Lab Project - 3

Objective: Linux process management lab

Lab 1 : Process Exploration and Identification

Objective:

Understand how processes work in Linux, and how to identify and explore running processes.

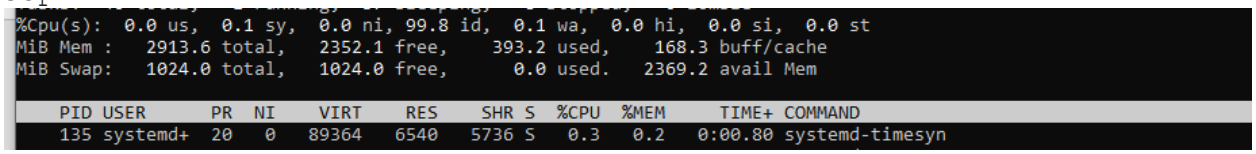
Task:

1. List Running Processes:

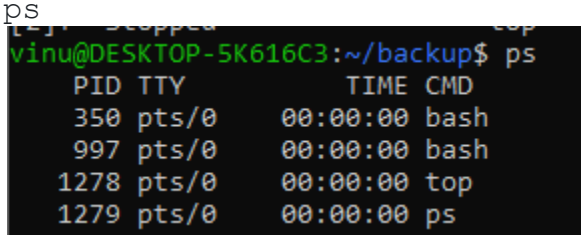
Use ps, top, or htop to list all running processes on the system.

Understand the difference between ps, top, and htop, and experiment with their options (e.g., ps aux, top -u <username>).

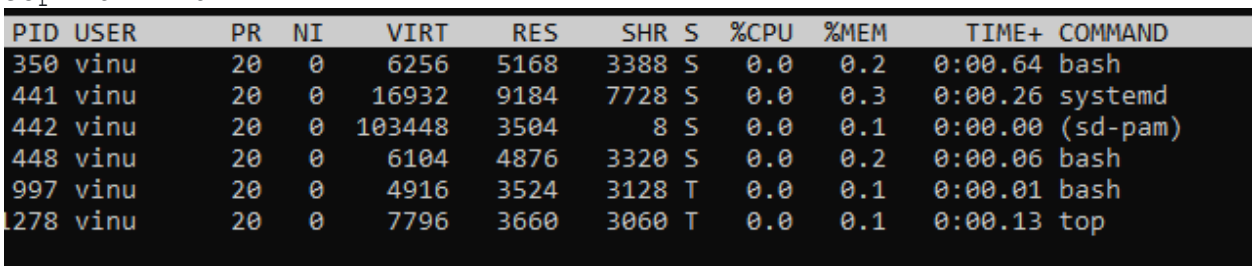
top



ps



top -u vinu



1. Using `ps` (Process Status)

The `ps` command provides a snapshot of the currently running processes.

Basic Usage:

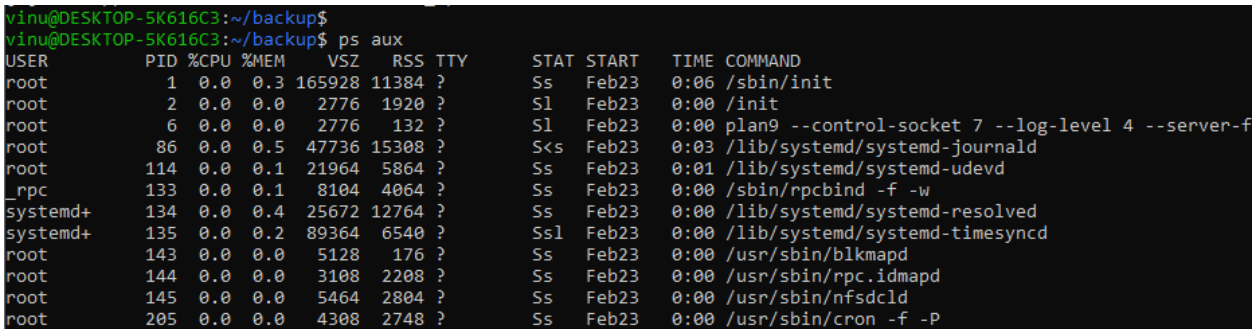
```bash
ps aux
```

- `a` → Shows processes from all users.
- `u` → Displays user-oriented format.
- `x` → Lists processes not attached to a terminal.

Detailed View:

```bash
ps -eo pid,user,%cpu,%mem,command --sort=-%cpu
```

- Lists all processes (`-e`).
- Displays user, CPU usage, memory usage, and command.



Detailed View:

```bash
ps -eo pid,user,%cpu,%mem,command --sort=-%cpu
```

- Lists all processes (`-e`).
- Displays user, CPU usage, memory usage, and command.
- Sorts by CPU usage in descending order.

2. Find a Specific Process:

```
 # Use pgrep to find the PID (process ID) of a specific running process like apache2 or nginx.

 # Use pstree to view a tree of processes and their parent-child relationships.
```

