CI/CD Infrastructure at Scale

Berlin DevOps, March edition, 2023

About Me: Serhii Vasylenko

Developer Experience Engineer at Grammarly

Specialization: CI/CD, AWS, Terraform

Contributor to aws and communities

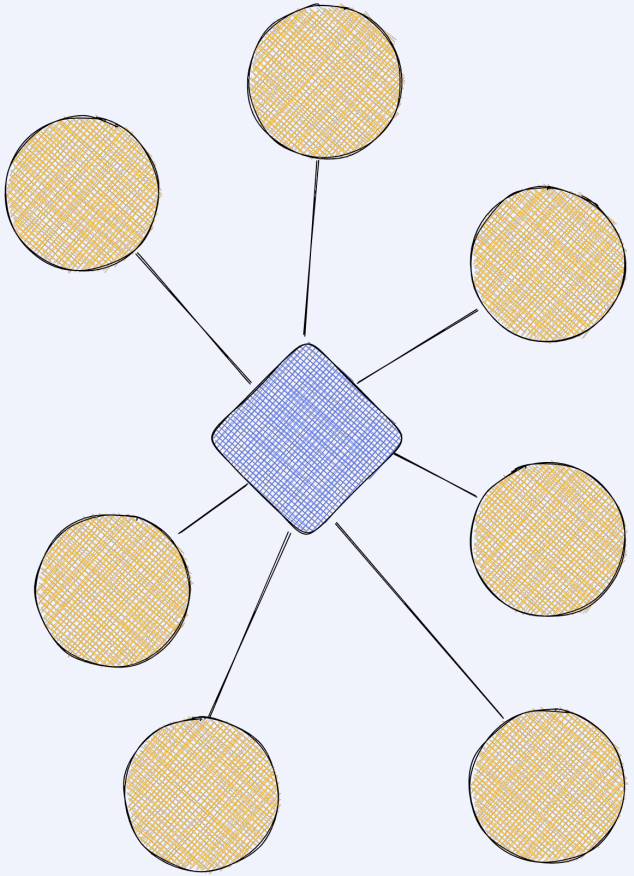
Agenda

- Context: why and where
- One CI account “to rule them all”
- Dynamic provisioning with Karpenter
- Extra CI run-time tweaks with Kyverno
- Deployment and self-service

