**ĐẠI HỌC QUỐC GIA TP. HỒ CHÍ MINH**

**TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN**

**KHOA MẠNG MÁY TÍNH VÀ TRUYỀN THÔNG**

**TRẦN NHỰT LINH**

**HOÀNG TRÍ TƯỜNG**

**ĐỒ ÁN CHUYÊN NGÀNH**

**TÌM HIỂU VÀ ĐÁNH GIÁ CÁC MÔ HÌNH CI/CD**

**Researching and evaluating CI/CD models**

**CỬ NHÂN NGÀNH MẠNG MÁY TÍNH VÀ TRUYỀN THÔNG DỮ LIỆU**

**TP. HỒ CHÍ MINH, 2024**

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**TRẦN NHỰT LINH – 21521081**

**HOÀNG TRÍ TƯỜNG – 21521654**

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**GIẢNG VIÊN HƯỚNG DẪN**

**TRẦN THỊ DUNG**

**TP. HỒ CHÍ MINH, 2024**

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Trần Nhựt Linh

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# TỔNG QUAN

## Giới thiệu đề tài

Trong bối cảnh các công ty công nghệ hàng đầu đầu tư vào tối ưu hóa quy trình phát triển phần mềm, việc áp dụng CI/CD trở nên quan trọng và tất yếu. CI/CD không chỉ tăng tốc độ phát triển và triển khai phần mềm, mà còn đảm bảo chất lượng và độ tin cậy của sản phẩm. Nó giúp các nhóm phát triển liên tục tích hợp và kiểm thử mã nguồn, nhanh chóng phát hiện và sửa lỗi, giảm thiểu rủi ro và nâng cao hiệu suất làm việc.

Các công ty phần mềm có thể triển khai và quản lý hệ thống CI/CD linh hoạt và hiệu quả, đáp ứng nhanh chóng yêu cầu thị trường và người dùng. Nhóm chúng em đã triển khai một số mô hình CI/CD nhưng hệ thống vẫn chưa hoàn chỉnh do các quy trình tự động hóa còn phức tạp. Mong cô góp ý để hệ thống CI/CD của chúng em hoàn thiện hơn. Công nghệ được sử dụng.

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Hình 1.1: Các công nghệ sử dụng

# CƠ SỞ LÝ THUYẾT

## Docker

### Giới thiệu

Docker là một nền tảng mã nguồn mở để phát triển, vận hành và quản lý các ứng dụng trong các container. Docker giúp đóng gói ứng dụng và các thư viện đi kèm vào một container, đảm bảo tính nhất quán khi triển khai trên nhiều môi trường khác nhau.

### Chức năng chính

* Containerization: Docker cho phép đóng gói ứng dụng và các thư viện đi kèm vào một container, đảm bảo ứng dụng có thể chạy ổn định trên bất kỳ môi trường nào.
* Images: Docker sử dụng images làm đơn vị xây dựng và phân phối ứng dụng. Một image là một snapshot của một container tại một thời điểm cụ thể.
* Registry: Docker Hub là một registry công cộng cho phép người dùng lưu trữ và chia sẻ images.

## Kubernetes

### Giới thiệu

Kubernetes (K8s) là một nền tảng mã nguồn mở để quản lý container, giúp tự động hóa việc triển khai, scaling, và quản lý các ứng dụng container.

### Chức năng chính

* Orchestration: Tự động hóa việc triển khai, quản lý và scaling của các container.
* Self-healing: Tự động khởi động lại các container bị lỗi, thay thế các container bị chết, và quản lý trạng thái của ứng dụng.
* Load balancing: Phân phối lưu lượng mạng đến các container một cách tự động và cân bằng.

## SonarQube/SonarCloud

### Giới thiệu

SonarQube là một nền tảng mã nguồn mở để phân tích và đo lường chất lượng source code, giúp các team Development quản lý chất lượng source code một cách liên tục.

### Chức năng chính

* Phân tích code: SonarQube kiểm tra mã nguồn để phát hiện lỗi, lỗ hổng bảo mật, và các vấn đề về chất lượng code như code smells, technical debt.
* Báo cáo chi tiết: SonarQube cung cấp các báo cáo chi tiết về chất lượng source code với các chỉ số quan trọng.

## Github Actions

### Giới thiệu

GitHub Actions là một nền tảng tích hợp liên tục và phân phối liên tục (CI/CD) cho phép tự động hóa quy trình xây dựng, kiểm tra và triển khai và có thể tạo các workflow để xây dựng và kiểm tra mọi pull request đến kho lưu trữ, hoặc triển khai các pull request đã được hợp nhất lên môi trường sản xuất.

### Chức năng chính

* CI (Continuous Integration): Tự động xây dựng và kiểm thử source code mỗi khi có thay đổi.
* CD (Continuous Delivery/Deployment): Tự động triển khai ứng dụng lên các môi trường khác nhau sau khi kiểm thử thành công.
* Pipeline: GitLab CI/CD sử dụng pipeline để xác định chuỗi các công việc cần thực hiện, từ xây dựng, kiểm thử, đến triển khai.

## Azure DevOps

### Giới thiệu

Azure DevOps hỗ trợ một văn hóa cộng tác và tập hợp các quy trình đưa các nhà phát triển, quản lý dự án và người đóng góp lại với nhau để phát triển phần mềm. Nó cho phép các tổ chức tạo ra và cải thiện sản phẩm với tốc độ nhanh hơn so với các phương pháp phát triển phần mềm truyền thống.

### Chức năng chính

Azure DevOps cung cấp các tính năng tích hợp có thể truy cập thông qua trình duyệt web hoặc IDE client.

|  |  |
| --- | --- |
| **Dịch vụ** | **Mô tả** |
| Azure Boards | Cung cấp một bộ công cụ Agile để hỗ trợ lập kế hoạch và theo dõi công việc, lỗi mã, và các vấn đề sử dụng các phương pháp Kanban và Scrum. |
| Azure Repos | Cung cấp Git repositories hoặc Team Foundation Version Control (TFVC) để kiểm soát mã nguồn |
| Azure Pipelines | Cung cấp các dịch vụ xây dựng và phát hành để hỗ trợ continuous integration and delivery cho các ứng dụng. |
| Azure Test Plans | Cung cấp nhiều công cụ để kiểm thử ứng dụng, bao gồm manual/exploratory testing và continuous testing. |
| Azure Artifacts | Cho phép các nhóm chia sẻ các gói như Maven, npm, NuGet và nhiều hơn nữa từ các nguồn công cộng và tư nhân và tích hợp việc chia sẻ gói vào các pipelines. |

Bảng 2.1: Chức năng chính của Azure DevOps

## Jenkins

### Giới thiệu

Jenkins là một công cụ tự động hóa mã nguồn mở, thường được sử dụng để thực hiện các tác vụ liên quan đến Continuous Integration (CI) và Continuous Delivery (CD). Jenkins hỗ trợ việc tự động hóa các quy trình xây dựng, kiểm thử, và triển khai phần mềm.

### Chức năng chính

* Continuous Integration (CI): Jenkins tự động xây dựng và kiểm thử mã nguồn từ các hệ thống kiểm soát phiên bản như Git, giúp phát hiện lỗi nhanh chóng và liên tục tích hợp các thay đổi mã nguồn.
* Continuous Delivery (CD): Jenkins giúp triển khai tự động các ứng dụng lên môi trường sản xuất hoặc môi trường thử nghiệm.
* Plugin: Jenkins có hàng nghìn plugin, cho phép mở rộng và tích hợp với nhiều công cụ khác nhau.

## GitLab CI/CD

### Giới thiệu

GitLab CI/CD là một phần của GitLab, cung cấp các tính năng CI/CD ngay trong GitLab, giúp tự động hóa các quy trình xây dựng, kiểm thử, và triển khai phần mềm.

### Chức năng chính

* CI (Continuous Integration): Tự động xây dựng và kiểm thử source code mỗi khi có thay đổi.
* CD (Continuous Delivery/Deployment): Tự động triển khai ứng dụng lên các môi trường khác nhau sau khi kiểm thử thành công.
* Pipeline: GitLab CI/CD sử dụng pipeline để xác định chuỗi các công việc cần thực hiện, từ xây dựng, kiểm thử, đến triển khai.

# PHƯƠNG PHÁP THỰC HIỆN

## Nghiên cứu lý thuyết và tài liệu

Thu thập tài liệu và nghiên cứu kiến trúc, nguyên lý hoạt động, tính năng chính của tất cả các mô hình CI/CD và chọn ra những mô hình tốt nhất.

## Thiết lập môi trường

* Thiết lập các server, các node hoặc các dịch vụ cloud: Cài đặt và cấu hình môi trường cần thiết cho từng mô hình CI/CD.
* Cấu hình công cụ cần thiết: Tùy theo mô hình CI/CD, cài đặt và cấu hình các công cụ hỗ trợ như Git, Docker, và các plugin liên quan.
* Thiết lập Runner/Agent: Đối với các nền tảng yêu cầu Runner/Agent, thiết lập và cấu hình các thành phần này để hỗ trợ thực hiện pipeline.
* Cấu hình file pipeline: Định nghĩa các bước trong pipeline thông qua các file cấu hình như Jenkinsfile, .gitlab-ci.yml, YAML file, hoặc workflow file.

