# Sharing secret keys in Docker containers and K8s

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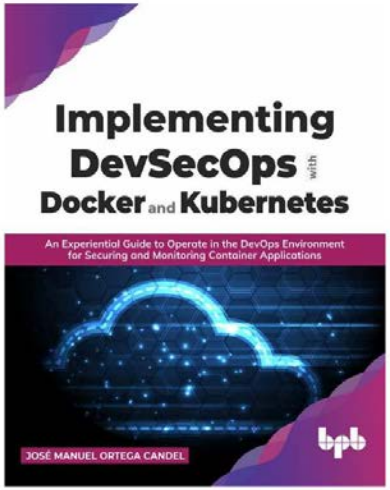


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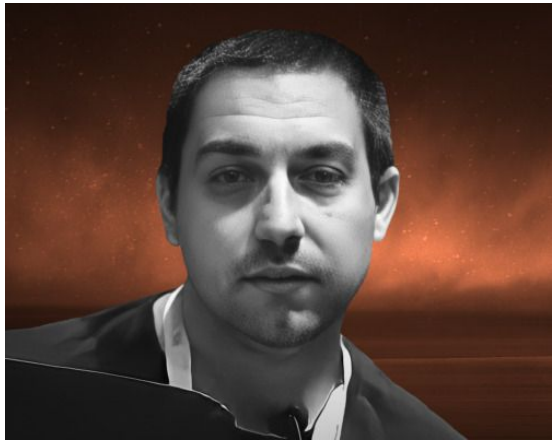

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1. Challenges of security and secret keys in containers
2. Best practices for saving and securing distribution of secrets in Docker Containers
3. Managing secrets in Kubernetes using volumes and sealed-secrets
4. Other tools for distributing secrets in containers

# Challenges of security and secret keys in containers

## The Twelve-Factor App

### Introduction

In the modern era, software is commonly delivered as a service: called *web apps*, or *software-as-a-service*. The twelve-factor app is a methodology for building software-as-a-service apps that:

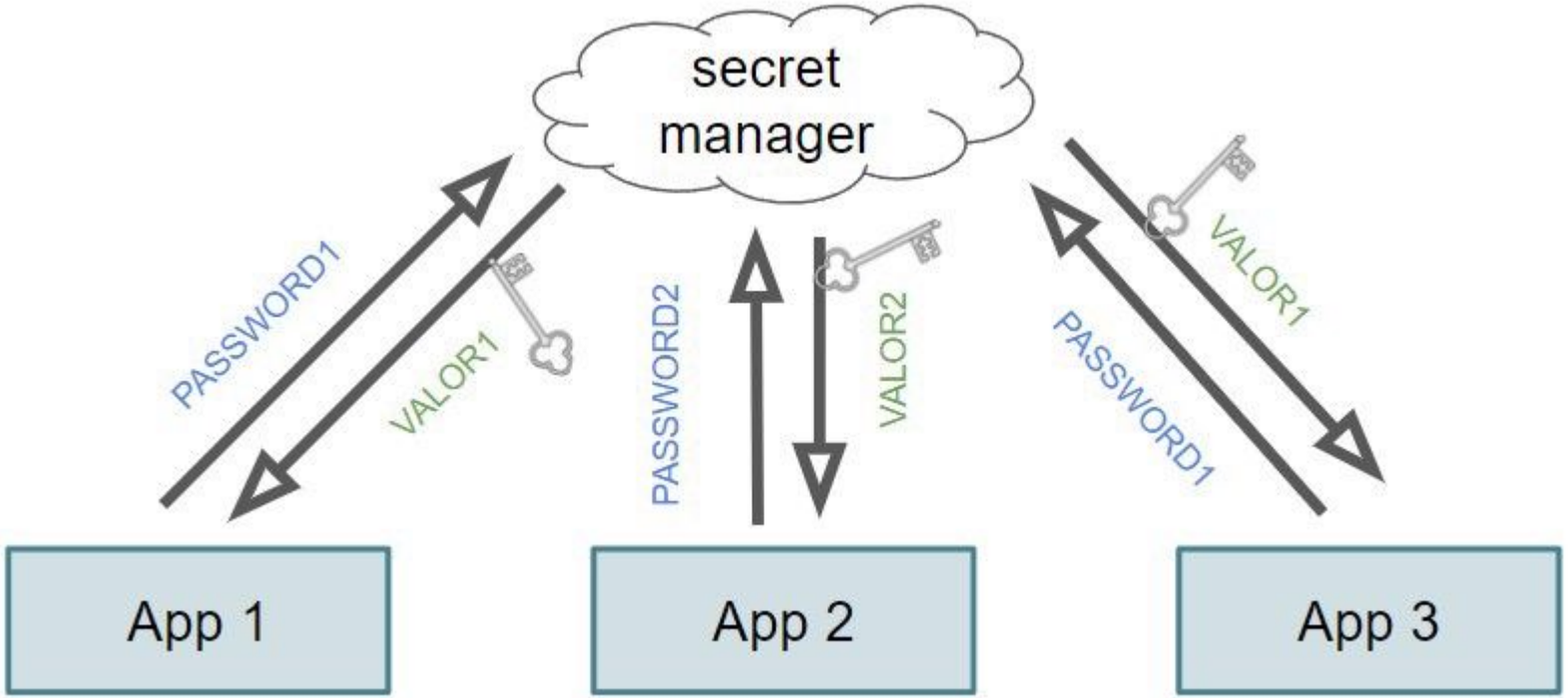
- Use **declarative** formats for setup automation, to minimize time and cost for new developers joining the project;
- Have a **clean contract** with the underlying operating system, offering **maximum portability** between execution environments;
- Are suitable for **deployment** on modern **cloud platforms**, obviating the need for servers and systems administration;
- **Minimize divergence** between development and production, enabling **continuous deployment** for maximum agility;
- And can **scale up** without significant changes to tooling, architecture, or development practices.

