ASSIGNMENT-2

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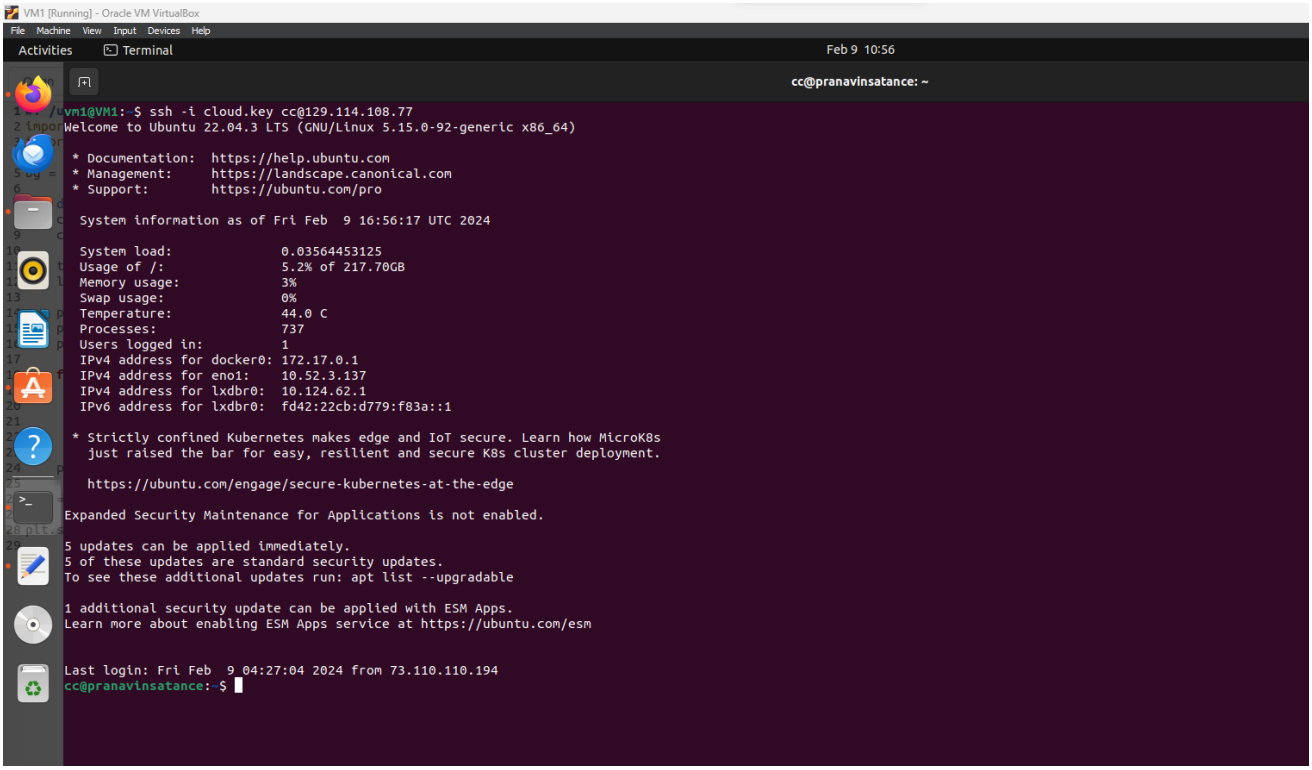
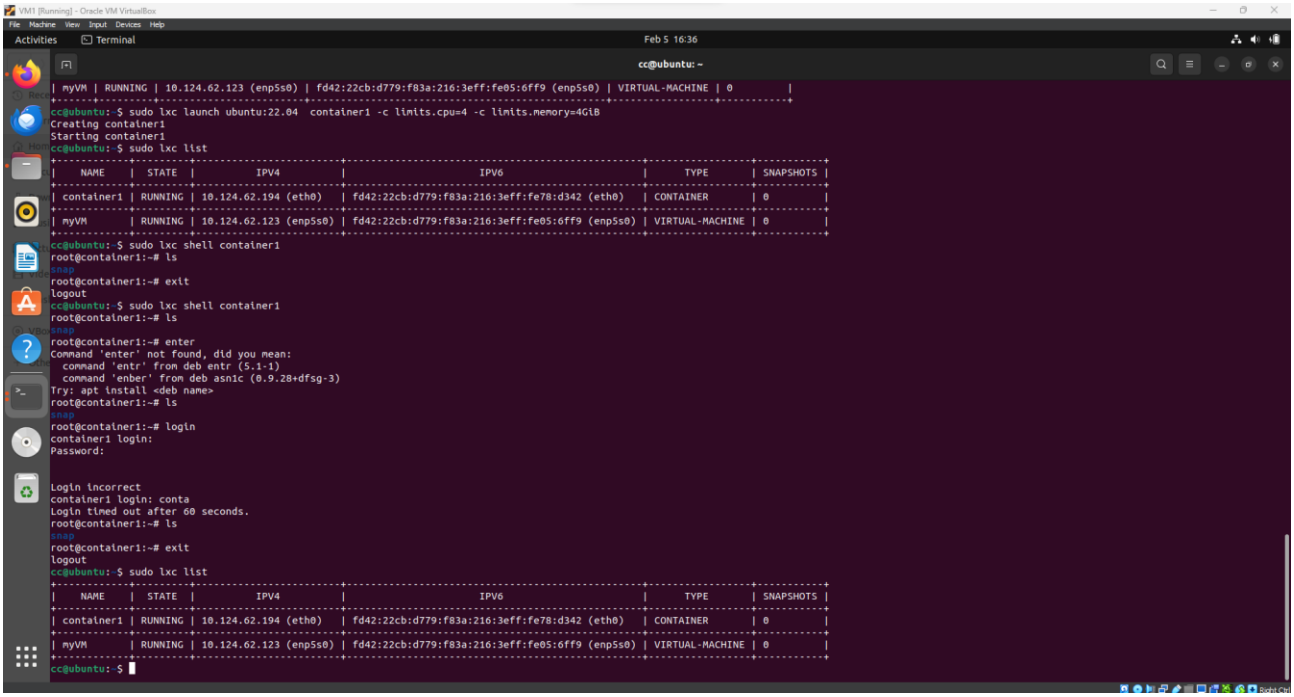
Cloud connection



