

## **Module 1: Critical Thinking**

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CSC507-2: Foundations of Operating Systems

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## Critical Thinking 1

Week 1's critical thinking assignment was an introduction to the Linux operating system. We were tasked with installing Linux on our computers and used shell commands to determine the specifications of four main structural components of our computer. This consisted of the processor, main memory, I/O modules, and storage devices.

### Processor

Figure 1 displays a screenshot of the shell command used to obtain the system's processor information. Here, the "lscpu" command (geeksforgeeks.org, December 8, 2023) was executed to gather details about the CPU configuration.

**Figure 1:** Processor shell command (image also attached in submission)

```
ubuntu@ubuntu:~$ lscpu
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Address sizes:          39 bits physical, 48 bits virtual
Byte Order:             Little Endian
CPU(s):                 8
On-line CPU(s) list:    0-7
Vendor ID:              GenuineIntel
Model name:             11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz
CPU family:             6
Model:                  140
Thread(s) per core:     2
Core(s) per socket:     4
Socket(s):              1
Stepping:               1
CPU(s) scaling MHz:     29%
CPU max MHz:            4800.0000
CPU min MHz:            400.0000
BogoMIPS:               5000.40
Flags:                  fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge n
ca cmov pat pse36 clflush dts acpi mmx fxsr sse sse2 s
s ht tm pbe syscall nx pdpe1gb rdtscp lm constant-tsc
art arch_perfmon pebs bts rep_good nopl xtopology nonst
op_tsc cpuid aperfmperf tsc_known_freq pni pclmulqdq
dtes64 monitor ds_cpl vnx est tni sse3 sdbg fma cx16
xtpr pcdm pcid sse4_1 sse4_2 x2apic movbe popcnt tsc_d
eadline_timer aes xsave avx f16c rdrand lahf_lm abm 3d
nowprefetch cpuid_fault epb cat_l2 cdp_l2 ssbd btrr lb
pb stibp lbrs_enhanced tpr_shadow flexpriority ept vpl
d ept_ad fsgsbase tsc_adjust bmi1 avx2 smep bmi2 erms
invpcid rdtd_a avx512f avx512dq rdseed adx smap avx512l
fma cflushopt clwb intel_pt avx512cd sha_ni avx512bw
avx512vl xsaveopt xsavec xgetbv1 xsaves split_lock_det
ect user_shstk dtherm ida arat pln pts hwp hwp_notify
hwp_act_window hwp_epp hwp_pkg_req vmmi avx512vbmi umi
p_kv ospke avx512_vbmi2 gfni vaes vpclmulqdq avx512_v
noi avx512_bitalg avx512_vpopcntdq rdpld movdiri movdi
r64b farr avx512_vp2intersect md_clear ibt flush_l3d a
rch_capabilities

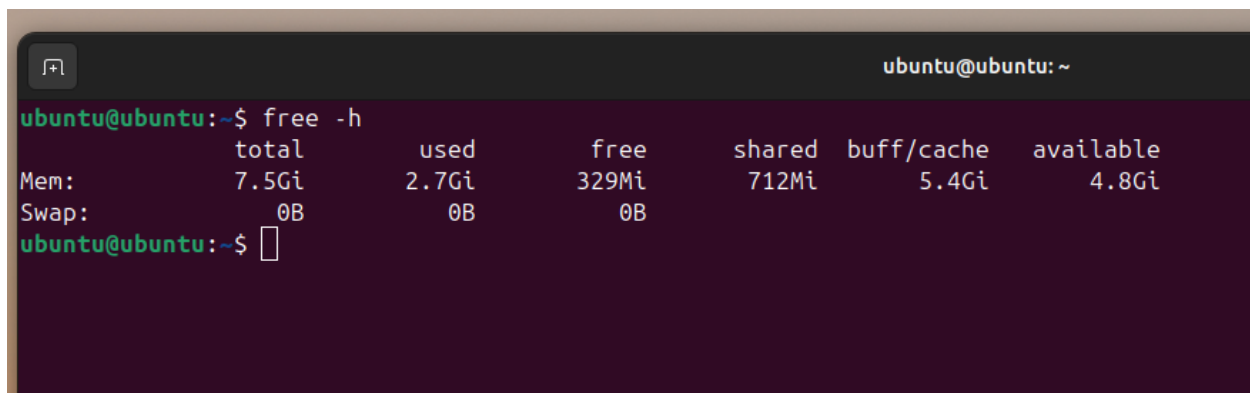
Virtualization features:
  Virtualization:       VT-x
Caches (sum of all):
  L1d:                   192 KiB (4 instances)
  L1i:                   128 KiB (4 instances)
  L2:                    5 MiB (4 instances)
  L3:                   12 MiB (1 instance)
NUMA:
  NUMA node(s):          1
  NUMA node CPU(s):      0-7
Vulnerabilities:
  Gather data sampling:   Mitigation; Microcode
  Itlb multihit:          Not affected
  L1tf:                   Not affected
  Mds:                    Not affected
  Meltdown:               Not affected
  Mmio stale data:        Not affected
  Reg file data sampling: Not affected
  Retbleed:               Not affected
  Spec rstack overflow:   Not affected
  Spec store bypass:      Mitigation; Speculative Store Bypass disabled via prct
  Spectre v1:             Mitigation; usercopy/swapgs barriers and __user_pointe
  Spectre v2:             Mitigation; Enhanced / Automatic IBRS; IBPB conditiona
  Srbds:                  Not affected
  Tsx async abort:        Not affected
```