## Xây dựng và cấu hình các pipeline

Source code dùng để chạy các mô hình pipeline là một ứng dụng MERN, sử dụng các công nghệ như MongoDB, Express, ReactJS, NodeJS. Source code được tham khảo trên trang GitHub. Tại MongoDB, connection string được sửa lại thành “mongodb://mongodb:27017/Instagram” để có thể kết nối với container back-end.

### Khởi tạo Dockerfile và file YAML deployment

#### Dockerfile

* Đầu tiên cần kéo image base là node về cho cả front-end và back-end.
* Tiếp đến thiết lập thư mục làm việc (/app) bên trong các container.
* Sao chép package.json vào thư mục làm việc.
* Cài đặt các dependency và sao chép các source code vào bên trong thư mục làm việc của các container.
* Expose cổng mà app đang chạy sau đó khởi động app.

#### File YAML deployment

* Service:

Service cho front-end với type là NodePort để traffic bên ngoài có thể truy cập vào UI của trang web.

Service back-end với type là NodePort để kiểm tra trạng thái server và để nhận request từ front-end.

Service mongodb để giao tiếp với service back-end trong việc đọc và ghi dữ liệu.

* Deployment:

Tạo các deployment dùng để quản lý các pod chạy container front-end, back-end và mongodb với image được kéo về từ dockerhub. Thông thường các replicas sẽ nhiều hơn 1, nhưng để demo cho pipeline, mặc định các replicas sẽ là 1.

### Khởi tạo file YAML cho Azure DevOps CI/CD

#### Kết nối các dịch vụ

Project Settings → Services Connection để thêm kết nối tới các dịch vụ sử dụng

Cấu hình kết nối tới Azure Students với các thông số

A screenshot of a computer

Description automatically generated

Hình 3.1: Kết nối với Azure Student

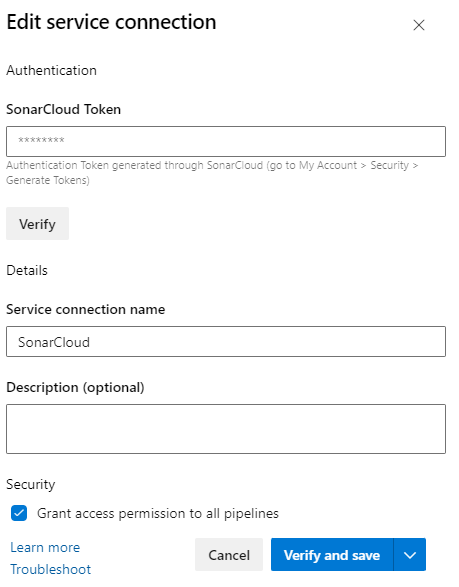
Cấu hình kết nối tới AKS với các thông số như sau

A screenshot of a computer

Description automatically generated

Hình 3.2: Kết nối với AKS

Cấu hình kết nối tới dịch vụ SonarCloud với Token lấy được như trình bày trên Github Actions



Hình 3.3: Kết nối với SonarCloud

Cấu hình kết nối tới Docker Hub Registry để push và pull image sử dụng username và password

A screenshot of a login box

Description automatically generated

Hình 3.4: Kết nối Docker Hub

#### Khởi tạo Self-hosted Runner

Truy cập Settings → Agent Pools → Tạo pool mới → Tạo Agent mới

Truy cập vào máy ảo EC2 bằng ssh và chạy các lệnh

A screenshot of a computer

Description automatically generated

Hình 3.5: Chạy các lệnh cài đặt Agent

A screen shot of a computer

Description automatically generated

Hình 3.6: Khởi chạy Agent

Cài đặt Docker trên Runner bằng các lệnh sau

A screenshot of a computer program

Description automatically generated

Hình 3.7: Lệnh cài đặt Docker

Cài đặt JAVA 17 trên Runner phục vụ cho việc quét và phân tích của SonarCloud với các lệnh sau

A screenshot of a computer program

Description automatically generated

Hình 3.8: Cài đặt JAVA 17

#### Cấu hình Pipeline

Tạo pipeline mới hoặc tạo file azure-pipeline.yml trong source code để cấu hình pipeline được trigger khi thực hiện thay đổi trên nhánh main và sử dụng self-hosted agent bao gồm 2 stages chính: Build và Deploy.

Stage Build:

* Sử dụng Task “Checkout” để checkout source code thuộc tính fetch-depth: 0 để phục vụ cho SonarCloud có thể quét và phân tích source code sâu hơn.
* Thiết lập Task “SonarCloud Prepare” thực hiện chuẩn bị cho quá trình quét và phân tích với ScannerMode: CLI và thiết lập ProjectKey và ProjectName.
* Bắt đầu quá trình quét và phân tích source code với Task “SonarCloudAnalyze” với JDK version là JAVA 17 như đã thiết lập trên Agent.
* Task “Docker” được sử dụng để build và push docker image của backend với build context là backend, tên repository đã thiết lập trên Docker Hub và vị trí Dockerfile.
* Tương tự với backend, build và push docker image của backend với build context là frontend.
* Publish Artifacts “manifests” là file deployment.yml để thực hiện deploy lên AKS ở Stage Deploy.

Stage Deploy:

* Thiết lập Stage Deploy phụ thuộc vào Stage Build để đảm bảo thực hiện Stage Build trước khi chạy Stage Deploy.
* Tải Artifacts đã Publish trước đó và lưu vào thư mục manifests của workspace
* Thiết lập Secret với Task “Deploy to Kubernetes” với thuộc tính action là createSecret, cung cấp thông tin về Azure Subscription, tên resource-group và cluster-name cùng với registry là Docker hub.
* Thực hiện Deploy ứng dụng lên AKS với Task “Deploy to Kubernetes” với thuộc tính action là deploy với các thuộc tính như tên resource-group và cluster-name cùng với vị trí file manifest (deployment.yml).

### Khởi tạo workflow file

#### Kết nối các dịch vụ

Sử dụng Actions Secret and Variables của Github đển lưu trữ các thông tin như Azure Credentials, Docker username và password, Access Token của git, Token để kết nối với SonarCloud

A screenshot of a black screen

Description automatically generated

Hình 3.9: Action Secrets và Variables Repository

Azure Credentials có thể lấy bằng lệnh sau

A computer screen with white and green text

Description automatically generated

Hình 3.10: Lệnh lấy Azure Credential

Sonar Token có thể lấy được sau khi import repository

A screenshot of a computer

Description automatically generated

Hình 3.11: Sonar Token

#### Cấu hình Pipeline

Khởi tạo file deploytoAKS.yml ở trong thư mục .github/worflows

Pipeline sẽ được trigger khi có sự thay đổi ở nhánh main (push và pull request), và được chạy trên máy ảo ubuntu do Github Actions host

Pipeline bao gồm 2 Job chính là Build và Deploy

Job Build:

* Sử dụng Action “Checkout” được cung cấp bởi Github Action trên Marketplace để checkout source code thuộc tính fetch-depth: 0 để phục vụ cho SonarCloud có thể quét và phân tích source code sâu hơn.
* Thiết lập Action “SonarCloud Scan” được cung cấp bởi SonarSource trên Marketplace với Git Token và Sonar Token để thực hiện kết nối và phân thích source code.
* Thực hiện đăng nhập vào Docker Hub với Action “Docker Login” được cung cấp bới docker trên Marketplace với 2 variables đã thiết lập trước đó là Docker Username và Docker Password.
* Build và push docker image của backend lên Docker Hub bằng Action “Build and push Docker images” được cung cấp bởi docker trên Marketplace với build context là backend, thuộc tính push: true và tags: trituong/insta-aks-be:latest là docker hub repository đã thiết lập trước đó.
* Thực hiện tương tự với build và push docker image của frontend với build context là frontend, thuộc tính push: true và tags: trituong/insta-aks-fe:latest là docker hub repository của frontend.

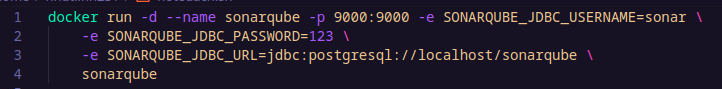
Job Deploy:

* Thiết lập thuộc tính needs: build để đảm bảo thực hiện Job Build trước khi chạy Job Deploy.
* Tương tự với Job Build đầu tiên checkout source code bằng Action “Checkout”
* Đăng nhập Azure bằng Action “Azure Login” được cung cấp bởi Azure với thuộc tính creds là variables Azure Credentials đã thiết lập.
* Set Context cho Azure Kubernetes Service bằng Action “Kubernetes Set Context” với 3 thuộc tính creds như bước trên và resource-group, cluster-name của AKS đã tạo, ở trường này thì là actions-aks-rg và actions-aks-cluster
* Khởi tạo Secret trong Kubernetes Cluster để pull image với registry là Docker Hub, thông tin đăng nhập Docker hub, thiết lập type và name cho secret
* Sử dụng Action “Deploy to Kubernetes cluster” của Azure để deploy ứng dụng với manifest là file yml kubernetes đã viết, tên images là tên docker hub repository đã thiết lập với secret đã khởi tạo bước trên.

