

# Project-1

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## 1. Configurations of Native system

- 2 vCPU
- 4 GB memory
- 30 GB disk size
- Ubuntu 18.04 LTS

## 2. Tools for Measurement

- iostat to measure the CPU and Disk performance
- Sysbench to measure the performance of Docker

## 3. Task-1

### Docker

#### **Installation-**

- Install the Docker container in repository.
- Steps to enable the container:
  1. `sudo docker run csminpp/ubuntu-sysbench`
  2. `sudo docker run -itd csminpp/ubuntu-sysbench`
  3. `sudo docker attach <first three chars from output of output>`

#### **Measurement-**

1. CPU Test Mode

### **Test Case 1**

Command - `sysbench --num-threads=2 --test=cpu --cpu-max-prime=30000 run`  
CPU measurement - `iostat -c 20`  
Disk Measurement – `iostat -xd 20`  
Total Time – 26.0249 sec

## ScreenShots-

```
root@a194d2b0cff0: / - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminProxy...

sparneet05@nativesystem:~$ sudo docker run -itd csminpp/ubuntu-sysbench
a194d2b0cff0652f07b381f28d8999970917c5e08f0e512c4e9429fe5a1ee5cf
sparneet05@nativesystem:~$ sudo docker attach <a19>
-bash: syntax error near unexpected token 'newline'
sparneet05@nativesystem:~$ sudo docker attach a19
root@a194d2b0cff0:/# sysbench --num-threads=2 --test=cpu --cpu-max-prime=30000 run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 2

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 30000

Test execution summary:
total time:                26.0249s
total number of events:    10000
total time taken by event execution: 52.0430
per-request statistics:
  min:                4.87ms
  avg:                5.20ms
  max:               17.23ms
  approx. 95 percentile: 5.35ms

Threads fairness:
  events (avg/stddev):    5000.0000/0.00
  execution time (avg/stddev): 26.0215/0.00

root@a194d2b0cff0:/#
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminPro...

sudo snap install microk8s --channel=1.19 --classic

https://microk8s.io/ has docs and details.

* Canonical Livepatch is available for installation.
- Reduce system reboots and improve kernel security. Activate at:
https://ubuntu.com/livepatch

3 packages can be updated.
1 update is a security update.

New release '20.04.1 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

Last login: Wed Oct  7 13:04:10 2020 from 35.235.241.17
sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem)    10/07/20    _x86_64_    (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.11    0.01   0.11   0.03    0.00   99.73

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.90    0.00   0.07   0.00    0.02    0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           18.77    0.00   0.08   0.03    0.03   81.10
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminPro...

^C
sparneet05@nativesystem:~$ iostat -xd 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

Device            r/s      w/s    rkB/s    wkB/s   rrqm/s   wrqm/s   %rrqm   %wrqm  r_await  w_await
aqu-sz rareq-sz wareq-sz  svctm   %util
loop0              0.03      0.00     0.03     0.00     0.00     0.00     0.00     0.00     0.08     0.00
  0.00      1.16      0.00     0.10     0.00
loop1              0.00      0.00     0.01     0.00     0.00     0.00     0.00     0.00     0.05     0.00
  0.00      2.32      0.00     0.42     0.00
loop2              0.00      0.00     0.02     0.00     0.00     0.00     0.00     0.00     0.04     0.00
  0.00      7.08      0.00     0.58     0.00
loop3              0.00      0.00     0.02     0.00     0.00     0.00     0.00     0.00     0.04     0.00
  0.00      5.52      0.00     0.70     0.00
sda                0.34      0.54     8.49    45.67     0.07     0.71    16.33    57.09     1.01     4.99
  0.00     24.65     84.98     1.46     0.13

Device            r/s      w/s    rkB/s    wkB/s   rrqm/s   wrqm/s   %rrqm   %wrqm  r_await  w_await
aqu-sz rareq-sz wareq-sz  svctm   %util
loop0              0.00      0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
  0.00      0.00      0.00     0.00     0.00
loop1              0.00      0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
  0.00      0.00      0.00     0.00     0.00
loop2              0.00      0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
  0.00      0.00      0.00     0.00     0.00
loop3              0.00      0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
  0.00      0.00      0.00     0.00     0.00
sda                0.00      0.10     0.00     0.60     0.00     0.05     0.00    33.33     0.00     1.50
  0.00      0.00      6.00     2.00     0.02

^C
sparneet05@nativesystem:~$
```

