HW1 Report
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Hardware Config Information

Configuration used for experiment
Processor: 11th Gen Intel© Core™ i5-11600KF @ 3.90GHz × 6
Memory: 15.5 GiB
Host OS: Linux Mint 21.1 Cinnamon (based on Ubuntu 20.04)
Disk: 20 GB available

Repo

Repo Link: https://github.com/CharryWu/csen241

QEMU VM installation

Ubuntu 20.04 64-bit PC (AMD64) server install image was downloaded from
https://releases.ubuntu.com/focal/ as per the HW instruction

Install QEMU
```
sudo apt-get install qemu
```

Create QEMU RAW/qcow2 system image:
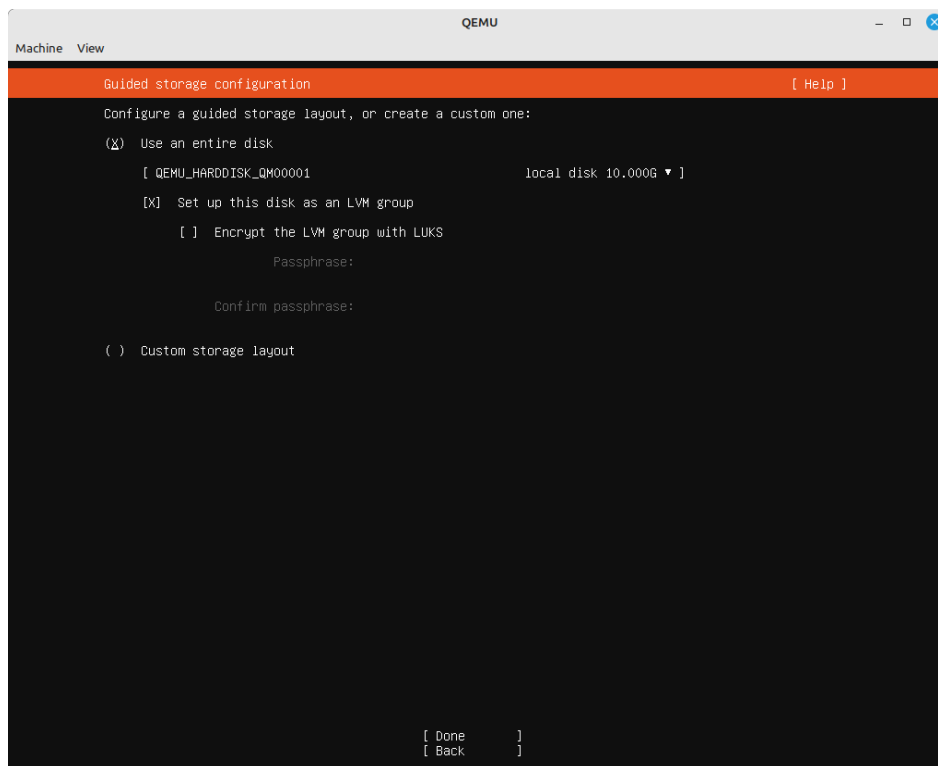```
sudo qemu-img create qcow2.img 10G -f qcow2
sudo qemu-img create raw.img 10G -f raw
```
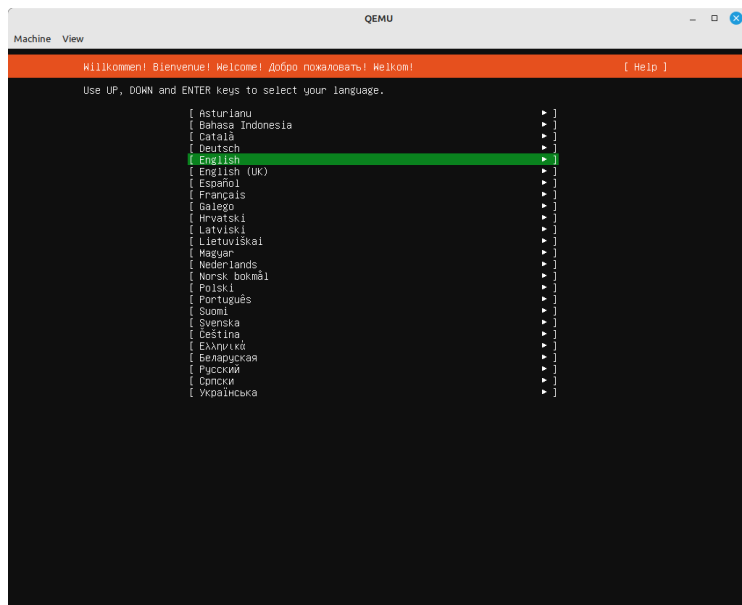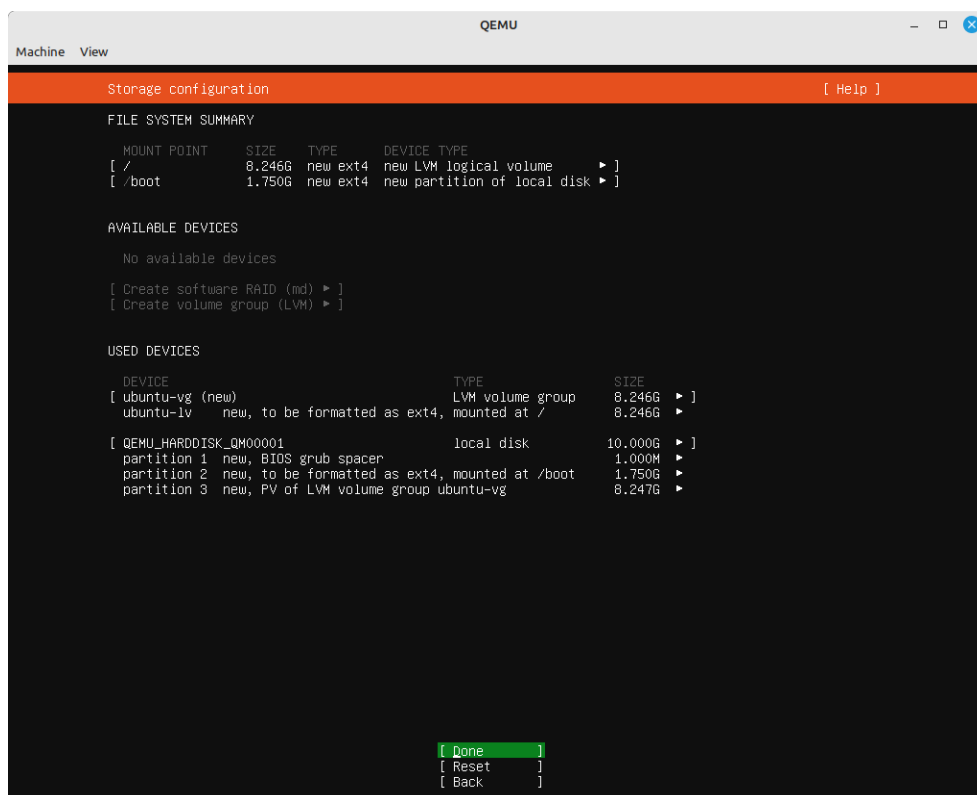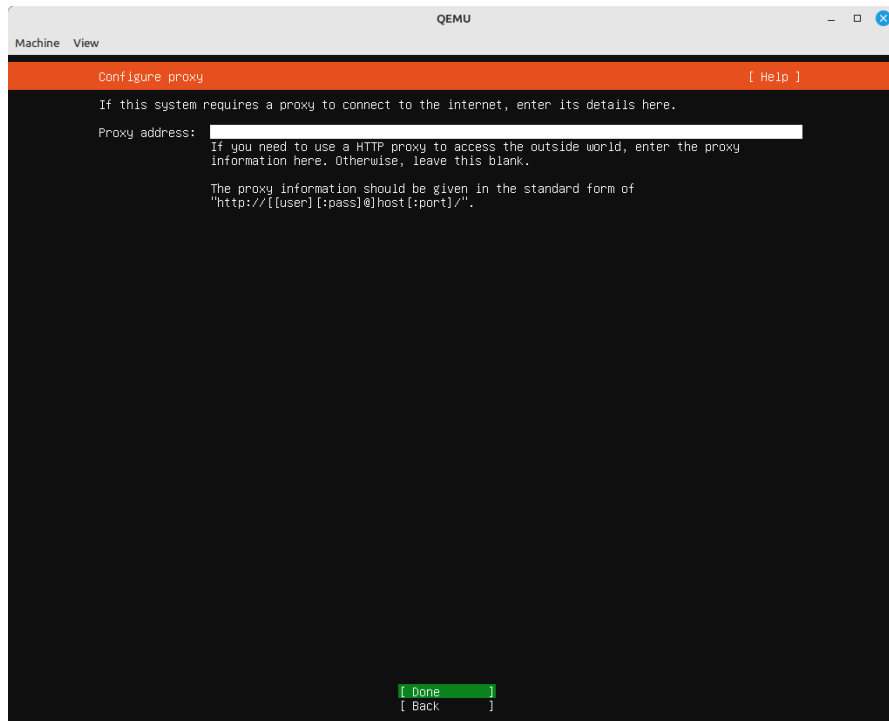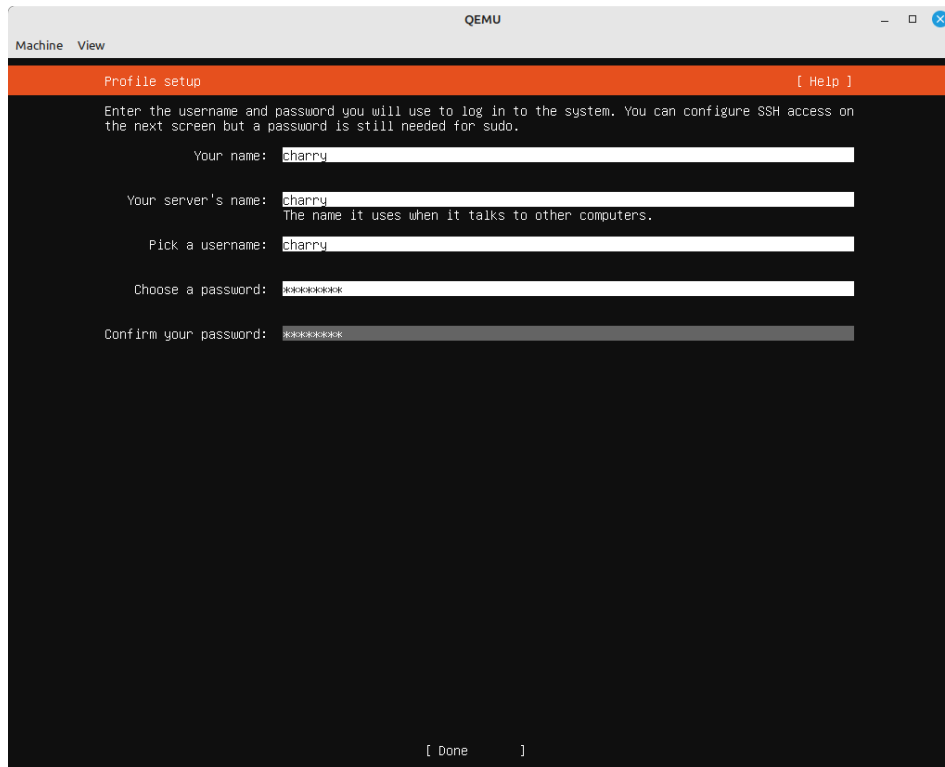
Load QEMU system image ISO
```
sudo qemu-system-x86_64 -hda qcow2.img -boot d -cdrom
./ubuntu-20.04.6-live-server-amd64.iso -m 2046 -boot strict=on

