

1708165

by Adam Bedner

FILE	13694_ADAM_BEDNER_1708165_172466_1812781740.PDF (1.45M)		
TIME SUBMITTED	21-MAY-2020 09:10PM (UTC+0100)	WORD COUNT	7702
SUBMISSION ID	128662298	CHARACTER COUNT	42026

PSDE5008 Networking Systems for Engineers

Network Design for Industry using CIDR Subnetting

Student name: Adam K. Bedner

This page was left blank intentionally

Table of Contents

Element 1.....	6
1.1 Research.....	6
Network layers.....	6
Encapsulation.....	7
Decapsulation.....	8
Broadcasting.....	8
Port Allocation	9
1.2 Routing.....	10
1.2.1 Network address configuration.....	10
Static routing.	11
RIP Routing.....	13
DHCP Routing.....	17
1.3 Evaluation	26
Element 2.....	27
2.1 Introduction.....	27
2.2 System Configuration & Requirements	27
2.3 CIDR/28 Networking.....	28
LAN Networks.....	28
WAN Networks	28
2.4 CIDR/27 and CIDR/30 Networking	31
LAN Networks.....	31
WAN Networks	31
2.5 VLAN for CIDR/27 sub network.....	34
2.6 ACL.....	38
2.7 Evaluation	41
Element 3.....	42
3.1 Router and Switch configuration	42
3.2 Siemens PLC Web Server Configuration	47
3.3 Conclusions and evaluation.....	53
References.....	54
Appendix A.....	55

Table of figures

Fig. 1 OSI 7 and 4 layer models	6
Fig. 2 Encapsulation	7
Fig. 3 Decapsulation.....	8
Fig. 4 Port Allocation	9
Fig. 5 network setup	10
Fig. 6 Static routing for Router 3	11
Fig. 7 Static routing for Router 4	11
Fig. 8 Static routing for router 5.....	12
Fig. 9 Proof that static addressing works	12
Fig. 10 Routing table for router 3.....	13
Fig. 11 Routing table for router 4.....	13
Fig. 12 Routing table for router 5.....	14
Fig. 13 IP configuration and show IP for router 3	14
Fig. 14 IP configuration and show IP for router 4	15
Fig. 15 IP configuration and show IP for router 5	16
Fig. 16 Test table for RIP routing.....	16
Fig. 17 Successful DHCP routing for PC0	17
Fig. 18 Successful DHCP routing for Laptop0.....	17
Fig. 19 Successful DHCP routing for PC1	17
Fig. 20 proof that the routed network is working.....	25
Fig. 21 Routing table for Warszawa, CIDR/28.....	29
Fig. 22 Routing table for Wroclaw, CIDR/28.....	29
Fig. 23 Routing table for Opole, CIDR/28	30
Fig. 24 Testing results for CIDR/28 networking	30
Fig. 25 Routing table for Warszawa, CIDR/27; CIDR/30.....	32
Fig. 26 Routing table for Wroclaw, CIDR/27; CIDR/30.....	33
Fig. 27 Routing table for Opole, CIDR/27; CIDR/30	33
Fig. 28 Testing results for CIDR/27; CIDR/30 networking	33
Fig. 29 Routing table for Wroclaw, VLAN	36
Fig. 30 Testing results for VLAN networking.....	37
Fig. 31 Diagram of the real-life built system.....	42
Fig. 32 physical setup of the system.....	42
Fig. 33 CMD shown the first round of tests carried out.....	46
Fig. 34 CMD shown the second round of tests carried out.....	47
Fig. 35 Activation of the Web server on the PLC.....	47
Fig. 36 Adding the file extension to the PLC.....	48
Fig. 37 Input and Output configuration	48
Fig. 38 WWW block in the main block of the PLC.....	49
Fig. 39 setting up .html index and downloading it to PLC.....	49
Fig. 40 Setting up IP addresses on PLC.....	49
Fig. 41 The start of the web page's program.....	50
Fig. 42 The on-page variables	50
Fig. 43 part of the program that writes data to the PLC's inputs.....	50
Fig. 44 Part of the program that reads the status of the PLC's outputs	51
Fig. 45 Siemen's standard diagnostic page.....	51
Fig. 46 web page test #1.....	52

Fig. 47 Web page test #2.....	52
Fig. 48 Web page test #3.....	52

*Extensive list of
figures*

Element 1

1.1 Research

Network layers

TCP/IP 4 layer model is a descriptive framework for the protocol suite while the OSI 7 layer model was intended for reference (Fig. 1).

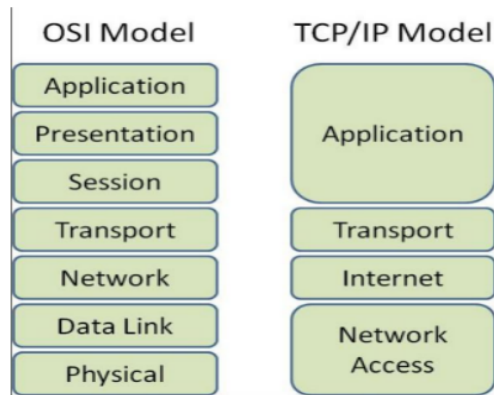


Fig. 1 OSI 7 and 4 layer models

TCP/IP is known as the internet protocol suite. This is a set of comms protocols used for the internet and named from 2 of the most important protocols in it. Can be viewed as a set of layers. Each layer solves a set of problems involving the transmission of data.

Layer 7 - supports application and end-user processes. Communication partners are identified, quality of service is identified, user authentication and privacy are considered, and any constraints on data syntax are identified.

Layer 6 - The presentation layer works to transform data into the form that the application layer can accept. This layer formats and encrypts data to be sent across a network, providing freedom from compatibility problems.

Layer 5 - Establishes, manages and terminates connections between applications.

Layer 4 - Provides transparent transfer of data between end systems, or hosts, and is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

Layer 3 - Provides switching and routing technologies, creating logical paths, known as virtual circuits, for transmitting data from node to node. Routing and forwarding are functions of this layer, as well as addressing, internetworking, error handling, congestion control and packet sequencing.

Layer 2 - Data packets are encoded and decoded into bits. It furnishes transmission protocol knowledge and management and handles errors in the physical layer, flow control and frame synchronization. The data link layer is divided into two sub layers: The Media Access Control (MAC) layer and the Logical Link Control (LLC) layer. The MAC sub layer. Controls how a computer on the network gains access to the data and permission to transmit it. The LLC layer controls frame synchronization, flow control and error checking.

Layer 1 - Conveys the bit stream - electrical impulse, light or radio signal — through the network at the electrical and mechanical level. It provides the hardware means of sending and receiving data on a carrier, including defining cables, cards and physical aspects. Fast Ethernet, RS232, and ATM are protocols with physical layer components.

Layer 3 devices are routers and this is at the IP address layer. Other protocols used are ICMP and IGMP which are used as part of a protocol suit.

Layer 2 devices are switches and operate at the MAC address level.

Layer 1 – is the hardware layer and network cards are at this level.

The 4 layer model assumes the top layers as the high level program application layer and focuses on the bottom network layers for system design. This is the model for interconnecting LAN networks. It is easier to combine some layers for design simplicity. (Forouzan, 2012)

Explanations here are very good and you have also

Encapsulation

This is the process of taking data from one protocol and translating it into another protocol, so the data can continue across a *network*.

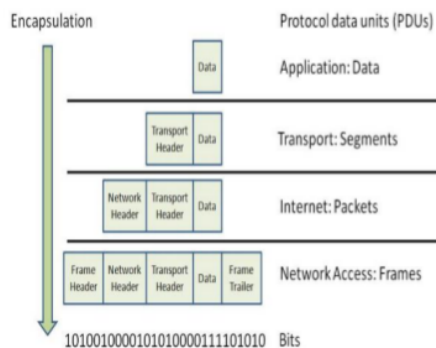


Fig. 2 Encapsulation

The data passes through the layers being transmitted with a header being added from each layer.

identified the devices associated with each layer by their protocols.

Decapsulation

The process of opening up encapsulated data that are usually sent in the form of packets over a communication network. It can be literally defined as the process of opening a capsule, which, in this case, refers to encapsulated or wrapped-up data.

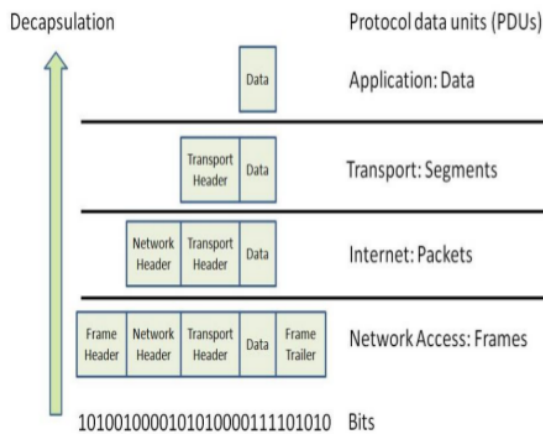


Fig. 3 Decapsulation

Excellent work here. Identified the purpose of encapsulation from the data examples.

This is the receive side and the headers are taken off as the data goes through each layer.

For example in Fig. 3 the frame is provided by the network access layer and can add a header. The packet is the data with a header containing the source and destination IP addresses. This data is taken off at the decapsulation end. (ccna, nd)

Broadcasting

This is used to send information to a large number of devices over the same network (LAN) or across multiple networks depending on the type of broadcast.

Broadcast is the term used to describe communication where a piece of information is sent from one point to all other points. In this case there is just one sender, but the information is sent to all connected receivers.

A broadcast is performed across the LAN as a handshake function to access all available IP and MAC addresses using ARP protocol.

Other broadcasts include unicast where only one sender and receiver and Multicast which is designed to send and receive to multiple devices over networks simultaneously.

The majority of LANs are able to support Multicast transmission mode. (Fairhurst, 2009)

Problem with broadcasting - is that the volume of broadcasts can severely impact on network performance.

The answer - reduce the size of the broadcast domain (which is the same as saying increase the number of broadcast domains).

Broadcast domain - The set of hosts that see each others broadcasts i.e. the network

Very good explanation which demonstrates your depth of reading

Port Allocation

Port numbers range from 0 to 65535, but only port numbers 0 to 1023 are reserved for privileged services and designated as well-known ports. The following list of well-known port numbers specifies the port used by the server process as its contact port.

The ports here are software ports and are allocated at random. The send and receive ports do not have to be the same for transmission as shown in Fig. 4. The client receives the data from the server sender and will identify the port 80 as HTTP protocol which is the web programming browser protocol.

