

Assignment 2

Network Operating Systems and Services

Hassan Bahzad

BAH18837264

Table of Contents

Routing Protocols	3
Routing Protocols	3
Open Shortest Path First (OSPF)	3
Border Gateway Protocol (BGP)	3
Routing Information Protocol (RIP)	3
Enhanced Interior Gateway Routing Protocol (EIGRP)	3
Routing Protocol Concepts	4
The Roles of Routing Protocols	4
Purpose of Routing Protocols	5
Static vs Dynamic Routing Protocols	5
Examples of Routing Protocols	6
Routing Protocol Deployment	6
Examples of Routing Protocols in Reality	6
Different Protocol for Different Network Scenarios	6
Advantages and Disadvantages of Routing Protocols	7
Swansea Network:	8
Routing & Remote Access Service / Modify Firewall to enable ICMP Traffic	8
Configure Site to Site VPN Connection to London Network	9
Setup Persistent Connection:	9
Setup Forest:	10
Create Appropriate Records:	11
Create PTR Records:	12
London Network	13
Configure Site to Site VPN:	14
Configure Child Domain:	14
Create accounts under child domain:	15
Install DHCP Server:	16
Configure DHCP:	17
Connection Testing	18
Swansea Server to London Server:	18
London Server to Swansea Server:	19
References	20

Routing Protocols

Routing Protocols

Routing protocols are necessary for any communication to occur over a network [1]. These protocols allow for routers, switches and endpoint devices to transmit information back and forth to each other [1]. Varying protocols work on different layers of the OSI model, primarily the network layer, which is used for IP routing, and the data link layer, which is used for ethernet switching [1]. A couple examples of routing protocols would be:

Open Shortest Path First (OSPF)

OSPF is typically used on larger scaled networks and operates on Layer 3 of the OSI model [2]. This protocol is efficient in determining the shortest path for data packets to be transmitted within a network connection [2]. The OSPF protocol separates a network into segments to optimise scalability by setting limitations on the routing information and enhancing routing [2].

Border Gateway Protocol (BGP)

BGP is a path-vector protocol which is primarily used to exchange information by autonomous systems across the internet [3]. This Protocol works on Layer 4 of the OSI network model and is critical when it comes to routing information through the internet [3]. This protocol uses Transmission Control Protocols (TCP) for communication [3].

Routing Information Protocol (RIP)

This protocol is an older protocol and is suitable for smaller to mid-ranged sized network systems due to it being simple to implement [4]. RIP, much like OSPF, works on Layer 3 of the OSI network model [4]. This protocol is known for sending out scheduled routing updates, these updates will hold information on routing tables and router information within the network [4].

Enhanced Interior Gateway Routing Protocol (EIGRP)

EIGRP is a Cisco routing protocol which is primarily designed to be used within organisational networks [5]. This protocol varies from distance-vector and link-state routing protocols and incorporates the efficient use of networking resources [5]. This protocol works on Layer 3 of the OSI network model and is based on the Diffusing Update Algorithm (DUA) [5]. The DUA is used to enable routers to calculate “loop-free” paths, which will limit the amount of information that is transmitted between two end devices [6].

Routing Protocol Concepts

Routing protocols concepts are an important aspect of troubleshooting network issues within network infrastructures. Routing protocol concepts include several key concepts that include:

- Routing Table: Routers will utilise data structures that store information about the network setup and all available paths for information to travel throughout the network [7].
- Routing Algorithms: These algorithms are used to calculate the most optimal path for data packets to be sent across a network topology [8].
- Metrics: Metrics are used to evaluate the different paths within a network based on their bandwidth delay, hop count, and reliability [9].
- Administrative Distance: Administrative distance is a value which is designated to each routing protocol in use in order to prioritise routes when multiple protocols store routing information that lead to the same address [10].
- Convergence: This is the procedure of when routers end up having the same information on a network after changes have occurred on its topology [11].
- Scalability: This is a key element of routing, it means to accommodate larger network growth while minimising performance issues across the network itself [12].

The Roles of Routing Protocols

As mentioned previously, protocols play a critical role in network connections, and the transferring of data across said networks. The roles they play are as follows:

- Topology Discovery: Routing protocols are used to pass around routing information that gets discovered in order to map out the best possible paths for the data to take to reach their destination [13].
- Route Calculation: Using the routing information discovered from the topology discovery, these protocols are responsible for calculating the most optimal paths in order to forward data [13].
- Route Maintenance: Protocols are used to monitor the network for any undesirable changes being made, and will update the routing tables in order to adapt to said changes. This can occur when there are link failures, network outages, or changes in the network topology [13].
- Loop Prevention: Routing loops are to be avoided, and it is the responsibility of the routing protocols [14]. They do this by having loop prevention mechanisms, this is to

ensure that the data packets being sent across the network do not end up in an endless loop, never reaching their desired destination [14].

- Load Balancing: There are a few protocols which support the feature of load balancing, this is used to send data packets across several paths on the network, which speeds up network traffic and prevents clogging [15].

Purpose of Routing Protocols

Routing protocols have many purposes, their main objective is to create efficient communications between computer systems across a network [16]. This is done by the protocols dynamically selecting paths for data packets to be sent across, but more than that they also:

- Facilitate Connectivity: Protocols are meant to allow communication between computer systems that are separated by network areas [16].
- Enhance Fault Tolerance: Protocols are used to ensure data packets reach their destination by utilising alternate possible paths for the data to be sent across if there is an issue with the flow of traffic [16].
- Optimise Performance: Protocols, as mentioned prior, are also used to provide the best possible path for the data to take in order to minimise the time it takes to receive and deliver information [16].
- Support Scalability: Protocols on a network serve the purpose of allowing network scaling without any manual intervention. This means that the protocols are responsible for upholding performance of the network even when a number of new systems are being linked [16].

