[Infra_Optimization]

[Project 3]

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Nov 12th, 2022.

PG DO DevOps Capstone Project

Project 3

DESCRIPTION

Create a DevOps infrastructure for an e-commerce application to run on high-availability mode.
Background of the problem statement:

A popular payment application, EasyPay where users add money to their wallet accounts, faces an issue in its payment success rate. The timeout that occurs with
the connectivity of the database has been the reason for the issue.
While troubleshooting, it is found that the database server has several downtime instances at irregular intervals. This situation compels the company to create their own infrastructure that runs in high-availability mode.
Given that online shopping experiences continue to evolve as per customer expectations, the developers are driven to make their app more reliable, fast, and secure for improving the performance of the current system.

Implementation requirements:

1. Create the cluster (EC2 instances with load balancer and elastic IP in case of AWS)
2. Automate the provisioning of an EC2 instance using Ansible or Chef Puppet
3. Install Docker and Kubernetes on the cluster
4. Implement the network policies at the database pod to allow ingress traffic from the front-end application pod
5. Create a new user with permissions to create, list, get, update, and delete pods
6. Configure application on the pod
7. Take snapshot of ETCD database
8. Set criteria such that if the memory of CPU goes beyond 50%, environments automatically get scaled up and configured

The following tools must be used:

1. EC2
2. Kubernetes
3. Docker
4. Ansible or Chef or Puppet

The following things to be kept in check:

1. You need to document the steps and write the algorithms in them.
2. The submission of your GitHub repository link is mandatory. In order to track the tasks, you need to share the link of the repository.
3. Document the step-by-step process starting from creating test cases, then executing them, and recording the results.
4. You need to submit the final specification document, which includes:
    - Project and tester details
    - Concepts used in the project
    - Links to the GitHub repository to verify the project completion
    - Your conclusion on enhancing the application and defining the USPs (Unique Selling Points

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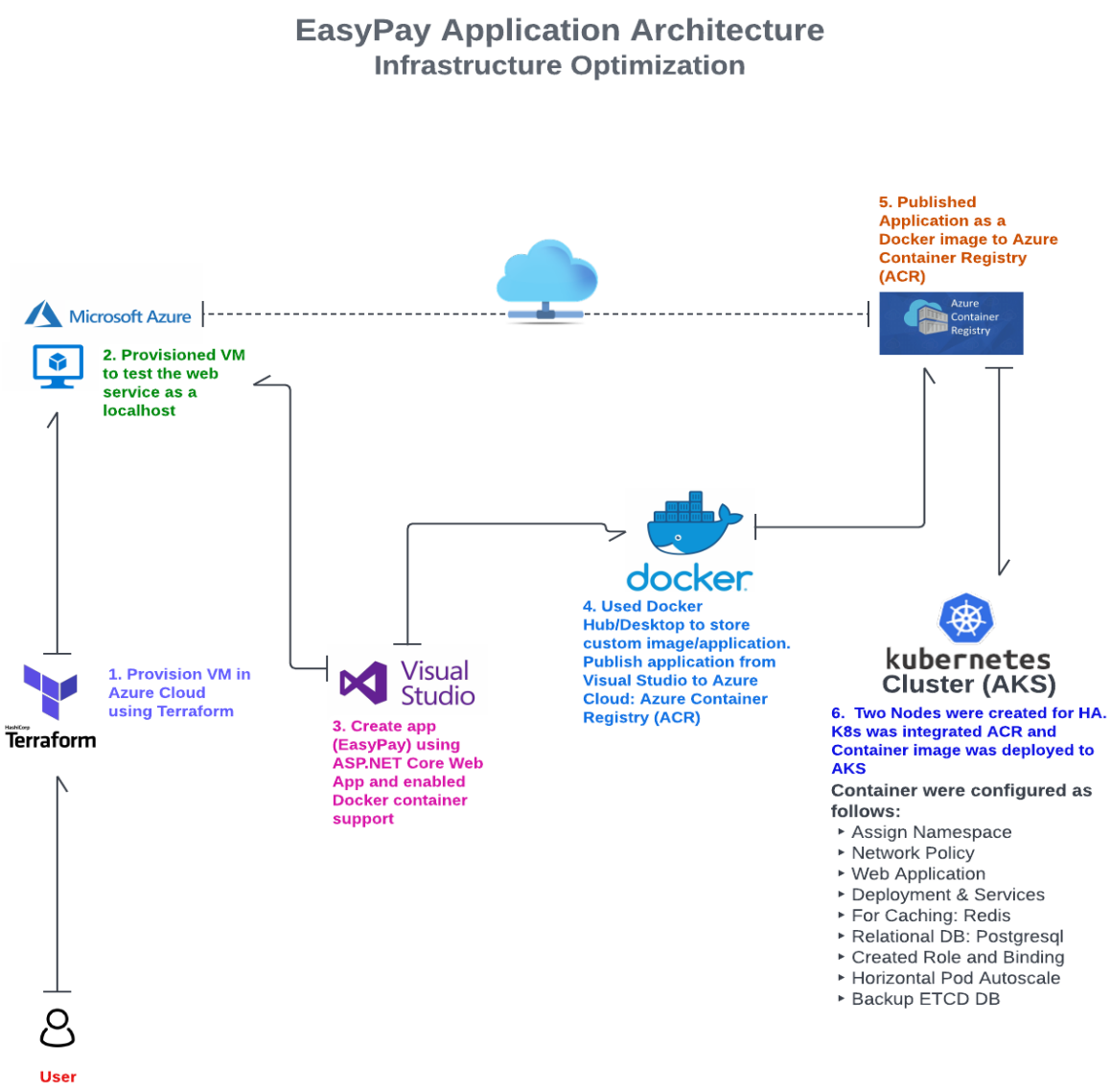
EasyPay App Architecture Diagram



Introduction

This documentation contains all steps and procedures in successfully managing a DevOps infrastructure for an eCommence application (EasyPay) to run on a high-availability state. The automating of using configuration management, integrated development environment (IDE), infrastructure as code, yaml files to be edited and reuse as desire, also tools used were Docker hub/desktop, Azure Container Registry, and Azure Kubernetes Services, by doing so will help the DevOps team to optimize and autoscaling either vertically or horizontally. Source codes/scripts are kept in the official version control tool. https://github.com/joshua-demebo/infra_optimization

The following specific tools were used

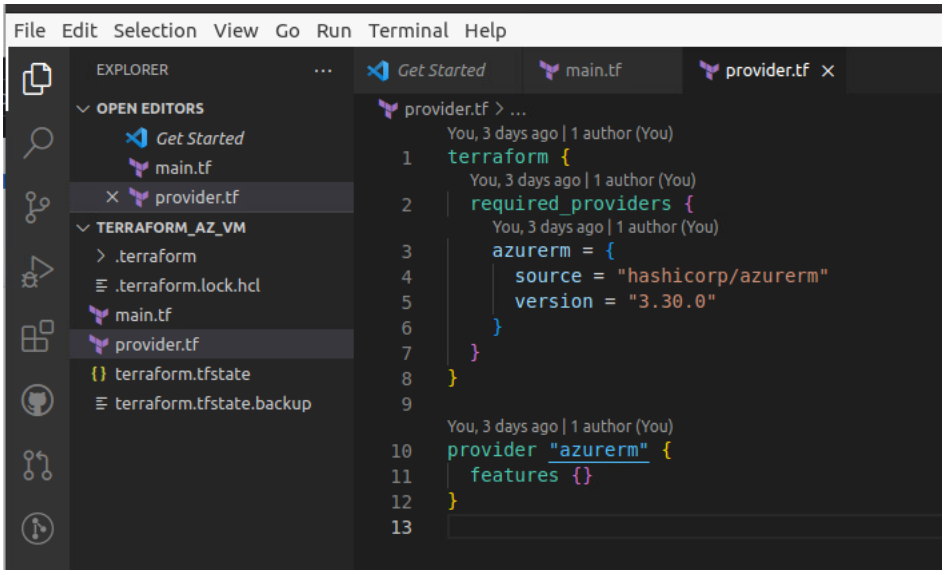
1. **Terraform** is used primarily to automate various infrastructure tasks like provisioning the VM in Microsoft Azure, used to test EasyPay app as a localhost, which describes the complete infrastructure as a form of code
2. **Visual Studio** provides a rich support for various language like JavaScript, ASP.Net etc. Is an open-source language often used in large size web app development, it was used to develop the EasyPay app.
3. **Microsoft Azure** a cloud computing platform with solutions including Infrastructure as a Service (IaaS), Platform as a Service and Software as a Service (SaaS) that can be used for services such as analytics, virtual computing, storage, networking, and much more. This was used with various services below:
    - **Azure Container Registry (ACR)** was used to build, store, and manage container images and artifacts in a private registry for Docker container deployment.
    - **Azure Kubernetes Service** (**AKS)** simplifies the deployment of managing Kubernetes cluster in Azure by offloading the operational overhead to Azure. As a hosted Kubernetes service, Azure handles critical tasks, like health monitoring and maintenance. This was used to provision clusters, nodes, pods to integrating with Docker custom image to build/deploy EasyPay app with a high-available, vertical and horizontal autoscaling etc.
4. **Docker** is a file used to execute code in a Docker container. Docker images act as a set of instructions to build a Docker container, like a template. Docker images also act as the starting point when using Docker. An image is comparable to a snapshot in virtual machine (VM) environments. To run our EasyPay application in a docker container, a customized docker image was created. This customized docker image includes instructions that install specific packages and copy the code into the docker container and was Publish to ACR via Visual Studio.
5. **GitHub** a version control system that lets you manage and keep track of source code history. GitHub is a cloud-based hosting service that lets you manage Git repositories. If you have open-source projects that use Git, then GitHub is designed to help manage them. All source code like Terraform, yaml etc, were stored in GitHub.

