# Monitoring a server: How to

## 1. Introduction

A server monitoring report aims at giving the most accurate view of what monitoring a server managed by a Linux distro encompasses. It also wants to underline the importance of said monitoring for companies' network infrastructure to remain safe according to the CIA triad (**C**onfidentiality, **I**ntegrity, **A**vailability).

Since this research is done in the context of my Cybersecurity studies at Becode, I'll be analysing the needs of a very simple network infrastructure (one server, one client) while considering that real-life needs call for greater care and attention to the intricacies a larger network requires.

## 2. Server Structure Overview

As said above, I'll do my research on a simple point-to-point network topology as I'll be looking into a "one client – one server" architecture that is currently installed on my laptop in the form of a Debian CLI server giving DHCP, DNS and HTTP access to another Debian GUI virtual machine.

It seems interesting here to then include a brief but detailed description of the servers used. This description could tackle the below components:

- The hardware used by the server.
- The software running on it.
- The network it is included in.

## 3. Monitoring Strategy

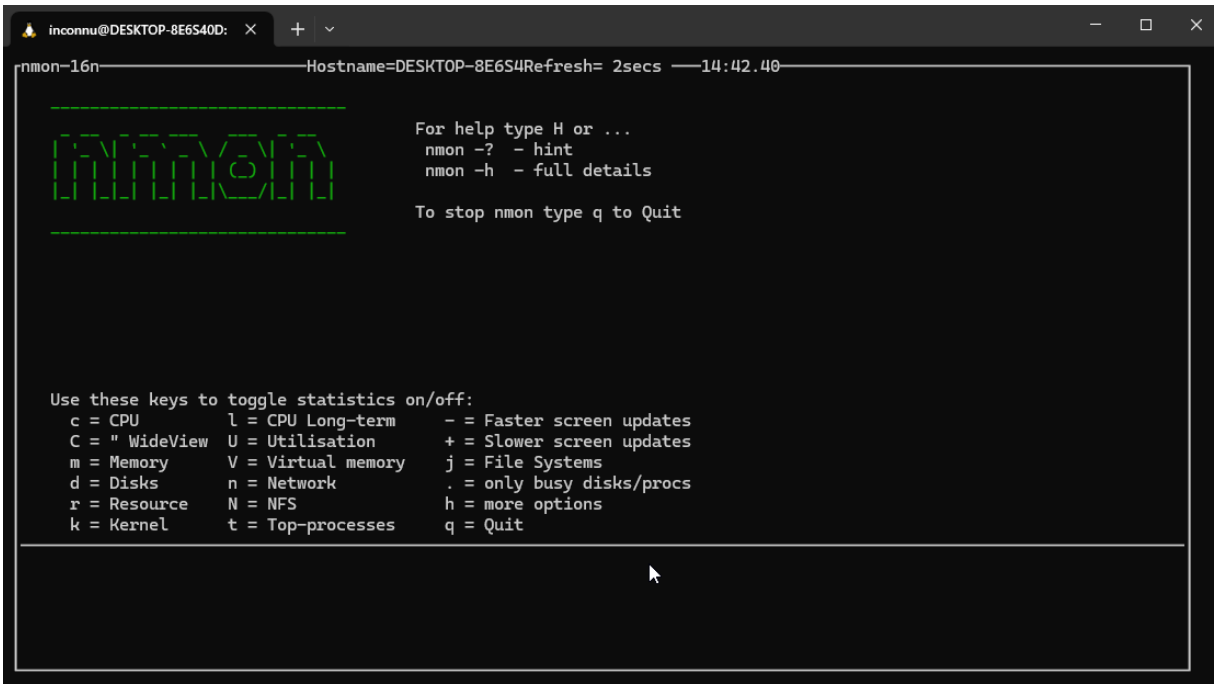
An efficient monitoring is dependent on a strategy designed uphill, before writing any commands. Such strategy can concentrate on multiple metrics to ensure maximum strength to the server, such as:

- CPU usage
- Memory load
- HDD/SDD space
- Network traffic
- Power usage
- Users' activities

These are major point to be paid attention to as they are the ones whose healthiness defines the availability and reachability of a server while maintaining security. Let's dig deeper into these points:

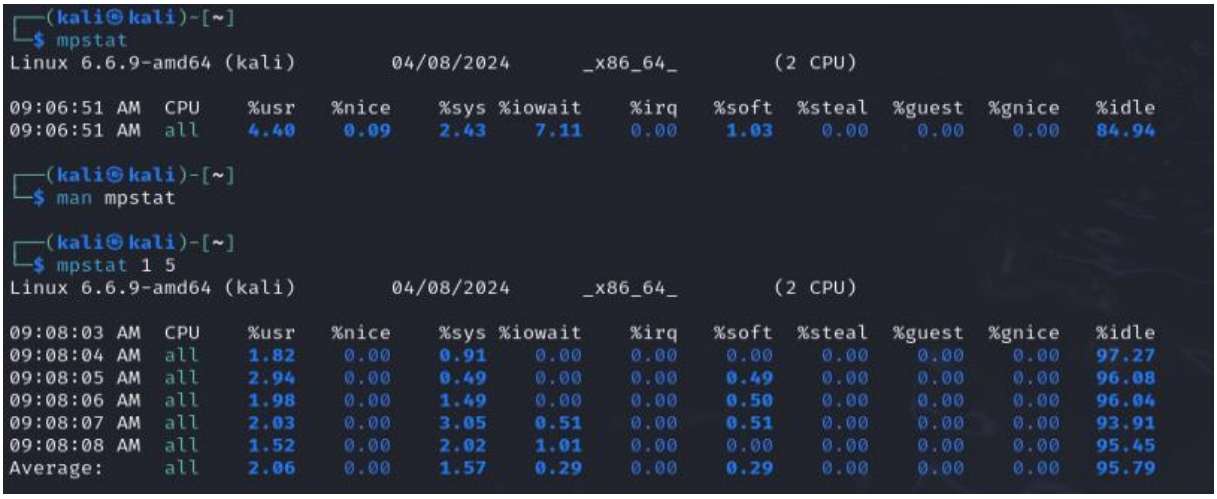
Before digging deeper into the more specific tools, we can mention that some commands can ensure you have a first general view of the health of your system. These commands may sometimes need to be installed as they rely on non-default Linux packages. For our own

projects, we will use the package “Nmon” as it shows a short and clean first look at your systems’ parameters without overflooding you in info.




## CPU usage

MPstat (sysstat): this is a part of the “Sysstat” package that helps looking at the pressure your CPU is currently being subjected to. As you can see below, you can also give it some options so that the CPU load gets checked every x seconds you tell it to check (among other options)




## Memory load

The “free” command can help you see the overall memory details of your current distro, although not hugely useful as you can’t pinpoint any apps that would/could take a huge portion of your available memory:

```
┌──(kali㉿kali)-[~]
└─$ free -h
              total        used        free      shared  buff/cache   available
Mem:          1.9Gi       850Mi       541Mi        20Mi       760Mi       1.1Gi
Swap:         1.0Gi          0B       1.0Gi
```

