

PAIGE HARRIS - DWA

by Paige Louise Harris

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1.0. Introduction

This report will explain the deployment of distributed type 1 hypervisors for a cloud-based application. It will explain the current principles and software development practices for a failover cluster as well as applying it and demonstrating the build process for the failover cluster.

It will firstly identify the concepts of a failover cluster, the rationale behind one and the rules that should be followed when creating one. It will also discussed what a quorum is and why it is used. It will discuss what the cluster modes are, and resource groups are as well as discussing the heartbeat network. The report discusses the failover network and the network load-balancing network and compares them to one another.

The report shows and discusses the build processes for the failover cluster that is managed using the Virtual Machine Manager. It shows the build of the storage area network and installing the operating systems to the virtual machines. It shows and discusses the networking layout used within the network as well as the failover cluster that has been created to ensure the network is up and running at all times. A test has then been done to demonstrate the cluster working.

The report also discusses the different cloud based technologies that are available; these include IaaS, PaaS, and SaaS.

2.0. Concepts of a Failover Cluster

This section will explain the main concepts of a failover cluster, including the justification of using this type of cluster, the quorum, the different cluster modes and resource groups as well as the heartbeat network and its operation.

2.1. Rationale behind failover clustering

A failover cluster's main priority is to reduce redundancy, ensuring that services within a network do not fail if one piece of hardware was to break down. The majority of cloud based computing is run using the failover cluster. "A failover cluster is a group of servers that work together to maintain high availability of applications and services. If one of the servers, or nodes, fails, another node in the cluster can take over its workload without any downtime (this process is known as failover)." [1] Microsoft offers a service called failover clustering which is used within the Windows Server. It is a group of independent computers which will work together in order to increase the availability and scalability of the cluster roles. Availability increases allow the computer to access the network with the least amount of downtime; it does this by having a number of nodes that will be able to be accessed from the computer in order to communicate within the network. If one node is not accessible, the network will use another path to access the required data. The scalability of the cluster is adding more instances of the product in hand and how the service will handle the growth without causing the uptime and feedback time to decrease. Horizontal scalability for example adding more clients (hardware/ computers) to the cluster, whether this be a virtual or physical machine. Vertical Scalability includes the addition of powerful hardware. The clustered services are what is called the nodes that are all connected via cables and networks.

Overview of a Failover Cluster

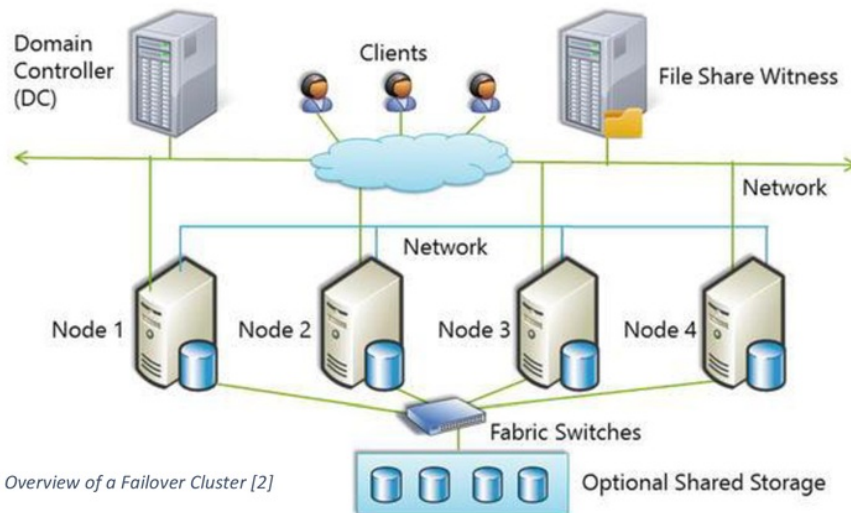


Figure 1 Overview of a Failover Cluster [2]

2.2. Failover Cluster Rules

When creating a failover cluster, rules must be followed to ensure the system is correctly implemented and to ensure the performance is acceptable. The failover clusters required at least two nodes, each node requires the hardware to be identical and all nodes must be members of a domain but cannot be domain controllers. Multiple network adaptors can be used to ensure the operations within the network are as fault tolerant as possible, these are often connected in teams. The failover clusters also required two or more switches that will usually be Ethernet. Ethernet is "...the technology that is most commonly used in wired local area networks (LANs). A LAN is a network of computers and other electronic devices that covers a small area such as a room, office, or building." [3]. The cluster will also require there to be two or more storage area networks, one to be a storage area, and one to be a disk witness. "In a shared storage cluster, you can use a small partition on the SAN disk as a disk witness to act as a vote If node one fails, node two and the SAN disk witness form a two-out-of-three majority, SQL Server will failover and operation will continue. Interestingly, a disk witness is not a single point of failure. If the witness fails, you still have two votes (nodes one and two) that represent a two out-of-three majority. It does not matter if you lose the witness whether it's disk, file share or cloud witness because you still have a two out of three votes. Because nodes one and two are still healthy, SQL will keep working on node one without any failure or failover." [4] The quorum defines how many failures there can be within the system before it complete failure; this is spoken in more detail in [Quorum](#).

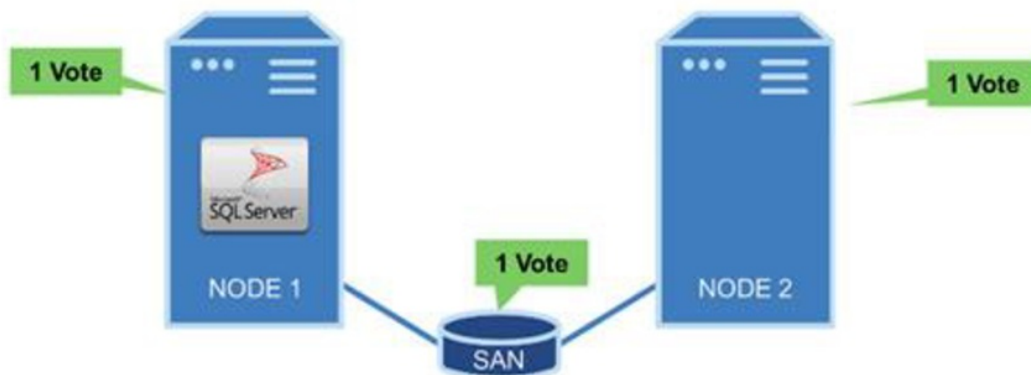


Figure 2 Majority node set with disk witness. [4]

2.3. Quorum

A quorum is relevant to the cluster as it can define how many fails within a cluster; the cluster can manage before it fails. After a number of failures, the cluster will eventually fail, and will shut down. "A cluster quorum disk is the storage medium on which the configuration database is stored for a cluster computing network. The cluster configuration database, also called the quorum, tells the cluster which physical server(s) should be active at any given time. The quorum disk comprises a shared block device that allows concurrent read/write access by all nodes in a cluster." [5] One model of this is similar to the SAN model; however, there is an additional disk that is used as the quorum disk. If a link between nodes has failed, the nodes are able to communicate through the quorum. The quorum is used as a voting system, ensuring that if part of the cluster fails, the other part is able to continue to run the cluster. The cluster is unable to identify whether failure is within the network or the hardware.

When configuring the quorum, there are four approaches that must be taken into consideration when defining the quorum's configuration. This again is based on votes.

1. Node Majority- this is where each of the nodes will gain one vote. This is used for failures within clusters for an odd number of nodes attached. This will only allow for the failure of half the nodes.
2. Node and disk Majority – this is where each node and the disk witness are given one vote. This is used for failures within clusters where there is an odd number of nodes. This will allow the failure of half the nodes providing the disk witness remains active.
3. Node and file share majority – this is similar to the node and disk majority, only using file share instead.
4. No Majority, disk only – this is where each disk has a vote, it will allow for failure of all but one node and will turn to disk into the point of failure.

Only one of the above configurations can be used, to help choose which quorum configuration to select is to ensure the split results make one side to obtain more than 50% of the votes.

2.4. Cluster Modes and Resource Groups

2.4.1. Cluster Modes

There are two different types of modes, which clusters can use; these are:

Unicast – "Unicast is the term used to describe communication where a piece of information is sent from one point to another point. In this case there is just one sender, and one receiver." [6] Unicast is used for one to one communications within a network, meaning it does not need to be configured as a cross-network.

Multicast - "Multicast is the term used to describe communication where a piece of information is sent from one or more points to a set of other points. In this case there may be one or more senders, and the information is distributed to a set of receivers (there may be no receivers or any other number of receivers)." [6] Multicast is used when the cluster is communicating from one to many nodes; this type of cluster mode has to be configured as a cross-network.

2.4.2. Resource Groups

The resource groups within the cluster are a set of resources which are all on a single node of a set of nodes which are either offline or online. The resources that will be within the failover resource group include:

- “Network address resources, which are instances of the built-in resource types Logical Hostname and Shared Address
- Failover resources, which are the data service application resources for a failover data service” [7]

“Cluster System is treated as a set of resource groups, each resource group including a highly available application and the resources upon which it depends.... In the event of failure of a data processing System within the cluster, only resource groups including the failed data processing System are affected. Each resource group having a quorum of its data processing Systems available continues to provide Services, allowing many applications within the cluster to continue functioning while the cluster is restored.” [8]

The cluster resource is required to be highly available; they can be moved or replicated throughout the nodes within the cluster. A cluster resource group is also used to identify the relationships between the nodes, this can include the current node where the resources are being held, which nodes can the resource groups be placed and which node the resources will be transferred to if it should fail. “When a cluster resource fails and cannot be restarted automatically, the entire cluster group is taken offline and failed over to another available cluster node.” [9]

2.5. The Heartbeat Network

The heartbeat network allows to failover a resource from one computer to another, “...you tell heartbeat which computer owns a particular resource (which computer is the primary server), and the other computer will automatically be the backup server. You then configure the heartbeat daemon running on the backup server to listen to the “heartbeats” coming from the primary server. If the backup server does not hear the primary server’s heartbeat, it initiates the failover and takes ownership on the resource.” [10] If a number of sequential heartbeats are missed, the node will then re-assess the clusters configuration. If there are one or more than one nodes which are unconnected, the quorum will begin the voting process, if there is still the necessary number of nodes active the work which is currently being performed will be redistributed.

3.0. Network Load Balancing VS Failover Clusters

3.1. Network Load Balancing Clusters - Stateless applications

This form of clustering allows for scalability, meaning the cluster can easily be expanded and reliability of the cluster is high even for larger or complex applications. "The Network Load Balancing (NLB) feature distributes traffic across several servers by using the TCP/IP networking protocol. By combining two or more computers that are running applications into a single virtual cluster, NLB provides reliability and performance for web servers and other mission-critical servers." [11] Network Load Balancing Clusters will only be operating for stateless applications such as the Web, File Transfer Protocols and Virtual Private Networks. These types of applications are not reliant on an internal state and they are able to write to shared storage if required.

"With a stateless server, there is no session affinity. The same client can be connected to different servers in the farm on multiple HTTP/TCP sessions; because there is no context stored locally on a server from one session to another." [12] This type of cluster has a high availability meaning there is minimal downtime; there are features that have been built into the cluster which are automatically able to detect a cluster host that has failed or has gone offline, and recover it. It is also able to manage the networks load when new hosts have been added to the cluster or if any hosts are removed. There is also a ten second period where the cluster is able to recover and re-distribute the workload. This cluster also is able to cope with scalability, meaning it is able to expand with the demands of a growing cluster. "For NLB clusters, scalability is the ability to incrementally add one or more systems to an existing cluster when the overall load of the cluster exceeds its capabilities." [11] In order to support scalability, there are options within network load balancing which can be implemented, some of these include, Supporting up to 32 computers in a single cluster, balancing multiple server load requests across a number of hosts within the cluster and removing hosts from the cluster when the load decreases. Stateful applications are essential to the use of the internet as it is always expanding.

