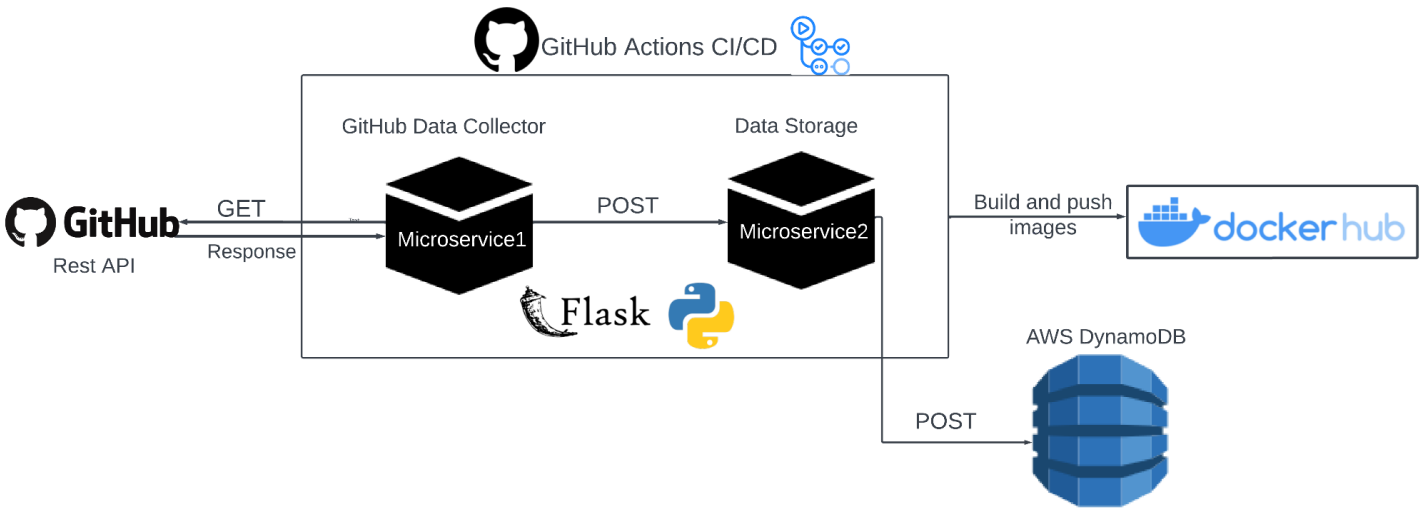
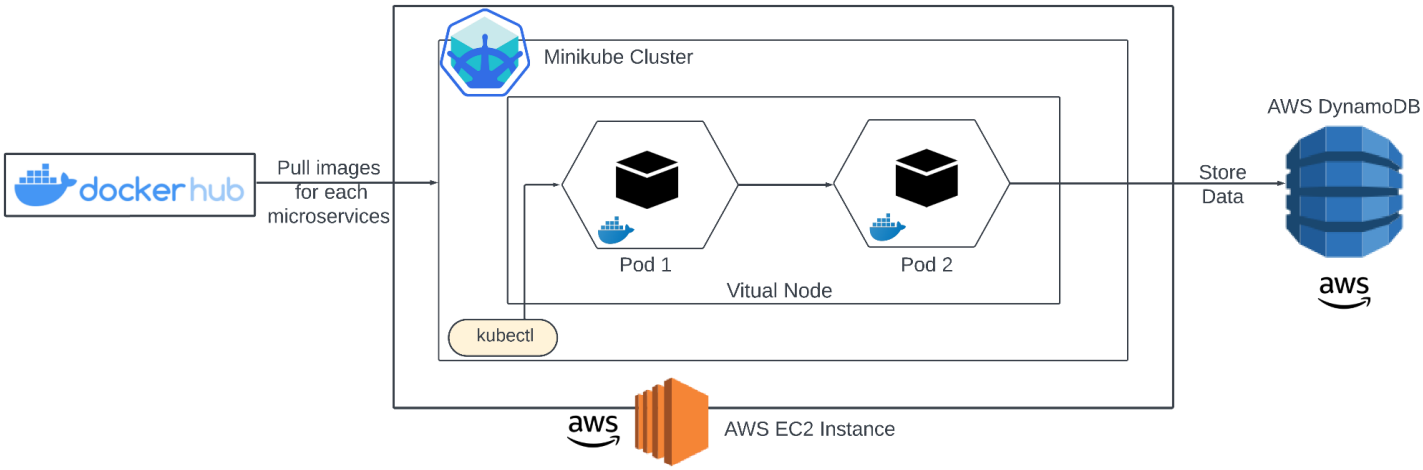
# Implementation of DeveloperIQ Tracking App for Developers.

## 1.1 Solution Architecture Diagram




- Developed 2 microservices such as GitHub_Data_Collector Microservice, and Data_Storage microservice using Python.
- Used Python Flask as the web framework.
- GitHub_Data_Collector microservice is using GitHub Rest API to get data.
- Created "Developer-Tracking-Data" DynamoDB table. Developer_Username is the partition key as it is unique.

## 1.2 Deployment Architectural Diagram




- Refer to 2 images for each of the microservices from Docker Hub and create separate pods for each microservice in the Minikube cluster.

- Replicas are mentioned respectively for each microservice in the deployment YAML files.
- Both github_data_collector microservice and data_storage have 2 replicas. The DeveloperIQ services will run periodically only when triggered.

## 2. Security and Ethic Challenges Faced during Cloud Implementation - DeveloperIQ

Security Challenges:

- Storing and transmitting data
  - DOCKER_USERNAME, DOCKER_PASSWORD, AWS_ACCESS_KEY_ID, and AWS_SECRET_ACCESS_KEY are stored in GitHub secrets.
  - Credentials of that IAM role such as AWS_ACCESS_KEY_ID, AWS_SECRET_ACCESS_KEY, and AWS_REGION are stored in GitHub secrets
- Access Control
  - Created an IAM role with full read-write access to AWS DynamoDB to access the DynamoDB table.

