
Flux Documentation

Flux development team

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INTRODUCING FLUX

Continuous delivery is a term that encapsulates a set of best practices that surround building, deploying and monitoring applications. The goal is to provide a sustainable model for maintaining and improving an application.

Flux is a tool that automates the deployment of containers to Kubernetes. It fills the automation void that exists between building and monitoring.

1.1 Automated git->cluster synchronisation

Flux's main feature is the automated synchronisation between a version control repository and a cluster. If you make any changes to your repository, those changes are automatically deployed to your cluster.

This is a simple, but dramatic improvement on current state of the art.

- All configuration is stored within version control and is inherently up to date. At any point anyone could completely recreate the cluster in exactly the same state of configuration.
- Changes to the cluster are immediately visible to all interested parties.
- During a postmortem, the git log provides the perfect history for an audit.
- End to end, code to production pipelines become not only possible, but easy.

1.2 Automated deployment of new container images

Another feature is the automated deployment of containers. It will continuously monitor a range of container registries and deploy new versions where applicable.

This is really useful for keeping the repository and therefore the cluster up to date. It allows separate teams to have their own deployment pipelines since Flux is able to see the new image and update the cluster accordingly.

This feature can be disabled and images can be locked to a specific version.

1.3 Integrations with other devops tools

For configuration customization across environments and clusters, Flux comes with builtin support for *Kustomize* and *Helm*.

For advanced deployment patterns like Canary releases, A/B testing and Blue/Green deployments, Flux can be used together with *Flagger*.

REQUIREMENTS AND LIMITATIONS

Flux has some requirements of the files it finds in your git repo.

- Flux can only deal with one such repo at a time. This limitation is technical and may go away.
- Flux only deals with YAML files at present. It tries to preserve comments and whitespace in YAMLs when updating them. You may see updates with incidental, harmless changes, like reindented blocks.
- All Kubernetes resource manifests should explicitly specify the namespace in which you want them to run. Otherwise, the conventional default ("default") will be assumed.
- Flux will ignore directories that look like Helm charts, to avoid applying templated YAML manifests. A directory will be skipped if its contents include the files `Chart.yaml` and `values.yaml`, as these are the (only) mandatory components of a Helm chart.

It is *not* a requirement that the files are arranged in any particular way into directories. Flux will look in subdirectories for YAML files recursively, but does not infer any meaning from the directory structure.

Flux uses the Docker Registry API to collect metadata about the images running in the cluster. This comes with at least one limitation:

- Since Flux runs in a container in your cluster, it may not be able to resolve all hostnames that you or Kubernetes can resolve. In particular, it won't be able to get image metadata for images in a private image registry that's made available at `localhost`.

GET STARTED

All you need is a Kubernetes cluster and a git repo. The git repo contains [manifests](#) (as YAML files) describing what should run in the cluster. Flux imposes *some requirements* on these files.

3.1 Installing Flux

Here are the instructions to *install Flux on your own cluster*.

If you are using Helm, we have a *separate section about this*.

REFERENCES

4.1 Blueprint

This page describes the goals of Flux, how it achieves them and significant architectural decisions. It is intentionally high level to prevent it from being out of date too quickly.

4.1.1 Flux's goals

The overall goal of Flux is to automate the deployment of services. A typical use case would be:

1. A developer makes changes
2. An operational cluster is now out of date and needs to be updated
3. Flux observes those changes and deploys them to the cluster
4. Flux maintains the current state of the cluster (e.g. in the event of failure)

Hence, the goal is to automate away the need for a developer to interact with an orchestrator (which is a common source of accidental failure) or with the systems that ensure that the orchestrator is in a working state.

Flux provides a CLI (`fluxctl`) to perform these operations manually. Flux is flexible enough to fit into any development process.

4.1.2 Implementation overview

The following describes how Flux achieves the goals.

Synchronisation of cluster state

The Flux team firmly believe that cluster state should be version controlled. This allows users to record the history of the cluster, fallback to previous versions and recreate clusters in exactly the same state when required.

But there is also another aspect. By tightly integrating the cluster with version control, the cluster becomes more tightly integrated with the deployment pipeline. This means that developers no longer have to interact directly with a cluster (with the inevitable consequences of a “fat-finger” mistake) which makes it far more stable and ideally immutable.

Flux achieves this by automatically synchronising the state of the cluster to match the code representing the cluster in the repository.

This simple idea then allows for a whole range of tools that can react to changes and simply write to a repository.

Monitoring for new images

Flux reads a list of running containers from the user git repository. For each image, it will query the container registry to obtain the most recently released tag.

Flux then compares the most recent image tag with that specified in the git repository. If they don't match, the repository is updated.

When services are in an “automated” mode, the service will periodically check to see whether there are any new images. If there are, then they are written to the repository.

When automation is disabled, images are not checked.

In order to access private registries, credentials may be required.

Deployment of images

Flux will only deploy different images. It will not re-deploy images with the same tag.

Once a list of new images have been established, it will alter the configuration of the cluster to deploy the new images.

Images can be “locked” to a specific version. “locked” images won't be updated by automated or manual means.

4.2 Daemon (`fluxd`)

4.2.1 Summary

Flux daemon (`fluxd`, aka Flux agent) allows automation of application deployments and version control of cluster configuration. Version controlling of cluster manifests provides reproducibility and a historical trail of events.

Responsibilities

Continuous Deployment

1. Flux daemon monitors user git repo Kubernetes manifests for changes, which it then deploys to the cluster.
2. Flux daemon monitors container registry for running container image updates. Detection of an image change (running container image tag vs container registry image tag) triggers k8s manifest update, which is committed to the user git repository, then deployed to the Kubernetes cluster.

Deployment approaches

1. Automate vs Deautomate

Deployment happens automatically when a new image tag is detected. Deautomated deployment will not proceed until manually released (through the CLI tool `fluxctl`).

2. Lock vs Unlock

Deployment is pinned to a particular image tag. New deployment will not proceed upon triggered release.

4.2.2 Setup and configuration

`fluxd` requires setup and offers customization through a multitude of flags.

4.2.3 More information

Setting up and configuring `fluxd` is discussed in “*Get started with Flux*”.

There is also more information on [garbage collection](#), [Git commit signing](#), and other elements in [references](#).

4.3 fluxctl

`fluxctl` provides an API that can be used from the command line.

The `--help` for `fluxctl` is described below.

4.3.1 Installing fluxctl

Mac OS

If you are using a Mac and use Homebrew, you can simply run:

```
brew install fluxctl
```

Linux

Ubuntu (and others): snaps

Many Linux distributions support snaps these days, which makes it very easy to install `fluxctl` and stay up to date.

To install it, simply run:

```
sudo snap install fluxctl
```

If you would prefer to track builds from master, run

```
sudo snap install fluxctl --edge
```

instead.

Arch Linux

Install the `fluxctl-bin` package from the AUR:

```
git clone https://aur.archlinux.org/fluxctl-bin.git
cd fluxctl-bin
makepkg -si
```

Windows

Chocolatey

Chocolatey is a third party package manager for Windows.

If you haven't already installed chocolatey you will need to [do this first](#).

fluxctl can then be installed from the [public package repository](#):

```
choco install fluxctl
```

Binary releases

With every release of Flux, we release binaries of fluxctl for Mac, Linux and Windows. Download them from the [Flux release page](#).

4.3.2 Connecting fluxctl to the daemon

By default, fluxctl will attempt to port-forward to your Flux instance, assuming it runs in the "default" namespace. You can specify a different namespace with the `--k8s-fwd-ns` flag:

```
fluxctl --k8s-fwd-ns=weave list-workloads
```

The namespace can also be given in the environment variable `FLUX_FORWARD_NAMESPACE`:

```
export FLUX_FORWARD_NAMESPACE=weave
fluxctl list-workloads
```

If you are not able to use the port forward to connect, you will need some way of connecting to the Flux API directly (NodePort, LoadBalancer, VPN, etc). **Be aware that exposing the Flux API in this way is a security hole, because it can be accessed without authentication.**

Once that is set up, you can specify an API URL with `--url` or the environment variable `FLUX_URL`:

```
fluxctl --url http://127.0.0.1:3030/api/flux list-workloads
```

Flux API service

Now you can easily query the Flux API:

```
fluxctl list-workloads --all-namespaces
```

Add an SSH deploy key to the repository

Flux connects to the repository using an SSH key. You have two options:

1. Allow Flux to generate a key for you

If you don't specify a key to use, Flux will create one for you. Obtain the public key through fluxctl:

```
$ fluxctl identity
ssh-rsa_
↪ AAAAB3NzaC1yc2EAAAADAQABAAQgQDCN2ECqUFMR413CURbLbcG41fLY75SfVZCd3LCsJBC1V1EcMk41wXxA3X4jowpv2v4Jw
↪ /+ov0qGt/uRueXMN7WUx6c93VFGV7Pjd60Yilb6GSF8B39iEVq7GQUC1OZRgQnKZWLSQ==
```


Alternatively, you can see the public key in the `flux` log.

The public key will need to be given to the service hosting the Git repository. For example, in GitHub you would create an SSH deploy key in the repository, supplying that public key.

The `flux` logs should show that it has now connected to the repository and synchronised the cluster.

When using Kubernetes, this key is stored as a Kubernetes secret. You can restart `flux` and it will continue to use the same key.

2. Specify a key to use

Create a Kubernetes Secret from a private key:

```
kubectl create secret generic flux-git-deploy --from-file=identity=/full/path/to/
↳private_key
```

this will result in a secret that has the structure:

```
apiVersion: v1
data:
  identity: <base64 encoded RSA PRIVATE KEY>
kind: Secret
type: Opaque
metadata:
  ...
```

Now add the secret to the `flux-deployment.yaml` manifest:

```
...
spec:
  volumes:
    - name: git-key
      secret:
        secretName: flux-git-deploy
```

And add a volume mount for the container:

```
...
spec:
  containers:
    - name: fluxd
      volumeMounts:
        - name: git-key
          mountPath: /etc/fluxd/ssh
```

You can customise the paths and names of the chosen key with the arguments (examples with defaults): `--k8s-secret-name=flux-git-deploy`, `--k8s-secret-volume-mount-path=/etc/fluxd/ssh` and `--k8s-secret-data-key=identity`

Using an SSH key allows you to maintain control of the repository. You can revoke permission for `flux` to access the repository at any time by removing the deploy key.

```
fluxctl helps you deploy your code.
```

```
Connecting:
```

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```

# To a fluxd running in namespace "default" in your current kubectl context
fluxctl list-workloads

# To a fluxd running in namespace "weave" in your current kubectl context
fluxctl --k8s-fwd-ns=weave list-workloads

# To a Weave Cloud instance, with your instance token in $TOKEN
fluxctl --token $TOKEN list-workloads

Workflow:
fluxctl list-workloads # Which
↪workloads are running?
fluxctl list-images --workload=default:deployment/foo # Which
↪images are running/available?
fluxctl release --workload=default:deployment/foo --update-image=bar:v2 # Release
↪new version.

Usage:
fluxctl [command]

Available Commands:
automate      Turn on automatic deployment for a workload.
deautomate   Turn off automatic deployment for a workload.
help         Help about any command
identity     Display SSH public key
install      Print and tweak Kubernetes manifests needed to install Flux in a
↪Cluster
list-images  Show deployed and available images.
list-workloads List workloads currently running in the cluster.
lock        Lock a workload, so it cannot be deployed.
policy      Manage policies for a workload.
release     Release a new version of a workload.
save       save workload definitions to local files in cluster-native format
sync      synchronize the cluster with the git repository, now
unlock    Unlock a workload, so it can be deployed.
version    Output the version of fluxctl

Flags:
-h, --help                help for fluxctl
--k8s-fwd-labels stringToString Labels used to select the fluxd pod a port
↪forward should be created for. You can also set the environment variable FLUX_
↪FORWARD_LABELS (default [app=flux])
--k8s-fwd-ns string        Namespace in which fluxd is running, for
↪creating a port forward to access the API. No port forward will be created if a URL
↪or token is given. You can also set the environment variable FLUX_FORWARD_NAMESPACE
↪(default "default")
--timeout duration        Global command timeout; you can also set the
↪environment variable FLUX_TIMEOUT (default 1m0s)
-t, --token string        Weave Cloud authentication token; you can
↪also set the environment variable WEAVE_CLOUD_TOKEN or FLUX_SERVICE_TOKEN
-u, --url string          Base URL of the Flux API (defaults to "https://
↪/cloud.weave.works/api/flux" if a token is provided); you can also set the
↪environment variable FLUX_URL

Use "fluxctl [command] --help" for more information about a command.

```

Using fluxctl install

Installs Flux into your cluster, taking as input your Git details and namespace you want to target.

Example:

```
fluxctl install --git-url 'git@github.com:<your username>/flux-get-started' | kubectl_
↪-f -
```

See [here](#) for a full tutorial which makes use of `fluxctl install`.

4.3.3 Workloads

What is a Workload?

This term refers to any cluster resource responsible for the creation of containers from versioned images - in Kubernetes these are objects such as Deployments, DaemonSets, StatefulSets and CronJobs.

Viewing Workloads

The first thing to do is to check whether Flux can see any running workloads. To do this, use the `list-workloads` subcommand:

```
$ fluxctl list-workloads
WORKLOAD                                CONTAINER  IMAGE
↪  RELEASE  POLICY
default:deployment/helloworld  helloworld  quay.io/weaveworks/helloworld:master-
↪a000001  ready
                                sidecar      quay.io/weaveworks/sidecar:master-a000002
```

Note that the actual images running will depend on your cluster.

Inspecting the Version of a Container

Once we have a list of workloads, we can begin to inspect which versions of the image are running.