Static vs Dynamic Routing Protocols

Static and Dynamic routing protocols offer a variety of differences in how to handle the transferring of data across the network topology [17]. Some differences between the two is that static routing protocols require manual configuration, while dynamic routing protocols automatically change their routing tables based on network changes and link failures [17].

Static routing protocols are more simplistic than dynamic routing protocols, however dynamic routing protocols are better suited for larger networks due to their ability to adapt their routing tables according to current events on the network [17][23].

Examples of Routing Protocols

Routing Protocol Deployment

There are many real-life examples I can give about routing protocols, for example, larger scaled organisations which consist of multiple offices, departments floors, and branches, will use the Open Shortest Path First (OSPF) routing protocol [18]. This is because OSPF allows for easy separation of a network into multiple areas, this means that OSPF can accommodate larger network connections and more complicated network topologies [18].

OSPF is typically configured to prioritise specific paths for specific applications, this ensures important information is sent and received quickly and efficiently [18]. OSPF also offers network monitoring features which are used to maintain a network's performance [18].

Examples of Routing Protocols in Reality

Routing protocols are typically used by ISP networks, more specifically the Border Gateway Protocol (BGP) [19][20], is used to transfer information to and from automatic systems across the internet. ISPs use this protocol to better market their free routes to said automatic systems on the internet, they also use this protocol to receive routing updates from them as well [19][20].

BGP plays an important role when it comes to data packets being sent across the internet that are being sent from the ISPs customers, as these customers will use the information gained from the BGP and it allows their packets to be delivered to the desired destination [19][20].

Different Protocol for Different Network Scenarios

Different protocols are better suited for different situations that a network is in. For smaller scaled networks that consist of lower amounts of traffic, then the Routing Information Protocol (RIP) would be the most effective protocol to use [21]. RIP is easy to configure and has lower resource requirements which make it perfect for small scaled network deployment [21].

Alternatively, larger scaled networks would use a more complex protocol such as OSPF or EIGRP [22]. These protocols offer scalability and are adaptable to network faults and traffic flow speeds [22]. These features, as well as a variety of others, are the reason why these protocols are best deployed for larger scaled organisational network topologies [22].

Advantages and Disadvantages of Routing Protocols

There are many advantages and disadvantages to using routing protocols, firstly the advantages to using routing protocols are that they offer the ability to monitor and maintain network traffic in real time. They can select the most optimal routes for data to take when being transferred to computer systems across the network [24].

Varying protocols offer a variety of features, some offer the ability to handle scaling of networks, which means they can automatically adapt to network extensions, changes, and outages, with no manual configuration [24].

Some protocols also allow network administrators to set their own policy-based routing configurations which can influence the protocols route selection based on the performance, and security requirements set by the policies [24].

Alternatively, there are downsides to some routing protocols. Despite routing protocols being a necessary aspect of network topologies, some protocols will present disadvantages that may be not worth the effort to handle, depending on the network scale [24].

Firstly, a lot of bigger organisations use OSPF or EIGRP to support their large scaled networks, and smaller corporations would use RIP for theirs. This is because despite the obvious advantages that OSPF or EIGRP offer, they also come with a lot of complications.

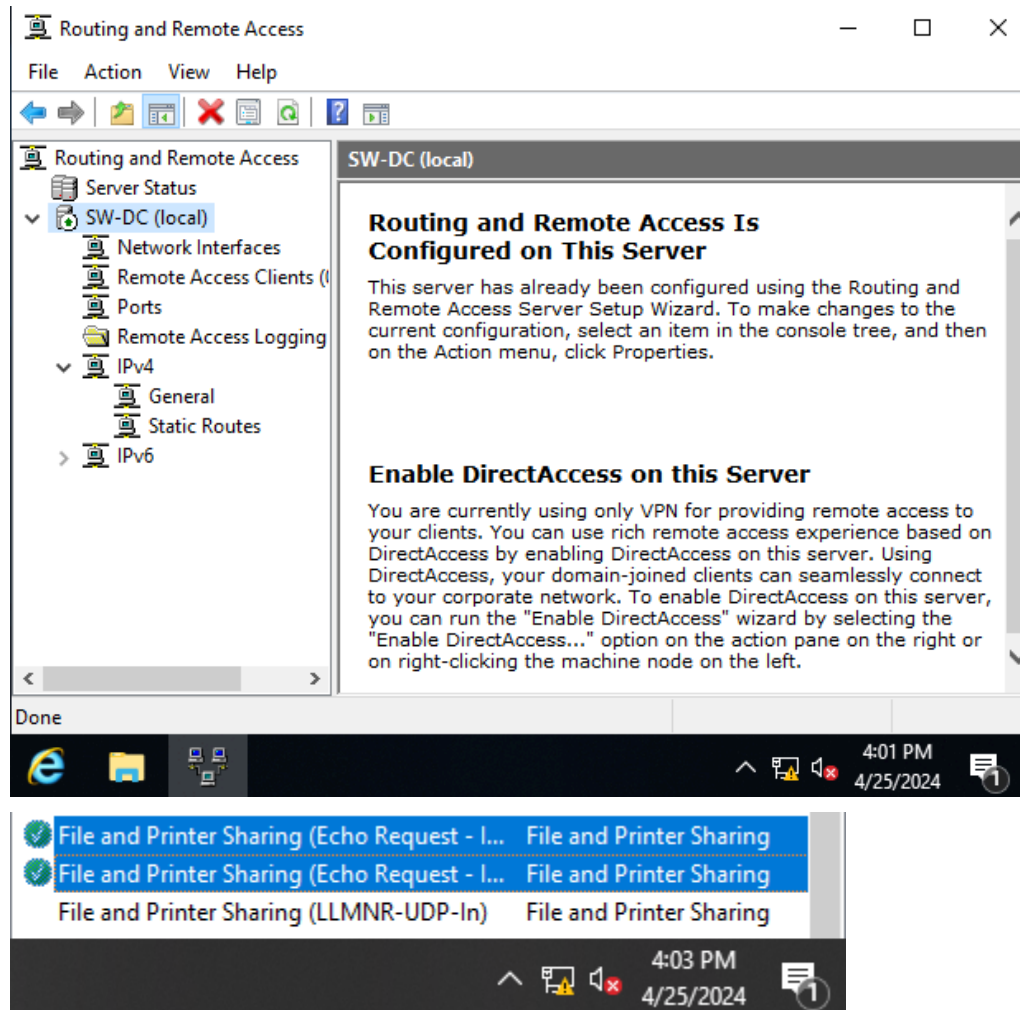
Secondly, routing protocols can also cause more traffic overhead as they will use the traffic routes for routing updates and other information exchanges. This uses bandwidth and system resources, so selecting a protocol that best fits the size of a network topology is vital for an appropriately efficient network system.