What can help you get more detailed info though is the “top” command, which can then list the entire list of processes being active on your machine while telling you the amount of memory used by them and which user triggered them:

```
top - 10:09:12 up  1:16,  1 user,  load average: 0.27, 0.32, 0.25
Tasks: 155 total,   3 running, 152 sleeping,   0 stopped,   0 zombie
%Cpu(s):  1.8 us,  2.2 sy,  0.0 ni, 95.7 id,  0.0 wa,  0.0 hi,  0.3 si,  0.0 st
MiB Mem :   1976.7 total,    537.5 free,    853.9 used,    760.9 buff/cache
MiB Swap:   1024.0 total,   1024.0 free,      0.0 used.   1122.0 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
    693 root      20   0  515076 173800  68076 R   1.8   8.6   1:22.14 /usr/lib/xorg/Xorg :0 -seat seat0 -auth /var/run/lightdm/root/:0 -nolisten tcp vt7 -novtswitch
   1081 kali      20   0  466576 108200  91452 S   1.1   5.3   0:51.22 /usr/bin/qterminal
   1079 kali      20   0  365264  52492  22616 S   0.6   2.6   0:27.27 /usr/lib/x86_64-linux-gnu/xfce4/panel/wrapper-2.0 /usr/lib/x86_64-linux-gnu/xfce4/panel/plugins/libcpugraph.so 13 27262988 cpugraph CPU Graph Graphical representat+
   1081 kali      20   0  342216  30604  21312 S   0.5   1.5   0:18.63 /usr/lib/x86_64-linux-gnu/xfce4/panel/wrapper-2.0 /usr/lib/x86_64-linux-gnu/xfce4/panel/plugins/libgenmon.so 15 27262990 genmon Generic Monitor Show output of a co+
   1023 kali      20   0  980788 128024  79436 S   0.4   6.3   0:21.19 xfwm4 --display :0.0 --sm-client-id 23261ee08-db4f-4d93-b57c-b2f10a970623
      1 root      20   0   22260  12752   9552 S   0.1   0.6   0:01.64 /sbin/init splash
    958 kali      20   0  217984   2944   2688 S   0.1   0.1   0:10.80 /usr/bin/VBoxClient --draganddrop
    985 kali      20   0  217576   3456   2944 S   0.1   0.2   0:01.21 /usr/bin/VBoxClient --vmsvga
  37569 kali      20   0   11808   5760   3584 R   0.1   0.3   0:00.16 top
     17 root      20   0       0      0      0 R   0.1   0.0   0:02.23 [rcu_preempt]
    518 root      20   0    8264   7512   1664 S   0.1   0.4   0:00.56 /usr/sbin/haveged --Foreground --verbose=1
    626 root      20   0  293016   3460   3072 S   0.1   0.2   0:01.33 /usr/sbin/VBoxService
    947 kali      20   0  217468   3072   2688 S   0.1   0.2   0:04.95 /usr/bin/VBoxClient --seamless
   1040 kali      20   0  305728  30004  20040 S   0.1   1.5   0:01.78 xfsettingsd --display :0.0 --sm-client-id 2d5069710-03bf-420e-9553-39d8420b135e
   1123 kali      20   0  465812  41912  33400 S   0.1   2.1   0:01.19 /usr/lib/x86_64-linux-gnu/xfce4/notifyd/xfce4-notifyd
  11060 root      20   0       0      0      0 I   0.1   0.0   0:00.97 [kworker/0:0-events]
  25128 root      20   0       0      0      0 I   0.1   0.0   0:01.06 [kworker/1:2-events]
      2 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [kthreadd]
      3 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [pool_workqueue_release]
      4 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-rcu_g]
      5 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-rcu_p]
      6 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-slub_]
      7 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-netns]
     10 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/0:0H-events_highpri]
     11 root      20   0       0      0      0 I   0.0   0.0   0:00.00 [kworker/u4:0-ext4-rsv-conversion]
     12 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-mm_pe]
     13 root      20   0       0      0      0 I   0.0   0.0   0:00.00 [rcu_tasks_kthread]
     14 root      20   0       0      0      0 I   0.0   0.0   0:00.00 [rcu_tasks_rude_kthread]
     15 root      20   0       0      0      0 I   0.0   0.0   0:00.00 [rcu_tasks_trace_kthread]
     16 root      20   0       0      0      0 S   0.0   0.0   0:00.91 [ksoftirqd/0]
     18 root      rt   0       0      0      0 S   0.0   0.0   0:00.04 [migration/0]
     19 root     -51   0       0      0      0 S   0.0   0.0   0:00.00 [idle_inject/0]
     20 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [cpuhp/0]
     21 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [cpuhp/1]
     22 root     -51   0       0      0      0 S   0.0   0.0   0:00.00 [idle_inject/1]
     23 root      rt   0       0      0      0 S   0.0   0.0   0:00.21 [migration/1]
     24 root      20   0       0      0      0 S   0.0   0.0   0:00.56 [ksoftirqd/1]
     27 root      20   0       0      0      0 I   0.0   0.0   0:00.00 [kworker/u5:0-events_unbound]
     30 root      20   0       0      0      0 I   0.0   0.0   0:00.24 [kworker/u6:1-events_unbound]
     31 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [kdevtmpfs]
     32 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-inet_]
     33 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [kauditd]
     34 root      20   0       0      0      0 I   0.0   0.0   0:01.06 [kworker/u5:1-flush-8:0]
     35 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [khungtaskd]
     36 root      20   0       0      0      0 S   0.0   0.0   0:00.00 [oom_reaper]
     37 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 [kworker/R-write]
     38 root      20   0       0      0      0 S   0.0   0.0   0:00.25 [kcompactd0]
     39 root      25   5       0      0      0 S   0.0   0.0   0:00.00 [ksmd]
```

