

CS 580K Mini-Project 1

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Google cloud instance configurations:

←

VM instance details

Instance ID

5520610699400250262

Machine type

custom (2 vCPUs, 4 GB memory)

Network interfaces

Name	Network	Subnetwork	Primary internal IP	Alias IP ranges	External IP	Network Tier ?	IP forwarding	Network details
nic0	default	default	10.128.0.4	—	146.148.103.39 (ephemeral)	Premium	Off	View details

Boot disk

Name	Image	Size (GB)	Device name	Type	Encryption
nativesystem	ubuntu-1604-xenial-v20200223	20	nativesystem	Standard persistent disk	Google-managed

Steps to enable Docker container:

I have installed Docker for this assignment using the repository option. The detailed steps are as follows:

Reference: <https://docs.docker.com/install/linux/docker-ce/ubuntu/#install-using-the-repository>

1. Update the apt package
2. Install packages to allow apt to use a repository over HTTPS
3. Add Docker's official GPG key (9DC8 5822 9FC7 DD38 854A E2D8 8D81 803C 0EBF CD88)
4. Install the specific version of Docker Engine – Community by providing the version in the command
5. Verify the Docker Engine – Community is installed by running hello-world image
6. We need to use csminpp/ubuntu-sysbench, pre-installed image for benchmarks. This can be done using `sudo docker pull` and image name.

Steps to install QEMU:

1. Install QEMU by using `sudo apt-get install qemu`
2. Download the Ubuntu image to install into QEMU
3. Create image to install Ubuntu in QEMU

Steps to install GUI for native Google instance:

Reference: <https://medium.com/google-cloud/graphical-user-interface-gui-for-google-compute-engine-instance-78fccda09e5c>

1. Install the Gnome components
`sudo apt-get install gnome-core`
2. Install VNC server to interact with desktop environment
`sudo apt-get install vnc4server`
3. Run server by using `vncserver` command and set password for this instance
4. Verify it's working by netcat command
5. To work this GUI properly, we need to make some changes in the configuration. First kill the session.
`vncserver -kill :1`
6. Open the xstartup file and make the changes as suggested in the assignment document as follows:

```
#!/bin/sh
```

```
Def
```

```
export XKL_XMODMAP_DISABLE=1
```

```
unset SESSION_MANAGER
```

```
unset DBUS_SESSION_BUS_ADDRESS
```

```
metacity &
```

```
gnome-settings-daemon &
```

```
gnome-panel &
```

```
nautilus &
```

```
gnome-terminal &
```

7. Install VNC client on local machine.
8. Add new firewall rule in the cloud by setting the configuration provided in the screenshot which is in the assignment document, as follows:

vnc-server

Description



Logs

Turning on firewall logs can generate a large number of logs which can increase costs in Stackdriver. [Learn more](#)

- ☐ On
- ☒ Off

Network

default

Priority *

1000



Priority can be 0–65535 [Check priority of other firewall rules](#)

Direction

Ingress

Action on match

Allow

Targets

All instances in the network



Source filter

IP ranges



Source IP ranges *

0.0.0.0/0 for example, 0.0.0.0/0, 192.168.2.0/24



Second source filter

None



Protocols and ports

- ☐ Allow all
- ☒ Specified protocols and ports

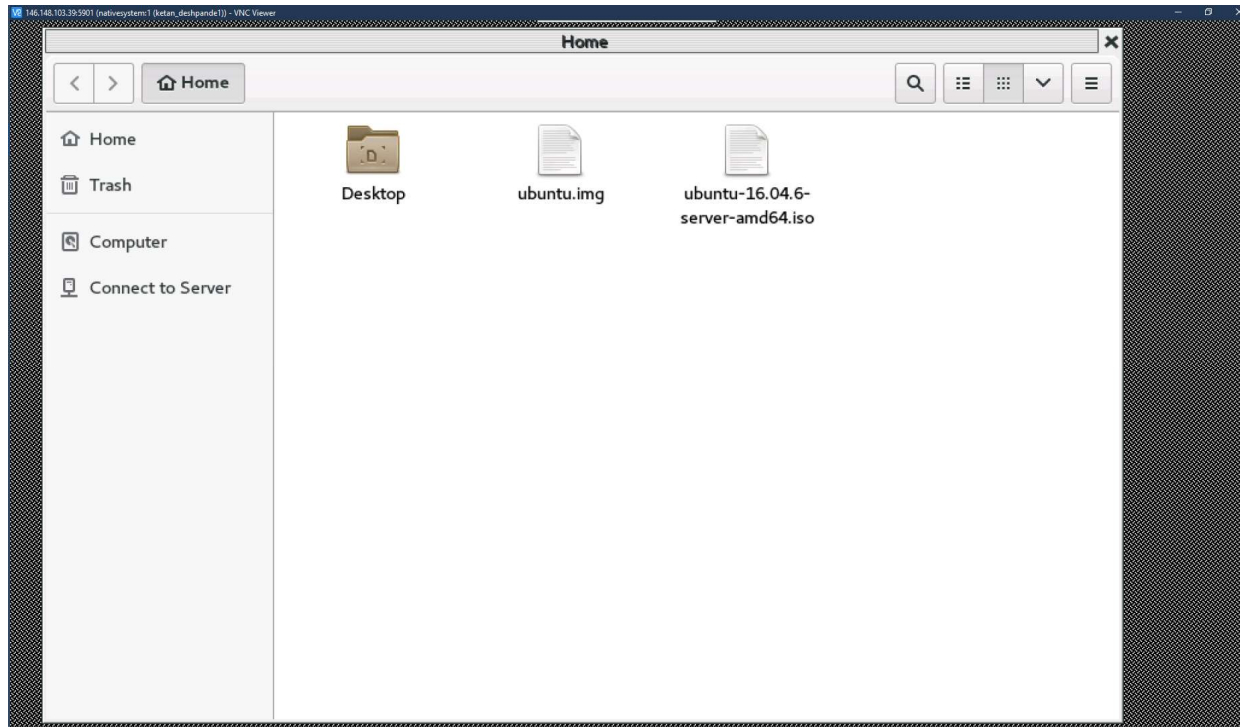
☒ tcp :

