National College of Ireland

ConfigurationManual

MScResearchProject
MScCloud Computing

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Project Submission Sheet School of Computing

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Programme:	Cloud Computing
Year:	2024
Module:	MSc Research Project
Supervisor:	Prof. Shaguna Gupta
Submission Due Date:	12/12/2023
Project Title:	Configuration Manual
Word Count:	710
Page Count:	10

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Configuration Manual

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INTRODUCTION

This configuration manual provides in-depth, step-by-step instructions for installing, configuring, and deploying all of the software, tools, and files that are necessary for the implementation of the proposed system.

PREREQUISITES

- **Programming**: Python, Flask
- **Containerization**: Docker
- **Cloud Services**: Azure ACR, AKS, AWS, ECR, EKS
- **Tools**: VS Code, Locust, Kubernetes (kubectl)

WORKFLOW

1. **Application Development**:
    - Implement a Flask web application with endpoints for:
        - **Home page** (/): Serves the main web interface.
        - **Start CPU Load** (/start-load): Initiates CPU stress testing with optional duration and core configuration.
        - **Stop CPU Load** (/stop-load): Stops ongoing stress testing.
        - **Status** (/status): Checks if CPU stress testing is running.
    - Use threading and multiprocessing for parallel stress simulation across all CPU cores.
2. **Containerization**:

- Create a Dockerfile to package the Flask application into a container image.
  - Include necessary dependencies, Python environment, and application files.
  - Expose the application on port 5000.
- Build and test the Docker image locally.

3. **Azure Deployment**:
   - **Azure Container Registry (ACR)**:
     - Push the Docker image to ACR for centralized image management.
   - **Azure Kubernetes Service (AKS)**:
     - Deploy the application to an AKS cluster.

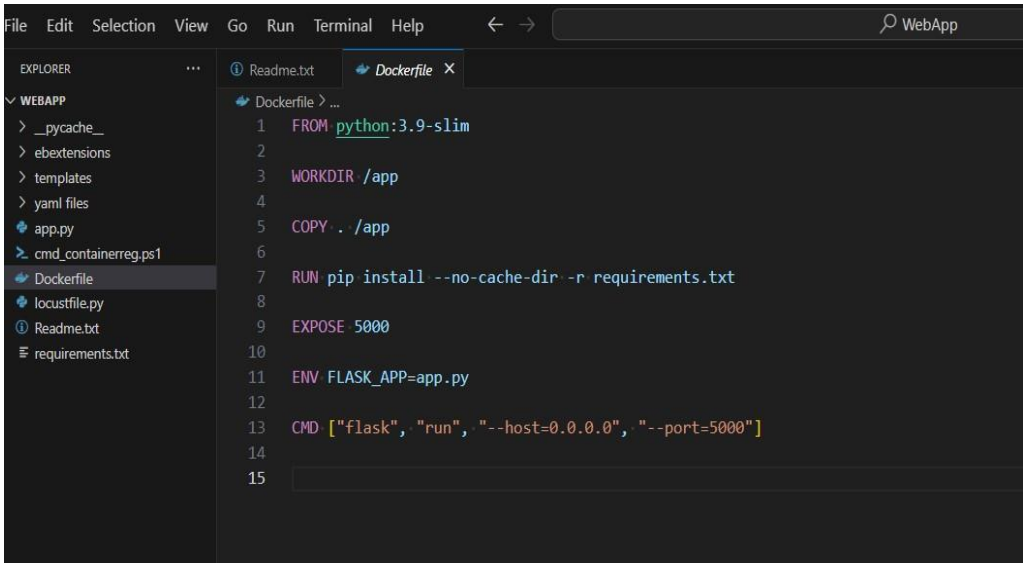
4. **AWS Deployment**:
   - **Elastic Container Registry (ECR)**:
     - Push the Docker image to ECR for centralized image management.
   - **Elastic Kubernetes Service (EKS)**:
     - Deploy the application to an EKS cluster.

5. **Locust**:
   - Load Test

IMPLEMENTATION

CONTAINERIZATION

Dockerfile:



Docker Build Commands:

Build Docker Image:

docker build -t cpuloadgenflask .

Run Docker Locally: docker run -p

5000:5000 -d cpuloadgenflask flask run

AZURE DEPLOYMENT

Azure Container Registry (ACR) Login

to ACR:

