Goals

- Learn how vector distance protocols work
- Understand the dynamics of network routing when links break
- Reinforce your computer interface configuration skills
- Practice your packet monitoring skills

Method

Each group will help build a simple ring-shaped Internet. Once that is completed, each table will patch all three of their computers into the ring and configure their interfaces. We will then turn on the RIP protocol on the routers and allow the routing tables to propagate around the ring. Once that happens, we'll verify connectivity between the computers. After everything is working, we'll disconnect various network links and observe and document the changes in the system.

Basic Addressing

For this lab, host computer IP addresses will be assigned as follows:

	Win2008	Mac OS	Linux
table 1	132.235.201.129/27	132.235.201.161/29	132.235.201.193/28
table 2	132.235.201.130/27	132.235.201.162/29	132.235.201.194/28
table 3	132.235.201.131/27	132.235.201.163/29	132.235.201.195/28
table 4	132.235.201.132/27	132.235.201.164/29	132.235.201.196/28

and the routers will be addressed as followed

	Buell	Harley	Davidson
eth 0/0	132.235.201.158	132.235.201.206	132.235.201.166
eth 0/1	132.235.201.165	132.235.201.157	132.235.201.205

Pre-lab

1. Print 4 copies of the network setup chart.
2. Complete the network setup chart, filling in the IP addresses of all 6 router interfaces.
3. Look at the first page to determine which IP addresses to use for your machines and then complete the network setup chart to include the IP addresses of your 3 computers. Note that each table will have one machine on each of the network segments, so be careful with the numbers.

Step-by-Step Instructions

1. We have already done the following to get your started:
   - Buell has access to the outside world
   - The Win2008 machine has one of its interfaces up on the admin network
   - All 3 Cisco 7000s have been set up so that Ethernet interface 5 is assigned the IP address that goes with their name (buell.itl.ohiou.edu). We'll call this its "admin" address.

2. Before we can start, we need to build the basic ring. Each table is responsible for the following pieces of the setup:

   Table 1

   (a) Patch Harley (Eth 0/1) and Buell (Eth 0/0) together through a hub
   (b) Use the Win2008 machine to Telnet to Buell
   (c) Configure Buell's eth0/0 interface and bring it up

   Table 2

   (a) Patch Davidson(Eth 0/0) and Buell(0/1) together through a second hub
   (b) Use the Win2008 machine to Telnet to Buell
   (c) Configure Buell's eth0/1 interface and bring it up

   Table 3

   (a) Patch Davidson (Eth 0/1) to a third hub (same hub used by table4)
   (b) Use the Win2008 machine to Telnet to Davidson
   (c) Configure Davidson's two Ethernet interfaces and bring them both up

   Table 4

   (a) Patch Harley (Eth 0/0) to a hub (same hub used by table3)
   (b) Use the Win2008 machine to Telnet to Harley
   (c) Configure Harley's two Ethernet interfaces and bring them both up

   The IP addresses to use for the routers are given on the first page of the handout.

3. Patch each of your computers into the appropriate hub. (Note that, for this lab, the Linux machines for all 4 tables will be plugged into the same hub, the Mac OS machines all share a second hub, and the Win2008 machines share a third hub!)

4. For each of your 3 computers, assign its interface the correct address. For the Mac OS machine **only**, assign a default gateway address for the router by way of buell. Bring up each machine. **Do not install a default route or any other routes!!!**

5. Disable your admin interface and verify that each of your computers can ping the IP addresses of the 2 routers on its local network. At this point, because neither the routers nor the hosts have routes to any non-local network, you won't be able to ping anything off of the local network (which you should verify).

6. **All four tables need to coordinate at this point**. Please don't continue until everyone is ready, but spend a few minutes reading ahead and getting familiar with the steps that follow!

7. Start RIP on each of the routers.

   Tables 1 and 2 should work together to do Buell, table 3 should do Harley, and table 4 should do Davidson.

   Telnet to a local router IP address (i.e. non-admin network IP address) from a machine local to the router that you are responsible for.

   Get into configure mode on the router

   (a) Enter RIP configuration mode with the command:
   `router rip`
   From there, you'll enter the commands:

```
network 132.235.201.xxx
network 132.235.201.yyy
passive-interface ethernet 0/5
```

giving the network address of each of the two networks that the particular router is attached to. The last command tells it **not** to send RIP updates out the admin interface. Then exit RIP mode and RIP will start.

(b) For each of the interfaces on the routers that you configured for your lab machines, go into interface config mode and do the following:

```
ip rip send version 2
```

Exit config mode and verify that RIP is running with the "`show ip protocol`" command.

8. Start the routing daemon on your windows and linux computers to watch for RIP advertisements and update the host route table automatically:

Linux

On the linux machine we will be using part of the Quagga dynamic routing project that is the successor to the Zebra project. To start rip processing on Linux type the two commands in order:

```
sudo /usr/lib/quagga/zebra -d -f /etc/quagga/zebra.conf
sudo /usr/lib/quagga/ripd -d -f /etc/quagga/ripd.conf
```

Win2008

Verify that the RIP v2 server is running (this server is a new addition to Windows 2008)

(a) Run the `Routing and Remote Access` utility (under `Start`→`Settings`→`Control Panel`, `Administrative Tools`)

(b) Check to ensure that, under the RIP item on the left-hand-side tree, the student interface is listed in the right-hand-side pane.