### Khởi tạo Jenkinsfile

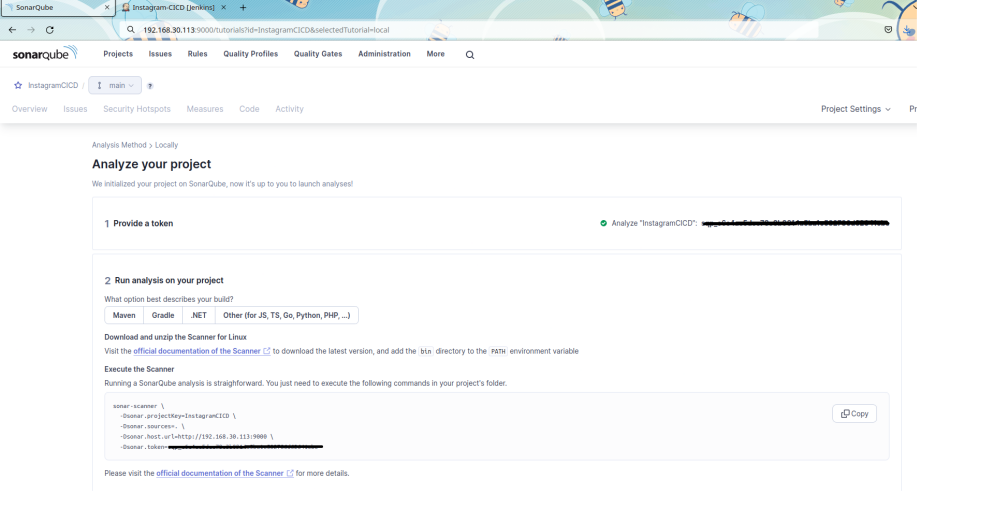
#### Cài đặt SonarQube trên Jenkins Server

Khởi tạo SonarQube container qua lệnh sau trên Server. Việc triển khai cài đặt Jenkins Server sẽ được đề cập ở chương sau.



Hình 3.12: Khởi tạo SonarQube

Truy cập đường dần của máy Server với cổng 9000 để vào SonarQube. Sau đó tạo project để generate token dùng để Jenkins xác thực với SonarQube



Hình 3.13: Xác thực Jenkins với SonarQuber

Thêm trigger của Jenkins Server vào SonarQube tại Adminstration→ Configuration → Webhooks → Create. Sau đó thêm đường dẫn như bên dưới

A screenshot of a computer

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Hình 3.14: Thêm trigger vào SonarQube

Vào phần Manage Jenkins → System → SonarQube Servers để thêm SonarQube server. Thêm Credential tên là sonarqube với type Secret Text và cho token của project SonarQube vào

A screenshot of a computer

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Hình 3.15: Thêm Credential SonarQube

#### Kết nối Jenkins với Kubernetes Cluster

Để Jenkins có thể sử dụng Kubernetes Cluster và triển khai ứng dụng, cần phải lưu file config của Master Node vào Jenkins. Sao chép file config tại đường dẫn “.kube/config” của Master Node vào Jenkins Server hoặc máy vật lý và đặt tên là “kubeconfig”. Việc cài đặt và cấu hình Kubernetes sẽ được đề cập ở chương sau

A screen shot of a computer

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Hình 3.16: Kubeconfig

Tại Dashboard, truy cập đến Manage Jenkins → Clouds → New Cloud, tạo tên Cloud và tick vào Kubernetes và click Create

A screenshot of a computer

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Hình 3.17: Tạo Cloud

Đến bước tiếp theo, tại phần Credentials, chọn Add để thêm Credential của Kubernetes vào Jenkins. Tiến hành điền các thông tin như sau

A screenshot of a computer

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Hình 3.18: Thêm Credential của Kubernetes

Click Add và click Test connection để kiểm tra kết nối Jenkins đến Kubernetes. Sau khi kết nối thành công, click Save

A screenshot of a computer

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Hình 3.19: Kiểm trả kết nối Kubernetes

#### Cấu hình pipeline

* Build stage: sử dụng Docker để build các image. Build context của back-end sẽ ở toàn thư mục và ignore folder “frontend/” và của front-end sẽ ở thư mục “frontend/”.
* Test stage: sử dụng container SonarQube và lệnh sonar-scanner để phân tích source code với key được tạo ra khi khởi tạo project bên phía SonarQube, host là địa chỉ trỏ đến SonarQube với port 9000.
* Push stage: tạo Docker Credential với account Dockerhub và sử dụng Docker để push image của front-end và back-end lên Dockerhub.
* Deploy stage: thêm config của Kubernetes Cluster vào Credential trong Jenkins. Sau đó chạy lệnh apply để triển khai ứng dụng lên Kubernetes Cluster. Đối với GitServer, sử dụng SSH Agent để ssh từ Jenkins đến Server.

### Khởi tạo file YAML .gitlab-ci

#### Cài đặt GitLab Runner self-hosted

Cấu hình máy ảo chạy GitLab Runner

|  |  |
| --- | --- |
| Hệ điều hành | Ubuntu 22.04 LTS |
| CPU | 2 |
| Bộ nhớ RAM | 2GB |
| Ổ cứng | 16GB |
| Địa chỉ IP | 192.168.30.172 |

Bảng 3.1: Cấu hình máy ảo GitLab Runner

Mặc định GitLab sẽ có riêng một GitLab Runner nhưng ta sẽ cài đặt một GitLab riêng để dễ dàng quản lý tài nguyên và tăng tính bảo mật.

Tại đường dẫn Setting → CICD → Runner trên GiLab, chọn new project runner để tạo một GitLab Runner. Sau đó sử dụng lệnh sau để đăng ký GitLab Runner



Hình 3.20: Đăng ký GitLab Runner

Để kết nối Kubernetes với GitLab Runner Copy file tại đường dẫn .kube/config của Master Node và paste vào file tại .kube/config của GitLab Runner bằng lệnh sau:



Hình 3.21: Kết nối Kubernetes qua file config

Cài đặt SonarQube bằng Docker tương tự như phần Jenkins CI/CD. Sau đó tạo một project mới với tên là InstagramGitLab

![A screenshot of a computer

Description automatically generated](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAATMAAACACAYAAABncY4xAAAACXBIWXMAAA7EAAAOxAGVKw4bAAAgAElEQVR4AQCfgWB+Afz8/f8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQEAwECAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Hình 3.22: SonarQube GitLab

#### Cấu hình pipeline

* Build stage: sử dụng image Docker, đăng nhập vào tài khoản GitLab Registry và build các image với build context của back-end sẽ ở toàn thư mục và ignore folder “frontend/” và của front-end sẽ ở thư mục “frontend/”.
* Test stage: sử dụng container SonarQube và image sonarsource/sonar-scanner-cli để phân tích source code với key được tạo ra khi khởi tạo project bên phía SonarQube, host là địa chỉ trỏ đến SonarQube với port 9000. Riêng test stage sử dụng GitLab Runner với tag “sonar”, các stage còn lại sử dụng tag ‘nt114”.
* Push stage: đăng nhập vào GitLab Registry và push các image lên registry thông qua image Docker.
* Deploy stage: sử dụng image bitnami/kubectl có chứa công cụ kubectl để quản lý các Kubernetes Cluster. Sau đó chạy lệnh apply để triển khai ứng dụng lên Kubernetes Cluster.

## Thực hiện các pipeline và thu thập kết quả

* Chạy các pipeline trên từng nền tảng với cùng một source code mẫu để đảm bảo sự nhất quán trong quá trình đánh giá.
* Ghi nhận thời gian thực hiện, tài nguyên sử dụng, và các lỗi hoặc các hạn chế.

## Đánh giá và so sánh

* Phân tích kết quả thu thập được từ các pipeline. So sánh về thời gian, chi phí, tốc độ, tính dễ sử dụng, tài nguyên.
* Đánh giá tốc độ và độ hao phí của từng mô hình CI/CD dựa trên các tiêu chí đã đề ra.

## Tài liệu và báo cáo

Tổng hợp kết quả, trình bày ưu nhược điểm, và đề xuất mô hình CI/CD phù hợp cho các loại dự án và quy mô khác nhau. Dựa vào đó ta có thể đảm bảo tiếp cận hệ thống và chi tiết, giúp đưa ra kết luận và đề xuất chính xác, khách quan.

