ConfigMaps and Secrets

Overview

In this lab, we will learn how to decouple application configuration data from the application itself and the advantages of taking this approach. By the end of this lab, you will be able to define Kubernetes ConfigMap and Secret objects, run a simple Pod that uses data from ConfigMaps and Secrets, describe the advantages of decoupling configuration data from applications, and use ConfigMaps and Secrets to decouple application configuration data from the application container.

Introduction

In *Lab 5*, *Pods*, we learned that Pods are the minimal unit of deployment in Kubernetes. Pods can have multiple containers, and each container can have a container image associated with it. This container image generally packages the target application that you plan to run. Once the developers are satisfied that the code is running as expected, the next step is to promote the code to testing, integration, and production environments.

Easy, right? One problem, however, is that as we move our packaged container from one environment to another, although the application remains the same, it needs environment-specific data, for example, the database URL to connect to. To overcome this problem, we can write our applications in such a way that the environment-specific data is provided to the application by the environment it is being deployed into.

In this lab, we will discover what Kubernetes provides to associate **environment-specific data** with our application containers without changing our container image. There are multiple ways to provide **environment-specific configuration** data to our application:

1. Provide command-line arguments to the Pods.
2. Provide environment variables to the Pods.
3. Mount configuration files in the containers.

First, we need to define our configuration data using an object called **ConfigMap**. Once the data is defined and loaded into Kubernetes, the second step is to provide the defined data to your application.

However, what if you have sensitive data, such as database passwords, that you want to provide to your application container? Well, Kubernetes **Secret** provides a way to define sensitive data to an application.

ConfigMap and Secret objects both serve a similar purpose. Both provide a way to define data that can be injected into your applications so that the same container can be used across different environments. There is little difference between them, which we will learn in detail later on in this lab. As a quick rule, Secrets are designed to hold confidential data (such as passwords, private keys, and more), while ConfigMaps are more suited for general configuration data such as a database location. ConfigMaps and Secrets reside in the specific namespace in which they are created. They can only be referenced by Pods residing in the same namespace.

Kubernetes uses an internal key-value store called **etcd** as its database to store all the objects defined in Kubernetes. As ConfigMaps and Secrets are Kubernetes objects, they get stored in the internal key-value store.

Let's dig a bit deeper into ConfigMaps first.

What Is a ConfigMap?

A ConfigMap allows us to define application-related data. A ConfigMap decouples the application data from the application so that the same application can be ported across different environments. It also provides a way to inject customized data into running services from the same container image.

ConfigMaps can be created through a literal value or from a file or all the files in a directory. Note that the primary data we stored in ConfigMaps is for non-sensitive configuration, for example, config files or environment variables.

Once a ConfigMap is defined, it will be loaded to the application via an environment variable or a set of files. The application can then see the files as local files and can read from them. It is important to note that (from 1.9.6 version onward of Kubernetes), files loaded from ConfigMaps are read-only. ConfigMaps can also hold configuration data for system applications such as operators and controllers.

In the following exercises, you will see different ways of defining ConfigMaps and different ways to make the ConfigMap data available to the running Pods.

Let's see what Kubernetes offers us in terms of ConfigMap creation. Kubernetes help commands provide a good starting point:

```
kubectl create configmap --help
```

You should see the following response:

```
Create a configmap based on a file, directory, or specified literal value.

A single configmap may package one or more key/value pairs.

When creating a configmap based on a file, the key will default to the basename of the file, and the value will default
to the file content.  If the basename is an invalid key, you may specify an alternate key.

When creating a configmap based on a directory, each file whose basename is a valid key in the directory will be
packaged into the configmap.  Any directory entries except regular files are ignored (e.g. subdirectories, symlinks,
devices, pipes, etc).

Aliases:
configmap, cm

Examples:
  # Create a new configmap named my-config based on folder bar
  kubectl create configmap my-config --from-file=path/to/bar

  # Create a new configmap named my-config with specified keys instead of file basenames on disk
  kubectl create configmap my-config --from-file=key1=/path/to/bar/file1.txt --from-file=key2=/path/to/bar/file2.txt

  # Create a new configmap named my-config with key1=config1 and key2=config2
  kubectl create configmap my-config --from-literal=key1=config1 --from-literal=key2=config2

  # Create a new configmap named my-config from the key=value pairs in the file
  kubectl create configmap my-config --from-file=path/to/bar

  # Create a new configmap named my-config from an env file
  kubectl create configmap my-config --from-env-file=path/to/bar.env
```

As you can see from the preceding output, ConfigMaps can be created for a single value, a list of values, or from an entire file or directory. We will learn exactly how to do each of these in the exercises in this lab. Note that the command to create a ConfigMap has the following format:

```
kubectl create configmap <map-name> <data-source>
```

Here, `<map-name>` is the name you want to assign to the ConfigMap and `<data-source>` is the directory, file, or literal value to draw the data from.

