Automated Certificate Issuance with Hashicorp Vault

Slides and walkthrough available on GitHub

What makes certificates so special (compared to regular keys and passwords)?

A certificate is a proof of your identity.

In computer terms, it means a certificate authority vouches that you have a **private** key.

Unlike a password, that private key is known only by the owner and never shared.

What are certificate used for?

Certificates prove your identity to a third party that shares a common trustee with you.

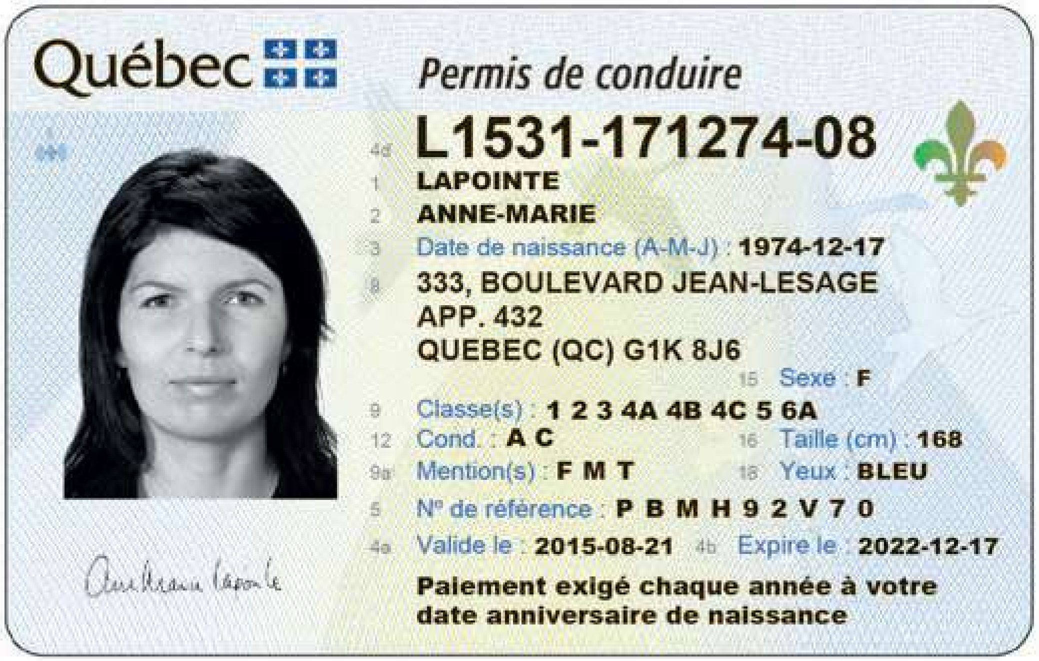
You don't need prior arrangement, but you must

- Trust the authority that issued the certificate
- Be able to confirme the certificate is authentic

Futur entities will be able to authenticate you if they decide to use the same trustee

Examples of certificates

High trust



Québec

Permis de conduire

4d **L1531-171274-08**
1 **LAPOINTE**
2 **ANNE-MARIE**
3 Date de naissance (A-M-J) : **1974-12-17**
8 333, BOULEVARD JEAN-LESAGE
APP. 432
QUEBEC (QC) G1K 8J6
15 Sexe : **F**
9 Classe(s) : **1 2 3 4A 4B 4C 5 6A**
12 Cond. : **A C** 16 Taille (cm) : **168**
9a Mention(s) : **F M T** 18 Yeux : **BLEU**
5 Nº de référence : **P B M H 9 2 V 7 0**
4a Valide le : **2015-08-21** 4b Expire le : **2022-12-17**

[illegible]

Paiement exigé chaque année à votre date anniversaire de naissance

Examples of certificates

Low trust

Issuing certificates

Old-school certificate process

1. Generate a key pair
    - Public that everyone will see
    - Private that **only the owner** will see
2. Generate a certificate signing request (CSR)
    - Prove that you own the private key, without sending it
3. Send the CSR to the certificate authority
4. Wait for the Certificate Authority to issue a certificate
    - The CA will sign your public key
5. Configure your web server to use the private key and certificate
6. Goto 1 every year or so… Don't forget!

Who/What should generate the key ?

