// GITOPS REPO STRUCTURES AND PATTERNS

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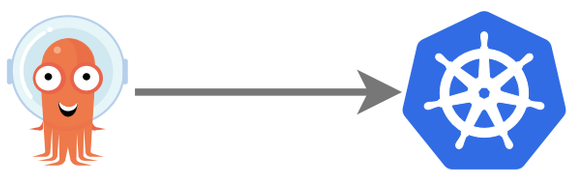
Categories of patterns

- **Operator deployment**: GitOps operators ↔️ Clusters/Namespaces
- **Repository**: How many repos?
- **Promotion**: How to model environments/stages?
- **Wiring**: Bootstrapping operator, linking repos and folders

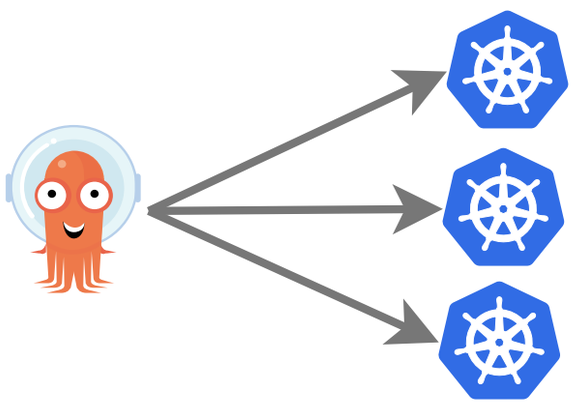
GitOps Operator deployment patterns

How many GitOps operators per cluster?

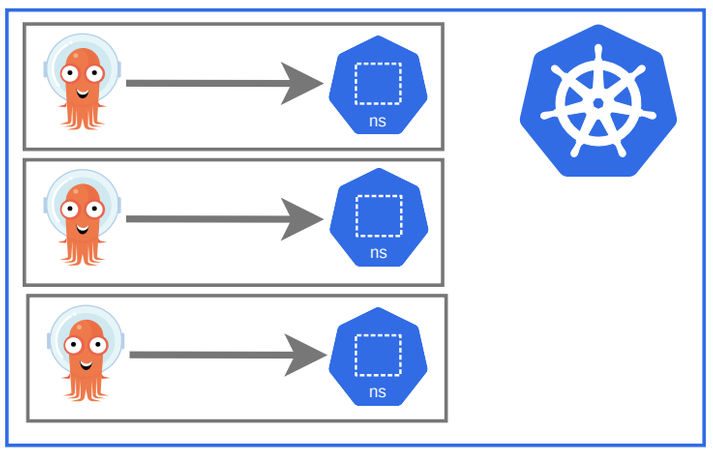
Instance per Cluster



Hub and Spoke



Instance per Namespace



Repository patterns

How many config repos?

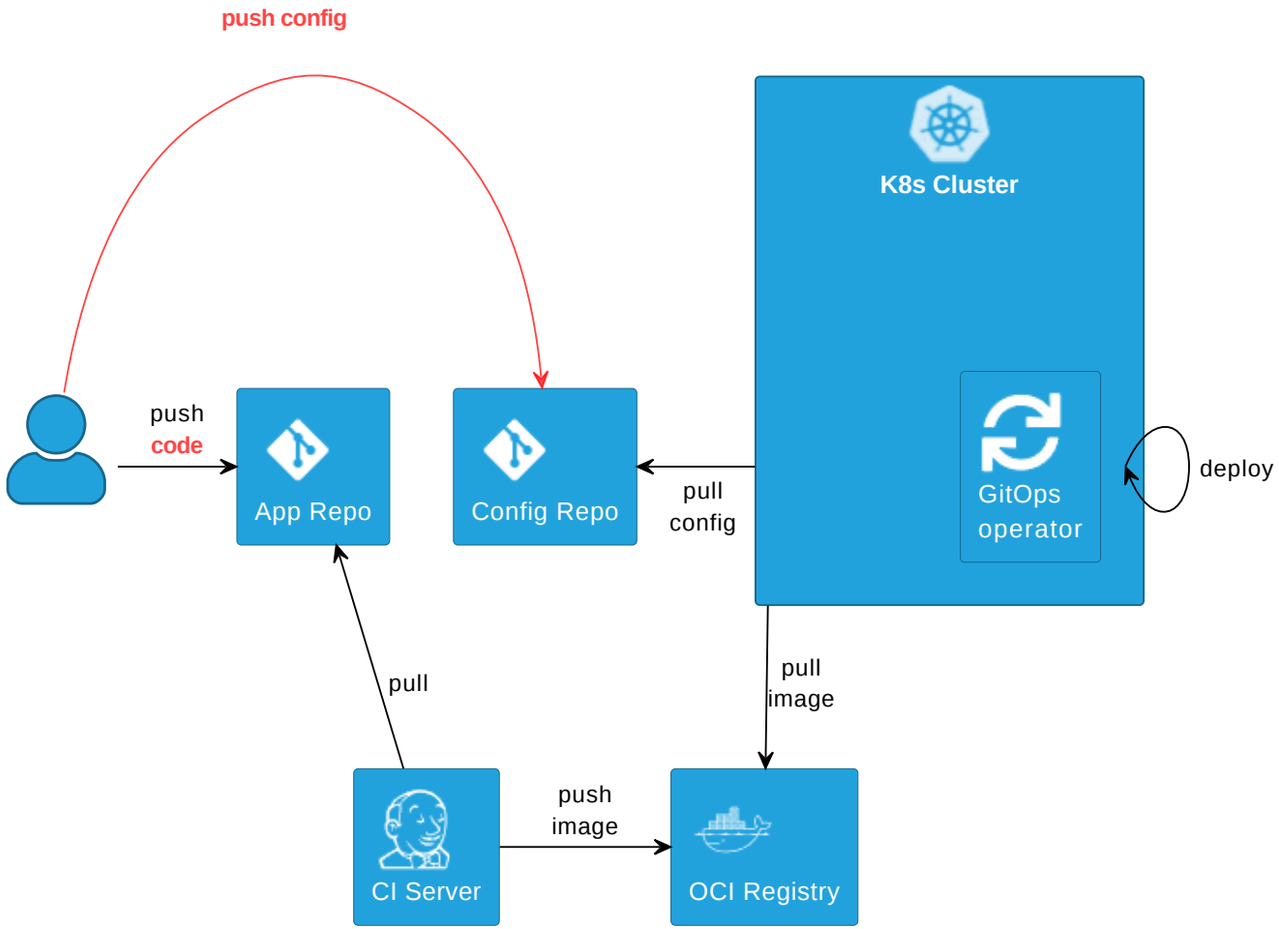
- **Monorepo** (opposite: polyrepo)
- **Repo per Team** / Tenant
- **Repo per App**
  - Repo Separation
  - Config replication
  - Repo pointer
  - Config Split
- **Repo per environment** 🕒

💡 Can be mixed 🏗️

Repository types

	Config repo	App repo
Content	Config/Manifests/YAMLs (IaC)	Application source code
Synonyms	• GitOps repo • Infra repo • Environment repo • Payload repo	• Source code repo • Source repo
Example		

Repo Separation



Recommendation: Keep config separate from code

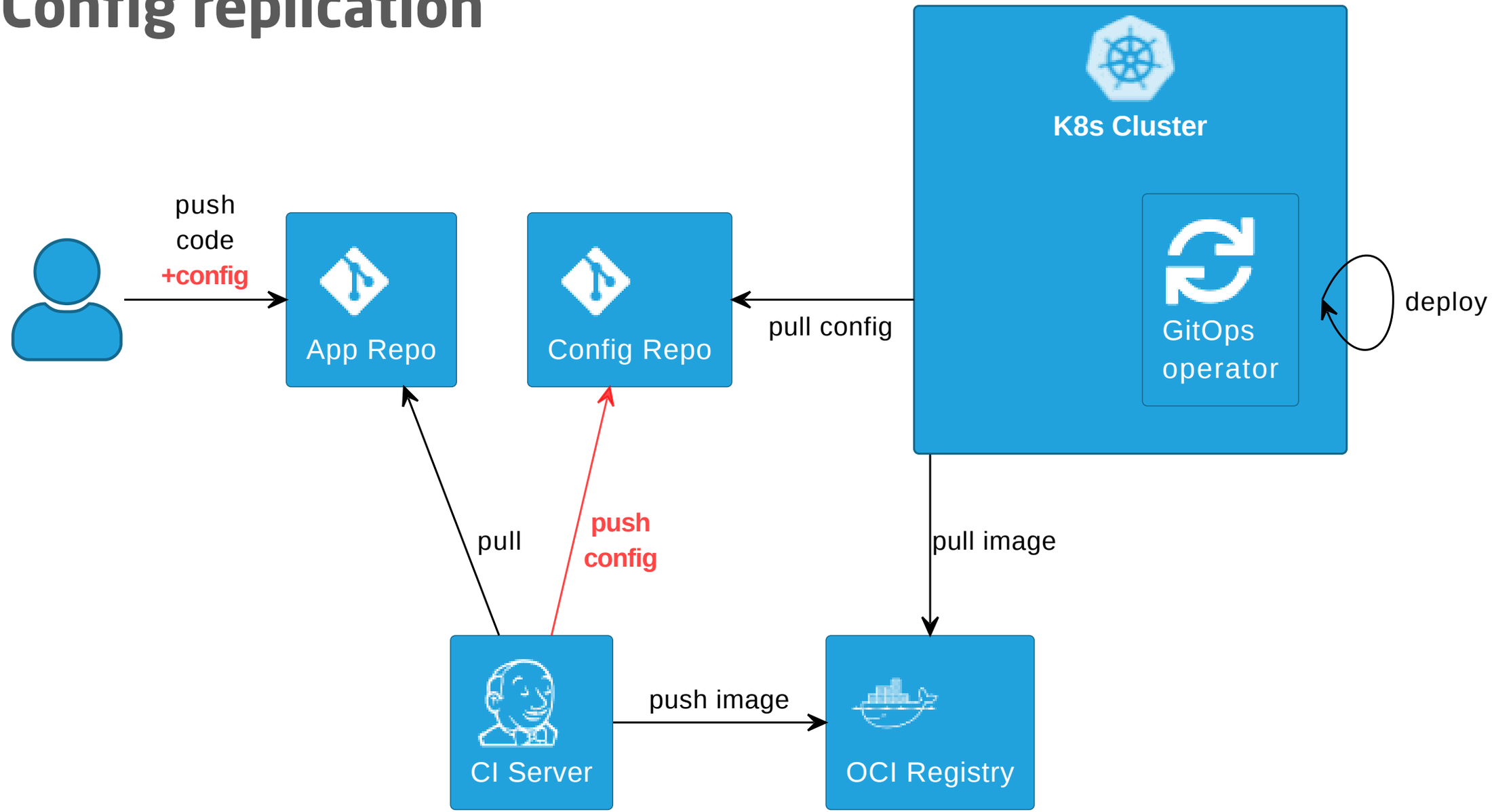
argo-cd.readthedocs.io/en/release-2.8/user-guide/best_practices

