



University of Wales

Trinity Saint David – London campus.

Assessment Title;

Research, build, and deploy a Virtual Enterprise network.

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BSc. Applied Computing .

Network Operating Systems and Services.

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Introduction .

In this study, Virtualization technology is used , which allows multiple operating systems and network services to be installed and run on a single machine using hardware resources managed by virtual machine . The student aims to documented the implementation of a virtual network environment using Windows Server 2022, Debian Server, and Clients in a simulated domain environment . The study aims to develop, implement, and evaluate a network topology, where IP addressing and connectivity configurations have been applied appropriately. This study aims to explain the process of choosing an appropriate virtual machine, virtual machine configurations , connectivity for reliable communication within the network environment.

Task 1

Research on Hypervisor

The hypervisor help in process of virtualization by creating an environment where multiple operating systems can run at the same time on a single physical machine. There are two types of hypervisor , namely Type 1 and Type 2. Type 1 runs directly on the physical hardware, and the virtual machines are run by the hypervisor. This type of hypervisor is better in terms of performance, security and efficiency, as the interaction with the physical hardware is direct. [1] . Example of Type 1 hypervisors are Microsoft hyper visor. On the other hand , Type 2 runs on top of an operating system. In this case , the interaction with the physical hardware is done by the operating system. This type of hypervisor is easier to install, especially in a desktop environment . However, it poses a security risk at it relies on the host operating system..{ 1 } , { 2 } . Examples of type 2 hypervisor are VMware Server, VirtualBox, and Microsoft Virtual PC.

For the BIRMINGHAM . ACCA domain , the best hypervisor that can be used in the topology is Microsoft Hyper-V , as it is a Type 1 hypervisor . This is due to the need for the topology to support enterprise level services such as Windows Server 2022 and Debian Server, Hyper-V is compatible with windows environments, as well as Linus environments such as Debian . { 2 } . Considering the improved topology, the use of a type 1 hypervisor would also improve the scalability of the system in case more clients are added. This is due to the ability

of Type 1 hypervisors to handle multiple operations systems at the same time. In a domain - based infrastructure, identity services and authentication are critical. As a result, the use of Type 1 hypervisor would provide a better solution compared to a Type 2 hypervisor.

Research on IP Address

The IP address is a essential for transmitting data between networks. In the context of network communication , the data transmitted over the internet through this process of segmentation includes source and destination IP addresses . These IP addresses enable routers to identify the path for the data to travel as it passes through various networks until it reaches the destination device { 3 }. Without IP addressing , the devices would not know the source or destination of the data being transmitted.

Two different iterations of IP addressing have been developed, namely IPv4 and IPv6. In IPv4 includes a 32 – bit IP addressing system. Using dotted decimal notation , for example, 192.168.1.10. This system enable 4.3 billion unique IP addresses . Due to the rapid expansion of the internet, IPv6 was developed, using a 128- bit hexadecimal notation ., for example , 2001; db8;;1. This significantly increased the number of IP addresses , thus enhancing the routing process. { 3 } Another important concept of IP addressing is subnetting , which enables the segmentation of a network into smaller, logical networks. This process of subnetting , for example , enables the segmentation of a network such as 192.168.1.0/24 into smaller subnets. This improves the organization of the network, reduces the number of broadcasts, and enhances the security of the network. This process of subnetting enable the effective allocation of IP addresses for enterprise networks. The use of structured IP addressing systems improves the management , scalability, and routing of networks. Addressing systems also improve the segmentation of VLANs , troubleshooting , and allocation of resources for IPv4 and IPv6 network. { 4 } {11 }.

Research On Routing

The routing, network devices are required to identify an optimum route for routing data from disparate networks. Routers utilize routing tables and routing protocols to identify the destinations of data packets. This ensures efficient routing of data from source to destination . Routing can be implemented through static routes or by utilizing routing protocols such as OSPF, RIP, or BGP.. { 5 } . For static routing , routes are manually configured in routers. This makes it efficient solution for a network with a small number of nodes or a network with a topology that does not change often. However , the method does not allow routers to respond to network topology change automatically. { 5 } . For the current topology , the Debian server is configured to act as a DHCP relay to forward DHCP relay to forward DHCP requires from client subnetwork to the windows server. For this network topology , it is deemed that a static routing solution would be most appropriate. This is because a static routing solution would ensure efficient connectivity among the windows server , Debian server, and client networks. This solution would also be ensure a high degree of simplicity and security for the network topology. Dynamic routing would be required only if there are changes to the network topology that would require routers to manage routes automatically . { 6 } .Routing has emerged as the primary addressing method on the internet, while bridging remains prevalent in local area network.

Research On Network Services

In Contemporary enterprise networks, various critical service are employed for managing identity , connecting , and secure communication . These services comprise the Dynamic Host Configuration Protocol (DHCP) , Virtual private Networks (VPNs) , Active Directory Domain Services (AD DS) and Certificate Authorities (CA) x, The dynamic Host Configuration Protocol (DHCP)is a service that enables the automation of IP addresses and

other network configuration parameters for devices in an enterprise network. DHCP helps in efficient management of Ip addresses by reducing manual errors in network configuration . In a domain network,, DHCP can be used in conjunction with Active Directory for better management and security. { 6 } . Active Directory Domain Service that enables efficient management of security , authentication , and directories in a windows -based enterprise network,. This service allows administrators to manage users , machines, and security in an entire domain networks. AD DS also allows administrators to apply group policies that ensure security configurations on various machines in the domain network. { 7 } . Certificate Authorities (CA) are responsible for managing certificates that are used for encryption , authentication , and secure communication . In an enterprise network, an internet public key infrastructure (KPI) is employed for trusted communication .{ 8 }. Best practices for PKI security recommend that root Cas should always be secured, and a hierarchical public key infrastructure should always be employed. Lastly, Virtual Private Networks (VPNs) provide secure remote access for user by creating an enterprise Network . This allows users to access domain resources from remote locations , maintaining the confidentiality and integrity of transmitted information .{9 } {10}

Task 2

2.1 Choose your Hypervisor

Selected Hypervisor ; Oracle VirtualBox

For this current network typology, oracle virtual Box , which is type 2 Hypervisor , has been selected for use in this setup. Hypervisor can be classified into Type 1 and Type 2 , with Type 1 being better for performance and scalability, while Type 2 is better suited for development and testing environment.

