Management and Security of Computing Systems

Implementing an Ethernet Network

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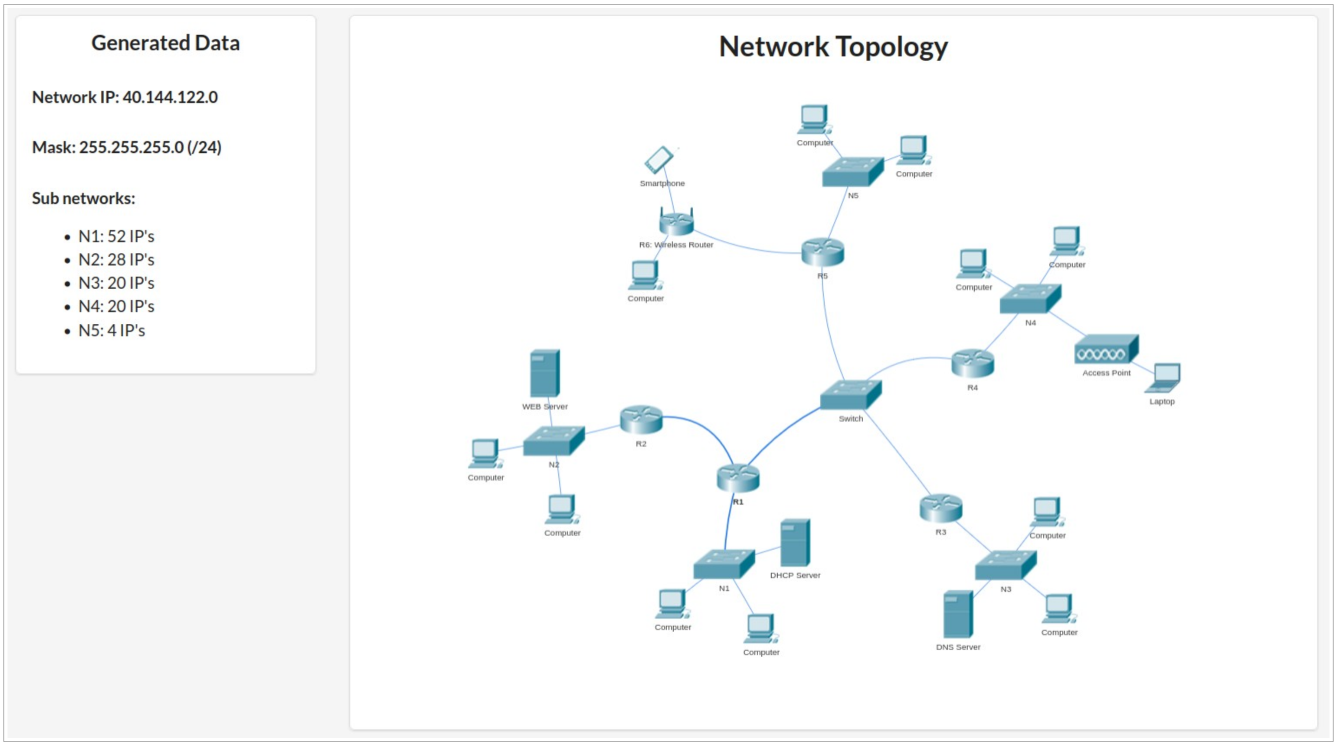
Below, you'll find the generated network for implementation, accompanied by relevant technical details and its subdivision into subnetworks. Subsequently, a concise analysis is provided on how these subnetworks have been distributed, offering a clear perspective on the capacity and utility of this implementation.



Generated Data

Network IP: 40.144.122.0

Mask: 255.255.255.0 (/24)

Sub networks:

- N1: 52 IP's
- N2: 28 IP's
- N3: 20 IP's
- N4: 20 IP's
- N5: 4 IP's

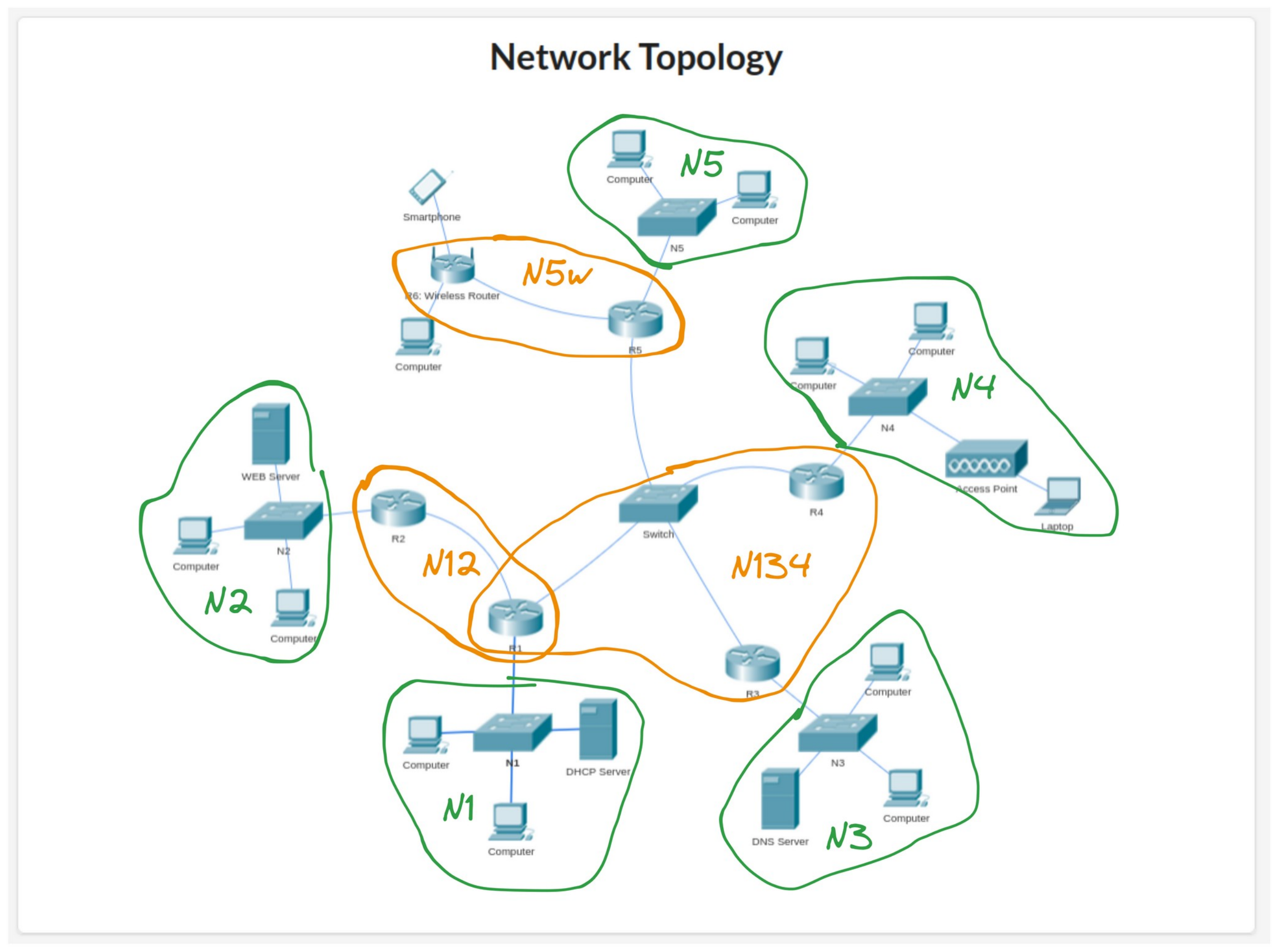
Network Topology

Here are the data associated with the network:

- **Starting IP address**: 40.144.112.0, identified as the **Network Address (NA)**
- **Subnet Mask**: 255.255.255.0, representing a valid subnet mask. The subnet mask converted to binary format: 11111111.11111111.11111111.00000000 (where the value 255 in binary format is 11111111).
- Network size is 2^(32-24) = 28, thus providing 256 available IP addresses for the network.
- NA is 40.144.112.0
- **Broadcast Address (BA)** is 40.144.112.255
- Occupied IP addresses: 64 + 32 + 16 + 16 + 8 + 8 + 4 + 4 = 152
- Available IP addresses in the network: 103

Subdividing the network into subnetworks.