9. If everything is working correctly, you'll see that the routing tables on both of these machines eventually get populated with entries for the two hidden subnetworks.

NOTE THAT AT THIS STEP, THESE MACHINES DO NOT HAVE A DEFAULT ROUTE. THAT'S OK, AND WE'LL FIX THAT BELOW

10. You'll need to collect the following information for your lab writeup (after the routes have stabilized):

(a) Make a copy of the routing table from each machine for your lab writeup.

(b) Write down the route taken by packets from each of your computers to each of your other computers on the ring

(c) Explain why you can't ping `132.235.64.1` and `128.10.2.1`

(d) Using the appropriate packet-capturing tool for each of the three computers, copy the contents of the RIP update packets (UDP port 520) that each computer sees. Write down the network and metric that you see for each advertisement and the IP address of the sender.

11. In this next step, we'll be making a change so that default routes get propagated too.

Recall that Buell has a default route, but that none of the other routers or hosts have one. Buell's default route isn't included in RIP updates because that route wasn't gathered by the RIP protocol, so isn't advertised by default

All four tables need to coordinate at this point. Please don't continue until everyone is ready, but spend a few minutes reading ahead and getting familiar with the steps that follow!

On Buell, have somebody type:

```
router rip
default-information originate
redistribute static
exit
```

this will cause Buell to add a default route to its updates.

12. Repeat the following until each group has completed the lab:

    (a) Start a packet capture on Linux, Mac OS, and Win2008 watching for RIP packets and packets to or from **any of your 3 computers**.

    (b) Have the Linux machine running a continuous ping to your Windows machine

    (c) Have the Windows machine running a continuous ping to your Linux machine

    (d) **Loudly announce** that a test is starting (be patient if another group is "almost ready to start" and wait for them)

    (e) Disconnect the patch cord leading to Harley eth0/1 (between Harley and the hub).

    (f) Notice that the pings have stopped working

    (g) Very carefully document the ICMP ping packets and RIP update contents that you see at the Win2008, Linux, and Mac OS machines until the pings start working again. **In particular, determine the path that the ping requests and responses are taking during the time that ping is failing and make sure that you understand why they're taking that path!** The packet traces on Mac OS machine are very useful here.

    (h) Record the routes that the pings are taking

    (i) After the network has stablized, and with the patch cord unconnected, Start a packet capture on your Mac OS machine.

    (j) Telnet from your Mac machine to your linux machine.

    (k) Note the route the Mac packets take. You should see an ICMP redirect packet. If you miss the ICMP packet, or for some reason the mac already had the new route before you started the test, delete the host specific route and rerun the test.

    (l) Note the telnet packets, ICMP packets, any duplicate packets, and the route the returned packets take from the linux box.

    (m) Use netstat -ran to show the new route to the linux machine on the mac.

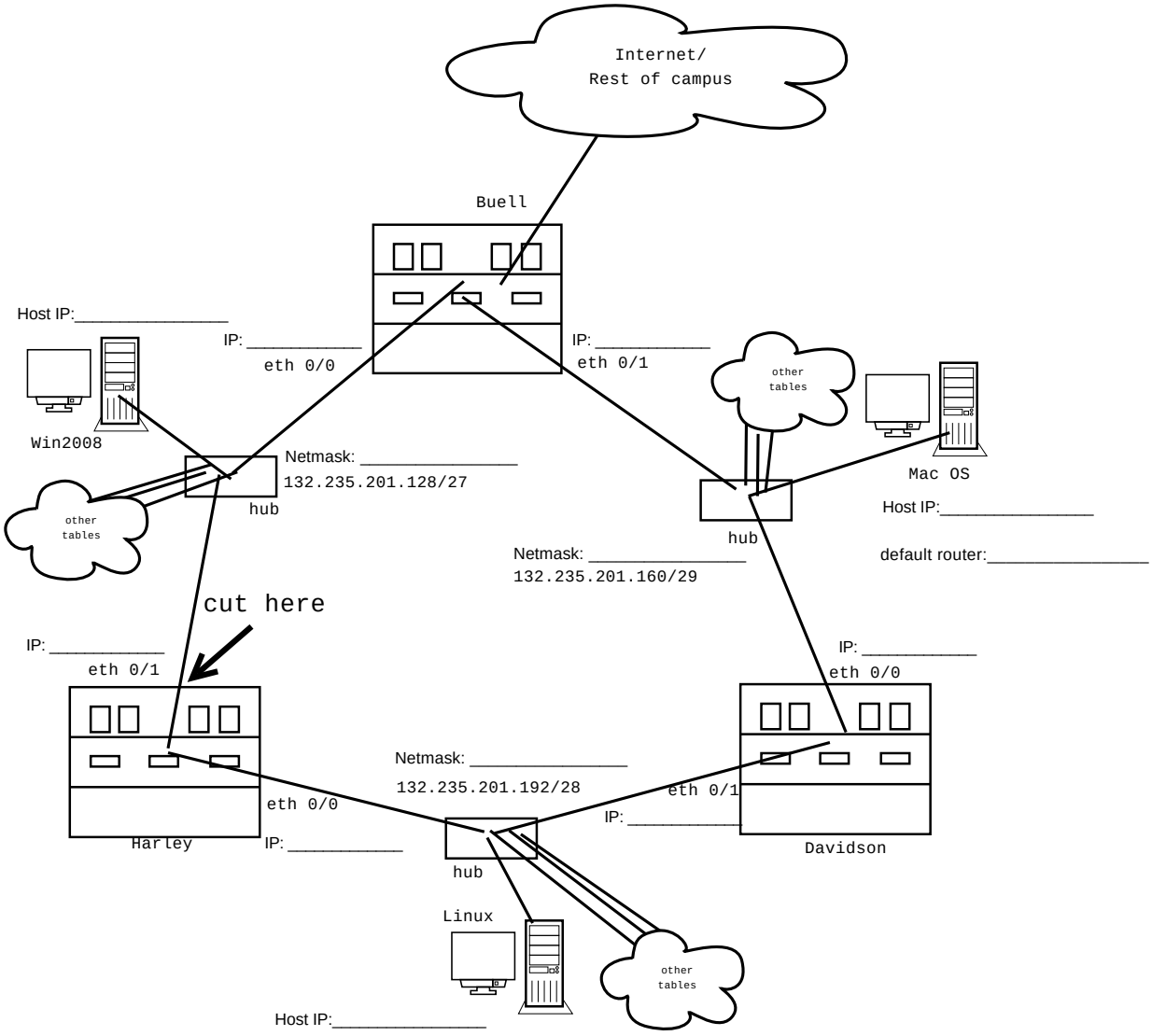
    (n) After the mac os capture is complete, reconnect the patch cord and monitor the network again until the ping packets return to their original paths