## Test Case 2

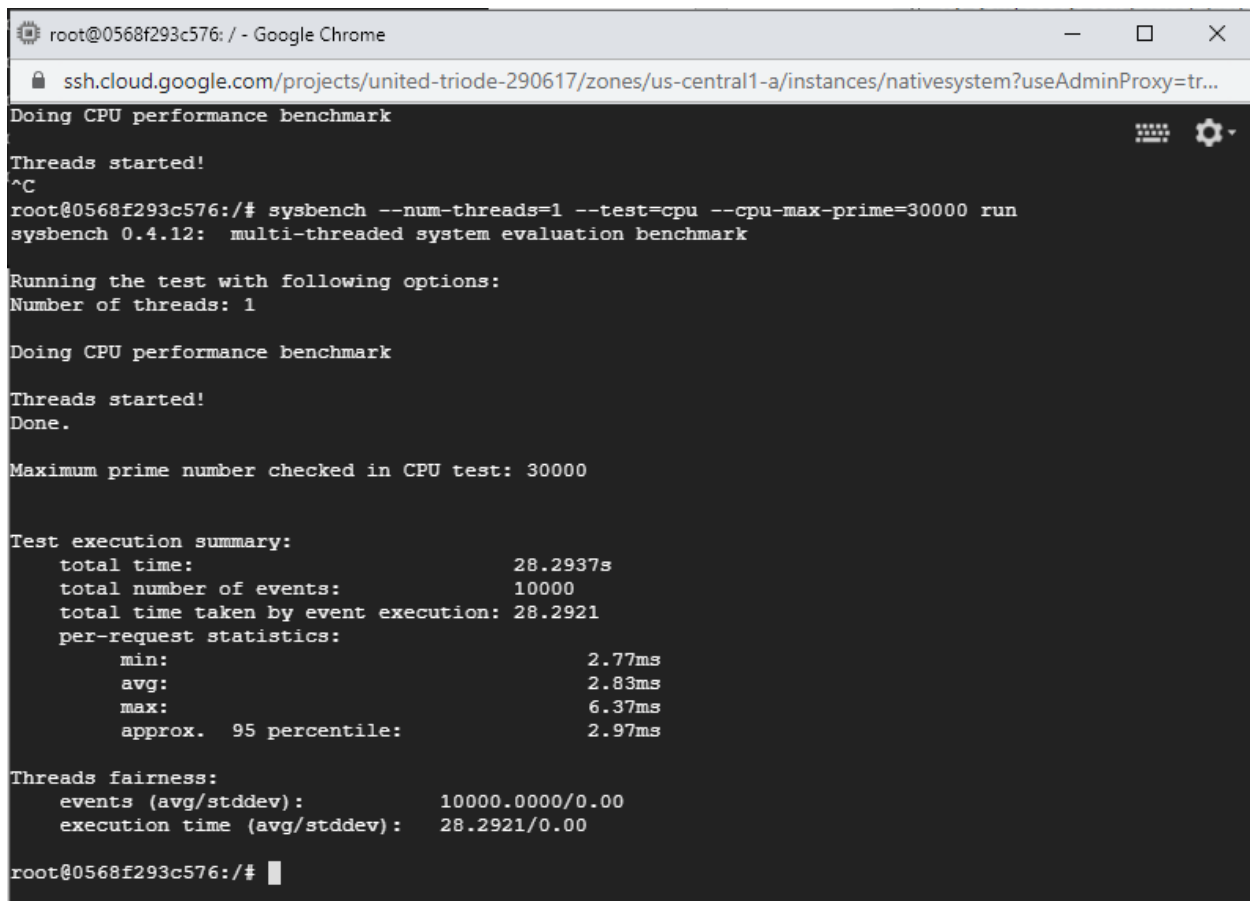
Command - `sysbench --num-threads=1 --test=cpu --cpu-max-prime=30000 run`

CPU measurement - `iostat -c 20`

Disk Measurement - `iostat -xd 20`

Total Time - 28.2937 sec

ScreenShots-



The screenshot shows a terminal window titled 'root@0568f293c576: / - Google Chrome'. The terminal output is as follows:

```
Doing CPU performance benchmark
Threads started!
^C
root@0568f293c576: /# sysbench --num-threads=1 --test=cpu --cpu-max-prime=30000 run
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: 30000

Test execution summary:
total time:                28.2937s
total number of events:    10000
total time taken by event execution: 28.2921
per-request statistics:
  min:                2.77ms
  avg:                2.83ms
  max:                6.37ms
  approx. 95 percentile: 2.97ms

Threads fairness:
  events (avg/stddev):    10000.0000/0.00
  execution time (avg/stddev): 28.2921/0.00

root@0568f293c576: /#
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances...

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.15    0.00    0.70   52.05    0.03   47.07

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.20    0.00    0.60   49.12    0.00   50.08

^C
sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2
CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.38    0.01    0.17    0.21    0.00   99.24

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          50.06    0.00    0.10    0.08    0.03   49.74

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          49.98    0.00    0.12    0.05    0.02   49.83

^C
sparneet05@nativesystem:~$
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesyste...

0.04 0.00 0.00 7.08 0.00 0.58 0.00
loop3 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00
0.04 0.00 0.00 5.52 0.00 0.70 0.00
sda 0.83 3.84 20.20 763.78 0.08 0.77 8.81 16.75
8.48 2.14 0.01 24.28 199.00 0.96 0.45

Device      r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await aqu-sz rareq-sz wareq-sz svctm %util
loop0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
loop1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
loop2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
loop3 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
sda 0.05 0.30 0.40 2.80 0.00 0.45 0.00 60.00
12.00 4.67 0.00 8.00 9.33 3.43 0.12

Device      r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await aqu-sz rareq-sz wareq-sz svctm %util
loop0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
loop1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
loop2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
loop3 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
sda 0.05 0.75 0.20 4.20 0.00 0.30 0.00 28.57
15.00 3.20 0.00 4.00 5.60 1.50 0.12

^C
sparneet05@nativesystem:~$
```

