

# Lab Module 2: Azure Kubernetes Service



*Estimated Duration: 60 minutes*

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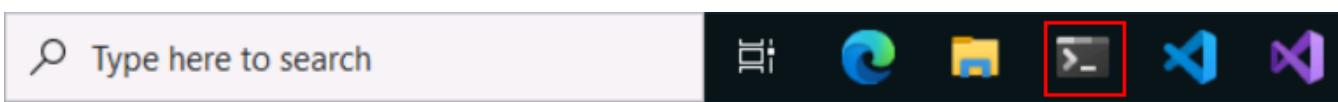
## Exercise: Create AKS Cluster Using Azure CLI

In this exercise you will create an AKS cluster using the Azure Command-line Interface (CLI).

You should complete this exercise **OR** the [Exercise: Create AKS Cluster Using Terraform](#), **NOT BOTH!**

### Task 1 - Create variables resource group

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



*Windows Terminal allows you to open tabbed command terminals.*

2. Login to Azure.

```
az login
```

3. Set the current subscription.

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

4. Register needed providers (if not performed in Lab 1).

```
az provider register --namespace Microsoft.Storage  
az provider register --namespace Microsoft.Compute  
az provider register --namespace Microsoft.Network  
az provider register --namespace Microsoft.Monitor  
az provider register --namespace Microsoft.ManagedIdentity  
az provider register --namespace Microsoft.OperationalInsights  
az provider register --namespace Microsoft.OperationsManagement  
az provider register --namespace Microsoft.KeyVault  
az provider register --namespace Microsoft.ContainerService  
az provider register --namespace Microsoft.Kubernetes
```

5. Open a browser and navigate to the Azure Portal: [portal.azure.com](https://portal.azure.com)

6. Search for and open the **Subscriptions** blade. Select your **Azure Pass - Sponsorship** subscription.

7. Scroll down and select **Resource providers**.

The screenshot shows the Azure Portal interface with the title bar "Azure Pass - Sponsorship | Resource providers". The left sidebar has a "Subscription" section and a "Settings" menu with options like Programmatic deployment, Resource groups, Resources, Preview features, Usage + quotas, Policies, Management certificates, My permissions, Resource providers (which is selected and highlighted in grey), Deployments, Properties, and Resource locks. At the top right are buttons for Register, Unregister, Refresh, and Feedback. A search bar at the top left contains "Search (Ctrl+/" and a filter bar below it says "Filter by name...". The main content area displays a table of resource providers with columns "Provider" and "Status". The providers listed are Microsoft.Storage (Registered), Microsoft.Compute (Registering), Microsoft.Monitor (Registered), Microsoft.OperationalInsights (Registering), Microsoft.OperationsManagement (Registering), Microsoft.ManagedIdentity (Registered), Microsoft.KeyVault (Registering), Microsoft.Network (Registering), and Microsoft.ContainerService (Registering). The status column uses green checkmarks for registered providers and blue circular icons with a plus sign for registering providers.

Provider	Status
Microsoft.Storage	Registered
Microsoft.Compute	Registering
Microsoft.Monitor	Registered
Microsoft.OperationalInsights	Registering
Microsoft.OperationsManagement	Registering
Microsoft.ManagedIdentity	Registered
Microsoft.KeyVault	Registering
Microsoft.Network	Registering
Microsoft.ContainerService	Registering

8. Watch the progress of the registration process until all the providers listed above have been registered. Click the *Refresh* button every few minutes to update the progress. Once everything has been registered, continue with the tasks in this lab.

## Task 2 - Define variables and create resource group

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.

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

3. Get list of available VM sizes with 2 cores in your region.

```
az vm list-sizes --location $LOCATION --query "[?numberOfCores == ``2``].{Name:name}" -o table
```

4. Set the VM SKU to one of the available values

```
$VM_SKU="Standard_D2as_v5"
```

5. Create Resource Group.

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

6. Create User Managed Identity

```
$AKS_IDENTITY_ID=$(az identity create --name $AKS_IDENTITY --resource-group $AKS_RESOURCE_GROUP --query id -o tsv)
```

## Task 2 - Create a Virtual Network and a Subnet

1. Define variables for network resources.

```
$AKS_VNET="aks-$($INSTANCE_ID)-vnet"  
$AKS_VNET_SUBNET="aks-$($INSTANCE_ID)-subnet"  
$AKS_VNET_ADDRESS_PREFIX="10.0.0.0/8"  
$AKS_VNET_SUBNET_PREFIX="10.240.0.0/16"
```

2. Create an Azure Virtual Network and a Subnet.

```
az network vnet create --resource-group $AKS_RESOURCE_GROUP `  
    --name $AKS_VNET `  
    --address-prefix $AKS_VNET_ADDRESS_PREFIX `  
    --subnet-name $AKS_VNET_SUBNET `  
    --subnet-prefix $AKS_VNET_SUBNET_PREFIX
```

### 3. Get virtual network default subnet id

```
$AKS_VNET_SUBNET_ID=$(az network vnet subnet show --resource-group $AKS_RESOURCE_GROUP --vnet-name $AKS_VNET --name $AKS_VNET_SUBNET --query id -o tsv)

Write-Host "Default Subnet ID: $AKS_VNET_SUBNET_ID"
```

## Task 3 - Create a Log Analytics Workspace (if needed)

1. Create a Log Analytics Workspace.

```
$LOG_ANALYTICS_WORKSPACE_NAME="aks-$(GetInstance_ID)-law"
$LOG_ANALYTICS_WORKSPACE_RESOURCE_ID=$(az monitor log-analytics workspace create --resource-group $AKS_RESOURCE_GROUP --workspace-name $LOG_ANALYTICS_WORKSPACE_NAME --query id -o tsv)
Write-Host "LAW Workspace Resource ID: $LOG_ANALYTICS_WORKSPACE_RESOURCE_ID"
```

