



NETWORK OPERATING SYSTEMS AND SERVICES

**Research, build, and deploy a Virtualised Enterprise
network**



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Assignment Title:

Research, build, and deploy a Virtualised Enterprise Network

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Task 1

1. Research on Hypervisor Architecture and Virtualisation Models

Hypervisor is a crucial piece of software which makes virtualisation possible and it abstracts the operating system running on it from the actual physical hardware. The hypervisor creates a virtualisation layer that separates CPU/ Process, RAM, Network cards, and other physical resources from the virtual machine running on it. The machine where hypervisor is installed is called a host machine whereas the operating system installed on top of these hypervisors are called Guest virtual machines. From the virtual machine point of view, there is no difference that it is running on Hypervisor or physical machine. [1]

Type of Hypervisor Architecture

Types of Hypervisor Architecture are Type1 and Type2

- Type 1 Hypervisor Bare-Metal

Hypervisor bare metal runs directly on physical hardware without a host operating system. For example, ESXI from VMware, Hyper-V, Xen from Microsoft. Used in enterprise data Centre for high performance virtual environments.

- Type 2 Hypervisor Hosted

Hypervisor Hosted and ran on an existing operating system and acted as an application. For example, VirtualBox from Oracle, VMware workstation from VMware, and Virtual PC from Microsoft. Used for development and testing on personal Laptop or computers. Therefore, it is unsuitable for production scale enterprise development.

Reflection on SWANSEA. ACCA network topologies, hosting Windows Server 2022 and Debian Server, a Type 1 hypervisor like Microsoft Hyper-V is the most suitable choice for it. [2]

- Performance:

Hyper-V offers minima overhead and efficient resource use, ideal for Active Directory and DHCP.

- Scalability:

Supports dynamic resource allocation and live migration for future growth. |

- Security:

Provides shielded VMs and better isolation with direct hardware access.

- Compatibility:

Fully supports Windows Server 2022 and Debian for mixed-OS environments.

Justification of Hypervisor Choice

Compared to VMware ESXi, Hyper-V offers cost efficiency through Windows Server integration. While VMware provides mature enterprise features, its licensing costs may not justify implementation in medium scale environments.

Compared to Oracle VM VirtualBox, Hyper-V offers superior scalability and performance due to its Type 1 architecture.

Therefore, Hyper-V is justified based on:

Cost effectiveness, integration with Windows ecosystem, scalability for organisational growth and enterprise level feature support.

2. Research on IP Addressing

IP Addresses represent where you live on the internet and are unique series numbers that identifying computers on internet enable communication between devices, with routers directing data, it is divided into packets, each containing the source and destination IP addresses between networks and switches managing traffic within local network.

There are two main IP addressing are IPv4 and IPv6, each with a defined structure, format, and purpose. [3]

IPv4 Addressing

IPv4 uses a 32- bit address, divided into four 8-bit octets and represented in dotted decimal format, such as 192.168.30.10.

Subnetting and Efficient IP Utilisation.

Subnetting divides a large network into smaller logical networks.

Example: 192.168.30.0/27

Subnet Mask: 255.255.255.224

Total Ips: 32

Usable Ips: 30

Network	Usable Hosts	Broadcast	Subnet Mask
.0	.1 - to- .30	.31	255.255.255.224

IPv6 Addressing

IPv6 uses a 128-bit address, represented in hexadecimal format, for example the IPv6 address 2001:db8:acad::1/64 expanded to its full uncompressed form is 2001:0db8:acad:0000:0000:0000:0000:0001/64 contain 8 groups of 4 hexadecimal digits, adopted due to the limitations of IPv4. Subnetting helps efficiently allocate IP addresses, preventing congestion and improving data flow.

IP addresses can be:

- **Static:** Are manually assigned and do not change.
- **Dynamic:** Are manually assigned by a DHCP server

Task 2

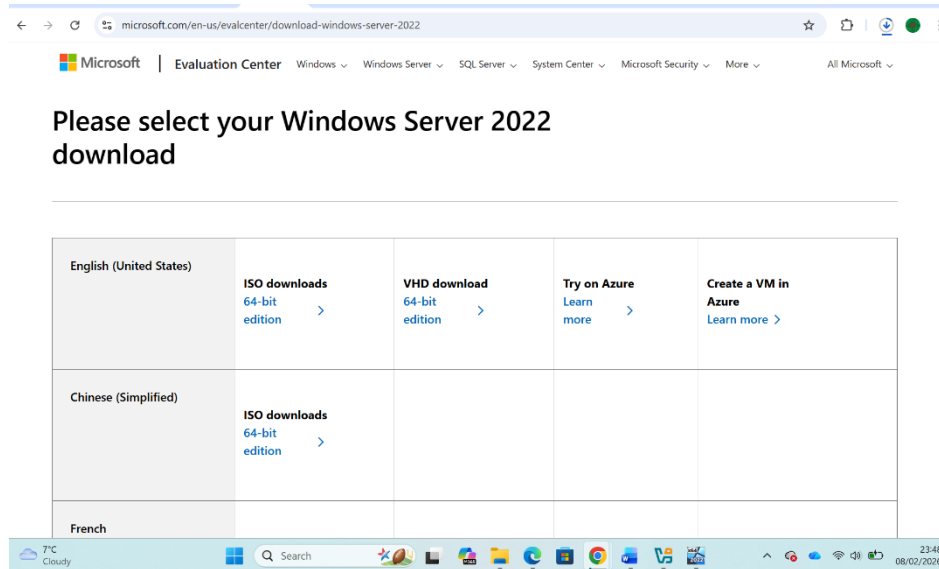
1. Chosen Hypervisor

A Type 1 Hypervisor Bare-Metal or Microsoft Hyper-V was selected to host Windows Server 2022 and a Debian Server due to its performance, strong security, and excellent compatibility with mixed operating systems. Running directly on hardware, Hyper-V minimizes overhead and supports scalable deployment of enterprise services such as Active Directory and DHCP, making it suitable for the SWANSEA.ACCA domain environment and future network expansion. [4]

2. Download and Set up

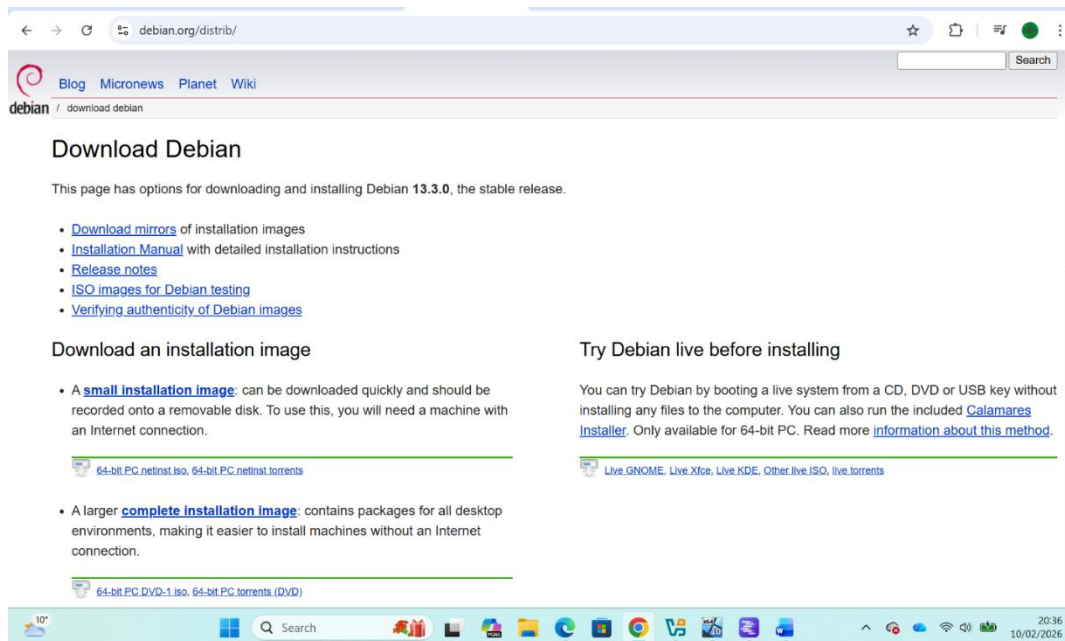
Download Evidence: Screenshots with timestamp showing ISO downloads 64-bit edition. Windows Server 2022 ISO [5]

Figure 1 Windows Server 2022 ISO



Debian ISO [6]

Figure 2 Debian ISO



Network Development

The network development topology using Hyper-V Manager with the following configuration:

Virtual Machines Created and named S-DC AND server and ClientS1

Windows Server 2022 Domain Controller

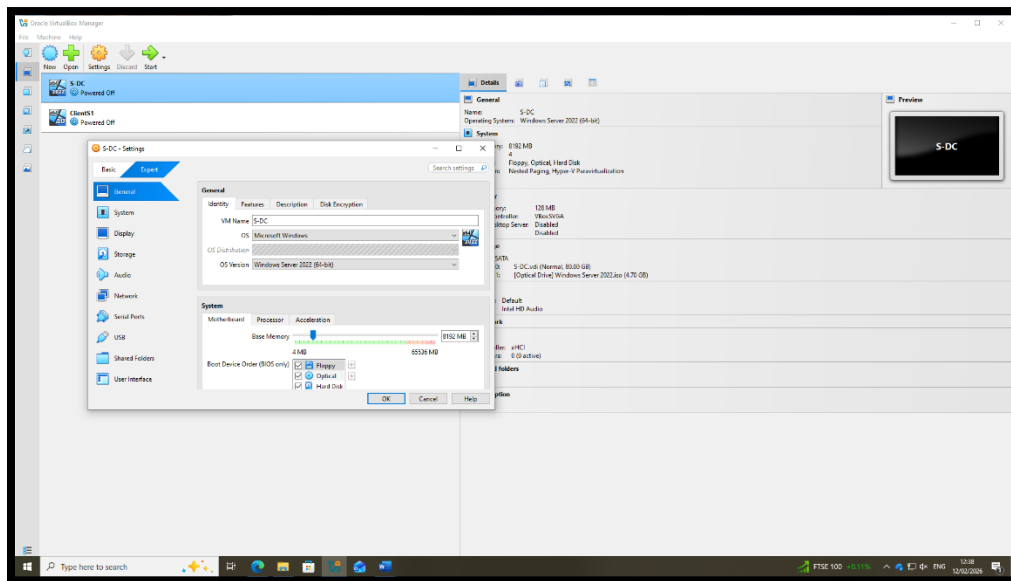
Debian Server DCHP Relay

Windows Client (S)

Windows Server 2022

Named S-DC

Figure 3 Changed devices name



Configuration of Central Process Unit, RAM, and storage required for the virtual machine to operate properly.

Figure 4 Motherboard Settings

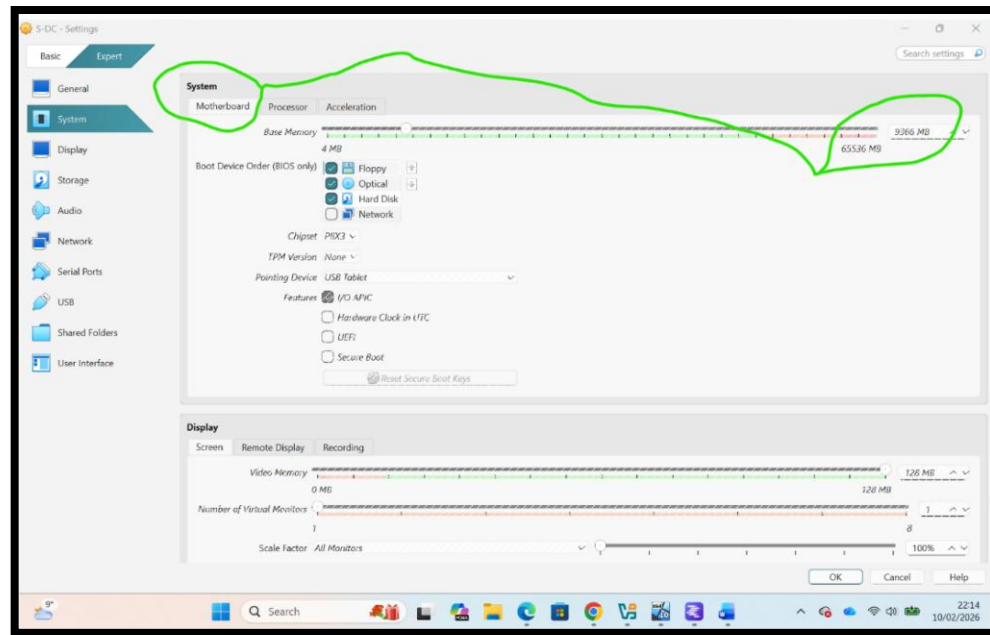


Figure 5 Processor Settings

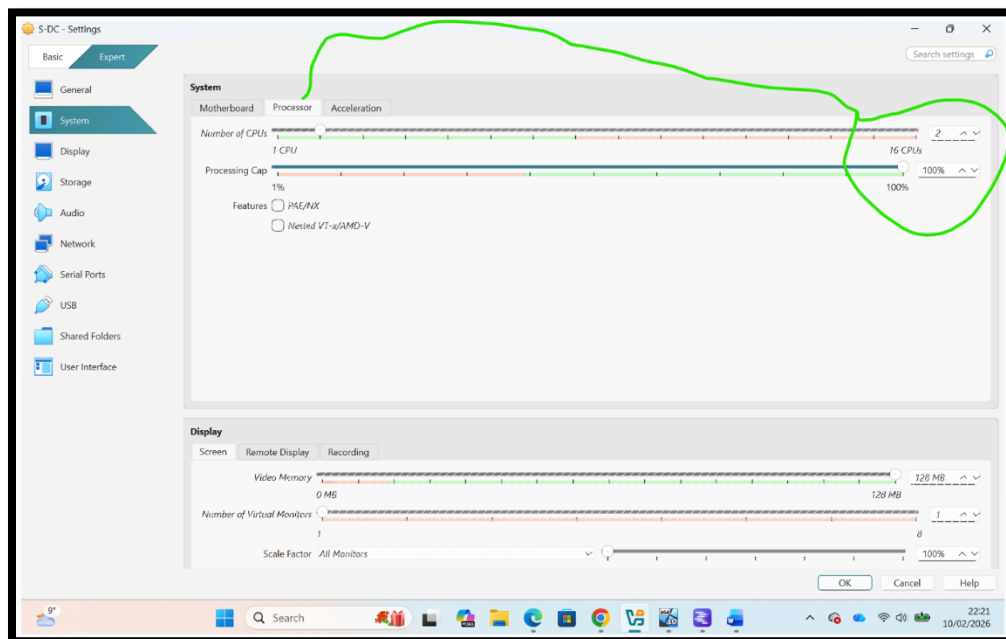
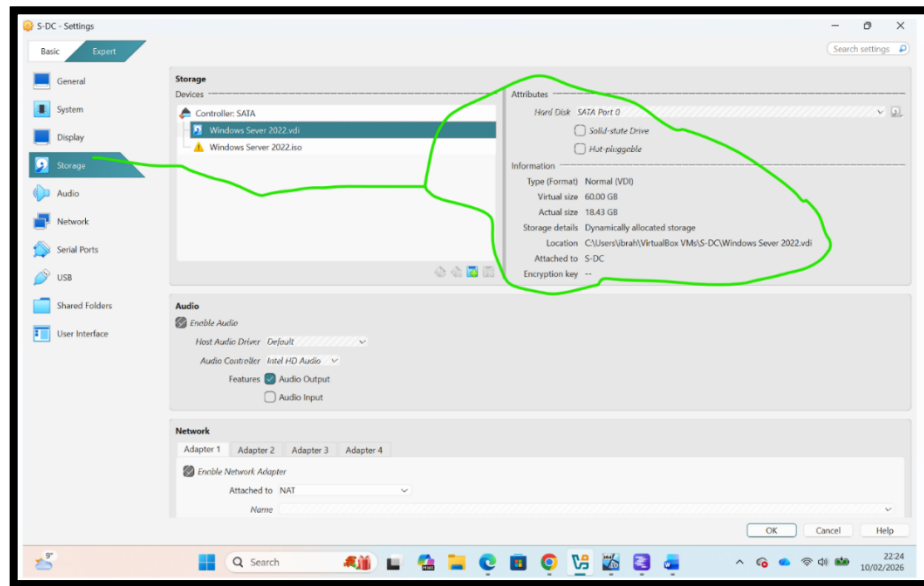


