Experiment 3

Dynamic Routing

Objectives

- ❖ Learn how to configure and verify IP routing with Cisco routers.
- ❖ Dynamic routing

Introduction

Backgoround:

There are two main routing classes used in data communication networks. The first class is called distance vector routing protocol and the second one is called link state routing protocol. Routing Information Protocol (RIP) and Interior Gateway Routing Protocol (IGRP), which will be used in this experiment, are distance vector routing protocols. An example of the other category is Open Shortest Path First (OSPF). In distance vector routing Protocols at the beginning each node (router) has only routing information about its direct neighbors. Each router broadcast periodically its routing information to its neighbors. This way, eventually, each node will get information about the entire network. When a node goes down, the direct neighbors will update their routing information and then update their neighbors using the periodic broadcasts and so on , until all nodes in the network knows about this change.

Dynamic Routing

Dynamic routing is when protocols are used to find networks and update routing tables on routers. True—this is easier than using static or default routing, but it'll cost you in terms of router CPU processes and bandwidth on the network links. A routing protocol defines the set of rules used by a router when it communicates routing information between neighbor routers.

The two routing protocols we will talk about in this Lab are Routing Information

Protocol (RIP) and Interior Gateway Routing Protocol (IGRP).

Routing Protocol Basics

There are some important things you should know about routing protocols before getting deeper into RIP. Specifically, you need to understand administrative distances, the three different kinds of routing protocols, and routing loops. We will look at each of these in more detail in the following sections.

Administrative Distances

The *administrative distance (AD)* is used to rate the trustworthiness of routing information received on a router from a neighbor router. An administrative distance is an integer from 0 to 255, where 0 is the most trusted and 255 means no traffic will be passed via this route.

If a router receives two updates listing the same remote network, the first thing the router checks is the AD. If one of the advertised routes has a lower AD than the other, then the route with the lowest AD will be placed in the routing table.

If both advertised routes to the same network have the same AD, then routing protocol metrics (such as *hop count* or bandwidth of the lines) will be used to find the best path to the remote network. The advertised route with the lowest metric will be placed in the routing table. But if both advertised routes have the same AD as well as the same metrics, then the routing protocol will load-balance to the remote network (which means that it sends packets down each link).

Table 1 shows the default administrative distances that a Cisco router uses to decide which route to take to a remote network.

Route Source	Default AD
Connected interface	0
Static route	1
IGRP	100
RIP	120

TABLE 1 Default Administrative Distances

If a network is directly connected, the router will always use the interface connected to the network.

If an administrator configures a static route, the router will believe that route over any other learned routes. You can change the administrative distance of static routes, but, by default, they have an AD of 1.

If you have a static route, a RIP-advertised route, and an IGRP-advertised route listing the same network, then by default, the router will always use the static route unless you change the AD of the static route.

Distance-Vector Routing Protocols

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. The distance-vector routing algorithm passes complete routing table contents to neighboring routers, which then combine the received routing table entries with their own routing tables to complete the router's routing table. This is called routing by rumor, because a router receiving an update from a neighbor router believes the information about remote networks without actually finding out for itself.

It's possible to have a network that has multiple links to the same remote network, and if that's the case, the administrative distance is checked first. If the AD is the same, the protocol will have to use other metrics to determine the best path to use to that remote network.

RIP uses only hop count to determine the best path to a network. If RIP finds more than one link to the same remote network with the same hop count, it will automatically perform a round-robin load balancing. RIP can perform load balancing for up to six equal-cost links (four by default).

Pre-lab:

Read the Procedure then, using Packet Tracer, build the network shown in Fig1 configuring the routers to use RIP as a dynamic routing protocol , show that it is possible to send packets between any two network (using ping and screen shots).
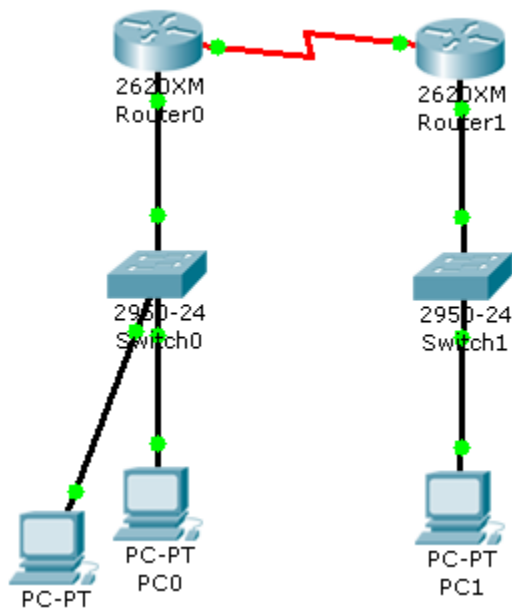

