National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

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Semester: **6th** **Section:** **D**

EE-357 Computer and Communication Networks

Experiment - 6

Introduction to Dynamic Routing

		PLO5/ CLO3		PLO5/ CLO3	PLO5/ CLO3	PLO5/ CLO3
Name	**Reg. No**	**Viva / Quiz / Lab Performance** **5 Marks**	**Analysis of data in Lab Report** **5 Marks**	**Modern Tool Usage** **5 Marks**	**Ethics and Safety** **5 Marks**	**Individual and Team Work** **5 Marks**
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EXPERIMENT NO 6

Introduction to Dynamic Routing (RIP)

1. Objective

- This lab exercise is designed to understand routing and procedure to setup RIP on routers

2. Resources Required

- Computer
- Packet Tracer (version 5 or higher)
- ENSP Software

3. Introduction

A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network, the choice of the route being done by routing algorithms. Each router has a priori knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, routers gain knowledge of the topology of the network.

3.1 Types of Routing Protocols

There are two main types of routing protocols:

- **Interior Gateway Protocol (IGP)** is a routing protocol that is used to exchange routing information within an autonomous system (AS). Examples are RIP, OSPF
- **Exterior Gateway Protocol (EGP)** is for determining network reachability between autonomous systems and makes use of IGPs to resolve routes within an AS. Examples are BGP & EGP.

3.2 Types of Interior Gateway Routing Protocols

IGPs can be divided into following three types:

a) **Distance vector:** The distance-vector protocols find the best path to a remote network by judging distance. Each time a packet goes through a router, that's called a hop. The route with the least number of hops to the network is determined to be the best route. The vector indicates the direction to the remote network. Both RIP and IGRP are distance-vector routing protocols. They send the entire routing table to directly connected neighbors.

b) **Link state:** In link-state protocols, also called shortest-path-first protocols, the routers each create three separate tables. One of these tables keeps track of directly attached neighbors, one determines the topology of the entire internetwork, and one is used as the routing table. Link state routers know more about the internetwork than any distance-vector routing protocol. OSPF is an IP routing protocol that is completely link state. Link state protocols send updates containing the state of their own links to all other routers on the network.

c) **Hybrid:** Hybrid protocols use aspects of both distance vector and link state—for example,EIGRP.

There's no set way of configuring routing protocols for use with every business. This is something you really have to do on a case-by-case basis. If you understand how the different routing protocols work, you can make good, solid decisions that truly meet the individual needs of any business.

3.3 Administrative Distance & Metric

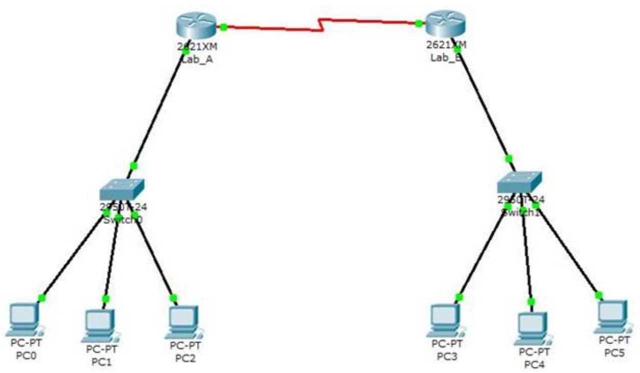
Metric is a property of a route in computer networking, consisting of any value used by routing algorithms to determine whether one route should perform better than another. It is used to choose the best route among the routes found by **same routing protocol**.

Administrative distance is the measure used by Cisco routers to select the best path when there are two or more different routes to the same destination from **two different routing protocols**. Administrative distance defines the reliability of a routing protocol. Each routing protocol is prioritized in order of most to least reliable (believable) using an administrative distance value.

Remember! Smaller value (metric or administrative distance) means better route and Administrative Distance has preference over Metric.

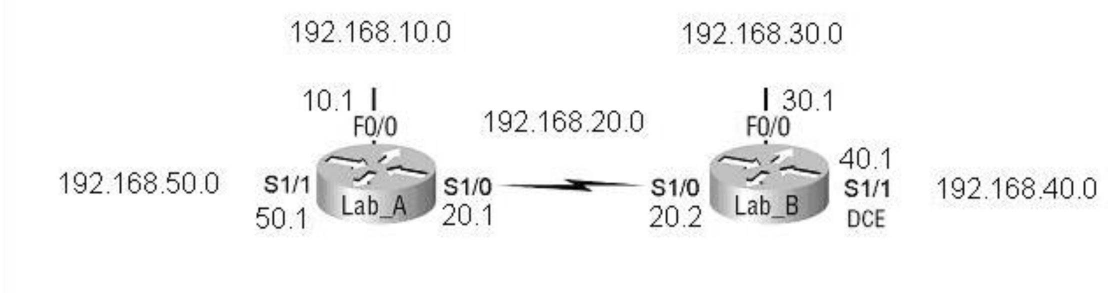
4. Procedure

Open Packet Tracer 5 and setup a network similar to the following network. Use Cisco 2950T switch & Cisco 2621XM router.



