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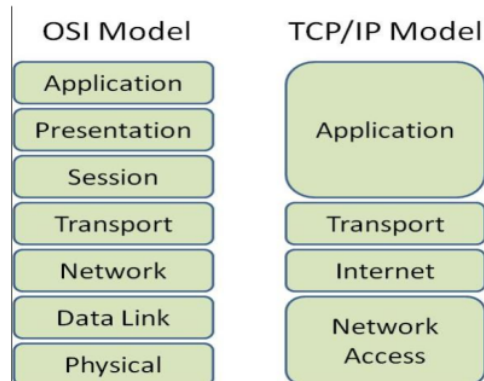
Good list of figures

1. Element 1

1.1 Research

The OSI 7 layer model is a reference model. The TCP/IP 4 layer model is a descriptive framework for the protocol suite.

This needs to be more descriptive



Good supporting image

Figure 1: OSI 7 layer

TCP/IP is the internet protocol suite. This is a group of internet communication protocols *Good point here* called after two of the most essential protocols within it. It can be known as a collection of layers and every layer will take control of a different task to do with the transfer of data.

Layer 7 - application

Layer 7 takes charge of supporting end user operations and supporting applications. Service quality is determined, Communication partners are identified, privacy and user authentication is considered and any syntactic limits are recognised.

Layer 6 - presentation

This layer changes the data format so that the application layer can recognise. It ensures that there are no issues with compatibility by encrypting and formatting the data before sending it across the network.

Layer 5 – session

At the session layer, when two computers or networked devices need to communicate a session is generated. The functions that are performed at this layer are coordination, setup, and termination between the programs at both ends of the session,

Layer 4 – transport

This layer takes control of data transfer coordination between the hosts and end systems. The most well known transport layer example is the transmission control protocol. It also takes control of what speed the data transfers, the amount of data transferred and where it should travel.

Layer 3 – network

There are two main functions of this layer. One is segments getting broken down into network packets, these packets are then re-assembled on the receiver end. The next main function is finding the best route across the physical network by routing the packets. It does this by using network addresses.

Layer 2 – data link

This layer takes two physically connected nodes and terminates the connection between the two. It turns the packets into frames and sends them from source to destination. There are two parts in this layer LLC which is logical link control and MAC media access control. LLC synchronizes frames, does error checks and recognises network protocols.

Layer 1 – physical

This layer takes responsibility for the wireless connections between network nodes or for a physical cable. It defines the electrical cable, the connector or the wireless technology that connects the devices, it also takes responsibility for raw data transmission which are a series of 0 and 1, while also controlling the bit rate. (imperva, 2021)

The 4 layer model considers the high level program application layer to be the top layer and on the lowest network layers it concentrates on system design. For LAN networks it's the interconnection model. [*Layers are explained with relevant sources*](#)

(shaw, 2022)

Encapsulation

When data is travelling in OSI or TCP/IP encapsulation is when additional information is added to that data. The additional information is added on the senders side from application layer to physical layer. (academy, 2020)

How it works

In the user data in the application layer no additional information will be added.

The data is then sent to the Transport layer by the Session layer.

The data is then broken down into different parts at the transport layer. In each of the broken data a header is added. The information that is contained in this layer is destination port, source port and sequence number. It is then combined into a new form.

In the transport layer the encapsulated data ^{are} is datagrams or segments. If TCP is used by the transmission it is then called segments or it will be called datagrams when UDP is used.

The data will now move down to the Network layer. Layer 3 header is now included. This includes details such as the originating IP, the destination IP, etc. This data is combined to create a new form. Packets are the enclosed data in the network layer.

The data link layer now receives packet from the network layer. Layer 2 is added when is enters the data link layer.

A trailer will be added which holds information such as destination MAC address, source MAC address. This trailer checks for errors. The data in the data link layer is called frames.

These frames are then called bits in the physical layer after the physical layer takes the frames from the data link layer. (geeksforgeeks, 2021)

This should be simplified. The explanation is very confusing

De-encapsulation

This process works opposite of encapsulation. When the data travels on the receivers side from the physical layer to the application layer the additional information gets removed.

How it works

The bits get de-encapsulated into frames from the physical layer and gets sent up to the upper layer.

The frames get received to the data link later and the MAC address gets checked to see if it matches. The layer 2 trailer and header are then removed if there is no error found. It then sent to the upper layer after the data packeted and is de-encapsulated. (academy, 2020)

The packet is received from the data link layer to the network layer. The ip address is then checked to see if it matches if the ip address matches the header is removed in layer 3. This data packet moves up to the transport layer.

The layer 4 header is then removed after the network layer sends the data segments to the transport layer. The de-encapsulated data is sent to the receiver after it has travelled through presentation, session and application layer. (geeksforgeeks, 2021) *This can be simplified. However the explanation is correct with supporting ref sources.*

Broadcasting

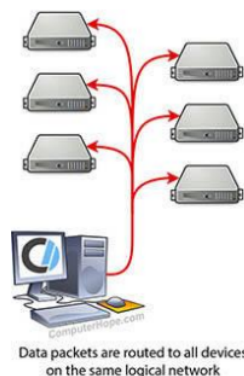
Broadcasting is when multiple users receive data packets all at once. For example a local area network can be set up so that a message can be broadcasted from any device on that network and be sent to every other device. *This is correct*

To broadcast a broadcast address receives a data packet which is sent from a networked device. The packet gets sent from the networks hardware such as a router or a switch. A broadcast domain is a group of eligible devices. *Grammatical error*

IPV4 is the most used network protocol. There are 4 other major techniques for routing computer network traffic these are multicast, unicast, geocast and anycast.

. (hope, 2017)

The significant properties of broadcast domains are not included in the explanation



This image is not very supportive

Figure 2:Broadcasting

Port Allocation

The port numbers can be 0-65535. There are port numbers that are kept for common TCP/IP applications these are from 0-1023 which are known as well-known ports. These ports are used so that corresponding server applications processes from other hosts can be found much easier. For example the datagram must be sent to a destination port if a client process wants to contact a DNS process which is running on a server. 53 is a common DNS port number. This is where the server process will be listening for client requests. Privileged ports are what these ports are called many applications these days do not run in privileged mode only when binding to the port. It is currently getting more difficult to register new applications under the space below 1023.

(sciencedirect, n.d.)

Good points here. This could be implemented using a more effective method i.e. paragraphs and images

1.2 Routing

1.2.1 Network address configuration *Switches not switchboard*

Three routers, three switchboard and three PCs are being used to set up the network. Serial links are used to connect the routers and LAN is used to connect the routers. (shown fig 3)

