KubeCon | CloudNativeCon

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Protect Your Kubernetes Data

Friends Don’t Let Friends Leave Their Kubernetes Data Unprotected

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- Kubernetes upstream features, Azure Kubernetes Service
- Maintainer for K8s KMS plugin for Azure Key Vault, Keyvault-flexvolume, aad-pod-identity

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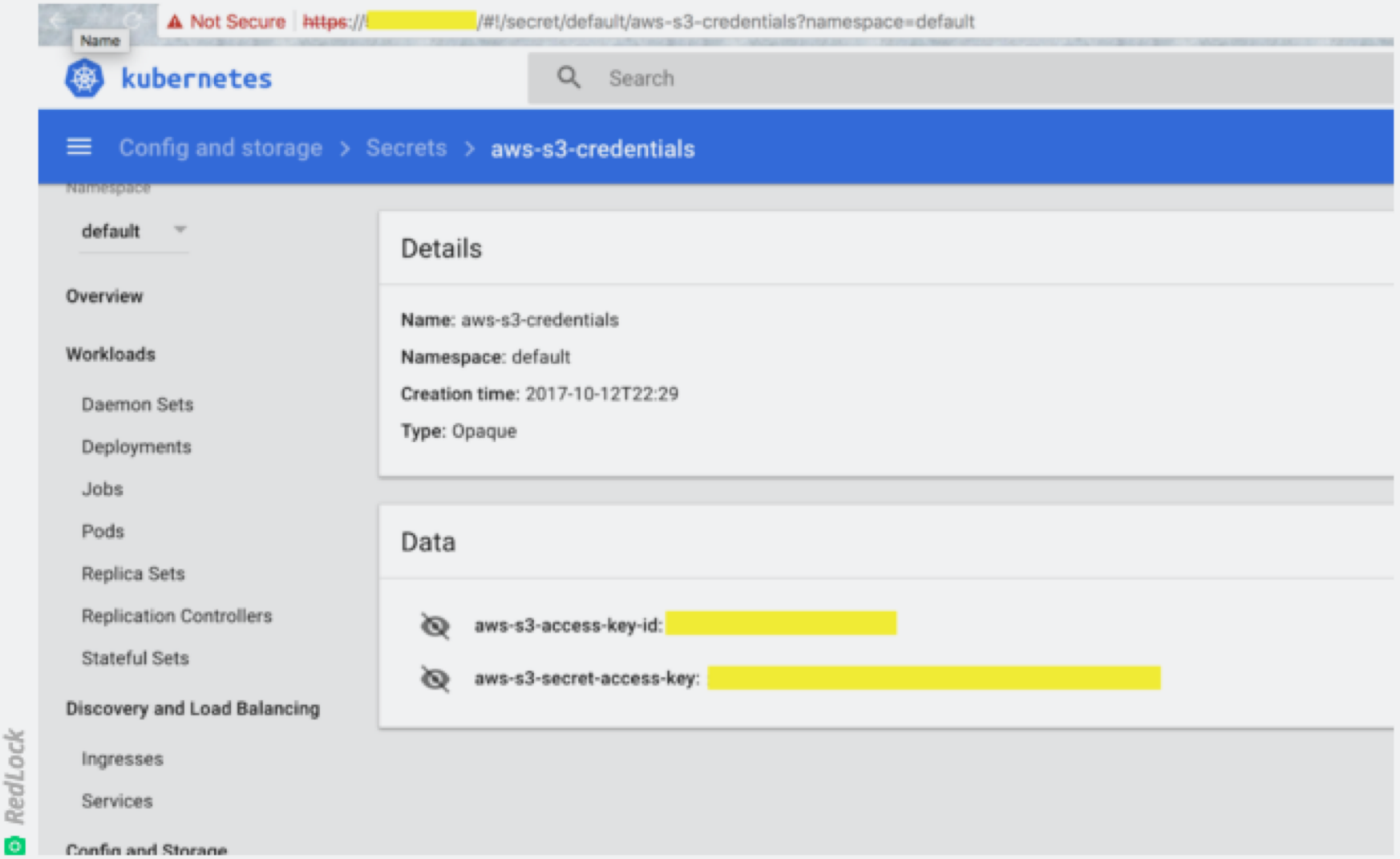
TRANSPORTATION CARS TESLA