The data source corresponds to a key-value pair in the ConfigMap, where:

- **Key** is the filename or the key you provided on the command line
- **Value** is the file content or the literal value you provided on the command line

Before we start with the exercises, let's make sure that you have Kubernetes running and that you can issue commands to it. We will use minikube to easily run a single-node cluster on your local computer.

Start up minikube using the following command:

```
minikube start
```

You should see the following response as minikube starts up:

```
There is a newer version of minikube available (v1.2.0).  Download it here:
https://github.com/kubernetes/minikube/releases/tag/v1.2.0

To disable this notification, run the following:
minikube config set WantUpdateNotification false
😄  minikube v1.1.1 on darwin (amd64)

⚠️ Ignoring --vm-driver=virtualbox, as the existing "minikube" VM was created using the vmwarefusion driver.
⚠️ To switch drivers, you may create a new VM using `minikube start -p <name> --vm-driver=virtualbox`
⚠️ Alternatively, you may delete the existing VM using `minikube delete -p minikube`

🔄  Restarting existing vmwarefusion VM for "minikube" ...
⌛  Waiting for SSH access ...
🐳  Configuring environment for Kubernetes v1.14.3 on Docker 18.09.6
🔄  Relaunching Kubernetes v1.14.3 using kubeadm ...

⌛  Verifying: apiserver proxy etcd scheduler controller dns
🏄  Done! kubectl is now configured to use "minikube"
```

For all of the exercises in this lab, we recommend creating a new namespace. Recall from *Lab 5*, *Pods*, that namespaces are Kubernetes' way to group components of the solution together. Namespaces can be used to apply policies, quotas, and could also be used to separate resources if the same Kubernetes resources are being used by different teams.

In the following exercise, we will create a ConfigMap from literal values using the kubectl CLI commands. The idea is that we have some configuration data (for example, the master database name) that we can inject into, for example, a MySQL Pod, and it will create the database as per the given environment variable. This set of commands can also be used in the automated code pipelines that are responsible for application deployments across multiple environments.

Exercise 10.01: Creating a ConfigMap from Literal Values and Mounting It on a Pod Using Environment Variables

In this exercise, we will create a ConfigMap in the Kubernetes cluster. This exercise shows how to create ConfigMaps using a key-value pattern. Please follow these steps to complete the exercise:

1. First, let's begin by creating a namespace for all of the exercises in this lab.

   ```
   kubectl create namespace configmap-test
   ```

   You should see a response like this:

   ```
   namespace/configmap-test created
   ```

   Note

   We will use the `configmap-test` namespace for all the exercises in this lab unless mentioned otherwise.

2. First, let's create a ConfigMap that contains a single name-value pair. Use the command shown here:

   ```
   kubectl create configmap singlevalue-map --from-literal=partner-
   url=https://www.auppost.com.au --namespace configmap-test
   ```

   You should see the following output in the terminal:

```
configmap/singlevalue-map created
```

3. Once we create the ConfigMap, let's confirm that it is created by issuing a command to get all the ConfigMaps in the namespace:

```
kubectl get configmaps --namespace configmap-test
```

As `singlevalue-map` is the only ConfigMap in the `configmap-test` namespace, you should see an output that looks something like this:

```
NAME                 DATA     AGE
singlevalue-map      1        111s
```

4. Let's see what the Kubernetes ConfigMap object looks like. Enter the Kubernetes `get` command as follows:

```
kubectl get configmap singlevalue-map -o yaml --namespace configmap-test
```

The full object should be described something like this:

```
apiVersion: v1
data:
  partner-url: https://www.auppost.com.au
kind: ConfigMap
metadata:
  creationTimestamp: "2019-07-24T01:48:32Z"
  name: singlevalue-map
  namespace: configmap-test
  resourceVersion: "547609"
  selfLink: /api/v1/namespaces/configmap-test/configmaps/singlevalue-map
  uid: 24d1f3ab-adb5-11e9-89ac-000c2917147b
$
```

```
As you can see in the third line of the preceding output, the
ConfigMap is created and the literal value we entered is available
as a key-value pair in the `data` section of the
ConfigMap.
```

5. Now, we will create a YAML file named `configmap-as-env.yaml` to create a Pod into which we will inject fields from our ConfigMap as an environment variable. Using your favorite text editor, create a YAML file with the following content:

```
apiVersion: v1
kind: Pod
metadata:
  name: configmap-env-pod
spec:
  containers:
    - name: configmap-container
      image: k8s.gcr.io/busybox
      command: [ "/bin/sh", "-c", "env" ]
      envFrom:
```

```
      - configMapRef:
          name: singlevalue-map
```

You can see that the `envFrom` section in the preceding file is loading the data from the ConfigMap.