The different thing is the red link which is serial link (used for WAN). By default, it is not available so we have to add the modules to the router. Double click on any router. Turn it off by using power button on the router figure in **Physical** tab. On left side modules bar is present. Drag two **WIC-2T** to smaller blank space and one **NM-8A/S** to larger blank space. Now, turn on the router using power switch. Do the same on second router. Then use **Serial DTE** or **Serial DCE** link from **Connections**. The router interface that is chosen first becomes that of that type while the second one becomes the other e.g if you choose DTE and click first router, it becomes DTE while the second one becomes DCE and vice versa. Just remember that by default all serial interfaces are DTE so we have to provide clocking on the DCE one!

3. Use the following values to setup IP addresses on respective interfaces.



Router	Network Address	Interface	Address
Lab_A	192.168.10.0	fa0/0	192.168.10.1
Lab_A	192.168.20.0	s1/0	192.168.20.1
Lab_A	192.168.50.0	s1/1	192.168.50.1
Lab_B	192.168.30.0	fa0/0	192.168.30.1
Lab_B	192.168.20.0	s1/0	192.168.20.2
Lab_B	192.168.40.0	s1/1	192.168.40.1

A sample configuration is given as under

Router>**en**

Router#**config t**

Router(config)#**hostname Lab_A**

Lab_A(config)#**interface fa0/0**

