

Pada Ujian Akhir Semester (UAS) mata kuliah komputasi awan (kowan) ini, saya akan berusaha untuk menampilkan proses melakukan deployment sebuah aplikasi di kubernetes, aplikasinya bebas. Lalu saya juga akan mengatur horizontal pod autoscaler, dan lakukan testing menggunakan ab (Apache Benchmark) sehingga pod diduplikasi otomatis oleh kubernetes. Terdapat 3 bagian yang saya lampirkan **hasil pengerjaan** (proses melakukan deployment di kubernetes, hasil dari AB, serta pod yang diduplikasi secara otomatis), **konfigurasi auto scaler (HorizontalPodAutoscalers)** dan juga **proses pengerjaan UAS (bagian tambahan)** ini dari awal dan akhir.

Hasil Pengerjaan

a. Langkah Pengerjaan

1. Membuat VM (Ubuntu, 22.04 LTS, amd64 jammy image, instance T2 Medium, Allow HTTP and HTTPS traffic, storage 30 Gib).
2. Melakukan instalasi docker
 - a. `sudo apt update && sudo apt upgrade -y`
 - b. `curl -fsSL https://get.docker.com -o get-docker.sh`
 - c. `sudo sh ./get-docker.sh`
 - d. `sudo usermod -aG docker $USER`
3. Melakukan instalasi kubectl dan start minikube
 - a. kubectl
 - i. `curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl"`
 - ii. **(opsional):** `curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl.sha256"`
 - iii. **(opsional):** `echo "$(cat kubectl.sha256) kubectl" | sha256sum --check`
 - iv. `sudo install -o root -g root -m 0755 kubectl /usr/local/bin/kubectl`
 - v. `kubectl version --client`
 - b. minikube
 - i. `curl -LO https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64`
 - ii. `sudo install minikube-linux-amd64 /usr/local/bin/minikube`
 - iii. `minikube start --driver=docker`
4. Deployment sebuah aplikasi (php-apache)
 - a. `kubectl apply -f https://k8s.io/examples/application/php-apache.yaml`
(konfigurasi AutoScaler nya ada di bagian bawah)
 - b. **(melakukan expose aplikasi agar dapat diakses)** `kubectl expose deployment php-apache --type=NodePort --name=php-apache-exposed`
 - c. **(membuat HorizontalPodAutoscaler untuk horizontal pod autoscaler):**
`kubectl autoscale deployment php-apache --cpu-percent=50 --min=1 --max=10`
 - d. **(opsional):** `kubectl get hpa`

- e. (opsional, untuk melihat IP dari *deployment* kita) `kubectl get services --all`
5. Melakukan inspeksi terhadap aplikasi yang telah kita buat
 - a. (Cek IP deployments yang sudah dilakukan sebelumnya): `minikube service list`
 - b. Catat IP pada deployment **php-apache-exposed**: (<http://192.168.49.2:30448>)
 - c. Setelah itu, **mengatur security group** (firewall) agar dapat menerima *request* melalui port tersebut (saya menggunakan **All TCP, port 0 - 65535**).
6. Melakukan instalasi terhadap Apache Benchmark (`apache2-utils`):
 - a. `sudo apt install apache2-utils`
 - b. `ab`
7. Melakukan penambahan pada load
 - a. `minikube addons enable metrics-server`
 - b. `kubectl get hpa php-apache --watch`
8. Melakukan `ab` dengan input `n` sebesar 1000 dan **concurrency** sebesar 75 pada aplikasi kita.
 - a. `ab -n 1000 -c 75 http://192.168.49.2:30448/`
 - b. Hasil output:

```
aws Services Q Search [Alt+S]
ubuntu@ip-172-31-95-33:~$ ab -n 1000 -c 75 http://192.168.49.2:30448/
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 192.168.49.2 (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Completed 600 requests
Completed 700 requests
Completed 800 requests
Completed 900 requests
Completed 1000 requests
Finished 1000 requests

Server Software:      Apache/2.4.10
Server Hostname:      192.168.49.2
Server Port:          30448

Document Path:        /
Document Length:       3 bytes

Concurrency Level:     75
Time taken for tests:   78.334 seconds
Complete requests:      1000
Failed requests:         0
Total transferred:      206000 bytes
HTML transferred:       3000 bytes
Requests per second:    12.77 [#/sec] (mean)
Time per request:       5875.021 [ms] (mean)
Time per request:       78.334 [ms] (mean, across all concurrent requests)
Transfer rate:          2.57 [Kbytes/sec] received

Connection Times (ms)
  min  mean[+/-sd] median  max
Connect:    0    0  0.9      0    5
Processing: 127 5768 3625.0   6108 15796
Waiting:    126 3682 3572.0   6020 15583
Total:      127 5769 3625.1   6108 15799

Percentage of the requests served within a certain time (ms)
 50%    6108
 66%    7635
 75%    8618
 80%    9168
 90%   10624
 95%   11388
 98%   12157
 99%   13230
100%   15799 (longest request)
ubuntu@ip-172-31-95-33:~$ kubectl get deployments
NAME      READY  UP-TO-DATE  AVAILABLE  AGE
php-apache 5/7      7            5          66m
ubuntu@ip-172-31-95-33:~$
```