5000-10000

9. Now check the connection by the firewall by netcat

```
nc 146.148.103.39 5901
```

10. After installing VNC client, connect to the external IP through it. It'll open GUI for the Google instance.



Performance measurements in the native, Docker, and QEMU:

I have run the test cases on all the three environments to measure the system performance from CPU utilization and IO perspective.

Commands used for CPU utilization and IO:

1. `sysbench --num-threads=2 --test=cpu --cpu-max-prime=30000 run`
This command calculates prime numbers up to the given number by using threads. Each thread executes the requests concurrently until either the total number of requests or the total execution time exceed the limits specified with the common command line options.
2. `iostat -<option> <seconds>`
`iostat` command is used to monitor CPU utilization and I/O (input /output) statistics of all the disks and file systems. Options are c for CPU and d for devices. Seconds are the time interval.
3. `sudo -i`
this command is used to change the user to root
4. `echo 3 > /proc/sys/vm/drop_caches`
this command is used to clear the cache
5. `sudo qemu-system-x86_64 -hda ubuntu.img -m 1536`
this command is used to start QEMU VM
6. `sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=<mode> <prepare/run/cleanup>`
this command will create 128 files with total size of 3 GB in current directory, run the bench mark and clean the test files by provided modes.

I have run the commands and test cases. Please see below the screenshots for all of them:

CPU Test 1

Command - sysbench --num-threads=2 --test=cpu --cpu-max-prime=30000 run

iostat -c 10

iostat -d 10

Native System: Total time taken: 27.45s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/char...
ketan_deshpande1@nativesystem:~$ 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:                27.4560s
  total number of events:    10000
  total time taken by event execution: 54.9080
  per-request statistics:
    min:                      5.39ms
    avg:                      5.49ms
    max:                      19.04ms
    approx. 95 percentile:    5.64ms

Threads fairness:
  events (avg/stddev):       5000.0000/23.00
  execution time (avg/stddev): 27.4540/0.00

ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -c 10
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
_x86_64_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.73    0.01   0.14   0.03    0.00   98.10

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.95    0.00   0.05   0.00    0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          100.00    0.00   0.00   0.00    0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           67.62    0.00   0.10   0.00    0.00   32.28

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.35    0.00   0.05   0.00    0.00   99.60

^Z
[6]+  Stopped                  iostat -c 10
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -d 10
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
_x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                1.52         7.08        129.19
1488719    27148477

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                0.00         0.00         0.00
0                0.00         0.00         0.00

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                0.80         0.00         3.60
0                36

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                0.00         0.00         0.00
0                0

^Z
[5]+  Stopped                  iostat -d 10
ketan_deshpande1@nativesystem:~$
```

Docker: Total time taken: 27.03s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/cha...
ketan_deshpande1@nativesystem:~$ sudo docker run -itd cs
minpp/ubuntu-sysbench
67d86da54ca81312f44a60d913d8e3d93a6a6c3670cb426435379341
402c26eb
ketan_deshpande1@nativesystem:~$ sudo docker attach 67d
root@67d86da54ca8:/#
root@67d86da54ca8:/# sysbench --num-threads=2 --test=cpu
--cpu-max-prime=30000 run
sysbench 0.4.12: multi-threaded system evaluation bench
mark

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: 27.0395s
total number of events: 10000
total time taken by event execution: 54.0720
per-request statistics:
min: 5.17ms
avg: 5.41ms
max: 8.41ms
approx. 95 percentile: 5.59ms

Threads fairness:
events (avg/stddev): 5000.0000/30.00
execution time (avg/stddev): 27.0360/0.00

root@67d86da54ca8:/#

ketan_deshpande1@nativesystem:~$ iostat -c 10
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2022
_x86_64_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.74    0.01   0.14   0.03    0.00   98.09

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.90    0.00   0.10   0.00    0.00    0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.85    0.00   0.15   0.00    0.00    0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           62.26    0.00   0.05   0.00    0.00   37.69

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.35    0.00   0.15   0.00    0.00   99.50

^Z
[7]+  Stopped                  iostat -c 10
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -d 10
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2022
_x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s
kB_read    kB_wrtn
loop0          8          0          0          0.00
sda         1492823      27150449      7.09      128.91

Device:            tps    kB_read/s    kB_wrtn/s
kB_read    kB_wrtn
loop0          0          0          0          0.00
sda           1.30          0.00          6.00

Device:            tps    kB_read/s    kB_wrtn/s
kB_read    kB_wrtn
loop0          0          0          0          0.00
sda           0.00          0.00          0.00

Device:            tps    kB_read/s    kB_wrtn/s
kB_read    kB_wrtn
loop0          0          0          0          0.00
sda           0.10          0.00          0.40

Device:            tps    kB_read/s    kB_wrtn/s
kB_read    kB_wrtn
loop0          0          0          0          0.00
sda           0.40          0.00          6.80

^Z
[6]+  Stopped                  iostat -d 10
ketan_deshpande1@nativesystem:~$
```


