

Assignment 1

Networking Operating Systems & Services

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Introduction

I have been tasked to set up a virtual network for the NOSS corporation. I am to research hypervisors, justifying my choice in hypervisor, document each step of my setting up the network workstations/servers, one workstation per server and one server per location. In this case, NOSS is stationed in Swansea and London which means I will be setting up two servers and two workstations.

I have already been presented with a topology that I must follow, while doing so I am to discuss IP addressing and am to document all testing done for the network.

Hypervisor Research

A hypervisor, also known as a virtual machine monitor (VMM), is a component which grants the user the ability to create/manage multiple virtual machines [1]. Virtual machines are known as virtualisation technology, which allows the use of multiple operating systems (OS) to run within a single machine [1].

Type 1 Hypervisor

There are two types of hypervisors, type one being “Bare Metal Hypervisors”, which runs the virtual machines using the hardware of the host system to control and manage the virtualized OS [2]. Some examples of type one hypervisors would be VMWare, Microsoft Hyper-V Server, or Xen. These virtualisation softwares are typically used within businesses and similar environments [2].

Type 2 Hypervisor

Type two hypervisors, or “Hosted Hypervisors,” are used mainly in development/testing environments [3]. These VM's run on a computer system's pre-existing operating system, as opposed to being installed directly onto the hardware like that of a type one VM [3]. Type two hypervisors are used for tasks such as developing/testing software that may impact the network [3].

Type two virtual machines are simpler to set up compared to a type one virtual machine [4]. This type of VM allows the hosting of multiple virtual machines without the requirement of a dedicated server being set up [4]. Some examples of type two virtual machines would be VMWare Workstation, Oracle, VirtualBox, or Parallels Desktop [5].

Hypervisor Features

Regardless of their type, all virtual machines will have specific traits. The traits are as follows:

Isolation

All virtual machines are their own devices, they do not interact with or acknowledge any other virtual machine or even the hosted system [6]. Any and all software within the VM will believe that the system they are currently running on is a real device and will have no indication that it is in fact a VM [6].

This grants security and stability within a network, as when developing network tools or opening strange files, the damage will only be limited within the realm of the virtual machine [6].

Snapshot & Cloning

Hypervisors will usually offer features such as snapshotting or cloning which enables the ability to save the state a virtual machine is in at any specific point in time [7]. This means that the virtual machine can be corrupted and then reverted back to save just before the action which caused the corruption can occur [7].

This is beneficial for development and testing as these tasks can cause damage to a network or system if not careful, and having to set up new virtual machines each time can take up a lot of time and effort [7].

Hardware Independence

Virtual machines are not physical machines, therefore they run on virtualized components [8]. They use a configured amount of storage/memory given to it by the creator of the VM [8]. This makes it easier to upgrade or configure the networks within the VM's without impacting other machines as well [8].

Networking Applications

Hypervisors are used in a variety of aspects within computing. They are crucial when creating or planning a network, and are often used by cyber security specialists to develop and test their softwares to accurately see if what they wrote can work on a network system [9].

Since I have been tasked to set up a network, I have looked into how hypervisors are used within the scope of networking. I found that each virtual machine has their own network settings, but can also be configured to communicate with each other like that of a standard network system. This can be done by configuring the IP addresses of each workstation VM and then creating a separate VM to act as a server. This allows the workstations to communicate with one another as well as the server.

Hypervisor Justification

After researching what hypervisors are, their types and the importance of their role in networking. I looked into individual hypervisor softwares to find which one would best suit the task assigned to me.

Each of the hypervisors I had found had their own advantages as well as disadvantages to their usage. Some had more user-friendly interfaces, others had more efficient hardware allocation for each virtual machine. However, I have decided to use the Type 2 hypervisor known as VMWare Workstation Pro.

I decided to use a type 2 VM as they are quite straightforward to set up, and lack the requirement of a dedicated server to be configured. I decided that VMWare Workstation Pro would be my selection of type 2 VM's for a number of reasons.

First off, VMWare Workstation has an easy to navigate, easy to understand, user interface. This makes it easier for me to configure each virtual machine for their intended purpose. Secondly, VMWare Workstation has been used within the networking industry for quite a long time, and is widely trusted [10]. From its history alone, I decided that this hypervisor would definitely suit the needs I have for the assigned task ahead.

Beyond those two reasons, VMWare Workstation Pro offers security and isolation for each of its virtual machines as well as VMWare Workstation Pro being quite cost effective, having a one time purchase of £200 [10][11].

IP Addressing

IP addresses are essentially the locations of devices within the network [12]. They are used to allocate a destination for when packets need to be sent across the network to a specific system [12]. There are two commonly used versions of IP address [13]. Firstly there's IPv4 which uses 4 bytes to create one address [14]. These addresses are formatted as such: "192.168.10.1" [14]. Each number, separated by the '.' represents one byte and each byte can range from 0 to 255 [14].

The second type of IP address is IPv6 which uses 128 bits as opposed to IPv4 which uses 32 bits [15]. IPv6 addresses are longer and can accommodate significantly more addresses than when using the IPv4 format addresses [15]. IPv6 addresses are formatted using eight groups of four hexadecimal values that are separated by colons and have the leading zeros being suppressed [16]. This results in an address that looks like this;
2001:0db8:85a3:0000:0000:8a2e:0370:7334.

Configuring the two types of addresses are slightly different as IPv4 addresses can be configured manually or dynamically [17]. Manually setting up an IPv4 address means to write out the 4 bytes by hand, dynamically setting up an IPv4 address uses DHCP to randomly allocate an address to the system [17]. IPv6 addresses can be configured manually or dynamically using DHCPv6 [18].

IPv4 addresses utilise subnet masking to ensure the addresses are kept unique and organised [19]. A subnet mask will dictate what values each byte within the address can use. A common subnet mask would be '255.255.255.0' where the only number that can change within any IP address that uses this mask, is the 0 [19]. This is because the other 3 bytes are set to the max value of a byte, therefore there is no room for change in any IP address [19].

IPv6 addresses may not use subnet masking, however, they do use subnetting to allocate IPv6 addresses their values [20]. Instead of a mask, IPv6 addresses use prefixes to specify their size [20]. For example, 2001:0db8:85a3::/64, the prefix in this instance is /64, limiting the address to 64 bits in length.

IP addresses are used to enable communication between systems across a network or the internet [12]. In terms of the internet, IP addresses are associated with a domain name which is stored in a Domain Name Server (DNS) [21]. For example, <https://LastMinuteGames.org/> is a domain name and when searched for on a browser, it compares that domain name within a DNS and finds its associated IP address.

This process begins when a request is sent from a system, in this case a domain name is entered in a browser by the user, the browser checks the cached domain names to see if it has already received that domain's IP address [22]. If the IP address is not cached, then it's then received by the router and the router then passes that request to the DNS, the DNS retrieves the data from the associated domain name address, and sends the data back to the sender's address [22].

IP addresses move across networks and the internet via packets [23]. When data is sent over the network, it is first broken down into smaller packets, these packets contain specific information that make transmission possible [23].

Each packet is broken down into three segments [24]:

Header

The header contains information such as the destination address, source address, packet sequence number, protocol type and the packet length [25].

Payload/Data

The payload or data field, is the actual information that is being transmitted across the network within the packet [26]. This data can be anything from text to images or videos, as the information being sent as packets will be put back together again at its destination [26].

Trailer

The trailer of a packet holds information such as verification/error checking data [27]. This includes the checksum which is the value which is used by all packets within the package sequence to calculate whether or not the package has been corrupted or if it is valid [27]. The loss of a packet does not necessarily cause the checksum to fail, however, checksums are recalculated when a new packet within the sequence is received. These checksums are used to detect when an error occurs while the individual packets are being transmitted [28].

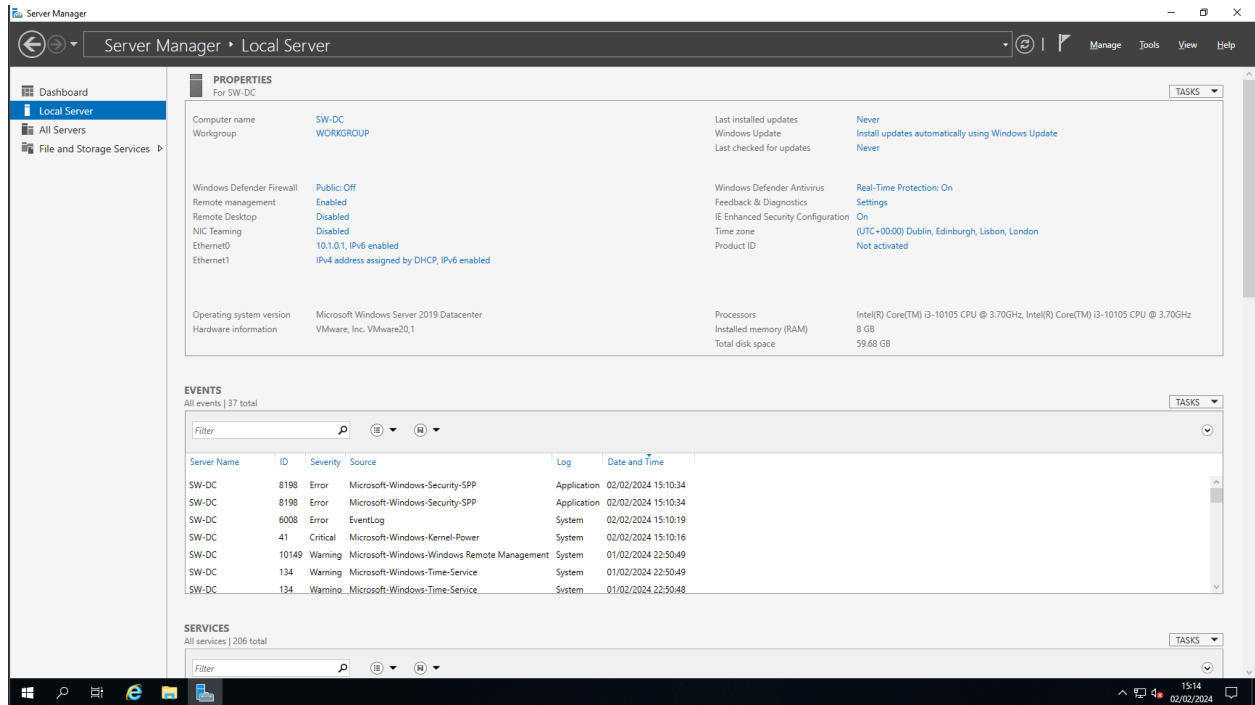
Packets are broken down by various protocols to assist in the transmission process [29]. The most common transmission protocol is a Transmission Control Protocol which breaks the packets down as mentioned above. There are additional protocols such as FTP (File Transfer Protocol) which is used for transmitting files between servers [30], or SMTP which is similar to that of TCP however SMTP (Simple Mail Transfer Protocol) is more secure as the information isn't sent over the network through plain text when using it along with some encryption protocols such as SSL/TLS [31].