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9. Melihat hasil **horizontal pod auto scaler (HPA)**:
 - a. Dari command `kubectl get hpa php-apache --watch` diatas:

```
ubuntu@ip-172-31-95-33:~$ kubectl get hpa php-apache --watch
```

NAME	REFERENCE	TARGETS	MINPODS	MAXPODS	REPLICAS	AGE
php-apache	Deployment/php-apache	0%/50%	1	10	2	64m
php-apache	Deployment/php-apache	163%/50%	1	10	2	65m
php-apache	Deployment/php-apache	163%/50%	1	10	4	65m
php-apache	Deployment/php-apache	163%/50%	1	10	7	65m

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10. Melihat evaluasi jumlah *pod* yang berjalan setelah dijalankannya auto scaler.

```
ubuntu@ip-172-31-95-33:~$ kubectl get hpa php-apache --watch
```

NAME	REFERENCE	TARGETS	MINPODS	MAXPODS	REPLICAS	AGE
php-apache	Deployment/php-apache	0%/50%	1	10	2	64m
php-apache	Deployment/php-apache	163%/50%	1	10	2	65m
php-apache	Deployment/php-apache	163%/50%	1	10	4	65m
php-apache	Deployment/php-apache	163%/50%	1	10	7	65m
php-apache	Deployment/php-apache	138%/50%	1	10	7	66m

```
^Cubuntu@ip-172-31-95-33:~$ kubectl get deployments
```

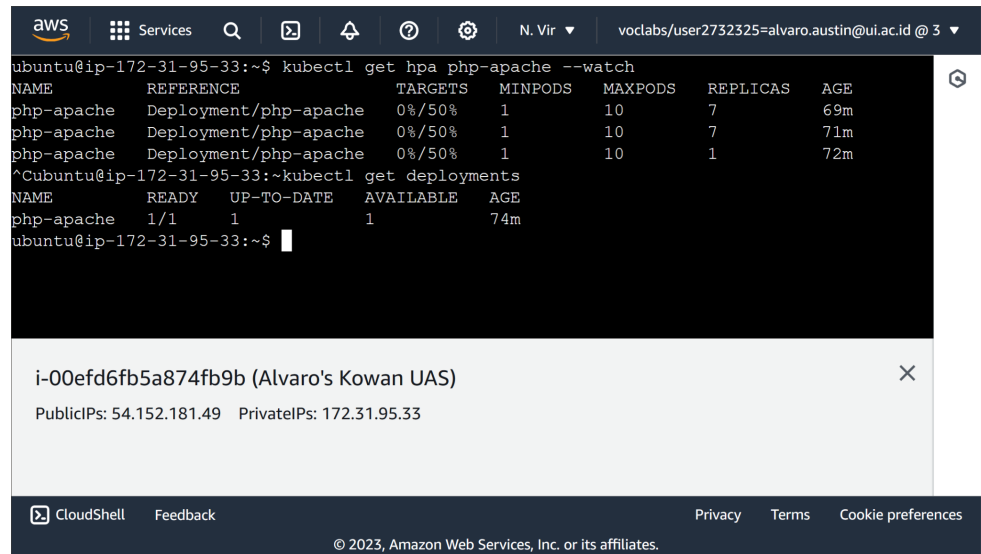
NAME	READY	UP-TO-DATE	AVAILABLE	AGE
php-apache	5/7	7	5	66m

```
ubuntu@ip-172-31-95-33:~$
```

