

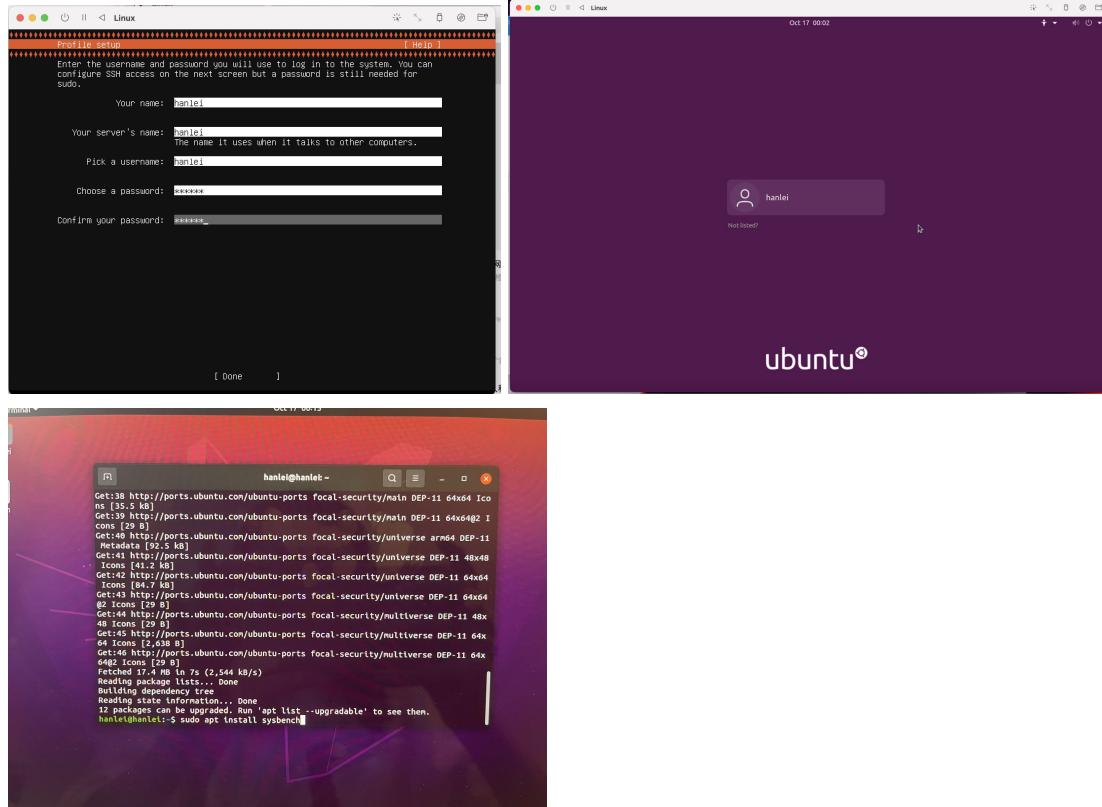
241HW1 Report

Han Lei

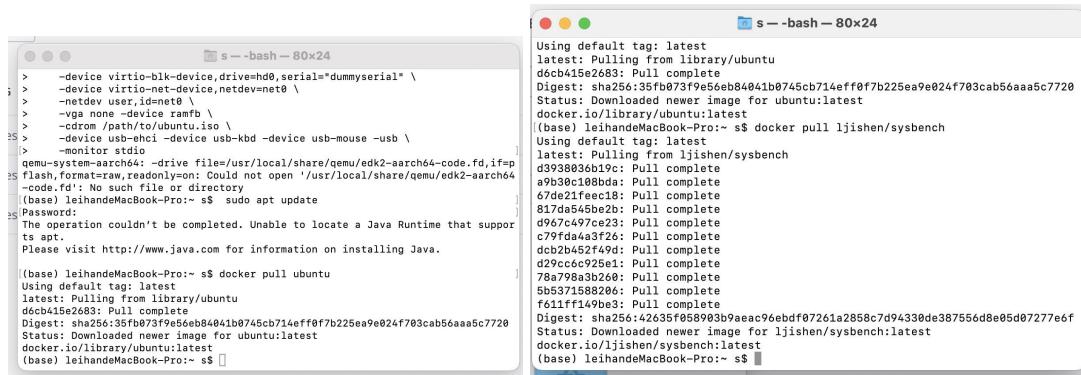
W1651627

- Detailed configurations (CPU, Mem, etc...) of your experimental setup: 5 points

UTM + QEMU + Ubuntu + Sysbench;