QEMU: Total time taken: 113.50s

V2 146.148.103.39:5901 (nativesystem:1 (ketan_deshpande1)) - VNC Viewer

QEMU - Press Ctrl-Alt to exit mouse grab (as superuser)

ketan@ubuntu:~\$ 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:	113.5080s
total number of events:	10000
total time taken by event execution:	226.9655

per-request statistics:

min:	14.90ms
avg:	22.70ms
max:	44.06ms
approx. 95 percentile:	24.19ms

Threads fairness:

events (avg/stddev):	5000.0000/1.00
execution time (avg/stddev):	113.4827/0.00

ketan@ubuntu:~\$

ketan_deshpande1@nativesystem: ~ - Mozilla Firefox

https://ssh.cloud.google.com/projects/charged-ske ...

ketan_deshpande1@nativesystem:~\$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020 _x86_64_ (2 CPU)

avg-cpu:	%user	%nice	%system	%iowait	%steal	%idle
	1.84	0.01	0.14	0.03	0.00	97.98
	50.48	0.00	0.12	0.00	0.00	49.40
	50.52	0.00	0.07	0.00	0.00	49.41
	50.43	0.07	0.13	0.02	0.00	49.35
	33.22	0.00	0.07	0.00	0.00	66.71
	0.22	0.00	0.13	0.00	0.00	99.65

^Z
[14]+ Stopped iostat -c 30
ketan_deshpande1@nativesystem:~\$

ketan_deshpande1@nativesystem: ~ - Mozilla Firefox

https://ssh.cloud.google.com/projects/cha ...

ketan_deshpande1@nativesystem:~\$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020 _x86_64_ (2 CPU)

Device:	tps	kB_read/s	kB_wrtn/s	kB_read	kB_wrtn
ead					
loop0	0.00	0.00	0.00	0	0
sda	1.49	6.92	125.38	203	27458689
Device: <th>tps</th> <th>kB_read/s</th> <th>kB_wrtn/s</th> <th>kB_read</th> <th>kB_wrtn</th>	tps	kB_read/s	kB_wrtn/s	kB_read	kB_wrtn
ead					
loop0	0.00	0.00	0.00	0	0
sda	0.10	0.00	1.60	0	48
Device: <th>tps</th> <th>kB_read/s</th> <th>kB_wrtn/s</th> <th>kB_read</th> <th>kB_wrtn</th>	tps	kB_read/s	kB_wrtn/s	kB_read	kB_wrtn
ead					
loop0	0.00	0.00	0.00	0	0
sda	0.13	0.00	1.73	0	52
Device: <th>tps</th> <th>kB_read/s</th> <th>kB_wrtn/s</th> <th>kB_read</th> <th>kB_wrtn</th>	tps	kB_read/s	kB_wrtn/s	kB_read	kB_wrtn
ead					
loop0	0.00	0.00	0.00	0	0
sda	0.53	0.00	3.07	0	92
Device: <th>tps</th> <th>kB_read/s</th> <th>kB_wrtn/s</th> <th>kB_read</th> <th>kB_wrtn</th>	tps	kB_read/s	kB_wrtn/s	kB_read	kB_wrtn
ead					
loop0	0.00	0.00	0.00	0	0
sda	0.50	0.00	3.33	0	100

^Z

CPU Test 2

```
Command - sysbench --num-threads=1 --test=cpu --cpu-max-prime=20000 run
```

```
iostat -c 10
```

```
iostat -d 10
```

Native System: Total time taken: 28.16s

The image displays three terminal windows from a Google Cloud VM, showing the execution of various system benchmarks and monitoring tools.

Terminal 1 (Left): Shows the execution of `sysbench` with the command `sysbench --num-threads=1 --test=cpu --cpu-max-prime=20000 run`. The output indicates that the test is a multi-threaded system evaluation benchmark. It shows the number of threads (1) and the maximum prime number checked (20000). The test execution summary shows a total time of 28.1673s, with a total number of events of 10000. The per-request statistics show a minimum time of 2.76ms, an average of 2.82ms, a maximum of 3.57ms, and an approximate 95th percentile of 2.91ms. The threads fairness section shows events (10000.0000/0.00) and execution time (28.1634/0.00).

Terminal 2 (Middle): Shows the execution of `iostat -c 10`. The output displays the average CPU usage for the system, including user, nice, system, iowait, steal, and idle percentages. The average CPU usage is shown for the system as a whole, and for each CPU (x86_64_0 and x86_64_1).

Terminal 3 (Right): Shows the execution of `iostat -d 10`. The output displays the average disk usage for the system, including read and write rates in KB/s. The average disk usage is shown for the system as a whole, and for each disk (loop0 and sda).

