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1. Element 1

1.1 Element 1 Introduction

The different types of OSI models i.e., 7- and 4-layer models were researched and analysed with reference to the network design, in addition to encapsulation, broadcasting and port allocation. Element 1 looked into different address classes and an address scheme was created for the network. *Intro briefly summarises the content requirements and indicates an understanding.*

1.2 Research

1.2.1 OSI Models

Figure 1 shows the OSI 7-layer model, all networks should follow this model.

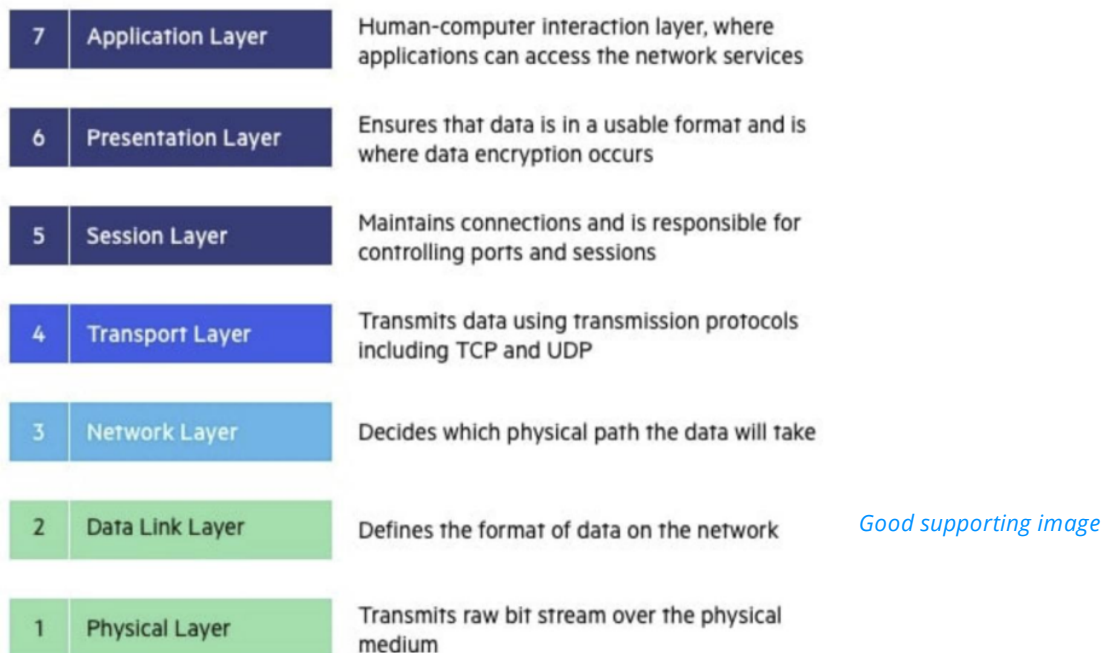


Figure 1: OSI 7-layer Model

The order the layers are followed in is specific and cannot be changed. The top level of the model is application and the bottom layer of the model is the physical layer.

The application layer is used by the end-user software. Applications include e-mail clients and web browsers. The protocol is always the sending and receiving of information and presents meaningful data (Imperva, n.d.). The presentation layer ensures that network communications

are in the same language. It encodes or decodes binary data for transport as well as convert text to ASCII or EBCDIC (Marshall, 2001).

The session layer is where the user would interface with the network to gain access. This manages the connection or session to the network. The transport layer is used as a layer of communication from the higher layers to the network layer. The routing of packets across the network takes place in the 'network' layer. The data link is the layer that would retransmit a packet if one was corrupted. It is responsible for low level error detection. In the physical layer, the transmissions and the definition on how the data is sent over the network takes place (Study Tonight, n.d.). Table 1 shows some of the advantages and disadvantages of the OSI reference model.

Advantages of OSI reference model	Disadvantages of OSI reference model
Distinguishes with high accuracy the services, interfaces and protocols.	Model was devised before the invention of protocols
Protocols are well hidden.	Fitting of protocols is a tedious task
Protocols can be easily replaced or updated with the advancement of technology.	Is just a reference model

Table 1: Advantages and Disadvantages of OSI reference model

An alternative model for IP/TCP is the OSI 4-layer model. The similarity and differences between the two models are shown below in Table 2.

	7-Layer	4-Layer
7	Application	Applications (FTP,SMTP,HTTP,etc.)
6	Presentation	
5	Session	
4	Transport	Transport
3	Network	Internet
2	Data Link	Network access
1	Physical	(usually ethernet)

Table 2: 7-Layer OSI compare to 4-Layer OSI

The OSI reference model had a strong influence on the development of the 4-layer IP/TCP model, hence a crossover of terminology.

The 4-layer model is used for network-to-network communication. The application layer defines the protocol of the IP application and how it will interface with the transport layer to use the network. The transport layer then permits devices onto the source and destination

hosts. The internet layer puts data into data packets known as IP datagrams. This will contain the IP address information. The internet layer allows the host to insert data packets onto the network and deliver them to the required destination. Data packs can arrive in a different order from what they are sent. They are then re-arranged by higher levels so that the correct applications are met (OmniSecu, n.d.). *There is good research carried out for this section*

1.2.2 Encapsulation

Encapsulation refers to the building of data within the models that operate on the data. During the process it either adds information in front of the data (a header) or after the data (a trailer).

It is used to redact the stat or values of a data object to prevent unauthorised parties gaining access (Braunschweig, n.d.). If using a Java programming language there are four types of access modifiers that can be applied to restrict access.

- Private – Can only be accessed by code with the same address
- Protected - Can be accessed by code within the same class, by any classes that are in the same package and by all sub-classes in the same or other packages.
- Public – Least restrictive access, can be accessed and viewed by code within the same or different classes.
- No modifier – Has no access modifier and can be viewed from within the same or from all other classes in the same package.

(Sumo Logic, n.d.)

Decapsulation is the opposite and is required to reverse the effects .It will remove the header or trailer to reveal just the data. Figure 2 shows the process of encapsulation and decapsulation with the data progressing through the different layers.

The encapsulation and decapsulation with reference to adding and subtracting headers and footers is explained.

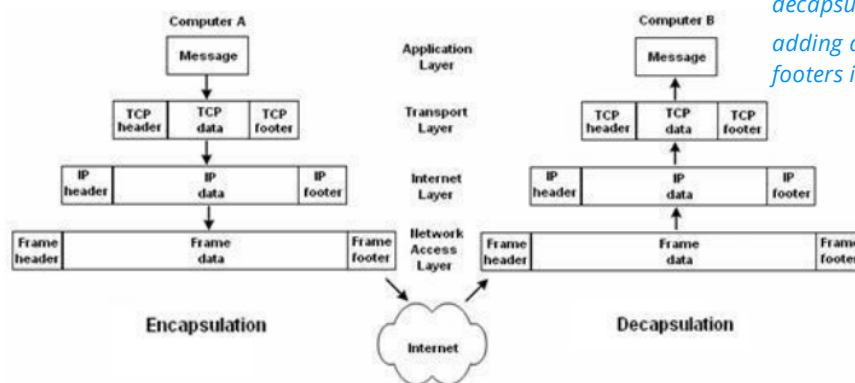
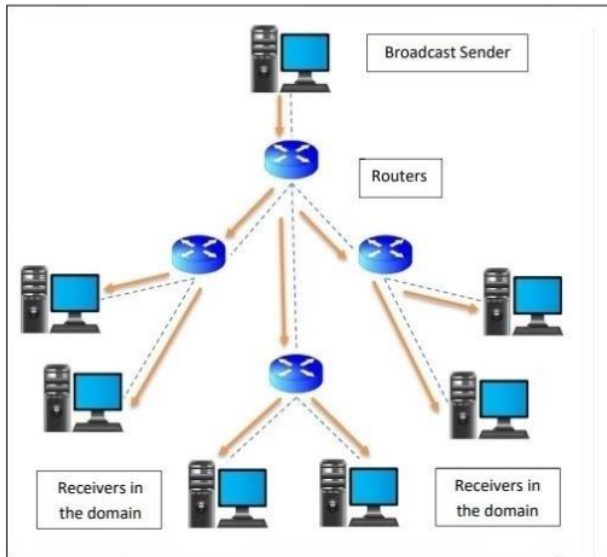


Figure 2: Encapsulation and decapsulation diagram (Network Cyclopedia, 2020)

1.2.3 Broadcasting

Broadcasting is a network group communication where the sender will send data to receivers simultaneously. An example would be one PC sending data to several other PCs across the network through routers and/or switches at the same time as illustrated in Figure 3.



Good supporting image for the explanation given

Figure 3: Network Broadcasting (Moumita, 2019)

Other types of broadcasting are unicast and multicast. A comparison of the purpose of the different types are shown below in Table 3.

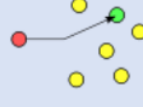
Type	Purpose	Diagram
Broadcast	Send data to all receivers in the network at the same time	
Unicast	Sends data to one receiver in the network	
Multicast	Sends data to a group of receivers in the network	

Table 3: Types of Broadcasts

Whilst broadcast is performed across a LAN (Local Area Network), the majority of LANs are also able to support multicast transmission mode. (Fairhurst, 2020)

Broadcasting is explained and there are some good details. There is significant point that is not included which suggest the re-sizing of domains for more efficient networks.

A weakness of broadcasting is that it is vulnerable to hackers to make a network redundant in denial-of-service attacks. This risk can be reduced by the use of firewalls and correct configuration of routers and switches (US Department of Homeland Security CISA Cyber + Infrastructure, 2019). Broadcasting also cannot handle a large number of devices and the personalisation of messages according to the individual preferences of the devices. However, it does allow for better utilisation of resources and can deliver data in a fast manner in comparison to several unicast communication.

1.2.4 Port Allocation

On a network, a port is the end point of a communication. Each port has software and a protocol assigned to it. They are 1-bit unsigned integer that would range from 0-65535. The first ports, up to 1023, are reserved for services as these are system ports. A list of available common ports is shown in Table 4 (Postel, 1981).

Port number	Assignment
20	File Transfer Protocol (FTP) Data Transfer
21	File Transfer Protocol (FTP) Command Control
22	Secure Shell (SSH) Secure Login
23	Telnet remote login service, unencrypted text messages
25	Simple Mail Transfer Protocol (SMTP) E-mail routing
53	Domain Name System (DNS) service
67, 68	Dynamic Host Configuration Protocol (DHCP)
80	Hypertext Transfer Protocol (HTTP) used in the World Wide Web
110	Post Office Protocol (POP3)
119	Network News Transfer Protocol (NNTP)
123	Network Time Protocol (NTP)
143	Internet Message Access Protocol (IMAP) Management of digital mail
161	Simple Network Management Protocol (SNMP)
194	Internet Relay Chat (IRC)
443	HTTP Secure (HTTPS) HTTP over TLS/SSL

Good example that supports explanation

Table 4: Common Port Assignments

Ports can be controlled when it receives a transmission from a particular network switch. The source of the MAC address is stored in the database of the switch. This is how ports are prevented from being flooded by using the control of the router/switches (Contemporary Control Systems Inc, 2011).

Good research carried out with relevant ref sources

1.3 Element 1 Design Requirements

1.3.1 Address scheme

An Address scheme was configured for class A,B and C addresses for the three LAN networks. They are set out below in Table 5 to Table 7.

Table 5 - 8

Class C Addresses

IP	Application
192.168.2.0	Network Address
192.168.2.254	Gateway
192.168.2.1	First Device Address

Table 5: Class C Address Scheme

Class B Addresses

IP	Application
170.2.0.0	Network Address
170.2.0.254	Gateway
170.2.0.1	First Device Address

Table 6: Class B Address Scheme

Class A Addresses

IP	Application
52.0.0.0	Network Address
52.0.0.254	Gateway
52.0.0.1	First Device Address

Table 7: Class A Address Scheme

Address schematic tables are identified for the three classes of address

Serial Port Addresses

19.0.0.0	10.10.10.1
	10.10.10.2
11.0.0.0	11.0.0.1
	11.0.0.2

Minor error here

Serial addresses are identified

Table 8: Serial Port Addresses

Data packets were then sent between devices to test the configuration with a 100% success rate.

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	PC2	ICMP		0.000	N	0	(edit)	
	Successful	PC0	PC1	ICMP		0.000	N	1	(edit)	
	Successful	PC2	PC1	ICMP		0.000	N	2	(edit)	

This is not all of the test

Figure 4: Address Testing

1.4 Element 1 Implementation

The 3 LANs were interconnected using layer 1,2 and 3 devices. After each implementation, testing was completed on the network, with the results shown in section 1.5 Element 1 Testing and Analysis.

1.4.1 Static routing using static addressing

The network was set up with 3 routers, 3 switches and 3 PCs all with a different class address. The class of address is defined by its IP. The network topology is shown in Figure 5.

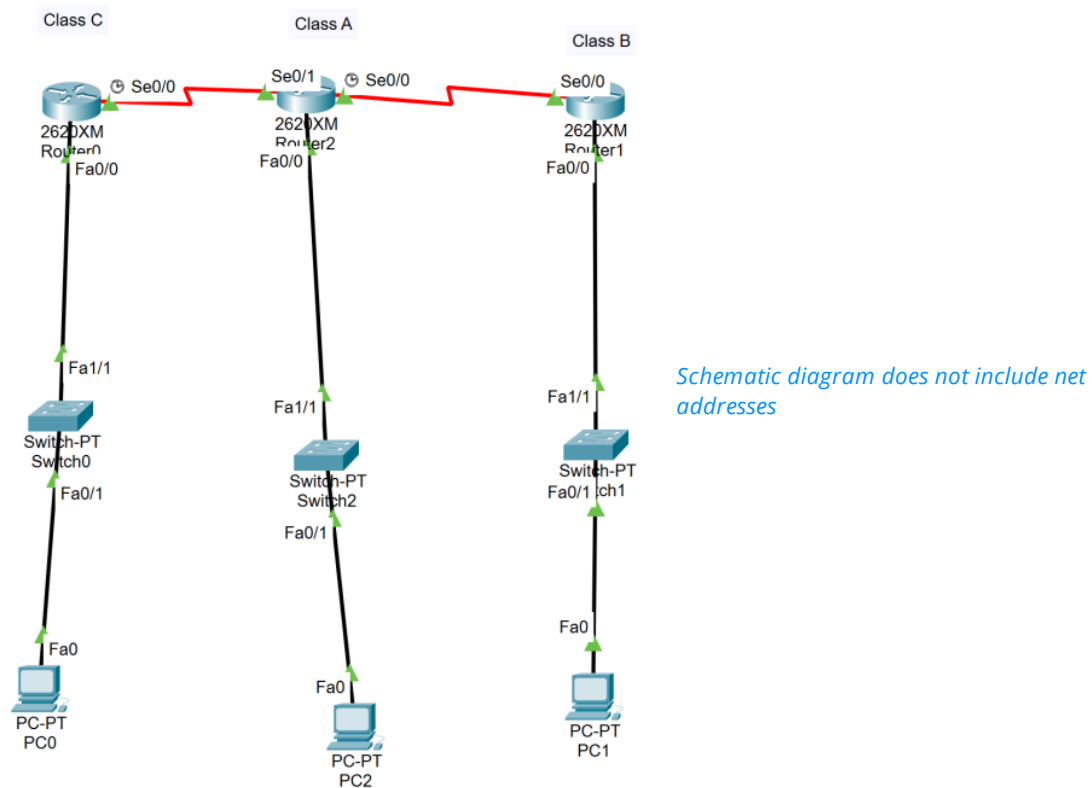


Figure 5: Network Topology

The routers were each set up for static routing addressing as shown in Figure 6 - Figure 8.

