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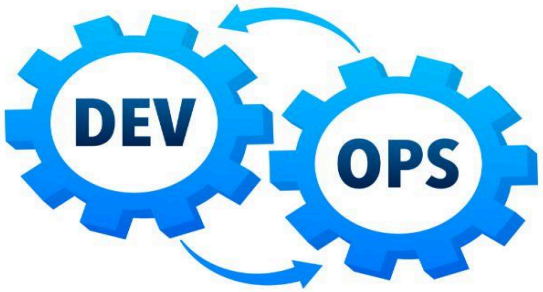

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Project 1: CI/CD Pipeline for a .NET Core Application Using Azure DevOps

1. Project Scope

This project focuses on setting up a **Continuous Integration and Continuous Deployment (CI/CD) pipeline** for a .NET Core web application using Azure DevOps. The pipeline automates code integration, testing, and deployment to **Azure App Service**. The goal is to ensure **fast, reliable, and automated software delivery** with minimal manual intervention.

Key Features:

- Automated build and testing of the application
- Deployment to **Azure App Service**
- Versioning control and rollback mechanism
- Integration with Azure DevOps Repos and GitHub

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2. Tools Used

- **Azure DevOps** – For managing repositories, pipelines, and releases
- **Azure Repos or GitHub** – Source code version control
- **Azure Pipelines** – CI/CD automation
- **Azure App Service** – Hosting the application
- **MSTest / NUnit** – For unit testing
- **SonarCloud** – Code quality and security analysis
- **Azure Key Vault** – Secure management of secrets
- **Application Insights** – Performance monitoring

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3. Analysis Approach

Current Challenges Without CI/CD

- Manual deployments are time-consuming and error-prone
- Lack of automated testing can lead to undetected issues in production
- Security vulnerabilities due to hardcoded credentials

Proposed Solution

Implement a fully automated CI/CD pipeline to handle **build, testing, security scanning, and deployment** seamlessly.

Pipeline Flow:

1. Developer commits code to **Azure Repos/GitHub**.
2. Azure Pipelines **triggers build** and runs tests.
3. SonarCloud performs **static code analysis**.
4. Security scanning using **Azure Key Vault** to fetch secrets.
5. If all tests pass, the build artifact is stored in **Azure Artifacts**.
6. Azure Pipelines **deploys the application** to Azure App Service.
7. Application Insights provides **monitoring and logs**.

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4. Step-by-Step Implementation

Step 1: Set Up Azure DevOps Repository

1. Go to Azure DevOps and create a new project.
2. Navigate to **Repos** → **Import Code** or clone a new repository.

Use the following Git commands to push an existing .NET Core app:

```
git init
git remote add origin <repo-url>
git add .
git commit -m "Initial commit"
git push origin main
```

3.

Step 2: Create a CI Pipeline in Azure DevOps

1. Go to **Pipelines** → **New Pipeline** → Choose **Azure Repos Git** or **GitHub**.

Select **Starter Pipeline** and replace it with this YAML:

```
trigger:
  branches:
    include:
      - main

pool:
```

```
  vmImage: 'ubuntu-latest'

steps:
- task: UseDotNet@2
  inputs:
    packageType: 'sdk'
    version: '6.x'

- script: dotnet build --configuration Release
  displayName: 'Build the project'

- script: dotnet test --logger trx
  displayName: 'Run Unit Tests'

- task: PublishBuildArtifacts@1
  inputs:
    pathToPublish: '$(Build.ArtifactStagingDirectory)'
    artifactName: 'drop'
```

2. Save and **run the pipeline** to build and test the application.

Step 3: Integrate SonarCloud for Code Quality

1. Go to SonarCloud and create an account.
2. Connect it to Azure DevOps and set up a new project.

Modify the pipeline to include:

```
- task: SonarCloudPrepare@1
  inputs:
    SonarCloud: 'SonarCloud'
    organization: '<your-org>'
    projectKey: '<your-project-key>'
    scannerMode: 'MSBuild'
- script: dotnet build
- task: SonarCloudAnalyze@1
- task: SonarCloudPublish@1
```

Step 4: Set Up CD Pipeline to Azure App Service

1. Go to **Releases → New Release Pipeline**.
2. Choose **Azure App Service Deployment** template.
3. Select **Azure Subscription** and the App Service name.
4. Choose the **drop** artifact from CI pipeline.
5. Configure deployment stages like **Staging** and **Production**.
6. Enable **Approval Gates** for manual approvals before production deployment.
7. Click **Create Release** and deploy.

Step 5: Secure Secrets Using Azure Key Vault

1. In Azure Portal, go to **Key Vault → Create a new vault**.
2. Add a secret (e.g., `DatabaseConnectionString`).

In Azure Pipelines, add the **Azure Key Vault task**:

```
- task: AzureKeyVault@1
  inputs:
    azureSubscription: 'MyAzureSubscription'
    KeyVaultName: 'my-keyvault'
    SecretsFilter: '*'
```

Step 6: Monitor Using Application Insights

1. In Azure Portal, navigate to **Application Insights** and link it to the app.

Modify `appsettings.json`:

```
"ApplicationInsights": {
    "InstrumentationKey": "<your-instrumentation-key>"
}
```

2. Update the Azure DevOps release pipeline to enable **monitoring logs**.

5. Conclusion

This project successfully implemented an **end-to-end CI/CD pipeline** for a .NET Core web application using Azure DevOps. Key benefits:

✅ **Automated Build & Testing** – Ensuring high code quality
✅ **Faster Deployment** – Reducing manual intervention
✅ **Secure Configuration Management** – Using **Azure Key Vault**
✅ **Monitoring & Logging** – With **Application Insights**

Real-Time Example:

A software company developing a **finance dashboard** can use this pipeline to deploy new features faster while ensuring security and stability.

Project 2: Infrastructure as Code (IaC) with Terraform and Azure DevOps

1. Project Scope

This project focuses on **automating infrastructure provisioning** using **Terraform** with Azure DevOps. The goal is to manage and deploy infrastructure resources, such as **Azure Virtual Machines (VMs), Storage Accounts, Networking, and Databases**, using Infrastructure as Code (IaC) principles.

Key Features:

- Fully automated **resource provisioning** using Terraform
- Integration with **Azure DevOps Pipelines** for continuous deployment
- State management with **Azure Storage**
- **Role-based access control (RBAC)** for secure deployments
- Infrastructure **drift detection and remediation**

---

2. Tools Used

- **Azure DevOps** – CI/CD pipeline for infrastructure deployment
- **Terraform** – Infrastructure as Code tool
- **Azure CLI** – To manage Azure resources
- **Azure Key Vault** – Secure storage for sensitive credentials
- **Azure Storage Account** – To store Terraform state files
- **GitHub/Azure Repos** – Source code management for Terraform scripts

---

3. Analysis Approach

Challenges Without IaC

- **Manual provisioning** of infrastructure is time-consuming and error-prone
- **Inconsistent environments** between development, testing, and production
- **Difficult rollback process** if an infrastructure change breaks the system

Proposed Solution

By using **Terraform with Azure DevOps**, we can:
✅ Automate infrastructure deployment
✅ Maintain **version-controlled** infrastructure code
✅ Improve **reliability and repeatability**
✅ Easily scale and modify infrastructure as per business needs

Workflow:

1. **Developers** write Terraform scripts and push to **Azure Repos/GitHub**.
2. **Azure DevOps Pipelines** trigger Terraform execution.