Figure 6 Storage Settings



Completed setting successfully

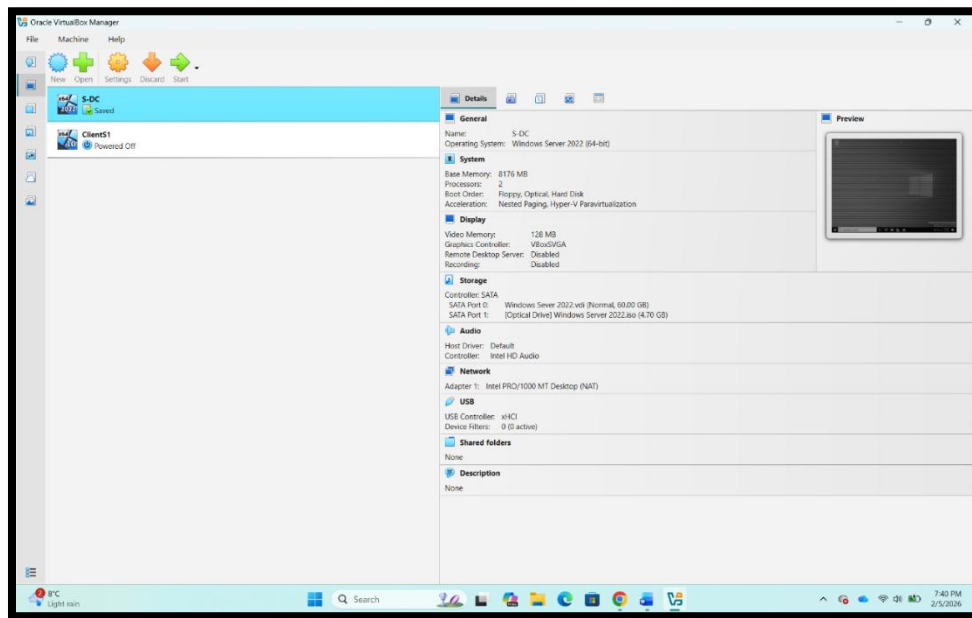


Figure 7 S-DC Server Manager Dashboard

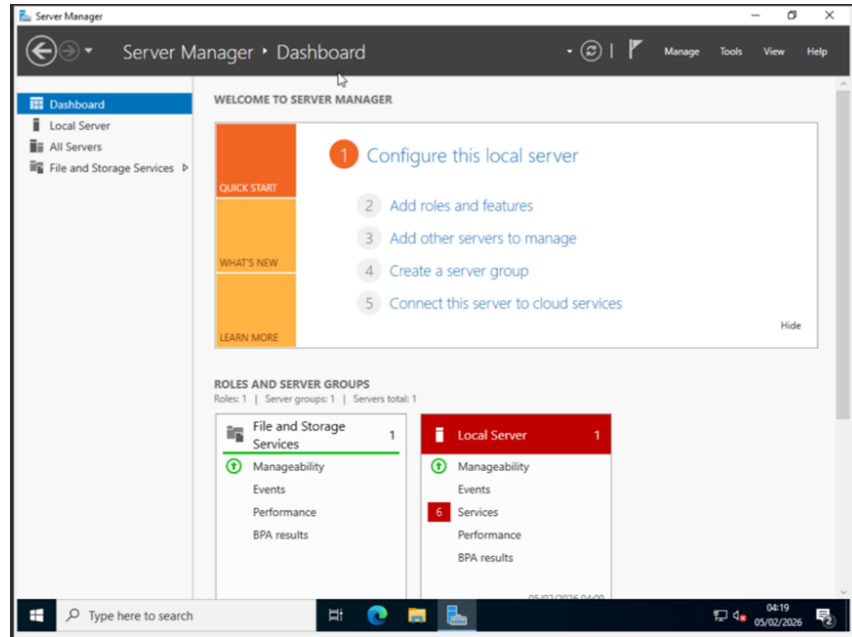
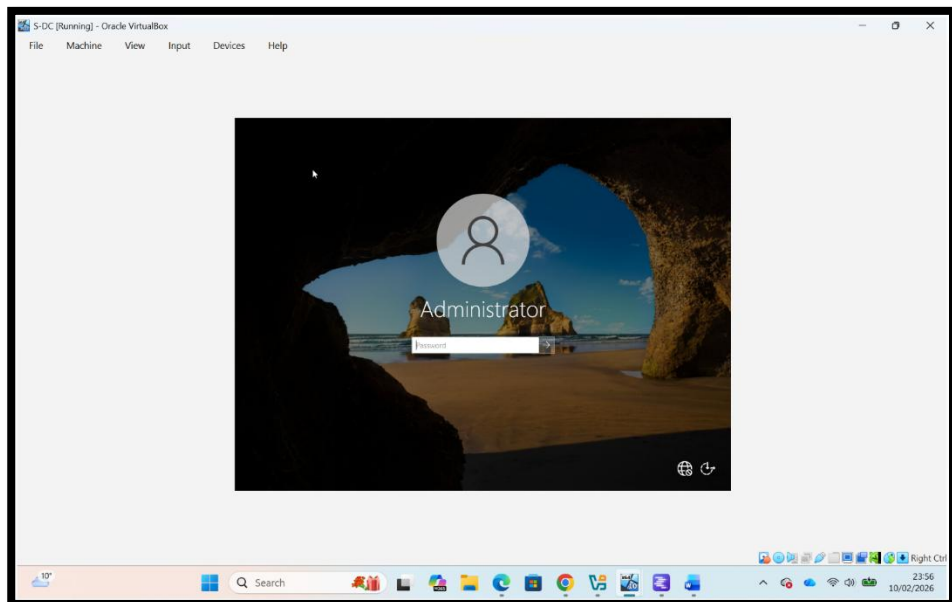
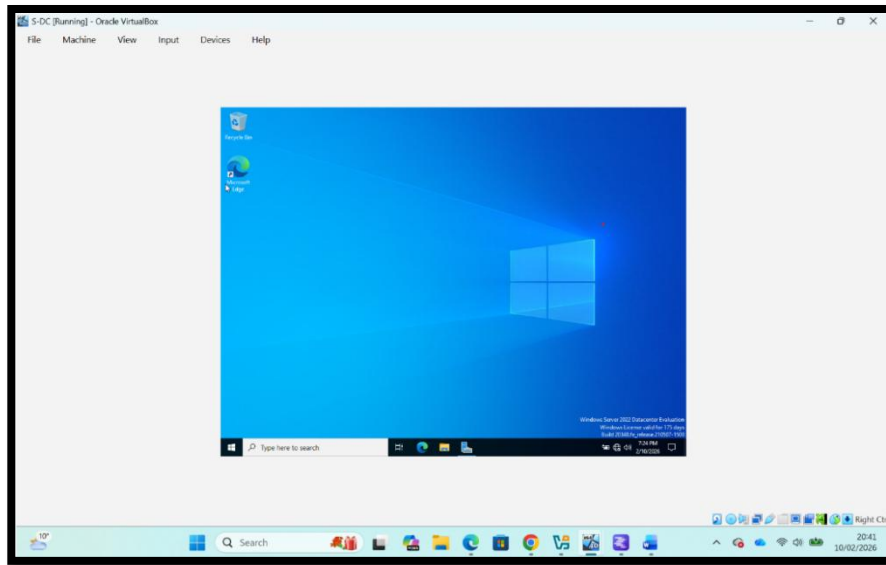


Figure 8 S-DC Running on Oracle VirtualBox

Sign in interface where users enter their credentials to access system.

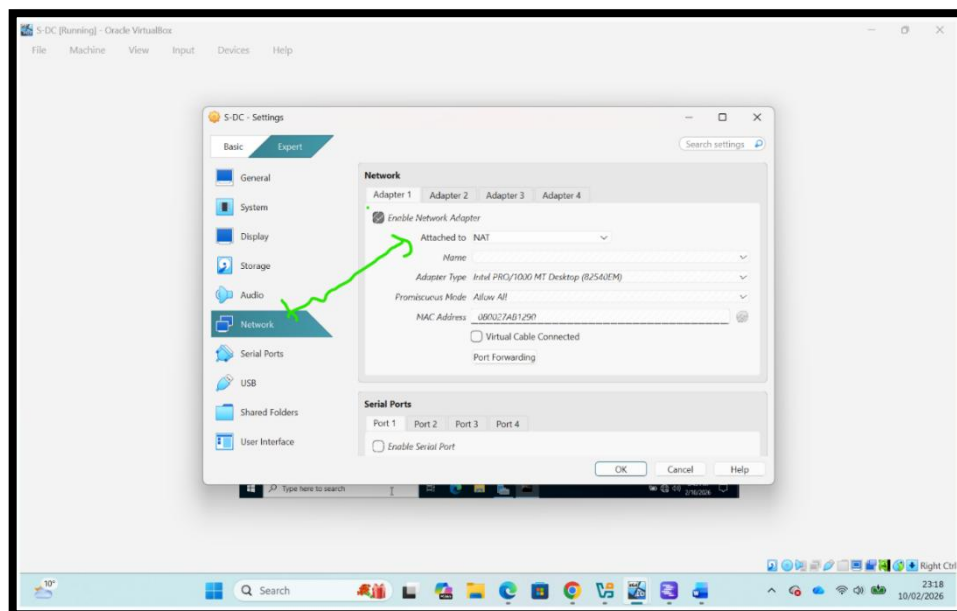


Unlock interface page.



Network adapter configuration

Allow the virtual machine to connect to the network and communicate with other systems. I have selected NAT.



ClientS1 Device:

Figure 9 ClientS1 Sign in interface where users enter their credentials to access system

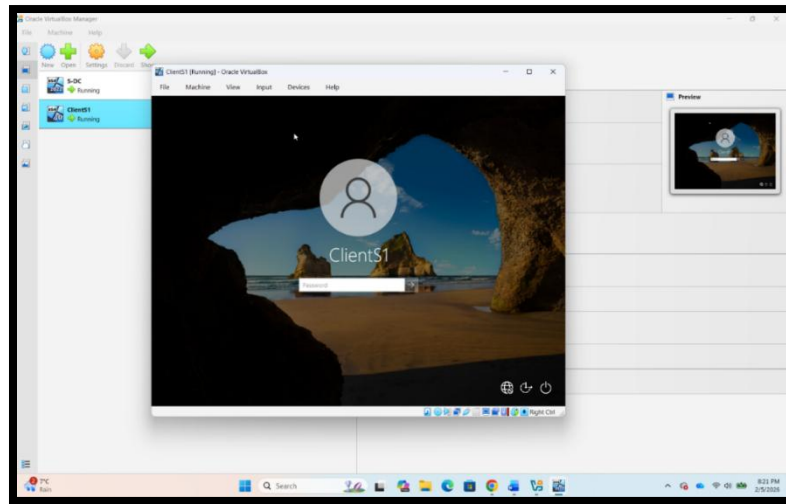
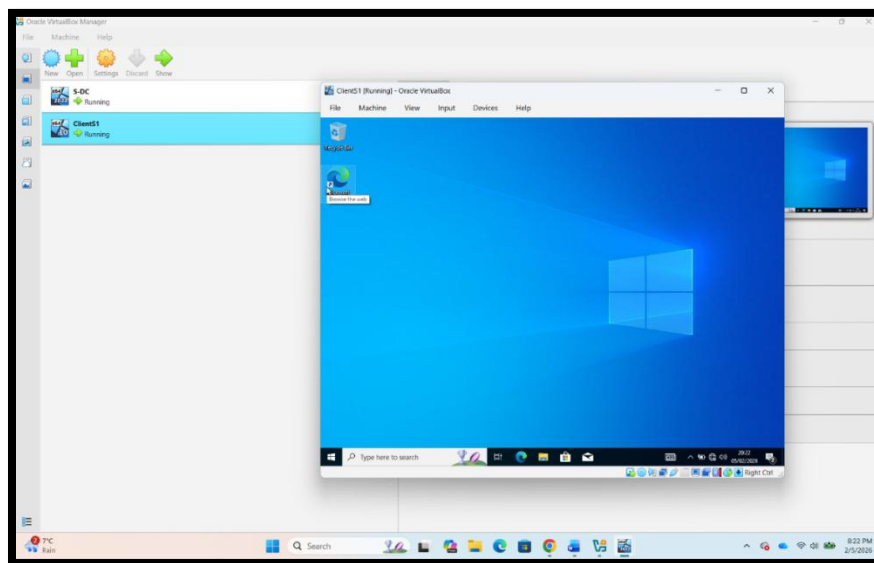


Figure 10 Unlock interface



3. Configure IP Addressing

IP Addressing Design and Configuration, Unique Subnets for New Users. [3]

To ensure efficient use of IP addresses and improve network organization, a Variable Length Subnet Masking VLSK approach was applied instead using a default Class C/24 network. This demonstrates effective network planning and avoids unnecessary IP address wastage.

For these topologies, the network 192.168.30.0/27 was selected

Subnet Mask	255.255.255.224
Total IP Addresses	32
Usable IP Addresses	30
Network Address	192.168.30.0
Broadcast Address	192.168.30.31

IP Address Allocation

Device	Role	IP Address	Subnet Mask	Default Gateway
S-DC	Windows Server Gateway	192.168.30.1	255.255.255.224	N/A
ClientS1	Client Machine	192.168.30.2	255.255.255.224	192.168.30.1
S-DC	external interface	20.0.0.1	255.255.255.252	
L-CD	external interface	20.0.0.2	255.255.255.252	
L-CD	DHCP Relay	192.168.20.1	255.255.255.224	
CL1	Client Machine	192.168.20.2	255.255.255.224	192.168.20.1

Point to Point Routing Network: 20.0.0.0/30

The /30 subnet is used appropriately for inter device routing because:

S-DC Server

Configured S-DC device as role windows Server dashboard

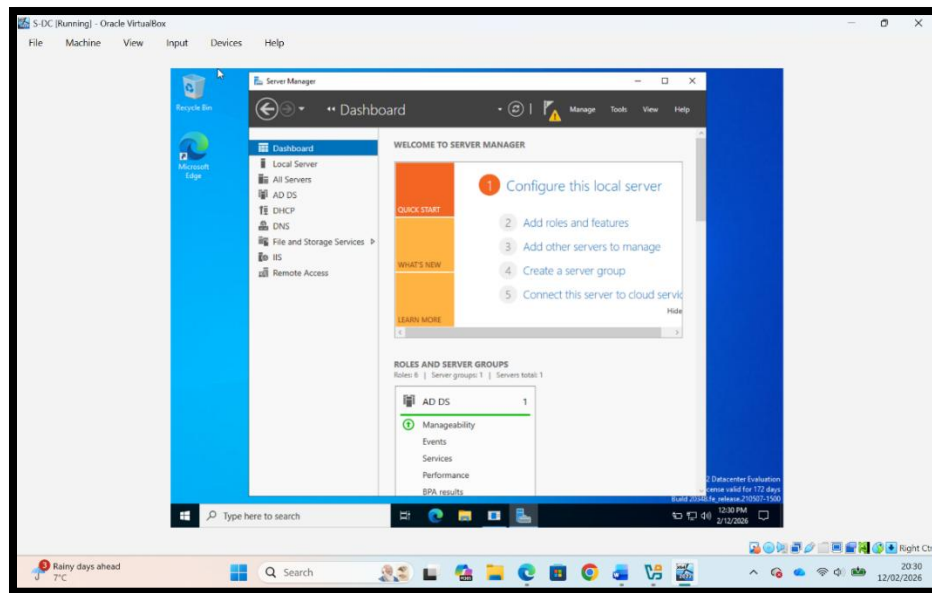


Figure 11 Ethernet and selected Properties.

Dubble clicked Internet Access, opened Advanced Network Setting S, then right clicked Ethernet and selected Properties.

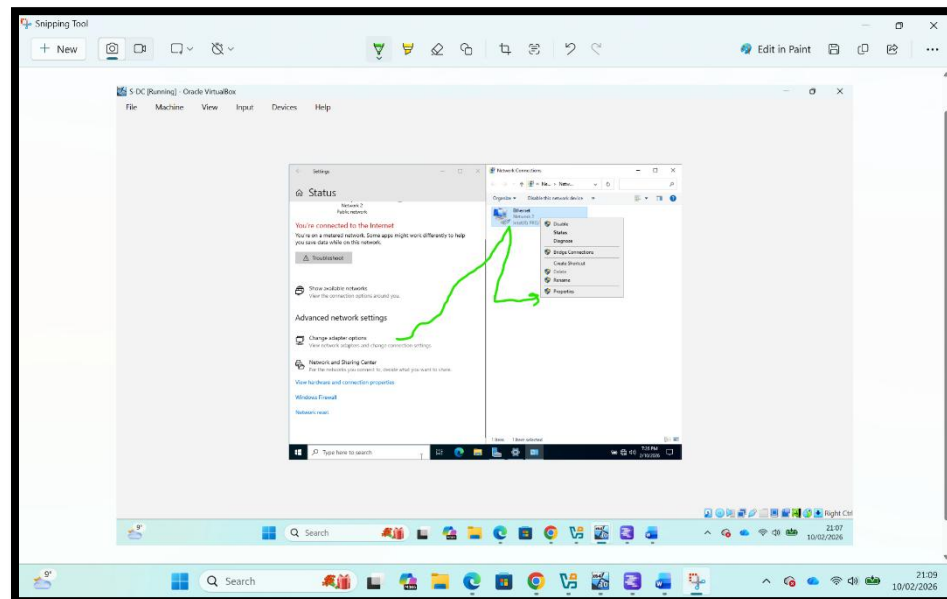


Figure 12 IP Settings Assigned

Dubble clicked Internet Protocol Version 4(TCP/IPv4), From General clicked second optional to assigned chosen IP address and Subnet mask.

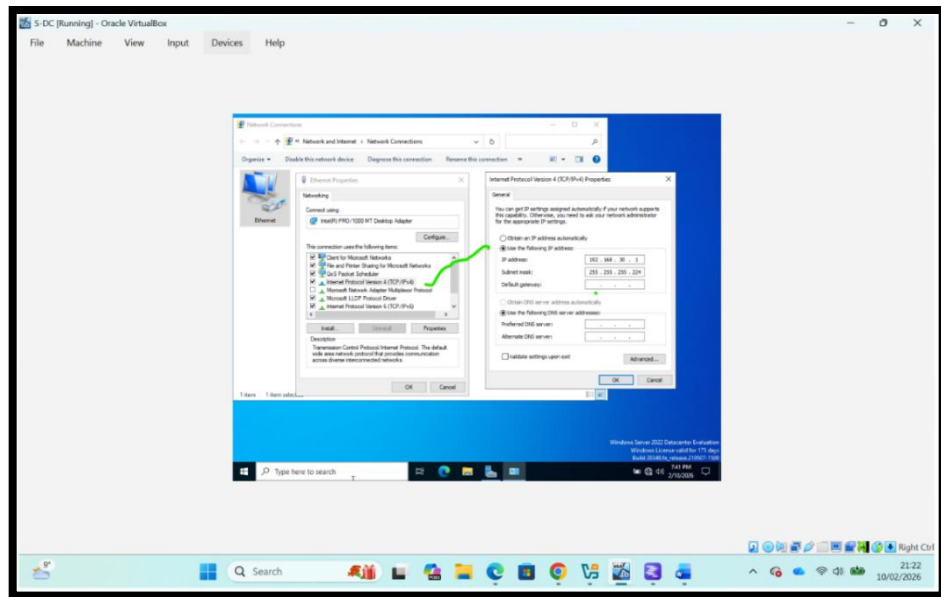


Figure 13 The DNS server Default Gateway list is empty

When clicked on shown following message:

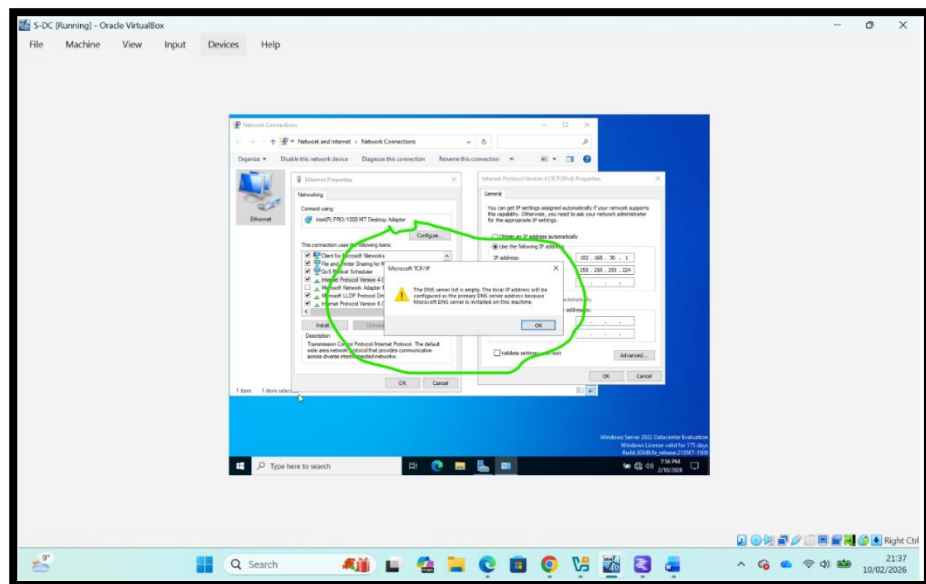


Figure 14 ipconfig

Step 1: Confirmed the target device has IP Address.