Router 1

Router0

Physical

Config

CLI

Attributes

GLOBAL

Settings

Algorithm Settings

ROUTING

Static

RIP

INTERFACE

FastEthernet0/0

Serial0/0

Serial0/1

Static Routes

Network

Mask

Next Hop

Add

Network Address

52.0.0.0/8 via 10.10.10.2

170.2.0.0/16 via 10.10.10.2

Remove

Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, Serial0/0

S 52.0.0.0/8 [1/0] via 10.10.10.2

S 170.2.0.0/16 [1/0] via 10.10.10.2

C 192.168.2.0/24 is directly connected, FastEthernet0/0

Figure 6: Router 0 Static Addressing

Router 1

Network Address

170.2.0.0/16 via 11.0.0.1

192.168.2.0/24 via 10.10.10.1

C 10.0.0.0/8 is directly connected, Serial0/1

C 11.0.0.0/8 is directly connected, Serial0/0

C 52.0.0.0/8 is directly connected, FastEthernet0/0

S 170.2.0.0/16 [1/0] via 11.0.0.1

S 192.168.2.0/24 [1/0] via 10.10.10.1

Figure 7: Router 1 Static Addressing

Router 2

Network Address
192.168.2.0/24 via 11.0.0.2
52.0.0.0/8 via 11.0.0.2

Router 0 evidence is missing

```
C 11.0.0.0/8 is directly connected, Serial0/0
S 52.0.0.0/8 [1/0] via 11.0.0.2
C 170.2.0.0/16 is directly connected, FastEthernet0/0
S 192.168.2.0/24 [1/0] via 11.0.0.2
```

Figure 8: Router 2 Static Addressing

1.4.2 Configure the 3 routers for dynamic routing using RIP (Routing Information Protocol)

Each router was then configured and tested with dynamic routing using RIP routing. This is shown in Figure 9 - Figure 11. Results are shown in Figure 23 in section 1.5 Element 1 Testing and Analysis.

Router 0

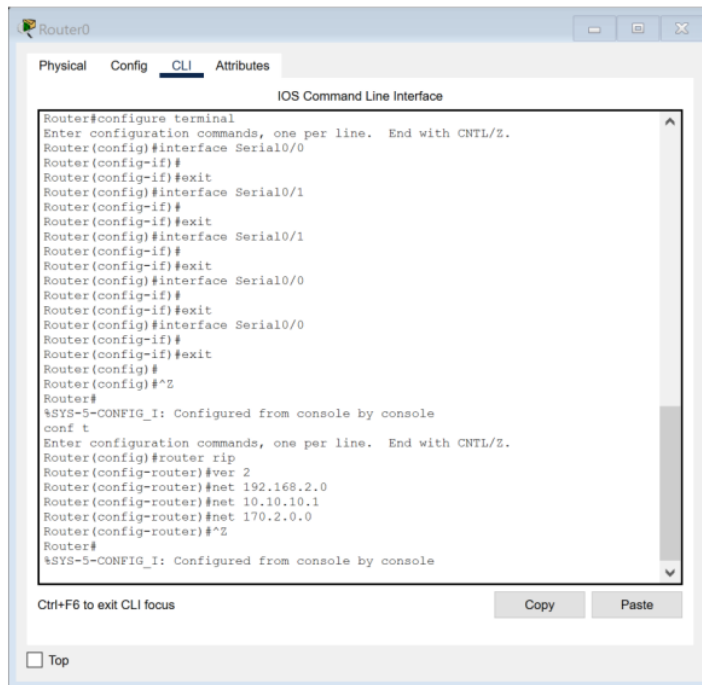


Figure 9: Configuring Router 0 for RIP Routing

Router 1

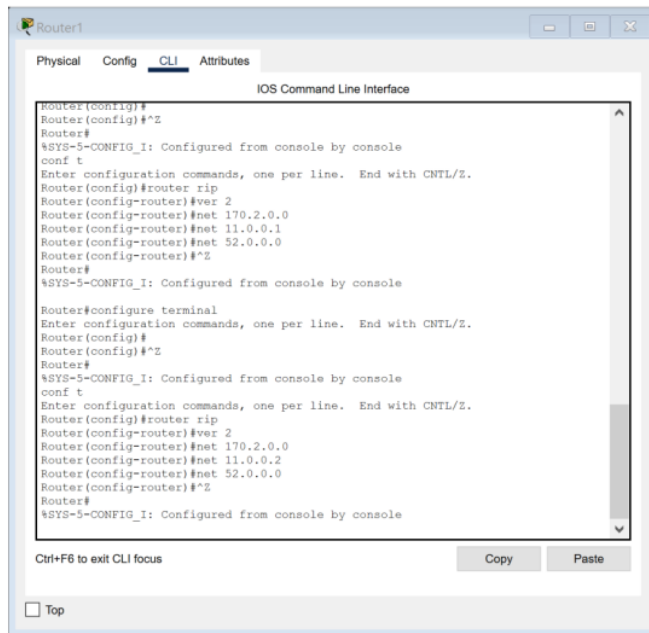
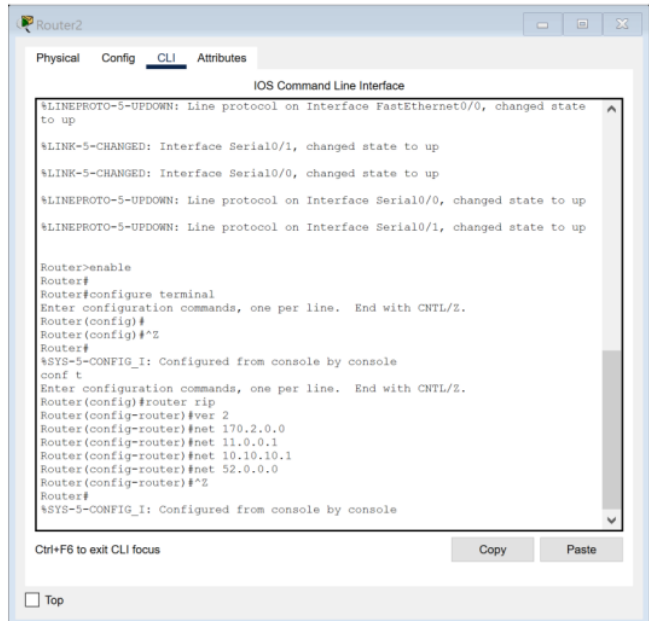


Figure 10: Configuring Router 1 for RIP Routing

Router 2



Router configuration for the address is correct

Figure 11: Configuring Router 2 for RIP Routing

The router RIP tables are shown below in Figure 12 to Figure 14.

Router 0

Routing Table for Router0				
Type	Network	Port	Next Hop IP	Metric
C	10.0.0.0/8	Serial0/0	---	0/0
R	11.0.0.0/8	Serial0/0	10.10.10.2	120/1
R	52.0.0.0/8	Serial0/0	10.10.10.2	120/1
R	170.2.0.0/16	Serial0/0	10.10.10.2	120/2
C	192.168.2.0/24	FastEthernet0/0	---	0/0

Figure 12: Router 0 Routing Table

Router 1

Routing Table for Router1				
Type	Network	Port	Next Hop IP	Metric
R	10.0.0.0/8	Serial0/0	11.0.0.2	120/1
C	11.0.0.0/8	Serial0/0	---	0/0
R	52.0.0.0/8	Serial0/0	11.0.0.2	120/1
C	170.2.0.0/16	FastEthernet0/0	---	0/0
R	192.168.2.0/24	Serial0/0	11.0.0.2	120/2

Figure 13: Router 1 Routing Table

Router 2

Routing Table for Router2				
Type	Network	Port	Next Hop IP	Metric
C	10.0.0.0/8	Serial0/1	---	0/0
C	11.0.0.0/8	Serial0/0	---	0/0
C	52.0.0.0/8	FastEthernet0/0	---	0/0
R	170.2.0.0/16	Serial0/0	11.0.0.1	120/1
R	192.168.2.0/24	Serial0/1	10.10.10.1	120/1

RIP tables show that each router has the routing information

Figure 14: Router 2 Routing Table

The configurations for the routers are shown below in Figure 15 to Figure 22.

Router 0

```
Router>show ip route
Codes: C - connected, S - static, I - IGRP, 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

C    10.0.0.0/8 is directly connected, Serial0/0
R    11.0.0.0/8 [120/1] via 10.10.10.2, 00:00:27, Serial0/0
R    52.0.0.0/8 [120/1] via 10.10.10.2, 00:00:27, Serial0/0
R    170.2.0.0/16 [120/2] via 10.10.10.2, 00:00:27, Serial0/0
C    192.168.2.0/24 is directly connected, FastEthernet0/0

Router>
```

Figure 15: Router 0 RIP configuration

Router 1

```
Router>show ip route
Codes: C - connected, S - static, I - IGRP, 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

R    10.0.0.0/8 [120/1] via 11.0.0.2, 00:00:17, Serial0/0
C    11.0.0.0/8 is directly connected, Serial0/0
R    52.0.0.0/8 [120/1] via 11.0.0.2, 00:00:17, Serial0/0
C    170.2.0.0/16 is directly connected, FastEthernet0/0
R    192.168.2.0/24 [120/2] via 11.0.0.2, 00:00:17, Serial0/0

Router>
```

Ctrl+F6 to exit CLI focus

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Figure 16: Router 1 RIP configuration

Router

2

```
Router(config)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console
show ip route_
Codes: C - connected, S - static, I - IGRP, 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

C    10.0.0.0/8 is directly connected, Serial0/1
C    11.0.0.0/8 is directly connected, Serial0/0
C    52.0.0.0/8 is directly connected, FastEthernet0/0
R    170.2.0.0/16 [120/1] via 11.0.0.1, 00:00:04, Serial0/0
R    192.168.2.0/24 [120/1] via 10.10.10.1, 00:00:29, Serial0/1

Router#
```

Ctrl+F6 to exit CLI focus

Copy Paste

☐ Top

*Reports from
routers confirm
config in routers*

Figure 17: Router 2 RIP configuration

1.4.3 Dynamic addressing across networks using DHCP

Router R0 was configured as the control router and routers R1 and R2 were configured without the helper address for dynamic addressing using DHCP. Router R0 configuration is shown in Figure 18.

Key point has been explained

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip dhcp pool net1
Router(dhcp-config)#net 192.168.2.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.2.254
Router(dhcp-config)#dns-server 192.168.2.254
Router(dhcp-config)#exit
Router(config)#ip dhcp pool net 2
      ^
% Invalid input detected at '^' marker.

Router(config)#ip dhcp pool net2
Router(dhcp-config)#52.0.0.0 255.0.0.0
      ^
% Invalid input detected at '^' marker.

Router(dhcp-config)#net 52.0.0.0 255.0.0.0
Router(dhcp-config)#default-router 52.0.0.254
Router(dhcp-config)#dns-server 52.0.0.254
Router(dhcp-config)#exit
Router(config)#ip dhcp net3
      ^
% Invalid input detected at '^' marker.

Router(config)#ip dhcp pool net3
Router(dhcp-config)#net 170.2.0.0 255.255.0.0
Router(dhcp-config)#default-router 170.2.0.254
Router(dhcp-config)#dns-server 170.2.0.254
Router(dhcp-config)#exit
Router(config)#
```

DHCP is configured

Ctrl+F6 to exit CLI focus

Copy

Paste

Figure 18: Router R0 configuration

DCHP Helper address for router 1 and 2

Routers 1 and 2 were then configured with IP Helper for cross-network communication.

```
en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int f0/0
Router(config-if)#ip helper-address 10.10.10.1
      ^
% Invalid input detected at '^' marker.

Router(config-if)#ip helper-address 10.10.10.1
Router(config-if)#exit
Router(config)#
```

Figure 19: Router 1 with IP helper

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int f0/0
Router(config-if)#ip helper-address 10.10.10.1
Router(config-if)#exit
Router(config)#

```

Helper addresses are set for remote routers

Figure 20: Router 2 with IP helper

The results are shown in Figure 27 and Figure 28.

Address Exclusion

Address exclusion was then set up using router R0 as the control device as shown in Figure 21.

```

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#dhcp excluded-address 192.168.2.10
      ^
% Invalid input detected at '^' marker.

Router(config)#ip dhcp excluded-address 192.168.2.10
      ^
% Invalid input detected at '^' marker.

Router(config)#ip dhcp excluded-address 192.168.2.10
Router(config)#ip dhcp excluded-address 52.0.0.10 52.0.0.10
Router(config)#ip dhcp excluded-address 192.168.2.1 192.168.2.10
Router(config)#ip dhcp excluded-address 170.2.0.1 170.2.0.10
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

```

Address exclusions are configured

```

Router(config)#ip dhcp excluded-address 52.0.0.1 52.0.0.10
Router(config)#

```

Figure 21: Router 0 configuration with address exclusion

Testing of the dynamic IP routing is shown in Figure 29 to Figure 31.

1.5 Element 1 Testing and Analysis

1.5.1 Static Routing

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	PC2	ICMP		0.000	N	0	(edit)	(delete)
	Successful	PC0	PC1	ICMP		0.000	N	1	(edit)	(delete)
	Successful	PC1	PC0	ICMP		0.000	N	3	(edit)	(delete)
	Successful	PC2	PC0	ICMP		0.000	N	4	(edit)	(delete)

Figure 22: Static Routing Test Results

Figure 22 shows the static routing testing with a 100% success rate. This proves that all devices can communicate across the network with other class addressing.

1.5.2 Dynamic Routing using RIP Routing

PDU List Window										
Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	PC1	ICMP		0.000	N	0	(edit)	
	Successful	PC0	PC2	ICMP		0.000	N	1	(edit)	
	Successful	PC2	PC0	ICMP		0.000	N	2	(edit)	
	Successful	PC2	PC1	ICMP		0.000	N	3	(edit)	
	Successful	PC1	PC2	ICMP		0.000	N	4	(edit)	
	Successful	PC1	PC0	ICMP		0.000	N	5	(edit)	

Figure 23: RIP Routing Test Results

Figure 23 shows the successful test results for RIP Routing.

1.5.3 Dynamic addressing across networks using DHCP

The PC address was looked at for the 3 PCs on the network to see if they had been set dynamically by the routers.