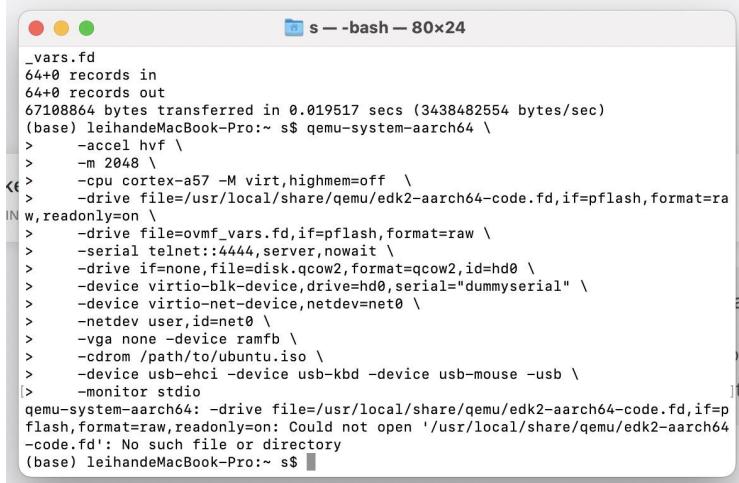
Docker + Ubuntu + Sysbench



- Present main steps to enable a QEMU VM. In addition, please present the detailed QEMU commands, and VM configurations: 10 points

1. Installing QEUM:

Because I use the M1 Apple Silicone that I encountered problem when install the ubuntu on the QEMU, as it is shown on the picture:

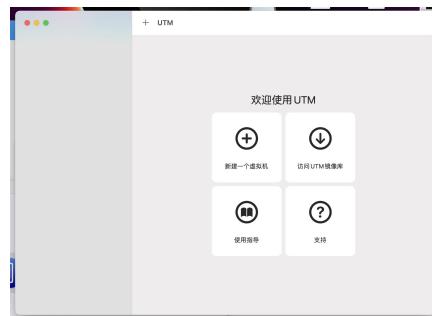


```
_vars.fd
64+0 records in
64+0 records out
67108864 bytes transferred in 0.019517 secs (3438482554 bytes/sec)
(base) leihandeMacBook-Pro:~ s$ qemu-system-aarch64 \
>   -accel hvf \
>   -m 2048 \
>   -cpu cortex-a57 -M virt,highmem=off \
>   -drive file=/usr/local/share/qemu/edk2-aarch64-code.fd,if=pflash,format=ra
IN w,readonly=on \
>   -drive file=ovmf_VARS.fd,if=pflash,format=raw \
>   -serial telnet::4444,server,nowait \
>   -drive if=none,file=disk.qcow2,format=qcow2,id=hd0 \
>   -device virtio-blk-device,drive=hd0,serial="dummyserial" \
>   -device virtio-net-device,netdev=net0 \
>   -netdev user,id=net0 \
>   -vga none -device ramfb \
>   -cdrom /path/to/ubuntu.iso \
>   -device usb-ehci -device usb-kbd -device usb-mouse -usb \
>   -monitor stdio
qemu-system-aarch64: -drive file=/usr/local/share/qemu/edk2-aarch64-code.fd,if=p
flash,format=raw,readonly=on: Could not open '/usr/local/share/qemu/edk2-aarch64
-code.fd': No such file or directory
(base) leihandeMacBook-Pro:~ s$
```

So I use UTM to install QEMU and Ubuntu.

Main steps:

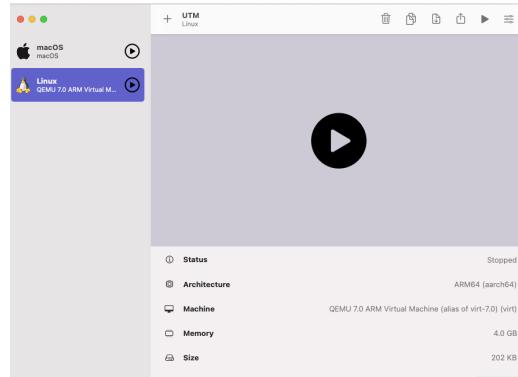
- (1) Download and install UTM
- (2) Download Ubuntu
- (3) Create a virtual machine



