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Assignment: Calculator Microservices on Kubernetes

1. Introduction

 we demonstrate the deployment of a calculator application split into five microservices (home, add, sub, mul, div), containerized using Docker, and orchestrated with Kubernetes on Minikube.

2. Prerequisites

- Docker Desktop (or Docker CLI)

- Minikube CLI

- kubectl

- (Optional) Apache Benchmark (ab) or PowerShell for stress testing

3. Steps

3.1 Build Docker Images

Run the following commands from the project root:

```
docker build -t calc-home:v1 ./home
docker build -t calc-add:v1  ./add
docker build -t calc-sub:v1  ./sub
docker build -t calc-mul:v1  ./mul
docker build -t calc-div:v1  ./div
```
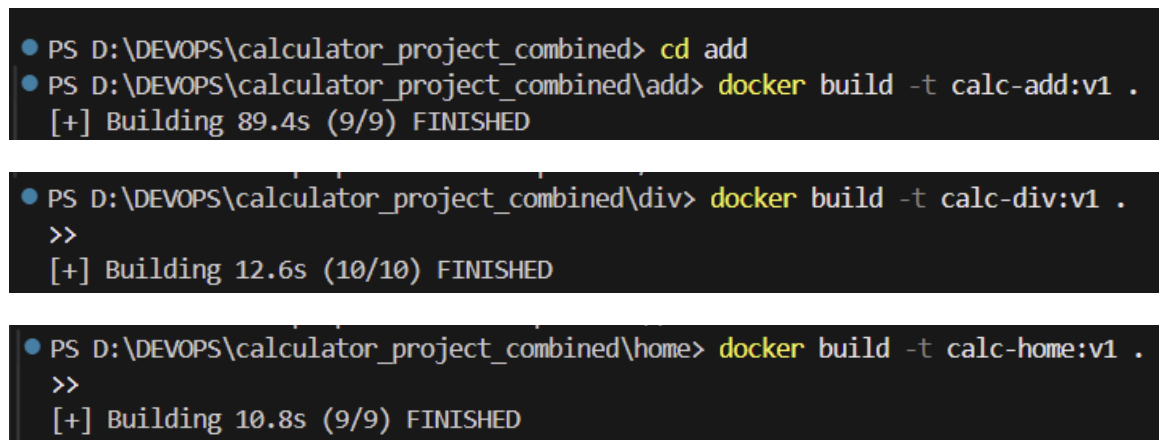
Screenshot:

```
PS D:\DEVOPS\calculator_project_combined> cd add
PS D:\DEVOPS\calculator_project_combined\add> docker build -t calc-add:v1 .
 [+] Building 89.4s (9/9) FINISHED
```

```
PS D:\DEVOPS\calculator_project_combined\div> docker build -t calc-div:v1 .
 >>
 [+] Building 12.6s (10/10) FINISHED
```

```
PS D:\DEVOPS\calculator_project_combined\home> docker build -t calc-home:v1 .
 >>
 [+] Building 10.8s (9/9) FINISHED
```

```
PS D:\DEVOPS\calculator_project_combined> cd mul
PS D:\DEVOPS\calculator_project_combined\mul> docker build -t calc-mul:v1 .
 [+] Building 19.3s (9/9) FINISHED
```