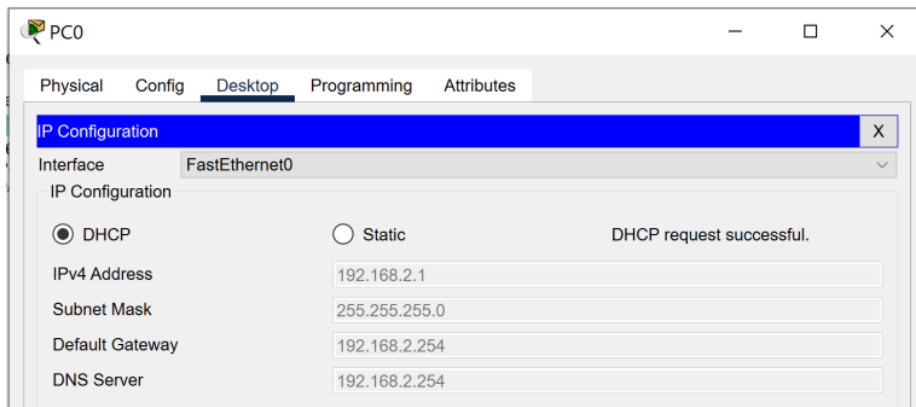


Figure 24: PC 0 which uses router R1

Figure 24 shows the address configuration 2 was set dynamically.

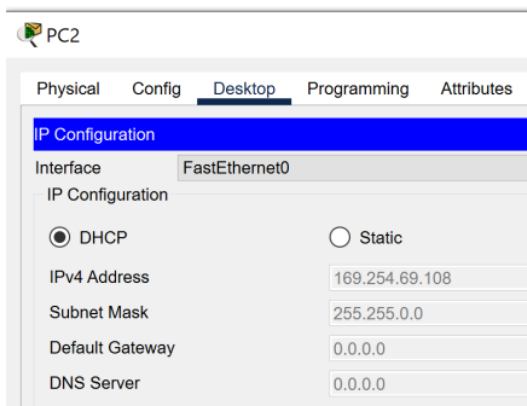
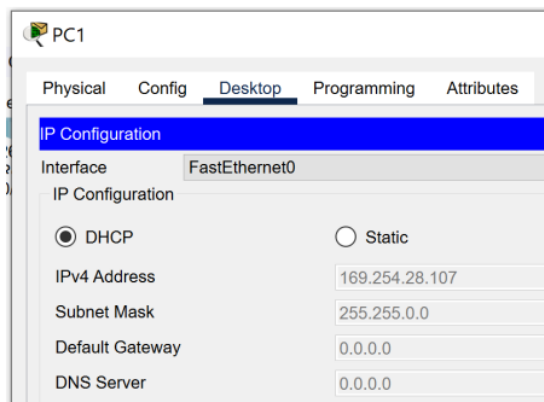


Figure 25: Device PC2 – Without IP Helper



Results prove the problem without helper address. This is also explained

Figure 26: Device PC1 - Without IP Helper

The address configuration was not set correctly for PC2 (Figure 25) and PC1 (Figure 26) and a default address is set. This is due to the router needing the helper address to transmit over the network. The helper address is the control router serial port address.

DCHP IP Helper address for router 1 and 2

The test shows that devices PC1 and PC2 on routers 1 and 2 were now configured dynamically.

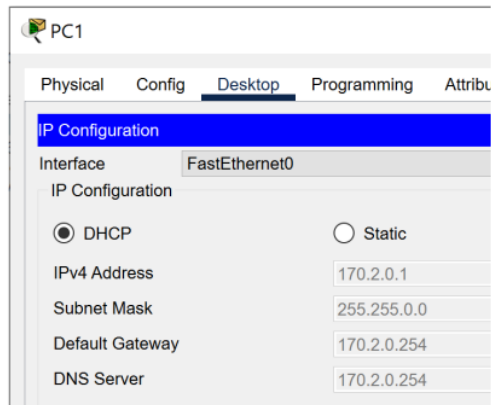


Figure 27: Device PC1 – IP Helper Address

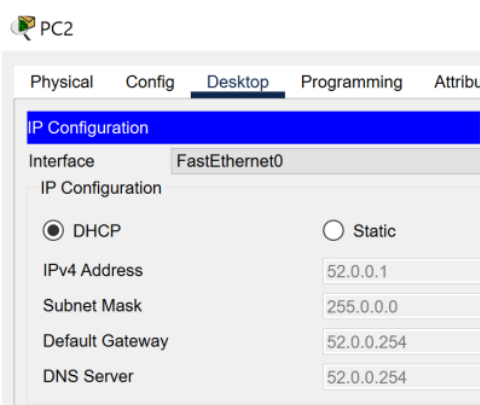


Figure 28: Device PC2 – IP Helper Address

Results prove the helper addresses solve the problem

Address Exclusion

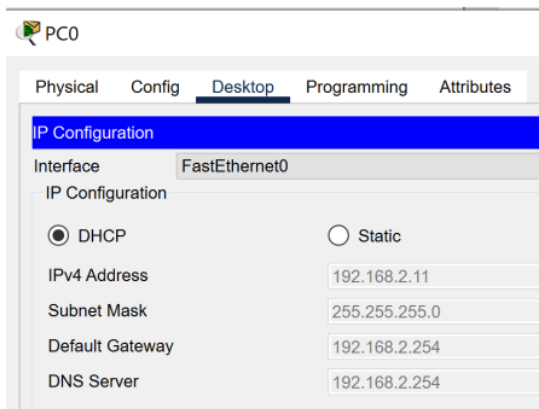


Figure 29: Device PC0 – Address Exclusion

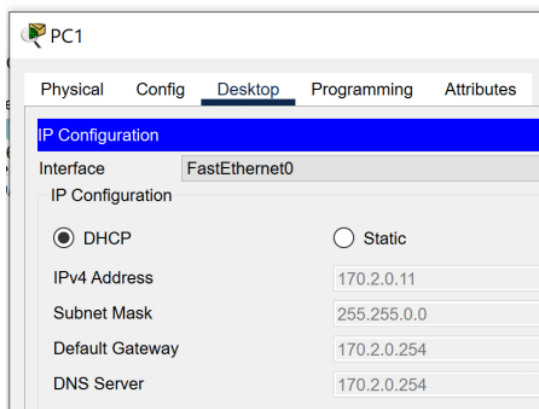


Figure 30: Device PC1 – Address Exclusion

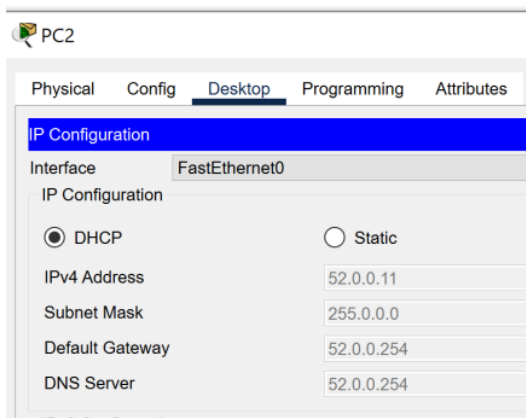


Figure 31: Device PC2 – Address Exclusion

Test proves exclusion addresses and this is also explained.

Figure 29 to Figure 31 demonstrate that the test proves the excluded addresses from 1 to 10 in each LAN was successful. This means that addresses for specific controllers can be kept static and not be affected by the DHCP dynamic addressing protocol.

A configuration test was then run on the three routers. This configuration can be seen in Figure 32 to Figure 34.

Router 0

```
Router>en
Router#show run
Building configuration...

Current configuration : 1167 bytes

version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
hostname Router
ip dhcp excluded-address 192.168.2.10
ip dhcp excluded-address 52.0.0.10
ip dhcp excluded-address 192.168.2.1 192.168.2.10
ip dhcp excluded-address 170.2.0.1 170.2.0.10
ip dhcp excluded-address 52.0.0.1 52.0.0.10

ip dhcp pool net1
network 192.168.2.0 255.255.255.0
default-router 192.168.2.254
dns-server 192.168.2.254
ip dhcp pool net2
network 52.0.0.0 255.0.0.0
default-router 52.0.0.254
dns-server 52.0.0.254
ip dhcp pool net3
network 170.2.0.0 255.255.0.0
default-router 170.2.0.254
dns-server 170.2.0.254

no ip cef
no ipv6 cef

interface FastEthernet0/0
ip address 192.168.2.254 255.255.255.0
duplex auto
speed auto

interface Serial0/0
ip address 10.10.10.1 255.0.0.0
```

```
clock rate 64000

interface Serial0/1
no ip address
clock rate 2000000
shutdown

router rip
version 2
network 10.0.0.0
network 170.2.0.0
network 192.168.2.0

ip classless

ip flow-export version 9
line con 0

line aux 0

line vty 0 4
login

end
```

Figure 32: Router 0 Running Configuration

Router 1

```
Router>en
Router#show run
Building configuration...

Current configuration : 674 bytes

version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption

hostname Router

no ip cef
no ipv6 cef

interface FastEthernet0/0
ip address 52.0.0.254 255.0.0.0
ip helper-address 10.10.10.1
duplex auto
speed auto
```

```
interface Serial0/0
ip address 11.0.0.2 255.0.0.0
clock rate 2000000

interface Serial0/1
ip address 10.10.10.2 255.0.0.0

router rip
version 2
network 10.0.0.0
network 11.0.0.0
network 52.0.0.0
network 170.2.0.0

ip classless

ip flow-export version 9

line con 0

line aux 0

line vty 0 4
login

end
```

Figure 33: Router 1 Running Configuration

Router 2

```
Router>en
Router#show run
Building configuration...

Current configuration : 651 bytes

version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption

hostname Router

no ip cef
no ipv6 cef

interface FastEthernet0/0
```

```
ip address 170.2.0.254 255.255.0.0
ip helper-address 10.10.10.1
duplex auto
speed auto

interface Serial0/0
ip address 11.0.0.1 255.0.0.0

interface Serial0/1
no ip address
clock rate 2000000
shutdown

router rip
version 2
network 11.0.0.0
network 52.0.0.0
network 170.2.0.0

ip classless

ip flow-export version 9

line con 0

line aux 0

line vty 0 4
login

end
```

Router reports show all the configurations made for the routers

Figure 34: Router 2 Running Configuration

1.6 Evaluation

All tests were successful with the set-up of static and dynamic routing including RIP routing and IP address exclusion with evidence supporting this from packet data tests and from the CLI of the routers.

This should have more relevant detail

2. Element 2

2.1 Element 2 Introduction

Element 2 looked at a network with class C addresses covering 6 subnetworks. The networks were configured and tested with a CIDR/28 scheme from a single class C network. The network was subsequently improved by implementing a Variable Length Subnet Mask with CIDR/27 covering networks 1, 2 and 3. CIDR/30 covered networks 4, 5 and 6. The network diagram is shown below in Figure 35.

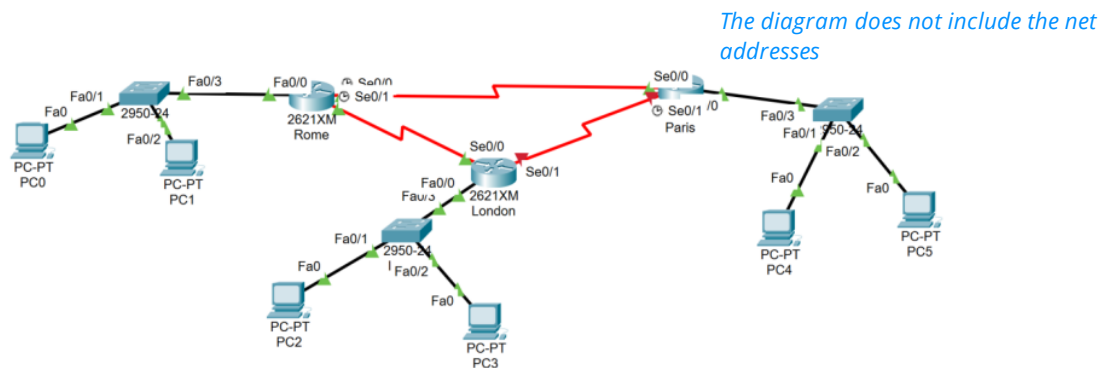


Figure 35: Network Diagram

2.2 Element 2 System Configuration Requirements

The network was set up using CIDR/28 subnetting before being improved by using VLSM routing with CIDR/27 and CIDR/30. The differences are shown below in Table 9.

CIDR	SUBNET MASK	# OF IP ADDRESSES	# OF USABLE IP ADDRESSES
/30	255.255.255.252	4	2
/28	255.255.255.240	16	14
/27	255.255.255.224	32	30

Informative table of usable net addresses

Table 9: CIDR Class (Koishigawa, 2021)

2.2.1 CIDR/28 Subnetting

Different subnets were set up with LANs 1-3 using CIDR/28 (Table 10 to Table 12) and WANs 4-6 (Wide area network) The WANs are shown in Table 13 to Table 15.

LAN Networks 1-3

Subnet is identified

CIDR/28 – London – Network 3 – LAN Address 16										
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
Network Address	0	0	0	1	0	0	0	0	Network Address	192.168.2.16
Net Address 16	0	0	0	1	0	0	0	1	Lowest host address 17	192.168.2.17
Net Address 16	0	0	0	1	0	0	1	0	Next host address 18	192.168.2.18
Default gateway	0	0	0	1	1	1	1	0	FastEthernet 0/0 address 30	192.168.2.30
Broadcast	0	0	0	1	1	1	1	1	Broadcast 31	192.168.2.31

Table for .16 is correct

Table 10: CIDR/28 London Addresses LAN

CIDR/28 – Rome – Network 1 – LAN Address 32										
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
Network Address	0	0	1	0	0	0	0	0	Network Address	192.168.32
Net Address 32	0	0	1	0	0	0	0	1	Lowest host address 33	192.168.2.33
Net Address 32	0	0	1	0	0	0	1	0	Next host address 34	192.168.2.34
Default gateway	0	0	1	0	1	1	1	0	FastEthernet 0/0 address 46	192.168.2.46
Broadcast	0	0	1	0	1	1	1	1	Broadcast 47	

Table for .32 is correct

Table 11: CIDR/28 Rome Addresses LAN

CIDR/28 – Paris – Network 2 – LAN Address 48										
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
Network Address	0	0	1	1	0	0	0	0	Network Address	192.168.2.48
Net Address 48	0	0	1	1	0	0	0	1	Lowest host address 49	192.168.2.49
Net Address 48	0	0	1	1	0	0	1	0	Next host address 50	192.168.2.50
Default gateway	0	0	1	1	1	1	1	0	FastEthernet 0/0 address 62	192.168.2.62
Broadcast	0	0	1	1	1	1	1	1	Broadcast 63	

Table for .48 is correct

Table 12: CIDR/28 Paris Addresses LAN

WAN Networks 4-6

London – Rome Network 6 Network address 64										
London Router	0	1	0	0	1	1	0	1	Serial 0/0 address 77	192.168.2.77
Rome Router	0	1	0	0	1	1	1	0	Serial 0/1 address 78	192.168.2.78

Serial port
addresses are
correct for .64

Table 13: CIDR/28 London – Rome WAN

Rome – Paris Network 4-Network address 80										
Paris Router	0	1	0	1	1	1	0	1	Serial 0/0 address 93	192.168.2.93
Rome Router	0	1	0	1	1	1	1	0	Serial 0/0 address 94	192.168.2.94

Table correct
for .80

Table 14: CIDR/28 Rome – Paris WAN

Paris –London Network 5 Network address 96										
Paris Router	0	1	1	0	1	1	0	1	Serial 0/1 address 109	192.168.2.109
London Router	0	1	1	0	1	1	1	0	Serial 0/1 address 110	192.168.2.110

Table correct
for .96

Table 15: CIDR/28 Paris - London WAN

2.2.2 CIDR/27 and CIDR/30 Subnetting

The network was then configured using CIDR/27 and CIDR/30 Subnetting.