Hypervisor Selection and Justification

Justification with Evidence

The choice of virtual-Box as the hypervisor for this network topology was informed by several factors, as discussed below;

- Multi-OS Compatibility;

The network topology requires windows server 2022 and Sebian Server to be installed, Virtual-Box supports both operating systems, ensuring that both environment can be integrated seamlessly..

- Hardware Constraints.

The network topology will be setup in one machine, and virtual Box can support this since it can be configured to utilized available CPU, RAM. And disk space, which could limited in this setup.

- Networking Capacities

Virtual Box has been noted to support severd networking factors , such as NAT, Bridge , Internal Network, and Host – Only Adaptor . Which can be used to create environments that can mimic real -world network scenarios as required in this topology.

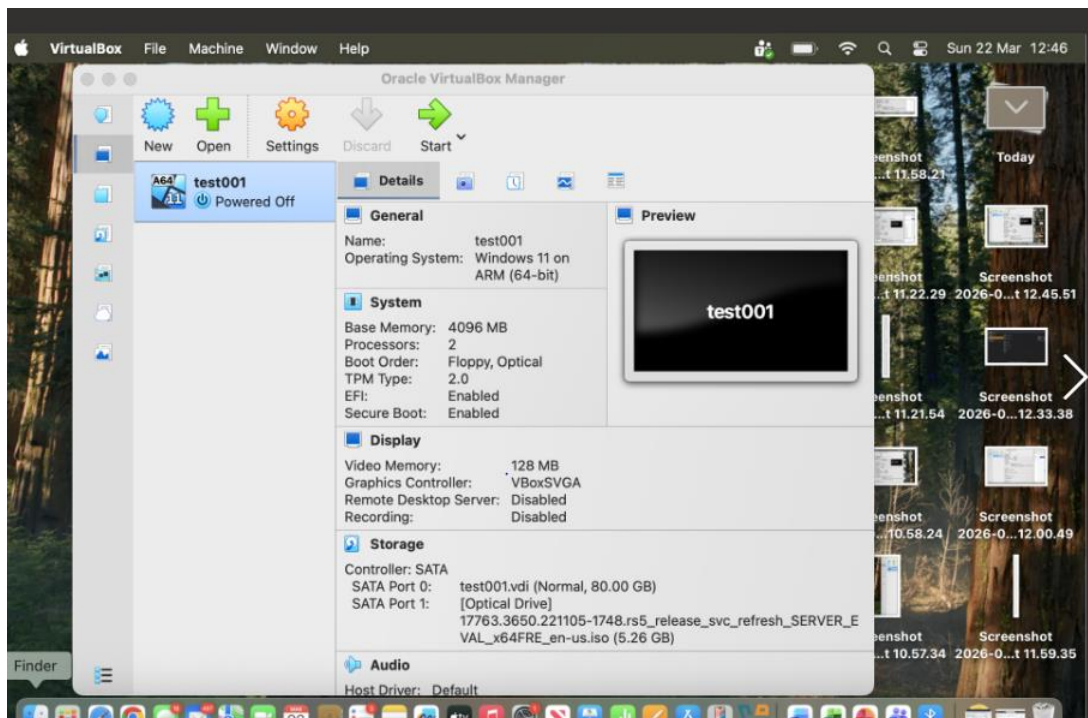
- Scalability For Coursework;

This network is to `be expected to include services such as Active Directory , DHCP, VPN, and certificate services. Virtual Box makes it easier to extend the network by adding more virtual machines and networks without having to purchase additional hardware .

- Ease Of Use and Deployment;

Virtual Box comes with a graphical interface that make it easier to use and deploy virtual machines , Therefore , it is suitable for the use in academic environments . From the above factors, it is evident that virtual Box is capable of providing a practical and cost effective solution for deploying the specified network topology.