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11. **(Informasi Tambahan)** Setelah 5 menit, kita dapat melihat hasilnya kembali dan terlihat bahwa jumlah *pod* yang berjalan sekarang menjadi 1.



```
aws Services 🔍 ⓘ 🔔 ⓘ ⚙️ N. Vir ▼ voclabs/user2732325=alvaro.austin@ui.ac.id @ 3 ▼
ubuntu@ip-172-31-95-33:~$ kubectl get hpa php-apache --watch
NAME          REFERENCE                TARGETS  MINPODS  MAXPODS  REPLICAS  AGE
php-apache    Deployment/php-apache     0%/50%   1         10        7          69m
php-apache    Deployment/php-apache     0%/50%   1         10        7          71m
php-apache    Deployment/php-apache     0%/50%   1         10        1          72m
^Cubuntu@ip-172-31-95-33:~$ kubectl get deployments
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
php-apache    1/1     1            1           74m
ubuntu@ip-172-31-95-33:~$
```

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Konfigurasi HorizontalPodAutoscalers:

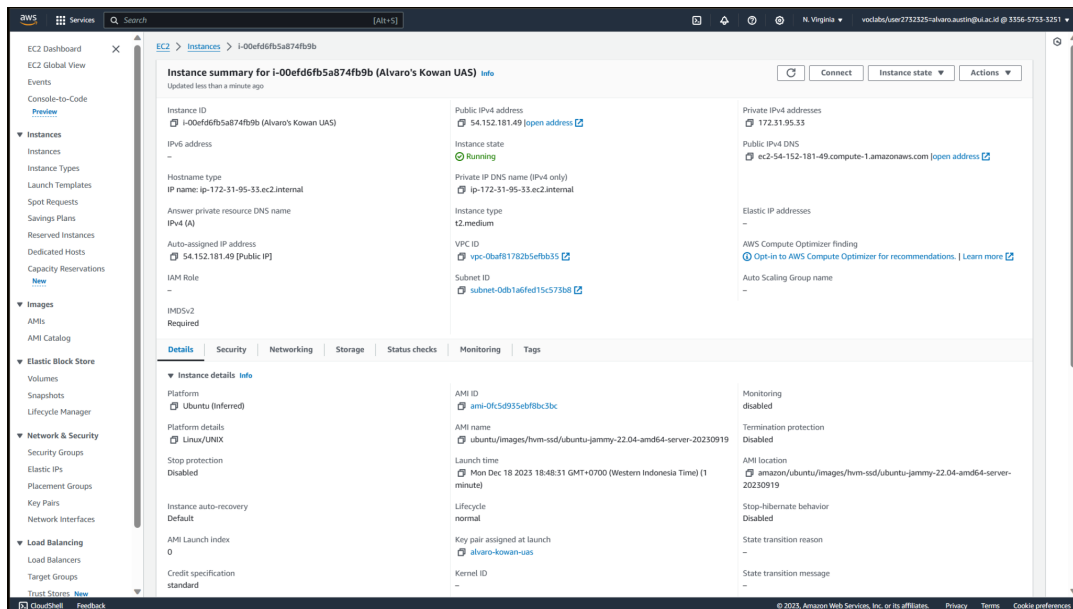
```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: php-apache
spec:
  selector:
    matchLabels:
      run: php-apache
  template:
    metadata:
      labels:
        run: php-apache
    spec:
      containers:
        - name: php-apache
          image: registry.k8s.io/hpa-example
          ports:
            - containerPort: 80
          resources:
            limits:
              cpu: 500m
            requests:
              cpu: 200m
---
apiVersion: v1
kind: Service
metadata:
```

