NashTech Training

Hands on: Practical DevOps for DEV

SD2350 – Hồ Phước Trúc

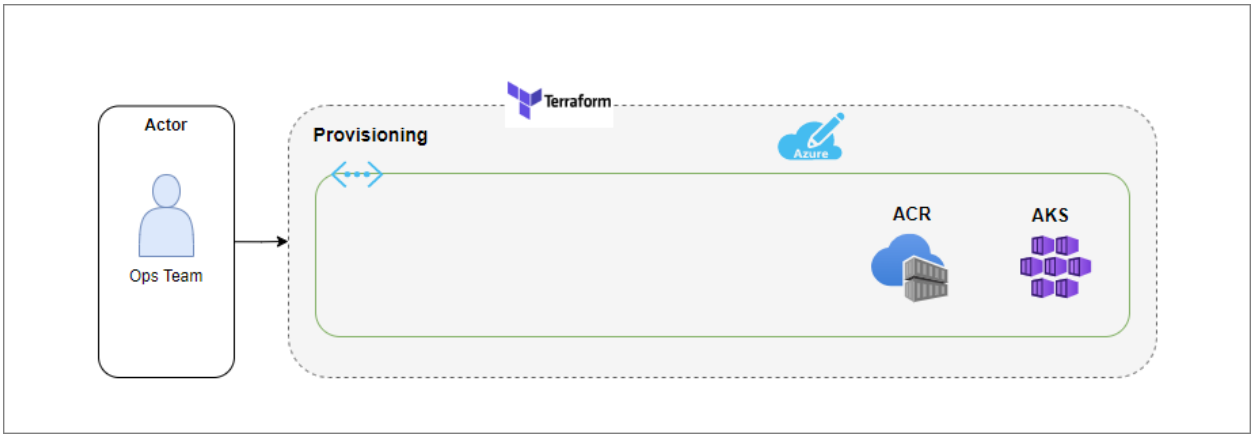
21 August 2023

1 Infrastructure as Code (IaC): Provision Azure resources with Terraform

Using Terraform to provision resources include VNET, ACR and AKS on Azure cloud.

GitHub repository: https://github.com/hptruc/sd2350_azure_infrastructure

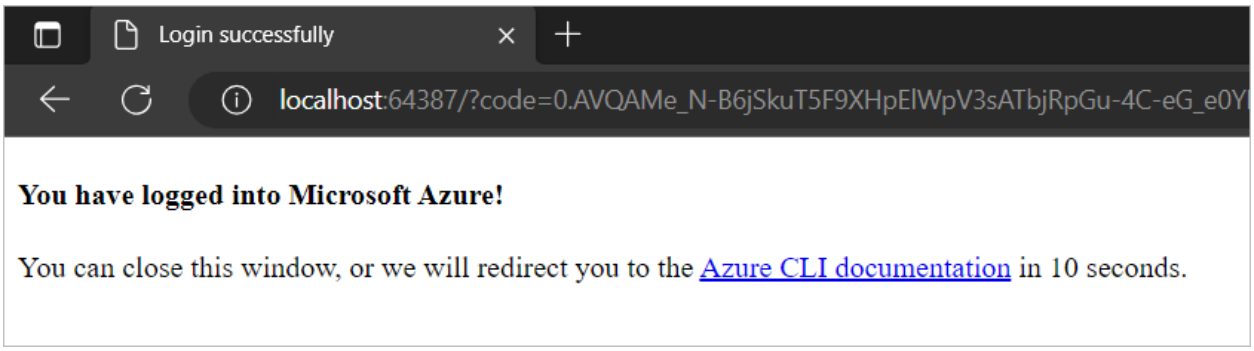
Architecture overview:



1.1 Authenticate using the Azure CLI

- In your terminal, use the Azure CLI tool to setup your account permissions locally.

- Your browser will open and prompt you to enter your Azure login credentials.
- After successful authentication, your terminal will display your subscription information.



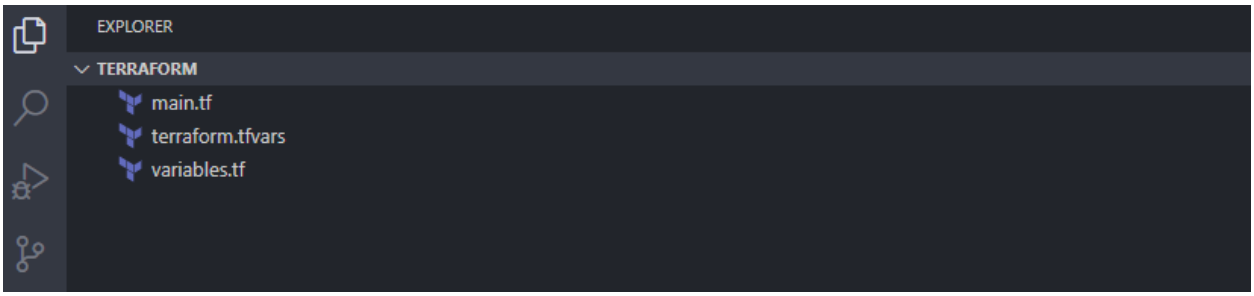
```
Windows PowerShell
PS C:\Users\truchop> az login
A web browser has been opened at https://login.microsoftonline.com/organizations/oauth2/v2.0/authorize. Please continue
the login in the web browser. If no web browser is available or if the web browser fails to open, use device code flow w
ith `az login --use-device-code`.
The following tenants don't contain accessible subscriptions. Use 'az login --allow-no-subscriptions' to have tenant lev
el access.
[redacted] 'Default Directory'
The following tenants require Multi-Factor Authentication (MFA). Use 'az login --tenant TENANT_ID' to explicitly login t
o a tenant.
[redacted] 'Default Directory'
[
  {
    "cloudName": "AzureCloud",
    "homeTenantId": "[redacted]",
    "id": "[redacted]",
    "isDefault": false,
    "managedByTenants": [],
    "name": "Visual Studio Enterprise",
    "state": "Enabled",
    "tenantId": "[redacted]",
    "user": {
      "name": "TruchoPhuoc@[redacted].com",
      "type": "user"
    }
  },
  {
    "cloudName": "AzureCloud",
    "homeTenantId": "[redacted]",
    "id": "[redacted]",
    "isDefault": true,
```

- Once you have chosen the account subscription ID, set the account with the Azure CLI.

```
Windows PowerShell    Windows PowerShell
PS C:\Users\truchop> az account set --subscription "c7130152[redacted]"
```

1.2 Prepare IaC project folders and variables

- Create a folder to store IaC source code, e.g. Terraform
- In this folder, create 3 files as below



- In **main.tf** file, add terraform script to configure the Azure provider (Azure resource manager – Azure RM)

```
main.tf > ...
# Configure the Azure provider
terraform {
  required_providers {
    azurerm = {
      source  = "hashicorp/azurerm"
      version = "~> 3.0.2"
    }
  }

  required_version = ">= 1.1.0"
}

provider "azurerm" {
  features {}
}
```

- In **variables.tfvars** file, define terraform variables as below

```
terraform.tfvars > ...
resource_group_name = "practice-devops-resource"
location            = "southeastasia"

vnet_name           = "aks-vnet"
vnet_address_space = ["10.1.0.0/16"]

subnet_name             = "aks-subnet"
subnet_address_prefixes = ["10.1.0.0/24"]

acr_name = "hptacr"
acr_sku  = "Standard"

aks_name                          = "aks-cluster-service"
aks_dns_prefix                    = "aks-dns"
aks_version                       = "1.26.6"
aks_sku                           = "Free"
aks_node_pool_name                = "aksagentpool"
aks_node_pool_count               = 1
aks_node_pool_size                = "Standard_D2_v2"
aks_node_pool_max_count           = 2
aks_node_pool_min_count           = 1
aks_rbac_enable                   = true
aks_network_plugin                = "azure"
aks_network_policy                = "azure"

role_assignment_name = "AcrPull"
```

- Notes: variable name and type defined in **terraform.tf** file

1.3 Script to create Virtual Network (VNET) and subnets using in the AKS cluster

- Open the **main.tf** file and add script to create a virtual network (VNET) and a subnet using in AKS cluster.

```
main.tf > ...
# Create a virtual network (VNET)
resource "azurerm_virtual_network" "aks_vnet" {
  name                = var.vnet_name
  location            = azurerm_resource_group.rg.location
  resource_group_name = azurerm_resource_group.rg.name
  address_space       = var.vnet_address_space
}

# Create a subnet for AKS
resource "azurerm_subnet" "aks_subnet" {
  name                 = var.subnet_name
  resource_group_name  = azurerm_resource_group.rg.name
  virtual_network_name = azurerm_virtual_network.aks_vnet.name
  address_prefixes     = var.subnet_address_prefixes
}
```

- Notes: reference to **variables.tfvars** file to get value of variables

1.4 Script to create Azure Container Registry (ACR)

- At the end of **main.tf** file, add script below to create ACR resource

```
# Create an ACR
resource "azurerm_container_registry" "acr" {
  name                = var.acr_name
  resource_group_name = azurerm_resource_group.rg.name
  location            = azurerm_resource_group.rg.location
  sku                 = var.acr_sku
  admin_enabled       = true
}
```

- Notes: reference to **variables.tfvars** file to get value of variables

1.5 Script to create Azure Kubernetes Service (AKS)

- At the end of **main.tf** file, add script to create AKS resource and grant permission to AKS can pull images form container registry (ACR).
- Grant permission for AKS

```
main.tf > ...
# Grant permission for AKS pull image from Container Registry (ACR)
resource "azurerm_role_assignment" "aks_role" {
  scope                = azurerm_container_registry.acr.id
  role_definition_name = "AcrPull"
  principal_id         = azurerm_kubernetes_cluster.aks.kubelet_identity[0].object_id

  depends_on = [azurerm_kubernetes_cluster.aks]
}
```

- Terraform script create the AKS resource

```
main.tf > resource "azurerm_kubernetes_cluster" "aks" > network_profile > network_policy
46  # Create an AKS cluster
47  resource "azurerm_kubernetes_cluster" "aks" {
48    name                = var.aks_name
49    location            = azurerm_resource_group.rg.location
50    resource_group_name = azurerm_resource_group.rg.name
51    dns_prefix          = var.aks_dns_prefix
52    kubernetes_version  = var.aks_version
53    sku_tier            = var.aks_sku
54
55    role_based_access_control_enabled = var.aks_rbac_enable
56
57    default_node_pool {
58      name                = var.aks_node_pool_name
59      node_count          = var.aks_node_pool_count
60      vm_size             = var.aks_node_pool_size
61      vnet_subnet_id      = azurerm_subnet.aks_subnet.id
62      enable_auto_scaling = true
63      min_count           = var.aks_node_pool_min_count
64      max_count           = var.aks_node_pool_max_count
65    }
66
67    network_profile {
68      network_plugin = var.aks_network_plugin
69      network_policy = var.aks_network_policy
70    }
71
72    identity {
73      type = "SystemAssigned"
74    }
75
76    depends_on = [azurerm_subnet.aks_subnet]
77  }
```

- Notes: reference to **variables.tfvars** file to get value of variables

1.6 Run Terraform scripts

- In the root folder, open a Terminal and type command > terraform init

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL

PS D:\Others\Practical DevOps\Source\Infrastructure\Terraform> terraform init

Initializing the backend...

Initializing provider plugins...
- Finding hashicorp/azurerm versions matching "~> 3.0.2"...
- Installing hashicorp/azurerm v3.0.2...
- Installed hashicorp/azurerm v3.0.2 (signed by HashiCorp)
```

- Then, type command > terraform plan

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL

PS D:\Others\Practical DevOps\Source\Infrastructure\Terraform> terraform plan

Terraform used the selected providers to generate the following execution plan. Resource actions are indicated with the following symbols:
  + create
```

```
Plan: 6 to add, 0 to change, 0 to destroy.
```

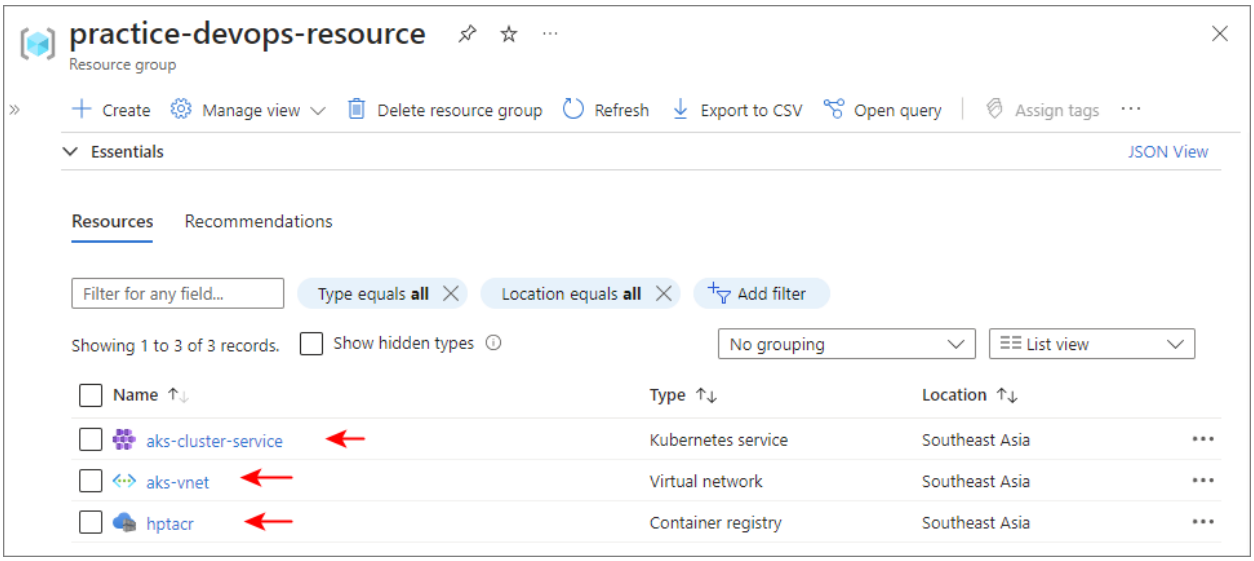
- Type commend > terraform apply

```
Do you want to perform these actions?
  Terraform will perform the actions described above.
  Only 'yes' will be accepted to approve.

  Enter a value: yes
```

