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BSIT – 4C

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IT414 – Systems Administration and Maintenance

FTA2: Exploring Linux Boot Process and System Startup

Part 1: Observing the Boot Process

1. Reboot your Linux virtual machine.

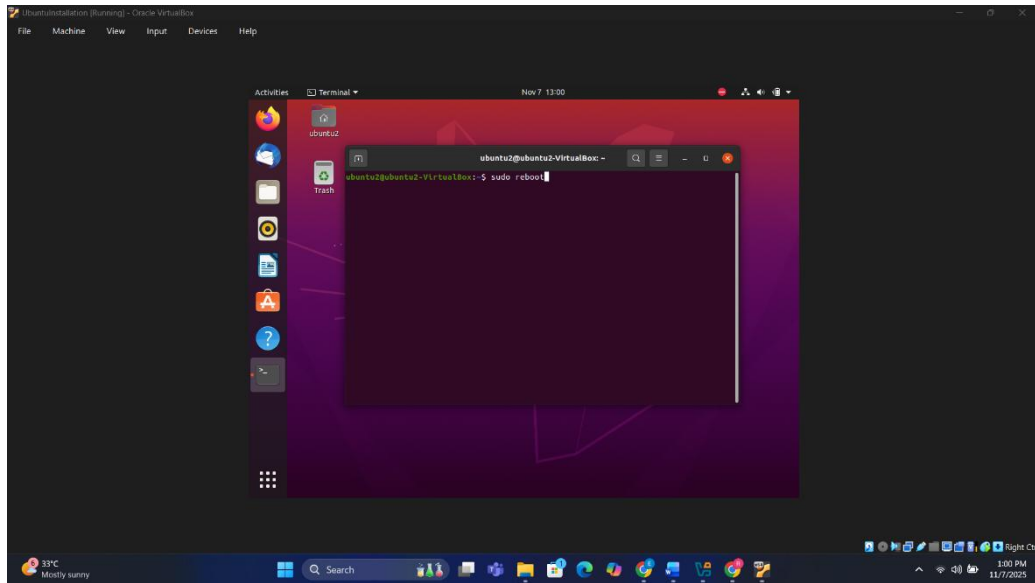


Figure 1: Restart or Reboot command in Linux Terminal

2. While the system starts, observe and note:
 - The appearance of the **BIOS/UEFI** screen.

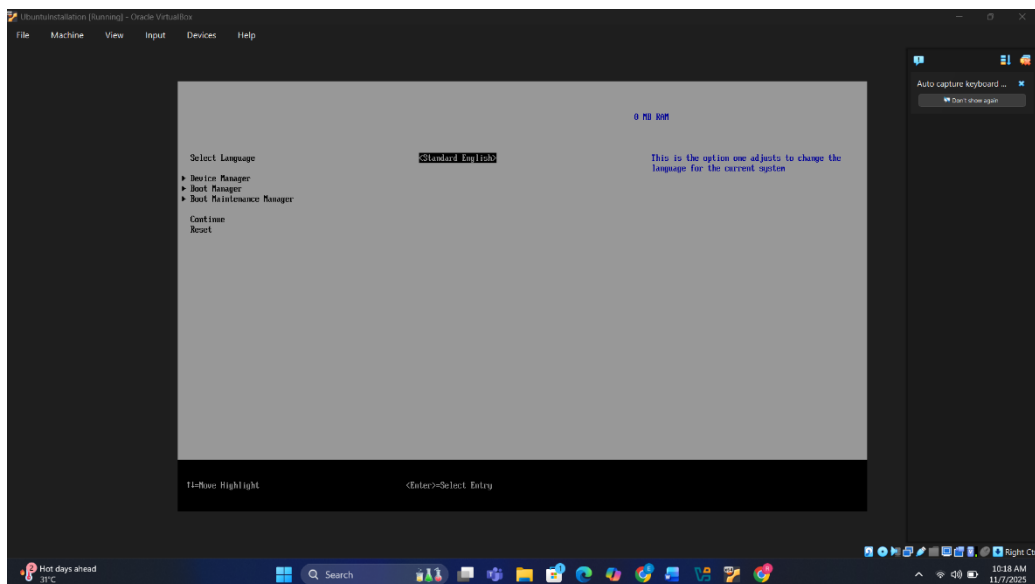


Figure 2: BIOS / UEFI Screen

- The **GRUB menu** (boot loader screen).