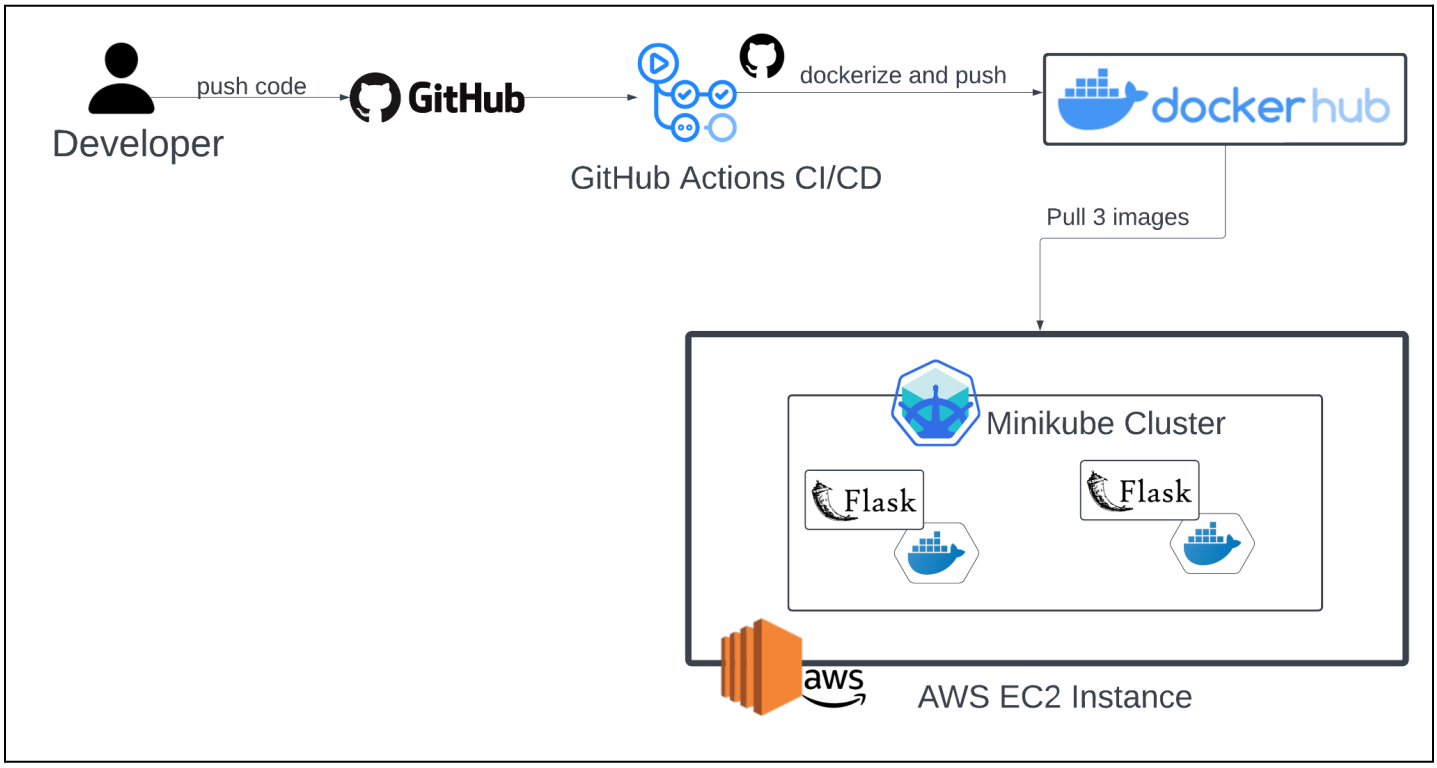
Ethical Challenges :

- Bias in testing
  - Without using the same repo for development and testing using some other GitHub public repository.
- Transparency and Accountability:
  - Maintain clear documentation, communicate openly about testing procedures, and establish accountability for the development, testing, and deployment phases.

```
env:
  aws_access_key_id: ${{ secrets.AWS_ACCESS_KEY_ID }}
  aws_secret_access_key: ${{ secrets.AWS_SECRET_ACCESS_KEY }}
```

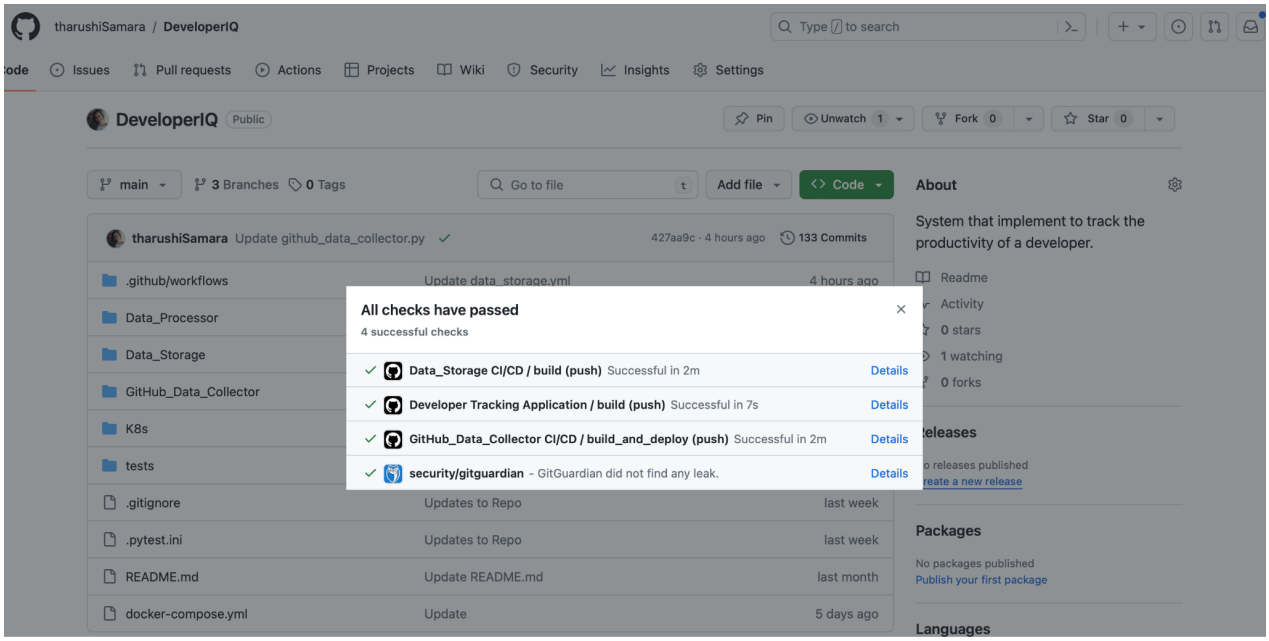
3. Implementation of CI/CD Pipeline using GitHub Actions