Some websites utilise these security protocols within their connections, these websites can be identified within the URL. None-secure sites will use the prefix "http://" while secure sites will use the prefix "https://." HTTP stands for Hyper Text Transfer Protocol, while HTTPS stands for Hyper Text Transfer Protocol Secure, which is an on the nose indication that this site uses encrypted transmission of data.

Virtualisation Network

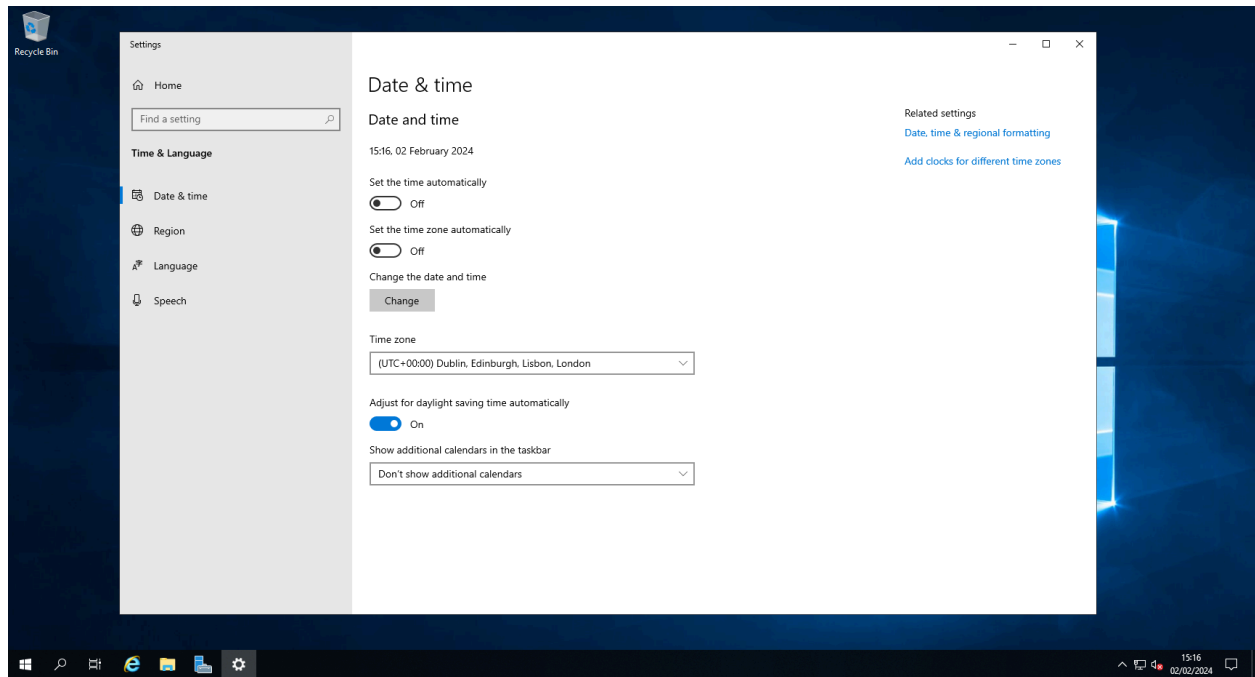
Swansea Server

Server Setup Name



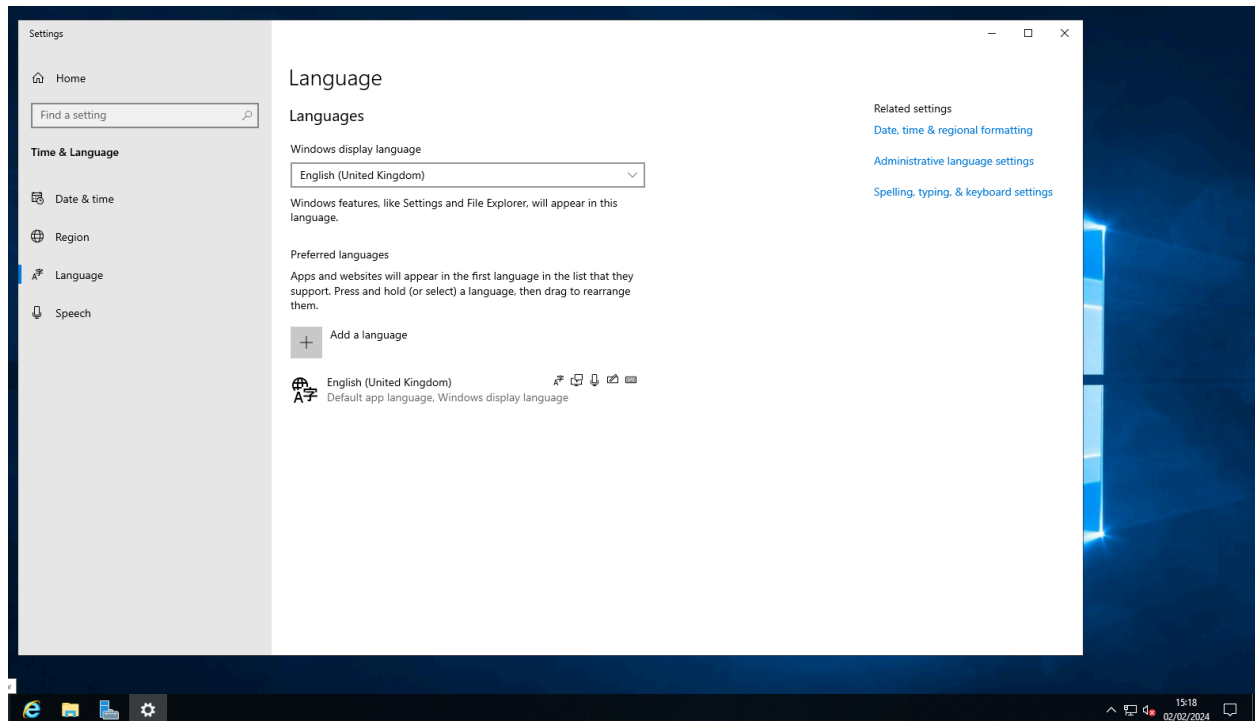
This screenshot shows that the server name has changed to “SW-DC”.

Server Setup Date/Time



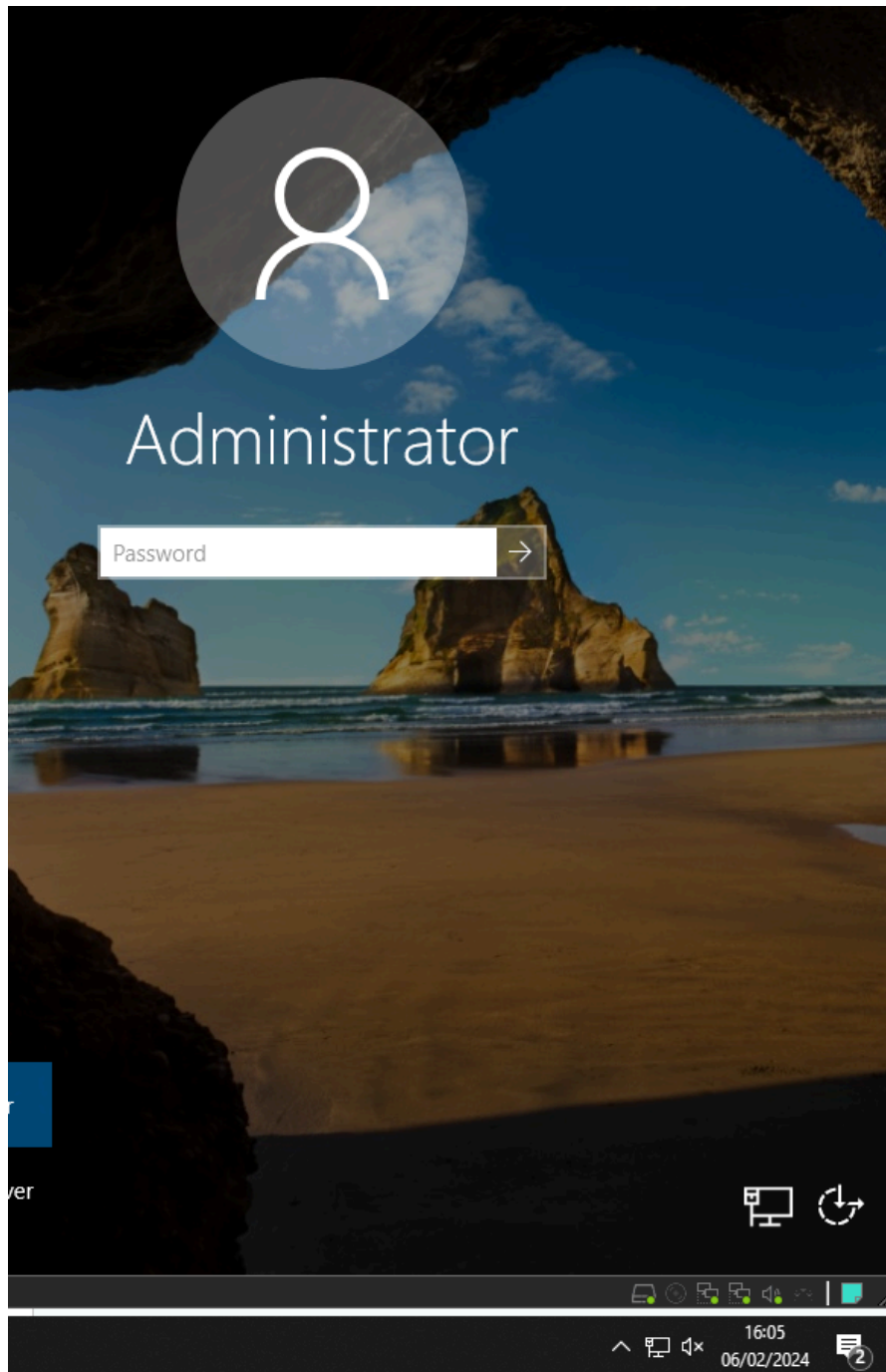
This screenshot shows that the date and time has been set to London UK's time region and that the automatic change has been disabled.

