Operator-SDK

Writing an Operator from Scratch is Challenging.

- Research client-library.
- Repo organization.
- Write boiler-plate code.
- Use code-generators.
- Knowledge of informers/shared informers and work queues for object cache and event handling.

The Operator-SDK provides...

- Use of the controller-runtime library to write operational logic more intuitively.
- Choice of writing a controller with Ansible, Go or the Helm App Operator Kit.
- Tools for scaffolding and code generation to bootstrap a new project fast.
- Extensions to cover common operator use cases.

Operator-SDK Workflow

(In 13 easy steps)

1) Create a New Operator Project.

```
$ operator-sdk new app-operator --type go
```

```
$ ls app-operator

  .git
  .gitignore
  Gopkg.lock
  Gopkg.toml
  build
  cmd
  deploy
  pkg
  vendor
  version
```

2) Add Custom Resource Definition (CRD) API.

```
$ operator-sdk add api --api-version=app.example.com/v1alpha1 --kind=App
```

```
$ cd app-operator
├── pkg/apis
│    ├── addtoscheme_app_v1alpha1.go
│    ├── apis.go
│    └── app
│         └── v1alpha1
│              ├── doc.go
│              ├── app_types.go
│              ├── register.go
│              └── zz_generated.deepcopy.go
├── deploy/crds
│    ├── app_v1alpha1_mug_cr.yaml
│    └── app_v1alpha1_mug_crd.yaml
├── operator.yaml
├── role.yaml
├── role_binding.yaml
└── service_account.yaml
```

3) Define your CRD Spec/Status

```
$ cat pkg/apis/app/v1alpha1/app_types.go
```

```
type AppSpec struct {
    Size int32   `json:"size"`
    Version string `json:"version"`
    ConfigMapName string `json:”configMapName"`
    TLS *TLSPolicy `json:"TLS,omitempty"`
    SecretName string `json:"secretName"`
}
type AppStatus struct {
    Pods []string `json:"pods"`
    Standby string `json:"standby"`
    ExternalAddresses map[string]string `json:"externalAddresses"`
}
```

4) Generate DeepCopy Functions

```
$ operator-sdk generate k8s
```

```
Running code-generation for custom resource group versions: [app:v1alpha1, ]
Generating deepcopy funcs

├── pkg/apis
│   ├── addtoscheme_app_v1alpha1.go
│   ├── apis.go
│   └── app
│       └── v1alpha1
│           ├── doc.go
│           ├── app_types.go
│           ├── register.go
│           └── zz_generated.deepcopy.go
│
```

5) Add a New Controller

```
$ operator-sdk add controller --api-version=app.example.com/v1alpha1 --kind=App

  Create pkg/controller/app/app_controller.go
  Create pkg/controller/add_app.go

  └── pkg/controller
      ├── add_app.go
      ├── app
      │   └── app_controller.go
      └── controller.go
```

6) Define the Operator Reconciling Logic

```
$ vim pkg/controller/app/app_controller.go
```

```
// Watch for changes to primary resource App
    err = c.Watch(&source.Kind{Type: &cachev1alpha1.App{}},
&handler.EnqueueRequestForObject{})
    if err != nil {
        return err
    }
...
     // Watch for changes to secondary resource Pods and requeue the owner
 Memcached
     err = c.Watch(&source.Kind{Type: &corev1.Pod{}},
 &handler.EnqueueRequestForOwner{
         IsController: true,
         OwnerType:    &cachev1alpha1.App{},
     })
     if err != nil {
         return err
     }
```

7) Create the CRD

```
$ oc create -f deploy/crds/app_v1alpha1_appservice_crd.yaml
```

8) Run your Operator locally

```
$ export OPERATOR_NAME=app-operator

$ operator-sdk run --local --namespace myproject --kubeconfig=
```

9) Create your CR and confirm your logic works as expected.

```
$ oc create -f deploy/crds/app_v1alpha1_appservice_cr.yaml
```

10) Once satisfied, build your Operator

```
operator-sdk build quay.io/example/app-operator:v.0.0.1
```

11) Push the image to a container registry

```
$ docker push quay.io/example/app-operator:v0.0.1
```

12) Create the Service Account, Role, and RoleBindings for the Operator

```
$ oc create -f deploy/service_account.yaml
$ oc create -f deploy/role.yaml
$ oc create -f deploy/role_binding.yaml
```

13) Apply the Operator Deployment Manifest

```
$ cat deploy/operator.yaml
```

```
...
apiVersion: apps/v1
kind: Deployment
metadata:
  name: app-operator
spec:
  replicas: 1
 …
    spec:
      containers:
        - name: plex-operator
          image: quay.io/example/app-operator:v0.0.1
...
```

```
$ oc create -f deploy/operator.yaml
```

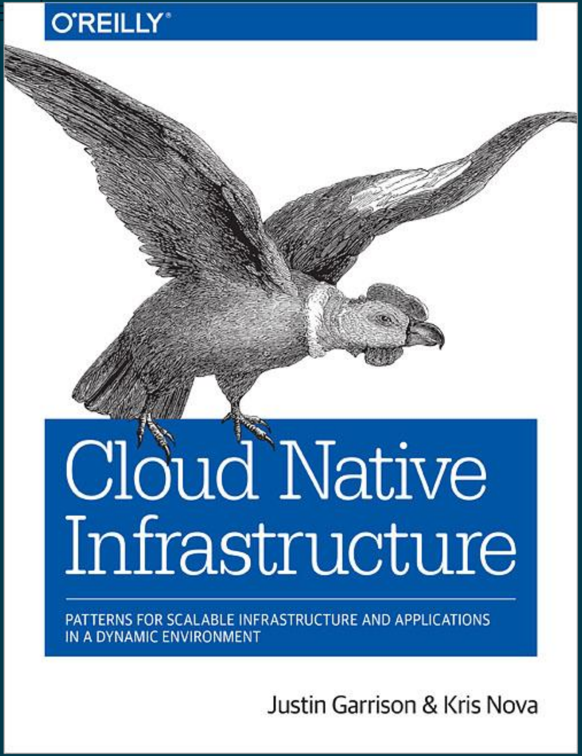
Your Operator is **Alive**!

OPERATOR-SDK - go, ansible, or helm.

