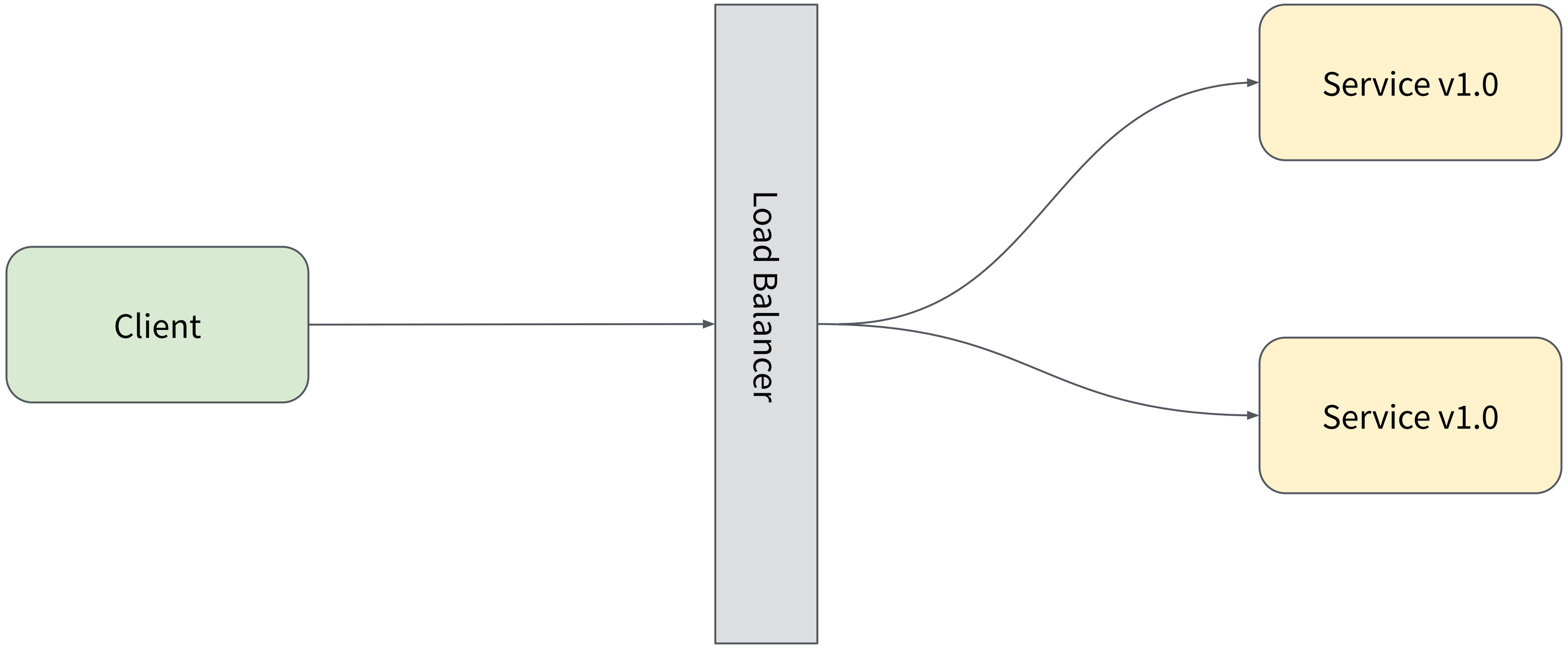
@yankcrime yankcrime



Overview

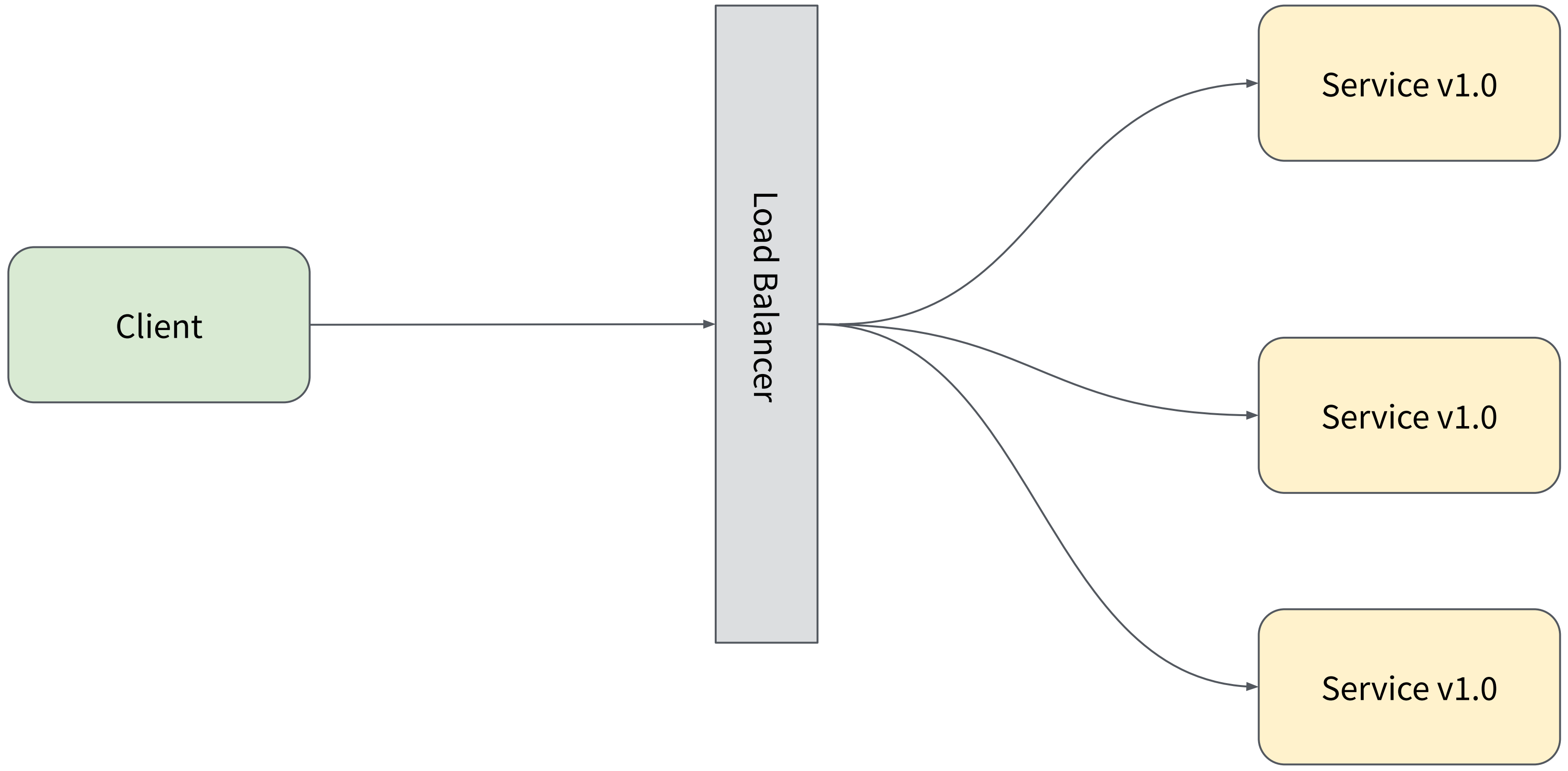
- Stateful vs. Stateless
- Kubernetes StatefulSets
- Kubernetes Operators
- KUDO
    - Background
    - Concepts
    - Demo 🤞
    - Future
    - Getting involved

