

ACCA5023

Network Operating Systems and Services

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Introduction

Scenario

I have been hired as an IT-professional by a Multinational Corporation called NOSS. NOSS operates currently at two locations: Swansea and London. I am asked to bring up a network as given in the topology.

The topology of the network

The topology I need to setup is the following (see picture below).

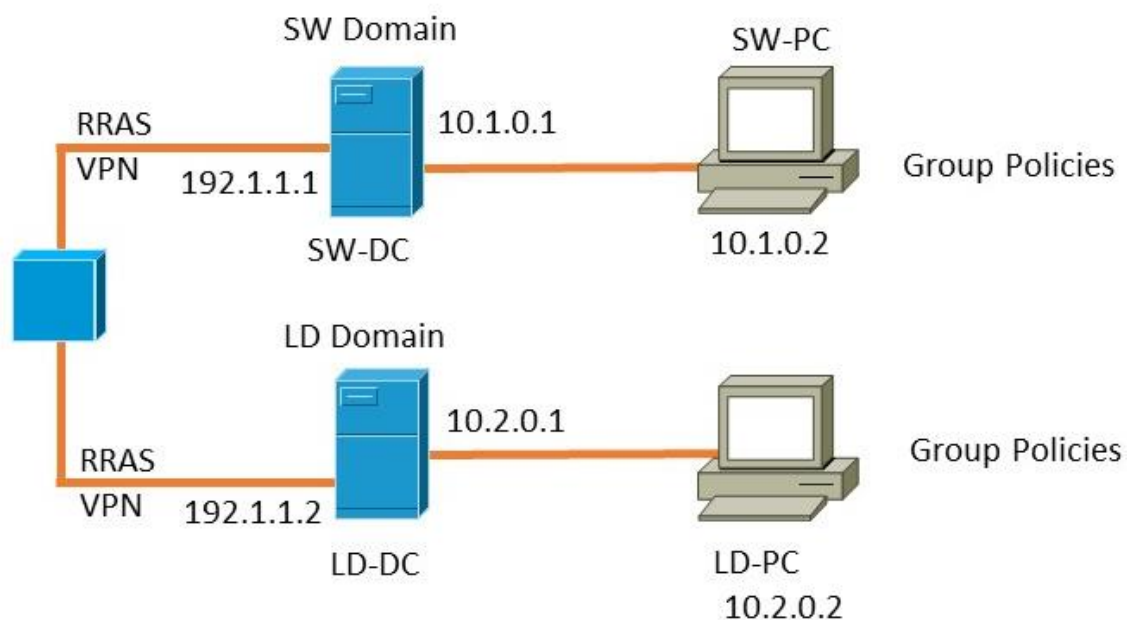


Image 1. Scheme of the topology of the network

The network needs to have two computers (one in London [LD-PC] and one in Swansea [LD-WS]) and two servers (one in London [LD-DC] and one in Swansea [SW-DC]). The computer in London needs to connect to the server in London but must not connect to any Swansea device. Same for the Swansea computer. However, the London server also needs be connected to the Swansea server.

The choice of the virtual machine

Introduction

To execute the scenario, I will be using Virtual Machines, mostly because VM helps understand the basis of networking without risking damaging the host computer or the network. Also, VM can be fully customized for the purpose of the project. [1]

Hypervisor

The first step of choosing the virtual machine is choosing the Hypervisor. Hypervisors (or Virtual Machine Monitor [VMM]) are the main component for the creation and management of virtual machines. VMM allows multiple computers, which includes operating systems or servers, to run in parallel (in virtual machines) in a single physical machine.

Also, there exist two types of hypervisors: type-1 and type-2 hypervisors.

What are the differences between type-1 and type-2 hypervisors ?