2.2.1 The Evidence download.



C

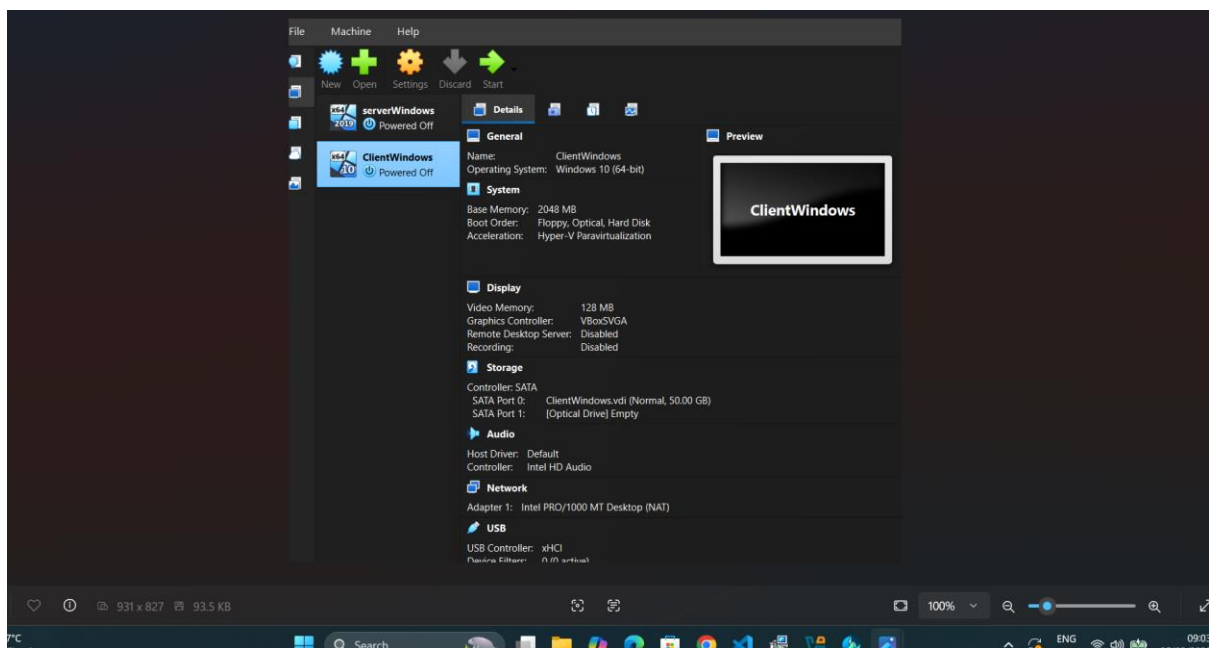
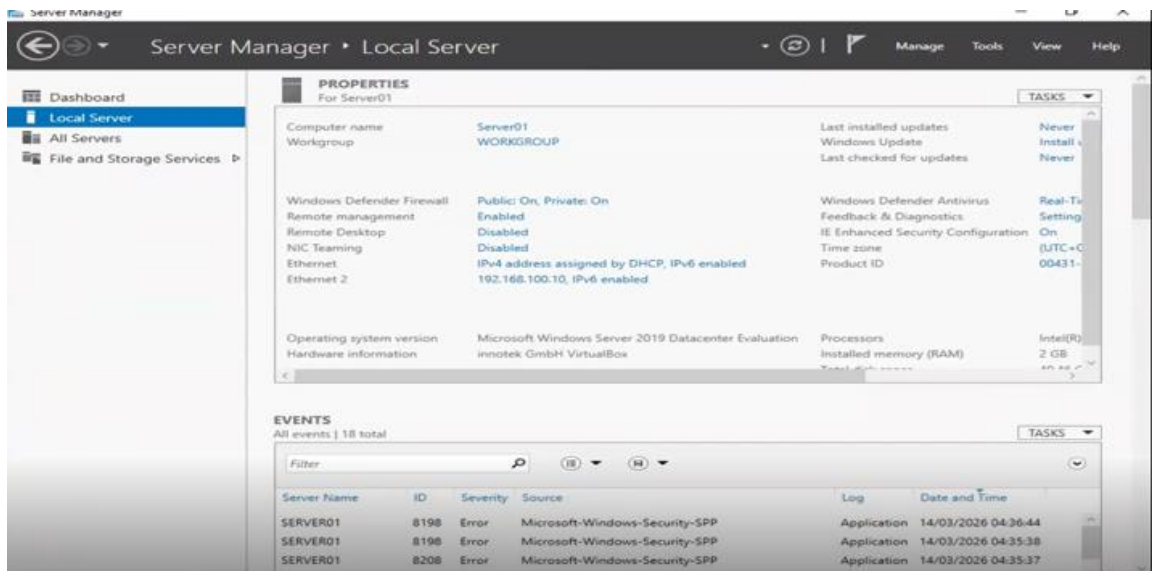
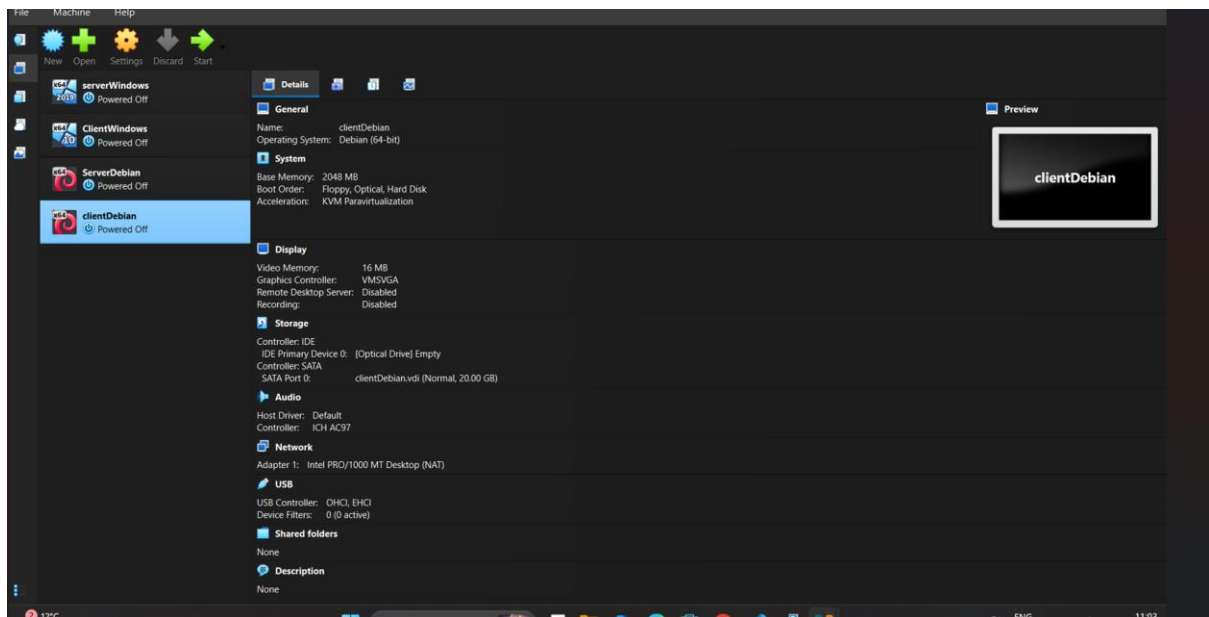
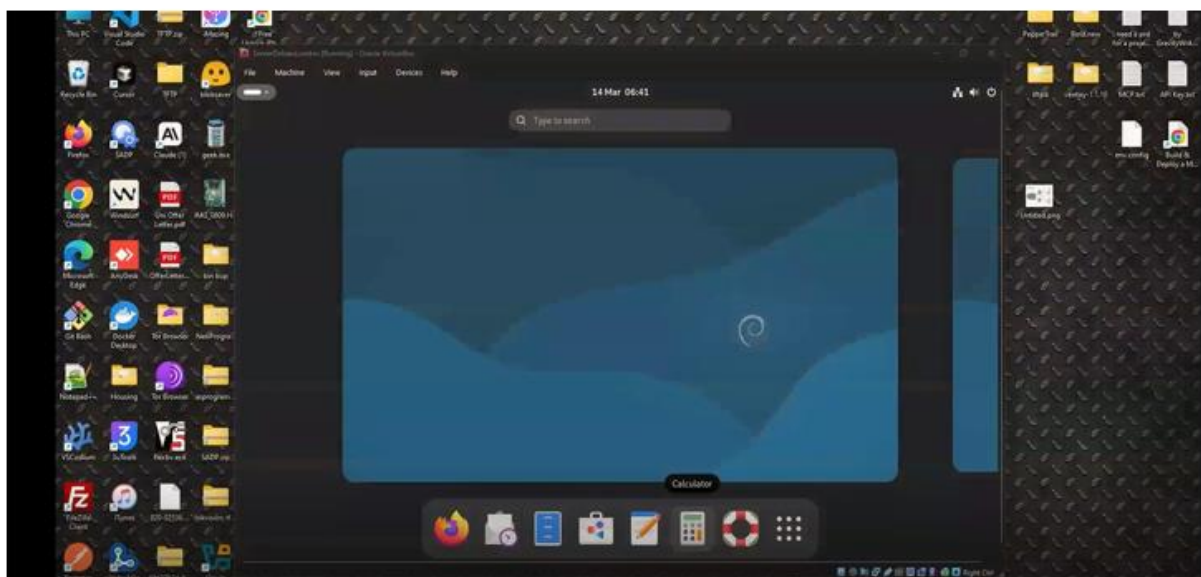