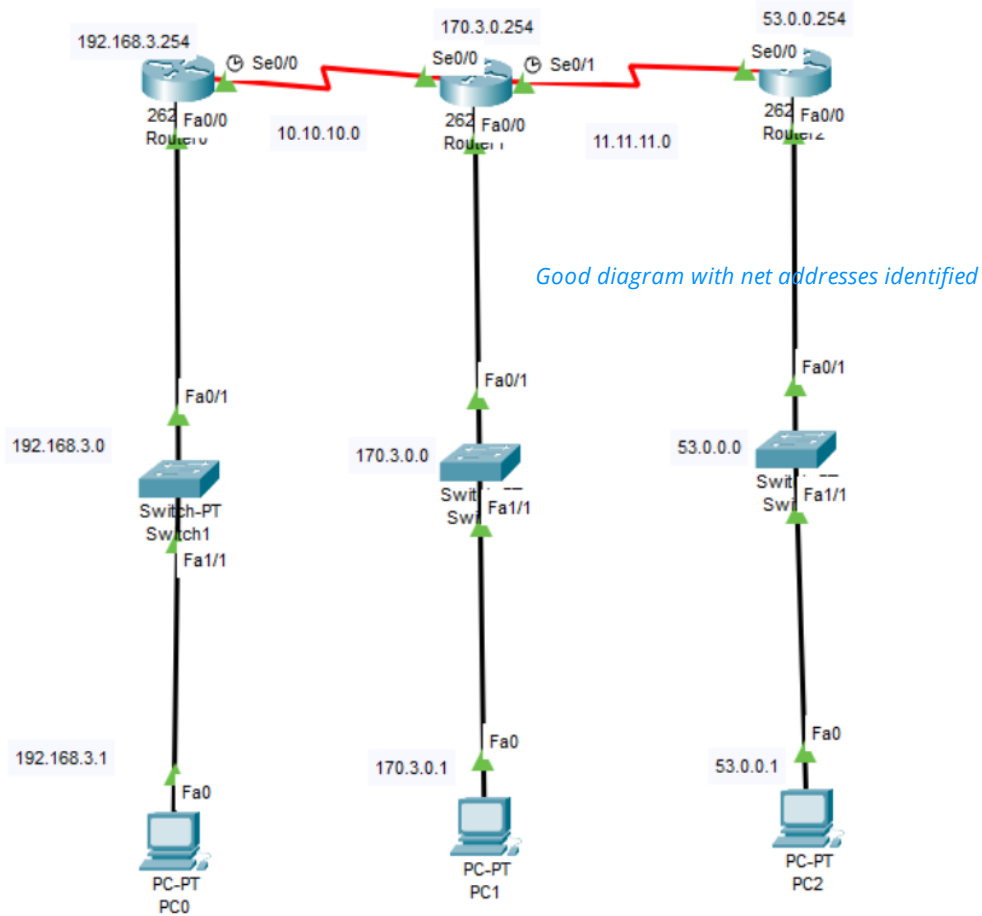


Figure 3: Network address configuration

The IP addresses were set up so that the three different network classes were used this is shown below.

Class C:

192.168.3.0 – Net address

192.168.3.254 – Gateway address

192.168.3.1 – Initial device address

Serial addresses:

10.10.10.0

11.11.11.0

Class B:

170.3.0.0 – Net address

170.3.0.254 – Gateway address

170.3.0.1 – Initial device address

Address schema is implemented

Class A:

53.0.0.0 – Net address

53.0.0.254 – Gateway address

53.0.0.1 – Initial device address

Static Routing config

router 0

Below is the static routing configuration for router 0,1 and 2. After the static routing was done a show IP route was done on the CLI for each of the routers. (This is shown fig 4-9)

Static Routes

Network

Mask

Next Hop

Network Address

53.0.0.0/8 via 10.10.10.2

170.3.0.0/16 via 10.10.10.2

Figure 4: Static routing router 0

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINK-5-CHANGED: Interface Serial0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up

Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console
^Z
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#do 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
S    53.0.0.0/8 [1/0] via 10.10.10.2
S    170.3.0.0/16 [1/0] via 10.10.10.2
C    192.168.3.0/24 is directly connected, FastEthernet0/0

Router(config)#
```

Figure 5: Show ip route router 0

router 1

Static Routes

Network

Mask

Next Hop

Network Address
53.0.0.0/8 via 11.0.0.2
192.168.3.0/24 via 10.10.10.1

Figure 6: Static routing router 1

```
Router(config)#do 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
C    11.0.0.0/8 is directly connected, Serial0/1
S    53.0.0.0/8 [1/0] via 11.0.0.2
C    170.3.0.0/16 is directly connected, FastEthernet0/0
S    192.168.3.0/24 [1/0] via 10.10.10.1
```

Figure 7: Show ip route router 1

router 2

Static Routes

Network

Mask

Next Hop

Add

Network Address

170.3.0.0/16 via 11.0.0.1

192.168.3.0/24 via 11.0.0.1

Remove

Static routing tables are configured

Figure 8: Static routing router 2

```
Router(config)#do 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    11.0.0.0/8 is directly connected, Serial0/0
C    53.0.0.0/8 is directly connected, FastEthernet0/0
S    170.3.0.0/16 [1/0] via 11.0.0.1
S    192.168.3.0/24 [1/0] via 11.0.0.1

Router(config)#
```

Reports show static routing configuration

Reports confirm configuration

Figure 9: Show ip route router 2

Testing the configuration

Testing was done by sending messages to the PCs to prove the static routing was done correctly. (fig 10) *This should be explained further. The point of the test and what the test proves should be included.*

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

Test table supports the configuration

Figure 10: Testing static routing

1.2.2 Configure the 3 routers for dynamic routing using RIP

Below (fig 11-13) is the SCI that was done for each of the routers

Router 0

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router)#ver 2
Router(config-router)#net 192.168.3.0
Router(config-router)#net 10.10.10.0
Router(config-router)#net 170.3.0.0
Router(config-router)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console
^Z
Router#
```

Figure 11: Rip routing router 0

Router 1

```
Router#
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router)#ver 2
Router(config-router)#net 170.3.0.0
Router(config-router)#net 10.10.10.0
Router(config-router)#net 192.168.3.254
Router(config-router)#net 11.11.11.0
Router(config-router)#net 53.0.0.254
Router(config-router)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console
^Z
Router#
```

Figure 12: Rip routing router 1

Router 2

```
Router#
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router)#ver 2
Router(config-router)#net 53.0.0.254
Router(config-router)#net 11.11.11.0
Router(config-router)#net 53.0.0.0
Router(config-router)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console
^Z
Router#
```

Figure 13: Rip routing router 2

Text should be same format

Dynamic routing is implemented

RIP tables in routers:

Below are the routing tables for the routers (fig 14-16)

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
S	53.0.0.0/8	---	10.10.10.2	1/0
S	170.3.0.0/16	---	10.10.10.2	1/0
C	192.168.3.0/24	FastEthernet0/0	---	0/0

Figure 14: Rip routing tables router 0

Router 1

Routing Table for Router1				
Type	Network	Port	Next Hop IP	Metric
C	10.0.0.0/8	Serial0/0	---	0/0
C	11.0.0.0/8	Serial0/1	---	0/0
S	53.0.0.0/8	---	11.0.0.2	1/0
C	170.3.0.0/16	FastEthernet0/0	---	0/0
S	192.168.3.0/24	---	10.10.10.1	1/0

Figure 15: Rip routing tables router 1

Router 2

Routing Table for Router2				
Type	Network	Port	Next Hop IP	Metric
R	10.0.0.0/8	Serial0/0	11.0.0.1	120/1
C	11.0.0.0/8	Serial0/0	---	0/0
C	53.0.0.0/8	FastEthernet0/0	---	0/0
S	170.3.0.0/16	---	11.0.0.1	1/0
S	192.168.3.0/24	---	11.0.0.1	1/0

Routing tables confirm configuration

Figure 16: Rip routing tables router 2

RIP configuration

A show IP route was done on the SCI to show that they are connected. (fig 17-19)

Router0

```
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, 00:00:08, Serial0/0
S    53.0.0.0/8 [1/0] via 10.10.10.2
S    170.3.0.0/16 [1/0] via 10.10.10.2
C    192.168.3.0/24 is directly connected, FastEthernet0/0

Router#
```

Figure 17: Show ip router 0

Router1

```
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
C    11.0.0.0/8 is directly connected, Serial0/1
S    53.0.0.0/8 [1/0] via 11.0.0.2
C    170.3.0.0/16 is directly connected, FastEthernet0/0
S    192.168.3.0/24 [1/0] via 10.10.10.1

Router#
```

Figure 18: Show ip router 1

Router 2

```
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 11.0.0.1, 00:00:04, Serial0/0
C    11.0.0.0/8 is directly connected, Serial0/0
C    53.0.0.0/8 is directly connected, FastEthernet0/0
S    170.3.0.0/16 [1/0] via 11.0.0.1
S    192.168.3.0/24 [1/0] via 11.0.0.1

Router#
```

Reports show router config

Figure 19: Show ip router 2

Testing RIP using ping command

The PCs were then pinged to prove that it is working correctly.

This should be explained

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

Figure 20: Rip routing testing

1.2.3 Dynamic addressing across networks using DHCP

Dynamic routing was done on the routers using DHCP.

