COEN 241 HW1

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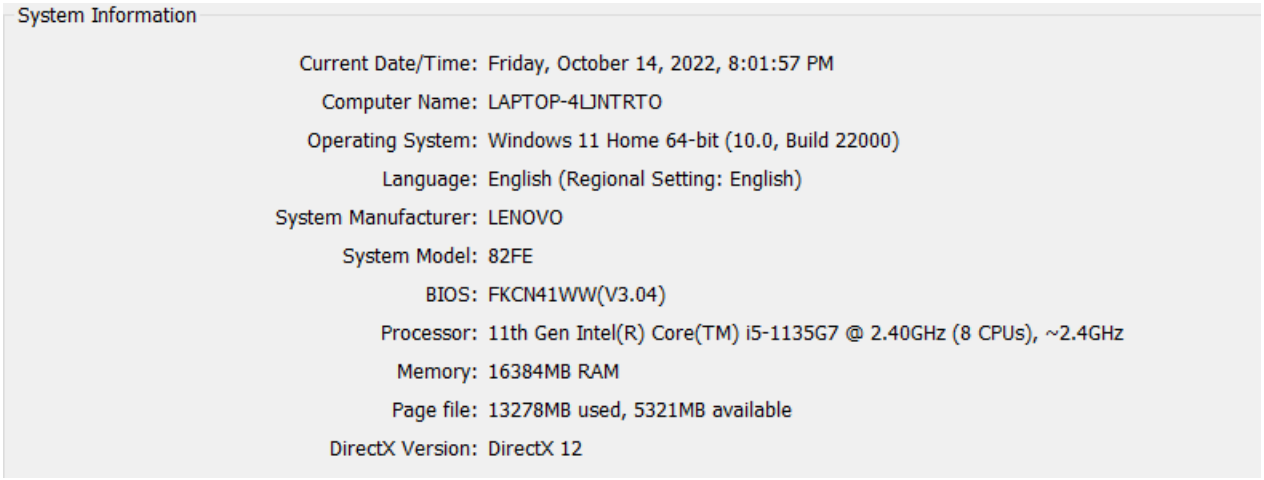
1.Configurations of experimental setup

(1) OS: Windows 11 Home 64-bit

(2) Processors: 11th Gen Inter Core i5-1135G7 @ 2.40GHz(8 CPUs)

(3) Memory: 16GB



2. QEMU VM

(1) Main steps

- Install QEMU:

  $ sudo apt-get install qemu

  $ sudo apt-get install qemu-utils

  $ sudo apt-get install qemu-system-x86
- Download Ubuntu 20.04 server ISO image
- Create the QEMU image

  $ sudo qemu-img create ubuntu.img 10G -f qcow2
- Install QEMU VM

  $ sudo qemu-system-x86_64 -hda ubuntu.img -boot d -cdrom ./ubuntu-20.04.5-live-server-amd64.iso -m 2046 -boot strict=on
- Boot ubuntu