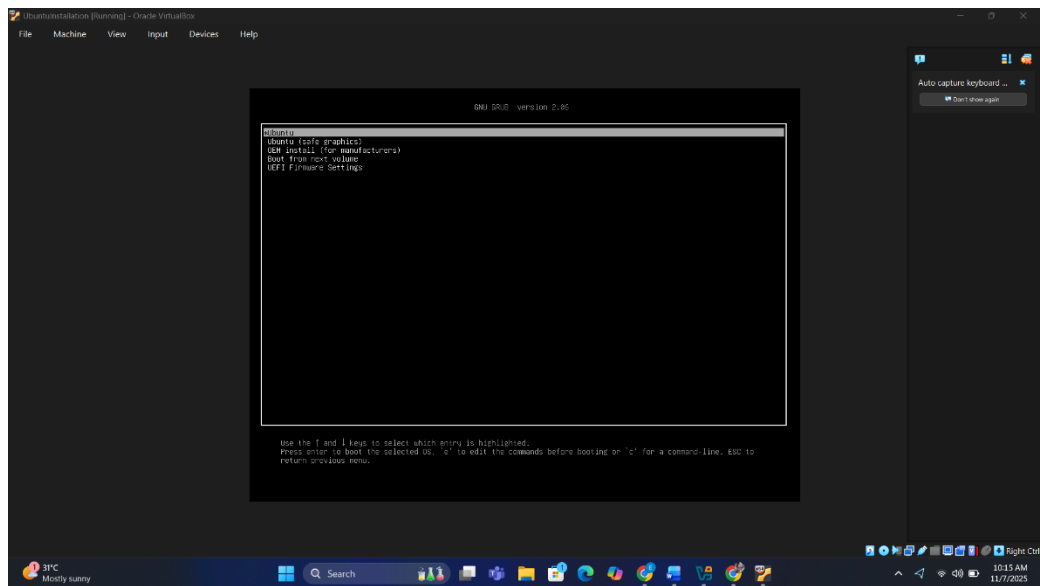


Figure 3: GRUB menu

3. After logging in, open the terminal and run:
4. `dmesg | less`

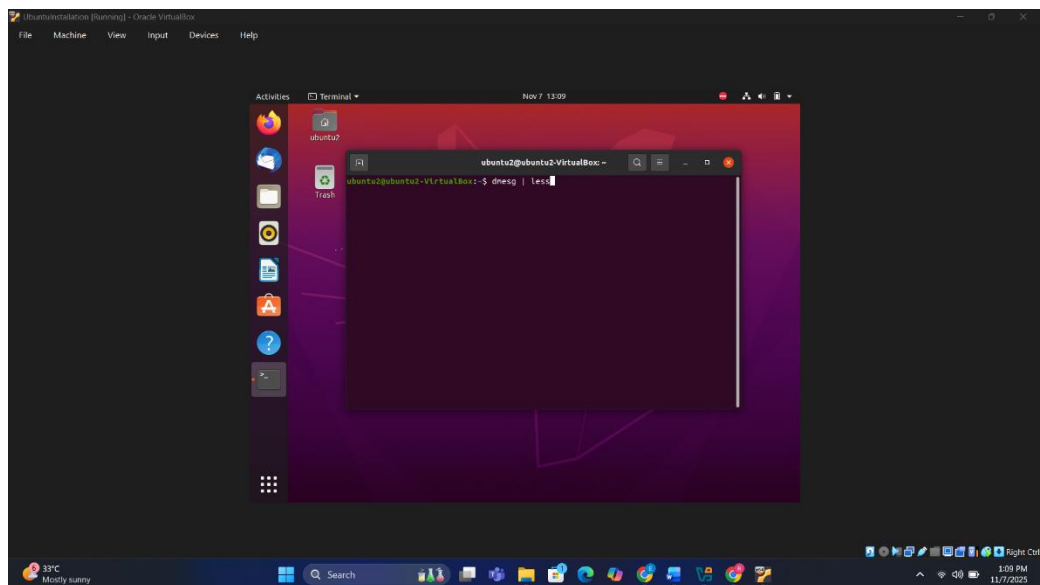


Figure 4: dmesg | less command in Linux Terminal

- The screenshot captures a Windows 11 desktop environment. At the top, the taskbar includes the Start button, a search bar, and several pinned applications. A notification area on the right shows weather information for 'Now' and the current time, 12:21 PM, on 11/7/2023. The main workspace features a large window titled 'ubuntu2@buntu2-VirtualBox -'. This window contains a terminal interface where the Ubuntu operating system is booting. The boot log visible in the terminal includes:

```
[ 0.000000] Linux version 5.15.0-139-generic (buildd@lgz-amd64-007) (gcc (Ubuntu 9.4.0-1ubuntu1~20.04) 9.4.0, GNU ld (GNU Simultell For Ubuntu) 2.34) #189-WM has:1-ubuntu SMP Wed Mar 16 08:23:56 UTC 2023 (ubuntu 5.15.0-139-gpr-20.04.1-generic 5.15.178)  
[ 0.000000] Command line: root=(hd0,hda)/wmlinux/5.15.0-139-generic root=hd0L7F7595FC-F32E-4B61-B8  
SF-9C8FA0A0806 ro quiet splash v.b.handoff;  
[ 0.000000] KERNEL supported cpus:  
[ 0.000000] Intel GenuineIntel  
[ 0.000000] AMD AuthenticAMD  
[ 0.000000] Hygon HygonGenuine  
[ 0.000000] Centaur CentaurHauls  
[ 0.000000] zhaoxin Shanghai  
[ 0.000000] BIOS-provided physical RAM map:  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] usable  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] usable  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] reserved  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] usable  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] reserved  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] ACPI data  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] ACPI NVS  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] usable  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] reserved  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] ACPI NVS  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] usable  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] reserved  
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000000fff] usable  
[ 0.000000] NX (Execute Only) protection active  
[ 0.000000] EFI: xz-v2.70 by EDE II  
[ 0.000000] ef: ACPI=efedf00e ACPI 2.0=efedf014 SMI=efedf00e ROM=x=efedf000 RHC=efedf01e  
[ 0.000000] random crng init done  
[ 0.000000] secureboot Secure boot disabled  
[ 0.000000] smbios 2.5 percent.  
[ 0.000000] dmi: Unlabeled Gnu VirtualBox/VirtualBox, BIOS VirtualBox 12/01/2006  
[ 0.000000] Hypervisor detected: KVM  
[ 0.000000] kvm-clock: Using msrc 4000000 and dsr 00000000  
[ 0.000000] Show Applications u-lock: cpu 0, msc 00000000, primary cpu clock
```


The terminal window also shows a file manager icon on the left sidebar, indicating the user's desktop environment.