Lab_A(config-if)#**ip address 192.168.10.1 255.255.255.0**

Lab_A(config-if)#**description Lab_A LAN Connection**

Lab_A(config-if)#**no shut**

Lab_A(config-if)#**interface serial 1/0**

Lab_A(config-if)#**ip address 192.168.20.1 255.255.255.0**

Lab_A(config-if)#**description WAN Connection to Lab_B**

Lab_A(config-if)#**no shut**

Lab_A(config-if)#**interface serial 1/1**

Lab_A(config-if)#**ip address 192.168.50.1 255.255.255.0**

Lab_A(config-if)#**no shut**

Lab_A(config-if)#**exit**

Lab_A(config)#**banner motd #**

This is the Lab_A router

#

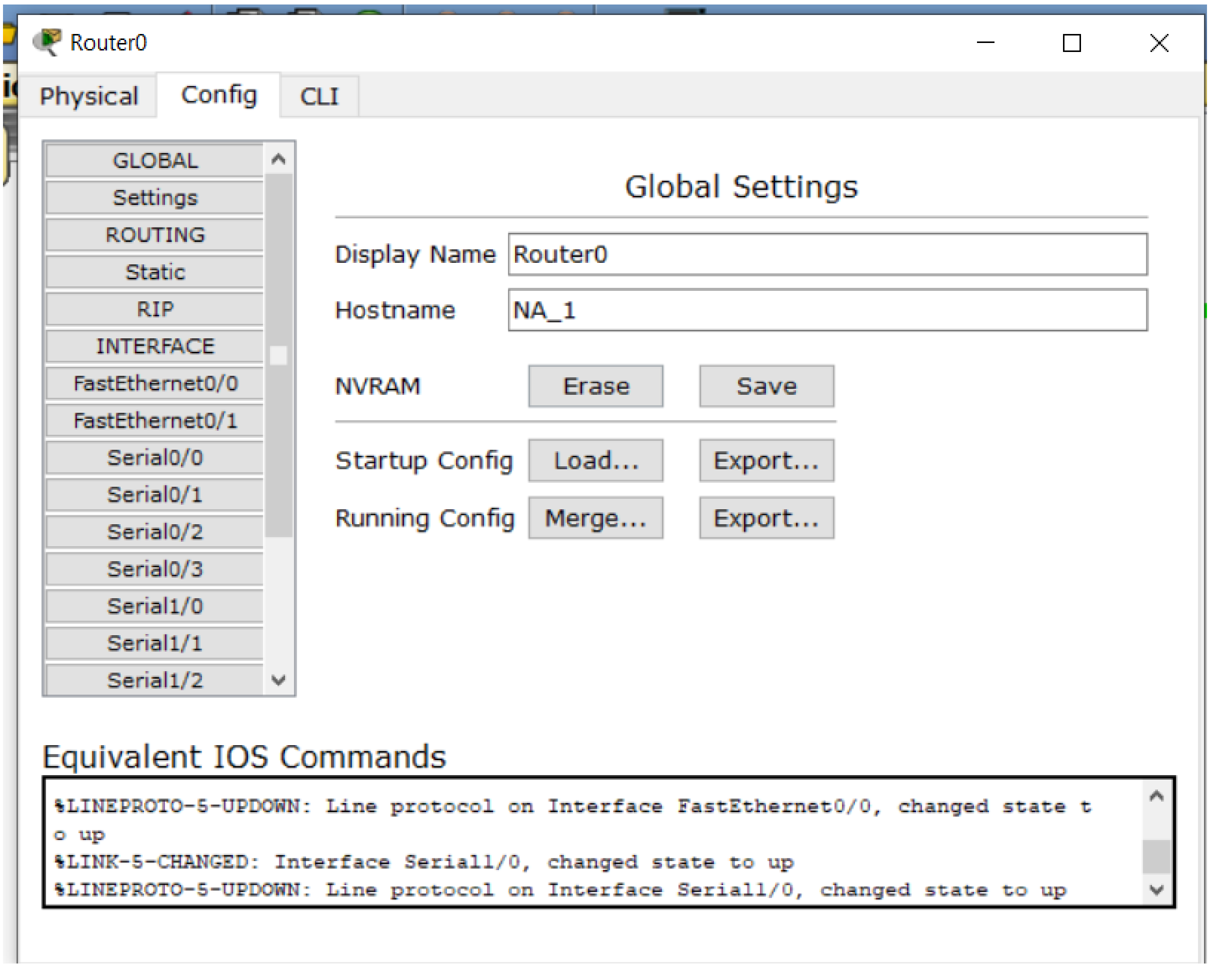
Lab_A(config)#**^z**

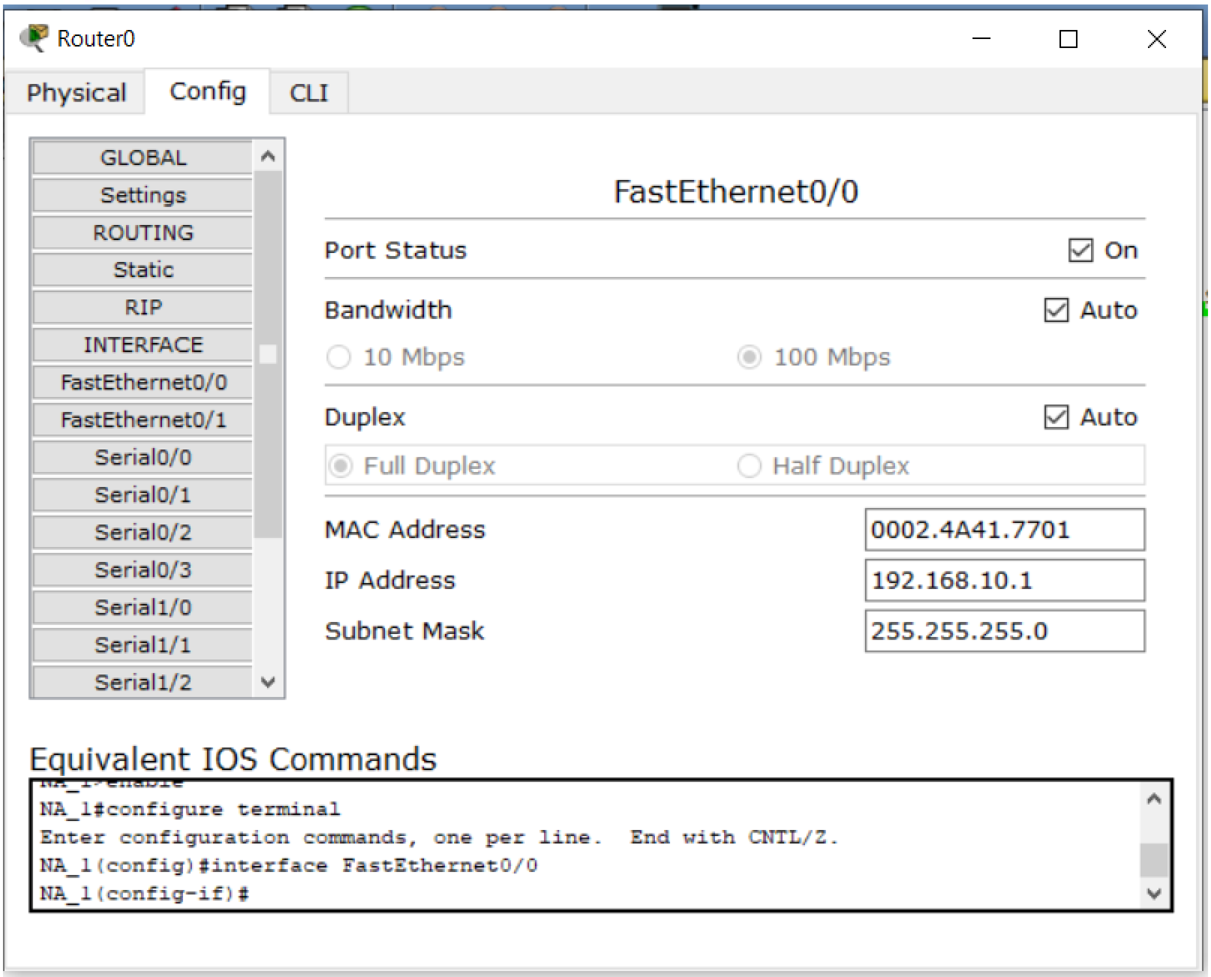
Lab_A#**copy running-config startup-config**

Destination filename [startup-config]? ***[Enter]***

Lab_A#

SCREENSHOT:





Before you jump in and configure a serial interface, there are a couple of things you need to know. First, the interface will usually be attached to a CSU/DSU type of device that provides clocking for the line to the router. But if you have a back-to-back configuration (for example, one that's used in a lab environment), one end—the data communication equipment (DCE) end of the cable—must provide clocking. By default, Cisco routers are all data terminal equipment (DTE) devices, so you must tell an interface to provide clocking if you need it to act like a DCE device.

