



BUILDING FOR THE ROAD AHEAD

DETROIT 2022

Towards Something Better Than CRDs in a Post-Operator World



Stefan Schimanski

How it started:

BUILDING FOR THE ROAD AHEAD

DETROIT 2022

I want a MySQL database to link it to some pod.

How hard can it be? 🤔

2022, 8 years into Kubernetes?

Think about it:

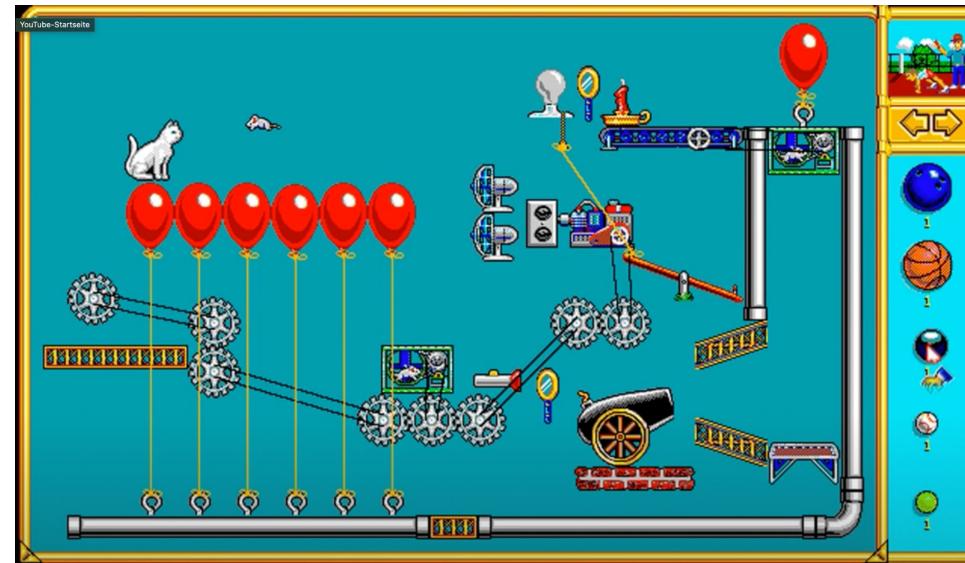
In the decade of SaaS, there is basically
zero SaaS support in Kubernetes



... instead we are spending the last **6 years** building operators to work around that in Kubernetes.



... and now use GitOps to install those operators, from helm charts using templating engines to customize them to our needs or invent complex package management systems.



... that's a lot of glue to get something that should be native.



Let's design a **post-operator / post-cluster** technology
that allows a **service provider persona** as 1st class citizen
that can securely provide
centrally operated **kube-native** services.

A future.

```
$ kubectl bind https://mangodb.com/kubernetes
```

```
$ kubectl bind https://mangodb.com/kubernetes
```

Redirecting to browser ...



Log in to your account



or

Email Address

A text input field with a blue border. A small lock icon is positioned at the end of the input field.

Next

Don't have an account? [Sign Up](#)

Deliver App Search Fast with Atlas Search

Build rich full-text search features into your applications without syncing your database to a separate search engine.

[Explore tutorial →](#)



Log in to your account



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Email Address

A text input field with a blue border. To its right is a small circular icon containing a lock symbol.

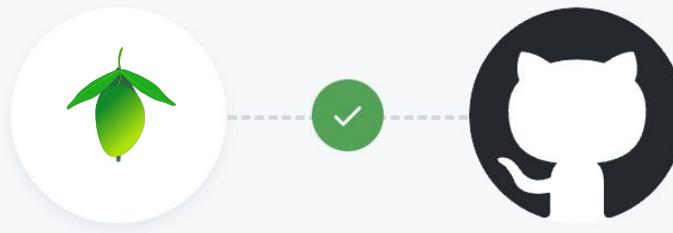
Next

Don't have an account? [Sign Up](#)

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Build rich full-text search features into your applications without syncing your database to a separate search engine.

[Explore tutorial →](#)



Authorize MongoDB Atlas

 **MongoDB Atlas by 10gen**
wants to access your **sttts** account

 **Personal user data**
Email addresses (read-only), profile information (read-only)

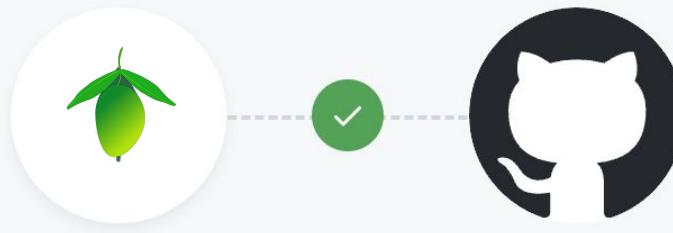
[Cancel](#) [Authorize 10gen](#)

 Not owned or
operated by GitHub

 Created
4 months ago

 More than 1K
GitHub users

[Learn more about OAuth](#)



Authorize MongoDB Atlas

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4 months ago

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GitHub users

[Learn more about OAuth](#)



Bind our Kubernetes API in no time

```
apiVersion: mangodb.com
kind: MongoDB
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
```

[Back](#)

Bind



Bind our Kubernetes API in no time

```
apiVersion: mangodb.com
kind: MongoDB
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
```

[Back](#)

Bind

```
$ kubectl bind https://mangodb.com/kubernetes
```

Redirecting to browser ...

MangoDB Inc. requests the following permission claims:

1. Create secrets referenced in MongoDB.spec.tokenSecret
2. Create service named MongoDB.metadata.name

Accept? [y,N]

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```

Redirecting to browser ...

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Accept? [y,N] y

Added APIs: mangodb.mangodb.com

Accepted permission claims.

```
$ |
```

```
$ kubectl bind https://mangodb.com/kubernetes
```

Redirecting to browser ...

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```
$ kubectl get mangodbs
```

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```
$ kubectl get mangodbs
```

No resources found in default namespace.

```
$ █
```

MangoDB Inc. requests the following permission claims:

1. Create secrets referenced in MongoDB.spec.tokenSecret
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Accept? [y,N] y

Added APIs: mangodb.mongodb.com

Accepted permission claims.

```
$ kubectl get mangodbs
```

No resources found in default namespace.

```
$ cat db-prod.yaml
```

```
$ cat db-prod.yaml
```

```
apiVersion: mangodb.com
kind: MongoDB
metadata:
  name: prod
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
```

```
$ █
```

```
$ cat db-prod.yaml
```

```
apiVersion: mangodb.com
kind: MongoDB
metadata:
  name: prod
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
```

```
$ kubectl apply -f db-prod.yaml █
```

```
kind: MongoDB
metadata:
  name: prod
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
```

```
$ kubectl apply -f db-prod.yaml
```

```
mongodb/prod created
```

```
$ █
```

```
kind: MongoDB
metadata:
  name: prod
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
```

```
$ kubectl apply -f db-prod.yaml
```

```
mongodb/prod created
```

```
$ kubectl get pods -A █
```

```
$ kubectl get pods -A
```

NAMESPACE	NAME	READY
STATUS	RESTARTS	AGE
kube-system	hostpath-provisioner-f57964d5f-zhh5w	1/1
Running	5 (15d ago)	25d
kube-system	coredns-66bcf65bb8-tdznx	1/1
Running	4 (15d ago)	25d
kube-system	calico-node-cpk82	1/1
Running	5 (15d ago)	25d
kube-system	metrics-server-5f8f64cb86-llv6t	1/1
Running	4 (15d ago)	25d

```
$ |
```

```
$ kubectl get pods -A
```

NAMESPACE	NAME	READY
STATUS	RESTARTS	AGE
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kube-system	calico-node-cpk82	1/1
Running	5 (15d ago)	25d
kube-system	metrics-server-5f8f64cb86-llv6t	1/1
Running	4 (15d ago)	25d

```
$ kubectl get mangodb$
```

```
kube-system    hostpath-provisioner-f57964d5f-zhh5w      1/1
Running   5 (15d ago)  25d

kube-system    coredns-66bcf65bb8-tdznx      1/1
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kube-system    calico-node-cpk82      1/1
Running   5 (15d ago)  25d

kube-system    metrics-server-5f8f64cb86-llv6t      1/1
Running   4 (15d ago)  25d
```

```
$ kubectl get mangodb
```

NAME	TIER	REGION	SIZE	PHASE	AGE
prod	dedicated	eu-central-1	0.1MB	Running	2m

```
$ |
```

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kube-system    hostpath-provisioner-f57964d5f-zhh5w      1/1
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```

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kube-system    calico-node-cpk82      1/1
Running      5 (15d ago)   25d
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```
$ kubectl get mangodbs
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NAME	TIER	REGION	SIZE	PHASE	AGE
prod	dedicated	eu-central-1	0.1MB	Running	2m

```
$ kubectl get mangodbs prod -o yaml
```

```
$ kubectl get mangodbs prod -o yaml
```

```
apiVersion: mongodb.com
```

```
kind: MongoDB
```

```
metadata:
```

```
  name: prod
```

```
spec:
```

```
  tier: dedicated
```

```
  region: eu-central-1
```

```
  backup: true
```

```
  tokenSecret: db-token
```

```
status:
```

```
  phase: Running
```

```
  conditions:
```

```
  - type: Ready
```

```
    value: "True"
```

```
  lastTransitionTime: "2022-08-17T16:34:28Z"
```

```
$ |
```

```
$ kubectl get mangodbs prod -o yaml
```

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apiVersion: mongodb.com
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  tokenSecret: db-token
status:
  phase: Running
  conditions:
  - type: Ready
    value: "True"
  lastTransitionTime: "2022-08-17T16:34:28Z"
```

```
$ kubectl get services █
```

```
name: prod
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
status:
  phase: Running
  conditions:
  - type: Ready
    value: "True"
  lastTransitionTime: "2022-08-17T16:34:28Z"
```

```
$ kubectl get services
```

NAMESPACE	NAME	TYPE	URL	PORT(S)	AGE
default	prod	ExternalName	as23129.eu-central-1.mongodb.com	27017/TCP	10m

```
$ |
```

```
name: prod
spec:
  tier: dedicated
  region: eu-central-1
  backup: true
  tokenSecret: db-token
status:
  phase: Running
  conditions:
  - type: Ready
    value: "True"
  lastTransitionTime: "2022-08-17T16:34:28Z"
```

```
$ kubectl get services
```

NAMESPACE	NAME	TYPE	URL	PORT(S)	AGE
default	prod	ExternalName	as23129.eu-central-1.mongodb.com	27017/TCP	10m

```
$ kubectl get apibindings
```

```
phase: Running
conditions:
- type: Ready
  value: "True"
  lastTransitionTime: "2022-08-17T16:34:28Z"
```

```
$ kubectl get services
```

NAMESPACE	NAME	TYPE	URL	PORT(S)	AGE
default	prod	ExternalName	as23129.eu-central-1.mongodb.com	27017/TCP	10m

```
$ kubectl get apibindings
```

NAME	EXPORT	PHASE	AGE
mongodb	https://mongodb.com/kubernetes	Connected	11m

```
$ |
```

```
phase: Running
conditions:
- type: Ready
  value: "True"
  lastTransitionTime: "2022-08-17T16:34:28Z"
```

```
$ kubectl get services
```

NAMESPACE	NAME	TYPE	URL	PORT(S)	AGE
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```
$ kubectl get apibindings
```

NAME	EXPORT	PHASE	AGE
mongodb	https://mongodb.com/kubernetes	Connected	11m

```
$ 🎉
```

DETROIT 2022

What have we seen?