1. Finding a Specific Process with `pgrep`

The `pgrep` command is used to search for processes by name and return

Basic Usage:

```bash
pgrep apache2
```

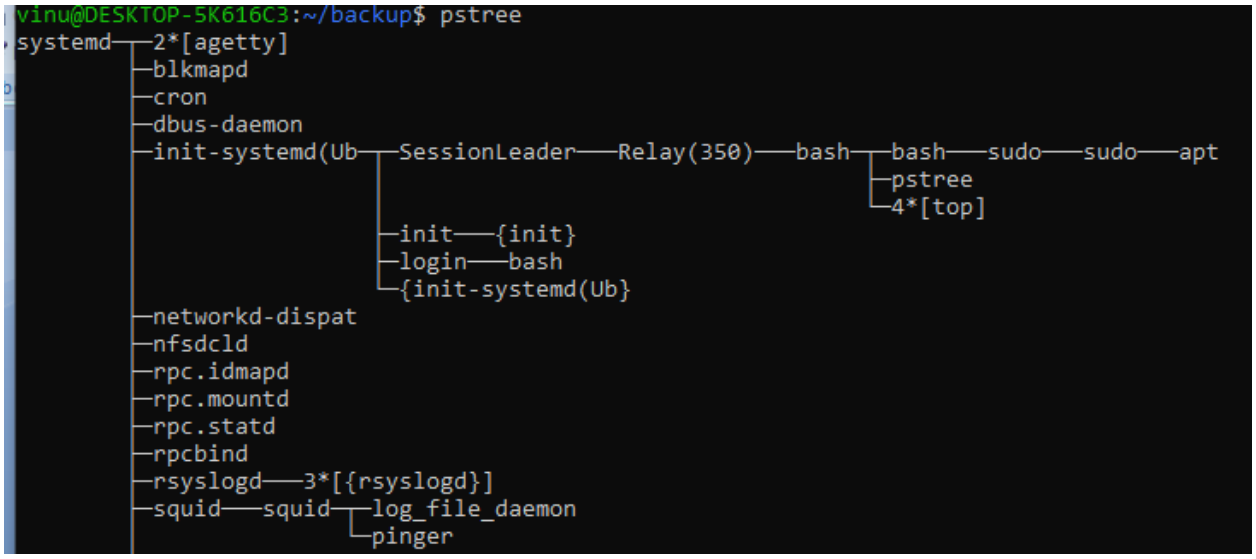
This command returns the process ID(s) of all running `apache2` processes.

- Find the PID of **Nginx:**

```bash
pgrep nginx
```

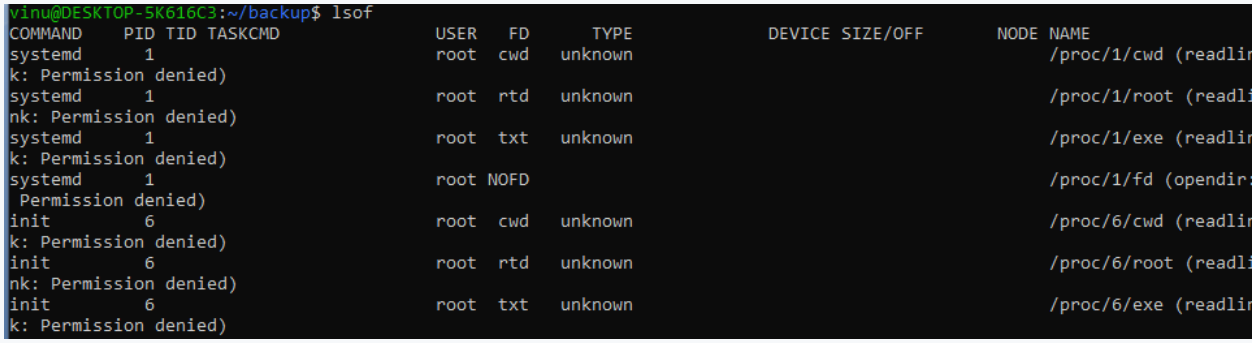
- To see more details, use:

```bash
ps -fp $(pgrep apache2)
```

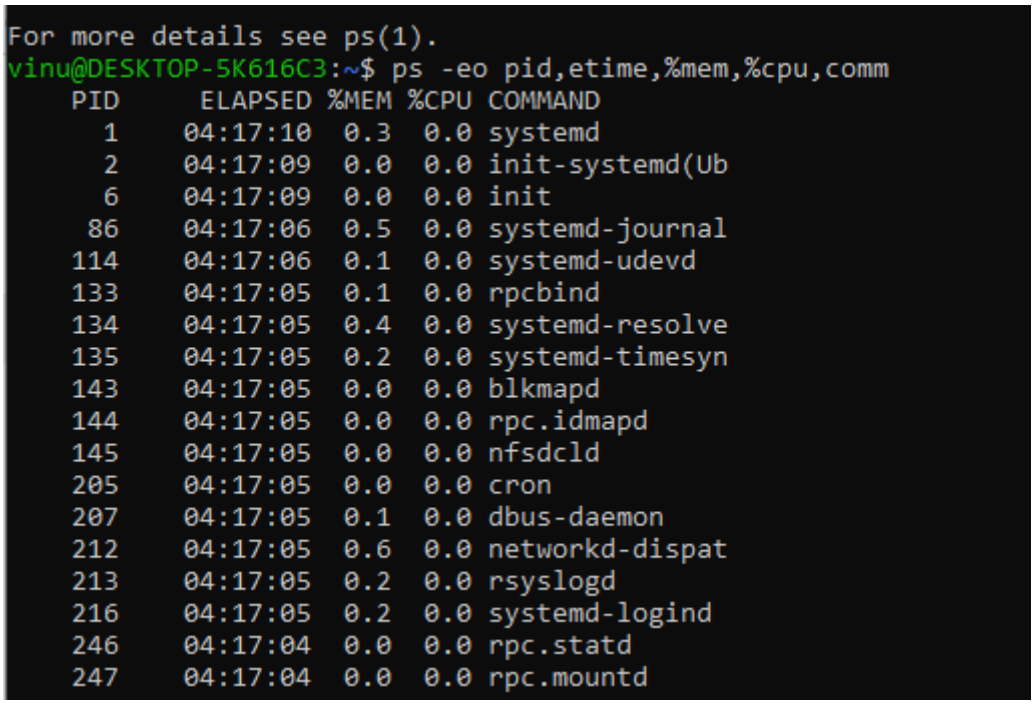


3.Investigate Process Details:

Use lsof to identify files opened by a process.