To check the DCE interface, just bring your mouse over serial link, the interface with whose name

you see a (clock symbol) is the DCE one. You configure a DCE serial interface with the clock rate command:

Lab_B(config)#**interface serial 1/0**

Lab_B(config-if)#**clock rate ?**

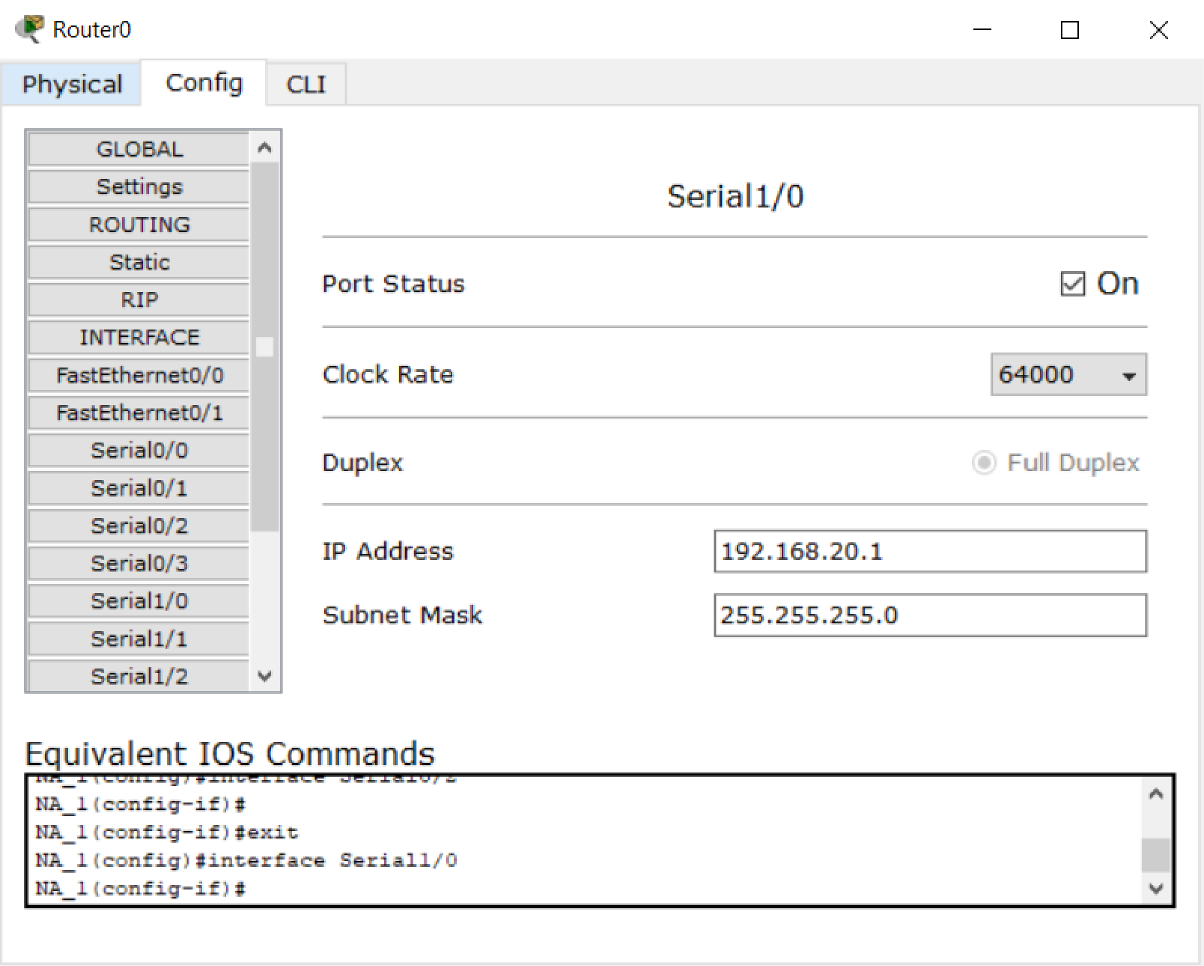
<300-4000000> Choose clockrate from list above

Router(config-if)#**clock rate 64000**

Notice that the clock rate command is in bits per second.

Configure the PCs and Switches too. Make sure all devices are communicating with each other (use **ping** to verify).

Now you must have noticed that routers can communicate with devices directly connected to them. PC0-PC2 and Switch0 can communicate with Lab_A router & in between themselves but can't with Lab_B router and Switch1 & PC2-PC5 and vice versa.



4.1 Configuring RIP (Routing Information Protocol)

The network command tells the routing protocol which network to advertise. Look at the next router configuration:

Lab_A(config)#**router rip**

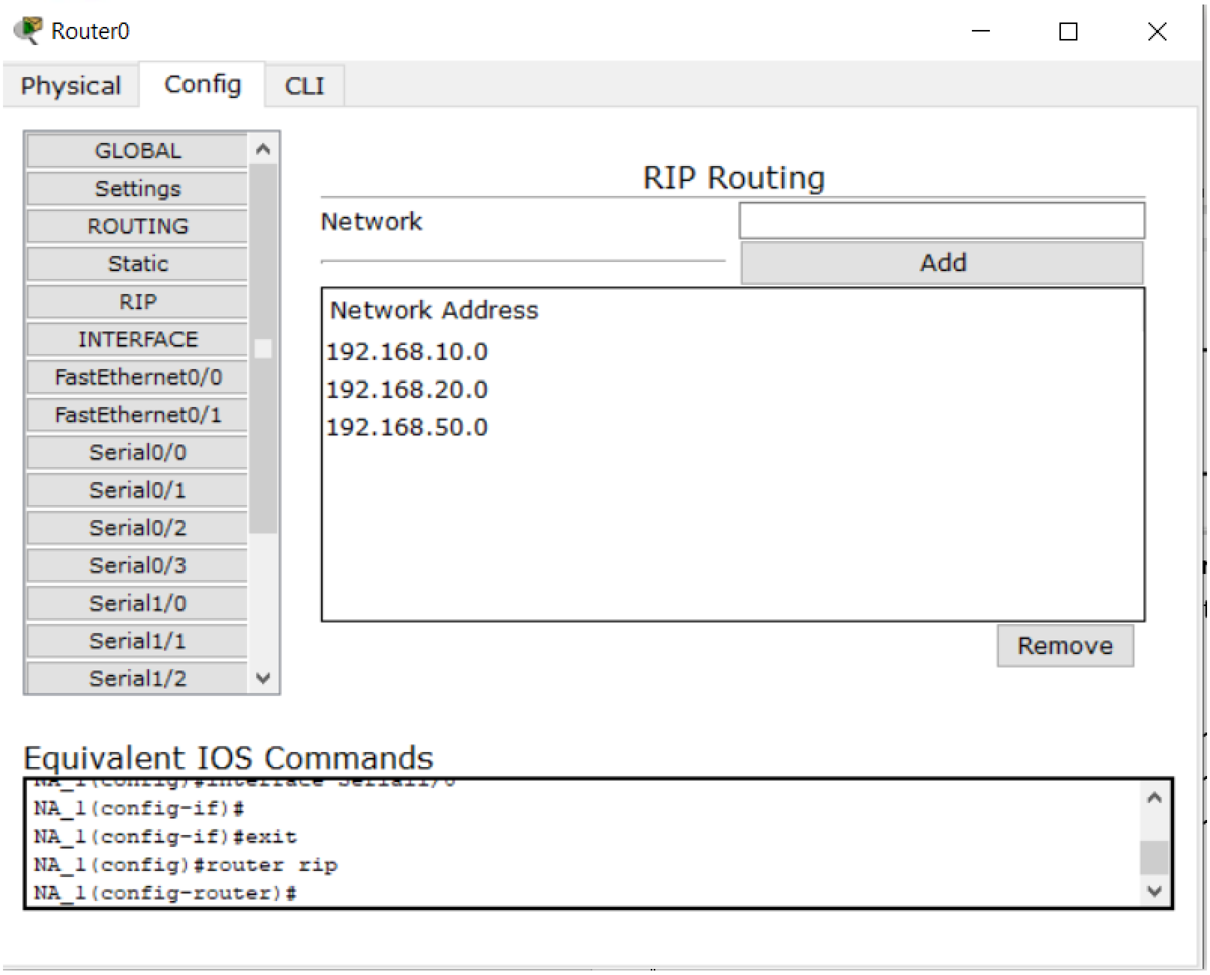
Lab_A(config-router)#**network 192.168.10.0**

Lab_A(config-router)#**network 192.168.20.0**

Lab_A(config-router)#**network 192.168.50.0**

Lab_A(config-router)#**^Z**

Lab_A#



Note the fact that you need to type in every directly connected network that you want RIP to advertise. But because they're not directly connected we're going to leave out networks 192.168.30.0 and 192.168.40.0—it's RIP's job to find them and populate the routing table. That's it. Dynamic routing makes your job a lot easier than when using static routes, doesn't it? However, keep in mind the extra router CPU process and bandwidth that you're consuming.

The Lab_B router has three directly connected networks and we want RIP to advertise them all, so we will add three network statements. Here are steps to configure RIP on the Lab_B:

Lab_B#**config t**

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

Lab_B(config)#**router rip**

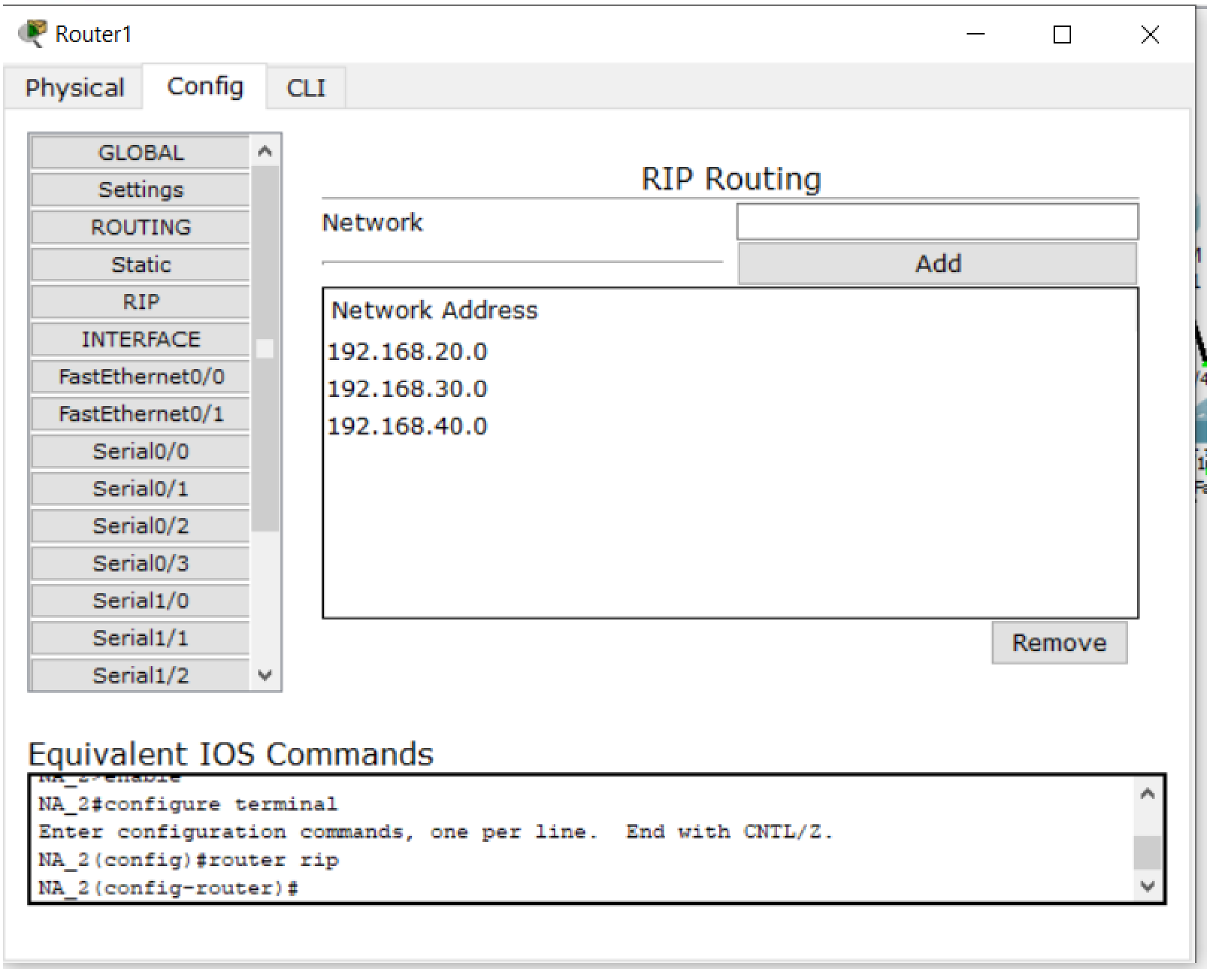
Lab_B(config-router)#**network 192.168.20.0**

