

Network Operating Systems and Services (ACCA5023): Coursework 1

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Task 1

Hypervisors:

Type 1 hypervisors run directly on physical hardware without a host OS, providing superior performance, security, and efficiency. They interact directly with the hardware of the device. Examples include VMware vSphere, KVM, and Xen, making them ideal for enterprise data centers and cloud environments. [1]

Type 2 hypervisors operate on top of an existing host operating system, which adds a layer of distance. This makes them easier for desktop use but less efficient for large applications due to higher use of energy. Examples are Oracle VirtualBox and VMware Workstation, suited for development and testing. [1]

Type 1 is best for hosting Windows Server 2022 and Debian in SWANSEA.ACCA's Enhanced Topology. It has superior performance, live migration, resource efficiency; often free/open-source options reduce costs. It isolates the device well, making it more secure.

However, using a Type 1 hypervisor means no underlying OS, which would mean having a whole device that only runs as a hypervisor. Since most of the people working on this project do not have much experience with hypervisors, a Type 2 hypervisor like Oracle VirtualBox would be simpler to use.

IP Addressing

Data travels as packets from source to destination across networks. Clients locate servers via logical IP addresses, which identify networks and hosts. Packets use physical (MAC) addresses locally, port addresses for applications, and IP for routing.

IP addresses work the way home addresses do in our physical lives; they tell us where to send information. Part of the IP address is used to identify the network of the device while the rest is used to identify the host device connected to that network.

Routers and switches are devices that connect to each other and to the internet. They can facilitate the flow of data between networks simply by adding routes for the data to take. Adding a router or a switch and connecting it with multiple networks might help data reach certain devices faster than if these devices were never put there in the first place. [3]

An IPv4 address is composed of 32 bits and is formatted with four decimal blocks that go from 0 to 255 separated by dots (e.g. 192.168.1.10). [3] An IPv6 address is

composed of 128 bits and is formatted with eight hexadecimal blocks that go from 0 to ffff separated by colons (e.g. 03e5:00b3:0:0:c5af:0021:ef97:1dfe). [2]

Routing

Routing protocols enable efficient data packet delivery from source to destination in networks by selecting the fastest paths. They prioritize accurate routing, simplicity, robustness, stability, fairness, and optimality. [4]

Static routing uses fixed, manually configured paths by admins. It offers minimal CPU use and no network overhead but requires manual updates for changes, doesn't scale, and is error-prone, making it ideal for small, stable networks. [4]

Dynamic routing adapts paths automatically via algorithms. Classified as Interior Gateway Protocols (IGP) like RIP (hop count, slow), OSPF (link-state, fast convergence), or Exterior Gateway Protocols (EGP) like BGP (path-vector for inter-AS). IGPs share updates to build routing tables; distance-vector (e.g. RIP) uses metrics like hops, while link-state (e.g. OSPF) maps full topology.

For our topology, static routing suits best. It's small-scale with predictable paths; Debian's DHCP Relay needs simple inter-server/internet routing without dynamic overhead. Dynamic adds unnecessary complexity for few changes.

Network Services

Virtual private networks (VPN) is a technology that connects a device to a public network securely. It allows users cloak their identities online and therefore makes it difficult for a third party to track your online activities. [5]

Dynamic Host Configuration Protocol (DHCP) is a protocol used to manage networks by automatically assigning IP addresses to the devices connected to the network. This technology makes IP address management simpler and more efficient.[6]

Active Directory Domain Services (AD DS) is Microsoft's directory service that stores and manages information about network resources, users, computers, and other objects in a centralized database, making it easier for administrators and users to access and utilize them.[7]

A Certificate Authority is an entity that issues and manages digital certificates to verify identities in PKI systems. It features certificate issuance, revocation through CRLs or OCSP, hierarchical trust chains, and X.509 standard support. It is used for securing root

CAs offline, enforcing strict access controls with MFA, separating roles, conducting regular audits, rotating keys, and renewing certificates at half their validity period. [8]