### Test Case 3

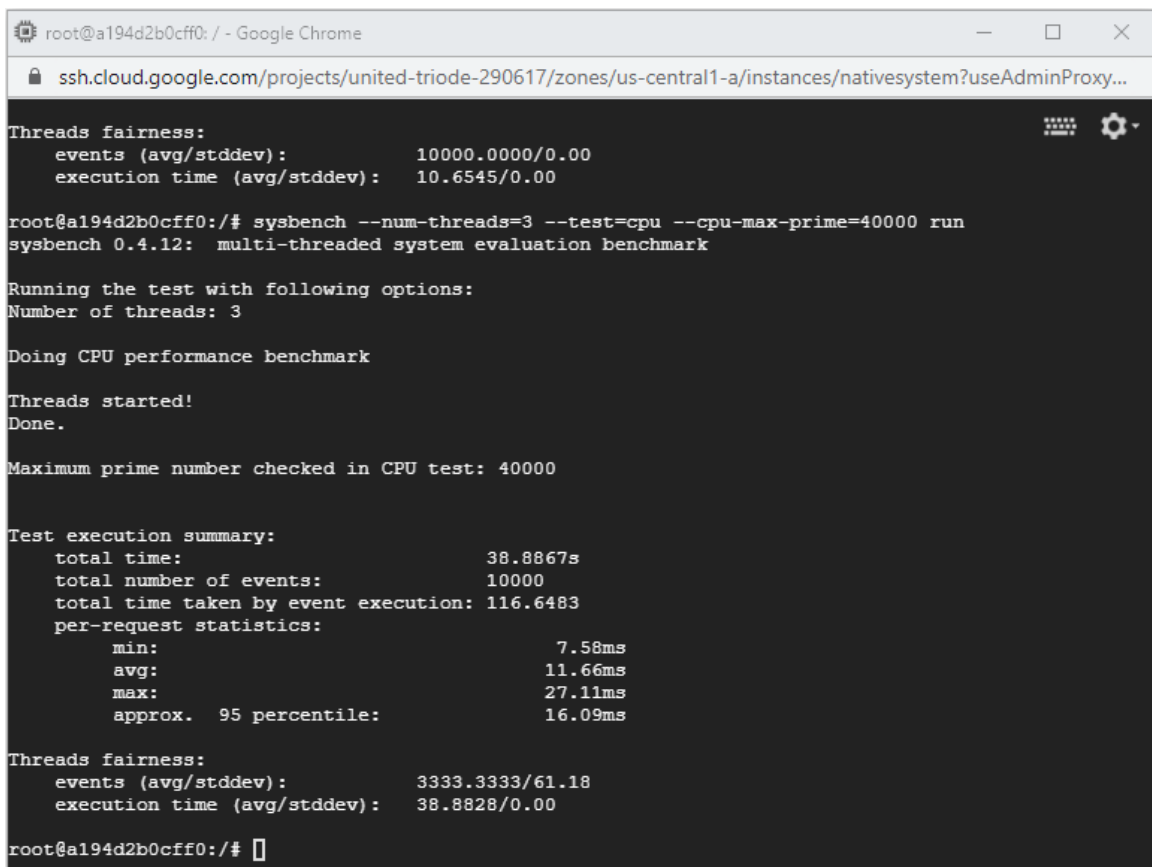
Command - `sysbench --num-threads=3 --test=cpu --cpu-max-prime=40000 run`

CPU measurement - `iostat -c 20`

Disk Measurement – `iostat -xd 20`

Total Time – 38.8867 sec

ScreenShots-



The screenshot shows a terminal window with the following content:

```
root@a194d2b0cff0: / - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminProxy...

Threads fairness:
  events (avg/stddev):       10000.0000/0.00
  execution time (avg/stddev): 10.6545/0.00

root@a194d2b0cff0: /# sysbench --num-threads=3 --test=cpu --cpu-max-prime=40000 run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 3

Doing CPU performance benchmark

Threads started!
Done.

Maximum prime number checked in CPU test: 40000

Test execution summary:
  total time:                38.8867s
  total number of events:     10000
  total time taken by event execution: 116.6483
  per-request statistics:
    min:                      7.58ms
    avg:                      11.66ms
    max:                      27.11ms
    approx. 95 percentile:    16.09ms

Threads fairness:
  events (avg/stddev):       3333.3333/61.18
  execution time (avg/stddev): 38.8828/0.00

root@a194d2b0cff0: /#
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminPro...

loop3      0.00  0.00  0.02  0.00  0.00  0.00  0.00  0.00  0.00  0.04  0.00
0.00      5.52  0.00  0.70  0.00
sda        0.34  0.54  8.36  45.04  0.07  0.71  16.33  56.83  1.01  5.00
0.00     24.65  83.89  1.46  0.13

Device      r/s    w/s    rkB/s    wkB/s    rrqm/s    wrqm/s    %rrqm    %wrqm    r_await    w_await
aqu-sz rareq-sz wareq-sz svctm %util
loop0      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00      0.00  0.00  0.00  0.00
loop1      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00      0.00  0.00  0.00  0.00
loop2      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00      0.00  0.00  0.00  0.00
loop3      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00      0.00  0.00  0.00  0.00
sda        0.00  0.10  0.00  0.60  0.00  0.05  0.00  33.33  0.00  15.00
0.00      0.00  6.00  6.00  0.06

^C
sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.37    0.01   0.11   0.03    0.00   99.48

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           96.02    0.00   3.95   0.00    0.03    0.00

^C
sparneet05@nativesystem:~$
```



```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminPro...

^C
sparneet05@nativesystem:~$ iostat -xd 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

Device            r/s      w/s      kB/s      kB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_await      w_await
aqu-sz rareq-sz wareq-sz svctm %util
loop0              0.03      0.00      0.03      0.00      0.00      0.00      0.00      0.00      0.08      0.00
  0.00      1.16      0.00      0.10      0.00
loop1              0.00      0.00      0.01      0.00      0.00      0.00      0.00      0.00      0.05      0.00
  0.00      2.32      0.00      0.42      0.00
loop2              0.00      0.00      0.02      0.00      0.00      0.00      0.00      0.00      0.04      0.00
  0.00      7.08      0.00      0.58      0.00
loop3              0.00      0.00      0.02      0.00      0.00      0.00      0.00      0.00      0.04      0.00
  0.00      5.52      0.00      0.70      0.00
sda                0.34      0.54      8.36      45.04      0.07      0.71      16.33      56.83      1.01      5.00
  0.00      24.65      83.89      1.46      0.13

Device            r/s      w/s      kB/s      kB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_await      w_await
aqu-sz rareq-sz wareq-sz svctm %util
loop0              0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00
loop1              0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00
loop2              0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00
loop3              0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00
sda                0.00      0.10      0.00      0.60      0.00      0.05      0.00      33.33      0.00      15.00
  0.00      0.00      6.00      6.00      0.06

^C
sparneet05@nativesystem:~$
```