Router R1 configuration

This should be explained

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip dhcp pool net1
Router(dhcp-config)#net 192.168.3.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.3.254
Router(dhcp-config)#dns-server 192.168.3.254
Router(dhcp-config)#exit
Router(config)#ip dhcp pool net2
Router(dhcp-config)#net 170.3.0.0 255.255.0.0
Router(dhcp-config)#default-router 170.3.0.254
Router(dhcp-config)#dns-server 170.3.0.254
Router(dhcp-config)#exit
Router(config)#ip dhcp pool net3
Router(dhcp-config)#net 53.0.0.0 255.0.0.0
Router(dhcp-config)#default-router 53.0.0.254
Router(dhcp-config)#dns-server 53.0.0.254
Router(dhcp-config)#exit
Router(config)#
```

DHCP configuration

[Network Analysis and Test]

Test DHCP

The PCs were then tested without the helper addresses

Device PC0

☒ DHCP	☐ Static
IPv4 Address	192.168.3.1
Subnet Mask	255.255.255.0
Default Gateway	192.168.3.254
DNS Server	192.168.3.254

Device PC1

☒ DHCP	☐ Static
IPv4 Address	169.254.64.90
Subnet Mask	255.255.0.0
Default Gateway	0.0.0.0
DNS Server	0.0.0.0

Device PC2

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	169.254.39.160
Subnet Mask	255.255.0.0
Default Gateway	0.0.0.0
DNS Server	0.0.0.0

Due to not having a helper address a default address was set for PC1 and PC2. This is because to get across the network the router needs the helper address. The helper address is the control router serial port address (10.10.10.1).

Configure DHCP helper address for Router2 and Router3 for cross network

The helper address was then implemented for router 2 and 3.

Router2

This should be explained

```
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)#
```

Router3

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int f0/0
Router(config-if)#ip helper-address 10.10.10.0
Router(config-if)#exit
Router(config)#
```

[Network Analysis and Test]

The dynamic addressing was tested with the helper address implemented shown (fig)

Device PC2

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	170.3.0.1
Subnet Mask	255.255.0.0
Default Gateway	170.3.0.254
DNS Server	170.3.0.254

Device PC3

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	53.0.0.1
Subnet Mask	255.0.0.0
Default Gateway	53.0.0.254
DNS Server	53.0.0.254

Test shows results after helper addresses have been configured

Implementation

Address exclusion configuration using Router1 as control device:

Router1

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip dhcp excluded-address 192.168.3.1 192.168.3.10
Router(config)#ip dhcp excluded-address 170.3.0.1 170.3.0.10
Router(config)#ip dhcp excluded-address 192.168.3.1 192.168.3.10
Router(config)#ip dhcp excluded-address 53.0.0.1 53.0.0.10
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Address exclusions are configured

Network Analysis and Test

Test for excluded addresses

Device PC0

IP Configuration	
☒ DHCP	☐ Static
DHCP request successful.	
IPv4 Address	192.168.3.11
Subnet Mask	255.255.255.0
Default Gateway	192.168.3.254
DNS Server	192.168.3.254

Device PC1

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	170.3.0.1
Subnet Mask	255.255.0.0
Default Gateway	170.3.0.254
DNS Server	170.3.0.254

Device PC2

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	53.0.0.1
Subnet Mask	255.0.0.0
Default Gateway	53.0.0.254
DNS Server	53.0.0.254

Test proves exclusions

Network Analysis and Test

A final test was then done using a “show run” on the CLI for each router. (fig)

Router1 running config:

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

Current configuration: 1177 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 192.168.3.1 192.168.3.10
ip dhcp excluded-address 170.3.0.1 170.3.0.10
ip dhcp excluded-address 53.0.0.1 53.0.0.10
ip dhcp pool net1
network 192.168.3.0 255.255.255.0
default-router 192.168.3.254
dns-server 192.168.3.254
ip dhcp pool net2
network 170.3.0.0 255.255.0.0
default-router 170.3.0.254
dns-server 170.3.0.254
ip dhcp pool net3
network 53.0.0.0 255.0.0.0
default-router 53.0.0.254
dns-server 53.0.0.254
no ip cef
no ipv6 cef
interface FastEthernet0/0
ip address 192.168.3.254 255.255.255.0
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 170.3.0.0
network 192.168.3.0
ip classless
ip route 53.0.0.0 255.0.0.0 10.10.10.2
ip route 170.3.0.0 255.255.0.0 10.10.10.2
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
```

Router2 running config:

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

Current configuration : 813 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 170.3.0.254 255.255.0.0
ip helper-address 10.10.10.0
ip helper-address 10.10.10.1
duplex auto
speed auto
interface Serial0/0
ip address 10.10.10.2 255.0.0.0
interface Serial0/1
ip address 11.0.0.1 255.0.0.0
clock rate 2000000
router rip
version 2
network 10.0.0.0
network 11.0.0.0
network 53.0.0.0
network 170.3.0.0
network 192.168.3.0
ip classless
ip route 53.0.0.0 255.0.0.0 11.0.0.2
ip route 192.168.3.0 255.255.255.0 10.10.10.1
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Router3 running config:

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

Current configuration : 823 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 53.0.0.254 255.0.0.0
ip helper-address 10.10.10.0
ip helper-address 10.10.10.1
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 11.0.0.2 255.0.0.0
interface Serial0/1
no ip address
clock rate 2000000
shutdown
router rip
version 2
network 11.0.0.0
network 53.0.0.0
ip classless
ip route 170.3.0.0 255.255.0.0 11.0.0.1
ip route 192.168.3.0 255.255.255.0 11.0.0.1
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Router reports show configurations

1.3 Evaluation

By using knowledge gathered from the research the tasks could be completed. Static routing was done where configuration of the devices was done manually from the terminal. RIP routing was then done this is quicker than static routing and if the IP address for the router is visible the router can be configured remotely. With Dynamic Host Communication Protocol (DHCP) the IP addresses of the devices are assigned automatically but it is a more complex way to configure the router. Addresses can also be excluded with this method. The tasks in this element will carry over onto element 2 where the concepts will be more in depth.

There are some good points here, however this could be implemented using more improve methods.

Element 2

2.1 introduction

In this element CIDR/28 CIDR/27, CIDR/30, VLAN and ACL will be implemented the knowledge learnt from element 1 will give a better understanding on the methods needed to build these networks.

2.2 Design requirements

The network in this system is made up of three routers which are connected in a triangle, these routers will be named London, Rome and Paris. Each router has its own network by connecting to a switch and 2 PCs. This will be a local area network. There is also wide area network which is the three routers connected together.

Topology is identified

Below is (Fig) of the system.

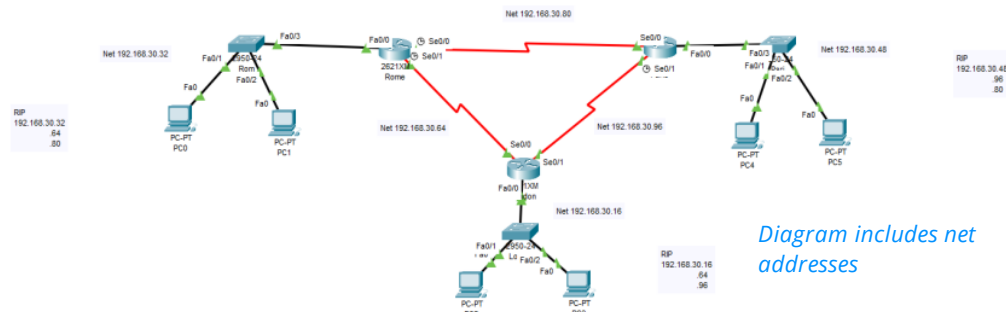


Diagram includes net addresses

2.3 CIDR/28 networking

The subnetting for CIDR/28 was applied for the LAN shown in the table (fig)

Subnet is identified

CIDR/28 Rome network 1 LAN address 32									
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240/28
	0	0	0	0	0	0	0	0	Not used
Network Address 32	0	0	1	0	0	0	0	1	Lowest host address 33
Network Address 32	0	0	1	0	0	0	1	0	Next host address 34
Default gateway	0	0	1	0	1	1	1	0	Fast ethernet 0/0 address 46
	0	0	1	0	1	1	1	1	Broadcast 47

Table for net address .32 is correct

CIDR/28 Paris network 2 LAN address 48									
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240/28
	0	0	0	0	0	0	0	0	Not used
Network Address 48	0	0	1	1	0	0	0	1	Lowest host address 49
Network Address 48	0	0	1	1	0	0	1	0	Next host address 50
Default gateway	0	0	1	1	1	1	1	0	Fast ethernet 0/0 address 62
	0	0	1	1	1	1	1	1	Broadcast 63

Table for net address .48 is correct

CIDR/28 London network 2 LAN address 16									
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240/28
	0	0	0	0	0	0	0	0	Not used
Network Address 16	0	0	0	1	0	0	0	1	Lowest host address 17
Network Address 16	0	0	0	1	0	0	1	0	Next host address 18
Default gateway	0	0	0	1	1	1	1	0	Fast ethernet 0/0 address 30
	0	0	0	1	1	1	1	1	Broadcast 31

Table for net address .16 is correct

Serial 0/0 and 0/1

London-Rome network 1 Wan address 64											
London router	0	1	0	0	1	1	0	1	Serial 0/0 add 77	192.168.3.77	Correct .64
Rome router	0	1	0	0	1	1	1	0	Serial 0/1 add 78	192.168.3.78	
Rome-Paris network 1 Wan address .80											
Paris router	0	1	0	0	1	1	0	1	Serial 0/0 add 93	192.168.3.93	This is incorrect
Rome router	0	1	0	0	1	1	1	0	Serial 0/0 add 94	192.168.3.94	
Paris-London network 1 Wan address .96											
Paris router	0	1	1	0	1	1	0	1	Serial 0/1 add 109	192.168.3.109	Correct .96
London router	0	1	1	0	1	1	1	0	Serial 0/1 add 110	192.168.3.110	

CLI router rip for CIDR/28

Below is the rip routing for the three routers which sets the network addresses for three routers.

Rome router RIP