Docker: Total time taken: 27.44s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/cha...
root@67d86da54ca8:/# sysbench --num-threads=1 --test=cpu
--cpu-max-prime=20000 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: 20000
Test execution summary:
  total time:                27.4467s
  total number of events:    10000
  total time taken by event execution: 27.4433
  per-request statistics:
    min:          2.68ms
    avg:          2.74ms
    max:          4.59ms
    approx. 95 percentile: 2.83ms
Threads fairness:
  events (avg/stddev):       10000.0000/0.00
  execution time (avg/stddev): 27.4433/0.00
root@67d86da54ca8:/#
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/cha...
ketan_deshpande1@nativesystem:~$ iostat -c 10
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
_x86_64_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.75    0.01   0.14   0.03    0.00   98.07

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.65    0.00   0.15   0.00    0.00   49.20

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.68    0.00   0.10   0.00    0.00   49.22

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           33.95    0.00   0.10   0.00    0.00   65.95

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.40    0.00   0.10   0.00    0.00   99.50
^Z
[8]+  Stopped                  iostat -c 10
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem: ~ - Moz...
https://ssh.cloud.google.com/proje...
ketan_deshpande1@nativesystem:~$ iostat -d 10
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
_x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0          0.00          0.00          0.00
      8              0
sda          1.52          7.08         128.82
1492831    27150801
Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0          0.00          0.00          0.00
      0              0
sda          0.20          0.00          1.20
      0              12
Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0          0.00          0.00          0.00
      0              0
sda          0.00          0.00          0.00
      0              0
Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0          0.00          0.00          0.00
      0              0
sda          0.60          0.00          4.00
      0              40
^Z
[7]+  Stopped                  iostat -d 10
ketan_deshpande1@nativesystem:~$
```

QEMU: Total time taken: 69.99s

146.148.103.39:5901 (nativesystem:1 (ketan_deshpande1)) - VNC Viewer

QEMU (as superuser)

```
ketan@ubuntu:~$ sysbench --num-threads=1 --test=cpu --cpu-max-prime=20000 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: 20000

Test execution summary:
  total time:          69.9929s
  total number of events: 10000
  total time taken by event execution: 69.9429
  per-request statistics:
    min:                6.49ms
    avg:                 6.99ms
    max:                11.54ms
    approx. 95 percentile: 7.53ms

Threads fairness:
  events (avg/stddev):    10000.0000/0.00
  execution time (avg/stddev): 69.9429/0.00

ketan@ubuntu:~$
```

nativesystem: ~

```
ketan_deshpande1@nativesystem:~$ iostat -c 20
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020  _x86_64_
4_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.86    0.01   0.14   0.03   0.00   97.95

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.61    0.00   0.13   0.00   0.00   49.27

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.57    0.00   0.13   0.00   0.00   49.31

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.59    0.00   0.18   0.00   0.00   49.23

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           21.88    0.00   0.13   0.00   0.00   77.99

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.28    0.00   0.25   0.03   0.00   99.45

^Z
[15]+  Stopped                  iostat -c 20
ketan_deshpande1@nativesystem:~$
```

ketan_deshpande1@nativesystem: ~ - Mozilla Firefox

https://ssh.cloud.google.com/projects/charged-sk...

```
ketan_deshpande1@nativesystem:~$ iostat -d 20
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020  _x86_64_
x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
ead                 0.00          0.00          0.00         0         0
loop0               0.00          0.00          0.00         0         0
sda                 1.49          6.91         125.20       203      27459337

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
ead                 0.00          0.00          0.00         0         0
loop0               0.00          0.00          0.00         0         0
sda                 0.15          0.00          2.20         0         44

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
ead                 0.00          0.00          0.00         0         0
loop0               0.00          0.00          0.00         0         0
sda                 0.00          0.00          0.00         0         0

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
ead                 0.00          0.00          0.00         0         0
loop0               0.00          0.00          0.00         0         0
sda                 0.35          0.00          1.60         0         32

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
ead                 0.00          0.00          0.00         0         0
loop0               0.00          0.00          0.00         0         0
sda                 0.00          0.00          0.00         0         0

^Z
```


CPU Test 3

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

iostat -c 20

iostat -d 20

Native System: Total time taken: 40.82s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/char...
ketan_deshpande1@nativesystem:~$ 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:                40.8216s
  total number of events:    10000
  total time taken by event execution: 122.4435
  per-request statistics:
    min:                      7.63ms
    avg:                      12.24ms
    max:                      32.31ms
    approx. 95 percentile:    20.15ms
Threads fairness:
  events (avg/stddev):       3333.3333/83.23
  execution time (avg/stddev): 40.8145/0.00
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -c 20
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
x86_64_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.70    0.01   0.14   0.03   0.00   98.12

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.90    0.00   0.10   0.00   0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.90    0.00   0.10   0.00   0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.61    0.00   0.15   0.00   0.00   98.24

^Z
[3]+  Stopped                  iostat -c 20
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -d 20
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0           8          0          0
sda          1488719      27147717      1.52          7.10      129.53

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0           0          0          0
sda              0          0          0

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0           0          0          0
sda              0          0          0

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0           0          0          0
sda              0          0          0

^Z
[2]+  Stopped                  iostat -d 20
ketan_deshpande1@nativesystem:~$
```