Tesla's cloud was used by hackers to mine cryptocurrency

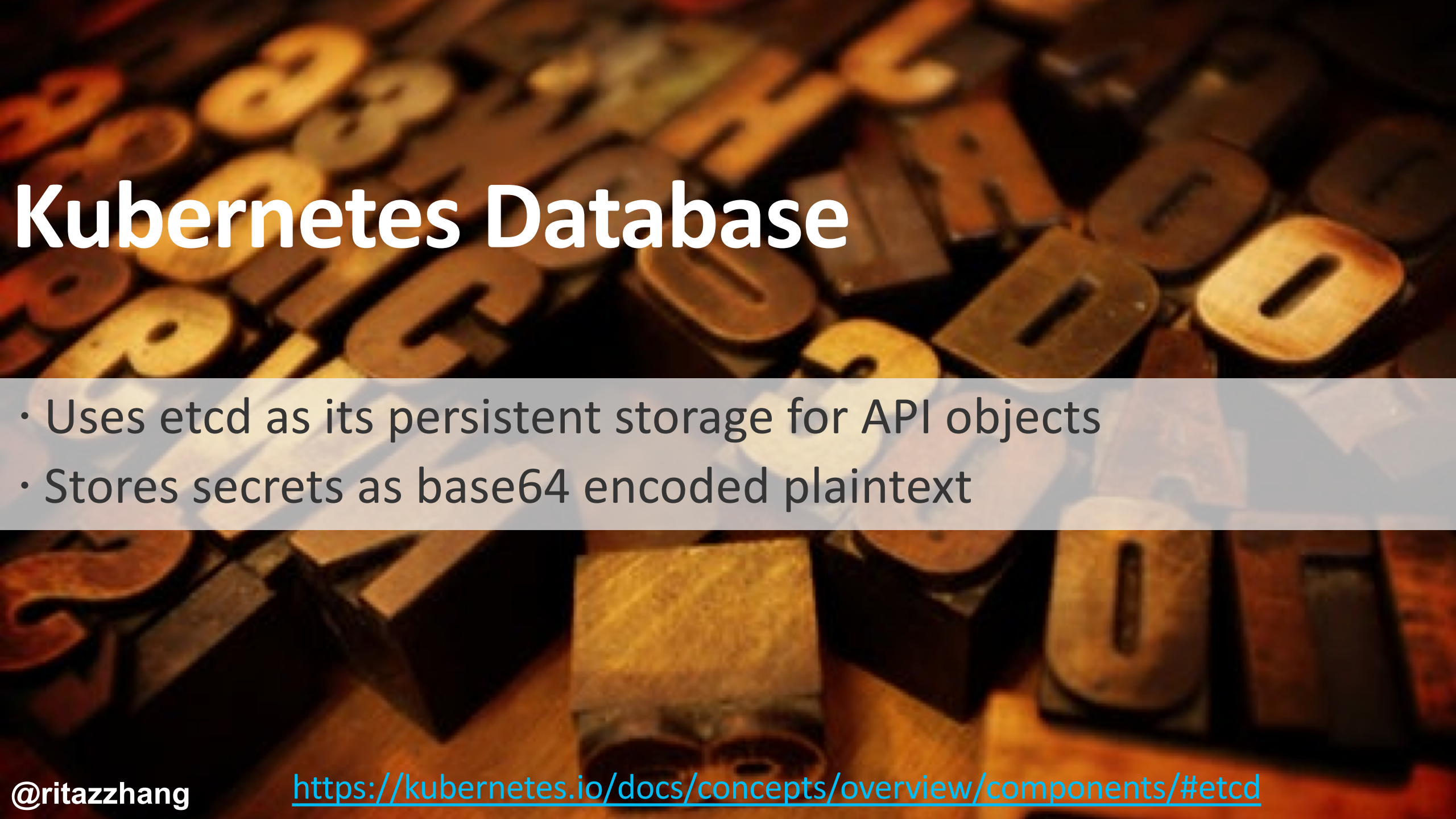
Mining bitcoin on Elon's dime

By Andrew J. Hawkins | @andyjayhawk | Feb 20, 2018, 1:39pm EST

The initial point of entry for the Tesla cloud breach, Tuesday's report said, was an unsecured administrative console for Kubernetes, an open source package used by companies to deploy and manage large numbers of cloud-based applications and resources.



An attacker who can successfully access your cluster database can compromise your entire cluster and have access to your cloud resources.