```
$ fluxctl list-images --workload default:deployment/helloworld
WORKLOAD                                CONTAINER  IMAGE                                CREATED
default:deployment/helloworld  helloworld  quay.io/weaveworks/helloworld
|   master-9a16ff945b9e              20 Jul 16_
↪13:19 UTC
|   master-b31c617a0fe3              20 Jul 16_
↪13:19 UTC
|   master-a000002                   12 Jul 16_
↪17:17 UTC
'-> master-a000001                   12 Jul 16_
↪17:16 UTC
                                sidecar      quay.io/weaveworks/sidecar
'-> master-a000002                   23 Aug 16_
↪10:05 UTC
                                master-a000001              23 Aug 16_
↪09:53 UTC
```

The arrows will point to the version that is currently running alongside a list of other versions and their timestamps.

Releasing a Workload

We can now go ahead and update a workload with the `release` subcommand. This will check whether each workload needs to be updated, and if so, write the new configuration to the repository.

```
$ fluxctl release --workload=default:deployment/helloworld --user=phil --message="New
↳version" --update-all-images
Submitting release ...
Commit pushed: 7dc025c
Applied 7dc025c61fdbbfc2c32f792ad61e6ff52cf0590a
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld success helloworld: quay.io/weaveworks/
↳helloworld:master-a000001 -> master-9a16ff945b9e

$ fluxctl list-images --workload default:deployment/helloworld
WORKLOAD          CONTAINER  IMAGE                                     CREATED
default:deployment/helloworld helloworld quay.io/weaveworks/helloworld
↳                                     '-> master-9a16ff945b9e          20 Jul 16
↳
↳13:19 UTC
↳                                     master-b31c617a0fe3          20 Jul 16
↳13:19 UTC
↳                                     master-a000002              12 Jul 16
↳17:17 UTC
↳                                     master-a000001              12 Jul 16
↳17:16 UTC
↳                                     sidecar    quay.io/weaveworks/sidecar
↳                                     '-> master-a000002          23 Aug 16
↳10:05 UTC
↳                                     master-a000001              23 Aug 16
↳09:53 UTC
```

Turning on Automation

Automation can be easily controlled from `fluxctl` with the `automate` subcommand.

```
$ fluxctl automate --workload=default:deployment/helloworld
Commit pushed: af4bf73
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld success

$ fluxctl list-workloads --namespace=default
WORKLOAD          CONTAINER  IMAGE                                     RELEASE POLICY
↳
↳ default:deployment/helloworld helloworld quay.io/weaveworks/helloworld:master-
↳9a16ff945b9e ready    automated
↳                                     sidecar    quay.io/weaveworks/sidecar:master-a000002
```

Automation can also be enabled by adding the annotation `fluxcd.io/automated: "true"` to the deployment.

We can see that the `list-workloads` subcommand reports that the `helloworld` application is automated. Flux will now automatically deploy a new version of a workload whenever one is available and commit the new configuration to the version control system.

Turning off Automation

Turning off automation is performed with the `deautomate` command:

```
$ fluxctl deautomate --workload=default:deployment/helloworld
Commit pushed: a54ef2c
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld  success

$ fluxctl list-workloads --namespace=default
WORKLOAD          CONTAINER  IMAGE
↔          RELEASE  POLICY
default:deployment/helloworld  helloworld  quay.io/weaveworks/helloworld:master-
↔9a16ff945b9e ready
                                sidecar    quay.io/weaveworks/sidecar:master-a000002
```

We can see that the workload is no longer automated.

Rolling back a Workload

Rolling back can be achieved by combining:

- `deautomate` to prevent Flux from automatically updating to newer versions, and
- `release` to deploy the version you want to roll back to.

```
$ fluxctl list-images --workload default:deployment/helloworld
WORKLOAD          CONTAINER  IMAGE                                     CREATED
default:deployment/helloworld  helloworld  quay.io/weaveworks/helloworld
↔13:19 UTC          '-> master-9a16ff945b9e                20 Jul 16
↔13:19 UTC          master-b31c617a0fe3                    20 Jul 16
↔17:17 UTC          master-a000002                          12 Jul 16
↔17:16 UTC          master-a000001                          12 Jul 16
                                sidecar    quay.io/weaveworks/sidecar
↔10:05 UTC          '-> master-a000002                      23 Aug 16
↔09:53 UTC          master-a000001                          23 Aug 16

$ fluxctl deautomate --workload=default:deployment/helloworld
Commit pushed: c07f317
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld  success

$ fluxctl release --workload=default:deployment/helloworld --update-image=quay.io/
↔weaveworks/helloworld:master-a000001
Submitting release ...
Commit pushed: 33ce4e3
Applied 33ce4e38048f4b787c583e64505485a13c8a7836
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld  success  helloworld: quay.io/weaveworks/
↔helloworld:master-9a16ff945b9e -> master-a000001
```

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```
$ fluxctl list-images --workload default:deployment/helloworld
WORKLOAD          CONTAINER  IMAGE                                     CREATED
default:deployment/helloworld  helloworld  quay.io/weaveworks/helloworld
|  master-9a16ff945b9e             20 Jul 16
↔13:19 UTC
|  master-b31c617a0fe3             20 Jul 16
↔13:19 UTC
|  master-a000002                   12 Jul 16
↔17:17 UTC
'→ master-a000001                   12 Jul 16
↔17:16 UTC
|  sidecar  quay.io/weaveworks/sidecar
'→ master-a000002                   23 Aug 16
↔10:05 UTC
|  master-a000001                   23 Aug 16
↔09:53 UTC
```

Locking a Workload

Locking a workload will stop manual or automated releases to that workload. Changes made in the file will still be synced.

```
$ fluxctl lock --workload=deployment/helloworld
Commit pushed: d726722
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld  success
```

Releasing an image to a locked workload

It may be desirable to release an image to a locked workload while maintaining the lock afterwards. In order to not having to modify the lock policy (which includes author and reason), one may use `--force`:

```
fluxctl release --workload=default:deployment/helloworld --update-all-images --force
```

Unlocking a Workload

Unlocking a workload allows it to have manual or automated releases (again).

```
$ fluxctl unlock --workload=deployment/helloworld
Commit pushed: 708b63a
WORKLOAD          STATUS  UPDATES
default:deployment/helloworld  success
```

Recording user and message with the triggered action

Issuing a deployment change results in a version control change/git commit, keeping the history of the actions. The Flux daemon can be started with several flags that impact the commit information:

Actions triggered by a user through the CLI `fluxctl` tool, can have the commit author information customized. This is handy for providing extra context in the notifications and history. Whether the customization is possible, depends

on the Flux daemon (fluxd) `git-set-author` flag. If set, the commit author will be customized in the following way:

4.3.4 Image Tag Filtering

When building images it is often useful to tag build images by the branch that they were built against for example:

```
quay.io/weaveworks/helloworld:master-9a16ff945b9e
```

Indicates that the `helloworld` image was built against master commit `9a16ff945b9e`.

When automation is turned on Flux will, by default, use whatever is the latest image on a given repository. If you want to only auto-update your image against a certain subset of tags then you can do that using tag filtering.

So for example, if you want to only update the “helloworld” image to tags that were built against the “prod” branch then you could do the following:

```
fluxctl policy --workload=default:deployment/helloworld --tag-all='prod-*'
```

If your pod contains multiple containers then you tag each container individually:

```
fluxctl policy --workload=default:deployment/helloworld --tag='helloworld=prod-*' --
↳tag='sidecar=prod-*'
```

Manual releases without explicit mention of the target image will also adhere to tag filters. This will only release the newest image matching the tag filter:

```
fluxctl release --workload=default:deployment/helloworld --update-all-images
```

To release an image outside of tag filters, either specify the image:

```
fluxctl release --workload=default:deployment/helloworld --update-
↳image=helloworld:dev-abc123
```

or use `--force`:

```
fluxctl release --workload=default:deployment/helloworld --update-all-images --force
```

Please note that automation might immediately undo this.

Filter pattern types

Flux currently offers support for glob, semver and regexp based filtering.

Glob

The glob (*) filter is the simplest filter Flux supports, a filter can contain multiple globs:

```
fluxctl policy --workload=default:deployment/helloworld --tag-all='glob:master-v1.*.*'
```

Semver

If your images use [semantic versioning](#) you can filter by image tags that adhere to certain constraints:

```
fluxctl policy --workload=default:deployment/helloworld --tag-all='semver:~1'
```

or only release images that have a stable semantic version tag (X.Y.Z):

```
fluxctl policy --workload=default:deployment/helloworld --tag-all='semver:*'
```

Using a semver filter will also affect how Flux sorts images, so that the higher versions will be considered newer.

Semver has a concept of “pre-release” versions which have an extra label like `-beta` at the end. If you want to include these then write a policy with a hyphen; for example `>=1.2.3` will skip prereleases while `>=1.2.3-0` will include prereleases.

Regexp

If your images have complex tags you can filter by regular expression:

```
fluxctl policy --workload=default:deployment/helloworld --tag-all='regexp:^([a-zA-Z]+)'  
↪ $'
```

Instead of `regexp` it is also possible to use its alias `regex`. Please bear in mind that if you want to match the whole tag, you must bookend your pattern with `^` and `$`.

Controlling image timestamps with labels

Some image registries do not expose a reliable creation timestamp for image tags, which could pose a problem for the automated roll-out of images.

To overcome this problem you can define one of the supported labels in your `Dockerfile`. Flux will prioritize labels over the timestamp it retrieves from the registry.

Supported label formats

- `org.opencontainers.image.created` date and time on which the image was built (string, date-time as defined by RFC 3339).
- `org.label-schema.build-date` date and time on which the image was built (string, date-time as defined by RFC 3339).

4.3.5 Actions triggered through `fluxctl`

`fluxctl` provides the following flags for the message and author customization:

```
-m, --message string    attach a message to the update  
--user    string       override the user reported as initiating the update
```


Commit customization

1. Commit message

```
fluxctl --message="Message providing more context for the action" .....
```

2. Committer

Committer information can be overridden with the appropriate fluxd flags:

```
--git-user
--git-email
```

See [daemon.md](#) for more information.

3. Commit author

The default for the author is the committer information, which can be overridden, in the following manner:

a) Default override uses user's git configuration, ie `user.name` and `user.email` (`.gitconfig`) to set the commit author. If the user has neither `user.name` nor `user.email` set up, the committer information will be used. If only one is set up, that will be used.

b) This can be further overridden by the use of the `fluxctl --user` flag.

Examples

1. `fluxctl --user="Jane Doe <jane@doe.com>"` This will always succeed as git expects a new author in the format "some_string <some_other_string>".
2. `fluxctl --user="Jane Doe"` This form will succeed if there is already a repo commit, done by Jane Doe.
3. `fluxctl --user="jane@doe.com"` This form will succeed if there is already a repo commit, done by jane@doe.com.

Errors due to author customization

In case of no prior commit by the specified author, an error will be reported for 2) and 3):

```
git commit: fatal: --author 'unknown' is not 'Name <email>' and matches
no existing author
```

4.3.6 Using Annotations

Automation and image tag filtering can also be managed using annotations (`fluxctl` is using the same mechanism).

Automation can be enabled with `fluxcd.io/automated: "true"`. Image filtering annotations take the form `fluxcd.io/tag.<container-name>: <filter-type>:<filter-value>` or `filter.fluxcd.io/<container-name>: <filter-type>:<filter-value>`. Values of `filter-type` can be *glob*, *semver*, and *regex*. Filter values use the same syntax as when the filter is configured using `fluxctl`.

