Linux Virtual Network Project
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Fig. 1: Oracle VirtualBox example

Networking & Virtualization

PROOF OF CONCEPT LINUX VIRTUAL NETWORK PROJECT

Project Introduction

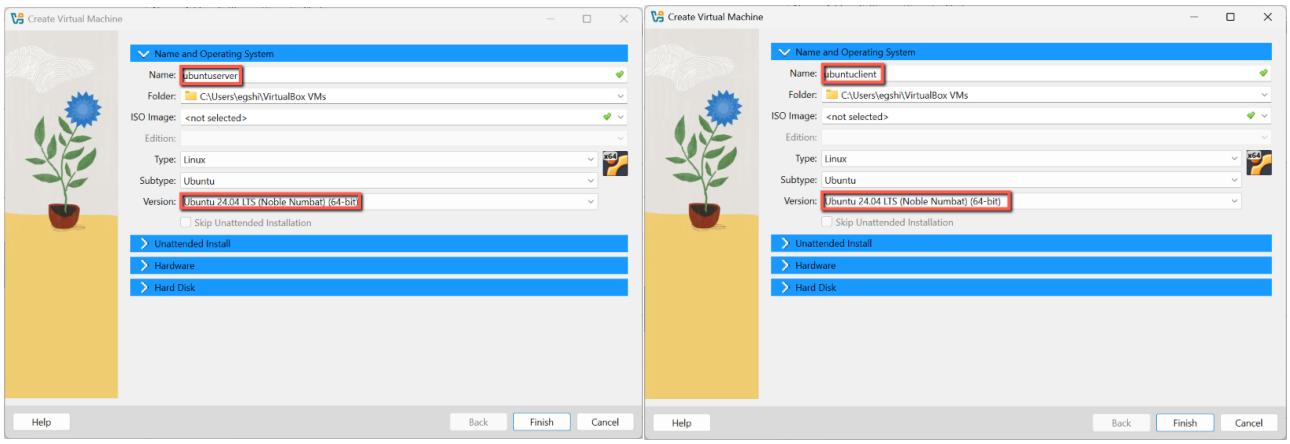
In this project, I've got a new role in a company called 'Consult & Connect Ltd' that serves as an information and communication technology consultancy. Our company is tasked with creating a virtualized Linux network infrastructure based on Dublin City College(DCC)'s network. They have instructed us to create a virtualized environment where they can simulate how their network and services can behave in a Linux environment. Our company created a client-server network that consists of two Ubuntu 24.04(Noble Numbat) virtual machines on Oracle VirtualBox, one acts as a web server and the other as a web client.

The aim of this project is to simulate how DCC's network and services will act in a Linux based environment including key aspects such as setting up an Apache web server, modifying the Apache default page, installing Lynx browser to see the DCC web page, using Wireshark to analyze the traffic, renaming the hostnames, establishing permanent IP addresses using Netplan, using SSH client on the host machine, Firewall configurations and other challenging tasks.

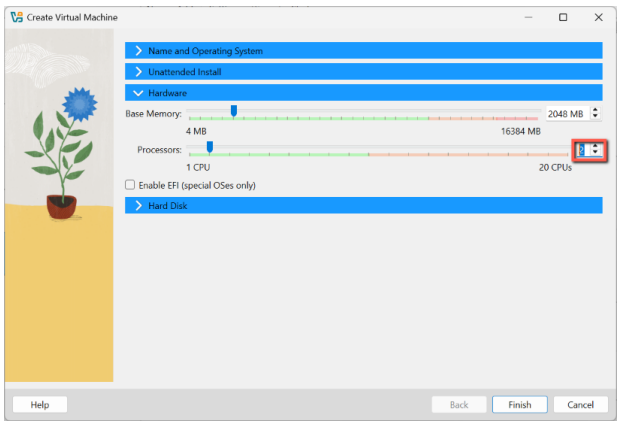
Hypothetical case: I'm the assistant to the ICT consultancy company named 'Consult & Connect'. I'm required to build 2 functional Linux-based virtual machines and work on the goals that has assigned to me.

PART 1: Virtual Linux Network and Web server(Initial setup)

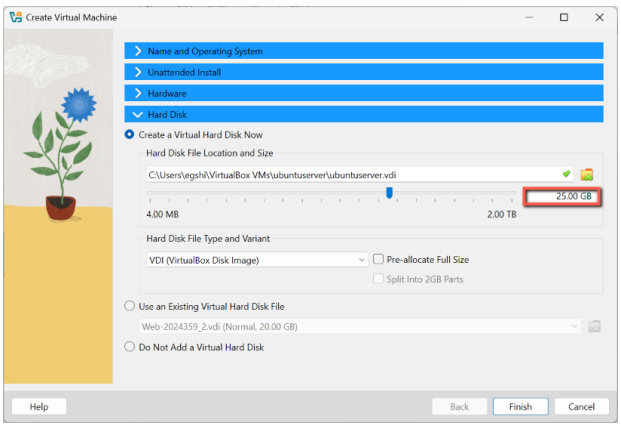
- ***Creating Virtual Machines (Linux-based environment)***



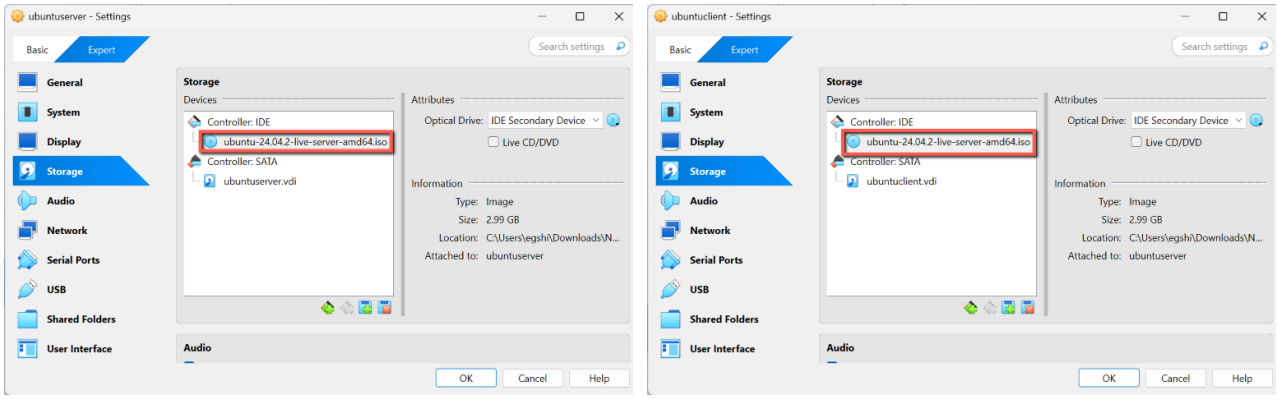
Note: First VM named ubuntuserver and second VM named ubuntuclient and they have Ubuntu 24.04 LTS(Noble Numbat) version.



Note: Both machines have 2 CPUs.

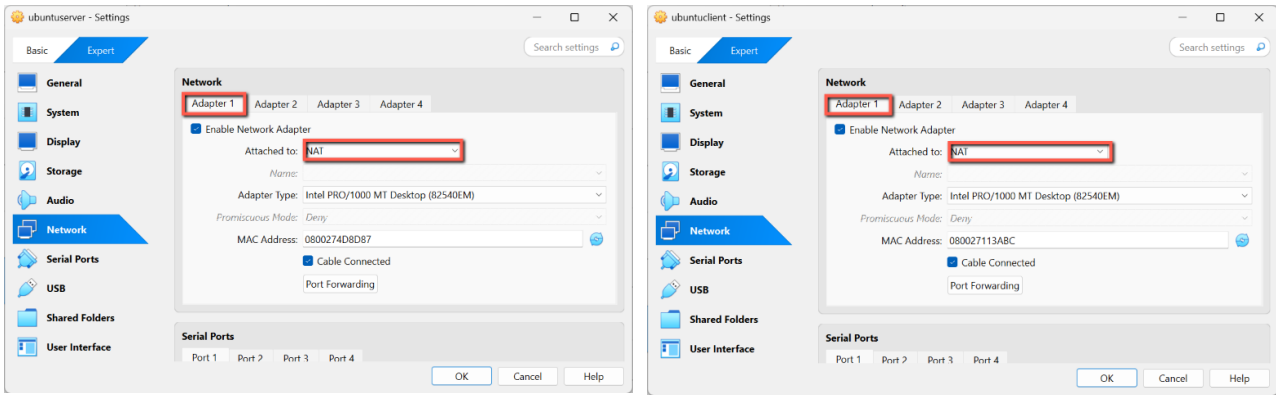


Note: Both machines have 25 GB hard disks.

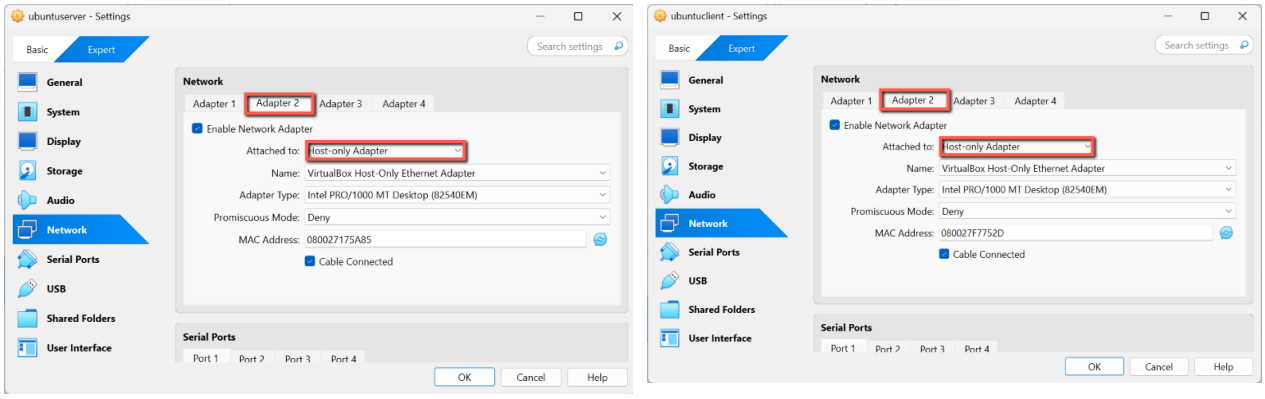


Note: Adding ubuntu iso to both virtual machines

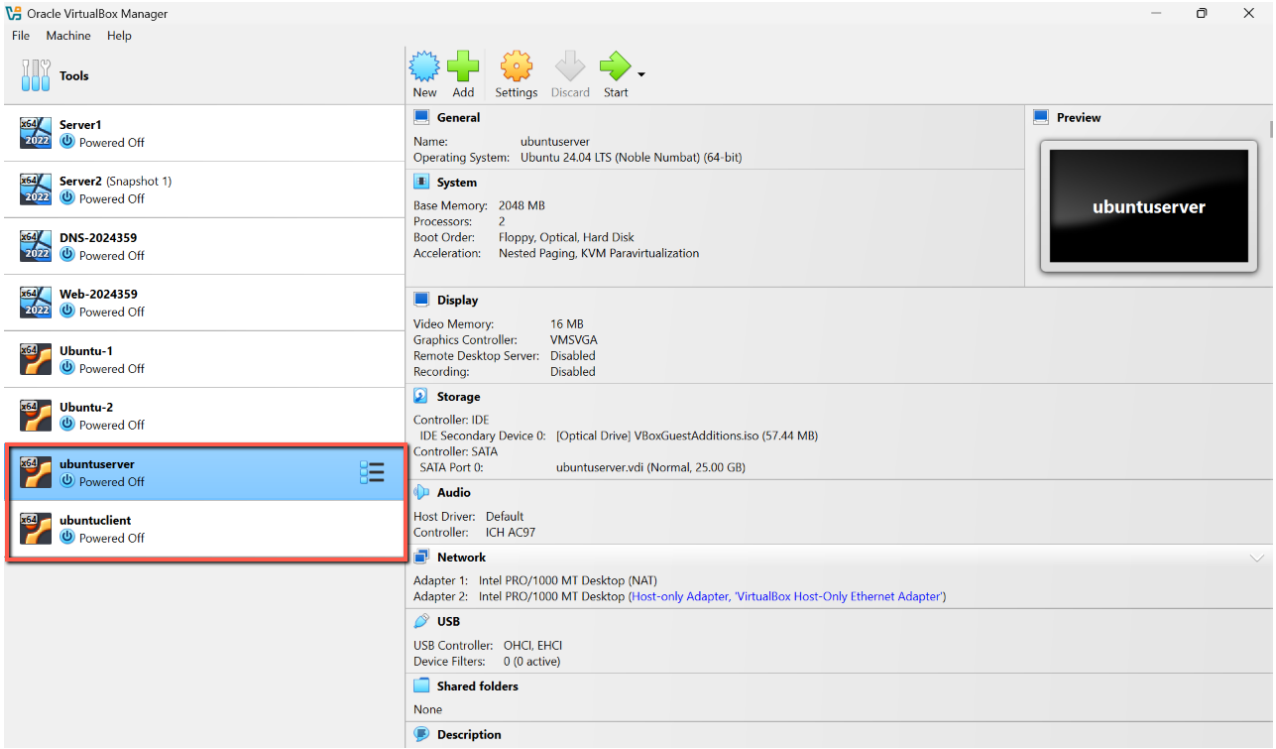
➢ ***Configuring the Network Adapters***



Note: Configuring the first adapter to NAT to have internet connection

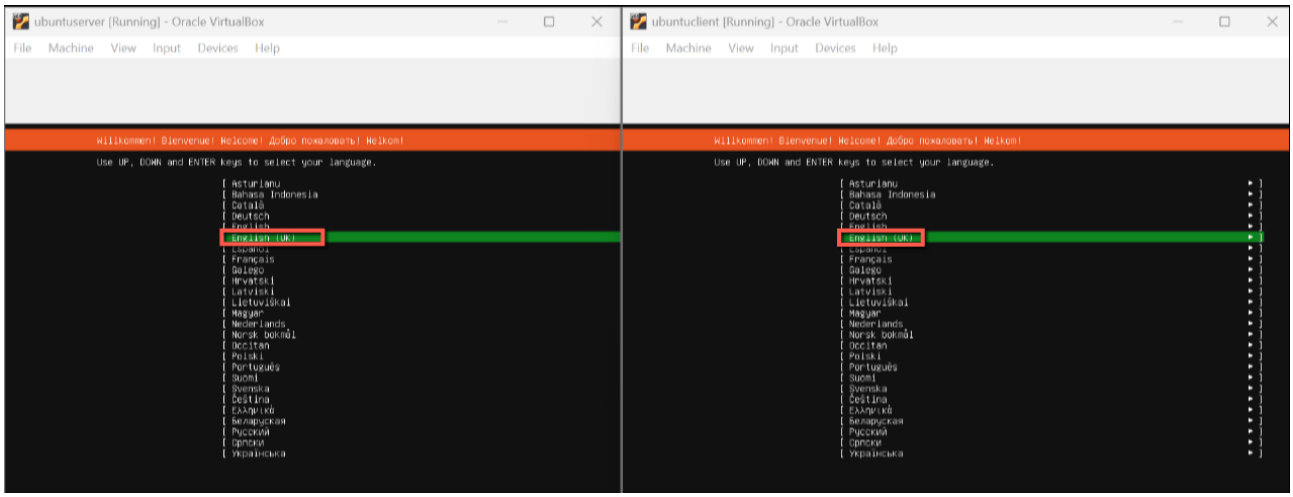


Note: Configuring the second adapter to Host-only-Adapter which assigns IP addresses to the VMs

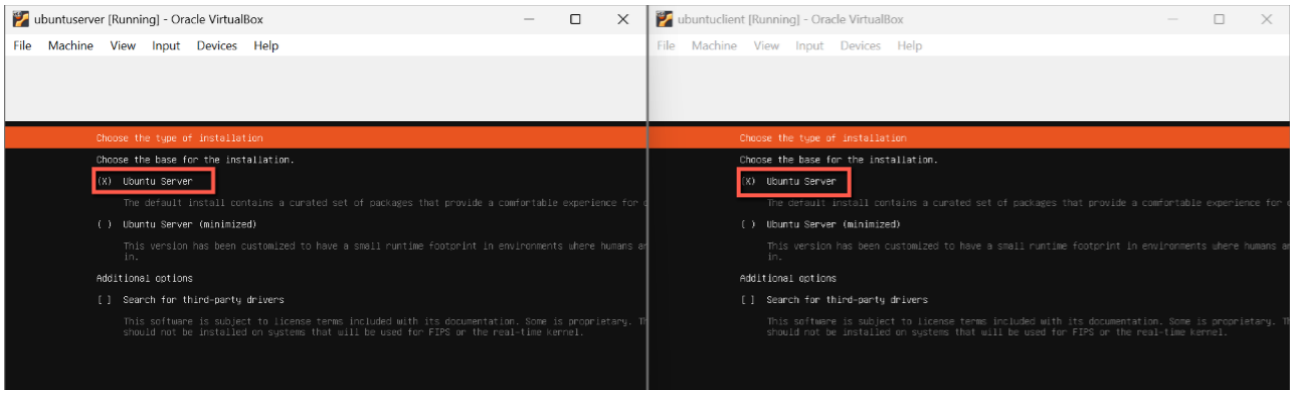


Note: The proof of 2 VMs as in creation.

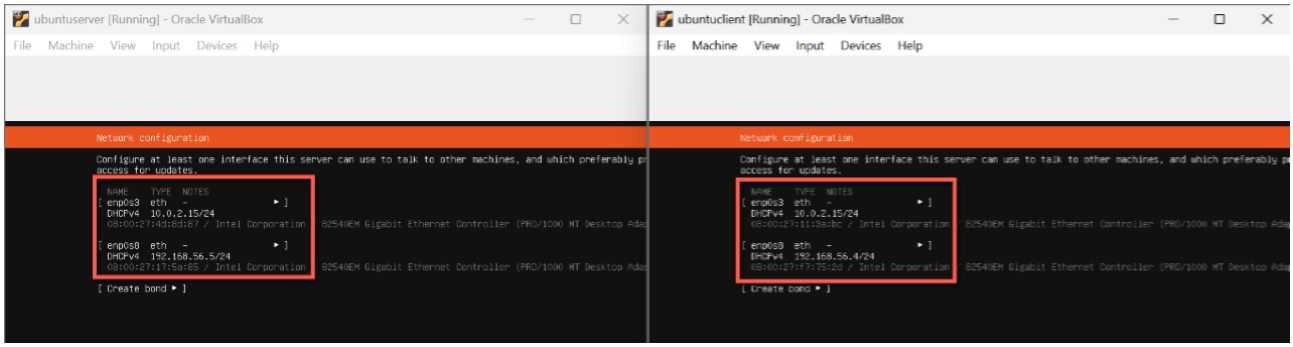
- ***Installation of Ubuntu***



Note: Setting the language to English UK version

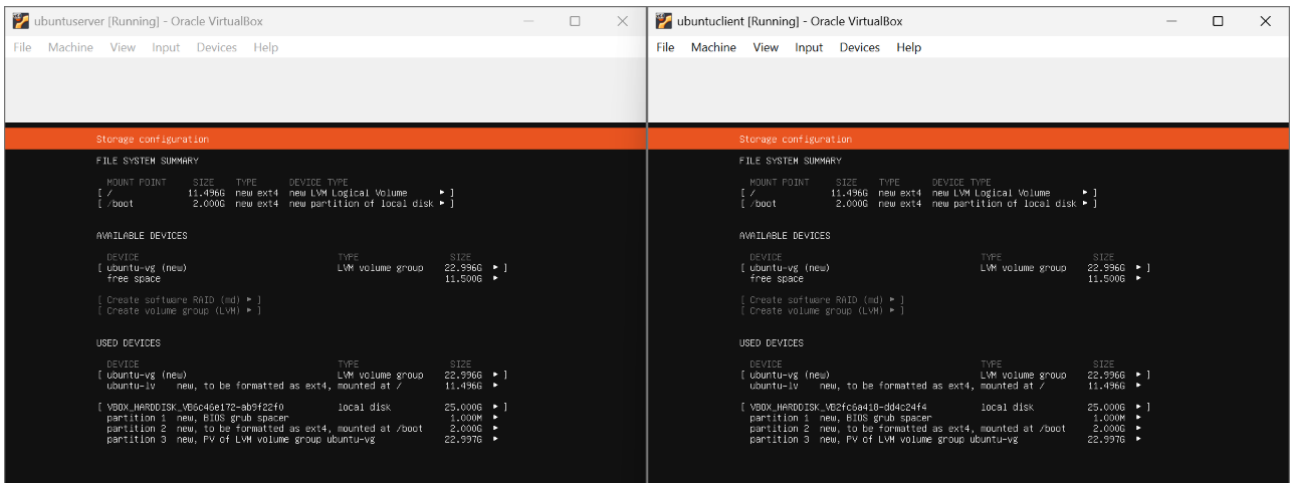


Note: Choosing Ubuntu Server

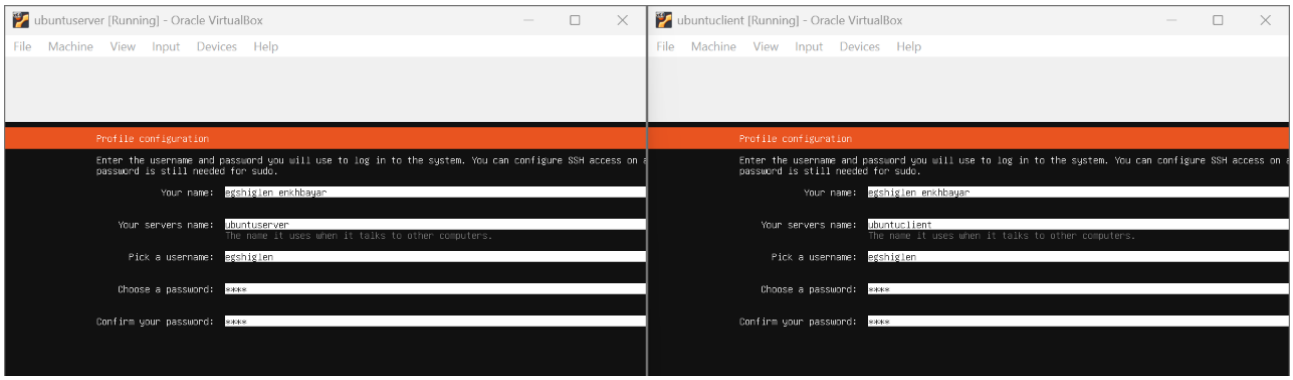


Note: Random IP addresses are assigned on the second network

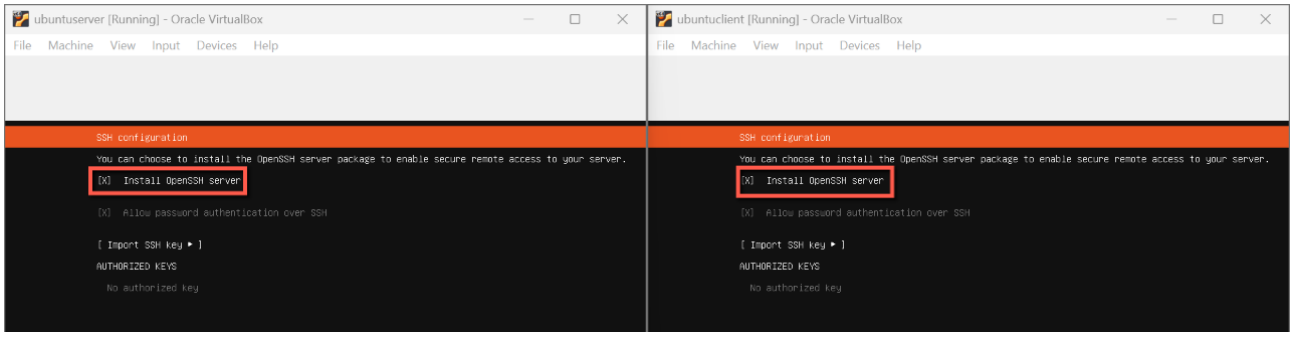
Note: In my case, the Host-Only network adapter were not working properly and my first few tries the ubuntu servers couldn't find any IP address on the second adapter. So I tried to delete and install and other configurations but after many tries it worked because of the update on VirtualBox. The old version wasn't supporting host only network but the new version did.



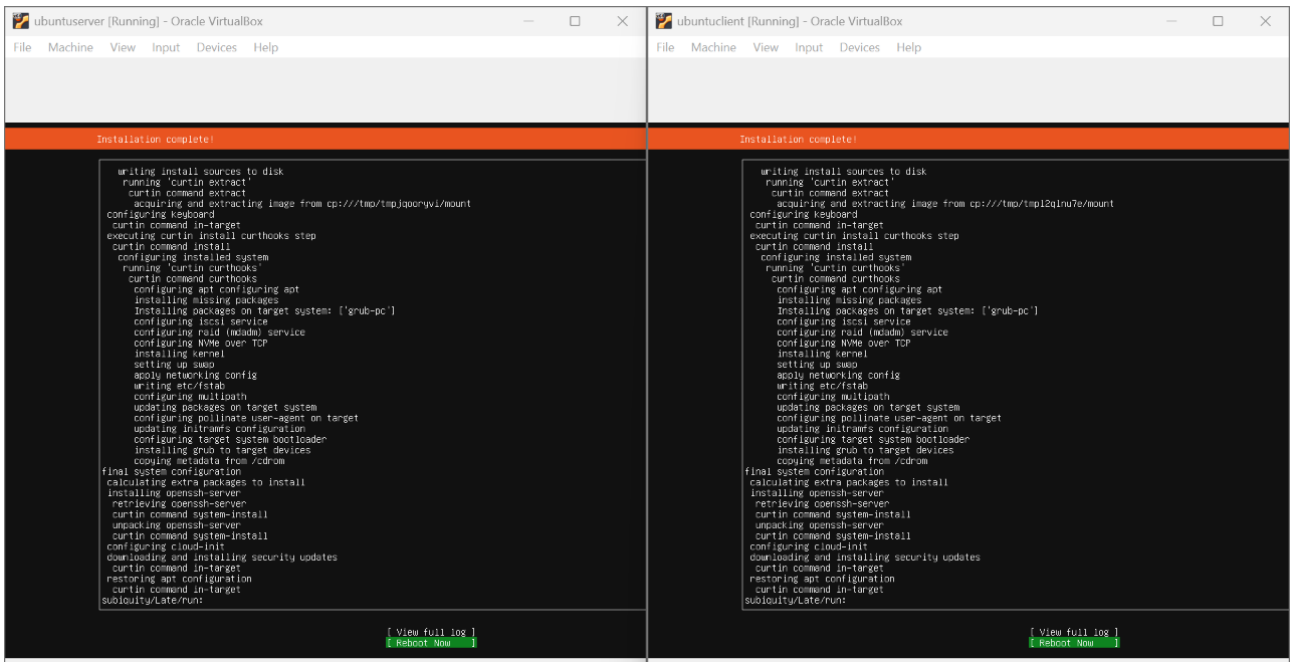
Note: Storage Configuration (25GB)



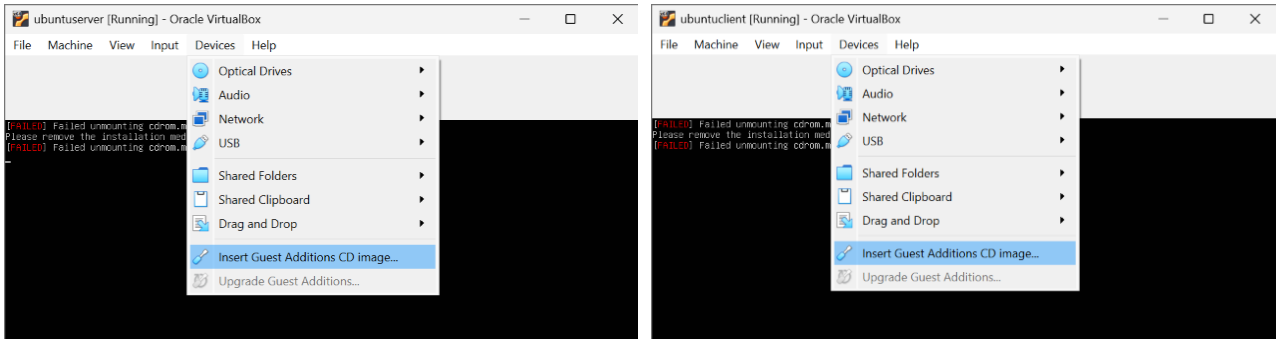
Note: Setting the profile including hostname as ubuntuserver and ubuntu client, username as egshiglen, and password as 'pppp'



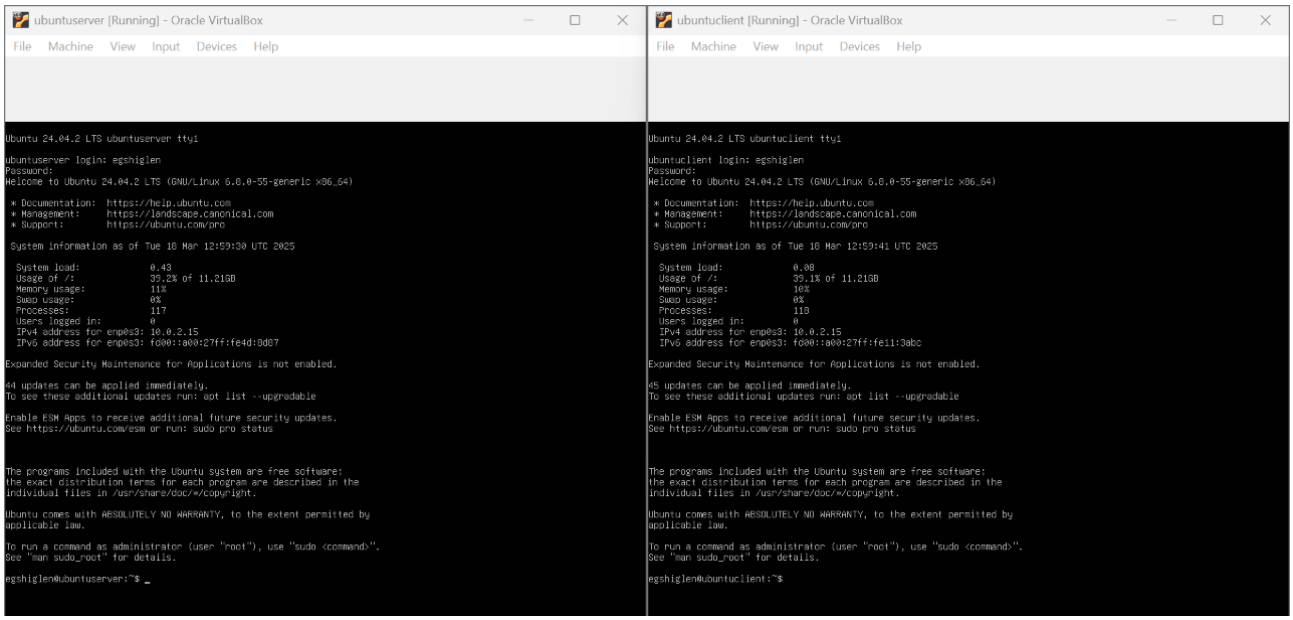
Note: During the initial installation of ubuntu, installing OpenSSH server too.



