COEN -241 Cloud Computing

Homework1:
System Vs OS Virtualization Report

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HW Github link:

Github Link for HW

Host System Configuration:

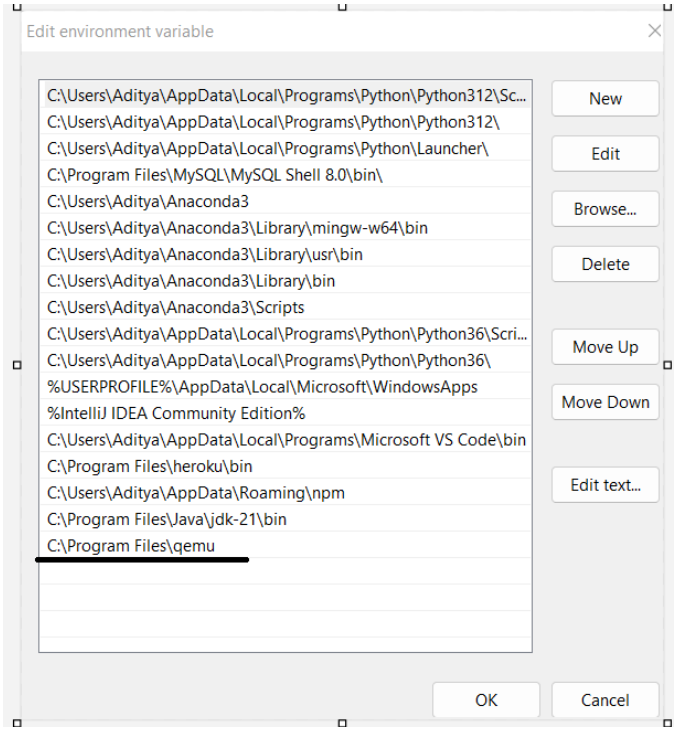
1	Processor	11th Gen Intel(R) Core(TM) i5-1155G7 @ 2.50GHz 2.50 GHz
2	CPU	10
3	Memory	8 GB
4	Free disk space	143 GB
5	Operating System	Windows 11

- We will be using two different disk images for QEMU namely raw and qcow2 with four different configurations which will be seen in the report further.
- We will also use four Docker which will again be seen further in the report.

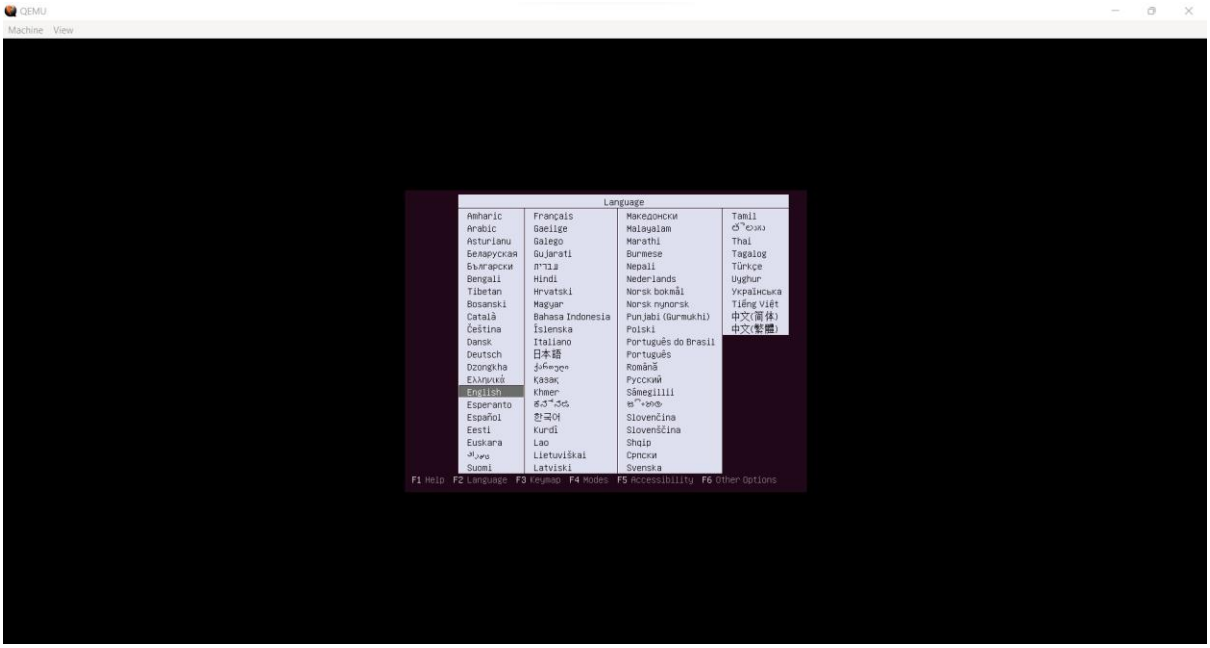
QEMU and Ubuntu Installation and setup:

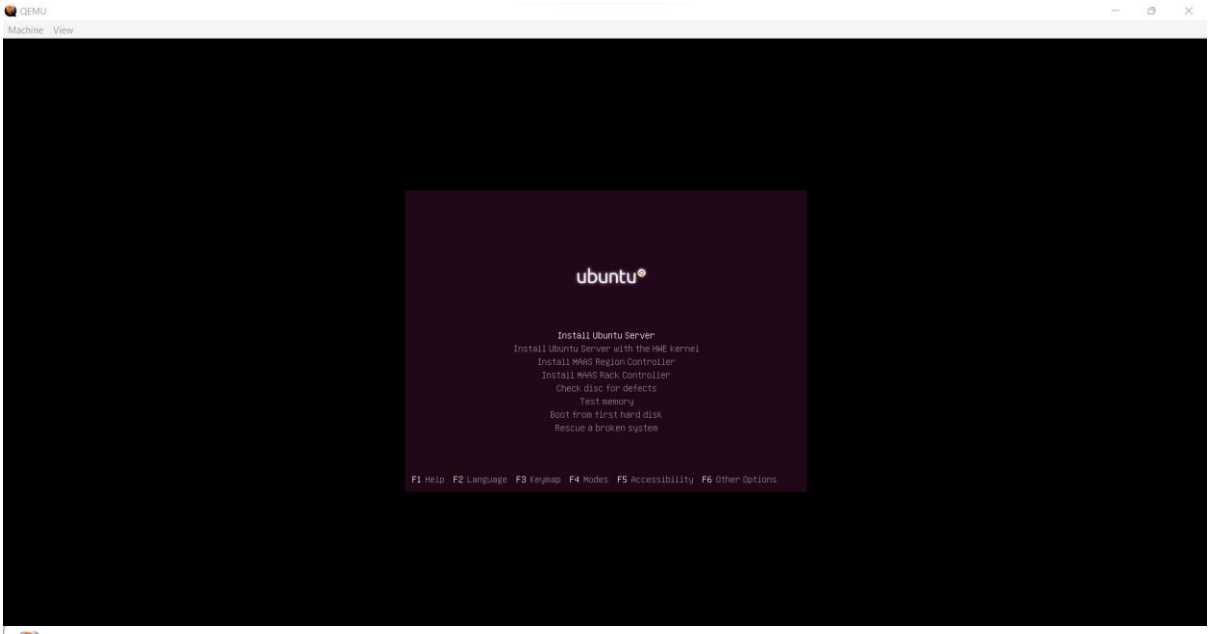
In this section we will discuss about the process of QEMU Installation and setup:

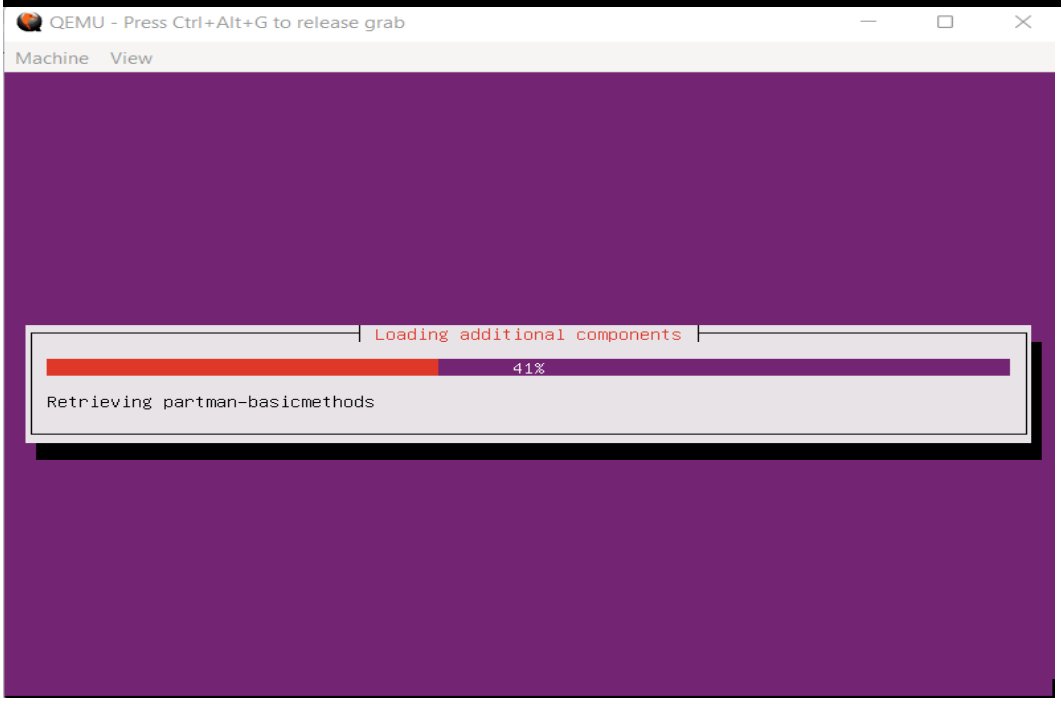
1) Download QEMU for windows from the link: QEMU Downloader
2) Then download Ubuntu 16.04 server ISO image to run ubuntu guest virtual Machine from the link: Ubuntu 16.04 Server
3) Then the next step is to add QEMU path to the path system variable section in the environment variables.



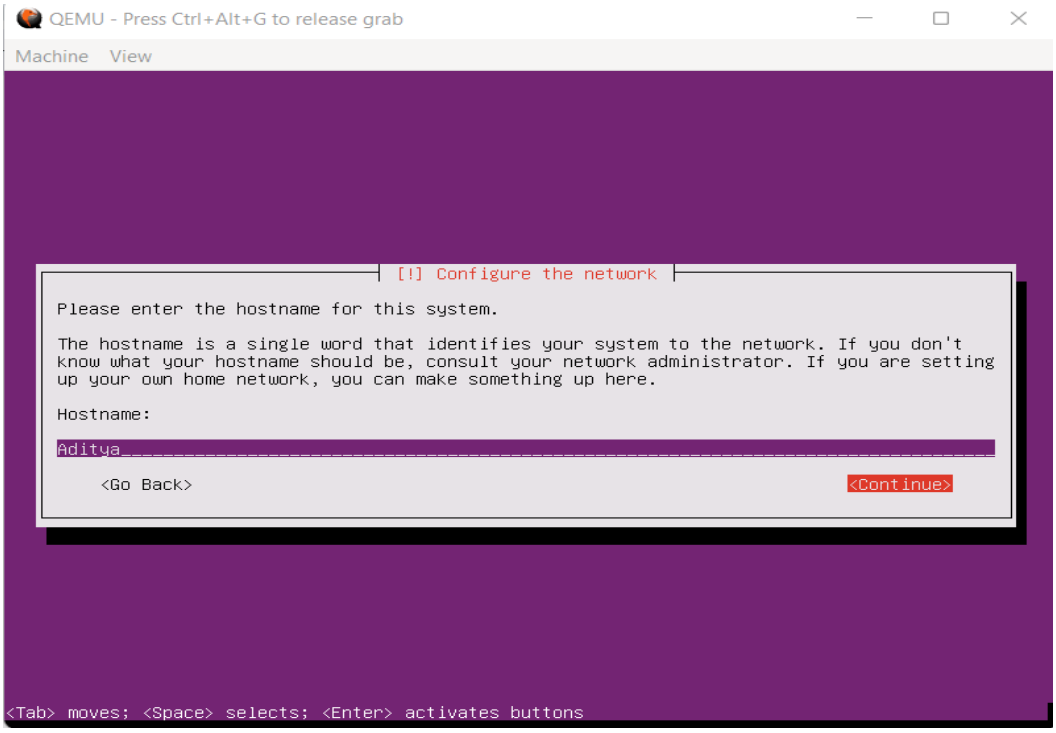
4) Once QEMU path has been added to the environment variables then open the PowerShell as administrator and the run the following commands.
   - Open the QEMU folder in PowerShell using **cd \qemu**
   - After that create an Ubuntu image in qcow2 file format with a virtual hard drive of 30 GB and the command to execute this is: **qemu-img create -f qcow2 ubuntu20.img 30G**
   - Now run the Ubuntu using CD/ROM with command: **qemu-system-x86_64.exe -m 1G -smp 2 -boot order=dc -hda ubuntu20.img -cdrom "e:\ubuntu-20.04.3-desktop-amd64.iso"**
   - This will start the ubuntu installation. Below are the screenshots for Ubuntu installation.



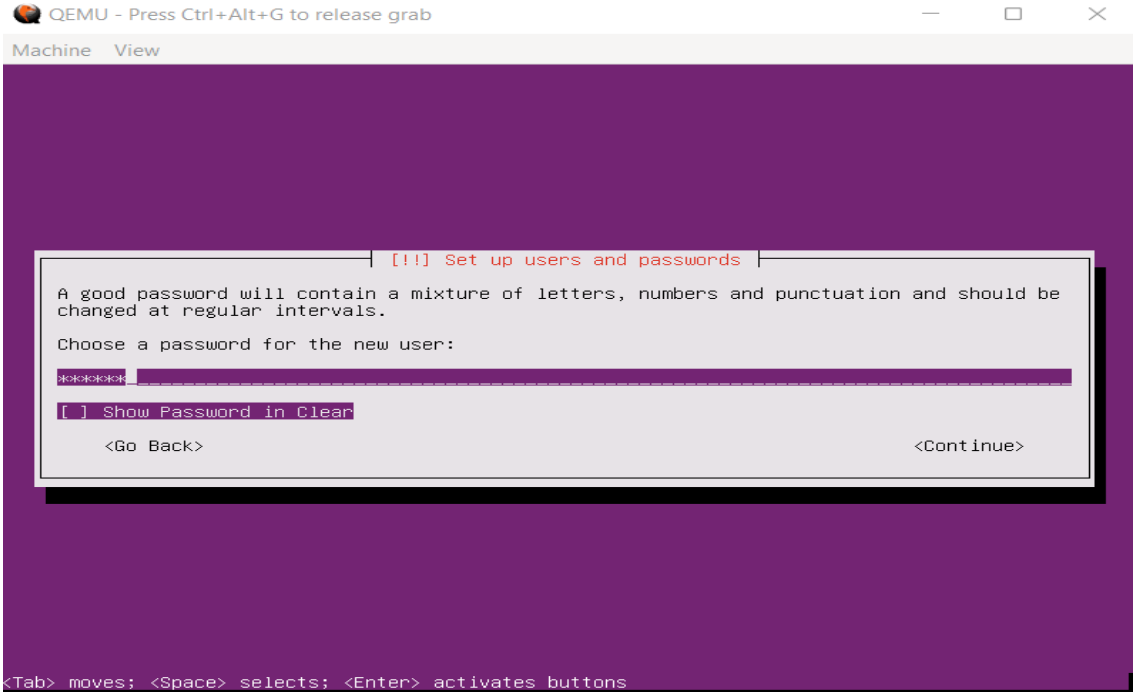




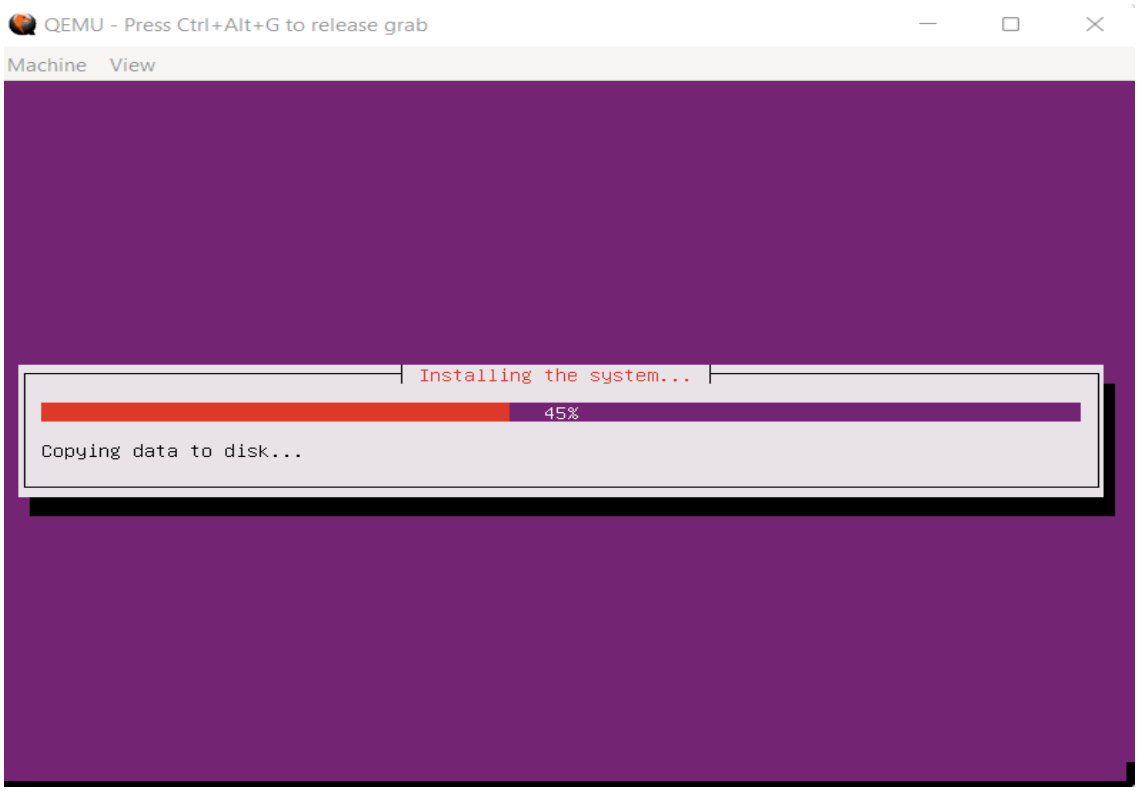
- Enter hostname for the ubuntu system.



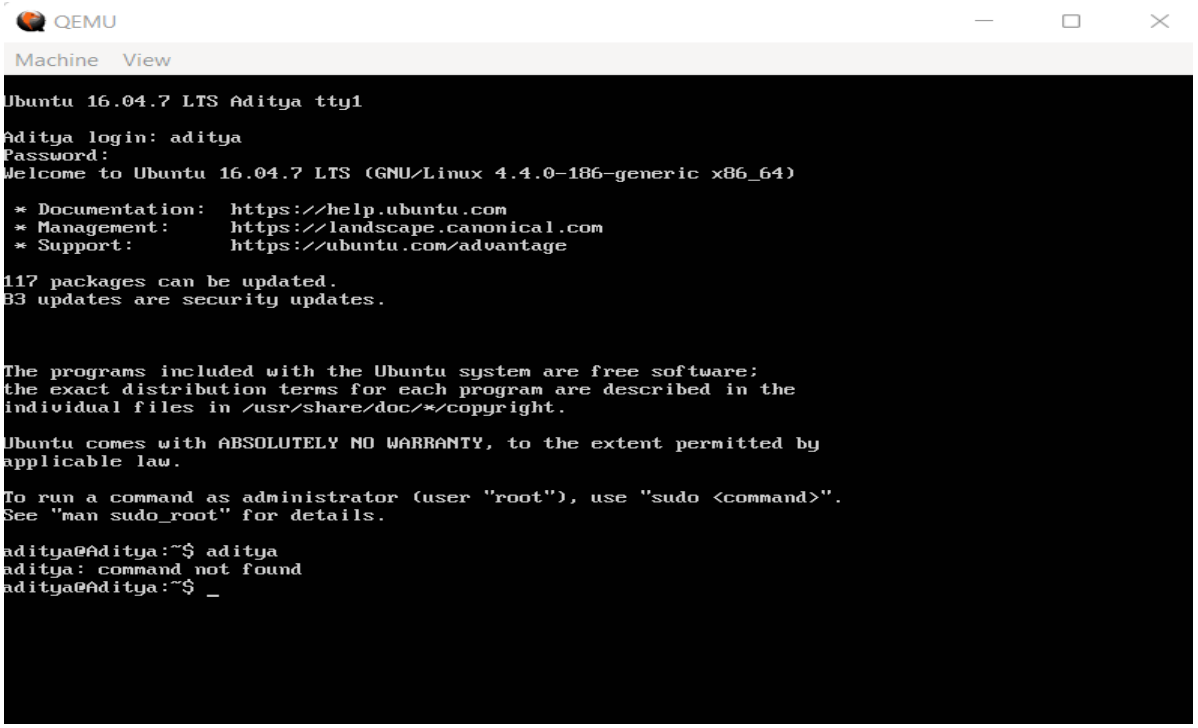
- Setup password for the ubuntu system.



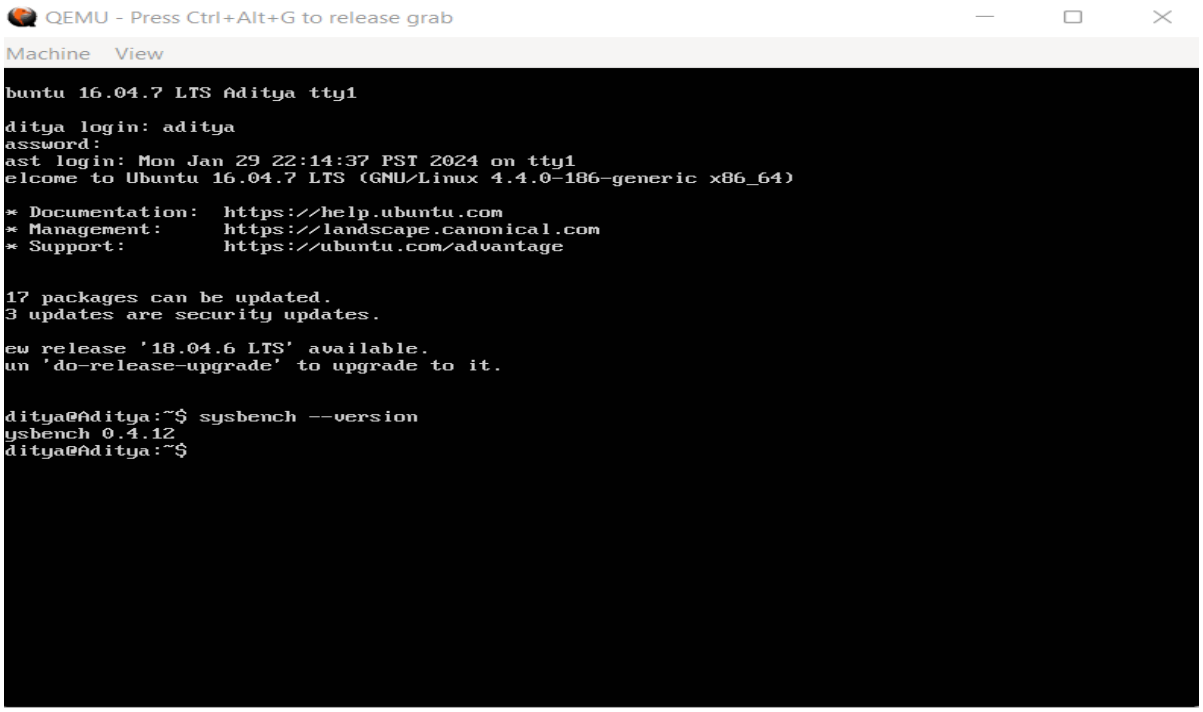
- System installation starts



- Once installation gets completed check the ubuntu version to verify if ubuntu has been installed successfully.

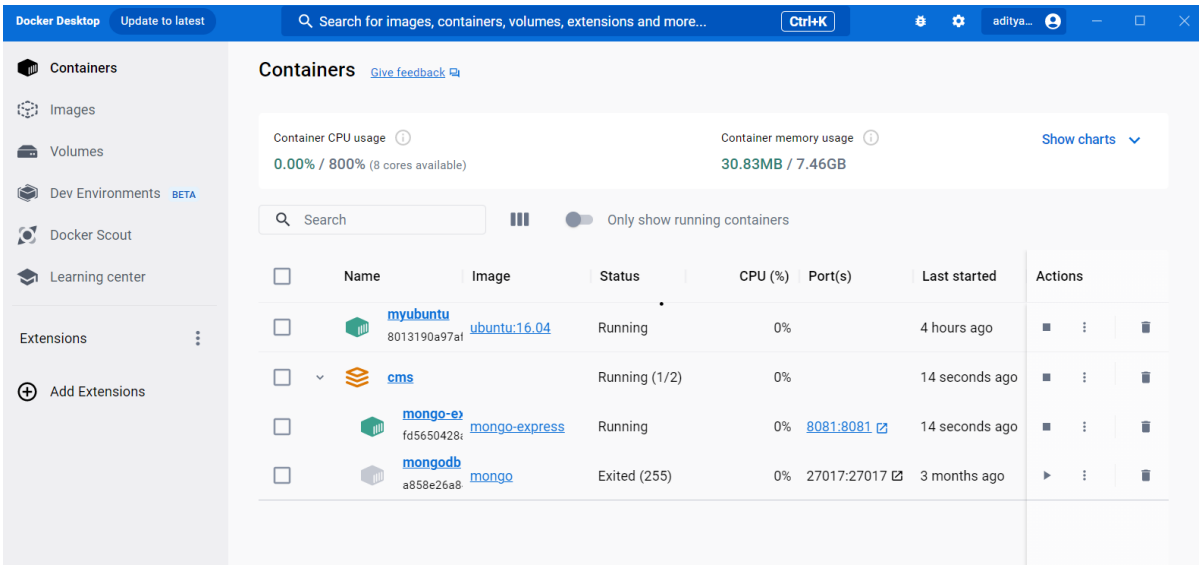


5) Now install sysbench on QEMU to do this run the following commands:
sudo apt-get update
sudo apt install sysbench

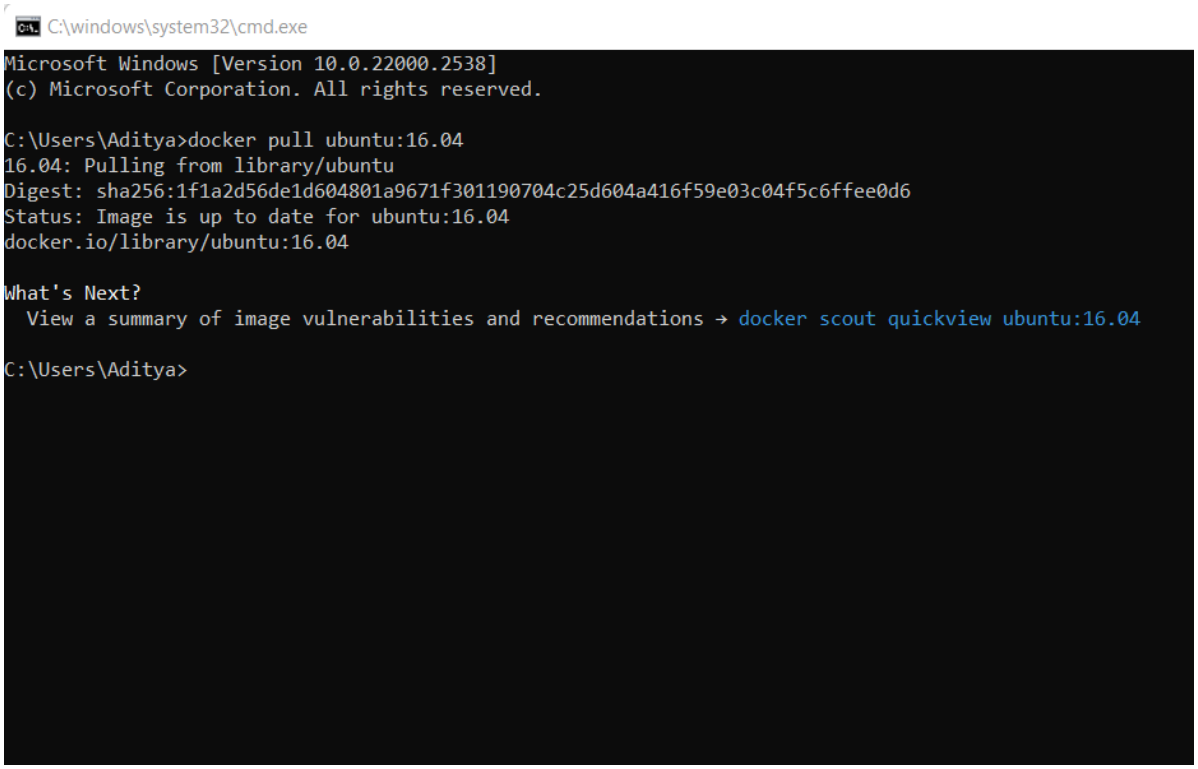


Docker Installation and Setup:

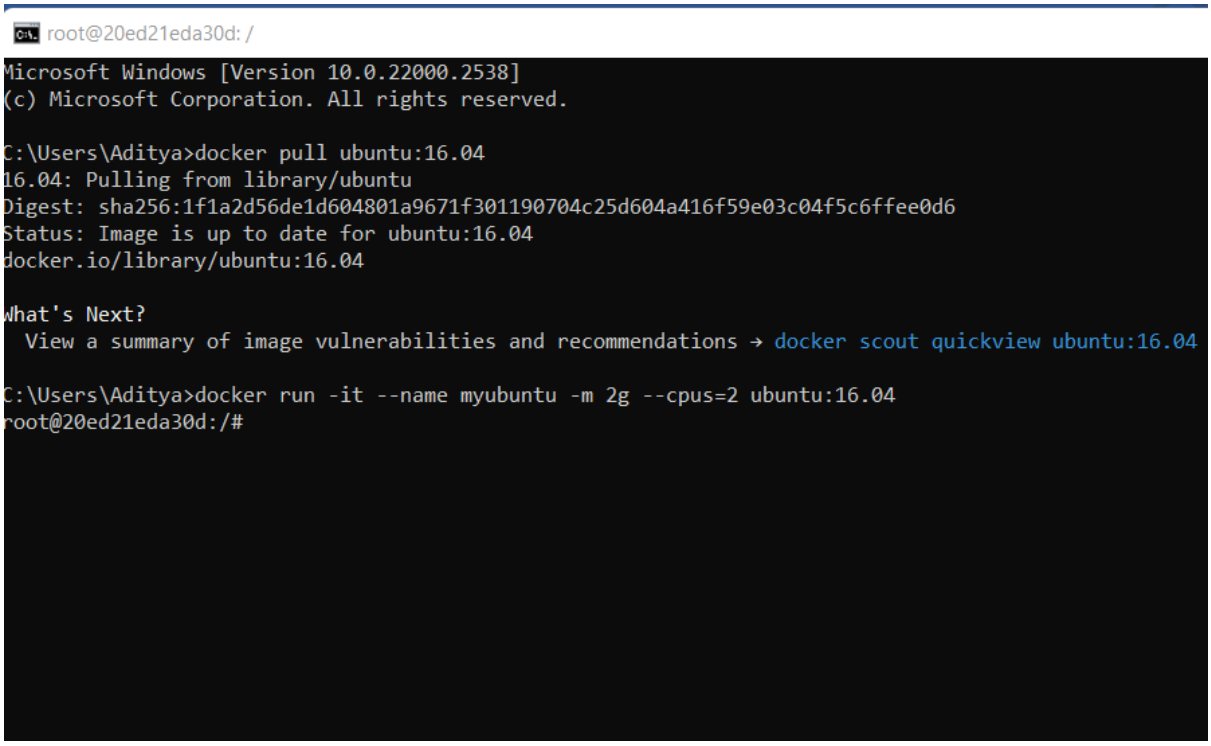
1. Firstly, install docker desktop from the official docker website.



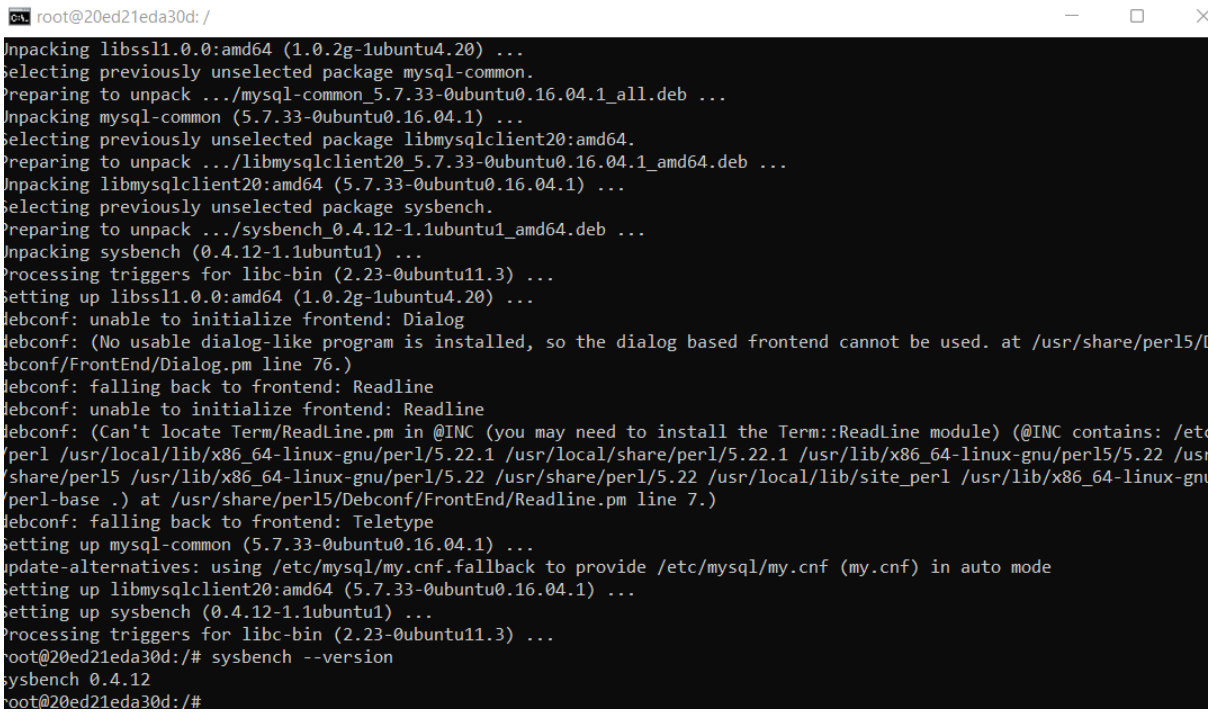
2. Open command prompt and download the ubuntu base image from docker hub using command: **docker pull ubuntu:16.04**



3. Now spin up an Ubuntu container with 4GB of RAM and 2 CPU cores using the command:
   docker run -it --name myubuntu -m 4g --cpus=2 ubuntu:16.04



4. Install nano on docker using the command: **apt-get install nano**
5. Also install sysbench on docker using command: **apt install sysbench**



6. Now you can write the bash scripts on nano.
7. After running the scripts with a particular resource then stop the container and then run it again with different resources.

Experimentation:

We'll start our experimentation on the virtual machine by examining four distinct CPU and RAM configurations. These settings will be initially applied to QEMU using the raw and qcow2 disk images. Next, the Docker run settings will be the same.

As part of this experiment, we will consider four configurations:

- 6 core and 3 GB memory allocation
- 8 core and 4 GB memory allocation
- 2 core and 2 GB memory allocation
- 3 core and 3 GB memory allocation

To complete this experiment successfully we will do three types of testing:

- CPU Testing: To assess CPU performance between QEMU and Docker, we will utilize the following two test scenarios. The sysbench tool and the test cases given below will be used in our testing.

    - **sysbench --test=cpu --cpu-max-prime=20000 run**
    - **sysbench --test=cpu --num-threads=4 --cpu-max-prime=10000 run**

- File I/O Testing: We will use random read/write (rndrw) for File I/O testing. Additionally, we will use the following Sysbench commands and alter the settings for various configurations in order to test.

  - **sysbench --test=fileio --file-total-size=250M --file-test-mode=seqwr prepare**
    sysbench --test=fileio --file-total-size=250M --file-test-mode=seqwr run
    sysbench --test=fileio --file-total-size=250M cleanup

  - **sysbench --test=fileio --file-total-size=1G --file-test-mode=rndrd prepare**
    sysbench --test=fileio --file-total-size=1G --file-test-mode=rndrd run
    sysbench --test=fileio --file-total-size=1G cleanup

- Memory testing: We will use random access (seq) and sequential access (rnd) for memory testing. We will also use the following Sysbench commands for testing, altering the settings for various configurations.

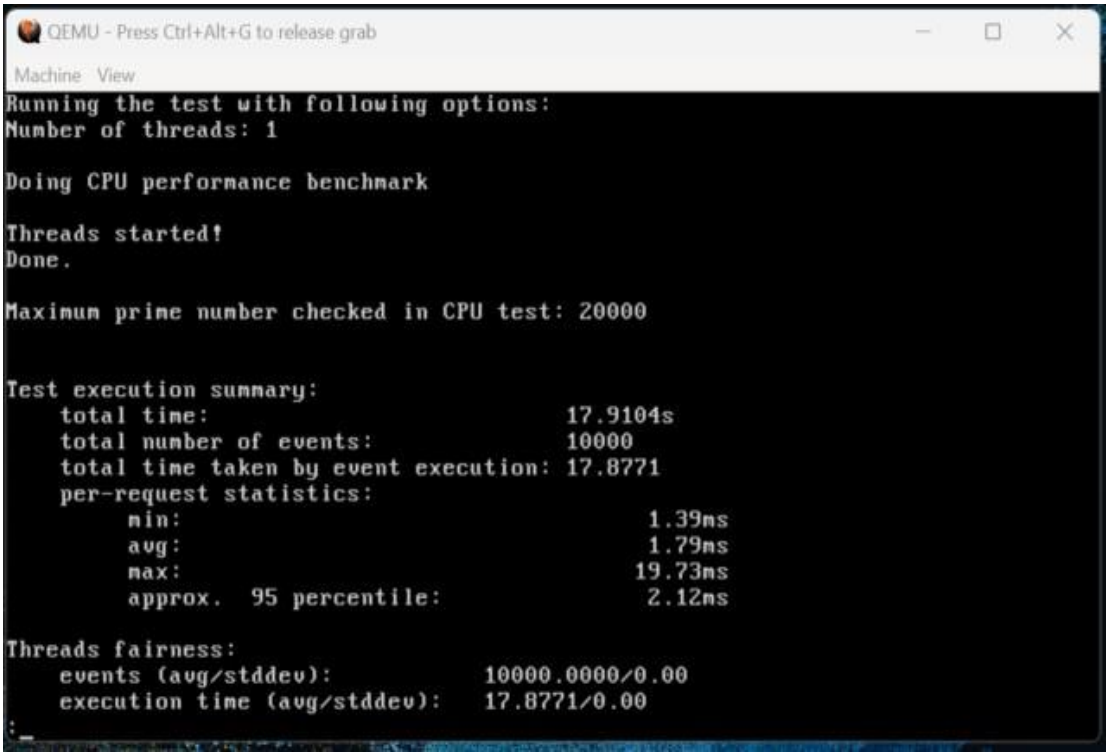
  - **sysbench --test=memory --memory-block-size=1K --memory-total-size=100G --memory-access-mode=seq run**
  - **sysbench --test=memory --memory-block-size=1K --memory-total-size=100G --memory-access-mode=rnd run**

1. Configuration: 2GB RAM & 2 Core

QEMU- Raw disk image:

CPU Testing:

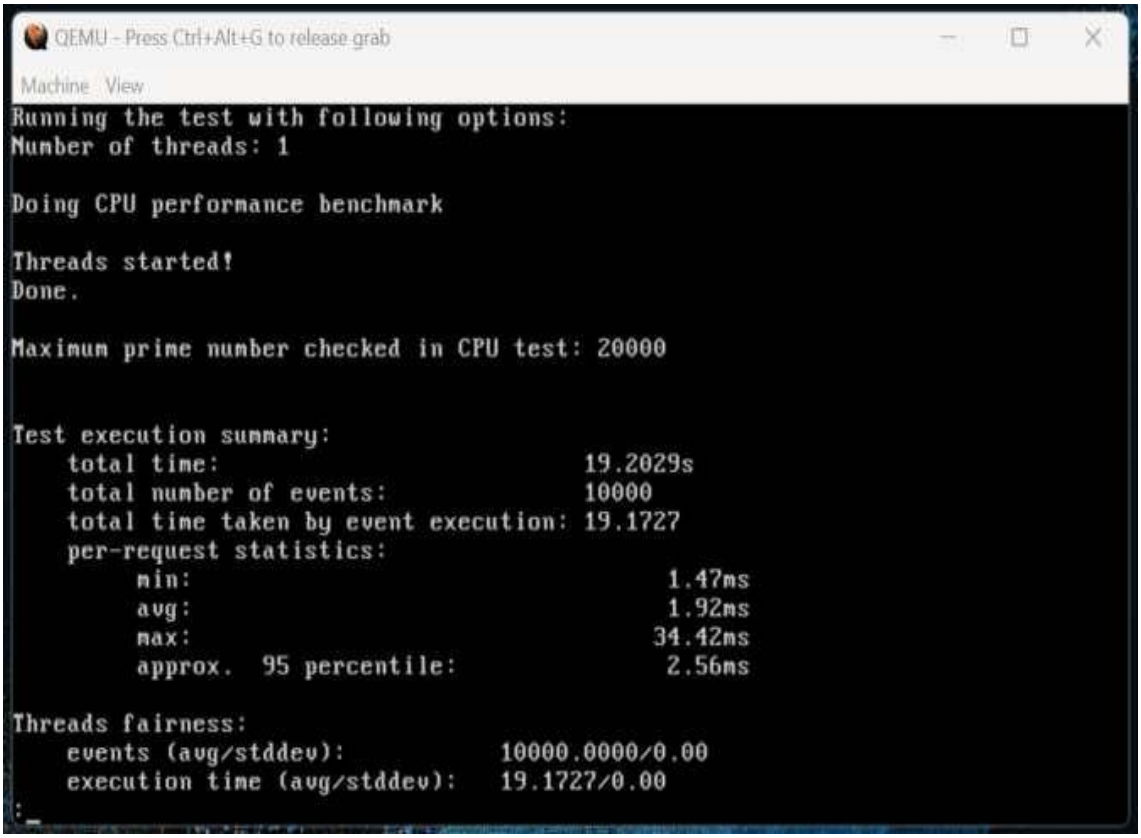
Result for **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	1.79 ms	1.88 ms	1.95 ms	1.92 ms	1.91 ms
Max. time taken	19.73 ms	16.24 ms	21.10 ms	34.42 ms	16.68 ms
Min. time taken	1.39 ms	1.44 ms	1.45 ms	1.47 ms	1.49 ms
Total time taken for event execution	17.8771	18.7636	19.4575	19.1727	19.1466

Result for **CPU Testing** where max-Prime =10000 – test case 2

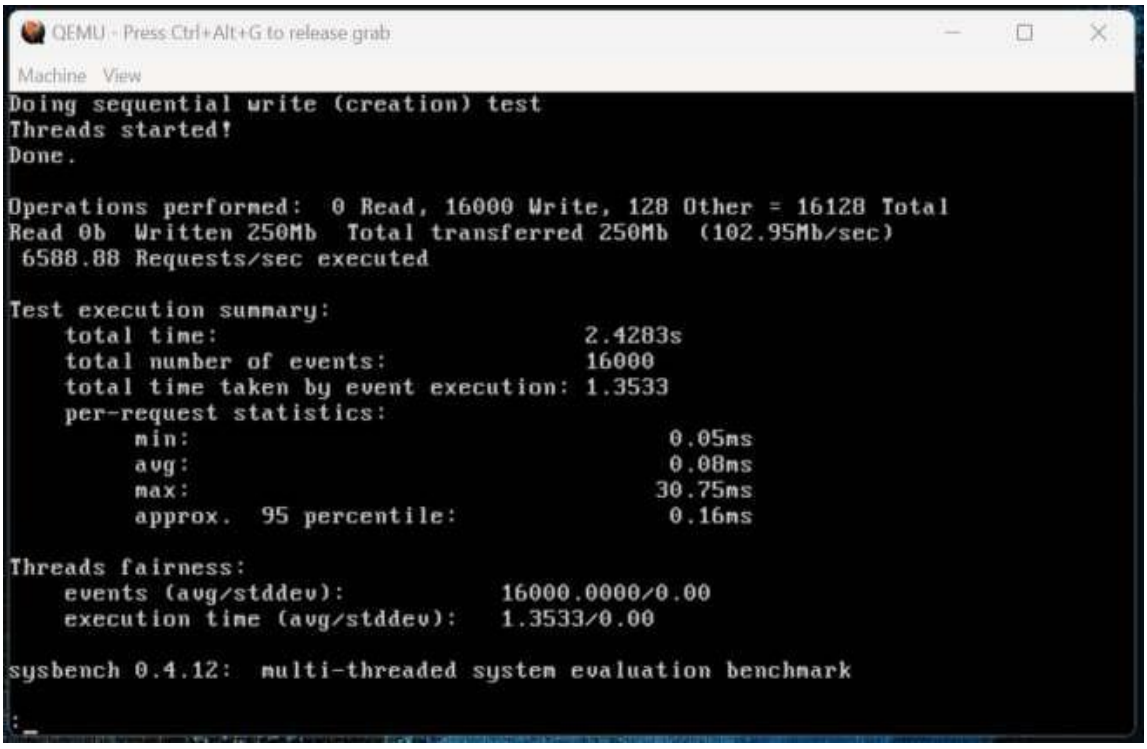


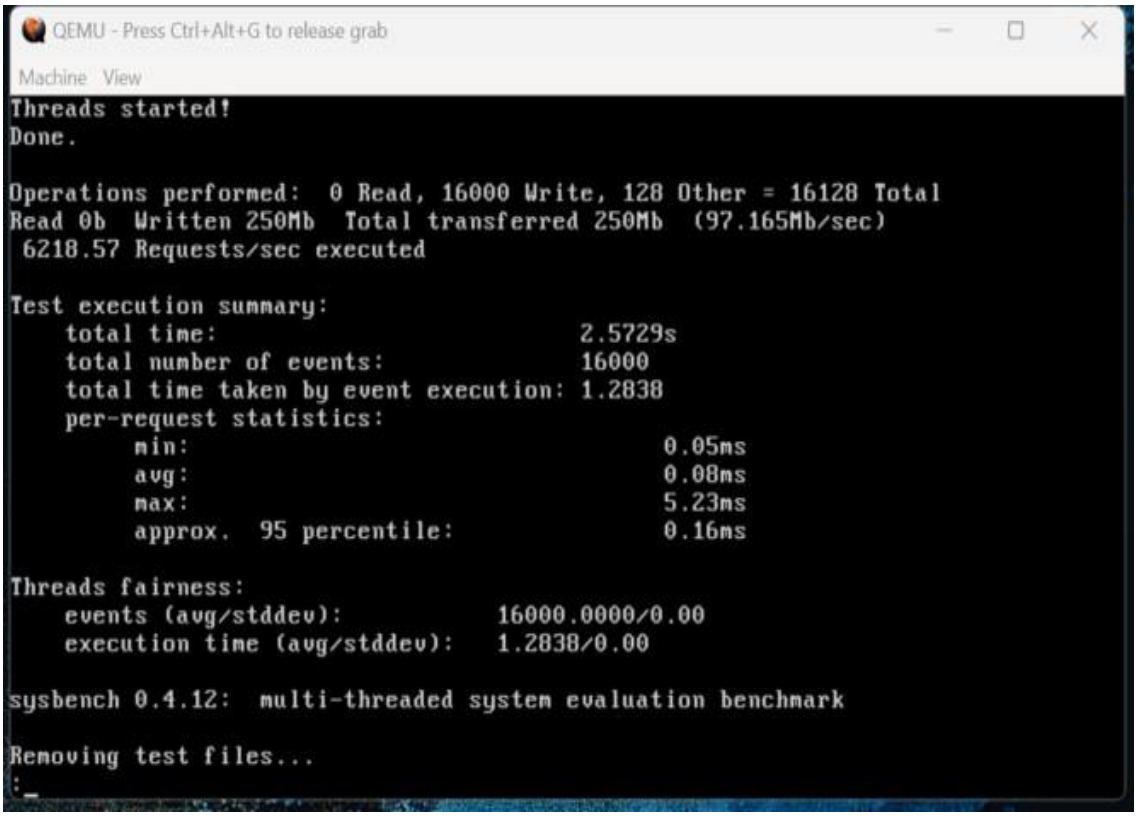
Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	1.92 ms	2.01 ms	2.20 ms	2.21 ms	2.17 ms
Max. time taken	63.20 ms	46.57 ms	37.04 ms	35.90 ms	34.58 ms
Min. time taken	0.66 ms	0.81 ms	0.81 ms	0.85 ms	0.83 ms
Total time taken for event execution	19.1767	20.0672	19.4575	22.0601	21.7440

