Lab Work No. 05
"Static and Dynamic Routing"

1.Aim

The three main objectives of this lab are:

- Configuration of interconnection between different networks using routers (IP addressing, subnetting, gateways, etc.).
- Configuration of static routing.
- Configuration of dynamic routing using the RIP protocol.

All tasks are performed using the Packet Tracer simulator.

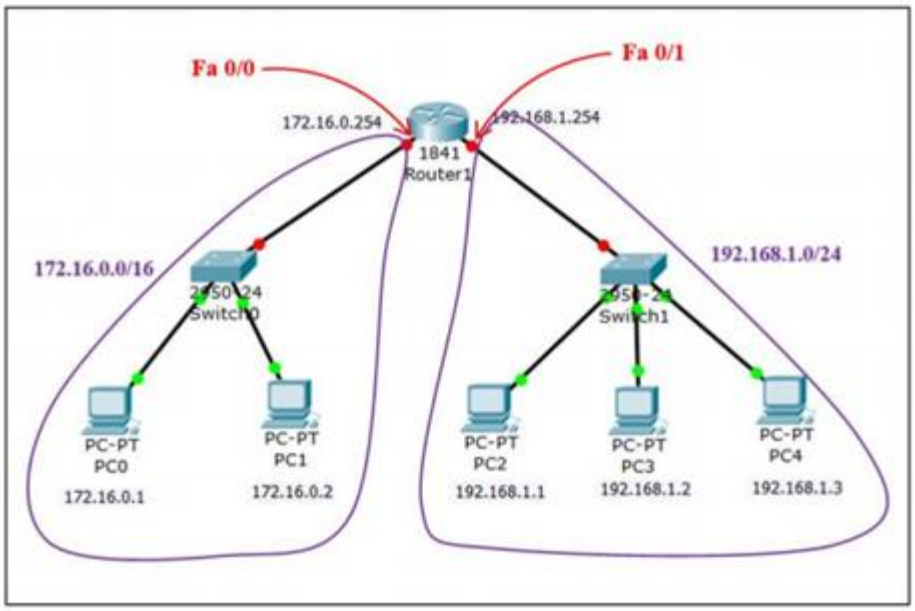
2. Basic Commands to Configure a Cisco Switch/Router

The following table lists the main commands necessary for configuring the interconnection of networks:

Command	Purpose
enable	Enters privileged executive mode.
configure terminal	Enters global configuration mode, which lets you start making changes to the router's configuration.
exit	Exits configuration mode for the Fast Ethernet interface and returns to global configuration mode.
interface *type number* Example: Router(config)# Interface FastEthernet 0/0	Enters the configuration mode for a Fast Ethernet interface on the router.
ip address *ip-address mask* Example: Router(config-if)# ip address 192.168.12.2 255.255.255.0	Sets the IP address and subnet mask for the specified Fast Ethernet interface.
no shutdown	Enables the Ethernet interface, changing its state from administratively down to administratively up.
copy running-config startup-config	Copies the current live configuration into the startup configuration file, so that your changes are saved and persist after a reboot.
show ip interface brief	Displays the usability status of interfaces configured for various IP addresses.
ip route *prefix mask* { *ip-address* | *interface-type interface-number* [*ip-address*]} Example: Router(config)# ip route 192.168.1.0 255.255.0.0 10.10.10.2	Specifies the static route for the IP packets.
show ip route	Displays the current state of the routing table.
no ip route *prefix mask ip-address* Example : Router(config)# no ip route 192.168.2.0 255.255.255.0 10.0.0.2	Removes a static route from the router's routing table.
router rip	Enters router configuration mode, and enables RIP on the router.
network *ip-address* Example: Router(config-router)# network 192.168.1.1	Specifies a list of networks on which RIP is to be applied, using the address of the network of each directly connected network.

3. Network Interconnection

Consider configuring the network shown in the figure:



This network consists of two local networks: LAN1 with IP 172.16.0.0 and LAN2 with IP 192.168.1.0. Both networks are connected via a router. LAN1 is connected through the FastEthernet 0/0 interface (denoted as Fa 0/0) and LAN2 through the FastEthernet 0/1 interface (denoted as Fa 0/1).