CONTROLLER RUNTIME

CLIENT GO

Controller-Runtime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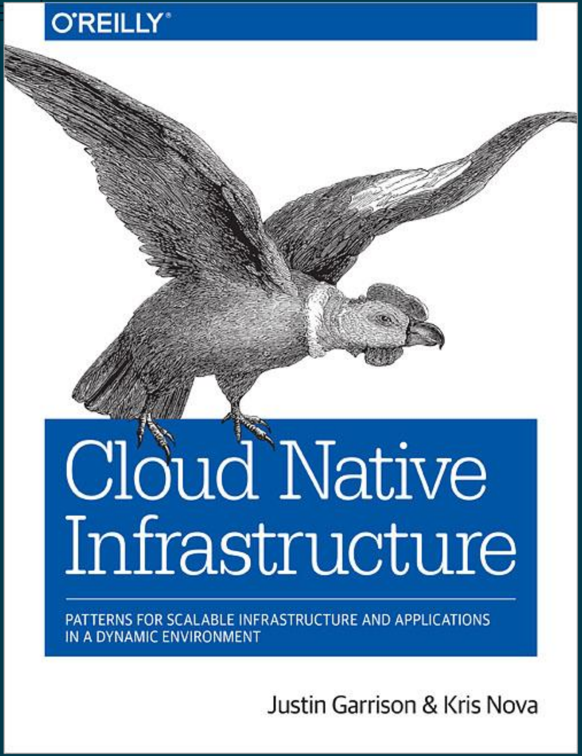
Cloud Native Infrastructure
PATTERNS FOR SCALABLE INFRASTRUCTURE AND APPLICATIONS IN A DYNAMIC ENVIRONMENT
Justin Garrison & Kris Nova

Chapter 4
Designing Infrastructure Applications

The ***reconciler pattern*** *is a software pattern that can be used or expanded upon for managing cloud native infrastructure. The pattern enforces the idea of having two representations of the infrastructure—the first being the actual state of the infrastructure, and the second being the expected state of the infrastructure.*



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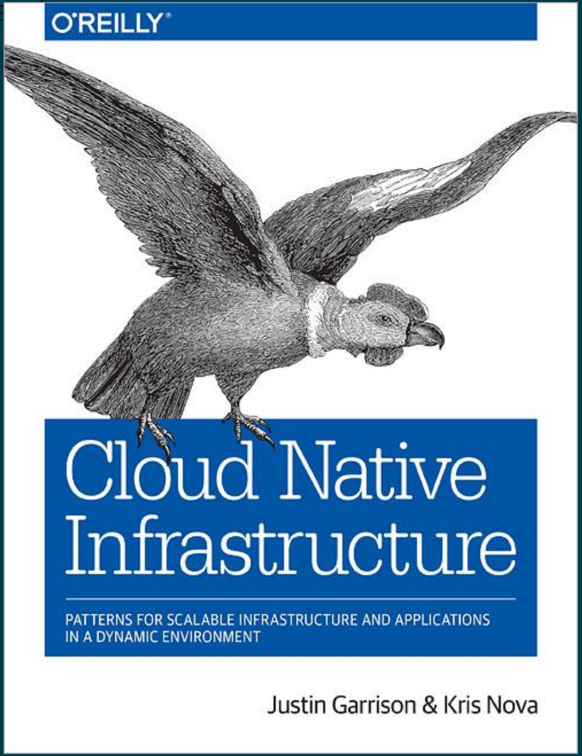
Four Philosophical Rules of the Reconciler Pattern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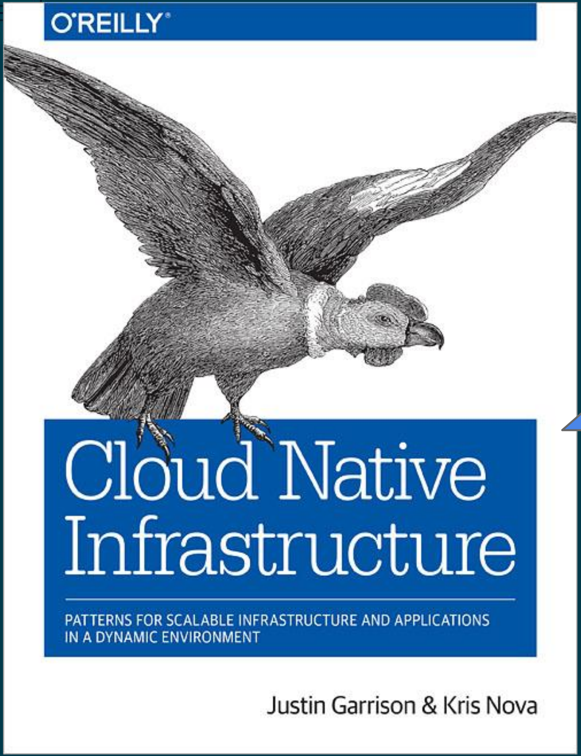
Four Philosophical Rules of the Reconciler Pattern

1. Use a data structure for all inputs and outputs.

```
{
    "apiVersion": "v1",
    "kind": "Pod",
    "metadata": {
        "creationTimestamp": null,
        "name": "test-pd",
        "selfLink": "/api/v1/namespaces/default/pods/test-pd"
    },
    "spec": {
        "containers": [
            {
                "image": "nginx",
                "imagePullPolicy": "Always",
                "name": "test-container",
                "resources": {},
                "terminationMessagePath": "/dev/termination-log",
                "terminationMessagePolicy": "File",
                "volumeMounts": [
                    {
                        "mountPath": "/var/run/secrets/kubernetes.io/serviceaccount",
………..
```