File I/O Testing:

QEMU Result for **File I/O Testing** for 2GB RAM and 2 Core for Sequential Write

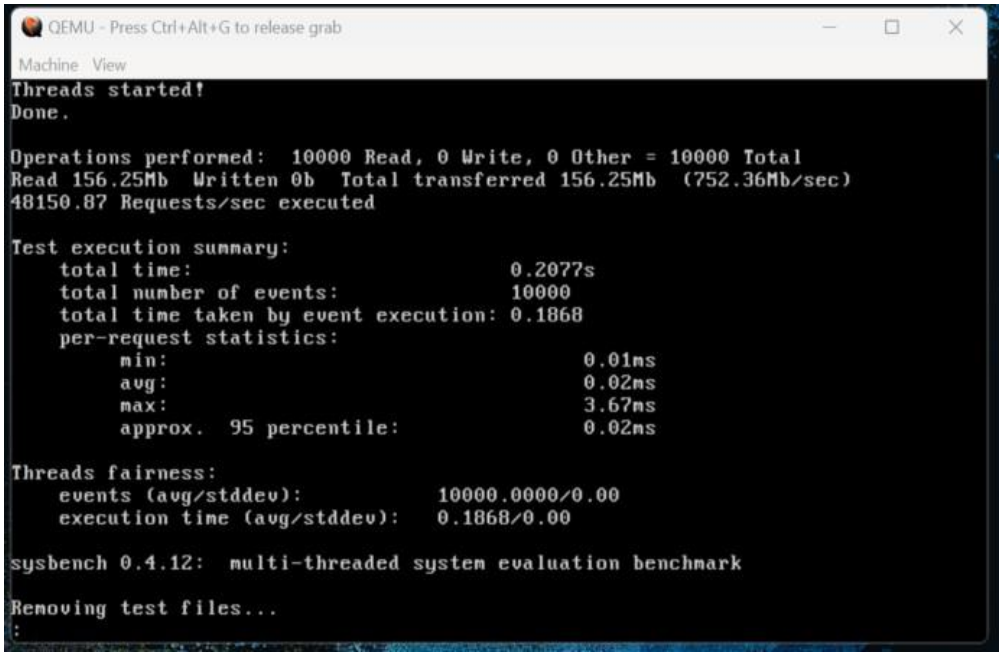


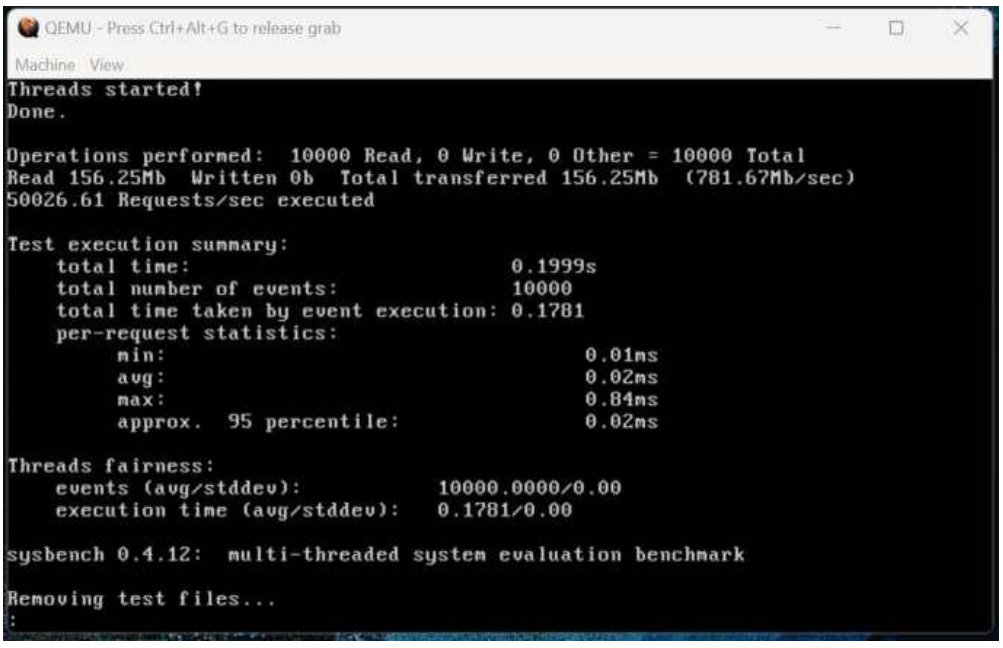


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.07 ms	0.08 ms	0.05 ms	0.09 ms	0.07 ms
Max. time taken	5.27 ms	5.38 ms	5.23 ms	5.28 ms	4.26 ms
Min. time taken	0.03 ms	0.05 ms	0.07 ms	0.08 ms	0.04 ms
Total time taken for event execution	1.1058	1.3533	1.2838	1.4032	1.1292

QEMU Result for **File I/O Testing** for 2GB RAM and 2 Core for Random reads



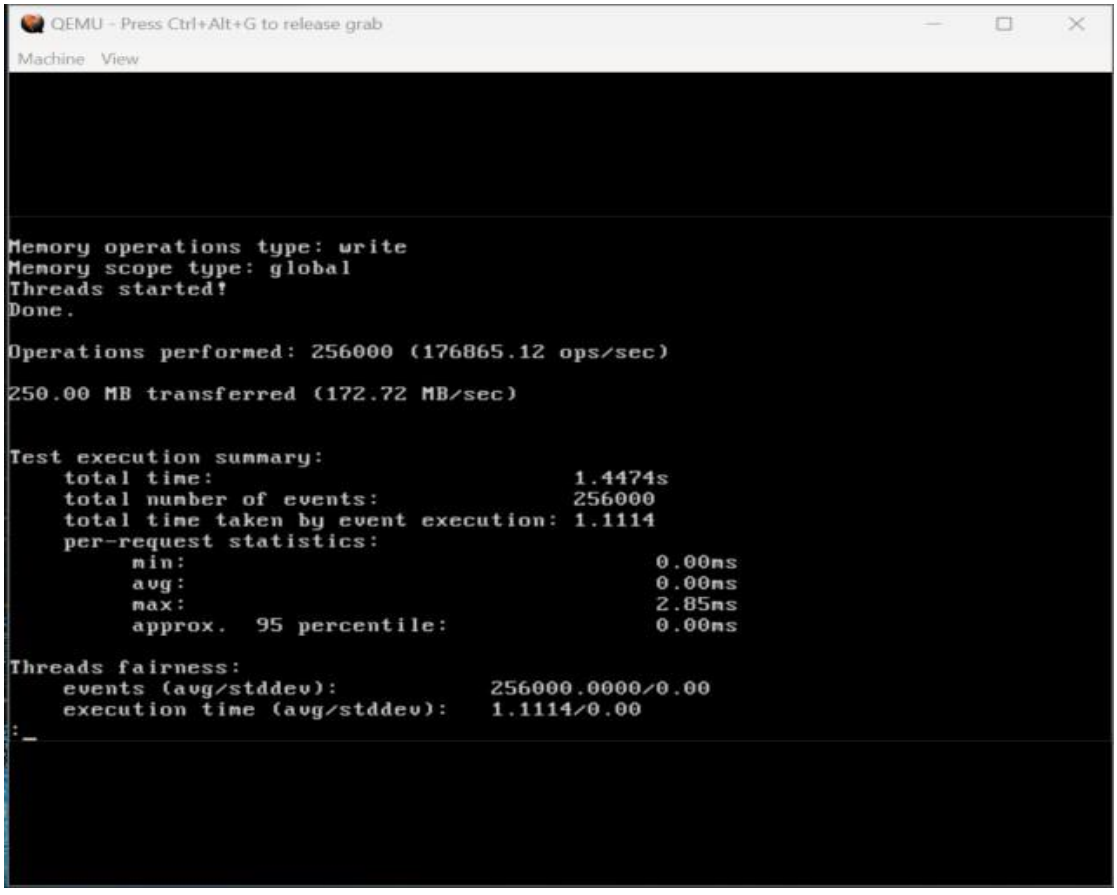


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.02 ms	0.02 ms	0.02 ms	0.02 ms	0.02 ms
Max. time taken	3.47 ms	3.67 ms	3.88 ms	2.86 ms	2.84 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.1770	0.1868	0.1781	0.1876	0.1835

Memory Testing:

QEMU Result for **Memory Testing** for 2GB RAM and 2 Core for Sequential Memory Access – Total memory size = 250 MB

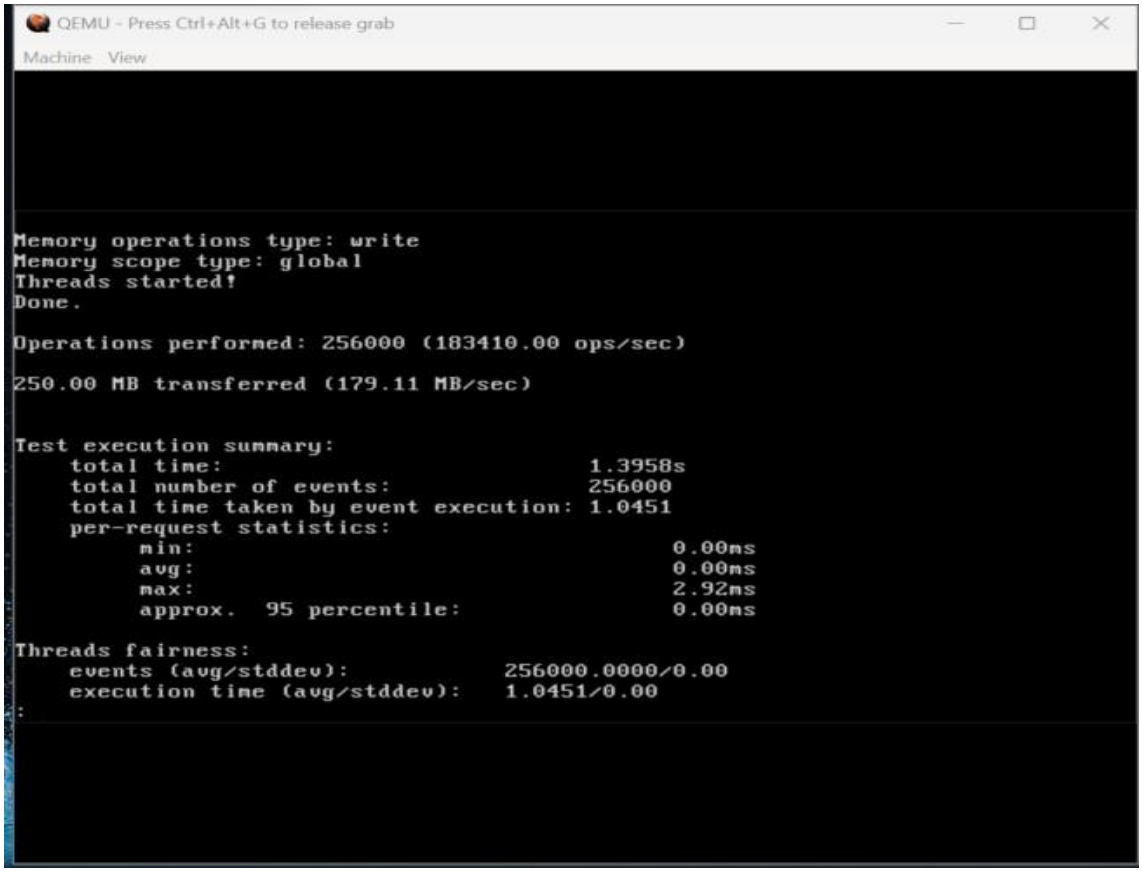


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.00 ms	0.01 ms	0.02 ms
Max. time taken	5.41 ms	5.55 ms	2.85 ms	3.45 ms	3.66 ms

Min. time taken	0.01 ms	0.01 ms	0.00 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.0000	0.1868	0.1781	0.1876	0.1835

QEMU Result for **Memory Testing** for 2GB RAM and 2 Core for Random read – Total memory size = 250MB



Test Execution Summary:

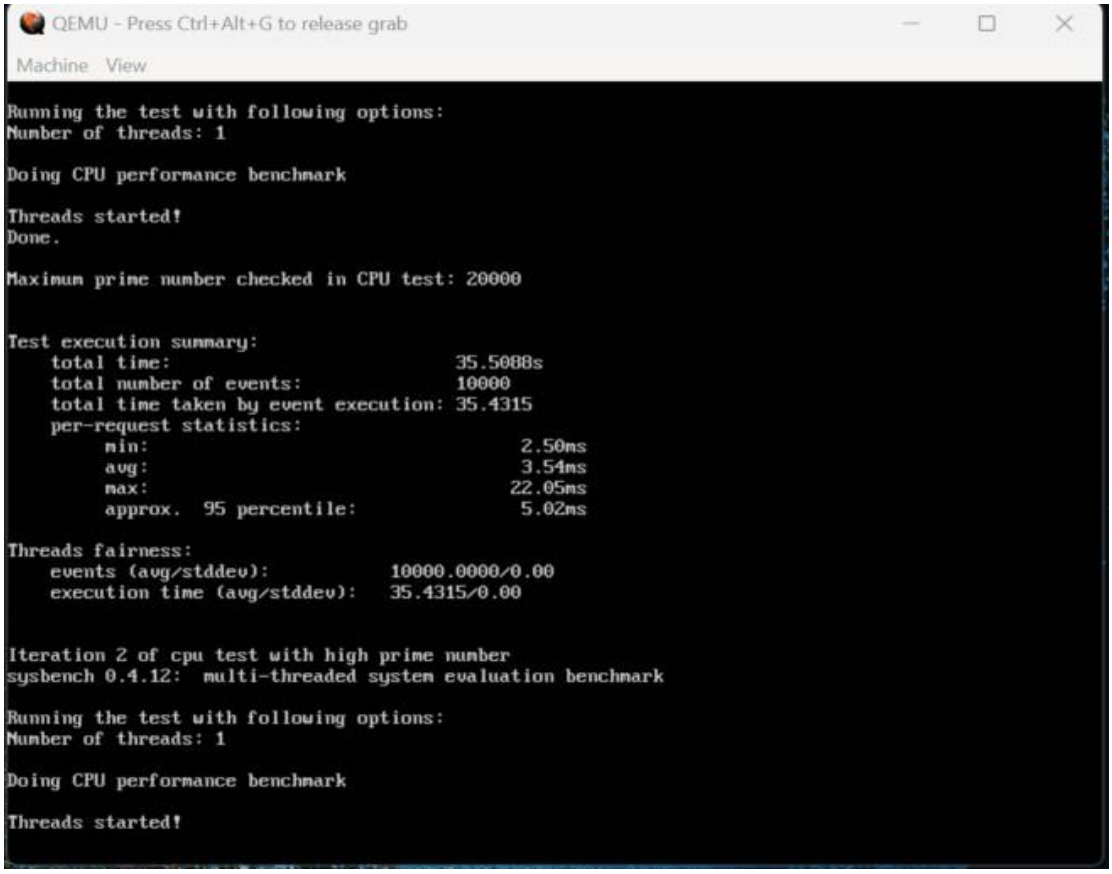
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.00 ms	0.00 ms	0.02 ms
Max. time taken	2.56 ms	2.21 ms	1.92 ms	2.85 ms	2.77 ms
Min. time taken	0.01 ms	0.01 ms	0.02 ms	0.00 ms	0.01 ms

Total time taken for event execution	0.9359	1.0404	0.9652	1.1114	1.0633

QEMU- qcow2 disk image:

CPU Testing:

Result for QEMU qcow2 for **CPU Testing** where Max-Prime = 20000 - test case 1

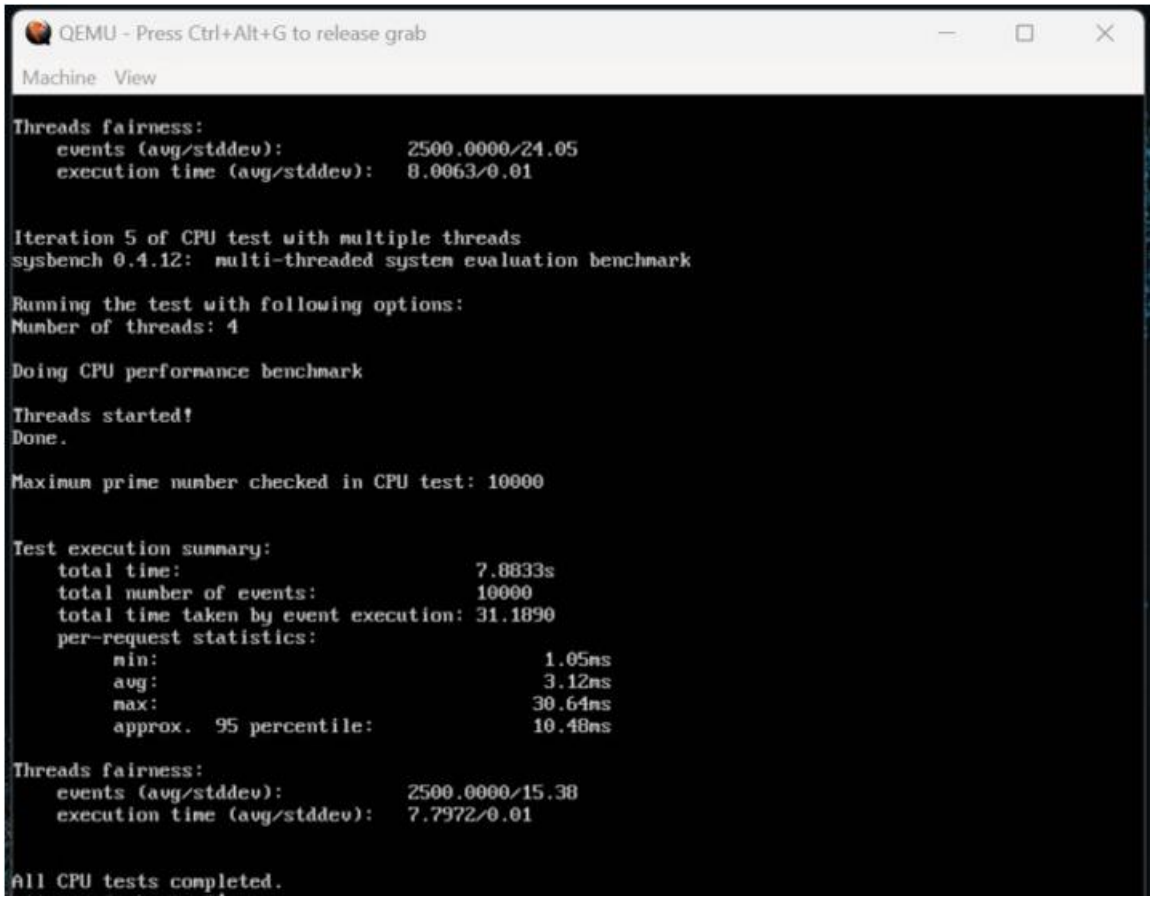


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	3.54 ms	3.68 ms	3.74 ms	2.89 ms	3.67 ms
Max. time taken	22.05 ms	22.25 ms	21.92 ms	22.06 ms	22.77 ms
Min. time taken	2.50 ms	2.67 ms	2.87 ms	2.53 ms	2.51 ms

Total time taken for event execution	35.4315	36.3325	34.2253	35.4521	36.2885

Result for QEMU qcow2 for **CPU Testing** where max-Prime =10000 – test case 2



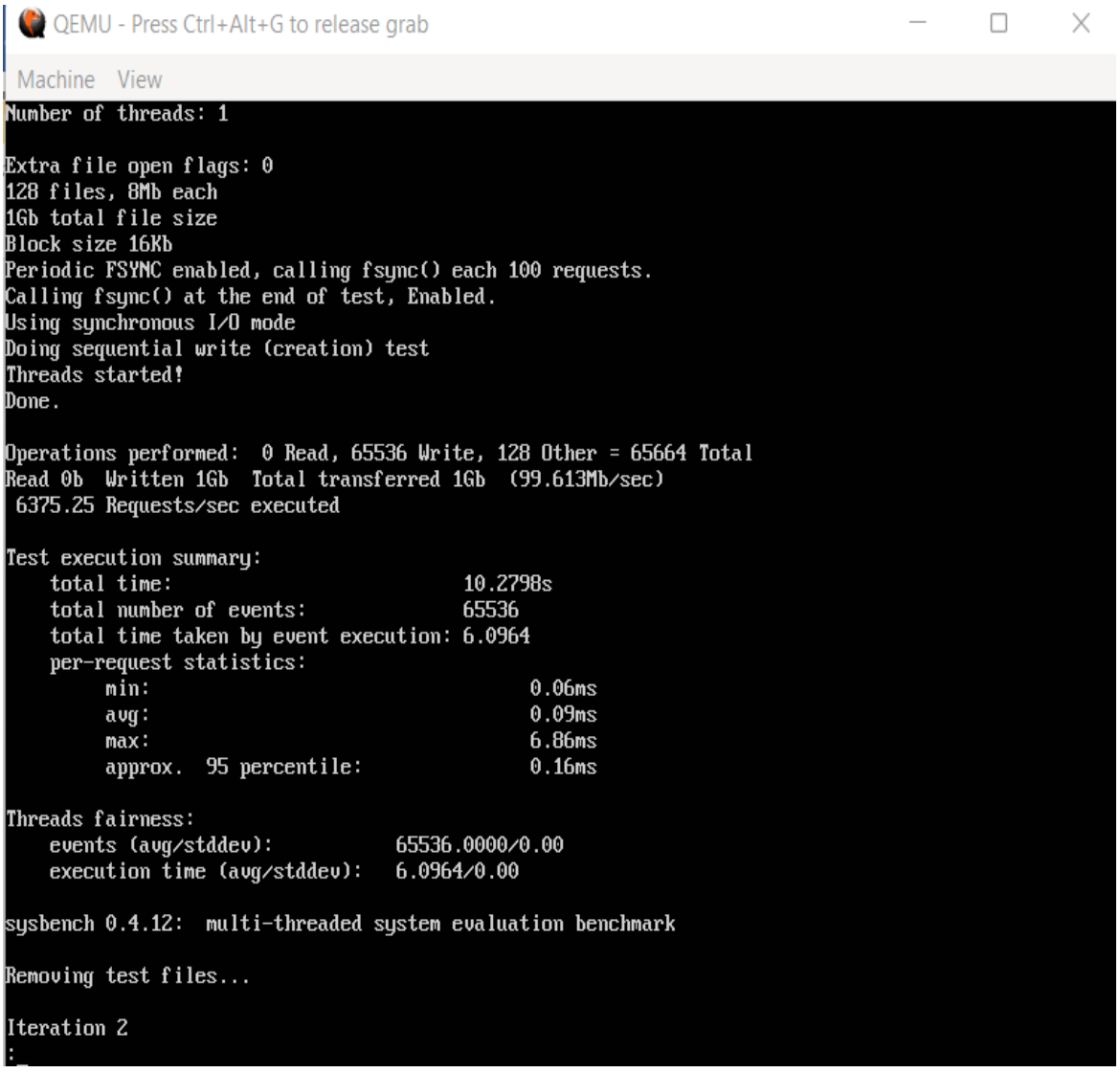
Test Execution Summary:

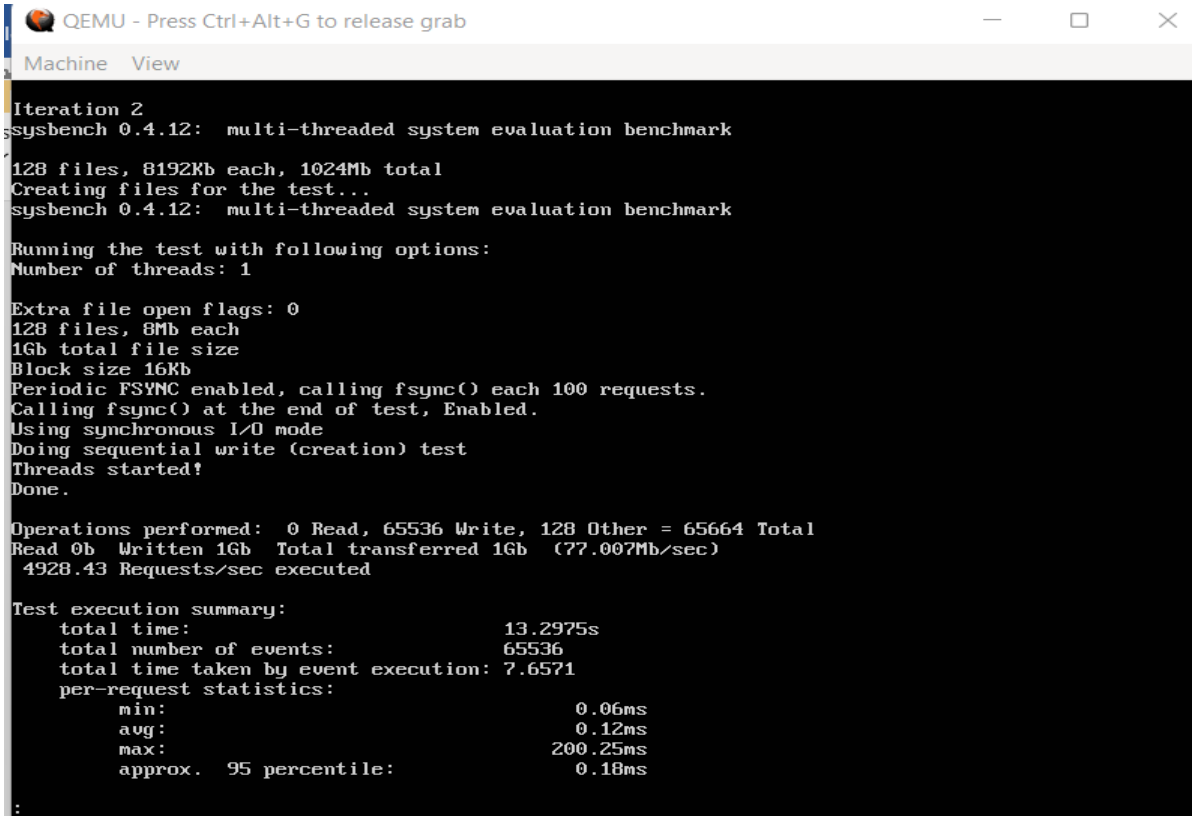
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	3.12 ms	3.15 ms	3.74 ms	3.89 ms	3.67 ms
Max. time taken	30.64 ms	31.01 ms	30.85 ms	30.06 ms	30.77 ms
Min. time taken	1.05 ms	1.12 ms	1.18 ms	1.53 ms	1.51 ms

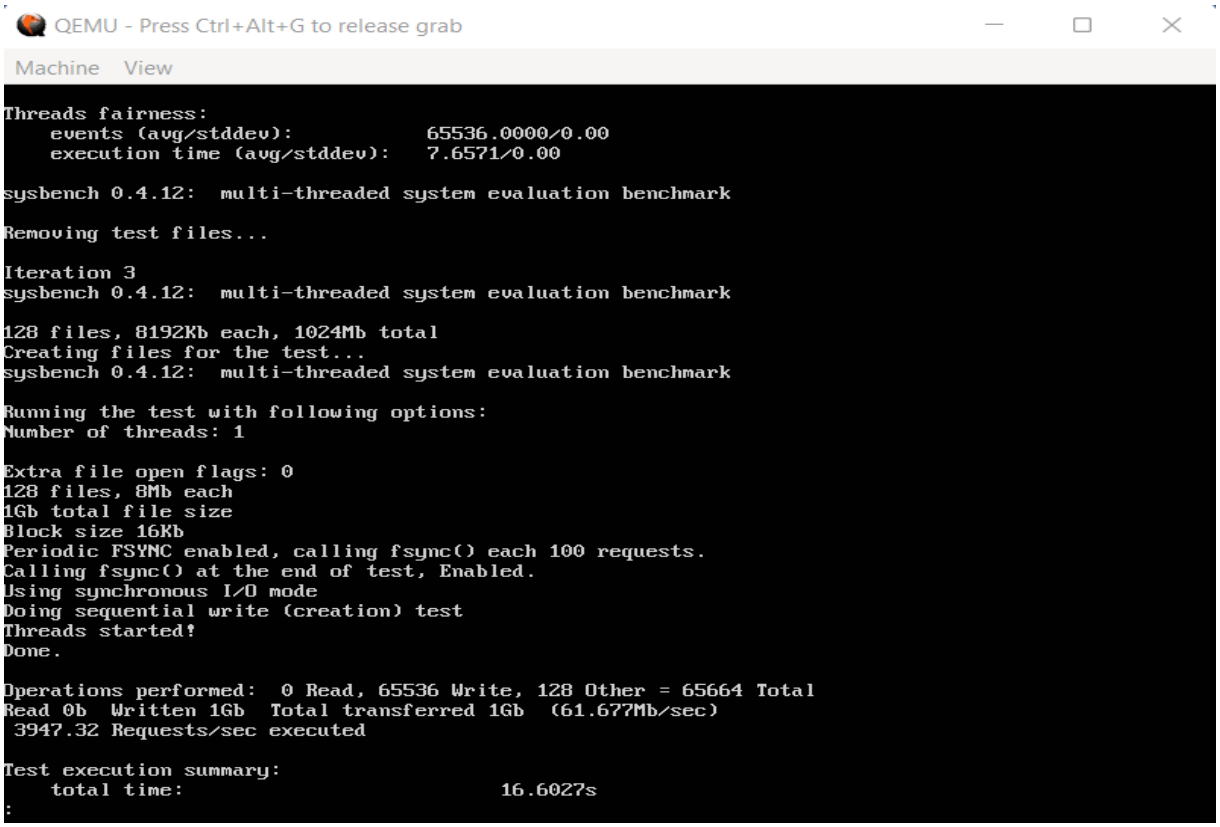
Total time taken for event execution	38.1890	37.3325	38.2253	38.4521	38.2885

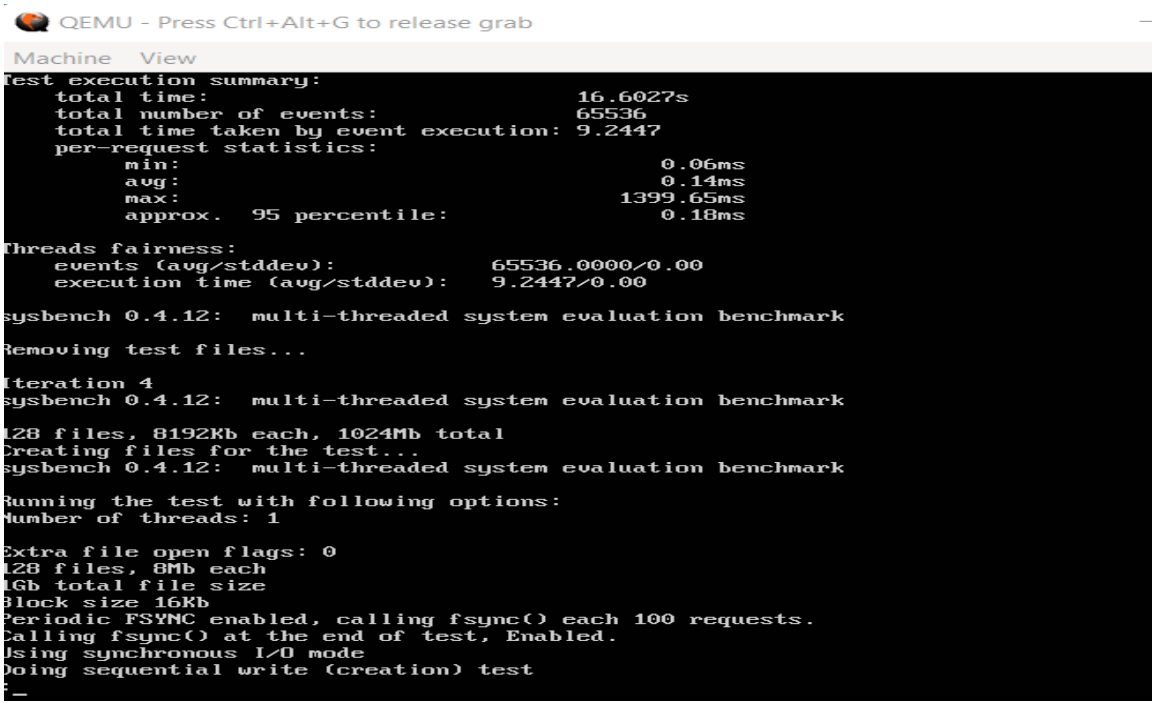
File I/O Testing:

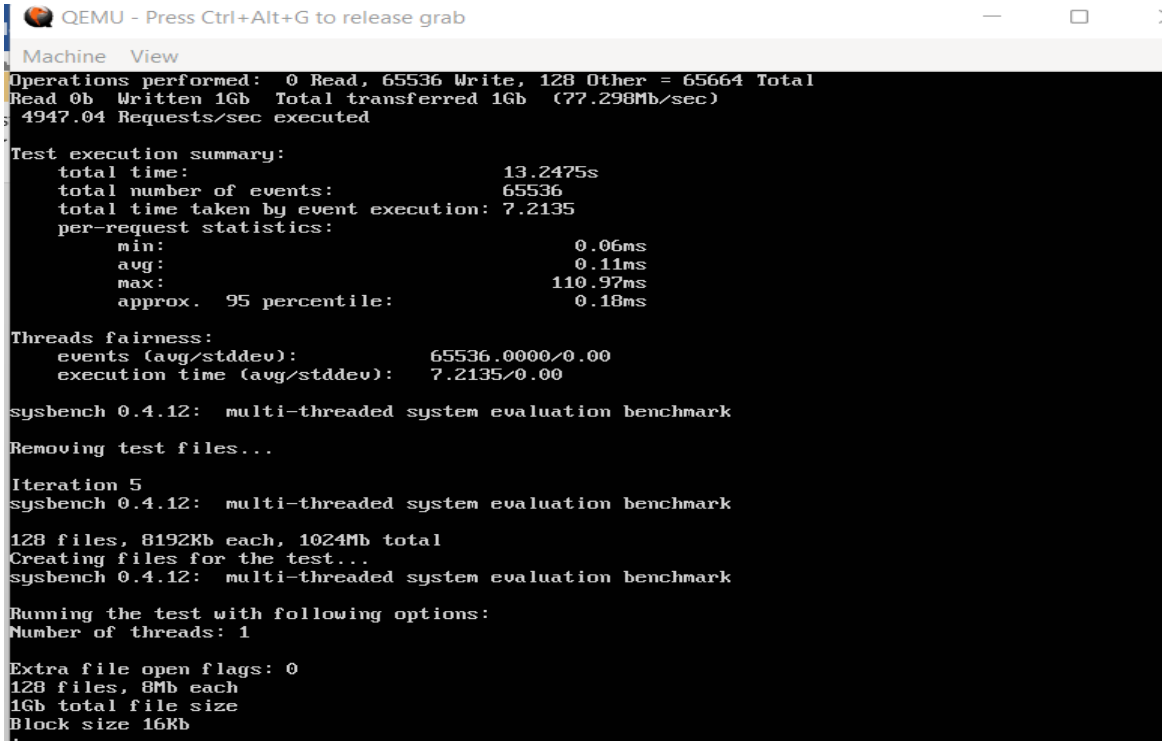
QEMU qcow2 Result for **File I/O Testing** for 2GB RAM and 2 Core for Sequential Write

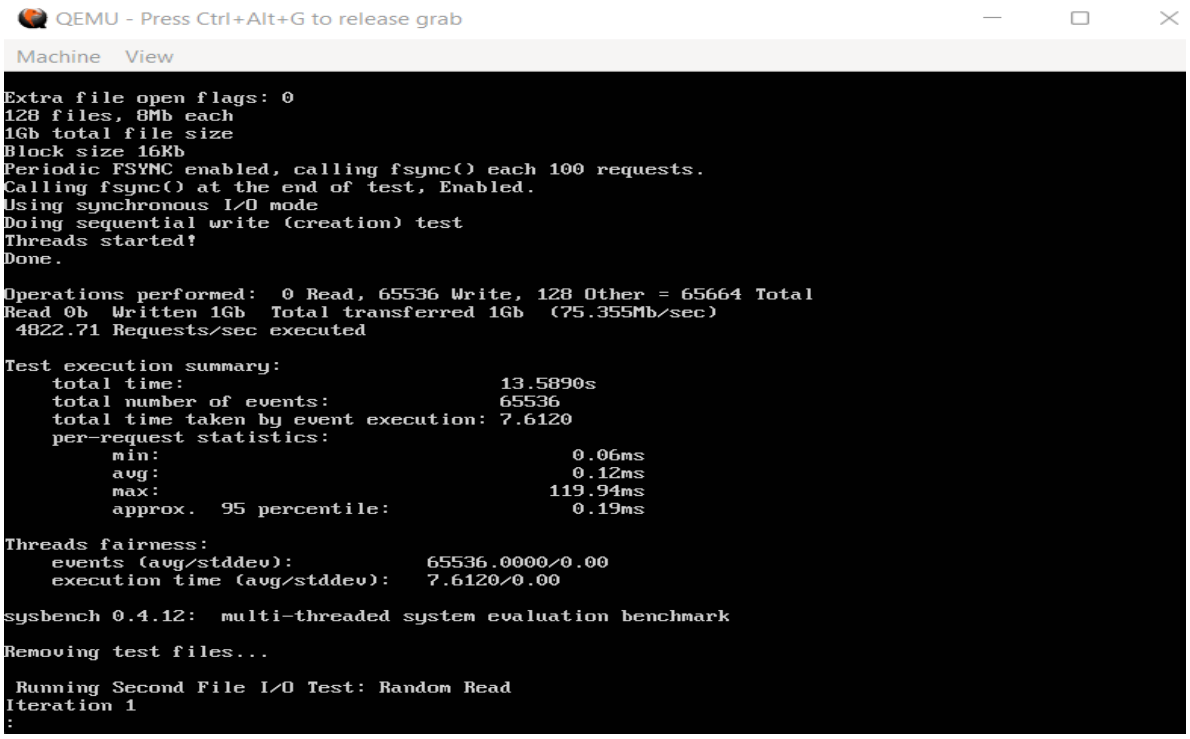



QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 2
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential write (creation) test
Threads started!
Done.
Operations performed: 0 Read, 65536 Write, 128 Other = 65664 Total
Read 0b Written 1Gb Total transferred 1Gb (77.007Mb/sec)
4928.43 Requests/sec executed
Test execution summary:
total time: 13.2975s
total number of events: 65536
total time taken by event execution: 7.6571
per-request statistics:
min: 0.06ms
avg: 0.12ms
max: 200.25ms
approx. 95 percentile: 0.18ms


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Threads fairness:
events (avg/stddev): 65536.0000/0.00
execution time (avg/stddev): 7.6571/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...
Iteration 3
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential write (creation) test
Threads started!
Done.
Operations performed: 0 Read, 65536 Write, 128 Other = 65664 Total
Read 0b Written 1Gb Total transferred 1Gb (61.677Mb/sec)
3947.32 Requests/sec executed
Test execution summary:
total time: 16.6027s


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Test execution summary:
total time: 16.6027s
total number of events: 65536
total time taken by event execution: 9.2447
per-request statistics:
min: 0.06ms
avg: 0.14ms
max: 1399.65ms
approx. 95 percentile: 0.18ms
Threads fairness:
events (avg/stddev): 65536.0000/0.00
execution time (avg/stddev): 9.2447/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...
Iteration 4
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential write (creation) test

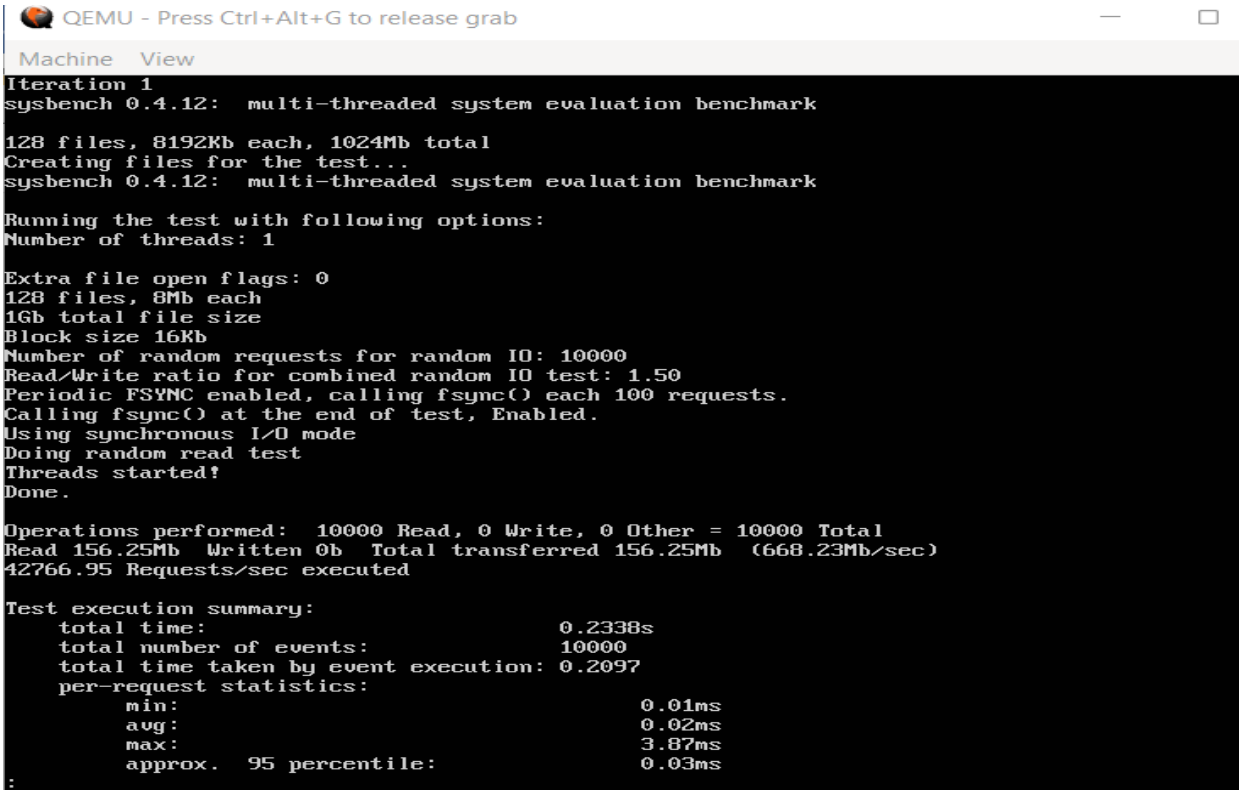

QEMU - Press Ctrl+Alt+G to release grab
Machine View
Operations performed: 0 Read, 65536 Write, 128 Other = 65664 Total
Read 0b Written 1Gb Total transferred 1Gb (77.298Mb/sec)
4947.04 Requests/sec executed
Test execution summary:
total time: 13.2475s
total number of events: 65536
total time taken by event execution: 7.2135
per-request statistics:
min: 0.06ms
avg: 0.11ms
max: 110.97ms
approx. 95 percentile: 0.18ms
Threads fairness:
events (avg/stddev): 65536.0000/0.00
execution time (avg/stddev): 7.2135/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...
Iteration 5
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb

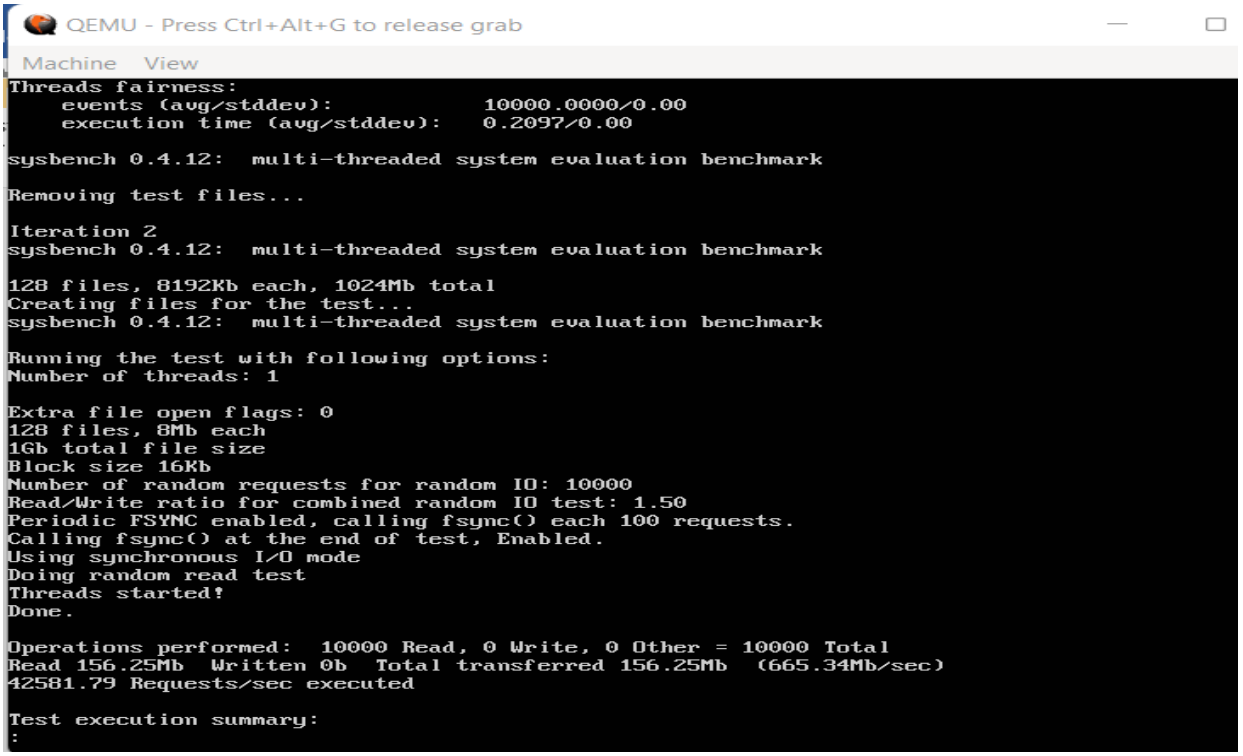


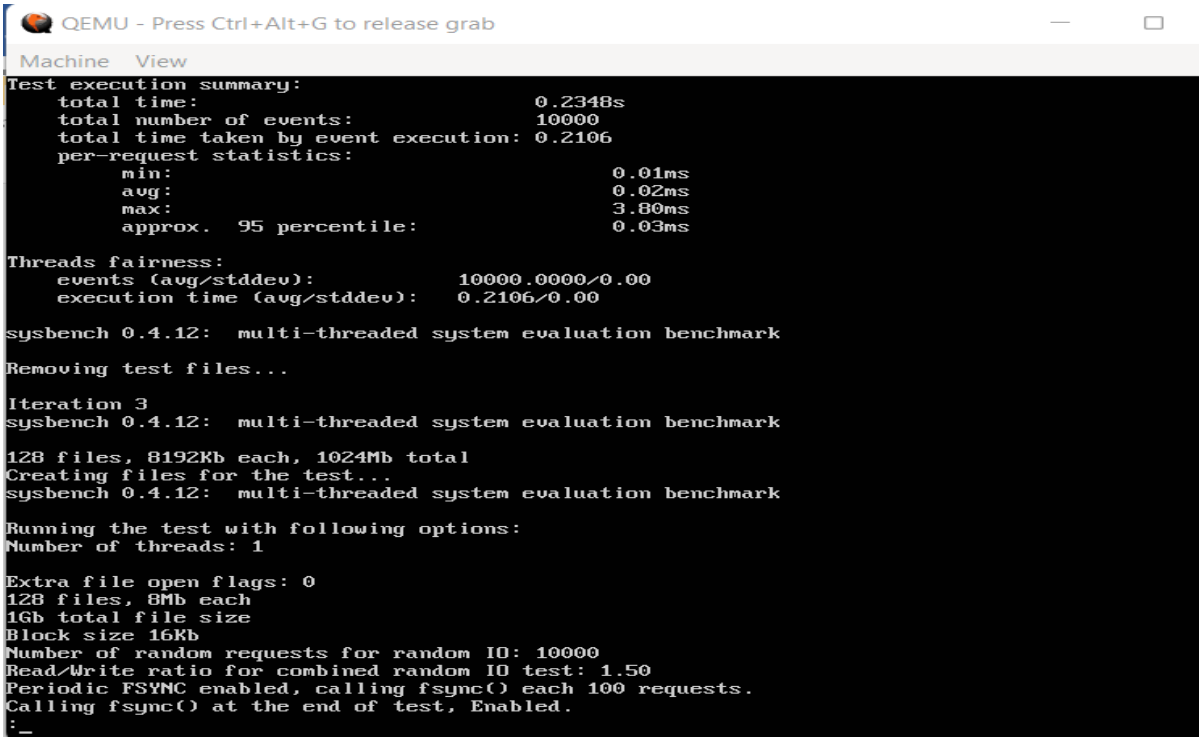
Test Execution Summary:

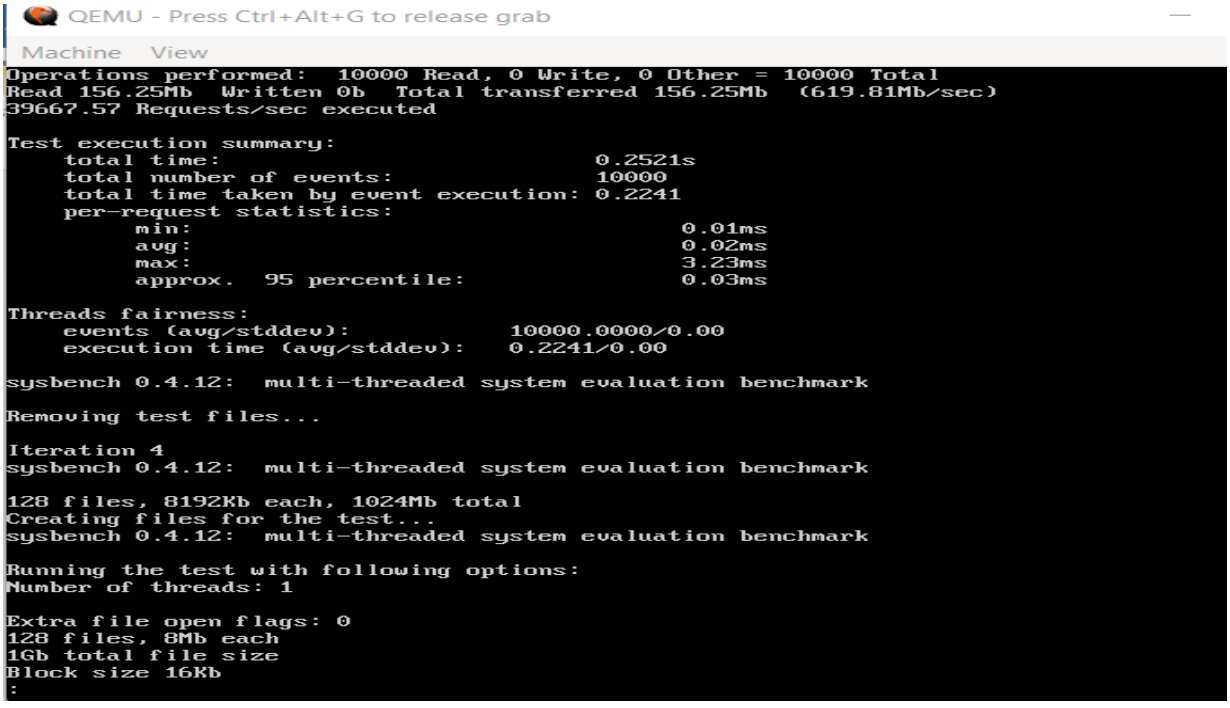
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.12 ms	2.15 ms	2.75 ms	2.65 ms	2.37 ms
Max. time taken	3.25 ms	3.18 ms	3.66 ms	3.42 ms	3.51 ms
Min. time taken	1.02ms	1.25 ms	1.32 ms	1.25 ms	1.38 ms
Total time taken for event execution	1.6544	1.8524	1.3652	1.8854	1.8527

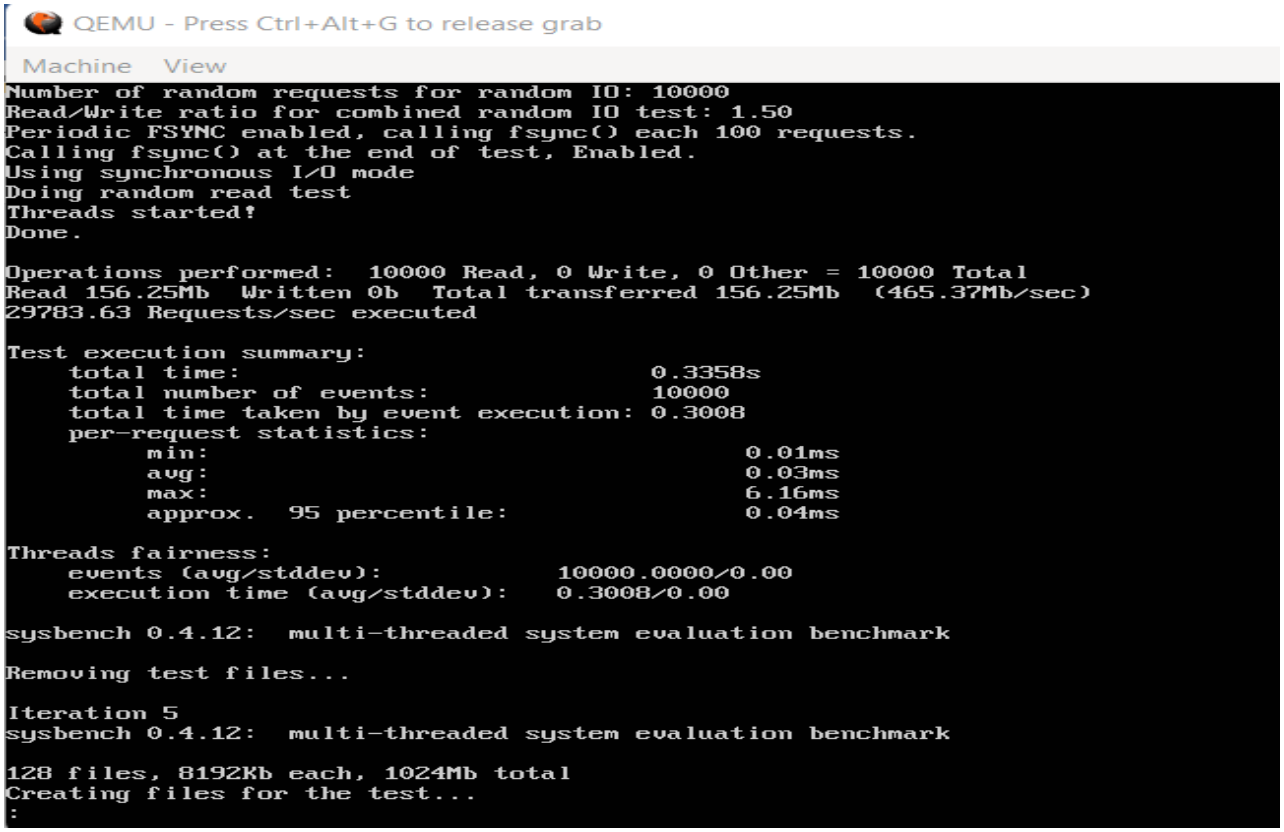
QEMU qcow2 Result for **File I/O Testing** for 2GB RAM and 2 Core for Random read and write.

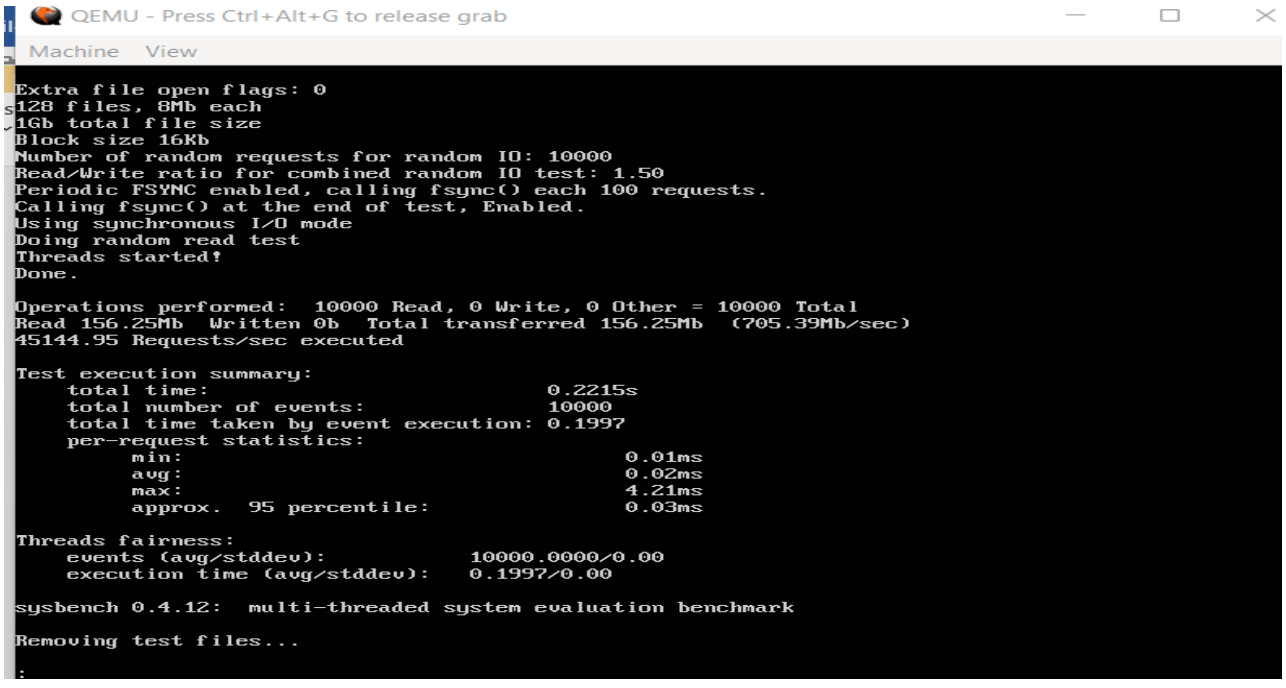





QEMU - Press Ctrl+Alt+G to release grab
Machine View
Test execution summary:
total time: 0.2348s
total number of events: 10000
total time taken by event execution: 0.2106
per-request statistics:
min: 0.01ms
avg: 0.02ms
max: 3.80ms
approx. 95 percentile: 0.03ms
Threads fairness:
events (avg/stddev): 10000.0000/0.00
execution time (avg/stddev): 0.2106/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...
Iteration 3
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb
Number of random requests for random IO: 10000
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.
:_


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Operations performed: 10000 Read, 0 Write, 0 Other = 10000 Total
Read 156.25Mb Written 0b Total transferred 156.25Mb (619.81Mb/sec)
39667.57 Requests/sec executed
Test execution summary:
total time: 0.2521s
total number of events: 10000
total time taken by event execution: 0.2241
per-request statistics:
min: 0.01ms
avg: 0.02ms
max: 3.23ms
approx. 95 percentile: 0.03ms
Threads fairness:
events (avg/stddev): 10000.0000/0.00
execution time (avg/stddev): 0.2241/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...
Iteration 4
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb
:


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Number of random requests for random IO: 10000
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 read test
Threads started!
Done.
Operations performed: 10000 Read, 0 Write, 0 Other = 10000 Total
Read 156.25Mb Written 0b Total transferred 156.25Mb (465.37Mb/sec)
29783.63 Requests/sec executed
Test execution summary:
total time: 0.3358s
total number of events: 10000
total time taken by event execution: 0.3008
per-request statistics:
min: 0.01ms
avg: 0.03ms
max: 6.16ms
approx. 95 percentile: 0.04ms
Threads fairness:
events (avg/stddev): 10000.0000/0.00
execution time (avg/stddev): 0.3008/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...
Iteration 5
sysbench 0.4.12: multi-threaded system evaluation benchmark
128 files, 8192Kb each, 1024Mb total
Creating files for the test...

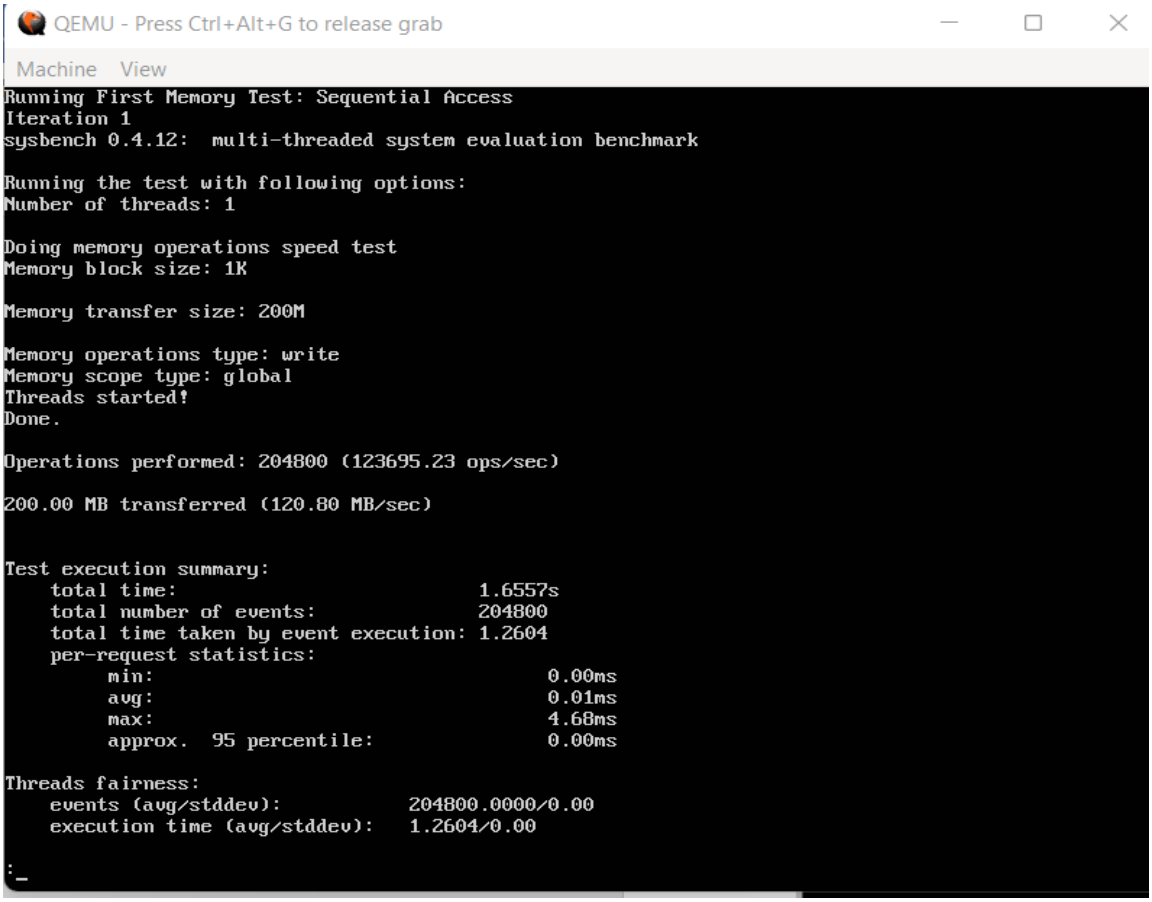

QEMU - Press Ctrl+Alt+G to release grab
Machine View
Extra file open flags: 0
128 files, 8Mb each
1Gb total file size
Block size 16Kb
Number of random requests for random IO: 10000
Read/Write ratio for combined random IO test: 1.50
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing random read test
Threads started!
Done.
Operations performed: 10000 Read, 0 Write, 0 Other = 10000 Total
Read 156.25Mb Written 0b Total transferred 156.25Mb (705.39Mb/sec)
45144.95 Requests/sec executed
Test execution summary:
total time: 0.2215s
total number of events: 10000
total time taken by event execution: 0.1997
per-request statistics:
min: 0.01ms
avg: 0.02ms
max: 4.21ms
approx. 95 percentile: 0.03ms
Threads fairness:
events (avg/stddev): 10000.0000/0.00
execution time (avg/stddev): 0.1997/0.00
sysbench 0.4.12: multi-threaded system evaluation benchmark
Removing test files...

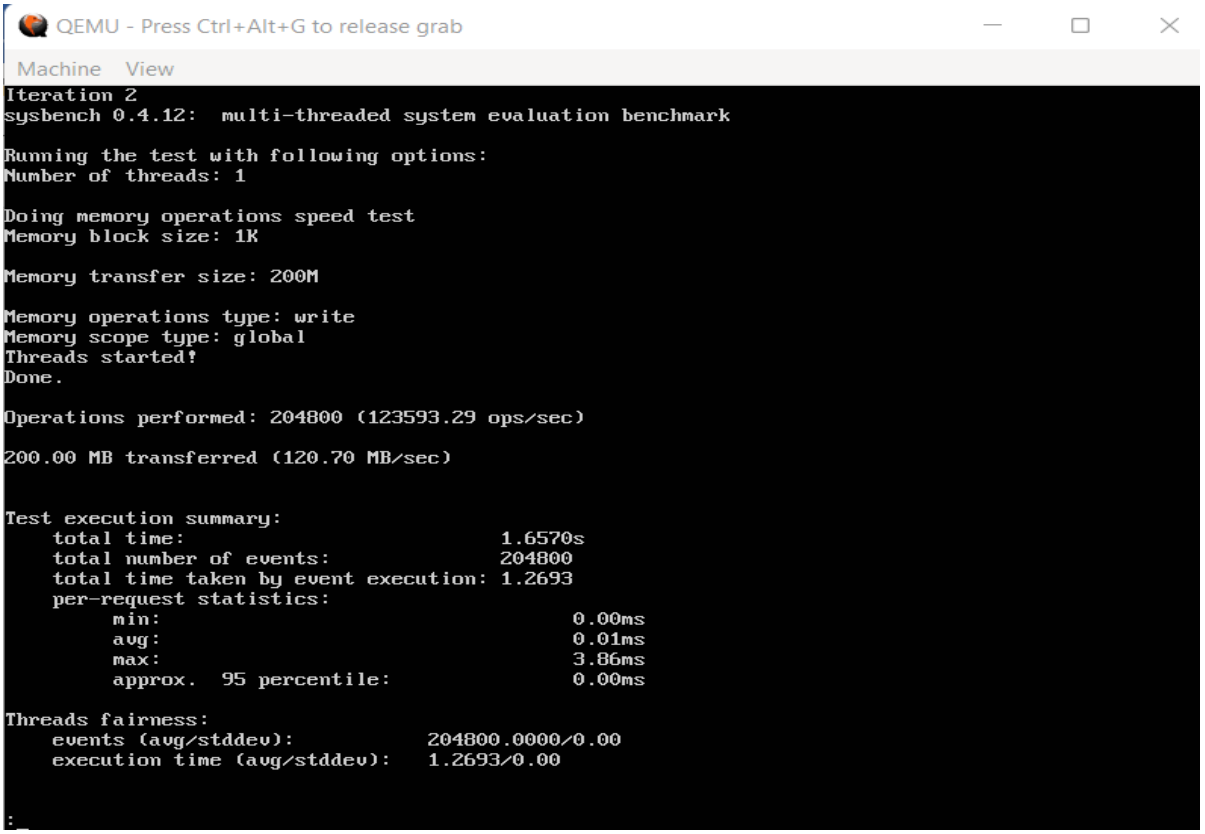
Test Execution Summary:

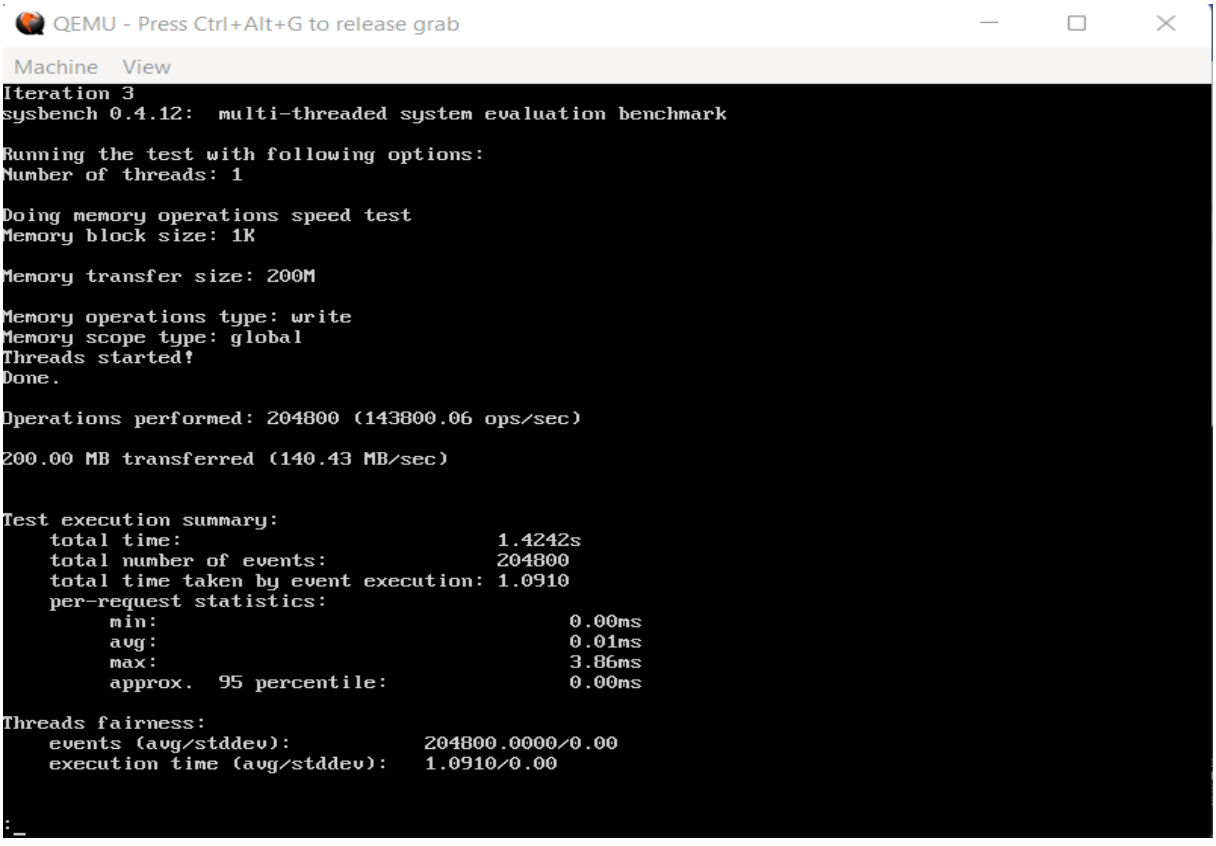
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.25 ms	2.65 ms	2.45 ms	2.65 ms	2.74 ms
Max. time taken	3.33 ms	3.52 ms	3.85 ms	3.32 ms	3.45 ms
Min. time taken	1.12ms	1.88 ms	1.36 ms	1.65 ms	1.65 ms
Total time taken for event execution	1.8522	1.4528	1.8854	1.4585	1.6522

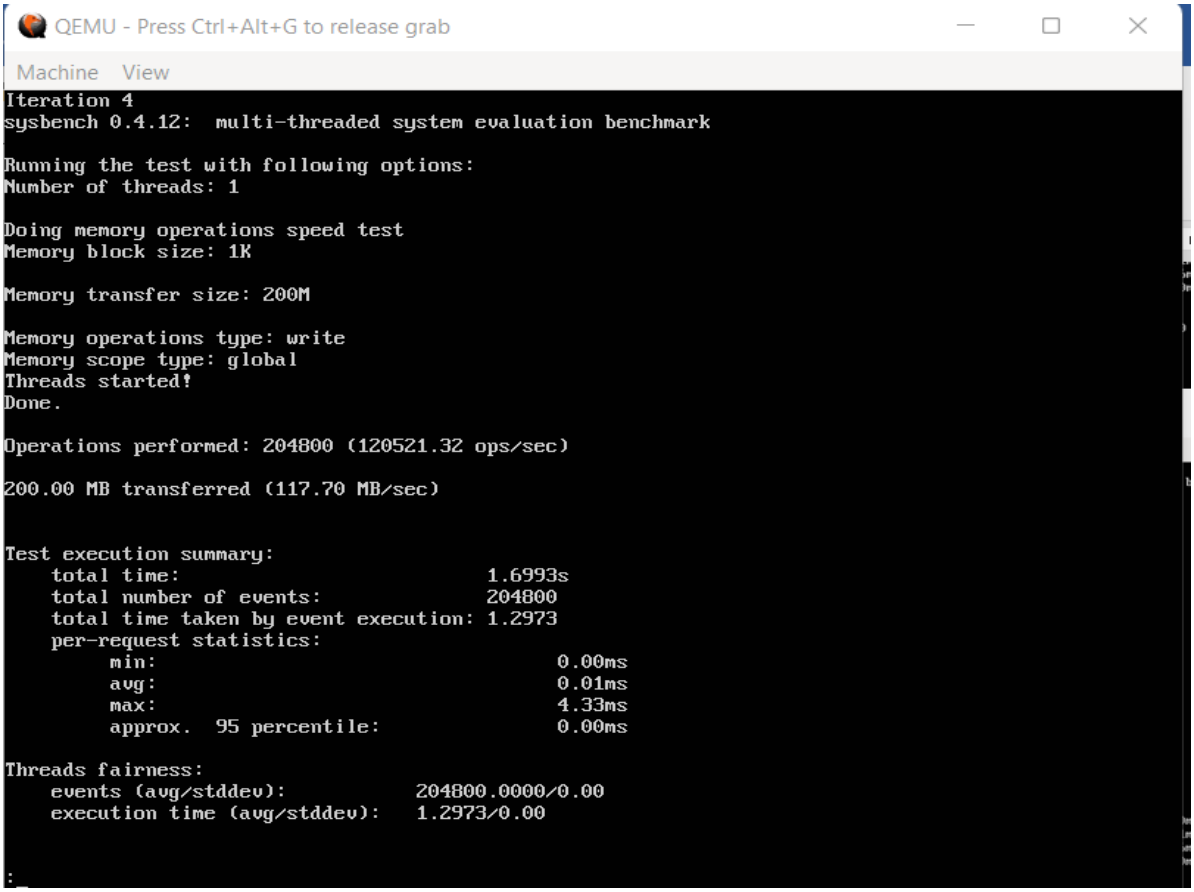
Memory Testing:

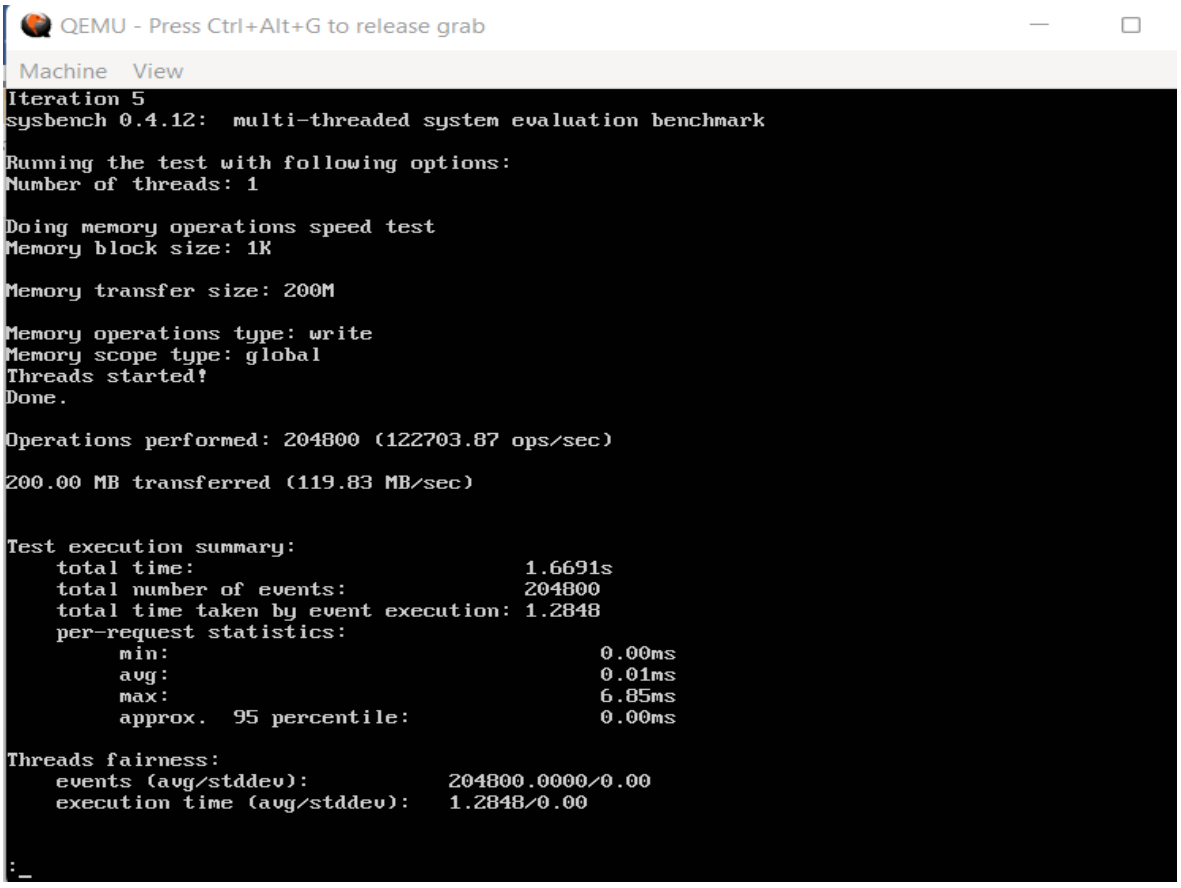
QEMU qcow2 Result for **Memory Testing** for 2GB RAM and 2 Core for Sequential Memory Access – Total memory size = 250 MB




QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 2
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (123593.29 ops/sec)
200.00 MB transferred (120.70 MB/sec)
Test execution summary:
total time: 1.6570s
total number of events: 204800
total time taken by event execution: 1.2693
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 3.86ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.2693/0.00
:_


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 3
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (143800.06 ops/sec)
200.00 MB transferred (140.43 MB/sec)
Test execution summary:
total time: 1.4242s
total number of events: 204800
total time taken by event execution: 1.0910
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 3.86ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.0910/0.00
:_

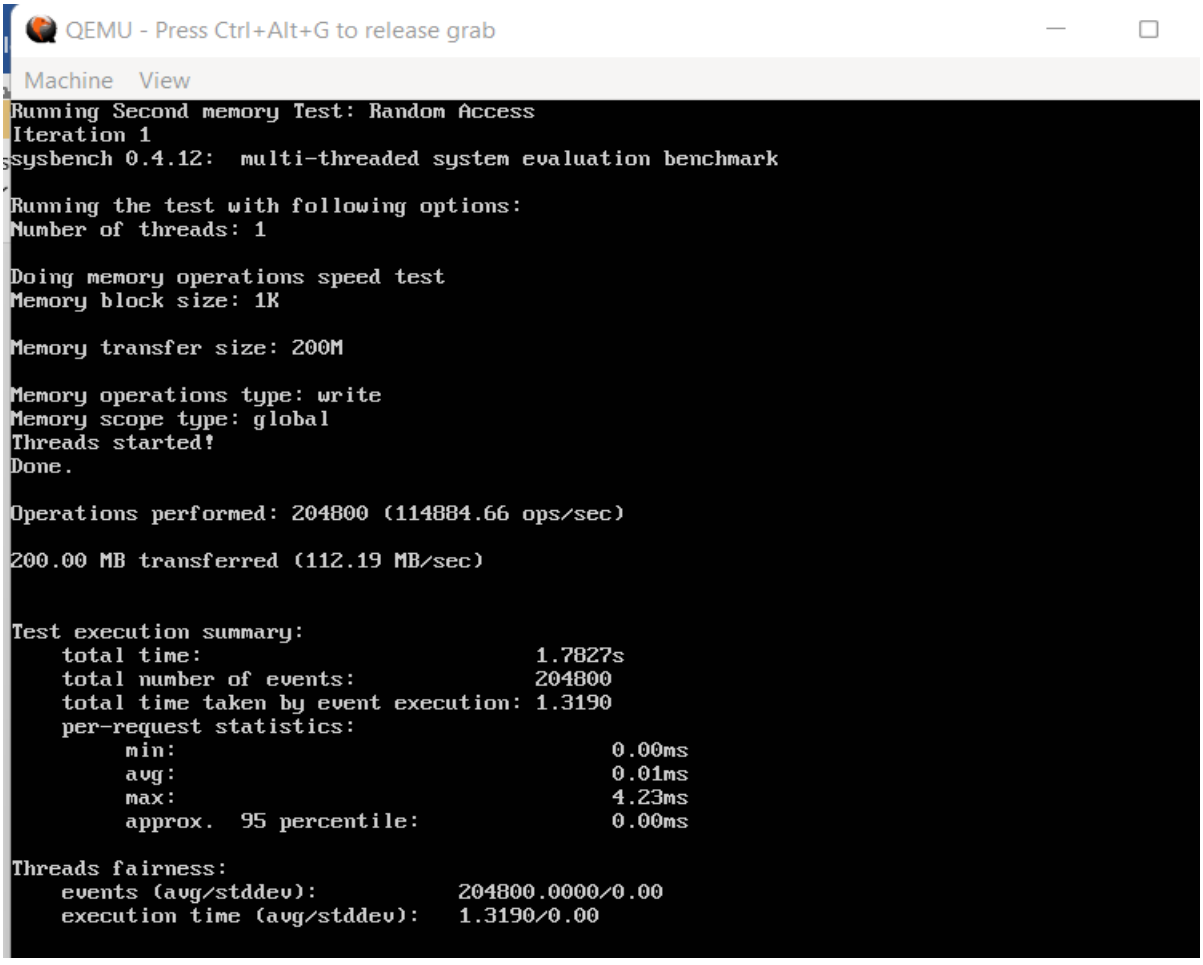

QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 4
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (120521.32 ops/sec)
200.00 MB transferred (117.70 MB/sec)
Test execution summary:
total time: 1.6993s
total number of events: 204800
total time taken by event execution: 1.2973
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 4.33ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.2973/0.00
:_

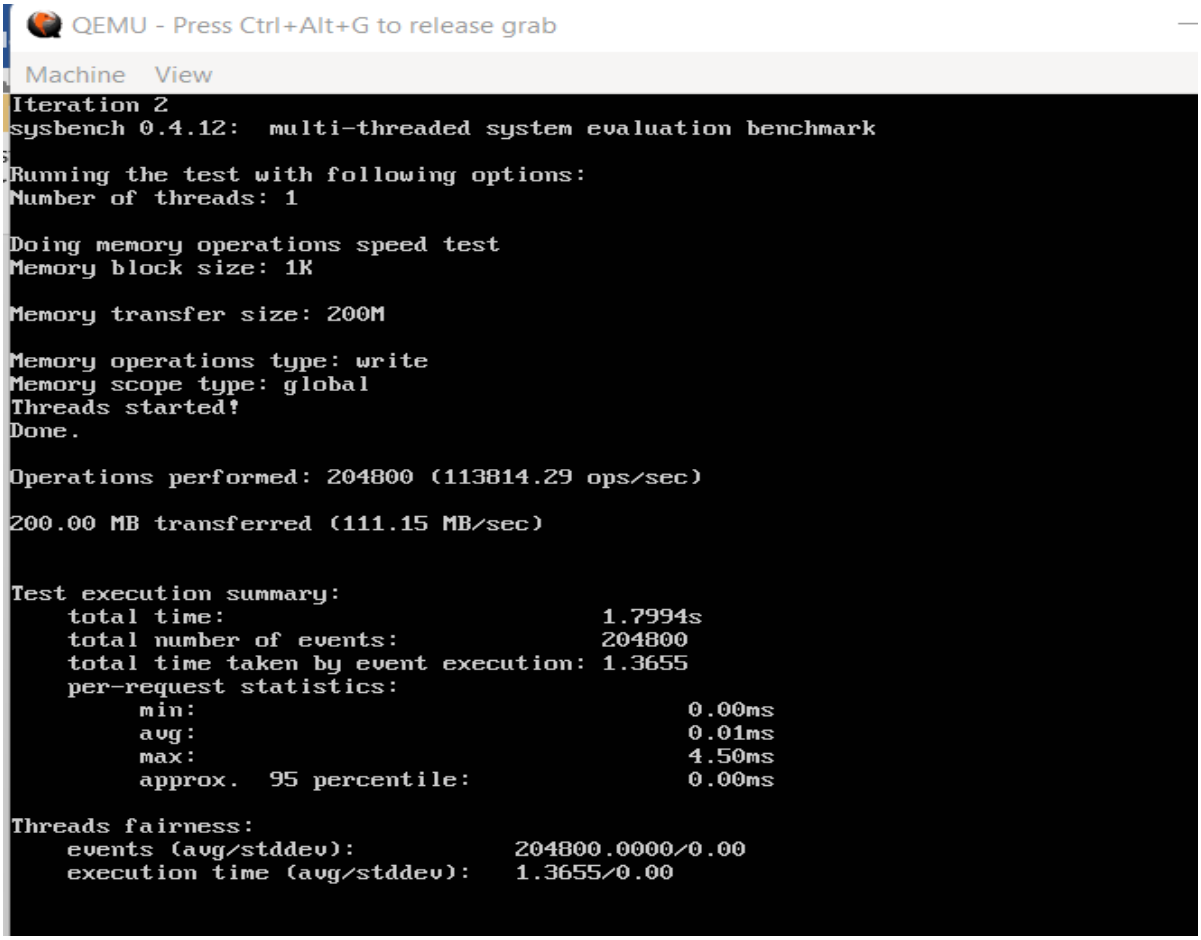

QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 5
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (122703.87 ops/sec)
200.00 MB transferred (119.83 MB/sec)
Test execution summary:
total time: 1.6691s
total number of events: 204800
total time taken by event execution: 1.2848
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 6.85ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.2848/0.00
:_

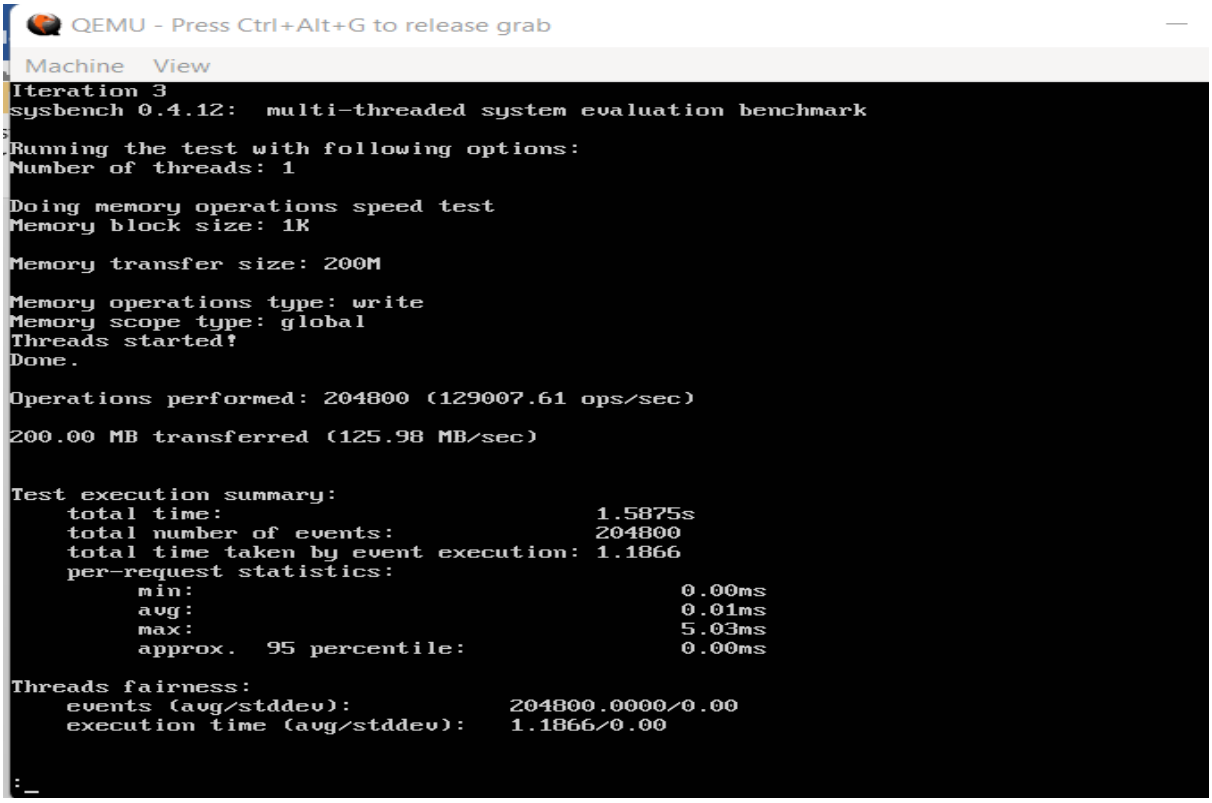
Test Execution Summary:

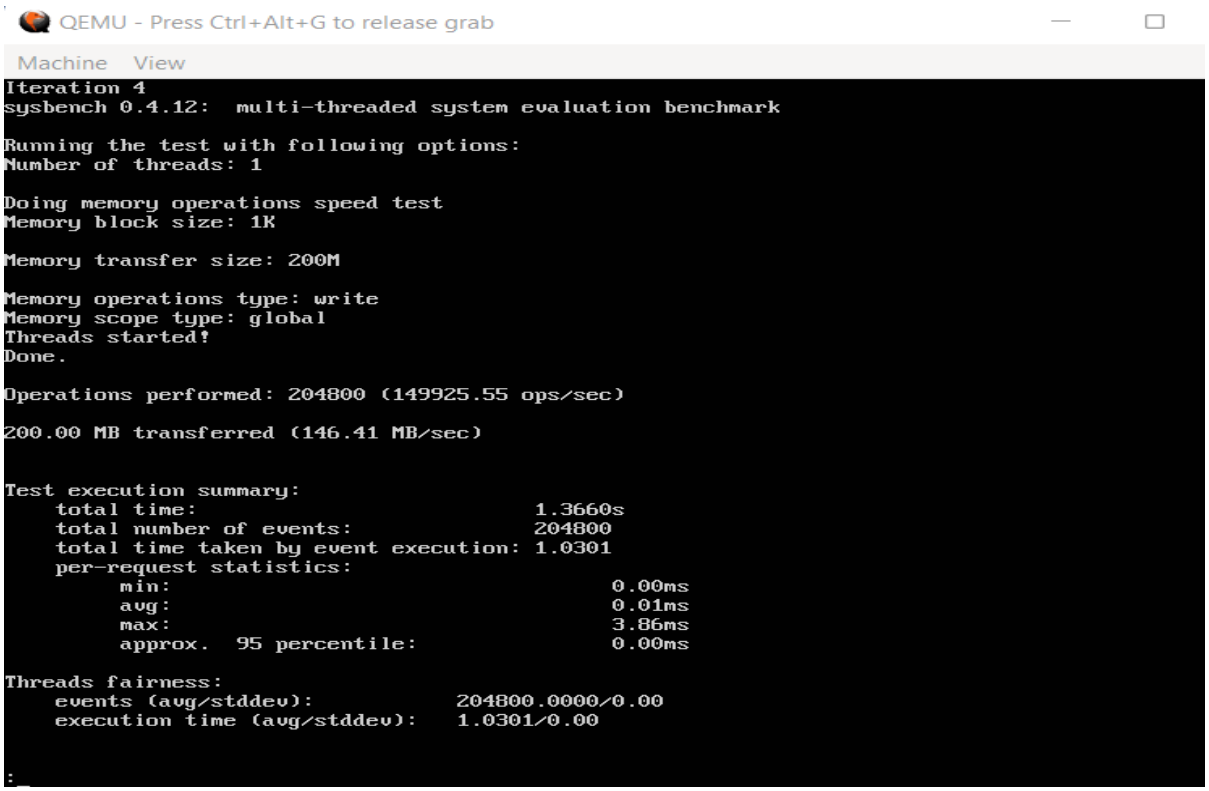
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	4.68 ms	3.86 ms	3.86 ms	4.33 ms	6.85 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.2604	1.2693	1.0910	1.2973	1.2848