Check the memory usage and CPU time of a process using ps -eo pid,etime,%mem,%cpu,comm.



Lab 2 : Process Control and Termination

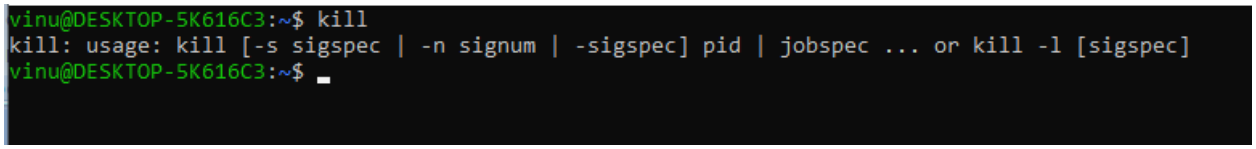
Objective:

Learn how to control, pause, resume, and terminate processes in Linux.

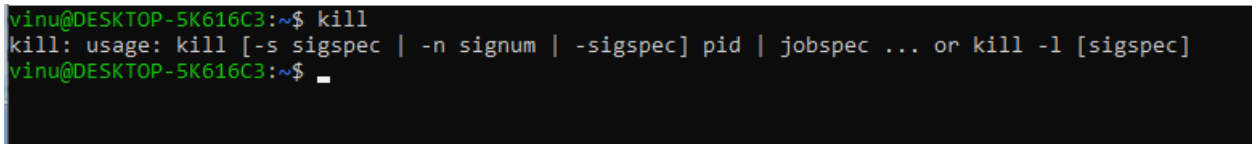
Task:

1. Send Signals to Processes:

Use kill to send signals to processes. Try sending a SIGTERM and SIGKILL to terminate a process by PID.



Use kill -s STOP <PID> and kill -s CONT <PID> to stop and resume a process.



Example Usage:

1. **Find the PID of a process**

```perl
ps aux | grep <process_name>
```

This command will display the process ID (PID) of the running process.

2. **Send a SIGTERM signal (graceful termination)**

```bash
kill -15 <PID>
```

OR

```bash
kill <PID>   # Default signal is SIGTERM
```

```
vinu@DESKTOP-5K616C3:~$ ps aux | grep 1333
vinu        1335  0.0  0.0   4028  2060 pts/0    S+   03:04   0:00 grep --color=auto 1333
vinu@DESKTOP-5K616C3:~$
```

2.Send Custom Signals:

Send a SIGINT signal to a running process (e.g., when running a program in the terminal, use Ctrl+C or kill -s SIGINT <PID>).

```bash
pkill -SIGINT process_name
```

Example:

```bash
pkill -SIGINT python
```

```
vinu@DESKTOP-5K616C3:~$ kill -s SIGINT
kill: usage: kill [-s sigspec | -n signum | -sigspec] pid | jobspec ... or kill -l [sigspec]
vinu@DESKTOP-5K616C3:~$
```

3.Test Process Termination:

Start a process, for example, sleep 300, then find its PID and try to terminate it using kill or kill -9.

3. **Send a SIGKILL signal (force termination)**

bash

```
kill -9 <PID>
```

```
vinu@DESKTOP-5K616C3:~$ kill -9
kill: usage: kill [-s sigspec | -n signum | -sigspec] pid | jobspec ... or kill -l [sigspec]
vinu@DESKTOP-5K616C3:~$ kill -l
```

Lab 3 : Managing Background and Foreground Processes

Objective:

Learn how to run processes in the background and manage jobs effectively.

Task:

1. Run a Process in the Background:

Start a process in the background using &, e.g., sleep 100 &.

```
vinu@DESKTOP-5K616C3:~$ sleep 100
^Z
[7]+  Stopped                 sleep 100
vinu@DESKTOP-5K616C3:~$
```

```
# Use jobs to see a list of background jobs.
```

```
vinu@DESKTOP-5K616C3:~$ job
Command 'job' not found, did you mean:
  command 'jo' from snap jo (1.9)
  command 'mob' from snap mob-sh (4.2.0)
  command 'joe' from deb joe (4.6-1build2)
  command 'joe' from deb joe-jupp (3.1.40-1)
  command 'jot' from deb athena-jot (9.0-8)
  command 'wob' from deb wob (0.12-1)
```

2. Bring a Process to the Foreground:

```
# Use the fg command to bring a background process to the foreground.
```

```
vinu@DESKTOP-5K616C3:~$ fg
sleep 100
vinu@DESKTOP-5K616C3:~$
```

3. Pause and Resume a Process:

```
# Pause a background process using Ctrl+Z and resume it in the background with the bg command.
```

```
vinu@DESKTOP-5K616C3:~$ sleep 100
^Z
[7]+  Stopped                 sleep 100
```

4. Control Multiple Jobs:

```
# Start multiple jobs in the background and manage them with jobs, fg, and bg.
```

Jobs

```
vinu@DESKTOP-5K616C3:~$ jobs
[1]   Stopped                 bash auto_update.sh  (wd: ~/backup)
[2]   Stopped                 top  (wd: ~/backup)
[3]   Stopped                 top -u vinu  (wd: ~/backup)
[4]   Stopped                 top -u vinu  (wd: ~/backup)
[5]-  Stopped                 top -u vinu  (wd: ~/backup)
[6]+  Stopped                 sleep 300
```

fg

```
vinu@DESKTOP-5K616C3:~$ fg
sleep 300
```

bg

```
vinu@DESKTOP-5K616C3:~$ bg
[5]+ top -u vinu &      (wd: ~/backup)
vinu@DESKTOP-5K616C3:~$
```

Lab 4 : Monitoring System Performance and Resource Usage

Objective:

Learn how to monitor system resources and analyze processes consuming system resources.