Here's a simple but complete deployment file with annotations:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: podinfo
  namespace: demo
  labels:
    app: podinfo
  annotations:
    fluxcd.io/automated: "true"
    fluxcd.io/tag.podinfod: semver:~1.3
spec:
  selector:
    matchLabels:
      app: podinfo
  template:
    metadata:
      labels:
        app: podinfo
    spec:
      containers:
      - name: podinfod
        image: stefanprodan/podinfo:1.3.2
        ports:
        - containerPort: 9898
          name: http
        command:
        - ./podinfo
        - --port=9898
```

Things to notice:

1. The annotations are made in `metadata.annotations`, not in `spec.template.metadata`.
2. The `fluxcd.io/tag....` references the container name `podinfod`, this will change based on your container name. If you have multiple containers you would have multiple lines like that.
3. The value for the `fluxcd.io/tag....` annotation should include the filter pattern type, in this case `semver`.

Annotations can also be used to tell Flux to temporarily ignore certain manifests using `fluxcd.io/ignore: "true"`. Read more about this in the [FAQ](#).

4.4 Manifest factorization through `.flux.yaml` configuration files

4.4.1 Enabling search of `.flux.yaml` files

To enable it supply the command-line flag `--manifest-generation=true` to `fluxd`.

4.4.2 Goal

It is a common pattern to run very similar resources in separate clusters. There are various scenarios in which this is required, the two main ones being:

- Having a staging/canary cluster and production cluster. The resources from the staging cluster are regularly promoted to the production cluster. In addition, there are long-term differences between the cluster resources

(e.g. different security keys, different database endpoints etc ...).

- Federation. Different clusters run in separate regions, usually with very similar resources but different configurations.

The main goal of `.flux.yaml` configuration files is to help deploying similar resources/clusters:

- with minimal replication of resource definitions
- while keeping Flux neutral about the factorization technology used

4.4.3 File-access behaviour in Flux

Flux performs two types of actions on raw manifest files from the Git repository:

1. Read manifest files when performing a sync operation (i.e making sure that the status of the cluster reflects what's in the manifest files, adjusting it if necessary)
2. Update the manifest files of `workload`. Specifically, flux can update:
 - container images, when releasing a new image version. A release can happen manually or automatically, when a new container image is pushed to a repository.
 - annotations, which establish the release policy of a workload (e.g. whether it should be automatically released, whether it should be locked from releasing, what image tags should be considered for automated releases ...)

Flux can be configured to confine the scope of (1) and (2):

- To specific (sub)directories (flag `--git-path`)
- To a Git branch other than `master` (flag `--git-branch`)

4.4.4 Abstracting out file-access: generators and updaters

Flux allows you to declare configuration files to override file operations (1) and (2), by declaring commands which perform equivalent actions.

The configuration files are formatted in YAML and named `.flux.yaml`. They must be located on the Git repository (more on this later).

A `commandUpdated` `.flux.yaml` file has the following loosely specified format:

```
version: X
commandUpdated:
  generators:
    - command: generator_command1 g1arg1 g1arg2 ...
    - command: generator_command2 g2arg2 g2arg2 ...
  updaters:
    - containerImage:
        command: containerImage_updater_command1 ci1arg1 ci1arg2 ...
        policy:
          command: policy_updater_command1 pu1arg1 pu1arg2 ...
    - containerImage:
        command: containerImage_updater_command2 ciu2arg1 ciu2arg2 ...
        policy:
          command: policy_updater_command2 pu2arg1 pu2arg2 ...
```

Note: For a simpler approach to updates, Flux provides a `patchUpdated` configuration file variant.

The file above is versioned (in order to account for future file format changes). Current version is 1, which is enforced.

Also, the file contains two generators (declared in the `generators` entry), used to generate manifests and two updaters (declared in the `updaters` entry), used to update resources in the Git repository.

The generators are meant as an alternative to Flux manifest reads (1). Each updater is split into a `containerImage` command and a `policy` command, covering the corresponding two types of workload manifest updates mentioned in (2).

Note Update commands operate on policies, rather than annotations. That is for two reasons:

- It is an implementation detail for Kubernetes manifests specifically that policies are represented as annotations.
- Some configurations (even those for Kubernetes clusters) may encode policies symbolically.

Here is a specific `.flux.yaml` example, declaring a generator and an updater using `Kustomize` (see <https://github.com/weaveworks/flux-kustomize-example> for a complete example).

```
version: 1
commandUpdated:
  generators:
    - command: kustomize build .
  updaters:
    # use https://github.com/squaremo/kubeyaml on flux-patch.yaml
    - containerImage:
        command: >-
          cat flux-patch.yaml |
          kubeyaml image --namespace $FLUX_WL_NS --kind $FLUX_WL_KIND --name $FLUX_WL_
↔NAME --container $FLUX_CONTAINER --image "$FLUX_IMG:$FLUX_TAG"
          > new-flux-patch.yaml &&
          mv new-flux-patch.yaml flux-patch.yaml
      policy:
        command: >-
          cat flux-patch.yaml |
          kubeyaml annotate --namespace $FLUX_WL_NS --kind $FLUX_WL_KIND --name $FLUX_
↔WL_NAME "fluxcd.io/$FLUX_POLICY=$FLUX_POLICY_VALUE"
          > new-flux-patch.yaml &&
          mv new-flux-patch.yaml flux-patch.yaml
```

For every flux target path, Flux will look for a `.flux.yaml` file in the target path and all its parent directories. If a `.flux.yaml` is found:

1. When syncing, `fluxd` will run each of the generators, collecting yaml manifests printed to `stdout` and applying them to the cluster.
2. When making a release or updating a policy, `fluxd` will run the updaters, which are in charge of updating the Git repository to reflect the required changes in workloads.
 - The `containerImage` updaters are invoked once for every container whose image requires updating.
 - The `policy` updaters are invoked once for every workload annotation which needs to be added or updated.
 - Updaters are supplied with environment variables indicating what image should be updated and what annotation to update (more on this later).
 - Updaters expected to modify the Git working tree in-place

After invoking the updaters, `fluxd` will then commit and push the resulting modifications to the git repository.

3. `fluxd` will ignore any other yaml files under that path (e.g. resource manifests).

Generators and updaters are intentionally independent, in case a matching updater cannot be provided. It is hard to create updaters for some factorization technologies (particularly Configuration-As-Code). To improve the situation, a separate configuration file variant (`patchedUpdated`) is provided, which will be described later on.

Execution context of commands

`generators` and `updaters` are run in a POSIX shell inside the Flux container. This means that the `commands` supplied should be available in the [Flux container image](#). Flux currently includes `Kustomize` and basic Unix shell tools. If the tools in the Flux image are not sufficient for your use case, you can include new tools in your own Flux-based image or, if the tools are popular enough, Flux maintainers can add them to the Flux image (please create an issue). In the future (once [Ephemeral containers](#) are available), you will be able to specify a container image for each command.

The working directory (also known as CWD) of the `commands` executed from a `.flux.yaml` file will be set to the target path (`--git-path` entry) used when finding that `.flux.yaml` file.

For example, when using `flux` with `--git-path=staging` on a git repository with this structure:

```
├── .flux.yaml
├── staging/
├── [...]
├── production/
├── [...]
```

The `commands` in `.flux.yaml` will be executed with their working directory set to `staging`.

In addition, updaters are provided with some environment variables:

- `FLUX_WORKLOAD`: Workload to be updated. Its format is `<namespace>:<kind>/<name>` (e.g. `default:deployment/foo`). For convenience (to circumvent parsing) `FLUX_WORKLOAD` is also broken down into the following environment variables:
 - `FLUX_WL_NS`
 - `FLUX_WL_KIND`
 - `FLUX_WL_NAME`
- `containerImage` updaters are provided with:
 - `FLUX_CONTAINER`: Name of the container within the workload whose image needs to be updated.
 - `FLUX_IMG`: Image name which the container needs to be updated to (e.g. `nginx`).
 - `FLUX_TAG`: Image tag which the container needs to be updated to (e.g. `1.15`).
- `policy` updaters are provided with:
 - `FLUX_POLICY`: the name of the policy to be added or updated in the workload. To make into an annotation name, prefix with `fluxcd.io/`
 - `FLUX_POLICY_VALUE`: value of the policy to be added or updated in the controller. If the `FLUX_POLICY_VALUE` environment variable is not set, it means the policy should be removed.

Please note that the default timeout for `sync` commands is set to one minute. If you run into errors like `error executing generator command: context deadline exceeded`, you can increase the timeout with the `--sync-timeout` `fluxcd` command flag or the `sync.timeout` Helm chart option.

Combining generators, updaters and raw manifest files

The `.flux.yaml` files support including multiple generators and updaters. Here is an example combining multiple generators:

```
version: 1
commandUpdated:
  generators:
    - command: kustomize build .
    - command: helm template ../charts/mychart -f overrides.yaml
```

The generators/updaters will simply be executed in the presented order (top down). Flux will merge their output.

Flux supports both generated manifests and raw manifests tracked in the same repository. If Flux doesn't find a configuration file associated to a target directory, Flux will inspect it in search for raw YAML manifest files.

The `patchUpdated` configuration variant

We mentioned before that, while it is simple for users to provide generator commands, matching updater commands are harder to construct. To improve the situation, Flux provides a different configuration variant: `patchUpdated`. `patchUpdated` configurations store the modifications from Flux into a [YAML merge patch file](#) and implicitly apply them to the resources printed by the generators.

Here is an example, allowing to deploy a [Helm chart without a Tiller installation](#)

```
version: 1
patchUpdated:
  generators:
    - command: helm template ../charts/mychart -f overrides.yaml
  patchFile: flux-patch.yaml
```

This configuration will cause:

1. modifications made by Flux (e.g. due to annotation or image updates) to the resources generated by `helm template ../charts/mychart -f overrides.yaml` to be stored into patch file `flux-patch.yaml`. `flux-patch.yaml` will be managed automatically by Flux (it will be added and updated on demand).
2. the patch file `flux-patch.yaml` to be always applied to the output of `helm template ../charts/mychart -f overrides.yaml`, in order to obtain the final manifests.

The patch file path should be relative to Flux target which matched the configuration file.

Note that the patch file will need to be kept consistent with any changes made in the generated manifests. In particular, the patch file will be sensitive to changes in workload names, workload namespaces or workload kinds.

Lastly, here is another example using Kustomize which is much simpler than the `commandUpdated`-based example presented earlier.

```
version: 1
patchUpdated:
  generators:
    - command: kustomize build .
  patchFile: flux-patch.yaml
```

4.5 Garbage collection

Part of syncing a cluster with a git repository is getting rid of resources in the cluster that have been removed in the repository. You can tell `fluxd` to do this “garbage collection” using the command-line flag `--sync-garbage-collection`. It’s important to know how it operates, and appreciate its limitations, before enabling it.

4.5.1 How garbage collection works

When garbage collection is enabled, syncing is done in two phases:

1. Apply all the manifests in the git repo (as delimited by the branch and path arguments), and give each resource a label marking it as having been synced from this source.
2. Ask the cluster for all the resources marked as being from this source, and delete those that were not applied in step 1.

In the above, “source” refers to the particular combination of git repo URL, branch, and paths that this `fluxd` has been configured to use, which is taken as identifying the resources under *this* `fluxd`’s control.

We need to be careful about identifying these accurately, since getting it wrong could mean *not* deleting resources that should be deleted; or (much worse), deleting resources that are under another `fluxd`’s control.

The definition of “source” affects how garbage collection behaves when you reconfigure `fluxd`. It is intended to be conservative: it ensures that `fluxd` will not delete resources that it did not create.

4.5.2 Limitations of this approach

In general, if you change an element of the source (the git repo URL, branch, and paths), there is a possibility that resources no longer present in the new source will be missed (i.e., not deleted) by garbage collection, and you will need to delete them by hand.

4.6 Git commit signing and verification

4.6.1 Summary

Flux can be configured to sign commits that it makes to the user git repo when, for example, it detects an updated Docker image is available for a release with automatic deployments enabled. To complete this functionality it is also able to verify signatures of commits (and the sync tag in git) to prevent Flux from applying unauthorized changes on the cluster.

4.6.2 Commit signing

The signing of commits (and the sync tag) requires two flags to be set:

1. `--git-gpg-key-import` should be set to the path(s) Flux should look for GPG key(s) to import, this can be direct paths to keys and/or the paths to folders Flux should scan for files.
2. `--git-signing-key` should be set to the ID of the key Flux should use to sign commits, this can be the full fingerprint or the long ID, for example: `700D397C988079BFF0DDAFED6A7436E8790F8689` (or `6A7436E8790F8689`)

Once enabled Flux will sign both commits and the sync tag with given `--git-signing-key`.

Creating a GPG signing key

Note: This requires `gnupg` to be installed on your system.

1. Enter the following shell command to start the key generation dialog:

```
$ gpg --full-generate-key
```

2. The dialog will guide you through the process of generating a key. Pressing the `Enter` key will assign the default value, please note that when in doubt, in almost all cases, the default value is recommended.

Select what kind of key you want and press `Enter`:

```
Please select what kind of key you want:
(1) RSA and RSA (default)
(2) DSA and Elgamal
(3) DSA (sign only)
(4) RSA (sign only)
Your selection? 1
```

3. Enter the desired key size (or simply press `Enter` as the default will be secure for almost any setup):

```
RSA keys may be between 1024 and 4096 bits long.
What keysize do you want? (2048)
```

4. Specify how long the key should be valid (or simply press `Enter`):

```
Please specify how long the key should be valid.
  0 = key does not expire
<n> = key expires in n days
<n>w = key expires in n weeks
<n>m = key expires in n months
<n>y = key expires in n years
Key is valid for? (0)
```

1. Verify your selection of choices and accept (`y` and `Enter`)
2. Enter your user ID information, it is recommended to set the email address to the same address as the daemon uses for Git operations.
3. **Do not enter a passphrase**, as Flux will be unable to sign with a passphrase protected private key, instead, keep it in a secure place.
4. You can validate the public and private keypair were created with success by running:

```
$ gpg --list-secret-keys --keyid-format long <email address>
sec  rsa2048/6A7436E8790F8689 2019-03-28 [SC]
    700D397C988079BFF0DDAFED6A7436E8790F8689
uid  [ultimate] Weaveworks Flux <support@weave.works>
ssb  rsa2048/ECA4FF5BD988B8E9 2019-03-28 [E]
```

Importing a GPG signing key

Any file found in the configured `--git-gpg-key-import` path(s) will be imported into GPG; therefore, by volume-mounting a key into that directory it will be made available for use by Flux.

1. Retrieve the key ID (second row of the `sec` column):


```
$ gpg --list-secret-keys --keyid-format long <email address>
sec  rsa2048/6A7436E8790F8689 2019-03-28 [SC]
    700D397C988079BFF0DDAFED6A7436E8790F8689
uid  [ultimate] Weaveworks Flux <support@weave.works>
ssb  rsa2048/ECA4FF5BD988B8E9 2019-03-28 [E]
```

2. Export the public and private keypair from your local GPG keyring to a Kubernetes secret with `--export-secret-keys <key id>`:

```
$ gpg --export-secret-keys 700D397C988079BFF0DDAFED6A7436E8790F8689 |
  kubectl create secret generic flux-gpg-signing-key --from-file=flux.asc=/dev/
  ↪stdin --dry-run -o yaml
apiVersion: v1
data:
  flux.asc: <base64 string>
kind: Secret
metadata:
  creationTimestamp: null
  name: flux-gpg-signing-key
```

3. Adapt your Flux deployment to mount the secret and enable the signing of commits:

```
spec:
  template:
    spec:
      volumes:
      - name: gpg-signing-key
        secret:
          secretName: flux-gpg-signing-key
          defaultMode: 0400
      containers:
      - name: flux
        volumeMounts:
        - name: gpg-signing-key
          mountPath: /root/gpg-signing-key/
          readOnly: true
        args:
        - --git-gpg-key-import=/root/gpg-signing-key
        - --git-signing-key=700D397C988079BFF0DDAFED6A7436E8790F8689 # key id
```

or set the `gpgKeys.secretName` in your Helm values `.yaml` to `gpg-keys`, and `signingKey` to your `<key id>`.

4. To validate your setup is working, run `git log --show-signature` or `git verify-tag <configured label>` to assure Flux signs its git actions.