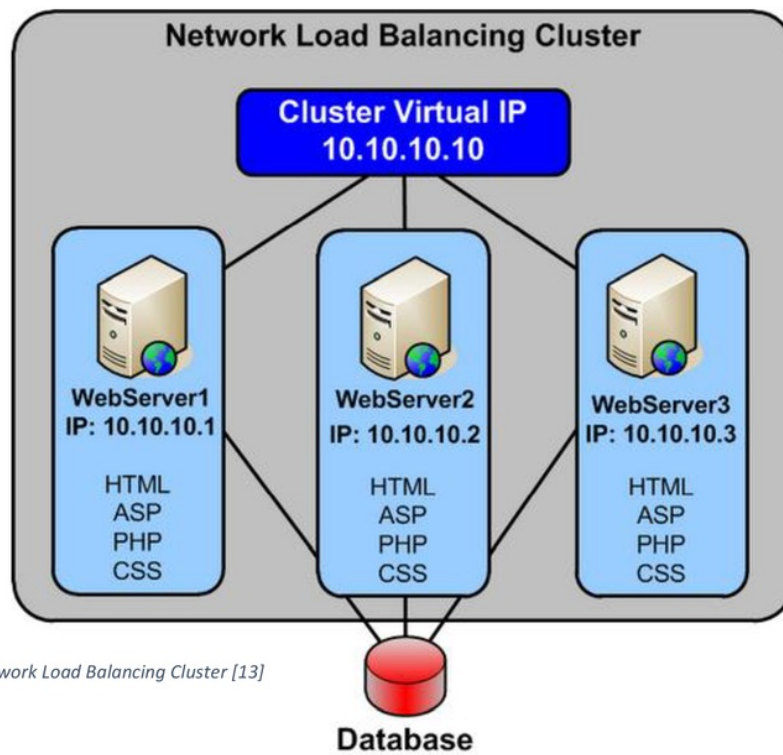


Figure 3 Network Load Balancing Cluster [13]

3.2. Failover – Stateful Applications

Stateful applications are generally made up of databases and the same server is used to process all of the requests from the network in order to communicate. The server will process each request from information that is stored from earlier requests, the server must be able to access and hold onto the state information or the information needs to be shared with all of the connecting servers.

3.3. Stateful vs Stateless?

The differences between a stateful cluster e.g. failover and a stateless cluster is that stateless applications will not store any data whereas a state full application will need backup storage available, to allow the application to survive a service restart. When running a stateful application, it is crucial that the applications are always up and running, the difference with a stateless application, any data that flows through the service is transitory and the state is then stored in an application such as a database. So dependent on the type of system that is being created, advantages and disadvantages should be weighed up to meet the full requirements for the system and ensure for optimum performance.

Stateful and Stateless Applications

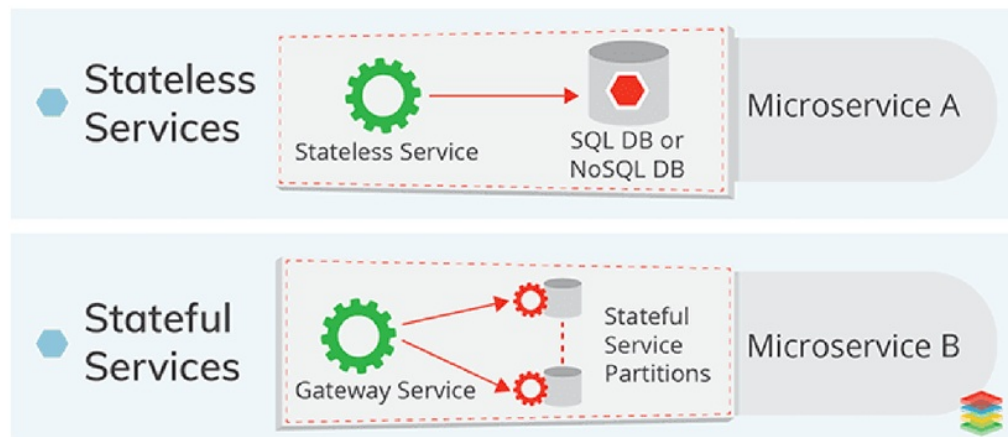


Figure 4 Stateful and Stateless Applications [14]

4.0. Build Process for the Failover Cluster

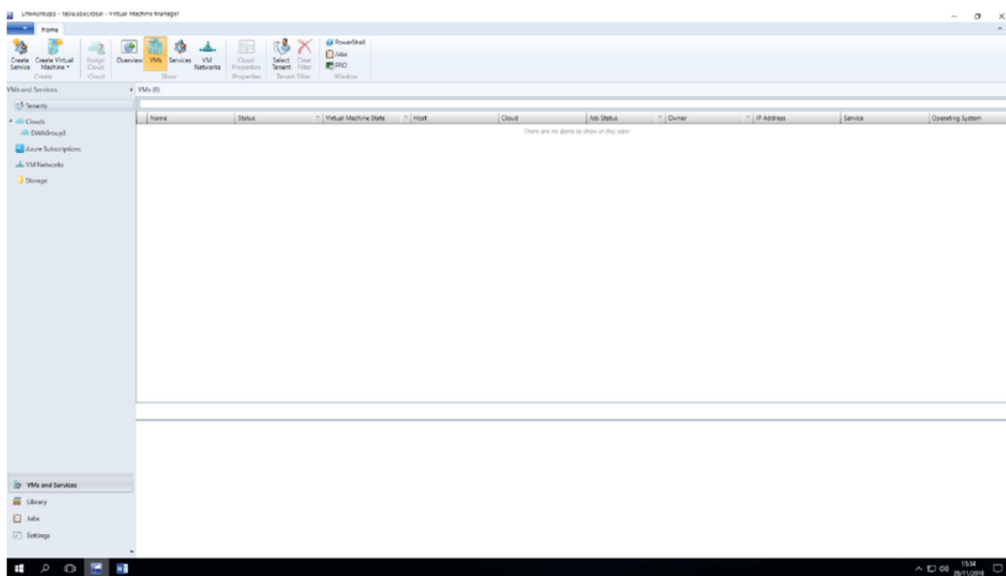
This section will describe in detail the steps taken to configure the cluster. The cluster is managed using the Virtual Machine Manager.

4.1. The Storage Area Network

The virtual machine manager is the storage area network; from here, new virtual machines can be created.

In total, four virtual machines will be created

1. Cardiff – Domain Controller
2. Swansea - Node
3. Bridgend - Node
4. Lab01 - Client



To begin, the virtual machine must be created with a blank virtual hard disk.

The screenshot shows the 'Create Virtual Machine Wizard' window, specifically the 'Select Source' step. The window has a title bar with the text 'Create Virtual Machine Wizard' and a close button. Below the title bar is a dark gray header with the text 'Select Source'. On the left side, there is a vertical list of steps: 'Select Source' (highlighted), 'Identity', 'Configure Hardware', 'Select Destination', 'Select Cloud', 'Add Properties', and 'Summary'. The main area of the wizard is titled 'Select the source for the new virtual machine'. It contains two radio button options. The first option is 'Use an existing virtual machine, VM template, or virtual hard disk', which is currently unselected. Below this option is a text box labeled 'Required' and a 'Browse...' button. The second option is 'Create the new virtual machine with a blank virtual hard disk', which is selected. At the bottom of the main area, there is an information icon and a paragraph of text: 'If you use a VM template, you can customize the hardware and operating system settings. If you use a stored virtual machine or a virtual hard disk, you can only customize the hardware settings. To be accessed, a virtual hard disk must be stored in the library.' At the bottom right of the window, there are three buttons: 'Previous', 'Next' (highlighted), and 'Cancel'.

Create Virtual Machine Wizard

Select Source

Select the source for the new virtual machine

☐ Use an existing virtual machine, VM template, or virtual hard disk

Required Browse...

☒ Create the new virtual machine with a blank virtual hard disk

i If you use a VM template, you can customize the hardware and operating system settings. If you use a stored virtual machine or a virtual hard disk, you can only customize the hardware settings. To be accessed, a virtual hard disk must be stored in the library.

Previous Next Cancel

The virtual machine is then given a name, in this case Swansea. Generation 2 is selected meaning the virtual machine will run on Windows Server 2012 R2.

Create Virtual Machine Wizard

Identity

Select Source

- Identity**
- Configure Hardware
- Select Destination
- Select Cloud
- Add Properties
- Summary

Specify Virtual Machine Identity

Virtual machine name:

Description:

Generation:

☐ Turn on shielding support in the virtual machine after deploying it

Information:

- The virtual machine name identifies the virtual machine to VMM. The name does not have to match the computer name of the virtual machine. However, using the same name ensures consistent displays in System Center Operations Manager.
- Generation 1 virtual machines have capabilities that were previously supported by Windows Server 2012 and other host operating systems. Generation 2 virtual machines have new capabilities, such as support for the Unified Extensible Firmware Interface (UEFI), and the ability to boot in ways that generation 1 virtual machines could not. For generation 2 virtual machines, the host must run Windows Server 2012 R2 or later.

[Learn about supported guest operating systems for generation 2 virtual machines](#)

Navigation:

When configuring the hardware for the virtual machine, the Cloud Capability profile used is Hyper-V.

Create Virtual Machine Wizard

Configure Hardware

Select Source
Identity
Configure Hardware
Select Destination
Select Cloud
Add Properties
Summary

Configure hardware for the virtual machine. You can import settings from a hardware profile or save a new profile based on your settings.

Hardware profile: [Default - create new hardware configuration settings]

Save As | New | Remove

Compatibility

Cloud Capability Pr...
Hyper-V

General

Processor
1 processor

Memory
1024 MB

Bus Configuration

SCSI Adapter 0
2 Devices attached

Swansea_disk_1
40.00 GB, ID 0

Virtual DVD drive
No Media Captured

Network Adapters

Network Adapter 1
Not connected

Fibre Channel Adapters

Advanced

Checkpoints

Availability
Normal

Firmware
Secure boot Enabled

CPU Priority

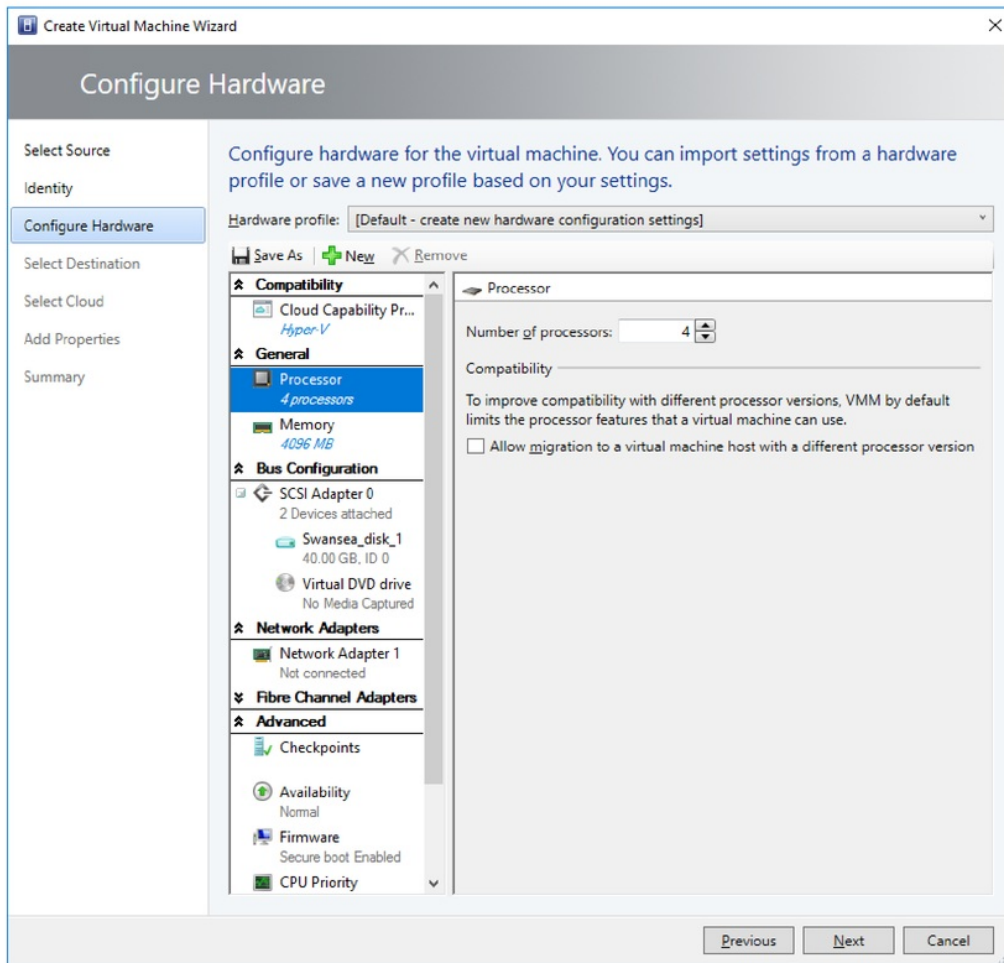
Compatibility

Select the capability profile that will be used to create this virtual machine. VMM will ensure that the settings provided are compatible with this capability profile.