Kubernetes Database

- Uses etcd as its persistent storage for API objects
- Stores secrets as base64 encoded plaintext

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https://kubernetes.io/docs/concepts/overview/components/#etcd

The security footgun in etcd

Giovanni Collazo

March 16, 2018

security

“Authentication was added in etcd 2.1. … etcd before 2.1 was a completely open system; anyone with access to the API could change keys. In order to preserve backward compatibility and upgradability, this feature is off by default.” [*Read more from coreos etcd doc*]

https://elweb.co/the-security-footgun-in-etcd/

I did a simple search on shodan and came up with **2,284 etcd servers on the open internet**.

CREDENTIALS, a lot of CREDENTIALS. Credentials for things like cms_admin, mysql_root, postgres, etc. Passwords for databases of all kinds, AWS secret keys, and API keys and secrets for a bunch of services.

GET http://<ip address>:2379/v2/keys/?recursive=true

password	8781
aws_secret_access_key	650
secret_key	23
private_key	8

```
- {
    key: "/registry/secrets/ci",
    dir: true,
  - nodes: [
      - {
          key: "/registry/secrets/ci/docker-repo-key",
          value: "{"kind":"Secret","apiVersion":"v1","metadata":{"name":"docker-repo-key","namespace":"ci","uid":"c98f370a-d825-11e6-a077-bc764e04
          modifiedIndex: 12910772,
          createdIndex: 12910772
        },
      - {
          key: "/registry/secrets/ci/default-token-dt40q",
          value: "{"kind":"Secret","apiVersion":"v1","metadata":{"name":"default-token-dt40q","namespace":"ci","uid":"f849c1c5-ea76-11e7-94ad-bc76
          {"ca.crt":"LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUZVVENDQXptZ0F3SUJBZ0lKQU1ydVRyaThFTnBjTUEwR0NTcUdTSWIzRFFFQkN3VUFNRDh4Q3pBSkJnTlVBQ
          modifiedIndex: 651393897,
          createdIndex: 651393897
        }
    ],
    modifiedIndex: 4005597,
    createdIndex: 4005597
  }
```


THIS IS FINE.

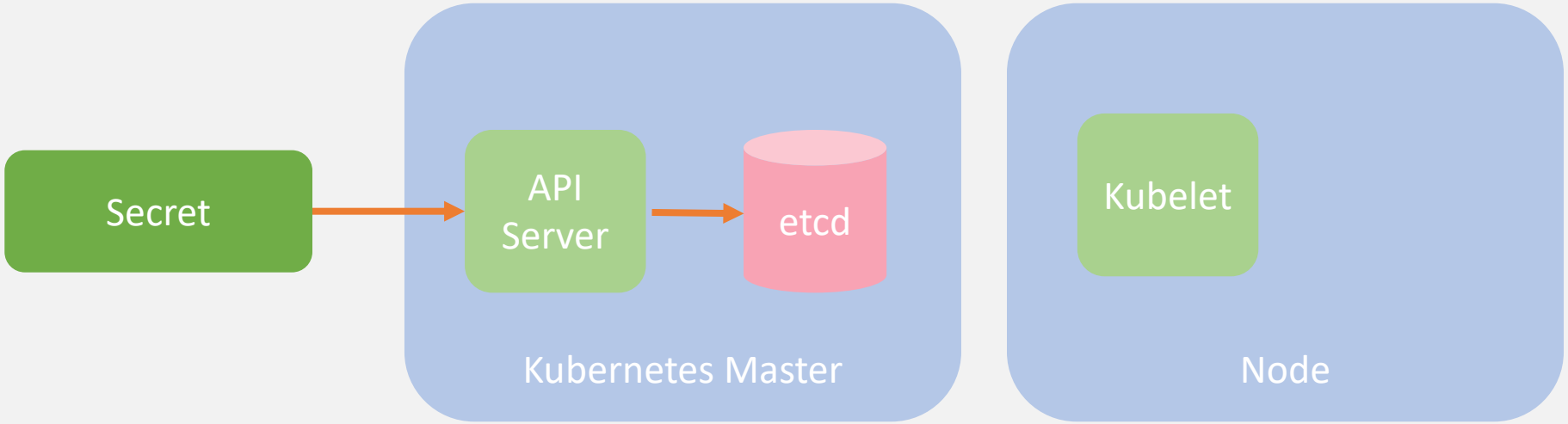
So…How do I secure my cluster?

