Sri Lanka Institute of Information Technology

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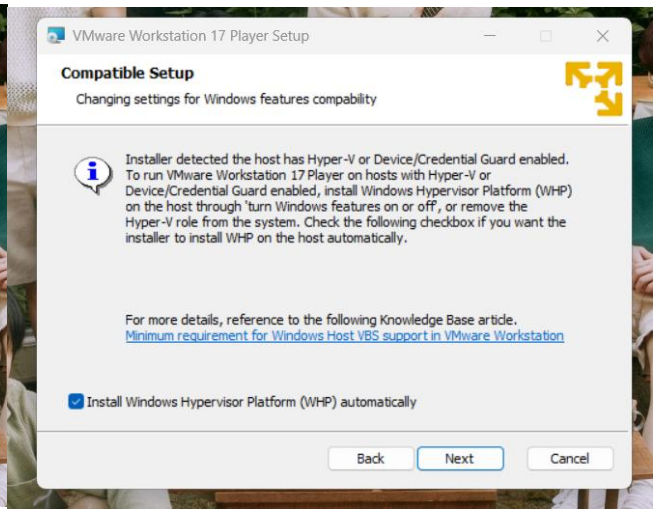
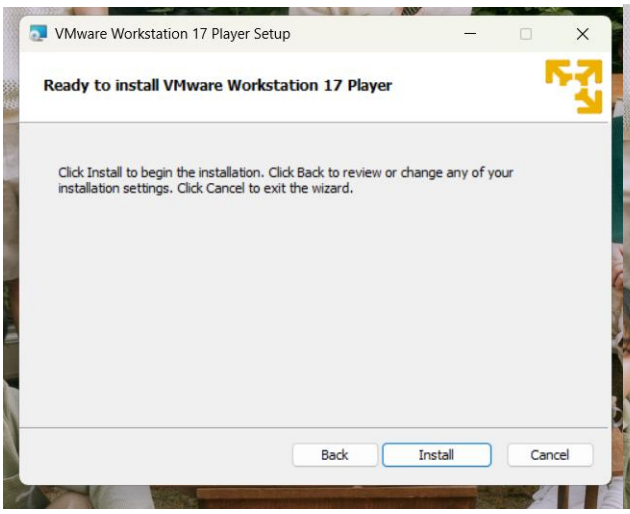
IE2012 – Systems and Network Programming

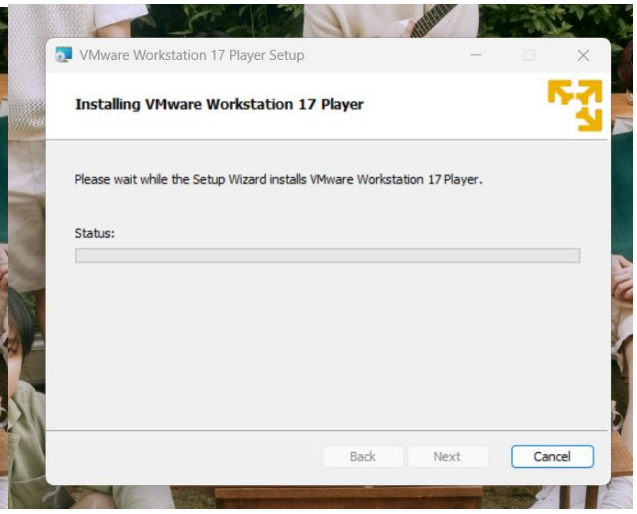
Year 2 Semester 1 – 2025

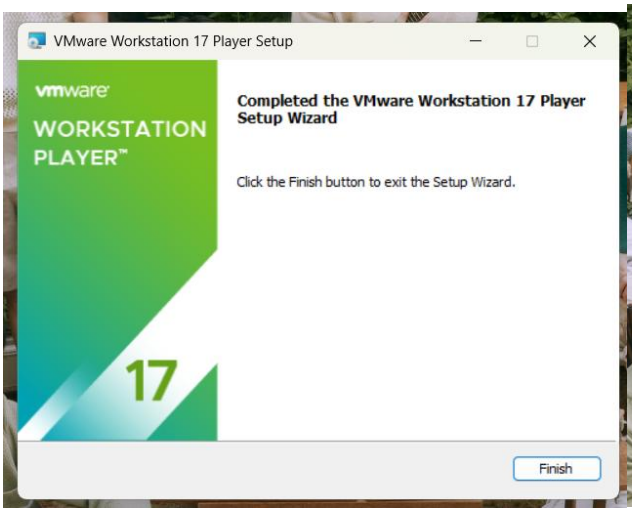
Virtual Machine Installation Steps

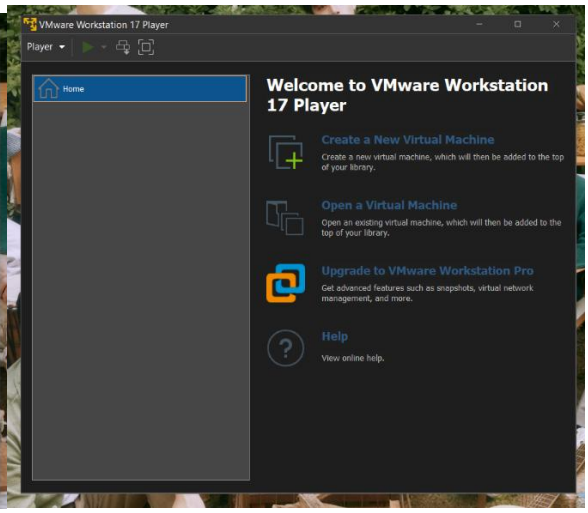
- Download and install a virtualization tool **VMware Workstation Player.**
- Download a Linux distribution **Ubuntu**
- Create a new virtual machine, allocate CPU, RAM, and disk space.
- Mount the ISO and follow the installation prompts to install Ubuntu in VMware Workstation Player.
- Set up a user account and password during installation.