  sudo qemu-system-x86_64 -hda ubuntu.img -boot c -m 2046 -boot strict=on

(2) QEMU command details

- -smp

  $ qemu-system-x86_64 -smp cores=2

  Set CPU core count as 2 for QEMU VM
- -m

  $ qemu-system-x86_64 -m 256

  Set memory Size(RAM) as 256MB for QEMU VM
- -accel

  $ qemu-system-x86_64 -accel tcg,thread=single

  Select accelerator of QEMU VM
- -nographic

  $ qemu-system-x86_64 -nographic

  Run directly in the terminal

(3) QEMU running environment

3. Docker container

(1) Main steps

- Install docker
- Pull the latest image og ubuntu

  $ docker pull ubuntu
- Create container

  $ docker run -it ubuntu bin/bash
- Install sudo/ping/sysbench in container

  $ apt update

  $ apt insatll sudo

$ apt install iputils-ping

$ sudo apt install sysbench

- Create own image

  $ docker commit --message "ubuntu+sysbench" 401adc40ae38 my_ubuntu:v1

- Check history

  $ docker history my_ubuntu:v1

```
zelu@zelu-virtual-machine:~/Downloads$ docker commit --message "ubuntu+sysbench" 401adc40ae38 my_ubuntu:v1
sha256:68721617019ee9493b2214db2ef9d65293a6e235b2e7d723267810c5dcfe6c88
zelu@zelu-virtual-machine:~/Downloads$ docker images
REPOSITORY    TAG       IMAGE ID       CREATED         SIZE
my_ubuntu     v1        68721617019e   3 seconds ago   128MB
ubuntu        latest    216c552ea5ba   10 days ago     77.8MB
hello-world   latest    feb5d9fea6a5   12 months ago   13.3kB
zelu@zelu-virtual-machine:~/Downloads$ docker history my_ubuntu:v1
IMAGE          CREATED          CREATED BY                                      SIZE      COMMENT
68721617019e   19 seconds ago   bash                                            50.5MB    ubuntu+sysbench
216c552ea5ba   10 days ago      /bin/sh -c #(nop)  CMD ["bash"]                 0B
<missing>      10 days ago      /bin/sh -c #(nop) ADD file:6cd2e13356aa5339c…   77.8MB
zelu@zelu-virtual-machine:~/Downloads$ gnome-screenshot -w -c
```

(2) Commands

- Create a container: $ docker run -ti ubuntu bin/bash
- Check running containers: $ docker ps
- Run the existed container: $ docker start <container ID>
- Stop running container: $ docker stop <container ID>
- Remove container: $ docker rm <container ID>
- Check logs: $ docker logs <container ID>
- Enter a running container: $ docker exec -ti <container ID> /bin/bash

(3) Docker running environment

```
zelu@zelu-virtual-machine:~/Downloads$ sudo systemctl start docker
[sudo] password for zelu:
zelu@zelu-virtual-machine:~/Downloads$ docker images
REPOSITORY    TAG       IMAGE ID       CREATED          SIZE
my_ubuntu     v1        68721617019e   54 minutes ago   128MB
ubuntu        latest    216c552ea5ba   10 days ago      77.8MB
hello-world   latest    feb5d9fea6a5   12 months ago    13.3kB
zelu@zelu-virtual-machine:~/Downloads$ docker run -it --name myUbuntu my_ubuntu /bin/bash
Unable to find image 'my_ubuntu:latest' locally
docker: Error response from daemon: pull access denied for my_ubuntu, repository does not exist or may requi
re 'docker login': denied: requested access to the resource is denied.
See 'docker run --help'.
zelu@zelu-virtual-machine:~/Downloads$ docker run -it --name myUbuntu my_ubuntu:v1 /bin/bash
root@f8126a095ead:/# zelu@zelu-virtual-machine:~/Downloads$
zelu@zelu-virtual-machine:~/Downloads$ docker ps
CONTAINER ID   IMAGE          COMMAND       CREATED          STATUS          PORTS     NAMES
f8126a095ead   my_ubuntu:v1   "/bin/bash"   57 seconds ago   Up 56 seconds             myUbuntu
```

4. Sysbench tests

(1) Steps

- Run into docker container or QEMU VM environment.
- Git clone the repository from GitHub to get the shell scripts.

- Under folder /HW1, using command " chmod +x sysbench_script.sh & ./sysbench_script.sh" to start the test.
- Git pull the test results after finishing.

(2) Docker tests

Sysbench version: 1.0.20 (using system LuaJIT 2.1.0-beta3)

Each test case has run for 5 times.