Disadvantages

- Separated maintenance & versioning of app and infra code
- Review spans across multiple repos
- Local dev more difficult
- No static code analysis on config repo

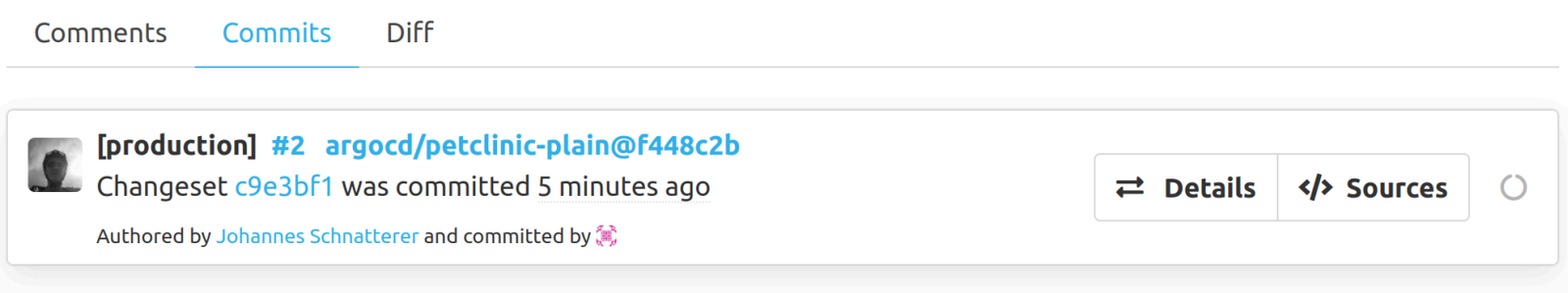
How to avoid those?

Config replication



Advantages

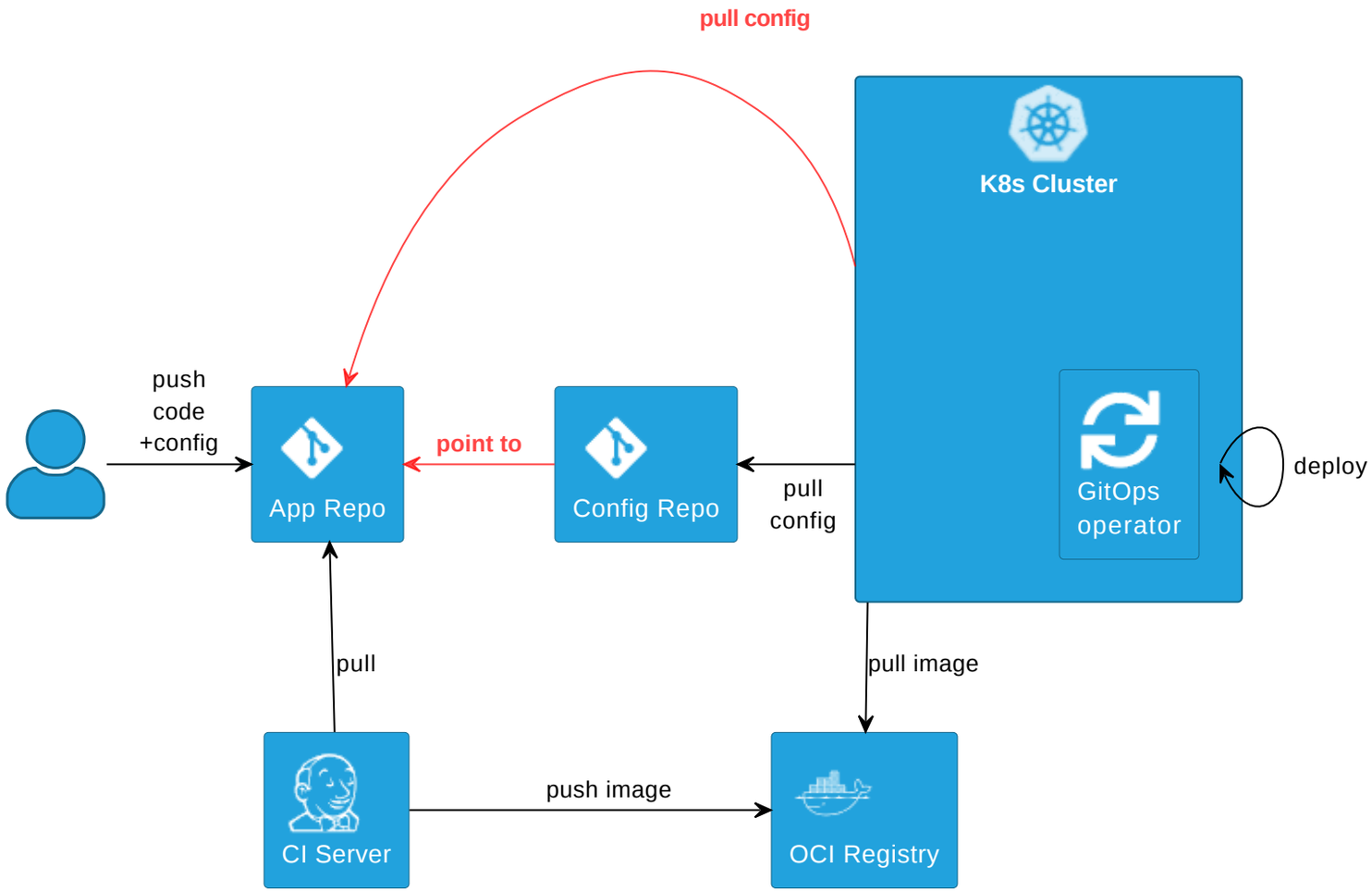
- Single repo for development: higher efficiency
- Shift left: static code analysis + policy check on CI server,
  e.g. yamlint, kubeconform, helm lint, conftest, security scanners
- Automate config update (image tag + PR creation) 🕓
- Simplify review by adding info to PRs



Disadvantages

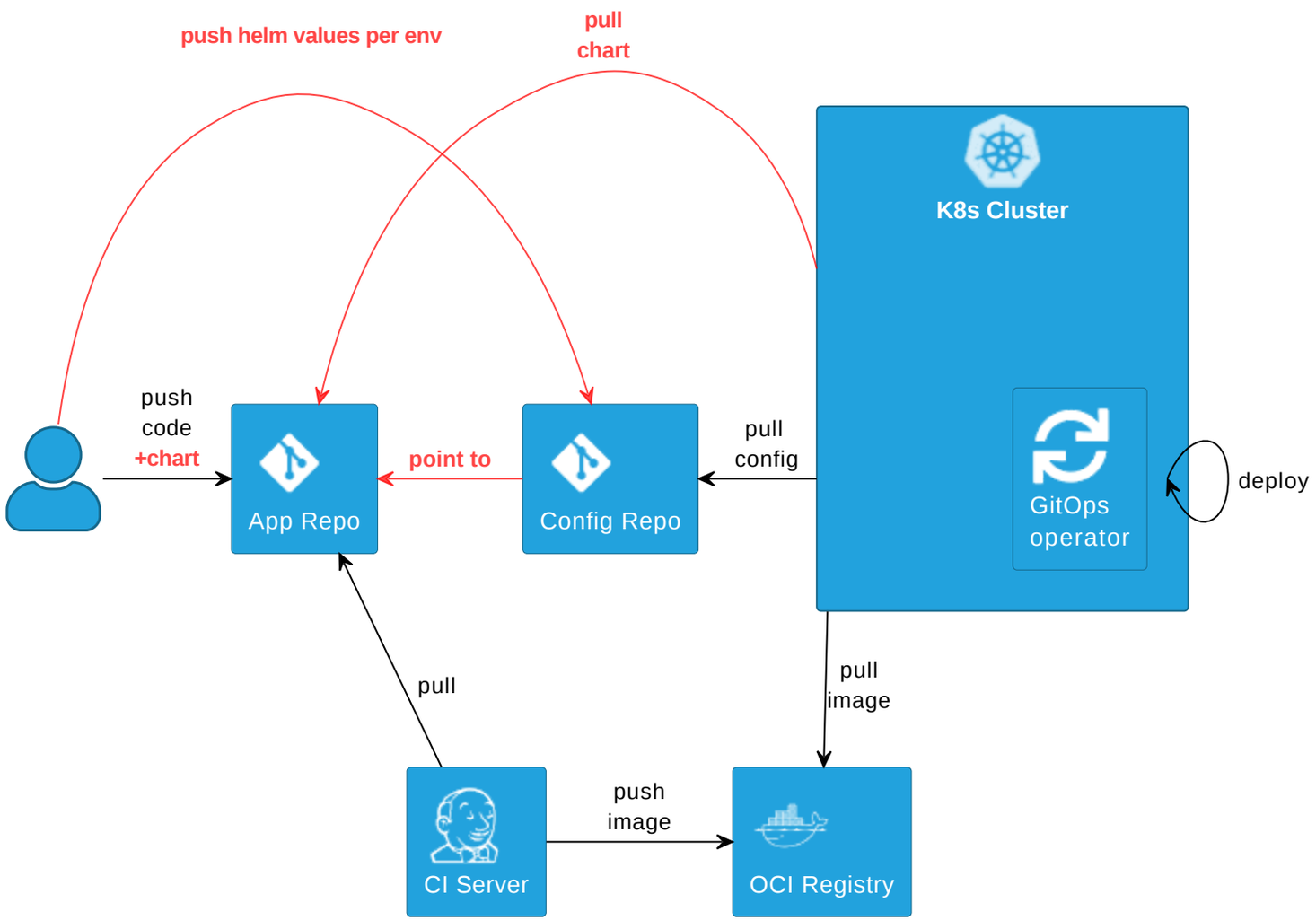
- Complexity in CI pipelines
  - ➡️ Recommendation: Use a plugin or library, e.g.
  - cloudogu/gitops-build-lib
- Redundant config (app repo + config repo)

