# Lab Module 3: Intermediate Kubernetes Concepts

> *Estimated Duration: 60 minutes*

## Module 3 Table of Contents



# Create a Basic Cluster

For the exercises in this module, you'll need simple AKS cluster.

### Task 1 - Create an AKS cluster

1. Select the region closest to your location. Use '**eastus**' for United States workshops, '**westeurope**' for European workshops. Ask your instructor for other options in your region: @lab.DropDownList(region) [eastus,westus,canadacentral,westeurope,centralindia,australiaeast]
2. Define variables (update as needed)

```
$INSTANCE_ID="@lab.LabInstance.Id"
$AKS_RESOURCE_GROUP="azure-$($INSTANCE_ID)-rg"
$LOCATION="@lab.Variable(region)"
$VM_SKU="Standard_D2as_v5"
```

```
$AKS_NAME="aks-$($INSTANCE_ID)"
$NODE_COUNT="3"
```

3. Create Resource Group

```
az group create --location $LOCATION `
                --resource-group $AKS_RESOURCE_GROUP
```

4. Create Basic cluster.

```
az aks create --node-count $NODE_COUNT `
              --generate-ssh-keys `
              --node-vm-size $VM_SKU `
              --name $AKS_NAME `
              --resource-group $AKS_RESOURCE_GROUP
```

5. Connect to local environment

```
az aks get-credentials --name $AKS_NAME `
                       --resource-group $AKS_RESOURCE_GROUP
```

6. Verify connection

```
kubectl get nodes
```

# Exercise: Working with Multi-Container Pods, Ephemeral Volumes and ConfigMaps

This exercise shows how multiple containers within the same pod can use volumes to communicate with each other and how you can use *ConfigMaps* to mount settings files into containers.

The example Deployment below configures a MySQL instance to write its activities to a log file. Another container reads that log file, and in a production setting, would send the contents to an external log aggrigator. In this example, the 2nd container just outputs the *tail* of the log file to the console.

### Task 1 - Review and deploy ConfigMaps

1. Open a Windows Terminal window (defaults to PowerShell).


2. Change current folder to **Module3**

```
cd  C:\k8s\labs\Module3
```

3. Review the **mysql-initdb-cm.yaml** file. This script will run automatically when MySql starts.

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: mysql-initdb-cm
data:
  initdb.sql: |
    CREATE DATABASE sample;
    USE sample;
    CREATE TABLE friends (id INT, name VARCHAR(256), age INT, gender VARCHAR(3));
    INSERT INTO friends VALUES (1, 'John Smith', 32, 'm');
    INSERT INTO friends VALUES (2, 'Lilian Worksmith', 29, 'f');
    INSERT INTO friends VALUES (3, 'Michael Rupert', 27, 'm');
```

When the ConfigMap is mounted in a container, it will create a file called **initdb.sql**.

4. Deploy the ConfigMap.

```
kubectl apply -f mysql-initdb-cm.yaml
```

5. Configure MySql to generate activity logs and save them to a file. Review the contents of **mysql-cnf-cm.yaml**. This file will replace the default **my.cnf** config file in the container.

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: mysql-cnf-cm
data:
  my.cnf: |
    !includedir /etc/mysql/conf.d/
    !includedir /etc/mysql/mysql.conf.d/

    [mysqld]
    #Set General Log
    general_log = on
    general_log_file=/usr/log/general.log
```

6. Deploy the ConfigMap.

```
kubectl apply -f mysql-cnf-cm.yaml
```

### Task 2 - Review and deploy multi-container Deployment

1. Review the Volumes section of **mysql-dep.yaml**.

```
      volumes:
      - name: mysql-initdb
        configMap:
          name: mysql-initdb-cm
      - name: mysql-cnf
        configMap:
```

```
          name: mysql-cnf-cm
      - name: mysql-log
        emptyDir: {}
```

> *Notice that both ConfigMaps are being mapped to volumes and an empty directory is being created for the logs.*

2. Review the volumeMounts section of **mysql-dep.yaml**.

```
    volumeMounts:
      - name: mysql-initdb
        mountPath: /docker-entrypoint-initdb.d
      - name: mysql-cnf
        mountPath: /etc/mysql/my.cnf
        subPath: my.cnf
      - name: mysql-log
        mountPath: /usr/log/
```

The init file is mapped to the known MySql folder. Anything placed is that folder is executed by MySql during it startup.

The config file is mapped to the MySql config folder. However, there are other config files already in that folder that MySql needs to access. As a result, replacing the entire folder with the contents of the ConfigMap will prevent MySql from working, because the other config files won't be there.

That's where the *subPath* property comes into play. It allow you to mount only a subset of your volume (in this case only a single file), leaving the exiting content in place at the destination.

The final mount points to the empty directory created to hold the logs.