Finally, some tools like Database (Redis and PostgreSQL) were used to enhance the database performance and caching of EasyPay app, a network policy including LoadBalancer to prevent connectivity downtime.
This infra optimization will make the app and give an online shopper more reliable, fast, and secure improved performance.

1. Automating the provisioning of an Azure VM using Terraform. Created using local git and using VS Code to edit the script.

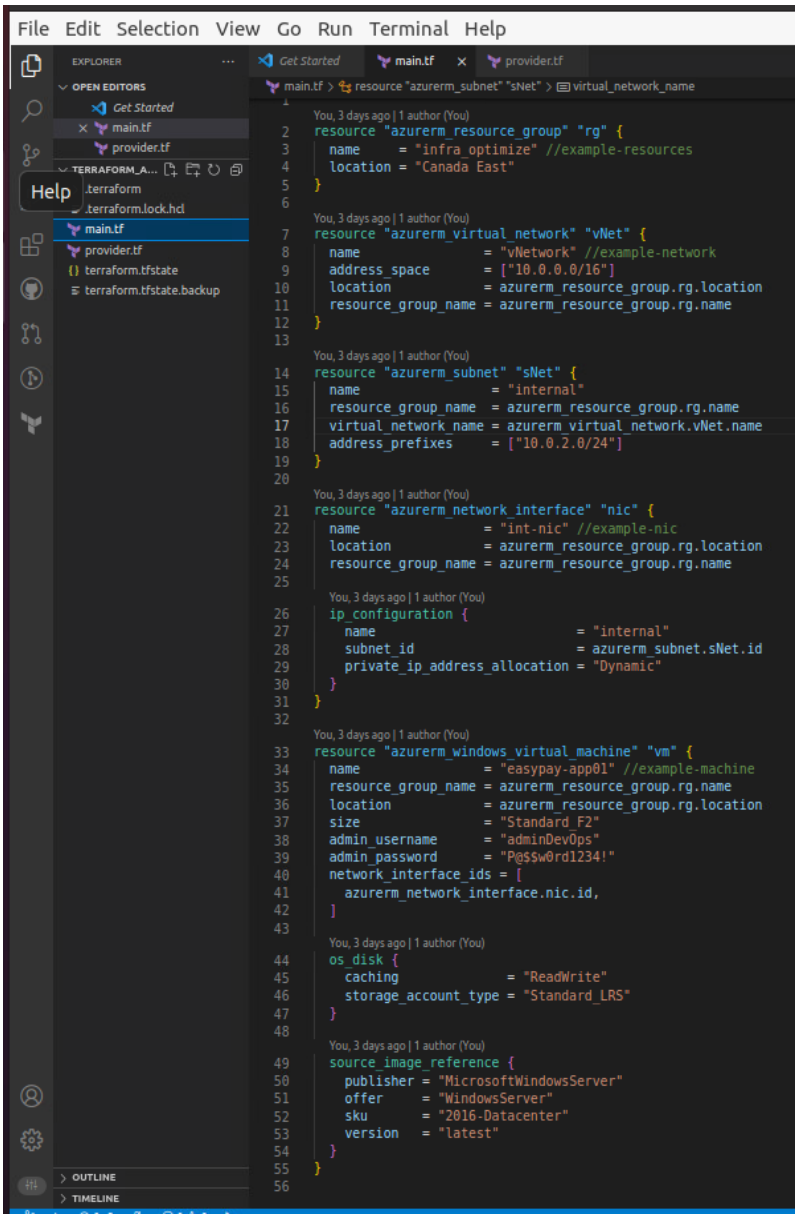
```
jdemebo@ubuntumachine:~/capstone_project/infra_optimization/terraform_az_vm$ ls -l
total 24
-rw-rw-r-- 1 jdemebo jdemebo 1666 Nov  8 06:15 main.tf
-rw-rw-r-- 1 jdemebo jdemebo  161 Nov  8 06:17 provider.tf
-rw-rw-r-- 1 jdemebo jdemebo 9766 Nov  8 06:21 terraform.tfstate
-rw-rw-r-- 1 jdemebo jdemebo  178 Nov  8 06:19 terraform.tfstate.backup
jdemebo@ubuntumachine:~/capstone_project/infra_optimization/terraform_az_vm$
```

- Provider.tf for provisioning a VM in Azure




```
terraform {
 required_providers {
  azurerm = {
   source = "hashicorp/azurerm"
   version = "3.30.0"
  }
 }
}

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

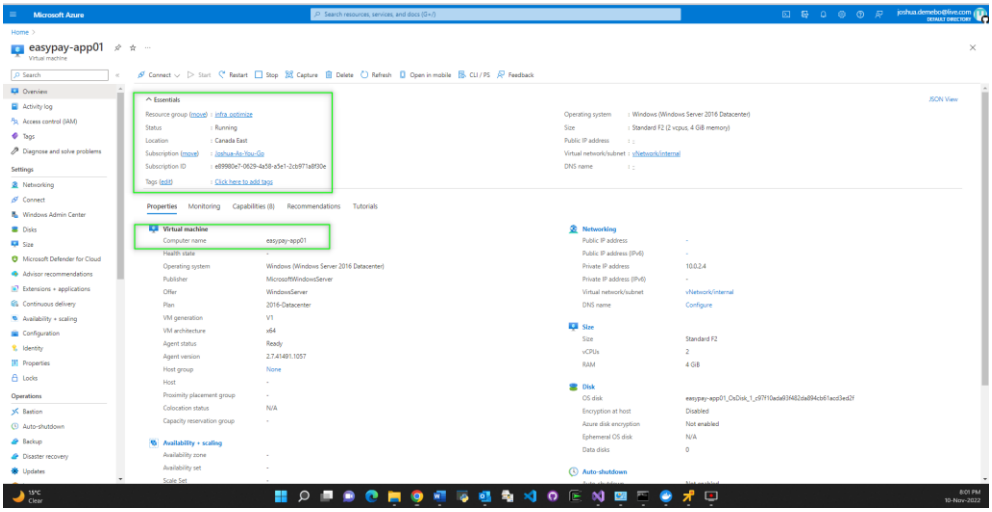
- Main.tf for provisioning a VM in Azure

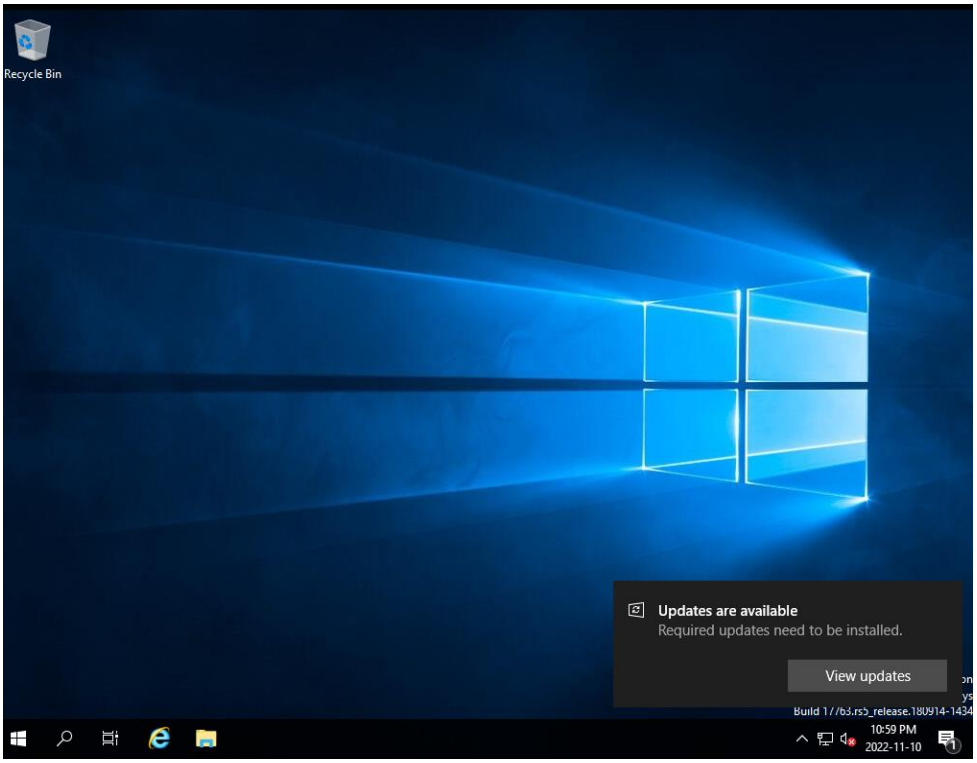