Avoid Redundancy: Repo pointer



e.g. fluxcd.io/flux/guides/repository-structure

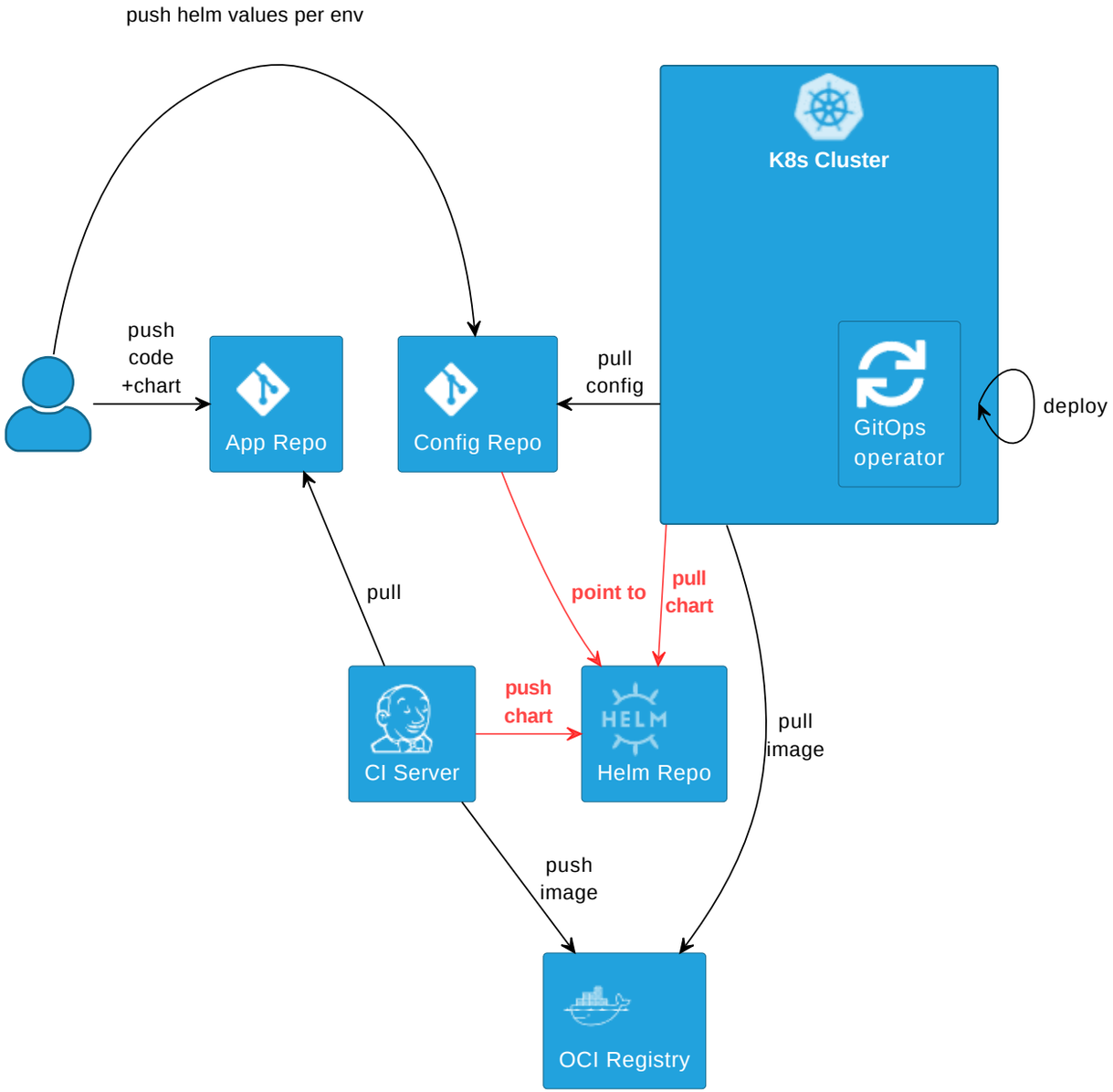
Middle ground: Config Split

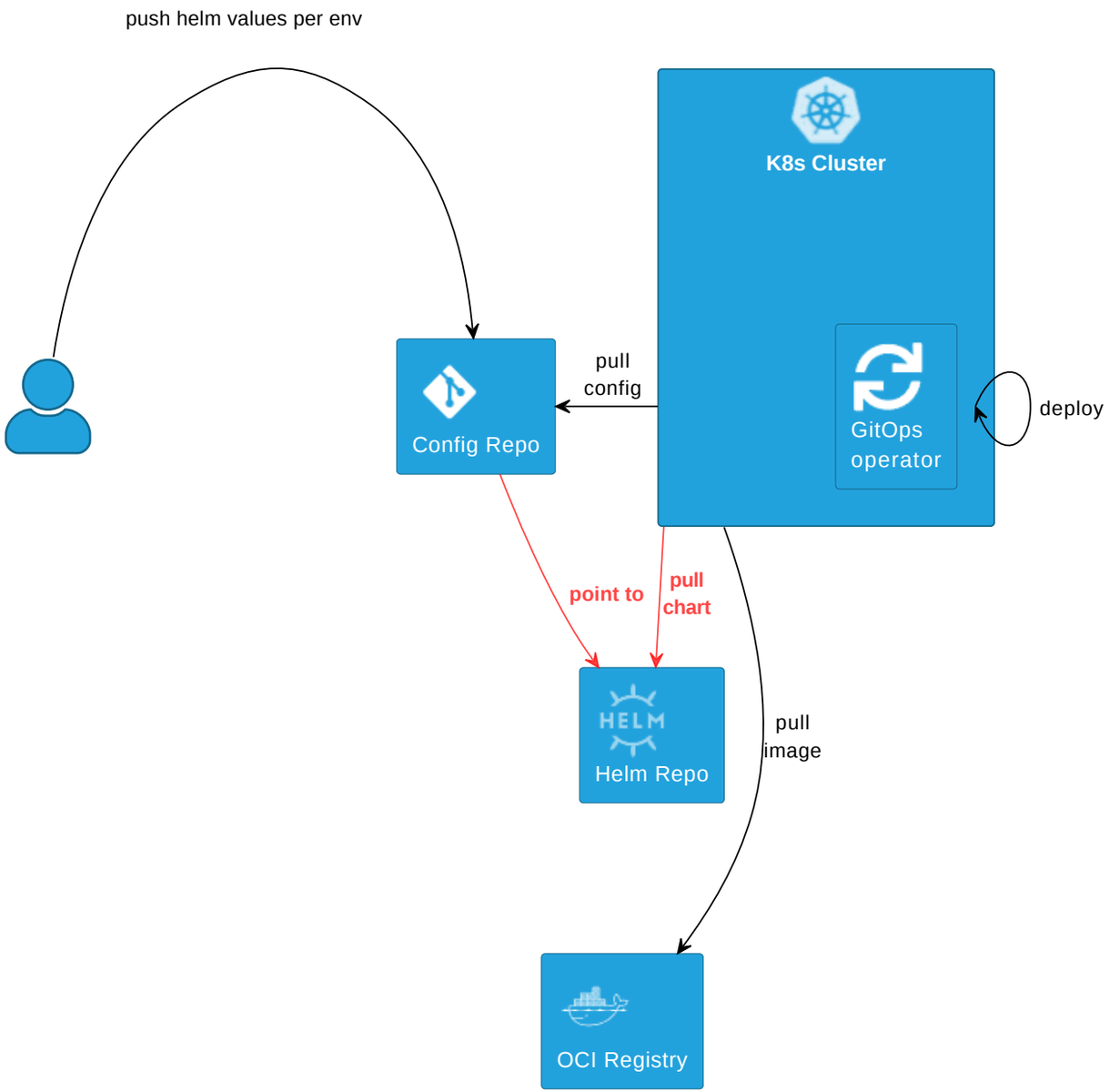


👉 HELM example

💡 Also works with K

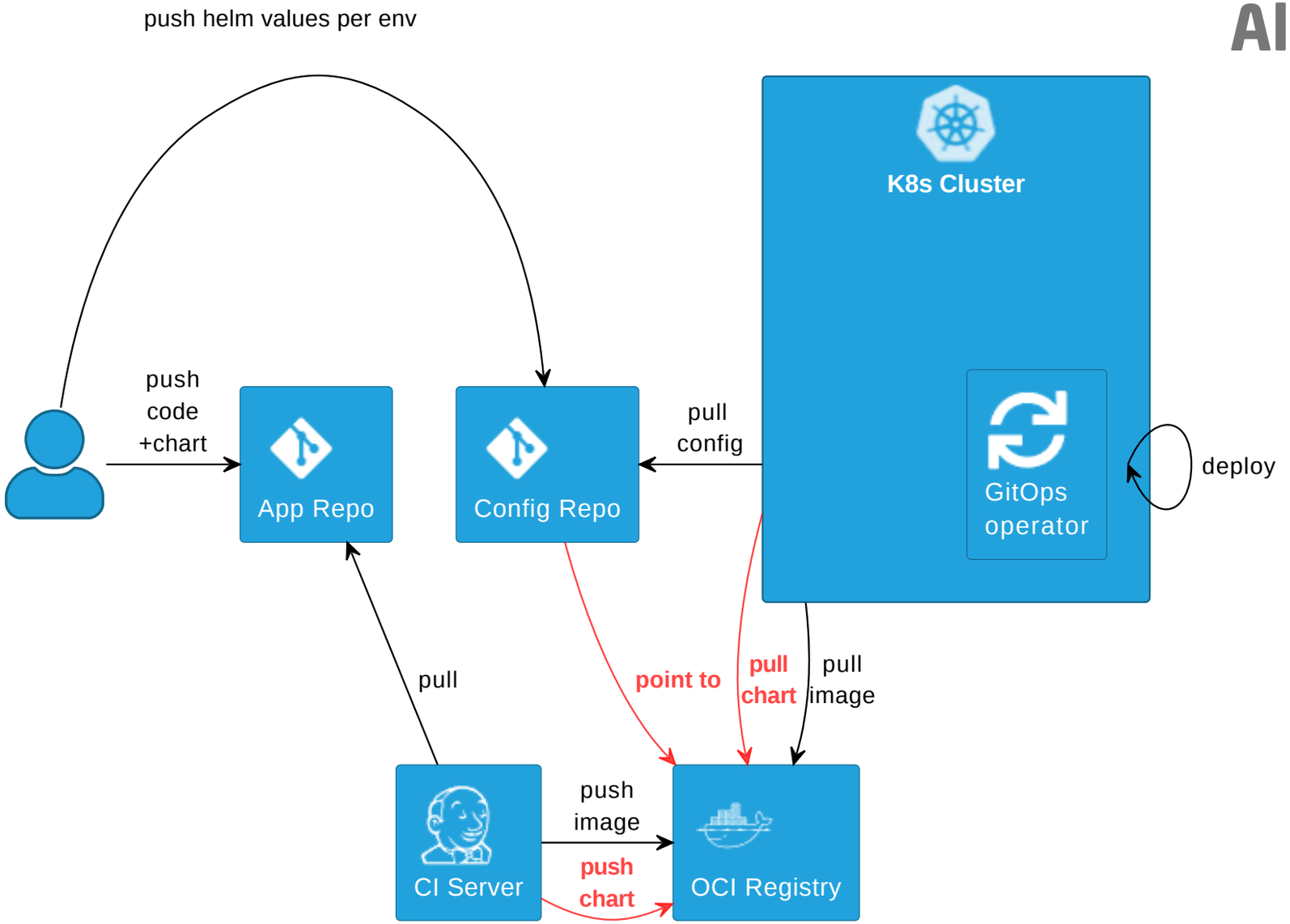
Alternative: Helm repo