Server Setup Language



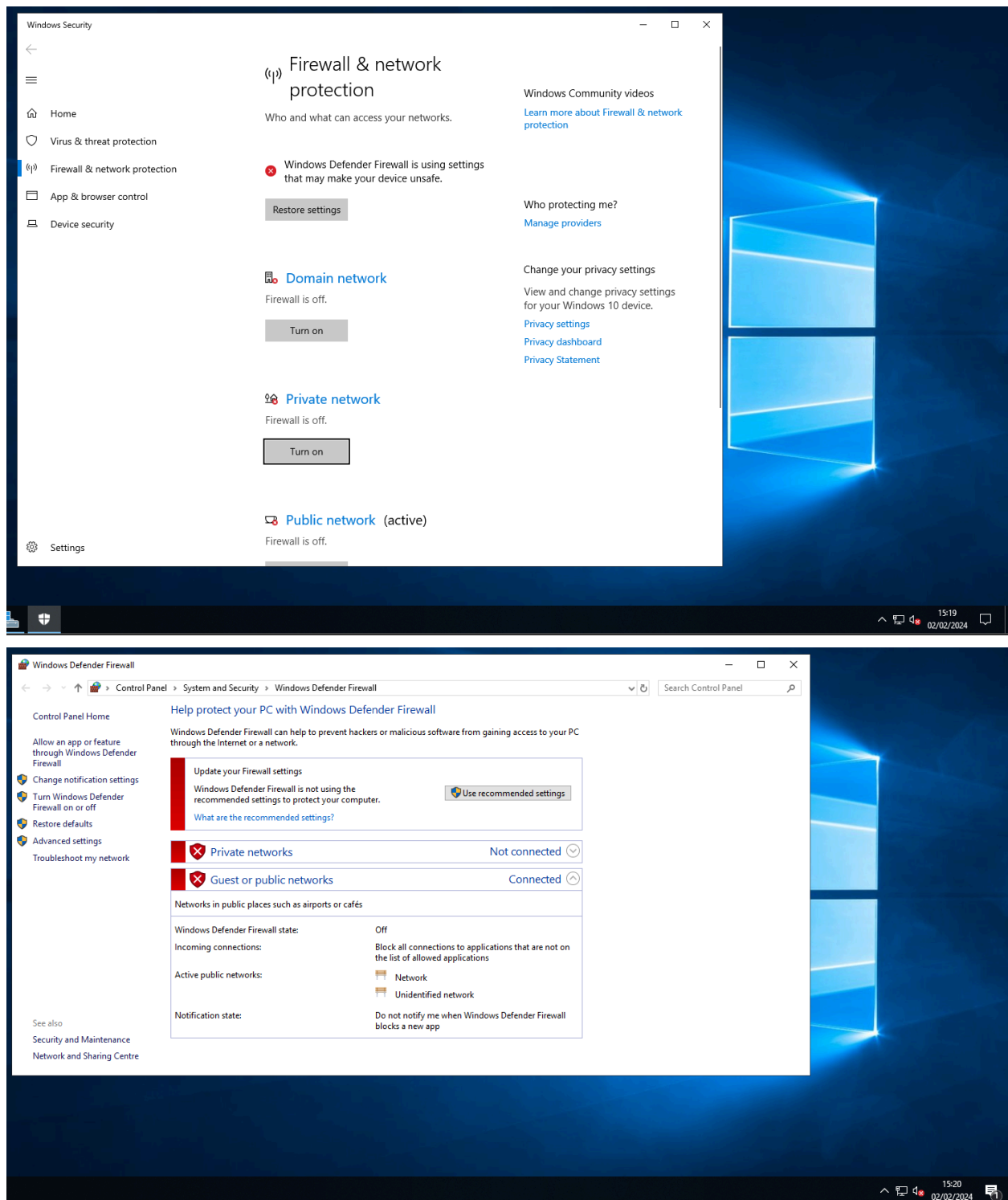
This screenshot shows the change of the default language from English (United States) to English (United Kingdom).

Username & Password



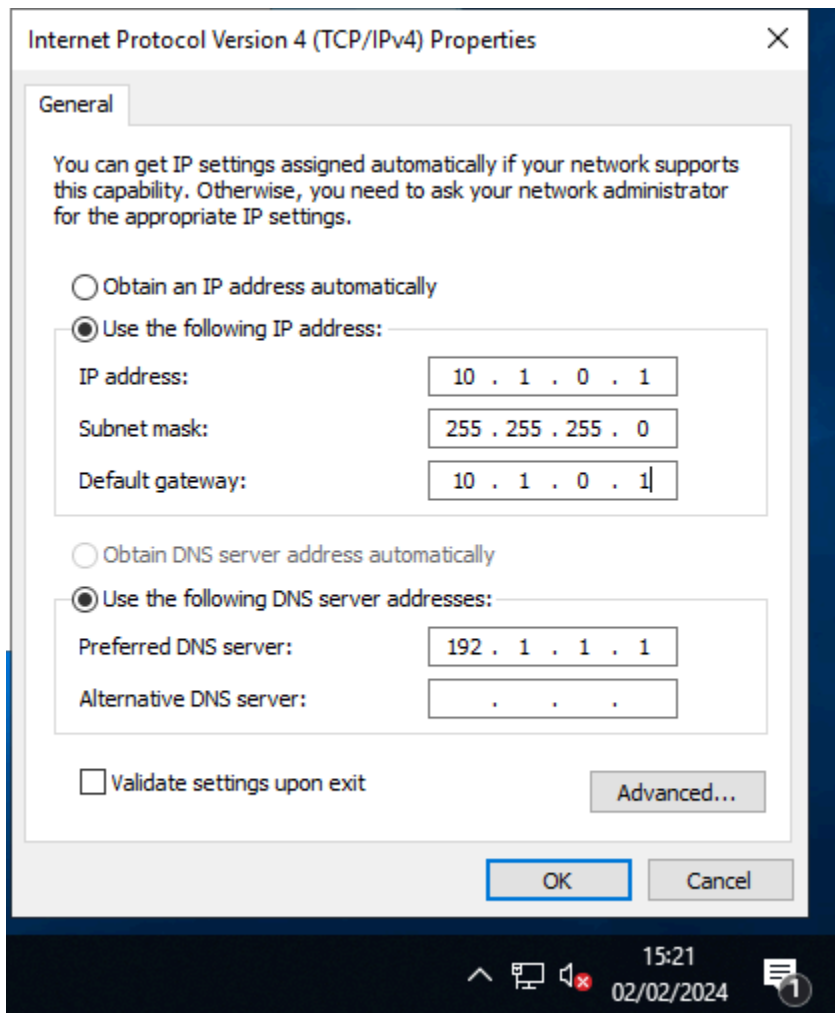
This screenshot shows that the password has been successfully added to the account "Administrator," the password being: Pa55w0rD!

Firewall Settings



These screenshots show that the firewalls have been disabled to enable the use of ping commands to be used to check if the machine is alive from other systems.

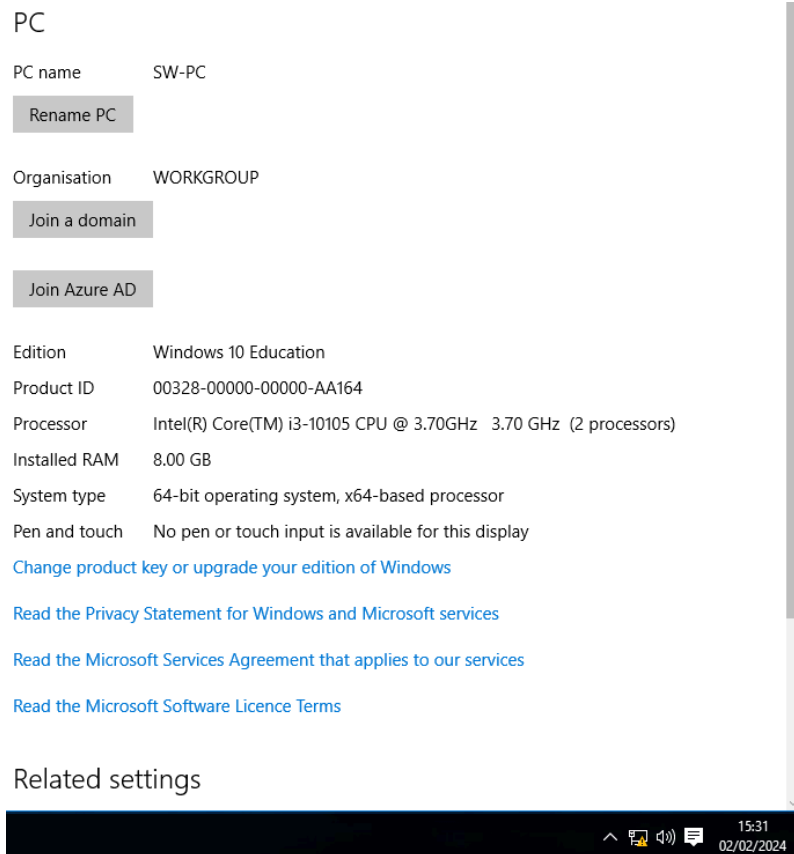
IP Configuration



This screenshot shows that the IP address has been assigned to “10.1.0.1” to the server, and the subnet mask and DNS server have been assigned the addresses given by the given topology.

Swansea Workstation

Workstation Setup Name



This screenshot shows that the PC name has been changed to be “SW-PC”.