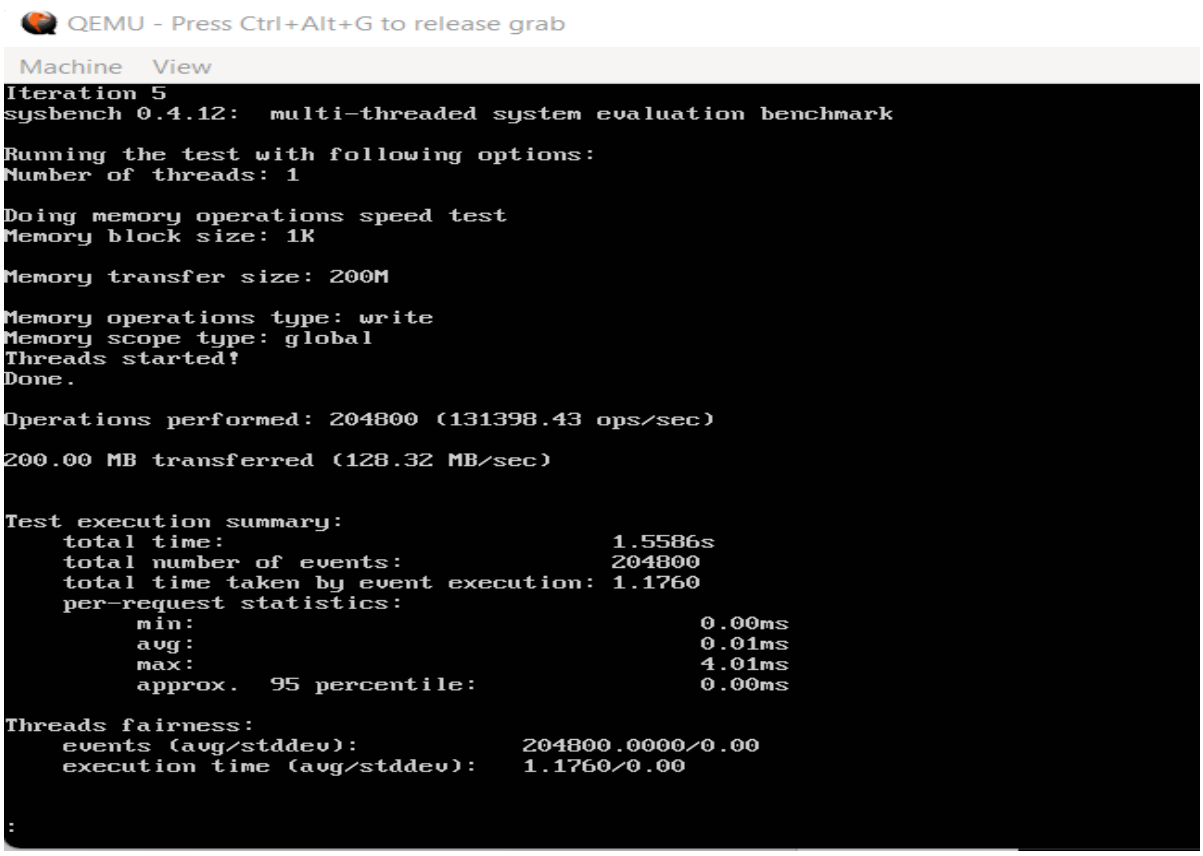
QEMU qow2 Result for **Memory Testing** for 2GB RAM and 2 Core for Random read – Total memory size = 250MB




QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 2
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (113814.29 ops/sec)
200.00 MB transferred (111.15 MB/sec)
Test execution summary:
total time: 1.7994s
total number of events: 204800
total time taken by event execution: 1.3655
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 4.50ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.3655/0.00


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 3
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (129007.61 ops/sec)
200.00 MB transferred (125.98 MB/sec)
Test execution summary:
total time: 1.5875s
total number of events: 204800
total time taken by event execution: 1.1866
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 5.03ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.1866/0.00
:_


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 4
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (149925.55 ops/sec)
200.00 MB transferred (146.41 MB/sec)
Test execution summary:
total time: 1.3660s
total number of events: 204800
total time taken by event execution: 1.0301
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 3.86ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.0301/0.00
:


QEMU - Press Ctrl+Alt+G to release grab
Machine View
Iteration 5
sysbench 0.4.12: multi-threaded system evaluation benchmark
Running the test with following options:
Number of threads: 1
Doing memory operations speed test
Memory block size: 1K
Memory transfer size: 200M
Memory operations type: write
Memory scope type: global
Threads started!
Done.
Operations performed: 204800 (131398.43 ops/sec)
200.00 MB transferred (128.32 MB/sec)
Test execution summary:
total time: 1.5586s
total number of events: 204800
total time taken by event execution: 1.1760
per-request statistics:
min: 0.00ms
avg: 0.01ms
max: 4.01ms
approx. 95 percentile: 0.00ms
Threads fairness:
events (avg/stddev): 204800.0000/0.00
execution time (avg/stddev): 1.1760/0.00
:

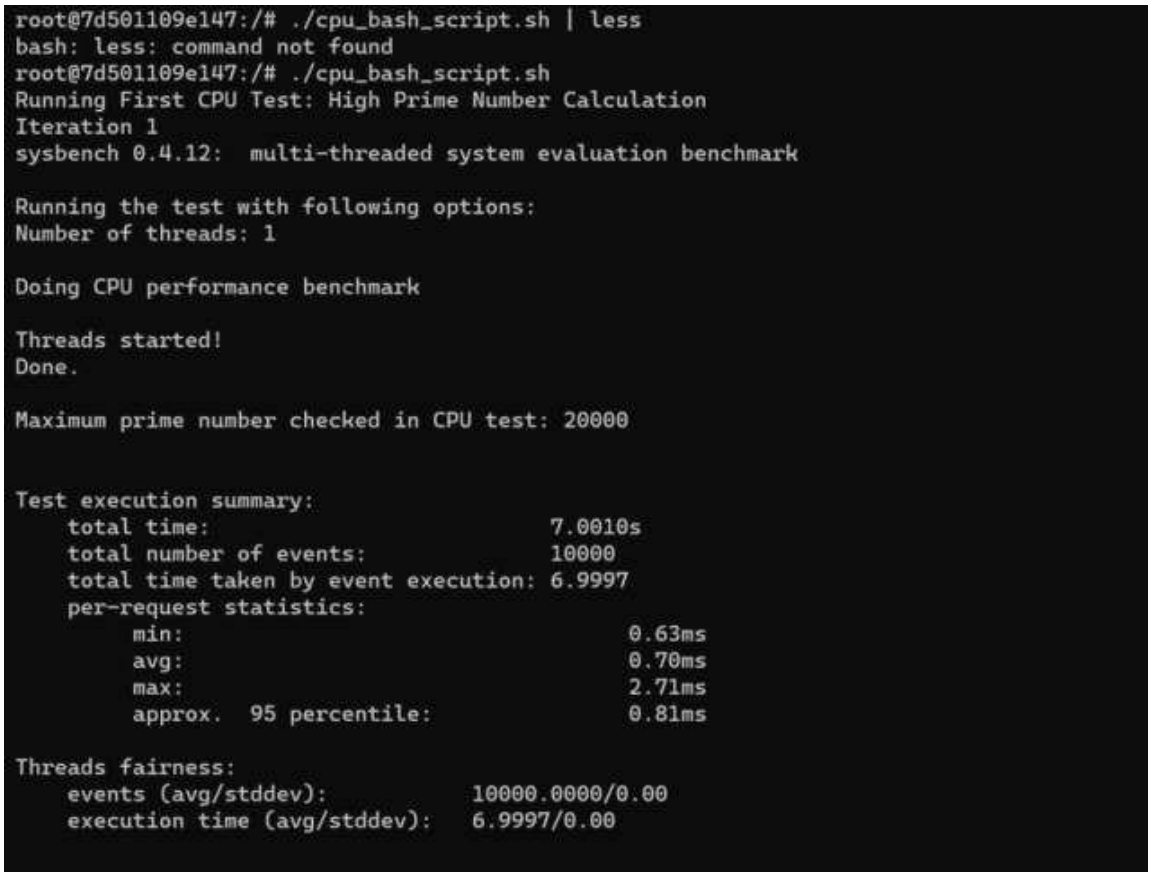
Test Execution Summary:

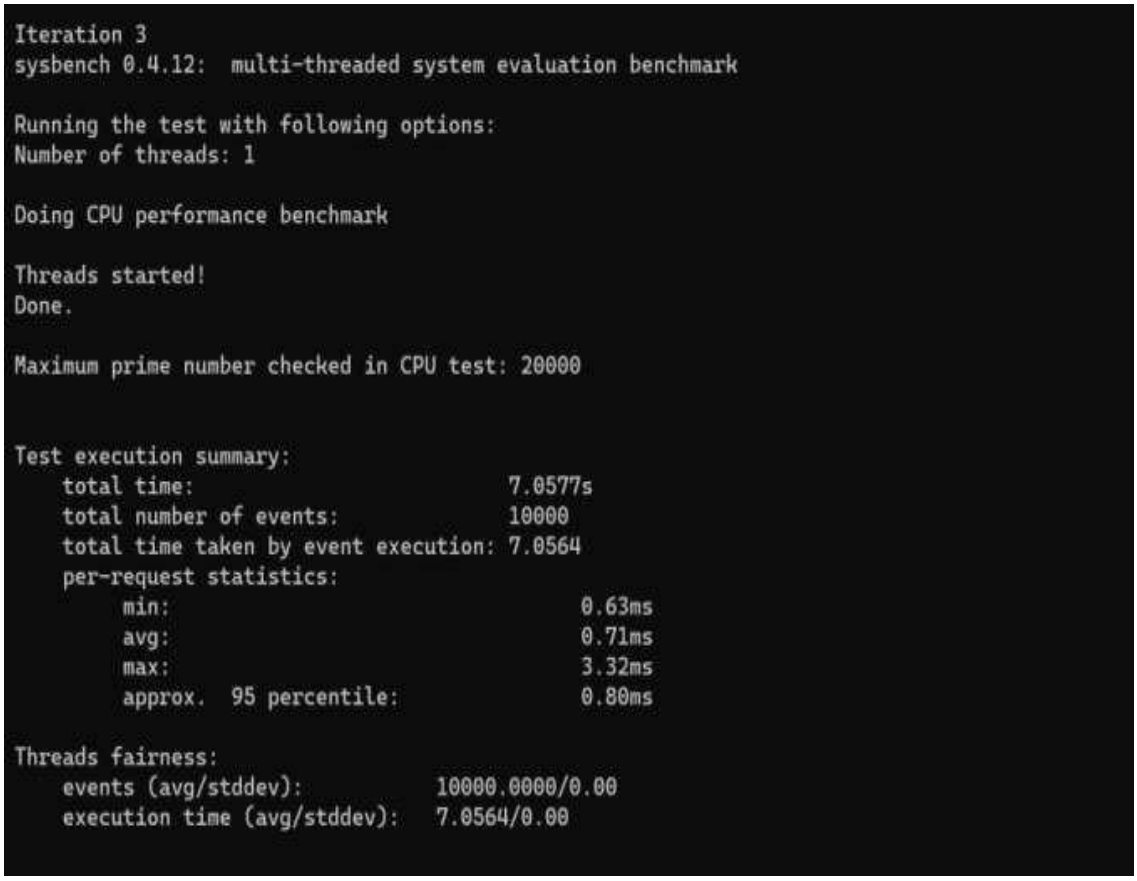
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	4.23 ms	4.50 ms	5.03 ms	3.86 ms	4.01 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.3190	1.3655	1.1866	1.0301	1.1760

Docker Results for 2 GB 2 Core:

CPU Testing:

Results for Docker based **CPU Testing** where Max-Prime = 20000 - test case 1





Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.70 ms	0.71 ms	0.71 ms	0.75 ms	0.76 ms
Max. time taken	2.72 ms	3.21 ms	3.32 ms	3.86 ms	3.01 ms
Min. time taken	0.63 ms	0.65 ms	0.63 ms	0.63 ms	0.63 ms
Total time taken for event execution	6.9997	7.2586	7.0564	7.4458	7.4589

Results for Docker based **CPU Testing** where Max-Prime = 10000 - test case 2

```
Iteration 2
sysbench 0.4.12:  multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 4

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 10000


Test execution summary:
    total time:                          1.5786s
    total number of events:              10000
    total time taken by event execution: 6.3099
    per-request statistics:
         min:                                  0.27ms
         avg:                                  0.63ms
         max:                                 56.91ms
         approx.  95 percentile:               0.54ms

Threads fairness:
    events (avg/stddev):           2500.0000/10.56
    execution time (avg/stddev):   1.5775/0.00
```

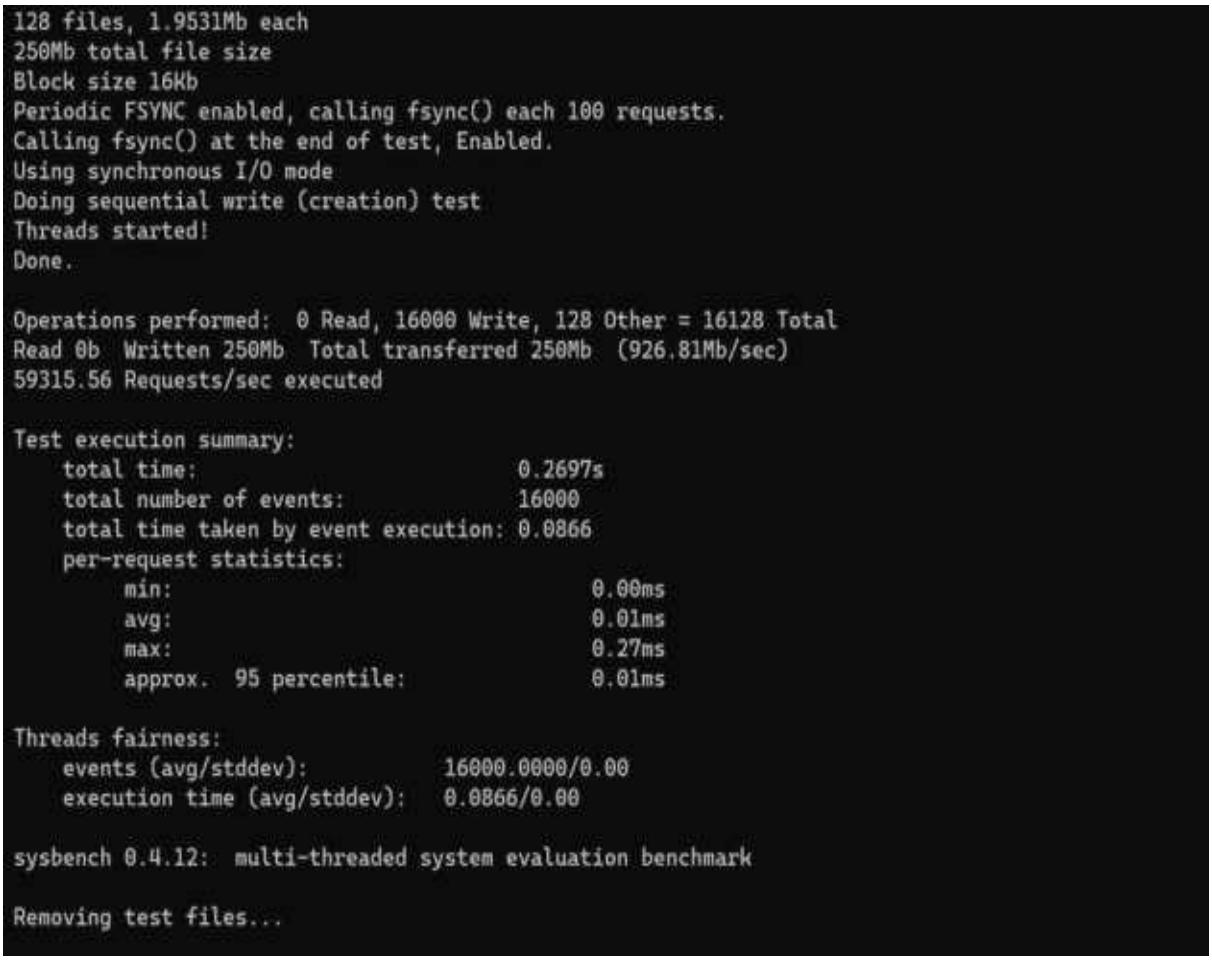
```
Iteration 4
sysbench 0.4.12:  multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 4

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 10000


Test execution summary:
    total time:                          1.5805s
    total number of events:              10000
    total time taken by event execution: 6.3191
    per-request statistics:
         min:                                  0.24ms
         avg:                                  0.63ms
         max:                                 51.65ms
         approx.  95 percentile:               0.55ms

Threads fairness:
    events (avg/stddev):           2500.0000/26.14
    execution time (avg/stddev):   1.5798/0.00
```

Test Execution Summary:

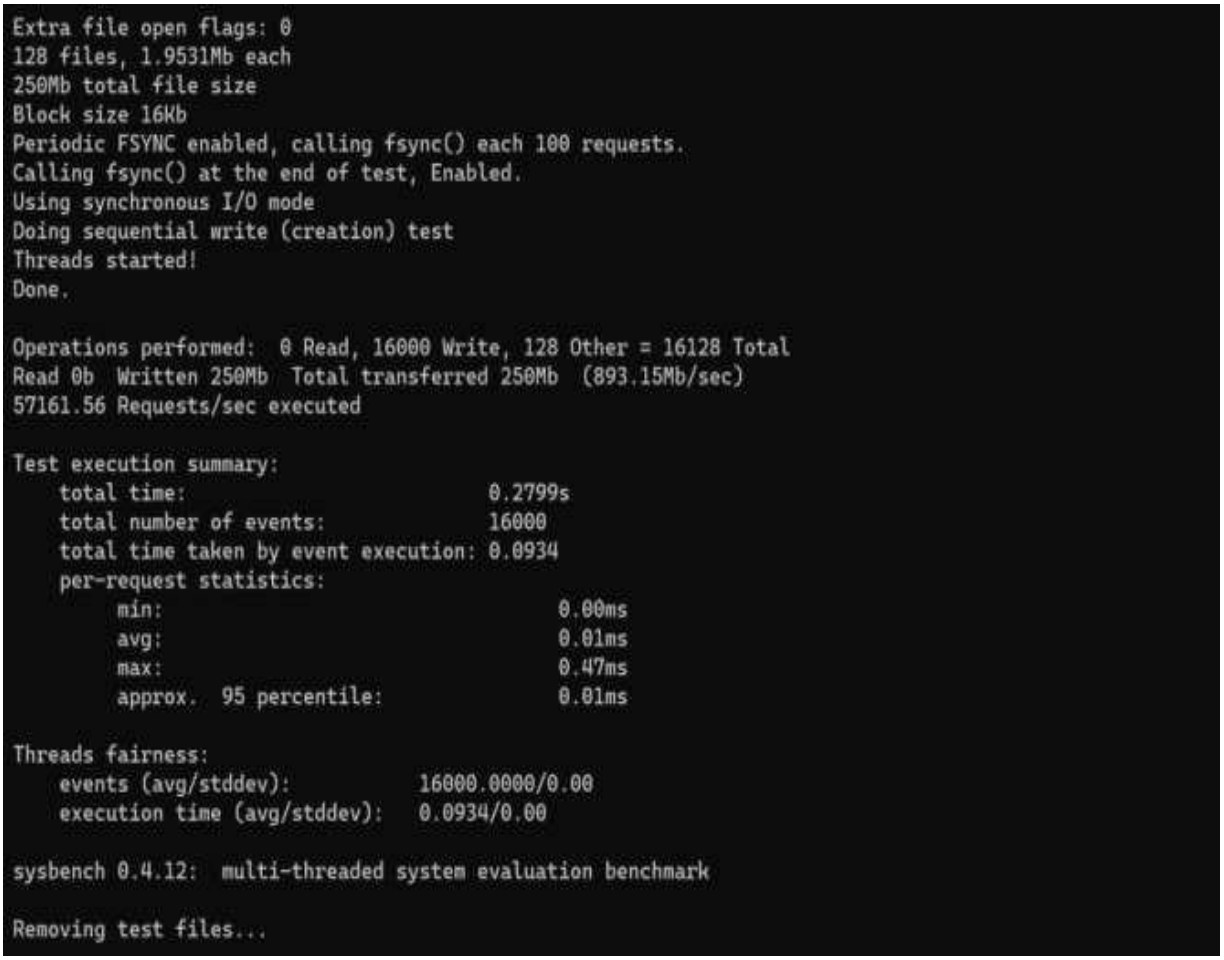
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.63 ms	0.63 ms	0.63 ms	0.63 ms	0.63 ms
Max. time taken	56.77 ms	56.91 ms	56.32 ms	51.65 ms	57.01 ms
Min. time taken	0.27 ms	0.27 ms	0.28 ms	0.24 ms	0.26 ms
Total time taken for event execution	6.3099	6.4587	6.1285	6.3191	6.6521

File I/O Testing:

Docker Result for **File I/O Testing** for 2GB RAM and 2 Core for Sequential Write



```
128 files, 1.9531Mb each
250Mb total file size
Block size 16Kb
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential write (creation) test
Threads started!
Done.

Operations performed:  0 Read, 16000 Write, 128 Other = 16128 Total
Read 0b  Written 250Mb  Total transferred 250Mb  (926.81Mb/sec)
59315.56 Requests/sec executed

Test execution summary:
    total time:                          0.2697s
    total number of events:              16000
    total time taken by event execution: 0.0866
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.01ms
         max:                                  0.27ms
         approx.  95 percentile:               0.01ms

Threads fairness:
    events (avg/stddev):           16000.0000/0.00
    execution time (avg/stddev):   0.0866/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark

Removing test files...
```



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.27 ms	0.25 ms	0.32 ms	0.26 ms	0.47 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0866	0.1244	0.9822	0.5288	0.0934

Docker Result for **File I/O Testing** for 2GB RAM and 2 Core for Random Read

```
300Mb total file size
Block size 16Kb
Number of random requests for random IO: 10000
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 read test
Threads started!
Done.

Operations performed:  10000 Read, 0 Write, 0 Other = 10000 Total
Read 156.25Mb  Written 0b  Total transferred 156.25Mb  (5.9137Gb/sec)
387557.35 Requests/sec executed

Test execution summary:
    total time:                          0.0258s
    total number of events:              10000
    total time taken by event execution: 0.0246
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.00ms
         max:                                  1.04ms
         approx.  95 percentile:               0.00ms

Threads fairness:
    events (avg/stddev):           10000.0000/0.00
    execution time (avg/stddev):   0.0246/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark

Removing test files...
```

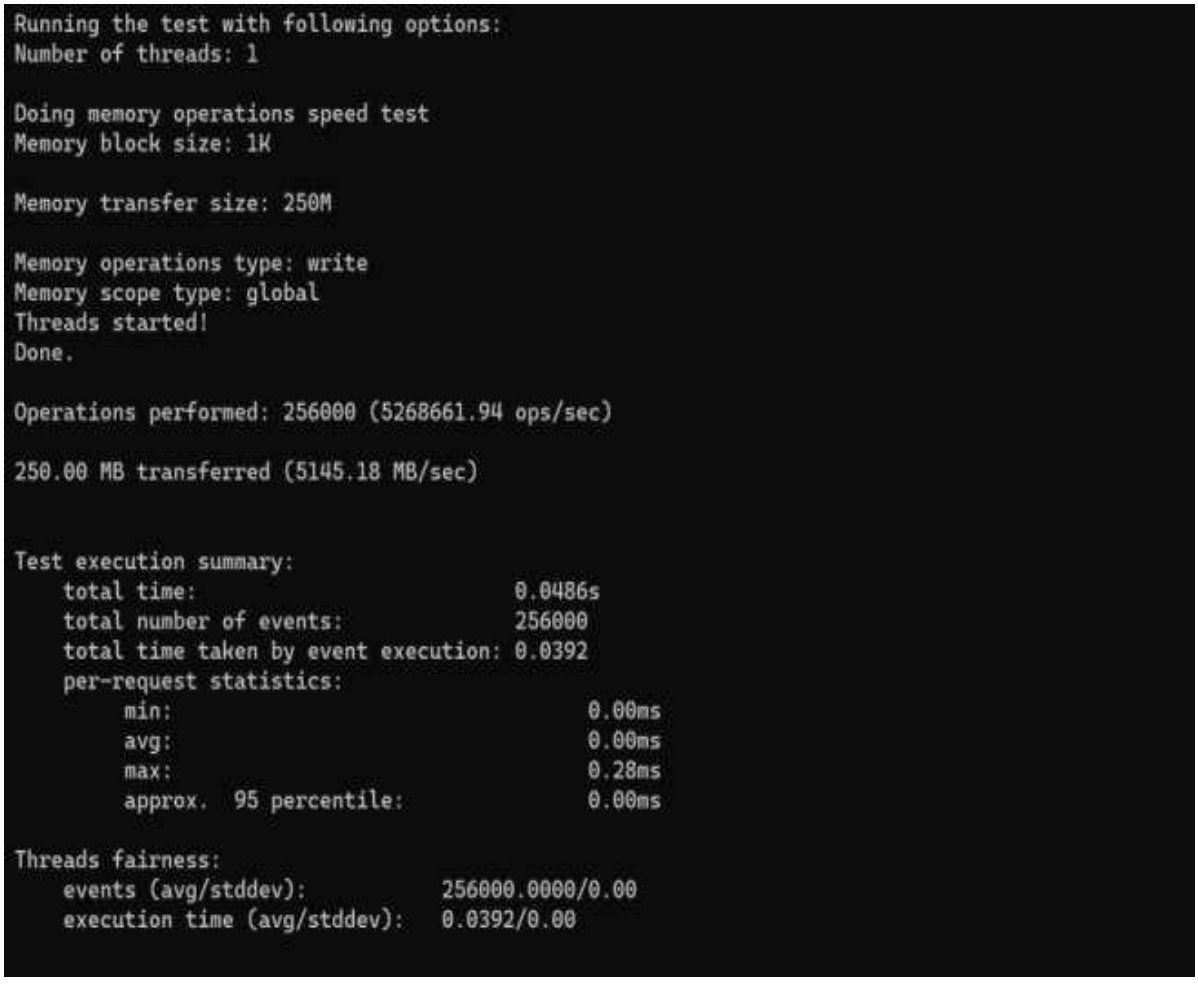
```
300Mb total file size
Block size 16Kb
Number of random requests for random IO: 10000
Read/Write ratio for combined random IO test: 1.50
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing random read test
Threads started!
Done.

Operations performed:  10000 Read, 0 Write, 0 Other = 10000 Total
Read 156.25Mb  Written 0b  Total transferred 156.25Mb  (6.2248Gb/sec)
407949.22 Requests/sec executed

Test execution summary:
    total time:                          0.0245s
    total number of events:              10000
    total time taken by event execution: 0.0230
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.00ms
         max:                                  0.44ms
         approx.  95 percentile:               0.00ms

Threads fairness:
    events (avg/stddev):           10000.0000/0.00
    execution time (avg/stddev):   0.0230/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark

Removing test files...
```

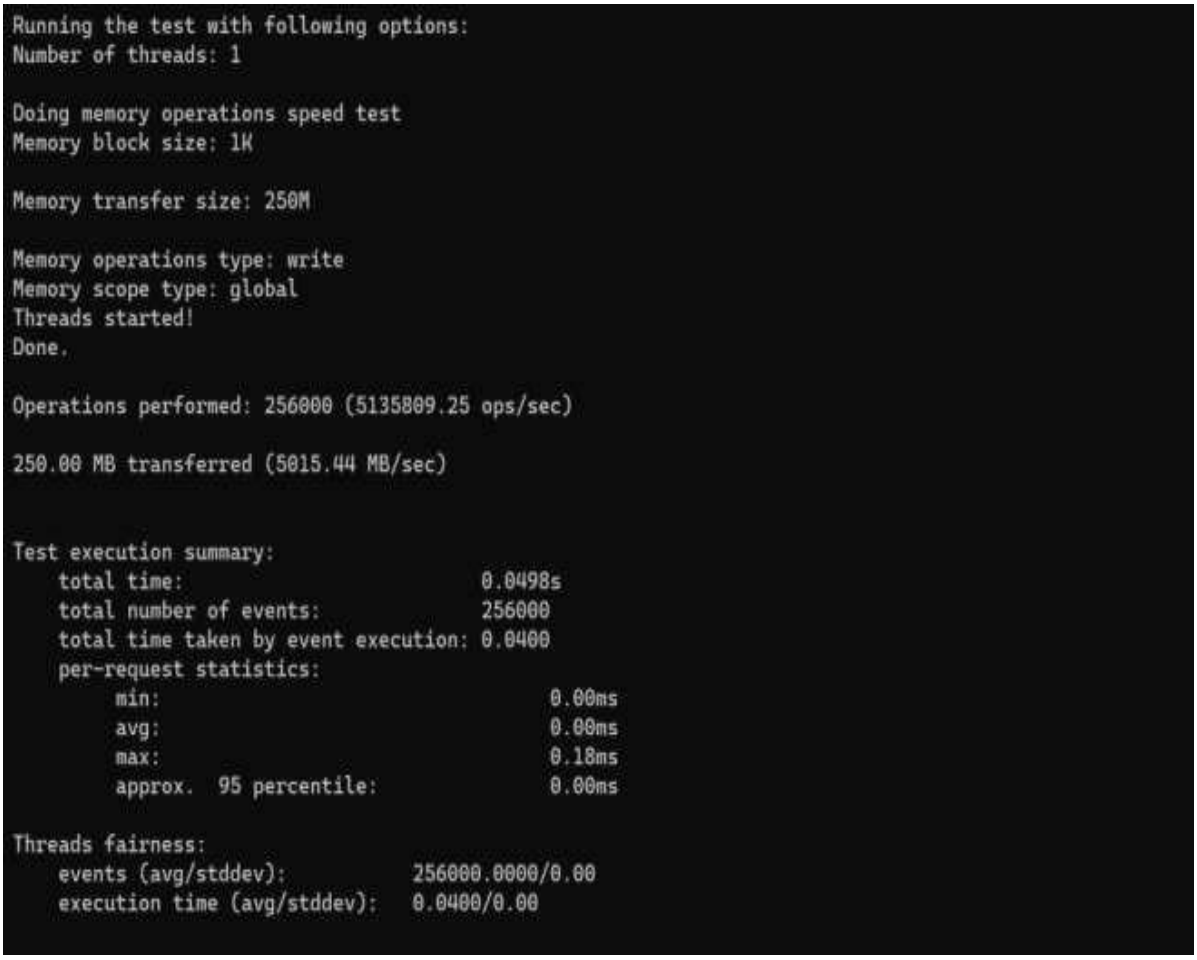
Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Max. time taken	0.77 ms	1.04 ms	0.52 ms	0.44 ms	0.46 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0158	0.0246	0.0668	0.0230	0.0452

Memory Testing:

Docker results for **Memory Testing** for 2GB RAM and 2 Core for Sequential Memory Access – Total memory size = 250 MB

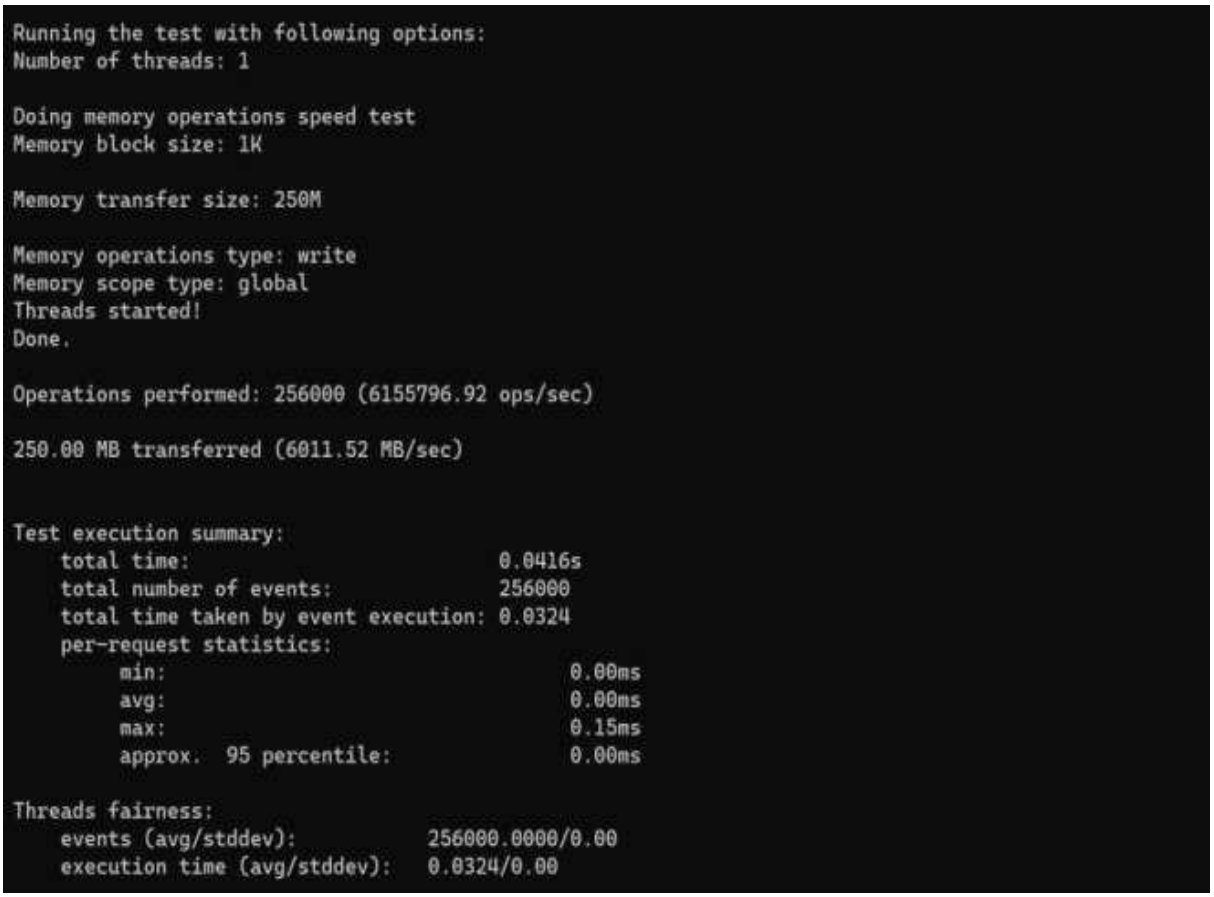




Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Max. time taken	0.25 ms	0.27 ms	0.22 ms	0.28 ms	0.18 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0365	0.0238	0.0395	0.0392	0.0400

Docker results for **Memory Testing** for 2GB RAM and 2 Core for Random Read – Total memory size = 250 MB



Test Execution Summary:

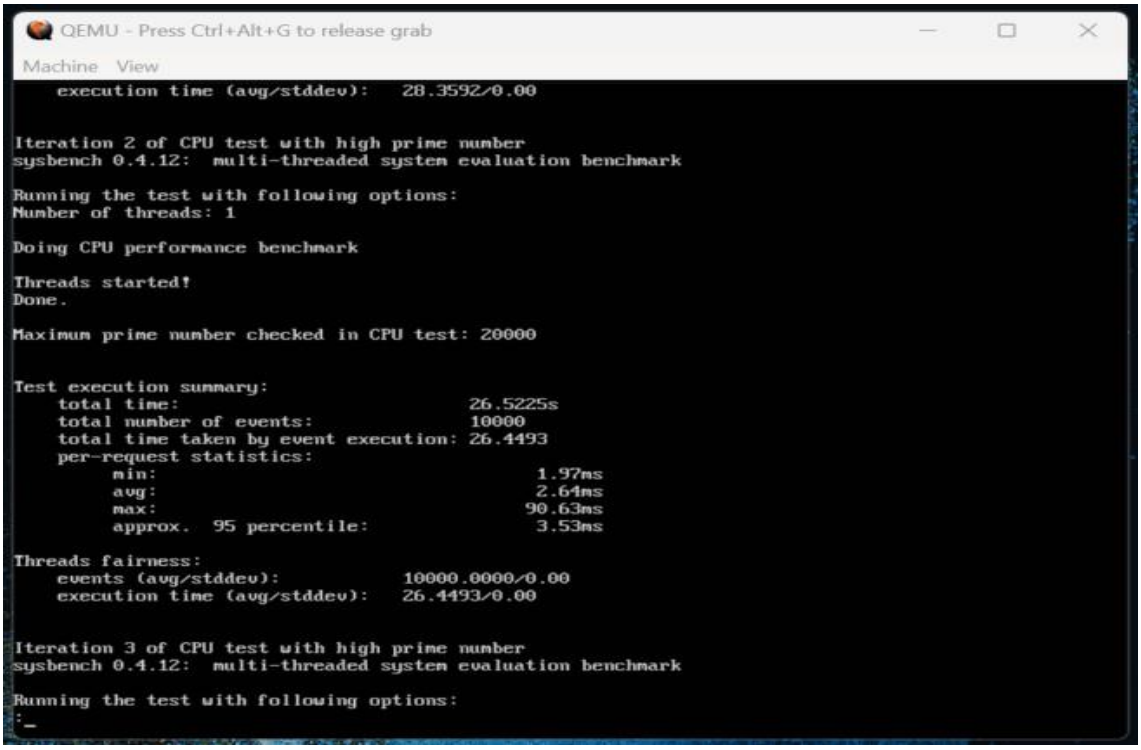
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Max. time taken	0.20 ms	0.16 ms	0.15 ms	0.17 ms	0.19 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0322	0.0323	0.0324	0.0325	0.0326

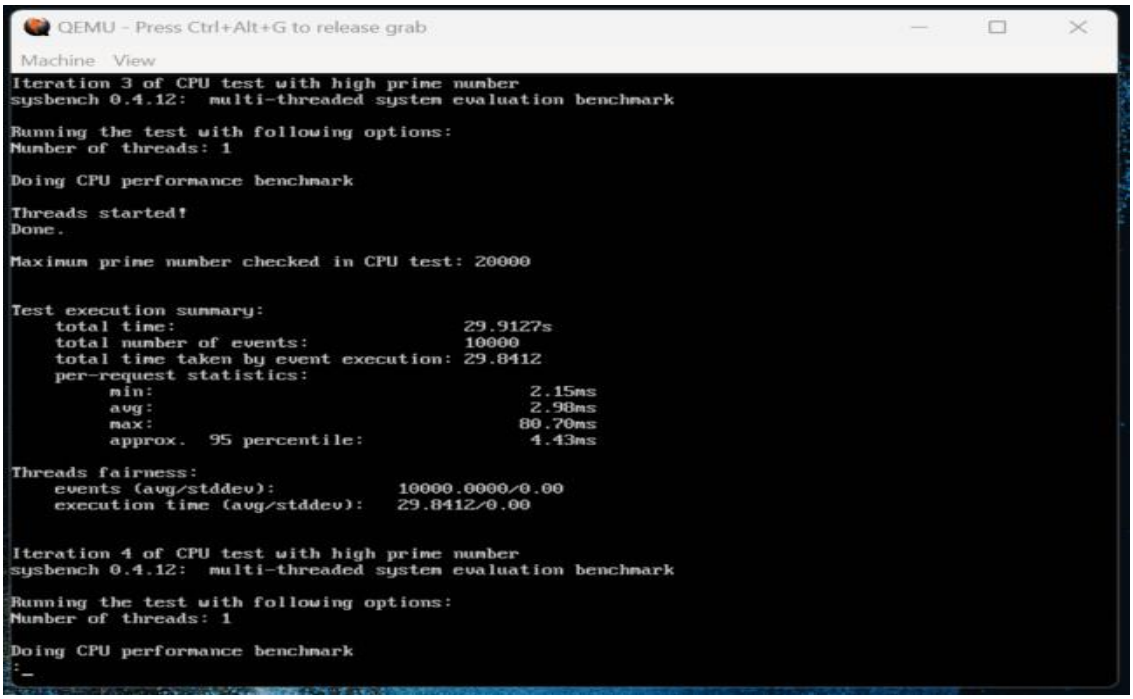
2. Configuration: 3GB RAM & 3 Core

QEMU- Raw disk image:

CPU Testing:

Result for **CPU Testing** where Max-Prime = 20000 - test case 1

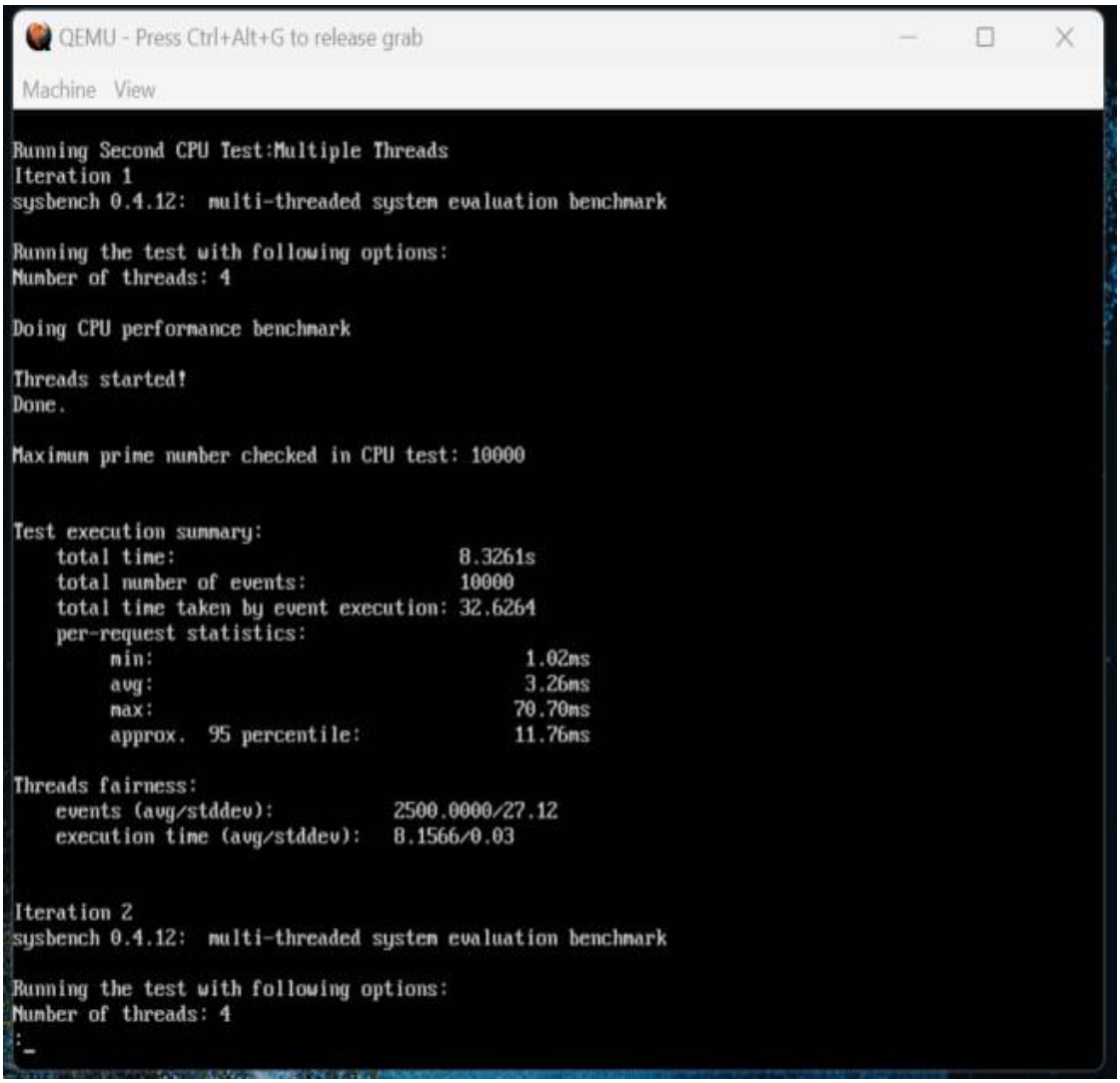




Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.61 ms	2.64 ms	2.15 ms	2.72 ms	2.76 ms
Max. time taken	3221 ms	90.63 ms	80.70 ms	73.32 ms	71.09 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	28.3592	26.4493	29.8412	32.3234	34.2015