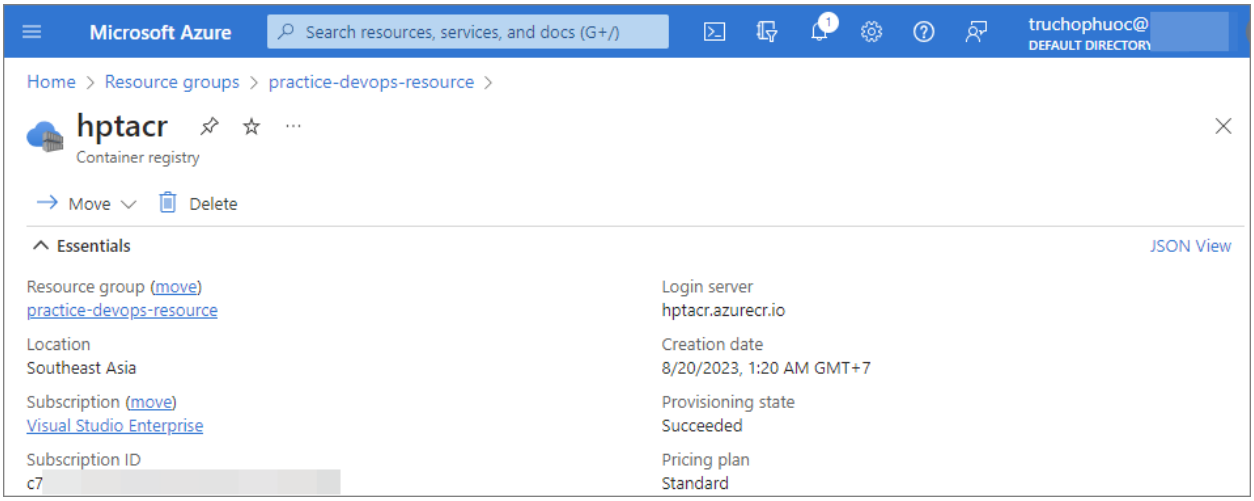
```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL


Do you want to perform these actions?
  Terraform will perform the actions described above.
  Only 'yes' will be accepted to approve.

  Enter a value: yes

azurerm_resource_group.rg: Creating...
azurerm_resource_group.rg: Creation complete after 1s [id=/subscriptions/c713[redacted]/resourceGroups/prac
azurerm_virtual_network.aks_vnet: Creating...
azurerm_container_registry.acr: Creating...
azurerm_virtual_network.aks_vnet: Creation complete after 4s [id=/subscriptions/c713[redacted]/resourceGrou
azurerm_subnet.aks_subnet: Creating...
azurerm_subnet.aks_subnet: Creation complete after 4s [id=/subscriptions/c713[redacted]/resourceGroups/prac
azurerm_kubernetes_cluster.aks: Creating...
azurerm_container_registry.acr: Still creating... [10s elapsed]
azurerm_container_registry.acr: Still creating... [20s elapsed]
azurerm_container_registry.acr: Creation complete after 26s [id=/subscriptions/c71[redacted]/resourceGroup
```

1.7 Verify resources created on Azure

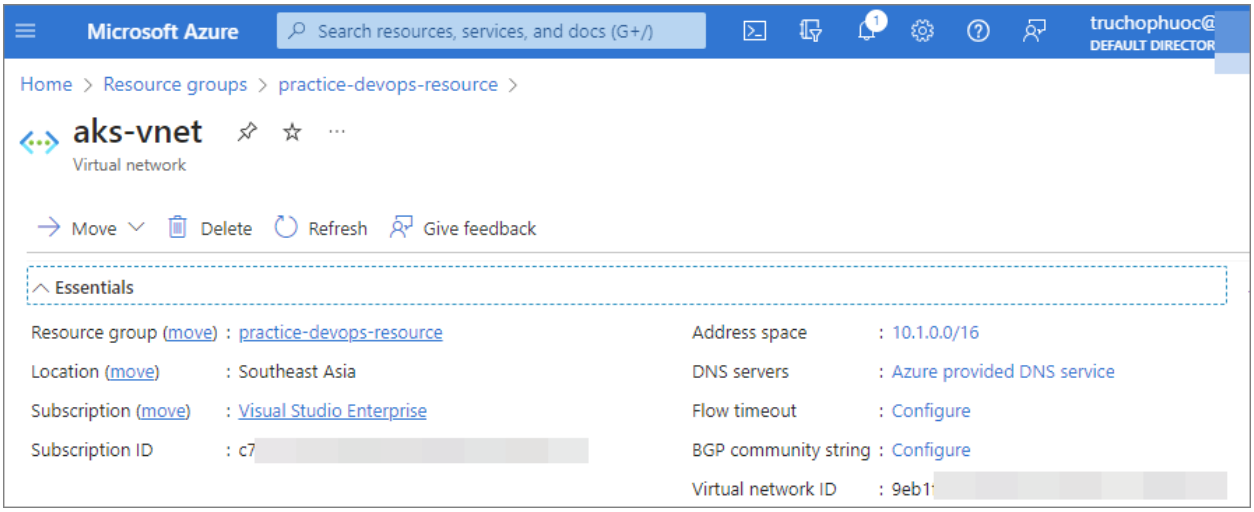
- After resources create successfully, login Azure portal to verify resources created
- Resource group

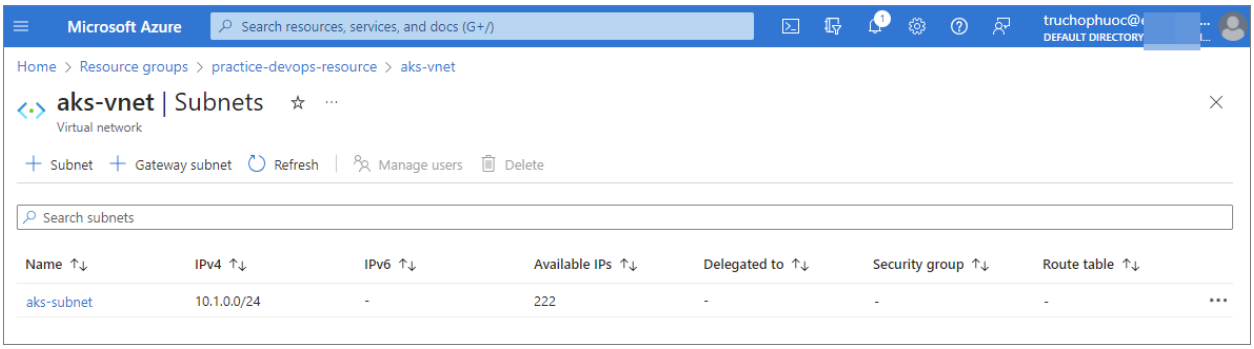


- Azure container registry (ACR)

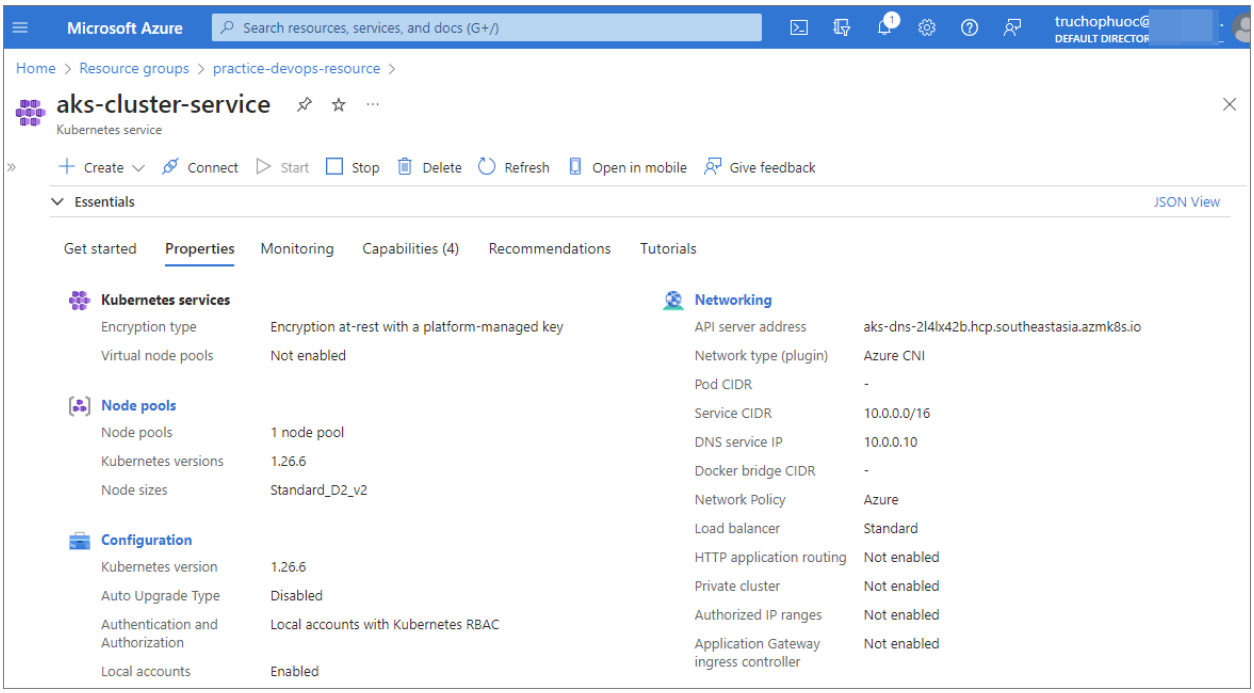


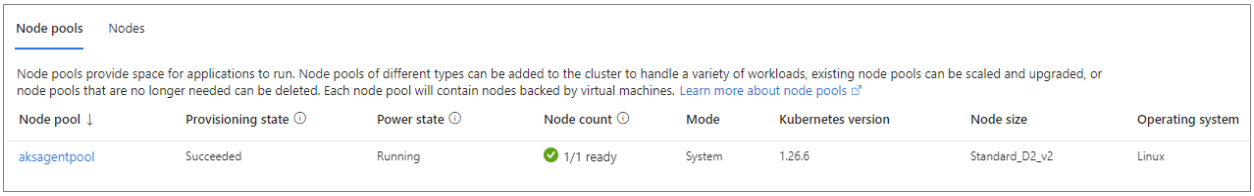
- Virtual network and subnets





- Azure Kubernetes service (AKS)





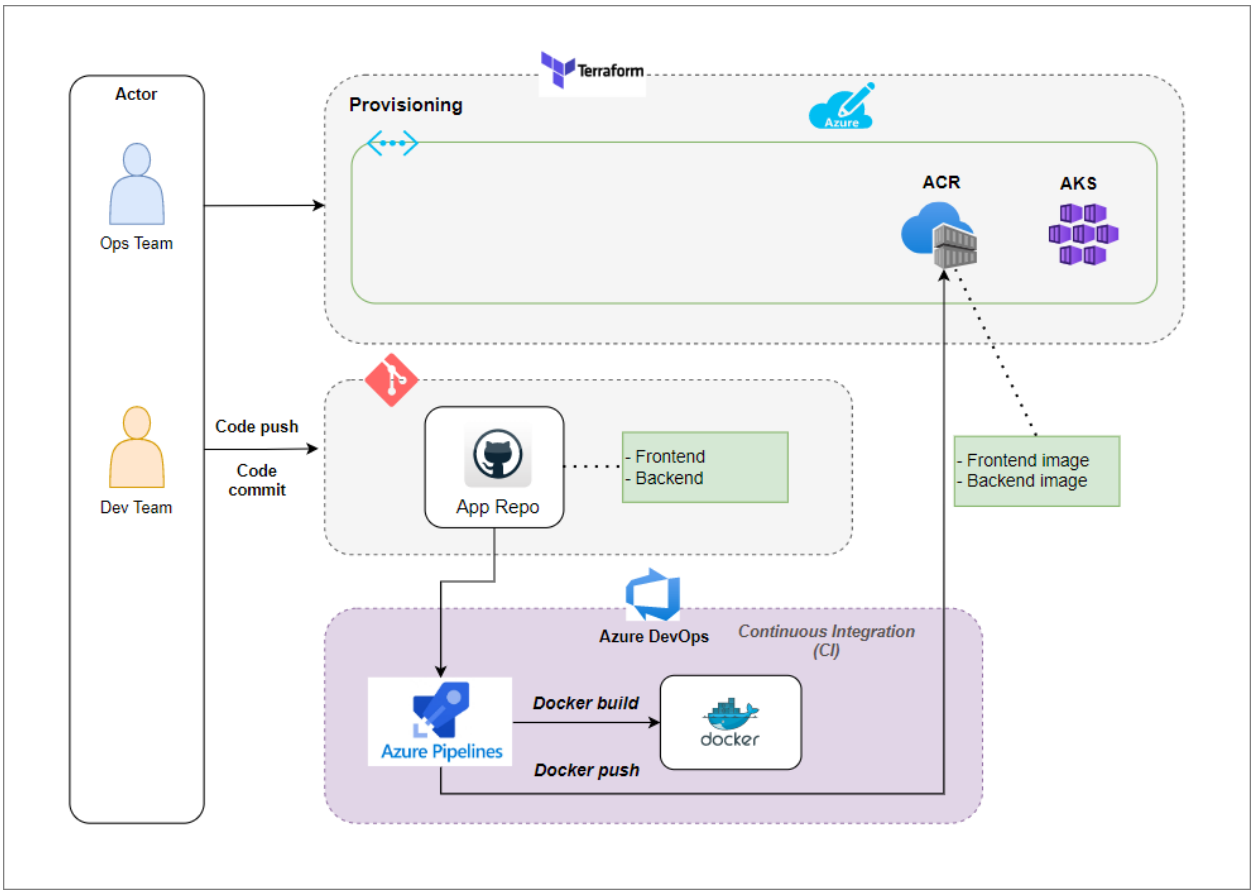
2 CI: Setting up an azure pipeline, build and push Docker image to ACR

GitHub repository: https://github.com/hptruc/sd2350_msa

Precondition:

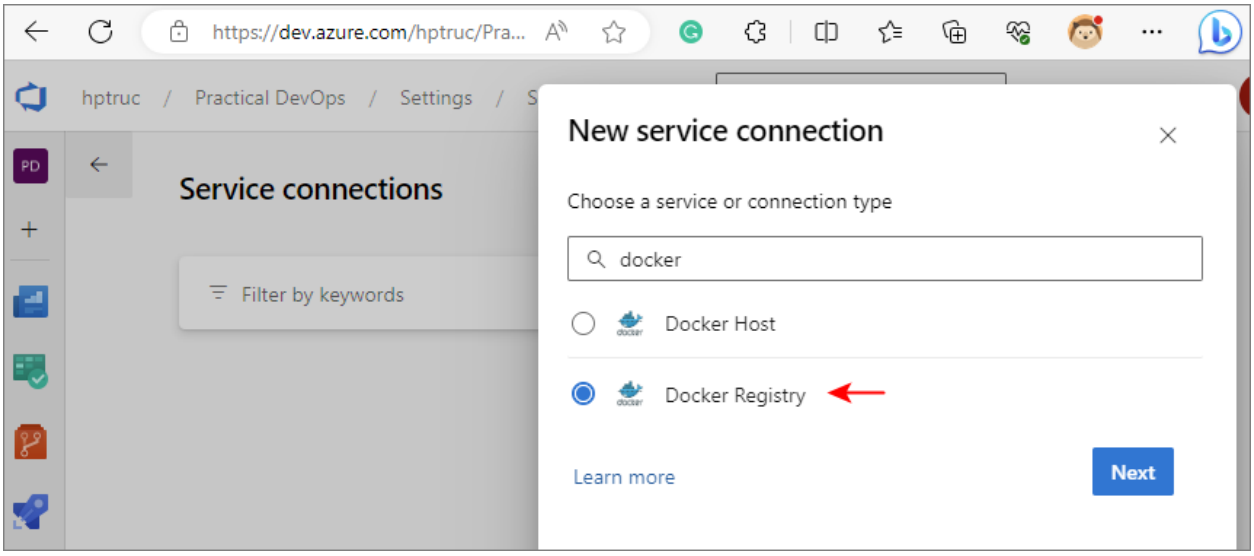
- Create an Azure DevOps instance and request to Microsoft (fill form) to get a Microsoft-hosted agents for build pipelines.