sudo qemu-system-x86_64 -hda raw.img -boot d -cdrom
./ubuntu-20.04.6-live-server-amd64.iso -m 2046 -boot strict=on
```

The command above will spin up a QEMU instance with graphical user interface installer

## QEMU

Machine   View

Use UP, DOWN and ENTER keys to select your language.

```
                    [ Asturianu                                    ► ]
                    [ Bahasa Indonesia                             ► ]
                    [ Català                                       ► ]
                    [ Deutsch                                      ► ]
                    [ English                                      ► ]
                    [ English (UK)                                 ► ]
                    [ Español                                      ► ]
                    [ Français                                     ► ]
                    [ Galego                                       ► ]
                    [ Hrvatski                                     ► ]
                    [ Latviski                                     ► ]
                    [ Lietuviškai                                  ► ]
                    [ Magyar                                       ► ]
                    [ Nederlands                                   ► ]
                    [ Norsk bokmål                                 ► ]
                    [ Polski                                       ► ]
                    [ Português                                    ► ]
                    [ Suomi                                        ► ]
                    [ Svenska                                      ► ]
                    [ Čeština                                      ► ]
                    [ Ελληνικά                                     ► ]
                    [ Беларуская                                   ► ]
                    [ Русский                                      ► ]
                    [ Српски                                       ► ]
                    [ Українська                                   ► ]
```

QEMU

Machine   View

Configure a guided storage layout, or create a custom one:

```
(X)  Use an entire disk

     [ QEMU_HARDDISK_QM00001                    local disk 10.000G ▼ ]

     [X]  Set up this disk as an LVM group

          [ ]  Encrypt the LVM group with LUKS

                    Passphrase:


                    Confirm passphrase:


( )  Custom storage layout
```

```
                              [ Done      ]
                              [ Back      ]
```

Configure proxy   [Help]

If this system requires a proxy to connect to the internet, enter its details here.

Proxy address: _____

If you need to use a HTTP proxy to access the outside world, enter the proxy
information here. Otherwise, leave this blank.

The proxy information should be given in the standard form of
"http://[[user][:pass]@]host[:port]/".

[Done]
[Back]

Storage configuration   [Help]

FILE SYSTEM SUMMARY

```
    MOUNT POINT     SIZE    TYPE      DEVICE TYPE
[ /              8.246G  new ext4  new LVM logical volume        ► ]
[ /boot          1.750G  new ext4  new partition of local disk  ► ]
```

AVAILABLE DEVICES

   No available devices

[Create software RAID (md) ►]
[Create volume group (LVM) ►]

USED DEVICES

```
    DEVICE                              TYPE                SIZE
[ ubuntu-vg (new)                     LVM volume group    8.246G  ► ]
  ubuntu-lv    new, to be formatted as ext4, mounted at /        8.246G  ►

[ QEMU_HARDDISK_QM00001               local disk          10.000G ► ]
  partition 1  new, BIOS grub spacer                       1.000M  ►
  partition 2  new, to be formatted as ext4, mounted at /boot  1.750G  ►
  partition 3  new, PV of LVM volume group ubuntu-vg       8.247G  ►
```

[Done]
[Reset]
[Back]

Install sysbench:

```
sudo apt install sysbench
sysbench —version
```

Docker Installation

Following https://docs.docker.com/engine/install/ubuntu/ to install docker on the host OS. LinuxMint is a derivation of Ubuntu

Install docker
```
sudo apt-get install docker-ce docker-ce-cli containerd.io
docker-buildx-plugin docker-compose-plugin
```

Pull docker ubuntu 20.04 image
```
sudo docker pull ubuntu:20.04
```

Launch docker container
```
docker run -it --cpus=2 --memory=2G ubuntu:20.04 /bin/bash
```

Install sysbench in docker
```
apt update
```

```
apt install sysbench vim
```



```
root@a87b6ee8eae4:/                                              _  □  ⊗

File  Edit  View  Search  Terminal  Tabs  Help

charry@cyberpower... ✕   charry@cyberpower... ✕   charry@cyberpower... ✕   sudo qemu-system-... ✕   root@a87b6ee8eae... ✕   ⊞  ▼

Preparing to unpack .../25-libmysqlclient21_8.0.36-0ubuntu0.20.04.1_amd64.deb ...
Unpacking libmysqlclient21:amd64 (8.0.36-0ubuntu0.20.04.1) ...
Selecting previously unselected package libpq5:amd64.
Preparing to unpack .../26-libpq5_12.17-0ubuntu0.20.04.1_amd64.deb ...
Unpacking libpq5:amd64 (12.17-0ubuntu0.20.04.1) ...
Selecting previously unselected package libsasl2-modules:amd64.
Preparing to unpack .../27-libsasl2-modules_2.1.27+dfsg-2ubuntu0.1_amd64.deb ...
Unpacking libsasl2-modules:amd64 (2.1.27+dfsg-2ubuntu0.1) ...
Selecting previously unselected package sysbench.
Preparing to unpack .../28-sysbench_1.0.18+ds-1_amd64.deb ...
Unpacking sysbench (1.0.18+ds-1) ...
Setting up mysql-common (5.8+1.0.5ubuntu2) ...
update-alternatives: using /etc/mysql/my.cnf.fallback to provide /etc/mysql/my.cnf (my.cnf) in auto mode
Setting up libkeyutils1:amd64 (1.6-6ubuntu1.1) ...
Setting up libssl1.1:amd64 (1.1.1f-1ubuntu2.21) ...
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based frontend cannot be used. at /usr/share/perl5
/Debconf/FrontEnd/Dialog.pm line 76.)
debconf: falling back to frontend: Readline
debconf: unable to initialize frontend: Readline
debconf: (Can't locate Term/ReadLine.pm in @INC (you may need to install the Term::ReadLine module) (@INC contains: /e
tc/perl /usr/local/lib/x86_64-linux-gnu/perl/5.30.0 /usr/local/share/perl/5.30.0 /usr/lib/x86_64-linux-gnu/perl5/5.30
/usr/share/perl5 /usr/lib/x86_64-linux-gnu/perl/5.30 /usr/share/perl/5.30 /usr/local/lib/site_perl /usr/lib/x86_64-lin
ux-gnu/perl-base) at /usr/share/perl5/Debconf/FrontEnd/Readline.pm line 7.)
debconf: falling back to frontend: Teletype
Setting up libsqlite3-0:amd64 (3.31.1-4ubuntu0.6) ...
Setting up libsasl2-modules:amd64 (2.1.27+dfsg-2ubuntu0.1) ...
Setting up krb5-locales (1.17-6ubuntu4.4) ...
Setting up libldap-common (2.4.49+dfsg-2ubuntu1.10) ...
Setting up libkrb5support0:amd64 (1.17-6ubuntu4.4) ...
Setting up libsasl2-modules-db:amd64 (2.1.27+dfsg-2ubuntu0.1) ...
Setting up libluajit-5.1-common (2.1.0~beta3+dfsg-5.1build1) ...
Setting up libk5crypto3:amd64 (1.17-6ubuntu4.4) ...
Setting up libsasl2-2:amd64 (2.1.27+dfsg-2ubuntu0.1) ...
Setting up libroken18-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libkrb5-3:amd64 (1.17-6ubuntu4.4) ...
Setting up libaio1:amd64 (0.3.112-5) ...
Setting up libheimbase1-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libmysqlclient21:amd64 (8.0.36-0ubuntu0.20.04.1) ...
Setting up libasn1-8-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libhcrypto4-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libluajit-5.1-2:amd64 (2.1.0~beta3+dfsg-5.1build1) ...
Setting up libwind0-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libgssapi-krb5-2:amd64 (1.17-6ubuntu4.4) ...
Setting up libhx509-5-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libkrb5-26-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libheimntlm0-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libgssapi3-heimdal:amd64 (7.7.0+dfsg-1ubuntu1.4) ...
Setting up libldap-2.4-2:amd64 (2.4.49+dfsg-2ubuntu1.10) ...
Setting up libpq5:amd64 (12.17-0ubuntu0.20.04.1) ...
Setting up sysbench (1.0.18+ds-1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.14) ...
root@a87b6ee8eae4:/# sysbench --version
sysbench 1.0.18
root@a87b6ee8eae4:/# |
```

sysbench --version
sysbench 1.0.18

Create docker image: get running container id by
`sudo docker ps`, and then run
```
sudo docker commit [container id] ubuntu-sysbench
```