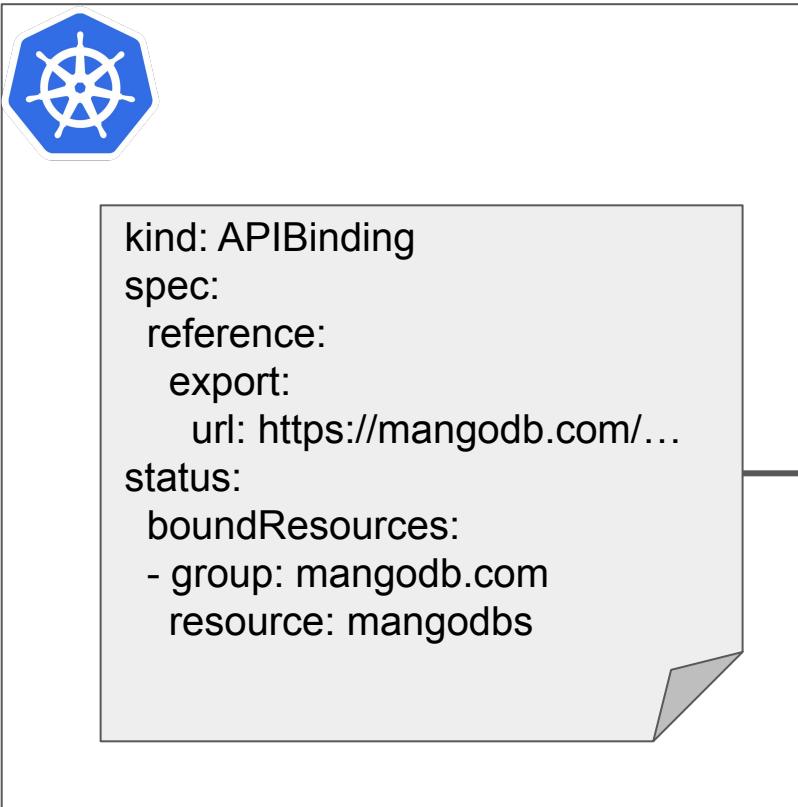
APIs consumed in a Kube cluster
without running anything in that cluster.