Type-1 hypervisors are directly running on the physical hardware and uses the hardware resources. They require hardware with virtualization support. Type-1 hypervisor provides an isolation between virtual machines and the hardware, and supports the most common operating systems (Ubuntu, Debian, MacOS, Windows, etc). [2]

On the other hand, type-2 hypervisors are running over the computer OS and deliver virtualization features via software emulation. They don't have a really important hardware requirement; they can run on almost every standard desktop or laptop and the hardware doesn't necessarily require virtualization support. However, type-2 hypervisors are less secure than type-1 hypervisor, due to the additional layer of the host OS. Like type-1 hypervisor, type-2 hypervisor supports the most common operating systems (Ubuntu, Debian, MacOS, Windows, etc). [2]

Hypervisor architecture

The type-1 hypervisor architecture is organized as follows:

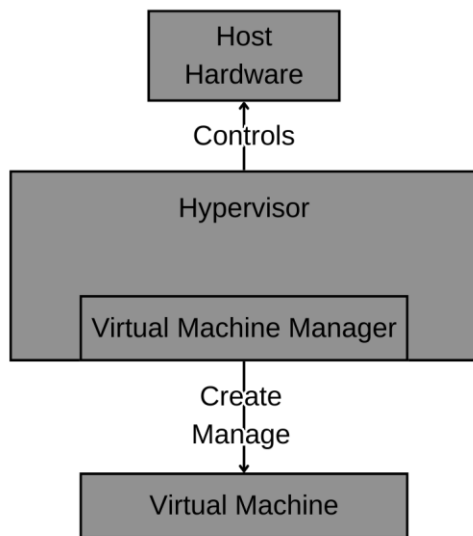


Image 2. Diagram of the architecture of Type-1 hypervisor

The hypervisor controls the Host physical hardware (CPU, memory, storage, etc.) in order to have a specific part for the virtual machine.

The virtual machine manager is a part of the hypervisor which allows the user to create, manage and execute virtual machines. The virtual machine manager is the visual aspect of the hypervisor, which means what the user sees when he launch the type-1 hypervisor.

Type-2 hypervisor architecture is organized as follows:

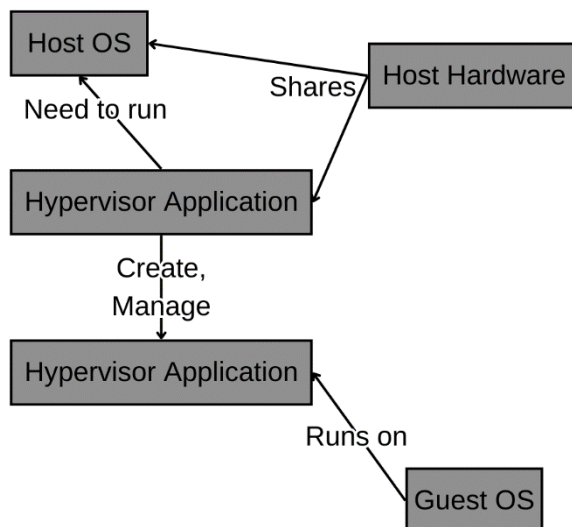


Image 3. Diagram of the architecture of Type-2 hypervisor

The hypervisor application needs to be downloaded and needs to run on the OS of the host.

The host hardware are shared between the host OS and the virtual machines managed by the hypervisor application.

Where hypervisor are used ?

Type-1 hypervisors can be used in enterprise, by consolidating physical servers into virtualized environments. They can also be used in cloud infrastructure.

Type-2 hypervisors can be used by software developers to build, test and debug applications into a virtual environment. They are also used in learning and teaching institutions.

What are the different solutions of hypervisor in the market ?

- Proxmox Virtual Environment. Proxmox is open-source, offers a web-based management interface and supports both Type 1 and Type 2 virtualization.
- VMware
- Microsoft Hyper-V. Microsoft Hyper-V is integrated with the Microsoft servers and supports the Microsoft ecosystem.
- Oracle VM VirtualBox. VirtualBox is open-source and support only type-2 hypervisors. It is mostly used for educational purposes.

What hypervisor did I choose ?

For this coursework, I will choose Oracle VM VirtualBox as my hypervisor for mostly three reasons: It is a type-2 hypervisor; it is open-source, and it is strongly recommended for educational and learning purposes.