Workstation Setup Date/Time

Date and time

15:33, 02 February 2024

Set time automatically

☐ Off

Change date and time

Change

Time zone

(UTC+00:00) Dublin, Edinburgh, Lisbon, London

Adjust for daylight saving time automatically

☒ On

Formats

First day of week: Monday

Short date: 02/02/2024

Long date: 02 February 2024

Short time: 15:32

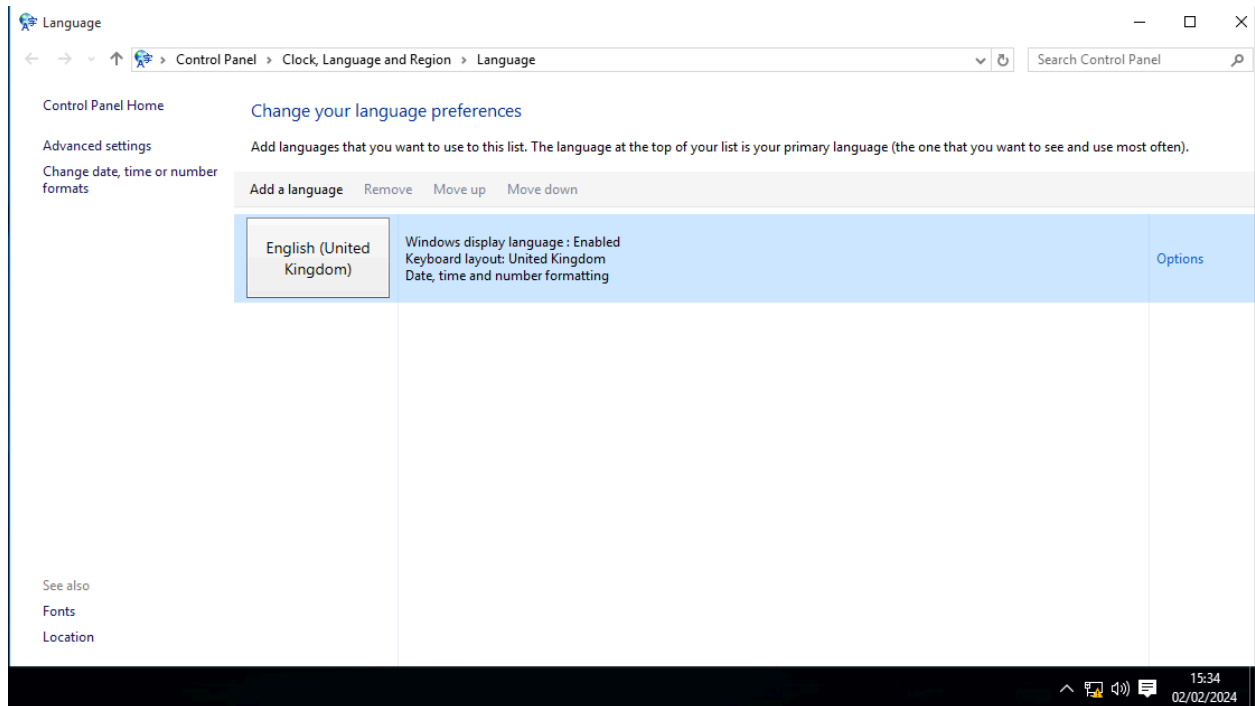
Long time: 15:32:57

[Change date and time formats](#)



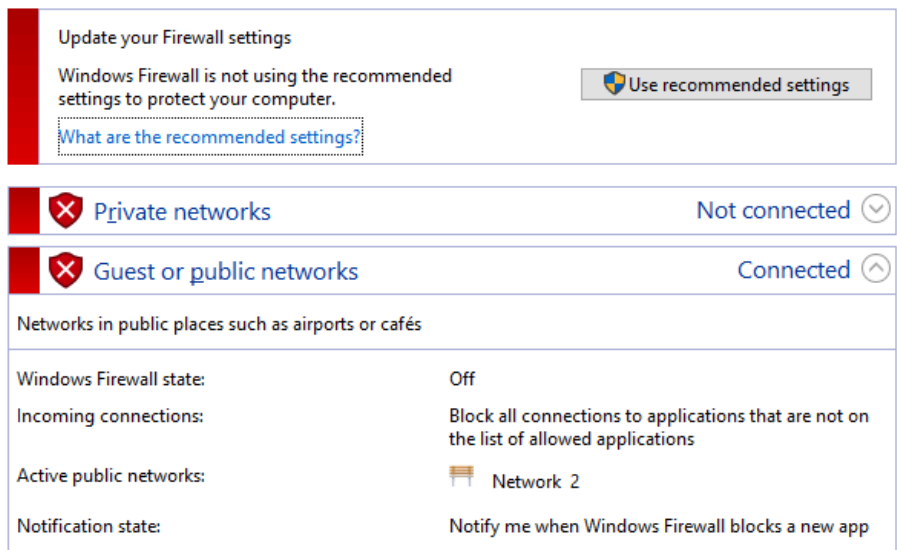
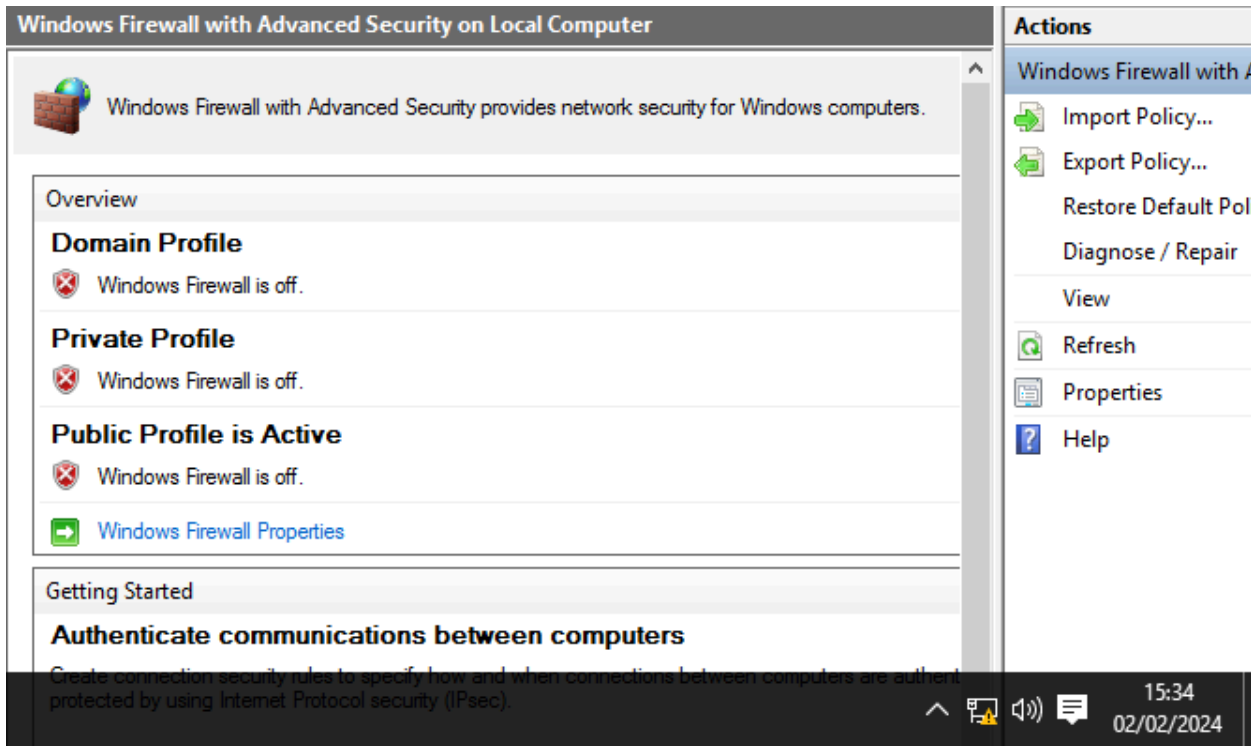
This screenshot shows that I have changed the date and time to London, United Kingdom.

Workstation Setup Language



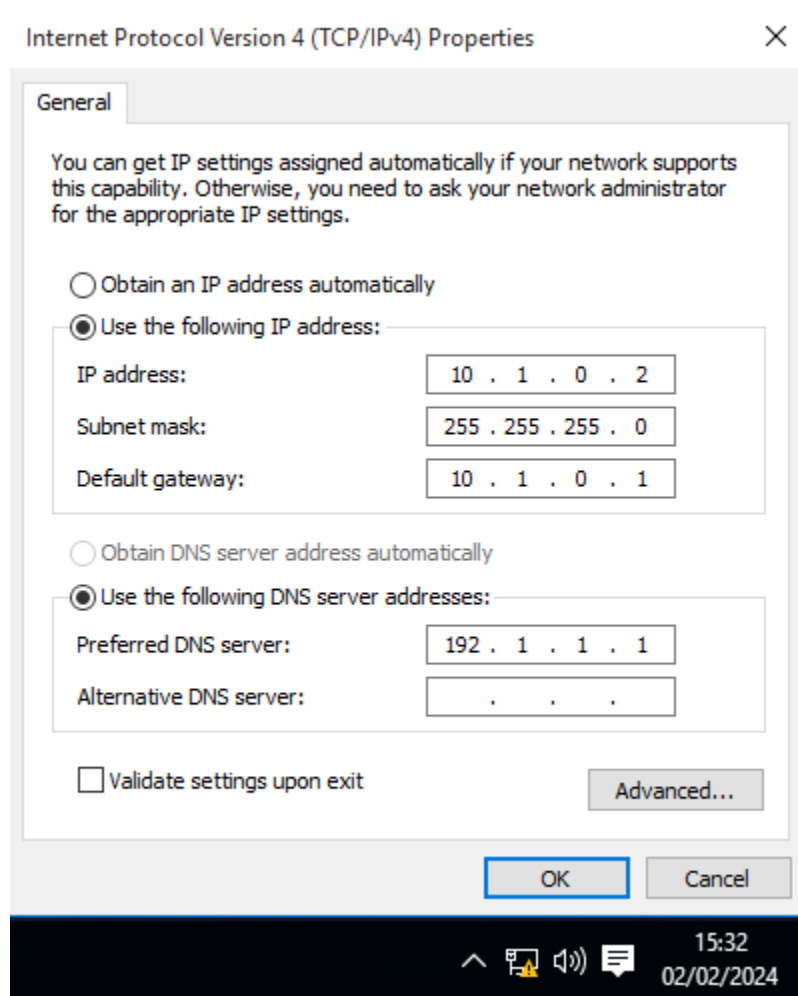
This screenshot shows I have set the language to be English (United Kingdom).