The twelve-factor methodology can be applied to apps written in any programming language, and which use any combination of backing services (database, queue, memory cache, etc).

# Challenges of security and secret keys in containers

- Secrets play a critical role in storing sensitive data separately from application code. This includes data such as passwords, hostnames, SSH keys, and more.
- Our application requires a database connection. To do this, it needs a hostname, username, and password. Furthermore, there's a different database server for development, testing, and production.
- With secrets, each environment can provide its own database information to the applications.

# Challenges of security and secret keys in containers

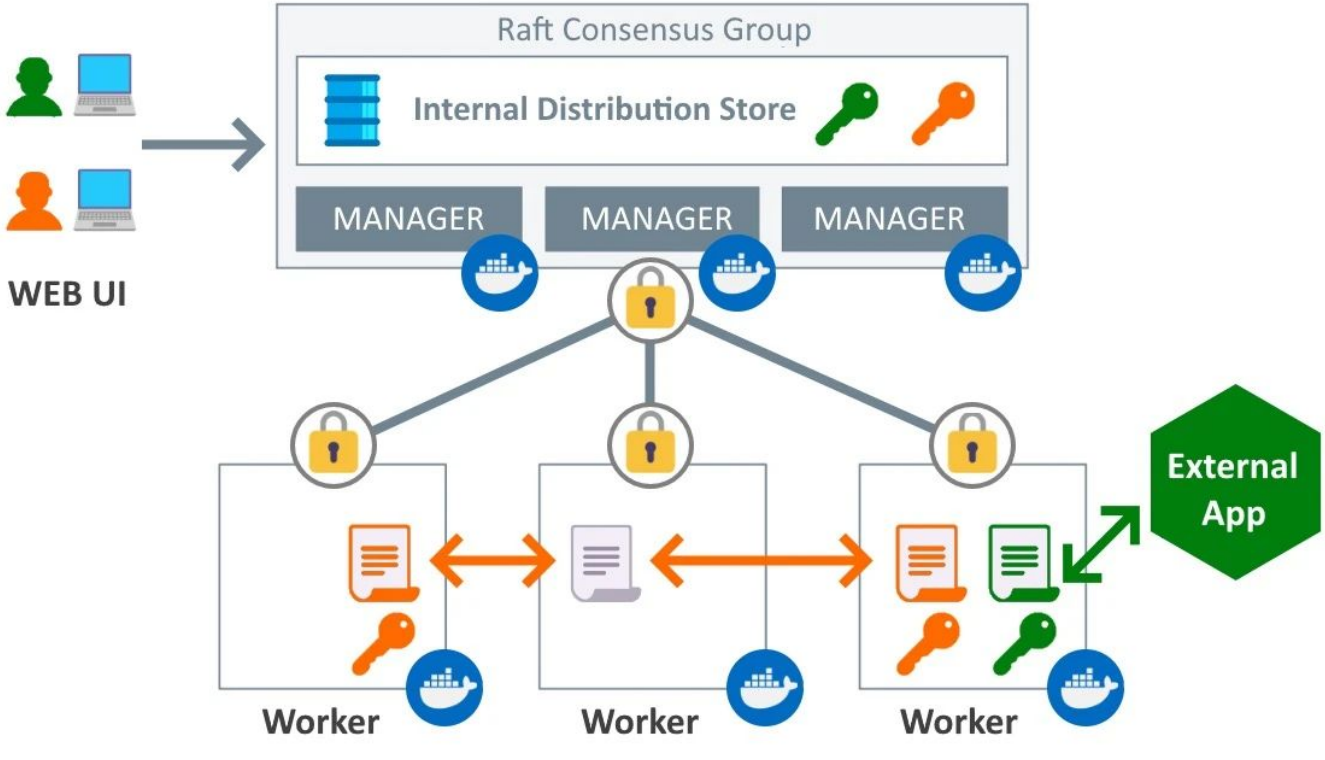


## How Docker manages secrets

Docker's implementation of secrets uses the following features:

- Secrets are created and managed separately from applications.
- Follows principles of least privileged and need-to-know access.
- Flexibility to store a variety of different data types.

# How Docker manages secrets



## How Docker manages secrets

```
$ docker swarm init --advertise-addr
<MANAGER-IP>
```

```
$ docker secret create my_secret
/path/to/secret/file
```

- **/run/secrets/<secret_name>**

# How Docker manages secrets

```
[manager1] (local) root@192.168.0.28 ~
$ docker secret ls
ID        NAME      DRIVER    CREATED   UPDATED
[manager1] (local) root@192.168.0.28 ~
$ printf "THis is a secret" | docker secret create my_secret_data -
crbbfdbwqrsz2e9r4x5fg2tjx
[manager1] (local) root@192.168.0.28 ~
$ docker secret ls
ID                          NAME             DRIVER    CREATED         UPDATED
crbbfdbwqrsz2e9r4x5fg2tjx   my_secret_data             7 seconds ago   7 seconds ago
[manager1] (local) root@192.168.0.28 ~
$ docker service create --name redis --secret my_secret_data redis:alpine
xh8gcscx76v7mn0m4cr9hqbr1
overall progress: 1 out of 1 tasks
1/1: running   [==================================================>]
verify: Service converged
```