## 2. IO Test Mode

### Test Case 1

Command -

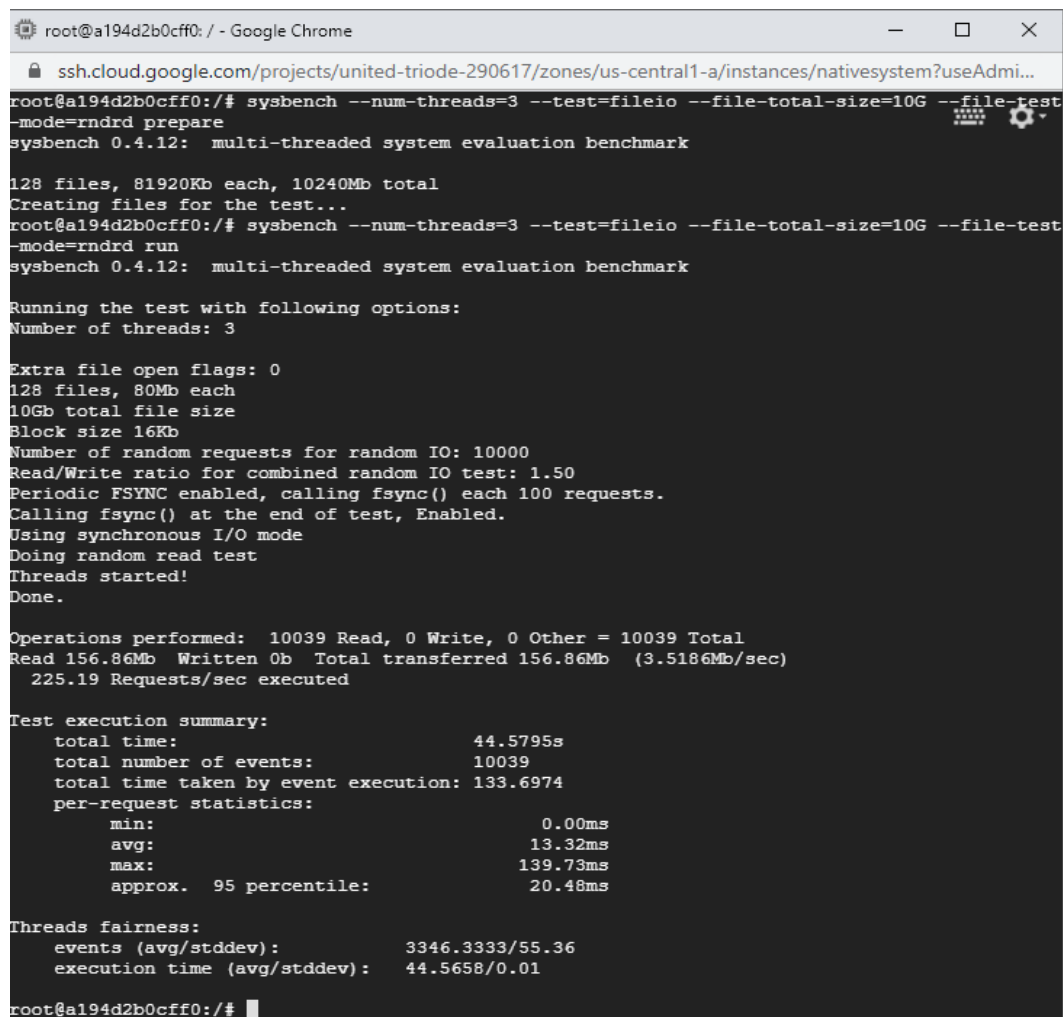
```
sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test-mode=rndrw prepare
sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test-mode=rndrw run
sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test-mode=rndrw cleanup
```