Firewall Settings



These screenshots show that the firewalls have been disabled to enable the use of ping commands to be used to check if the machine is alive from other systems.

IP Configuration



This screenshot shows that the IP address has been assigned to “10.1.0.2” to the server, and the subnet mask and DNS server have been assigned the addresses given by the given topology.

London Server

Server Setup Name

PROPERTIES

For LS-DC

TASKS

Computer name

LS-DC

Last installed updates

Never

Workgroup

WORKGROUP

Windows Update

Download updates only, using Windows Update

Last checked for updates

Today at 15:42

Windows Defender Firewall

Public: Off

Windows Defender Antivirus

Real-Time Protection: On

Remote management

Enabled

Feedback & Diagnostics

Settings

Remote Desktop

Disabled

IE Enhanced Security Configuration

On

NIC Teaming

Disabled

Time zone

(UTC+00:00) Dublin, Edinburgh, Lisbon, London

Ethernet0

10.2.0.1, IPv6 enabled

Product ID

Not activated

Ethernet1

IPv4 address assigned by DHCP, IPv6 enabled

Operating system version

Microsoft Windows Server 2019 Datacenter

Processors

Intel(R) Core(TM) i3-10105 CPU @ 3.70GHz, Intel(R) Core(TM) i3-10105 CPU @ 3.70GHz

Hardware information

VMware, Inc. VMware20,1

Installed memory (RAM)

8 GB

Total disk space

59.68 GB

EVENTS

All events | 22 total

TASKS

Filter

Filter

Filter

Filter

Server Name

ID

Severity

Source

Log

Date and Time

LS-DC

8198

Error

Microsoft-Windows-Security-SPP

Application

02/02/2024 15:46:54

LS-DC

8198

Error

Microsoft-Windows-Security-SPP

Application

02/02/2024 15:46:53

LS-DC

1014

Warning

Microsoft-Windows-DNS Client Events

System

02/02/2024 15:46:46

LS-DC

4440

Warning

Microsoft-Windows-Complus

Application

02/02/2024 15:46:18

LS-DC

10149

Warning

Microsoft-Windows-Windows Remote Management

System

02/02/2024 15:45:59

LS-DC

10010

Warning

Microsoft-Windows-RestartManager

Application

02/02/2024 15:44:33

LS-DC

1014

Warning

Microsoft-Windows-DNS Client Events

System

02/02/2024 15:39:23

SERVICES

All services | 206 total

TASKS

Services

Services

Services

Services

15:54

02/02/2024

This screenshot shows that the PC name has been changed to be “LS-DC”.

Server Setup Date/Time

Date & time

Date and time

15:54, 02 February 2024

Set the time automatically

☐ Off

Set the time zone automatically

☐ Off

Change the date and time

Change

Time zone

(UTC+00:00) Dublin, Edinburgh, Lisbon, London

Adjust for daylight saving time automatically

☒ On

Show additional calendars in the taskbar

Don't show additional calendars

Related settings

[Date, time & regional formatting](#)

[Add clocks for different time zones](#)



This screenshot shows that I have disabled the auto change function of the date and time settings, and set the time zone region to be London UK.

Server Setup Language

Language

Languages

Windows display language

English (United Kingdom) ▾

Windows features, like Settings and File Explorer, will appear in this language.

Preferred languages

Apps and websites will appear in the first language in the list that they support. Press and hold (or select) a language, then drag to rearrange them.



Add a language



English (United Kingdom)

Default app language, Windows display language



Related settings

[Date, time & regional formatting](#)

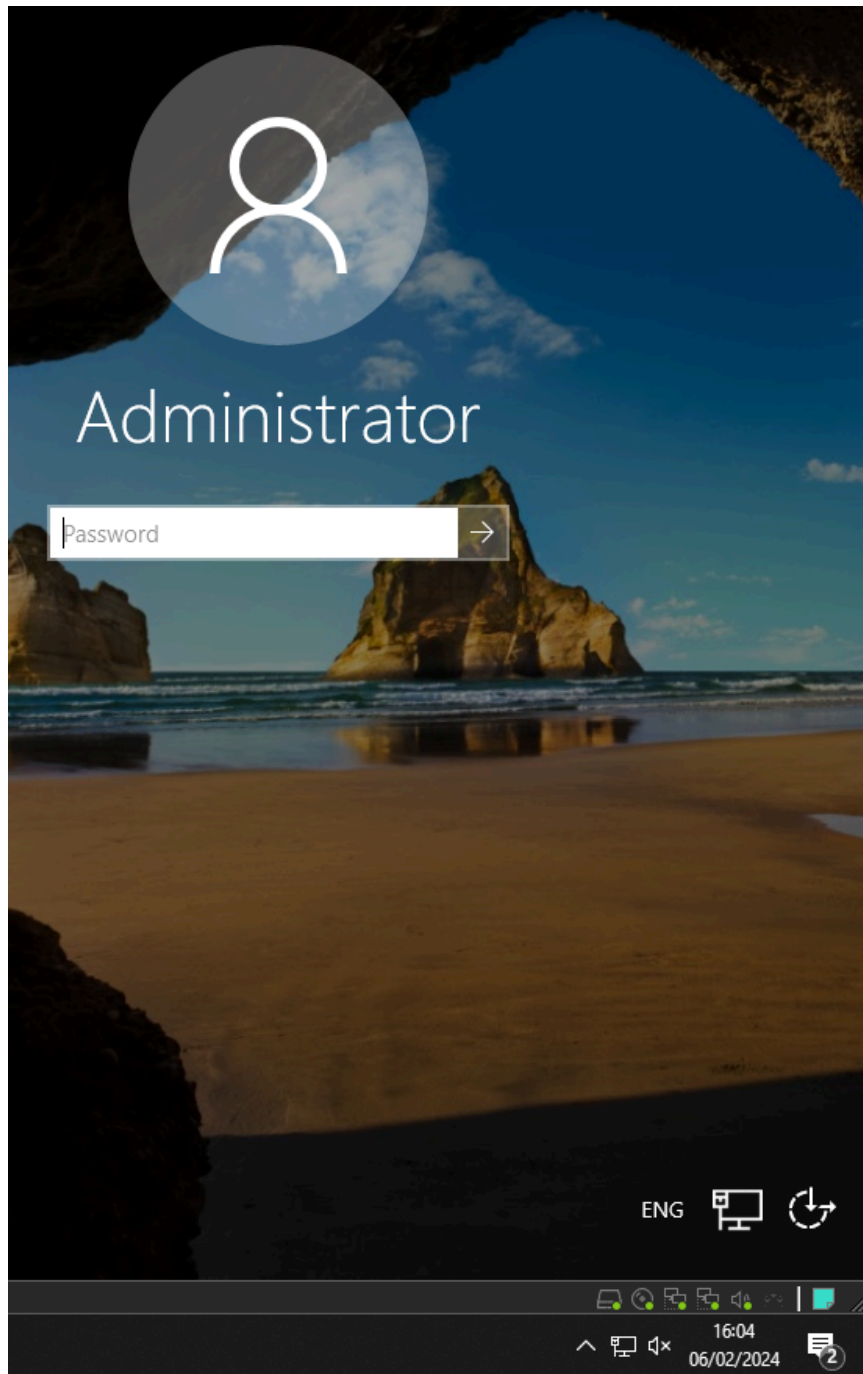
[Administrative language settings](#)

[Spelling, typing, & keyboard settings](#)



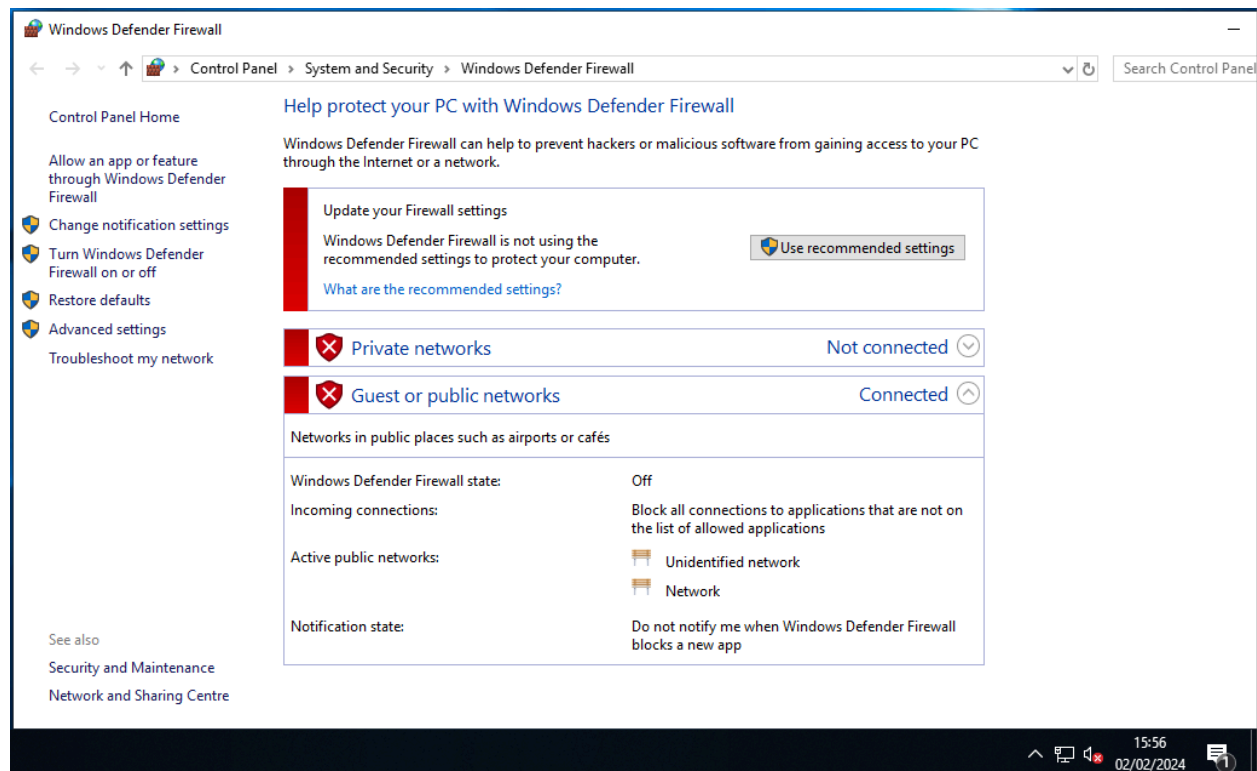
This screenshot shows that I have changed the server language from English (United States) to English (United Kingdom).