Task:

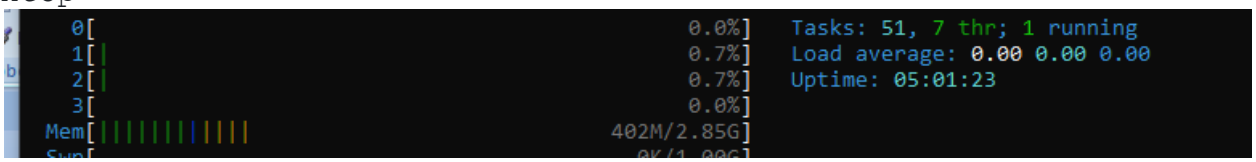
1. Monitor CPU Usage:

```
 # Use top or htop to monitor CPU usage in real-time.
```

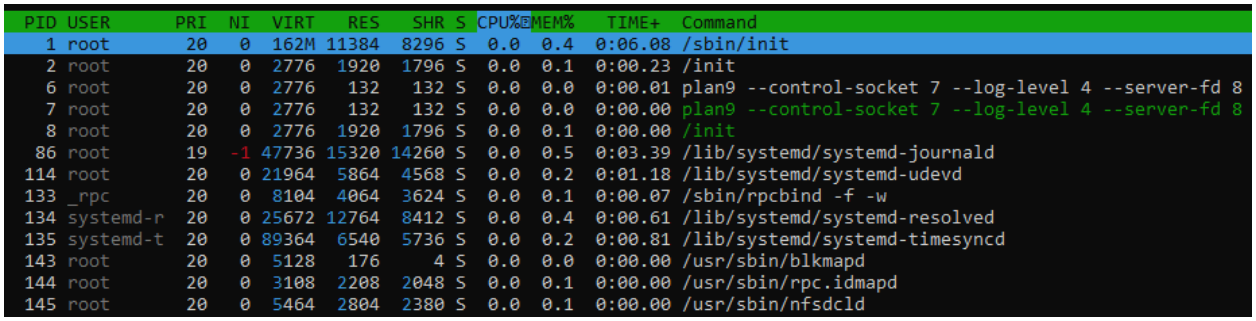
top

```
    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
      1 root      20   0  165928  11384   8296 S   0.0   0.4   0:06.08 systemd
      2 root      20   0    2776   1920   1796 S   0.0   0.1   0:00.23 init-systemd(Ub
      6 root      20   0    2776    132    132 S   0.0   0.0   0:00.01 init
     86 root      19  -1   47736  15320  14260 S   0.0   0.5   0:03.39 systemd-journal
    114 root      20   0   21964   5864   4568 S   0.0   0.2   0:01.18 systemd-udevd
    133 _rpc      20   0    8104   4064   3624 S   0.0   0.1   0:00.06 rpcbind
    134 systemd+  20   0   25672  12764   8412 S   0.0   0.4   0:00.61 systemd-resolve
    135 systemd+  20   0   89364   6540   5736 S   0.0   0.2   0:00.81 systemd-timesyn
```

htop



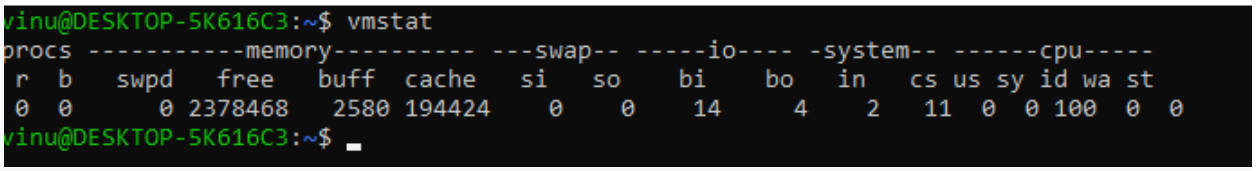
Look for processes consuming high CPU and analyze them.



2.Monitor Memory Usage:

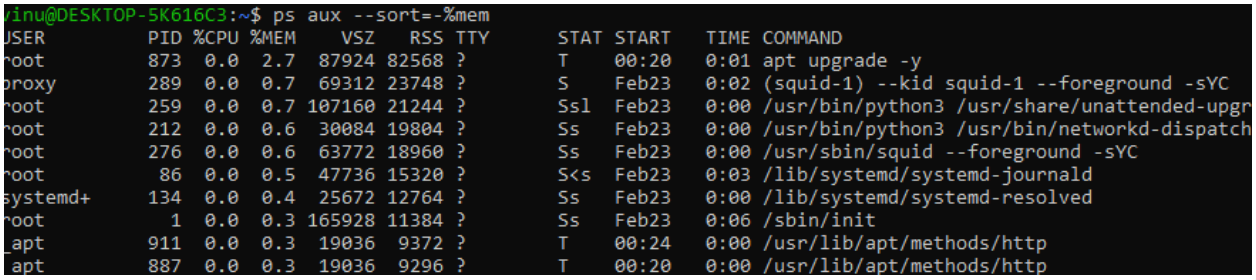
Use free or vmstat to check system memory usage.

vmstat



Use ps aux --sort=-%mem to find processes using the most memory.

