

CCNA Project Portfolio

Enterprise Network Implementation: Switching, Routing, and Services

A Technical Report

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General Introduction

As part of the implementation of the company's network, we will configure VLANs to control broadcasts, enhance security, and group users. We will use RFC 1918 private addresses for the entire autonomous system, as well as DHCP on most LAN segments and NAT for Internet connectivity. We will also configure OSPF for internal routing and HSRP for gateway redundancy. The objective is to limit Internet access to web traffic while allowing multiple protocols within our WAN. To optimize the use of IP addresses and minimize waste, we will use VLSM where appropriate. Here is how we will proceed to configure the VLANs in Limerick, Galway, Cork, and Belfast as part of Phase I. Subsequently, we will address the next steps of the network configuration. Therefore, we will be working with the following schema:

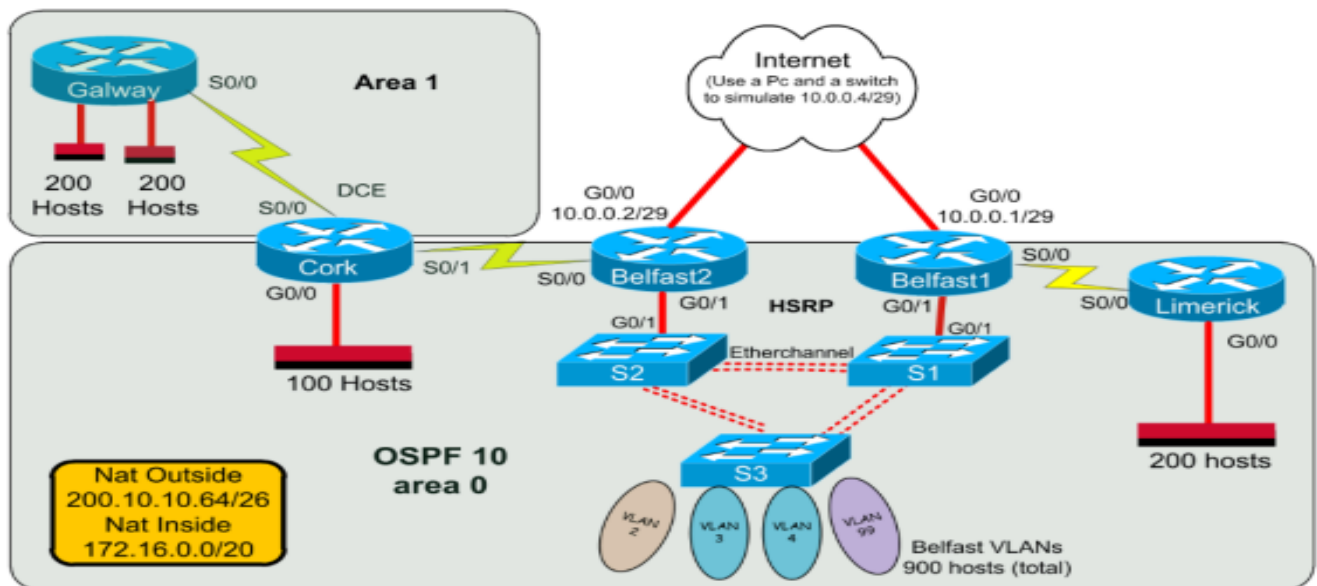


Figure 1: Working Network Topology

Chapter 1

WAN and LAN Addressing

The objective of this phase is to establish a coherent and efficient addressing plan for our network, using appropriate subnets for each VLAN to minimize address waste and optimize performance.

1.1 Subnetting with the VLSM Method

In this section, we started by applying the VLSM method to address our LANs (Galway, Cork, Limerick, Belfast), using the IP address 172.16.0.0/20. We then applied /30 subnets on all serial interfaces, as represented in the following table:

Subnet Name	Needed Size	Allocated Size	Address	Mask	Dec Mask	Assignable Range	Broadcast
Belfst	900	1022	172.16.0.0	/22	255.255.252.0	172.16.0.1 - 172.16.3.254	172.16.3.255
Galway's	400	510	172.16.4.0	/23	255.255.254.0	172.16.4.1 - 172.16.5.254	172.16.5.255
Limerick	200	254	172.16.6.0	/24	255.255.255.0	172.16.6.1 - 172.16.6.254	172.16.6.255
Cork	100	126	172.16.7.0	/25	255.255.255.128	172.16.7.1 - 172.16.7.126	172.16.7.127
Serial between Galway's&Cork	2	2	172.16.7.128	/30	255.255.255.252	172.16.7.129 - 172.16.7.130	172.16.7.131
Serial between Limerick&Belfst1	2	2	172.16.7.132	/30	255.255.255.252	172.16.7.133 - 172.16.7.134	172.16.7.135
Serial btwen Cork&Belfst2	2	2	172.16.7.136	/30	255.255.255.252	172.16.7.137 - 172.16.7.138	172.16.7.139

Figure 1.1: Network summary, including required sizes and addressing details for different subnets

The **Belfast** subnet must be configured to support up to 900 devices, with the following distributions: 40 devices for VLAN 99 (Management VLAN), 120 hosts for VLAN 2, 250 hosts for VLAN 3, and 500 hosts for VLAN 4.

Subnet Name	Needed Size	Allocated Size	Address	Mask	Dec Mask	Assignable Range	Broadcast
VLAN 4	500	510	172.16.0.0	/23	255.255.254.0	172.16.0.1 - 172.16.1.254	172.16.1.255
VLAN 3	250	254	172.16.2.0	/24	255.255.255.0	172.16.2.1 - 172.16.2.254	172.16.2.255
VLAN 2	120	126	172.16.3.0	/25	255.255.255.128	172.16.3.1 - 172.16.3.126	172.16.3.127
VLAN 99	40	62	172.16.3.128	/26	255.255.255.192	172.16.3.129 - 172.16.3.190	172.16.3.191

Figure 1.2: Summary of VLAN configurations, including required and allocated sizes, IP addresses, subnet masks, assignable ranges, and broadcast addresses

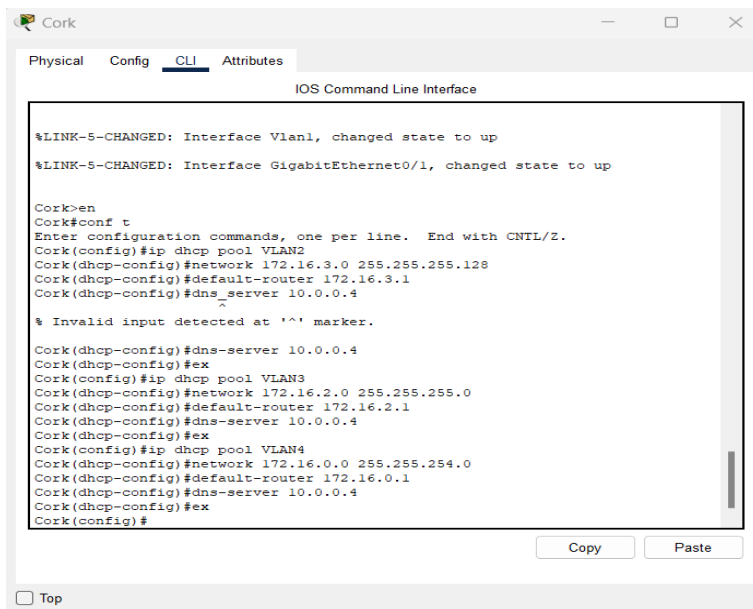
1.2 DHCP Pool Configuration on the Cork Router

Let's configure DHCP services on the Cork router. DHCP should provide services to the following LAN hosts:

- **VLAN 2, VLAN 3, and VLAN 4 of Belfast**

DHCP must transmit the following parameters to the hosts:

- **IP Address, Subnet Mask, Default Gateway, and DNS (10.0.0.4)**

The image shows a screenshot of a network configuration window titled 'Cork'. It has tabs for 'Physical', 'Config', 'CLI', and 'Attributes', with 'CLI' selected. The main area is labeled 'IOS Command Line Interface' and contains a text box with the following text:

```
%LINK-5-CHANGED: Interface Vlan1, changed state to up
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up

Cork>en
Cork#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Cork(config)#ip dhcp pool VLAN2
Cork(dhcp-config)#network 172.16.3.0 255.255.255.128
Cork(dhcp-config)#default-router 172.16.3.1
Cork(dhcp-config)#dns_server 10.0.0.4
Cork(dhcp-config)#^
% Invalid input detected at '^' marker.
Cork(dhcp-config)#dns-server 10.0.0.4
Cork(dhcp-config)#ex
Cork(config)#ip dhcp pool VLAN3
Cork(dhcp-config)#network 172.16.2.0 255.255.255.0
Cork(dhcp-config)#default-router 172.16.2.1
Cork(dhcp-config)#dns-server 10.0.0.4
Cork(dhcp-config)#ex
Cork(config)#ip dhcp pool VLAN4
Cork(dhcp-config)#network 172.16.0.0 255.255.254.0
Cork(dhcp-config)#default-router 172.16.0.1
Cork(dhcp-config)#dns-server 10.0.0.4
Cork(dhcp-config)#ex
Cork(config)#
```

At the bottom of the window, there are 'Copy' and 'Paste' buttons, and a 'Top' button with a checkbox.