❖ Design Diagram




❖ Process Descriptions

- After every push the CI/CD pipelines will automatically start and files in .github/workflow scrips.
- CI/CD pipelines will run for each microservice.



4. CI/CD Scrips

❖ github_data_collector.yml

```yaml
name: GitHub_Data_Collector CI/CD

on:
  push:
    branches: [ "main" ]
  pull_request:
    branches: [ "main" ]

jobs:
  build_and_deploy:
    runs-on: ubuntu-latest

    steps:
    - name: Checkout repository
      uses: actions/checkout@v2

    - name: Set up Docker Buildx
      uses: docker/setup-buildx-action@v1

    - name: Log in to Docker Hub
      uses: docker/login-action@v1
      with:
        username: ${{ secrets.DOCKER_USERNAME }}
        password: ${{ secrets.DOCKER_PASSWORD }}

    - name: Build and push Docker image
      run: |
        docker buildx build -t tharushisamara/github-data-collector:latest --file
./GitHub_Data_Collector/Dockerfile --platform linux/amd64,linux/arm64 --push .

    - name: Connect with EC2
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          docker pull tharushisamara/github-data-collector:latest
```

```yaml
    - name: Copy deployemnt file to EC2
      uses: appleboy/scp-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        source: "./K8s/github_data_collector_deployment.yml"
        target: "/home/${{ secrets.EC2_USERNAME }}/"

    - name: Delete Kubernetes Service if exists
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          kubectl delete -f ./K8s/github_data_collector_deployment.yml || true

          kubectl wait --for=delete service/github-data-collector --timeout=300s
--ignore-not-found || echo "Service not found or deletion completed"


    - name: Deploy to Minikube
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          kubectl apply -f ./K8s/github_data_collector_deployment.yml
          kubectl get pods

          kubectl wait --for=condition=available --timeout=150s
deployment/github-data-collector
      # run: |
      #     whoami
        # kubectl apply -f ./K8s/github_data_collector_deployment.yml
        # kubectl wait --for=condition=available --timeout=150s
deployment/github-data-collector
```

```yaml
    - name: Getting Minikube IP
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          minikube ip
          kubectl get service github-data-collector-service
-o=jsonpath='{.spec.ports[0].nodePort}'

    - name: Delete Kubernetes Service if exists
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          kubectl delete service github-data-collector --ignore-not-found

    - name: Expose deployment
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          kubectl get pods
          kubectl expose deployment github-data-collector --type=LoadBalancer
--port=8080

    - name: Expose Minikube service externally (for demo purposes)
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          minikube service github-data-collector-service --url
          kubectl get svc
```

❖ Data_storage.yml

```yaml
name: Data_Storage CI/CD

on:
    push:
      branches: [ "main" ]
    pull_request:
      branches: [ "main" ]
env:
  aws_access_key_id: ${{ secrets.AWS_ACCESS_KEY_ID }}
  aws_secret_access_key: ${{ secrets.AWS_SECRET_ACCESS_KEY }}

jobs:
  build:
    runs-on: ubuntu-latest

    steps:
    - name: Checkout repository
      uses: actions/checkout@v2

    - name: Set up Docker Buildx
      uses: docker/setup-buildx-action@v1

    - name: Set up Docker CLI
      uses: docker/login-action@v1
      with:
        username: ${{ secrets.DOCKER_USERNAME }}
        password: ${{ secrets.DOCKER_PASSWORD }}

    - name: Build and push Docker image
      run: |
        docker buildx build -t tharushisamara/data-storage:latest --file
./Data_Storage/Dockerfile --platform linux/amd64,linux/arm64 --push .

    - name: Deploy to Minikube on EC2
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
```

```
          docker pull tharushisamara/data-storage:latest

    - name: Copy deployemnt file to EC2
      uses: appleboy/scp-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        source: "./K8s/data_storage_deployment.yml"
        target: "/home/${{ secrets.EC2_USERNAME }}/"

    - name: Set Environment Variables on EC2
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
            echo "export aws_access_key_id=${{ secrets.AWS_ACCESS_KEY_ID }}" >>
~/.bashrc
            echo "export aws_secret_access_key=${{ secrets.AWS_SECRET_ACCESS_KEY }}" >>
~/.bashrc
            source ~/.bashrc

    - name: Deploy to Minikube
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          kubectl apply -f ./K8s/data_storage_deployment.yml
          kubectl get pods

          kubectl wait --for=condition=available --timeout=150s deployment/data-storage

    - name: Getting Minikube IP
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
```

```
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          minikube ip
          kubectl get service data-storage-service
-o=jsonpath='{.spec.ports[0].nodePort}'

    - name: Check if Service Exists
      id: check_service
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          SERVICE_NAME="data-storage-service"
          NAMESPACE="default"
          if kubectl get service "$SERVICE_NAME" -n "$NAMESPACE" &> /dev/null; then
            echo "::set-output name=service_exists::true"
          else
            echo "::set-output name=service_exists::false"
          fi

    - name: Expose deployment
      if: steps.check_service.outputs.service_exists == 'false'
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          kubectl get pods
          kubectl expose deployment data-storage --type=LoadBalancer --port=8081

    - name: Expose Minikube service externally (for demo purposes)
      uses: appleboy/ssh-action@master
      with:
        host: ${{ secrets.EC2_HOST }}
        username: ${{ secrets.EC2_USERNAME }}
        key: ${{ secrets.EC2_SSH_KEY }}
        script: |
          minikube service data-storage --url
```

```
kubectl get svc
```