```
resource "azurerm_resource_group" "rg" {
  name     = "infra_optimize" //example-resources
  location = "Canada East"
}

resource "azurerm_virtual_network" "vNet" {
  name                = "vNetwork" //example-network
  address_space       = ["10.0.0.0/16"]
  location            = azurerm_resource_group.rg.location
  resource_group_name = azurerm_resource_group.rg.name
```

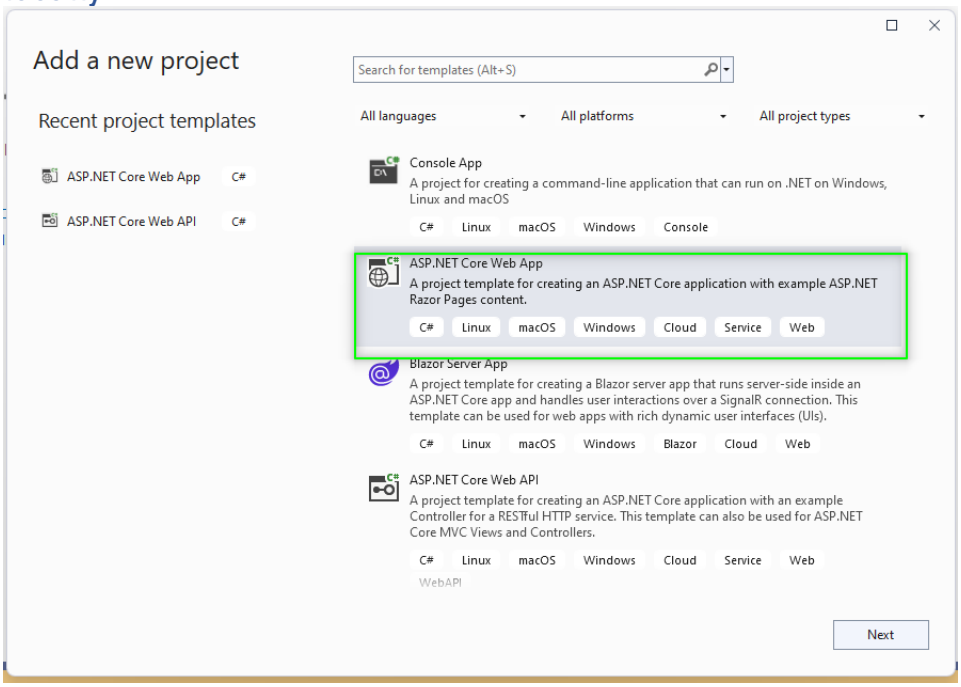
```
}

resource "azurerm_subnet" "sNet" {
  name                 = "internal"
  resource_group_name  = azurerm_resource_group.rg.name
  virtual_network_name = azurerm_virtual_network.vNet.name
  address_prefixes     = ["10.0.2.0/24"]
}

resource "azurerm_network_interface" "nic" {
  name                = "int-nic" //example-nic
  location            = azurerm_resource_group.rg.location
  resource_group_name = azurerm_resource_group.rg.name

  ip_configuration {
    name                          = "internal"
    subnet_id                     = azurerm_subnet.sNet.id
    private_ip_address_allocation = "Dynamic"
  }
}

resource "azurerm_windows_virtual_machine" "vm" {
  name                = "easypay-app01" //example-machine
  resource_group_name = azurerm_resource_group.rg.name
  location            = azurerm_resource_group.rg.location
  size                = "Standard_F2"
  admin_username      = "adminDevOps"
  admin_password      = "P@$$w0rd1234!"
  network_interface_ids = [
    azurerm_network_interface.nic.id,
  ]

  os_disk {
    caching              = "ReadWrite"
    storage_account_type = "Standard_LRS"
  }