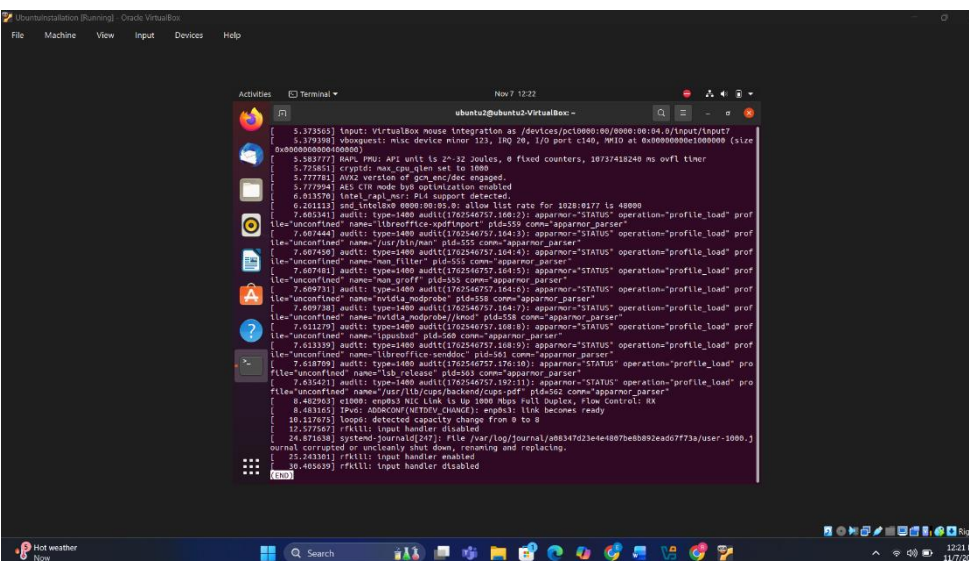
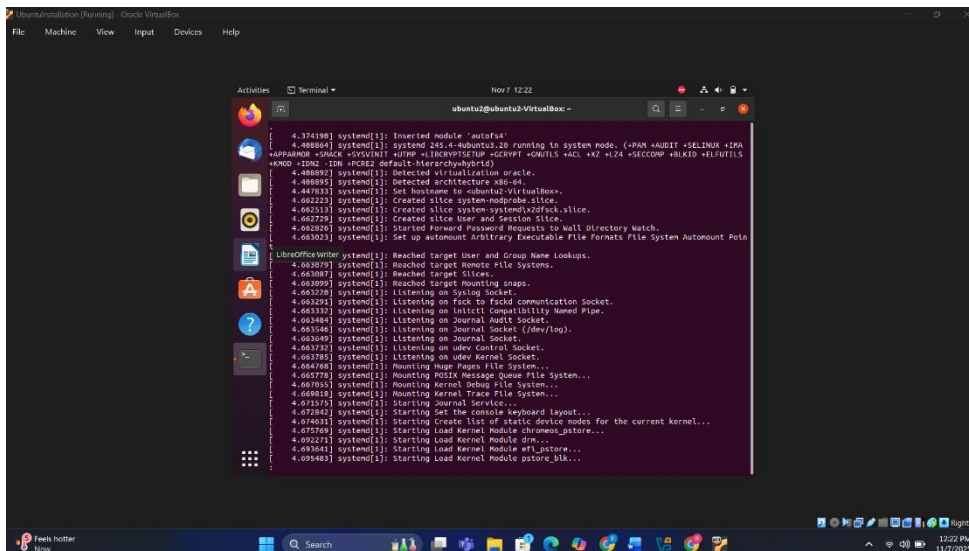
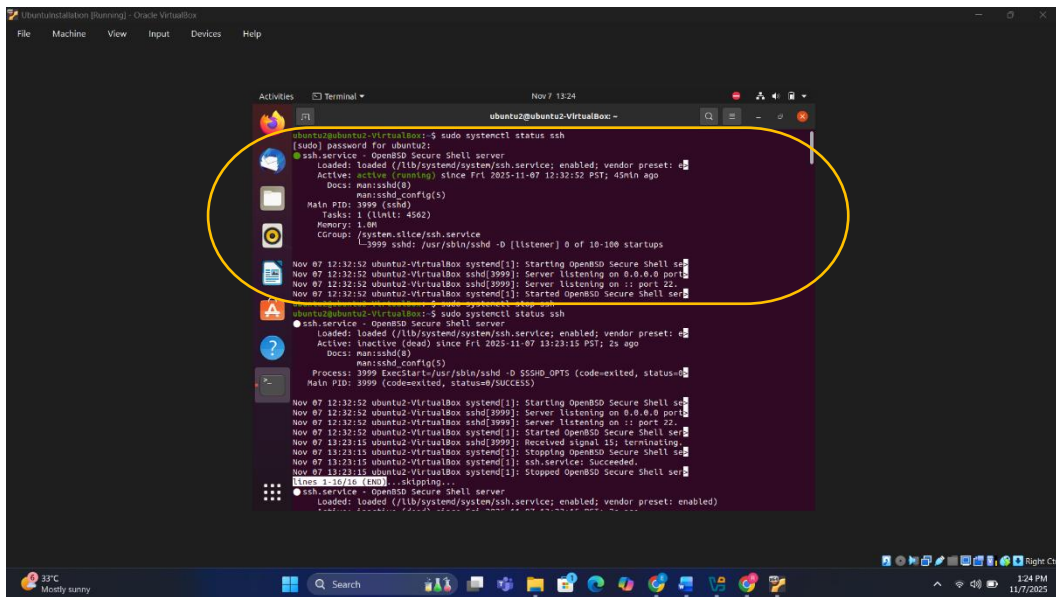