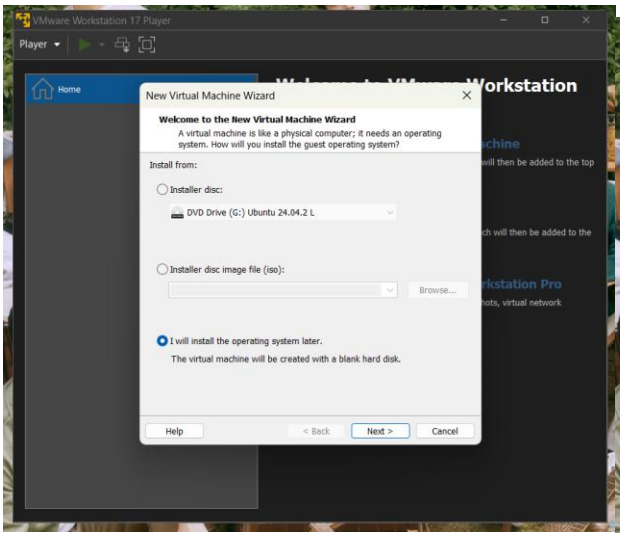


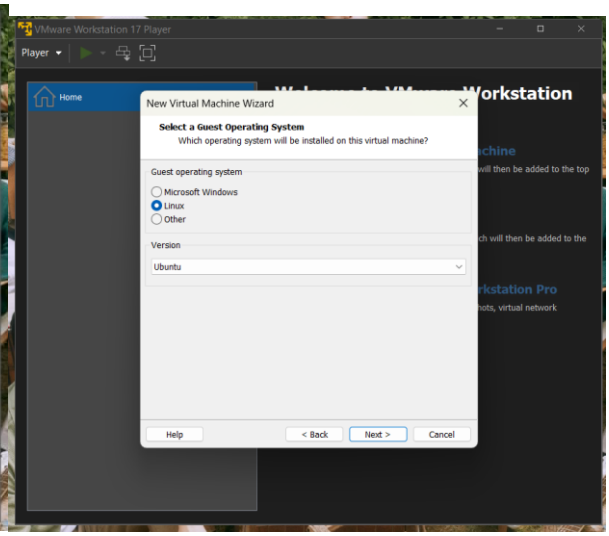


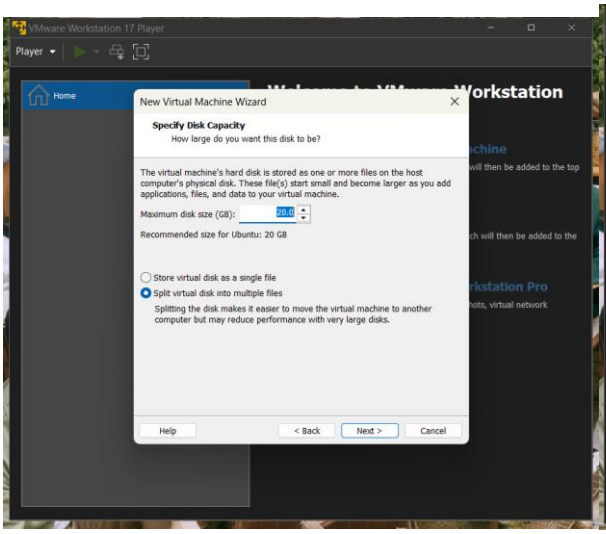


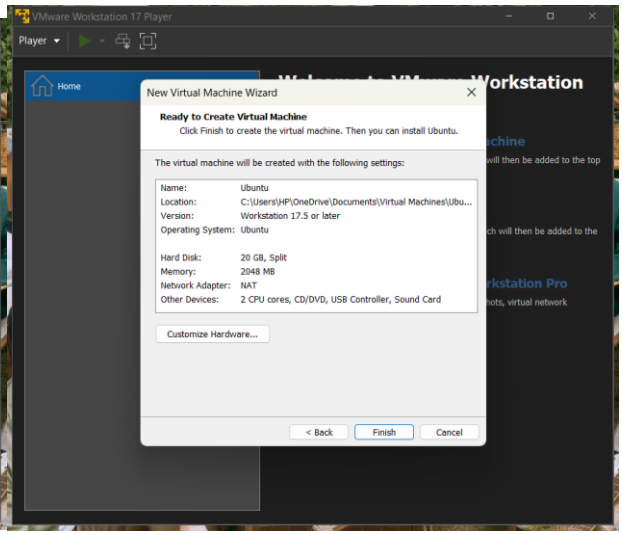

VMware Workstation 17 Player Setup
vmware
WORKSTATION
PLAYER™
17
Completed the VMware Workstation 17 Player Setup Wizard
Click the Finish button to exit the Setup Wizard.
Finish

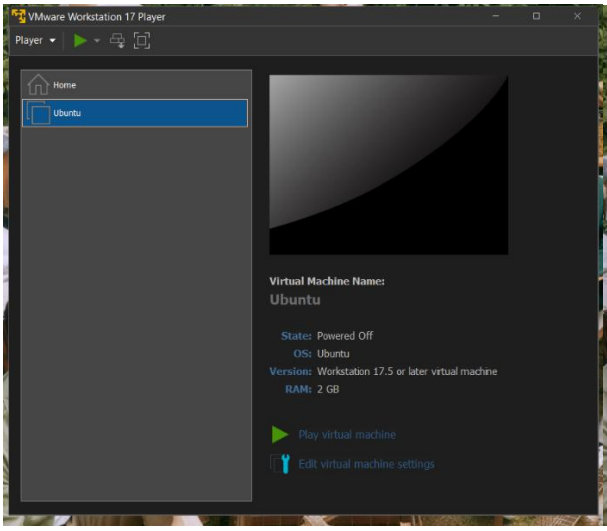

VMware Workstation 17 Player
Player
Home
Welcome to VMware Workstation 17 Player
Create a New Virtual Machine
Create a new virtual machine, which will then be added to the top of your library.
Open a Virtual Machine
Open an existing virtual machine, which will then be added to the top of your library.
Upgrade to VMware Workstation Pro
Get advanced features such as snapshots, virtual network management, and more.
Help
View online help.

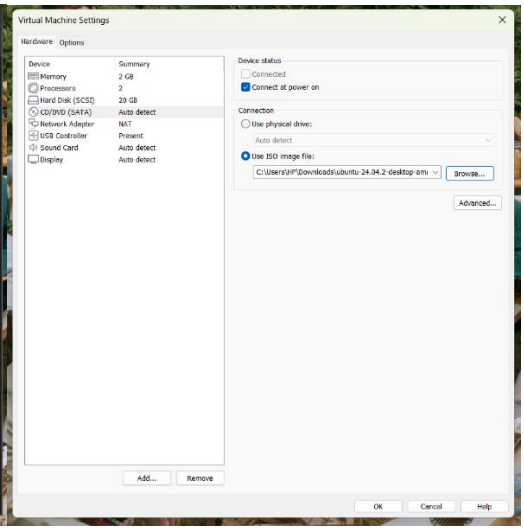

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Welcome to the New Virtual Machine Wizard
A virtual machine is like a physical computer; it needs an operating system. How will you install the guest operating system?
Install from:
Installer disc:
DVD Drive (G:) Ubuntu 24.04.2 L
Installer disc image file (iso):
Browse...
I will install the operating system later.
The virtual machine will be created with a blank hard disk.
Help
< Back
Next >
Cancel

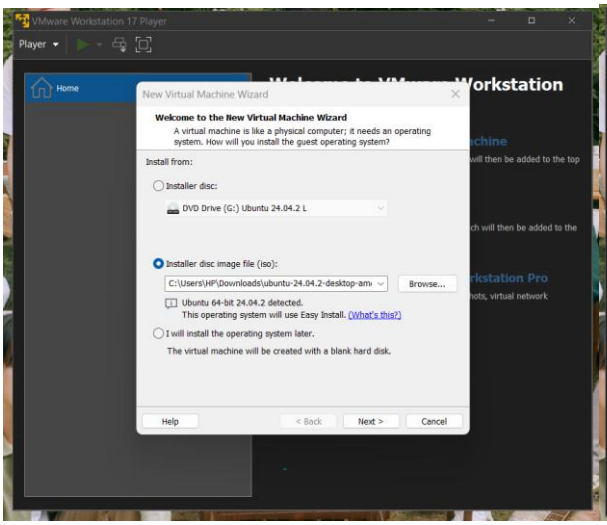

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Select a Guest Operating System
Which operating system will be installed on this virtual machine?
Guest operating system
Microsoft Windows
Linux
Other
Version
Ubuntu
Help
< Back
Next >
Cancel