3.2 Deploy to Kubernetes

Apply all YAML files in the k8s directory:

```
kubectl apply -f k8s/
```

Screenshot:

```
deployment "home-deployment" successfully rolled out
PS D:\DEVOPS\calculator_project_combined> kubectl get pods -w
>>
NAME                                  READY   STATUS            RESTARTS   AGE
add-deployment-7db5fb9d5c-f9ms8       1/1     Running           0          115s
add-deployment-7db5fb9d5c-pzb6r       1/1     Running           0          116s
chatbot-7f6bbfb6fc-nhqhl              0/1     ImagePullBackOff  0          4d3h
chatbot-7fc667878b-7k57l              0/1     ImagePullBackOff  0          4d4h
chatbot-7fc667878b-sxjc5              0/1     ImagePullBackOff  0          4d4h
div-deployment-54c857d449-7qb8x       1/1     Running           0          80s
div-deployment-54c857d449-jhchr       1/1     Running           0          78s
home-deployment-6bc8fb9897-hggjl      1/1     Running           0          66s
home-deployment-6bc8fb9897-mr8jv      1/1     Running           0          67s
journal-logger-5864c94997-fxq56       0/1     ImagePullBackOff  0          4d3h
journal-logger-668bdbc967-gr2xx       0/1     ImagePullBackOff  0          4d4h
journal-logger-668bdbc967-kp8ds       0/1     ImagePullBackOff  0          4d4h
mood-checker-55cb87b6c-24zng          0/1     ImagePullBackOff  0          4d4h
mood-checker-55cb87b6c-vcz2w          0/1     ImagePullBackOff  0          4d4h
mood-checker-6bdc7f6786-twq2k         0/1     ImagePullBackOff  0          4d3h
mul-deployment-864cb74d78-f7z5m       1/1     Running           0          90s
mul-deployment-864cb74d78-rpg42       1/1     Running           0          92s
quote-generator-8474474684-mk9ml      0/1     ImagePullBackOff  0          4d4h
quote-generator-8474474684-vn86h      0/1     ImagePullBackOff  0          4d4h
quote-generator-9f6b66c49-xknwp       0/1     ImagePullBackOff  0          4d3h
resource-suggester-675fb5c775-pqz9d   0/1     ImagePullBackOff  0          4d4h
resource-suggester-675fb5c775-sm6pz   0/1     ImagePullBackOff  0          4d4h
resource-suggester-7567649556-6dxrh   0/1     ErrImagePull      0          4d3h
sub-deployment-6fb895d48b-5sctk       1/1     Running           0          103s
sub-deployment-6fb895d48b-qk8rp       1/1     Running           0          102s
resource-suggester-7567649556-6dxrh   0/1     ImagePullBackOff  0          4d3h
```

```
PS D:\DEVOPS\calculator_project_combined> kubectl get svc
NAME                       TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)         AGE
add-service                NodePort    10.106.128.133   <none>        80:30507/TCP    2m4s
chatbot-service            ClusterIP   10.101.202.229   <none>        80/TCP          4d3h
div-service                NodePort    10.104.113.147   <none>        80:31389/TCP    2m4s
home-service               NodePort    10.100.72.99     <none>        80:31075/TCP    2m4s
journal-logger-service     ClusterIP   10.107.30.115    <none>        80/TCP          4d3h
kubernetes                 ClusterIP   10.96.0.1        <none>        443/TCP         4d3h
mood-checker-service       ClusterIP   10.100.218.137   <none>        80/TCP          4d3h
mul-service                NodePort    10.108.3.14      <none>        80:31034/TCP    2m3s
quote-generator-service    ClusterIP   10.107.133.9     <none>        80/TCP          4d3h
sub-service                NodePort    10.99.50.245     <none>        80:32445/TCP    2m3s
```

3.3 Expose Services

Use minikube service to access each microservice:

```

minikube service add-service
minikube service sub-service
minikube service mul-service
minikube service div-service
minikube service home-service
```

Screenshot:

```
>> minikube service home-service
>>
|-----------|-------------|-------------|--------------------------|
| NAMESPACE |    NAME     | TARGET PORT |          URL             |
|-----------|-------------|-------------|--------------------------|
| default   | add-service |          80 | http://192.168.49.2:30507 |
|-----------|-------------|-------------|--------------------------|
*  Starting tunnel for service add-service.
|-----------|-------------|-------------|--------------------------|
| NAMESPACE |    NAME     | TARGET PORT |          URL             |
|-----------|-------------|-------------|--------------------------|
| default   | add-service |             | http://127.0.0.1:62202   |
|-----------|-------------|-------------|--------------------------|
   Opening service default/add-service in default browser...
!  Because you are using a Docker driver on windows, the terminal needs to be open to run it.
```
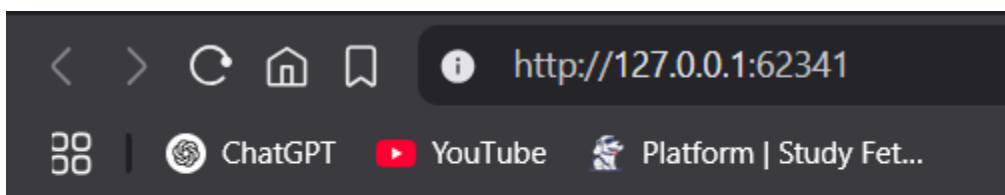
http://127.0.0.1:62341

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Welcome to the Calculator Microservices!

```
PS D:\DEVOPS\calculator_project_combined> minikube service sub-service
|-----------|-------------|-------------|--------------------------|
| NAMESPACE |    NAME     | TARGET PORT |            URL           |
|-----------|-------------|-------------|--------------------------|
|  default  | sub-service |          80 | http://192.168.49.2:32445 |
|-----------|-------------|-------------|--------------------------|
🏃 Starting tunnel for service sub-service.
|-----------|-------------|-------------|----------------------|
| NAMESPACE |    NAME     | TARGET PORT |          URL         |
|-----------|-------------|-------------|----------------------|
|  default  | sub-service |             | http://127.0.0.1:62243 |
|-----------|-------------|-------------|----------------------|
🎉 Opening service default/sub-service in default browser...
❗ Because you are using a Docker driver on windows, the terminal needs to be open to run it.
```