3. Review the second container definition.

```
  - name: logreader
    image: busybox
    command:
      - "/bin/sh"
    args:
      - "-c"
      - "tail -f /usr/log/general.log;"
    volumeMounts:
      - name: mysql-log
        mountPath: /usr/log/
```

> *Notice that the same empty directory is mounted to this container and that the container simply executes a tail command, outputting the last line in the file.*

4. Apply the deployment.

```
kubectl apply -f mysql-dep.yaml
```

### Task 3 - Confirm communications between containers

1. Get list of Pods.

```
kubectl get pods
```

2. Once the Pod is running, look at the log of the second container.

```
kubectl logs -c logreader -f "name of mysql-dep-xxxxx pod"
```

3. Open another shell window and execute into the first container

```
kubectl exec -it -c mysql "name of mysql-dep-xxxxx pod" -- bash
```

4. In the shell, type **mysql** to enter the MySql console.

```
mysql
```

5. Type the following commands in the ***mysql>*** prompt:

```
use sample;
select * from friends;
```

6. Switch to the other window and verify that the second container is showing the log.

```
mysqld, Version: 5.7.35-log (MySQL Community Server (GPL)). started with:
Tcp port: 0  Unix socket: /var/run/mysqld/mysqld.sock
Time                 Id Command    Argument
2021-08-05T03:57:25.617816Z         2 Connect   root@localhost on  using Socket
2021-08-05T03:57:25.618005Z         2 Query     select @@version_comment limit 1
2021-08-05T03:57:43.601557Z         2 Query     SELECT DATABASE()
2021-08-05T03:57:43.601797Z         2 Init DB   sample
2021-08-05T03:57:43.602822Z         2 Query     show databases
2021-08-05T03:57:43.603177Z         2 Query     show tables
2021-08-05T03:57:43.603323Z         2 Field List        friends
2021-08-05T03:57:47.077235Z         2 Query     select * from friends
```

7. Exit out of the **MySql** console.

```
exit;
```

8. Exit out of the container.

```
exit
```

[Module 3 Table of Contents]
[List of Modules]

# Exercise: Working with Persistent Volumes, Persistent Volume Claims and Secrets

This exercise shows an example of using a secret to store the password needed by an Azure File Share. You will first create the Azure File Share, get its Access Key and then configure a secret to use that access key to connect a volume to a Pod.

### Task 1 - Create an Azure Storage Account and an Azure File Share

1. Open a Windows Terminal window (defaults to PowerShell).


2. Login to Azure.

```
az login
az account set --subscription "Azure Pass - Sponsorship"
```

3. Define variables.

```
$INSTANCE_ID="@lab.LabInstance.Id"
$AKS_RESOURCE_GROUP="azure-$($INSTANCE_ID)-rg"
$LOCATION="@lab.Variable(region)"
$STORAGE_ACCOUNT_NAME="sa$($INSTANCE_ID)"
$SHARE_NAME="share$($INSTANCE_ID)"
```

4. Create the Azure Storage Account.

```
az group create --location $LOCATION  --resource-group $AKS_RESOURCE_GROUP

az storage account create --name $STORAGE_ACCOUNT_NAME `
                          --resource-group $AKS_RESOURCE_GROUP `
                          --sku Standard_LRS
```

5. Create the Azure File Share.

```
az storage share create --name $SHARE_NAME `
                        --connection-string `
                        $(az storage account show-connection-string `
                        --name $STORAGE_ACCOUNT_NAME `
                        --resource-group $AKS_RESOURCE_GROUP -o tsv)
```

6. The ***Account Name*** and ***Account Key*** will be echoed to the screen for reference.

```
$STORAGE_KEY=$(az storage account keys list `
       --resource-group $AKS_RESOURCE_GROUP `
       --account-name $STORAGE_ACCOUNT_NAME `
       --query "[0].value" -o tsv)

$STORAGE_ACCOUNT_NAME
$STORAGE_KEY
```

### Task 2 - Create a Namespace for this lab

All the objects related to this lab will be self-contained in a Namespace. When you're done, delete the Namespace and all the objects it contains will also be deleted. The the Persistent Volume, which is scoped across the entire cluster, will remain.

1. Create a new Namespace.

```
kubectl create ns lab3volume
```

2. Set the new Namespace as the current namespace, so it doesn't have to be specified in future commands.

```
kubectl config set-context --current --namespace lab3volume
```