Username/Password



This screenshot shows that the password has been successfully added to the account "Administrator," the password being: Pa55w0rD!

Firewall Settings



Firewall & network protection

Who and what can access your networks.

Windows Commu

[Learn more about F protection](#)



Windows Defender Firewall is using settings that may make your device unsafe.

Restore settings

Who protecting m

[Manage providers](#)



Domain network

Firewall is off.

Turn on

Change your priva

View and change p
for your Windows

[Privacy settings](#)

[Privacy dashboard](#)

[Privacy Statement](#)



Private network

Firewall is off.

Turn on



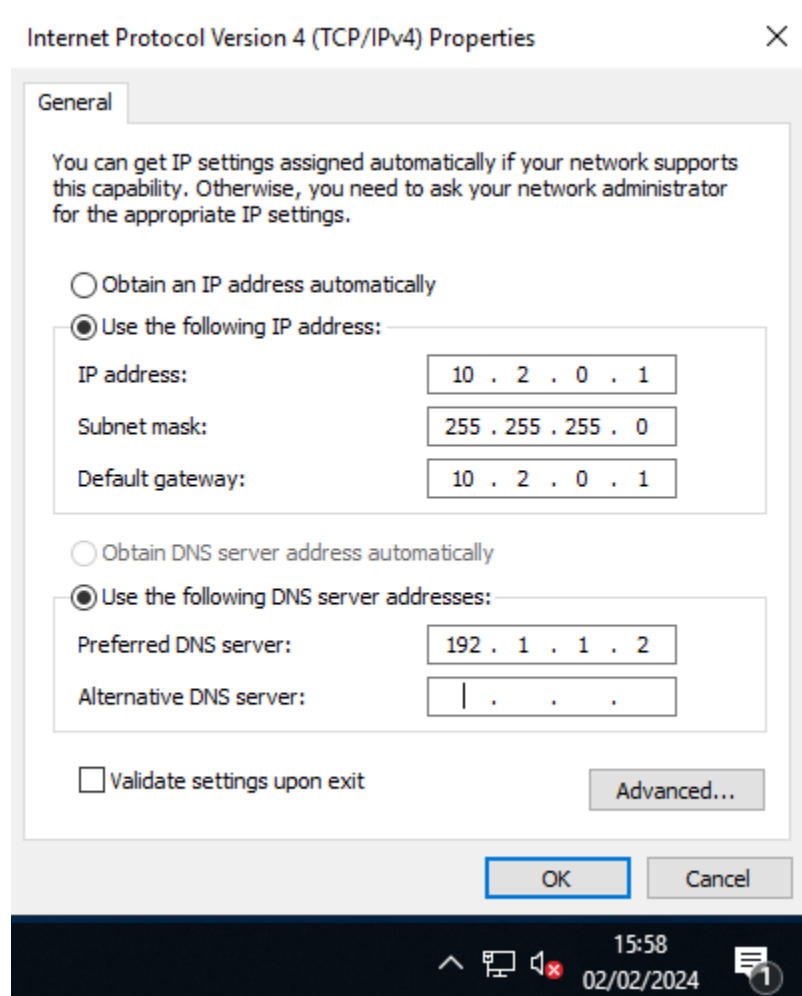
Public network (active)

Firewall is off.

15:56
02/02/2024

These screenshots show that the firewalls have been disabled to enable the use of ping commands to be used to check if the machine is alive from other systems.

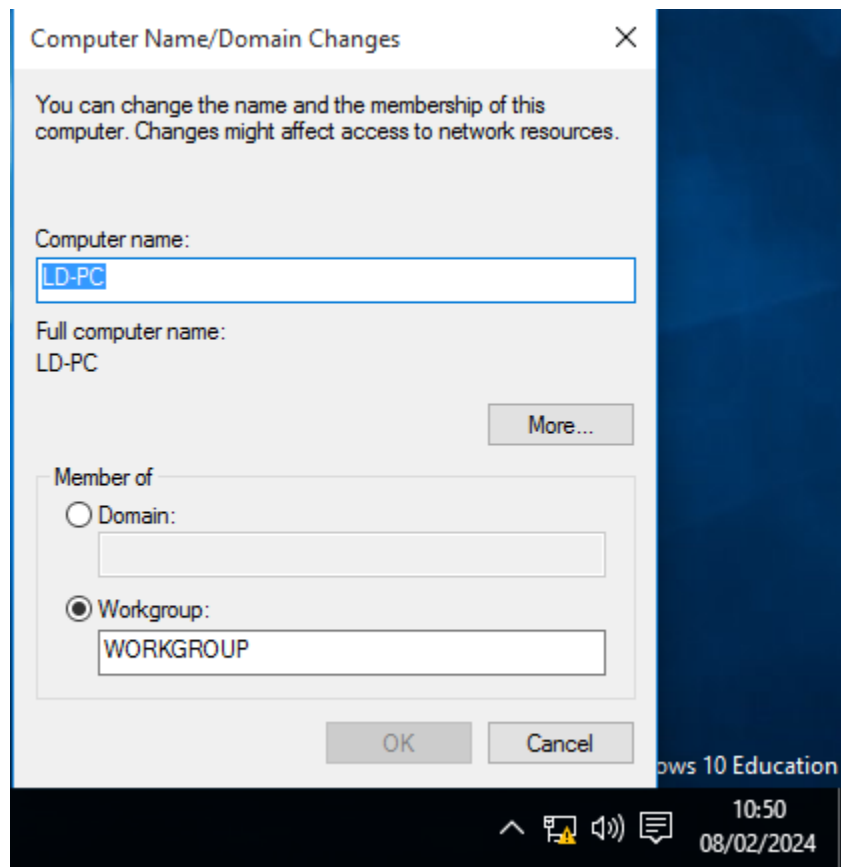
IP Configuration



This screenshot shows that the IP address has been assigned to “10.2.0.1” to the server, and the subnet mask and DNS server have been assigned the addresses given by the given topology.

London Workstation

Workstation Setup Name



This screenshot shows that the PC name has been changed to be LD-PC”.

Workstation Setup Date/Time

Date and time

16:15, 02 February 2024

Set time automatically



Change date and time

Change

Time zone

(UTC+00:00) Dublin, Edinburgh, Lisbon, London



Adjust for daylight saving time automatically



Formats

First day of week: Monday



16:15

02/02/2024

This screenshot shows that I have disabled the automatic change function of the date and time settings, and set the region to be London UK.

Workstation Setup Language

Country or region

Windows and apps might use your country or region to give you local content

United Kingdom

Languages

Add a language to read and type in that language



Add a language



English (United Kingdom)
Windows display language

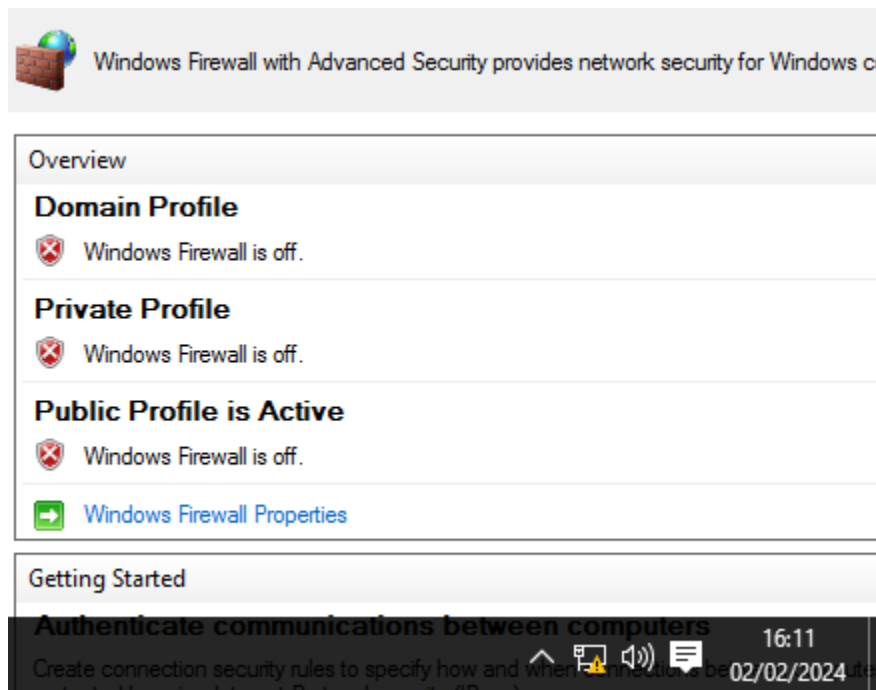
Related settings

[Additional date, time & regional settings](#)