The subnetworks in the project are illustrated in the figure below.



As can be observed (highlighted in green), the network consists of 5 subnetworks. For each of these, the distribution of IP addresses is as follows:

N (IP addresses) + 1 (Router) + 1 NA + 1 BA
N_1: 52 + 3 => 64 (/26)
N_2: 28 + 3 => 32 (/27)
N_3: 20 + 3 => 16 (/28)
N_4: 29 + 3 => 16 (/28)
N_5: 4 + 3 => 8 (/29)

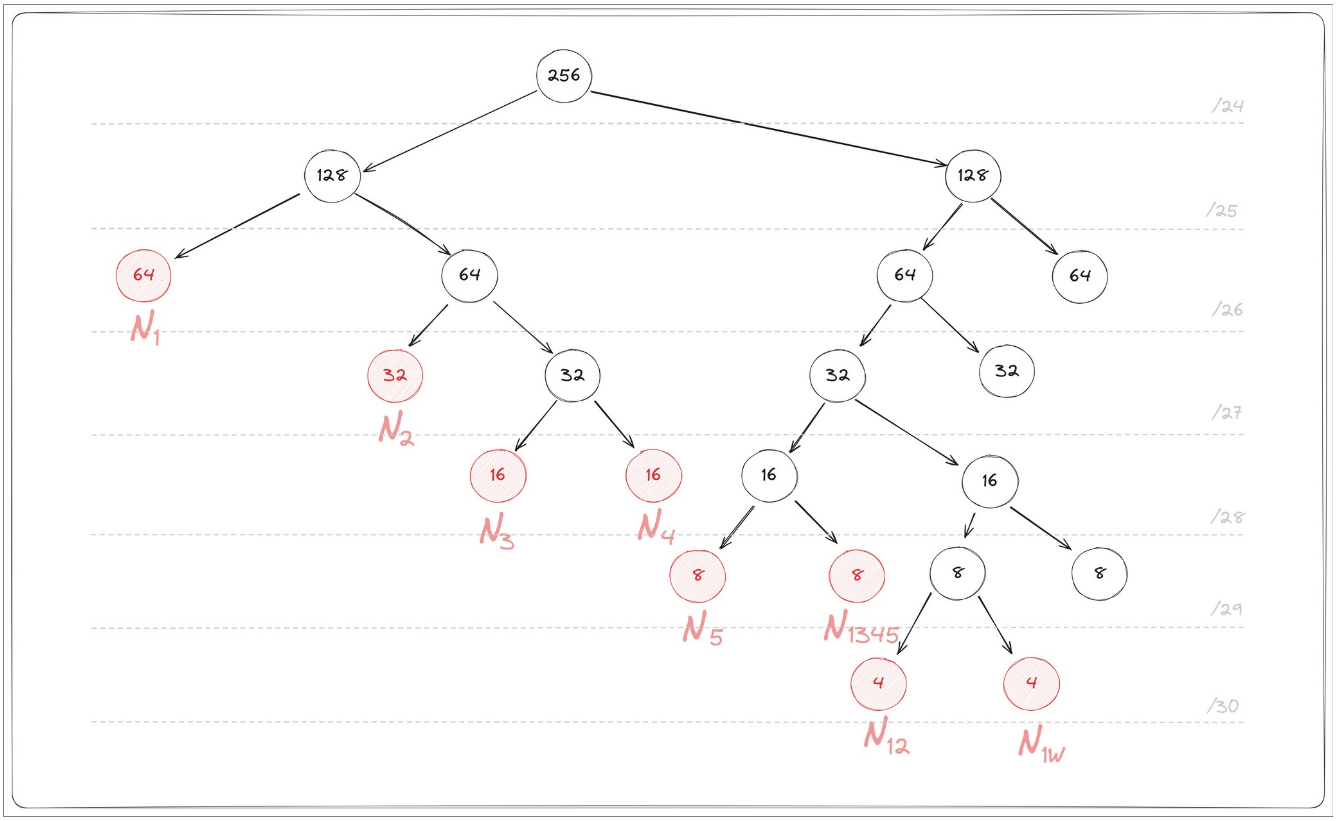
The additional 3 subnetworks (between routers) have been created in addition to the initial 5, defined as follows:

N (IP addresses) + 1 NA + 1 BA
N_{1345}: 4 + 2 => 8 (/29)
N_{12}: 2 + 2 => 4 (/30)
N_{5W}: 2+2 => 4 (/30)

In conclusion, we now have a total of 8 subnetworks.

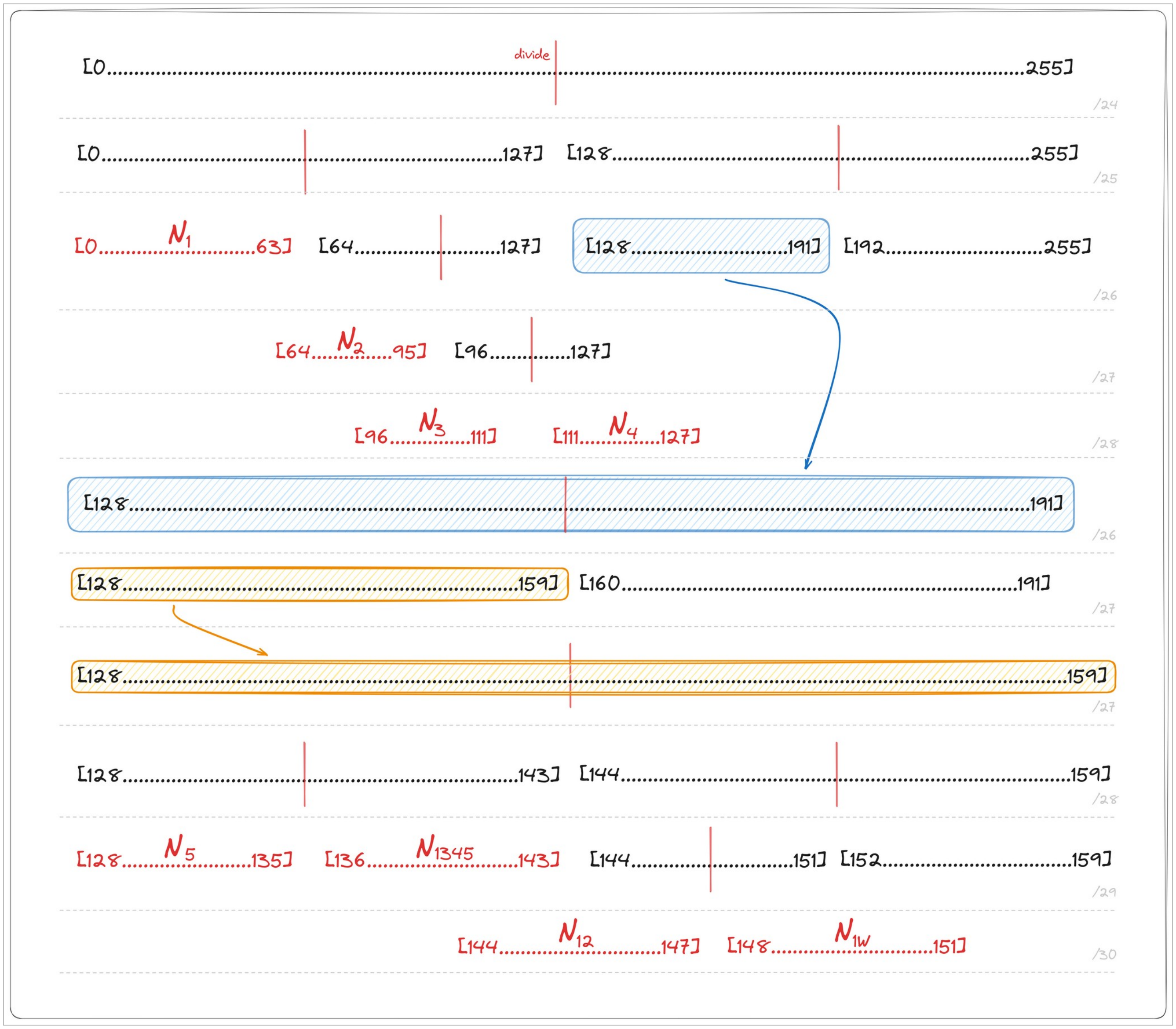
Binary Tree.