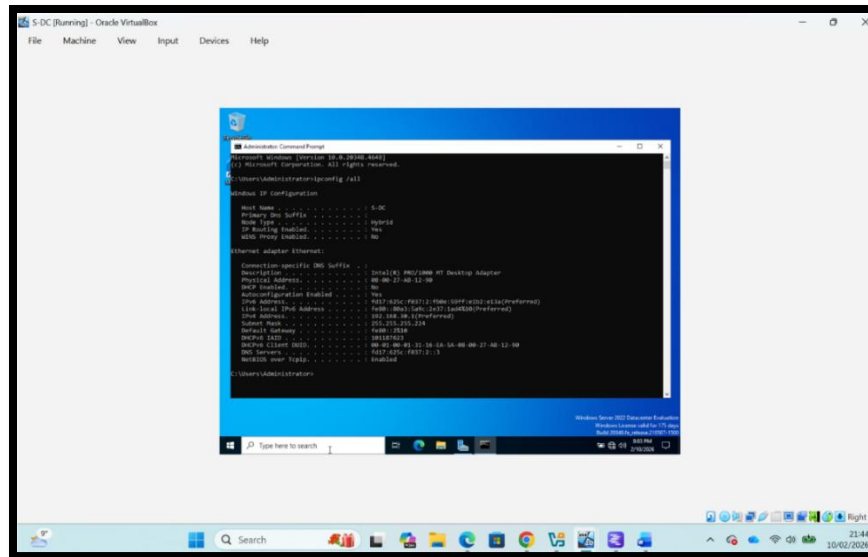
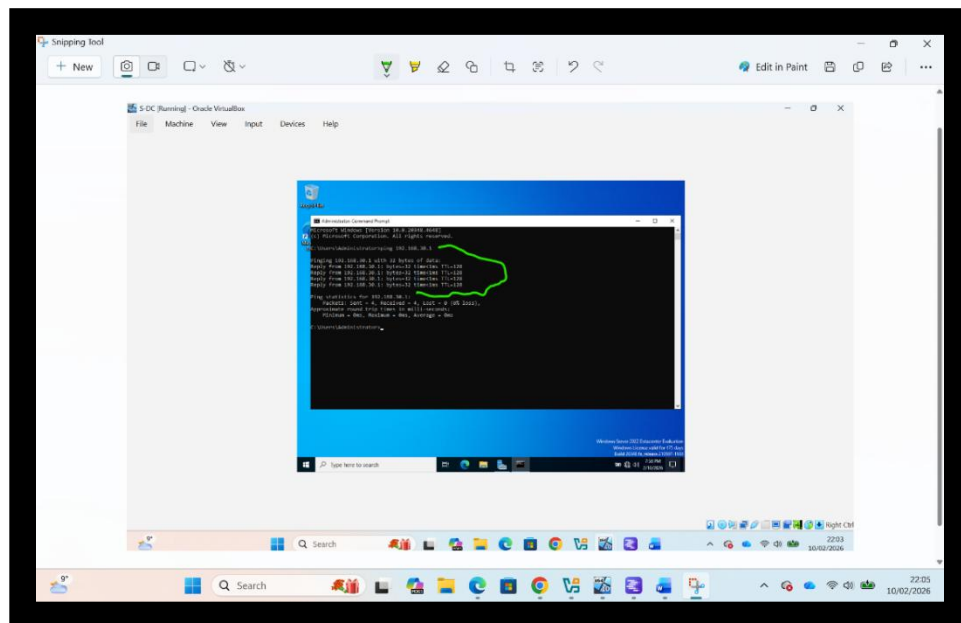


Figure 15 pinging device itself

S-DC device ping itself successfully.



ClientS1 Device:

Figure 16 Setting up Memory and number of CPUs

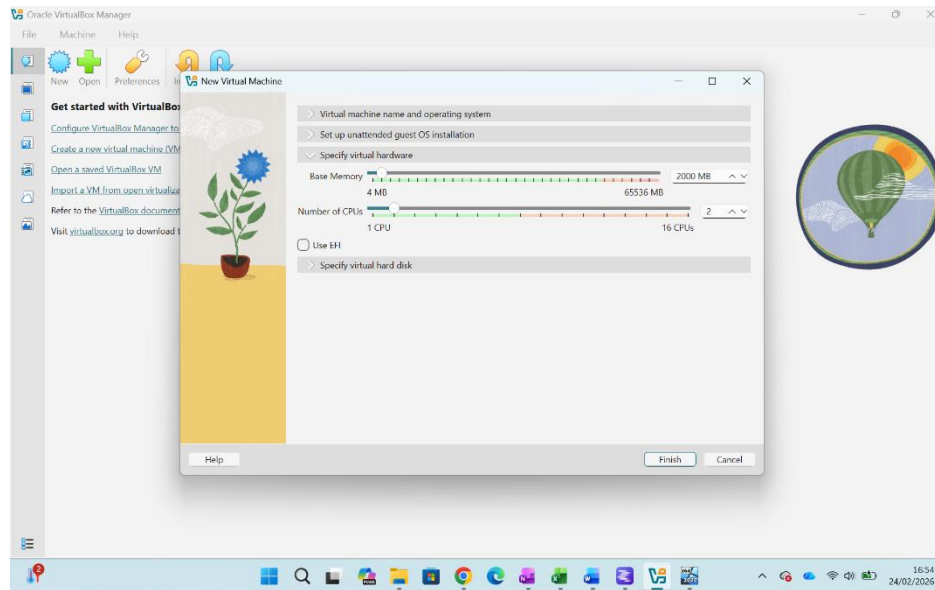


Figure 17 ClientS1 Sign in interface where users enter their credentials to access system.

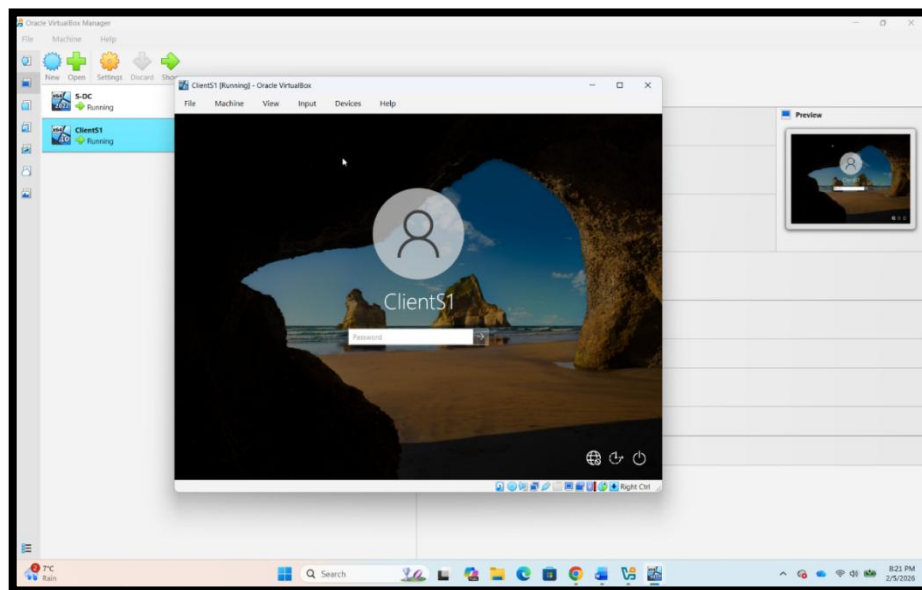


Figure 18 Unlock interface

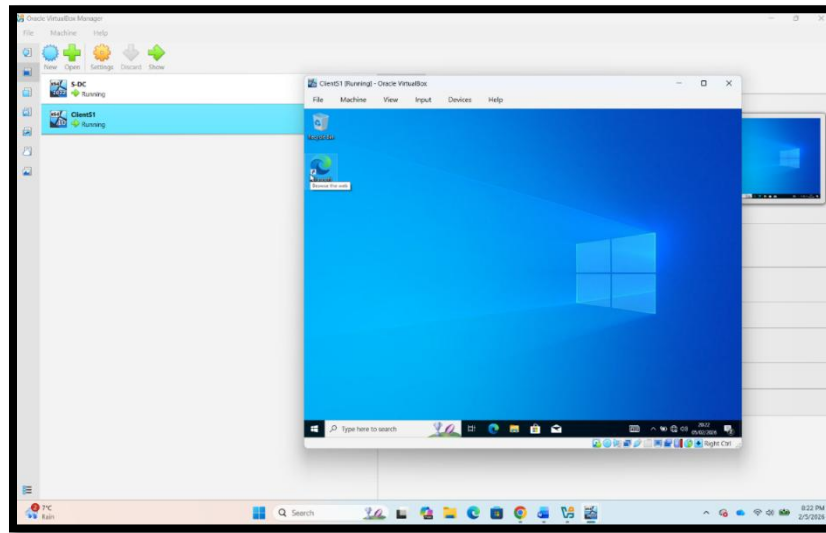


Figure 19 Ethernet and selected the properties

Dubble clicked Internet Access, opened Advanced Network Setting S, then right clicked Ethernet and selected Properties.

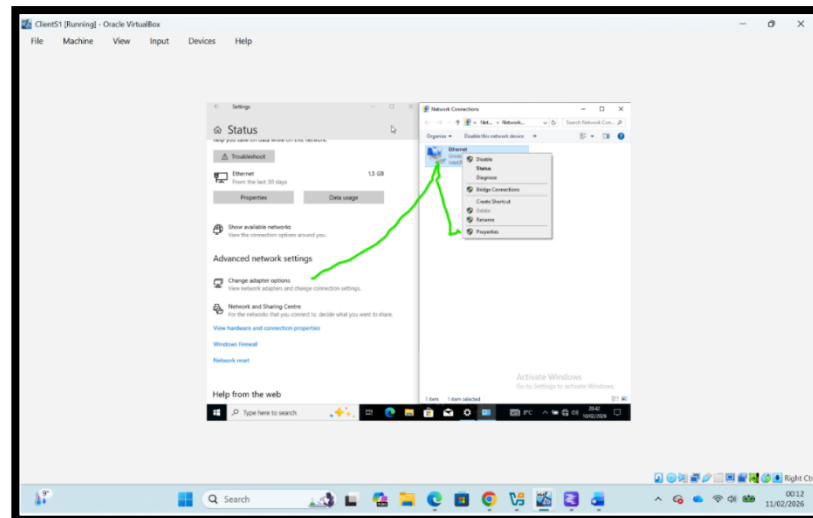


Figure 20 Assigned IP Address

Dubble clicked Internet Protocol Version 4(TCP/IPv4), From General clicked second optional to assigned chosen IP address and Subnet mask

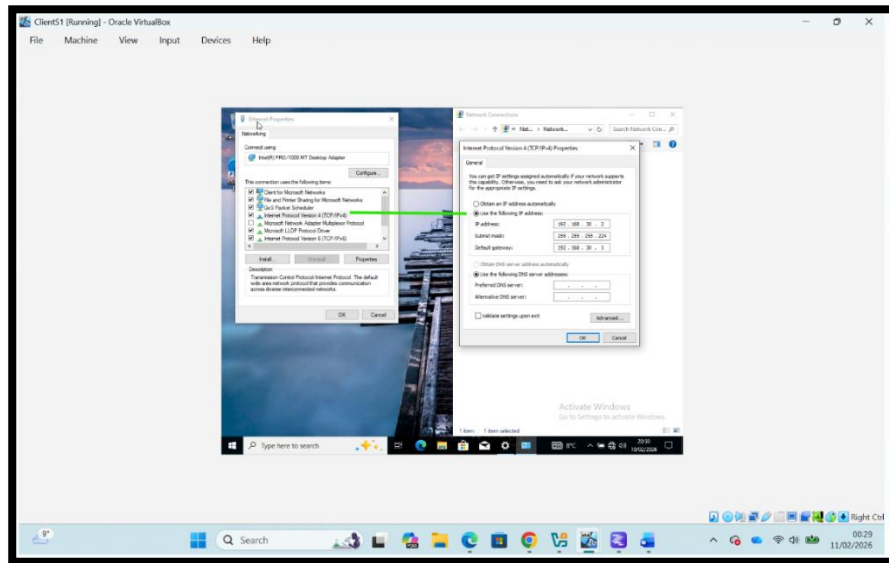


Figure 21 ipconfig

Step 1: Confirmed the ClientS1 device has IP Address

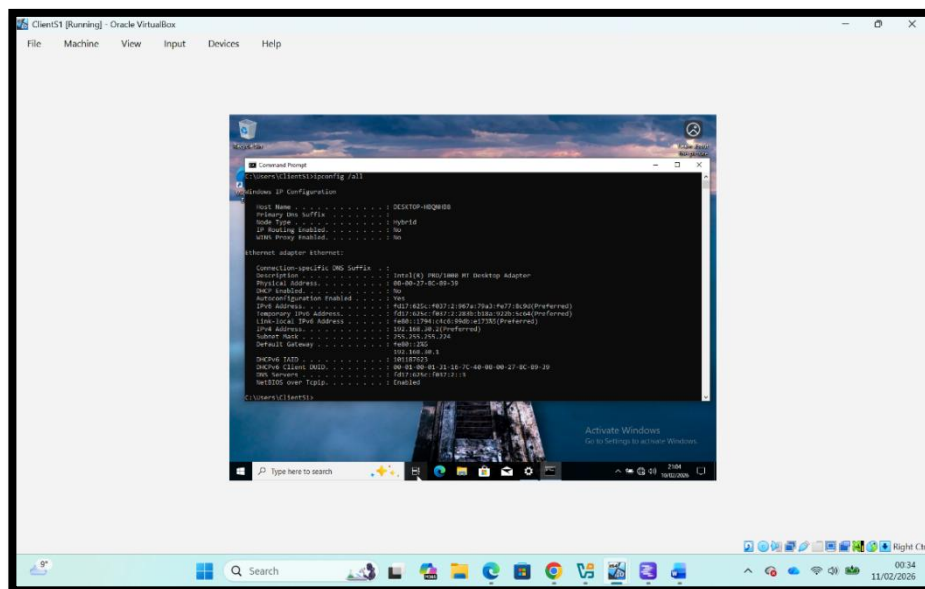
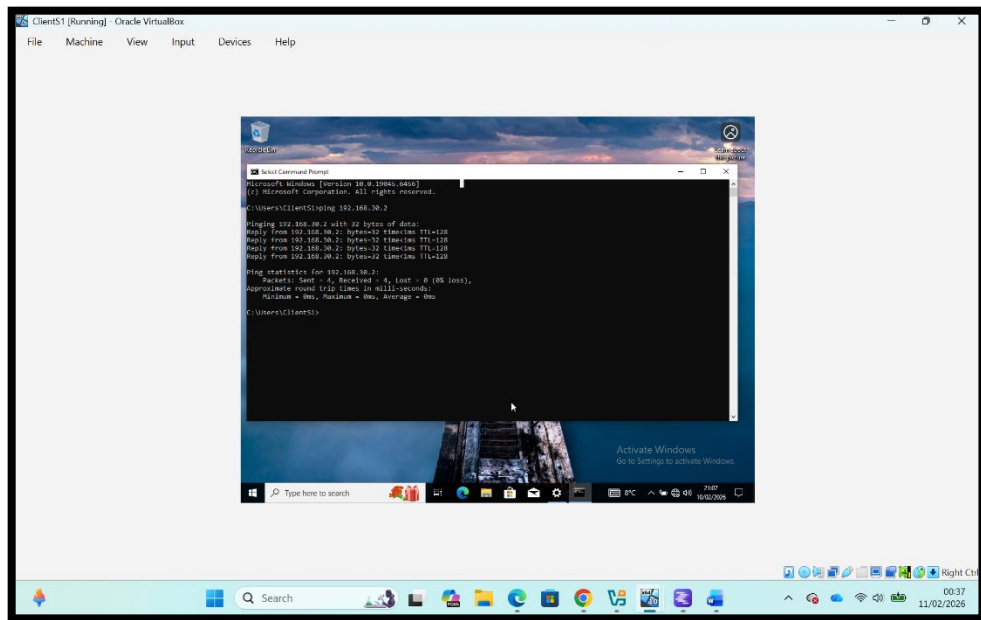


Figure 22 pinging itself

S-DC device ping itself successfully



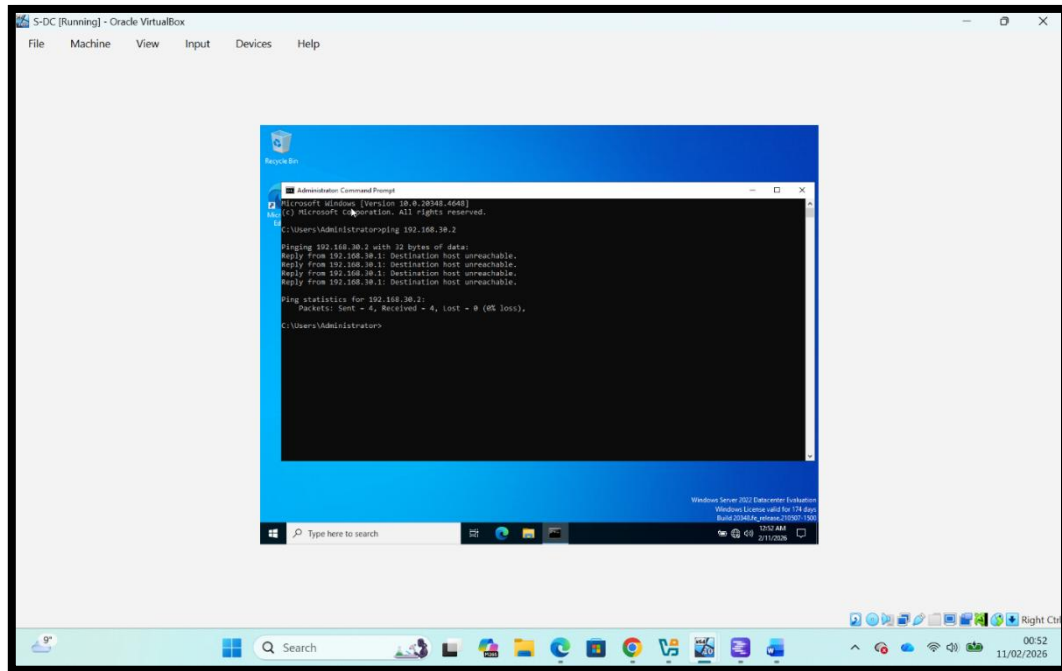
4. Testing

Tested: One

Verifying network connection by pinging an IP address.

Screenshot for pinging to ClientS1 from S-DC and result shown that ClientS1 IP Address destination hosts unreachable.