6. Let's create a Pod from the preceding specification. This Pod is using the **busybox** container image, which runs the command specified in the `command` section of the YAML file mentioned in the previous step:

```
kubectl create -f configmap-as-env.yaml --namespace configmap-test
```

You should see an output like this:

```
pod/configmap-env-pod created
```

7. Let's check the logs for this Pod using the following command:

```
kubectl logs -f configmap-env-pod --namespace configmap-test
```

You should see the logs as shown here:

```
KUBERNETES_PORT=tcp://10.96.0.1:443
KUBERNETES_SERVICE_PORT=443
HOSTNAME=configmap-env-pod
SHLVL=1
HOME=/root
partner-url=https://www.auppost.com.au
KUBERNETES_PORT_443_TCP_ADDR=10.96.0.1
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
KUBERNETES_PORT_443_TCP_PORT=443
KUBERNETES_PORT_443_TCP_PROTO=tcp
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
KUBERNETES_SERVICE_PORT_HTTPS=443
PWD=/
KUBERNETES_SERVICE_HOST=10.96.0.1
```

The `[ "/bin/sh", "-c", "env" ]` command will display all the environment variables loaded into the Pod. In the ConfigMap, we have defined the property name as `partner-url`, which is part of the output.

In this exercise, the name of the environment variable, `partner-url`, is the same as the key in our key-value pair. We can also make the name of the environment variable different from the key. For example, if we want to have `partner-server-location` as the name of our environment variable, we can replace the content of the YAML file in the exercise with the following:

```
apiVersion: v1
kind: Pod
metadata:
  name: configmap-multi-env-pod
spec:
  containers:
    - name: configmap-container
      image: k8s.gcr.io/busybox
      command: [ "/bin/sh", "-c", "echo $(partner-server-location)"         ]
      env:
```

```
        - name: partner-server-location
          valueFrom:
            configMapKeyRef:
              name: singlevalue-map
              key: partner-url
```

Pay special attention to the `env` section in the preceding YAML file. The first `name` field after `env` defines the name of the environment variable, and the `key` field under `configMapKeyRef` defines the name of the key in the ConfigMap.

Defining a ConfigMap from a File and Loading It onto a Pod

In this section, we will create a ConfigMap from a file and then load the file onto the application Pod. As mentioned previously, this newly mounted file will be accessible as a local file to the application running inside the Pod.

This is common when applications store their configuration data externally, allowing easier upgrades, as well as patches of the container image across different environments. We can have such a file in our source control repository, and we load the correct file in the correct container using a ConfigMap.

Let's understand this through an example. Imagine that you have written a web application that connects to a database to store information. When you deploy the application in a development environment, you will want to connect to the development database. Once you are satisfied that the application is working correctly, you will want to deploy the application to a testing environment. Since the application is packaged in a container, you would not want to change the container to deploy the application to the testing environment. But to run the application in the testing environment, you need to connect to a different database. An easy solution to this is that you configure your application to read the database server URL from a file, and that file can be mounted through a ConfigMap. This way, the file is not packaged as part of the container, but injected from outside via Kubernetes; thus, you do not need to modify your containerized application. Another use case would be that external software vendors can provide a container image, and any specific configuration settings can be mounted on the image as per a specific client's requirements.

Exercise 10.02: Creating a ConfigMap from a File

In this exercise, we will create a ConfigMap from a file, which can be mounted onto any Pods later on:

1. First, create a file named `application.properties` containing the following configuration details. You may use your preferred text editor:

   ```
   partner-url=https://www.fedex.com
   partner-key=1234
   ```

2. Now, create a ConfigMap from the file using the following command:

   ```
   kubectl create configmap full-file-map --from-file=./application.properties --
   namespace configmap-test
   ```

   You should see the following output indicating that the ConfigMap has been created:

   ```
   configmap/full-file-map created
   ```

3. Get the list of all ConfigMaps to confirm that our ConfigMap has been created:

   ```
   kubectl get configmaps --namespace configmap-test
   ```

You should see a list of all ConfigMaps, as shown here:

```
NAME                DATA      AGE
full-file-map       1         109m
singlevalue-map     1         127m
```

You can see that the names of the ConfigMaps are displayed alongside the number of keys they have.

You might be wondering, why does this output show only one key, even though we have added two keys? Let's understand this in the next step.

4. Let's see how the ConfigMap is being stored by using the following command:

```
kubectl get configmap full-file-map -o yaml --namespace configmap-test
```

You should see the following output:

```
apiVersion: v1
data:
  application.properties: |
    partner-url=https://www.fedex.com
    partner-key=1234
kind: ConfigMap
metadata:
  creationTimestamp: "2019-07-29T11:56:14Z"
  name: full-file-map
  namespace: configmap-test
  resourceVersion: "1220"
  selfLink: /api/v1/namespaces/configmap-test/configmaps/full-file-map
  uid: e47d88da-4082-4101-9dbf-37b40063aae1
```

```
Note that the name of the file, `application.properties`,
becomes the **key** under the `data` section, and the
entire file payload is the **value** of the key.
```

5. Now that we have defined our ConfigMap, the next step is to mount it onto a container. Create a YAML file named `mount-configmap-as-volume.yaml` to be used as our Pod configuration using the following content:

```
apiVersion: v1
kind: Pod
metadata:
  name: configmap-test-pod
spec:
  containers:
    - name: configmap-container
      image: k8s.gcr.io/busybox
      command: [ "/bin/sh", "-c", "ls /etc/appconfig/" ]
      volumeMounts:
      - name: config-volume
        mountPath: /etc/appconfig
  volumes:
    - name: config-volume
```

```
      configMap:
        # Provide the name of the ConfigMap containing the           files you
want
        # to add to the container
        name: full-file-map
  restartPolicy: Never
```

First, let's focus on the `volumes` section in the preceding file. In this section, we are instructing Kubernetes to define a volume from our ConfigMap named `full-file-map`.