AWS Environment

Multi-account AWS organization

Around 200 accounts and growing

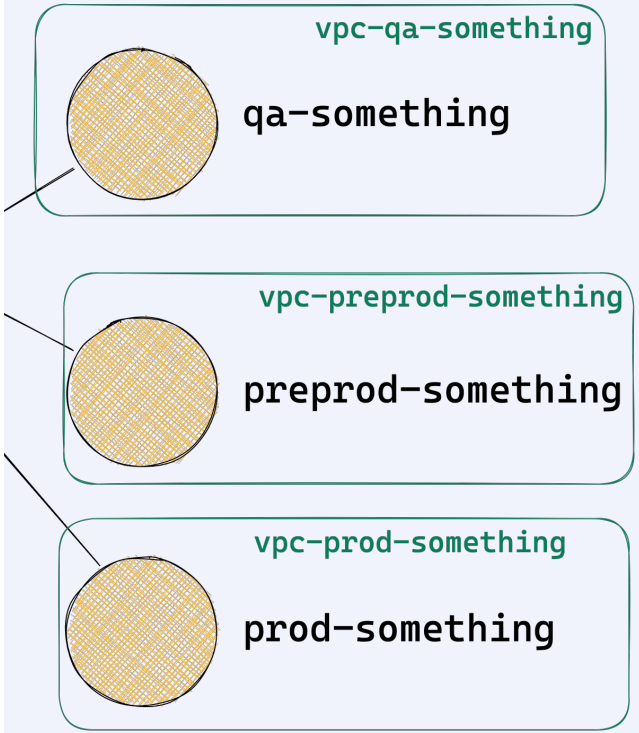


AWS Environment

AWS account per project's environment

Each account has its own VPC

Transit Gateways used for cross-VPC communication



Why: Code Management

Self-hosted GitLab server:
1,500 projects and 450 users

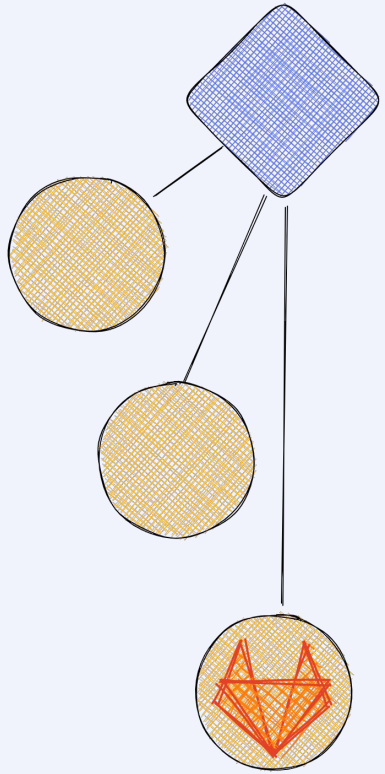
Projects grouped by teams

CI runners access most of AWS accs

Everyone can contribute to any project

Security and Audit

And deploy QA / Preprod



Why: Old Infra Management

CI runners deployed in AWS every account

No auto-scaling

“Best guess” provisioning, no capacity review later

Duplicated runners for access to the same AWS account from different GitLab projects

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One CI account “to rule them all”

CI/CD Runners EKS Cluster

Centralized resource management

Access to all AWS accounts

Customizable CI environment options

Fast scaling and cost efficiency

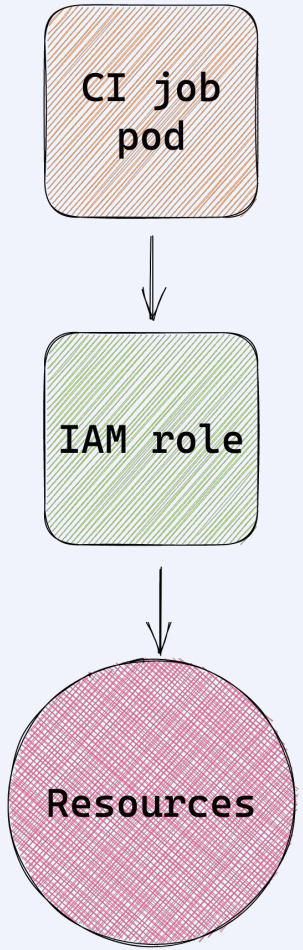
Access Control With IAM

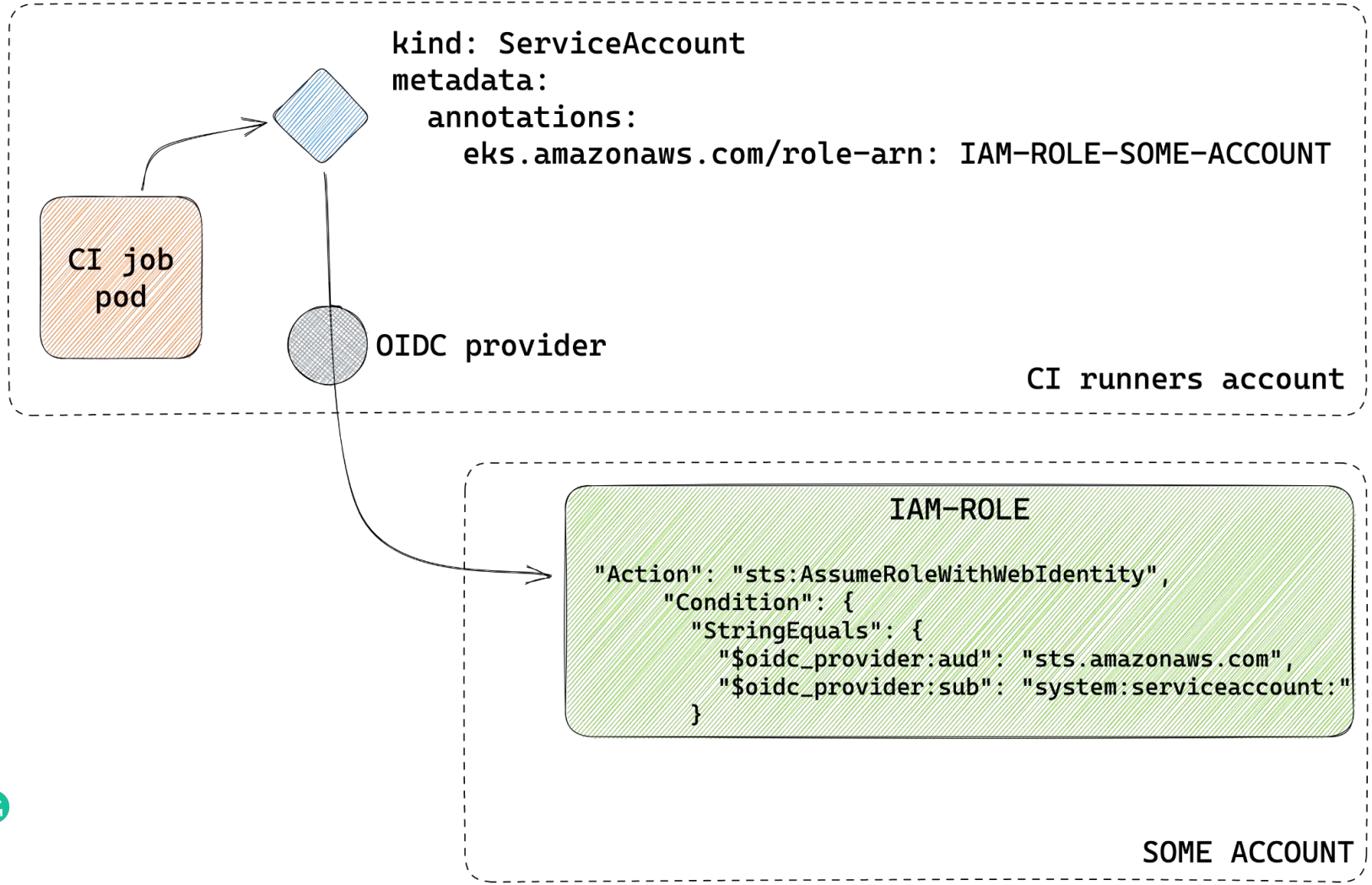
Pod with a CI job uses service accounts (SA)