```
$ git verify-tag <configured label>
gpg: Signature made vr 29 mrt 2019 15:28:34 CET
gpg:          using RSA key 700D397C988079BFF0DDAFED6A7436E8790F8689
gpg: Good signature from "Weaveworks Flux <support@weave.works>" [ultimate]
```

Note: Flux *does not* recursively scan a given directory but does understand symbolic links to files.

Note: Flux will automatically add any imported key to the GnuPG trustdb. This is required as git will otherwise not trust signatures made with the imported keys.

4.6.3 Signature verification

The verification of commit signatures is enabled by importing all trusted public keys (`--git-gpg-key-import=<path>,<path2>`), and by setting the `--gpg-verify-signatures` flag. Once enabled Flux will verify all commit signatures, and the signature from the sync tag it is comparing revisions with.

In case a signature can not be verified, Flux will sync state up to the last valid revision it can find *before* the unverified commit was made, and lock on this revision.

Importing trusted GPG keys and enabling verification

1. Collect the public keys from all trusted git authors.
2. Create a ConfigMap with all trusted public keys:

```
$ kubectl create configmap generic flux-gpg-public-keys \
  --from-file=author.asc --from-file=author2.asc --dry-run -o yaml
apiVersion: v1
data:
  author.asc: <base64 string>
  author2.asc: <base64 string>
kind: ConfigMap
metadata:
  creationTimestamp: null
  name: flux-gpg-public-keys
```

3. Mount the config map in your Flux deployment, add the mount path to `--git-gpg-key-import`, and enable the verification of commits:

```
spec:
  template:
    spec:
      volumes:
      - name: gpg-public-keys
        configMap:
          name: flux-gpg-public-keys
          defaultMode: 0400
      containers:
      - name: flux
        volumeMounts:
        - name: gpg-public-keys
          mountPath: /root/gpg-public-keys
          readOnly: true
        args:
        - --git-gpg-key-import=/root/gpg-public-keys
        - --git-verify-signatures
```

Note: Flux *does not* recursively scan a given directory but does understand symbolic links to files.

Enabling verification for existing repositories, disaster recovery, and deleted sync tags

In case you have existing commits in your repository without a signature you may want to:

- a. First enable signing by setting the `--git-gpg-key-import` and `--git-signing-key`, after Flux has synchronized the first commit with a signature, enable verification.

b. Sign the sync tag by yourself, with a key that is imported, to point towards the first commit with a signature (or the current HEAD). Flux will then start synchronizing the changes between the sync tag revision and HEAD.

```
$ git tag --force --local-user=<key id> -a -m "Sync pointer" <tag name> <revision>
$ git push --force origin <tag name>
```

4.7 Automated deployment of new container images

Flux can be used to automate container image updates in your cluster. Flux periodically scans the pods running in your cluster and builds a list of all container images. Using the image pull secrets, it connects to the container registries, pulls the images metadata and stores the image tag list in memcached.

You can enable the automate image tag updates by annotating your deployments, statefulsets, daemonsets or cronjobs objects. You can also control what tags should be considered for an update by using glob, regex or semantic version expressions.

Note: that Flux only works with immutable image tags (:latest is not supported). Every image tag must be unique, for this you can use the Git commit SHA or semver when tagging images.

4.7.1 Examples

What follows is a list of examples on how you can control the image update automation. If you're using Helm releases please see the [Helm operator integration docs](#).

Turn on automation based on timestamp:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  annotations:
    fluxcd.io/automated: "true"
spec:
  template:
    spec:
      containers:
      - name: app
        image: docker.io/org/my-app:1.0.0
```

The above configuration will make Flux update the `app` container when you push a new image tag, be it `my-app:1.0.1` or `my-app:9e3bdaf`.

Restrict image updates with sem ver:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  annotations:
    fluxcd.io/automated: "true"
    fluxcd.io/tag.app: semver:~1.0
spec:
  template:
    spec:
      containers:
      - name: app
        image: docker.io/org/my-app:1.0.0
```

The above configuration will make Flux update the image when you push an image tag that matches the [semantic version](#) expression e.g `my-app:1.0.1` but not `my-app:1.2.0`.

Restrict image updates with glob and regex expressions:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  annotations:
    fluxcd.io/automated: "true"
    fluxcd.io/tag.sidecar: regex:^stg.*
    fluxcd.io/tag.app: glob:dev-*
spec:
  template:
    spec:
      containers:
        - name: sidecar
          image: docker.io/org/my-proxy:stg-4s7bsgv
        - name: app
          image: docker.io/org/my-app:dev-9e3bdaf
```

The above configuration will make Flux update the `sidecar` when you push a tag for the `my-proxy` image that begins with `stg`. For the `app` container, Flux will update it when you push a tag for the `my-app` image that begins with `dev-`.

To target a specific container the annotation format is `fluxcd.io/tag.<CONTAINER>:<TYPE>:<EXPRESSION>`.

You can turn off the automation with `fluxcd.io/automated: "false"` or with `fluxcd.io/locked: "true"`.

4.8 Integration with the Helm operator

You can release charts to your cluster via “GitOps”, by combining Flux and the [Helm operator](#).

The essential mechanism is this: the declaration of a Helm release is represented by a custom resource, specifying the chart and its values. If you put such a resource in your git repo as a file, Flux will apply it to the cluster, and once it’s in the cluster, the Helm Operator will make sure the release exists by installing or upgrading it.

4.8.1 Upgrading images in a HelmRelease using Flux

If the chart you’re using in a `HelmRelease` lets you specify the particular images to run, you will usually be able to update them with Flux, the same way you can with Deployments and so on.

Note: for automation to work, the repository *and* tag should be defined (either as a whole string, or under separate keys), as Flux determines image updates based on what it reads in the `.spec.values` of the `HelmRelease`.

Automated image detection

Flux interprets certain commonly used structures in the `values` section of a `HelmRelease` as referring to images, at least an `image` key needs to be specified. The following are understood (showing just the `values` section):

```
values:
  image: repo/image:version
```

```
values:
  image: repo/image
  tag: version
```

```
values:
  registry: docker.io
  image: repo/image
  tag: version
```

```
values:
  image:
    repository: repo/image
  tag: version
```

```
values:
  image:
    registry: docker.io
    repository: repo/image
  tag: version
```

These can appear at the top level (immediately under `values:`), or in a subsection (under a key, itself under `values:`). Other values may be mixed in arbitrarily. Here's an example of a `values` section that specifies two images, along with some other configuration:

```
values:
  persistent: true

  # image that will be labeled "chart-image"
  image: repo/image1:version

  subsystem:
    # image that will be labeled "subsystem"
    image:
      repository: repo/image2
      tag: version
      imagePullPolicy: IfNotPresent
    port: 4040
```

Annotations

If Flux does not automatically detect your image, it is possible to map the image paths by alias with YAML dot notation annotations. An alias overrules a detected image.

The following annotations are available, you need to at least specify the `repository.fluxcd.io` annotation:

Two images specified in a `HelmRelease` as an example:

```
metadata:
  annotations:
    # image and tag
    repository.fluxcd.io/app: appImage
    tag.fluxcd.io/app: appTag
    filter.tag/app: 'glob: *'
    # nested image with registry and tag
    registry.fluxcd.io/submarine: sub.marinesystem.reg
```

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```
repository.fluxcd.io/submarine: sub.marinesystem.img
tag.fluxcd.io/submarine: sub.marinesystem.tag

spec:
  values:
    # image and tag
    appImage: repo/image1
    appTag: version
    sub:
      marinesystem:
        # nested image with registry and tag
        reg: domain.com
        img: repo/image2
        tag: version
```

Filter

You can use the [same annotations](#) in the `HelmRelease` as you would for a `Deployment` or other workload, to control updates and automation. For the purpose of specifying filters, the container name is either `chart-image` (if at the top level), the key under which the image is given (e.g., "subsystem" from the example above), or the alias you are using in your annotations.

Top level image example:

```
kind: HelmRelease
metadata:
  annotations:
    fluxcd.io/automated: "true"
    fluxcd.io/tag.chart-image: semver:~4.0
spec:
  values:
    image:
      repository: bitnami/mongodb
      tag: 4.0.3
```

Sub-section images example:

```
kind: HelmRelease
metadata:
  annotations:
    fluxcd.io/automated: "true"
    fluxcd.io/tag.prometheus: semver:~2.3
    fluxcd.io/tag.alertmanager: glob:v0.15.*
    filter.fluxcd.io/nats: regex:^0.6.*
spec:
  values:
    prometheus:
      image: prom/prometheus:v2.3.1
    alertmanager:
      image: prom/alertmanager:v0.15.0
    nats:
      image:
        repository: nats-streaming
        tag: 0.6.0
```

4.9 Monitoring Flux

The Flux daemon exposes `/metrics` endpoints which can be scraped for monitoring data in Prometheus format; exact metric names and help are available from the endpoints themselves.

The following metrics are exposed:

Flux sync state can be obtained by using the following PromQL expressions:

- `delta(flux_daemon_sync_duration_seconds_count{success='true'}[6m]) < 1` - for general flux sync errors - usually if that is true then there are some problems with infrastructure or there are manifests parse error or there are manifests with duplicate ids.
- `flux_daemon_sync_manifests{success='false'} > 0` - for git manifests errors - if true then there are either some problems with applying git manifests to kubernetes - e.g. configmap size is too big to fit in annotations or immutable field (like label selector) was changed.

5.1 Providing your own SSH key

Flux connects to the repository using an SSH key it retrieves from a Kubernetes secret, if the configured (`--k8s-secret-name`) secret has no `identity` key/value pair, it will generate new private key.

With this knowledge, providing your own SSH key is as simple as creating the configured secret in the expected format.

1. create a Kubernetes secret from your own private key:

```
kubectl create secret generic flux-git-deploy --from-file=identity=/full/path/to/  
↳private_key
```

this will result in a secret that has the structure:

```
apiVersion: v1  
data:  
  identity: <base64 encoded RSA PRIVATE KEY>  
kind: Secret  
type: Opaque  
metadata:  
  ...
```

2. (optional) if you created the secret with a non-default name (default: `flux-git-deploy`), set the `--k8s-secret-name` flag to the name of your secret (i.e. `--k8s-secret-name=foo`).

Note: the SSH key must be configured to have R/W access to the repository. More specifically, the SSH key must be able to create and update tags. E.g. in Gitlab, that means it requires `Maintainer` permissions. The `Developer` permission can create tags, but not update them.

5.2 Using Git over HTTPS

Instead of making use of Flux' capabilities to generate an SSH private key, or [supplying your own](#), it is possible to set environment variables and use these in your `--git-url` argument to provide your HTTPS basic auth credentials without having to expose them as a plain value in your workload.

Note: setting an HTTP(S) URL as `--git-url` will disable the generation of a private key and prevent the setup of the SSH keyring.

Note: the variables *must be escaped with \$ ()* for Kubernetes to pass the values to the Flux container, e.g. `$(GIT_AUTHKEY)`. [Read more about this Kubernetes feature.](#)

1. Create a personal access token to be used as the `GIT_AUTHKEY`:

- [GitHub](#)
- [GitLab](#)
- [BitBucket](#)

2. Create a Kubernetes secret with two environment variables and their respective values (replace <username> and <token/password>):

```
kubectl create secret generic flux-git-auth --from-literal=GIT_AUTHUSER=<username>
↪ --from-literal=GIT_AUTHKEY=<token/password>
```

this will result in a secret that has the structure:

```
apiVersion: v1
data:
  GIT_AUTHKEY: <base64 encoded token/password>
  GIT_AUTHUSER: <base64 encoded username>
kind: Secret
type: Opaque
metadata:
  ...
```

3. Mount the Kubernetes secret as environment variables using envFrom and use them in your --git-url argument:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: flux
  ...
spec:
  containers:
    - name: flux
      envFrom:
        - secretRef:
            name: flux-git-auth
      args:
        # Replace `github.com/...` with your git repository
        - --git-url=https://$(GIT_AUTHUSER):$(GIT_AUTHKEY)@github.com/fluxcd/flux-get-
↪started.git
        ...
```

5.3 Using a private Git host

If you're using your own git host – e.g., your own installation of gitlab, or bitbucket server – you will need to add its host key to ~/.ssh/known_hosts in the Flux daemon container.