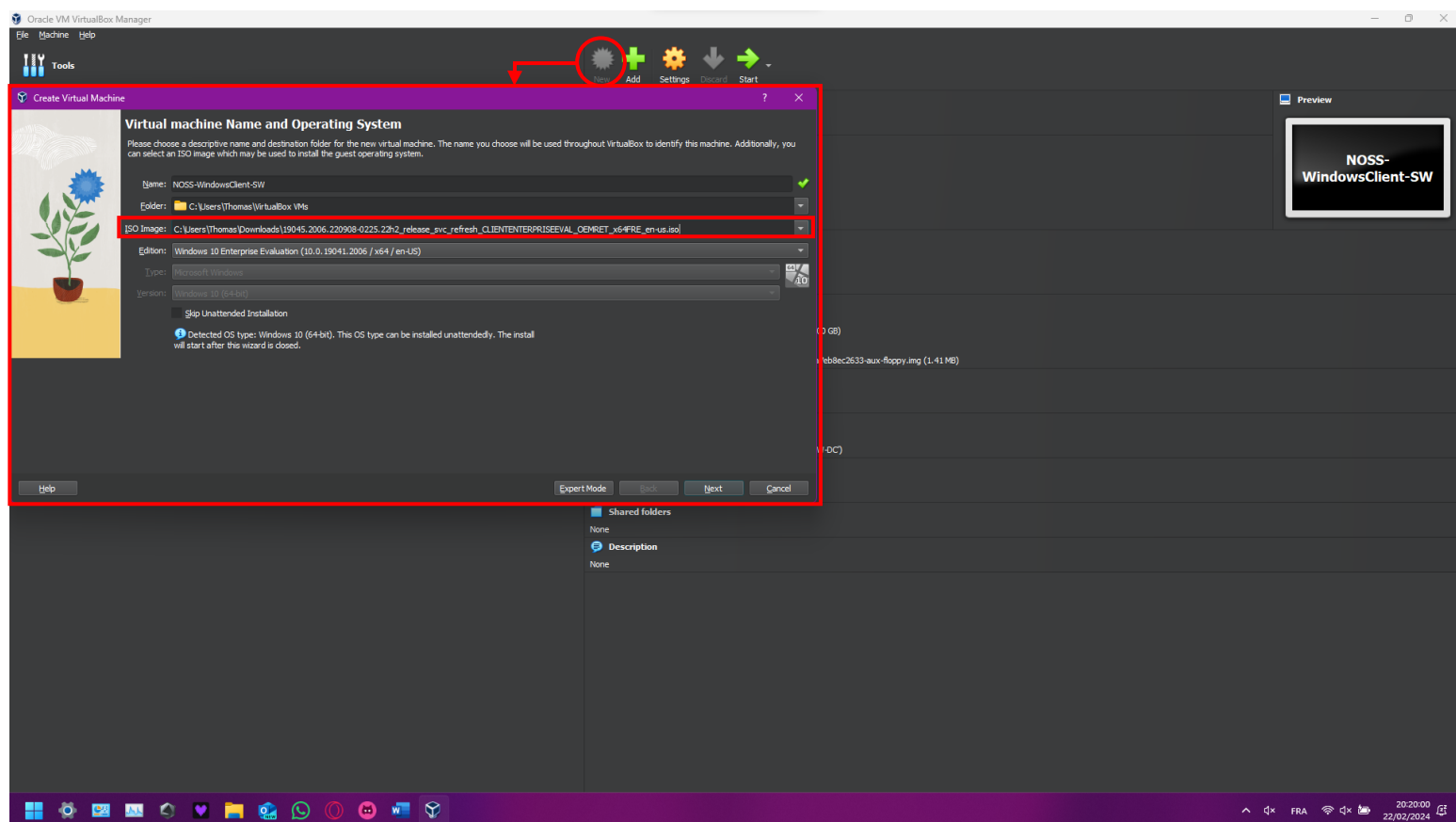
Setting up the network

Introduction

As said previously, I will use VirtualBox as my hypervisor. For the devices in the network, I will use *Microsoft Server 2022* for the servers (both London and Swansea), and I will use *Windows 10 Enterprise Evaluation* for the client operating software (both London and Swansea).