Four Philosophical Rules of the Reconciler Pattern

2. Ensure That the Data Structure Is Immutable.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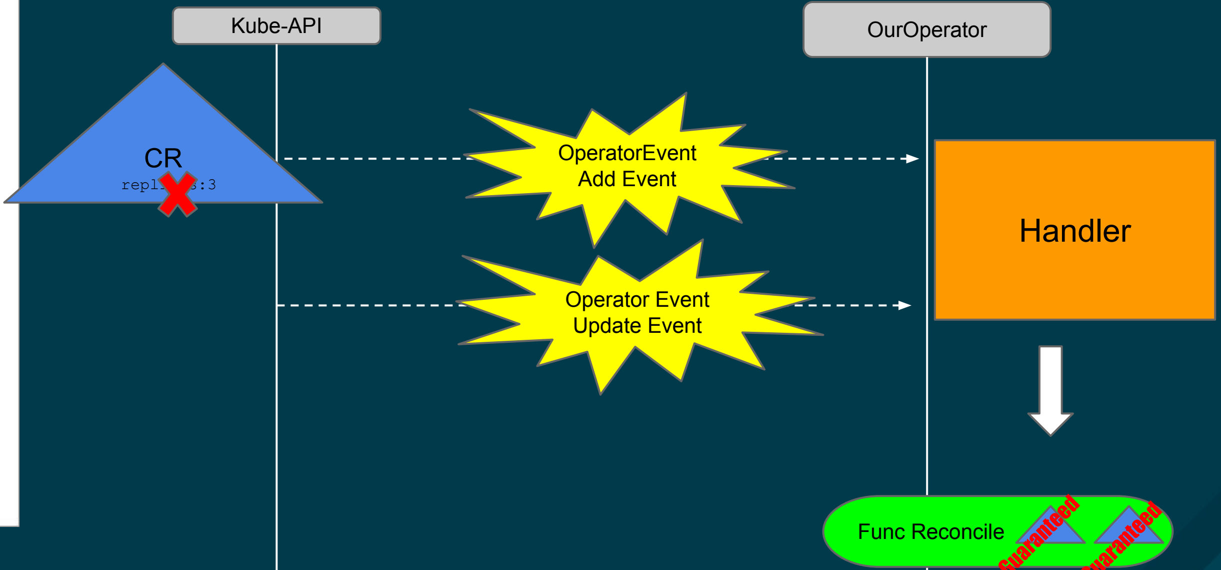
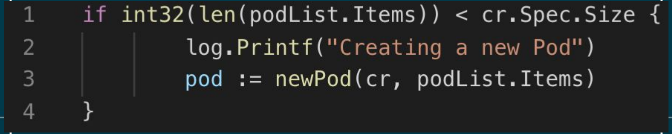
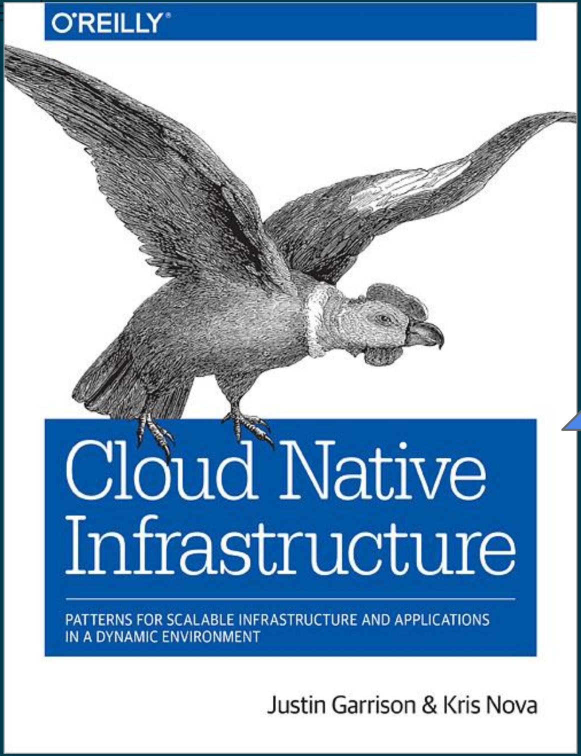




```
if int32(len(podList.Items)) < cr.Spec.Size {
		log.Printf("Creating a new Pod")
		pod := newPod(cr, podList.Items)
}
```

Four Philosophical Rules of the Reconciler Pattern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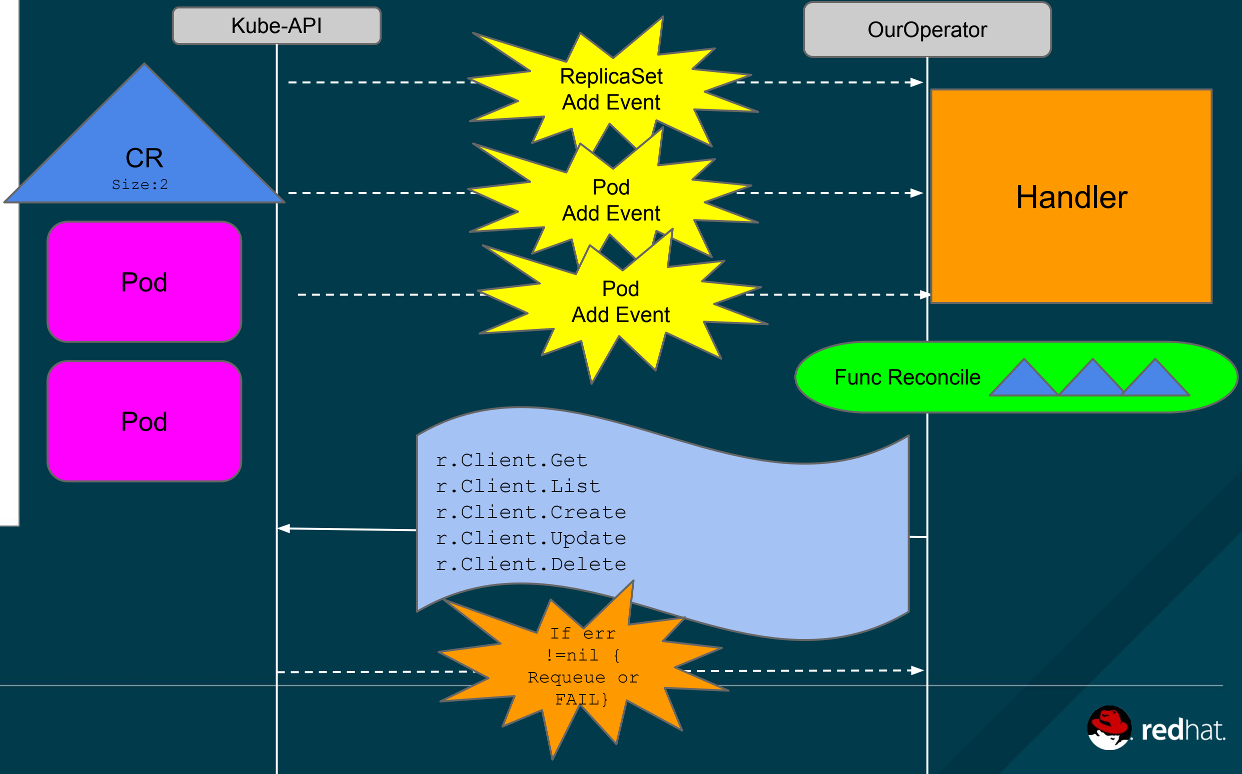
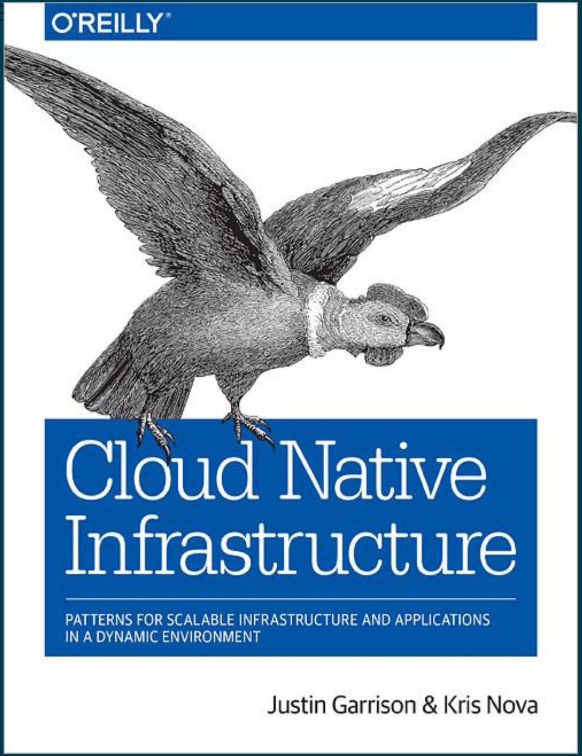
3. Keep the resource map simple.