- Deployment and service scripts
  - github_data_collector.yml

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: github-data-collector
spec:
  replicas: 2
  selector:
    matchLabels:
      app: github-data-collector
  template:
    metadata:
      labels:
        app: github-data-collector
    spec:
      containers:
      - name: github-data-collector
        image: tharushisamara/github-data-collector:latest
        imagePullPolicy: Always
        envFrom:
        - configMapRef:
            name: github-config
        ports:
        - containerPort: 8080
---
apiVersion: v1
kind: Service
metadata:
  name: github-data-collector-service
spec:
  selector:
    app: github-data-collector
  ports:
    - protocol: "TCP"
      port: 8080
      targetPort: 8080
  type: LoadBalancer
```

❖ data_storage_deployment.yml

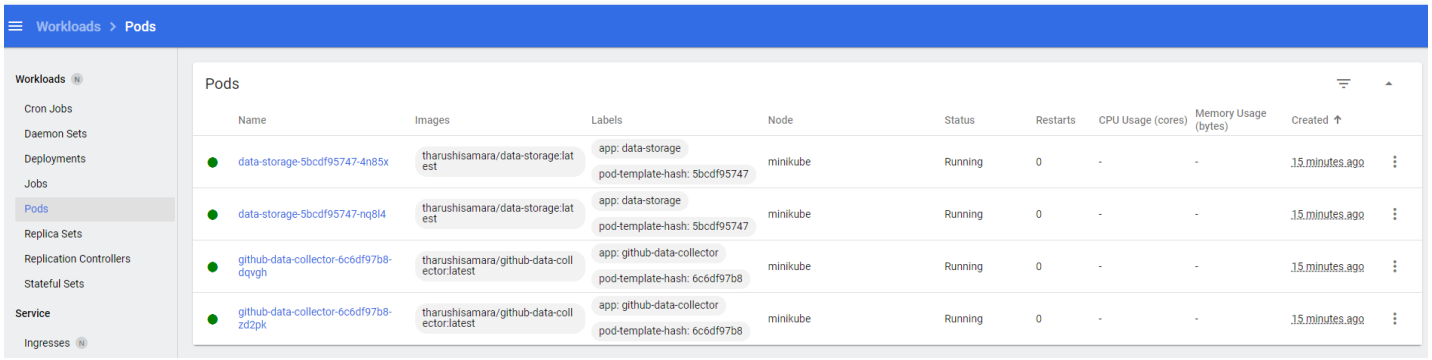
```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: data-storage
spec:
  replicas: 2
  selector:
    matchLabels:
      app: data-storage
  template:
    metadata:
      labels:
        app: data-storage
    spec:
      containers:
      - name: data-storage
        image: tharushisamara/data-storage:latest
        imagePullPolicy: Always
        envFrom:
        - configMapRef:
            name: dynamo-config
        ports:
        - containerPort: 8081
---
apiVersion: v1
kind: Service
metadata:
  name: data-storage-service
spec:
  selector:
    app: data-storage
  ports:
    - protocol: "TCP"
      port: 8081
      targetPort: 8081
  type: LoadBalancer
```

# 5. Observability Cluster

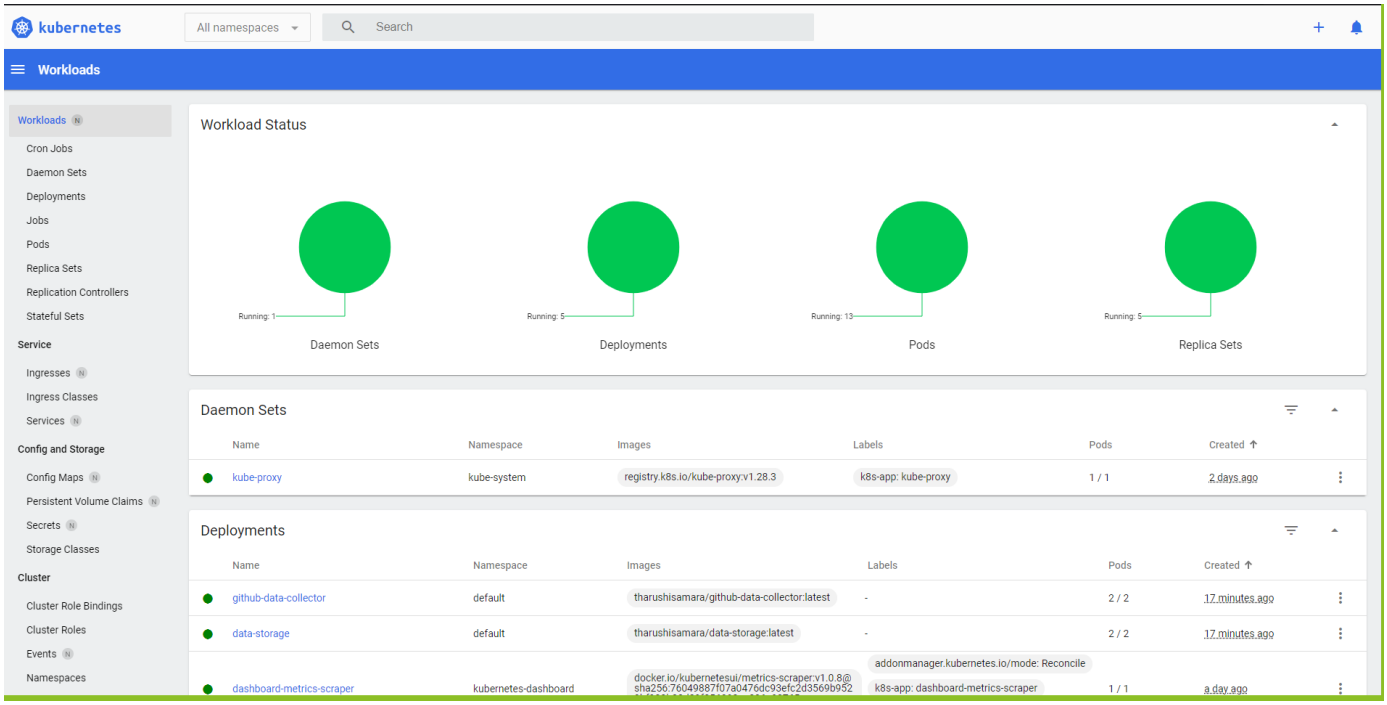
- ❖ Tunneling