3. Terraform **plans and applies** infrastructure changes.
4. Resources are deployed to **Azure**.
5. Terraform **state is stored securely** in an Azure Storage Account.

---

4. Step-by-Step Implementation

Step 1: Set Up Azure DevOps Repository

1. Go to **Azure DevOps** → Create a new project.
2. Navigate to **Repos** → Clone a new Git repository.

Push the Terraform code:

```
git init
git remote add origin <repo-url>
git add .
git commit -m "Initial Terraform commit"
git push origin main
```

Step 2: Create Terraform Configuration for Azure Infrastructure

Inside the repository, create a file `main.tf`:

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

resource "azurerm_resource_group" "rg" {
  name     = "my-resource-group"
  location = "East US"
}

resource "azurerm_storage_account" "storage" {
  name                     = "mystorageacct"
  resource_group_name      = azurerm_resource_group.rg.name
  location                 = azurerm_resource_group.rg.location
  account_tier             = "Standard"
```

```
  account_replication_type = "LRS"
}
```

Initialize Terraform:

```
terraform init
```

Check the execution plan:

```
terraform plan
```

Apply changes to create resources:

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

Step 3: Configure Remote State Storage in Azure

Create an **Azure Storage Account** to store Terraform state:

```
az storage account create --name mystoragestate --resource-group my-resource-group
--location eastus --sku Standard_LRS
```

Update `backend.tf`:

```
terraform {
  backend "azurerm" {
    resource_group_name   = "my-resource-group"
    storage_account_name  = "mystoragestate"
```

```
    container_name        = "tfstate"
    key                   = "terraform.tfstate"
  }
}
```

Run:

```
terraform init
```

Step 4: Create a CI/CD Pipeline in Azure DevOps

1. In **Azure DevOps**, go to **Pipelines → New Pipeline**.
2. Select **Azure Repos Git** or **GitHub**.

Choose **Starter Pipeline** and modify the YAML as follows:

```
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: TerraformInstaller@0
  inputs:
    terraformVersion: 'latest'

- script: terraform init
  displayName: 'Initialize Terraform'

- script: terraform plan -out=tfplan
  displayName: 'Terraform Plan'

- script: terraform apply -auto-approve tfplan
```

```
  displayName: 'Apply Terraform Changes'
```

3. Save and **run the pipeline**.

Step 5: Secure Credentials with Azure Key Vault

1. In Azure Portal, navigate to **Key Vault** and create a vault.
2. Store **Terraform service principal credentials** as secrets.

Add the **Azure Key Vault task** to the pipeline:

```
- task: AzureKeyVault@1
  inputs:
    azureSubscription: 'MyAzureSubscription'
    KeyVaultName: 'my-keyvault'
    SecretsFilter: '*'
```

Step 6: Deploy Changes Automatically

Push a **new Terraform resource** (e.g., Virtual Machine) in `main.tf`:

```
resource "azurerm_virtual_machine" "vm" {
  name                = "myVM"
  resource_group_name = azurerm_resource_group.rg.name
  location            = azurerm_resource_group.rg.location
  size               = "Standard_DS1_v2"
  admin_username     = "azureuser"

  os_profile {
    computer_name  = "myVM"
    admin_password = "SecureP@ssw0rd!"
  }

  network_interface_ids = [azurerm_network_interface.nic.id]
```

```
}
```

1. **Commit and push the changes** to trigger the pipeline and deploy the VM.

---

5. Conclusion

This project implemented **Infrastructure as Code (IaC) using Terraform and Azure DevOps**, enabling **automated, scalable, and version-controlled infrastructure provisioning**.

Key Benefits:

✅ **Automated Infrastructure Deployment** – No manual configuration
✅ **State Management** – Azure Storage ensures team collaboration
✅ **Security Best Practices** – Using **Azure Key Vault**
✅ **Seamless CI/CD Integration** – Infrastructure is provisioned on every commit

Real-Time Example:

A company migrating to **Azure Cloud** can use this approach to **automate provisioning of Virtual Machines, Storage, and Networking**, ensuring consistency across all environments.

Project 3: Automating Application Deployment with Azure DevOps CI/CD and Kubernetes (AKS)

1. Project Scope

This project focuses on **automating the deployment of a containerized application** on **Azure Kubernetes Service (AKS) using Azure DevOps CI/CD pipelines**.

Key Features:

✅ Build and package the application using **Docker**
✅ Push the container image to **Azure Container Registry (ACR)**
✅ Deploy the application to **AKS using Helm charts**
✅ Use **Azure DevOps Pipelines** for CI/CD automation
✅ Implement **rolling updates** and rollback strategies

---

2. Tools Used

- **Azure DevOps** – Continuous Integration & Continuous Deployment
- **Azure Kubernetes Service (AKS)** – Kubernetes cluster for container orchestration
- **Docker** – Containerization of applications
- **Helm** – Kubernetes package manager for deployment
- **Azure Container Registry (ACR)** – To store Docker images
- **Kubernetes Manifest (YAML)** – For AKS deployment
- **Azure CLI & Kubectl** – For managing the AKS cluster

---

3. Analysis Approach

Challenges Without CI/CD & Kubernetes

- **Manual deployments** lead to inconsistency and errors
- **Difficult rollback process** in case of failures
- **Scaling applications manually** is inefficient

Proposed Solution

By using **Azure DevOps CI/CD with AKS**, we can:
✅ **Automate application builds and deployments**
✅ **Ensure version-controlled releases**

✅ **Enable rolling updates and rollback**
✅ **Improve application scalability and reliability**

Workflow:

1. **Developers push code** to Azure Repos (or GitHub).
2. **Azure DevOps triggers a build pipeline**, creating a Docker image.
3. **The image is pushed** to Azure Container Registry (ACR).
4. **A release pipeline** deploys the application to AKS using Helm.

---

4. Step-by-Step Implementation

Step 1: Set Up Azure Kubernetes Service (AKS)

Create a **Resource Group** in Azure:

```
az group create --name MyResourceGroup --location eastus
```

Create an **AKS Cluster**:

```
az aks create --resource-group MyResourceGroup --name MyAKSCluster --node-count 2
--enable-addons monitoring --generate-ssh-keys
```

Connect to the cluster:

```
az aks get-credentials --resource-group MyResourceGroup --name MyAKSCluster
```

Step 2: Set Up Azure Container Registry (ACR)

Create an **ACR instance**:

```
az acr create --resource-group MyResourceGroup --name MyACR --sku Basic
```

Attach ACR to AKS:

```
az aks update --resource-group MyResourceGroup --name MyAKSCluster --attach-acr
MyACR
```

Step 3: Build and Push a Docker Image to ACR

Clone a sample app:

```
git clone https://github.com/Azure-Samples/azure-voting-app-redis.git
cd azure-voting-app-redis
```

Build and tag the Docker image:

```
docker build -t myacr.azurecr.io/azure-vote:v1 .
```

Push the image to ACR:

```
docker login myacr.azurecr.io
docker push myacr.azurecr.io/azure-vote:v1
```

Step 4: Create a CI/CD Pipeline in Azure DevOps

1. Create a CI Pipeline for Building & Pushing the Docker Image

1. In **Azure DevOps**, go to **Pipelines → New Pipeline**
2. Select **GitHub or Azure Repos** as the source

Choose **Starter Pipeline** and modify the YAML:

```yaml
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: Docker@2
  inputs:
    command: 'buildAndPush'
    repository: 'myacr.azurecr.io/azure-vote'
    dockerfile: 'Dockerfile'
    containerRegistry: 'MyACR'
    tags: 'v$(Build.BuildId)'
```

3. Save and run the pipeline. This builds and pushes the container image to **ACR**.

---

2. Create a Kubernetes Deployment YAML File

Create a `deployment.yaml` file:

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: azure-vote
spec:
  replicas: 2
  selector:
```

```
    matchLabels:
      app: azure-vote
  template:
    metadata:
      labels:
        app: azure-vote
    spec:
      containers:
      - name: azure-vote
        image: myacr.azurecr.io/azure-vote:v1
        ports:
        - containerPort: 80
```

---

3. Create a Release Pipeline for Deployment to AKS

1. In **Azure DevOps**, go to **Releases → New Release Pipeline**.
2. Select **Azure Kubernetes Service Deployment**.
3. Set up stages:
    - **Build Stage**: Uses the CI pipeline to build and push the Docker image.
    - **Release Stage**: Deploys to **AKS** using the `kubectl` command.

Add a **task** to deploy the app:

```
- task: Kubernetes@1
  inputs:
    command: apply
    connectionType: 'Azure Resource Manager'
    azureSubscriptionEndpoint: 'MyAzureSubscription'
    resourceGroupName: 'MyResourceGroup'
    clusterName: 'MyAKSCluster'
    namespace: 'default'
    manifests: '$(System.DefaultWorkingDirectory)/deployment.yaml'
```

Step 5: Enable Rolling Updates & Rollback

Modify the **deployment.yaml** to use a new image tag:

```
image: myacr.azurecr.io/azure-vote:v2
```

Push the changes → The pipeline automatically **updates** the app on AKS.

If something breaks, rollback using:

```
kubectl rollout undo deployment azure-vote
```

---

5. Conclusion

This project automated the **end-to-end deployment of a containerized application** using **Azure DevOps and AKS**.

Key Benefits:

✅ **Seamless CI/CD integration** – No manual deployments
✅ **Automatic scaling & self-healing** – Handled by **Kubernetes**
✅ **Rolling updates & rollback support**
✅ **Secure and efficient container image management** using **ACR**

Real-Time Example:

A **DevOps team** managing a **microservices-based application** can use this setup to **automate deployments, improve reliability, and enable rapid scaling**.

Project 4: Infrastructure as Code (IaC) with Terraform and Azure DevOps

1. Project Scope

This project focuses on using **Terraform to provision and manage Azure infrastructure** through **Azure DevOps CI/CD pipelines**.

Key Features:

✅ Automate the creation of Azure infrastructure (VMs, Networks, Storage)
✅ Use Terraform for **Infrastructure as Code (IaC)**
✅ Store Terraform state files in **Azure Storage Account**
✅ Implement **Azure DevOps Pipelines** for **automated provisioning**
✅ Enable **approval-based deployment** for controlled infrastructure changes

---

2. Tools Used

- **Azure DevOps** – CI/CD for Infrastructure deployment
- **Terraform** – Infrastructure as Code tool
- **Azure CLI** – To manage Azure resources
- **Azure Storage Account** – For Terraform state management
- **Azure Key Vault** – To store sensitive credentials
- **Azure Virtual Network (VNet), Virtual Machines, Storage Accounts**

---

3. Analysis Approach

Challenges Without IaC & DevOps

- **Manual infrastructure provisioning** is error-prone and time-consuming
- **Difficult to track changes** made to cloud resources
- **No version control** for infrastructure changes
- **Security risks** due to hardcoded credentials

Proposed Solution

By integrating **Terraform with Azure DevOps**, we can:
✅ **Automate Azure resource provisioning**
✅ **Enable version control** for infrastructure
✅ **Improve security by managing credentials in Azure Key Vault**
✅ **Enforce approval-based deployment for governance**

Workflow:

1. **Terraform code** is stored in Azure Repos (or GitHub).
2. **Azure DevOps CI Pipeline** validates and formats Terraform code.
3. **Terraform applies infrastructure changes** in Azure.
4. **Terraform state file** is stored in an **Azure Storage Account**.

---

4. Step-by-Step Implementation

Step 1: Set Up Azure DevOps & Terraform Repository

1. **Create a new repository** in Azure DevOps (or GitHub)

Clone the repo locally:

```
git clone https://dev.azure.com/MyOrg/MyTerraformRepo.git
cd MyTerraformRepo
```

2. **Create Terraform Configuration Files:**
   - `main.tf` → Defines Azure infrastructure
   - `variables.tf` → Stores variables
   - `terraform.tfvars` → Defines actual values

Step 2: Configure Terraform Backend in Azure Storage

Create a Resource Group:

```
az group create --name MyResourceGroup --location eastus
```

Create an Azure Storage Account:

```
az storage account create --name myterraformstate --resource-group MyResourceGroup
--location eastus --sku Standard_LRS
```

Create a Storage Container for Terraform state:

```
az storage container create --name terraform-state --account-name myterraformstate
```

Define Terraform backend in `main.tf`:

```
terraform {
  backend "azurerm" {
    resource_group_name   = "MyResourceGroup"
    storage_account_name  = "myterraformstate"
    container_name        = "terraform-state"
    key                   = "terraform.tfstate"
  }
}
```

Step 3: Define Infrastructure in Terraform

1. Define Azure Provider (`main.tf`)

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

2. Create an Azure Virtual Network

```
resource "azurerm_virtual_network" "my_vnet" {
  name                = "myVnet"
  location            = "East US"
  resource_group_name = "MyResourceGroup"
  address_space       = ["10.0.0.0/16"]
}
```

3. Create an Azure Virtual Machine

```
resource "azurerm_linux_virtual_machine" "my_vm" {
  name                = "MyVM"
  resource_group_name = "MyResourceGroup"
  location            = azurerm_virtual_network.my_vnet.location
  size                = "Standard_B1s"
  admin_username      = "adminuser"
  admin_password      = "P@ssw0rd123!"

  network_interface_ids = [azurerm_network_interface.my_nic.id]
}
```

Step 4: Create an Azure DevOps Pipeline for Terraform

1. Create a CI Pipeline to Validate Terraform Code

1. In **Azure DevOps**, go to **Pipelines → New Pipeline**
2. Select **GitHub or Azure Repos** as the source

Choose **Starter Pipeline** and modify the YAML:

```
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: TerraformInstaller@1
  inputs:
    terraformVersion: '1.2.0'

- script: |
    terraform init
    terraform validate
  displayName: 'Terraform Init & Validate'
```

3. Save and run the pipeline. This **validates Terraform code** before deployment.

Step 5: Create a CD Pipeline for Infrastructure Deployment

1. Add Terraform Plan & Apply Steps in Azure DevOps

Modify the **release pipeline YAML**:

```
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- script: |
    terraform init
    terraform plan -out=tfplan
  displayName: 'Terraform Plan'

- task: ManualValidation@0
  inputs:
    notifyUsers: 'user@example.com'
    instructions: 'Approve Terraform Apply'
  displayName: 'Manual Approval for Apply'

- script: |
    terraform apply -auto-approve tfplan
  displayName: 'Terraform Apply'
```

Step 6: Secure Terraform Secrets with Azure Key Vault

Create an Azure Key Vault:

```
az keyvault create --name MyKeyVault --resource-group MyResourceGroup --location
eastus
```

Store Terraform Admin Password:

```
az keyvault secret set --vault-name MyKeyVault --name TerraformAdminPassword
--value "P@ssw0rd123!"
```

Modify Terraform Code to Retrieve Secrets:

```
data "azurerm_key_vault_secret" "admin_password" {
  name         = "TerraformAdminPassword"
  key_vault_id = azurerm_key_vault.my_keyvault.id
}
```

---

5. Conclusion

This project **automates infrastructure provisioning using Terraform and Azure DevOps**.