Another downside to using routing protocols are the potential security risks associated with them. For example, BGP lacks built-in security measures, and interacts with automatic systems on the internet. This makes BGP susceptible to cyber threats such as:

- Route Hijacking: Cyber-activists could potentially use falsified routes and divert the traffic being sent using this protocol away from the desired destination. This could lead to the interception of the data or the manipulation of the data before reaching its destination.
- Route Flapping: Cyber-activists could advertise their own routes, and remove them consistently, this would cause instability and possible disruption within the BGP's routing table. This could potentially create a vulnerability for a Denial of Service attack to be made against the network using the protocol.
- Prefix Hijacking: Cyber-activists could pose as automatic systems on the internet in order to divert the traffic being sent by the network using BGP, to themselves or another malicious destination.

Swansea Network:

Routing & Remote Access Service / Modify Firewall to enable ICMP Traffic



This is a screenshot of the remote access and ICMP traffic being set up on the swansea server.

Configure Site to Site VPN Connection to London Network

Completing the Routing and Remote Access Server Setup Wizard

You have successfully completed the Routing and Remote Access Server Setup wizard.

Summary of selections:

VPN access
Demand-dial connections
LAN routing

After you close this wizard, configure the selected services in the Routing and Remote Access console.

To close this wizard, click Finish.



These are screenshots of the site to site VPN being configured on the swansea server.

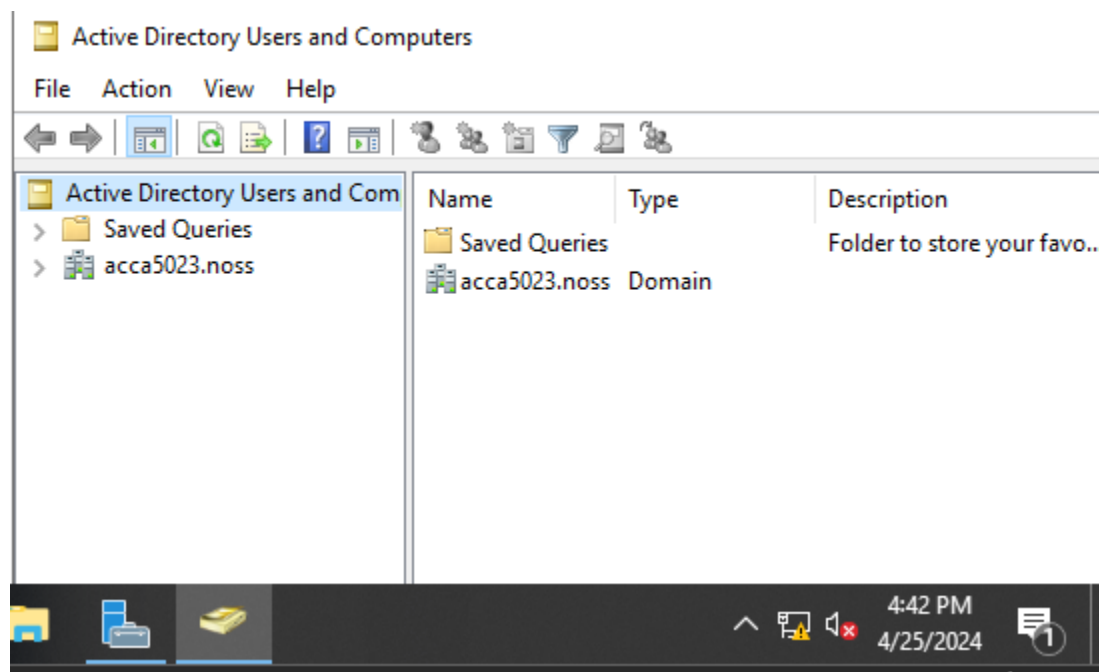
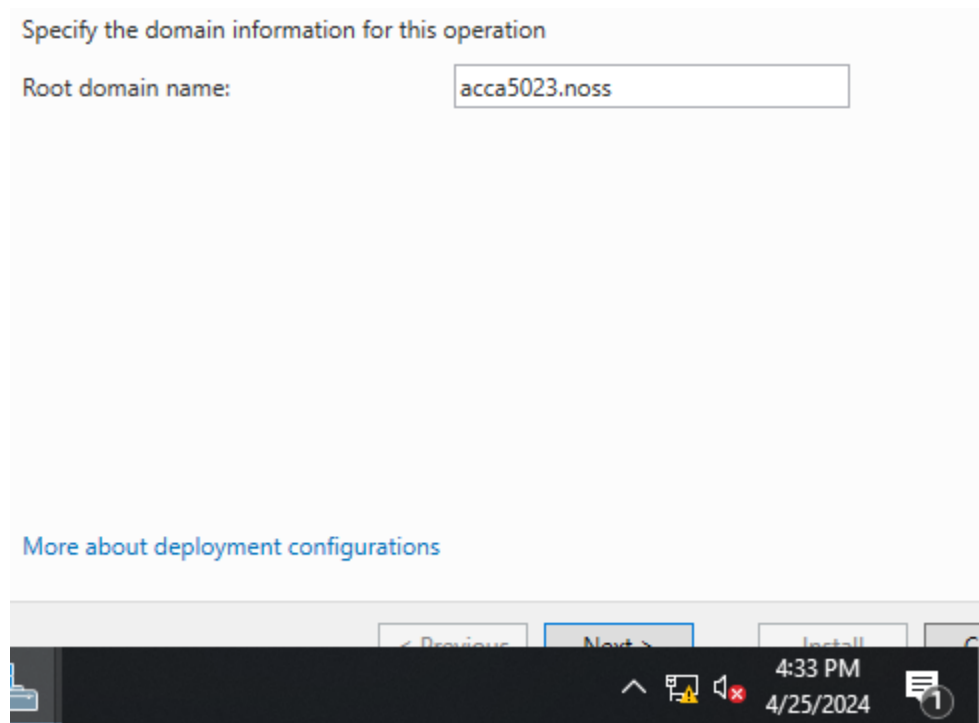
Setup Persistent Connection:

LAN and Demand Dial Interfaces		Type
Loopback		Loopba
London VPN		Demar
Internal		Interna
Ethernet1		Dedica
Ethernet0		Dedica



This screenshot shows that a consistent connection is setup to the london vpn.

Setup Forest:



These are screenshots of the forest named acca5023.noss being set up on the swansea server.

Create Appropriate Records:

The screenshot displays two Windows administrative tools side-by-side. The top window is 'DNS Manager', showing the hierarchy: DNS > SW-DC > Forward Lookup Zones > acca5023.noss. The main pane shows a list of DNS records for the 'acca5023.noss' zone.

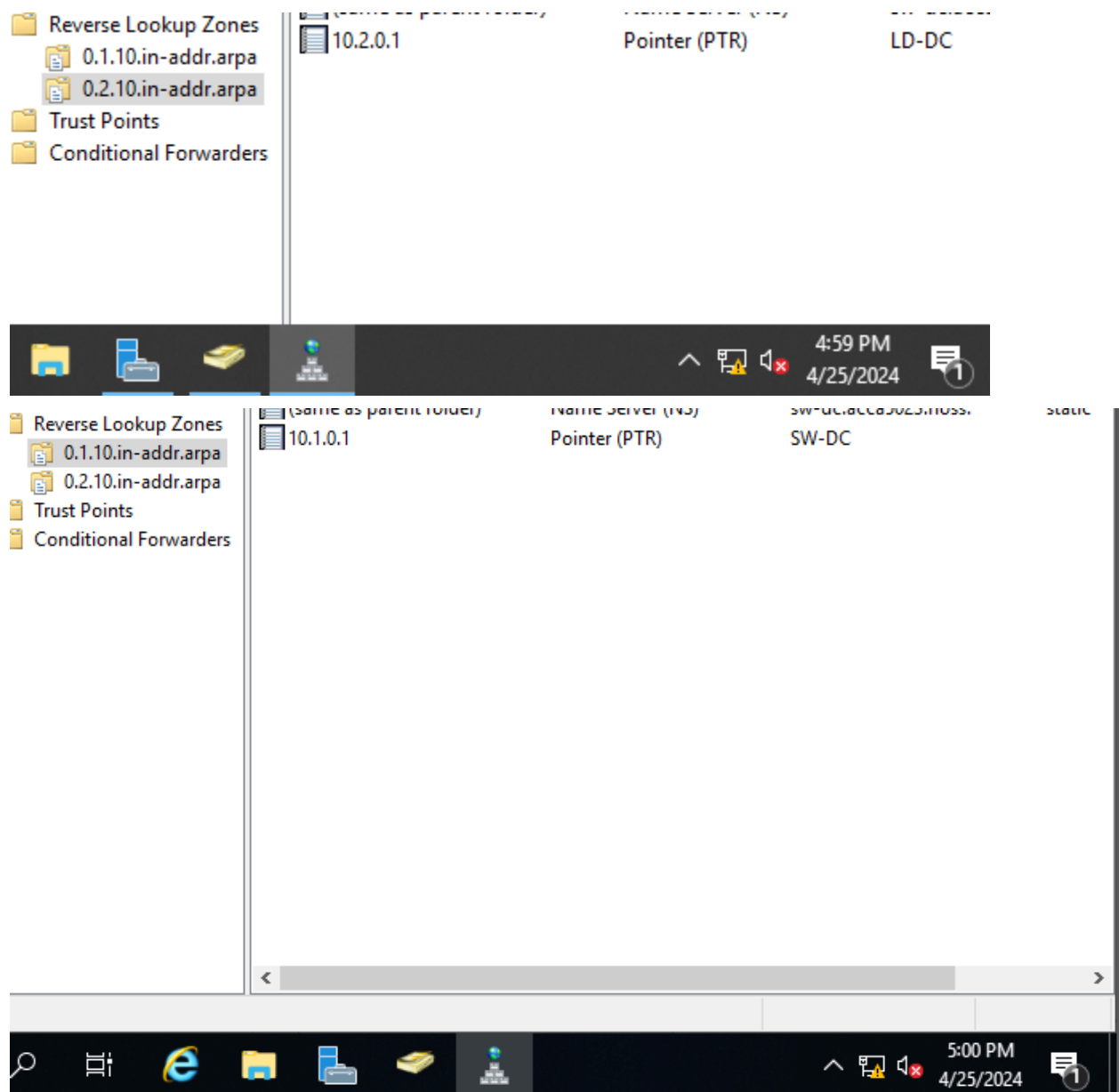
Name	Type	Data	Timestamp
_msdcs			
_sites			
_tcp			
_udp			
DomainDnsZones			
ForestDnsZones			
(same as parent folder)	Start of Authority (SOA)	[22], sw-dc.acca5023.noss....	static
(same as parent folder)	Name Server (NS)	sw-dc.acca5023.noss.	static
(same as parent folder)	Host (A)	10.1.0.3	4/25/20
(same as parent folder)	Host (A)	10.1.0.1	4/25/20
sw-dc	Host (A)	10.1.0.1	static
sw-dc	Host (A)	10.1.0.3	static
London-Server	Host (A)	10.2.0.1	
Swansea-Server	Host (A)	10.1.0.1	