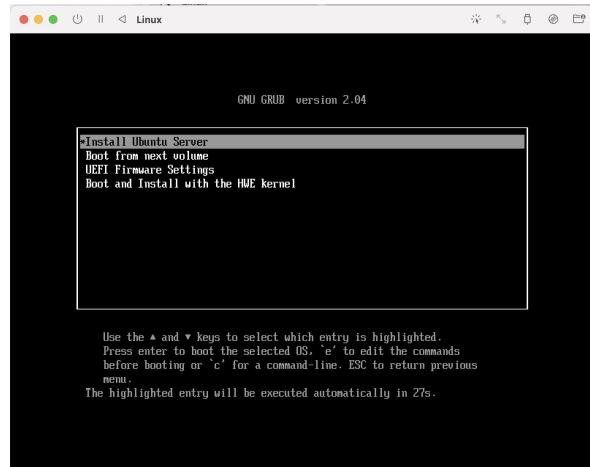
- (4) Create an OS with Ubuntu Package



- (5) Start the virtual machine

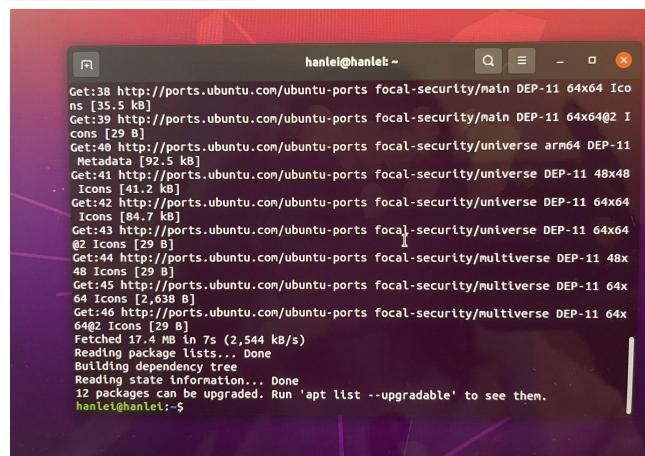


(6) Install ubuntu server

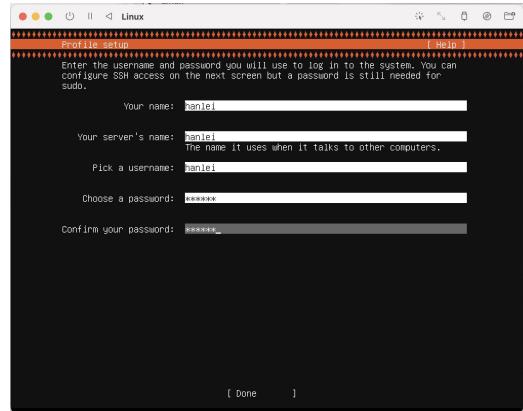


(7) Login in the VM and install the Ubuntu with following command lines:

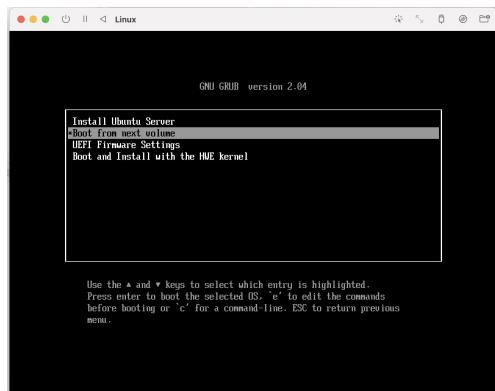
```
$ sudo apt update
$ sudo apt install ubuntu-desktop
$ sudo reboot
```



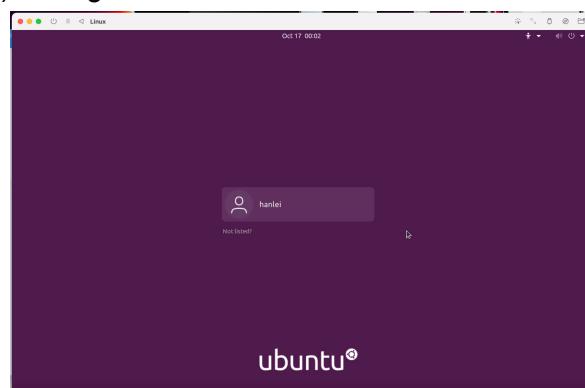
(8) Boot the VM and set profile



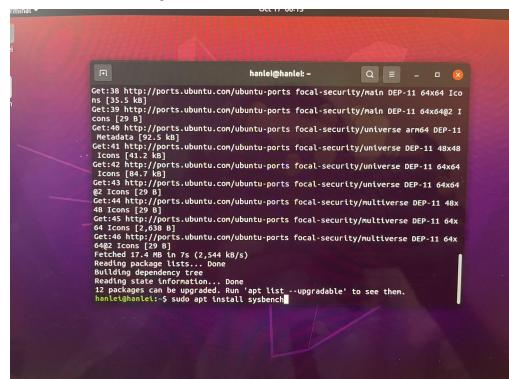
(9) Reboot the VM



(10) Login in to the VM and launch the ubuntu desktop



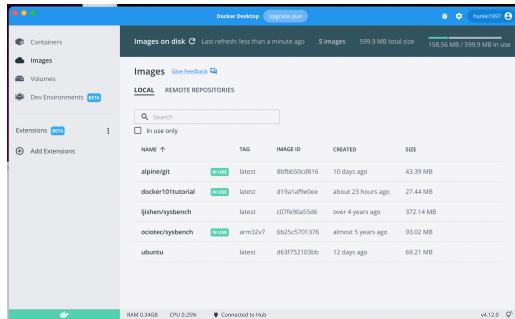
(11) Install Sysbench



○ Present main steps to enable the Docker container. This must show your steps in creating your own image and your image history! Do not copy any classmate's image.