After executing this command, I was able to get an overview of my laptops configuration and capabilities, including how many cores, threads, and caches the processor has, as well as its clock speed and virtualization capabilities.

### Main Memory

Figure 2 show the main memory after executing shell command “free -h” (InMotion Hosting Contributor, 2023, December 7). In this case, the “free” command shows the memory usage while the “-h” means that the output is human readable. This uses units like Gi or Mi instead of raw numbers. In the image you can see that the total memory on my CPU is 7.5 Gi and I have used 2.7 Gi.

**Figure 2:** Main Memory shell command.

A terminal window with a dark purple background. The prompt is 'ubuntu@ubuntu: ~'. The command 'free -h' has been entered and executed. The output is a table with 7 columns: total, used, free, shared, buff/cache, and available. The rows are for Mem and Swap. Mem shows 7.5Gi total, 2.7Gi used, 329Mi free, 712Mi shared, 5.4Gi buff/cache, and 4.8Gi available. Swap shows 0B for all categories.

```
ubuntu@ubuntu:~$ free -h
              total        used        free      shared  buff/cache   available
Mem:          7.5Gi        2.7Gi        329Mi       712Mi       5.4Gi        4.8Gi
Swap:          0B           0B           0B
ubuntu@ubuntu:~$
```

### I/O Modules

Figure 3 shows the I/O stats for each partition in the system by executing the shell command “iostat” (Carrigan, T., 2020, July 9). This output includes speeds for both read and write operations as well as the total number of transfers per second. As Carrigan explains, this shell command is helpful because if you know what hardware is being used, you know what parameters you should be operating in.