# How Docker manages secrets

```
$ docker ps
CONTAINER ID   IMAGE          COMMAND                  CREATED          STATUS          PORTS      NAMES
ec67a589d92e   redis:alpine   "docker-entrypoint.s…"   21 minutes ago   Up 21 minutes   6379/tcp   redis.1.2bbxr
a2ya8t0vu11a18kzcywz
[worker1] (local) root@192.168.0.27 ~
$ docker container exec $(docker ps --filter name=redis -q) ls -l /run/secrets
total 4
-r--r--r--    1 root     root            16 Sep 26 17:21 my_secret_data
[worker1] (local) root@192.168.0.27 ~
$ docker container exec $(docker ps --filter name=redis -q) cat /run/secrets/my_secret_data
THis is a secret[worker1] (local) root@192.168.0.27 ~
```

# How Docker manages secrets

```
$ docker secret rm my_secret_data
Error response from daemon: rpc error: code = InvalidArgument desc = secret 'my_secret_data' is in use by the following service: redis
[manager1] (local) root@192.168.0.28 ~
$ docker service update
"docker service update" requires exactly 1 argument.
See 'docker service update --help'.

Usage:  docker service update [OPTIONS] SERVICE

Update a service
[manager1] (local) root@192.168.0.28 ~
$docker service update --secret-rm my_secret_data redis
redis
overall progress: 1 out of 1 tasks
1/1: running   [==================================================>]
verify: Service converged
```

# How Docker manages secrets

```
$ docker service ps redis
ID             NAME          IMAGE          NODE       DESIRED STATE   CURRENT STATE            ERROR     PORTS
ycdjxiscr8w5   redis.1       redis:alpine   manager1   Running         Running 3 minutes ago
2bbxra2ya8t0    \_ redis.1   redis:alpine   worker1    Shutdown        Shutdown 3 minutes ago
[manager1] (local) root@192.168.0.28 ~
$ docker ps
CONTAINER ID   IMAGE          COMMAND                  CREATED         STATUS         PORTS      NAMES
a05b863c117a   redis:alpine   "docker-entrypoint.s…"   5 minutes ago   Up 5 minutes   6379/tcp   redis.1.ycdjxis
cr8w5d4p513mhiadwf
[manager1] (local) root@192.168.0.28 ~
$ docker container exec -it $(docker ps --filter  name=redis -q) cat /run/secrets/my_secret_data
cat: can't open '/run/secrets/my_secret_data': No such file or directory
[manager1] (local) root@192.168.0.28 ~
```

# Best practices for saving and securing distribution of secrets in Docker Containers

```
$ docker service rm redis
redis
[manager1] (local) root@192.168.0.28 ~
$ docker secret rm my_secret_data
my_secret_data
[manager1] (local) root@192.168.0.28 ~
$ docker secret ls
ID          NAME      DRIVER    CREATED    UPDATED
[manager1] (local) root@192.168.0.28 ~
```

$ docker secret rm my_secret


**Best practices for saving and securing distribution of secrets in Docker Containers**

```
$ docker service create
  --name my_app
  --secret
source=my_secret,target=/different/path/to/secret/file,mode
=0400
```

# Best practices for saving and securing distribution of secrets in Docker Containers

```
version: '3.1'
services:
  my_app:
    image: my_app:latest
    secrets:
     - my_external_secret
     - my_file_secret
secrets:
  my_external_secret:
    external: true
  my_file_secret:
    file: /path/to/secret/file.txt
```


**Best practices for saving and securing distribution of secrets in Docker Containers**

```
$ docker stack deploy -c docker-compose.yml secrets1
Creating service secrets1_viewer

$ docker logs $(docker ps -aqn1 -f status=exited)
my_secret
```

# Managing secrets in Kubernetes

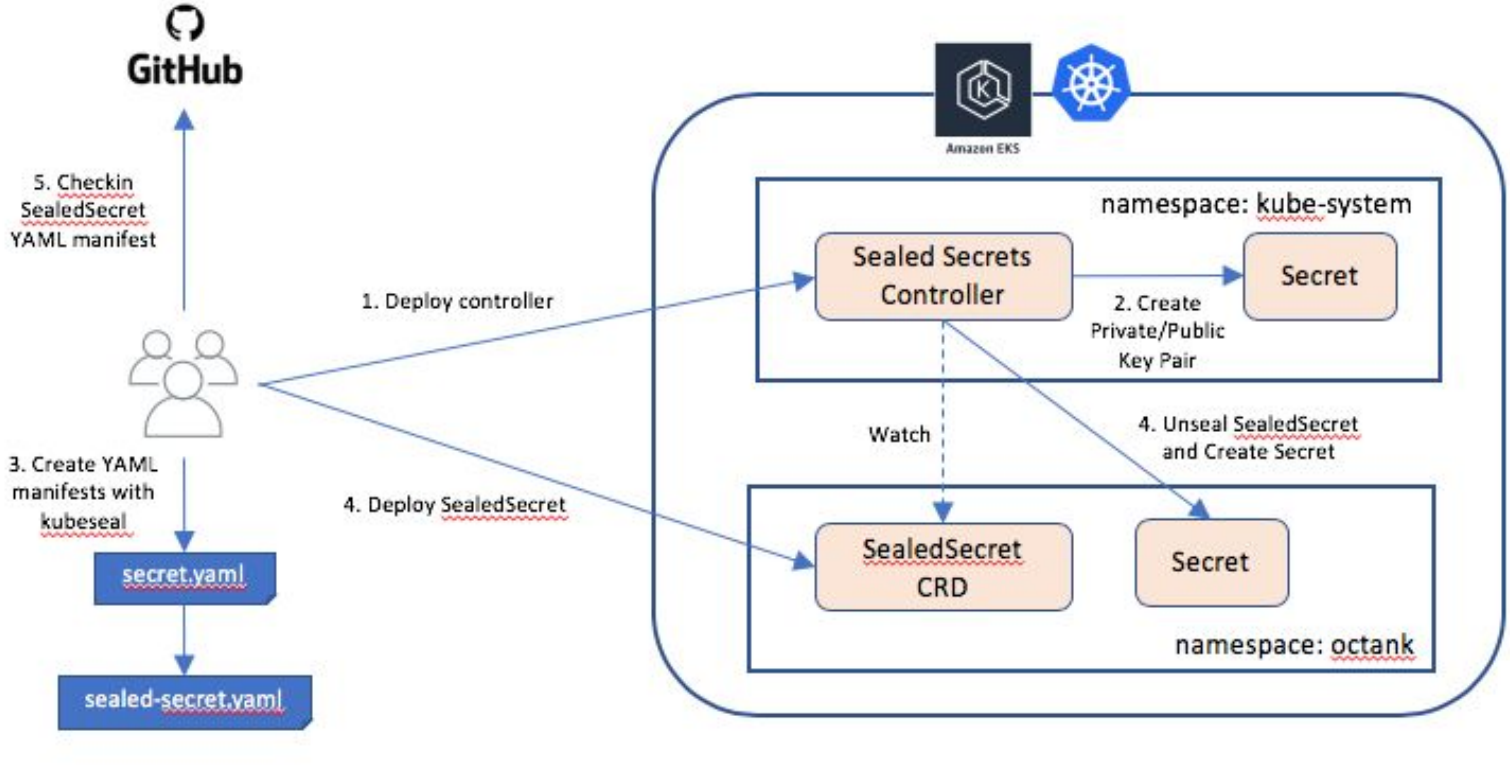
```
→ raw-manifests git:(master) ✗ cat secret.yaml
apiVersion: v1
kind: Secret
metadata:
  name: my-secret
type: Opaque
data:
  username: anNtaXRo
  password: bXlzZWNyZXRwYXNzd29yZA==%
→ raw-manifests git:(master) ✗ kubectl create -f secret.yaml
```

```
→ raw-manifests git:(master) ✗ kubectl get secrets
NAME                  TYPE                                  DATA   AGE
default-token-hsvnc   kubernetes.io/service-account-token   3
my-secret             Opaque                                2
→ raw-manifests git:(master) ✗
```