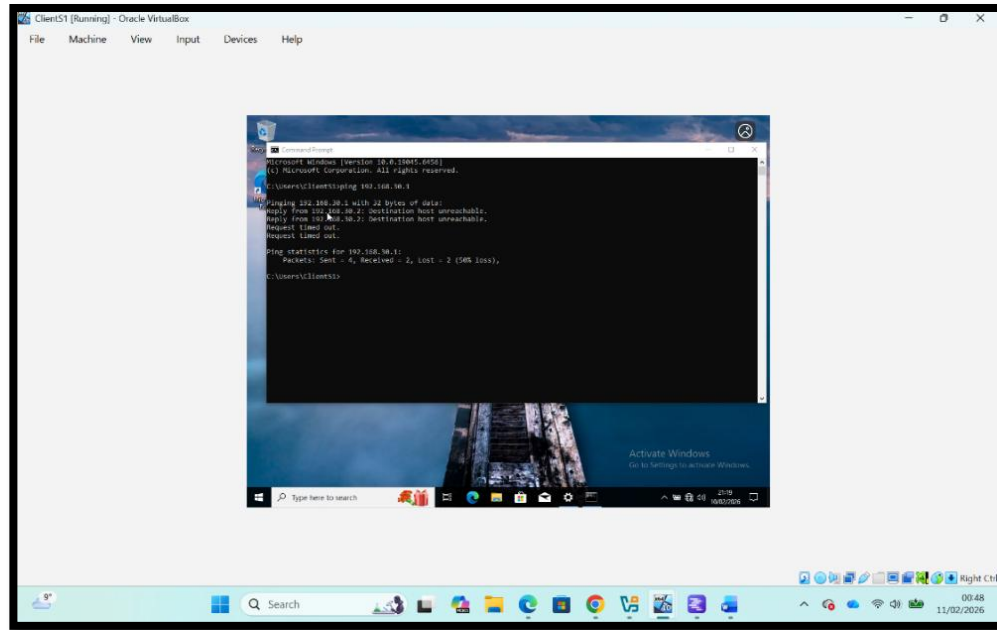
Figure 23pinging to ClientS1 from S-DC



Tested: Two

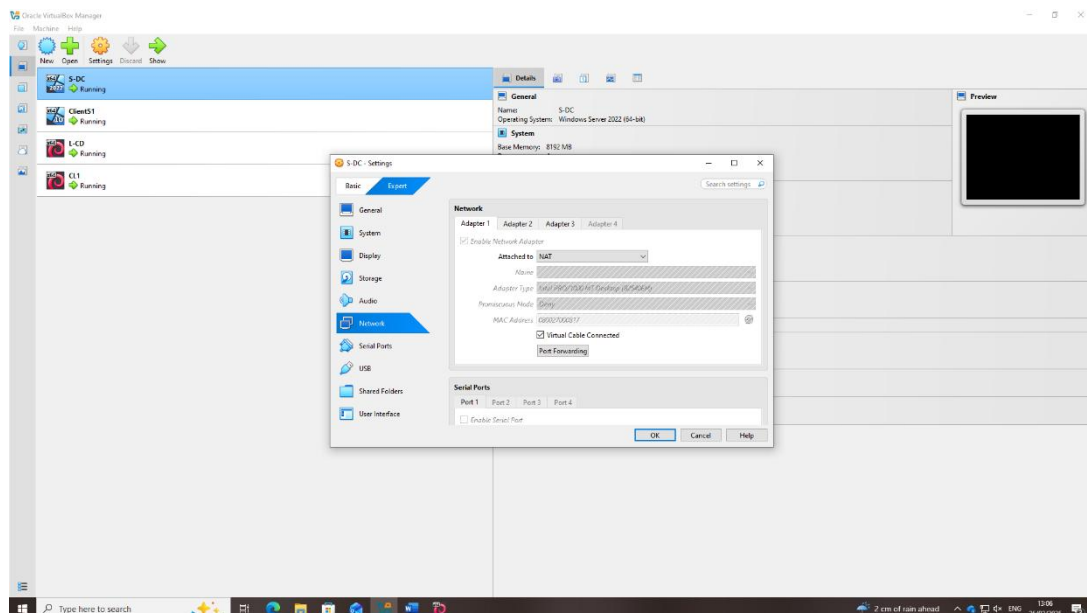
Figure 24 Pinging S-DC Server from ClientS1 Devices

Screenshot for pinging to S-DC Server from ClientS1 and results show that ClientS1 IP Address destination hosts unreachable.

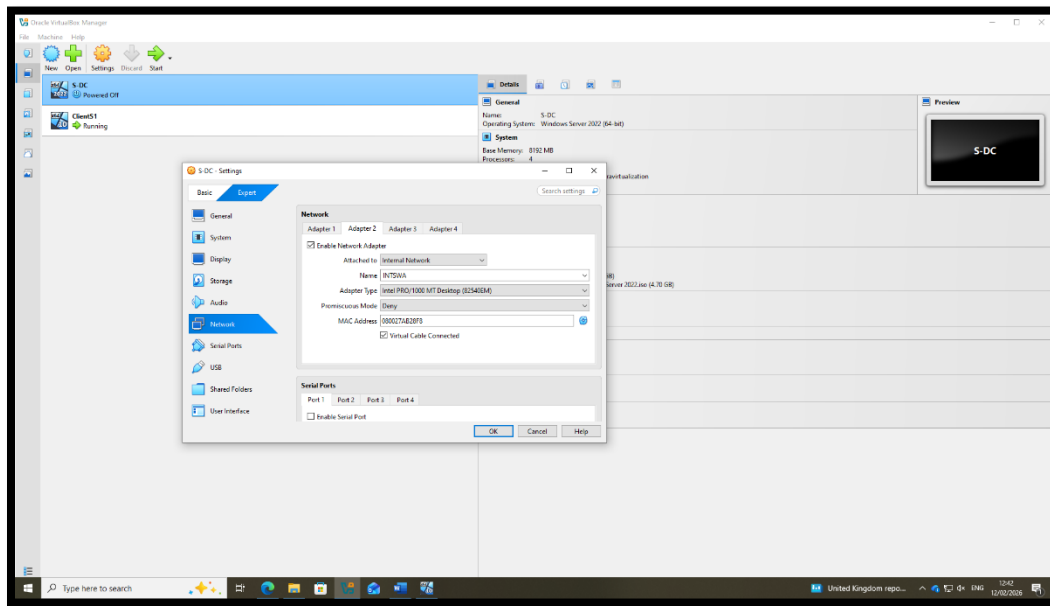


Testing and Troubleshoot

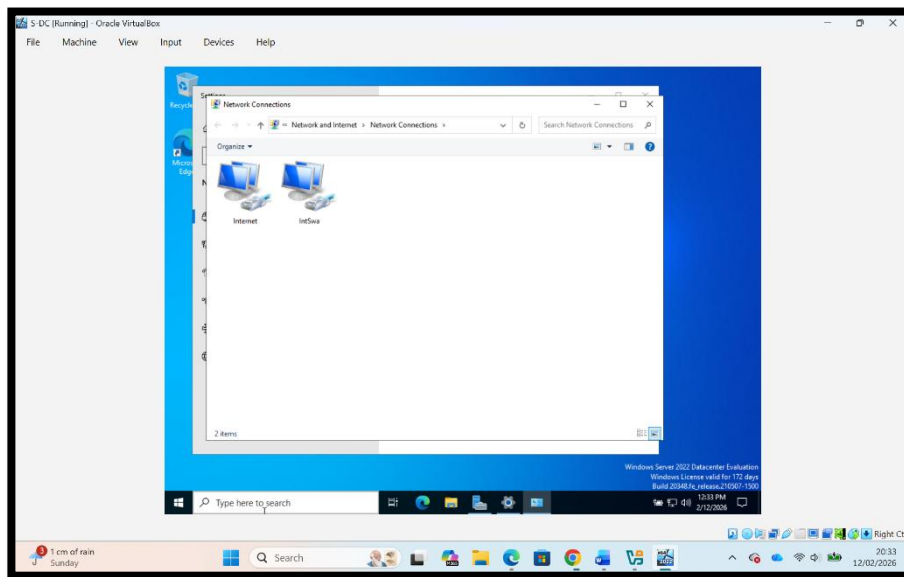
Troubleshooting For S-DC Server



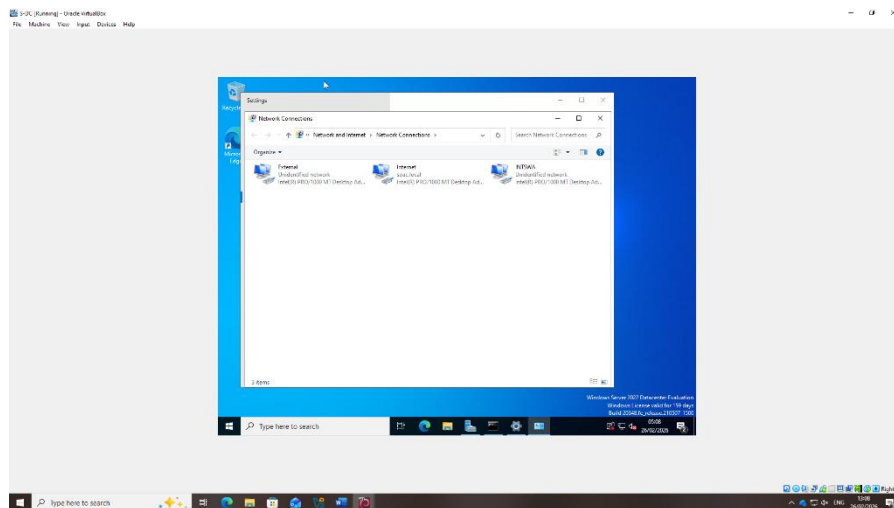
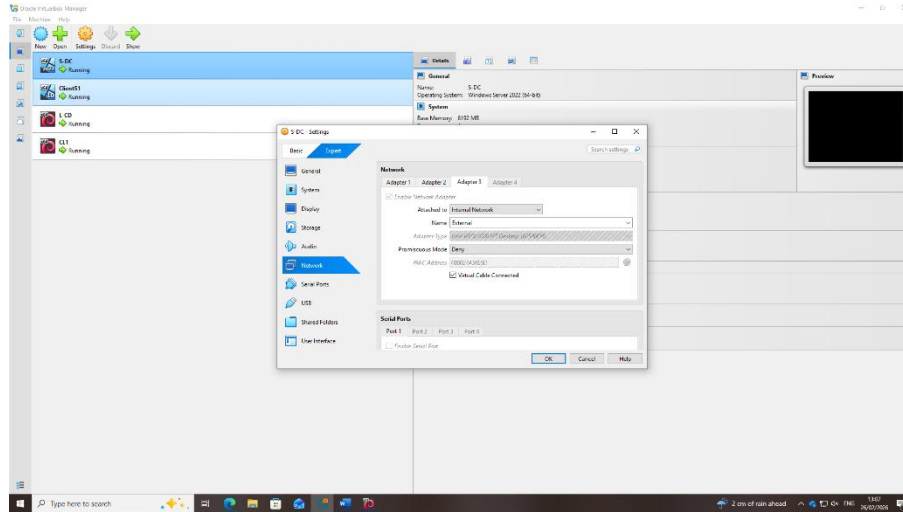
Step: 1 setup adapter 2 and given name as INTSWA



Hare is two Network Connections, Internet and INTSWA



Now are three Network Connections, External, Internet and INTSWA



Right clicked INTSWA then clicked Properties and assigned IP addresses as shown in the following bellow on figurehead.

Figure 25 Assigned IP Addressed

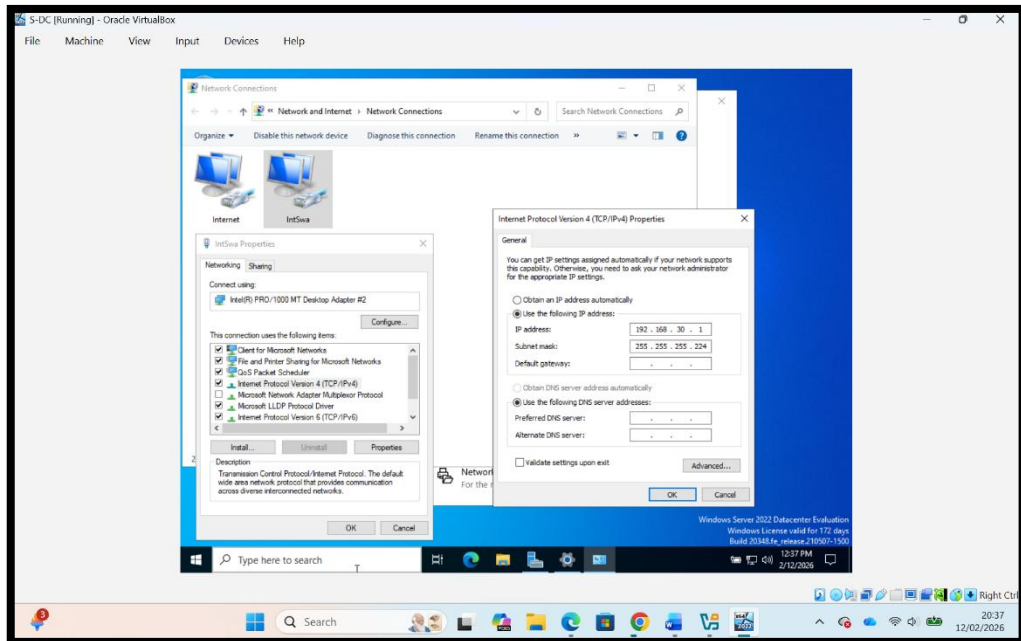
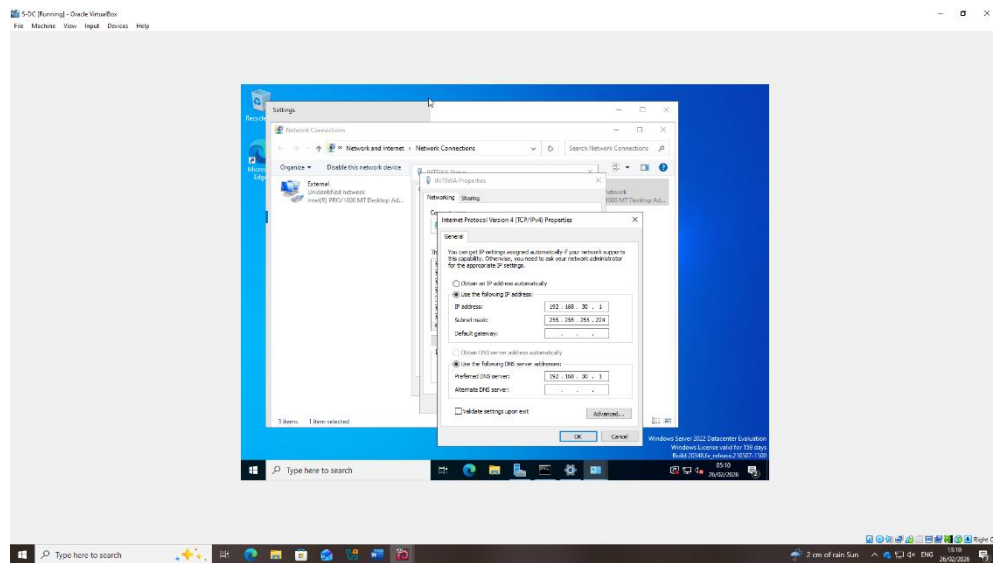


Figure 26 Setup DNS Server



Step 2: Adapter 1

Figure 27 Physical address

Internet has physical address as 08.00.27.AB.12.90

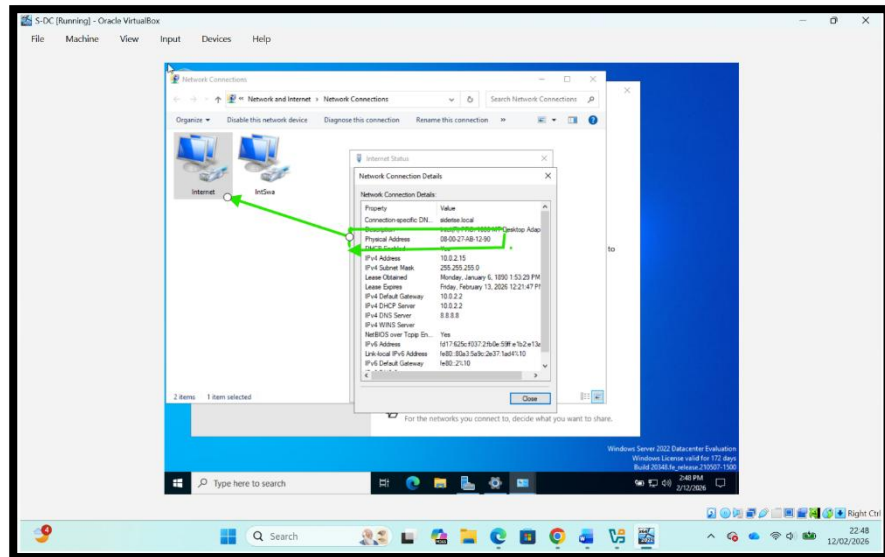
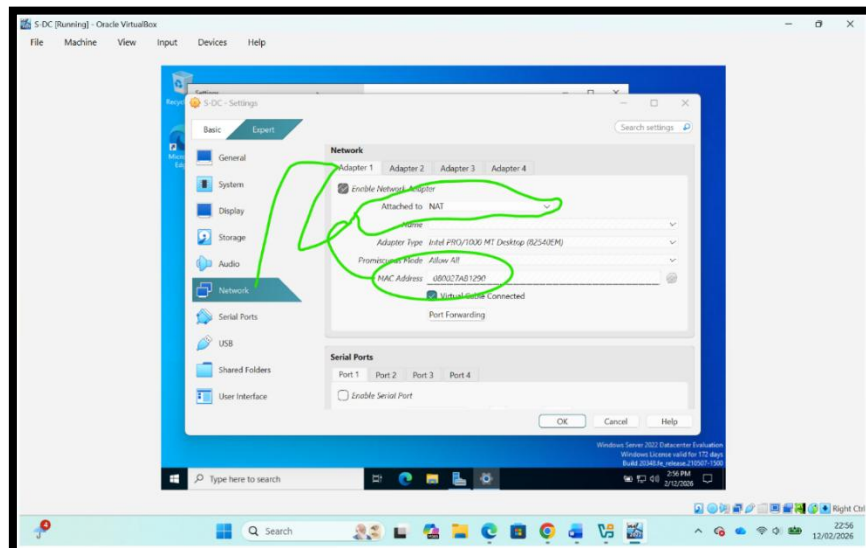


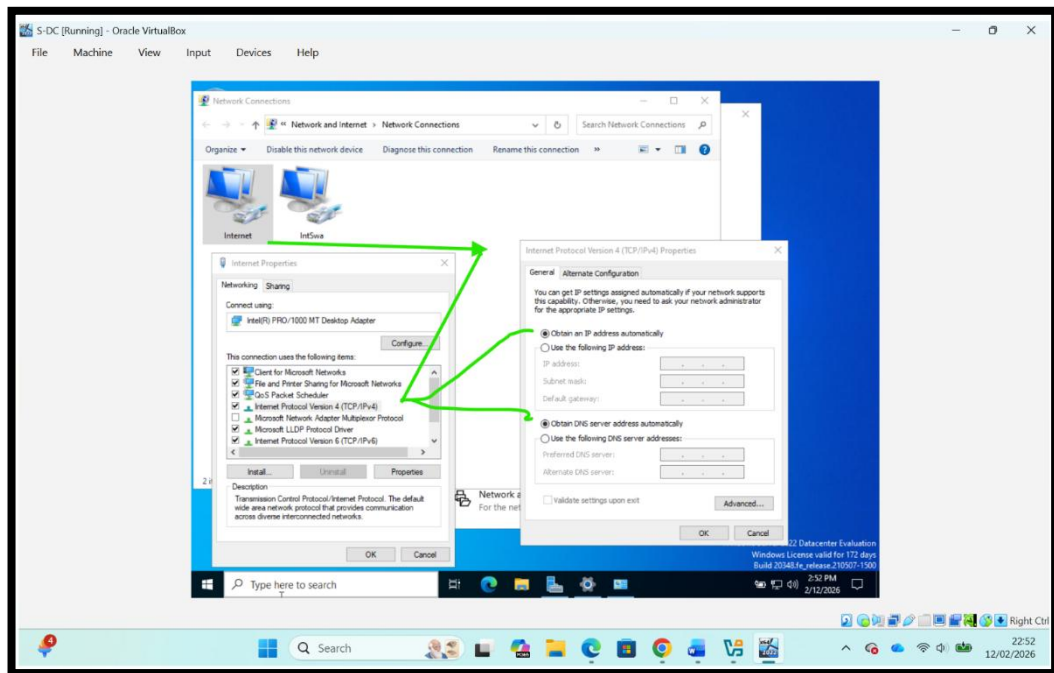
Figure 28 MAC Address

Below MAC Address same as above Physical Address.



