

Homework 1

COEN 241 System vs OS Virtualization

Host System Configuration

- CPU: Apple M1 Pro with 10 CPU cores
- Memory: 16GB
- OS: MacOS

QEMU Installation:

```
brew install qemu
```

```
qemu-img create -f raw /qemu/ubuntu-latest.raw 35G
```

Download UEFI driver files namely, QEMU_EFI.fd and QEMU_VARS.fd

https://gist.github.com/theboreddev/5f79f86a0f163e4a1f9df919da5eea20#:~:text=QEMU_EFI%2Dcb438b9%2Dedk2%2Dstable202011%2Dwith%2Dextra%2Dresolutions.tar.gz

Install Ubuntu (CPUs set to 4 and memory 3000MB)

```
qemu-system-aarch64 \
    -monitor stdio \
    -M virt,highmem=off \
    -accel hvf \
    -cpu host \
    -smp 4 \
    -m 3000 \
    -bios QEMU_EFI.fd \
    -device virtio-gpu-pci \
    -display default,show-cursor=on \
    -device qemu-xhci \
    -device usb-kbd \
    -device usb-tablet \
    -device intel-hda \
    -device hda-duplex \
    -drive file=ubuntu-latest.raw,format=raw,if=virtio,cache=writethrough \
    -cdrom ubuntu-22.04.1-live-server-arm64.iso
```

Start Ubuntu with 4 cpus and 3000MB memory

```
himanshudahiya@Himanshus-MacBook-Pro coen241 % qemu-system-aarch64 \
    -monitor stdio \
    -M virt,highmem=off \
    -accel hvf \
    -cpu host \
    -smp 4 \
    -m 3000 \
    -bios QEMU_EFI.fd \
    -device virtio-gpu-pci \
    -display default,show-cursor=on \
    -device qemu-xhci \
    -device usb-kbd \
    -device usb-tablet \
    -device intel-hda \
    -device hda-duplex \
    -drive file=ubuntu.raw,format=raw,if=virtio,cache=writethrough
QEMU 7.2.0 monitor - type 'help' for more information
(qemu) audio: Failed to create voice 'adc'
himanshudahiya@Himanshus-MacBook-Pro coen241 %
```

Login Ubuntu



The screenshot shows a terminal window titled "QEMU - (Press ctrl + alt + g to release Mouse)". The terminal displays the following text:

```
Ubuntu 20.04.5 LTS hd tty1
hd login: hdahiya
Password:
Welcome to Ubuntu 20.04.5 LTS (GNU/Linux 5.4.0-137-generic aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 System information as of Tue 07 Feb 2023 09:24:53 AM UTC

 System load:          0.05
 Usage of /:            34.4% of 15.62GB
 Memory usage:          7%
 Swap usage:            0%
 Processes:             132
 Users logged in:      0
 IPv4 address for enp0s1: 10.0.2.15
 IPv6 address for enp0s1: fec0::5054:ff:fe12:3456

25 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

Last login: Sun Feb  5 02:19:00 UTC 2023 on tty1
hdahiya@hd:~$
```

Install sysbench on Ubuntu

```
sudo apt update
```

```
sudo apt install sysbench
```

```
hdahiya@hd:~$ sudo apt update
[sudo] password for hdahiya:
Hit:1 http://ports.ubuntu.com/ubuntu-ports focal InRelease
Get:2 http://ports.ubuntu.com/ubuntu-ports focal-updates InRelease [114 kB]
Get:3 http://ports.ubuntu.com/ubuntu-ports focal-backports InRelease [108 kB]
Get:4 http://ports.ubuntu.com/ubuntu-ports focal-security InRelease [114 kB]
Get:5 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 Packages [1,690 kB]
Get:6 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 c-n-f Metadata [15.9 kB]
Get:7 http://ports.ubuntu.com/ubuntu-ports focal-updates/universe arm64 Packages [946 kB]
Get:8 http://ports.ubuntu.com/ubuntu-ports focal-updates/universe Translation-en [237 kB]
Get:9 http://ports.ubuntu.com/ubuntu-ports focal-updates/universe arm64 c-n-f Metadata [21.7 kB]
Get:10 http://ports.ubuntu.com/ubuntu-ports focal-security/universe arm64 Packages [718 kB]
Get:11 http://ports.ubuntu.com/ubuntu-ports focal-security/universe Translation-en [154 kB]
Get:12 http://ports.ubuntu.com/ubuntu-ports focal-security/universe arm64 c-n-f Metadata [15.0 kB]
Fetched 4,138 kB in 3s (1,278 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
27 packages can be upgraded. Run 'apt list --upgradable' to see them.
hdahiya@hd:~$
```

```
● ● ● QEMU - (Press ctrl + alt + g to release Mouse)
Fetched 1,770 kB in 2s (993 kB/s)
Selecting previously unselected package libluajit-5.1-common.
(Reading database ... 70577 files and directories currently installed.)
Preparing to unpack .../0-libluajit-5.1-common_2.1.0~beta3+dfsg-5.1build1_all.deb ...
Unpacking libluajit-5.1-common (2.1.0~beta3+dfsg-5.1build1) ...
Selecting previously unselected package libluajit-5.1-2:arm64.
Preparing to unpack .../1-libluajit-5.1-2_2.1.0~beta3+dfsg-5.1build1_arm64.deb ...
Unpacking libluajit-5.1-2:arm64 (2.1.0~beta3+dfsg-5.1build1) ...
Selecting previously unselected package mysql-common.
Preparing to unpack .../2-mysql-common_5.8+1.0.5ubuntu2_all.deb ...
Unpacking mysql-common (5.8+1.0.5ubuntu2) ...
Selecting previously unselected package libmysqclient21:arm64.
Preparing to unpack .../3-libmysqclient21_8.0.32-0ubuntu0.20.04.2_arm64.deb ...
Unpacking libmysqclient21:arm64 (8.0.32-0ubuntu0.20.04.2) ...
Selecting previously unselected package libpq5:arm64.
Preparing to unpack .../4-libpq5_12.13-0ubuntu0.20.04.1_arm64.deb ...
Unpacking libpq5:arm64 (12.13-0ubuntu0.20.04.1) ...
Selecting previously unselected package sysbench.
Preparing to unpack .../5-sysbench_1.0.18+ds-1_arm64.deb ...
Unpacking sysbench (1.0.18+ds-1) ...
Setting up mysql-common (5.8+1.0.5ubuntu2) ...
Update-alternatives: using /etc/mysql/my.cnf (my.cnf) in auto mode
Setting up libmysqlclient21:arm64 (8.0.32-0ubuntu0.20.04.2) ...
Setting up libpq5:arm64 (12.13-0ubuntu0.20.04.1) ...
Setting up libluajit-5.1-common (2.1.0~beta3+dfsg-5.1build1) ...
Setting up libluajit-5.1-2:arm64 (2.1.0~beta3+dfsg-5.1build1) ...
Setting up sysbench (1.0.18+ds-1) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
hdahiya@hd:~$ sudo apt install sysbench
Reading package lists... Done
Building dependency tree
Reading state information... Done
sysbench is already the newest version (1.0.18+ds-1).
0 upgraded, 0 newly installed, 0 to remove and 27 not upgraded.
hdahiya@hd:~$
```

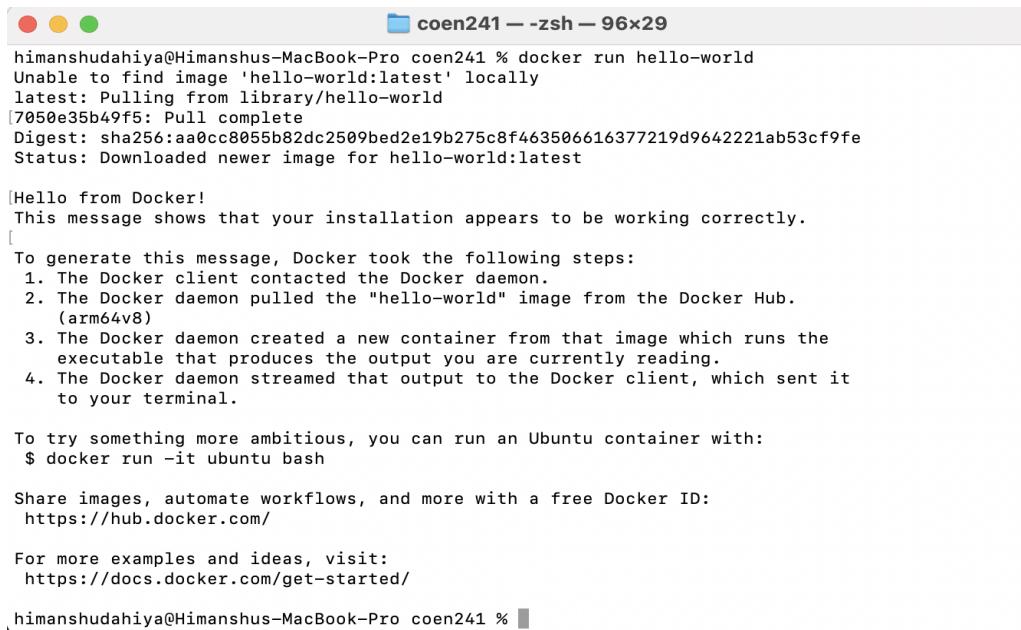
```
Last login: Sun Feb  5 02:12:59 UTC 2023 on tty1
hdahiya@hd:~$ sysbench --version
sysbench 1.0.18
hdahiya@hd:~$
```

Docker Installation:

Download docker and install

Start docker

docker run hello-world



```
himanshudahiya@Himanshus-MacBook-Pro coen241 % docker run hello-world
Unable to find image 'hello-world:latest' locally
latest: Pulling from library/hello-world
7050e35b49f5: Pull complete
Digest: sha256:aa0cc8055b82dc2509bed2e19b275c8f463506616377219d9642221ab53cf9fe
Status: Downloaded newer image for hello-world:latest

[Hello from Docker!
This message shows that your installation appears to be working correctly.
]

To generate this message, Docker took the following steps:
1. The Docker client contacted the Docker daemon.
2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
   (arm64v8)
3. The Docker daemon created a new container from that image which runs the
   executable that produces the output you are currently reading.
4. The Docker daemon streamed that output to the Docker client, which sent it
   to your terminal.

To try something more ambitious, you can run an Ubuntu container with:
$ docker run -it ubuntu bash

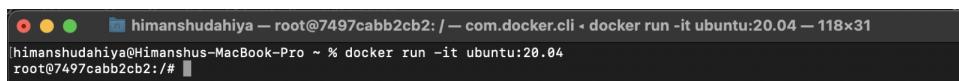
Share images, automate workflows, and more with a free Docker ID:
https://hub.docker.com/

For more examples and ideas, visit:
https://docs.docker.com/get-started/
```