Setting up the virtual machines

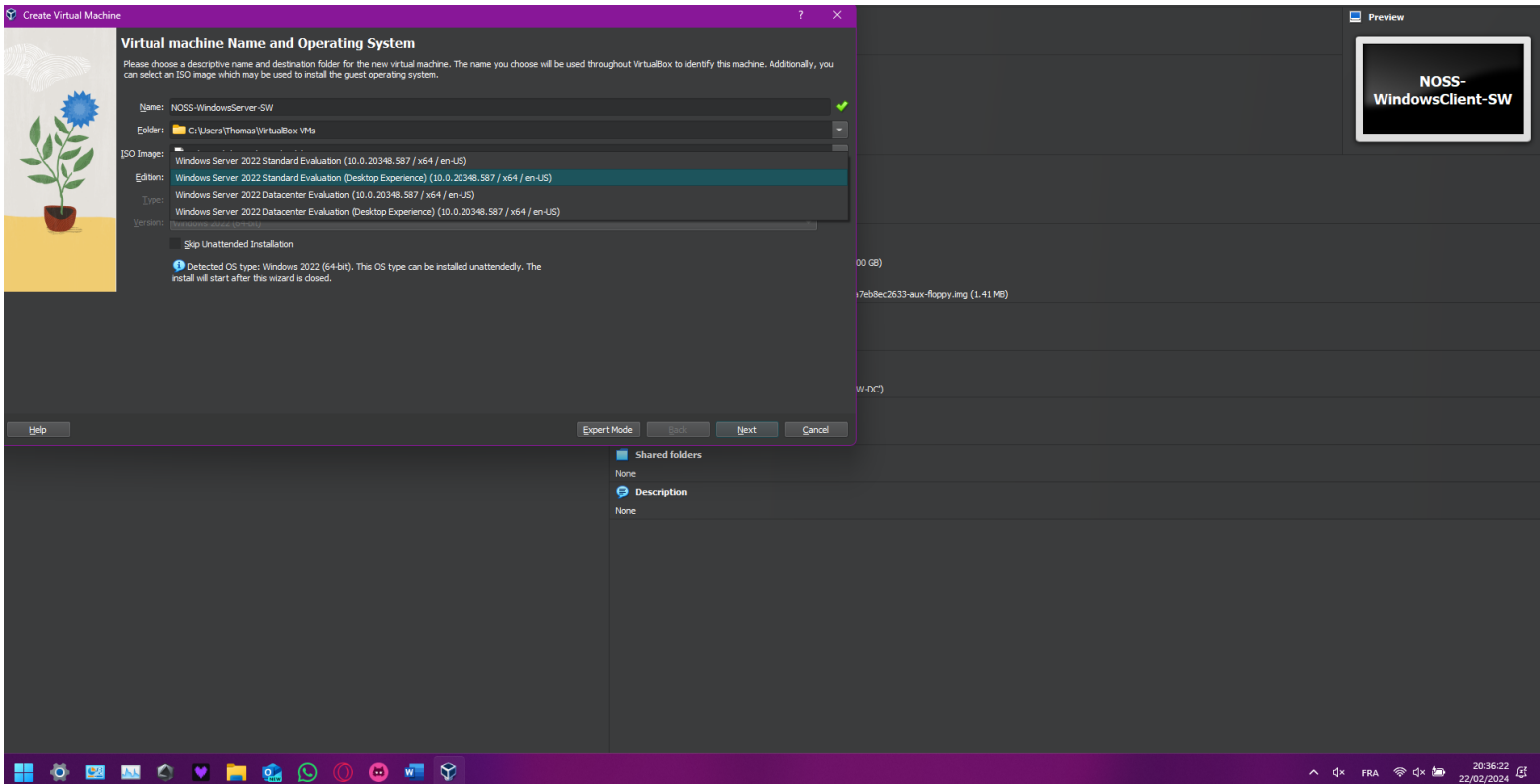
I first downloaded the *Windows 10 Enterprise Evaluation* ISO and the *Microsoft Server 2022* ISO from the shared file. In VirtualBox, I created a new virtual machine and set the *Windows 10 Enterprise Evaluation* as an ISO.



Once I did this, I chose the Username to be Admin and the password to be the one given in the document. Right after, I set the base memory of the virtual machine to be 8000 MB, thus 8 Giga bit of RAM, and I put 2 CPUs.

After This, I could launch the virtual machine, and wait to Windows 10 to download.