SA authenticates through OpenID Connect provider to get to the target AWS account

Target AWS account has IAM role for EKS CI pods

IAM role trusts only CI pods, and users can extend policies




kind: ServiceAccount
metadata:
annotations:
eks.amazonaws.com/role-arn: IAM-ROLE-SOME-ACCOUNT
CI job pod
OIDC provider
CI runners account
IAM-ROLE
"Action": "sts:AssumeRoleWithWebIdentity",
"Condition": {
"StringEquals": {
"$oidc_provider:aud": "sts.amazonaws.com",
"$oidc_provider:sub": "system:serviceaccount:"
}
SOME ACCOUNT

How It Looks in a CI Job

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What Is It?

A bit smarter than CAS:

- Group-less node provisioning
- Highly customizable

Picks most suitable and cheap EC2 instances to meet the requirements

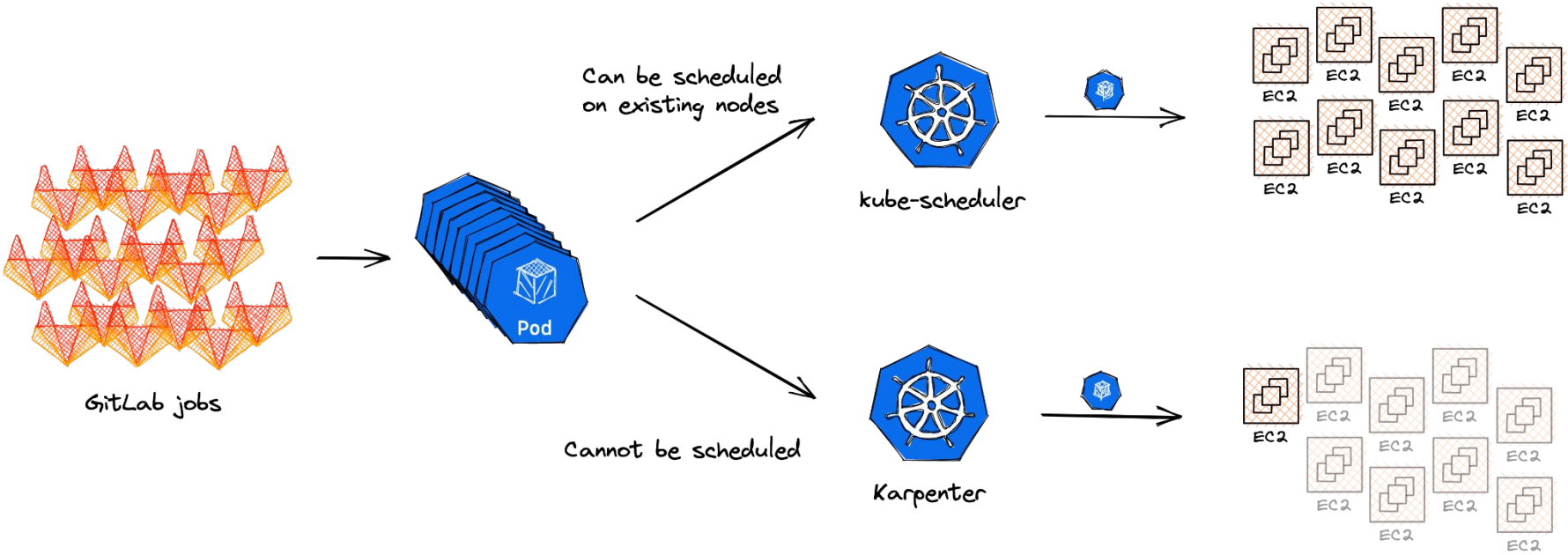
Coexists with nodes provisioned by other provisioners