Name	Description	Validation Status
☒ Hyper-V	The built-in fabric capabilit...	

Previous Next Cancel

The number of Processors the virtual machine as is four.



The memory is set to static, a total of 4 GB.

The screenshot shows the 'Configure Hardware' window of the 'Create Virtual Machine Wizard'. The left sidebar contains a list of steps: 'Select Source', 'Identity', 'Configure Hardware' (which is highlighted), 'Select Destination', 'Select Cloud', 'Add Properties', and 'Summary'. The main area is titled 'Configure hardware for the virtual machine. You can import settings from a hardware profile or save a new profile based on your settings.' Below this, there is a 'Hardware profile:' dropdown menu set to '[Default - create new hardware configuration settings]'. A toolbar with 'Save As', 'New', and 'Remove' icons is present. The hardware configuration is organized into sections: 'Compatibility' (with 'Cloud Capability Pr...' and 'Hyper-V'), 'General' (with 'Processor' set to '4 processors' and 'Memory' set to '4096 MB'), 'Bus Configuration' (with 'SCSI Adapter 0' showing '2 Devices attached', including 'Swansea_disk_1' at '40.00 GB, ID 0' and a 'Virtual DVD drive' with 'No Media Captured'), 'Network Adapters' (with 'Network Adapter 1' as 'Not connected'), 'Fibre Channel Adapters', and 'Advanced' (with 'Checkpoints', 'Availability' set to 'Normal', 'Firmware' with 'Secure boot Enabled', and 'CPU Priority'). The 'Memory' section on the right is expanded, showing options for 'Static' (selected) and 'Dynamic' memory. The 'Static' option is configured with 'Virtual machine memory' set to '4 GB'. The 'Dynamic' option shows 'Startup memory' at '1024 MB', 'Minimum memory' at '32 MB', 'Maximum memory' at '1048576 MB', and 'Memory buffer percentage' at '20'. At the bottom right, there are 'Previous', 'Next', and 'Cancel' buttons.

Create Virtual Machine Wizard

Configure Hardware

Select Source

Identity

Configure Hardware

Select Destination

Select Cloud

Add Properties

Summary

Configure hardware for the virtual machine. You can import settings from a hardware profile or save a new profile based on your settings.

Hardware profile: [Default - create new hardware configuration settings]

Save As New Remove

Compatibility

- Cloud Capability Pr...
Hyper-V

General

- Processor
4 processors
- Memory**
4096 MB

Bus Configuration

- SCSI Adapter 0
2 Devices attached
 - Swansea_disk_1
40.00 GB, ID 0
 - Virtual DVD drive
No Media Captured

Network Adapters

- Network Adapter 1
Not connected

Fibre Channel Adapters

Advanced

- Checkpoints
- Availability
Normal
- Firmware
Secure boot Enabled
- CPU Priority

Memory

Specify how much memory (32.00 MB - 1,024.00 GB) to allocate to the virtual machine, or specify a range to allow the virtualization host to allocate memory dynamically.

☒ Static

Virtual machine memory: 4 GB

☐ Dynamic

Startup memory: 1024 MB

Minimum memory: 32 MB

Maximum memory: 1048576 MB

Memory buffer percentage: 20

Previous Next Cancel

The virtual machine is set to be highly available.

Create Virtual Machine Wizard

Configure Hardware

Select Source
Identity
Configure Hardware
Select Destination
Select Cloud
Add Properties
Summary

Configure hardware for the virtual machine. You can import settings from a hardware profile or save a new profile based on your settings.

Hardware profile: [Default - create new hardware configuration settings]

Save As | New | Remove

- Compatibility
 - Cloud Capability Pr...
Hyper-V
- General
 - Processor
4 processors
 - Memory
4096 MB
- Bus Configuration
 - SCSI Adapter 0
2 Devices attached
 - Swansea_disk_1
40.00 GB, ID 0
 - Virtual DVD drive
No Media Captured
- Network Adapters
 - Network Adapter 1
Not connected
- Fibre Channel Adapters
- Advanced
 - Checkpoints
- Availability**
High
- Firmware
 - Secure boot Enabled
- CPU Priority

Availability

Availability sets

Use availability sets to identify virtual machines that you want VMM to keep on separate hosts for improved continuity of service.

Manage availability sets

High availability

This option places the virtual machine on a virtualization server that is part of a host cluster.

☒ Make this virtual machine highly available

Virtual machine priority

This setting assigns a priority to the virtual machine to be used when the virtual machines are started or placed on a node. Virtual machines are started in priority order up to the limits of the host cluster node.

☐ High
☐ Medium
☐ Low
☐ Do not restart automatically

Previous Next Cancel

The virtual machine will be deployed onto a private cloud.

Create Virtual Machine Wizard

Select Destination

Select Source

Identity

Configure Hardware

Select Destination

Select Cloud

Add Properties

Summary

Choose whether to deploy or store the virtual machine.

 ☒ Deploy the virtual machine to a private cloud

 ☐ Place the virtual machine on a host

Destination:

Copies the files associated with the virtual machine to the virtual machine host that you designate. You can then start the virtual machine immediately if desired.

 ☐ Store the virtual machine in the library

Stores the virtual machine in the library for later use. Before you can start the virtual machine, you must deploy it on a host or cloud.

Previous Next Cancel

The private cloud that has been selected is 'DWAGroup3'.

Create Virtual Machine Wizard

Select Cloud

Select Source
Identity
Configure Hardware
Select Destination
Select Cloud
Add Properties
Summary

Select a destination for the virtual machine
Destinations are rated based on the virtual machine requirements and on the default placement options.

Expected Utilization...

Search in **All Clouds**

Rating	Destination	Transfer Type
★★★★★	DWAGroup3	Network

Placement has finished calculating ratings for each potential destination of this virtual machine.

☒ Details

Details | Rating Explanation | Deployment and Transfer Explanation

Create Virtual Machine Wizard

Add Properties

Select Source

Identity

Configure Hardware

Select Destination

Select Cloud

Add Properties

Summary

Automatic actions

Select an action to perform automatically when the virtualization server starts:

Don't turn on the virtual machine

Delay start up (seconds): 0

Action to take when the virtualization server stops:

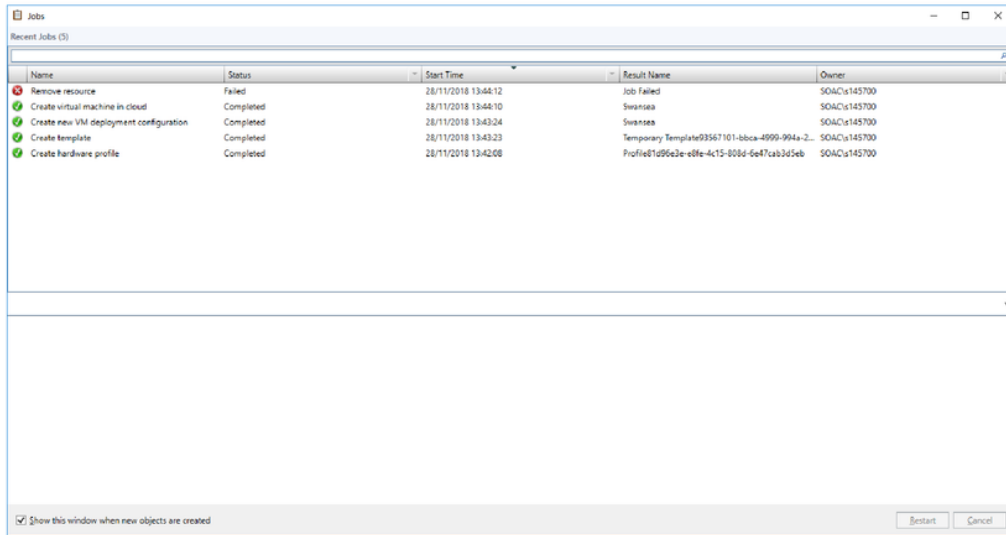
Save State

Previous

Next

Cancel

The job list being completed.

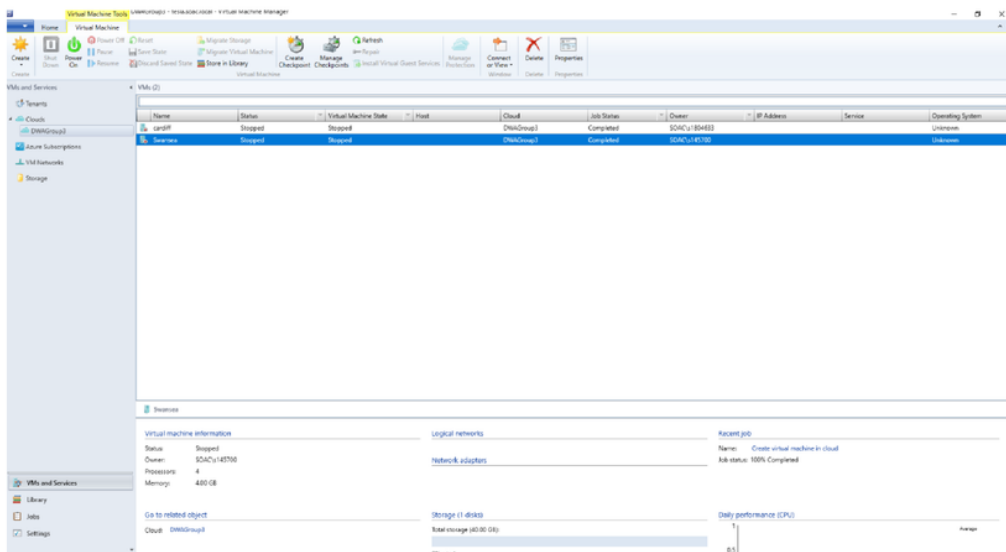


The screenshot shows the 'Jobs' window in Hyper-V Manager. It displays a table of recent jobs with columns for Name, Status, Start Time, Result Name, and Owner. The jobs listed are:

Name	Status	Start Time	Result Name	Owner
Remove resource	Failed	28/11/2018 13:44:12	Job Failed	SOAC\145700
Create virtual machine in cloud	Completed	28/11/2018 13:44:10	Swansea	SOAC\145700
Create new VM deployment configuration	Completed	28/11/2018 13:43:24	Swansea	SOAC\145700
Create template	Completed	28/11/2018 13:43:23	Temporary Template93567101-bbca-4999-994a-2...	SOAC\145700
Create hardware profile	Completed	28/11/2018 13:42:08	Profile01d96e3e-e0fe-4c15-000d-5e7cab3d5eb	SOAC\145700

At the bottom of the window, there is a checkbox labeled 'Show this window when new objects are created' which is checked. There are also 'Restart' and 'Cancel' buttons.

Cardiff and Swansea's virtual machines have now been created.



The screenshot shows the Hyper-V Manager console. The left pane shows the 'Virtual Machines' list with two entries: 'Cardiff' and 'Swansea'. The right pane shows the details for the 'Swansea' virtual machine. The details are as follows:

Category	Value
Virtual machine information	
Status	Stopped
Owner	SOAC\145700
Processors	4
Memory	400 GB
Logical networks	
Network adapters	
Storage (i disks)	
Total storage (40.00 GB)	
Daily performance (CPU)	
Average	6.5

The 'Recent job' section on the right shows a job named 'Create virtual machine in cloud' with a status of '100% Completed'.