# Managing secrets in Kubernetes using volumes

```
apiVersion: v1
kind: Pod
metadata:
  name: volume-pod
spec:
  containers:
  - name: express-test
    image: lukondefmwila/express-test:latest
    volumeMounts:
    - name: secret-volume
      mountPath: /etc/config/secret
  volumes:
  - name: secret-volume
    secret:
      secretName: my-secret
```

# Managing secrets in Kubernetes using sealed-secrets



# Managing secrets in Kubernetes using sealed-secrets

```
apiVersion: v1

kind: Secret

metadata:

  name: my-secret

type: Opaque

data:

  username: dXNlcg==

  password: cGFzc3dvcmQ=
```

# Managing secrets in Kubernetes using sealed-secrets

```
kubeseal --cert=public-key-cert.pem --format=yaml < secret.yaml > sealed-secret.yaml
```

- https://github.com/bitnami-labs/sealed-secrets/releases

| | | |
|---|---|---|
| kubeseal-0.18.5-darwin-amd64.tar.gz | 17.8 MB | 8 days ago |
| kubeseal-0.18.5-darwin-amd64.tar.gz.sig | 96 Bytes | 8 days ago |
| kubeseal-0.18.5-darwin-arm64.tar.gz | 17.1 MB | 8 days ago |
| kubeseal-0.18.5-darwin-arm64.tar.gz.sig | 96 Bytes | 8 days ago |
| kubeseal-0.18.5-linux-amd64.tar.gz | 17.9 MB | 8 days ago |

# Managing secrets in Kubernetes using sealed-secrets

```
apiVersion: bitnami.com/v1alpha1
kind: SealedSecret
metadata:
  creationTimestamp: null
  name: my-secret
  namespace: default
spec:
  encryptedData:
    password: AgBvA5WMunlZ5rF9...
    username: AgCCo8eSORsCbeJSoRs/...
```