Lab_B(config-router)#**network 192.168.30.0**

Lab_B(config-router)#**network 192.168.40.0**

Lab_B(config-router)#**^Z**

Lab_B#



Each routing table should now have the routers' directly connected routes as well as RIP injected routes received from neighboring routers.

This output shows us the contents of the Lab_A routing table (your output may differ):

Lab_A#**sh ip route**

[output cut]

R 192.168.40.0 [120/1] via 192.168.20.2, 00:00:23, Serial1/0

R 192.168.30.0 [120/1] via 192.168.20.2, 00:00:23, Serial1/0

C 192.168.50.0 is directly connected, Serial1/1

C 192.168.20.0 is directly connected, Serial1/0

C 192.168.10.0 is directly connected, FastEthernet0/0

Lab_A#

```
NA_1#sh 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    192.168.10.0/24 is directly connected, FastEthernet0/0
C    192.168.20.0/24 is directly connected, Serial1/0
R    192.168.30.0/24 [120/1] via 192.168.20.2, 00:00:14, Serial1/0
NA_1#
```

Looking at this, you can see that the routing table has the same entries that they had when we were using static routes, except for that R. The R means that the networks were added dynamically using the RIP routing protocol. The [120/1] is the administrative distance of the route (120) along with the number of hops to that remote network (1).

The following output displays Lab_B's routing table.

Lab_B#**sh ip route**

[output cut]

R 192.168.50.0 [120/1] via 192.168.20.1, 00:00:11, Serial1/0

C 192.168.40.0 is directly connected, Serial1/1

C 192.168.30.0.0 is directly connected, FastEthernet0/0

C 192.168.20.0 is directly connected, Serial1/0

R 192.168.10.0 [120/1] via 192.168.20.1, 00:00:21, Serial1/0

Lab_B#

```
NA_2>enable
NA_2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
NA_2(config)#router rip
NA_2(config-router)#^Z
%SYS-5-CONFIG_I: Configured from console by console
NA_2#sh 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    192.168.20.0/24 is directly connected, Serial0/2
C    192.168.30.0/24 is directly connected, FastEthernet0/0
NA_2#
```

So while yes, it's true that RIP has worked really well in our little internetwork, it's not the solution for every enterprise. That's because this technique has a maximum hop count of only 15 (16 is deemed unreachable) and it performs full routing-table updates every 30 seconds, both things that can wreak havoc in a larger internetwork.

You probably don't want your RIP network advertised everywhere on your LAN and WAN. There's not a whole lot to be gained by advertising your RIP network to the Internet.

There are a few different ways to stop unwanted RIP updates from propagating across your LANs and WANs. The easiest one is through the passive-interface command. This command prevents RIP update broadcasts from being sent out a defined interface, but that same interface can still receive RIP updates.

Here's an example of how to configure a passive-interface on a router:

Lab_A#**config t**

Lab_A(config)#**router rip**

Lab_A(config-router)#**network 192.168.10.0**

Lab_A(config-router)#**passive-interface serial 1/0**

This command will stop RIP updates from being propagated out serial interface 1/0, but serial interface 1/0 can still receive RIP updates.

```
Enter configuration commands, one per line.  End with CNTL/Z.
NA_1(config)#router rip
NA_1(config-router)#network 192.168.10.0
NA_1(config-router)#passive-interface serial 1/0
NA_1(config-router)#
```

4.3 The *debug ip rip* Command

The debug ip rip command sends routing updates as they are sent and received on the router to the console session. If you are telnetted into the router, you'll need to use the terminal monitor command to be able to receive the output from the debug commands.