```
~
Rome#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Rome(config)#router rip
Rome(config-router)#ver 2
Rome(config-router)#net 192.168.3.32
Rome(config-router)#net 192.168.3.64
Rome(config-router)#net 192.168.3.80
Rome(config-router)#exit
Rome(config)#end
Rome#
%SYS-5-CONFIG_I: Configured from console by console
```

London router rip

```
~
London#conf t
Enter configuration commands, one per line. End with CNTL/Z.
London(config)#router rip
London(config-router)#ver 2
London(config-router)#net 192.168.3.16
London(config-router)#net 192.168.3.64
London(config-router)#net 192.168.3.96
London(config-router)#exit
London(config)#end
London#
%SYS-5-CONFIG_I: Configured from console by console
|
```

Paris router rip

```
~Z
Paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Paris(config)#router rip
Paris(config-router)#ver 2
Paris(config-router)#net 192.168.3.48
Paris(config-router)#net 192.168.3.96
Paris(config-router)#net 192.168.3.80
Paris(config-router)#exit
Paris(config)#end
Paris#
%SYS-5-CONFIG_I: Configured from console by console
|
```

/28 is configured

Routing table

Below are the routing tables for each of the routers

London routing Table

Routing Table for London

Type	Network	Port	Next Hop IP	Metric
C	192.168.3.16/28	FastEthernet0/0	---	0/0
R	192.168.3.32/28	Serial0/0	192.168.3.78	120/1
R	192.168.3.48/28	Serial0/1	192.168.3.109	120/1
C	192.168.3.64/28	Serial0/0	---	0/0
R	192.168.3.80/28	Serial0/0	192.168.3.78	120/1
R	192.168.3.80/28	Serial0/1	192.168.3.109	120/1
C	192.168.3.96/28	Serial0/1	---	0/0

Rome routing table

Routing Table for Rome

Type	Network	Port	Next Hop IP	Metric
R	192.168.3.16/28	Serial0/1	192.168.3.77	120/1
C	192.168.3.32/28	FastEthernet0/0	---	0/0
R	192.168.3.48/28	Serial0/0	192.168.3.93	120/1
C	192.168.3.64/28	Serial0/1	---	0/0
C	192.168.3.80/28	Serial0/0	---	0/0
R	192.168.3.96/28	Serial0/1	192.168.3.77	120/1
R	192.168.3.96/28	Serial0/0	192.168.3.93	120/1

Routing tables indicate configuration

Paris routing table

Routing Table for Paris

Type	Network	Port	Next Hop IP	Metric
R	192.168.3.16/28	Serial0/1	192.168.3.110	120/1
R	192.168.3.32/28	Serial0/0	192.168.3.94	120/1
C	192.168.3.48/28	FastEthernet0/0	---	0/0
R	192.168.3.64/28	Serial0/1	192.168.3.110	120/1
R	192.168.3.64/28	Serial0/0	192.168.3.94	120/1
C	192.168.3.80/28	Serial0/0	---	0/0
C	192.168.3.96/28	Serial0/1	---	0/0

Testing

Testing was then done by pinging the PCs to ensure the rip routing was done correctly.

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

Test results support config

This should be explained

Router configurations

A show run was done on the routers which show the ip addresses.

Rome

```
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
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 192.168.3.46 255.255.255.240
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.94 255.255.255.240
clock rate 64000
interface Serial0/1
ip address 192.168.3.78 255.255.255.240
clock rate 64000
router rip
version 2
network 192.168.3.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

London

```
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 192.168.3.30 255.255.255.240
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.77 255.255.255.240
interface Serial0/1
ip address 192.168.3.110 255.255.255.240
router rip
version 2
network 192.168.3.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Paris

```
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 192.168.3.62 255.255.255.240
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.93 255.255.255.240
interface Serial0/1
ip address 192.168.3.109 255.255.255.240
clock rate 64000
router rip
version 2
network 192.168.3.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Router reports show configurations

2.4 CIDR/27 and CIDR/30 Networking

The LAN networks uses CIDR/27 this needs less networks but on each network there are more devices. Below are the CIDR/27 LAN networks.

Subnet is identified

CIDR/27 Rome network 1 LAN address 48									
Subnet mask	1	1	1	0	0	0	0	0	255.255.255.224/27
	0	0	0	0	0	0	0	0	Not used
Network Address 32	0	1	0	0	0	0	0	1	Lowest host address 33
Network Address 32	0	1	0	0	0	0	1	0	Next host address 34
Default gateway	0	1	0	0	1	1	1	0	Fast ethernet 0/0 address 62
	0	1	0	0	1	1	1	1	Broadcast 63

Table for .48 is incorrect

CIDR/27 Paris network 2 LAN address 96									
Subnet mask	1	1	1	1	0	0	0	0	255.255.255.224/27
	0	0	0	0	0	0	0	0	Not used
Network Address 96	0	1	1	0	0	0	0	1	Lowest host address 97
Network Address 96	0	1	1	0	0	0	1	0	Next host address 98
Default gateway	1	1	1	1	1	1	1	0	Fast ethernet 0/0 address 126
	1	1	1	1	1	1	1	1	Broadcast 127

Table for .96 is incorrect for 126 and 127

CIDR/27 London network 2 LAN address 64									
Subnet mask	1	1	1	0	0	0	0	0	255.255.255.224/27
	0	0	0	0	0	0	0	0	Not used
Network Address 96	0	1	0	0	0	0	0	1	Lowest host address 65
Network Address 96	0	1	0	0	0	0	1	0	Next host address 66
Default gateway	0	1	0	1	1	1	1	0	Fast ethernet 0/0 address 94
	0	1	0	1	1	1	1	1	Broadcast 95

Table is correct for address .64

CIDR/30 WAN Addresses

CIDR/30 is used to set the addresses between the routers. This will create more networks but there will be less devices per network. The starting address for CIDR/30 will be 192 since this is the next address after the last CIDR/27 address.