# TRIỂN KHAI HỆ THỐNG

## Docker và Kubernetes

### Cài đặt Docker

Để Jenkins Server có thể sử dụng được Docker, trước tiên cần phải cài đặt Docker bằng các câu lệnh

A computer screen shot of a program code

Description automatically generated

Hình 4.1: Cài đặt Docker

### Cài đặt Kubernetes Cluster

#### Cấu hình các node trong Kubernetes

|  |  |  |  |
| --- | --- | --- | --- |
|  | Master node | Node 1 | Node 2 |
| Hệ điều hành | Ubuntu 22.04 LTS | Ubuntu 22.04 LTS | Ubuntu 22.04 LTS |
| CPU | 2 | 2 | 1 |
| Bộ nhớ RAM | 4GB | 4GB | 2GB |
| Ổ cứng | 30GB | 25GB | 15GB |
| Địa chỉ IP | 192.168.30.60 | 192.168.30.87 | 192.168.30.89 |

Bảng 4.1: Cấu hình node trong Kubernetes

#### Tiến hành cài đặt

Để dựng một Kubernetes Cluster, cần cài đặt công cụ kubeadm thông qua các lệnh



Hình 4.2: Cài đặt containerd



Hình 4.3: Tạo file containerd config

Chỉnh sửa file containerd config, thay đổi giá trị của biến “SystemdCgroup” thành true



Hình 4.4: Nano config file

A screenshot of a computer program

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Hình 4.5: Đổi giá trị biến SystemdCgroup



Hình 4.6: Khởi động lại containerd

A computer screen shot of a program code

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Hình 4.7: Lệnh cài đặt kubeadm

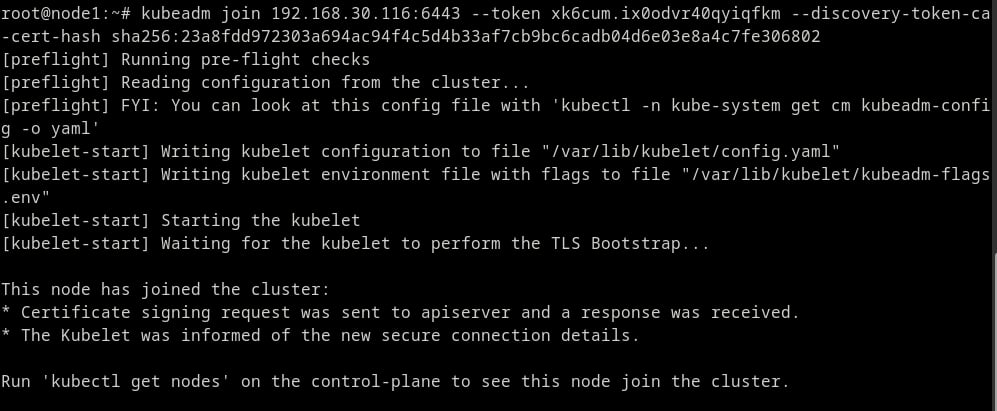
Khởi tạo Cluster trên Master node

A computer screen shot

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Hình 4.8: Lệnh khởi tạo Cluster

Từ các worker node, tiến hành join node



Hình 4.9: Thêm node

## Azure Devops CI/CD

### Mô hình triển khai

A screenshot of a computer

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Hình 4.10: Mô hình triển khai Azure DevOps CI/CD

### Chuẩn bị tài nguyên

Tạo tài khoản Microsoft Azure và Azure DevOps bằng tài khoản edu

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Hình 4.11: Thông tin tài khoản Azure

Tạo Project mới trên Azure DevOps

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Hình 4.12: Tạo Project mới

Vì đã có Repository bên Github nên sử dụng tính năng import Repository sang Azure Repos

A screenshot of a computer

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Hình 4.13: Repository được sử dụng

Tạo Docker Image Repository cho backend và frontend với Docker Hub

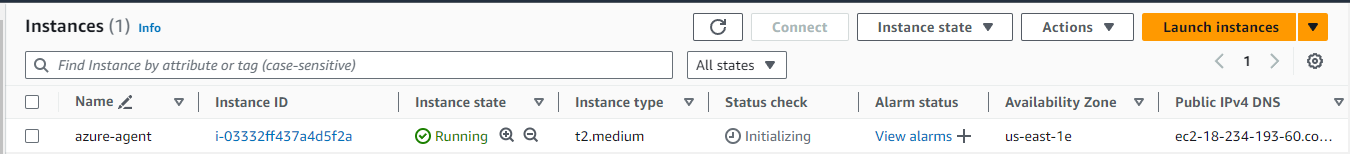
A screenshot of a computer

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Hình 4.14: Docker Hub Repository

Tạo kết nối dịch vụ Docker Hub như đã trình bày ở phần phương pháp thực hiện

Tạo máy ảo EC2 Ubuntu 22.04 để làm Agent cho pipeline



Hình 4.15: EC2 Agent

### Khởi tạo Self-hosted Agent Runner cho Azure DevOps

Truy cập Settings → Agent Pools → Tạo pool mới → Tạo Agent mới

Truy cập vào máy ảo EC2 bằng ssh và chạy các lệnh cài đặt Docker và JAVA 17 như đã trình bày ở phần phương pháp thực hiện

### Khởi tạo AKS Cluster

Tạo AKS Cluster với các thông số

A screenshot of a computer screen

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Hình 4.16: Thông số AKS Cluster (1)

A screenshot of a computer

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Hình 4.17: Thông số AKS Cluster (2)

Review + Create AKS Cluster và tạo AKS Cluster

A close-up of a computer screen

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Hình 4.18: Tạo thành công Cluster

Tạo kết nối kubectl tới AKS Cluster

A screen shot of a computer screen

Description automatically generated

Hình 4.19: Lệnh kết nối kubectl tới AKS Cluster

### Khởi tạo SonarCloud Scanner

Đăng nhập bằng tài khoản AzureDevOps → tạo Project mới → Import Repository → chọn Method AzureDevOps Pipelines

A screenshot of a computer

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Hình 4.20: Import Repository

A screenshot of a computer

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Hình 4.21: Analysis Method

Vào Marketplace và tải SonarCloud cho AzureDevOps

A screenshot of a computer

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Hình 4.22: Tải SonarCloud từ Marketplace

Tạo kết nối dịch vụ với SonarCloud với token được cấp như phần phương pháp thực hiện đã trình bày

Tạo file sonar-project.properties trong repository với 2 trường dữ liệu

A screenshot of a computer

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Hình 4.23: Cấu hình file sonar-project.properties

### Khởi tạo và chạy Pipelines

Tạo một Pipeline mới sử dụng Azure Repos và chọn Repository đã import

A screenshot of a computer

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Hình 4.24: Tạo pipeline mới

Tiến hành edit và khởi chạy Pipeline

A screenshot of a computer

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Hình 4.25: Khởi chạy pipeline

Có thể bấm vào chi tiết để xem quá trình chạy

A screen shot of a computer

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Hình 4.26: Chi tiết quá trình chạy pipeline

Pipeline chạy thành công với thời gian 3 phút 35s

A screenshot of a computer

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Hình 4.27: Pipeline chạy thành công

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A screenshot of a computer

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Hình 4.28: Kết quả Scan của SonarCloud

Ứng dụng triển khai thành công trên Azure Kubernetes Service

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Hình 4.29: Triển khai thành công

## Github Actions CI/CD

### Mô hình triển khai

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Hình 4.30: Mô hình triển khai Github Actions CI/CD

### Chuẩn bị tài nguyên

Source Code sẽ được quản lý bằng Github Repository

A screenshot of a computer

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Hình 4.31: Repository được sử dụng

Tạo Secrets cho Github Actions để kết nối các dịch vụ AKS, Docker, SonarCloud như đã trình bày ở phần phương pháp thực hiện

Tạo Docker Image Repository cho frontend và backend với Docker Hub

A screenshot of a computer

Description automatically generated

Hình 4.32: Docker Hub Repository

### Khởi tạo AKS Cluster

Khởi tạo AKS Cluster theo phương pháp và thông số đã làm ở Azure Devops CI/CD, lấy Azure Credentials và tạo secret như bước chuẩn bị tài nguyên

A computer screen with white and green text

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Hình 4.33: Azure Credentials

### Khởi tạo SonarCloud

Đăng nhập bằng tài khoản Github → Tạo một organize mới → Tạo project mới → Import Repository

A screenshot of a computer

Description automatically generated

Hình 4.34: Import Repository

Thiết lập Secrets bằng Token được cấp như ở phần phương pháp thực hiện đã trình bày