The bottom window is 'Active Directory Users and Computers', showing the hierarchy: Active Directory Users and Computers > Saved Queries > acca5023.noss. The main pane shows a list of objects for the 'acca5023.noss' domain.

Name	Type	Description
Saved Queries		Folder to store your favo..
acca5023.noss	Domain	

This is proof that the appropriate records have been created for the forest.

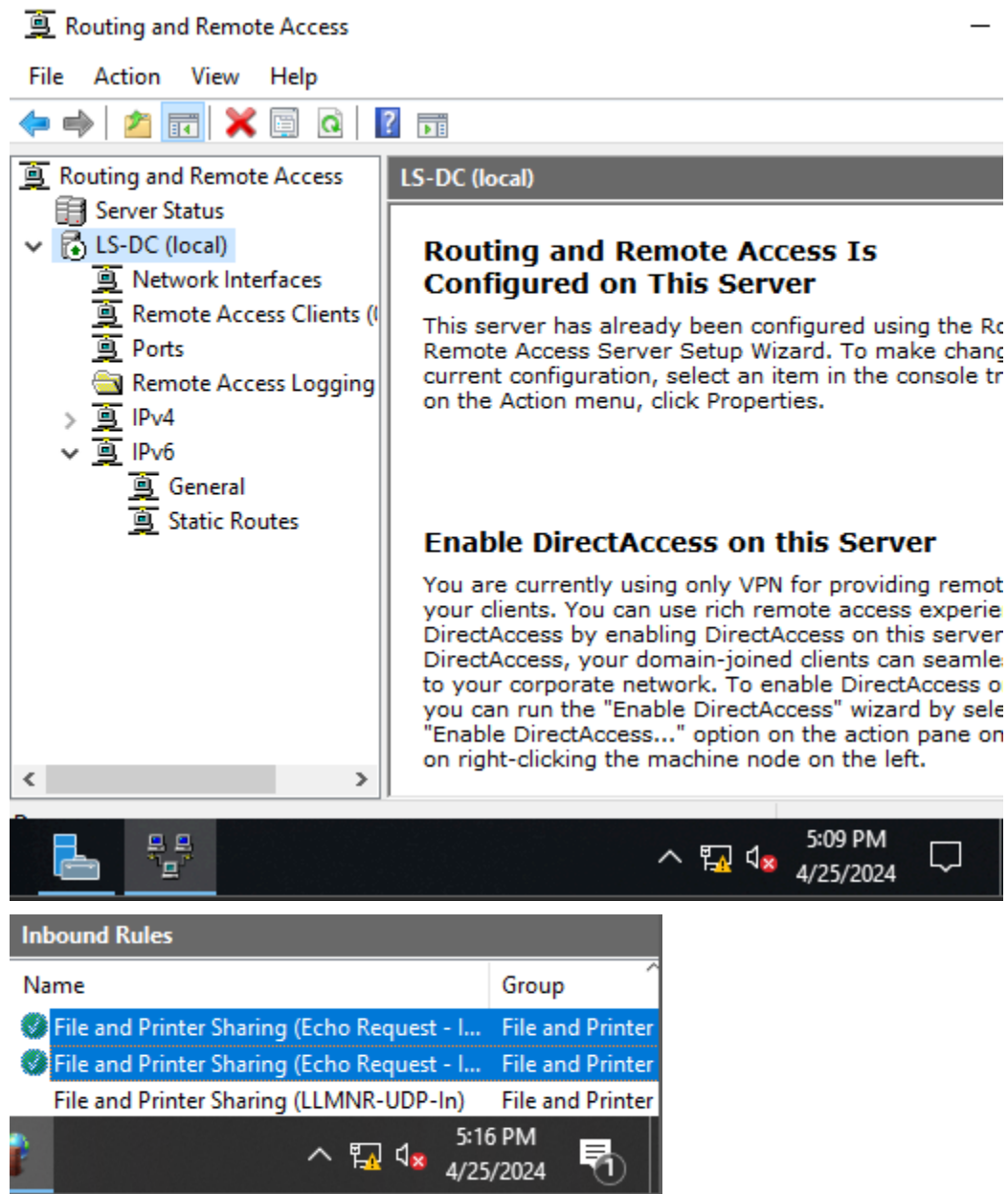
Create PTR Records:



These are screenshots of the PTR records having been set up.