Key Benefits:

✅ **Eliminates manual provisioning**
✅ **Ensures version control for infrastructure changes**
✅ **Improves security by storing secrets in Azure Key Vault**
✅ **Enables approval-based deployments**

Real-Time Example:

A **cloud operations team** managing a **large-scale Azure environment** can use this setup to **automate deployments, enforce governance, and improve security**.

Project 5: CI/CD Pipeline for a .NET Core Application Using Azure DevOps

1. Project Scope

In this project, we will build a **Continuous Integration and Continuous Deployment (CI/CD) pipeline** in **Azure DevOps** for a **.NET Core web application**. The goal is to automate the **build, testing, and deployment** of the application to **Azure App Service**.

Key Features:

✅ Automate **code build and testing** using Azure DevOps pipelines
✅ Deploy the application to **Azure App Service**
✅ Implement **branch policies** to ensure code quality
✅ Enable **rollbacks** in case of failures
✅ Use **Secrets Management** with Azure Key Vault

---

2. Tools Used

- **Azure DevOps** – CI/CD automation
- **Azure App Service** – Hosting the .NET Core application
- **GitHub/Azure Repos** – Source code repository
- **Azure Key Vault** – Secrets management
- **Azure CLI** – To manage Azure resources
- **YAML Pipelines** – For defining the CI/CD workflow

---

3. Analysis Approach

Challenges Without CI/CD

- **Manual deployment takes time** and is error-prone
- **Inconsistent environments** between development, testing, and production
- **No automated testing**, leading to deployment failures
- **Security risks** due to hardcoded credentials

Proposed Solution

By integrating **Azure DevOps with .NET Core and Azure App Service**, we can:
✅ **Automate build and deployment** of the application
✅ **Enforce code quality checks** using branch policies

✅ **Secure application secrets** in Azure Key Vault
✅ **Enable rollback options** in case of failed deployments

Workflow:

1. **Developers push code** to Azure Repos (or GitHub).
2. **CI Pipeline builds and tests** the application automatically.
3. **CD Pipeline deploys** the application to Azure App Service.
4. **Azure Key Vault stores** sensitive configuration data.
5. **Rollback mechanism** enables safe deployment.

---

4. Step-by-Step Implementation

Step 1: Set Up Azure DevOps & Repository

1. **Create a new repository** in Azure DevOps (or GitHub).

Clone the repository and create a sample .NET Core web app:

```
git clone https://dev.azure.com/MyOrg/MyDotNetRepo.git
cd MyDotNetRepo
dotnet new webapp -o MyWebApp
```

Step 2: Create an Azure App Service

Create a Resource Group:

```
az group create --name MyResourceGroup --location eastus
```

Create an Azure App Service Plan:

```
az appservice plan create --name MyAppServicePlan --resource-group MyResourceGroup
--sku B1 --is-linux
```

Create the Azure Web App:

```
az webapp create --resource-group MyResourceGroup --plan MyAppServicePlan --name
MyWebApp --runtime "DOTNET:6.0"
```

Step 3: Create CI Pipeline in Azure DevOps

1. **Go to Azure DevOps → Pipelines → New Pipeline**
2. **Select Azure Repos Git or GitHub** as the source
3. **Choose Starter Pipeline** and modify the YAML:

YAML Configuration for CI Pipeline

```
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: UseDotNet@2
  inputs:
    packageType: 'sdk'
    version: '6.x'
    installationPath: $(Agent.ToolsDirectory)/dotnet

- script: |
    dotnet restore
    dotnet build --configuration Release
  displayName: 'Build .NET Core Application'

- script: |
    dotnet test --configuration Release
  displayName: 'Run Unit Tests'

- task: PublishBuildArtifacts@1
  inputs:
```

```
    pathToPublish: '$(Build.ArtifactStagingDirectory)'
    artifactName: 'drop'
  displayName: 'Publish Build Artifacts'
```

4. **Save and run the pipeline**. This will build and test the .NET Core app automatically.

Step 4: Create CD Pipeline to Deploy to Azure App Service

1. Modify the Deployment YAML

```
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: DownloadBuildArtifacts@0
  inputs:
    buildType: 'current'
    artifactName: 'drop'
    targetPath: '$(Build.ArtifactStagingDirectory)'

- task: AzureWebApp@1
  inputs:
    azureSubscription: 'MyAzureServiceConnection'
    appName: 'MyWebApp'
    package: '$(Build.ArtifactStagingDirectory)/**/*.zip'
    deploymentMethod: 'zipDeploy'
  displayName: 'Deploy to Azure App Service'
```

Step 5: Secure Credentials Using Azure Key Vault

Create an Azure Key Vault:

```
az keyvault create --name MyKeyVault --resource-group MyResourceGroup --location
eastus
```

Store Database Connection String:

```
az keyvault secret set --vault-name MyKeyVault --name "DBConnectionString" --value
"Server=myserver.database.windows.net;Database=mydb;User
Id=myuser;Password=mypassword;"
```

Modify Azure DevOps Pipeline to Fetch Secrets:

```
- task: AzureKeyVault@1
  inputs:
    azureSubscription: 'MyAzureServiceConnection'
    keyVaultName: 'MyKeyVault'
    secretsFilter: '*'
    runAsPreJob: true
```

Step 6: Implement Rollback Strategy

Enable Deployment Slots in Azure App Service

```
az webapp deployment slot create --resource-group MyResourceGroup --name MyWebApp
--slot staging
```

Modify Deployment Pipeline to Use Staging Slot

```
- task: AzureWebApp@1
  inputs:
    azureSubscription: 'MyAzureServiceConnection'
    appName: 'MyWebApp'
    slotName: 'staging'
    package: '$(Build.ArtifactStagingDirectory)/**/*.zip'
    deploymentMethod: 'zipDeploy'
```

Perform a Swap to Production on Successful Deployment

```
az webapp deployment slot swap --resource-group MyResourceGroup --name MyWebApp
--slot staging
```

---

5. Conclusion

This project **automates the CI/CD process for a .NET Core application** using Azure DevOps.

Key Benefits:

✅ **Automated Build & Testing** ensures code quality
✅ **Seamless Deployment** to Azure App Service
✅ **Secrets Management** with Azure Key Vault
✅ **Rollback Support** using deployment slots

Real-Time Example:

A **software development team** working on a **.NET Core web application** can use this pipeline to **automate deployments, reduce manual effort, and improve software quality**.