CPU measurement - iostat -c 20

Disk Measurement – iostat -xd 20

Total Time –44.5795 sec

ScreenShots-

A screenshot of a terminal window titled 'root@a194d2b0cff0: / - Google Chrome'. The terminal shows the execution of sysbench commands and its output. The commands are: 'sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test-mode=rndrd prepare', 'sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test-mode=rndrd run', and 'sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test-mode=rndrd cleanup'. The output includes the sysbench version (0.4.12), the number of files and total size (128 files, 81920Kb each, 10240Mb total), and the test results. The test was run with 3 threads, 10000 random requests, and a read/write ratio of 1.50. The total time taken was 44.5795s, with 10039 events executed. The per-request statistics show a minimum of 0.00ms, an average of 13.32ms, a maximum of 139.73ms, and a 95th percentile of 20.48ms. The threads fairness is also shown, with an average of 3346.3333/55.36 events and an execution time of 44.5658/0.01s.

```
root@a194d2b0cff0: / - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdmi...
root@a194d2b0cff0:/# sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test
-mode=rndrd prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 81920Kb each, 10240Mb total
Creating files for the test...
root@a194d2b0cff0:/# sysbench --num-threads=3 --test=fileio --file-total-size=10G --file-test
-mode=rndrd run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 3

Extra file open flags: 0
128 files, 80Mb each
10Gb 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: 10039 Read, 0 Write, 0 Other = 10039 Total
Read 156.86Mb Written 0b Total transferred 156.86Mb (3.5186Mb/sec)
225.19 Requests/sec executed

Test execution summary:
total time: 44.5795s
total number of events: 10039
total time taken by event execution: 133.6974
per-request statistics:
  min: 0.00ms
  avg: 13.32ms
  max: 139.73ms
  approx. 95 percentile: 20.48ms

Threads fairness:
  events (avg/stddev): 3346.3333/55.36
  execution time (avg/stddev): 44.5658/0.01
root@a194d2b0cff0:/#
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesyste...

0.42  0.01  0.12  0.05  0.00  99.40

^C
sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.42    0.01    0.13    0.06    0.00   99.39

^C
sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.41    0.01    0.15    0.12    0.00   99.30

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.10    0.00    0.70   70.43    0.05   28.72

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.08    0.00    0.68   76.09    0.05   23.10

^C
sparneet05@nativesystem:~$
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdminProxy=true...

sparneet05@nativesystem:~$ iostat -xd 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

Device            r/s      w/s    rkB/s    wkB/s   rrqm/s   wrqm/s   %rrqm   %wrqm
r_await w_await aqu-sz rareq-sz wareq-sz svctm  %util
loop0             0.08     0.00    0.03    0.00    0.00    0.10    0.00    0.00
0.00     0.00    0.00    1.16    0.00    0.00    0.00    0.00
loop1             0.05     0.00    0.00    0.00    0.00    0.42    0.00    0.00
0.00     0.00    0.00    2.32    0.00    0.00    0.00    0.00
loop2             0.04     0.00    0.00    0.00    0.00    0.02    0.00    0.00
0.00     0.00    0.00    7.08    0.00    0.58    0.00    0.00
loop3             0.04     0.00    0.00    0.00    0.00    0.02    0.00    0.00
0.00     0.00    0.00    5.52    0.00    0.70    0.00    0.00
sda               6.98     2.21    0.52    2.89   11.40   511.86    0.07    0.79
0.01     21.97   177.04    0.84    0.29   11.98   21.52

Device            r/s      w/s    rkB/s    wkB/s   rrqm/s   wrqm/s   %rrqm   %wrqm
r_await w_await aqu-sz rareq-sz wareq-sz svctm  %util
loop0             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
loop1             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
loop2             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
loop3             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
sda              149.15    0.10  2377.20    2.20    0.25    0.45    0.17   81.82
19.98   23.50    2.91   15.94   22.00    4.11   61.36

Device            r/s      w/s    rkB/s    wkB/s   rrqm/s   wrqm/s   %rrqm   %wrqm
r_await w_await aqu-sz rareq-sz wareq-sz svctm  %util
loop0             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
loop1             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
loop2             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
loop3             0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00     0.00    0.00    0.00    0.00    0.00    0.00    0.00
sda              148.75    0.05  2377.60    1.80    0.15    0.40    0.10   88.89
20.02   37.00    2.87   15.98   36.00    4.09   60.84

^C
sparneet05@nativesystem:~$
```

## Test Case-2

### Command -

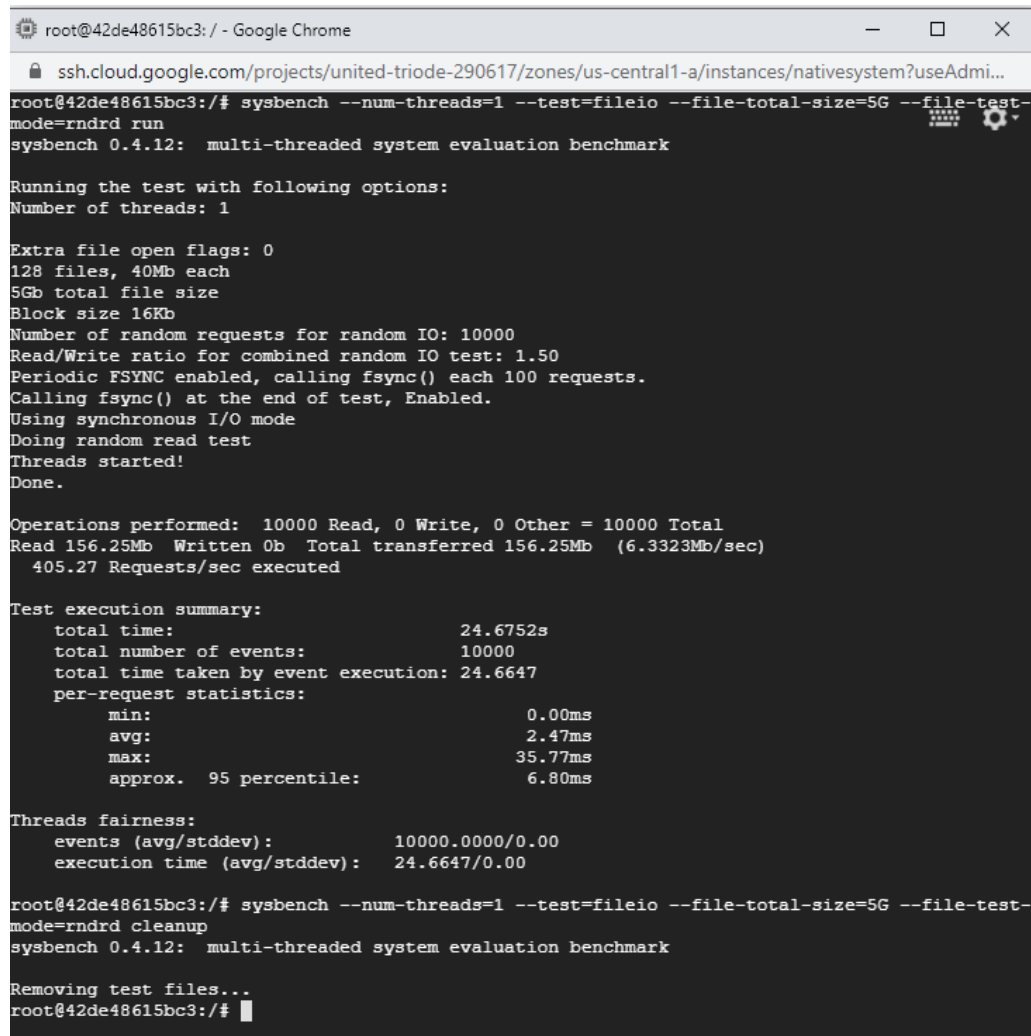
```
sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-mode=rndrw prepare
sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-mode=rndrw run
sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-mode=rndrw cleanup
```