Using the binary tree helps us divide the network into subnetworks, and this concept is illustrated in the figure below. Thus, out of the 256 available IP addresses, 103 addresses remain free for our network, as the other addresses are already used for other purposes (152 addresses being allocated to the created subnetworks: 64 + 32 + 16 + 16 + 8 + 8 + 4 + 4).



N_1 64 + N_2 32 + N_3 16 + N_4 16 + N_5 8 + N_{1345} 8 + N_{12} 4 + N_{5W} 4 = occupy 152 IPs.

Divide the interval of the initial network into subintervals for 40.144.112.0 (/24):



The process involves enumerating the subnetworks and determining the IP addresses of each distinct device, whether it's a router or a server, in each subnetwork. Thus, we proceed as follows:

N_1: 40.144.122.0 /26	R_1: 40.144.122.1 S_{DHCP}: 40.144.122.2
N_2: 40.144.122.64 /27	R_2: 40.144.122.65 S_{WEB}: 40.124.122.66
N_3: 40.144.122.96 /28	R_3: 40.144.122.97 S_{DNS}: 40.144.122.98
N_4: 40.144.122.112 /28	R_4: 40.144.122.113
N_5: 40.144.122.128 /29	R_5: 40.144.122.129
N_{1345}: 40.144.122.136 / 29	R_1: 40.144.122.137

	R_3: 40.144.122.138 R_4: 40.144.122.139 R_5: 40.144.122.140
N_{12}: 40.144.122.144 /30	R_1: 40.144.122.145 R_2: 40.144.122.146
N_{5W}: 40.144.122.148 /30	R_5: 40.144.122.149 R_{ROUTER}: 40.144.122.150

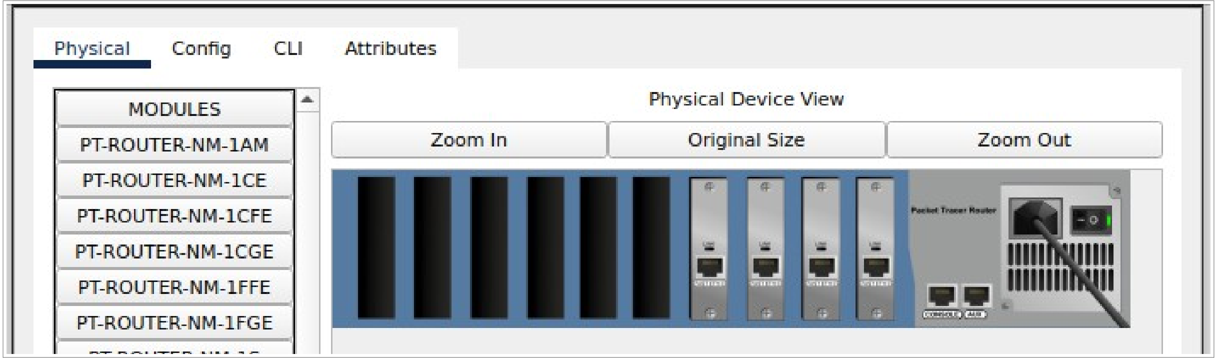
The next step involves enumerating the subnetworks and identifying the subnetmasks associated with each:

$N_{1''}$	40.144.122.0 (/26)	→ 32 – 26 = 6	→ *11000000*	→ **255.255.255.192**
N_2:	40.144.122.64 (/27)	→ 32 - 27 = 5	→ *11100000*	→ **255.255.255.224**
N_3:	40.144.122.96 (/28)	→ 32 - 28 = 4	→ *11110000*	→ **255.255.255.240**
N_4:	40.144.122.112 (/28)	→ 32 – 28 = 4	→ *11110000*	→ **255.255.255.240**
N_5:	40.144.122.128 (/29)	→ 32 – 29 = 3	→ *11111000*	→ **255.255.255.248**
N_{1345}:	40.144.122.136 (/29)	→ 32 – 29 = 3	→ *11111000*	→ **255.255.255.248**
N_{12}:	40.144.122.144 (/30)	→ 32 – 30 = 2	→ *11111100*	→ **255.255.255.252**
N_{5W}:	40.144.122.148 (/30)	→ 32 – 30 = 2	→ *11111100*	→ **255.255.255.252**

In conclusion, after enumerating the subnetworks and identifying the associated subnet masks, we observe that each subnet is characterized by a network IP address and a specific subnet mask. These pieces of information are essential for configuring and managing networks, ensuring an efficient distribution of IP addresses and available resources. Therefore, this step is crucial for establishing a functional and well-defined network infrastructure.

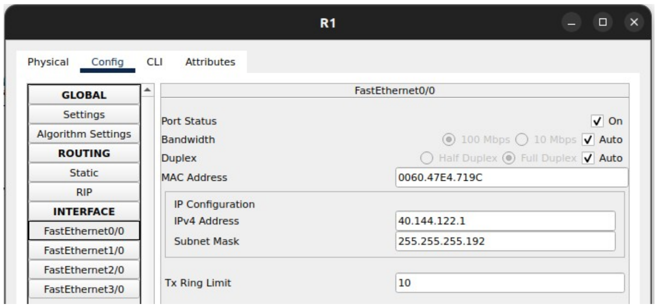
Setting up the network in Packet Tracer (Cisco).

To clarify, we aim to configure a basic router, for which we'll use an Empty-Router as a template. First, we'll configure this Empty-Router with the necessary initial settings, then we'll power it off to add 4 Fast-Ethernet network cards. After this, we'll make four copies of this router's configuration to create the other four routers needed.



Starting with the five given subnetworks and proceeding with the other three subnetworks derived from the network topology, we will configure each subnetwork individually. Each router will be connected to its own subnet via the Fast-Ethernet 0/0 interface.

Within subnetwork N_1, we will configure the DHCP server to generate IP addresses for the two personal computers using this protocol.



FastEthernet0/0

Port Status ☑ On

Bandwidth ● 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ● Full Duplex ☑ Auto

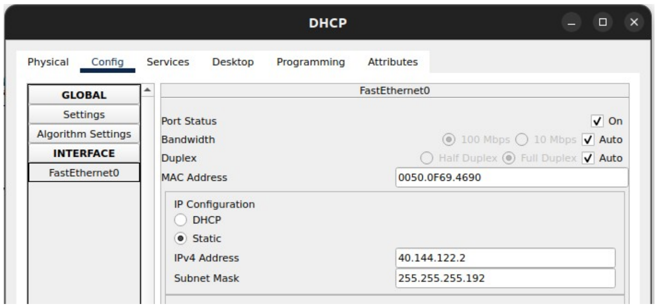
MAC Address 0060.47E4.719C

IP Configuration

IPv4 Address 40.144.122.1

Subnet Mask 255.255.255.192

Tx Ring Limit 10



FastEthernet0

Port Status ☑ On

Bandwidth ● 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ● Full Duplex ☑ Auto

