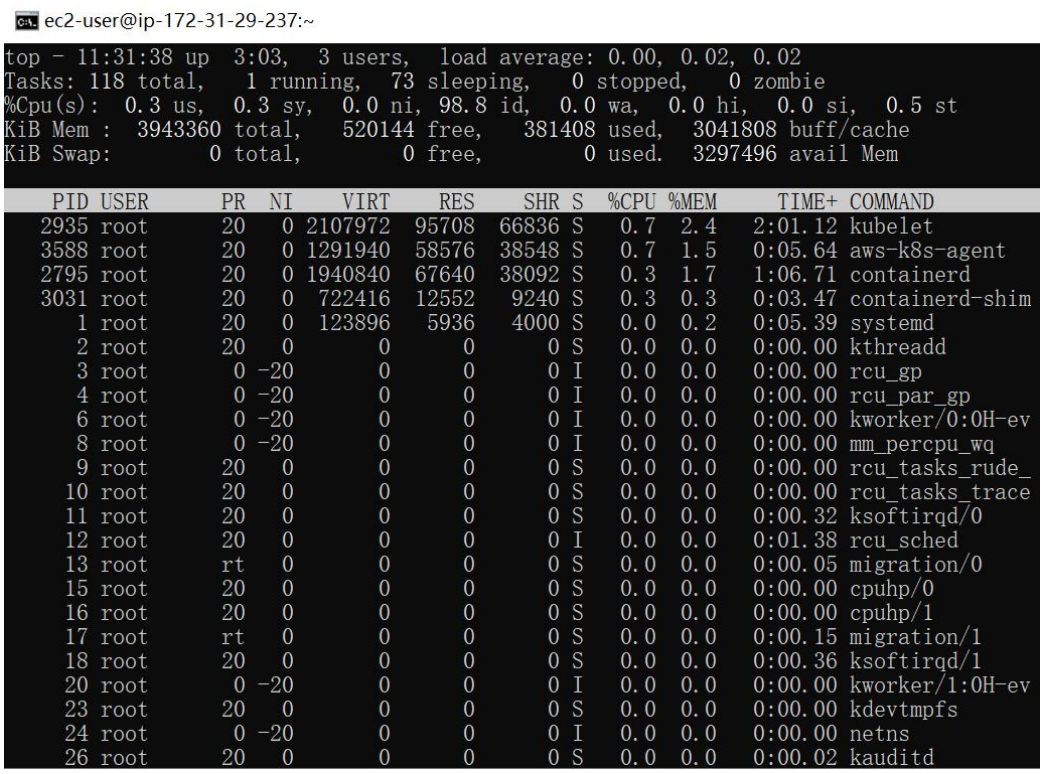
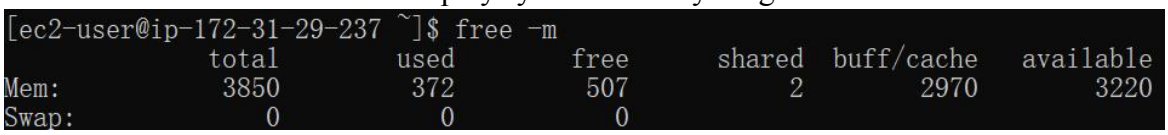
Overall Performance of CPU and memory:

Utilize '**top**' command to display the overall performance of CPU and memory.



Memory:

Use the '**free -m**' command to display system memory usage:



Internet:

a) Network Throughput Test:

Use iperf3 to test the cluster performance of Kubernetes:

For server node: '**iperf3 -s**'

For client node: '**iperf3 -c [IP adress of server node]**'