CPU measurement - iostat -c 20

Disk Measurement – iostat -xd 20

Total Time –44.5795 sec

### ScreenShots-

A screenshot of a terminal window titled 'root@42de48615bc3: / - Google Chrome'. The terminal shows the execution of sysbench with the command 'sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-mode=rndrd run'. The output includes the sysbench version (0.4.12), the test name (multi-threaded system evaluation benchmark), and the options used. It then shows the test results: 10000 Read, 0 Write, 0 Other = 10000 Total; Read 156.25Mb, Written 0b, Total transferred 156.25Mb (6.3323Mb/sec); 405.27 Requests/sec executed. A test execution summary follows, showing a total time of 24.6752s, 10000 events, and per-request statistics (min: 0.00ms, avg: 2.47ms, max: 35.77ms, approx. 95 percentile: 6.80ms). It also shows thread fairness (events: 10000.0000/0.00, execution time: 24.6647/0.00). Finally, it shows the cleanup command 'sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-mode=rndrd cleanup' and the removal of test files. The prompt 'root@42de48615bc3: /#' is visible at the bottom.

```
root@42de48615bc3: / - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesystem?useAdmi...
root@42de48615bc3: /# sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-
mode=rndrd run
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, 40Mb each
5Gb 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 (6.3323Mb/sec)
405.27 Requests/sec executed

Test execution summary:
total time: 24.6752s
total number of events: 10000
total time taken by event execution: 24.6647
per-request statistics:
  min: 0.00ms
  avg: 2.47ms
  max: 35.77ms
  approx. 95 percentile: 6.80ms

Threads fairness:
  events (avg/stddev): 10000.0000/0.00
  execution time (avg/stddev): 24.6647/0.00

root@42de48615bc3: /# sysbench --num-threads=1 --test=fileio --file-total-size=5G --file-test-
mode=rndrd cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
root@42de48615bc3: /#
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances...

sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem) 10/07/20 _x86_64_ (2
CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.38    0.01   0.15   0.16    0.00   99.30

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.13    0.00   0.70   3.55    0.00   95.62

^C
sparneet05@nativesystem:~$
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesyste...

Mem:      total      used      free      shared  buff/cache  available
Swap:      0          0          0          0         115        3492
root@nativesystem:~# exit
logout
sparneet05@nativesystem:~$ iostat -xd 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

Device            r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await aqu-sz rareq-sz wareq-sz svctm  %util
loop0             0.02     0.00     0.03     0.00     0.00     0.00     0.00     0.00     0.00
0.08     0.00     0.00     1.16     0.00     0.11     0.00     0.00     0.00     0.00
loop1             0.00     0.00     0.01     0.00     0.00     0.00     0.00     0.00     0.00
0.05     0.00     0.00     2.32     0.00     0.42     0.00     0.00     0.00     0.00
loop2             0.00     0.00     0.02     0.00     0.00     0.00     0.00     0.00     0.00
0.04     0.00     0.00     7.08     0.00     0.58     0.00     0.00     0.00     0.00
loop3             0.00     0.00     0.02     0.00     0.00     0.00     0.00     0.00     0.00
0.04     0.00     0.00     5.52     0.00     0.70     0.00     0.00     0.00     0.00
sda               0.62     2.91     16.79     528.24     0.08     0.75     11.19     20.45
8.34     2.21     0.01     27.23     181.31     0.91     0.32

Device            r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await aqu-sz rareq-sz wareq-sz svctm  %util
loop0             0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
loop1             0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
loop2             0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
loop3             0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
sda              150.05     0.35    2404.00     6.00     1.55     1.15     1.02    76.67
6.65    12.29     0.61    16.02    17.14     4.08    61.32

^C
sparneet05@nativesystem:~$
```