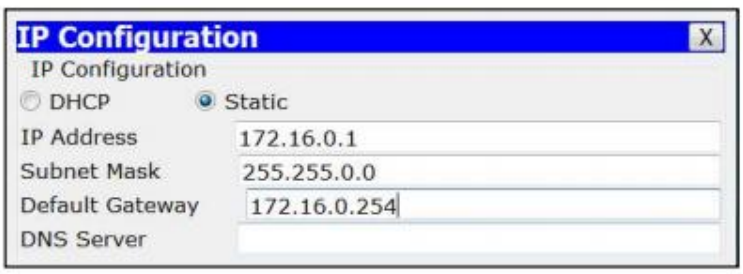
3.1. IP Configuration of Network Interfaces

Every network card (for PCs and routers) must have an IP address. The router interface gets an IP address from the LAN it connects to and acts as its gateway.

Remember that the gateway address is the address of the interface through which the network is connected to other networks — in other words, it is the interface through which a packet will exit to reach an external network. We start by configuring the local networks (the PCs), and then the routers.

3.1.1. Configuring PC Interfaces

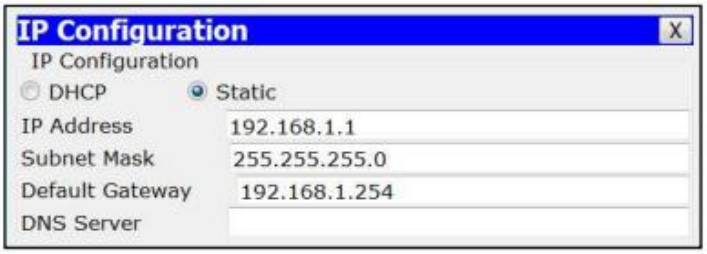
- On each PC, go to "Desktop" > "IP Configuration"
- Example for PC0 on 172.16.0.0/16:



The gateway for this network is the Fa 0/0 interface of the router, with the address 172.16.0.254

Do the same for the other PCs in this network.

- For a PC in the 192.168.1.0/24 network, do the following:



The gateway for this network is the Fa 0/1 interface of the router, with the address 192.168.1.254
Do the same for the other PCs in this network.

3.1.2. Configuring Router Interfaces

The router must be configured so that it knows it is connected to the "171.16.0.0" network via its FastEthernet 0/0 interface, and to the "192.168.1.0" network via its FastEthernet 0/1 interface. Click on the router and select the CLI tab, which stands for "Command-Line Interface." The prompt "Router>" will appear, allowing you to use command lines to configure each of the router's interfaces. To configure the Fa 0/0 interface, proceed as follows:

```
Router> enable
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface fastEthernet 0/0
Router(config-if)#ip address 172.16.0.254 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#exit
```

To configure the Fa 0/1 interface, proceed in the same way:

```
Router(config)#interface fastEthernet 0/1
Router(config-if)#ip address 192.168.1.254 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

To save the configuration:

```
Router# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#
```

3.1.3. Configuration Testing

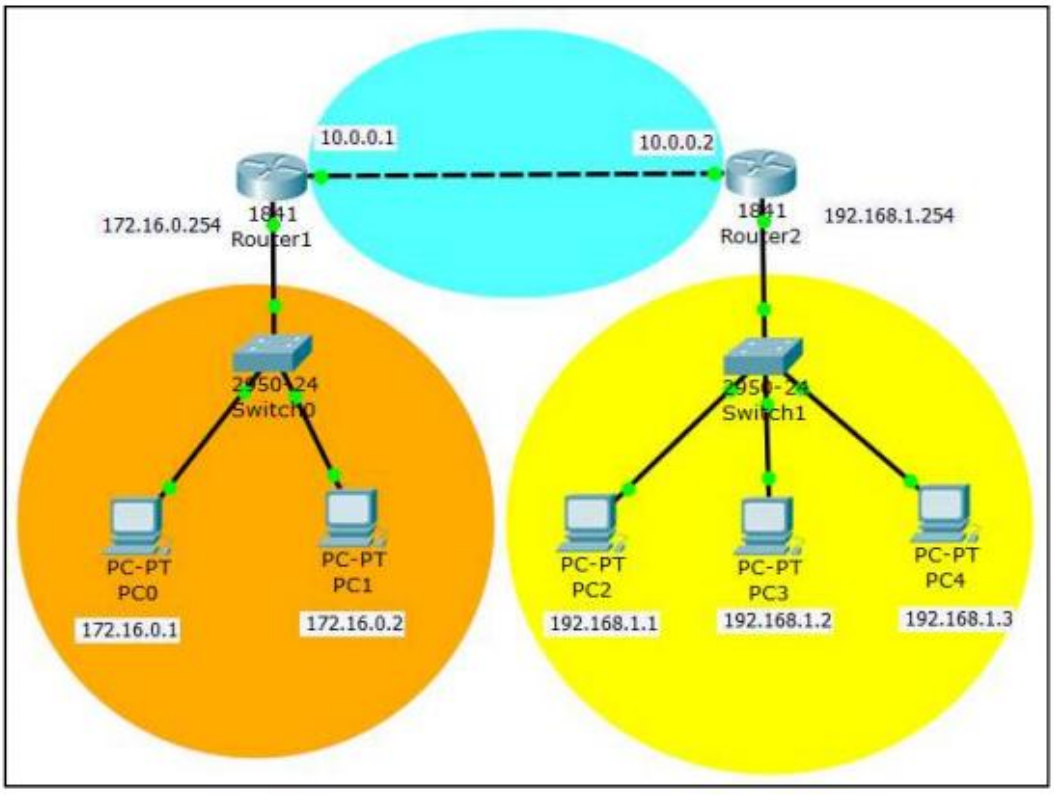
Use the ping command from a PC in LAN1 to a PC in LAN2 (or vice versa) to verify connection. For example, on PC0 in the 172.16.1.0/16 network, run the command ping 192.168.1.1. You will notice that the connection is established and the network is properly configured.

```
Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time=0ms TTL=127
Reply from 192.168.1.1: bytes=32 time=12ms TTL=127
Reply from 192.168.1.1: bytes=32 time=1ms TTL=127
Reply from 192.168.1.1: bytes=32 time=0ms TTL=127

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 12ms, Average = 3ms
```

Note: It is possible to visualize the ping in "Simulation" mode to see the path taken by the packets.

3.2. Static Routing Configuration

Routing is a feature of forwarding ensured through networks. To study it, we modify the configuration of the previous network as follows: A second router is added in such a way that there will be three interconnected LAN networks; the two networks LAN1 and LAN2 become interconnected through the 10.0.0.0/8 network.



The router interfaces are configured, taking into account this time the addition of a third LAN network.

3.2.1. Configuring Router 1

Change Fa0/1 to use an address in 10.0.0.0, e.g., 10.0.0.1

```
Router# show ip interface brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 172.16.0.254 YES manual up up
FastEthernet0/1 192.168.1.254 YES manual up up
Vlan1 unassigned YES unset administratively down down
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface fastEthernet 0/1
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]

Router#
```

3.2.2. Configuring Router 2

We assign the address 10.0.0.2 to the Fa 0/0 interface and the address 192.168.1.254 to the Fa 0/1 interface, and we follow the same procedure as that used for Router 1 (see section 3.1.2. Configuring router interfaces).

3.2.3. Routing Table Configuration

If we ping from PC0 on the 172.16.0.0/16 network to PC2 on the 192.168.1.0/24 network, we will get:

```
PC>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 172.16.0.254: Destination host unreachable.
Reply from 172.16.0.254: Destination host unreachable.
Reply from 172.16.0.254: Destination host unreachable.
Reply from 172.16.0.254: Destination host unreachable.