Download Ubuntu image

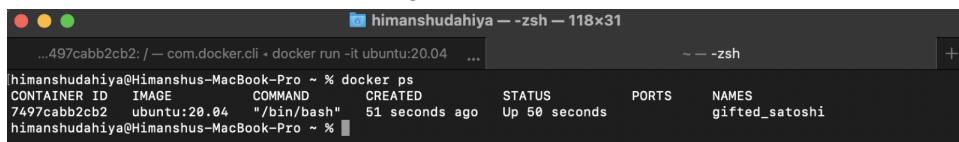
```
himanshudahiya@Himanshus-MacBook-Pro coen241 % docker pull ubuntu:latest
latest: Pulling from library/ubuntu
8b150fd943bc: Pull complete
Digest: sha256:9a0bdde4188b896a372804be2384015e90e3f84906b750c1a53539b585fbbe7f
Status: Downloaded newer image for ubuntu:latest
docker.io/library/ubuntu:latest
himanshudahiya@Himanshus-MacBook-Pro coen241 %
```

Run Ubuntu container



```
himanshudahiya — root@7497cab2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 — 118x31
himanshudahiya@Himanshus-MacBook-Pro ~ % docker run -it ubuntu:20.04
root@7497cab2cb2:/#
```

Check if the container is running



```
...497cab2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 ...
~ — -zsh
himanshudahiya@Himanshus-MacBook-Pro ~ % docker ps
CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES
7497cab2cb2 ubuntu:20.04 "/bin/bash" 51 seconds ago Up 50 seconds gifted_satoshi
himanshudahiya@Himanshus-MacBook-Pro ~ %
```

Update and install sudo command

```
himanshudahiya - root@7497cabbb2cb2: / - com.docker.cli - docker run -it ubuntu:20.04 - 118x31
...497cabbb2cb2: / - com.docker.cli - docker run -it ubuntu:20.04
+---zsh

[root@7497cabbb2cb2: /# apt-get update
Get:1 http://ports.ubuntu.com/ubuntu-ports focal InRelease [265 kB]
Get:2 http://ports.ubuntu.com/ubuntu-ports focal-updates InRelease [114 kB]
Get:3 http://ports.ubuntu.com/ubuntu-ports focal-backports InRelease [108 kB]
Get:4 http://ports.ubuntu.com/ubuntu-ports focal-security InRelease [114 kB]
Get:5 http://ports.ubuntu.com/ubuntu-ports focal/multiverse arm64 Packages [139 kB]
Get:6 http://ports.ubuntu.com/ubuntu-ports focal/restricted arm64 Packages [1317 kB]
Get:7 http://ports.ubuntu.com/ubuntu-ports focal/main arm64 Packages [1234 kB]
Get:8 http://ports.ubuntu.com/ubuntu-ports focal/universe arm64 Packages [11.1 MB]
Get:9 http://ports.ubuntu.com/ubuntu-ports focal-updates/multiverse arm64 Packages [9068 kB]
Get:10 http://ports.ubuntu.com/ubuntu-ports focal-updates/universe arm64 Packages [1196 kB]
Get:11 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 Packages [2115 kB]
Get:12 http://ports.ubuntu.com/ubuntu-ports focal-updates/restricted arm64 Packages [5240 B]
Get:13 http://ports.ubuntu.com/ubuntu-ports focal-backports/universe arm64 Packages [27.8 kB]
Get:14 http://ports.ubuntu.com/ubuntu-ports focal-backports/main arm64 Packages [54.8 kB]
Get:15 http://ports.ubuntu.com/ubuntu-ports focal-security/multiverse arm64 Packages [3252 B]
Get:16 http://ports.ubuntu.com/ubuntu-ports focal-security/main arm64 Packages [1727 kB]
Get:17 http://ports.ubuntu.com/ubuntu-ports focal-security/restricted arm64 Packages [5003 B]
Get:18 http://ports.ubuntu.com/ubuntu-ports focal-security/universe arm64 Packages [898 kB]
Fetched 19.1 MB in 4s (5304 kB/s)
Reading package lists... Done
root@7497cabbb2cb2: /# ]]

[root@7497cabbb2cb2: /# apt-get -y install sudo
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  sudo
0 upgraded, 1 newly installed, 0 to remove and 4 not upgraded.
Need to get 474 kB of archives.
After this operation, 2175 kB of additional disk space will be used.
Get:1 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 sudo arm64 1.8.31-1ubuntu1.4 [474 kB]
Fetched 474 kB in 1s (394 kB/s)
debconf: delaying package configuration, since apt-utils is not installed
Selecting previously unselected package sudo.
(Reading database ... 4119 files and directories currently installed.)
Preparing to unpack .../sudo_1.8.31-1ubuntu1.4_arm64.deb ...
Unpacking sudo (1.8.31-1ubuntu1.4) ...
Setting up sudo (1.8.31-1ubuntu1.4) ...
root@7497cabbb2cb2: /# ]]
```

Install sysbench

```
himanshudahiya — root@7497cab2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 130x62
...root@7497cab2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04
root@7497cab2cb2:# sudo apt install -y sysbench
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
krb5-locales liblai0 libasn1-8-heimdal libgssapi-krb5-2 libgssapi3-heimdal libhcrypto4-heimdal
libheimbase1-heimdal libheimntlm0-heimdal libhx509-5-heimdal libk5crypto3 libkeyutils1 libkrb5-26-heimdal
libkrb5-3 libkrb5support0 libldap-2.4-2 libldap-common libluajit-5.1-2 libluajit-5.1-common libmysqlclient21
libpq5 libroken18-heimdal libssasl2-2 libssasl2-modules libssasl2-modules-db libsqlite3-0 libssl1.1 libwind0-heimdal
mysql-common
Suggested packages:
krb5-doc krb5-user libssasl2-modules-gssapi-mit | libssasl2-modules-gssapi-heimdal libssasl2-modules-ldap
libssasl2-modules-otp libssasl2-modules-sql
The following NEW packages will be installed:
krb5-locales liblai0 libasn1-8-heimdal libgssapi-krb5-2 libgssapi3-heimdal libhcrypto4-heimdal
libheimbase1-heimdal libheimntlm0-heimdal libhx509-5-heimdal libk5crypto3 libkeyutils1 libkrb5-26-heimdal
libkrb5-3 libkrb5support0 libldap-2.4-2 libldap-common libluajit-5.1-2 libluajit-5.1-common libmysqlclient21
libpq5 libroken18-heimdal libssasl2-2 libssasl2-modules libssasl2-modules-db libsqlite3-0 libssl1.1 libwind0-heimdal
mysql-common sysbench
0 upgraded, 29 newly installed, 0 to remove and 4 not upgraded.
Need to get 5015 kB of archives.
After this operation, 20.2 MB of additional disk space will be used.
Get:1 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libsqlite3-0 arm64 3.31.1-4ubuntu0.5 [506 kB]
Get:2 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libssl1.1 arm64 1.1.1f-1ubuntu2.16 [1156 kB]
Get:3 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 krb5-locales all 1.17.6ubuntu4.2 [11.5 kB]
Get:4 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libkrb5support0 arm64 1.17-6ubuntu4.2 [30.5 kB]
Get:5 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libk5crypto3 arm64 1.17-6ubuntu4.2 [80.4 kB]
Get:6 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libkeyutils1 arm64 1.6-6ubuntu1.1 [18.1 kB]
Get:7 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libkrb5-3 arm64 1.17-6ubuntu4.2 [312 kB]
Get:8 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libgssapi-krb5-2 arm64 1.17-6ubuntu4.2 [113 kB]
Get:9 http://ports.ubuntu.com/ubuntu-ports focal/main arm64 liblai0 arm64 0.3.112-5 [7072 B]
Get:10 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libroken18-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [40.1 kB]
Get:11 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libasn1-8-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [158 kB]
Get:12 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libheimbase1-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [28.6 kB]
Get:13 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libhcrypto4-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [85.8 kB]
Get:14 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libwind0-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [47.4 kB]
Get:15 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libhx509-5-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [99.0 kB]
Get:16 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libkrb5-26-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [192 kB]
Get:17 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libheimntlm0-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [14.7 kB]
Get:18 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libgssapi3-heimdal arm64 7.7.0+dfsg-1ubuntu1.3 [88.3 kB]
Get:19 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libssasl2-modules-db arm64 2.1.27+dfsg-2ubuntu0.1 [14.9 kB]
Get:20 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libssasl2-2 arm64 2.1.27+dfsg-2ubuntu0.1 [48.4 kB]
Get:21 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libldap-common all 2.4.49+dfsg-2ubuntu1.9 [16.6 kB]
Get:22 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libldap-2.4-2 arm64 2.4.49+dfsg-2ubuntu1.9 [145 kB]
Get:23 http://ports.ubuntu.com/ubuntu-ports focal/universe arm64 libluajit-5.1-common all 2.1.0-beta3+dfsg-5.1build1 [44.3 kB]
Get:24 http://ports.ubuntu.com/ubuntu-ports focal/universe arm64 libluajit-5.1-2 arm64 2.1.0-beta3+dfsg-5.1build1 [212 kB]
Get:25 http://ports.ubuntu.com/ubuntu-ports focal/main arm64 mysql-common all 5.8+1.0.5ubuntu2 [7496 B]
Get:26 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libmysqlclient21 arm64 8.0.32-0ubuntu0.20.04.2 [1289 kB]
Get:27 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libpq5 arm64 12.13-0ubuntu0.20.04.1 [111 kB]
Get:28 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libssasl2-modules arm64 2.1.27+dfsg-2ubuntu0.1 [46.1 kB]
Get:29 http://ports.ubuntu.com/ubuntu-ports focal/universe arm64 sysbench arm64 1.0.18+ds-1 [106 kB]
Fetched 5015 kB in 3s (1940 kB/s)
debconf: delaying package configuration, since apt-utils is not installed
Selecting previously unselected package libsqlite3-0:arm64.
(Reading database ... 4177 files and directories currently installed.)
Preparing to unpack .../0@:libsqlite3-0_3.31.1-4ubuntu0.5_arm64.deb ...
Unpacking libsqlite3-0:arm64 (3.31.1-4ubuntu0.5) ...
Selecting previously unselected package libssl1.1:arm64.
Preparing to unpack .../0@:libssl1.1_1.1.1f-1ubuntu2.16_arm64.deb ...
Unpacking libssl1.1:arm64 (1.1.1f-1ubuntu2.16) ...
Selecting previously unselected package krb5-locales.
Preparing to unpack .../02-krb5-locales_1.17-6ubuntu4.2_all.deb ...
```

Running Tests on Docker and QEMU

Testcase 1

sysbench --test=cpu run

Run 1

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 104x41
...2cb2: / — com.docker.cli - docker run -it ubuntu:20.04
~ — zsh
Setting up libheimntlm0-heimdal:arm64 (7.7.0+dfsg-1ubuntu1.3) ...
Setting up libgssapi3-heimdal:arm64 (7.7.0+dfsg-1ubuntu1.3) ...
Setting up libldap-2.4-2:arm64 (2.4.49+dfsg-2ubuntu1.9) ...
Setting up libpq5:arm64 (12.13-0ubuntu0.20.04.1) ...
Setting up sysbench (1.0.18+ds-1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
root@7497cabb2cb2:/# sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!
CPU speed:
events per second: 10895.98