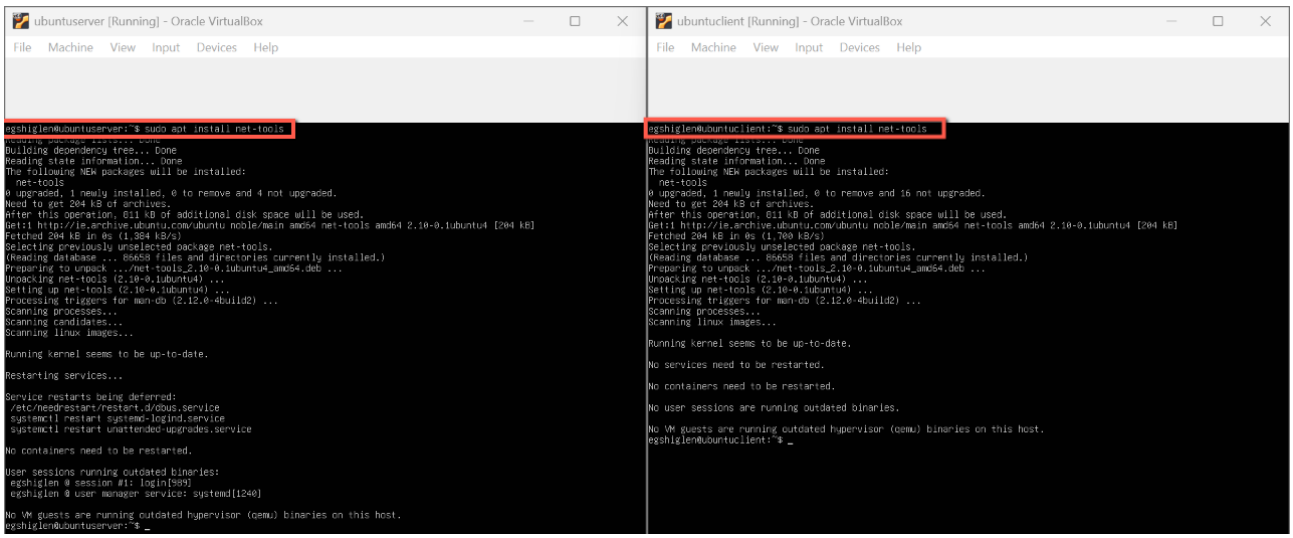
Note: Installation is complete and successful.



Note: Inserting Guest Additions to both VMs

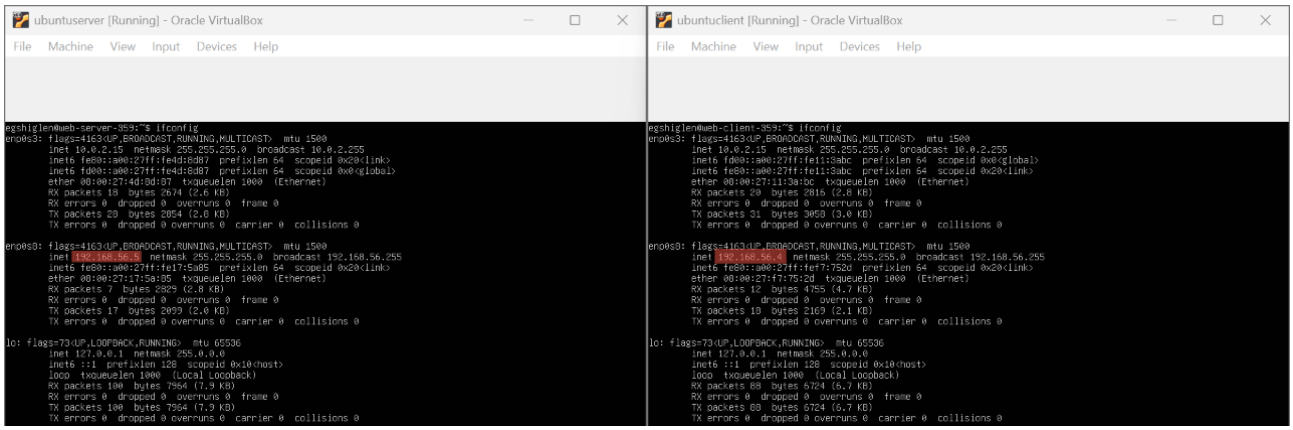


Note: Proof of working Ubuntu server on both Machines

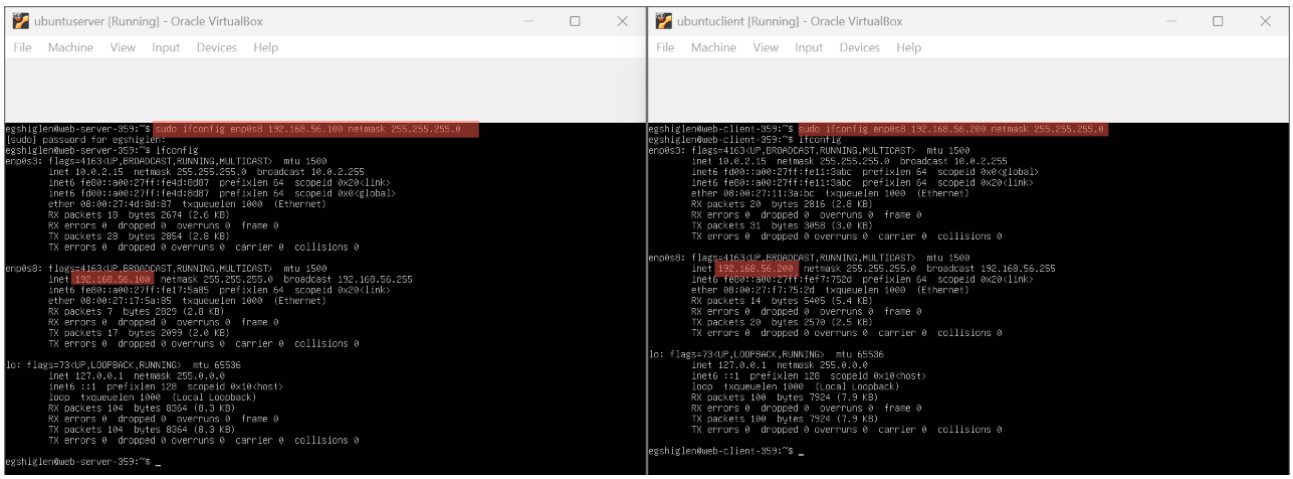


Note: Installing essential networking tools for Ubuntu

- **Configuring Temporary IP Addresses**



Note: Before the configuration of temporary IP Addresses

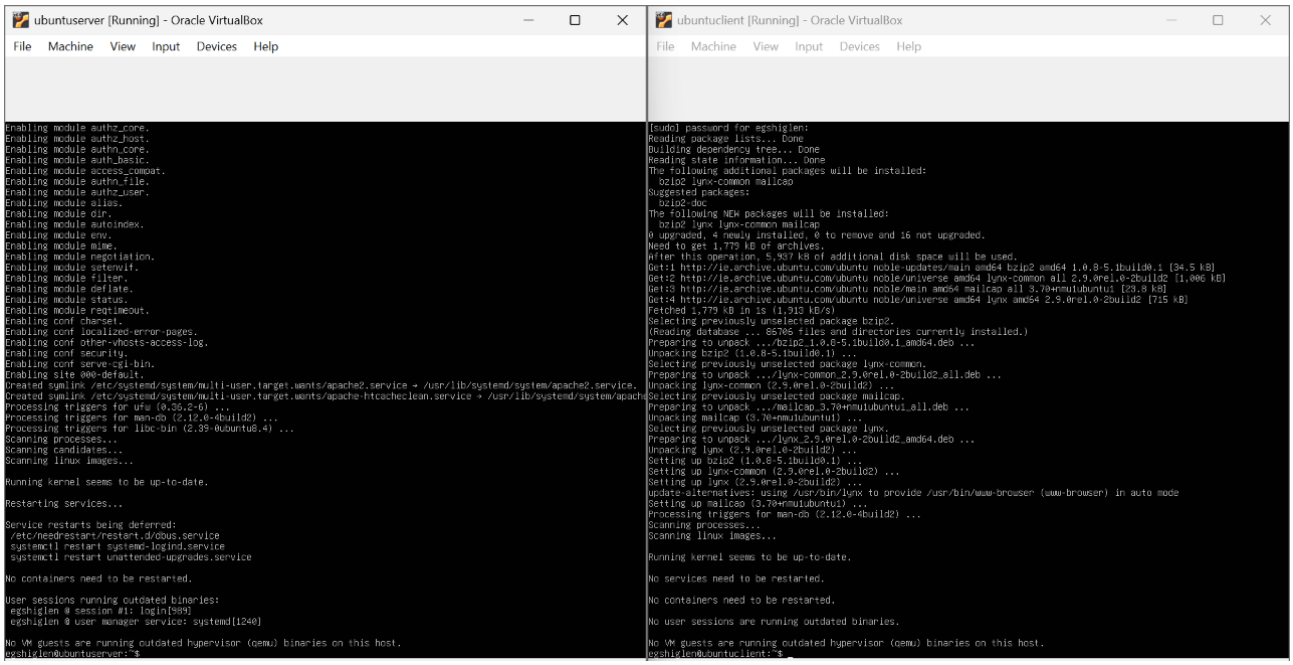


Note: After the configuration of temporary IP Addresses

Note: Since it's temporary IP Address, after reboot the ip address goes back to the old IP address (192.168.56.5-ubuntuserver, 192.168.56.4-ubuntuclient). I've decided to use the old IP address and rebooted the system. Source: (Team)

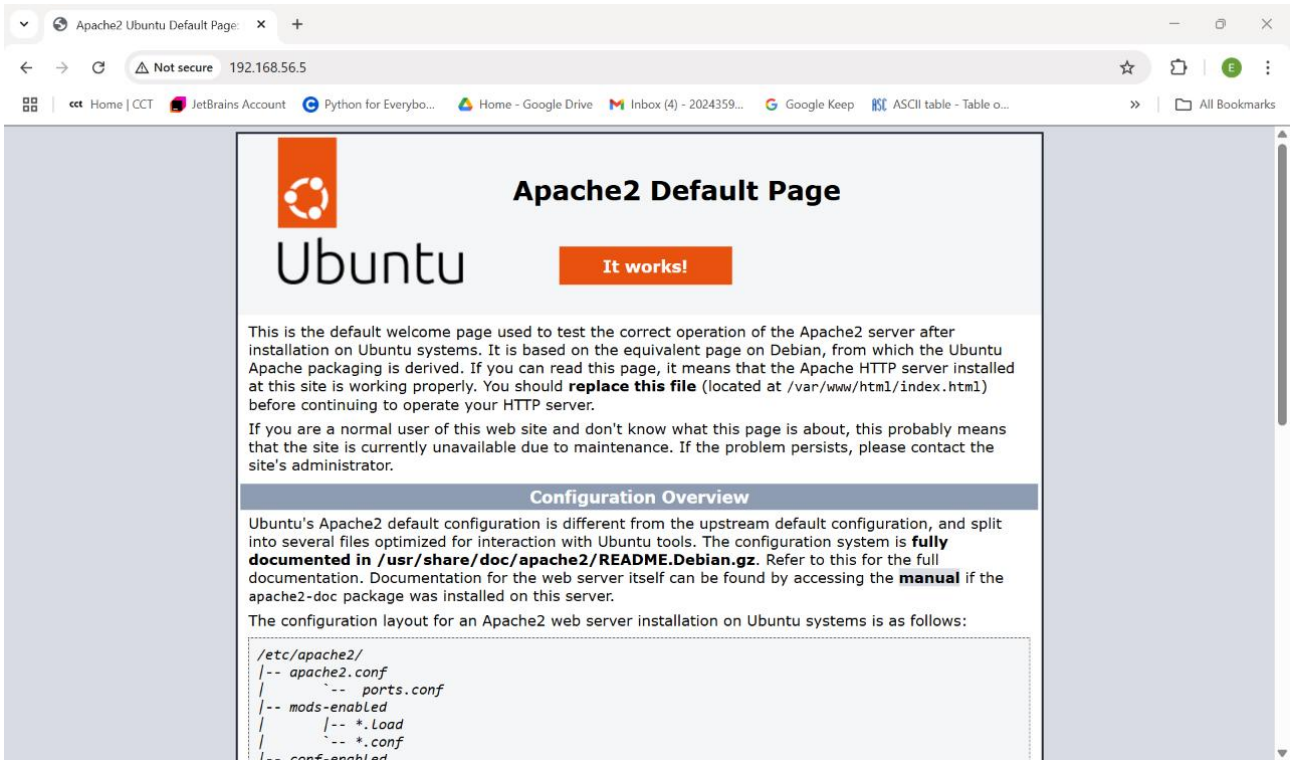
- ***Installing Apache on ubuntuserver and Lynx Web Browser on ubuntuclient***

Note: Command to install Apache and Lynx on designated machines

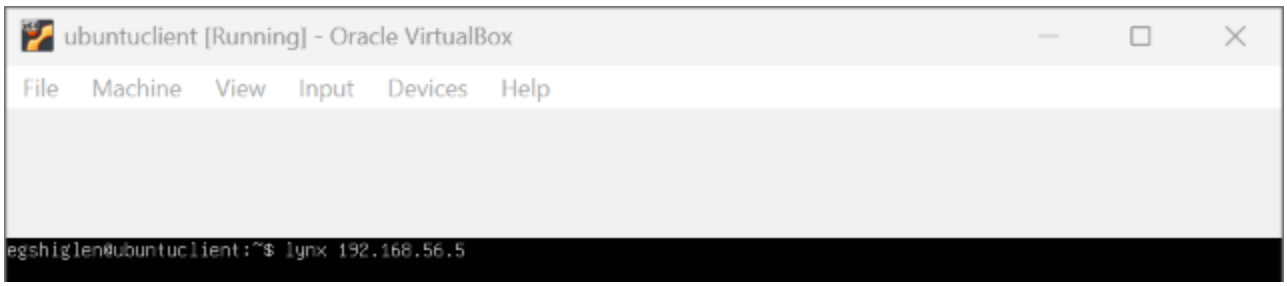


Note: Installation of Apache and Lynx are successful

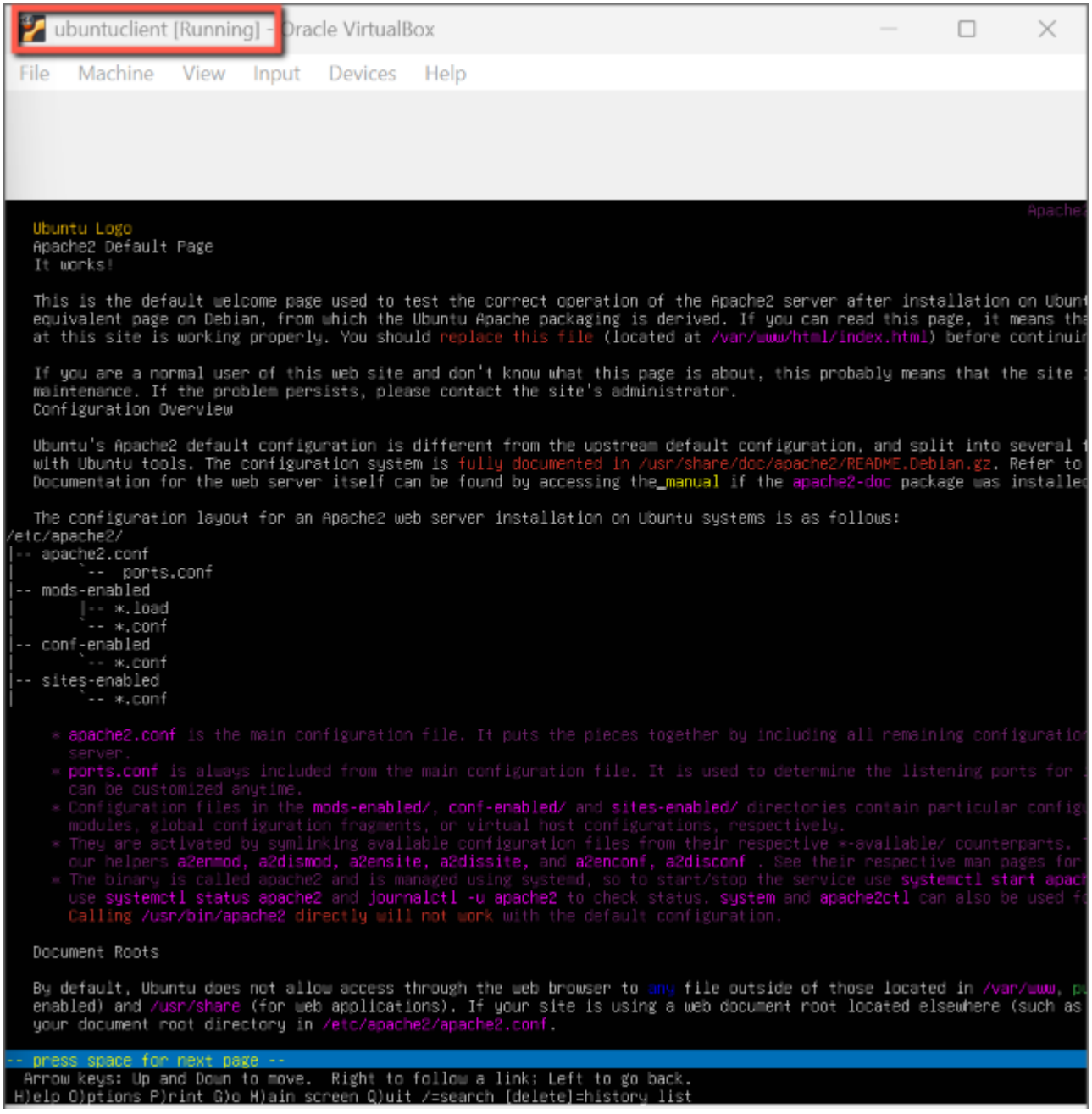
- ***Editing Apache Default Web Page***



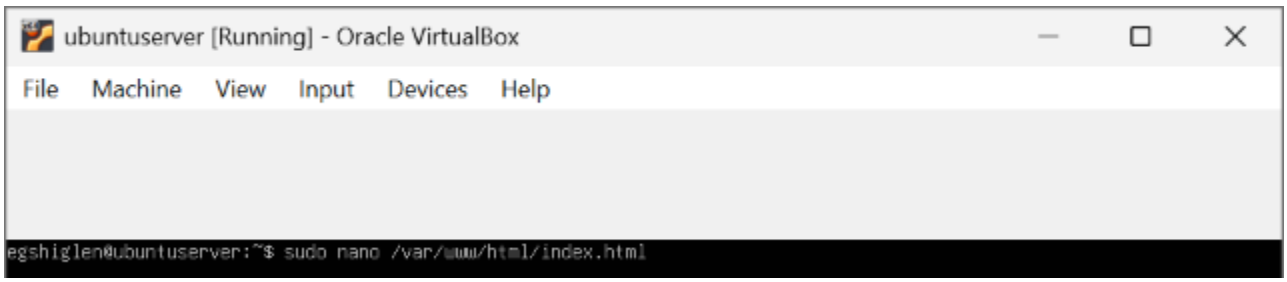
Note: Apache Default Web Page on Chrome browser from host



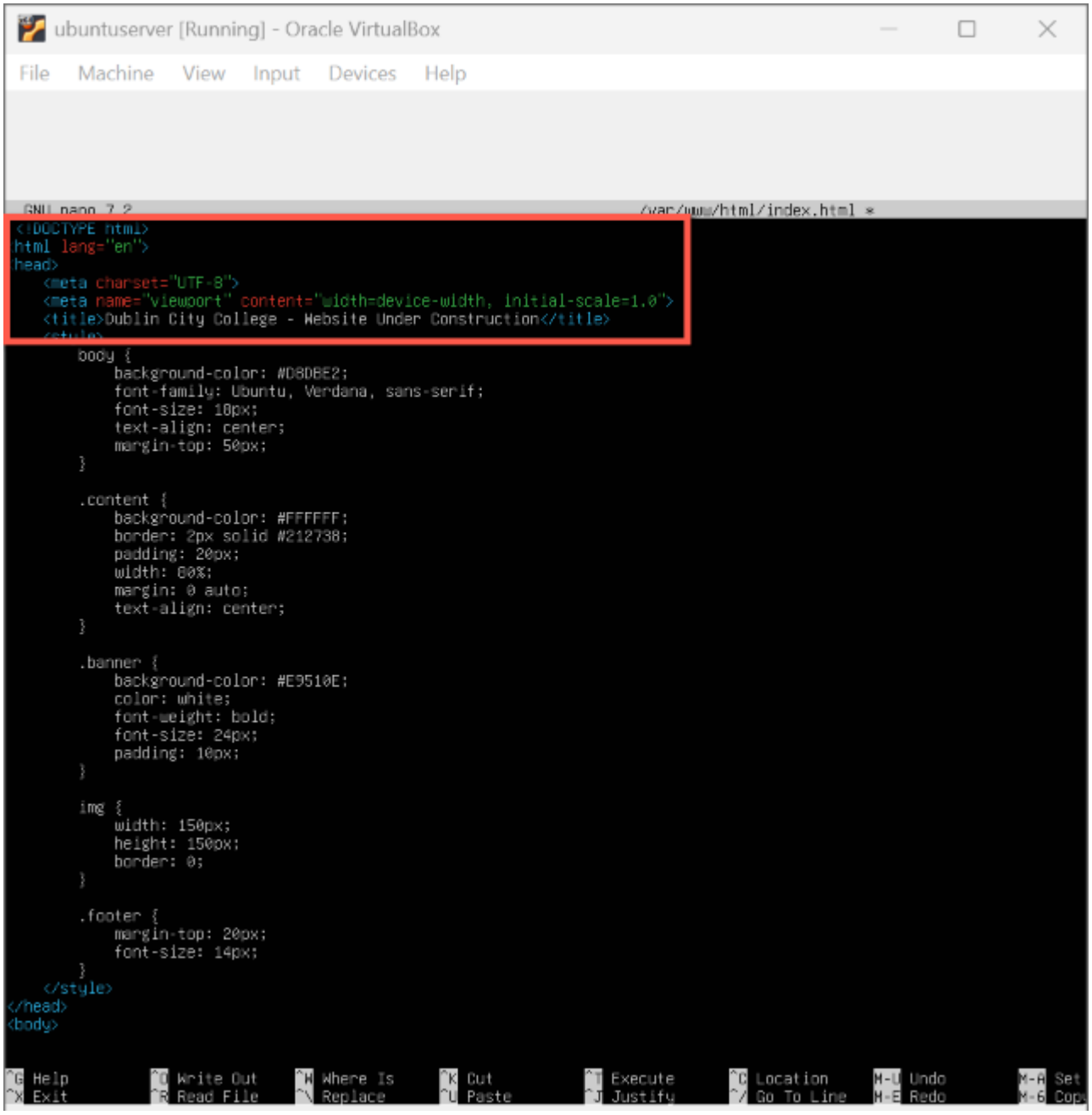
Note: Command to open the Lynx browser on client machine



Note: Apache default page on Lynx browser on client machine



Note: Sudo command to open the html code for the webpage on the server machine



Note: Changed the title to DCC – Website under construction (edited html code)

ubuntuserver [Running] - Oracle VirtualBox

File Machine View Input Devices Help

GNU nano 7.2 /var/www/html/index.html *

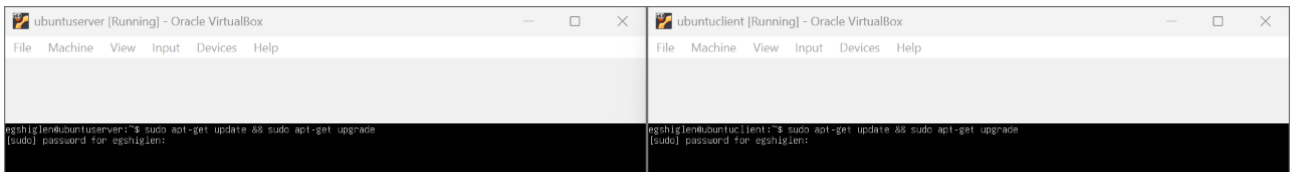
```
        .content {
            background-color: #FFFFFF;
            border: 2px solid #212738;
            padding: 20px;
            width: 80%;
            margin: 0 auto;
            text-align: center;
        }

        .banner {
            background-color: #E9510E;
            color: white;
            font-weight: bold;
            font-size: 24px;
            padding: 10px;
        }

        img {
            width: 150px;
            height: 150px;
            border: 0;
        }

        .footer {
            margin-top: 20px;
            font-size: 14px;
        }
    </style>
</head>
<body>

    <div class="content">
        <div class="banner">
            Dublin City College - Website Under Construction
        </div>
        <img src="https://www.pvsd.org/wp-content/uploads/2022/08/Page_Under_Construction.jpeg" alt="Under Construction"
        <div class="footer">
            <p>Student Name: Egshiglen Enkhbayar | Student Number: 2024359</p>
        </div>
    </div>

</body>
</html>
```

^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location M-U Undo M-A Set
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^/ Go To Line M-E Redo M-6 Cop

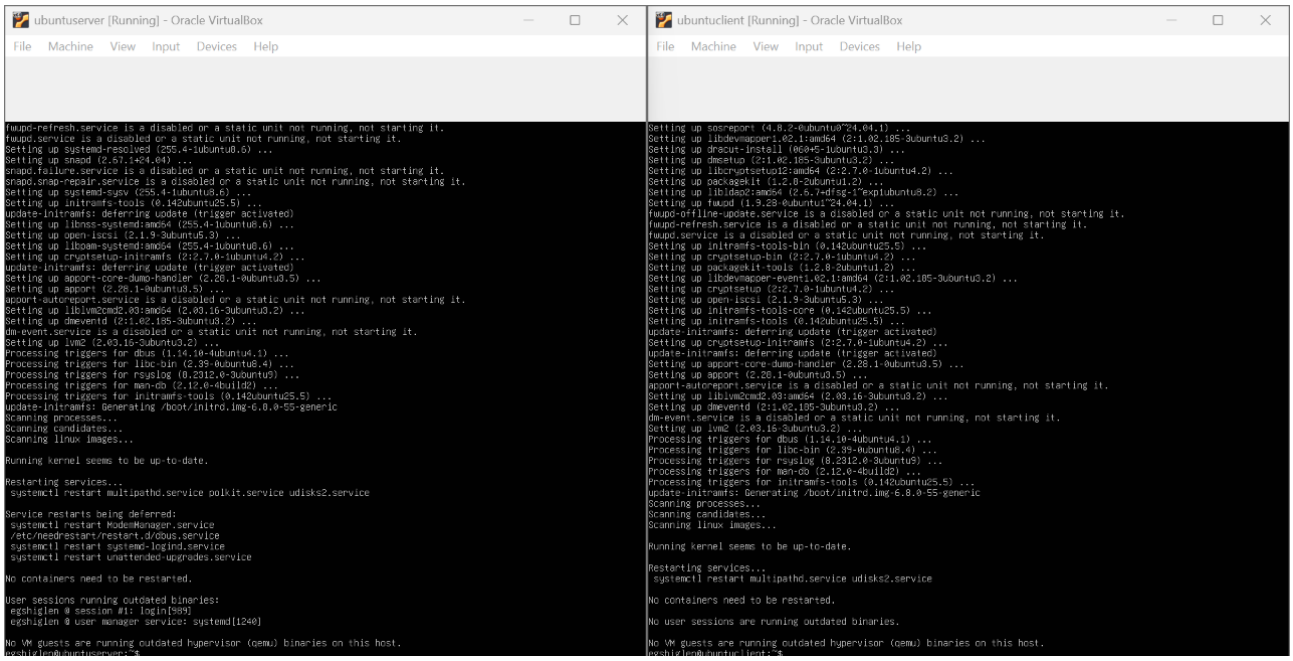
Note: Added the Dublin City College – Website under construction and included my name and student number and a photo from internet (edited html code)

PART 1A: Virtual Linux Network and Web server

➢ *1. Obtaining Linux updates and Upgrade*

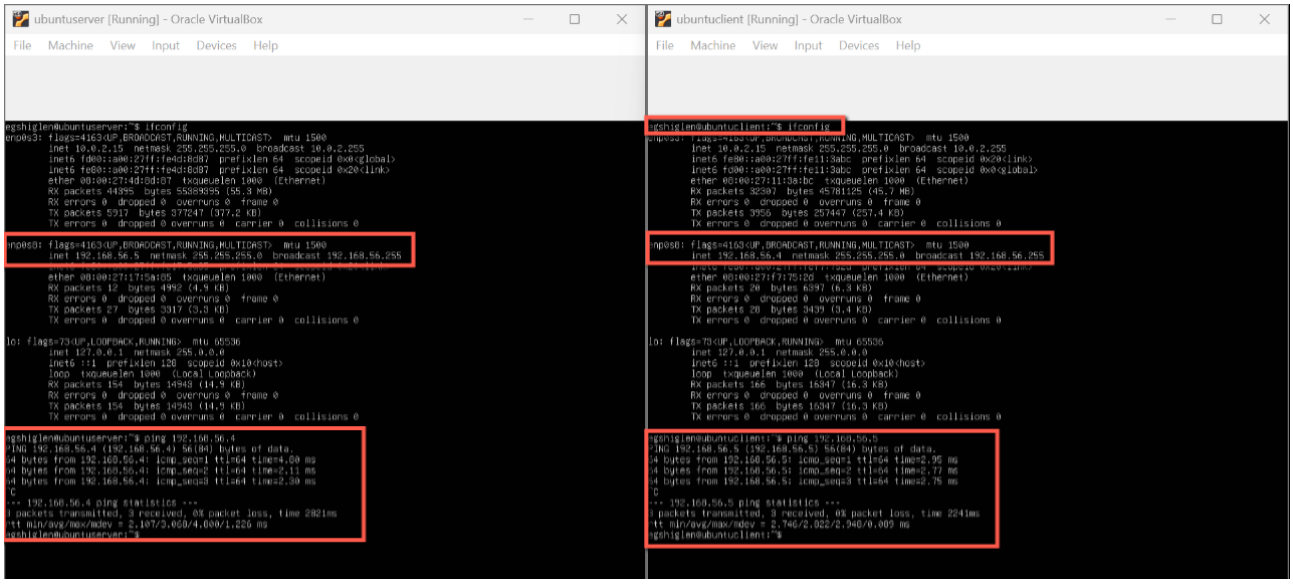


Note: Commanding to update and upgrade

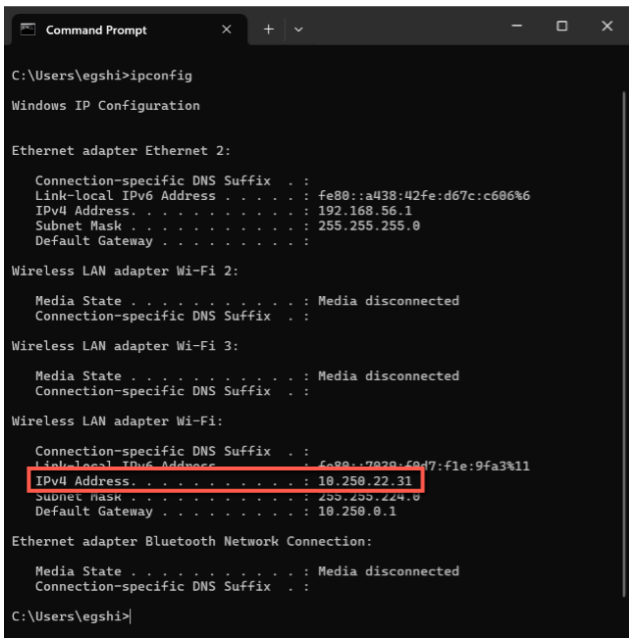


Note: Update and upgrade are successful

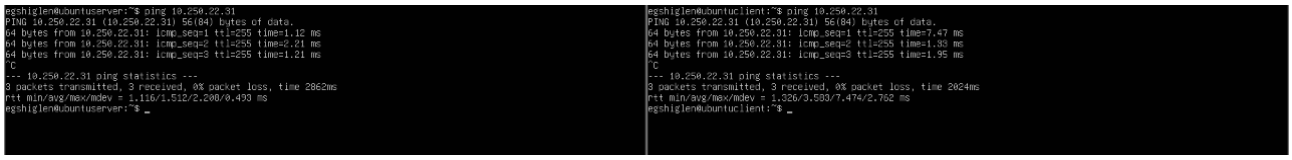
➢ 2. Testing Network Connectivity between both systems