Tạo file sonar-project.properties với 2 trường dữ liệu

A screenshot of a computer program

Description automatically generated

Hình 4.35: Cấu hình file sonar-project.properties

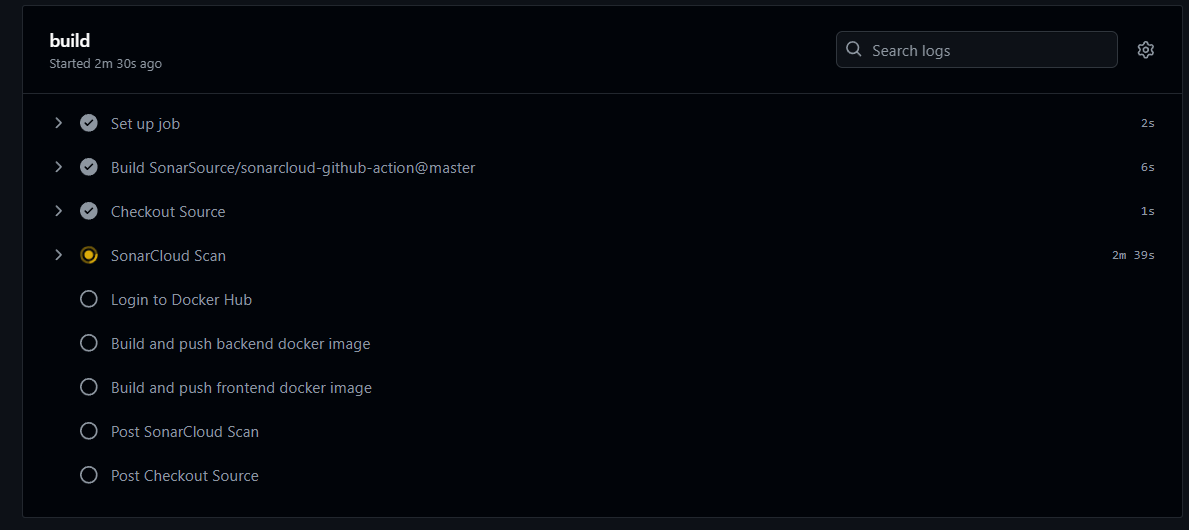
### Khởi tạo và chạy Pipeline

Tạo file deploytoAKS.yml theo tại .github/worflows và tiến hành cấu hình pipelines. Sau đó, khởi chạy pipeline bằng cách trigger nhánh main bằng git push hoặc pull request

A black rectangular object with a blue text

Description automatically generated

Hình 4.36: Khởi chạy Pipeline



Hình 4.37: Chi tiết quá trình chạy pipeline

Pipeline chạy thành công với thời gian 5 phút 12 giây

A screenshot of a computer

Description automatically generated

Hình 4.38: Pipeline chạy thành công

A screenshot of a computer

Description automatically generated

Hình 4.39: Kết quả SonarCloud Scan

Triển khai ứng dụng thành công lên AKS

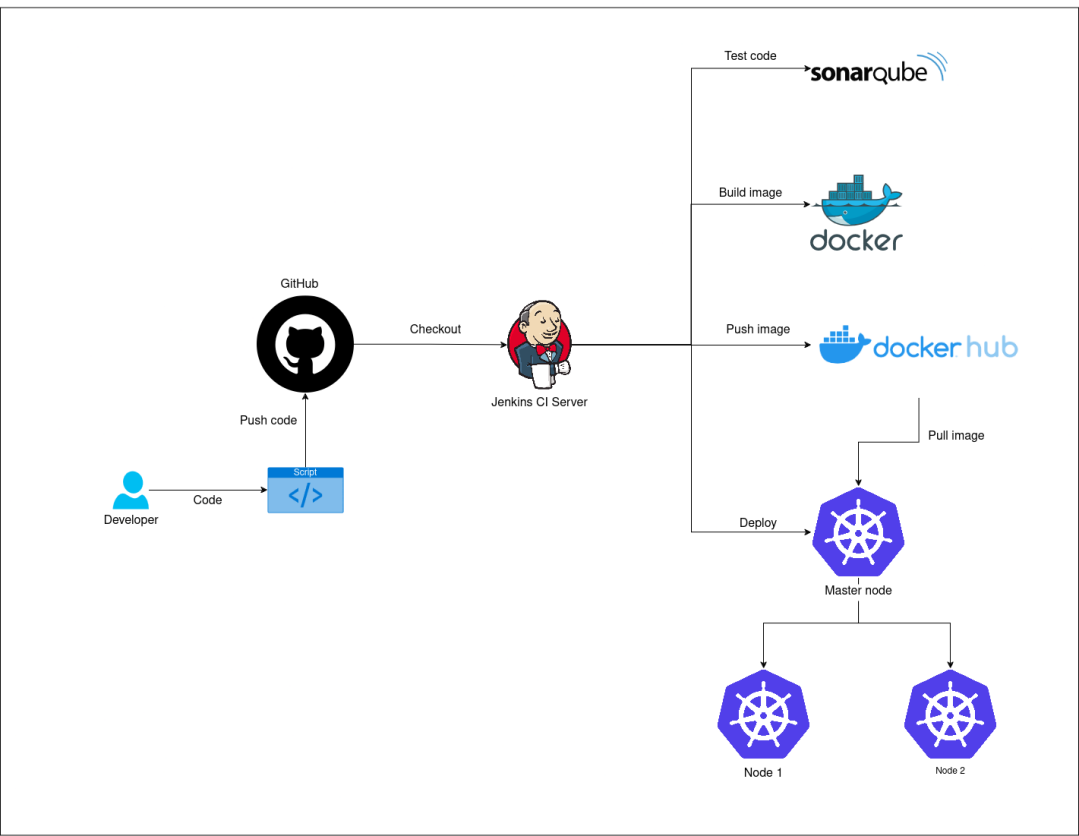
A screenshot of a computer

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Hình 4.40: Triển khai thành công

## Jenkins CI/CD trên Github

### Mô hình triển khai



Hình 4.41: Mô hình triển khải CI/CD trên Github

### Chuẩn bị tài nguyên

#### Source code Github

A screenshot of a computer

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Hình 4.42: Source Github

#### Cài đặt Jenkins Server

Cấu hình máy ảo chạy Jenkins Server

|  |  |
| --- | --- |
| Hệ điều hành | Ubuntu 22.04 LTS |
| CPU | 2 |
| Bộ nhớ RAM | 4GB |
| Ổ cứng | 45GB |
| Địa chỉ IP | 192.168.30.113 |

Bảng 4.2: Cấu hình node trong Kubernetes

Cài đặt Jenkins thông qua các lệnh

A computer screen shot of a code

Description automatically generated

Hình 4.43: Cài đặt Jenkins

Truy cập vào url [http://192.168.30.113:8080](http://192.168.30.116:8080) để vào Jenkins và đăng nhập bằng mật khẩu được lưu tại đường dẫn “/var/lib/jenkins/secrets/initialAdminPassword”

A screenshot of a computer

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Hình 4.44: Web UI Jenkins

Tiến hành cài thêm plugin để cài setup Pipeline tại Manage Jenkins → Plugins → Available plugins

A screenshot of a computer

Description automatically generated

Hình 4.45: Các plugins cần thiết cho pipeline

Để Jenkins push image lên Dockerhub, ta cần tạo Credentials Dockerhub cho Jenkins tại đường dẫn Manage Jenkins → Credentials → System → Add Credential. Sau đó điền vào username và access token của tài khoản Dockerhub và chọn Create

A screenshot of a login box

Description automatically generated

Hình 4.46: Tạo Credentials Docker Hub

### Tạo pipeline CI/CD

Đầu tiên cần chọn New Item tại Dashboard. Chọn tên và click chọn Pipeline sau đó click OK

A screenshot of a computer

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Hình 4.47: Tạo Pipeline

Tại phần Buid Triggers, click vào ô “GitHub hook trigger for GITScm polling”

A screenshot of a survey

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Hình 4.48: Build Trigger

Tại phần Pipeline, chọn đường dẫn của repository cần chạy và thêm Credential của Docker. Tại đây, Jenkins sẽ chạy pipeline dựa trên file Jenkinsfile

A screenshot of a computer

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Hình 4.49: Pipeline Config

Tại Dashboard, Pipeline mới đã được tạo thành công

A screenshot of a computer

Description automatically generated

Hình 4.50: Tạo thành công pipeline

### Chạy Pipeline CI/CD

Click vào tên pipeline cần chạy và click Build Now, Jenkins sẽ tiến hành build source code. Dùng Ocean Blue hoặc Console Output để xem quá trình chạy của Pipeline

A screenshot of a computer

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Hình 4.51: Chi tiết pipeline chạy