## Task 4 - Create an AKS Cluster with a System Node Pool

1. Use all the prior settings and resources to create the AKS cluster. This step will take 5-10 minutes to complete.

**NOTE:** See Microsoft reference: [https://docs.microsoft.com/en-us/cli/azure/aks?view=azure-cli-latest#az\\_aks\\_create](https://docs.microsoft.com/en-us/cli/azure/aks?view=azure-cli-latest#az_aks_create)

```
$AKS_NAME="aks-$(GetInstance_ID)"
Write-Host "AKS Cluster Name: $AKS_NAME"
```

```
az aks create --resource-group $AKS_RESOURCE_GROUP ` 
    --generate-ssh-keys ` 
    --enable-managed-identity ` 
    --assign-identity $AKS_IDENTITY_ID ` 
    --node-count 1 ` 
    --enable-cluster-autoscaler ` 
    --min-count 1 ` 
    --max-count 3 ` 
    --network-plugin azure ` 
    --service-cidr 10.0.0.0/16 ` 
    --dns-service-ip 10.0.0.10 ` 
    --docker-bridge-address 172.17.0.1/16 ` 
    --vnet-subnet-id $AKS_VNET_SUBNET_ID ` 
    --node-vm-size $VM_SKU ` 
    --nodepool-name system1 ` 
    --enable-addons monitoring ` 
    --workspace-resource-id $LOG_ANALYTICS_WORKSPACE_RESOURCE_ID ` 
    --enable-ahub ` 
    --name $AKS_NAME
```

2. Once the cluster is ready (after at least 5 minutes), connect your local machine to it.

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

3. List the nodes in the cluster. There should be **1** node to start with.

```
kubectl get nodes
```

4. Get the list of system nodes only. At this point, the list should return **1** node.

```
kubectl get nodes -l="kubernetes.azure.com/mode=system"
```

NAME	STATUS	ROLES	AGE	VERSION
aks-system1-42326736-vmss000000	Ready	agent	108s	v1.20.9

5. List the node pools in the cluster. There should be 1 node pool returned.

```
az aks nodepool list --cluster-name $AKS_NAME --resource-group $AKS_RESOURCE_GROUP -o table
```

Name	OsType	KubernetesVersion	VmSize	Count	MaxPods	ProvisioningState	Mode
system1	Linux	1.20.9	Standard_DS2_v2	1	30	Succeeded	System

## Task 5 - Create a Linux User Node Pool

1. Create a Linux user node pool.

```
az aks nodepool add --resource-group $AKS_RESOURCE_GROUP `  
    --cluster-name $AKS_NAME `  
    --os-type Linux `  
    --name linux1 `  
    --node-count 1 `  
    --enable-cluster-autoscaler `  
    --min-count 1 `  
    --max-count 3 `  
    --mode User `  
    --node-vm-size $VM_SKU
```

2. List the nodes in the cluster. There should be 2 nodes now.

```
kubectl get nodes
```

3. Get the list of system nodes only. There should still be only 1 system node.

```
kubectl get nodes -l="kubernetes.azure.com/mode=system"
```

4. List the node pools in the cluster. Again there should be 2 now.

```
az aks nodepool list --cluster-name $AKS_NAME --resource-group $AKS_RESOURCE_GROUP -o table
```

Name	OsType	KubernetesVersion	VmSize	Count	MaxPods	ProvisioningState	Mode
linux1	Linux	1.20.9	Standard_DS2_v2	1	30	Succeeded	User
system1	Linux	1.20.9	Standard_DS2_v2	1	30	Succeeded	System

## Task 6 - Create a Windows User Node Pool

1. Create a Windows user node pool.

```
az aks nodepool add --resource-group $AKS_RESOURCE_GROUP ` 
    --cluster-name $AKS_NAME ` 
    --os-type Windows ` 
    --name win1 ` 
    --node-count 1 ` 
    --mode User ` 
    --node-vm-size $VM_SKU
```

2. List the nodes in the cluster. There should be 3 nodes.

```
kubectl get nodes
```

NAME	STATUS	ROLES	AGE	VERSION
aks-linux1-42326736-vmss000000	Ready	agent	10m	v1.20.9
aks-system1-42326736-vmss000000	Ready	agent	16m	v1.20.9
akswin1000000	Ready	agent	2m30s	v1.20.9

3. Get the list of system nodes only. There should still be only 1 node.

```
kubectl get nodes -l="kubernetes.azure.com/mode=system"
```

4. Get the list of Linux nodes. There should be 2 nodes.

```
kubectl get nodes -l="kubernetes.io/os=linux"
```

5. List the node pools in the cluster. Again there should be 3.

```
az aks nodepool list --cluster-name $AKS_NAME --resource-group $AKS_RESOURCE_GROUP -o table
```

Name	OsType	KubernetesVersion	VmSize	Count	MaxPods	ProvisioningState	Mode
linux1	Linux	1.20.9	Standard_DS2_v2	1	30	Succeeded	User
system1	Linux	1.20.9	Standard_DS2_v2	1	30	Succeeded	System
win1	Windows	1.20.9	Standard_DS2_v2	1	30	Succeeded	User

## Task 7 - Adjust the Auto Scaler for the lab

The default settings for the AKS Auto Scaler are tuned for production environments, but take too long to scale up/down during demos and practice labs.

1. Configure the cluster-wide auto scaling profile so all the node pool auto scalers are more responsive.

```
az aks update --resource-group $AKS_RESOURCE_GROUP `  
    --name $AKS_NAME `  
    --cluster-autoscaler-profile `  
        scale-down-delay-after-add=1m `  
        scale-down-unready-time=1m `  
        scale-down-unneeded-time=1m `  
        skip-nodes-with-system-pods=true
```

**NOTE:** Refer to this link for a complete description of the options available: [AKS Cluster Autoscaler](#)

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## Exercise: Create AKS Cluster Using Terraform

In this exercise you will create an AKS cluster using the Terraform utility by HashiCorp.