I did the same thing for setting up the virtual machine of the *Microsoft Server 2022*, but this time using *Microsoft Server 2022* as the ISO, and by choosing “Desktop Experience” in the choice available.



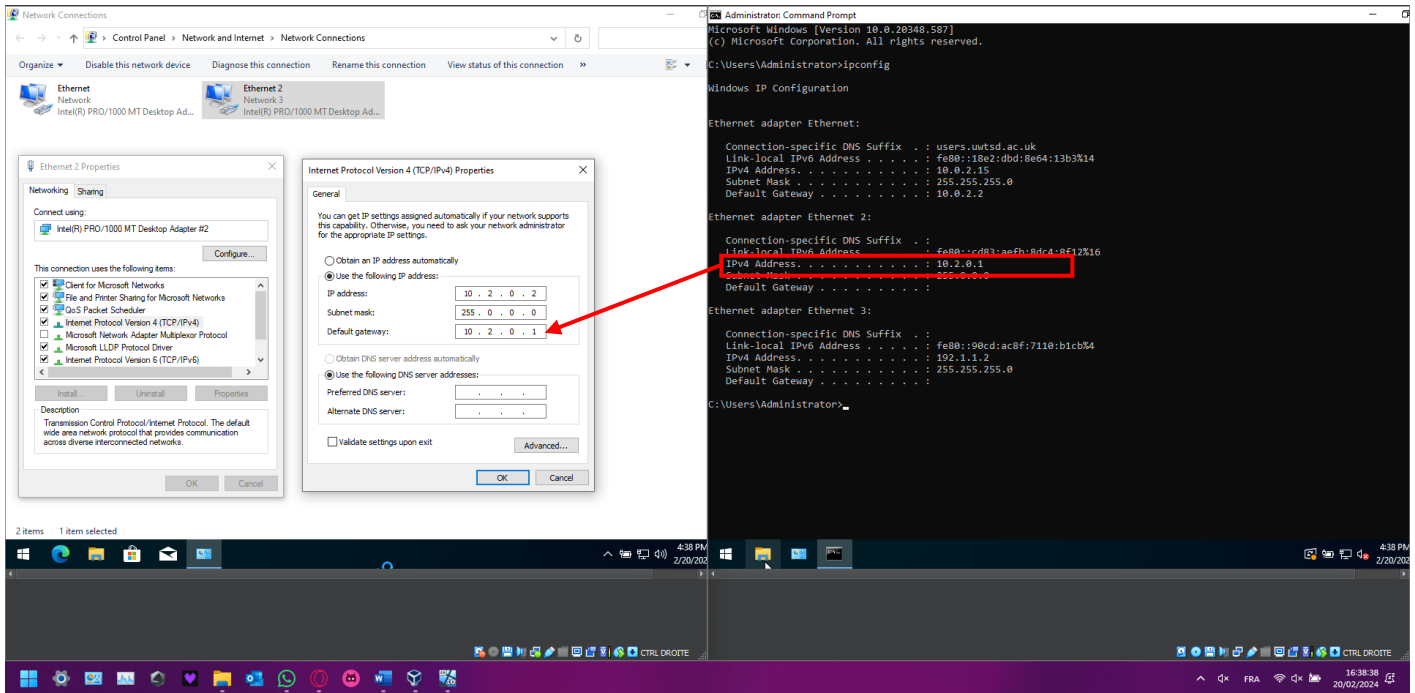
Setting up the connection between the devices

Once the virtual machines are created and loaded, I created three internal networks, called SW-DC, LD-DC and server. SW-DC and LD-SW are the networks for the connections between the computers and the servers (respectfully for the Swansea domain and for the London domain). The server internal network is for the connection between the 2 servers.

