CS 360 Special Topics: Computer Networking

Spring 2007   **DUE: May 9, 2007**
Assignment #5   **30 points**

Routing with Cisco

The focus of this assignment is to understand how routers work, to see routing tables being built and change, and watch data run around the network. This lab will consist of you applying various router commands to build the network and enable the various routing protocols. As you build the network, you need to determine what is reachable from each point and how data gets from one point to the other. You will need to record what you find out and answer some questions based on your findings.

Network Architecture – The Goal

The five routers will be connected serially to build a network that simulates a basic Internet service provider network. The routers on the end will represent Customer Edge routers (CE1 and CE2). The PCs requesting Internet service are attached to these routers. These CE routers are each connected to one Provider Edge router (PE1 and PE2). These routers denote the end of the ISP's network and act as the customer's view of the ISP. These PE routers are both connected to the same Provider Core router (P) which represents the ISP's internal network. In an actual ISP there would be many of these core routers. The diagram below describes the final configuration of the network that you should achieve.
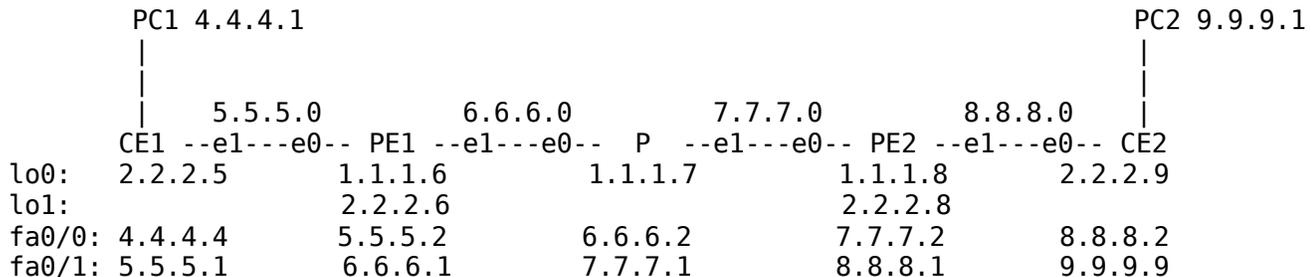
```
      PC1 4.4.4.1                                                    PC2 9.9.9.1
       |                                                              |
       |                                                              |
       |      5.5.5.0           6.6.6.0           7.7.7.0      8.8.8.0 |
      CE1 --e1---e0-- PE1 --e1---e0--  P  --e1---e0-- PE2 --e1---e0-- CE2
lo0:   2.2.2.5         1.1.1.6           1.1.1.7         1.1.1.8       2.2.2.9
lo1:                   2.2.2.6                           2.2.2.8
fa0/0: 4.4.4.4         5.5.5.2           6.6.6.2         7.7.7.2       8.8.8.2
fa0/1: 5.5.5.1         6.6.6.1           7.7.7.1         8.8.8.1       9.9.9.9
```
Figure 1

The addresses on the two lines directly below the routers are the addresses assigned to the routers' loopback addresses (lo0 and lo1). The the next two lines contain the interface addresses for the FastEthernet 0/0 and 0/1 ports, respectively. These FastEthernet ports are the physical ports used to connect the routers together. For example, fa 0/1 on CE1 is connected to fa 0/0 on PE1. Notice that the addresses assigned to these two ports are on the same subnet. The 5.5.5.0 subnet is used to connect these two routers. The PCs are shown connected to each of the CE routers, with their IP addresses specified. PC1 is connected to CE1 via CE1's fa 0/0 port.

Network Architecture – Base Configuration

The network you will start with will look like the following:
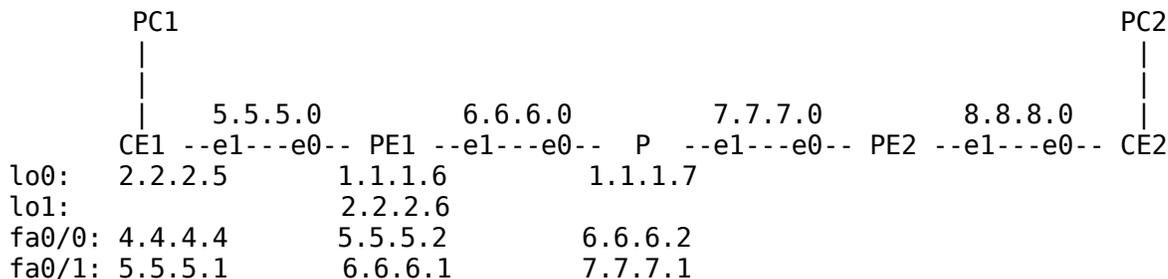
```
      PC1                                                            PC2
       |                                                              |
       |                                                              |
       |      5.5.5.0           6.6.6.0           7.7.7.0      8.8.8.0 |
      CE1 --e1---e0-- PE1 --e1---e0--  P  --e1---e0-- PE2 --e1---e0-- CE2
lo0:   2.2.2.5         1.1.1.6           1.1.1.7
lo1:                   2.2.2.6
fa0/0: 4.4.4.4         5.5.5.2           6.6.6.2
fa0/1: 5.5.5.1         6.6.6.1           7.7.7.1
```
Figure 2