Pipe chạy thành công với thời gian chạy là 3 phút 59 giây

A screenshot of a computer

Description automatically generated

Hình 4.52: Pipeline chạy thành công

Ứng dụng đã được triển khai thành công trên Kubernetes Cluster

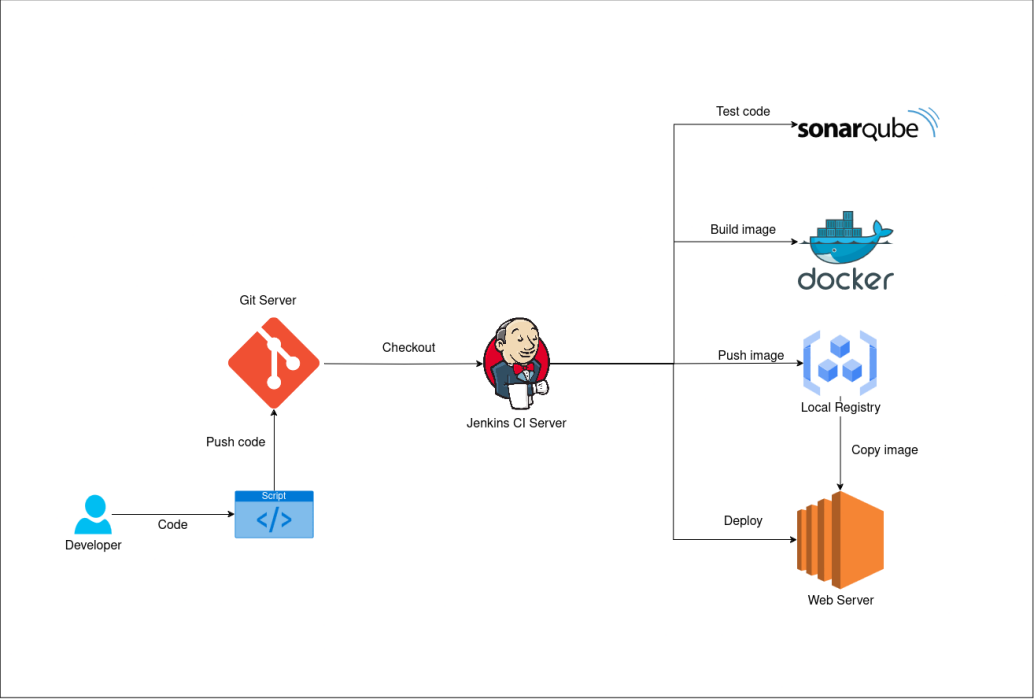
A screenshot of a computer

Description automatically generated

Hình 4.53: Triển khai thành công

## Jenkins CI/CD trên Git Server

### Mô hình triển khai



Hình 4.54: Mô hình triển khai

### Chuẩn bị tài nguyên

#### Source code Git Server

A screenshot of a computer

Description automatically generated

Hình 4.64: Source code trên Git Server

#### Cài đặt Git Server

Cấu hình máy ảo chạy Git Server

|  |  |
| --- | --- |
| Hệ điều hành | Ubuntu 22.04 LTS |
| CPU | 1 |
| Bộ nhớ RAM | 2GB |
| Ổ cứng | 16GB |
| Địa chỉ IP | 192.168.30.126 |

Bảng 4.3: Cấu hình máy ảo Git Server

Cài đặt Git Server thông qua cách lệnh

A screenshot of a computer program

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Hình 4.55: Lệnh cài dặt Git Server



Hình 4.56: Clone Repository về máy

Sau khi chỉnh sửa source code, tiến hành code lên repository trên. Truy cập vào url [http://192.168.30.183:1234](http://192.168.30.126:1234) để xem các repository đã tạo trên Git Server.

#### Cài đặt SSH Agent

Để cài đặt SSH Agent dùng để ssh đến server, trước tiên cần vào phần Manage Jenkins → Plugin để tải các plugin SSH Agent

A screenshot of a computer

Description automatically generated

Hình 4.57: SSH Agent

### Tạo và chạy pipline CI/CD

Quá trình tạo pipeline được thực hiện như mô hình Jenkins với GitHub. Tại phần Pipeline, chọn đường dẫn của repository cần chạy. Tại đây, Jenkins sẽ chạy pipeline dựa trên file Jenkinsfile

A screenshot of a computer

Description automatically generated

Hình 4.58: Pipeline Config

Tại Dashboard, Pipeline mới đã được tạo thành công

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Hình 4.59: Tạo thành công pipeline

Click vào tên pipeline cần chạy và click Build Now, Jenkins sẽ tiến hành build source code. Sau đó, dùng Ocean Blue hoặc Console Output để xem quá trình chạy của Pipeline

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Hình 4.60: Chi tiết pipelines chạy

Pipe chạy thành công với thời gian là 6 phút 4 giây

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Hình 4.61: Pipeline chạy thành công

Ứng dụng đã được triển khai lên Server

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Hình 4.62: Triển khai thành công

## Gitlab CI/CD

### Mô hình triển khai

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADX19cA2NjYABEREQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQABAQEAAQEBAAEBAQABAQEAAgICAAEBAQAAAAAAAgICAAEBAQABAQEAAgICAAEBAQABAQEAAQEBAAEBAQACAgIAAQEBAAEBAQABAQEAAQEBAAEBAQACAgIAAQEBAAEBAQABAQEAAQEBAAICAgABAQEAAQEBAAEBAQABAQEAAgICAAEBAQABAQEAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAKSkpADPz88AcXFxAC8vLwAAAAAAAAAAAAAAAAAA4bgAAAMAAAAw/wAAxgEAAPgAAAAAAAAAAAAAAQABAQAAAAAAAAAAAAAAAAAAAADo/QwA6P0MANT6EwABAAEAAAD/AAAAAAAAAAEAAAAAAAAAAAAAAAAAAQAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGQAAACIAAADx3QAA8NsAABQtAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAP8AAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD/AAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAEAAAD/AAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA+O4AAPvxAAAAAAAAAAAAAA8AAAAbAAAA4wAAAP8AAAAA/wAIDf8A+/gBAAAAAAAAAAAAAAAAAAIEAAAFCAAAAAAAAP8AAAAACAAAACIAAAACAAAAAAAAAP8AAAHv2wD/AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA+/v7ANnZ2QDPz88ABAQEAKSkpAABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADY2NgA7+/vAMzMzAAW/wYAAAAAAAAAAAAA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAOP2BwBQxi4AdyfhAG0k4wAEIP8ABd8AAAMH/wD99wAABw7/AP0FAAAAJwAA6vsGAGTNKQDG7Q8A/v8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wDu7u4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8AEBAQAPv7+wD29vYAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AP///wD///8A////AP7+/gD///8A/v7+AAAAAAD///8A/v7+AP///wD///8A////AP///wD+/v4A////AP///wD///8A////AP///wD+/v4A////AP///wD///8A////AP///wD+/v4A////AP///wD///8A////AP7+/gD///8A////AP///wD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADp6ekAsbGxAM3NzQCpqakAKioqAAAAAAAA/voAAOS9AAAAAAAABAAAAC8AAADOAAAA+///AAAAAf8A//8BAAEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAP8A//8BAAEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///ACcAAQAA//8AAAEBAOK3AAAULQAAAAAAAAAAAAAAAAAAAAD/AAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD/AAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAEAAAD/AAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAEAAAD/AAAAAQAAAAAAAAAAAAAAAAAAAP8AAAABAAAA/wAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP8AAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAH/////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP8AAAABAAAA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD+/v4A/f39AAAAAAAAAAAAAAAAAAAAAAAAAAAAAf/9AADguQAB0IcAAPvvAAD//wAA/wAAANwAAADvAAAA/wAA+/kBAOzfAgD//gAAAAAAAAAAAAAJDv8AERz+AAAAAAAABAAAACYAAAANAAAAAAAAAAEDAP8WPQAAN4EA/wkUAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAICAgADAwMA8fHxALa2tgBOTk4ACwsLAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAwsLCAP///wA7OzsApsPJAGmWoAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAAA8E/EAkC/aAB7r+AD41wEA9eoBABMk/gABKQAAwP0RAGzPJgDo+AYAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAANCQkA6KKSAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Hình 4.63: Mô hình triển khai Gilab CI/CD

### Chuẩn bị tài nguyên

Source code được lấy từ bên repository Instagram-mern của GitHub, đường dẫn:<https://gitlab.com/nhutlin/GitLab-Instagram.git>

A screenshot of a computer

Description automatically generated

Hình 4.64: Source Code GitLab

### Tạo pipeline CI/CD

Khác với Jenkins, GitLab CI/CD sẽ sử dụng file .gitlab-ci.yml để chạy pipeline. Trước tiên cần tạo file .gitlab-ci.yml và đưa script pipeline vào file đó.

