Vault Kubernetes Integration

Agenda

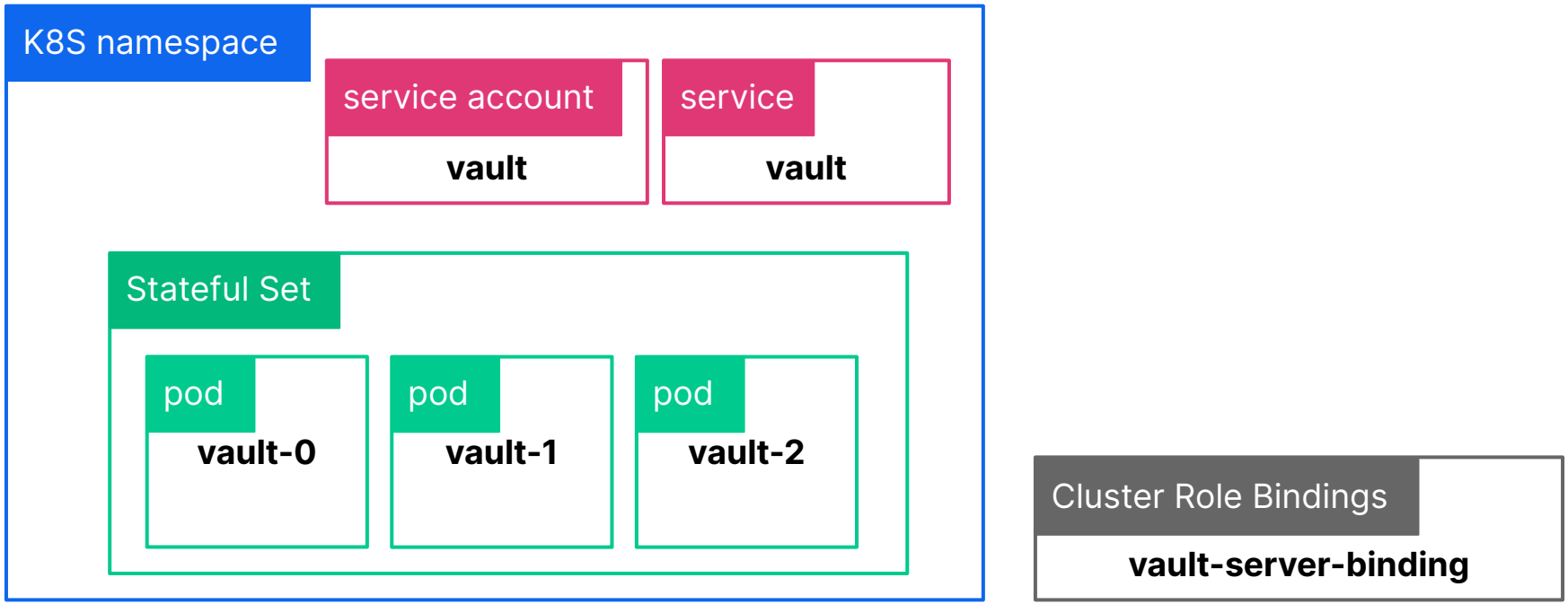
01

Helm Chart for Vault

Helm Chart for Vault

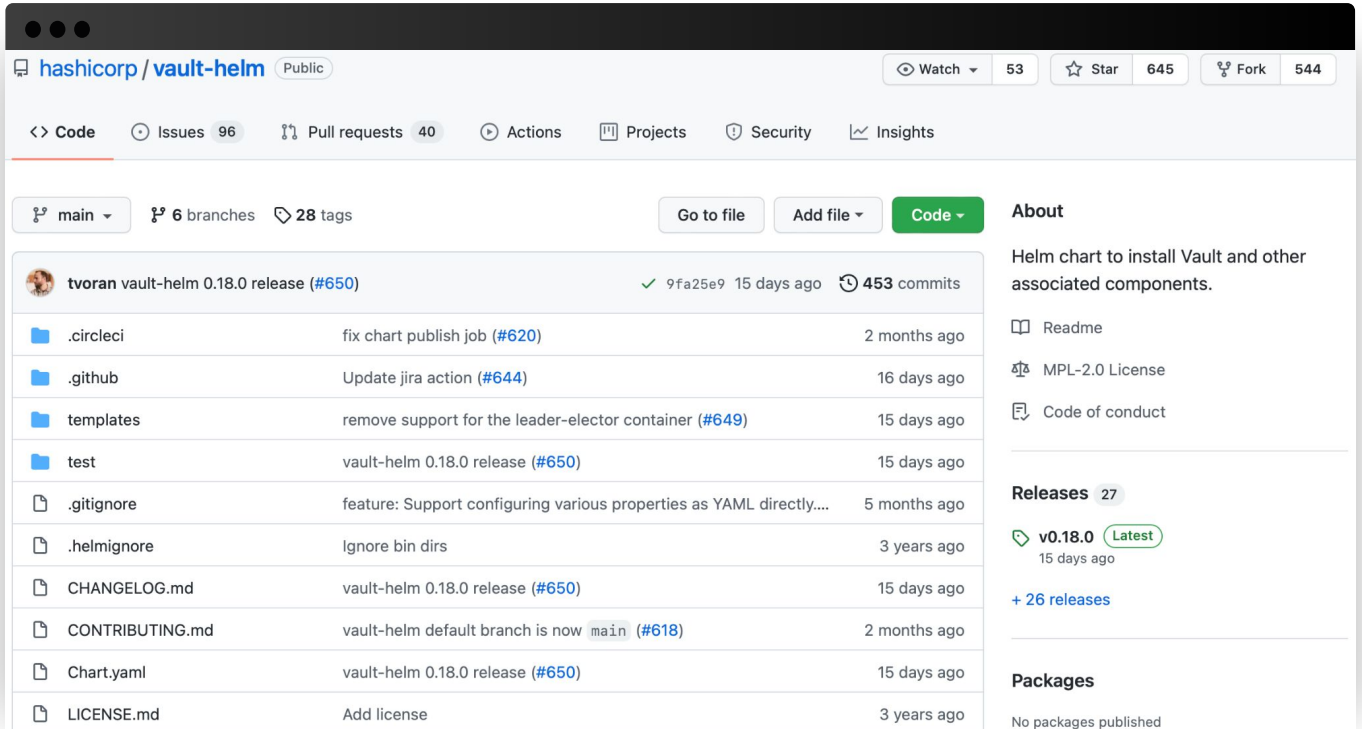
- Deployment via Helm is the recommended installation and configuration method for Vault on Kubernetes
- The Helm chart can be used to install a Vault server cluster and/or the Agent Injector
- Managing your Vault deployment using Helm can also simplify lifecycle management of your Vault Servers
- Vault Helm chart is compatible with Helm 3.6+ and Kubernetes 1.16+

Vault in Kubernetes



Vault Helm Chart

[hashicorp/vault-helm](https://github.com/hashicorp/vault-helm)



Helm Repository

```
$ helm repo add hashicorp \ https://helm.releases.hashicorp.com

"Hashicorp" has been added to your repositories


$ helm search repo

hashicorp/consul ...

hashicorp/vault …


$ helm install vault hashicorp/vault

NAME: vault

...
```

Default Values

```
# ...
server:
  # Run Vault in "dev" mode. This requires no further setup, no ...
  # and no initialization. This is useful for experimenting with ...
  # needing to unseal, store keys, et. al. All data is lost on ...
  # use dev mode for anything other than experimenting.
  # See https://www.vaultproject.io/docs/concepts/dev-server.html ...
  dev:
    enabled: false
```

--set "server.dev.enabled=true"