Container and VM created



CPU:

- Strong scaling studies: Fixed prime numbers limit at 100,000. Then, measure the performance of each virtualization technologies when varying the number of threads.
- Sample command (you might need to use additional command line arguments):
  $ sysbench cpu --cpu-max-prime=100000 --threads=1 run
- Fill in the below using benchmark results of each scale regarding the processor performance:
  Note that the efficiency denotes a relative performance of a virtualization type vs. baremetal. EX:
  - Baremetal: 10 events per second
  - Container: 9 events per second
  - VM: 8 events per second

  This translates to the efficiency of:
  - Baremetal: 100%
  - Container: 90% (Container is 10% slower than Baremetal)
  - VM: 80% (VM is 20% slower than Baremetal)

Virtualization Type	Threads	Avg. Latency (ms)	Measured Throughput (Events per Second)	Efficiency
Baremetal	1	28.11	35.56	100
Container	1	28.26	35.37	99.47
Virtual Machine	1	28.37	35.23	99.07
Baremetal	2	28.12	71.06	100
Container	2	28.33	70.55	99.28
Virtual Machine	2	28.37	70.46	99.04
Baremetal	4	28.12	142.09	100
Container	4	30.38	131.19	92.33
Virtual Machine	4	28.30	141.28	99.34
Baremetal	8	28.09	284.27	100
Container	8	56.50	140.74	49.51
Virtual Machine	8	72.14	141.36	49.93
Baremetal	16	28.27	565.15	100
Container	16	112.09	141.44	25.03
Virtual Machine	16	112.29	141.84	25.13
Baremetal	32	31.92	1000.04	100
Container	32	222.57	141.43	14.14
Virtual Machine	32	223.62	141.77	14.20
Baremetal	64	48.48	1317.14	100
Container	64	439.57	141.66	10.76
Virtual Machine	64	442.07	142.09	10.70

```
cc@pranavinsatance:~$ sudo lxc shell container1
root@container1:~# nano networkcontainer.sh
root@container1:~# ./cputextcontainer.sh
Threads Avg. Latency (ms)       Measured Throughput (Events per Second)
1       28.26   35.37
2       28.33   70.55
4       30.38   131.19
8       56.50   140.74
16      112.09  141.44
32      222.57  141.43
64      439.57  141.66
root@container1:~#
```

```
cc@pranavinsatance: ~
cc@pranavinsatance:~$ ./cputestbare.sh
Threads Avg. Latency (ms)       Measured Throughput (Events per Second) Efficiency
1       28.11   35.56   100.00
2       28.12   71.06   100.00
4       28.12   142.09  100.00
8       28.09   284.27  100.00
16      28.27   565.15  100.00
32      31.92   1000.04 100.00
64      48.48   1317.14 100.00
cc@pranavinsatance:~$
```

```
root@myVM:~# nano cputestvm.sh
root@myVM:~# ./cputestvm.sh
Threads Avg. Latency (ms)       Measured Throughput (Events per Second)
1       28.37   35.23
2       28.37   70.46
4       28.30   141.28
16      112.29  141.84
32      223.62  141.77
64      442.07  142.09
root@myVM:~#
```

Efficiency = (vm or container measured Throughput/baremetal measured Throughput)*100

Memory:

- Strong scaling studies: Fixed total data size in memory at 120GB. Then, measure the performance of each virtualization technologies with the following specifications:
  a. Block size: 1KB i.e., 2^{10} to 2^{20} bytes
  b. Operations: Read
  c. Access pattern: Random
- Sample command:
  $ sysbench memory --memory-block-size=1K --memory-total-size=120G --threads=1 run
- Fill in the below using benchmark results of each scale/type regarding the memory performance: Similar to efficiency example in CPU benchmark, the efficiency denotes a relative performance of a virtualization type vs. baremetal.