az acr login --name cpuloadgenacr

Push Docker Image: docker tag cpuloadgenflask

cpuloadgenacr.azurecr.io/cpuloadgenflask docker push

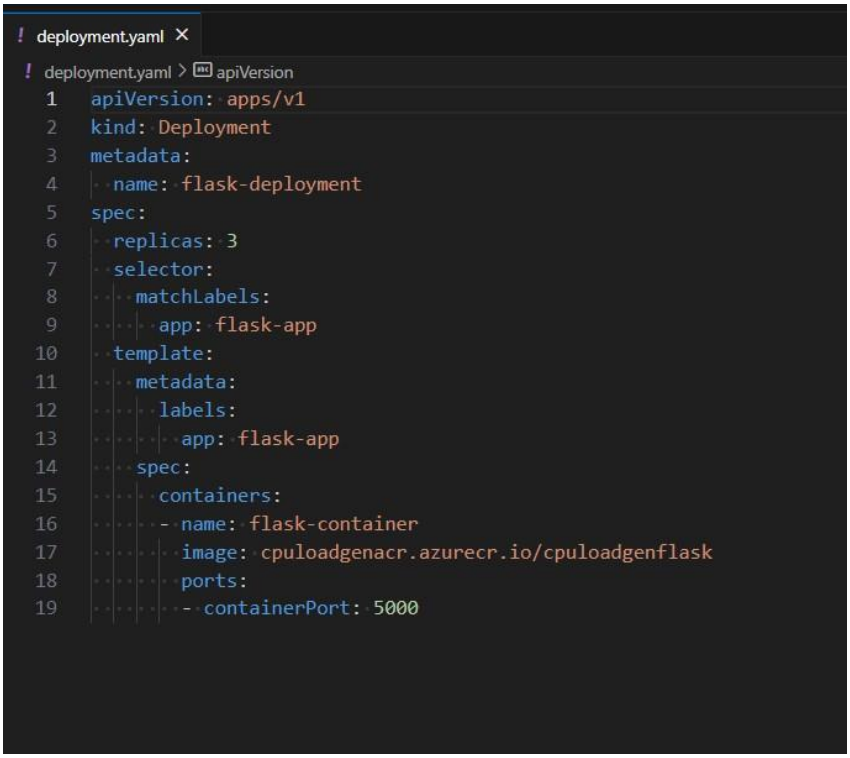
cpuloadgenacr.azurecr.io/cpuloadgenflask

Azure Kubernetes Service (AKS) Connect

to Cluster:

az aks get-credentials --resource-group cpuloadgenrg --name cpuloadgenaks --overwriteexisting

Deploy to AKS:



kubectl apply -f deployment.yaml

service.yaml

```yaml
apiVersion: v1
kind: Service
metadata:
  name: flask-service
spec:
  type: LoadBalancer
  ports:
  - port: 80
    targetPort: 5000
  selector:
    app: flask-app
```

kubectl apply -f service.yaml

kubectl get service flask-service

```
e
NAME            TYPE       CLUSTER-IP     EXTERNAL-IP   PORT(S)        AGE
flask-service   NodePort   10.100.237.2   <none>        80:30007/TCP   14d
```

AWS DEPLOYMENT

Elastic Container Registry (ECR) Login

to ECR:

aws ecr get-login-password --region eu-west-2 | docker login --username AWS --password-stdin 820242902892.dkr.ecr.eu-west-2.amazonaws.com

Push Docker Image:

docker tag cpuloadgenflask:latest 820242902892.dkr.ecr.eu-west-2.amazonaws.com/cpuloadgenecr:latest

docker push 820242902892.dkr.ecr.eu-west-2.amazonaws.com/cpuloadgenecr:latest

Elastic Kubernetes Service (EKS) Create

EKS Cluster:

eksctl create cluster --name cpuloadgeneks-cluster --version 1.31 --region eu-west-2 -nodegroup-name linux-nodes1 --node-type t3.medium --nodes 3 --nodes-min 1 --nodesmax 10 –managed

Connect to Cluster:

aws eks update-kubeconfig --name cpuloadgeneks-cluster

Deploy to EKS:

deployment.yaml

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: flask-deployment1
spec:
  replicas: 1
  selector:
    matchLabels:
      app: flask-app
  template:
    metadata:
      name: myapp-pod
      labels:
        app: flask-app
    spec:
      containers:
      - name: flask-container
        image: 820242902892.dkr.ecr.eu-west-2.amazonaws.com/cpuloadgenecr:latest
        ports:
        - containerPort: 5000
```

kubectl apply -f deployment.yaml --validate=false

service.yaml

```yaml
apiVersion: v1
kind: Service
metadata:
  name: flask-service1
spec:
  type: LoadBalancer
  ports:
  - port: 80
    targetPort: 5000
  selector:
    app: flask-app
```

kubectl apply -f service.yaml --validate=false

kubectl get service flask-service1

```
NAME           TYPE           CLUSTER-IP      EXTERNAL-IP                                                              PORT(S)        AGE
flask-service1 LoadBalancer   10.100.211.170  a14e82085a0ac4ba5af09fb49438ab86-1898328803.eu-west-2.elb.amazonaws.com   80:32015/TCP   6d6h
```

INSTALLATION OF MONITORING AND VISUALISATION TOOLS

Created a kubernetes service of Grafana and Prometheus using YAML file. GRAFANA

grafana_service1.yaml | grafana_deployment1.yaml

yaml files > grafana_deployment1.yaml > {} spec > {} template > {} spec > [ ] volumes > {} 0

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: grafana1
  namespace: default
  labels:
    app: grafana
spec:
  replicas: 1
  selector:
    matchLabels:
      app: grafana
  template:
    metadata:
      labels:
        app: grafana
    spec:
      containers:
        - name: grafana
          image: grafana/grafana:latest
          ports:
            - containerPort: 3000
          volumeMounts:
            - name: grafana-storage
              mountPath: /var/lib/grafana
      volumes:
        - name: grafana-storage
          emptyDir: {}
```

kubectl apply -f grafana_deployment1.yaml

grafana_service1.yaml grafana_deployment1.yaml

yaml files > grafana_service1.yaml > apiVersion

```yaml
apiVersion: v1
kind: Service
metadata:
  name: grafana1
  namespace: default
  labels:
    app: grafana
spec:
  selector:
    app: grafana
  ports:
    - protocol: TCP
      port: 80
      targetPort: 3000
  type: LoadBalancer