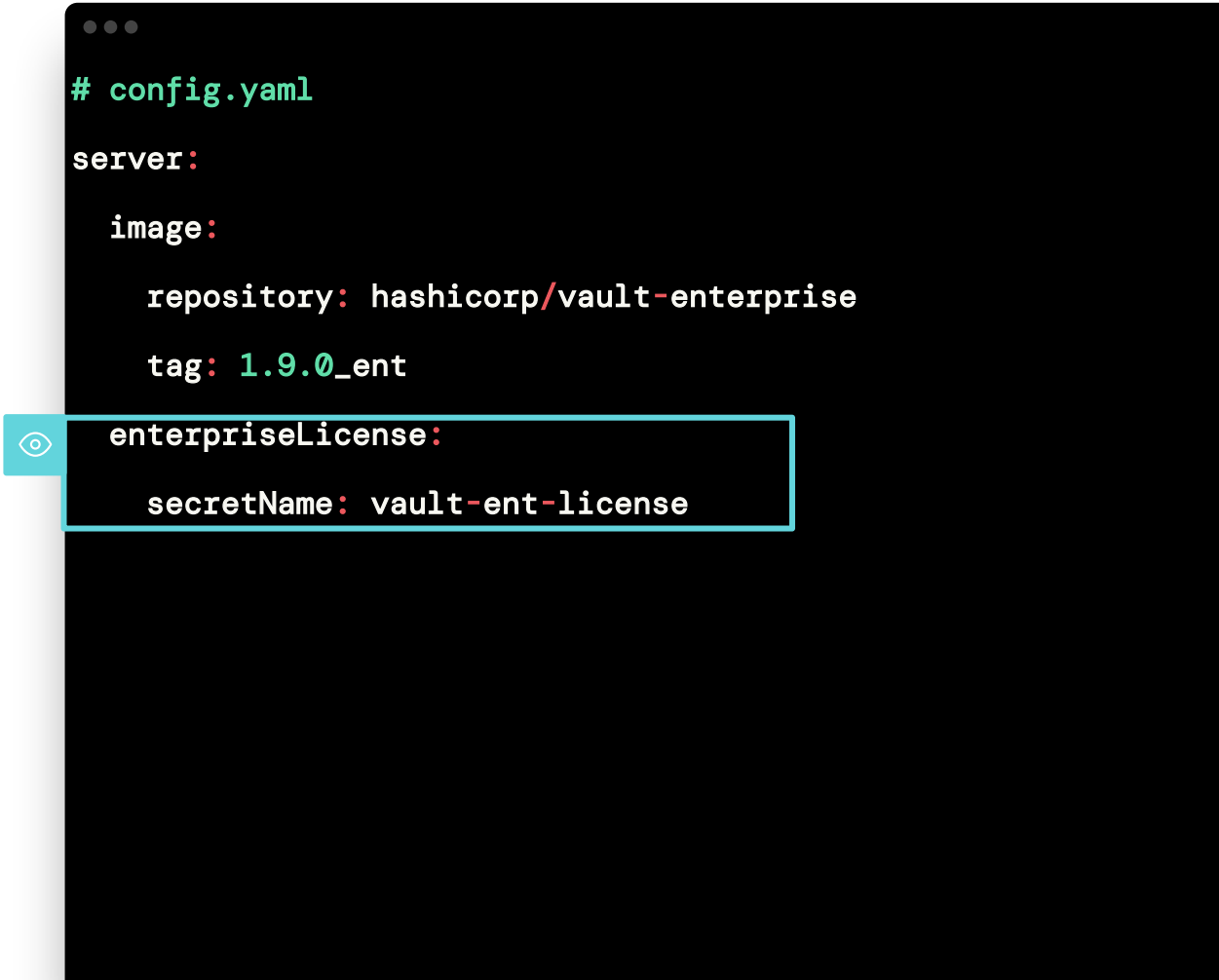
Override Default Values in a File

```yaml
server:
  affinity: ""
  ha:
    enabled: true
```

Licensing

```
$ secret=$(cat licensefile.hclic)

$ kubectl create secret generic vault-ent-license
--from-literal="license=${secret}"

$ helm install hashicorp hashicorp/vault -f
config.yaml

$ kubectl exec -ti vault-0 -- vault license get
```

Licensing



Primary HA Vault ENT Cluster Deployment

```
$ secret=$(cat licensefile.hclic)

$ $ kubectl create secret generic vault-ent-license
--from-literal="license=${secret}"

$ helm install vault hashicorp/vault \

  --set='server.image.repository=hashicorp/vault-enterprise' \

  --set='server.image.tag=1.9.0_ent' \

  --set='server.ha.enabled=true' \

  --set='server.ha.raft.enabled=true' \

  --set='server.enterpriseLicense.secrertName=vault-ent-license'
```

Primary HA Vault ENT Cluster Deployment

```
Initialize cluster and unseal first node

$ kubectl exec -ti vault-primary-0 -- vault operator init

$ kubectl exec -ti vault-primary-0 -- vault operator unseal

Join second pod to raft cluster and unseal

$ kubectl exec -ti vault-primary-1 -- vault operator raft join \
http://vault-primary-0.vault-primary-internal:8200

$ kubectl exec -ti vault-primary-1 -- vault operator unseal

Join third pod to raft cluster and unseal

$ kubectl exec -ti vault-primary-2 -- vault operator raft join \
http://vault-primary-0.vault-primary-internal:8200

$ kubectl exec -ti vault-primary-2 -- vault operator unseal
```