Result for **CPU Testing** where Max-Prime = 10000 - test case 2

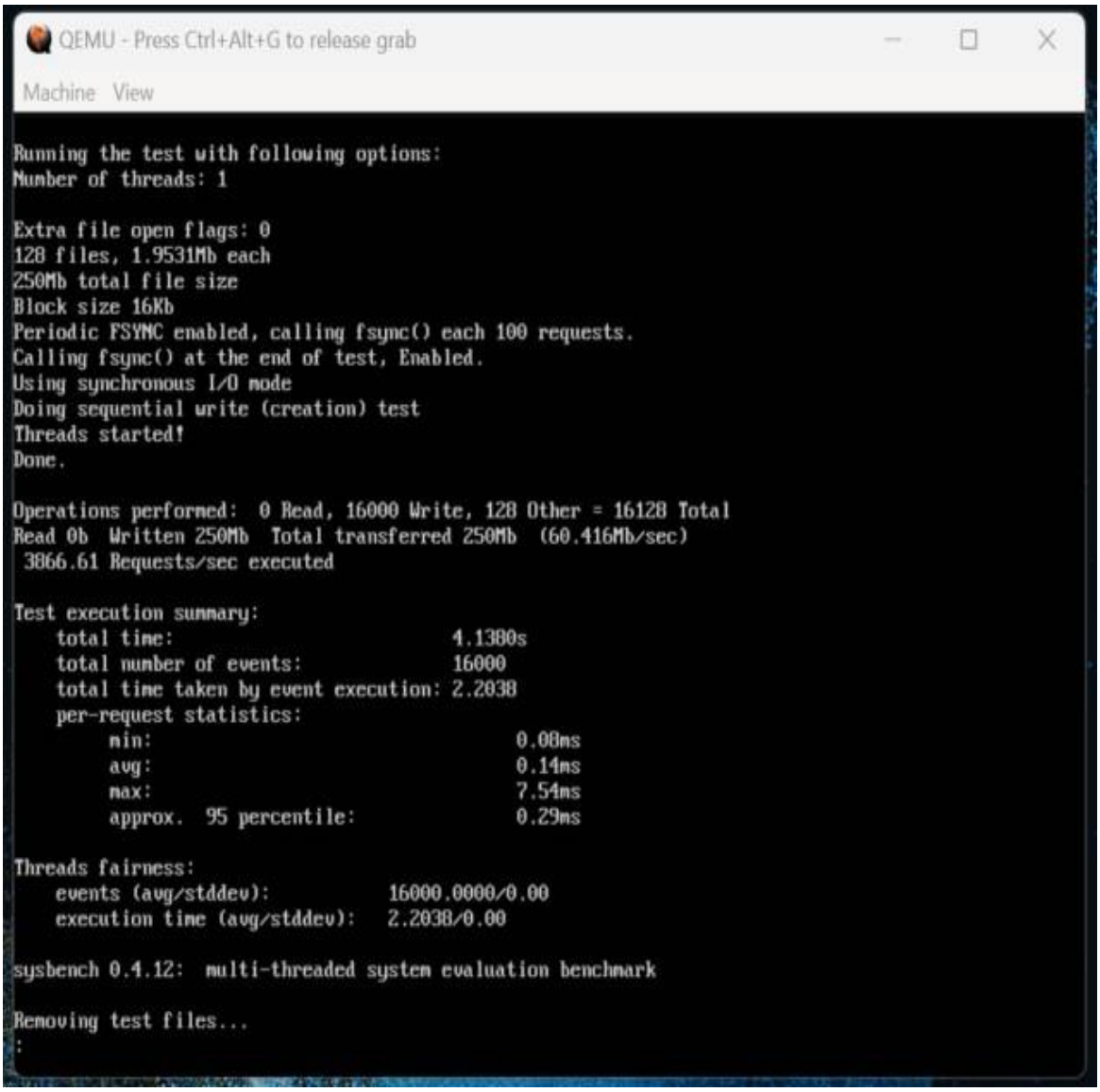


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	3.21 ms	3.96 ms	3.65 ms	3.04 ms	2.92 ms
Max. time taken	70.76 ms	136.95 ms	46.87 ms	97.29 ms	61.26 ms
Min. time taken	1.82 ms	1.12 ms	1.10 ms	1.82 ms	0.98 ms
Total time taken for event execution	32.6254	39.5958	35.5314	30.4200	29.1859

File I/O Testing:

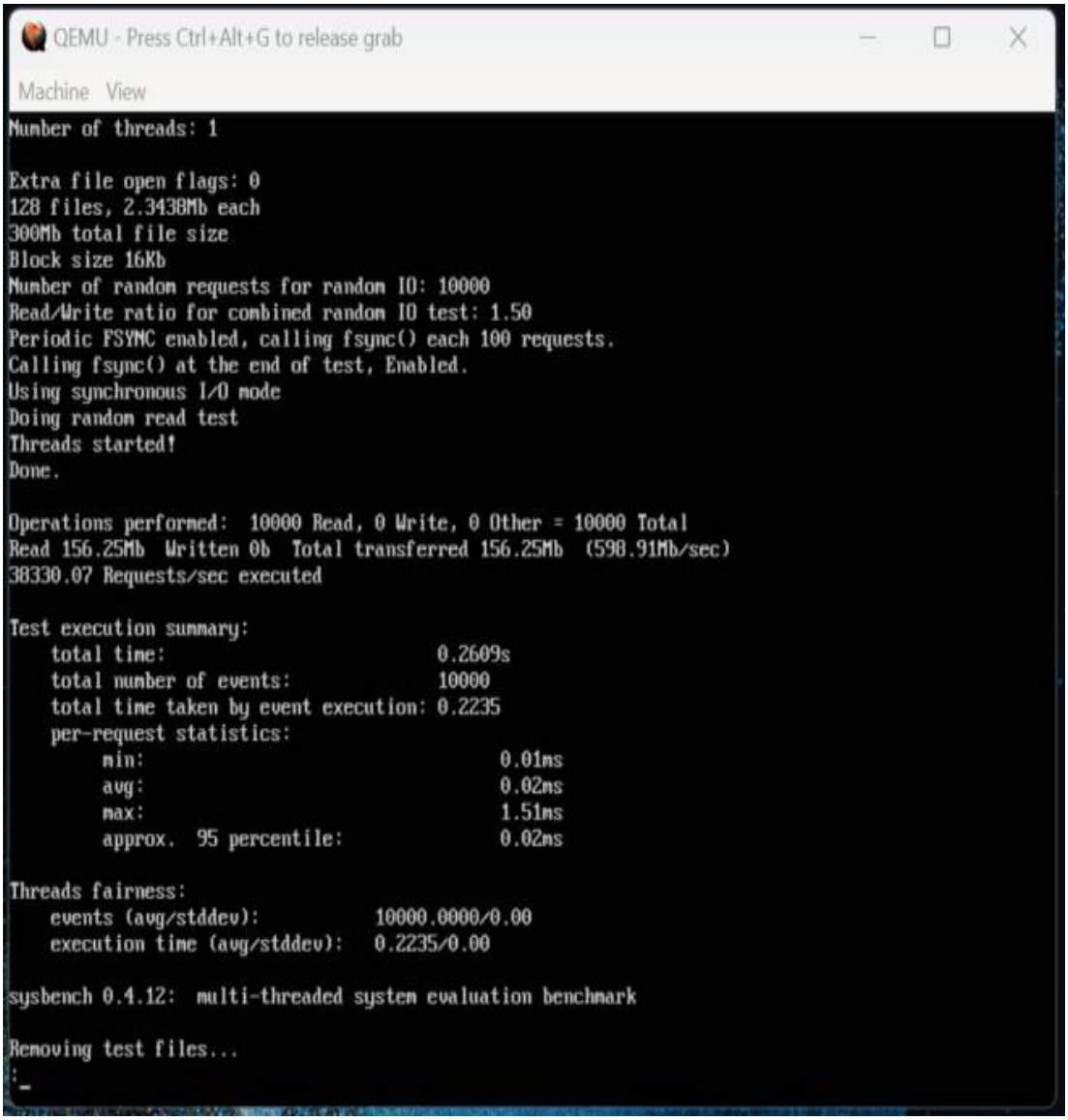
QEMU raw Result for **File I/O Testing** for 3 GB RAM and 3 Core for Sequential Write



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	3.21 ms	3.96 ms	3.65 ms	3.04 ms	2.92 ms
Max. time taken	70.76 ms	136.95 ms	46.87 ms	97.29 ms	61.26 ms
Min. time taken	1.82 ms	1.12 ms	1.10 ms	1.82 ms	0.98 ms
Total time taken for event execution	32.6254	39.5958	35.5314	30.4200	29.1859

QEMU raw Result for **File I/O Testing** for 3 GB RAM and 3 Core for Random reads

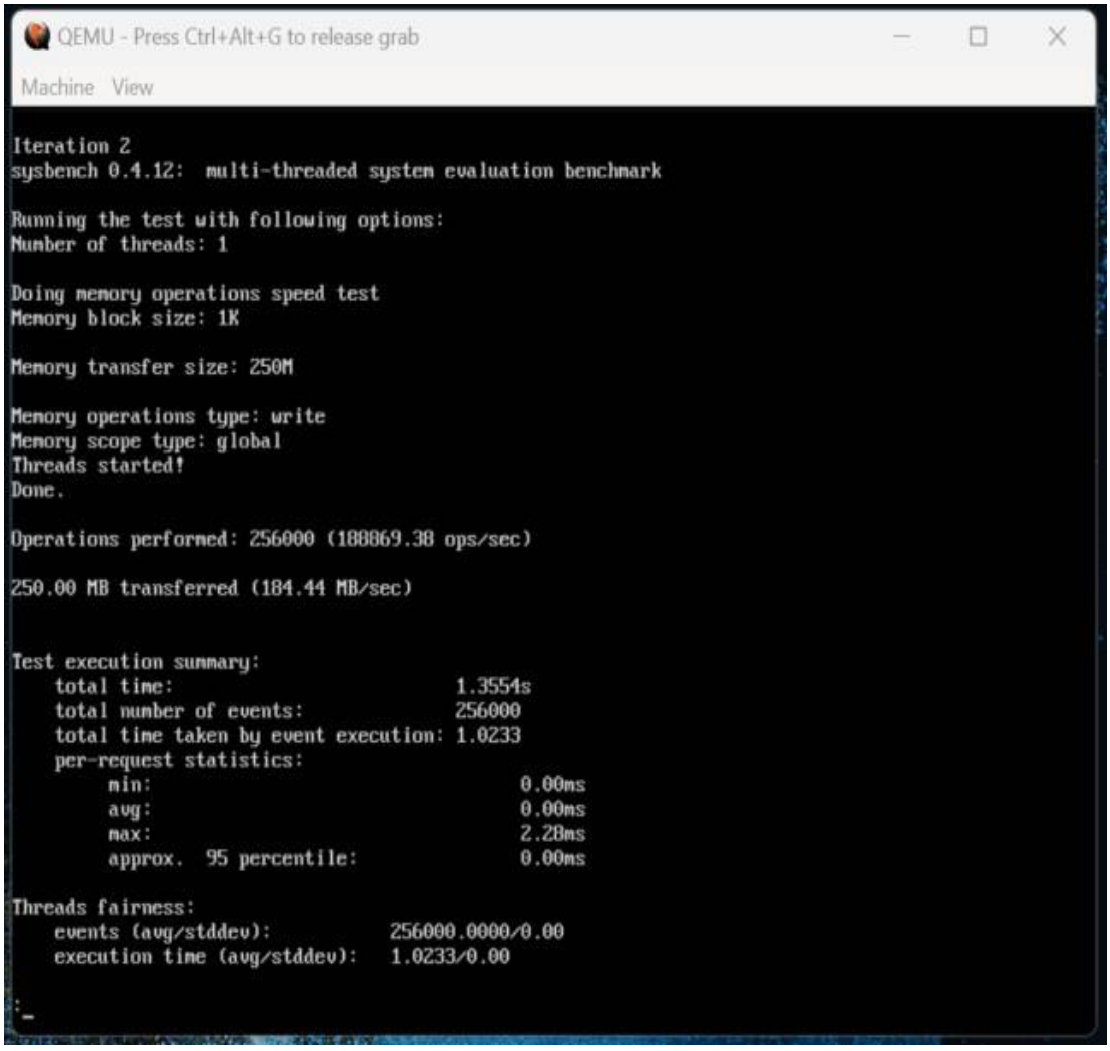


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.02 ms	0.02 ms	0.02 ms	0.02 ms	0.02 ms
Max. time taken	1.33 ms	11.94 ms	15.45 ms	11.13 ms	1.51 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.3400	0.2720	0.2306	0.2323	0.2235

Memory Testing:

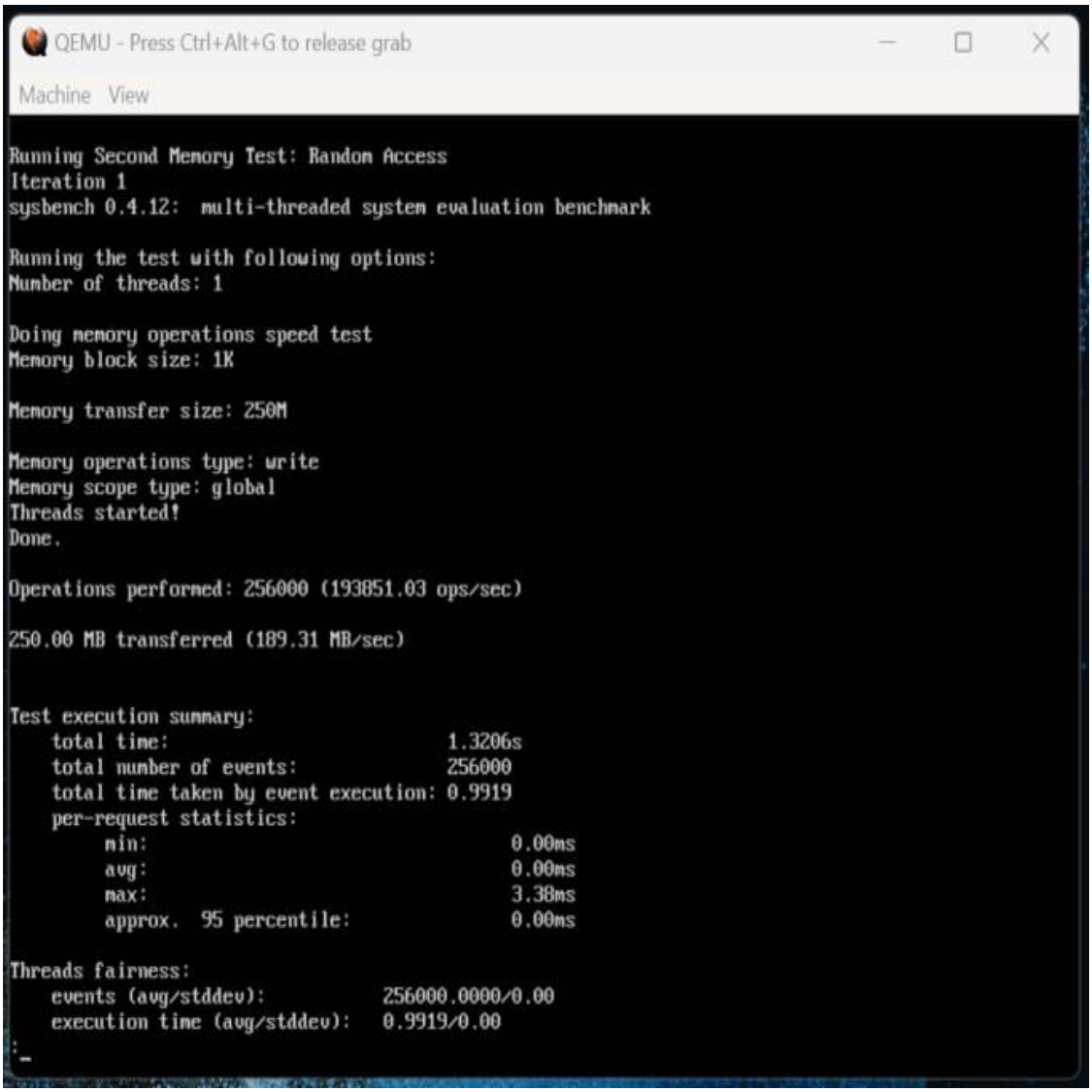
QEMU raw results for **Memory Testing** for 2GB RAM and 2 Core for Sequential Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Max. time taken	5.72 ms	2.28 ms	2.45 ms	3.10 ms	4.09 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	1.1330	1.0233	0.9632	1.6297	0.9770

QEMU raw results for **Memory Testing** for 2GB RAM and 2 Core for Random Memory Access – Total memory size = 250 MB



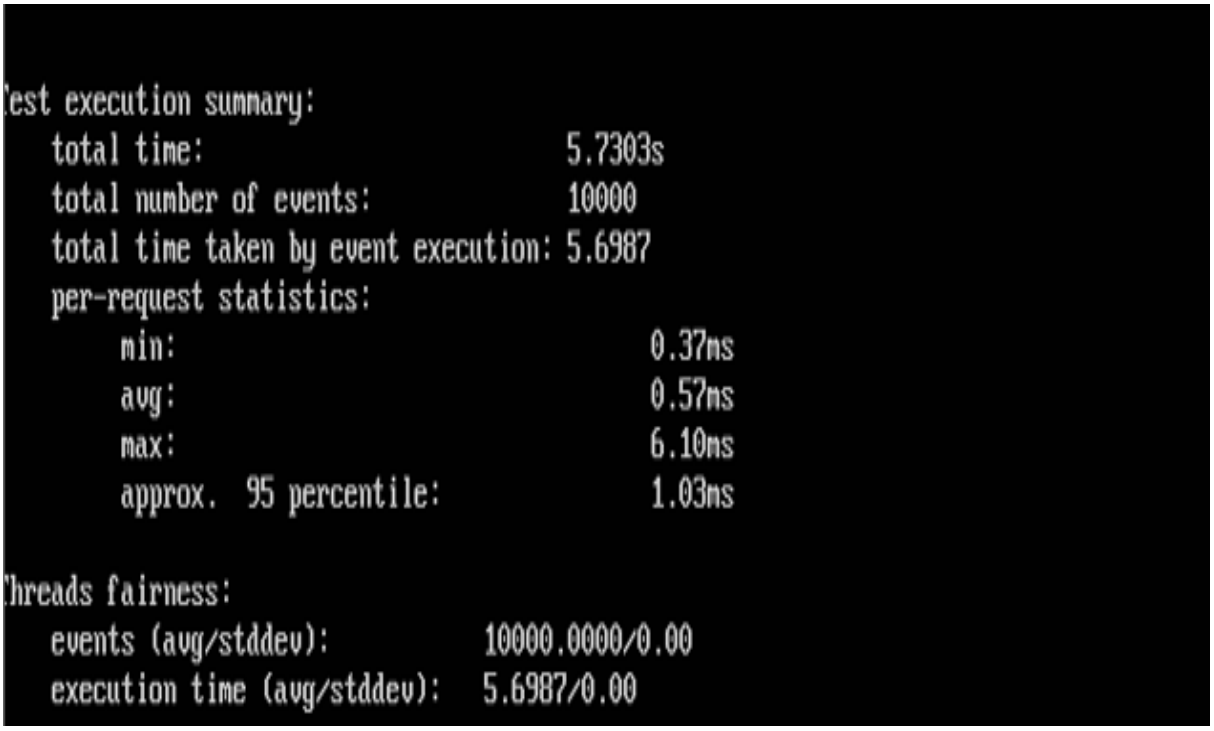
Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Max. time taken	3.38 ms	2.67 ms	20.64 ms	2.85 ms	4.56 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.9919	1.1701	1.3049	1.1829	1.0373

QEMU- qcow2 disk image:

CPU Testing:

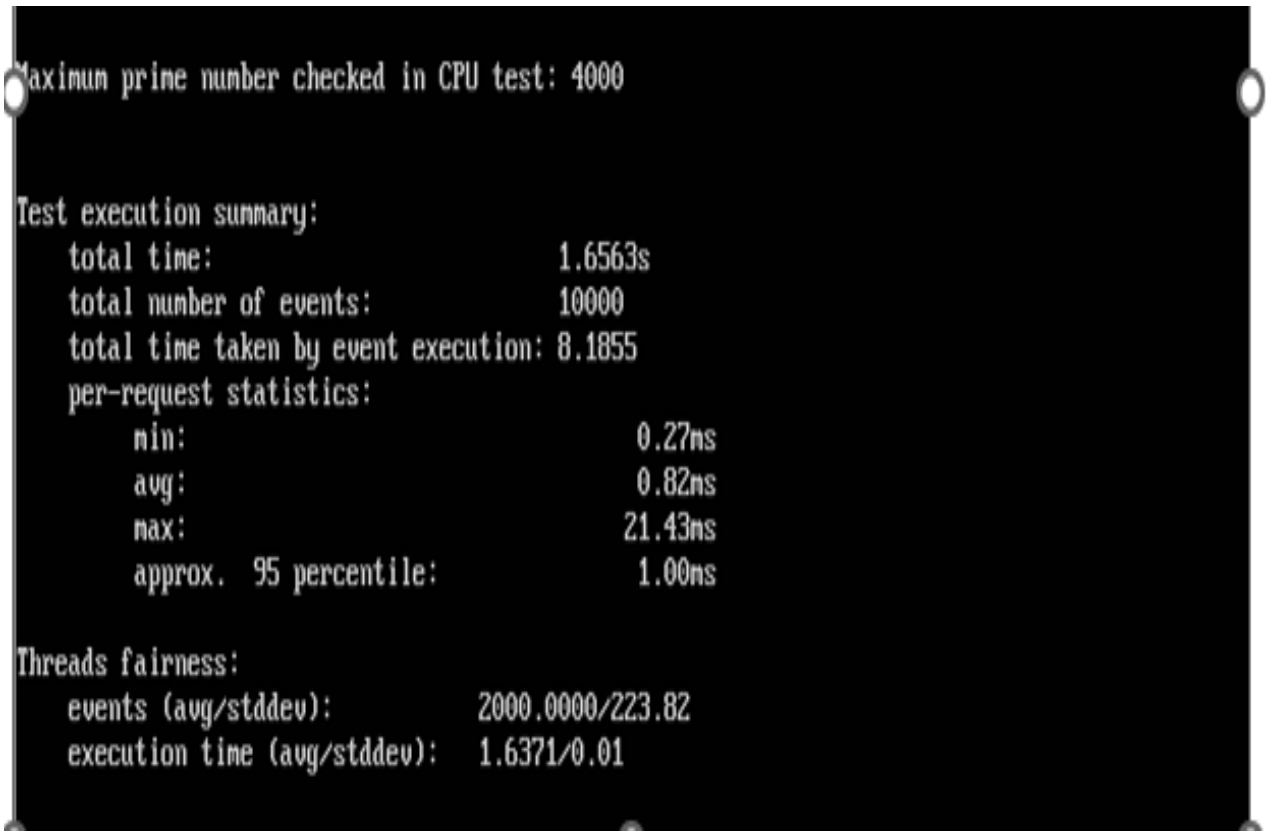
Result for **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.57 ms	1.80 ms	1.83 ms	1.86 ms	1.39 ms
Max. time taken	6.10 ms	10.39 ms	7.75 ms	14.12 ms	16.33 ms
Min. time taken	0.37 ms	1.39 ms	1.41 ms	1.38 ms	1.39 ms
Total time taken for event execution	5.6987	17.9964	18.2734	18.5544	19.5683

Result for **CPU Testing** where Max-Prime = 10000 - test case 2

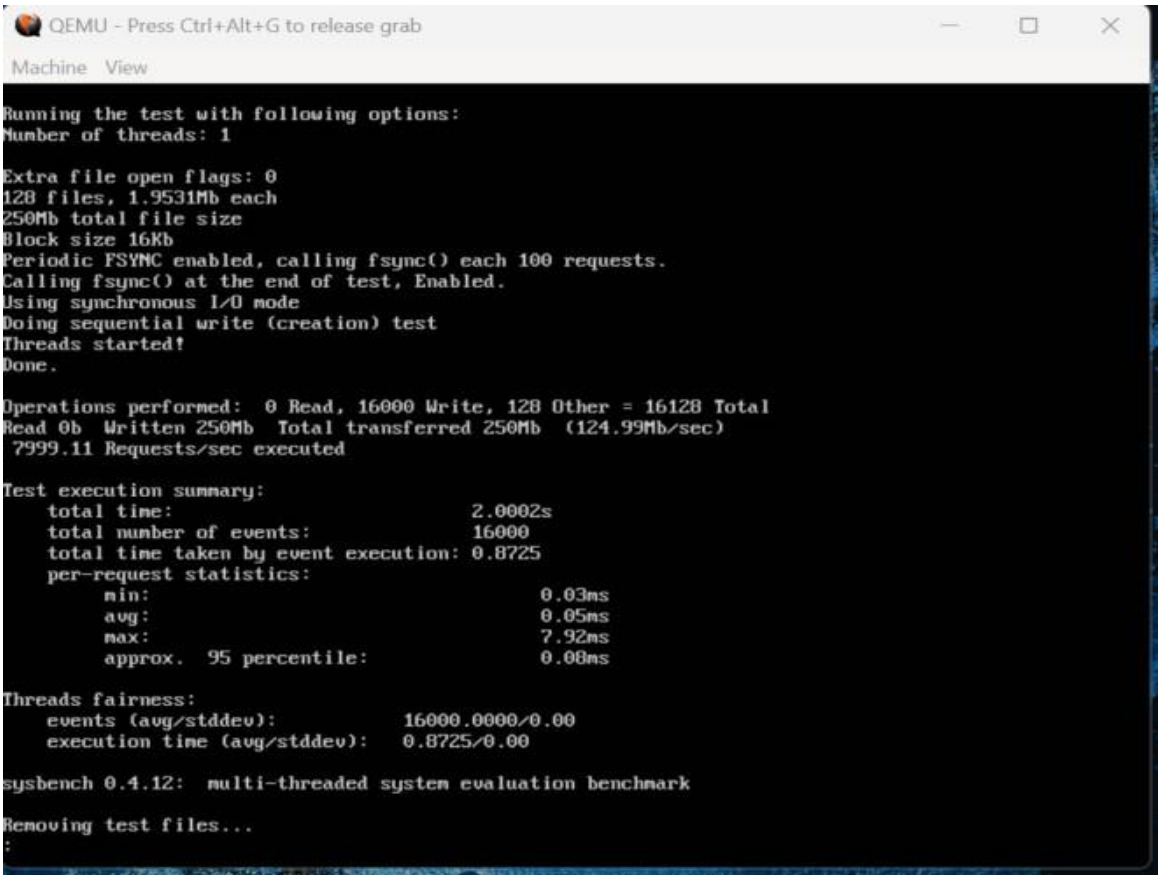


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.82 ms	1.96 ms	2.00 ms	1.69 ms	1.75 ms
Max. time taken	21.43 ms	59.79 ms	48.04 ms	49.55 ms	42.36 ms
Min. time taken	0.27 ms	0.90 ms	0.93 ms	0.75 ms	0.86 ms
Total time taken for event execution	8.1855	19.6328	20.8327	18.4528	19.7562

File I/O Testing:

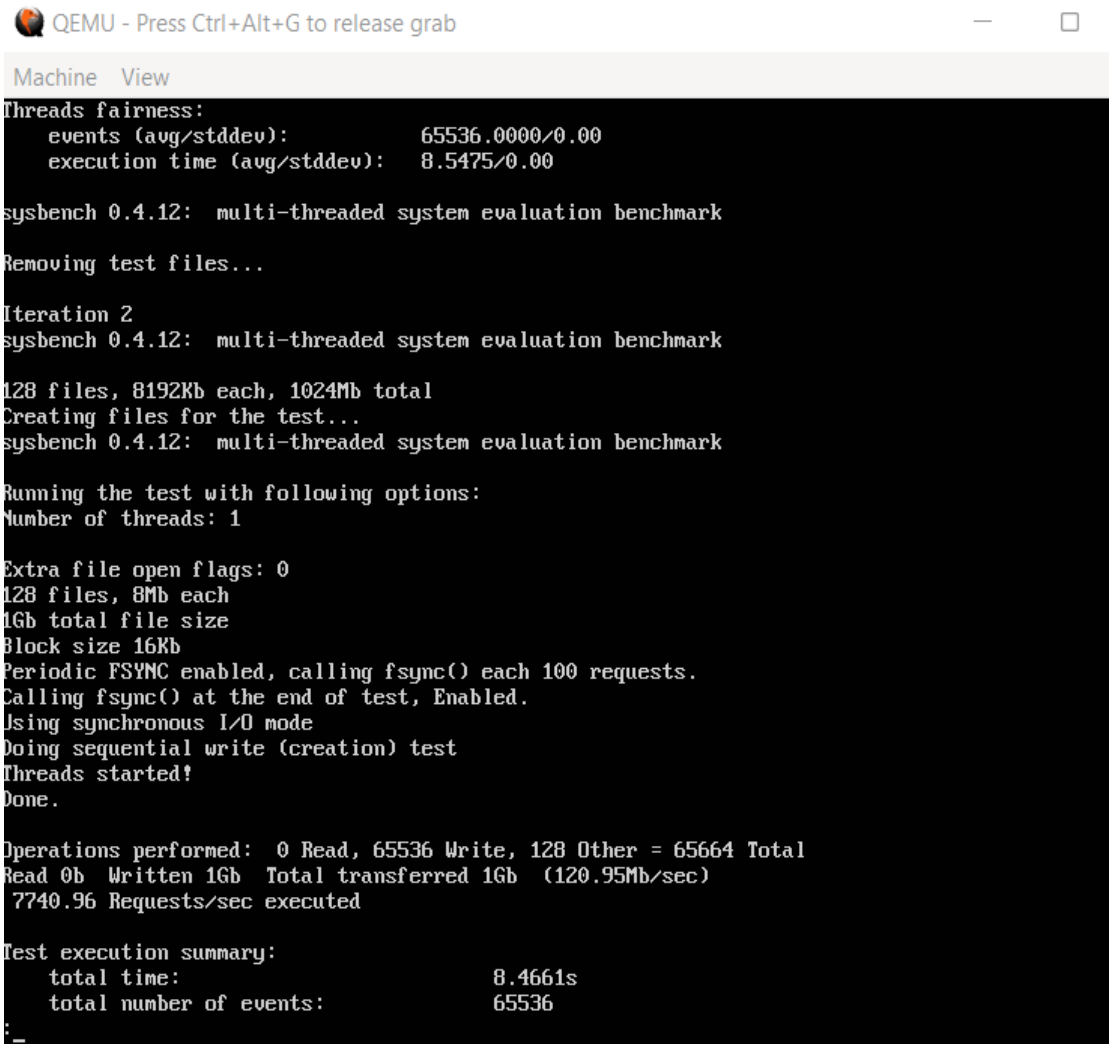
QEMU qcow2 Result for **File I/O Testing** for 3 GB RAM and 3 Core for Sequential Write

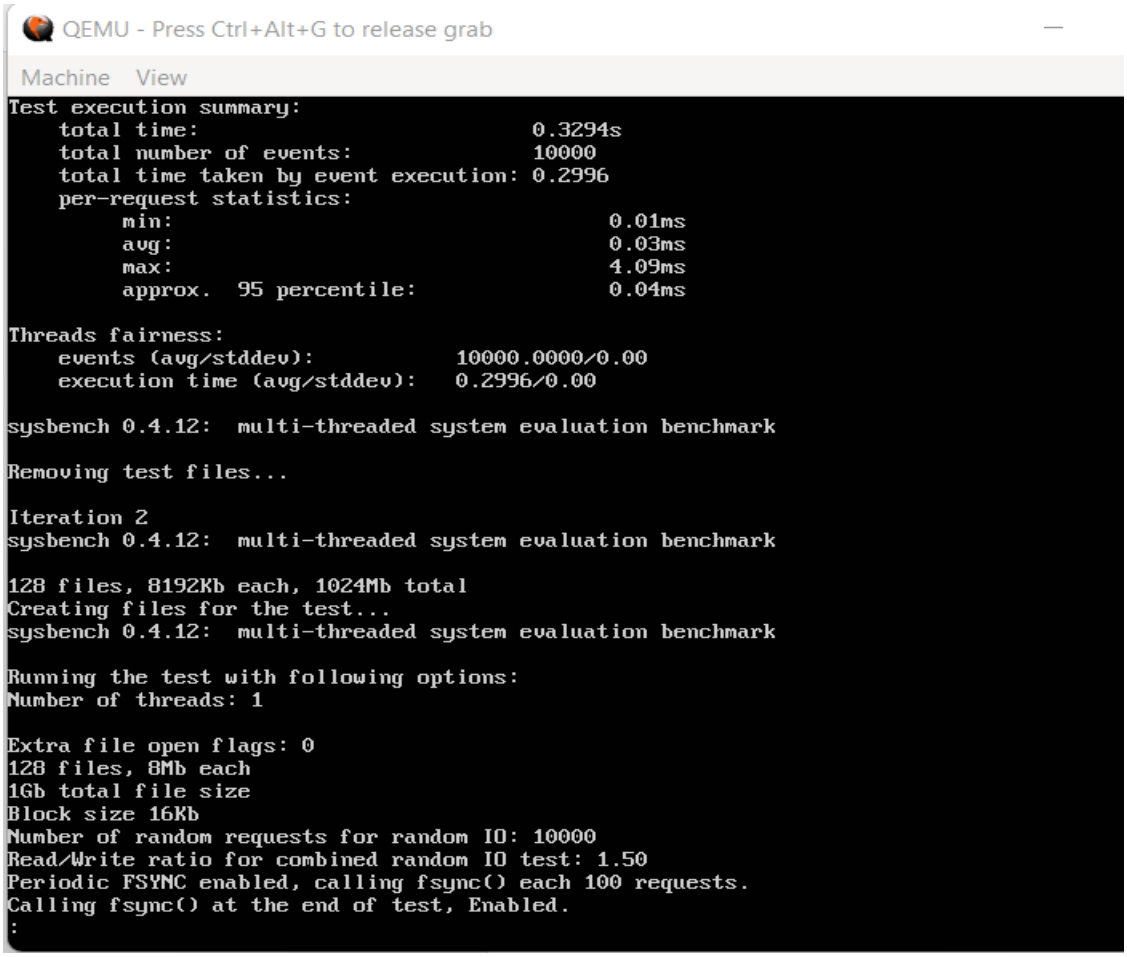


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.06 ms	0.05 ms	0.05 ms	0.05 ms	0.06 ms
Max. time taken	7.69 ms	7.76 ms	7.86 ms	7.96 ms	8.06 ms
Min. time taken	0.03 ms	0.03 ms	0.03 ms	0.03 ms	0.03 ms
Total time taken for event execution	0.8872	0.8461	20.8327	18.4528	19.7562

QEMU qcow2 Result for **File I/O Testing** for 3 GB RAM and 3 Core for Random read



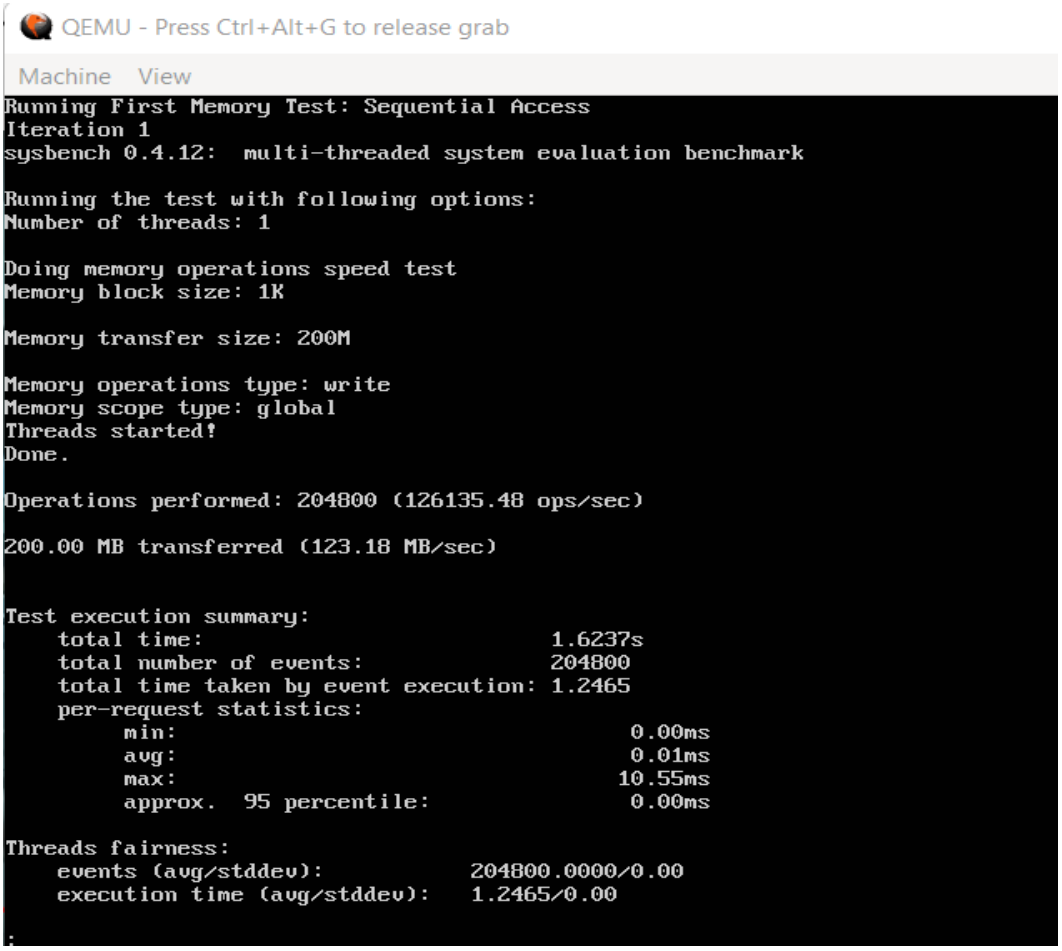


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	3.47 ms	3.85 ms	3.65 ms	3.88 ms	3.48 ms
Min. time taken	0.03 ms	0.03 ms	0.03 ms	0.03 ms	0.03 ms
Total time taken for event execution	0.3127	0.4566	0.8522	0.2489	0.6654

Memory Testing:

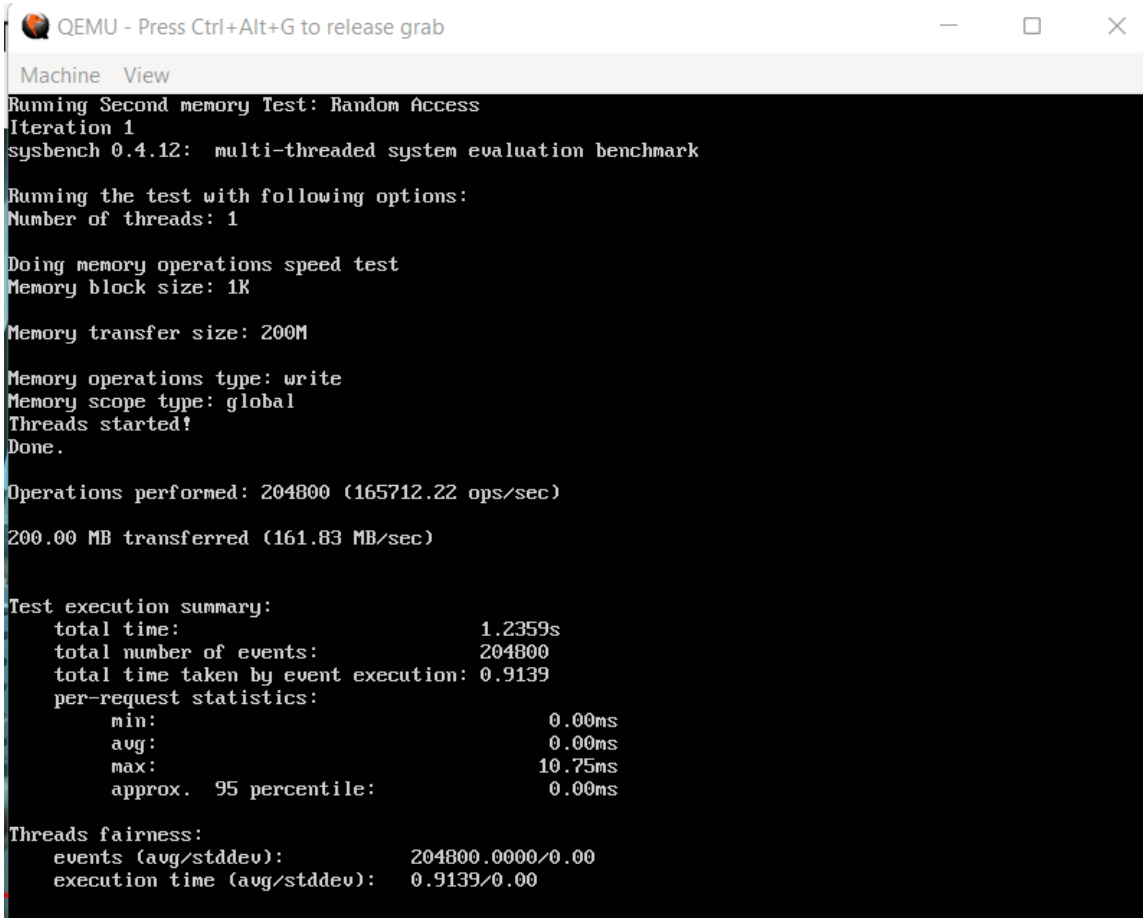
QEMU qcow2 results for **Memory Testing** for 2GB RAM and 2 Core for Sequential Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	10.55 ms	10.44 ms	10.88 ms	10.21 ms	10.35 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	1.2645	1.5568	1.5582	1.7458	1.6588

QEMU qcow2 results for **Memory Testing** for 2GB RAM and 2 Core for Random Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	10.75 ms	10.65 ms	10.25 ms	10.33 ms	10.78 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.9139	0.6658	0.9877	0.9544	0.6521

Docker Results for 3 GB 3 Core:

CPU Testing:

Results for Docker based **CPU Testing** where Max-Prime = 20000 - test case 1

```
root@03e0f2f95d9d:/# ./cpu_bash_script.sh
Running First CPU Test: High Prime Number Calculation
Iteration 1
sysbench 0.4.12:  multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 1

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 20000


Test execution summary:
    total time:                          7.0151s
    total number of events:              10000
    total time taken by event execution: 7.0139
    per-request statistics:
         min:                                  0.63ms
         avg:                                  0.70ms
         max:                                  6.83ms
         approx.  95 percentile:               0.81ms

Threads fairness:
    events (avg/stddev):           10000.0000/0.00
    execution time (avg/stddev):   7.0139/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.70 ms	0.66 ms	0.68 ms	0.72 ms	0.76 ms
Max. time taken	6.83 ms	7.21 ms	6.25 ms	6.75 ms	6.82 ms
Min. time taken	0.63 ms	0.63 ms	0.63 ms	0.63 ms	0.63 ms
Total time taken for event execution	7.0139	0.7752	0.7786	0.6998	0.7725

Results for Docker based **CPU Testing** where Max-Prime = 10000 - test case 2

```
Iteration 2
sysbench 0.4.12:  multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 4

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 10000


Test execution summary:
    total time:                          0.9864s
    total number of events:              10000
    total time taken by event execution: 3.9425
    per-request statistics:
         min:                                  0.26ms
         avg:                                  0.39ms
         max:                                 30.86ms
         approx.  95 percentile:               0.35ms

Threads fairness:
    events (avg/stddev):           2500.0000/49.05
    execution time (avg/stddev):   0.9856/0.00
```

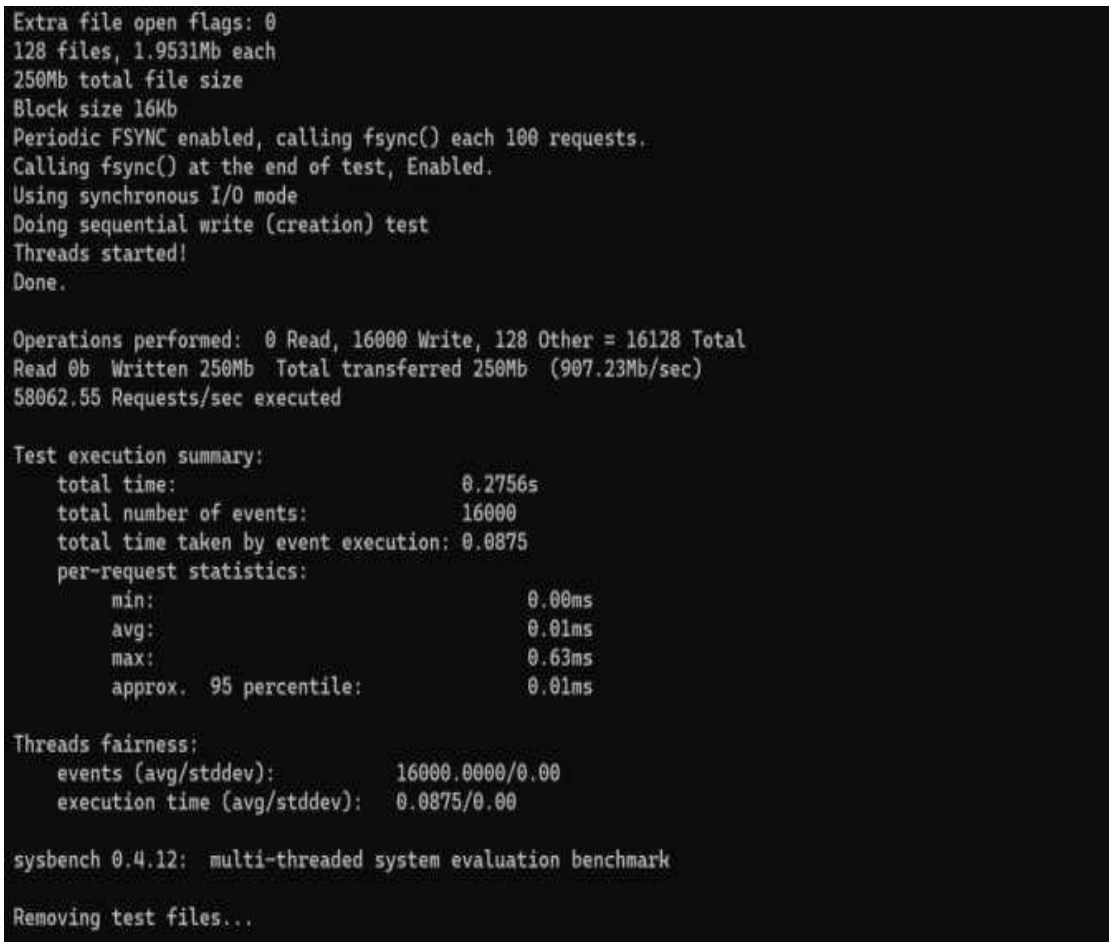
```
Iteration 3
sysbench 0.4.12:  multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 4

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 10000


Test execution summary:
    total time:                          0.9831s
    total number of events:              10000
    total time taken by event execution: 3.9298
    per-request statistics:
         min:                                  0.27ms
         avg:                                  0.39ms
         max:                                 30.62ms
         approx.  95 percentile:               0.35ms

Threads fairness:
    events (avg/stddev):           2500.0000/31.00
    execution time (avg/stddev):   0.9824/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.38 ms	0.39 ms	0.39 ms	0.39 ms	0.39 ms
Max. time taken	30.86 ms	30.86 ms	30.62 ms	30.66 ms	30.85 ms
Min. time taken	0.26 ms	0.26 ms	0.27 ms	0.27 ms	0.27 ms
Total time taken for event execution	3.0139	3.9425	3.9298	3.6998	3.7725

File I/O Testing:

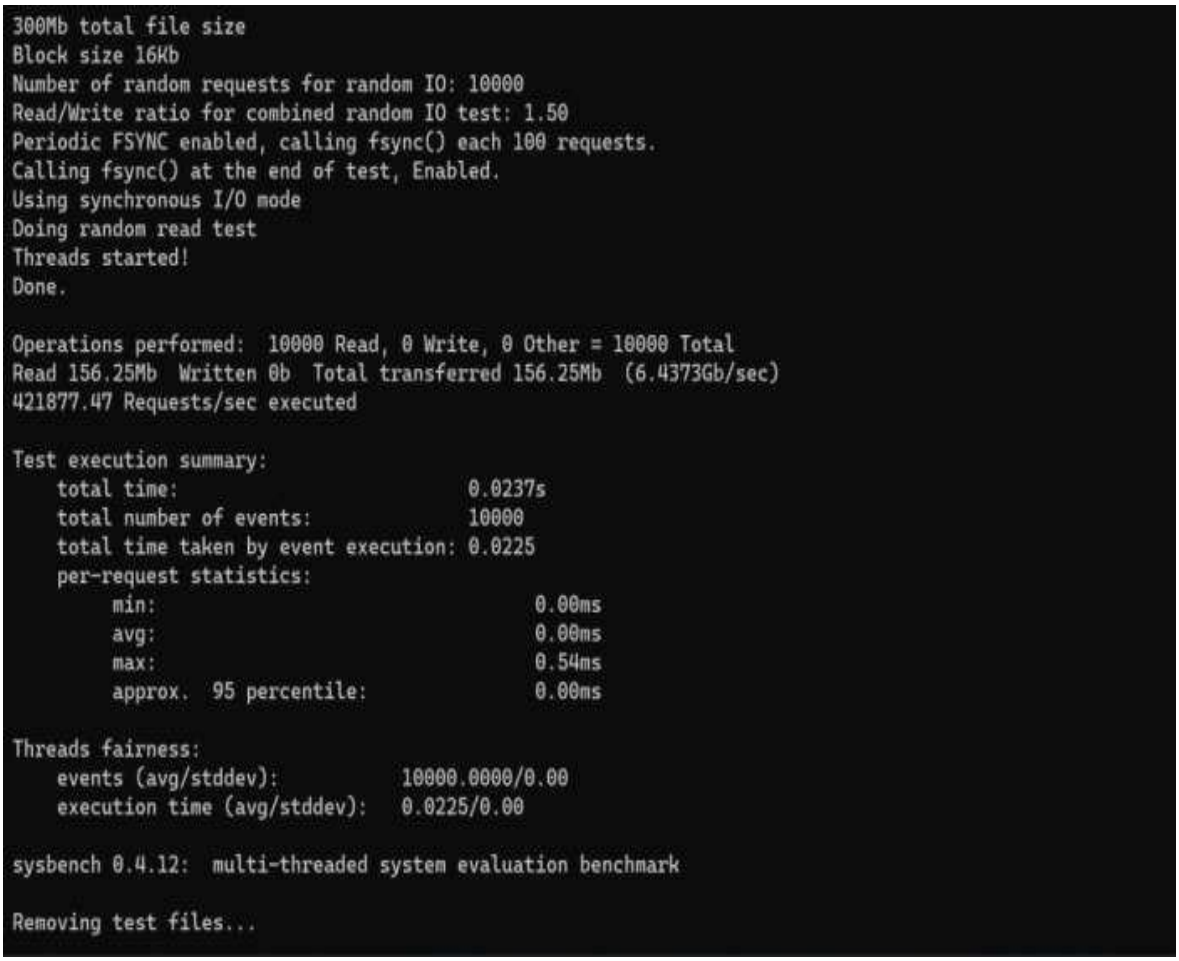
Docker results for **File I/O Testing** for 3 GB RAM and 3 Core for Sequential Write



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.86 ms	0.86 ms	0.62 ms	0.66 ms	0.85 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0139	0.9425	0.9298	0.6998	0.7725

Docker results for **File I/O Testing** for 3 GB RAM and 3 Core for Random Read



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.54 ms	0.55 ms	0.55 ms	0.55 ms	0.55 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0255	0.5645	0.2589	0.1588	0.1689

Memory Testing:

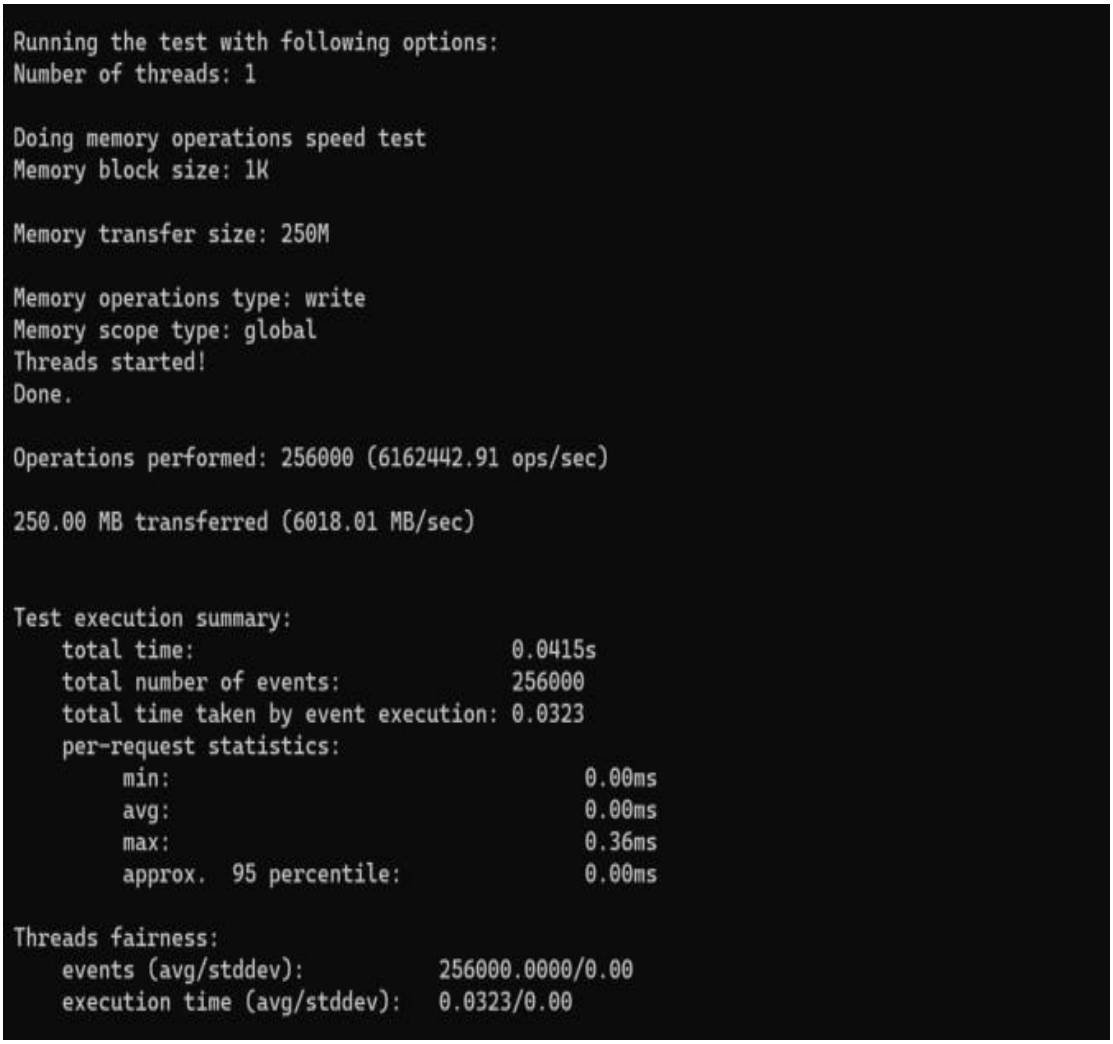
Docker results for **Memory Testing** for 3GB RAM and 3 Core for Sequential Memory Access – Total memory size = 250 MB

```
Running the test with following options:
Number of threads: 1

Doing memory operations speed test
Memory block size: 1K

Memory transfer size: 250M

Memory operations type: write
Memory scope type: global
Threads started!
Done.

Operations performed: 256000 (5776658.28 ops/sec)

250.00 MB transferred (5641.27 MB/sec)


Test execution summary:
    total time:                          0.0443s
    total number of events:              256000
    total time taken by event execution: 0.0357
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.00ms
         max:                                  0.11ms
         approx.  95 percentile:               0.00ms

Threads fairness:
    events (avg/stddev):           256000.0000/0.00
    execution time (avg/stddev):   0.0357/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.11 ms	0.12 ms	0.15 ms	0.16 ms	0.18 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0357	0.0645	0.0655	0.0887	0.0582

Docker results for **Memory Testing** for 3GB RAM and 3 Core for Random memory access – Total memory size = 250 MB



Test Execution Summary:

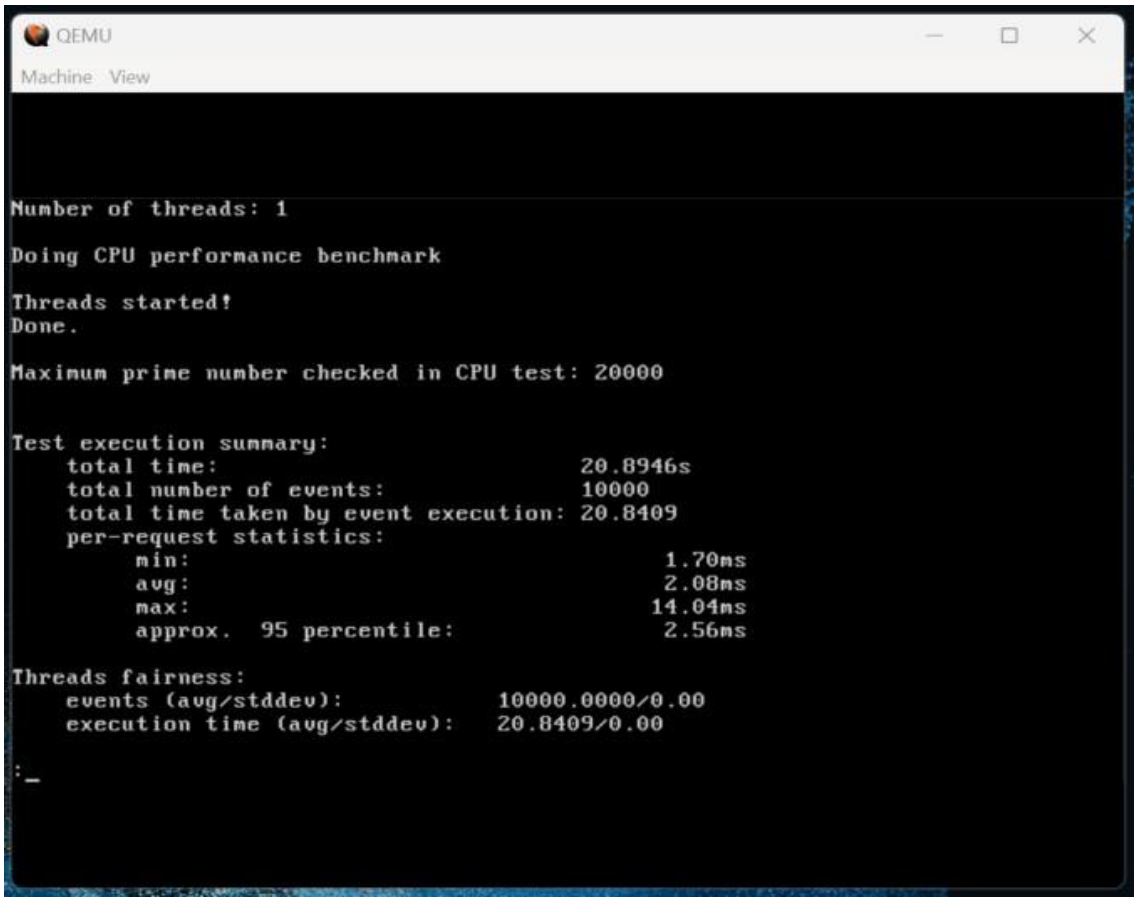
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.36 ms	0.35 ms	0.38 ms	0.36 ms	0.35 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0323	0.0528	0.0352	0.0874	0.0458

3. Configuration: 3 GB RAM & 6 Core

QEMU- Raw disk image:

CPU Testing:

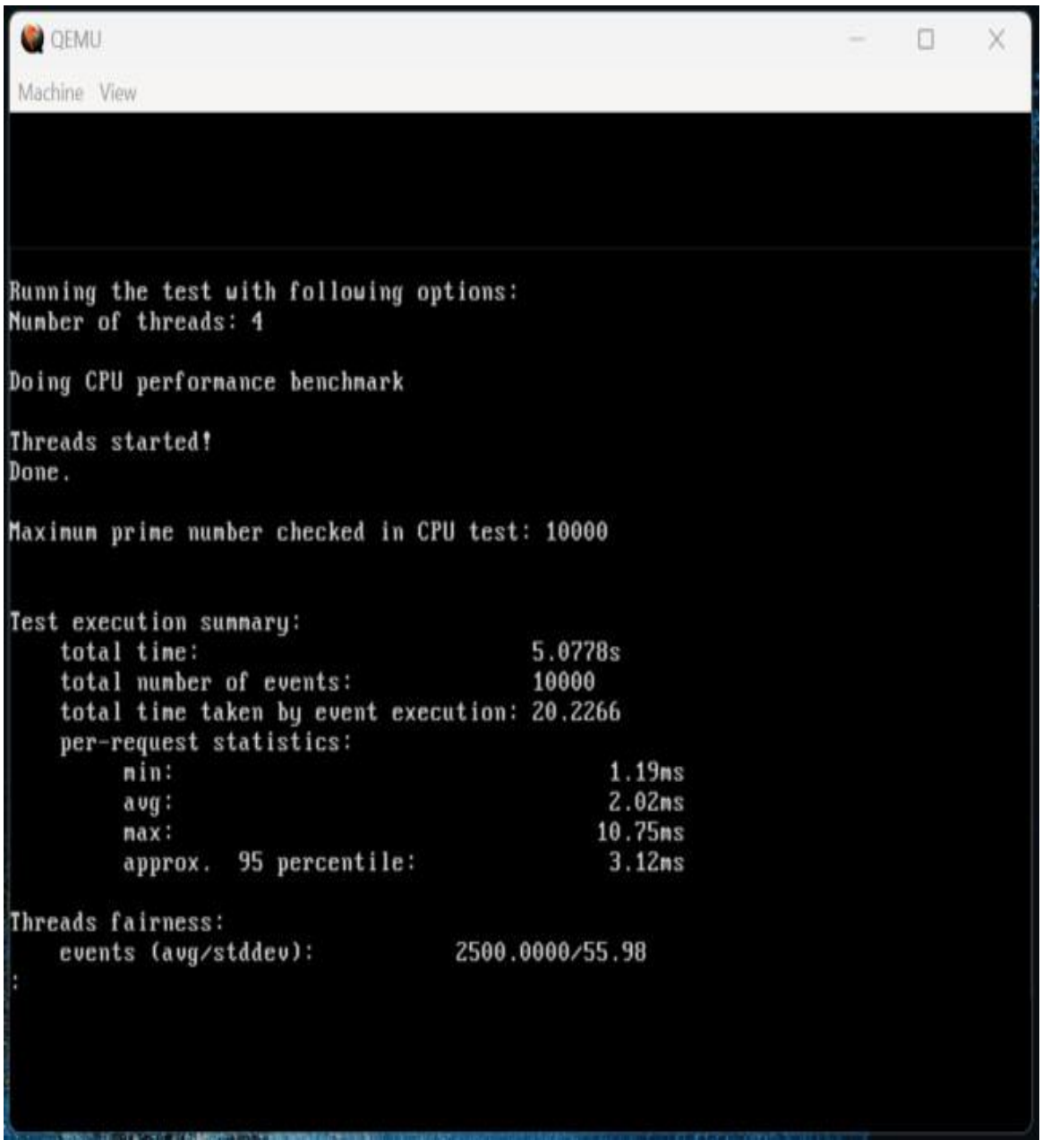
Result for **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.08 ms	2.10 ms	2.06 ms	2.09 ms	2.15 ms
Max. time taken	14.04 ms	14.35 ms	14.38 ms	14.36 ms	14.35 ms
Min. time taken	1.70 ms	1.62 ms	1.72 ms	1.78 ms	1.76 ms
Total time taken for event execution	20.8409	20.8856	20.8896	20.8875	20.7756

Result for **CPU Testing** where Max-Prime = 10000 - test case 2

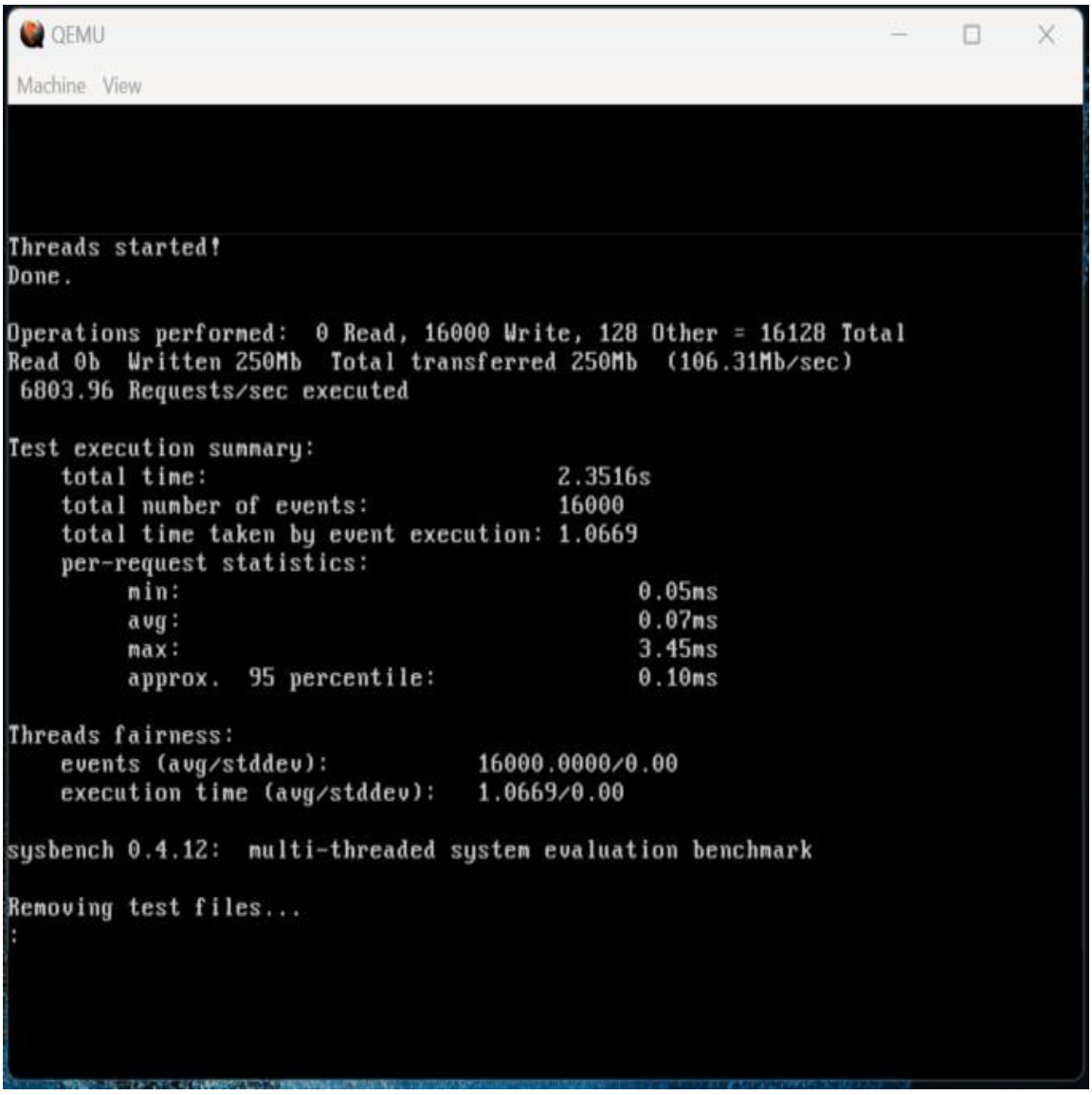


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.02 ms	2.01 ms	2.06 ms	2.09 ms	2.15 ms
Max. time taken	10.75 ms	10.35 ms	10.38 ms	10.36 ms	10.35 ms
Min. time taken	1.19 ms	1.62 ms	1.72 ms	1.78 ms	1.76 ms
Total time taken for event execution	20.2266	20.4585	20.6522	20.7588	20.3125

File I/O Testing:

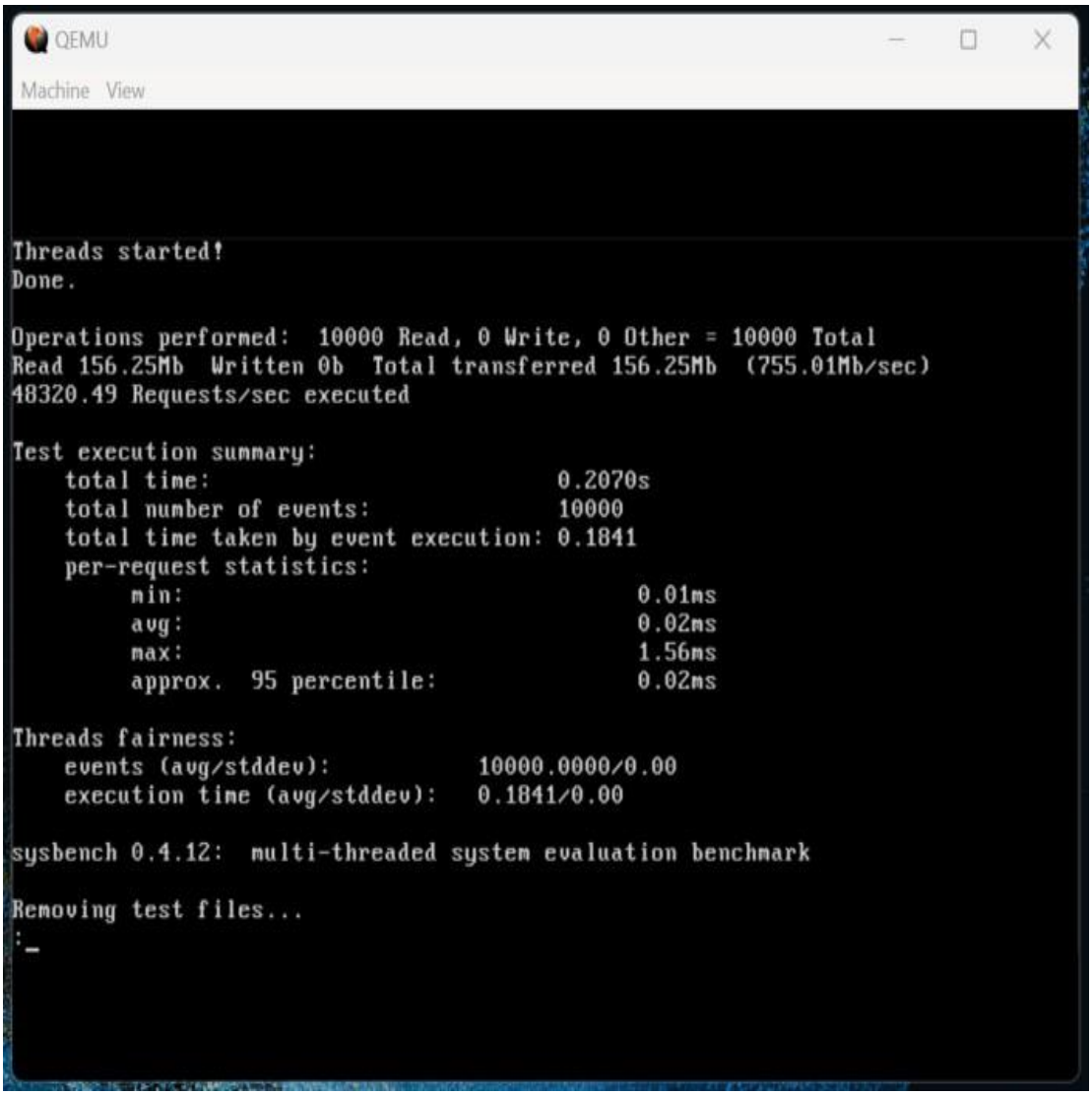
QEMU qcow2 Result for **File I/O Testing** for 3 GB RAM and 6 Core for Sequential Write



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.07 ms	0.06 ms	0.07 ms	0.05 ms	0.06 ms
Max. time taken	3.35 ms	3.58 ms	3.45 ms	3.55 ms	3.57 ms
Min. time taken	0.05 ms	0.02 ms	0.05 ms	0.03 ms	0.05 ms
Total time taken for event execution	1.0558	1.0877	1.0669	1.0778	1.0551

QEMU raw result for **File I/O Testing** for 3 GB RAM and 6 Core for Random Read

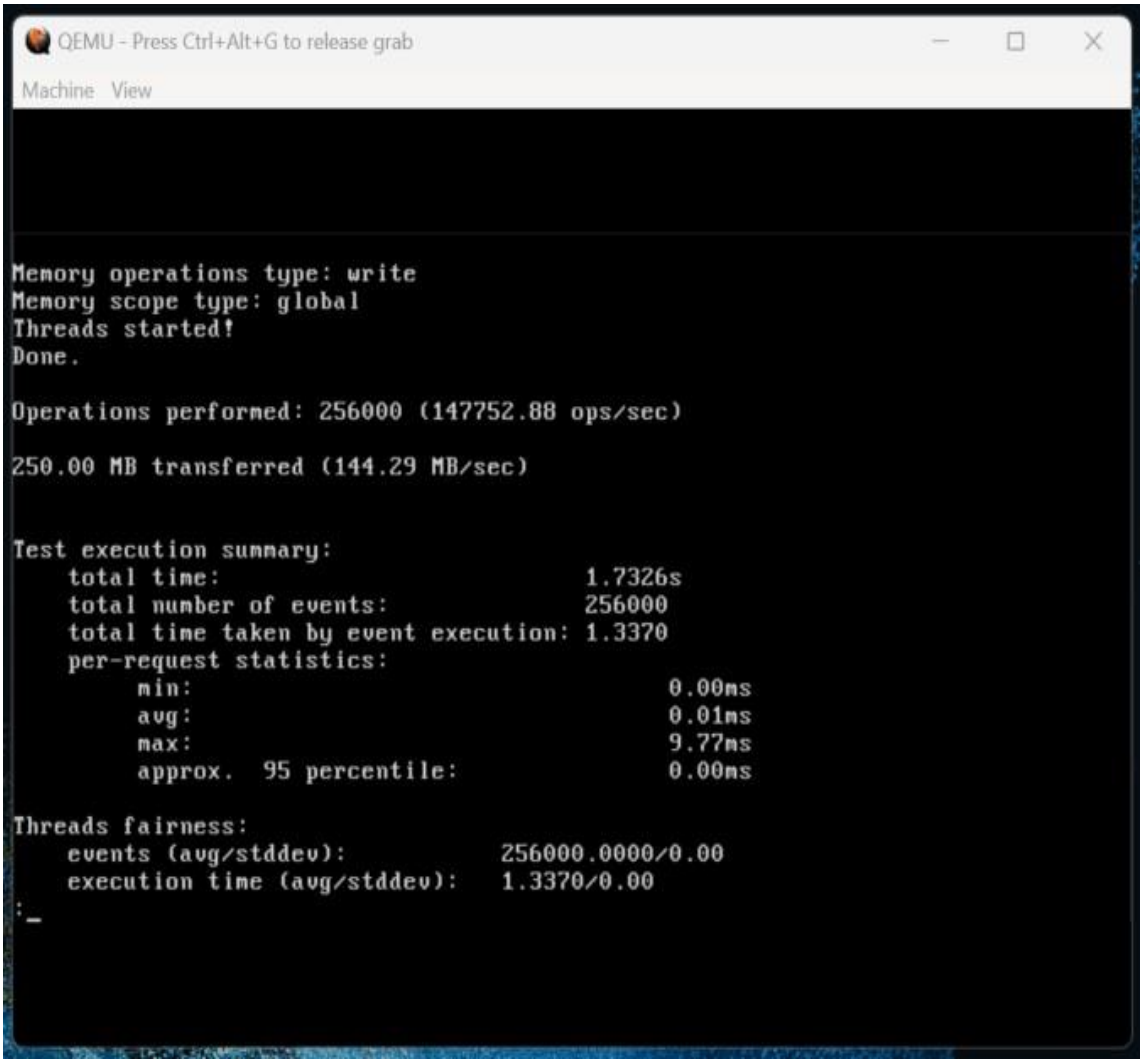


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.07 ms	0.06 ms	0.07 ms	0.05 ms	0.06 ms
Max. time taken	0.02 ms	0.02 ms	0.02 ms	0.02 ms	0.02 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.1841	0.0877	0.0669	0.0778	0.0551

Memory Testing:

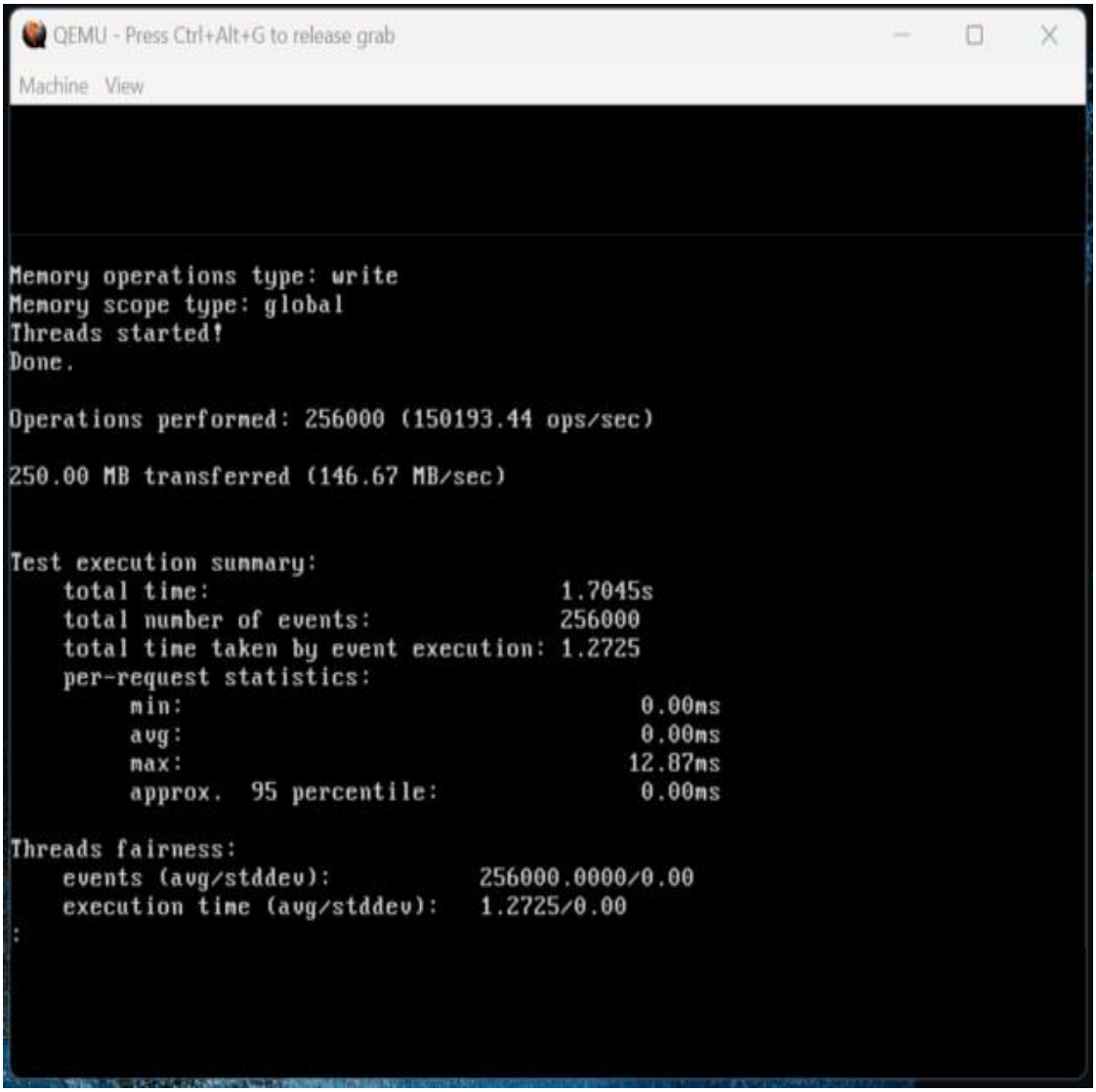
QEMU raw results for **Memory Testing** for 3GB RAM and 6 Core for Sequential Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	9.97 ms	9.55 ms	9.64 ms	9.55 ms	9.45 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.3370	1.5587	1.3365	1.3856	1.8857

QEMU raw results for **Memory Testing** for 3GB RAM and 6 Core for Random Memory Access – Total memory size = 250 MB



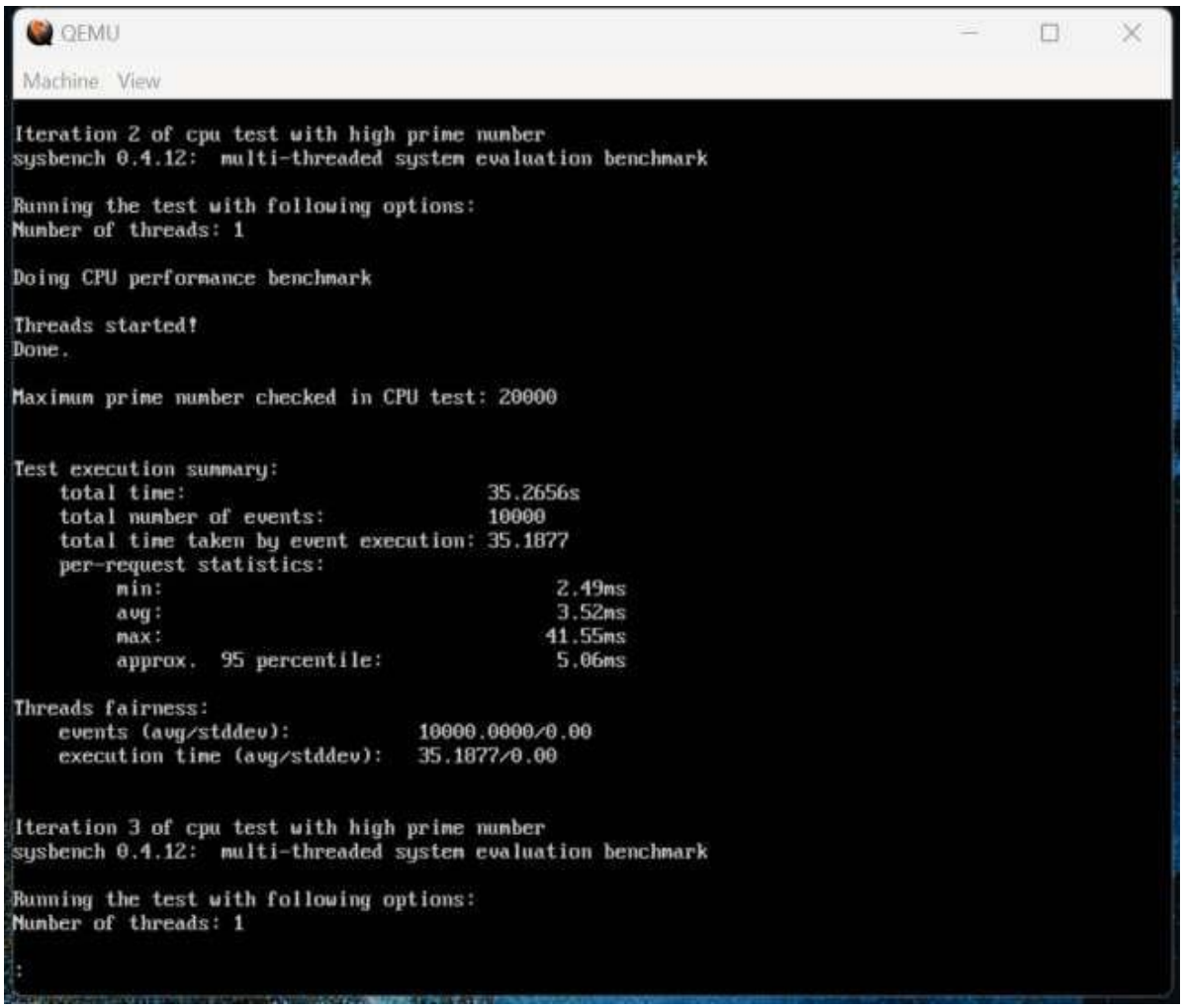
Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	11.55 ms	11.55 ms	11.64 ms	11.55 ms	11.45 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.2725	1.5587	1.3365	1.3856	1.8857

QEMU- Qcow2 disk image:

CPU Testing:

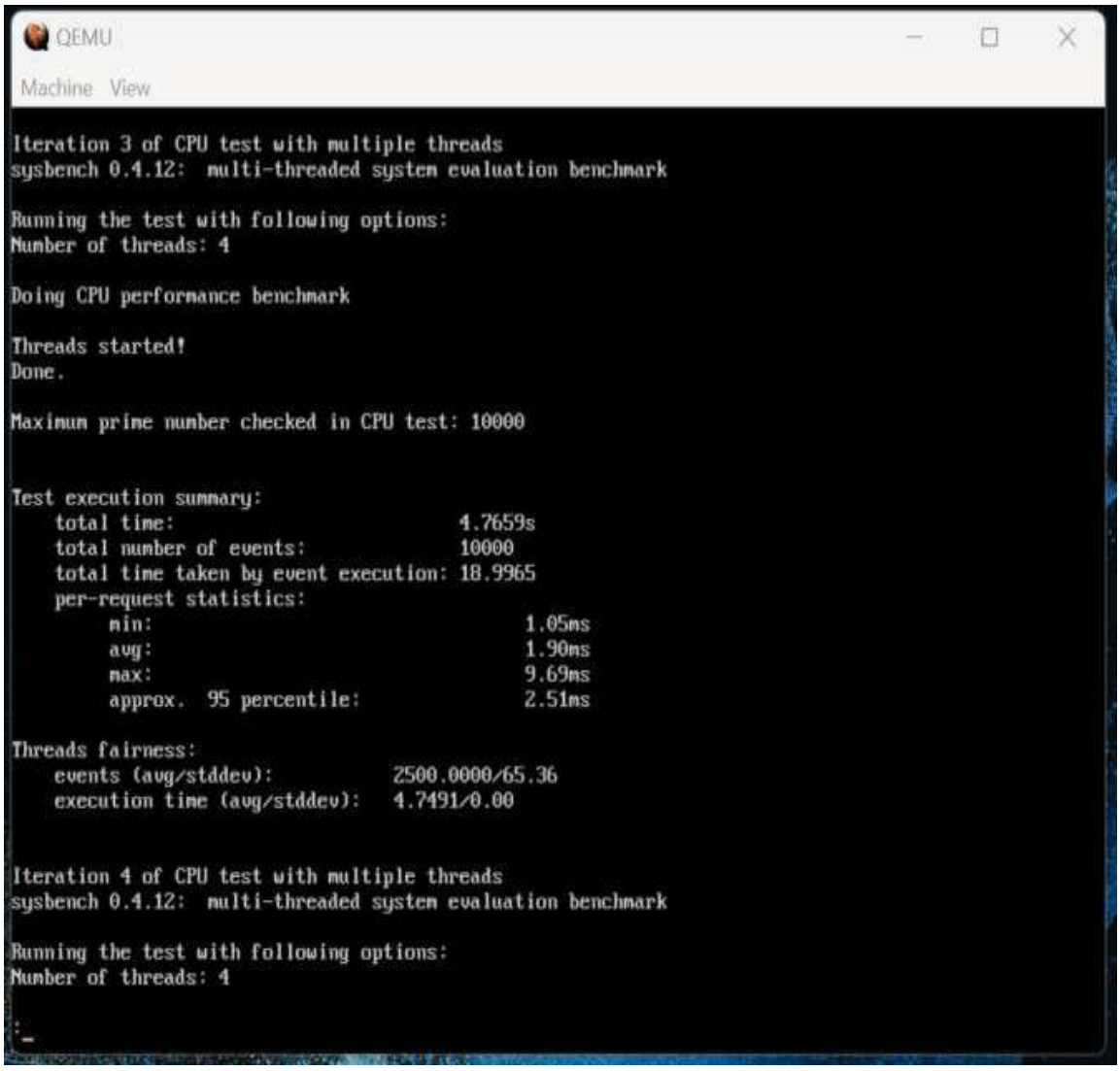
Result for **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	3.52 ms	3.54 ms	3.57 ms	3.87 ms	3.63 ms
Max. time taken	41.55 ms	42.09 ms	41.23 ms	41.88 ms	41.96 ms
Min. time taken	2.49 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	35.1877	35.2857	35.1147	35.2248	35.4896

Result for **CPU Testing** where Max-Prime = 10000 - test case 2

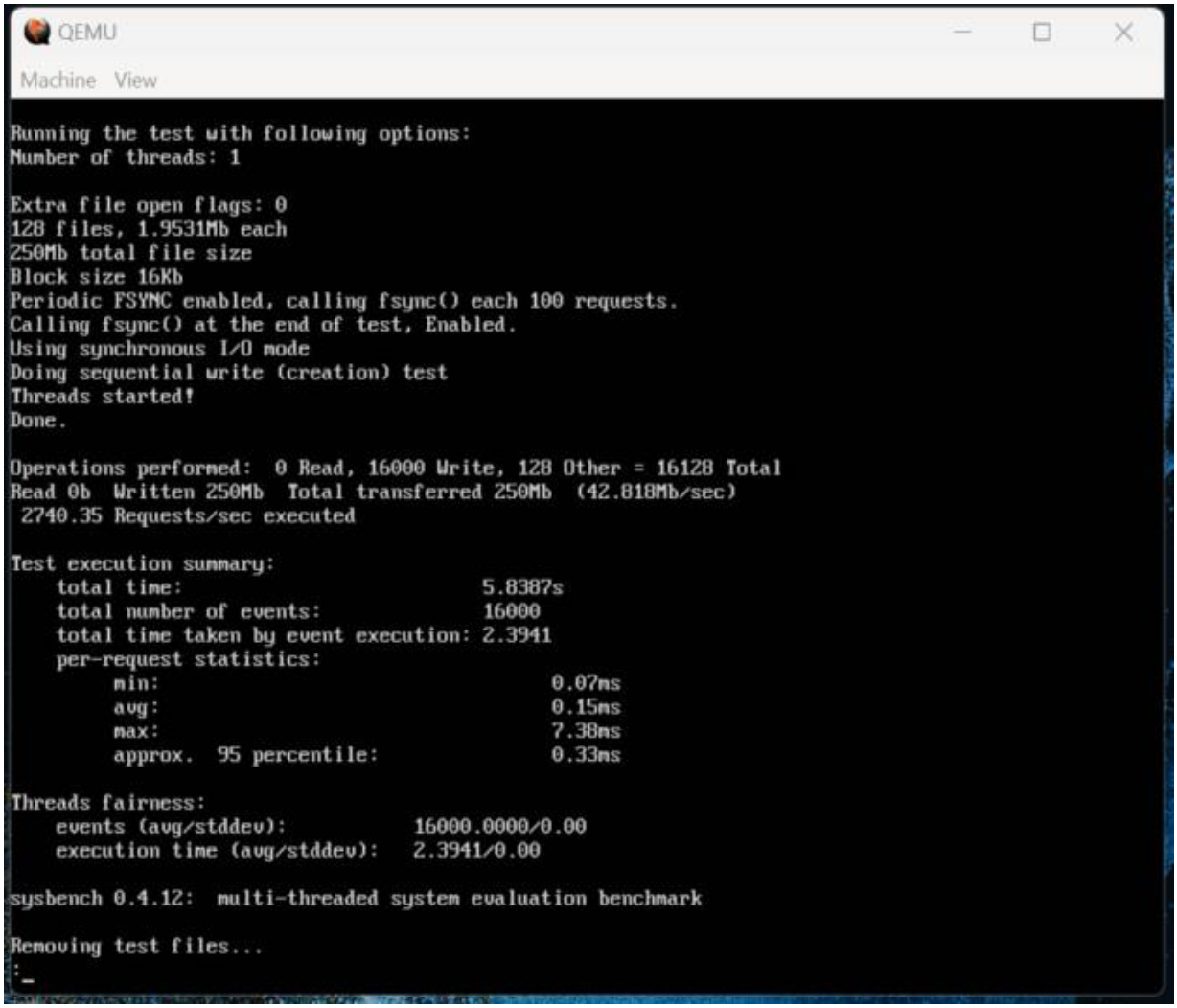


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	1.90 ms	1.91 ms	1.57 ms	1.87 ms	1.63 ms
Max. time taken	9.69 ms	9.09 ms	9.23 ms	9.88 ms	9.96 ms
Min. time taken	1.05 ms	1.01 ms	1.07 ms	1.12 ms	1.05 ms
Total time taken for event execution	18.9965	18.2857	18.1147	18.2248	18.4896

File I/O Testing:

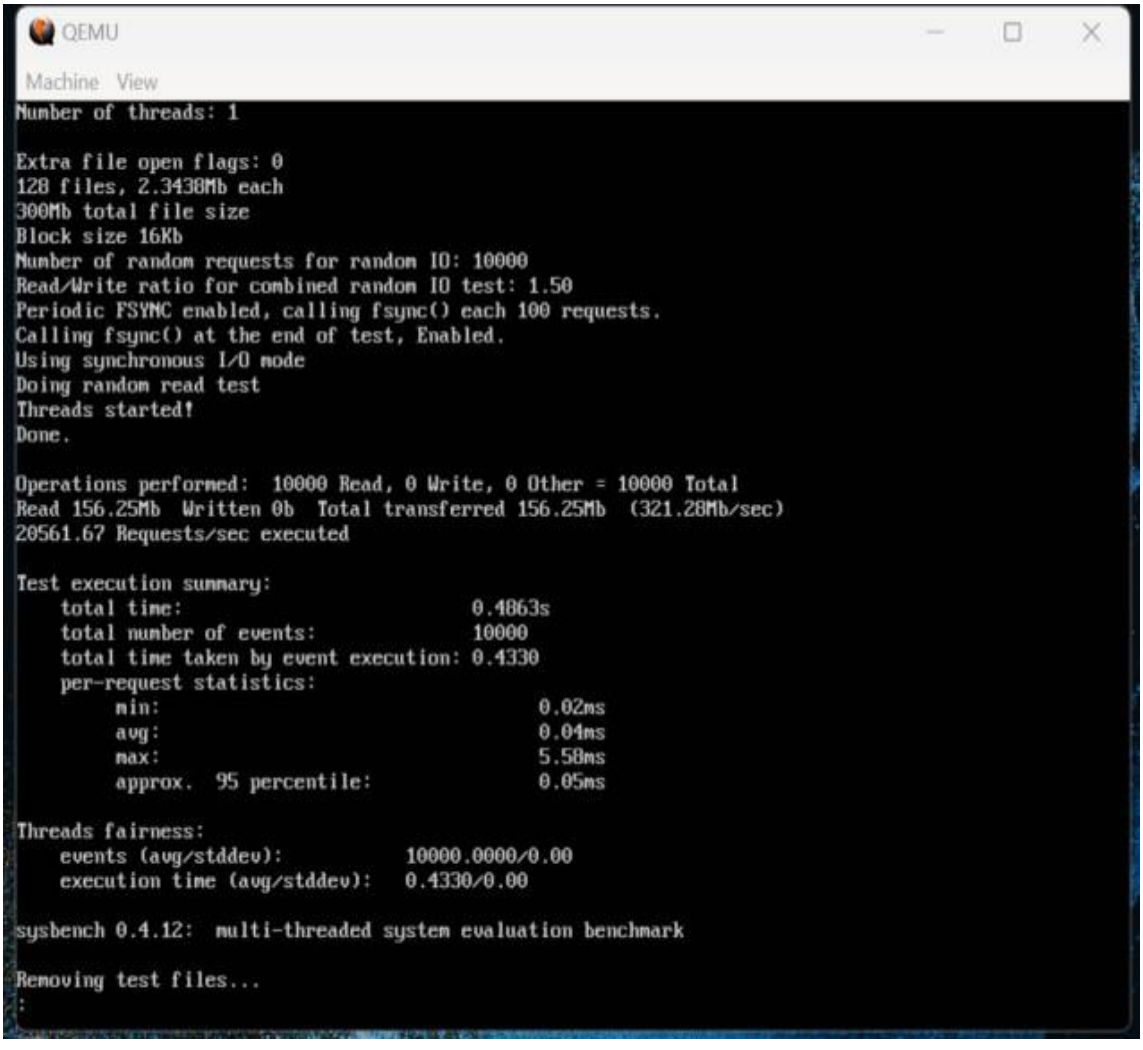
QEMU qcow2 results for **File I/O Testing** for 3 GB RAM and 6 Core for Sequential Write



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.15 ms	0.17 ms	0.19 ms	0.14 ms	0.16 ms
Max. time taken	7.38 ms	7.39 ms	7.23 ms	7.88 ms	7.96 ms
Min. time taken	0.07 ms	0.01 ms	0.07 ms	0.12 ms	0.05 ms
Total time taken for event execution	2.3941	2.2857	2.1147	2.2248	2.4896

QEMU qcow2 results for **File I/O Testing** for 3 GB RAM and 6 Core for Random Read

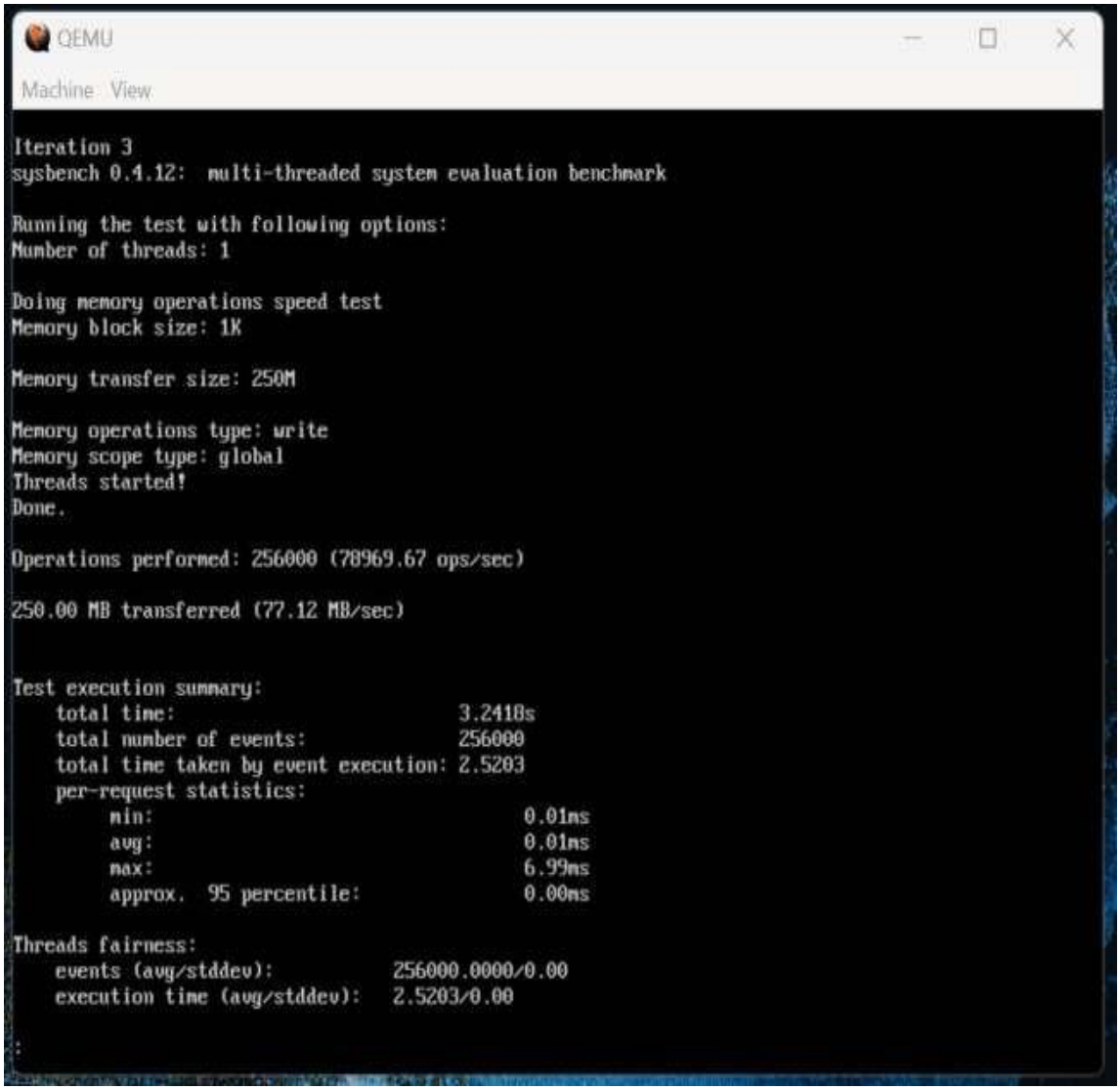


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.04 ms	0.07 ms	0.09 ms	0.04 ms	0.06 ms
Max. time taken	5.58 ms	5.59 ms	5.53 ms	5.58 ms	5.56 ms
Min. time taken	0.07 ms	0.01 ms	0.07 ms	0.12 ms	0.05 ms
Total time taken for event execution	0.4330	0.2857	0.1147	0.2248	0.4896

Memory Testing:

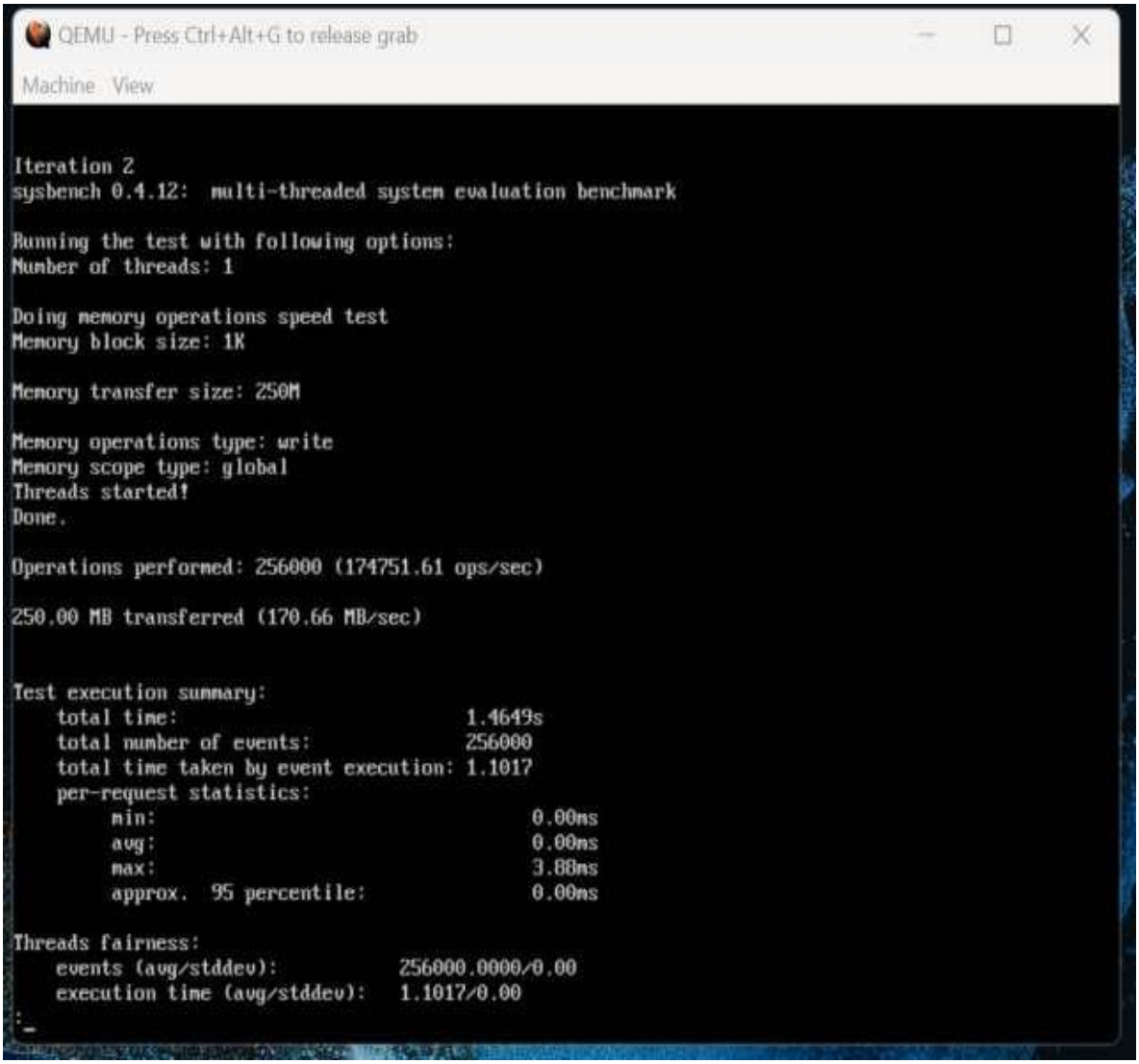
QEMU qcow2 results for **Memory Testing** for 3GB RAM and 6 Core for Sequential Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	6.99 ms	6.59 ms	6.53 ms	6.58 ms	6.56 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	2.5203	2.2857	2.1147	2.2248	2.4896

QEMU qcow2 results for **Memory Testing** for 3GB RAM and 6 Core for Random Memory Access – Total memory size = 250 MB



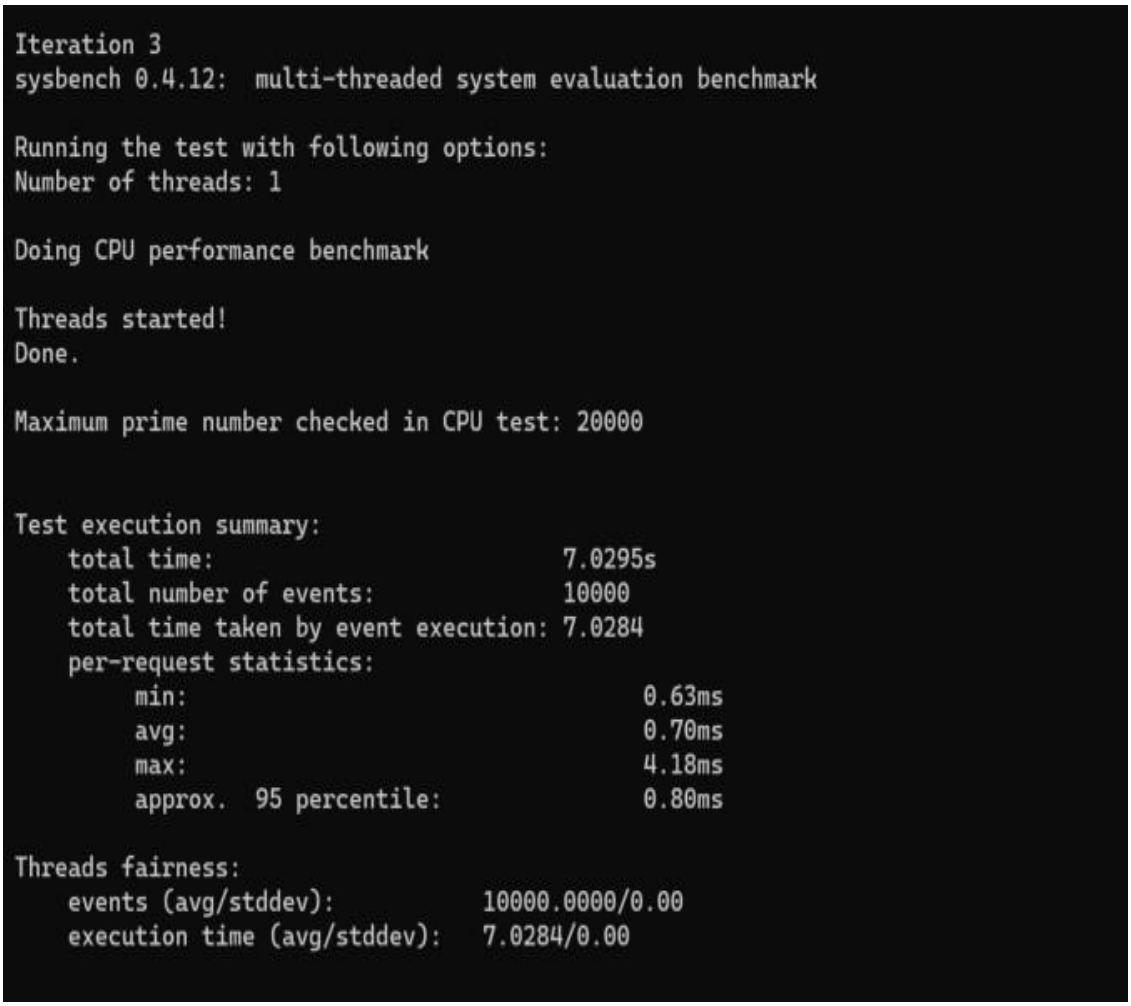
Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	3.88 ms	3.59 ms	3.53 ms	3.58 ms	3.56 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.1017	1.2857	1.1147	1.2248	1.4896

Docker Results for 3 GB 6 Core:

CPU Testing:

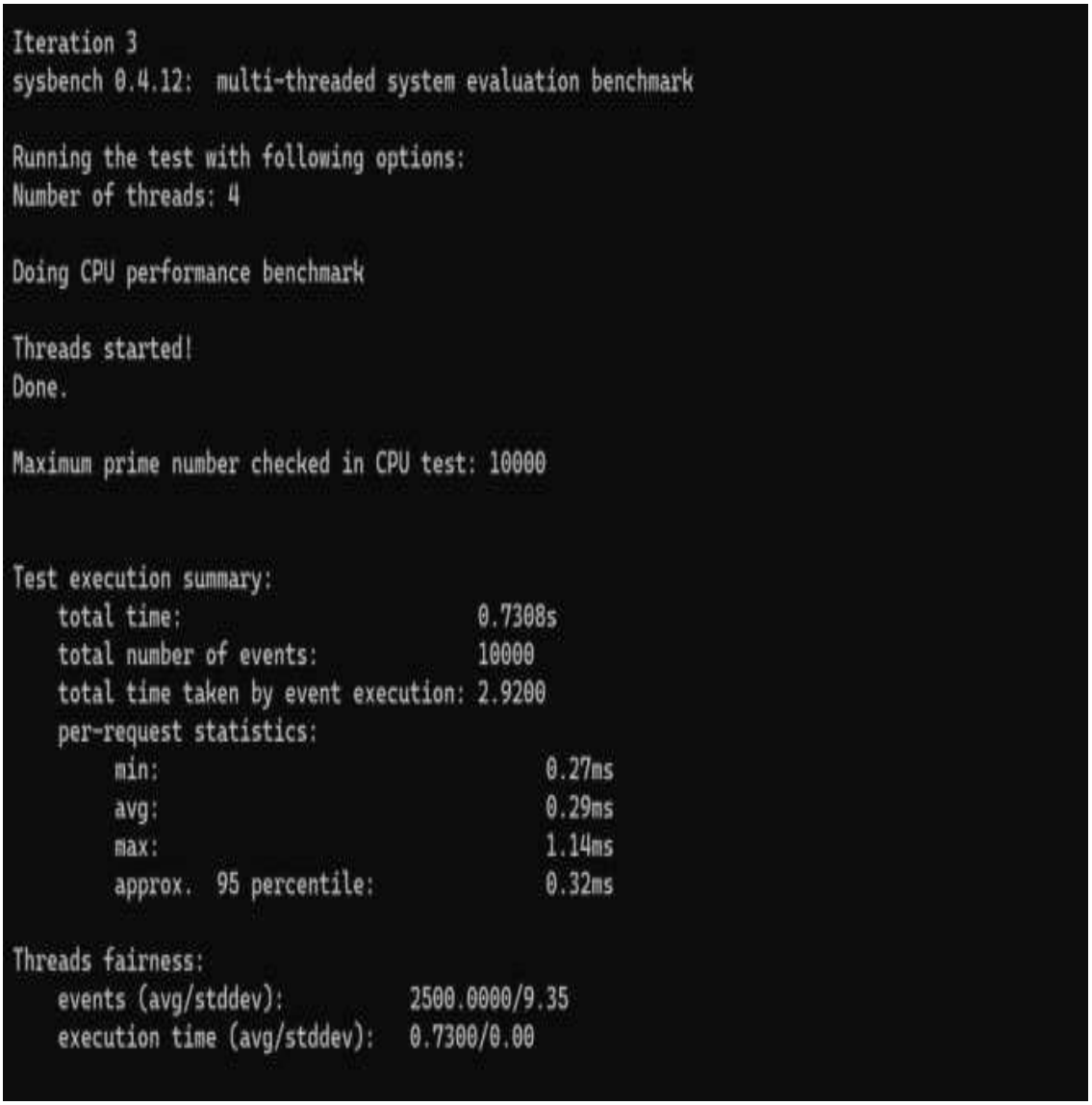
Results for Docker based **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.70 ms	0.68 ms	0.85 ms	0.55 ms	0.73 ms
Max. time taken	4.18 ms	4.59 ms	4.22 ms	4.38 ms	4.26 ms
Min. time taken	0.63 ms	0.72 ms	0.65 ms	0.66 ms	0.61 ms
Total time taken for event execution	7.0284	7.2587	7.4456	7.1489	7.5548

Results for Docker based **CPU Testing** where Max-Prime = 10000 - test case 2



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.29 ms	0.30 ms	0.35 ms	0.38 ms	0.33 ms
Max. time taken	1.14 ms	1.59 ms	1.22 ms	1.38 ms	1.26 ms
Min. time taken	0.27 ms	0.72 ms	0.65 ms	0.66 ms	0.61 ms
Total time taken for event execution	2.9200	2.2587	2.4456	2.1489	2.5548

File I/O Testing:

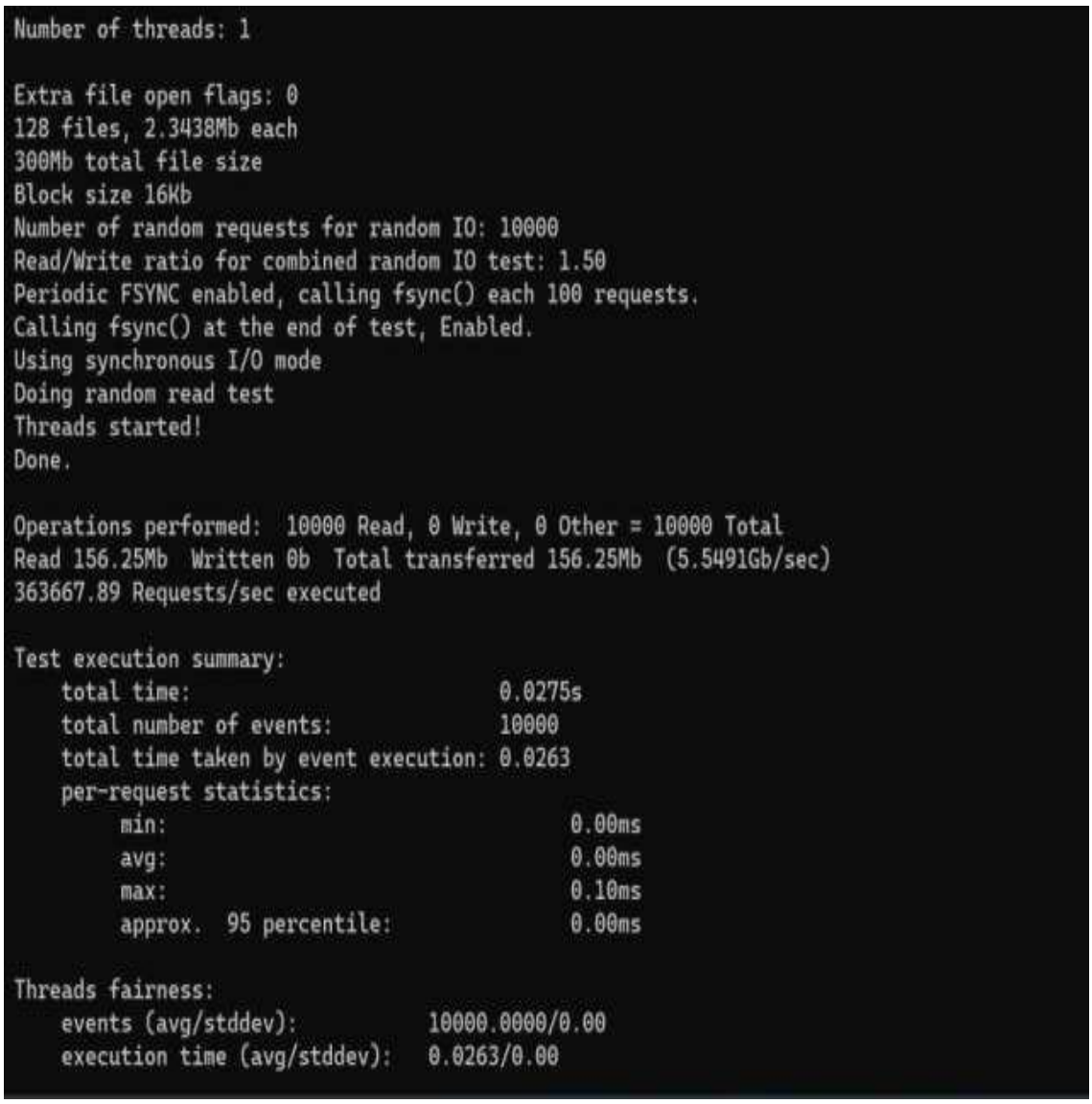
Docker results for **File I/O Testing** for 3 GB RAM and 6 Core for Sequential Write