###CPU performance tests###

Test case1: --cpu-max-prime=10000

	1	2	3	4	5	Mean	stddev
CPU speed							
events per second	996.32	918.3	935.91	892.88	961.3	940.2729	39.77784584
total number of events	9065	9185	9361	8931	9615	9228.343	266.4710116
Latency(ms)							
min	0.72	0.72	0.72	0.72	0.72	0.72	0
avg	1.1	1.09	1.07	1.12	1.04	1.083655	0.030495901
max	11.01	4.48	4.08	3.53	8.35	5.683781	3.251914821
95th percentile	2.14	2.14	2.11	2.18	2.07	2.127685	0.040865633
sum	9988.16	9986.82	9988.71	9988.53	9987	9987.844	0.877684454

Test case2: --cpu-max-prime=20000

	1	2	3	4	5	Mean	stddev
CPU speed							
events per second	996.32	918.3	935.91	892.88	961.3	940.2729	39.77784584
total number of events	9065	9185	9361	8931	9615	9228.343	266.4710116
Latency(ms)							
min	0.72	0.72	0.72	0.72	0.72	0.72	0
avg	1.1	1.09	1.07	1.12	1.04	1.083655	0.030495901
max	11.01	4.48	4.08	3.53	8.35	5.683781	3.251914821
95th percentile	2.14	2.14	2.11	2.18	2.07	2.127685	0.040865633
sum	9988.16	9986.82	9988.71	9988.53	9987	9987.844	0.877684454

Test case3: --cpu-max-prime=30000

	1	2	3	4	5	Mean	stddev
CPU speed							
events per second	585.68	533.48	566.32	541.49	516.43	548.1362	27.39967244
total number of events	5858	5336	5665	5419	5166	5483.372	273.7584702
Latency(ms)							
min	1.39	1.3	1.31	1.3	1.31	1.321566	0.038340579
avg	1.71	1.87	1.76	1.84	1.93	1.820309	0.087578536
max	4.64	9.43	4.34	17.36	14.18	8.589128	5.760460051
95th percentile	2.43	3.62	3.3	3.49	3.68	3.268138	0.509833306
sum	9993.05	9990.96	9992.44	9991.21	9987.57	9991.046	2.125801025

###I/O performance tests###

Test case1: --file-test-mode=rndrw

	1	2	3	4	5	Mean	stddev
File operations							
read/s	7246.41	5806.25	8018.61	8571.25	8941.91	7629.8928	1244.34085
writes/s	4829.94	3870.67	5345.71	5714.14	5961.27	5086.33065	829.710668
fsyncs/s	15656.54	12583.78	17303.74	18487.06	19278.78	16478.5448	2656.738601
Throughput							
read,MiB/s	113.23	90.72	125.29	133.93	139.72	119.218453	19.44471831
writted, MiB/s	75.47	60.48	83.53	89.28	93.14	79.4737683	12.9621391
General statistics							
total time	10.0157	10.0071	10.0199	10.0028	10.0026	10.0096176	0.007822851
tota; number of events	275824	220860	305573	325835	339928	290301.817	47264.74699
Latency(ms)							
min	0	0	0	0	0	0	0
avg	0.58	0.72	0.52	0.49	0.47	0.54930247	0.100647901
max	156.05	204.25	149.69	140.68	115.62	150.652655	32.38647511
95th percentile	2.18	2.48	2.11	1.76	2.26	2.14467924	0.262335663
sum	159533.98	159314.54	159218.53	159051.22	158941.6	159211.84	230.8649919

Test case2: --file-test-mode=seqwr

	1	2	3	4	5	Mean	stddev
File operations							
read/s	0	0	0	0	0	0	0
writes/s	16647.31	26841.36	28052.89	29921.4	29768.3	25678.66415	5515.190768
fsyncs/s	21503.12	34554.58	36101.41	38497.9	38296.31	33069.30337	7059.847182
Throughput							
read,MiB/s	0	0	0	0	0	0	0
writted, MiB/s	260.11	419.4	438.33	467.52	465.13	401.2289334	86.17682444
General statistics							
total time	10.0047	10.0112	10.0081	10.0032	10.0052	10.0064796	0.003180723
tota; number of even	379699	612690	640115	682680	679076	585888.2149	125882.0744
Latency(ms)							
min	0	0	0	0	0	0	0
avg	0.42	0.26	0.25	0.23	0.23	0.270348313	0.08043631
max	162.88	108.77	93.1	95.95	111.91	112.1109645	28.20560884
95th percentile	0.03	0.03	0.03	0.03	0.03	0.03	0
sum	159360.45	159322.51	159209.8	159058.49	159100.59	159210.3239	132.4942392