Figure 1.3: DHCP services configuration on the Cork router for Belfast's VLANs 2, 3, and 4

Chapter 2

Configuration of Default Routes, OSPF Routing, and HSRP

2.1 Configure each router with a hostname and the required passwords

2.1.1 For the Galway Router

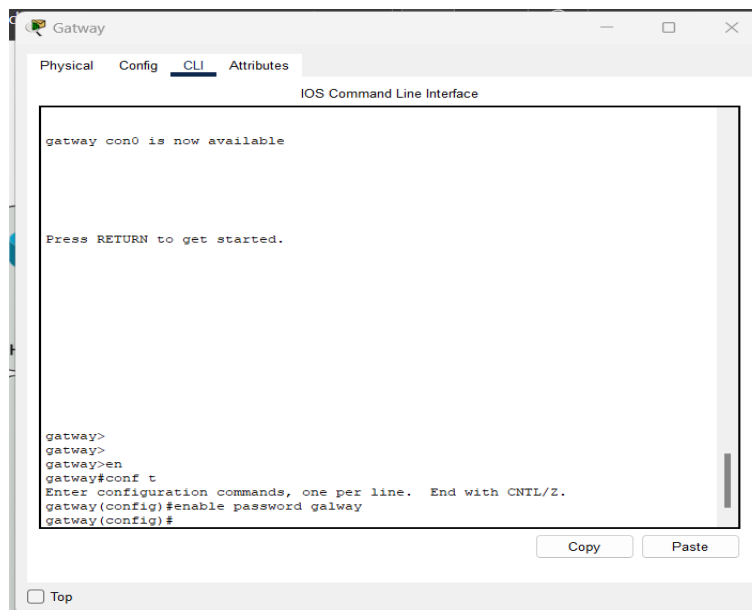


Figure 2.1: Configuration of hostname and password for the Galway router

⇒ **The same configuration is applied to each router.**

2.2 Configure each interface for every router

2.2.1 For the Limerick Router

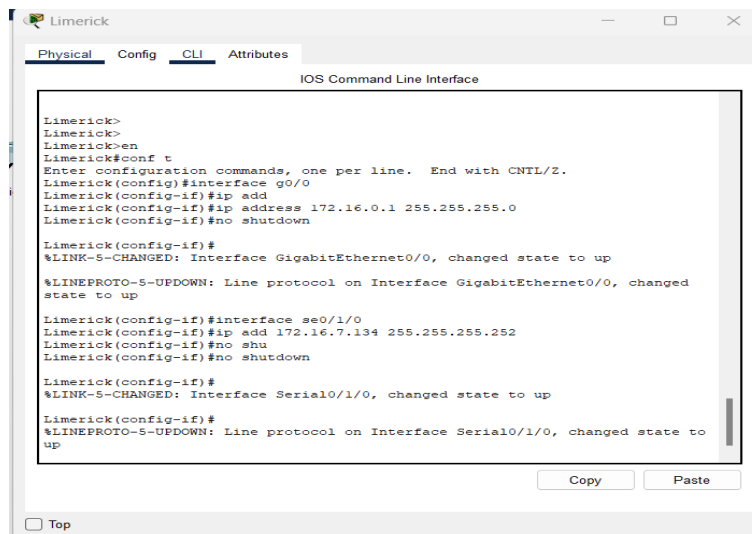


Figure 2.2: Interface configuration for the Limerick router

⇒ **The same interface configuration is applied to each router.**

2.3 Configure multi-area OSPF on the routers (Galway, Cork, Limerick, and Belfast)

Multi-area OSPF configuration on the routers involves dividing the network into different OSPF areas and configuring communication between these areas. The Cork router is configured in two areas (Area 0 and Area 1), making it an Area Border Router (ABR).

2.3.1 For the routers in Area 0

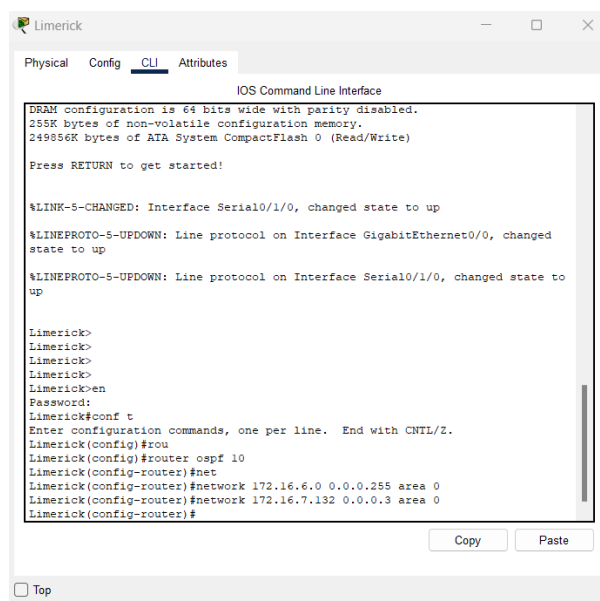


Figure 2.3: For the Limerick Router

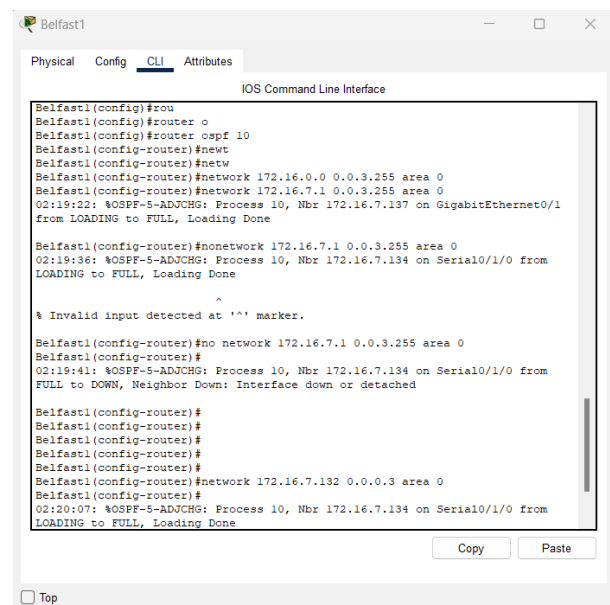
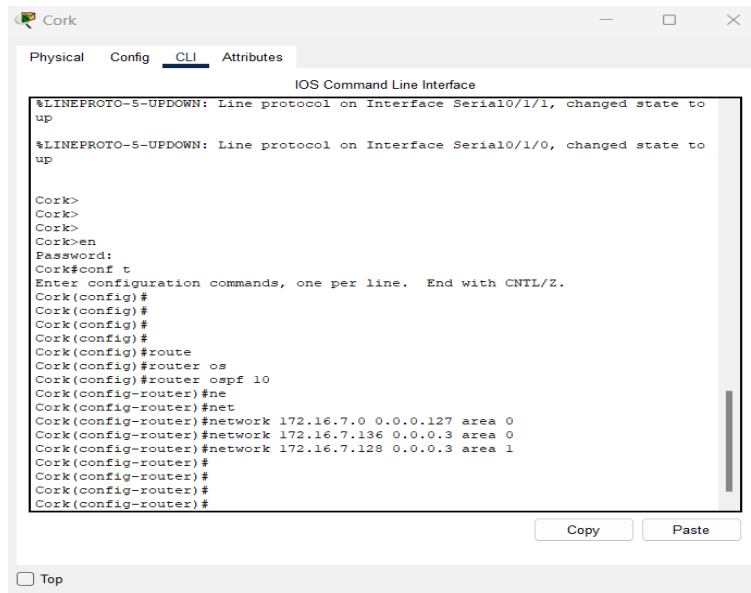


Figure 2.4: For the Belfast1 Router

⇒ **The same for the Belfast2 Router.**

2.3.2 For the Cork Router (ABR between Area 0 and Area 1)

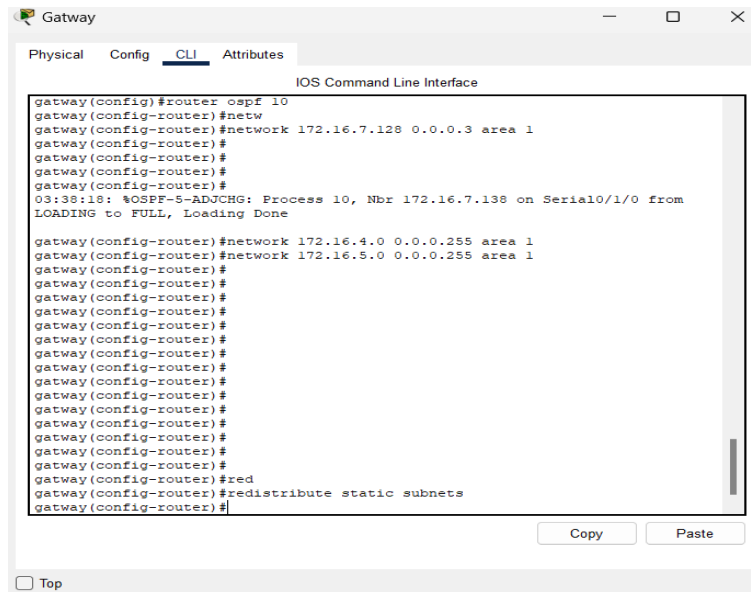


```
Cork
Physical Config CLI Attributes
IOS Command Line Interface
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1/0, changed state to up

Cork>
Cork>
Cork>
Cork>en
Password:
Cork#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Cork(config)#
Cork(config)#
Cork(config)#
Cork(config)#
Cork(config)#route
Cork(config)#router os
Cork(config)#router ospf 10
Cork(config-router)#ne
Cork(config-router)#net
Cork(config-router)#network 172.16.7.0 0.0.0.127 area 0
Cork(config-router)#network 172.16.7.136 0.0.0.3 area 0
Cork(config-router)#network 172.16.7.128 0.0.0.3 area 1
Cork(config-router)#
Cork(config-router)#
Cork(config-router)#
Cork(config-router)#
```

