CIS 192 Linux Lab Exercise

Lab 3: Configuring a Network Router
Spring 2010

Lab 3: Configuring a Network Router

The purpose of this lab is to join three network segments (Shire, Rivendell and Mordor) by configuring two routers between them. The three networks are shown below. You will be using four different systems: A Shire client, a Shire-Rivendell router, a Rivendell-Mordor router and a Mordor client. The goal is to obtain connectivity between the client in Mordor with the client in the Shire by utilizing layer 3 routing. You will verify success by successfully pinging from one side of the network to the other.

I strongly suggest that you read through this lab before doing it. Making a good network diagram will help you immensely. Start with the diagram below and add to it as you design and implement the end-to-end solution.
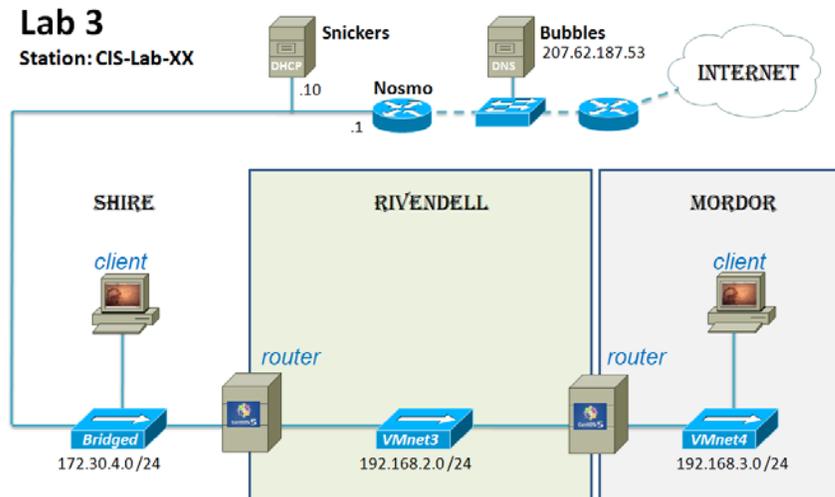
Supplies

- VMWare Server 1.08 or higher
- 192 VMs: Frodo, Elrond, Arwen, and Sauron
- Virtual networks: VMnet3 (Rivendell) and VMnet4 (Mordor)

Preconfiguration

- Original versions of all VMs. Note, this will set the network configurations back to down or DHCP settings.
- You will need access to a DHCP server to assign addresses for the 172.30.4.0/24 network. This is already configured if the lab is done using the CIS VMware Stations in the CIS Lab (room 2504) or the CTC. If you plan to do this lab at home see: http://simms-teach.com/howtos/202-working-at-home-nat.pdf

Forum

Use the forum to ask questions, collaborate, post tips and any lessons learned when you have finished. Forum is at: http://opus.cabrillo.edu/forum/viewforum.php?f=5

Background

Setting up a router involves 3 steps:

1. Configuring appropriate IP addresses on the routers.
2. Configuring the routing table of each router and client
3. Turning on IP forwarding so that packets will travel through each router's two interfaces.

The commands we will be using for this lab are:

- ifconfig
- route
- ping

Most of these commands require root access, so you will need to log on as root.

Part I

Design your overall network with the following requirements:

- Three /24 networks: 172.30.4.0/24 (Shire), 192.168.2.0/24 (Rivendell) and 192.168.3.0/24 (Mordor). Use VMnet3 for Rivendell and VMnet4 for Mordor.

- Use Elrond for the Shire-Rivendell router. This is a CentOS VM. The eth0 interface should be connected to the Shire network.

- Use Arwen for the Rivendell-Mordor router. This is a CentOS VM.

- Use Frodo and Sauron, both Ubuntu VMs, as the Shire and Mordor clients respectively.

- Assign IP addresses of your choice to interfaces on the Rivendell and Mordor networks.

- For the Shire network, use the table below for assigning static IP addresses. The Shire-Rivendell router's eth0 interface will need a static address from the table. The Shire client can be configured with either a static address from the table or DHCP.