To connect a computer to the respective server, I need to set up a correct IPv4 address (respecting the topology) for both server and client and add for the client the IPv4 of the server in the Default Gateway area. (see image below)

Client

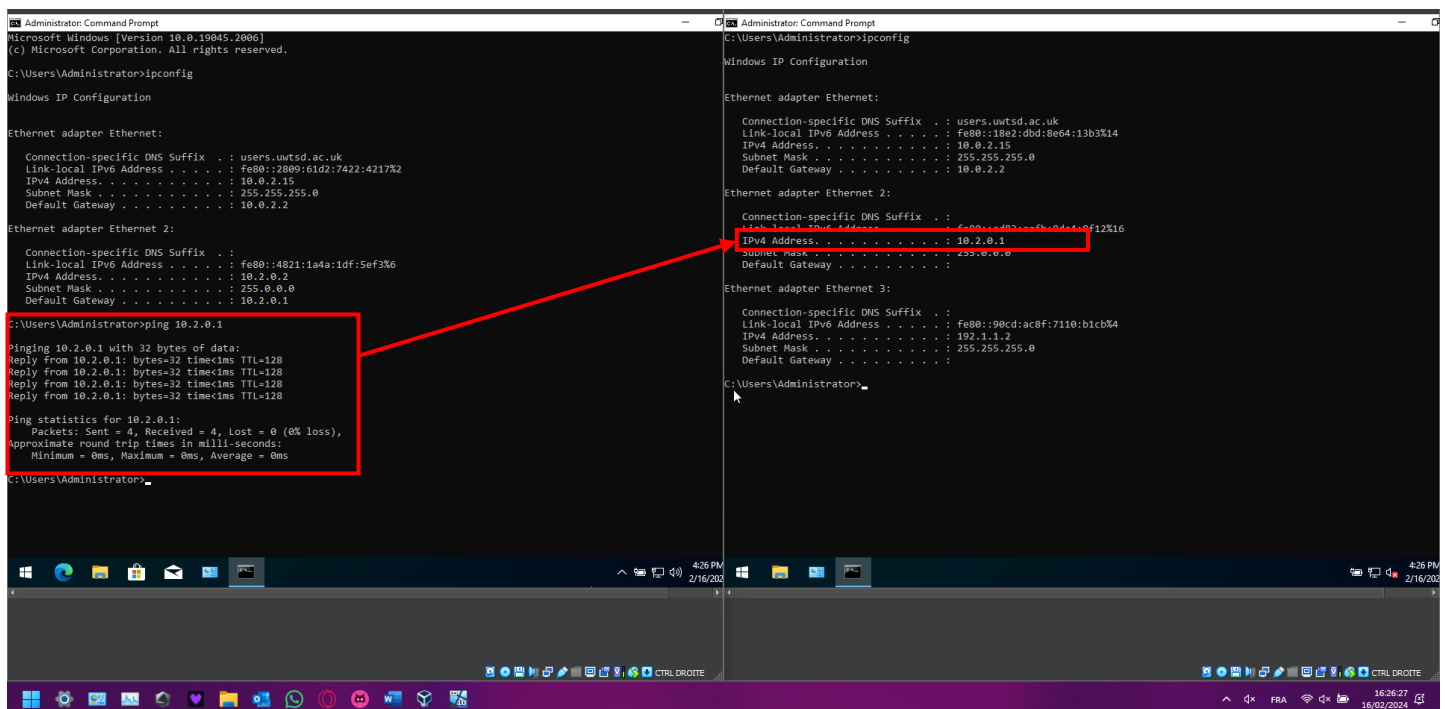
Server



Once this is done, I can use the ping command to check if the client and the server are connected.

Client

Server



I can do the same method to connect the other client with the other server and use the ping command to see if they are connected.

Client

Server

```

Client:
C:\Users\Administrator>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : users.uwtsd.ac.uk
    Link-local IPv6 Address . . . . . : fe80::3dd5:9f23:5fd7:7343%7
    IPv4 Address. . . . . : 10.0.2.15
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.0.2.2

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::5c42:4b00:6bfb:2d59%3
    IPv4 Address. . . . . : 10.1.0.2
    Subnet Mask . . . . . : 255.0.0.0
    Default Gateway . . . . . : 10.1.0.1

C:\Users\Administrator>ping 10.1.0.1

Pinging 10.1.0.1 with 32 bytes of data:
Reply from 10.1.0.1: bytes=32 time=1ms TTL=128
Reply from 10.1.0.1: bytes=32 time=1ms TTL=128
Reply from 10.1.0.1: bytes=32 time=1ms TTL=128
Reply from 10.1.0.1: bytes=32 time=1ms TTL=128

Ping statistics for 10.1.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

Server:
C:\Users\Administrator>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : users.uwtsd.ac.uk
    Link-local IPv6 Address . . . . . : fe80::19d59:552:5c5f:338b%7
    IPv4 Address. . . . . : 10.0.2.15
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.0.2.2

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::a1b7:fd44:b714:6cd%17
    IPv4 Address. . . . . : 10.1.0.1
    Subnet Mask . . . . . : 255.0.0.0
    Default Gateway . . . . . : 

Ethernet adapter Ethernet 3:

    Connection-specific DNS Suffix  . : users.uwtsd.ac.uk
    Link-local IPv6 Address . . . . . : fe80::f016:6bd3:dbf1:b8c%9
    IPv4 Address. . . . . : 192.1.1.1
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 
  