Test case3: --file-test-mode=seqrd

	1	2	3	4	5	Mean	stddev
File operations							
read/s	41367.83	41380.26	36754.99	41976.8	37764.62	39789.9453	2402.949875
writes/s	0	0	0	0	0	0	0
fsyncs/s	0	0	0	0	0	0	0
Throughput							
read,MiB/s	646.37	646.57	574.3	655.89	590.07	621.718829	37.54624082
writted, MiB/s	0	0	0	0	0	0	0
General statistics							
total time	10.011	10.01	10.0046	10.0056	10.052	10.0166241	0.019956653
tota; number of events	414542	414318	368007	420092	379886	398796.395	23697.56101
Latency(ms)							
min	0	0	0	0	0	0	0
avg	0.38	0.38	0.43	0.38	0.42	0.39738705	0.024899799
max	169.79	194.31	217.72	144.96	151.92	173.713569	30.23809104
95th percentile	0.23	0.27	0.45	0.37	0.32	0.3191032	0.086139422
sum	158733.91	158198.89	158081	158849.75	158261.89	158424.79	343.4765334

(3) QEMU VM tests

Sysbench version: 1.0.20 (using system LuaJIT 2.1.0-beta3)

CPU performance tests

Test case1: --cpu-max-prime=10000

	1	2	3	4	5	Mean	stddev
CPU speed							
events per second	412.8	426.26	449	457.35	428.37	434.46	18.09
total number of events	4145	4272	4502	4579	4289	4354.49	178.26
Latency(ms)							
min	1.03	1.03	1.03	1.03	1.03	1.03	0.00
avg	2.38	2.32	2.2	2.16	2.31	2.27	0.09
max	48.85	10.44	13.81	14.13	13.22	16.74	16.14
95th percentile	3.82	3.82	3.68	3.55	3.89	3.75	0.14
sum	9861.16	9914.76	9898.69	9908.15	9901.76	9896.89	20.91

Test case2: --cpu-max-prime=20000

	1	2	3	4	5	Mean	stddev
CPU speed							
events per second	156.43	179.38	175.62	188.72	182.64	176.20	12.24
total number of events	1567	1798	1758	1890	1830	1765.05	122.60
Latency(ms)							
min	2.89	2.86	2.87	2.81	2.76	2.84	0.05
avg	6.32	5.53	5.65	5.26	5.44	5.63	0.41
max	44.02	17.99	16.25	15.24	16.9	20.14	12.31
95th percentile	11.45	8.74	8.74	8.43	8.58	9.12	1.27
sum	9899.95	9942.59	9940.25	9943.53	9950.85	9935.42	20.23

Test case3: --cpu-max-prime=30000

	1	2	3	4	5	Mean	stddev
CPU speed							
events per second	109.91	100.37	109.8	106.6	95.2	104.21	6.43
total number of events	1101	1005	1099	1068	954	1043.79	64.15
Latency(ms)							
min	5.05	5.09	4.87	5.05	5.04	5.02	0.09
avg	9.04	9.9	9.06	9.32	10.44	9.54	0.61
max	26.51	30	29.89	24.09	26.01	27.20	2.58
95th percentile	14.46	14.21	14.21	14.46	14.21	14.31	0.14
sum	9954.19	9953.04	9954.89	9955.04	9959.59	9955.35	2.50