### Test Case-3

#### Command -

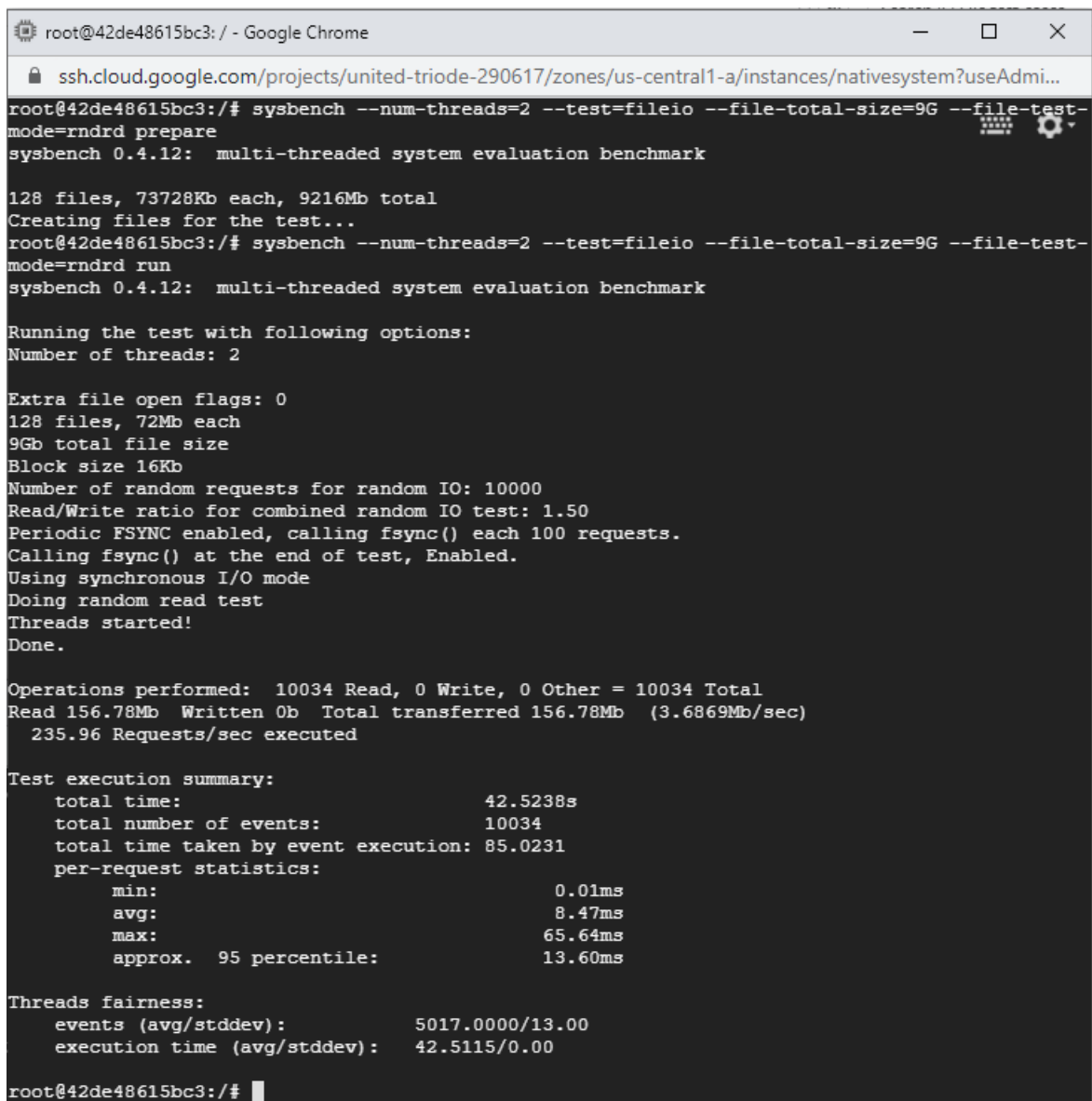
```
sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-mode=rndrw prepare
sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-mode=rndrw run
sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-mode=rndrw cleanup
```