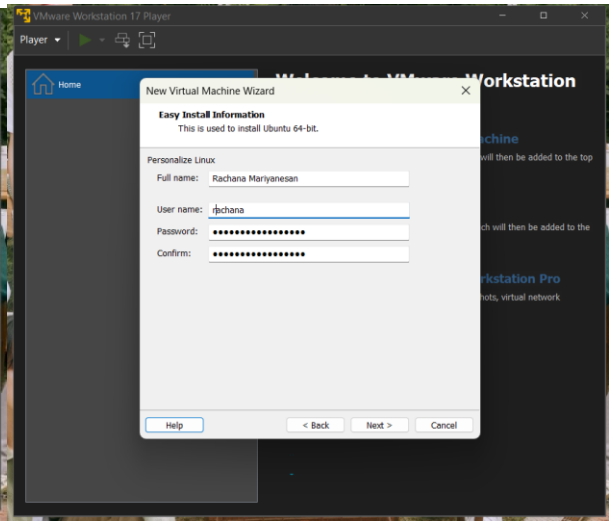

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Specify Disk Capacity
How large do you want this disk to be?
The virtual machine's hard disk is stored as one or more files on the host computer's physical disk. These file(s) start small and become larger as you add applications, files, and data to your virtual machine.
Maximum disk size (GB):
20.0
Recommended size for Ubuntu: 20 GB
Store virtual disk as a single file
Split virtual disk into multiple files
Splitting the disk makes it easier to move the virtual machine to another computer but may reduce performance with very large disks.
Help
< Back
Next >
Cancel

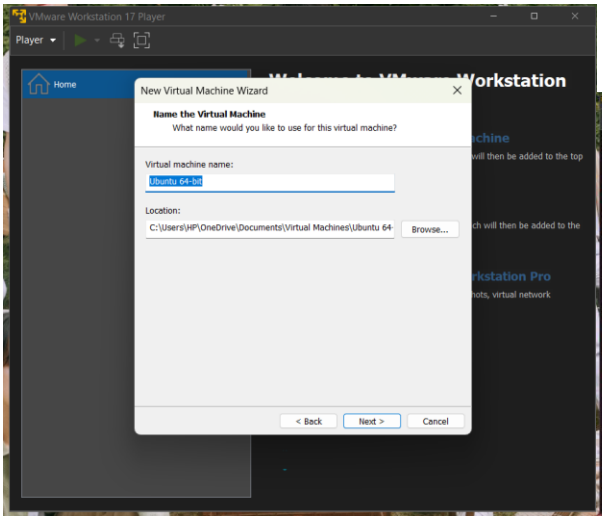

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Ready to Create Virtual Machine
Click Finish to create the virtual machine. Then you can install Ubuntu.
The virtual machine will be created with the following settings:
Name: Ubuntu
Location: C:\Users\HP\OneDrive\Documents\Virtual Machines\Ubu...
Version: Workstation 17.5 or later
Operating System: Ubuntu
Hard Disk: 20 GB, Split
Memory: 2048 MB
Network Adapter: NAT
Other Devices: 2 CPU cores, CD/DVD, USB Controller, Sound Card
Customize Hardware...
< Back
Finish
Cancel


VMware Workstation 17 Player
Player
Home
Ubuntu
Virtual Machine Name:
Ubuntu
State: Powered Off
OS: Ubuntu
Version: Workstation 17.5 or later virtual machine
RAM: 2 GB
Play virtual machine
Edit virtual machine settings

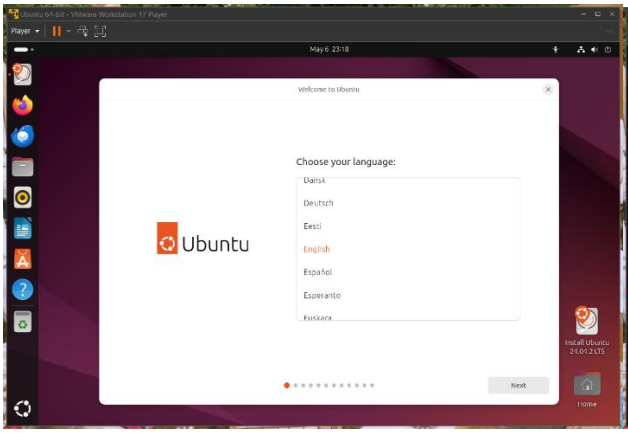

Virtual Machine Settings
Hardware
Options
Device
Summary
Memory
2 GB
Processors
2
Hard Disk (SCSI)
20 GB
CD/DVD (SATA)
Auto detect
Network Adapter
NAT
USB Controller
Present
Sound Card
Auto detect
Display
Auto detect
Device status
Connected
Connect at power on
Connection
Use physical drive:
Auto detect
Use ISO image file:
Browse...
Advanced...
Add...
Remove
OK
Cancel
Help

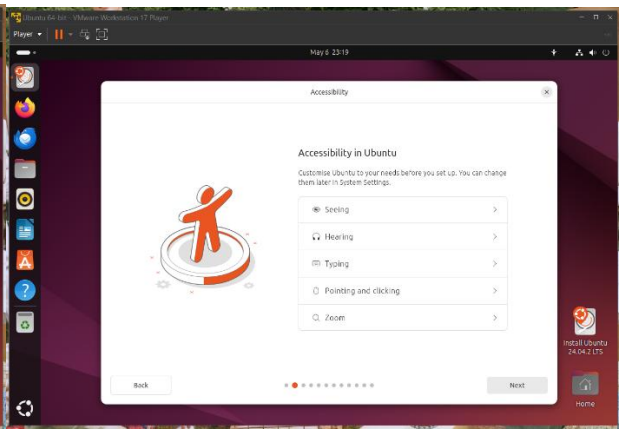

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Welcome to the New Virtual Machine Wizard
A virtual machine is like a physical computer; it needs an operating system. How will you install the guest operating system?
Install from:
Installer disc:
DVD Drive (G:) Ubuntu 24.04.2 L
Installer disc image file (iso):
C:\Users\HP\Downloads\ubuntu-24.04.2-desktop-am
Browse...
Ubuntu 64-bit 24.04.2 detected.
This operating system will use Easy Install. (What's this?)
I will install the operating system later.
The virtual machine will be created with a blank hard disk.
Help
< Back
Next >
Cancel

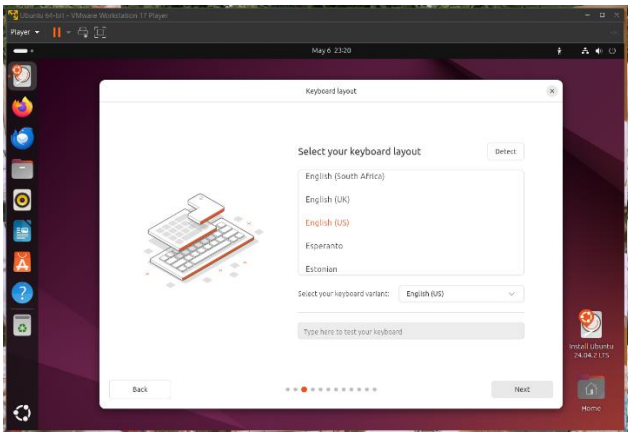

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Easy Install Information
This is used to install Ubuntu 64-bit.
Personalize Linux
Full name:
Rachana Mariyanesan
User name:
rachana
Password:
Confirm:
Help
< Back
Next >
Cancel