CIDR/27 Networks 1-3

Subnet is identified

CIDR/27 – Networks 1, 2 and 3									
Subnet mask	1	1	1	0	0	0	0	255.255.255.224	
	0	0	0	0	0	0	0	Not used	
Network Address	0	0	1	0	0	0	0	Network Address	192.168.2.32
Dev 1	0	0	1	0	0	0	1	Lowest Host Address 33 Rome 1	192.168.2.33
Dev 2	0	0	1	0	0	0	1	Next Host Address 34 Rome 2	192.168.2.34
Gateway	0	0	1	1	1	1	0	Gateway Address Rome	192.168.2.62
Broadcast	0	0	1	1	1	1	1	Highest Router Address 62 Rome Router	192.168.2.63
Network Address	0	1	0	0	0	0	0	Network Address	192.168.2.64
Dev 1	0	1	0	0	0	0	1	Lowest Host Address 65 London 1	192.168.2.65
Dev 2	0	1	0	0	0	0	1	Next Host Address 66 London 2	192.168.2.66
Gateway	0	1	0	1	1	1	0	Highest Router Address 94 London Router	192.168.2.94
Broadcast	0	1	0	1	1	1	1	Broadcast Address 95 London	192.168.2.95
Network Address	0	1	1	0	0	0	0	Network Address	192.168.2.96
Dev 1	0	1	1	0	0	0	1	Lowest Host Address 97 Paris 1	192.168.2.97
Dev 2	0	1	1	0	0	0	1	Next Host Address 98 Paris 2	192.168.2.98
Gateway	0	1	1	1	1	1	0	Highest Router Address 126 Paris Router	192.168.2.126
Broadcast	0	1	1	1	1	1	1	Broadcast Address 127 Paris	192.168.2.127

Table correct for .32

Table correct for .64

Table correct for .96

Table 16: CIDR/27 Addresses for networks 1-3

CIDR/30 Networks 4-6

Subnet is identified

CIDR/30 – Networks 4, 5 and 6.									
Subnet mask	1	1	1	1	1	1	0	255.255.255.252	
	0	0	0	0	0	0	0	Not used	
Net Address 4	0	0	0	0	0	1	0	Lowest interface Address 5 Rome serial 0/0	192.168.2.5
Net Address 4	0	0	0	0	0	1	1	Highest interface Address 6 Paris serial 0/0	192.168.2.6
Net Address 8	0	0	0	0	1	0	0	Lowest interface Address 9 Rome serial 0/1	192.168.2.9
Net Address 8	0	0	0	0	1	0	1	Highest interface Address 10 London serial 0/0	192.168.2.10
Net Address 12	0	0	0	0	1	1	0	Lowest interface Address 13 London serial 0/1	192.168.2.13
Net Address 12	0	0	0	0	1	1	1	Highest interface Address 14 Paris serial 0/1	192.168.2.14

Correct for .4

Correct for .8

Correct for .12

Table 17: CIDR/30 Addresses for networks 4-6

Table are correct for address configurations

2.3 Element 2 Implementation

After the configurations, tests were carried out and results can be found in section 2.4 Element 2 Testing and analysis.

2.3.1 CIDR/28 Subnetting

Figure 36 shows the network and routing table for subnet mask CIDR/28. Figure 37 to Figure 39 shows the configuration of the routers.

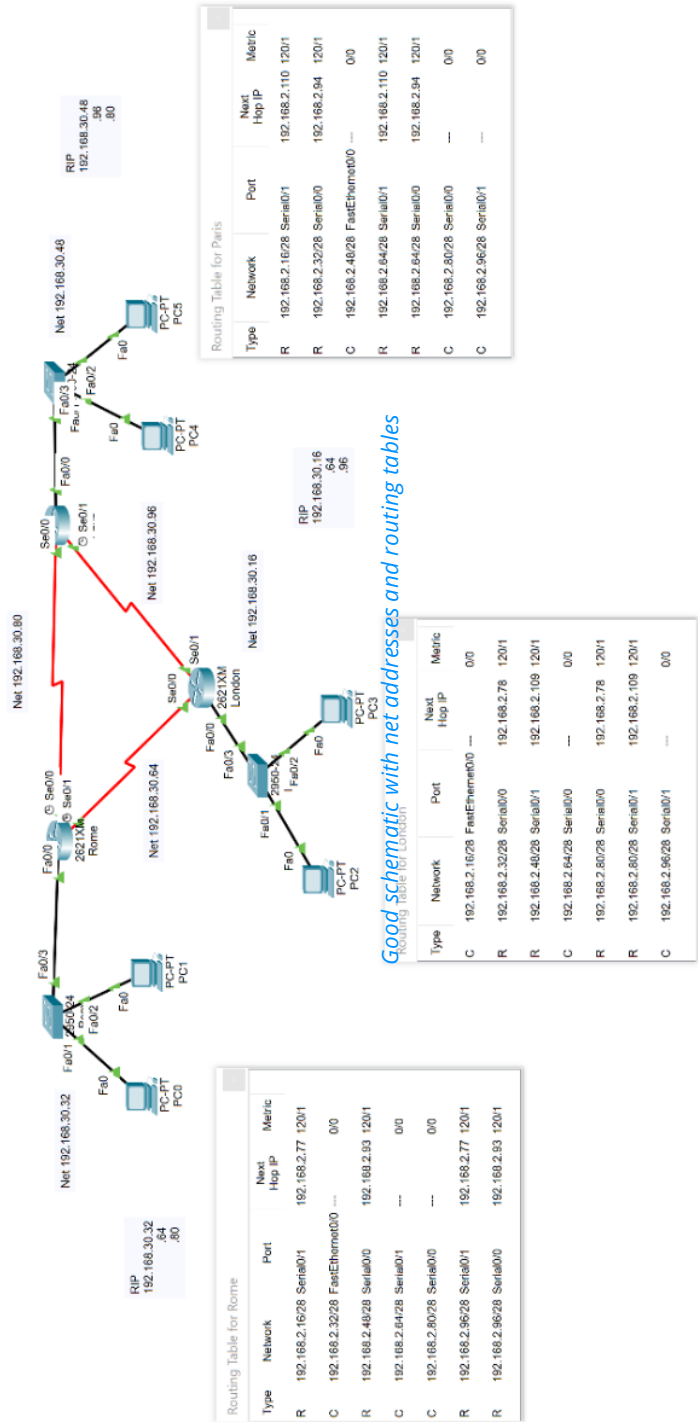


Figure 36: CIDR/28 Network and Routing Tables

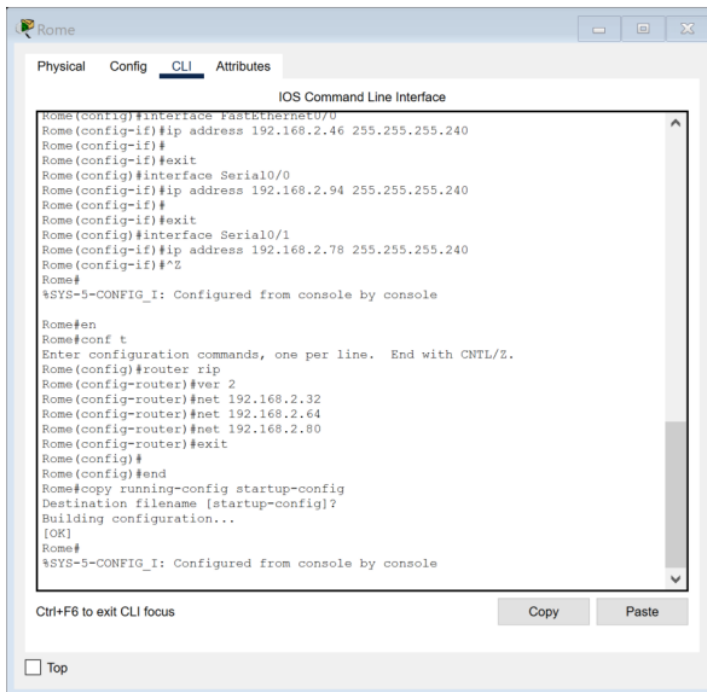


Figure 37: CIDR/28 Rome RIP Routing

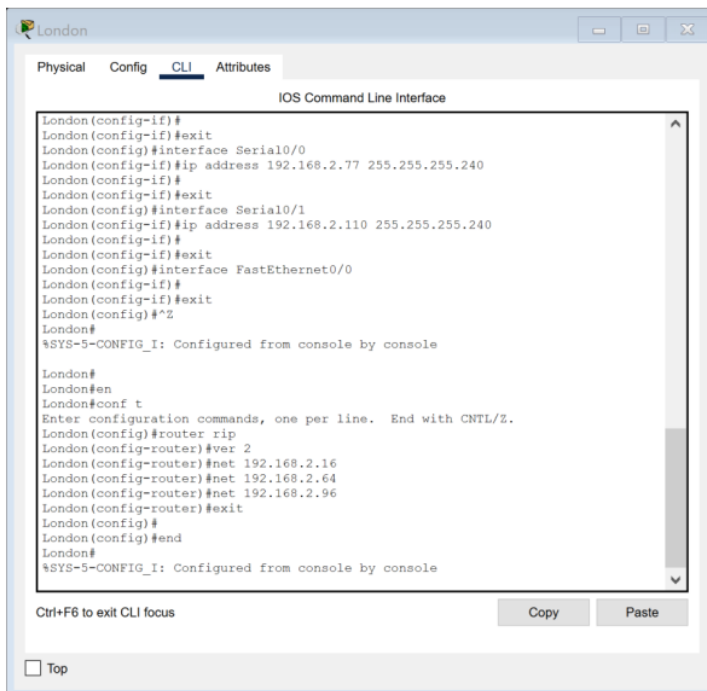
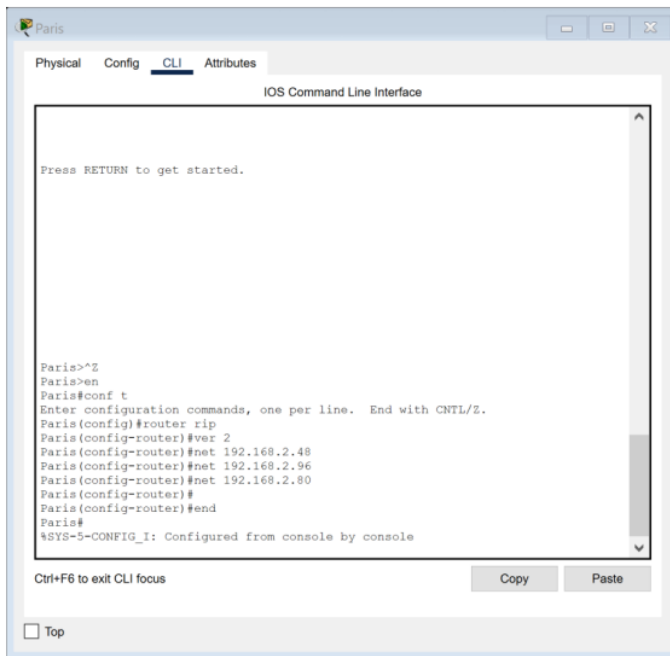


Figure 38: CIDR/28 London RIP Routing



RIP routing configuration is implemented

Figure 39: CIDR/28 Paris RIP Routing

The router running configurations are shown in 2.6.1 Element 2 Appendix 1.

2.3.2 CIDR/27 and CIDR/30 Subnetting

The RIP routing was set up below as shown in Figure 40 to Figure 42.

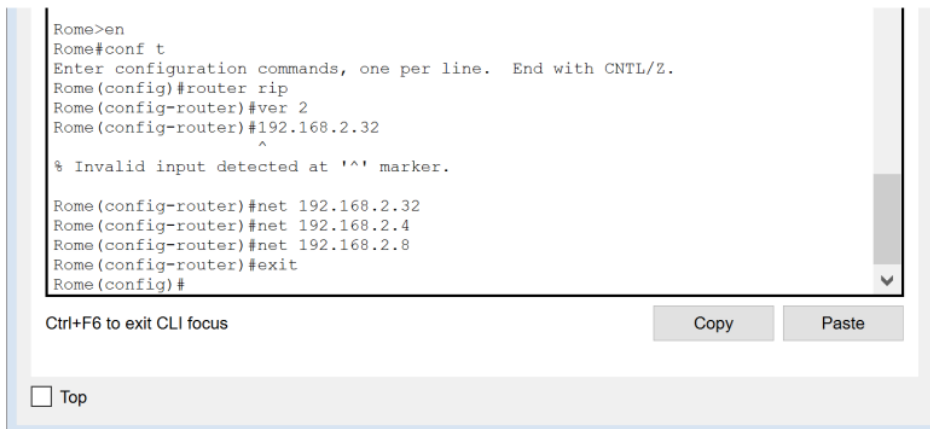


Figure 40: CIDR/27 RIP Routing Rome

```
London>enable
London#
London#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
London(config)#
London(config)#
London(config)#router rip
London(config-router)#ver 2
London(config-router)#net 192.168.2.64
London(config-router)#net 192.168.2.4
London(config-router)#net 192
^
% Invalid input detected at '^' marker.

London(config-router)#
London(config-router)#router rip
London(config-router)#ver 2
London(config-router)#net 192.168.2.64
London(config-router)#net 192.168.2.8
London(config-router)#net 192.168.2.12
London(config-router)#exit
London(config)#
```

Ctrl+F6 to exit CLI focus

Copy Paste

☐ Top

Figure 41: CIDR/27 RIP Routing London

This should be explained because this should update automatically.

```
Paris>enable
Paris#
Paris#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Paris(config)#
Paris(config)#
Paris(config)#router rip
Paris(config-router)#ver 2
Paris(config-router)#net 192.168.2.96
Paris(config-router)#net 192.168.2.4
Paris(config-router)#net 192.168.2.12
Paris(config-router)#exit
Paris(config)#
```

Ctrl+F6 to exit CLI focus

Copy Paste

☐ Top

Figure 42: CIDR/27 RIP Routing Paris

The router running configurations are shown in section 2.6.2 Element 2 Appendix 2. Below in Figure 43 shows the network with CIDR/27 and CIDR/30 subnetting with routing tables displayed.