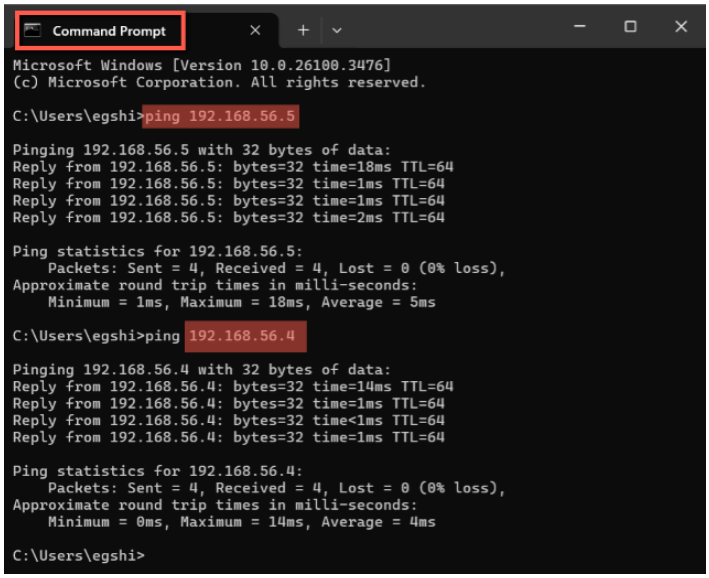
Note: IP address configuration after installation of Ubuntu (ubuntuserver: 192.168.56.5, ubuntuclient:192.168.56.4) and Pinging each internal IP address



Note: IP configuration on the host machine(Windows 11: 10.250.22.31)



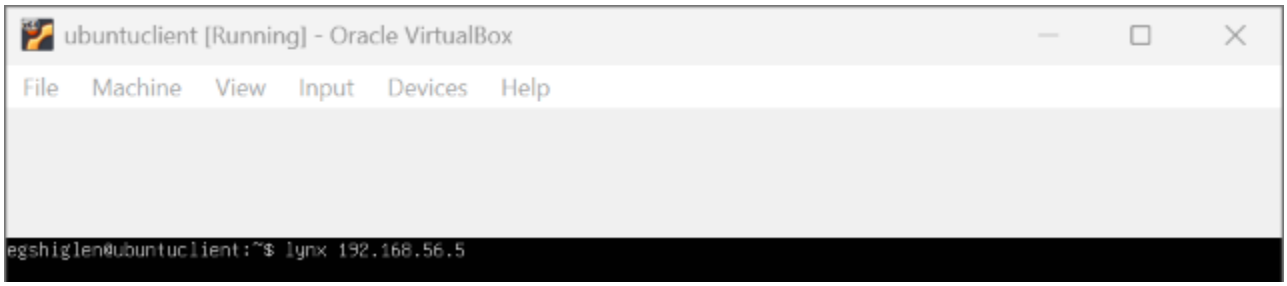
Note: Pinging host computer on each VMs



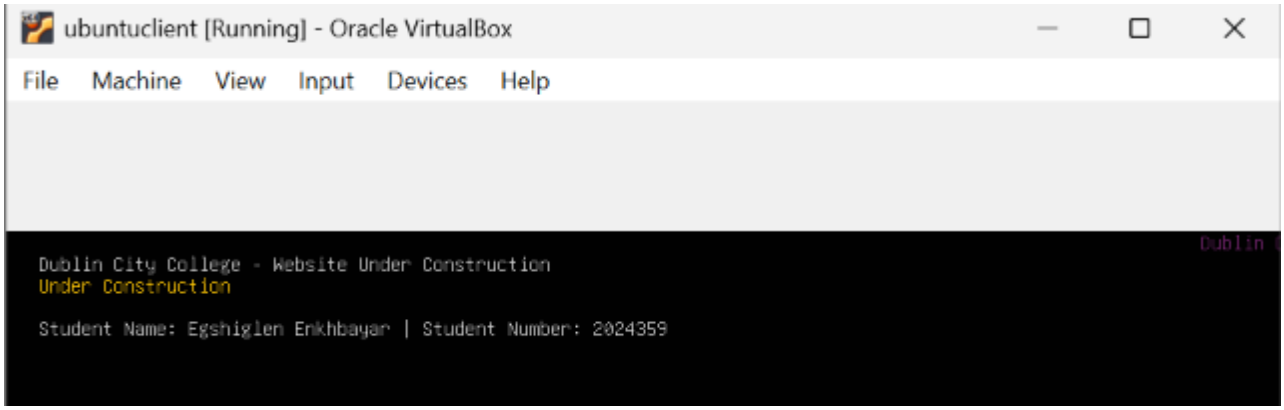
Note: Pinging Virtual Machines' IP address on the host computer

Note: Pinging Google.com to verify internet connection

- ***3. Testing Web Server Access from ubuntuclient***

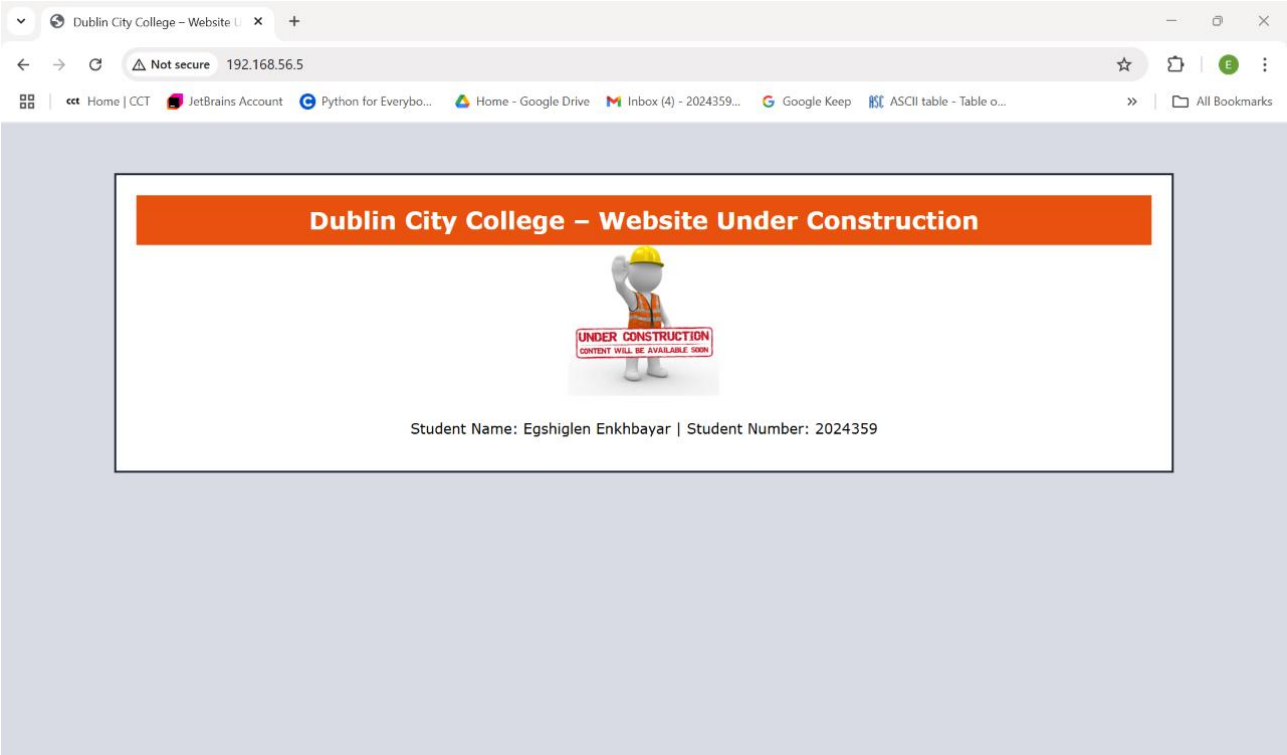


Note: Command to open the Lynx browser on client machine



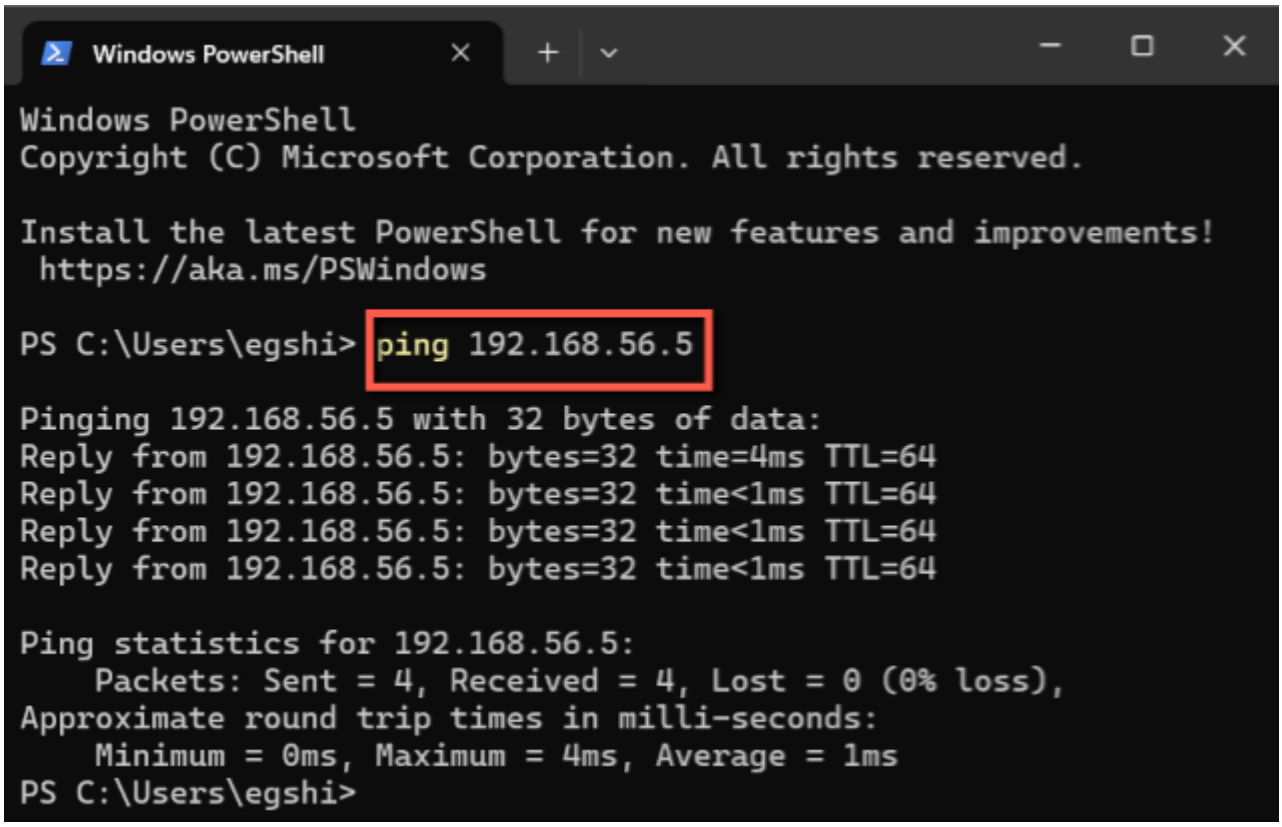
Note: Final result for DCC Under Construction web page on Lynx browser on the client machine

- ***4. Testing Web Server Access from host computer***

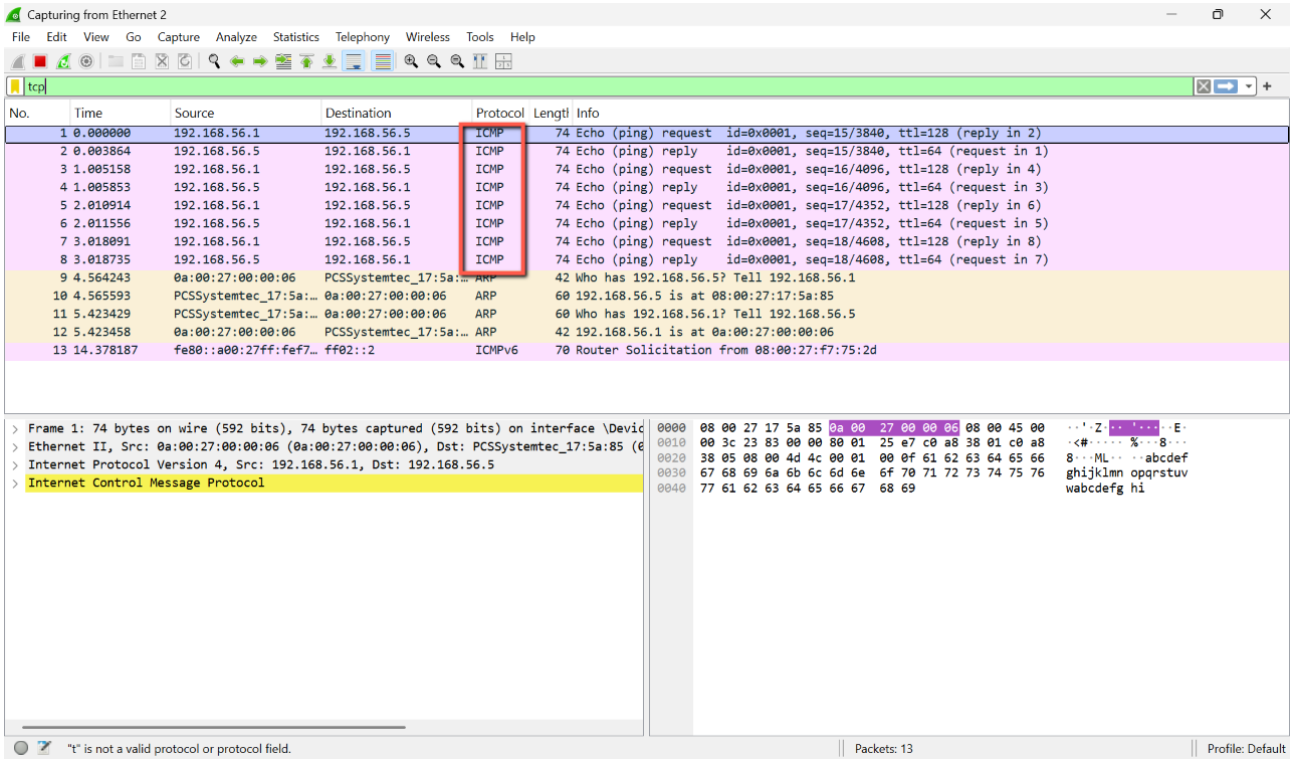


Note: Final result for DCC Under Construction web page on Chrome browser on the host computer

➢ 5. Capturing ICMP Traffic with Wireshark

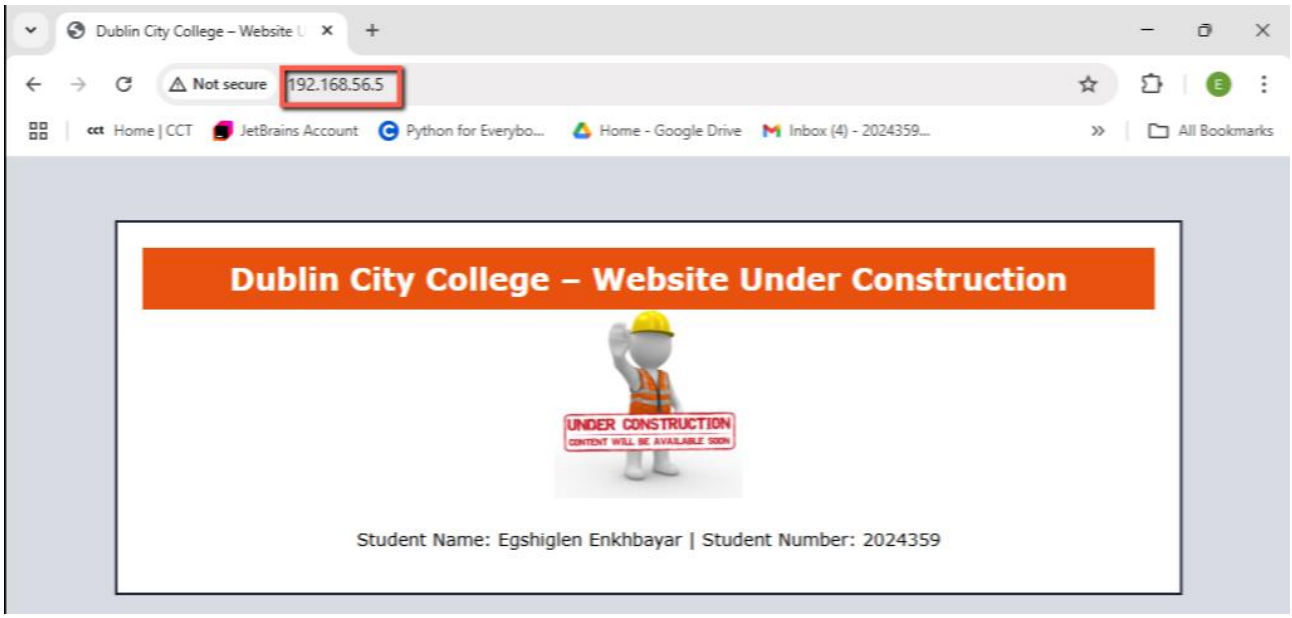


Note: Pinging the IP address of ubuntuserver on host computer

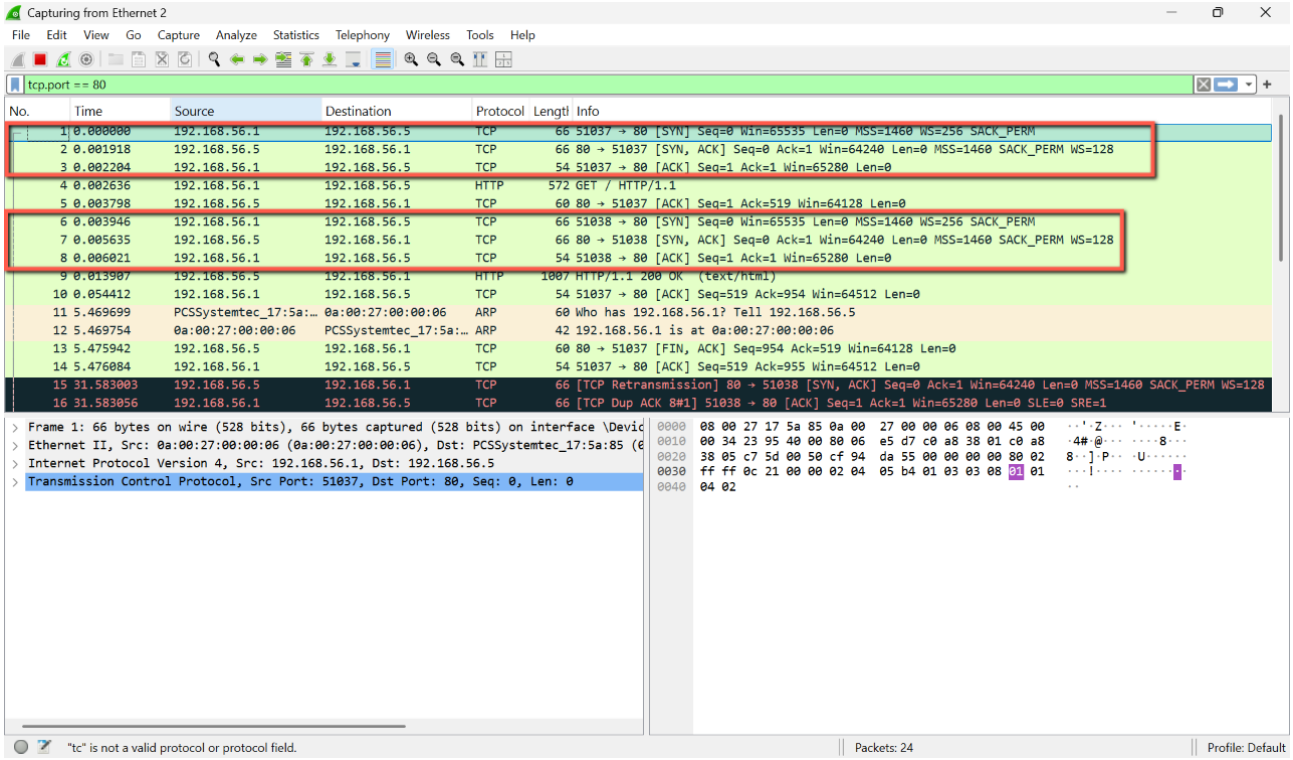


Note: the ICMP traffic between the host (Windows) and ubuntuserver on Wireshark while pinging the IP address on host computer

➢ *6. Capturing TCP/IP 3-way Handshake with Wireshark*

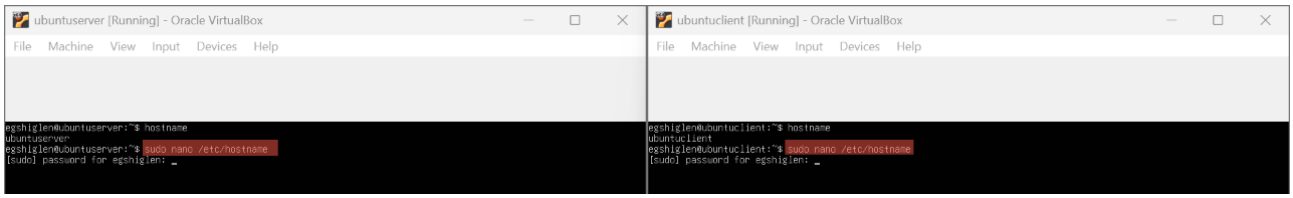


Note: Putting the address of ubuntuserver on Chrome browser on host machine

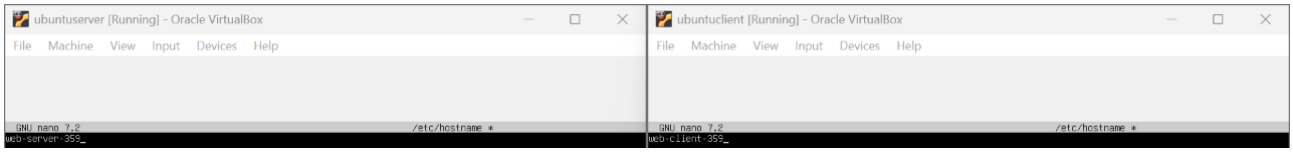


Note: TCP/IP 3-Way handshake on Wireshark while accessing the web page on Chrome

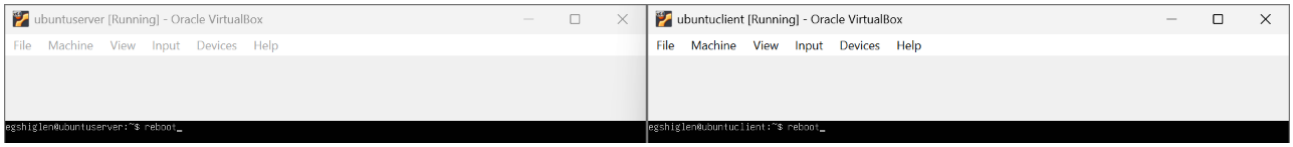
PART 1B: HOSTNAME MANAGEMENT -Renaming the Linux servers



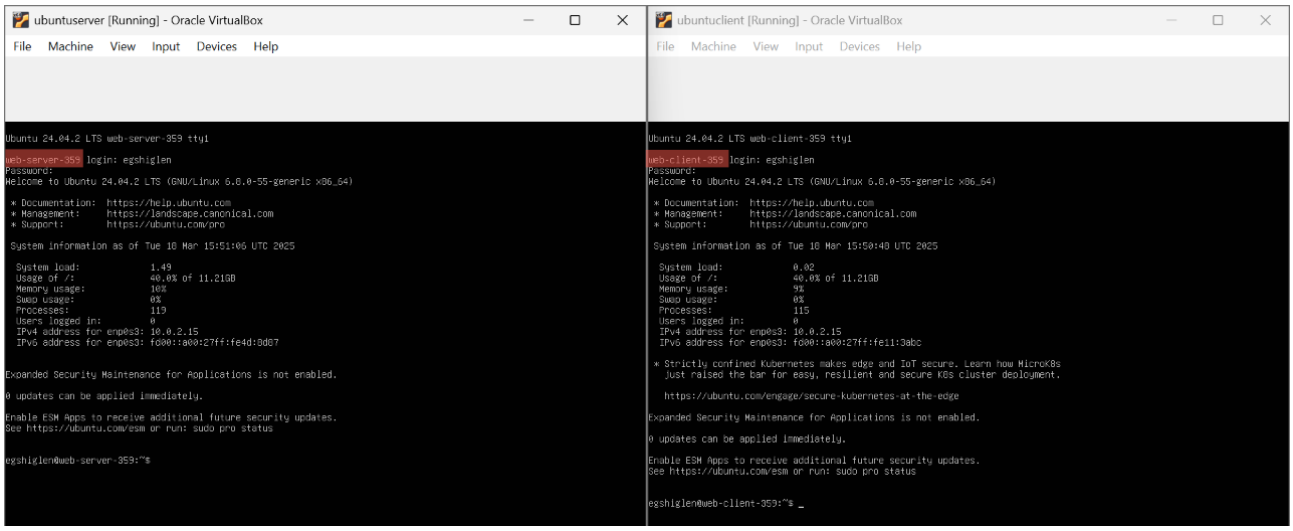
Note: Command to change the hostname permanently



Note: Changing ubuntuserver to web-server-359 and ubuntuclient to web-client-359



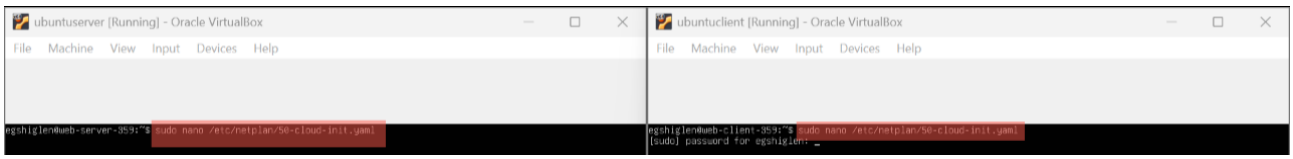
Note: Reboot after name change



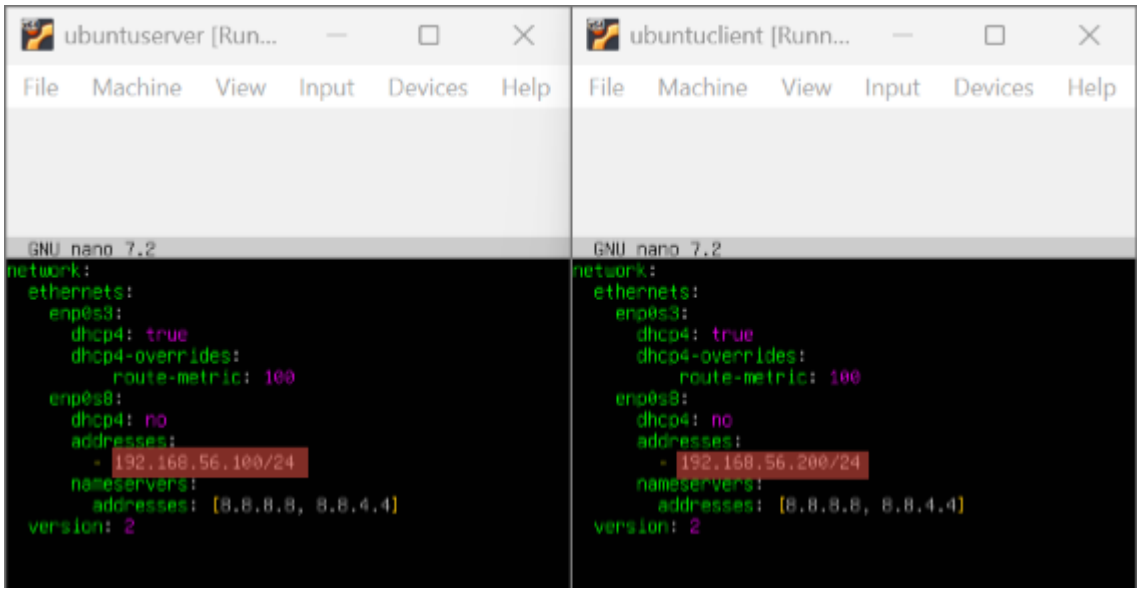
Note: Hostnames are changed successfully after reboot

PART 1C: IP ADDRESS MANAGEMENT

- ***1. Editing Netplan to Assign a Permanent IP address on both machines***

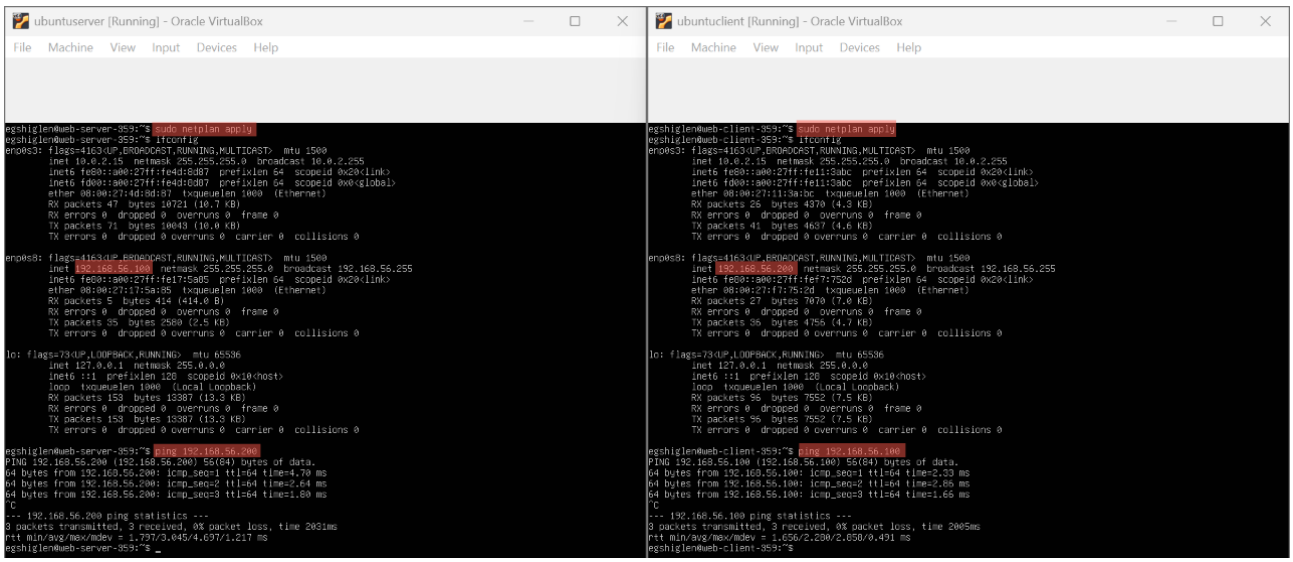


Note: Command to change the IP address permanently using nano



Note: Changing web-server-359 IP address 192.168.56.5 to 192.168.56.100/24 and web-client-359 IP address 192.168.56.4 to 192.168.200/24

- ***2. Testing network Connectivity with PING***



Note: After Netplan apply the IP addresses are changed and pinging each other

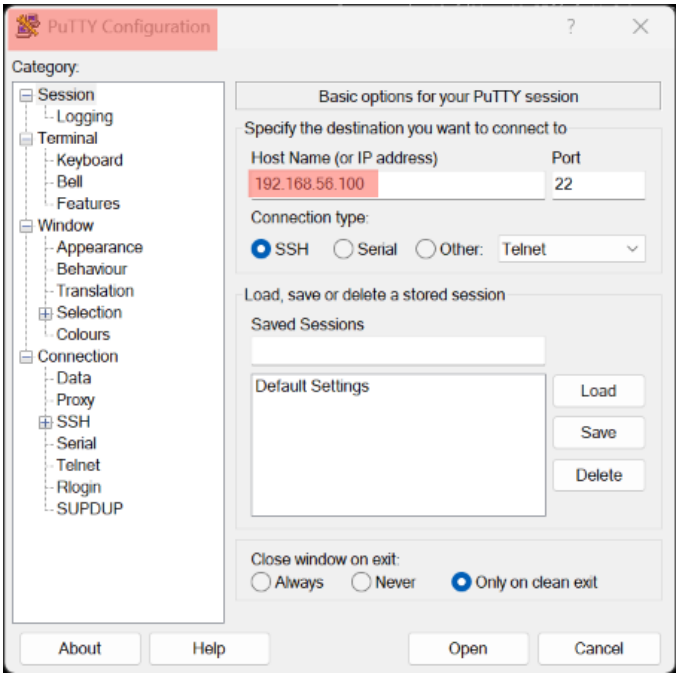
PART 2: Using SSH for secure transfer of data between the two server

Note: Openssh-server has been installed during the installation of ubuntu and Putty has been installed through (Chiark).