16:16
02/02/2024

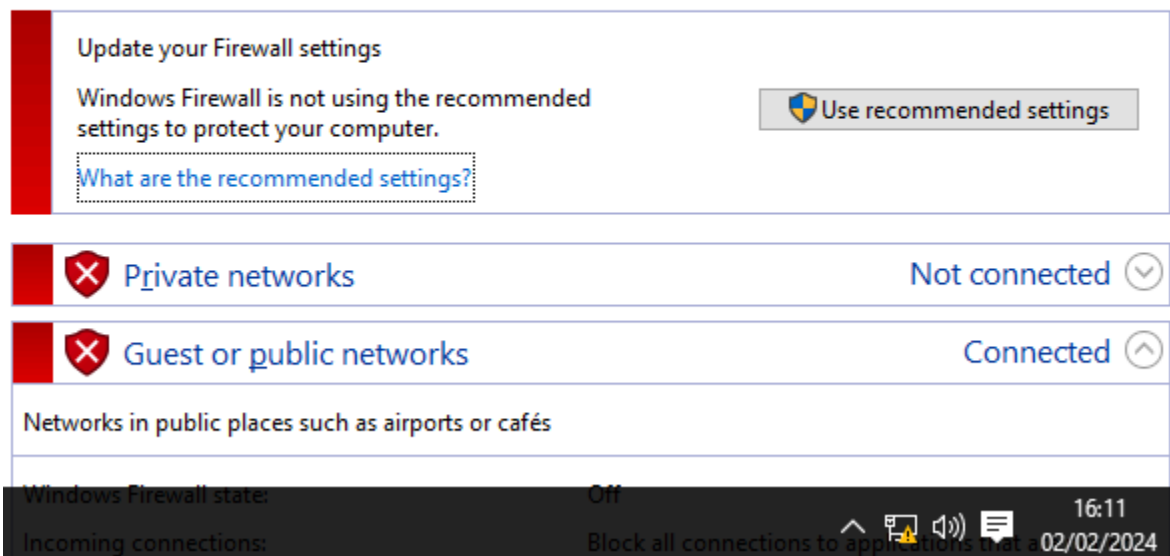
This screenshot shows that I have changed the language of this system to be English (United Kingdom).

Firewall Settings



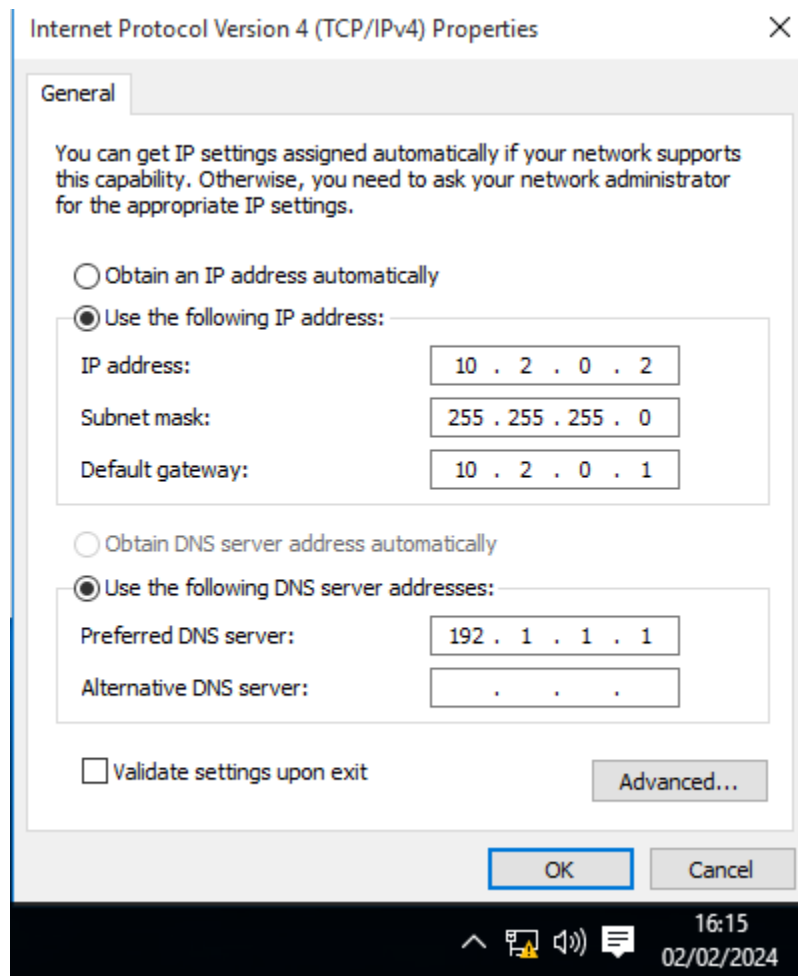
Help protect your PC with Windows Firewall

Windows Firewall can help prevent hackers or malicious software from gaining access to your PC through the Internet or a network.



These screenshots show that the firewalls have been disabled to enable the use of ping commands to be used to check if the machine is alive from other systems.

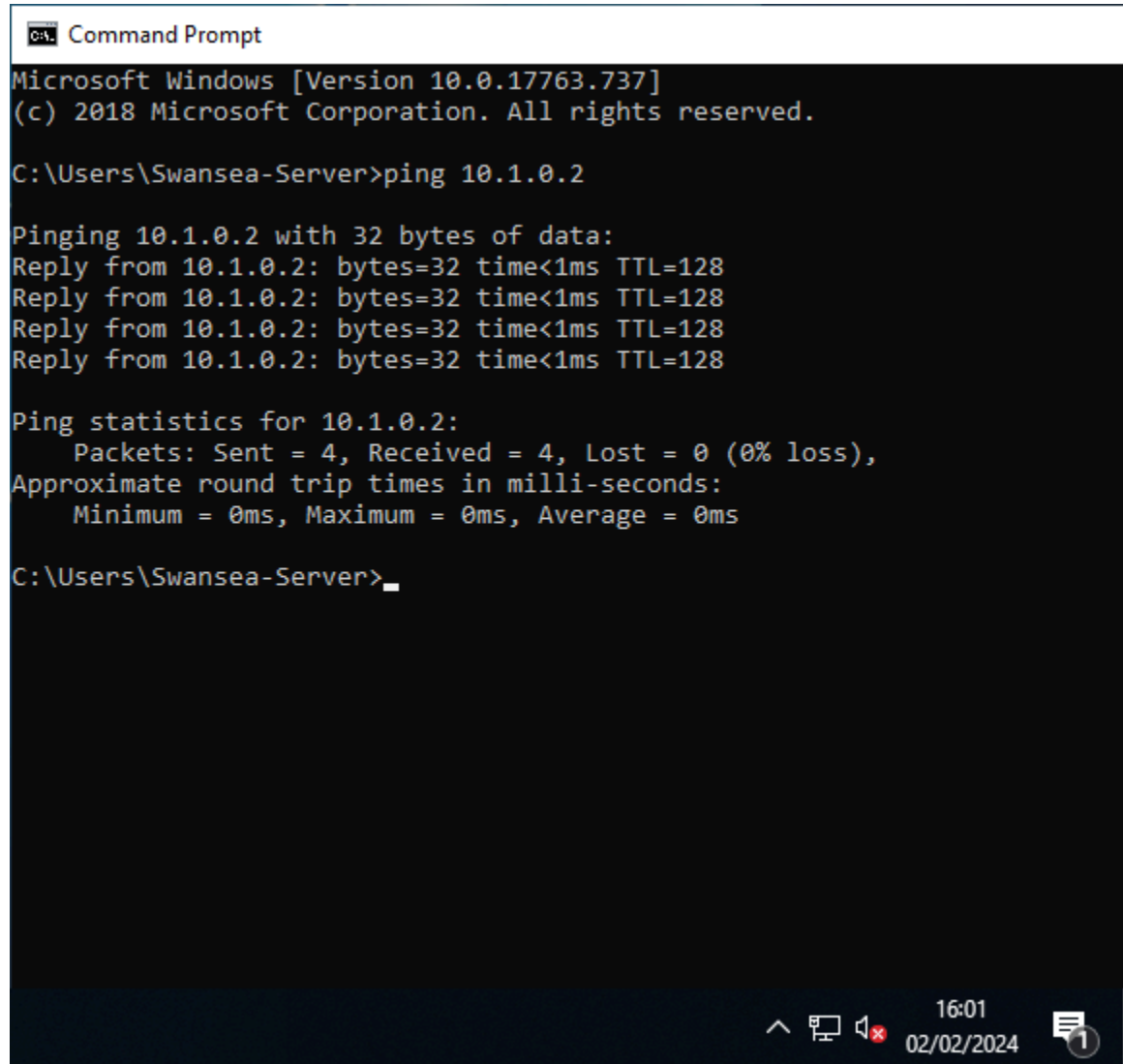
IP Configuration



This screenshot shows that the IP address has been assigned to “10.2.0.2” to the server, and the subnet mask and DNS server have been assigned the addresses given by the given topology.

Network Testing

Swansea Domain Server -> Swansea Workstation



```
Command Prompt
Microsoft Windows [Version 10.0.17763.737]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\Swansea-Server>ping 10.1.0.2

Pinging 10.1.0.2 with 32 bytes of data:
Reply from 10.1.0.2: bytes=32 time<1ms TTL=128
Reply from 10.1.0.2: bytes=32 time<1ms TTL=128
Reply from 10.1.0.2: bytes=32 time<1ms TTL=128
Reply from 10.1.0.2: bytes=32 time<1ms TTL=128

Ping statistics for 10.1.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\Swansea-Server>
```

As shown above, the Swansea Server is getting a response from the Swansea Workstation system.