Figure 2.5: Configuring the Cork router with OSPF in both areas

2.3.3 For the Galway Router in Area 1



```
Gatway
Physical Config CLI Attributes
IOS Command Line Interface
gatway(config)#router ospf 10
gatway(config-router)#netw
gatway(config-router)#network 172.16.7.128 0.0.0.3 area 1
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
03:38:18: %OSPF-5-ADJCHG: Process 10, Nbr 172.16.7.138 on Serial0/1/0 from
LOADING to FULL, Loading Done

gatway(config-router)#network 172.16.4.0 0.0.0.255 area 1
gatway(config-router)#network 172.16.5.0 0.0.0.255 area 1
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#
gatway(config-router)#red
gatway(config-router)#redistribute static subnets
gatway(config-router)#
```

Figure 2.6: Configuring the Galway router with OSPF in Area 1

2.3.4 Routing Table for Each Router

2.4 Configure route summarization for Area 1

```

Belfast1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C    10.0.0.0/29 is directly connected, GigabitEthernet0/0
L    10.0.0.1/32 is directly connected, GigabitEthernet0/0
C    172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
L    172.16.0.2/32 is directly connected, GigabitEthernet0/1
O IA  172.16.4.0/24 [110/130] via 172.16.0.1, 01:08:30, GigabitEthernet0/1
O IA  172.16.5.0/24 [110/130] via 172.16.0.1, 01:08:30, GigabitEthernet0/1
O    172.16.6.0/24 [110/65] via 172.16.7.136, 01:14:47, Serial0/3/0
O    172.16.7.0/25 [110/66] via 172.16.0.1, 01:11:47, GigabitEthernet0/1
O IA  172.16.7.128/30 [110/129] via 172.16.0.1, 01:11:19,
GigabitEthernet0/1
C    172.16.7.132/30 is directly connected, Serial0/3/0
L    172.16.7.133/32 is directly connected, Serial0/3/0
O    172.16.7.136/30 [110/65] via 172.16.0.1, 01:12:47, GigabitEthernet0/1
Belfast1#
  
```

Figure 2.7: Routing table for the Belfast1 Router

```

Cork>
Cork#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 11 subnets, 5 masks
O    172.16.0.0/22 [110/65] via 172.16.7.136, 01:09:15, Serial0/3/1
O    172.16.4.0/24 [110/65] via 172.16.7.129, 01:05:53, Serial0/3/0
O    172.16.5.0/24 [110/65] via 172.16.7.129, 01:05:53, Serial0/3/0
O    172.16.6.0/24 [110/130] via 172.16.7.136, 01:09:15, Serial0/3/1
C    172.16.7.0/25 is directly connected, GigabitEthernet0/0
L    172.16.7.1/32 is directly connected, GigabitEthernet0/0
C    172.16.7.128/30 is directly connected, Serial0/3/0
L    172.16.7.130/32 is directly connected, Serial0/3/0
O    172.16.7.132/30 [110/129] via 172.16.7.136, 01:09:15, Serial0/3/1
C    172.16.7.136/30 is directly connected, Serial0/3/1
L    172.16.7.137/32 is directly connected, Serial0/3/1
Cork#
  
```

Figure 2.8: Routing table for the Cork Router

```

Gateway>en
Gateway#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 172.16.7.130 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 11 subnets, 5 masks
O IA  172.16.0.0/22 [110/129] via 172.16.7.130, 01:04:25, Serial0/3/0
C    172.16.4.0/24 is directly connected, GigabitEthernet0/0
L    172.16.4.1/32 is directly connected, GigabitEthernet0/0
C    172.16.5.0/24 is directly connected, GigabitEthernet0/1
L    172.16.5.1/32 is directly connected, GigabitEthernet0/1
O IA  172.16.6.0/24 [110/194] via 172.16.7.130, 01:04:25, Serial0/3/0
O IA  172.16.7.0/25 [110/65] via 172.16.7.130, 01:04:25, Serial0/3/0
C    172.16.7.128/30 is directly connected, Serial0/3/0
L    172.16.7.129/32 is directly connected, Serial0/3/0
O IA  172.16.7.132/30 [110/193] via 172.16.7.130, 01:04:25, Serial0/3/0
O IA  172.16.7.136/30 [110/128] via 172.16.7.130, 01:04:25, Serial0/3/0
S*   0.0.0.0/0 [1/0] via 172.16.7.130
Gateway#
  
```

Figure 2.9: Routing table for the Galway Router

```

Limerick>
Limerick#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 10 subnets, 5 masks
O    172.16.0.0/22 [110/65] via 172.16.7.133, 01:14:04, Serial0/3/0
O IA  172.16.4.0/24 [110/194] via 172.16.7.133, 01:09:15, Serial0/3/0
O IA  172.16.5.0/24 [110/194] via 172.16.7.133, 01:09:15, Serial0/3/0
C    172.16.6.0/24 is directly connected, GigabitEthernet0/0
L    172.16.6.1/32 is directly connected, GigabitEthernet0/0
O    172.16.7.0/25 [110/130] via 172.16.7.133, 01:12:32, Serial0/3/0
O IA  172.16.7.128/30 [110/193] via 172.16.7.133, 01:12:04, Serial0/3/0
C    172.16.7.132/30 is directly connected, Serial0/3/0
L    172.16.7.134/32 is directly connected, Serial0/3/0
O    172.16.7.136/30 [110/129] via 172.16.7.133, 01:13:32, Serial0/3/0
Limerick#
  
```

Figure 2.10: Routing table for the Limerick Router

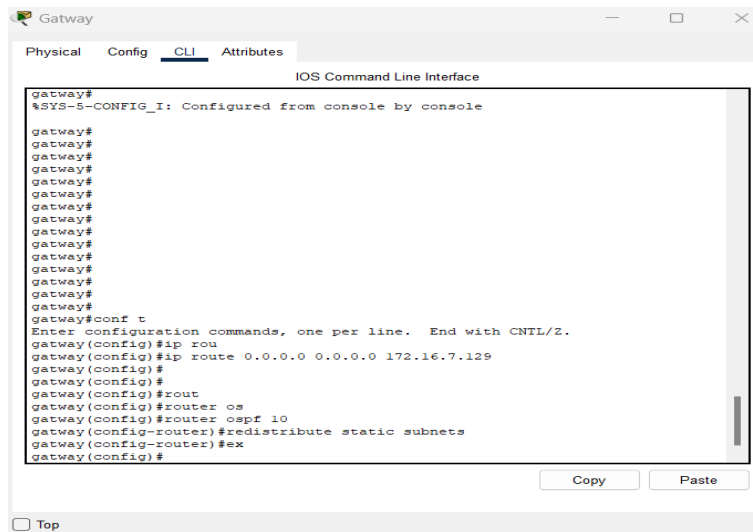


Figure 2.11: Configuration of route summarization for the Galway Router

2.5 Configure a default route on Belfast and redistribute it into the OSPF process

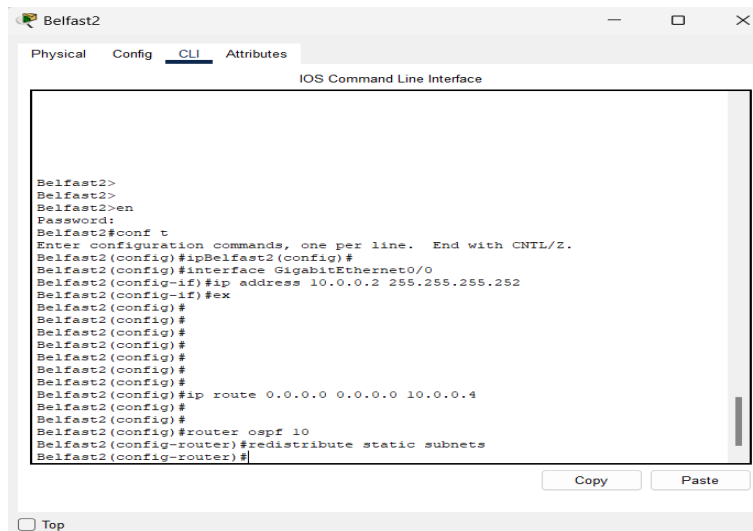


Figure 2.12: Configuring the default route on Belfast and redistributing it into OSPF

2.6 Configure MD5 authentication between OSPF routers on all WAN links

MD5 authentication is a security method used to secure OSPF routing exchanges. When enabled, it verifies the authenticity of OSPF packets using an MD5 hashing algorithm, preventing unauthorized routers from injecting false information. The configuration is shown in the following figure:

\Rightarrow The same for each router.