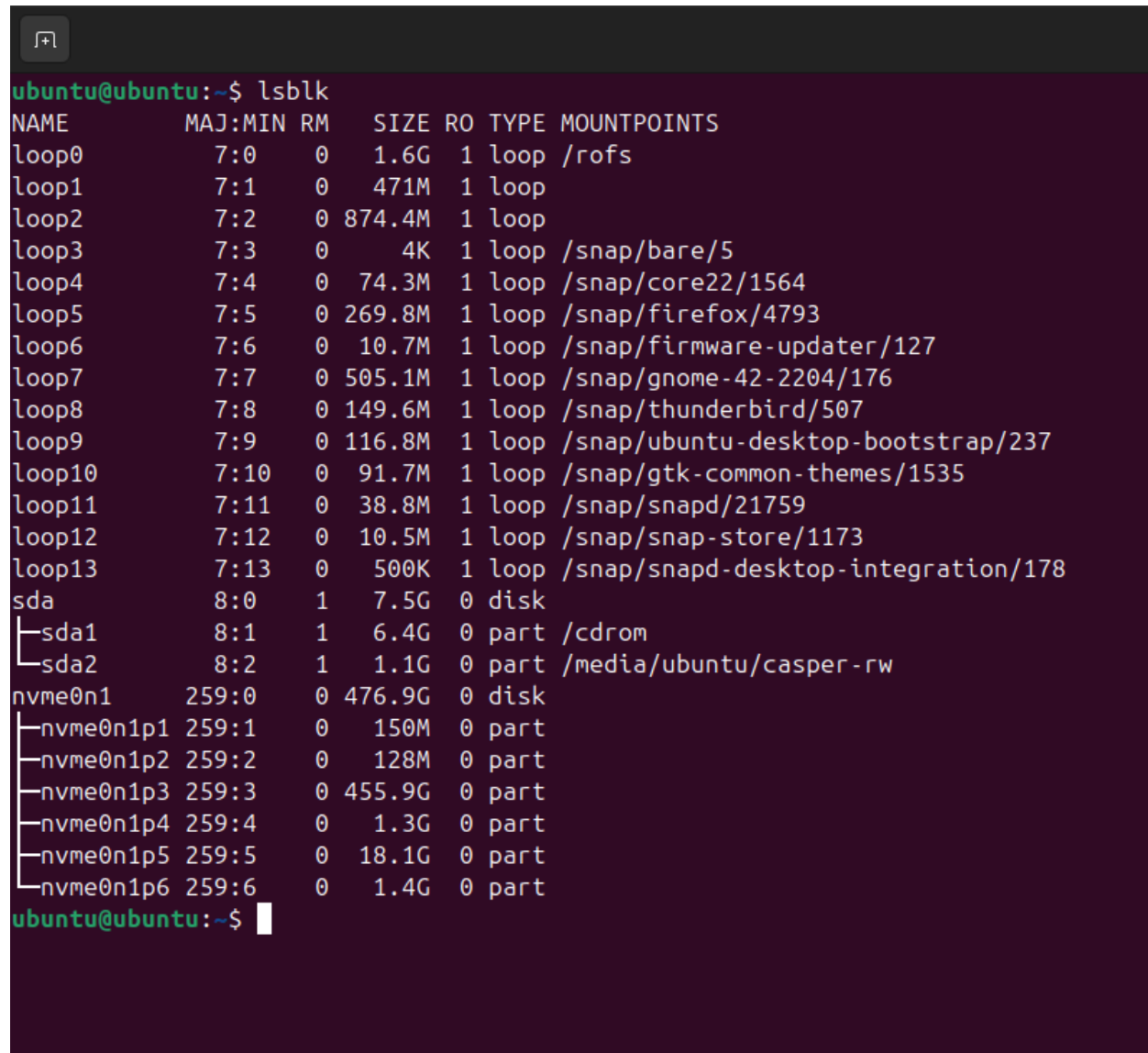
**Figure 3:** I/O Module shell command.

```
ubuntu@ubuntu: ~  
ubuntu@ubuntu:~$ iostat  
Linux 6.8.0-41-generic (ubuntu)      01/19/2025      _x86_64_      (8 CPU)  
  
avg-cpu:  %user   %nice %system %iowait  %steal   %idle  
           2.09    0.33   7.32   37.80    0.00   52.46  
  
Device            tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd  
loop0             134.62     1374.96         0.00         0.00     361793         0         0  
loop1              11.09      178.92         0.00         0.00      47080         0         0  
loop10             6.02       21.15         0.00         0.00       5566         0         0  
loop11             0.20        3.87         0.00         0.00       1018         0         0  
loop12             0.12        1.19         0.00         0.00        312         0         0  
loop13             0.35        8.77         0.00         0.00       2308         0         0  
loop14             0.04         0.05         0.00         0.00         14         0         0  
loop2             17.23     373.22         0.00         0.00     98205         0         0  
loop3              0.05        0.06         0.00         0.00         17         0         0  
loop4              1.89     43.75         0.00         0.00     11513         0         0  
loop5              0.25        6.73         0.00         0.00       1771         0         0  
loop6             11.14     133.31         0.00         0.00     35078         0         0  
loop7              0.26        6.67         0.00         0.00       1754         0         0  
loop8              0.20        3.88         0.00         0.00       1021         0         0  
loop9             10.27     208.33         0.00         0.00     54818         0         0  
nvme0n1           15.24     467.32         0.01         0.00    122965         3         0  
sda               174.56     8318.98        684.71         0.00   2188972    180168         0  
  
ubuntu@ubuntu:~$
```