CIDR/30 London-Rome network 1 wan address .8									
London router	0	0	0	0	1	1	0	1	Serial 0/0 add .10
Rome router	0	0	0	0	1	0	0	1	Serial 0/1 add 9

Error here

CIDR/30 Rome-Paris network 1 wan address .4

Paris router	0	0	0	0	0	1	0	1	Serial 0/0 add 5	192.168.3.5
Rome router	0	0	0	0	0	1	1	0	Serial 0/0 add 6	192.168.3.6

*Correct***CIDR/30 Paris-London network 1 wan address .12**

Paris router	0	0	0	0	1	1	0	1	Serial 0/1 add 13	192.168.3.13
London router	0	0	0	0	1	1	1	0	Serial 0/1 add 14	192.168.3.14

*Correct***CIDR/27/30 Router Rip**

The CIDR/27/30 router rip was then set for the IP addresses. This is shown below.

Rome

```
-
Rome#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Rome(config)#router rip
Rome(config-router)#ver 2
Rome(config-router)#net 192.168.3.32
Rome(config-router)#net 192.168.3.4
Rome(config-router)#net 192.168.3.12
Rome(config-router)#exit
```

London

```
London#conf t
Enter configuration commands, one per line. End with CNTL/Z.
London(config)#router rip
London(config-router)#ver 2
London(config-router)#net 192.168.3.64
London(config-router)#net 192.168.3.8
London(config-router)#net 192.168.3.12
London(config-router)#exit
```

Paris

```
Paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Paris(config)#router rip
Paris(config-router)#ver 2
Paris(config-router)#net 192.168.3.96
Paris(config-router)#net 192.168.3.12
Paris(config-router)#net 192.168.3.4
Paris(config-router)#exit
```

RIP routing is configured

Router configurations

A show run was done on the CLI of each router to show the IP addresses.

Rome

```
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 192.168.3.62 255.255.255.224
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.6 255.255.255.252
clock rate 64000
interface Serial0/1
ip address 192.168.3.9 255.255.255.252
clock rate 64000
router rip
version 2
network 192.168.3.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

London

```
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 192.168.3.94 255.255.255.224
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.10 255.255.255.252
interface Serial0/1
ip address 192.168.3.14 255.255.255.252
router rip
version 2
network 192.168.3.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Paris

```
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 192.168.3.126 255.255.255.224
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.5 255.255.255.252
interface Serial0/1
ip address 192.168.3.13 255.255.255.252
clock rate 64000
router rip
version 2
network 192.168.3.0
network 192.168.30.0
ip classless
ip flow-export version 9
line con 0
line aux 0
line vty 0 4
login
end
```

Reports show configurations

Routing table

Below are the routing tables for the routers.

Rome

Routing Table for Rome

Type	Network	Port	Next Hop IP	Metric
C	192.168.3.4/30	Serial0/0	---	0/0
C	192.168.3.8/30	Serial0/1	---	0/0
R	192.168.3.12/30	Serial0/1	192.168.3.10	120/1
R	192.168.3.12/30	Serial0/0	192.168.3.5	120/1
C	192.168.3.32/27	FastEthernet0/0	---	0/0
R	192.168.3.64/27	Serial0/1	192.168.3.10	120/1
R	192.168.3.96/27	Serial0/0	192.168.3.5	120/1

These should be explained as they are updated automatically from /28 configuration

London

Routing Table for London

Type	Network	Port	Next Hop IP	Metric
R	192.168.3.4/30	Serial0/1	192.168.3.13	120/1
R	192.168.3.4/30	Serial0/0	192.168.3.9	120/1
C	192.168.3.8/30	Serial0/0	---	0/0
C	192.168.3.12/30	Serial0/1	---	0/0
R	192.168.3.32/27	Serial0/0	192.168.3.9	120/1
C	192.168.3.64/27	FastEthernet0/0	---	0/0
R	192.168.3.96/27	Serial0/1	192.168.3.13	120/1

Paris

Routing Table for Paris

Type	Network	Port	Next Hop IP	Metric
C	192.168.3.4/30	Serial0/0	---	0/0
R	192.168.3.8/30	Serial0/1	192.168.3.14	120/1
R	192.168.3.8/30	Serial0/0	192.168.3.6	120/1
C	192.168.3.12/30	Serial0/1	---	0/0
R	192.168.3.32/27	Serial0/0	192.168.3.6	120/1
R	192.168.3.64/27	Serial0/1	192.168.3.14	120/1
C	192.168.3.96/27	FastEthernet0/0	---	0/0

Testing

Below is the testing to prove that the system have been set up correctly by pinging the PCs.

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

*Explanations
should be
included*

2.5 VLAN for CIDR/27 sub network

A VLAN was set up for the London network. It works by using 2 networks to the same router port through a switch. The IP address for PC2 has been changed to a available network in CIDR/27.

Below is the VLAN configuration for the switch

This should have an explanation

```
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

London#show vlan

London#conf t
Enter configuration commands, one per line. End with CNTL/Z.
London(config)#int f0/2
London(config-if)#switchport mode access
London(config-if)#switchport access vlan 2
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)#^Z
London#
%SYS-5-CONFIG_I: Configured from console by console

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#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

London(config-if)#^Z
London#
%SYS-5-CONFIG_I: Configured from console by console

London#show interface trunk

```

Switch is configured but no explanation

```
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
```

Router CLI

The router was then configured on the CLI for the VLAN network.

```
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)#encapsulation dot1Q 2
London(config-subif)#ip address 192.168.3.94 255.255.255.224
London(config-subif)#no shutdown
London(config-subif)#exit
London(config)#
London(config)#int f0/0.3
London(config-subif)#
London(config-subif)#encapsulation dot1Q 3
London(config-subif)#ip address 192.168.3.158 255.255.255.224
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 brie
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES manual up          up
FastEthernet0/0.2  192.168.3.94    YES manual up          up
FastEthernet0/0.3  192.168.3.158   YES manual up          up
FastEthernet0/1    unassigned      YES unset  administratively down down
Serial0/0          192.168.3.10    YES manual up          up
Serial0/1          192.168.3.14    YES manual up          up
```

Two gateways are implemented

Routing table

Below is the routing table for the London network.

Routing Table for London

Type	Network	Port	Next Hop IP	Metric
R	192.168.3.4/30	Serial0/0	192.168.3.9	120/1
R	192.168.3.4/30	Serial0/1	192.168.3.13	120/1
C	192.168.3.8/30	Serial0/0	---	0/0
C	192.168.3.12/30	Serial0/1	---	0/0
R	192.168.3.32/27	Serial0/0	192.168.3.9	120/1
C	192.168.3.64/27	FastEthernet0/0.2	---	0/0
R	192.168.3.96/27	Serial0/1	192.168.3.13	120/1
C	192.168.3.128/27	FastEthernet0/0.3	---	0/0

Testing

Below is the testing to ensure the VLAN and the system has been set up correctly.

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

This should be explained

2.6 ACL

An ACL system is set up on the Paris router this will prevent a signal passing from the previous VLAN system. The ACL will block the IP address of (192.168.3.129). The CLI coding of the ACL is shown below.

```

Paris#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Paris(config)#hostname Paris
Paris(config)#access-list 1 2
deny Specify packets to reject
permit Specify packets to forward
remark Access list entry comment
Paris(config)#access-list 1 2
deny Specify packets to reject
permit Specify packets to forward
remark Access list entry comment
Paris(config)#access-list 1 2
deny Specify packets to reject
permit Specify packets to forward
remark Access list entry comment
Paris(config)#access-list 1 deny 192.168.3.129 0.0.0.0
Paris(config)#access-list 1 permit any
Paris(config)#^Z
Paris#
%SYS-5-CONFIG_I: Configured from console by console

```

```

Paris#show run
Building configuration...
Current configuration: 778 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 192.168.3.126 255.255.255.224
duplex auto
speed auto
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
interface Serial0/0
ip address 192.168.3.5 255.255.255.252
interface Serial0/1
ip address 192.168.3.13 255.255.255.252
clock rate 64000
router rip
version 2
network 192.168.3.0

```

```

network 192.168.30.0
ip classless
ip flow-export version 9
access-list 1 deny host 192.168.3.129
access-list 1 permit any
line con 0
line aux 0
line vty 0 4
login
end

```

```

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 ?
    in    inbound packets
    out   outbound packets
Paris(config-if)#ip access-group 1 out

```

Testing using command prompt

Testing was done by pinging PC4 to VLAN 3 (192.168.3.129) which was the blocked VLAN
this proves that the VLAN is blocked.