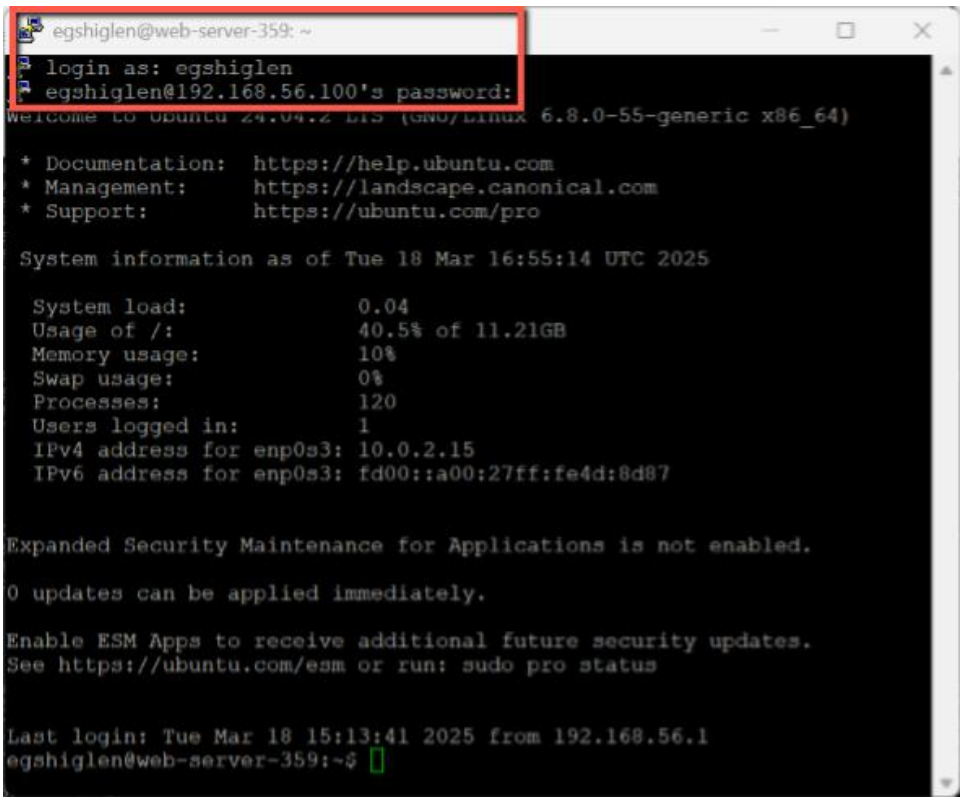
- ***1. Connecting to ubuntuserver via SSH from Windows***

```
egshiglen@web-server-359:~$ sudo systemctl status ssh
[sudo] password for egshiglen:
● ssh.service - OpenBSD Secure Shell server
     Loaded: loaded (/usr/lib/systemd/system/ssh.service; disabled; preset: enabled)
     Active: inactive (dead)
TriggeredBy: ● ssh.socket
       Docs: man:sshd(8)
             man:sshd_config(5)
egshiglen@web-server-359:~$ sudo systemctl enable ssh
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
Created symlink /etc/systemd/system/sshd.service → /usr/lib/systemd/system/ssh.service.
Created symlink /etc/systemd/system/multi-user.target.wants/ssh.service → /usr/lib/systemd/system/ssh.service.
egshiglen@web-server-359:~$ sudo systemctl start ssh
egshiglen@web-server-359:~$ sudo status ssh
sudo: status: command not found
egshiglen@web-server-359:~$ sudo systemctl status ssh
● ssh.service - OpenBSD Secure Shell server
     Loaded: loaded (/usr/lib/systemd/system/ssh.service; enabled; preset: enabled)
     Active: active (running) since Sun [illegible] 10:13:22 UTC; 27s ago
TriggeredBy: ● ssh.socket
       Docs: man:sshd(8)
             man:sshd_config(5)
    Process: 1031 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
   Main PID: 1033 (sshd)
      Tasks: 1 (limit: 2263)
     Memory: 2.1M (peak: 2.2M)
        CPU: 91ms
     CGroup: /system.slice/ssh.service
             └─1033 "sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups"

Mar 23 10:13:22 web-server-359 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...
Mar 23 10:13:22 web-server-359 sshd[1033]: Server listening on :: port 22.
Mar 23 10:13:22 web-server-359 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
egshiglen@web-server-359:~$ _
```

Note: Checking the SSH server status and enabling it to make it active using the source from (DedicatedCore).

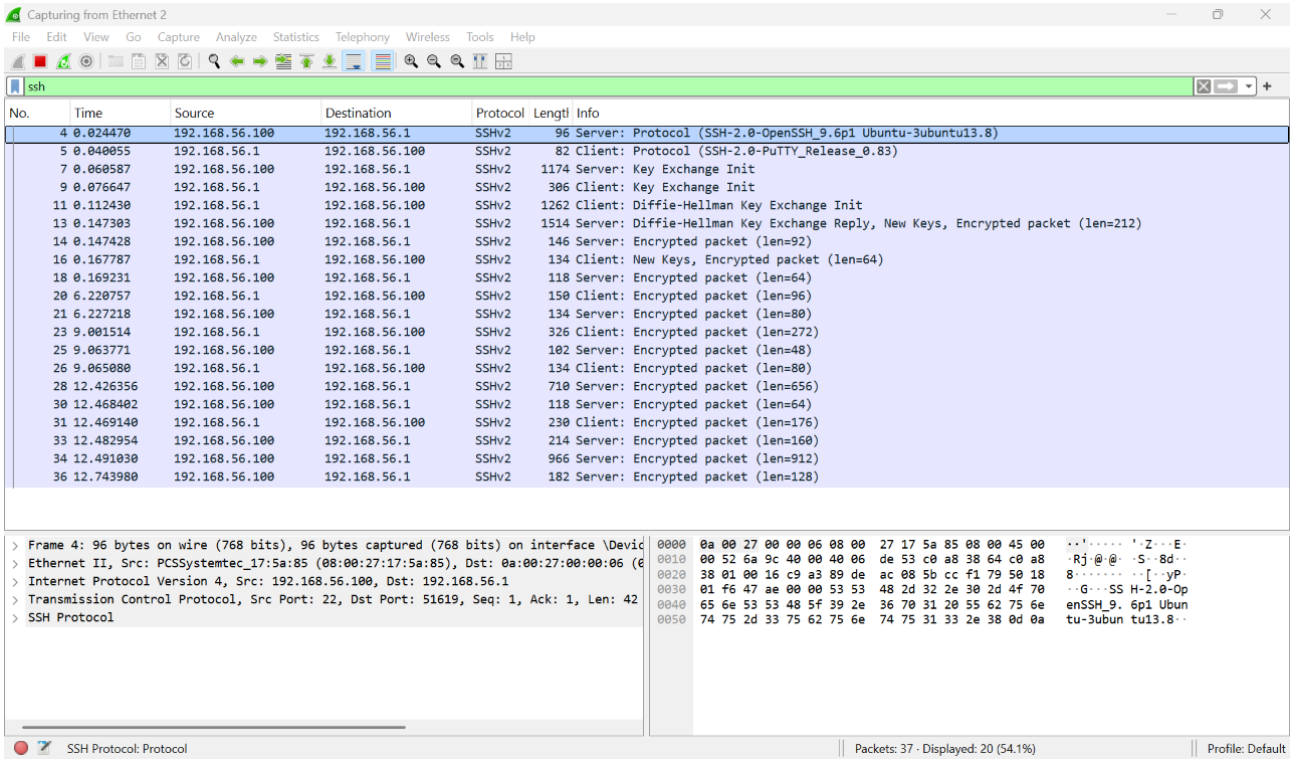


Note: Opening Putty on Windows and entering SSH details



Note: Logging into web-server-359 via SSH from Putty

- ***2. Capturing Encrypted SSH traffic using Wireshark***



Note: Using Wireshark to track SSH traffic between ubuntuserver and Putty(windows)

PART 3: Security configuration #1:

- ***1. UFW Status Enable***

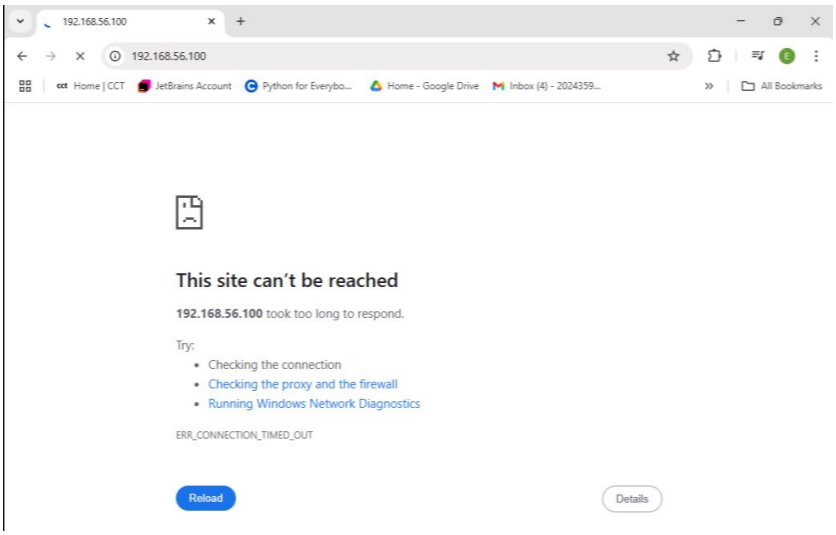
```
egshiglen@web-server-359:~$ sudo ufw status
[sudo] password for egshiglen:
Status: inactive
egshiglen@web-server-359:~$ sudo ufw enable
Firewall is active and enabled on system startup
egshiglen@web-server-359:~$ sudo ufw status
Status: active
egshiglen@web-server-359:~$
```

Note: Setting firewall to active

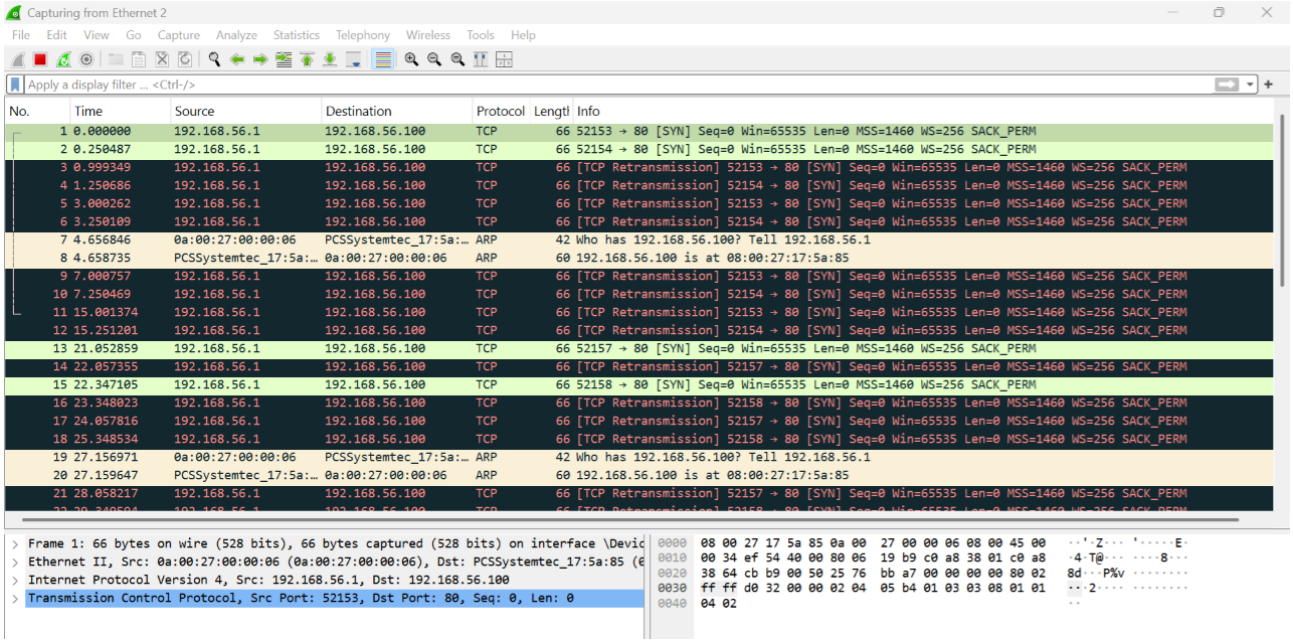
- ***2. HTTP Traffic via Firewall***

```
egshiglen@web-server-359:~$ sudo ufw status
Status: inactive
egshiglen@web-server-359:~$ sudo ufw enable
Firewall is active and enabled on system startup
egshiglen@web-server-359:~$ sudo ufw deny http
Rule added
Rule added (v6)
egshiglen@web-server-359:~$ sudo ufw status
Status: active

To                         Action      From
--                         ------      ----
22/tcp                     DENY        Anywhere
80/tcp                     DENY        Anywhere
22/tcp (v6)                DENY        Anywhere (v6)
80/tcp (v6)                DENY        Anywhere (v6)

egshiglen@web-server-359:~$
```

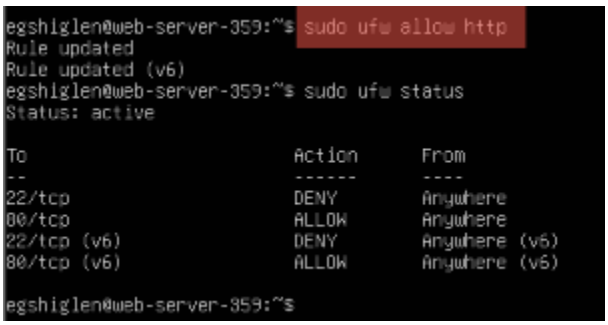
Note: Blocking HTTP traffic



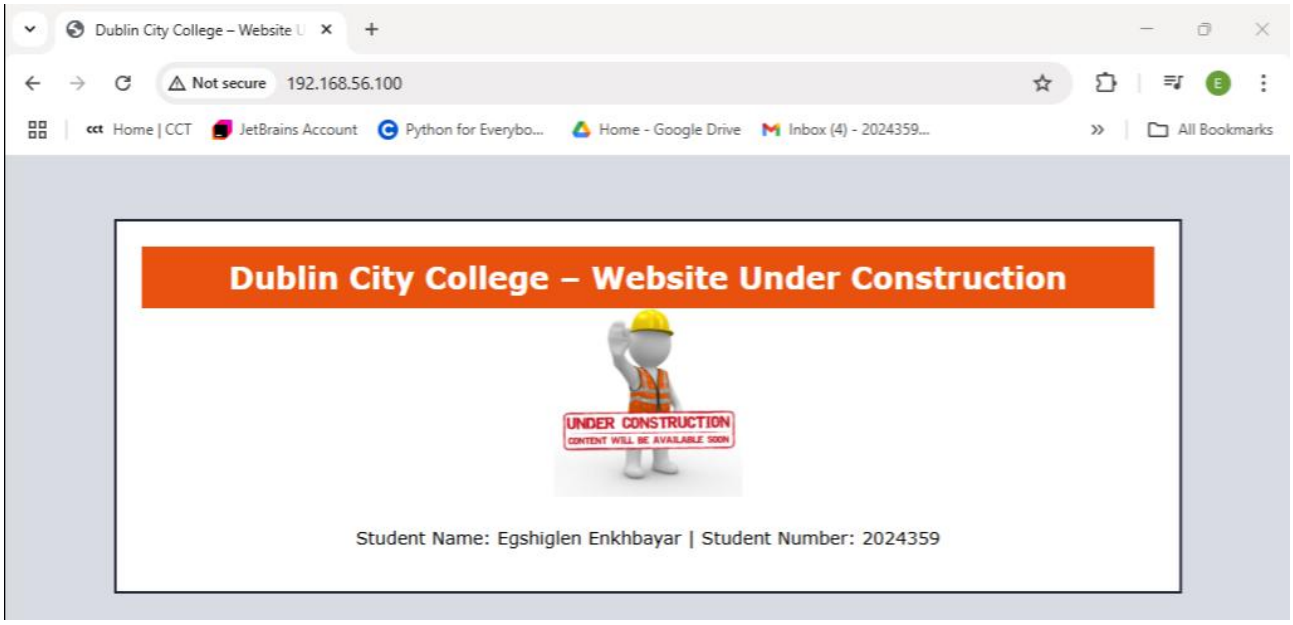
Note: Can't access to the web server on ubuntu using Chrome browser on Windows host



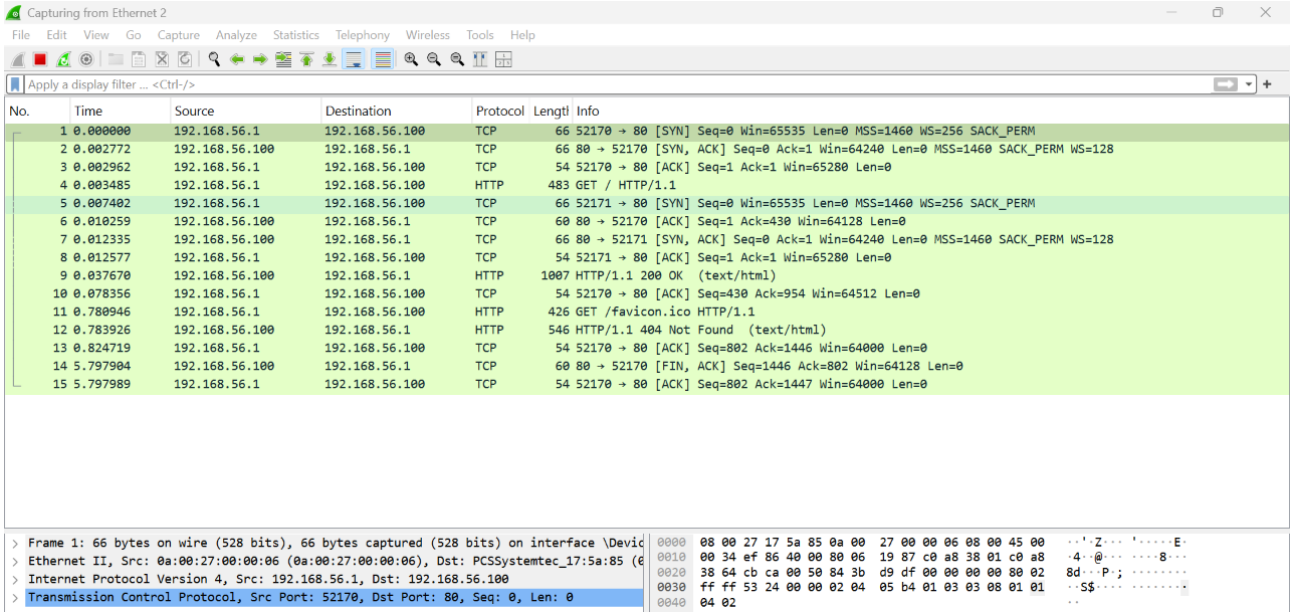
Note: Showing traffic is being blocked via Wireshark



Note: Allowing the HTTP traffic



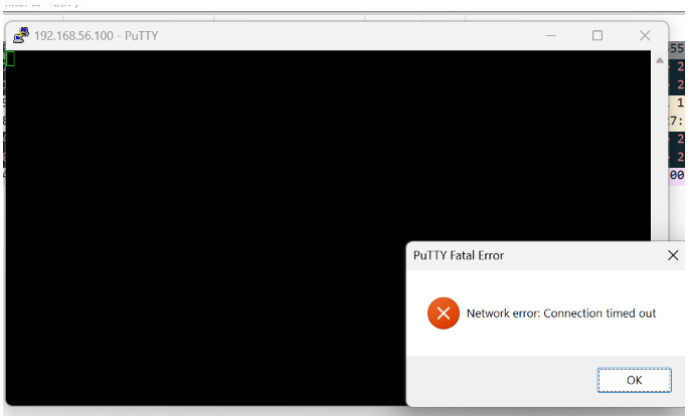
Note: Can access to the DCC page via Chrome browser on host



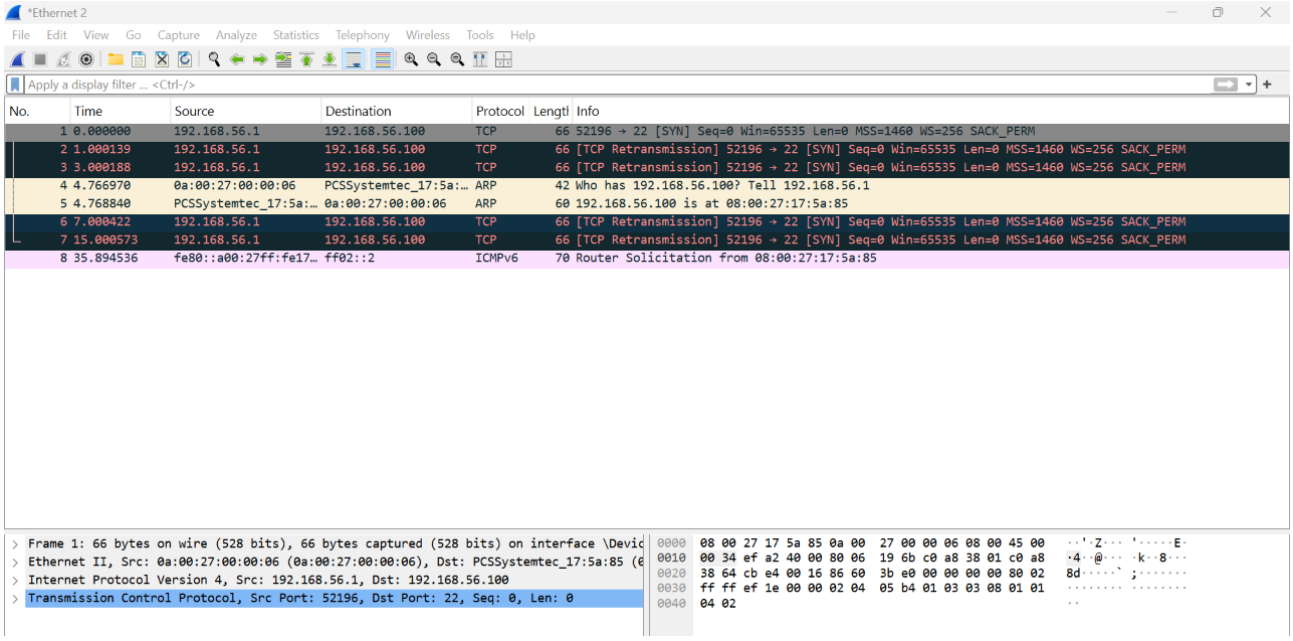
Note: Showing the traffic of HTTP being allowed

➢ *3. SSH Traffic via Firewall*

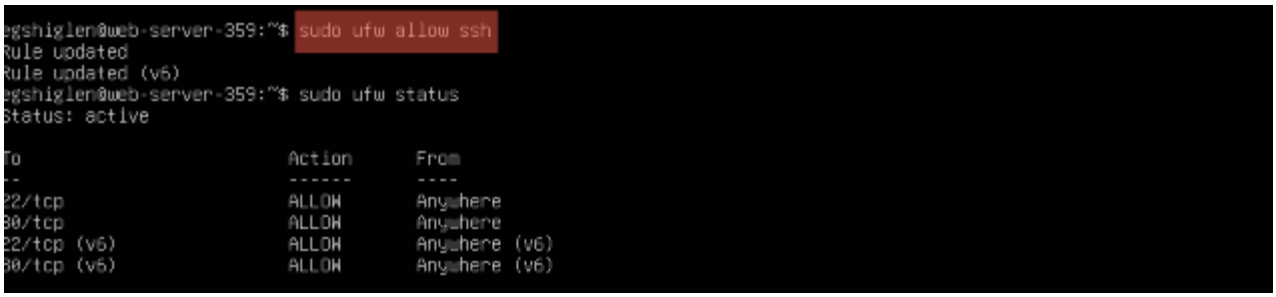
Note: Blocking SSH traffic



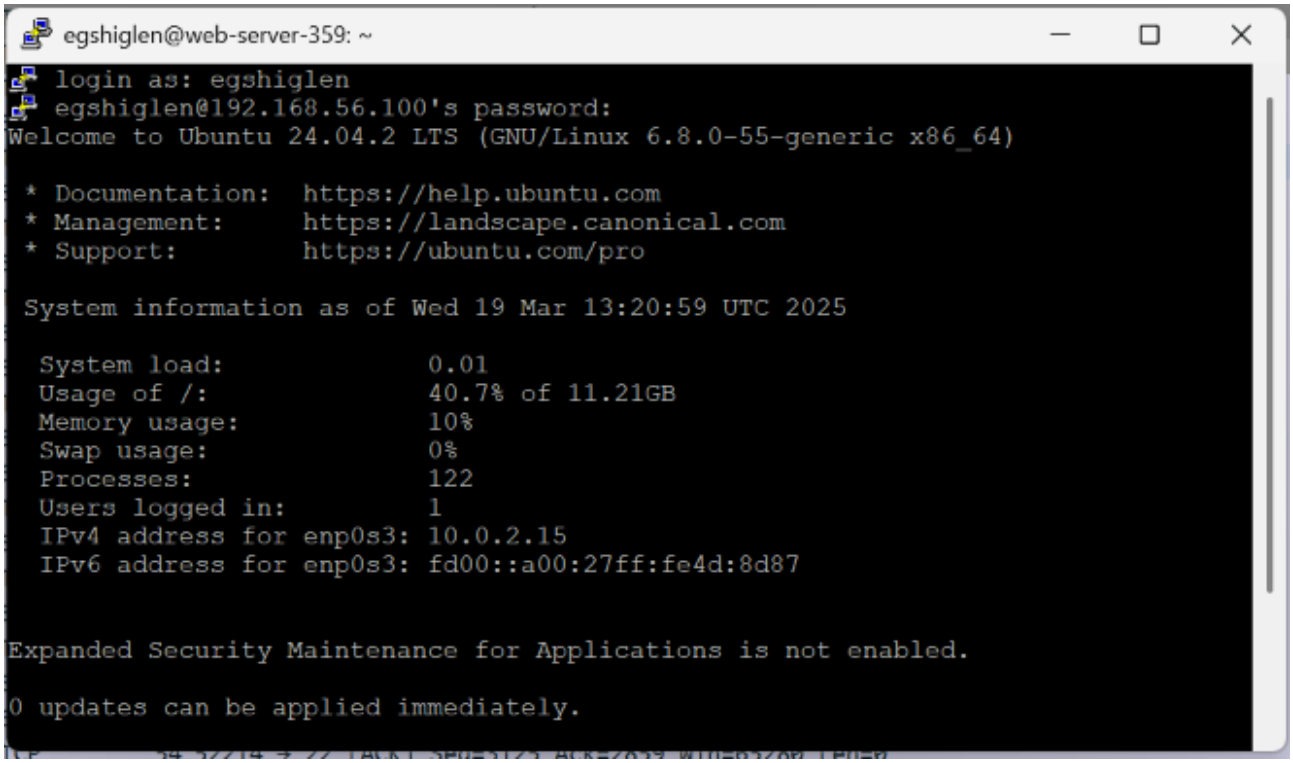
Note: Can't access to SSH via Putty because it's blocked