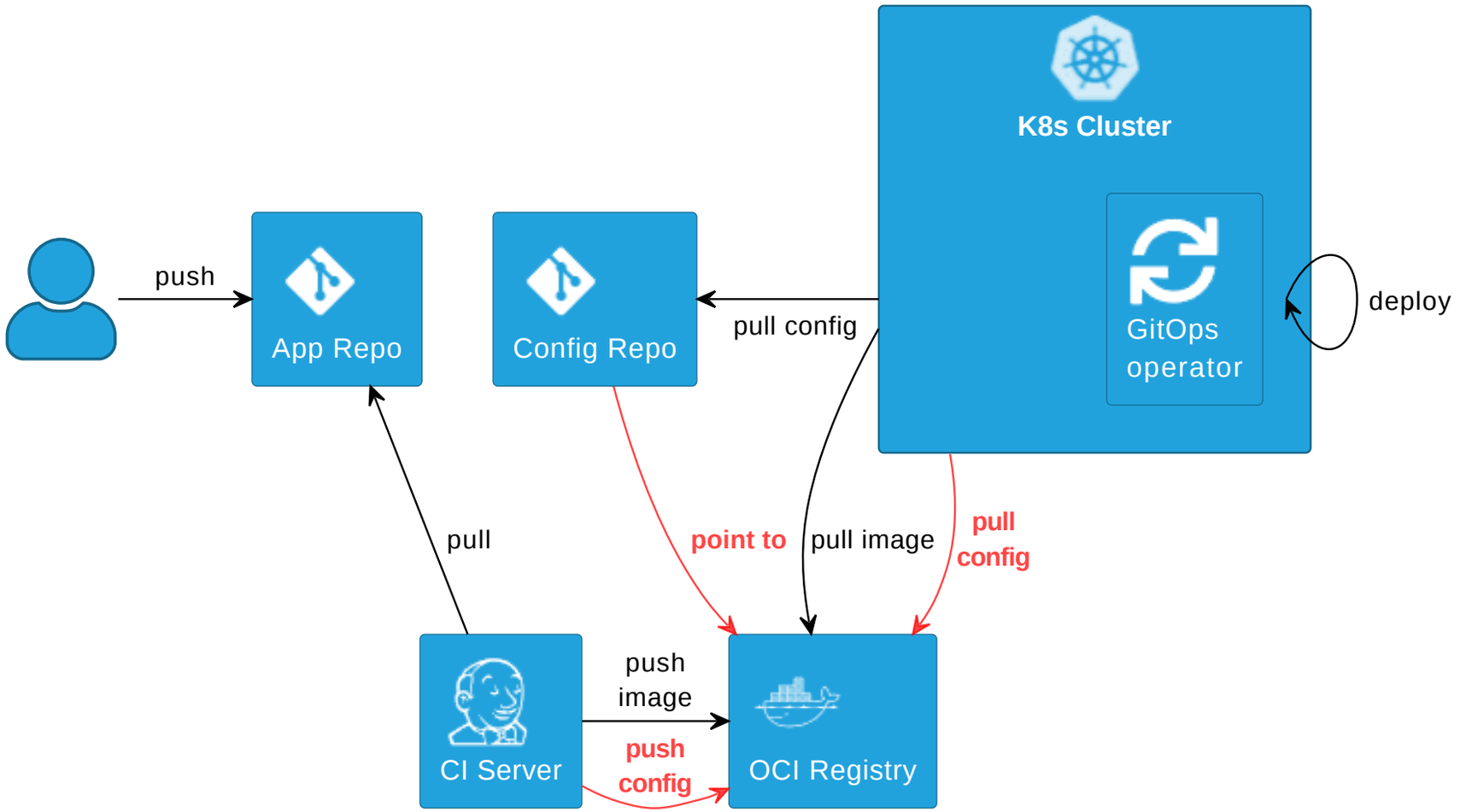


💡 Same pattern for 3rd-party apps

Alternative 2: Helm in OCI



Alternative 3: OCI artifacts



CUE

fluxcd.io/flux/cheatsheets/oci-artifacts

Promotion patterns

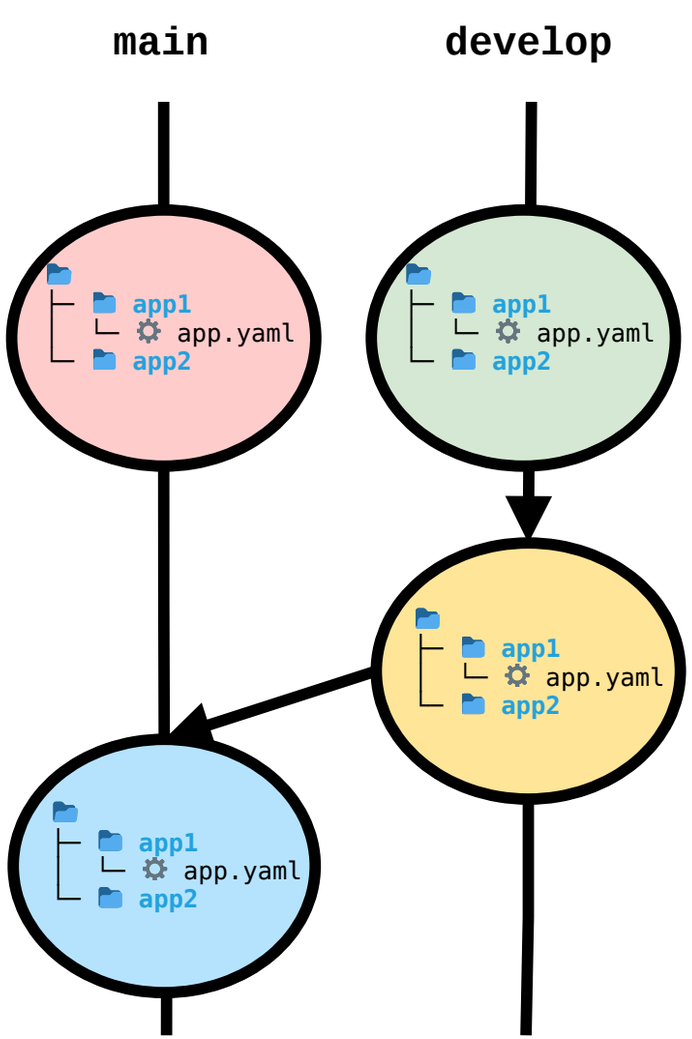
How to model environments/stages?