Architecture overview:

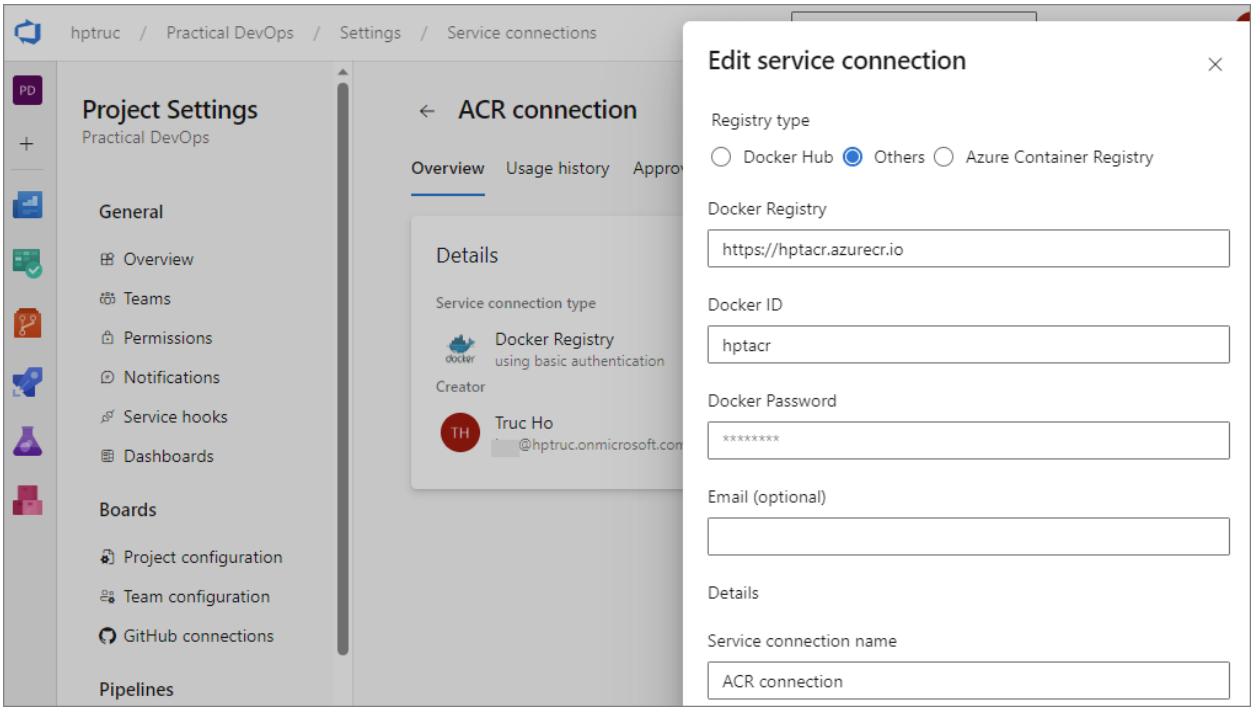


2.1 Setting up Azure Docker Registry service connection

- Login to Azure DevOps instance and create new a project, e.g. Practical DevOps
- Go to Project settings page > Service connections > New service connection
- Select Docker Registry and click on Next button



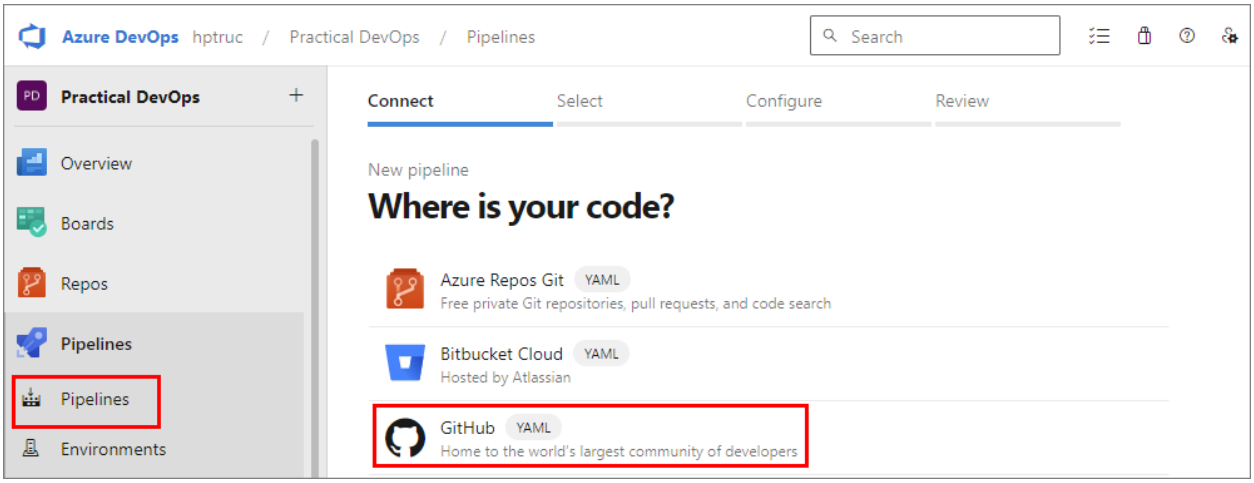
- Select **Others** option and fill required information



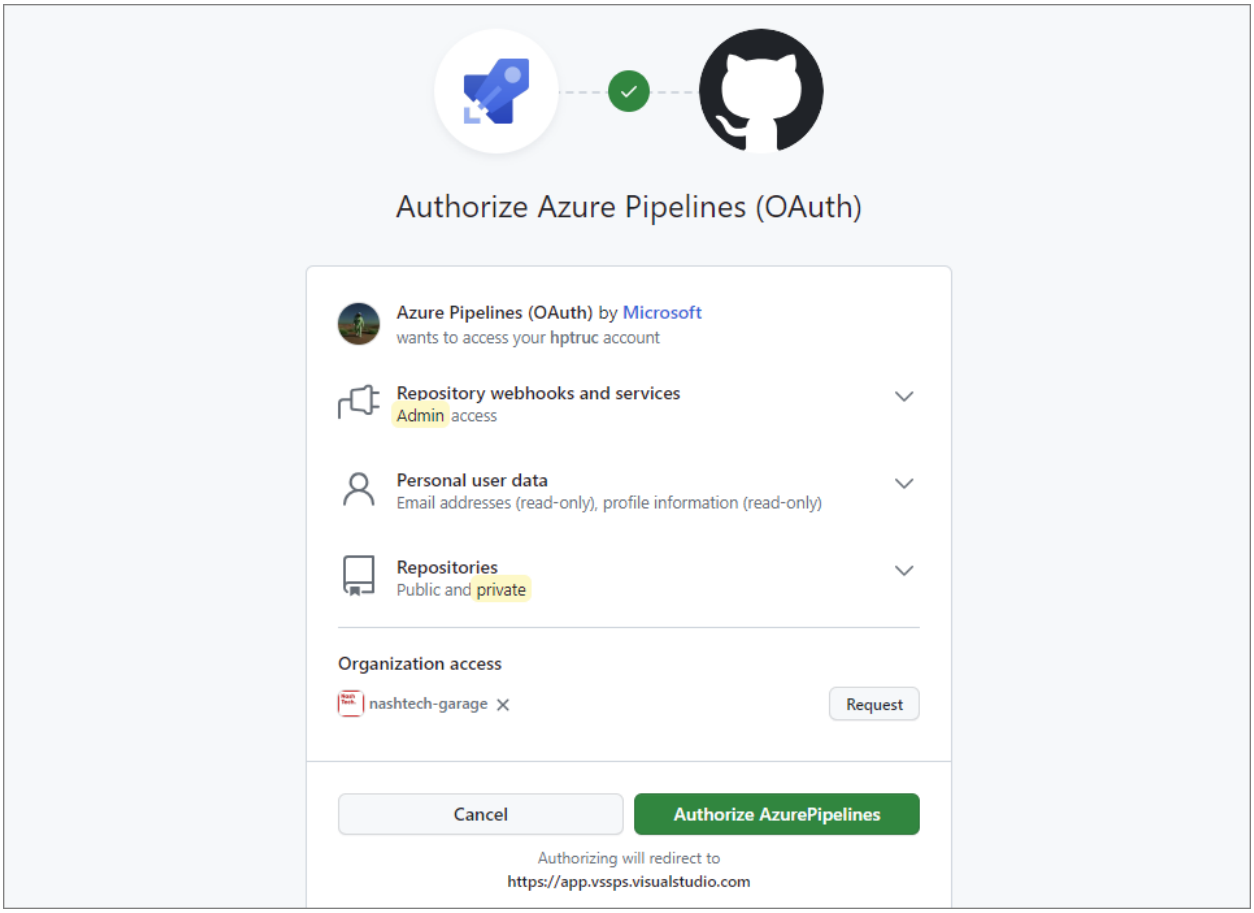
- The "**Azure container registry login server**" field: Link of ACR instance.

2.2 Create new a CI pipeline and connect to MSA GitHub repository

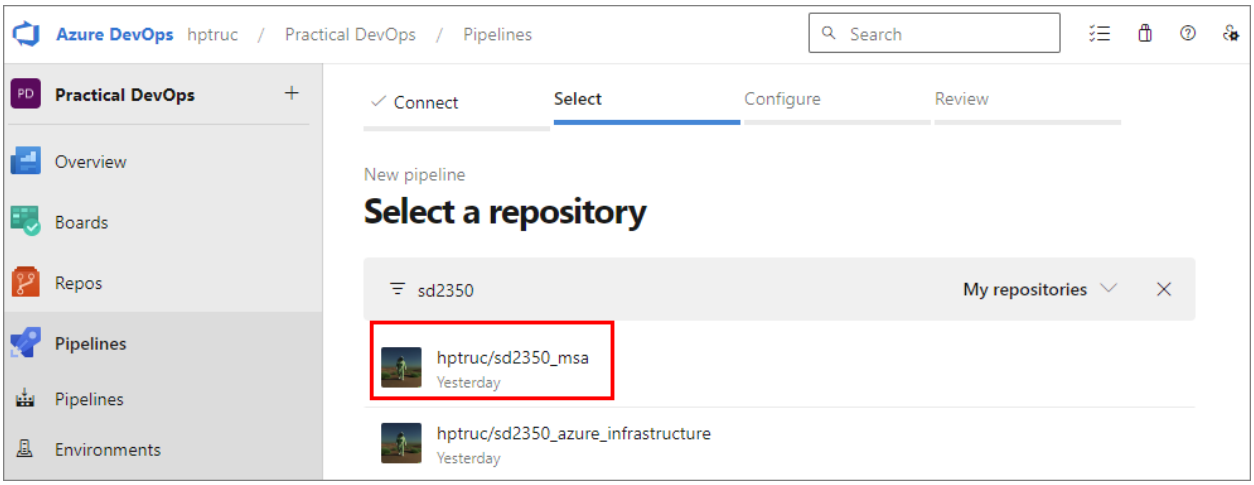
- Click on Pipelines item from left side bar > New pipeline
- Select GitHub method



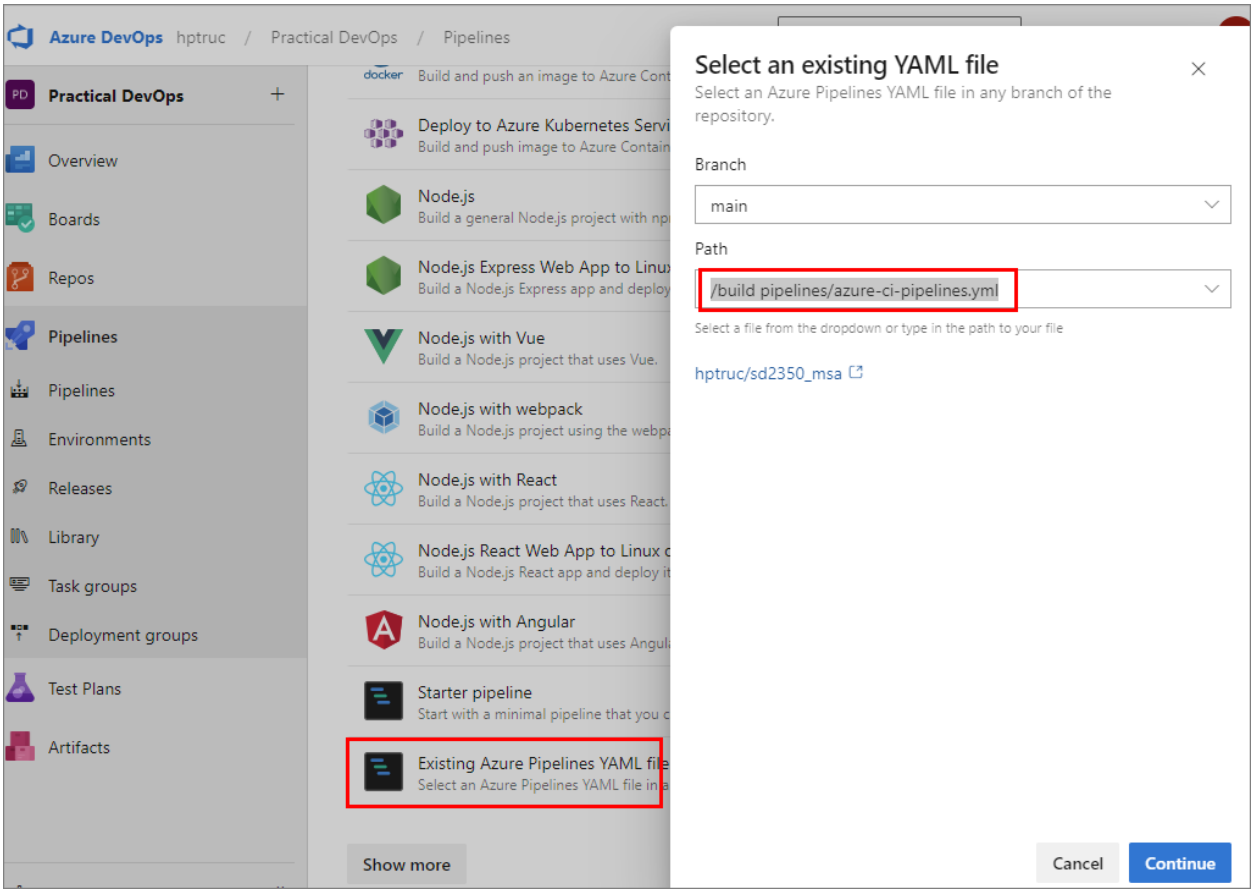
- Azure DevOps will redirect to GitHub authorize page