Sau khi hoàn thành file .gitlab-ci.yml, tạo 2 GitLab runner dùng để build, push, deploy và test stage:

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQEBAQH/////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD+//4A4/HqAK7WwQDV6uAADgcKAEckNgA8Hy8ACwYIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////APz+AAAEAgAAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wD8/v8AAwIBAAIBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADl5ecADQ0LAA4ODgDz8/MA29vdAAAAAAAfHx0AEhISAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAN3d3wAdHRsABgYGAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA3GZTAALGvAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPYHCgAszecAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQEBAQQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACAQIAHxAYAHE6VwAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQEBAAUDAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQAFAwEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQAA//8AAAAAAAANDQ0AMjIwAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAABAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Hình 4.65: GitLab Pipeline

### Chạy pipeline CI/CD

Sau khi hoàn thành các bước setup, tiến hành push code lên GitLab để chạy pipeline:

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Description automatically 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AAAAAAAAAAAAA6PP+AObx/QD/AAAAAAAAAAAAAAD+/wAA9fr/AN/t/AD8EQMAFgwDAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD09PUA8PDxABgYFwADAwMAAQEBAAAAAAD///8A9/f4AObm5wAbGxkAAwMDAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wDt7e0A8vLzAAAAAAAAAAAAAAAAAP39/QD09PQA+fn5ABoaGAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/f39AObm5wASEhEACgoKAAEBAQAAAAAA////AP39/QDp6esA////AA0NDAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A7u7vAPHx8gAAAAAAAAAAAAAAAAD+/v4A9/f4APn56gAVFRQADAwLAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD8/PwA5ubnABQUFAAJCQgAAQEBAAAAAAD///8A/Pz9AOnp6gAAAAAACwsKAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP7+/gDs7O4A8/PzAAAAAAAAAAAAAAAAAP7+/gD39/cA+fn5ABcXFQAKCgoAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA+vr7AOjo6gAYGBcABgYFAAEBAQAAAAAA////APr6+gDo6OgAGhoZAAUFBQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPT5/gDl8f0A/wAAAAUDAAAUCwIA6/H4AO3z+QACAf8A/wAAAOTw/QD2+v4AAAAAAAAAAAAAAP8A6eDaAOfv9wAAAAAAAAAAAAAAAAAAAAAAAAAAAPju5ADV3eUA19PWAPj8/wAAAAAA/ffyANPX3gD+/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/f39AO3t7gAaGhgAAwMDAOTj5QDBwcQA0dDSAPn4+QAJCQgAExMSAOrq7AD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA9fX2APLy8wAAAAAACAgIAAwMCwAMDAsACAgHAAAAAAD7+/sA7OztAP///wAAAAAAAAAAAAD//wD6+fgA/f7/AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP/+/AD4+fsA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wDs7O0AEREQAAoKCgDz8/QAycnLAMTExgDs7O0ABAQEABkZFwDv7+8A/Pz8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPX19gDx8fIAAAAAAAQEBAAMDAsACwsKAAsLCgACAgIA/v7+AOzs7QD7+/sAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPv47gDU1+MAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AOrq7AAUFBQACQkIAPHx8gDIyMoAxcXHAO/u7wAFBQQAGhoYAOvr7AD+/v4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A9PT1APPz8wAAAAAABQUEAAwMCwALCwsACwsKAAEBAQD+/v4A6+vtAPz8/AAAAAAAAAAAAAAAAAAAAAAAAP//AOXb1QDp8vsAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA//35ANXS2AD6/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wDm5ucAHBwaAAYGBQDr6+wAxMTGAMrKzAD09PQABwcHABsbGgDl5ecA////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA6/T+AAAAAAANBwEAKRYFACASBADR4vIAb6TaANTj8gAKBQEA/v8AAOz1/gAAAAAAAAAAAAAAAADs5d4A3uDkAOPm6wD9/v4A8O7wAP3//wDv7u4AAAQGAAkHAADc2d0A+v4AAPDr5wDk4+MA19zjAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD09PUADw8OAAICAgDV1dcAurq8ADAwLQAUFBMAwcLEAP39/QAKCgkA///+APz8/AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADy8vMAAQEBABUVFADu7e0Ap6eqAKqqrQDz8/MAFBQSAAAAAAD39/gA+/v7AAAAAAAAAAAA/fz6ALSnpQDV4e8A+/j0AOLh4wDx9fkA//37AOfk4wDp7fIA7d7RAKSsuwD1+f0AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/f39APz8/AALCwsA9/f4AKemqQANDAwALi4tANTU1QDm5eYAAgICAA8PDwDz8/QAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA8fHyAAAAAAALCwsADQ0LALe3ugCjo6YA0M/RABYWFAAEBAQA/f39APX19gAAAAAAAAAAAAAAAAD28/EA6+nnAOPm6wD9/v4A8O/wAP3+/wDx7e4A/P79AOzo5QDk6O0A+/jwANXU2gDi4uUA9/r9AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD8/PwAAAAAAAkJCADy8vMAqairABISEgAtLCsAz9DRAOnp6gACAgIADw8OAPT09QAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADy8vMAAAAAAA0NDAAJCAgAtLS3AKSjpgDU09UAGBgWAAMDAwD8/PwA9vb3AAAAAAAAAAAAAAAAAPz59gDj4+QA39vYAO31/QD28e0A4uLlAPj7/gD18/AA6ujnAOTn7QD//foA3NndAPv//wDw6+gA4+bqAPr6+ADu8PMA////APDt7QD8//8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA9/f4AAsLCgADAwMA5OPlAK+usQAkJCMAIiEgAMjHygDy8vMAAwMDAAoKCQD4+PgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACAAAAAAA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39wAAAAAAICAfANLS1AAQEA8ALCwqALq5vAAfIB4A////APf3+AAHBwcAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAB/////wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPz7/gAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD5+fkAAgMBAAkJCAAAAAAAAAAAAAAAAADu9v4A3u38ABIKAgATCgAAq8vtAMvg8wA5Iw4AUzMTAOjz/gDy+P8AJBQEAA8JAgAAAAAAAAD/APDq5gDo6+8A8voFADEvJgD57+cA1d3qAA0PDQAhGhAA7PYEAAX25wD6CxsAAO/fAOz3BAAQExMAIRwXAAEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPv7+wDp6eoAGxsaAAEBAQDY2NoA6urrAAYFBQAsLSsADAwLAPr6+gDr6+wAGhoZAAEBAQAAAAAAAAAAAAAAAADu7fAADg4OAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPPz8gAREhAAAAAAAAAAAAAAAAAAAAAAAPDw8QDv7/AAFxcWAAkJCADq6eoAAgMCABQUFAD29vcA6enqAAYGBgAaGhgAAgICAAAAAAAAAAAA8+zkAODs/QAjGQoA0tTdABkkKQAbDwIA0tDUAAcUHwApIhUA3dXVAA4fKgAXDgYAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A5+foABMTEgAHBwcA7e3uANjY2QD9/P0AICEfAB4eHQD///8A5uboABQUEwAHBwYAAAAAAAAAAAAAAAAA7+/xAA0MDQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD19vUACgoJAAUFBAAAAAAAAAAAAAAAAADw8PEA7e3uAA8PDwASEhAA9vb2APDw8QAXFxYAAQEBAOjo6QD7+/sAGRkZAAgIBwAAAAAAAAAAANG8tgDuDBQADAcPAC8vJgD67+cA1NvpABISDwAeIRoA3tTTAPYEEgAuJhYA5+v5AB4WCADf6PYAIR0WAAEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wDl5ecAFxcVAAUFBQDq6usA29vcAP38/QAkJCIAGhsaAP///wDk5OYAGRkXAAQEBAAAAAAAAAAAAAAAAADv7/AADQwOAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPP08gARERAAAAAAAAAAAAAAAAAA////AO/v8ADv7/AAEREQABAQDwD09PUA8/LyABcYFwD///8A6OjpAPz8/QAbGxkABgYGAAAAAAAAAAAA+fPtANHU3QAQFBMAFhsfAP3v4gDY4e0AKS8vAN3IugD1BxUADA0TADEuIgDo3NoAABMcAP3r3gDo9gUALi0nAAL35QCgrNEAZWFMAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD+/v4A4+PlAB0dHAACAgEA4uHjAOLj4wAA/wAAKSooABMTEgD+/v4A4+PlAB0dGwACAgIAAAAAAAAAAAAAAAAA7+7wAA0NDgAAAAAAAAAAAAAAAAAAAAAABQYDAQHHXjihAf////8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD8+/4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA+fn5AAIDAQAJCQgAAAAAAAAAAAAAAAAA/v//AN7t/ADw9/8ACwYBABIKAgAHBAEA+Pz/AO71/gD2+/8AEwsCAB8RAwACAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A7e3uAAAAAQATExEAAQEBAAAAAAAAAAAAAAAAAP39/QDn5+gAExMSAAkJCQAAAAAAAAAAAAAAAAAAAAAA7u3wAA4ODgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADz8/IAERIQAAAAAAAAAAAAAAAAAAAAAAD9/f4A6OjoAPr6+wAMDAsACQkJAAAA/wD29vcA9PT1AAAAAAAYGBcACgoJAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPj4+ADr6+0AGRkXAAQEBAAAAAAAAAAAAAAAAAD///8A7+/wAP39/QAUFBMAAQEBAAAAAAAAAAAAAAAAAO/v8QANDA0AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA9fb1AAoKCQAFBQQAAAAAAAAAAAAAAAAA/f39AOjo6gD4+PgACQkIAAwMDAADAwMA+vr6APPz9AD7+/sAEBAPABISEQABAQEAAAAAAAAAAADe0MwAAx8qAB8RCgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA9vb3AO7u7wAZGRcAAwMDAAAAAAAAAAAAAAAAAP///wDt7e4AAAABABMTEQABAQEAAAAAAAAAAAAAAAAA7+/wAA0MDgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADz9PIAEREQAAAAAAAAAAAAAAAAAAAAAAD8/PwA6OjqAPn5+QAKCgkACwsLAAMDAgD6+voA8vL0APz8/AASEhEAEBAPAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wDa0cwACx0sABsSCQAAAAAAAAAAAAAAAAAAAAAAAAAAAAD/+gDJvL0ACSQ1AC4hFAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPLy8gD19fcAFxcVAAICAgAAAAAAAAAAAAAAAAD+/v4A6enqAAsLCwAODg0AAAAAAAAAAAAAAAAAAAAAAO/u8AANDQ4AAAAAAAAAAAAAAAAAAAAAAAUGAwEB/////wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPz7/gAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD5+fkAAgMBAAkJCAAAAAAAAAAAAAAAAAAAAAAA/P3/AOTx/QDt9f4A/wAAAAAAAAAAAAAAAQEAABULAgAbDwMAAwIBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A7e3uAPf3+AARERAACgoJAP7+/gDy8vMA8/PzABUVFAAKCgoAAAAAAAAAAAAAAAAAAAAAAAAAAADu7fAADg4OAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPPz8gAREhAAAAAAAAAAAAAAAAAAAAAAAAAAAAD8/PwA6+vtAPb29gAAAAAAAAAAAAAAAAAEBAQAFBQTAAsLCgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPf39wDq6uwADQ0MAA4ODQACAgIA9/f4AO/v7wAHBwcAExMTAAICAQAAAAAAAAAAAAAAAAAAAAAA7+/xAA0MDQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD19vUACgoJAAUFBAAAAAAAAAAAAAAAAAAAAAAA/Pz8AOzs7QD19fYAAAAAAAAAAAAAAAAAAQEBABERDwAPDxAAAgIBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA9vb2AOrq7AAPDw4ADQ0MAAICAgD29vcA7+/wAAkJCAATExIAAQEBAAAAAAAAAAAAAAAAAAAAAADv7/AADQwOAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPP08gARERAAAAAAAAAAAAAAAAAAAAAAAAAAAAD7+/sA7OztAPb29wAAAAAAAAAAAAAAAAACAgIAEREQAA8PDgABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////APLy8gDx8fIADw8PAAwMDAAAAP8A9PT1APDw8QAQEA8ADw8OAAAAAAAAAAAAAAAAAAAAAAAAAAAA7+7wAA0NDgAAAAAAAAAAAAAAAAAAAAAABQYDAQH/////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/Pv+AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPn5+QACAwEACQkIAAAAAAAAAAAAAAAAAAAAAAAAAAAA////APj8AADz+f4A/P0AAAUDAAANBwIABwQAAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A/f39APHx8gD39/gAAgICAAwMCwAMDAsAAgICAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAO7t8AAODg4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA8/PyABESEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A+fn6APj4+AD///8ABgYFAAkJCQABAQEAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP7+/gD19fYA8/P0AP7+/gAICAcADw8PAAQEAwABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAADv7/EADQwNAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPX29QAKCgkABQUEAAAAAAAAAAAAAAAAAAAAAAAAAAAA////APr6+wD39/cA/v7+AAUFBAAJCQkAAwMDAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/v7+APT09QD09PUA/v7+AAkJCAAPDw4AAwMDAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAO/v8AANDA4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA8/TyABEREAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A+fn6APj4+AD///8ABAQEAAkJCAADAwMAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AP7+/gDz8/QA9fX2AAAAAAALCwoADQ0MAAICAgABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAADv7vAADQ0OAAAAAAAAAAAAAAAAAAAAAAAFBgMBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQEACQUAAAkFAwAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQAEBAQAExMSAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQAICAcACAgHAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAgICAA0NDAANDQwAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQEABwcGAAcHBgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACAgIADg4NAA4ODQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQAICAcACAgHAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQEAAwMDABAQDwAQEA8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADVMsRTAAAgAElEQVQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAECAQD///4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/f39AAMCAwAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQECAP7+/gAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAMCAwD+/v0AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAP///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP7+/gABAgIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAMEAPr6/AD+/v4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wD29vcABwcHAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAwQA+vr6AP///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/Pz8AAEBAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABgYGAPj4+QD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD7+/sAAgIDAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACAgMA+/v7AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A+fn5AAUEBQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAB/////wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPz7/gAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/Pz8APj59wAICAcAAgIDAAAA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8A+fn6AAICAwAHBgcAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wD39/YAAgMCAAYGBQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPv7/AD7+/wACwoLAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA+vv6APv7+gAHBwcAAgICAAAA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA+/v8APz7/AAKCgsAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wD29vUABAUEAAUFBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAPn5+gD//wAACQgJAAEBAQAAAAAAAAAAAAAAAAAAAAAABQYDAQH/////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/Pv+AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/v7+APv7+wD9/v0AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIBAgAFBQUAAgICAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wD8/fwA/Pv8AP8A/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAEAAwQDAAUEBQABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/f7+APv7+gD+/v4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAQAEBAQABAQEAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wD8/PwA/Pz8AP8A/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAEABQUFAAMDAwABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAFBgMBAf////8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD8+/4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAUGAwECAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Hình 4.66: Chạy Pipeline