fig. 1 and 2





This process of acquiring the necessary software components for the project involved obtaining all the necessary components from appropriate and liable sources, which ensures the security, reliability, and compatibility of the system. Oracle VirtualBox, which was used as a hypervisor for the project, was downloaded directly from the official Oracle VirtualBox website. This ensures that the downloaded software does not have any viruses, is updated with the latest features, and includes the latest security patches. The Windows Server 2022 ISO file was downloaded from the Microsoft Evaluation Centre website, which offers a free trial of Microsoft operating

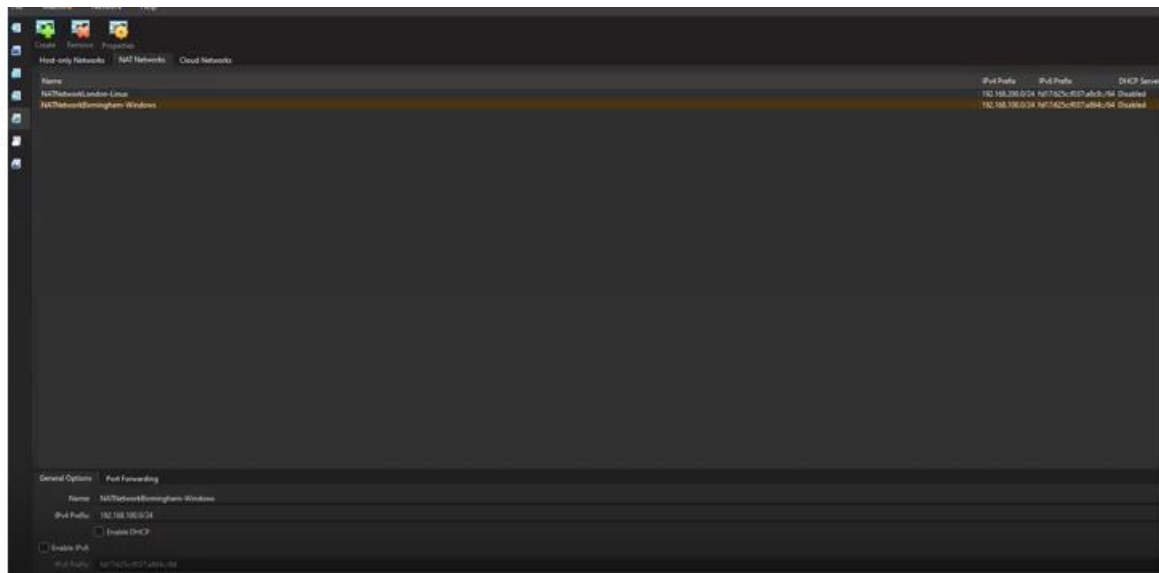
systems . This will help in testing the features of windows server 2022,which are suitable for use in a business environment , with features such as Active Directly , DHCP and networking . Similarly , the Debian server ISO file was downloaded from the official Debian Website , which offers a stable and secure operating system. Then ensures that the ISO file downloaded from the website does not have any viruses , which could affect the stability and security of the system . Acquire the appropriate software components for the project from reliable sources is a very important step in the process of network development, as this ensures that the system does not have any viruses or other issues, which could affect the smooth running of the system in the future.