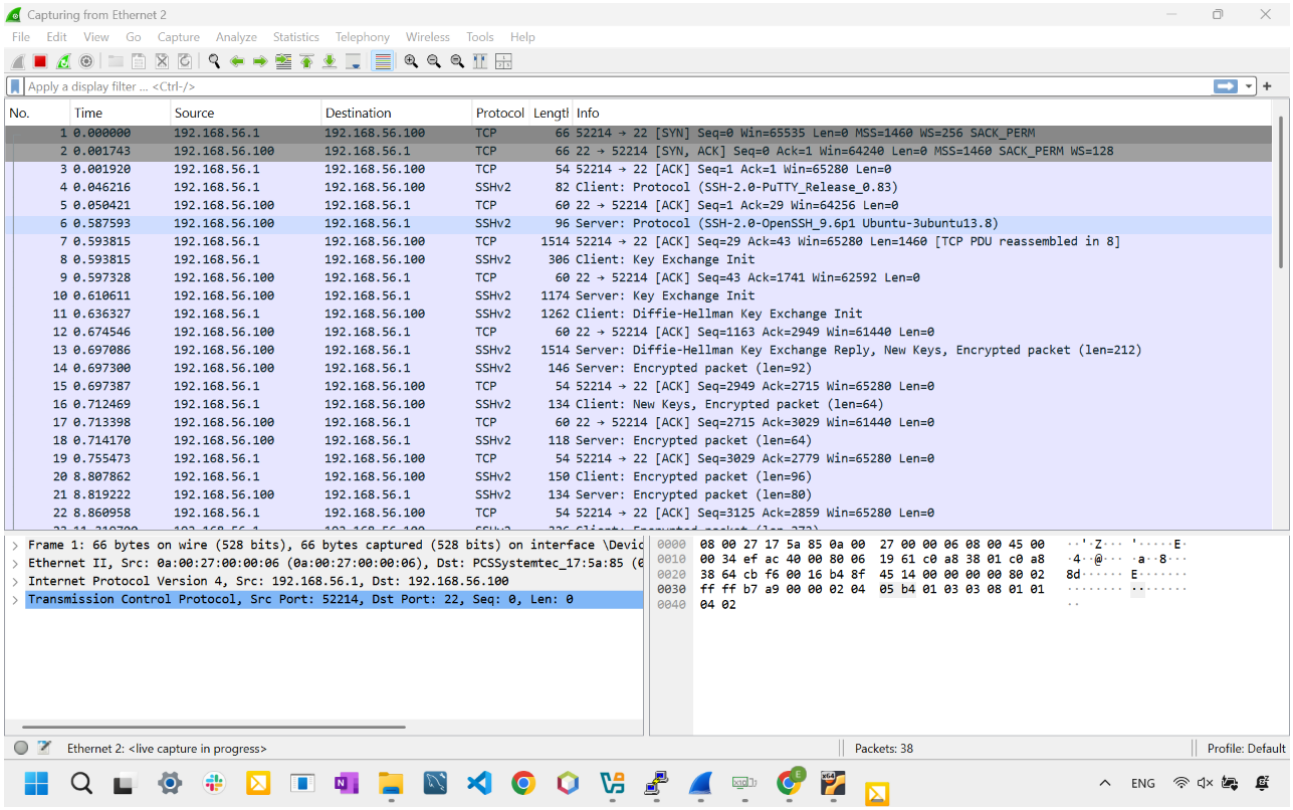
Note: Showing Wireshark SSH traffic being blocked



Note: Allowing SSH traffic on ubuntuserver



Note: Accessing to SSH via Putty on Host computer



Note: Showing the SSH traffic on Wireshark while accessing to the Putty

PART 4: The SAMBA file server

- ***Installiation of Samba on Ubuntu and configuration***

```
egshiglen@web-server-359:~$ sudo apt update
Hit:1 http://ie.archive.ubuntu.com/ubuntu noble InRelease
Hit:2 http://ie.archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:3 http://ie.archive.ubuntu.com/ubuntu noble-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu noble-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
4 packages can be upgraded. Run 'apt list --upgradable' to see them.
egshiglen@web-server-359:~$ sudo apt install samba -y
```

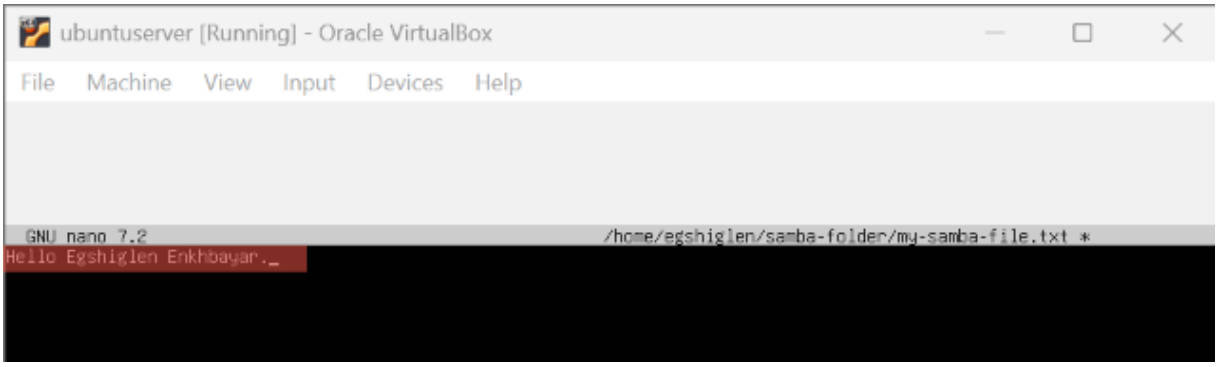
Note: Installing Samba on Ubuntu

```
egshiglen@web-server-359:~$ ls -al
total 32
drwxr-x--- 4 egshiglen egshiglen 4096 Mar 18 15:28 .
drwxr-xr-x 3 root      root      4096 Mar 18 12:55 ..
-rw------- 1 egshiglen egshiglen  459 Mar 18 16:33 .bash_history
-rw-r--r-- 1 egshiglen egshiglen  220 Mar 31  2024 .bash_logout
-rw-r--r-- 1 egshiglen egshiglen 3771 Mar 31  2024 .bashrc
drwx------ 2 egshiglen egshiglen 4096 Mar 18 12:59 .cache
-rw-r--r-- 1 egshiglen egshiglen  807 Mar 31  2024 .profile
drwx------ 2 egshiglen egshiglen 4096 Mar 18 12:55 .ssh
-rw-r--r-- 1 egshiglen egshiglen    0 Mar 18 13:09 .sudo_as_admin_successful
egshiglen@web-server-359:~$ sudo mkdir /home/egshiglen/samba-folder
egshiglen@web-server-359:~$ ls -al
total 36
drwxr-x--- 5 egshiglen egshiglen 4096 Mar 19 13:45 .
drwxr-xr-x 3 root      root      4096 Mar 18 12:55 ..
-rw------- 1 egshiglen egshiglen  459 Mar 18 16:33 .bash_history
-rw-r--r-- 1 egshiglen egshiglen  220 Mar 31  2024 .bash_logout
-rw-r--r-- 1 egshiglen egshiglen 3771 Mar 31  2024 .bashrc
drwx------ 2 egshiglen egshiglen 4096 Mar 18 12:59 .cache
-rw-r--r-- 1 egshiglen egshiglen  807 Mar 31  2024 .profile
drwxr-xr-x 2 root      root      4096 Mar 19 13:45 samba-folder
drwx------ 2 egshiglen egshiglen 4096 Mar 18 12:55 .ssh
-rw-r--r-- 1 egshiglen egshiglen    0 Mar 18 13:09 .sudo_as_admin_successful
egshiglen@web-server-359:~$
```

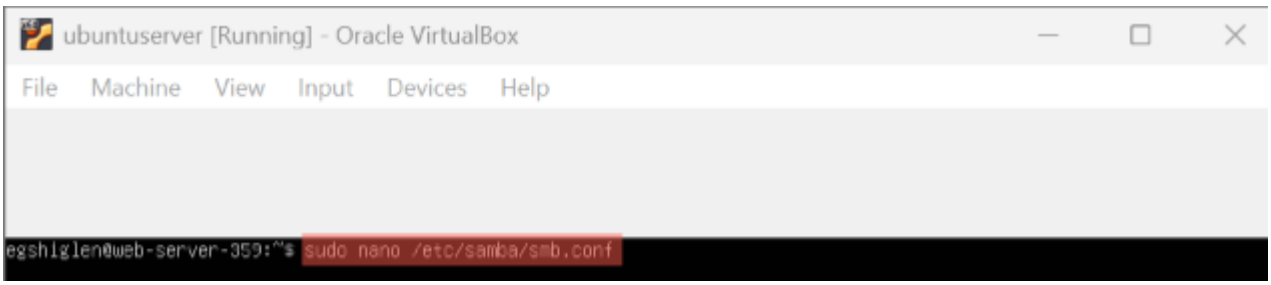
Note: Creating Samba Share Directory

```
egshiglen@web-server-359:~$ sudo nano /home/egshiglen/samba-folder/my-samba-file.txt
```

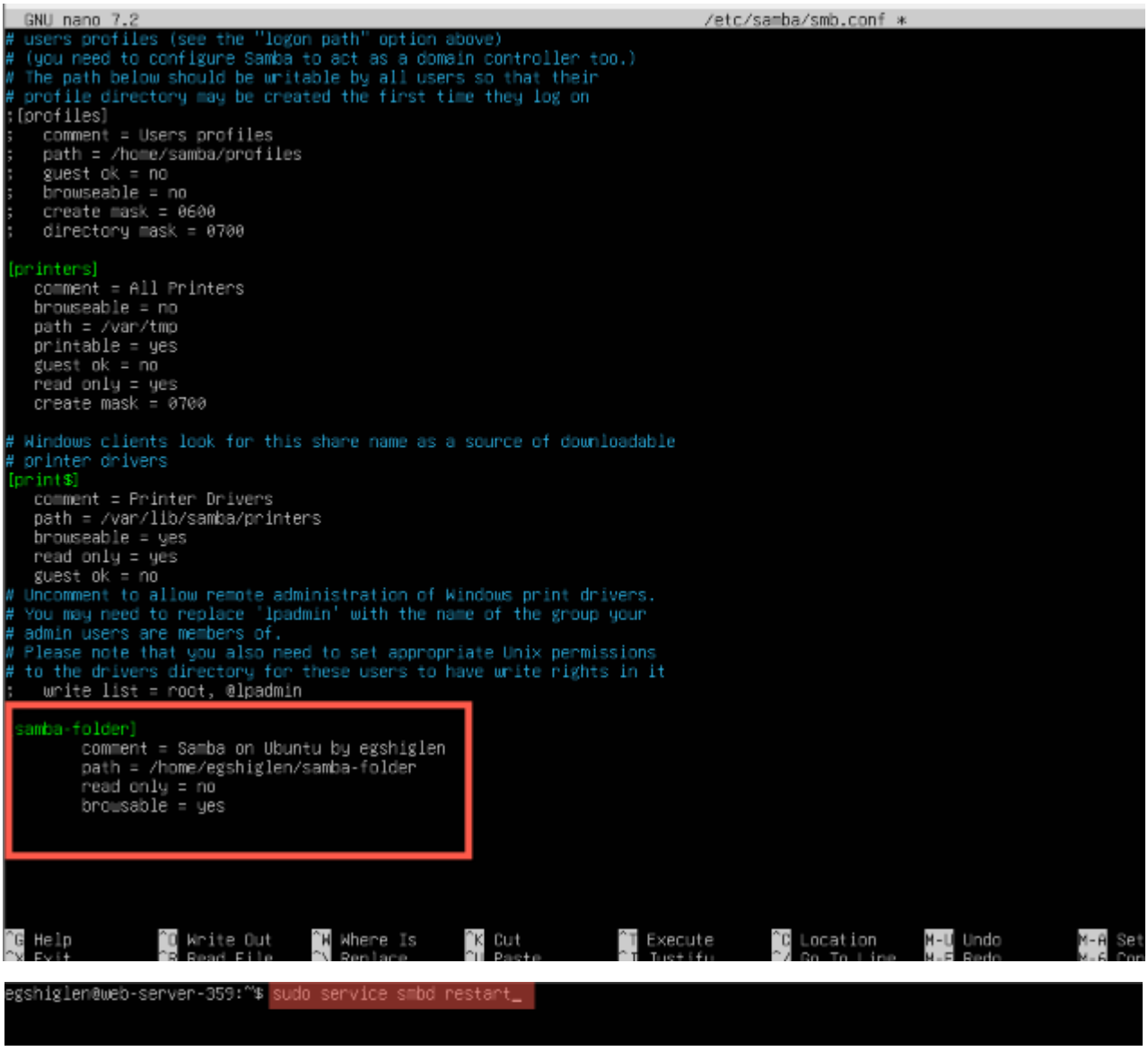
Note: Creating a test file for Samba Share



Note: Editing the test file



Note: Configuring Samba Share in smb.conf



Note: Adding the configuration code

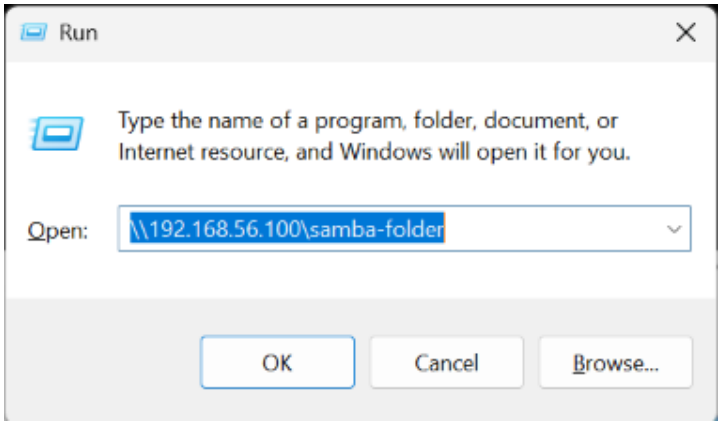
- ***Setting permissions for Samba Share***

```
egshiglen@web-server-359:~$ sudo service smbd restart
egshiglen@web-server-359:~$ sudo ufw status
Status: active

To                         Action      From
--                         ------      ----
22/tcp                     ALLOW       Anywhere
80/tcp                     ALLOW       Anywhere
22/tcp (v6)                ALLOW       Anywhere (v6)
80/tcp (v6)                ALLOW       Anywhere (v6)

egshiglen@web-server-359:~$ sudo ufw allow samba
Rule added
Rule added (v6)
egshiglen@web-server-359:~$ sudo ufw status
Status: active

To                         Action      From
--                         ------      ----
22/tcp                     ALLOW       Anywhere
80/tcp                     ALLOW       Anywhere
Samba                      ALLOW       Anywhere
22/tcp (v6)                ALLOW       Anywhere (v6)
80/tcp (v6)                ALLOW       Anywhere (v6)
Samba (v6)                 ALLOW       Anywhere (v6)
```

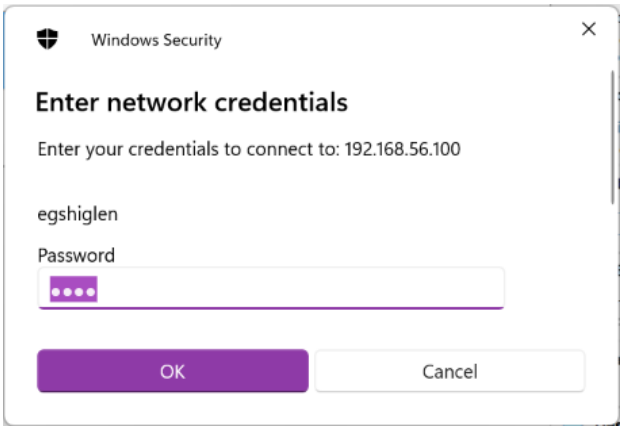
Note: Allowing Samba Traffic

```
egshiglen@web-server-359:~$ sudo smbpasswd -a egshiglen
New SMB password:
Retype new SMB password:
Added user egshiglen.
egshiglen@web-server-359:~$
```

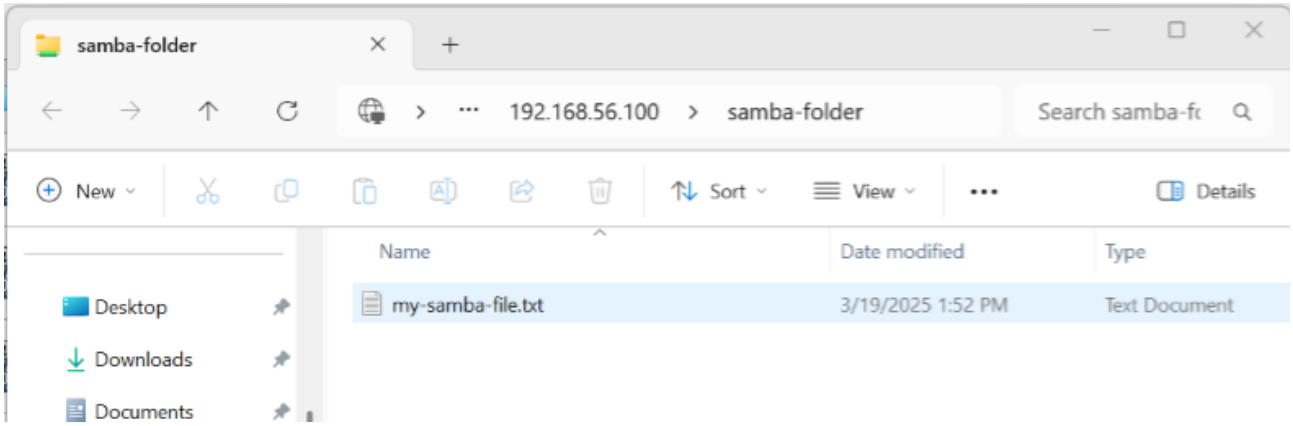
Note: Creating a new password for username "egshiglen"



Note: Accessing Samba Share from Host using windows + R and putting the ping number and folder nam

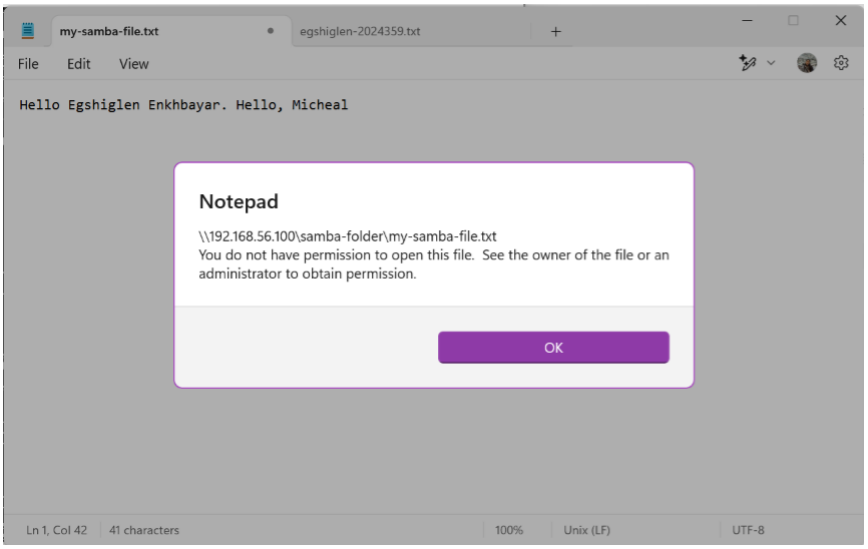


Note: Entering the necessary credentials



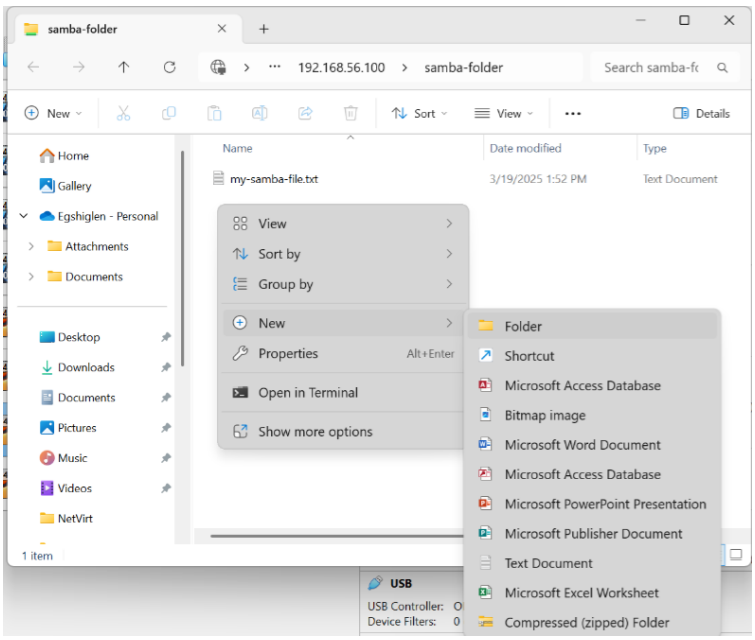
Note: Opened the Samba Folder successfully

Note: Opening the test file and it has the content that was created in the ubuntuserver

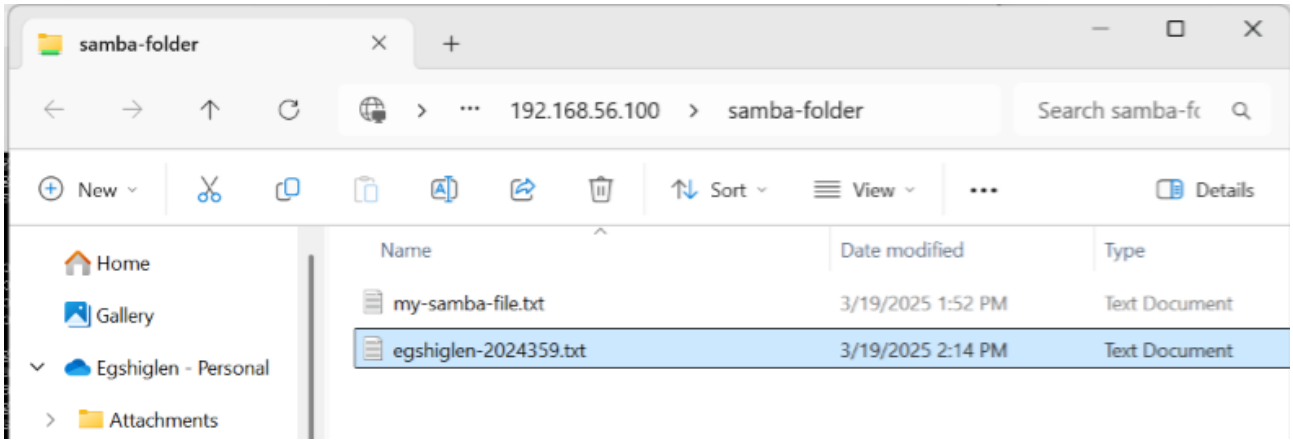


Note: Can't edit and only view the file

Note: Permitting to write and edit to the samba folder, chmod 777 command enables to write to the file.

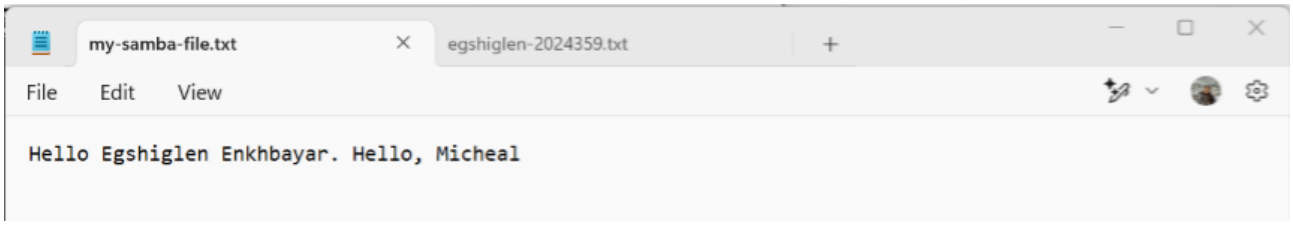


Note: Creating a new file to test if a new file can be added



Note: New file named egshiglen-2024359.txt has been created

Note: Editing egshiglen-2024359.txt



Note: Editing the test file and adding new text "Hello, Micheal"

```
egshiglen@web-server-359:~$ sudo nano /home/egshiglen/samba-folder/my-samba-file.txt_
```

Note: Opening the test file using nano command

```
  GNU nano 7.2                                    /home/egshiglen/samba-folder/my-samba-file.txt
Hello Egshiglen Enkhbayar. Hello, Micheal
```

Note: The test file has been successfully edited on the host machine and saved on ubuntuserver

```
egshiglen@web-server-359:~$ sudo nano /home/egshiglen/samba-folder/egshiglen-2024359.txt
```

Note: Opening the new created file on ubuntuserver

```
  GNU nano 7.2                                    /home/egshiglen/samba-folder/egshiglen-2024359.txt
Student name: Egshiglen Enkhbayar
Student number: 2024359
```

Note: The new file called "egshiglen-2024359.txt" has been successfully created on ubuntu via host machine

- ***Explanation and Examples of Samba***

What is Samba?

The Unix and Windows operating systems have completely different cultures and in the past they had a problem communicating with each other. Therefore, to solve that issue and make a peaceful coexistence between these operating systems, Samba has been created. Samba runs on Unix platforms like Linux and speaks to Windows. It allows Unix to move into a Windows network neighborhood without causing any trouble. Windows users can access file and print services that is offered by a Unix host. Samba is a free and open source software that provides file and print services to SMB/CIFS clients. *(Source:* (Hertel)*)*

What does Samba do?

- File & Print Services *(Source:* (Hertel)*)*
- Authentication & Authorization (*Source:* (Hertel)*)*
- Name resolution *(Source:* (Hertel)*)*
- Service announcement(browsing) *(Source:* (Hertel)*)*

Server Message Block (SMB)

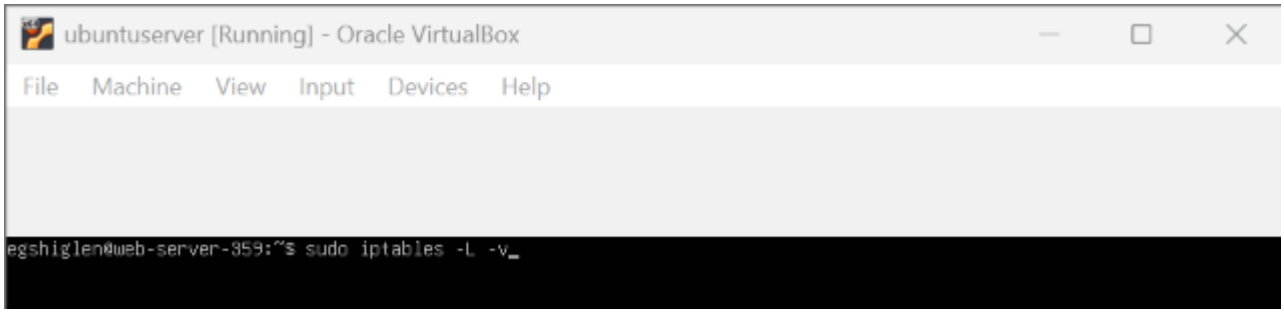
Server Message Block is at the heart of Common Internet File System(CIFS) and a communication protocol to share files, print shares, serial ports. It allows applications and users to read, write, and request from files, printers, and other network devices in Windows-based environment. The protocol allows for file sharing, printer sharing, named pipes, and authentication. *(Source:* (Wikipedia)*)*

Examples of Samba usage:

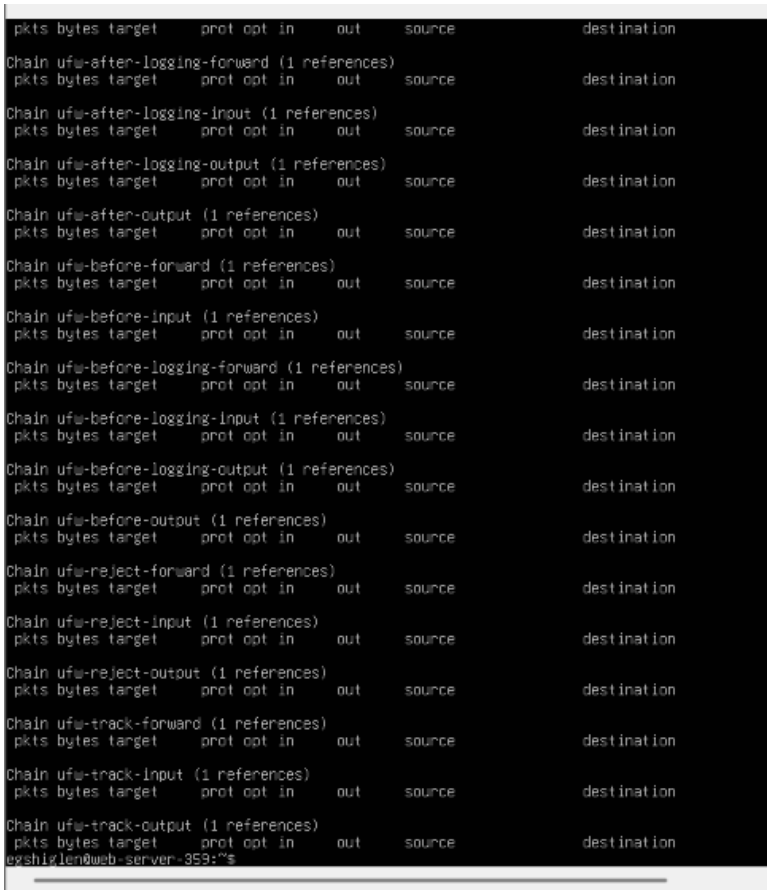
- DCC can use Samba if they continue to use Linux and the students can have Windows system. Samba can be used to share and transfer files like we did in this task and send files to remote printers to Windows system. *(Source:* (Hertel)*)*
- It's a mixed environment of Linux and Windows machine, so users(teachers and students) can access a shared folder on Linux server *(Source:* (Hertel)*)*
- It can also be used to back up file from Windows to Linux server using Samba *(Source:* (Hertel)*)*

PART 5: Advanced Linux Security and System Administration

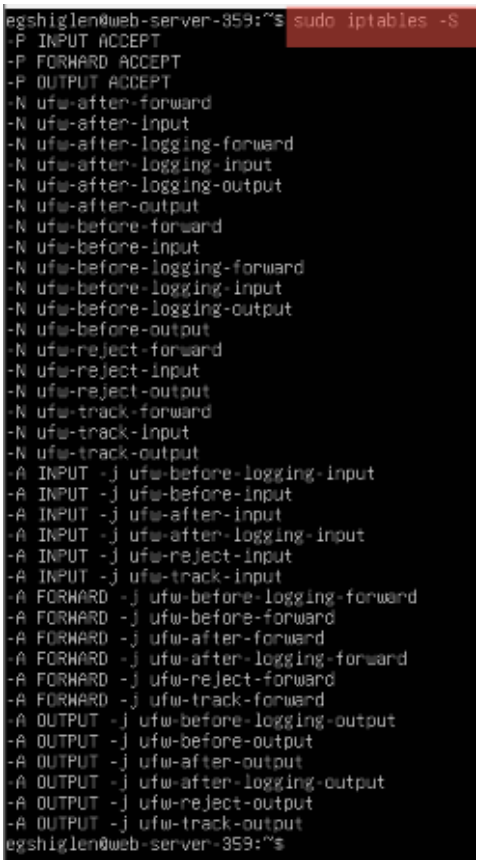
Part 5A: Security Configuration #2:



Note: Enlisting the current firewall rules in iptables



Note: List of current firewall rules in iptables

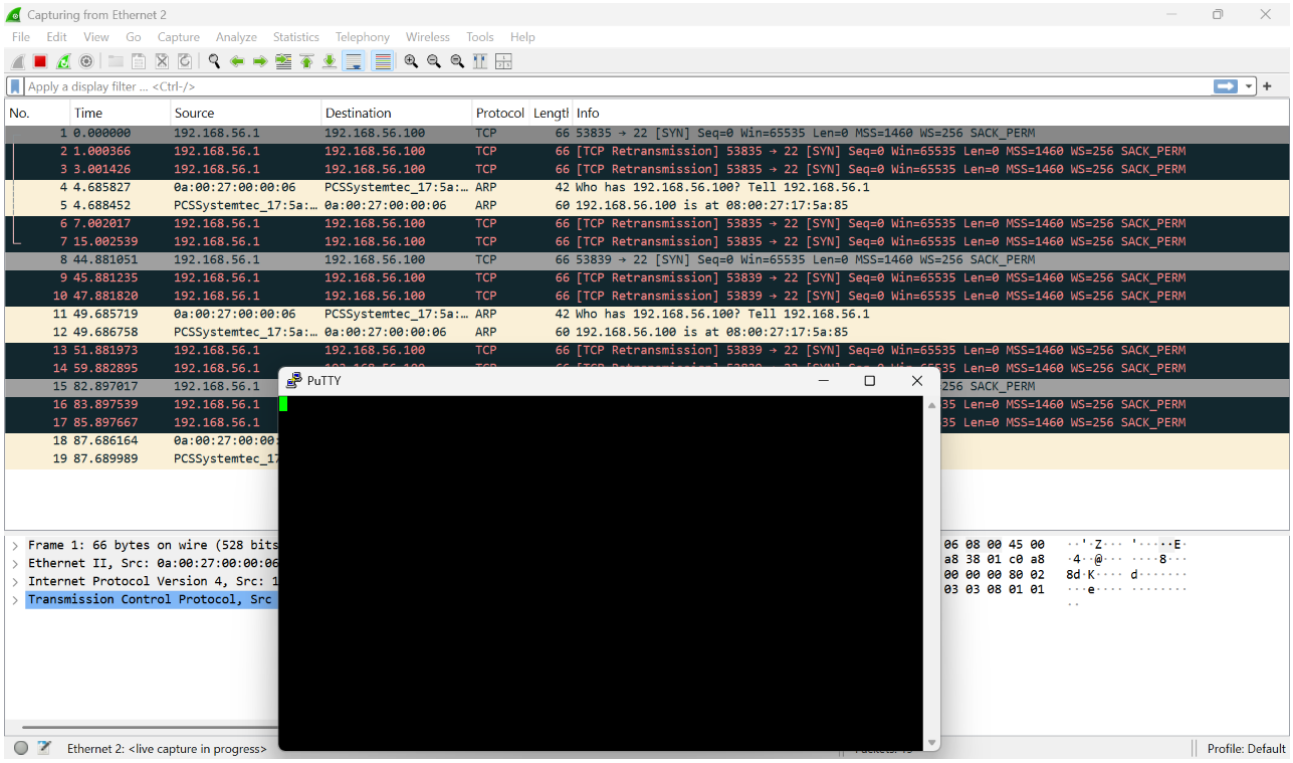


Note: All the rules applied in iptables

- ***Block and Allow SSH traffic using iptables***

```
egshiglen@web-server-359:~$ sudo iptables -A INPUT -p tcp --dport 22 -j DROP
egshiglen@web-server-359:~$ sudo iptables -S
-P INPUT ACCEPT
-P FORWARD ACCEPT
-P OUTPUT ACCEPT
-N ufw-after-forward
-N ufw-after-input
-N ufw-after-logging-forward
-N ufw-after-logging-input
-N ufw-after-logging-output
-N ufw-after-output
-N ufw-before-forward
-N ufw-before-input
-N ufw-before-logging-forward
-N ufw-before-logging-input
-N ufw-before-logging-output
-N ufw-before-output
-N ufw-reject-forward
-N ufw-reject-input
-N ufw-reject-output
-N ufw-track-forward
-N ufw-track-input
-N ufw-track-output
-A INPUT -j ufw-before-logging-input
-A INPUT -j ufw-before-input
-A INPUT -j ufw-after-input
-A INPUT -j ufw-after-logging-input
-A INPUT -j ufw-reject-input
-A INPUT -j ufw-track-input
-A INPUT -p tcp -m tcp --dport 22 -j DROP
-A FORWARD -j ufw-before-logging-forward
-A FORWARD -j ufw-before-forward
```

Notes: Blocking SSH Traffic using iptables



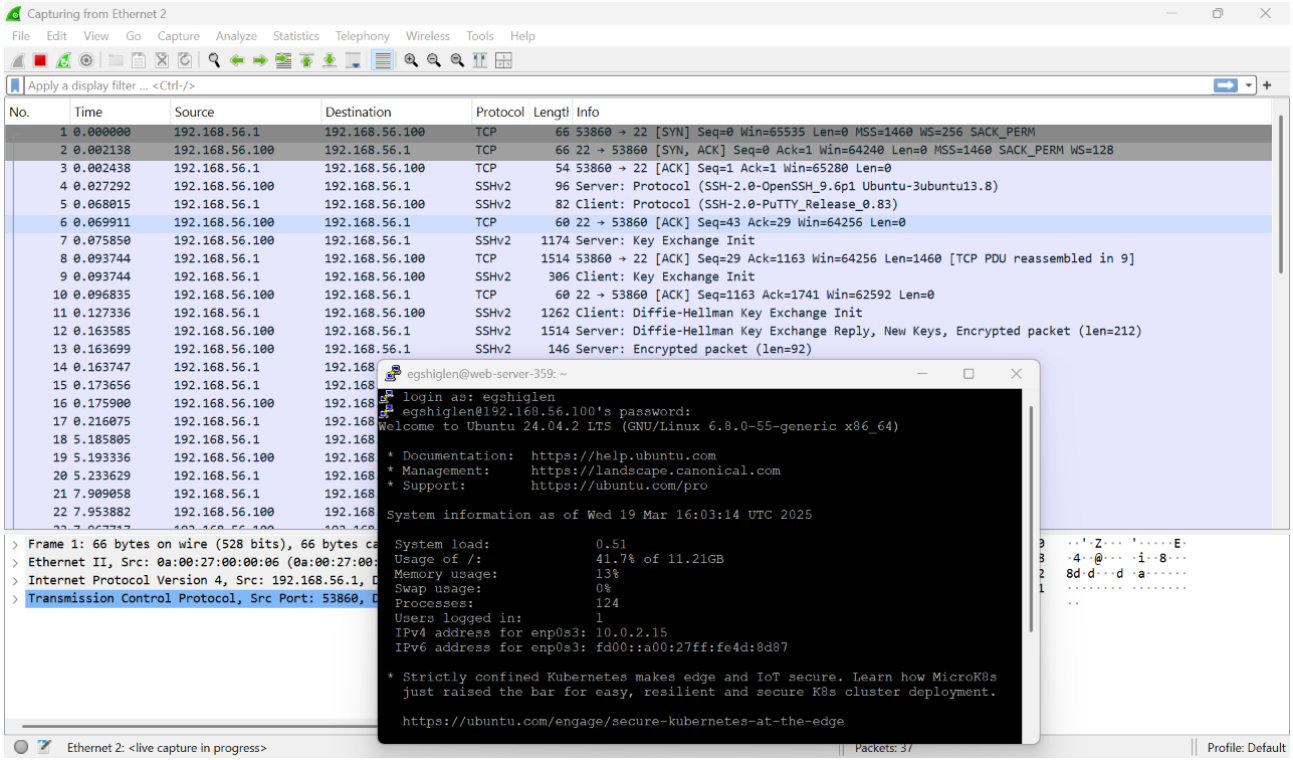
Note: The result of blocked SSH traffic after the block rule

```
egshiglen@web-server-359:~$ sudo iptables -D INPUT -p tcp --dport 22 -j DROP
egshiglen@web-server-359:~$ _
```

Note: Deleting the block rule of SSH traffic to add new rule

```
egshiglen@web-server-359:~$ sudo iptables -A INPUT -p tcp --dport 22 -j ACCEPT
egshiglen@web-server-359:~$ sudo iptables -S
-P INPUT ACCEPT
-P FORWARD ACCEPT
-P OUTPUT ACCEPT
-N ufw-after-forward
-N ufw-after-input
-N ufw-after-logging-forward
-N ufw-after-logging-input
-N ufw-after-logging-output
-N ufw-after-output
-N ufw-before-forward
-N ufw-before-input
-N ufw-before-logging-forward
-N ufw-before-logging-input
-N ufw-before-logging-output
-N ufw-before-output
-N ufw-reject-forward
-N ufw-reject-input
-N ufw-reject-output
-N ufw-track-forward
-N ufw-track-input
-N ufw-track-output
-A INPUT -j ufw-before-logging-input
-A INPUT -j ufw-before-input
-A INPUT -j ufw-after-input
-A INPUT -j ufw-after-logging-input
-A INPUT -j ufw-reject-input
-A INPUT -j ufw-track-input
-A INPUT -p tcp -m tcp --dport 22 -j ACCEPT
-A FORWARD -j ufw-before-logging-forward
-A FORWARD -j ufw-before-forward
```

Note: Adding allow rule to enable SSH traffic using iptables



Note: The result of enabled SSH traffic after the allow rule

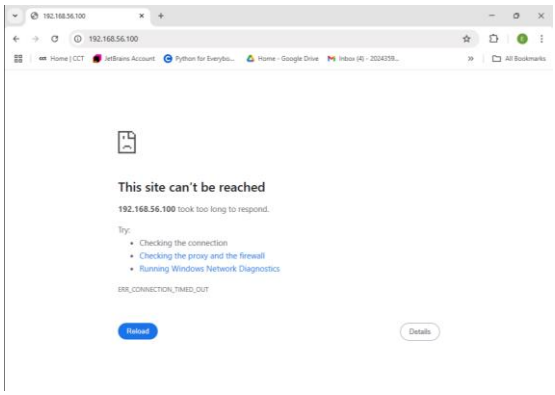
```
egshiglen@web-server-359:~$ sudo iptables -D INPUT -p tcp --dport 22 -j ACCEPT
egshiglen@web-server-359:~$ sudo iptables -S
-P INPUT ACCEPT
```

Note: Deleting the enable rule for SSH traffic

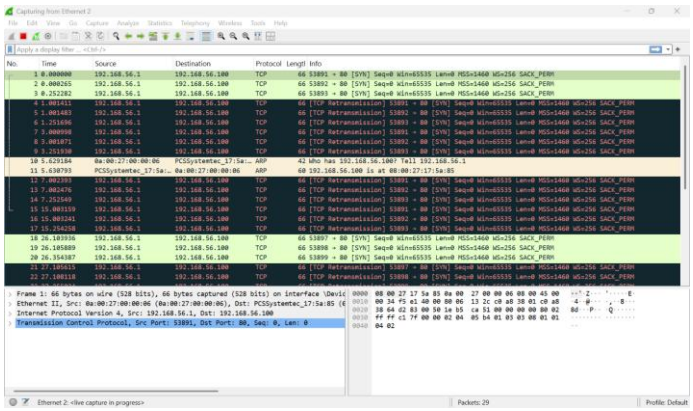
- ***Block and Allow HTTP traffic using iptables***

```
egshiglen@web-server-359:~$ sudo iptables -A INPUT -p tcp --dport 80 -j DROP
egshiglen@web-server-359:~$ sudo iptables -S
-P INPUT ACCEPT
-P FORWARD ACCEPT
-P OUTPUT ACCEPT
-N ufw-after-forward
-N ufw-after-input
-N ufw-after-logging-forward
-N ufw-after-logging-input
-N ufw-after-logging-output
-N ufw-after-output
-N ufw-before-forward
-N ufw-before-input
-N ufw-before-logging-forward
-N ufw-before-logging-input
-N ufw-before-logging-output
-N ufw-before-output
-N ufw-reject-forward
-N ufw-reject-input
-N ufw-reject-output
-N ufw-track-forward
-N ufw-track-input
-N ufw-track-output
-A INPUT -j ufw-before-logging-input
-A INPUT -j ufw-before-input
-A INPUT -j ufw-after-input
-A INPUT -j ufw-after-logging-input
-A INPUT -j ufw-reject-input
-A INPUT -j ufw-track-input
-A INPUT -p tcp -m tcp --dport 80 -j DROP
-A FORWARD -j ufw-before-logging-forward
-A FORWARD -j ufw-before-forward
```

Note: Adding a new rule to block the HTTP traffic



Note: Checking if the chrome browser is working when the firewall is blocked through iptables



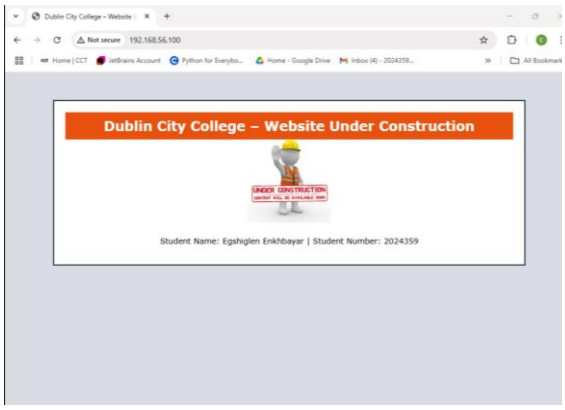
Note: Using Wireshark to prove the HTTP traffic is blocked through iptables

```
egshiglen@web-server-359:~$ sudo iptables -D INPUT -p tcp --dport 80 -j DROP
egshiglen@web-server-359:~$ sudo iptables -S
```

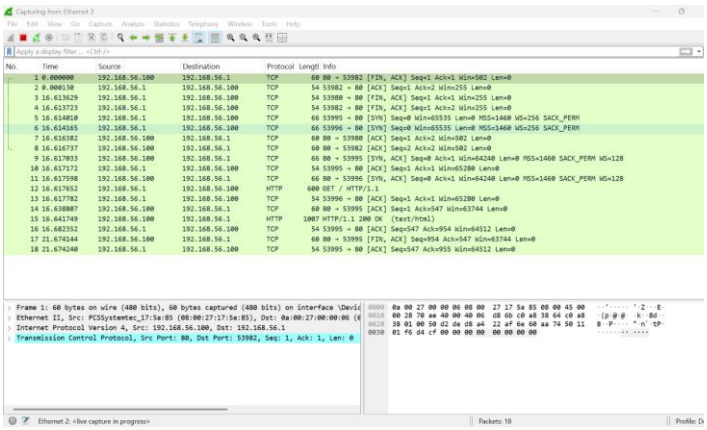
Note: Deleting the block rule of HTTP traffic to add new rule

```
egshiglen0web-server-359:~$ sudo iptables -A INPUT -p tcp --dport 80 -j ACCEPT
egshiglen0web-server-359:~$ sudo iptables -S
-P INPUT ACCEPT
-P FORWARD ACCEPT
-P OUTPUT ACCEPT
-N ufw-after-forward
-N ufw-after-input
-N ufw-after-logging-forward
-N ufw-after-logging-input
-N ufw-after-logging-output
-N ufw-after-output
-N ufw-before-forward
-N ufw-before-input
-N ufw-before-logging-forward
-N ufw-before-logging-input
-N ufw-before-logging-output
-N ufw-before-output
-N ufw-reject-forward
-N ufw-reject-input
-N ufw-reject-output
-N ufw-track-forward
-N ufw-track-input
-N ufw-track-output
-A INPUT -j ufw-before-logging-input
-A INPUT -j ufw-before-input
-A INPUT -j ufw-after-input
-A INPUT -j ufw-after-logging-input
-A INPUT -j ufw-reject-input
-A INPUT -j ufw-track-input
-A INPUT -p tcp -m tcp --dport 80 -j ACCEPT
-A FORWARD -j ufw-before-logging-forward
-A FORWARD -j ufw-before-forward
```

Note: Adding a new rule to enable the HTTP traffic



Note: Checking if the chrome browser is working when the firewall is enabled through iptables



Note: Using Wireshark to prove the HTTP traffic is enabled through iptables

```
egshiglen0web-server-359:~$ sudo iptables -D INPUT -p tcp --dport 80 -j ACCEPT
egshiglen0web-server-359:~$ sudo iptables -S
```

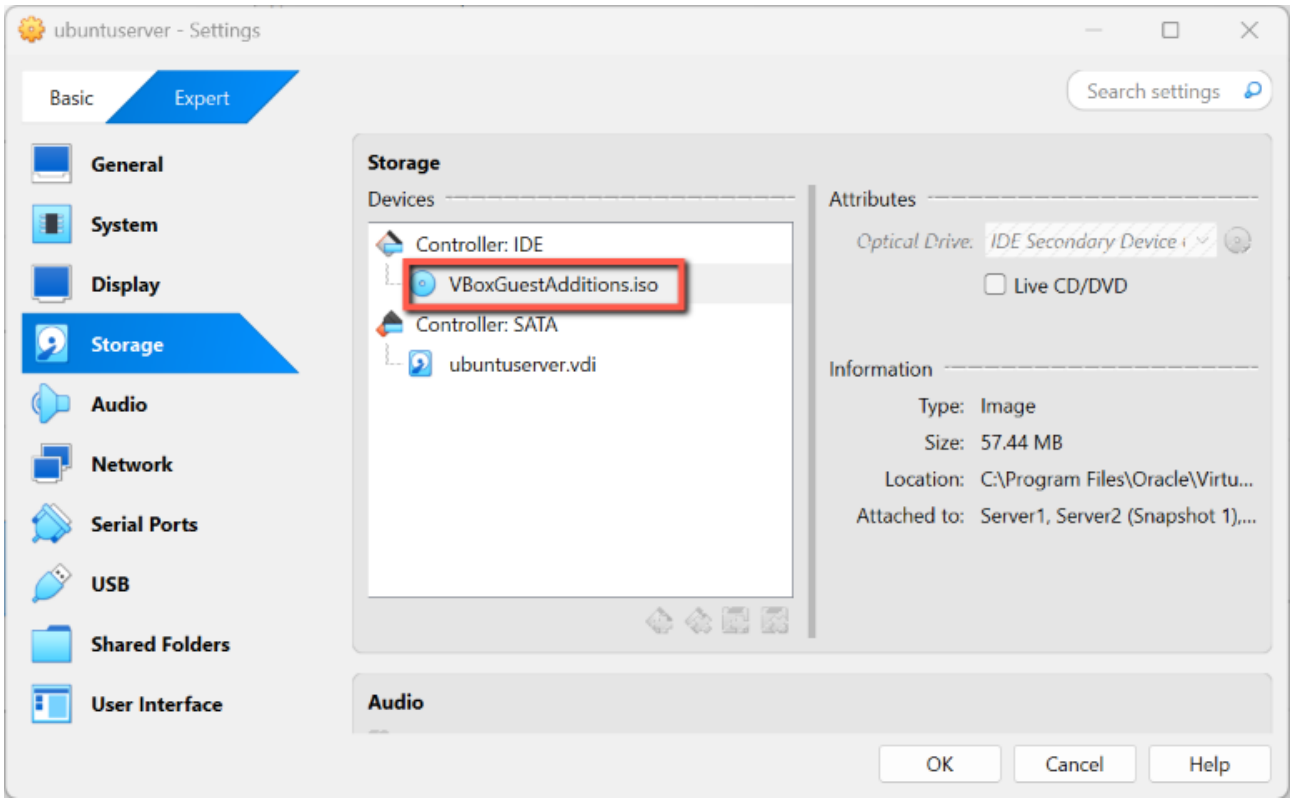
Note: Deleting the enable rule for HTTP traffic

Note: To do this first challenge using iptables to block and allow SSH and HTTP traffic DigitalOcean's (DigitalOcean) *tutorial is used.*

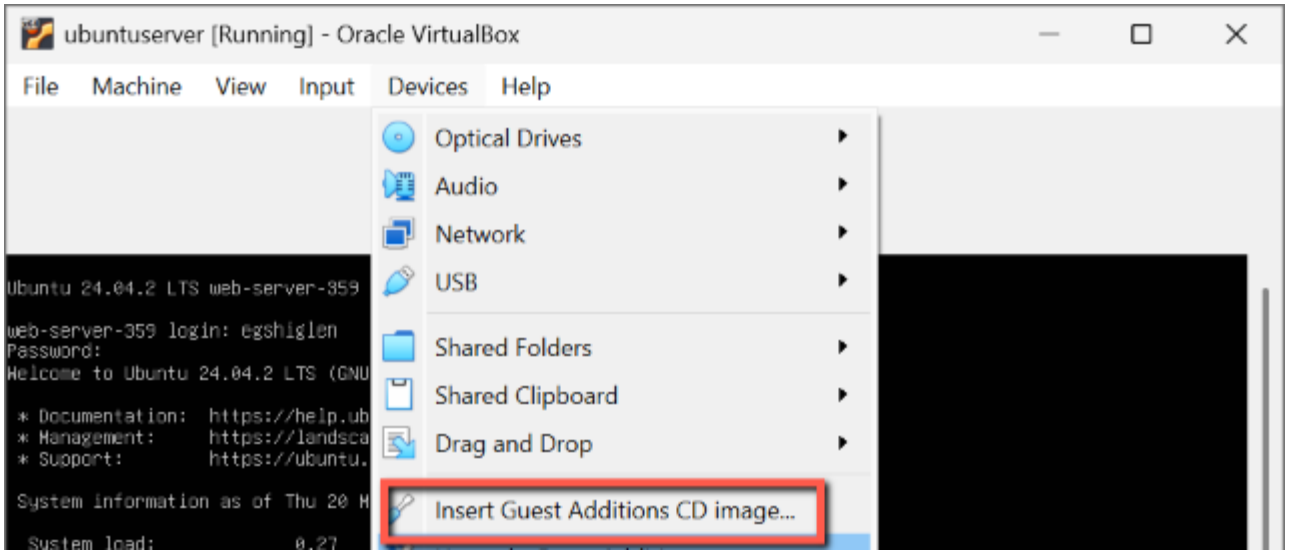
Part 5B: VirtualBox Guest Additions & Linux Desktop Configuration

Note: To achieve this task, the VirtualBox's manual document Chapter 4: Guest Additions section is used. (Source: (Manual)*)*

- ***Accessing and Inserting the Virtual CD drive for guest additions***



Note: The Guest additions CD drive is mounted on the ubuntuserver machine



Note: Inserting the VirtualBox Guest Additions CD

- ***Installation of Guest Additions (Source: (Galazka, 2024))***

```
egshiglen@web-server-359:~$ sudo apt update
[sudo] password for egshiglen:
Hit:1 http://ie.archive.ubuntu.com/ubuntu noble InRelease
Hit:2 http://ie.archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:3 http://ie.archive.ubuntu.com/ubuntu noble-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu noble-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
5 packages can be upgraded. Run 'apt list --upgradable' to see them.
egshiglen@web-server-359:~$ sudo apt install build-essential dkms linux-headers-$(uname -r)
```

Note: Installing build tools and kernel headers to compile kernel modules

```
Setting up libatomic1:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libdpkg-perl (1.22.6ubuntu6.1) ...
Setting up libubsan1:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libhwasan0:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libasan8:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libtsan2:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libbinutils:amd64 (2.42-4ubuntu2.4) ...
Setting up libisl23:amd64 (0.26-3build1.1) ...
Setting up libalgorithm-diff-xs-perl:amd64 (0.04-0build3) ...
Setting up libcc1-0:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up liblsan0:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libitm1:amd64 (14.2.0-4ubuntu2~24.04) ...
Setting up libalgorithm-merge-perl (0.08-5) ...
Setting up libctf0:amd64 (2.42-4ubuntu2.4) ...
Setting up cpp-13-x86-64-linux-gnu (13.3.0-6ubuntu2~24.04) ...
Setting up libgprofng0:amd64 (2.42-4ubuntu2.4) ...
Setting up libgcc-13-dev:amd64 (13.3.0-6ubuntu2~24.04) ...
Setting up libstdc++-13-dev:amd64 (13.3.0-6ubuntu2~24.04) ...
Setting up binutils-x86-64-linux-gnu (2.42-4ubuntu2.4) ...
Setting up cpp-x86-64-linux-gnu (4:13.2.0-7ubuntu1) ...
Setting up cpp-13 (13.3.0-6ubuntu2~24.04) ...
Setting up gcc-13-x86-64-linux-gnu (13.3.0-6ubuntu2~24.04) ...
Setting up binutils (2.42-4ubuntu2.4) ...
Setting up dpkg-dev (1.22.6ubuntu6.1) ...
Setting up gcc-13 (13.3.0-6ubuntu2~24.04) ...
Setting up cpp (4:13.2.0-7ubuntu1) ...
Setting up g++-13-x86-64-linux-gnu (13.3.0-6ubuntu2~24.04) ...
Setting up gcc-x86-64-linux-gnu (4:13.2.0-7ubuntu1) ...
Setting up gcc (4:13.2.0-7ubuntu1) ...
Setting up dkms (3.0.11-1ubuntu13) ...
Setting up g++-x86-64-linux-gnu (4:13.2.0-7ubuntu1) ...
Setting up g++-13 (13.3.0-6ubuntu2~24.04) ...
Setting up g++ (4:13.2.0-7ubuntu1) ...
update-alternatives: using /usr/bin/g++ to provide /usr/bin/c++ (c++) in auto mode
Setting up build-essential (12.10ubuntu1) ...
Processing triggers for man-db (2.12.0-4build2) ...
Processing triggers for libc-bin (2.39-0ubuntu8.4) ...
Scanning processes...
Scanning linux images...

Running kernel seems to be up-to-date.

No services need to be restarted.

No containers need to be restarted.

No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
egshiglen@web-server-359:~$
```

Note: Installation is successful

```
egshiglen@web-server-359:~$ sudo mkdir /mnt/cdrom
egshiglen@web-server-359:~$ sudo mount /dev/cdrom /mnt/cdrom
mount: /mnt/cdrom: WARNING: source write-protected, mounted read-only.
egshiglen@web-server-359:~$ _
```

Note: Creating a new directory to mount the Virtual CD and mounting the Virtual CD Drive

```
egshiglen@web-server-359:~$ cd /mnt/cdrom
egshiglen@web-server-359:/mnt/cdrom$ sudo ./VBoxLinuxAdditions.run
Verifying archive integrity...  100%   MD5 checksums are OK. All good.
Uncompressing VirtualBox 7.1.6 Guest Additions for Linux  100%
VirtualBox Guest Additions installer

VirtualBox Guest Additions: Starting.
VirtualBox Guest Additions: Setting up modules
VirtualBox Guest Additions: Building the VirtualBox Guest Additions kernel
modules.  This may take a while.
VirtualBox Guest Additions: To build modules for other installed kernels, run
VirtualBox Guest Additions:   /sbin/rcvboxadd quicksetup <version>
VirtualBox Guest Additions: or
VirtualBox Guest Additions:   /sbin/rcvboxadd quicksetup all
VirtualBox Guest Additions: Building the modules for kernel 6.8.0-55-generic.
update-initramfs: Generating /boot/initrd.img-6.8.0-55-generic
VirtualBox Guest Additions: Running kernel modules will not be replaced until
the system is restarted or 'rcvboxadd reload' triggered
VirtualBox Guest Additions: reloading kernel modules and services
VirtualBox Guest Additions: kernel modules and services 7.1.6 r167084 reloaded
VirtualBox Guest Additions: NOTE: you may still consider to re-login if some
user session specific services (Shared Clipboard, Drag and Drop, Seamless or
Guest Screen Resize) were not restarted automatically
egshiglen@web-server-359:/mnt/cdrom$ cd
egshiglen@web-server-359:~$ sudo reboot_
```

Note: Running the Guest Additions installer

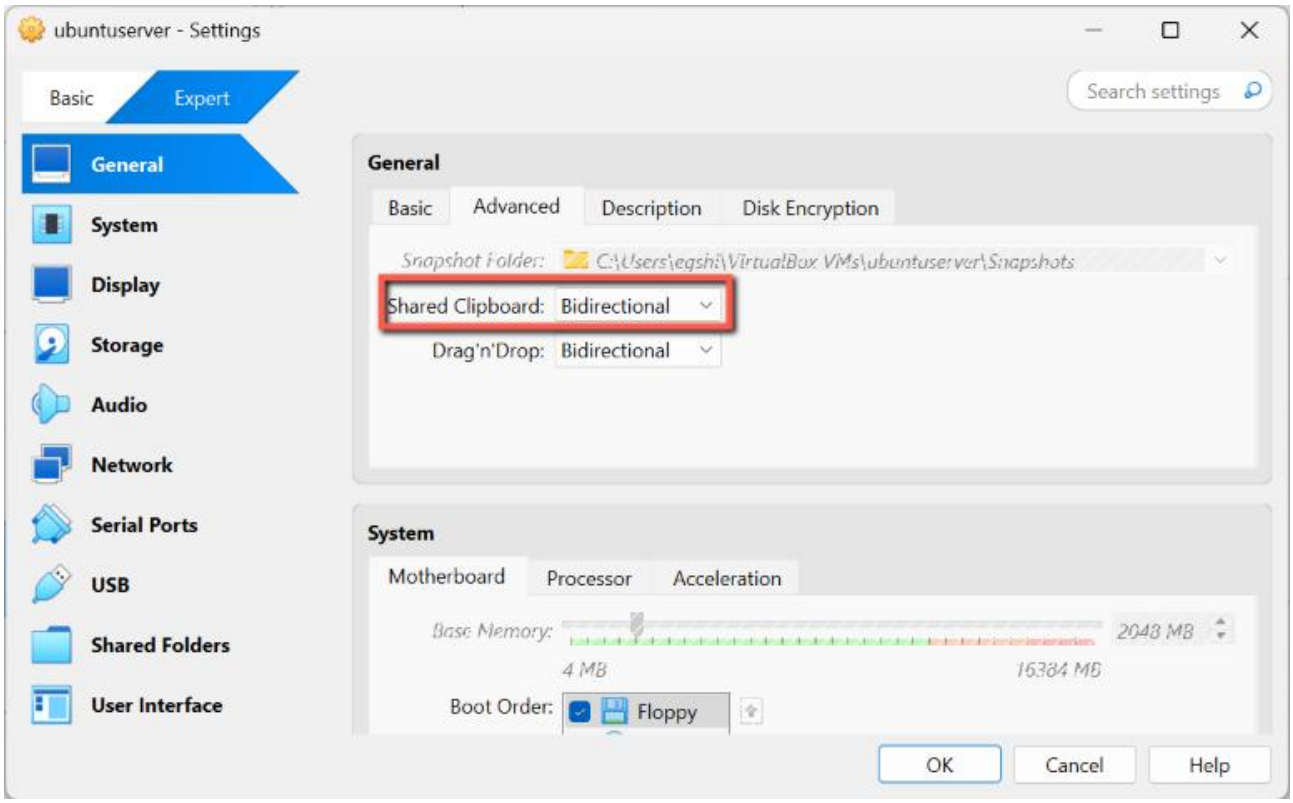
```
egshiglen@web-server-359:~$ VBoxService --version
7.1.6r167084
egshiglen@web-server-359:~$
```