Result on server node:

```
[ec2-user@ip-172-31-84-95 ~]$ iperf3 -s
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 172.31.29.237, port 38512
[  5] local 172.31.84.95 port 5201 connected to 172.31.29.237 port 38518
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-1.00   sec   499 MBytes  4.19 Gbits/sec
[  5]   1.00-2.00   sec   503 MBytes  4.22 Gbits/sec
[  5]   2.00-3.00   sec   510 MBytes  4.27 Gbits/sec
[  5]   3.00-4.00   sec   529 MBytes  4.44 Gbits/sec
[  5]   4.00-5.00   sec   518 MBytes  4.34 Gbits/sec
[  5]   5.00-6.00   sec   541 MBytes  4.53 Gbits/sec
[  5]   6.00-7.00   sec   532 MBytes  4.47 Gbits/sec
[  5]   7.00-8.00   sec   529 MBytes  4.44 Gbits/sec
[  5]   8.00-9.00   sec   532 MBytes  4.46 Gbits/sec
[  5]   9.00-10.00  sec   536 MBytes  4.50 Gbits/sec
[  5]  10.00-10.04  sec  18.8 MBytes  3.79 Gbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-10.04  sec  0.00 Bytes  0.00 bits/sec                  sender
[  5]   0.00-10.04  sec  5.13 GBytes  4.38 Gbits/sec                  receiver
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
^Ciperf3: interrupt - the server has terminated
[ec2-user@ip-172-31-84-95 ~]$
```

Result on client node:

```
[ec2-user@ip-172-31-29-237 ~]$ iperf3 -c 172.31.84.95
Connecting to host 172.31.84.95, port 5201
[  4] local 172.31.29.237 port 38518 connected to 172.31.84.95 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec   525 MBytes  4.39 Gbits/sec   39   2.42 MBytes
[  4]   1.00-2.00   sec   502 MBytes  4.23 Gbits/sec   22   1.94 MBytes
[  4]   2.00-3.00   sec   509 MBytes  4.27 Gbits/sec    0   2.16 MBytes
[  4]   3.00-4.00   sec   531 MBytes  4.45 Gbits/sec    3   1.79 MBytes
[  4]   4.00-5.00   sec   516 MBytes  4.33 Gbits/sec    0   2.07 MBytes
[  4]   5.00-6.00   sec   541 MBytes  4.54 Gbits/sec    0   2.22 MBytes
[  4]   6.00-7.00   sec   530 MBytes  4.45 Gbits/sec    0   2.36 MBytes
[  4]   7.00-8.00   sec   529 MBytes  4.44 Gbits/sec    1   1.89 MBytes
[  4]   8.00-9.00   sec   535 MBytes  4.49 Gbits/sec    0   2.13 MBytes
[  4]   9.00-10.00  sec   532 MBytes  4.47 Gbits/sec    2   1.79 MBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  5.13 GBytes  4.41 Gbits/sec   67             sender
[  4]   0.00-10.00  sec  5.13 GBytes  4.40 Gbits/sec                  receiver

iperf Done.
[ec2-user@ip-172-31-29-237 ~]$
```

iperf3 supports direct conversion of the data sending direction, so we use the iperf3 command on the client, set the report echo interval to 1s, the test time to 10s, and set up the reverse test for testing:

On server node: '**iperf3 -c [IP adress of server node] -i 1 -t 10 -R**'

Result on server node:

```
[ec2-user@ip-172-31-84-95 ~]$ iperf3 -s
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 172.31.29.237, port 35990
[  5] local 172.31.84.95 port 5201 connected to 172.31.29.237 port 35994
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  5]   0.00-1.00   sec   510 MBytes  4.27 Gbits/sec   17   1.60 MBytes
[  5]   1.00-2.00   sec   528 MBytes  4.42 Gbits/sec    0   2.00 MBytes
[  5]   2.00-3.00   sec   540 MBytes  4.53 Gbits/sec   21   1.51 MBytes
[  5]   3.00-4.00   sec   526 MBytes  4.41 Gbits/sec    5   1.81 MBytes
[  5]   4.00-5.00   sec   536 MBytes  4.50 Gbits/sec    0   2.03 MBytes
[  5]   5.00-6.00   sec   522 MBytes  4.38 Gbits/sec    0   2.17 MBytes
[  5]   6.00-7.00   sec   542 MBytes  4.55 Gbits/sec    0   2.31 MBytes
[  5]   7.00-8.00   sec   536 MBytes  4.50 Gbits/sec    0   2.45 MBytes
[  5]   8.00-9.00   sec   536 MBytes  4.50 Gbits/sec    8   1.89 MBytes
[  5]   9.00-10.00  sec   539 MBytes  4.51 Gbits/sec    0   2.18 MBytes
[  5]  10.00-10.04  sec  18.8 MBytes  3.85 Gbits/sec    0   2.18 MBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  5]   0.00-10.04  sec  5.21 GBytes  4.46 Gbits/sec   51             sender
[  5]   0.00-10.04  sec  0.00 Bytes  0.00 bits/sec                  receiver
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
```