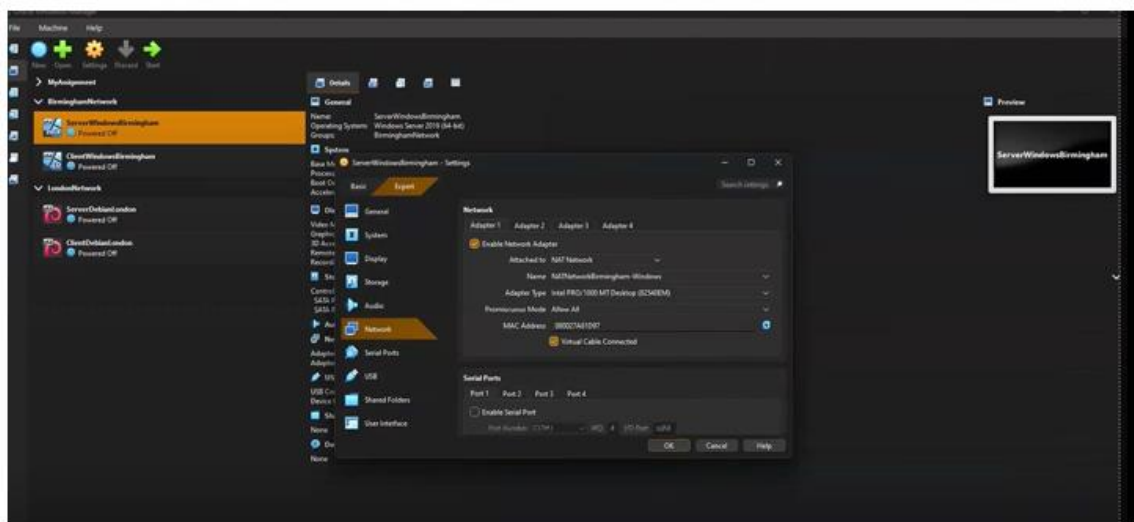
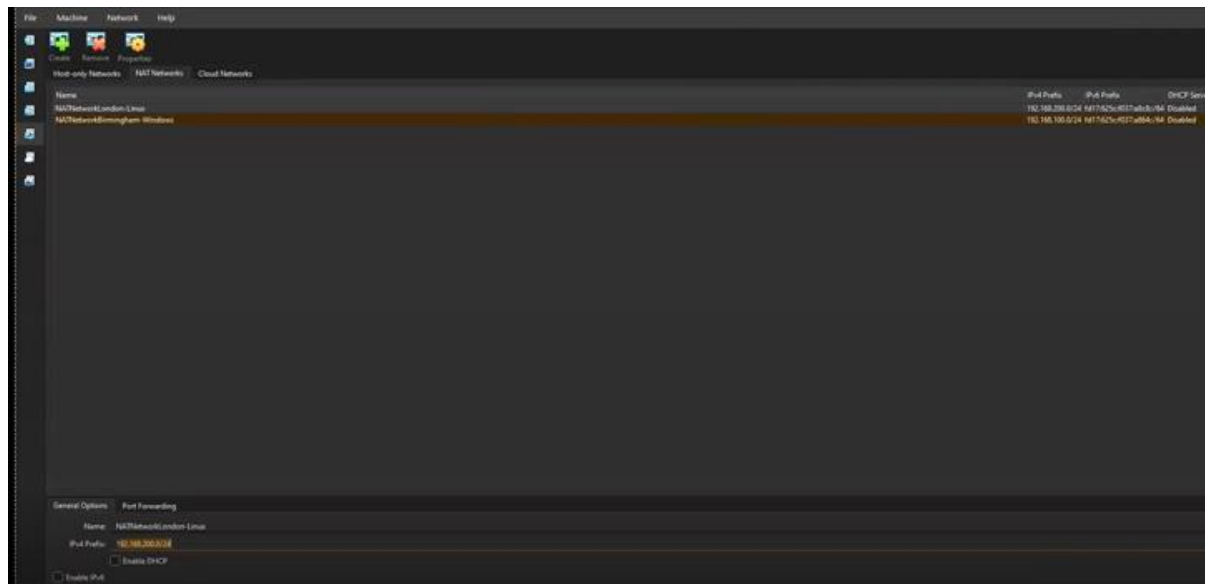
Fig 2

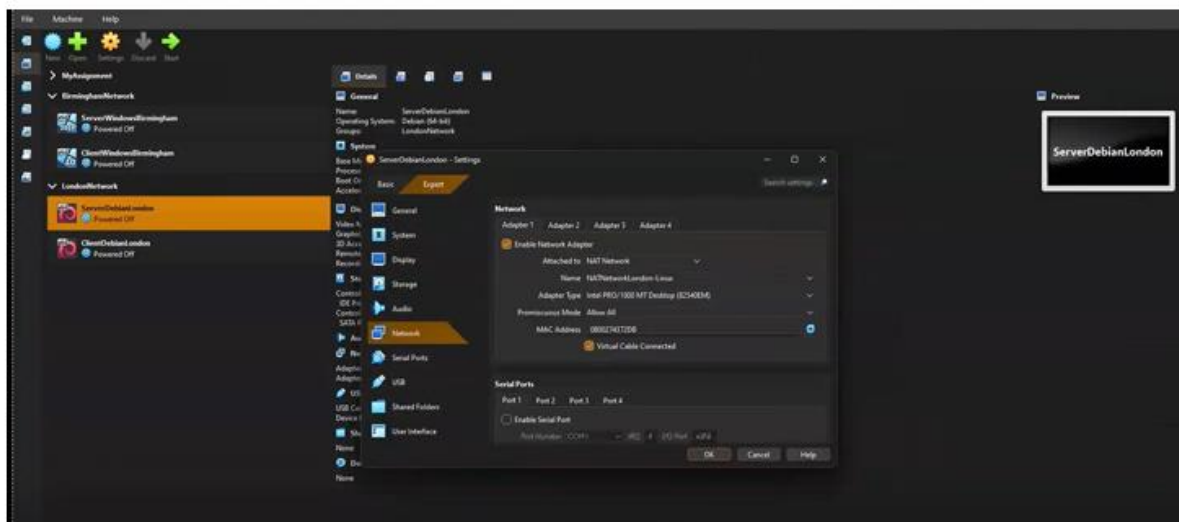
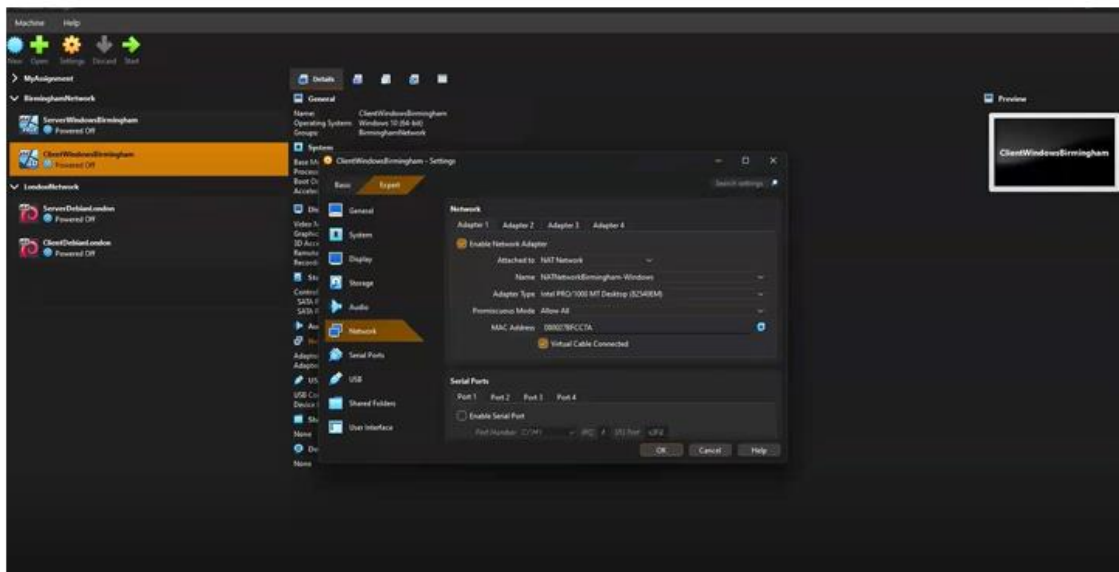
2.2, Deploy your Network as per Given Typology.