I/O performance tests

Test case1: --file-test-mode=rndrw

	1	2	3	4	5	Mean	stddev
File operations							
read/s	327.44	361.04	265.75	378.51	340.38	332.23	43.16
writes/s	218.15	240.69	176.91	252.04	226.68	221.29	28.80
fsyncs/s	863.47	950.01	736.85	980.95	901.03	882.16	94.99
Throughput							
read,MiB/s	5.12	5.64	4.15	5.91	5.32	5.19	0.67
writted, MiB/s	3.41	3.76	2.76	3.94	3.54	3.46	0.45
General statistics							
total time	11.9091	10.9632	11.6279	11.0921	11.2143	11.36	0.39
tota; number of events	14739	14972	11680	15842	14428	14257.43	1573.03
Latency(ms)							
min	0.01	0.01	0.01	0.01	0.01	0.01	0.00
avg	10.72	10.51	13.51	9.96	10.92	11.06	1.38
max	197.03	157.06	203.35	121.42	112.32	153.72	41.85
95th percentile	35.59	35.59	46.63	33.12	35.59	37.03	5.32
sum	158016.34	157320.4	157751.65	157748.76	157596.39	157686.54	254.49

Test case2: --file-test-mode=seqwr

	1	2	3	4	5	Mean	stddev
File operations							
read/s	0	0	0	0	0	0.00	0.00
writes/s	745.35	690.87	690.87	776.22	791.16	737.70	46.85
fsyncs/s	1130.69	1059.27	1059.27	1167.68	1198.06	1121.58	62.87
Throughput							
read,MiB/s	0	0	0	0	0	0.00	0.00
writted, MiB/s	11.65	10.79	10.79	12.13	12.36	11.53	0.73
General statistics							
total time	11.1272	10.9923	10.9923	11.3332	10.8659	11.06	0.18
tota; number of events	18843	17197	17197	19990	19575	18523.11	1310.61
Latency(ms)							
min	0.08	0.08	0.08	0.08	0.08	0.08	0.00
avg	8.44	9.23	13.51	7.93	8.11	9.25	2.33
max	259.81	256.01	256.01	213.87	257.39	247.96	19.49
95th percentile	25.74	28.16	28.16	24.38	25.74	26.39	1.67
sum	159016.84	158741.13	158741.13	158446.48	158771.12	158743.24	202.31

Test case3: --file-test-mode=seqrd

	1	2	3	4	5	Mean	stddev
File operations							
read/s	4520.84	3653.32	5057.9	5067.83	4805.05	4588.59	585.42
writes/s	0	0	0	0	0	0.00	0.00
fsyncs/s	0	0	0	0	0	0.00	0.00
Throughput							
read,MiB/s	70.64	57.08	79.03	79.18	75.08	71.70	9.15
writted, MiB/s	0	0	0	0	0	0.00	0.00
General statistics							
total time	10.0299	10.0371	10.022	10.0104	10.0066	10.02	0.01
tota; number of events	45454	36714	50786	50756	48133	46048.51	5829.31
Latency(ms)							
min	0.01	0.01	0.01	0.01	0.01	0.01	0.00
avg	3.31	4.18	2.98	2.97	3.14	3.29	0.50
max	213.53	165.59	143.51	190.39	138.84	168.08	31.63
95th percentile	19.29	21.5	16.71	17.32	18.61	18.61	1.87
sum	150542.14	153348.83	151355.04	150925.71	151275.68	151486.37	1088.15

5. Shell scripts

All the shell scripts are under folder /HW1/shell_scripts

CPU test: parameter –cpu-max-prime

```
#!/bin/bash

for((i=0;i<5;i++))
do
    sysbench cpu --cpu-max-prime=10000 run
done
```

```
#!/bin/bash

for((i=0;i<5;i++))
do
    sysbench cpu --cpu-max-prime=20000 run
done
```

```
#!/bin/bash

for((i=0;i<5;i++))
do
    sysbench cpu --cpu-max-prime=30000 run
done
```