Private key **can be exported** unless it is on a smartcard

- If you can use the key, you can export it (iSECPartner's jailbreak)
- Using smartcards is not pratical unless you are sitting next to the server

Private key reuse is a handy Wireshark hack

- Most CA don't check for that
- It lowers security

Vault can do both, and you can mix them at will

- Generate the private key and certificate at once
- Sign a certificate request

Pick the one that works best for every circomstance

Prepare the PKI backend

Mount the backend

```
#Nothing to install, just enable the PKI secret backend

vault secrets enable --path=issuer pki
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Vault doesn't know how it can be reached on the network, tell it

```
#Set the OCSP and CRL protocol URL
```

```
vault write issuer/config/urls \
    issuing_certificates="http://localhost:8200/v1/issuer/ca" \
    crl_distribution_points="http://localhost:8200/v1/issuer/crl" \
    ocsp_servers="http://localhost:8200/v1/issuer/ocsp"
```

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Link Vault to your corporate PKI

Your Public Key Infrastructure (PKI) looks like this:

- A Root Certificate Authority (CA) is used only to sign the Issuing CA's certificates
- Issuers are the ones actually giving out certificates

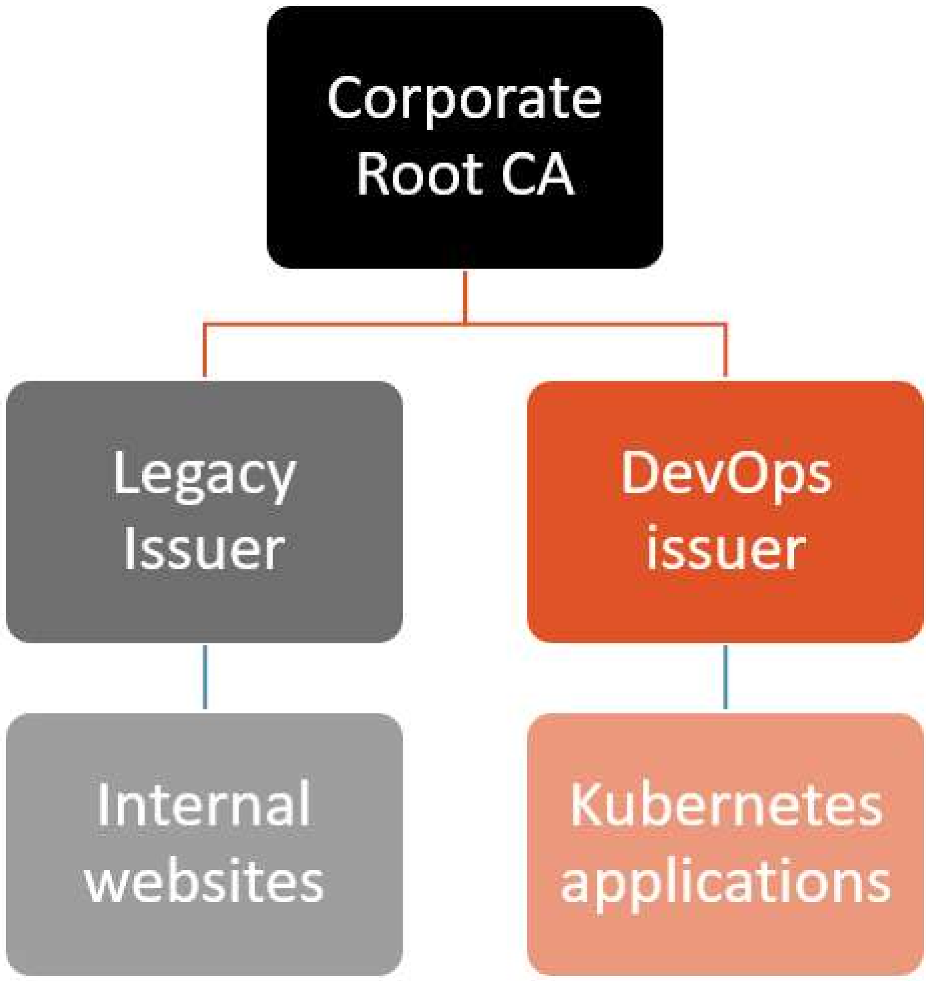
Vault will create a CSR, for your PKI CA to sign

- Old school, long lived certificate, not automated
- Root CA are usually offline and revived every 2 years, plan accordingly

Vault will be another issuer of your PKI

- You will need to push the certificate to your corporate desktops

Link Vault to your corporate PKI



Create key pair and Certificate Signing Request

Vault's private key can be

- Imported: You are tranfering from a legacy PKI, like openssl
- Generated: Private key will never leave Vault

To have vault generate (and keep) its private key:

```
#Using internal in this command means the private key never leaves Vault
#Gives the name devops-issuer.paralint.lab to your issuer

vault write --field=csr issuer/intermediate/generate/internal \
   common_name=devops-issuer.paralint.lab | tee devops-request.csr
```

The certificate signing request is saved in the file `devops-request.csr`

Give Vault its certificate

Have the certificate request signed by your certificate authority

- Remember, root CA are offline most of the time

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Add the certificate to Vault

```
#Complete the issuer base configuration

vault write issuer/intermediate/set-signed certificate=@devops-cert.pem
```

Define your certificate template (aka Role)

About one template per use case

- HTTPS for internal applications
- Email signature
- User authentication

You can restrict many aspect of the certificate you issue with a given tempalte

- Hostnames
- Validity period
- Key usage
- Many more documented online

Example certificate template (aka Role)

This would be the content of `devops-role.json` managed "as-code"

```
{
  "allow_any_name": false,
  "allow_bare_domains": false,
  "allow_glob_domains": true,
  "allow_ip_sans": false,
  "allow_localhost": false,
  "allow_subdomains": false,
  "allowed_domains": [ "app*.cloud.paralint.lab" ],
  "allowed_other_sans" : "email;UTF-8:*@paralint.lab",
  "country": [ "CA" ],
  "enforce_hostnames": true,
  "ext_key_usage": [ "ServerAuth" ],
  "key_bits": 2048,
  "key_type": "rsa",
  "key_usage": [ "DigitalSignature", "KeyAgreement", "KeyEncipherment" ],
  "locality": [ "Montreal" ],
  "max_ttl": "72h",
  "organization": [ "Hashicorp User Group" ],
  "ou": [ "Kubernetes DevOps" ],
  "postal_code": [ "H3B 2E3" ],
  "province": [ "Quebec" ],
  "server_flag": true,
  "ttl": "24h"
}
```

Add the template to Vault

Just POST the JSON file to the endpoint name:

```
vault write issuer/roles/devops @devops-role.json
```

This operation should be restricted to the security team

Issue a certificate using that template

You must be authenticated Post a JSON request to Vault and the get the goods right back

```
#This translate to a POST request to Vault
vault write issuer/issue/devops @- << EOF
{
   "ttl" : "48h",
   "common_name": "apptastic.cloud.paralint.lab",
   "alt_names":   "app5678.cloud.paralint.lab, app9999.cloud.paralint.lab"
}
EOF
```

How to use it is up to you

- Your platform knows how to automate this
- It might require to use the `sign` endpoint

Renew a certificate

You don't really renew a certificate, you get a new one

Should you revoke the certificate you are replacing?

- Certificates are short lived
- What happens if you restore a backup?

Certificate revocation

The hard part about revocation, is when to do it

You just post the certificate serial number to Vault API

You will likely have this endpoint restricted

Permissions

Use Vault path based ACL, like you would for anything else

Task	Performed by	Vault path
Mount the PKI backend	Vault Root token	`sys/mount`
Create/Update a certificate template	Security administrator	`pki/roles/:name`
Issue a certificate	Infrastructure	`pki/issue/:name` `pki/sign/:name`
Revoke a certificate	Security Administrator	`pki/revoke/`

In this talk, the default mount name "`pki`" was replaced by "`issuer`"

Integrating with Kubernetes cert-manager

Define an `Issuer` resource

```
apiVersion: certmanager.k8s.io/v1alpha1
kind: Issuer
metadata:
  name: vault-issuer
  namespace: default
spec:
  vault:
    path: issuer/sign/devops
    server: https://vault.paralint.lab
    caBundle: <base64 encoded caBundle PEM file>
    auth:
      appRole:
        path: approle
        roleId: "291b9d21-8ff5-..."
        secretRef:
          name: cert-manager-vault-approle
          key: secretId
```

Automation

Define a `Certificate` resource that uses your `Issuer` resource:

```
apiVersion: certmanager.k8s.io/v1alpha1
kind: Certificate
metadata:
  name: apptastic
  namespace: default
spec:
  secretName: apptastic-tls
  issuerRef:
    name: vault-issuer
  commonName: apptastic.cloud.paralint.lab
  dnsNames:
  - app5678.cloud.paralint.lab
  - app9999.cloud.paralint.lab
```

Cert-manager will store the create certificate in the `apptastic-tls` Kubernetes secret