You should complete this exercise **OR** the [Exercise: Create AKS Cluster Using Azure CLI](#), **NOT BOTH!**

### Task 1 - Ensure resource names are unique

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



2. Login to Azure.

```
az login
```

4. Define variables.

```
$INSTANCE_ID="@lab.LabInstance.Id"  
$env:TF_VAR_AKS_RESOURCE_GROUP="azure-$($INSTANCE_ID)-rg"  
$env:TF_VAR_ACR="acr$($INSTANCE_ID)"
```

### Task 2 - Go to the Main Terraform folder and Initialize It

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

2. Change current folder to **Main**

```
$ROOT_PATH="C:\k8s\Labs\Module2\Terraform"  
cd C:\k8s\labs\Module2\Terraform>Main
```

3. To initialize the Terraform directory it is necessary the **main.tf** file that is already created in the **Main** folder.

```

# We strongly recommend using the required_providers block to set the
# Azure Provider source and version being used
terraform {
  required_providers {
    azurerm = {
      source  = "hashicorp/azurerm"
      version = "=3.3.0"
    }
  }
}

# Configure the Microsoft Azure Provider
provider "azurerm" {
  features {}
}

```

4. Open a Terminal in VS Code and initialize the Terraform directory.

```
terraform init
```

### Task 3 - Create an Azure Resource Group

1. Add the following variable in the **rg\_vars.tf** in the **Resources** folder to the **vars.tf** file in the **Main** folder. This code will use the environment variable defined earlier.

```

variable "AKS_RESOURCE_GROUP" {
  type     = string
  description = "This is the rg name"
}

```

```

$From = Get-Content -Path (Join-Path $ROOT_PATH Resources\rg_vars.tf)
Add-Content -Path (Join-Path $ROOT_PATH Main\vars.tf) -Value $From

```

2. Move the file **rg.tf** in the **Resources** folder to the **Main** folder.

```

resource "azurerm_resource_group" "arg" {
  name     = var.AKS_RESOURCE_GROUP
  location = "East US"
}

```

```
Move-Item (Join-Path $ROOT_PATH Resources\rg.tf) -Destination (Join-Path $ROOT_PATH Main)
```

3. Have Terraform plan and apply your changes. Then this step finishes, you should have a new Resource Group available in the Azure Portal.

```

terraform plan
terraform apply -auto-approve

```

## Task 4 - Create an Azure Container Registry

1. Add the following variables in the **acr\_vars.tf** in the **Resources** folder to the **vars.tf** file in the **Main** folder. This code will use the environment variables defined earlier.

```
variable "ACR" {
  type     = string
  description = "This is the acr name"
}
```

```
$From = Get-Content -Path $(Join-Path $ROOT_PATH Resources\acr_vars.tf)
Add-Content -Path $(Join-Path $ROOT_PATH Main\vars.tf) -Value $From
```

2. Move the file **acr.tf** in the **Resources** folder to the **Main** folder.

```
resource "azurerm_container_registry" "acr" {
  name        = var.ACR
  location    = "East US"
  resource_group_name = var.AKS_RESOURCE_GROUP
  sku         = "Standard"
  admin_enabled = false
}
```

```
Move-Item $(Join-Path $ROOT_PATH Resources\acr.tf) -Destination $(Join-Path $ROOT_PATH Main)
```

3. Have Terraform plan and apply your changes. Then this step finishes, you should have a new ACR available in the Azure Portal.

```
terraform plan
terraform apply -auto-approve
```

## Task 5 - Create a Virtual Network and a Subnet

1. Define variables.

```
$env:TF_VAR_AKS_VNET="aks-$($INSTANCE_ID)-vnet"
$env:TF_VAR_AKS_VNET_SUBNET="aks-$($INSTANCE_ID)-subnet"
$env:TF_VAR_AKS_VNET_ADDRESS_PREFIX='["10.0.0.0/8"]'
$env:TF_VAR_AKS_VNET_SUBNET_PREFIX="10.240.0.0/16"
```

2. Add the following variables in the **vnet\_vars.tf** in the **Resources** folder to the end of the **vars.tf** file in the **Main** folder.

```
variable "AKS_VNET" {
  type     = string
  description = "This is the vnet name"
}

variable "AKS_VNET_SUBNET" {
```

```

    type      = string
    description = "This is the subnet name"
}

variable "AKS_VNET_ADDRESS_PREFIX" {
    type      = list(string)
    description = "This is the vnet address prefix"
}

variable "AKS_VNET_SUBNET_PREFIX" {
    type      = string
    description = "This is the subnet address prefix"
}

```

```

$From = Get-Content (Join-Path $ROOT_PATH Resources\vnet_vars.tf)
Add-Content (Join-Path $ROOT_PATH Main\vars.tf) -Value $From

```

- Move the file called **vnet.tf** in the **Resources** folder to the **Main** folder.

```

resource "azurerm_virtual_network" "network" {
    name          = var.AKS_VNET
    location       = "West US 2"
    resource_group_name = var.AKS_RESOURCE_GROUP
    address_space     = var.AKS_VNET_ADDRESS_PREFIX

    subnet {
        name          = var.AKS_VNET_SUBNET
        address_prefix = var.AKS_VNET_SUBNET_PREFIX
    }
}

```

```

Move-Item (Join-Path $ROOT_PATH Resources\vnet.tf) -Destination (Join-Path $ROOT_PATH Main)

```

- Have Terraform plan and apply your changes. When this step finishes, there will be a VNET created and ready to be used by your cluster.

```

terraform plan
terraform apply -auto-approve

```

## Task 6 - Create a Log Analytics Workspace

- Define variables.

```

$env:TF_VAR_LOG_ANALYTICS_WORKSPACE_NAME="aks-$($INSTANCE_ID)-law"

```

- Add the following variables in the **law\_vars.tf** in the **Resources** folder to the end of the **vars.tf** file in the **Main** folder.

```

variable "LOG_ANALYTICS_WORKSPACE_NAME" {
    type      = string
    description = "This is the law name"
}

```

```

$From = Get-Content (Join-Path $ROOT_PATH Resources\law_vars.tf)
Add-Content (Join-Path $ROOT_PATH Main\vars.tf) -Value $From