DR HA Vault ENT Cluster Deployment

```
$ secret=$(cat licensefile.hclic)

$ $ kubectl create secret generic vault-ent-license
--from-literal="license=${secret}"

$ helm install vault hashicorp/vault \

  --set='server.image.repository=hashicorp/vault-enterprise' \

  --set='server.image.tag=1.9.0_ent' \

  --set='server.ha.enabled=true' \

  --set='server.ha.raft.enabled=true' \

  --set='server.enterpriseLicense.secrertName=vault-ent-license'
```

DR HA Vault ENT Cluster Deployment

```
Initialize cluster and unseal first node

$ kubectl exec -ti vault-primary-0 -- vault operator init

$ kubectl exec -ti vault-primary-0 -- vault operator unseal


Join second pod to raft cluster and unseal

$ kubectl exec -ti vault-primary-1 -- vault operator raft
join \
http://vault-primary-0.vault-primary-internal:8200

$ kubectl exec -ti vault-primary-1 -- vault operator unseal


Join third pod to raft cluster and unseal

$ kubectl exec -ti vault-primary-2 -- vault operator raft
join \ http://vault-primary-0.vault-primary-internal:8200

$ kubectl exec -ti vault-primary-2 -- vault operator unseal
```

Enable Disaster Recovery Replication

Primary Cluster

```
$ kubectl exec -ti vault-primary-0 -- vault write -f
sys/replication/dr/primary/enable
primary_cluster_addr=https://vault-primary-active:8201


$ kubectl exec -ti vault-primary-0 -- vault write
sys/replication/dr/primary/secondary-token id=secondary
```

Enable Disaster Recovery Replication

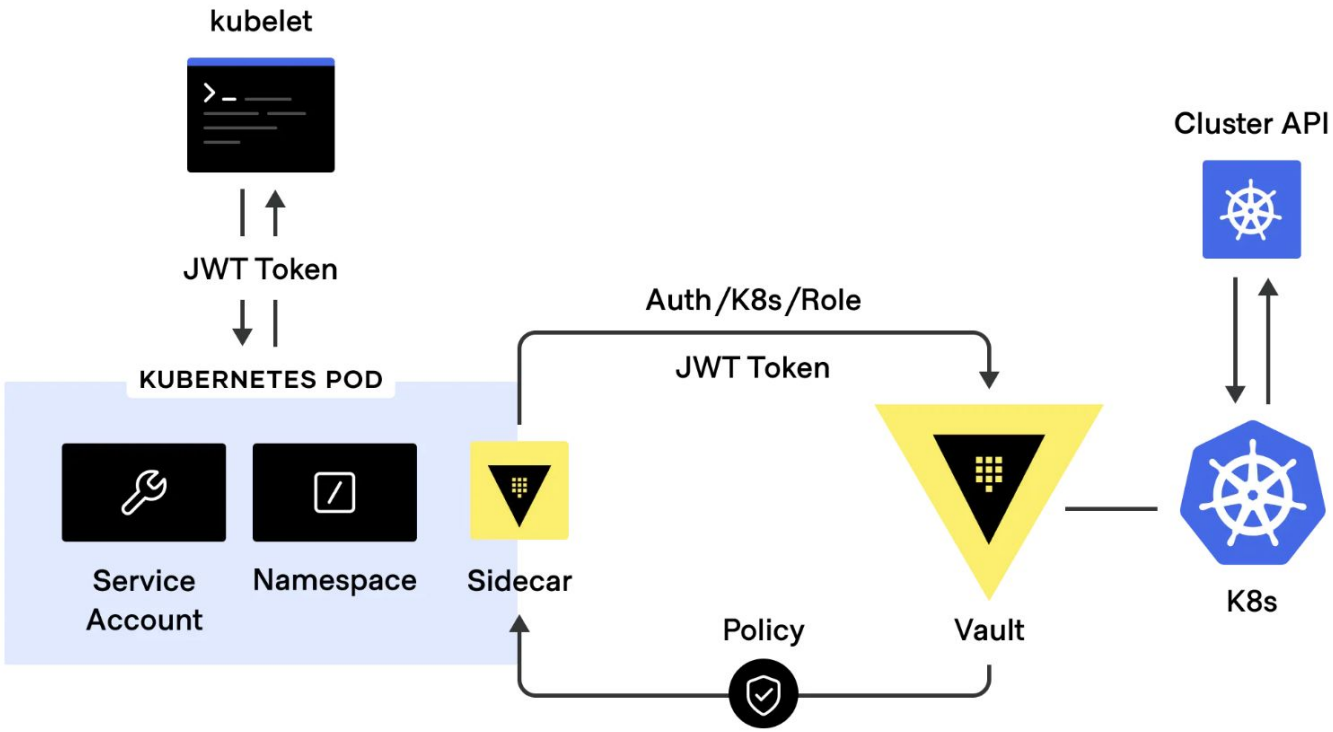
Secondary Cluster

```
$ kubectl exec -ti vault-secondary-0 -- vault write
sys/replication/dr/secondary/enable token=<TOKEN FROM
PRIMARY>


$ kubectl delete pod vault-secondary-1

$ kubectl exec -ti vault-secondary-1 -- vault operator
unseal <PRIMARY UNSEAL TOKEN>


$ kubectl delete pod vault-secondary-2

$ kubectl exec -ti vault-secondary-2 -- vault operator
unseal <PRIMARY UNSEAL TOKEN>
```