Station	IP	Static 1	Static 2
CIS-Lab-01	172.30.4.101	172.30.4.121	172.30.4.122
CIS-Lab-02	172.30.4.102	172.30.4.123	172.30.4.124
CIS-Lab-03	172.30.4.103	172.30.4.125	172.30.4.126
CIS-Lab-04	172.30.4.104	172.30.4.127	172.30.4.128
CIS-Lab-05	172.30.4.105	172.30.4.129	172.30.4.130
CIS-Lab-06	172.30.4.106	172.30.4.131	172.30.4.132
CIS-Lab-07	172.30.4.107	172.30.4.133	172.30.4.134
CIS-Lab-08	172.30.4.108	172.30.4.135	172.30.4.136
CIS-Lab-09	172.30.4.109	172.30.4.137	172.30.4.138
CIS-Lab-10	172.30.4.110	172.30.4.139	172.30.4.140
CIS-Lab-11	172.30.4.111	172.30.4.141	172.30.4.142
CIS-Lab-12	172.30.4.112	172.30.4.143	172.30.4.144
Pod 1		172.30.4.113	172.30.4.145
Pod 2		172.30.4.114	172.30.4.146
Pod 3		172.30.4.115	172.30.4.147
Pod 4		172.30.4.116	172.30.4.148

Design: Make a network diagram showing your design with your favorite diagramming tool (e.g. Visio, PowerPoint, etc.).

Include the information from the diagram above and add hostnames, interfaces and IP addresses. Note all default gateways and static routes. Also include notation showing forwarding status on the routers.

If you want to use the PowerPoint diagram above as a starting point it is at
http://simms-teach.com/docs/cis192/lab3.logname.ppt

Implement: Don't rush to implement this lab. A complete design will save you a lot of time doing the implementation steps:

1. **Revert** the four VMs you selected to their snapshots.
2. **Cable** and configure the Shire client. Make sure it connects to the lab's Shire network properly using DHCP.
    - Use **ifconfig** and **route –n** to verify you have an IP address and a default route. Record the IP address to use later.
    - **Verify** you can **ping 172.30.4.1** (lab router) and **ping opus.cabrillo.edu**.

3. **Cable** the Shire-Rivendell router and configure both interfaces with static IP addresses using the **ifconfig** command (refer to your command summary from Lab 2). Be sure the Shire interface uses an IP address from the table above.
4. Ping the Shire client from the Shire-Rivendell router.
5. Does it work?
   Now try pinging the Shire client again from the Shire-Rivendell router, but this time pinging from its Rivendell IP address. **ping -I 192.168.2.*xxx <shire-client-ip>***, where xxx is the address you assigned the eth1 interface on the Shire-Rivendell router and *<shire-client-ip>* is the Shire client's IP address. Does this work? Why or why not?
6. Look at the Shire client's routing table with the **route -n** command. Notice that the default route is **172.30.4.1**
   The Shire computers don't know what to do with addresses from the **192.168.2.0** network, so they get sent out the default route, not back to the Shire-Rivendell router.
7. Let's fix this problem by adding a route to Shire Client's routing table. We want to make the Shire-Rivendell router be the gateway for any packets heading for 192.168.2.0/24:
   route add -net 192.168.2.0 netmask 255.255.255.0 gw 172.30.4.1xx
   Use **route –n** to verify. Note the gateway address should be the Shire-Rivendell router's Shire address.
8. Now go back and re-execute the ping command from the Shire-Rivendell router:
   ping -I 192.168.2.*xxx <shire-client-ip>*
   Does it work this time? It should.
9. **Cable and configure** the Rivendell interface on the Rivendell-Mordor router.
10. What should the default gateway be on the Rivendell-Mordor router? In general, you want the default gateway to send packets in the direction of the Internet.
11. Set the default gateway using the following command:
    route add default gw 192.168.2.*xxx*
12. Now try to ping the Shire client from the Rivendell-Mordor router:
    ping *<shire-client-ip>*
    Does it work?
13. If it doesn't work, it might be because **ip_forwarding** is not turned on. Back on the Shire-Rivendell router, execute the following commands:
    cd /proc/sys/net/ipv4
    echo 1 > ip_forward
14. Now you should be able to ping the Shire client from the Rivendell-Mordor router.