Virtualization Type	Threads	Block Size (KB)	Operation	Access Pattern	Total Operations	Throughput (MiB/sec)	Efficiency
Baremetal	1	1	Read	Random	47578731	4645.04	100
Container	1	1	Read	Random	41161665	4017.73	86.50
Virtual Machine	1	1	Read	Random	42375020	4136.19	89.05
Baremetal	2	1	Read	Random	62988787	6149.59	100
Container	2	1	Read	Random	59958945	5854.04	95.19
Virtual Machine	2	1	Read	Random	56073237	5473.29	89.00
Baremetal	4	1	Read	Random	61182239	5973.20	100
Container	4	1	Read	Random	33080994	3229.84	54.07
Virtual Machine	4	1	Read	Random	69210308	6757.30	113.13
Baremetal	8	1	Read	Random	41076365	4010.25	100
Container	8	1	Read	Random	32991963	3221.17	80.32
Virtual Machine	8	1	Read	Random	69360870	6772.17	168.87
Baremetal	16	1	Read	Random	39400751	3846.83	100
Container	16	1	Read	Random	32520912	3175.17	82.54
Virtual Machine	16	1	Read	Random	69620981	6797.54	176.70
Baremetal	32	1	Read	Random	52018301	5078.69	100
Container	32	1	Read	Random	32623170	3185.09	62.71
Virtual Machine	32	1	Read	Random	71327932	6964.11	137.12
Baremetal	64	1	Read	Random	70963582	6928.38	100
Container	64	1	Read	Random	33146373	3236.09	46.71
Virtual Machine	64	1	Read	Random	70046274	6838.87	98.71

```
cc@pranavinsatance:~$ ./networkbare.sh
Threads Total Operations        Throughput (MiB/sec)
1       47578731        4645.04
2       62988787        6149.59
4       61182239        5973.20
8       41076365        4010.25
16      39400751        3846.83
32      52018301        5078.69
64      70963582        6928.38
cc@pranavinsatance:~$ nano networkbare.sh
cc@pranavinsatance:~$ sudo lxc shell myVM
root@myVM:~# nano networkvm.sh
root@myVM:~# ./networkvm.sh
-bash: ./networkvm.sh: Permission denied
root@myVM:~# chmod u+x networkvm.sh
root@myVM:~# ./networkvm.sh
Threads Total Operations        Throughput (MiB/sec)
1       42375020        4136.19
2       56073237        5473.29
4       69210308        6757.30
8       69360870        6772.17
16      69620981        6797.54
32      71327932        6964.11
64      70046274        6838.87
root@myVM:~# exit
logout
cc@pranavinsatance:~$ sudo lxc shell container
Error: Instance not found
cc@pranavinsatance:~$ sudo lxc shell container1
root@container1:~# nano networkcontainer.sh
root@container1:~# ./networkcontainer.sh
-bash: ./networkcontainer.sh: Permission denied
root@container1:~# chmod u+x networkcontainer.sh
root@container1:~# ./networkcontainer.sh
Threads Total Operations        Throughput (MiB/sec)
1       41161665        4017.73
2       59958945        5854.04
4       33080994        3229.84
8       32991963        3221.17
16      32520912        3175.17
32      32623170        3185.09
64      33146373        3236.09
root@container1:~# exit
logout
```

Disk:

- Strong scaling studies: Fixed total data size on disk at 120GB. Then, measure the performance of each virtualization technologies with the following specifications:
  a. Number of files: 128
  b. File block size: 4,096 bytes
  c. Total file size: 120GB
  d. Test mode: Random Read
  e. IO Mode: Synchronous
  f. Extra IO flag: DirectIO
- Sample commands:
  $ sysbench fileio --file-num=128 --file-block-size=4096 --file-total-size=120G --file-test-mode=rndrd --file-io-mode=sync --file-extra-flags=direct --threads=1 <prepare/run/cleanup>
- Fill in the below using benchmark results of each scale/type regarding the I/O performance:
- Similar to efficiency example in CPU benchmark, the efficiency denotes a relative performance of a virtualization type vs. baremetal.