Below is an example of how debug output looks, your output may differ according to your configurations. We can see in this output that RIP is both sent and received on serial 0/0 and serial 0/1 interfaces (the metric is the hop count):

Lab_B#**debug ip rip**

RIP protocol debugging

is on Lab_B#

RIP: sending v1 update to 255.255.255.255 via FastEthernet0/0

(192.168.30.1) RIP: build update entries

network 192.168.10.0

metric 2 network

192.168.20.0 metric 1

RIP: sending v1 update to 255.255.255.255 via Serial1/0

(192.168.20.2) RIP: build update entries

network 192.168.30.0 metric 1

RIP: received v1 update from 192.168.20.1 on

Serial1/0 192.168.10.0 in 1 hops

```
NA_2#debug ip rip
RIP protocol debugging is on
NA_2#RIP: sending  v1 update to 255.255.255.255 via FastEthernet0/0 (192.168.30.
1)
RIP: build update entries
      network 192.168.20.0 metric 1
RIP: sending  v1 update to 255.255.255.255 via Serial0/2 (192.168.20.2)
RIP: build update entries
      network 192.168.30.0 metric 1
RIP: sending  v1 update to 255.255.255.255 via FastEthernet0/0 (192.168.30.1)
RIP: build update entries
      network 192.168.20.0 metric 1
RIP: sending  v1 update to 255.255.255.255 via Serial0/2 (192.168.20.2)
RIP: build update entries
      network 192.168.30.0 metric 1
```

To turn off debugging, use the undebug all or the no debug all command. Here is an example of using the undebug all command:

Lab_B#**undebug all**

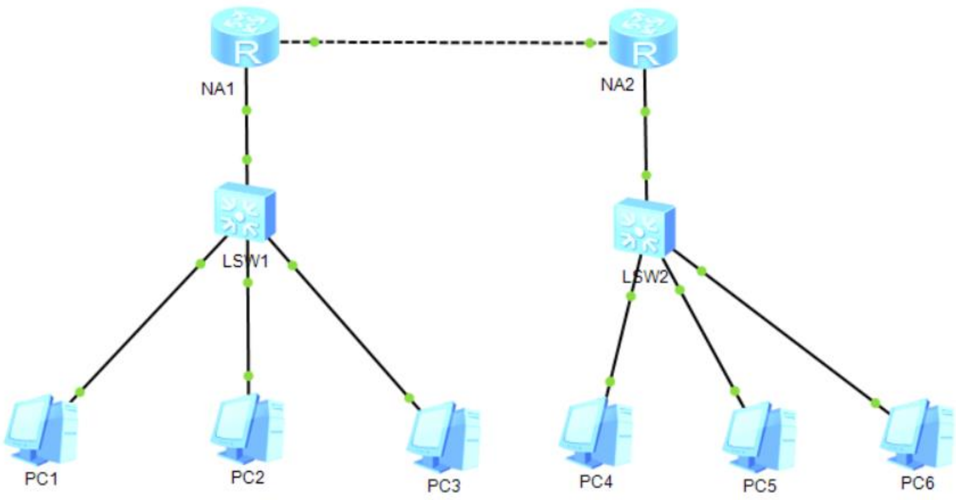
All possible debugging has been turned off

Lab_B#

```
NA_2#undebug all
All possible debugging has been turned off
NA_2#
```

4.4: Student activity:

Convert the topology designed above in ENSP software such that it utilizes dynamic routing while ensuring it is converged. Write a report detailing your topology along with configuration files of any two routers.



NA1

CONFIGURATION:

```
[Huawei]sysname NA1
[NA1]
May 25 2022 01:18:40-08:00 NA1 %%01PHY/1/PHY(1)[2]:    Serial0/0/0: change statu
s to down
May 25 2022 01:18:40-08:00 NA1 %%01PPP/4/PHYSICALDOWN(1)[3]:On the interface Ser
ial0/0/0, PPP link was closed because the status of the physical layer was Down.
May 25 2022 01:18:40-08:00 NA1 %%01IFNET/4/LINK_STATE(1)[4]:The line protocol PP
P on the interface Serial0/0/0 has entered the DOWN state.
May 25 2022 01:18:41-08:00 NA1 %%01PHY/1/PHY(1)[5]:    Serial0/0/0: change statu
s to up
May 25 2022 01:18:41-08:00 NA1 %%01IFNET/4/LINK_STATE(1)[6]:The line protocol PP
P on the interface Serial0/0/0 has entered the UP state.
[NA1]
May 25 2022 01:18:45-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 1, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA1]interface ethernet 0/0/1
[NA1-Ethernet0/0/1]ip address 192.168/10.1 255.255.255.0
                                        ^
Error: Wrong parameter found at '^' position.
[NA1-Ethernet0/0/1]ip address 192.168.10.1 255.255.255.0
[NA1-Ethernet0/0/1]
May 25 2022 01:20:15-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 2, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA1-Ethernet0/0/1]no shut
                     ^
Error: Unrecognized command found at '^' position.
[NA1-Ethernet0/0/1]no shut
                     ^
Error: Unrecognized command found at '^' position.
[NA1-Ethernet0/0/1]undo shutdown
Info: Interface Ethernet0/0/1 is not shutdown.
[NA1-Ethernet0/0/1]
```

```
[NA1-Ethernet0/0/1]
<NA1>system
Enter system view, return user view with Ctrl+Z.
[NA1]interface serial0/0/0
[NA1-Serial0/0/0]ip address 192.168.20.1
                                        ^
Error:Incomplete command found at '^' position.
[NA1-Serial0/0/0]ip address 192.168.20.1 255.255.255.0
[NA1-Serial0/0/0]undo shutdown
Info: Interface Serial0/0/0 is not shutdown.
[NA1-Serial0/0/0]
May 25 2022 01:23:35-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 3, the c
hange loop count is 0, and the maximum number of records is 4095.
```