Figure 5: Messages in the Kernel Loading Process

Part 2: Managing Services Using systemctl

1. Check the status of a service (example: SSH or Network Manager):
2. `sudo systemctl status ssh`



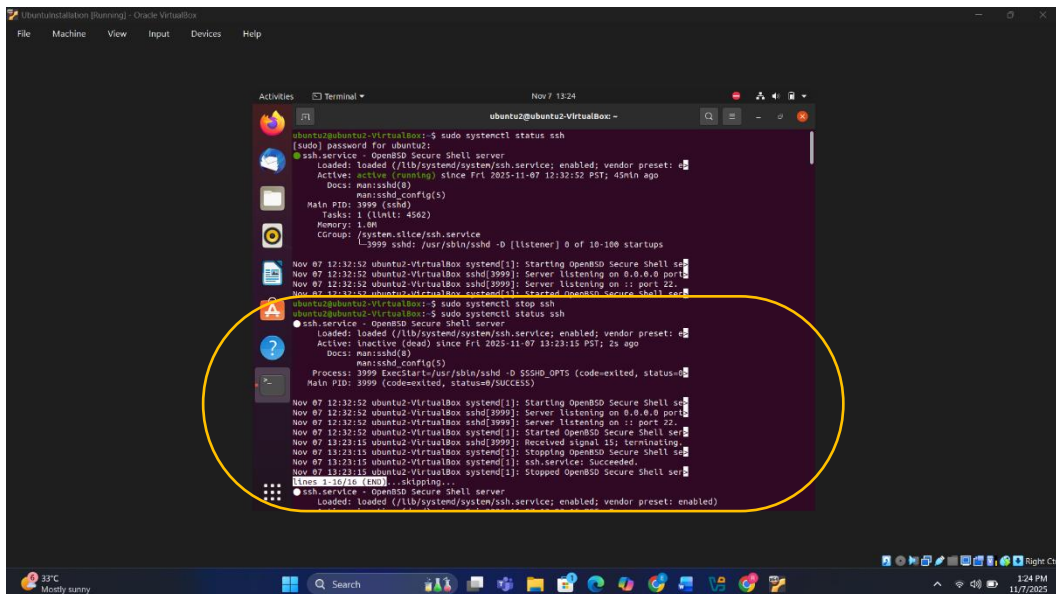
```
ubuntu2@ubuntu2-VirtualBox:~$ sudo systemctl status ssh
[sudo] password for ubuntu2:
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: en
   Active: active (running) since Fri 2025-11-07 12:32:52 PST; 45min ago
     Docs: man:ssh(8)
           man:ssh_config(5)
    Main PID: 3999 (sshd)
      Tasks: 1 (limit: 4562)
     Memory: 1.0M
    CGroup: /system.slice/ssh.service
            └─3999 sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups

Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell se
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Server listening on 0.0.0.0 port
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Server listening on :: port 22.
Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Started OpenSSH Secure Shell se
Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Stopped OpenSSH Secure Shell se
ubuntu2@ubuntu2-VirtualBox:~$ sudo systemctl status ssh
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: en
   Active: inactive (dead) since Fri 2025-11-07 13:23:15 PST; 2s ago
     Docs: man:ssh(8)
           man:ssh_config(5)
    Process: 3999 ExecStart=/usr/sbin/sshd -D $SSH_OPTS (code=exited, status=0
    Main PID: 3999 (code=exited, status=0/SUCCESS)

Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell se
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Server listening on 0.0.0.0 port
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Server listening on :: port 22.
Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Started OpenSSH Secure Shell se
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Received signal 15; terminatin
Nov 07 13:23:15 ubuntu2-VirtualBox systemd[1]: Stopping OpenSSH Secure Shell s
Nov 07 13:23:15 ubuntu2-VirtualBox systemd[1]: ssh.service: Succeeded.
Nov 07 13:23:15 ubuntu2-VirtualBox systemd[1]: Stopped OpenSSH Secure Shell se
Since 13:23:15 (1min) ...skipping...
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: en
```