```
ssh -i node-js.pem -L 6565:10.105.112.250:8081 ec2-user@13.234.239.76
```

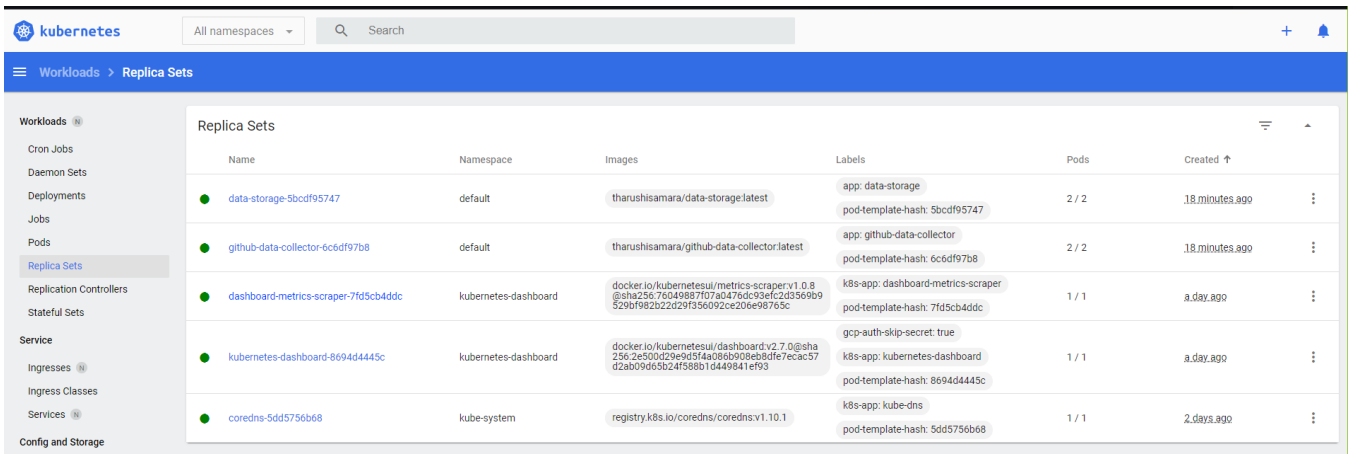
- ❖ Using Minikube Dashboard



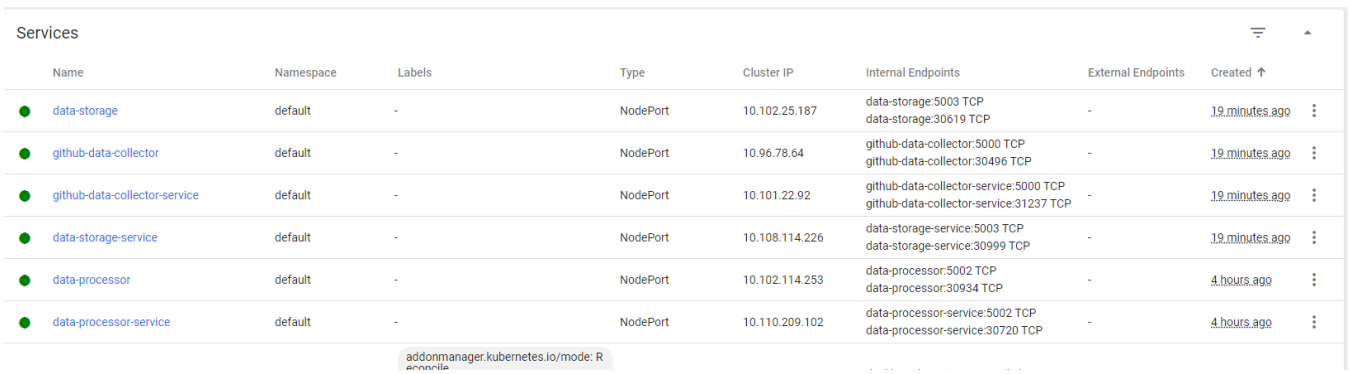

- ❖ Demon Sets - Deployments - Pods - Replica Sets




- ❖ Replica Sets



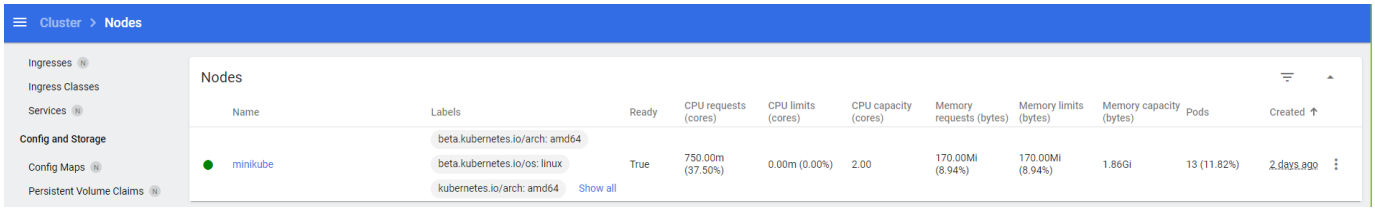

## ❖ Services



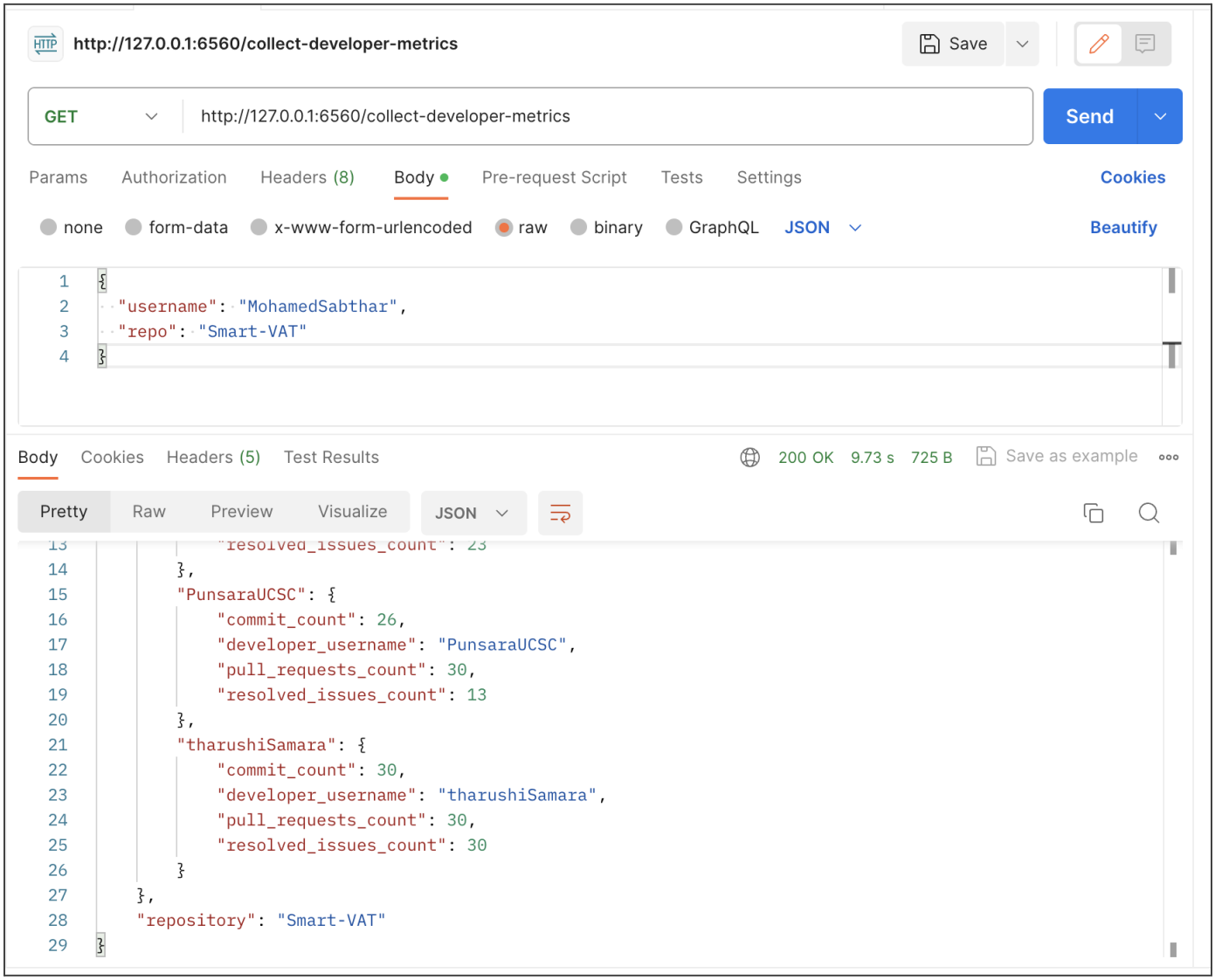

## ❖ Running Pods with the respective replicas of each Pod