Docker: Total time taken: 40.24s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/cha...
root@67d86da54ca8:/# 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:                40.2490s
  total number of events:    10000
  total time taken by event execution: 120.7170
  per-request statistics:
    min:                      7.83ms
    avg:                      12.07ms
    max:                      30.83ms
    approx. 95 percentile:    19.98ms
Threads fairness:
  events (avg/stddev):       3333.3333/49.56
  execution time (avg/stddev): 40.2390/0.01
root@67d86da54ca8:/#
```

```
ketan_deshpande1@nativesystem:~$ iostat -c 20
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
_x86_64_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.75    0.01   0.14   0.03    0.00   98.07

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           99.95    0.00   0.05   0.00    0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           97.10    0.00   0.15   0.00    0.00   2.75

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            0.33    0.00   0.18   0.00    0.00   99.50

^Z
[9]+  Stopped                  iostat -c 20
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem:~$ iostat -d 20
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020
_x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                1.52         7.08        128.74
1492831    27150993

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                0.60         0.00         2.80
0              56

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                0.10         0.00         0.60
0              12

Device:            tps    kB_read/s    kB_wrtn/s
  kB_read    kB_wrtn
loop0              0.00         0.00         0.00
sda                0.40         0.00         3.40
0              68

^Z
[8]+  Stopped                  iostat -d 20
ketan_deshpande1@nativesystem:~$
```

QEMU: Total time taken: 169.55s

146.148.103.39:5901 (nativesystem:1 (ketan_deshpande1)) - VNC Viewer

QEMU (as superuser)

```
ketan@ubuntu:~$ 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:                169.5583s
  total number of events:    10000
  total time taken by event execution: 500.4520
  per-request statistics:
    min:                    33.69ms
    avg:                    50.85ms
    max:                    85.08ms
    approx. 95 percentile:  57.77ms

Threads fairness:
  events (avg/stddev):      3333.3333/1.25
  execution time (avg/stddev): 169.4843/0.02

ketan@ubuntu:~$ _
```

nativesystem: ~

```
ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020  _x86_64_ (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.88    0.01   0.14   0.03    0.00   97.94

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.61    0.00   0.05   0.00    0.00   49.34

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.61    0.00   0.15   0.00    0.00   49.23

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.58    0.00   0.10   0.02    0.00   49.30

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.60    0.00   0.13   0.00    0.00   49.27

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           50.61    0.00   0.15   0.00    0.00   49.23

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           30.04    0.00   0.15   0.00    0.00   69.81

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.24    0.00   0.29   0.00    0.00   99.48

^Z
[16]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$
```

ketan_deshpande1@nativesystem: ~ - Mozilla Firefox

<https://ssh.cloud.google.com/projects/charged-sk...>

```
ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/27/2020  _x86_64_ (2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s    kB_
ead    kB_wrtn
loop0              0.00         0.00         0.00
      8              0
sda              1.48         6.90        125.00   15
203  27459877

Device:            tps    kB_read/s    kB_wrtn/s    kB_
ead    kB_wrtn
loop0              0.00         0.00         0.00
      0              0
sda              0.37         0.00         1.60
      0         48

Device:            tps    kB_read/s    kB_wrtn/s    kB_
ead    kB_wrtn
loop0              0.00         0.00         0.00
      0              0
sda              0.27         0.00         2.13
      0         64

Device:            tps    kB_read/s    kB_wrtn/s    kB_
ead    kB_wrtn
loop0              0.00         0.00         0.00
      0              0
sda              0.33         0.00         1.60
      0         48

Device:            tps    kB_read/s    kB_wrtn/s    kB_
ead    kB_wrtn
loop0              0.00         0.00         0.00
      0              0
sda              0.47         0.00         3.20
      0         96

Device:            tps    kB_read/s    kB_wrtn/s    kB_
ead    kB_wrtn
loop0              0.00         0.00         0.00
      0              0
sda              0.07         0.00         0.27
      0              8
```


File IO Test 1

Commands - sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqwr prepare

- sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqwr run

- sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqwr cleanup

Native System: Total time taken: 26.16s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/u ...
ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=seqwr prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=seqwr run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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, 196608 Write, 128 Other = 196736 Total
Read 0b Written 3Gb Total transferred 3Gb (117.42Mb/sec)
7514.61 Requests/sec executed

Test execution summary:
total time:                26.1634s
total number of events:    196608
total time taken by event execution: 355.1391
per-request statistics:
  min:                      0.01ms
  avg:                      1.81ms
  max:                      692.21ms
  approx. 95 percentile:    0.04ms

Threads fairness:
  events (avg/stddev):      12288.0000/1116.53
  execution time (avg/stddev): 22.1962/0.01

ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=seqwr cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
PU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.02    0.01   0.22   0.09   0.00   97.66

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           10.94    0.00  10.22  25.08   0.00   53.76

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           5.13    0.00  11.23  57.72   0.00   25.93

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.92    0.00   0.50   0.05   0.00   98.53

^Z
[7]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 2.70        25.68        265.79    6207599    64248701

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                401.60        32.27       100520.93     968    3015628

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                410.83       119.07      102394.80    3572    3071844

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 0.53        19.87         5.60         596        168

^Z
[7]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```

Docker: Total time taken: 25.87s