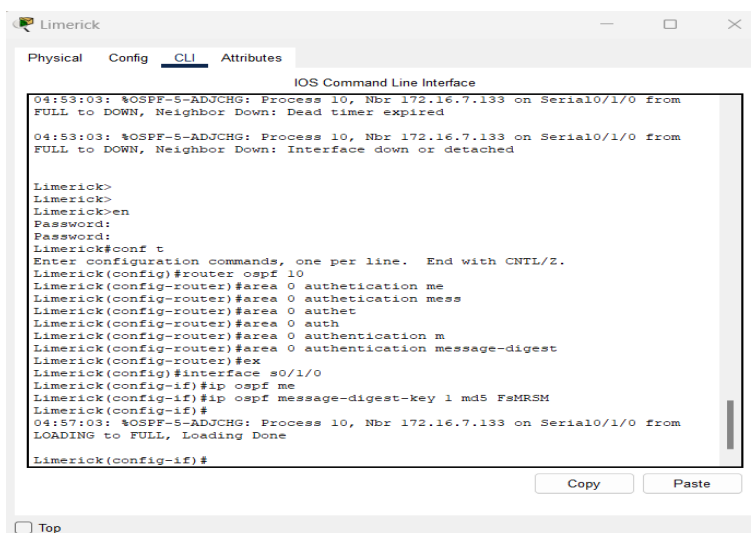


Figure 2.13: Configuration of OSPF MD5 authentication on WAN links

2.7 Set the Hello timer to 40 and the Dead timer to 160 on the link between Cork and Galway

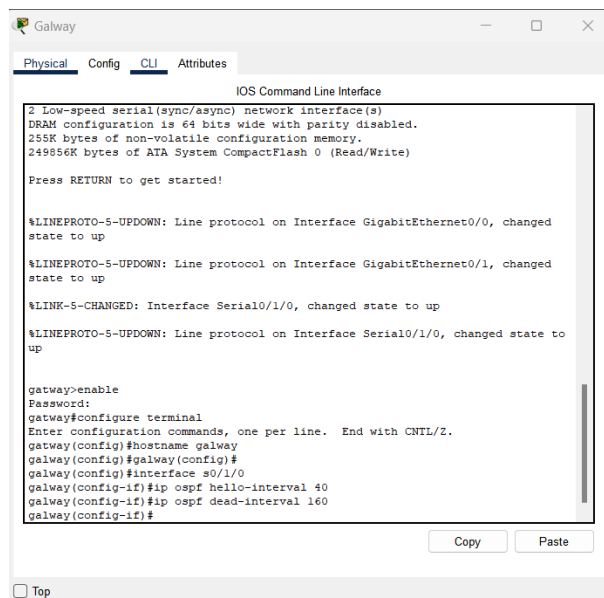


Figure 2.14: For the Galway Router

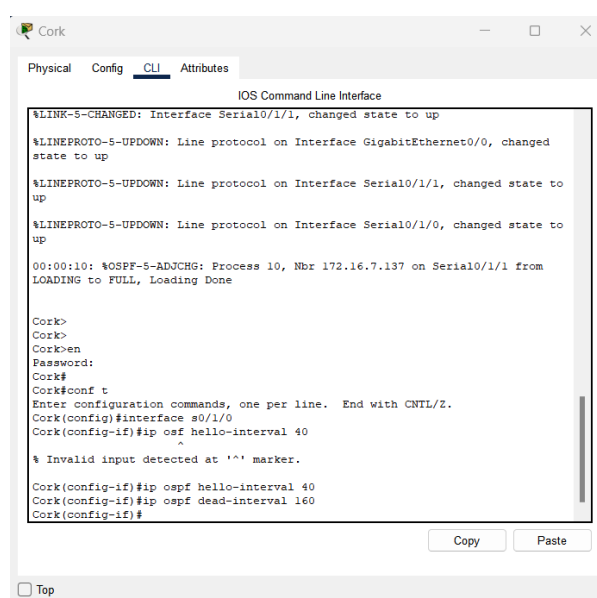
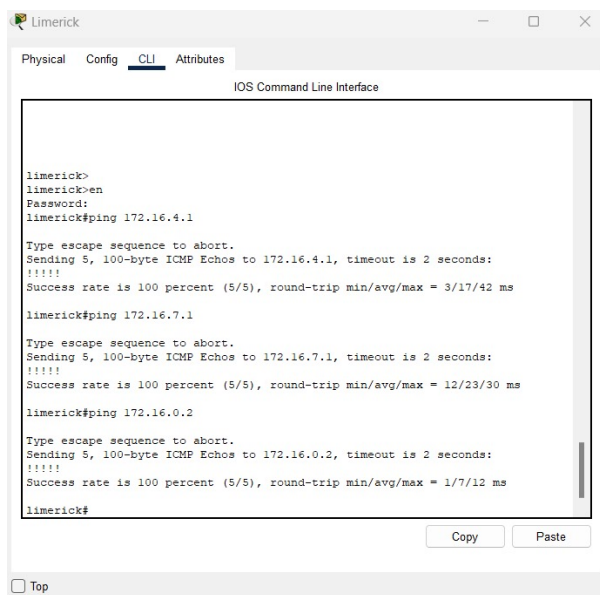


Figure 2.15: For the Cork Router

2.8 Verify that the Limerick, Belfast, Galway, and Cork routers are connected through Layers 1-7



```
limerick>
limerick>en
Password:
limerick#ping 172.16.4.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.4.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 3/17/42 ms

limerick#ping 172.16.7.1

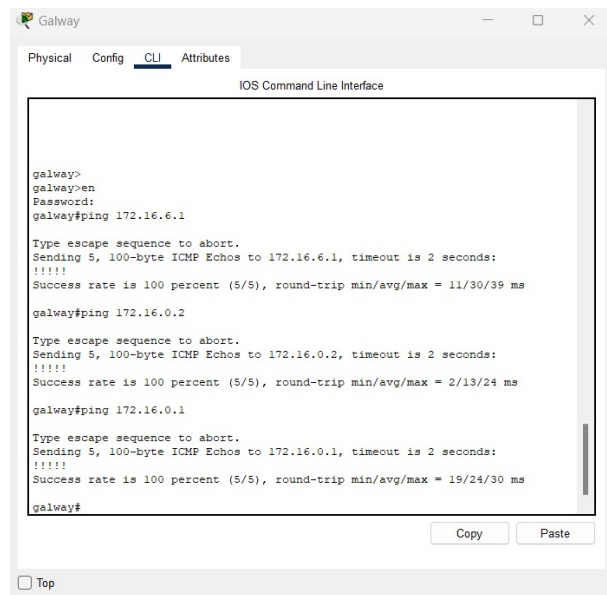
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.7.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/23/30 ms

limerick#ping 172.16.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/7/12 ms

limerick#
```

Figure 2.16: Successful ping results from the Limerick router to various IPs



```
galway>
galway>en
Password:
galway#ping 172.16.6.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.6.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 11/30/39 ms

galway#ping 172.16.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/13/24 ms

galway#ping 172.16.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.0.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 19/24/30 ms

galway#
```

Figure 2.17: Successful ping results from the Galway router

Chapter 3

Virtual Local Area Network (VLAN) Configuration

3.1 Apply basic switch configuration

To configure a basic switch, it is important to set a hostname and passwords to secure access. Additionally, it is often necessary to configure specific features such as the Root Bridge for the Spanning Tree Protocol (STP) and server mode for specific interfaces. These basic steps are essential for ensuring the proper functioning and security of our network.

3.1.1 Configure the hostname and passwords for each switch

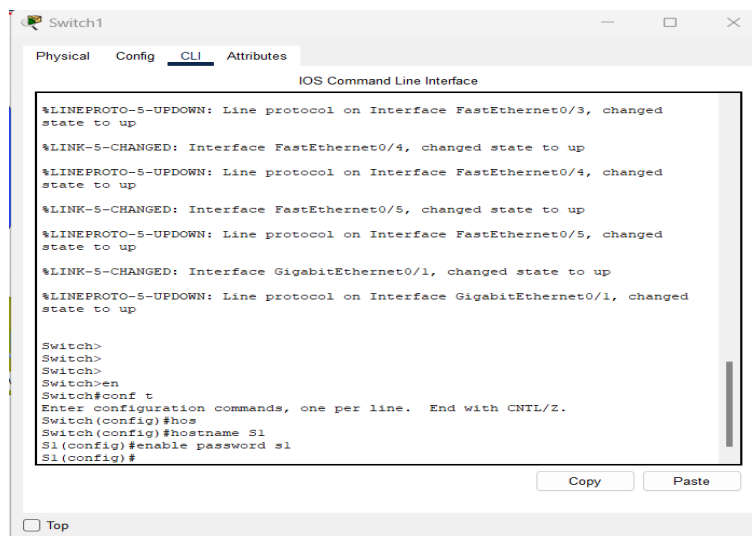


Figure 3.1: Configuration of hostname and password on a switch

⇒ **The same configuration for each switch.**

3.1.2 Configure VTP Server on S1

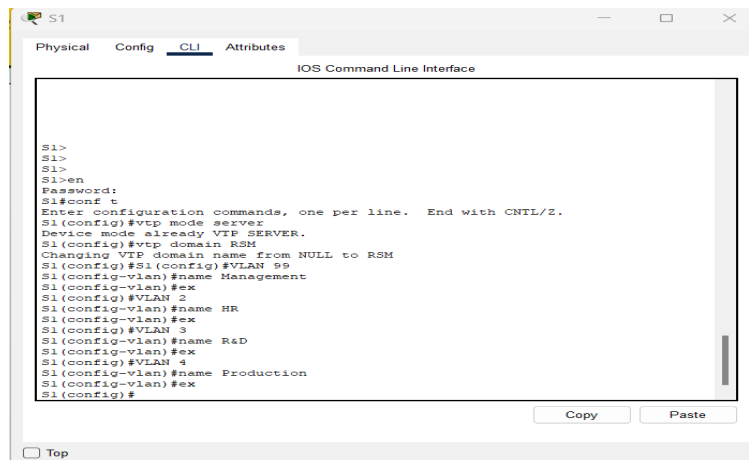


Figure 3.2: Configuration of the VTP domain, VLANs, and their names on the *S1* switch

3.1.3 Configure the Root Bridge (PVST+)

For *S1*

Giving S1 a priority of 0 means this switch has been configured to be the root bridge of the network. In a network using Spanning Tree Protocol (STP), the root bridge is the central point to which all other interfaces connect. A lower priority (0 being the lowest) ensures that S1 will be elected as the root bridge, which is desirable in our configuration to control the data propagation path.