02

Pod Secret Access

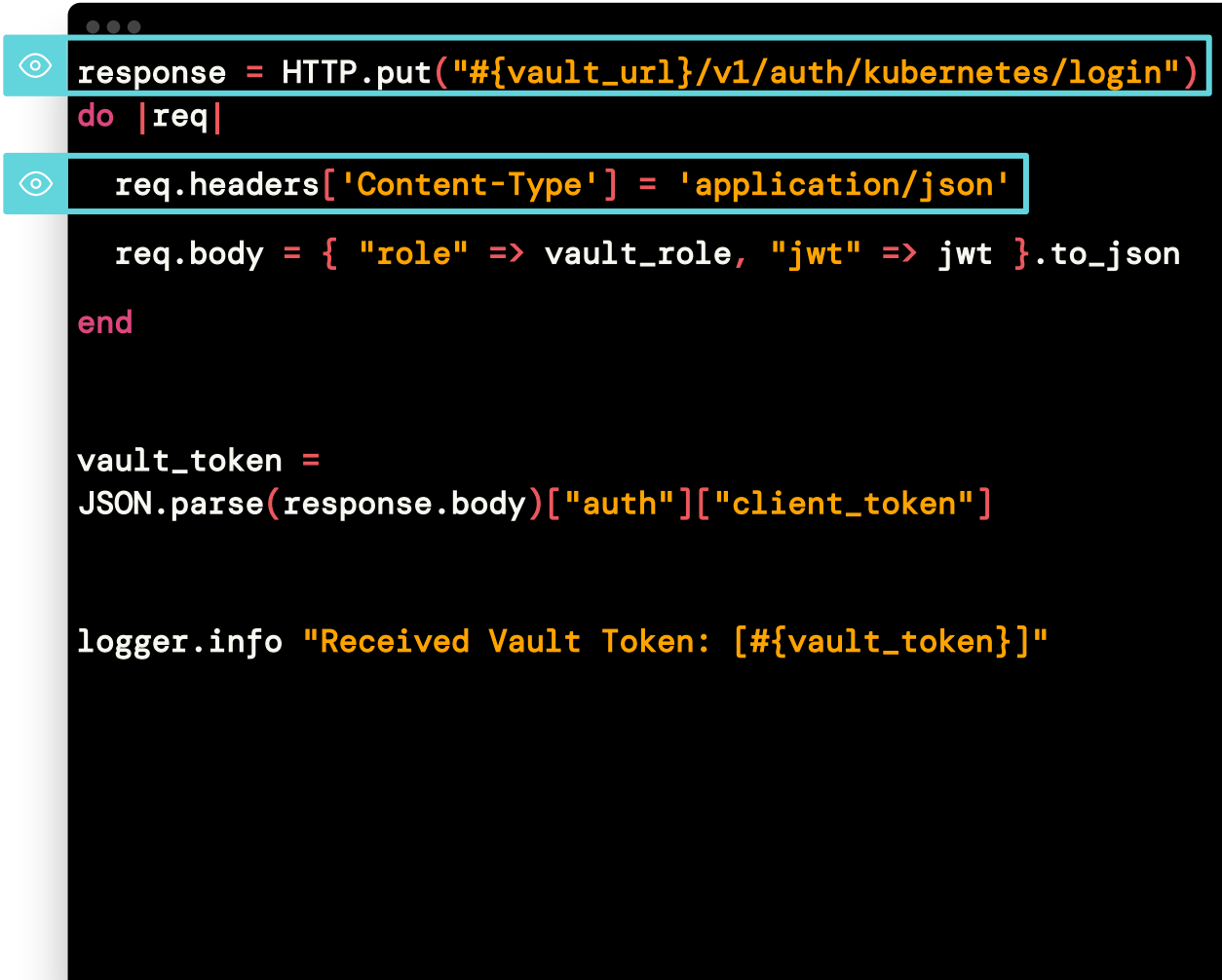
Kubernetes Auth Flow



Application Pod Definition

```
apiVersion: v1
kind: Pod
...
spec:
  serviceAccountName: k8s-service-acct
  containers:
    - name: app
      image: burtlo/exampleapp-ruby:k8s
       env:
        - name: VAULT_ADDR
        - value:
"http://vault.default.svc.cluster.local:8200"
        - name: VAULT_ROLE
        - value: "internal-app"
```