Figure 1

Procedure:

1. Configuring RIP Routing

To configure RIP routing, just turn on the protocol with the router rip command and tell the RIP routing protocol which networks to advertise. That's it. Let's configure our three-router internetwork (shown again in Figure 2) with RIP routing and practice that.

2. Lab_A Configuration

RIP has an administrative distance of 120. Static routes have an administrative distance of 1 by default and, since you in previous lab have configured static routes, the routing tables won't be propagated with RIP information. So, the first thing you need to do is to delete the static routes off each router.

This is done with the no ip route command:

Lab_A(config)#**no ip route 192.168.30.0 255.255.255.0**

192.168.20.2

Lab_A(config)#**no ip route 192.168.40.0 255.255.255.0**

192.168.20.2

Lab_A(config)#**no ip route 192.168.50.0 255.255.255.0**

192.168.20.2

Notice that in the preceding Lab_A router output, you must type the whole ip route command after the keyword no to delete the entry.

Once the static routes are deleted from the configuration, you can add the RIP routing protocol by using the router rip command and the network command. 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)#**^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 30, 40, and 50 because it's RIP's job to find them and populate the routing table.

That's it. Two or three commands, and you're done—sure 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.

RIP and IGRP use the classful address when configuring the network address. Because of this, all subnet masks must be the same on all devices in the network (this is called classful routing).

To clarify this, let's say you're using a Class B network address of 172.16.0.0/24 with subnets 172.16.10.0, 172.16.20.0 and 172.16.30.0. You would only type in the classful network address of 172.16.0.0 and let RIP find the subnets and place them in the routing table.
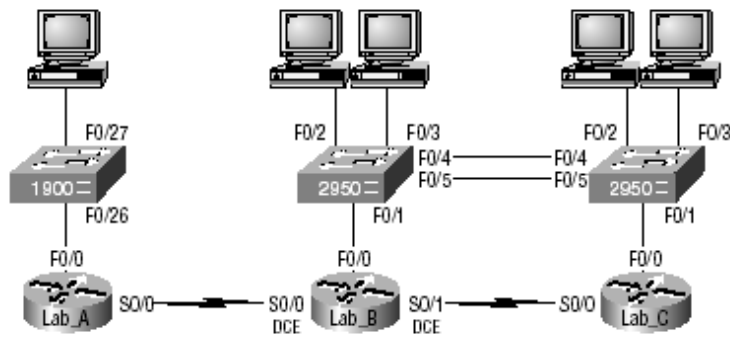

Figure 2: Dynamic routing example with more routers

3. Lab_B Configuration

Do the Lab_B configuration in the same way of Lab_A configuration.

4. Lab_C Configuration

Do the Lab_C configuration in the same way of Lab_A configuration.

5. Verifying the RIP Routing Tables

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:

Lab_A#**sh ip route**

[output cut]

R 192.168.50.0 [120/2] via 192.168.20.2, 00:00:23, Serial0/0

R 192.168.40.0 [120/1] via 192.168.20.2, 00:00:23, Serial0/0

R 192.168.30.0 [120/1] via 192.168.20.2, 00:00:23, Serial0/0

C 192.168.20.0 is directly connected, Serial0/0

C 192.168.10.0 is directly connected, FastEthernet0/0

Lab_A#

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).

Displays Lab_B's routing table.????

There's one more thing we want to show you about RIP routing tables and the parameters used to advertise remote networks. Notice, as an example, that the following routing table shows [120/15] in the 192.168.10.0 network metric. This means that the administrative distance is 120, the default for RIP, but that the hop count is 15. Remember that each time a router receives an update from another router, it increments the hop count by one for each route.