```

And again, I can do the same thing, but this time without writing anything in the “Default Gateway” option, with the two servers to connect them and use the ping command to show this works. However, this time, the IP addresses are not in the 10.X.0.X format, but in the 192.1.1.X format.

Server LD

Server SW

```

Server LD:
C:\Users\Administrator>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : users.uwtsd.ac.uk
    Link-local IPv6 Address . . . . . : fe80::1182:dbd:8e64:13b%14
    IPv4 Address. . . . . : 10.0.2.15
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.0.2.2

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::cd83:ae6b:8dc4:8f12%16
    IPv4 Address. . . . . : 10.2.0.1
    Subnet Mask . . . . . : 255.0.0.0
    Default Gateway . . . . . : 

Ethernet adapter Ethernet 3:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::90cd:ac8f:7118:b1cb%4
    IPv4 Address. . . . . : 192.1.1.2
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 

C:\Users\Administrator>ping 192.1.1.1

Pinging 192.1.1.1 with 32 bytes of data:
Reply from 192.1.1.1: bytes=32 time=1ms TTL=128
Reply from 192.1.1.1: bytes=32 time=1ms TTL=128
Reply from 192.1.1.1: bytes=32 time=1ms TTL=128
Reply from 192.1.1.1: bytes=32 time=1ms TTL=128

Ping statistics for 192.1.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

Server SW:
C:\Users\Administrator>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : users.uwtsd.ac.uk
    Link-local IPv6 Address . . . . . : fe80::19d59:552:5c5f:338b%7
    IPv4 Address. . . . . : 10.0.2.15
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.0.2.2

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::a1b7:fd44:b714:6cd%17
    IPv4 Address. . . . . : 10.1.0.1
    Subnet Mask . . . . . : 255.0.0.0
    Default Gateway . . . . . : 

Ethernet adapter Ethernet 3:

    Connection-specific DNS Suffix  . : users.uwtsd.ac.uk
    Link-local IPv6 Address . . . . . : fe80::f016:6bd3:dbf1:b8c%9
    IPv4 Address. . . . . : 192.1.1.1
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 
  
```

Research on IP Addresses

Introduction

Data travels over the internet by being divided into packets and transmitted using protocols like TCP/IP (Transmission Control Protocol/Internet Protocol). IP addresses uniquely identify devices, guiding data routing. Each of these devices are called “host”. [1]

IP addresses are defined by different organizations depending on where you live in the world (see image on the right).

For Europe, this organization is the RIPE NCC and for North America, the organization is the ARIN. [3]



Image 4. Regional Internet Registries Map [9]

Each network on the internet has a unique IP address, and every host on the same network will have the same IP address but will be differentiated by the host number. The host number can be either set automatically, or by the network administrator.

There exist two types of IP address, IPv4 and IPv6.

The main difference between IPv4 and IPv6 is that IPv4 is written in decimal (from 0 to 9) and is a 32-bit address and IPv6 is written in hexadecimal (from 0 to 9 and from a to f) and is a 128-bit address.

IPv4.