- Click on **Authorize Pipelines** button
- After authorize successfully, at the Azure DevOps page, select MSA repository



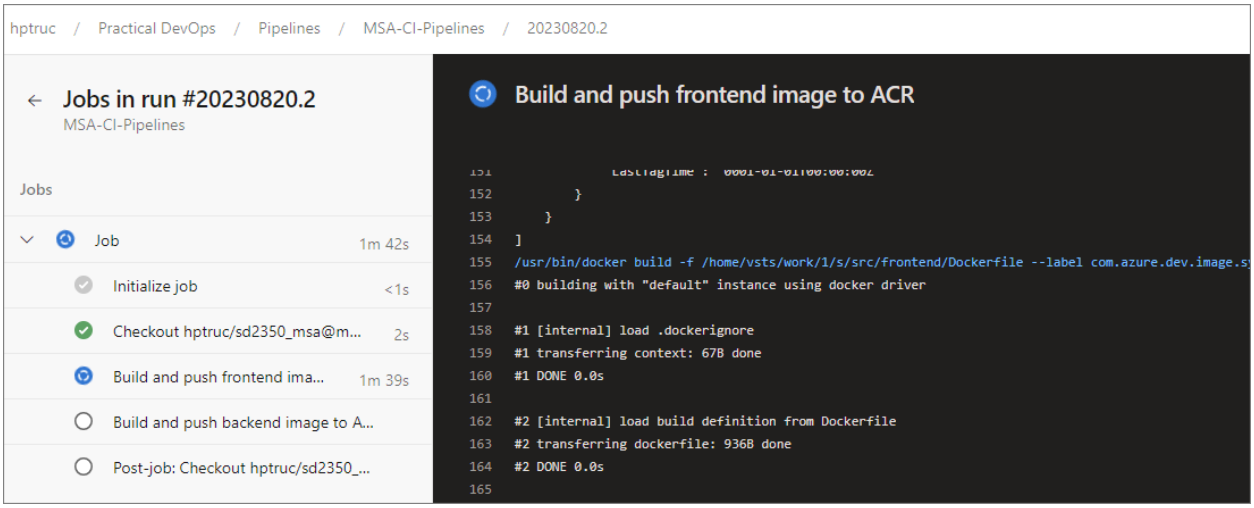
- Approve permission from GitHub page to access to this repository
- The next, in tab Configure > select item **Existing Azure Pipelines YAML file**
- In the select file popup > select **ci pipeline** file in Path dropdown



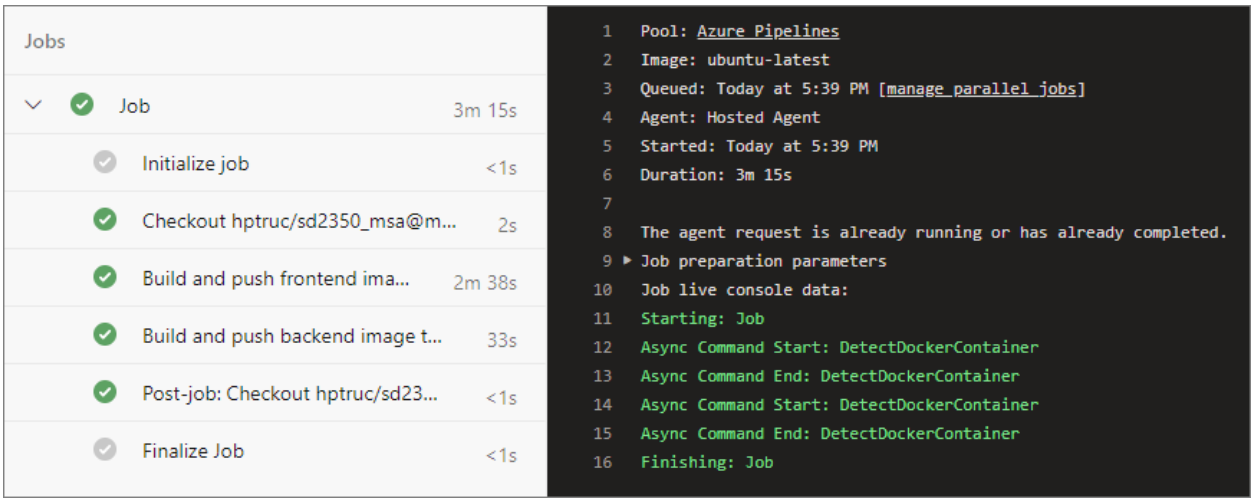
- Verify **ACR connection** to make sure that it work correctly.
- Save pipeline with name **MSA-CI-Pipelines**

2.3 Run CI build pipeline and verify results

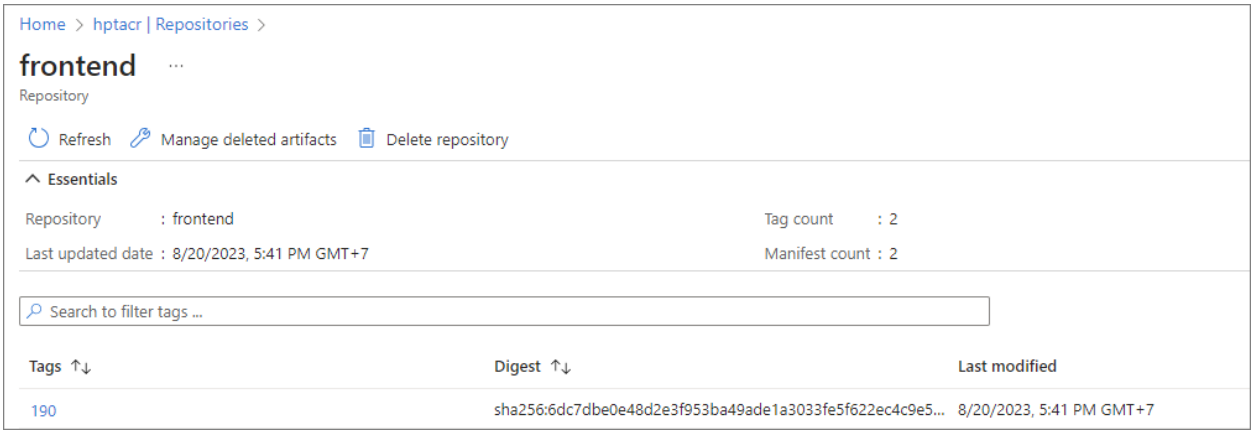
- Select pipeline **MSA-CI-Pipelines** and click on run button to start build pipeline



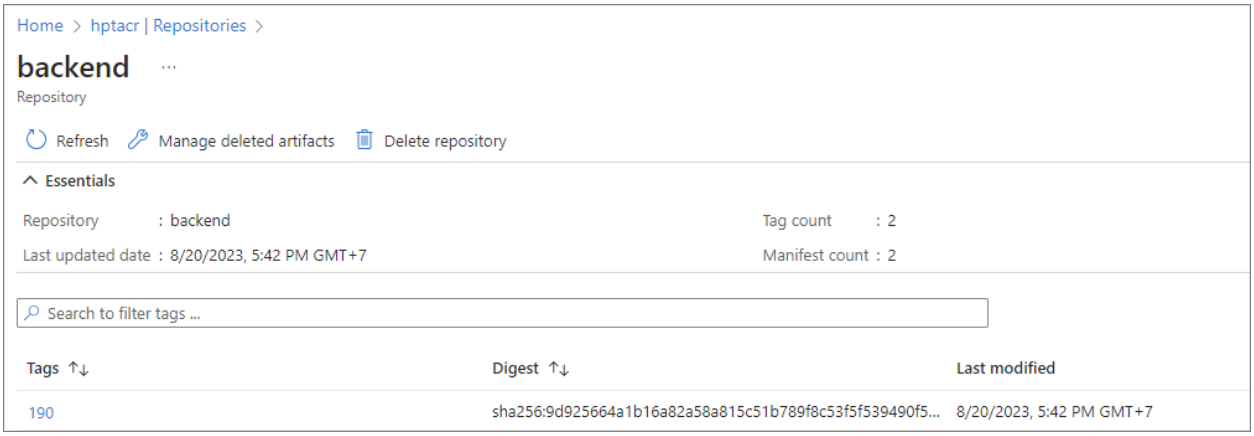
- Waiting for 3-5 minutes
- Check results from console to make sure that build pipeline complete without any error.



- Login to Azure portal to verify images
- Frontend image



- Backend image



- Complete Azure CI build pipeline.

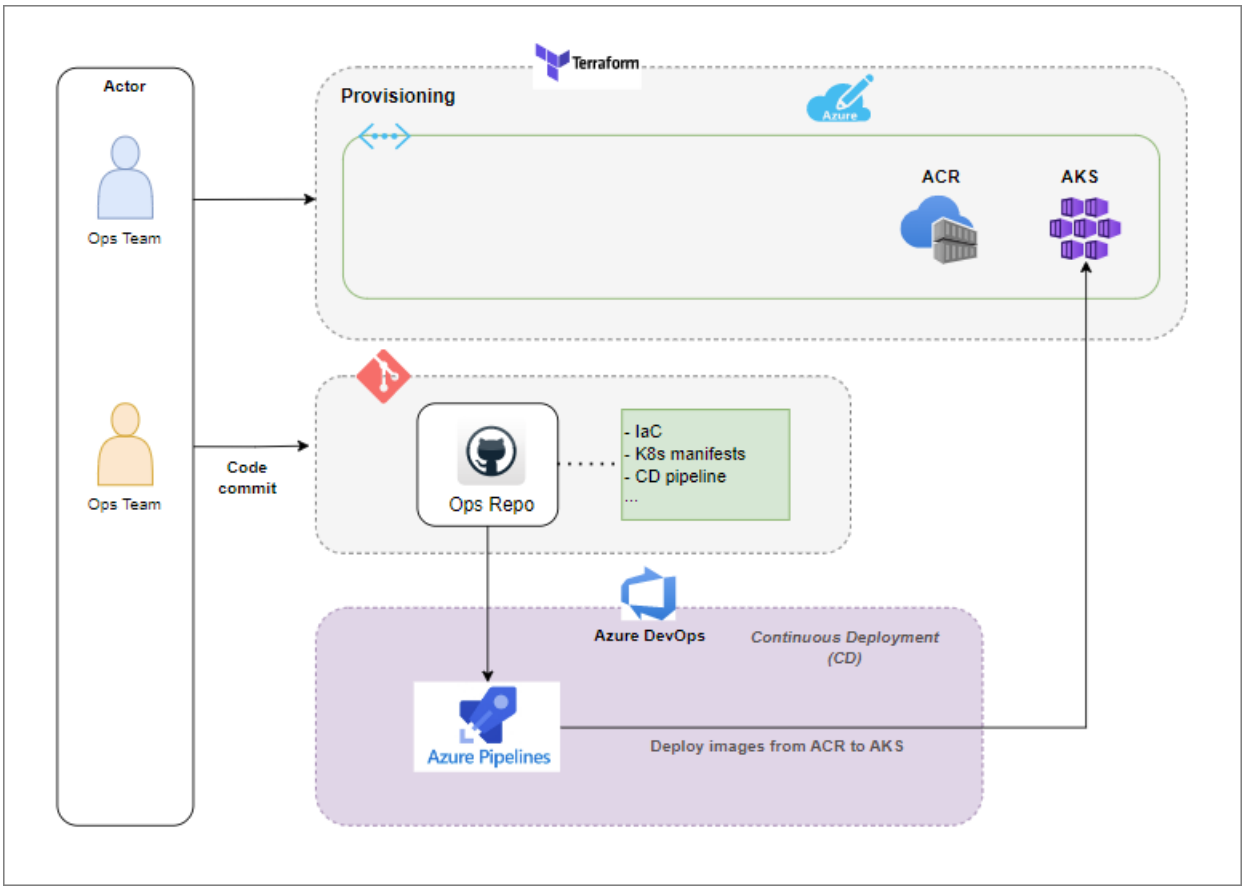
3 CD: Setting up an azure pipeline and deploying applications on AKS

GitHub repository: https://github.com/hptruc/sd2350_azure_infrastructure

Precondition:

- CI build pipeline executed to push MSA images to Azure Container Registry

Architecture overview:



3.1 Create a Kubernetes namespace using for deployment

- Open terminal and type this command to create a namespace
- Namespace: **aks-ns**