Stateless Applications



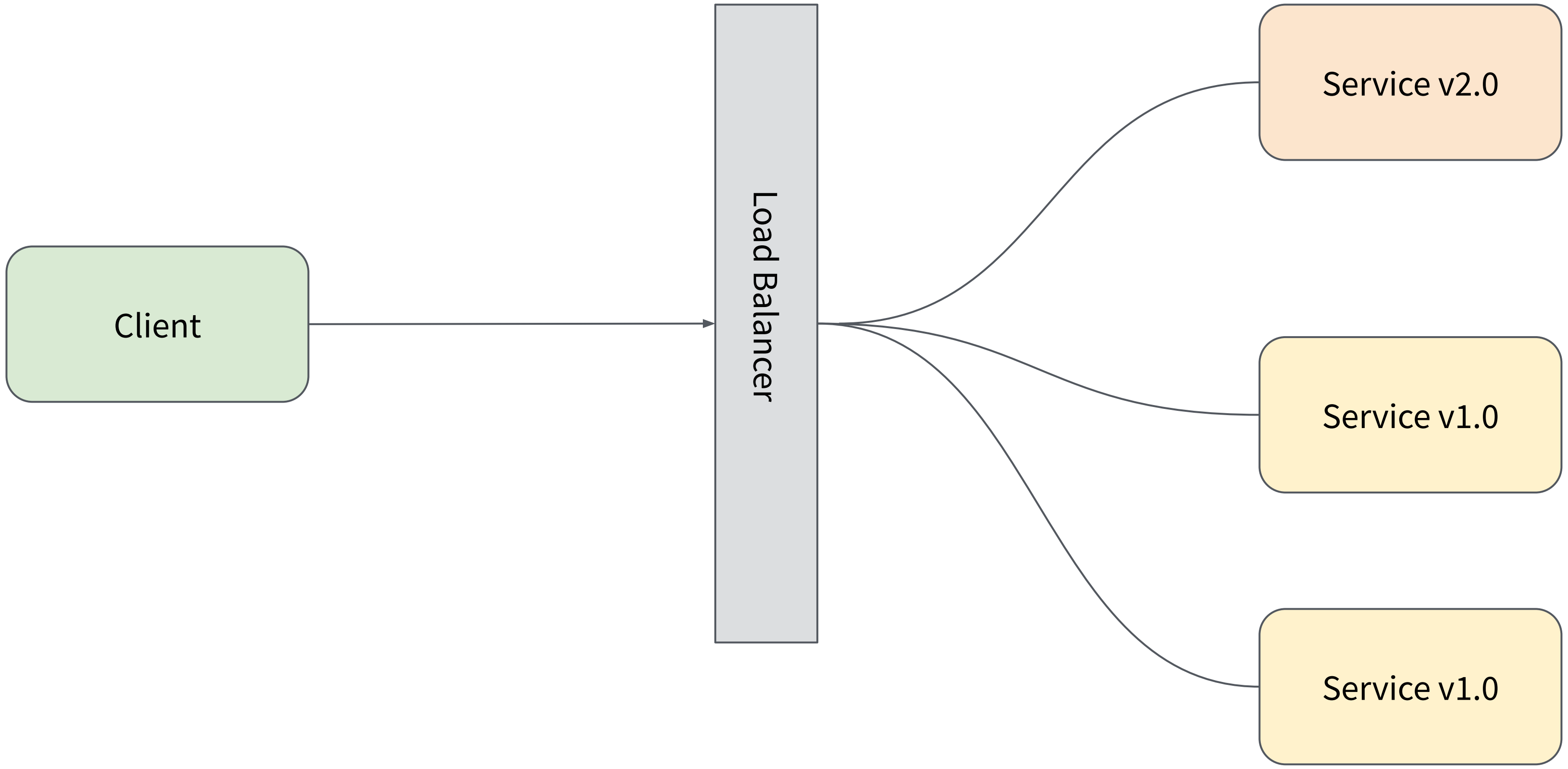
- No state persisted

Stateless Applications



- No state persisted
- Easy to scale up / down

Stateless Applications



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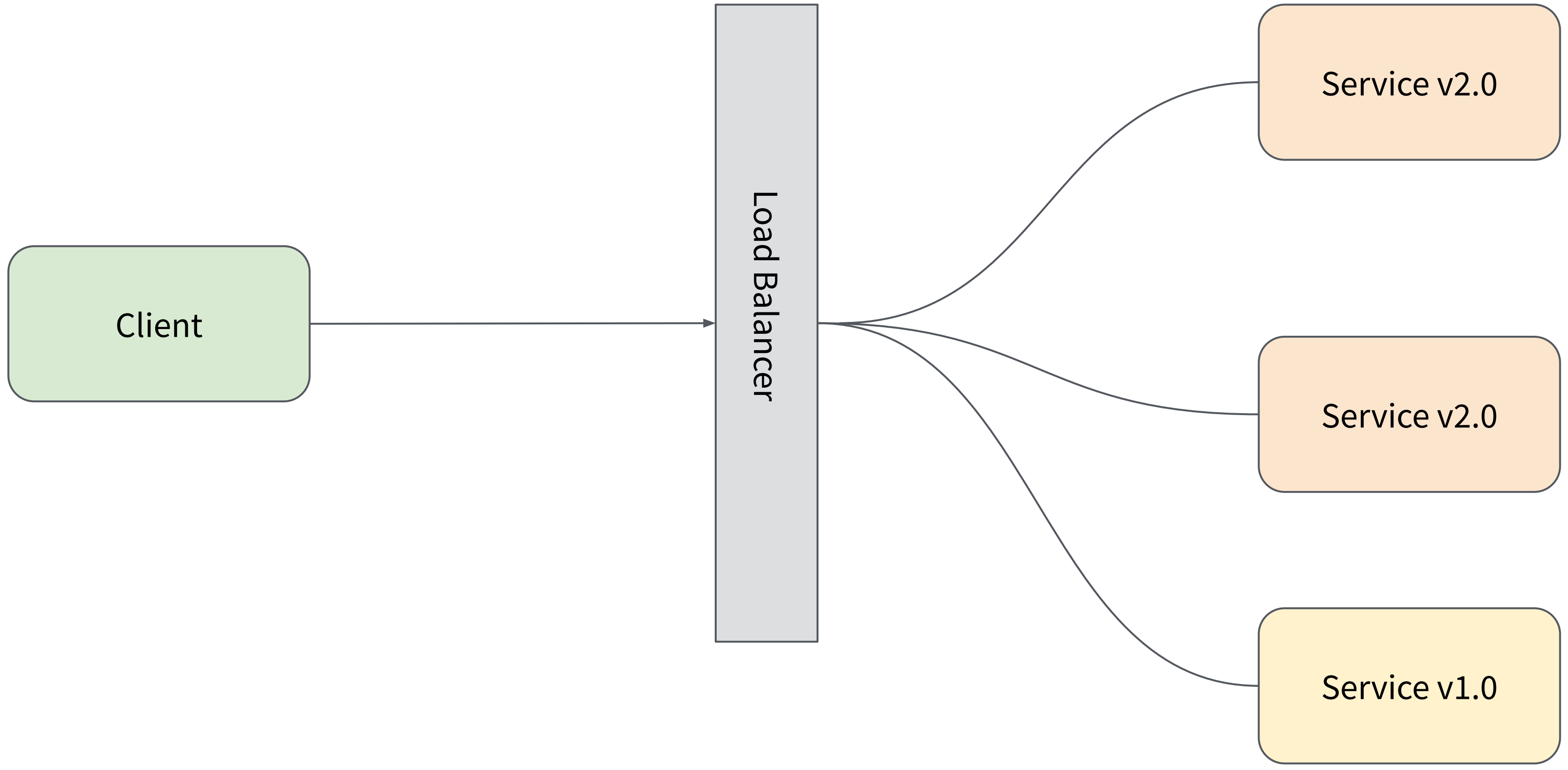

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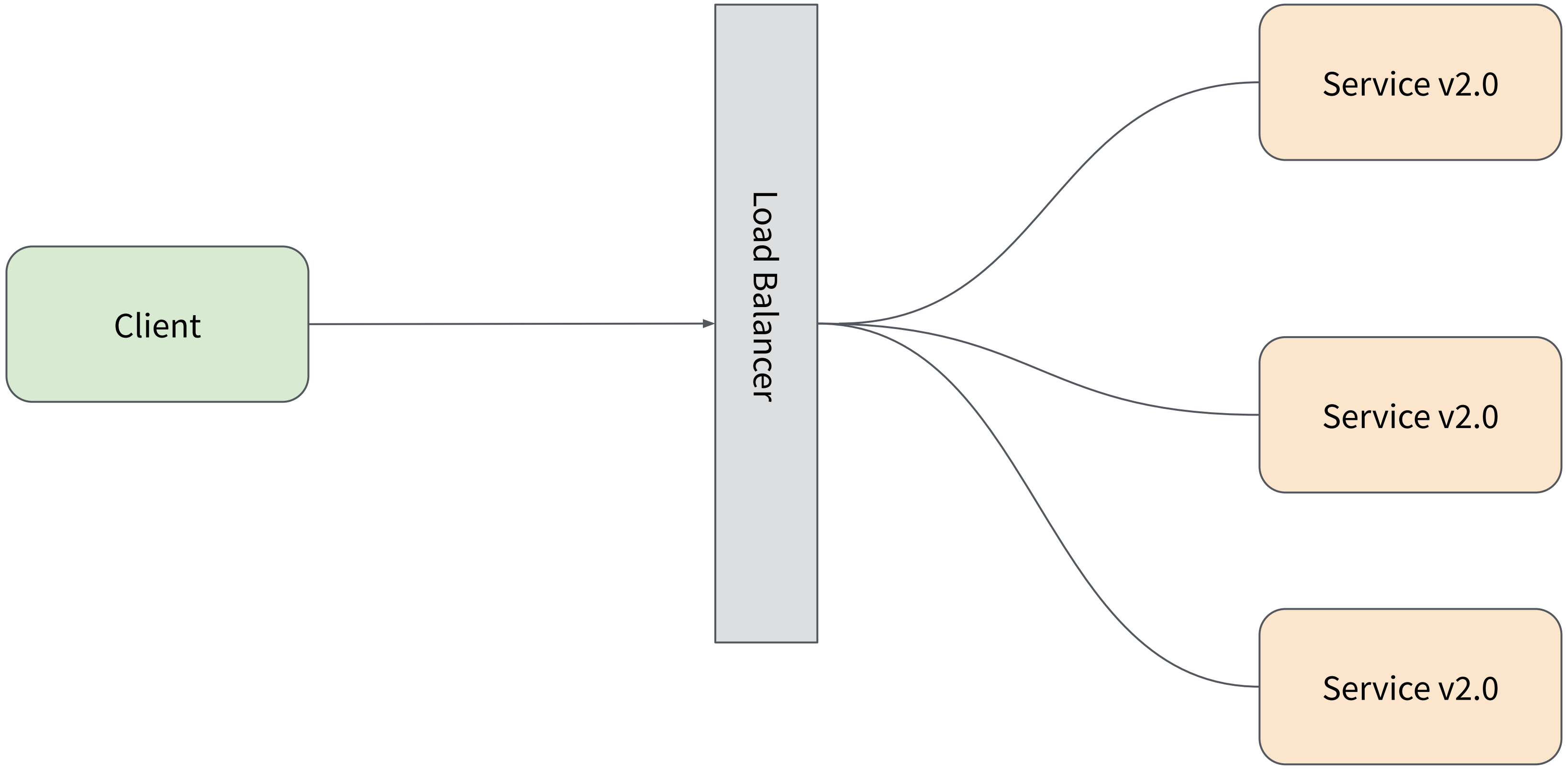
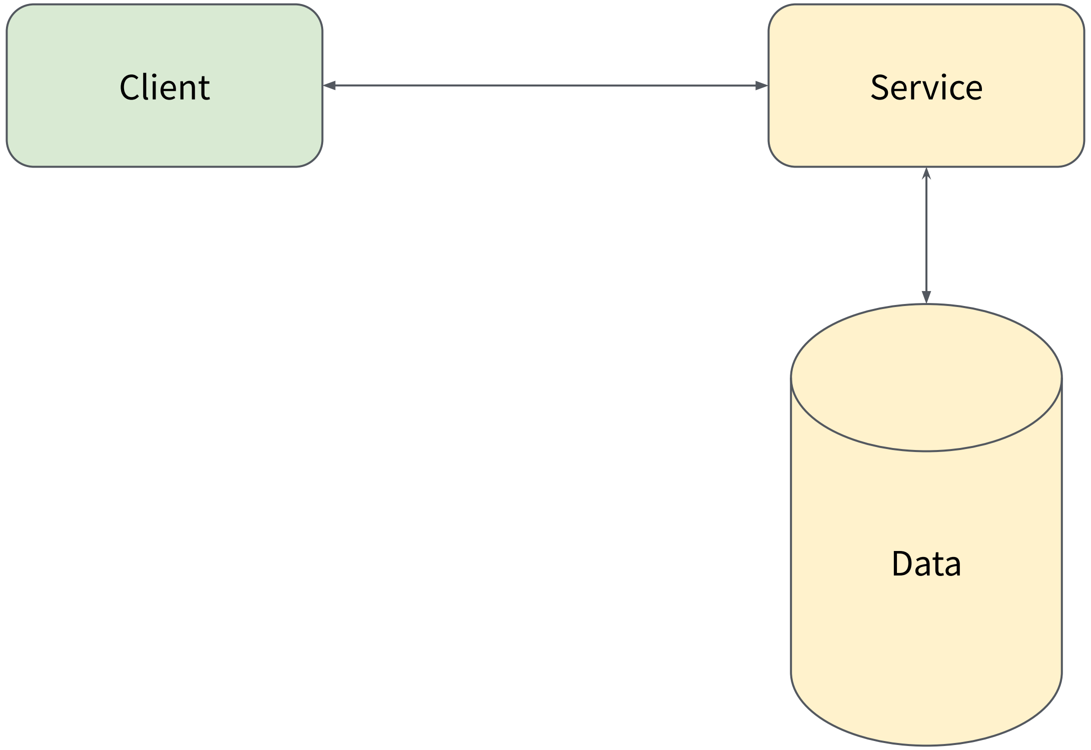
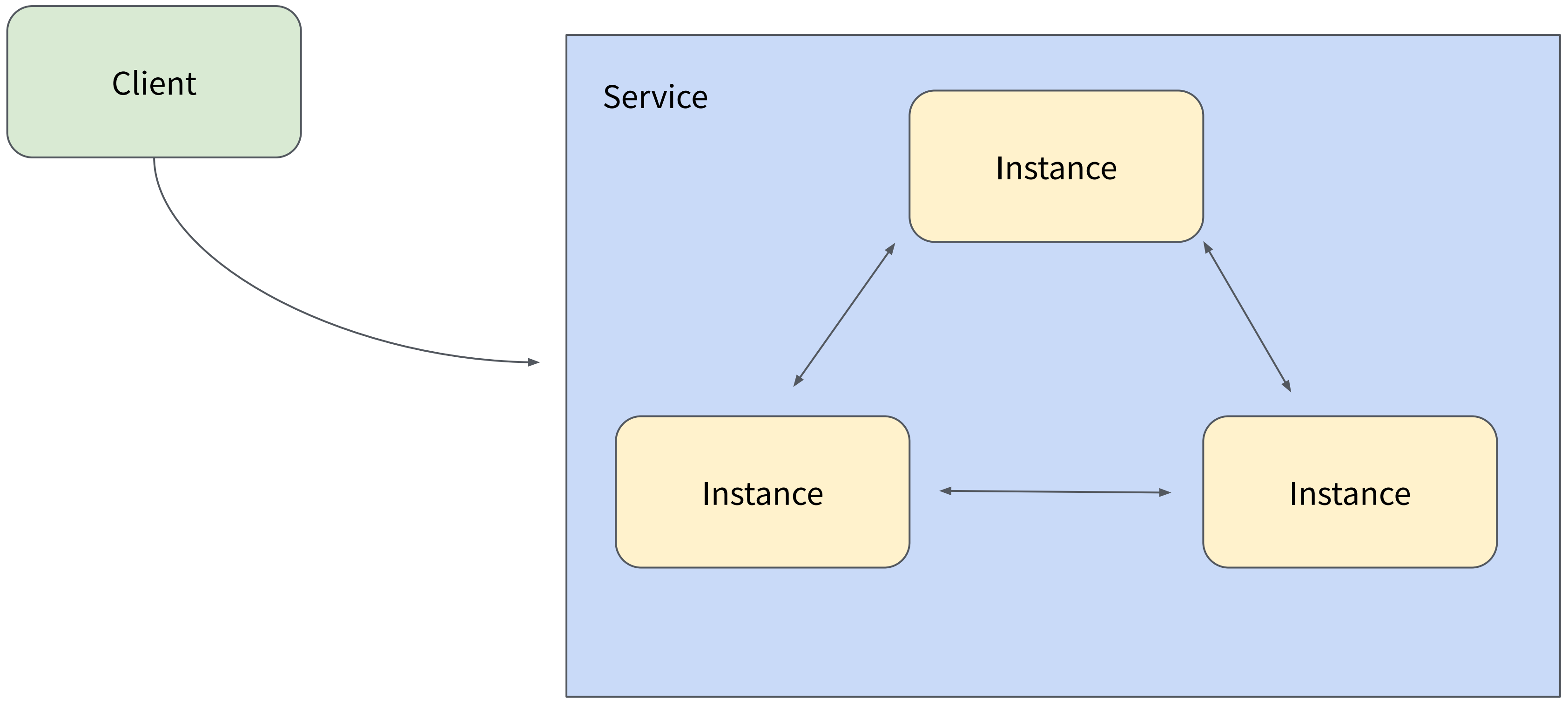