```
root@0d2cfba99fad: / - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/...
ketan_deshpande1@nativesystem:~$ sudo -i
root@nativesystem:~# echo 3 > /proc/sys/vm/drop_caches
root@nativesystem:~# exit
logout
ketan_deshpande1@nativesystem:~$ sudo docker run -itd csminpp/ubuntu-sysbench
0d2cfba99fad7d8f36c6b983964caff7f58388059b46ba9f1166241d644c63c1
ketan_deshpande1@nativesystem:~$ sudo docker attach 0d2
root@0d2cfba99fad:/#
root@0d2cfba99fad:/# sysbench --num-threads=16 --test=fileio --file-total-size
e=3G --file-test-mode=seqwr prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
root@0d2cfba99fad:/# sysbench --num-threads=16 --test=fileio --file-total-size
e=3G --file-test-mode=seqwr run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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, 196608 Write, 128 Other = 196736 Total
Read 0b Written 3Gb Total transferred 3Gb (118.7Mb/sec)
7597.02 Requests/sec executed

Test execution summary:
total time: 25.8796s
total number of events: 196608
total time taken by event execution: 377.2298
per-request statistics:
min: 0.01ms
avg: 1.92ms
max: 504.59ms
approx. 95 percentile: 0.04ms

Threads fairness:
events (avg/stddev): 12288.0000/1620.88
execution time (avg/stddev): 23.5769/0.07

root@0d2cfba99fad:/# sysbench --num-threads=16 --test=fileio --file-total-size
e=3G --file-test-mode=seqwr cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
root@0d2cfba99fad:/#
```

```
ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
PU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.03    0.01   0.22   0.13   0.00   97.61

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.41    0.00   9.47  19.25   0.00   70.87

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.44    0.00   7.17  54.85   0.00   37.54

^Z
[10]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
Device:
tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0    0.00         0.00         0.00         0         0
sda      3.07        27.17        329.83    6595251    80048145

Device:
tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0    0.00         0.00         0.00         0         0
sda     458.17       103.87     111357.87    3116     3340736

Device:
tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0    0.00         0.00         0.00         0         0
sda     369.63       52.53     92403.20    1576     2772096

^Z
[10]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```

QEMU: Total time taken: 42.89s

```
146.148.103.39:5901 (nativesystem:1 (ketan_deshpande1)) - VNC Viewer
QEMU (as superuser)
Number of threads: 16
Extra file open flags: 0
128 files, 24Mb each
3Gb total file size
Block size 16Mb
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, 196608 Write, 128 Other = 196736 Total
Read 0b Written 3Gb Total transferred 3Gb (71.619Mb/sec)
4583.59 Requests/sec executed

Test execution summary:
total time: 42.8939s
total number of events: 196608
total time taken by event execution: 625.079s
per-request statistics:
min: 0.10ms
avg: 3.18ms
max: 162.32ms
approx. 95 percentile: 15.20ms

Threads fairness:
events (avg/stddev): 12288.0000/328.73
execution time (avg/stddev): 39.0675/0.02

ketan@ubuntu:~$ sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqwr
cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
ketan@ubuntu:~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/ut...
root@029c0bf15694:/# echo 3 > /proc/sys/vm/drop_caches
bash: /proc/sys/vm/drop_caches: Read-only file system
root@029c0bf15694:/# exit
exit
ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
(2 CPU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            1.92    0.01   0.17   0.06   0.00   97.85
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            33.31    0.00   11.13   8.83   0.00   46.74
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            29.71    0.00   4.31   6.75   0.00   59.23
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            50.46    0.00   6.73  13.82   0.00   28.99
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            21.51    0.00   2.94   6.76   0.00   68.79
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            0.37    0.00   0.22   0.07   0.00   99.34
^Z
[1]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones...
root@f8ec2221c5c9:/# echo 3 > /proc/sys/vm/drop_caches
bash: /proc/sys/vm/drop_caches: Read-only file system
root@f8ec2221c5c9:/# exit
exit
ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
(2 CPU)
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 1.86         9.08        171.22    2163167    40776053
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                237.07        32.53       57428.93     976      1722868
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 185.57        91.60       44301.87     2748     1329056
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 296.77        38.67       73758.13     1160     2212744
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 136.83        64.40       31096.27     1932     932888
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                  4.43        49.33        10.67      1480       320
^Z
[1]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```

File IO Test 2

Commands - sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqrewr prepare

- sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqrewr run

- sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqrewr cleanup

Native System: Total time taken: 26.02s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/u ...
root@5085b2fc175d:/# echo 3 > /proc/sys/vm/drop_caches
bash: /proc/sys/vm/drop_caches: Read-only file system
root@5085b2fc175d:/# exit
exit
ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=seqrewr prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=seqrewr run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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 rewrite test
Threads started!
Done.

Operations performed: 0 Read, 196608 Write, 128 Other = 196736 Total
Read 0b Written 3Gb Total transferred 3Gb (118.04Mb/sec)
7554.43 Requests/sec executed

Test execution summary:
total time: 26.0255s
total number of events: 196608
total time taken by event execution: 382.8969
per-request statistics:
min: 0.01ms
avg: 1.95ms
max: 556.89ms
approx. 95 percentile: 0.03ms

Threads fairness:
events (avg/stddev): 12288.0000/1437.79
execution time (avg/stddev): 23.9311/0.01

ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=seqrewr cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
PU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.02    0.01   0.22   0.10   0.00   97.65
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           11.14    0.00   10.44   26.61   0.00   51.81
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           3.92    0.00    8.59   58.37   0.00   29.12
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.45    0.00    0.32   0.00   0.00   99.23

^Z
[8]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                2.81        26.03        291.46    6298623    70525229
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda               411.73        55.73    102743.47    1672    3082304
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda               406.37       184.93    100908.67    5548    3027260
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                0.70         4.27        13.87        128        416

^Z
[8]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```


Docker: Total time taken: 25.66s