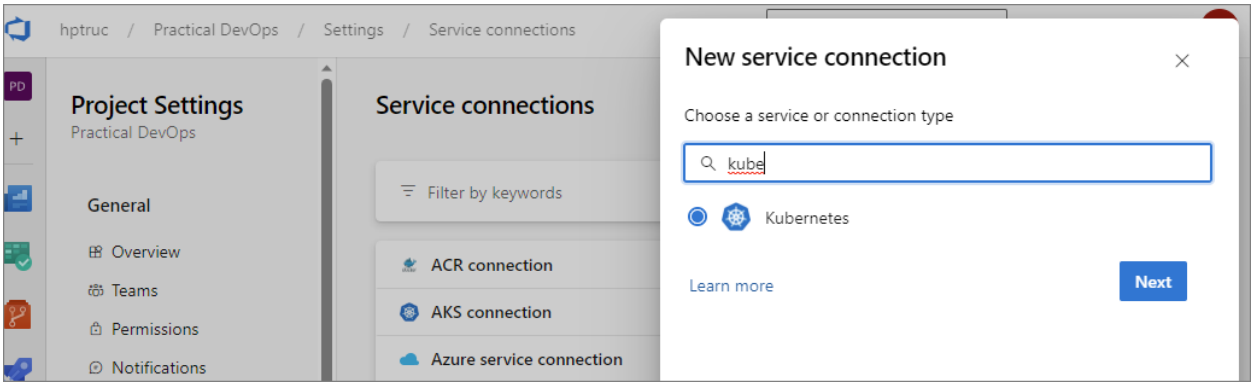
```
Windows PowerShell
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe create namespace aks-ns
```

- Verify namespace created

```
Windows PowerShell
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe get namespace
NAME              STATUS   AGE
aks-ns            Active   3h4m
```

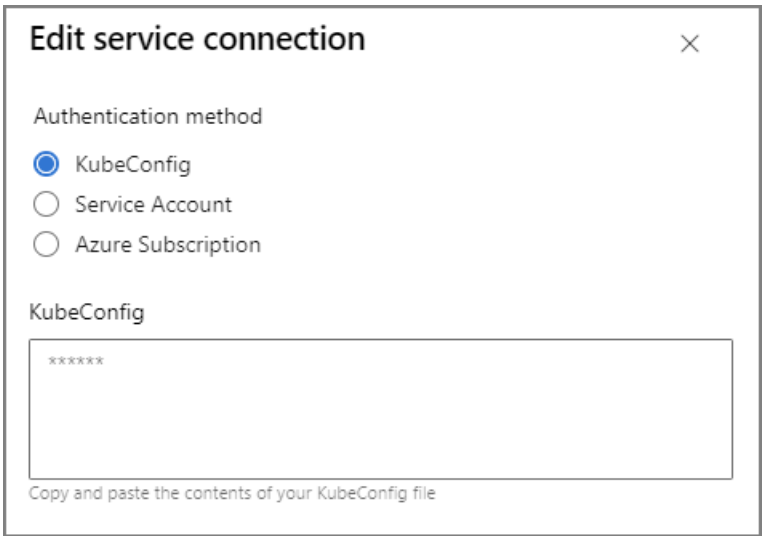
3.2 Setting up AKS service connection

- Login to Azure DevOps instance > access **Practical DevOps** project
- Go to Project settings page > Service connections > New service connection
- Select **Kubernetes** and click on Next button



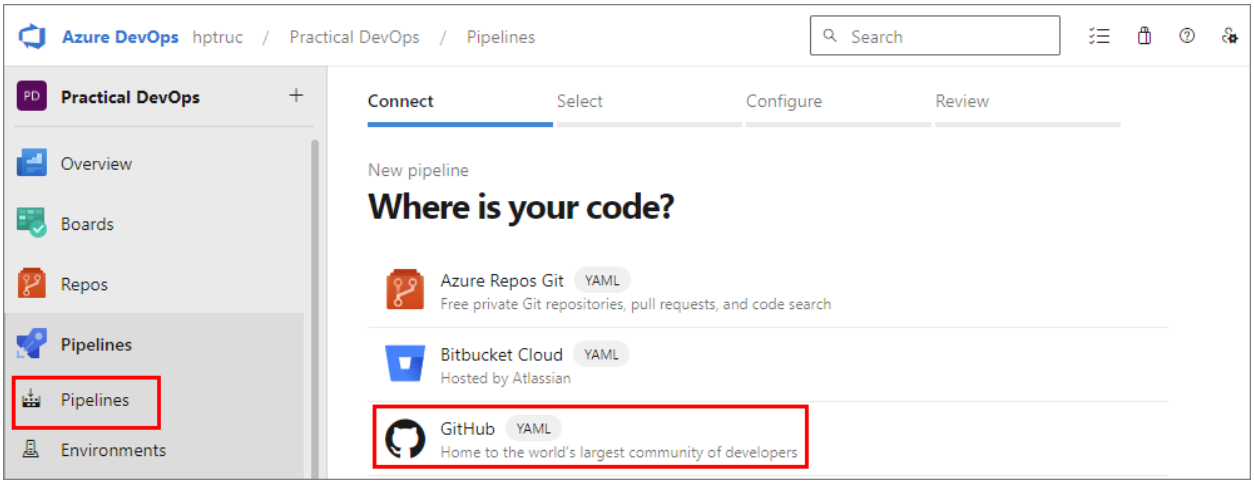
- You can choose one of three options depending on the Azure account you are using. In this demo, I choose the option KubeConfig.
- Open terminal and type this command to set Kubernetes credential to configure file

- Go to configure file with path in console (C:\Users\...)
- Copy all content of configure file and paste into textbox KubeConfig
- Click on verify button and save service connection with name **AKS connection**



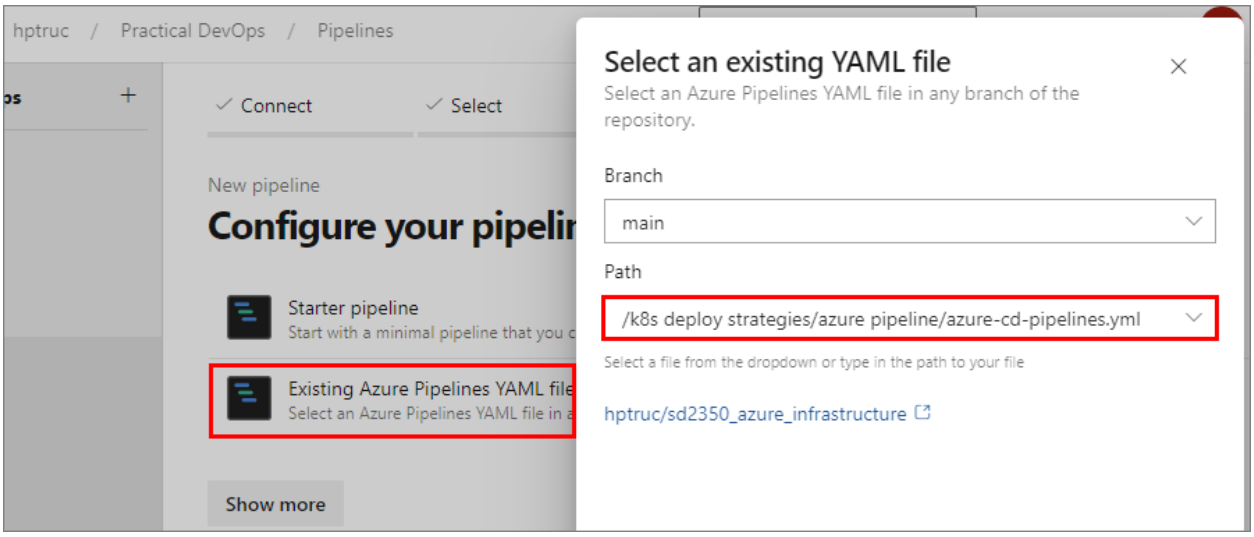
3.3 Create new a CD pipeline and connect to Infrastructure GitHub repository

- Click on Pipelines item from left side bar > New pipeline
- Select GitHub method



- In the Azure DevOps page, select infrastructure repository

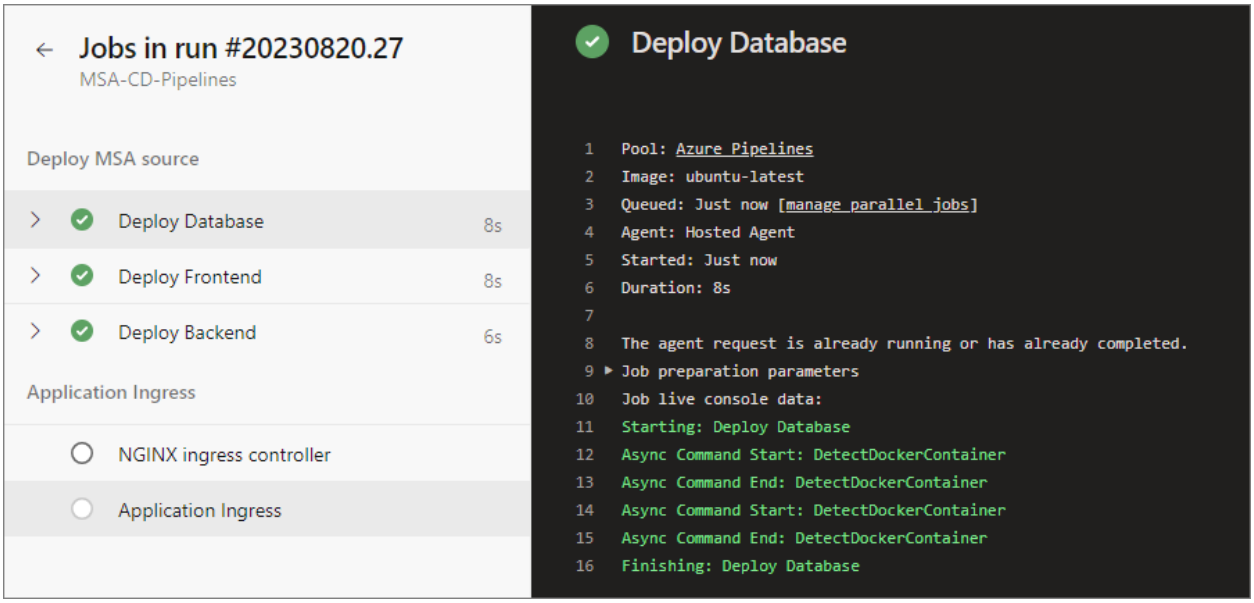
- Approve permission from GitHub page to access to this repository
- The next, in tab Configure > select **Existing Azure Pipelines YAML file** item
- In the select file popup > select [cd pipeline file]() in Path dropdown



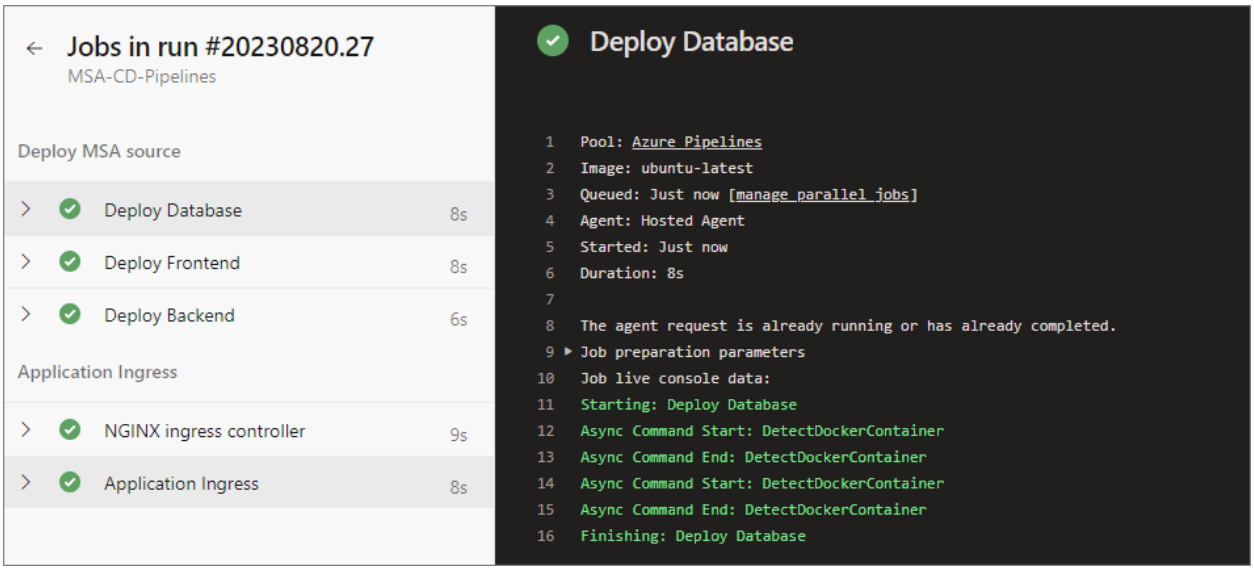
- Save pipeline with name **MSA-CD-Pipelines**

3.4 Run CD build pipeline and verify results

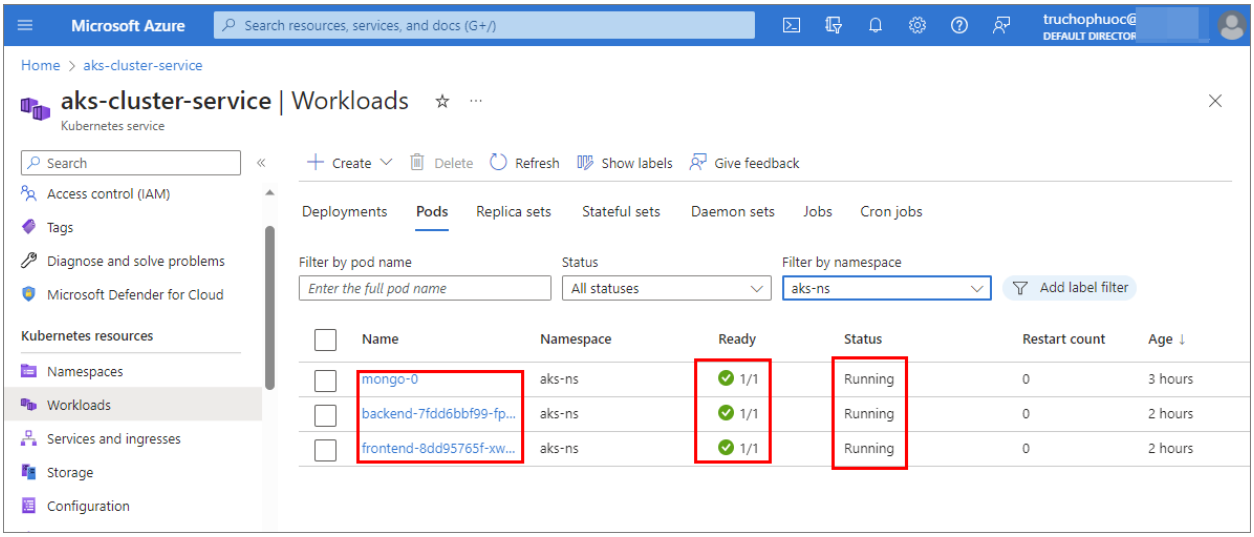
- Select pipeline **MSA-CD-Pipelines** and click on run to start build pipeline