Virtualization Type	Threads	Block Size (KB)	Operation	Access Pattern	I/O Mode	I/O Flag	Total Operations	Measured Throughput (MiB/s)	Efficiency
Baremetal	1	4	Read	Random	SYNC	DirectIO			
Container	1	4	Read	Random	SYNC	DirectIO	381570		
Virtual Machine	1	4	Read	Random	SYNC	DirectIO			
Baremetal	2	4	Read	Random	SYNC	DirectIO			
Container	2	4	Read	Random	SYNC	DirectIO	737237		
Virtual Machine	2	4	Read	Random	SYNC	DirectIO			
Baremetal	4	4	Read	Random	SYNC	DirectIO			
Container	4	4	Read	Random	SYNC	DirectIO	1315837		
Virtual Machine	4	4	Read	Random	SYNC	DirectIO			
Baremetal	8	4	Read	Random	SYNC	DirectIO			
Container	8	4	Read	Random	SYNC	DirectIO	1306997		
Virtual Machine	8	4	Read	Random	SYNC	DirectIO			
Baremetal	16	4	Read	Random	SYNC	DirectIO			
Container	16	4	Read	Random	SYNC	DirectIO	1300893		
Virtual Machine	16	4	Read	Random	SYNC	DirectIO			
Baremetal	32	4	Read	Random	SYNC	DirectIO			
Container	32	4	Read	Random	SYNC	DirectIO	1295967		
Virtual Machine	32	4	Read	Random	SYNC	DirectIO			
Baremetal	64	4	Read	Random	SYNC	DirectIO			
Container	64	4	Read	Random	SYNC	DirectIO	1304732		
Virtual Machine	64	4	Read	Random	SYNC	DirectIO			

```
cc@pranavinsatance:~$ sudo lxc shell container1
root@container1:~# nano 3.sh
root@container1:~#  ./3.sh
Threads: 1 | Total Operations:  | Measured Throughput:
Threads: 1 | Total Operations: 381570 | Measured Throughput:
Threads: 2 | Total Operations: 737237 | Measured Throughput:
Threads: 4 | Total Operations: 1315837 | Measured Throughput:
Threads: 8 | Total Operations: 1306997 | Measured Throughput:
Threads: 16 | Total Operations: 1300893 | Measured Throughput:
Threads: 32 | Total Operations: 1295967 | Measured Throughput:
Threads: 64 | Total Operations: 1304732 | Measured Throughput:
Threads: 1 | Total Operations:  | Measured Throughput:
```

Network:

- Strong scaling studies using one server vs. *N* number of clients. Measure the performance of each virtualization technologies with the following specifications:
  a. Server TCP window size: 1MB
  b. Client TCP write buffer size: 8,192KB
  c. Client TCP window size: 2.5MB
  d. Naggle algorithm: Off
- The configuration of client/server should communicate using TCP over local loopback.
- Sample commands:
  $ iperf -s -w 1M
  $ iperf -c 127.0.0.1 -e -i 1 --nodelay -l 8192K --trip-times --parallel 1
- Fill in the below using benchmark results of each scale/type regarding the I/O performance:
- Similar to efficiency example in CPU benchmark, the efficiency denotes a relative performance of a virtualization type vs. baremetal.

Virtualization Type	Server	Client Threads	Latency (ms)	Measured Throughput (Gbits/s)	Efficiency
Baremetal	1	1	1.910	46.3	
Container	1	1	2.037	42.7	
Virtual Machine	1	1	2.137	40.1	
Baremetal	1	2	2.110	41.5	
Container	1	2	2.055	41.2	
Virtual Machine	1	2	2.035	42.8	
Baremetal	1	4	2.133	40.8	
Container	1	4	3.727	23.5	
Virtual Machine	1	4	1.809	43.5	
Baremetal	1	8	2.656	32.4	
Container	1	8	4.549	14.9	
Virtual Machine	1	8	3.717	18.9	
Baremetal	1	16	3.241	26.7	
Container	1	16	10.28	6.45	
Virtual Machine	1	16	7.763	9.03	
Baremetal	1	32	5.571	15.9	
Container	1	32	17.765	4.9	
Virtual Machine	1	32	15.800	4.95	
Baremetal	1	64	7.437	13.3	
Container	1	64	22.657	3.06	
Virtual Machine	1	64	37.145	1.66	

System used

Chameleon Instance: compute_haswell_ib at CHI@NACC
o CPU: 2x Intel® Xeon® E5-2670 v3 @2.30GHz
o Memory: 8x 16GB (128GB) of DDR4-2,133 ECC Registered RAM
o Disk: 1x Seagate ST9250610NS SATA 7,200 RPM HDD
o Network: Broadcom NetXtreme II BCM57800 1/10 Gigabit Ethernet