- No state persisted
- Easy to scale up/down
- Straightforward to upgrade

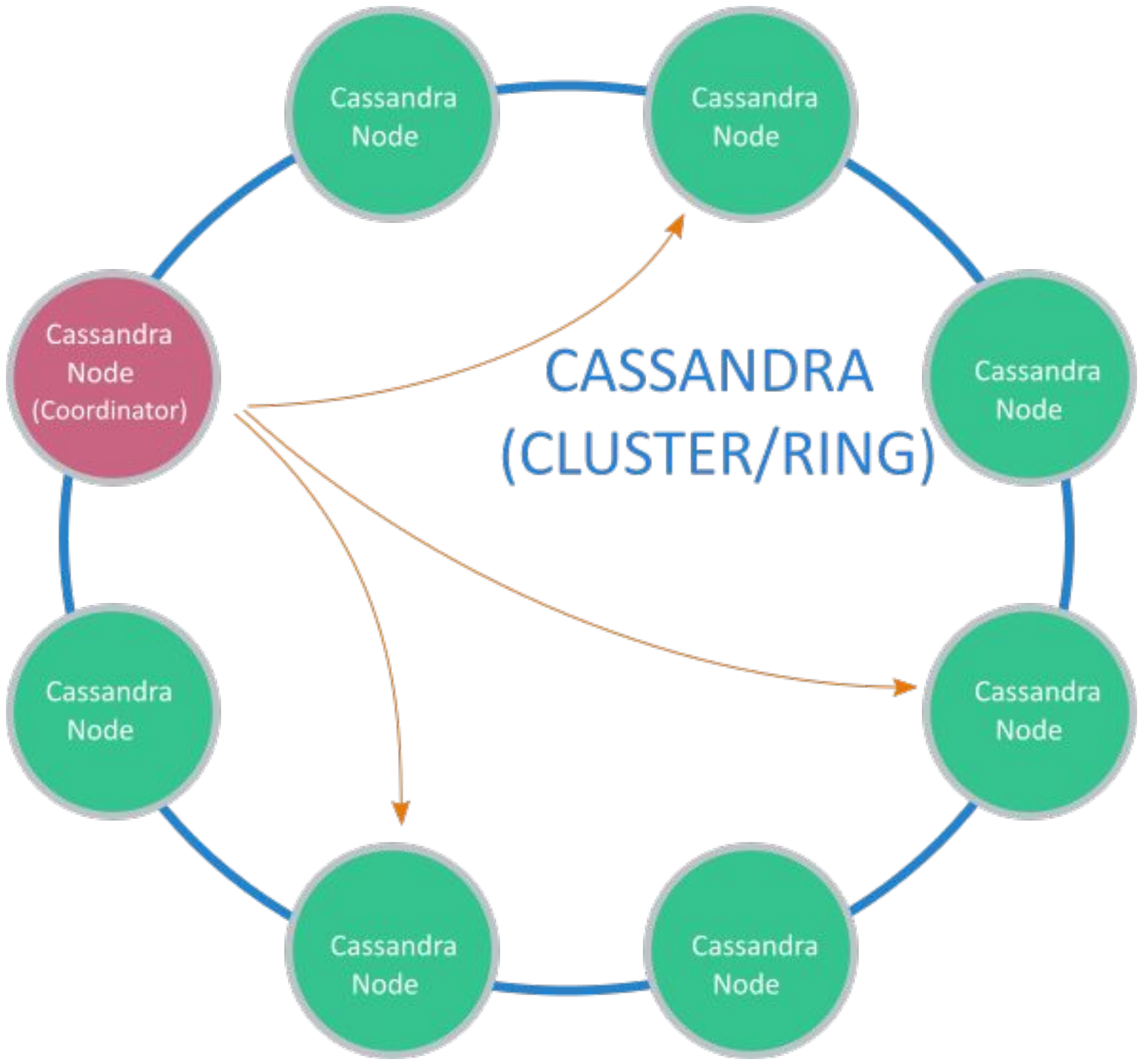
Stateful Applications



Stateful Applications



Distributed Stateful Applications



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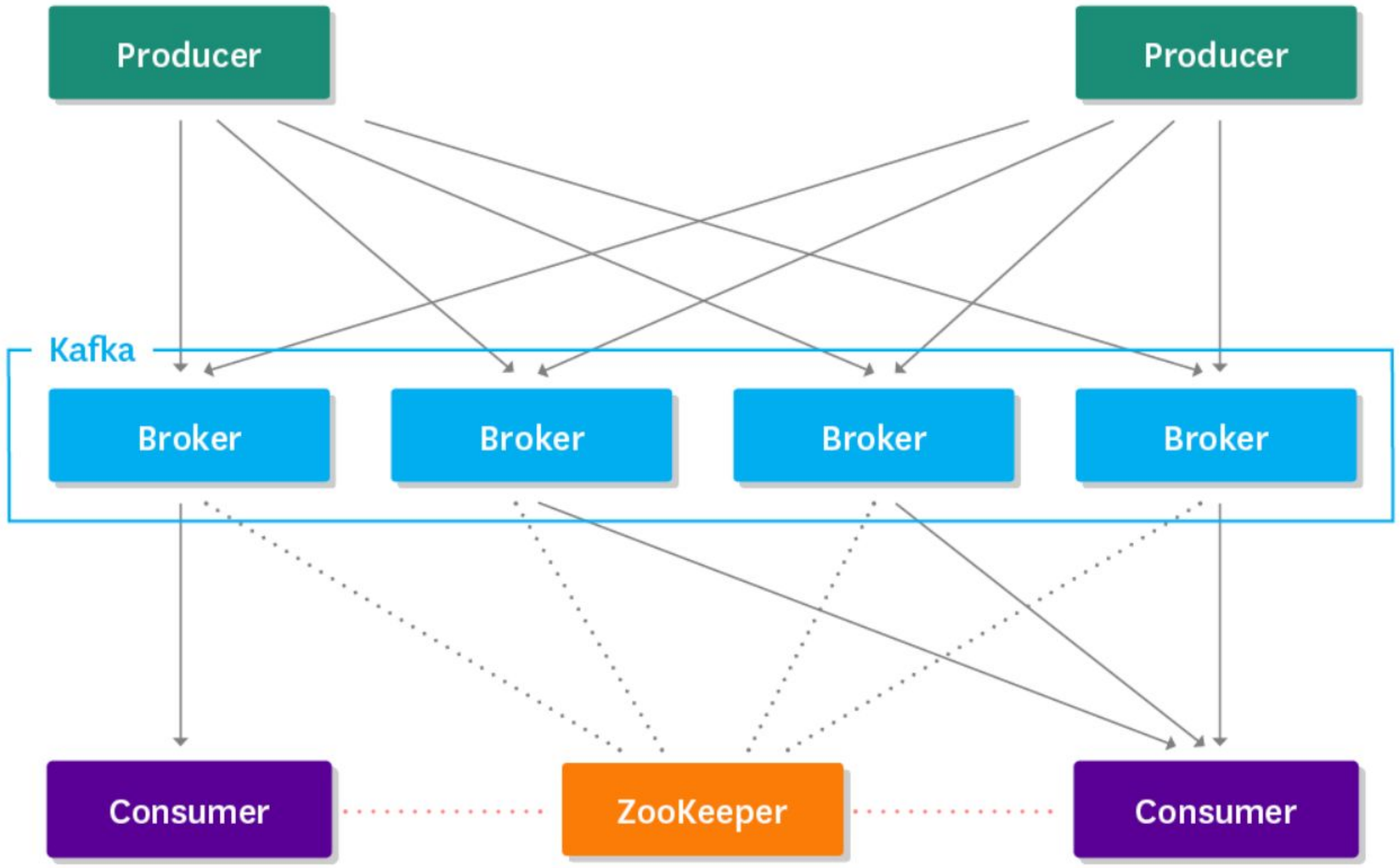


Kubernetes

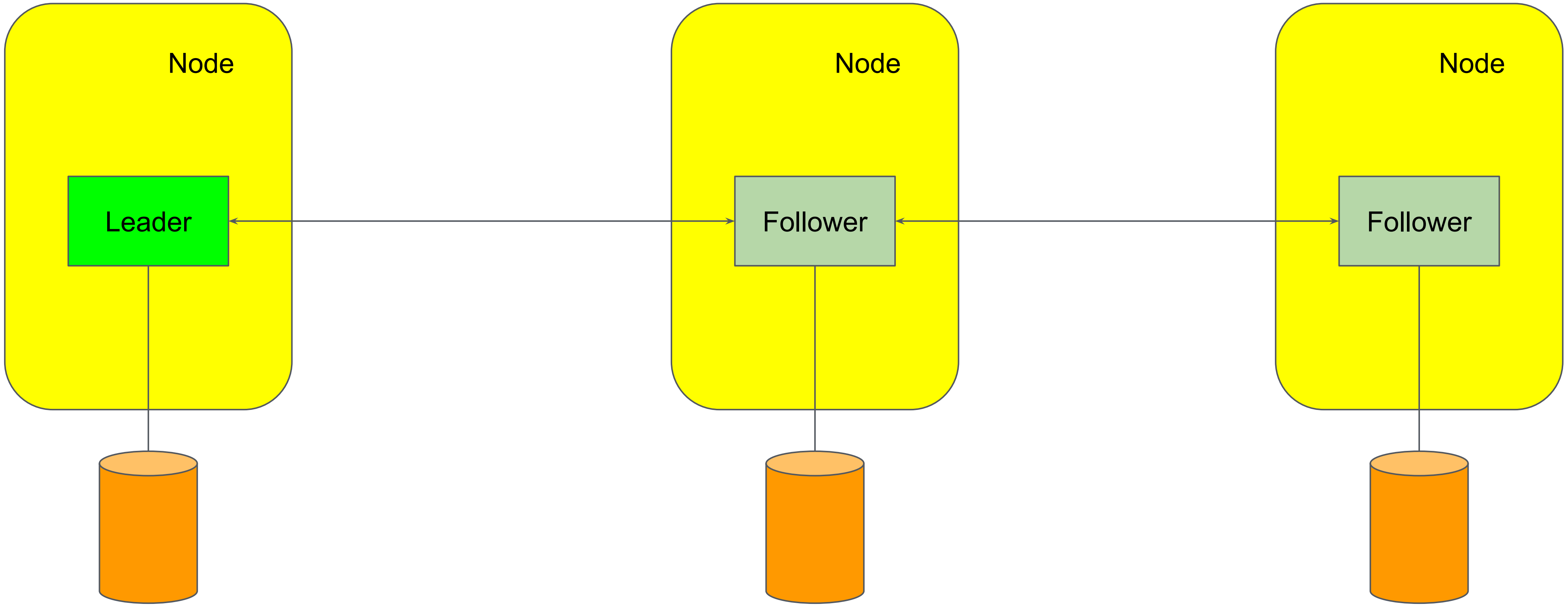
- Focused initially for purely stateless workloads
- Scheduler can move pods around

Kubernetes - StatefulSets

StatefulSets are valuable for applications that require one or more of the following:

- Stable, unique network identifiers.
- Stable, persistent storage.
- Ordered, graceful deployment and scaling.
- Ordered, graceful deletion and termination.
- Ordered, automated rolling updates.