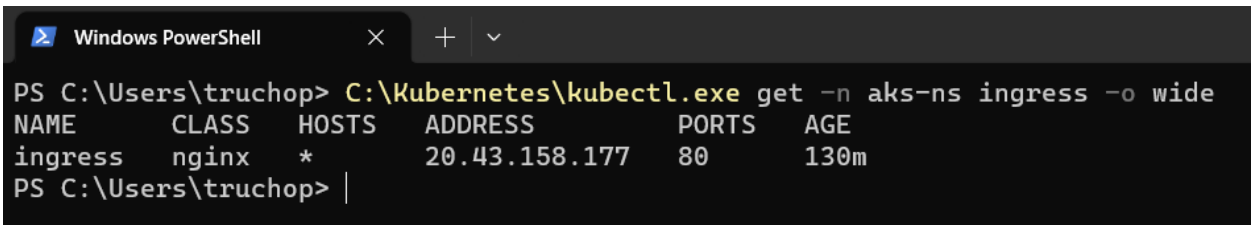
- Waiting for 3-5 minutes
- Check result from console logs to make sure build pipeline complete without any error



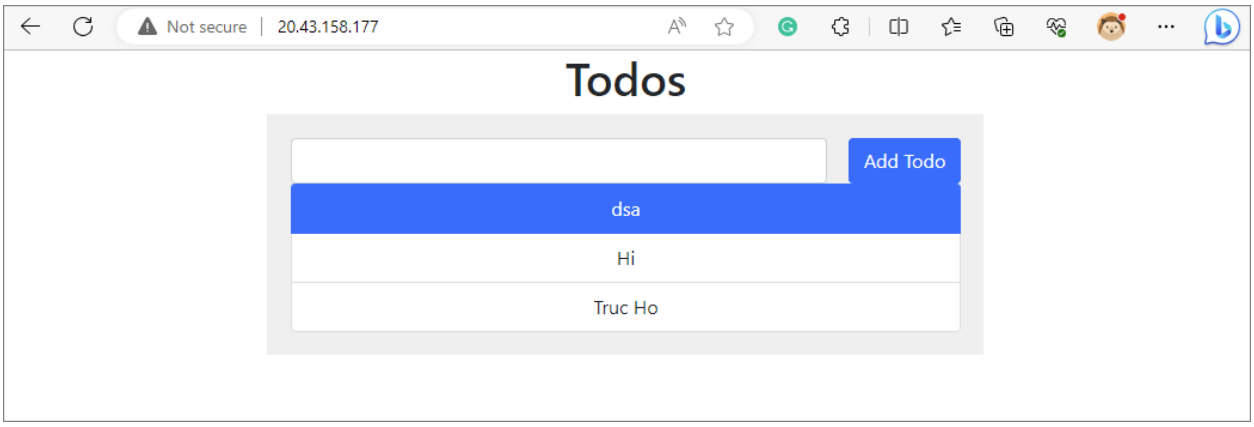
- Login to Azure portal to verify images



- Open terminal and type this command



- Copy ingress IP ADDRESS and paste to browser to go to web page



- Complete Azure CD deployment pipeline.

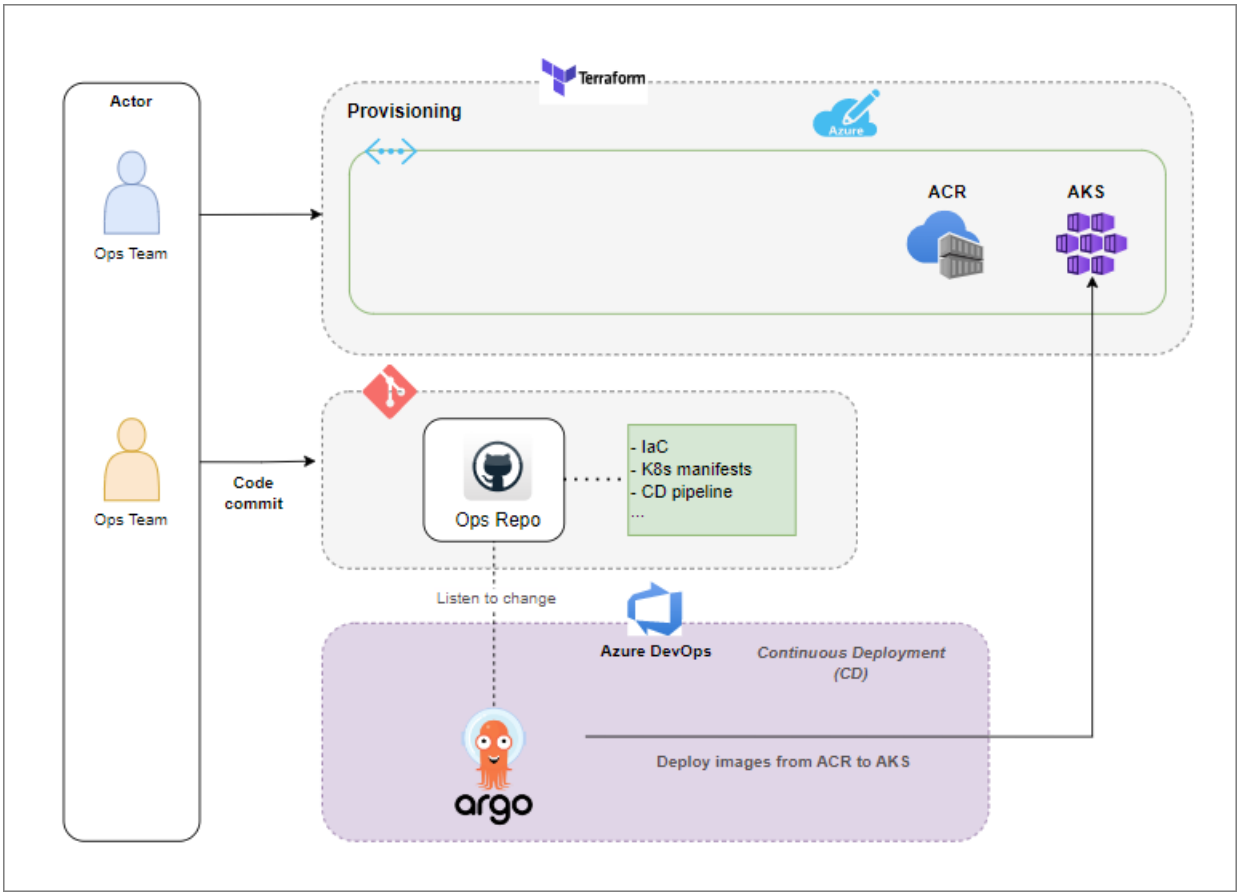
4 GitOps: Replace azure pipeline CD by Argo CD

GitHub repository:

Precondition:

- CI build pipeline executed to push MSA images to Azure Container Registry.

Architecture overview:



4.1 Install Argo CD on AKS

- Open terminal and create a namespace for Argo CD
- Namespace: argocd

```
Windows PowerShell
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe create namespace argocd
namespace/argocd created
```

- Verify namespace created

```
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe get namespace
NAME              STATUS   AGE
aks-ns            Active   3h53m
argocd            Active   8s
default           Active   17h
ingress-nginx     Active   126m
kube-node-lease   Active   17h
kube-public       Active   17h
kube-system       Active   17h
```

- Install Argo CD by script: https://raw.githubusercontent.com/argoproj/argo-cd/stable/manifests/install.yaml

```
Windows PowerShell
kube-public       Active   17h
kube-system       Active   17h
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe apply -n argocd -f https://raw.githubusercontent.com/argoproj/argo-cd/stable/ma
nifests/install.yaml
customresourcedefinition.apiextensions.k8s.io/applications.argoproj.io created
customresourcedefinition.apiextensions.k8s.io/applicationsets.argoproj.io created
customresourcedefinition.apiextensions.k8s.io/appprojects.argoproj.io created
serviceaccount/argocd-application-controller created
serviceaccount/argocd-applicationset-controller created
serviceaccount/argocd-dex-server created
serviceaccount/argocd-notifications-controller created
serviceaccount/argocd-redis created
serviceaccount/argocd-repo-server created
serviceaccount/argocd-server created
role.rbac.authorization.k8s.io/argocd-application-controller created
role.rbac.authorization.k8s.io/argocd-applicationset-controller created
role.rbac.authorization.k8s.io/argocd-dex-server created
role.rbac.authorization.k8s.io/argocd-notifications-controller created
role.rbac.authorization.k8s.io/argocd-server created
clusterrole.rbac.authorization.k8s.io/argocd-application-controller created
clusterrole.rbac.authorization.k8s.io/argocd-server created
```

- Verify Argo CD installed successfully

```
Windows PowerShell
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe get all -n argocd
NAME                                                READY   STATUS              RESTARTS   AGE
pod/argocd-application-controller-0                 0/1     ContainerCreating   0          12s
pod/argocd-applicationset-controller-5787d44dff-dwffn   1/1     Running             0          13s
pod/argocd-dex-server-858cfd495f-ncb68              0/1     Init:0/1            0          13s
pod/argocd-notifications-controller-5d889fdf74-sf5xn    0/1     ContainerCreating   0          13s
pod/argocd-redis-7d8d46cc7f-cqrck                   0/1     ContainerCreating   0          13s
pod/argocd-repo-server-7b6d785784-2vgqm             0/1     Init:0/1            0          13s
pod/argocd-server-67f667d48c-6cdts                  0/1     ContainerCreating   0          12s
```

- Get raw password (base 64) login to Argo CD

```
Windows PowerShell   Windows PowerShell
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe -n argocd get secret argocd-initial-admin-secret -o jsonpath="{.data.password}"
emQ0ckVXYTR3RVRwRDN0SQ==
PS C:\Users\truchop>
```

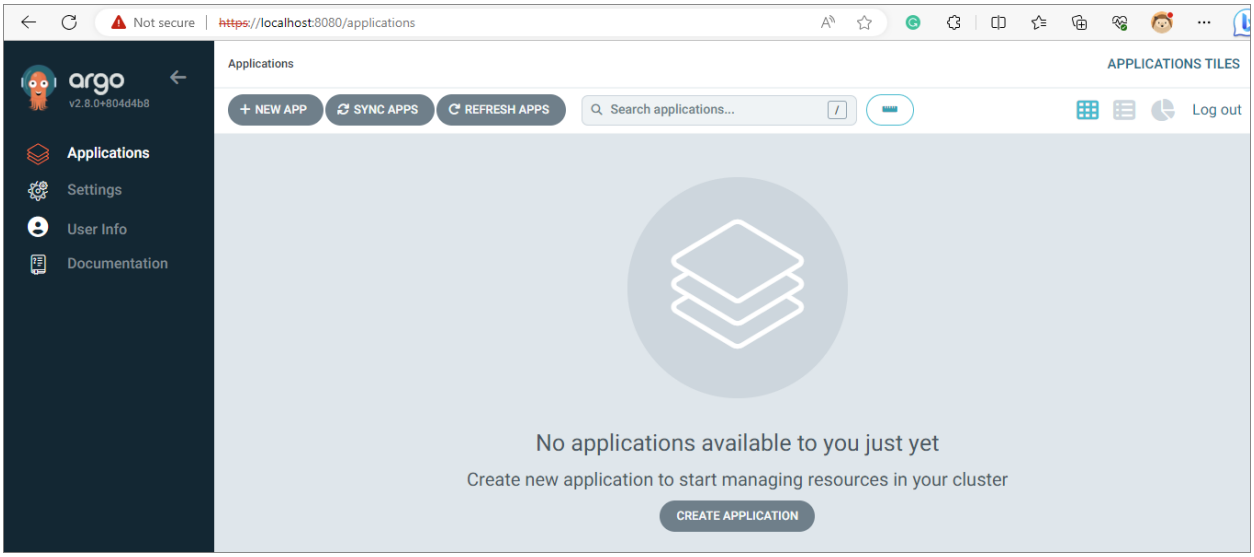
- Decode password by command

```
Windows PowerShell   Windows PowerShell   Windows PowerShell
PS C:\Users\truchop> [System.Text.Encoding]::UTF8.GetString([System.Convert]::FromBase64String("emQ0ckVXYTR3RVRwRDN0SQ==”))
zd4rEWa4wETpD3tI
PS C:\Users\truchop>
```

- Finally, use port forwarding to connect to the `argocd-server` service in AKS cluster.

```
Windows PowerShell
zd4rEWa4wETpD3tI
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe port-forward svc/argocd-server -n argocd 8080:443
Forwarding from 127.0.0.1:8080 -> 8080
Forwarding from [::1]:8080 -> 8080
Handling connection for 8080
Handling connection for 8080
Handling connection for 8080
```

- Open browser and go to address: http://localhost:8080 with credential
    - Username: admin
    - Password: { decoded in previous step }



4.2 Add new applications to Argo CD

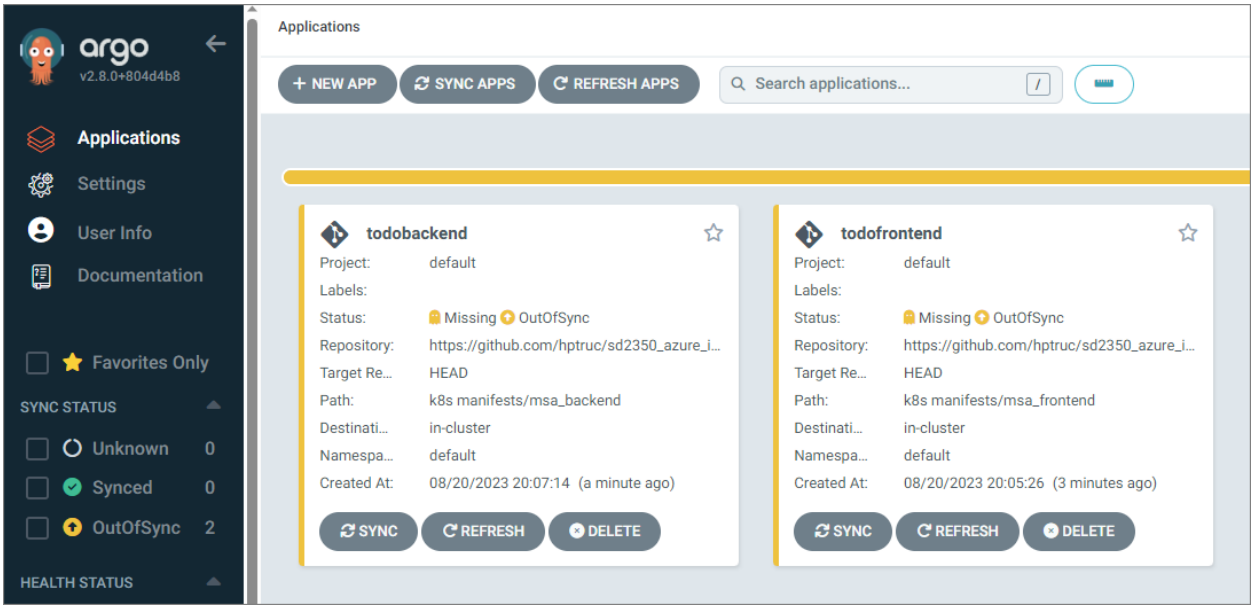
- In Argo CD portal, click on New App button to create new application
- For demo purpose, I will create 2 applications Frontend and Backend (skip database)
- Frontend

