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Course: Cloud Computing

Homework 1 – Containers and Virtual Machines

Experiment 1

- **Create a Vagrant file to start an Ubuntu VM that hosts a web server with NGINX.**

Link to the Vagrant File - Server:

https://github.com/Gabeinstein/GO-cloud_computing_fall24/blob/main/Server/VM/Vagrantfile

Description:

- Vagrant ubuntu distribution -> hashicorp/bionic64
- Network: public_network
- Port Forwarding -> guest:80, host:8082
- File movement: host: /app, guest: /tmp
- Installation: nginx, htop
- Environment Variable: SERVICE_NAME="Vagrant"
- Envsubst to replace the env variable in the index.html.template and move to /var/www/html/index.html

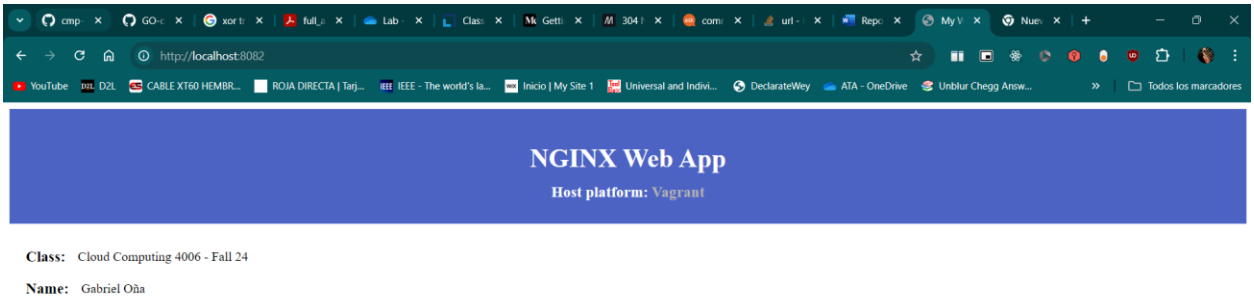
Files in app folder:

- Index.html
- Styles.css

Commands to bring up server:

- vagrant up

Web page preview



Experiment 2

- **Create a Docker file to start NGINX container that hosts a web server.**

Link to the Docker File - Server:

https://github.com/Gabeinstein/GO-cloud_computing_fall24/blob/main/Server/Container/Dockerfile

Description:

- Docker image -> nginx:alpine
- COPY /app to /usr/share/nginx/html
- COPY start.sh file to use envsubt

- Give privileges to start.sh
- Environment Variable: SERVICE_NAME="Vagrant"
- Expose port 80
- Last RUN start.sh

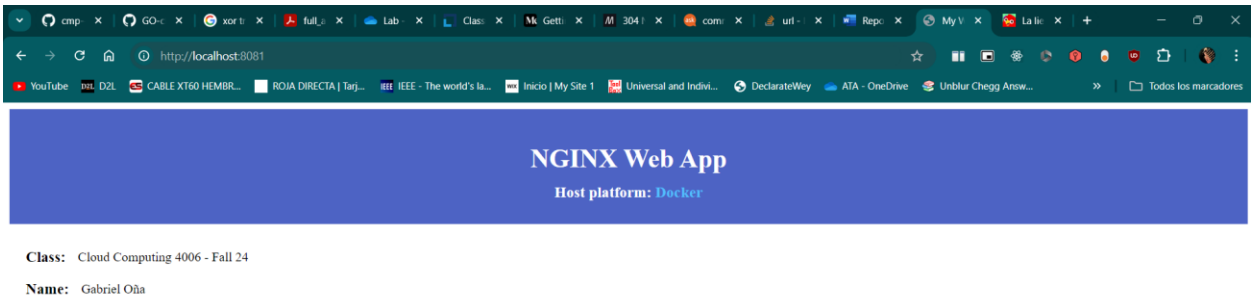
Files in app folder:

- Index.html
- Styles.css

Commands to bring up server:

- Docker buildx build -t my-web-image .
- Docker run -it –-rm -d -p 8081:80 –-name docker-web-server my-web-image

Web page preview



- **Create a Vagrant File with wrk to overload each server.**

Link to Vagrant File - Client:

https://github.com/Gabeinstein/GO-cloud_computing_fall24/blob/main/Client/VM/Vagrantfile

Description:

- Network: public_network
- Installation: build-essential libssl-dev git zip unzip
- Clone wrk Github repo: git clone https://github.com/wg/wrk.git wrk
- make and copy make file to /usr/local/bin

Commands to bring up client:

- vagrant up
- vagrant ssh

Commands to overload Vagrant server:

- wrk -t14 -c100 -d3m http://<IP-HOST>:8082

  Replace ip, in my case: 192.168.1.19

  For number of threads -t, use the number of cores of your processor

  Connections -c, stable connections overloading per thread

- **Vagrant Server Utilization**

  1. 14 threads and 100 connections

Figure 1. Under Max connections

```
vagrant@client-user:~$ wrk -t14 -c100 -d3m http://192.168.1.19:8082
Running 3m test @ http://192.168.1.19:8082
  14 threads and 100 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   103.95ms   74.08ms   1.91s    85.61%
    Req/Sec    62.05     35.95   300.00     71.46%
  145352 requests in 3.00m, 173.54MB read
  Socket errors: connect 0, read 0, write 0, timeout 19
Requests/sec:    807.07
Transfer/sec:      0.96MB
```

Figure 2. wrk -t14 -c100 report

We can see that CPU% utilization is not 100% and there are few socket errors with the 145352 requests that had happened in 3min.

2. 14 threads and 500 connections

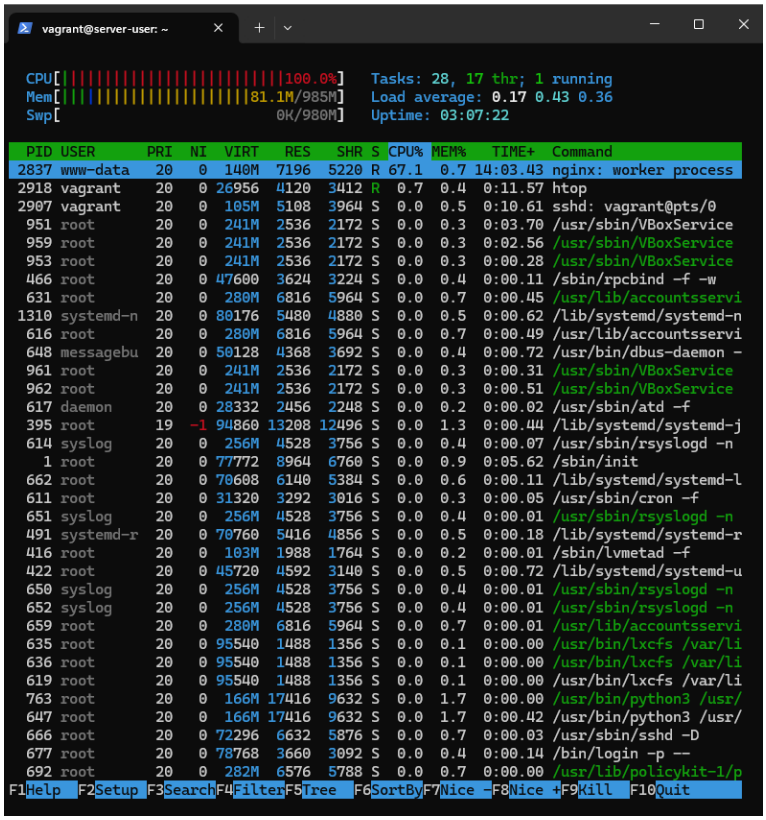


Figure 3. Overloading Vagrant server

```
vagrant@client-user:~$ wrk -t14 -c500 -d3m http://192.168.1.19:8082
Running 3m test @ http://192.168.1.19:8082
  14 threads and 500 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   346.80ms  167.88ms   1.93s    70.91%
    Req/Sec    75.88     55.96   696.00     72.93%
  179461 requests in 3.00m, 214.27MB read
  Socket errors: connect 0, read 45, write 0, timeout 882
Requests/sec:    996.48
Transfer/sec:      1.19MB
```

Figure 4. wrk -t14 -c500 report

As noticed, the number of socket errors has increased significantly. The latency of the server has also increased due to the request overload.