# Managing secrets in Kubernetes using sealed-secrets

## $ kubectl apply -f sealed-secret.yaml

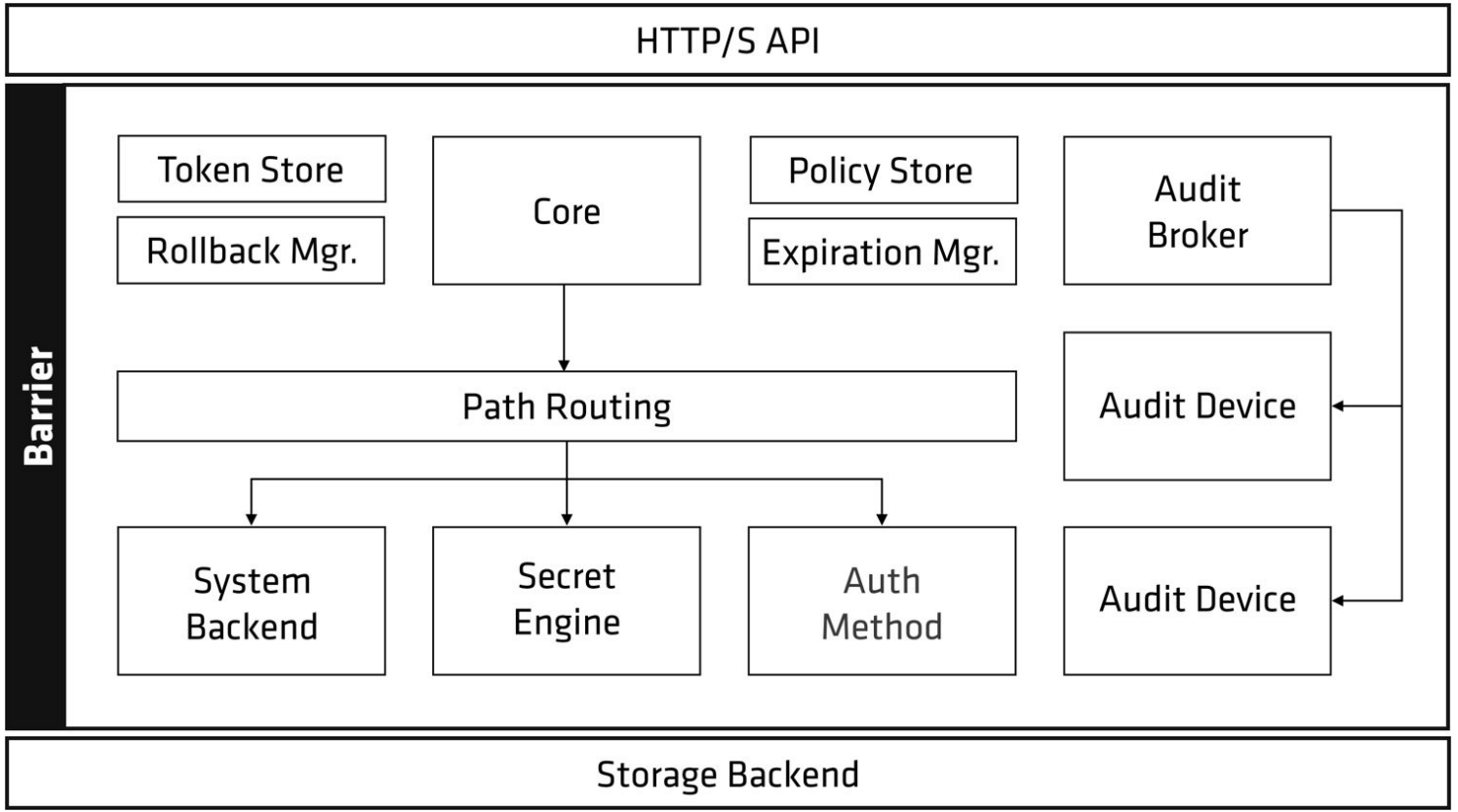
```
Describe(default/my-secret)
Name:         my-secret
Namespace:    default
Labels:       <none>
Annotations:  <none>

Type:  Opaque

Data
====
password:  8 bytes
username:  4 bytes
```

<secret> <describe>

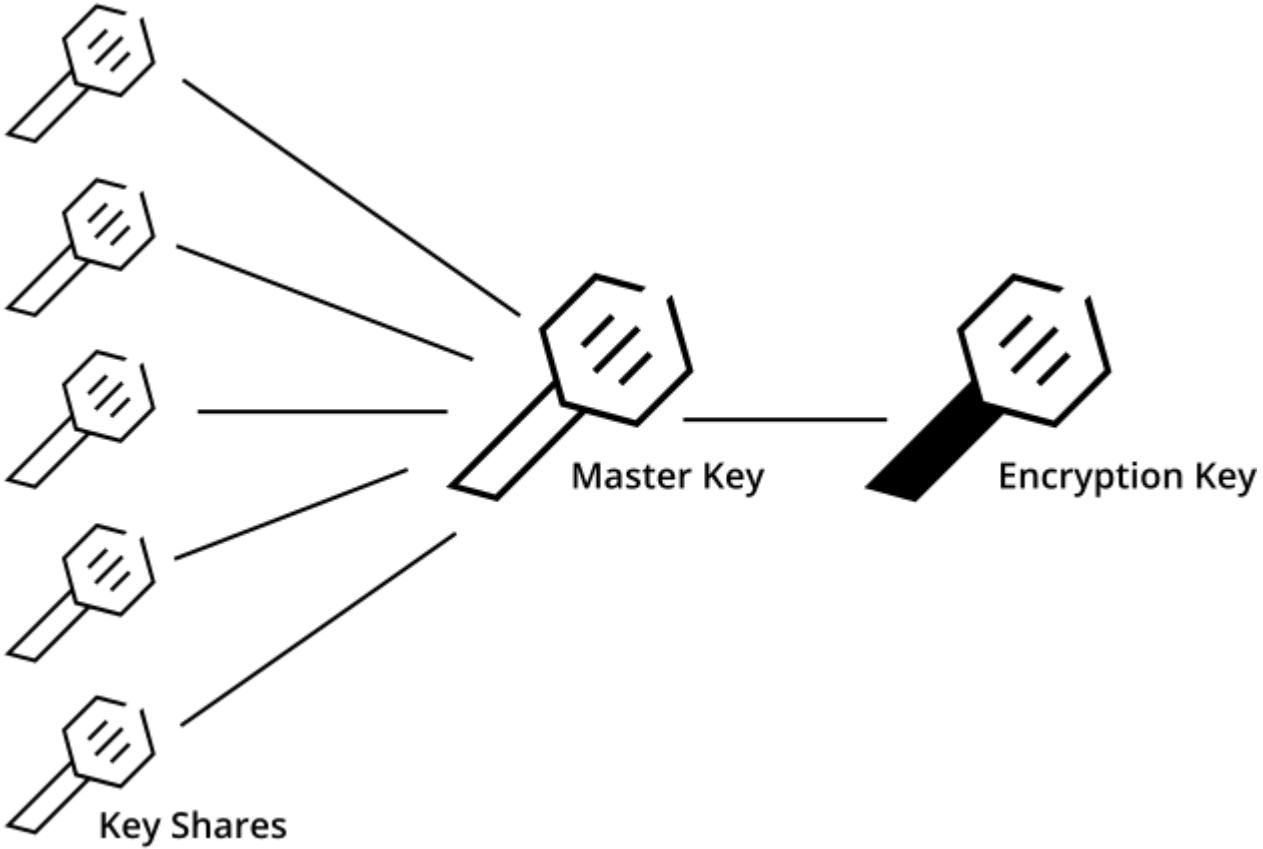
## Other tools for distributing secrets in containers