Field Name	Value
Application Nam	todofrontend
Project Name	default
Sync Policy	Manual
Repository URL	https://github.com/hptruc/sd2350_azure_infrastructure.git
Path	k8s manifests/msa_frontend
Cluster URL	https://kubernetes.default.svc
Namespace	default

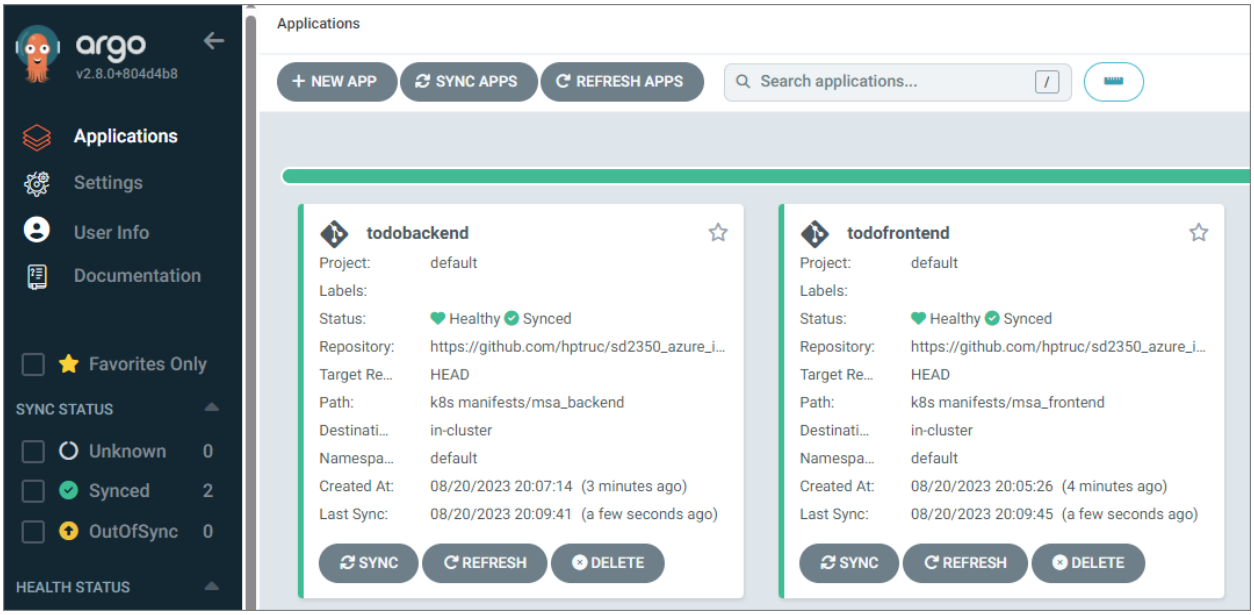
- Backend

Field Name	Value
Application Nam	todobackend
Project Name	default
Sync Policy	Manual
Repository URL	https://github.com/hptruc/sd2350_azure_infrastructure.git
Path	k8s manifests/msa_backend
Cluster URL	https://kubernetes.default.svc
Namespace	default

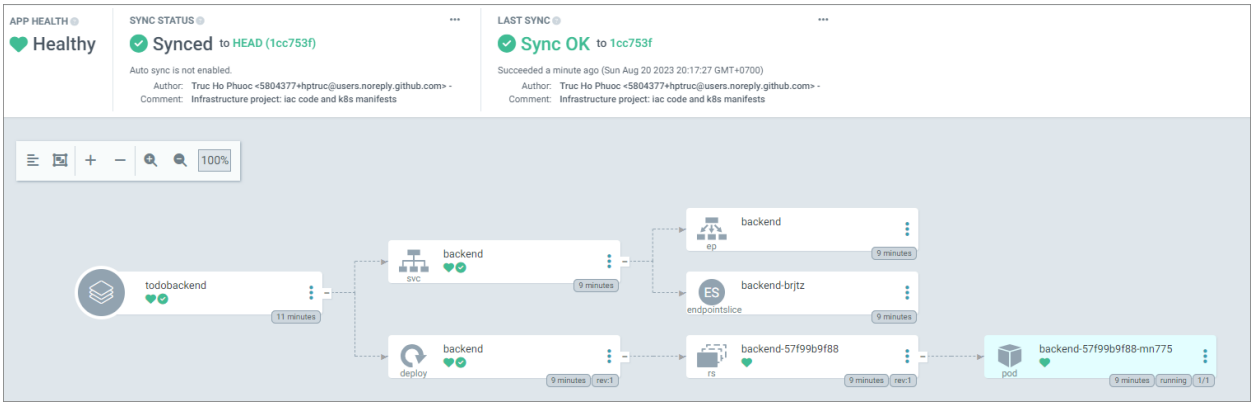
- Click on Create button to create application
- Initially, you will notice your application sync status is **OutOfSync** and your health status is **Missing**



- Click on SYNC button > SYNCHRONIZE



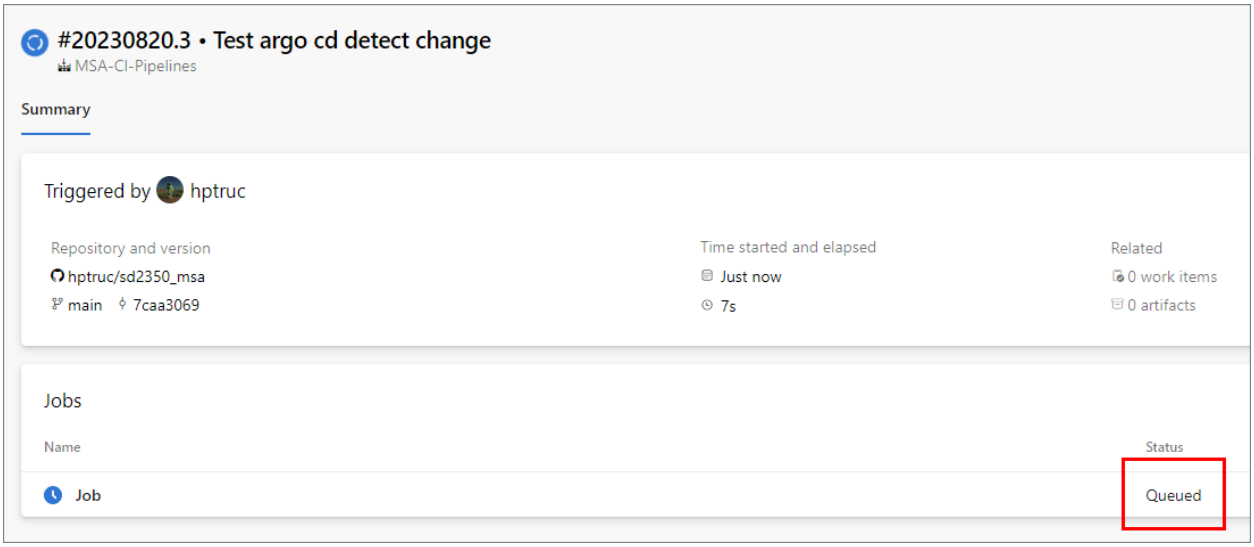
- Verify status of applications after sync



4.3 Test deployment with Argo CD

- Open MSA frontend source code and change something then commit change to MSA repo to build pipeline trigger create new image on ACR
- I will change as below

- Commit code change
- CI trigger build



- Login to Azure portal to check new image tag

- New image tag: 195
- Update K8s manifest of frontend to get image by new tag 195

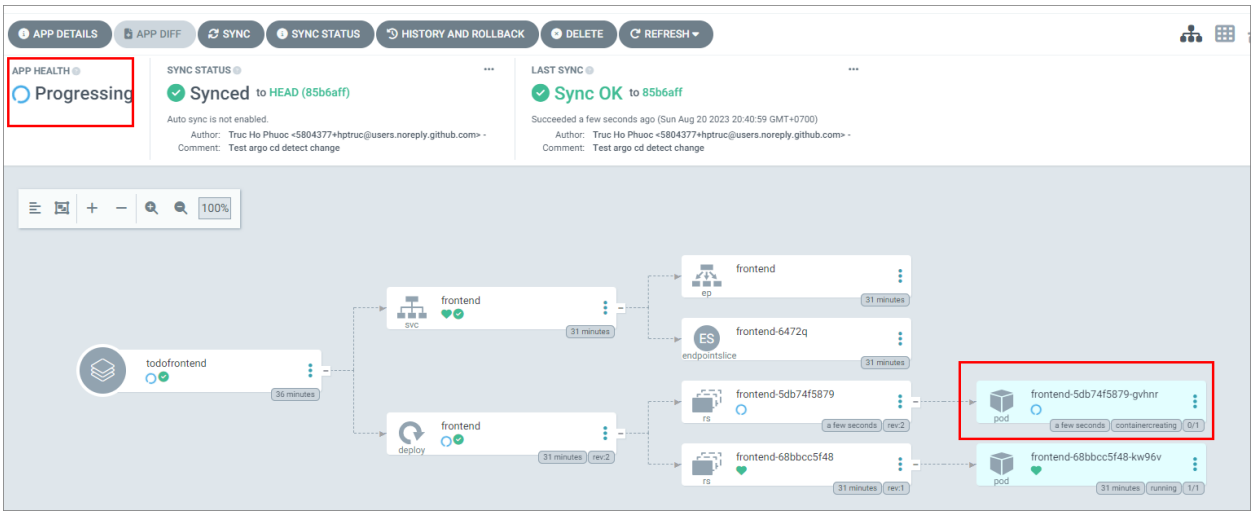
```
    labels:
      app: backend
  spec:
    containers:
      - name: backend
        image: hptacr.azurecr.io/backend:190
        imagePullPolicy: Always
        ports:
          - containerPort: 3000
```

```
    labels:
      app: backend
  spec:
    containers:
      - name: backend
        image: hptacr.azurecr.io/backend:195
        imagePullPolicy: Always
        ports:
          - containerPort: 3000
```

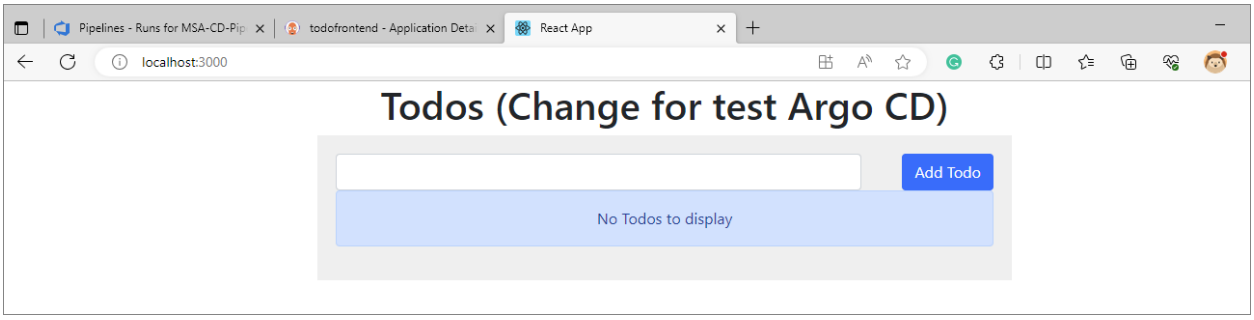
```
  template:
    metadata:
      labels:
        app: frontend
    spec:
      containers:
        - name: frontend
          image: hptacr.azurecr.io/frontend:190
          imagePullPolicy: Always
          ports:
            - containerPort: 3000
```

```
  template:
    metadata:
      labels:
        app: frontend
    spec:
      containers:
        - name: frontend
          image: hptacr.azurecr.io/frontend:195
          imagePullPolicy: Always
          ports:
            - containerPort: 3000
```

- Commit code change
- Login to Argo CD dashboard, status of repo changed to **OutOfSync**
- Click on SYNC button
- Argo CD triggered deploy to AKS automatically



- Forward port to localhost and try access to AKS

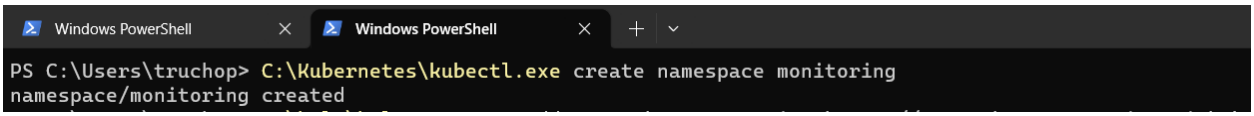


- Argo CD deployed new image successfully.