Testing using command prompt

CMD code from pc4

```

C:\>ping 192.168.3.129

Pinging 192.168.3.129 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.3.129:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

```

PC4 was then pinged to VLAN 2 (192.168.3.62) to prove that the VLAN is not blocked.

```

Pinging 192.168.3.62 with 32 bytes of data:

Reply from 192.168.3.62: bytes=32 time=20ms TTL=254
Reply from 192.168.3.62: bytes=32 time=14ms TTL=254
Reply from 192.168.3.62: bytes=32 time=15ms TTL=254
Reply from 192.168.3.62: bytes=32 time=17ms TTL=254

Ping statistics for 192.168.3.62:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 14ms, Maximum = 20ms, Average = 16ms

```

ACL test is successful but should be briefly explained

CMD code from pc5

PC5 was then pinged to VLAN 3 (192.168.3.129) to prove the VLAN is blocked.

```
C:\>ping 192.168.3.129

Pinging 192.168.3.129 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.3.129:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

PC5 was pinged to VLAN 2 (192.168.3.62) to prove that the VLAN is not blocked.

```
C:\>ping 192.168.3.62

Pinging 192.168.3.62 with 32 bytes of data:

Reply from 192.168.3.62: bytes=32 time=13ms TTL=254
Reply from 192.168.3.62: bytes=32 time=1ms TTL=254
Reply from 192.168.3.62: bytes=32 time=9ms TTL=254
Reply from 192.168.3.62: bytes=32 time=1ms TTL=254

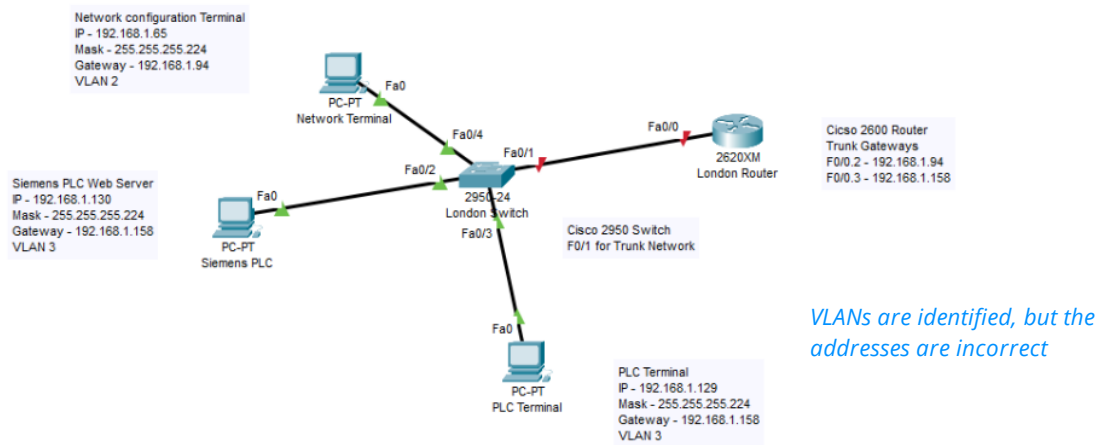
Ping statistics for 192.168.3.62:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 13ms, Average = 6ms
```

2.7 Evaluation

In this element CIDR, VLAN and ACL networks have all been implemented into the system. A further understanding of the systems has been obtained throughout the element. Testing was then done on the systems to prove that it is working correctly. This will then be implemented into element 3.

Evaluation is limited

3. Element 3



3.1 Router and Switch configuration

VLAN on London switch

Hardware:

Laptop PC's x 2

Siemens PLC

Cisco 2600 router

Cisco 2950 switch

To set up the system one laptop was used to code the router and switch and the other router was used to program the PLC and set up the HMI screen for the PLC where it would read the data off the motor.

VLAN configuration

Below is the VLAN coding that was set up off the laptop.

```
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
Switch#show vlan
////////////////////////////////report on vlan config////////////////////////////////
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

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

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#
```

Switch#show vlan

//////////report shows vlans with port config//////////

End of VLAN configuration

Inter VLAN routing

Switch config:

Switch#conf t

Switch(config)#int f0/1

Switch(config-if)#switchport mode trunk

Switch(config-if)#^Z

Switch#

Switch#show interface trunk

Switch is configured

//////////report shows trunk config//////////

//////////might have to show this again after router config//////////

Router config:

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

```
Router(config)#int f0/0.2
```

```
Router(config-subif)#encapsulation dot1Q 2
```

```
Router(config-subif)#ip address 192.168.3.94 255.255.255.224
```

```
Router(config-subif)#no shutdown
```

```
Router(config-subif)#exit
```

Gateways are configured on the TRUNK port

```
Router(config)#int f0/0.3
```

```
Router(config-subif)#encapsulation dot1Q 3
```

```
Router(config-subif)#ip address 192.168.3.158 255.255.255.224
```

```
Router(config-subif)#no shutdown
```

```
Router(config-subif)#exit
```

```
Router(config)#^Z
```

```
Router#show ip interfaces brie
```

```
//////////report int status for f0/0.2 and f0/0.3//////////
```

```
Router#show run
```

```
//////////running config for router//////////
```

Testing

Once the coding was done a test was done where it would ping the networks to ensure that the system was working correctly.

```
C:\Documents and Settings\Administrator>ping 192.168.3.129
Pinging 192.168.3.129 with 32 bytes of data:
Reply from 192.168.3.129: bytes=32 time=2ms TTL=127
Reply from 192.168.3.129: bytes=32 time<1ms TTL=127
Reply from 192.168.3.129: bytes=32 time<1ms TTL=127
Reply from 192.168.3.129: bytes=32 time<1ms TTL=127
Ping statistics for 192.168.3.129:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 2ms, Average = 0ms
C:\Documents and Settings\Administrator>ping 192.168.3.130
Pinging 192.168.3.130 with 32 bytes of data:
Reply from 192.168.3.130: bytes=32 time=4ms TTL=29
Reply from 192.168.3.130: bytes=32 time<1ms TTL=29
Reply from 192.168.3.130: bytes=32 time<1ms TTL=29
Reply from 192.168.3.130: bytes=32 time<1ms TTL=29
Ping statistics for 192.168.3.130:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 4ms, Average = 1ms
C:\Documents and Settings\Administrator>
```

*VLANs test confirms
implementation*

```
Microsoft Windows [Version 10.0.19044.1645]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Leila>ping 192.168.3.65

Pinging 192.168.3.65 with 32 bytes of data:
Reply from 192.168.3.65: bytes=32 time=1ms TTL=127
Reply from 192.168.3.65: bytes=32 time<1ms TTL=127
Reply from 192.168.3.65: bytes=32 time<1ms TTL=127
Reply from 192.168.3.65: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.3.65:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\Leila>ping 192.168.3.130

Pinging 192.168.3.130 with 32 bytes of data:
Reply from 192.168.3.130: bytes=32 time=4ms TTL=30
Reply from 192.168.3.130: bytes=32 time<1ms TTL=30
Reply from 192.168.3.130: bytes=32 time<1ms TTL=30
Reply from 192.168.3.130: bytes=32 time<1ms TTL=30