General statistics:
total time:          10.0003s
total number of events: 108975

Latency (ms):
min:                  0.09
avg:                  0.09
max:                  0.47
95th percentile:     0.10
sum:                 9982.38

Threads fairness:
events (avg/stddev): 108975.0000/0.00
execution time (avg/stddev): 9.9824/0.00
root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)

Last login: Sun Feb  5 02:19:00 UTC 2023 on tty1
hdahiya@hd:~$ sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 11063.49

General statistics:
total time: 10.0001s
total number of events: 110642

Latency (ms):
min: 0.09
avg: 0.09
max: 0.70
95th percentile: 0.10
sum: 9987.94

Threads fairness:
events (avg/stddev): 110642.0000/0.00
execution time (avg/stddev): 9.9879/0.00

hdahiya@hd:~$
```

Run 2

```
[root@7497cab2cb2:/# sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 11034.85

General statistics:
total time: 10.0002s
total number of events: 110360

Latency (ms):
min: 0.09
avg: 0.09
max: 0.29
95th percentile: 0.10
sum: 9986.95

Threads fairness:
events (avg/stddev): 110360.0000/0.00
execution time (avg/stddev): 9.9870/0.00

root@7497cab2cb2:/# ]
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
> execution time (avg/stddev): 9.9879/0.00
hdahiya@hd:~$ sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 11048.82

General statistics:
total time: 10.00003s
total number of events: 110499

Latency (ms):
min: 0.09
avg: 0.09
max: 0.53
95th percentile: 0.10
sum: 9987.54

Threads fairness:
events (avg/stddev): 110499.0000/0.00
execution time (avg/stddev): 9.9875/0.00

hdahiya@hd:~$ _
```

Run 3

```
himanshudahiya — root@7497cabb2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 — 104x41
...2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 ~ — -zsh | +
root@7497cabb2cb2:/# sysbench --test=cpu run
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: 10000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 11039.41

General statistics:
total time: 10.0002s
total number of events: 110404

Latency (ms):
min: 0.09
avg: 0.09
max: 0.58
95th percentile: 0.10
sum: 9989.66

Threads fairness:
events (avg/stddev): 110404.0000/0.00
execution time (avg/stddev): 9.9897/0.00

root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
execution time (avg/stddev): 9.9875/0.00

hdahiya@hd:~$ sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 10982.85

General statistics:
total time: 10.00002s
total number of events: 109836

Latency (ms):
min: 0.09
avg: 0.09
max: 0.41
95th percentile: 0.10
sum: 9979.64

Threads fairness:
events (avg/stddev): 109836.0000/0.00
execution time (avg/stddev): 9.9796/0.00

hdahiya@hd:~$
```

Run 4

```
root@7497cab2cb2:/# sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 11042.58

General statistics:
total time: 10.00003s
total number of events: 110441

Latency (ms):
min: 0.09
avg: 0.09
max: 0.31
95th percentile: 0.10
sum: 9989.32

Threads fairness:
events (avg/stddev): 110441.0000/0.00
execution time (avg/stddev): 9.9893/0.00

root@7497cab2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
execution time (avg/stddev): 9.9796/0.00

ndahiya@hd:~$ sysbench --test=cpu run
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: 10000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 11070.32

General statistics:
total time: 10.00001s
total number of events: 110710

Latency (ms):
min: 0.09
avg: 0.09
max: 0.77
95th percentile: 0.10
sum: 9988.45

Threads fairness:
events (avg/stddev): 110710.0000/0.00
execution time (avg/stddev): 9.9884/0.00

ndahiya@hd:~$ _
```

Run 5

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 100...
...b2:/ — com.docker.cli - docker run -it ubuntu:20.04 ~ — -zsh +-
[root@7497cabb2cb2:/# sysbench --test=cpu run
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: 10000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 10965.44

General statistics:
total time: 10.0002s
total number of events: 109663

Latency (ms):
min: 0.09
avg: 0.09
max: 0.39
95th percentile: 0.10
sum: 9986.60

Threads fairness:
events (avg/stddev): 109663.0000/0.00
execution time (avg/stddev): 9.9866/0.00
root@7497cabb2cb2:/#
```

```
QEMU
execution time (avg/stddev): 9.9884/0.00
hdahiya@hd:~$ sysbench --test=cpu run
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: 10000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 10860.74

General statistics:
total time: 10.0002s
total number of events: 108616

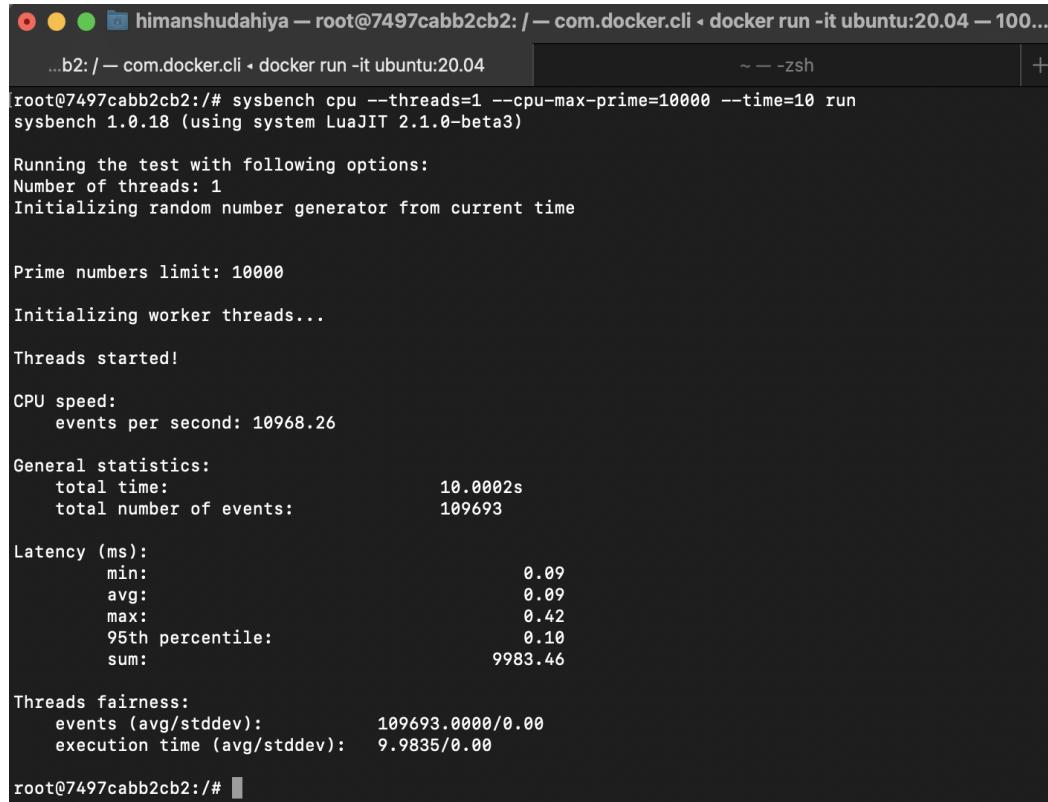
Latency (ms):
min: 0.09
avg: 0.09
max: 0.77
95th percentile: 0.10
sum: 9977.08

Threads fairness:
events (avg/stddev): 108616.0000/0.00
execution time (avg/stddev): 9.9771/0.00
hdahiya@hd:~$
```

Testcase 2

```
sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
```

Run 1



```
himanshudahiya — root@7497cabb2cb2:/ — com.docker.cli • docker run -it ubuntu:20.04 — 100...
```

```
...b2: / — com.docker.cli • docker run -it ubuntu:20.04 ~ — zsh +
```

```
root@7497cabb2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000

Initializing worker threads...

Threads started!

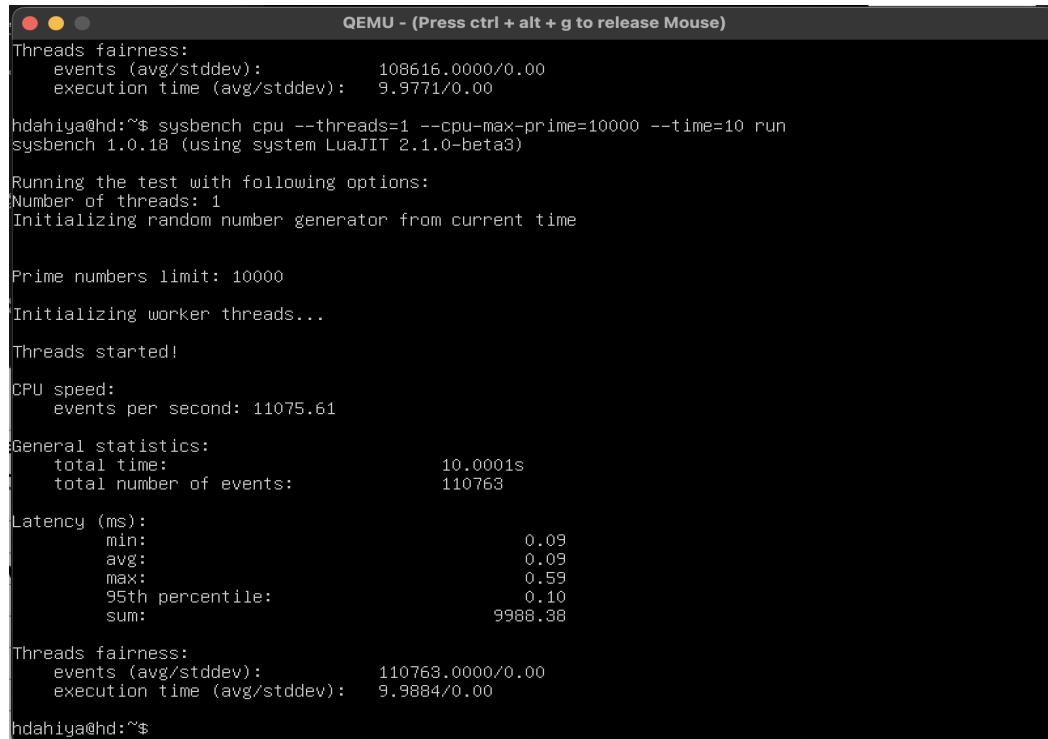
CPU speed:
events per second: 10968.26

General statistics:
total time: 10.0002s
total number of events: 109693

Latency (ms):
min: 0.09
avg: 0.09
max: 0.42
95th percentile: 0.10
sum: 9983.46

Threads fairness:
events (avg/stddev): 109693.0000/0.00
execution time (avg/stddev): 9.9835/0.00

root@7497cabb2cb2:/#
```



```
QEMU - (Press ctrl + alt + g to release Mouse)
```

```
Threads fairness:
events (avg/stddev): 108616.0000/0.00
execution time (avg/stddev): 9.9771/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 11075.61

General statistics:
total time: 10.0001s
total number of events: 110763

Latency (ms):
min: 0.09
avg: 0.09
max: 0.59
95th percentile: 0.10
sum: 9988.38

Threads fairness:
events (avg/stddev): 110763.0000/0.00
execution time (avg/stddev): 9.9884/0.00

hdahiya@hd:~$
```