- **Docker Server Utilization**

  1. 14 threads and 100 connections

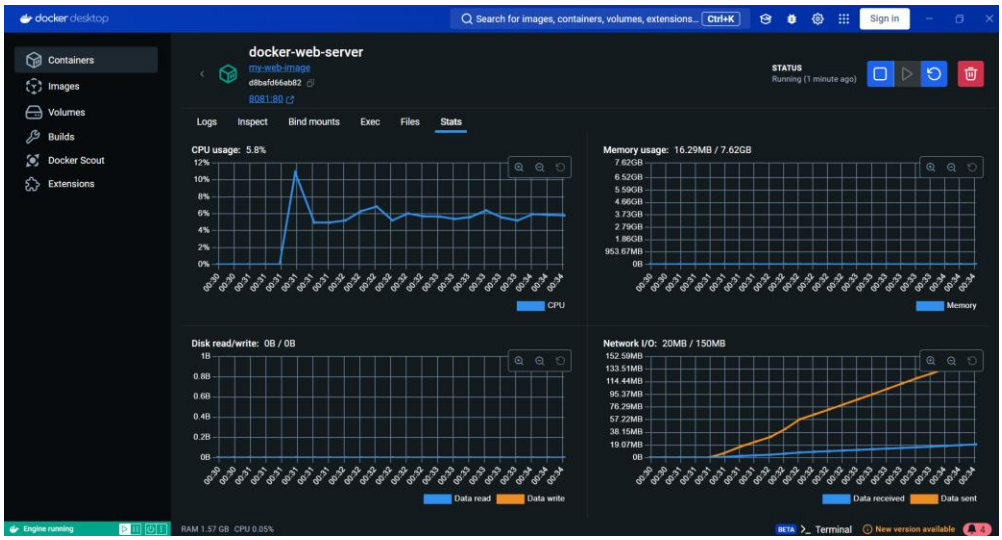


Figure 5. Docker under MAX

```
vagrant@client-user:~$ wrk -t14 -c100 -d3m http://192.168.1.19:8081
Running 3m test @ http://192.168.1.19:8081
  14 threads and 100 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   100.32ms   56.17ms 420.53ms   70.31%
    Req/Sec    46.76     22.37   228.00     85.06%
  110936 requests in 3.00m, 131.40MB read
Requests/sec:    616.04
Transfer/sec:    747.19KB
```

Figure 6. wrk -t14 -c100 report docker

We can see that the CPU utilization on average was 6% and there is no report of socket errors.

2. 14 threads and 500 connections

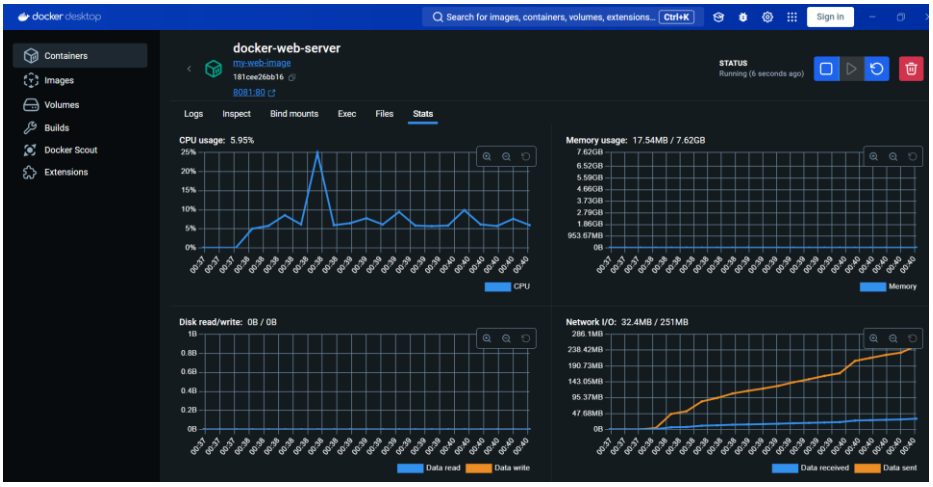


Figure7. Docker stats 500 connections 14 threads

```
vagrant@client-user:~$ wrk -t14 -c500 -d3m http://192.168.1.19:8081
Running 3m test @ http://192.168.1.19:8081
  14 threads and 500 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   252.27ms  253.51ms   1.60s    81.59%
    Req/Sec   174.54    215.96     1.27k    82.50%
  194564 requests in 3.00m, 230.45MB read
Requests/sec:   1079.62
Transfer/sec:      1.28MB
```

Figure 8. wrk -t14 -c500 report docker

We can see that with 500 connections the container is still under overload. CPU% average has increased to 10%. There are no error packets. Unfortunately, the latency has increased as expected due to more connections.