### Task 3 - Create a Secret imperatively

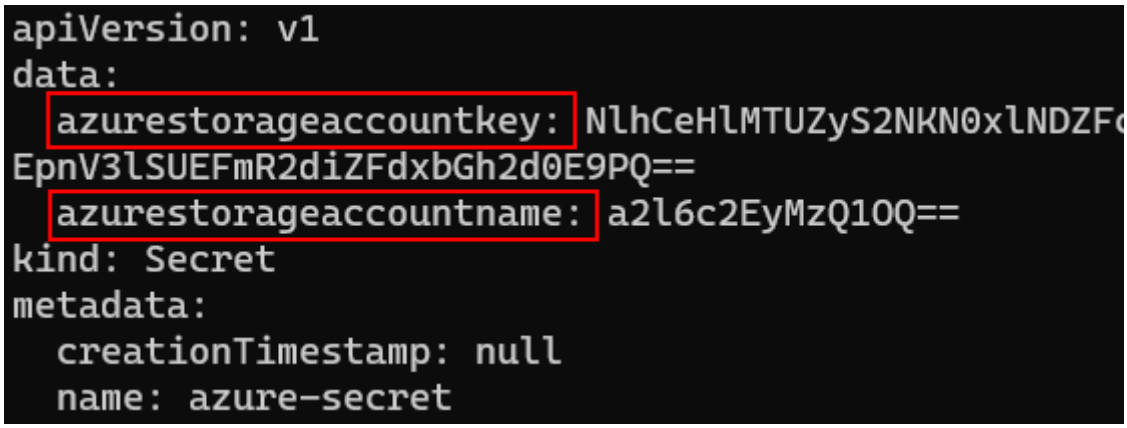
1. The ***Account Name*** and ***Account Key*** need to be saved into a Kubernetes Secret object. The best way to do this is to create the Secret imperatively:

```
kubectl create secret generic azure-secret `
      --from-literal=azurestorageaccountname=$STORAGE_ACCOUNT_NAME `
      --from-literal=azurestorageaccountkey=$STORAGE_KEY `
      --dry-run=client `
      --namespace lab3volume `
      -o yaml > azure-secret.yaml
```

2. A YAML file is generated with all the information needed to create the secret. Review the new file.

```
cat azure-secret.yaml
```

**NOTE:** It's best to create the file first and then apply it so you can repeat the process if needed.




3. Apply the secret in the **default** namespace. Since the Persistent Volume is not a namespaced resource, it will expect to find the secret in the **default** namespace.

```
kubectl apply -f azure-secret.yaml -n lab3volume
```

### Task 4 - Create a Persistent Volume and a Persistent Volume Claim

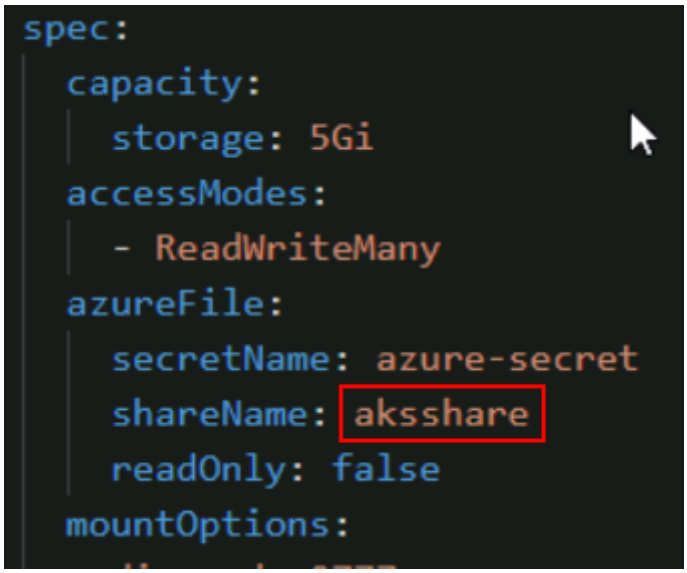
The first step to accessing an Azure File Share is creating a *PersistentVolume* object that connects to that share.

1. Review the value of **SHARE_NAME** created in Task 1 above.

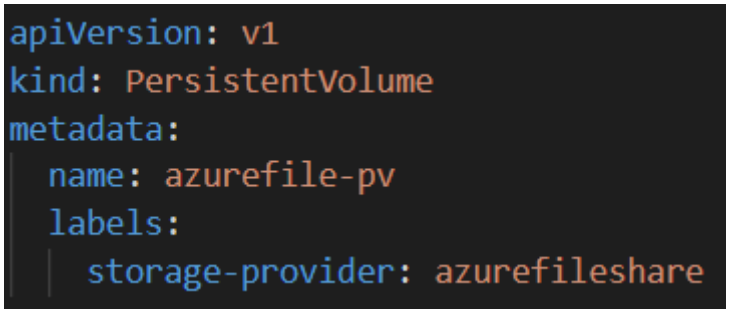
```
echo $SHARE_NAME
```

**CRITICAL STEP:**

2. Review the contents of **azurefile-pv.yaml**. Make sure the **shareName** property matches the value of **SHARE_NAME**.




3. Also notice there's a label associated with the persistent volume:




4. When the file is ready, apply it.

```
kubectl apply -f azurefile-pv.yaml
```

5. Make sure the *PersistentVolume* was created and has a status of *Available*.

```
kubectl get pv
```

```
NAME          CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS      CLAIM   STORAGECLASS   REASON   AGE
azurefile-pv  5Gi        RWX            Retain           Available                                   48s
```

6. Review the contents of **azurefile-pvc.yaml**. Notice that the label selector is set to look for the persistent volume:

```yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: azurefile-pvc
spec:
  selector:
    matchLabels:
      storage-provider: azure-file-share
  storageClassName: azurefile-csi
  accessModes:
    - ReadWriteMany
  resources:
    requests:
      storage: 5Gi
```

Also the label selector is set to find the PV.