Run 2

```
himanshudahiya — root@7497cab2cb2: / — com.docker.cli < docker run -it ubuntu:20.04 — 100...
...b2: / — com.docker.cli < docker run -it ubuntu:20.04 ~ -- zsh + 
[root@7497cab2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 11057.88

General statistics:
total time: 10.0001s
total number of events: 110587

Latency (ms):
min: 0.09
avg: 0.09
max: 0.63
95th percentile: 0.10
sum: 9989.24

Threads fairness:
events (avg/stddev): 110587.0000/0.00
execution time (avg/stddev): 9.9892/0.00

root@7497cab2cb2:/#
```

```
QEMU
Threads fairness:
events (avg/stddev): 110763.0000/0.00
execution time (avg/stddev): 9.9884/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 11056.43

General statistics:
total time: 10.0002s
total number of events: 110572

Latency (ms):
min: 0.09
avg: 0.09
max: 0.47
95th percentile: 0.10
sum: 9988.01

Threads fairness:
events (avg/stddev): 110572.0000/0.00
execution time (avg/stddev): 9.9880/0.00

hdahiya@hd:~$
```

Run 3

```
himanshudahiya — root@7497cab2cb2:/ — com.docker.cli ~ docker run -it ubuntu:20.04 — 100...  
...b2:/ — com.docker.cli ~ docker run -it ubuntu:20.04 ~ — -zsh +  
[root@7497cab2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run  
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: 10000  
  
Initializing worker threads...  
  
Threads started!  
  
CPU speed:  
events per second: 11028.36  
  
General statistics:  
total time: 10.0003s  
total number of events: 110298  
  
Latency (ms):  
min: 0.09  
avg: 0.09  
max: 0.34  
95th percentile: 0.10  
sum: 9987.01  
  
Threads fairness:  
events (avg/stddev): 110298.0000/0.00  
execution time (avg/stddev): 9.9870/0.00  
root@7497cab2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)  
Threads fairness:  
events (avg/stddev): 110572.0000/0.00  
execution time (avg/stddev): 9.9880/0.00  
  
hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run  
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: 10000  
  
Initializing worker threads...  
  
Threads started!  
  
CPU speed:  
events per second: 10901.72  
  
General statistics:  
total time: 10.0002s  
total number of events: 109025  
  
Latency (ms):  
min: 0.09  
avg: 0.09  
max: 0.41  
95th percentile: 0.10  
sum: 9976.02  
  
Threads fairness:  
events (avg/stddev): 109025.0000/0.00  
execution time (avg/stddev): 9.9760/0.00  
hdahiya@hd:~$ _
```

Run 4

```
himanshudahiya — root@7497cab2cb2: / — com.docker.cli < docker run -it ubuntu:20.04 — 10
...b2:/ — com.docker.cli < docker run -it ubuntu:20.04 ...
root@7497cab2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 10899.57

General statistics:
total time: 10.0002s
total number of events: 109006

Latency (ms):
min: 0.09
avg: 0.09
max: 0.25
95th percentile: 0.10
sum: 9982.54

Threads fairness:
events (avg/stddev): 109006.0000/0.00
execution time (avg/stddev): 9.9825/0.00

root@7497cab2cb2:/# ■

hdahiya@hd:~$ QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
events (avg/stddev): 109025.0000/0.00
execution time (avg/stddev): 9.9760/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 10931.49

General statistics:
total time: 10.0002s
total number of events: 109322

Latency (ms):
min: 0.09
avg: 0.09
max: 2.66
95th percentile: 0.10
sum: 9981.80

Threads fairness:
events (avg/stddev): 109322.0000/0.00
execution time (avg/stddev): 9.9818/0.00

hdahiya@hd:~$ -
```

Run 5

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 100
...b2: / — com.docker.cli - docker run -it ubuntu:20.04
root@7497cabb2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 10967.97

General statistics:
total time: 10.0001s
total number of events: 109690

Latency (ms):
min: 0.09
avg: 0.09
max: 0.26
95th percentile: 0.10
sum: 9979.93

Threads fairness:
events (avg/stddev): 109690.0000/0.00
execution time (avg/stddev): 9.9799/0.00

root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run
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: 10000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 10816.28

General statistics:
total time: 10.0002s
total number of events: 108170

Latency (ms):
min: 0.09
avg: 0.09
max: 0.47
95th percentile: 0.10
sum: 9986.38

Threads fairness:
events (avg/stddev): 108170.0000/0.00
execution time (avg/stddev): 9.9864/0.00

hdahiya@hd:~$ _
```

Testcase 3

```
sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
```

Run 1

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 — 100.  
...b2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 ~ — -zsh  
[root@7497cabb2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run  
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: 50000  
  
Initializing worker threads...  
  
Threads started!  
  
CPU speed:  
    events per second: 1234.01  
  
General statistics:  
    total time: 30.0003s  
    total number of events: 37022  
  
Latency (ms):  
    min: 0.78  
    avg: 0.81  
    max: 2.54  
    95th percentile: 0.83  
    sum: 29993.65  
  
Threads fairness:  
    events (avg/stddev): 37022.0000/0.00  
    execution time (avg/stddev): 29.9937/0.00  
root@7497cabb2cb2:/#
```

```
QEMU  
Threads fairness:  
    events (avg/stddev): 109322.0000/0.00  
    execution time (avg/stddev): 9.9818/0.00  
  
hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run  
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: 50000  
  
Initializing worker threads...  
  
Threads started!  
  
CPU speed:  
    events per second: 1232.10  
  
General statistics:  
    total time: 30.0008s  
    total number of events: 36965  
  
Latency (ms):  
    min: 0.78  
    avg: 0.81  
    max: 1.59  
    95th percentile: 0.84  
    sum: 29988.62  
  
Threads fairness:  
    events (avg/stddev): 36965.0000/0.00  
    execution time (avg/stddev): 29.9886/0.00  
hdahiya@hd:~$
```

Run 2

```
himanshudahiya — root@7497cab2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 — 100...
...b2: / — com.docker.cli - docker run -it ubuntu:20.04                                     ~ -- zsh
[ro...7497cab2cb2:# sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 1224.02

General statistics:
total time:          30.0009s
total number of events: 36723

Latency (ms):
min:                  0.79
avg:                  0.82
max:                  2.54
95th percentile:     0.86
sum:                 29990.24

Threads fairness:
events (avg/stddev): 36723.0000/0.00
execution time (avg/stddev): 29.9902/0.00
root@7497cab2cb2:/# ■

QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
events (avg/stddev): 36965.0000/0.00
execution time (avg/stddev): 29.9886/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 1227.32

General statistics:
total time:          30.0006s
total number of events: 36821

Latency (ms):
min:                  0.78
avg:                  0.81
max:                  1.70
95th percentile:     0.86
sum:                 29986.16

Threads fairness:
events (avg/stddev): 36821.0000/0.00
execution time (avg/stddev): 29.9862/0.00
hdahiya@hd:~$ _
```

Run 3

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 100...
...b2: / — com.docker.cli - docker run -it ubuntu:20.04          ~ -- -zsh          +
[root@7497cabb2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000
Initializing worker threads...

Threads started!

CPU speed:
  events per second: 1219.98

General statistics:
  total time:           30.0007s
  total number of events: 36601

Latency (ms):
  min:                  0.79
  avg:                  0.82
  max:                  1.75
  95th percentile:      0.87
  sum:                 29989.98

Threads fairness:
  events (avg/stddev): 36601.0000/0.00
  execution time (avg/stddev): 29.9900/0.00
root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
  events (avg/stddev): 36821.0000/0.00
  execution time (avg/stddev): 29.9862/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000
Initializing worker threads...

Threads started!

CPU speed:
  events per second: 1228.53

General statistics:
  total time:           30.0005s
  total number of events: 36857

Latency (ms):
  min:                  0.78
  avg:                  0.81
  max:                  1.55
  95th percentile:      0.86
  sum:                 29987.65

Threads fairness:
  events (avg/stddev): 36857.0000/0.00
  execution time (avg/stddev): 29.9876/0.00
hdahiya@hd:~$
```

Run 4

```
himanshudahiya — root@7497cab2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 100...
...b2: / — com.docker.cli - docker run -it ubuntu:20.04 ~ — zsh + 
[root@7497cab2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 1222.13

General statistics:
total time: 30.0003s
total number of events: 36665

Latency (ms):
min: 0.79
avg: 0.82
max: 2.34
95th percentile: 0.87
sum: 29988.42

Threads fairness:
events (avg/stddev): 36665.0000/0.00
execution time (avg/stddev): 29.9884/0.00
root@7497cab2cb2:/# 

hdahiya@hd:~/com.docker.cli$ Docker run -it ubuntu bash ~ QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
events (avg/stddev): 36857.0000/0.00
execution time (avg/stddev): 29.9876/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 1230.08

General statistics:
total time: 30.0006s
total number of events: 36904

Latency (ms):
min: 0.78
avg: 0.81
max: 1.52
95th percentile: 0.86
sum: 29988.39

Threads fairness:
events (avg/stddev): 36904.0000/0.00
execution time (avg/stddev): 29.9884/0.00
hdahiya@hd:~$ _
```

Run 5

```
himanshudahiya — root@7497cab2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 — 100...
...b2: / — com.docker.cli - docker run -it ubuntu:20.04           ~ -- zsh           +
[root@7497cab2cb2:/# sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 1220.48

General statistics:
total time:          30.0007s
total number of events: 36617

Latency (ms):
min:                  0.78
avg:                  0.82
max:                  2.10
95th percentile:     0.87
sum:                 29987.57

Threads fairness:
events (avg/stddev): 36617.0000/0.00
execution time (avg/stddev): 29.9876/0.00

root@7497cab2cb2:/# ]
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
events (avg/stddev): 36904.0000/0.00
execution time (avg/stddev): 29.9884/0.00

hdahiya@hd:~$ sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run
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: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 1229.86

General statistics:
total time:          30.0008s
total number of events: 36897

Latency (ms):
min:                  0.78
avg:                  0.81
max:                  1.33
95th percentile:     0.86
sum:                 29987.55

Threads fairness:
events (avg/stddev): 36897.0000/0.00
execution time (avg/stddev): 29.9875/0.00

hdahiya@hd:~$ ]
```

Testcase 4

sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run

Run 1

```
himanshudahiya — root@7497cab2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 9...
...2: / — com.docker.cli - docker run -it ubuntu:20.04           ~ -- zsh
[root@7497cab2cb2:/# sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 4651.33

General statistics:
total time:          30.0018s
total number of events: 139550

Latency (ms):
min:                  0.79
avg:                 2.15
max:                 29.85
95th percentile:    13.95
sum:                299779.23

Threads fairness:
events (avg/stddev): 13955.0000/1523.68
execution time (avg/stddev): 29.9779/0.01
root@7497cab2cb2:/#
```

```
QEMU
hdahiya@hd:~$ sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000
Initializing worker threads...
Threads started!