Alvaro Austin - 2106752180

```
name: php-apache
labels:
  run: php-apache
spec:
  ports:
    - port: 80
  selector:
    run: php-apache
```

Proses beserta Screenshot (sebagai referensi pengerjaan):

- Membuat VM untuk server aplikasi



- Melakukan instalasi docker

```
To run Docker as a non-privileged user, consider setting up the
Docker daemon in rootless mode for your user:

    dockerd-rootless-setuptool.sh install

Visit https://docs.docker.com/go/rootless/ to learn about rootless mode.

To run the Docker daemon as a fully privileged service, but granting non-root
users access, refer to https://docs.docker.com/go/daemon-access/

WARNING: Access to the remote API on a privileged Docker daemon is equivalent
to root access on the host. Refer to the 'Docker daemon attack surface'
documentation for details: https://docs.docker.com/go/attack-surface/

=====

ubuntu@ip-172-31-95-33:~$ sudo usermod -aG docker $USER
ubuntu@ip-172-31-95-33:~$
```

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- Melakukan instalasi kubectl dan minikube (serta start)

```
aws [Alt+S]
ubuntu@ip-172-31-95-33:~$ curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl"
% Total % Received % Xferd Average Speed Time Time Current
100 138 100 138 0 0 1120 0 --:--:-- --:--:-- --:--:-- 1121
100 47.4k 100 47.4k 0 0 74.2k 0 --:--:-- --:--:-- --:--:-- 74.2k
ubuntu@ip-172-31-95-33:~$ curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl.sha256"
% Total % Received % Xferd Average Speed Time Time Current
100 138 100 138 0 0 1096 0 --:--:-- --:--:-- --:--:-- 1104
100 64 100 64 0 0 287 0 --:--:-- --:--:-- --:--:-- 287
ubuntu@ip-172-31-95-33:~$ echo "$(cat kubectl.sha256) kubectl" | sha256sum --check
kubectl: OK
ubuntu@ip-172-31-95-33:~$ sudo install -o root -g root -m 0755 kubectl /usr/local/bin/kubectl
ubuntu@ip-172-31-95-33:~$ kubectl version --client
Client Version: v1.29.0
Kustomize Version: v5.0.4-0.20230601165947-6ce8bf390ce3
ubuntu@ip-172-31-95-33:~$ curl -LO https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64
% Total % Received % Xferd Average Speed Time Time Current
100 89.3M 100 89.3M 0 0 104k 0 --:--:-- --:--:-- --:--:-- 104k
ubuntu@ip-172-31-95-33:~$ sudo install minikube-linux-amd64 /usr/local/bin/minikube
ubuntu@ip-172-31-95-33:~$ minikube start --driver=docker
* minikube v1.28.0 on Ubuntu 22.04 (amd/amd64)
* Using the docker driver based on user configuration
* Using Docker driver with root privileges
* Starting control plane node minikube in cluster minikube
* Pulling base image ...
* Downloading Kubernetes v1.28.3 preload ...
  > preloaded-images-k8s-v18-v1...: 403.35 MiB / 403.35 MiB 100.00% 68.40 M
  > gcr.io/k8s-minikube/kicbase...: 453.90 MiB / 453.90 MiB 100.00% 64.49 M
* Creating docker container (CPUs=2, Memory=2200Mi) ...
* Preparing Kubernetes v1.28.3 on Docker 24.0.7 ...
  - Generating certificates and keys ...
  - Booting up control plane ...
  - Configuring RBAC rules ...
* Configuring kubelet (Container Networking Interface) ...
  - Using image gcr.io/k8s-minikube/storage-provisioner:v5
  - Verifying Kubernetes components...
* Enabled addons: default-storageclass, storage-provisioner
* Done! kubectl is now configured to use "minikube" cluster and "default" namespace by default
ubuntu@ip-172-31-95-33:~$
```