Secondly, in the `volumeMounts` section, we are defining that Kubernetes should mount the volume in the `/etc/appconfig` directory.

Note that the `command` field in the container allows us to configure what command we want the container to execute when it starts. In this example, we are running the `ls` command, which is a Linux command to list the contents of a directory. This is similar to the Windows `dir` command. This will print the contents of directory `/etc/appconfig`, where we have mounted the ConfigMap.

Note

The `name` field under the `volume` and `volumeMounts` sections has to be the same so that Kubernetes can identify which `volume` is associated with which `volumeMounts`.

6. Now, use the following command to start a Pod using the YAML file we just created:

```
kubectl create -f mount-configmap-as-volume.yaml --namespace configmap-test
```

You should get a response saying that the Pod has been created:

```
pod/configmap-test-pod created
```

7. The YAML file we used specifies the name of the Pod as `configmap-test-pod` and configures it to just display the content of the folder. To verify this, just issue the following command to get the output logs of the Pod:

```
kubectl logs -f configmap-test-pod --namespace configmap-test
```

This should print `application.properties`, which is the file we placed in the folder:

```
application.properties
```

As you can see, we get the contents of `/etc/appconfig`, which is the output of the `ls` command in the Pod.

You have just successfully defined a ConfigMap and mounted it as a file in a Pod that printed the name of the file.

Exercise 10.03: Creating a ConfigMap from a Folder

In this exercise, we will load all the files in a folder as a ConfigMap. Each filename becomes a key for the ConfigMap, and when you mount it, all the files will be mounted at the `volumeMounts` location (as defined in the YAML file for the container):

1. Create two files in a new folder. Name one of them `fileone.txt`, with its contents as `file one`, and name the other `filetwo.txt`, with its contents as `file two`. The folder name can be anything for this exercise. You can confirm that the files have been created using the `ls` command:

   ```
   ls
   ```

   You will see the following list of files:

   ```
   fileone.txt     filetwo.txt
   ```

2. Use the following command to create ConfigMap from a folder. Note that instead of specifying the filename, we just mentioned the name of the folder:

   ```
   kubectl create configmap map-from-folder --from-file=./ -n configmap-test
   ```

   You should see the following response:

   ```
   configmap/map-from-folder created
   ```

3. Now, let's describe the ConfigMap to see what it contains:

   ```
   kubectl describe configmap map-from-folder -n configmap-test
   ```

   You should see the following output:

   ```
   Name:         map-from-folder
   Namespace:    configmap-test
   Labels:       <none>
   Annotations:  <none>

   Data
   ====
   fileone.txt:
   ----
   file one

   filetwo.txt:
   ----
   file two

   Events:  <none>
   ```

Notice that there are two keys in the ConfigMap -- one for each file, that is, `fileone.txt` and `filetwo.txt`. The values of the keys are the contents of the files. Thus, we can see that a ConfigMap can be created from all the files in a folder.

What Is a Secret?

A ConfigMap provides a way to decouple application configuration data from the application itself. However, the problem with a ConfigMap is that it stores the data in plain text as a Kubernetes object. What if we want to store some **sensitive data** such as a database password? Kubernetes Secret provides a way to store sensitive data that can then be made available to the applications that require it.

Secret versus ConfigMap

You can think of a Secret as the same as a ConfigMap with the following differences:

1. Unlike a ConfigMap, a Secret is intended to store a small amount (1 MB for a Secret) of sensitive data. A Secret is **base64**-encoded, so we cannot treat it as secure. It can also store binary data such as a public or private key.
2. Kubernetes ensures that Secrets are passed only to the nodes that are running the Pods that need the respective Secrets.

   Note

   Another way to store sensitive data is a vault solution, such as HashiCorp Vault. We have left such implementation out of the scope of the workshop.

But wait; if the Kubernetes Secrets are not secure enough due to their base64 encoding, then what is the solution for storing extremely sensitive data? One way is to encrypt it and then store it in Secrets. The data can be decrypted while it is being loaded to the Pod, though we are leaving this implementation out of the scope of this workshop.

Once we define our Secrets, we need to expose them to the applications Pods. The way we expose Secrets to the running application is the same as for ConfigMaps, that is, by mounting them as an environment variable or as a file.