Your Job

You will need to configure the PE2 router, CE2 router, and the IP addresses for PC1 and PC2 as well as enable the routing protocols need to send data from end to end. This document will walk you through those steps. You will need to answer various questions as you do this. The questions to answer will be embedded in the step by step directions. Answer these questions directly on this document.

Accessing a Router

To access the routers, we will be using the terminal server which is connected to one of the lab PCs (this PC is NOT of the PCs shown in the figures above). The PC is attached to the terminal server via an Ethernet cable and the terminal server is attached to each router via that router's console port. From the PC, you can telnet to a specific port on the terminal server to attach to a particular router. The mapping is as follows:

telnet 192.168.1.1 2034	CE1
telnet 192.168.1.1 2035	PE1
telnet 192.168.1.1 2036	P
telnet 192.168.1.1 2037	PE2
telnet 192.168.1.1 2038	CE2

When you telnet in you should be shown the Router> prompt, where Router is replaced by CE1, PE1, etc. If you connect via telnet and do not receive a prompt, press the Enter key a number of times until the prompt is shown.

The Cisco router command line interface (CLI) is based on *modes*. Read Cisco IOS in a Nutshell, Second Edition *Chapter 1 Getting Started,* available via Safari Online. Be sure to study the User Modes, Command line completion, and the question mark.

Note that exit does not close the connection. Since you are connected via a dedicated console line, the session stays active. You need to close the window on the Linux shell to disconnect (after exiting).

PC access

In order to set the IP addresses on the PCs you will need root access. The temporary root accounts you can use for both the Windows and Linux machines are: username: cs360 password: cs360s07

Linux: Login with your regular username and password. Open up a terminal window and type:
Smither$ su cs360
The password is the password given above. This allows you root access from inside this terminal window only!

Windows: Login with the username and password above. Be sure the domain is set to BURNS.

Lab Setup

When you start working on the lab, you will need to make sure that the last person to work with the routers left them in the state described in Figure 2. Just to be sure, you will need to log on to each router and run:

    Router>enable
    Router#copy flash:cs360_assign5_base.config running-config
    Destination filename [running-config]? <cr>

    XXXX bytes copied in 0.169 secs (xxxxx bytes/sec)
    Router#

    ►If you are restarting your lab from previous work, reload your saved configuration files rather than the
     base configurations.
    Router# copy flash:cs360_assign5_PUNetID running-config

Lab Cleanup

When you are finished with your two hour block or finished with your project, you need to save your configurations on the routers and reset the routers to the base configurations as described in Lab Setup. After saving your configurations, copy over the base configurations to the running-config.

To save your configurations, on each router do the following:

    Router>enable
    Router#copy running-config flash:cs360_assign5_PUNetID

To reset the router for the next student, copy the cs360_assign5_base.config file over to running-config on each router as show above.

If you have set the IP address of the PCs be sure to reset them to 192.168.1.9 (linux), 192.168.1.10 (Windows) with a gateway of 192.168.1.25 for the next student.

What do you turn in?

You will need to turn in the answers to the questions posed with the step by step instructions. You will also need to save your router configurations on each router as you go along.

Notes:
        The routers are a shared resource, you will need to sign up for 2 hour blocks on the MUTEX SHEET. Be sure to correctly SETUP and CLEANUP the routers and computers before and after your 2 hour block. This will be like a CHEM or BIO lab, you will need to get the equipment ready to go and to clean up after yourself so the next student has a clean setup.

Start on this today! Come see me with questions!

Be sure you setup the routers as described above.