Multiple provisioners configuration

Karpenter Provisioner Example

```yaml
apiVersion: karpenter.sh/v1alpha5
kind: Provisioner
...
  requirements:
    - key: "karpenter.k8s.aws/instance-family"
      operator: In
      values: ["c5", "c5a", "c6i", "c6a", "m5", "m5a"]
    - key: "karpenter.k8s.aws/instance-size"
      operator: NotIn
      values: ["nano", "micro", "24xlarge", "32xlarge", "48xlarge"]
    - key: "kubernetes.io/arch"
      operator: In
      values: ["amd64"]
    - key: "karpenter.sh/capacity-type"
      operator: In
      values: ["on-demand", "spot"]
```

Dynamic CI Runners Provisioning

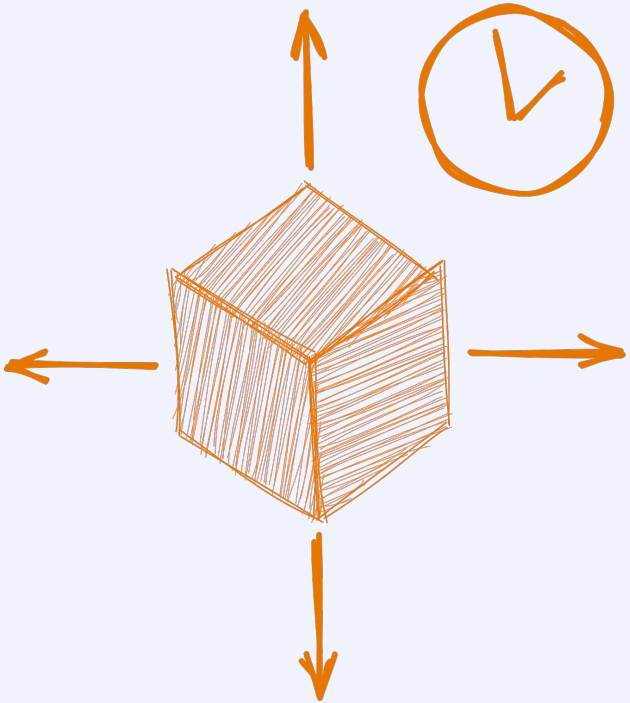


Warm Pools for Better UX

Group of nodes to handle around a half of the jobs demand

Two node groups of different sizes

Scale to zero on weekends



More for Customizable CI

Capacity select:
- On-demand
- Spot

GPU
for ML-related CI

Specific
instance
type
(for snowflakes)

Evenly spread
across AZs

But GitLab and Karpenter need an "assistant"

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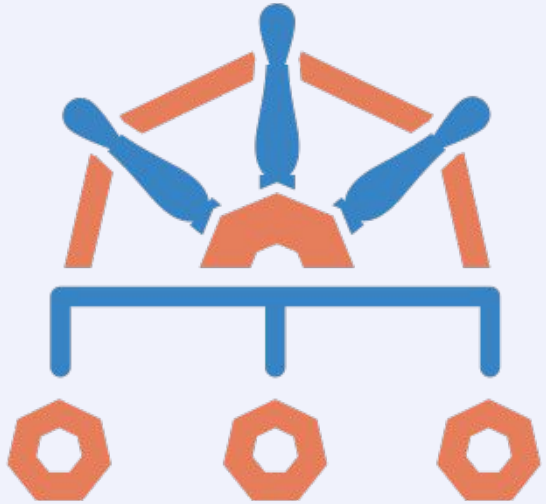
Kyverno — Policy Engine