```
root@0d2cfba99fad: / - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/u ...
root@0d2cfba99fad: /# sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqrewr prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
root@0d2cfba99fad: /# sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqrewr run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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 rewrite test
Threads started!
Done.

Operations performed: 0 Read, 196608 Write, 128 Other = 196736 Total
Read 0b Written 3Gb Total transferred 3Gb (119.7Mb/sec)
7660.71 Requests/sec executed

Test execution summary:
total time: 25.6645s
total number of events: 196608
total time taken by event execution: 380.8377
per-request statistics:
  min: 0.01ms
  avg: 1.94ms
  max: 576.61ms
  approx. 95 percentile: 0.03ms

Threads fairness:
  events (avg/stddev): 12288.0000/1495.10
  execution time (avg/stddev): 23.8024/0.00

root@0d2cfba99fad: /# sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqrewr cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
root@0d2cfba99fad: /#
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/ ...
ketan_deshpande1@nativesystem: ~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
PU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.02    0.01   0.22   0.14   0.00   97.60

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.48    0.00   8.17  22.08   0.00   69.28

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.40    0.00   6.47  52.47   0.00   40.66

^Z
[11]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem: ~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/u ...
ketan_deshpande1@nativesystem: ~$ sudo -i
root@nativesystem: ~# echo 3 > /proc/sys/vm/drop_caches
root@nativesystem: ~# exit
logout
ketan_deshpande1@nativesystem: ~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_ (2 CPUs)

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 3.18        27.28        355.43    6625167    86318057

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                475.07        218.27    112233.87    6548     3367016

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 369.27        79.07     92467.87     2372     2774036

^Z
[11]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem: ~$
```

QEMU: Total time taken: 36.04s

```
146.148.103.39:5901 (nativesystem:1 (ketan_deshpande1)) - VNC Viewer
QEMU (as superuser)
ketan@ubuntu:~$ sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=seqwrite --run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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 rewrite test
Threads started!
Done.

Operations performed: 0 Read, 196608 Write, 128 Other = 196736 Total
Read 0b Written 3Gb Total transferred 3Gb (85.215Mb/sec)
5453.79 Requests/sec executed

Test execution summary:
total time: 36.0498s
total number of events: 196608
total time taken by event execution: 542.6463
per-request statistics:
min: 0.06ms
avg: 2.76ms
max: 381.33ms
approx. 95 percentile: 8.43ms

Threads fairness:
events (avg/stddev): 12208.0000/450.54
execution time (avg/stddev): 33.9154/0.85
ketan@ubuntu:~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/uc...
root@8fd8e2ba6f37:/# echo 3 > /proc/sys/vm/drop_caches
bash: /proc/sys/vm/drop_caches: Read-only file system
root@8fd8e2ba6f37:/# exit
exit
ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
(2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            1.93    0.01   0.17   0.06   0.00   97.82

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            38.01    0.00   5.88   9.26   0.00   46.85

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            34.40    0.00   5.00   9.32   0.00   51.28

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            45.50    0.00   7.43  21.45   0.00   25.62

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            0.34    0.00   0.15   0.08   0.00   99.43

^Z
[2]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/uc...
root@e6979deeac3f:/# echo 3 > /proc/sys/vm/drop_caches
bash: /proc/sys/vm/drop_caches: Read-only file system
root@e6979deeac3f:/# exit
exit
ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
(2 CPU)

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 1.98         9.47       197.27    2258743    47065689

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                273.57         4.53     66894.13       136    2005024

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                218.10        60.27     52606.40      1808    1578192

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 351.27        32.13     87489.20       964    2624676

^Z
[2]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```


File IO Test 3

Commands - sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=rndrw prepare

- sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=rndrw run

- sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=rndrw cleanup

Native System: Total time taken: 42.93s

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/u ...
root@0bd10b0a6e9a:/# echo 3 > /proc/sys/vm/drop_caches
bash: /proc/sys/vm/drop_caches: Read-only file system
root@0bd10b0a6e9a:/# exit
exit
ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=rndrw prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=rndrw run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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 r/w test
Threads started!
Done.