7. Apply the Persistent Volume Claim.

```
kubectl apply -f azurefile-pvc.yaml
```

8. Verify that the Persistent Volume Claim is *bound* to the Persistent Volume.

```
kubectl get pvc
```

```
NAME           STATUS   VOLUME         CAPACITY   ACCESS MODES   STORAGECLASS   AGE
azurefile-pvc  Bound    azurefile-pv   5Gi        RWX                           3s
```

9. Review the PersistentVolume again

```
kubectl get pv
```

```
NAME           CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                      STORAGECLASS
azurefile-pv   5Gi        RWX            Retain           Bound    lab3volume/azurefile-pvc   azurefile-csi
```

Notice that the PVC claimed the PV:

### Task 5 - Use the Persistent Volume Claim in a Pod

Now that the connection is configured to the Azure File Share, create a Pod to use the Persistent Volume Claim.

1. Review the contents of **test-pvc-pod.yaml**. Notice how the *persistentVolumeClaim* is being used and *mountPath* of the *volumeMount*.

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: test-pvc-pod
spec:
  containers:
  - image: nginx
    name: nginx
    volumeMounts:
    - mountPath: /sharedfolder
      name: azure-file-volume
  volumes:
  - name: azure-file-volume
    persistentVolumeClaim:
      claimName: azurefile-pvc
```

2. Apply the Pod.

```
kubectl apply -f pvc-pod.yaml
```

3. Confirm the Pod is running. It might take a few minutes for the Pod to connect to the PVC.

```
kubectl get pod pvc-pod
```

4. Once the Pod is running, shell into the Pod.

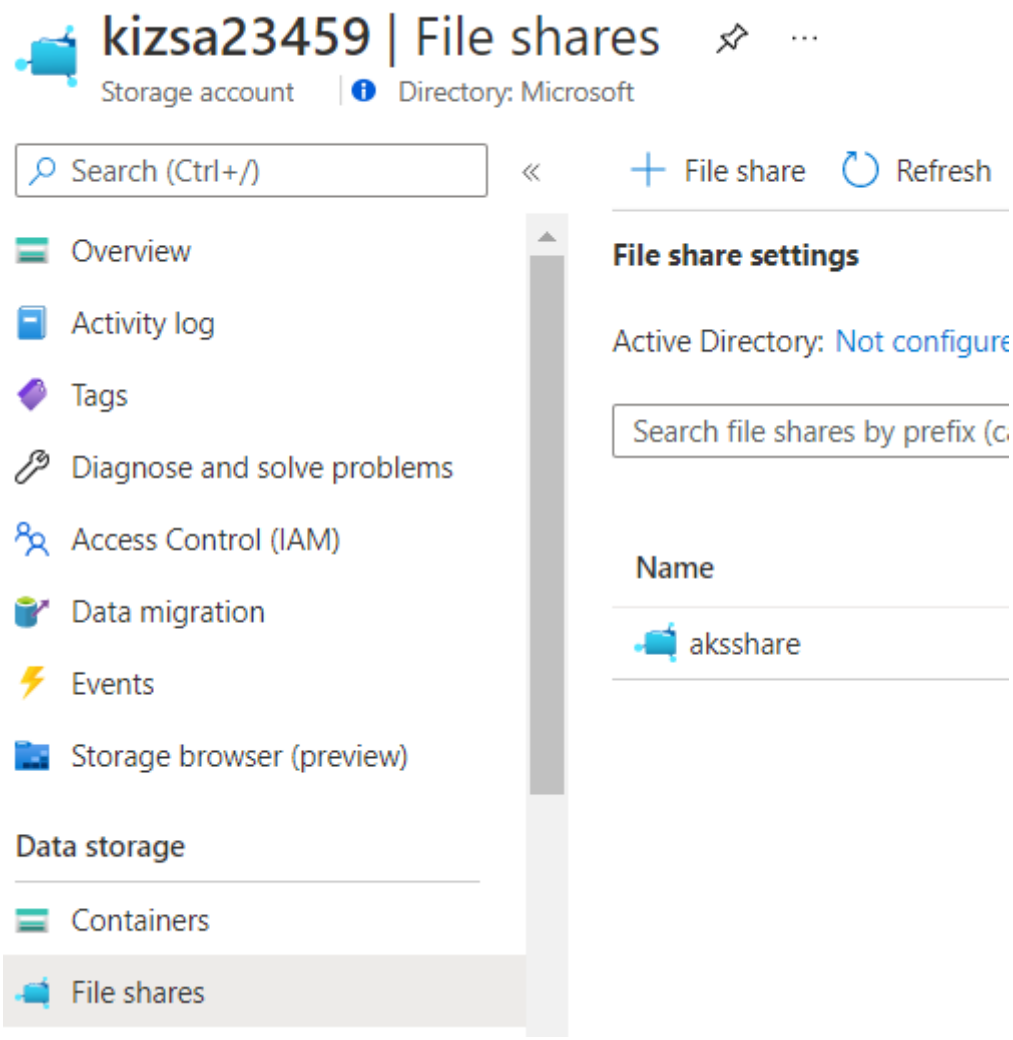
```
kubectl exec -it pvc-pod -- bash
```

5. Change into the shared folder, create a file and confirm it's there.

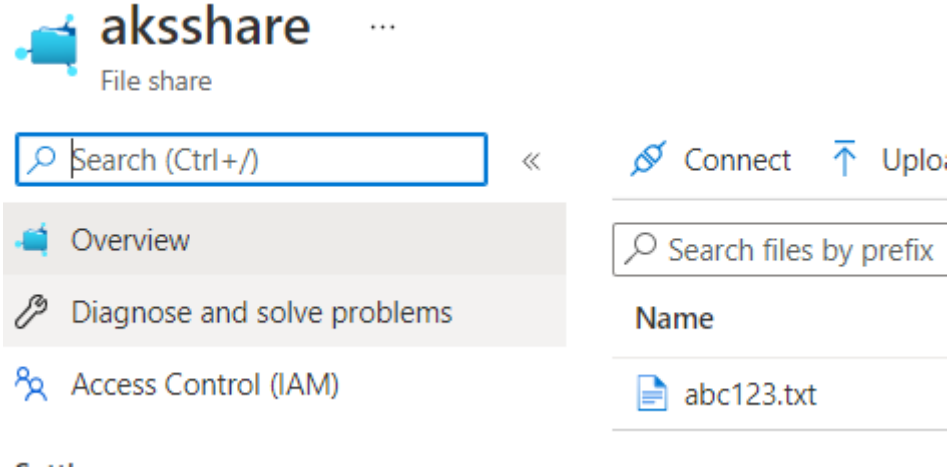
```
cd /sharedfolder
touch abc123.txt
```