References

- [1]. R. Nirek, "Comparative Study of Hypervisor Technologies for Running Enterprise Applications on Linux VMs," *ResearchGate*, 2021.
https://www.researchgate.net/publication/386140370_Comparative_Study_of_Hypervisor_Technologies_for_Running_Enterprise_Applications_on_Linux_VMs (accessed Feb. 17, 2026).
- [2]. M. C. Patole, P. Kanani, L. Raut, D. Jhaveri, and M. Nagda, "An Insight into IP Addressing," *Oriental Journal of Computer Science & Technology*, Aug. 2017.
<https://www.computerscijournal.org/vol10no1/an-insight-into-ipaddressing/> (accessed Feb. 20, 2026).
- [3]. T. Dooley, *Ip Address Management*. S.L.: Wiley-Blackwell, 2021.
- [4]. D. Mitra, S. Sarkar, and D. Hati, "A Comparative Study of Routing Protocols," *International Research Journal of Advanced Engineering and Science*, Jan. 2026.
<https://irjaes.com/wp-content/uploads/2020/10/IRJAES-V1N4P168Y16.pdf> (accessed Feb. 26, 2026).
- [5]. N. Alsayed, "Virtual Private Networks (VPN)," *ResearchGate*, May 15, 2015.
https://www.researchgate.net/publication/348295807_Virtual_Private_Networks_VPN_Research_Paper (accessed Feb. 27, 2026).
- [6]. A. Purnomo, "Implementation of DHCP Snooping Method to Improve Security on Computer Networks," *Bit-Tech*, Apr. 30, 2024.
<https://jurnal.kdi.or.id/index.php/bt/article/view/1174> (accessed Feb. 27, 2026).
- [7]. [Nalini Chandrashekar Iyer and Anil Mallappa Kabbur, "Implementation of Active Directory for efficient management of networks," *ScienceDirect*, Jan. 2020.
<https://www.sciencedirect.com/science/article/pii/S1877050920313399> (accessed Feb. 27, 2026).
- [8]. S. Tanwar and A. Kumar, "Extended Design and Implementation of Certificate Authorities," *ResearchGate*, Aug. 2017.
https://www.researchgate.net/publication/320447904_Extended_Design_and_Implementation_of_Certificate_Authorities (accessed Feb. 27, 2026).

Task 2

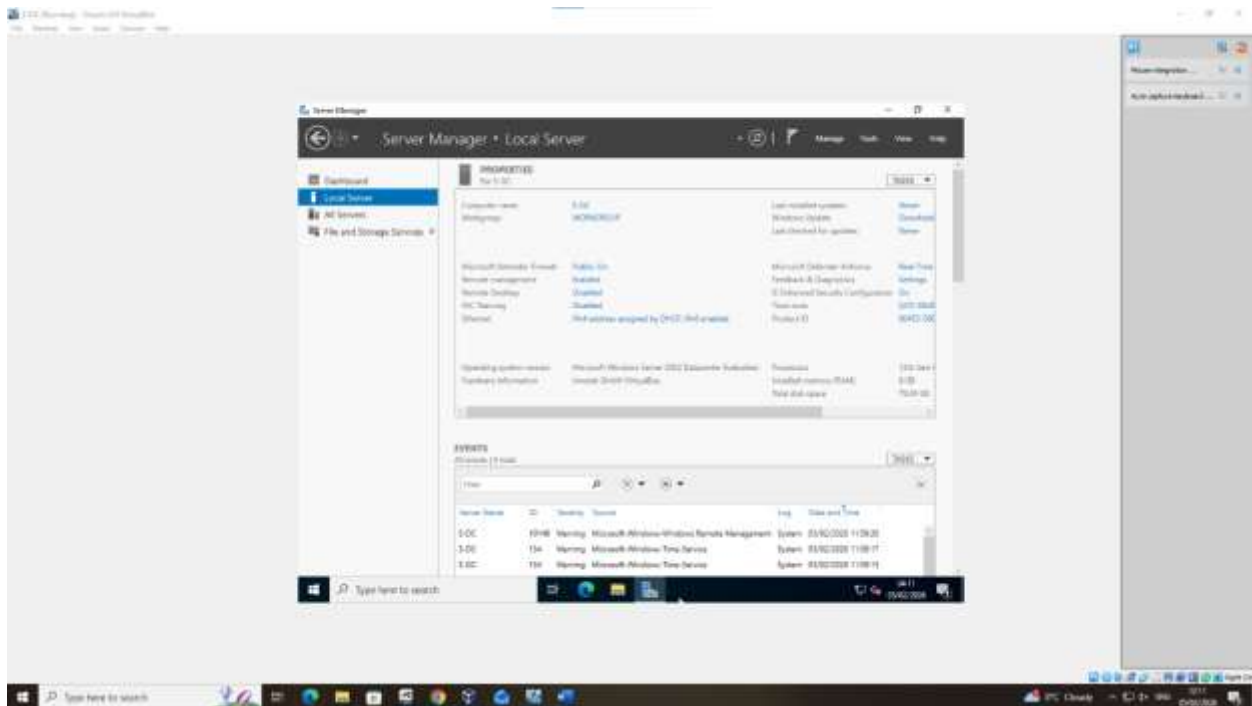
The chosen hypervisor for this project is Oracle VirtualBox, which is a Type 2 hypervisor.