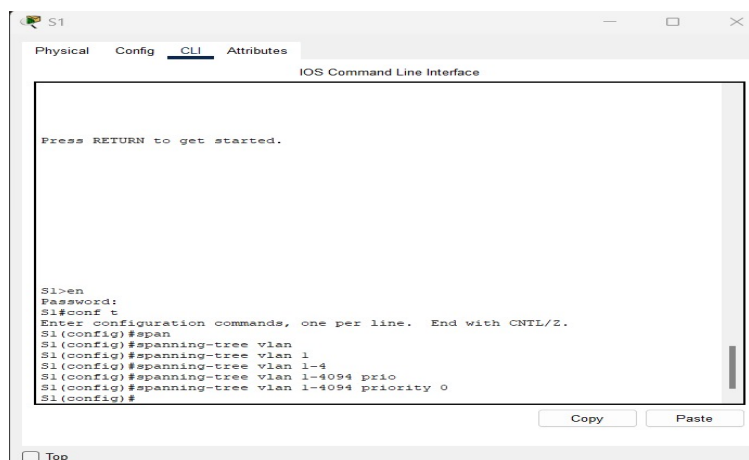


Figure 3.3: Setting the priority of switch S1 to 0 to designate it as the network's Root Bridge

For *S2* and *S3*

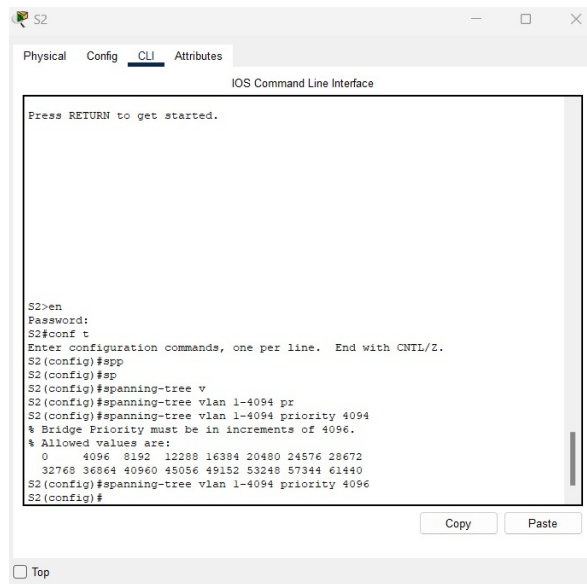


Figure 3.4: Configuring the priority for VLANs 1-4094 on switch *S2* to 4096

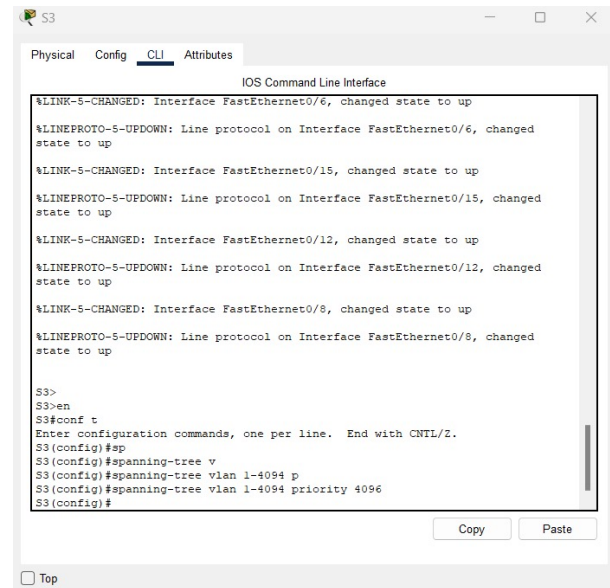


Figure 3.5: Configuring the priority for VLANs 1-4094 on switch *S3* to 4096

3.2 Configure the *Belfast* LAN

3.2.1 Create and name three data VLANs and one management VLAN on a switch

We have already created the VLANs on the VTP server; the VTP client switches will share this database.

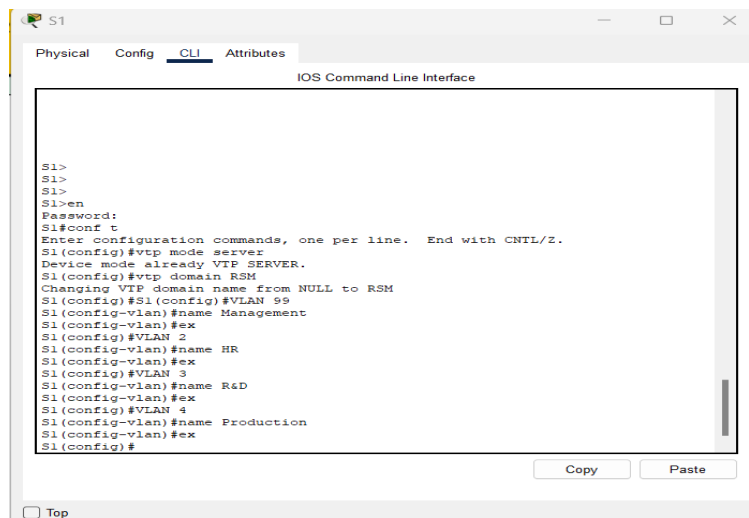
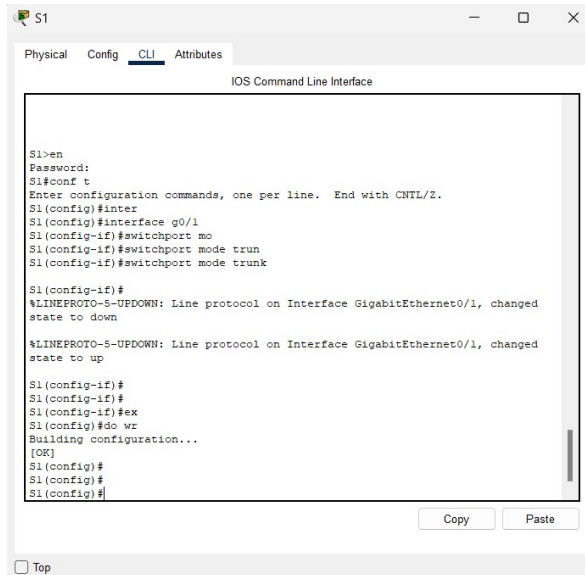


Figure 3.6: Configuration of VLANs and their names on the *S1* switch

⇒ **The same configuration for each switch.**

3.3 Configure ports *G0/0* as Trunk links (802.1Q) on S1 and S2



```

S1>en
Password:
S1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S1(config)#inter
S1(config)#interface g0/1
S1(config-if)#switchport mo
S1(config-if)#switchport mode trun
S1(config-if)#switchport mode trunk

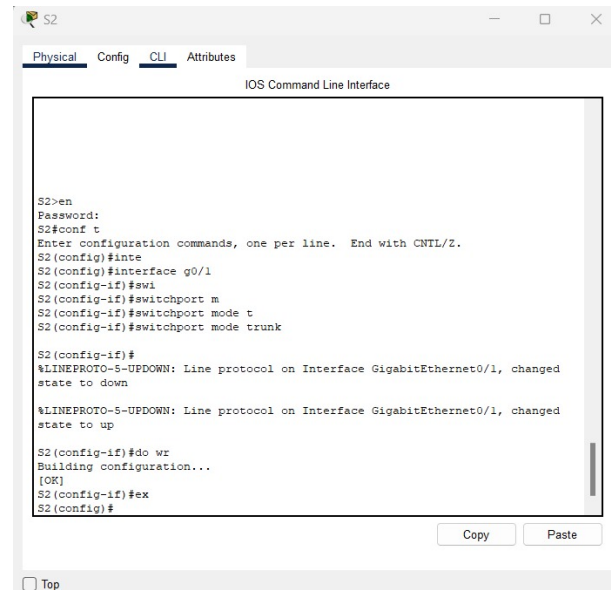
S1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed
state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed
state to up

S1(config-if)#
S1(config-if)#
S1(config-if)#ex
S1(config)#do wr
Building configuration...
[OK]
S1(config)#
S1(config)#
S1(config)#