Pattern 1 – API Bindings

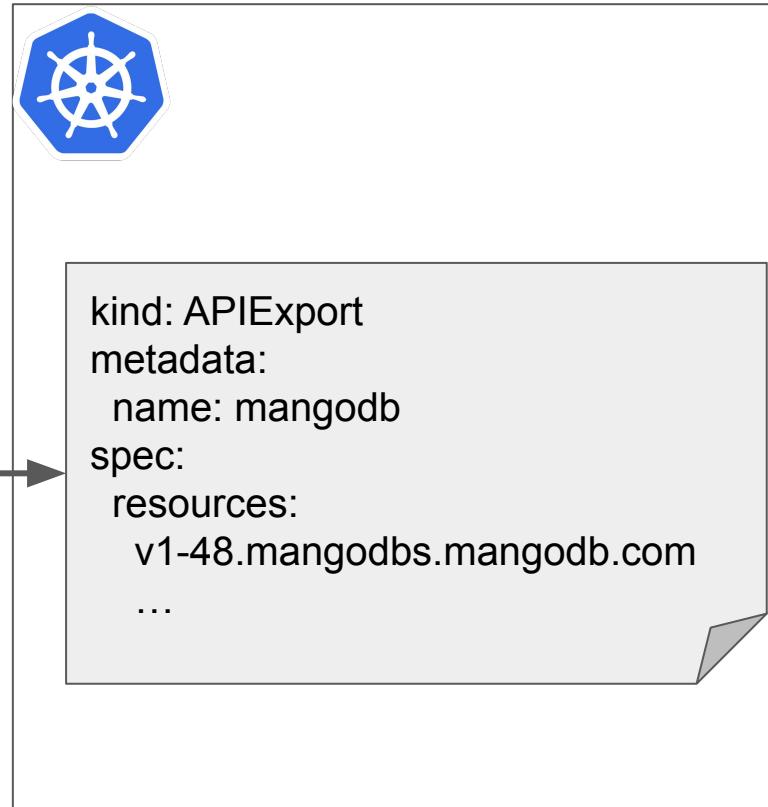
API Exports and Bindings



API
Consumer



bound

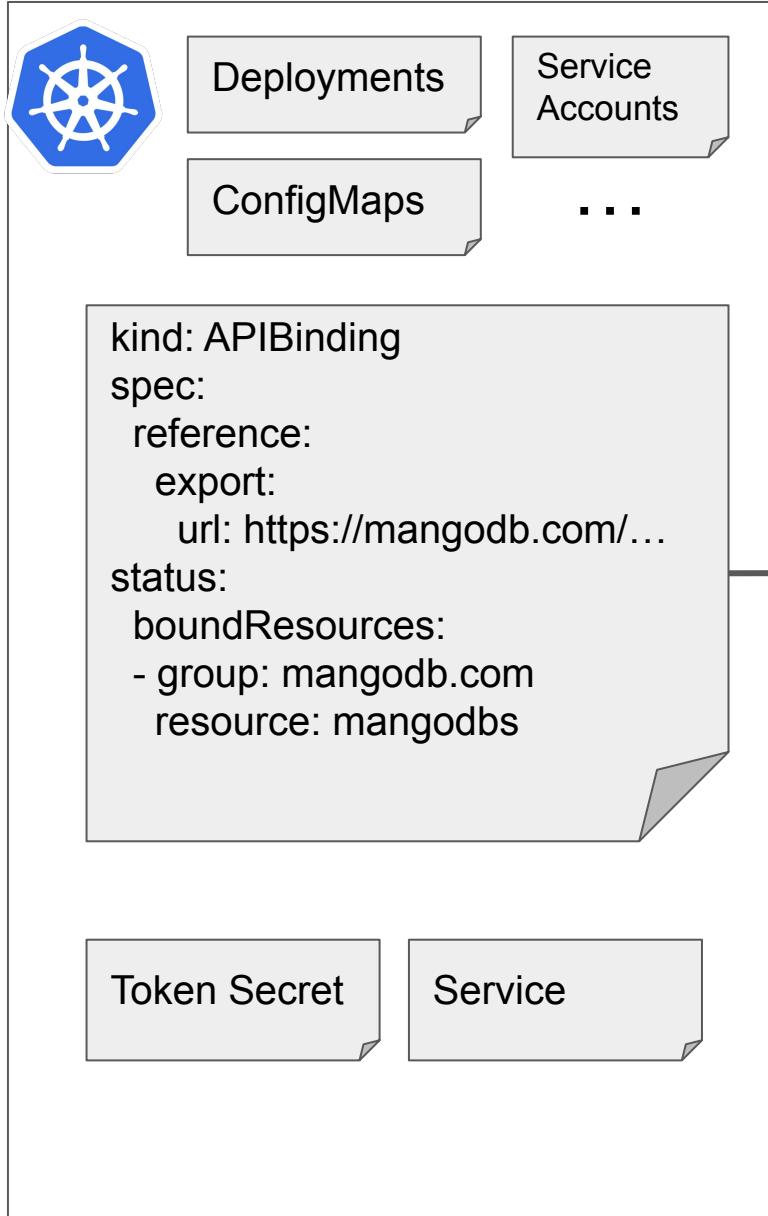


API
Service
Provider

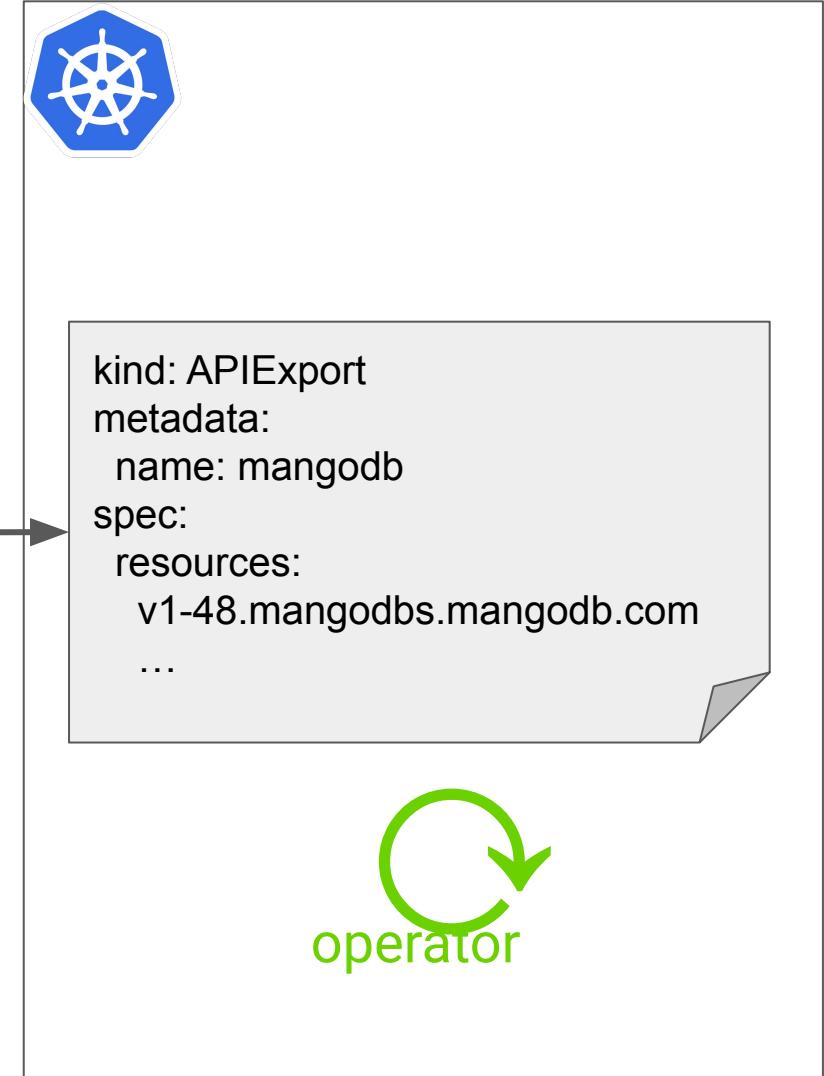
API Exports and Bindings



API
Consumer

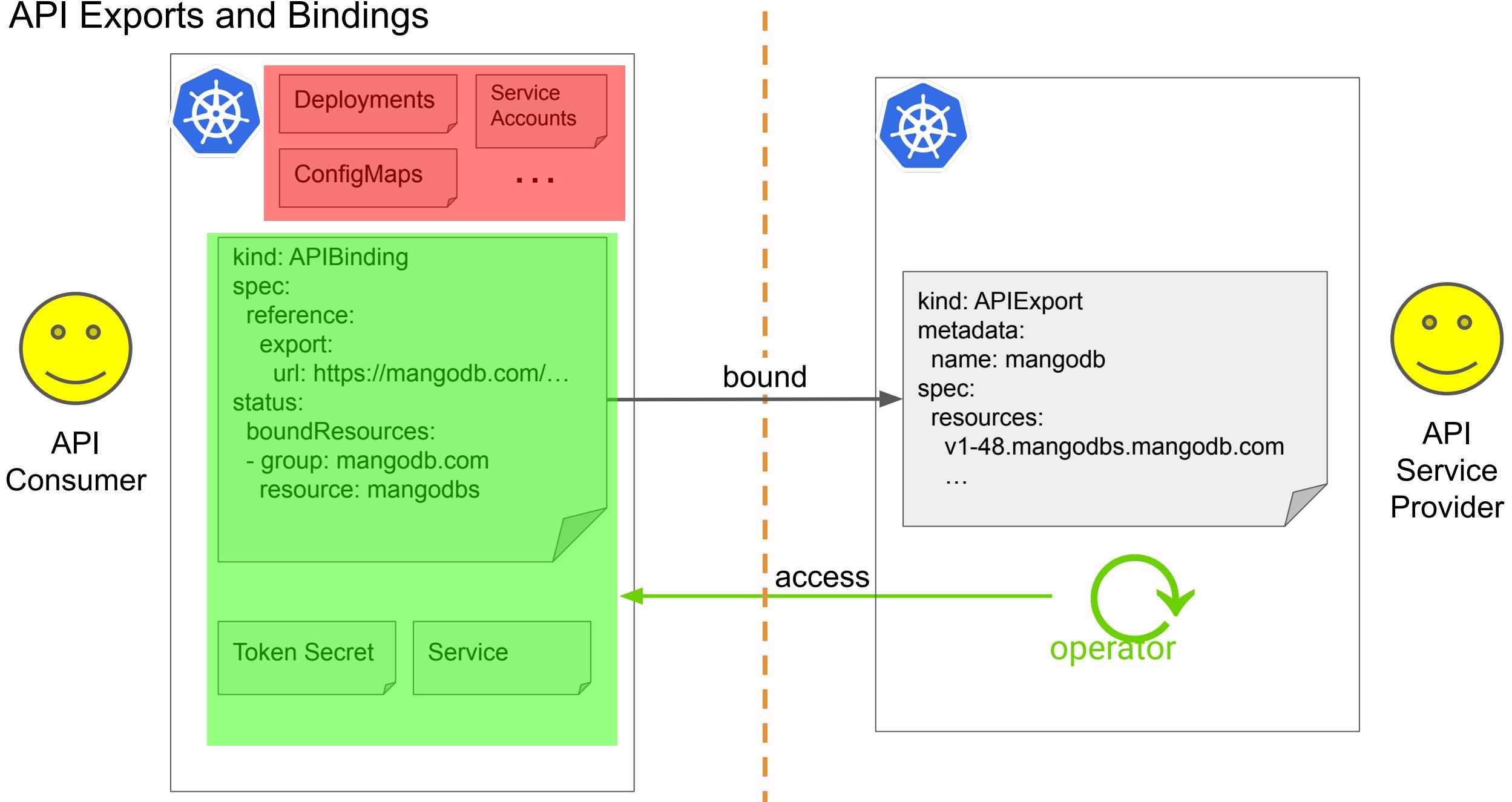


bound

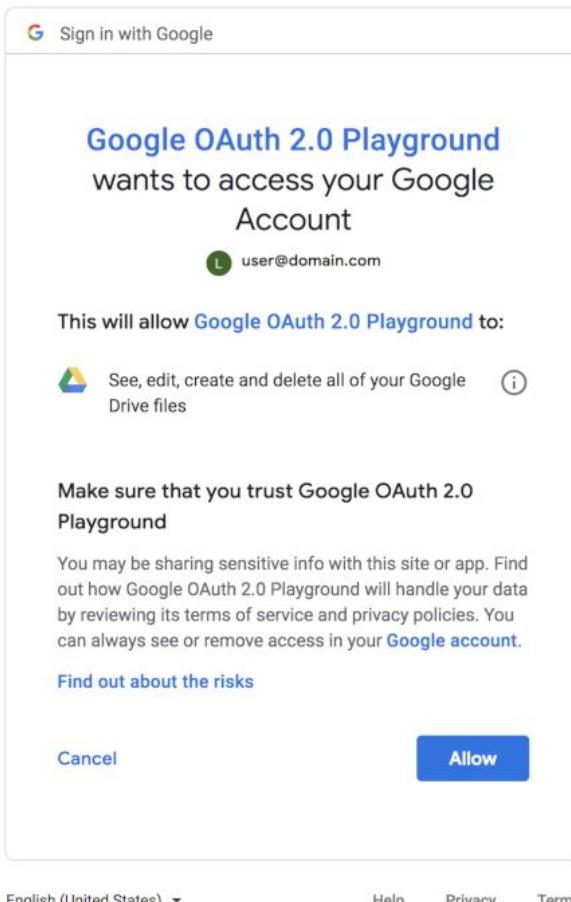


API
Service
Provider

API Exports and Bindings



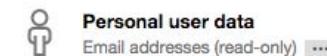
Pattern 2 – Permission Claims



Authorize application

My Octocat App by @octocat would like permission to access your account

Review permissions



Authorize application

English (United States) ▾

Help Privacy Terms

Permission Claims



API
Consumer

```
kind: APIBinding
spec:
  reference:
    export:
      url: https://mangodb.com/...
  permissionClaims:
    - group: core
      resource: secrets
      referenced:
        - group: mangodb.com
          resource: mangodbs
          name:
            jsonPath: .spec.tokenSecret
      state: Accepted
  status:
    boundResources:
      - group: mangodb.com
        resource: mangodbs
```

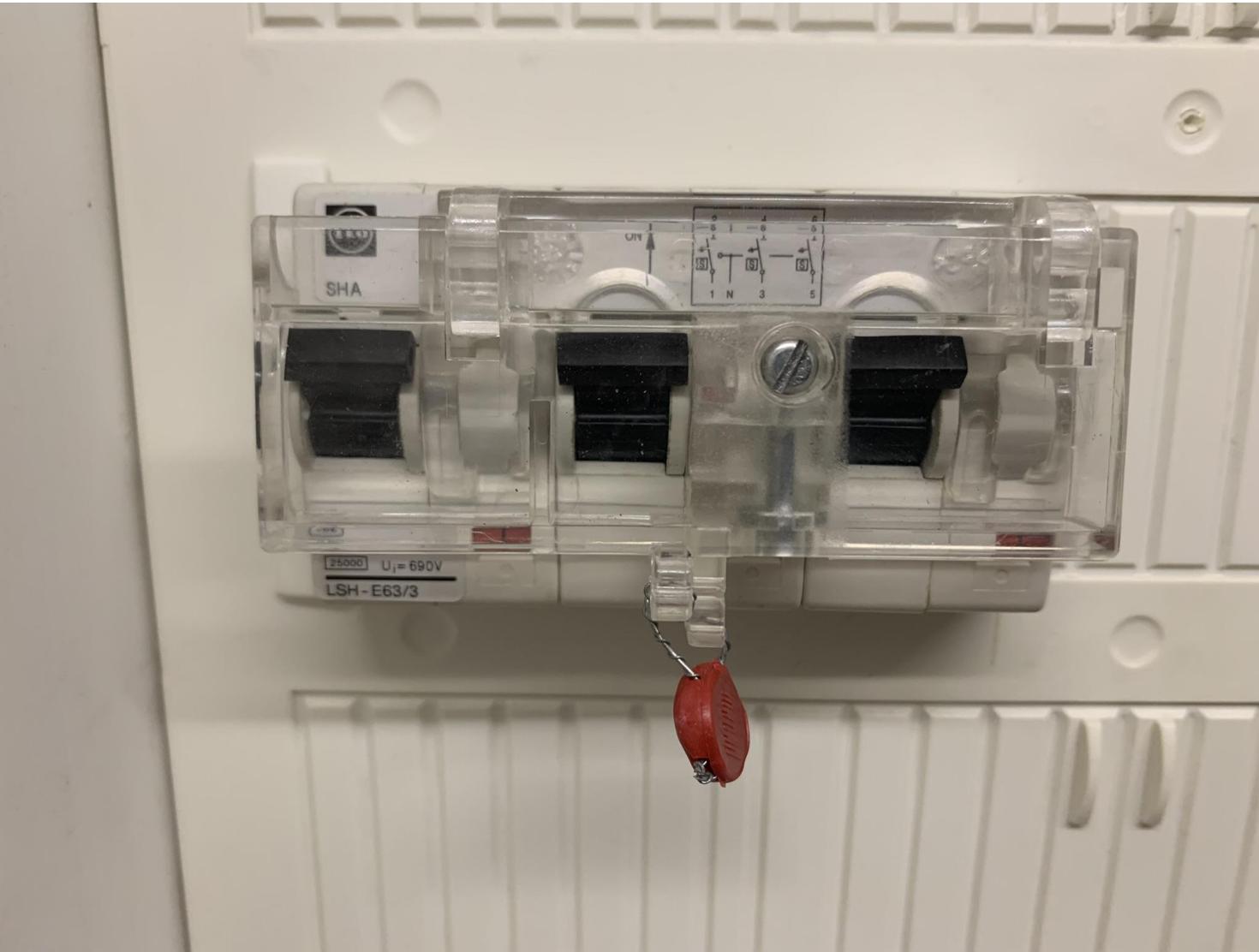
bound

```
kind: APIExport
metadata:
  name: mongodb
spec:
  resources:
    v1-48.mangodbs.mongodb.com
    ...
  permissionClaims:
    - group: core
      resource: secrets
      referenced:
        - group: mangodb.com
          resource: mangodbs
          name:
            jsonPath: .spec.tokenSecret
```