```

- Move the file called **law.tf** in the **Resources** folder to the **Main** folder.

```

resource "azurerm_log_analytics_workspace" "log_analytics" {
    name          = var.LOG_ANALYTICS_WORKSPACE_NAME
    location      = "West US 2"
    resource_group_name = var.AKS_RESOURCE_GROUP
    sku           = "PerGB2018"
    retention_in_days = "90"
}

resource "azurerm_log_analytics_solution" "log_analytics" {
    solution_name      = "ContainerInsights"
    location          = azurerm_log_analytics_workspace.log_analytics.location
    resource_group_name = azurerm_log_analytics_workspace.log_analytics.resource_group_name
    workspace_resource_id = azurerm_log_analytics_workspace.log_analytics.id
    workspace_name     = azurerm_log_analytics_workspace.log_analytics.name

    plan {
        publisher = "Microsoft"
        product   = "OMSGallery/ContainerInsights"
    }
}

```

```

Move-Item (Join-Path $ROOT_PATH Resources\law.tf) -Destination (Join-Path $ROOT_PATH Main)

```

- Have Terraform plan and apply your changes. When this step finishes, there will be a Log Analytics Workspace for your cluster to send telemetry to.

```

terraform plan
terraform apply -auto-approve

```

## Task 7 - Create an AKS Cluster

- Use all the prior settings and resources to create the AKS cluster.

```

$env:TF_VAR_AKS_CLUSTER="aks-$($INSTANCE_ID)-tf"

```

- Add the following variable in the **aks\_vars.tf** in the **Resources** folder to the end of the **vars.tf** file in the **Main** folder.

```

variable "AKS_CLUSTER" {
  type     = string
  description = "This is the aks name"
}

```

```

$From = Get-Content (Join-Path $ROOT_PATH Resources\aks_vars.tf)
Add-Content (Join-Path $ROOT_PATH Main\vars.tf) -Value $From

```

3. Move the file called **aks.tf** in the **Resources** folder to the **Main** folder.

```

resource "azurerm_kubernetes_cluster" "aks" {

  name          = var.AKS_CLUSTER
  location      = "East US"
  resource_group_name = var.AKS_RESOURCE_GROUP
  dns_prefix    = var.AKS_CLUSTER
  azure_policy_enabled = true

  default_node_pool {
    name          = "systempool"
    node_count    = 1
    enable_auto_scaling = true
    min_count     = 1
    max_count     = 3
    vnet_subnet_id = element(azurerm_virtual_network.network.subnet.*.id, 0)
    vm_size       = "Standard_D2as_v5"
    zones         = ["1"]
  }

  identity {
    type = "SystemAssigned"
  }

  oms_agent {
    log_analytics_workspace_id = azurerm_log_analytics_workspace.log_analytics.id
  }

  network_profile {
    network_plugin    = "azure"
    service_cidr     = "10.0.0.0/16"
    dns_service_ip   = "10.0.0.10"
    docker_bridge_cidr = "172.17.0.1/16"
  }
}

resource "azurerm_role_assignment" "aks_acr" {
  scope          = azurerm_container_registry.acr.id
  role_definition_name = "AcrPull"
  principal_id    = azurerm_kubernetes_cluster.aks.kubelet_identity[0].object_id
}

```

```
Move-Item (Join-Path $ROOT_PATH Resources\aks.tf) -Destination (Join-Path $ROOT_PATH Main)
```

4. Have Terraform plan and apply your changes. This step will take 5-10 minutes to complete.

```
terraform plan  
terraform apply -auto-approve
```

5. Once the cluster is ready, connect your local machine to it.

```
az aks get-credentials --name $env:TF_VAR_AKS_CLUSTER --resource-group  
$env:TF_VAR_AKS_RESOURCE_GROUP
```

6. List the nodes in the cluster. There should be 1 nodes to start with.

```
kubectl get nodes
```

## Task 8 - Create a Linux User Node Pool

1. Create a Linux user node pool, add this code from the **aks\_linux\_node\_pool.tf** in the **Resources** folder to the bottom of the **aks.tf** file.

```
resource "azurerm_kubernetes_cluster_node_pool" "linuxnp" {  
    name          = "linuxagent1"  
    kubernetes_cluster_id = azurerm_kubernetes_cluster.aks.id  
    os_type       = "Linux"  
    node_count    = 1  
    enable_auto_scaling = true  
    min_count     = 1  
    max_count     = 3  
    mode          = "User"  
    vm_size        = "Standard_D2as_v5"  
    zones          = ["1"]  
    vnet_subnet_id = element(azurerm_virtual_network.network.subnet.*.id, 0)  
}
```

```
$From = Get-Content (Join-Path $ROOT_PATH Resources\aks_linux_node_pool.tf)  
Add-Content (Join-Path $ROOT_PATH Main\aks.tf) -Value $From
```

2. Have Terraform plan and apply your changes.

```
terraform plan  
terraform apply -auto-approve
```

3. List the nodes in the cluster. There should be 2 nodes now.

```
kubectl get nodes
```

## Task 9 - Create a Windows User Node Pool

1. Create a Windows user node pool, add this code from the **aks\_windows\_node\_pool.tf** in the **Resources** folder to the bottom of the **aks.tf** file.

```
resource "azurerm_kubernetes_cluster_node_pool" "winnp" {
  name          = "win1"
  kubernetes_cluster_id = azurerm_kubernetes_cluster.aks.id
  os_type       = "Windows"
  node_count    = 1
  enable_auto_scaling = true
  min_count     = 1
  max_count     = 3
  mode          = "User"
  vm_size        = "Standard_D2as_v5"
  zones          = ["1"]
  vnet_subnet_id = element(azurerm_virtual_network.network.subnet.*.id, 0)
}
```

```
$From = Get-Content (Join-Path $ROOT_PATH Resources\aks_windows_node_pool.tf)
Add-Content (Join-Path $ROOT_PATH Main\aks.tf) -Value $From
```