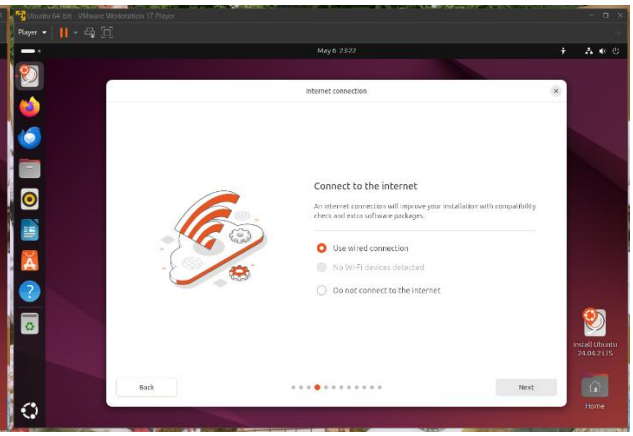

VMware Workstation 17 Player
Player
Home
New Virtual Machine Wizard
Name the Virtual Machine
What name would you like to use for this virtual machine?
Virtual machine name:
Ubuntu 64-bit
Location:
C:\Users\HP\OneDrive\Documents\Virtual Machines\Ubuntu 64-
Browse...
< Back
Next >
Cancel

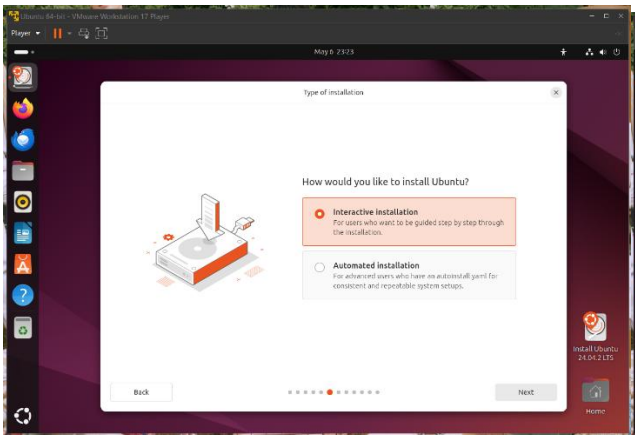

Player
May 6 23:14
Install Ubuntu 24.04.2 LTS
Home

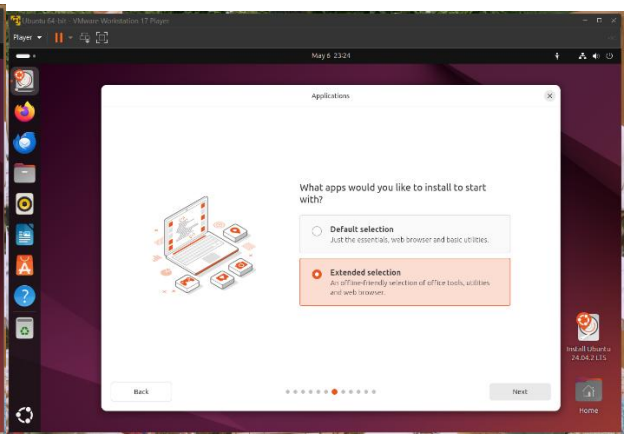

Welcome to Ubuntu
Choose your language:
Ubuntu
Dansk
Deutsch
Eesti
English
Español
Esperanto
Euskara
Next

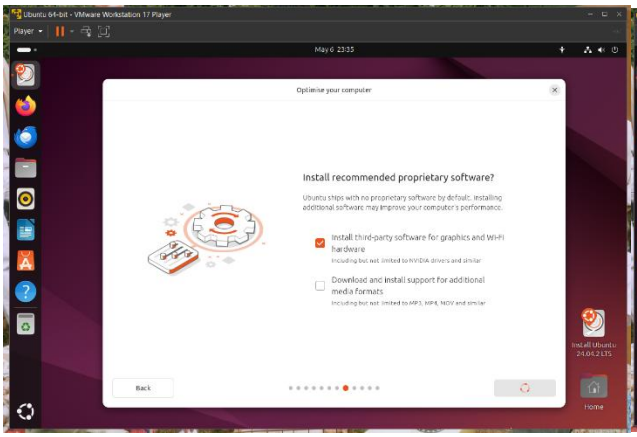

Accessibility
Accessibility in Ubuntu
Customise Ubuntu to your needs before you set up. You can change them later in System Settings.
Seeing
Hearing
Typing
Pointing and clicking
Zoom
Back
Next

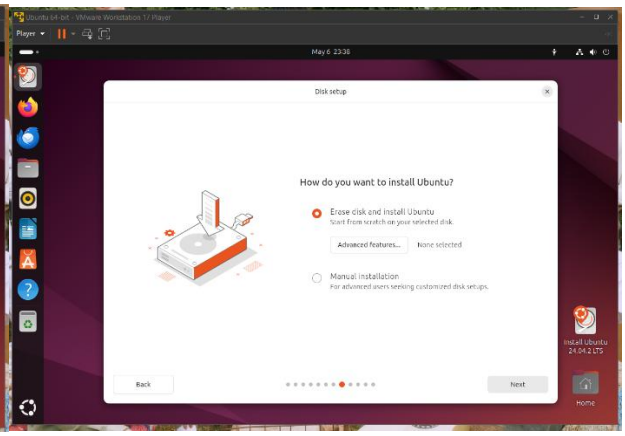

Keyboard layout
Select your keyboard layout
Detect
English (South Africa)
English (UK)
English (US)
Esperanto
Estonian
Select your keyboard variant:
English (US)
Type here to test your keyboard
Back
Next

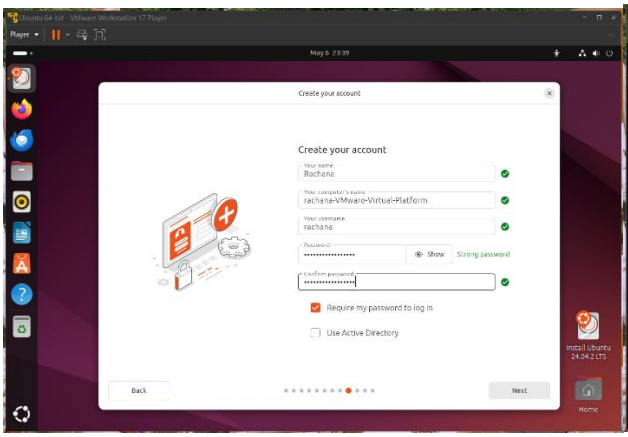

Internet connection
Connect to the internet
Use wired connection
No Wi-Fi devices detected
Do not connect to the internet
Back
Next

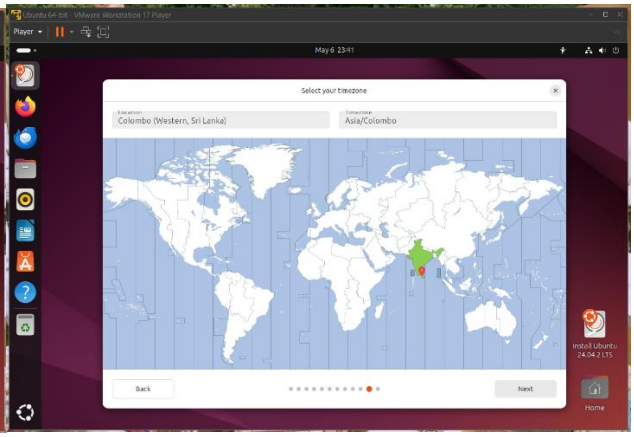

Type of installation
How would you like to install Ubuntu?
Interactive installation
Automated installation
Back
Next