A shorter output can be caught with the “ps” command, as it’ll only give you a snapshot of the running processes without giving you all the “hidden” processes running :

```
┌──(kali㉿kali)-[~]
└─$ ps
    PID TTY          TIME CMD
   1804 pts/0    00:00:17 zsh
  53188 pts/0    00:00:00 ps
```

You can then use the “lsof” command and the Process ID (PID) number to target a specific program and see all its dependencies’ memory use:

```
┌──(kali㉿kali)-[~]
└─$ lsof -p 1801
COMMAND    PID USER   FD      TYPE             DEVICE  SIZE/OFF    NODE NAME
qterminal 1801 kali  cwd       DIR                8,1      4096  917506 /home/kali
qterminal 1801 kali  rtd       DIR                8,1      4096       2 /
qterminal 1801 kali  txt       REG                8,1    485608 4353522 /usr/bin/qterminal
qterminal 1801 kali  DEL       REG                0,1               116 /memfd:xorg
qterminal 1801 kali  mem       REG                8,1   4033420 3685399 /usr/share/fonts/truetype/droid/DroidSansFallbackFull.ttf
qterminal 1801 kali  mem       REG                8,1  24061128 3545859 /usr/lib/x86_64-linux-gnu/libz3.so.4
qterminal 1801 kali  mem       REG                8,1 124536680 3546295 /usr/lib/x86_64-linux-gnu/libLLVM-17.so.1
qterminal 1801 kali  mem       REG                8,1    708920 3685456 /usr/share/fonts/truetype/dejavu/DejaVuSans-Bold.ttf
qterminal 1801 kali  DEL       REG                0,1               117 /memfd:xorg
qterminal 1801 kali  mem       REG                8,1  32948200 3545562 /usr/lib/x86_64-linux-gnu/dri/swrast_dri.so
qterminal 1801 kali  DEL       REG                0,1              1109 /memfd:xorg
qterminal 1801 kali  mem       REG                8,1    320028 3685360 /usr/share/fonts/truetype/firacode/FiraCode-Bold.ttf
qterminal 1801 kali  mem       REG                8,1      6160 3546252 /usr/lib/x86_64-linux-gnu/libxshmfence.so.1.0.0
qterminal 1801 kali  DEL       REG                0,1              1108 /memfd:xorg
qterminal 1801 kali  mem       REG                8,1   1770584 3544979 /usr/lib/x86_64-linux-gnu/libxml2.so.2.9.14
qterminal 1801 kali  mem       REG                8,1     22816 3545647 /usr/lib/x86_64-linux-gnu/libXxf86vm.so.1.0.0
qterminal 1801 kali  DEL       REG                0,1              1107 /memfd:xorg
qterminal 1801 kali  mem       REG                8,1    510612 3685435 /usr/share/fonts/truetype/noto/NotoSansMono-Regular.ttf
qterminal 1801 kali  mem       REG                8,1    147248 3544949 /usr/lib/x86_64-linux-gnu/libdrm_intel.so.1.0.0
qterminal 1801 kali  mem       REG                8,1    216368 3544643 /usr/lib/x86_64-linux-gnu/libtinfo.so.6.4
qterminal 1801 kali  mem       REG                8,1    216656 3544623 /usr/lib/x86_64-linux-gnu/libedit.so.2.0.72
qterminal 1801 kali  mem       REG                8,1     49180 4337902 /usr/share/icons/hicolor/icon-theme.cache
qterminal 1801 kali  mem       REG                8,1     43472 3545039 /usr/lib/x86_64-linux-gnu/libpciaccess.so.0.11.1
qterminal 1801 kali  mem       REG                8,1     39216 3544665 /usr/lib/x86_64-linux-gnu/libdrm_nouveau.so.2.0.0
```