API
Service
Provider

Pattern 3 – Inverse Permission Claims

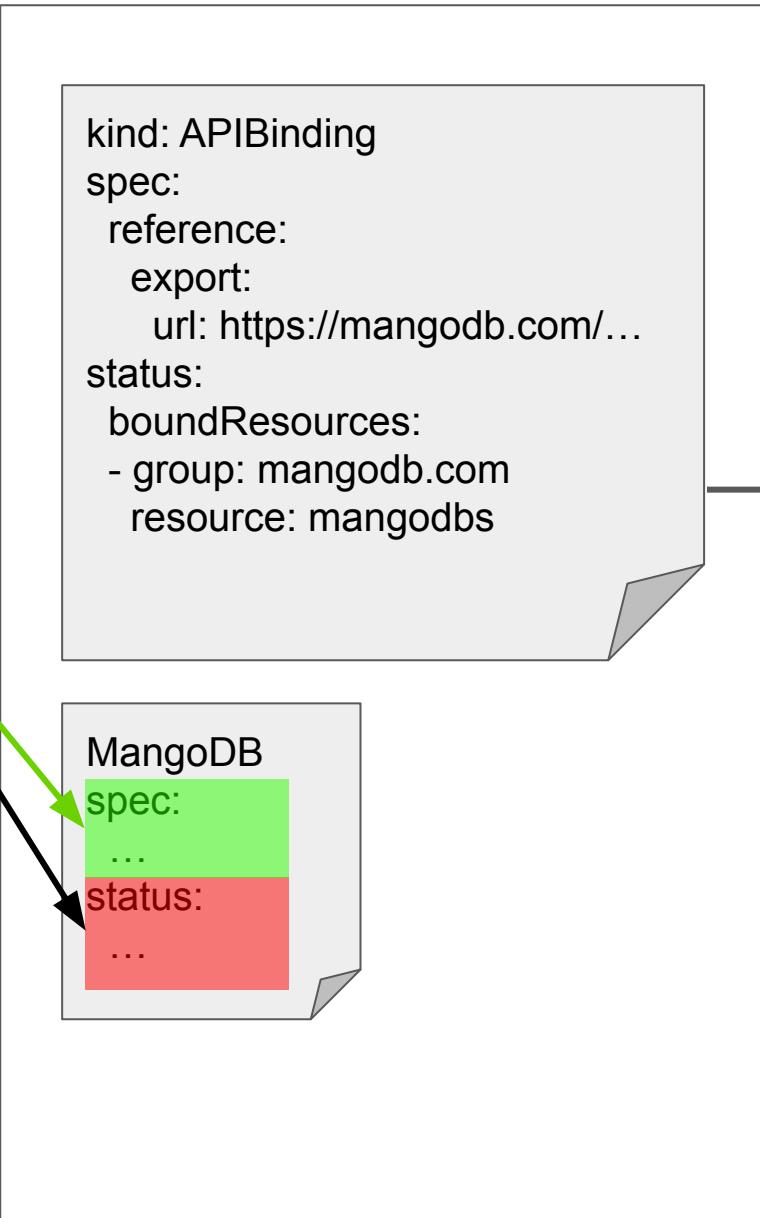


anti-tamper seal

Maximal User Permission

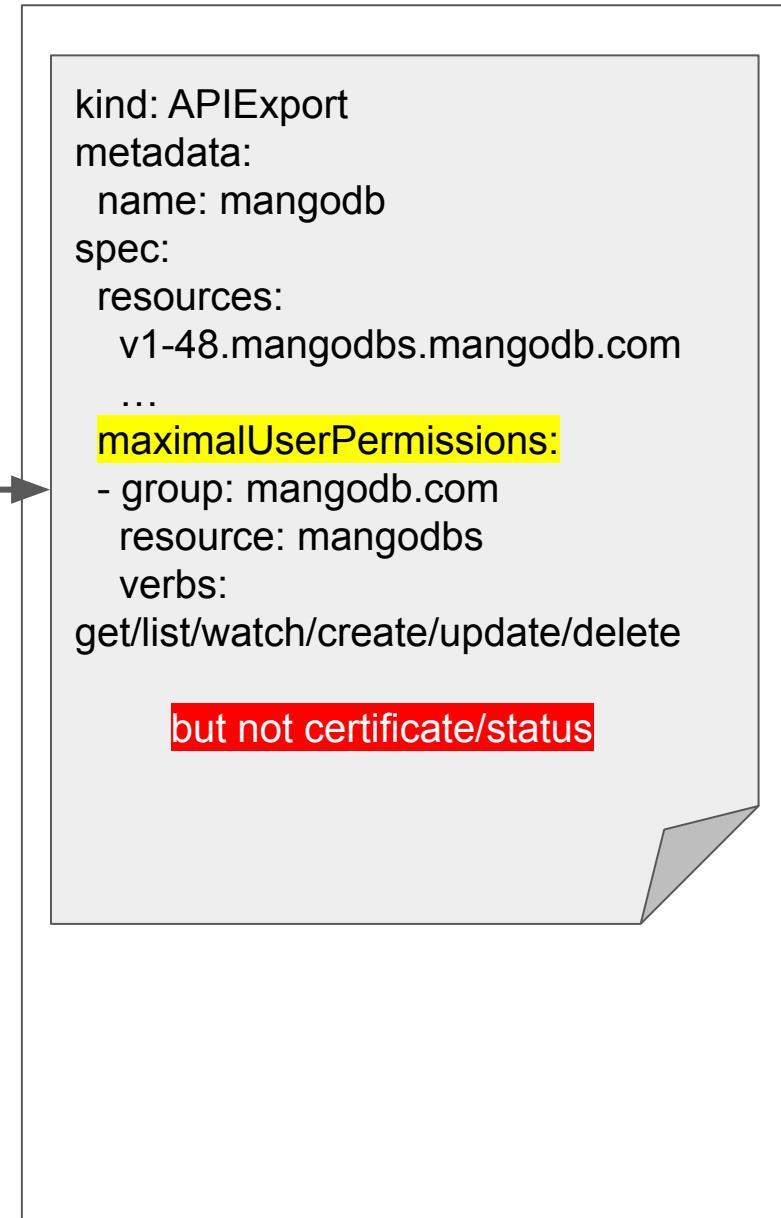


API
Consumer



~~Update~~

bound



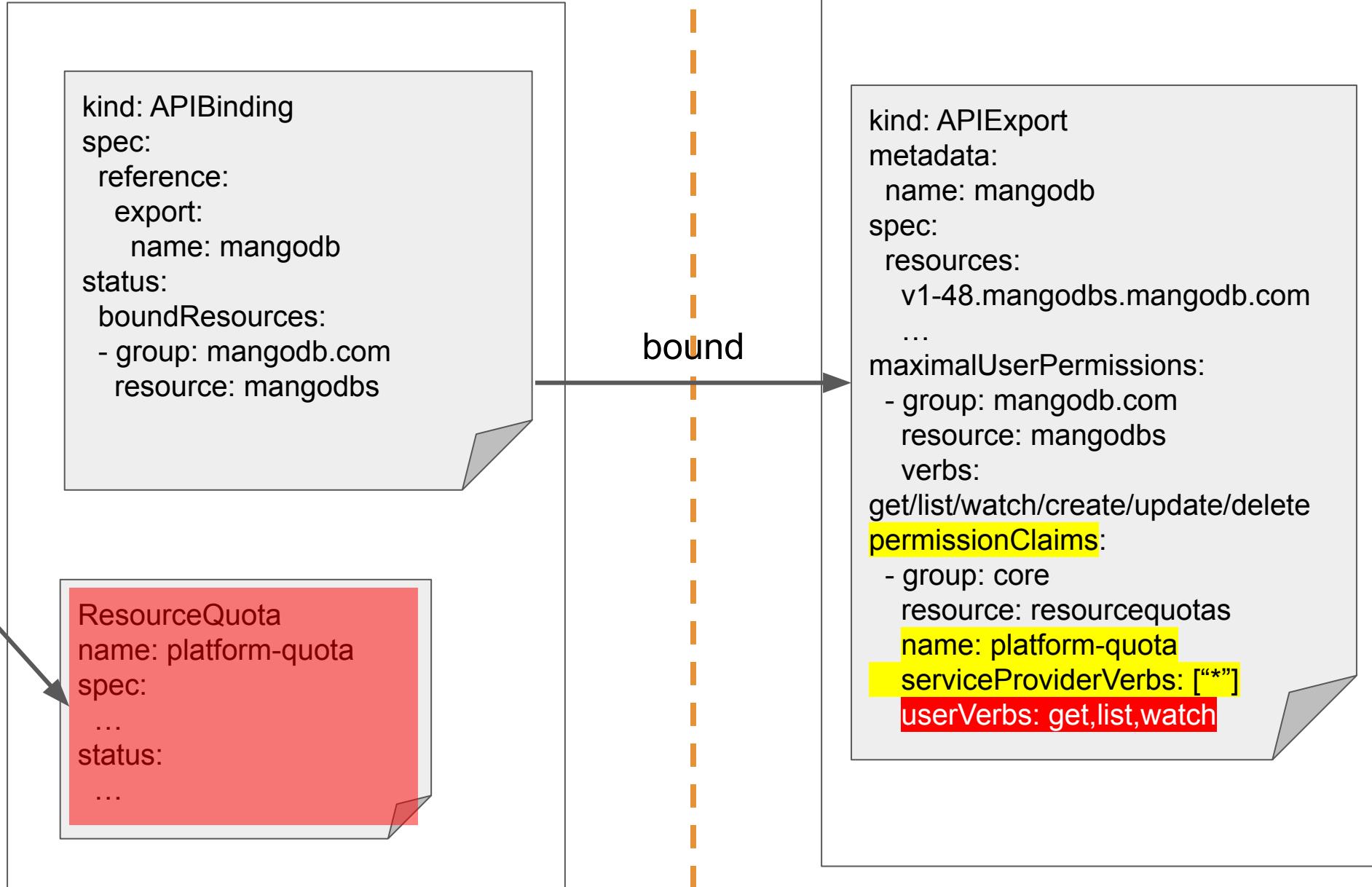
API
Service
Provider

Inverse Permission Claims



API
Consumer

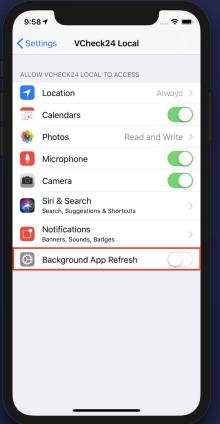
~~update~~



API
Service
Provider

Three Patterns

1. API Exports and API Bindings
2. Permission Claims
3. Inverse Permission Claims and Maximal Permission Policy



Think about it:

In the **SaaS**, there is basically
zero SaaS support in Kubernetes



Think about it:

In the decade of SaaS, there is basically
zero SaaS support in Kubernetes

August 17



[Original tweet](#)

Let's design a post-operator / post-cluster technology
that allows a service provider persona as 1st class citizen
that can securely provide
centrally operated kube-native services.