- There are many things you can do
  - Control access to the Kubernetes APIs
  - Control access to the Kubelet
  - Control privileges containers run with
  - Restrict network access
  - Restrict resource access
  - Restrict access to etcd
  - **Encrypt etcd data at rest**
  - **Store application secrets outside of Kubernetes**
  - **Restrict access to resources with pod identity**

https://kubernetes.io/docs/tasks/administer-cluster/securing-a-cluster/

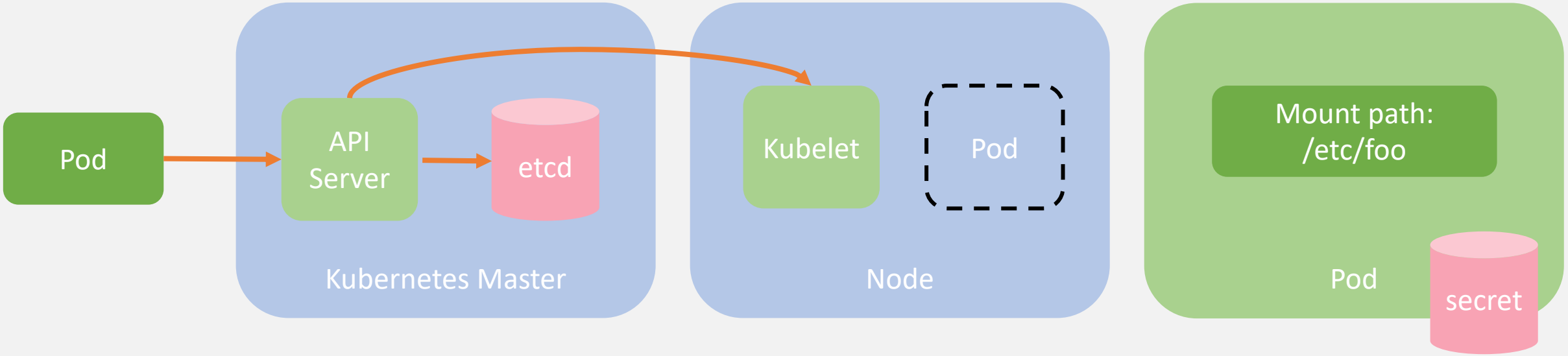
Secrets

kubectl create secret generic secret1

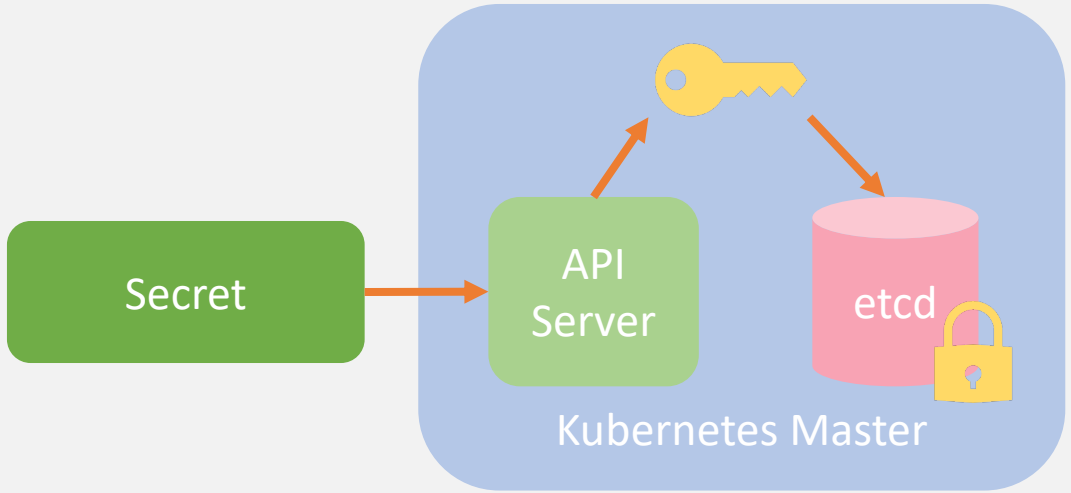


Pod using Secret

kubectl create –f pod-using-secret.yaml



Encryption at Rest

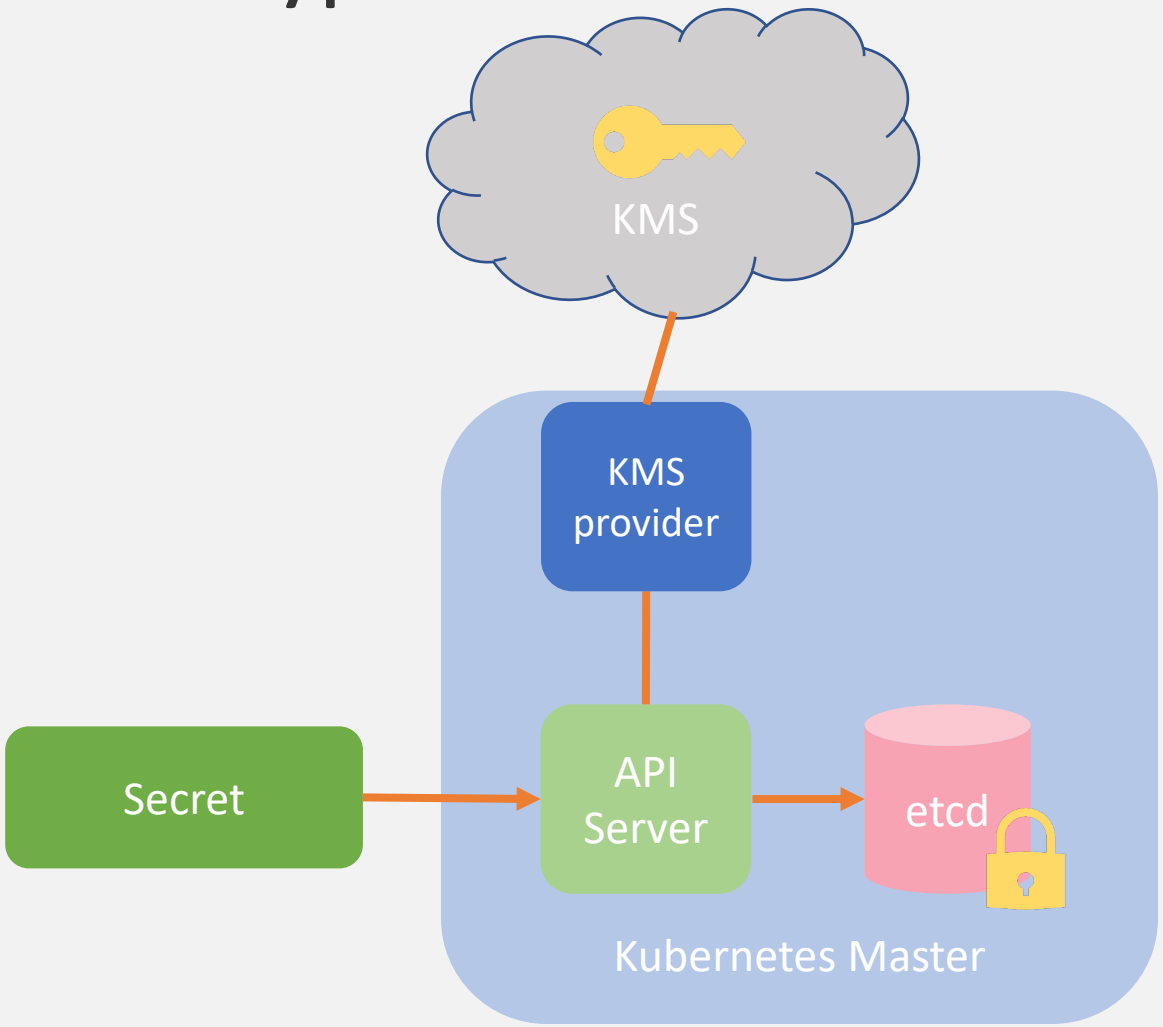


- Kubernetes v1.7+
- etcd v3 required
- encryption using keys in config file on master
- Plain text, encoded with base64

https://kubernetes.io/docs/tasks/administer-cluster/encrypt-data/

```
kind: EncryptionConfig
apiVersion: v1
resources:
  - resources:
    - secrets
    providers:
    - aescbc:
        keys:
        - name: key1
          secret: <BASE 64 ENCODED SECRET>
    - identity: {}
```

Key Management Service (KMS) Provider for Encryption at Rest



- Kubernetes v1.10, v1.13 stable
- etcd v3 required
- Separate key management from K8s cluster management
- Supports encryption using keys stored in external trusted Key Management Service (KMS), e.g. Azure Key Vault, Google Cloud KMS
- HSM-protected keys

https://kubernetes.io/docs/tasks/administer-cluster/kms-provider/

Before V1.13

```
kind: EncryptionConfig
apiVersion: v1
resources:
  - resources:
    - secrets
    providers:
    - kms:
        name: myKmsPlugin
        endpoint: unix:///tmp/socketfile.sock
        cachesize: 100
   - identity: {}
```