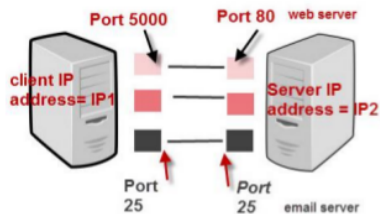
You have identified really significant point here and explained it very well

Some well-known port numbers are HTTP port 80, FTP port 20 and DNS port 53.

In computer networking, a port is a communication endpoint. At the software level, within an operating system, a port is a logical construct that identifies a specific process or a type of network service. Ports are identified for each protocol and address combination by 16-bit unsigned numbers, commonly known as the port number. The most common protocols that use port numbers are the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).

There is control of the ports when a transmission is received on a particular switch, the source of the MAC address is stored in the database of the switch. This explains how the router/switches can prevent flooding all ports. (Contemporary Systems Inc, 2011)

Just as the IP address identifies the computer, the network **port** identifies the **application or service** running on the computer.



A very detailed explanation

Fig. 4 Port Allocation

1.2 Routing

1.2.1 Network address configuration

The network has been set up using three routers, three switch-boards and three computers; two stationary PCs and one Laptop. The routers are connected using serial links and each router is connected to a computer through a switch board using LAN (Fig. 5).

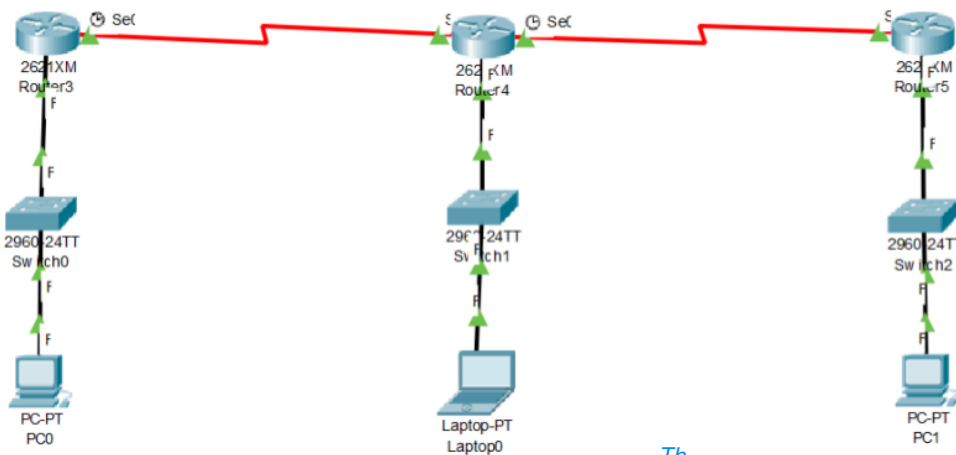


Fig. 5 network setup

The IP addressing of the network was configured so the three network classes would be present. The table below shows the IP configuration.

The table of addressing scheme should be here. Even though the addressing can be worked out from the router configs and your CAD programs, it is best practice to have the addressing in a table form. This would have to be the case for a larger system which in reality they will be.

The use of other CAD programs, it is best practice to have the addressing in a table form. This would have to be the case for a larger system which in reality they will be.

Static routing.

Below is shown the static routing for the routers 3, 4 and 5 respectively (Fig. 6, Fig. 7 & Fig. 8).

The screenshot shows the configuration window for Router3. The 'Config' tab is active, and the 'Static' option under the 'ROUTING' section is selected in the left sidebar. The 'Static Routes' section on the right contains three input fields: 'Network', 'Mask', and 'Next Hop'. Below these fields is an 'Add' button. A table below the 'Add' button lists the configured static routes:

Network Address
102.0.0.0/8 via 10.5.5.2
162.102.0.0/16 via 10.5.5.2

At the bottom right of the table is a 'Remove' button.

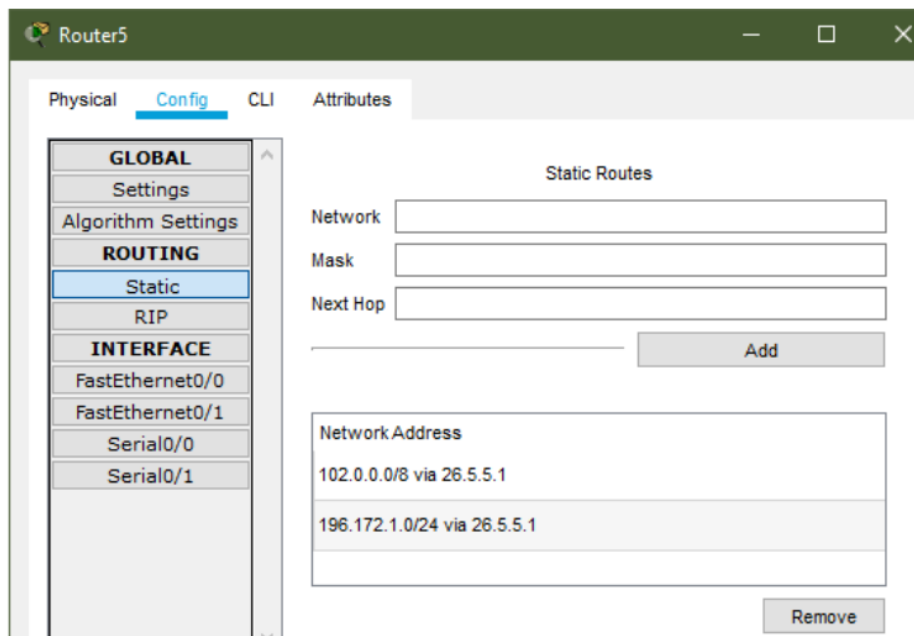
Fig. 6 Static routing for Router 3

The screenshot shows the configuration window for Router4. The 'Config' tab is active, and the 'Static' option under the 'ROUTING' section is selected in the left sidebar. The 'Static Routes' section on the right contains three input fields: 'Network', 'Mask', and 'Next Hop'. Below these fields is an 'Add' button. A table below the 'Add' button lists the configured static routes:

Network Address
196.172.1.0/24 via 10.5.5.1
162.102.0.0/16 via 26.5.5.2

At the bottom right of the table is a 'Remove' button.

Fig. 7 Static routing for Router 4



Screenshots show good evidence of the routing configurations

Fig. 8 Static routing for router 5

Fire	Last Status	Source	Destination	Type
	Successful	PC0	Laptop0	ICMP
	Successful	PC0	PC1	ICMP
	Successful	Laptop0	PC1	ICMP
	Successful	PC1	Laptop0	ICMP
	Successful	PC1	PC0	ICMP
	Successful	Laptop0	PC0	ICMP

Test are successful which indicates the configuration is correct. Good method of testing which eliminates redundancies

Fig. 9 Proof that static addressing works

On Fig. 9 is shown a table with a result of sending simple packages between the computers to prove that the network works.

RIP Routing

On Fig. 10, Fig. 11 & Fig. 12 are shown the RIP routing tables for routers 3, 4 & 5 respectively.

Routing Table for Router3

Type	Network	Port	Next Hop IP	Metric
C	10.0.0.0/8	Serial0/0	---	0/0
R	26.0.0.0/8	Serial0/0	10.5.5.2	120/1
R	102.0.0.0/8	Serial0/0	10.5.5.2	120/1
R	162.102.0.0/16	Serial0/0	10.5.5.2	120/2
C	196.172.1.0/24	FastEthernet0/0	---	0/0

Fig. 10 Routing table for router 3

Routing Table for Router4

Type	Network	Port	Next Hop IP	Metric
C	10.0.0.0/8	Serial0/1	---	0/0
C	26.0.0.0/8	Serial0/0	---	0/0
C	102.0.0.0/8	FastEthernet0/0	---	0/0
R	162.102.0.0/16	Serial0/0	26.5.5.2	120/1
R	196.172.1.0/24	Serial0/1	10.5.5.1	120/1

Fig. 11 Routing table for router 4

Routing Table for Router5

Type	Network	Port	Next Hop IP	Metric
R	10.0.0.0/8	Serial0/0	26.5.5.1	120/1
C	26.0.0.0/8	Serial0/0	---	0/0
R	102.0.0.0/8	Serial0/0	26.5.5.1	120/1
C	162.102.0.0/16	FastEthernet0/0	---	0/0
R	196.172.1.0/24	Serial0/0	26.5.5.1	120/2

RIP tables show evidence of correct configuration

Fig. 12 Routing table for router 5

```
Router3>Enable
Router3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router3(config)#router rip
Router3(config-router)#ver 2
Router3(config-router)#net 196.172.1.0
Router3(config-router)#net 10.5.5.0
Router3(config-router)#net 102.0.0.0
Router3(config-router)#!^Z
Router3#
%SYS-5-CONFIG_I: Configured from console by console

Router3#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    26.0.0.0/8 [120/1] via 10.5.5.2, 00:00:04, Serial0/0
R    102.0.0.0/8 [120/1] via 10.5.5.2, 00:00:04, Serial0/0
R    162.102.0.0/16 [120/2] via 10.5.5.2, 00:00:04, Serial0/0
C    196.172.1.0/24 is directly connected, FastEthernet0/0
```

Fig. 13 IP configuration and show IP for router 3

```

Router4>enable
Router4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router4(config)#router rip
Router4(config-router)#ver 2
Router4(config-router)#net 196.172.1.0
Router4(config-router)#net 10.5.5.0
Router4(config-router)#net 102.0.0.0
Router4(config-router)#net 26.5.5.0
Router4(config-router)#net 162.102.0.0
Router4(config-router)#!^Z
Router4#
%SYS-5-CONFIG_I: Configured from console by console
Router4#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    26.0.0.0/8 is directly connected, Serial0/0
C    102.0.0.0/8 is directly connected, FastEthernet0/0
R    162.102.0.0/16 [120/1] via 26.5.5.2, 00:00:20, Serial0/0
R    196.172.1.0/24 [120/1] via 10.5.5.1, 00:00:08, Serial0/1

```

Fig. 14 IP configuration and show IP for router 4

```

Router5>enable
Router5#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router5(config)#router rip
Router5(config-router)#ver 2
Router5(config-router)#net 102.0.0.0
Router5(config-router)#net 26.5.5.0
Router5(config-router)#net 162.102.0.0
Router5(config-router)#!^Z
Router5#
%SYS-5-CONFIG_I: Configured from console by console
Router5#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 26.5.5.1, 00:00:04, Serial0/0
C    26.0.0.0/8 is directly connected, Serial0/0
R    102.0.0.0/8 [120/1] via 26.5.5.1, 00:00:04, Serial0/0
C    162.102.0.0/16 is directly connected, FastEthernet0/0
R    196.172.1.0/24 [120/2] via 26.5.5.1, 00:00:04, Serial0/0

```

Screenshots show the config process and the report from each router the connected ip's and the routed ip's.