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🔒 kube-bind / kube-bind

Private

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Issues

Pull requests 2

Actions

Projects

Security

Insights

Settings

76 lines (57 sloc) | 2.74 KB

<> Raw Blame



kube-bind

Disclaimer: work in progress and not ready for production use.

kube-bind is a prototype project with the goal to establish a new extension model for Kubernetes clusters:

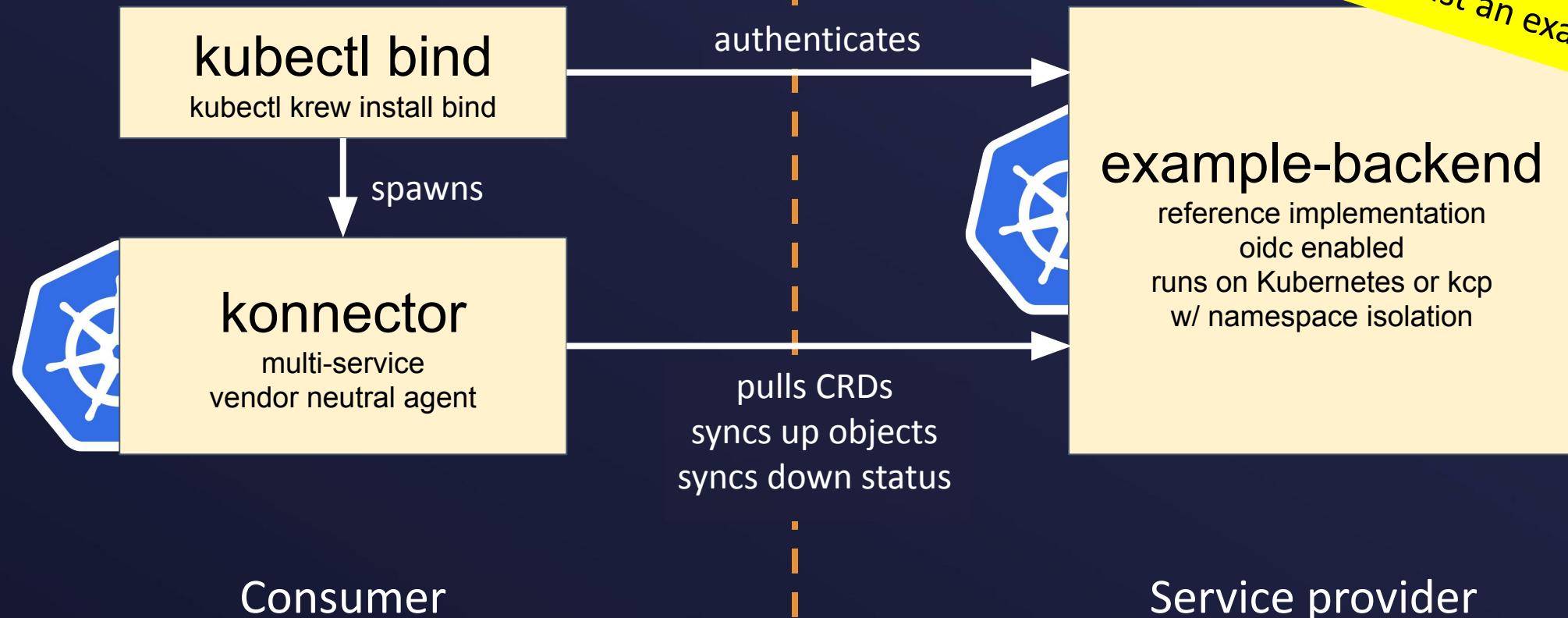
- APIs should be bindable into a cluster and operated by a service provider
- these APIs should not require (custom) controllers/operators run locally in the consuming cluster
- only a single vendor-neutral, OpenSource agent should be required.

This is the 3 line pitch:

```
$ kubectl krew install bind
$ kubectl bind https://mangodb/exports
Redirect to the brower to authenticate via OIDC.
BOOM - the MongoDB API is available in the local cluster,
      without anything MongoDB-specific running.
$ kubectl get mangodb
```

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*Lots of freedom here
Just an example.*



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Demo



CockroachDB

Their stock operator, running on a Kube cluster (bottom), providing **CRDBaaS** to any other Kube (top).

<https://github.com/cockroachdb/cockroach-operator>

```
$ kubectl bind https://mangodb.com/exports
```

interactively

```
$ kubectl bind https://mangodb.com/exports --dry-run -o yaml > apiservice-binding-requests.yaml
```

dry-run
to get the request

```
$ kubectl bind apiservice -f apiservice-binding-requests.yaml  
--remote-kubeconfig name
```

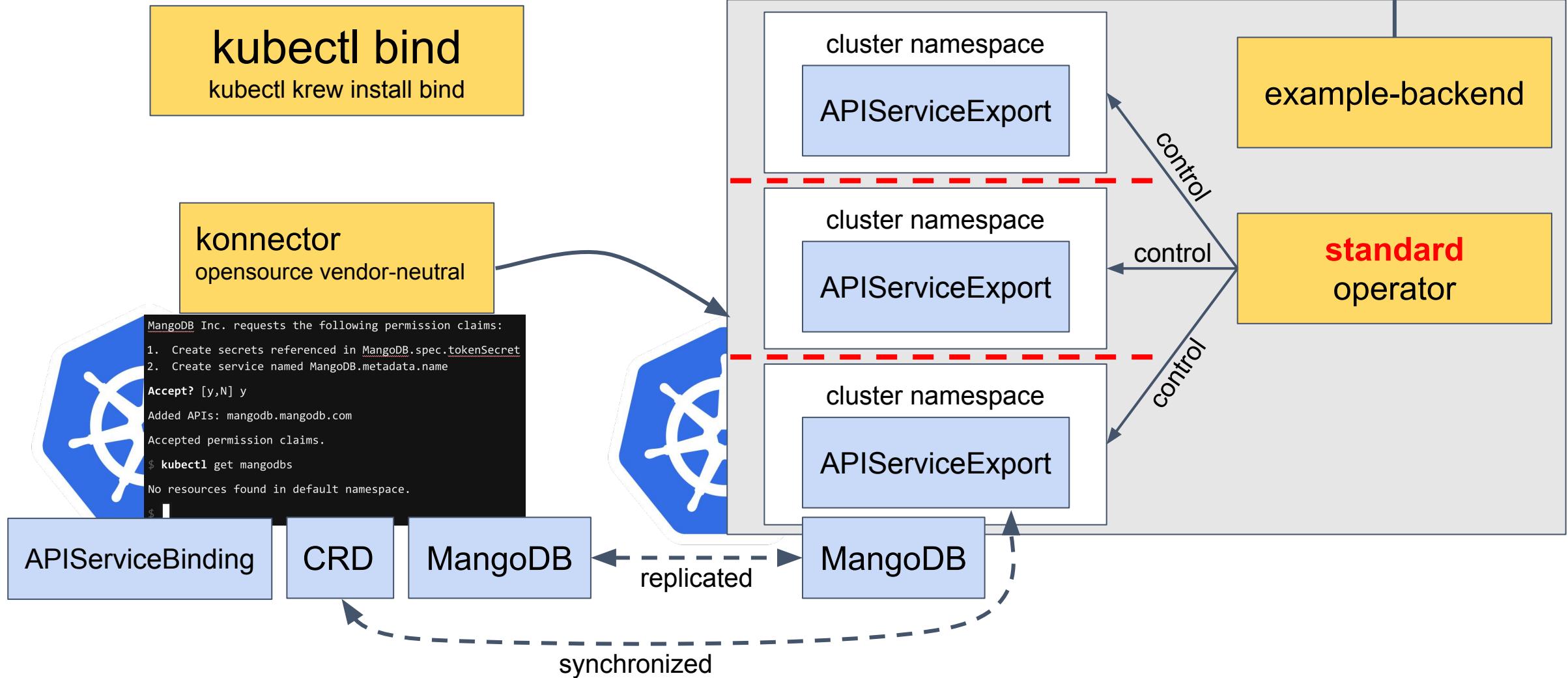
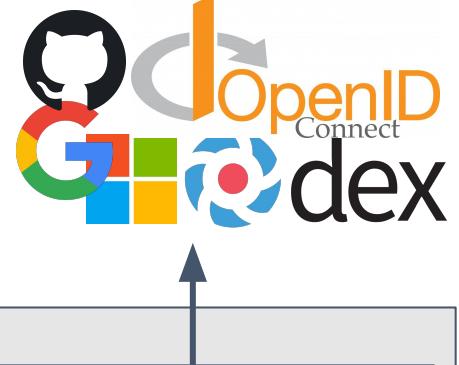
automated, e.g.
GitOps

```
$ kubectl bind apiservice https://some-url.com/apiservice-binding-requests.yaml  
--remote-kubeconfig name
```

kubernetes for in-house

for reasonably sized deployment

authentication via OIDC



Let's build MongoDB in real

We are now service providers.



Search or jump to...

Pull requests Issues Marketplace Explore



[mongodb / mongodb-kubernetes-operator](#)

Public

Watch 36

Fork 328

Star 719



Code



Issues 39



Pull requests 11



Actions



Projects



Security



Insights

master

66 branches

38 tags

Go to file

Add file

Code



[adamliesko](#) Fix validation of references to CA certificate in TLS config... ... cece58a 6 days ago 604 commits

.action_templates

CLOUDP-132091: Add TLS and arbiters to operator upgrade tes... 2 months ago

.github

Add missing AWS credentials to image release job (#1107) 2 months ago

api/v1

CLOUDP-132091: Add TLS and arbiters to operator upgrade tes... 2 months ago

build/bin

CLOUDP-82159: Upgrade to operator-sdk v1.4.0 (#327) 2 years ago

cmd

CLOUDP-132091: Add TLS and arbiters to operator upgrade tes... 2 months ago

config

Release MongoDB Kubernetes Operator v0.7.6 (#1106) 2 months ago

controllers

Fix validation of references to CA certificate in TLS config (#1119) 6 days ago

deploy

Release MongoDB Kubernetes Operator v0.7.6 (#1106) 2 months ago

docs

List prerequisites (#1133) 16 days ago

hack

CLOUDP-82159: Upgrade to operator-sdk v1.4.0 (#327) 2 years ago

helm-charts @ 3581f98

Pin helm-charts to community-release 0.7.6 (#1108) 2 months ago

About

MongoDB Community Kubernetes Operator

Readme

View license

Code of conduct

Security policy

719 stars

36 watching

328 forks

Releases 24

MongoDB Kubernetes Operator Latest

on 2 Sep

+ 23 releases

```
1  apiVersion: mongodbcommunity.mongodb.com/v1
2  kind: MongoDBCommunity
3  metadata:
4    name: demo
5  spec:
6    members: 3
7    type: ReplicaSet
8    version: "4.2.6"
9    security:
10      authentication:
11        modes: ["SCRAM"]
12      users:
13        - db: admin
14          name: admin
15          passwordSecretRef:
16            name: mongodb-credentials
17          roles:
18            - db: admin
19              name: clusterAdmin
20            - db: admin
21              name: userAdminAnyDatabase
22          scramCredentialsSecretName: admin-scram
```