Kubernetes - StatefulSets



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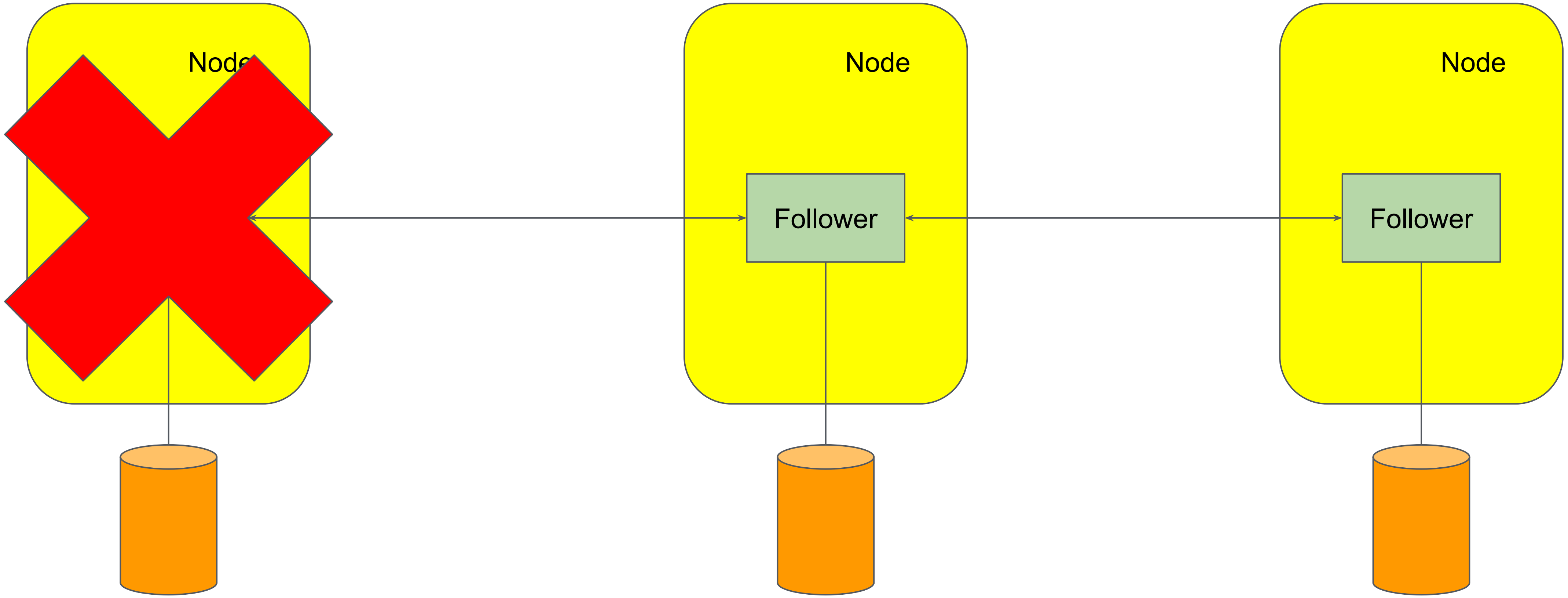

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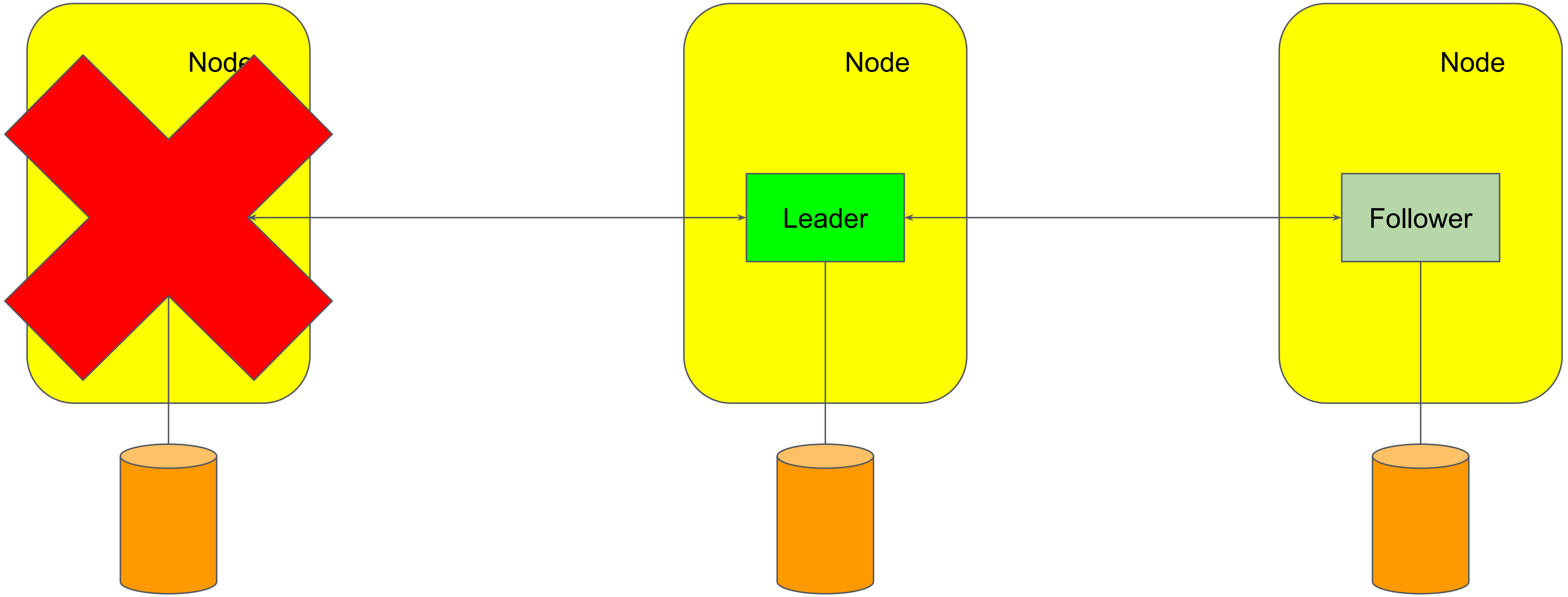

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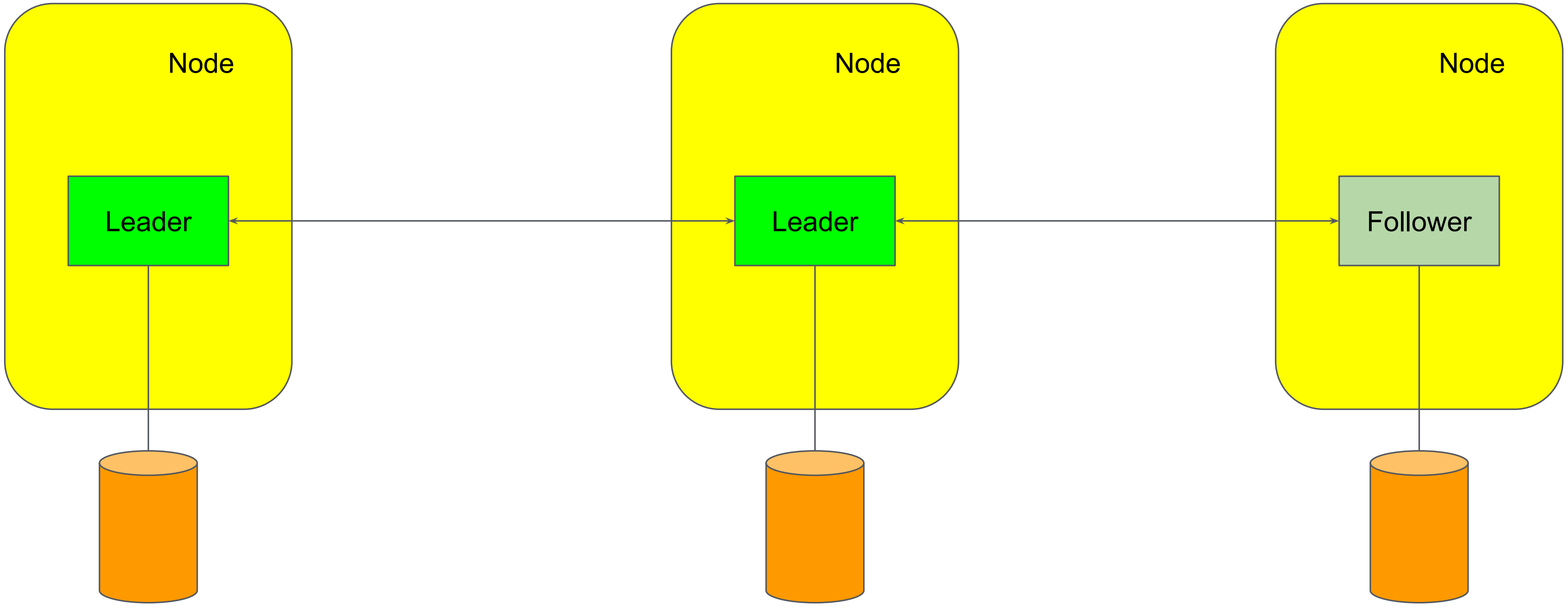