The main reason for this decision is the fact that I do not have any experience with hypervisors and Type 2 is simpler to use and allows me to run multiple virtualized devices at once. Installing a Type 1 hypervisor would also mean overwriting the existing OS on the computer I plan on using, which I do not want either on my personal computer or the school computer.

Overall, Type 2 hypervisors are simpler and easier to use, and therefore a better choice for someone with no experience with virtualization.

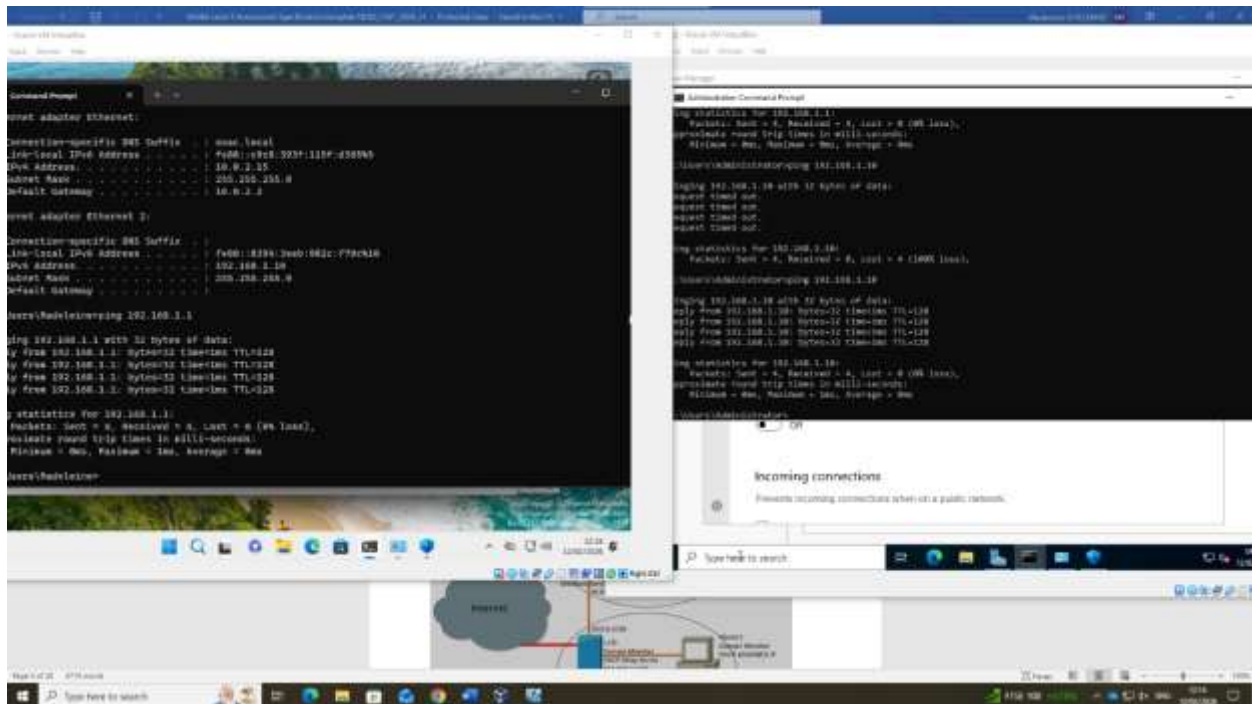
The following images demonstrate my progress in simulating the different networks.

Image 1: Renaming the Windows server



The Windows Server has been properly renamed “S-DC”, as shown above.