Per instance / namespace

ServiceAccount
mongodb-database

ServiceAccount
mongodb-kubernetes-operator

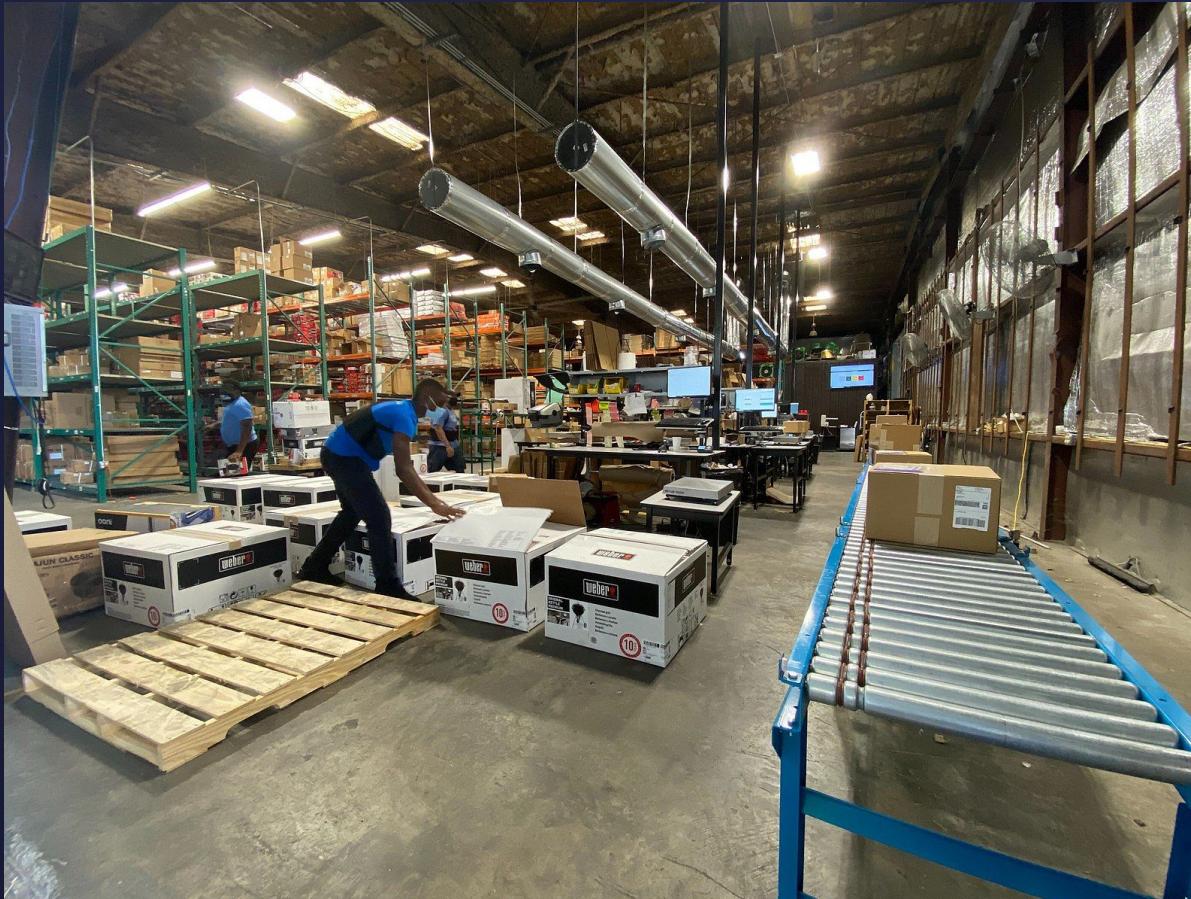
Role
operator-role

RoleBinding
mongodb-kubernetes-operator

Role
mongodb-database

RoleBinding
mongodb-database

Warehouse style computing.



What the consumer should create. Super simple! Polished!

```
1  apiVersion: mangodb.de/v1alpha1
2  kind: MongoDB
3  metadata:
4    name: demo
5  spec:
6    replicas: 1
7    version: "4.2.6"
```





Crossplane to the rescue.

```
1  apiVersion: mongodbcommunity.mongodb.com/v1
2  kind: MongoDBCommunity
3  metadata:
4    name: demo
5  spec:
6    members: 3
7    type: ReplicaSet
8    version: "4.2.6"
9    security:
10      authentication:
11        modes: ["SCRAM"]
12      users:
13        - db: admin
14          name: admin
15          passwordSecretRef:
16            name: mongodb-credentials
17          roles:
18            - db: admin
19              name: clusterAdmin
20            - db: admin
21              name: userAdminAnyDatabase
22          scramCredentialsSecretName: admin-scram
```



Per instance / namespace

ServiceAccount
mongodb-database

ServiceAccount
mongodb-kubernetes-operator

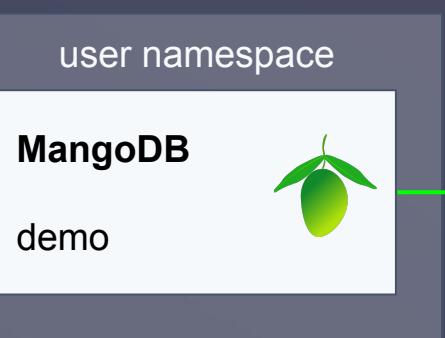
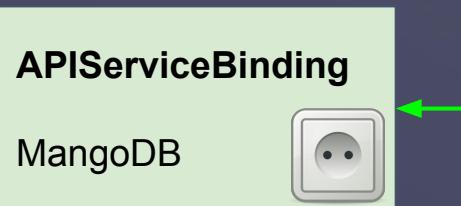
Role
operator-role

RoleBinding
mongodb-kubernetes-operator

Role
mongodb-database

RoleBinding
mongodb-database

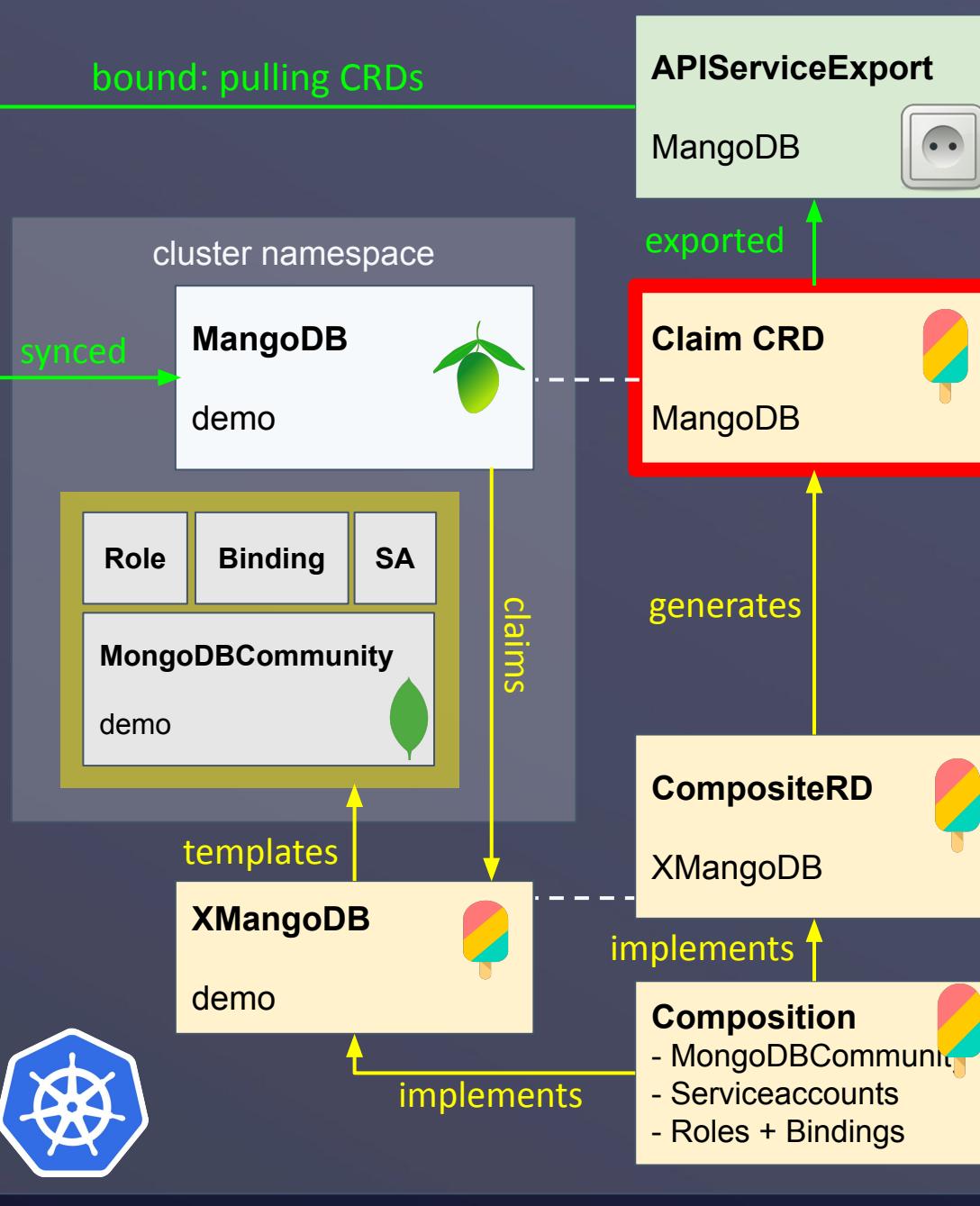
Consumer Cluster



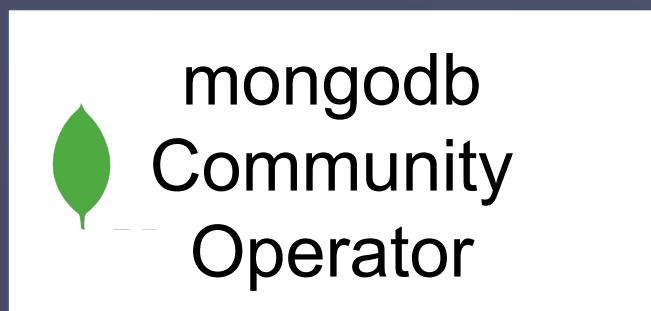
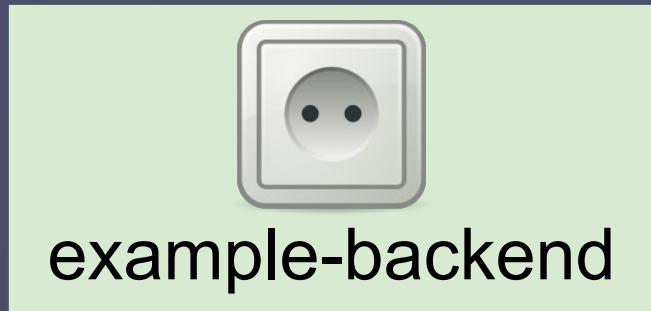
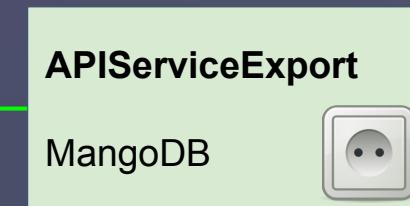
API contract



synced



Service Provider Cluster



```
1 apiVersion: apiextensions.crossplane.io/v1
2 kind: CompositeResourceDefinition
3 metadata:
4   name: xmangodb.mongodb.de
5   labels:
6     kube-bind.io/exported: "true"
7 spec:
8   group: mongodb.de
9   names:
10    kind: XMangoDB
11    plural: xmangodb
12 claimNames:
13   kind: MongoDB ← our service CRD
14   plural: mangodb
15 versions:
16 - name: v1alpha1
17   served: true
18   referenceable: true
19 schema:
20   openAPIV3Schema:
21     type: object
22     properties:
23       spec: ← CRD schema
24         type: object
25         properties:
26           replicas:
27             type: integer
28             default: 3
29           version:
30             type: string
31             minLength: 1
32             default: "4.2.6"
33
```

```
1 apiVersion: apiextensions.crossplane.io/v1
2 kind: Composition
3 metadata:
4   name: on-prem
5   labels:
6     crossplane.io/xrd: xmangodb.mongodb.de
7     provider: on-prem
8 spec:
9   writeConnectionSecretsToNamespace: crossplane-system
10 compositeTypeRef:
11   apiVersion: mongodb.de/v1alpha1
12   kind: XMangoDB
13 resources: ← the “template” to
14   - name: mongodb-community stamp out
15     base:
16       apiVersion: kubernetes.crossplane.io/v1alpha1
17       kind: Object
18       spec:
19         forProvider:
20           manifest:
21             apiVersion: mongodbcommunity.mongodb.com/v1
22             kind: MongoDBCommunity ← how we implement
23             metadata: {}
24             spec:
25               type: ReplicaSet
26               security:
27                 authentication:
28                   modes: ["SCRAM"]
29               users:
30                 - db: admin
31                   name: admin
32                   passwordSecretRef:
```