```
charry@cyberpowerpc  ~/csen241  main  sudo docker ps
[sudo] password for charry:
CONTAINER ID   IMAGE          COMMAND        CREATED          STATUS            PORTS     NAMES
8a6fce70345c   ubuntu:20.04   "/bin/bash"    About a minute ago   Up About a minute         confident_rosalind
charry@cyberpowerpc  ~/csen241  main  docker commit 8a6fce70345c ubuntu-sysbench
Cannot connect to the Docker daemon at unix:///home/charry/.docker/desktop/docker.sock. Is the docker daemon running?
X charry@cyberpowerpc  ~/csen241  main  sudo docker commit 8a6fce70345c ubuntu-sysbench
sha256:28592dd1c66a784ed4a20ea85e334bb4b2e88a90c8d89030c1addbff4af38a0d
charry@cyberpowerpc  ~/csen241  main  sudo docker images
REPOSITORY                                          TAG       IMAGE ID       CREATED         SIZE
ubuntu-sysbench                                     latest    28592dd1c66a   5 seconds ago   142MB
ubuntu                                              20.04     18ca3f4297e7   2 weeks ago     72.8MB
```

QEMU Experiment:

Machine configurations:
Machine config varies on # CPUs, 2 core vs 4 core, and Memory size, 2 GiB vs 4 GiB, and disk
format, QCOW2 vs. RAW
2 CPU, 2 GiB Memory, QCOW2
2 CPU, 4 GiB Memory, QCOW2
4 CPU, 2 GiB Memory, QCOW2
4 CPU, 4 GiB Memory, QCOW2
2 CPU, 2 GiB Memory, RAW
2 CPU, 4 GiB Memory, RAW
4 CPU, 2 GiB Memory, RAW
4 CPU, 4 GiB Memory, RAW

Test cases setup for QEMU config
1) CPU Test1: --cpu-max-prime=2000
2) CPU Test2: --cpu-max-prime=5000
3) Memory Test1: --memory-block-size=1K
4) Memory Test2: --memory-block-size=1M
5) File read Test: --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndrd
6) File write Test: --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndwr

```bash
You, 7 minutes ago | 1 author (You)
#!/bin/bash


for ((current=1;current ≤ 5;current++))
do
    echo "Round: $current"

    # CPU-Test-1
    sysbench --test=cpu --cpu-max-prime=500 run | tee cpu-test-1-$current.txt

    # CPU-Test-2
    sysbench --test=cpu --cpu-max-prime=5000 run | tee cpu-test-2-$current.txt        You, 9 minutes ago • Add  test case

    # Memory-Test-1
    sysbench --test=memory --memory-block-size=1K run | tee memory-test-1-$current.txt

    # Memory-Test-2
    sysbench --test=memory --memory-block-size=1M run | tee memory-test-2-$current.txt

    # File Read
    sysbench --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndrd prepare && echo 3 > /proc/sys/vm/drop_caches
    sysbench --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndrd run | tee fileio-test-rndrd-$current.txt && echo 3 > /proc/sys/vm/drop_caches
    sysbench --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndrd cleanup && echo 3 > /proc/sys/vm/drop_caches


    # File Write
    sysbench --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndwr prepare && echo 3 > /proc/sys/vm/drop_caches
    sysbench --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndwr run | tee fileio-test-rndwr-$current.txt && echo 3 > /proc/sys/vm/drop_caches
    sysbench --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndwr cleanup && echo 3 > /proc/sys/vm/drop_caches

done
```

```
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing random write test
Initializing worker threads...

Threads started!


File operations:
    reads/s:                    0.00
    writes/s:                   2406.75
    fsyncs/s:                   3092.22

Throughput:
    read, MiB/s:                0.00
    written, MiB/s:             37.61

General statistics:
    total time:                         10.0123s
    total number of events:             54936

Latency (ms):
        min:                                0.00
        avg:                                0.18
        max:                                9.26
        95th percentile:                    0.59
        sum:                             9980.76