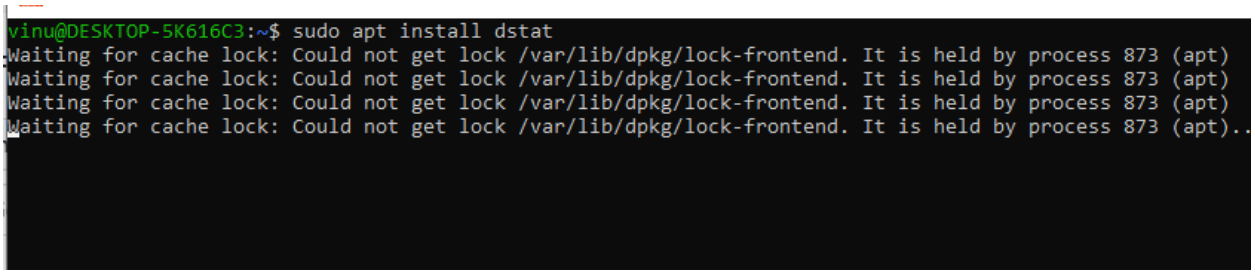
ps aux --sort=-%mem



3.Disk Usage and I/O Monitoring:

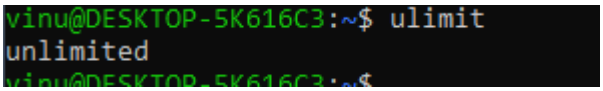
 # Use iotop or dstat to monitor real-time disk I/O usage by processes.

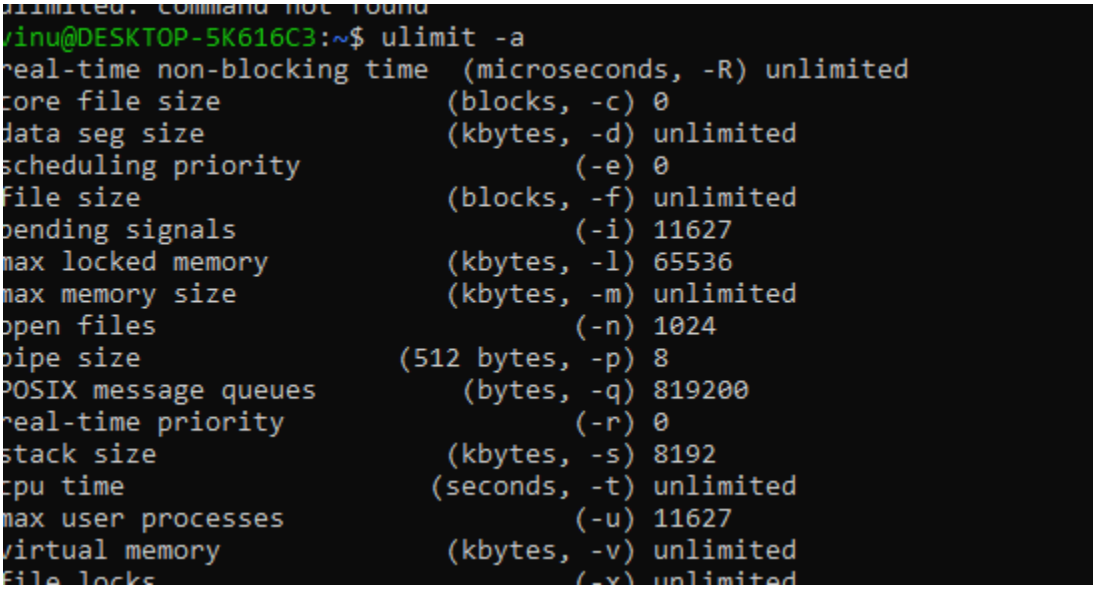
dstat



4. Check Process Limits:

 # Use ulimit to check and modify user limits on processes (e.g., maximum number of open files).





1. Viewing Current Limits

To check the current limits for a user, run:

```bash
ulimit -a
```

This command displays all the limits for the current shell session, including:

- **open files** (`nofile`)
- **max user processes** (`nproc`)
- **stack size** (`stack`)
- **memory usage** (`memlock`)
- **core dump size** (`core`)
- **CPU time** (`cpu`)
- **file size** (`fsize`)

```
file locks                          (-x) unlimited
vinu@DESKTOP-5K616C3:~$ ulimit -n
1024
vinu@DESKTOP-5K616C3:~$ ulimit -1024
-bash: ulimit: -1: invalid option
ulimit: usage: ulimit [-SHabcdefiklmnpqrstuvxPT] [limit]
vinu@DESKTOP-5K616C3:~$
```

Lab 5 : Managing Daemons and Background Services

Objective:

Learn how to manage background services and daemons in Linux.

Task:

1. Start and Stop Services:

Use systemctl to start, stop, and restart system services

```
vinu@DESKTOP-5K616C3:~$ systemctl
  UNIT
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-a4f30f41\x2d2314\x2d4ad2\x2d9c50\x2d26dbee134f82-pci2314
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-a4f30f41\x2d2314\x2d4ad2\x2d9c50\x2d26dbee134f82-pci2314
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-a4f30f41\x2d2314\x2d4ad2\x2d9c50\x2d26dbee134f82-pci2314
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-f80b1d83\x2dc44b\x2d4b95\x2da887\x2d1f77235f50c4-net-eth
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-fd1d2cbd\x2dce7c\x2d535c\x2d966b\x2deb5f811c95f0-host0-t
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-fd1d2cbd\x2dce7c\x2d535c\x2d966b\x2deb5f811c95f0-host0-t
  sys-devices-LNXSYSTM:00-LNXSYBUS:00-ACPI0004:00-VMBUS:00-fd1d2cbd\x2dce7c\x2d535c\x2d966b\x2deb5f811c95f0-host0-t
```

(e.g., systemctl start apache2, systemctl stop nginx).