The reconciler pattern should be mapped with a set of resources - reconciler should iterate through the resources procedurely and offer a simple, linear approach.



```
r.Client.Get
r.Client.List
r.Client.Create
r.Client.Update
r.Client.Delete
```



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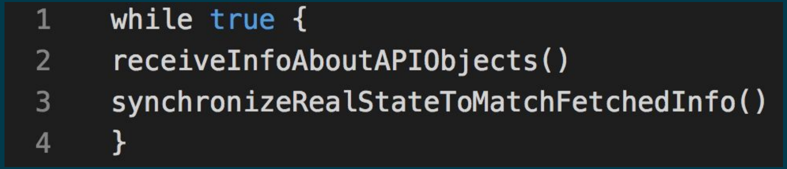
Four Philosophical Rules of the Reconciler Pattern

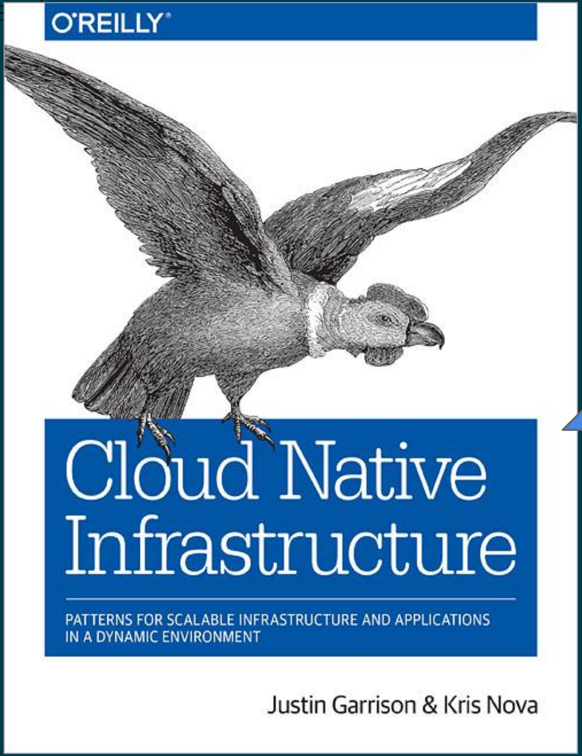
4. Make the Actual State Match the Expected State



```
while true {
receiveInfoAboutAPIObjects()
synchronizeRealStateToMatchFetchedInfo()
}
```

Four Philosophical Rules of the Reconciler Pattern

4. Make the Actual State Match the Expected State



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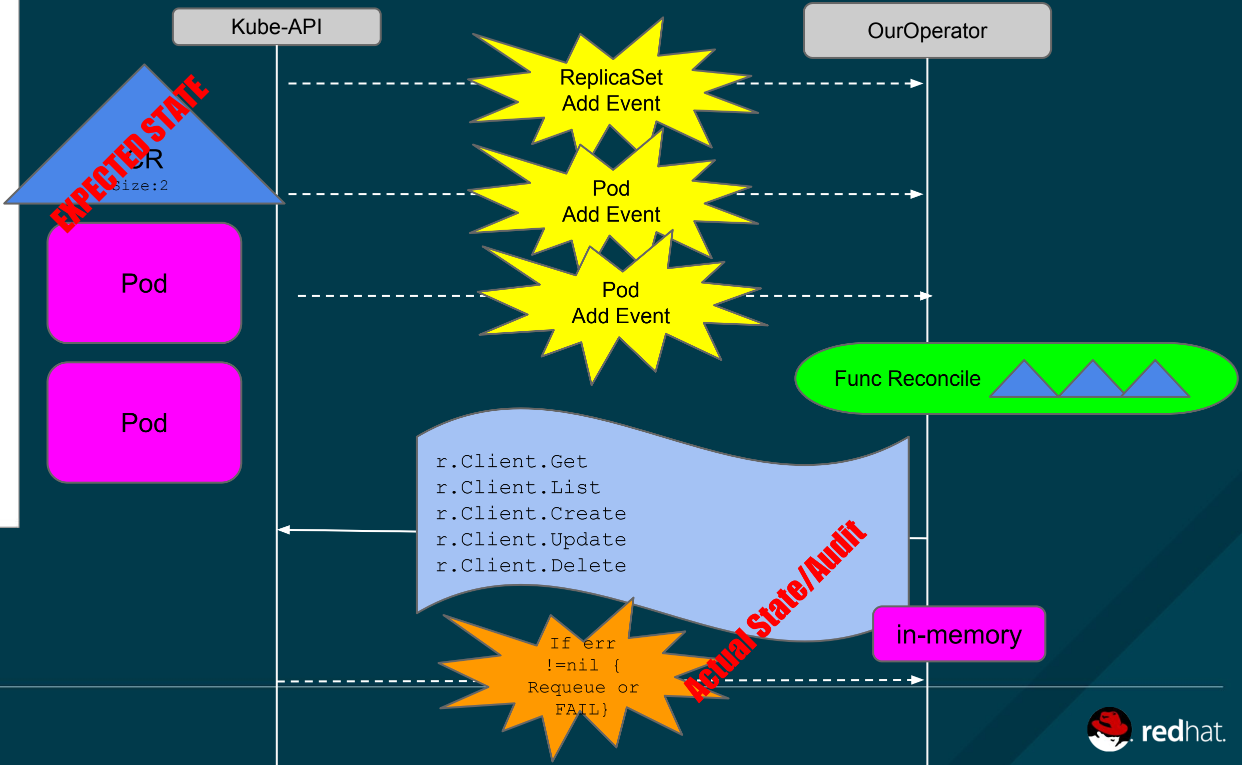
Cloud Native Infrastructure

PATTERNS FOR SCALABLE INFRASTRUCTURE AND APPLICATIONS IN A DYNAMIC ENVIRONMENT

Justin Garrison & Kris Nova



```
r.Client.Get
r.Client.List
r.Client.Create
r.Client.Update
r.Client.Delete
```

```
If err
!=nil {
Requeue or
FAIL}
```

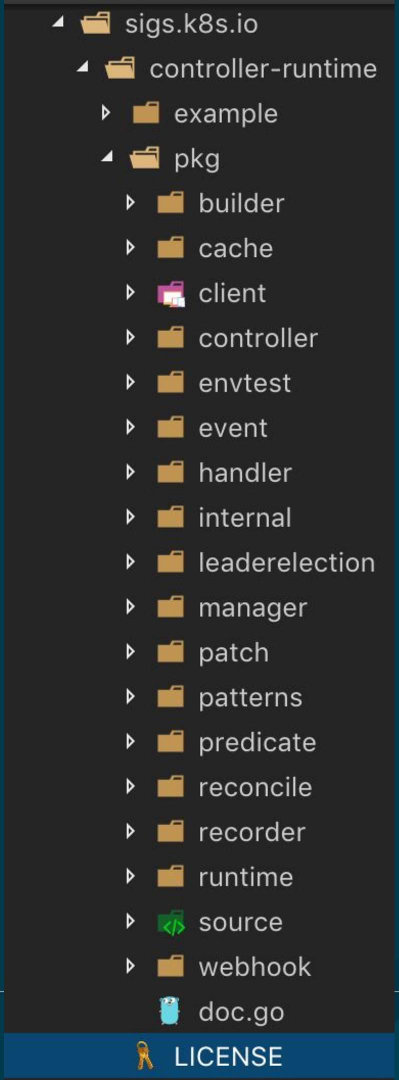
Operator-SDK Project Layout

What is Controller-Runtime?