These are all of the virtual machines that have been created along with the disk and capacity on each virtual machine.

soac4-2.soac.local - Remote Desktop Connection

Virtual Machine Tools DWAGroup3 - test1.soac.local - Virtual Machine Manager

Home Virtual Machine

Create Shut Down Power On Pause Power Off Resume Create Checkpoint Manage Checkpoints Manage Protection Connect or View Delete Properties

Navigation Pane

Disk Information for Virtual Machines (4)

Name	A	Type	Total Capacity	Available Capacity
Bridgend		Dynamic	40.00 GB	31.00 GB
Bridgend_disk_1		Dynamic	40.00 GB	31.00 GB
cardiff		Dynamic	65.00 GB	55.33 GB
cardiff_disk_1		Dynamic	40.00 GB	30.43 GB
cardiff_disk_2		Dynamic	25.00 GB	24.90 GB
Lab01-01		Dynamic	40.00 GB	30.86 GB
Lab01-01_disk_1		Dynamic	40.00 GB	30.86 GB
Swansea		Dynamic	40.00 GB	30.96 GB
Swansea_disk_1		Dynamic	40.00 GB	30.96 GB

Swansea

Virtual machine information

Status: Running

Owner: SOACs145700

Processors: 1

Memory: 4.00 GB

Logical networks

PrivateCloud3Network1

PrivateCloud3Network2

Recent job

Name: Refresh virtual machine

Job status: 100% Completed

Network adapters

00:15:5D:87:1E:86: 192.168.0.2, fe80::805d:c2f2:71:8756

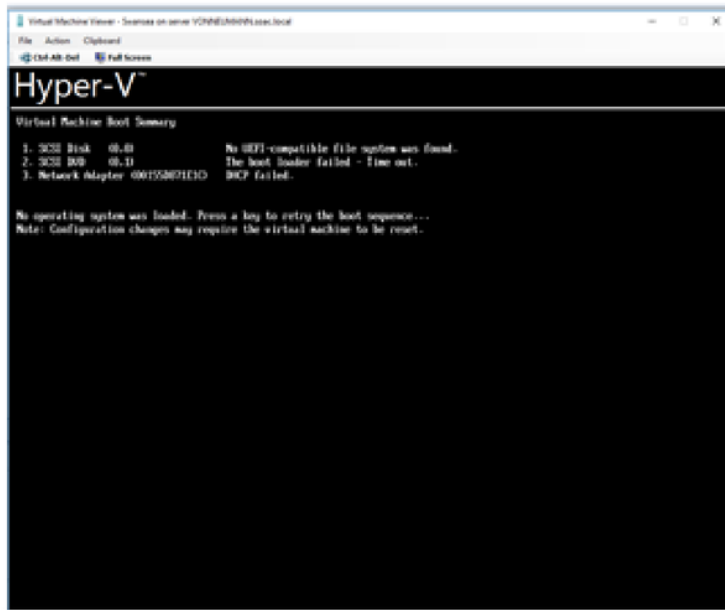
00:15:5D:87:1E:87: 192.168.11.2, fe80::209f904c:8b4f:2205

4.2. The Windows operating system

The following screenshots are of the steps taken to install the windows operating system on the Swansea virtual machine.

Swansea's virtual machine was started using the virtual machine manager, connecting via the console.

When the Virtual machine is booted, there is no operating system loaded, it prompts the user to press any key to move forward to the installation.

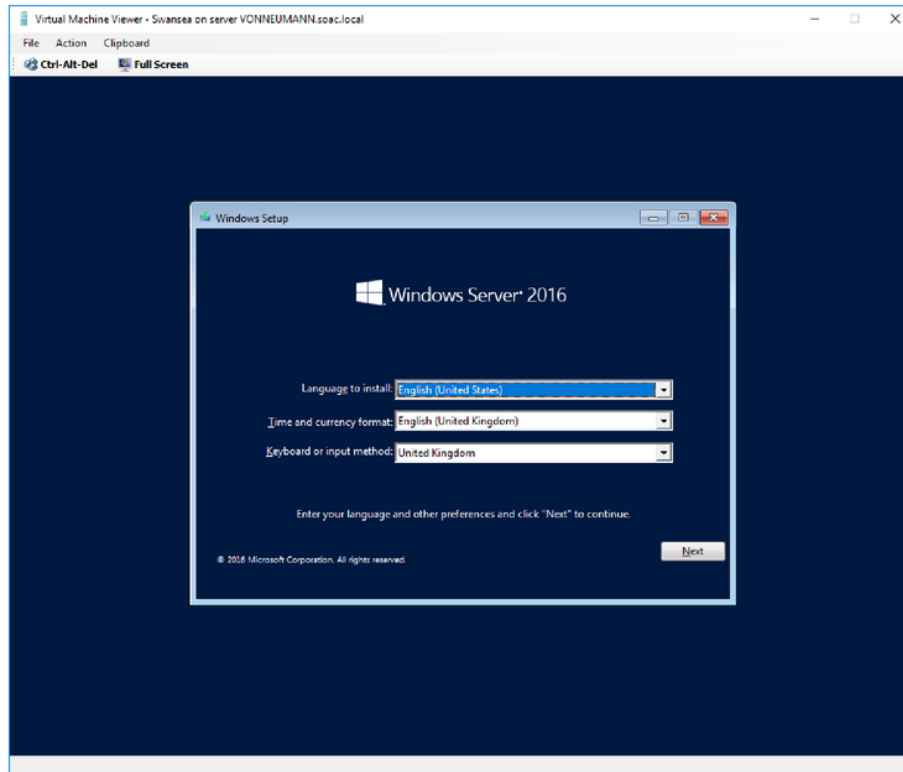


Windows Server 2016 needs to know what language, time and current format and keyboard or input method is being used.

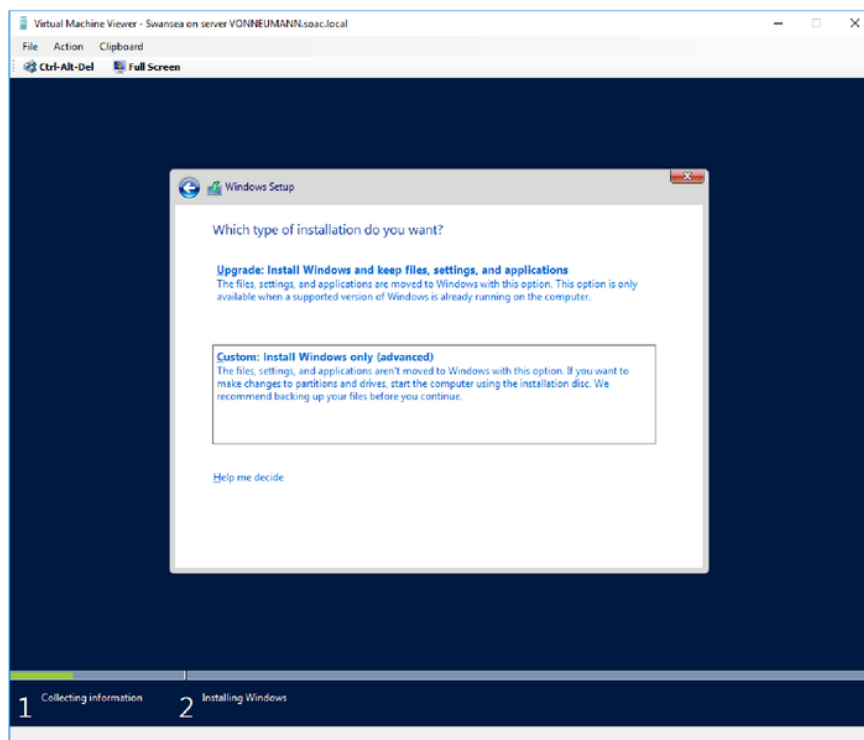
Language: English (United States)

Time and Currency format: English (United Kingdom)

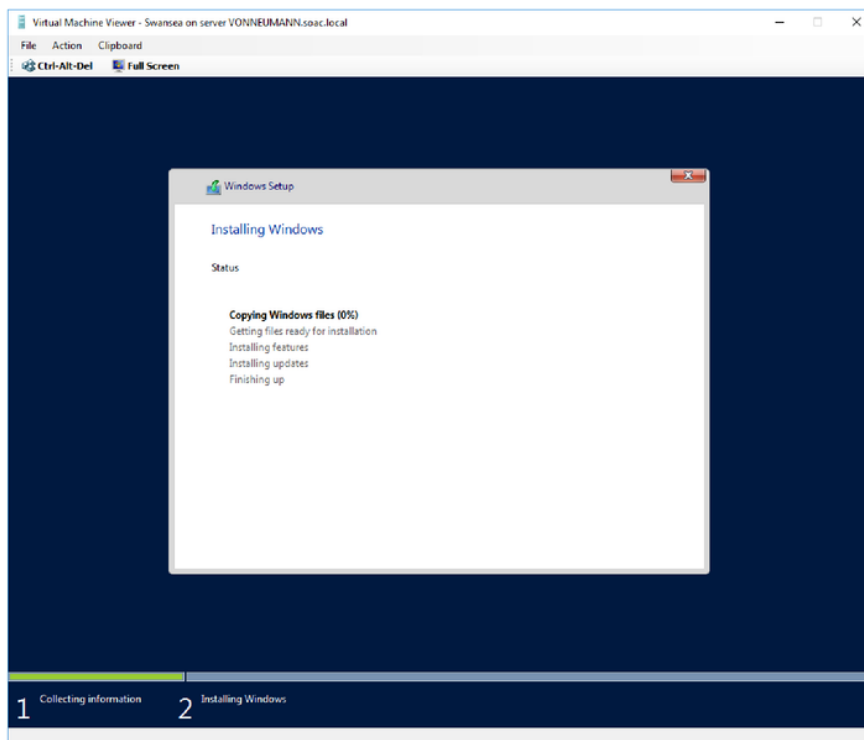
Keyboard or input method: United Kingdom



The type of installation that has been used is the custom installation that will only install Windows and will not move the files, settings and applications.



Windows is now being installed to Swansea's Virtual Machine.

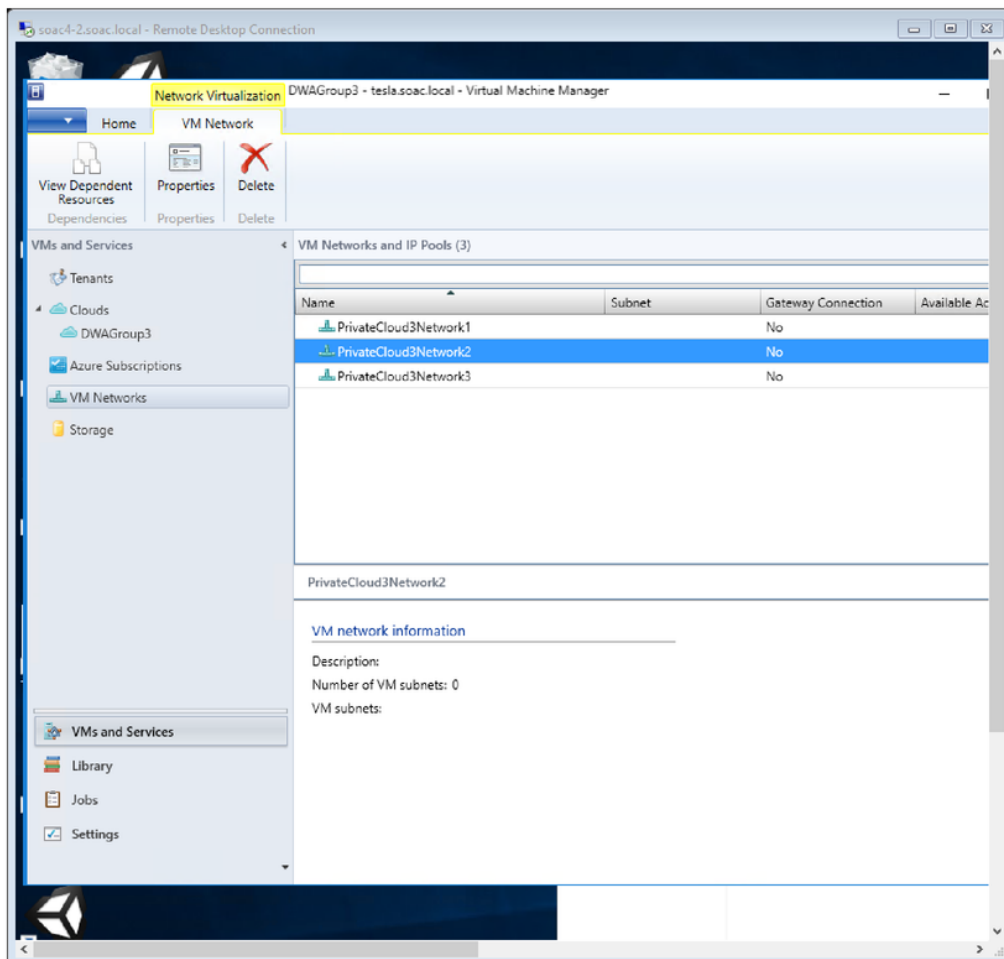


4.3. Networking and Network Layout

Two networks have been created, the 0 network and the 11 network. Each network has a purpose, one to be solely for applications and the other to be for the cluster. A network created for the applications is “Application-defined networking (ADN) is a networking scenario in which applications have the ability to adapt network environments to meet their needs, rather than having resources allocated by the network.” [15] These networks can be seen in the [Network Connection Details for Cardiff](#) and the other cities network connections. The virtual networks that have been created for the group include:

PrivateCloud3Network1
PrivateCloud3Network2
PrivateCloud3Network3

These private clouds do not allow the virtual machines that have been created within the Virtual Machine Manager to access the internet. The network adapters allow the virtual machines to connect and communicate between one another.