Example App Code Changes



```
response = HTTP.put("#{vault_url}/v1/auth/kubernetes/login")
do |req|
  req.headers['Content-Type'] = 'application/json'
  req.body = { "role" => vault_role, "jwt" => jwt }.to_json
end


vault_token =
JSON.parse(response.body)["auth"]["client_token"]


logger.info "Received Vault Token: [#{vault_token}]"
```

03

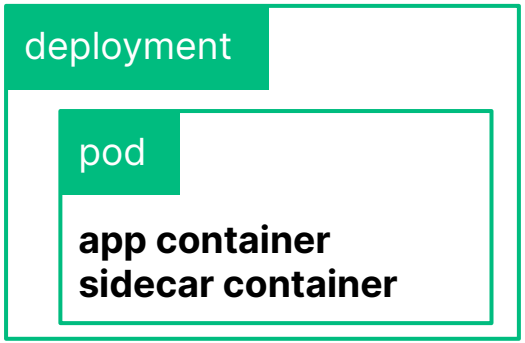
Vault Agent Injector

Sidecar Pattern

Vault unaware pods would offload the authentication and secret retrieval to a dedicated container appended to every deployment/pod

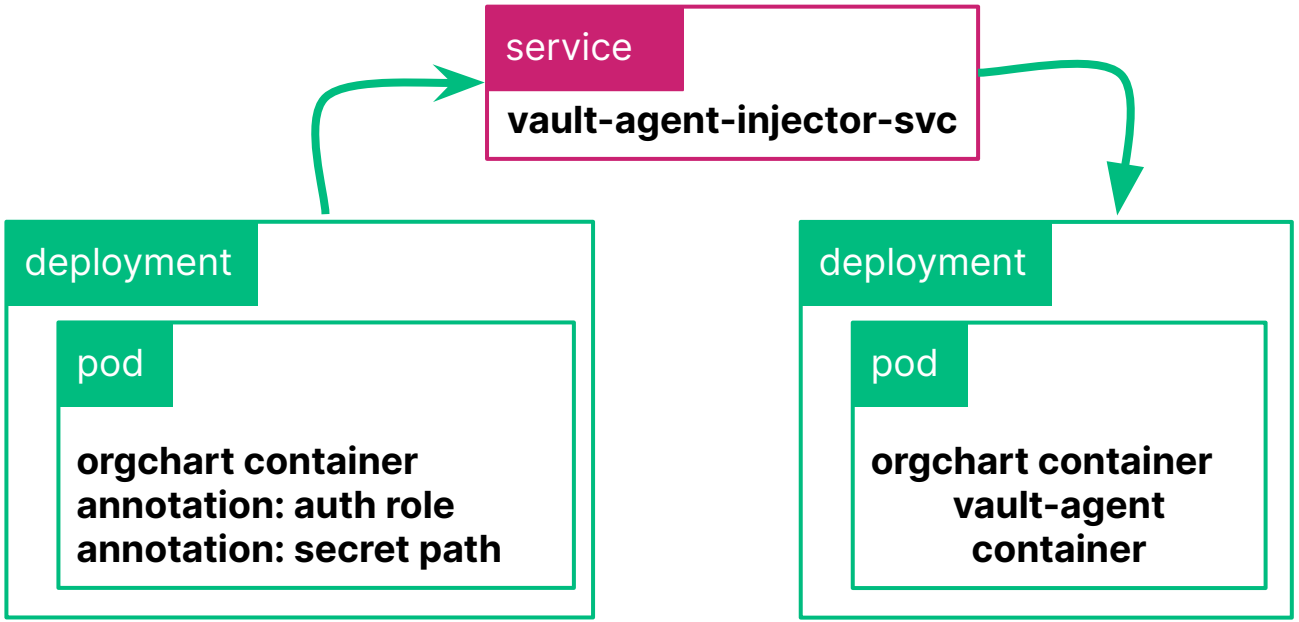
Sidecar container needs:

- Vault address
- Vault authentication role
- Vault secret path



Sidecar Pattern

Registers a Mutating Webhook Configuration that takes action when pod/deployment annotations are defined



Install Agent Injector

```
$ helm repo add hashicorp
https://helm.releases.hashicorp.com

"hashicorp" has been added to your repositories


$ helm search repo hashicorp/vault

NAME            CHART VERSION   APP VERSION DESCRIPTION

hashicorp/vault 0.18.0          1.9.0       Official
HashiCorp Vault Chart


$ helm install vault hashicorp/vault \
--set="injector.enabled=true"
```

Agent Annotations

```
spec:
  template:
    metadata:
      annotations:
        vault.hashicorp.com/agent-inject: "true"
        vault.hashicorp.com/role: "internal-app"
        vault.hashicorp.com/agent-inject-secret-database-config.txt:
"internal/data/database/config"
```

View the Secret

```
$ kubectl exec orgchart --container orgchart \
    -- cat /vault/secrets/database-config.txt


data: map[password:db-secret-password
username:db-readonly-user]

metadata: map[created_time:2019-12-20T18:17:50.9302647592
deletion_time: destroyed:false version:2]
```

04

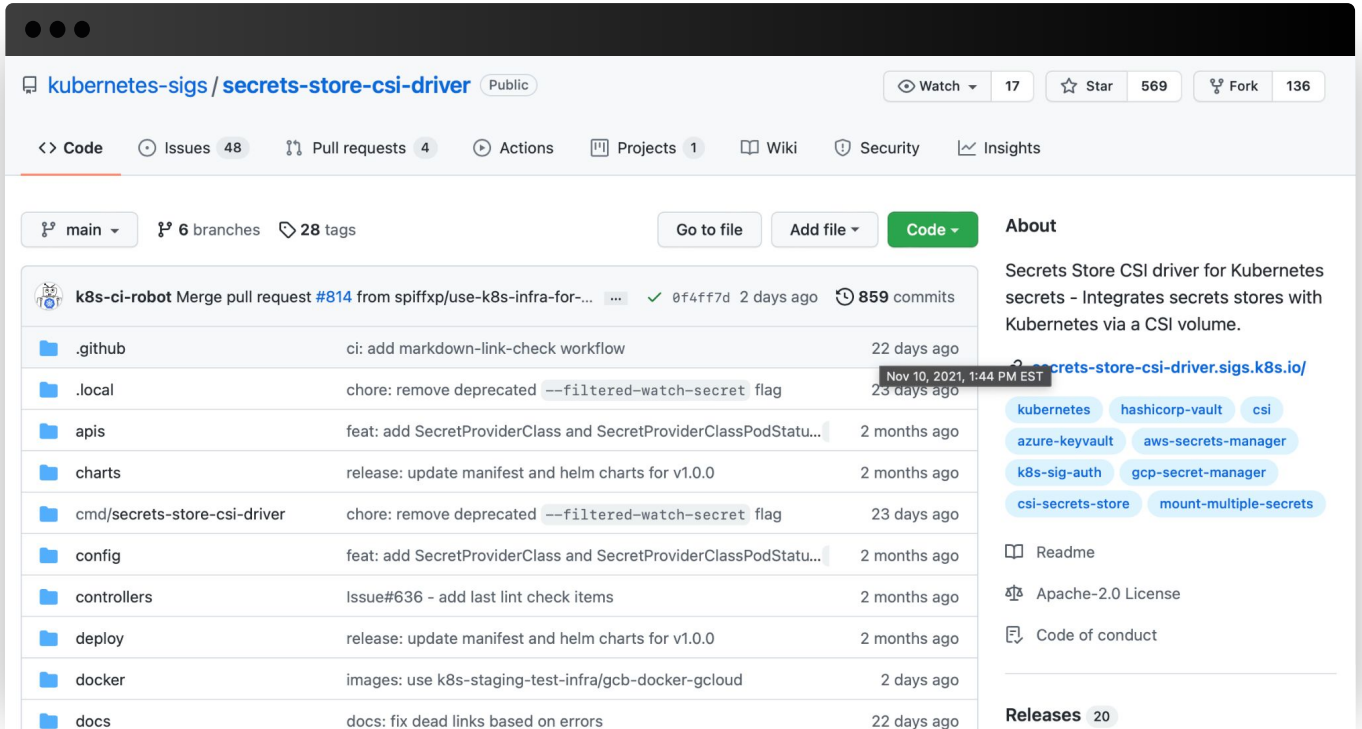
Container Storage Interface

Overview

- Secrets Store CSI driver for Kubernetes secrets - Integrates secrets stores with Kubernetes via a Container Storage Interface (CSI) volume
- The Secrets Store CSI driver allows Kubernetes to mount multiple secrets, keys, and certs stored in enterprise-grade external secrets stores into their pods as a volume
- Once the Volume is attached, the data is mounted into the container's file system