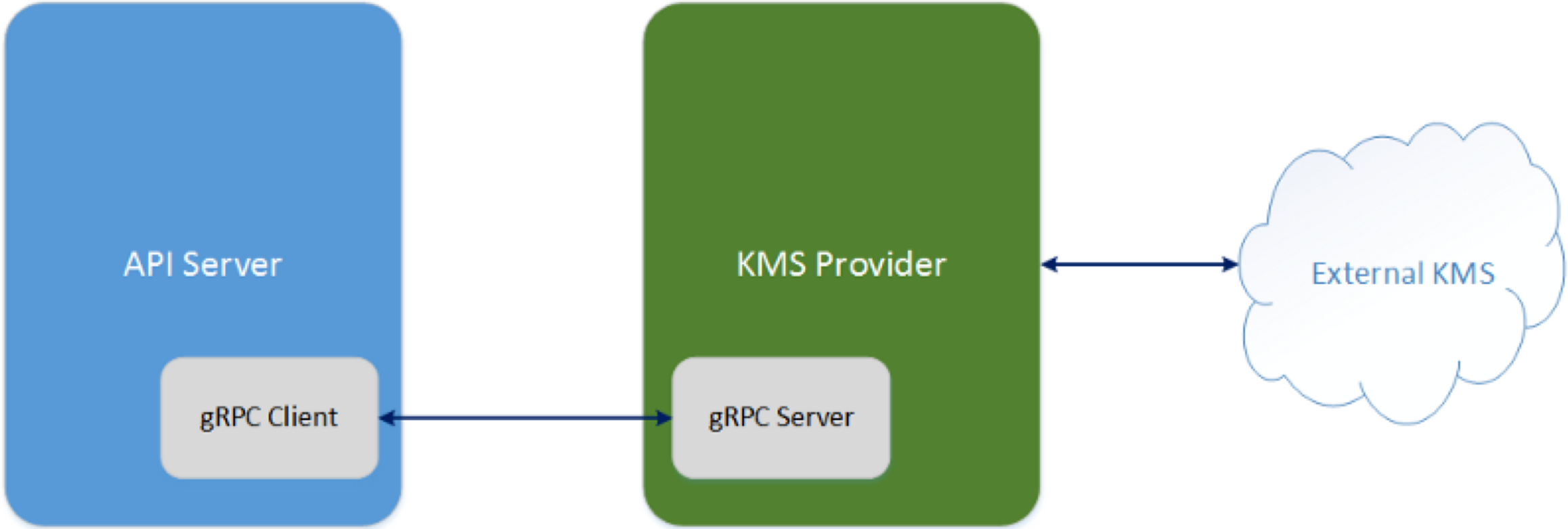
V1.13

```
kind: EncryptionConfiguration
apiVersion: apiserver.config.k8s.io/v1
resources:
  - resources:
    - secrets
    providers:
    - kms:
        name: myKmsPlugin
        endpoint: unix:///tmp/socketfile.sock
        cachesize: 100
   - identity: {}
```