MAC Address 0050.0F69.4690

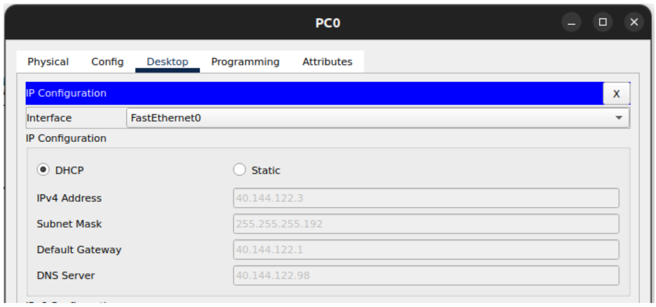
IP Configuration

○ DHCP

● Static

IPv4 Address 40.144.122.2

Subnet Mask 255.255.255.192



IP Configuration

Interface FastEthernet0

IP Configuration

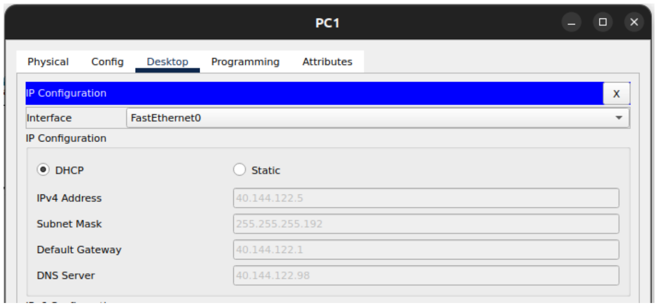
● DHCP ○ Static

IPv4 Address 40.144.122.3

Subnet Mask 255.255.255.192

Default Gateway 40.144.122.1

DNS Server 40.144.122.98



IP Configuration

Interface FastEthernet0

IP Configuration

● DHCP ○ Static

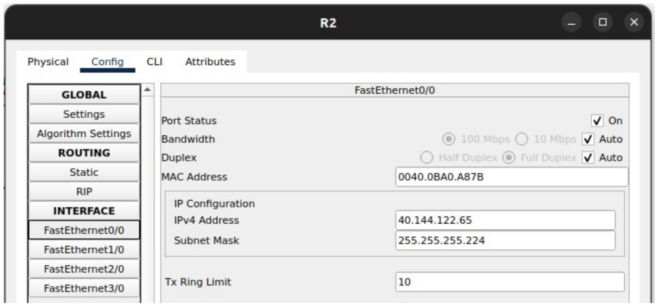
IPv4 Address 40.144.122.5

Subnet Mask 255.255.255.192

Default Gateway 40.144.122.1

DNS Server 40.144.122.98

Within subnet N_2, we will configure both the DHCP server and the WEB server. Additionally, we will create a new webpage displaying "Hello World!" and verify its accessibility.



FastEthernet0/0

Port Status ☑ On

Bandwidth ● 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ● Full Duplex ☑ Auto

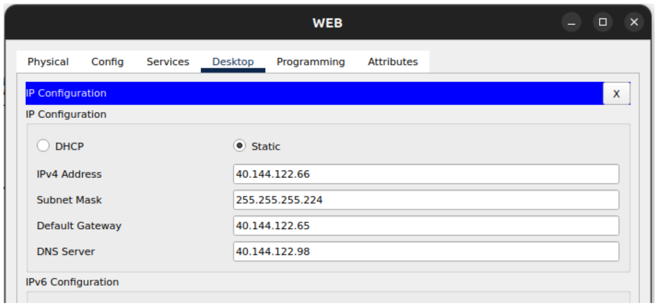
MAC Address 0040.0BA0.A87B

IP Configuration

IPv4 Address 40.144.122.65

Subnet Mask 255.255.255.224

Tx Ring Limit 10



IP Configuration

IP Configuration

○ DHCP ● Static

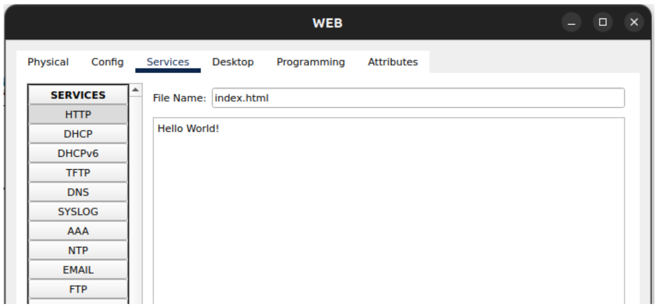
IPv4 Address 40.144.122.66

Subnet Mask 255.255.255.224

Default Gateway 40.144.122.65

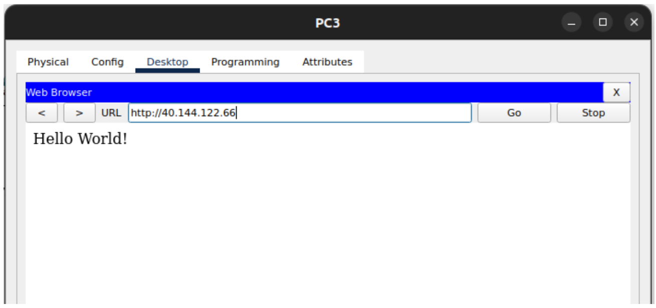
DNS Server 40.144.122.98

IPv6 Configuration



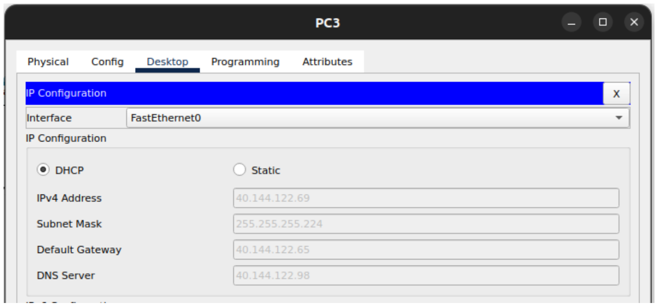
File Name: index.html

Hello World!



URL http://40.144.122.66

Hello World!



Interface: FastEthernet0

IP Configuration

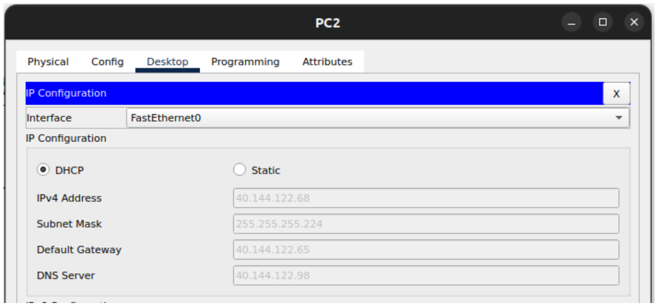
● DHCP ○ Static

IPv4 Address: 40.144.122.69

Subnet Mask: 255.255.255.224

Default Gateway: 40.144.122.65

DNS Server: 40.144.122.98



Interface: FastEthernet0

IP Configuration

● DHCP ○ Static

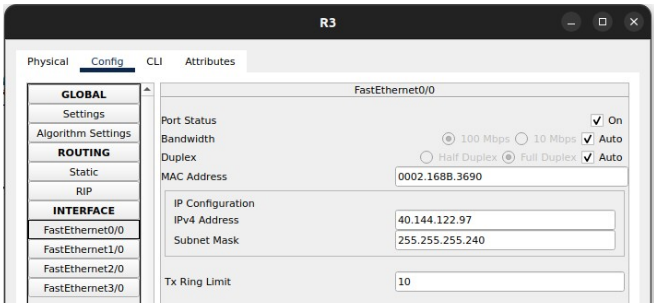
IPv4 Address: 40.144.122.68

Subnet Mask: 255.255.255.224

Default Gateway: 40.144.122.65

DNS Server: 40.144.122.98

Within subnet N_3, the server will be configured as both a DHCP and DNS server. We will associate the IP address 40.144.122.66 with the web page named "hello.com".



FastEthernet0/0

Port Status ☑ On

Bandwidth ○ 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ○ Full Duplex ☑ Auto

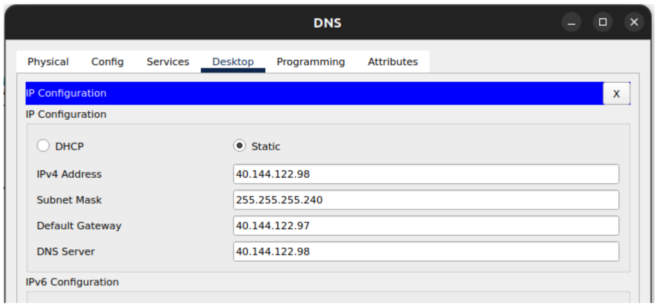
MAC Address: 0002.168B.3690

IP Configuration

IPv4 Address: 40.144.122.97

Subnet Mask: 255.255.255.240

Tx Ring Limit: 10



IP Configuration

○ DHCP ● Static

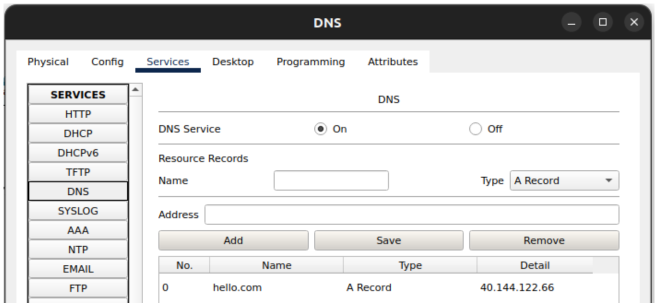
IPv4 Address: 40.144.122.98

Subnet Mask: 255.255.255.240

Default Gateway: 40.144.122.97

DNS Server: 40.144.122.98

IPv6 Configuration



DNS

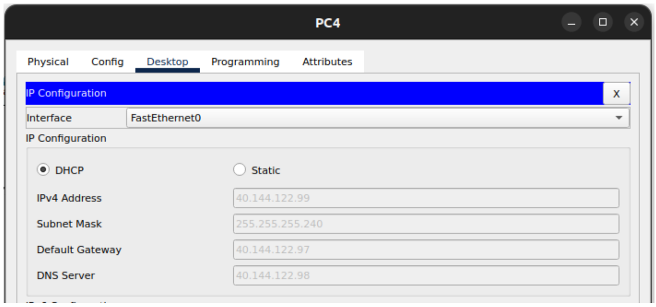
DNS Service ● On ○ Off

Resource Records

Name: Type: A Record

Address:

No.	Name	Type	Detail
0	hello.com	A Record	40.144.122.66



Interface: FastEthernet0

IP Configuration

● DHCP ○ Static

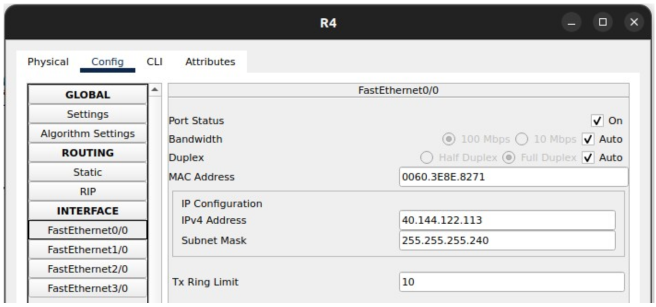
IPv4 Address: 40.144.122.99

Subnet Mask: 255.255.255.240

Default Gateway: 40.144.122.97

DNS Server: 40.144.122.98

Within subnet N_4, we have an Access Point but no server. Therefore, we have configured the router to act as a DHCP server capable of generating IP addresses. We have configured the laptop with a wireless network card on port 1 of the Access Point, and then we have named the wireless network "ap". The laptop has been configured wirelessly with the SSID "ap".

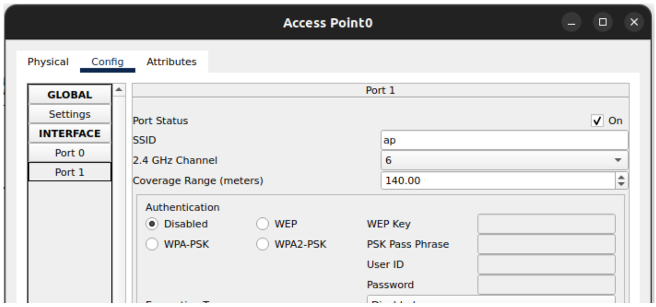


FastEthernet0/0

Port Status ☑ On
Bandwidth ● 100 Mbps ○ 10 Mbps ☑ Auto
Duplex ○ Half Duplex ● Full Duplex ☑ Auto
MAC Address 0060.3E8E.8271

IP Configuration
IPv4 Address 40.144.122.113
Subnet Mask 255.255.255.240

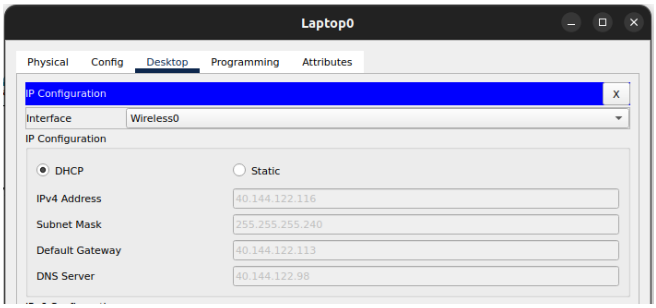
Tx Ring Limit 10



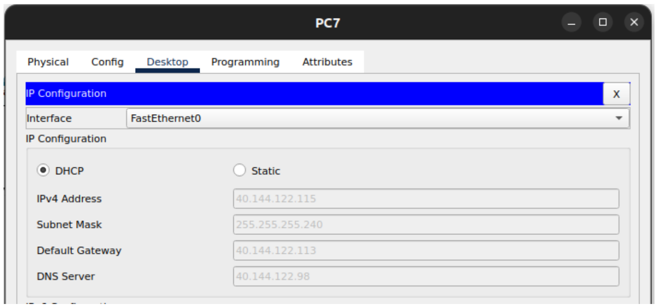
Port 1

Port Status ☑ On
SSID ap
2.4 GHz Channel 6
Coverage Range (meters) 140.00

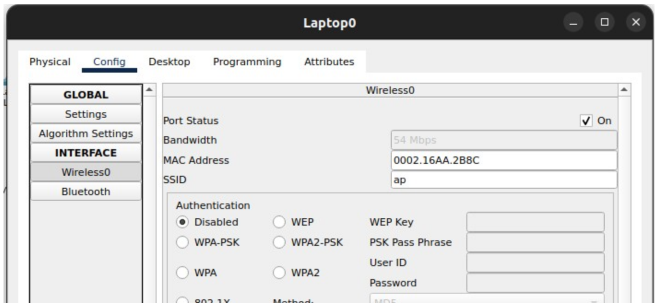
Authentication
● Disabled ○ WEP WEP Key
○ WPA-PSK ○ WPA2-PSK PSK Pass Phrase
User ID
Password



IP Configuration
Interface Wireless0
IP Configuration
● DHCP ○ Static
IPv4 Address 40.144.122.116
Subnet Mask 255.255.255.240
Default Gateway 40.144.122.113
DNS Server 40.144.122.98



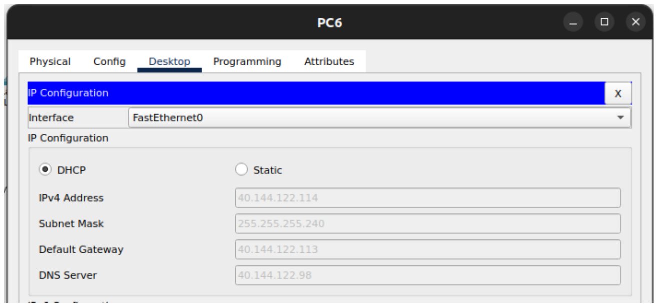
IP Configuration
Interface FastEthernet0
IP Configuration
● DHCP ○ Static
IPv4 Address 40.144.122.115
Subnet Mask 255.255.255.240
Default Gateway 40.144.122.113
DNS Server 40.144.122.98



Wireless0

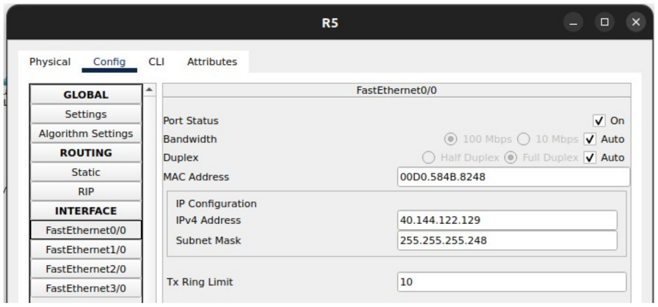
Port Status ☑ On
Bandwidth 54 Mbps
MAC Address 0002.16AA.2B8C
SSID ap

Authentication
● Disabled ○ WEP WEP Key
○ WPA-PSK ○ WPA2-PSK PSK Pass Phrase
User ID
○ WPA ○ WPA2 Password



IP Configuration
Interface FastEthernet0
IP Configuration
● DHCP ○ Static
IPv4 Address 40.144.122.114
Subnet Mask 255.255.255.240
Default Gateway 40.144.122.113
DNS Server 40.144.122.98

Within subnet N_5, we have configured the router to act as a DHCP server capable of generating IP addresses.