Fig. 15 IP configuration and show IP for router 5

Fire	Last Status	Source	Destination	Type	Color	Time(sec)
	Successful	PC1	Laptop0	ICMP		0.000
	Successful	Laptop0	Router4	ICMP		0.000
	Successful	Laptop0	Router5	ICMP		0.000
	Successful	Laptop0	PC1	ICMP		0.000
	Successful	Laptop0	PC1	ICMP		0.000
	Successful	PC1	Laptop0	ICMP		0.000
	Successful	PC1	PC0	ICMP		0.000
	Successful	PC0	Laptop0	ICMP		0.000
	Successful	PC0	PC1	ICMP		0.000
	Successful	Laptop0	PC1	ICMP		0.000

Tests are successful with redundant tests eliminated

Fig. 16 Test table for RIP routing

The above table shows that the router configuration was successful, and it is working correctly.

DHCP Routing

Below is shown the proof of successful dynamic routing for each of the computers (Fig. 17-Fig. 19). The routers were configured to exclude the first 10 addresses (.1 - .10). The configuration is shown on pg. 17-25.

IP Configuration	
☒ DHCP	
☐ Static	
IP Address	196.172.1.11
Subnet Mask	255.255.255.0

Fig. 17 Successful DHCP routing for PC0

IP Configuration	
☒ DHCP	
☐ Static	
IP Address	102.0.0.11
Subnet Mask	255.0.0.0

Fig. 18 Successful DHCP routing for Laptop0

IP Configuration	
☒ DHCP	
☐ Static	
IP Address	162.102.0.11
Subnet Mask	255.255.0.0

Fig. 19 Successful DHCP routing for PC1

The DHCP here shows the ip addresses being dynamically assigned. The helper address needs to be explained here and what happens if the helper address is not implemented.

Router3 Configuration and show run

```
Router3>enable
Router3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router3(config)#ip dhcp pool net1
Router3(dhcp-config)#net 196.172.1.0 255.255.255.0
Router3(dhcp-config)#default-router 196.172.1.254
Router3(dhcp-config)#dns-server 196.172.1.254
Router3(dhcp-config)#exit
Router3(config)#ip dhcp pool net2
Router3(dhcp-config)#net 102.0.0.0 255.0.0.0
Router3(dhcp-config)#default-router 102.0.0.254
Router3(dhcp-config)#dns-server 102.0.0.254
Router3(dhcp-config)#exit
Router3(config)#ip dhcp pool net3
Router3(dhcp-config)#net 162.102.0.0 255.255.0.0
Router3(dhcp-config)#default-router 162.102.0.254
Router3(dhcp-config)#dns-server 162.102.0.254
Router3(dhcp-config)#exit
Router3(config)#!^Z
Router3#
%SYS-5-CONFIG_I: Configured from console by console
Router3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router3(config)#ip dhcp excluded-address 196.172.1.10
Router3(config)#ip dhcp excluded-address 102.0.0.1 102.0.0.10
Router3(config)#ip dhcp excluded-address 196.172.1.1 196.172.1.10
Router3(config)#ip dhcp excluded-address 162.102.1.1 162.102.1.10
Router3(config)#!^Z
Router3#
Router3#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    26.0.0.0/8 [120/1] via 10.5.5.2, 00:00:18, Serial0/0
R    102.0.0.0/8 [120/1] via 10.5.5.2, 00:00:18, Serial0/0
R    162.102.0.0/16 [120/2] via 10.5.5.2, 00:00:18, Serial0/0
C    196.172.1.0/24 is directly connected, FastEthernet0/0

Router3#
```

*Configurations are correct and
the screenshots are good
evidence*

```

Router3#show run
Building configuration...

Current configuration : 1385 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname Router3
!
!
!
!
ip dhcp excluded-address 196.172.1.10
ip dhcp excluded-address 102.0.0.1 102.0.0.10
ip dhcp excluded-address 196.172.1.1 196.172.1.10
ip dhcp excluded-address 162.102.0.1 162.102.0.10
ip dhcp excluded-address 162.102.1.1 162.102.1.10
!
ip dhcp pool net1
network 196.172.1.0 255.255.255.0
default-router 196.172.1.254
dns-server 196.172.1.254
ip dhcp pool net2
network 102.0.0.0 255.0.0.0
default-router 102.0.0.254
dns-server 102.0.0.254
ip dhcp pool net3
network 162.102.0.0 255.255.0.0
default-router 162.102.0.254
dns-server 162.102.0.254
ip dhcp pool net1
network 196.172.1.0 255.255.255.0
default-router 196.172.1.254
dns-server 196.172.1.254
!
!
!
no ip cef
no ipv6 cef

```

The router report here shows the addresses used which in this element are class A, B and C.

```

interface FastEthernet0/0
ip address 196.172.1.254 255.255.255.0
duplex auto
speed auto
!
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
!
interface Serial0/0
ip address 10.5.5.1 255.0.0.0
clock rate 2000000
!
interface Serial0/1
no ip address
clock rate 2000000
shutdown
!
router rip
version 2
network 10.0.0.0
network 102.0.0.0
network 196.172.1.0
!
ip classless
!
ip flow-export version 9
!
!
!
!
!
!
!
!
line con 0
!
line aux 0
!
line vty 0 4
login
!
!
!
end

```

Router4 configuration and showrun

```
Router4>enable
Router4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router4(config)#int f0/0
Router4(config-if)#ip helper-address 10.5.5.1
Router4(config-if)#exit
Router4(config)#!^Z
Router4#
%SYS-5-CONFIG_I: Configured from console by console
Router4#
Router4#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    26.0.0.0/8 is directly connected, Serial0/0
C    102.0.0.0/8 is directly connected, FastEthernet0/0
R    162.102.0.0/16 [120/1] via 26.5.5.2, 00:00:23, Serial0/0
R    196.172.1.0/24 [120/1] via 10.5.5.1, 00:00:04, Serial0/1

Router4#
Router4#show run
Building configuration...

Current configuration : 774 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname Router4
!
!
!
!
!
!
!
no ip cef
no ipv6 cef
!
!
!
```

```

interface FastEthernet0/0
ip address 102.0.0.254 255.0.0.0
ip helper-address 10.5.5.1
duplex auto
speed auto
!
interface FastEthernet0/1
no ip address
duplex auto
speed auto
shutdown
!
interface Serial0/0
ip address 26.5.5.1 255.0.0.0
clock rate 2000000
!
interface Serial0/1
ip address 10.5.5.2 255.0.0.0
!
router rip
version 2
network 10.0.0.0
network 26.0.0.0
network 102.0.0.0
network 162.102.0.0
network 196.172.1.0
!
ip classless
!
ip flow-export version 9
!
!
!
!
!
!
!
line con 0
!
line aux 0
!
line vty 0 4
login
!
!
!
end

```

Router5 configuration and showrun

```
Router5>enable
Router5#conf t
Enter configuration commands, one per line. End with CNIL/Z.
Router5(config)#int f0/0
Router5(config-if)#ip helper-address 10.5.5.1
Router5(config-if)#exit
Router5(config)#!^Z
Router5#
%SYS-5-CONFIG_I: Configured from console by console

Router5#
Router5#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 26.5.5.1, 00:00:18, Serial0/0
C    26.0.0.0/8 is directly connected, Serial0/0
R    102.0.0.0/8 [120/1] via 26.5.5.1, 00:00:18, Serial0/0
C    162.102.0.0/16 is directly connected, FastEthernet0/0
R    196.172.1.0/24 [120/2] via 26.5.5.1, 00:00:18, Serial0/0

Router5#
Router5#show run
Building configuration...

Current configuration : 733 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname Router5
!
!
!
!
!
!
!
no ip cef
no ipv6 cef
!
!
!
```

```

!
!
!
interface FastEthernet0/0
 ip address 162.102.0.254 255.255.0.0
 ip helper-address 10.5.5.1
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface Serial0/0
 ip address 26.5.5.2 255.0.0.0
!
interface Serial0/1
 no ip address
 clock rate 2000000
 shutdown
!
router rip
 version 2
 network 26.0.0.0
 network 102.0.0.0
 network 162.102.0.0
!
ip classless
!
ip flow-export version 9
!
!
!
!
!
!
!
line con 0
!
line aux 0
!
line vty 0 4
 login
!
!
!
end

```

Full configuration is shown in the screenshots and the individual router reports show the routers are correctly configured for RIP and DHCP with excluded addresses assigned.

Fire	Last Status	Source	Destination	Type	Color	Time(sec)
	Successful	PC0	PC1	ICMP		0.000
	Successful	PC0	Laptop0	ICMP		0.000
	Successful	Laptop0	PC0	ICMP		0.000
	Successful	Laptop0	PC1	ICMP		0.000
	Successful	PC1	Laptop0	ICMP		0.000
	Successful	PC1	PC0	ICMP		0.000

Fig. 20 proof that the routed network is working

T
 h
 e
 t
 e
 s
 t
 r
 e
 s
 u
 l
 t
 s
 c
 l
 e
 a
 r
 l
 y
 s
 h
 o
 w
 t
 h
 e
 s
 y
 s
 t
 e
 m
 i
 s
 w
 o
 r
 k
 i
 n
 g

1.3 Evaluation

Using the research into the layout of those tasks, the task of using different routing methods and using different IP classes could be conducted

Static routing was explored, where each device and router must be configured manually from the terminal. The RIP dynamic routing allowed to route many devices much quicker and it allows for the router to be configured remotely, as long as the IP address of the router is known.

Dynamic Host Communication Protocol (DHCP) is more complex to configure on the router, but once configured, the connected devices don't need to be configured as the IP address is assigned to them automatically. This type of routing also allows for certain addresses to be excluded from the automatic assignment of addresses to devices.

In general, the practical tasks tie with the research and it is essential for the next part of the element where those concepts will be explored further.

*Good
evaluation*

Element 2

2.1 Introduction

This element will use the knowledge and skills gained in the previous element to build a new network that will implement CIDR/27, CIDR/30, VLAN and ACL at the end of this element. Throughout this element, CIDR/28 will also be used for a better understanding of CIDR workings and how it is implemented in a wider network with the use of RIP routing.

2.2 System Configuration & Requirements

The networking will have a triangular network between three routers situated in three different cities: Wrocław, Warszawa and Opole. There will be 6 separate networks: 3 LAN networks and 3 WAN networks. The LAN networks being the connections from router to PCs and the WAN networks being the inter-router networks.