```

Figure 3.7: Trunk mode configuration on S1



```

S2>en
Password:
S2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)#inte
S2(config)#interface g0/1
S2(config-if)#swi
S2(config-if)#switchport m
S2(config-if)#switchport mode t
S2(config-if)#switchport mode trunk

S2(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed
state to down

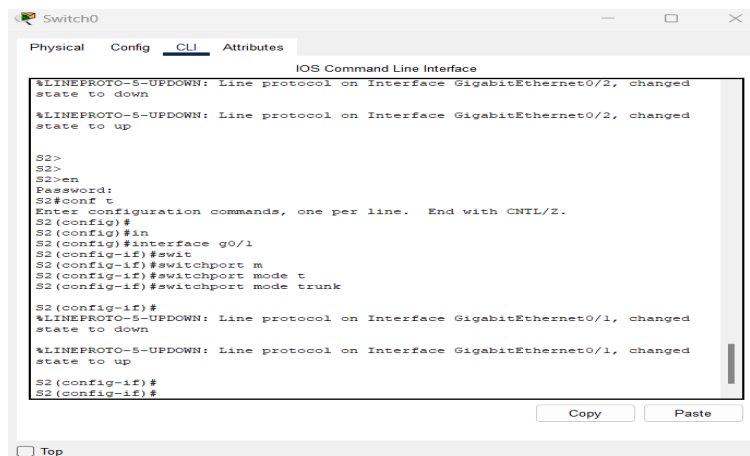
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed
state to up

S2(config-if)#do wr
Building configuration...
[OK]
S2(config-if)#ex
S2(config)#

```

Figure 3.8: Trunk mode configuration on S2

3.4 Configure S1, S2, and S3 so that ports 1 to 4 are trunks using the 802.1Q protocol



```

Switch0>
Switch0>en
Password:
Switch0#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch0(config)#in
Switch0(config)#interface g0/1
Switch0(config-if)#swit
Switch0(config-if)#switchport m
Switch0(config-if)#switchport mode t
Switch0(config-if)#switchport mode trunk

Switch0(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed
state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed
state to up

Switch0(config-if)#
Switch0(config-if)#

```

Figure 3.9: Trunk mode configuration on S2 for ports 1-4

⇒ **The same configuration for each switch.**

3.5 Access mode configuration on S3

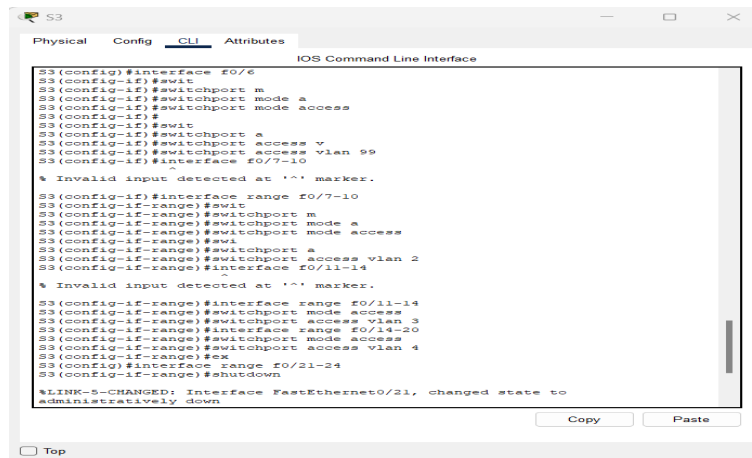


Figure 3.10: Access mode configuration on S3

3.6 Connect G0/0 of the 2 Belfast routers to G0/0 of S1 and S2, and also a workstation per VLAN

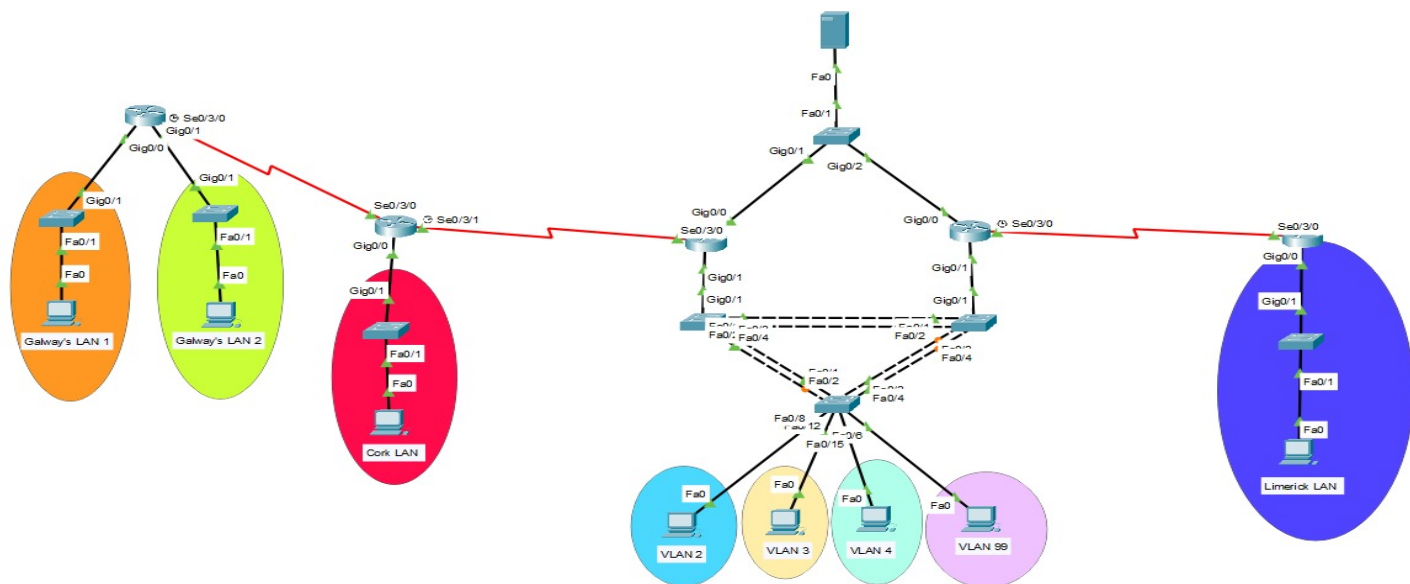
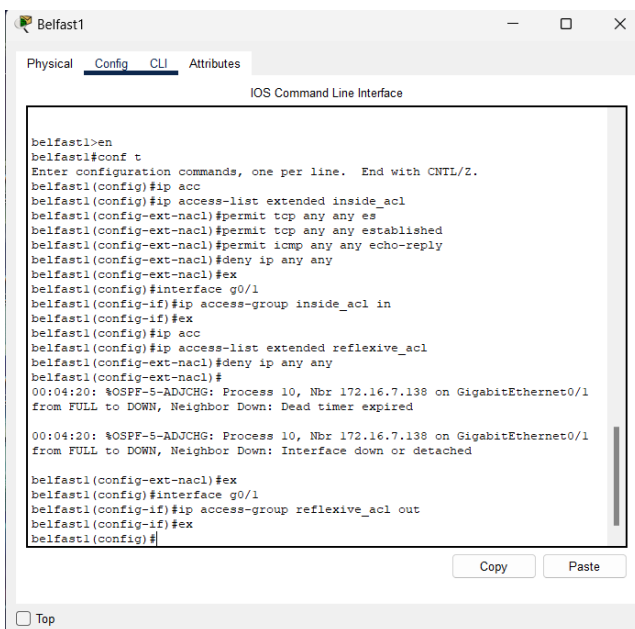


Figure 3.11: Connecting the G0/0 ports of the two Belfast routers to the G0/0 ports of S1 and S2 respectively, and also connecting one workstation per VLAN.

Chapter 4

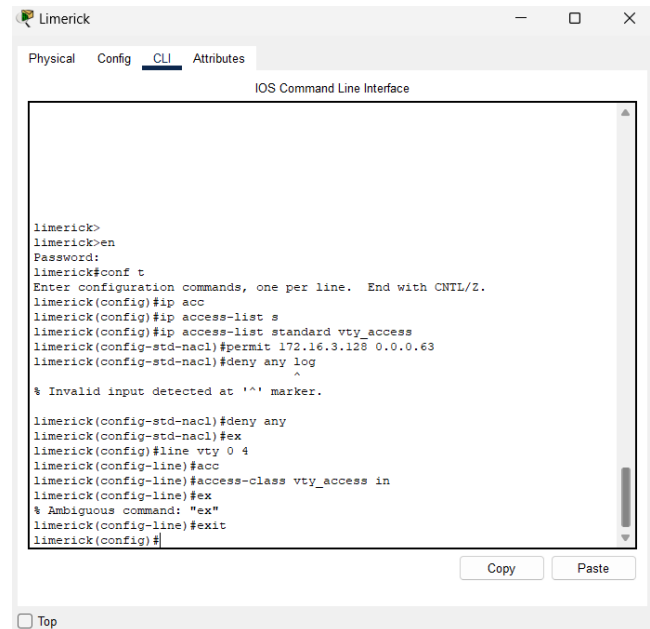
ACL Configurations

4.1 Configure a Reflexive ACL in Belfast and use an ACL to control VTY access for Limerick



```
belfast1>en
belfast1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
belfast1(config)#ip acc
belfast1(config)#ip access-list extended inside_acl
belfast1(config-ext-nacl)#permit tcp any any es
belfast1(config-ext-nacl)#permit tcp any any established
belfast1(config-ext-nacl)#permit icmp any any echo-reply
belfast1(config-ext-nacl)#deny ip any any
belfast1(config-ext-nacl)#ex
belfast1(config)#interface g0/1
belfast1(config-if)#ip access-group inside_acl in
belfast1(config-if)#ex
belfast1(config)#ip acc
belfast1(config)#ip access-list extended reflexive_acl
belfast1(config-ext-nacl)#deny ip any any
belfast1(config-ext-nacl)#
00:04:20: %OSPF-5-ADJCHG: Process 10, Nbr 172.16.7.138 on GigabitEthernet0/1
from FULL to DOWN, Neighbor Down: Dead timer expired
00:04:20: %OSPF-5-ADJCHG: Process 10, Nbr 172.16.7.138 on GigabitEthernet0/1
from FULL to DOWN, Neighbor Down: Interface down or detached
belfast1(config-ext-nacl)#ex
belfast1(config)#interface g0/1
belfast1(config-if)#ip access-group reflexive_acl out
belfast1(config-if)#ex
belfast1(config)#
```