Lab_C#**sh ip route**

[output cut]

Gateway of last resort is not set

C 192.168.50.0 is directly connected, FastEthernet0/0

C 192.168.40.0 is directly connected, Serial0/0

R 192.168.30.0 [120/1] via 192.168.40.1, 00:00:04, Serial0/0

R 192.168.20.0 [120/1] via 192.168.40.1, 00:00:26, Serial0/

R 192.168.10.0 [120/15] via 192.168.40.1, 00:00:04, Serial0/0

Lab_C#

Interior Gateway Routing Protocol (IGRP)

Interior Gateway Routing Protocol (IGRP) is a Cisco-proprietary distance-vector routing protocol. This means that all your routers must be Cisco routers to use IGRP in your network. Cisco created this routing protocol to overcome the problems associated with RIP.

IGRP has a maximum hop count of 255 with a default of 100. This is helpful in larger networks and solves the problem of 15 hops being the maximum possible in a RIP network. IGRP also uses a different metric than RIP. IGRP uses bandwidth and delay of the line by default as a metric for determining the best route to an internetwork. This is called a *composite metric*. Reliability, load, and maximum transmission unit (MTU) can also be used, although they are not used by default.

The main difference between RIP and IGRP configuration is that when you configure IGRP, you supply the autonomous system number. All routers must use the same number in order to share routing table information.

Here is a list of IGRP characteristics that you won't find in RIP:

- ❖ _ IGRP can be used in large Internetworks
- ❖ IGRP uses an Autonomous System number for activation

❖ IGRP gives a full route table update every 90 seconds

❖ IGRP uses bandwidth and delay of the line as metric (lowest composite metric)

Configuring IGRP Routing

The command used to configure IGRP is the same as the one used to configure RIP routing with one important difference: you use an autonomous system (AS) number. All routers within an autonomous system must use the same AS number, or they won't communicate with routing information. Here's how to turn on IGRP routing:

Lab_A#**config t**

Lab_A(config)#**router igrp 10**

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

Notice that the configuration in the above router commands is as simple as in RIP routing except that IGRP uses an AS number. This number advertises only to the specific routers you want to share routing information with.

You absolutely *must* remember that you type a classful network number in when configuring IGRP!

IGRP can load-balance up to six unequal links. RIP networks must have the same hop count to load-balance, whereas IGRP uses bandwidth to determine how to load-balance. To load-balance over unequal-cost links, the variance command controls the load balancing between the best metric and the worst acceptable metric.

Configuring IGRP is pretty straightforward and not much different from configuring RIP. You do need to decide on an AS number before you configure your routers. Remember that all routers in your internetwork must use the same AS number if you want them to share routing information.

In the sample internetwork we've been using throughout this chapter, we'll use AS 10 to configure the routers.

Okay, let's configure our internetwork with IGRP routing.

Lab_A

The AS number, as shown in the router output below, can be any number from 1 to 65535. A router can be a member of as many AS as you need it to be.

Lab_A#**config t**

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

Lab_A(config)#**router igrp ?**

<1-65535> Autonomous system number

Lab_A(config)#**router igrp 10**

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

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

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

Lab_A#

The router igrp command turns IGRP routing on in the router. As with RIP, you still need to add the network numbers you want to advertise. IGRP uses classful routing, which means that subnet mask information isn't sent along with the routing protocol updates.

If you're using the 172.16.0.0/24 network, know that if you did type in the subnet

172.16.10.0, the router would accept it and then change the configuration to a

classful entry of 172.16.0.0. But don't do that—at least not on the exam! It's definitely not so forgiving and will simply mark your answer wrong if you type the wrong network number. I cannot stress this enough: **Think classful if you are using subnets!**

Lab_B

Configure the Lab_B router.

Lab_C

Configure Lab_C router.

Verifying the IGRP Routing Tables

It's important to verify your configurations once you've completed them, or at least once you *think* you've completed them. The following list includes the commands you can use to verify the routed and routing protocols configured on your Cisco routers:

- ❖ show ip route
- ❖ show protocols
- ❖ show ip protocols
- ❖ debug ip rip
- ❖ debug ip igrp events
- ❖ debug ip igrp transactions