## HDD/SDD disk usage

After install the “iotop” package, you’ll then be able to have an overview of your disks’ write & read activities in a very precise way:

```
Total DISK READ:         0.00 B/s | Total DISK WRITE:         0.00 B/s
Current DISK READ:       0.00 B/s | Current DISK WRITE:       0.00 B/s
    TID  PRIO  USER     DISK READ>  DISK WRITE    COMMAND
      1 be/4 root        0.00 B/s    0.00 B/s init splash
      2 be/4 root        0.00 B/s    0.00 B/s [kthreadd]
      3 be/4 root        0.00 B/s    0.00 B/s [pool_workqueue_release]
      4 be/0 root        0.00 B/s    0.00 B/s [kworker/R-rcu_g]
      5 be/0 root        0.00 B/s    0.00 B/s [kworker/R-rcu_p]
      6 be/0 root        0.00 B/s    0.00 B/s [kworker/R-slub_]
      7 be/0 root        0.00 B/s    0.00 B/s [kworker/R-netns]
     10 be/0 root        0.00 B/s    0.00 B/s [kworker/0:0H-events_highpri]
     11 be/4 root        0.00 B/s    0.00 B/s [kworker/u4:0-ext4-rsv-conversion]
     12 be/0 root        0.00 B/s    0.00 B/s [kworker/R-mm_pe]
     13 be/4 root        0.00 B/s    0.00 B/s [rcu_tasks_kthread]
     14 be/4 root        0.00 B/s    0.00 B/s [rcu_tasks_rude_kthread]
     15 be/4 root        0.00 B/s    0.00 B/s [rcu_tasks_trace_kthread]
     16 be/4 root        0.00 B/s    0.00 B/s [ksoftirqd/0]
     17 be/4 root        0.00 B/s    0.00 B/s [rcu_preempt]
     18 rt/4 root        0.00 B/s    0.00 B/s [migration/0]
     19 rt/4 root        0.00 B/s    0.00 B/s [idle_inject/0]
     20 be/4 root        0.00 B/s    0.00 B/s [cpuhp/0]
     21 be/4 root        0.00 B/s    0.00 B/s [cpuhp/1]
     22 rt/4 root        0.00 B/s    0.00 B/s [idle_inject/1]
     23 rt/4 root        0.00 B/s    0.00 B/s [migration/1]
     24 be/4 root        0.00 B/s    0.00 B/s [ksoftirqd/1]
     27 be/4 root        0.00 B/s    0.00 B/s [kworker/u5:0-events_unbound]
     30 be/4 root        0.00 B/s    0.00 B/s [kworker/u6:1-events_unbound]
     31 be/4 root        0.00 B/s    0.00 B/s [kdevtmpfs]
     32 be/0 root        0.00 B/s    0.00 B/s [kworker/R-inet_]
     33 be/4 root        0.00 B/s    0.00 B/s [kauditd]
     34 be/4 root        0.00 B/s    0.00 B/s [kworker/u5:1-events_unbound]
     35 be/4 root        0.00 B/s    0.00 B/s [khungtaskd]
     36 be/4 root        0.00 B/s    0.00 B/s [oom_reaper]
     37 be/0 root        0.00 B/s    0.00 B/s [kworker/R-write]
     38 be/4 root        0.00 B/s    0.00 B/s [kcompactd0]
     39 be/5 root        0.00 B/s    0.00 B/s [ksmd]
     40 be/7 root        0.00 B/s    0.00 B/s [khugepaged]
     41 be/0 root        0.00 B/s    0.00 B/s [kworker/R-kinte]
     42 be/0 root        0.00 B/s    0.00 B/s [kworker/R-kbloc]
     43 be/0 root        0.00 B/s    0.00 B/s [kworker/R-blkcg]
     44 be/0 root        0.00 B/s    0.00 B/s [kworker/R-tpm_d]
     45 be/0 root        0.00 B/s    0.00 B/s [kworker/R-edac-]
     46 be/0 root        0.00 B/s    0.00 B/s [kworker/R-devfr]
     48 be/0 root        0.00 B/s    0.00 B/s [kworker/0:1H-kblockd]
     49 be/4 root        0.00 B/s    0.00 B/s [kswapd0]
     57 be/0 root        0.00 B/s    0.00 B/s [kworker/R-kthro]
     59 be/0 root        0.00 B/s    0.00 B/s [kworker/R-acpi_]
     60 be/0 root        0.00 B/s    0.00 B/s [kworker/R-mld]
```