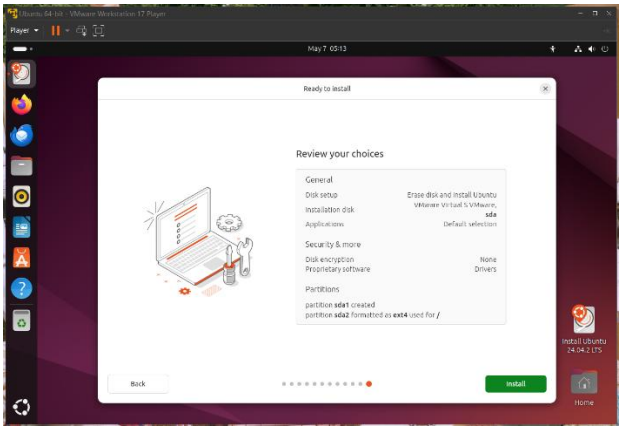

Applications
What apps would you like to install to start with?
Default selection
Extended selection
Back
Next


Ubuntu 64-bit - VMware Workstation 17 Player
Player
May 6 23:35
Optimise your computer
Install recommended proprietary software?
Ubuntu ships with no proprietary software by default. Installing additional software may improve your computer's performance.
Install third-party software for graphics and Wi-Fi hardware
Including but not limited to NVIDIA drivers and similar
Download and install support for additional media formats
Including but not limited to MP3, MP4, MOV and similar
Back
Install Ubuntu 24.04.2 LTS
Home


Ubuntu 64-bit - VMware Workstation 17 Player
Player
May 6 23:38
Disk setup
How do you want to install Ubuntu?
Erase disk and install Ubuntu
Start from scratch on your selected disk.
Advanced features...
None selected
Manual installation
For advanced users seeking customized disk setups.
Back
Next
Install Ubuntu 24.04.2 LTS
Home


Ubuntu 64-bit - VMware Workstation 17 Player
Player
May 6 23:39
Create your account
Create your account
Your name
Rachana
Your computer's name
rachana-VMware-Virtual-Platform
Your username
rachana
Password
Show
Strong password
Confirm password
Require my password to log in
Use Active Directory
Back
Next
Install Ubuntu 24.04.2 LTS
Home


Ubuntu 64-bit - VMware Workstation 17 Player
Player
May 6 23:41
Select your timezone
Location
Colombo (Western, Sri Lanka)
Timezone
Asia/Colombo
Back
Next
Install Ubuntu 24.04.2 LTS
Home


Ubuntu 64-bit - VMware Workstation 17 Player
Player
May 7 05:13
Ready to install
Review your choices
General
Disk setup
Erase disk and install Ubuntu
Installation disk
VMware Virtual S VMware, sda
Applications
Default selection
Security & more
Disk encryption
None
Proprietary software
Drivers
Partitions
partition sda1 created
partition sda2 formatted as ext4 used for /
Back
Install
Install Ubuntu 24.04.2 LTS
Home

Basic Navigation Commands

- cd: Change directory.
- ls: List directory contents.
- pwd: Print working directory.
- mkdir: Make a new directory.
- rmdir: Remove an empty directory.

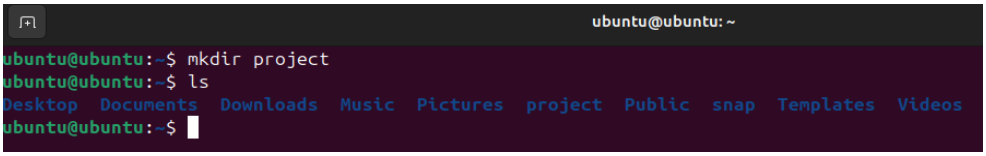
File Manipulation Commands

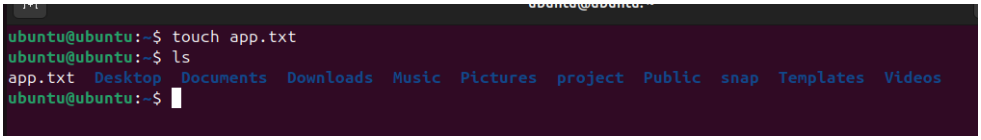
- cp: Copy files or directories.
- mv: Move or rename files or directories.
- cat: Display file contents
- rm: Remove files or directories.
- touch: Create an empty file.

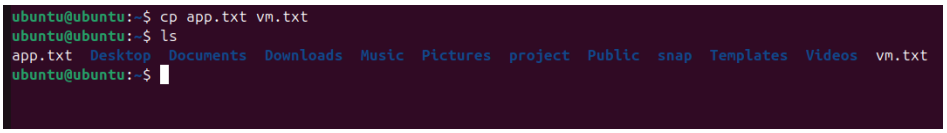
15 Basic Linux Commands with Descriptions

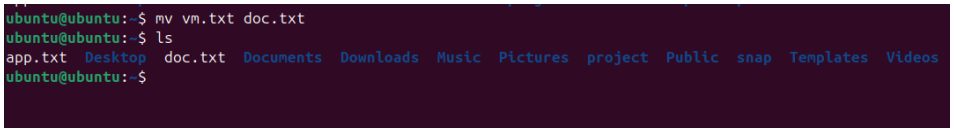
Command	Description
Pwd	Print current working directory
ls	List files and directories
cd	Change Directories
mkdir	Create a new directory
rmdir	Remove an empty directory
touch	Create an empty file
cat	Display file contents
cp	Copy files or directories
mv	Move or rename files/directories
rm	Remove files or directories
echo	Display a line of text
nano	Simple text editor
vi	Advanced text editor
chmod	Change file/directory permissions
chown	Change file/directory owner and group

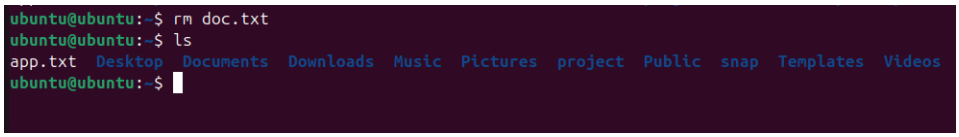

ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ pwd
/home/ubuntu
ubuntu@ubuntu:~$

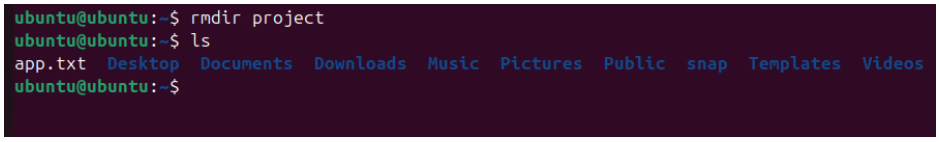

ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ mkdir project
ubuntu@ubuntu:~$ ls
Desktop Documents Downloads Music Pictures project Public snap Templates Videos
ubuntu@ubuntu:~$

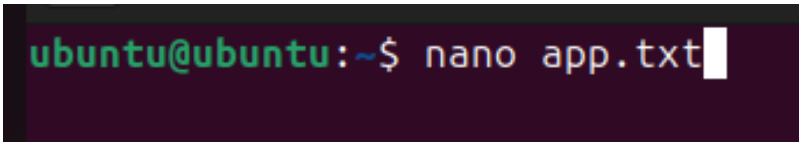

ubuntu@ubuntu:~$ touch app.txt
ubuntu@ubuntu:~$ ls
app.txt Desktop Documents Downloads Music Pictures project Public snap Templates Videos
ubuntu@ubuntu:~$


ubuntu@ubuntu:~$ cp app.txt vm.txt
ubuntu@ubuntu:~$ ls
app.txt Desktop Documents Downloads Music Pictures project Public snap Templates Videos vm.txt
ubuntu@ubuntu:~$


ubuntu@ubuntu:~$ mv vm.txt doc.txt
ubuntu@ubuntu:~$ ls
app.txt Desktop doc.txt Documents Downloads Music Pictures project Public snap Templates Videos
ubuntu@ubuntu:~$