IPv4 follows the Dotted Decimal Notation, which means there is 4 octets of 8 bits each and each octet goes from 0 to 255 (e.g. 192.168.135.50). [1]

The subnet mask is a small network inside the network. It only works for internal usage and is used by routers to route data inside the subnet. Packets travelling from a device in the subnet to another one device on the same subnet will not interact with the internet. Packets arriving from the internet won't display the subnet mask, only the IP address; and routers inside the network will make the link between the IP address and the subnet. [4]

CIDR (Classless Inter-Domain Routing) is a method of managing IP addresses for IP routing that merges IP addresses into blocks. This was made to slow down the creation of IPv4 addresses, which would become a problem with the creations of new technologies. [5]

IPv4 addresses are divided into multiple parts, called “classes”:

Class	Start Address	End Address	Default Subnet mask	CIDR notation
A	0.0.0.0	127.255.255.255	255.0.0.0	/8
B	128.0.0.0	191.255.255.255	255.255.0.0	/16
C	192.0.0.0	223.255.255.255	255.255.255.0	/24
D (multicast)	224.0.0.0	239.255.255.255	Not defined	/7
E (reserved)	240.0.0.0	255.255.255.255	Not defined	Not defined

[6]

IPv6.

IPv6 is the newest version of the Internet Protocol.

IPv6 addresses are represented as eight groups of four hexadecimal digits each, separated by colons (e.g: 2001:0db8:0000:00a3:abcd:0000:0000:1234). In IPv6, a “hextet” is the unofficial term used to refer to a segment of 16 bits, or four hexadecimal values. [1]

Not only does it provide more internet addresses, IPv6 also implements new features that are not present in IPv4. For example, the IPv6 subnet is a fixed sized subnet of 64 bits, or it enhances packet processing efficiency in routers by delegating the task of packet fragmentation to end points. [7]

How does data travels on the internet ?

Data travelling on the internet is divided into packets. Each packet is divided into 2 sections : A part of the original data, and a header. The header contains information about the content of the packet, the origin of the packet and the destination of the packet. [8]

Those packets can travel via two different path: via switch or via routers. While switches oversee communication within a network by directing packets according to MAC addresses and facilitating VLANs for logical segmentation, routers manage communication between different networks by directing packets based on IP addresses and utilizing routing protocols for dynamic adaptation.

Troubleshooting

Introduction

Throughout the creation of the network, I encountered different types of difficulties. Going from small ones to very problematic ones.

Network

Once I set up the virtual machines, I needed to connect them to each other. I first tried using a bridge connection, but it didn't work. I after done some research with the help of the documentation of VirtualBox, and I found out that I could use NAT Network instead of bridge connection. NAT Network helps me connect the client to the server, and reverse; however, the client also detected the client on the other side of the network (LD-client detected SW-client and reversed). With the help of other student, I figured that I needed to create 3 internal network, one for the LD part, one for the SW part and one for the Server. When I set correct internal network, I could at the same time resolve another problem I had: the IP problem.

IP

During the set up of the virtual machines, I figured that I needed to set the correct IP addresses. But the problem was, because I first used NAT Network, the IP address I set manually wasn't the same as the one shown in the cmd. However, when I changed the network to "internal

network”, I could set the correct IP address, which allows me to ping the devices from one to the other.

Clone Virtual Machine

When I created the first virtual machine, which was a Windows 10 Client, I thought that I could copy paste this virtual machine to create the other Windows 10 Client. But when I launched the second virtual machine, I got an error message saying that the virtual machine had an internal error, and right after, it crashed. Because I didn't know about the VirtualBox documentation yet, I decided to create from scratch a new virtual machine, which will become the second Windows 10 Client.

References

- [1] UWTSO, *Lecture Slides - NOSS*, Swansea, 2024.
- [2] [Online]. Available: <https://aws.amazon.com/>.
- [3] [Online]. Available: https://en.wikipedia.org/wiki/Regional_Internet_registry.
- [4] [Online]. Available: <https://www.cloudflare.com/en-gb/learning/network-layer/what-is-a-subnet/>.
- [5] [Online]. Available: https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing.
- [6] [Online]. Available: https://en.wikipedia.org/wiki/Classful_network.
- [7] [Online]. Available: <https://en.wikipedia.org/wiki/IPv6>.
- [8] [Online]. Available: <https://www.cloudflare.com/learning/network-layer/what-is-a-packet/>.
- [9] [Online]. Available: <https://www.ripe.net/about-us/what-we-do/ripe-ncc-service-region/>.