```
ls -l
```

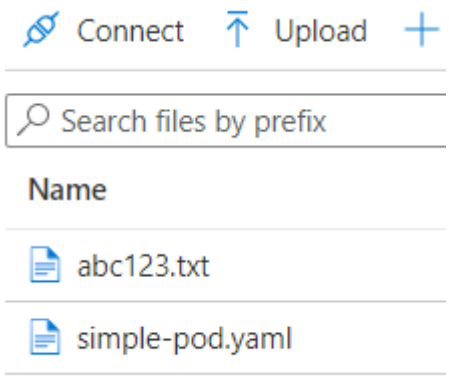
6. Open the Azure Portal in a browser.
7. Navigate to the storage account created earlier (as defined in **STORAGE_ACCOUNT_NAME**).
8. Click on the File shares selection.




9. Click on the file share name.




10. You should see the file you created in the container. Click the **Upload** button and upload a file from your hard drive to the share.




10. Get a list of files in the shared folder again.

```
ls -l
```

Both files should be in the shared folder:

```
root@test-pvc:/sharedfolder# ls -l
total 1
-rwxrwxrwx 1 1000 1000   0 Jul 29 03:55 abc123.txt
-rwxrwxrwx 1 1000 1000 205 Jul 29 04:02 simple-pod.yaml
```

This confirms that the **sharedfolder** is mapped to the Azure File Share.

11. Exit the container.

```
exit
```

### Task 6 - Set the current Namespace back to default

1. Set the current namespace back to default so all of these objects stay separate from the other labs.

```
kubectl config set-context --current --namespace default
```

2. **OPTIONAL**: If you prefer, you can delete the namespace. This will delete all the objects (secrets, persistent volume claim, pods) from the cluster. The only object that will remain will be the Persistent Volume, because it's not tied to any specific namespace.

```
kubectl delete ns lab3volume
```

Module 3 Table of Contents
List of Modules

# Exercise: Using Ingress Resources and Ingress Controller to control external access

Ingress resources and 3rd-party Ingress Controllers can be used to centrally control external access to the cluster.

### Task 1 - Install NGinx Ingress Controller

1. Change current folder to **C:\k8s\labs\Module3**.

```
cd C:\k8s\labs\Module3
```

2. Install **Nginx Ingress Controller** using **Helm**:

```
helm repo add ingress-nginx https://kubernetes.github.io/ingress-nginx
helm repo update
```

```
helm install nginx-ingress ingress-nginx/ingress-nginx `
    --namespace ingress-nginx --create-namespace `
    --set controller.nodeSelector."kubernetes\.io/os"=linux `
    --set defaultBackend.nodeSelector."kubernetes\.io/os"=linux
```

3. Wait a few minutes to allow the Nginx Load Balancer service to aquire an external IP address.
4. Query the services in the ***ingress-nginx*** namespace.