Figure 6: Output using `sudo systemctl status ssh` in Linux Terminal

3. Stop the service, then restart it:
4. `sudo systemctl stop ssh`

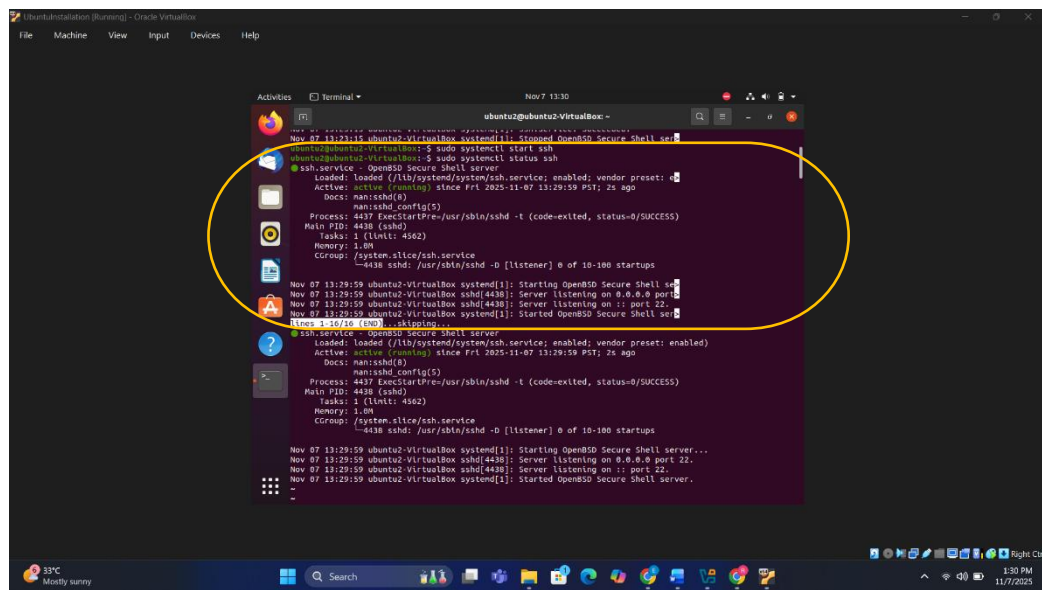


```
ubuntu2@ubuntu2-VirtualBox:~$ sudo systemctl stop ssh
[sudo] password for ubuntu2:
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: en
   Active: inactive (dead) since Fri 2025-11-07 13:23:15 PST; 2s ago
     Docs: man:ssh(8)
           man:ssh_config(5)
    Process: 3999 ExecStart=/usr/sbin/sshd -D $SSH_OPTS (code=exited, status=0
    Main PID: 3999 (code=exited, status=0/SUCCESS)

Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell se
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Server listening on 0.0.0.0 port
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Server listening on :: port 22.
Nov 07 12:32:52 ubuntu2-VirtualBox systemd[1]: Started OpenSSH Secure Shell se
Nov 07 12:32:52 ubuntu2-VirtualBox sshd[3999]: Received signal 15; terminatin
Nov 07 13:23:15 ubuntu2-VirtualBox systemd[1]: Stopping OpenSSH Secure Shell s
Nov 07 13:23:15 ubuntu2-VirtualBox systemd[1]: ssh.service: Succeeded.
Nov 07 13:23:15 ubuntu2-VirtualBox systemd[1]: Stopped OpenSSH Secure Shell se
Since 13:23:15 (1min) ...skipping...
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: en
```