After all #nocode machinery:

A MongoDB CRD

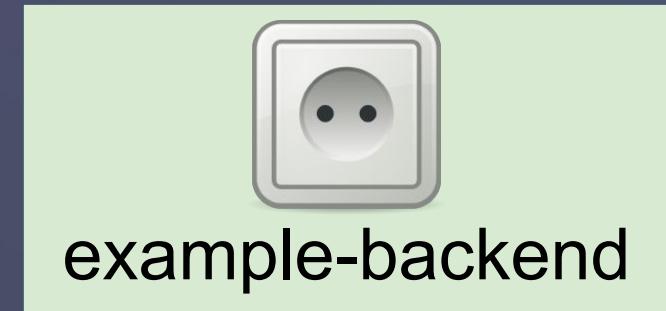
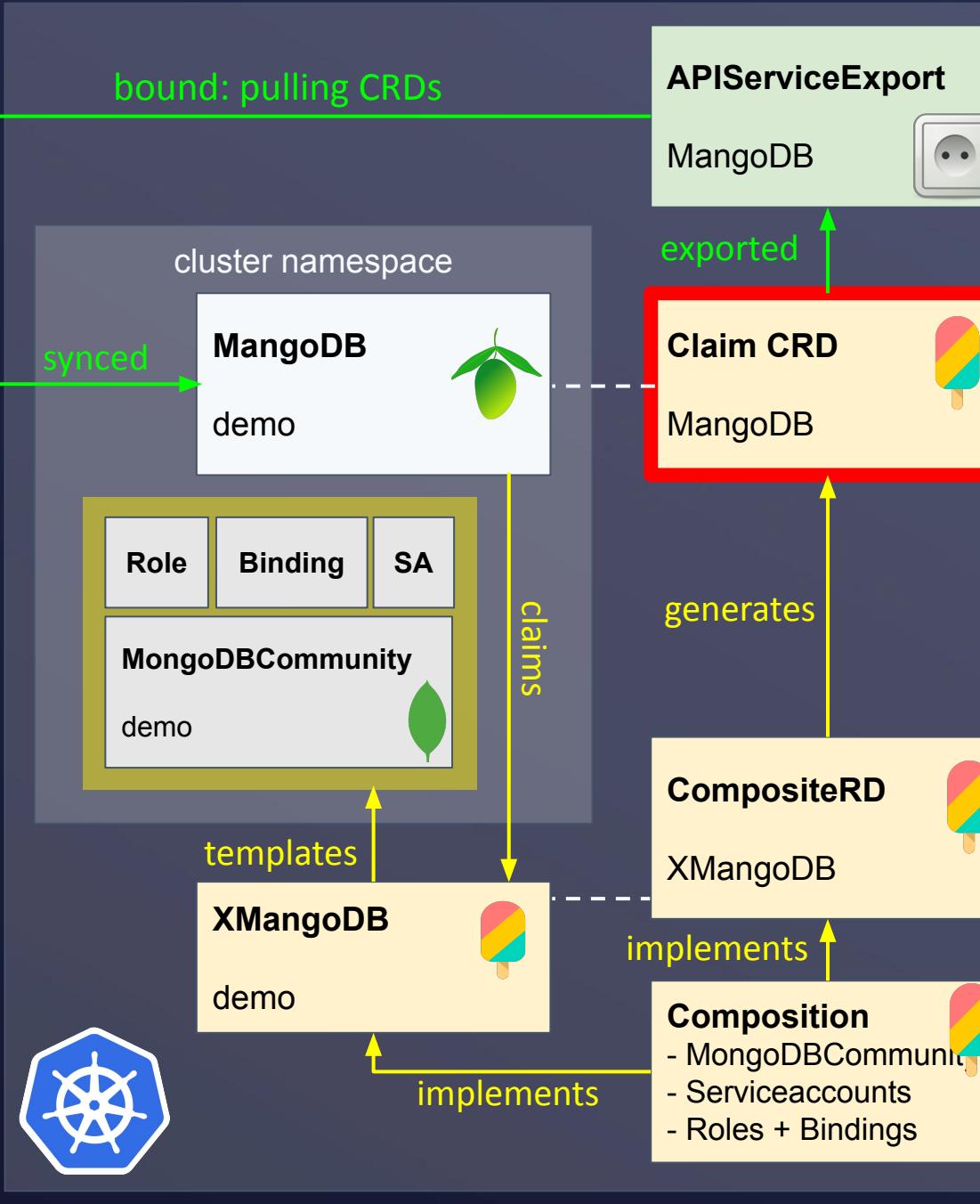
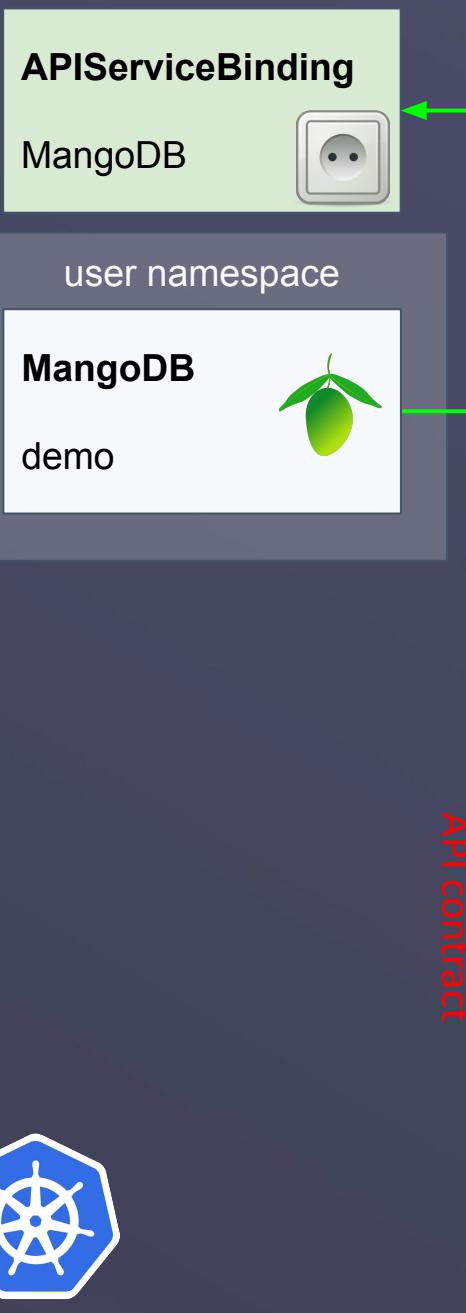
```
1  apiVersion: apiextensions.k8s.io/v1
2  kind: CustomResourceDefinition
3  metadata:
4    creationTimestamp: "2022-10-21T19:53:09Z"
5    generation: 3
6    labels:
7      kube-bind.io/exported: "true" ← offer it through
8    name: mangodbs.mongodb.de          the example-backend
9    ownerReferences:
10   - apiVersion: apiextensions.crossplane.io/v1
11     controller: true
12     kind: CompositeResourceDefinition
13     name: xmangodbs.mongodb.de
14     uid: d334a357-5deb-4d0c-9c91-711ad6140596
15     resourceVersion: "1973960"
16     uid: fd9b061a-0315-4a82-b1da-c1e94aff48de
17   spec:
18     conversion:
19       strategy: None
20     group: mongodb.de
21   status:
```