Result on client node:

```
[ec2-user@ip-172-31-29-237 ~]$ iperf3 -c 172.31.84.95 -i 1 -t 10 -R
Connecting to host 172.31.84.95, port 5201
Reverse mode, remote host 172.31.84.95 is sending
[  4] local 172.31.29.237 port 35994 connected to 172.31.84.95 port 5201
[ ID] Interval           Transfer     Bandwidth
[  4]   0.00-1.00   sec   527 MBytes  4.42 Gbits/sec
[  4]   1.00-2.00   sec   530 MBytes  4.44 Gbits/sec
[  4]   2.00-3.00   sec   541 MBytes  4.54 Gbits/sec
[  4]   3.00-4.00   sec   526 MBytes  4.41 Gbits/sec
[  4]   4.00-5.00   sec   536 MBytes  4.50 Gbits/sec
[  4]   5.00-6.00   sec   522 MBytes  4.38 Gbits/sec
[  4]   6.00-7.00   sec   545 MBytes  4.57 Gbits/sec
[  4]   7.00-8.00   sec   533 MBytes  4.47 Gbits/sec
[  4]   8.00-9.00   sec   535 MBytes  4.49 Gbits/sec
[  4]   9.00-10.00  sec   538 MBytes  4.52 Gbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  5.21 GBytes  4.47 Gbits/sec   51             sender
[  4]   0.00-10.00  sec  5.21 GBytes  4.47 Gbits/sec                  receiver

iperf Done.
[ec2-user@ip-172-31-29-237 ~]$
```

b) Network Latency Test

Use '**ping**' command to test the network latency:

```
[ec2-user@ip-172-31-29-237 ~]$ ping 172.31.84.95
PING 172.31.84.95 (172.31.84.95) 56(84) bytes of data.
64 bytes from 172.31.84.95: icmp_seq=1 ttl=255 time=0.425 ms
64 bytes from 172.31.84.95: icmp_seq=2 ttl=255 time=0.420 ms
64 bytes from 172.31.84.95: icmp_seq=3 ttl=255 time=0.437 ms
64 bytes from 172.31.84.95: icmp_seq=4 ttl=255 time=0.426 ms
64 bytes from 172.31.84.95: icmp_seq=5 ttl=255 time=0.478 ms
64 bytes from 172.31.84.95: icmp_seq=6 ttl=255 time=0.500 ms
64 bytes from 172.31.84.95: icmp_seq=7 ttl=255 time=0.416 ms
64 bytes from 172.31.84.95: icmp_seq=8 ttl=255 time=0.403 ms
64 bytes from 172.31.84.95: icmp_seq=9 ttl=255 time=0.393 ms
64 bytes from 172.31.84.95: icmp_seq=10 ttl=255 time=0.406 ms
64 bytes from 172.31.84.95: icmp_seq=11 ttl=255 time=0.411 ms
64 bytes from 172.31.84.95: icmp_seq=12 ttl=255 time=0.394 ms
64 bytes from 172.31.84.95: icmp_seq=13 ttl=255 time=0.444 ms
64 bytes from 172.31.84.95: icmp_seq=14 ttl=255 time=0.406 ms
64 bytes from 172.31.84.95: icmp_seq=15 ttl=255 time=0.376 ms
64 bytes from 172.31.84.95: icmp_seq=16 ttl=255 time=0.425 ms
^C
--- 172.31.84.95 ping statistics ---
16 packets transmitted, 16 received, 0% packet loss, time 15364ms
rtt min/avg/max/mdev = 0.376/0.422/0.500/0.036 ms
[ec2-user@ip-172-31-29-237 ~]$
```