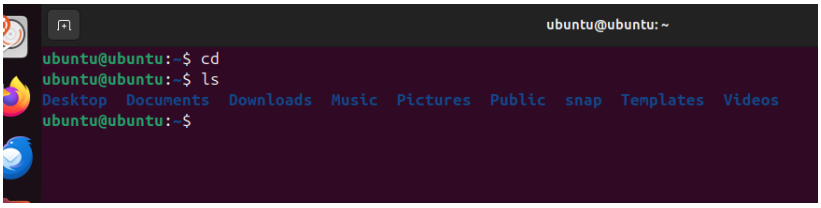

ubuntu@ubuntu:~$ rm doc.txt
ubuntu@ubuntu:~$ ls
app.txt Desktop Documents Downloads Music Pictures project Public snap Templates Videos
ubuntu@ubuntu:~$


ubuntu@ubuntu:~$ rmdir project
ubuntu@ubuntu:~$ ls
app.txt Desktop Documents Downloads Music Pictures Public snap Templates Videos
ubuntu@ubuntu:~$


ubuntu@ubuntu:~$ nano app.txt


ubuntu@ubuntu: ~
GNU nano 7.2 app.txt *
Hello World


ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ cd
ubuntu@ubuntu:~$


ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ cd
ubuntu@ubuntu:~$ ls
Desktop Documents Downloads Music Pictures Public snap Templates Videos
ubuntu@ubuntu:~$

DHCP (Dynamic Host Configuration Protocol)

- **Role in Network Configuration:** Automatically assigns IP addresses to devices in a network, reducing manual configurations.

- **Installation & Configuration:**
  - **Install DHCP server:**
    - sudo apt update
    - sudo apt install isc-dhcp-server -y
  - **Edite the DHCP configuration file:**
    - sudo nano /etc/dhcp/dhcpd.conf
  - **Define a subnet configuration:**
    - subnet 192.168.1.0 netmask 255.255.255.0 { range 192.168.1.100 192.168.1.200; option domain-name-servers 8.8.8.8; option routers 192.168.1.1; option broadcast-address 192.168.1.255;default-lease-time 600; max-lease-time 7200;}
  - **Restart the DHCP server:**
    - sudo systemctl restart isc-dhcp-server

- **Configure the client virtual machines to use DHCP:**
  - sudo nano /etc/netplan/00-installer-config.yaml
  - network:

    ethernets:

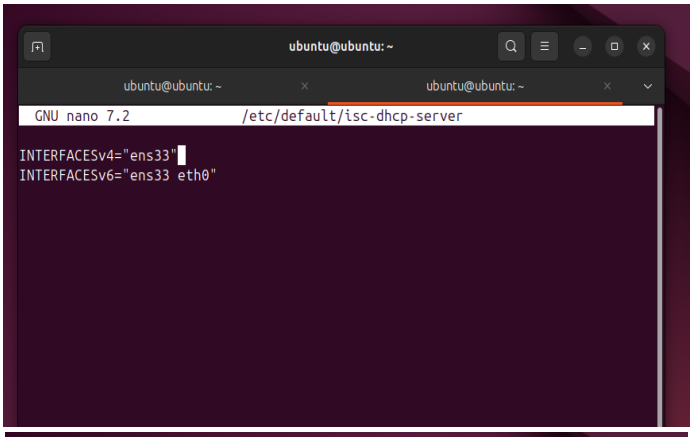
    ens33:

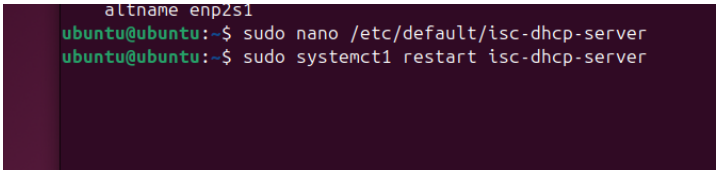
    dhcp4: true

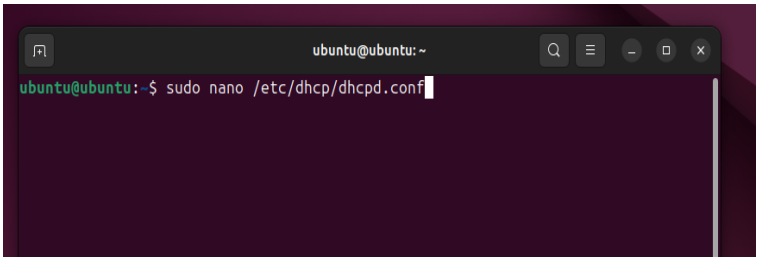
    version: 2
  - sudo netplan apply
- **Set DHCP:**
  - auto eth0

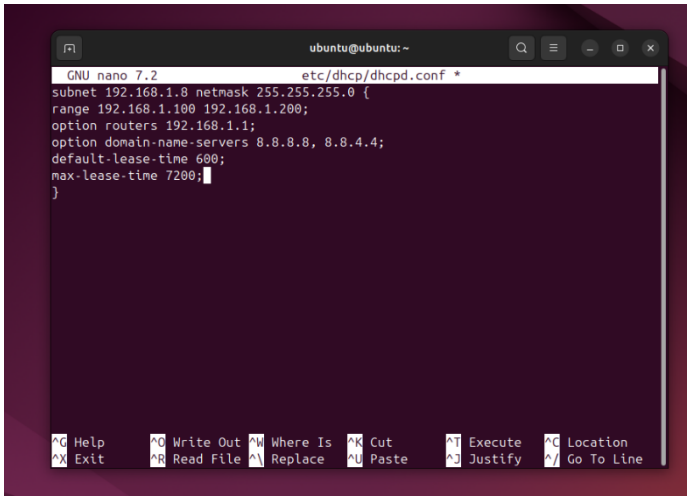
    iface eth0 inet dhcp
- **Restart the network service:**
  - sudo systemctl restart networking

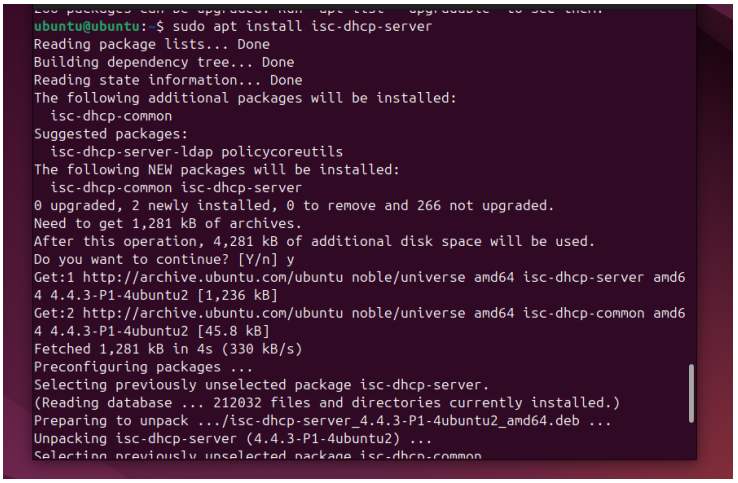
- **Verify IP allocation:**
  - **Dynamically:** ip a | grep inet
- **Testing Connectivity:**
  - ping -c 5 192.168.1.1