CPU measurement - iostat -c 20

Disk Measurement – iostat -xd 20

Total Time –42.5238 sec

#### Screenshots-

A screenshot of a terminal window titled 'root@42de48615bc3: / - Google Chrome'. The terminal shows the execution of sysbench benchmarks. It starts with the command 'sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-mode=rndrd prepare', followed by 'sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-mode=rndrd run', and finally 'sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-mode=rndrw cleanup'. The output shows the preparation of 128 files, each 73728Kb, totaling 9216Mb. The run phase shows the execution of the benchmark with 2 threads, 10000 random requests, and a read/write ratio of 1.50. The cleanup phase shows the removal of the files. The final output shows the test execution summary, including total time (42.5238s), total number of events (10034), and per-request statistics (min: 0.01ms, avg: 8.47ms, max: 65.64ms, approx. 95 percentile: 13.60ms). The threads fairness section shows events (avg/stddev): 5017.0000/13.00 and execution time (avg/stddev): 42.5115/0.00.

```
root@42de48615bc3: /# sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-
mode=rndrd prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 73728Kb each, 9216Mb total
Creating files for the test...
root@42de48615bc3: /# sysbench --num-threads=2 --test=fileio --file-total-size=9G --file-test-
mode=rndrd run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 2

Extra file open flags: 0
128 files, 72Mb each
9Gb 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: 10034 Read, 0 Write, 0 Other = 10034 Total
Read 156.78Mb Written 0b Total transferred 156.78Mb (3.6869Mb/sec)
235.96 Requests/sec executed

Test execution summary:
total time: 42.5238s
total number of events: 10034
total time taken by event execution: 85.0231
per-request statistics:
    min: 0.01ms
    avg: 8.47ms
    max: 65.64ms
    approx. 95 percentile: 13.60ms

Threads fairness:
events (avg/stddev): 5017.0000/13.00
execution time (avg/stddev): 42.5115/0.00

root@42de48615bc3: /#
```



```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances...

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.18    0.00    0.73   17.94    0.03   81.13

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.18    0.00    0.73   17.09    0.08   81.93

^C
sparneet05@nativesystem:~$ iostat -c 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2
CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.38    0.01    0.17    0.18    0.00   99.26

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.15    0.00    0.70   52.05    0.03   47.07

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.20    0.00    0.60   49.12    0.00   50.08

^C
sparneet05@nativesystem:~$
```

```
sparneet05@nativesystem: ~ - Google Chrome
ssh.cloud.google.com/projects/united-triode-290617/zones/us-central1-a/instances/nativesyste...

sparneet05@nativesystem:~$ iostat -xd 20
Linux 5.4.0-1025-gcp (nativesystem)      10/07/20      _x86_64_      (2 CPU)

Device            r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await  aqu-sz  rareq-sz  wareq-sz  svctm  %util
loop0              0.02      0.00        0.03      0.00      0.00      0.00      0.00      0.00
0.08      0.00      0.00      1.16      0.00      0.11      0.00
loop1              0.00      0.00        0.01      0.00      0.00      0.00      0.00      0.00
0.05      0.00      0.00      2.32      0.00      0.42      0.00
loop2              0.00      0.00        0.02      0.00      0.00      0.00      0.00      0.00
0.04      0.00      0.00      7.08      0.00      0.58      0.00
loop3              0.00      0.00        0.02      0.00      0.00      0.00      0.00      0.00
0.04      0.00      0.00      5.52      0.00      0.70      0.00
sda                0.75      3.86      18.98      768.51      0.08      0.77      9.57      16.69
7.99      2.14      0.01      25.17      199.13      0.90      0.42

Device            r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await  aqu-sz  rareq-sz  wareq-sz  svctm  %util
loop0              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
loop1              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
loop2              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
loop3              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
sda                148.30      0.55      2371.60      6.20      0.00      1.00      0.00      64.52
13.39      24.00      1.79      15.99      11.27      4.12      61.36

Device            r/s      w/s      rkB/s      wkB/s      rrqm/s      wrqm/s      %rrqm      %wrqm      r_
await w_await  aqu-sz  rareq-sz  wareq-sz  svctm  %util
loop0              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
loop1              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
loop2              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
loop3              0.00      0.00        0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
sda                148.78      0.00      2374.01      0.00      0.10      0.00      0.07      0.00
13.30      0.00      1.76      15.96      0.00      4.11      61.19

^C
sparneet05@nativesystem:~$
```

\*The above number of threads, file sizes(for IO test mode) and CPU max prime(for CPU test mode) are chosen in accordance such that the process may last longer i.e. around 30-60 seconds. The less number of threads and larger file size or max prime number will result in increase of total time. This is done so that with the use of iostat, a proper CPU and disk measurements can be taken.(The first line of measurement is usually not considered useful as it does not display the true use of resources.)

## **CPU Performance Analysis**

### CPU Utilization

	User-level(%user)	Kernel-level(%system)
Test Case 1	<u>99.90</u>	0.07
Test Case 2	50.06	0.10
Test Case 3	96.02	3.95

### IO Utilization

	Throughput(%tps)	Latency(%await)	Disk Utilization(%util)
Test Case 1	0.10	0.00	0.02
Test Case 2	0.00	0.00	0.12
Test Case 3	0.00	0.00	0.06

## **IO Performance Analysis**

### CPU Utilization

	User-level(%user)	Kernel-level(%system)
Test Case 1	0.10	0.70
Test Case 2	<u>0.13</u>	0.70
Test Case 3	0.15	<u>0.70</u>

### IO Utilization

	Throughput(%tps)	Latency(%await)	Disk Utilization(%util)
Test Case 1	149.25	2.91	61.36
Test Case 2	150.40	0.61	61.32
Test Case 3	148.85	1.79	61.36

## Data Analysis

- User-level CPU usage is much higher in the CPU test mode performance analysis than the IO test mode performance analysis.
- Throughput, Latency and Disk Utilization is much higher in the IO test mode performance analysis since the files are being transferred in the process.
- There is much higher latency in the IO test mode performance analysis than its counter one.
- Disk utilization is very low in the CPU test mode performance analysis since CPU processing does not require disk space.

## QEMU

### Installation steps

- Installed QEMU on Google Instance
- Downloaded ubuntu 18.04 LTS server and created bootable image
- Setup the Firewall
- Accessed the instance from VNC Viewer
- Installed Ubuntu VM instance on QEMU

Commands in the process:

- `sudo apt-get install qemu`
- `wget http://mirror.pnl.gov/releases/18.04/ubuntu-18.04.5-live-server-amd64.iso`
- `sudo qemu-img create ubuntu.img 10G`
- `$sudo qemu-system-x86_64 -hda ubuntu.img -boot d -cdrom ./ubuntu-16.04.6-server-amd64.iso -m 1536`
- `$sudo qemu-system-x86_64 -hda ubuntu.img -m 1536 [To start QEMU]`

**Time taken to boot:** It took around 3 mins to the time it asks for username and password. Total time was approx. 17 mins.

### **Why it is so slow to run such a VM under QEMU?**

Running a VM under QEMU is slow because it will have to share its resources for the VM itself as well as the emulated operating system (Ubuntu in our case). The OS running in a virtual machine will run slower than if it would run directly on that same machine without a virtualization layer. We will have a performance penalty of VM processing + Ubuntu processing - before actually running any application under Ubuntu. As we add layers of software between the physical hardware and the application you choose to run, there will be a performance hit at each layer.

In general, CPU and DRAM virtualization overheads are comparatively low due to the hardware-assisted virtualization techniques. However, the disk virtualization or emulation has considerable overheads, because the virtual disk emulation is implemented in userspace.