  source_image_reference {
    publisher = "MicrosoftWindowsServer"
    offer     = "WindowsServer"
    sku       = "2016-Datacenter"
    version   = "latest"
  }
}
```

- A provisioned VM in Azure (hostname easypay-app01)

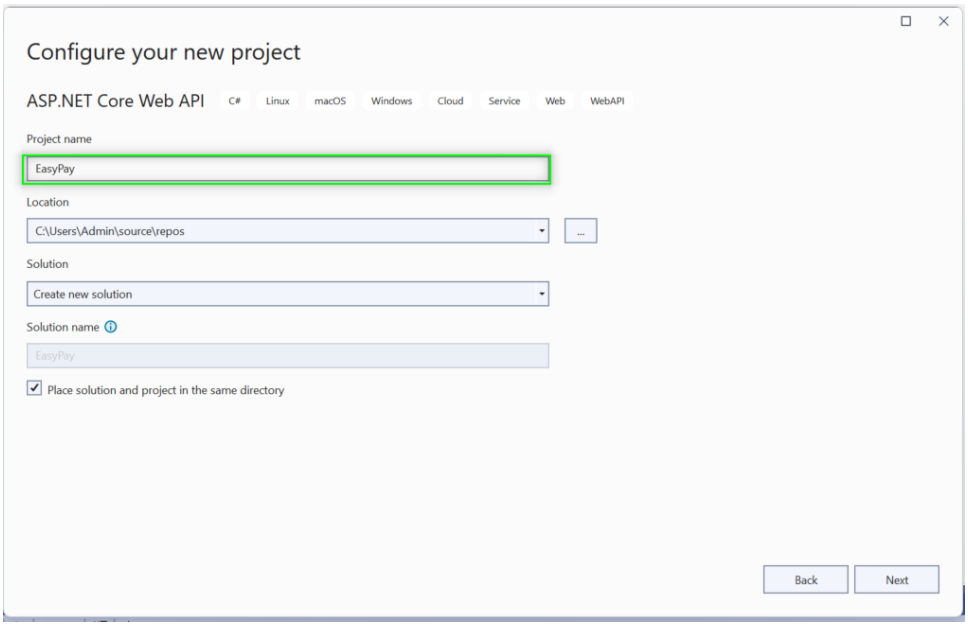




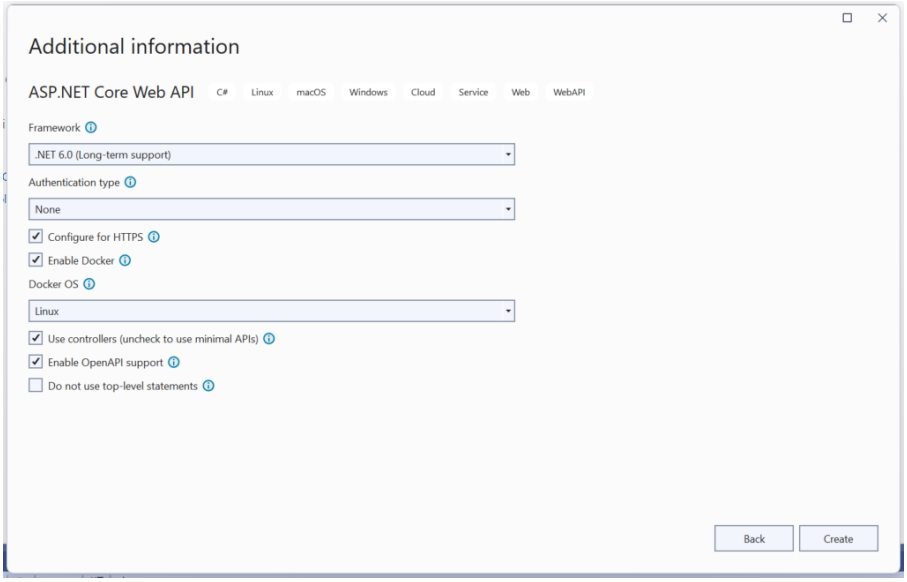
2. Creating a new app in Visual Studio as an ASP.NET Core Web App, enable Docker support, and make a small change to it. Ensure it builds and runs locally.



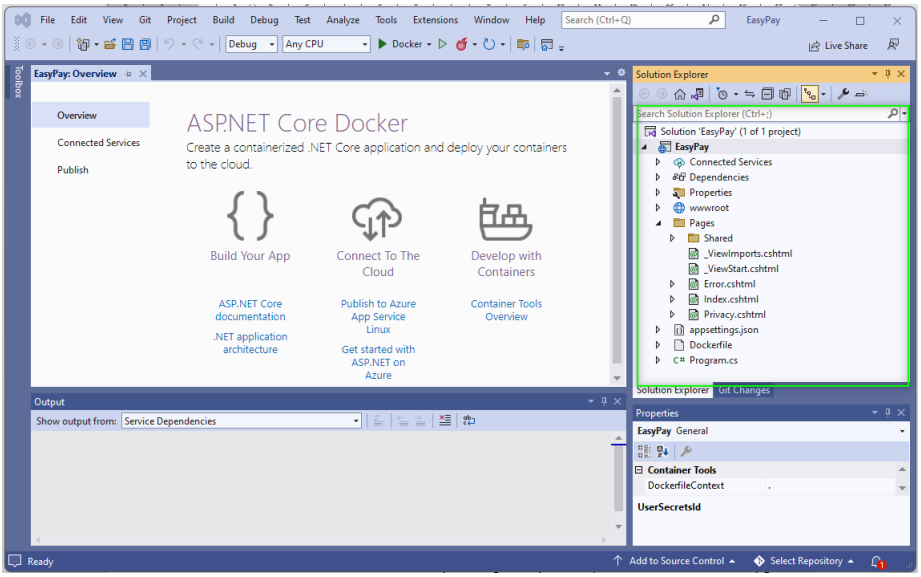
- Naming the project as EasyPay



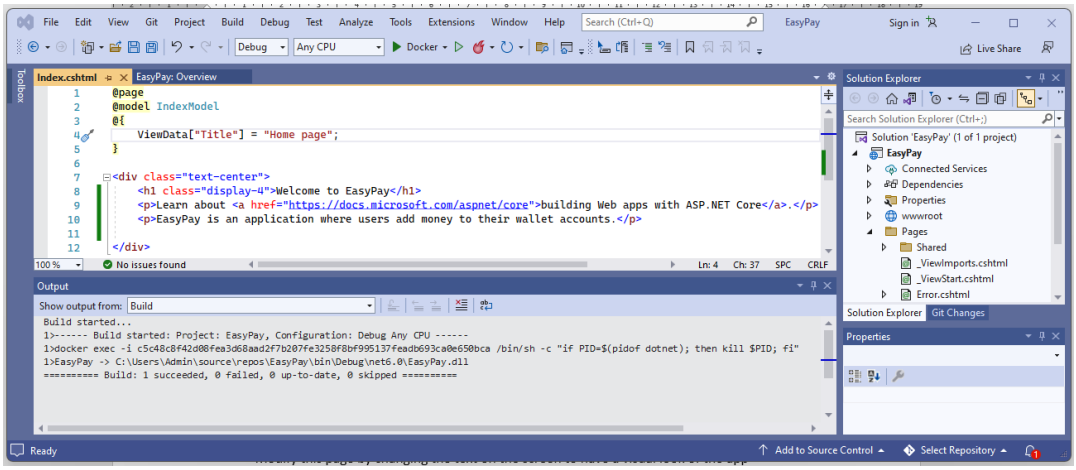
- Selecting ".NET 6.0 (Long-term support)" as the language, "Enable Docker" to enable container support, and "Linux" as the container language.



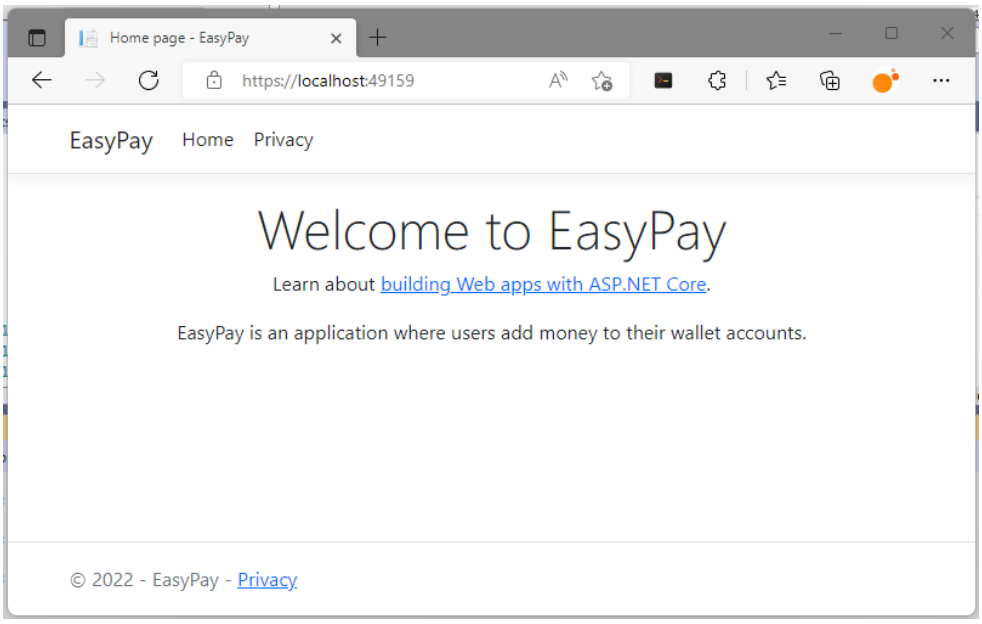
- EasyPay application created



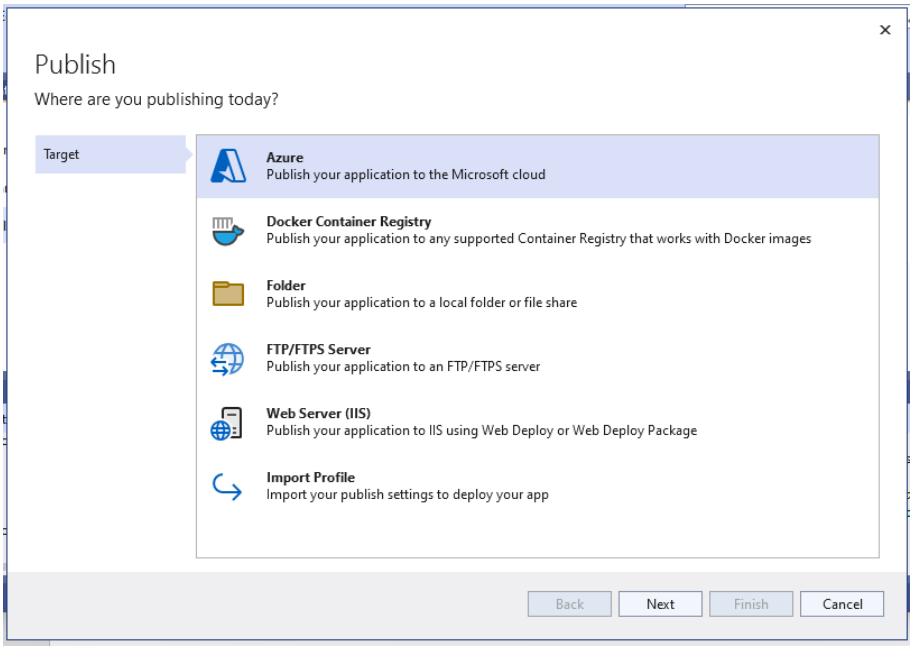
- Modify this page by changing the text on the screen to have a visual look of the app. App was Built successfully.



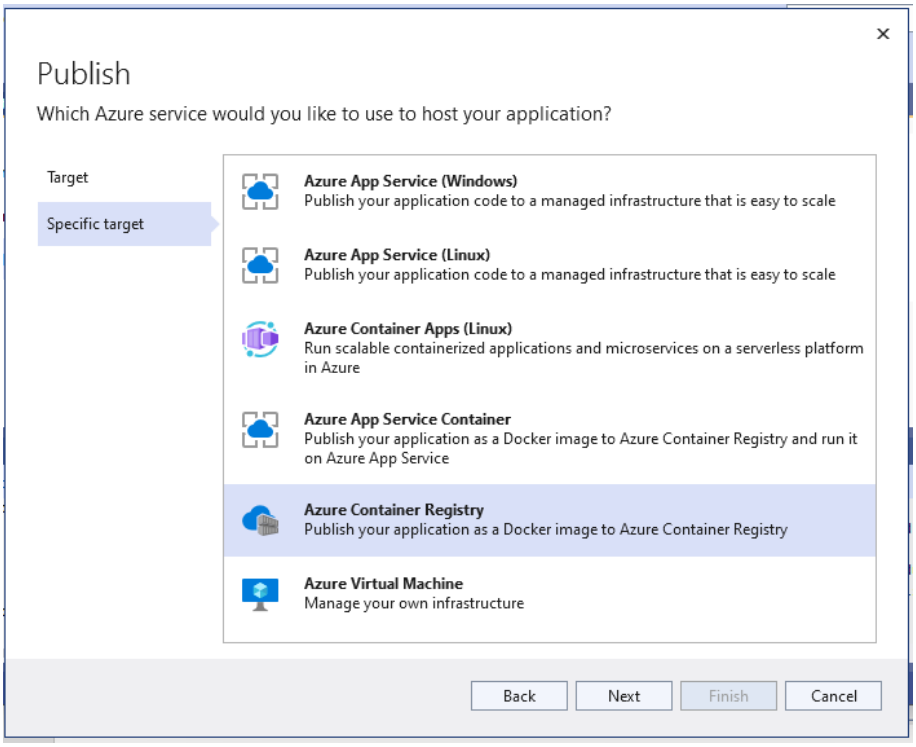