Ping statistics for 192.168.3.130:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 4ms, Average = 1ms
```

3.2 Siemens PLC configuration

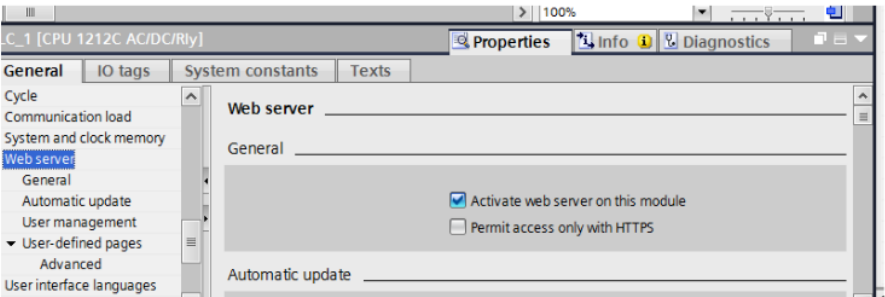
To configure the PLC a webserver was activated which is shown below. File extensions need to be added for the web program these are listed below.

.js – javascript (jquery, ajax)

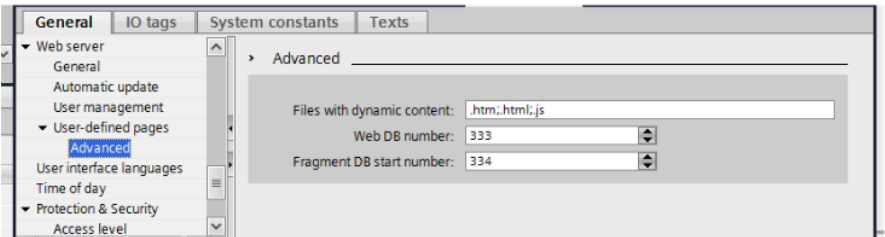
.json – an extension library of javascript

HTML – Hypertext Markup Language

HTM – Allowable short version of HTML. Both extensions are permitted.



PLC web server activated



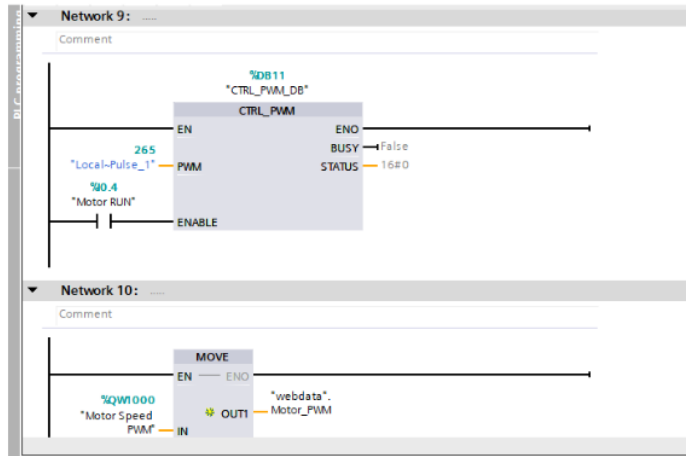
After this was set the default tags are implemented.

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

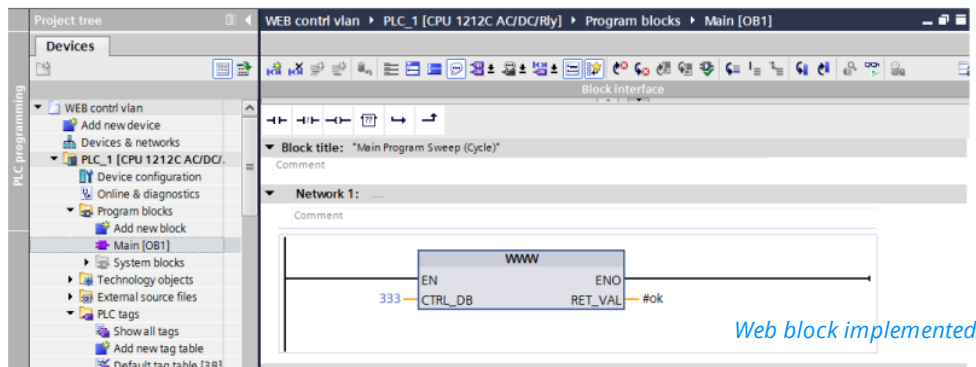
The tags are added into a DB1 datablock

11		Motor_PWM	Int	0
3		web_ok	Int	

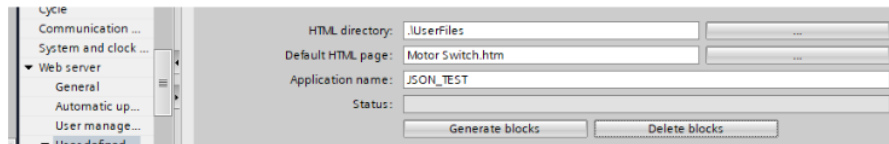
The PWM for the motor drive function is then placed in the program.



A WWW web server is added into the main function block. The web pages can now be downloaded due to the web server being configured.



The index .html page with the http:// source can be downloaded for the motor switch.htm page.



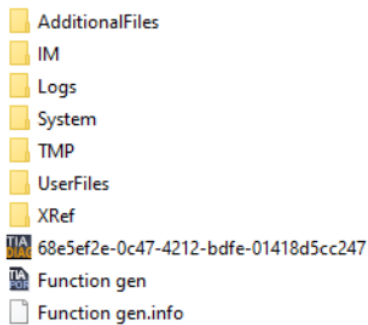
The web data blocks can be generated to download the web pages on the PLC server.

In the PLC the gateway ip address for the VLAN can be set.



PLC gateway configured

The web pages are held in the PLC program files in the same place as the user files.



Below is the program coding for the motor switch.htm. this file is downloaded onto the PLC which include all the ajax function calls.

```

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 gauge graphic. g1 is the dynamic variable for the gauge. This is contained in a <style> tag-->
13
14 <style>
15     body {
16         text-align: center;
17     }
18
19     #g1 {
20         width: 500px; height: 350px;
21         display: inline-block;
22         margin: 1em;
23         title: "Result 1";
24     }
25
26     p {
27         display: block;
28         width: 450px;
29         margin: 2em auto;
30         text-align: left;
31     }
32 </style>

```

```

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 dis
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" cellpadding="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 g1 dynamic gauge 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 value 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 $('#img5').html('');
111 }
112 else
113 {
114 //change image to green if condition is on
115 $('#img5').html('');
116 }

```