2. Installing Docker:

(1) Download Docker



(2) Download Ubuntu

(3) Pull the Ubuntu

with command line:

```
docker pull ubuntu
```

```
> -device virtio-blk-device,drive=hd0,serial="dummymserial" \
> -device virtio-net-device,netdev=net0 \
> -netdev user,id=net0 \
> -vga none -device ramfb \
> -cdrom /path/to/ubuntu.iso \
> -device usb-ehci -device usb-kbd -device usb-mouse -usb \
> -monitor stdio
qemu-system-aarch64: -drive file=/usr/local/share/qemu/edk2-aarch64-code.fd,if=ps
flash,format=raw,readonly=: Could not open '/usr/local/share/qemu/edk2-aarch64
-code.fd': No such file or directory
[(base) leihandeMacBook-Pro:~ s$ sudo apt update
Password:
The operation couldn't be completed. Unable to locate a Java Runtime that suppor
ts apt.
Please visit http://www.java.com for information on installing Java.

[(base) leihandeMacBook-Pro:~ s$ docker pull ubuntu
Using default tag: latest
latest: Pulling from library/ubuntu
d6cb415e2683: Pull complete
Digest: sha256:35fb073f9e56eb84041b0745cb714eff0f7b225ea9e024f703cab56aaa5c7720
Status: Downloaded newer image for ubuntu:latest
docker.io/library/ubuntu:latest
(base) leihandeMacBook-Pro:~ s$ ]
```

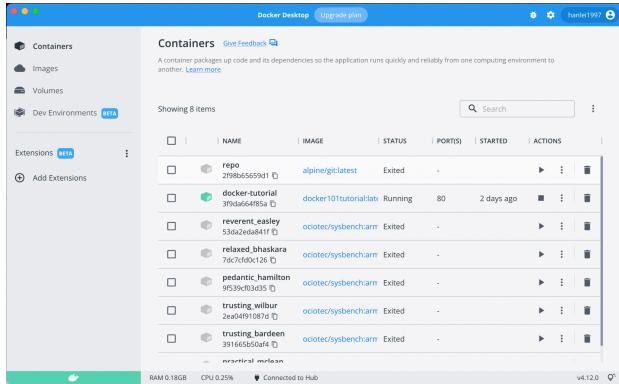
(4) Pull the Sysbench

with command line:

```
docker pull ljishen/sysbench
```

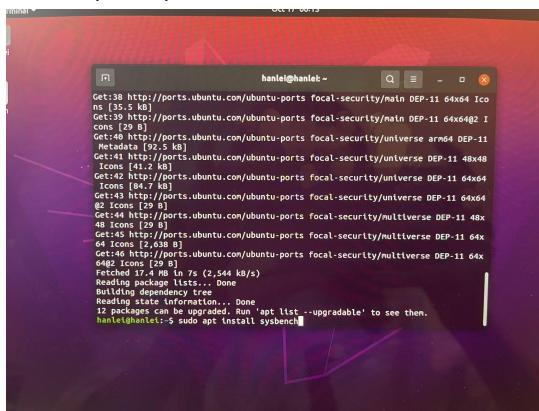
```
Using default tag: latest
latest: Pulling from library/ubuntu
d6cb415e2683: Pull complete
Digest: sha256:35fb073f9e56eb84041b0745cb714eff0f7b225ea9e024f703cab56aaa5c7720
Status: Downloaded newer image for ubuntu:latest
docker.io/library/ubuntu:latest
[(base) leihandeMacBook-Pro:~ s$ docker pull ljishen/sysbench
Using default tag: latest
latest: Pulling from ljishen/sysbench
d3938036b19c: Pull complete
a9b38c18b0da: Pull complete
67de21feec18: Pull complete
817da845be2b: Pull complete
d967c497e623: Pull complete
c797fd4a55: Pull complete
dcb0155f4fa0: Pull complete
d92cc4c925a1: Pull complete
78a798a5b260: Pull complete
5b53715882806: Pull complete
f611ff149be3: Pull complete
Digest: sha256:a2435f058903b9aeac96ebdf07261a2858c7d94330de387556d8e05d07277e6f
Status: Downloaded newer image for ljishen/sysbench:latest
docker.io/ljishen/sysbench:latest
(base) leihandeMacBook-Pro:~ s$ ]
```

In addition, please describe the operations you use to manage Docker containers (and some other operations which you think are also important): 10 points



o Proof of experiment. Include screen snapshots of your Docker and QEMU running environments for each experiment: 5 points

QEMU(UTM):