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Demo

Consumer

Service Provider



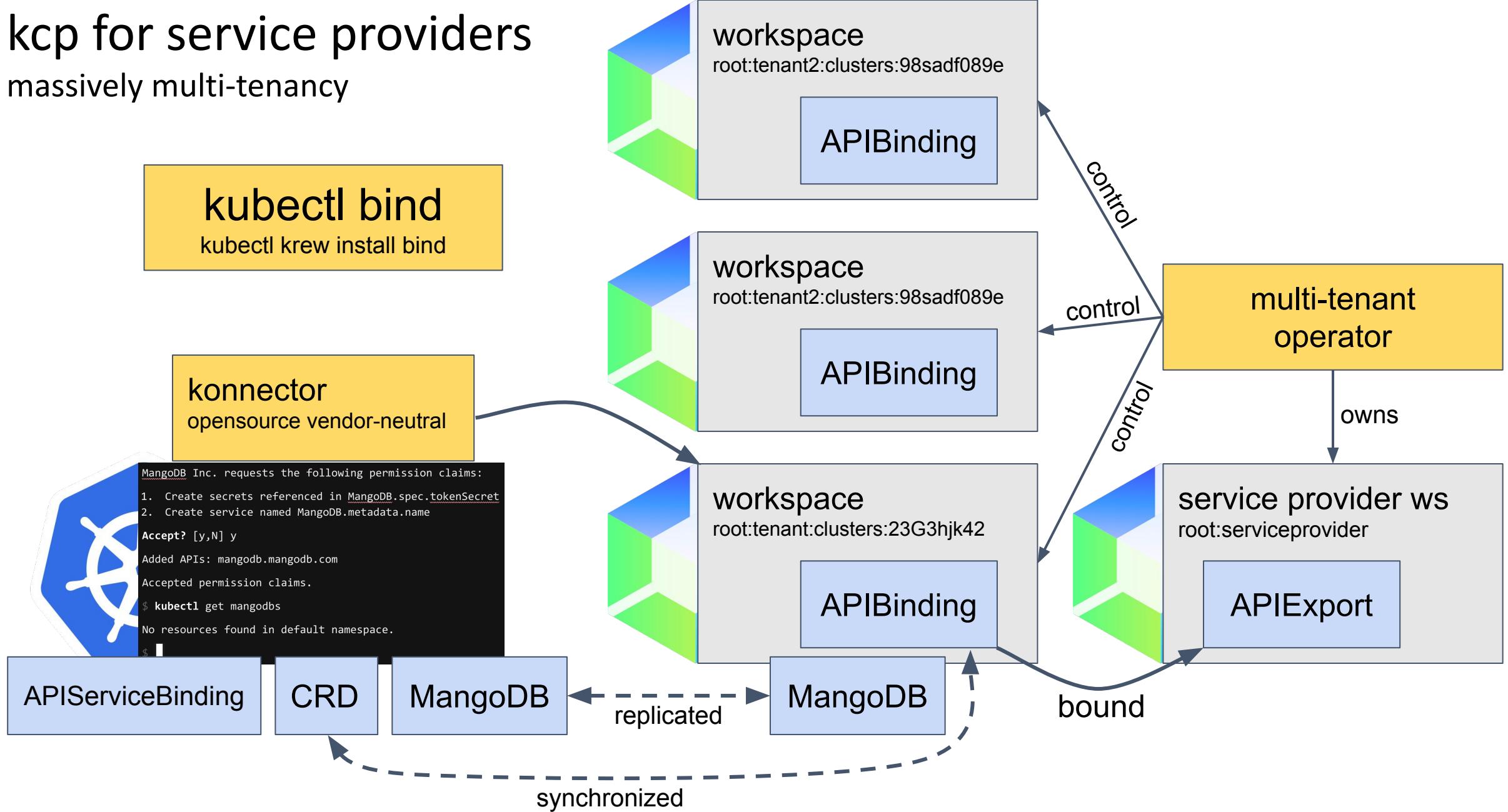
Even more serious as a service provider



kcp

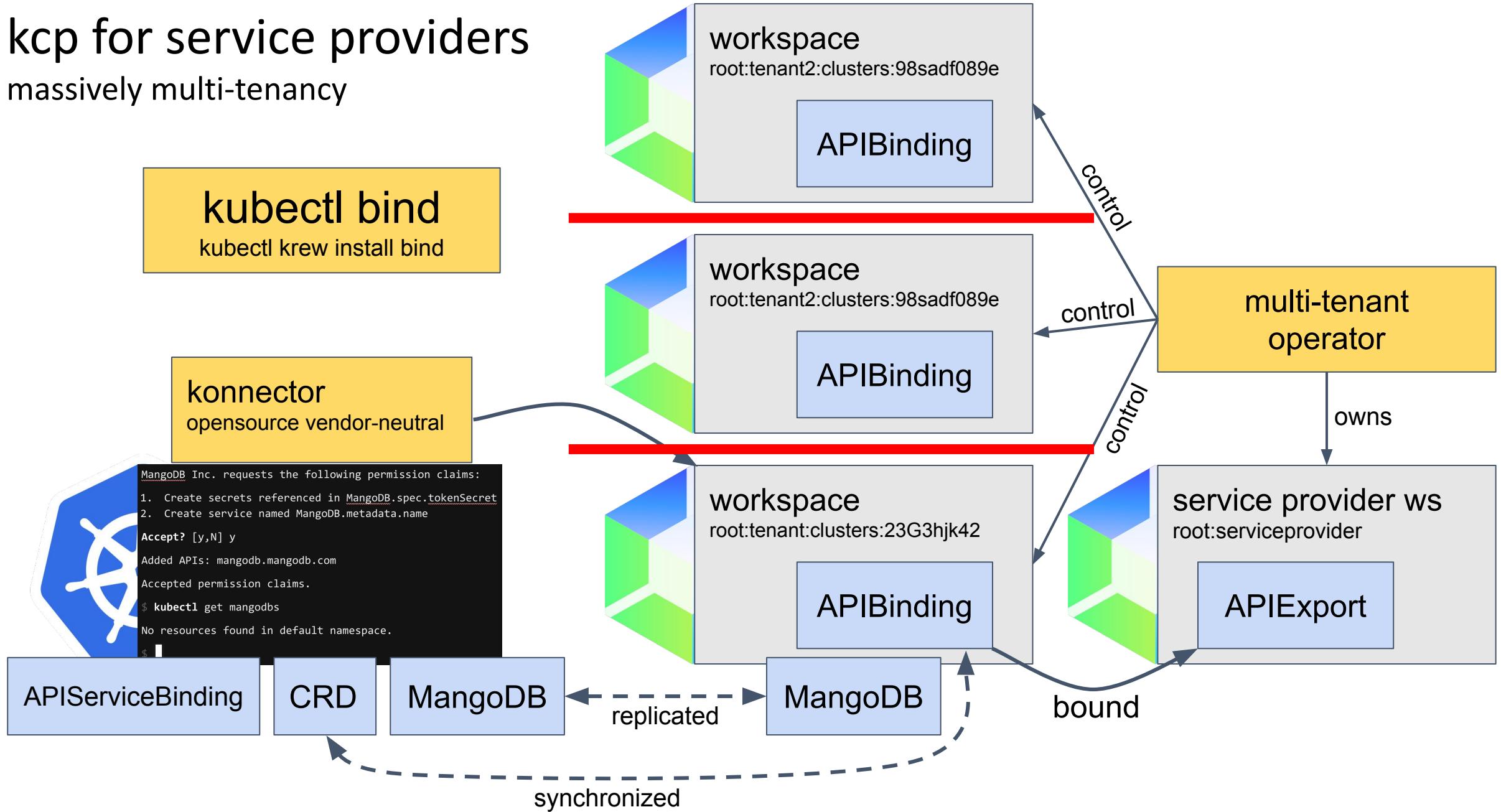
kcp for service providers

massively multi-tenancy



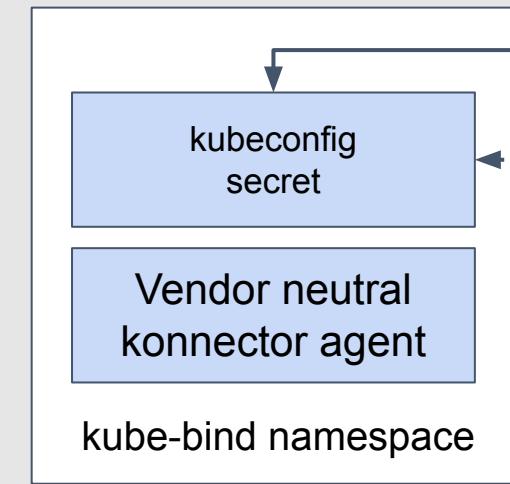
kcp for service providers

massively multi-tenancy

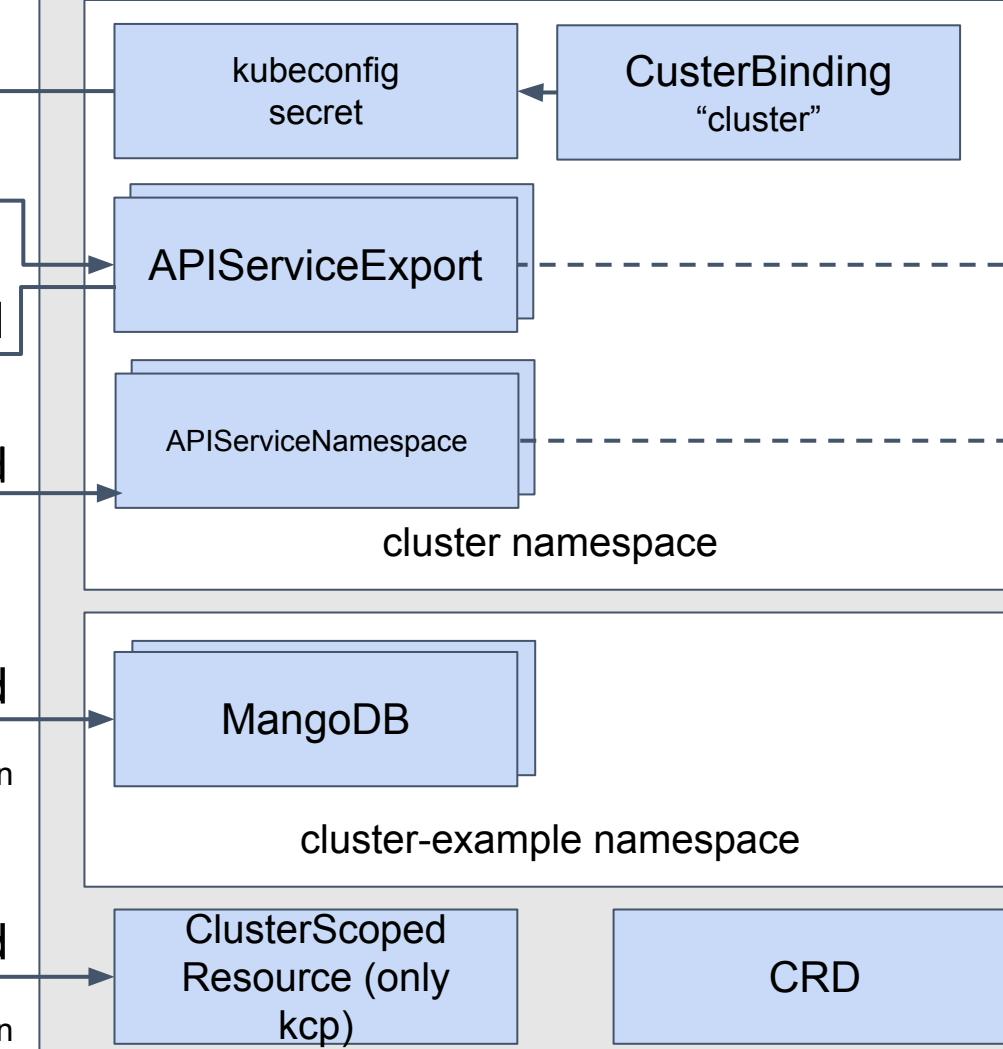




Consumer Kubernetes (downstream)



Provider Kubernetes / kcp (upstream)



kubectl-bind.io



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kube-bind / kube-bind Private

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76 lines (57 sloc) | 2.74 KB

<> Raw Blame



kube-bind

Disclaimer: work in progress and not ready for production use.

kube-bind is a prototype project with the goal to establish a new extension model for Kubernetes clusters:

- APIs should be bindable into a cluster and operated by a service provider
- these APIs should not require (custom) controllers/operators run locally in the consuming cluster
- only a single vendor-neutral, OpenSource agent should be required.

This is the 3 line pitch:

```
$ kubectl krew install bind
$ kubectl bind https://mangodb/exports
Redirect to the browser to authenticate via OIDC.
BOOM - the MongoDB API is available in the local cluster,
      without anything MongoDB-specific running.
$ kubectl get mangodb
```

For more information go to <https://kubectl-bind.io> or watch the ContainerDays talk.

The kube-bind prototype is following this manifesto from the linked talk:

Let's design a **post-operator / post-cluster** technology

that allows a **service provider persona** as 1st class citizen

that can **securely** provide
centrally operated **kube-native** services.

A Community Project Join us!



#kube-bind



<https://kubectl-bind.io>



<https://github.com/kube-bind/kube-bind>



We love collaboration

Any good talk needs a task
(and a t-shirt) to take home

```
$ kubectl krew index add bind https://github.com/kube-bind/krew-index.git  
$ kubectl krew install bind/bind  
$ kubectl bind https://tshirt.k8c.io/export
```

```
$ cat > t-shirt.yaml <<EOF  
apiVersion: kubecon.kube-bind.io/v1alpha1  
kind: TShirtClaim  
metadata:  
  name: stefan  
spec:  
  size: XL  
EOF  
$ kubectl create -f t-shirt.yaml
```



```
$ kubectl get -f t-shirt.yaml -o yaml
```

```
apiVersion: kubecon.kube-bind.io/v1alpha1
kind: TShirtClaim
metadata:
  creationTimestamp: "2022-10-27T15:02:46Z"
  name: stefan
  namespace: default
spec:
  size: L
status:
  booth: <redacted>
  code: <redacted>
  conditions:
    TShirtOrderedSuccessfully:
      message: T-Shirt Size L has been ordered su
      reason: T-Shirt Available
      status: "True"
  ordered: true
```



Towards Something Better Than CRDs in a Post-Operator World



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North America 2022

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Stefan Schimanski
Senior Principal Software Engineer

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Technical Team Lead



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