Right click on Internet then Internet Protocols Version 4 (TCP/IPv4) selected obtain an IP address automatically. And click on obtain DNS server address automatically.

Figure 29 Obtain DNS server address automatically.



Tested after troubleshooting

Figure 30 Test: one

Ping 192.168.30.2 from S-DC

Well, done pining was successfully completed

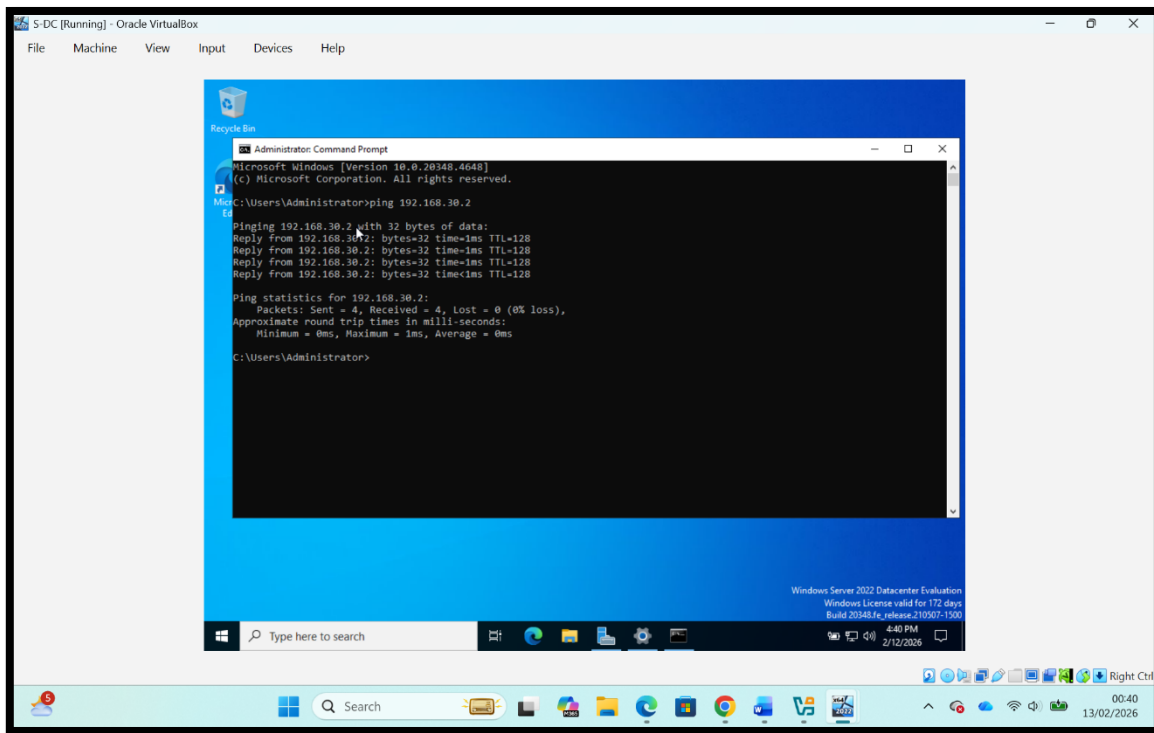
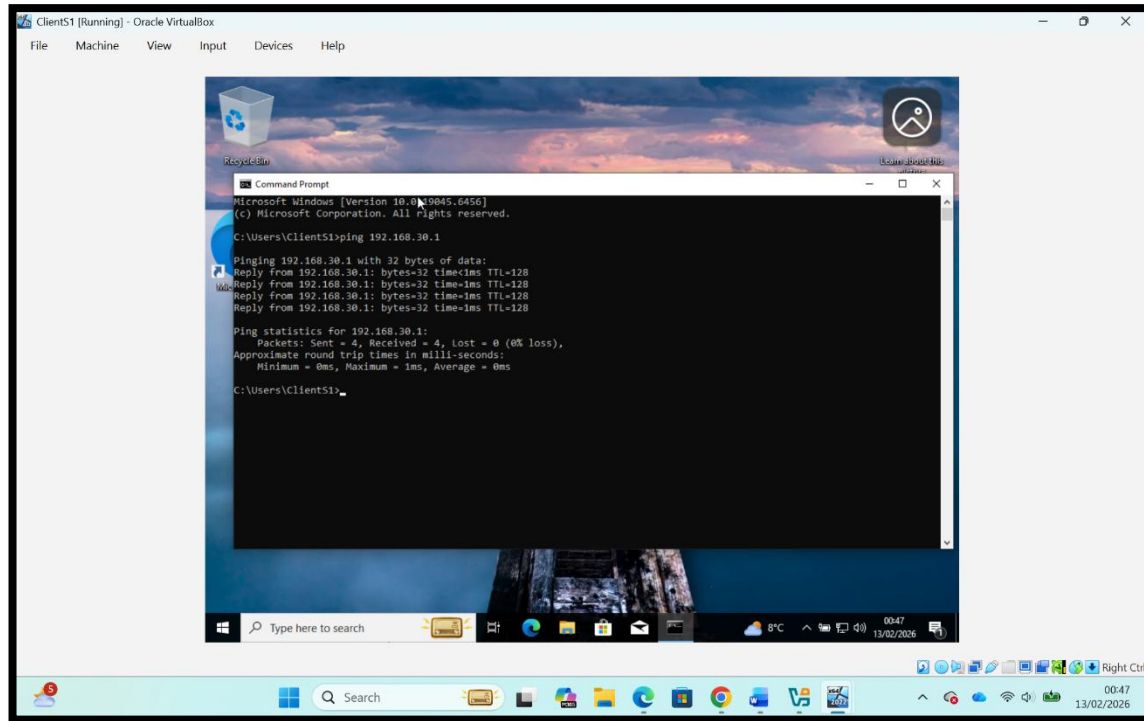


Figure 31 Test: two

Ping 192.168.30.1 from ClientS1 devices

Well, done ping was successfully completed see screenshot below



Test and Troubleshoot outcome:

Connectivity test with the same network was successfully completed confirming that S-DC server and virtual machines are properly configured.