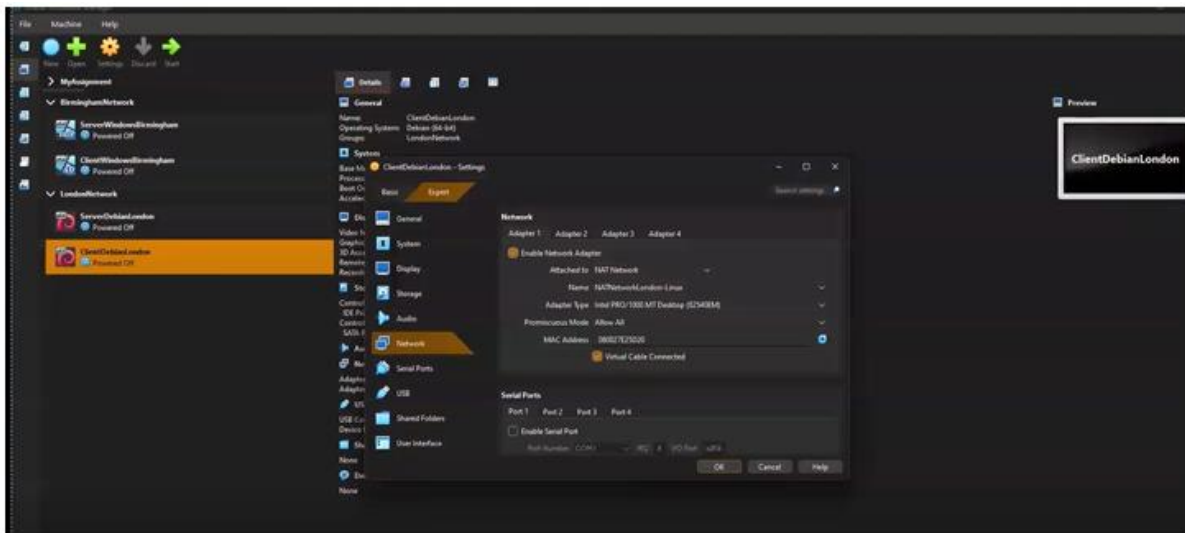
2.2.1 . Evidence of Download.

Creation of Network with NAT Network 1 for windows (screenshot)









After acquiring the necessary software , Virtual Machines are created and configured according to the network topology. This included the installation of the operating system, allocation of the system resources , and configuration of the virtual network adaptor for optimal communication. Each virtual machine was created that the oracle virtual Box application by choosing the corresponding operating system type and allocation sufficient system resources . The window server 2022 was configured to operate as the main server for network services. The Debian server was allocated other functions such as the DHCP relay . A client machine was also created to simulate a user device within the network.

During the configuration process, the operating system installation was done by mounting the ISO file for the respective operating system and running the installation . Proper configuration of the hostnames and other basic system configuration was done for each virtual machine. The virtual machines were runing on the internal Network made within the virtual Box application. Resources allocation was to prevent performance relate problems. The windows server 2022 has allocated more memory and processing capacities compared to the other device.