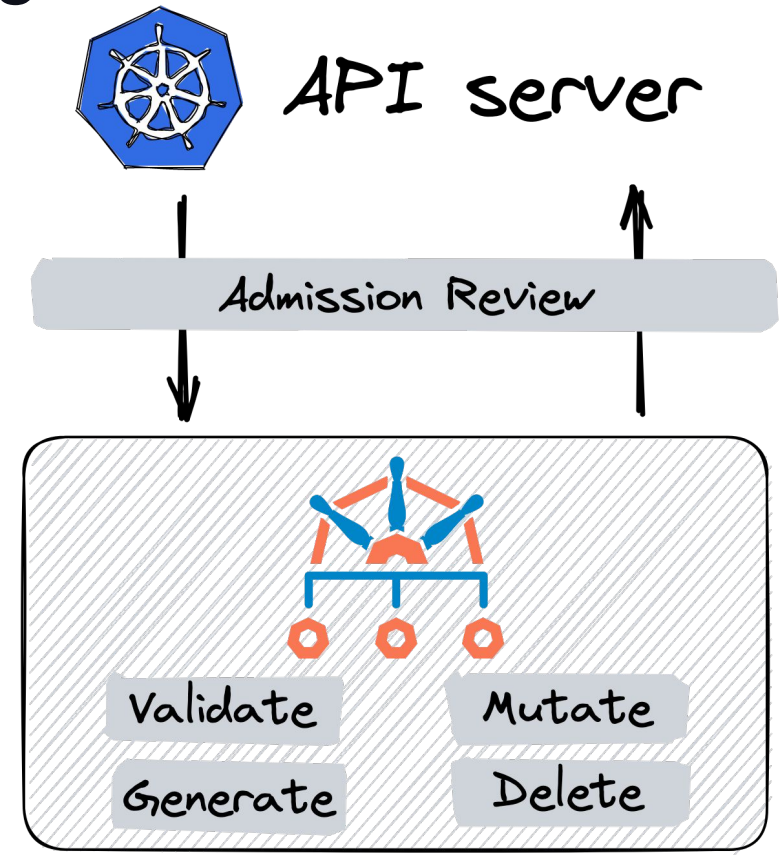
Policies are another kind of Kubernetes resources

What policies do:

Validate, mutate, generate, or delete other K8s resources



How It Works


API server
Admission Review
Validate
Mutate
Generate
Delete

Example: Spot Instances for CI Jobs

```yaml
apiVersion: kyverno.io/v1
kind: ClusterPolicy
metadata:
  name: set-capacity-type
spec:
  rules:
    - name: set-spot
      match:
        any:
          - resources:
              annotations:
                k8s.gitlab.runner/capacity-type: "spot"
              kinds:
                - Pod
      mutate:
        patchesJson6902: |-
          - op: add
            path: "/spec/tolerations/-"
            value: {"key":"spot","operator":"Exists","effect":"NoSchedule"}
          - op: add
            path: "/spec/nodeSelector"
            value: {"karpenter.sh/capacity-type": "spot"}
```

This is checked by Karpenter

Example: Spot Instances for CI Jobs

GitLab CI configuration

```yaml
my-ci-job:
  variables:
    KUBERNETES_POD_ANNOTATIONS_1: "k8s.gitlab.runner/capacity-type=spot"
    KUBERNETES_MEMORY_REQUEST: 1Gi
    KUBERNETES_MEMORY_LIMIT: 8Gi
  script:
    - some command to execute
```

Example: Spread CI Pods Evenly

```yaml
apiVersion: kyverno.io/v1
kind: ClusterPolicy
metadata:
  name: set-topology-spread-zone
spec:
  rules:
    - name: "set-topology-spread-zone"
      match:
        any:
        - resources:
            kinds:
            - Pod
            selector:
              matchLabels:
                app: "gitlab-runner-job"
      mutate:
        patchStrategicMerge:
          spec:
            topologySpreadConstraints:
              - labelSelector:
                  matchLabels:
                    app: "gitlab-runner-job"
                maxSkew: 1
                topologyKey: "topology.kubernetes.io/zone"
                whenUnsatisfiable: ScheduleAnyway
```