2. Have Terraform plan and apply your changes.

```
terraform plan
terraform apply -auto-approve
```

3. List the nodes in the cluster. There should be 3 nodes.

```
kubectl get nodes
```

## Task 10 - Create the Diagnostic Settings Module

1. Define variables.

```
$env:TF_VAR_DIAGNOSTIC_SETTING_NAME="ds-$($INSTANCE_ID)"
```

2. Add the following variable in the **ds\_vars.tf** in the **Resources** folder to the end of the **vars.tf** file in the **Main** folder.

```
variable "DIAGNOSTIC_SETTING_NAME" {
  type      = string
  description = "This is the ds name"
}
```

```
$From = Get-Content (Join-Path $ROOT_PATH Resources\ds_vars.tf)
Add-Content (Join-Path $ROOT_PATH Main\vars.tf) -Value $From
```

- Move the file called **ds.tf** in the **Resources** folder to the **Main** folder.

```

resource "azurerm_monitor_diagnostic_setting" "diagnostic_logs" {
  name          = var.DIAGNOSTIC_SETTING_NAME
  target_resource_id = azurerm_kubernetes_cluster.aks.id
  storage_account_id = azurerm_storage_account.storage.id

  dynamic "log" {
    for_each = ["kube-apiserver", "kube-controller-manager", "cluster-autoscaler", "kube-scheduler", "kube-audit", "kube-audit-admin", "guard"]
    content {
      category = log.value
      enabled   = true

      retention_policy {
        enabled = true
        days    = 30
      }
    }
  }

  metric {
    category = "AllMetrics"
    enabled   = true

    retention_policy {
      days    = 30
      enabled = true
    }
  }
}

```

```
Move-Item (Join-Path $ROOT_PATH Resources\ds.tf) -Destination (Join-Path $ROOT_PATH Main)
```

## Task 11 - Create the Storage Account Module for the Diagnostic Settings

- Define variables.

```
$env:TF_VAR_STORAGE_ACCOUNT_NAME="sa$($INSTANCE_ID)"
```

- Add the following variable in the **sa\_vars.tf** in the **Resources** folder to the end of the **vars.tf** file in the **Main** folder.

```

variable "STORAGE_ACCOUNT_NAME" {
  type     = string
  description = "This is the sa name"
}

```

```
$From = Get-Content (Join-Path $ROOT_PATH Resources\sa_vars.tf)
Add-Content (Join-Path $ROOT_PATH Main\vars.tf) -Value $From
```

3. Move the file called **sa.tf** in the **Resources** folder to the **Main** folder.

```
resource "azurerm_storage_account" "storage" {
    name          = var.STORAGE_ACCOUNT_NAME
    location      = "West US 2"
    resource_group_name = var.AKS_RESOURCE_GROUP
    account_kind   = "StorageV2"
    account_tier    = "Standard"
    account_replication_type = "LRS"
    access_tier     = "Hot"
    enable_https_traffic_only = true
}
```

```
Move-Item (Join-Path $ROOT_PATH Resources\sa.tf) -Destination (Join-Path $ROOT_PATH Main)
```

4. Have Terraform plan and apply your changes.

```
terraform plan
terraform apply -auto-approve
```

## Task 12 - Adjust the Auto Scaler for the lab

1. The default settings for the AKS Auto Scaler are tuned for production environments, but take too long to scale up/down during demos and practice labs.
2. Configure the cluster-wide auto scaling profile so all the node pool auto scalers are more responsive. Add the following code inside the resource **"azurerm\_kubernetes\_cluster" "aks" {}** module, for example, below the **default\_node\_pool {}**. For this purpose replace **aks.tf** file in the **Main** folder with the content of **aks2.tf** in the **Resources** folder.

```
auto_scaler_profile {
    scale_down_unneeded      = "1m"
    scale_down_delay_after_add = "1m"
    scale_down_unready       = "1m"
    skip_nodes_with_system_pods = true
}
```

```
Get-Content (Join-Path $ROOT_PATH Resources\aks2.tf) | Set-Content (Join-Path $ROOT_PATH Main\aks.tf)
```

3. Have Terraform plan and apply your changes.

```
terraform plan
terraform apply -auto-approve
```

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# Exercise: Deploying Workloads to Nodes

In this exercise you will deploy different pods to various node pools in your cluster.

## Task 1 - Deploy a simple workload with no Node Selector

1. Change current folder to **Module2**

```
cd C:\k8s\labs\Module2
```

2. Deploy a workload with 6 replicas and no *Node Selector*.

```
kubectl apply -f workload.yaml
```

3. Get a complete list of all pods and review the results.

```
kubectl get pods -o wide
```

NAME	READY	STATUS	RESTARTS	AGE	IP	NODE
ATES						
workload-5f795755d8-8v8lb	1/1	Running	0	37s	10.240.0.28	aks-system1-42326736-vmss000000
workload-5f795755d8-gs7r8	0/1	ImagePullBackOff	0	37s	10.240.0.84	akswin1000000
workload-5f795755d8-ph4t6	0/1	ErrImagePull	0	37s	10.240.0.92	akswin1000000
workload-5f795755d8-q6zxw	1/1	Running	0	37s	10.240.0.52	aks-linux1-42326736-vmss000000
workload-5f795755d8-r4szw	1/1	Running	0	37s	10.240.0.43	aks-linux1-42326736-vmss000000
workload-5f795755d8-srn79	0/1	ImagePullBackOff	0	37s	10.240.0.71	akswin1000000

**NOTE:** Notice some of the pods got created on the Linux nodes, while others got scheduled on the Windows nodes, and thus could not be run. The Linux image specified in the Deployment is not compatible with the Windows 2019 OS running on the Windows nodes.