London Network

Routing & Remote Access & Enable ICMP connection:



This is a screenshot of the remote access and ICMP traffic being set up on the London server.

Configure Site to Site VPN:

LAN and Demand Dial Interfaces		
	Type	Status
SwanseaVPN	Demand-dial	Enabl
Loopback	Loopback	Enabl
Internal	Internal	Enabl
Ethernet1	Dedicated	Enabl
Ethernet0	Dedicated	Enabl



These are screenshots of the site to site VPN being configured on the London server.

Configure Child Domain:

PROPERTIES

For LS-DC

Computer name

LS-DC

Domain

ld.acca5023.noss

Last installed updates

Windows Update

Last checked for updates

Windows Defender Firewall

Public: Off

Remote management

Enabled

Remote Desktop

Disabled

NIC Teaming

Disabled

Windows Defender Antivirus

Feedback & Diagnostics

IE Enhanced Security Configu

Time zone

3:00 PM

5/1/2024

This screenshot shows that the child forest has been configured on the London server.

Create accounts under child domain:

Dolan Griffith Properties

General Address Account Profile Telephones Organization Mem

User logon name:
d.griffith @ld.acca5023.noss

User logon name (pre-Windows 2000):
LD\ d.griffith

Logon Hours... Log On To...

☐ Unlock account

3:07 PM 5/1/2024

Roary RC. Cox Properties

General Address Account Profile Telephones Organization Mem

User logon name:
r.cox @ld.acca5023.noss

User logon name (pre-Windows 2000):
LD\ r.cox

Logon Hours... Log On To...

☒ Unlock account

Account options:

3:08 PM 5/1/2024

Derek DC. Curry Properties

General Address Account Profile Telephones Organization Mem

User logon name:
d.curry @ld.acca5023.noss

User logon name (pre-Windows 2000):
LD\ d.curry

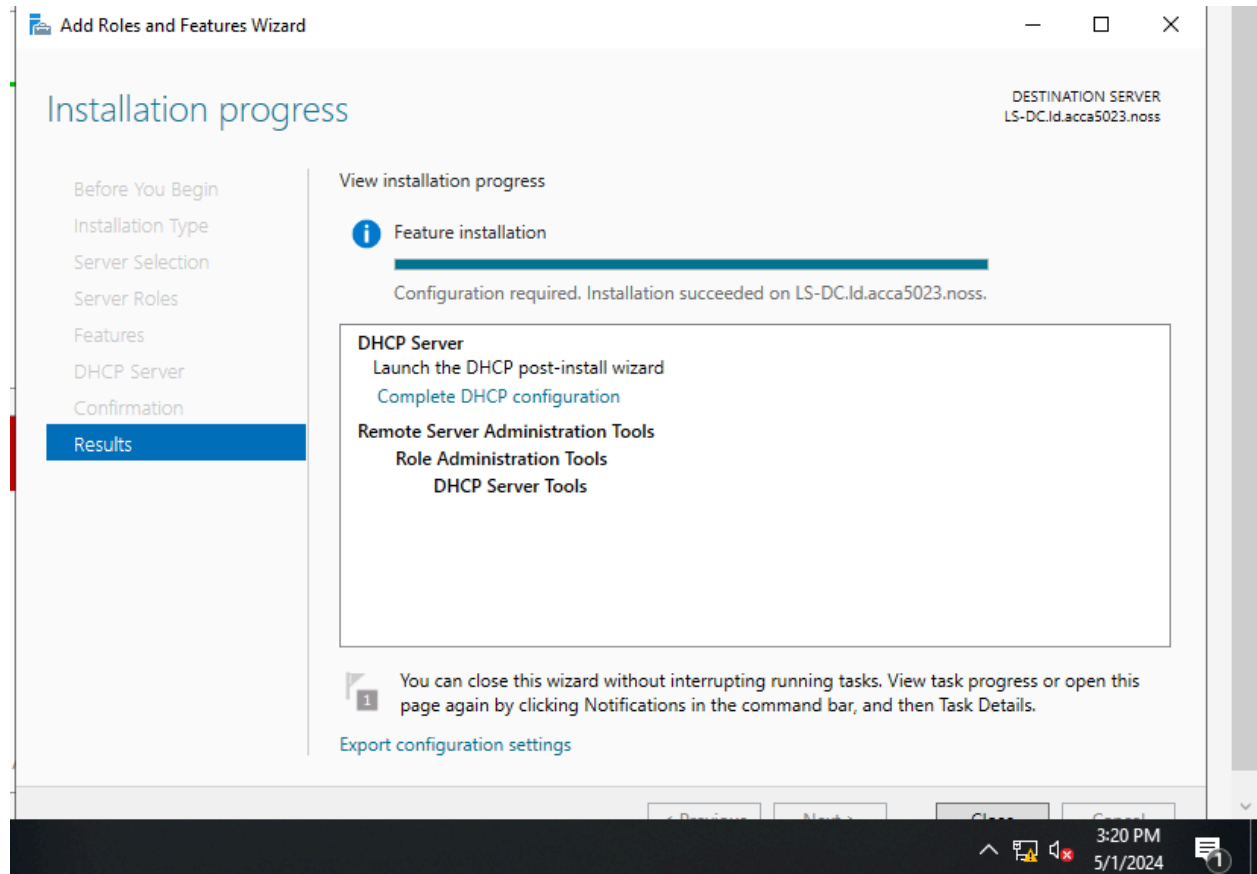
Logon Hours... Log On To...