Threads fairness:
    events (avg/stddev):            54936.0000/0.00
    execution time (avg/stddev):    9.9808/0.00

run_testcase.sh: line 28: /proc/sys/vm/drop_caches: Permission denied
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Removing test files...
run_testcase.sh: line 29: /proc/sys/vm/drop_caches: Permission denied
charry@charry:~$ ls
cpu-test-1-1.txt  cpu-test-2-3.txt        fileio-test-rndrd-5.txt  memory-test-1-2.txt  memory-test-2-4.txt
cpu-test-1-2.txt  cpu-test-2-4.txt        fileio-test-rndwr-1.txt  memory-test-1-3.txt  memory-test-2-5.txt
cpu-test-1-3.txt  cpu-test-2-5.txt        fileio-test-rndwr-2.txt  memory-test-1-4.txt  run_testcase.sh
cpu-test-1-4.txt  fileio-test-rndrd-1.txt  fileio-test-rndwr-3.txt  memory-test-1-5.txt
cpu-test-1-5.txt  fileio-test-rndrd-2.txt  fileio-test-rndwr-4.txt  memory-test-2-1.txt
cpu-test-2-1.txt  fileio-test-rndrd-3.txt  fileio-test-rndwr-5.txt  memory-test-2-2.txt
cpu-test-2-2.txt  fileio-test-rndrd-4.txt  memory-test-1-1.txt      memory-test-2-3.txt
charry@charry:~$
```

```
                        avg:                              0.04
                        max:                              0.39
                        95th percentile:                  0.04
                        sum:                           3708.45

Threads fairness:
        events (avg/stddev):           102400.0000/0.00
        execution time (avg/stddev):   3.7085/0.00

charry@charry:~$ cat memory-test-2-4.txt
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time


Running memory speed test with the following options:
  block size: 1024KiB
  total size: 102400MiB
  operation: write
  scope: global

Initializing worker threads...

Threads started!

Total operations: 102400 (28245.24 per second)

102400.00 MiB transferred (28245.24 MiB/sec)


General statistics:
    total time:                        3.6241s
    total number of events:            102400

Latency (ms):
        min:                              0.03
        avg:                              0.04
        max:                              0.11
        95th percentile:                  0.04
        sum:                           3604.58

Threads fairness:
        events (avg/stddev):           102400.0000/0.00
        execution time (avg/stddev):   3.6046/0.00

charry@charry:~$ cat memory-test-2-4.txt
```

Docker Experiment:

4 Docker configurations, 2 CPU vs 4 CPU, 2GB Mem vs. 4GB Mem:

```
sudo docker run --cpus=2 --memory=2048M -it ubuntu-sysbench /bin/bash
sudo docker run --cpus=4 --memory=2048M -it ubuntu-sysbench /bin/bash
sudo docker run --cpus=2 --memory=4096M -it ubuntu-sysbench /bin/bash
sudo docker run --cpus=4 --memory=4096M -it ubuntu-sysbench /bin/bash
```

Test cases setup for Docker (same as qemu)
  7) CPU Test1: --cpu-max-prime=2000, measurement: events per second
  8) CPU Test2: --cpu-max-prime=5000, measurement: events per second
  9) Memory Test1: --memory-block-size=1K
  10) Memory Test2: --memory-block-size=1M
  11) File read Test: --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndrd
  12) File write Test: --num-threads=1 --test=fileio --file-total-size=2G --file-test-mode=rndwr

Sample screenshot:

```
                              root@d02b2ff4ebf3: /                    _  □  ⊗

File  Edit  View  Search  Terminal  Tabs  Help

  sudo qemu-system-x86_64 -hda qcow2.img -boot d -cdrom -m 2...  ×        root@d02b2ff4ebf3: /              ×    ⊞  ▼

Using synchronous I/O mode
Doing random write test
Initializing worker threads...

Threads started!


File operations:
    reads/s:                    0.00
    writes/s:                   3183.83
    fsyncs/s:                   4075.50

Throughput:
    read, MiB/s:                0.00
    written, MiB/s:             49.75

General statistics:
    total time:                         10.0495s
    total number of events:             72834

Latency (ms):
        min:                                    0.00
        avg:                                    0.14
        max:                                    118.09
        95th percentile:                        0.32
        sum:                                    9977.49

Threads fairness:
    events (avg/stddev):            72834.0000/0.00
    execution time (avg/stddev):    9.9775/0.00

run_testcase.sh: line 28: /proc/sys/vm/drop_caches: Read-only file system
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Removing test files...
run_testcase.sh: line 29: /proc/sys/vm/drop_caches: Read-only file system
Round: 3
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time


Prime numbers limit: 500

Initializing worker threads...

Threads started!