2.3 CIDR/28 Networking

LAN Networks

CIDR/28 Warszawa Network 1 LAN Address 64

Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
	0	1	0	0	0	0	0	0	Not used	
Network address 64	0	1	0	0	0	0	0	1	Lowest host address 65	
Network address 64	0	1	0	0	0	0	1	0	Next host address 66	
Default gateway	0	1	0	0	1	1	1	0	Fastethernet 0/0 address 78	
	0	1	0	0	1	1	1	1	Broadcast 79	

CIDR/28 Wroclaw Network 2 LAN Address 80

Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
	0	1	0	1	0	0	0	0	Not used	
Network address 80	0	1	0	1	0	0	0	1	Lowest host address 81	
Network address 80	0	1	0	1	0	0	1	0	Next host address 82	
Default gateway	0	1	0	1	1	1	1	0	Fastethernet 0/0 address 94	
	0	1	0	1	1	1	1	1	Broadcast 95	

CIDR/28 Opole Network 3 LAN Address 96

Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
	0	1	1	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	0	1	1	0	1	1	1	0	Fastethernet 0/0 address 110	
	0	1	1	0	1	1	1	1	Broadcast 111	

WAN Networks

CIDR/28 Warszawa ⇌ Wroclaw Network 4 Network address 160

Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
					0	0	0	0	Not used	
Warszawa Router	1	0	1	0	1	1	0	1	Serial 0/0 address 173	
Wroclaw Router	1	0	1	0	1	1	1	0	Serial 0/0 address 174	

CIDR/28 Wroclaw ⇌ Opole Network 5 Network address 176

Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
					0	0	0	0	Not used	
Wroclaw Router	1	0	1	1	1	1	0	1	Serial 0/1 address 189	
Opole Router	1	0	1	1	1	1	1	0	Serial 0/1 address 190	

Addressing scheme tables are correct and the subnetted addresses are clearly shown. All 6 networks have been subnetted and you have assigned appropriate addresses to the serial WAN networks.

CIDR/28

Opole $\rightleftharpoons$ Warszawa Network 6

Network address 192

Subnet mask	1	1	1	1	0	0	0	0	255.255.255.240	/28
					0	0	0	0	Not used	
Opole Router	1	1	0	0	1	1	0	1	Serial 0/0 address 205	
Warszawa Router	1	1	0	0	1	1	1	0	Serial 0/1 address 206	

Routing Table for Warszawa					
Type	Network	Port	Next Hop IP	Metric	
C	198.169.102.64/28	FastEthernet0/0	---	0/0	
R	198.169.102.80/28	Serial0/0	198.169.102.174	120/1	
R	198.169.102.96/28	Serial0/1	198.169.102.205	120/1	
C	198.169.102.160/28	Serial0/0	---	0/0	
R	198.169.102.176/28	Serial0/1	198.169.102.205	120/1	
R	198.169.102.176/28	Serial0/0	198.169.102.174	120/1	
C	198.169.102.192/28	Serial0/1	---	0/0	

Fig. 21 Routing table for Warszawa, CIDR/28

Routing Table for Wroclaw					
Type	Network	Port	Next Hop IP	Metric	
R	198.169.102.64/28	Serial0/0	198.169.102.173	120/1	
C	198.169.102.80/28	FastEthernet0/0	---	0/0	
R	198.169.102.96/28	Serial0/1	198.169.102.190	120/1	
C	198.169.102.160/28	Serial0/0	---	0/0	
C	198.169.102.176/28	Serial0/1	---	0/0	
R	198.169.102.192/28	Serial0/1	198.169.102.190	120/1	
R	198.169.102.192/28	Serial0/0	198.169.102.173	120/1	

Fig. 22 Routing table for Wroclaw, CIDR/28

Routing Table for Opole					
Type	Network	Port	Next Hop IP	Metric	
R	198.169.102.64/28	Serial0/0	198.169.102.206	120/1	
R	198.169.102.80/28	Serial0/1	198.169.102.189	120/1	
C	198.169.102.96/28	FastEthernet0/0	---	0/0	
R	198.169.102.160/28	Serial0/0	198.169.102.206	120/1	
R	198.169.102.160/28	Serial0/1	198.169.102.189	120/1	
C	198.169.102.176/28	Serial0/1	---	0/0	
C	198.169.102.192/28	Serial0/0	---	0/0	

RIP tables clearly show the routed addresses

Fig. 23 Routing table for Opole, CIDR/28

Fire	Last Status	Source	Destination	Type	Color	Time(sec)
	Successful	Laptop0	Laptop1	ICMP		0.000
	Successful	Laptop2	PC0	ICMP		0.000
	Successful	PC3	Laptop1	ICMP		0.000
	Successful	Laptop2	PC1	ICMP		0.000
	Successful	PC3	Laptop0	ICMP		0.000
	Successful	PC0	PC1	ICMP		0.000

Fig. 24 Testing results for CIDR/28 networking

Screenshot shows evidence of the tests and also redundant test are eliminated using good test methods

2.4 CIDR/27 and CIDR/30 Networking

LAN Networks

CIDR/27 used for the LAN networks and it requires less networks but usually there is a lot of devices on each of the networks.

CIDR/27 Warszawa Network 1 LAN Address 96

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	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	0	1	1	1	1	1	1	0	Fastethernet 0/0 address 126	
	0	1	1	1	1	1	1	1	Broadcast 127	

CIDR/27 Wroclaw Network 2 LAN Address 128

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 128	1	0	0	0	0	0	0	1	Lowest host address 129	
Network address 128	1	0	0	0	0	0	1	0	Next host address 130	
Default gateway	1	0	0	1	1	1	1	0	Fastethernet 0/0 address 158	
	1	0	0	1	1	1	1	1	Broadcast 159	

VLSM for the LAN networks are correct and the use of tables is a good method of setting out the address scheme.

CIDR/27 Opole Network 3 LAN Address 160

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 160	1	0	1	0	0	0	0	1	Lowest host address 161	
Network address 160	1	0	1	0	0	0	1	0	Next host address 162	
Default gateway	1	0	1	1	1	1	1	0	Fastethernet 0/0 address 190	
	1	0	1	1	1	1	1	1	Broadcast 191	

WAN Networks

CIDR/30 is used for addressing the between routers networks as in this case more networks are required and there is very few devices per network. To make sure that the addresses do not overlap, the first network address used is 192, as it is the follow up from the last LAN address in CIDR/27 as shown above (Network 3)

CIDR/30 Warszawa ⇌ Wroclaw Network 4 Network address 192

Subnet mask	1	1	1	1	1	1	0	0	255.255.255.252	/30
	0	0	0	0	0	0	0	0	Not used	
Warszawa Router	1	1	0	0	0	0	0	1	Serial 0/0 address 193	
Wroclaw Router	1	1	0	0	0	0	1	0	Serial 0/0 address 194	

CIDR/30 Wroclaw ⇌ Opole Network 5 Network address 196

Subnet mask	1	1	1	1	1	1	0	0	255.255.255.252	/30
	0	0	0	0	0	0	0	0	Not used	
Wroclaw Router	1	1	0	0	0	1	0	1	Serial 0/1 address 197	
Opole Router	1	1	0	0	0	1	1	0	Serial 0/1 address 198	

VLSM /30 is

clearly shown

here and the

spacing out of

the WAN

serial

addresses

can be

considered

good practice

CIDR/30

Opole $\Rightarrow$ Warszawa Network 6

Network address 200

Subnet mask	1	1	1	1	1	1	0	0	255.255.255.252	/30
	0	0	0	0	0	0	0	0	Not used	
Opole Router	1	1	0	0	1	0	0	1	Serial 0/0 address 201	
Warszawa Router	1	1	0	0	1	0	1	0	Serial 0/1 address 202	

As the RIP routing was already set on the previous network, there was no need to set it up again this time. It automatically detected the changes in the CIDR class (through the subnet mask) and their corresponding IP addresses.

Routing Table for Warszawa

Type	Network	Port	Next Hop IP	Metric
C	198.169.102.96/27	FastEthernet0/0	---	0/0
R	198.169.102.128/27	Serial0/0	198.169.102.194	120/1
R	198.169.102.160/27	Serial0/1	198.169.102.201	120/1
C	198.169.102.192/30	Serial0/0	---	0/0
R	198.169.102.196/30	Serial0/0	198.169.102.194	120/1
R	198.169.102.196/30	Serial0/1	198.169.102.201	120/1
C	198.169.102.200/30	Serial0/1	---	0/0

Fig. 25 Routing table for Warszawa, CIDR/27; CIDR/30

Routing Table for Wroclaw

Type	Network	Port	Next Hop IP	Metric
R	198.169.102.96/27	Serial0/0	198.169.102.193	120/1
C	198.169.102.128/27	FastEthernet0/0	---	0/0
R	198.169.102.160/27	Serial0/1	198.169.102.198	120/1
C	198.169.102.192/30	Serial0/0	---	0/0
C	198.169.102.196/30	Serial0/1	---	0/0
R	198.169.102.200/30	Serial0/0	198.169.102.193	120/1
R	198.169.102.200/30	Serial0/1	198.169.102.198	120/1

Fig. 26 Routing table for Wroclaw, CIDR/27; CIDR/30

Routing Table for Opole

Type	Network	Port	Next Hop IP	Metric
R	198.169.102.96/27	Serial0/0	198.169.102.202	120/1
R	198.169.102.128/27	Serial0/1	198.169.102.197	120/1
C	198.169.102.160/27	FastEthernet0/0	---	0/0
R	198.169.102.192/30	Serial0/0	198.169.102.202	120/1
R	198.169.102.192/30	Serial0/1	198.169.102.197	120/1
C	198.169.102.196/30	Serial0/1	---	0/0
C	198.169.102.200/30	Serial0/0	---	0/0

Fig. 27 Routing table for Opole, CIDR/27; CIDR/30

Screen shots show the RIP tables are setup for the VLSM network.

Fire	Last Status	Source	Destination	Type	Color	Time(sec)
	Successful	Laptop2	Laptop0	ICMP		0.000
	Successful	PC0	Laptop1	ICMP		0.000
	Successful	Laptop1	PC3	ICMP		0.000
	Successful	PC1	Laptop2	ICMP		0.000
	Successful	PC3	Laptop0	ICMP		0.000
	Successful	PC0	PC1	ICMP		0.000

Fig. 28 Testing results for CIDR/27; CIDR/30 networking

Testing shows the network is working correctly. Good test method used with no redundant tests.