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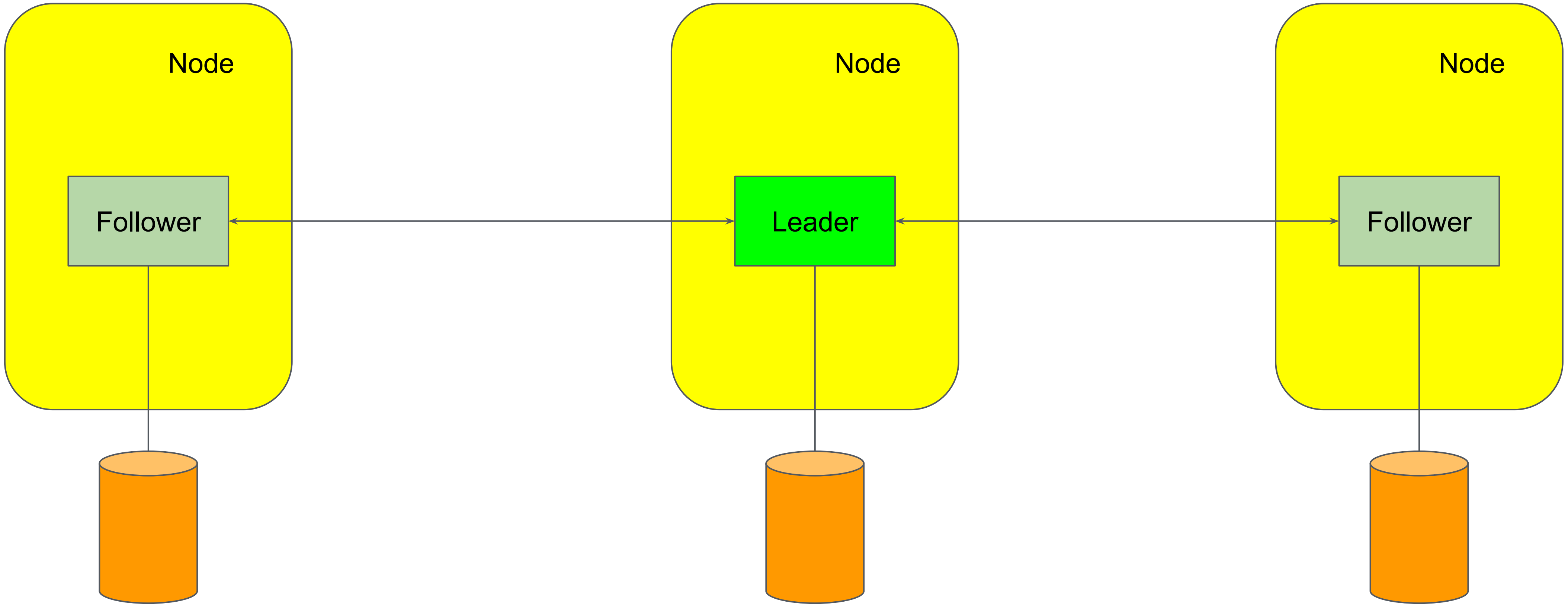
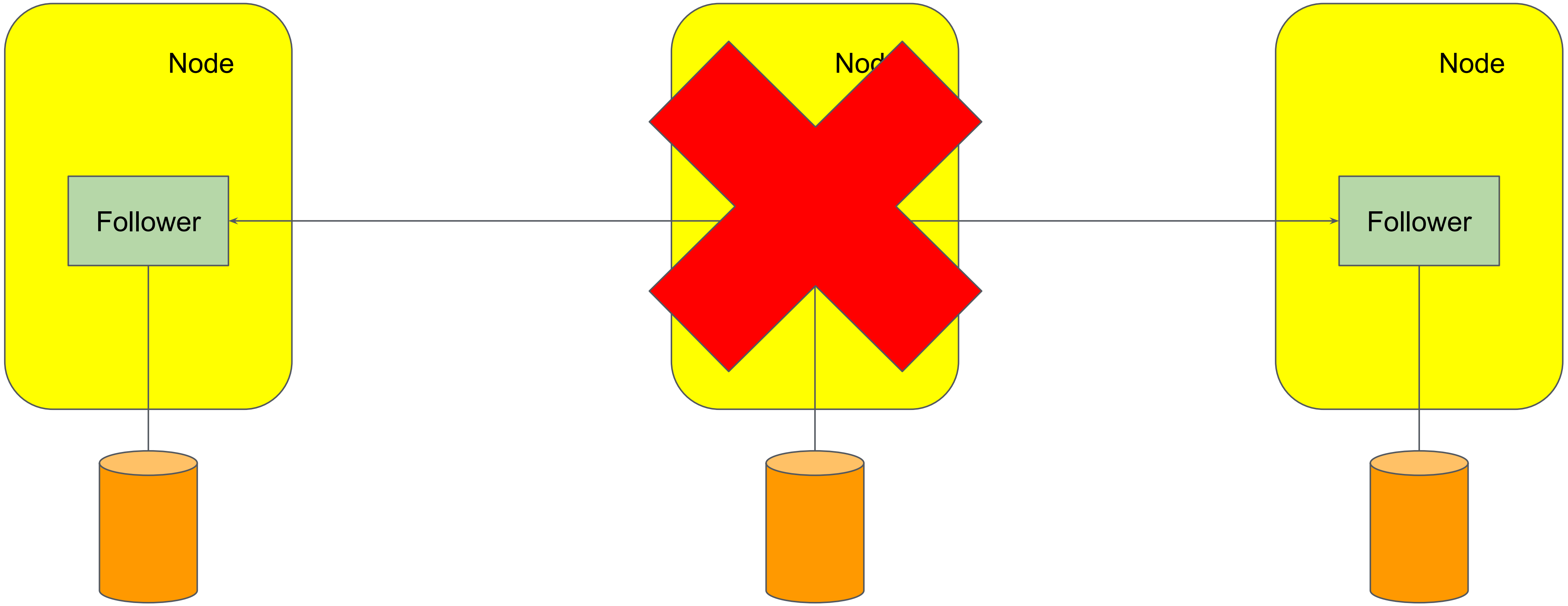
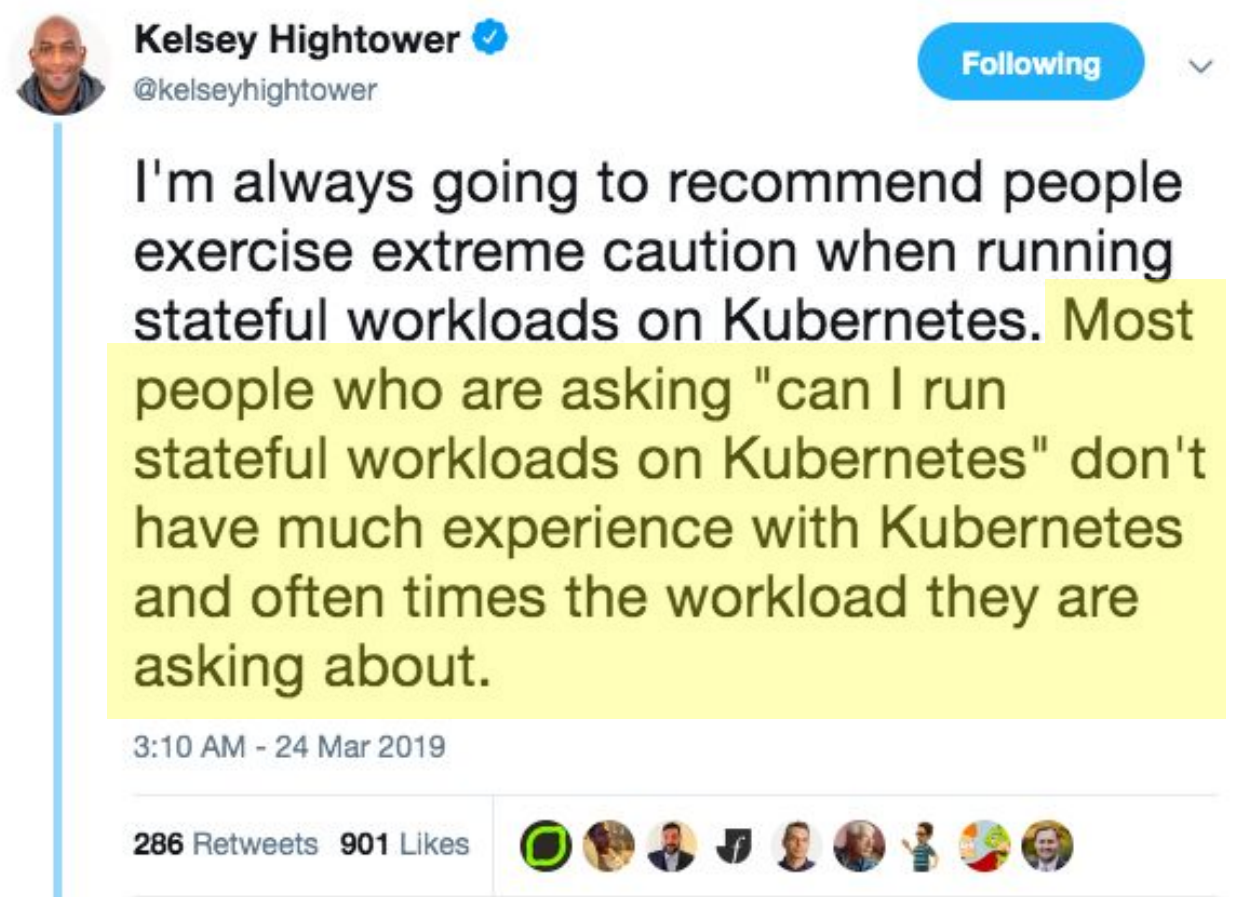


Kubernetes - StatefulSets



Kubernetes


Kelsey Hightower
@kelseyhightower

I'm always going to recommend people exercise extreme caution when running stateful workloads on Kubernetes. Most people who are asking "can I run stateful workloads on Kubernetes" don't have much experience with Kubernetes and often times the workload they are asking about.

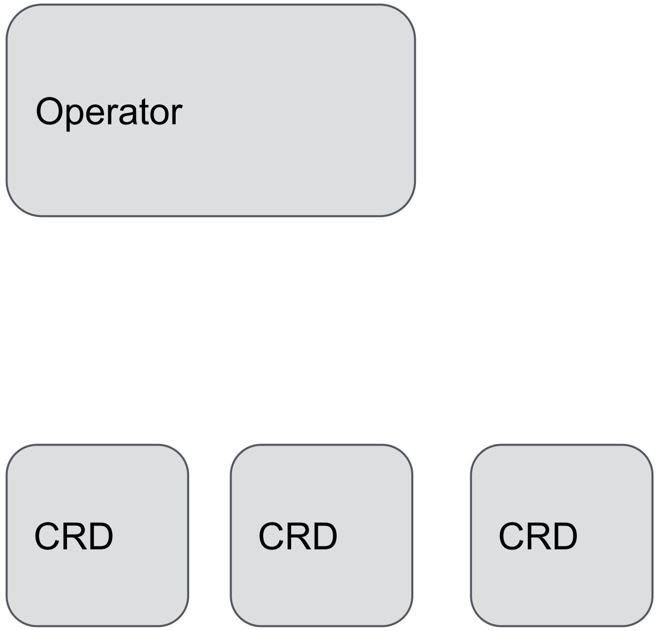
3:10 AM - 24 Mar 2019

286 Retweets 901 Likes

Kubernetes Operators

- Orchestrate stateful applications using K8s API
- Extend API using Custom Resource Definitions
- Encode domain specific operational knowledge
- Upgrades
- Failure and Recovery Scenarios
- Scaling up / down
- Purpose built per application
- “Kubernetes is an Operations API”:
    - https://blog.atomicinc.com/2018/05/23/kubernetes-is-an-operations-api/

Kubernetes Operators



- Operator manages and monitors lifecycle
- CRD’s represent application elements / actions

```
apiVersion:
mysql.presslabs.org/v1alpha1
kind: MysqlCluster
metadata:
  name: my-cluster
spec:
  replicas: 2
  secretName: my-secret
```

```
$ kubectl apply -f mysql-cluster.yaml
```