CPU speed:
    events per second: 273485.07

General statistics:
```

Result:

QEMU

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
	CPU Test 1	events per second	39569.15	39392.45	38706.24	38765.11	38936.35	386.067286	39073.86	39569.15	38706.24
	CPU Test 2	events per second	10613.82	10417.9	10416.13	10517.3	10401.13	91.14266087	10473.256	10613.82	10401.13
	Memory Test 1	operations per second	8088495.3	8048981.77	7765123.4	8016711.31	7983291.45	126549.2656	7980520.646	8088495.3	7765123.4
	Memory Test 2	operations per second	2845451.51	2854772	2742885	2824524	2800414	447.3095952	2813696.092	2854772	2742885
2CPU 2GB RAM QCOW2	fileio-test-rndrd-	read, MiB/s	331.76	498.98	498.74	517.14	500.73	77.3647749	469.47	517.14	331.76
	fileio-test-rndwr-	written, MiB/s	36.81	35.82	37.26	37.91	37.61	0.8158860215	37.082	37.91	35.82

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
	CPU Test 1	events per second	39270.61	39342.39	39590.44	39368.62	37404.72	897.1860491	38995.356	39590.44	37404.72
	CPU Test 2	events per second	10252.86	10565.45	10608.01	10516.71	9972.78	267.867786	10383.162	10608.01	9972.78
	Memory Test 1	operations per second	7969669.2	8049912.28	8096641.76	8020502.58	7632790.52	185330.4059	7953903.268	8096641.76	7632790.52
	Memory Test 2	operations per second	2814850.5	2848383.01	2809379	2831135	2768534	298.2630132	2814444.398	2848383.01	2768534
2CPU 4GB RAM QCOW2	fileio-test-rndrd-	read, MiB/s	7447.4	7533.59	7577.76	7387.71	7354.47	94.6096159 5	7460.186	7577.76	7354.47
	fileio-test-rndwr-	written, MiB/s	37.87	37.9	37.89	35.82	37.04	0.9070446516	37.304	37.9	35.82

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
	CPU Test 1	events per second	39348.84	38459.67	39147.65	38349.79	39493.63	522.9379415	38959.916	39493.63	38349.79
	CPU Test 2	events per second	10441.89	10461.89	10443.02	10257.33	10574.57	113.8843058	10435.74	10574.57	10257.33
	Memory Test 1	operations per second	8032121.04	7977483.52	7938829.37	7902540.91	8037965.86	58637.54382	7977788.14	8037965.86	7902540.91
	Memory Test 2	operations per second	28346.73	28209.33	28024.83	28104.14	28047.35	132.7293674	28146.476	28346.73	28024.83
4CPU 2GB RAM QCOW2	fileio-test-rndrd-	read, MiB/s	423.57	506.91	525.36	538.46	522.04	45.94550217	503.268	538.46	423.57
	fileio-test-rndwr-	written, MiB/s	35.48	36.94	37.03	37.36	37.44	0.794606821	36.85	37.44	35.48

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
	CPU Test 1	events per second	38888.18	39554.6	39557.93	39656.68	39307.03	310.2731109	39392.884	39656.68	38888.18
	CPU Test 2	events per second	10452.83	10341.04	10599.77	10596.48	10544.67	110.1238778	10506.958	10599.77	10341.04
	Memory Test 1	operations per second	10058601.03	9199862.38	8898490.42	9383722.42	9585749.64	434998.112	9425285.178	10058601.03	8898490.42
	Memory Test 2	operations per second	7939044.31	7763770.87	8099686.21	8060812.09	8095252.34	143077.6876	7991713.164	8099686.21	7763770.87
4CPU 4GB RAM QCOW2	fileio-test-rndrd-	read, MiB/s	7382.88	7520.41	7692.29	7551.87	7679.79	127.1877	7565.448	7692.29	7382.88
	fileio-test-rndwr-	written, MiB/s	37.39	37.89	37.66	37.61	37.42	0.2025586335	37.594	37.89	37.39

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
2CPU 2GB RAM RAW	CPU Test 1	events per second	39813.46	39788.43	39828.7	39077.41	39323.76	345.370320 3	39566.352	39828.7	39077.41
	CPU Test 2	events per second	10619.65	10618.22	10601.53	10527.65	10471.45	65.69 552268	10567.7	10619.65	10471.45
	Memory Test 1	operations per second	8122233.6	8138954.44	8090918.56	8076308.56	8088850.67	26077.8834 9	8103453.16 6	8138954.44	8076308.56
	Memory Test 2	operations per second	28691.15	28745.94	28520.2	28155.46	28381.2	239.9 201832	28498.79	28745.94	28155.46
	fileio-test-rndrd-	read, MiB/s	389.17	507.23	516.58	528.25	545.38	62.11 281406	497.322	545.38	389.17
	fileio-test-rndwr-	written, MiB/s	38.39	38.65	36.89	37.82	38	0.675 758327	37.95	38.65	36.89

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
4CPU 2GB RAM RAW	CPU Test 1	events per second	39511.55	39440.12	39114.77	39526.09	38161.86	577.4923513	39150.878	39526.09	38161.86
	CPU Test 2	events per second	10426.78	10524.97	10528.64	10566.46	10384.26	76.92273994	10486.222	10566.46	10384.26
	Memory Test 1	operations per second	8002568.71	7987267.68	8051617.68	8036828.95	7917809.74	52301.17643	7999218.552	8051617.68	7917809.74