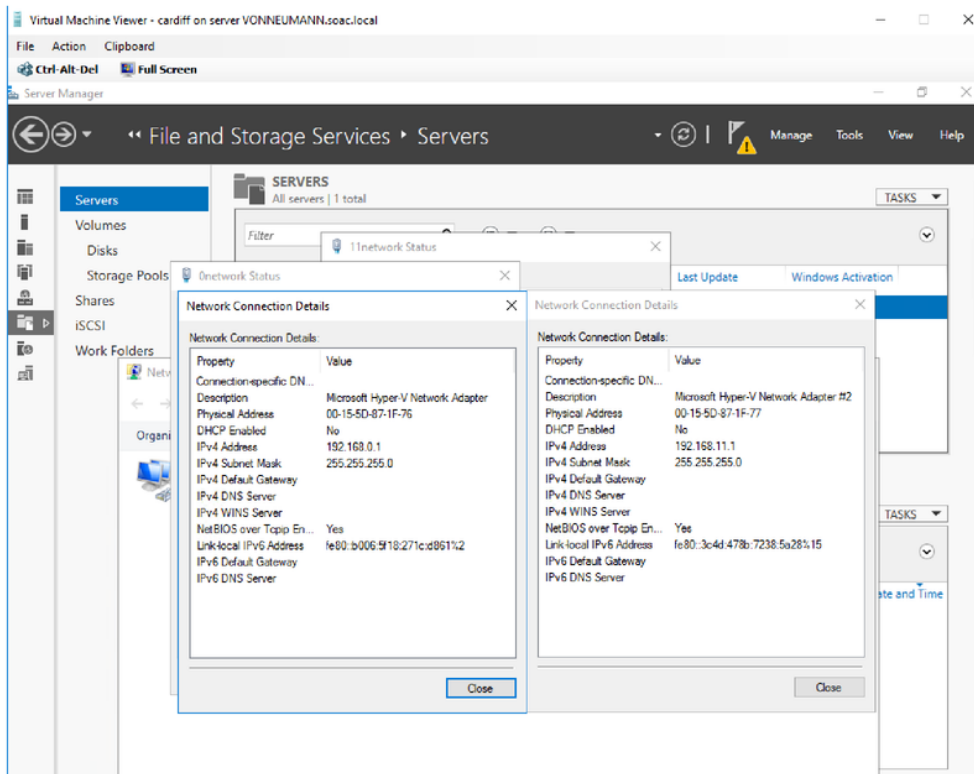


4.3.1. Network Connection Details for Cardiff

The screenshot below shows the network connection details for the Cardiff virtual machine. It shows the details for both the 0 network and the 11 network.

0 network	
DHCP- Enabled	No
IPv4 Address	192.168.0.1
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	NONE
IPv4 DNS Server	NONE

11 network	
DHCP- Enabled	No
IPv4 Address	192.168.11.1
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	NONE
IPv4 DNS Server	NONE

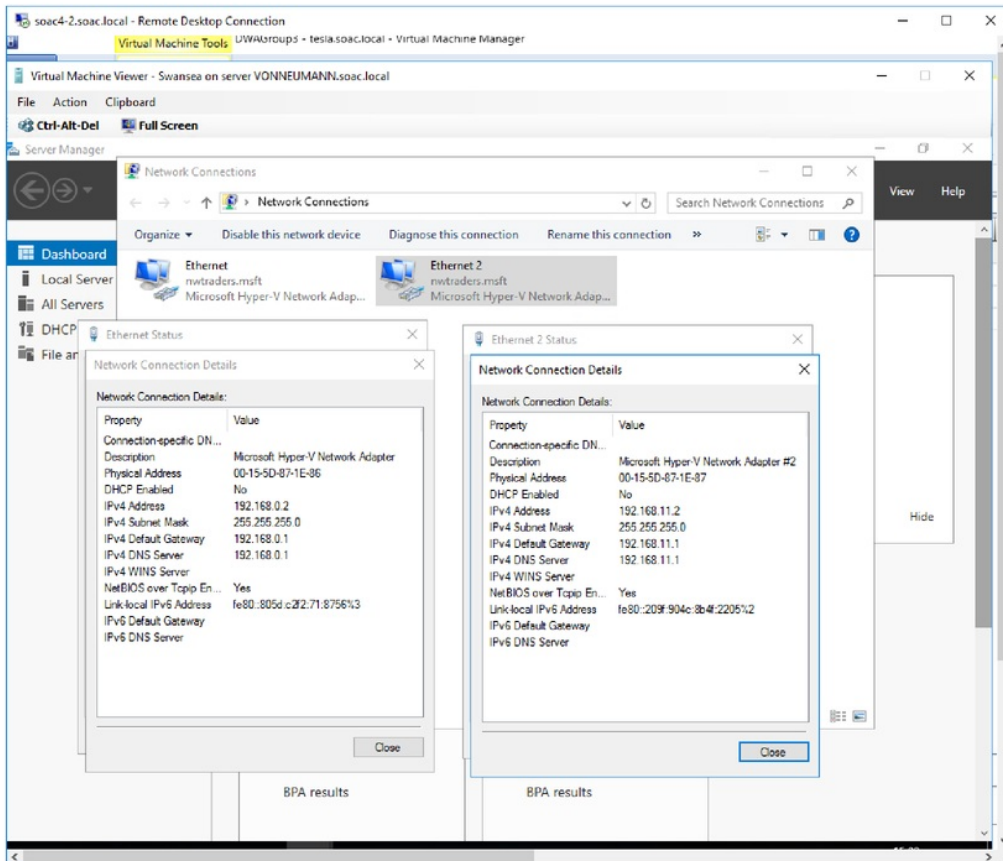


4.3.2. Network Connection Details for Swansea

The screenshot below shows the network connection details for the Swansea virtual machine. It shows the details for both the 0 network and the 11 network.

0 network	
DHCP- Enabled	No
IPv4 Address	192.168.0.2
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	192.168.0.1
IPv4 DNS Server	192.168.0.1

11 network	
DHCP- Enabled	No
IPv4 Address	192.168.11.2
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	192.168.11.1
IPv4 DNS Server	192.168.11.1

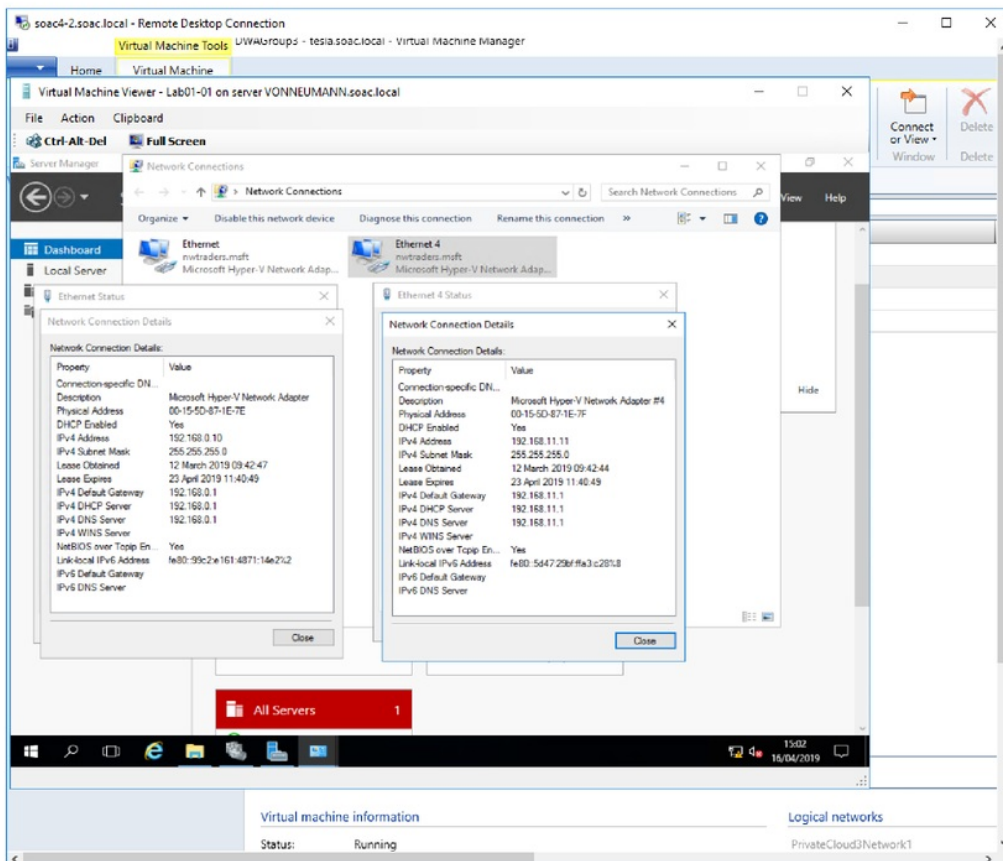


4.3.3. Network Connection Details for Lab01

The screenshot below shows the network connection details for the Lab01's virtual machine. It shows the details for both the 0 network and the 11 network.

0 network	
DHCP- Enabled	Yes
IPv4 Address	192.168.0.10
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	192.168.0.1
IPv4 DHCP Server	192.168.0.1
IPv4 DNS Server	192.168.0.1

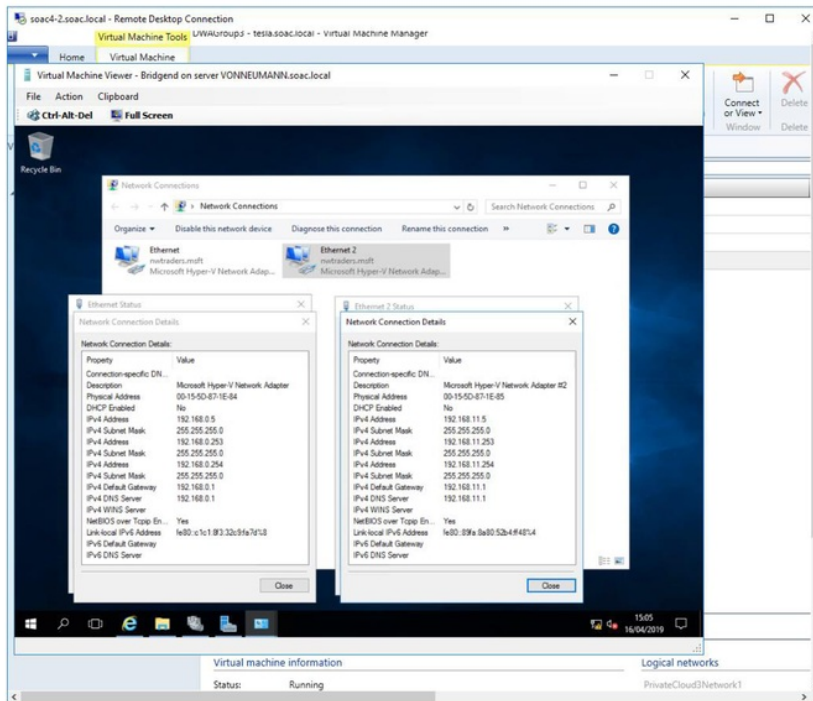
11 network	
DHCP- Enabled	Yes
IPv4 Address	192.168.11.2
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	192.168.11.1
IPv4 DHCP Server	192.168.11.1
IPv4 DNS Server	192.168.11.1



4.3.4. Network Connections for Bridgend

The screenshot below shows the network connection details for the Bridgend's virtual machine. It shows the details for both the 0 network and the 11 network. On this virtual machine, there are three different IPv4 Addresses.