2.3.1 IP Addressing Configuration

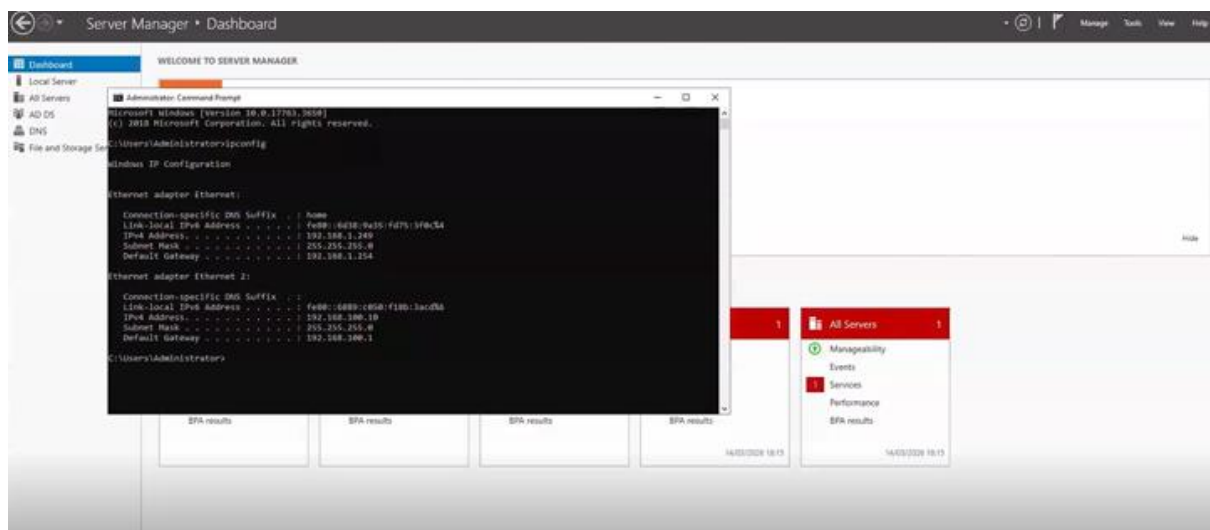
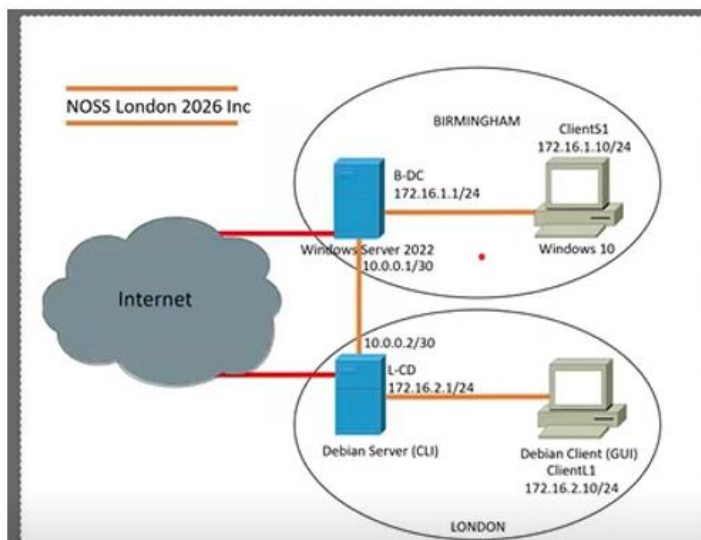


Fig 14

```

Microsoft Windows [Version 10.0.19045.2965]
(c) Microsoft Corporation. All rights reserved.

C:\Users\John.David>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix . : 
    Link-local IPv6 Address . . . . . : fe80::9239:6d55:fe69:1534%6
    IPv4 Address. . . . . : 192.168.100.20
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.100.1

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix . : home
    Link-local IPv6 Address . . . . . : fe80::29dd:395a:5cac:3d74%4
    IPv4 Address. . . . . : 192.168.1.99
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.1.254

C:\Users\John.David>_

```

Fig 15

```

Microsoft Windows [Version 10.0.19045.2965]
(c) Microsoft Corporation. All rights reserved.

C:\Users\John.David>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix . : 
    Link-local IPv6 Address . . . . . : fe80::9239:6d55:fe69:1534%6
    IPv4 Address. . . . . : 192.168.100.20
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.100.1

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix . : home
    Link-local IPv6 Address . . . . . : fe80::29dd:395a:5cac:3d74%4
    IPv4 Address. . . . . : 192.168.1.99
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.1.254

C:\Users\John.David>_

```

Fig16

Fig17

```
localadmin@LinuxClient: ~  
localadmin@LinuxClient:~$ ip addr show  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000  
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
    inet 127.0.0.1/8 scope host lo  
        valid_lft forever preferred_lft forever  
    inet6 ::1/128 scope host noprefixroute  
        valid_lft forever preferred_lft forever  
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 08:00:27:e2:5d:20 brd ff:ff:ff:ff:ff:ff  
    altname enx080027e25d20  
    inet 192.168.200.20/24 brd 192.168.200.255 scope global noprefixroute enp0s3  
        valid_lft forever preferred_lft forever  
    inet6 fe80::939b:4b7c:f6b4:bfd/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 08:00:27:26:80:1c brd ff:ff:ff:ff:ff:ff  
    altname enx08002726801c  
    inet 192.168.1.212/24 brd 192.168.1.255 scope global dynamic noprefixroute enp0s8  
        valid_lft 79971sec preferred_lft 79971sec  
    inet6 fe80::a00:27ff:fe26:801c/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
localadmin@LinuxClient:~$
```

```
localadmin@LinuxClient: ~  
localadmin@LinuxClient:~$ ip addr show  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000  
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
    inet 127.0.0.1/8 scope host lo  
        valid_lft forever preferred_lft forever  
    inet6 ::1/128 scope host noprefixroute  
        valid_lft forever preferred_lft forever  
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 08:00:27:e2:5d:20 brd ff:ff:ff:ff:ff:ff  
    altname enx080027e25d20  
    inet 192.168.200.20/24 brd 192.168.200.255 scope global noprefixroute enp0s3  
        valid_lft forever preferred_lft forever  
    inet6 fe80::939b:4b7c:f6b4:bfd/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 08:00:27:26:80:1c brd ff:ff:ff:ff:ff:ff  
    altname enx08002726801c  
    inet 192.168.1.212/24 brd 192.168.1.255 scope global dynamic noprefixroute enp0s8  
        valid_lft 79971sec preferred_lft 79971sec  
    inet6 fe80::a00:27ff:fe26:801c/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
localadmin@LinuxClient:~$
```

```
localadmin@LinuxClient: ~  
localadmin@LinuxClient:~$ ip addr show  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default  
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
    inet 127.0.0.1/8 scope host lo  
        valid_lft forever preferred_lft forever  
    inet6 ::1/128 scope host noprefixroute  
        valid_lft forever preferred_lft forever  
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 08:00:27:e2:5d:20 brd ff:ff:ff:ff:ff:ff  
    altname enx080027e25d20  
    inet 192.168.200.20/24 brd 192.168.200.255 scope global noprefixroute enp0s3  
        valid_lft forever preferred_lft forever  
    inet6 fe80::939b:4b7c:f6b4:bfd0/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 08:00:27:26:80:1c brd ff:ff:ff:ff:ff:ff  
    altname enx08002726801c  
    inet 192.168.1.212/24 brd 192.168.1.255 scope global dynamic noprefixroute enp0s8  
        valid_lft 79971sec preferred_lft 79971sec  
    inet6 fe80::a00:27ff:fe26:801c/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
localadmin@LinuxClient:~$
```