- Test application on Azure VM. Before deploying this solution to Azure, it will be nice to test the application on the tenant VM as a web app.



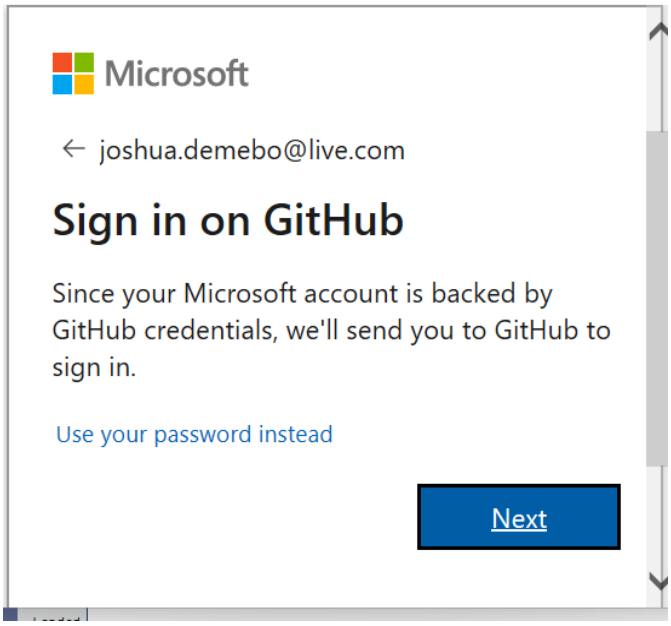
3. The application will be published from Visual Studio to a new Azure Container Registry. A new Azure Container Registry will be created using Visual Studio. Under Build menu, choose Publish. And Choose Azure as the Target. Click Next.



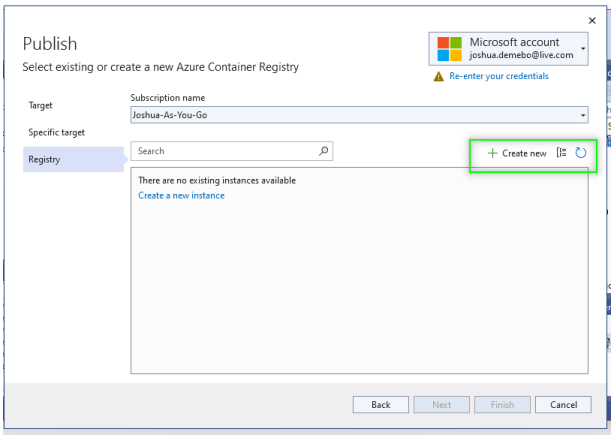
- Select Azure Container Registry. Click Next.

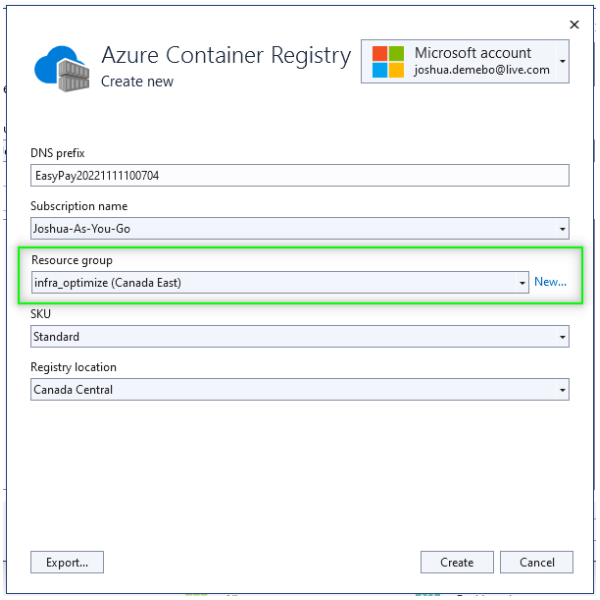


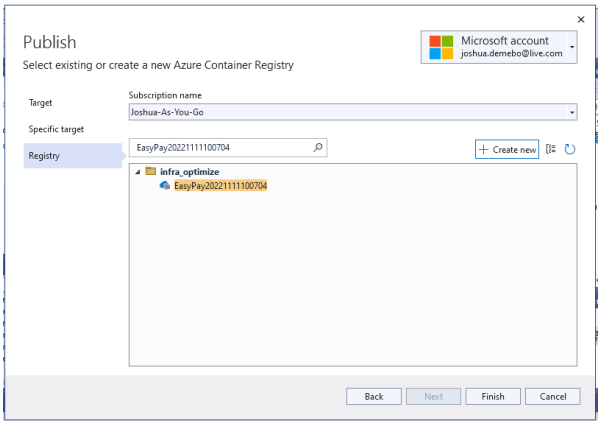
- Signing in with my credential



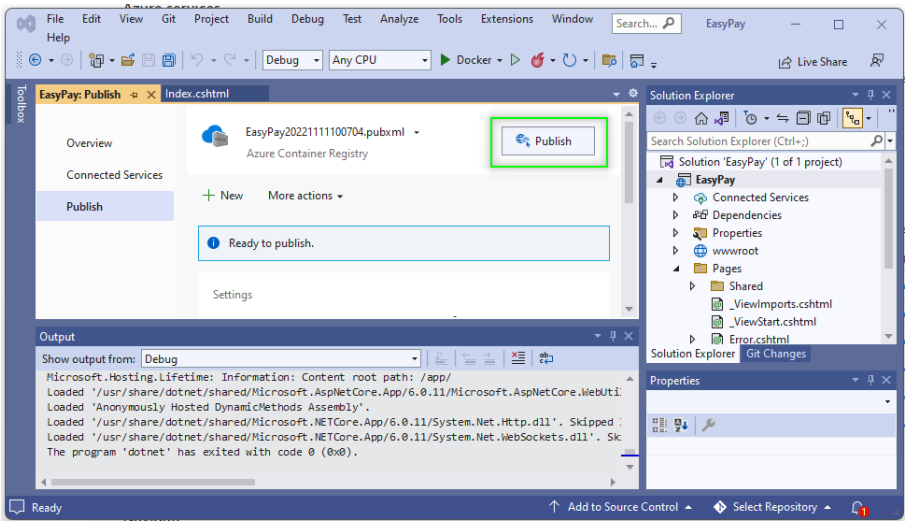
- Create a new Azure Container Registry using same Resource Group as infra_optimization



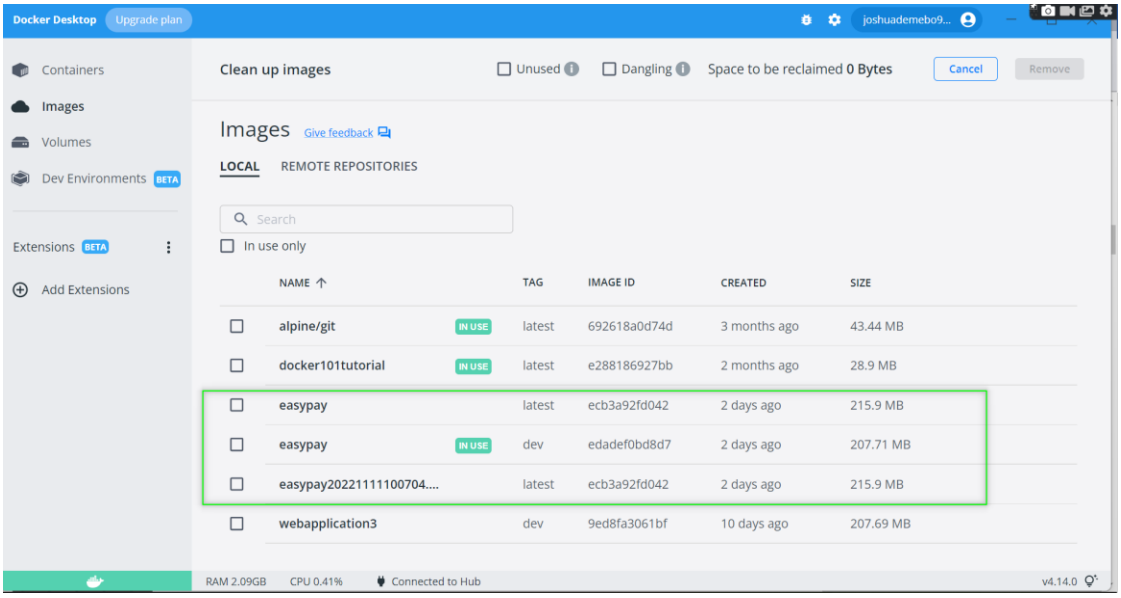


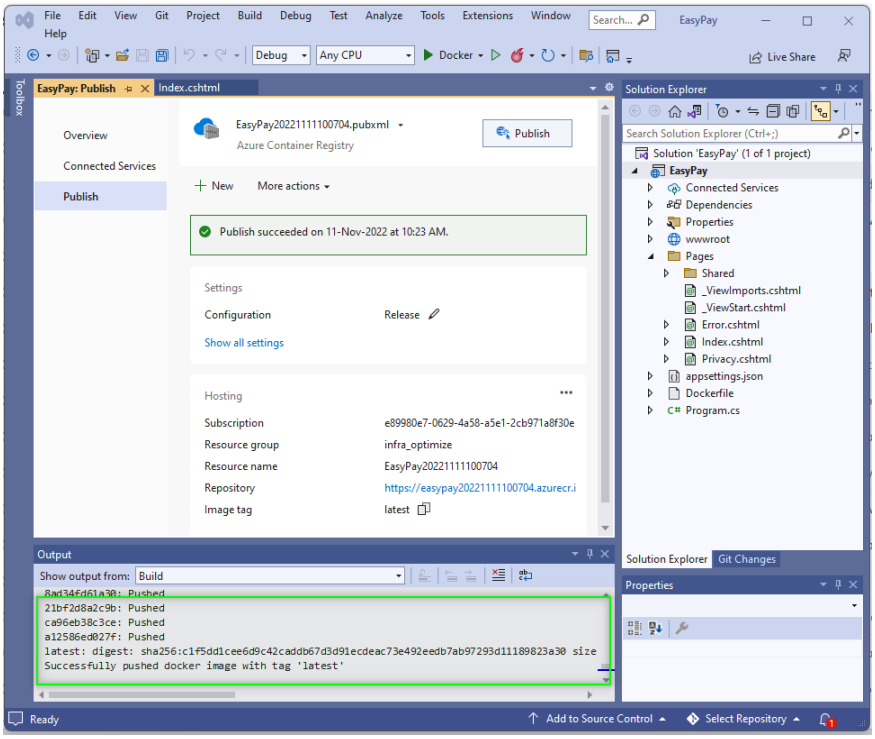


- Click Publish. Monitor the output console for messages.

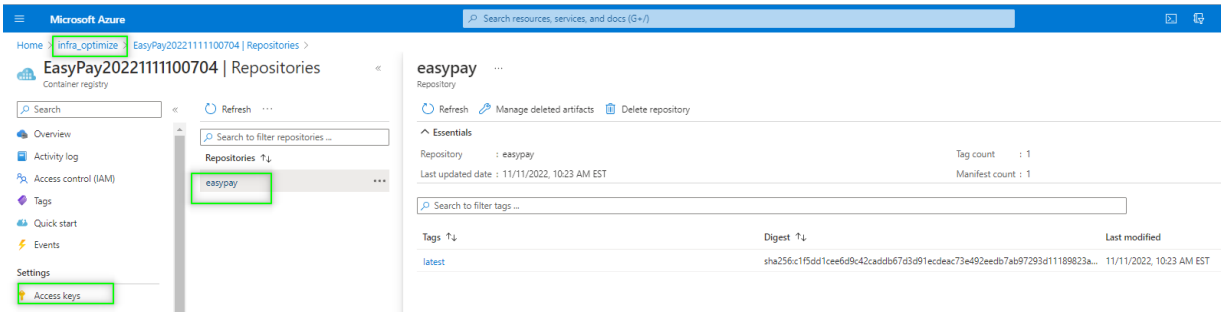


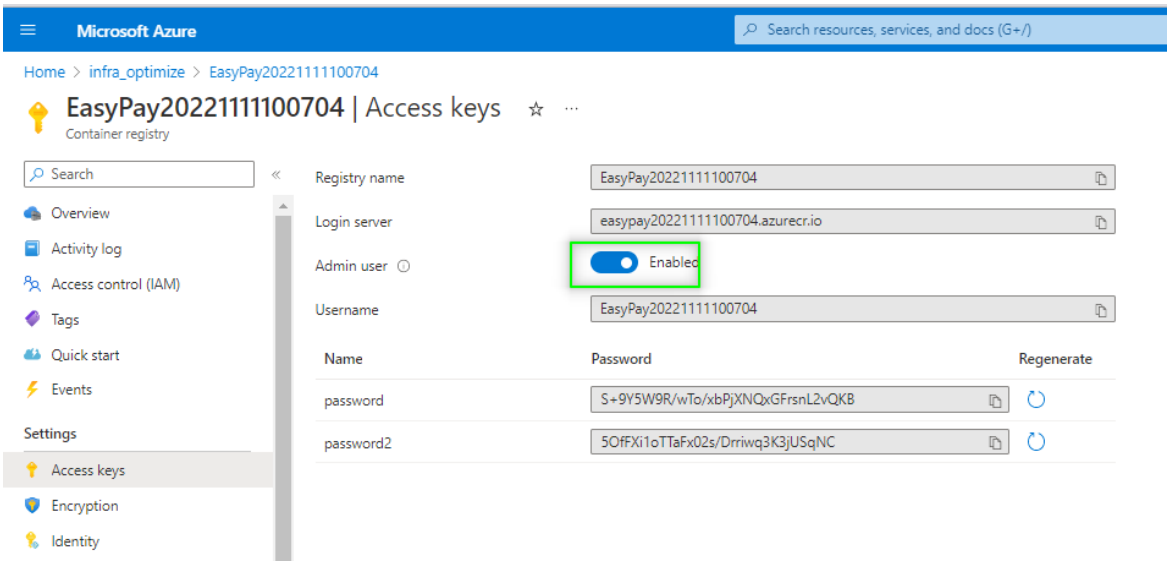