- Hashicorp Vault
- Keywhiz
- Akeyless Vault
- Cloud Provider solutions (AWS Secrets Manager, GCP Secret Manager)

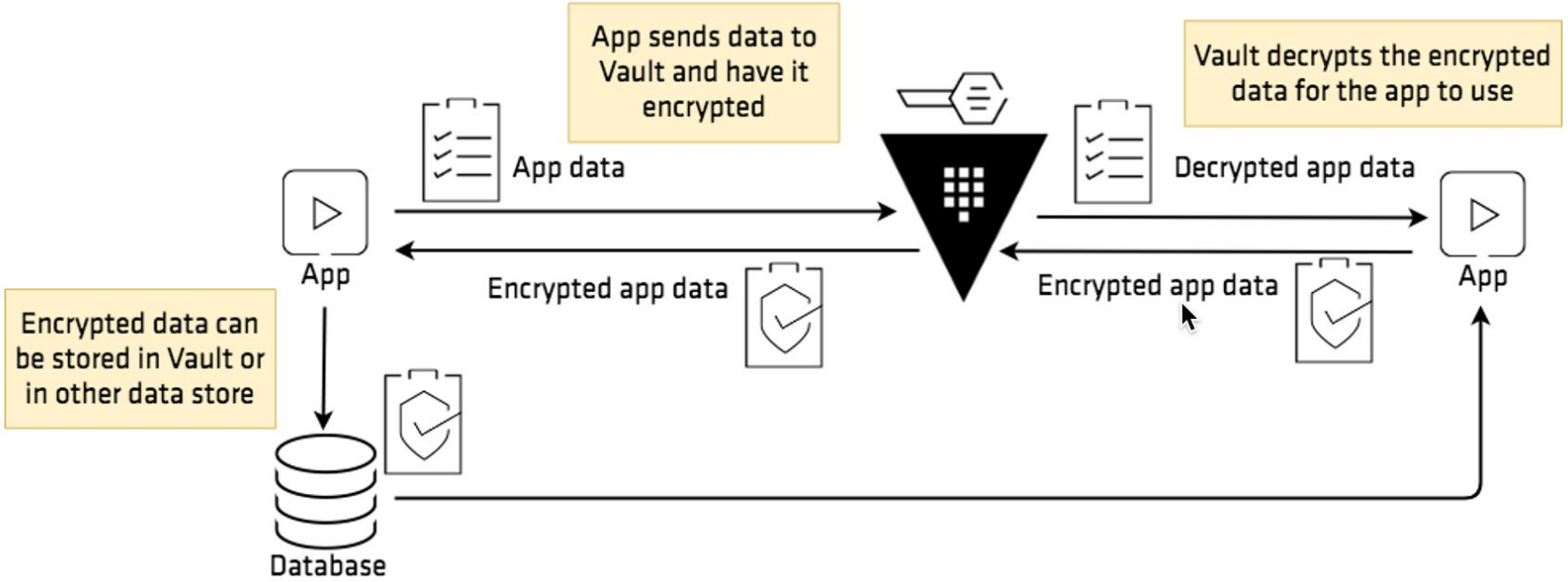

# Hashicorp Vault



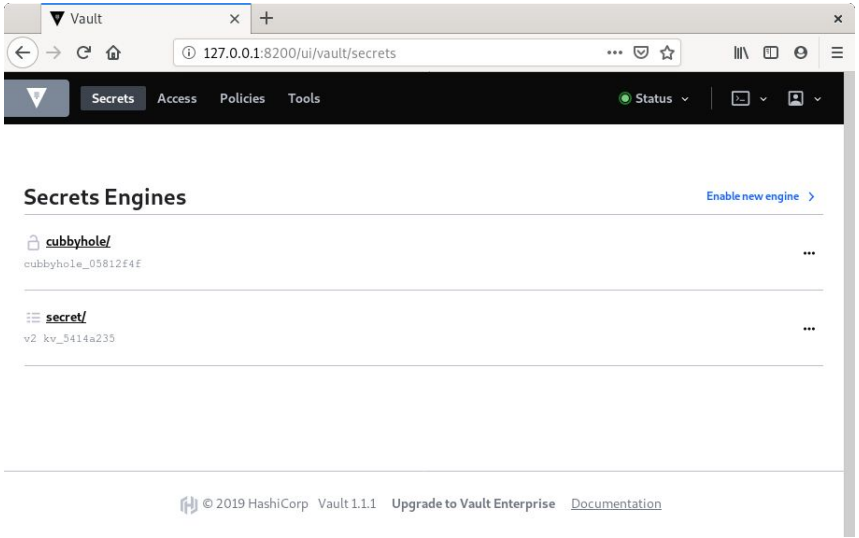
# Hashicorp Vault

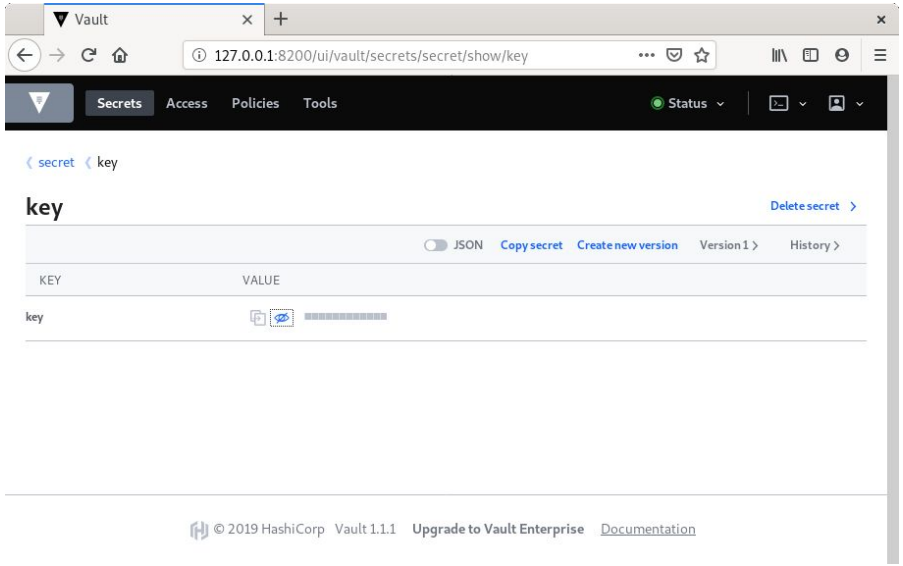


# Hashicorp Vault



# Hashicorp Vault



## Hashicorp Vault

The key features of the Vault are:

- It encrypts and decrypts data without storing it.
- Vault can generate secrets on-demand for some operations, such as AWS or SQL databases.
- Allows replication across multiple data centers.
- Vault has built-in protection for secret revocation.
- Serves as a secret repository with access control details.

# Keywhiz

- Keywhiz helps with infrastructure secrets, GPG keyrings, and database credentials, including **TLS** certificates and keys, symmetric keys, API tokens, and SSH keys for external services.
  - **Keywhiz Server**
  - **Keysync**
  - **Keywhiz CLI**
  - **Keywhiz automation API**

# Keywhiz

ADDING A SECRET

### Using Keywhiz CLI

```
$ keywhiz.cli --devTrustStore --user keywhizAdmin login
$ keywhiz.cli add secret --name mySecretName < mySecretFile
```

### Using Keywhiz automation API

The automation API requires a client certificate and `automationAllowed=true` in the clients DB table. For development purpose, you can use the pre-generated `client.p12` keystore:

```
$ cat request.json
{
  "name":"example.keytab",
  "description":"example kerberos keytab",
  "content":"a2V5dGFiIGNvbnRlbnQ=",
  "metadata":{"owner":"root","group":"root","mode":"0400"}
}
$ curl --cert ./server/src/test/resources/clients/client.p12:ponies -H "Content-Type:application/json" -d @request.json https://localhost:4444/automation/secrets/
```

## Keywhiz

The key features of Keywhiz are:

- Helps with infrastructure secrets, GPG keyrings, and database credentials, including TLS certificates and keys, symmetric keys, API tokens, and SSH keys for external services.
- Keywhiz Server provides JSON APIs for collecting and managing secrets.
- **It stores all secrets in memory only.**