CPU speed:
events per second: 4616.81

General statistics:
total time:          30.0015s
total number of events: 138518

Latency (ms):
min:                  0.79
avg:                 2.16
max:                 37.02
95th percentile:    12.98
sum:                299800.64

Threads fairness:
events (avg/stddev): 13851.3000/1517.89
execution time (avg/stddev): 29.9801/0.01
hdahiya@hd:~$ _
```

Run 2

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 — 9...
...2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 ~ — -zsh + 
root@7497cabb2cb2:/# sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 4652.23

General statistics:
total time: 30.0017s
total number of events: 139577

Latency (ms):
min: 0.79
avg: 2.15
max: 30.86
95th percentile: 13.95
sum: 299837.91

Threads fairness:
events (avg/stddev): 13957.7000/1219.17
execution time (avg/stddev): 29.9838/0.01

root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
events (avg/stddev): 13851.3000/1517.89
execution time (avg/stddev): 29.9801/0.01

hdahiya@hd:~$ sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 4610.22

General statistics:
total time: 30.0014s
total number of events: 138315

Latency (ms):
min: 0.78
avg: 2.17
max: 41.18
95th percentile: 12.98
sum: 299789.94

Threads fairness:
events (avg/stddev): 13831.5000/874.22
execution time (avg/stddev): 29.9790/0.02

hdahiya@hd:~$
```

Run 3

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 — 9...
...2: / — com.docker.cli ▾ docker run -it ubuntu:20.04                                ~ — -zsh
[ro...@7497cabb2cb2:/# sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuAJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000
Initializing worker threads...

Threads started!

CPU speed:
  events per second: 4645.50

General statistics:
  total time:          30.0017s
  total number of events: 139375

Latency (ms):
  min:                  0.78
  avg:                  2.15
  max:                  33.88
  95th percentile:     13.95
  sum:                 299795.40

Threads fairness:
  events (avg/stddev): 13937.5000/1455.70
  execution time (avg/stddev): 29.9795/0.01
root@7497cabb2cb2:/# █

QEMU
Threads fairness:
  events (avg/stddev): 13831.5000/874.22
  execution time (avg/stddev): 29.9790/0.02

dahiya@hd:~$ sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuAJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000
Initializing worker threads...

Threads started!

CPU speed:
  events per second: 4613.89

General statistics:
  total time:          30.0021s
  total number of events: 138413

Latency (ms):
  min:                  0.78
  avg:                  2.17
  max:                  49.04
  95th percentile:     12.98
  sum:                 299734.60

Threads fairness:
  events (avg/stddev): 13841.3000/703.77
  execution time (avg/stddev): 29.9735/0.01
dahiya@hd:~$
```

Run 4

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 — 9...
...2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 ~ -- zsh +[1]
root@7497cabb2cb2:/# sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 4649.69

General statistics:
total time: 30.0016s
total number of events: 139500

Latency (ms):
min: 0.78
avg: 2.15
max: 29.89
95th percentile: 13.95
sum: 299854.36

Threads fairness:
events (avg/stddev): 13950.0000/1526.92
execution time (avg/stddev): 29.9854/0.01

root@7497cabb2cb2:/#
```

```
QEMU
Threads fairness:
events (avg/stddev): 138841.3000/703.77
execution time (avg/stddev): 29.9735/0.01

hdahiya@hd:~$ sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 4612.81

General statistics:
total time: 30.0017s
total number of events: 1388394

Latency (ms):
min: 0.78
avg: 2.17
max: 46.66
95th percentile: 14.46
sum: 299701.85

Threads fairness:
events (avg/stddev): 138839.4000/1048.59
execution time (avg/stddev): 29.9702/0.02

hdahiya@hd:~$
```

Run 5

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 — 9...
...2: / — com.docker.cli • docker run -it ubuntu:20.04 ~ — -zsh + [root@7497cabb2cb2:/# sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 4641.92

General statistics:
total time: 30.0013s
total number of events: 139265

Latency (ms):
min: 0.79
avg: 2.15
max: 31.88
95th percentile: 13.22
sum: 299854.70

Threads fairness:
events (avg/stddev): 13926.5000/1521.04
execution time (avg/stddev): 29.9855/0.01

root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)
Threads fairness:
events (avg/stddev): 13889.4000/1048.59
execution time (avg/stddev): 29.9702/0.02

hdahiya@hd:~$ sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 10
Initializing random number generator from current time

Prime numbers limit: 50000
Initializing worker threads...

Threads started!

CPU speed:
events per second: 4619.10

General statistics:
total time: 30.0016s
total number of events: 138582

Latency (ms):
min: 0.78
avg: 2.16
max: 40.95
95th percentile: 12.98
sum: 299687.71

Threads fairness:
events (avg/stddev): 13858.2000/1517.78
execution time (avg/stddev): 29.9688/0.01

hdahiya@hd:~$
```

Experiment Analysis

QEMU vs Docker

Test 1

sysbench cpu --threads=1 --cpu-max-prime=10000 --time=10 run

	min	Average	Max	No. of events
Docker	0.09	0.09	0.42	109963
QEMU	0.09	0.09	0.59	110763

Test 2

sysbench cpu --threads=1 --cpu-max-prime=50000 --time=30 run

	min	Average	Max	No. of events
Docker	0.78	0.81	2.54	37022
QEMU	0.78	0.81	1.59	36365

Test 3

sysbench cpu --threads=10 --cpu-max-prime=50000 --time=30 run

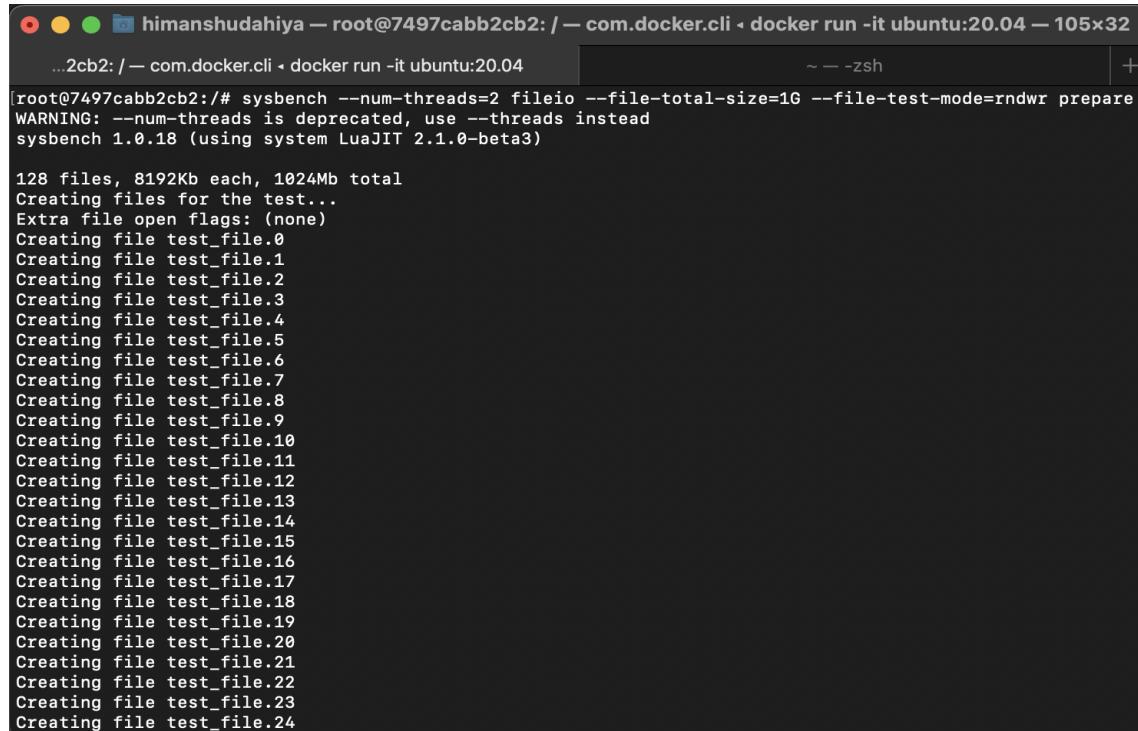
	min	Average	Max	No. of events
Docker	0.79	2.15	29.85	13955
QEMU	0.79	2.16	37.02	13851

In the CPU test cases, we can conclude that they have very close performance but docker outperforms QEMU slightly.

FileIO

Testcase 1

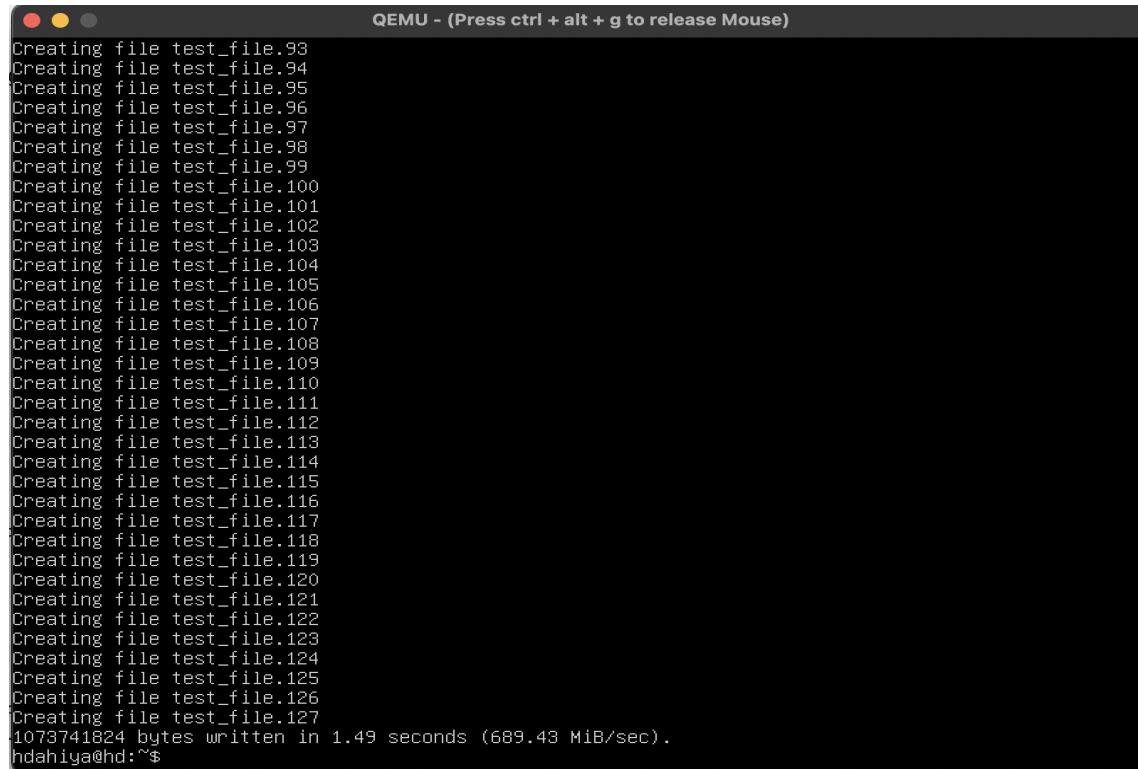
```
sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr prepare
```



A screenshot of a terminal window titled "himanshudahiya — root@7497cabb2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 — 105x32". The window shows the command "sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr prepare" being run. The output indicates that 128 files, each 8192Kb, are being created. A warning message states: "WARNING: --num-threads is deprecated, use --threads instead". The process continues to create files from test_file.0 to test_file.24.