```
kubectl get svc -n ingress-nginx
```

Get the *EXTERNAL IP* of the Load Balancer:

```
NAME                                 TYPE           CLUSTER-IP     EXTERNAL-IP     PORT(S)
AGE
service/ingress-nginx-controller     LoadBalancer   10.0.240.47    52.146.66.160
80:32616/TCP,443:31149/TCP   108s
```

```
service/ingress-nginx-controller-admission   ClusterIP      10.0.244.155   <none>          443/TCP
108s
```

### Task 2 - Install Deployments, Services and Ingress Resource in a separate namespace

1. Create the *dev* namespace

```
kubectl create ns dev
```

2. Change current folder to **C:\k8s\labs\Module3**.

```
cd C:\k8s\labs\Module3
```

3. Apply the deployments and services.

```
kubectl apply -f blue-dep.yaml -f blue-svc.yaml -n dev
kubectl apply -f red-dep.yaml -f red-svc.yaml -n dev
```

4. Review the contents of **C:\k8s\labs\Module3\colors-ingress.yaml** file in an editor. Notice the *path* setting to route traffic to the correct service.

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  annotations:
    kubernetes.io/ingress.class: nginx
    nginx.ingress.kubernetes.io/rewrite-target: /$1
  name: colors-ingress
spec:
  rules:
    - http:
        paths:
        - path: /blue/(.*)
          pathType: Prefix
          backend:
            service:
              name: blue-svc
              port:
                number: 8100
        - path: /red/(.*)
          pathType: Prefix
          backend:
            service:
              name: red-svc
              port:
                number: 8100
```

5. Apply the Ingress resource.

```
kubectl apply -f colors-ingress.yaml -n dev
```

6. Verify the ingress resource was created.

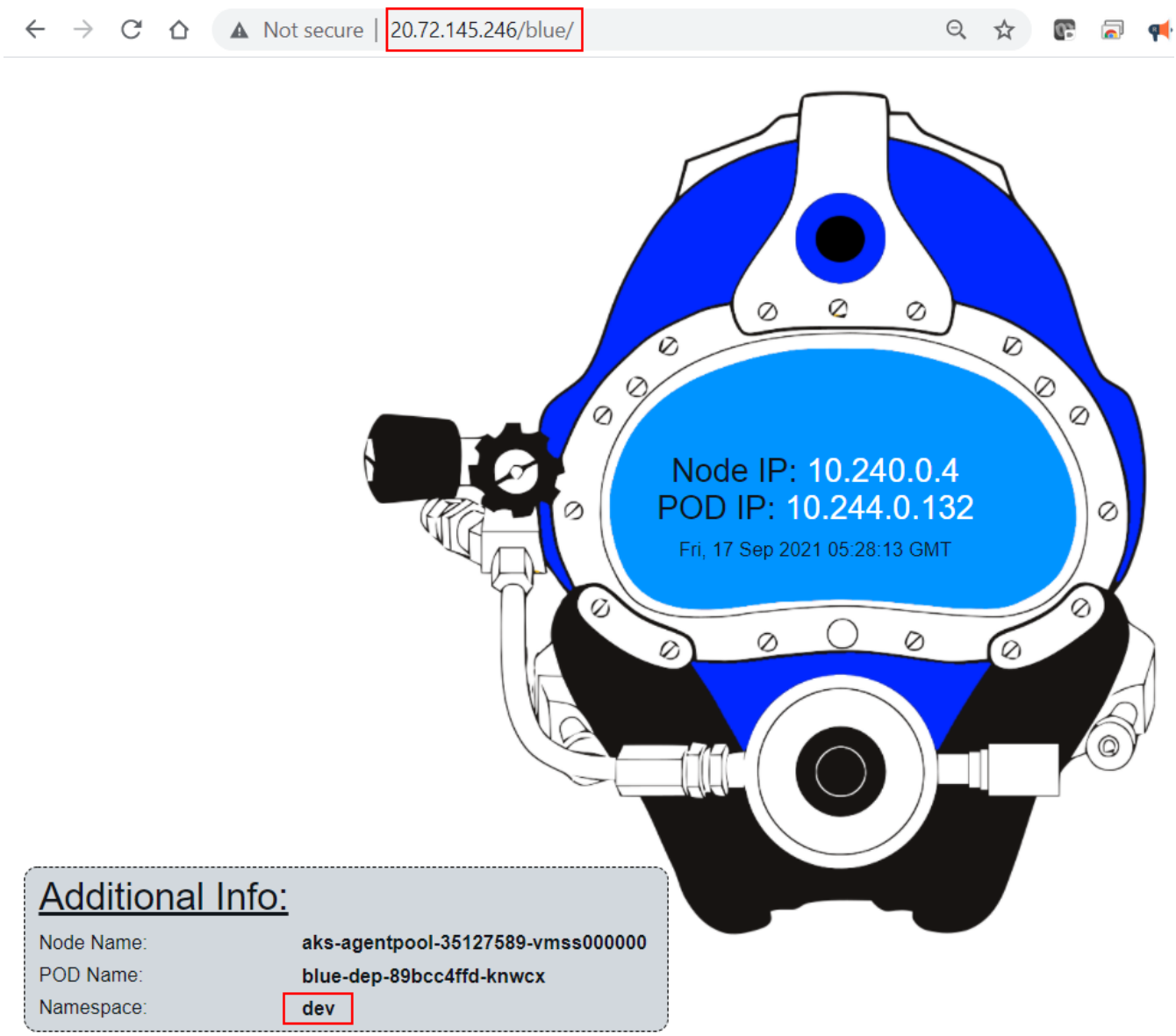
```
kubectl get ing -n dev
```

Returns:

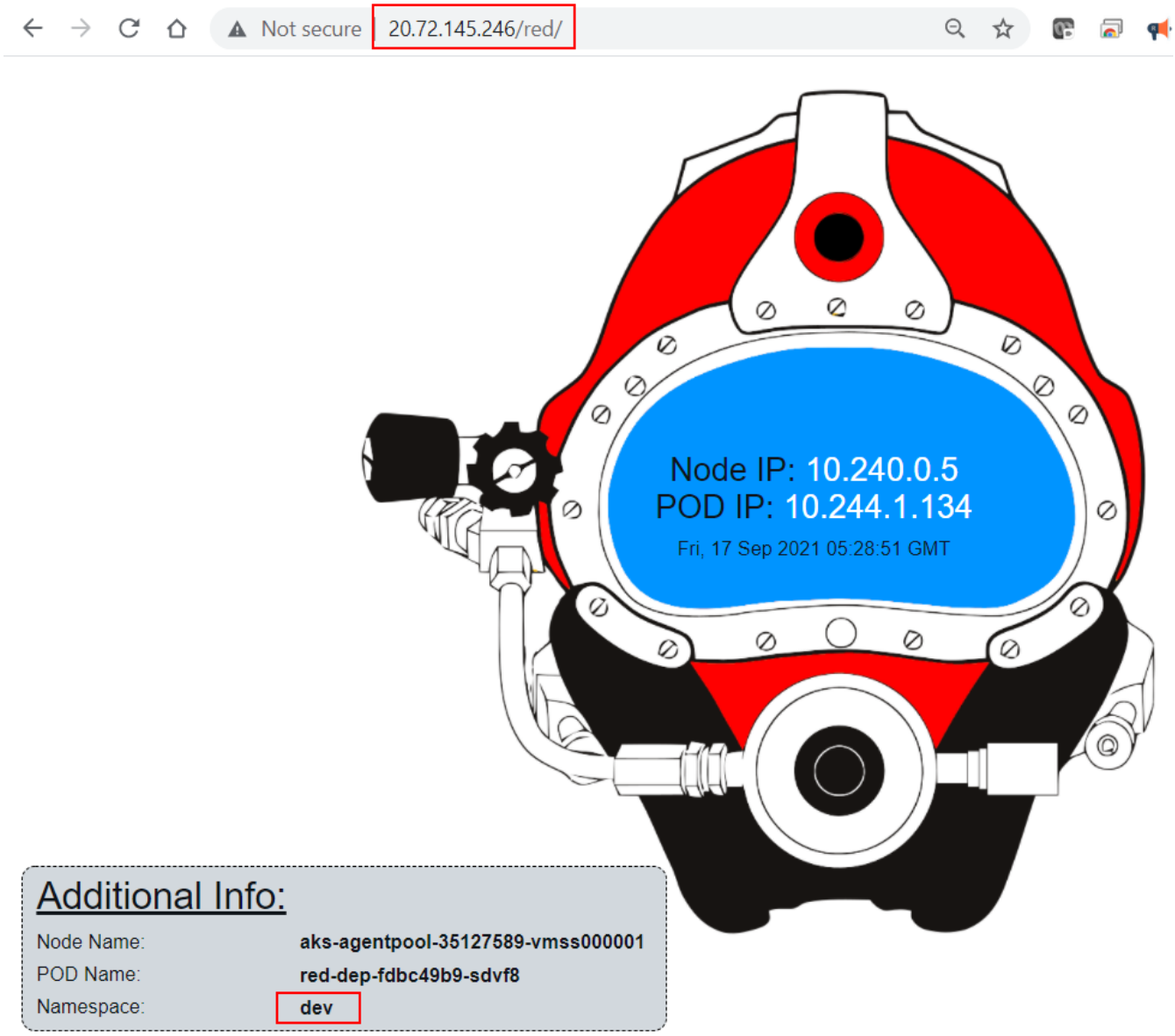
```
NAME             CLASS    HOSTS   ADDRESS   PORTS   AGE
colors-ingress   <none>   *                 80      16s
```

### Task 3 - Access Pods From a single external IP

1. Open the browser and enter the exnteral IP of the Ingress controller service and append "/blue/" to the path: **http://"external ip"/blue/** (make sure to include the last /).




2. Open the browser and enter the exnteral IP of the Ingress controller service and append "/red/" to the path: **http://"external ip"/red/** (make sure to include the last /)




**Task 4 - Define a Default Backend**

1. Open the browser and enter the exnteral IP of the Ingress controller by itself: **http://"external ip"**


This is the default NGinx Ingress Controller page.