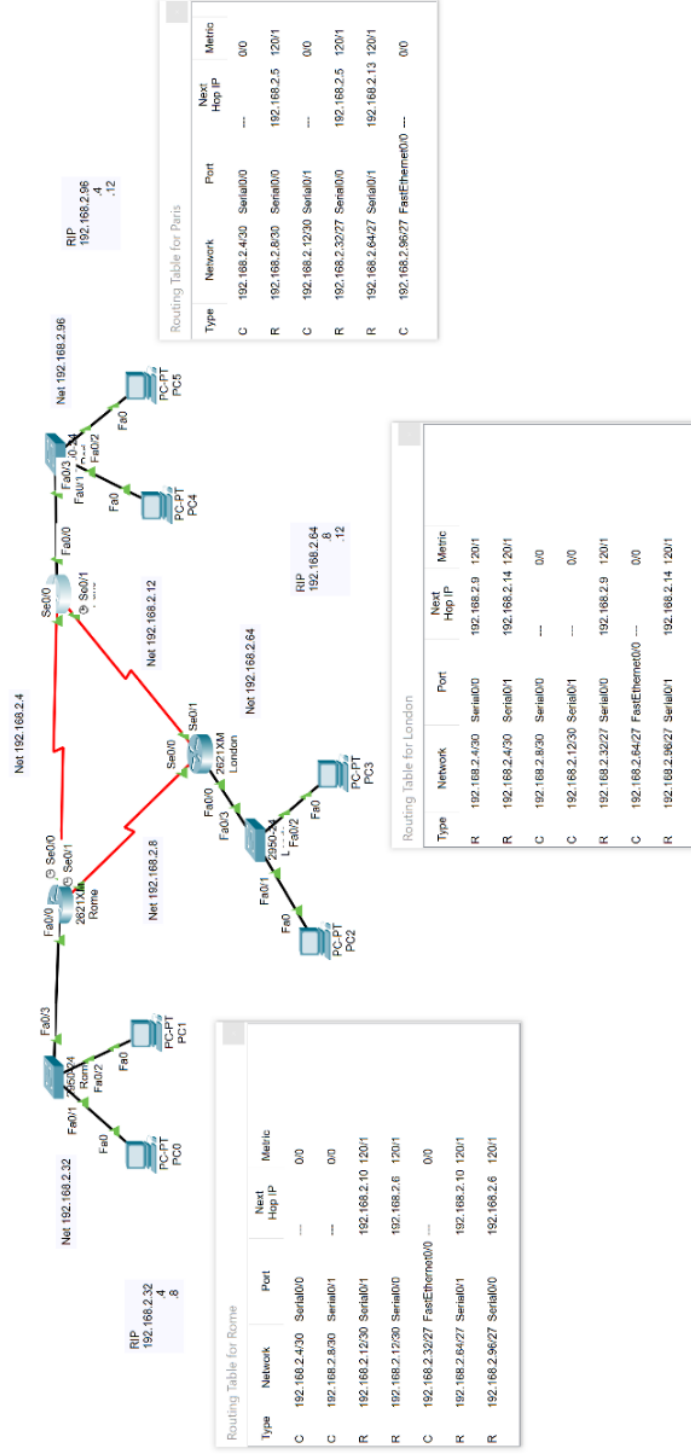


Figure 43: CIDR/27 and CIDR/30 Network and Routing Table

2.3.3 Virtual Local Area Network (VLAN)

A VLAN is a virtual area network. Its purpose is that it can host several networks virtually to work as one LAN. VLANs can reduce broadcast traffic and allow devices to be grouped into the same network even if not physically connected to the same switch. Ports are assigned to VLANs through the command line interface (CLI).

A very good significant point. VLANs do have this purpose to limit broadcast domains

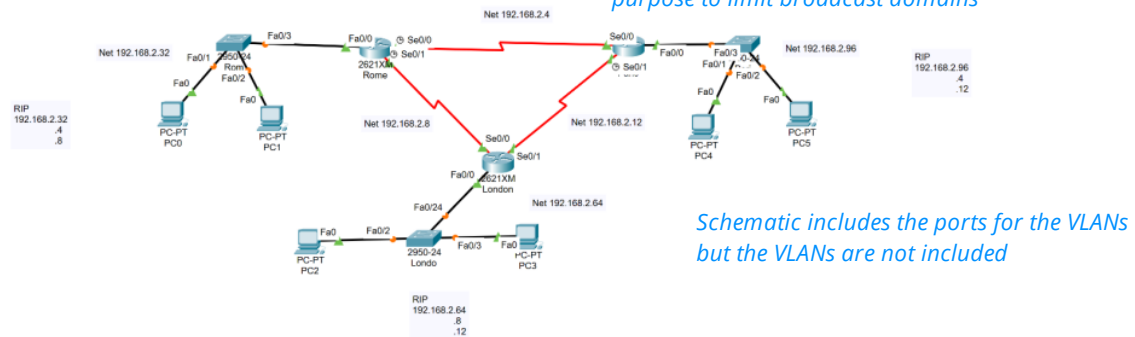


Figure 44: VLAN Network Diagram

Figure 45 below shows the VLAN set up using the CLI.

```
London>en
London#conf t
Enter configuration commands, one per line. End with CNTL/Z.
London(config)#vlan 2
London(config-vlan)#name vlan2
London(config-vlan)#exit
London(config)#vlan 3
London(config-vlan)#name vlan3
London(config-vlan)#exit
London(config)#^Z
London#
%SYS-5-CONFIG_I: Configured from console by console
en
London#show vlan

VLAN Name Status Ports
-----
1 default active Fa0/1, Fa0/2, Fa0/3, Fa0/4
Fa0/5, Fa0/6, Fa0/7, Fa0/8
Fa0/9, Fa0/10, Fa0/11, Fa0/12
Fa0/13, Fa0/14, Fa0/15, Fa0/16
Fa0/17, Fa0/18, Fa0/19, Fa0/20
Fa0/21, Fa0/22, Fa0/23, Fa0/24
2 vlan2 active
3 vlan3 active
```

VLANs are set

```

1002 fddi-default active
1003 token-ring-default active
1004 fddinet-default active
1005 trnet-default active

```

```

VLAN Type SAID MTU Parent RingNo BridgeNo Stp BrdgMode Trans1 Trans2
-----

```

```

1 enet 100001 1500 - - - - 0 0
2 enet 100002 1500 - - - - 0 0
3 enet 100003 1500 - - - - 0 0
1002 fddi 101002 1500 - - - - 0 0
1003 tr 101003 1500 - - - - 0 0
1004 fdnet 101004 1500 - - - ieee - 0 0
1005 trnet 101005 1500 - - - ibm - 0 0

```

```

VLAN Type SAID MTU Parent RingNo BridgeNo Stp BrdgMode Trans1 Trans2
-----

```

```

Remote SPAN VLANs
-----

```

```

Primary Secondary Type Ports
-----

```

```

London#

```

```

London#

```

```

London#

```

```

London#conf t

```

```

Enter configuration commands, one per line. End with CNTL/Z.

```

```

London(config)#int f0/2

```

```

^

```

```

% Invalid input detected at '^' marker.

```

```

London(config)#int f0/2

```

```

London(config-if)#switchport mode access

```

```

London(config-if)#switchport access vlan 2

```

Ports are allocated to VLANs

```

London(config-if)#exit

```

```

London(config)#int f0/3

```

```

London(config-if)#switchport mode access

```

```

London(config-if)#switchport access vlan 3

```

```

London(config-if)#exit

```

```

London(config)#

```

```

London(config)#^Z

```

```

London#

```

```

%SYS-5-CONFIG_I: Configured from console by console

```

```

en

```

```

London#show vlan

```

```

VLAN Name Status Ports
-----

```

```

1 default active Fa0/1, Fa0/4, Fa0/5, Fa0/6
Fa0/7, Fa0/8, Fa0/9, Fa0/10

```

```
Fa0/11, Fa0/12, Fa0/13, Fa0/14
Fa0/15, Fa0/16, Fa0/17, Fa0/18
Fa0/19, Fa0/20, Fa0/21, Fa0/22
Fa0/23, Fa0/24
```

```
2 vlan2 active Fa0/2
```

```
3 vlan3 active Fa0/3
```

```
1002 fddi-default active
```

```
1003 token-ring-default active
```

```
1004 fddinet-default active
```

```
1005 trnet-default active
```

```
VLAN Type SAID MTU Parent RingNo BridgeNo Stp BrdgMode Trans1 Trans2
```

```
-----
```

```
1 enet 100001 1500 ----- 0 0
```

```
2 enet 100002 1500 ----- 0 0
```

```
3 enet 100003 1500 ----- 0 0
```

```
1002 fddi 101002 1500 ----- 0 0
```

```
1003 tr 101003 1500 ----- 0 0
```

```
1004 fdnet 101004 1500 --- ieee - 0 0
```

```
1005 trnet 101005 1500 --- ibm - 0 0
```

```
VLAN Type SAID MTU Parent RingNo BridgeNo Stp BrdgMode Trans1 Trans2
```

```
-----
```

```
Remote SPAN VLANs
```

```
-----
```

```
Primary Secondary Type Ports
```

```
-----
```

```
London#
```

```
London# Trunk port is configured. Gateway is set to no IP address
```

```
London#
```

```
London#conf t
```

```
Enter configuration commands, one per line. End with CNTL/Z.
```

```
London(config)#int f0/24
```

```
London(config-if)#switchport mode trunk
```

```
London(config-if)#
```

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to
down
```

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/24, changed state to
up
```

```
^Z
```

```
London#
```

```
%SYS-5-CONFIG_I: Configured from console by console
```

```
en
```

```
London#show interface trunk
```

```
Port Mode Encapsulation Status Native vlan
```

```
Fa0/24 on 802.1q trunking 1
```

```

Port Vlans allowed on trunk
Fa0/24 1-1005

Port Vlans allowed and active in management domain
Fa0/24 1,2,3

Port Vlans in spanning tree forwarding state and not pruned
Fa0/24 1,2,3

```

Figure 45: VLAN Set up switch

Figure 46 shows the CLI for not assigning an IP address to the two connections as these will be split into sub interface.

```

London>en
London#conf t
Enter configuration commands, one per line. End with CNTL/Z.
London(config)#int f0/0
London(config-if)#no ip address
London(config-if)#exit
London(config)#int f0/0.2
London(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/0.2, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.2, changed state
to up
en
% Ambiguous command: "en"
London(config)#conf t
^
% Invalid input detected at '^' marker.
London(config)#conf t
%Invalid hex value
London(config)#int f0/0
London(config-if)#no ip address
London(config-if)#exit
London(config)#int f0/0.2
London(config-subif)#encapsulation dot1Q 2
London(config-subif)#ip address 192.168.2.94 255.255.255.254
Bad mask /31 for address 192.168.2.94
London(config-subif)#ip address 192.168.2.94 255.255.255.224
^
% Invalid input detected at '^' marker.
London(config-subif)#ip address 192.168.2.94 255.255.255.224
London(config-subif)#no shutdown
London(config-subif)#exit
London(config)#
London(config)#
London(config)#int f0/0.3
London(config-subif)#

```

```

%LINK-5-CHANGED: Interface FastEthernet0/0.3, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.3, changed state
to up
London (config-subif)#encapsulation dot1Q 3
^
% Invalid input detected at '^' marker.
London(config-subif)#encapsulation dot1Q 3
London(config-subif)#ip address 192.168.2.158 255.255.255.224
London(config-subif)#no shutdown
^
% Invalid input detected at '^' marker.
London(config-subif)#exit
London(config)# int f0/0.3
London(config-subif)#encapsulation dot 1Q 3
^
% Invalid input detected at '^' marker.
London(config-subif)#encapsulation dot1Q 3
London(config-subif)#192.168.2.158 255.255.255.224
^
% Invalid input detected at '^' marker.
London(config-subif)#ip address 192.168.2.158 255.255.255.224
London(config-subif)#no shutdown
London(config-subif)#exit
London(config)#^Z
London#
%SYS-5-CONFIG_I: Configured from console by console

London#show ip int brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES manual up up
FastEthernet0/0.2 192.168.2.94 YES manual up up
FastEthernet0/0.3 192.168.2.158 YES manual up up
FastEthernet0/1 unassigned YES unset administratively down down
Serial0/0 192.168.2.10 YES manual up up
Serial0/1 192.168.2.13 YES manual up up
London#

```

Figure 46: VLAN CLI for router

A Show interface trunk command was run to show the port VLANs allowed on the trunk as shown in Figure 47. *Trunk should be explained*

```

London#show interface trunk
Port Mode Encapsulation Status Native vlan
Fa0/24 on 802.1q trunking 1

Port Vlans allowed on trunk
Fa0/24 1-1005

```

Port Vlans allowed and active in management domain
Fa0/24 1,2,3

Port Vlans in spanning tree forwarding state and not pruned
Fa0/24 1,2,3

Figure 47: VLANs allowed on trunk

2.3.4 Access Control Lists (ACL)

An access control list defines what IP addresses are accepted or denied by a device on the network. This can also act as a local firewall to the network.

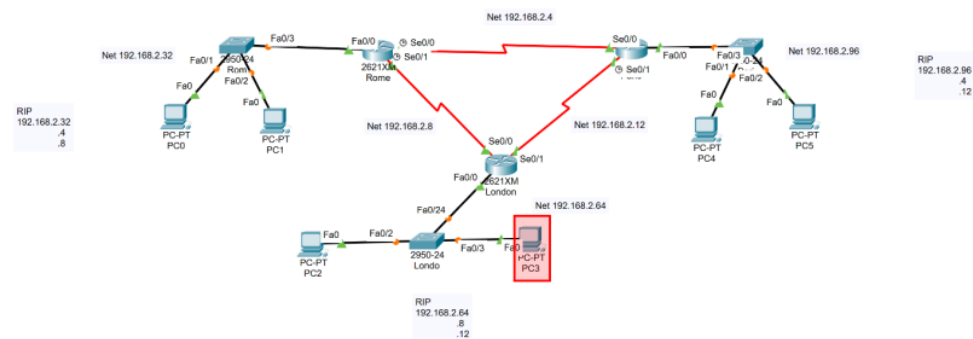


Figure 48: Network Diagram of denied IP

The ACL was set up on the Paris router to deny London PC3 access while PC2 can still access the network as shown in Figure 48. A standard ACL would use a lists 1-99 and extended ACL would run from 100-129. An extended list also has the capability of accepting and rejecting destination IP addresses and service ports in addition to standard source IP addresses.