Pipeline đã chạy thành công với thời gian 2m32s là :

A screenshot of a test

Description automatically generated

Hình 4.67: Pipeline chạy thành công

Ứng dụng đã triển khai thành công trên Kubernetes Cluster

A screenshot of a computer

Description automatically generated

Hình 4.68: Ứng dụng triển khai thành công

\*Demo tất cả các mô hình: <https://drive.google.com/drive/folders/1d0yS4kGXboDv3qP1NOGOAuqJbGawpWad?usp=sharing>

# KẾT LUẬN

## Đánh giá hiệu năng các mô hình CI/CD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Thời gian cập nhập** | **Thời gian deploy** | **Cấu hình yêu cầu** | **Giá** |
| **Github Actions** | 5 phút 21 giây | 2 phút 10 giây | Không yêu cầu cấu hình nếu dùng Runner của Github Actions | Miễn phí với Public Repository |
| **GitLab CI/CD** | 2 phút 32 giây | | 7 core CPU, 12 GB RAM, 86GB Disk Space | Miễn phí |
| **Azure DevOps** | 3 phút 35 giây | 1 phút 39 giây | 2 core CPU, 7GB RAM, 14GB Disk Space | 5 người dùng đầu miễn phí  6$/tháng/người |
| **Jenkins (Github)** | 3 phút 59 giây | | 7 core CPU, 14GB RAM, 115GB Disk Space | Miễn phí |
| **Jenkins (GitServer)** | 6 phút 4 giây | | 8 core CPU, 16GB RAM, 131GB Disk Space | Miễn phí |

Bảng 5.1: Bảng so sánh và đánh giá các mô hình CI/CD đã thực hiện

\*Azure AKS sử dụng VM Size DS2v2 với cấu hình 2 core CPUs, 7GB RAM, 14GB Disk Space có giá 106.58$/tháng

AWS EC2 (Agent/Runner cho Azure DevOps) sử dụng instance type t2.medium, 30GB Storage có giá 1.53$/tháng

## Khó khăn gặp phải & hạn chế

* Chi phí sử dụng Cloud cần phải cân nhắc.
* Chưa thể triển khai Kubernetes Cluster trên Git Server.

## Hướng phát triển

* Triển khai trên nhiều Cloud Provider khác.
* Tích hợp thêm nhiều công cụ IaC như Ansible, Terraform...
* Tích hợp thêm nhiều công cụ Monitoring như Grafana, Prometheus, RabbitMQ...
* Triển khai Nginx để làm map domain và tạo Ingress, Reverse Proxy...
* Triển khai trên source code phức tạp khác.
* Tìm hiểu và triển khai các công cụ bảo mật, ngăn chặn lỗ hỏng như OWASP ZAP, Snyk...
* Hướng đến khóa luận tốt nghiệp với đề tài liên quan đến DevSecOps.

TÀI LIỆU THAM KHẢO

* <https://docs.gitlab.com>
* <https://www.jenkins.io/doc/book>
* <https://docs.sonarsource.com/sonarqube/latest/>
* <https://github.com/devopsproin/certified-kubernetes-administrator/tree/main/cluster%20Setup>
* <https://www.youtube.com/watch?v=jp83Gbn4Wq8&t=602s>
* <https://docs.github.com/en/actions>
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* <https://learn.microsoft.com/en-us/azure/devops/?view=azure-devops>
* <https://www.youtube.com/watch?v=AYUaIiWZ-_w&t=1210s>