	Memory Test 2	operations per second	28016.16	27849.94	28446.45	28312.13	27550.1	359.103846	28034.956	28446.45	27550.1
	fileio-test-rndrd-	read, MiB/s	427.65	467.9	524.67	524.7	525.74	44.6486614	494.132	525.74	427.65
	fileio-test-rndwr-	written, MiB/s	37.98	37.89	37.82	37.67	33.7	1.854931266	37.012	37.98	33.7

Docker

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
2 CPU, 2GB Ram	CPU Test 1	events per second	38938.12	38681.14	38666.01	39406.29	39575.75	418.1264323	39053.462	39575.75	38666.01
	CPU Test 2	events per second	10613.82	10417.23	10416.13	10517.94	10401.43	91.26356091	10473.31	10613.82	10401.43
	Memory Test 1	operations per second	8088495.11	8048981.15	7765123.51	8016711.37	7983291.71	126549.1001	7980520.57	8088495.11	7765123.51
	Memory Test 2	operations per second	28454.74	28547.16	27428.28	28245.11	27726.48	483.6436104	28080.354	28547.16	27428.28
	fileio-test-rndrd-	read, MiB/s	2294.4	3138.49	3404.12	3236.72	3312.5	448.392044	3077.246	3404.12	2294.4

			Round 1	Round 2	Round d 3	Round d 4	Round d 5	STD	AVG	MAX	MIN
	fileio-test-rndwr-	written, MiB/s	56.74	49.75	47.79	59.98	59.02	5.5439904	54.656	59.98	47.79
			Round 1	Round 2	Round d 3	Round d 4	Round d 5	STD	AVG	MAX	MIN
	CPU Test 1	events per second	39326.91	39083.65	39129.12	39449.44	39147.08	154.9017406	39227.24	39449.44	39083.65
	CPU Test 2	events per second	10660.4	10573.71	10525.74	10565.39	10559.19	50.11460595	10576.886	10660.4	10525.74
	Memory Test 1	operations per second	9146849.82	9085308.52	9034468.06	9043096.39	9114371.12	47427.26905	9084818.782	9146849.82	9034468.06
	Memory Test 2	operations per second	27440.98	27882.9	28426.76	28416.4	28644.36	491.2368689	28162.28	28644.36	27440.98
	fileio-test-rndrd-	read, MiB/s	4818.87	9556.89	9785.81	9650.99	9532.23	2154.56403	8668.958	9785.81	4818.87
2 CPU, 4GB Ram	fileio-test-rndwr-	written, MiB/s	65.23	66.14	65.84	66.15	66.11	0.3925939378	65.894	66.15	65.23
			Round 1	Round 2	Round d 3	Round d 4	Round d 5	STD	AVG	MAX	MIN
	CPU Test 1	events per second	40152.52	39570.41	39878.35	39694.04	39542.95	252.5824353	39767.654	40152.52	39542.95
	CPU Test 2	events per second	10660.4	10629.56	10643.16	10605.15	10613.92	22.2073686	10630.438	10660.4	10605.15
	Memory Test 1	operations per second	9180704.1	9153574.35	9160980.01	9201513.09	9191219.18	20127.15381	9177598.146	9201513.09	9153574.35
4 CPU, 2GB Ram	Memory Test 2	operations per second	28671.36	28560.95	28635.24	28646.8	28679.59	47.06716764	28638.788	28679.59	28560.95

			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
	fileio-test-rndrd-	read, MiB/s	3744.1	3832.22	3769.81	3813.6	3806.55	35.61891815	3793.256	3832.22	3744.1
	fileio-test-rndwr-	written, MiB/s	65.19	63.68	63.99	66.09	65.8	1.07403445	64.95	66.09	63.68
			Round 1	Round 2	Round 3	Round 4	Round 5	STD	AVG	MAX	MIN
4 CPU, 4GB Ram	CPU Test 1	events per second	39648.2	38984.14	39532.37	39557.93	39239.35	275.011961	39392.398	39648.2	38984.14
	CPU Test 2	events per second	10466.58	10470.09	10541.09	10486.34	10521.1	32.74099189	10497.04	10541.09	10466.58
	Memory Test 1	operations per second	9105161.16	9144597.64	9141222.92	8862597.46	9014369.88	118993.5627	9053589.812	9144597.64	8862597.46
	Memory Test 2	operations per second	28159.38	28679.9	28453.97	26821.4	27933.65	722.286034	28009.66	28679.9	26821.4
	fileio-test-rndrd-	read, MiB/s	8683.33	9367.16	9673.32	8793.23	9514.15	442.4024381	9206.238	9673.32	8683.33
	fileio-test-rndwr-	written, MiB/s	65.06	65.65	49.27	48.06	66.3	9.334150738	58.868	66.3	48.06

Conclusion

The above data was the average of 5 times for each case. From the table:

Test case cpu-max-prime=2000 has higher performance to cpu-max-prime=5000

4 CPU count and 4GB Memory size have slightly better performance than 2CPU and 2GB memory across CPU Test 1, CPU Test 2, Memory Test 1, Memory Test 2.

However, 4CPU and 4GB memory yields much better performance gains than 2CPU and 2GB memory for file io read test: fileio-test-rndrd.

The first test case of fileio-test-rndrd has lower performance than subsequent iterations, this could be due to cold start.

docker experiment shows more variation in performance in fileio write test cases, but QEMU experiment all configurations are almost identical for file io write test