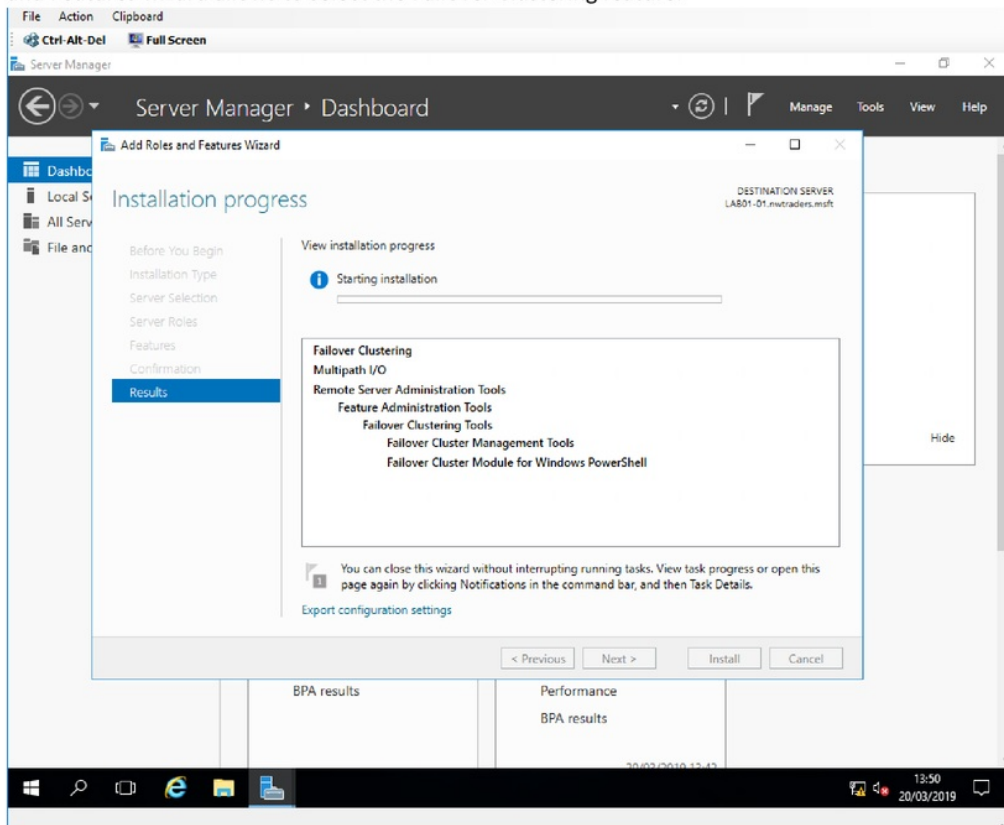
<u>0 network</u>	
DHCP- Enabled	No
IPv4 Address	192.168.0.5
IPv4 Subnet Mask	255.255.255.0
IPv4 Address	192.168.0.253
IPv4 Subnet Mask	255.255.255.0
IPv4 Address	192.168.0.254
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	192.168.0.1
IPv4 DHCP Server	192.168.0.1
IPv4 DNS Server	192.168.0.1
<u>11 network</u>	
DHCP- Enabled	No
IPv4 Address	192.168.11.5
IPv4 Subnet Mask	255.255.255.0
IPv4 Address	192.168.11.253
IPv4 Subnet Mask	255.255.255.0
IPv4 Address	192.168.11.254
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	192.168.11.1
IPv4 DNS Server	192.168.11.1



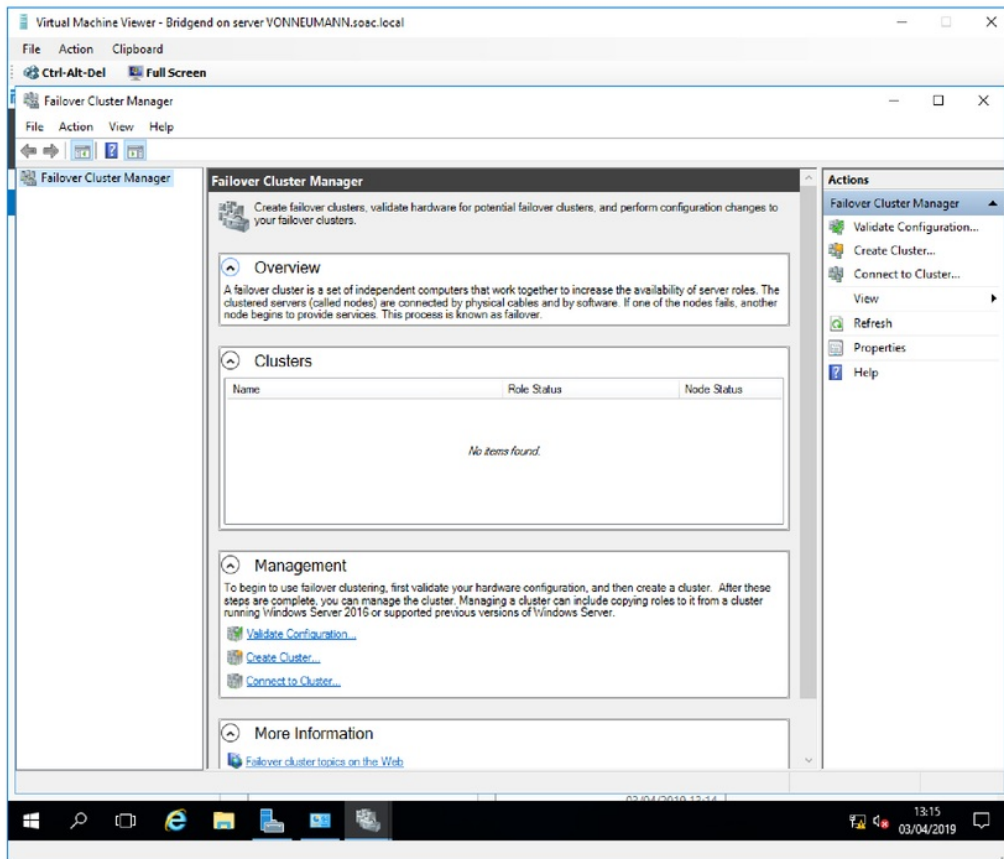
4.4. The Failover Cluster feature itself

This section shows the installation process for the failover cluster, including a 'failover cluster validation report' and the creation of the clusters. The failover cluster was installed on both Swansea and Bridgend.

Whilst on the Bridgend virtual machine, within the Server Manager Dashboard, selecting Add Roles and Features wizard allows to select the Failover Clustering feature.



The failover Cluster Manager has now been installed.



The failover cluster validation report has been completed. This test is done to ensure that, the configuration of the servers and the attached storage has been correctly set up. This cluster can only be supported when the correct configuration of the servers, network and storage passes the validation tests performed. All of the components within the cluster should be certified for Windows Server 2016.

Virtual Machine Viewer - Bridgend on server VONNEUMANNLoec.local

File Action Clipboard
Ctrl-Alt-Del Full Screen

C:\Users\administrator.NWTRADERS\AppData\Local\Temp\TempE34... Failover Cluster Validation R... x

Microsoft Home

Failover Cluster Validation Report

Node: Bridgend.nwtraders.mst Validated
Node: Swansea.nwtraders.mst Validated
Started: 03/04/2019 13:21:20
Completed: 03/04/2019 13:24:04

The Validate a Configuration Wizard must be run after any change is made to the configuration of the cluster or hardware. For more information, see <http://go.microsoft.com/fwlink/?linkid=200145>.

Results by Category

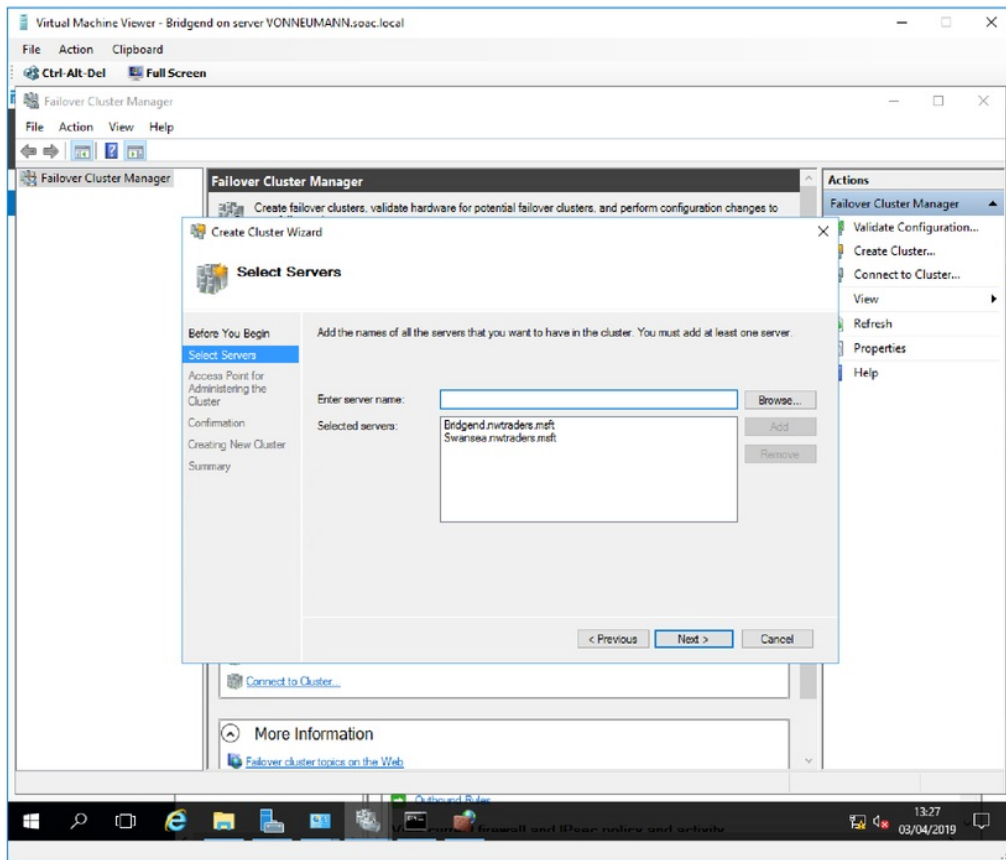
Name	Result Summary	Description
Inventory	Success	Success
Network	Warning	Warning
Storage	Success	Success
System Configuration	Success	Success

Inventory

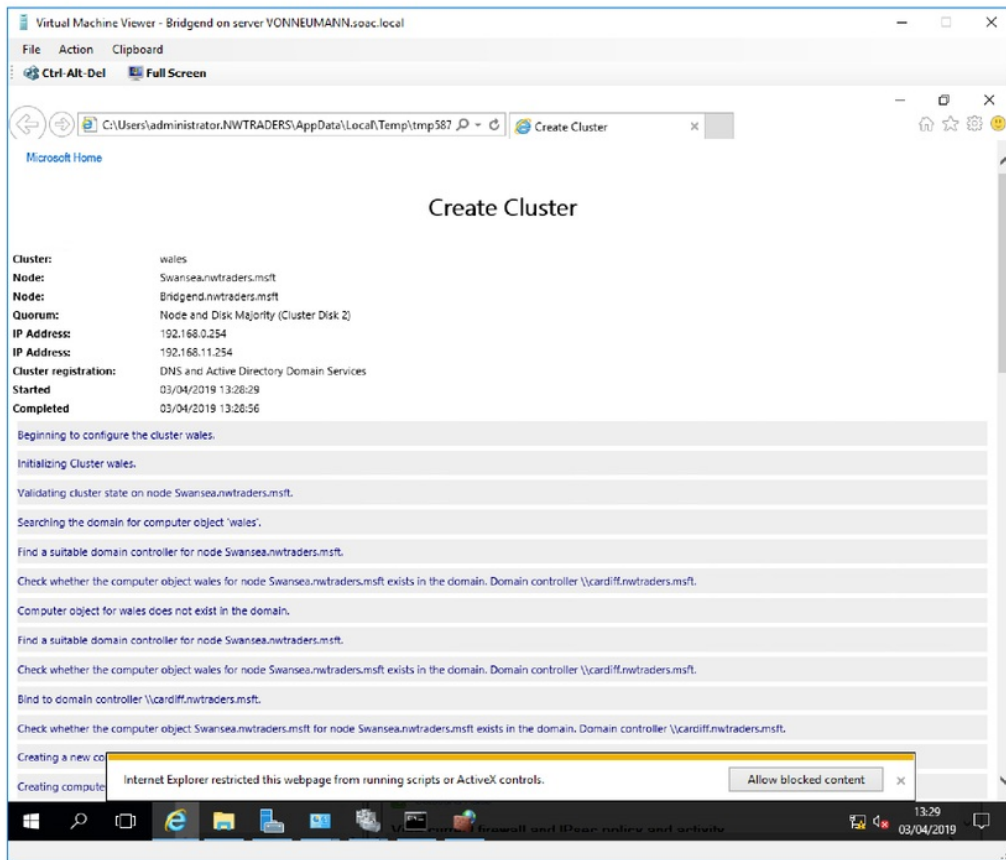
Name	Result	Description
List BIOS Information	Success	Success
List Environment Variables	Success	Success
List Fibre Channel Host Bus Adapters	Success	Success