A set of Go libraries for building Controllers.

It is a subproject of the kubebuilder project by sig-apimachinery.

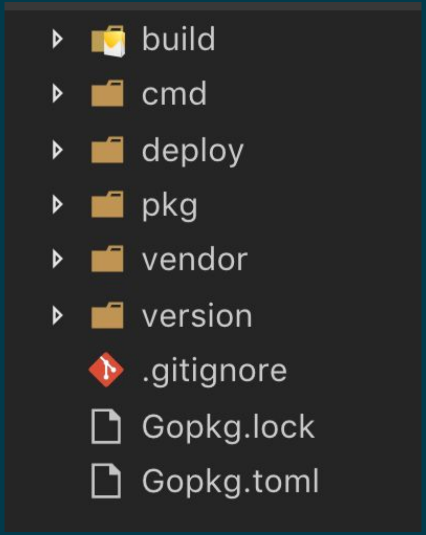
Created to simplify the development of controllers.



```
sigs.k8s.io
  controller-runtime
    example
    pkg
      builder
      cache
      client
      controller
      envtest
      event
      handler
      internal
      leaderelection
      manager
      patch
      patterns
      predicate
      reconcile
      recorder
      runtime
      source
      webhook
      doc.go
    LICENSE
```

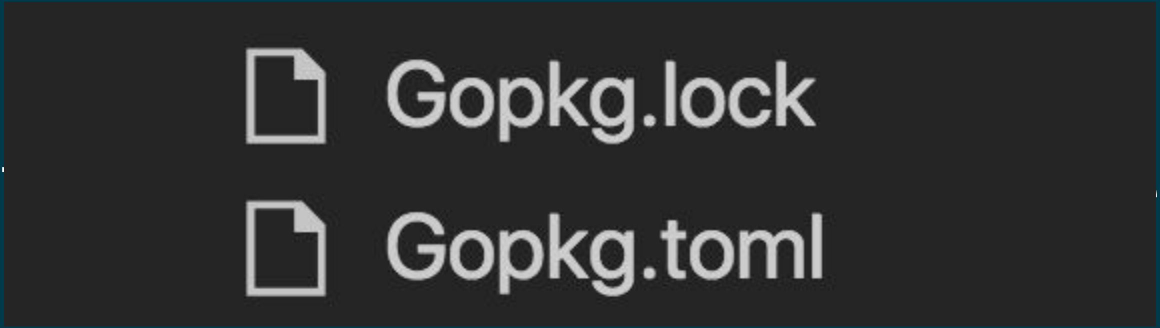
operator-sdk new Command

```
$ operator-sdk new app-operator --type go
```



```
▸ build
▸ cmd
▸ deploy
▸ pkg
▸ vendor
▸ version
  .gitignore
  Gopkg.lock
  Gopkg.toml
```

Go Dep Manifests

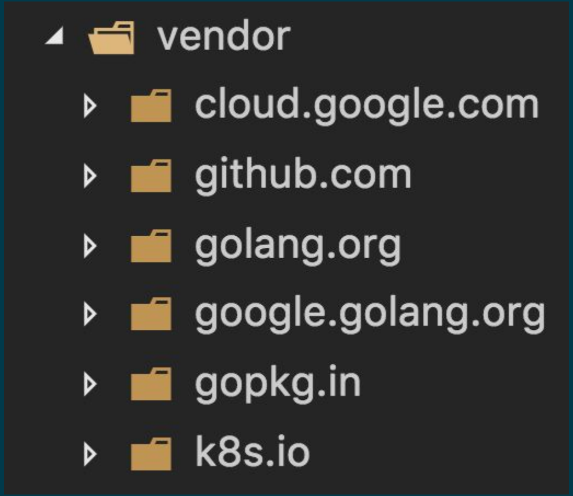


Gopkg.lock

Gopkg.toml

- These files are generated when one runs *dep init*.
- *gopkg.toml*: typically handwritten; where one specifies direct dependency based on branch, version, etc.
- *gopkg.lock:* computed outputs (automatically generated).
- **operator-sdk takes care of these for you.**

vendor

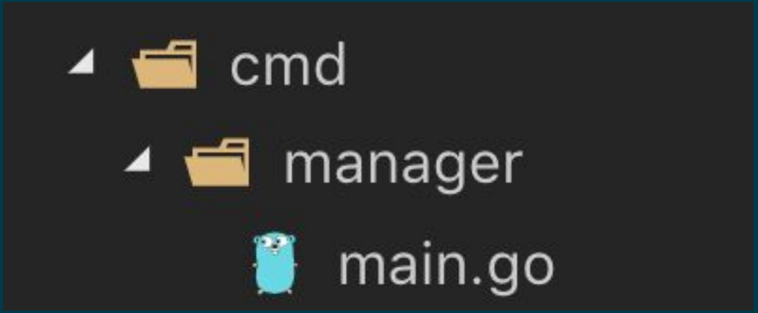


```
vendor
  cloud.google.com
  github.com
  golang.org
  google.golang.org
  gopkg.in
  k8s.io
```

Contains the local copies of the external dependencies that satisfy the imports of the project.

- Managed by go dep.