Operations performed: 6024 Read, 4006 Write, 12801 Other = 22831 Total
Read 94.125Mb Written 62.594Mb Total transferred 156.72Mb (3.6501Mb/sec)
233.61 Requests/sec executed

Test execution summary:
total time: 42.9349s
total number of events: 10030
total time taken by event execution: 406.4181
per-request statistics:
min: 0.01ms
avg: 40.52ms
max: 223.72ms
approx. 95 percentile: 123.58ms

Threads fairness:
events (avg/stddev): 626.8750/36.94
execution time (avg/stddev): 25.4011/0.55

ketan_deshpande1@nativesystem:~$ sysbench --num-threads=16 --test=fileio --fi
le-total-size=3G --file-test-mode=rndrw cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
PU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.03    0.01   0.22   0.11   0.00   97.63
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           10.84   0.00   9.68  25.28   0.00   54.20
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           9.07    0.00   1.96  69.07   0.00   19.91
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           8.64    0.00   1.78  53.06   0.00   36.52
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.22    0.00   0.13   0.03   0.00   99.62

^Z
[9]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$

ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 2.92        26.39        317.27    6391691    76840781
^[[ADevice:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                392.63        25.47       98229.47     764    2946884
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 406.07       1416.13      1399.47    42484    41984
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 290.73       973.73      1023.60    29212    30708
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                  0.93        13.87         8.13        416        244

^Z
[9]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```

Docker: Total time taken: 38.32s

```
root@0d2cfba99fad: / - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/...
root@0d2cfba99fad: /# sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=rndrw prepare
sysbench 0.4.12: multi-threaded system evaluation benchmark

128 files, 24576Kb each, 3072Mb total
Creating files for the test...
root@0d2cfba99fad: /# sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=rndrw run
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
3Gb 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 r/w test
Threads started!
Done.

Operations performed: 6011 Read, 3997 Write, 12800 Other = 22808 Total
Read 93.922Mb Written 62.453Mb Total transferred 156.38Mb (4.0805Mb/sec)
261.15 Requests/sec executed

Test execution summary:
total time: 38.3226s
total number of events: 10008
total time taken by event execution: 327.4963
per-request statistics:
min: 0.00ms
avg: 32.72ms
max: 242.10ms
approx. 95 percentile: 108.23ms

Threads fairness:
events (avg/stddev): 625.5000/47.91
execution time (avg/stddev): 20.4685/0.59

root@0d2cfba99fad: /# sysbench --num-threads=16 --test=fileio --file-total-size=3G --file-test-mode=rndrw cleanup
sysbench 0.4.12: multi-threaded system evaluation benchmark

Removing test files...
root@0d2cfba99fad: /#
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/...
ketan_deshpande1@nativesystem: ~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
PU)
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.02    0.01   0.23   0.15   0.00   97.59

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.39    0.00   6.78  29.10   0.00   63.73

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.44    0.00   1.08  97.65   0.00   80.14

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.00    0.00   0.80  18.07   0.00   80.14

^Z
[13]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem: ~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/...
ketan_deshpande1@nativesystem: ~$ sudo -i
root@nativesystem: ~# echo 3 > /proc/sys/vm/drop_caches
root@nativesystem: ~# exit
logout
ketan_deshpande1@nativesystem: ~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_ (2 CP
U)

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 3.35        27.41        393.95     6662867     95765577

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                490.83       486.53      100164.93    14596     3004948

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 510.40      1507.07      2124.00     45212     63720

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0               0.00         0.00         0.00         0         0
sda                 93.43       254.00       401.33      7620     12040

^Z
[13]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem: ~$
```

QEMU: Total time taken: 37.80s

```
146.148.103.39:5901 (nativesystem:1 (ketan_deshpande1)) - VNC Viewer
QEMU (as superuser)
sysbench 0.4.12: multi-threaded system evaluation benchmark

Running the test with following options:
Number of threads: 16

Extra file open flags: 0
128 files, 24Mb each
36b total file size
Block size 16Mb
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 r/w test
Threads started!
Done.

Operations performed: 6013 Read, 3999 Write, 12800 Other = 22812 Total
Read 93.953Mb Written 62.484Mb Total transferred 156.44Mb (4.1384Mb/sec)
264.86 Requests/sec executed

Test execution summary:
total time: 37.8014s
total number of events: 10012
total time taken by event execution: 386.4447
per-request statistics:
min: 0.02ms
avg: 38.60ms
max: 583.48ms
approx. 95 percentile: 178.15ms

Threads fairness:
events (avg/stddev): 625.7500/29.15
execution time (avg/stddev): 24.1528/0.52

ketan@ubuntu:~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones/uc...
ketan_deshpande1@nativesystem:~$ iostat -c 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.02    0.01   0.21   0.08   0.00   97.68
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           34.52    0.00   9.46   8.88   0.00   47.14
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           27.73    0.00   4.36  10.43   0.00   57.48
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           11.13    0.00   1.95  27.62   0.00   59.30
avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.83    0.00   0.47   4.52   0.00   93.17

^Z
[5]+  Stopped                  iostat -c 30
ketan_deshpande1@nativesystem:~$
```

```
ketan_deshpande1@nativesystem: ~ - Mozilla Firefox
https://ssh.cloud.google.com/projects/charged-skein-267904/zones...
ketan_deshpande1@nativesystem:~$ iostat -d 30
Linux 4.15.0-1055-gcp (nativesystem) 02/28/2020 _x86_64_
CPU
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                2.54        25.09        239.55    6047215    57737033
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                251.00         1.20       61527.60         36    1845828
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                224.57       331.60     41352.13       9948    1240564
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                308.27     1508.93     1853.47     45268     55604
Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.00         0.00         0.00         0         0
sda                37.23        205.87       195.20        6176        5856

^Z
[5]+  Stopped                  iostat -d 30
ketan_deshpande1@nativesystem:~$
```