```
[ec2-user@ip-172-31-33-151 ~]$ kubectl get pods
NAME                                  READY   STATUS    RESTARTS   AGE
data-storage-5bcdf95747-4n85x         1/1     Running   0          3m19s
data-storage-5bcdf95747-nq814         1/1     Running   0          3m19s
github-data-collector-6c6df97b8-dqvgh   1/1     Running   0          3m19s
github-data-collector-6c6df97b8-zd2pk   1/1     Running   0          3m19s
[ec2-user@ip-172-31-33-151 ~]$ minikube dashboard
🔌  Verifying dashboard health ...
🚀  Launching proxy ...
🔌  Verifying proxy health ...
🤔  Opening http://127.0.0.1:36157/api/v1/namespaces/kubernetes-dashboard/services/http:kubernetes-dashboard:/proxy/ in your default browser...
👉  http://127.0.0.1:36157/api/v1/namespaces/kubernetes-dashboard/services/http:kubernetes-dashboard:/proxy/
^?^C
[ec2-user@ip-172-31-33-151 ~]$ kubectl get deployments
NAME                   READY   UP-TO-DATE   AVAILABLE   AGE
data-storage           2/2     2            2           22m
github-data-collector  2/2     2            2           22m
[ec2-user@ip-172-31-33-151 ~]$
```

## ❖ Running Nodes



❖ API requests visibility using Postman



❖ Storing in AWS DynamoDB table - Developer-Tracking-Data

DynamoDB > Explore items: Developer-Tracking-Data > Edit item

# Edit item

You can add, remove, or edit the attributes of an item. You can nest attributes inside other attributes up to 32 levels deep. Learn

**Attributes** View DynamoDB JSON