```
...2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 — 105x32
root@7497cabb2cb2:/# sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr prepare
WARNING: --num-threads is deprecated, use --threads instead
sysbench 1.0.18 (using system LuajIT 2.1.0-beta3)

128 files, 8192Kb each, 1024Mb total
Creating files for the test...
Extra file open flags: (none)
Creating file test_file.0
Creating file test_file.1
Creating file test_file.2
Creating file test_file.3
Creating file test_file.4
Creating file test_file.5
Creating file test_file.6
Creating file test_file.7
Creating file test_file.8
Creating file test_file.9
Creating file test_file.10
Creating file test_file.11
Creating file test_file.12
Creating file test_file.13
Creating file test_file.14
Creating file test_file.15
Creating file test_file.16
Creating file test_file.17
Creating file test_file.18
Creating file test_file.19
Creating file test_file.20
Creating file test_file.21
Creating file test_file.22
Creating file test_file.23
Creating file test_file.24
```



A screenshot of a terminal window titled "QEMU - (Press ctrl + alt + g to release Mouse)". The window shows the command "sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr prepare" being run. The output shows the creation of files from test_file.93 to test_file.127. The final line of output is "1073741824 bytes written in 1.49 seconds (689.43 MiB/sec.)." The prompt "hdahiya@hd:~\$" is visible at the bottom.

```
Creating file test_file.93
Creating file test_file.94
Creating file test_file.95
Creating file test_file.96
Creating file test_file.97
Creating file test_file.98
Creating file test_file.99
Creating file test_file.100
Creating file test_file.101
Creating file test_file.102
Creating file test_file.103
Creating file test_file.104
Creating file test_file.105
Creating file test_file.106
Creating file test_file.107
Creating file test_file.108
Creating file test_file.109
Creating file test_file.110
Creating file test_file.111
Creating file test_file.112
Creating file test_file.113
Creating file test_file.114
Creating file test_file.115
Creating file test_file.116
Creating file test_file.117
Creating file test_file.118
Creating file test_file.119
Creating file test_file.120
Creating file test_file.121
Creating file test_file.122
Creating file test_file.123
Creating file test_file.124
Creating file test_file.125
Creating file test_file.126
Creating file test_file.127
1073741824 bytes written in 1.49 seconds (689.43 MiB/sec).
hdahiya@hd:~$
```

```
sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr run
```

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 105x49
...2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 ~ — zsh + 
root@7497cabb2cb2:/# sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr run
WARNING: --num-threads is deprecated, use --threads instead
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Extra file open flags: (none)
128 files, 8MiB each
1GiB total file size
Block size 16KiB
Number of IO requests: 0
Read/Write ratio for combined random IO test: 1.50
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:        16179.04
  fsyncs/s:        20724.89

Throughput:
  read, MiB/s:      0.00
  written, MiB/s:   252.80

General statistics:
  total time:           10.0107s
  total number of events: 369209

Latency (ms):
  min:                 0.00
  avg:                 0.05
  max:                 3.88
  95th percentile:     0.14
  sum:                19870.42

Threads fairness:
  events (avg/stddev): 184604.5000/156.50
  execution time (avg/stddev): 9.9352/0.00

root@7497cabb2cb2:/#
```

```
QEMU
Block size 16KiB
Number of IO requests: 0
Read/Write ratio for combined random IO test: 1.50
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: 22690.06
 fsyncs/s: 29061.67

Throughput:
 read, MiB/s: 0.00
 written, MiB/s: 354.53

General statistics:
 total time: 10.0037s
 total number of events: 517488

Latency (ms):
 min: 0.00
 avg: 0.04
 max: 2.21
 95th percentile: 0.14
 sum: 19850.71

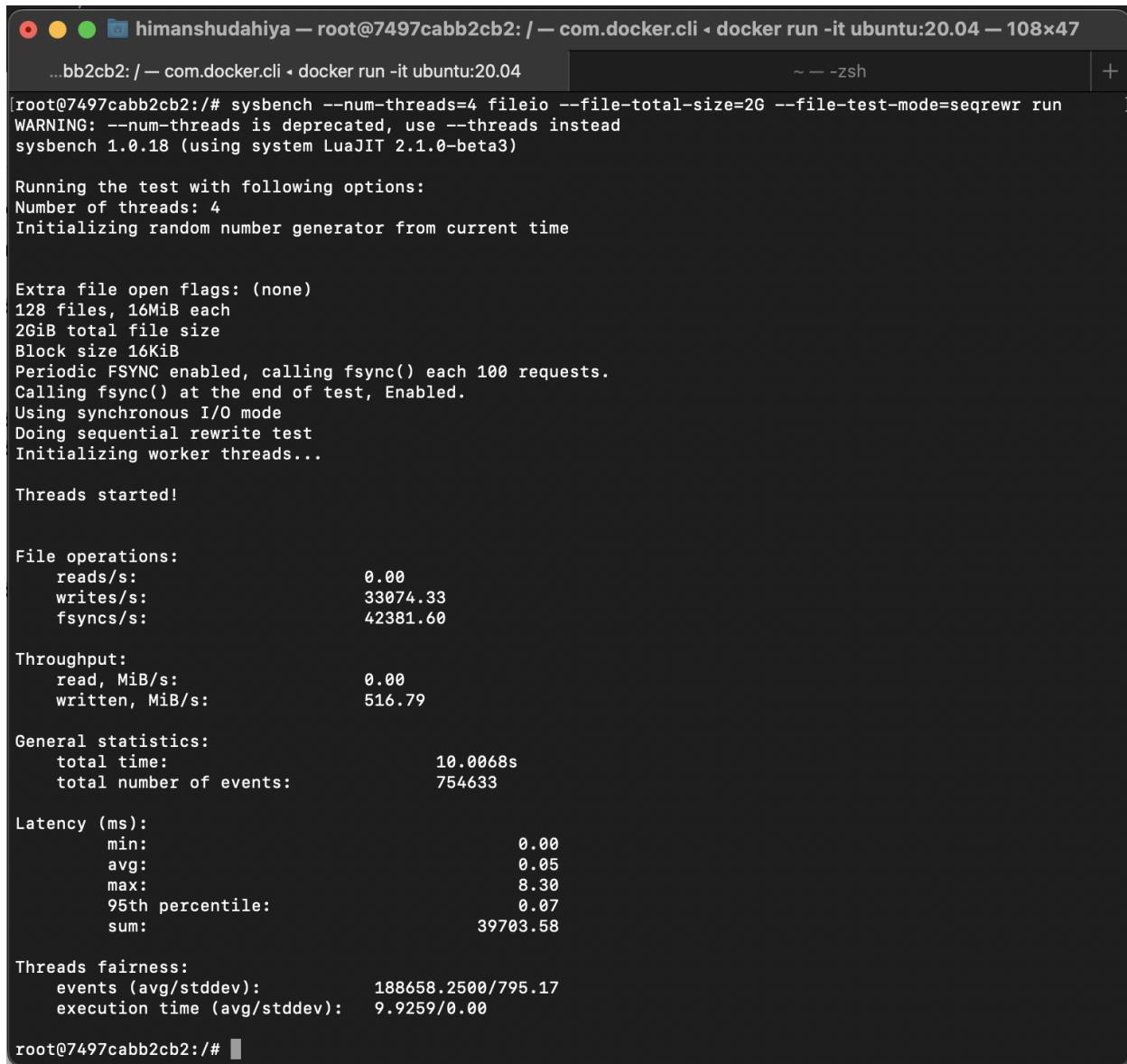
Threads fairness:
 events (avg/stddev): 258744.0000/627.00
 execution time (avg/stddev): 9.9254/0.00

hdahiya@hd:~$
```

sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr cleanup

Testcase 2

```
sysbench --num-threads=4 fileio --file-total-size=2G --file-test-mode=seqrewr prepare  
sysbench --num-threads=4 fileio --file-total-size=2G --file-test-mode=seqrewr run
```



himanshudahiya — root@7497cabb2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 — 108x47

```
...bb2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 ~ -- zsh +  
[root@7497cabb2cb2:/# sysbench --num-threads=4 fileio --file-total-size=2G --file-test-mode=seqrewr run  
WARNING: --num-threads is deprecated, use --threads instead  
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)  
  
Running the test with following options:  
Number of threads: 4  
Initializing random number generator from current time  
  
Extra file open flags: (none)  
128 files, 16MiB each  
2GiB total file size  
Block size 16KiB  
Periodic FSYNC enabled, calling fsync() each 100 requests.  
Calling fsync() at the end of test, Enabled.  
Using synchronous I/O mode  
Doing sequential rewrite test  
Initializing worker threads...  
  
Threads started!  
  
File operations:  
    reads/s:          0.00  
    writes/s:        33074.33  
    fsyncs/s:        42381.60  
  
Throughput:  
    read, MiB/s:      0.00  
    written, MiB/s:   516.79  
  
General statistics:  
    total time:       10.0068s  
    total number of events: 754633  
  
Latency (ms):  
    min:              0.00  
    avg:              0.05  
    max:              8.30  
    95th percentile:  0.07  
    sum:             39703.58  
  
Threads fairness:  
    events (avg/stddev): 188658.2500/795.17  
    execution time (avg/stddev): 9.9259/0.00  
  
root@7497cabb2cb2:/#
```

```
QEMU - (Press ctrl + alt + g to release Mouse)

128 files, 16MiB each
2GiB total file size
Block size 16KiB
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential rewrite test
Initializing worker threads...

Threads started!

File operations:
  reads/s:          0.00
  writes/s:         118813.01
  fsyncs/s:         152128.21

Throughput:
  read, MiB/s:      0.00
  written, MiB/s:   1856.45

General statistics:
  total time:        10.0111s
  total number of events: 2712088

Latency (ms):
  min:                0.00
  avg:                0.01
  max:                17.22
  95th percentile:    0.01
  sum:               39338.23

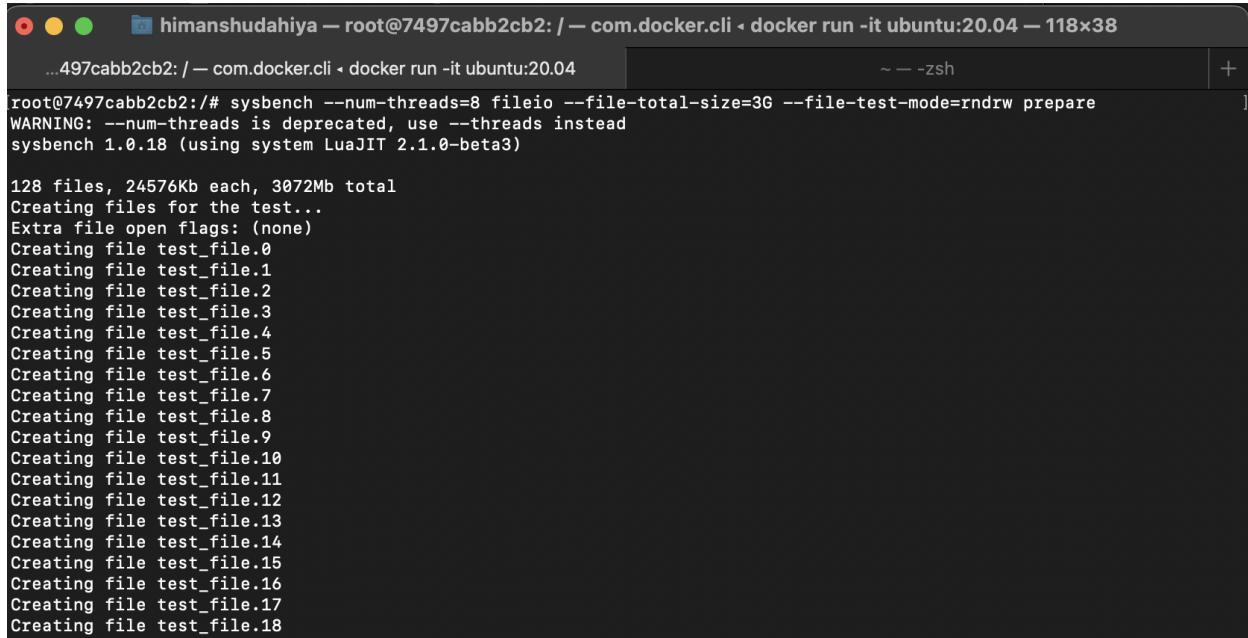
Threads fairness:
  events (avg/stddev): 678022.0000/6919.42
  execution time (avg/stddev): 9.8346/0.01

hdahiya@hd:~$ _
```