Main.go aka the Manager

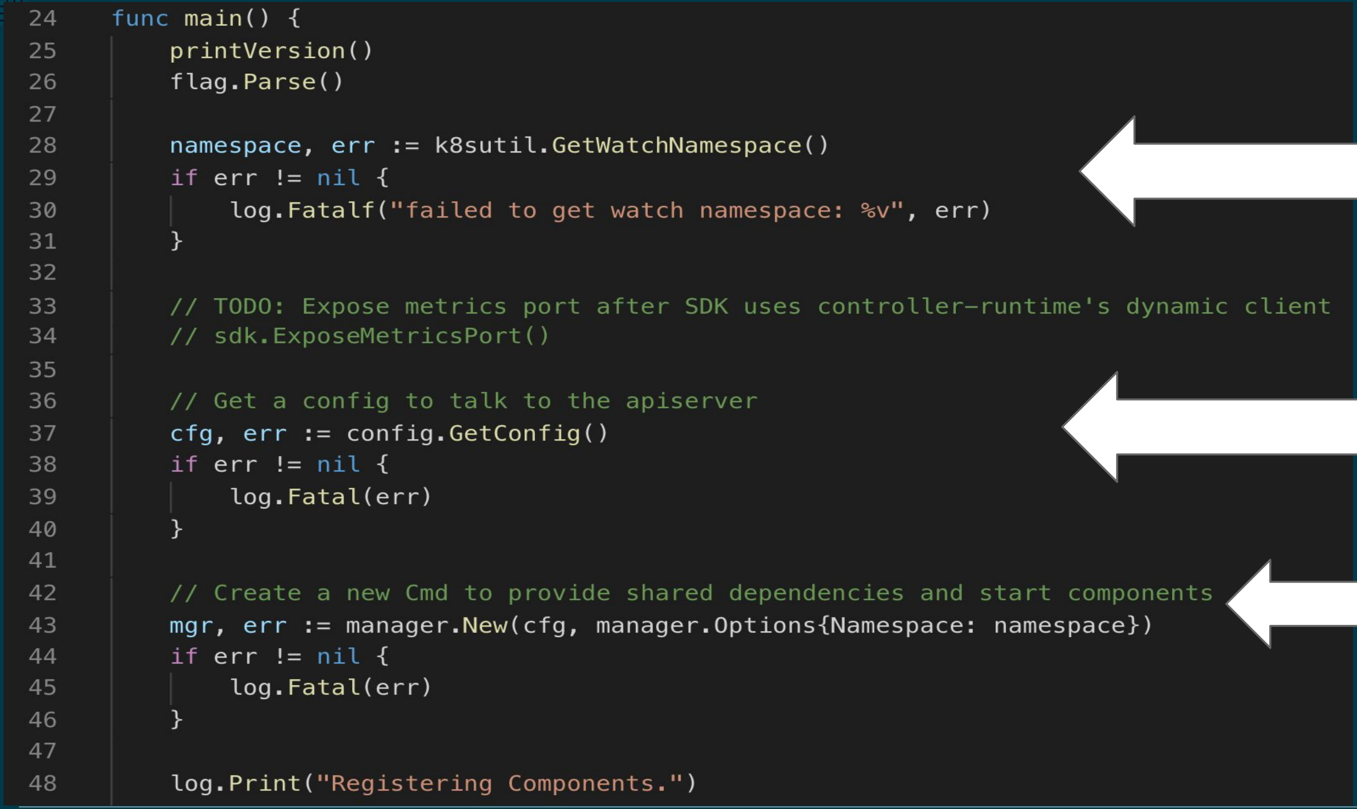


```
cmd
  manager
    main.go
```

An executable that wraps one or more Controllers.

- Performs setup steps:
  - Getting a `kubeconfig` to talk to the API
  - Add APIs to the Manager's scheme.
  - Add Controllers to the Manager
  - Initializes Shared Dependencies like Caches and Clients

Main.go aka the Manager



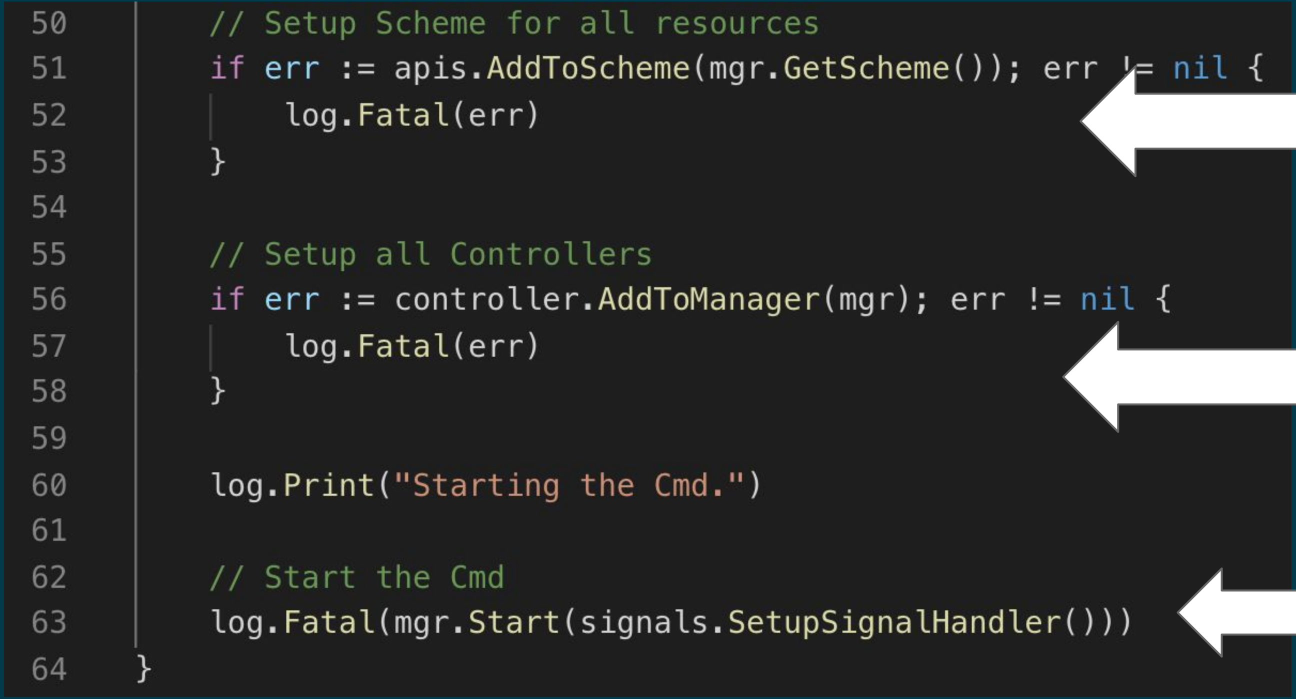
```go
func main() {
    printVersion()
    flag.Parse()

    namespace, err := k8sutil.GetWatchNamespace()
    if err != nil {
        log.Fatalf("failed to get watch namespace: %v", err)
    }

    // TODO: Expose metrics port after SDK uses controller-runtime's dynamic client
    // sdk.ExposeMetricsPort()

    // Get a config to talk to the apiserver
    cfg, err := config.GetConfig()
    if err != nil {
        log.Fatal(err)
    }

    // Create a new Cmd to provide shared dependencies and start components
    mgr, err := manager.New(cfg, manager.Options{Namespace: namespace})
    if err != nil {
        log.Fatal(err)
    }

    log.Print("Registering Components.")
```

Namespace passed via flag or variable.