1. Checking Service Status

Before taking action on a service, you may want to check its current status.

bash

```
systemctl status <service_name>
```

Example:

bash

```
systemctl status apache2
```

This command provides information about the service's state, including whether it is **(running)** or **inactive (stopped)**.

```
vinu@DESKTOP-5K616C3:~$ systemctl status
● DESKTOP-5K616C3
    State: running
     Jobs: 0 queued
   Failed: 0 units
    Since: Sun 2025-02-23 18:33:27 IST; 9h ago
   CGroup: /
           ├─user.slice
           │ └─user-1000.slice
           │   ├─user@1000.service
           │   │ └─init.scope
           │   │   ├─441 /lib/systemd/systemd --user
```

3. Stopping a Service

To stop a running service:

```bash
systemctl stop <service_name>
```

Example:

```bash
systemctl stop nginx
```

This will stop the Nginx web server.

```
vinu@DESKTOP-5K616C3:~$ systemctl stop nginux
Failed to stop nginux.service: Interactive authentication required.
```

4. Restarting a Service

Restarting is useful when changes have been made to a service's configuration and

```bash
systemctl restart <service_name>
```

Example:

```bash
systemctl restart sshd
```

This will restart the SSH service.

2. Enable/Disable Services on Boot:

Use systemctl enable and systemctl disable to manage whether a service starts on boot.

```
vinu@DESKTOP-5K616C3:~$ systemctl enable
Too few arguments.
vinu@DESKTOP-5K616C3:~$ systemctl disable
Too few arguments.
vinu@DESKTOP-5K616C3:~$
```

```
vinu@DESKTOP-5K616C3:~$ service starts on boot
starts: unrecognized service
vinu@DESKTOP-5K616C3:~$
```

3.Check Service Status:

Use systemctl status to check the status of a service (e.g., systemctl status apache2).

```
        └─init.scope
          ├─441 /lib/systemd/systemd --user
          └─442 (sd-pam)
      └─session-1.scope
        ├─351 /bin/login -f
        └─448 -bash
  ├─init.scope
  │ └─1 /sbin/init
  └─system.slice
    ├─systemd-udevd.service
    │ └─114 /lib/systemd/systemd-udevd
    ├─cron.service
    │ └─205 /usr/sbin/cron -f -P
    ├─nfs-mountd.service
    │ └─247 /usr/sbin/rpc.mountd
    ├─polkit.service
    │ └─1538 /usr/libexec/polkitd --no-debug
    ├─networkd-dispatcher.service
```

```
vinu@DESKTOP-5K616C3:~$ systemctl status apache2
Unit apache2.service could not be found.
vinu@DESKTOP-5K616C3:~$
```

4.Managing Logs for Services:

Use journalctl to check logs for systemd services.

```
vinu@DESKTOP-5K616C3:~$ systemd services
Excess arguments.
vinu@DESKTOP-5K616C3:~$
```

Filter logs for specific services or time periods to troubleshoot issues.

```
vinu@DESKTOP-5K616C3:~$ journalctl -u nginx -f

^Z
[4]+  Stopped                 journalctl -u nginx -f
vinu@DESKTOP-5K616C3:~$ journalctl -u nginx
-- No entries --
vinu@DESKTOP-5K616C3:~$ journalctl -u nginx -f
```

2. Filtering Logs for a Specific Service

To check logs for a specific systemd service:

```bash
journalctl -u <service-name>
```

Example:

```bash
journalctl -u nginx
```

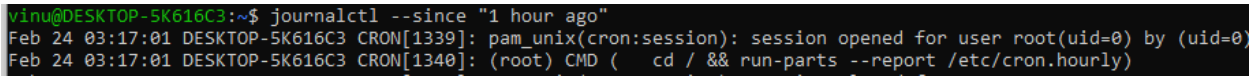
For real-time logs:

```bash
journalctl -u nginx -f
```

3. Filtering Logs by Time

To check logs from the last hour:

```bash
journalctl --since "1 hour ago"
```



4. Filtering Logs by Priority (Severity)

Systemd logs have priority levels, where **0 is emergency** and **7 is debug**. To filter by

```bash
journalctl -p 3 -u nginx
```

This will show only **errors** (priority 3 and above) for the **nginx** service.

Priority levels:

- `0` - Emergency
- `1` - Alert
- `2` - Critical
- `3` - Error
- `4` - Warning
- `5` - Notice
- `6` - Info
- `7` - Debug

6. Checking Logs for Previous Boots

List previous boot sessions:

bash

```
journalctl --list-boots
```

To view logs from the previous boot:

bash

```
journalctl -b -1
```

Or a specific boot (e.g., `-2` for two boots ago):

bash

```
journalctl -b -2 -u nginx
```

7. Persisting Logs Across Reboots

By default, logs may be stored in memory only. To ensure logs persist after reboots:

```bash
sudo mkdir -p /var/log/journal sudo systemctl restart systemd-journald
```

8. Exporting Logs

Save logs to a file:

```bash
journalctl -u nginx --since "1 hour ago" > nginx_logs.txt
```

9. Clearing Logs

To clear logs:

```bash
sudo journalctl --vacuum-time=7d
```

(This keeps logs for the last 7 days)

To limit the log size:

Lab 6 : Process Scheduling and Prioritization

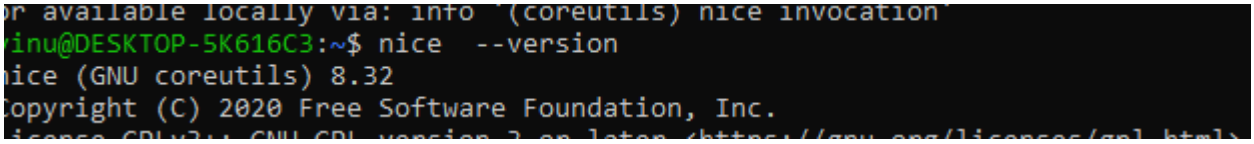
Objective:

Learn how to control process priority and manage process scheduling.