Should you want less information to get a quick overview, the “iostat” command can then help you for this:

```
┌──(kali㉿kali)-[~]
└─$ iostat -h
Linux 6.6.9-amd64 (kali)        04/08/2024      _x86_64_        (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           2.5%    0.0%    2.3%    1.3%    0.0%   93.8%

      tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd Device
     5.05       126.0k        86.7k         0.0k     678.4M     467.2M       0.0k sda
```

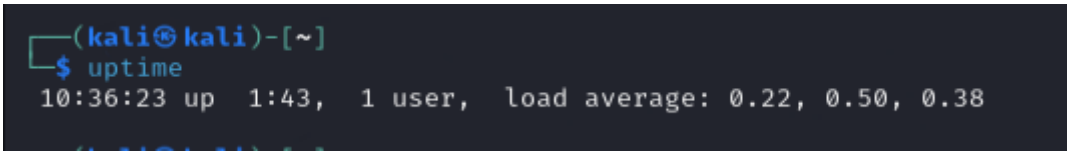
## Network traffic

The “iftop” command, after being installed, can help you display the current in- and outgoing data flow of the operating system currently running.

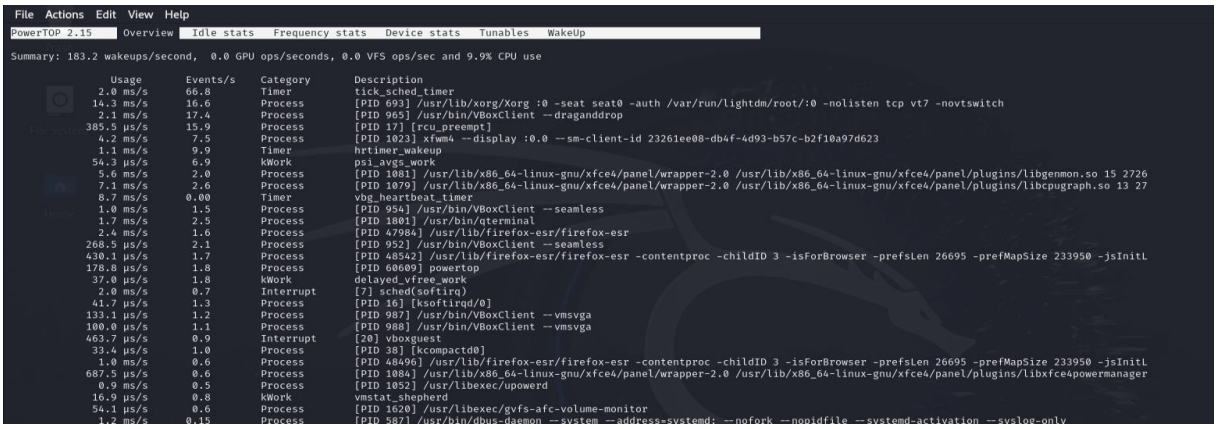

However, if you’d like a finer tool to work with, the “ss” command can help you see which process of your computer tried to use which port:


## Power usage

On this matter, it may be interesting to also know as of when you machine was running (since when there’s an uptime). For this, the very logical “uptime” command will help you:




After getting this info, you can retrieve the proper power usage information with the “Powertop” package :



```
File  Actions  Edit  View  Help
PowerTOP 2.15     Overview   Idle stats   Frequency stats   Device stats   Tunables   WakeUp

Summary: 183.2 wakeups/second,  0.0 GPU ops/seconds, 0.0 VFS ops/sec and 9.9% CPU use

            Usage       Events/s    Category       Description
          2.0 ms/s      66.8        Timer          tick_sched_timer
         14.3 ms/s      16.6        Process        [PID 693] /usr/lib/xorg/Xorg :0 -seat seat0 -auth /var/run/lightdm/root/:0 -nolisten tcp vt7 -novtswitch
          2.1 ms/s      17.4        Process        [PID 965] /usr/bin/VBoxClient --draganddrop
        385.5 µs/s      15.9        Process        [PID 17] [rcu_preempt]
          4.2 ms/s       7.5        Process        [PID 1023] xfwm4 --display :0.0 --sm-client-id 23261ee08-db4f-4d93-b57c-b2f10a97d623
          1.1 ms/s       9.9        Timer          hrtimer_wakeup
         54.3 µs/s       6.9        kWork          psi_avgs_work
          5.6 ms/s       2.0        Process        [PID 1081] /usr/lib/x86_64-linux-gnu/xfce4/panel/wrapper-2.0 /usr/lib/x86_64-linux-gnu/xfce4/panel/plugins/libgenmon.so 15 2726
          7.1 ms/s       2.6        Process        [PID 1079] /usr/lib/x86_64-linux-gnu/xfce4/panel/wrapper-2.0 /usr/lib/x86_64-linux-gnu/xfce4/panel/plugins/libcpugraph.so 13 27
          8.7 ms/s      0.00        Timer          vbg_heartbeat_timer
          1.0 ms/s       1.5        Process        [PID 954] /usr/bin/VBoxClient --seamless
          1.7 ms/s       2.5        Process        [PID 1801] /usr/bin/qterminal
          2.4 ms/s       1.6        Process        [PID 47984] /usr/lib/firefox-esr/firefox-esr
        268.5 µs/s       2.1        Process        [PID 952] /usr/bin/VBoxClient --seamless
        430.1 µs/s       1.7        Process        [PID 48542] /usr/lib/firefox-esr/firefox-esr -contentproc -childID 3 -isForBrowser -prefsLen 26695 -prefMapSize 233950 -jsInitL
        178.8 µs/s       1.8        Process        [PID 60609] powertop
         37.0 µs/s       1.8        kWork          delayed_vfree_work
          2.0 ms/s       0.7        Interrupt      [7] sched(softirq)
         41.7 µs/s       1.3        Process        [PID 16] [ksoftirqd/0]
        133.1 µs/s       1.2        Process        [PID 987] /usr/bin/VBoxClient --vmsvga
        100.0 µs/s       1.1        Process        [PID 988] /usr/bin/VBoxClient --vmsvga
        463.7 µs/s       0.9        Interrupt      [20] vboxguest
         33.4 µs/s       1.0        Process        [PID 38] [kcompactd0]
          1.0 ms/s       0.6        Process        [PID 48496] /usr/lib/firefox-esr/firefox-esr -contentproc -childID 3 -isForBrowser -prefsLen 26695 -prefMapSize 233950 -jsInitL
        687.5 µs/s       0.6        Process        [PID 1084] /usr/lib/x86_64-linux-gnu/xfce4/panel/wrapper-2.0 /usr/lib/x86_64-linux-gnu/xfce4/panel/plugins/libxfce4powermanager
          0.9 ms/s       0.5        Process        [PID 1052] /usr/libexec/upowerd
         16.9 µs/s       0.8        kWork          vmstat_shepherd
         54.1 µs/s       0.6        Process        [PID 1620] /usr/libexec/gvfs-afc-volume-monitor
          1.2 ms/s      0.15        Process        [PID 587] /usr/bin/dbus-daemon --system --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
```

Although it seems to contain some errors as I can't yet retrieve the mw/h data for each process, but rather a ms/s value.

**<u>Users' activities</u>**

Lastly, we need to know where to look for the logs, what happened during our server's session, who did what, etc.

All logs being in the "var/log" folder, we can dig into them to see the multiple apps' activity history.

As for the users, we can check multiple data concerning them :

- When they were connected thanks to the "W" or "Finger" command (to be installed first)
- When the last sessions were running with the "last" command
- With the output of the "W" or "Finger" command, we can have a deeper look at the commands that were run by certain users after typing "PS -ef | grep ^username

## 4. Monitoring logs and alerts

I'll mention quickly here two aspects of the logs and alerts that are important to consider when monitoring a server: their setup and their frequencies.

- <u>Setup</u>: one needs to ensure that the alerts are correctly configured as to ensure that the incident team won't need to filter through countless alerts, thus increasing the possibility of missing an important one.
- <u>Frequency</u>: logs and alerts need to be monitored live, but a manual human check may be done fewer times (daily)

## 5. Conclusion

Although the above theoretical documentation doesn't encompass all the available tools that can perform monitoring activities, and maybe not always the most efficient one, it gave a first look at the commands and programs that may help one monitor efficiently and speedily the activities of a server.