Part II

We now have the Shire and Rivendell network segments joined by the Shire-Rivendell router. For a third network, we are going to use the Rivendell-Mordor router to get to the Mordor client.

1. **Cable and configure** the second interface on the Rivendell-Mordor router.
2. On the Rivendell-Mordor router, turn on **ip-forwarding**.
3. **Cable and configure** the Mordor client interface.
4. Put a default route on the **Mordor** client; it should point to your Rivendell-Mordor router.
5. Are we done? Can you ping a machine in the Shire?
   Why doesn't it work?

We've forgotten about the other machines in the network. They need to be able to send packets back to this new network!

6. **The Shire-Rivendell Router**:
   - We must configure this router to route 192.168.3.0 packets back to Mordor. Add this route:
     route add -net 192.168.3.0 netmask 255.255.255.0 gw 192.168.2.xxx (the Rivendell-Mordor router)
   - Set the default gateway:
     route add default gw 172.30.4.1
     Check the routing table to see that this has been done correctly.

7. **The Shire Client**:
   The Shire client must also be told where to route packets destined for this new 192.168.3.0 subnet:
   route add -net 192.168.3.0 netmask 255.255.255.0 gw 172.30.4.xxx (the Shire-Rivendell router)

8. Did we get everything? See if you can ping through all three networks. Make sure each computer knows what to do with packets from each of the three networks. Your ping packets should make two hops from Mordor to the Shire.

9. Note: You will not be able to ping opus or any internet computer from Mordor. Why not?

10. Note: if you make errors in the routing tables, these errors may be cached even though you have corrected them. To flush the routing table cache, use the command:
    ip route flush cache

To turn in

For this lab you will submit a text file (with scp) and a network diagram (with email) as described below:

A) Results
   Your *lab3* file should be a text file and contain the following sections. Use your own lab report format or use the generic boilerplate template at: http://simms-teach.com/docs/cis192/labx.logname

   - Standard boilerplate information:
     – CIS 192 Lab XX
     – Name
     – Date
     – TBA hours used
     – Station used
     – CPU
     – RAM
   - ifconfig and route –n output for Shire Client
   - ifconfig and route –n output for Shire-Rivendell Router
   - ifconfig and route –n output for Rivendell-Mordor Router
   - ifconfig and route –n output for Mordor Client
   - The successful ping from Mordor Client to Shire Client
   - Command/Configuration summary

   Submit this file using:
   scp lab3 cis192@opus.cabrillo.edu:lab3.logname

B) Your network diagram which should show:
- Hostnames of clients and routers
- Network information (using CIDR notation)
- Interfaces and their IP addresses
- Default gateways and static routes noted
- Server forwarding status noted

Email me an electronic version at **risimms@cabrillo.edu**

Check your work for completeness then submit as many times as you wish up until the due date deadline. Remember, **late work is not accepted**, so start early, plan ahead for things to go wrong and use the forum to ask questions.

Grading rubric (30 points)

2 points for correct submittal, professional appearance and quality
2 points for correct station ID/static IP address on Shire-Rivendell router's eth0
3 points for correct configuration of Shire Client
3 points for correct configuration of Shire-Rivendell Router
3 points for correct configuration of Rivendell-Mordor Router
3 points for correct configuration of Mordor Client
4 points for successful ping
4 points for useful command summary
6 points for complete and accurate network map

Extra Credit (5 points)

- (2 points) Update /etc/hosts on all four systems so you can ping Frodo, Elrond, Arwen and Sauron by name rather than just by cd IP address from any of the four systems. Include the four modified /etc/hosts files at the end of your lab report.

- (1 point) From Frodo, **ping** Elrond, Arwen, and Sauron and explain why the TTL value differs each time. Copy the ping commands and output to your report.

- (2 points) On Frodo, try the following:
    ping –Rc1 sauron
    mtr sauron
    traceroute sauron
    traceroute –I sauron
and copy the commands and output to your report. Use the –rc1 option on **mtr** so the output is not cleared. Note, if you need to install the traceroute tool on Frodo, use:
    apt-get install traceroute