- **Branch per environment**
- **Folder/Directory per environment**
- **Repo per environment** (edge case)
- 🔥 **Preview environments**

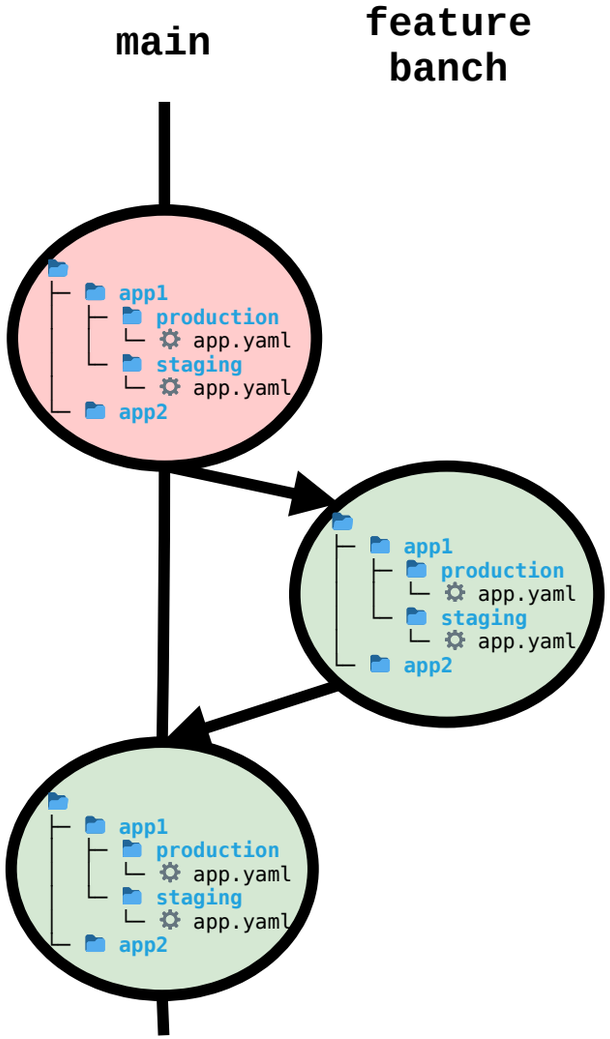
Branch vs folder per Environment

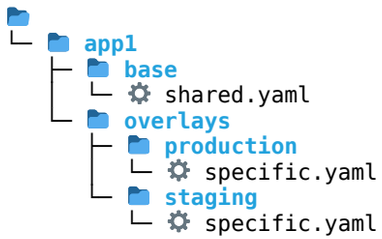
	Branch per env	Folder per env
envs	permanent branches	trunk-based folders
mapping example	`develop` ➡ staging `main` ➡ production	`staging` ➡ Staging `production` ➡ Production
promotion	merge	copy (+merge short-lived branches)

Branch per env



Folder per env



	Branch per env	Folder per env
pros	• Forces PRs • Feels natural for devs	• Avoids conflicts/drift • Copy vs cherry pick • Scales with envs
CM tool support (DRY) HELM K	?	✓ 
references	1	1, 2, 3, 4, … Branches = `anti-pattern`

Repo per environment

Why would you want to use one repo per env?

- Access to folders more difficult to constrain than repos
- Organizational constraints, e.g.
  - "devs are not allowed to acces prod"
  - security team needs to approve releases

➡️ Repos more complicated than folders. Use only when really necessary.

🔥 Preview environments

- An environment that is created with a pull request
- and deleted on merge/close

`ApplicationSet`, using the `PullRequest` generator

`GitOpsSets` ≈

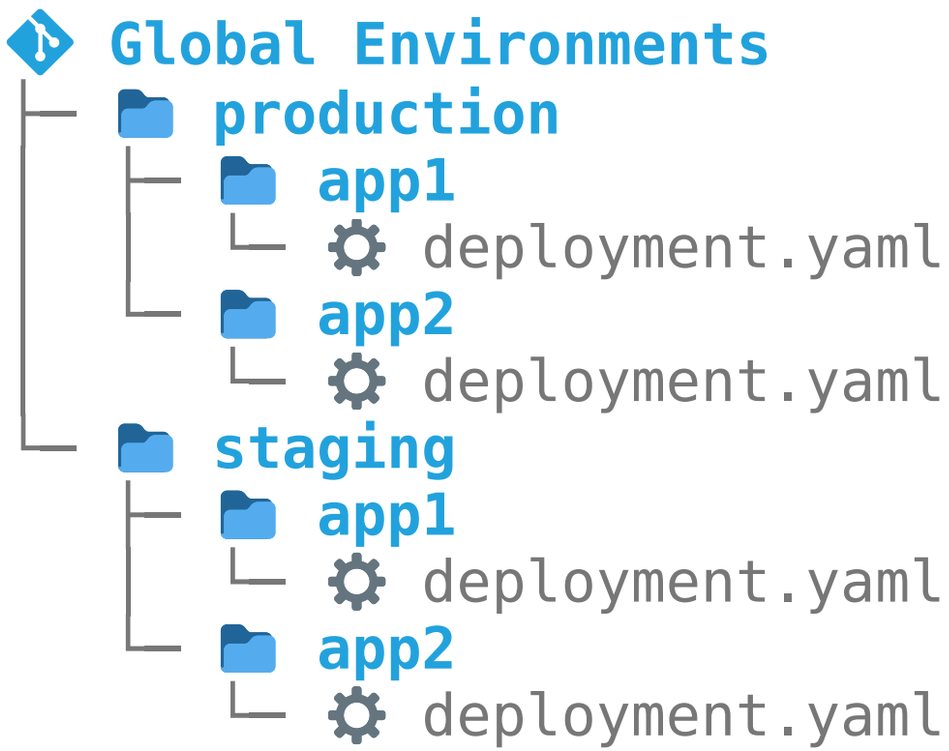
Implementing promotion

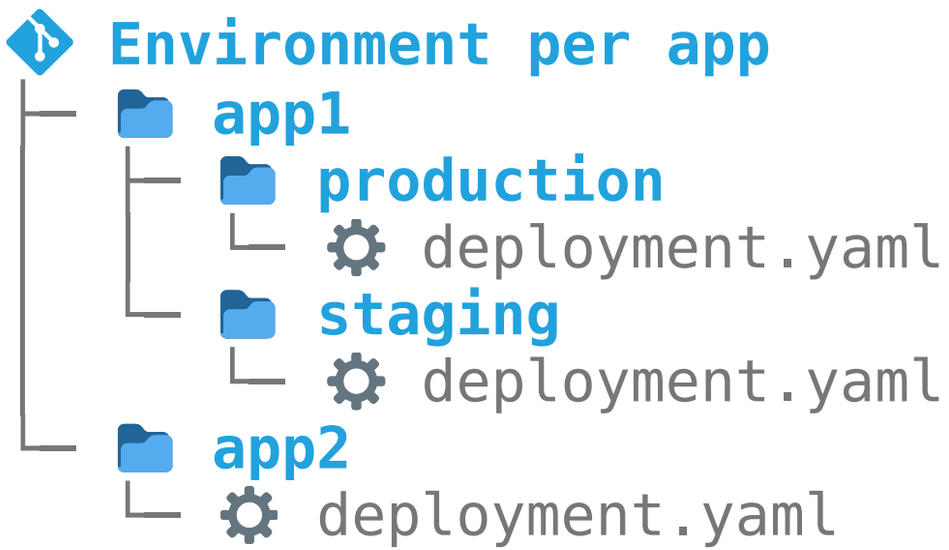
Configuration Management tools

Tools for separating config of envs, keeping them DRY

- Kustomize
  - plain `kustomization.yaml` “agnostic”
  - ≠ Flux CRD `Kustomization`
  - `kustomize build` / `kubectl kustomize` via CI server
- Helm
  - CRD (`Application`, `HelmRelease`)
  - Umbrella Chart
  - `helm template` via CI server

Global envs vs. env per app





e.g. Preview Envs

Config update

> Who updates image version in config repo, creates branch and PR?