L-DC role as a DHCP Relay

Figure 32 Entered the hostname

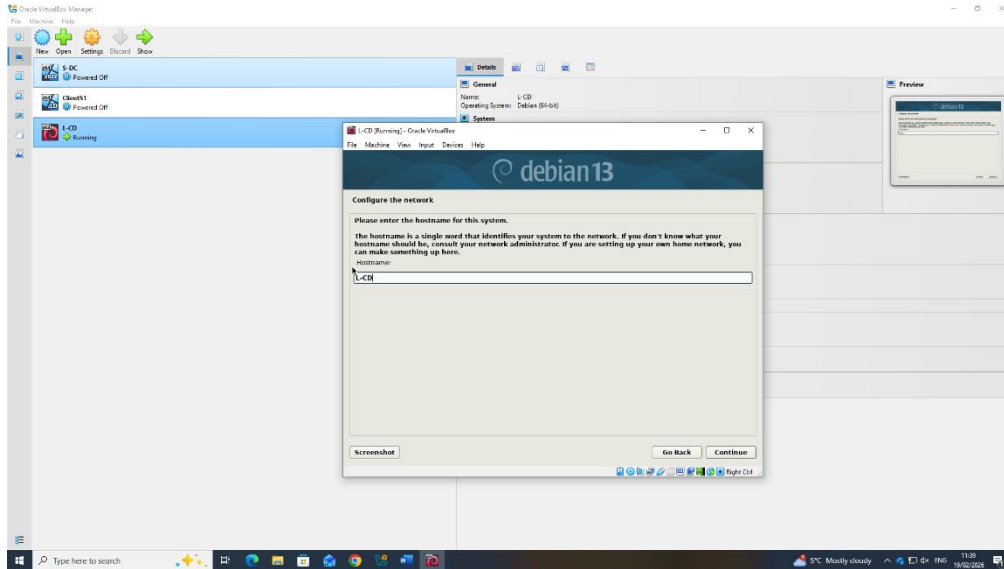


Figure 33 Set up users' password

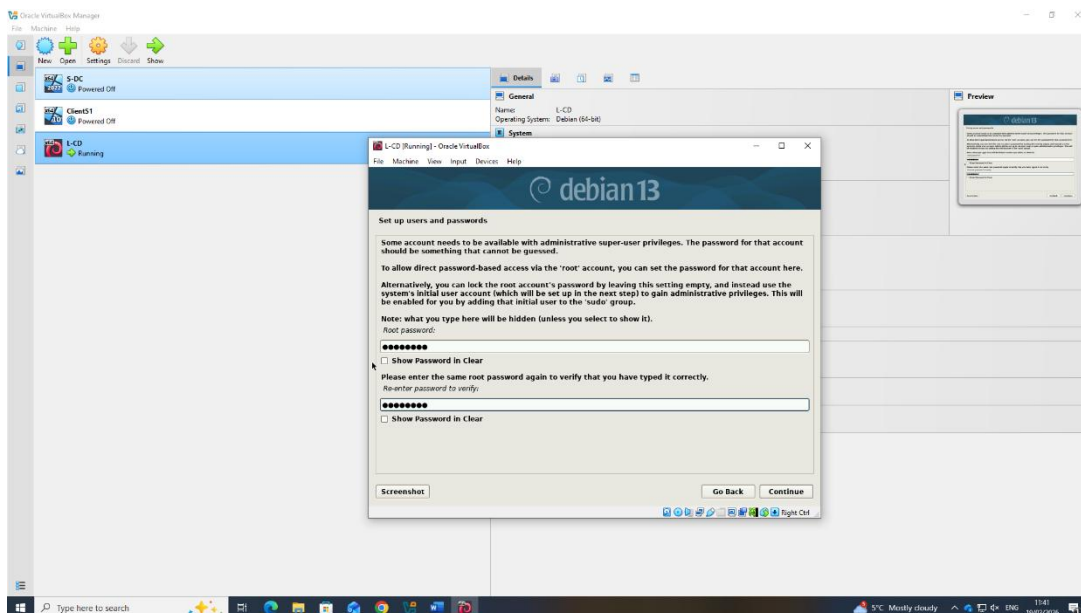


Figure 34 Set up user's name

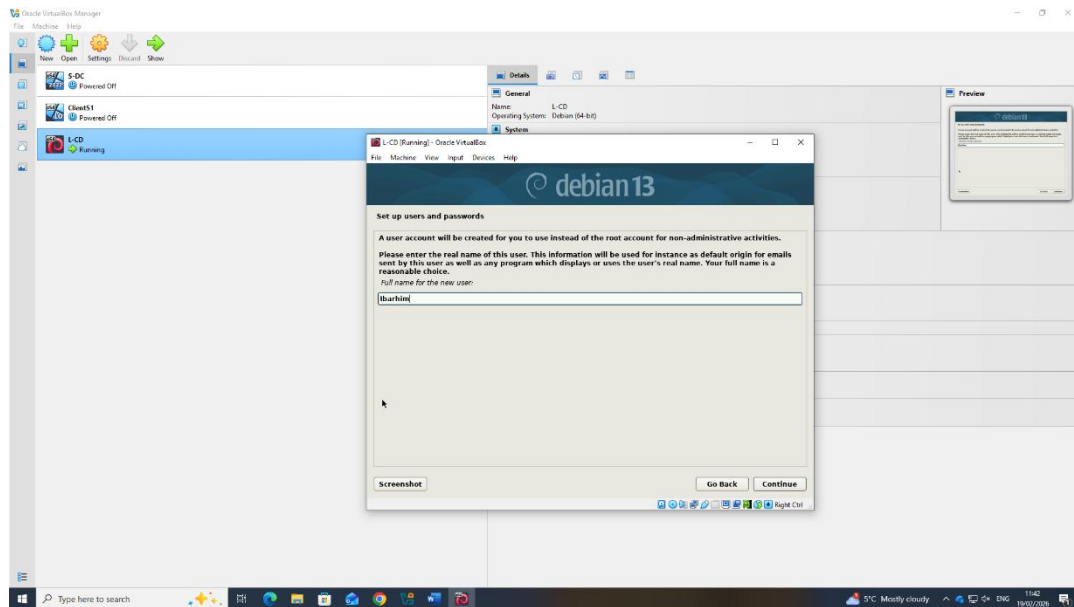


Figure 35 Finish partitioning and write changes to disk

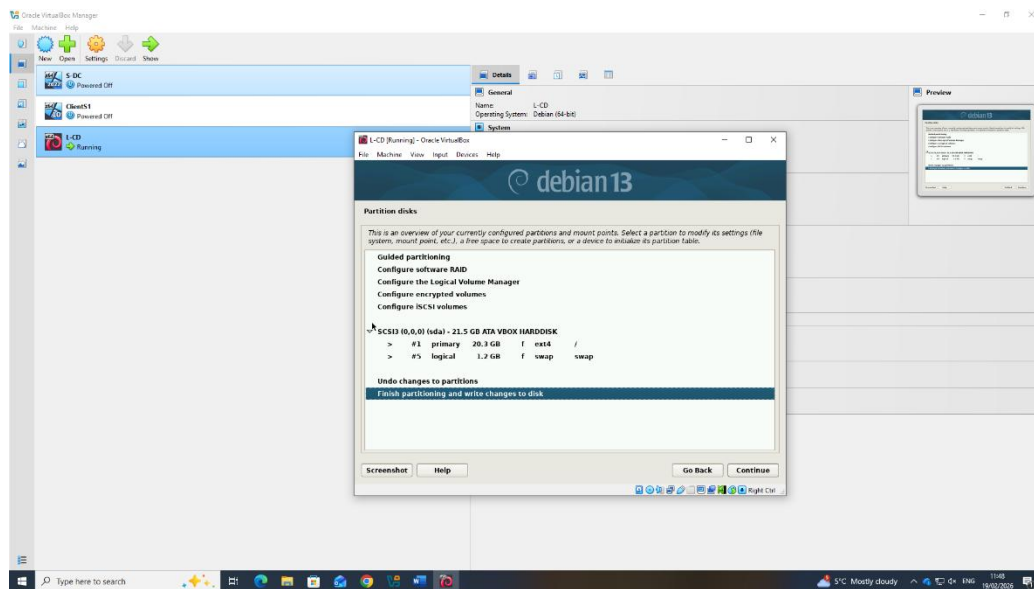


Figure 36 Software selection

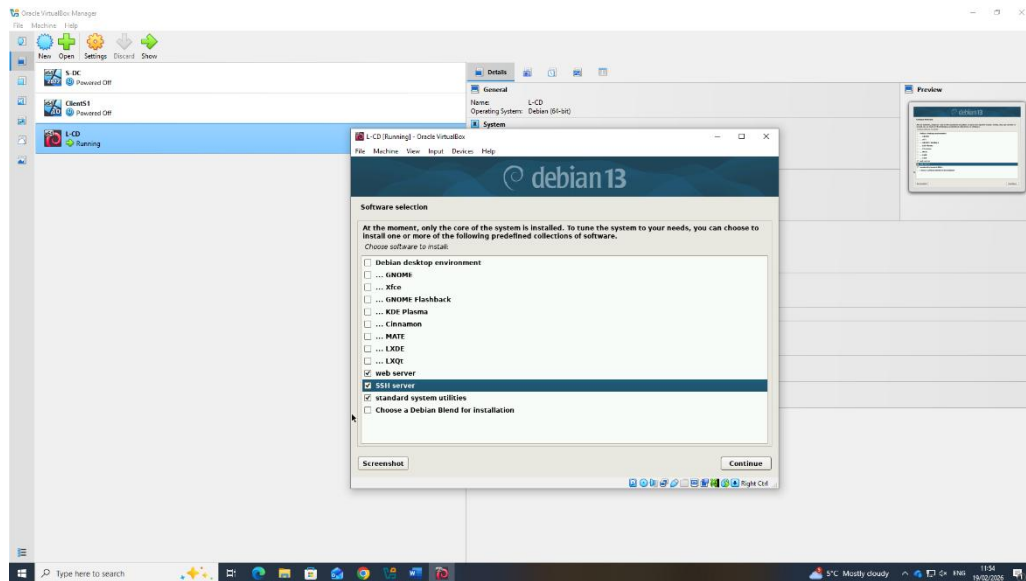


Figure 37 Select and install software

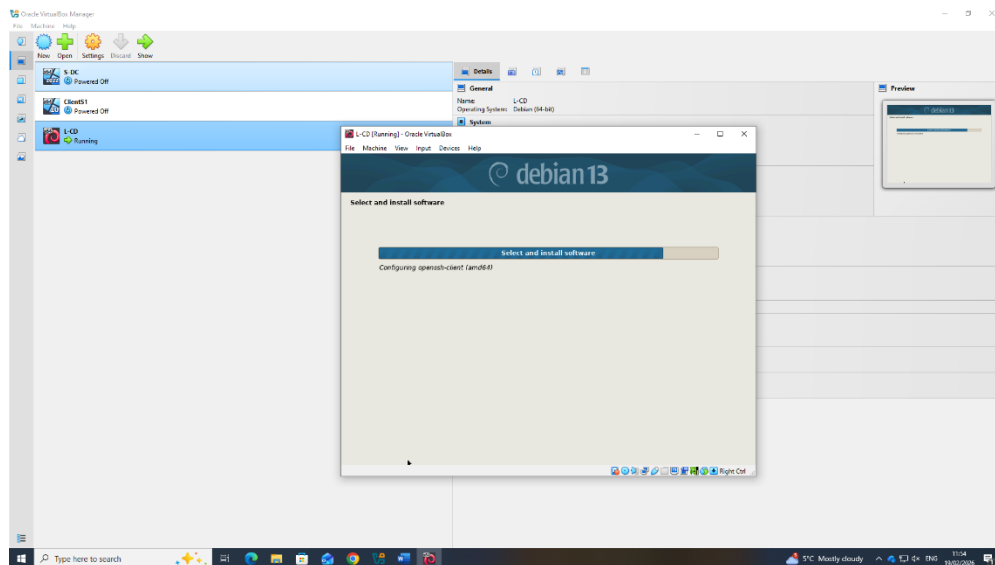


Figure 38 setting up memory and number of CPUs

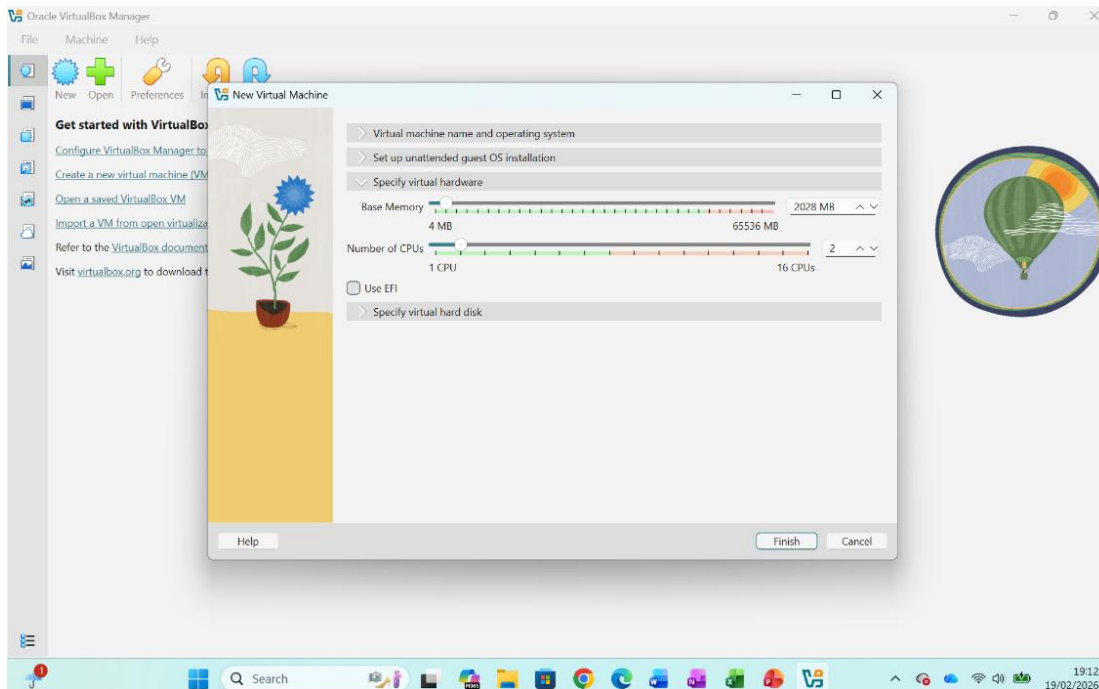


Figure 39 Base Memory

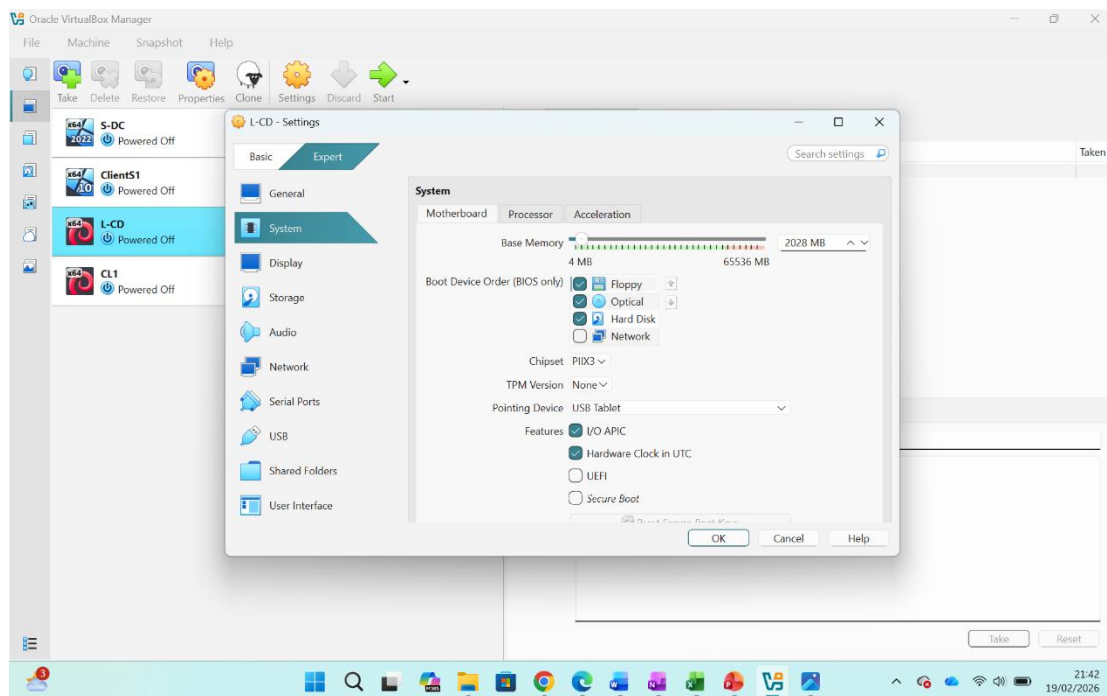
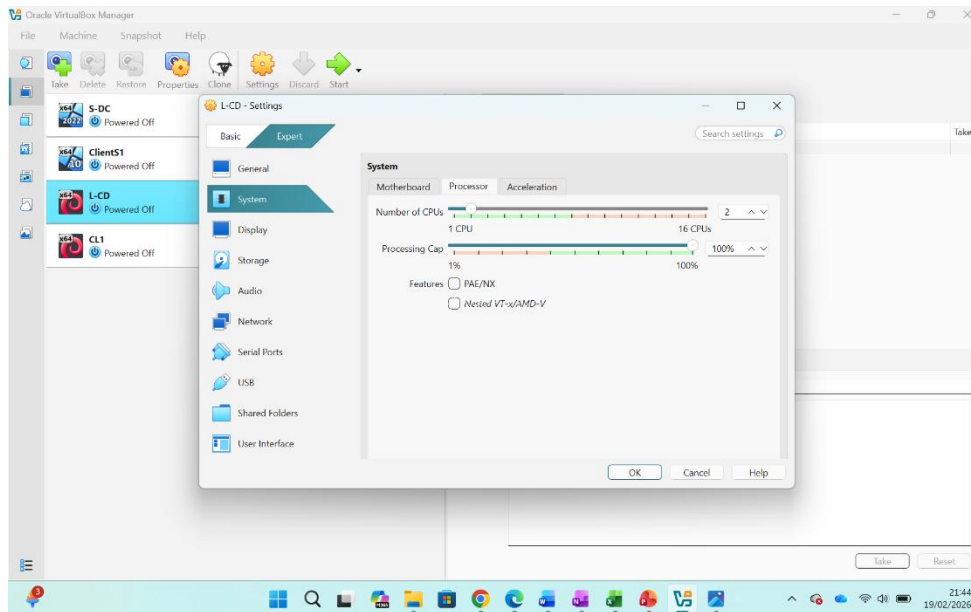


Figure 40 Number of CPUs Processor



Now are three Network Adapters Connections, External, Internet and INTLON

Figure 41 Adapter 1

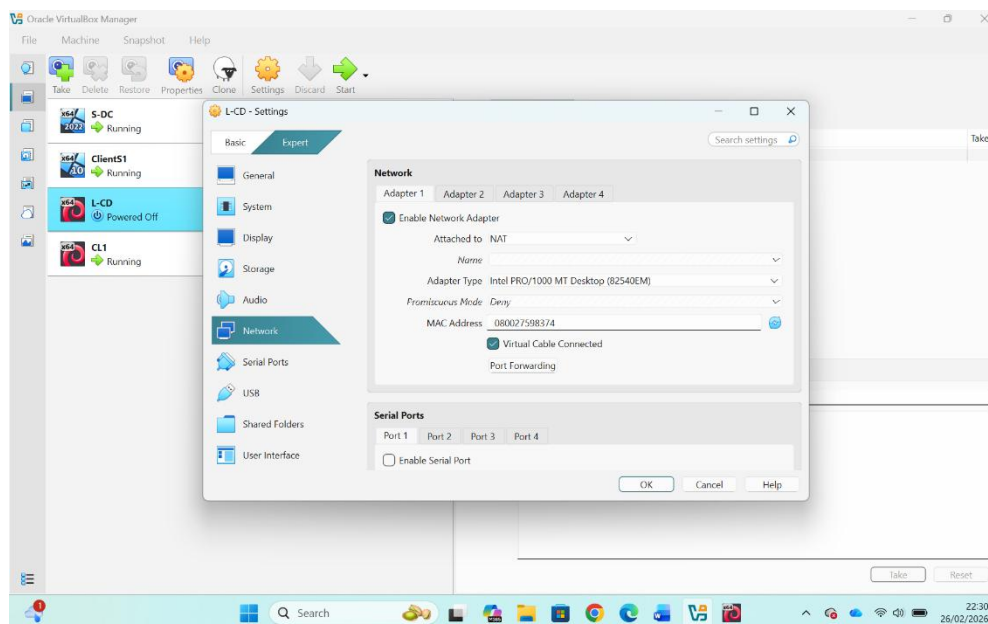


Figure 42 Adapter 2

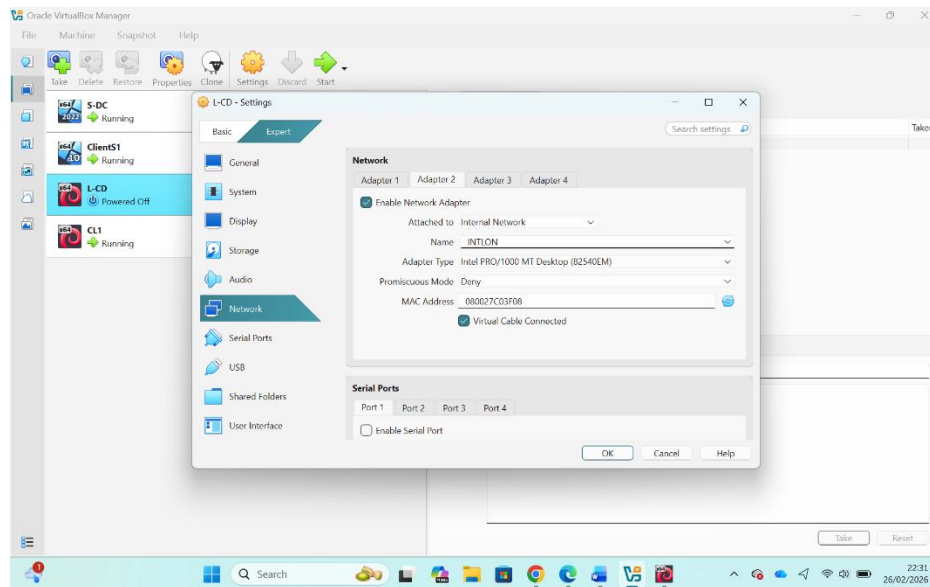


Figure 43 Adapter 3

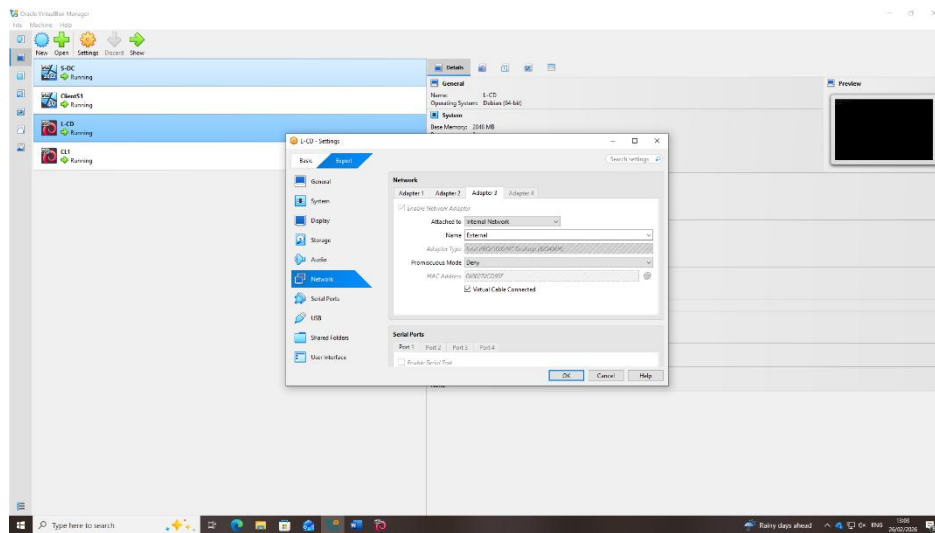
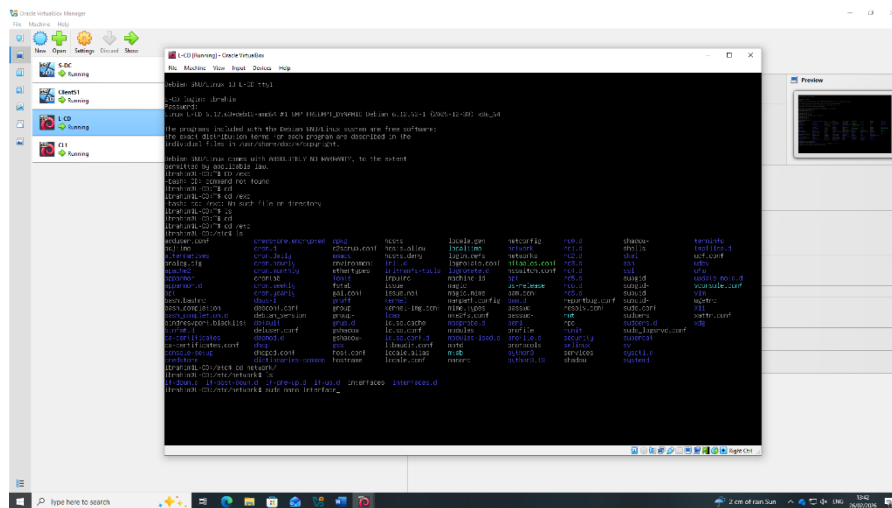
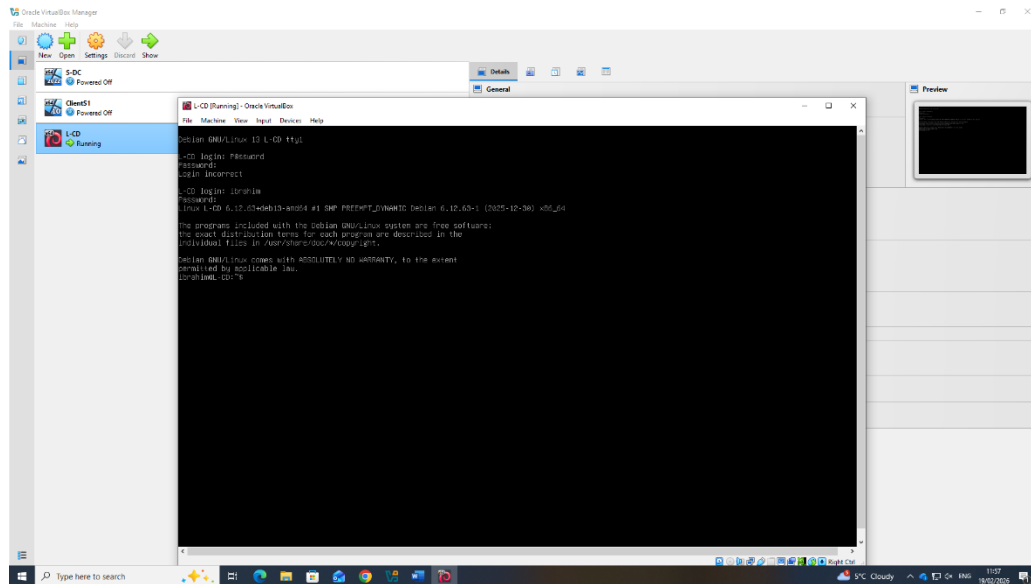
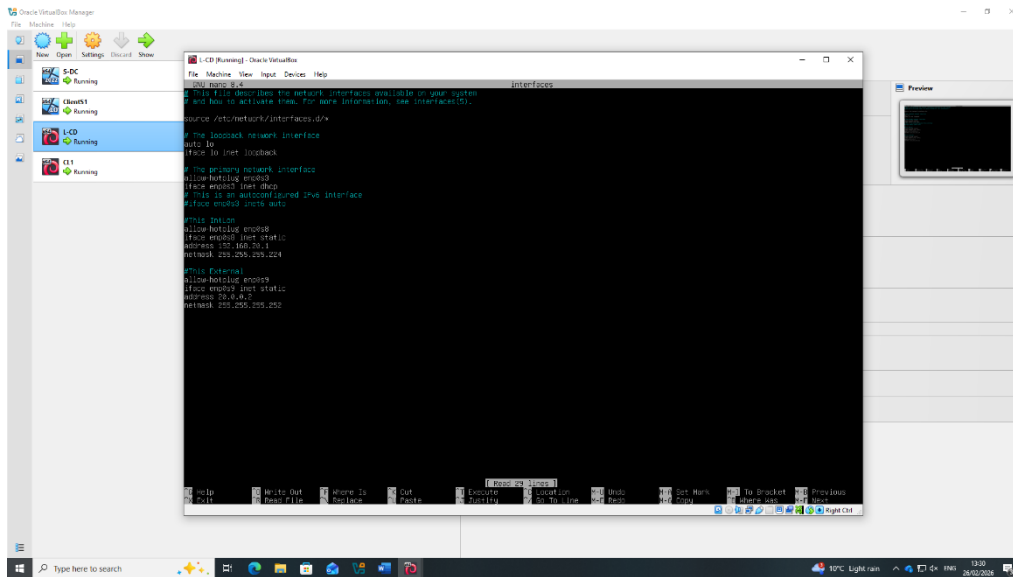


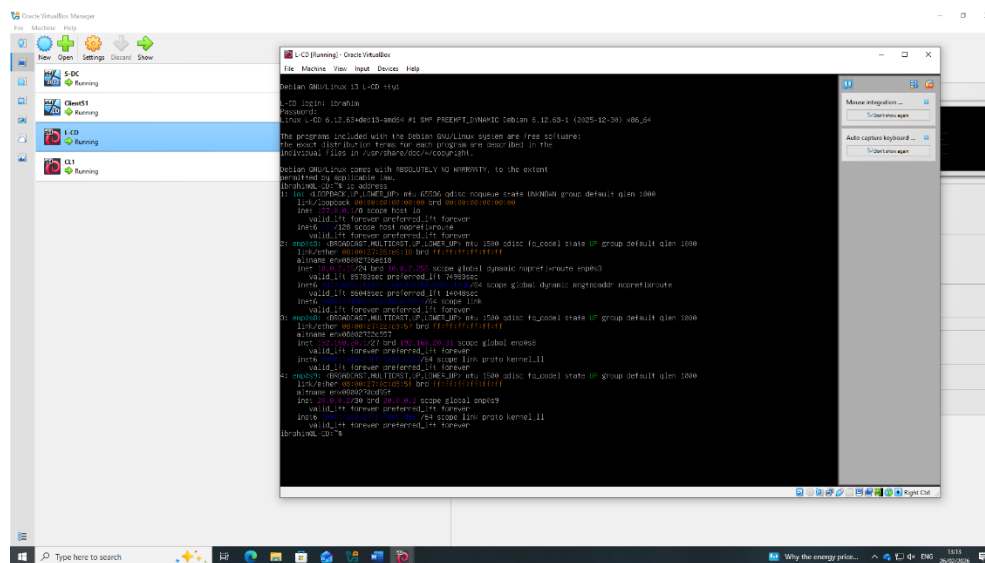
Figure 44 L-CD is ready to use



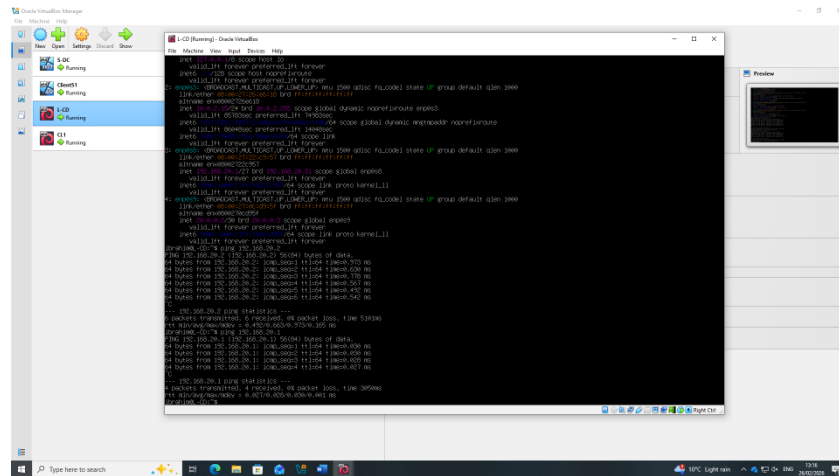
Setting up IP address configuration to L-CD