First, run a check that you can clone the repo. The following assumes that your git server's hostname (e.g., githost) is in \$GITHOST and the URL you'll use to access the repository (e.g., user@githost:path/to/repo) is in \$GITREPO.

```
$ # Find the fluxd daemon pod:
$ kubectl get pods --all-namespaces -l name=flux
NAMESPACE   NAME                               READY   STATUS    RESTARTS   AGE
weave       flux-85cdc6cdfc-n2tgf             1/1     Running   0           1h
```

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```
$ kubectl exec -n weave flux-85cdc6cdfc-n2tgf -ti -- \
  env GITHOST="$GITHOST" GITREPO="$GITREPO" PS1="container$ " /bin/sh

container$ git clone $GITREPO
Cloning into <repository name>...
No ECDSA host key is known for <GITHOST> and you have requested strict checking.
Host key verification failed.
fatal: Could not read from remote repository

container$ # ^ that was expected. Now we'll try with a modified known_hosts
container$ ssh-keyscan $GITHOST >> ~/.ssh/known_hosts
container$ git clone $GITREPO
Cloning into '...'
...
```

If `git clone` doesn't succeed, you'll need to check that the SSH key has been installed properly first, then come back. `ssh -vv $GITHOST` from within the container may help debug it.

If it *did* work, you will need to make it a more permanent arrangement. Back in that shell, create a `ConfigMap` for the cluster. To make sure the `ConfigMap` is created in the namespace of the Flux deployment, the namespace is set explicitly:

```
container$ kubectl create configmap flux-ssh-config --from-file=$HOME/.ssh/known_
↪hosts -n $(cat /var/run/secrets/kubernetes.io/serviceaccount/namespace)
configmap "flux-ssh-config" created
```

To use the `ConfigMap` every time the Flux daemon restarts, you'll need to mount it into the container. The example deployment manifest includes an example of doing this, commented out. Uncomment those two blocks:

```
- name: ssh-config
  configMap:
    name: flux-ssh-config
```

```
- name: ssh-config
  mountPath: /root/.ssh
```

It assumes you used `flux-ssh-config` as name of the `ConfigMap` and then reapply the manifest.

Another alternative is to create the `ConfigMap` from a template. This could be something like:

```
apiVersion: v1
data:
  known_hosts: |
    # github
    192.30.253.112 ssh-rsa_
    ↪AAAAB3NzaC1yc2EAAAABIwAAAQEAq2A7hRGmdnm9tUDbO9IDSwBK6TbQa+PXYPcPy6rbTrTtw7PHkccKrpp0yVhp5HdEIcKr6p
    ↪yMf+Se8xhHTvKSCZIFImWwoG6mbUoWf9nzpIoaSjB+weqqUUmppaaasXVal72J+UX2B+2RPW3RcT0eOzQgq1JL3RKrTJvdsjE3J
    ↪w4yCE6gbODqnTWlg7+wC604ydGXA8VJiS5ap43JXiUFFAaQ==
    # github
    192.30.253.113 ssh-rsa_
    ↪AAAAB3NzaC1yc2EAAAABIwAAAQEAq2A7hRGmdnm9tUDbO9IDSwBK6TbQa+PXYPcPy6rbTrTtw7PHkccKrpp0yVhp5HdEIcKr6p
    ↪yMf+Se8xhHTvKSCZIFImWwoG6mbUoWf9nzpIoaSjB+weqqUUmppaaasXVal72J+UX2B+2RPW3RcT0eOzQgq1JL3RKrTJvdsjE3J
    ↪w4yCE6gbODqnTWlg7+wC604ydGXA8VJiS5ap43JXiUFFAaQ==
    # private gitlab
    gitlab._____ ssh-rsa AAAAB3N...
```

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```
kind: ConfigMap
metadata:
  name: flux-ssh-config
  namespace: <OPTIONAL NAMESPACE (if not default)>
```

You will need to explicitly tell `fluxd` to use that service account by uncommenting and possible adapting the line `# serviceAccountName: flux` in the file `flux-deployment.yaml` before applying it.

5.4 Upgrading to Flux v1

Flux v1 is a major improvement over the previous versions, and is different enough that you need to do a bit of work to upgrade it.

In previous releases of Flux, much of the work was done by the service. This meant that to get a useful system, you had to run both the daemon and the service in your cluster. In version 1, the daemon does all of the mechanical work by itself.

5.4.1 Differences between old Flux and Flux v1

In version 1 the daemon is more self-sufficient and easier to set up. It is also more capable, and in particular, it now synchronises your cluster with the manifests you keep in git – enabling you to use git (and GitHub) workflows to manage your cluster.

5.4.2 Upgrade process

In summary, you will need to:

1. Remove the old Flux resources from your cluster
2. Delete any deployment keys
3. Run the new Flux resources
4. Install a new deploy key

First, it will help in a few places to have an old `fluxctl` around. Download it from GitHub:

```
curl -o fluxctl_030 https://github.com/fluxcd/flux/releases/download/0.3.0/fluxctl_
↳linux_amd64
# or if using macOS,
# curl -o fluxctl_030 https://github.com/fluxcd/flux/releases/download/0.3.0/fluxctl_
↳darwin_amd64
chmod a+x ./fluxctl_030
```

5.4.3 If you are running Flux in “standalone” mode

Set the environment variable `FLUX_URL` to point to the Flux service you are running, as described in [the old deployment docs](#). The particular URL will differ, depending on how you have told Kubernetes to expose the Flux service.

Before making any changes, get the config so that it can be consulted later:

```
./fluxctl_030 get-config --fingerprint=md5 | tee old-config.yaml
```

Remove old Flux resources

Important! If you have Flux resources committed to git

The first thing to do here is to remove any manifests for running Flux you have stored in git, before deleting them in the cluster (below). If you don't remove these, running the new Flux daemon will restore the old configuration.

You can delete the Flux resources by referring to the manifest files used to create them. If you don't have the files on hand, you can try using the example deployment as a stand-in:

```
git clone --branch 0.3.0 git@github.com:fluxcd/flux flux-0.3.0
kubectl delete --ignore-not-found -R -f ./flux-0.3.0/deploy
```

That's something of a sledgehammer! But it should cover most cases.

Delete deployment keys

It's good practice to remove any unused deployment keys. If you're using GitHub, look at the settings for the repository you were pointing Flux at, and delete the key Flux was using. To check you are removing the correct key, you can see the fingerprint of the key used by Flux in the file `old-config.yaml` that was created earlier.

Configure and run new Flux resources

First, it is important to understand that Flux manages more of your cluster resources now. It will automatically apply the manifests that appear in your config repo, either by creating or by updating them. In other words, it tries to keep the cluster running whatever is represented in the repo. (Though it doesn't delete things, yet).

To run Flux without connecting to Weave Cloud, adapt the manifests provided in the [Flux repo](#) with the git parameters (URL, path, and branch) from `old-config.yaml`, and then apply them with `kubectl`. Consider adding these adapted manifests to your own config repo.

The daemon now has an API itself, so you can point `fluxctl` directly at it (the example manifests include a Kubernetes service so you can do just that).

You may find that you need to set `FLUX_URL` again, to take account of the new deployment. See the [setup instructions](#) for guidance.

To see the SSH key created by Flux, download the latest `fluxctl` from [the release page](#) and run:

```
fluxctl identity
```

You will need to add this as a deploy key, which is also described in the setup instructions linked above.

5.4.4 Troubleshooting

The `kubectl delete` commands didn't delete anything

It's possible that the Flux resources are in an unusual namespace or given a different name. As a last resort, you can hunt down the resources by name and delete them. Use `kubectl` to look for likely suspects.

```
kubectl get serviceaccount,service,deployment --all-namespaces
```

Have a look for deployments and services with "flux" in the name.

I deleted the Flux resources but when I install Flux v1 they come back

The most likely explanation is that you have manifests for the resources in your config repo. When Flux v1 starts, it does a sync – and if there are manifests for the old Flux still in git, it will create those as resources.

If that's the case, you will need to remove the manifests from git before running Flux v1.

6.1 Get started with Flux

This short guide shows a self-contained example of Flux and just takes a couple of minutes to get set up. By the end you will have Flux running in your cluster and it will be deploying any code changes for you.

Note: If you would like to install Flux using Helm, refer to the [Helm section](#).

6.1.1 Prerequisites

You will need to have Kubernetes set up. For a quick local test, you can use minikube, kubeadm or kind. Any other Kubernetes setup will work as well though.

If working on e.g. GKE with RBAC enabled, you will need to add a `ClusterRoleBinding`:

```
kubectl create clusterrolebinding "cluster-admin-$(whoami)" \
--clusterrole=cluster-admin \
--user="$(gcloud config get-value core/account) "
```

6.1.2 Set up Flux

In our example we are going to use [flux-get-started](#). If you want to use that too, be sure to create a fork of it on GitHub.

First, please *install fluxctl*.

Create the `flux` namespace:

```
kubectl create ns flux
```

Then, install Flux in your cluster (replace `YOURUSER` with your GitHub username):

```
export GHUSER="YOURUSER"
fluxctl install \
--git-user=${GHUSER} \
--git-email=${GHUSER}@users.noreply.github.com \
--git-url=git@github.com:${GHUSER}/flux-get-started \
--git-path=namespaces,workloads \
--namespace=flux | kubectl apply -f -
```

`--git-path=namespaces,workloads`, is meant to exclude Helm manifests. Again, if you want to get started with Helm, please refer to the [Helm section](#).

Wait for Flux to start:

```
kubectl -n flux rollout status deployment/flux
```

6.1.3 Giving write access

At startup Flux generates a SSH key and logs the public key. Find the SSH public key by installing *fluxctl* and running:

```
fluxctl identity --k8s-fwd-ns flux
```

In order to sync your cluster state with git you need to copy the public key and create a deploy key with write access on your GitHub repository.

Open GitHub, navigate to your fork, go to **Setting > Deploy keys**, click on **Add deploy key**, give it a Title, check **Allow write access**, paste the Flux public key and click **Add key**. See the [GitHub docs](#) for more info on how to manage deploy keys.

(Or replace YOURUSER with your GitHub ID in this url: <https://github.com/YOURUSER/flux-get-started/settings/keys/new> and paste the key there.)

Note: the SSH key must be configured to have R/W access to the repository. More specifically, the SSH key must be able to create and update tags. E.g. in Gitlab, that means it requires `Maintainer` permissions. The `Developer` permission can create tags, but not update them.

6.1.4 Committing a small change

In this example we are using a simple example of a webservice and change its configuration to use a different message.

Replace YOURUSER in <https://github.com/YOURUSER/flux-get-started/blob/master/workloads/podinfo-dep.yaml> with your GitHub ID), open the URL in your browser, edit the file, change the `PODINFO_UI_MESSAGE` env var to `Welcome to Flux` and commit the file.

By default, Flux git pull frequency is set to 5 minutes. You can tell Flux to sync the changes immediately with:

```
fluxctl sync --k8s-fwd-ns flux
```

6.1.5 Confirm the change landed

To access our webservice and check out its welcome message, simply run:

```
kubectl -n demo port-forward deployment/podinfo 9898:9898 &  
curl localhost:9898
```

Notice the updated message value in the JSON reply.

6.1.6 Conclusion

As you can see, the actual steps to set up Flux, get our app deployed, give Flux access to it and see modifications land are very straight-forward and are a quite natural work-flow.

As a next step, you might want to dive deeper into [how to control Flux](#), or go through our hands-on tutorial about driving Flux, e.g. [automations](#), [annotations](#) and [locks](#).

6.2 Get started with Flux using Helm

If you are using Helm already, this guide is for you. By the end you will have Helm installing Flux in the cluster and deploying any code changes for you.

If you are looking for more generic notes for how to install Flux using Helm, we collected them in the [chart's README](#).

6.2.1 Prerequisites

You will need to have Kubernetes set up. To get up and running fast, you might want to use minikube or kubernetes. Any other Kubernetes setup will work as well though.

Download Helm:

- On MacOS:

```
brew install kubernetes-helm
```

- On Linux:

- Download the [latest release](#), unpack the tarball and put the binary in your \$PATH.

Now create a service account and a cluster role binding for Tiller:

```
kubectl -n kube-system create sa tiller

kubectl create clusterrolebinding tiller-cluster-rule \
  --clusterrole=cluster-admin \
  --serviceaccount=kube-system:tiller
```

Deploy Tiller in kube-system namespace:

```
helm init --skip-refresh --upgrade --service-account tiller --history-max 10
```

Note: This is a quick guide and by no means a production ready Tiller setup, please look into ‘[Securing your Helm installation](#)’ and be aware of the `--history-max` flag before promoting to production.