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

The 172.16.0.0 network cannot communicate with the 192.168.1.0 network because the communication does not occur directly (as in the previous case where only the LAN1 and LAN2 networks were connected); it now goes through the 10.0.0.0/8 network, and the router is not configured to recognize this.

Therefore, we need to configure the routes that will allow communication between the 172.16.0.0/16 network and the 192.168.1.0/24 network.

We start by configuring the routes on Router 1. To do this, we add a route to 192.168.1.0/24 through the next-hop with the address 10.0.0.2:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip route 192.168.1.0 255.255.255.0 10.0.0.2
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

We can view the new routing table:

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D-EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1-OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1-OSPF external type 1, E2 - OSPF external type 2, E - EGP
i-IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, FastEthernet0/1
C 172.16.0.0/16 is directly connected, FastEthernet0/0
S 192.168.1.0/24 [1/0] via 10.0.0.2
Router#
```

Now we configure the routes on Router 2. To do this, we add a route to 172.16.0.0/16 through the next-hop with the address 10.0.0.1:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip route 172.16.0.0 255.255.0.0 10.0.0.1
Router(config)#exit
Router#
```

The new routing table of Router 2 is:

```
Router# show ip route
        .
        .
        .
Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, FastEthernet0/0
S 172.16.0.0/16 [1/0] via 10.0.0.1
C 192.168.1.0/24 is directly connected, FastEthernet0/1
Router#
```

The connection between the two networks can be tested with a ping from PC0 on the 172.16.0.0/16 network to PC2 on the 192.168.1.0/24 network. You will notice that the connection is established and the network is properly configured.

3.2.4. Default Route

When the router needs to access a server (internet, DNS, file server, etc.) or another network that is unknown to it, a default route must be set. The default route provides the router with a fallback path. To do this, the following command is used:

```
Router(config)# ip route 0.0.0.0 0.0.0.0 next-hop
```

3.3. Dynamic Routing Configuration

The drawback of static routing is that it does not automatically adapt to changes in topology during an incident, such as a route failure. For this reason, dynamic routing is used.

In the following steps, we configure dynamic routing for the same network as before. First, we clear the routing tables, and to do this, we delete the routes one by one as follows:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#no ip route 192.168.1.0 255.255.255.0 10.0.0.2
Router(config)#exit
```

We do this for all the routes on both routers.

3.3.1. Routing Algorithms

There are several routing algorithms that differ in their operating principles and the metrics used to choose a path between the source and the destination. One such class is known as "Distance Vector" routing. Algorithms in this class use the number of hops as the metric to determine the best path between two devices. The representative algorithm of this class is the Routing Information Protocol (RIP).

This is the algorithm we will use to implement dynamic routing in the network. Note that this algorithm is installed by default on Cisco routers.

3.3.2. RIP Configuration

For each router, we configure dynamic routing using the RIP algorithm with the command **"router rip"**. Then, for each interface on the router, we add the route to the LAN network connected to that interface using the **"network"** command.

For Router 1:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router) # network 172.16.0.0
Router(config-router) # network 10.0.0.0
Router(config)#exit
Router#
```

For Router 2:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router) # network 10.0.0.0
Router(config-router) # network 192.168.1.0
Router(config)#exit
Router#
```

The routing table view of Router 1 shows:

```
Router#show ip route
        .
        .
        .
Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, FastEthernet0/1
C 172.16.0.0/16 is directly connected, FastEthernet0/0
```

There are only two entries.
If we test the connection between the two networks, 172.16.0.0 and 192.168.1.0, we observe that the connection is established and the network is properly configured.
The routing table of Router 1 shows:

```
Router# show ip route
        .
        .
        .
Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, FastEthernet0/1
C 172.16.0.0/16 is directly connected, FastEthernet0/0
R 192.168.1.0/24 [120/1] via 10.0.0.2, 00:00:16, FastEthernet0/1
```

Notice that a route to the 192.168.1.0 network has been added—this is thanks to the execution of the **RIP algorithm** by Routers 1 and 2 (they exchange their routing tables and update them accordingly).