Set for every CI pod

Read by Karpenter

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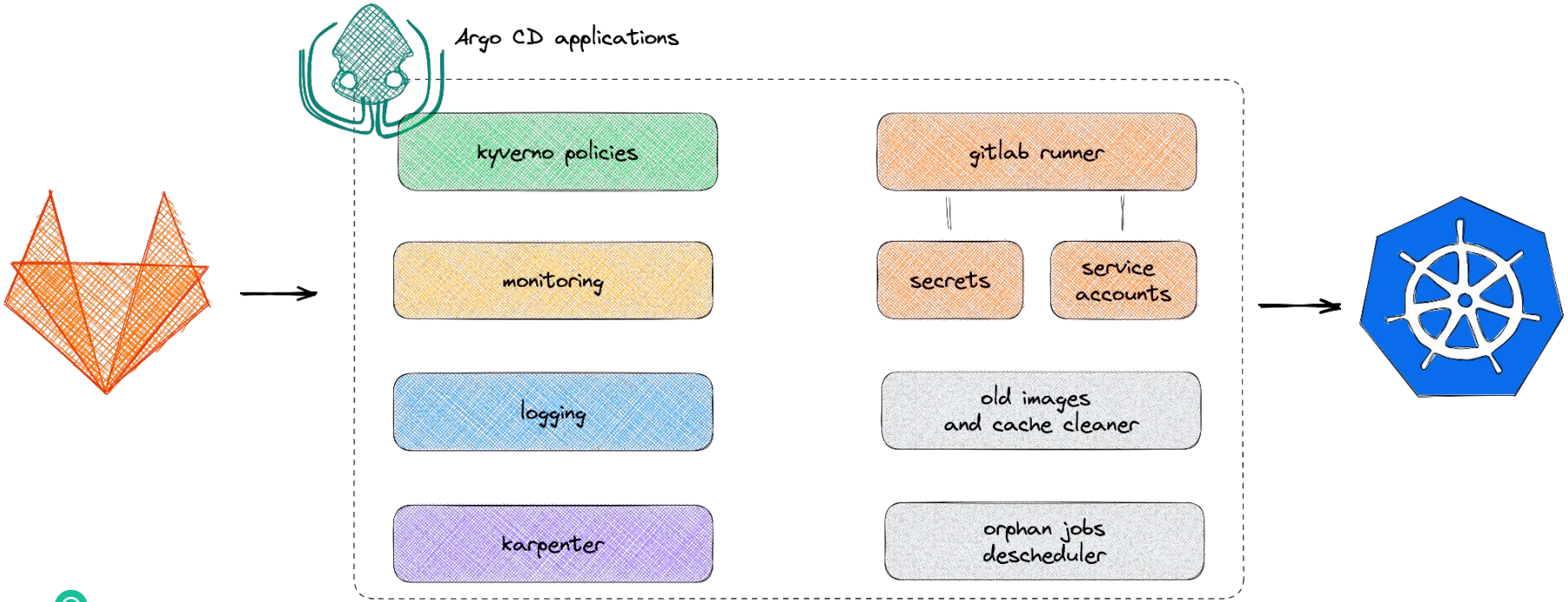
GitOps With Argo CD

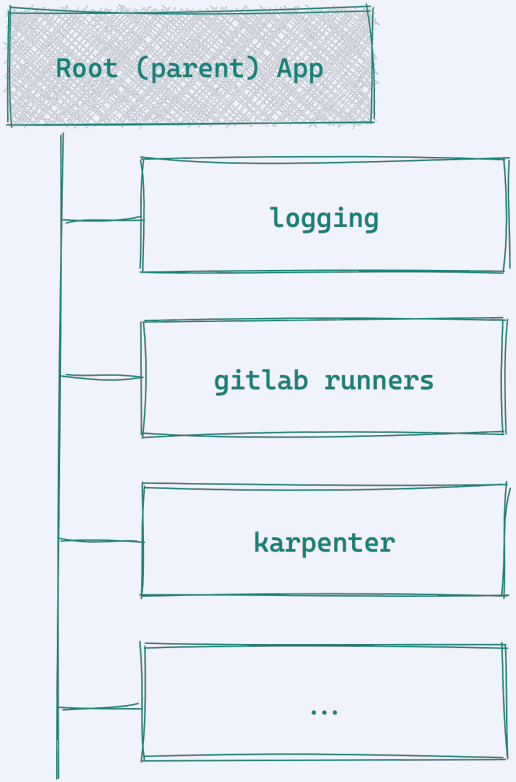


Approaches: App of Apps

The parent app — helm chart with specs for children

Child apps — separate subprojects, also Helm charts

Works fine for static set of applications



Approaches: Application Set

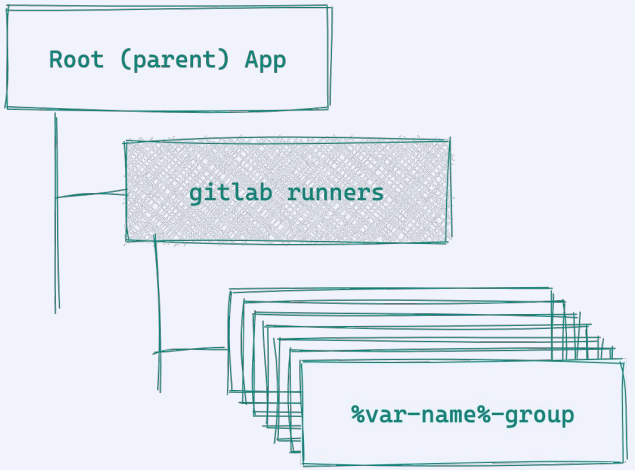
Generates application configs from templates