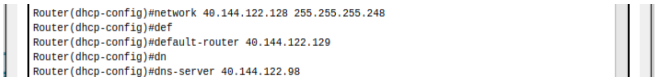


FastEthernet0/0

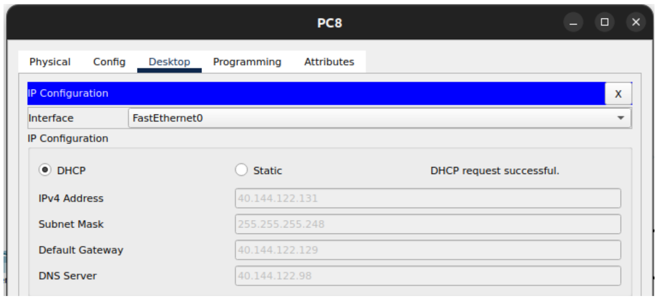
Port Status ☑ On
Bandwidth ● 100 Mbps ○ 10 Mbps ☑ Auto
Duplex ○ Half Duplex ● Full Duplex ☑ Auto
MAC Address 00D0.584B.8248

IP Configuration
IPv4 Address 40.144.122.129
Subnet Mask 255.255.255.248

Tx Ring Limit 10



```
Router(dhcp-config)#network 40.144.122.128 255.255.255.248
Router(dhcp-config)#def
Router(dhcp-config)#default-router 40.144.122.129
Router(dhcp-config)#dn
Router(dhcp-config)#dns-server 40.144.122.98
```



PC8

IP Configuration

Interface: FastEthernet0

IP Configuration

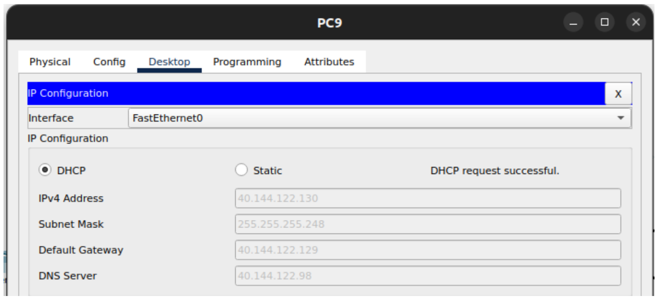
● DHCP ○ Static DHCP request successful.

IPv4 Address: 40.144.122.131

Subnet Mask: 255.255.255.248

Default Gateway: 40.144.122.129

DNS Server: 40.144.122.98



PC9

IP Configuration

Interface: FastEthernet0

IP Configuration

● DHCP ○ Static DHCP request successful.

IPv4 Address: 40.144.122.130

Subnet Mask: 255.255.255.248

Default Gateway: 40.144.122.129

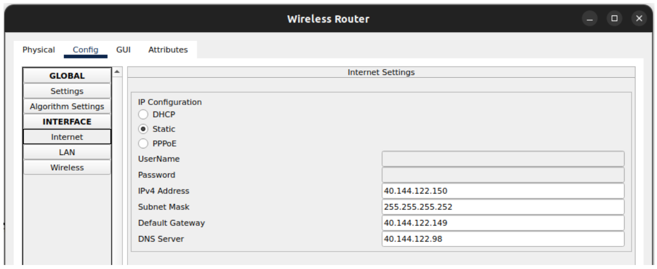
DNS Server: 40.144.122.98

For R_{345}, we connect it to the main switch through the Fast-Ethernet 1/0 interface.

For R_{12}, we connect them together through the Fast-Ethernet 1/0 interface, and we connect R_1 to the main switch through the Fast-Ethernet 2/0 interface.

For R_5, we connect it via RWIRELESS through the Fast-Ethernet 2/0 interface. In this section, we configured a static wireless network named "r". Afterwards, we connected the smartphone and PC to the Wireless Router and generated IP addresses along with other addresses through the DHCP protocol.

Additionally, we configured routing packets by establishing static routes.



Wireless Router

Internet Settings

IP Configuration

○ DHCP

● Static

○ PPPoE

UserName:

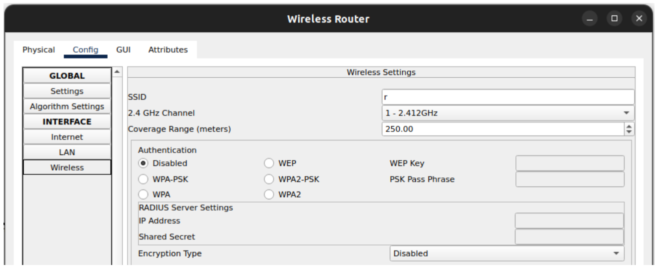
Password:

IPv4 Address: 40.144.122.150

Subnet Mask: 255.255.255.252

Default Gateway: 40.144.122.149

DNS Server: 40.144.122.98



Wireless Router

Wireless Settings

SSID: r

2.4 GHz Channel: 1 - 2.412GHz

Coverage Range (meters): 250.00

Authentication

● Disabled ○ WEP WEP Key

○ WPA-PSK ○ WPA2-PSK PSK Pass Phrase

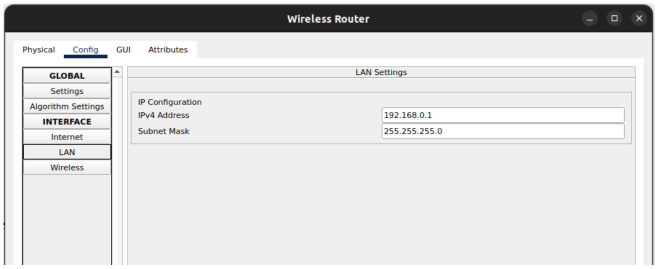
○ WPA ○ WPA2

RADIUS Server Settings

IP Address

Shared Secret

Encryption Type: Disabled



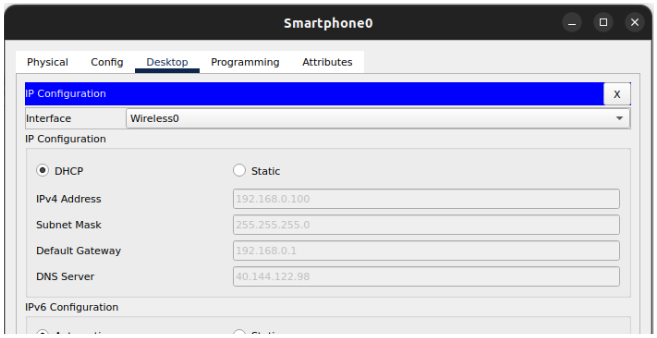
Wireless Router

LAN Settings

IP Configuration

IPv4 Address: 192.168.0.1

Subnet Mask: 255.255.255.0



Smartphone0

IP Configuration

Interface: Wireless0

IP Configuration

● DHCP ○ Static

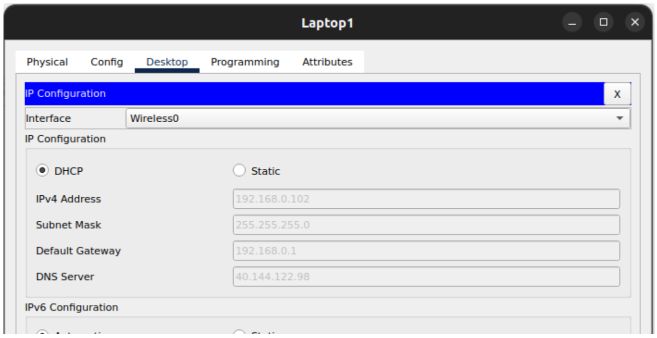
IPv4 Address: 192.168.0.100

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.0.1

DNS Server: 40.144.122.98

IPv6 Configuration



IP Configuration

Interface: Wireless0

IP Configuration

● DHCP ○ Static

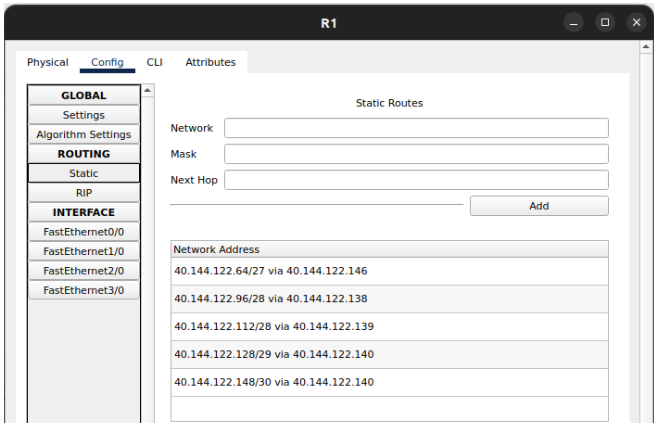
IPv4 Address: 192.168.0.102

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.0.1

DNS Server: 40.144.122.98

IPv6 Configuration



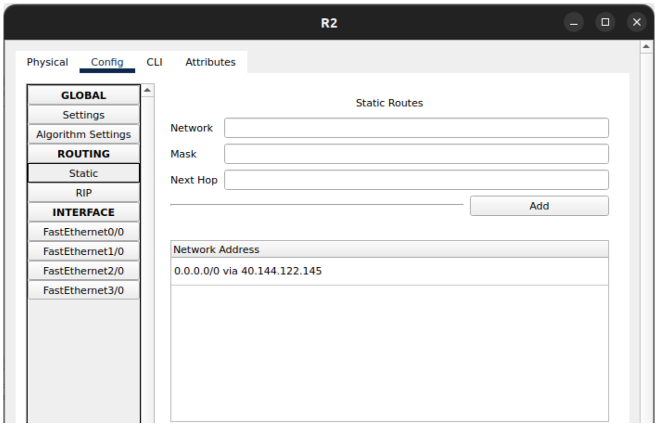
Static Routes

Network:

Mask:

Next Hop:

```
Network Address
40.144.122.64/27 via 40.144.122.146
40.144.122.96/28 via 40.144.122.138
40.144.122.112/28 via 40.144.122.139
40.144.122.128/29 via 40.144.122.140
40.144.122.148/30 via 40.144.122.140
```



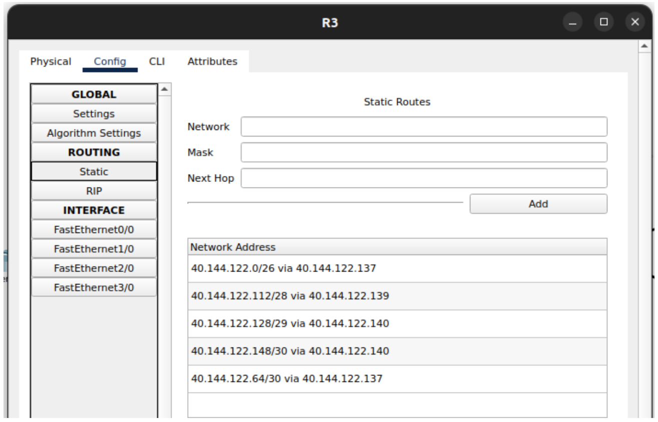
Static Routes

Network:

Mask:

Next Hop:

```
Network Address
0.0.0.0/0 via 40.144.122.145
```



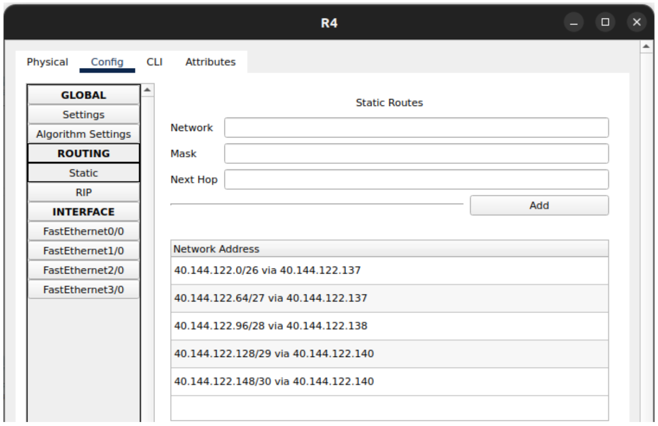
Static Routes

Network:

Mask:

Next Hop:

```
Network Address
40.144.122.0/26 via 40.144.122.137
40.144.122.112/28 via 40.144.122.139
40.144.122.128/29 via 40.144.122.140
40.144.122.148/30 via 40.144.122.140
40.144.122.64/30 via 40.144.122.137
```



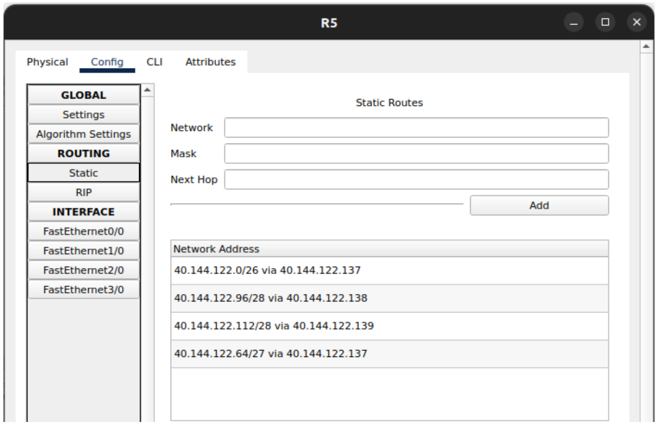
Static Routes

Network:

Mask:

Next Hop:

```
Network Address
40.144.122.0/26 via 40.144.122.137
40.144.122.64/27 via 40.144.122.137
40.144.122.96/28 via 40.144.122.138
40.144.122.128/29 via 40.144.122.140
40.144.122.148/30 via 40.144.122.140
```



Static Routes

Network:

Mask:

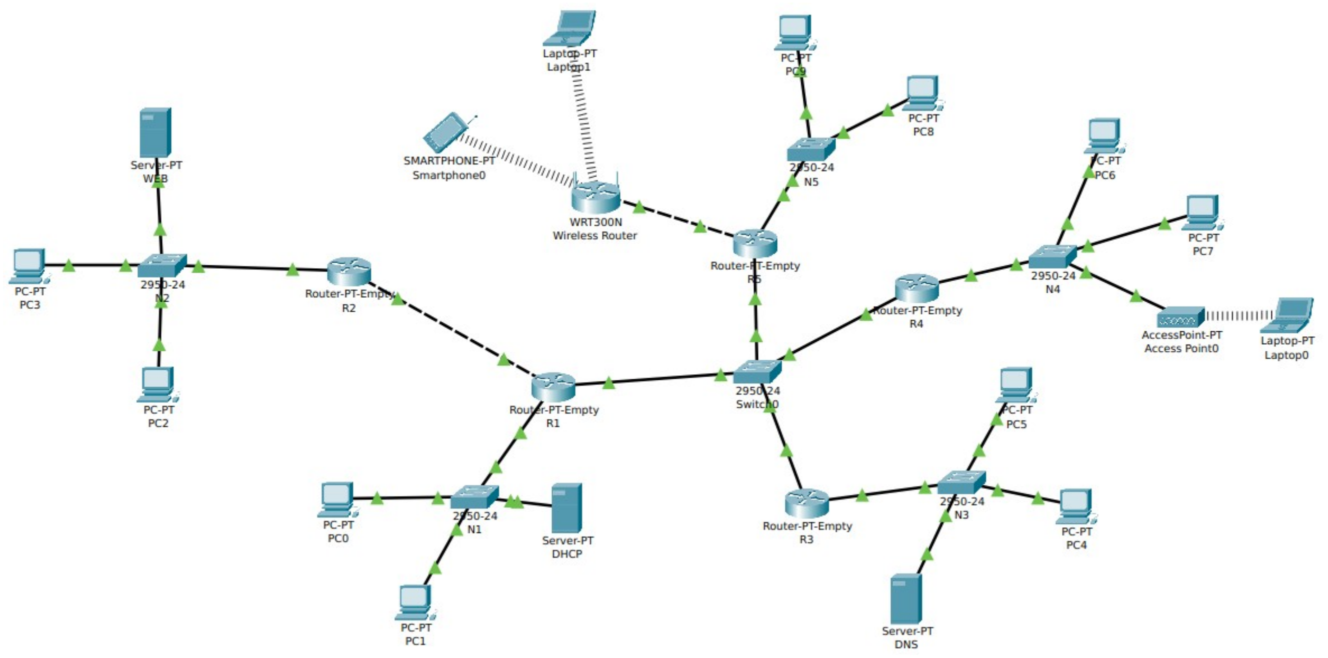
Next Hop:

```
Network Address
40.144.122.0/26 via 40.144.122.137
40.144.122.96/28 via 40.144.122.138
40.144.122.112/28 via 40.144.122.139
40.144.122.64/27 via 40.144.122.137
```

In conclusion, the network in Packet Tracer appears as follows:

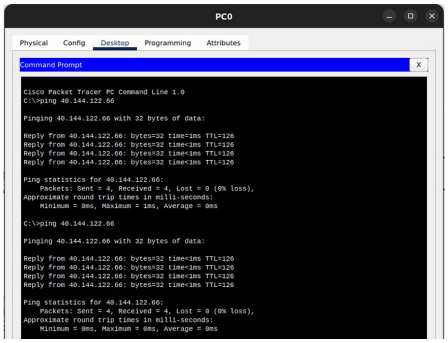
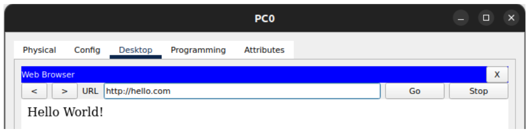
With each subnet meticulously configured and connectivity established between routers, the network is now fully operational. Through the utilization of Packet Tracer, an array of networking devices have been interconnected to form a cohesive infrastructure.