Note: Verifying installation and it's successful

```
egshiglen@web-server-359:~$ lsmod | grep vbox
vboxsf                  98304  0
vboxguest              499712  3 vboxsf
vboxvideo               53248  0
vboxnetadp              28672  0
vboxnetflt              32768  0
vboxdrv                 696320  2 vboxnetadp,vboxnetflt
drm_ttm_helper          12288  2 vmwgfx,vboxvideo
ttm                    110592  3 vmwgfx,vboxvideo,drm_ttm_helper
egshiglen@web-server-359:~$ which VBoxClient
/usr/bin/VBoxClient
egshiglen@web-server-359:~$ ps aux | grep vbox
root        1075  0.0  0.0      0     0 ?        S    12:28   0:00 [iprt-VBoxTscThread]
root        7569  0.3  0.1 218472  2304 ?        Sl   12:29   0:02 /usr/bin/VBoxDRMClient
root        7571  0.1  0.1 355732  3720 ?        Sl   12:29   0:01 /usr/sbin/VBoxService --pidfile /var/run/vboxadd-service.sh
egshigl+    8078 50.0  0.0    640   128 tty1     R+   12:43   0:00 grep --color=auto vbox
egshiglen@web-server-359:~$
```

Note: Verifying VirtualBox Kernel Modules Loaded using lsmod | grep vbox and VirtualBox Guest Additions Services running using ps aux | grep vbox

➢ ***Configuring Bidirectional Shared Clipboard***



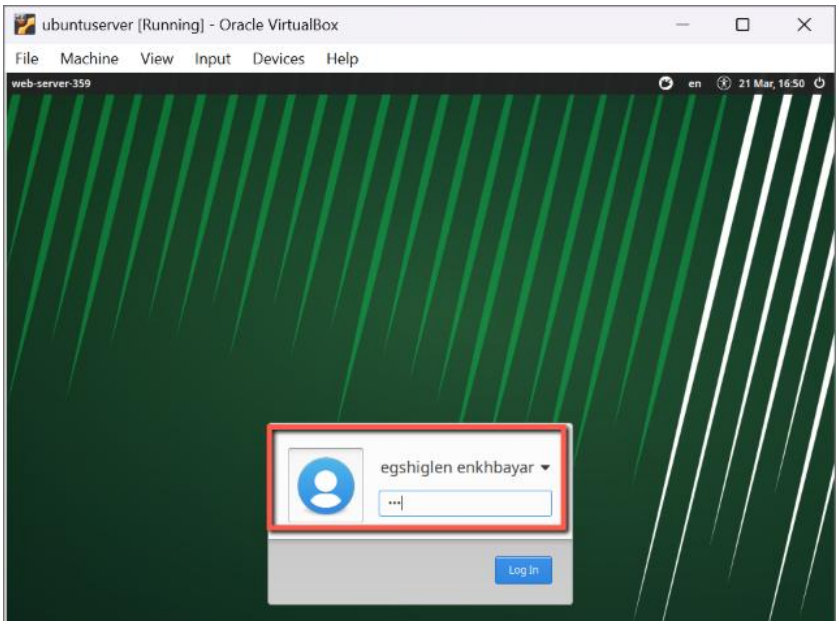
Note: Setting the ubuntuserver's shared clipboard feature to bidirectional which means it can share clipboards from host to guest or guest to host

Note: With only CLI based Linux environment, the shared clipboard doesn't seem be to working as you can see the cutbuffer was always empty if copying a text from the Windows host machine

Note: It was stated by many users on internet that they have the same problem so I decided to install xubuntu desktop version. (Source: (Superuser)*)*

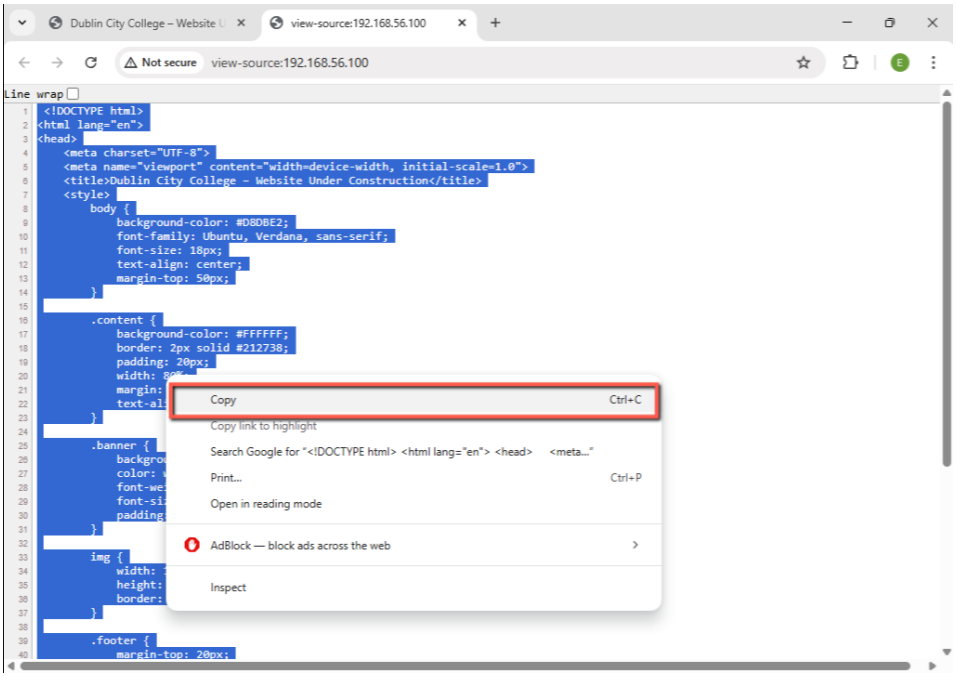
- ***Installation of Xubuntu desktop version***

Note: Installing xubuntu desktop version which uses x11 by default. X11 package is required to use shared clipboard (Saive)

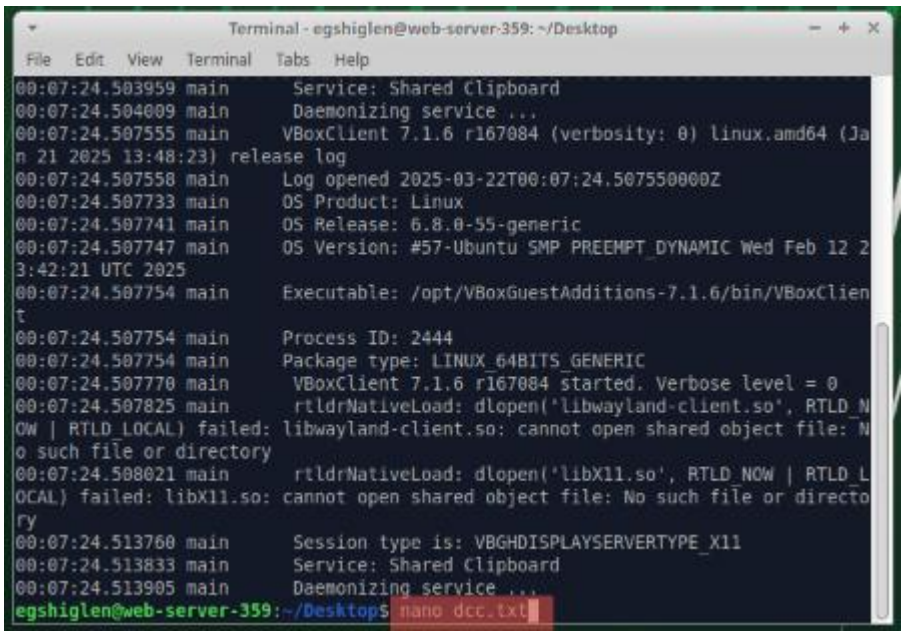


Note: Working ubuntuserver with GUI after reboot

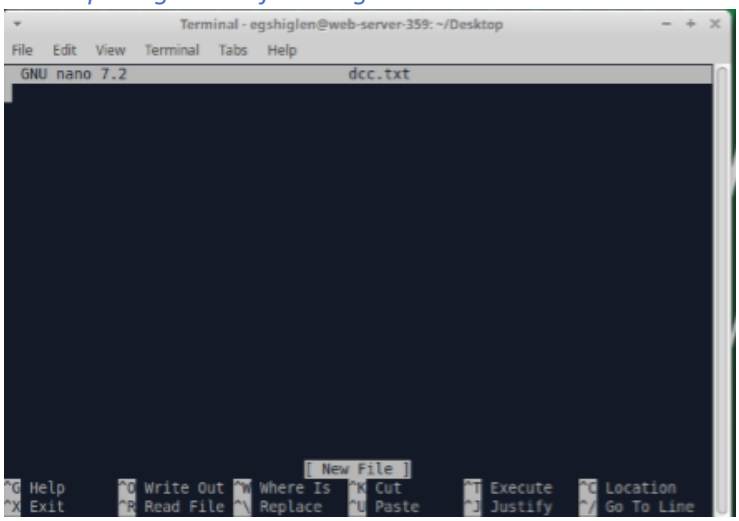
- **Copy-Paste test: From Host to Guest**



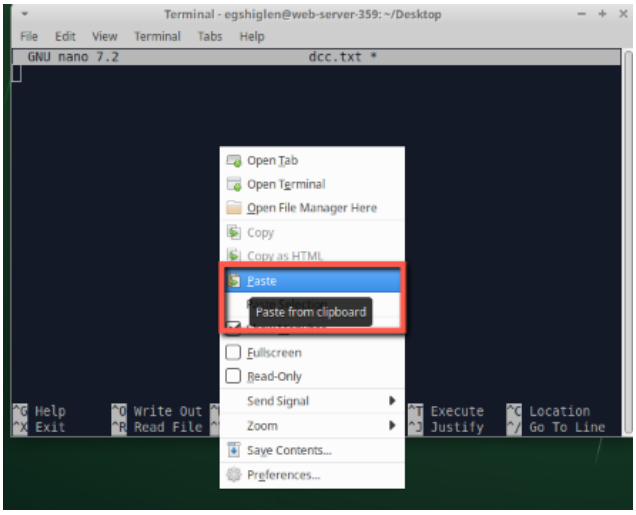
Note: Copying the DCC html code to clipboard from Windows host computer



Note: Opening dcc.txt file using nano on ubuntuserver machine



Note: Empty file on dcc.txt file



Note: Pasting from clipboard to ubuntuserver using nano dcc.txt

ubuntuserver [Running] - Oracle VirtualBox

File Machine View Input Devices Help

Terminal - egshiglen@web-s...

Terminal - egshiglen@web-server-359: ~/Desktop

File Edit View Terminal Tabs Help

GNU nano 7.2 dcc.txt *

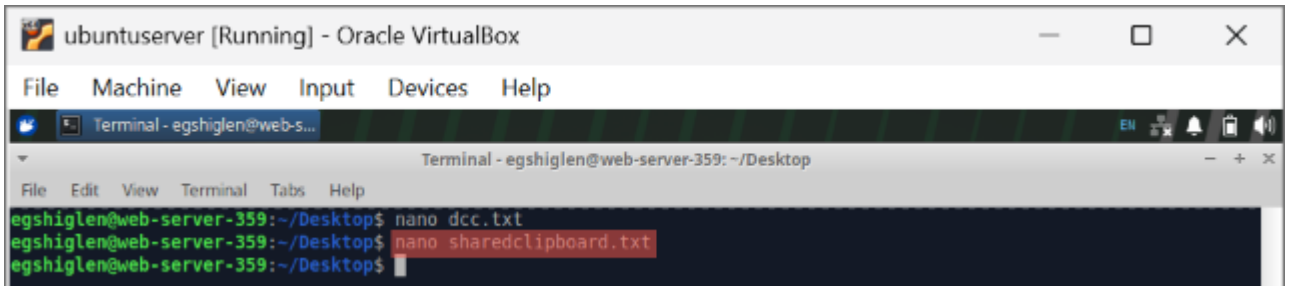
```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Dublin City College – Website Under Construction</title>
    <style>
        body {
            background-color: #D8DBE2;
            font-family: Ubuntu, Verdana, sans-serif;
            font-size: 18px;
            text-align: center;
            margin-top: 50px;
        }

        .content {
            background-color: #FFFFFF;
            border: 2px solid #212738;
            padding: 20px;
            width: 80%;
            margin: 0 auto;
            text-align: center;
        }

        .banner {
            background-color: #E9510E;
            color: white;
            font-weight: bold;
            font-size: 24px;
            padding: 10px;
        }

        img {
            width: 150px;
            height: 150px;
            border: 0;
        }

        .footer {
            margin-top: 20px;
            font-size: 14px;
        }
    </style>
</head>
<body>

    <div class="content">
        <div class="banner">
            Dublin City College – Website Under Construction
        </div>
```

^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location M-U Undo
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^/ Go To Line M-E Redo

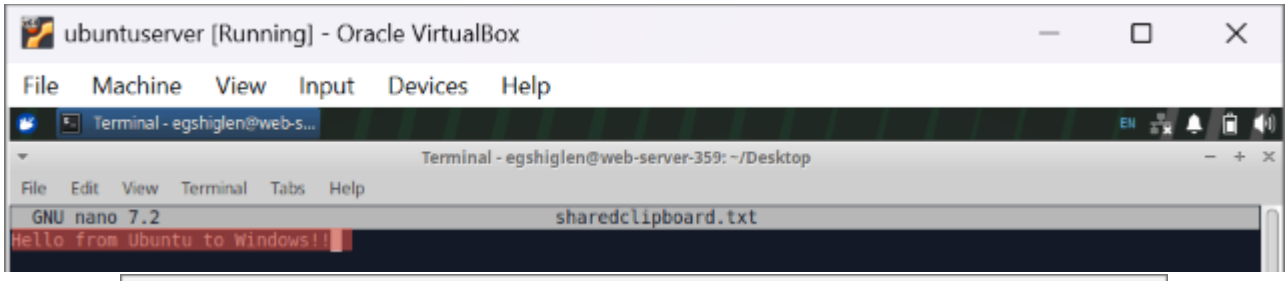
Right Ctrl

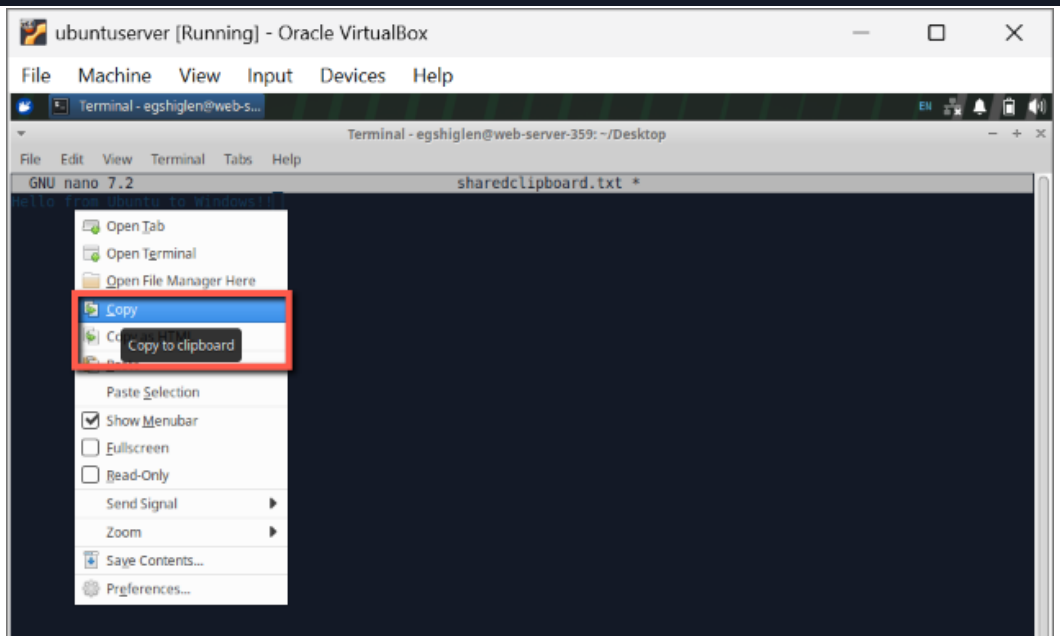
Note: Proof of the copied and pasted text on ubuntu

- **Copy-Paste test: From Guest to Host**

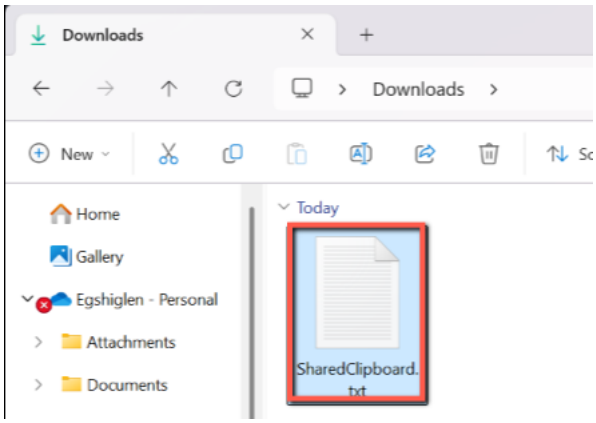


Note: Opening sharedclipboard.txt to copy the text inside

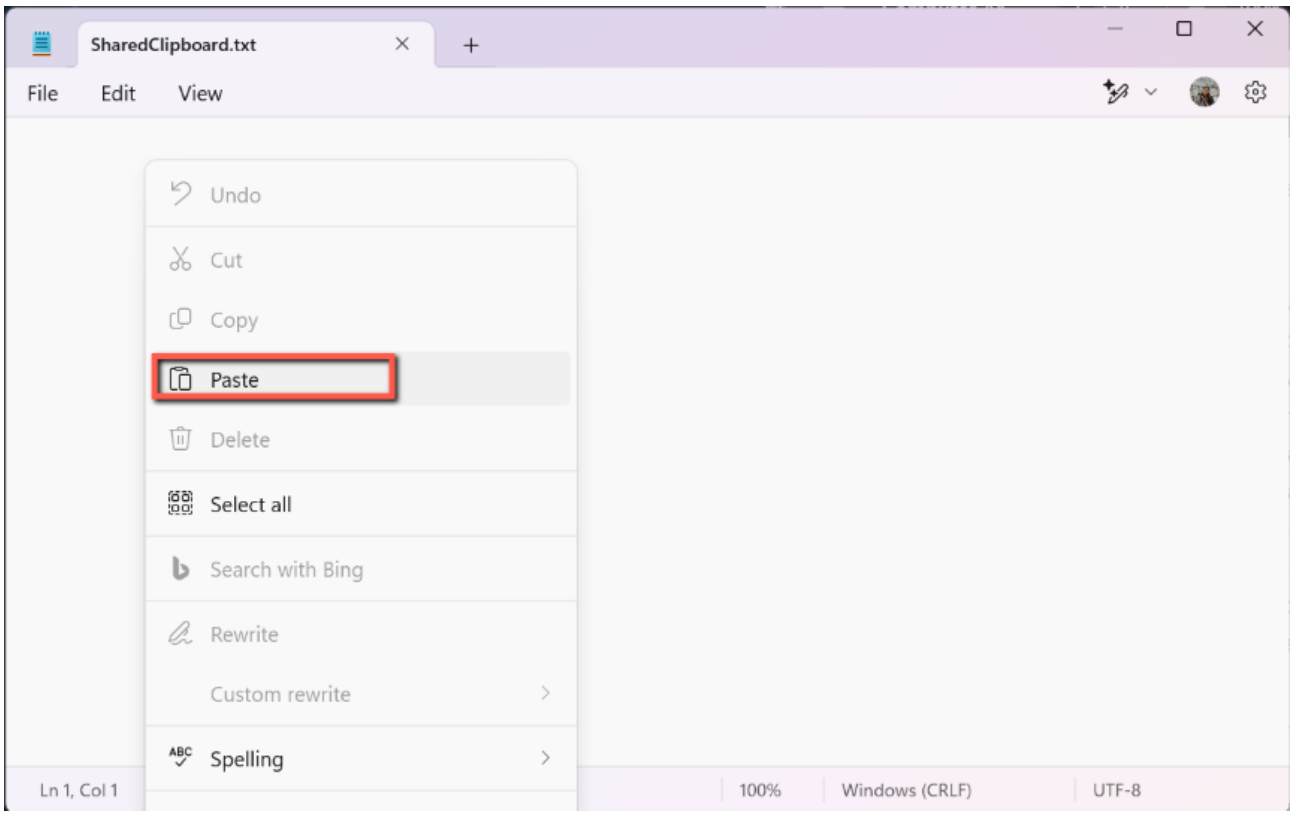




Note: Copying Hello from Ubuntu to Windows!! Text to clipboard



Note: Creating a new text file on Windows host



Note: Pasting from the clipboard to test text file on Windows host

Note: Successfully pasted from the clipboard on Windows host machine

Part 5C: Comparative Study – Linux vs Windows Boot Process

- ***Windows Booting Process (Source: (Ferdous & Majumder, 2018))***

Windows booting process has user-friendly features compared to Linux. There are four steps to start the booting.

1. BIOS initialization. When turning on the computer, BIOS starts.

2. Inventory and critical step - POST(Power on Self-Test). Here the hardware configuration and detection performs.

3. BIOS looks for Booting priority that stored in the booting process and called MBR(Master Boot Record)

4. Kernel Loading. The OS loads KERNEL into main memory, finding NTLDR (NT loader) which loads the partitions and try to identify other partitions in the computer system. Also boot.inf file check the partitions and win.sys, NTOSKERNEL.exe etc other files are supported, installed for the application oriented environment.

- ***Linux Booting Process (Source: (Ferdous & Majumder, 2018))***

Linux Booting Process is quite different from Windows. BIOS and MBR features has 4 basic steps during the booting.

1. MBR and Bootloader Execution. In MBR, floppy, bootable compact disk, of flash drive is stored, GRUB (Grand Unified Boot Loader) or LiLo (Linux loader) try to load the OS feature form.

2. Initial RAM Disk(initrd/initramfs) loading

3. Kernel initialization and file system mounting

4. System initialization and user environment setup

Stage	Windows	Linux
Firmware	BIOS/UEFI	BIOS/UEFI
Bootloader	Windows Boot Manager (BCD)	GRUB(grub.cfg) or alternative
Kernel Load	Winload.exe -> ntoskrnl.exe	Kernel(vmlinuz) + initramfs
Init System	smss.exe, services.exe	systemd, SysVinit, OpenRC
GUI	explorer.exe	Display Manager (GDM)
Configurability	Limited (BCD, registry)	High (GRUB, init scripts)

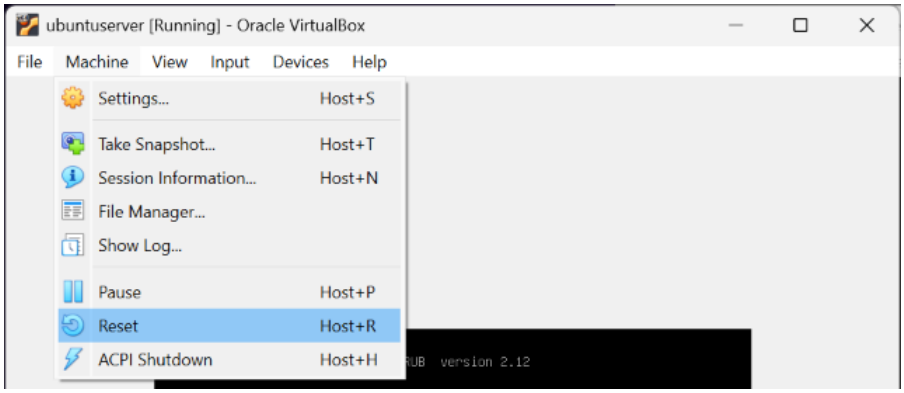
Note: Comparative Table of Booting Features of Linux and Windows OS (Source: (Bisht, 2025)*)*

PART 5D: Forgotten password

- ***Reset password on Linux (ubuntuserver VM)***

Note: To reset password on Linux ubuntu, cyberpanel.net's guide has been used. ((Cyberpanel, 2024) *This guide suggests several methods and in this task method 1 – Ubuntu Password Reset in Recovery Mode has been used.*

Access the GRUB menu

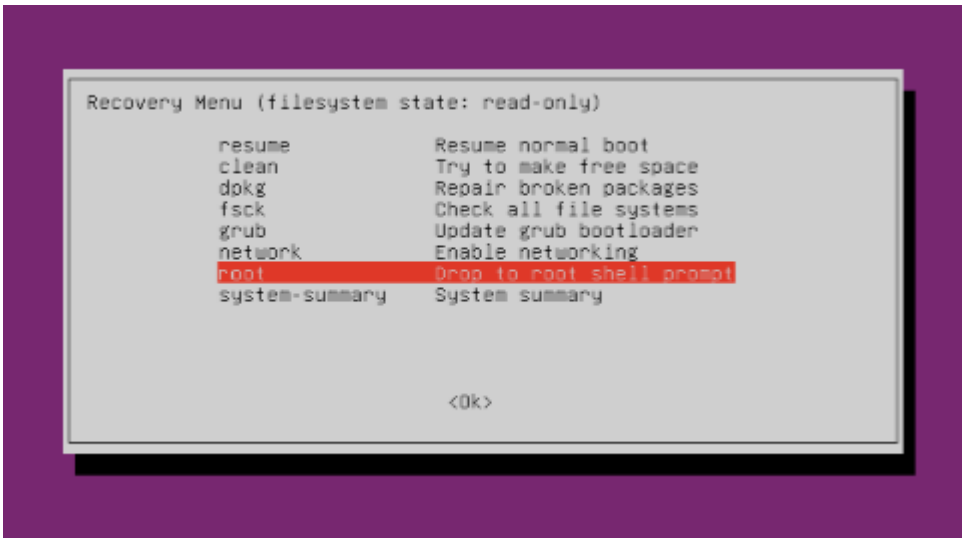


Note: Restarting the ubuntuserver while holding down the Shift key to enter the GRUB menu

Note: Opening Advanced options for Ubuntu

Note: Going to Recovery mode in Advanced options

Drop into Root Shell Prompt



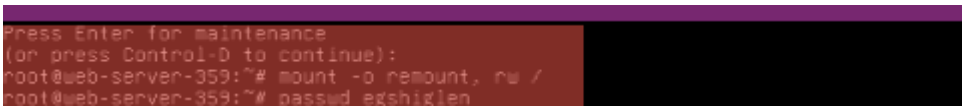
Note: In the recovery mode, choosing the Drop into root shell prompt

Mount Filesystem as Writable

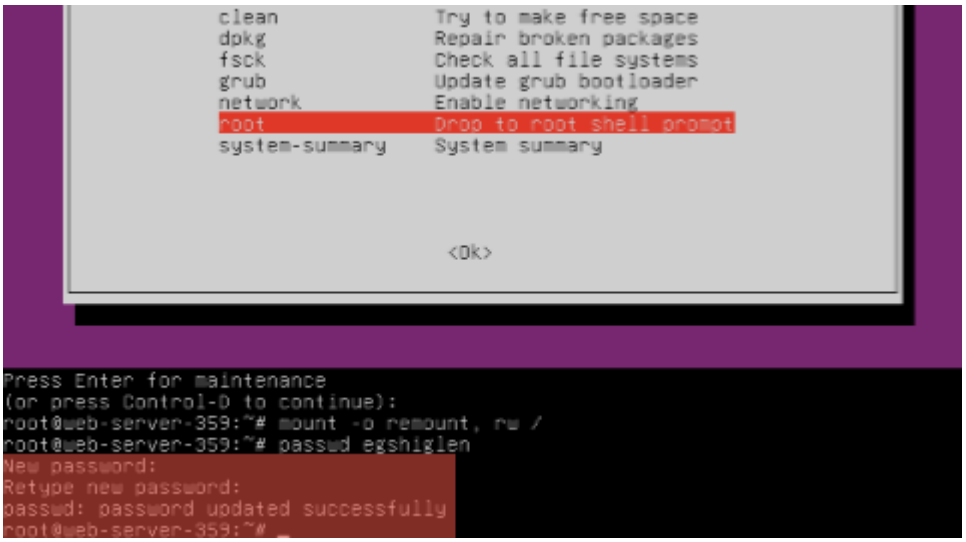
Note: Pressing enter for maintanenc

Note: Since by default filesystem is read-only, mounting it to make writable

Resetting the password



Note: Resetting the Password using passwd username command



Note: Setting the new password for egshiglen (user)

```
Ubuntu 24.04.2 LTS web-server-359 tty1

web-server-359 login: egshiglen
Password:
```

Note: After rebooting the system, entering the new password (new password = new, old password = pppp)

```
  Users logged in:          0
  IPv4 address for enp0s3: 10.0.2.15
  IPv6 address for enp0s3: fd00::a00:27ff:fe4d:0d07

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status


14:31:11.215500 main     VBoxClient 7.1.6 r167084 (verbosity: 0) linux.amd64 (Jan 21 2025 13:40:23) release log
14:31:11.215502 main     Log opened 2025-03-21T14:31:11.215496000Z
14:31:11.217547 main     OS Product: Linux
14:31:11.217579 main     OS Release: 6.8.0-55-generic
14:31:11.217599 main     OS Version: #57-Ubuntu SMP PREEMPT_DYNAMIC Wed Feb 12 23:42:21 UTC 2025
14:31:11.217625 main     Executable: /opt/VBoxGuestAdditions-7.1.6/bin/VBoxClient
14:31:11.217626 main     Process ID: 1345
14:31:11.217627 main     Package type: LINUX_64BITS_GENERIC
14:31:11.217716 main      VBoxClient 7.1.6 r167084 started. Verbose level = 0
14:31:11.217830 main      rtldrNativeLoad: dlopen('libwayland-client.so', RTLD_NOW | RTLD_LOCAL) failed: libwayland-cli
o such file or directory
14:31:11.218075 main      rtldrNativeLoad: dlopen('libX11.so', RTLD_NOW | RTLD_LOCAL) failed: libX11.so: cannot open sh
ry
14:31:11.218510 main      Session type is: VBGHDISPLAYSERVERTYPE_NONE
14:31:11.220174 main      Service: Shared Clipboard
14:31:11.222306 main      Daemonizing service ...
14:31:11.234477 main     VBoxClient 7.1.6 r167084 (verbosity: 0) linux.amd64 (Jan 21 2025 13:40:23) release log
14:31:11.234480 main     Log opened 2025-03-21T14:31:11.234471000Z
14:31:11.235093 main     OS Product: Linux
14:31:11.235297 main     OS Release: 6.8.0-55-generic
14:31:11.235493 main     OS Version: #57-Ubuntu SMP PREEMPT_DYNAMIC Wed Feb 12 23:42:21 UTC 2025
14:31:11.235691 main     Executable: /opt/VBoxGuestAdditions-7.1.6/bin/VBoxClient
14:31:11.235691 main     Process ID: 1349
14:31:11.235692 main     Package type: LINUX_64BITS_GENERIC
14:31:11.236270 main      VBoxClient 7.1.6 r167084 started. Verbose level = 0
14:31:11.236582 main      rtldrNativeLoad: dlopen('libwayland-client.so', RTLD_NOW | RTLD_LOCAL) failed: libwayland-cli
o such file or directory
14:31:11.237231 main      rtldrNativeLoad: dlopen('libX11.so', RTLD_NOW | RTLD_LOCAL) failed: libX11.so: cannot open sh
ry
14:31:11.238019 main      Session type is: VBGHDISPLAYSERVERTYPE_NONE
14:31:11.238240 main      Service: Shared Clipboard
14:31:11.238549 main      Daemonizing service ...
```