Phase One: Configure the PCs

Windows PC

Set the IP address for the Windows PC to 9.9.9.1. You will need to be logged in as user cs360 to do this. From the Start Menu|Setting|Network Connections. Right click on the network connection and inspect the properties. Select TCP/IP and open its properties. Specify the IP address here. What should the subnet mask be? The default gateway should be 9.9.9.9 (the fa 0/1 interface on CE2). Remove all the DNS entries as our sample network is not running DNS.

Linux PC

Set the IP address for the Linux PC to 4.4.4.1. You will need to be logged in as user cs360 to do this. Open the file /etc/sysconfig/network-scripts/ifcfg-eth0. Do not removed the commented out lines, but use them as a guide to change the IP address. Open the file /etc/sysconfig/network and set the gateway. What should it be set to?

Phase Two: Basic Configuration

Note: The basic configuration of CE1, PE1, and P is done for you by the lab setup.

Configure CE2

Telnet to CE2 from the PC. Run the following commands:

```
CE2> enable
CE2# configure terminal
CE2(config)# ip cef
CE2(config)# mpls ip
CE2(config)# no ip dom loo
CE2(config)# int lo 0
CE2(config-if)# ip add 2.2.2.9 255.255.255.255
CE2(config-if)# int fa 0/0
CE2(config-if)# ip add 8.8.8.2 255.255.255.0
CE2(config-if)# no shut
CE2(config-if)# int fa 0/1
CE2(config-if)# ip add 9.9.9.9 255.255.255.0
CE2(config-if)# no shut
CE2(config-if)# line con 0
CE2(config-line)# exec-t 0
CE2(config-line)# end

CE2#copy running-config flash:cs360_assign5_PUNetID
```

Configure PE2
```
en
conf t
no ip dom loo
ip cef
mpls ip
int lo 0
```

```
            ip add 1.1.1.8 255.255.255.255
            int lo 1
            ip add 2.2.2.8 255.255.255.255
            int fa 0/0
            ip add 7.7.7.2 255.255.255.0
            no shut
            int fa 1/0
            ip add 8.8.8.1 255.255.255.0
            no shut
            line con 0
            exec-t 0
            end
             copy running-config flash:cs360_assign5_PUNetID
```

Questions:

1. View the routing tables on CE2 and PE2 using the command "show ip route". What do you see? What IP addresses are directly connected to each?

2. The routing protocols have not yet been turned on. From PE2 and CE2, what other routers can you ping? For example:

```
        ping 1.1.1.7
        ping 7.7.7.1
        ping 2.2.2.9
        ping 1.1.1.6
        ping 2.2.2.5
        ping 4.4.4.1 (This is the Linux PC)
        ping 8.8.8.1
```

Which router is each of these addresses attached to? Why can you ping or not ping each of these addresses?

 3. Can you ping the Linux PC from CE1?

Phase Three: Enable RIP

To enable rip, between CE1 and PE1, on both CE1 and PE1 type:

```
  enable
  conf t
  router rip
  network 2.2.2.0
  network 5.5.5.0
  network 4.4.4.0
  version 2
  no auto-summary
  end
```

```
  copy running-config flash:cs360_assign5_PUNetID
```

To enable rip between CE2 and PE2, on both PE2 and CE2 type:

```
  enable
  conf t
  router rip
```

network 2.2.2.0
network 8.8.8.0
network 9.9.9.0
version 2
no auto-summary
end
copy runn flash:cs360_assign5_PUNetID

Questions:

1. View the routing tables on CE2 and PE2 using the command "show ip route". What do you see? What IP addresses are directly connected to each?

2. The routing protocol RIP has now been turned on. From PE2, what other routers can you ping?
For example:
> ping 1.1.1.7
> ping 7.7.7.1
> ping 2.2.2.9
> ping 1.1.1.6
> ping 2.2.2.5
> ping 8.8.8.1

Why can you ping or not ping each of these addresses?

3. Can you ping the Linux PC (4.4.4.1) from PE1 or PE2? From CE1 or CE2?

4. Run the "debug ip rip" command on PE2. This will show you all the RIP updates as they come into the router. Let this run for a few minutes. Then turn it off using the command "u all". What IP addresses were advertised in these RIP updates? In how many hops?

5. As root, startup wireshark on the Linux PC. Open a shell and type "wireshark &". This will display to you every packet of data that goes across the PCs network wire. Click on the Capture|Options menu. Make sure the eth0 interface is selected and select "Update list of packets in real time." Click Start. Let this run for a while and then Click Capture|Stop. Find some RIP packets (click on the Protocol column title to sort by protocol name). What IP addresses are they advertising paths for? How are these different from the RIP packets in question 4 above? The Next Hop field is 0.0.0.0. What does this mean (you may need to search for this answer later)?