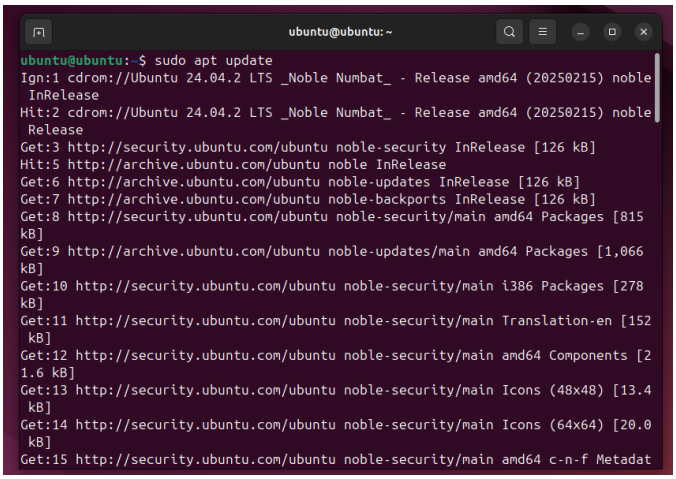

ubuntu@ubuntu: ~
ubuntu@ubuntu: ~
ubuntu@ubuntu: ~
GNU nano 7.2 /etc/default/isc-dhcp-server
INTERFACESv4="ens33"
INTERFACESv6="ens33 eth0"

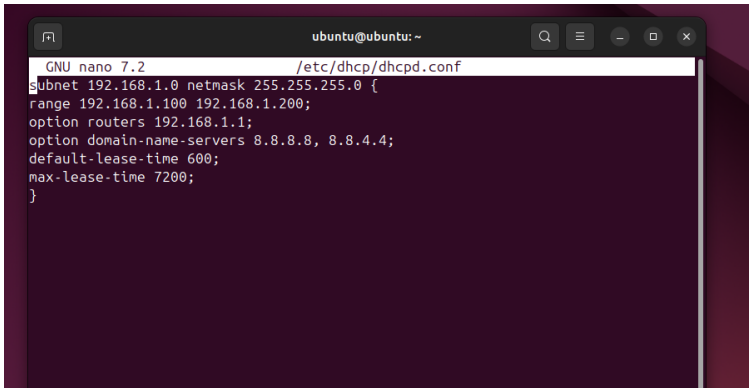

altname enp2s1
ubuntu@ubuntu:~$ sudo nano /etc/default/isc-dhcp-server
ubuntu@ubuntu:~$ sudo systemct1 restart isc-dhcp-server


ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ sudo nano /etc/dhcp/dhcpd.conf


ubuntu@ubuntu: ~
GNU nano 7.2 etc/dhcp/dhcpd.conf *
subnet 192.168.1.8 netmask 255.255.255.0 {
range 192.168.1.100 192.168.1.200;
option routers 192.168.1.1;
option domain-name-servers 8.8.8.8, 8.8.4.4;
default-lease-time 600;
max-lease-time 7200;
}
^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^/ Go To Line


ubuntu@ubuntu:~$ sudo apt install isc-dhcp-server
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
isc-dhcp-common
Suggested packages:
isc-dhcp-server-ldap policycoreutils
The following NEW packages will be installed:
isc-dhcp-common isc-dhcp-server
0 upgraded, 2 newly installed, 0 to remove and 266 not upgraded.
Need to get 1,281 kB of archives.
After this operation, 4,281 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.ubuntu.com/ubuntu noble/universe amd64 isc-dhcp-server amd64 4.4.3-P1-4ubuntu2 [1,236 kB]
Get:2 http://archive.ubuntu.com/ubuntu noble/universe amd64 isc-dhcp-common amd64 4.4.3-P1-4ubuntu2 [45.8 kB]
Fetched 1,281 kB in 4s (330 kB/s)
Preconfiguring packages ...
Selecting previously unselected package isc-dhcp-server.
(Reading database ... 212032 files and directories currently installed.)
Preparing to unpack .../isc-dhcp-server_4.4.3-P1-4ubuntu2_amd64.deb ...
Unpacking isc-dhcp-server (4.4.3-P1-4ubuntu2) ...


ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ sudo apt update
Ign:1 cdrom://Ubuntu 24.04.2 LTS _Noble Numbat_ - Release amd64 (20250215) noble InRelease
Hit:2 cdrom://Ubuntu 24.04.2 LTS _Noble Numbat_ - Release amd64 (20250215) noble Release
Get:3 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Hit:5 http://archive.ubuntu.com/ubuntu noble InRelease
Get:6 http://archive.ubuntu.com/ubuntu noble-updates InRelease [126 kB]
Get:7 http://archive.ubuntu.com/ubuntu noble-backports InRelease [126 kB]
Get:8 http://security.ubuntu.com/ubuntu noble-security/main amd64 Packages [815 kB]
Get:9 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Packages [1,066 kB]
Get:10 http://security.ubuntu.com/ubuntu noble-security/main i386 Packages [278 kB]
Get:11 http://security.ubuntu.com/ubuntu noble-security/main Translation-en [152 kB]
Get:12 http://security.ubuntu.com/ubuntu noble-security/main amd64 Components [21.6 kB]
Get:13 http://security.ubuntu.com/ubuntu noble-security/main Icons (48x48) [13.4 kB]
Get:14 http://security.ubuntu.com/ubuntu noble-security/main Icons (64x64) [20.0 kB]
Get:15 http://security.ubuntu.com/ubuntu noble-security/main amd64 c-n-f Metadat


ubuntu@ubuntu: ~
GNU nano 7.2 /etc/dhcp/dhcpd.conf
subnet 192.168.1.0 netmask 255.255.255.0 {
range 192.168.1.100 192.168.1.200;
option routers 192.168.1.1;
option domain-name-servers 8.8.8.8, 8.8.4.4;
default-lease-time 600;
max-lease-time 7200;
}

DNS (Domain Name System)

- **Purpose:** Resolves human-readable domain names into IP addresses**.**
- **Installation:**
  - **Install BIND DNS server:** sudo apt install bind9 -y
  - **Backup default config file :** sudo cp /etc/bind/named.conf.options /etc/bind/named.conf.options.backup
  - **Configure the DNS server:** cat <<EOT | sudo tee /etc/bind/named.conf.options

    options {directory "/var/cache/bind"; forwarders { 8.8.8.8; # Google DNS 8.8.4.4; };

    dnssec-validation auto; listen-on { any; };allow-query { any; };};EOT
  - **Restart the service**: sudo systemctl restart bind9
  - **Enable BIND to start on boot:**
    - sudo systemctl enable bind9
    - echo "BIND DNS Server is configured and running."
  - **Run the script:** chmod +x setup_dns_server.sh
    ./setup_dns_server.sh

```
ubuntu@ubuntu:~$ sudo apt install bind9 bind9utils bind9-doc -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  bind9-utils
Suggested packages:
  bind-doc
The following NEW packages will be installed:
  bind9 bind9-doc bind9-utils bind9utils
0 upgraded, 4 newly installed, 0 to remove and 266 not upgraded.
Need to get 3,669 kB of archives.
After this operation, 9,244 kB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 bind9-utils amd6
4 1:9.18.30-0ubuntu0.24.04.2 [159 kB]
```

```
ubuntu@ubuntu:~$ sudo nano /etc/bind/named.conf.options
ubuntu@ubuntu:~$
```

```
  GNU nano 7.2              /etc/bind/named.conf.options
options {
        directory "/var/cache/bind";
        forwarders{
                    8.8.8.8;
                    8.8.4.4;
dnssec validation auto;
listen on { any; };
allow query { any;};
};
```

```
  GNU nano 7.2              /etc/bind/named.conf.local *
zone "example.com" {
type master;
file "file/bind/db.example.com";
};

zone "1.168.192.in-addr.arpa"{
type master;
file etc/bind/db.192.168.1";
};
```