Check ip address from L-CD



Ping CL1 from L-CD



CL1 Device

Figure 45 Entered the hostname

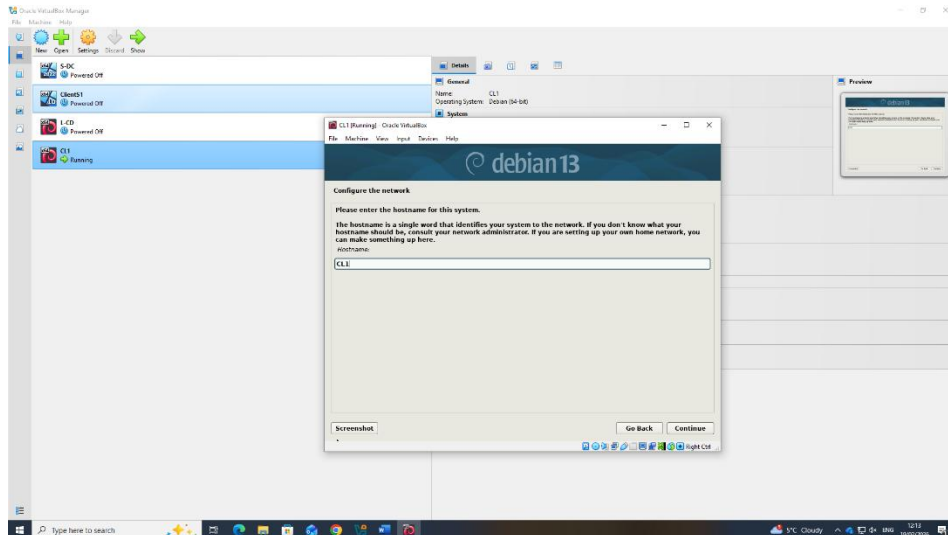


Figure 46 Set up users' password

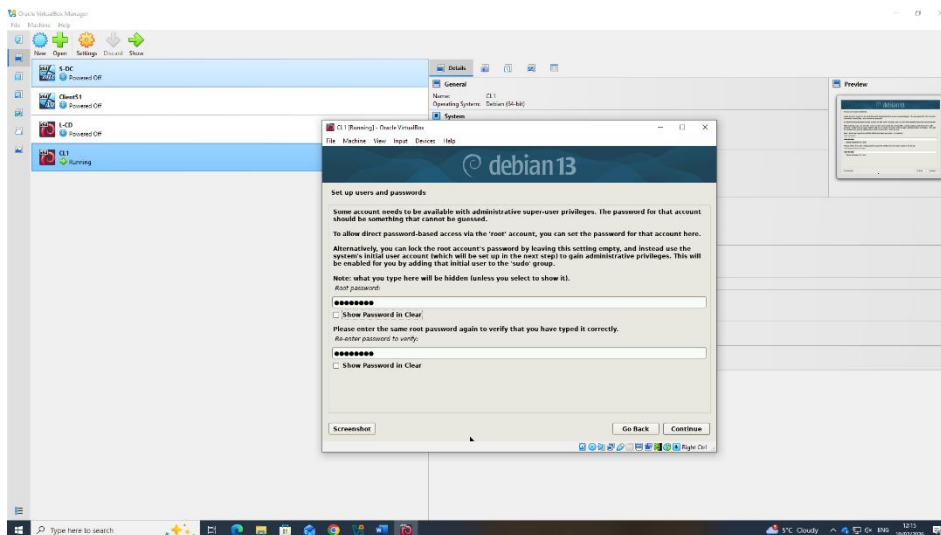


Figure 47 Selected Partition disks

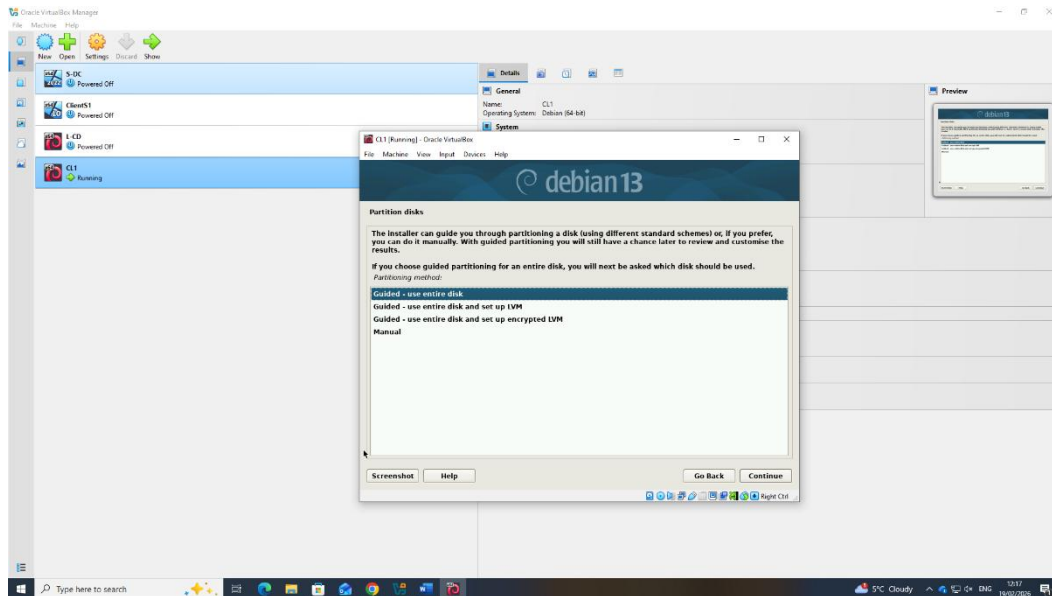


Figure 48 Software selection to install

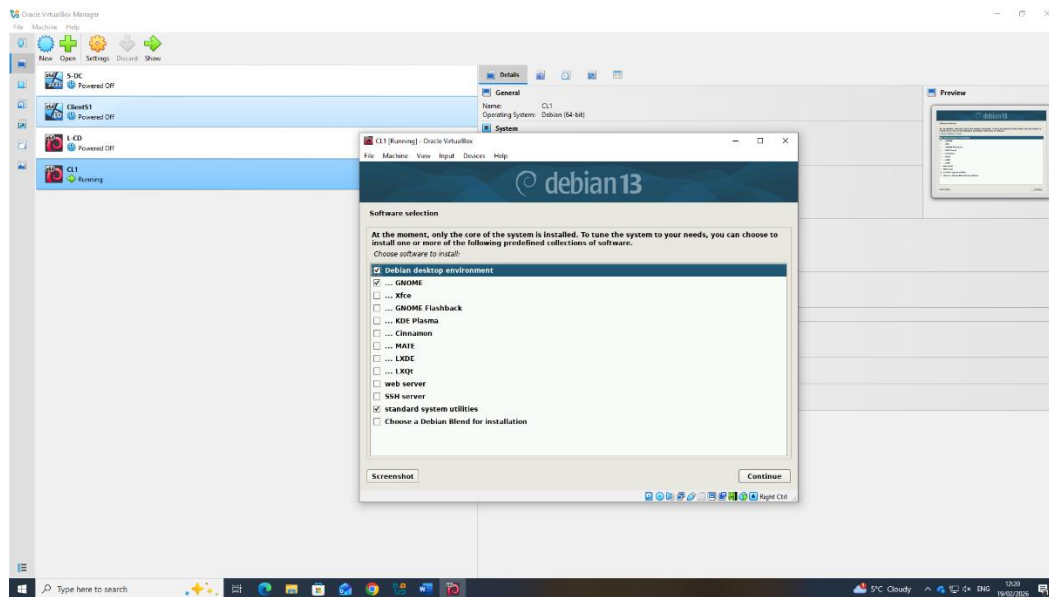


Figure 49 Require password to login

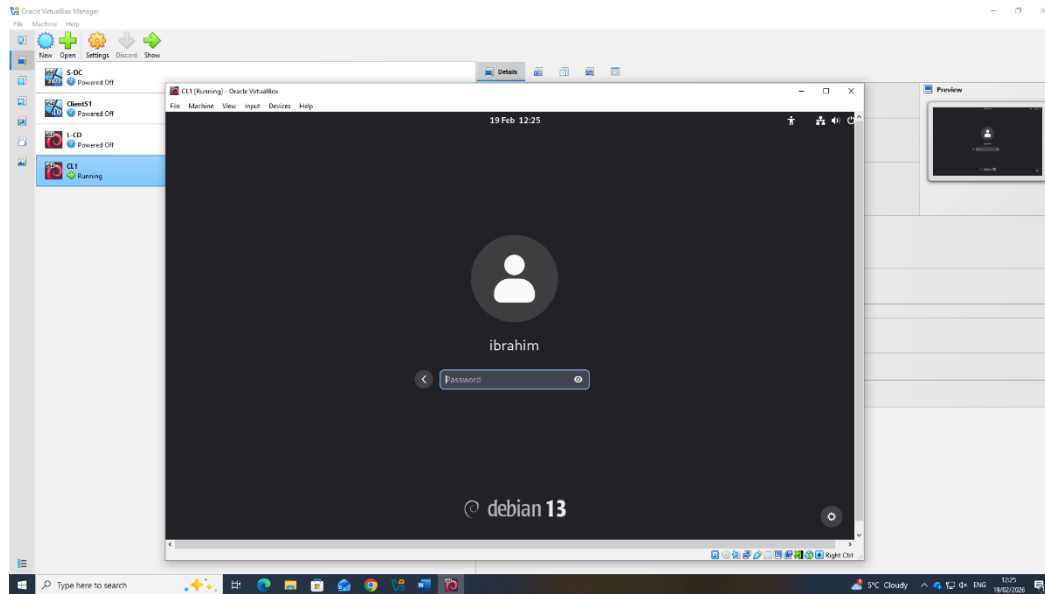
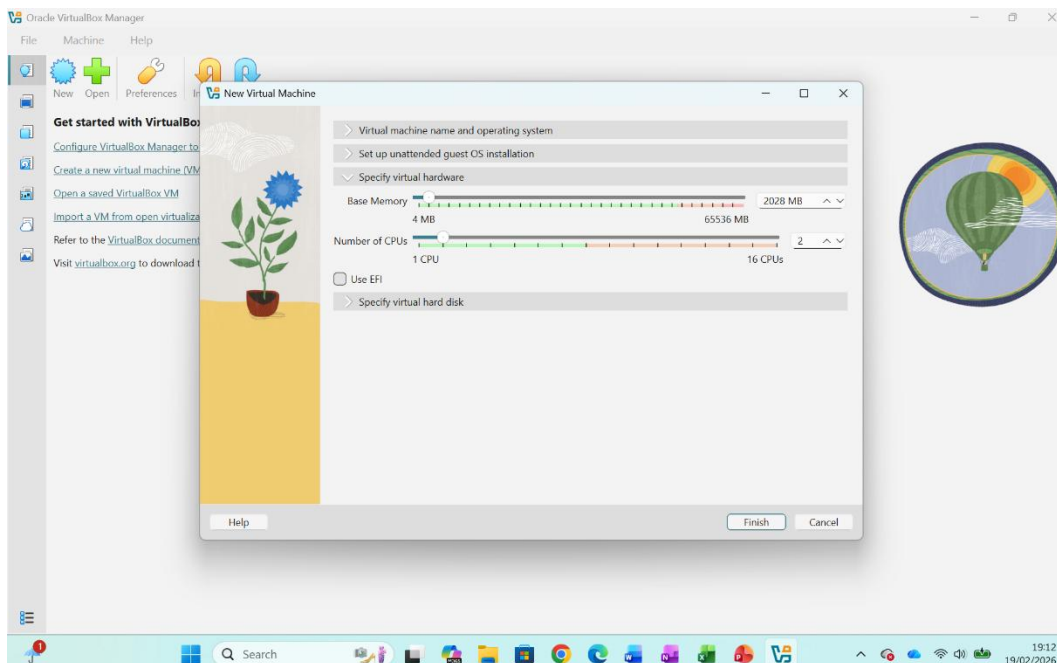


Figure 50 Set up base memory and number of processes are the screenshots.



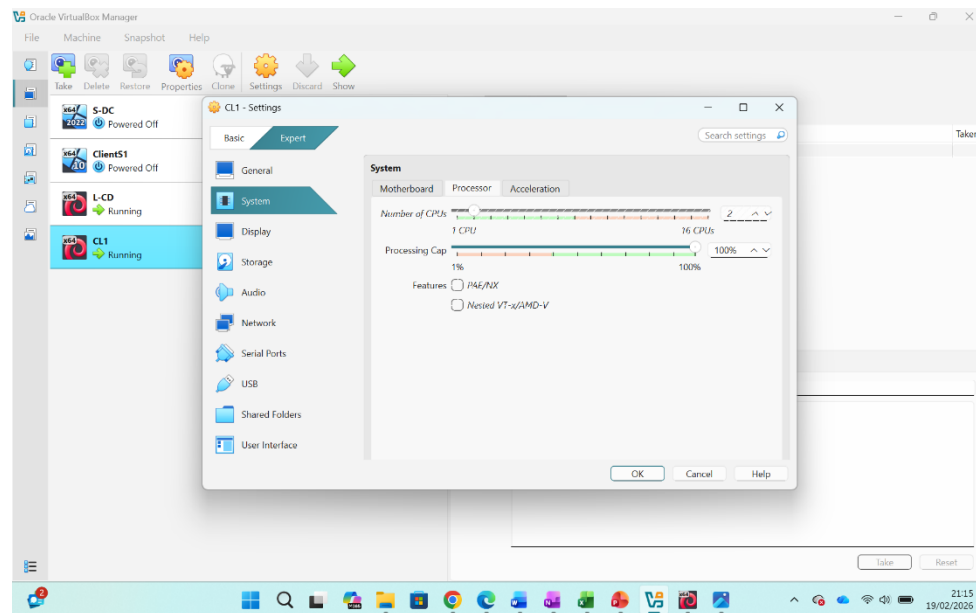
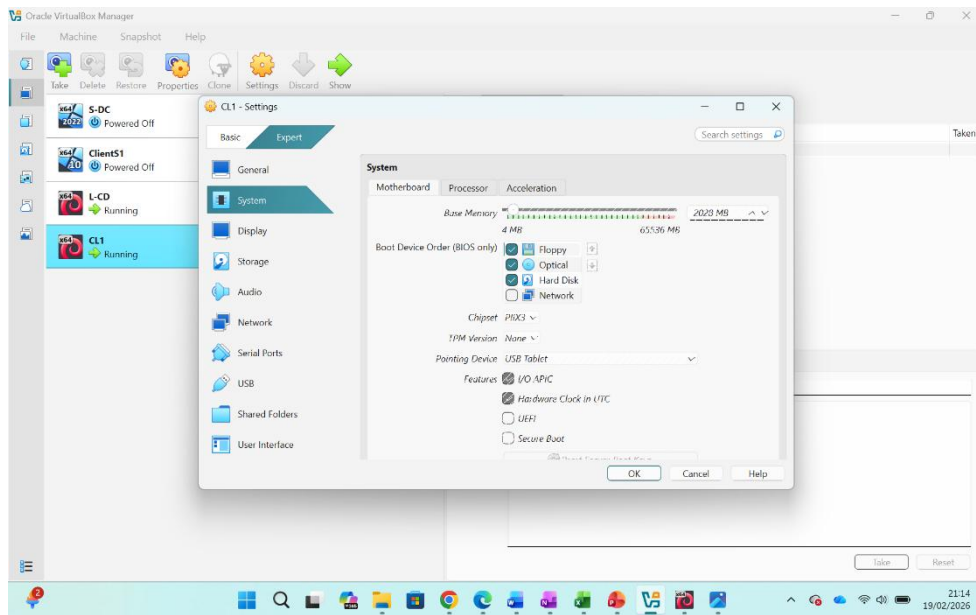