- **Manual**: Human pushes branch and create PR 😈
- **CI Server**: Build job pushes branch, creates PR
- **Image Updater**: Operator pushes branch, create PR manually
- **Dependency Bot**: Bot pushes branch, creates PR

Promotion via CI Server

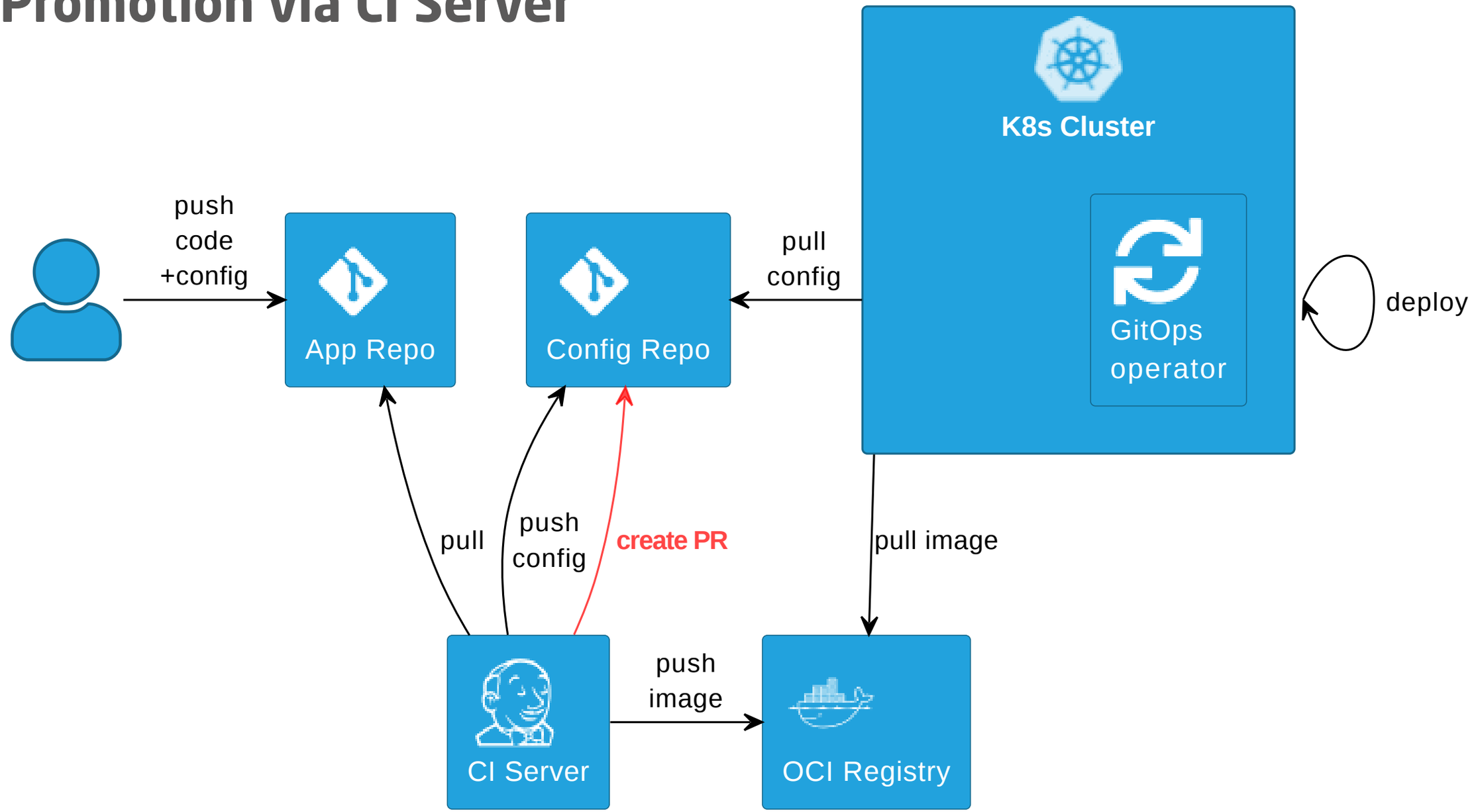
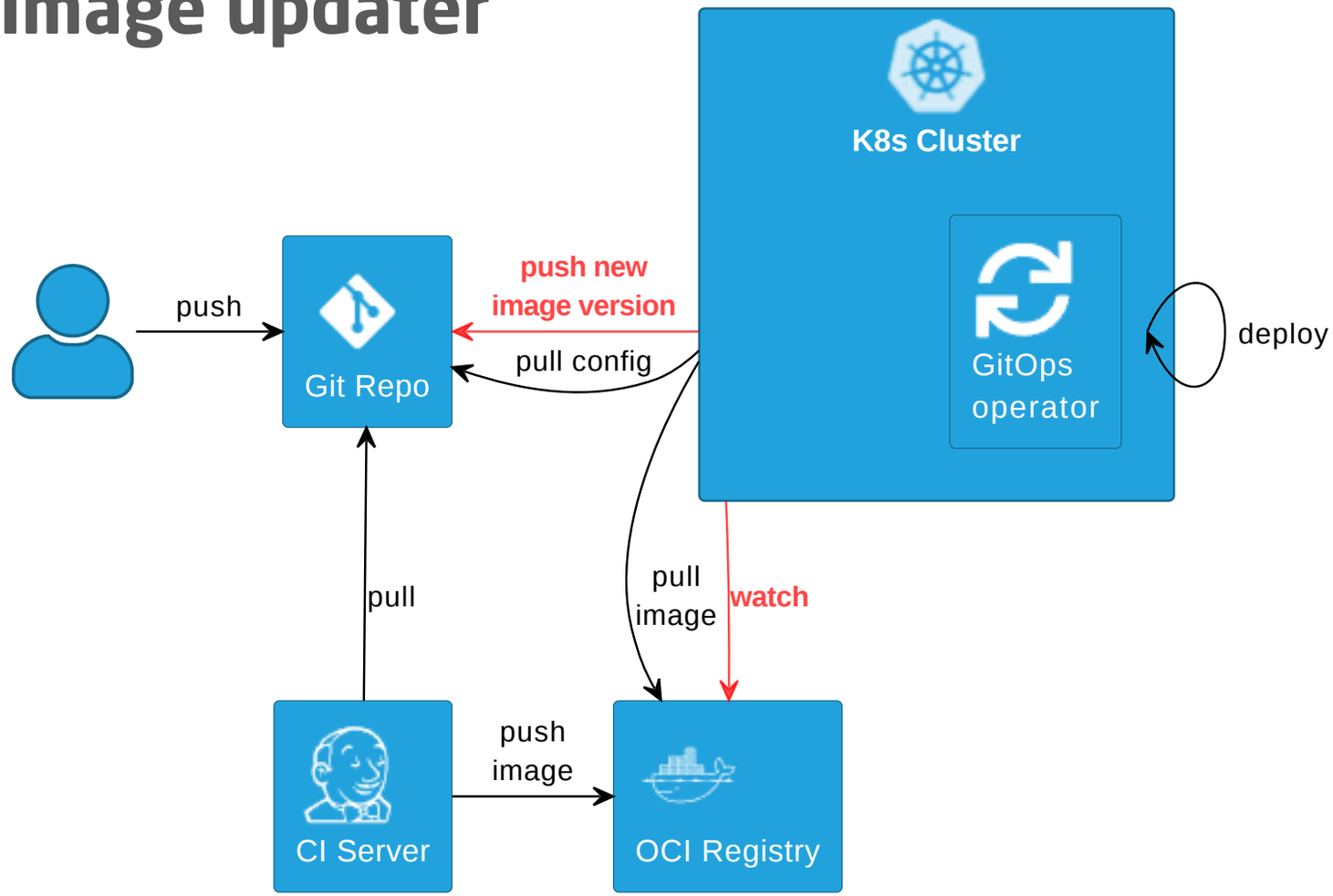


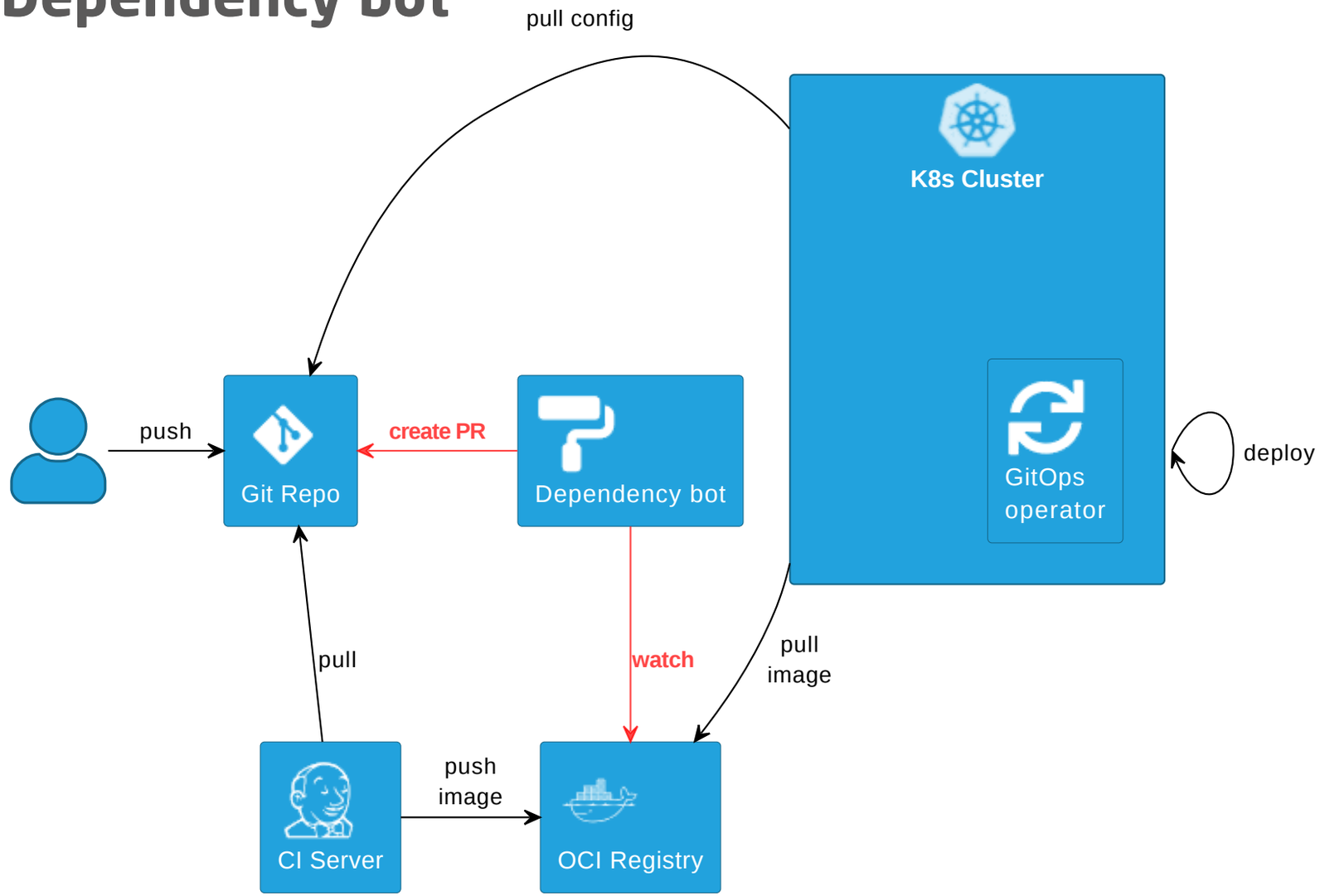
Image updater



github.com/argoproj-labs/argocd-image-updater

fluxcd.io/docs/guides/image-update

Dependency bot



e.g. github.com/renovatebot/renovate

Pull Requests

> GitOps - Operations by Pull Request
> 🌐 weave.works/blog/gitops-operations-by-pull-request

But: avoid cargo cult

ℹ️ PRs not mentioned in principles

Wiring patterns

Wiring up operator, repos, folders, envs, etc.