< > C ⌂ 🔖   ⓘ http://127.0.0.1:62243

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Pretty-print ☐

```
{"operation":"subtraction","result":0}
```

```
PS D:\DEVOPS\calculator_project_combined> minikube service mul-service
|-----------|-------------|-------------|--------------------------|
| NAMESPACE |    NAME     | TARGET PORT |            URL           |
|-----------|-------------|-------------|--------------------------|
|  default  | mul-service |          80 | http://192.168.49.2:31034 |
|-----------|-------------|-------------|--------------------------|
🏃 Starting tunnel for service mul-service.
|-----------|-------------|-------------|----------------------|
| NAMESPACE |    NAME     | TARGET PORT |          URL         |
|-----------|-------------|-------------|----------------------|
|  default  | mul-service |             | http://127.0.0.1:62272 |
|-----------|-------------|-------------|----------------------|
🎉 Opening service default/mul-service in default browser...
❗ Because you are using a Docker driver on windows, the terminal needs to be open to run it.
```

< > C ⌂ 🔖   ⓘ http://127.0.0.1:62272

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Pretty-print ☐

```
{"operation":"multiplication","result":0}
```

```
PS D:\DEVOPS\calculator_project_combined> minikube service div-service
|-----------|-------------|-------------|---------------------------|
| NAMESPACE |    NAME     | TARGET PORT |            URL            |
|-----------|-------------|-------------|---------------------------|
| default   | div-service |          80 | http://192.168.49.2:31389 |
|-----------|-------------|-------------|---------------------------|
🏃 Starting tunnel for service div-service.
|-----------|-------------|-------------|-----------------------|
| NAMESPACE |    NAME     | TARGET PORT |          URL          |
|-----------|-------------|-------------|-----------------------|
| default   | div-service |             | http://127.0.0.1:62316 |
|-----------|-------------|-------------|-----------------------|
🎉 Opening service default/div-service in default browser...
❗ Because you are using a Docker driver on windows, the terminal needs to be open to run it.
```

< > C ⌂ 🔖 ⓘ http://127.0.0.1:62316

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Pretty-print ☐

{"operation":"division","result":0.0}

```
PS D:\DEVOPS\calculator_project_combined> minikube service home-service
|-----------|--------------|-------------|---------------------------|
| NAMESPACE |     NAME     | TARGET PORT |            URL            |
|-----------|--------------|-------------|---------------------------|
| default   | home-service |          80 | http://192.168.49.2:31075 |
|-----------|--------------|-------------|---------------------------|
🏃 Starting tunnel for service home-service.
|-----------|--------------|-------------|-----------------------|
| NAMESPACE |     NAME     | TARGET PORT |          URL          |
|-----------|--------------|-------------|-----------------------|
| default   | home-service |             | http://127.0.0.1:62341 |
|-----------|--------------|-------------|-----------------------|
🎉 Opening service default/home-service in default browser...
```

< > C ⌂ 🔖 ⓘ http://127.0.0.1:62202

⊞ | ⑨ ChatGPT ▶ YouTube 🦝 Platform | Study Fet...
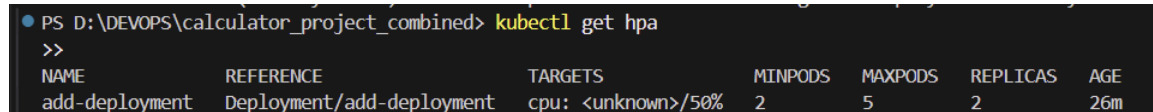
Pretty-print ☐

{"operation":"addition","result":0}

3.4 Enable Horizontal Pod Autoscaler (HPA)

Enable metrics-server and apply autoscaling:

```
```

minikube addons enable metrics-server
kubectl autoscale deployment add-deployment --cpu-percent=50 --min=2 --max=5
```
```

Screenshot:

```
● PS D:\DEVOPS\calculator_project_combined> kubectl get hpa
  >>
  NAME            REFERENCE                     TARGETS              MINPODS   MAXPODS   REPLICAS   AGE
  add-deployment  Deployment/add-deployment     cpu: <unknown>/50%   2         5         2          26m
```

3.6 Cleanup

Delete resources and stop Minikube:

```
```

kubectl delete hpa add-deployment
kubectl delete -f k8s/
minikube stop
minikube delete
```
```