Figure 51 Adapter 1

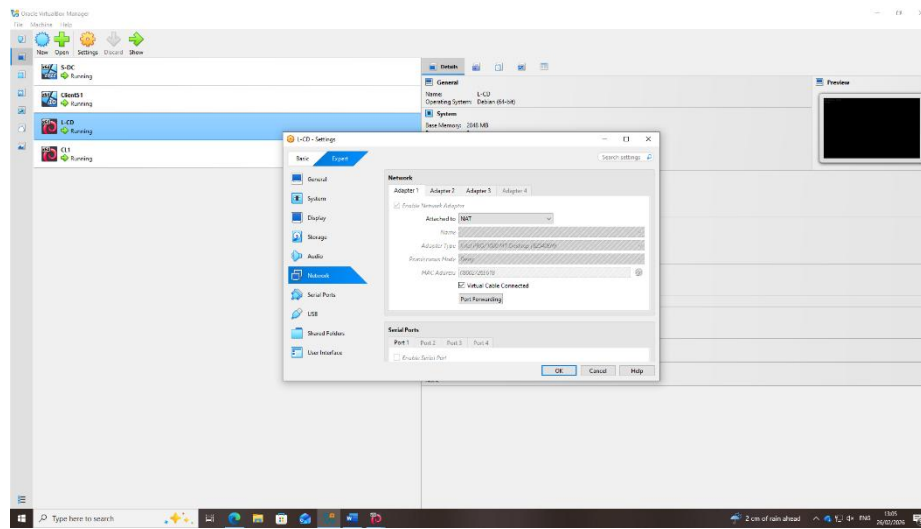


Figure 52 Adapter 2

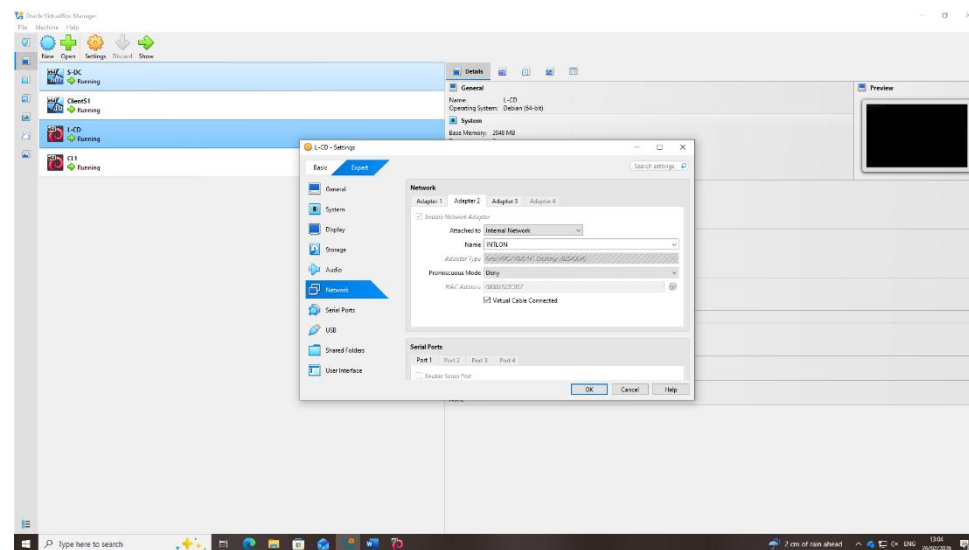


Figure 53 Setting up IP address for CLI

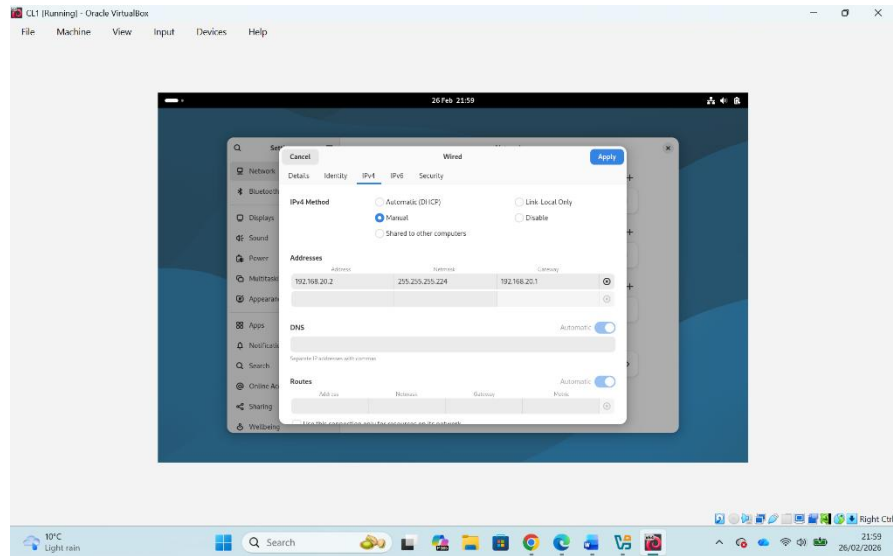


Figure 54 Download Sudo

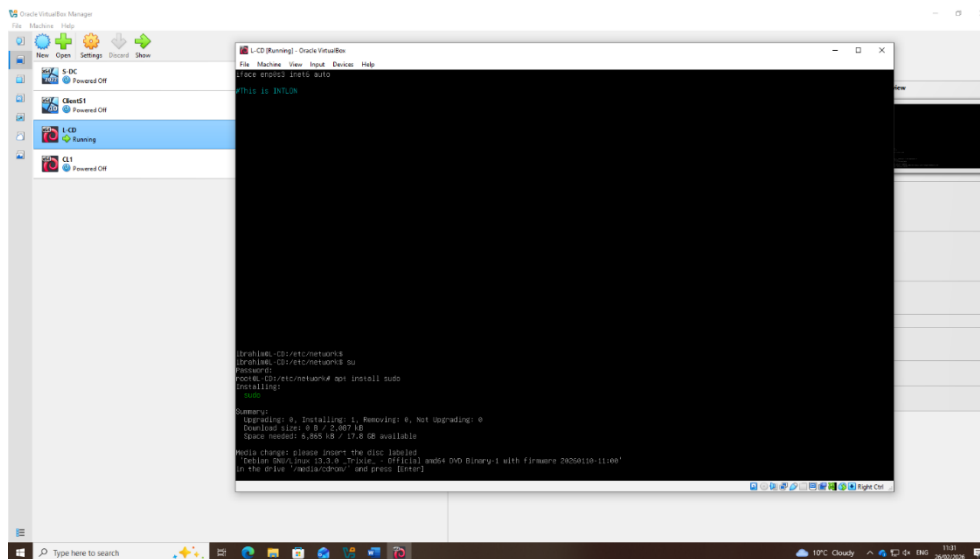
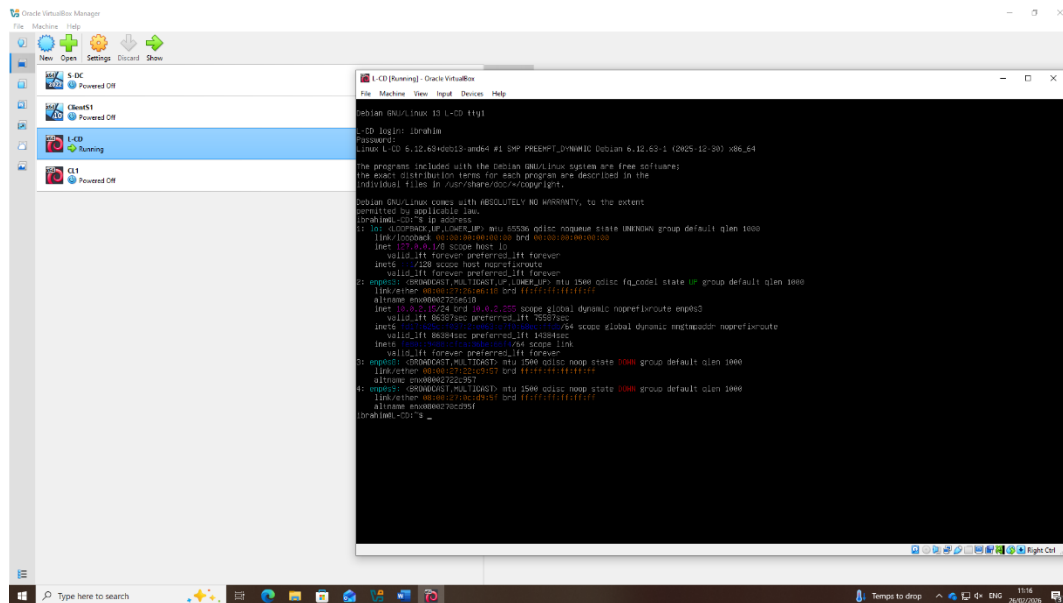
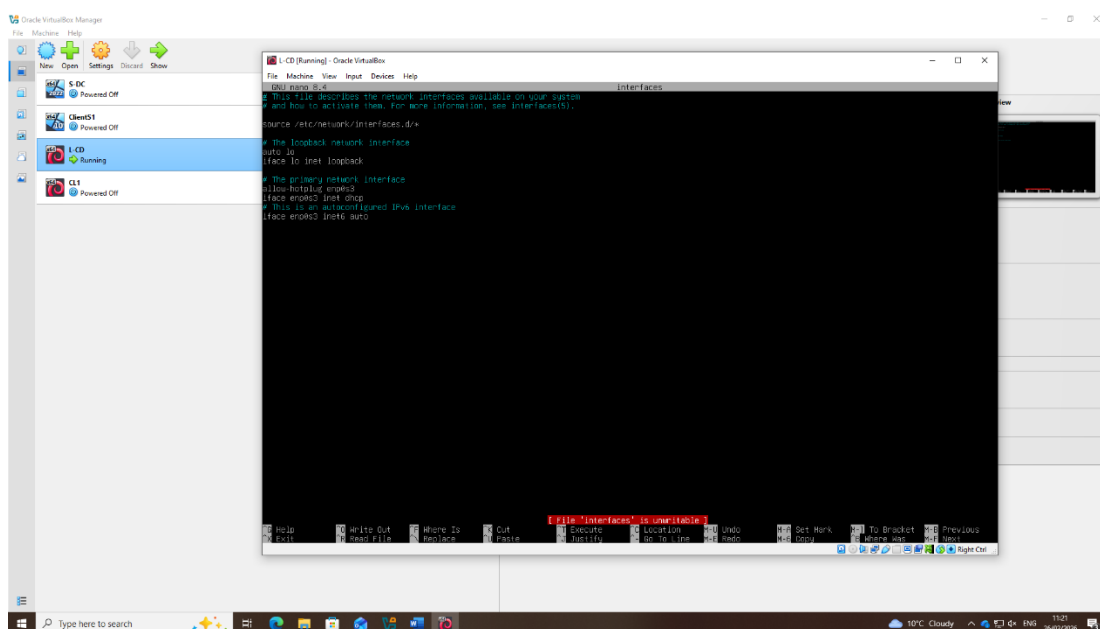
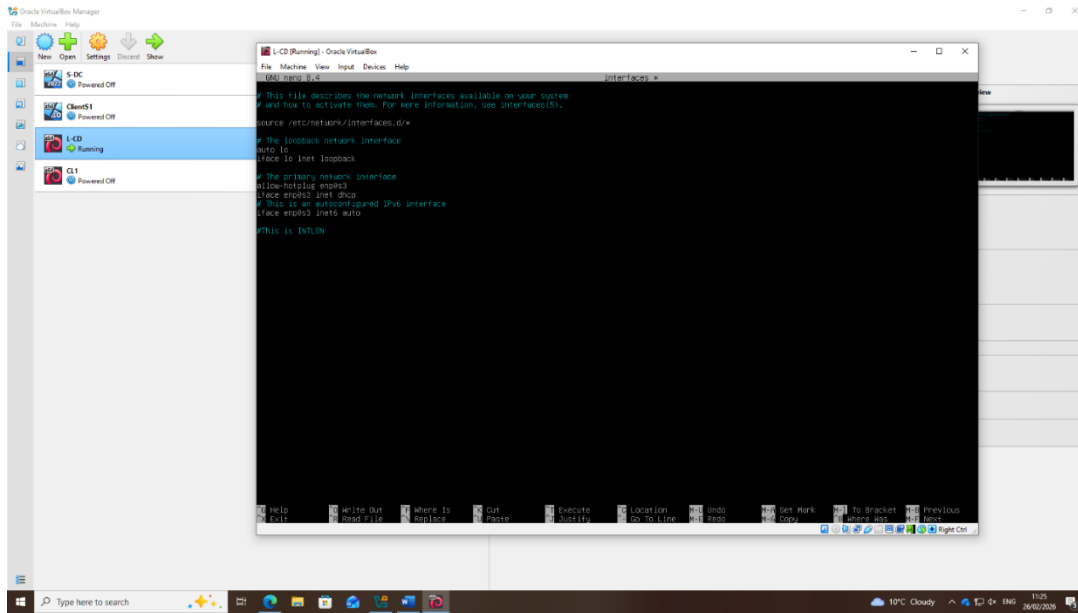


Figure 56 Checking IP Address from L-CD



Setting up loopback network, primary interface and autoconfigured IPv6 interface





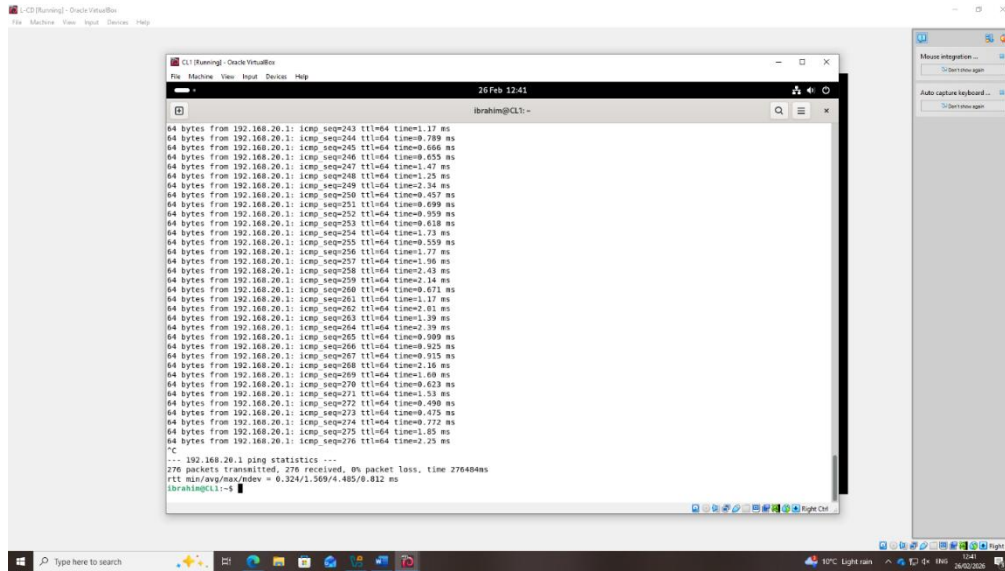
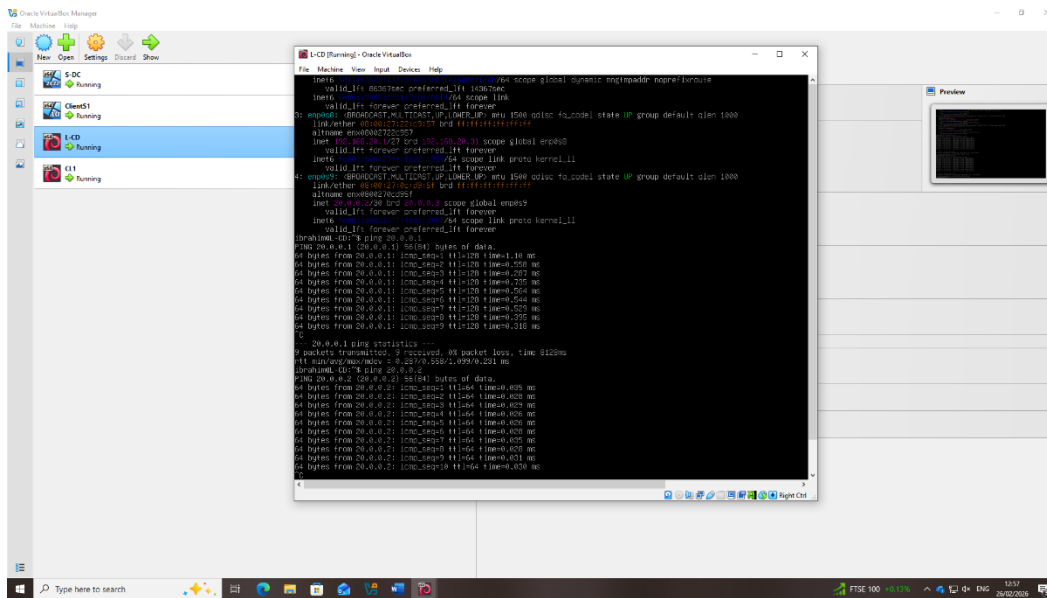


Figure 57 PINGING FROM L-CD TO S-DC

Pinging connectivity from L-CD to S-DC is working properly.



3. Research on Routing

Routing protocols determine how data is directed across networks. Static routing requires manual configuration of routing tables, suitable for small, stable networks, while dynamic routing uses protocols like routing information protocol (RIP), open shortest path first (OSPF) and border gateway protocol (BGP) to automatically update routing tables based on network changes, making it ideal for larger or more dynamic networks.

For the network topology with a Debian Server as a dynamic host configuration protocol (DHCP) Relay and a Windows Server providing DHCP services, dynamic routing such as OSPF is recommended [3]. This ensures that routers automatically adapt to network changes, providing seamless connectivity for devices across multiple subnets while facilitating efficient DHCP communication. [7]

There are two main types of routing:

- **Static Routing:** Are manually configured by an administrator.
- **Dynamic Routing:** Are automatically learned using protocols such as RIP, OSPF, or BGP.

4. Research on Network Services

Network Services are applications or processes that provide functionality to users and devices over a network. Common network services include:

Virtual Private Network.

A VPN creates a secure, encrypted connection for remote users to access a private network over the internet, ensuring data confidentiality and integrity.

Key Features:

- Remote Access allows users to connect from anywhere.
- Encryption for secure data transmission.
- Tunneling encapsulates data for secure transfer.

Best Practices

- Use strong encryption protocols. Implement multi factor authentication and update VPN software.

Dynamic Host Configuration Protocol

DHCP automatically assigns IP addresses and network configurations to devices, eliminating the need for manual address management. [8]

Key Features:

Automated IP Assignment reduces administrative tasks. Centralised management simplifies IP address management, and lease duration ensures temporary IP assignments, preventing conflicts.

Best Practices:

Use DHCP reservations for critical devices. Configure DHCP scopes to avoid addressing conflicts and monitor and log into DHCP transactions for auditing.

Active Directory Domain Services:

AD DS is a Microsoft directory service that stores and manages data about network resources, such as users and devices, and provides access to authorized users and applications. [9]

Key Features:

- Group Policy to enforce security and configuration policies across the network.
- Scalability to manage networks from small to large enterprises environments. Centralised authentication for secure user access.

Best Practices:

- Regularly back up AD for disaster recovery.
- Use role-based access control to manage permissions.
- Implement group policies for consistent security.

Certificate Authorities (CA)

The CA issues digital certificates that authenticate entities in a network, ensuring communication through encryption. [10]

Key Practices:

- Trust Chain establishes trust between parties using digital certificates.
- PKI stand for Public Key Infrastructure manages cryptographic keys
- Verify the identity of websites, emails, and users by digital signatures.

Best Practices:

- Renew certificates before expiration
- Use strong encryption standards and implement certificate revocation lists for compromised certificates.
- Domain Name System, translates domain names into IP addresses
- Dynamic Host Configuration Protocol automatically assigns IP addresses.
- Web Services, provide access to websites and web applications
- File and Print Services, allow sharing of files and printers over a network.

These services help manage networks and improve usability, performance, and security. [11]

Task 3

Reflection on Technical and Personal

- **Technical Reflection:**

During the Hyper-V setup, I encountered IP address conflicts caused by the S-DC server assigned duplicate IP addresses, leading to connectivity issues between virtual machines. Additionally, I have faced DNS resolution problems that hindered server communication.

Solutions Implementation:

Adjusted NAT settings to resolve firewall issues, enabling communication between virtual machines. Added a second network adapter, named INTSWA, and assigned the correct IP address of my chosen and configured static IP reservations for critical servers to avoid conflicts.

Personal Reflection

Key Learning:

Gained deeper understanding of virtualization and network services.

Hands on experience with setting up and configuring Hyper-V in a mixed Windows and Debian environment.

Skills Development

Improved problem-solving skills through troubleshooting.

Understanding how different network services like DHCP, DNS, and NAT interact to ensure seamless network communication with each other.

Overall, this coursework done improved my understanding of virtualisation and network configuration. By deploying and troubleshooting the network, I improved my technical and problem-solving skills and gained practical insight into the how different network components work together to ensure reliable communication.

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