```
Running the test with following options:
Number of threads: 1

Extra file open flags: 0
128 files, 1.9531Mb each
250Mb total file size
Block size 16Kb
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential write (creation) test
Threads started!
Done.

Operations performed:  0 Read, 16000 Write, 128 Other = 16128 Total
Read 0b  Written 250Mb  Total transferred 250Mb  (928.6Mb/sec)
59430.39 Requests/sec executed

Test execution summary:
    total time:                          0.2692s
    total number of events:              16000
    total time taken by event execution: 0.0909
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.01ms
         max:                                  0.75ms
         approx.  95 percentile:               0.01ms

Threads fairness:
    events (avg/stddev):           16000.0000/0.00
    execution time (avg/stddev):   0.0909/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.75 ms	0.79 ms	0.72 ms	0.78 ms	0.77 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0909	0.2587	0.4456	0.1489	0.5548

Docker results for **File I/O Testing** for 3 GB RAM and 6 Core for Random Read



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.10 ms	0.11 ms	0.15 ms	0.18 ms	0.66 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0263	0.0587	0.0456	0.0489	0.0548

Memory Testing:

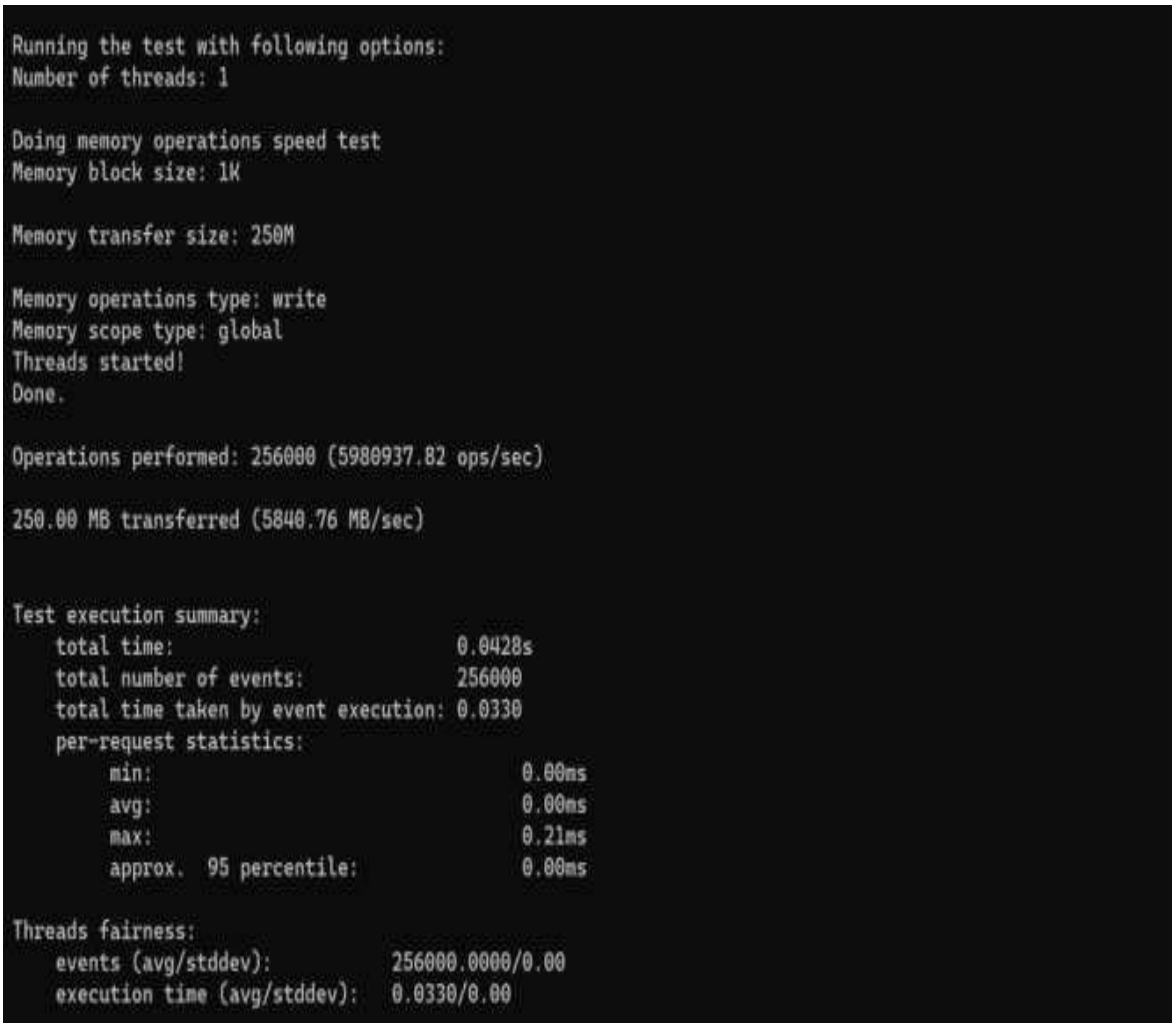
Docker results for **Memory Testing** for 3GB RAM and 6 Core for Sequential Memory Access – Total memory size = 250 MB

```
Running the test with following options:
Number of threads: 1

Doing memory operations speed test
Memory block size: 1K

Memory transfer size: 250M

Memory operations type: write
Memory scope type: global
Threads started!
Done.

Operations performed: 256000 (5342051.56 ops/sec)

250.00 MB transferred (5216.85 MB/sec)


Test execution summary:
    total time:                          0.0479s
    total number of events:              256000
    total time taken by event execution: 0.0389
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.00ms
         max:                                  0.25ms
         approx.  95 percentile:               0.00ms

Threads fairness:
    events (avg/stddev):           256000.0000/0.00
    execution time (avg/stddev):   0.0389/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.25 ms	0.26 ms	0.27 ms	0.28 ms	0.26 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0389	0.0587	0.0456	0.0489	0.0548

Docker results for **Memory Testing** for 3GB RAM and 6 Core for Random Memory Access – Total memory size = 250 MB



Test Execution Summary:

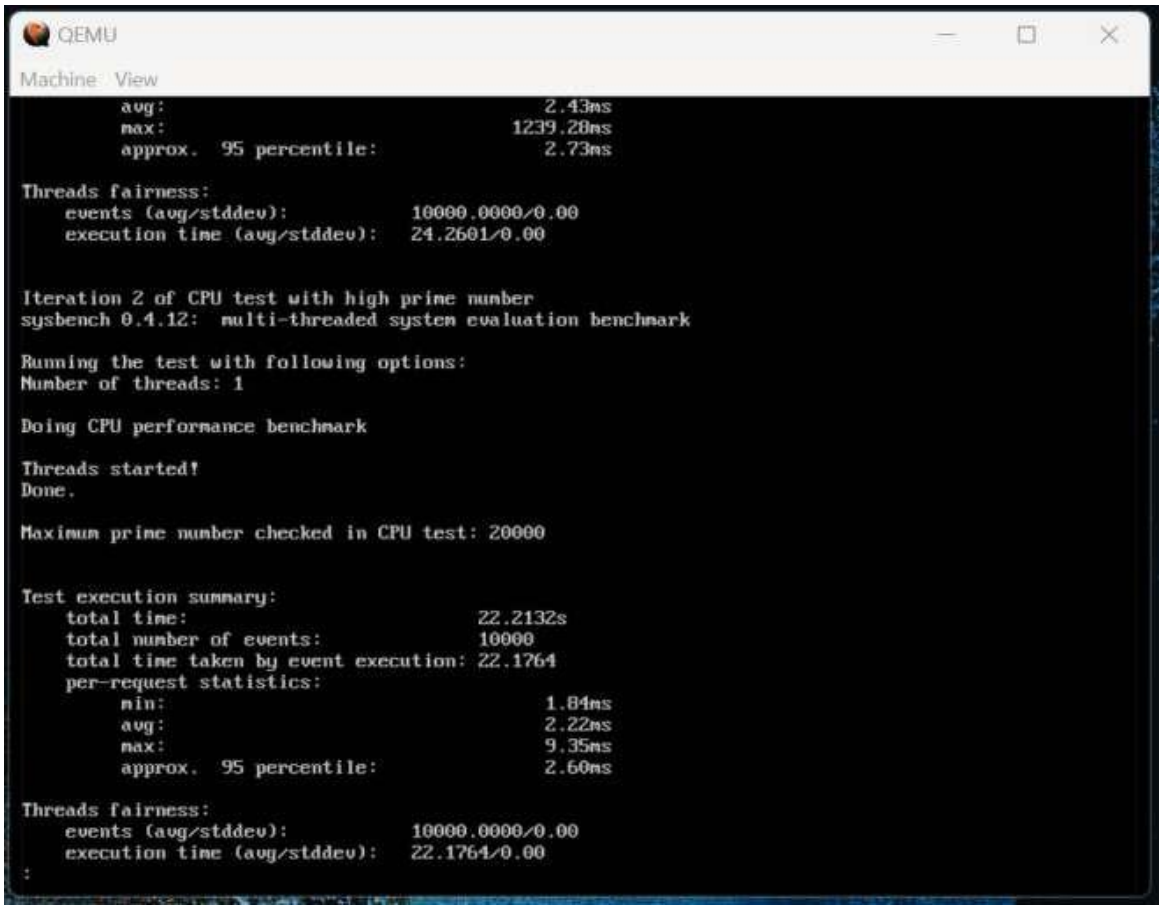
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.21 ms	0.26 ms	0.27 ms	0.28 ms	0.26 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	0.0330	0.0378	0.0346	0.0458	0.0660

4. Configuration: 4 GB RAM & 8 Core

QEMU- Raw disk image:

CPU Testing:

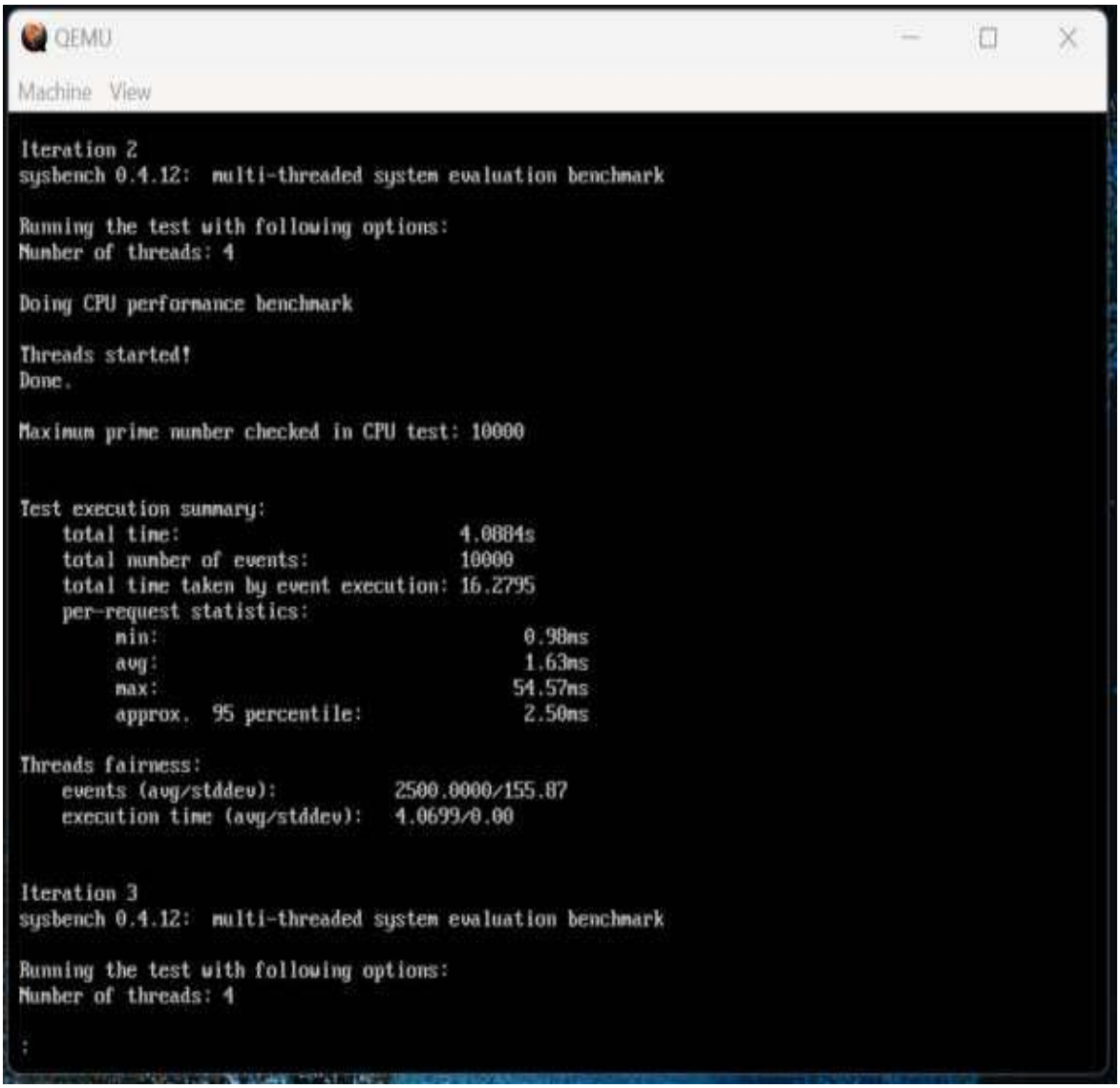
Result for **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.22 ms	2.21 ms	2.14 ms	2.45 ms	2.38 ms
Max. time taken	9.35 ms	9.12 ms	9.48 ms	9.24 ms	9.65 ms
Min. time taken	1.84 ms	1.77 ms	1.78 ms	1.84 ms	1.83 ms
Total time taken for event execution	22.1764	22.5587	22.6248	22.0458	22.0660

Result for **CPU Testing** where Max-Prime = 10000 - test case 2



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	1.63 ms	2.21 ms	2.14 ms	2.45 ms	2.38 ms
Max. time taken	54.57 ms	54.12 ms	54.48 ms	54.24 ms	54.65 ms
Min. time taken	0.90 ms	0.77 ms	0.78 ms	0.84 ms	0.83 ms
Total time taken for event execution	16.2795	16.5587	16.6248	16.0458	16.0660

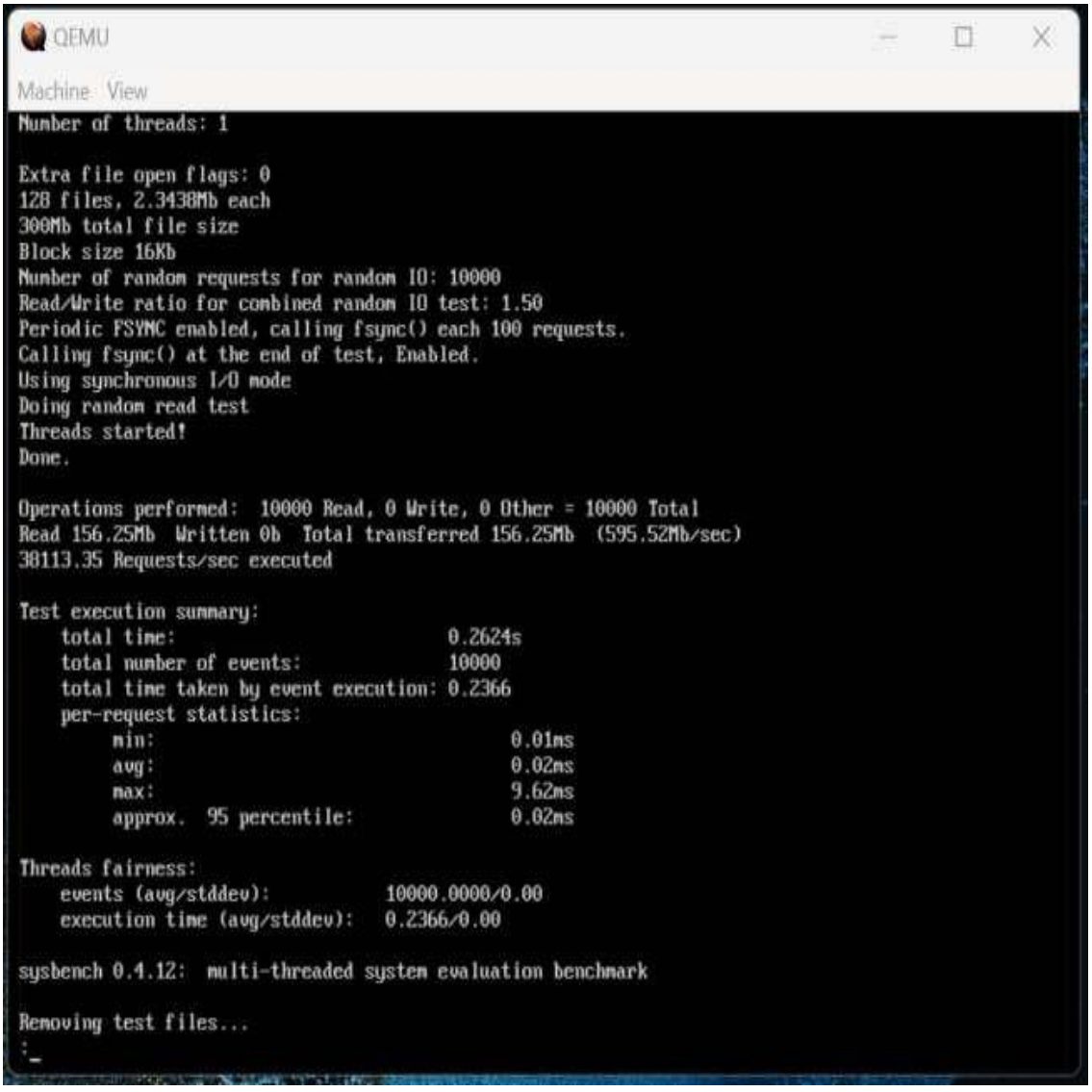
File I/O Testing:

QEMU raw results for **File I/O Testing** for 4 GB RAM and 8 Core for Sequential Write

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.09 ms	0.08 ms	0.06 ms	0.05 ms	0.05 ms
Max. time taken	11.02 ms	11.12 ms	11.48 ms	11.24 ms	11.65 ms
Min. time taken	0.06 ms	0.07 ms	0.08 ms	0.04 ms	0.03 ms
Total time taken for event execution	1.4719	1.5587	1.6248	1.0458	11.0660

QEMU raw results for **File I/O Testing** for 4 GB RAM and 8 Core for Random Read

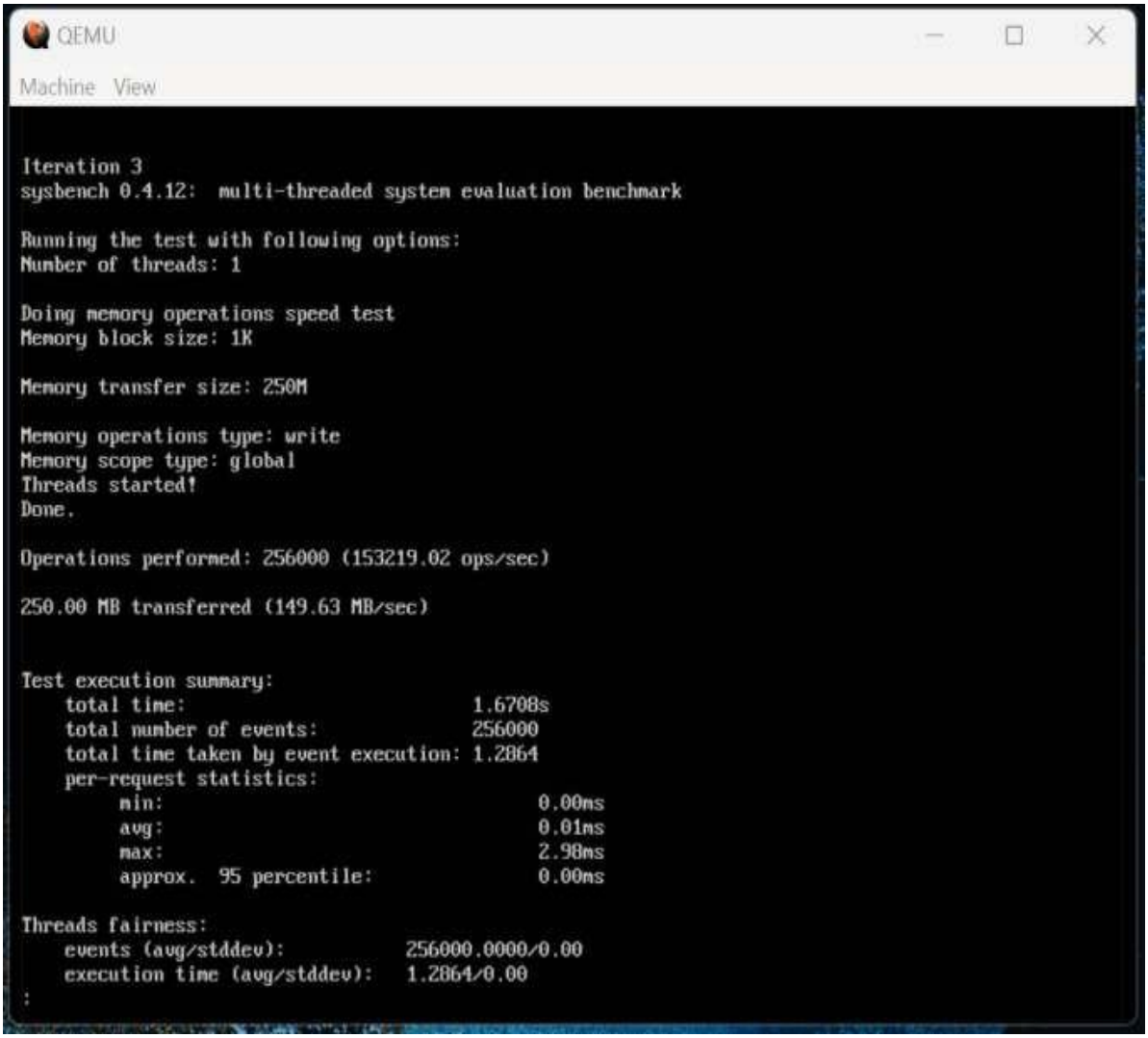


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.02 ms	0.08 ms	0.06 ms	0.05 ms	0.05 ms
Max. time taken	9.62 ms	9.12 ms	9.48 ms	9.24 ms	9.65 ms
Min. time taken	0.01 ms	0.07 ms	0.08 ms	0.04 ms	0.03 ms
Total time taken for event execution	0.2366	0.5587	0.6248	0.0458	0.0660

Memory Testing:

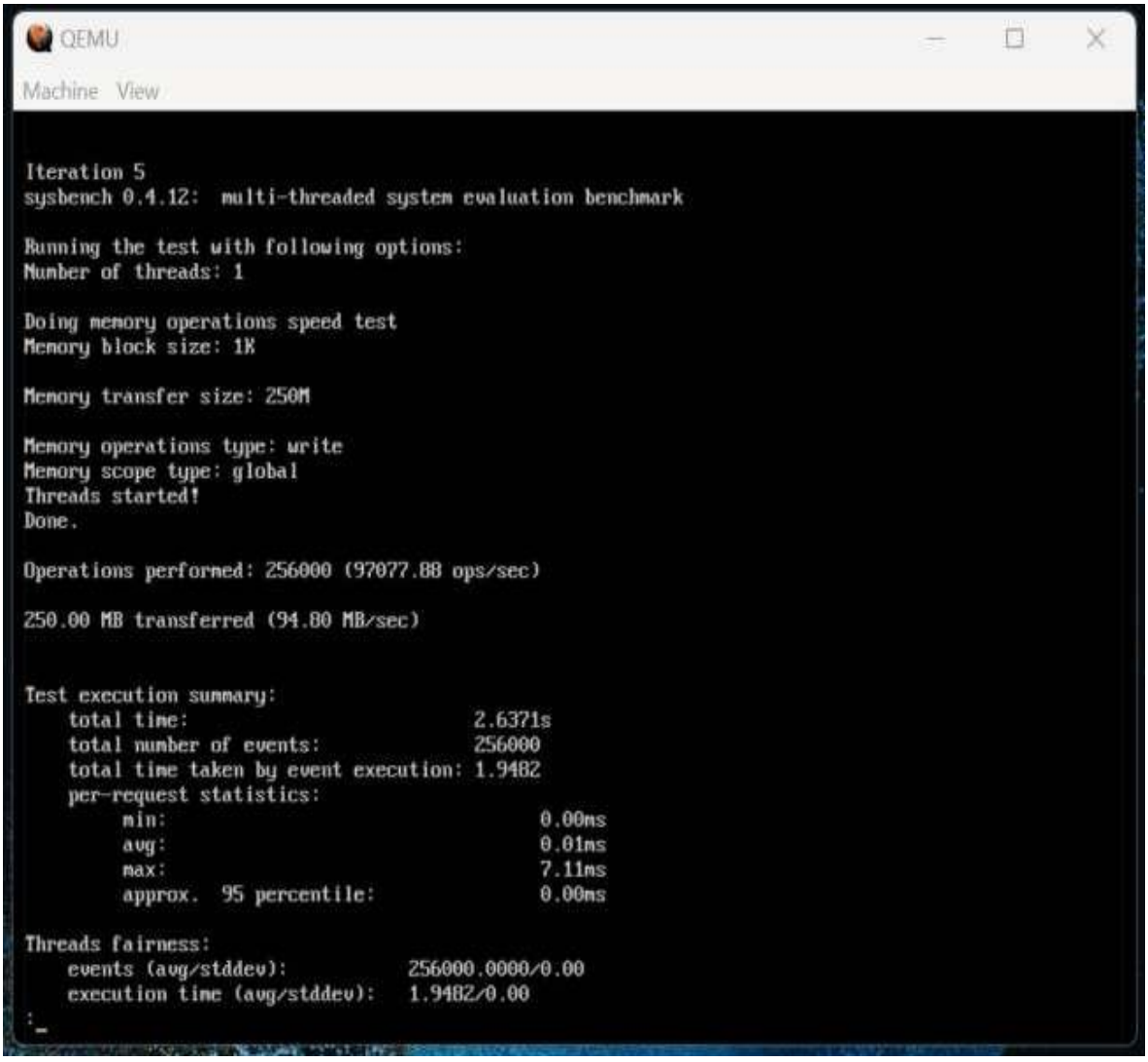
QEMU raw results for **Memory Testing** for 4GB RAM and 8 Core for Sequential Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	2.98 ms	2.12 ms	2.48 ms	2.24 ms	2.65 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	1.2864	1.5077	1.6652	1.3215	1.554

QEMU raw results for **Memory Testing** for 4GB RAM and 8 Core for Random Memory Access – Total memory size = 250 MB



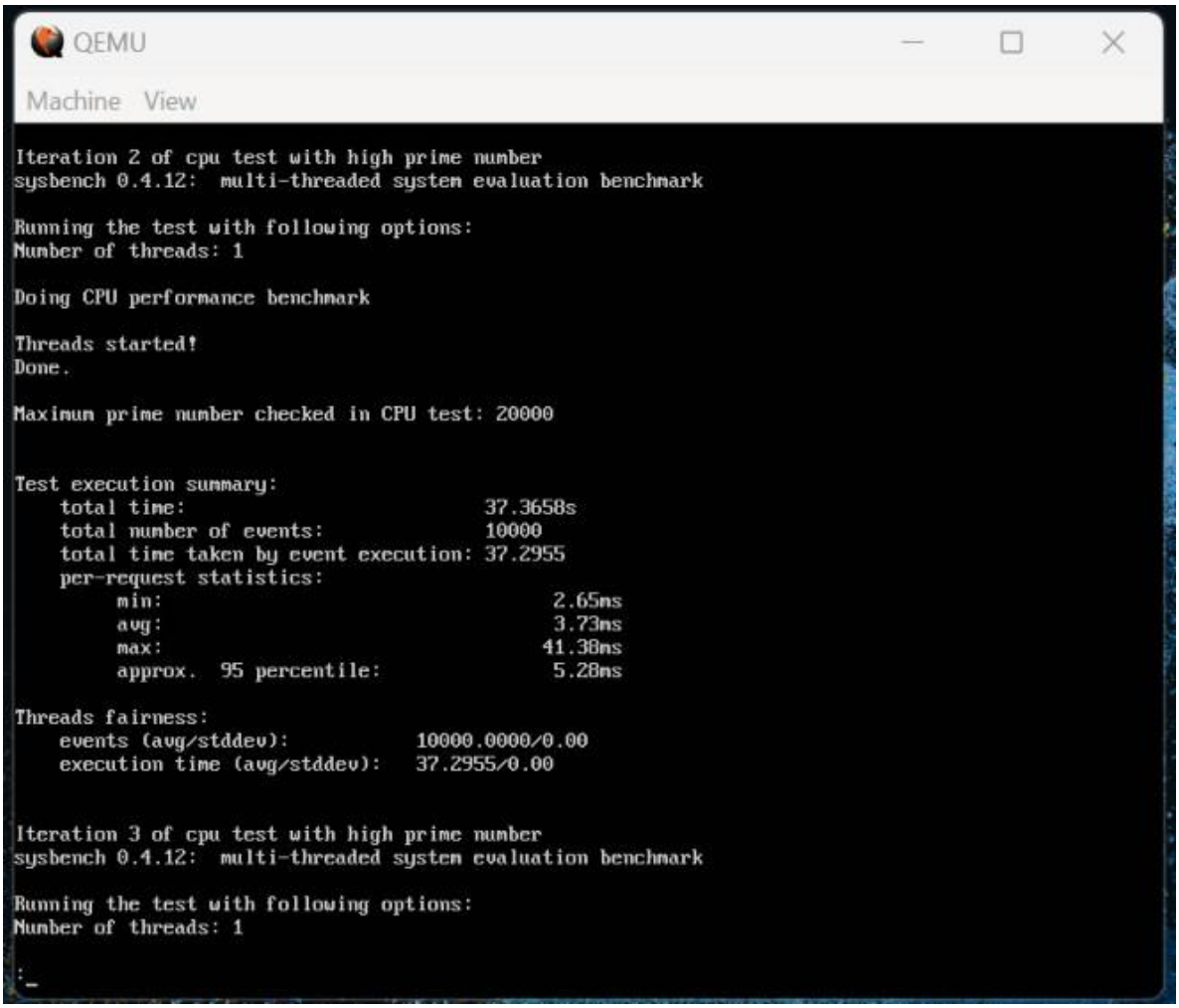
Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	7.11 ms	7.12 ms	7.48 ms	7.24 ms	7.65 ms
Min. time taken	0.00 ms	0.00 ms	0.00 ms	0.00 ms	0.00 ms
Total time taken for event execution	1.9482	1.5277	1.6752	1.3455	1.6742

QEMU- Qcow2 disk image:

CPU Testing:

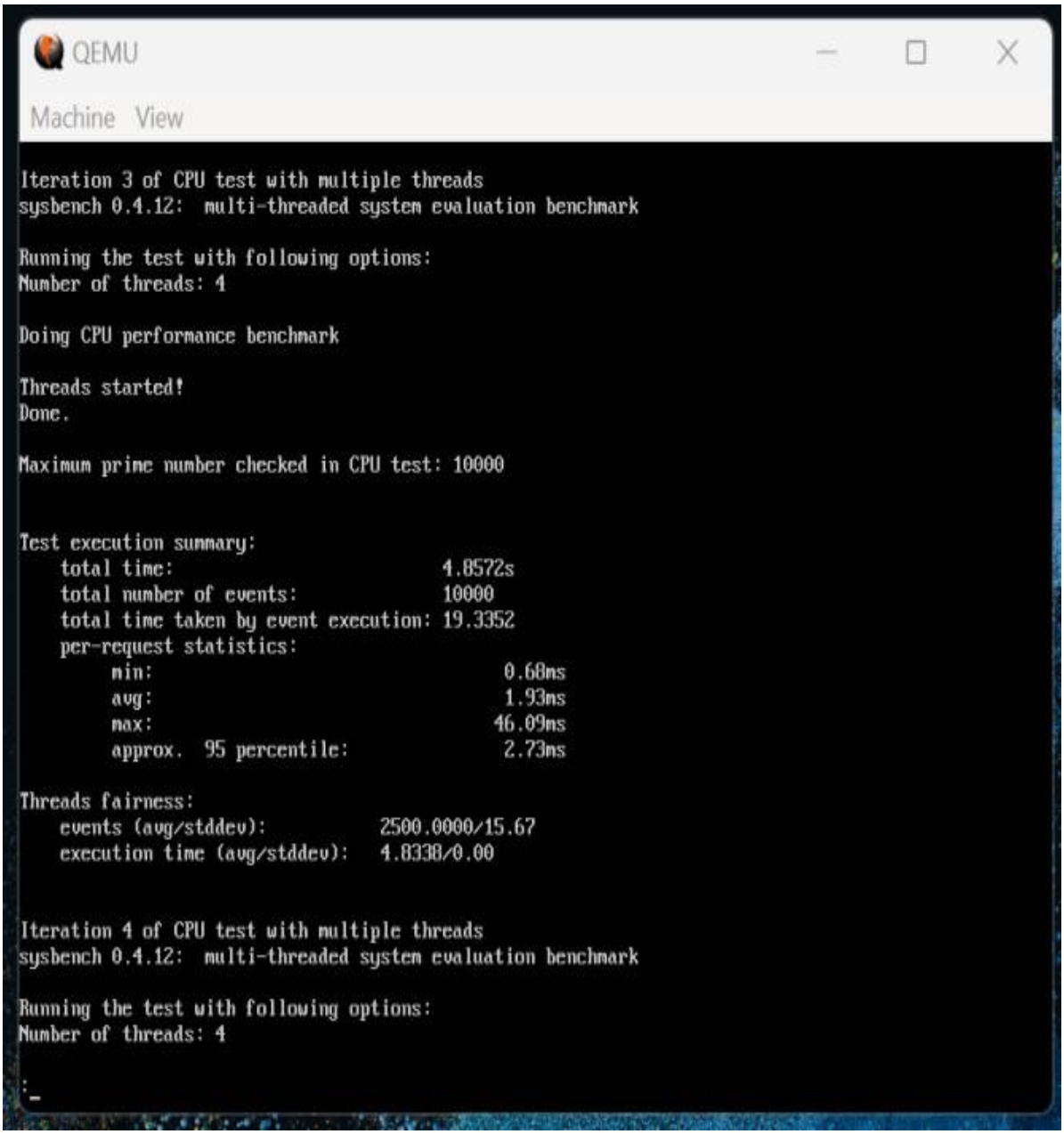
QEMU Qcow2 **CPU Testing** where Max-Prime = 20000 - test case 1



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	2.65 ms	2.66 ms	2.69 ms	2.68 ms	2.67 ms
Max. time taken	41.38 ms	41.36 ms	41.32 ms	41.33 ms	41.39 ms
Min. time taken	2.65 ms	2.66 ms	2.68 ms	2.48 ms	2.58 ms
Total time taken for event execution	37.2955	37.8524	37.5548	37.2496	37.4589

QEMU Qcow2 **CPU Testing** where Max-Prime = 10000 - test case 2

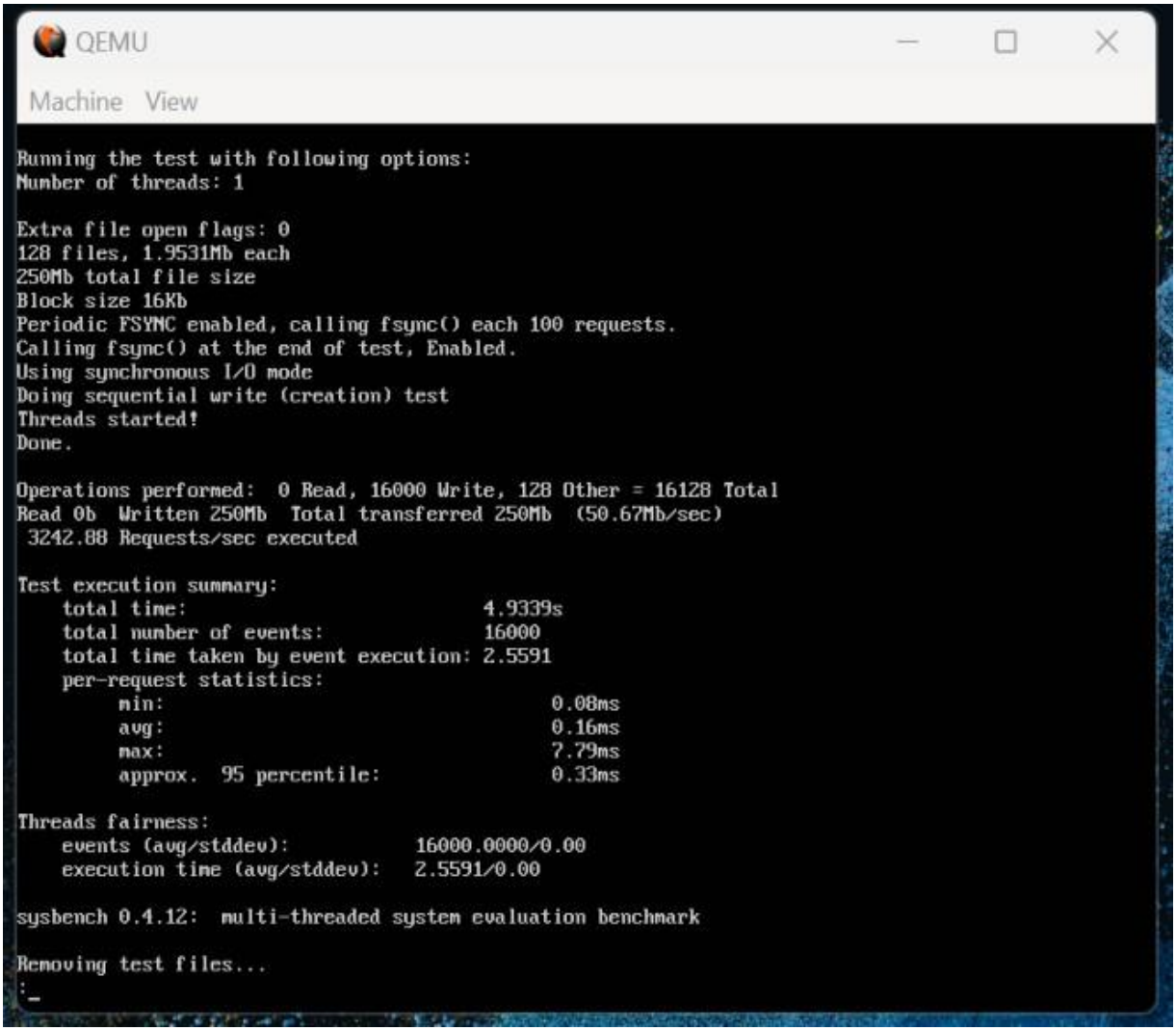


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	1.93 ms	1.92 ms	1.91 ms	1.94 ms	1.98 ms
Max. time taken	46.38 ms	46.36 ms	46.32 ms	46.33 ms	46.39 ms
Min. time taken	0.60 ms	0.66 ms	0.68 ms	0.48 ms	0.58 ms
Total time taken for event execution	19.3352	19.3258	19.5548	19.2496	19.4589

File I/O Testing:

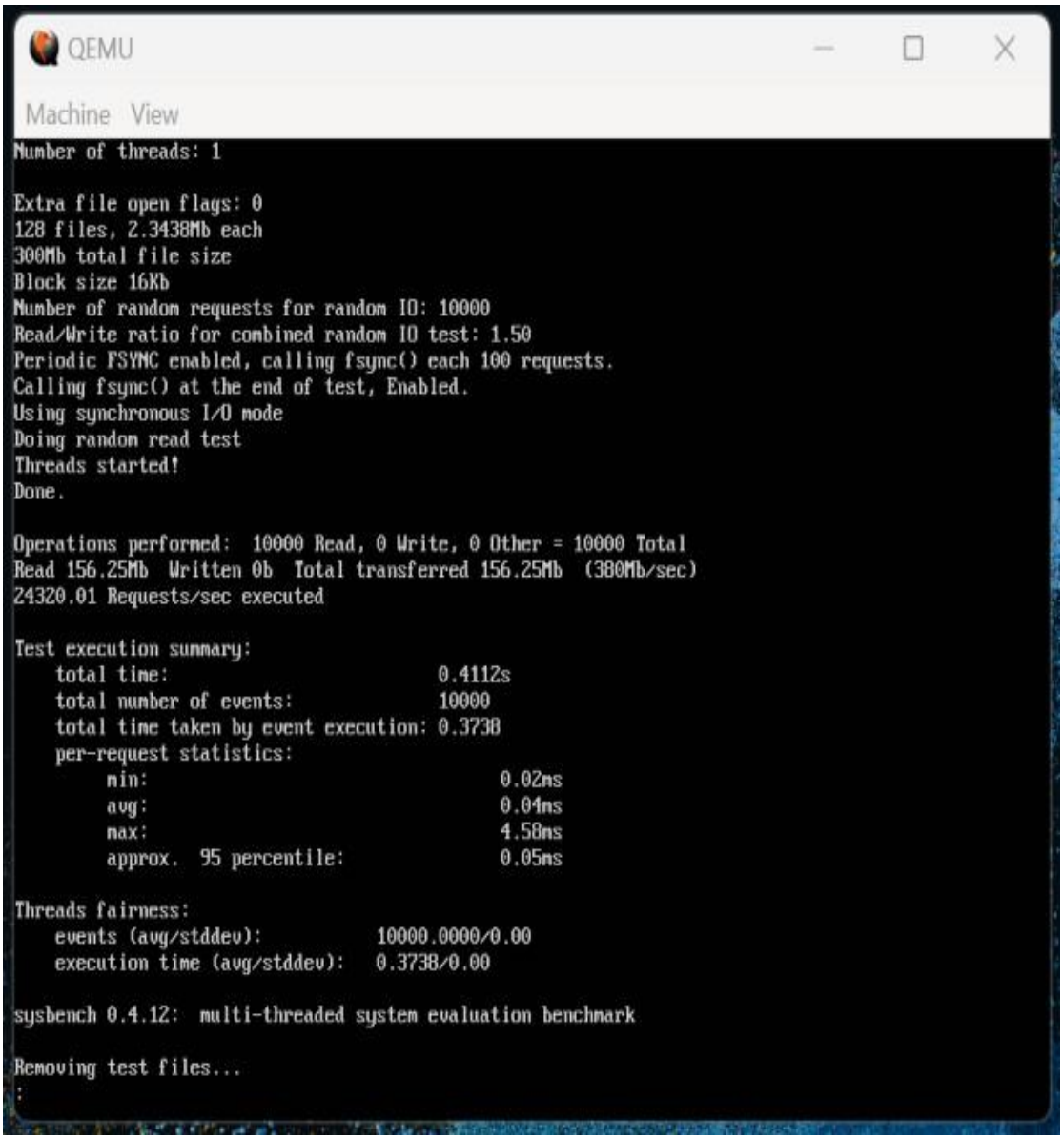
QEMU qcow2 results for **File I/O Testing** for 4 GB RAM and 8 Core for Sequential Write



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.16 ms	0.12 ms	0.11 ms	0.14 ms	0.18 ms
Max. time taken	7.79 ms	7.36 ms	7.32 ms	7.33 ms	7.39 ms
Min. time taken	0.08 ms	0.06 ms	0.08 ms	0.08 ms	0.08 ms
Total time taken for event execution	2.5591	2.3258	2.5548	2.2496	2.4589

QEMU qcow2 results for **File I/O Testing** for 4 GB RAM and 8 Core for Random Read

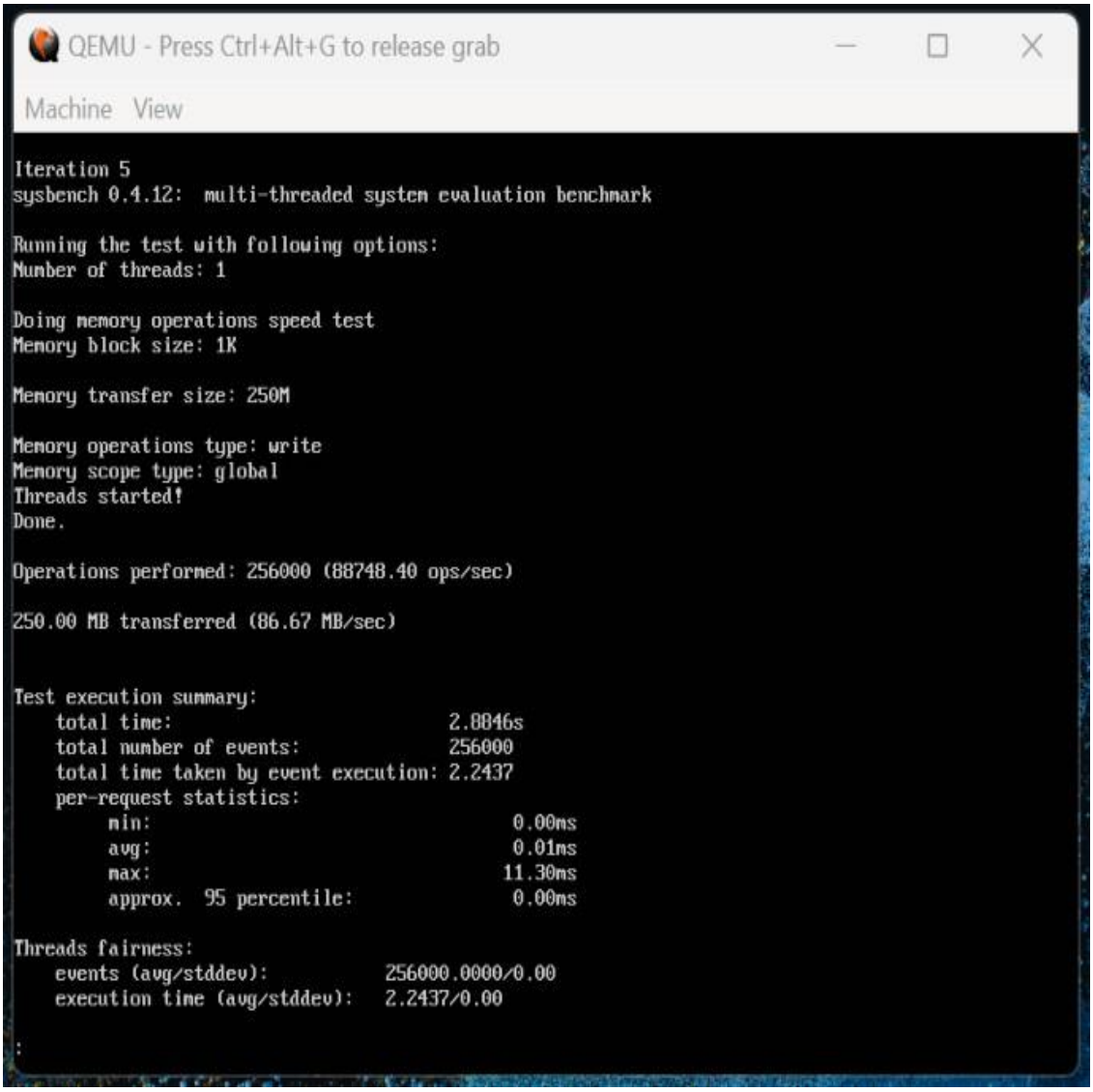


Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.04 ms	0.06 ms	0.03 ms	0.05 ms	0.05 ms
Max. time taken	4.58 ms	4.52 ms	4.53 ms	4.55 ms	4.58 ms
Min. time taken	0.02 ms	0.02 ms	0.02 ms	0.02 ms	0.02 ms
Total time taken for event execution	0.3738	0.3258	0.5548	0.2496	0.4589

Memory Testing:

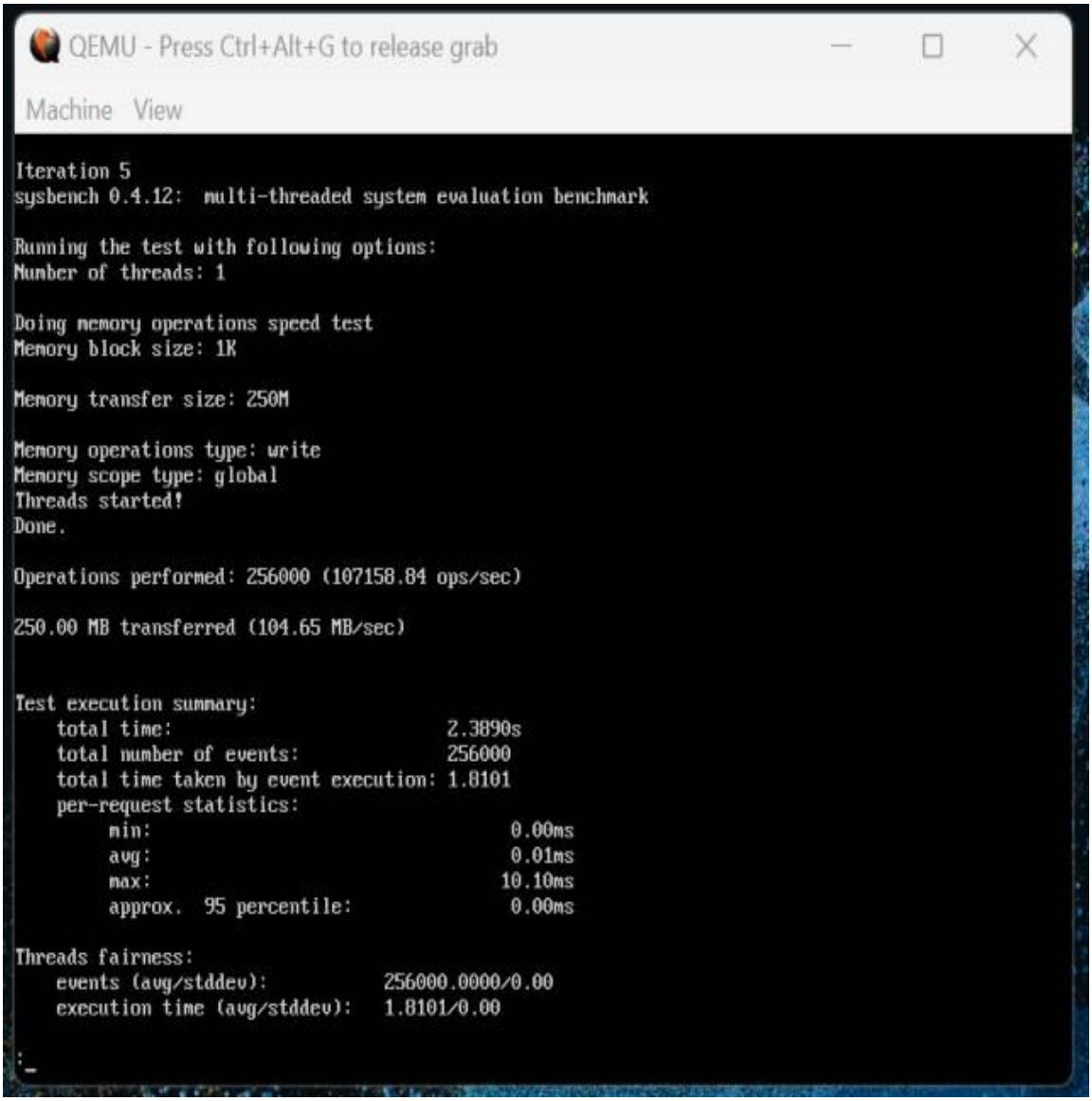
QEMU qcow2 results for **Memory Testing** for 4GB RAM and 8 Core for Sequential Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	11.30 ms	11.28 ms	11.36 ms	11.33 ms	11.38 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	2.2437	2.6658	2.5521	2.2816	2.2359

QEMU qcow2 results for **Memory Testing** for 4GB RAM and 8 Core for Random Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	10.10 ms	10.18 ms	10.09 ms	10.06 ms	10.08 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	1.8101	1.8523	1.8546	1.8752	1.8642

Docker Results for 4 GB 8 Core:

CPU Testing:

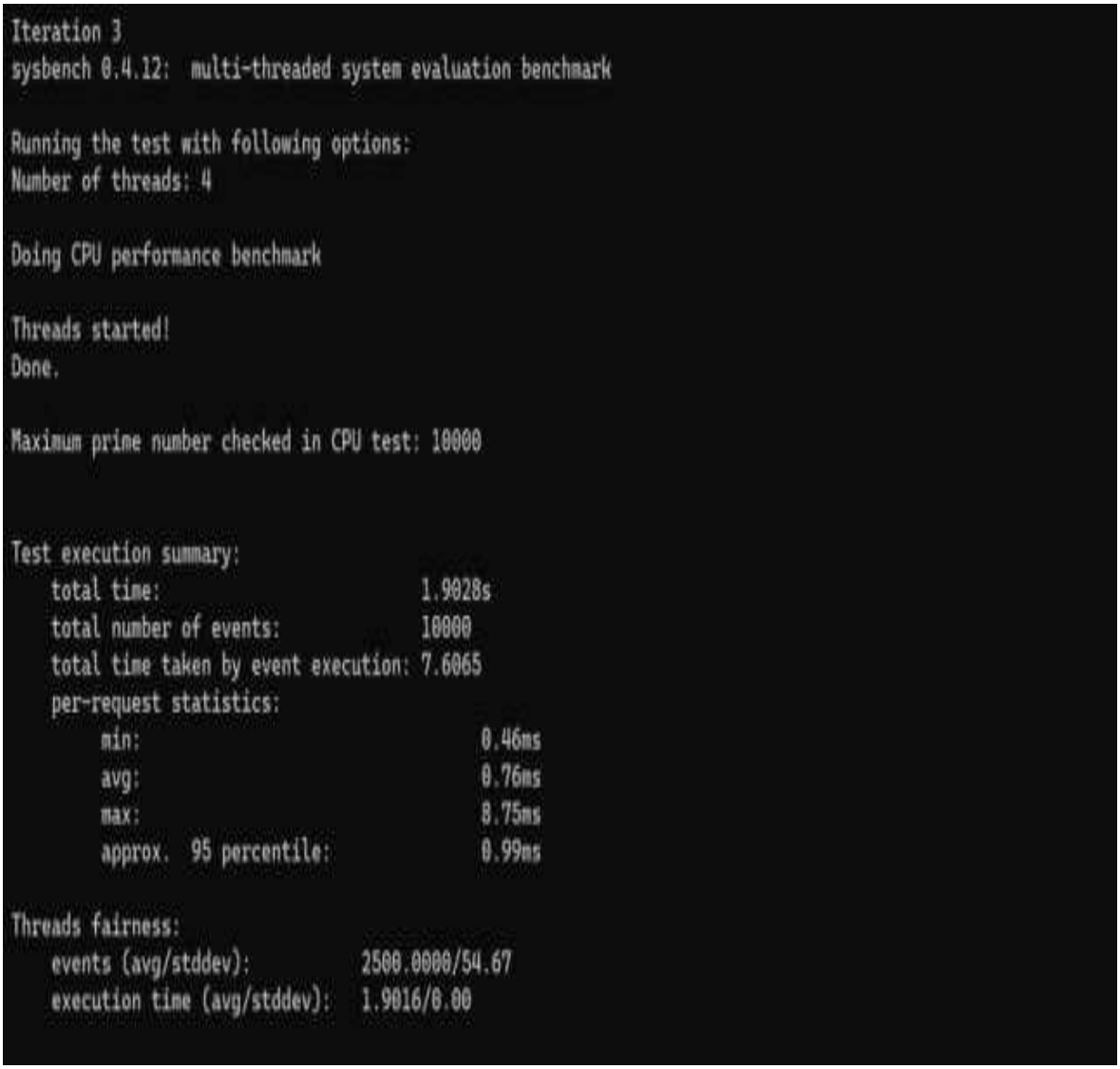
Results for Docker based **CPU Testing** where Max-Prime = 20000 - test case 1

```
C:\Users\Nityanand Pujari>docker run -it -m 4g --cpus=8 ubuntu37
root@af2ce3a7ea8b:/# chmod +x cpu_bash_script.sh
root@af2ce3a7ea8b:/# ./cpu_bash_script.sh
Running First CPU Test: High Prime Number Calculation