5 Monitoring: Setup Prometheus and Grafana to monitor AKS resources

5.1 Create a namespace for monitoring

- Open terminal and create a namespace with name **monitoring**



- Verify namespace created

```
Windows PowerShell        Windows PowerShell

PS C:\Users\truchop> C:\Kubernetes\kubectl.exe get namespaces
NAME              STATUS   AGE
aks-ns            Active   6h47m
argocd            Active   174m
default           Active   20h
ingress-nginx     Active   5h
kube-node-lease   Active   20h
kube-public       Active   20h
kube-system       Active   20h
monitoring        Active   42m
PS C:\Users\truchop>
```

5.2 Install Prometheus and Grafana tools

- Install helm charts

```
PS C:\Users\truchop> C:\helm\helm.exe repo add prometheus-community https://prometheus-community.github.io/helm-charts
"prometheus-community" has been added to your repositories
PS C:\Users\truchop> C:\helm\helm.exe repo update
Hang tight while we grab the latest from your chart repositories...
...Successfully got an update from the "prometheus-community" chart repository
Update Complete. ⎈Happy Helming!⎈
```

- Install Prometheus tool

```
PS C:\Users\truchop>  C:\helm\helm.exe install prometheus prometheus-community/kube-prometheus-stack --namespace monitoring
NAME: prometheus
LAST DEPLOYED: Sun Aug 20 21:20:24 2023
NAMESPACE: monitoring
STATUS: deployed
REVISION: 1
NOTES:
kube-prometheus-stack has been installed. Check its status by running:
  kubectl --namespace monitoring get pods -l "release=prometheus"
```

- Verify Prometheus & Grafana installed

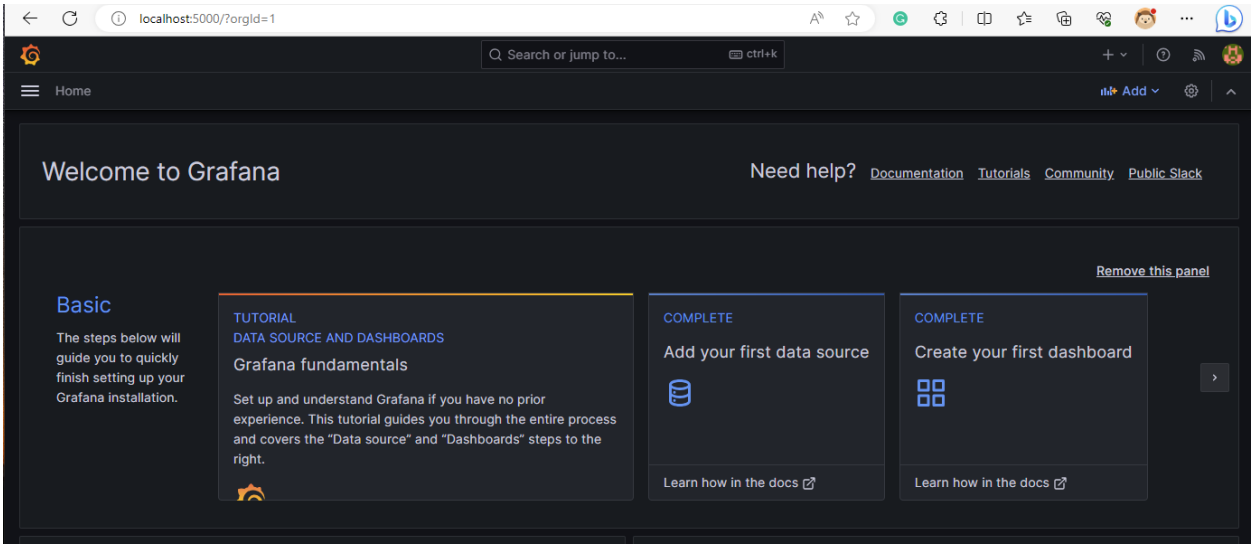
```
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe get all -n monitoring
NAME                                                     READY   STATUS    RESTARTS   AGE
pod/alertmanager-prometheus-kube-prometheus-alertmanager-0   2/2     Running   0          2m13s
pod/prometheus-grafana-7db8f7d857-g66rf                  3/3     Running   0          2m23s
pod/prometheus-kube-prometheus-operator-795b9759b8-q9rfc     1/1     Running   0          2m23s
pod/prometheus-kube-state-metrics-6df4697c45-f8zjn           1/1     Running   0          2m23s
pod/prometheus-prometheus-kube-prometheus-prometheus-0       2/2     Running   0          2m12s
pod/prometheus-prometheus-node-exporter-wzcng                1/1     Running   0          83s
pod/prometheus-prometheus-node-exporter-x4rkh                1/1     Running   0          2m24s

NAME                                              TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)
AGE
service/alertmanager-operated                     ClusterIP   None           <none>        9093/TCP,9094/TCP,9094/UDP   2m13s
service/prometheus-grafana                        ClusterIP   10.0.43.80     <none>        80/TCP
2m24s
service/prometheus-kube-prometheus-alertmanager   ClusterIP   10.0.125.255   <none>        9093/TCP,8080/TCP
2m24s
2m24s
service/prometheus-kube-prometheus-prometheus     ClusterIP   10.0.89.102    <none>        9090/TCP,8080/TCP            2m24s
service/prometheus-kube-state-metrics             ClusterIP   10.0.32.137    <none>        8080/TCP                     2m24s
service/prometheus-operated                       ClusterIP   None           <none>        9090/TCP                     2m12s
service/prometheus-prometheus-node-exporter       ClusterIP   10.0.45.81     <none>        9100/TCP                     2m24s

           AGE
os=linux   2m24s
NAME                                                 READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/prometheus-grafana                   1/1     1            1           2m24s
deployment.apps/prometheus-kube-prometheus-operator  1/1     1            1           2m24s
deployment.apps/prometheus-kube-state-metrics        1/1     1            1           2m24s
```

- Forward port to localhost to access dashboard

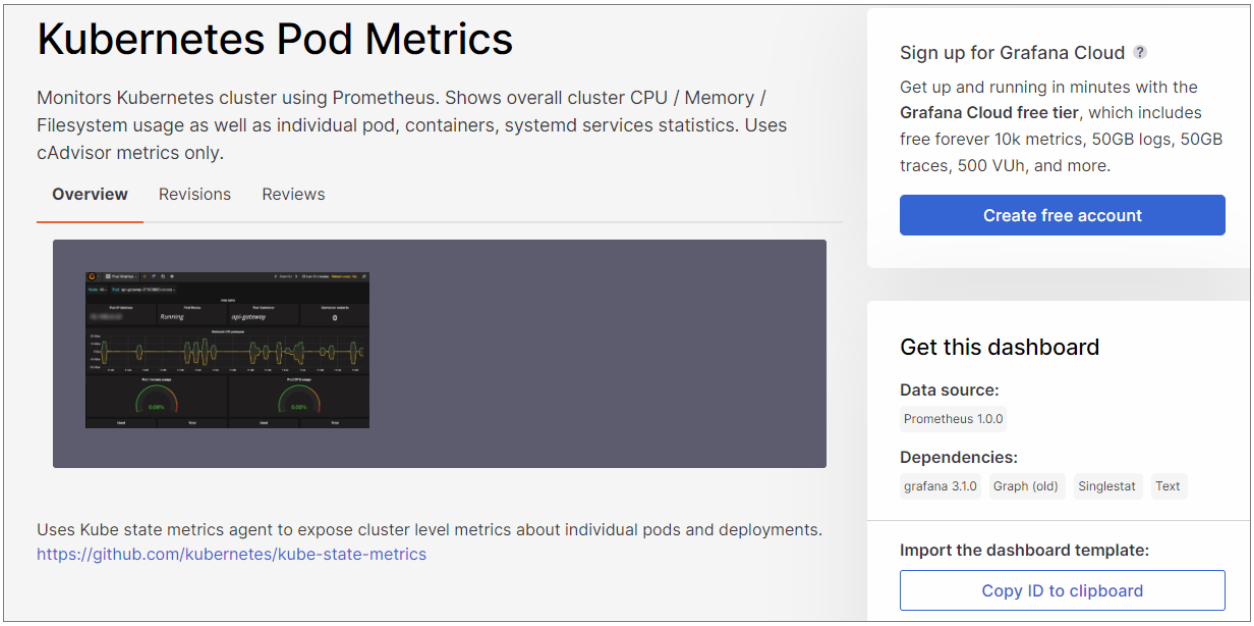
```
PS C:\Users\truchop> C:\Kubernetes\kubectl.exe port-forward svc/prometheus-grafana -n monitoring 5000:80
Forwarding from 127.0.0.1:5000 -> 3000
Forwarding from [::1]:5000 -> 3000
Handling connection for 5000
Handling connection for 5000
Handling connection for 5000
Handling connection for 5000
Handling connection for 5000
Handling connection for 5000
Handling connection for 5000
```

5.3 Verify dashboard monitoring

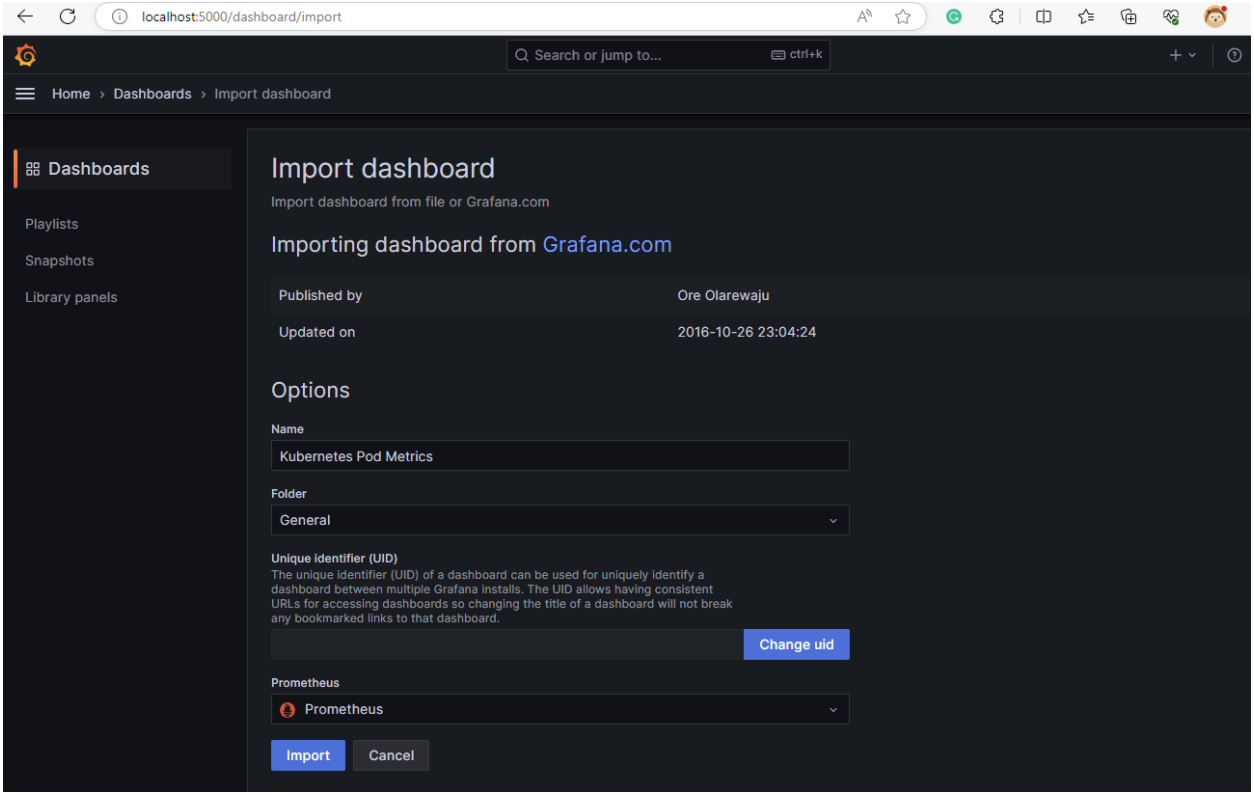
- Open browser and paste link: http://localhost:5000
- Credential default: admin/prom-operator

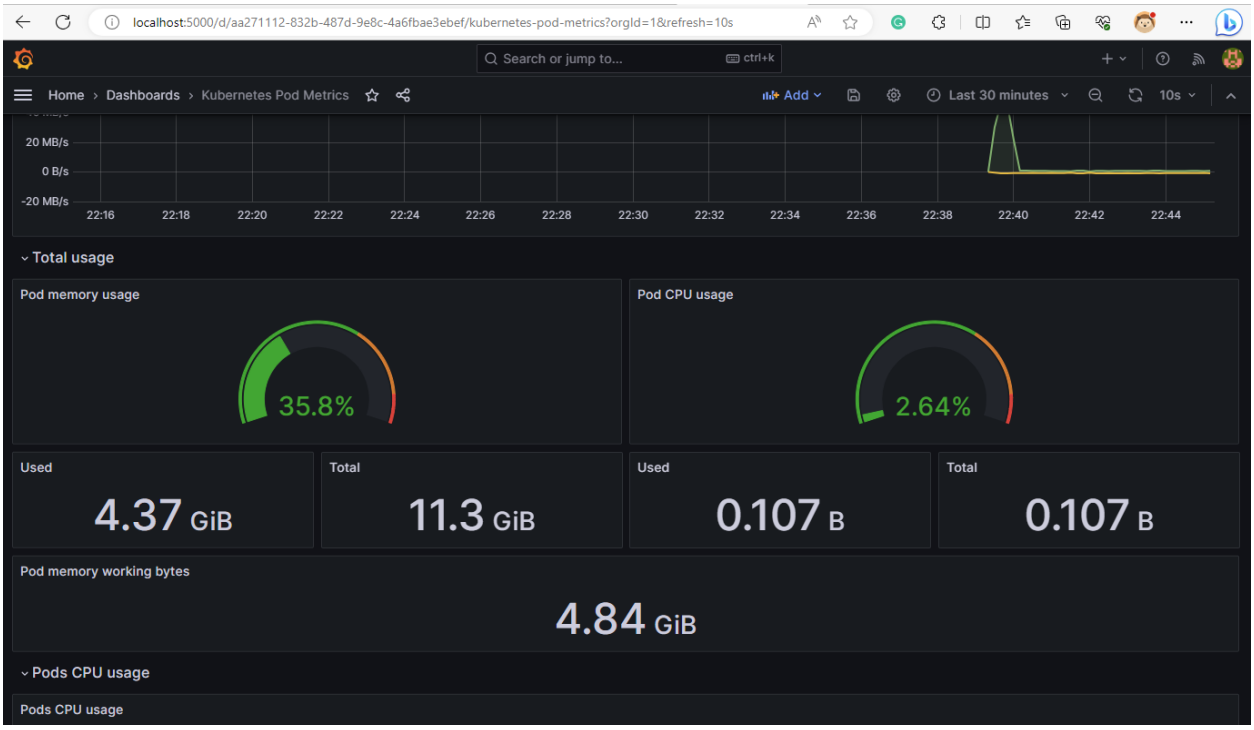


- Go to Grafana home page and select a type dashboard to import (by ID). For example, I select this dashboard: Kubernetes Pod Metrics. ID 747



- Import to our dashboard





--- End documents ---