```

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 gauge dynamic variables. Only g1, g2 and g3 used. g1 and g3 are dynamic variables from 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 gl 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         gl.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>

```

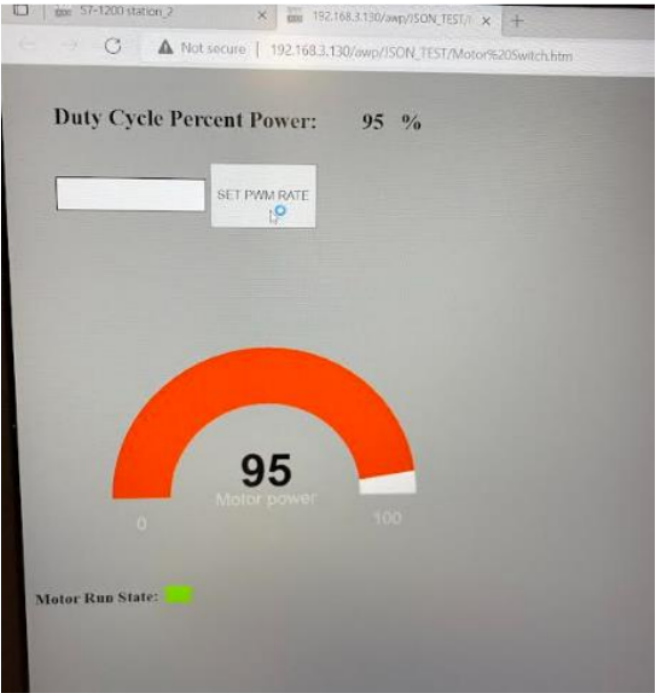
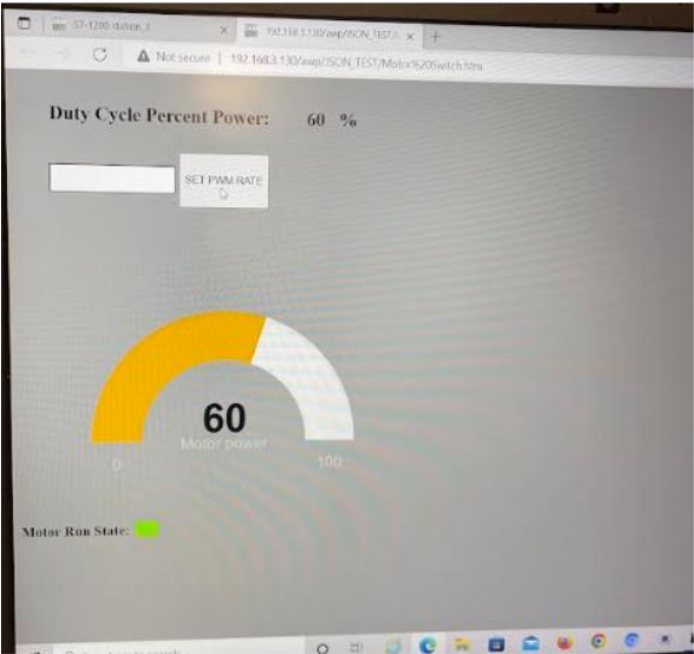
Testing the dynamics of the PLC web server over the VLAN Network.

After the system was functional it was then tested by connecting up a motor to the PLC and setting the duty cycle percentage. Below is a photo of the motor set up.

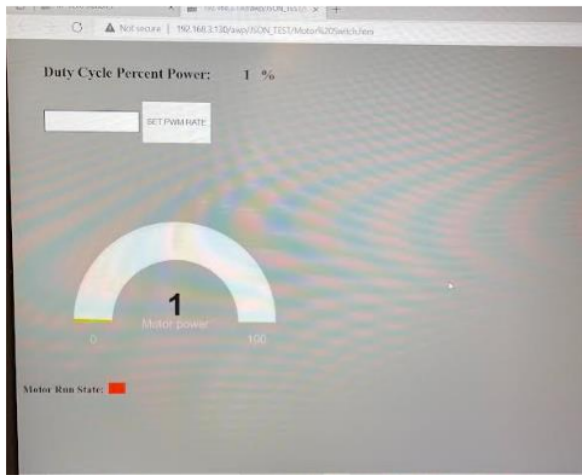


Supportive image

Different duty cycle percentages were then set which are shown below.



Another test was done with the run state off when previously on the other two tests the run state was on.



Test shows browser function. There should be a test on the PLC to associate the same test readings.

3.3 Evaluation and Conclusion

In this element it has shown how industry 4.0 is a very effective way to run equipment in industry, this is because it can run through ethernet which can be accessed anywhere in the world. It also provides a lot of information of the PLC for example in element 3 it shows the duty cycle of the motor and the run state of the motor. This is only a little of what is capable with industry 4.0. In this element is has given a better understanding of industry 4.0 and how PLC and networking can be used together.

Reasonable evaluation. Something should be included about the VLAN

4. References

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Limited sources

1909752

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

61 / 100

PAGE 1

PAGE 2

Text Comment. Good table of contents

PAGE 3

Text Comment. Good list of figures

PAGE 4

Text Comment. This needs to be more descriptive

Text Comment. Good supporting image

Text Comment. Good point here

PAGE 5

Text Comment. Layers are explained with relevant sources

PAGE 6

Text Comment. are

Text Comment. This should be simplified. The explanation is very confusing

Text Comment. This can be simplified. However the explanation is correct with supporting ref sources.

Text Comment. This is correct

Text Comment. Grammatical error

Text Comment. The significant properties of broadcast domains are not included in the explanation

Text Comment. This image is not very supportive

Text Comment. Good points here. This could be implemented using a more effective method i.e. paragraphs and images

Text Comment. Switches not switchboard

Text Comment. Good diagram with net addresses identified

Text Comment. Address schema is implemented

Text Comment. Static routing tables are configured

Text Comment. Reports show static routing configuration

Text Comment. Reports confirm configuration

Text Comment. This should be explained further. The point of the test and what the test proves should be included.

Text Comment. Test table supports the configuration

PAGE 14

Text Comment. Text should be same format

Text Comment. Dynamic routing is implemented

PAGE 15

Text Comment. Routing tables confirm configuration

PAGE 16

Text Comment. Reports show router config

PAGE 17

Text Comment. This should be explained

Text Comment. This should be explained

Text Comment. DHCP configuration

PAGE 18

Text Comment. This should be explained

PAGE 19

Text Comment. Test shows results after helper addresses have been configured

PAGE 20

Text Comment. Address exclusions are configured

PAGE 21

Text Comment. Test proves exclusions

PAGE 22

PAGE 23

Text Comment. Router reports show configurations

PAGE 24

Text Comment. There are some good points here, however this could be implemented using more improve methods.

PAGE 25

Text Comment. Topology is identified

Text Comment. Diagram includes net addresses

Text Comment. Subnet is identified

Text Comment. Table for net address .32 is correct

PAGE 26

Text Comment. Table for net address .48 is correct

Text Comment. Table for net address .16 is correct

Text Comment. Correct .64

Text Comment. This is incorrect

Text Comment. Correct .96

PAGE 27

Text Comment. /28 is configured

PAGE 28

Text Comment. Routing tables indicate configuration

PAGE 29

Text Comment. Test results support config

Text Comment. This should be explained

Text Comment. Router reports show configurations

Text Comment. Subnet is identified

Text Comment. Table for .48 is incorrect

Text Comment. Table for .96 is incorrect for 126 and 127

Text Comment. Table is correct for address .64

Text Comment. Error here

Text Comment. Correct

Text Comment. Correct

Text Comment. RIP routing is configured

Text Comment. Reports show configurations

Text Comment. These should be explained as they are updated automatically from /28 configuration

Text Comment. Explanations should be included

Text Comment. This should have an explanation

PAGE 40

PAGE 41

Text Comment. Switch is configured but no explanation

Text Comment. Two gateways are implemented

PAGE 42

Text Comment. This should be explained

PAGE 43

PAGE 44

Text Comment. ACL test is successful but should be briefly explained

PAGE 45

Text Comment. Evaluation is limited

PAGE 46

Text Comment. VLANs are identified, but the addresses are incorrect

PAGE 47

PAGE 48

Text Comment. Switch is configured

PAGE 49

Text Comment. Gateways are configured on the TRUNK port

PAGE 50

Text Comment. VLANs test confirms implementation

PAGE 51

Text Comment. PLC web server activated

Text Comment. Web block implemented

Text Comment. PLC gateway configured

Text Comment. Supportive image

Text Comment. Test shows browser function. There should be a test on the PLC to associate the same test readings.

Text Comment. Reasonable evaluation. Something should be included about the VLAN

Text Comment. Limited sources

GRADING FORM: CSG-RUBIC

JORDAN REES

61

RESEARCH-INFORMED LITERATURE



Research has parts missing, however relevant ref sources are included. 5/10 Sources are limited and quality of content could be improved.

5

KNOWLEDGE AND UNDERSTANDING



Element 1 - missing explanations for DHCP and RIP. Other explanations are too brief. Implementation is successful, however explanations are limited. 6/10 Element 2 - has errors in the evidence for the implementation and the explanations are very limited in content. 6/10 Element 3 - incorrect diagram of VLAN and no explanations. However implementation was successful. 6/10

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ANALYSIS



Element 1- test explanations are missing and evaluation is limited. Test evidence is included . 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 configuration. ACL testing proved successful with evidence of the test outcomes. Limited evaluation. 7/10 E3 - Practical VLAN is implemented and tested No explanations are included and no test carried out to associate PLC values with web browser values. 6/10

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PRACTICAL APPLICATION AND DEP.



Element 1- implementation has the technical evidence, however the explanations are missing in most cases and limited in others. Testing proved successful. 3/5
Element 2 - Implementation evidence for CIDR has many errors in the address schema tables and limited explanations. The tests are successful that prove configurations. 3/5
Element 3 - Practical network has been successfully implemented and tested. PLC test evidence to match browser is not included and VLAN not explained. 6/10

12

SKILLS FOR PROFESSIONAL PRAC.



Report follows a logical sequence. The quality of content could be improved. 10/15

10