4. Describe any of the failed pods to see the actual error.

```
kubectl describe pod <failed pod name>
```

Events:				
Type	Reason	Age	From	Message
Normal	Scheduled	7m3s	default-scheduler	Successfully assigned default/workload-5f795755d8-bb4ct to akswin000001
Normal	SandboxChanged	6m59s	kubelet	Pod sandbox changed, it will be killed and re-created.
Warning	Failed	6m15s (x3 over 7m)	kubelet	Failed to pull image "nginx:1.18": rpc error: code = Unknown desc = no matching manifest for windows/amd64 10.0.17763 in the manifest list entries
Normal	Pulling	5m23s (x4 over 7m)	kubelet	Pulling image "nginx:1.18"
Warning	Failed	114s (x22 over 6m55s)	kubelet	Error: ImagePullBackOff

**NOTE:** Without any guidance, the Kubernetes scheduler does its best to distribute workloads evenly across all the nodes that have available resources. It doesn't examine the contents of Deployments to confirm that their images are compatible with the nodes it selects.

5. Update the **workload.yaml** file to add the following node selector:

```
nodeSelector:  
  kubernetes.io/os: linux
```

```

spec:
  nodeSelector:
    kubernetes.io/os: linux
  containers:
    - name: nginx
      image: nginx:1.18

```

6. Apply the deployment again and list the pods.

```

kubectl apply -f workload.yaml
kubectl get pods -o wide

```

**NOTE:** It will take a few seconds for the bad pods to be deleted, so they may show as **Terminated** for little some time.

NAME	READY	STATUS	RESTARTS	AGE	IP	NODE
workload-86dd8dfdd6-4tnzg	1/1	Running	0	13s	10.240.0.65	aks-linux1-42326736-vmss000000
workload-86dd8dfdd6-87k4c	1/1	Running	0	11s	10.240.0.7	aks-system1-42326736-vmss000000
workload-86dd8dfdd6-s9wxm	1/1	Running	0	11s	10.240.0.45	aks-linux1-42326736-vmss000000
workload-86dd8dfdd6-vb7z9	1/1	Running	0	11s	10.240.0.46	aks-linux1-42326736-vmss000000
workload-86dd8dfdd6-w7dr6	1/1	Running	0	13s	10.240.0.11	aks-system1-42326736-vmss000000
workload-86dd8dfdd6-zm8sb	1/1	Running	0	13s	10.240.0.64	aks-linux1-42326736-vmss000000

*Notice that all the pods are running now, but they're spread across both the system and user nodes. The reason for creating user nodes is to separate your workloads from system utilities.*

7. Update the **workload.yaml** file to add an additional label "**kubernetes.azure.com/mode: user**" to the Node Selector. The final *nodeSelector* section should look like this:

```

nodeSelector:
  kubernetes.io/os: linux
  kubernetes.azure.com/mode: user

```

8. Apply the deployment again and list the pods.

```

kubectl apply -f workload.yaml
kubectl get pods -o wide

```

NAME	READY	STATUS	RESTARTS	AGE	IP	NODE
workload-bbc8765b7-5gnts	1/1	Running	0	23s	10.240.0.40	aks-linux1-42326736-vmss000000
workload-bbc8765b7-5mzbz	1/1	Running	0	23s	10.240.0.55	aks-linux1-42326736-vmss000000
workload-bbc8765b7-n8j9r	1/1	Running	0	20s	10.240.0.36	aks-linux1-42326736-vmss000000
workload-bbc8765b7-pzz59	1/1	Running	0	21s	10.240.0.43	aks-linux1-42326736-vmss000000
workload-bbc8765b7-rsrc5	1/1	Running	0	23s	10.240.0.42	aks-linux1-42326736-vmss000000
workload-bbc8765b7-xnsvb	1/1	Running	0	21s	10.240.0.49	aks-linux1-42326736-vmss000000

**PERFECT!**

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# Exercise: Scaling Nodes to Meet Demand

In this exercise you'll watch how the AKS Auto Scaler adjusts the number of nodes based on increased demand and then scales them back down when the load is reduced.

## Task 1 - Verify the names and number of current nodes

1. Get a list of the Linux user nodes.

```
kubectl get nodes -l="kubernetes.azure.com/mode=user","kubernetes.io/os=linux"
```

## Task 2 - Increase the number of replicas to trigger the Auto Scaler to scale up

1. Increase the number of replicas to force the Auto Scaler to create more nodes in the Linux user node pool.

```
kubectl scale --replicas=40 deploy/workload
```

2. Get the list of pods.

```
kubectl get pods -o wide
```

*Notice that some pods are **Pending** state.*

NAME	READY	STATUS	RESTARTS	AGE	IP	NODE
ATES						
workload-bbc8765b7-4fptg	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-4ttsk	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-5852w	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-5gnts	1/1	Running	0	2m3s	10.240.0.40	aks-linux1-42326736-vmss000000
workload-bbc8765b7-5mzbz	1/1	Running	0	2m3s	10.240.0.55	aks-linux1-42326736-vmss000000
workload-bbc8765b7-6d4cv	1/1	Running	0	4s	10.240.0.37	aks-linux1-42326736-vmss000000
workload-bbc8765b7-6pdxj	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-6qt9p	1/1	Running	0	4s	10.240.0.58	aks-linux1-42326736-vmss000000
workload-bbc8765b7-75bsh	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-9pjxj	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-b2qkr	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-b6r2f	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-c7ph6	1/1	Running	0	4s	10.240.0.41	aks-linux1-42326736-vmss000000
workload-bbc8765b7-dk748	0/1	Pending	0	4s	<none>	<none>
workload-bbc8765b7-fv9hd	1/1	Running	0	4s	10.240.0.46	aks-linux1-42326736-vmss000000
workload-bbc8765b7-hr14h	0/1	Pending	0	4s	<none>	<none>

3. Describe one of the Pending pods

```
kubectl describe pod <pending pod name>
```

*Notice that the Events section describes the problem and the solution.*

Events:				
Type	Reason	Age	From	Message
Warning	FailedScheduling	74s	default-scheduler	0/3 nodes are available: 1 Insufficient cpu, 2 node(s) didn't match Pod's node affinity.
Warning	FailedScheduling	74s	default-scheduler	0/3 nodes are available: 1 Insufficient cpu, 2 node(s) didn't match Pod's node affinity.
Normal	TriggeredScaleUp	66s	cluster-autoscaler	pod triggered scale-up: [[aks-linux1-42326736-vmss 1->3 (max: 3)]]

4. Start a watch on the nodes

```
kubectl get nodes -l="kubernetes.azure.com/mode=user","kubernetes.io/os=linux" -w
```

In a few minutes you'll see the number of nodes increase.