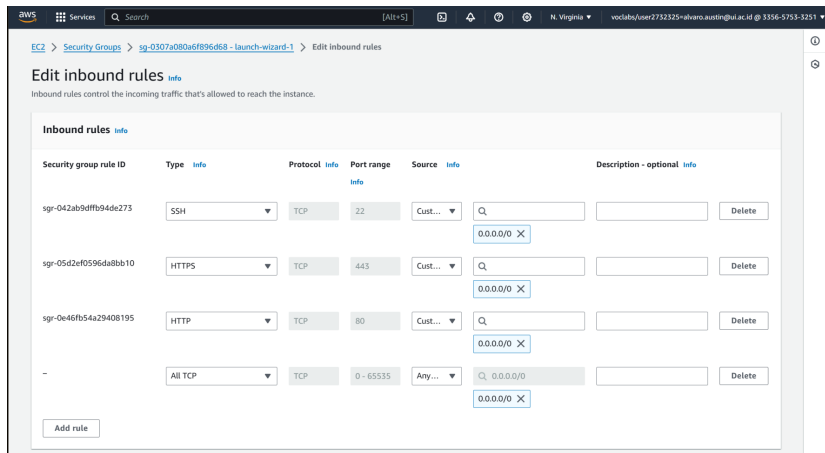
- Deployment sebuah aplikasi (php-apache)

```
aws [Alt+S]
ubuntu@ip-172-31-95-33:~$ kubectl apply -f https://k8s.io/examples/application/php-apache.yaml
deployment.apps/php-apache created
service/php-apache created
ubuntu@ip-172-31-95-33:~$ kubectl expose deployment php-apache --type=NodePort --name=php-apache-exposed
service/php-apache-exposed exposed
ubuntu@ip-172-31-95-33:~$ kubectl autoscale deployment php-apache --cpu-percent=50 --min=1 --max=10
horizontalpodautoscaler.autoscaling/php-apache autoscaled
ubuntu@ip-172-31-95-33:~$ kubectl get hpa
NAME REFERENCE TARGETS MINPODS MAXPODS REPLICAS AGE
php-apache Deployment/php-apache <unknown>/50% 1 10 1 16s
ubuntu@ip-172-31-95-33:~$
```

- Melakukan inspeksi terhadap aplikasi yang telah kita buat

```
aws [Alt+S]
ubuntu@ip-172-31-95-33:~$ minikube service list
|-----|
| NAMESPACE | NAME | TARGET PORT | URL |
|-----|
| default | kubernetes | No node port | |
| default | php-apache | No node port | |
| default | php-apache-exposed | 80 | http://192.168.49.2:30448 |
| kube-system | kube-dns | No node port | |
|-----|
ubuntu@ip-172-31-95-33:~$
```

- Mengatur *security group* pada AWS.