NA2 CONFIGURATION:

```
[Huawei]sysname NA2
[NA2]
May 25 2022 01:28:46-08:00 NA2 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 1, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA2]interface ethernet0/0/1
[NA2-Ethernet0/0/1]ip address 192.168.30.1 255.255.255.0
[NA2-Ethernet0/0/1]undo
May 25 2022 01:29:56-08:00 NA2 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 2, the c
hange loop count is 0, and the maximum number of records is 4095.
                        ^
Error:Incomplete command found at '^' position.
[NA2-Ethernet0/0/1]undo shut
Info: Interface Ethernet0/0/1 is not shutdown.
[NA2-Ethernet0/0/1]
<NA2>system-view
Enter system view, return user view with Ctrl+Z.
[NA2]interface serial 0/0/0
[NA2-Serial0/0/0]ip address 192.168.20.2 255.255.255.0
[NA2-Serial0/0/0]undo shut
Info: Interface Serial0/0/0 is not shutdown.
[NA2-Serial0/0/0]q
May 25 2022 01:30:56-08:00 NA2 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 3, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA2]quit
<NA2>
```

NA1 RIP CONFIGURATION:

NA1

```
[NA1-Serial0/0/0]
May 25 2022 01:23:35-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 3, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA1-Serial0/0/0]
<NA1>system-view
Enter system view, return user view with Ctrl+Z.
[NA1]Rip
[NA1-rip-1]
May 25 2022 01:32:16-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 4, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA1-rip-1]network 192.168.10.0
[NA1-rip-1]
May 25 2022 01:32:36-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 5, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA1-rip-1]network 192.168.20.0
[NA1-rip-1]
May 25 2022 01:32:56-08:00 NA1 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 6, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA1-rip-1]
<NA1>
```

NA2 RIP CONFIGURATION:

```
[NA2]quit
<NA2>system-view
Enter system view, return user view with Ctrl+Z.
[NA2]Rip
[NA2-rip-1]
May 25 2022 01:34:26-08:00 NA2 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 4, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA2-rip-1]network 192.168.30.0
[NA2-rip-1]
May 25 2022 01:34:47-08:00 NA2 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 5, the c
hange loop count is 0, and the maximum number of records is 4095.
[NA2-rip-1]network 192.168.20.0
[NA2-rip-1]
May 25 2022 01:35:27-08:00 NA2 DS/4/DATASYNC_CFGCHANGE:OID 1.3.6.1.4.1.2011.5.25
.191.3.1 configurations have been changed. The current change number is 6, the c
hange loop count is 0, and the maximum number of records is 4095.
```

ROUTING TABLE NA1:

```
Routing Tables: Public
         Destinations : 8        Routes : 8

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
   192.168.10.0/24  Direct  0    0           D   192.168.10.1    Ethernet0/0/0
   192.168.10.1/32  Direct  0    0           D   127.0.0.1       Ethernet0/0/0
   192.168.20.0/24  Direct  0    0           D   192.168.20.1    Serial0/0/0
   192.168.20.1/32  Direct  0    0           D   127.0.0.1       Serial0/0/0
   192.168.20.2/32  Direct  0    0           D   192.168.20.2    Serial0/0/0
   192.168.30.0/24  RIP     100  1           D   192.168.20.2    Serial0/0/0
```

ROUTING TABLE NA2:

```
Routing Tables: Public
         Destinations : 8        Routes : 8

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
   192.168.10.0/24  RIP     100  1           D   192.168.20.1    Serial0/0/0
   192.168.20.0/24  Direct  0    0           D   192.168.20.2    Serial0/0/0
   192.168.20.1/32  Direct  0    0           D   192.168.20.1    Serial0/0/0
   192.168.20.2/32  Direct  0    0           D   127.0.0.1       Serial0/0/0
   192.168.30.0/24  Direct  0    0           D   192.168.30.1    Ethernet0/0/0
   192.168.30.1/32  Direct  0    0           D   127.0.0.1       Ethernet0/0/0
```

PINGING:

```
PC>ping 192.168.30.2

Ping 192.168.30.2: 32 data bytes, Press Ctrl_C to break
From 192.168.30.2: bytes=32 seq=1 ttl=126 time=937 ms
From 192.168.30.2: bytes=32 seq=2 ttl=126 time=141 ms
From 192.168.30.2: bytes=32 seq=3 ttl=126 time=125 ms
From 192.168.30.2: bytes=32 seq=4 ttl=126 time=109 ms
From 192.168.30.2: bytes=32 seq=5 ttl=126 time=110 ms

--- 192.168.30.2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 109/284/937 ms

PC>
```

4.5: Conclusion:

In this lab, we learned how to configure dynamic routing in packet tracer and then learned about how to implement dynamic ip routing in eNSp. Moreover, we also learned about passive interfaces and debugging ip rips. To sum it up, this lab helped us familiarize with different methods of dynamic routing.