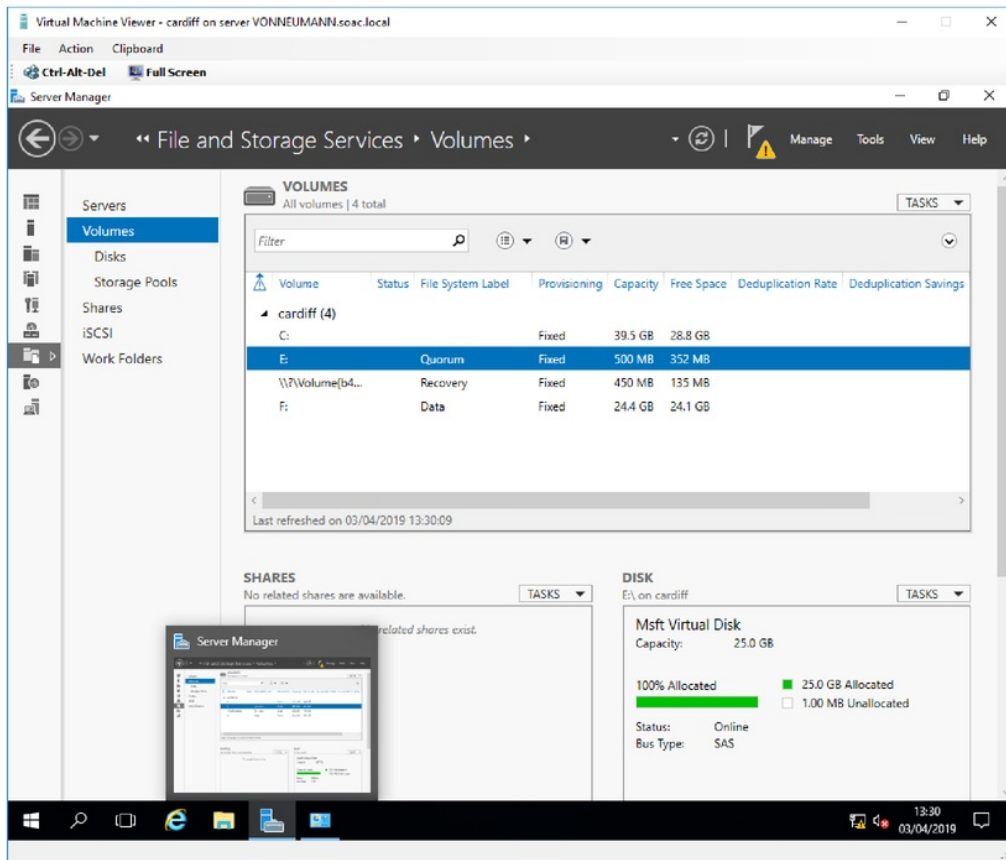
13:26 03/04/2019

Whilst still on the Bridgend virtual machine, the user begins to create the cluster using the wizard. Both servers (Bridgend and Swansea) are selected.



The Cluster has now been created and has been named Wales. It is using the Swansea node and the Bridgend node. The Quorum which has been used in the Node and Disk Majority (Cluster disk 2).





5.0. Evaluation of the Implemented Cluster Architecture for Operation and Performance

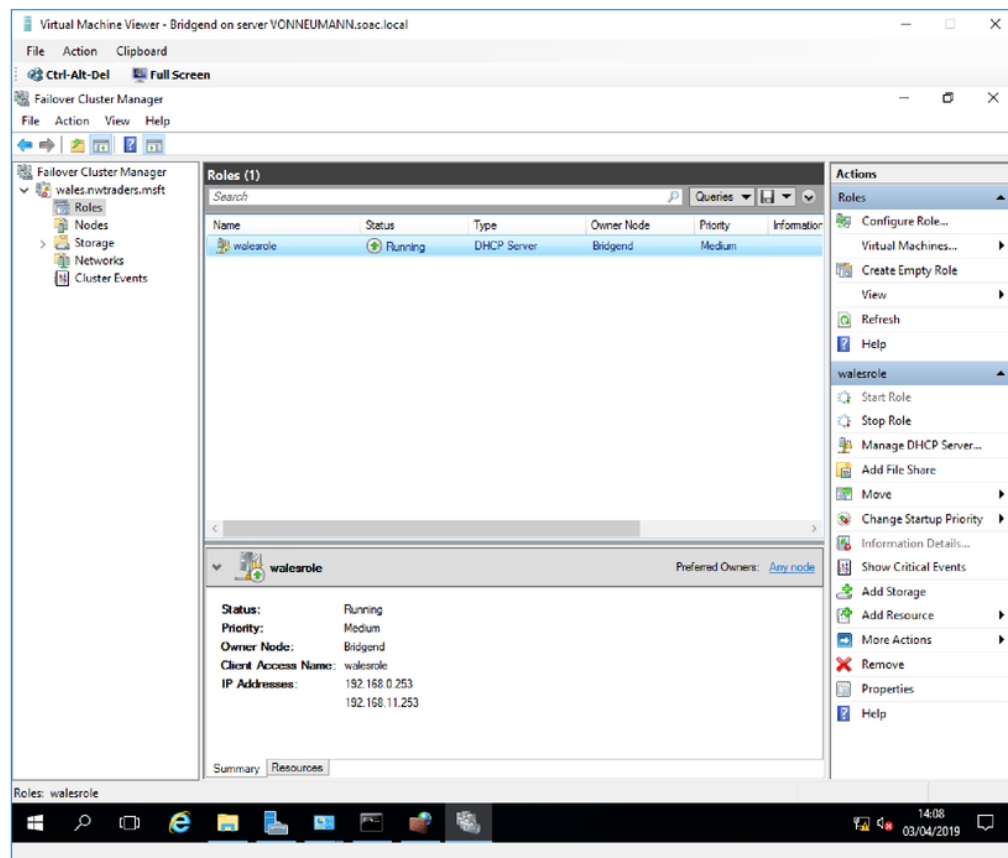
This section demonstrates the effect of using the cluster architecture when one of the nodes fails, the other node who has control will take over to ensure the DHCP Server is still operational.

From the screenshot below, the role that has been created is called 'walesrole'. At the current time the role was running, the owner node is Bridgend and the priority is medium. The IP addresses that have been designated to the role are:

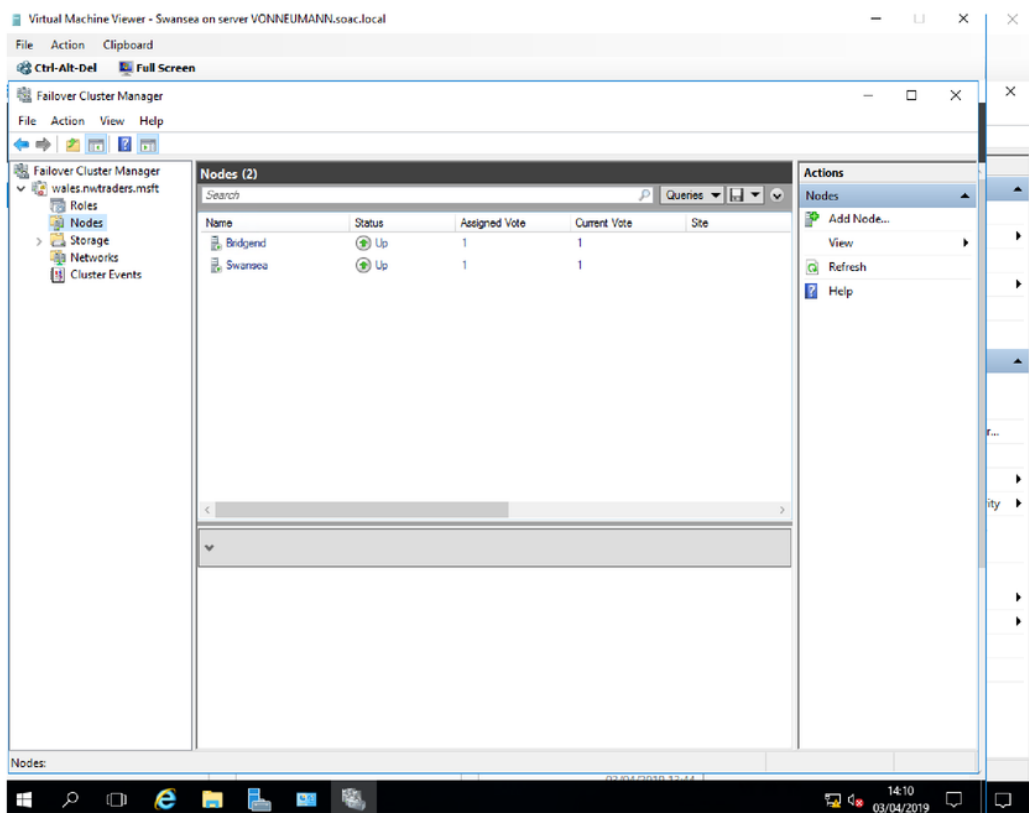
192.168.0.253

192.168.11.253

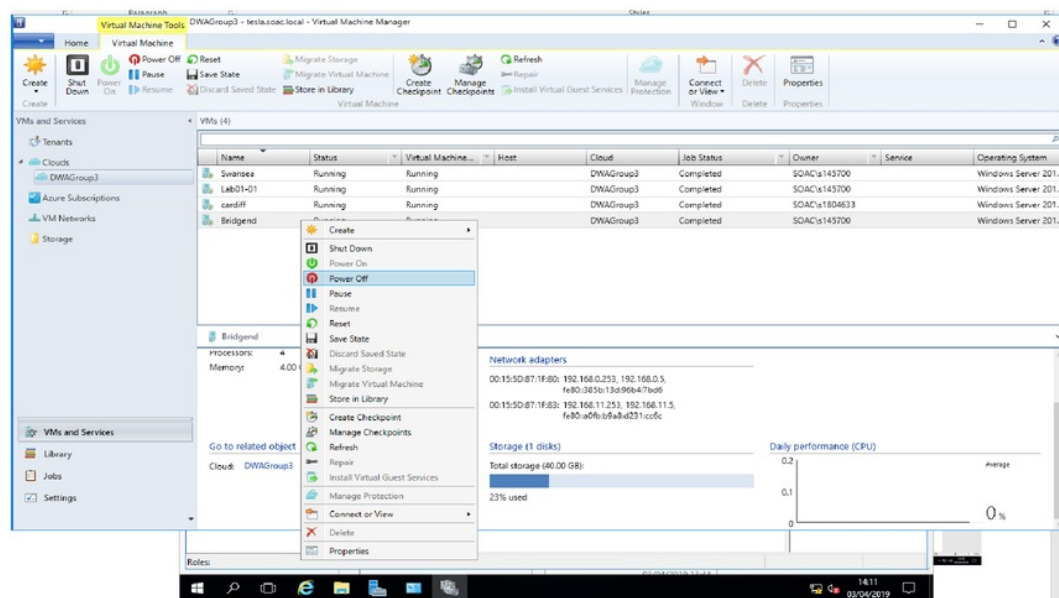
These are for the 0 network and the 11 network.



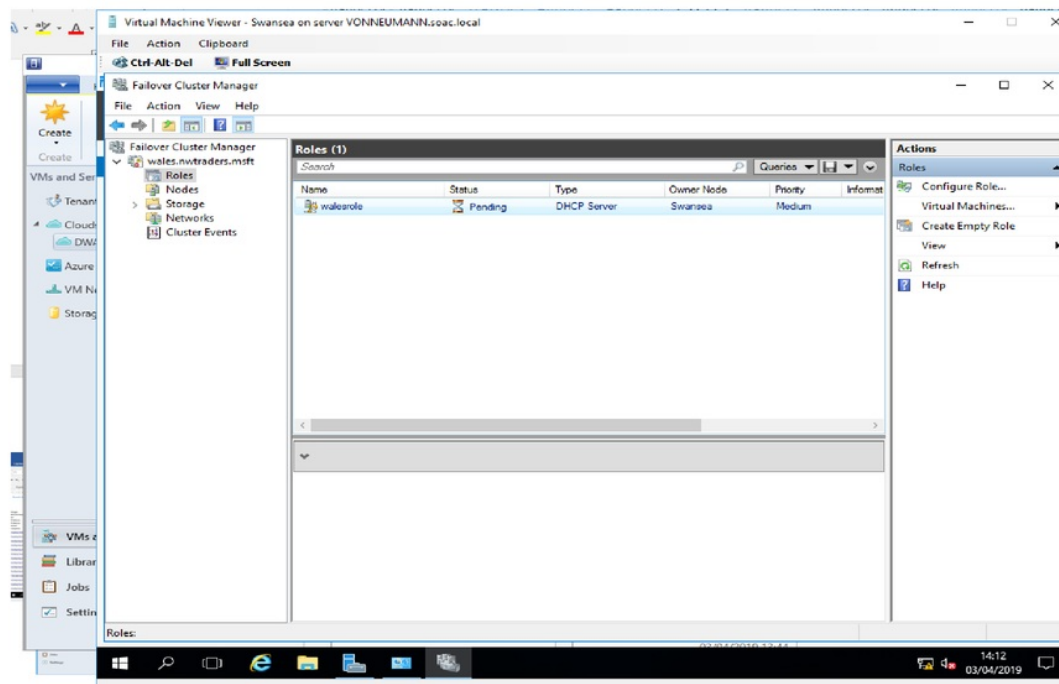
When looking into the nodes which have been assigned to the cluster, the nodes are Bridgend and Swansea. Their current status is they are both up and running. Each of the nodes have 1 vote each.