Figure 7: Output using `sudo systemctl stop ssh` in Linux Terminal

5. sudo systemctl start ssh



```
Nov 07 13:29:18 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell server:
Nov 07 13:29:18 ubuntu2-VirtualBox: $ sudo systemctl start ssh
Nov 07 13:29:18 ubuntu2-VirtualBox: $ sudo systemctl status ssh
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: enab
   Active: active (running) since Fri 2025-11-07 13:29:59 PST; 2s ago
     Docs: man:ssh(8)
           man:ssh_config(5)
   Process: 4437 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
    Main PID: 4438 (sshd)
       Tasks: 1 (limit: 4562)
      Memory: 1.0M
      CGroup: /system.slice/ssh.service
              └─4438 sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups

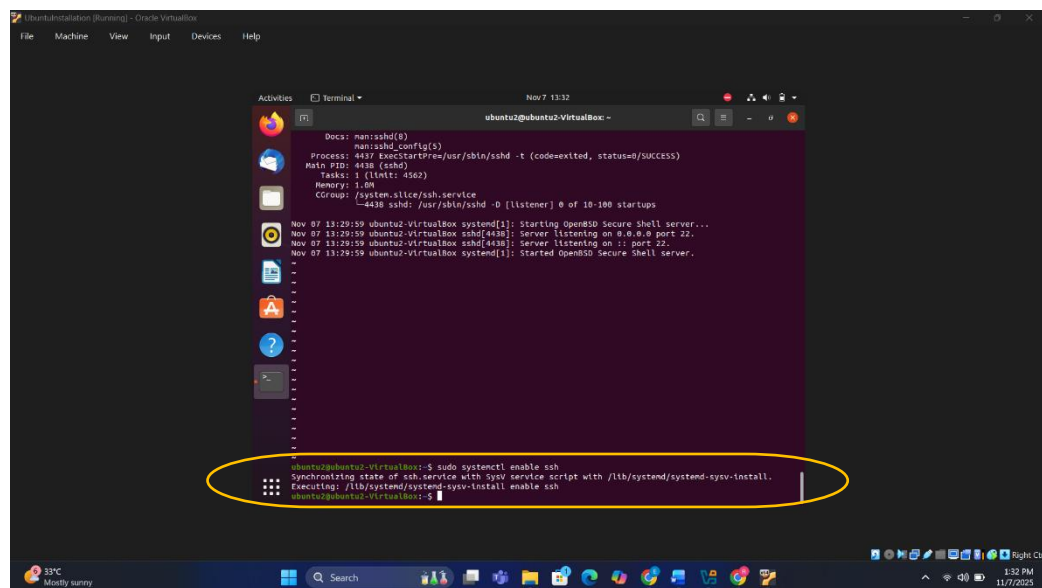
Nov 07 13:29:59 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell server...
Nov 07 13:29:59 ubuntu2-VirtualBox sshd[4438]: Server listening on 0.0.0.0 port 22.
Nov 07 13:29:59 ubuntu2-VirtualBox sshd[4438]: Server listening on :: port 22.
Nov 07 13:29:59 ubuntu2-VirtualBox systemd[1]: Started OpenSSH Secure Shell server.
lines 1-10/10 (END) ...skipping...
● ssh.service - OpenSSH Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: enabled)
   Active: active (running) since Fri 2025-11-07 13:29:59 PST; 2s ago
     Docs: man:ssh(8)
           man:ssh_config(5)
   Process: 4437 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
    Main PID: 4438 (sshd)
       Tasks: 1 (limit: 4562)
      Memory: 1.0M
      CGroup: /system.slice/ssh.service
              └─4438 sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups

Nov 07 13:29:59 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell server...
Nov 07 13:29:59 ubuntu2-VirtualBox sshd[4438]: Server listening on 0.0.0.0 port 22.
Nov 07 13:29:59 ubuntu2-VirtualBox sshd[4438]: Server listening on :: port 22.
Nov 07 13:29:59 ubuntu2-VirtualBox systemd[1]: Started OpenSSH Secure Shell server.
```

Figure 8: Output using **sudo systemctl start ssh** in Linux Terminal

6. Enable the service to start at boot:

7. sudo systemctl enable ssh



```
Nov 07 13:29:59 ubuntu2-VirtualBox systemd[1]: Starting OpenSSH Secure Shell server...
Nov 07 13:29:59 ubuntu2-VirtualBox sshd[4438]: Server listening on 0.0.0.0 port 22.
Nov 07 13:29:59 ubuntu2-VirtualBox sshd[4438]: Server listening on :: port 22.
Nov 07 13:29:59 ubuntu2-VirtualBox systemd[1]: Started OpenSSH Secure Shell server.

ubuntu2@ubuntu2-VirtualBox:~$ sudo systemctl enable ssh
Synchronizing state of ssh.service with SysV service script with /lib/systemd/systemd-sysv-install.
Executing: /lib/systemd/systemd-sysv-install enable ssh
ubuntu2@ubuntu2-VirtualBox:~$
```