Figure 49 shows the command line used to configure the access control on the network.

```
Paris>en
Paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Paris(config)#hostname paris
paris(config)#access-list 1 deny 192.168.2.129 0.0.0.0
paris(config)#access-list 1 permit any
paris(config)#exit
paris#
%SYS-5-CONFIG_I: Configured from console by console
en
Paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
paris(config)#int f0/0
paris(config-if)#ip access-group 1 out
paris(config-if)#exit
paris(config)#show run
```

ACL firewall is configured

Figure 49: Access Control CLI setup

2.4 Element 2 Testing and analysis

2.4.1 CIDR/28 Subnetting

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	PC2	ICMP		0.000	N	0	(edit)	
	Successful	PC2	PC0	ICMP		0.000	N	1	(edit)	
	Successful	PC3	PC4	ICMP		0.000	N	2	(edit)	
	Successful	PC4	PC3	ICMP		0.000	N	3	(edit)	
	Failed	PC5	PC1	ICMP		0.000	N	4	(edit)	
	Successful	PC5	PC1	ICMP		0.000	N	5	(edit)	
	Successful	PC1	PC5	ICMP		0.000	N	6	(edit)	

Test results prove the network operations

Figure 50: CIDR/28 RIP Routing Testing

Figure 50 shows the testing results of the packet tester for the CIDR/28 subnetting. One test failed but this was due to the simulation speed as when the test PC5 to PC1 was repeated and was then successful. Good point as failures in the network are always retried

2.4.2 CIDR/27 and CIDR/30 Subnetting

PDU List Window										
Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	PC2	ICMP		0.000	N	0	(edit)	(delete)
	Successful	PC1	PC3	ICMP		0.000	N	1	(edit)	(delete)
	Successful	PC2	PC1	ICMP		0.000	N	2	(edit)	(delete)
	Successful	PC3	PC0	ICMP		0.000	N	3	(edit)	(delete)
	Failed	PC2	PC4	ICMP		0.000	N	4	(edit)	(delete)
	Successful	PC2	PC4	ICMP		0.000	N	5	(edit)	(delete)
	Failed	PC3	PC5	ICMP		0.000	N	6	(edit)	(delete)
	Successful	PC3	PC5	ICMP		0.000	N	7	(edit)	(delete)
	Successful	PC4	PC3	ICMP		0.000	N	8	(edit)	(delete)
	Successful	PC5	PC2	ICMP		0.000	N	9	(edit)	(delete)
	Successful	PC4	PC0	ICMP		0.000	N	10	(edit)	(delete)
	Successful	PC5	PC1	ICMP		0.000	N	11	(edit)	(delete)
	Successful	PC1	PC4	ICMP		0.000	N	12	(edit)	(delete)
	Successful	PC0	PC5	ICMP		0.000	N	13	(edit)	(delete)

Good results that prove the network operations

Figure 51: CIDR/27 and CIDR/30 RIP Routing Testing

Figure 51 shows the testing results of the packet tester. Failed tests were due to the simulation speed of the software. The tests were repeated with an increased and past as proved in the Figure 51. Good point

IP Routes

Using the CLI, the show IP route command was used to show the IP routes as shown in Figure 52 to Figure 54

```
Rome>show ip route
Codes: C - connected, S - static, I - IGRP, 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

    192.168.2.0/24 is variably subnetted, 6 subnets, 2 masks
C       192.168.2.4/30 is directly connected, Serial0/0
C       192.168.2.8/30 is directly connected, Serial0/1
R       192.168.2.12/30 [120/1] via 192.168.2.6, 00:00:26, Serial0/0
          [120/1] via 192.168.2.10, 00:00:03, Serial0/1
C       192.168.2.32/27 is directly connected, FastEthernet0/0
R       192.168.2.64/27 [120/1] via 192.168.2.10, 00:00:03, Serial0/1
R       192.168.2.96/27 [120/1] via 192.168.2.6, 00:00:26, Serial0/0
```

Figure 52: Rome IP Route

```
London>en
London#show ip route
Codes: C - connected, S - static, I - IGRP, 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

    192.168.2.0/24 is variably subnetted, 6 subnets, 2 masks
R       192.168.2.4/30 [120/1] via 192.168.2.14, 00:00:06, Serial0/1
          [120/1] via 192.168.2.9, 00:00:07, Serial0/0
C       192.168.2.8/30 is directly connected, Serial0/0
C       192.168.2.12/30 is directly connected, Serial0/1
R       192.168.2.32/27 [120/1] via 192.168.2.9, 00:00:07, Serial0/0
C       192.168.2.64/27 is directly connected, FastEthernet0/0
R       192.168.2.96/27 [120/1] via 192.168.2.14, 00:00:06, Serial0/1
```

Figure 53: London IP Route

```

Paris>en
Paris#show ip route
Codes: C - connected, S - static, I - IGRP, 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

    192.168.2.0/24 is variably subnetted, 6 subnets, 2 masks
C       192.168.2.4/30 is directly connected, Serial0/0
R       192.168.2.8/30 [120/1] via 192.168.2.5, 00:00:24, Serial0/0
           [120/1] via 192.168.2.13, 00:00:17, Serial0/1
C       192.168.2.12/30 is directly connected, Serial0/1
R       192.168.2.32/27 [120/1] via 192.168.2.5, 00:00:24, Serial0/0
R       192.168.2.64/27 [120/1] via 192.168.2.13, 00:00:17, Serial0/1
C       192.168.2.96/27 is directly connected, FastEthernet0/0

```

Router reports
confirm routing
tables are
configured

Figure 54: Paris IP Route

2.4.3 Virtual Local Area Network (VLAN)

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC2	PC0	ICMP		0.000	N	0	(edit)	(delete)
	Successful	PC1	PC2	ICMP		0.000	N	1	(edit)	(delete)
	Successful	PC2	PC3	ICMP		0.000	N	2	(edit)	(delete)
	Successful	PC3	PC2	ICMP		0.000	N	3	(edit)	(delete)
	Successful	PC2	PC4	ICMP		0.000	N	4	(edit)	(delete)
	Successful	PC5	PC2	ICMP		0.000	N	5	(edit)	(delete)
	Successful	PC3	PC0	ICMP		0.000	N	6	(edit)	(delete)
	Successful	PC1	PC3	ICMP		0.000	N	7	(edit)	(delete)
	Successful	PC3	PC4	ICMP		0.000	N	8	(edit)	(delete)
	Successful	PC5	PC3	ICMP		0.000	N	9	(edit)	(delete)

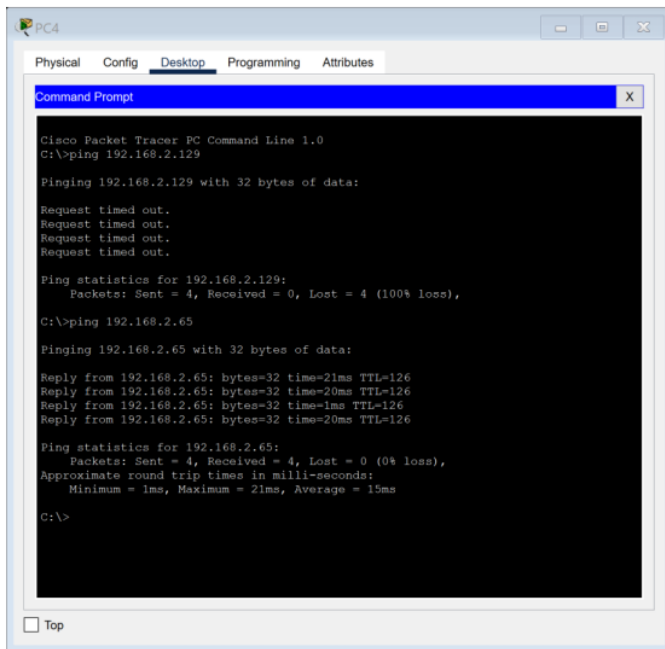
Tests prove
VLANs are
operational

Figure 55: VLAN Testing

Figure 55 shows the packet testing of the VLAN set up showing all devices can communicate as required.

2.4.4 Access Control Lists (ACL)

The Access control can be tested by using a ping command on command prompt from a PC on the Paris network, Figure 56 below shows this. The first ping is unreachable as it has denied access to London PC3 but has allowed access for London PC2 proving the access control works.



Test for ACL proves implementation and is explained.

Figure 56: Access Control Command Prompt

2.5 Element 2 Evaluation

All testing during the element was successful with tests only failing due to simulation speeds. Overall, CIDR/28 was applied to the network before being improved by the implementation of VLSM on the networks using a combination of CIDR/27 and CIDR/30. The access control was then implemented and tested successfully with London PC3 having its access denied to the Paris server while London PC2 still had full access.

Evaluation is limited. There should be VLAN outcomes included

2.6 Element 2 Appendix

2.6.1 Element 2 Appendix 1

```
Rome>en
Rome#show run
Building configuration...

Current configuration : 732 bytes

version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption

hostname Rome

no ip cef
no ipv6 cef

interface FastEthernet0/0
ip address 192.168.2.46 255.255.255.240
duplex auto
speed auto

interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown

interface Serial0/0
ip address 192.168.2.94 255.255.255.240
clock rate 64000

interface Serial0/1
ip address 192.168.2.78 255.255.255.240
clock rate 64000

router rip
version 2
network 192.168.2.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Figure 57: CIDR/28 Run Configuration Rome

```
London>en
London#show run
Building configuration...

Current configuration : 699 bytes

version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption

hostname London

no ip cef
no ipv6 cef

interface FastEthernet0/0
ip address 192.168.2.30 255.255.255.240
duplex auto
speed auto

interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown

interface Serial0/0
ip address 192.168.2.77 255.255.255.240

interface Serial0/1
ip address 192.168.2.110 255.255.255.240

router rip
version 2
network 192.168.2.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Figure 58: CIDR/28 Run Configuration London

```
Paris>en
Paris#show run
```

Building configuration...

Current configuration : 716 bytes

```
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
```

```
hostname Paris
```

```
no ip cef
no ipv6 cef
```

```
interface FastEthernet0/0
ip address 192.168.2.62 255.255.255.240
duplex auto
speed auto
```

```
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
```

```
interface Serial0/0
ip address 192.168.2.93 255.255.255.240
```

```
interface Serial0/1
ip address 192.168.2.109 255.255.255.240
clock rate 64000
```

```
router rip
version 2
network 192.168.2.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Figure 59: CIDR/28 Run Configuration Paris

2.6.2 Element 2 Appendix 2

```
Rome>en
Rome#show run
```

Building configuration...

Current configuration : 730 bytes

```
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
```

```
hostname Rome
no ip cef
no ipv6 cef
```

```
interface FastEthernet0/0
ip address 192.168.2.62 255.255.255.224
duplex auto
speed auto
```

```
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
```

```
interface Serial0/0
ip address 192.168.2.5 255.255.255.252
clock rate 64000
```

```
interface Serial0/1
ip address 192.168.2.9 255.255.255.252
clock rate 64000
```

```
router rip
version 2
network 192.168.2.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Figure 60: CIDR/27 Run Configuration Rome

London>en

London#show run

Building configuration...

Current configuration : 698 bytes

```
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption

hostname London

no ip cef
no ipv6 cef

interface FastEthernet0/0
ip address 192.168.2.94 255.255.255.224
duplex auto
speed auto

interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown

interface Serial0/0
ip address 192.168.2.10 255.255.255.252

interface Serial0/1
ip address 192.168.2.13 255.255.255.252

router rip
version 2
network 192.168.2.0
network 192.168.30.0

ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Figure 61: CIDR/27 Run Configuration London

```
Paris>en
Paris#show run
Building configuration...

Current configuration : 715 bytes

version 12.2
no service timestamps log datetime msec
```

```

no service timestamps debug datetime msec
no service password-encryption

hostname Paris

no ip cef
no ipv6 cef
interface FastEthernet0/0
ip address 192.168.2.126 255.255.255.224
duplex auto
speed auto

interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown

interface Serial0/0
ip address 192.168.2.6 255.255.255.252

interface Serial0/1
ip address 192.168.2.14 255.255.255.252
clock rate 64000

router rip
version 2
network 192.168.2.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end

```

Figure 62: CIDR/27 Run Configuration Paris

2.6.3 Element 2 Appendix 3

```

Paris>en
Paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Paris(config)#hostname paris
paris(config)#access-list 1 deny 192.168.2.129 0.0.0.0
paris(config)#access-list 1 permit any
paris(config)#exit
paris#
%SYS-5-CONFIG_I: Configured from console by console
en

```

```
paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
paris(config)#int f0/0
paris(config-if)#ip access-group 1 out
paris(config-if)#exit
paris(config)#show run
^
% Invalid input detected at '^' marker.
paris(config)#exit
paris#
%SYS-5-CONFIG_I: Configured from console by console
```

```
paris#show run
Building configuration...

Current configuration : 801 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
```

```
hostname paris
no ip cef
no ipv6 cef
interface FastEthernet0/0
ip address 192.168.2.126 255.255.255.224
ip access-group 1 out
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.2.6 255.255.255.252
interface Serial0/1
ip address 192.168.2.14 255.255.255.252
clock rate 64000
```

```
router rip
version 2
network 192.168.2.0
network 192.168.30.0
```

```
ip classless
ip flow-export version 9
access-list 1 deny host 192.168.2.129
access-list 1 permit any
```

```
line con 0
line aux 0
line vty 0 4
login
```

Figure 63: CLI for Access control with show run configuration

3. Element 3

3.1 Element 3 Introduction

Element 3 looked at practically implanting the network using routers and switches. The HTTP protocols were tested between the PLC and a PC station using the web page server to control the speed of a PMW motor via the PLC.

3.2 Element 3 System Configuration Requirements

The network was physically set up as shown below in Figure 1 with the following hardware.

- Switch – Cisco 2950
- Router – Cisco 2600
- PLC – Siemens S7-1200
- PC for webpage
- PC for configuring the terminal.

Hardware is identified

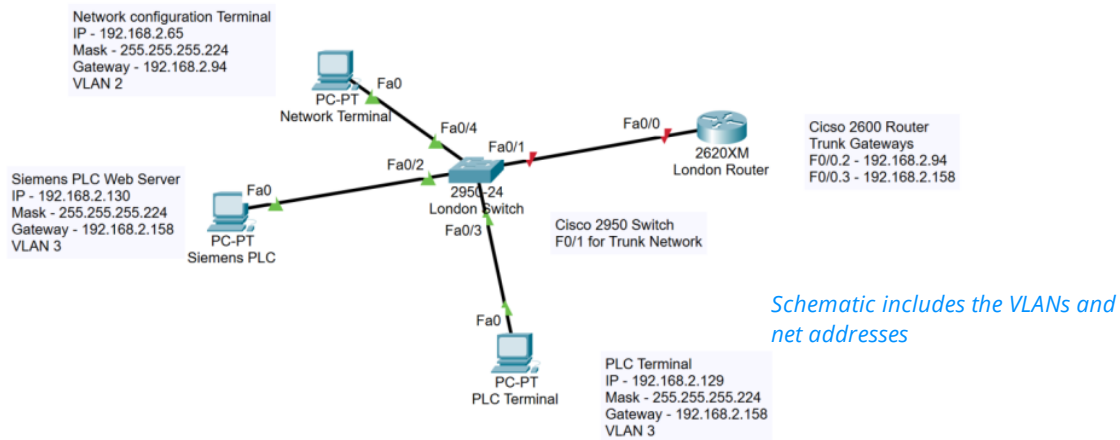


Figure 64: Element 3 Network Topology

The PC network terminal needed to be able to communicate with PLC terminal and the PLC. The PLC terminal likewise must be able to communicate with the PLC and the PLC network terminal.

3.3 Element 3 Implementation

3.3.1 Physical Implementation of London Network

Once the network was physically created using the hardware mentioned above, the VLAN was then configured using Cmdr of PuTTY (a terminal emulator software). This is shown in

Figure 65 to Figure 68. Subsequent testing results are shown in section 3.4 Element 3 Testing and analysis.