6.2.2 Install Flux

Add the Flux repository:

```
helm repo add fluxcd https://charts.fluxcd.io
```

Apply the Helm Release CRD:

```
kubectl apply -f https://raw.githubusercontent.com/fluxcd/flux/helm-0.10.1/deploy-
↪helm/flux-helm-release-crd.yaml
```

In this next step you install Flux using helm. Simply

1. Fork [fluxcd/flux-get-started](#) on GitHub and replace the fluxcd with your GitHub username in [here](#)
2. Install Flux and the Helm operator by specifying your fork URL:

Just make sure you replace YOURUSER with your GitHub username in the command below:

- Using a public git server from `bitbucket.com`, `github.com`, `gitlab.com`, `dev.azure.com`, or `vs-ssh.visualstudio.com`:

```
helm upgrade -i flux \
--set helmOperator.create=true \
--set helmOperator.createCRD=false \
--set git.url=git@github.com:YOURUSER/flux-get-started \
--namespace flux \
fluxcd/flux
```

- Using a private git server:

When deploying from a private repo, the `known_hosts` of the git server needs to be configured into a kubernetes configmap so that `StrictHostKeyChecking` is respected. See the [README of the chart](#) for further installation instructions in this case.

Allow some time for all containers to get up and running. If you're impatient, run the following command and see the pod creation process.

```
watch kubectl -n flux get pods
```

You will notice that `flux` and `flux-helm-operator` will start turning up in the `flux` namespace.

6.2.3 Giving write access

For the real benefits of GitOps, Flux will need access to your git repository to update configuration if necessary. To facilitate that you will need to add a deploy key to your fork of the repository.

This is pretty straight-forward as Flux generates a SSH key and logs the public key at startup. Find the SSH public key by installing `fluxctl` and running:

```
fluxctl identity --k8s-fwd-ns flux
```

In order to sync your cluster state with git you need to copy the public key and create a deploy key with write access on your GitHub repository.

Open GitHub, navigate to your fork, go to **Setting > Deploy keys**, click on **Add deploy key**, give it a Title, check **Allow write access**, paste the Flux public key and click **Add key**.

(Or replace `YOURUSER` with your GitHub ID in this url: `https://github.com/YOURUSER/flux-get-started/settings/keys/new` and paste the key there.)

Once Flux has confirmed access to the repository, it will start deploying the workloads of `flux-get-started`. After a while you will be able to see the Helm releases deployed by Flux (which are deployed into the `demo` namespace) listed like so:

```
helm list --namespace demo
```

6.2.4 Committing a small change

`flux-get-started` is a simple example in which three services (`mongodb`, `redis` and `ghost`) are deployed. Here we will simply update the version of `mongodb` to a newer version to see if Flux will pick this up and update our cluster.

The easiest way is to update your fork of `flux-get-started` and change the image argument.

Replace `YOURUSER` in `https://github.com/YOURUSER/flux-get-started/edit/master/releases/mongodb.yaml` with your GitHub ID, open the URL in your browser, edit the file, change the `tag` line to the following:

```

values:
  image:
    repository: bitnami/mongodb
    tag: 4.0.6

```

Commit the change to your `master` branch. It will now get automatically deployed to your cluster.

You can check out the Flux logs with:

```
kubectl -n flux logs deployment/flux -f
```

The default sync frequency for Flux using the Helm chart is five minutes. This can be tweaked easily. By observing the logs you can see when the change landed in the cluster.

Confirm the change landed by checking the `demo` namespace that Flux is deploying to:

```
kubectl describe -n demo deployment/mongodb | grep Image
```

6.2.5 Conclusion

As you can see, the actual steps to set up Flux, get our app deployed, give Flux access to it and see modifications land are very straight-forward and are a quite natural workflow.

6.2.6 A more advanced setup

For a more advanced Helm setup, take a look at the [fluxcd/helm-operator-get-started](#) repository.

6.3 How to bootstrap Flux using Kustomize

This guide shows you how to use Kustomize to bootstrap Flux on a Kubernetes cluster.

6.3.1 Prerequisites

You will need to have Kubernetes set up. For a quick local test, you can use `minikube` or `kubeadm`. Any other Kubernetes setup will work as well though.

A note on GKE with RBAC enabled

If working on e.g. GKE with RBAC enabled, you will need to add a cluster role binding:

```

kubectl create clusterrolebinding "cluster-admin-$(whoami)" \
  --clusterrole=cluster-admin \
  --user="$(gcloud config get-value core/account)"

```

6.3.2 Prepare Flux installation

First you'll need a git repository to store your cluster desired state. In our example we are going to use [fluxcd/flux-get-started](#). If you want to use that too, be sure to create a fork of it on GitHub.

Create a directory, and add a `kustomization.yaml` file that uses the Flux deploy YAMLS as a base:

```
cat > fluxcd/kustomization.yaml <<EOF
namespace: flux
bases:
  - github.com/fluxcd/flux//deploy
patchesStrategicMerge:
  - patch.yaml
EOF
```

Note: If you want to install a specific Flux release, add the version number to the base URL: `github.com/fluxcd/flux//deploy?ref=v1.14.1`

Create a patch file for Flux deployment and set the `--git-url` parameter to point to the config repository (replace `YOURUSER` with your GitHub username):

```
export GHUSER="YOURUSER"
cat > fluxcd/patch.yaml <<EOF
apiVersion: apps/v1
kind: Deployment
metadata:
  name: flux
spec:
  template:
    spec:
      containers:
        - name: flux
          args:
            - --manifest-generation=true
            - --memcached-hostname=memcached.flux
            - --memcached-service=
            - --ssh-keygen-dir=/var/fluxd/keygen
            - --git-branch=master
            - --git-path=namespaces,workloads
            - --git-user=${GHUSER}
            - --git-email=${GHUSER}@users.noreply.github.com
            - --git-url=git@github.com:${GHUSER}/flux-get-started
EOF
```

We set `--git-path=namespaces,workloads` to exclude Helm manifests. If you want to get started with Helm, please refer to the [“Get started with Flux using Helm”](#) tutorial.

Overwriting the default namespace

Overwriting the default (`flux`) namespace is possible by defining your own namespace resource and a patch to remove the default from the base.

Create your own namespace definition:

```
cat > fluxcd/namespace.yaml <<EOF
apiVersion: v1
kind: Namespace
metadata:
  name: <namespace>
EOF
```

Create a patch to remove the default namespace from the base:

```
cat > fluxcd/patch-default-ns.yaml <<EOF
apiVersion: v1
kind: Namespace
metadata:
  name: flux
$patch: delete
EOF
```

Adapt your `fluxcd/kustomization.yaml` to include your own namespace resource, patch, and change the namespace:

```
namespace: <namespace>
resources:
- namespace.yaml
bases:
- github.com/fluxcd/flux//deploy
patchesStrategicMerge:
- patch-default-ns.yaml
- patch.yaml
```

6.3.3 Install Flux with Kustomize

In the next step, deploy Flux to the cluster (you'll need `kubectl 1.14` or newer):

```
kubectl apply -k fluxcd
```

Wait for Flux to start:

```
kubectl -n flux rollout status deployment/flux
```

6.3.4 Setup GitHub write access

At startup Flux generates a SSH key and logs the public key. Find the SSH public key by installing `fluxctl` and running:

```
fluxctl identity --k8s-fwd-ns flux
```

In order to sync your cluster state with git you need to copy the public key and create a deploy key with write access on your GitHub repository.

Open GitHub, navigate to your fork, go to **Setting > Deploy keys**, click on **Add deploy key**, give it a `Title`, check **Allow write access**, paste the Flux public key and click **Add key**. See the [GitHub docs](#) for more info on how to manage deploy keys.

6.3.5 Committing a small change

In this example we'll be making a configuration change to a web application and display a different message in the UI.

Replace `YOURUSER` in `https://github.com/YOURUSER/flux-get-started/blob/master/workloads/podinfo-dep.yaml` with your GitHub ID), open the URL in your browser, edit the file, change the `PODINFO_UI_MESSAGE` env var to `Welcome to Flux` and commit the file.

By default, Flux git pull frequency is set to 5 minutes. You can tell Flux to sync the changes immediately with:

```
fluxctl sync --k8s-fwd-ns flux
```

6.3.6 Confirm the change landed

To access our webservice and check out its welcome message, simply run:

```
kubectl -n demo port-forward deployment/podinfo 9898:9898 &  
curl localhost:9898
```

Notice the updated message value in the JSON reply.

6.3.7 Next steps

Try out [flux-kustomize-example](#) for using Flux with Kustomize to manage a staging and production clusters while minimizing duplicated declarations.

Try out [fluxcd/multi-tenancy](#) for using Flux with Kustomize to manage a multi-tenant cluster.

6.4 Automations, locks and annotations

In this tutorial we want to get a better feel for what we can do with Flux. We won't spend too much time with getting it up and running, so let's get that out of the way first.

In our example we are going to use the `flux-get-started` example deployment. So as your first step, please head to [our example deployment](#) and click on the "Fork" button.

6.4.1 Setup

First, please *install fluxctl*.

Then, run (replace YOURUSER with your GitHub username):

```
export GHUSER="YOURUSER"  
fluxctl install \  
--git-user=${GHUSER} \  
--git-email=${GHUSER}@users.noreply.github.com \  
--git-url=git@github.com:${GHUSER}/flux-get-started \  
--git-path=namespaces,workloads \  
--namespace=flux | kubectl apply -f -
```

Alternative: Using Helm for the setup

If you have never used Helm, you first need to

- Download/install Helm
- Set up Tiller. First create a service account and a cluster role binding for Tiller:

```
kubectl -n kube-system create sa tiller  
kubectl create clusterrolebinding tiller-cluster-rule \  
--clusterrole=cluster-admin \  
--serviceaccount=kube-system:tiller
```

Deploy Tiller in the `kube-system` namespace:

```
helm init --skip-refresh --upgrade --service-account tiller --history-max 10
```

Note: This is a quick guide and by no means a production ready Tiller setup, please look into ‘Securing your Helm installation’ and be aware of the `--history-max` flag before promoting to production.

Now you can take care of the actual installation. First add the Flux chart repository:

```
helm repo add fluxcd https://charts.fluxcd.io
```

Apply the Helm Release CRD:

```
kubectl apply -f https://raw.githubusercontent.com/fluxcd/flux/helm-0.10.1/deploy-  
→helm/flux-helm-release-crd.yaml
```

Install Flux and its Helm Operator by specifying your fork URL. Just make sure you replace `YOURUSER` with your GitHub username in the command below:

```
helm upgrade -i Flux \  
--set helmOperator.create=true \  
--set helmOperator.createCRD=false \  
--set git.url=git@github.com:YOURUSER/flux-get-started \  
--namespace default \  
fluxcd/flux
```

Note: In this tutorial we keep things simple, so we deploy Flux into the default namespace. Normally you would pick a separate namespace for it. `fluxctl` has the `-k&s-fwd-ns <NAMESPACE>` option for specifying the right namespace.

Connecting to your git config

The first step is done. Flux is now and up running (you can confirm by running `kubectl get pods --all-namespaces`).

In the second step we will use `fluxctl` to talk to Flux in the cluster and interact with the deployments. (It enables you to drive all of Flux, so have a look at the output of `fluxctl -h` to get a better idea.)

Note: Another option (without installing `fluxctl` is to take a look at the resulting annotation changes and make the changes in Git. This is GitOps after all. :-)

Tell `fluxctl` in which namespace is Flux installed:

```
export FLUX_FORWARD_NAMESPACE=flux
```

To enable Flux to sync your config, you need to add the deployment key to your fork.

Get your Flux deployment key by running:

```
fluxctl identity
```

Copy/paste the key and add it to `https://github.com/YOUR-USER-ID/flux-get-started/settings/keys/new` and enable write access for it.

Wait for sync to happen or run:

```
fluxctl sync
```

6.4.2 Driving Flux

After syncing, Flux will find out which workloads there are, which images are available and what needs doing. To find out which workloads are managed by Flux, run:

```
fluxctl list-workloads -a
```

Notice that `podinfo` is on `v1.3.2` and in state `automated`.

To check which images are available for `podinfo` run:

```
fluxctl list-images -w demo:deployment/podinfo
```

Now let's change the policy for `podinfo` to target `1.4.*` releases:

```
fluxctl policy -w demo:deployment/podinfo --tag-all='1.4.*'
```

On the command-line you should see a message just like this one:

```
WORKLOAD          STATUS  UPDATES
demo:deployment/podinfo success
Commit pushed: 4755a3b
```

If you now go back to <https://github.com/YOUR-USER-ID/flux-get-started> in your browser, you will notice that Flux has made a commit on your behalf. The policy change is now in Git, which is great for transparency and for defining expected state.

It should look a little something like this:

```
--- a/workloads/podinfo-dep.yaml
+++ b/workloads/podinfo-dep.yaml
@@ -8,8 +8,8 @@ metadata:
   app: podinfo
   annotations:
     fluxcd.io/automated: "true"
-   fluxcd.io/tag.init: regexp:^3.*
-   fluxcd.io/tag.podinfod: semver:~1.3
+   fluxcd.io/tag.init: glob:1.4.*
+   fluxcd.io/tag.podinfod: glob:1.4.*
spec:
  strategy:
    rollingUpdate:
```

If you have a closer look at the last change which was committed, you'll see that the image filtering pattern has been changed. (Our docs explain how to use `semver`, `glob`, `regex` filtering.)

Again, wait for the sync to happen or run

```
fluxctl sync
```

To check which image is current, run:

```
fluxctl list-images -w demo:deployment/podinfo
```

In our case this is `1.4.2` (it could be a later image too). Let's say an engineer found that `1.4.2` was faulty and we have to go back to `1.4.1`. That's easy.