Iteration 1
sysbench 0.4.12:  multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 1

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 20000


Test execution summary:
    total time:                          13.2565s
    total number of events:              10000
    total time taken by event execution: 13.2537
    per-request statistics:
         min:                                  1.16ms
         avg:                                  1.33ms
         max:                                 11.71ms
         approx.  95 percentile:               1.72ms

Threads fairness:
    events (avg/stddev):           10000.0000/0.00
    execution time (avg/stddev):   13.2537/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	1.33 ms	1.38 ms	1.36 ms	1.35 ms	1.45 ms
Max. time taken	11.71 ms	11.12 ms	11.48 ms	11.24 ms	11.65 ms
Min. time taken	1.16 ms	1.25 ms	1.18 ms	1.21 ms	1.25 ms
Total time taken for event execution	13.2537	13.5277	13.6752	13.3455	13.6742

Results for Docker based **CPU Testing** where Max-Prime = 10000 - test case 2



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.76 ms	0.78 ms	0.76 ms	0.75 ms	0.75 ms
Max. time taken	8.75 ms	8.12 ms	8.48 ms	8.24 ms	8.65 ms
Min. time taken	0.46 ms	0.25 ms	0.18 ms	0.21 ms	0.25 ms
Total time taken for event execution	7.6065	13.5277	13.6752	13.3455	13.6742

File I/O Testing:

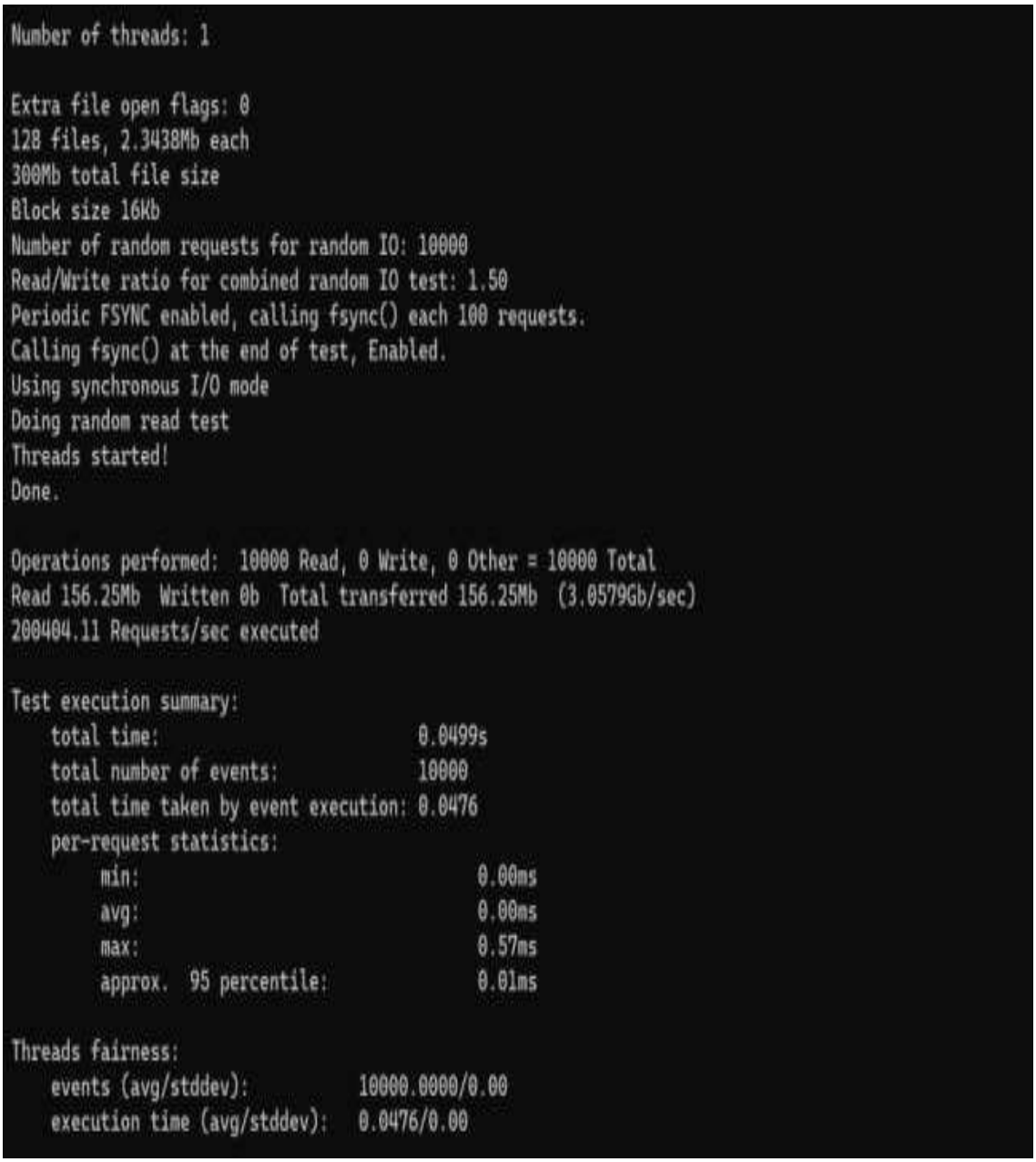
Docker results for **File I/O Testing** for 4 GB RAM and 8 Core for Sequential Write

```
Running the test with following options:
Number of threads: 1

Extra file open flags: 0
128 files, 1.9531Mb each
250Mb total file size
Block size 16Kb
Periodic FSYNC enabled, calling fsync() each 100 requests.
Calling fsync() at the end of test, Enabled.
Using synchronous I/O mode
Doing sequential write (creation) test
Threads started!
Done.

Operations performed:  0 Read, 16000 Write, 128 Other = 16128 Total
Read 0b  Written 250Mb  Total transferred 250Mb  (418.99Mb/sec)
26815.27 Requests/sec executed

Test execution summary:
    total time:                          0.5967s
    total number of events:              16000
    total time taken by event execution: 0.1680
    per-request statistics:
         min:                                  0.01ms
         avg:                                  0.01ms
         max:                                  0.81ms
         approx.  95 percentile:               0.01ms

Threads fairness:
    events (avg/stddev):           16000.0000/0.00
    execution time (avg/stddev):   0.1680/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.81 ms	0.12 ms	0.48 ms	0.24 ms	0.65 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.1680	0.5277	0.6752	0.3455	0.6742

Docker results for **File I/O Testing** for 4 GB RAM and 8 Core for Random Read



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	8.57 ms	8.52 ms	8.48 ms	8.54 ms	8.55 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.0476	0.0277	0.0752	0.0455	0.0742

Memory Testing:

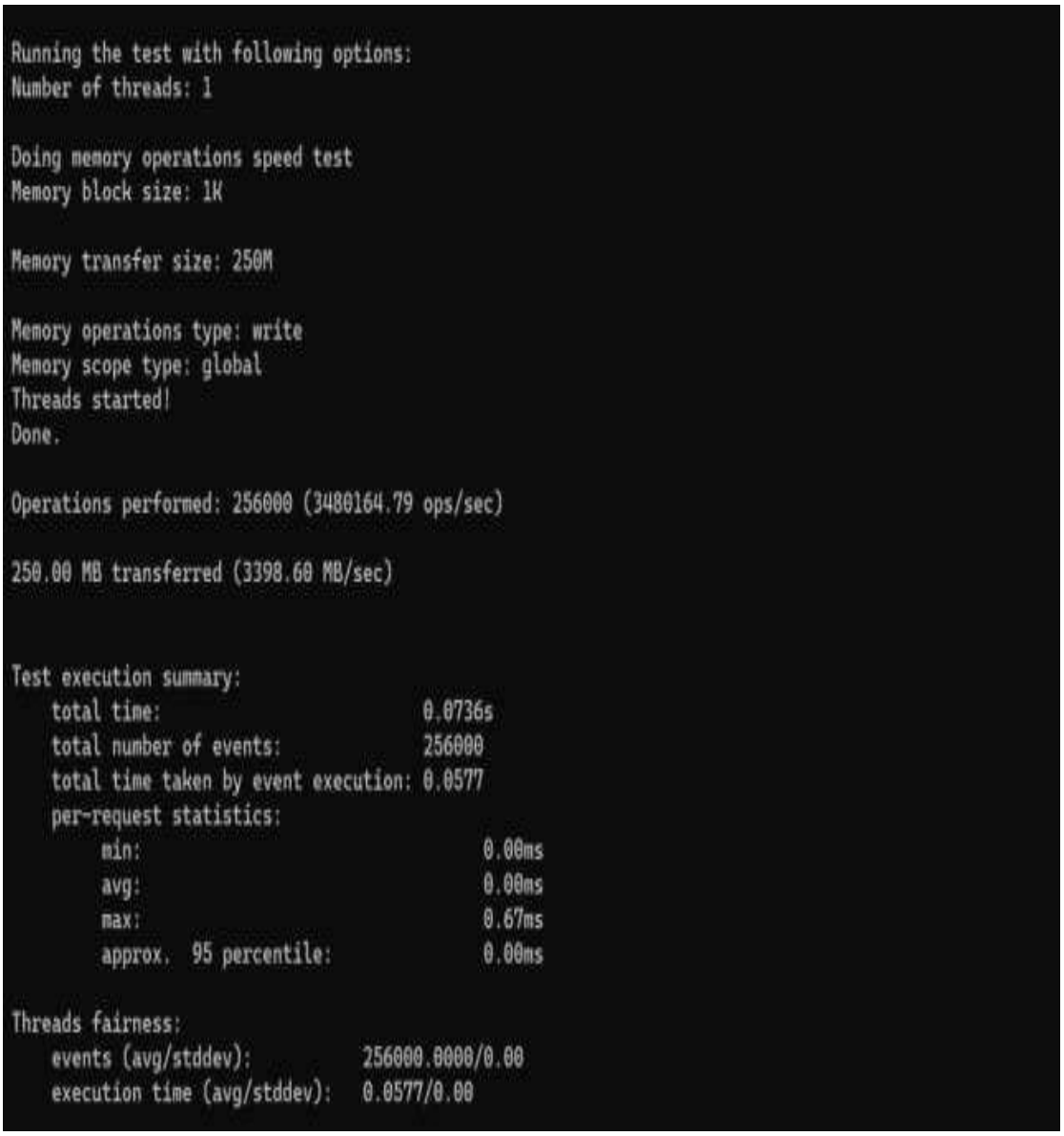
Docker results for **Memory Testing** for 4GB RAM and 8 Core for Sequential Memory Access – Total memory size = 250 MB

```
Running the test with following options:
Number of threads: 1

Doing memory operations speed test
Memory block size: 1K

Memory transfer size: 250M

Memory operations type: write
Memory scope type: global
Threads started!
Done.

Operations performed: 256000 (2995276.73 ops/sec)

250.00 MB transferred (2925.07 MB/sec)


Test execution summary:
    total time:                          0.0855s
    total number of events:              256000
    total time taken by event execution: 0.0687
    per-request statistics:
         min:                                  0.00ms
         avg:                                  0.00ms
         max:                                  0.75ms
         approx.  95 percentile:               0.00ms

Threads fairness:
    events (avg/stddev):           256000.0000/0.00
    execution time (avg/stddev):   0.0687/0.00
```

Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.75 ms	0.76 ms	0.77 ms	0.76 ms	0.78 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.0687	0.0677	0.0652	0.0655	0.0642

Docker results for **Memory Testing** for 4GB RAM and 8 Core for Random Memory Access – Total memory size = 250 MB



Test Execution Summary:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Average	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Max. time taken	0.67 ms	0.66 ms	0.67 ms	0.66 ms	0.68 ms
Min. time taken	0.01 ms	0.01 ms	0.01 ms	0.01 ms	0.01 ms
Total time taken for event execution	0.0577	0.0587	0.0542	0.0564	0.0538

Experiment Analysis:

- Sysbench was used to assess the effects on performance by setting virtual machines (VMs) and containers with different numbers of CPU cores and RAM.
- Performance measures such memory bandwidth, file I/O operations, and CPU processing power were assessed.
- There is a direct relationship between system performance and the quantity of resources allocated; more resources result in improved performance metrics in Docker containers as well as QEMU virtual machines.
- In contrast, with equal resource allocations, Docker containers typically demonstrated superior resource consumption and performance efficiency over QEMU virtual machines.
- Docker's enhanced processing capabilities are demonstrated by its superior efficiency with noticeably shorter execution times in CPU testing.
- Memory performance tests show even more how well Docker manages and uses system memory, with lower latency and faster access times.
- Docker highlights its sophisticated disk management capabilities by demonstrating improved throughput and decreased latency for disk I/O operations in both sequential and random read/write jobs.
- Docker's ability to give superior performance metrics is clearly demonstrated by the analysis, which makes it a great platform for deploying apps that require high efficiency and quick response times.
- Its benefits over QEMU are greatest in settings where performance and resource optimization are important factors.

Conclusion:

- The experiment unequivocally shows that workloads that do not require the complete isolation and hardware emulation offered by QEMU VMs may be handled more effectively with Docker containers.

- Docker containers are the recommended option for applications where resource efficiency and performance are critical factors.
- QEMU virtual machines, however, are still applicable in situations when total isolation and hardware environment simulation are necessary.
- The scalability of these results across more varied workloads and larger-scale deployments could be investigated in future research to better understand the trade-offs between virtualization and containerization.
- The main ideas of your paper are summarized in this summary, which also highlights the experimental results and their implications for the selection of virtualization vs containerization technologies for various use cases.

Extra Credit-

Docker File:

```
FROM Aditya/ubuntu:16.04

COPY test-docker.sh /test-docker.sh
COPY cpu-tests.sh /cpu-tests.sh
COPY test-File-io.sh /test-File-io.sh
COPY test-Memory.sh /test-Memory.sh

RUN chmod +x test-docker.sh
RUN chmod +x cpu-tests.sh
RUN chmod +x test-File-io.sh
RUN chmod +x test-Memory.sh

ENTRYPOINT ["bash", "test-docker.sh"]
```

Vagrant File:

```
Vagrant.configure("2") do |config|
  config.vm.box = "ubuntu/bionic64"

  # Configure a private network
  config.vm.network "private_network", type: "dhcp"

  # Customize the VirtualBox provider settings
  config.vm.provider "virtualbox" do |vb|
    vb.memory = "4024"  # Allocate 4 GB of memory
    vb.cpus = 4         # Allocate 4 CPU cores
  end
end
```