Figure 4.1: Configuration of a Reflexive ACL in Belfast



```
limerick>
limerick#en
Password:
limerick#conf t
Enter configuration commands, one per line. End with CNTL/Z.
limerick(config)#ip acc
limerick(config)#ip access-list s
limerick(config)#ip access-list standard vty_access
limerick(config-std-nacl)#permit 172.16.3.128 0.0.0.63
limerick(config-std-nacl)#deny any log
^
% Invalid input detected at '^' marker.
limerick(config-std-nacl)#deny any
limerick(config-std-nacl)#ex
limerick(config)#line vty 0 4
limerick(config-line)#acc
limerick(config-line)#access-class vty_access in
limerick(config-line)#ex
% Ambiguous command: "ex"
limerick(config-line)#exit
limerick(config)#
```

Figure 4.2: Configuration of VTY access on the Limerick router using an ACL

Chapter 5

DHCP Configurations

5.1 Configuration of DHCP service for hosts in the Belfast LANs

See the first chapter.

5.2 DHCP services configuration on the Cork Router

```
belfast2(config)#interface g0/1.2
belfast2(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1.2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1.2, changed
state to up
belfast2(config-subif)#ip ad
belfast2(config-subif)#enc
belfast2(config-subif)#encapsulation dot1Q 2
belfast2(config-subif)#ip add 172.16.3.1 255.255.255.128
belfast2(config-subif)#ip h
belfast2(config-subif)#ip hel
belfast2(config-subif)#ip helpe
belfast2(config-subif)#ip helper-address 10.0.0.4
belfast2(config-subif)#no shu
belfast2(config-subif)#no shutdown
belfast2(config-subif)#interface g0/1.3
belfast2(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1.3, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1.3, changed
state to up
belfast2(config-subif)#encapsulation dot1Q 3
belfast2(config-subif)#ip add 172.16.2.1 255.255.255.0
belfast2(config-subif)#ip helper-address 10.0.0.4
belfast2(config-subif)#no shutdown
belfast2(config-subif)#ex
belfast2(config)#interface g0/1.4
belfast2(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1.4, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1.4, changed
state to up
belfast2(config-subif)#ip add 172.16.0.1 255.255.254.0
% Configuring IP routing on a LAN subinterface is only allowed if that
subinterface is already configured as part of an IEEE 802.10, IEEE 802.1Q,
or ISL VLAN.
belfast2(config-subif)#enc
belfast2(config-subif)#encapsulation dot1Q 4
belfast2(config-subif)#ip add 172.16.0.1 255.255.254.0
belfast2(config-subif)#ip helper-address 10.0.0.4
belfast2(config-subif)#no shutdown
belfast2(config-subif)#
belfast2(config-subif)#ex
```

Figure 5.1: Configuring workstations to obtain their IP address automatically



```
Cork
Physical Config CLI Attributes
IOS Command Line Interface

Press RETURN to get started.

cork>
cork>
cork>en
Password:
cork#conf t
Enter configuration commands, one per line. End with CNTL/Z.
cork(config)#ip dhcp
cork(config)#ip dhcp e
cork(config)#ip dhcp excluded-address 172.16.3.1 172.16.3.10
cork(config)#ip dhcp excluded-address 172.16.2.1 172.16.2.10
cork(config)#ip dhcp excluded-address 172.16.0.1 172.16.0.10
cork(config)#
```

Figure 5.2: Configuring DHCP services on the Cork router

5.3 Verification that each VLAN receives its address from DHCP

The following figures show that each VLAN receives its address from the DHCP server.

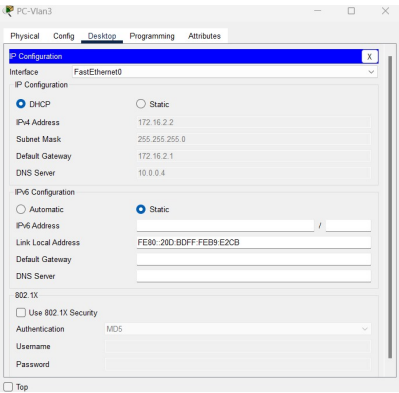


Figure 5.3: PC in VLAN 2

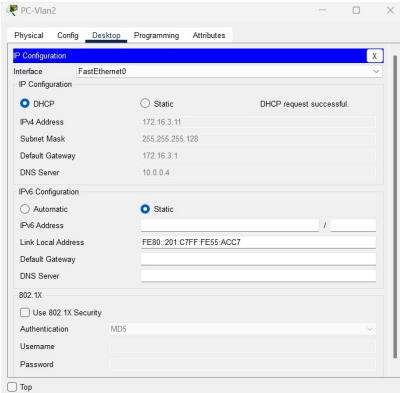


Figure 5.4: PC in VLAN 3

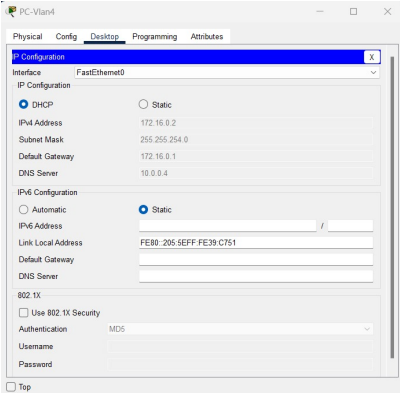


Figure 5.5: PC in VLAN 4

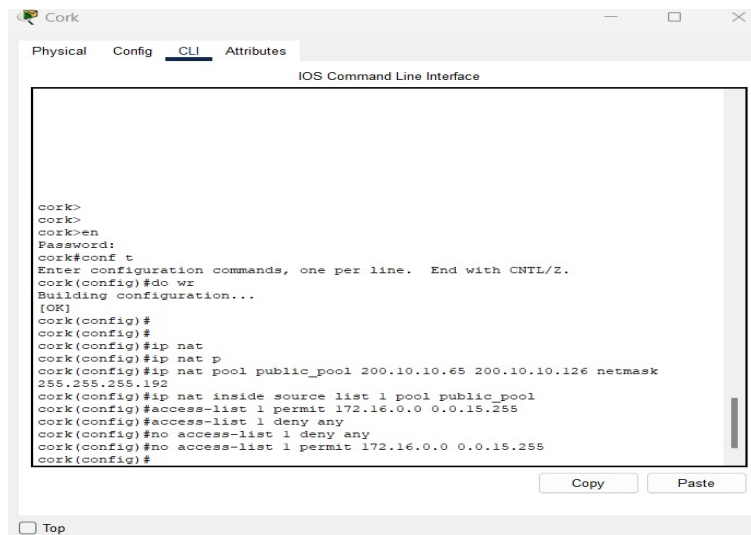
Chapter 6

NAT Configurations

6.1 Configuration of the Cork Router

6.1.1 NAT pool configuration

The pool consists of the public network address 200.10.10.64/26. Exclude the first 10 addresses from this pool (to be used for servers when necessary).

A screenshot of a web-based interface for a device named 'Cork'. The interface has tabs for 'Physical', 'Config', 'CLI', and 'Attributes', with 'CLI' selected. Below the tabs is a title bar 'IOS Command Line Interface'. The main area is a text box containing the following commands:

```
cork>
cork>
cork>en
Password:
cork#conf t
Enter configuration commands, one per line. End with CNTL/Z.
cork(config)#do wr
Building configuration...
[OK]
cork(config)#
cork(config)#
cork(config)#ip nat
cork(config)#ip nat p
cork(config)#ip nat pool public_pool 200.10.10.65 200.10.10.126 netmask
255.255.255.192
cork(config)#ip nat inside source list 1 pool public_pool
cork(config)#access-list 1 permit 172.16.0.0 0.0.15.255
cork(config)#access-list 1 deny any
cork(config)#no access-list 1 deny any
cork(config)#no access-list 1 permit 172.16.0.0 0.0.15.255
cork(config)#
```

At the bottom right of the text box are 'Copy' and 'Paste' buttons. At the bottom left is a 'Top' link.