NAME	STATUS	ROLES	AGE	VERSION
aks-linux1-42326736-vmss000000	Ready	agent	35m	v1.20.9
aks-linux1-42326736-vmss000001	Ready	agent	2m	v1.20.9
aks-linux1-42326736-vmss000002	Ready	agent	119s	v1.20.9

5. When the new nodes are in a **Ready** state, press **Ctrl-C** to break out of the watch and return to the console.

6. Get a list of pods.

```
kubectl get pods -o wide
```

*Notice all the pending Pods are running and they're all in the same node pool, scheduled on the new nodes.*

NAME	READY	STATUS	RESTARTS	AGE	IP	NODE
workload-bbc8765b7-4fptg	1/1	Running	0	5m50s	10.240.0.106	aks-linux1-42326736-vmss000001
workload-bbc8765b7-4tttk	1/1	Running	0	5m50s	10.240.0.137	aks-linux1-42326736-vmss000002
workload-bbc8765b7-5852w	1/1	Running	0	5m50s	10.240.0.110	aks-linux1-42326736-vmss000001
workload-bbc8765b7-5gnts	1/1	Running	0	7m49s	10.240.0.40	aks-linux1-42326736-vmss000000
workload-bbc8765b7-5mzbz	1/1	Running	0	7m49s	10.240.0.55	aks-linux1-42326736-vmss000000
workload-bbc8765b7-6d4cv	1/1	Running	0	5m50s	10.240.0.37	aks-linux1-42326736-vmss000000
workload-bbc8765b7-6pdxj	1/1	Running	0	5m50s	10.240.0.155	aks-linux1-42326736-vmss000002
workload-bbc8765b7-6qt9p	1/1	Running	0	5m50s	10.240.0.58	aks-linux1-42326736-vmss000000
workload-bbc8765b7-75bsh	1/1	Running	0	5m50s	10.240.0.126	aks-linux1-42326736-vmss000001

### Task 3 - Reduce workload to trigger the Auto Scaler to scale down

1. Delete the workload.

```
kubectl delete deploy/workload
```

2. Watch the nodes

```
kubectl get nodes -l="kubernetes.azure.com/mode=user","kubernetes.io/os=linux" -w
```

**NOTE:** In a few minutes, two of the nodes will go into a **NotReady** state and then disappear. It will probably *NOT* be both the new nodes that were created. The "victim" nodes are picked using an internal scale-in policy.

NAME	STATUS	ROLES	AGE	VERSION
aks-linux1-42326736-vmss000000	NotReady	agent	42m	v1.20.9
aks-linux1-42326736-vmss000001	NotReady	agent	8m22s	v1.20.9
aks-linux1-42326736-vmss000002	Ready	agent	8m21s	v1.20.9

**NOTE:** The cluster autoscaler may be unable to scale down if pods can't be deleted, such as in the following situations:

- A pod is directly created and isn't backed by a controller object, such as a deployment or replica set.
  - A pod disruption budget (PDB) is too restrictive and doesn't allow the number of pods to be fall below a certain threshold.
  - A pod uses node selectors or anti-affinity that can't be honored by other nodes when the replacement Pod is scheduled.
3. Break out of the watch and keep getting the list of nodes manually. Repeat the command below until there is only 1 node left.

```
kubectl get nodes -l="kubernetes.azure.com/mode=user","kubernetes.io/os=linux"
```

NAME	STATUS	ROLES	AGE	VERSION
aks-linux1-42326736-vmss000002	Ready	agent	10m	v1.20.9

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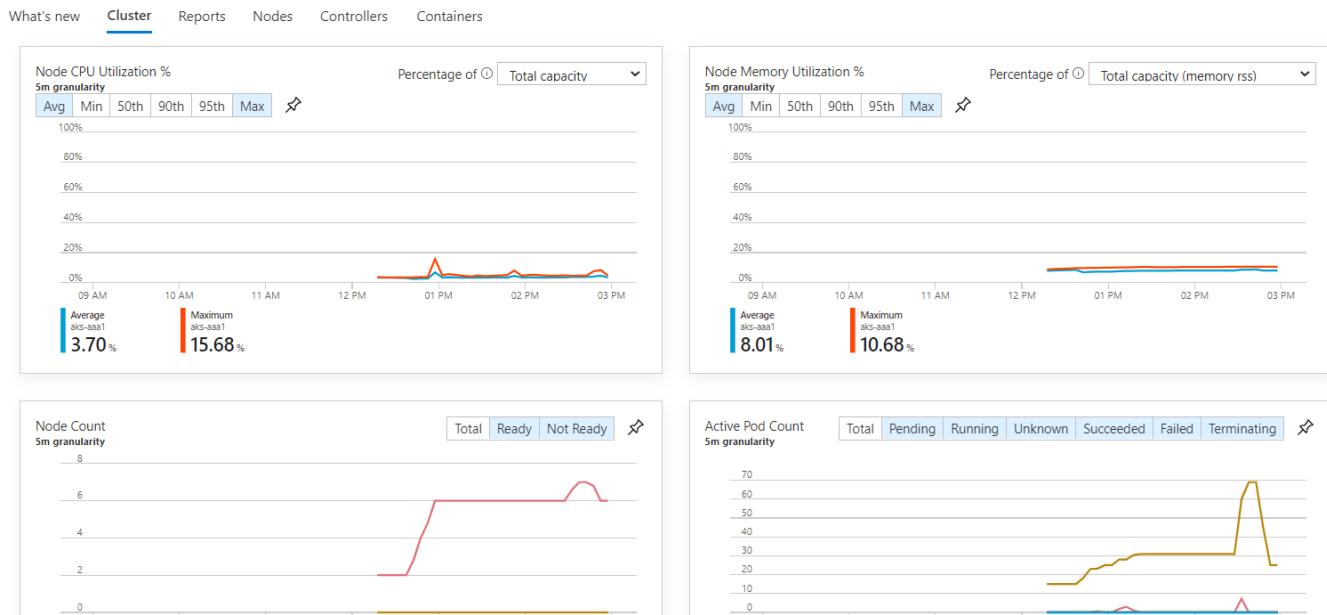
## Exercise: Examine Container Insights

Now that you've used your cluster for a little while, you should have some metrics and logs in Container Insights to review.