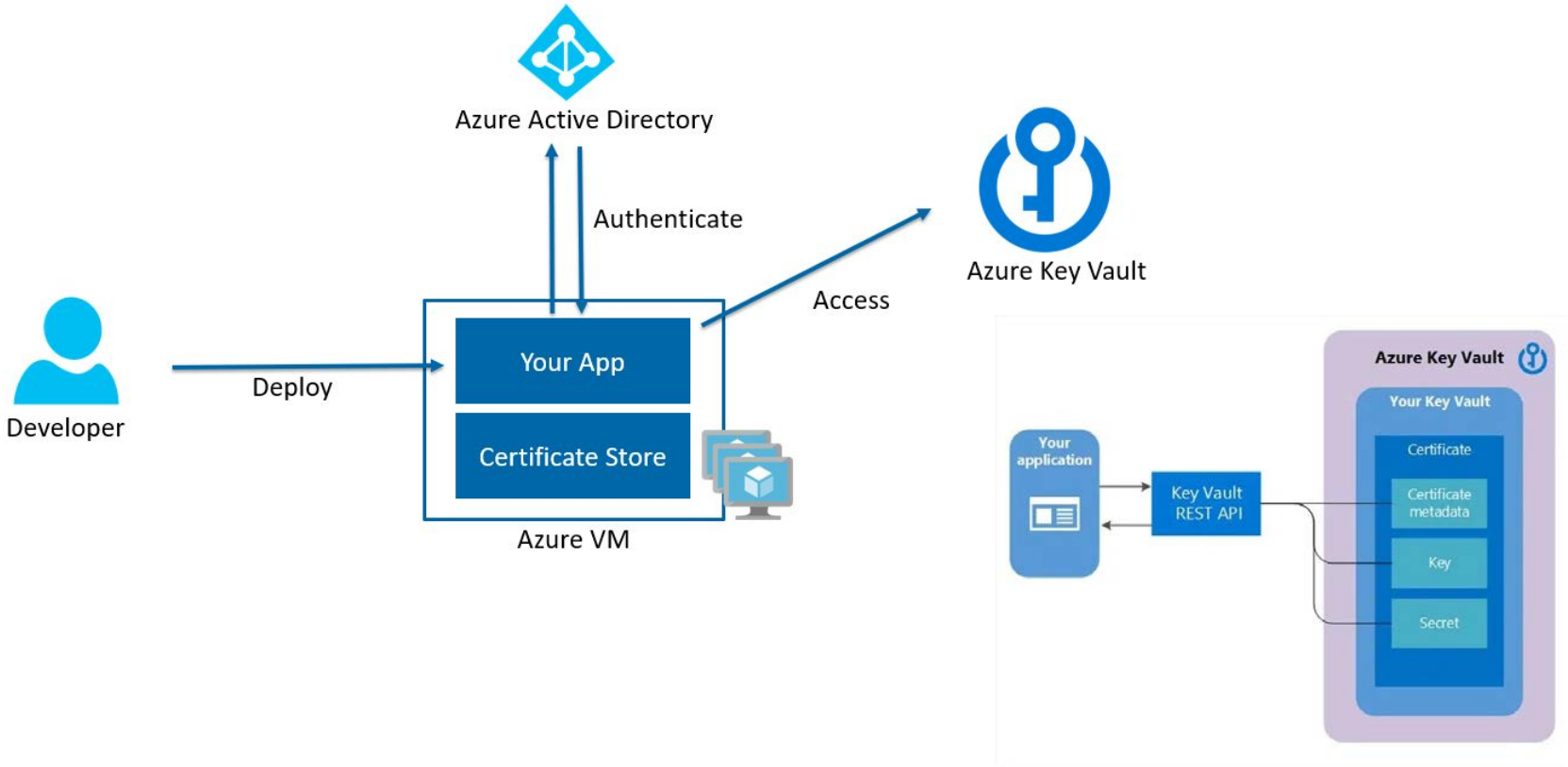
# AWS Secrets Manager

## AWS Secrets Manager

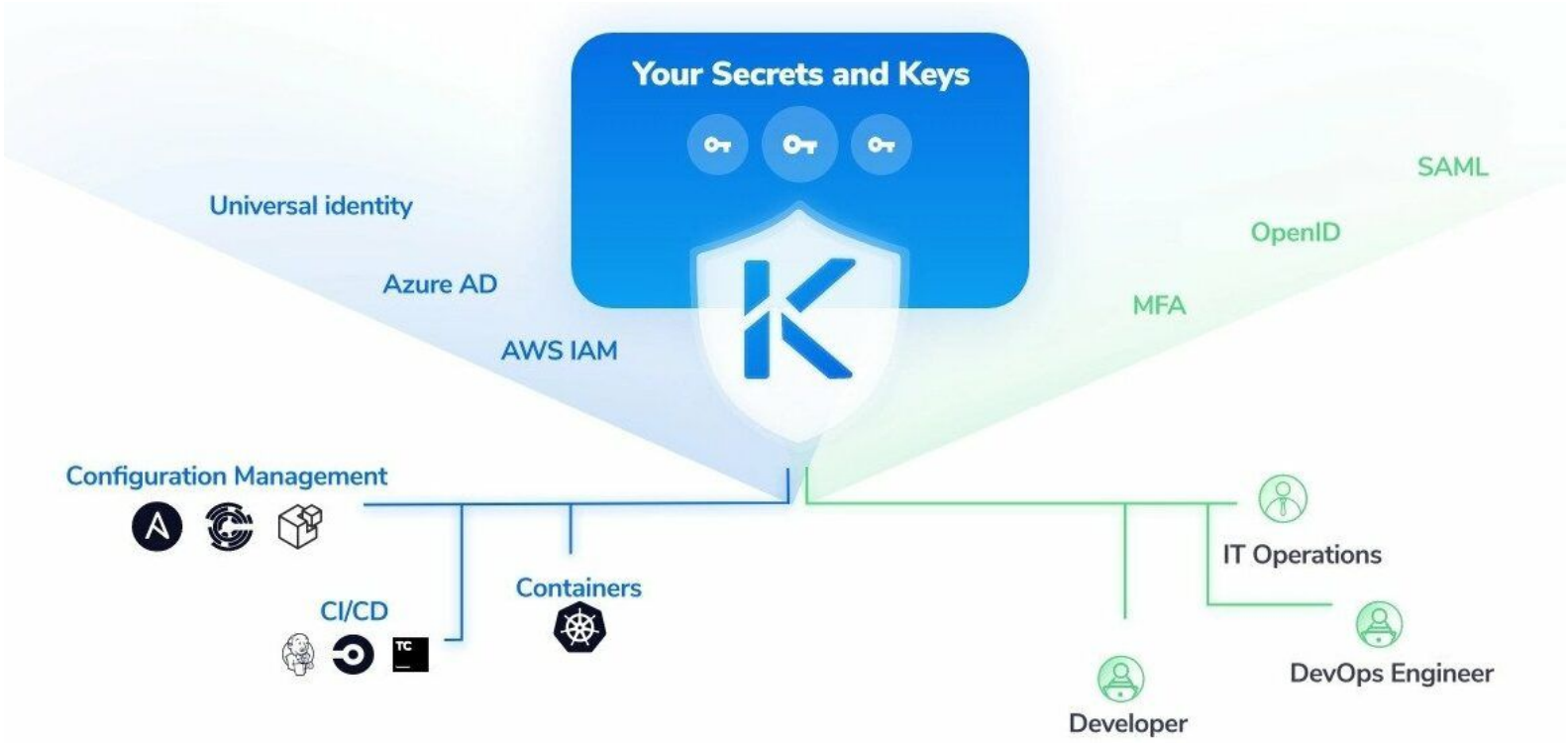
The key features of AWS Secrets Manager are:

- Encrypts and decrypts secrets, transmiting securely over TLS.
- Provides **client-side caching libraries** to improve the availability and reduce the latency of using your secrets.
- You can configure Amazon VPC (Virtual Private Cloud) endpoints to keep traffic within the AWS network.

# Azure Key Vault



# Akeyless Vault



## Akeyless Vault


The platform supports two more pillars:

- **Zero-Trust Application Access** by providing unified authentication and just-in-time access credentials, allowing you to secure the perimeter of applications and infrastructure.
- **Encryption as-a-Service**, allows customers to protect sensitive personal & business data by applying FIPS 140-2 certified app-level encryption.

## Conclusions

- Secrets are an important tool for any container-based architecture because they help us achieve the goal of keeping code and configuration separate.
- **Manage secrets in secure storage**