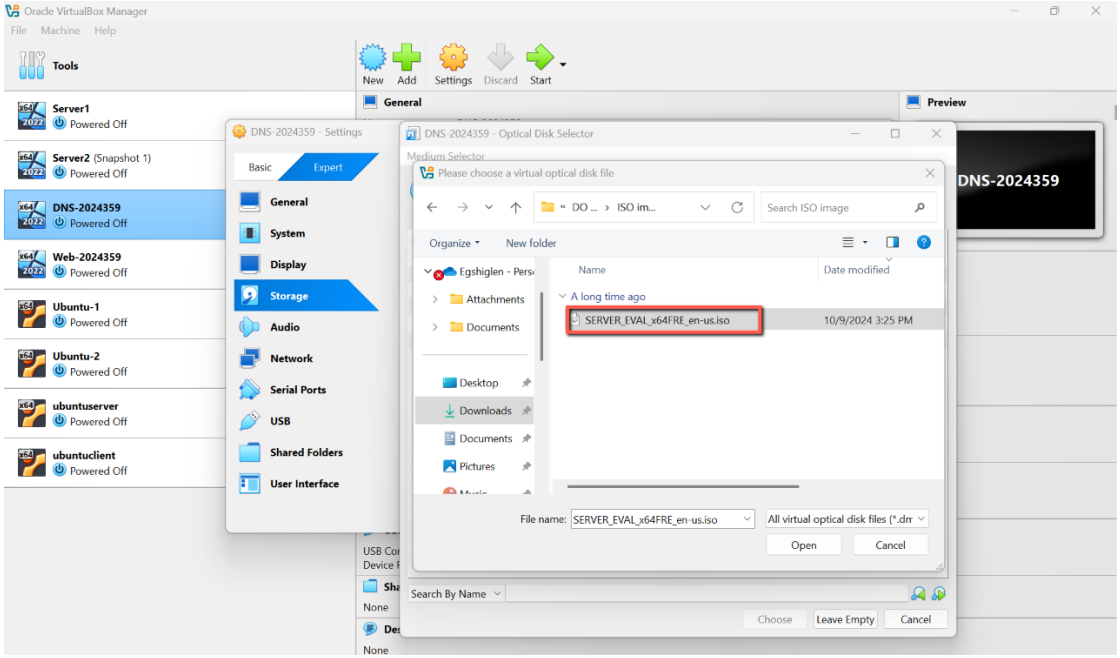
Note: Successfully logged in to ubuntu using the new password

- ***Reset password on Windows (DNS-2024359 VM)***

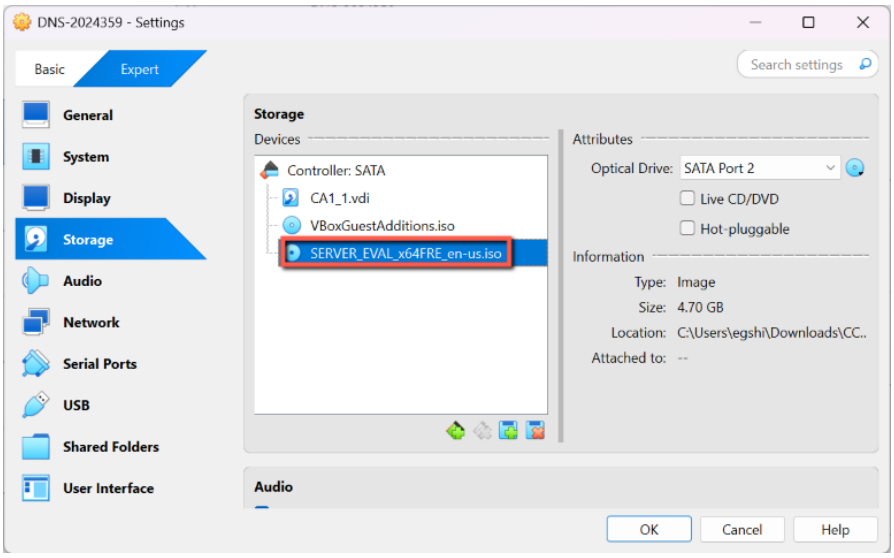
Note: The source used for this configuration is from((Clouvider, 2022)*. This method is to reset Windows Administrator password with Utilman Exploit. Because it uses utilman.exe (Ease of Access Utility Manager).*

Booting from Windows Server 2022 ISO

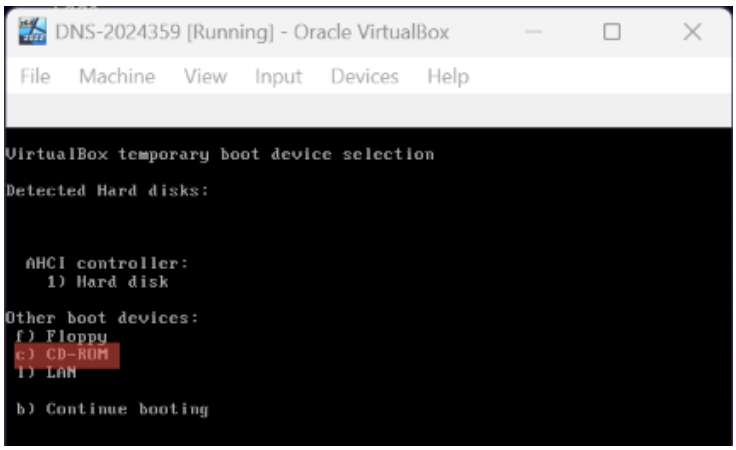
Note: So I've failed many times in this section because the windows ISO wasn't attached. In the first semester I've attached and used it but my mistake was that I moved the location of the ISO image and didn't realize until now. Therefore, I'm reattaching the Windows Server 2022 ISO again to make it successful.



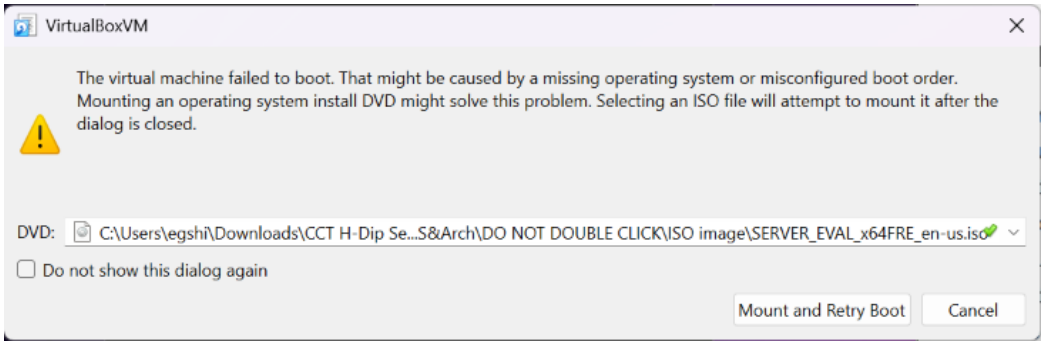
Note: Choosing Windows Server ISO on Storage-Controller SATA (DNS-2024359 (domain controller server) Windows Virtual Machine)



Note: Attaching the Windows Server ISO to the virtual machine

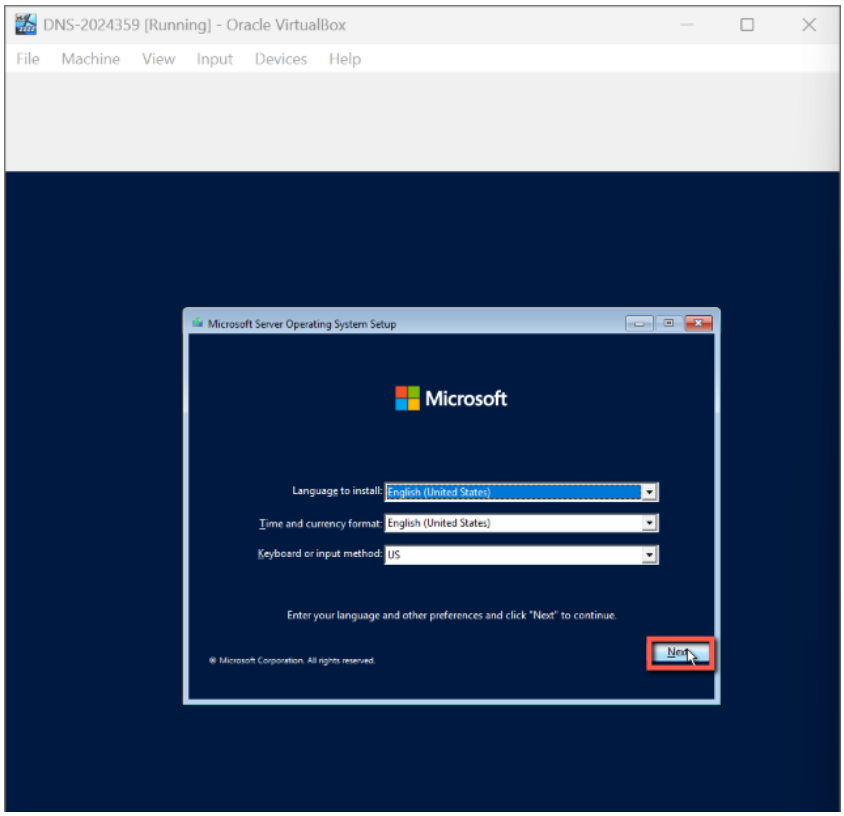


Note: Pressing F12 key to go to boot menu and choosing CD-ROM

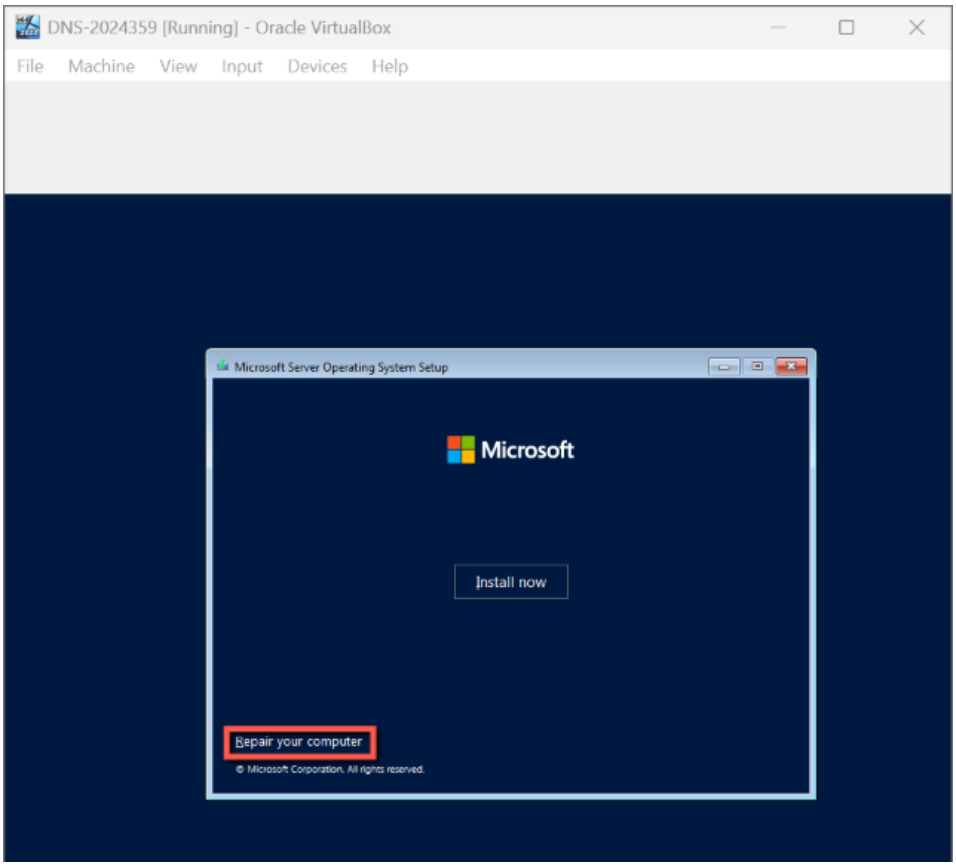


Note: Mounting the ISO image and retry boot

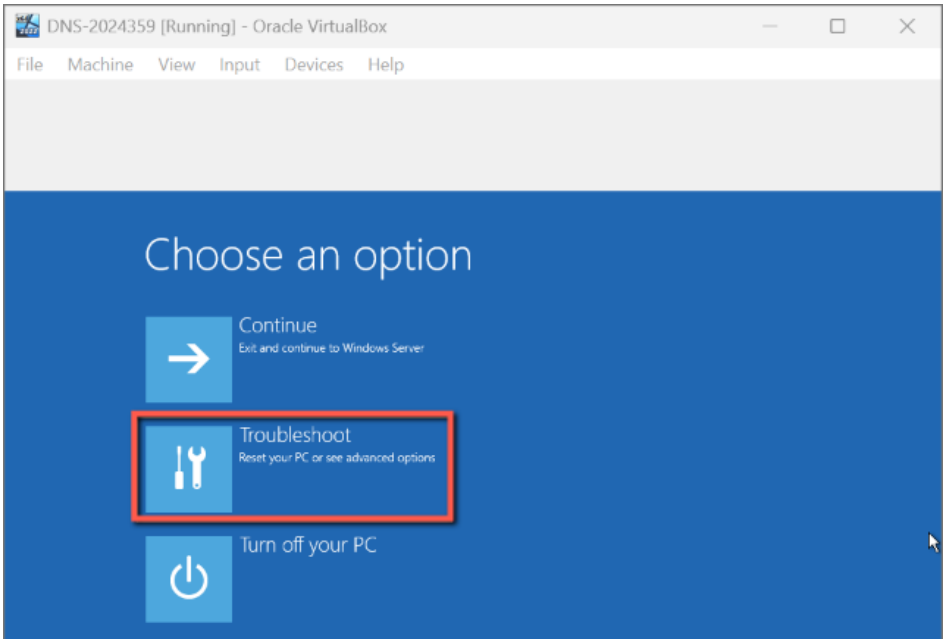
Accessing Command Prompt



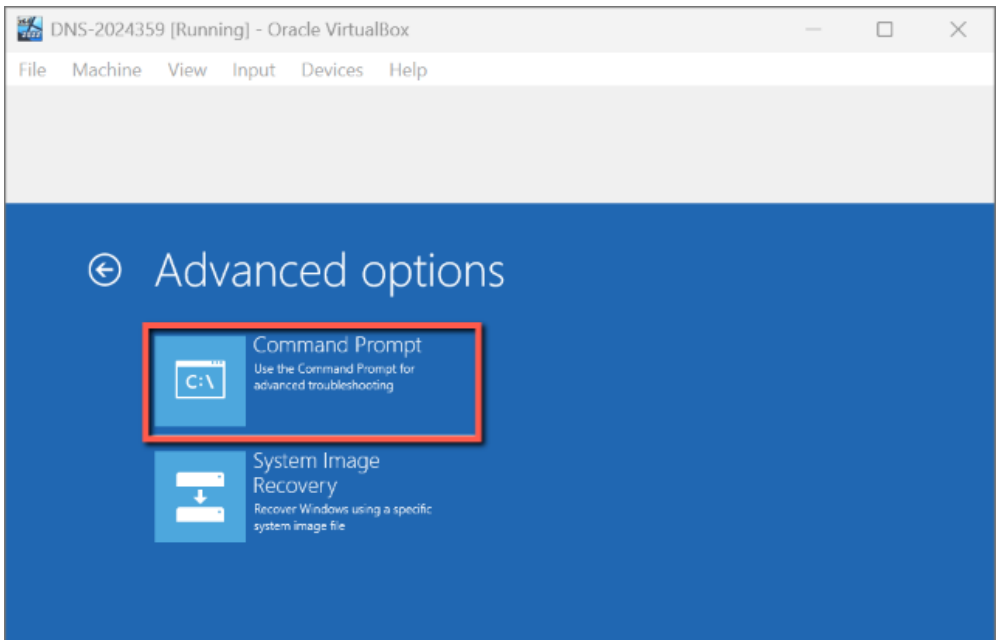
Note: Choosing Next option



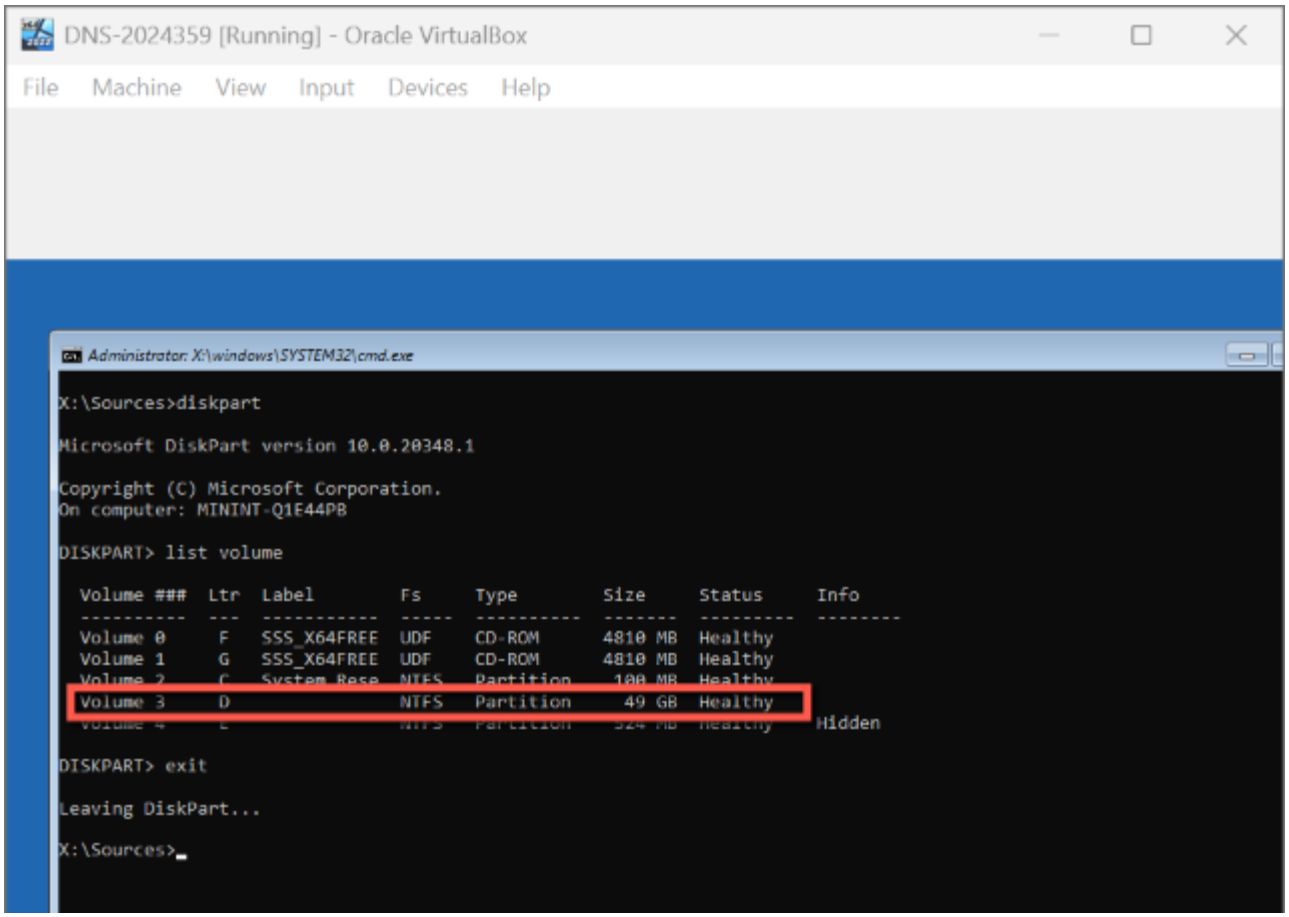
Note: Selecting repair your computer option



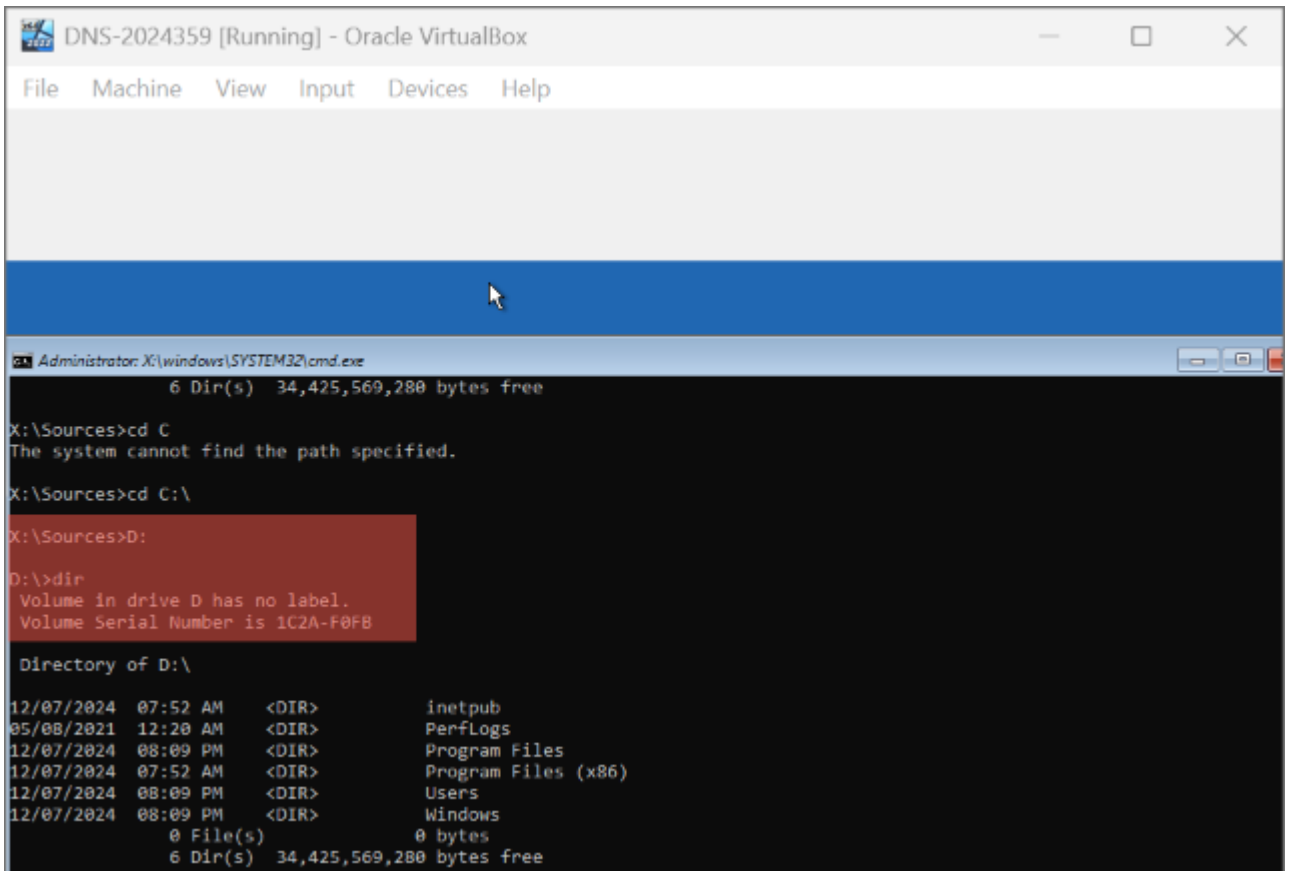
Note: Selecting troubleshoot option



Note: Selecting Command Prompt option

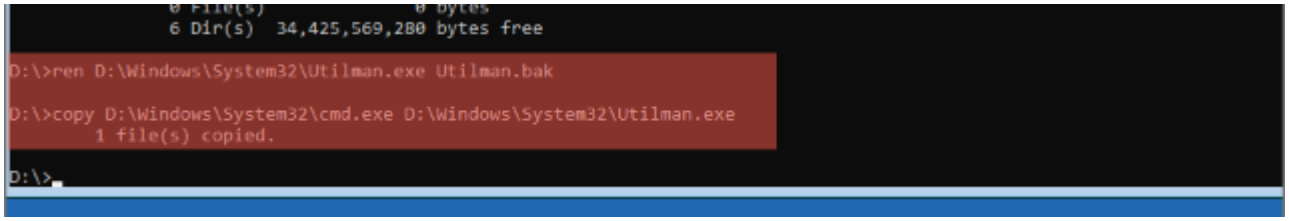


Note: Checking which disk is the main one (D) using diskpart command



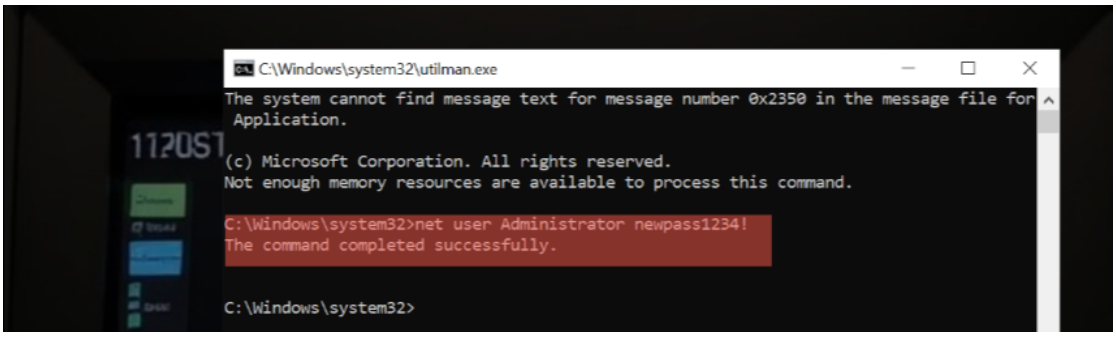
Note: Going inside the D disk

Replacing Utilman with cmd

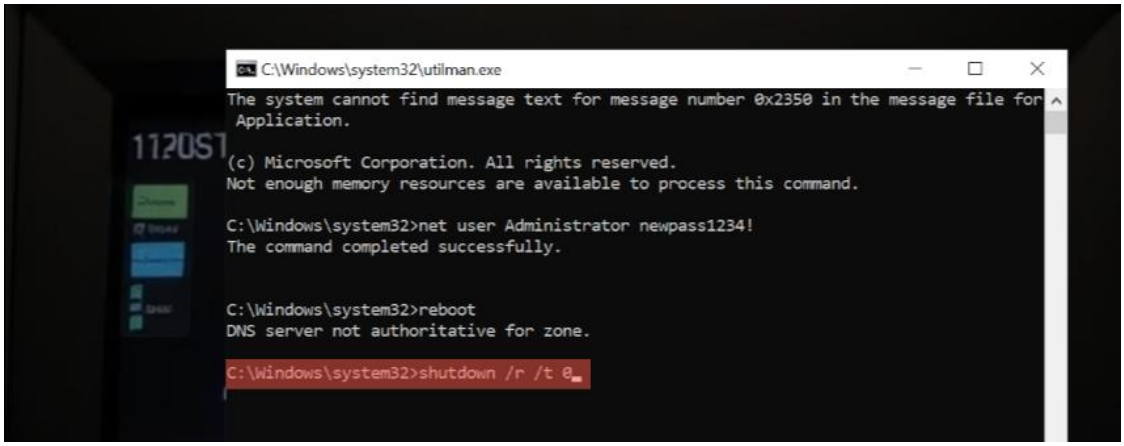


Note: Replacing the utilman with cmd

Note: Replacement of Utilman with cmd allowed the ease of access panel to enter the command prompt on Windows



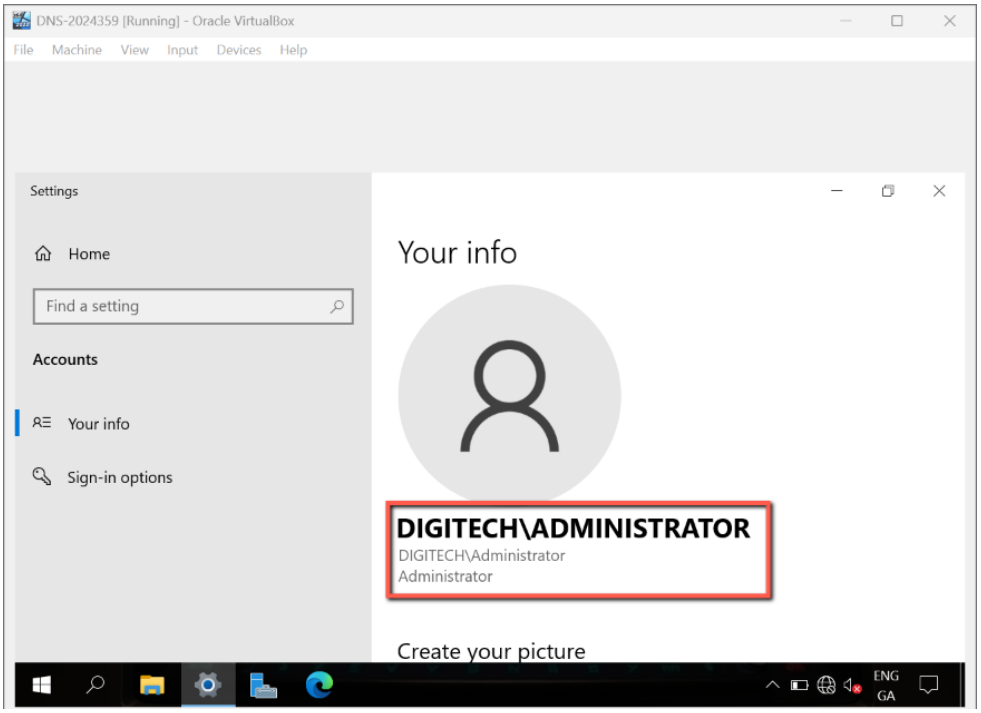
Note: After reboot, Resetting the password with command prompt (new password = newpass1234!, old password = pass1234!)



Note: Rebooting the system

Testing the new password on DNS-2024359

Note: Entering the new password on Adminstrator account



Note: Successful log in to Digitech administrator account after the password reset

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Table of Figures

Fig. 1: Oracle VirtualBox example..... 3