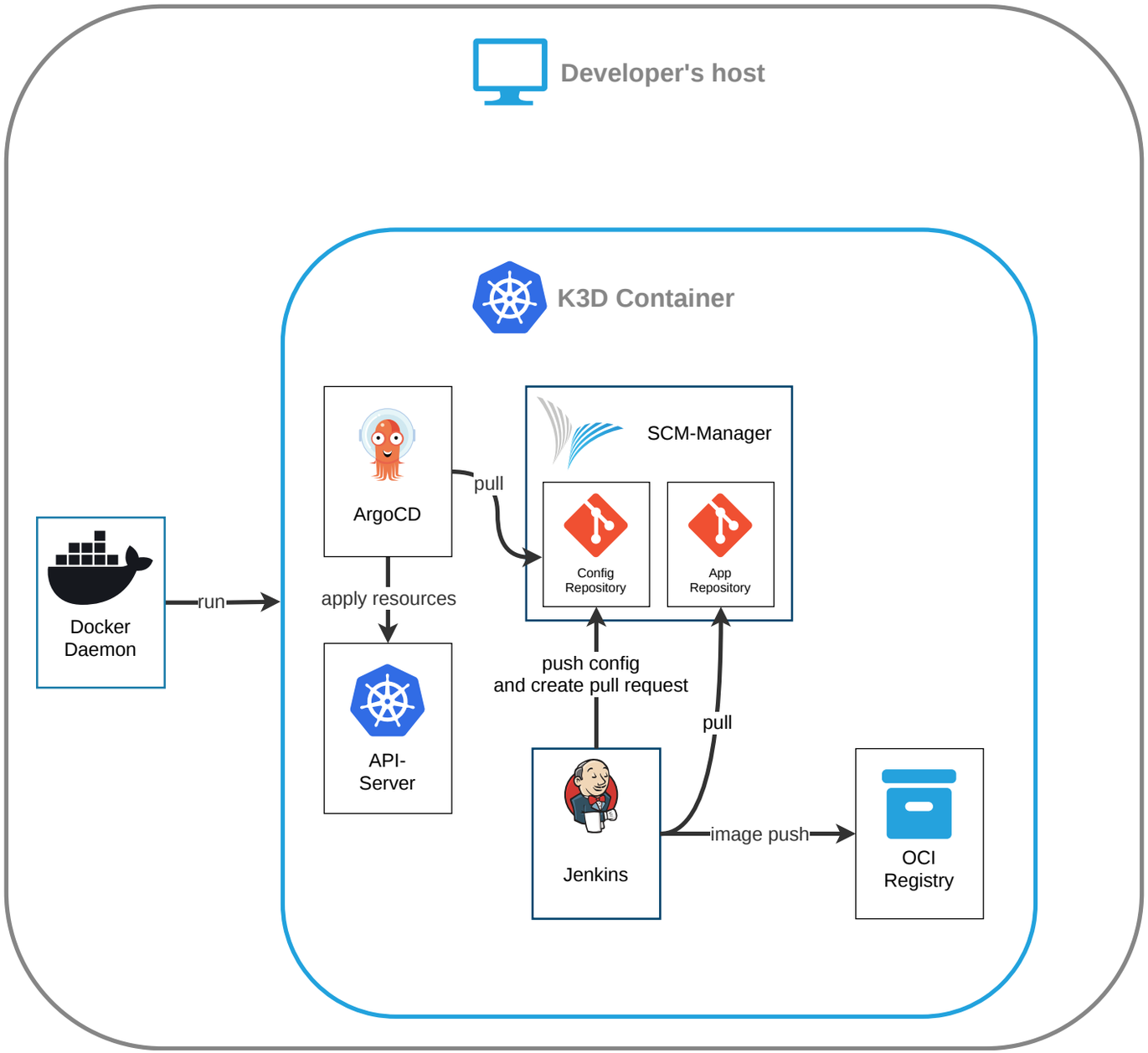
- **Bootstrapping**: `kubectl`, operator-specific CLI
- **Linking/Grouping**:
  - Operator-specific CRDs
    -  `Kustomization`
    -  `Application`
  - **Nesting**:  App of Apps

    (same pattern with  `Kustomization`)
  - **Templating**:  `ApplicationSets` - folders, lists, config files, PRs

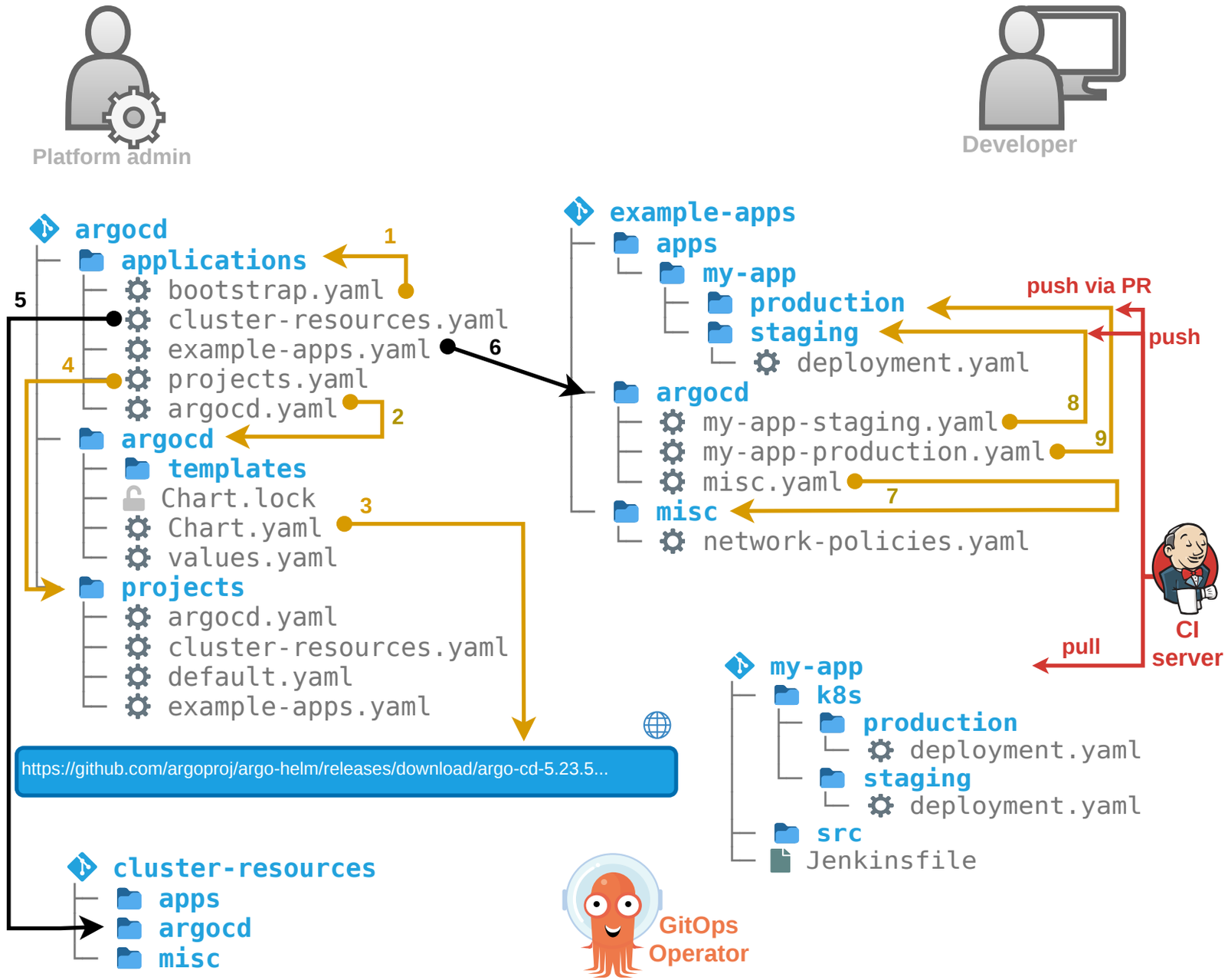
Example + Demo

GitOps playground

- **Repo pattern:** Per team 🏗 per app
- **Operator pattern:** Instance per Cluster (Hub and Spoke)
- **Operator:**
- **Boostrapping:** `Helm`, `kubectl`
- **Linking:** `Application`
- **Features:**
  - Operate ArgoCD with GitOps
  - Solution for cluster resources
  - Config update + replication via CI
  - Mixed repo patterns
  - Env per app pattern
- **Source:** cloudogu/gitops-playground