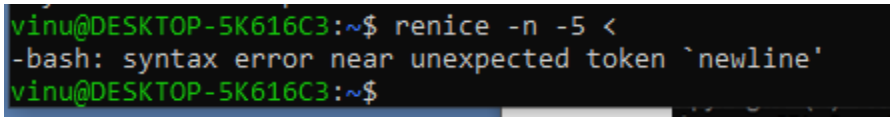
Task:

1.Change Process Priority (Nice Value):

Use nice to start a new process with a custom priority level (e.g., nice -n 10 command).



Use renice to change the priority of an already running process by its PID (e.g., renice -n -5 <



2.Scheduling Processes:

Use at to schedule a one-time task (e.g., at 09:00 to run a script).

Crontab Examples

- Run a script every day at 9 AM:

```bash
0 9 * * * /home/user/script.sh
```

- Run a script every Monday at 6 PM:

```bash
0 18 * * 1 /home/user/script.sh
```

- Run a backup at midnight on the first day of each month:

```bash
0 0 1 * * /home/user/backup.sh
```

- Run a script every 5 minutes:

```bash
*/5 * * * * /home/user/script.sh
```

```
 # Use cron to schedule recurring tasks by adding entries to
/etc/crontab or using crontab -e for user-specific jobs.
```

Crontab Examples

- Run a script every day at 9 AM:

```bash
0 9 * * * /home/user/script.sh
```

- Run a script every Monday at 6 PM:

```bash
0 18 * * 1 /home/user/script.sh
```

- Run a backup at midnight on the first day of each month:

```bash
0 0 1 * * /home/user/backup.sh
```

- Run a script every 5 minutes:

```bash
*/5 * * * * /home/user/script.sh
```

```
3.    Monitor Process Execution Time:

 # Use time to measure the execution time of a command or
script.
```

1. Using the `time` Command (Linux/macOS)

The `time` command is the simplest way to measure the execution time of a script

```bash
time ./script.sh
```

Output Example:

```sql
real    0m2.345s
user    0m1.456s
sys     0m0.234s
```

- **real**: Total elapsed time (wall clock time).
- **user**: CPU time spent in user mode.
- **sys**: CPU time spent in kernel mode.

> **Use `\time` to ensure you're using the built-in shell version, or `/usr/bin/time`**

Lab 7 : Investigating and Debugging Stuck Processes

Objective:

Learn how to identify and debug processes that are stuck or unresponsive.

Task:

```
1.    Check for Stuck Processes:

 # Use ps or top to identify processes that are stuck in a
specific state, like D (uninterruptible sleep).
```

1. Identify Stuck Processes Using `ps`

The `ps` command can be used to find processes in a **D (uninterruptible sleep) state**, indicates I/O issues, such as waiting for disk responses.

```bash
ps aux | awk '$8 ~ /D/ { print $0 }'
```

- `$8` represents the process state.
- **D** means uninterruptible sleep (often caused by disk I/O).

To display only essential information:

```bash
ps -eo pid,ppid,user,state,%cpu,%mem,cmd | grep ' D'
```

This shows:

- **PID** (Process ID)
- **PPID** (Parent Process ID)
- **User** running the process
- **State**
- **CPU & Memory Usage**

2. Use `top` or `htop` to Check for Stuck Processes

Using `top`

Run:

```bash
top
```

Press:

- **Shift** + **M** to sort by memory usage.

- **Shift** + **P** to sort by CPU usage.
- Look for processes in **D** state.

Using `htop` (if installed)

```bash
htop
```

- Press **F4** and type **D** to filter for stuck processes.

---

3. Checking Kernel Logs for Clues

If processes are stuck, check kernel logs:

```bash
dmesg | tail -50
```

or

```bash
journalctl -k -n 50
```

- Look for disk errors or messages related to **I/O wait**.

4. Find the File/Resource Holding the Process

To see which files a stuck process is accessing, use:

```bash
lsof -p <PID>
```

Replace `<PID>` with the stuck process ID.

Check for blocked I/O:

```bash
strace -p <PID>
```

- This shows system calls the process is waiting on.

5. Force Kill the Process (if necessary)

If the process is stuck and unresponsive:

```bash
kill -9 <PID>
```

If that doesn't work:

```bash
echo 1 > /proc/<PID>/oom_score_adj kill -9 <PID>
```

OR forcefully terminate the parent:

```bash
kill -9 $(ps -o ppid= -p <PID>)
```

Note: If processes keep getting stuck in **D state**, it could indicate:

- A failing disk (`smartctl -a /dev/sdX` to check).
- A bad NFS mount.
- Kernel bugs.

```
2.Trace Process Execution:

 # Use strace to trace the system calls made by a process (e.g., strace -p <PID>).
```

1. Basic Usage of `strace`

1.1 Attaching `strace` to a Running Process

To trace a running process, use:

```bash
strace -p <PID>
```

Example:

```bash
strace -p 1234
```

This attaches `strace` to process ID `1234` and starts logging its system calls.

1.2 Running a Program with `strace`

Instead of attaching to an existing process, you can start a program with `strace`:

```bash
strace <command>
```

3.Analyze Process Core Dumps:

Set up core dumps for processes by configuring /etc/security/limits.conf.

```
root@DESKTOP-5K616C3:~# nano /etc/security/limits.conf
root@DESKTOP-5K616C3:~# cat /proc/sys/kernel/core_pattern
|/wsl-capture-crash %t %E %p %s
root@DESKTOP-5K616C3:~#
```

1. Enable Core Dumps in `/etc/security/limits.conf`

By default, core dumps may be restricted. You need to enable them by configuring the limits.

Modify `/etc/security/limits.conf`

Add or modify the following lines to allow core dumps:

markdown Copy

```
*    soft    core    unlimited
*    hard    core    unlimited
```

This ensures that all users can generate core dumps without size restrictions.