Demo:
K8s cluster with Azure Key Vault data encryption

https://github.com/Azure/kubernetes-kms

High Level Design

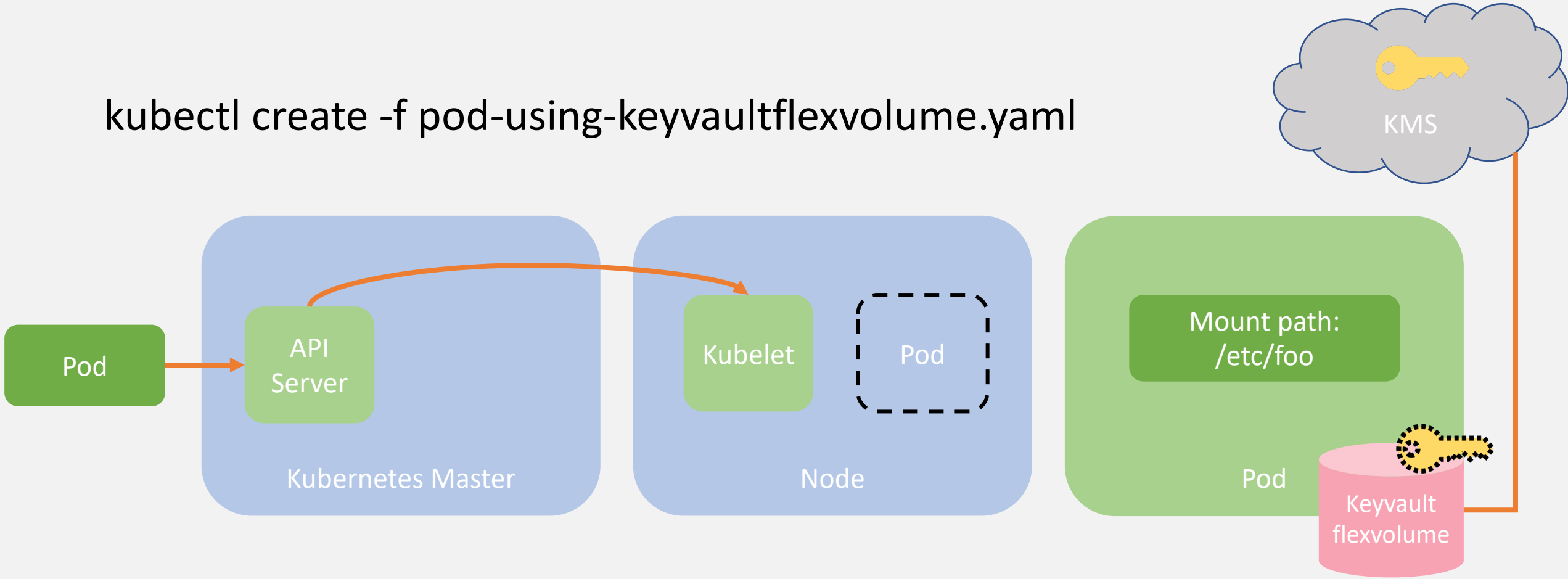


With the KMS provider plugin, we can encrypt Kubernetes data stored in etcd at rest with a KMS managed key.

What if instead of storing my secrets in etcd, I want to store and manage access to application secrets outside of Kubernetes?

Pod using Key Vault Flexvolume

kubectl create -f pod-using-keyvaultflexvolume.yaml



Kubernetes Key Vault FlexVolume

- Flexvolume enables users to mount vendor volumes into kubernetes. It expects vendor drivers to be installed in the volume plugin path on every kubelet node.
- Key Vault flexvol driver makes a request to Key Management Service, (e.g. Azure Key Vault) and mounts secret and secret value as a volume to pods
- Separation of concern/role based management access to secrets

https://github.com/Azure/kubernetes-keyvault-flexvol

Demo:
K8s cluster with Azure Key Vault flexvolume

https://github.com/Azure/kubernetes-keyvault-flexvol

With the Kubernetes Key Vault FlexVolume driver, we can store and retrieve secrets from an Azure Key Vault instance and mount the values as a volume to containers.

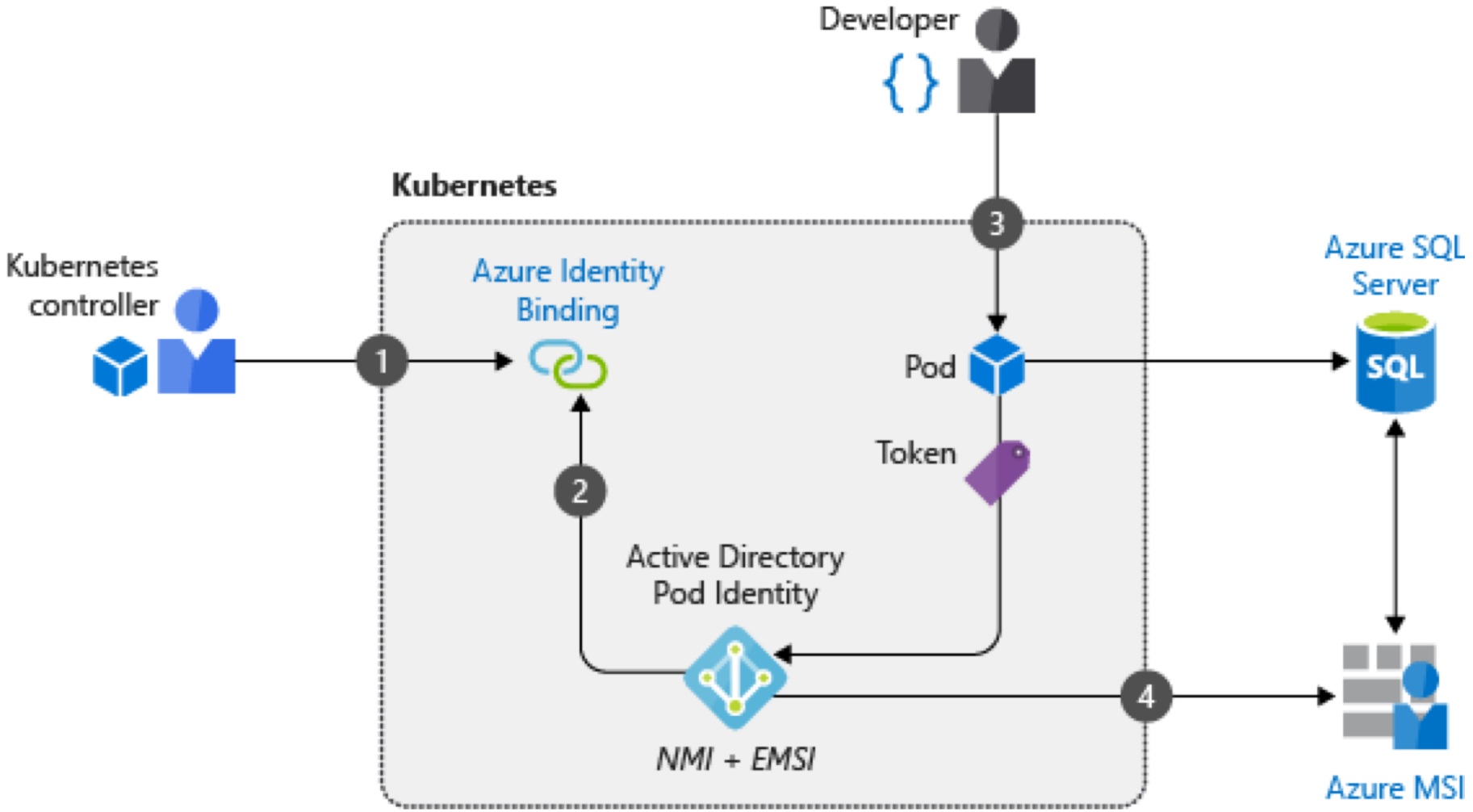
What if I want to restrict access to my cloud resources to specific pods?