Kubeconfig passed via flag or pod mount (in-cluster)

Creates New Manager

Main.go aka the Manager



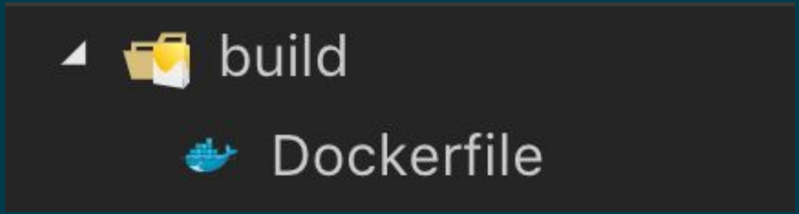
```go
    // Setup Scheme for all resources
    if err := apis.AddToScheme(mgr.GetScheme()); err != nil {
        log.Fatal(err)
    }

    // Setup all Controllers
    if err := controller.AddToManager(mgr); err != nil {
        log.Fatal(err)
    }

    log.Print("Starting the Cmd.")

    // Start the Cmd
    log.Fatal(mgr.Start(signals.SetupSignalHandler()))
}
```

Add Core Resource
Type Schemes

Setup All Controllers

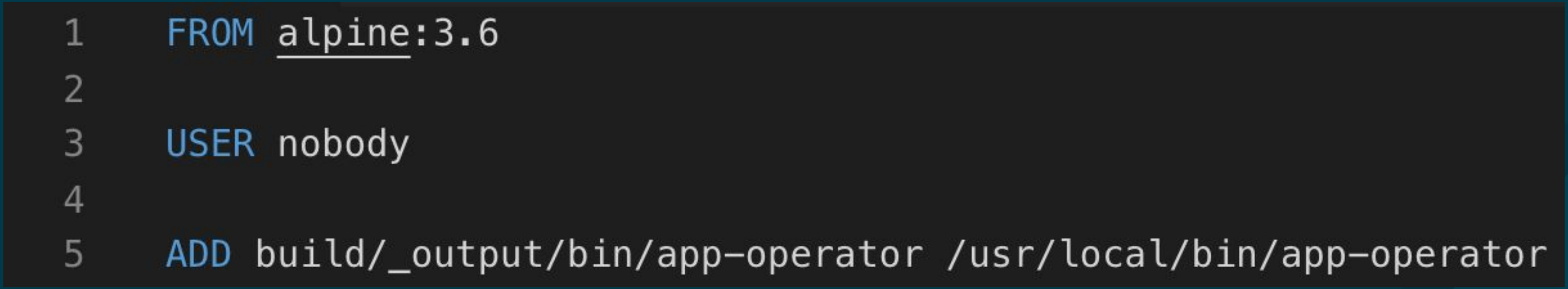
Start the Manager

Dockerfile



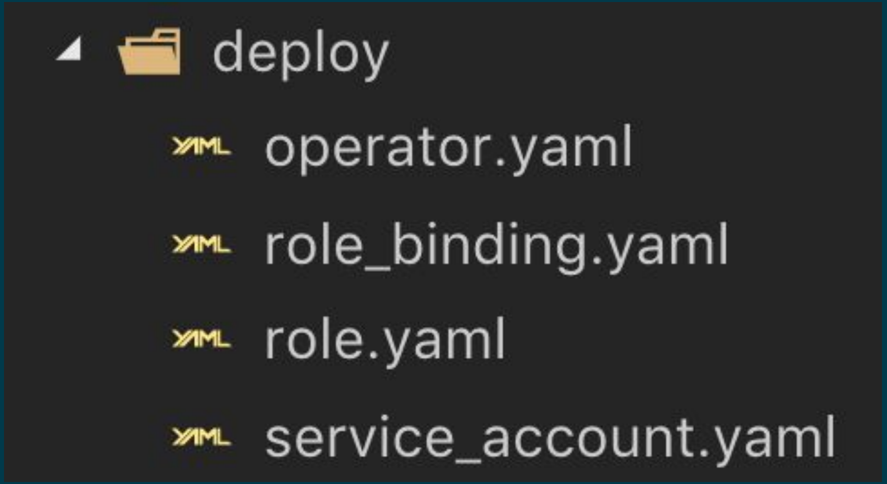
Used during `operator-sdk build`.

Copies the Operator binary to an alpine-based container



```
FROM alpine:3.6

USER nobody

ADD build/_output/bin/app-operator /usr/local/bin/app-operator
```

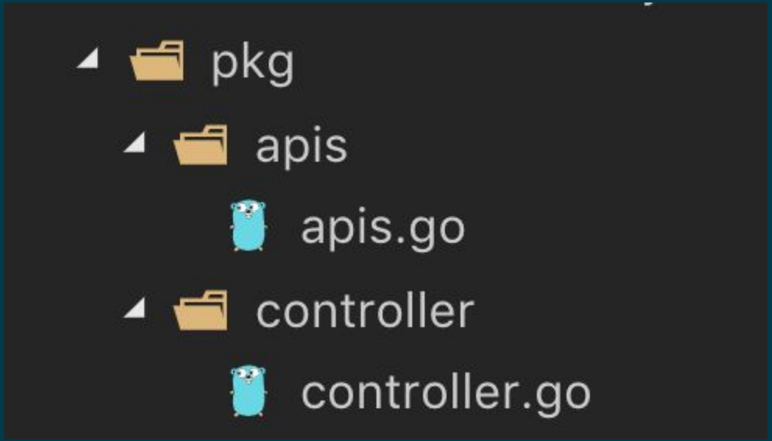
deploy



```
deploy
  operator.yaml
  role_binding.yaml
  role.yaml
  service_account.yaml
```

A generic set of kubernetes manifests for deploying the operator on a Kubernetes cluster.

pkg/apis & pkg/controller



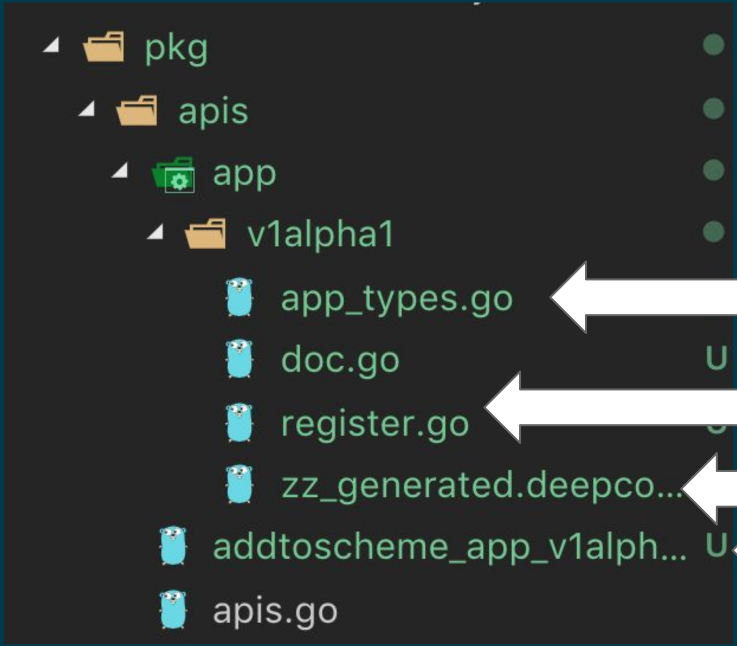
```
pkg
  apis
    apis.go
  controller
    controller.go
```

Defines Custom API type(s) and Controller(s).