Swansea Workstation -> Swansea Domain Server

```
Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\Swansea-Workstation>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

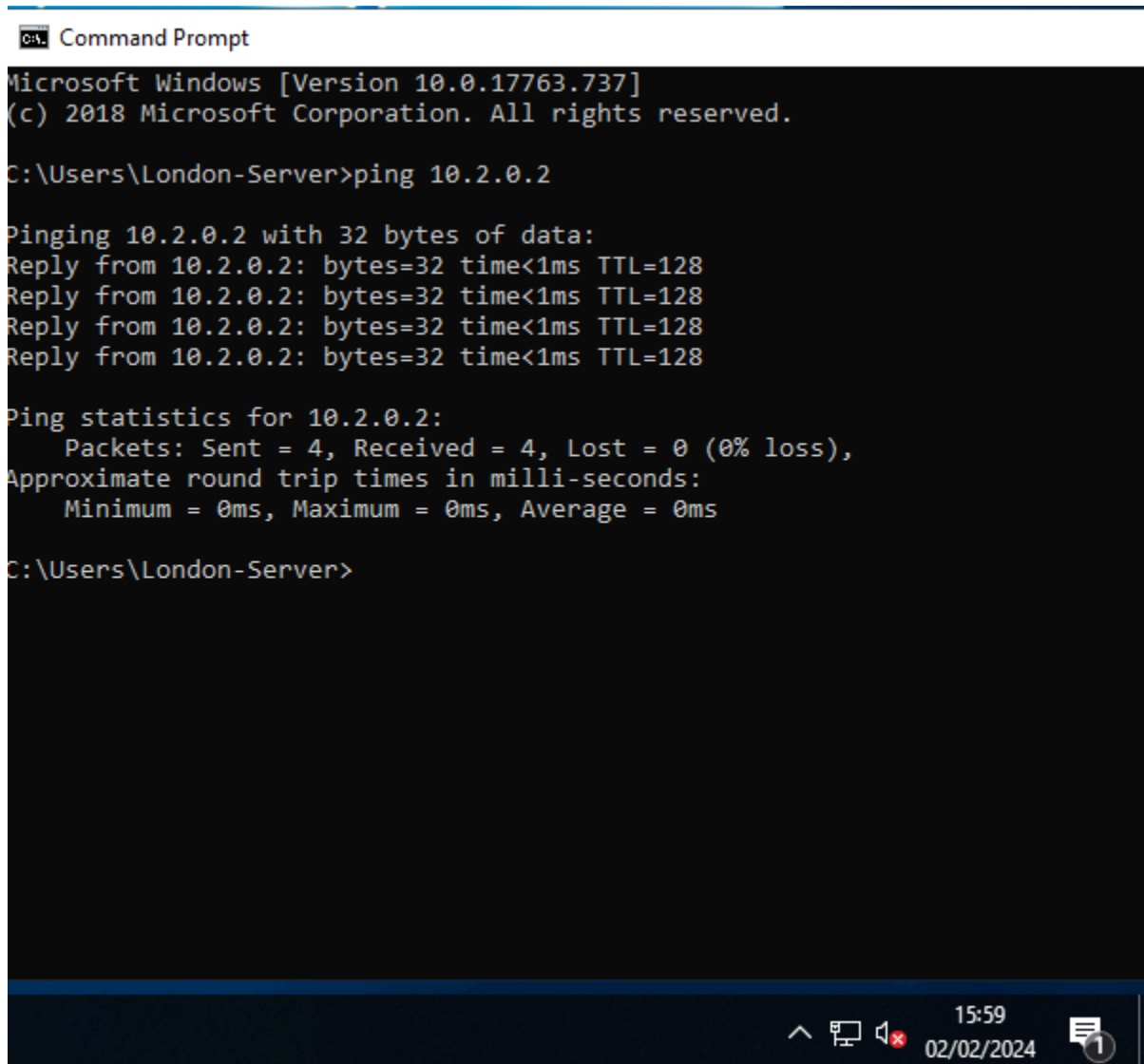
Ping statistics for 10.1.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\Swansea-Workstation>
```

16:01
02/02/2024

This screenshot shows that the Swansea Workstation can communicate back and forth with the Swansea Server system.

London Domain Server -> London Workstation



```
Command Prompt
Microsoft Windows [Version 10.0.17763.737]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\London-Server>ping 10.2.0.2

Pinging 10.2.0.2 with 32 bytes of data:
Reply from 10.2.0.2: bytes=32 time<1ms TTL=128
Reply from 10.2.0.2: bytes=32 time<1ms TTL=128
Reply from 10.2.0.2: bytes=32 time<1ms TTL=128
Reply from 10.2.0.2: bytes=32 time<1ms TTL=128

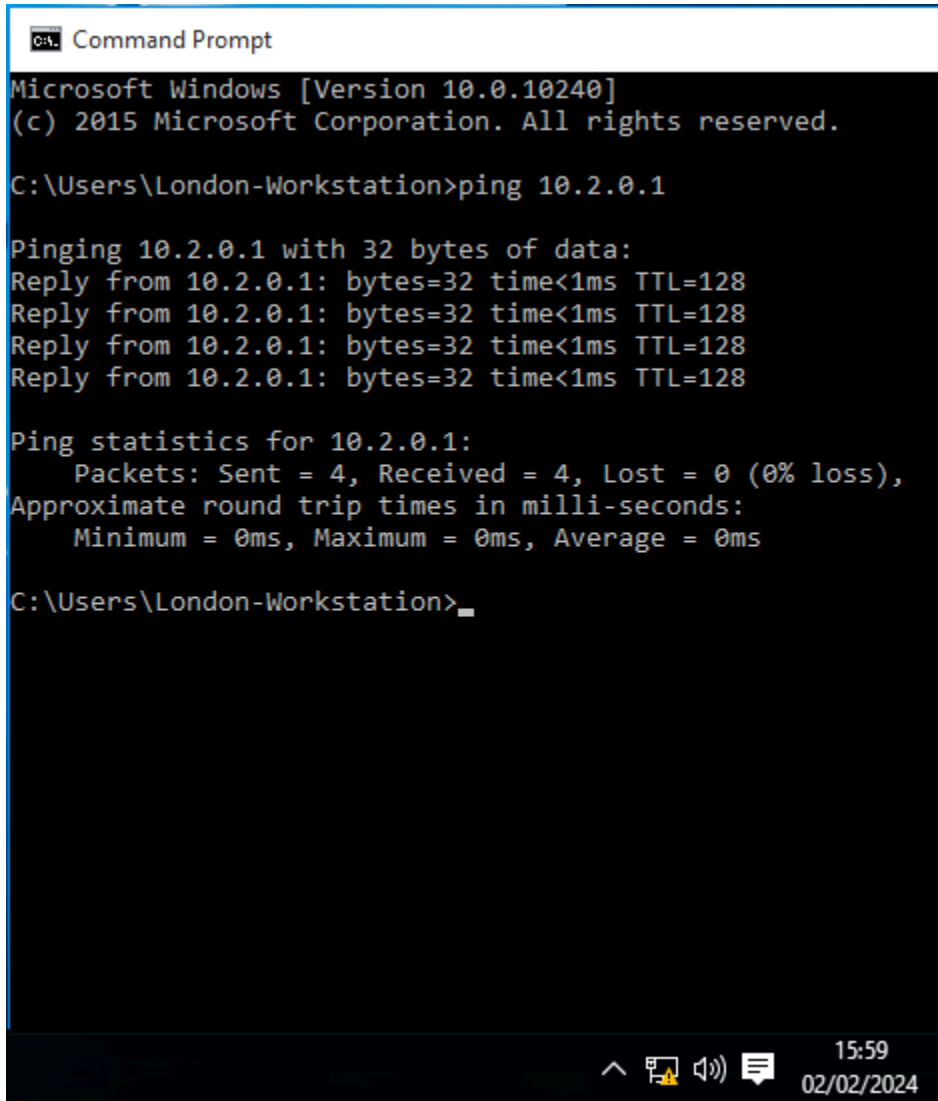
Ping statistics for 10.2.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\London-Server>
```

The screenshot shows a Windows Command Prompt window with a black background and white text. The title bar reads 'Command Prompt'. The window displays the output of a 'ping' command executed from the 'C:\Users\London-Server' directory. The command is 'ping 10.2.0.2'. The output shows four successful replies from 10.2.0.2, each with a response time of less than 1ms and a TTL of 128. Below the replies, the ping statistics are shown: 4 packets sent, 4 received, 0 lost (0% loss), and approximate round trip times of 0ms for minimum, maximum, and average. The command prompt ends with 'C:\Users\London-Server>'. The taskbar at the bottom shows the system clock as 15:59 on 02/02/2024, along with icons for network, volume, and a notification bubble with the number 1.

This screenshot shows that the London Server can communicate with the London Workstation without issue.

London Workstation -> London Domain Server

A screenshot of a Windows Command Prompt window. The title bar reads "Command Prompt". The text inside the window shows the Windows version (10.0.10240) and copyright (c) 2015 Microsoft Corporation. The user is at the prompt "C:\Users\London-Workstation>" and has entered the command "ping 10.2.0.1". The output shows four successful replies from 10.2.0.1 with a time of less than 1ms and a TTL of 128. Ping statistics show 4 packets sent, 4 received, and 0% loss. The taskbar at the bottom shows the system clock as 15:59 on 02/02/2024.

```
Command Prompt
Microsoft Windows [Version 10.0.10240]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\London-Workstation>ping 10.2.0.1

Pinging 10.2.0.1 with 32 bytes of data:
Reply from 10.2.0.1: bytes=32 time<1ms TTL=128
Reply from 10.2.0.1: bytes=32 time<1ms TTL=128
Reply from 10.2.0.1: bytes=32 time<1ms TTL=128
Reply from 10.2.0.1: bytes=32 time<1ms TTL=128

Ping statistics for 10.2.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\London-Workstation>
```

This screenshot shows that the London Workstation system can communicate with the London Server without issue.

Network Testing Techniques

Communication Testing

There are a number of tests that can be conducted within a network. To test connections between systems on a computer systems on a network, the 'ping' command can be used to see if the systems can communicate with each other over the network. This command works by sending a request for data to one system from another, and once the request is received, the system then sends back a pulse to indicate it exists and is alive.

Packet Loss Testing

After testing the network to see if systems can communicate, the next step is to verify that when data is sent across systems, the data isn't corrupted or interrupted on transmission. We can first check for packet loss within the network using the "pathping" command on a windows command prompt.

This command works in a similar manner to that of the ping command, however, this command will also reveal the packet loss rate between one IP address and another. This can be used to test the network to see if it's properly set up to withstand data transfers between two systems on a network.

Network managers could also use continuous monitoring to keep track of packet loss across the network as time passes. Simple Network Management Protocol (SNMP) or any dedicated network monitoring software can be utilised to do that very task.

Bandwidth Testing

The speed in which data is sent across a network is a vital aspect of any organisation. Files will need to be transferred between devices quickly and without error. To ensure the bandwidth of the network meets the needs of the organisation we can enact some bandwidth testing measures.

Tools such as iPerf or the popular site speedtest.net, will give users and network admins an idea of how fast their network speed is. These tools will reveal the upload/download speeds of the network, and therefore will indicate if files will be transferred at a fast enough pace for the organisation's needs.

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