Secrets Store CSI Driver

[CSI Driver]



Install Container Storage Interface

```
$ helm repo add hashicorp
https://helm.releases.hashicorp.com

"hashicorp" has been added to your repositories

$ helm search repo hashicorp/vault

NAME            CHART VERSION   APP VERSION DESCRIPTION

hashicorp/vault 0.18.0          1.9.0       Official
HashiCorp Vault Chart

$ helm install vault hashicorp/vault \

 --set "injector.enabled=false" \

 --set "csi.enabled=true" \

 --set "injector.externalVaultAddr=http://addr:8200"
```

Install Secrets Store CSI Driver

```
$ helm repo add secrets-store-csi-driver \
https://raw.githubusercontent.com/kubernetes-sigs/secrets
-store-csi-driver/master/charts
...

$ helm install csi
secrets-store-csi-driver/secrets-store-csi-driver
...
```

Install Secrets Store CSI Driver

```
apiVersion: secrets-store.csi.x-k8s.io/v1alpha1
kind: SecretProviderClass
metadata:
 name: vault-database
spec:
  provider: vault
  parameters:
    vaultAddress:
"http://vault.default.svc.cluster.local:8200"
    roleName: "internal-app"
    objects: |
      - objectName: "db-password"
        secretPath: "internal/data/database/config"
        secretKey: "password"
```

Define a Pod with a Volume

```
spec:
  containers:
  - image: nginx
    name: webapp
    volumeMounts:
    - name: secrets-store-inline
      mountPath: "/mnt/secrets-store"
      readOnly: true
  volumes:
    - name: secrets-store-inline
      csi:
        driver: secrets-store.csi.k8s.io
        readOnly: true
        volumeAttributes:
          secretProviderClass: "vault-database"
```

Pattern Comparison

[Kubernetes Vault Integration via Sidecar Agent Injector vs. CSI Provider]

	Agent Sidecar	CSI
Secret projection	Shared Memory Volume Environment Variable	Ephemeral Disk Environment Variables Kubernetes Secrets
Secret scope	Global	Global
Secret types	All Secret Engines (Static & Dynamic)	All Secret Engines (Static & Dynamic)
Secret templating	Yes	No
Secret size limit	No Limit (both storage types)	No Limit (both storage types)
Secret definitions	CLI / API / UI	CLI / API / UI
Encryption	Yes (at rest & in-transit)	Yes (at rest & in-transit)
Secret rotation	Yes	No
Secret caching	Yes	No
Auditability	Yes	Yes
Deployment method	1 Shared K8s Cluster Service + 1 Sidecar Container Per Application Pod	Daemonset
Vault agent support	Yes	No
Helm support	Yes	Yes

05

Vault Secrets Operator

Vault Secrets Operator (VSO)

- The Vault Secrets Operator (VSO) is in public beta and should **NOT be used in production** deployments
- Allows K8S Pods to consume Vault secrets natively from Kubernetes Secrets
- Operates by watching for changes to its supported set of Custom Resource Definitions (CRD)
- Currently supports the Kubernetes Auth Method, additional Vault Auth methods are on the development roadmap

Vault Secrets Operator (VSO)

- All Vault secrets engines are supported
- Communication via TLS/mTLS with Vault is supported by default
- Secret rotation is supported for **`Deployment`**, **`ReplicaSet`**, and **`StatefulSet`** Kubernetes resource types
- Installation is supported via Helm or Kustomize
- Supported Kubernetes versions:
  - 1.26
  - 1.25
  - 1.24
  - 1.23
  - 1.22

Resources

Resources

- Vault on Kubernetes Security Considerations
- Vault on Kubernetes Reference Architecture
- Vault Helm Chart
- Vault Enterprise License Management - Kubernetes
- Helm Chart Examples
- Running Vault - OpenShift
- Tutorials - Vault Installation to Managed Kubernetes Services
  - Google GKE
  - Azure AKS
  - Amazon EKS
- Injecting Secrets into Kubernetes Pods via Vault Agent Containers
- Mount Vault Secrets through Container Storage Interface (CSI) Volume
- Integrate a Kubernetes Cluster with an External Vault

Q&A

Thank you

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