Lock deployment with a message describing why:


```
fluxctl lock -w demo:deployment/podinfo -m "1.4.2 does not work for us"
```

The resulting diff should look like this:

```
--- a/workloads/podinfo-dep.yaml
+++ b/workloads/podinfo-dep.yaml
@@ -10,6 +10,7 @@ metadata:
   app: podinfo
   annotations:
     fluxcd.io/automated: "true"
     fluxcd.io/tag.init: glob:1.4.*
     fluxcd.io/tag.podinfod: glob:1.4.*
+   fluxcd.io/locked: 'true'
spec:
  strategy:
    rollingUpdate:
```

Rollback to 1.4.1. Flag `--force` is needed because the workload is locked:

```
fluxctl release --force --workload demo:deployment/podinfo -i stefanprodan/podinfo:1.
↪4.1
```

The response should be:

```
Submitting release ...
CONTROLLER          STATUS    UPDATES
demo:deployment/podinfo success  podinfod: stefanprodan/podinfo:1.4.2 -> 1.4.1
Commit pushed: 426d723
Commit applied: 426d723
```

and the diff for this is going to look like this:

```
--- a/workloads/podinfo-dep.yaml
+++ b/workloads/podinfo-dep.yaml
@@ -33,7 +33,7 @@ spec:
   - "1"
   containers:
     - name: podinfod
       image: stefanprodan/podinfo:1.3.2
+     image: stefanprodan/podinfo:1.4.1
     imagePullPolicy: IfNotPresent
     ports:
       - containerPort: 9898
```

And that's it. At the end of this tutorial, you have automated, locked and annotated deployments with Flux.

Another tip, if you should get stuck anywhere: check what Flux is doing. You can do that by simply running:

```
kubectl logs -n flux deploy/flux -f
```

If you should have any questions, find us on Slack in the [#flux channel](#), get an invite to it [here](#).

FREQUENTLY ASKED QUESTIONS

7.1 General questions

Also see

- *the introduction* for Flux's design principles
- *the troubleshooting section*

7.1.1 What does Flux do?

Flux automates the process of deploying new configuration and container images to Kubernetes.

7.1.2 How does it automate deployment?

It synchronises all manifests in a repository with a Kubernetes cluster. It also monitors container registries for new images and updates the manifests accordingly.

7.1.3 How is that different from a bash script?

The amount of functionality contained within Flux warrants a dedicated application/service. An equivalent script could easily get too large to maintain and reuse.

Anyway, we've already done it for you!

7.1.4 Why should I automate deployment?

Automation is a principle of lean development. It reduces waste, to provide efficiency gains. It empowers employees by removing dull tasks. It mitigates against failure by avoiding silly mistakes.

7.1.5 I thought Flux was about service routing?

That's [where we started a while ago](#). But we discovered that automating deployments was more urgent for our own purposes.

Staging deployments with clever routing is useful, but it's a later level of operational maturity.

There are some pretty good solutions for service routing: [Envoy](#), [Istio](#) for example. We may return to the matter of staged deployments.

7.1.6 Are there prerelease builds I can run?

There are builds from CI for each merge to master branch. See [fluxcd/flux-prerelease](#).

7.2 Technical questions

7.2.1 Does it work only with one git repository?

At present, yes it works only with a single git repository containing Kubernetes manifests. You can have as many git repositories with application code as you like, to be clear – see [below](#).

There's no principled reason for this, it's just a consequence of time and effort being in finite supply. If you have a use for multiple git repo support, please comment in <https://github.com/fluxcd/flux/issues/1164>.

In the meantime, for some use cases you can run more than one Flux daemon and point them at different repos. If you do this, consider trimming the RBAC permissions you give each daemon's service account.

This [Flux \(daemon\) operator](#) project may be of use for managing multiple daemons.

7.2.2 Do I have to put my application code and config in the same git repo?

Nope, but they can be if you want to keep them together. Flux doesn't need to know about your application code, since it deals with container images (i.e., once your application code has already been built).

7.2.3 Is there any special directory layout I need in my git repo?

Nope. Flux doesn't place any significance on the directory structure, and will descend into subdirectories in search of YAMLs. Although [kubectrl works with JSON files](#), Flux will ignore JSON. It avoids directories that look like Helm charts.

If you have YAML files in the repo that *aren't* for applying to Kubernetes, use `--git-path` to constrain where Flux starts looking.

See also [requirements.md](#) for a little more explanation.

7.2.4 Why does Flux need a git ssh key with write access?

There are a number of Flux commands and API calls which will update the git repo in the course of applying the command. This is done to ensure that git remains the single source of truth.

For example, if you use the following `fluxctl` command:

```
fluxctl release --controller=deployment/foo --update-image=bar:v2
```

The image tag will be updated in the git repository upon applying the command.

For more information about Flux commands see [the fluxctl docs](#).

7.2.5 Can I run Flux with readonly Git access?

Yes. You can use the `--git-readonly` command line argument. The Helm chart exposes this as `git.readonly`. This will prevent Flux from trying to write to your repository. You should also provide a readonly SSH key; e.g., on GitHub, leave the `Allow write access` box unchecked when you add the deploy key.

7.2.6 Does Flux automatically sync changes back to git?

No. It applies changes to git only when a Flux command or API call makes them.

7.2.7 Will Flux delete resources when I remove them from git?

Flux has an garbage collection feature, enabled by passing the command-line flag `--sync-garbage-collection` to `fluxd`.

The garbage collection is conservative: it is designed to not delete resources that were not created by `fluxd`. This means it will sometimes *not* delete resources that *were* created by `fluxd`, when reconfigured. Read more about garbage collection [here](#).

7.2.8 How do I give Flux access to an image registry?

Flux transparently looks at the image pull secrets that you attach to workloads and service accounts, and thereby uses the same credentials that Kubernetes uses for pulling each image. In general, if your pods are running, then Kubernetes has pulled the images, and Flux should be able to access them too.

There are exceptions:

- One way of supplying credentials in Kubernetes is to put them on each node; Flux does not have access to those credentials.
- In some environments, authorisation provided by the platform is used instead of image pull secrets:
 - Google Container Registry works this way; Flux will automatically attempt to use platform-provided credentials when scanning images in GCR.
 - Amazon Elastic Container Registry (ECR) has its own authentication using IAM. If your worker nodes can read from ECR, then Flux will be able to access it too.

To work around exceptional cases, you can mount a docker config into the Flux container. See the argument `--docker-config` in [the daemon arguments reference](#).

See also [Why are my images not showing up in the list of images?](#)

7.2.9 How often does Flux check for new images?

- Flux scans image registries for metadata as quickly as it can, given rate limiting; and,
- checks if any automated workloads needs updates every five minutes, by default.

The latter default is quite conservative, so you can try lowering it (it's set with the flag `--automation-interval`).

Please don't *increase* the rate limiting numbers (`--registry-rps` and `--registry-burst`) – it's possible to get blacklisted by image registries if you spam them with requests.

If you are using GCP/GKE/GCR, you will likely want much lower rate limits. Please see [fluxcd/flux#1016](#) for specific advice.

7.2.10 How often does Flux check for new git commits (and can I make it sync faster)?

Short answer: every five minutes; and yes.

There are two flags that control how often Flux syncs the cluster with git. They are

- `--git-poll-interval`, which controls how often it looks for new commits
- `--sync-interval`, which controls how often it will apply what's in git, to the cluster, absent new commits.

Both of these have five minutes as the default. When there are new commits, it will run a sync then and there, so in practice syncs happen more often than `--sync-interval`.

If you want to be more responsive to new commits, then give a shorter duration for `--git-poll-interval`, so it will check more often.

It is less useful to shorten the duration for `--sync-interval`, since that just controls how often it will sync *without* there being new commits. Reducing it below a minute or so may hinder Flux, since syncs can take tens of seconds, leaving not much time to do other operations.

7.2.11 How do I use my own deploy key?

Flux uses a k8s secret to hold the git ssh deploy key. It is possible to provide your own.

First delete the secret (if it exists):

```
kubectl delete secret flux-git-deploy
```

Then create a new secret named `flux-git-deploy`, using your private key as the content of the secret (you can generate the key with `ssh-keygen -q -N "" -f /full/path/to/private_key`):

```
kubectl create secret generic flux-git-deploy --from-file=identity=/full/path/to/private_key
```

Now restart `fluxd` to re-read the k8s secret (if it is running):

```
kubectl delete $(kubectl get pod -o name -l name=flux)
```

If you have installed flux through Helm, make sure to pass `--set git.secretName=flux-git-deploy` when installing/upgrading the chart.

7.2.12 How do I use a private git host (or one that's not github.com, gitlab.com, bitbucket.org, dev.azure.com, or vs-ssh.visualstudio.com)?

As part of using git+ssh securely from the Flux daemon, we make sure `StrictHostKeyChecking` is on in the [SSH config](#). This mitigates against man-in-the-middle attacks.

We bake host keys for `github.com`, `gitlab.com`, `bitbucket.org`, `dev.azure.com`, and `vs-ssh.visualstudio.com` into the image to cover some common cases. If you're using another service, or running your own git host, you need to supply your own host key(s).

How to do this is documented in *"Using a private Git host"*.

7.2.13 Why does my CI pipeline keep getting triggered?

There's a couple of reasons this can happen.

The first is that Flux pushes commits to your git repo, and if that repo is configured to go through CI, usually those commits will trigger a build. You can avoid this by supplying the flag `--ci-skip` so that Flux's commit will append `[ci skip]` to its commit messages. Many CI systems will treat that as meaning they should not run a build for that commit. You can use `--ci-skip-message`, if you need a different piece of text appended to commit messages.

The other thing that can trigger CI is that Flux pushes a tag to the upstream git repo whenever it has applied new commits. This acts as a "high water mark" for Flux to know which commits have already been seen. The default name for this tag is `flux-sync`, but it can be changed with the flags `--git-sync-tag` and `--git-label`. The simplest way to avoid triggering builds is to exclude this tag from builds – how to do that will depend on how your CI system is configured.

Here's the relevant docs for some common CI systems:

- [CircleCI](#)
- [TravisCI](#)
- [GitLab](#)
- [Bitbucket Pipelines](#)
- [Azure Pipelines](#)

7.2.14 Can I restrict the namespaces that Flux can see or operate on?

Flux will only operate on the namespaces that its service account has access to; so the most effective way to restrict it to certain namespaces is to use Kubernetes' role-based access control (RBAC) to make a service account that has restricted access itself. You may need to experiment to find the most restrictive permissions that work for your case.

You will need to use the command-line flag `--k8s-allow-namespace` to enumerate the namespaces that Flux attempts to scan for workloads.

7.2.15 Can I change the namespace Flux puts things in by default?

Yes. The `fluxd` image has a "kubeconfig" file baked in, which specifies a default namespace of `"default"`. That means any manifest not specifying a namespace (in `.metadata.namespace`) will be given the namespace `"default"` when applied to the cluster.

You can override this by mounting your own "kubeconfig" file into the container from a configmap, and using the `KUBECONFIG` environment entry to point to it. The [example deployment](#) shows how to do this, in commented out sections – it needs extra bits of config in three places (the `volume`, `volumeMount`, and `env` entries).

The easiest way to create a suitable "kubeconfig" will be to adapt the [file that is baked into the image](#). Save that locally as `my-kubeconfig`, edit it to change the default namespace, then create the configmap, in the same namespace you run Flux in, with something like:

```
kubectl create configmap flux-kubeconfig --from-file=config=./my-kubeconfig
```

Be aware that the expected location (`$HOME/.kube/`) of the `kubeconfig` file is *also* used by `kubectl` to cache API responses, and mounting from a configmap will make it read-only and thus effectively disable the caching. For that reason, take care to mount your configmap elsewhere in the filesystem, as the example shows.

7.2.16 Can I temporarily make Flux ignore a manifest?

Yes. The easiest way to do that is to use the following annotation in the manifest, and commit the change to git:

```
fluxcd.io/ignore: true
```

To stop ignoring these annotated resources, you simply remove the annotation from the manifests in git. A live example can be seen [here](#).

Flux will ignore any resource that has the annotation *either* in git, or in the cluster itself; sometimes it may be easier to annotate a *running resource in the cluster* as opposed to committing a change to git.

Mixing both kinds of annotations (in git, and in the cluster), can make it a bit hard to figure out how/where to undo the change (cf [flux#1211](#)). If the annotation exists in either the cluster or in git, it will be respected, so you may need to remove it from both places.

7.2.17 How can I prevent Flux overriding the replicas when using HPA?

When using a horizontal pod autoscaler you have to remove the `spec.replicas` from your deployment definition. If the `replicas` field is not present in Git, Flux will not override the replica count set by the HPA.

7.2.18 Can I disable Flux registry scanning?

You can exclude images from being scanned by providing a list of glob expressions using the `registry-exclude-image` flag.

Exclude images from Docker Hub and Quay.io:

```
--registry-exclude-image=docker.io/*,quay.io/*
```

And the Helm install equivalent (note the `\`, separator):

```
--set registry.excludeImage="docker.io/*\,quay.io/*"
```

Exclude images containing `test` in the FQN:

```
--registry-exclude-image=*test*
```

Disable image scanning for all images:

```
--registry-exclude-image=*
```

7.2.19 Does Flux support Kustomize/Templating/My favorite manifest factorization technology?

Yes!