2.5 VLAN for CIDR/27 sub network

The router on which the VLAN will be configured is *Wroclaw* from network 2. The VLAN networking is based on the built and tested CIDR/27;CIDR/30 networking. The principle of the VLAN networking is to have two different networks hooked up to the same port of a router through a switch. First of the IP address of PC1 is changed to one of the available networks within the CIDR/27. The new IP address is 198.169.102.66 with a default gateway 198.169.102.94.

Below is shown the configuration of the switch:

```
WroclawSwitch>enable
WroclawSwitch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
WroclawSwitch(config)#vlan 2
WroclawSwitch(config-vlan)#name vlan2
WroclawSwitch(config-vlan)#exit
WroclawSwitch(config)#vlan 3
WroclawSwitch(config-vlan)#name vlan3
WroclawSwitch(config-vlan)#exit
WroclawSwitch(config)#!^Z
WroclawSwitch#
%SYS-5-CONFIG_I: Configured from console by console
WroclawSwitch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
WroclawSwitch(config)#int fa0/2
WroclawSwitch(config-if)#switchport mode access
WroclawSwitch(config-if)#switchport access vlan 2
WroclawSwitch(config-if)#exit
WroclawSwitch(config)#int fa0/3
WroclawSwitch(config-if)#switch mode access
WroclawSwitch(config-if)#switch access vlan 3
WroclawSwitch(config-if)#exit
WroclawSwitch(config)#!^Z
WroclawSwitch#
%SYS-5-CONFIG_I: Configured from console by console
!^Z
WroclawSwitch#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, Gig0/1, Gig0/2
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	

You could point out here that the VLAN will reduce the broadcast domain size and allow configurable security

VLANs are configured with interfaces assigned

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

```
WroclawSwitch#
WroclawSwitch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
WroclawSwitch(config)#int fa0/1
WroclawSwitch(config-if)#switchport mode trunk

WroclawSwitch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

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

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

Port      Vlans allowed on trunk
Fa0/1     1-1005

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

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

Report shows trunking is configured on the switch

WroclawSwitch#

Once the switch was configured, the router had to be configured. The configuration of the router is shown below:

```
WroclawRouter>enable
WroclawRouter#conf t
Enter configuration commands, one per line. End with CNTL/Z.
WroclawRouter(config)#int fa0/0
WroclawRouter(config-if)#no shutdown
WroclawRouter(config-if)#no ip address
WroclawRouter(config-if)#exit
WroclawRouter(config)#int f0/0.2
WroclawRouter(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

WroclawRouter(config-subif)#encapsulation dot1Q 2
WroclawRouter(config-subif)#ip address 198.169.102.94 255.255.255.224
WroclawRouter(config-subif)#no shutdown
WroclawRouter(config-subif)#exit
WroclawRouter(config)#int fa0/0.3
WroclawRouter(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

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

```

WroclawRouter(config-subif)#ip address 198.169.102.158 255.255.255.224
WroclawRouter(config-subif)#no shutdown
WroclawRouter(config-subif)#exit
WroclawRouter(config)#!^Z
WroclawRouter#
%SYS-5-CONFIG_I: Configured from console by console

```

```

WroclawRouter#show ip int brie
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0 unassigned      YES manual up          up
FastEthernet0/0.2 198.169.102.94 YES manual up          up
FastEthernet0/0.3 198.169.102.158 YES manual up          up
FastEthernet0/1 unassigned      YES unset administratively down down
Serial0/0        198.169.102.194 YES manual up          up
Serial0/1        198.169.102.197 YES manual up          up
WroclawRouter#

```

The report shows the original gateway address has now been subnetted with two separate gateways using the trunk protocol.

On Fig. 29 is shown the new routing table for Wroclaw. The routing tables for other routers are omitted as those has not changed.

Routing Table for Wroclaw				
Type	Network	Port	Next Hop IP	Metric
C	198.169.102.64/27	FastEthernet0/0.2	---	0/0
R	198.169.102.96/27	Serial0/0	198.169.102.193	120/1
C	198.169.102.128/27	FastEthernet0/0.3	---	0/0
R	198.169.102.160/27	Serial0/1	198.169.102.198	120/1
C	198.169.102.192/30	Serial0/0	---	0/0
C	198.169.102.196/30	Serial0/1	---	0/0
R	198.169.102.200/30	Serial0/0	198.169.102.193	120/1
R	198.169.102.200/30	Serial0/1	198.169.102.198	120/1

RIP table recognises the subnetted gateway using the ver 2 RIP.

Fig. 29 Routing table for Wroclaw, VLAN

To make sure that the network is working properly, the packages were sent in and out the new VLAN networks and all transmissions were successful as it is shown on Fig. 30.

Fire	Last Status	Source	Destination	Type	Color	Time(sec)
	Successful	Laptop0	PC1	ICMP		0.000
	Successful	PC1	PC0	ICMP		0.000
	Successful	Laptop0	PC3	ICMP		0.000
	Successful	PC3	PC0	ICMP		0.000
	Successful	Laptop1	PC1	ICMP		0.000
	Successful	PC3	Laptop1	ICMP		0.000
	Successful	PC1	Laptop1	ICMP		0.000
	Successful	Laptop1	PC3	ICMP		0.000

Fig. 30 Testing results for VLAN networking

*Screenshot shows
the tests are
successful with test
method eliminating
redundancies*

2.6 ACL

Now an ACL will be set up in Opole's router to block the signal from one of the previously configured VLAN networks. The ACL will be configured to block VLAN 3 (IP=198.169.102.132) but allow connection with VLAN 2 (IP=198.169.102.66). The router has been configured as follows:

```
OpoleRouter>Enable
OpoleRouter#conf t
Enter configuration commands, one per line. End with CNTL/Z.
OpoleRouter(config)#access-list 1 ?
    deny      Specify packets to reject
    permit    Specify packets to forward
    remark    Access list entry comment
OpoleRouter(config)#access-list 1 deny 198.169.102.132 0.0.0.0
OpoleRouter(config)#access-list 1 permit any
OpoleRouter(config)#!
OpoleRouter#
%SYS-5-CONFIG I: Configured from console by console
```

```
OpoleRouter#show run
Building configuration...
```

```
Current configuration : 777 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
```

```
hostname OpoleRouter
```

```

!
!
!
!
!
!
!
!
no ip cef
no ipv6 cef

```

```
!
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
  
interface FastEthernet0/0  
ip address 198.169.102.190 255.255.255.224  
duplex auto  
speed auto  
!  
interface FastEthernet0/1  
no ip address
```

Screen shot shows evidence of ACL configuration

```

duplex auto
speed auto
shutdown
!
interface Serial0/0
ip address 198.169.102.201 255.255.255.252
!
interface Serial0/1
ip address 198.169.102.198 255.255.255.252
clock rate 2000000
!
router rip
version 2
network 198.169.102.0
!
ip classless
!
ip flow-export version 9
!
!
access-list 1 deny host 198.169.102.132
access-list 1 permit any
!
!
!
!
!
line con 0
!
line aux 0
!
line vty 0 4
login
!
!
!
end

OpoleRouter#conf t
Enter configuration commands, one per line. End with CNTL/Z.
OpoleRouter(config)#int fa0/0
OpoleRouter(config-if)#ip access-group 1 ?
    in    inbound packets
    out   outbound packets
OpoleRouter(config-if)#ip access-group 1 out
OpoleRouter(config-if)#!
OpoleRouter#
%SYS-5-CONFIG_I: Configured from console by console

OpoleRouter#
```

Once the router was configured, the connections were tested by using the CMD of *Laptop 1* and *Laptop 2* from Opole's network (Network 3). The connections were tested to both VLAN networks to confirm that there is connection with VLAN 2 (IP=198.169.102.66) but not with VLAN 3 (IP=198.169.102.132).

CMD code from *Laptop 1*:

```
"Packet Tracer PC Command Line 1.0
C:\>ping 198.169.102.132
```

Pinging 198.169.102.132 with 32 bytes of data:

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

```
Ping statistics for 198.169.102.132:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

```
C:\>ping 198.169.102.66
```

Pinging 198.169.102.66 with 32 bytes of data:

```
Reply from 198.169.102.66: bytes=32 time=9ms TTL=126
Reply from 198.169.102.66: bytes=32 time=21ms TTL=126
Reply from 198.169.102.66: bytes=32 time=11ms TTL=126
Reply from 198.169.102.66: bytes=32 time=7ms TTL=126
```

```
Ping statistics for 198.169.102.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 7ms, Maximum = 21ms, Average = 12ms"
```

And the CMD command lines from *Laptop 2*:

```
"C:\>ping 198.169.102.132
```

Pinging 198.169.102.132 with 32 bytes of data:

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

```
Ping statistics for 198.169.102.132:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

```
C:\>ping 198.169.102.66
```

Pinging 198.169.102.66 with 32 bytes of data:

```
Reply from 198.169.102.66: bytes=32 time=10ms TTL=126
Reply from 198.169.102.66: bytes=32 time=1ms TTL=126
Reply from 198.169.102.66: bytes=32 time=1ms TTL=126
Reply from 198.169.102.66: bytes=32 time=1ms TTL=126
```

```
Ping statistics for 198.169.102.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 10ms, Average = 3ms"
```

Screen shot of ping test clearly shows successful connection to 198.169.102.66 and no connection to 198.169.102.132. And the CMD command lines from Laptop 2: "C:\>ping 198.169.102.132" "C:\>ping 198.169.102.66" Ping statistics for 198.169.102.132: Packets: Sent = 4, Received = 0, Lost = 4 (100% loss), Ping statistics for 198.169.102.66: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss), Approximate round trip times in milli-seconds: Minimum = 1ms, Maximum = 10ms, Average = 3ms"

2.7 Evaluation

The use of CIDR networks, VLAN and ACLs have been proven to be understood by building and thoroughly testing the networks ensuring that every part and component of the network works as it was expected to. It is ok to carry the workings onto the next element.

Element 3

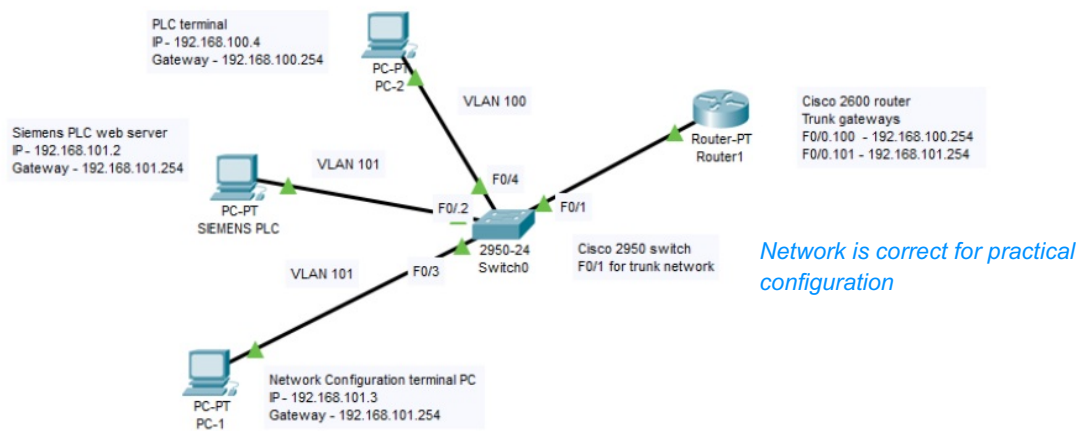


Fig. 31 Diagram of the real-life built system



Image showing practical connections to Cisco devices

Fig. 32 physical setup of the system

3.1 Router and Switch configuration

The above diagram represents how the system is set-up during the practical. The system is composed by the following:

Laptop x 2

Siemens PLC

Cisco 2600 router

Cisco 2950 switch

The list of components for the network shows the PLC and the two PCs. One PC will be assigned to program and control the PLC and the other will be assigned to configure the VLAN network.

As it is shown on Fig. 31, one of the laptops is for configuring the switch and the router, while the other PLC is used to first program the PLC and then read real-time data from the PLC. The configuration codes for the routing and switch are shown below.

Device allocation has been identified

VLAN configuration:

```
Switch>enable
Switch#conf t
Switch(config)#vlan 100
Switch(config-vlan)#name vlan100
Switch(config-vlan)#exit
Switch(config)#vlan 101
Switch(config-vlan)#name vlan101
Switch(config-vlan)#exit
Switch(config)#^Z
Switch#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, Gig0/1, Gig0/2
2	vlan2	active	
3	vlan3	active	
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
---------	-----------	------	-------

```
Switch#conf t
Switch(config)#int f0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 101
Switch(config-if)#exit
Switch(config)#int f0/3
Switch(config-if)#switchport mode access
```

```
Switch(config-if)#switchport access vlan 101
Switch(config-if)#exit
Switch(config)#int f0/4
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 100
Switch(config-if)#exit
Switch(config)#^Z
Switch#show vlan
```

VLAN	Name	Status	Ports
1	default	active	Fa0/1, 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, Gig0/1, Gig0/2
2	vlan2	active	Fa0/4
3	vlan3	active	Fa0/2, Fa0/3
1002	fddi-default	active	
1003	token-ring-default	active	
1004	fddinet-default	active	
1005	trnet-default	active	

Screenshot shows VLANs are configured for interfaces

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
---------	-----------	------	-------

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
```

Port	Mode	Encapsulation	Status	Native vlan
Fa0/1	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Fa0/1	1-4094

Port	Vlans allowed and active in management domain
------	---

Fa0/1 1,100-101

Port Vlans in spanning tree forwarding state and not pruned
Fa0/1 none

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 f0/0.100
Router(config-subif)#encapsulation dot1Q 100
Router(config-subif)#ip address 192.168.100.254 255.255.255.0
Router(config-subif)#no shutdown
Router(config-subif)#exit
Router(config)#int f0/0.101
Router(config-subif)#encapsulation dot1Q 101
Router(config-subif)#ip address 192.168.101.254 255.255.255.0
Router(config-subif)#no shutdown
Router(config-subif)#exit
Router(config)#^Z
Router#show ip interfaces brie
Interface            IP-Address        OK? Method Status            Protocol
FastEthernet0/0      unassigned        YES manual up                up
FastEthernet0/0.100   192.168.100.254 YES manual up                up
FastEthernet0/0.101   192.168.101.254 YES manual up                up
Serial0/0            unassigned        YES unset   administratively down down
FastEthernet0/1      unassigned        YES unset   administratively down down
Serial0/1            unassigned        YES unset   administratively down down
WroclawRouter#
Router#show run
.
.
Interface FastEthernet0/0
 no ip address
 no ip derected broadcast
 duplex auto
 speed auto
.
interface FastEthernet0/0.100
 encapsulation dot1Q 100
 ip address 192.168.100.254 255.255.255.0
 no ip directed-broadcast
.
interface FastEthernet0/0.101
 encapsulation dot1Q 101
 ip address 192.168.101.254 255.255.255.0
 no ip directed-broadcast
.
interface Serial0/0
 no ip address
 no ip directed-broadcast
 no ip nroute-cache
 shutdown
--More--
```

*This
procedure
for
configuring
the VLANs
is followed
on from
element 2.
The config
process on
the Cisco
switch and
router is
exactly the
same as the
CAD
design.*

Once router and switch were configured, the connections were tested. On *** are show screenshots from the testing of the connections using the CMD on the laptops.

```
C:\WINDOWS\system32\cmd.exe

Pinging 192.168.101.2 with 32 bytes of data:
Reply from 192.168.101.2: bytes=32 time=2ms TTL=30
Reply from 192.168.101.2: bytes=32 time<1ms TTL=30
Reply from 192.168.101.2: bytes=32 time<1ms TTL=30
Reply from 192.168.101.2: bytes=32 time<1ms TTL=30

Ping statistics for 192.168.101.2:
    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>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix  . : 
    IP Address. . . . . : 192.168.101.3
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.101.254

C:\Documents and Settings\Administrator>
C:\Documents and Settings\Administrator>ping 192.168.101.2

Pinging 192.168.101.2 with 32 bytes of data:
Reply from 192.168.101.2: bytes=32 time=2ms TTL=30
Reply from 192.168.101.2: bytes=32 time<1ms TTL=30
Reply from 192.168.101.2: bytes=32 time<1ms TTL=30
Reply from 192.168.101.2: bytes=32 time<1ms TTL=30

Ping statistics for 192.168.101.2:
    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>_
```

*PLC address
test is good*

Fig. 33 CMD shown the first round of tests carried out

```

C:\Users\Leils>ping 192.168.101.2

Pinging 192.168.101.2 with 32 bytes of data:
Reply from 192.168.101.2: bytes=32 time=6ms TTL=29
Reply from 192.168.101.2: bytes=32 time=1ms TTL=29
Reply from 192.168.101.2: bytes=32 time<1ms TTL=29
Reply from 192.168.101.2: bytes=32 time<1ms TTL=29

Ping statistics for 192.168.101.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 6ms, Average = 1ms

C:\Users\Leils>ping 192.168.101.3

Pinging 192.168.101.3 with 32 bytes of data:
Request timed out.
Reply from 192.168.101.3: bytes=32 time=1ms TTL=127
Reply from 192.168.101.3: bytes=32 time<1ms TTL=127
Reply from 192.168.101.3: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.101.3:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

```

PLC and config PC ip tests are good when tested from PLC terminal PC.

Fig. 34 CMD shown the second round of tests carried out

3.2 Siemens PLC Web Server Configuration

A new PLC project was created, the right PLC added etc. To configure the PLC, first the web server had to be activated on the PLC (Fig. 35). Then the file extension could be added for the web program (Fig. 36). Below is a list of file extension examples:

HTML – Hypertext Markup Language

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

.js – javascript (jquery, ajax)

.json – an extension library of javascript

File extensions for PLC web server are identified

Not all PLCs accept all of the file extensions. In case of the Siemens PLCs, models older than S7-1500 does not accept the file extension .js. But the PLC can be tricked by embedding the .js file in an HTML or HTM extension file. Also graphic files can be embedded in HTML programs. That is briefly shown later on.

This is a good point here because the web servers in Siemens PLCs have been developed in stages. The 1500 has more features than the 1200 series.

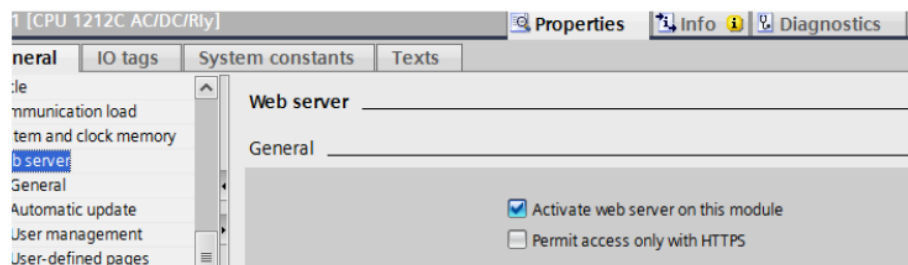
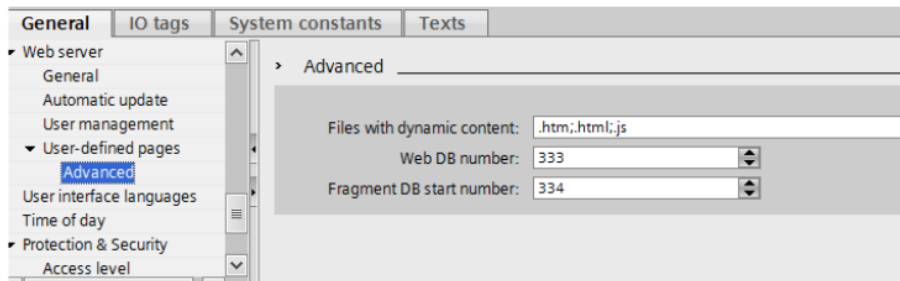


Fig. 35 Activation of the Web server on the PLC

Image clearly shows web server enabled.



File extensions are entered and the start address of the web server initialised

Fig. 36 Adding the file extension to the PLC

The program will be basic, it will be switching a row of LED depending on the input. The programming of the PLC is as follows.