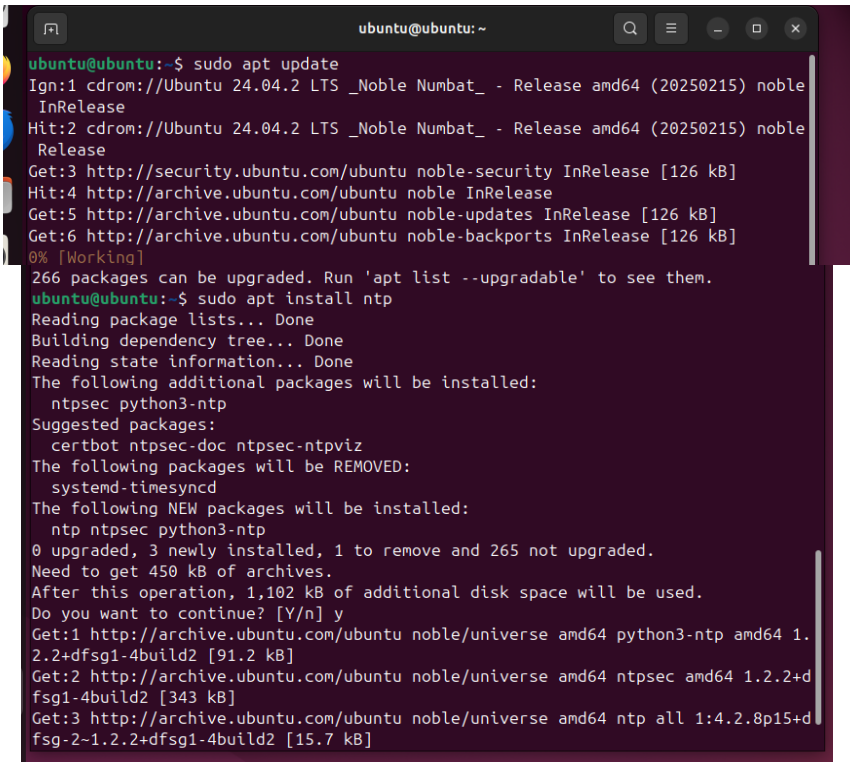
```
ubuntu@ubuntu:~$ sudo nano /etc/bind/named.conf.local
ubuntu@ubuntu:~$
```

```
ubuntu@ubuntu:~$ sudo cp /etc/bind/db.local /etc/bind/db.example.com
ubuntu@ubuntu:~$ sudo cp /etc/bind/db.127 /etc/bind/db.192.168.1
ubuntu@ubuntu:~$
```

```
ubuntu@ubuntu:~$ sudo systemctl restart bind9
```

NTP (Network Time Protocol)

- **Importance: Ensures accurate time synchronization across systems.**
- **Installation & Configuration:**
    - **Install NTP client:** sudo apt install ntp
    - **Configure** /etc/ntp.conf **to sync with an internet NTP server.**
    - **Start service**: sudo systemctl restart ntp
- **Validation:** Check time sync using ntpq -p.



Need & Use of These Services

- **DHCP**: Automates IP assignments, reducing misconfigurations**.**
- **DNS**: Essential for hostname-to-IP resolution in networks.
- **NTP:** Prevents clock drift, ensuring time-sensitive operations function correctly.

System Details Script & Cron Job

Sample Script:

```
#!/bin/bash

DATE=$(date)

UPTIME=$(uptime -p)

MEMORY=$(free -h | grep Mem | awk '{print $3 "/" $2}')

DISK=$(df -h / | tail -1 | awk '{print $3 "/" $2}')

echo "Date: $DATE"

echo "Uptime: $UPTIME"

echo "Free Memory: $MEMORY"

echo "Disk Usage: $DISK"
```

Cron Job:

- **Edit crontab:** crontab -e
- **Add:** 0 0 * * 0 /path/to/script.sh >> /var/log/sysdetails.log (runs every Sunday at midnight)

Cron Job

- **Use** crontab -e **to edit cron jobs.**
- **Syntax:** * * * * * command
- **Example:** 0 12 * * 1 /home/user/backup.sh **(runs every Monday at noon).**
- **Save and exit to activate the job.**
- **Check jobs:** crontab -l

Connecting to VM Remotely Using SSH

- **Ensure SSH server is installed:** sudo apt install openssh-server
- **Find VM IP :** ip a
- **From another computer:** ssh username@VM-IP
- **Accept the fingerprint and enter your password to connect**

iptables Rule Description with Command

Rule Description	Command Example
Allow SSH	sudo iptables -A INPUT -p tcp --dport 22 -j ACCEPT
Allow HTTP	sudo iptables -A INPUT -p tcp --dport 80 -j ACCEPT
Allow HTTPS	sudo iptables -A INPUT -p tcp --dport 443 -j ACCEPT
Block all incoming traffic by default	sudo iptables -P INPUT DROP
Allow established connections	sudo iptables -A INPUT -m state –state ESTABLISHED,RELATED -j ACCE PT

Web Server

Apache:

- **Install:** sudo apt install apache2
- **Start:** sudo systemctl start apache2 or sudo systemctl start httpd
- **Enable:** sudo systemctl enable apache2 or sudo systemctl enable httpd
- **Place web files in** /var/www/html/
- **Access via browser:** http://[VM-IP]/

Email Server

Postfix Example Ubuntu

- **Install:** sudo apt install postfix
- **Choose** "Internet Site" **during setup**
- **Set system mail name (FQDN)**
- **Configure** /etc/postfix/main.cf **as needed.**
- **Start and enable:** sudo systemctl start postfix , sudo systemctl enable postfix
- **Test with:** echo "Test mail" | mail -s "Test" user@example.com

Linux GDB

Execution process

- **Check System Architecture:** uname -m
- **Choose the executable:** x86_64
- **Run the selected executable:** sudo ./x86_64
- A new executable named IT23833920 got generated when entered IT number as an input.
- **Analyze the Generated Executable:**
    - **Run the new executable:** ./IT23833920
    - **Inspect the generated file:** cat data.txt

Debugging process

- **Start GDB**: gdb ./IT23833920
- **Track file modification:** Set breakpoints on file writing functions.
    - **Break when files are opened:** (gbd) break fopen
    - **Break when data is written:** (gbd) break fwrite

File System Analysis

- **Before execution:**
    - **List files:** ls -l
    - **Check metadata:** stat data.txt
- **During execution:**
    - **Monitor directory charges in real-time:** inotifywait -m .
- **After execution:**
    - **Recheck files and metadata:** ls -l
    - **Verify creation/ modification time:** stat data.txt
    - **Extract printable strings:** strings data.txt
    - **View hex and ASCII:** hexdumb -C data.txt

Analysis of "data.txt" file

- **Check for encoding/encryption:**
    - **Base 64:** base64 -d data.txt
    - **Hex:** xxd -r -p data.txt
- **Hidden data:**
    - **Use binwalk to detect embedded files:** binwalk data.txt