Disk read and write:

First, we use the '**sudo fio -filename=[path to test file] -direct=1 -iodepth 1 -thread -rw=read -ioengine=psync -bs=16k -size=2G -numjobs=10 -runtime=60 -group_reporting -name=test_r**' command to perform a sequential read benchmark on a file test.file located in /var, using the psync I/O engine with a block size of 16k and a file size of 2GB. The test will run for 60 seconds, using 10 threads or processes, and the results will be grouped by the job name test_r. The result is like below:

```
[ec2-user@ip-172-31-29-237 ~]$ sudo fio -filename=/var/test.file -direct=1 -iodepth 1 -thread -rw=read -ioengine=psync -
bs=16k -size=2G -numjobs=10 -runtime=60 -group_reporting -name=test_r
test_r: (g=0): rw=read, bs=16K-16K/16K-16K/16K-16K, ioengine=psync, iodepth=1
...
fio-2.14
Starting 10 threads
test_r: Laying out IO file(s) (1 file(s) / 2048MB)
Jobs: 10 (f=10): [R(10)] [100.0% done] [48016KB/0KB/0KB /s] [3001/0/0 iops] [eta 00m:00s]
test_r: (groupid=0, jobs=10): err= 0: pid=72458: Sun Apr 21 11:57:25 2024
  read : io=2855.8MB, bw=48735KB/s, iops=3045, runt= 60003msec
    clat (usec): min=187, max=14450, avg=3281.13, stdev=888.12
     lat (usec): min=187, max=14450, avg=3281.28, stdev=888.12
    clat percentiles (usec):
     |  1.00th=[  490],  5.00th=[ 1848], 10.00th=[ 2288], 20.00th=[ 2800],
     | 30.00th=[ 3088], 40.00th=[ 3248], 50.00th=[ 3312], 60.00th=[ 3408],
     | 70.00th=[ 3536], 80.00th=[ 3760], 90.00th=[ 4192], 95.00th=[ 4576],
     | 99.00th=[ 5664], 99.50th=[ 6560], 99.90th=[ 8896], 99.95th=[ 9536],
     | 99.99th=[11712]
    lat (usec) : 250=0.05%, 500=1.00%, 750=1.03%, 1000=0.44%
    lat (msec) : 2=3.95%, 4=79.83%, 10=13.67%, 20=0.04%
  cpu          : usr=0.15%, sys=0.30%, ctx=182915, majf=0, minf=40
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued    : total=r=182765/w=0/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
   READ: io=2855.8MB, aggrb=48734KB/s, minb=48734KB/s, maxb=48734KB/s, mint=60003msec, maxt=60003msec

Disk stats (read/write):
  nvme0n1: ios=182641/40, merge=0/3, ticks=595415/149, in_queue=595564, util=99.90%
[ec2-user@ip-172-31-29-237 ~]$
```

Perform a random write benchmark. The results will be grouped by the job test_randw: '**sudo fio -filename=[path to test file] -direct=1 -iodepth 1 -thread -rw=randwrite**

-ioengine=psync -bs=16k -size=2G -numjobs=10 -runtime=60 -group_reporting -name=test_randw’.