As for ConfigMaps, let's use the built-in `help` command for `secret` to see what types of Secrets are offered by Kubernetes:

```
kubectl create secret --help
```

The `help` command should show the following:

```
Create a secret using specified subcommand.

Available Commands:
  docker-registry Create a secret for use with a Docker registry
  generic         Create a secret from a local file, directory or literal value
  tls             Create a TLS secret

Usage:
  kubectl create secret [flags] [options]

Use "kubectl <command> --help" for more information about a given command.
Use "kubectl options" for a list of global command-line options (applies to all commands).
```

As you can see in the preceding output, the `Available Commands` section lists three types of Secrets:

- `generic`: A generic Secret holds any custom-defined key-value pair.
- `tls`: A TLS Secret is a special kind of Secret for holding a public-private key pair for communication using the TLS protocol.
- `docker-registry`: This is a special kind of Secret that stores the username, password, and email address to access a Docker registry.

We will take a deeper dive into the implementation and uses of these Secrets in the following exercises.

Exercise 10.04: Defining a Secret from Literal Values and Loading the Values onto the Pod as an Environment Variable

In this exercise, we will define a Secret from a literal value and load it as an environment variable in the running Pod on Kubernetes. This literal value maybe something like a password to your internal database. Since we are creating this Secret from a literal value, it would be categorized as a **generic** Secret. Follow these steps to perform the exercise:

1. First, create a Secret that will hold a simple password by using the following command:

   ```
   kubectl create secret generic test-secret --from-literal=password=secretvalue -
   -namespace configmap-test
   ```

   You should get a response as follows:

   ```
   secret/test-secret created
   ```

2. Once we define our Secret, we can use the Kubernetes `describe` command to obtain more details about it:

   ```
   kubectl describe secret test-secret --namespace configmap-test
   ```

   ```
   Name:         test-secret
   Namespace:    configmap-test
   Labels:       <none>
   Annotations:  <none>

   Type:  Opaque

   Data
   ====
   password:  11 bytes
   ```

```
You can see that it stored our value against the
`password` key:
```

3. Now that our Secret is created, we will mount it as an environment variable in a Pod. To create a Pod, make a YAML file named `mount-secret-as-env.yaml` with the following content:

   ```
   apiVersion: v1
   kind: Pod
   metadata:
     name: secret-env-pod
   spec:
     containers:
       - name: secret-container
         image: k8s.gcr.io/busybox
         command: [ "/bin/sh", "-c", "env" ]
   ```

```
      envFrom:
      - secretRef:
          name: test-secret
```

Pay attention to the `envFrom` section, which mentions the Secret to load. In the `command` section for the container, we specify the `env` command, which will make the container display all the environment variables loaded into the Pod.

4. Now, let's use the YAML configuration to create a Pod and see it in action:

```
kubectl create -f mount-secret-as-env.yaml --namespace=configmap-test
```

You should see a response as follows:

```
pod/secret-env-pod created
```

5. Now, let's get the logs for the Pod to see all the environment variables displayed by our container:

```
kubectl logs -f secret-env-pod --namespace=configmap-test
```

You should see the logs similar to the following screenshot:

```
KUBERNETES_PORT=tcp://10.96.0.1:443
KUBERNETES_SERVICE_PORT=443
HOSTNAME=secret-env-pod
SHLVL=1
HOME=/root
KUBERNETES_PORT_443_TCP_ADDR=10.96.0.1
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
KUBERNETES_PORT_443_TCP_PORT=443
KUBERNETES_PORT_443_TCP_PROTO=tcp
password=secretvalue
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
KUBERNETES_SERVICE_PORT_HTTPS=443
PWD=/
KUBERNETES_SERVICE_HOST=10.96.0.1
```

As you can see in the highlighted line of the preceding output, the `password` key is displayed with its value as `secretvalue`, which was what we had specified.

The following exercise demonstrates how to use a public-private key combination and mount the private key file into a Pod. The public key can then be made available to any other service connecting to this Pod, but that is not demonstrated in this exercise. Using a separate file as a Secret enables us to use any kind of file instead of simple key-value strings. This opens up the possibility of using binary files like private key stores.

Exercise 10.05: Defining a Secret from a File and Loading the Values onto the Pod as a File

In this exercise, we will create a private key, store it in a new Secret, and then load it onto a Pod as a file:

1. First, let's create a private key. We will use a tool used to create SSH keys. Enter the following command in the terminal:

```
ssh-keygen -f ~/test_rsa -t rsa -b 4096 -C "test@example.com"
```

If prompted, do not provide any password for the key.

Note

If you require more information about the SSH protocol and its uses, please refer to https://www.ssh.com/ssh/protocol/.