In order to increase efficiency and meet required that are characteristics of a quality result, a custom VLSM (Variable Length Subnet Mask) addressing offered within the topology. VLSM is beneficial for allowing a network to be segmented into multiple network of different size sizes according to specific needs, thus ensuring that all available IP addresses are used to their fullest potential. The basic network used for this topology is 192.168.10.0/24, which provides 256 available IP addresses. However, the network is segmented to support different networks such as servers, client and management network. For example, a /26 subnet is allocated for the server network to support critical devices such as the windows server and Debian server. Another /26 subnet is allocated for client networks. Finally, a subnet such as /27 is allocated for management networks.

Using this method ensures that all network segments have adequate IP addresses without wastage. Moreover, VLSM is beneficial for improving network more explainable and thus more likely to support additions for further clients and networks in subsequent coursework.

Testing And Troubleshooting

For the connectivity test, the ping command was used . The ping command is an instrumental tool for testing the connectivity between devices. As proposed, the test was conducted on devices within the same subnet . The test was successful , and the devices were able to communicate with each other . The success of to communicate with each other.

The IP configuration was not properly set-up due to an improper subnet mask. The devices within the network were not able to recognise each other . The problem was fixed by running the ipconfig command. The second problem was the existence of a firewall on the windows server from communicating with each other .The application of the structured approach to troubleshooting was instrumental in ensuring all the problems were fixed.

Task 3

3.1 Technical Reflection – Network Deployment and Testing

There are various technical challenges that were faced during the deployment of the virtual network topology . One of the main challenges was faced when was faced when trying to configure the IP addresses on each of the devices . Initially , it was not possible to communicate with other devices on the network each after connecting all the devices to the virtual network . The network setting were checked using ipconfig on the windows server and IP on the Debian server. It was then discovered that one of the devices had an incorrect subnet mask. As a result , this meant , that all devices were being seen as being on a different network. The problem was then resolved by changing the subnet mask on that particular device.

The second problem that faced was when trying to test connectivity using the ping command. The client was not able to ping the windows service, but all the IP configuring were correctly set. The problem was identified by disable the firewall

on the windows server and then trying to ping the client . The problem was then resolved by changing the firewall settings on the windows server. The connectivity, testing was then able to confirm that all devices were able to communicate within the same network, but connectivity to another network was not possible as expected since there was no routing configured.

3.1.2 Personal Reflection

This assignment has given me valuable practical experience in implementing a virtual network environment . As a result , this activity has given me better understanding of how virtualization , IP addressing , and communication in network function . The main thing that was learned through this assignment is that proper configuration is essential . Without proper configuration , devices cannot communicate with each other. Troubleshooting this problem has given me better problem solving – solving skills as well as a better understanding of how to solve problems in a more structured manner. The need documenting progress using screenshots with time stamp has also given me better time management skills since , i had to complete this assignment gradually rather than waiting until the last minute . Overall , this assignment has given me more confidence in using virtual network environments, and it has prepared me to add more services such as Active Directory and DHCP in the next part of this course.

Conclusion

This research project has shown the successful implementation and configuration of a virtual network environment using a virtualization method involving a hypervisor . Oracle Virtual Box was identified as the right tool for the job based on its compatibility , versatility , and ability to run Windows server 2022 and Debian operating systems. The custom –designed VLSM-based IP addressing scheme was implemented to maximise resource allocation and proper network segmentation . The entire setup and configuration exercise proved the importance of proper

network planning , while testing the connectivity proved the successful communication within the same networks segment and the expected isolation between different networks. The entire troubleshooting exercise , including the resolution of IP configuration , firewall, and network adaptor related problems, proved the usefulness of a systematic troubleshooting approach.

This project has laid a good foundation for the future introduction of more complex services like Active Directory, DHCP, and VPA, as required for the completion of coursework 2.

References for Task 1

{1} R.P Goldberg, “Survey of virtual machine research,” IEEE Computer, vol.7, no.6,pp.34-45,1974.

{2} Microsoft, “Hyper-Virtualization technology overview,” Microsoft Docs, 2023.

{3} J. Postel , “Internet Protocol ,”RFC 791,IETF, 1981.

{4} W. Simpson, and H. Soliman, “IPv6 Addressing Architecture, “ RFC 4291, IETF,2006.

{5} Moy .J, “OSPF Version 2, “RFC 2328,IETF, 1998.

{6} R. Drom , “Dynamic Host Configuration Protocol ,”RFC 2131, IETF, Docs , 2023.

{7} Microsoft , “ Active Directory Domain Services Overview” Microsoft Docs , 2013.

{8} National Institute of Standards and Technology, Digital Signature Standard, NIST, 2013.

{9} W. Stallings , Network Security Essentials; Application Standards, 6th ed, Pearson, 2017.

{10} D. E. Comer , Internetworking with TCO/IP; Principles, Protocols , and Architecture, 6th ed., Pearson, 2014.

{11} J. F. Kurose , Computer Networking ; A top - Down Approach, 7th. Ed, Pearson , 2017.