First the inputs and outputs are set up:

WEB ctrl vlan ▶ PLC_1 [CPU 1212C AC/DC/Rly] ▶ PLC tags ▶ Default tag table [38]

Tags User constants

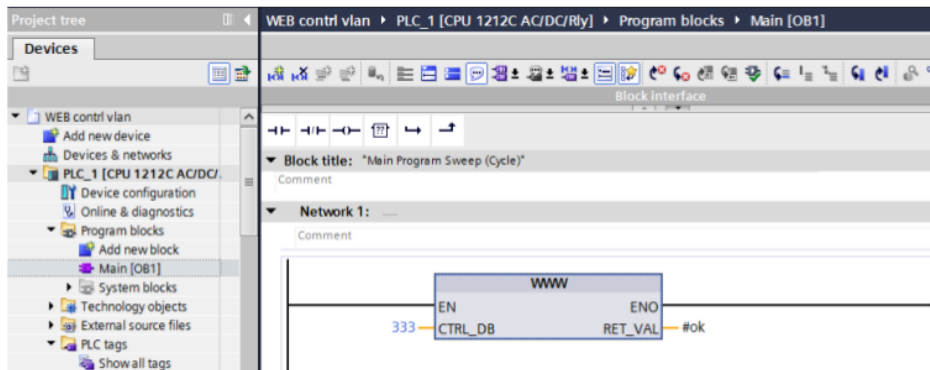
Default tag table

	Name	Data type	Address	Retain	Acces...	Writa...	Visibl...
1	op	Bool	%Q0.0	☐	☒	☒	☒
2	op2	Bool	%Q0.1	☐	☒	☒	☒
3	op3	Bool	%Q0.2	☐	☒	☒	☒
4	ip	Bool	%I0.0	☐	☒	☒	☒
5	ip1	Bool	%I0.1	☐	☒	☒	☒
6	ip2	Bool	%I0.2	☐	☒	☒	☒
7	ip3	Bool	%I0.3	☐	☒	☒	☒
8	ip4	Bool	%I0.4	☐	☒	☒	☒
9	ip5	Bool	%I0.5	☐	☒	☒	☒
10	ip6	Bool	%I0.6	☐	☒	☒	☒
11	ip7	Bool	%I0.7	☐	☒	☒	☒
12	<Add new>			☐	☒	☒	☒

IO tags are declared

Fig. 37 Input and Output configuration

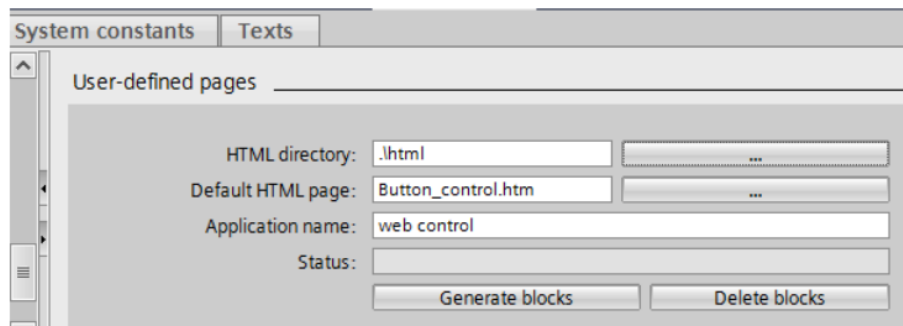
Then the WWW (web server) block is added to the main block of the PLC (Fig. 38). There is no other program written in PLC blocks. The web server is now configured and ready for the web pages to be downloaded.



Web server block is implemented in main program block

Fig. 38 WWW block in the main block of the PLC

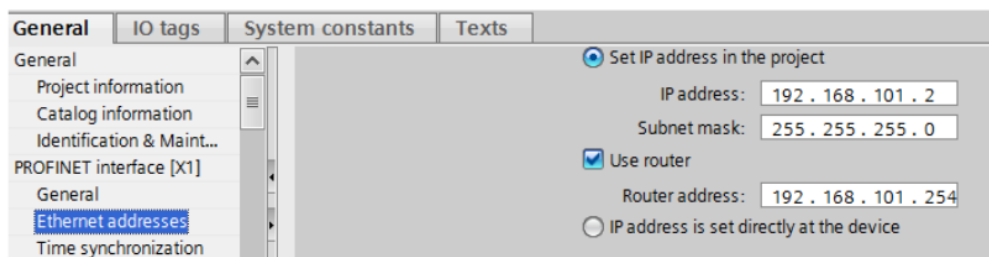
Then the index .html page with the http:// source for the index page was downloaded just as shown on Fig. 39.



The web (HTML) program is downloaded to the PLC web server

Fig. 39 setting up .html index and downloading it to PLC

Then to finish of the PLC's configuration, the VLAN gateway and ip address were set up as shown on Fig. 40.



This shows the gateway router address enabled for access to the PLC VLAN

Fig. 40 Setting up IP addresses on PLC

The web page program is stored in the PLC's program folder in the folder "UserFiles". It also contains all the files used for the web page, in this case it is two LEDs to indicate an on and off stated of the I/Os.

Then the HTML web page program was written, the full program can be found in Appendix A.

The HTML program can be split in few parts:

The start of the program defines the title, background colour, refresh rate etc.

Good point about the location of the web pages

```

1 <html>
2
3 <head>
4 <meta http-equiv="refresh" content="0.2">
5
6 <title>Web_control</title>
7 <meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1"><style type="text/css">
8 <!--
9 body,td,th {
10     color: #000033;
11 }
12 body {
13     background-color: #CCCCCC;
14 }
15 -->
16 </style></head>

```

Fig. 41 The start of the web page's program

Next in the program are the on page variables that change with every refreshment of the page. That is one of the advantages of Java scripts over HTML where Java can refresh the individual on-page variables where HTML has to refresh the whole page.

```

16 </style></head>
17
18 <body>
19
20 <!-- AWP_In_Variable Name="op" -->
21 <!-- AWP_In_Variable Name="op2" -->
22 <!-- AWP_In_Variable Name="op3" -->
23 <!-- AWP_In_Variable Name="ip" -->
24 <!-- AWP_In_Variable Name="ip1" -->
25 <!-- AWP_In_Variable Name="ip2" -->
26 <!-- AWP_In_Variable Name="ip3" -->
27 <!-- AWP_In_Variable Name="ip4" -->
28 <!-- AWP_In_Variable Name="ip5" -->
29 <!-- AWP_In_Variable Name="ip6" -->
30 <!-- AWP_In_Variable Name="ip7" -->

```

Fig. 42 The on-page variables

Then the two next sections are the ones that write and read data from the PLC.

```

31
32 <form>
33 <input type="submit" value="Set_Output_1_1">
34 <input type="hidden" name="op" value="1">
35 </form>
36
37 <form>
38 <input type="submit" value="Set_Output_1_0">
39 <input type="hidden" name="op" value="0">
40 </form>
41
42
43
44 <p>
45 <form>
46 <input type="submit" value="Set_Output_2_1">
47 <input type="hidden" name="op2" value="1">
48 </form>
49 <form>
50 <input type="submit" value="Set_Output_2_0">
51 <input type="hidden" name="op2" value="0">
52 </form>
53 <p>
54 <form>
55 <input type="submit" value="Set_Output_3_1">
56 <input type="hidden" name="op3" value="1">
57 </form>

```

Fig. 43 part of the program that writes data to the PLC's inputs

Tags for use in the web program are declared in the web page program

The forms will write boolean data to the PLC outputs to set and reset.

```

66
67 <p align="center">ip 0 : := "ip":&nbsp;&nbsp;&nbsp;
68 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 1 : := "ip1":&nbsp;&nbsp;&nbsp;
69 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 2 : := "ip2":&nbsp;&nbsp;&nbsp;
70 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 3 : := "ip3":&nbsp;&nbsp;&nbsp;
71 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 4 : := "ip4":&nbsp;&nbsp;&nbsp;
72 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 5 : := "ip5":&nbsp;&nbsp;&nbsp;
73 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 6 : := "ip6":&nbsp;&nbsp;&nbsp;
74 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;ip 7 : := "ip7":&nbsp;&nbsp;&nbsp;
75 <p align="center">Output 0 : := "op":&nbsp;&nbsp;&nbsp;
76 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Output 2 : := "op2":&nbsp;&nbsp;&nbsp;
77 &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Output 3 : := "op3":&nbsp;&nbsp;&nbsp;
78
79 </body>
80 </html>
81

```

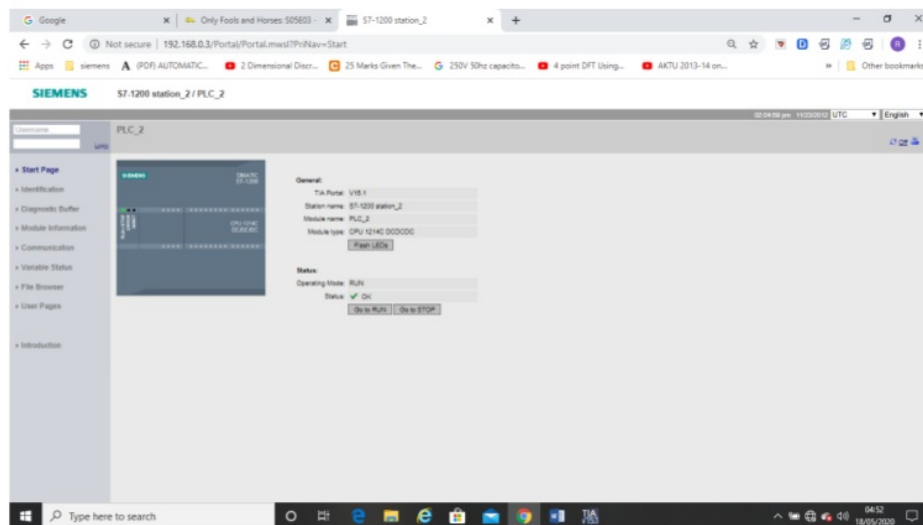
This part will read the input boolean status and indicate using images

Fig. 44 Part of the program that reads the status of the PLC's outputs.

Here the data is read from the PLC through the IP sets. As the signals are digital, it can only be 1 or 0, and the status of the I/O of the PLC determines which LED .png file is displayed.

With the program loaded to the PLC and the HTML page program also written up, the system was tested:

When the PLC is accessed through a web browser by typing in its IP address, the first page that is displayed is the Siemens's standard diagnostic page which has the option for user developed pages.



The front page of the PLC web server is generated by the server.

Fig. 45 Siemens's standard diagnostic page

Once the user developed page was accessed, the test could be carried out by comparing the I/O states on the page with those on the PLC. A total of three tests were carried out:

Inputs: 01111000 Output: 1000000

Test shows the status of the PLC io is the same as the io on the web page



Fig. 46 web page test #1

Input: 10011011 Output: 10100000



Fig. 47 Web page test #2

Input: 10010000 Output: 10000000



Fig. 48 Web page test #3

Se
co
nd
co
ndi
tio
n
Sh
ow
s
tha
t
the
re
al
ti
er
dat
as
isa
can
pl
re
ds
h
o
w
in
g
m
o
r
e
p
r
o
o
f

3.3 Conclusions and evaluation

This last element has proven that a relatively simple HTML program and two .png files can show quite well the conditions of a PLC. In the element, that has been done as a prototype with the PLC right next to the PC, but in a real-world application, with some security in place, the PC and PLC could be on opposite ends of the world. That is the basic concept of the Industry 4.0 that is being developed now a days. In Industry 4.0, theoretically, all devices can be connected and talking to each other, providing much more feedback from the production and giving more possibilities of self-diagnostics. What is more important is that all of that communication tends to be done over an Ethernet network which allows it to be used in a more extensive way as it is been shown in this element 3. With future development of the PLC systems and implementation of the JavaScript, much more complex web pages could be used in the future, capabilities and response similar or even better than those of HMI screens. And with appropriate security in place, it could be connected to the world's network and accessed and monitored from any point around the globe.