After this is executed successfully, you will see two files named `test_rsa` and `test_rsa.pub`. You should see an output similar to the one shown here:

```
Generating public/private rsa key pair.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /Users/faisalmasood/test_rsa.
Your public key has been saved in /Users/faisalmasood/test_rsa.pub.
The key fingerprint is:
SHA256:AXDE/3UZ4oVjT168TJZgURTU7QVsZ3bR54k+8K7OgYw test@example.com
The key's randomart image is:
+---[RSA 4096]----+
|    .++      *BOB|
|     ...    * *+&|
|       ..  o O=X*|
|        .. .o.=+o|
|        S. .+.   |
|        o o  +   |
|       E o .. .  |
|          . ..   |
|          .+.    |
+----[SHA256]-----+
```

```
Your output may not be exactly the same as shown here because the
keys are randomized.

Note

Most Linux distros include the `ssh-keygen` tool. However,
if you don\'t have or cannot use `ssh-keygen`, you can use
any other file instead of the private key to proceed with this
exercise.
```

2. Now, let's load the newly created private key as a Secret. This time, we will use the `from-file` argument of the `create secret` command:

```
kubectl create secret generic test-key-secret --from-file=private-
key=/Users/faisalmassod/test_rsa --namespace=configmap-test
```

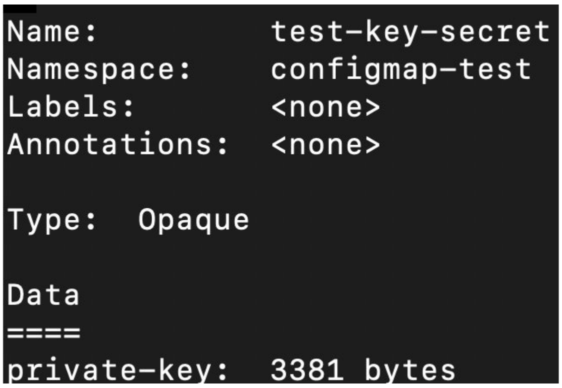
You should get a response like this:

```
secret/test-key-secret created
```

3. Once the Secret is created, we can get its details using the `describe` command:

```
kubectl describe secret test-key-secret --namespace=configmap-test
```

The Secret should be described as follows:



4. Now that our Secret is created, let's mount it onto a Pod. The process is similar to mounting a ConfigMap. First, create a YAML file named `mount-secret-as-volume.yaml` with the following content:

```
apiVersion: v1
kind: Pod
metadata:
  name: secret-test-pod
spec:
  containers:
    - name: secret-container
      image: k8s.gcr.io/busybox
      command: [ "/bin/sh", "-c", "ls /etc/appconfig/; cat
/etc/appconfig/private-key" ]
      volumeMounts:
      - name: secret-volume
        mountPath: /etc/appconfig
  volumes:
    - name: secret-volume
      secret:
        # Provide the name of the Secret containing the files           you
want
        # to add to the container
        secretName: test-key-secret
```

In the preceding Pod specification, note that `volumes` are mounted the same way as we mounted the earlier ConfigMap. In the volumes section, we are instructing Kubernetes to define a volume from our Secret. In the `volumeMounts` section, we are defining the specific path on which Kubernetes should mount the volume. The `"/bin/sh", "-c", "ls /etc/appconfig/; cat /etc/appconfig/private-key"` command will print out the contents of the file loaded onto it as a Secret.

Note

The `name` field in the `volume` and `volumeMounts` sections has to be the same so that Kubernetes can identify which `volume` is associated with which `volumeMounts`. For this example, we have used `secret-volume` as the name in both places.

5. Now, let's create a Pod using the YAML file as the Pod definition using the following command:

```
kubectl create -f mount-secret-as-volume.yaml --namespace=configmap-test
```

If the Pod is successfully created, you should see the following output:

```
pod/secret-test-pod created
```

6. To check whether our Pod has the Secret loaded, we can get its logs and examine them. Use the following command:

```
kubectl logs -f secret-test-pod --namespace=configmap-test
```