This project serves as a practical learning experience in managing and securing computing systems through the implementation of an Ethernet network.

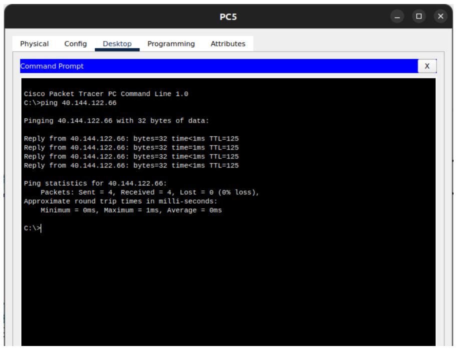


Testing Web Server Connectivity and DNS Resolution Across Subnets.

To verify the access to the web server, we will use the command ***ping 40.144.122.66*** in the terminal to check the connectivity. Additionally, we'll test webpage access by typing the domain name ***"hello.com"*** in a web browser to confirm if it resolves to the IP address 40.144.122.66. This ensures that the DNS server correctly maps **"hello.com"** to **40.144.122.66.**

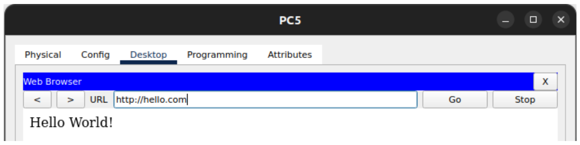
test the web server connection	subnet	webpage access through DNS for each subnet:
	N_1	 Web Browser URL http://hello.com Hello World!

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

Reply from 40.144.122.66: bytes=32 time=1ms TTL=126
Reply from 40.144.122.66: bytes=32 time<1ms TTL=126
Reply from 40.144.122.66: bytes=32 time<1ms TTL=126
Reply from 40.144.122.66: bytes=32 time<1ms TTL=126

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

Reply from 40.144.122.66: bytes=32 time<1ms TTL=126
Reply from 40.144.122.66: bytes=32 time<1ms TTL=126
Reply from 40.144.122.66: bytes=32 time<1ms TTL=126
Reply from 40.144.122.66: bytes=32 time<1ms TTL=126

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```



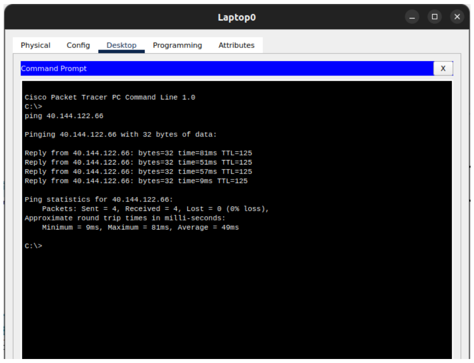
```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

Reply from 40.144.122.66: bytes=32 time<1ms TTL=125
Reply from 40.144.122.66: bytes=32 time=1ms TTL=125
Reply from 40.144.122.66: bytes=32 time<1ms TTL=125
Reply from 40.144.122.66: bytes=32 time<1ms TTL=125

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

N_3



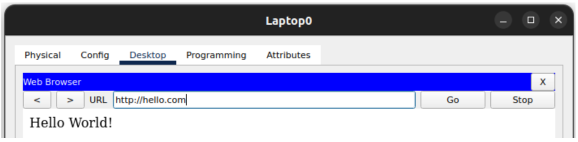
URL http://hello.com

Hello World!



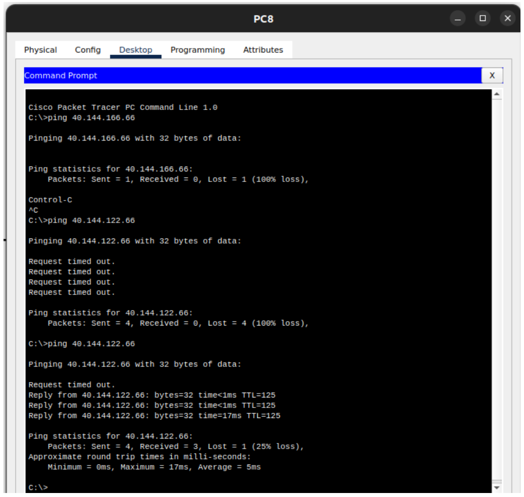
```
Cisco Packet Tracer PC Command Line 1.0
C:\>
ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

Reply from 40.144.122.66: bytes=32 time=81ms TTL=125
Reply from 40.144.122.66: bytes=32 time=51ms TTL=125
Reply from 40.144.122.66: bytes=32 time=57ms TTL=125
Reply from 40.144.122.66: bytes=32 time=9ms TTL=125

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 81ms, Average = 49ms

C:\>
```

N_4



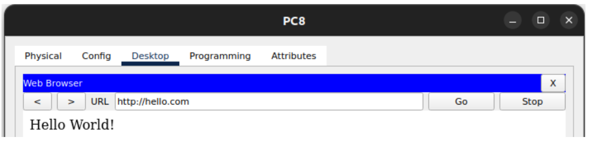
URL http://hello.com

Hello World!



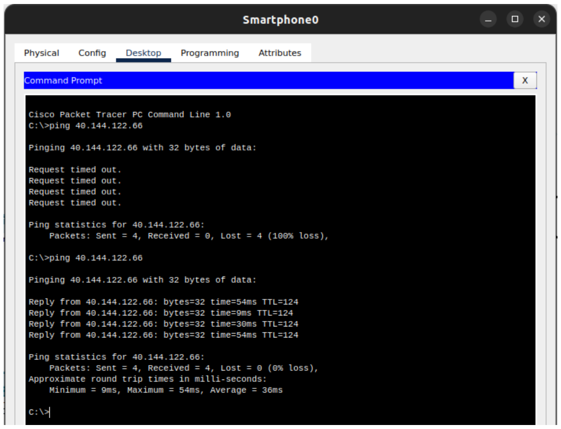
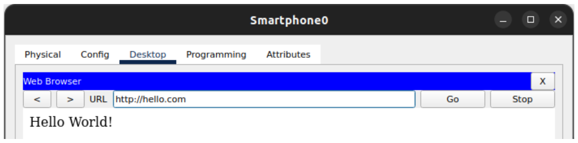
```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 40.144.166.66

Pinging 40.144.166.66 with 32 bytes of data:


Ping statistics for 40.144.166.66:
    Packets: Sent = 1, Received = 0, Lost = 1 (100% loss),

Control-C
^C
C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

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

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

Request timed out.
Reply from 40.144.122.66: bytes=32 time<1ms TTL=125
Reply from 40.144.122.66: bytes=32 time<1ms TTL=125
Reply from 40.144.122.66: bytes=32 time=17ms TTL=125

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 17ms, Average = 5ms

C:\>
```

N_5



URL http://hello.com

Hello World!

	**N_W**	

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

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

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 40.144.122.66

Pinging 40.144.122.66 with 32 bytes of data:

Reply from 40.144.122.66: bytes=32 time=54ms TTL=124
Reply from 40.144.122.66: bytes=32 time=9ms TTL=124
Reply from 40.144.122.66: bytes=32 time=30ms TTL=124
Reply from 40.144.122.66: bytes=32 time=54ms TTL=124

Ping statistics for 40.144.122.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 54ms, Average = 36ms

C:\>
```

URL http://hello.com

Hello World!

This comprehensive approach ensures that we check both the server's accessibility via ping and the webpage's resolution through DNS for each subnet.