sysbench --num-threads=4 fileio --file-total-size=2G --file-test-mode=seqrewr cleanup

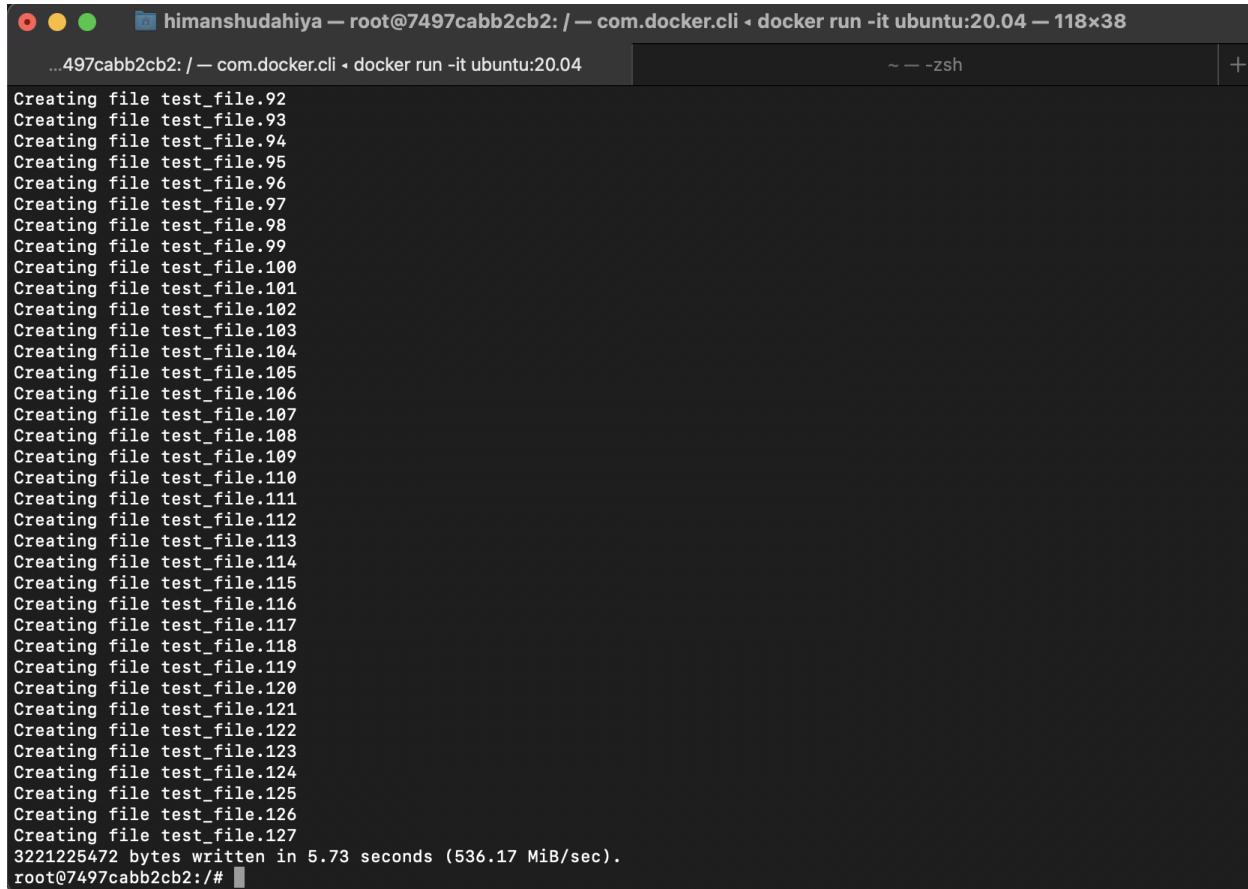
Testcase 3

```
sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw prepare
```



```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 — 118x38
...497cabb2cb2:/ — com.docker.cli • docker run -it ubuntu:20.04
root@7497cabb2cb2:/# sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw prepare
WARNING: --num-threads is deprecated, use --threads instead
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
Extra file open flags: (none)
Creating file test_file.0
Creating file test_file.1
Creating file test_file.2
Creating file test_file.3
Creating file test_file.4
Creating file test_file.5
Creating file test_file.6
Creating file test_file.7
Creating file test_file.8
Creating file test_file.9
Creating file test_file.10
Creating file test_file.11
Creating file test_file.12
Creating file test_file.13
Creating file test_file.14
Creating file test_file.15
Creating file test_file.16
Creating file test_file.17
Creating file test_file.18
```



```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli • docker run -it ubuntu:20.04 — 118x38
...497cabb2cb2:/ — com.docker.cli • docker run -it ubuntu:20.04
root@7497cabb2cb2:/# sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw prepare
Creating file test_file.92
Creating file test_file.93
Creating file test_file.94
Creating file test_file.95
Creating file test_file.96
Creating file test_file.97
Creating file test_file.98
Creating file test_file.99
Creating file test_file.100
Creating file test_file.101
Creating file test_file.102
Creating file test_file.103
Creating file test_file.104
Creating file test_file.105
Creating file test_file.106
Creating file test_file.107
Creating file test_file.108
Creating file test_file.109
Creating file test_file.110
Creating file test_file.111
Creating file test_file.112
Creating file test_file.113
Creating file test_file.114
Creating file test_file.115
Creating file test_file.116
Creating file test_file.117
Creating file test_file.118
Creating file test_file.119
Creating file test_file.120
Creating file test_file.121
Creating file test_file.122
Creating file test_file.123
Creating file test_file.124
Creating file test_file.125
Creating file test_file.126
Creating file test_file.127
3221225472 bytes written in 5.73 seconds (536.17 MiB/sec).
root@7497cabb2cb2:/#
```

QEMU - (Press ctrl + alt + g to release Mouse)

```
Creating file test_file.93
Creating file test_file.94
Creating file test_file.95
Creating file test_file.96
Creating file test_file.97
Creating file test_file.98
Creating file test_file.99
Creating file test_file.100
Creating file test_file.101
Creating file test_file.102
Creating file test_file.103
Creating file test_file.104
Creating file test_file.105
Creating file test_file.106
Creating file test_file.107
Creating file test_file.108
Creating file test_file.109
Creating file test_file.110
Creating file test_file.111
Creating file test_file.112
Creating file test_file.113
Creating file test_file.114
Creating file test_file.115
Creating file test_file.116
Creating file test_file.117
Creating file test_file.118
Creating file test_file.119
Creating file test_file.120
Creating file test_file.121
Creating file test_file.122
Creating file test_file.123
Creating file test_file.124
Creating file test_file.125
Creating file test_file.126
Creating file test_file.127
3221225472 bytes written in 3.16 seconds (972.28 MiB/sec).
hdahiya@hd:~$ _
```

```
sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw run
```

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli ▾ docker run -it ubuntu:20.04 — 116x49
...97cabb2cb2:/ — com.docker.cli ▾ docker run -it ubuntu:20.04 ~ — zsh
[+]
[root@7497cabb2cb2:/# sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw run
WARNING: --num-threads is deprecated, use --threads instead
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 8
Initializing random number generator from current time

Extra file open flags: (none)
128 files, 24MiB each
3GiB total file size
Block size 16KiB
Number of IO requests: 0
Read/Write ratio for combined random IO test: 1.50
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing random r/w test
Initializing worker threads...

Threads started!

File operations:
  reads/s:           20439.72
  writes/s:          13626.65
  fsyncs/s:          43703.56

Throughput:
  read, MiB/s:      319.37
  written, MiB/s:   212.92

General statistics:
  total time:        10.0090s
  total number of events: 777443

Latency (ms):
  min:               0.00
  avg:               0.10
  max:               4.79
  95th percentile:  0.29
  sum:              79522.09

Threads fairness:
  events (avg/stddev): 97180.3750/646.34
  execution time (avg/stddev): 9.9403/0.00
root@7497cabb2cb2:/# ]
```

```
QEMU - (Press ctrl + alt + g to release Mouse)

Block size 16KiB
Number of IO requests: 0
Read/Write ratio for combined random IO test: 1.50
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing random r/w test
Initializing worker threads...

Threads started!