Figure 9: Output using **sudo systemctl enable ssh** in Linux Terminal

Part 3: Exploring the Linux Filesystem Hierarchy

1. Using the terminal, explore the following directories:

- /boot

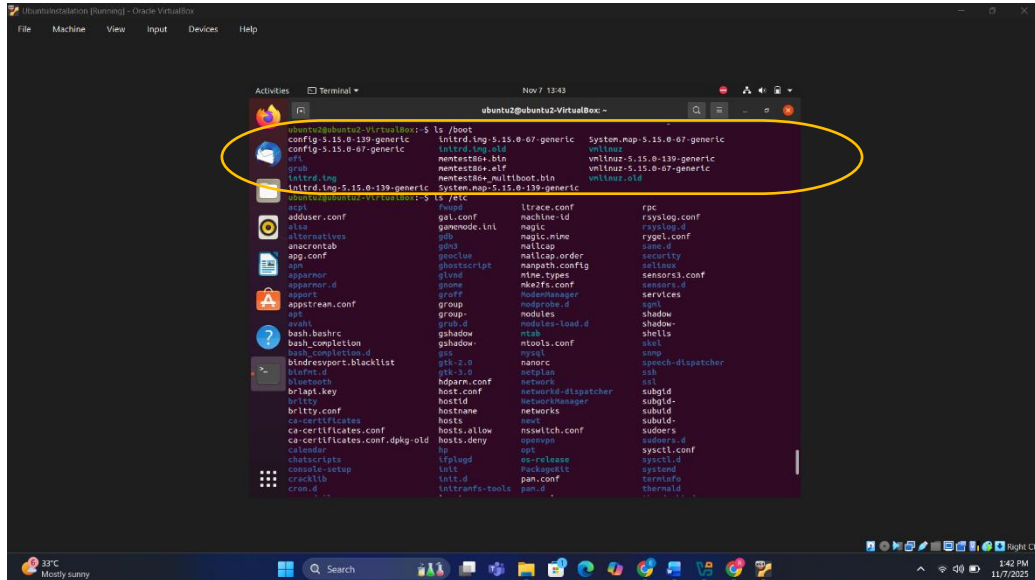


Figure 10: Output using /boot command in Linux Terminal

- /etc

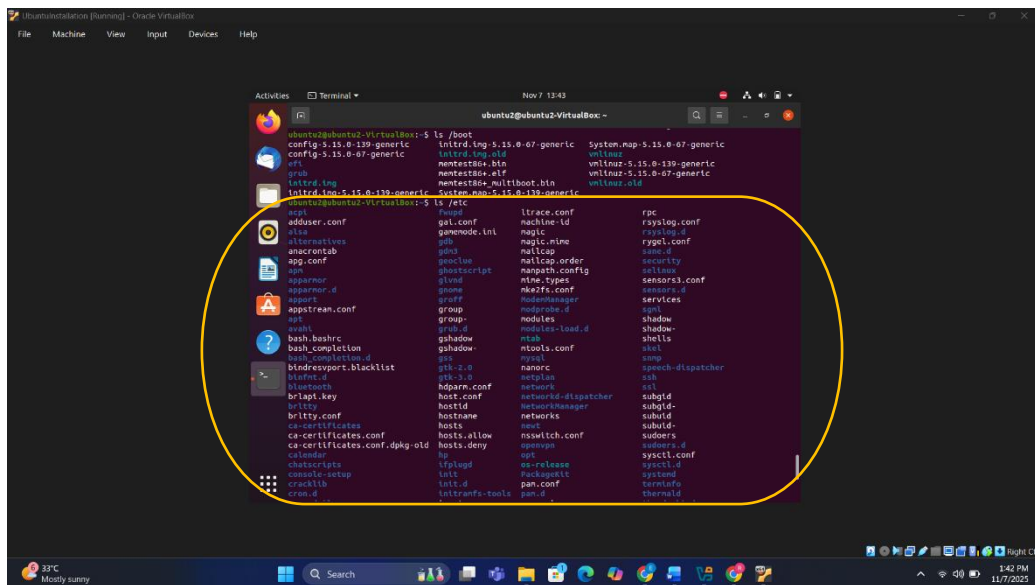


Figure 11: Output using /etc command in Linux Terminal

- /usr

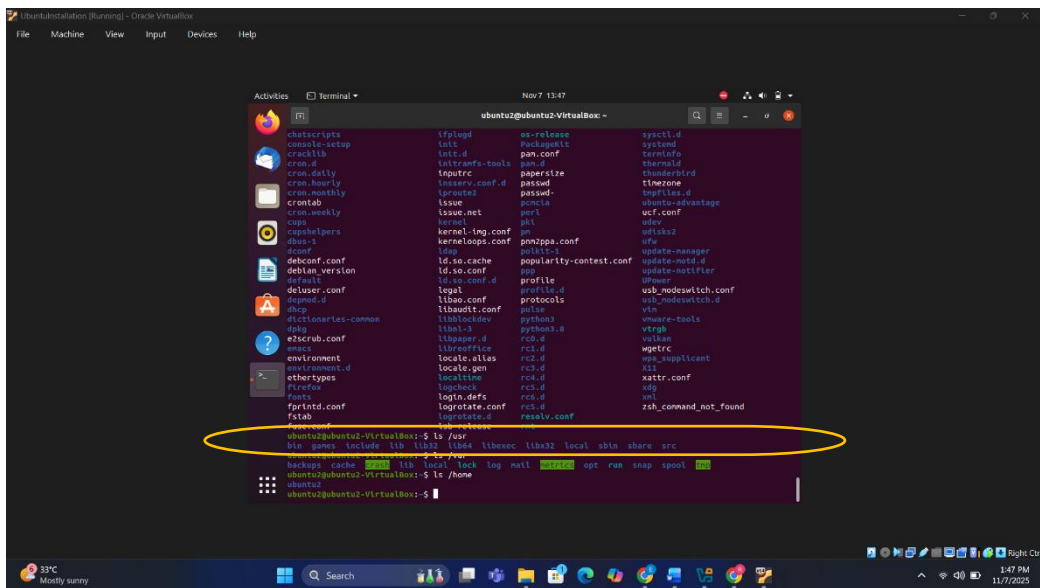


Figure 12: Output using /usr command in Linux Terminal

- /var

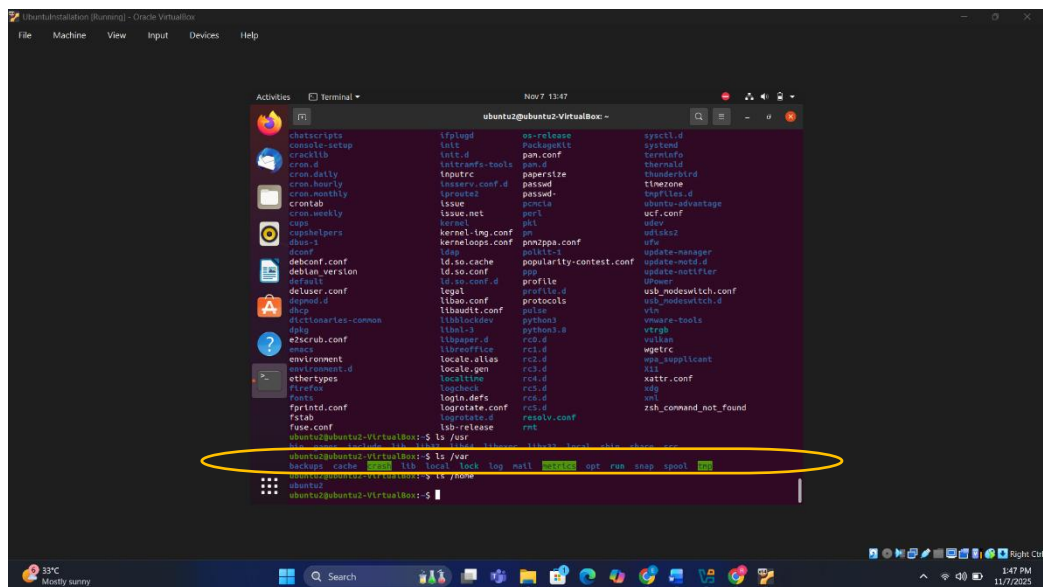


Figure 13: Output using /var command in Linux Terminal

- /home

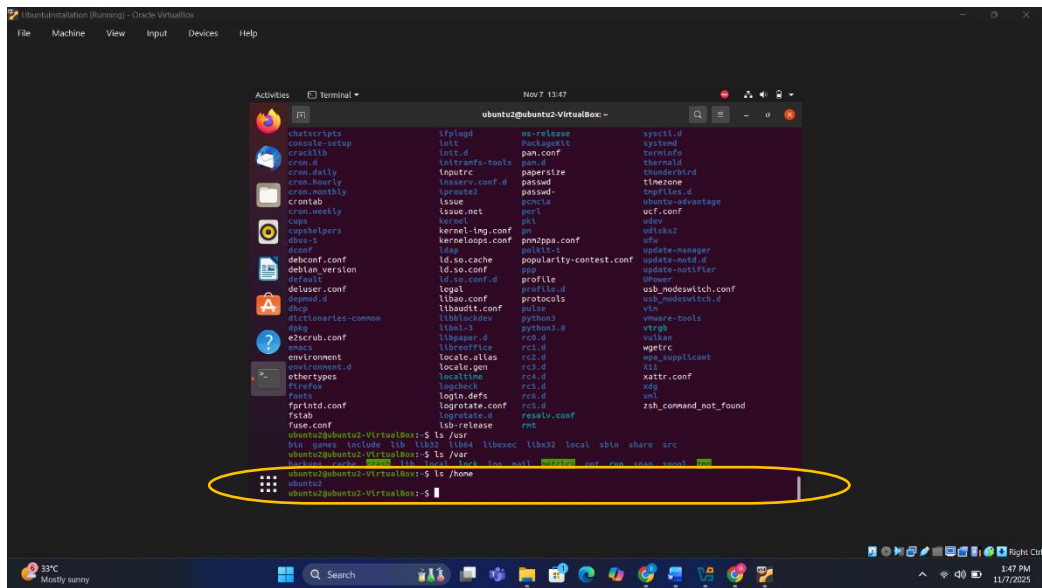


Figure 14: Output using /home command in Linux Terminal

- For each directory, describe its purpose and list **two subdirectories or files** it contains.
- Present your findings in a simple table (Directory | Description | Example Contents).

Directory	Description	Example Contents
/boot	Hosts vital files required to boot the system including the Linux kernel and bootloader settings.	vmlinuz-5.15.0-122-generic, grub/
/etc	Contain the system-wide configuration files which regulate the operation of the system and services.	hostname, network/
/usr	Includes applications installed by the user, common libraries and documentation utilized by every user.	bin/, share/
/var	Stores variable data files like logs, mail spools and caches, which are changed as long as the store operates.	log/, cache/
/home	The personal directories of every user are inside it; each user gets their files, documents and settings in them.	ubuntu2, Documents/

Part 4: Reflection

Write a short paragraph (5–8 sentences) reflecting on:

- What you learned about the Linux boot process.
- How systemctl helps in managing system services.
- Why understanding the filesystem structure is essential for system administrators.

Answer:

In this lab activity, we came to know that the process of boot in Linux occurs in a series of steps with the first step being the BIOS/UEFI, the second step being the GRUB bootloader, the third step is the Kernel loading, and the last step is the Init system which launches necessary services. The following stages assisted us in the realization of how the system gets started and gets ready to allow user access. We also got to know that systemctl is an efficient service in controlling system services whereby administrators can control startup, stop, or enable of the services upon booting to ensure the system operates smoothly. Visiting the Linux file system search revealed the structure of the hierarchy of directories, which are structured to serve a certain purpose. The /etc command used by the system to store configuration, /var used by the system to store logs and the /home used by the system to store user information. This structure is important to system administrators to trouble shoot, configure software and ensure the safety of the systems effectively. On the whole, the exercise increased our practical literacy on the management of Linux systems and emphasized the relevance of system booting processes as well as systematized file systems.