*Conclusion
is
good
with
relevance to
IIOT
4.0*

References

Forouzan. B.A. 2012, Data Communications and Networking. ISBN-13: 978-0073376226

CCNA, nd. Encapsulation.

Available at: <https://study-ccna.com/encapsulation>

[Accessed 29/1/2020]

Contemporary Control Systems Inc, 2011. Understanding Ethernet Switches and Routers

Available at: <https://www.ccontrols.com/pdf/Essentials0411.pdf>

[Accessed 29/1/2020]

Fairhurst. G. 2009. University of Aberdeen.

Available at: <https://erg.abdn.ac.uk/users/gorry/course/intro-pages/uni-b-mcast.html>

[Accessed 29/1/2020]

*A good list
of relevant
sources*

Appendix A.

```
<html>

<head>
<meta http-equiv="refresh" content="0.2">

<title>Web_control</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1"><style
type="text/css">
<!--
body,td,th {
    color: #000033;
}
body {
    background-color: #CCCCCC;
}
-->
</style></head>

<body>

<!-- AWP_In_Variable Name=""op"" -->
<!-- AWP_In_Variable Name=""op2"" -->
<!-- AWP_In_Variable Name=""op3"" -->
<!-- AWP_In_Variable Name=""ip"" -->
<!-- AWP_In_Variable Name=""ip1"" -->
<!-- AWP_In_Variable Name=""ip2"" -->
<!-- AWP_In_Variable Name=""ip3"" -->
<!-- AWP_In_Variable Name=""ip4"" -->
<!-- AWP_In_Variable Name=""ip5"" -->
<!-- AWP_In_Variable Name=""ip6"" -->
<!-- AWP_In_Variable Name=""ip7"" -->

<form>
<input type="submit" value="Set_Output_1_1">
<input type="hidden" name=""op"" value="1">
</form>

<form>
    <input type="submit" value="Set_Output_1_0">
<input type="hidden" name=""op"" value="0">
</form>

<p>
<form>
    <input type="submit" value="Set_Output_2_1">
<input type="hidden" name=""op2"" value="1">
</form>
    <form>
        <input type="submit" value="Set_Output_2_0">
<input type="hidden" name=""op2"" value="0">
</form>
<p>
<form>
    <input type="submit" value="Set_Output_3_1">
<input type="hidden" name=""op3"" value="1">
```


1708165

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

72/100

PAGE 1

PAGE 2

PAGE 3

Text Comment. Good detailed list of contents

PAGE 4

PAGE 5

Text Comment. Extensive list of figures

PAGE 6

Text Comment. Explanation is correct and a good supporting image for comparison

PAGE 7

Text Comment. Explanations here are very good and you have also identified the devices associated with each layer by their comms protocols.

PAGE 8

Text Comment. Excellent work here. Identified the purpose of encapsulation and given examples.

Text Comment. Very good explanation which demonstrates your depth of reading

PAGE 9

Text Comment. You have identified really significant point here and explained it very well

Text Comment. A very detailed explanation

PAGE 10

Text Comment. The use of other devices besides the PC demonstrates your understanding of the network system

Text Comment. The table of addressing scheme should be here. Even though the addressing can be worked out from the router configs and your CAD programs, it is best practice to have the addressing in a table form. This would have to be the case for a larger system which in reality they will be.

PAGE 11

PAGE 12

Text Comment. Screenshots show good evidence of the routing configurations

Text Comment. Test are successful which indicates the configuration is correct. Good method of testing which eliminates redundancies

PAGE 13

PAGE 14

Text Comment. RIP tables show evidence of correct configuration

PAGE 15

PAGE 16

Text Comment. Screenshots show the config process and the report from each router the connected ip's and the routed ip's.

Text Comment. Tests are successful with redundant tests eliminated

PAGE 17

Text Comment. The DHCP here shows the ip addresses being dynamically assigned. The helper address needs to be explained here and what happens if the helper address is not implemented.

PAGE 18

Text Comment. Configurations are correct and the screenshots are good evidence

PAGE 19

Text Comment. The router report here shows the addresses used which in this element are class A, B and C.

PAGE 20

PAGE 21

PAGE 22

PAGE 23

PAGE 24

Text Comment. Full configuration is shown in the screenshots and the individual router reports show the routers are correctly configured for RIP and DHCP with excluded addresses assigned.

PAGE 25

Text Comment. The test results clearly show the system is working

PAGE 26

Text Comment. Good evaluation

PAGE 27

PAGE 28

Text Comment. Addressing scheme tables are correct and the subnetted addresses are clearly shown. All 6 networks have been subnetted and you have assigned appropriate addresses to the serial WAN networks.

PAGE 29

PAGE 30

Text Comment. RIP tables clearly show the routed addresses

Text Comment. Screenshot shows evidence of the tests and also redundant test are eliminated using good test methods

Text Comment. VLSM for the LAN networks are correct and the use of tables is a good method of setting out the address scheme.

Text Comment. VLSM /30 is clearly shown here and the spacing out of the WAN serial addresses can be considered good practice

Text Comment. Screen shots show the RIP tables are setup for the VLSM network.

Text Comment. Testing shows the network is working correctly. Good test method used with no redundant tests.

Text Comment. You could point out here that the VLAN will reduce the broadcast domain size and allow configurable security

Text Comment. VLANs are configured with interfaces assigned

Text Comment. Report shows trunking is configured on the switch

Text Comment. The report shows the original gateway address has now been subnetted with two separate gateways using the trunk protocol.

Text Comment. RIP table recognises the subnetted gateway using the ver 2 RIP.

Text Comment. Screenshot shows the tests are successful with test method eliminating redundancies

Text Comment. Screenshot shows evidence of ACL configuration

Text Comment. Screenshot of ping test clearly shows address .132 denied access

Text Comment. Screenshot of ping test clearly shows address .66 has access

Text Comment. Same test from different device gives the same result which proves the ACL is working correctly.

Text Comment. Network is correct for practical configuration

Text Comment. Image showing practical connections to Cisco devices

Text Comment. The list of components for the network shows the PLC and the two PCs. One PC will be assigned to program and control the PLC and the other will be assigned to configure the VLAN network.

Text Comment. Device allocation has been identified

Text Comment. Screenshot shows VLANs are configured for interfaces

Text Comment. This procedure for configuring the VLANs is followed on from element 2. The config process on the Cisco switch and router is exactly the same as the CAD design.

Text Comment. PLC address test is good

Text Comment. PLC and config PC ip tests are good when tested from PLC terminal PC.

Text Comment. File extensions for PLC web server are identified

Text Comment. This is a good point here because the web servers in Siemens PLCs have been developed in stages. The 1500 has more features than the 1200 series.

Text Comment. Image clearly shows web server enabled.

PAGE 48

Text Comment. File extensions are entered and the start address of the web server initialised

Text Comment. IO tags are declared

PAGE 49

Text Comment. Web server block is implemented in main program block

Text Comment. The web (HTML) program is downloaded to the PLC web server

Text Comment. This shows the gateway router address enabled for access to the PLC VLAN

Text Comment. Good point about the location of the web pages

PAGE 50

Text Comment. The start of the simple web program to test the HTTP protocol of the web server using the VLAN

Text Comment. Tags for use in the web program are declared in the web page program

Text Comment. The forms will write boolean data to the PLC outputs to set and reset .

PAGE 51

Text Comment. This part will read the input boolean status and indicate using images

Text Comment. The front page of the PLC web server is generated by the server.

PAGE 52

Text Comment. Test shows the status of the PLC io is the same as the io on the web page

Text Comment. Second condition shows that the real time data is captured.

Text Comment. Third sample showing more proof

PAGE 53

Text Comment. Conclusion is good with relevance to IIOT 4.0

PAGE 54

Text Comment. A good list of relevant sources

PAGE 55

PAGE 56

Text Comment. Good use of appendix. This could have been extended to include the router reports and some config images which are more or less repeated.

GRADING FORM: CSG-RUBIC

ADAM BEDNER

0

RESEARCH-INFORMED LITERATURE



Your research covers all what is required in very good detail with good relevant sources used.

8/10

KNOWLEDGE AND UNDERSTANDING



Element 1: Good introduction to start the project. The design and implementation of the network is

20/30

explained with supporting images. There are some parts missing i.e the table for ip address scheme and helper address explanation. There is sufficient evidence for correct implementation. 6/10 Element 2: Introduction explains the requirements clearly. The configuration is explained and documentation requirements for addressing schemes are good. 7/10 Element 3: The sections from the CAD designs in elements 1 and 2 are implemented using level 2, and 3 Cisco devices. The implementation of the VLAN and web server are clearly documented supported with good explanations and images. There is sufficient evidence of the ACL configuration. The web program implementation is achieved over the existing Cisco switch and router and explained clearly. 7/10

ANALYSIS



Element 1: Testing and results are explained and supported with sufficient images. However there are parts missing such as the DHCP test explanation. 3/5 Element 2: A good analysis of test results has been carried out with supporting images and a good method of testing used. Good use of tables in this section. 7/10 Element 3: Good test results obtained and are clearly explained. All the requirements have been achieved with good evidence. Some images could have been used to back up the recommendation for further development using .js. 7/10

17/25

PRACTICAL APPLICATION AND DEP.



Element 1: Design and implementation from address scheme to class A, B and C and serial links are implemented and tested. This should contain the table of address scheme. The procedures followed from design to implementation were efficient which simplified the testing stage. Test procedure used meant that redundant testing is eliminated. 3/5

Element 2: The configuration is more complex due to the subnetting required and the tables of addressing are very well ordered and follow your own pattern. Implementation of the required network parameters has been carried out with significant points explained. This should have included the reason for RIP ver 2 and not ver 1. The differences are important points. Test procedures and methods eliminate redundant tests while testing all components. 7/10

Element 3: The practical implementation was carried out using Cisco level 2 and 3 devices. The testing carried out demonstrated the VLANs and ACLs security used in industry. 7/10

17/25

SKILLS FOR PROFESSIONAL PRAC.



Quality of report is good. The layout could have been improved by making further use of the appendix for the router reports and tables. 9/15

10/15