Figure 6.1: NAT pool configuration

6.1.2 Define an Access Control List (ACL)

To define an ACL that will translate all internal addresses (172.16.0.0/20) and deny all other traffic, we can use the following configuration:

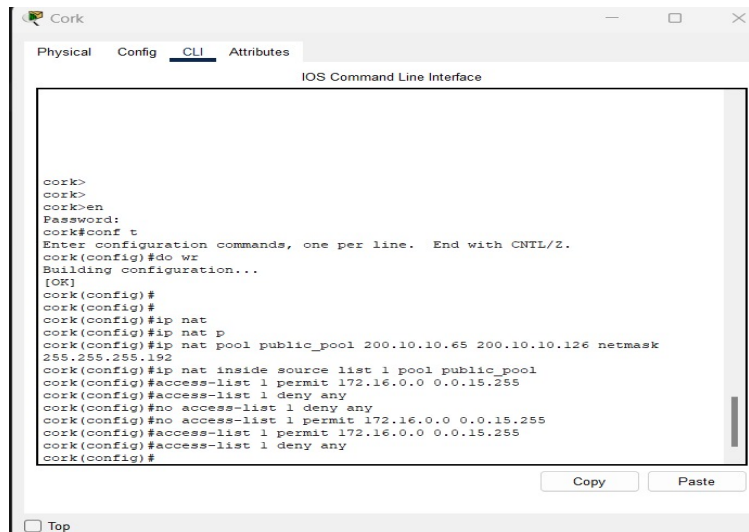


Figure 6.2: Defining the ACL for NAT

6.1.3 Dynamic Source Address Translation (NAT)

This configuration will apply NAT to all traffic from the internal network, translating their source addresses. Any traffic not matching the ACL will be denied.

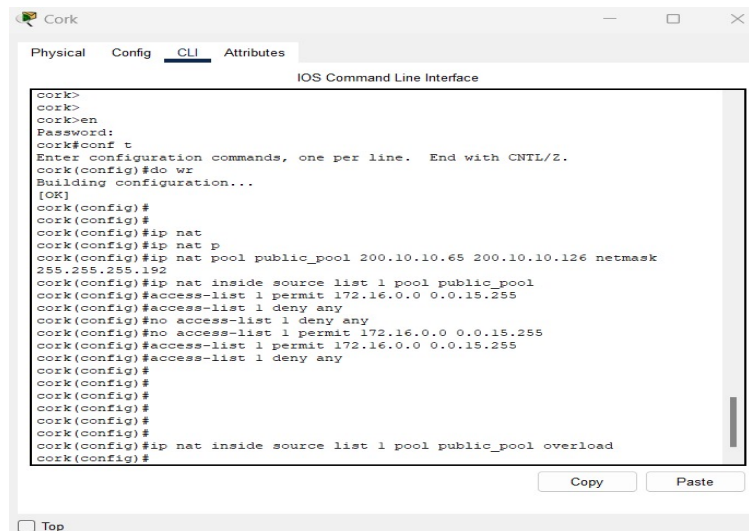


Figure 6.3: Configuring dynamic source NAT with an ACL

6.1.4 Specify the internal and external NAT interfaces

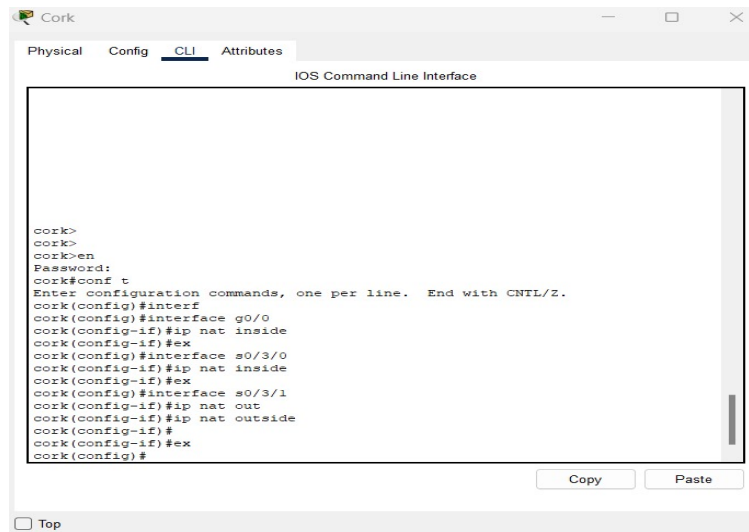


Figure 6.4: Configuring the internal and external NAT interfaces

6.2 Connect a workstation to port Fa0/0 of Belfast to simulate an ISP server

Configure this workstation as follows:

- Configure the IP address
- The subnet mask as 10.0.0.4/29
- Configure the default gateway

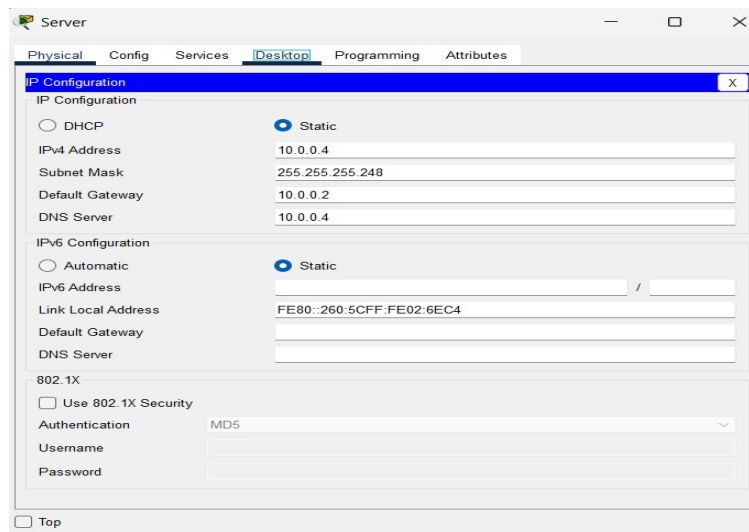


Figure 6.5: Connecting a workstation to simulate an ISP server

6.3 Configure the workstation to act as a web server

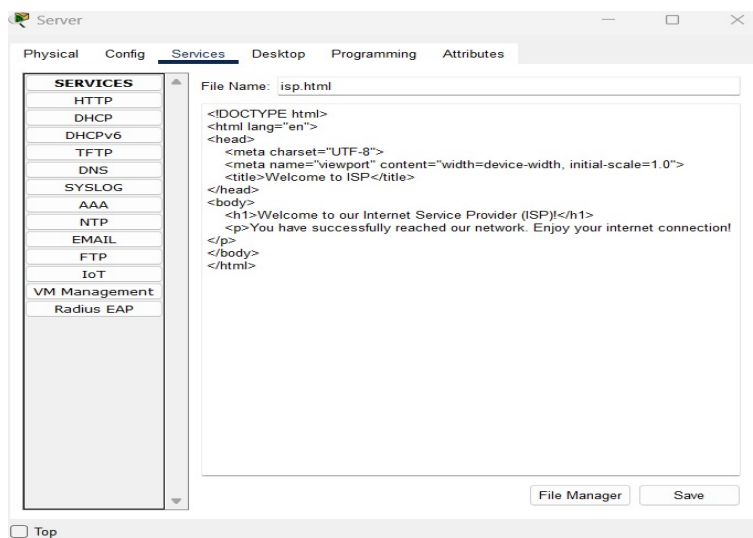


Figure 6.6: Configuring the workstation to act as a web server

Chapter 7

Verification and Testing

7.1 Verify communication between the different hosts on the network

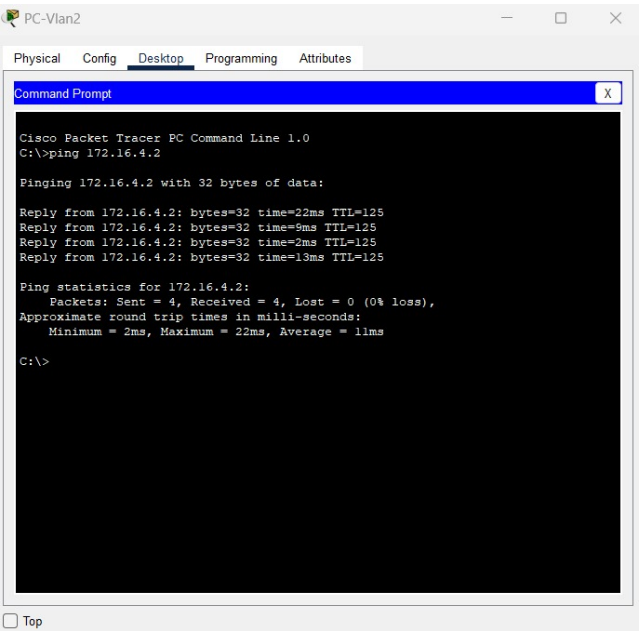


Figure 7.1: Ping between a station in VLAN 2 and a station in the Galway network

Successful	PC-Vlan2	PC-Vlan3	ICMP	0.000	N	0	(edit)	(delete)
Successful	PC-Vlan4	PC-Vlan2	ICMP	0.000	N	1	(edit)	(delete)
Successful	PC-Cork	PC-Vlan2	ICMP	0.000	N	2	(edit)	(delete)
Successful	PC-Vlan4	PC-Galway-Vlan1	ICMP	0.000	N	3	(edit)	(delete)

Figure 7.2: Ping between different stations across the network