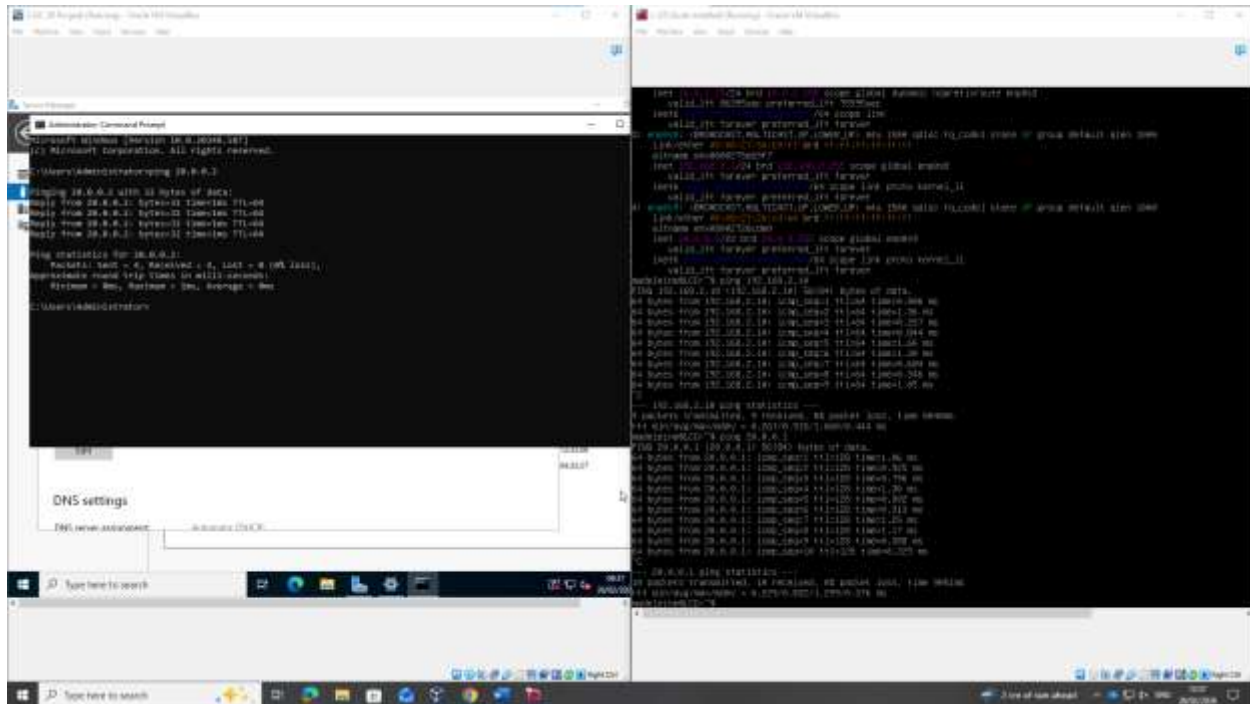
Image 2: Pinging the Windows client and server



The screen on the left is ClientS1 while the one on the right is S-DC. ClientS1 is seen successfully ping 192.168.1.1, the IP address of S-DC on the Swansea network. Likewise, S-DC is seen successfully ping 192.168.1.10, the IP address of ClientS1.

The screen on the left is ClientL1 while the one on the right is L-CD. ClientL1 is seen successfully ping 192.168.2.1, the IP address of L-CD on the London network. Likewise, L-CD is seen successfully ping 192.168.2.10, the IP address of ClientL1.

Image 5: Pinging the two servers



The screen on the left is S-DC while the one on the right is L-CD. S-DC is seen successfully ping 20.0.0.2, the IP address of L-CD on the external network. Likewise, L-CD is seen successfully ping 20.0.0.1, the IP address of S-DC on the external network.

The screenshots provided show the successful creation of the Swansea network, the London network, and the external network that connects both servers.

Task 3

Throughout the project, we had to virtualize three different networks: two that connect a server and a client and one that connected both servers.

We started with the Swansea network. We created the Windows 2022 server, which we named “S-DC”, and after naming it properly, we created the client Windows 11 desktop, ClientS1. Once both devices were set up, we added a new network for an internal network, which we named “IntSwan”, to both devices. After giving them the proper IP addresses, we were able to connect them to each other.

We then repeated the process with the London network with a Debian server and client, named L-CD and ClientL1 respectively, with an internal network named “IntLon”. When both networks were completed, it was time to create the external network that connected S-DC and L-CD. We added a new internal network to both servers, which we named “External”. We then added the proper IP addresses to both devices before connecting them to each other.

Throughout this project, I have faced no unforeseen issue. Anytime there was a problem, it was a problem that the teacher saw coming and immediately told us how to fix. The creation of those networks was smooth and easy, so long as I followed the instructions. This project taught me how to virtualize networks and how to manage both Windows and Debian servers — and how to not wipe the school computers clean.