Docker:

```
s -- bash -- 80x24
(base) leihandeMacBook-Pro:~ s$ docker pull ljishen/sysbench
Using default tag: latest
latest: Pulling from ljishen/sysbench
d3938036b19c: Pull complete
a9b30c10bda: Pull complete
67de21feec18: Pull complete
817d545be2b: Pull complete
d9e7c497ce23: Pull complete
c79fdac43f26: Pull complete
dcb2b452f49d: Pull complete
d29cc6c925e1: Pull complete
78a798a3b240: Pull complete
5b5371582806: Pull complete
f611ff149be3: Pull complete
Digest: sha256:42635f058983b9aeac96ebdf07261a2858c7d94330de387556d8e05d07277e6f
Status: Downloaded newer image for ljishen/sysbench:latest
docker.io/ljishen/sysbench:latest
(base) leihandeMacBook-Pro:~ s$ docker image ls
REPOSITORY          TAG      IMAGE ID      CREATED       SIZE
docker10tutorial   latest   d191af9e0ee   21 hours ago  27.4MB
alpine/git          latest   8bfbb50cd816  10 days ago   43.4MB
ubuntu              latest   d63f752103bb  12 days ago   69.2MB
ljishen/sysbench    latest   c807fe90a55d6  4 years ago   372MB
(base) leihandeMacBook-Pro:~ s$
```

o Present how you use performance tools to collect performance data. For CPU utilization, you should at least divide them into two parts including user-level and kernel-level. For I/O, you should present I/O throughput, latency, and disk utilization:10 points

QEMU CPU:

(1) Test with the following command line:

```
$ sysbench --test=cpu --cpu-max-prime=25000 run
```

(2) Analysis:

the events per second of five experiments are:

3147.33, 3142.04, 3150.12, 3142.21, 3146.72

the total time of five experiments are(s):

10.0002, 10.0002, 10.0004, 10.0003, 10.0003, the average time is:10.0003

user-level:

kernel-level:

The image displays four terminal windows side-by-side, each showing the output of a sysbench CPU test. The terminals are labeled 'hanlei@hanlei: ~' at the top.

- User-level (Top Left):** Shows results for 3147.33 events per second. General statistics include a total time of 10.0002s and a total number of events of 31476. Latency statistics show a minimum of 0.31ms, an average of 0.32ms, a maximum of 0.79ms, a 95th percentile of 0.34ms, and a sum of 9974.01ms. Threads fairness shows 31476.0000/0.00 events and 9.9746/0.00 execution time.
- Kernel-level (Top Right):** Shows results for 3142.04 events per second. General statistics include a total time of 10.0002s and a total number of events of 31423. Latency statistics show a minimum of 0.31ms, an average of 0.32ms, a maximum of 0.81ms, a 95th percentile of 0.34ms, and a sum of 9972.51ms. Threads fairness shows 31423.0000/0.00 events and 9.9725/0.00 execution time.
- User-level (Bottom Left):** Shows results for 3150.12 events per second. General statistics include a total time of 10.0004s and a total number of events of 31505. Latency statistics show a minimum of 0.31ms, an average of 0.32ms, a maximum of 0.80ms, a 95th percentile of 0.34ms, and a sum of 9978.41ms. Threads fairness shows 31505.0000/0.00 events and 9.9784/0.00 execution time.
- Kernel-level (Bottom Right):** Shows results for 3142.21 events per second. General statistics include a total time of 10.0003s and a total number of events of 31425. Latency statistics show a minimum of 0.31ms, an average of 0.32ms, a maximum of 0.84ms, a 95th percentile of 0.34ms, and a sum of 9968.92ms. Threads fairness shows 31425.0000/0.00 events and 9.9689/0.00 execution time.

Docker CPU:

(1) Test with the following command line:

```
$ docker run ociotec/sysbench:arm32v7 sysbench --test=cpu --cpu-max-prime=25000 run
```

(2) Analysis:

the total time of execution of five experiments are(s):