```
Switch>enable
Switch#conf t
Switch(config)#vlan 2
Switch(config-vlan)#name vlan2
Switch(config-vlan)#exit
Switch(config)#vlan 3
Switch(config-vlan)#name vlan3
Switch(config-vlan)#exit
Switch(config)#^Z
```

Figure 65: Element 3 VLAN Configuration

```
Switch#conf t
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 3
Switch(config-if)#exit
```

Figure 66: Interface f0/2 set up

```
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 3
Switch(config-if)#exit
```

Figure 67: Interface f0/3 set up

```
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 2
Switch(config-if)#exit
Switch(config)#^Z
```

Switch is configured for the correct net address ID

Figure 68: Interface f0/4 set up

Inter VLAN routing was the set up using the configuration in Figure 69.

```
Switch#conf t
Switch(config)#int f0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#^Z
```

Figure 69: Inter VLAN routing

The router configuration was then set up using the configuration commands in CLI as shown in Figure 70 to Figure 72.

```
Router>enable
Router#conf t
Router(config)#int f0/0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#int f0/0
Router(config-if)#no ip address
Router(config-if)#exit
```

Figure 70: No IP address command for router

```
Router(config)#int f0/0.2
Router(config-subif)#encapsulation dot1Q 2
Router(config-subif)#ip address 192.168.2.94 255.255.255.0
Router(config-subif)#no shutdown
Router(config-subif)#exit
```

Figure 71: Encapsulation for VLAN 2

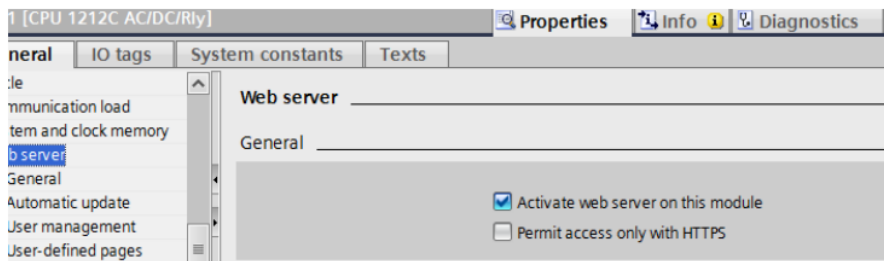
```
Router(config)#int f0/0.3
Router(config-subif)#encapsulation dot1Q 3
Router(config-subif)#ip address 192.168.2.158 255.255.255.0
Router(config-subif)#no shutdown
Router(config-subif)#exit
Router(config)#^Z
```

Router configuration is correct for address ID

Figure 72: Encapsulation for VLAN 3

3.3.2 Siemens PLC Web Server Configuration

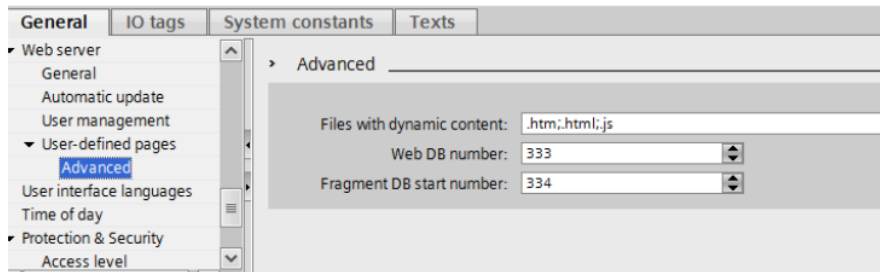
The web server had to be activated and configured on the TIA portal for the Siemens S7-1200 PLC as it is off by default. This is completed in the CPU properties by checking the tick box as shown in Figure 73.



Server is activated

Figure 73: Web server Activation

The web program file extensions were then added to the PLC as shown in Figure 74.



File extensions are declared

Figure 74: Web server File extension configuration

Whilst using web based programming, different file extensions can be used such as;

- HTML – Hypertext Markup Language
- HTM – Allowable short version of HTML. Both extensions are permitted
- .js – javascript (jquery, ajax)
- .json – an extension library of javascript

Any Siemens PLC that is older than the S7-1500 series, does not accept the .js file extension. An alternative solution was to embed the .js in the extension file of an HTML or HTM file. Graphic extensions can also be used such as .png and .gif. They can be embedded in the ajax scripts. The LED's used on the web-server are .png images.

PLC Setup to control PWM Motor

PLC tags were created for the motor control and monitoring as shown in Figure 75.

Default tag table			
	Name	Data type	Address
	Motor Speed PWM	Word	%QW1000
	Motor RUN	Bool	%I0.4
	Motor PWM output	Bool	%Q1.1

Tag names that are accessed over the network

Figure 75: Motor Control PLC Tags

The tags were then created in the data block as shown in Figure 76.



Figure 76: Web data [DB1] data block tags

The code was then constructed in the main programme to control the motor and adding the web server block as shown in Figure 77.

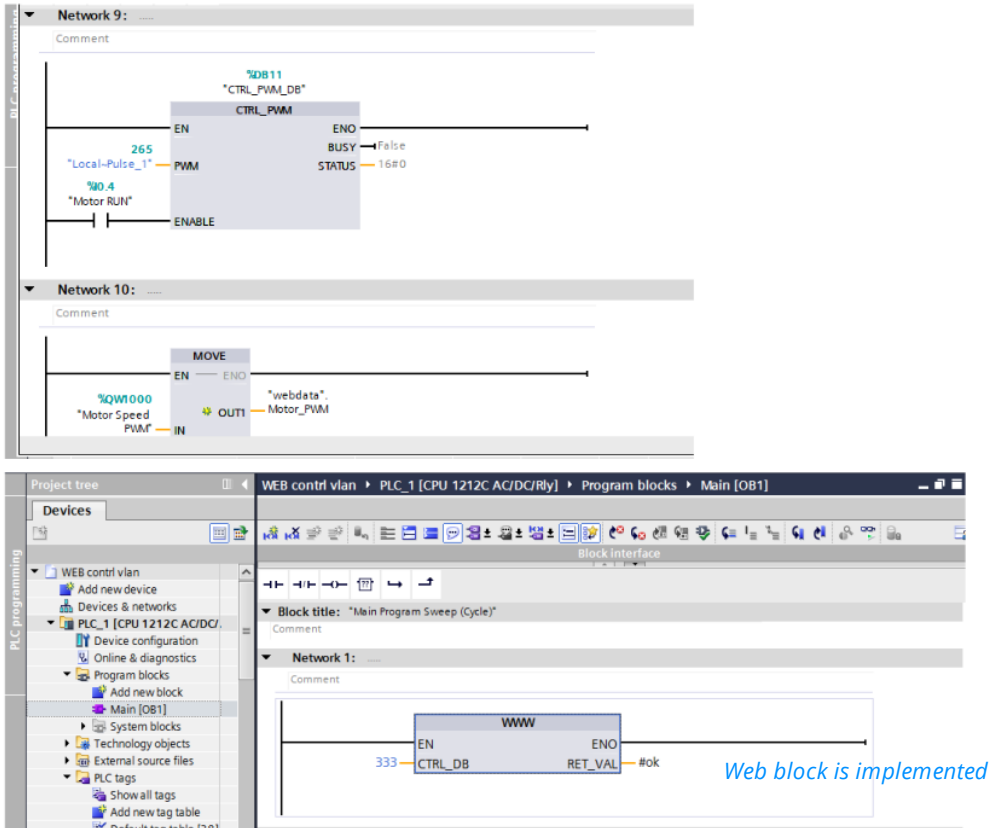


Figure 77: PLC Code Construction

The index .html page that includes the http:// source for the motor switch html page was then downloaded as shown in Figure 78.

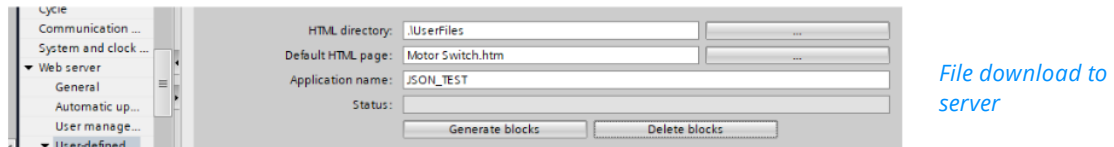


Figure 78: HTML Index Setup

The VLAN gateway IP address was then setup in the PLC as shown below in Figure 79. The VLAN gateway IP address was the Router Gateway address.

Figure 79: Setting VLAN IP Address

A short program using HTML and using two images was created so the PLC conditions could be visually represented. This is to keep up with the industry 4.0 revolution. The Java script libraries enable real time data monitoring without the need of a page refresh giving a better display with a higher rate of data refresh and a smoother graphic on the web page.

Good explanation

Programme explanation

Figure 80 holds and sets the variable of the PWM that is sent to the Motor. It is called from the 'Motor Switch.htm' file by its ID name

IOwrite.htm:

```
<!-- AWP_In_Variable Name=""Motor Speed PWM" -->:="Motor Speed PWM":
```

Figure 80: Sets value of PWM

Figure 81 is the variable that stores the PWM value that is used for the motor and is read from 'Motor Switch.htm' file.

IOresult3.htm:

```
:= "webdata".Motor_PWM:
```

Figure 81: Stores PWM Value

Figure 82 assigns the ID names to the tags stored in the PLC which are then called in the main 'Motor Switch.htm' file.

IOCounter.json:

```
"Motor Speed PWM" :      "!="Motor Speed PWM":",  
"Motor_PWM" :           "!="webdata".Motor_PWM":",  
"Motor_RUN" :           "!="Motor RUN":"
```

Data tags are identified

Figure 82: Assigns ID Names

The Motor Switch .htm: is the file that was downloaded to the PLC. It contains the ajax function calls. The code used is shown in section 3.6.1 Element 3 Appendix 1.

Good significant point

The dynamic Ajax functions read the motor on or off status binary value and the value of the PWM that drives the motor. The code below in Figure 83 would then write the value that has been inserted in the web page text box and send it to the PLC using a separate button on the web page.

```
$("#button").click(function(){  
    url="IOwrite.htm";  
    name="Motor Speed PWM";  
    val=$('#input[id=setvar]').val();  
    sdata=escape(name)+'='+val;  
    $.post(url,sdata,function(result){});  
    document.getElementById('setvar').value="";  
});
```

Good explanation

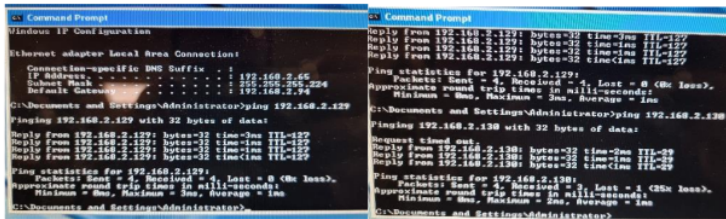
Figure 83: Web page interface code

The other 2 functions are not included

3.4 Element 3 Testing and analysis

3.4.1 Physical Implementation of London Network

The network connections were tested using ping commands on the PC terminals. Figure 84 shows the network terminal testing communication with the PLC web server and the PLC terminal via a ping command.



```
Windows IP Configuration

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix . : 
    Link-local IPv6 Address . . . . . : fe80::9c84:acc4:e632:1bc6%4
    IPv4 Address. . . . . : 192.168.2.127
    Subnet Mask . . . . . : 255.255.255.224
    Default Gateway . . . . . : 192.168.2.129

C:\Documents and Settings\Administrator>ping 192.168.2.129

Pinging 192.168.2.129 with 32 bytes of data:

Reply from 192.168.2.129: bytes=32 time=3ms TTL=127
Reply from 192.168.2.129: bytes=32 time=1ms TTL=127
Reply from 192.168.2.129: bytes=32 time=1ms TTL=127
Reply from 192.168.2.129: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.2.129:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 3ms, Average = 1ms

C:\Documents and Settings\Administrator>

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix . : 
    Link-local IPv6 Address . . . . . : fe80::9c84:acc4:e632:1bc6%4
    IPv4 Address. . . . . : 192.168.2.127
    Subnet Mask . . . . . : 255.255.255.224
    Default Gateway . . . . . : 192.168.2.129

C:\Documents and Settings\Administrator>ping 192.168.2.130

Pinging 192.168.2.130 with 32 bytes of data:

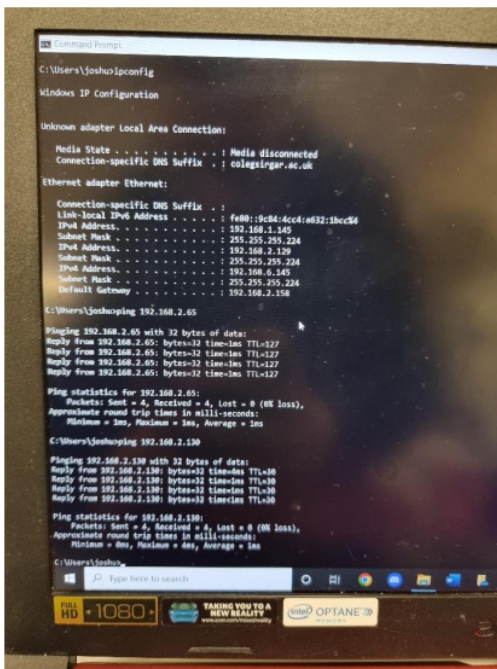
Request timed out.
Reply from 192.168.2.130: bytes=32 time=3ms TTL=64
Reply from 192.168.2.130: bytes=32 time=1ms TTL=64
Reply from 192.168.2.130: bytes=32 time=1ms TTL=64
Reply from 192.168.2.130: bytes=32 time=1ms TTL=64

Ping statistics for 192.168.2.130:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 3ms, Average = 1ms