3. 14 threads and 700 connections

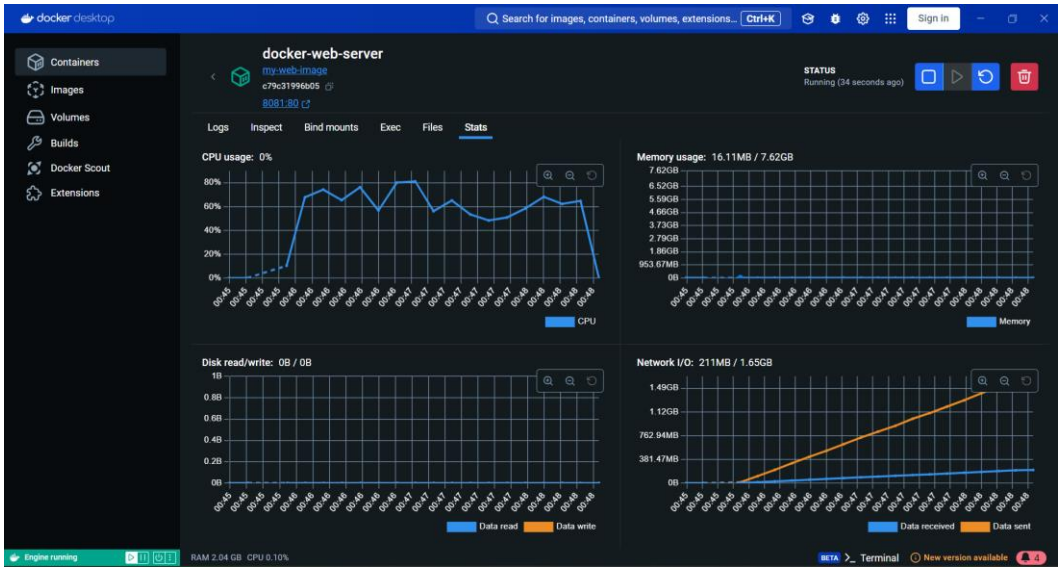


Figure 9. Docker stats 700 connections 14 threads

```
vagrant@client-user:~$ wrk -t14 -c700 -d3m http://192.168.1.19:8081
Running 3m test @ http://192.168.1.19:8081
  14 threads and 700 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   124.03ms  139.46ms   1.96s    86.20%
    Req/Sec   523.20    204.45     1.57k    69.75%
  1198577 requests in 3.00m, 1.39GB read
  Socket errors: connect 0, read 0, write 0, timeout 4
Requests/sec:   6655.08
Transfer/sec:      7.88MB
```

Figure 10. wrk -t14 -c700 report docker

With 700 connections per thread, we can see that the CPU% usage has increased to an average of 70%. What this means is that we are achieving the overloading of the server and that is why we are starting to have socket errors.

4. 14 threads and 1000 connections

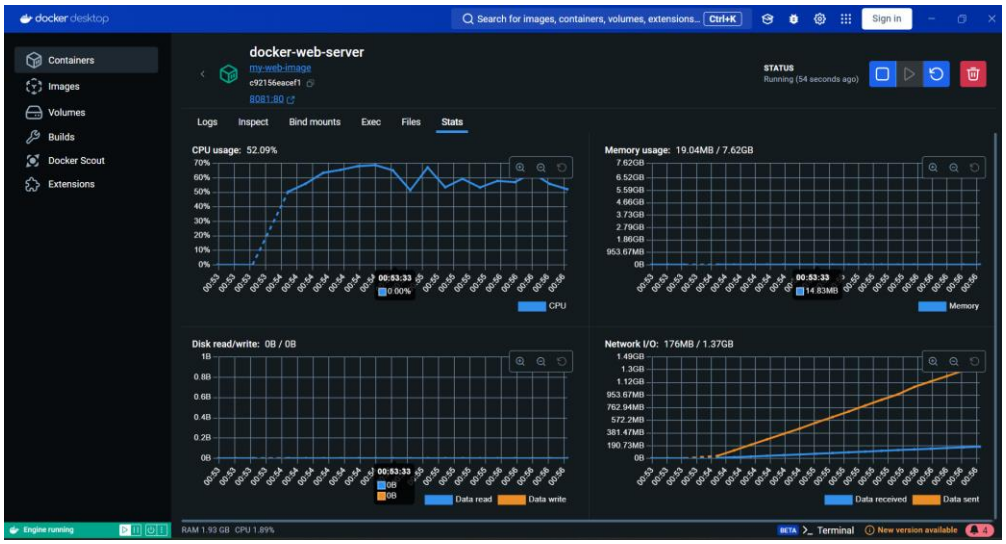


Figure 11. Docker stats 1000 connections 14 threads

```
vagrant@client-user:~$ wrk -t14 -c1000 -d3m http://192.168.1.19:8081
Running 3m test @ http://192.168.1.19:8081
  14 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   209.98ms  230.82ms   2.00s    86.79%
    Req/Sec   442.20    202.81     1.85k    69.06%
  998914 requests in 3.00m, 1.16GB read
  Socket errors: connect 0, read 0, write 0, timeout 367
Requests/sec:   5546.67
Transfer/sec:      6.57MB
```

Figure 12. wrk -t14 -c1000 report docker

We can observe that the number of socket errors have increased significantly and the latency. These are indicators that the server had been overloaded for the 3 minutes of the experiment.

- **Conclusion**

The implementation using Docker was able to handle more requests per second. This occurred due to the lightweight resources utilization of a container compared with a virtual machine.

To conclude, it is important to know the number of connections that can be handled for each implementation. With this information, we can adequate other resources if we need to allocate more requesters. A good method is using a load balancer to distribute the traffic.