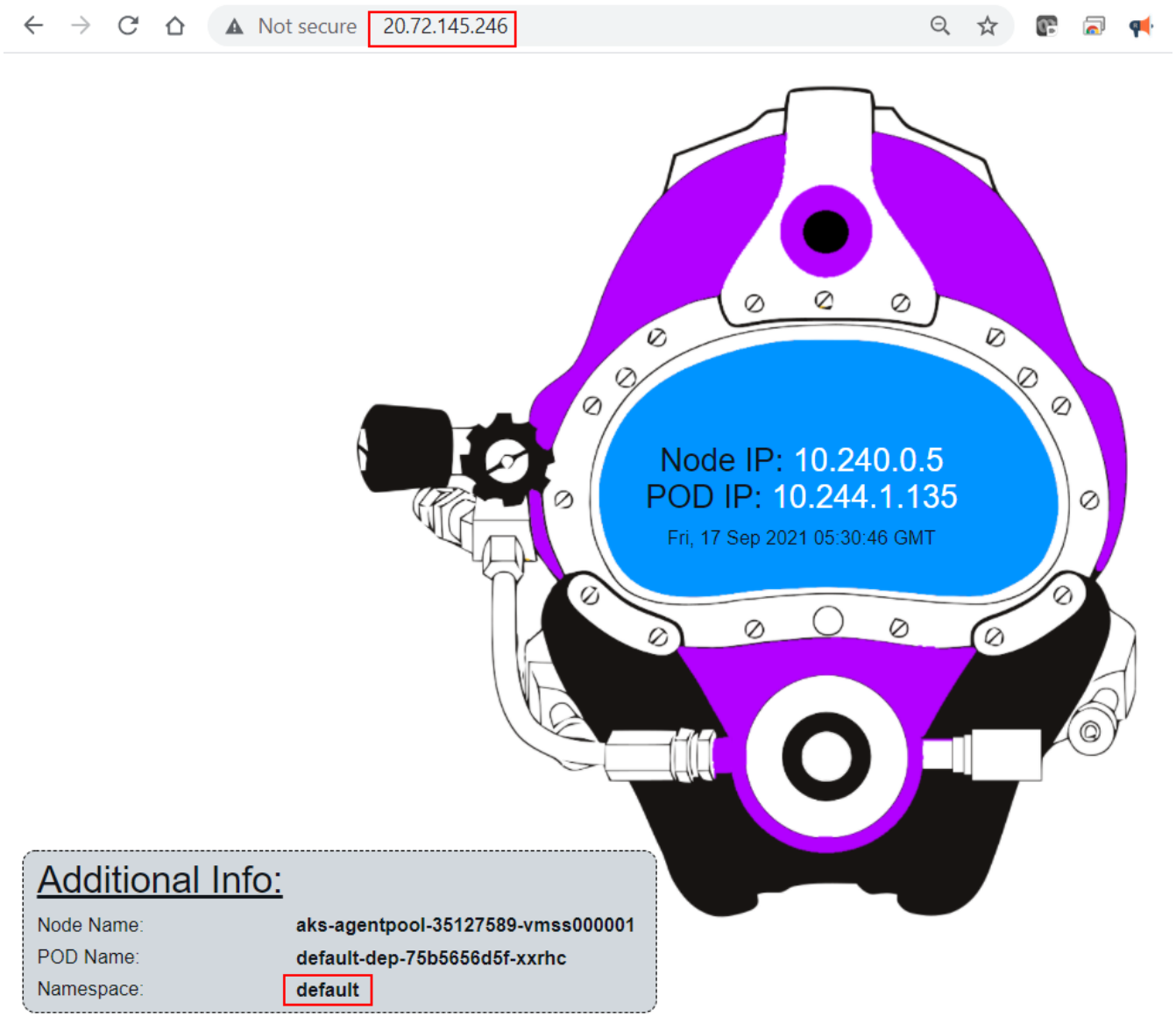
2. Review the contents of **C:\k8s\labs\Module3\default-backend.yaml** file in an editor. Notice the special property to specify the default backend. There's no *path* property needed.

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: default-ingress-backend
spec:
  defaultBackend:
    service:
      name: default-svc
      port:
        number: 8100
```

3. Apply the *Default Backend* deployment, service and ingress resource to the *default* namespace (not *dev*).

```
kubectl apply -f default-dep.yaml -n default
kubectl apply -f default-svc.yaml -n default
kubectl apply -f default-backend.yaml -n default
```

4. Open the browser and enter the exnteral IP of the Ingress controller by itself: **http://"external ip"**




Module 3 Table of Contents

List of Modules

# Shutdown or Delete the Cluster

When you're done for the day, you can shutdown your cluster to avoid incurring charges when you're not using it. This will delete all your nodes, but keep your configuration in tact.

```
az aks stop --name $AKS_NAME `
            --resource-group $AKS_RESOURCE_GROUP
```

Or you can choose to delete the entier resource group instead. You can create a new one prior to the next lab.

```
az group delete --resource-group $AKS_RESOURCE_GROUP
```

Module 3 Table of Contents
List of Modules