C:\Documents and Settings\Administrator>
```

Figure 84: Network Terminal Connection Test

Figure 85 shows the PLC terminal testing communication via a ping command to the PLC web server and Network terminal PC.



Ping test proves the VLANs are functioning

Figure 85: PLC Terminal Connection Test

3.4.2 Siemens PLC Web Server Configuration

The web server integration was then tested by changing the input of the motor and watching for the change on the web page. Figure 86 shows the motor run state set to off on the web page.

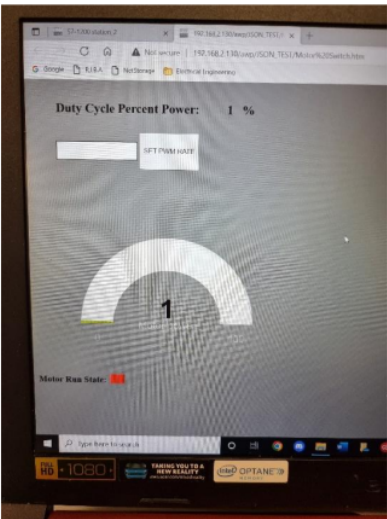


Figure 86: Motor Run state off

The motor running at 53% and 94% is shown in Figure 87 and Figure 88

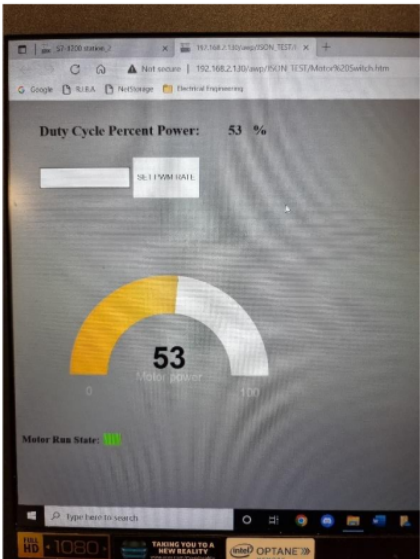


Figure 87: 53% PWM

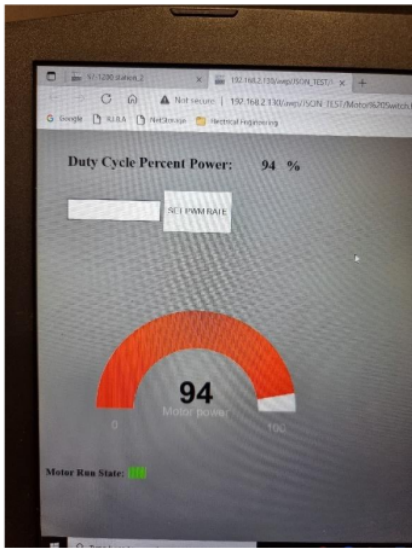
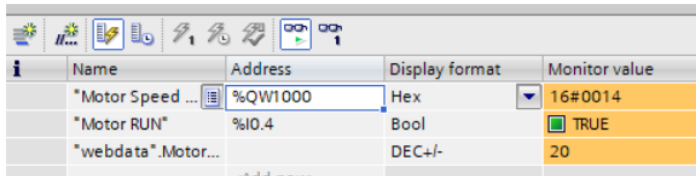


Figure 88: 94% PWM

Test indicates dynamic data in browser from function calls

The watch table of the motor running at 20% is shown in Figure 89.



Name	Address	Display format	Monitor value
*Motor Speed ...	%QW1000	Hex	16#0014
Motor RUN	%IO.4	Bool	TRUE
webdata.Motor...		DEC+/-	20

Watch table confirms the data is associated with the browser values

Figure 89: 20% PWM Watch table

3.5 Element 3 Conclusions and Recommendations

Element 3 put the theory from elements 1 and 2 into practical use by physically setting up a network with a VLAN and then integrating a web server to stay inline and up to date with industry 4.0. with all devices can communicate over a network without the need to be hardwired. During the programming of the physical switches and routers, the same command lines are used as in element 2 as the physical configuration has the same commands as Cisco's CAD package, 'Cisco Packet Tracer' where elements 1 and 2 were designed and simulated.

The Discrepancies from the VLAN in Element 2 are that the switch used in Element 2 was a Cisco 2950-24 (a 24-channel switch) where in element 3 a Cisco 2950-12 switch was used (a 12-channel switch). Then the Trunk port used in Element 2 was F0/24 where the trunk port used in Element 3 was F0/1.

The web wage could be further developed to have a graph showing the speed of the PWM%. This could be achieved by using the existing Java script technology and using the jQuery, Ajax and JSON libraries write another line of code using the existing tags to plot a graph similar to the graphic used to show the speed.

Good evaluation

3.6 Element 3 Appendix

3.6.1 Element 3 Appendix 1

```
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4 <meta charset="utf-8">
5 <meta http-equiv="X-UA-Compatible" content="IE=edge,chrome=1">
6 <meta name="viewport" content="user-scalable=yes, width=device-width, initial-scale=1.0, maximum-scale=1.0">
7
8 <meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
9
10 <!--All the above code is standard and is given in all HTML program pages. This does not effect the program function
11
12 <!-- Aligns the guage graphic. gl is the dynamic variable for the guage. This is contained in a <style> tag-->
13 <style>
14     body {
15         text-align: center;
16     }
17
18     #gl {
19         width:500px; height:350px;
20         display: inline-block;
21         margin: 1em;
22         title: "Result 1";
23     }
24
25     p {
26         display: block;
27         width: 450px;
28         margin: 2em auto;
29         text-align: left;
30     }
31 </style>
32
```

```
33
34
35 </head> <!--Nothing in the <head> </head> tags is displayed in the web page. Only the values between the <body> and </body> tags is displayed
36
37 <!--Everything inside the <body> tag is displayed on screen-->
38 <body bgcolor="#999999">
39
40 <!--table for a text heading and then read the duty cycle % value-->
41 <table style="height 100px" width="450px" font size="16" face="calibri" cellspacing="10">
42 <tr>
43 <th><h2>Duty Cycle Percent Power:</h2></th>
44 <td><h2><label id="Motor_PWM">0</label></h2></td>
45 <td><h2>%</h2></td>
46 </tr>
47
48 <!--this is the button for setting the duty cycle %-->
49 <!--This button modifies the value in the background using JavaScript without a postback-->
50 <tr>
51 <td><input id='setvar' type="text" style="width: 150px; height: 30px; background-color:white;color:black;"/>
52 <button style="height: 70px" width="70px"> SET PWM RATE </button></td>
53 </tr>
54 </table>
55
56 <!--declare .js sources which are given libraries-->
57 <script src="js/jquery-2.0.2.min.js"></script>
58 <script src="js/raphael.2.1.0.min.js"></script>
59 <script src="js/jstgauge.1.0.1.min.js"></script>
60
```

```

60
61
62 <!--Give an id to the gl dynamic guage variable contained inside a <div> tag -->
63 <div style="float: center">
64   <table>
65     <tr>
66       <td><div id="g1"></div></td>
67     </tr>
68   </table>
69 </div>
70
71 <!--Give id to the variables for reading the digital value for the MOTOR RUN state LED.
72 The img variable will hold the red or green LED images-->
73 <div>
74   <table>
75     <tr>
76       <th><h3>Motor Run State:</h3></th>
77       <td><label id="Motor RUN"></label></td>
78       <td><label id="img9"></label></td>
79     </tr>
80   </table>
81 </div>
82
83 </body>
84
85 <!--End of the <body> tag. Everything from here on are function call which will send data values
86 to all the ID tag names in the <body> tag-->
87

```

```

87
88
89 <!-- This is the JSON function call for reading the Motor_PWM vcalue from the tag in the IOCounter.json file.
90 Script to refresh every 1000ms -->
91
92 <script type="text/javascript">
93   //All ajax and JSON is held in this document.
94   $(document).ready(function()
95   {
96
97     //ajax JSON to read the PLC Tag values
98     $.ajaxSetup({ cache: false });
99     setInterval(function()
100     {
101       $.getJSON("IOCounter.json", function(result)
102       {
103         $('#Motor_PWM').text(result["Motor_PWM"]);
104         $('#Motor RUN').text(result["Motor RUN"]);
105
106         //condition image RED / GREEN for 'Motor RUN' tag. Images are held in the User file in the PLC program directory
107         if(result["Motor RUN"]==0){
108
109           //change image to red if condition is off
110           $('#img9').html('');
111         }
112         else
113         {
114           //chnage image to green if condition is on
115           $('#img9').html('');
116         }
117       }
118     }
119   )
120 }

```

```

117
118
119
120 -});
121 -},
122 //Refresh rate in ms.
123 1000); //this timing value is critical for the write to tag function
124 //If this is too small the write misses the first pole and takes too long to update.
125 //If this is too large the inputs will take too long to update. 1000ms is about right.
126
127 //END OF THE JSON FUNCTION CALL
128
129
130
131
132 <!--Initialise the guage dynamic variables. Only g1, g2 and g3 used. g1 and g3 are dynamic variables form PLC Tags->
133 var g1;
134
135 var g1 = new JustGage({
136     id: "g1",
137     value: getRandomInt(0, 100),
138     min: 0,
139     max: 100,
140     title: "Duty Cycle %",
141     label: "Motor power"
142
143 });
144

```

```

144
145 //ajax call function for g1 dynamic variable which is linked to Motor_PWM tag in file IOresult3 in PLC directory/////
146 //call the ajax function. This can easily be converted to JSON if necessary
147 $.ajaxSetup({ cache: false });
148 $.setInterval(function() {
149     $.get("IOresult3.htm", function(result){
150         g1.refresh(parseInt(result));
151     });
152 }, 1000); //END OF THIS AJAX FUNCTION CALL
153
154
155
156
157
158
159
160 //modify the counter value from button. This is the part that writes to the PLC Tag variable i.e.Motor Speed PWM
161 //This is the function that writes the PWM values and sends using the button
162 $( "button" ).click(function(){
163     url="IOwrite.htm";
164     name="Motor Speed PWM";
165     val=$('#input[id=setvar]').val();
166     sdata=escape(name)+'='+val;
167     $.post(url,sdata,function(result){});
168     document.getElementById('setvar').value='';
169 });
170
171
172
173
174
175 </script>
176
177 </html>

```

4.0

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Good number of relevant sources

FINAL GRADE

GENERAL COMMENTS

Instructor

73 /100

PAGE 1

PAGE 2

PAGE 3

Text Comment. Good table of contents

PAGE 4

PAGE 5

PAGE 6

Text Comment. Extensive list of figures and tables

PAGE 7

Text Comment. Intro briefly summarises the content requirements and indicates an understanding.

Text Comment. Good supporting image

PAGE 8

Text Comment. Good research carried out with significant points included. Good comparison between models.

PAGE 9

Text Comment. There is good research carried out for this section

Text Comment. The encapsulation and decapsulation with reference to adding and subtracting headers and footers is explained.

PAGE 10

Text Comment. Good supporting image for the explanation given

PAGE 11

Text Comment. Broadcasting is explained and there are some good details. There is significant point that is not included which suggest the re-sizing of domains for more efficient networks.

Text Comment. Good example that supports explanation

Text Comment. Good research carried out with relevant ref sources

PAGE 12

Text Comment. Table 5 - 8

Text Comment. Address schematic tables are identified for the three classes of address

Text Comment. Minor error here

Text Comment. Serial addresses are identified

PAGE 13

Text Comment. This is not all of the test

PAGE 14

Text Comment. Schematic diagram does not include net addresses

PAGE 15

PAGE 16

Text Comment. Router 0 evidence is missing

PAGE 17

Text Comment. Router configuration for the address is correct

PAGE 18

Text Comment. RIP tables show that each router has the routing information

PAGE 19

PAGE 20

Text Comment. Reports from routers confirm config in routers

PAGE 21

Text Comment. Key point has been explained

Text Comment. DHCP is configured

PAGE 22

Text Comment. Helper addresses are set for remote routers

Text Comment. Address exclusions are configured

PAGE 23

Text Comment. Static routing test support implementation

Text Comment. RIP routing test supports implementation

PAGE 24

PAGE 25

Text Comment. Results prove the problem without helper address. This is also explained

Text Comment. Results prove the helper addresses solve the problem

PAGE 26

Text Comment. Test proves exclusion addresses and this is also explained.

Text Comment. Router reports show all the configurations made for the routers

Text Comment. This should have more relevant detail

Text Comment. The diagram does not include the net addresses

Text Comment. Informative table of usable net addresses

Text Comment. Subnet is identified

Text Comment. Table for .16 is correct

Text Comment. Table for .32 is correct

Text Comment. Table for .48 is correct

Text Comment. Serial port addresses are correct for .64

Text Comment. Table correct for .80

Text Comment. Table correct for .96

Text Comment. Subnet is identified

Text Comment. Table correct for .32

Text Comment. Table correct for .64

Text Comment. Table correct for .96

Text Comment. Subnet is identified

Text Comment. Correct for .4

Text Comment. Correct for .8

Text Comment. Correct for .12

Text Comment. Table are correct for address configurations

PAGE 35

PAGE 36

Text Comment. Good schematic with net addresses and routing tables

PAGE 37

PAGE 38

Text Comment. RIP routing configuration is implemented

PAGE 39

Text Comment. This should be explained because this should update automatically.

PAGE 40

PAGE 41

Text Comment. A very good significant point. VLANs do have this purpose to limit broadcast domains

Text Comment. Schematic includes the ports for the VLANs but the VLANs are not included

Text Comment. VLANs are set

PAGE 42

Text Comment. Ports are allocated to VLANs

Text Comment. Trunk port is configured. Gateway is set to no IP address

Text Comment. Inter VLAN routing is configured. The two gateways are configured in the trunk port.

Text Comment. Trunk should be explained

Text Comment. ACL firewall is configured

Text Comment. Test results prove the network operations

Text Comment. Good point as failures in the network are always retried

Text Comment. Good results that prove the network operations

Text Comment. Good point

Text Comment. Router reports confirm routing tables are configured

Text Comment. Tests prove VLANs are operational

Text Comment. Test for ACL proves implementation and is explained.

Text Comment. Evaluation is limited. There should be VLAN outcomes included

Text Comment. Router reports confirm router configurations

Text Comment. Hardware is identified

Text Comment. Schematic includes the VLANs and net addresses

Text Comment. Switch is configured for the correct net address ID

Text Comment. Router configuration is correct for address ID

Text Comment. Server is activated

Text Comment. File extensions are declared

Text Comment. Tag names that are accessed over the network

Text Comment. Web block is implemented

Text Comment. File download to server

Text Comment. PLC set to be accessed over VLAN gateway

Text Comment. Good explanation

PAGE 65

Text Comment. Data tags are identified

Text Comment. Good significant point

Text Comment. Good explanation

Text Comment. The other 2 functions are not included

PAGE 66

Text Comment. Ping test proves the VLANs are functioning

PAGE 67

Text Comment. Test indicates dynamic data in browser from function calls

PAGE 68

Text Comment. Watch table confirms the data is associated with the browser values

Text Comment. Good evaluation

PAGE 69

PAGE 70

PAGE 71

PAGE 72

PAGE 73

Text Comment. Good number of relevant sources

GRADING FORM: CSG-RUBIC

RESEARCH-INFORMED LITERATURE

 Very good research carried out. The only point not included is the limitation of the broadcast domain which is only partially covered. There are a wide range of ref sources included. 8/10

8**KNOWLEDGE AND UNDERSTANDING**

 E1 - Schematic does not include the net addresses. Implementation is explained and tested. 6.5/10
Element 2 - RIP tables should have some explanation. Trunk protocol should be explained. Explanations are good. Good explanation of VLAN. Trunk protocol is not explained. 7.5/10
Element 3 - VLAN has good explanations with discrepancies identified. Functions are partly explained in the program. Implementation is successful. 7/10

21**ANALYSIS**

 Element 1- test and explanations cover good points and prove the system. Test evidence is included. Limited evaluation. 3/5
Element 2 - test results prove the operation of the network for all CIDR arrangements. The VLAN is developed from the final CIDR design and tests prove the

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configuration. ACL testing proved successful with evidence of the test outcomes. Limited evaluation. Minor error in address table plan /28. 7.5/10
Element 3 - practical VLAN is implemented with good address plan. Practical discrepancies are included. Test carried out to associate PLC values with web browser values. 7.5/10

PRACTICAL APPLICATION AND DEP.



Element 1- implementation has the technical evidence, however there are minor errors and limited evaluation. Testing proved successful. 3/5
Element 2 - Implementation evidence for CIDR is included. Good address plan and schematic diagrams. Explanations are good ,and significant points covered, however the trunk protocol is not explained. Limited evaluation. 3.5/5
Element 3 - Some functions calls have not been explained. Explanations and evaluation is good. Good evidence included. 8/10

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SKILLS FOR PROFESSIONAL PRAC.



Report is a good standard and follows a logical sequence. Good structure of research and evidence. 11/15

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