

Deploying a Multi-Tier Web Application on Kubernetes

Prerequisites

Before starting, ensure you have the following installed:

- Kubernetes Cluster (Minikube/Kubeadm)
- Docker
- kubectl CLI

Folder Structure & File Usages

k8s-project/

```
|— mysql/          # MySQL Database Configuration
|  |— mysql-pv.yaml    # Persistent Volume for MySQL Data Storage
|  |— mysql-secret.yaml # Stores MySQL Root Password Securely
|  |— mysql-deployment.yaml # Deploys MySQL Database as a
StatefulSet
|— flask/          # Flask Backend Configuration
|  |— app.py          # Flask API Code to Handle Requests
|  |— Dockerfile      # Flask App Containerization Instructions
|  |— requirements.txt # Dependencies for Flask
|  |— flask-deployment.yaml # Deploys Flask Application
|  |— flask-service.yaml # Exposes Flask App as a Cluster Service
|— nginx/          # Nginx Configuration
|  |— nginx-configmap.yaml # Reverse Proxy Configuration for Flask
|  |— nginx-deployment.yaml # Deploys Nginx
|  |— nginx-service.yaml # Exposes Nginx via NodePort
```

Step-by-Step Deployment Guide

Step 1: Build and Push Docker Image

1.1 Navigate to the Flask directory

```
cd flask
```

1.2 Build the Docker image

`docker build -t dockerhub_username/flaskapp .`

```
master@master-vm:~/multi-tier-application/flask$ docker build -t kirthiksubbiah/flaskapp .
DEPRECATED: The legacy builder is deprecated and will be removed in a future release.
             Install the buildx component to build images with BuildKit:
             https://docs.docker.com/go/buildx/

Sending build context to Docker daemon  8.192kB
Step 1/6 : FROM python:3.8
--> 3ea6eaad4f17
Step 2/6 : WORKDIR /app
--> Using cache
--> 435bcd22c7d9
Step 3/6 : COPY app.py .
--> Using cache
--> bd37b9902a9d
Step 4/6 : COPY requirements.txt .
--> Using cache
--> d0e4d5d607cc
Step 5/6 : RUN pip install --no-cache-dir -r requirements.txt
--> Using cache
--> c5fc81f43e3f
Step 6/6 : CMD ["python", "app.py"]
--> Using cache
--> d6aa84b5beae
Successfully built d6aa84b5beae
Successfully tagged kirthiksubbiah/flaskapp:latest
```

1.3 Push the image to Docker Hub

`docker push dockerhub_username/flaskapp`

```
master@master-vm:~/multi-tier-application/flask$ docker push kirthiksubbiah/flaskapp
Using default tag: latest
The push refers to repository [docker.io/kirthiksubbiah/flaskapp]
8eb96175afb1: Pushed
4a27519a0380: Pushed
28aa611d3e8a: Pushed
4cad94de7904: Pushed
32ee710ca3c7: Pushed
1767e4d52b5a: Pushed
45b98afd69b3: Pushed
2bce433c3a29: Pushing [=====>] 208.9MB/587.5MB
f91dc7a486d9: Pushing [=====>] 181.9MB
2bce433c3a29: Pushed
f91dc7a486d9: Pushed
d50132f2fe78: Pushing [=====>] 99.07MB/116.5MB
8: Pushed
latest: digest: sha256:5b6439ab975872fff83b372d93c6a19ab65d1458c201564a505929b540383761 size: 2628
Active
Go to S
```

Step 2: Apply Kubernetes Configurations

2.1 Deploy Flask application

`kubectl apply -f flask-deployment.yaml`

`kubectl apply -f flask-service.yaml`

```

worker2-vm Ready <none> 2d23h v1.28.15
master@master-vm:~/multi-tier-application/flask$ kubectl get nodes
NAME STATUS ROLES AGE VERSION
master-vm Ready control-plane 2d23h v1.28.15
worker1-vm Ready <none> 2d23h v1.28.15
worker2-vm Ready <none> 2d23h v1.28.15
master@master-vm:~/multi-tier-application/flask$ kubectl apply -f flask-deployment.yaml
deployment.apps/flask-app created
master@master-vm:~/multi-tier-application/flask$ kubectl apply -f flask-service.yaml
service/flask-service created
master@master-vm:~/multi-tier-application/flask$ cd ../mysql
master@master-vm:~/multi-tier-application/mysql$ kubectl apply -f mysql-deployment.yaml
deployment.apps/mysql created
service/mysql created
master@master-vm:~/multi-tier-application/mysql$ kubectl apply -f mysql-pv.yaml
persistentvolume/mysql-pv created
persistentvolumeclaim/mysql-pvc created
master@master-vm:~/multi-tier-application/mysql$ cd ..

```

2.2 Deploy MySQL database

cd ../mysql

kubectl apply -f mysql-deployment.yaml

kubectl apply -f mysql-pv.yaml

kubectl apply -f mysql-secret.yaml

```

master@master-vm:~/multi-tier-application/mysql$ kubectl apply -f mysql-deployment.yaml
deployment.apps/mysql created
service/mysql created
master@master-vm:~/multi-tier-application/mysql$ kubectl apply -f mysql-secret.yaml
secret/mysql-secret created
master@master-vm:~/multi-tier-application/mysql$ kubectl apply -f mysql-pv.yaml
persistentvolume/mysql-pv unchanged
persistentvolumeclaim/mysql-pvc unchanged
master@master-vm:~/multi-tier-application/mysql$ nano mysql-deployment.yaml

```

2.3 Deploy Nginx

cd ../nginx

kubectl apply -f nginx-configmap.yaml

kubectl apply -f nginx-deployment.yaml

kubectl apply -f nginx-service.yaml

```

master@master-vm:~/multi-tier-application/nginx$ nano nginx-configmap.yaml
master@master-vm:~/multi-tier-application/nginx$ kubectl apply -f nginx-deployment.yaml
deployment.apps/nginx unchanged
master@master-vm:~/multi-tier-application/nginx$ kubectl apply -f nginx-service.yaml
service/nginx-service created
master@master-vm:~/multi-tier-application/nginx$ kubectl apply -f nginx-configmap.yaml
configmap/nginx-config created
master@master-vm:~/multi-tier-application/nginx$ 
master@master-vm:~/multi-tier-application/nginx$ cd ..

```

Step 5: Initialize MySQL Database

5.1 Access MySQL inside the Pod

kubectl exec -it mysql-0 -- mysql -u root -p

```
master@master-vm:~/multi-tier-application/nginx$ kubectl exec -it mysql-66d468f74c-b4wk9 -- mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 3
Server version: 5.7.44 MySQL Community Server (GPL)

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owners.
```

5.2 Create and populate the database

CREATE DATABASE mydb;

USE mydb;

CREATE TABLE users (
 id INT AUTO_INCREMENT PRIMARY KEY,
 name VARCHAR(100),
 email VARCHAR(100)
);

INSERT INTO users (name, email) VALUES ('Alice', 'alice@example.com');

INSERT INTO users (name, email) VALUES ('Bob', 'bob@example.com');

SELECT * FROM users;

GRANT ALL PRIVILEGES ON mydb.* TO 'user'@'%';

```
mysql> INSERT INTO users (name, email) VALUES ('kirthiksubbiah', 'kirthiksubbiah@gmail.com');
Query OK, 1 row affected (0.01 sec)

mysql> INSERT INTO users (name, email) VALUES ('kirthiksubbiahp', 'kirthiksubbiahp@gmail.com');
Query OK, 1 row affected (0.00 sec)

mysql> delete * from users where name=
```

FLUSH PRIVILEGES;