Developing Operators

Operator Framework

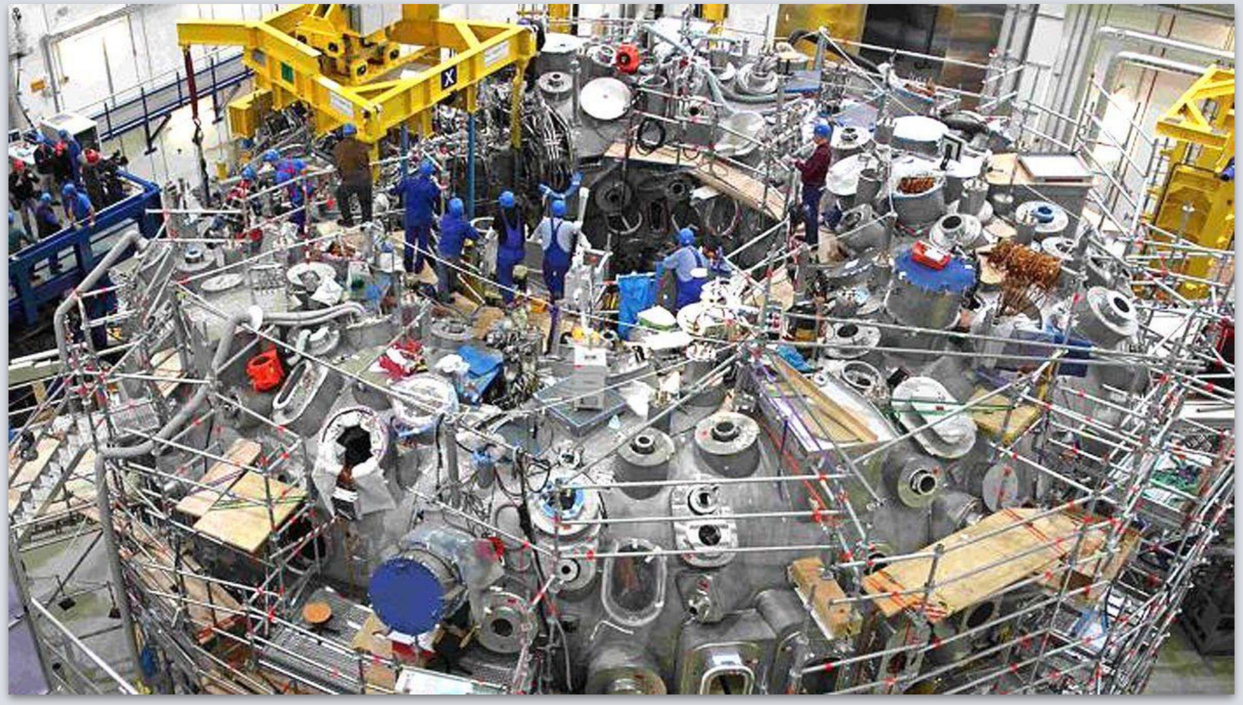
- RedHat / IBM project
- Implement using Ansible, Helm charts, or Go
- Existing implementations often don’t cover the entire lifecycle
- Ansible and Helm are limited. Go requires 1,000s of lines of controller code

Kubebuilder

- Kubernetes SIG API Machinery sub-project
- Operators written in Go with a focus on code generation
- Existing implementations often don’t cover the entire lifecycle

Developing Operators

- Operators require deep knowledge of Kubernetes internals
- Significant software development undertaking
- May require (10s of) thousands of lines of code
- Controller sprawl can be a thing



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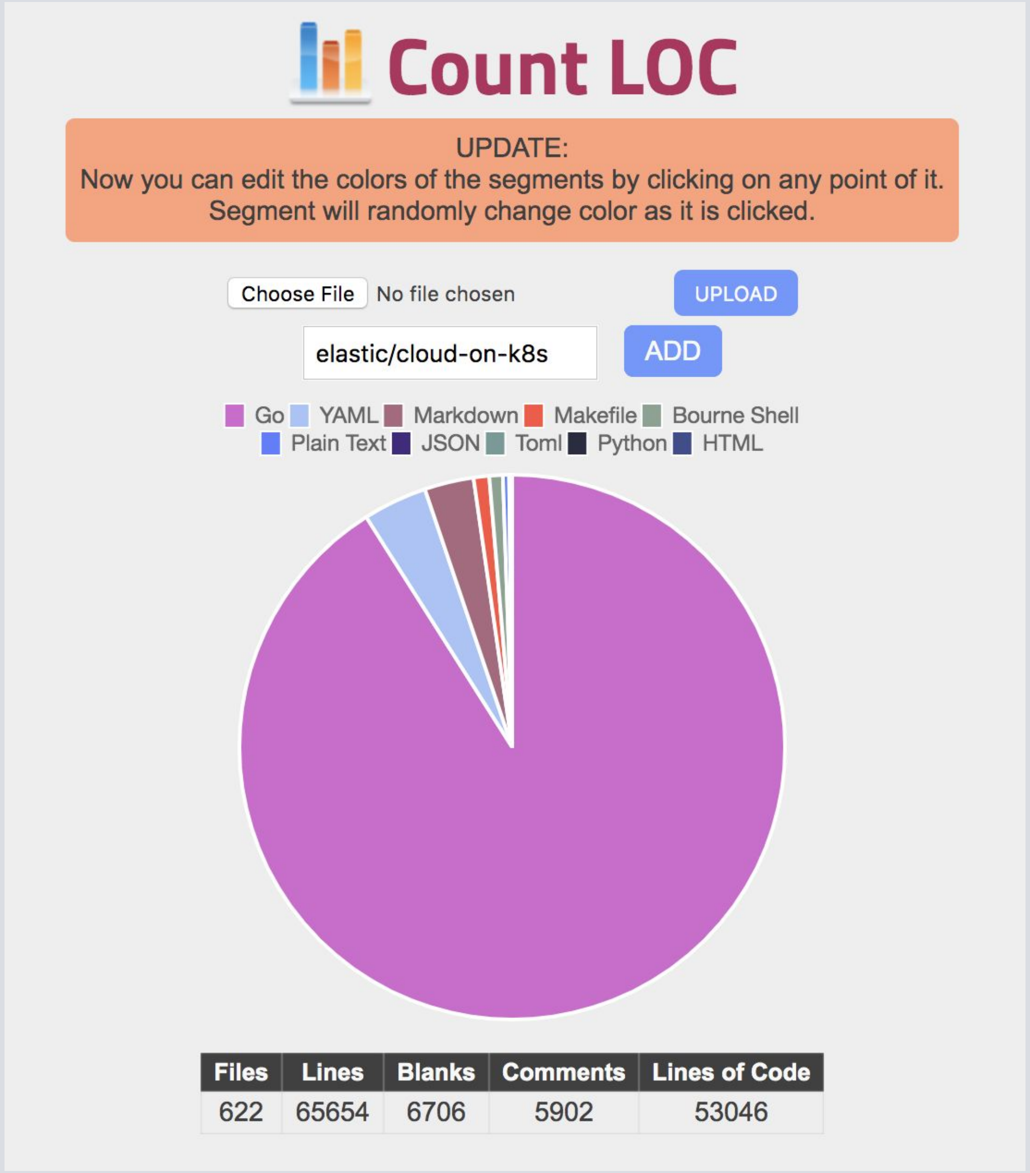


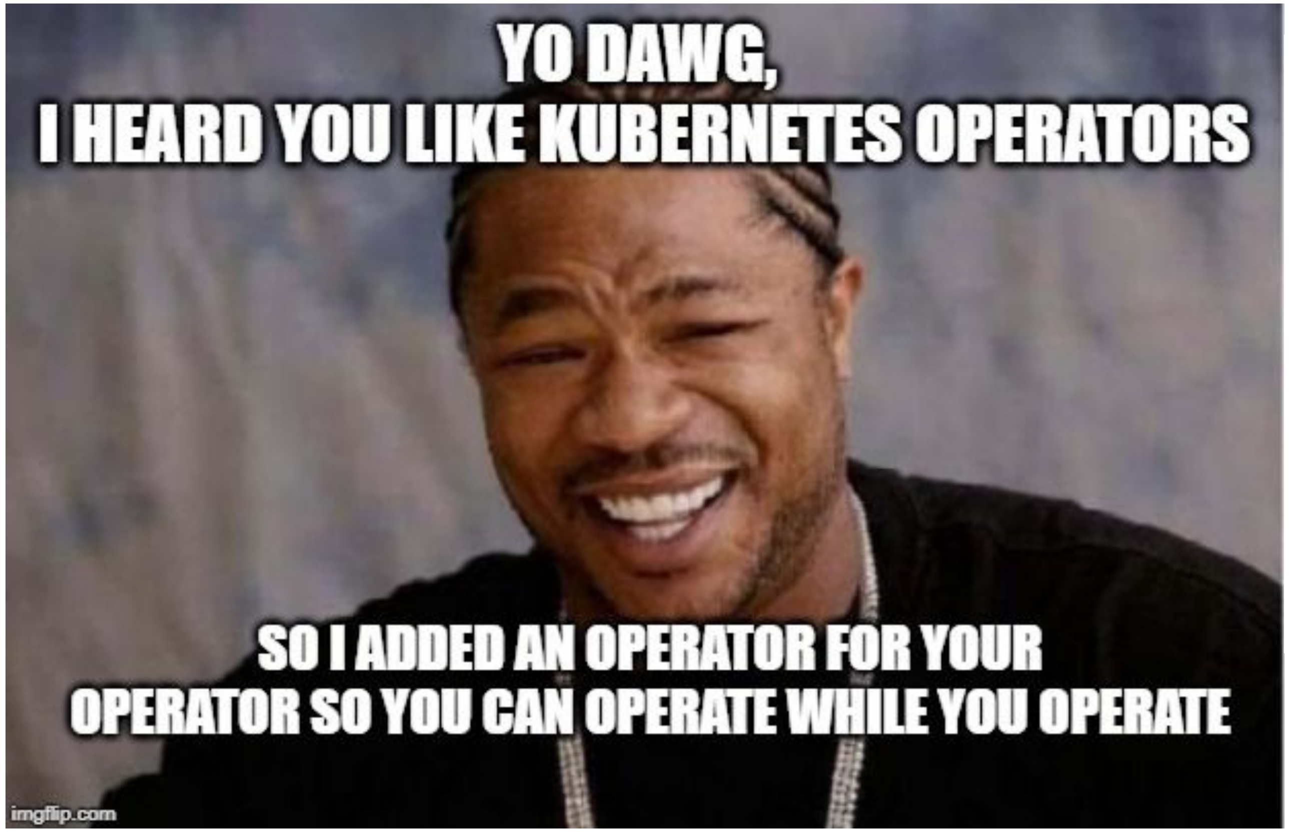
UPDATE:
Now you can edit the colors of the segments by clicking on any point of it.
Segment will randomly change color as it is clicked.

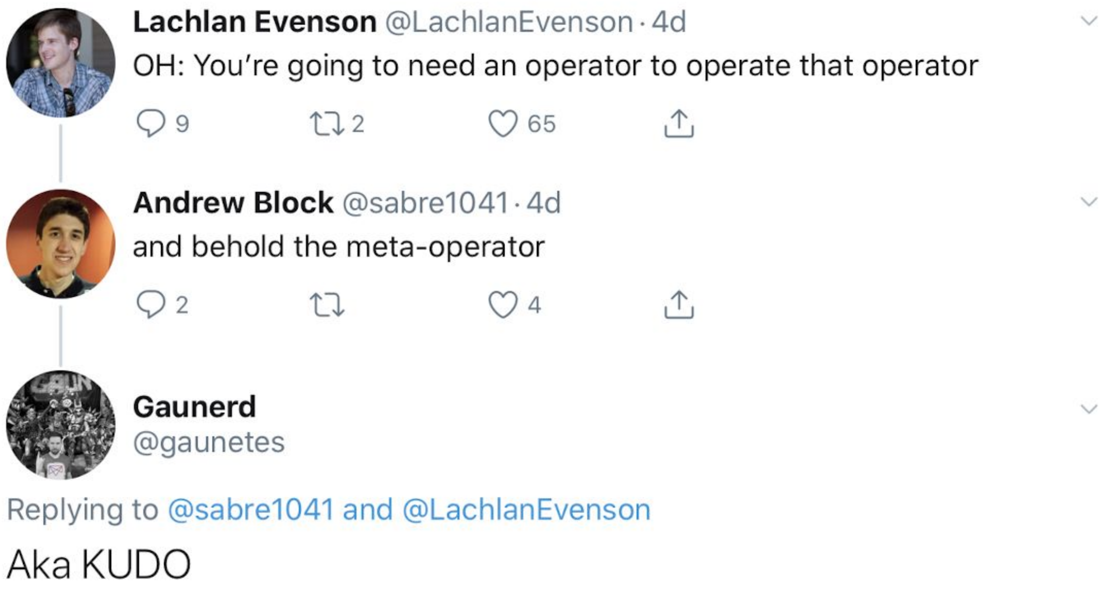
elastic/cloud-on-k8s

Files	Lines	Blanks	Comments	Lines of Code
622	65654	6706	5902	53046

👏operators 👏operators 👏 operators 👏 operators

operators


YO DAWG,
I HEARD YOU LIKE KUBERNETES OPERATORS
SO I ADDED AN OPERATOR FOR YOUR OPERATOR SO YOU CAN OPERATE WHILE YOU OPERATE
imgflip.com