- Melakukan instalasi terhadap Apache Benchmark (apache2-utils)

```
Restarting services...
Service restarts being deferred:
/etc/needrestart/restart.d/dbus.service
systemctl restart getty@tty1.service
systemctl restart networkd-dispatcher.service
systemctl restart unattended-upgrades.service

No containers need to be restarted.

No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
ubuntu@ip-172-31-95-33:~$ ab

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```

- Melakukan penambahan pada load

```
ubuntu@ip-172-31-95-33:~$ minikube addons enable metrics-server
* metrics-server is an addon maintained by Kubernetes. For any concerns contact minikube on GitHub.
You can view the list of minikube maintainers at: https://github.com/kubernetes/minikube/blob/master/OWNERS
- Using image registry.k8s.io/metrics-server/metrics-server:v0.6.4
* The 'metrics-server' addon is enabled
ubuntu@ip-172-31-95-33:~$ kubectl get hpa php-apache --watch
NAME           REFERENCE             TARGETS      MINPODS  MAXPODS  REPLICAS  AGE
php-apache     Deployment/php-apache  <unknown>/50%  1        10        1          34m
```

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- Melakukan ab dengan input **n** sebesar 1000 dan **concurrency** sebesar 75 pada aplikasi kita.

```

805  Services  Search  [Alt+S]
ubuntu@ip-172-31-95-33:~$ ab -n 1000 -c 5 http://192.168.49.2:30448/
This is ApacheBench, Version 2.3 <Revision: 1879490>
Copyright 1996 Adam Twiss, Jesse Technology Ltd, http://www.jesse-tech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 192.168.49.2 (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Completed 600 requests
Completed 700 requests
Completed 800 requests
Completed 900 requests
Completed 1000 requests
Finished 1000 requests

Server Software: Apache/2.4.10
Server Hostname: 192.168.49.2
Server Port: 30448

Document Path: /
Document Length: 5 bytes

Concurrency Level: 35
Time taken for tests: 78.334 seconds
Complete requests: 1000
Failed requests: 0
Total transferred: 206000 bytes
HTML transferred: 3000 bytes
Requests per second: 12.77 [#/sec] (mean)
Time per request: 5875.021 [ms] (mean)
Time per request: 78.334 [ms] (mean, across all concurrent requests)
Transfer rate: 2.57 [Kbytes/sec] received

Connection Times (ms)
      min      mean  max
Connect: 0 0 0.9
Processing: 127 5763 3425.0
Waiting: 126 5682 3372.0
Total: 127 5763 3425.1
Percentage of the requests served within a certain time (ms)
 50%  4108
 66%  7633
 75%  8418
 80%  8163
 90% 10624
 95% 11868
 98% 12157
 99% 12310
100% 12792 (longest request)
ubuntu@ip-172-31-95-33:~$ kubectl get deployments
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
php-apache    5/7     7             5           66m
ubuntu@ip-172-31-95-33:~$

```

- Melakukan benchmark ab dan melihat proses auto scaling

```

ubuntu@ip-172-31-95-33:~$ kubectl get hpa php-apache --watch
NAME          REFERENCE          TARGETS   MINPODS   MAXPODS   REPLICAS   AGE
php-apache    Deployment/php-apache  0%/50%    1         10        2          64m
php-apache    Deployment/php-apache  163%/50%  1         10        2          65m
php-apache    Deployment/php-apache  163%/50%  1         10        4          65m
php-apache    Deployment/php-apache  163%/50%  1         10        7          65m

```

- Setelah 5 menit, memberhentikan pemantauan HPA, lalu mengecek status deployment.

```

aws  Services  Search  [Alt+S]  N. Vir  voclabs/user2732325=alvaro.austin@ui.ac.id @ 3
ubuntu@ip-172-31-95-33:~$ kubectl get hpa php-apache --watch
NAME          REFERENCE          TARGETS   MINPODS   MAXPODS   REPLICAS   AGE
php-apache    Deployment/php-apache  0%/50%    1         10        7          69m
php-apache    Deployment/php-apache  0%/50%    1         10        7          71m
php-apache    Deployment/php-apache  0%/50%    1         10        1          72m
^Cubuntu@ip-172-31-95-33:~$ kubectl get deployments
NAME          READY   UP-TO-DATE   AVAILABLE   AGE
php-apache    1/1     1             1           74m
ubuntu@ip-172-31-95-33:~$

```