- Successfully pushed to Docker Hub/Desktop and in Visual Studio



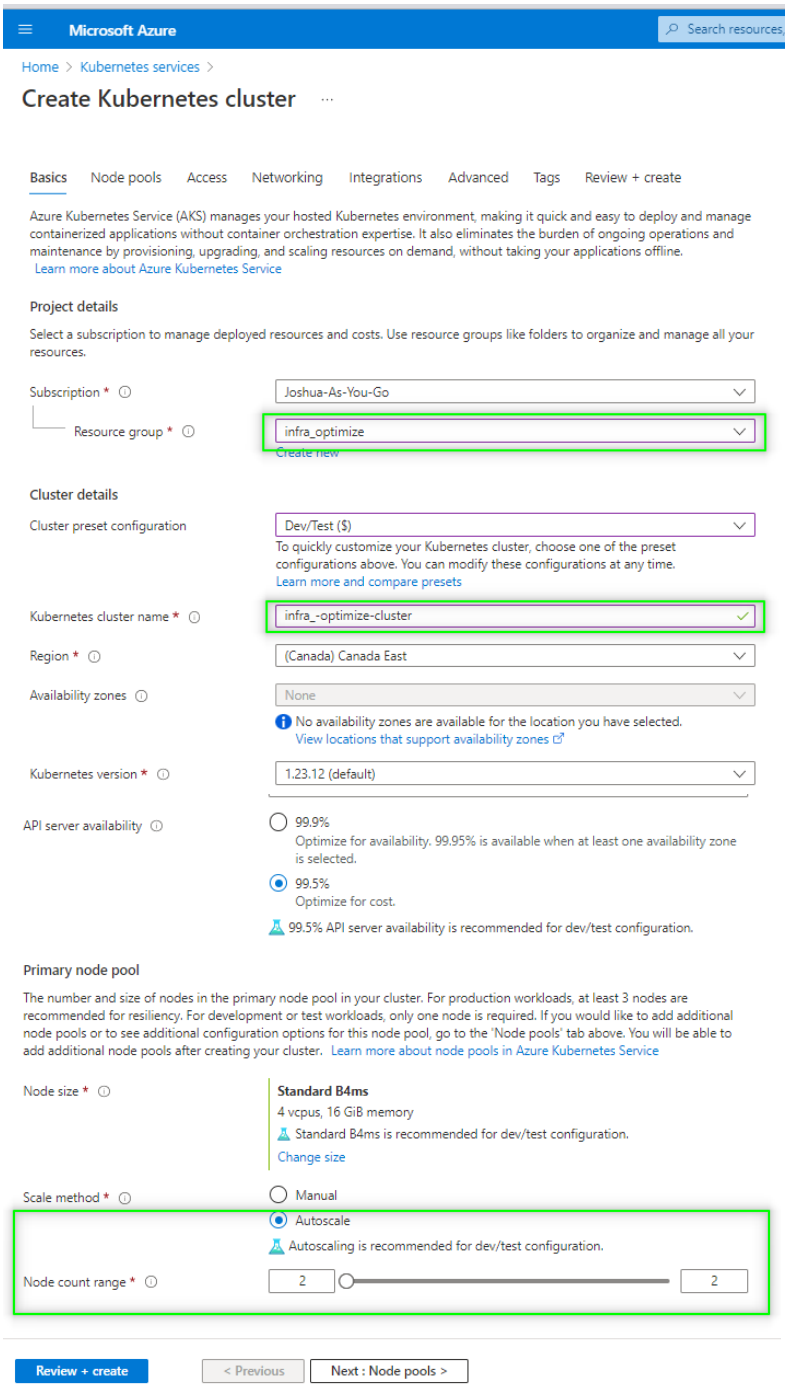


4. Validate Azure Container Registry

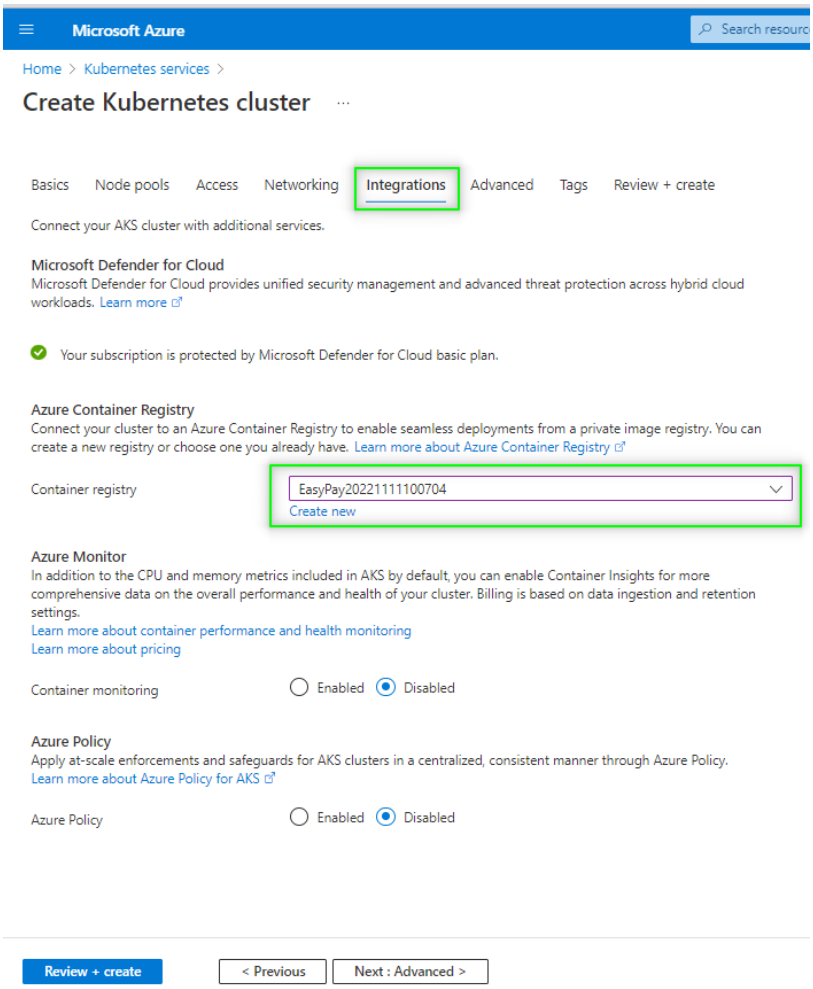




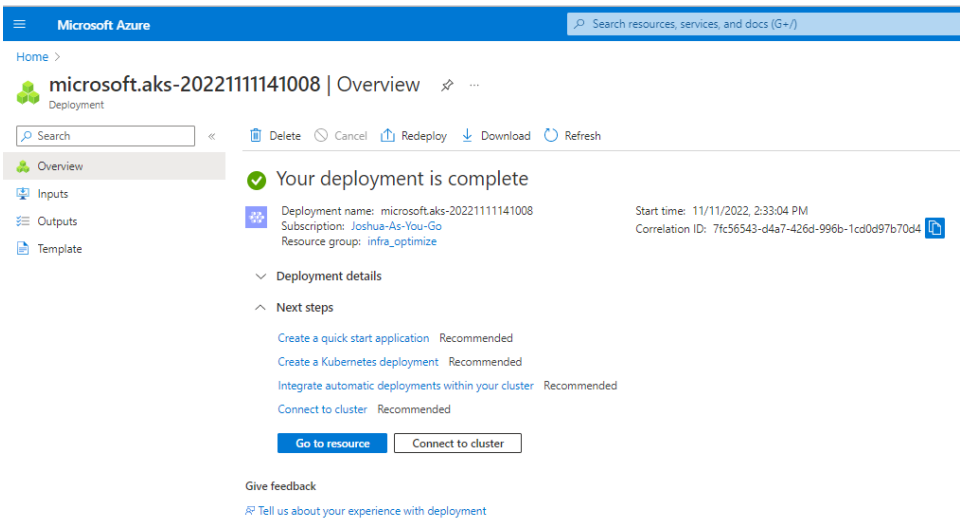
5. Create a Kubernetes on the cluster to run on high-availability (HA) mode

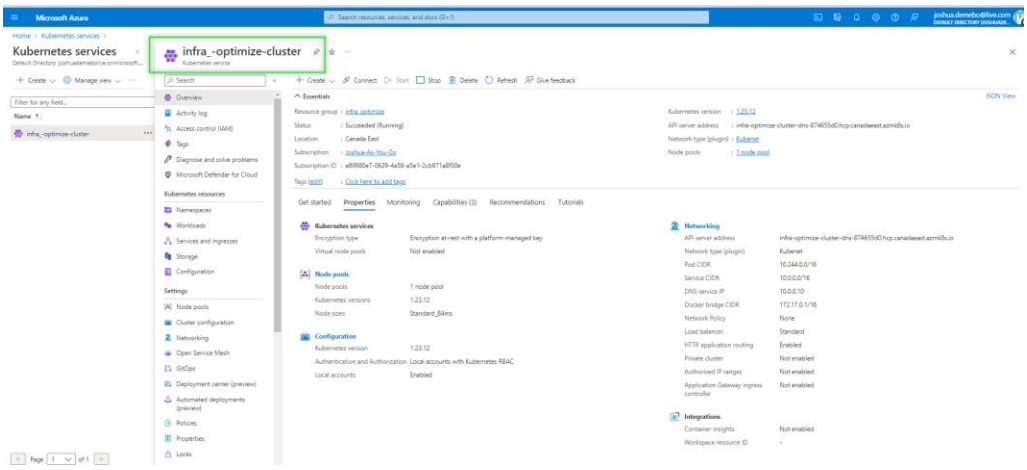


- ## Integrating Container Registry



- ## Completion of Kubernetes Cluster





6. Deploy the Container Image to the AKS (Azure Kubernetes Services) Cluster

Deploy Azure Container Registry (ACR) in the AKS (Azure Kubernetes Services) that was just created. YAML files will be created to deploy the images within the cluster. The following steps will be followed:

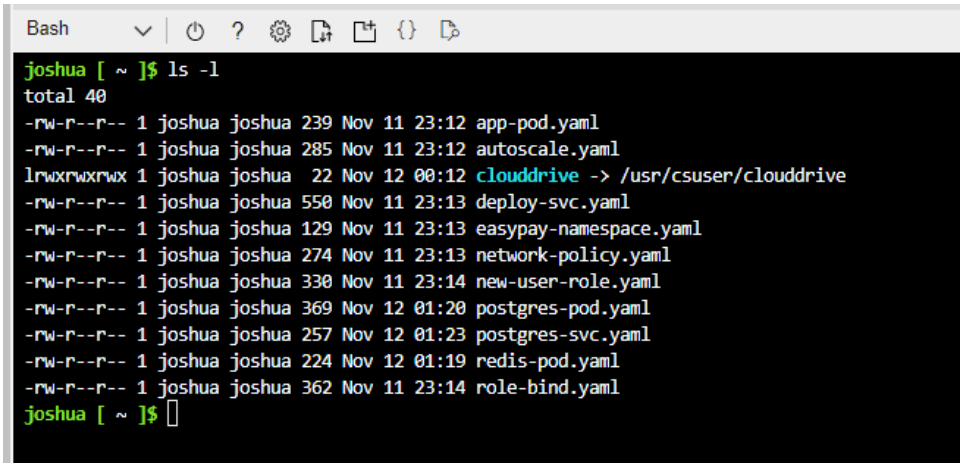
- Open the Azure Cloud Shell and choose the **Bash/CLI** command prompt. **Azure Cloud Shell** is represented by the **">_"** symbol at the top of the Azure Portal. Choose **CLI**.
  Type "**az aks get-credentials --resource-group infra_optimize --name infra_-optimize-cluster**"