383.2574, 380.8122, 498.9249, 385.0232, 385.7251, the average time is:1406.74856

```
total time taken by event execution: 12.515s
per-request statistics:
    min:                      0.29ms
    avg:                      1.20ms
    max:                      3.89ms
    approx. 95 percentile:     1.30ms

Threads fairness:
events (avg/stddev):   10000.0000/0.00
execution time (avg/stddev): 12.5154/0.00

(base) leihandeMacBook-Pro:- $ docker run ociote/sysbench:arm32v7 sysbench --test=cpu --cpu-max-prime=25000 run
WARNING: The requested image's platform (linux/arm) does not match the detected host platform (linux/arm64/v8) and no specific platform was requested
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: 25000

Test execution summary:
total time:           383.2574s
total number of events: 10000
total time taken by event execution: 383.2438s
per-request statistics:
    min:                      37.90ms
    avg:                      38.32ms
    max:                      55.91ms
    approx. 95 percentile:     38.78ms

Threads fairness:
events (avg/stddev):   10000.0000/0.00
execution time (avg/stddev): 383.2438/0.00

(base) leihandeMacBook-Pro:- $$
(base) leihandeMacBook-Pro:- $$

(base) leihandeMacBook-Pro:- $ docker run ociote/sysbench:arm32v7 sysbench --test=cpu --cpu-max-prime=25000 run
WARNING: The requested image's platform (linux/arm) does not match the detected host platform (linux/arm64/v8) and no specific platform was requested
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: 25000

Test execution summary:
total time:           380.8295s
total number of events: 10000
total time taken by event execution: 380.8122s
per-request statistics:
    min:                      37.55ms
    avg:                      38.68ms
    max:                      50.54ms
    approx. 95 percentile:     38.76ms

Threads fairness:
events (avg/stddev):   10000.0000/0.00
execution time (avg/stddev): 380.8122/0.00

(base) leihandeMacBook-Pro:- $$
(base) leihandeMacBook-Pro:- $

(base) leihandeMacBook-Pro:- $ docker run ociote/sysbench:arm32v7 sysbench --test=cpu --cpu-max-prime=25000 run
WARNING: The requested image's platform (linux/arm) does not match the detected host platform (linux/arm64/v8) and no specific platform was requested
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: 25000

Test execution summary:
total time:           498.9349s
total number of events: 10000
total time taken by event execution: 498.9191s
per-request statistics:
    min:                      37.55ms
    avg:                      49.89ms
    max:                      116210.25ms
    approx. 95 percentile:     39.81ms

Threads fairness:
events (avg/stddev):   10000.0000/0.00
execution time (avg/stddev): 498.9191/0.00

(base) leihandeMacBook-Pro:- $$
(base) leihandeMacBook-Pro:- $

(base) leihandeMacBook-Pro:- $ docker run ociote/sysbench:arm32v7 sysbench --test=cpu --cpu-max-prime=25000 run
WARNING: The requested image's platform (linux/arm) does not match the detected host platform (linux/arm64/v8) and no specific platform was requested
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: 25000

Test execution summary:
total time:           385.0232s
total number of events: 10000
total time taken by event execution: 385.0015s
per-request statistics:
    min:                      37.75ms
    avg:                      38.50ms
    max:                      51.45ms
    approx. 95 percentile:     39.13ms

Threads fairness:
events (avg/stddev):   10000.0000/0.00
execution time (avg/stddev): 385.0015/0.00

(base) leihandeMacBook-Pro:- $$
(base) leihandeMacBook-Pro:- $

(base) leihandeMacBook-Pro:- $ docker run ociote/sysbench:arm32v7 sysbench --test=cpu --cpu-max-prime=25000 run
WARNING: The requested image's platform (linux/arm) does not match the detected host platform (linux/arm64/v8) and no specific platform was requested
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: 25000

Test execution summary:
total time:           385.7251s
total number of events: 10000
total time taken by event execution: 385.7009s
per-request statistics:
    min:                      37.59ms
    avg:                      38.57ms
    max:                      50.05ms
    approx. 95 percentile:     40.74ms

Threads fairness:
events (avg/stddev):   10000.0000/0.00
execution time (avg/stddev): 385.7009/0.00

(base) leihandeMacBook-Pro:- $$
```

QEMU IO:

- (1) Test with the following command line:

```
$ 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
```

- (2) Analysis:

I/O throughput: the result of five experiments are:

read(MiB/s): 104.13, 93.32, 92.44, 103.05, 105.19, the mathematical average is:

written(MiB/s): 69.41, 62.20, 61.62, 68.70, 70.12, the mathematical average is:

Latency: the average result of five experiments are:

0.63, 0.70, 0.70, 0.63, 0.62, the mathematical average is: 0.66

reads/s:	6664.14
writes/s:	4441.93
fsyncs/s:	14418.37

read, MiB/s:	104.13
written, MiB/s:	69.41

total time:	10.0931s
total number of events:	255585

min:	0.00
avg:	0.63
max:	63.64
95th percentile:	1.79
sum:	159786.45

events (avg/stddev):	15974.0625/235.61
execution time (avg/stddev):	9.9867/0.00

reads/s:	5972.65
writes/s:	3981.11
fsyncs/s:	12934.27

read, MiB/s:	93.32
written, MiB/s:	62.20

total time:	10.1263s
total number of events:	229735

min:	0.00
avg:	0.70
max:	53.20
95th percentile:	2.00
sum:	159820.64

events (avg/stddev):	14358.4375/179.17
execution time (avg/stddev):	9.9888/0.00

reads/s:	5915.88
writes/s:	3943.85
fsyncs/s:	12821.17

read, MiB/s:	92.44
written, MiB/s:	61.62

total time:	10.1328s
total number of events:	227783

min:	0.00
avg:	0.70
max:	32.97
95th percentile:	2.03
sum:	159788.80

events (avg/stddev):	14236.4375/268.07
execution time (avg/stddev):	9.9868/0.00

reads/s:	6595.28
writes/s:	4396.69
fsyncs/s:	14262.95

read, MiB/s:	103.05
written, MiB/s:	68.70

total time:	10.1068s
total number of events:	253213

min:	0.00
avg:	0.63
max:	31.25
95th percentile:	1.89
sum:	159810.90

events (avg/stddev):	15825.8125/213.87
execution time (avg/stddev):	9.9882/0.00

```

Threads started!

File operations:
  reads/s:          6732.31
  writes/s:         4487.88
  fsyncs/s:        14561.12

Throughput:
  read, MiB/s:      105.19
  written, MiB/s:   70.12

General statistics:
  total time:       10.1063s
  total number of events: 258518

Latency (ms):
  min:              0.00
  avg:              0.62
  max:             32.45
  95th percentile:  1.86
  sum:            159779.08

Threads fairness:
  events (avg/stddev):    16157.3750/289.76
  execution time (avg/stddev): 9.9862/0.00

hanlei@hanlei:~$
```

Docker IO:

I use the following command lines to test but it didn't work

```
$sysbench fileio --threads=16 --file-total-size=10G --file-test-mode=rndrw prepare
$sysbench fileio --threads=16 --file-total-size=10G --file-test-mode=rndrw run
```

QEMU Disk utilization:

```

hanlei@hanlei:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G   0  1.9G  0% /dev
tmpfs           392M  1.7M 390M  1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv  30G  12G  17G  41% /
tmpfs           2.0G   0  2.0G  0% /dev/shm
tmpfs           5.0M  4.0K  5.0M  1% /run/lock
tmpfs           2.0G   0  2.0G  0% /sys/fs/cgroup
/dev/loop0       58M   58M   0 100% /snap/core20/1614
/dev/loop2       41M   41M   0 100% /snap/snapd/16299
/dev/loop1       62M   62M   0 100% /snap/lxd/22761
/dev/vda2       2.0G  112M  1.7G  7% /boot
/dev/vda1       1.1G  5.1M  1.1G  1% /boot/efi
tmpfs           392M  88K  392M  1% /run/user/1000
/dev/sr0         1.3G  1.3G   0 100% /media/hanlei/Ubuntu-Server 20.04.5 LTS arm64
/dev/loop3       42M   42M   0 100% /snap/snapd/17032
/dev/loop4       60M   60M   0 100% /snap/core20/1627
```

Docker Disk utilization:

\$df -h

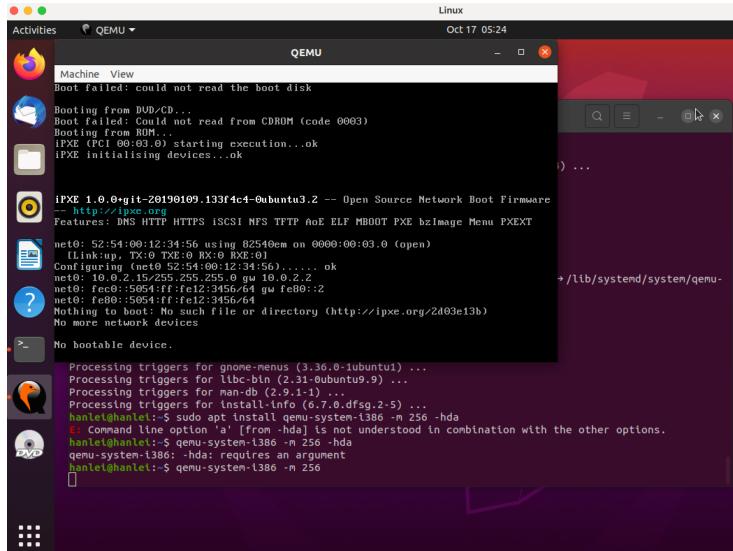
```

(base) leihandeMacBook-Pro:~ $ df -h
Filesystem      Size  Used Avail Capacity iused      ifree %iused Mounted on
/dev/disk3s3s1  4600i  220i 335Gi  7% 500632 3515076848  0% /
devfs           208Ki  0Bi 100%    718          0  100% /dev
/dev/disk3s6    4600i 1.0Gi 335Gi  1% 3515076848  0% /System/Volumes/V
/dev/disk3s4    4600i 692Mi 335Gi  1% 929 3515076848  0% /System/Volumes/Preboot
/dev/disk3s2    4600i 64Mi 335Gi  1% 204 3515076848  0% /System/Volumes/Prestart
/dev/disk1s2    508Mi 6.0Mi 480Mi  2% 1 4913648  0% /System/Volumes/Xarts
/dev/disk1s1    508Mi 7.3Mi 480Mi  2% 32 4913648  0% /System/Volumes/ISCPreboot
/dev/disk1s3    508Mi 2.0Mi 480Mi  1% 52 4913648  0% /System/Volumes/Hardware
/dev/disk3s1    4600i 99Gi 335Gi  23% 918492 3515076848  0% /System/Volumes/Data
map auto_home   0Bi  0Bi 100%    0          0  100% /System/Volumes/Data/home
/dev/disk3s3    4600i 220i 335Gi  7% 502878 3515076848  0% /System/Volumes/Update/mnt1
/dev/disk4s1    7.9Mi 5.6Mi 2.2Mi  72% 85 4294967194  0% /Volumes/Install Parallels Desktop
/dev/disk5s2    1.8Gi 1.6Gi 161Mi  92% 4443 4294962836  0% /Volumes/Docker
/dev/disk6s1    1.5Gi 1.1Gi 428Mi  72% 1033 4294962624  0% /Volumes/UTM
/Users/s/Downloads/Visual Studio Code.app 4600i 98Gi 337Gi  23% 982849 3533018120  0% /private/var/folders/nz/vn989ty94vbd0dh6y4z10tbr0000gp/
T/AppTranslocation/FC6EA16C-3D0B-40CE-BAF4-A60C8EB4239D
```

```
(base) leihandeMacBook-Pro:~ $ df -h
Filesystem      Size   Used  Avail Capacity iused   ifree %iused Mounted on
/dev/disk3s1     460Gi  220i  335Gi    7%  500632 3514793840  0%   /
devfs          298Ki  0Bi   100%    718      0  100%   /dev
/dev/disk3s6     460Gi  1.0Gi  335Gi   1%   1 3514793840  0%   /System/Volumes/VM
/dev/disk3s4     460Gi  6.0Gi  335Gi   1%   929 3514793840  0%   /System/Volumes/Boot
/dev/disk3s2     460Gi  6.47Mi  335Gi   1%   2048 3514793840  0%   /System/Volumes/Update
/dev/disk1s2     500Mi  0.0Mi  480Mi   2%   1 4933640  0%   /System/Volumes/Xarts
/dev/disk1s1     500Mi  0.3Mi  480Mi   2%   32 4933640  0%   /System/Volumes/ISCPboot
/dev/disk1s3     500Mi  2.0Mi  480Mi   1%   52 4933640  0%   /System/Volumes/Hardware
/dev/disk1s1     460Gi  99Gi   335Gi  23%  918954 3514793840  0%   /System/Volumes/Data
map auto_home    0Bi   0Bi   100%    0      0  100%   /System/Volumes/Data/home
/dev/disk3s3     460Gi  22Gi  335Gi   7%  502870 3514793840  0%   /System/Volumes/Update/mnt1
/dev/disk4s1     7.9Mi  5.6Mi  2.2Mi   72%   85 4294967194  0%   /Volumes/Install Parallels Desktop
/dev/disk4s2     1.8Gi  1.6Gi  161Mi   92%   4443 4294962836  0%   /Volumes/Docker
/dev/disk4s1     1.5Gi  1.1Gi  428Mi   72%   1833 4294966246  0%   /Volumes/UTM
/Users/~/Downloads/Visual Studio Code.app 460Gi  980i  337Gi   23%  982849 3533018120  0%   /private/var/folders/nz/vn989ty94vbd0dh6y4z10tbr0000gp/
T/AppTranslocation/FC6EA16C-3D0B-40CE-BAF4-A60C8EB4239D
```

- Present how you conduct your measurements in three different scenarios for each virtualization technology: 20 points

```
haneli@haneli:~ $ df -m
Filesystem      1M-blocks  Used Available Use% Mounted on
udev           1896       0  1896  0%   /dev
tmpfs          392        2   390  1%   /run
/dev/mapper/ubuntu--vg-ubuntu--lv  30538 11657  17306  41%   /
tmpfs          1959       0  1959  0%   /dev/shm
tmpfs           5         1   5  1%   /run/lock
tmpfs          1959       0  1959  0%   /sys/fs/cgroup
/dev/loop0        58        58   0 100%  /snap/core20/1614
/dev/loop2        41        41   0 100%  /snap/snapd/16299
/dev/loop1        62        62   0 100%  /snap/lxd/22761
/dev/vda2       1946      112  1717  7%   /boot
/dev/vda1       1073       6  1068  1%   /boot/efi
tmpfs          392        1   392  1%   /run/user/1000
/dev/sr0          1311     1311   0 100%  /media/haneli/Ubuntu-Server 20.04.5 LTS
arm64
/dev/loop3        42        42   0 100%  /snap/snapd/17032
/dev/loop4        60        60   0 100%  /snap/core20/1627
```



- Shell scripts for running the experiment: 20 points – In the git repository
- Git Repository Information: 5 points