Combines (if needed) multiple configuration sources

Generators: list, matrix, git (files/folders), clusters

Our case:

- Register runners on GitLab groups
- Add service accounts for runners to allow AWS access

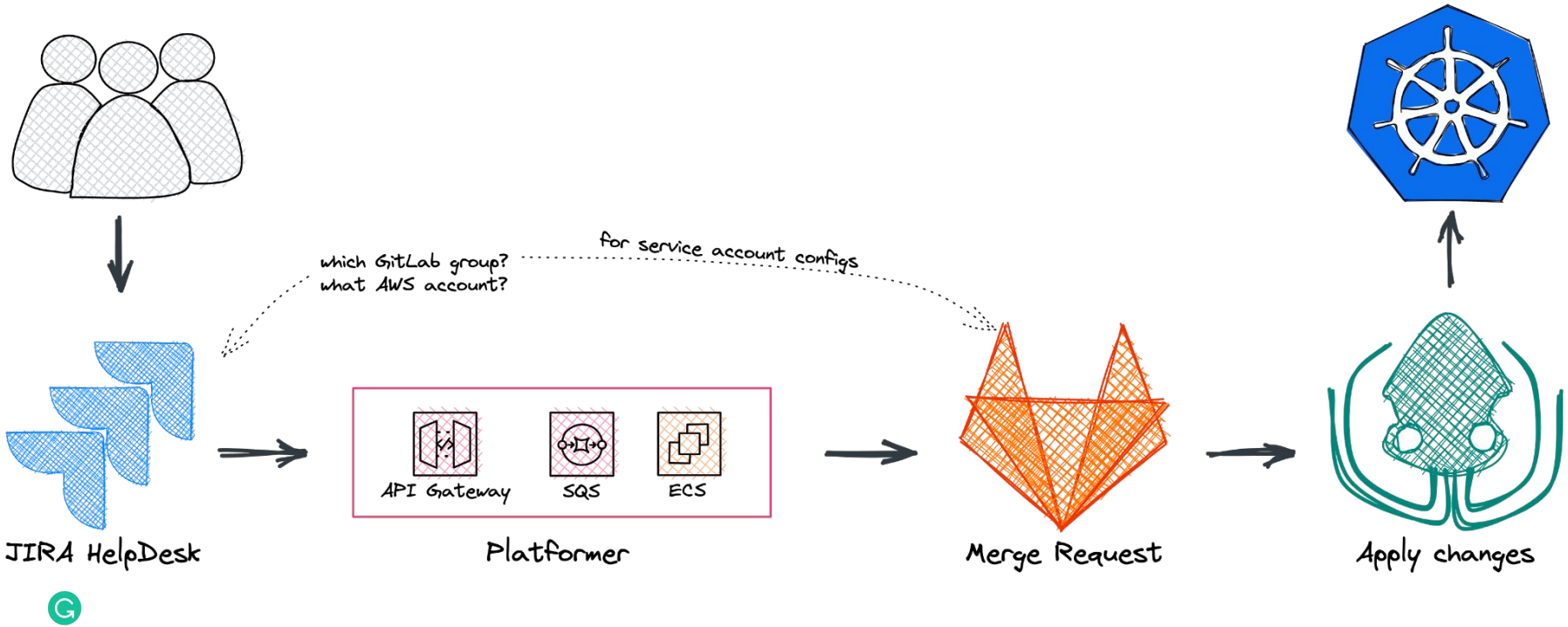


Example: Application Set

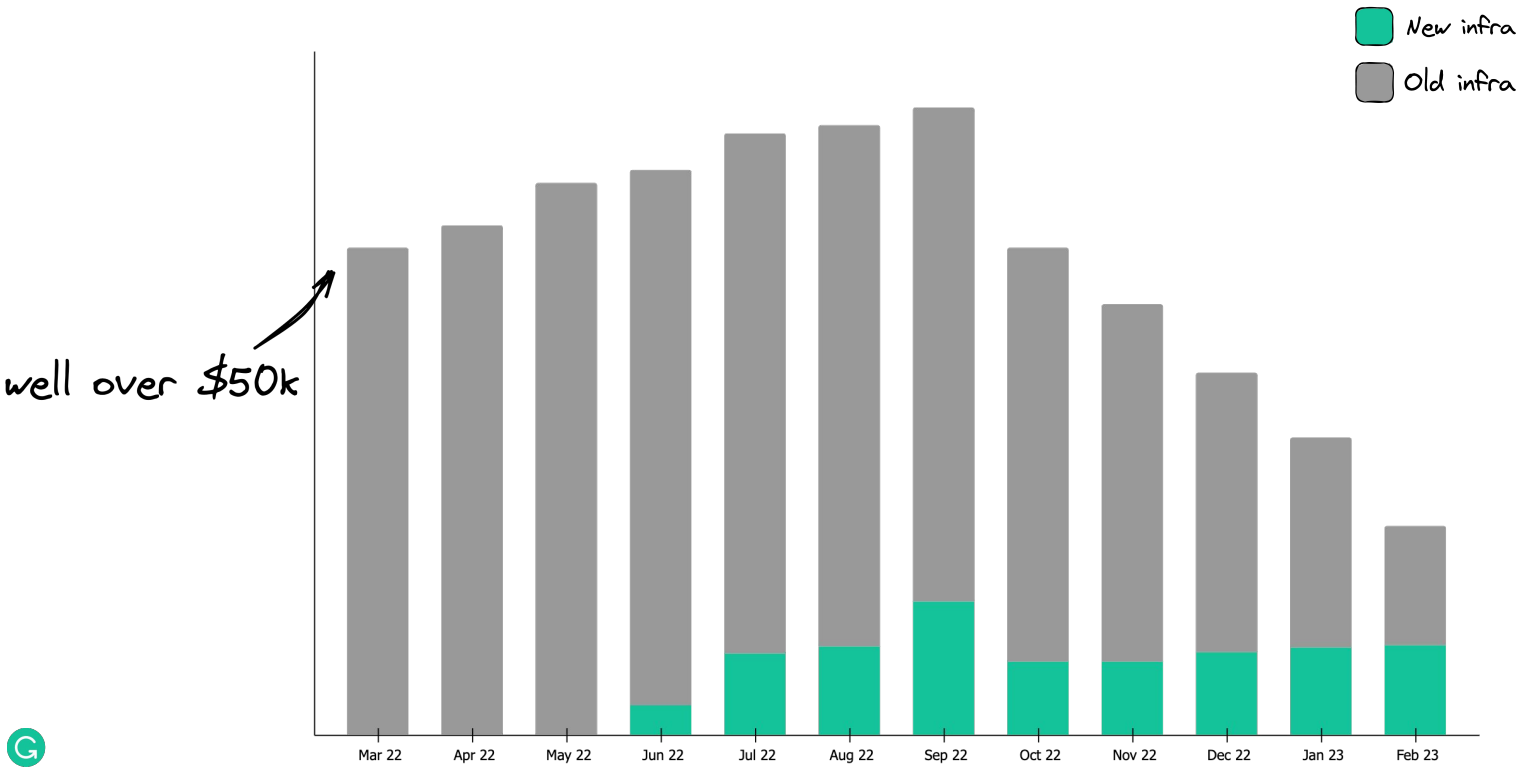
```
. . .

spec:
  generators:
    - git:
        repoURL: redacted-git-url
        revision: main
        files:
          - path: "redacted-path-to-config.json"
  template:
    metadata:
      name: 'gitlab-group-runners-{{name}}-app'
    spec:
      project: default
      syncPolicy:
        automated:
          prune: true
        syncOptions:
          - CreateNamespace=true
      source:
        repoURL: redacted-git-url
        path: "charts/gitlab-runners"
        targetRevision: main
        helm:
          ignoreMissingValueFiles: true
          valueFiles:
            - redacted-path-to-values.yaml # chart default values
            - redacted-path-to-group-{{name}}-values.yaml # chart customized values
            - .redacted-path-to-values.yaml # namespace values
          releaseName: gitlab-runner
          parameters:
            - name: 'redacted-parameter-name'
              value: 'k8s-gl-{{name}}'
      destination:
        server:  https://kubernetes.default.svc
        namespace: 'gitlab-group-runners-{{name}}'
```

When Users Need Runners



What About Costs?



Thank you
for being here today!

Q&A

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