Lachlan Evenson @LachlanEvenson · 4d

OH: You're going to need an operator to operate that operator

9 2 65

Andrew Block @sabre1041 · 4d

and behold the meta-operator

2 4

Gaunerd
@gaunetes

Replying to @sabre1041 and @LachlanEvenson

Aka KUDO

KUDO

- Kubernetes Universal Declarative Operator
- A toolkit and runtime for building operators
- Encodes commonality and reuse between lifecycle operations
- Optimised for complex, stateful applications
- Increases developer productivity when **building operators**
- Increases operator productivity when **operating services**
- OS project licensed as Apache 2.0

Operator Development

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Kubebuilder

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KUDO

- Polymorphic
- Universal Operator
- Built using community projects (Kubebuilder, Kustomize, ...)
- Write Operators as templated YAML manifests
- Provide high level CRDs that represent workloads
- Focused on higher level coordination of software lifecycles
- “Day 2 Operators”

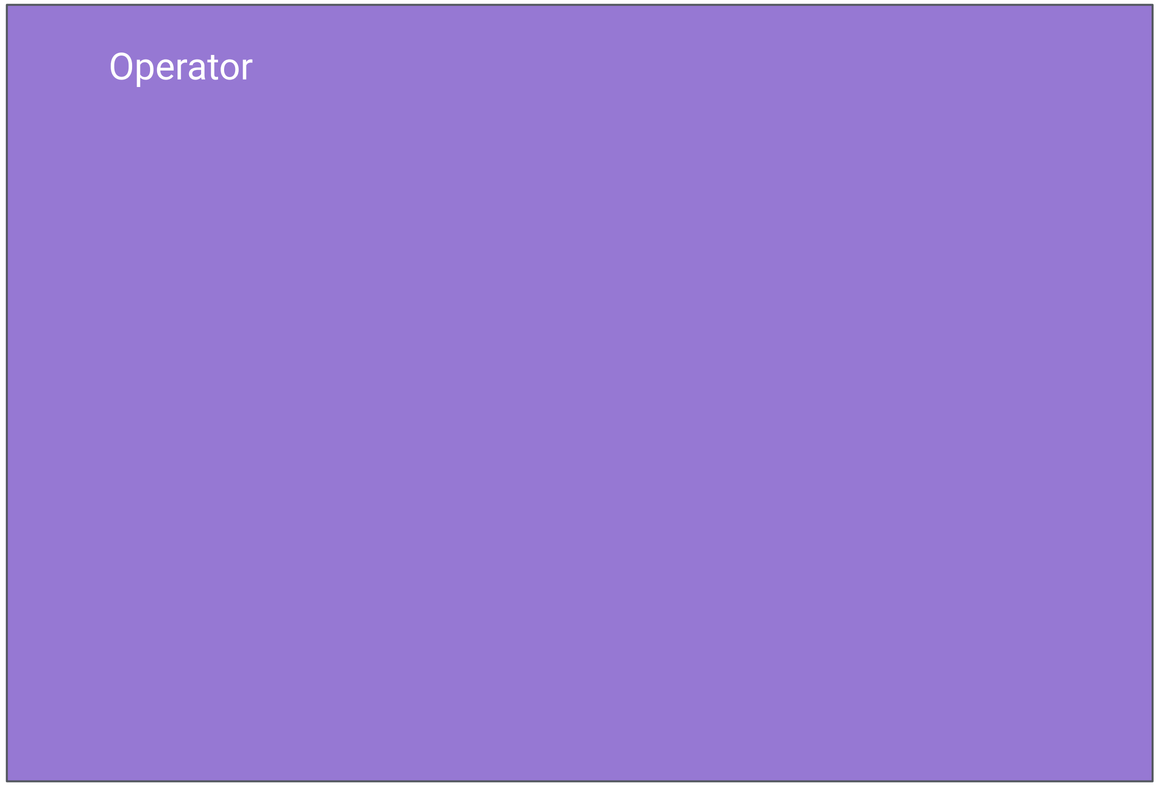
How KUDO Helps Developers

- Provides abstractions for sequencing lifecycle operations using Kubernetes objects and “plans”, conceptually similar to runbooks
- Encodes commonality and reuse between lifecycle operations
- Reduces boilerplate and code duplication between Operators
- Provides and extension mechanism to create “flavors” of a base Operator for customisation specific to a user’s environment
- Provides ISVs with a tool to ship best practices for Day 2 operations alongside their software
- Ships with testing tool to enable TDD of Kubernetes resources

How KUDO Helps Users

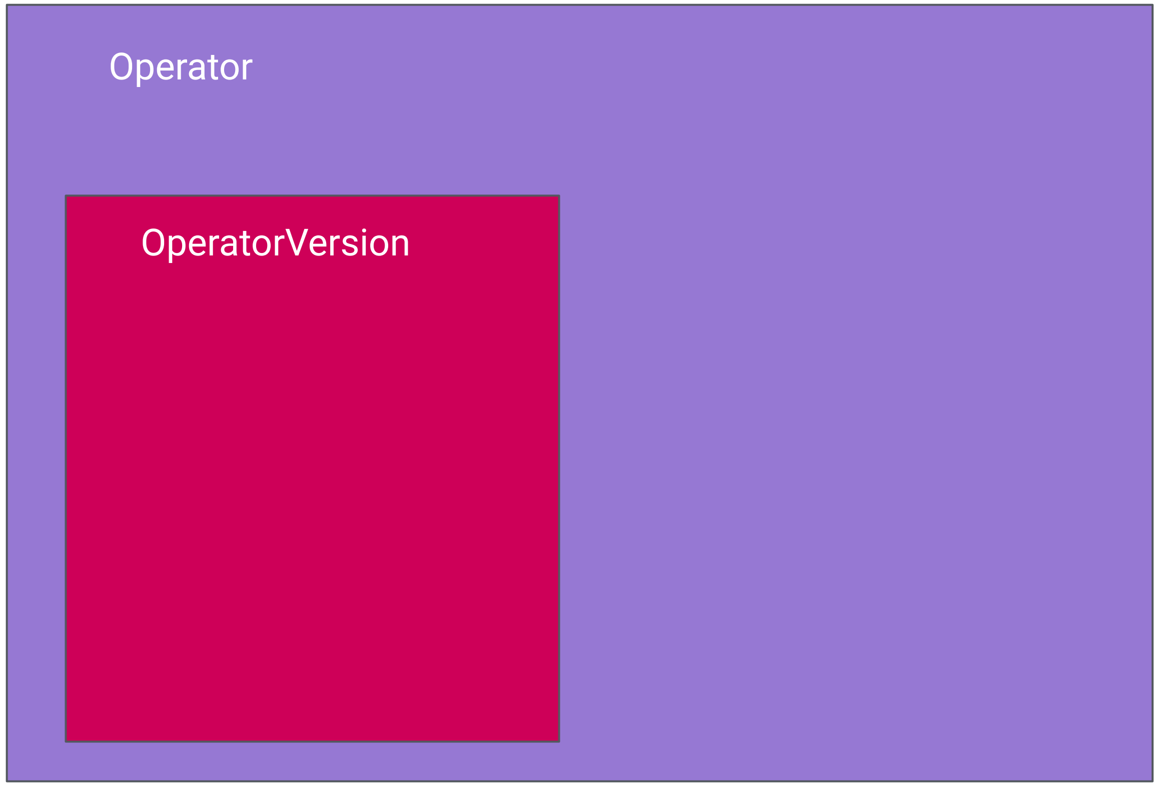
- KUDO provides the `kubectl kudo` plugin to deploy, manage and debug their workloads
    - It’s possible to just use kubectl - KUDO is Kubernetes!
- As it’s common to deploy multiple Operators to a cluster, KUDO provides a similar API and CLI / workflow experience for all
- All workloads are managed as CRDs, facilitating GitOps
- Existing Operators can be managed by KUDO, natively understanding how to deploy CRDs, custom resource, and other operators, enabling dependencies as part of other workloads
- (Future) Centralised supportability, metrics / alerting, as well as security and RBAC features for Enterprise workloads

KUDO Concepts - ***Operator***



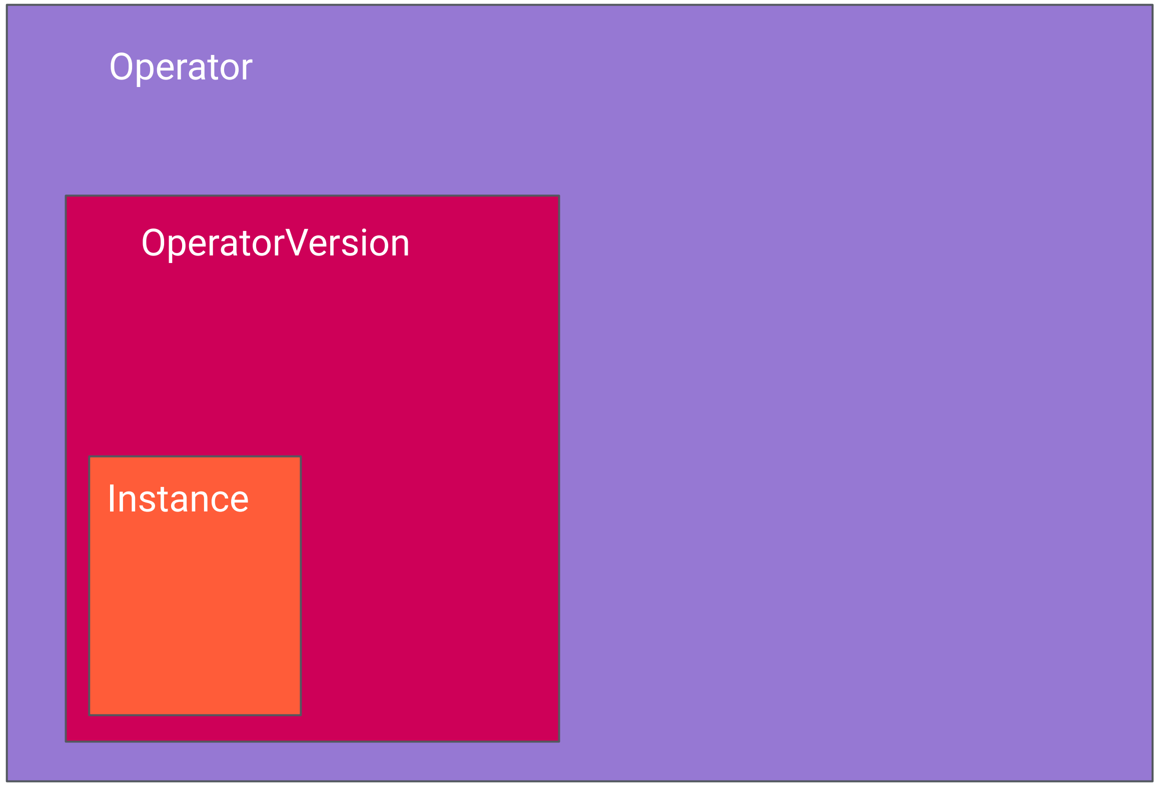
- High level description of a deployable service
- A deployable service can be anything that you'd want to run on your cluster
- Represented as a CRD object