### Task 1 - Review Container Insights

1. Open the Azure Portal in a browser.
2. Search for "Kubernetes". Click on your cluster.
3. Scroll down to **Insights** on the option blade.
4. Navigate through the various tabs.

#### Cluster metrics overview:



## Nodes list:

What's new	Cluster	Reports	Nodes	Controllers	Containers							
Search by name...						Metric: CPU Usage (millicores) (computed from Capacity)	Min	Avg	50th	90th	95th	Max
8 items												
Name	Status	95th % ↓	95th	Containers	UpTime	Controller	Trend 95th % (1 bar = 15m)					
▶  akswin1000000	Ok	7%	143 mc	2	3 hours	-						
▶  akswin1000001	Ok	7%	131 mc	3	3 hours	-						
▶  aks-linuxagent1-36262365-vms0000000	Ok	4%	86 mc	25	2 hours	-						
▶  aks-systempool-36262365-vms000001	Ok	4%	82 mc	9	3 hours	-						
▶  aks-linuxagent1-36262365-vms000001	Ok	4%	74 mc	25	2 hours	-						
▶  aks-linuxagent1-36262365-vms000002	Ok	4%	72 mc	12	29 mins	-						
▶  aks-systempool-36262365-vms0000000	Ok	3%	69 mc	11	3 hours	-						

## Containers:

What's new	Cluster	Reports	Nodes	Controllers	Containers							
Search by name...						Metric: CPU Usage (millicores)	Min	Avg	50th	90th	95th	Max
87 items												
Name	Status	95th % ↓	95th	Pod	Node	Restarts	UpTime	Trend 95th % (1 bar = 15m)				
omsagent-win	Ok	8%	17 mc	omsagent-win-8dtvw	akswin1000000	0	2 hours					
omsagent-win	Ok	7%	14 mc	omsagent-win-mb5zk	akswin1000001	0	2 hours					
omsagent	Ok	2%	11 mc	omsagent-89jn8	aks-systempool...	0	2 hours					

5. Scroll down to **Logs** on the option blade.

6. Copy this query into the editor and click **Run**

```
KubePodInventory
| where TimeGenerated > ago(1h)
| join ContainerLog on ContainerID
| project TimeGenerated, Computer, PodName=Name, ContainerName=split(ContainerName, "/", 1)[0],
LogEntry
```

The screenshot shows the Azure Log Analytics workspace interface. At the top, there are navigation links: Run, Time range: Set in query, Save, Share, New alert rule, Export, Pin to dashboard, and Format query. Below this is a code editor containing a Kusto query:

```

1 KubePodInventory
2 | where TimeGenerated > ago(1h)
3 | join ContainerLog on ContainerID
4 | project TimeGenerated, Computer, PodName=Name, ContainerName=split(ContainerName, "/", 1)[0], LogEntry

```

Below the query editor is a results table. The table has columns: TimeGenerated [UTC], Computer, PodName, ContainerName, and LogEntry. The table displays 280 records from 8/4/2021 at 8:14:10.000 PM. The LogEntry column contains log messages related to container startup and configuration.

TimeGenerated [UTC]	Computer	PodName	ContainerName	LogEntry
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000001	workload-bbc8765b7-sdwz8	nginx	10-listen-on-ipv6-by-default.sh: Ge
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000001	workload-bbc8765b7-sdwz8	nginx	10-listen-on-ipv6-by-default.sh: En
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000001	workload-bbc8765b7-sdwz8	nginx	/docker-entrypoint.sh: Launching ,
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000001	workload-bbc8765b7-sdwz8	nginx	/docker-entrypoint.sh: Configurati
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	/docker-entrypoint.sh: /docke-ent
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	/docker-entrypoint.sh: Looking fo
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	/docker-entrypoint.sh: Launching ,
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	10-listen-on-ipv6-by-default.sh: Ge
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	10-listen-on-ipv6-by-default.sh: En
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	/docker-entrypoint.sh: Launching ,
8/4/2021, 8:14:10.000 PM	aks-linuxagent1-36262365-vmss000000	workload-bbc8765b7-4b2qj	nginx	/docker-entrypoint.sh: Configurati

You'll see how the container logs are sent to a Log Analytics Workspace for analysis.

## Sample Kusto Queries for Container Insights

The link below list some common Kusto queries for Container Insights data:

<https://docs.microsoft.com/en-us/azure/azure-monitor/containers/container-insights-log-query>

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# Exercise: Cleanup Resources

## Task 1 - Delete the cluster and its resources - Azure CLI

When you're done working with the cluster, you can delete it. You have the complete instructions here on how to recreate it.

It's a good idea to repeat this lab several times, changing some of the settings, in order to get the hang of working with AKS clusters.

1. Deleting the cluster is much easier than creating it.

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

2. You can skip deleting these resources if you're planning on recreating just the cluster at a later time.

3. Delete the Log Analytics Workspace.

```
az monitor log-analytics workspace delete --resource-group $AKS_RESOURCE_GROUP --workspace-name $LOG_ANALYTICS_WORKSPACE_NAME
```

4. Delete the Virtual Network

```
az network vnet delete --resource-group $AKS_RESOURCE_GROUP --name $AKS_VNET
```

**HINT: You could go through and delete individual resources above or you could delete the ENTIRE resource group, which will delete everything in it. Only do this if you place to recreate all the supporting resources**

5. Delete the entire resource group

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

## Task 2 - Delete the cluster and its resources - Terraform

1. If you used Terraform to create your cluster, you can delete the cluster and all it supporting resources with the following command:

```
terraform destroy -auto-approve
```

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