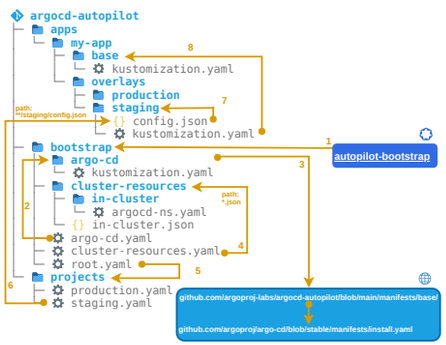

Developer's host
K3D Container
ArgoCD
pull
SCM-Manager
Config Repository
App Repository
Docker Daemon
run
apply resources
API-Server
push config and create pull request
pull
Jenkins
image push
OCI Registry

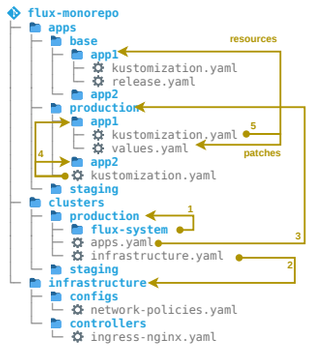
```
COMMIT='8e21bd4'
bash <(curl -s \
  "https://raw.githubusercontent.com/cloudogu/gitops-playground/$COMMIT/scripts/init-cluster.sh") \
  --bind-ingress-port=80  \
  && sleep 2 && docker run --rm -it --pull=always -u $(id -u) \
    -v ~/.config/k3d/kubeconfig-gitops-playground.yaml:/home/.kube/config \
    --net=host \
    ghcr.io/cloudogu/gitops-playground:$COMMIT --yes --argocd --base-url=http://local.gd
# Other interesting options --monitoring --vault=dev
```

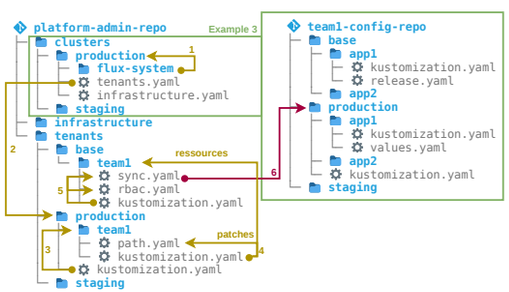

Platform admin
Developer
argocd
applications
bootstrap.yaml
cluster-resources.yaml
example-apps.yaml
projects.yaml
argocd.yaml
argocd
templates
Chart.lock
Chart.yaml
values.yaml
projects
argocd.yaml
cluster-resources.yaml
default.yaml
example-apps.yaml
1
2
3
4
5
6
https://github.com/argoproj/argo-helm/releases/download/argo-cd-5.23.5...
cluster-resources
apps
argocd
misc
example-apps
apps
my-app
production
staging
deployment.yaml
argocd
my-app-staging.yaml
my-app-production.yaml
misc.yaml
misc
network-policies.yaml
7
8
9
push via PR
push
pull
CI
server
my-app
k8s
production
deployment.yaml
staging
deployment.yaml
src
Jenkinsfile
GitOps
Operator

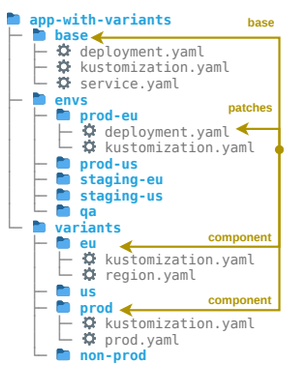
More examples + further reading

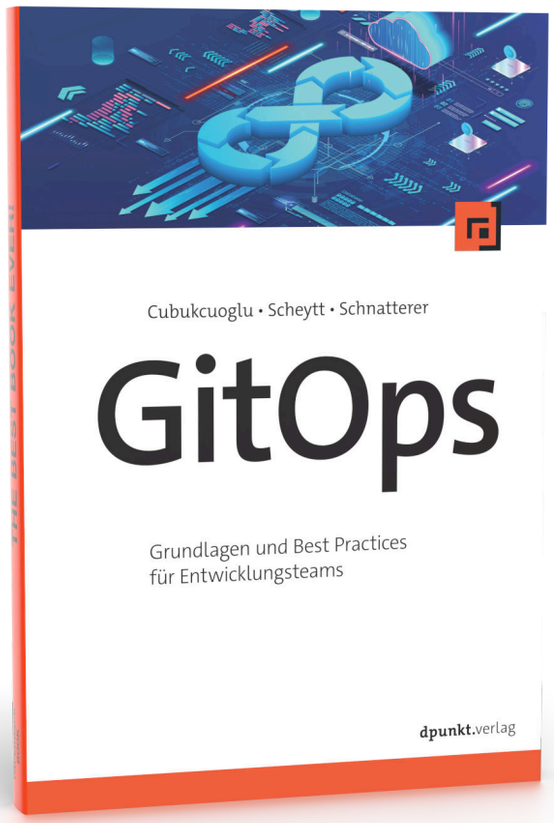
cloudogu/gitops-patterns

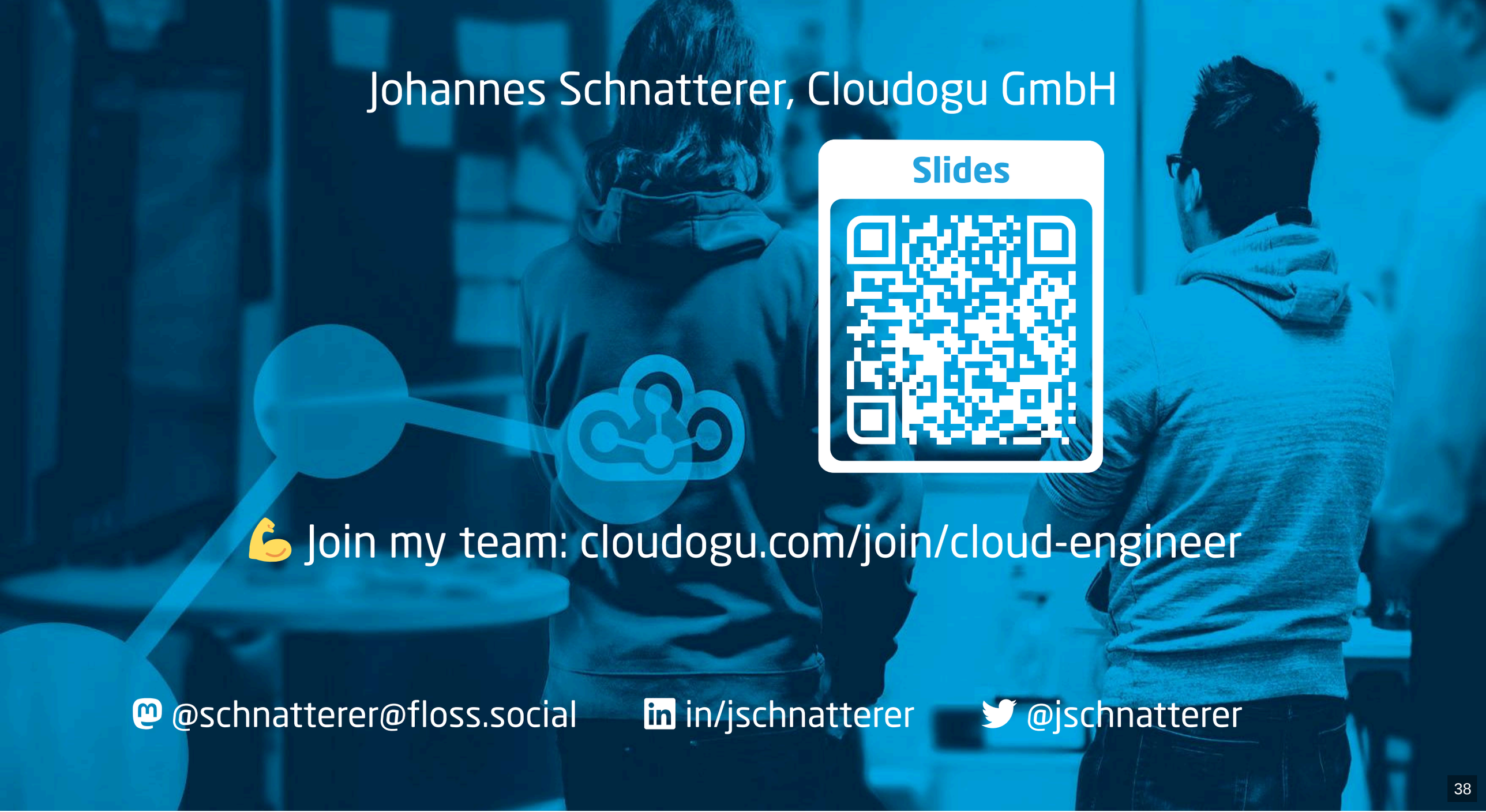












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Slides

💪 Join my team: cloudogu.com/join/cloud-engineer

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Wir entwickeln einen open source GitOps-Stack für K8s

Sag uns wie wir GitOps für dich leichter machen können

Image sources

- Implementation
  https://unsplash.com/photos/selective-focus-photography-blue-and-black-makita-power-drill-KIby0nxseY8
- Demo
  https://unsplash.com/photos/assorted-color-hot-air-balloons-during-daytime-DuBNA1QMpPA
- coloured-parchment-paper background by brgfx on Freepik
  https://www.freepik.com/free-vector/coloured-parchment-paper-designs_1078492.htm
- Question mark
  https://pixabay.com/illustrations/question-mark-question-response-1020165/