```
Bash
Requesting a Cloud Shell.Succeeded.
Connecting terminal...

Welcome to Azure Cloud Shell

Type "az" to use Azure CLI
Type "help" to learn about Cloud Shell

joshua [ ~ ]$ az account set --subscription e89980e7-0629-4a58-a5e1-2cb971a8f30e
joshua [ ~ ]$ az aks get-credentials --resource-group infra_optimize --name infra_-optimize-cluster
Merged "infra_-optimize-cluster" as current context in /home/joshua/.kube/config
joshua [ ~ ]$
```

- Type "kubectl get nodes" to see the running nodes.

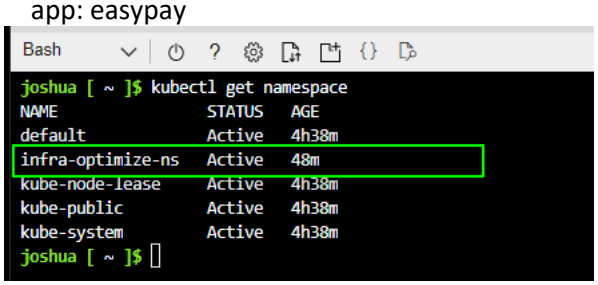
```
Bash
joshua [ ~ ]$ kubectl get all
NAME                 TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
service/kubernetes   ClusterIP   10.0.0.1     <none>        443/TCP   76m
joshua [ ~ ]$ kubectl get nodes
NAME                                STATUS   ROLES   AGE   VERSION
aks-agentpool-21221973-vmss000000   Ready    agent   72m   v1.23.12
aks-agentpool-21221973-vmss000001   Ready    agent   75m   v1.23.12
joshua [ ~ ]$
```

- Create all yaml files and upload to the /home/joshua directory



- Create a custom Namespace “infra-optimize-ns”

```
apiVersion: v1
kind: Namespace
metadata:
  name: infra-optimize-ns
  labels:
    name: easypay-namespace
    app: easypay
```

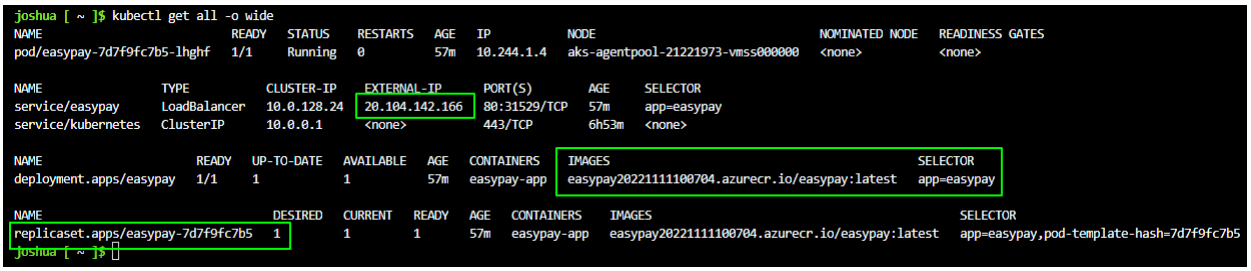


- Deployment of “easypay20221111100704.azurecr.io/easypay:latest” custom image and LoadBalancer service also in custom namespace “infra-optimize-ns”apiVersion: apps/v1

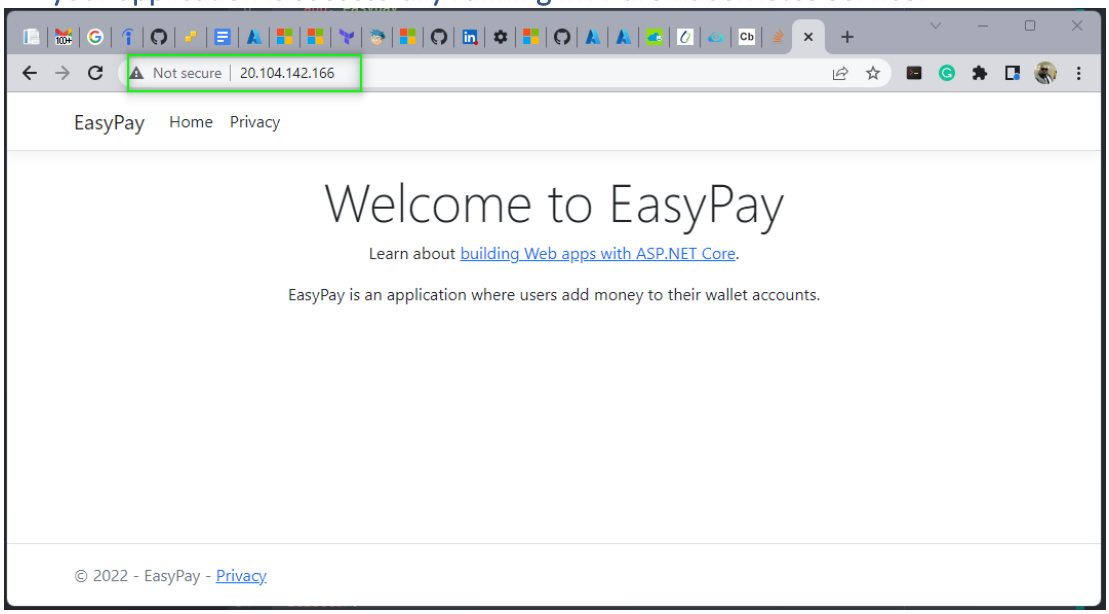
```
kind: Deployment
metadata:
  labels:
    app: easypay
  name: easypay
  namespace: infra-optimize-ns
spec:
  replicas: 1
  selector:
    matchLabels:
```