Project 6: Implementing Infrastructure as Code (IaC) Using Terraform and Azure DevOps

1. Project Scope

In this project, we will automate the provisioning of **Azure cloud infrastructure** using **Terraform** within an Azure DevOps pipeline. The goal is to create a **fully automated Infrastructure as Code (IaC) solution** that deploys a **virtual network, subnets, a virtual machine, and storage accounts** on Azure.

Key Features:

✅ Automate infrastructure provisioning using Terraform
✅ Store Terraform state files securely in Azure Storage
✅ Implement **CI/CD pipeline** for Terraform deployment
✅ Use Azure DevOps **Service Connections** for authentication
✅ Enforce **Infrastructure as Code (IaC)** best practices

---

2. Tools Used

- **Azure DevOps** – CI/CD automation
- **Terraform** – Infrastructure as Code (IaC)
- **Azure Storage Account** – Terraform state management
- **Azure Virtual Network (VNet)** – Network provisioning
- **Azure Virtual Machine (VM)** – Compute resource
- **Azure CLI** – Command-line automation

---

3. Analysis Approach

Challenges Without Infrastructure as Code

- **Manual infrastructure setup** leads to inconsistencies
- **Difficult to replicate environments** (dev, staging, prod)
- **Security risks** due to improper state management
- **No version control** for infrastructure changes

Proposed Solution

By using **Terraform with Azure DevOps**, we can:

✅ **Automate Infrastructure Deployment** via pipelines
✅ **Manage Terraform state securely** in Azure Storage
✅ **Enable version control** and rollback for infrastructure changes
✅ **Ensure consistency** across multiple environments

Workflow:

1. **Terraform scripts define infrastructure** as code
2. **Azure DevOps pipeline applies Terraform** to Azure
3. **Terraform state is stored** in an Azure Storage Account
4. **Changes are validated** before deployment
5. **Infrastructure is deployed/updated** automatically

---

4. Step-by-Step Implementation

Step 1: Set Up Azure DevOps & Repository

1. **Create a new repository** in Azure DevOps (or GitHub).

Clone the repository and create a Terraform configuration folder:

```
git clone https://dev.azure.com/MyOrg/TerraformAzureRepo.git
cd TerraformAzureRepo
mkdir terraform
```

Step 2: Install Terraform & Configure Backend Storage

Install Terraform on your local machine (if not installed):

```
sudo apt-get update && sudo apt-get install -y terraform
```

Create an Azure Storage Account for Terraform state management:

```
az group create --name TerraformStateRG --location eastus
az storage account create --name tfstateaccount --resource-group TerraformStateRG
--sku Standard_LRS
az storage container create --name terraform-state --account-name tfstateaccount
```

Update Terraform backend configuration (`terraform/backend.tf`):

```
terraform {
  backend "azurerm" {
    resource_group_name  = "TerraformStateRG"
    storage_account_name = "tfstateaccount"
    container_name       = "terraform-state"
    key                  = "terraform.tfstate"
  }
}
```

Step 3: Write Terraform Configuration for Infrastructure

Create a new Terraform configuration file (`terraform/main.tf`) to define infrastructure:

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

resource "azurerm_resource_group" "rg" {
  name     = "MyTerraformRG"
  location = "East US"
}

resource "azurerm_virtual_network" "vnet" {
  name                = "MyVNet"
  location            = azurerm_resource_group.rg.location
```

```
  resource_group_name = azurerm_resource_group.rg.name
  address_space       = ["10.0.0.0/16"]
}

resource "azurerm_subnet" "subnet1" {
  name                 = "MySubnet1"
  resource_group_name  = azurerm_resource_group.rg.name
  virtual_network_name = azurerm_virtual_network.vnet.name
  address_prefixes     = ["10.0.1.0/24"]
}

resource "azurerm_virtual_machine" "vm" {
  name                  = "MyTerraformVM"
  location              = azurerm_resource_group.rg.location
  resource_group_name   = azurerm_resource_group.rg.name
  network_interface_ids = [azurerm_network_interface.nic.id]
  vm_size               = "Standard_B2s"

  storage_os_disk {
    name              = "myosdisk"
    caching           = "ReadWrite"
    create_option     = "FromImage"
  }

  os_profile {
    computer_name  = "MyVM"
    admin_username = "azureuser"
    admin_password = "MySecurePassword123!"
  }

  os_profile_linux_config {
    disable_password_authentication = false
  }

  source_image_reference {
    publisher = "Canonical"
    offer     = "UbuntuServer"
    sku       = "18.04-LTS"
    version   = "latest"
  }
}
```

Step 4: Create Terraform CI/CD Pipeline in Azure DevOps

1. **Go to Azure DevOps → Pipelines → New Pipeline**
2. **Select Azure Repos Git or GitHub** as the source
3. **Choose Starter Pipeline** and modify the YAML:

YAML Configuration for Terraform Pipeline

```yaml
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: TerraformInstaller@0
  inputs:
    terraformVersion: '1.0.0'

- script: |
    terraform init
  displayName: 'Initialize Terraform'

- script: |
    terraform plan -out=tfplan
  displayName: 'Plan Terraform Changes'

- script: |
    terraform apply -auto-approve tfplan
  displayName: 'Apply Terraform Configuration'
```

Step 5: Secure Credentials Using Azure DevOps Service Connection

1. **Go to Azure DevOps → Project Settings → Service connections**
2. **Create a new service connection** for Azure Resource Manager
3. **Grant permissions** to the pipeline to use this connection

Modify the pipeline YAML to use the service connection:

```
- task: TerraformCLI@0
  inputs:
    command: 'init'
    backendType: 'azurerm'
    backendAzureRmSubscriptionId: '$(AZURE_SUBSCRIPTION_ID)'
```

Step 6: Validate & Deploy Infrastructure

Commit changes to the repository:

```
git add .
git commit -m "Added Terraform configuration"
git push origin main
```

1. **Run the Azure DevOps Pipeline**
2. **Verify Infrastructure in Azure Portal**

---

5. Conclusion

This project **automates infrastructure provisioning using Terraform** with Azure DevOps.

Key Benefits:

✅ **Automated Infrastructure Deployment**
✅ **Secure Terraform State Management**
✅ **Version-Controlled Infrastructure**
✅ **Consistent & Repeatable Environments**

Real-Time Example:

A **DevOps team** responsible for **managing Azure infrastructure** can use this approach to **provision, update, and scale** cloud resources efficiently.

Project 7: Implementing Blue-Green Deployment for an Azure Web App Using Azure DevOps

1. Project Scope

This project focuses on implementing a **Blue-Green deployment strategy** for an **Azure Web App** using **Azure DevOps Pipelines**. The goal is to reduce downtime and minimize risk when deploying new application versions by maintaining two identical environments (Blue and Green).

Key Features:

✅ Automate Blue-Green deployment using Azure DevOps
✅ Deploy and test new versions before switching traffic
✅ Use **Azure App Service Slots** for zero-downtime deployment
✅ Implement rollback strategies in case of failure

---

2. Tools Used

- **Azure DevOps Pipelines** – Automate CI/CD
- **Azure App Service** – Web application hosting
- **App Service Deployment Slots** – Blue-Green switch
- **Azure Monitor** – Track application performance
- **Azure Traffic Manager** – Route traffic between slots
- **GitHub or Azure Repos** – Store application source code

---

3. Analysis Approach

Challenges With Traditional Deployments

- **Application downtime** during deployment
- **High risk of breaking production** with new updates
- **Rollback process is slow and manual**
- **Testing in production impacts users**

Proposed Solution: Blue-Green Deployment

With Blue-Green deployment, we:
✅ Maintain **two identical environments** (Blue & Green)
✅ Deploy and test the new version **in the Green slot**
✅ **Switch traffic** to the Green slot only after successful validation
✅ Keep Blue slot as a backup for **instant rollback** if needed

Workflow:

1. **Blue Slot (Current Production) runs the existing app**
2. **Green Slot (Staging) is used for new deployments**
3. **Traffic is routed to Green slot after testing**
4. **If issues arise, rollback instantly by swapping slots**

---

4. Step-by-Step Implementation

Step 1: Create an Azure Web App with Deployment Slots

1. **Go to Azure Portal → App Services → Create a Web App**
   - Name: `myapp-bluegreen`
   - Runtime: `Node.js / .NET / Python / Java` (as needed)
   - Plan: `Standard or Premium` (supports deployment slots)
2. **Create a deployment slot:**
   - In the Web App, go to **Deployment Slots**
   - Click **+ Add Slot**
   - Name the slot `green`
   - Clone settings from the Blue slot

Step 2: Configure CI/CD in Azure DevOps

1. **Go to Azure DevOps → Pipelines → Create New Pipeline**
2. **Select Repository** (Azure Repos or GitHub)
3. **Choose Starter Pipeline and Update the YAML**

CI/CD YAML for Blue-Green Deployment