The result is like below:

```
[ec2-user@ip-172-31-29-237 ~]$ sudo fio -filename=/var/test.file -direct=1 \
>  -iodepth 1 -thread -rw=randwrite \
>  -ioengine=psync -bs=16k -size=2G -numjobs=10 \
>  -runtime=60 -group_reporting -name=test_randw
test_randw: (g=0): rw=randwrite, bs=16K-16K/16K-16K/16K-16K, ioengine=psync, iodepth=1
...
fio-2.14
Starting 10 threads
Jobs: 10 (f=10): [w(10)] [100.0% done] [0KB/47984KB/0KB /s] [0/2999/0 iops] [eta 00m:00s]
test_randw: (groupid=0, jobs=10): err= 0: pid=73199: Sun Apr 21 11:59:59 2024
  write: io=2857.2MB, bw=48760KB/s, iops=3047, runt= 60003msec
    clat (usec): min=651, max=14998, avg=3278.69, stdev=777.93
     lat (usec): min=652, max=14999, avg=3279.29, stdev=777.95
    clat percentiles (usec):
     |  1.00th=[  932],  5.00th=[ 2024], 10.00th=[ 2448], 20.00th=[ 2864],
     | 30.00th=[ 3120], 40.00th=[ 3248], 50.00th=[ 3312], 60.00th=[ 3376],
     | 70.00th=[ 3472], 80.00th=[ 3696], 90.00th=[ 4048], 95.00th=[ 4384],
     | 99.00th=[ 5408], 99.50th=[ 6304], 99.90th=[ 8384], 99.95th=[ 9280],
     | 99.99th=[11840]
    lat (usec) : 750=0.06%, 1000=1.47%
    lat (msec) : 2=3.35%, 4=83.55%, 10=11.53%, 20=0.03%
  cpu          : usr=0.18%, sys=0.30%, ctx=183068, majf=0, minf=0
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued    : total=r=0/w=182858/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
  WRITE: io=2857.2MB, aggrb=48759KB/s, minb=48759KB/s, maxb=48759KB/s, mint=60003msec, maxt=60003msec

Disk stats (read/write):
  nvme0n1: ios=4/182679, merge=0/1, ticks=12/595253, in_queue=595265, util=99.87%
[ec2-user@ip-172-31-29-237 ~]$
```

Perform a sequential write benchmar. The results will be grouped by the job test_w:

‘**sudo fio -filename=[path to test file] -direct=1 -iodepth 1 -thread -rw=write -ioengine=psync -bs=16k -size=2G -numjobs=10 -runtime=60 -group_reporting -name=test_w**’

The result is like below:

```
[ec2-user@ip-172-31-29-237 ~]$ sudo fio -filename=/var/test.file -direct=1 \
>  -iodepth 1 -thread -rw=write \
>  -ioengine=psync -bs=16k -size=2G -numjobs=10 \
>  -runtime=60 -group_reporting -name=test_w
test_w: (g=0): rw=write, bs=16K-16K/16K-16K/16K-16K, ioengine=psync, iodepth=1
...
fio-2.14
Starting 10 threads
Jobs: 10 (f=10): [W(10)] [100.0% done] [0KB/48048KB/0KB /s] [0/3003/0 iops] [eta 00m:00s]
test_w: (groupid=0, jobs=10): err= 0: pid=73893: Sun Apr 21 12:02:14 2024
  write: io=2854.7MB, bw=48716KB/s, iops=3044, runt= 60004msec
    clat (usec): min=665, max=23950, avg=3281.94, stdev=833.14
     lat (usec): min=666, max=23950, avg=3282.52, stdev=833.11
    clat percentiles (usec):
     |  1.00th=[ 1004],  5.00th=[ 1944], 10.00th=[ 2384], 20.00th=[ 2864],
     | 30.00th=[ 3120], 40.00th=[ 3248], 50.00th=[ 3312], 60.00th=[ 3376],
     | 70.00th=[ 3472], 80.00th=[ 3696], 90.00th=[ 4080], 95.00th=[ 4384],
     | 99.00th=[ 5600], 99.50th=[ 6688], 99.90th=[ 9408], 99.95th=[10816],
     | 99.99th=[17792]
    lat (usec) : 750=0.02%, 1000=0.98%
    lat (msec) : 2=4.34%, 4=82.88%, 10=11.71%, 20=0.07%, 50=0.01%
  cpu          : usr=0.18%, sys=0.31%, ctx=182873, majf=0, minf=0
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued    : total=r=0/w=182696/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
  WRITE: io=2854.7MB, aggrb=48715KB/s, minb=48715KB/s, maxb=48715KB/s, mint=60004msec, maxt=60004msec

Disk stats (read/write):
  nvme0n1: ios=0/182676, merge=0/5, ticks=0/595178, in_queue=595178, util=99.85%
[ec2-user@ip-172-31-29-237 ~]$
```