File operations:
  reads/s:          20626.05
  writes/s:         13750.57
  fsyncs/s:        44100.98

Throughput:
  read, MiB/s:      322.28
  written, MiB/s:   214.85

General statistics:
  total time:       10.0041s
  total number of events: 784119

Latency (ms):
  min:              0.00
  avg:              0.10
  max:              6.21
  95th percentile:  0.53
  sum:             79642.96

Threads fairness:
  events (avg/stddev): 98014.8750/508.90
  execution time (avg/stddev): 9.9554/0.00

hdahiya@hd:~$
```

sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw cleanup

```
[root@7497cabb2cb2:/# sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw cleanup
WARNING: --num-threads is deprecated, use --threads instead
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Removing test files...
root@7497cabb2cb2:/# ]
```

```
hdahiya@hd:~$ sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw cleanup
WARNING: --num-threads is deprecated, use --threads instead
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Removing test files...
hdahiya@hd:~$
```

Installing sysstat

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 116x35
...97cabb2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 ~ -- -zsh +]

root@7497cabb2cb2:/# sudo apt install sysstat -
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  cron libsensors-config libsensors5 ucf xz-utils
Suggested packages:
  anacron logrotate checksecurity default-mta | mail-transport-agent lm-sensors isag
The following NEW packages will be installed:
  cron libsensors-config libsensors5 sysstat ucf xz-utils
0 upgraded, 6 newly installed, 0 to remove and 4 not upgraded.
Need to get 666 kB of archives.
After this operation, 2367 kB of additional disk space will be used.
Get:1 http://ports.ubuntu.com/ubuntu-ports focal/main arm64 cron arm64 3.0pl1-136ubuntu1 [69.7 kB]
Get:2 http://ports.ubuntu.com/ubuntu-ports focal/main arm64 ucf all 3.0038+nmu1 [51.6 kB]
Get:3 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 xz-utils arm64 5.2.4-1ubuntu1.1 [81.4 kB]
Get:4 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libsensors-config all 1:3.6.0-2ubuntu1.1 [6052 B]
Get:5 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libsensors5 arm64 1:3.6.0-2ubuntu1.1 [26.0 kB]
Get:6 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 sysstat arm64 12.2.0-2ubuntu0.2 [431 kB]
Fetched 666 kB in 1s (462 kB/s)
debconf: delaying package configuration, since apt-utils is not installed
Selecting previously unselected package cron.
(Reading database ... 4421 files and directories currently installed.)
Preparing to unpack .../0-cron_3.0pl1-136ubuntu1_arm64.deb ...
Unpacking cron (3.0pl1-136ubuntu1) ...
Selecting previously unselected package ucf.
Preparing to unpack .../1-ucf_3.0038+nmu1_all.deb ...
Moving old data out of the way
Unpacking ucf (3.0038+nmu1) ...
Selecting previously unselected package xz-utils.
Preparing to unpack .../2-xz-utils_5.2.4-1ubuntu1.1_arm64.deb ...
Unpacking xz-utils (5.2.4-1ubuntu1.1) ...
Selecting previously unselected package libsensors-config.
Preparing to unpack .../3-libsensors-config_1%3a3.6.0-2ubuntu1.1_all.deb ...
```

```
himanshudahiya — root@7497cabb2cb2: / — com.docker.cli - docker run -it ubuntu:20.04 — 116x35
...97cabb2cb2:/ — com.docker.cli - docker run -it ubuntu:20.04 ~ -- -zsh +]

an/man1/xzgrep.1.gz (of link group lzma) doesn't exist
update-alternatives: warning: skip creation of /usr/share/man/man1/lzfgrep.1.gz because associated file /usr/share/m
an/man1/xzgrep.1.gz (of link group lzma) doesn't exist
Setting up ucf (3.0038+nmu1) ...
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/per
l5/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:
  /etc/perl  /usr/local/lib/aarch64-linux-gnu/perl/5.30.0  /usr/local/share/perl/5.30.0  /usr/lib/aarch64-linux-gnu/perl5
  /5.30  /usr/share/perl5  /usr/lib/aarch64-linux-gnu/perl/5.30  /usr/share/perl/5.30  /usr/local/lib/site_perl  /usr/lib/a
  arch64-linux-gnu/perl-base) at /usr/share/perl5/Debconf/FrontEnd/Readline.pm line 7.)
debconf: falling back to frontend: Teletype
Setting up libsensors5:arm64 (1:3.6.0-2ubuntu1.1) ...
Setting up sysstat (12.2.0-2ubuntu0.2) ...
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/per
l5/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:
  /etc/perl  /usr/local/lib/aarch64-linux-gnu/perl/5.30.0  /usr/local/share/perl/5.30.0  /usr/lib/aarch64-linux-gnu/perl5
  /5.30  /usr/share/perl5  /usr/lib/aarch64-linux-gnu/perl/5.30  /usr/share/perl/5.30  /usr/local/lib/site_perl  /usr/lib/a
  arch64-linux-gnu/perl-base) at /usr/share/perl5/Debconf/FrontEnd/Readline.pm line 7.)
debconf: falling back to frontend: Teletype

Creating config file /etc/default/sysstat with new version
update-alternatives: using /usr/bin/sar.sysstat to provide /usr/bin/sar (sar) in auto mode
update-alternatives: warning: skip creation of /usr/share/man/man1/sar.1.gz because associated file /usr/share/man/m
an1/sar.sysstat.1.gz (of link group sar) doesn't exist
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
root@7497cabb2cb2:/#
```

The following NEW packages will be installed:
libsensors-config libsensors5 sysstat
0 upgraded, 3 newly installed, 0 to remove and 27 not upgraded.
Need to get 463 kB of archives.
After this operation, 1,563 kB of additional disk space will be used.
Get:1 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libsensors-config all 1:3.6.0-2ubuntu1.1 [6,052 B]
Get:2 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 libsensors5 arm64 1:3.6.0-2ubuntu1.1 [26.0 kB]
Get:3 http://ports.ubuntu.com/ubuntu-ports focal-updates/main arm64 sysstat arm64 12.2.0-2ubuntu0.2 [431 kB]
Fetched 463 kB in 1s (362 kB/s)
Preconfiguring packages ...
Selecting previously unselected package libsensors-config.
(Reading database ... 70648 files and directories currently installed.)
Preparing to unpack .../libsensors-config_1%3a3.6.0-2ubuntu1.1_all.deb ...
Unpacking libsensors-config (1:3.6.0-2ubuntu1.1) ...
Selecting previously unselected package libsensors5:arm64.
Preparing to unpack .../libsensors5_1%3a3.6.0-2ubuntu1.1_arm64.deb ...
Unpacking libsensors5:arm64 (1:3.6.0-2ubuntu1.1) ...
Selecting previously unselected package sysstat.
Preparing to unpack .../sysstat_12.2.0-2ubuntu0.2_arm64.deb ...
Unpacking sysstat (12.2.0-2ubuntu0.2) ...
Setting up libsensors-config (1:3.6.0-2ubuntu1.1) ...
Setting up libsensors5:arm64 (1:3.6.0-2ubuntu1.1) ...
Setting up sysstat (12.2.0-2ubuntu0.2) ...

Creating config file /etc/default/sysstat with new version
update-alternatives: using /usr/bin/sar.sysstat to provide /usr/bin/sar (sar) in auto mode
Created symlink /etc/systemd/system/multi-user.target.wants/sysstat.service → /lib/systemd/system/sysstat.service.
Processing triggers for systemd (245.4-4ubuntu3.17) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
hdahiya@hd:~\$

```
sudo iostat -dxzm 1
```

himanshudahiya - root@7497cabb2cb2: / - com.docker.cli + docker run -it ubuntu:20.04 - 185x40																		
~ -- root@7497cabb2cb2: / - com.docker.cli + docker run -it ubuntu:20.04											~ -- zsh							
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
vda	14.54	0.39	1.04	6.70	0.06	27.68	406.96	5.53	26.73	6.16	0.09	13.92	0.00	0.00	0.00	1.41		
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
vda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	66.67	2.00	13.33	0.00	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
Device	r/s	rb/s	rqms/s	%rrqm r_await	rreq-sz	w/s	wMB/s	wrqm/s	%wrqm w_await	wreq-sz	d/s	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util	
vda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	1.14	4.57	0.00	dMB/s	drqm/s	%drqm d_await	dreq-sz	aqu-sz	util

QEMU - (Press ctrl + alt + g to release Mouse)														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
vda	0.23	25.04	1.74	5.94	0.21	1.54	20.61	0.21	36.07	387.98	9.49	88.23	18.53	
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
dm-0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.95	0.02	0.00	0.00	0.00	
3.20	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.79				
vda	1.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	1.98	0.02	2.97	60.00		
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
Device_await_wreq-sz	r/s	d/s		rMB/s	rrqm/s	%rrqm	r_await	rareq-sz	w/s	wMB/s	wrqm/s	%wrqm	w	
-														

The above screenshots show Disk IO utilization, latency throughput for QEMU and Docker.

Ubuntu processes

QEMU										
PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+ COMMAND
36	root	20	0	0	0	0	I	0.3	0.0	0:01.32 kworker/1:1-events
2153	hdahiya	20	0	8956	3100	2660	R	0.3	0.1	0:00.08 top
1	root	20	0	168964	10688	7232	S	0.0	0.4	0:01.27 systemd
2	root	20	0	0	0	0	S	0.0	0.0	0:00.01 kthreadd
3	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 rcu_gp
4	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 rcu_par_gp
6	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 kworker/0:0H-kblockd
8	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 mm_percpu_wq
9	root	20	0	0	0	0	S	0.0	0.0	0:00.03 ksoftirqd/0
10	root	20	0	0	0	0	I	0.0	0.0	0:00.19 rcu_sched
11	root	rt	0	0	0	0	S	0.0	0.0	0:00.02 migration/0
12	root	-51	0	0	0	0	S	0.0	0.0	0:00.00 idle_inject/0
14	root	20	0	0	0	0	S	0.0	0.0	0:00.00 cpuhp/0
15	root	20	0	0	0	0	S	0.0	0.0	0:00.00 cpuhp/1
16	root	-51	0	0	0	0	S	0.0	0.0	0:00.00 idle_inject/1
17	root	rt	0	0	0	0	S	0.0	0.0	0:00.02 migration/1
18	root	20	0	0	0	0	S	0.0	0.0	0:00.00 ksoftirqd/1
20	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 kworker/1:0H-kblockd
21	root	20	0	0	0	0	S	0.0	0.0	0:00.00 cpuhp/2
22	root	-51	0	0	0	0	S	0.0	0.0	0:00.00 idle_inject/2
23	root	rt	0	0	0	0	S	0.0	0.0	0:00.02 migration/2
24	root	20	0	0	0	0	S	0.0	0.0	0:00.01 ksoftirqd/2
25	root	20	0	0	0	0	I	0.0	0.0	0:02.47 kworker/2:0-events
26	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 kworker/2:0H-kblockd
27	root	20	0	0	0	0	S	0.0	0.0	0:00.00 cpuhp/3
28	root	-51	0	0	0	0	S	0.0	0.0	0:00.00 idle_inject/3
29	root	rt	0	0	0	0	S	0.0	0.0	0:00.02 migration/3
30	root	20	0	0	0	0	S	0.0	0.0	0:00.01 ksoftirqd/3
32	root	0	-20	0	0	0	I	0.0	0.0	0:00.00 kworker/3:0H-kblockd
33	root	20	0	0	0	0	S	0.0	0.0	0:00.00 kdevtmpfs

Experiment Analysis

QEMU vs Docker

Test 1

sysbench --num-threads=2 fileio --file-total-size=1G --file-test-mode=rndwr run

	min	Average	Max	No. of events
Docker	0.00	0.05	3.88	184604
QEMU	0.00	0.04	2.21	258744

Test 2

sysbench --num-threads=4 fileio --file-total-size=2G --file-test-mode=seqrewr run

	min	Average	Max	No. of events
Docker	0.00	0.05	8.30	188658
QEMU	0.00	0.01	17.22	678022

Test 3

sysbench --num-threads=8 fileio --file-total-size=3G --file-test-mode=rndrw run

	min	Average	Max	No. of events
Docker	0.00	0.10	4.79	97180
QEMU	0.00	0.10	6.21	98014

In the CPU test cases, we can conclude that QEMU outperforms Docker.