KUDO Concepts - ***OperatorVersion***



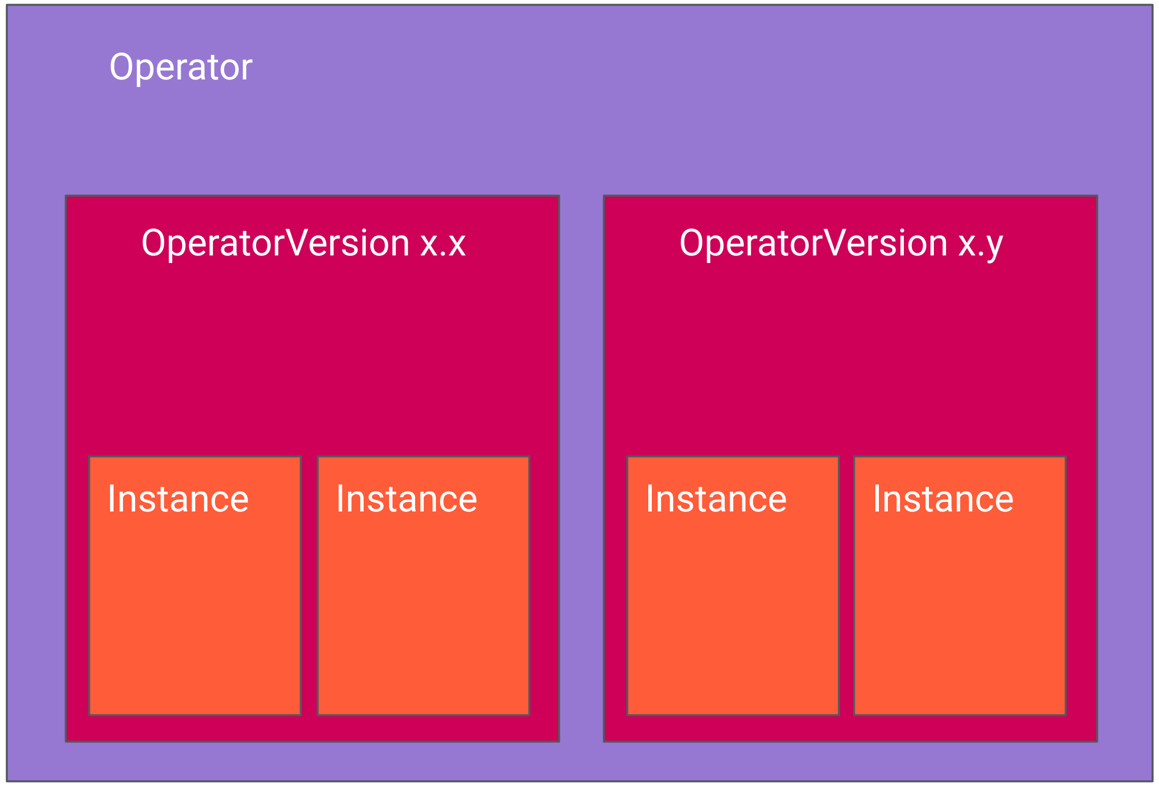
- Implementation of an Operator
- Specific version of a deployable application
- Contains parameters, objects, plans

KUDO Concepts - ***Instance***



- Ties application instantiation to an OperatorVersion
- Once created, renders parameters in templates such as services, pods or StatefulSets
- Can create multiple instances of an OperatorVersion within your cluster

KUDO Concepts - ***Instance***



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KUDO Concepts - ***Plan***

```
Plan foo
├─ Phase bar
│   ├─ Step qux
│   └─ Step quux
└─ Phase baz
    ├─ Step quuz
    ├─ Step corge
    └─ Step grault
```

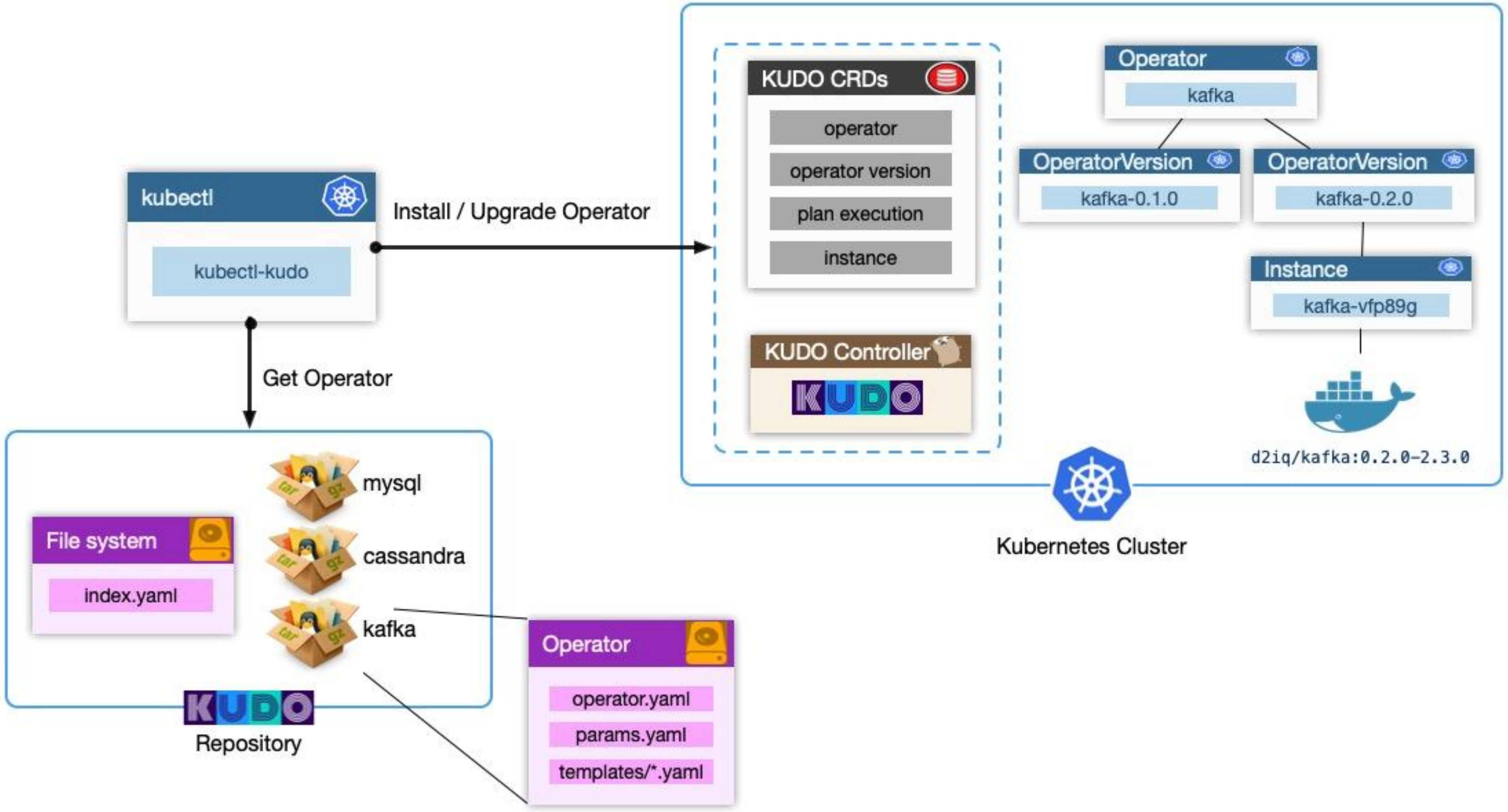
- Orchestrate tasks through phases and steps
- A structured ‘runbook’ which can then be executed by software
- Typically define several plans:
  - Deploy
  - Backup
  - Restore
  - Upgrade
- Phases and steps can be run serial or parallel

KUDO Concepts - ***CLI***

- CLI extension to kubectl
- Can still use ‘vanilla’ kubectl

```
# Install a KUDO package from the official GitHub repo.
 kubectl kudo install <name> [flags]

 # View plan history of a specific package
 kubectl kudo plan history <name> [flags]

 # View all plan history of a specific package
 kubectl kudo plan history [flags]

 # List instances
 kubectl kudo list instances [flags]

 # View plan status
 kubectl kudo plan status [flags]
```

KUDO Concepts - ***Architecture***



Demo - https://butt.holdings

Demo

KUDO Roadmap

- Dynamic CRDs

  Manage the lifecycle of operator CRDs for the operator developers and users
- Operator Dependencies

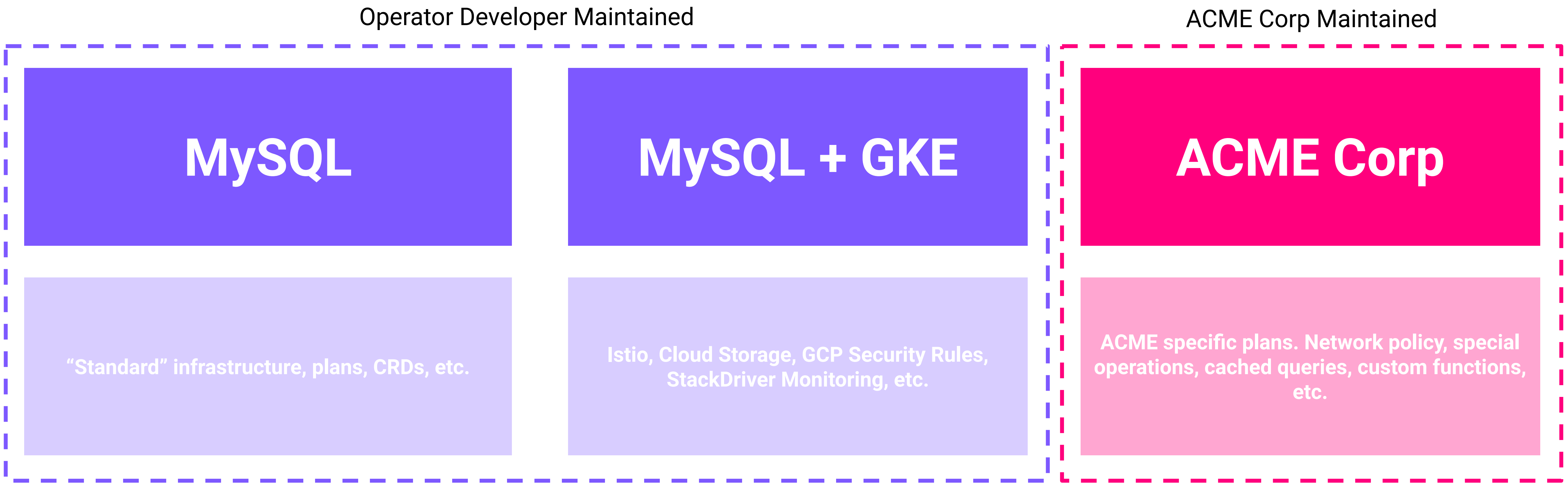
  Ability for KUDO to support a wide range of dependencies (from existing instances and connection strings to entirely new dependencies that are KUDO managed), and for tighter control of dependency specification by operator developers.
- Operator Extensions

  Extend from other formats such as other KUDO operators, Helm charts, or CNAB bundles without forking an operator.
- Something other than YAML! Starlark or CUE likely candidates.
- Pipe Tasks
  - Generation of content which can then be ‘piped’ to another task
  - E.g certificate generation / creation as part of bootstrap
  - Just landed (https://github.com/kudobuilder/kudo/pull/1105) 🎉

KUDO Roadmap - Other

- Helm chart
  - Import and extend
- Operator Development
  - Skeleton Generator
  - Linter
  - Snippet / extension library
- KUDO API
- Roadmap here: https://github.com/orgs/kudobuilder/projects/2

KUDO Roadmap - Operator Extensions


Operator Developer Maintained
ACME Corp Maintained
MySQL
MySQL + GKE
ACME Corp
"Standard" infrastructure, plans, CRDs, etc.
Istio, Cloud Storage, GCP Security Rules, StackDriver Monitoring, etc.
ACME specific plans. Network policy, special operations, cached queries, custom functions, etc.

KUDO Community - Get Involved!

https://kudo.dev/

https://github.com/kudobuilder/kudo

#kudo http://slack.k8s.io/

https://groups.google.com/forum/#!forum/kudobuilder

Community Meeting - bi-weekly, Thursdays 10am PT