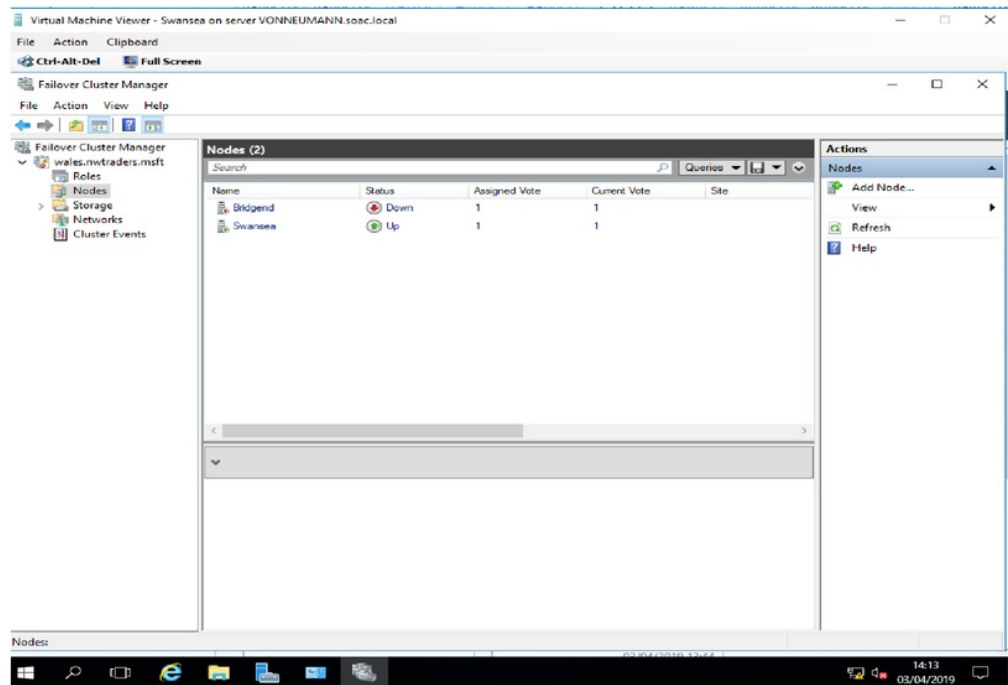
In order to test the cluster configuration is correct, Bridgend is powered off using the Virtual Machine Manager.



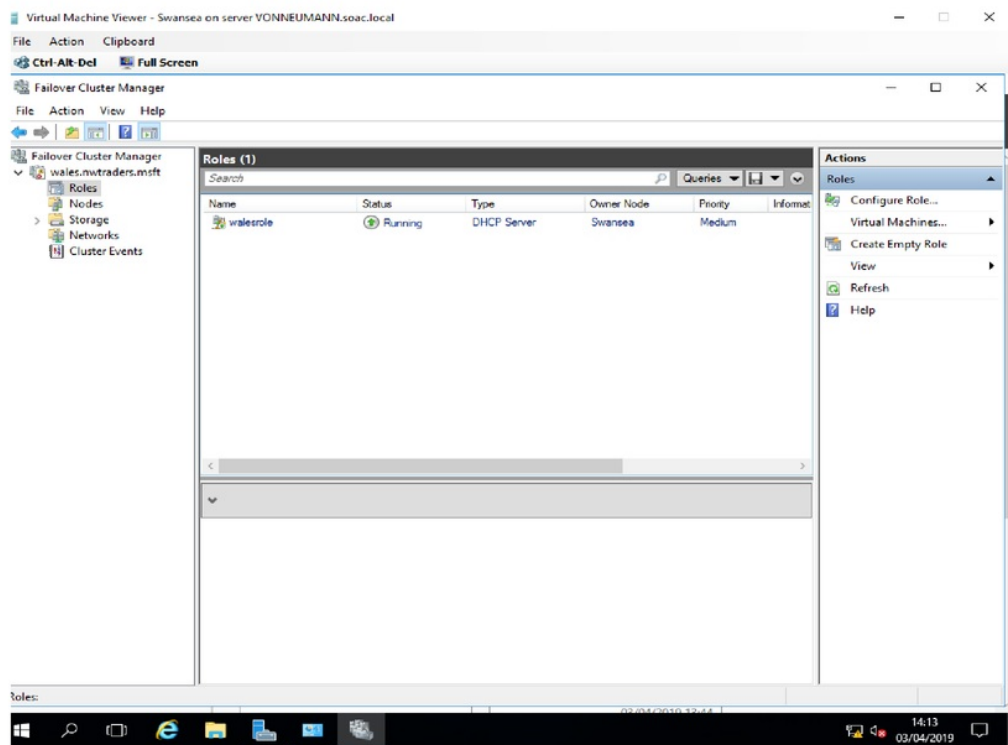
Once the node is powered off, returning to the Failover Cluster Manager shows the status of the role 'walesrole' is pending. This is the time where the owner node, Bridgend, has been powered off and therefore the cluster is switching the owner node to Swansea to continue to run the Role.



When looking at the Nodes, Bridgend is down, but Swansea is still up.



The Swansea node has now taken ownership of the role to allow it to continue operating.



6.0. IaaS, PaaS and SaaS

There are many cloud-based services, these can help organisations to build, manage and deploy applications globally. The three types of services they are able to provide are:

- Infrastructure as a Service
- Platform as a service
- Software as a Service

Some of the best cloud computing service providers are:

- "Rackspace Cloud
- IBM Cloud
- Amazon Web Services
- Microsoft Azure
- Google Cloud" [16]

6.1. Infrastructure as a Service

Infrastructure as a Service, also known as IaaS, "is an instant computing infrastructure, provisioned and managed over the internet. It is one of the four types of cloud services, along with software as a service (SaaS), platform as a service (PaaS), and serverless... It helps you avoid the expense and complexity of buying and managing your own physical servers and other datacentre infrastructure. Each resource is offered as a separate service component, and you only need to rent a particular one for as long as you need it." [17] Infrastructure as a Service means the user still required to have a cloud service provider to manage the infrastructure, however the user is in control of the installation, configuration and management of the software, operating system, middleware and the applications. A cloud service provider is "... a company that delivers cloud computing based services and solutions to businesses and/or individuals. This service organization may provide rented and provider-managed virtual hardware, software, infrastructure and other related services." [18] When discussing the middleware, this includes the software which is a layer between the operating system and the applications which are running on it, "Essentially functioning as a hidden translation layer, middleware enables communication and data management for distributed applications." [19]

Examples scenarios where this infrastructure is used can include:

- "Test and development.
- Website hosting
- Storage, backup and recovery
- Web apps
- High-performance computing
- Big data analysis" [17]

Advantages of using the IaaS include:

- "Eliminates capital expense and reduces ongoing cost.
- Improves business continuity and disaster recovery.
- Innovate rapidly.
- Respond more quickly to shifting business conditions.
- Focus on your core business.
- Increase stability, reliability and supportability.
- Better security.

- Gets new apps to users faster.” [17]

6.2. Platform as a service

Platform as a service, also referred to as PaaS, is an environment within the cloud which is completed with the resources which are required to deliver “simple cloud-based apps to sophisticated, cloud-enabled enterprise applications” [20]. The user is able to purchase the resources that are required from their cloud service provider and access through the internet. Platform as a Service include infrastructure including the servers storage and networking as well as development tools, business intelligence services and database management etc. It will support web applications from the build, test, deployment, management and updates. Platform as a Service will mean the users will control the applications and services being developed, however the cloud service provider will manage the software licencing, application infrastructures, and middleware. “Due to the higher abstraction level the deployment of distributed services does not have to deal with a multitude of single server nodes but can be run against a “virtual single but scalable server node” (consisting of several single servers). This virtual single and scalable server node is normally called a cluster and provides on the one hand a higher internal complexity than a single server node but also a reduced external complexity for deployment purposes.” [21] By using platform as a Service, there are programmes that are available from the cloud service provider that will easily create network clusters for the user.

Examples scenarios where this environment is used can include:

- “Development framework
- Analytics or business intelligence
- Additional services. PaaS providers may offer other services that enhance applications, such as workflow, directory, security and scheduling.” [20]

Some of the advantages of using this Platform as a Service environment include the same as IaaS, however the additional features which are included will give the users more advantages, including;

- “Cut coding time.
- Add development capabilities without adding staff.
- Develop for multiple platforms – including mobile – more easily.
- Use sophisticated tools affordably.
- Support geographically distributed development teams.
- Efficiently manage the application life cycle” [20]

6.3. Software as a service

Software as a Service can also be known as SaaS, it allows the users to connect to cloud based applications through an internet connection. SaaS means the cloud service provider will manage the “underlying infrastructure, middleware, app software and app data are located in the service provider’s data centre. The service provider manages the hardware and software, and with the appropriate service agreement, will ensure the availability and the security of the app and your data as well.” [22] This type of service allows the business to start running quickly, where the cloud service provider charges a minimal upfront cost compared to purchasing the needs discussed in [Infrastructure as a Service](#).

An example of where this environment is used is web-based e-mail such as Outlook, Hotmail and Yahoo!

Advantages of using Software and a Service include:

- Gain access to sophisticated applications
- Only pay for what you use
- Use free client software
- Mobilise your workforce easily
- Access app data from anywhere

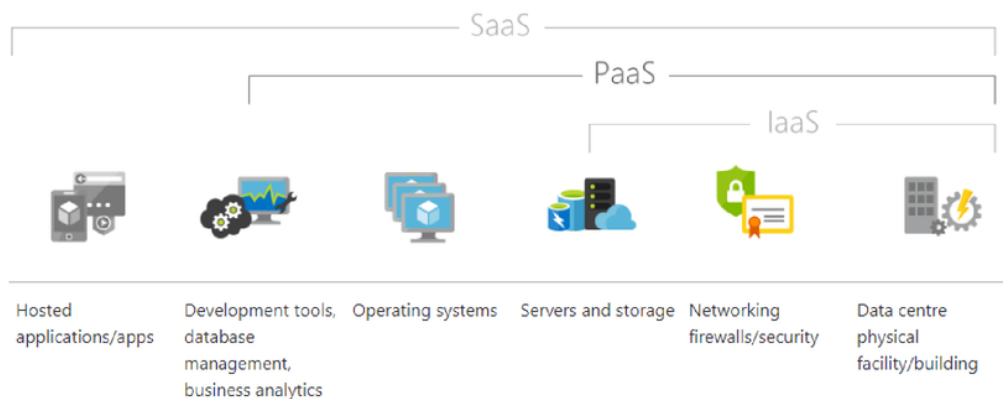


Figure 5- SaaS, PaaS, IaaS [20]

Identifying the business needs, will decipher on which cloud based service they should be using. The costs to run the cloud service goes from the most expensive being IaaS as it is the most advanced service with the most benefits. PaaS is the mid-range option, which is currently being used more often within businesses as it allows them to begin using the system from day one. It does still include some technical elements and therefore some expertise may be needed. SaaS is the cheapest option, allowing multiple users to access the in house software provided.

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FINAL GRADE

55/100

GENERAL COMMENTS

Instructor

Engagement with Literature Skills (50): 24

Knowledge and Understanding Skills (10): 5

Cognitive and Intellectual Skills (15): 6

Practical Application Skills (15): 12

Transferable Skills for Life and

Professional Practice (10): 8

Your report is vastly too quote-oriented. You should only ever use quotes if preserving the original wording of something is crucial - and even then, only sparingly. Far too many of your sources are from unauthoritative websites. While, in this work in particular, it's likely you'll need to rely to some degree on sources, you should consider their veracity. For example, source 7 is likely to be OK - Oracle are authoritative on their own technology. By contrast, can we actually trust techradar, evidian or electricmonk to be credible? Very hard to say. Have a chat with me at some point if you'd like - it's important you don't repeat these mistakes in your dissertation.

The practical work, however, is completed to a high standard.

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