```yaml
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'
```

```yaml
steps:
- task: UseDotNet@2
  inputs:
    packageType: 'sdk'
    version: '6.x'

- task: DotNetCoreCLI@2
  inputs:
    command: 'restore'
    projects: '**/*.csproj'

- task: DotNetCoreCLI@2
  inputs:
    command: 'build'
    projects: '**/*.csproj'

- task: DotNetCoreCLI@2
  inputs:
    command: 'publish'
    publishWebProjects: true
    arguments: '--configuration Release --output
$(Build.ArtifactStagingDirectory)'
    zipAfterPublish: true

- task: AzureWebApp@1
  inputs:
    azureSubscription: 'MyAzureServiceConnection'
    appType: 'webApp'
    appName: 'myapp-bluegreen'
    deployToSlotOrASE: true
    resourceGroupName: 'MyResourceGroup'
    slotName: 'green'
    package: '$(Build.ArtifactStagingDirectory)/*.zip'
  displayName: 'Deploy to Green Slot'

- script: echo "Swapping Blue and Green slots"
  displayName: 'Swap Slots'
- task: AzureCLI@2
  inputs:
    azureSubscription: 'MyAzureServiceConnection'
    scriptType: 'bash'
    scriptLocation: 'inlineScript'
```

```
    inlineScript: |
      az webapp deployment slot swap --resource-group MyResourceGroup --name
myapp-bluegreen --slot green
  displayName: 'Swap Slots Blue <-> Green'
```

Step 3: Secure Azure DevOps Pipeline With Service Connection

1. **Go to Azure DevOps → Project Settings → Service connections**
2. **Create a new Azure Resource Manager service connection**
3. **Authorize the pipeline to use this connection**

Modify the YAML to reference the service connection securely:

```
azureSubscription: '$(AZURE_SERVICE_CONNECTION)'
```

Step 4: Validate Deployment & Swap Slots

Commit and push changes to GitHub or Azure Repos:

```
git add .
git commit -m "Added Blue-Green deployment pipeline"
git push origin main
```

1. **Azure DevOps Pipeline triggers the deployment** to the **Green slot**
2. **Manually verify the Green slot** before switching traffic
3. **Run slot swap command** to make Green the new production

---

Step 5: Implement Rollback Strategy

If something goes wrong after deployment:

Instant rollback by swapping slots again:

```
az webapp deployment slot swap --resource-group MyResourceGroup --name
```

```
myapp-bluegreen --slot green
```

Monitor logs and Azure Application Insights for debugging

---

5. Conclusion

Key Benefits of Blue-Green Deployment:

✅ **Zero-Downtime Deployment** – Users experience no service interruptions
✅ **Instant Rollback** – Revert to the previous version in seconds
✅ **Safe Testing in Staging** – Test before going live
✅ **Increased Deployment Frequency** – Deploy confidently

Real-World Use Case:

A **banking application** that requires **high availability** can use this **Blue-Green deployment strategy** to push updates **without affecting live users**.

Project 8: Implementing Canary Deployment for an Azure Kubernetes Service (AKS) Using Azure DevOps

1. Project Scope

This project focuses on **Canary Deployment** in **Azure Kubernetes Service (AKS)** using **Azure DevOps Pipelines**. The **Canary strategy** allows gradual release of new application versions to a small subset of users before rolling it out to everyone.

Key Features:

✅ Deploy a **new version to a small percentage** of traffic
✅ Monitor performance before increasing rollout
✅ Use **Azure DevOps Pipelines for automated CI/CD**
✅ **Rollback if issues occur** before full rollout

---

2. Tools Used

- **Azure Kubernetes Service (AKS)** – Hosts the containerized application
- **Azure DevOps Pipelines** – Automates CI/CD
- **Helm** – Manages Kubernetes deployments
- **Kustomize** – Manages environment-specific configurations
- **Prometheus + Grafana** – Monitors deployment performance
- **Nginx Ingress Controller** – Manages Canary traffic routing

---

3. Analysis Approach

Challenges With Traditional Deployments

- Deploying to **all users at once increases risk**
- Difficult to **test new features safely in production**
- **Rollback is complex** if issues occur after full deployment

Proposed Solution: Canary Deployment

With **Canary Deployment**, we:
✅ Deploy **new version to a small % of users** first
✅ Monitor performance with **Prometheus and Grafana**
✅ Gradually **increase rollout percentage** if no issues occur
✅ **Rollback immediately** if failures are detected

Workflow:

1. **Deploy the current stable version (V1) to 100% of users**
2. **Deploy new version (V2) to 10% of users** (Canary)
3. **Monitor logs, metrics, and user feedback**
4. **Gradually increase to 25%, 50%, then 100%**
5. **Rollback to V1 if failures occur**

---

4. Step-by-Step Implementation

Step 1: Set Up Azure Kubernetes Service (AKS)

Create an AKS Cluster:

```
az aks create --resource-group MyResourceGroup --name myAKSCluster --node-count 2
--enable-addons monitoring --generate-ssh-keys
```

Connect to AKS Cluster:

```
az aks get-credentials --resource-group MyResourceGroup --name myAKSCluster
```

Install Nginx Ingress Controller (for traffic routing):

```
kubectl apply -f
https://raw.githubusercontent.com/kubernetes/ingress-nginx/main/deploy/static/prov
ider/cloud/deploy.yaml
```

Step 2: Configure CI/CD Pipeline in Azure DevOps

1. Go to Azure DevOps → Pipelines → Create New Pipeline
2. Select Repository (Azure Repos or GitHub)
3. Choose Starter Pipeline and Update YAML

CI/CD YAML for Canary Deployment