```

kubectl apply -f grafana_service1.yaml

kubectl get service grafana1

```
NAME       TYPE           CLUSTER-IP      EXTERNAL-IP                                                                PORT(S)        AGE
grafana1   LoadBalancer   10.100.26.196   a1cd4b035250a42d1a98cdd9ef46ebfe-1636237739.eu-west-2.elb.amazonaws.com     80:31949/TCP   6d5h
```

PROMETHEUS

prometheus_deployment1.yaml | prometheus_service1.yaml

yaml files > prometheus_deployment1.yaml > {} spec > {} template > {} spec > [ ] volumes > {} 1

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: prometheus
  namespace: default
  labels:
    app: prometheus
spec:
  replicas: 1
  selector:
    matchLabels:
      app: prometheus
  template:
    metadata:
      labels:
        app: prometheus
    spec:
      containers:
        - name: prometheus
          image: prom/prometheus:latest
          args:
            - "--config.file=/etc/prometheus/prometheus.yml"
            - "--storage.tsdb.path=/prometheus"
            - "--web.enable-lifecycle"
          ports:
            - containerPort: 9090
          volumeMounts:
            - name: prometheus-config-volume
              mountPath: /etc/prometheus
            - name: prometheus-data
              mountPath: /prometheus
      volumes:
        - name: prometheus-config-volume
          configMap:
            name: prometheus-config
        - name: prometheus-data
          emptyDir: {}
```

kubectl apply -f prometheus_deployment1.yaml

prometheus_deployment1.yaml | prometheus_service1.yaml

yaml files > prometheus_service1.yaml > apiVersion

```yaml
apiVersion: v1
kind: Service
metadata:
  name: prometheus
  namespace: default
  labels:
    app: prometheus
spec:
  selector:
    app: prometheus
  ports:
    - protocol: TCP
      port: 80
      targetPort: 9090
  type: LoadBalancer
```

kubectl apply -f prometheus_service1.yaml kubectl get service prometheus

```
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP                                                              PORT(S)        AGE
prometheus   LoadBalancer   10.100.180.139  a828207e0a9474c66872e35ba98d30e2-1355634064.eu-west-2.elb.amazonaws.com   80:31082/TCP   6d5h
```

GET ALL RUNNING SERVICE

kubectl get svc -n default

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
flask-service	NodePort	10.100.237.2	<none>	80:30007/TCP	15d
flask-service1	LoadBalancer	10.100.211.170	a14e82085a0ac4ba5af09fb49438ab86-1898328803.eu-west-2.elb.amazonaws.com	80:32015/TCP	6d6h
grafana	NodePort	10.100.62.97	<none>	80:32000/TCP	6d6h
grafana1	LoadBalancer	10.100.26.196	a1cd4b035250a42d1a98cdd9ef46ebfe-1636237739.eu-west-2.elb.amazonaws.com	80:31949/TCP	6d5h
kubernetes	ClusterIP	10.100.0.1	<none>	443/TCP	15d
prometheus	LoadBalancer	10.100.180.139	a828207e0a9474c66872e35ba98d30e2-1355634064.eu-west-2.elb.amazonaws.com	80:31082/TCP	6d5h

LINEAR MODEL FOR CPU RESOURCE SCHEDULING

```
def linear_cpu_prediction():
    #linear model for cpu prediction
    from sklearn.linear_model import LinearRegression
    from sklearn.metrics import mean_squared_error

    # Train the model
    model = LinearRegression()
    model.fit(X_train, y_train)

    # Evaluate the model
    y_pred = model.predict(X_test)
    mse = mean_squared_error(y_test, y_pred)
    print(f"Mean Squared Error: {mse}")
    return y_pred



def schedule_pod():
    def schedule_pod_resource():
        return linear_cpu_prediction()
    predicted_cpu, predicted_memory = schedule_pod_resource()

    print(f"Predicted CPU Usage: {predicted_cpu}m")
    print(f"Predicted Memory Usage: {predicted_memory}Mi")

    pod = client.V1Pod(
        metadata=client.V1ObjectMeta(name="novelty-pod"),
        spec=client.V1PodSpec(
            containers=[
                client.V1Container(
                    name="novelty-container",
                    image="nginx",
                    resources=client.V1ResourceRequirements(
                        requests={
                            "cpu": f"{predicted_cpu}m",
                            "memory": f"{predicted_memory}Mi"
```