The logs should show the contents of the private key, as follows:


```
private-key
-----BEGIN OPENSSH PRIVATE KEY-----
b3BlbnNzaC1rZXktdjEAAAAABG5vbmUAAAAEbm9uZQAAAAAAAAABAAACFwAAAAdzc2gtcn
NhAAAAAwEAAQAAAgEAuyK4s7tLoRtEzdIr1o6FWA8qW7N9rMCFfPsVh7M8s7J2iYA/HhS8
WQS+RzhliTlaYfTdbjwaVJZhhgEVN6PCqAWZGCRCiw+UBKWe0uGm4whDIDhdnXF3y20/BS
bhb+iIBLlKj7Z4+1wdQRT28AsytY9iNZPA22ApWxeAsHi/qffIUp+hhITJ9ije0IUQeQLC
8qwvEHx89CP1+rVSP02DrCd1RmbbGRsd2uPeWfE9aKKkxFwoR7XXK24vmkTyL+2elUODdH
i3pJXMpo1hFcYhFr/4vml4m6qRyRWwhnMieYzHX70xmGTu/ta6TjQLJxtSzDvIj+/dEKIt
iPGkLhSoon3rnGa20xltTBci/m86JhGpob3/6H03UuhOZv8+XNO7eMj7ev8Mat/7sOSS62
K4+z2hZovk9i9zuMfDmJAqJqoRlMl55V3EPyM/ouHNB0fjxkODZ1bApLxz1KicpeKJBMUF
DAmxBKHYjFgam02Mxci9EIvCNymfjFQFnPkUSFj+mFCwTt1RLD/+hP4WeSiHJRHIyibUfa
sD2cN8mN3CE1TV/ONez431QKaWPJFa6tMlngcrcgDA3jYYI8HzrNuIJCYEc7rBkNAe4NZm
GCKfT0nRQAUhApxMoQmc9qtkFhLNO/AbrKMfZfR3gCm1AkN/zo9uCpxxL/VC9MUam43S9c
cAAAdITMfpVUzH6VUAAAAHc3NoLXJzYQAAAgEAuyK4s7tLoRtEzdIr1o6FWA8qW7N9rMCF
fPsVh7M8s7J2iYA/HhS8WQS+RzhliTlaYfTdbjwaVJZhhgEVN6PCqAWZGCRCiw+UBKWe0u
Gm4whDIDhdnXF3y20/BSbhb+iIBLlKj7Z4+1wdQRT28AsytY9iNZPA22ApWxeAsHi/qffI
Up+hhITJ9ije0IUQeQLC8qwvEHx89CP1+rVSP02DrCd1RmbbGRsd2uPeWfE9aKKkxFwoR7
```


```
As you can see from the log, the container is displaying the
contents of the Secret mounted onto the Pod.

Note

Since the SSH key is randomized, your output may not look exactly
the same as the one shown here.
```

7. The SSH key is randomized, so each time you will get a different output. You can try this exercise multiple times and see for yourself. Make sure to either delete the Pod or change the name every time. You can delete the Pod using the following command:

```
kubectl delete pod secret-test-pod --namespace=configmap-test
```

You will see the following output if the Pod is successfully deleted:

```
pod "secret-test-pod" deleted
```

In this exercise, we created a key pair using another tool and loaded the private key onto our Pod by mounting it as a binary file. However, public-private key pairs are used for encryption in the TLS protocol, which is a cryptographic standard for securing web traffic.

Note

To learn more about TLS, please refer to https://www.cloudflare.com/learning/ssl/transport-layer-security-tls/.

Kubernetes provides its own way of creating a key pair and storing keys for TLS. Let's see how to create a TLS Secret in the following exercise.

Exercise 10.06: Creating a TLS Secret

In this exercise, we will see how to create a Secret that can store a cryptographic key for TLS:

1. Use the following command to create a pair of private-public keys:

   ```
   openssl req -x509 -nodes -days 365 -newkey rsa:2048 -keyout tls.key -out
   tls.crt -subj "/CN=kube.example.com"
   ```

   This command creates the private key in the file named `tls.key`, and the public certificate in the file named `tls.crt`.

   Note

   For more details on how the **openssl** tool is used here, you can refer to https://www.openssl.org/docs/manmaster/man1/req.html.

   If the key is successfully generated, you should see an output like this:

   ```
   Generating a 2048 bit RSA private key
   ...................................+++
   ................................................+++
   writing new private key to 'tls.key'
   -----
   ```

2. Once it is successful, we can create a Secret to hold the files using the following command:

   ```
   kubectl create secret tls test-tls --key="tls.key" --cert="tls.crt" --
   namespace=configmap-test
   ```

   Once the Secret is successfully created, you will see the following output:

   ```
   secret/test-tls created
   ```

3. Verify that our Secret is created by listing down all Secrets in the `configmap-test` namespace using the following command:

   ```
   kubectl get secrets --namespace configmap-test
   ```

   Our Secret must be listed in the following output:

```
NAME                  TYPE                                  DATA   AGE
default-token-hvn5s   kubernetes.io/service-account-token   3      27m
test-key-secret       Opaque                                1      5m2s
test-secret           Opaque                                1      7m34s
test-tls              kubernetes.io/tls                     2      17s
```

4. If we issue the `describe` command for the newly created Secret, you can see that it stores the two parts, the public and the private key, as two different keys of the Secret:

   ```
   kubectl describe secrets test-tls --namespace configmap-test
   ```

   You should see the following response:

   ```
   Name:         test-tls
   Namespace:    configmap-test
   Labels:       <none>
   Annotations:  <none>

   Type:  kubernetes.io/tls

   Data
   ====
   tls.key:  1704 bytes
   tls.crt:  997 bytes
   ```

Thus, we have created a set of public-private keys for TLS using a special set of commands provided by Kubernetes. This Secret can be mounted in a similar way as demonstrated in *Exercise 10.05*, *Defining a Secret from a File and Loading the Values onto the Pod as a File*.

Another common task is to fetch Docker images from an external Docker registry. Many organizations use **enterprise container registries** (for example, Nexus) for their applications, which can then be fetched and deployed as needed. Kubernetes also provides a special type of Secret to store authentication information for accessing these Docker registries. Let's see how to implement it in the following exercise.