Fileio test: parameter --file-test-mode

```
#!/bin/bash

for((i=0;i<5;i++))
do
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=rndrw prepare
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=rndrw run
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=rndrw cleanup
done
```

```bash
#!/bin/bash

for((i=0;i<5;i++))
do
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=seqwr prepare
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=seqwr run
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=seqwr cleanup
done
```

```bash
#!/bin/bash

for((i=0;i<5;i++))
do
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=seqrd prepare
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=seqrd run
    sysbench --threads=16 fileio --file-total-size=2G --file-test-mode=seqrd cleanup
done
```

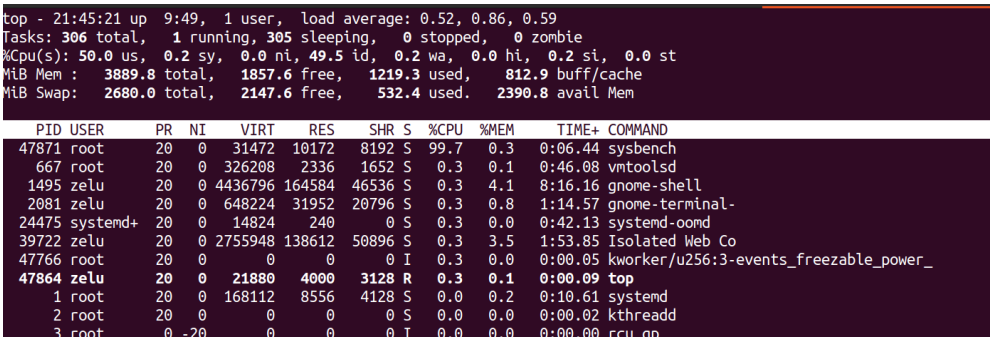
sysbench_script.sh

```bash
#!/bin/bash

chmod +777 ./shell_scripts/*.sh
mkdir results

for((i=1;i<4;i++))
do
    ./shell_scripts/cpu_test$i.sh > ./results/result_cpu$i.txt
done

for((i=1;i<4;i++))
do
    ./shell_scripts/fileio_test$i.sh > ./results/result_fileio$i.txt
done
```

6. Performance data --- CPU utilization

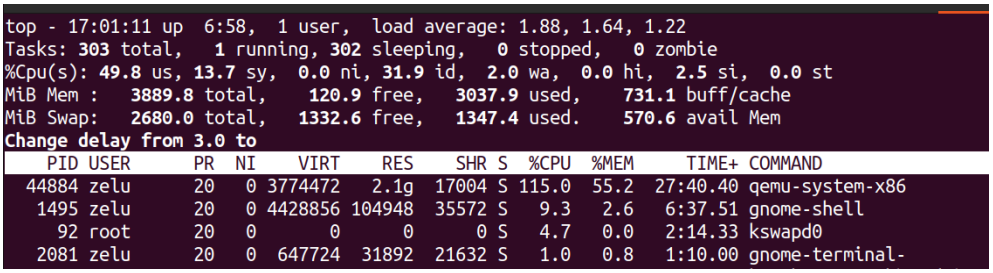
Docker:

user-level: 50.0% kernel-level: 0.2%



QEMU:

User-level: 49.8% kernel-level: 13.7%



7. Analysis

(1) From the results of CPU performance tests, no matter in Docker container or QEMU VM, more –cpu-max-prime will result in lower cpu speed and longer latency which is more obvious in QEMU VM.

(2) The cpu speed can be faster in docker than in QEMU.

(3) From the results of Fileio performance tests, single read or single write perform better than random read or write, considered latency and throughput.

(4) Fileio performance for docker is better than in QEMU (throughput and latency).

8. Git repository

https://github.com/VKLED/COEN241-2022FALL.git

commit id: 8eedb2db63f96af0eb654b221481fc836e0cfa32