Flux supports technology-agnostic manifest factorization through `.flux.yaml` configuration files placed in the Git repository. To enable it supply the command-line flag `--manifest-generation=true` to `fluxd`.

See [flux.yaml configuration files documentation](#) for further details.

TROUBLESHOOTING

Also see the [issues](#) labeled with [FAQ](#), which often explain workarounds.

8.1 Flux is taking a long time to apply manifests when it syncs

If you notice that Flux takes tens of seconds or minutes to get through each sync, while you can apply the same manifests very quickly by hand, you may be running into this issue: <https://github.com/fluxcd/flux/issues/1422>

Briefly, the problem is that mounting a volume into `$HOME/.kube` effectively disables `kubectl`'s caching, which makes it much much slower. You may have used such a volume mount to override `$HOME/.kube/config`, possibly unknowingly – the Helm chart did this for you, prior to [fluxcd/flux#1435](#).

The remedy is to mount the override to some other place in the filesystem, and use the environment entry `KUBECONFIG` to point `kubectl` at it. This is what the Helm chart now does, so fixing it may be as easy as reapplying the chart if that's what you're using.

This is also documented in the [FAQ](#).

8.2 `fluxctl` returns a 500 Internal Server Error

This usually indicates there's a bug in the Flux daemon somewhere – in which case please [tell us about it!](#)

8.3 Flux answers everything with `git repo is not configured`

This means Flux can't read from and write to the git repo. Check that

- ... you've supplied a git repo URL. If it's of the form `https://github.com/user/repo` then you will need to use the SSH-style URL, `git@github.com:user/repo` instead.
- ... the deploy key has read/write access to the repo. In GitHub, deploy keys are installed in the settings for a repository. To get the deploy key Flux is using, use `fluxctl identity`.
- ... that the host where your git repo lives is in `~/ .ssh/known_hosts` in the `fluxd` container. We prime the container `image` with host keys for `github.com`, `gitlab.com`, `bitbucket.org`, `dev.azure.com`, and `vs-ssh.visualstudio.com`, but if you're using your own git server, you'll need to add its host key. See "[Using a private Git host](#)".

8.4 I'm using GCR/GKE and I keep seeing "Quota exceeded" in logs

GCP (in general) has quite conservative API rate limiting, and Flux's default settings can bump API usage over the limits. See [fluxcd/flux#1016](#) for advice.

8.5 Flux doesn't seem to be able to use my imagePullSecrets

If you're using `kubectl v1.13.x` to create them, then it may be due to [this problem](#). In short, there was a breaking change to how `kubectl` creates secrets, that found its way into the Kubernetes 1.13.0 release. It has been corrected in `kubectl v1.13.2`, so using that version or newer to create secrets should fix the problem.

8.6 Why are my images not showing up in the list of images?

Sometimes, instead of seeing the various images and their tags, the output of `fluxctl list-images` shows nothing. There's a number of reasons this can happen:

- Flux just hasn't fetched the image metadata yet. This may be the case if you've only just started using a particular image in a workload.
- Flux can't get suitable credentials for the image repository. At present, it looks at `imagePullSecrets` attached to workloads, service accounts, platform-provided credentials on GCP, AWS or Azure, and a Docker config file if you mount one into the `fluxd` container (see the [command-line usage](#)).
- When using images in ECR, from EC2, the `NodeInstanceRole` for the worker node running `fluxd` must have permissions to query the ECR registry (or registries) in question. `eksctl` and `kops` (with `.iam.allowContainerRegistry=true`) both make sure this is the case.
- When using images from ACR in AKS, the `HostPath /etc/kubernetes/azure.json` should be mounted into the Flux Pod. Set `registry.acr.enabled=True` in the [helm chart](#) or alter the [Deployment](#):

```
spec:
  containers:
    image: docker.io/fluxcd/flux
    ...
  volumeMounts:
  - name: acr-credentials
    mountPath: /etc/kubernetes/azure.json
    readOnly: true
  volumes:
  - name: acr-credentials
    hostPath:
      path: /etc/kubernetes/azure.json
      type: ""
```

If you encounter [permission errors](#), you can alternatively create a secret `acr-credentials` based on the `azure.json` file and set `registry.acr.secretName=acr-credentials`.

- Flux excludes images with no suitable manifest (linux amd64) in manifestlist
- Flux doesn't yet understand image refs that use digests instead of tags; see [fluxcd/flux#885](#).

If none of these explanations seem to apply, please [file an issue](#).

8.7 Why do my image tags appear out of order?

You may notice that the ordering given to image tags does not always correspond with the order in which you pushed the images. That's because Flux sorts them by the image creation time; and, if you have retagged an older image, the creation time won't correspond to when you pushed the image. (Why does Flux look at the image creation time? In general there is no way for Flux to retrieve the time at which a tag was pushed from an image registry.)

This can happen if you explicitly tag an image that already exists. Because of the way Docker shares image layers, it can also happen *implicitly* if you happen to build an image that is identical to an existing image.

If this appears to be a problem for you, one way to ensure each image build has its own creation time is to label it with a build time; e.g., using [OpenContainers pre-defined annotations](#).

8.8 What is the “sync tag”; or, why do I see a `flux-sync` tag in my git repo?

Flux keeps track of the last commit that it's applied to the cluster, by pushing a tag (controlled by the command-line flags `--git-sync-tag` and `--git-label`) to the git repository. This gives it a persistent high water mark, so even if it is restarted from scratch, it will be able to tell where it got to.

Technically, it only needs this to be able to determine which image releases (including automated upgrades) it has applied, and that only matters if it has been asked to report those with the `--connect` flag. Future versions of Flux may be more sparing in use of the sync tag.

CONTRIBUTING

9.1 Get started developing

This guide shows a workflow for making a small (actually, tiny) change to Flux, building and testing that change locally.

9.1.1 TL;DR

From a very high level, there are at least 3 ways you can develop on Flux once you have your environment set up:

1. The “minimalist” approach (only requires and `kubectl`):
 1. `make`
 2. copy the specific image tag (e.g. `docker.io/fluxcd/flux:master-a86167e4`) for what you just built and paste it into `/deploy/flux-deployment.yaml` as the image you’re targeting to deploy
 3. deploy the resources in `/develop/*.yaml` manually with `kubectl apply`
 4. make a change to the code
 5. see your code changes have been deployed
 6. repeat
2. Use `freshpod` to deploy changes to the `/deploy` directory resources:
 1. `make`
 2. make a change to the code
 3. see your changes have been deployed
 4. repeat
3. Remote cluster development approach:
 1. ensure local `kubectl` access to a remote Kubernetes cluster
 2. have an available local `memcached` instance
 3. make a change to the code

```
4. go run cmd/fluxd/main.go \  
   --memcached-hostname localhost \  
   --memcached-port 11211 \  
   --memcached-service "" \  
   --memcached-service "" \  
   --memcached-service ""
```

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```
--git-url git@github.com:fluxcd/flux-get-started \  
--k8s-in-cluster=false
```

This guide covers approaches 1 and 2 using minikube. `freshpod` is superseded by `Skaffold` and is generally the future. That said, `freshpod` is very simple to use and reason about (and is still well supported by minikube) which is why it's used in this guide.

9.1.2 Run fluxcd/flux-getting-started

We're going to make some changes soon enough, but just to get a good baseline please follow the *"Get started with Flux"* tutorial and run the `fluxcd/flux-getting-started` repo through its normal paces.

Now that we know everything is working with `flux-getting-started`, we're going to try and do nearly the same thing as `flux-getting-started`, except instead of using official releases of flux, we're going to build and run what we have locally.

9.1.3 Prepare your environment

1. Install the prerequisites. This guide is written from running Linux, but the same instructions will generally apply to OSX. Although everything you need has been known to work independently in Windows from time to time, results may vary.

- minikube
- kubectl
- docker
- go

2. Configure your environment so you can run tests. Run:

```
make test
```

3. We want to make sure we're starting fresh. Tell minikube to clear any previously running clusters:

```
minikube delete
```

4. The `minikube` addon called `freshpod` that will be very useful to us later. You'll see. It's gonna be cool.

```
minikube addons enable freshpod
```

5. This part is really important. You're going to set some environment variables which will intercept any images pulled by docker. Run `minikube docker-env` to see what we're talking about. You'll get an output that shows you what the script is doing. Thankfully, it's not terribly complicated - it just sets some environment variables which will allow minikube to man-in-the-middle the requests Kubernetes makes to pull images. It will look something like this:

```
export DOCKER_TLS_VERIFY="1"  
export DOCKER_HOST="tcp://192.168.99.128:2376"  
export DOCKER_CERT_PATH="/home/fluxrulez/.minikube/certs"  
export DOCKER_API_VERSION="1.35"  
# Run this command to configure your shell:  
# eval $(minikube docker-env)
```

So, as the script suggests, run the following command:

```
eval $(minikube docker-env)
```

Now, be warned. These are local variables. This means that if you run this `eval` in one terminal and then switch to another for later when we build the Flux project, you're gonna hit some issues. For one, you'll know it isn't working because Kubernetes will tell you that it can't pull the image when you run `kubectl get pods`:

NAME	READY	STATUS	RESTARTS	AGE
flux-7f6bd57699-shx9v	0/1	ErrImagePull	0	35s

9.1.4 Prepare the repository

1. Fork the [repo on GitHub](#).
2. Clone `git@github.com:<YOUR-GITHUB-USERNAME>/flux.git` replacing `<YOUR-GITHUB-USERNAME>` with your GitHub username.

In the same terminal you ran `eval $(minikube docker-env)`, run `GO111MODULE=on go mod download` followed by `make` from the root directory of the Flux repo. You'll see docker's usual output as it builds the image layers. Once it's done, you should see something like this in the middle of the output:

```
Successfully built 606610e0f4ef
Successfully tagged docker.io/fluxcd/flux:latest
Successfully tagged docker.io/fluxcd/flux:master-a86167e4
```

This confirms that a new docker image was tagged for your image.

3. Open up `deploy/flux-deployment.yaml` and update the image at `spec.template.spec.containers[0].image` to be simply `docker.io/fluxcd/flux`. While we're here, also change the `--git-url` to point towards your fork. It will look something like this in the YAML:

```
spec:
  template:
    spec:
      containers:
      - name: flux
        image: docker.io/fluxcd/flux
        imagePullPolicy: IfNotPresent
        args:
        - --git-url=git@github.com:<YOUR-GITHUB-USERNAME>/flux-getting-started
        - --git-branch=master
```

4. We're ready to apply your newly-customized deployment! Since `kubectl` will apply all the Kubernetes manifests it finds (recursively) in a folder, we simply need to pass the directory to `kubectl apply`:

```
kubectl apply --filename ./deploy
```

You should see an output similar to:

```
serviceaccount/flux created
clusterrole.rbac.authorization.k8s.io/flux created
clusterrolebinding.rbac.authorization.k8s.io/flux created
deployment.apps/flux created
secret/flux-git-deploy created
deployment.apps/memcached created
service/memcached created
secret/flux-git-deploy configured
```


This pod was deployed even though we didn't run any `kubectl` commands or interact with Kubernetes directly because of the `freshpod minikube addon` that we enabled earlier. Freshpod saw that a new Docker image was tagged for `docker.io/fluxcd/flux:latest` and it went ahead and redeployed that pod for us.

Consider that simply applying the `flux-deployment.yaml` file again wouldn't do anything since the actual image we're targeting (which is actually `docker.io/fluxcd/flux` with no `:latest` tag, but it's the same difference) hasn't changed. The Kubernetes api server will get that JSON request from `kubectl` and go: "right... so nothing has changed in the file so I have nothing to do... IGNORE!".

There is another way to do this, of course. Remember that before when we ran `make` that we did *also* get an image tagged with the `:<branch>-<commit hash>` syntax (in our specific example above it was `:master-a86167e4`). We could, in theory, grab that tag every time we `make`, and then paste it into `spec.template.spec.containers[0].image` of our deployment. That's tedious and error prone. Instead, `freshpod` cuts this step out for us and accomplishes the same end goal.

3. Check the logs again (with `kubectl logs --selector=name=flux`) to find that your obnoxious chain of Zs is present.

9.1.6 Congratulations!

You have now modified Flux and deployed that change locally. From here on out, you simply need to run `make` after you save your changes and wait a few seconds for your new pod to be deployed to `minikube`. Keep in mind, that (as in the situation where you run `make` without saving any changes) if the Docker image you pointed to in the Kubernetes deployment for Flux is not Successfully tagged, `freshpod` won't have anything new to deploy. Other than that, you should be good to go!

9.2 Building

You'll need a working `go` environment version `>= 1.11` (official releases are built against `1.13`). It's also expected that you have a Docker daemon for building images.

Clone the repository. The project uses [Go Modules](#), so if you explicitly define `$GOPATH` you should clone somewhere else.

Then, from the root directory:

```
make
```

This makes Docker images, and installs binaries to `$GOBIN` (if you define it) or `$(go env GOPATH)/bin`.

Note: the default target architecture is `amd64`. If you would like to try to build Docker images and binaries for a different architecture you will have to set `ARCH` variable:

```
$ make ARCH=<target_arch>
```

9.2.1 Running tests

```
# Unit tests
make test

# End-to-end tests
make e2e
```