```yaml
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: Kubernetes@1
  displayName: 'Deploy Canary Version'
  inputs:
    connectionType: 'Azure Resource Manager'
    azureSubscription: 'MyAzureServiceConnection'
    azureResourceGroup: 'MyResourceGroup'
    kubernetesCluster: 'myAKSCluster'
    namespace: 'default'
    command: 'apply'
    useConfigurationFile: true
    configuration: |
      apiVersion: apps/v1
      kind: Deployment
      metadata:
        name: myapp
        labels:
          app: myapp
      spec:
        replicas: 3
        selector:
          matchLabels:
            app: myapp
        template:
          metadata:
            labels:
              app: myapp
```

```
            version: canary
        spec:
          containers:
          - name: myapp
            image: myacr.azurecr.io/myapp:v2
            ports:
            - containerPort: 80
            resources:
              limits:
                cpu: "500m"
                memory: "256Mi"
              requests:
                cpu: "250m"
                memory: "128Mi"

- script: echo "Applying Traffic Routing Rules"
  displayName: 'Route 10% Traffic to Canary'
- task: Kubernetes@1
  inputs:
    connectionType: 'Azure Resource Manager'
    azureSubscription: 'MyAzureServiceConnection'
    kubernetesCluster: 'myAKSCluster'
    namespace: 'default'
    command: 'apply'
    useConfigurationFile: true
    configuration: |
      apiVersion: networking.k8s.io/v1
      kind: Ingress
      metadata:
        name: myapp-ingress
      spec:
        rules:
        - host: myapp.example.com
          http:
            paths:
            - path: /
              pathType: Prefix
              backend:
                service:
                  name: myapp
                  port:
                    number: 80
        canary:
```

```
        weight: 10
```

Step 3: Monitor Canary Performance

Deploy Prometheus for Monitoring

```
helm repo add prometheus-community
https://prometheus-community.github.io/helm-charts
helm repo update
helm install prometheus prometheus-community/kube-prometheus-stack
```

Deploy Grafana for Dashboards

```
helm install grafana grafana/grafana
```

1. **Check Performance Metrics**
   - Open **Grafana** and connect it to **Prometheus**
   - Monitor CPU, memory, and response times
   - If issues occur, **rollback Canary Deployment**

Step 4: Gradual Rollout of Canary

Increase traffic to 25% if V2 is stable

```
kubectl patch ingress myapp-ingress --type='json' -p='[{"op": "replace", "path":
"/spec/canary/weight", "value": 25}]'
```

1. **Monitor Logs and Errors**
2. **Increase to 50%, then 100% if successful**

Step 5: Rollback If Issues Occur

Rollback to V1 immediately if users report issues:

```
kubectl rollout undo deployment myapp
```

1. **Monitor System Logs**
2. **Fix Issues & Restart Canary Process**

---

5. Conclusion

Key Benefits of Canary Deployment:

✅ **Reduces Risk** – Only a small % of users are affected if issues arise
✅ **Better User Experience** – Catch issues before full rollout
✅ **Quick Rollback** – Instantly revert to the previous version
✅ **Data-Driven Deployment** – Use real user feedback to validate releases

Real-World Use Case:

A **SaaS company** rolling out a new **payment feature** can use **Canary Deployment** to release it **gradually** and detect **bugs early** before full rollout.

Project 9: Implementing Infrastructure as Code (IaC) with Terraform in Azure DevOps

1. Project Scope

This project focuses on **Infrastructure as Code (IaC) using Terraform** in **Azure DevOps**. Terraform allows provisioning and managing Azure infrastructure in a **declarative and automated manner**, eliminating manual setup.

Key Features:

✅ Automate **Azure infrastructure provisioning**
✅ Use **Terraform as IaC** within Azure DevOps Pipelines
✅ **Apply changes consistently** across environments (Dev, QA, Prod)
✅ **Maintain version control** for infrastructure

---

2. Tools Used

- **Azure DevOps Pipelines** – Automates Terraform execution
- **Terraform** – Defines and deploys infrastructure
- **Azure Resource Manager (ARM)** – Manages Azure resources
- **Azure Key Vault** – Stores sensitive Terraform credentials
- **Azure Storage Account** – Stores Terraform state files

---

3. Analysis Approach

Challenges Without IaC:

❌ Manual deployment **is time-consuming and error-prone**
❌ Difficult to **maintain infrastructure consistency**
❌ No **version control** over infrastructure changes

Proposed Solution: Using Terraform With Azure DevOps

✅ Define **infrastructure as code** using Terraform
✅ Automate deployments via **Azure DevOps Pipelines**
✅ Use **Terraform state management** for tracking infrastructure
✅ Store **secrets securely in Azure Key Vault**

Workflow:

1. **Write Terraform scripts** to define Azure infrastructure
2. **Store Terraform files in an Azure DevOps repository**
3. **Use Azure DevOps Pipelines to execute Terraform commands**
4. **Manage infrastructure across multiple environments (Dev, QA, Prod)**
5. **Apply, update, and destroy infrastructure as needed**

---

4. Step-by-Step Implementation

Step 1: Install Terraform Locally

Download and install **Terraform**:

```
wget
https://releases.hashicorp.com/terraform/1.2.0/terraform_1.2.0_linux_amd64.zip
unzip terraform_1.2.0_linux_amd64.zip
sudo mv terraform /usr/local/bin/
terraform --version
```

Step 2: Create an Azure Storage Account for Terraform State Files

Terraform needs a **backend storage** to store state files.

Create a Resource Group:

```
az group create --name terraform-rg --location eastus
```

Create a Storage Account:

```
az storage account create --name terraformstorageacct --resource-group
```

```
terraform-rg --location eastus --sku Standard_LRS
```

Create a Storage Container:

```
az storage container create --name tfstate --account-name terraformstorageacct
```

Step 3: Define Terraform Configuration Files

Create the following Terraform files in an Azure DevOps Git repository:

1. main.tf (Defines Azure Resources)

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

resource "azurerm_resource_group" "rg" {
  name     = "my-devops-rg"
  location = "East US"
}

resource "azurerm_virtual_network" "vnet" {
  name                = "my-vnet"
  location            = azurerm_resource_group.rg.location
  resource_group_name = azurerm_resource_group.rg.name
  address_space       = ["10.0.0.0/16"]
}

resource "azurerm_subnet" "subnet" {
  name                 = "my-subnet"
  resource_group_name  = azurerm_resource_group.rg.name
  virtual_network_name = azurerm_virtual_network.vnet.name
  address_prefixes     = ["10.0.1.0/24"]
}
```

2. variables.tf (Defines Variables)

```
variable "location" {
  default = "East US"
}

variable "resource_group_name" {
  default = "my-devops-rg"
}
```

3. backend.tf (Configures Terraform State)

```
terraform {
  backend "azurerm" {
    resource_group_name   = "terraform-rg"
    storage_account_name  = "terraformstorageacct"
    container_name        = "tfstate"
    key                   = "terraform.tfstate"
  }
}
```

Step 4: Create an Azure DevOps Pipeline for Terraform

1. Go to Azure DevOps → Pipelines → Create New Pipeline
2. Select Git Repository
3. Add Terraform Tasks to Pipeline YAML

Terraform CI/CD Pipeline in Azure DevOps (azure-pipelines.yml)

```
trigger:
  branches:
```

```
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

steps:
- task: TerraformInstaller@0
  displayName: 'Install Terraform'
  inputs:
    terraformVersion: '1.2.0'

- script: |
    terraform init
  displayName: 'Initialize Terraform'

- script: |
    terraform validate
  displayName: 'Validate Terraform Configuration'

- script: |
    terraform plan -out=tfplan
  displayName: 'Terraform Plan'

- script: |
    terraform apply -auto-approve tfplan
  displayName: 'Apply Terraform Changes'
```