6. Where do the addresses in the "network x.x.x.0" commands above come from?

Phase Four: Enable OSPF

Enable OSPF between PE1 and P, on PE1 type:

```
PE1> en
PE1# conf t
PE1(config)# router ospf 1
PE1(config-router)# network 1.1.1.0 0.0.0.255 area 0
PE1(config-router)# network 6.6.6.0 0.0.0.255 area 0
PE1(config-router)# end
PE1#copy runn flash:cs360_assign5_PUNetID
```

Enable ospf between PE1 and P, and P and PE2, on P type:

```
P> en
P# conf t
P(config)# router ospf 1
P(config-router)# network 1.1.1.0 0.0.0.255 area 0
P(config-router)# network 6.6.6.0 0.0.0.255 area 0
P(config-router)# network 7.7.7.0 0.0.0.255 area 0
P(config-router)# end
P#copy runn flash:cs360_assign5_PUNetID
```

Enable ospf between P and PE2, on PE2 type:

```
PE2> en
PE2# conf t
PE2(config)# router ospf 1
PE2(config-router)# network 1.1.1.0 0.0.0.255 area 0
PE2(config-router)# network 7.7.7.0 0.0.0.255 area 0
PE2(config-router)# end
PE2#copy runn flash:cs360_assign5_PUNetID
```

Questions:
1. What does the routing table look like on each of the routers? "show ip route"?   CE1 and CE2 have no OSPF routes. Why?

2. The routing protocol OSPF has now been turned on. From PE2, what other routers can you ping?
For example:
>   ping 1.1.1.7
>   ping 7.7.7.1
>   ping 2.2.2.9
>   ping 1.1.1.6
>   ping 2.2.2.5

For one of the successful pings above, run "trace x.x.x.x" to see the path taken to reach that machine. Record that here.

3. From PE2, can you ping the Linux PC (4.4.4.1)?

4. Turn on OSPF debugging on PE1. "debug ip ospf events" What do you see? Let this run for at least 60 seconds. You can turn this off using "u all"

Phase Five: Connect OSPF and RIP

Link rip and ospf together, on PE1 *and* PE2 we can have the two protocol redistribute their routes by typing:

```
PE1> en
PE1# conf t
PE1(config)# router rip
PE1(config-router)# redistribute connected
PE1(config-router)# redistribute ospf 1 match internal external 1 external 2
PE1(config-router)# default-metric 1
PE1(config-router)# end
PE1# conf t
PE1(config)# router ospf 1
PE1(config-router)# redistribute rip subnets
PE1(config-router)# end
PE1# copy runn flash:cs360_assign5_PUNetID
```

Questions:
1. What does the routing table look like on each of the routers? "show ip route"?

2. The routing protocol OSPF has now been turned on. From PE2, what other routers can you ping?
For example:
  ping 1.1.1.7
  ping 7.7.7.1
  ping 2.2.2.9
  ping 1.1.1.6
  ping 2.2.2.5

3. Can you ping the Linux PC (4.4.4.1) from PE2? From CE1? From CE2?

4. Do a trace from CE2 to the PC attached to CE1 (4.4.4.1). What do you see?

5. Run the "debug ip rip" command on CE2. This will show you all the RIP updates as they come into the router. Let this run for a few minutes. Then turn it off using the command "u all". What IP addresses were advertised in these RIP updates? In how many hops?

6. Run the "debug ip ospf events" on CE2. Let this run for at least 60 seconds. What do you see? Why? Turn this off with the "u all" command.

Phase : Test it all!
Restart wireshark on the Linux PC. Open up a web browser on the Windows PC and point it at: http://4.4.4.1:8080. This is a web server running on the Linux PC. What do you see in wireshark? Can you find the http traffic? Can you decipher the web page that was sent?

Start an SSH session from the Windows PC to the Linux PC (use putty to ssh to 4.4.4.1). Did you get connected? What did you see in wireshark? Can you identify the ssh traffic? Can you decipher the data? Can you find the TCP 3 way handshake?

On PE1 run the "debug ip rip" command. Pull the plug on CE1 in FE 0/0 (the top router, red cable). What happens on PE1? (wait at least 60 seconds). Plug the cable back in. What happens? Use "u all" to turn off this debugging.