- Populated when running `operator-sdk add api` or `operator-sdk add controller`.

operator-sdk add Command

```
$ operator-sdk add api --api-version=app.example.com/v1alpha1 --kind=App
```



```
pkg
  apis
    app
      v1alpha1
        app_types.go
        doc.go                      U
        register.go                 U
        zz_generated.deepco...
    addtoscheme_app_v1alph...       U
    apis.go
```

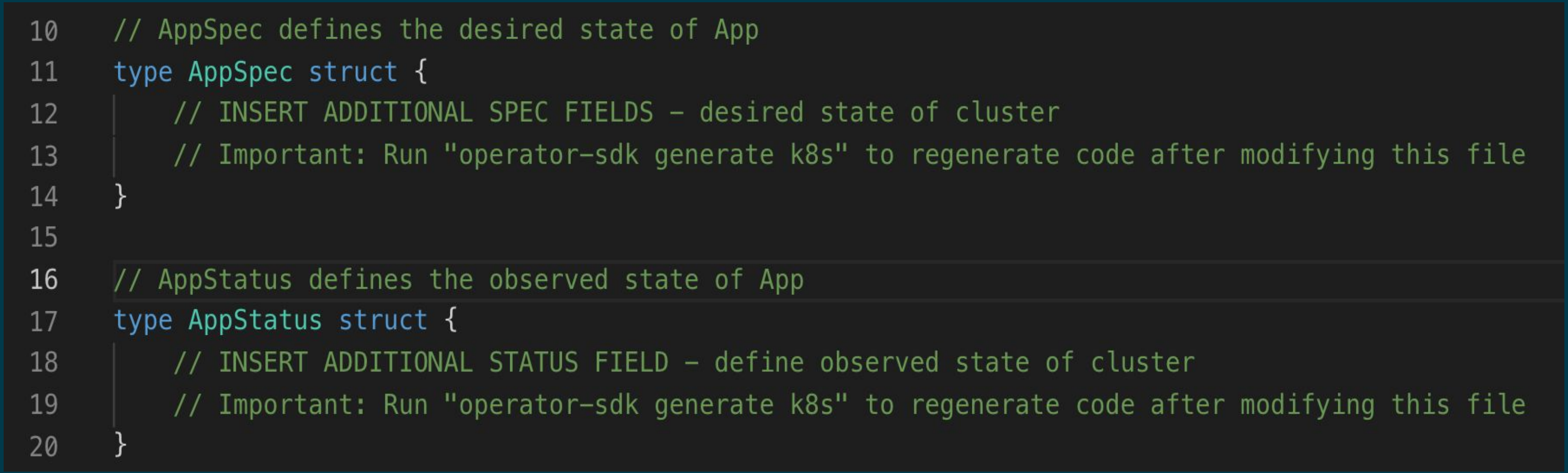
CRD Spec/Status that you specify.

Sets up the CRD Scheme.

Creates the DeepCopy functions for your CRD.

Creates the DeepCopy functions for your CRD.

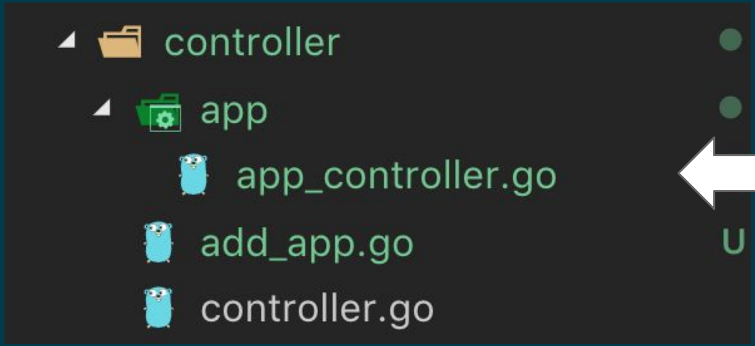
*_types.go



```go
// AppSpec defines the desired state of App
type AppSpec struct {
	// INSERT ADDITIONAL SPEC FIELDS - desired state of cluster
	// Important: Run "operator-sdk generate k8s" to regenerate code after modifying this file
}

// AppStatus defines the observed state of App
type AppStatus struct {
	// INSERT ADDITIONAL STATUS FIELD - define observed state of cluster
	// Important: Run "operator-sdk generate k8s" to regenerate code after modifying this file
}
```

operator-sdk add Command

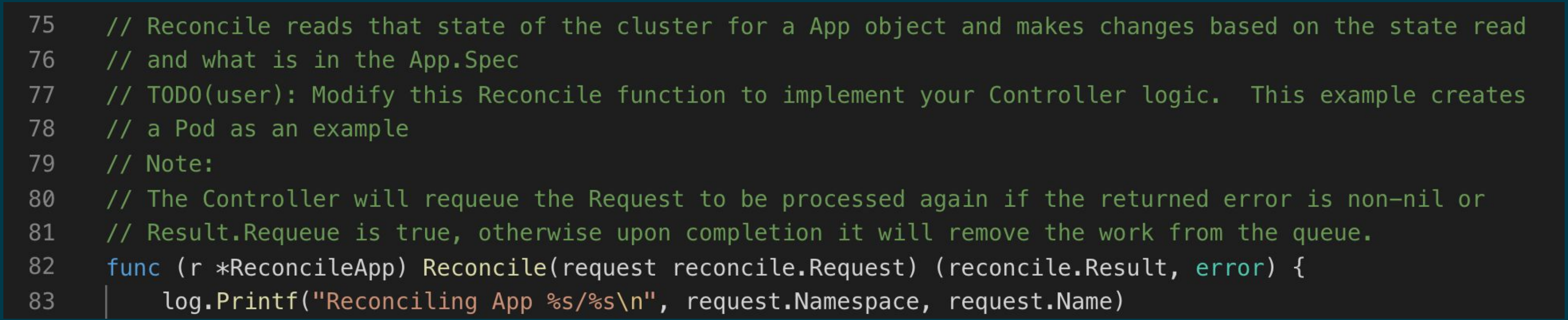
```
$ operator-sdk add controller --api-version=app.example.com/v1alpha1 --kind=App
```



```
controller
  app
    app_controller.go
  add_app.go
  controller.go
```

Reconciler/Operator Logic.

app_controller.go



```go
// Reconcile reads that state of the cluster for a App object and makes changes based on the state read
// and what is in the App.Spec
// TODO(user): Modify this Reconcile function to implement your Controller logic.  This example creates
// a Pod as an example
// Note:
// The Controller will requeue the Request to be processed again if the returned error is non-nil or
// Result.Requeue is true, otherwise upon completion it will remove the work from the queue.
func (r *ReconcileApp) Reconcile(request reconcile.Request) (reconcile.Result, error) {
    log.Printf("Reconciling App %s/%s\n", request.Namespace, request.Name)
```