Exercise 10.07: Creating a docker-registry Secret

In this exercise, we will create a **docker-registry** Secret that can be used for authentication while fetching a Docker image from a registry:

1. We can create the Secret directly using the following command:

   ```
   kubectl create secret docker-registry test-docker-registry-secret --docker-username=test --docker-password=testpassword --docker-email=example@a.com --namespace configmap-test
   ```

   As you can see in the command arguments, we need to specify the username, password, and email address for the Docker account. Once the Secret is created, you should see the following response:

   ```
   secret/test-docker-registry-secret created
   ```

2. Verify that it is created by using this command:

```
kubectl get secrets test-docker-registry-secret --namespace configmap-test
```

You should see `test-docker-registry-secret` as displayed in the following output:

```
NAME                          TYPE                             DATA   AGE
test-docker-registry-secret   kubernetes.io/dockerconfigjson   1      30s
```

3. Let's use the `describe` command and get more details about our Secret:

```
kubectl describe secrets test-docker-registry-secret --namespace configmap-test
```

The command should return the following details:

```
Name:         test-docker-registry-secret
Namespace:    configmap-test
Labels:       <none>
Annotations:  <none>

Type:  kubernetes.io/dockerconfigjson

Data
====
.dockerconfigjson:  145 bytes
```

As you can see under the `Data` section of the preceding output, a single key with the name `.dockerconfigjson` has been created.

Note

This exercise is just an easy way to load a `.dockerconfigjson` file. You can create and load the file manually using other methods and achieve the same objective as we have in this exercise.

Activity 10.01: Using a ConfigMap and Secret to Promote an Application through Different Stages

Let's assume that we have an application and we want to promote it to different environments. Your task is to promote the application from testing to production environments, and each environment has different configuration data.

In this activity, we will use the ConfigMap and Secret to easily reconfigure the application for different stages in its life cycle. It should also give you an idea of how the separation of ConfigMap data and Secret data from the application can help in the easier transition of an application through various stages of development and deployment.

These guidelines should help you to complete the activity:

1. Define a namespace called `my-app-test`.

2. Define a ConfigMap named `my-app-data` in the `my-app-test` namespace with the following key values:

   ```
   external-system-location=https://testvendor.example.com
   external-system-basic-auth-username=user123
   ```

3. Define a Secret named `my-app-secret` in the `my-app-test` namespace with the following key values:

   ```
   external-system-basic-auth-password=password123
   ```

4. Define a Pod specification and deploy the ConfigMap in the `/etc/app-data` folder with the filename `application-data.properties`.

5. Define a Pod specification and deploy the Secret in the `/etc/secure-data` folder with the filename `application-secure.properties`.

6. Run the Pod so that it displays all the contents from the ConfigMap and the Secret. You should see something like this:

   ```
   external-system-location=https://testvendor.example.com
   external-system-basic-auth-username=user123
   external-system-basic-auth-password=password123
   ```

7. Define another namespace called `my-app-production`.

8. Define a ConfigMap named `my-app-data` in `my-app-production` with the following key values:

   ```
   external-system-location=https://vendor.example.com
   external-system-basic-auth-username=activityapplicationuser
   ```

9. Define a Secret named `my-app-secret` in `my-app-production` with the following key values:

   ```
   external-system-basic-auth-password=A#4b*(1=B88%tFr3
   ```

10. Use the same Pod specification as defined in *step 5* and run the Pod in the `my-app-production` namespace.

11. Check whether the application running in `my-app-production` displays the correct data. You should see output like this:

    ```
    external-system-location=https://vendor.example.com
    external-system-basic-auth-username=activityapplicationuser
    external-system-basic-auth-password=A#4b*(1=B88%tFr3
    ```

Note

The solution to this activity can be found at the following address: `Activity_Solutions\Solution_Final.pdf`. The GitHub repository also includes a Bash script for this activity, which will execute all these solution steps automatically. However, please take a look at the detailed steps provided in the solution to get a complete understanding of how to perform the activity.

Summary

In this lab, we have seen the different ways that Kubernetes provides to associate environment-specific data with our applications running as containers.

Kubernetes provides ways to store sensitive data as Secrets and normal application data as ConfigMaps. We have also seen how to create ConfigMaps and Secrets and associate them with our containers via CLI. Running everything via the command line will facilitate the automation of these steps and improve the overall agility of your application.

Associating data with containers enables us to use the same container across different environments in our IT systems (for example, in test and production). Using the same container across different environments provides a way for secure and trusted code promotion techniques for IT processes. Each team can use a container as a unit of deployment and sign the container so that other parties can trust the container. This also provides a trusted way of distributing code not only across the same IT organizations but also across multiple organizations. For example, a software vendor can just provide you with a container as packaged software. ConfigMaps and Secrets can then be used to provide specific configurations for using the packaged software in your organization.

The next set of labs is all about deploying Kubernetes and running it in high availability mode. These labs will provide you with fundamental and practical knowledge regarding how to run stable clusters for Kubernetes.