☐ Unlock account

3:08 PM 5/1/2024

The screenshots above represent the fact that the three accounts following the specified template have been added to the child forest.

Install DHCP Server:



This is a screenshot that shows the DHCP server tools being installed on the London server.

Configure DHCP:

New Scope Wizard

IP Address Range
You define the scope address range by identifying a set of consecutive IP addresses.

Configuration settings for DHCP Server

Enter the range of addresses that the scope distributes.

Start IP address: 10 . 2 . 0 . 10

End IP address: 10 . 2 . 0 . 20

Configuration settings that propagate to DHCP Client

Length: 8

Subnet mask: 255 . 255 . 255 . 0

< Back Next > Cancel

Start IP Address	End IP Address	Description	Actions
10.2.0.10	10.2.0.20	Address range for di	Address Pool More Actions

These screenshots show that DHCP has been set up for the range between 10.2.0.10 and 10.2.0.20 as per the requirement of the task.

Connection Testing

Swansea Server to London Server:

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

C:\Users\Administrator>ping 192.1.1.2

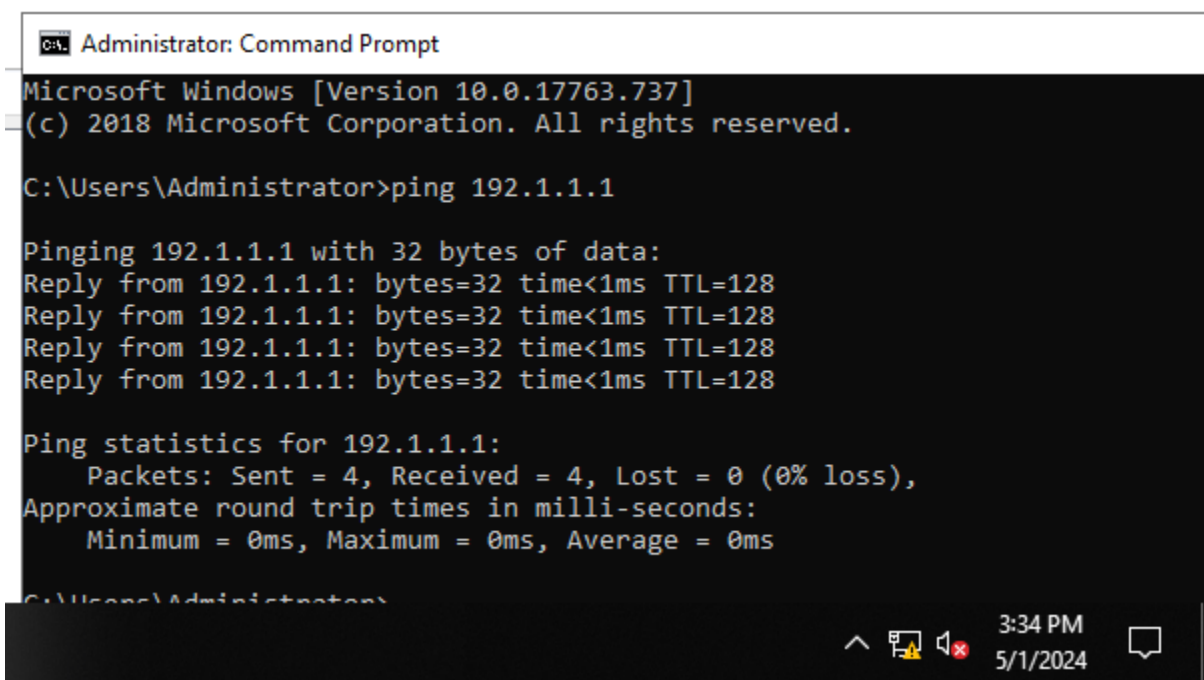
Pinging 192.1.1.2 with 32 bytes of data:
Reply from 192.1.1.2: bytes=32 time<1ms TTL=128
Reply from 192.1.1.2: bytes=32 time<1ms TTL=128
Reply from 192.1.1.2: bytes=32 time<1ms TTL=128
Reply from 192.1.1.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.1.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\Administrator>
```

This screenshot shows that the swansea server is able to communicate with the london server.

London Server to Swansea Server:

A screenshot of a Windows Command Prompt window titled "Administrator: Command Prompt". The window shows the output of a ping command to the IP address 192.1.1.1. The text displayed is: "Microsoft Windows [Version 10.0.17763.737] (c) 2018 Microsoft Corporation. All rights reserved. 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". The window has a taskbar at the bottom showing the time as 3:34 PM on 5/1/2024.

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

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

C:\Users\Administrator>
```

This screenshot shows that the london server is able to communicate with the swansea server.