AAD Pod Identity

- Restrict/enable pods to access individual resources that depend on Azure AD for access with its own identity (e.g. Azure SQL server or your own custom API that uses AAD)
- Kubernetes Custom Resource Definition objects that map pods to Azure AD identities
- When pods request access to a resource that uses Azure AD for access, a matching Azure identity is assigned

https://github.com/Azure/aad-pod-identity

AAD Pod Identity



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https://docs.microsoft.com/en-us/azure/aks/operator-best-practices-identity - use-pod-identities

Demo:
K8s cluster with AAD Pod Identity

https://github.com/Azure/aad-pod-identity

With AAD Pod Identity, we can restrict and enable specific pods access to resources that need Azure AD for access based on its identity.

Demo:
K8s cluster with Azure Key Vault Flexvolume and AAD Pod Identity

https://github.com/Azure/kubernetes-keyvault-flexvol - option-2---pod-identity

Recap

Azure Key Vault KMS plugin

- Use a key in Key Vault for etcd encryption
- Secrets/keys/certs are stored in etcd, managed as part of Kubernetes
- Restrict access using K8s concepts: RBAC, Service Accounts, namespaces
- Bring your own keys, import or generate HSM-protected (Hardware Security Modules) keys
- Available on AKS-engine

Flexvol + AAD Pod Identity

- Mounts secrets/keys/certs to the pod using a flexvolume
- Secrets/keys/certs are stored in Azure Key Vault
- Restrict access to secrets/keys/certs with specific pod identities
- Manage secrets in Key Vault via Azure API's/CLI/Portal
- Separation of concerns/role-based management access to secrets
- Import or generate HSM-protected (Hardware Security Modules) keys
- Industry compliance
- More granular RBAC at the pod level

Resources

- Blog post: https://ritazh.com/using-azure-key-vault-for-kubernetes-data-encryption-d5eac8daee71
- Kubernetes doc: https://kubernetes.io/docs/tasks/administer-cluster/kms-provider/
- aks-engine doc: https://github.com/Azure/aks-engine/blob/master/docs/kubernetes/features.md#azure-key-vault-data-encryption
- KMS plugin service PR: https://github.com/kubernetes/kubernetes/pull/55684
- Kubernetes KMS Plugin for Azure Key Vault: https://github.com/Azure/kubernetes-kms
- Kubernetes KMS Plugin for Google CloudKMS: https://github.com/GoogleCloudPlatform/k8s-cloudkms-plugin/
- Kubernetes Key Vault FlexVolume: https://github.com/Azure/kubernetes-keyvault-flexvol
- AAD Pod Identity: https://github.com/Azure/aad-pod-identity


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