```
1  {
2    "developer_username": {
3      "S": "Smart-VAT-developer_metrics_2023-12-11 07:51:49.571763"
4    },
5    "varibles": {
6      "M": {
7        "ImalshaRathnaweera": {
8          "M": {
9            "developer_username": {
10             "S": "ImalshaRathnaweera"
11           },
12           "commit_count": {
13             "N": "30"
14           },
15           "pull_requests_count": {
16             "N": "30"
17           },
18           "resolved_issues_count": {
19             "N": "30"
20           }
21         }
22       },
23       "MohamedSabthar": {
24         "M": {
```


JSON Ln 1, Col 1 Errors: 0 Warnings: 0

❖ In every run, the data is stored with the current date on the DynamoDB table

**Items returned** (16)

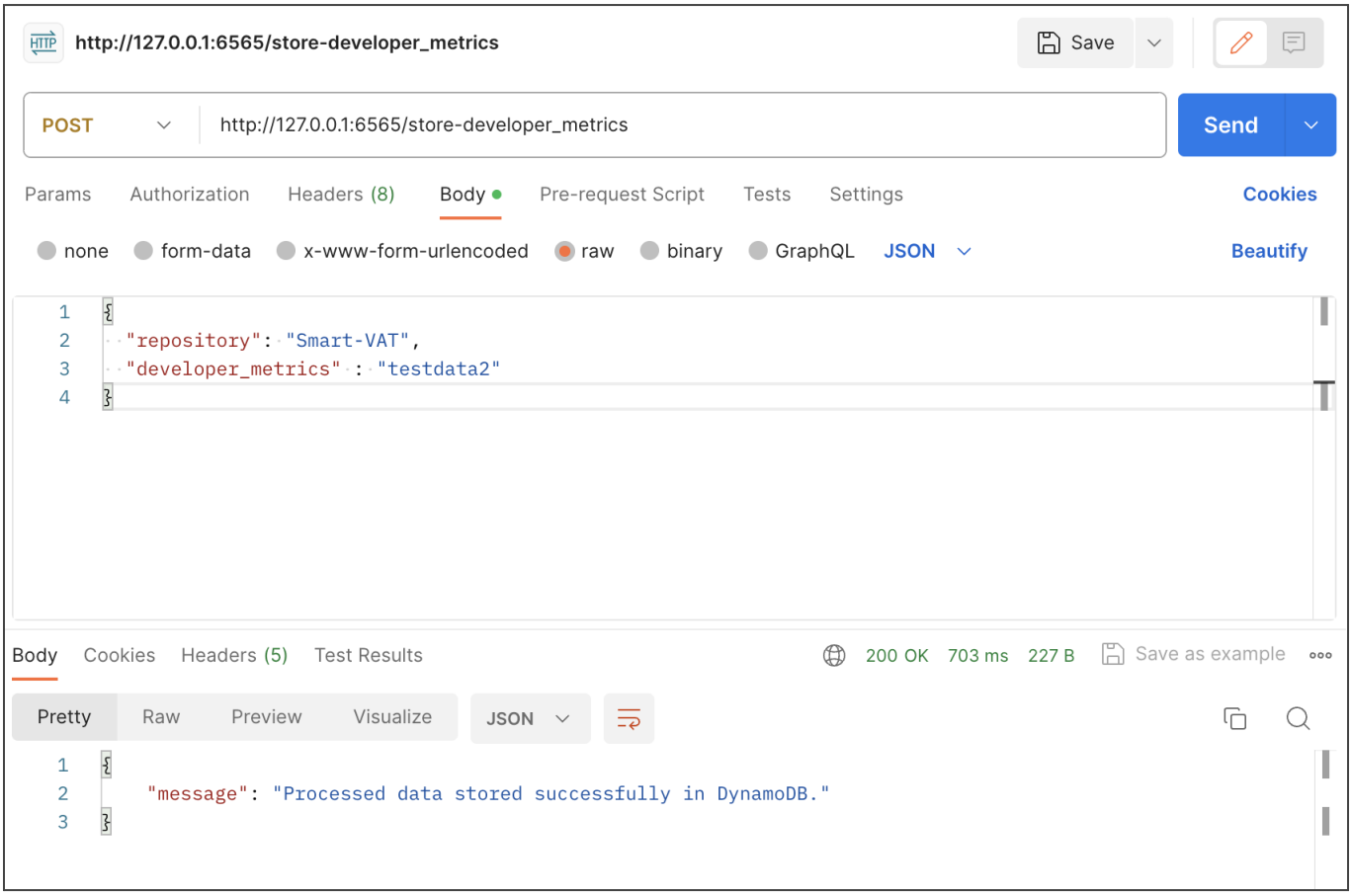
Actions ▼ | Create item

1

| developer_username *(String)* | varibles |
|---|---|
| Smart-VAT-developer_metrics_2023-12-11 07:51:49.571763 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 03:53:58.071069 | testdata |
| Smart-VAT-processed-data_2023-12-08 04:52:30.787555 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 04:28:01.959037 | testdata2 |
| Smart-VAT-processed-data_2023-12-07 16:10:45.152037 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 05:34:16.315201 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-processed-data_2023-12-07 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 09:05:13.092042 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 08:12:09.016096 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-processed-data | { "MohamedSabthar" : { "M" : { "commit_... |
| test | |
| Smart-VAT-processed-data_2023-12-08 05:02:01.045552 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-processed-data_2023-12-07 16:55:13.931992 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 04:56:29.830921 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-processed-data_2023-12-07 16:13:30.815228 | { "MohamedSabthar" : { "M" : { "commit_... |
| Smart-VAT-developer_metrics_2023-12-11 04:35:14.885591 | testdata2 |

6. Testing

Testing the data-storage microservice which is connected to the initial microservice This is tested via Postman to show that the 2nd microservice is working



# Deploying DeveloperIQ App to Kubernetes(Minikube) on AWS EC2

DeveloperIQ App Overview

DeveloperIQ App is designed using 2 microservices such as GitHub_Data_Collector and Data_Storage and developed using Python Flask.

## Pre-requisites:

- GitHub Repository Setup:
  - Ensure your microservices code is hosted on a GitHub repository.
  - Set up GitHub Actions workflows for CI/CD (eg: github_data_collector.yml and data_store.yml).
- Create Docker Hub Account:
  - Build Docker images for your microservices and push them to a container registry (e.g., Docker Hub).
  - Need to create separate Dockerfiles for every microservice. Since this app contains relatively small microservices, use one repo and create separate folders for each microservice.
- Create an AWS Account:
  - Create a separate IAM user in addition to the root user which had DynamoDB access, and EC2 access.
  - Store AWS_ACCESS_KEY_ID and AWS_SECRET_ACCESS_KEY of the IAM role on GitHub Secrets

Below is the file structure:

```
DeveloperIQ/
|--.github/
|   |--workflows/
|   |   |--python-app.yml
|   |   |--github_data_collector.yml
|   |   |--data_storage.yml
|-- GitHub_Data_Collector/
|   |-- github_data_collector.py
|   |-- requirements.txt
|   |-- Dockerfile
|-- Data_Storage/
|   |-- data_storage.py
```

```
|   |-- requirements.txt
|   |-- Dockerfile
|--K8s/
|   |--github_data_collector_deployment.yml
|   |--data_storage_deployment.yml
|-- docker-compose.yml
```

Deployment Steps:

- AWS EC2:
  - Launch AWS EC2 instances while having at least minimum requirements
    - 2 CPUs or more
    - 2GB of free memory (t3 small)
    - 20GB of free disk space
  - Store EC2 information such as `EC2_HOST, EC2_SSH_KEY, EC2_USERNAME` on GitHub Secrets
  - Connect with the EC2 instance

```
ssh -i <PEM file> ec2-user@<Public_IP>
```

  - Install minikube

```
curl -LO
https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd
64
sudo install minikube-linux-amd64 /usr/local/bin/minikube
```

  - Install Docker

```
sudo yum install docker
sudo usermod -aG docker ec2-user
sudo service docker start
```

```
minikube start --driver=docker
```

- Install kubectl

```
curl -LO "https://dl.k8s.io/release/$(curl -L -s
https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl"

sudo mv kubectl /usr/local/bin/

sudo chmod 755 /usr/local/bin/kubectl
```

- Test the kubectl installation

```
kubectl get namespaces
kubectl get pods -n kube-system
```

- Configure security groups to allow necessary traffic.
- Create a DynamoDB table
  - Store all the credentials such as `DYNAMODB_REGION` on GitHub secrets.
- Update Code on GitHub:
  - Make changes to your microservices code and push it to the GitHub repository.
- GitHub Actions CI/CD:
  - GitHub Actions will trigger automatically upon code push.
  - CI workflow should include steps for building and testing microservices. Refer to the GitHub repository here. The steps for each deployment are under **.github/workflows**
  - CD workflow should include steps for building Docker images and pushing them to the container registry.

Note: The below docker image building pushing it to Docker Hub and Deploy microservices to conduct the CI/CD pipeline. The below commands need to be run inside the workflow files separately for each microservice.

- Build and Push Docker Images to Minikube:
  - Build Docker images locally using Minikube's Docker daemon:

```
docker build -t <your-image-name>:<tag> .
```

  - Tag the image for minikube

```
docker tag <your-image-name>:<tag
$(minikubeip):5000/<your-image-name>:<tag>
```

- ➢ Push the image to Minikube's registry:

```
docker push $(minikube ip):5000/<your-image-name>:<tag>
```

- ❖ Deploy microservices to Minikube

```
kubectl apply -f path/to/deployment.yaml
kubectl apply -f path/to/service.yaml
```

- ❖ Prepare Kubernetes Manifests:
  - ➢ Create Kubernetes manifest files for your microservices (e.g., github_data_collector_deployment.yml, data_collector_deployment.yml).
  - ➢ Note:- These _deployments.yml files can be created separately as deployment.yml and services.yml
  - ➢ Customize these files with appropriate configurations.

To verify the deployments need to connect to the EC2 instance locally. Type the below command in cmd/PowerShell.

```
ssh -i <EC2 secret key file>.pem ec2-user@<EC2 host ID>
```

- ❖ Verify Deployments:

```
kubectl get pods
kubectl get svc
```

- ❖ Tunneling to generate External IP for each service

```
ssh -i node-js.pem -L <local random port>:<External IP>:<port given
to service> ec2-user@13.234.239.76
```

Example: ssh -i node-js.pem -L 6560:10.102.190.88:8080 ec2-user@13.234.239.76

- Generating Observability cluster
  - For this case use Minikube Dashboard as the observer.

```
minikube dashboard
```

  - Create a tunnel using ssh as above

  - Open the URL in a browser that uses the Minikube dashboard.