References

- [1] "Routing Protocol - an overview | ScienceDirect Topics," *www.sciencedirect.com*.
<https://www.sciencedirect.com/topics/computer-science/routing-protocol#:~:text=Routing%20protocols%20are%20used%20to>
- [2] "Open Shortest Path First," *www.ibm.com*.
[https://www.ibm.com/docs/en/i/7.4?topic=routing-open-shortest-path-first#:~:text=Open%20Shortest%20Path%20First%20\(OSPF](https://www.ibm.com/docs/en/i/7.4?topic=routing-open-shortest-path-first#:~:text=Open%20Shortest%20Path%20First%20(OSPF)
- [3] "What is BGP? - BGP Routing Explained - AWS," *Amazon Web Services, Inc.*
[https://aws.amazon.com/what-is/border-gateway-protocol/#:~:text=Border%20Gateway%20Protocol%20\(BGP\)%20is](https://aws.amazon.com/what-is/border-gateway-protocol/#:~:text=Border%20Gateway%20Protocol%20(BGP)%20is)
- [4] "Routing Information Protocol (RIP)," *GeeksforGeeks*, May 17, 2018.
[https://www.geeksforgeeks.org/routing-information-protocol-rip/#:~:text=Routing%20Information%20Protocol%20\(RIP\)%20is](https://www.geeksforgeeks.org/routing-information-protocol-rip/#:~:text=Routing%20Information%20Protocol%20(RIP)%20is)
- [5] "What is Enhanced Interior Gateway Routing Protocol (EIGRP)?," *SearchNetworking*.
[https://www.techtarget.com/searchnetworking/definition/EIGRP#:~:text=Enhanced%20Interior%20Gateway%20Routing%20Protocol%20\(EIGRP\)%20is%20a%20network%20protocol](https://www.techtarget.com/searchnetworking/definition/EIGRP#:~:text=Enhanced%20Interior%20Gateway%20Routing%20Protocol%20(EIGRP)%20is%20a%20network%20protocol)
- [6] upravnik, "EIGRP Diffusing Update Algorithm (DUAL)," *Study CCNA*, May 26, 2021.
<https://study-ccna.com/eigrp-diffusing-update-algorithm-dual/>
- [7] K. Yasar, "What is routing table? - Definition from WhatIs.com," *SearchNetworking*, Nov. 2022. <https://www.techtarget.com/searchnetworking/definition/routing-table>
- [8] "What is Routing? - Network Routing Explained - AWS," *Amazon Web Services, Inc.*
<https://aws.amazon.com/what-is/routing/#:~:text=Routing%20algorithms%20are%20software%20programs>
- [9] "EIGRP Metrics: Optimization Approaches," *ExamCollection*.
<https://www.examcollection.com/certification-training/ccnp-optimize-eigrp-metrics.html>
- [10] "What is Administrative Distance?," *Cisco*.
<https://www.cisco.com/c/en/us/support/docs/ip/border-gateway-protocol-bgp/15986-admin-distance.html#:~:text=Administrative%20distance%20is%20the%20first>
- [11] "What is Network Convergence? | VMware Glossary," *VMware*, Jan. 27, 2022.
<https://www.vmware.com/topics/glossary/content/network-convergence.html>
- [12] "Strategies for Optimizing OSPF Convergence," *This Bridge is the Root*.
<https://thisbridgeistheroot.com/blog/strategies-for-optimizing-ospf-convergence#:~:text=One%20of%20the%20primary%20advantages>

- [13] T. Keary, "Routing Protocol Types - The Ultimate Guide (The Essentials!)," *Comparitech.com*, 2018. <https://www.comparitech.com/net-admin/routing-protocol-types-guide/>
- [14] "What are some common causes and symptoms of routing loops and how do you diagnose them?," *www.linkedin.com*.
<https://www.linkedin.com/advice/0/what-some-common-causes-symptoms-routing-loops>
- [15] "What is Load Balancing? - Load Balancing Algorithm Explained - AWS," *Amazon Web Services, Inc.*
<https://aws.amazon.com/what-is/load-balancing/#:~:text=Load%20balancing%20is%20the%20method>
- [16] "IP Routing Fundamentals – The Objectives of Routing Protocols," *www.howtonetwork.org*.
<https://www.howtonetwork.org/route/module-1/the-objectives-of-routing-protocols/>
- [17] "Static Vs. Dynamic Routing: What is the Difference?," *Networking*.
<https://www.techtarget.com/searchnetworking/answer/Static-and-dynamic-routing#:~:text=Static%20routing%20doesn%27t%20use>
- [18] "How can you choose a routing protocol that balances scalability and performance?," *www.linkedin.com*.
<https://www.linkedin.com/advice/3/how-can-you-choose-routing-protocol-balances-vcdrf#:~:text=One%20routing%20protocol%20known%20for>
- [19] "Border Gateway Protocol (BGP): A Comprehensive Guide," *Site24x7*.
<https://www.site24x7.com/learn/border-gateway-protocol.html#:~:text=A%20routing%20protocol%20establishes%20the>
- [20] G. Upadhaya, "BGP Best Practices for ISPs Packet Clearing House." . Available:
<https://conference.apnic.net/22/docs/tut-routing-pres-bgp-bcp.pdf>
- [21] "About Routing Information Protocol (RIP and RIPng)," *www.watchguard.com*.
https://www.watchguard.com/help/docs/help-center/en-US/Content/en-US/Fireware/dynamicrouting/rip_about_c.html#:~:text=RIP%20is%20best%20for%20small
- [22] "BGP vs. OSPF: When to use each protocol," *SearchNetworking*.
<https://www.techtarget.com/searchnetworking/tip/BGP-vs-OSPF-When-to-use-each-protocol>
- [23] "Dynamic Routing Protocols," *www.catchpoint.com*.
<https://www.catchpoint.com/dynamic-routing-protocols>
- [24] "Pros And Disadvantages Of Routing - 1270 Words | Bartleby," *www.bartleby.com*.
<https://www.bartleby.com/essay/Pros-And-Disadvantages-Of-Routing-FCRE9R4XN6>