Check and Modify Other Configurations

- Ensure the core pattern is properly set in `/proc/sys/kernel/core_pattern` :

  bash Copy

  ```
  cat /proc/sys/kernel/core_pattern
  ```

To store core dumps in a specific directory, modify it:

```bash
echo "/var/dumps/core.%e.%p" | sudo tee /proc/sys/kernel/core_pattern
```

This stores core dumps as `core.<executable>.<pid>` in `/var/dumps`.

- Enable core dumps for systemd services by setting in `/etc/systemd/system.conf`:

```ini
DefaultLimitCORE=infinity
```

- Restart services to apply changes.

```
# Use gdb to analyze the core dump of a crashed process.
```

2. Use `gdb` to Analyze Core Dumps

Once a core dump is generated, use `gdb` to analyze it.

Load the Core Dump

```bash
gdb /path/to/executable /path/to/core
```

For example:

```bash
gdb /usr/bin/myapp /var/dumps/core.myapp.1234
```

```
root@DESKTOP-5K616C3:~# gdb /path/to/executable /path/to/core
GNU gdb (Ubuntu 12.1-0ubuntu1~22.04.2) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
/path/to/executable: No such file or directory.
/path/to/core: No such file or directory.
(gdb)
```

4.Terminate or Kill a Stuck Process:

Use kill -9 to forcefully terminate a stuck process.

```
vinu@DESKTOP-5K616C3:~$ kill -9
kill: usage: kill [-s sigspec | -n signum | -sigspec] pid | jobspec ... or kill -l [sigspec]
vinu@DESKTOP-5K616C3:~$ kill -l
```

Investigate logs (e.g., /var/log/syslog) for additional clues.

```
vinu@DESKTOP-5K616C3:~$ tail -f /var/log/syslog
Feb 24 08:38:45 DESKTOP-5K616C3 systemd[1]: Condition check resulted in Landscape client daemons being skipped.
Feb 24 08:38:45 DESKTOP-5K616C3 systemd[1]: Starting Cleanup of Temporary Directories...
Feb 24 08:38:45 DESKTOP-5K616C3 systemd[1]: systemd-tmpfiles-clean.service: Deactivated successfully.
Feb 24 08:38:45 DESKTOP-5K616C3 systemd[1]: Finished Cleanup of Temporary Directories.
Feb 24 08:48:43 DESKTOP-5K616C3 kernel: [ 1500.908095] mini_init (117): drop_caches: 1
Feb 24 09:09:14 DESKTOP-5K616C3 squid[272]: Logfile: opening log stdio:/var/spool/squid/netdb.state
Feb 24 09:09:14 DESKTOP-5K616C3 squid[272]: Logfile: closing log stdio:/var/spool/squid/netdb.state
Feb 24 09:09:14 DESKTOP-5K616C3 squid[272]: NETDB state saved; 0 entries, 14 msec
Feb 24 09:17:01 DESKTOP-5K616C3 CRON[1548]: (root) CMD (   cd / && run-parts --report /etc/cron.hourly)
Feb 24 09:40:43 DESKTOP-5K616C3 kernel: [ 4621.266485] mini_init (117): drop_caches: 1
```

Lab 8 : Process Resource Usage and Optimization

Objective:

Optimize processes to improve system performance and reduce resource usage.

Task:

1. Analyze Resource Usage:

 # Use ps aux --sort=-%mem or top to find the processes consuming the most memory and CPU.

```
vinu@DESKTOP-5K616C3:~$ ps aux --sort=-%mem
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root        1886  0.0  1.1 382404 34888 pts/0    Tl   09:39   0:00 gdb /path/to/executable /path/to/core
root        1892  0.0  1.0 380860 30448 pts/0    Tl   09:41   0:00 gdb /path/to/executable /path/to/core
```

2. Optimize Memory Usage:

 # Identify memory leaks or inefficient memory usage with valgrind or smem.

1. Identify Memory Leaks with Valgrind

Valgrind's **memcheck** tool helps detect memory leaks and improper memory usage programs.

Install Valgrind

```
bash

sudo apt install valgrind # Debian/Ubuntu sudo dnf install valgrind # Fedo
-S valgrind # Arch
```

Run Valgrind

```
bash

valgrind --leak-check=full --show-leak-kinds=all --track-origins=yes ./you
```

- `--leak-check=full` : Provides detailed memory leak information.
- `--show-leak-kinds=all` : Displays all types of memory leaks.
- `--track-origins=yes` : Helps track uninitialized memory usage.

2. Analyze Memory Usage with smem

`smem` provides detailed per-process memory usage, including shared memory.

Install smem

bash

```
sudo apt install smem # Debian/Ubuntu sudo yum install smem # Fedora/CentOS
```

View Memory Usage per Process

bash

```
smem -t
```

- `-t` : Shows total memory usage.

Sort by Resident Set Size (RSS)

```bash
smem -r -s rss
```

- `-r` : Reverse sort.
- `-s rss` : Sort by RSS, the actual memory used.

Per-User Memory Usage

```bash
smem -u
```

Additional Tips for Optimization

- **Use** `top` , `htop` , **or** `free -m` to monitor real-time memory usage.
- **Optimize data structures** (use efficient containers in C++ like `std::vector` instead of `std::list`).
- **Free memory properly** using `free()` (C) or `delete` / `delete[]` (C++).
- **Use** `mtrace` (glibc tool) to track memory allocations.
- **Avoid memory fragmentation** by reducing frequent allocations/deallocations.

Would you like help analyzing a specific program's memory usage? 🚀

```
root@DESKTOP-5K616C3:~# smem -r -s rss
  PID User     Command                         Swap      USS      PSS      RSS
 1886 root     gdb /path/to/executable /pa        0    12448    20921    35344
```

**********THANK YOU**********