## Storage Devices

Figure 4 shows information about the storage devices, or block devices. This was found by executing shell command “lsblk” (Iftikhar, H., 2024, September 4). This command give a table of all block devices and their partitions. Some of the key information here includes columns NAME (the name of device), RM, (removable or non-removable), and SIZE (size of the partition).

**Figure 4:** Storage device shell command.



```
ubuntu@ubuntu:~$ lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
loop0        7:0      0   1.6G  1 loop /rofs
loop1        7:1      0   471M  1 loop
loop2        7:2      0 874.4M  1 loop
loop3        7:3      0     4K  1 loop /snap/bare/5
loop4        7:4      0   74.3M  1 loop /snap/core22/1564
loop5        7:5      0 269.8M  1 loop /snap/firefox/4793
loop6        7:6      0   10.7M  1 loop /snap/firmware-updater/127
loop7        7:7      0 505.1M  1 loop /snap/gnome-42-2204/176
loop8        7:8      0 149.6M  1 loop /snap/thunderbird/507
loop9        7:9      0 116.8M  1 loop /snap/ubuntu-desktop-bootstrap/237
loop10       7:10     0   91.7M  1 loop /snap/gtk-common-themes/1535
loop11       7:11     0   38.8M  1 loop /snap/snapd/21759
loop12       7:12     0   10.5M  1 loop /snap/snap-store/1173
loop13       7:13     0    500K  1 loop /snap/snapd-desktop-integration/178
sda          8:0      1   7.5G  0 disk
├─sda1       8:1      1   6.4G  0 part /cdrom
└─sda2       8:2      1   1.1G  0 part /media/ubuntu/casper-rw
nvme0n1     259:0     0 476.9G  0 disk
├─nvme0n1p1 259:1     0   150M  0 part
├─nvme0n1p2 259:2     0   128M  0 part
├─nvme0n1p3 259:3     0 455.9G  0 part
├─nvme0n1p4 259:4     0   1.3G  0 part
├─nvme0n1p5 259:5     0  18.1G  0 part
└─nvme0n1p6 259:6     0   1.4G  0 part
ubuntu@ubuntu:~$
```

## **Conclusion**

For me, this assignment was an introduction to the linux operating system. It was helpful to execute some basic commands and understand the outputs. It was very interesting to have have my laptop running on a new operating system. I'm looking forward gaining more experience with it.

## References

Carrigan, T., (2020, July 9) *I/O reporting from the Linux command line*. Red Hat.

<https://www.redhat.com/en/blog/io-reporting-linux>

[geeksforgeeks.org](https://www.geeksforgeeks.org), (2023, December 8) *How to use the Linux lscpu Command*.

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Iftikhar, H., (2024, September 4) *Linux List Disk Made Easy: Essential Commands for Disk Management*. Cyberpanel.

<https://cyberpanel.net/blog/linux-list-disks>

InMotion Hosting Contributor (2023, December 7) *How to Check the Memory Usage on Linux*.  
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<https://www.inmotionhosting.com/support/server/linux/check-memory-usage/>