```
    app: easypay
  template:
    metadata:
      labels:
        app: easypay
    spec:
      containers:
      - image: easypay20221111100704.azurecr.io/easypay:latest
        name: easypay-app
        ports:
        - containerPort: 80
---
apiVersion: v1
kind: Service
metadata:
  name: easypay
  namespace: infra-optimize-ns
spec:
  type: LoadBalancer
  ports:
  - port: 80
  selector:
    app: easypay
```

- Make a note of the public IP address under “external-IP <20.104.142.166>” to be use

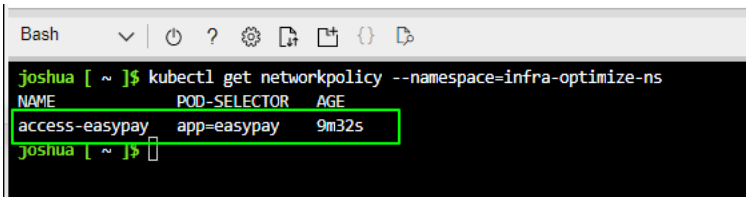


- Copy the IP address to your clipboard. Open a browser and go to that IP address, see that your application is successfully running in Azure Kubernetes Service.



7. Implement the network policies at the database pod to allow ingress traffic from the front-end application pod

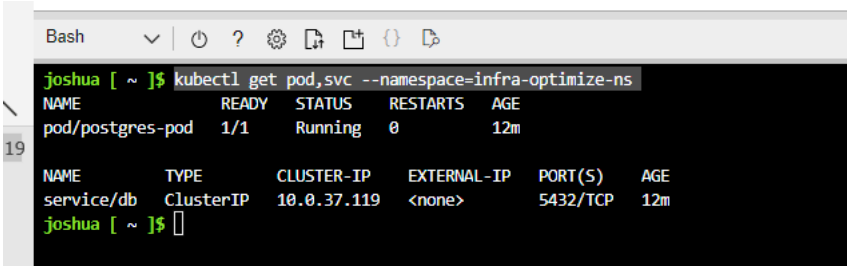
- Network Policy created. "kubectl get networkpolicy --namespace=infra-optimize-ns"



- Created a postgresql db pod and redis caching to custom namespace=infra-optimize-ns"

```
apiVersion: v1
kind: Pod
metadata:
  name: postgres-pod
  namespace: infra-optimize-ns
  labels:
    app: easypay
spec:
  containers:
    - name: postgres
      image: postgres
      ports:
        - containerPort: 5432
      env:
        - name: POSTGRES_USER
          value: "postgres"
```

```
      - name: POSTGRES_PASSWORD
        value: "postgres"
---
apiVersion: v1
kind: Service
metadata:
  name: db
  namespace: infra-optimize-ns
  labels:
    name: postgres-service
    app: easypay
spec:
  ports:
    - port: 5432
      targetPort: 5432
  selector:
    name: postgres-pod
    app: easypay
---
apiVersion: v1
kind: Pod
metadata:
  name: redis-pod
  namespace: infra-optimize-ns
  labels:
    app: easypay
spec:
  containers:
    - name: redis
      image: redis
      ports:
        - containerPort: 6379
```



- Create a new user (joshua-demebo) with permissions to create, list, get, update, and delete pods

```
kind: Role
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  namespace: infra-optimize-ns
```

```
  name: joshua-demebo
rules:
  - apiGroups: ["", "extensions", "apps"]
    resources: ["deployments", "pods", "services","namespaces"]
    verbs: ["create", "list", "get", "update", "Pod", "delete"]
```

```
joshua [ ~ ]$ kubectl create -f new-user-role.yaml
role.rbac.authorization.k8s.io/joshua-demebo created
joshua [ ~ ]$
```

- Create a Role Binding

```
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: role-bind
  namespace: infra-optimize-ns
subjects:
  - kind: ServiceAccount
    name: joshua-demebo
    namespace: infra-optimize-ns
roleRef:
      kind: Role
      name: joshua-demebo
      apiGroup: ""
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: role-bind
  namespace: infra-optimize-ns
subjects:
  - kind: ServiceAccount
    name: joshua-demebo
    namespace: infra-optimize-ns
roleRef:
      kind: Role
      name: joshua-demebo
      apiGroup: ""
```

```
rolebinding.rbac.authorization.k8s.io/role-bind created
joshua [ ~ ]$
```

- Created a Redis for caching

```
apiVersion: v1
kind: Pod
metadata:
  name: redis-pod
  namespace: infra-optimize-ns
  labels:
    app: easypay
spec:
  containers:
    - name: redis
      image: redis
      ports:
        - containerPort: 6379
apiVersion: v1
kind: Pod
metadata:
  name: redis-pod
  namespace: infra-optimize-ns
  labels:
    app: easypay
spec:
  containers:
    - name: redis
      image: redis
      ports:
        - containerPort: 6379
```

```
joshua [ ~ ]$ kubectl create -f redis-pod.yaml
pod/redis-pod created
joshua [ ~ ]$ ls
```

- Set criteria such that if the memory of CPU goes beyond 50%, environments automatically get scaled up and configured

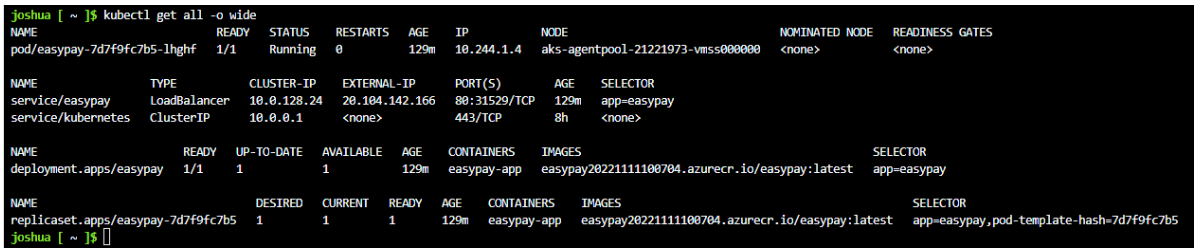
```
apiVersion: autoscaling/v1
kind: HorizontalPodAutoscaler
metadata:
  name: auto-pod
  namespace: infra-optimize-ns
spec:
 scaleTargetRef:
    apiVersion: apps/v1
    kind: Deployment
    name: easypay
  minReplicas: 1
  maxReplicas: 5
  targetCPUUtilizationPercentage: 50
```

```
joshua [ ~ ]$ kubectl create -f autoscale.yaml
horizontalpodautoscaler.autoscaling/auto-pod created
joshua [ ~ ]$
```

8. Take snapshot of ETCD database

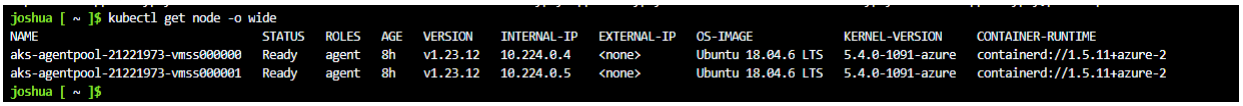
sudo ETCDCTL_API=3 etcdctl snapshot save snapshot.db --cacert /etc/kubernetes/pki/etcd/ca.crt --cert /etc/kubernetes/pki/etcd/server.crt --key /etc/kubernetes/pki/etcd/server.key

- kubectl get all -o wide



```
joshua [ ~ ]$ kubectl get all -o wide
NAME                          READY   STATUS    RESTARTS   AGE    IP           NODE                                NOMINATED NODE   READINESS GATES
pod/easypay-7d7f9fc7b5-lhghf  1/1     Running   0          129m   10.244.1.4   aks-agentpool-21221973-vmss000000   <none>           <none>

NAME                 TYPE           CLUSTER-IP    EXTERNAL-IP      PORT(S)       AGE   SELECTOR
service/easypay      LoadBalancer   10.0.128.24   20.104.142.166   80:31529/TCP  129m  app=easypay
service/kubernetes   ClusterIP      10.0.0.1      <none>           443/TCP       8h    <none>

NAME                     READY   UP-TO-DATE   AVAILABLE   AGE    CONTAINERS    IMAGES                                                  SELECTOR
deployment.apps/easypay  1/1     1            1           129m   easypay-app   easypay20221111100704.azurecr.io/easypay:latest   app=easypay

NAME                                DESIRED   CURRENT   READY   AGE    CONTAINERS    IMAGES                                                  SELECTOR
replicaset.apps/easypay-7d7f9fc7b5  1         1         1       129m   easypay-app   easypay20221111100704.azurecr.io/easypay:latest   app=easypay,pod-template-hash=7d7f9fc7b5
joshua [ ~ ]$
```

- kubectl get all -o wide



```
joshua [ ~ ]$ kubectl get node -o wide
NAME                                STATUS   ROLES   AGE   VERSION   INTERNAL-IP   EXTERNAL-IP   OS-IMAGE             KERNEL-VERSION      CONTAINER-RUNTIME
aks-agentpool-21221973-vmss000000   Ready    agent   8h    v1.23.12  10.224.0.4    <none>        Ubuntu 18.04.6 LTS   5.4.0-1091-azure    containerd://1.5.11+azure-2
aks-agentpool-21221973-vmss000001   Ready    agent   8h    v1.23.12  10.224.0.5    <none>        Ubuntu 18.04.6 LTS   5.4.0-1091-azure    containerd://1.5.11+azure-2
joshua [ ~ ]$
```

Conclusion

To improve the DevOps infrastructure for an eCommerce application to run on high-availability state, which EasyPay app was used in this case, the above configuration was tested and deployed using various tools to accomplish the result. All source code was uploaded to GitHub for continues improvement either vertical or horizontal autoscaling.

I strongly believe all being done and with the documentation, it will improve the quality and performance of the eCommerce and prevent connectivity downtime.

This infra optimization will improve the app and give an online shoppers more reliable, fast, and secure improved performance of the EasyPay app.