Step 5: Secure Terraform Secrets Using Azure Key Vault

Create an Azure Key Vault

```
az keyvault create --name my-keyvault --resource-group terraform-rg --location
eastus
```

Store Terraform Service Principal Credentials

```
az keyvault secret set --vault-name my-keyvault --name "terraform-client-id"
--value "<your-client-id>"
az keyvault secret set --vault-name my-keyvault --name "terraform-client-secret"
--value "<your-client-secret>"
```

Update Terraform Pipeline to Fetch Secrets

```
- task: AzureKeyVault@1
  inputs:
    azureSubscription: 'MyAzureSubscription'
    keyVaultName: 'my-keyvault'
    secretsFilter: '*'
```

Step 6: Deploy Terraform Infrastructure

1. **Commit Terraform files to Azure DevOps Git repository**
2. **Run Azure DevOps Pipeline**
3. **Verify Resources in Azure Portal**

Step 7: Destroy Infrastructure (Cleanup)

If you want to **destroy all resources**, run:

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

---

5. Conclusion

Key Benefits of Terraform in Azure DevOps:

✅ **Automates Infrastructure** – No manual intervention
✅ **Ensures Consistency** – Infrastructure is identical across environments
✅ **Enables Rollbacks** – Easily revert infrastructure changes
✅ **Improves Security** – Secrets are stored in Azure Key Vault

Real-World Use Case:

A **financial services company** managing **multi-cloud infrastructure** can use Terraform for **repeatable, version-controlled** infrastructure deployments across **Azure, AWS, and Google Cloud**.

Project 10: Implementing Blue-Green Deployment Strategy in Azure DevOps

1. Project Scope

This project focuses on **Blue-Green Deployment** using **Azure DevOps Pipelines and Azure App Services**. The goal is to ensure **zero downtime deployment** by switching traffic between two identical environments (Blue & Green) in **a controlled manner**.

Key Features:

✅ **Deploy new versions without downtime**
✅ **Instant rollback if issues occur**
✅ **Ensure smooth traffic switching using Azure Traffic Manager**
✅ **Improve reliability in production deployments**

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2. Tools Used

- **Azure DevOps Pipelines** – Automates application deployment
- **Azure App Services** – Hosts web applications
- **Azure Traffic Manager** – Routes traffic between Blue & Green
- **Azure Repos** – Stores application source code
- **Azure CLI & PowerShell** – Manages deployments

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3. Analysis Approach

Traditional Deployment Issues:

❌ **Downtime** when updating production
❌ **Rollback complexity** if issues arise
❌ **Customer impact** during application restarts

Proposed Solution: Blue-Green Deployment

✅ Maintain **two identical environments (Blue & Green)**
✅ Deploy updates to **Green** while **Blue serves traffic**
✅ **Switch traffic** to Green once verified
✅ If issues occur, **switch back to Blue instantly**

Workflow:

1. **Deploy application to Blue (Production) and Green (Staging)**
2. **Update application in Green** and run tests
3. **Switch traffic** to Green if tests pass
4. **If failure occurs**, roll back to Blue

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4. Step-by-Step Implementation

Step 1: Create Two Azure App Service Instances

Create a Resource Group:

```
az group create --name bluegreen-rg --location eastus
```

Create Two App Services for Blue & Green:

```
az webapp create --resource-group bluegreen-rg --plan myAppServicePlan --name
blue-app --runtime "DOTNETCORE:6.0"
```

```
az webapp create --resource-group bluegreen-rg --plan myAppServicePlan --name
green-app --runtime "DOTNETCORE:6.0"
```

Step 2: Set Up Azure Traffic Manager

Create Traffic Manager Profile:

```
az network traffic-manager profile create --resource-group bluegreen-rg --name
bluegreen-tm --routing-method Weighted --dns-name bluegreen-tm
```

Add Endpoints (Blue & Green) to Traffic Manager:

```
az network traffic-manager endpoint create --resource-group bluegreen-rg
--profile-name bluegreen-tm --name blue-endpoint --type azureEndpoints
--target-resource-id
/subscriptions/<sub_id>/resourceGroups/bluegreen-rg/providers/Microsoft.Web/sites/
blue-app --endpoint-status enabled --weight 100
```

```
az network traffic-manager endpoint create --resource-group bluegreen-rg
--profile-name bluegreen-tm --name green-endpoint --type azureEndpoints
--target-resource-id
/subscriptions/<sub_id>/resourceGroups/bluegreen-rg/providers/Microsoft.Web/sites/
green-app --endpoint-status enabled --weight 0
```

Step 3: Configure Azure DevOps Pipeline for Blue-Green Deployment

1. **Go to Azure DevOps → Pipelines → Create New Pipeline**
2. **Select Git Repository**
3. **Add Blue-Green Deployment Stages**

Pipeline YAML (azure-pipelines.yml)

```
trigger:
  branches:
    include:
      - main

pool:
  vmImage: 'ubuntu-latest'

variables:
```

```
  blueAppServiceName: 'blue-app'
  greenAppServiceName: 'green-app'
  azureSubscription: 'AzureServiceConnection'

stages:
- stage: DeployToGreen
  jobs:
  - job: Deploy
    steps:
    - task: AzureWebApp@1
      displayName: 'Deploy to Green App'
      inputs:
        azureSubscription: $(azureSubscription)
        appName: $(greenAppServiceName)
        package: $(Build.ArtifactStagingDirectory)/app.zip

- stage: SwitchTraffic
  dependsOn: DeployToGreen
  jobs:
  - job: TrafficManagerUpdate
    steps:
    - script: |
        az network traffic-manager endpoint update --resource-group bluegreen-rg
--profile-name bluegreen-tm --name green-endpoint --weight 100
        az network traffic-manager endpoint update --resource-group bluegreen-rg
--profile-name bluegreen-tm --name blue-endpoint --weight 0
      displayName: 'Switch Traffic to Green'

- stage: Rollback
  condition: failed()
  dependsOn: SwitchTraffic
  jobs:
  - job: RevertTraffic
    steps:
    - script: |
        az network traffic-manager endpoint update --resource-group bluegreen-rg
--profile-name bluegreen-tm --name blue-endpoint --weight 100
        az network traffic-manager endpoint update --resource-group bluegreen-rg
--profile-name bluegreen-tm --name green-endpoint --weight 0
      displayName: 'Rollback to Blue'
```

Step 4: Test and Verify the Deployment

1. **Trigger the Azure DevOps pipeline**
2. **Verify Green environment updates correctly**
3. **Ensure traffic switches to Green smoothly**
4. **If rollback triggers, confirm traffic returns to Blue**

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5. Conclusion

Key Benefits of Blue-Green Deployment:

✅ **Zero downtime deployment**
✅ **Immediate rollback in case of failure**
✅ **Ensures stable releases in production**
✅ **Traffic can be gradually shifted for controlled testing**

Real-World Use Case:

A **banking application** that must be **available 24/7** can use this approach to deploy updates **without disrupting customers** and quickly rollback in case of an issue.

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