13. You'll probably want to repeat the previous step two or three times to make sure that you fully understand what is happening. (You can leave out the mac telnet step on succeeding tests.) Each iteration should take 10 or 15 minutes, so don't panic if you're a little behind, there's plenty of time to repeat the experiment.

    Note that what's really happening is slightly asymmetric, so watch carefully so that you really understand what's happening!!

Network Setup

The figure below shows all of the lab connections that you will need to deal with.



Lab Report

General Guidelines

Each report is to be written individually, although the data for the lab will be collected during the lab with your partner/group. They should be typed/word processed and brought to class in printed form.

Lab writeups are due **in class** on the Monday following the lab. The written part doesn't generally need to be more than a couple of pages at most. Officially, they need to be "long enough to answer the questions". Each lab writeup **must** include

- Your name
- The lab section that you attended
- Your table number
- Your affiliation (CS ugrad, CS grad, ITS ugrad, ITS grad)
- Your lab partner's name
- Your lab partner's affiliation

1 Include in your report

- Patch panel chart
- **Prelab:** Four copies of the physical network picture with details added:
  - Show the IP address/mask for all 3 computers
  - Show the IP address/mask for all 6 router interfaces

2 For the case when all of the patch cords are connected, but there is no default route, document:

- The route from each of your machines to each of your other machines
- The contents (network, metric, mask, sending machine) of the RIP packets that you see at each of your three computers

3 For the case when all of the patch cords are connected, and Buell is advertising a default route, document:

- The route from each of your machines to each of your other machines **and to the outside world**
- The contents (network, metric, mask, sending machine) of the RIP packets that you see at each of your three computers

4 For the case when the patch cord is **DIS**connected, and you used telnet from the mac, document:

- The starting route each machine takes to reach the other
- The actual route of the packets
- ICMP redirect messages to the mac. Highlight the new preferred router address in one of the packets
- Show that the mac either recognized the icmp redirect and changed the route to the linux box, or that the mac ignored it.

5 For the case when the patch cord is **DIS**connected, and routes have stabilized, document:

- The route from each of your machines to each of your other machines **and to the outside world**
- The contents (network, metric, mask, sending machine) of the RIP packets that you see at each of your three computers

6 Spend some time and explain carefully exactly the sequence of events that takes place:

- After the patch cords are removed to allow full connectivity to be restored
- After the patch cords are replaced to allow the original paths to be resumed

This final portion of the lab writeup is worth 25% of the total points, so put some time into your answer and carefully explain and document your observations. Explain changes in the RIP advertisements, route tables, ping packet paths, and etc... Document the amount of time it takes for things to change and explain why it takes that long.

7 Graduate required/Undergrad extra credit Explain how the Mac OS machine does dynamic route updates without using the rip update packets. Either in lab if you have the time or after lab at the Cisco web site research which routing protocols are supported by the Cisco 7xxx series routers with IOS version 12.2 (the version we are currently running). Give a brief 5-6 sentence overview of all of the protocols, including a classification as to whether the protocol is an interior or exterior gateway routing protocol and whether it has any elements of a distance vector algorithm, a link state algorithm, both, neither, or other.