

## CIS 192 Linux Lab Exercise

### Lab 2: Joining a network Spring 2013

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The purpose of this lab is to configure permanently the network settings of several systems to join one or more networks. This includes setting the IP address, network mask, default gateway, and DNS settings for different distributions of Linux. Once joined, the connectivity will be tested and network traffic observed.

#### Supplies

- Frodo, Elrond and William VMs

#### Forum

Use the forum to ask for help, post tips and any lessons learned when you have finished.

Forum is at: <http://oslab.cabrillo.edu/forum/>

#### Background

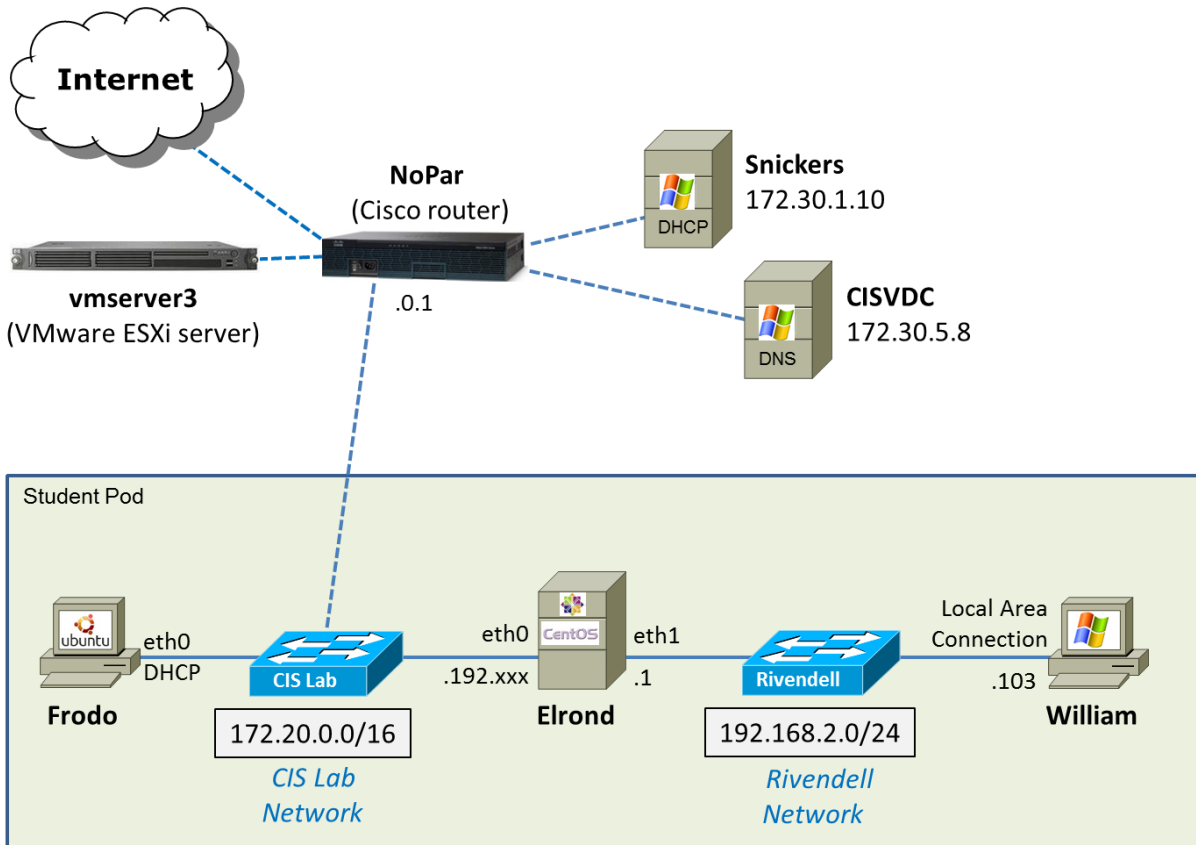
For a Linux system to join a LAN (Local Area Network) an IP address and subnet mask must be configured on one of its NIC interfaces. The IP address can be dynamic (obtained automatically from a DHCP server) or static (manually configured IP address). To reach beyond the LAN to the Internet, a default gateway must be configured. To be able to use hostnames, e.g. google.com, rather than numerical IP address a DNS name server must be configured.

The IP and gateway settings can be configured temporarily with the `ifconfig` and `route` commands. These settings will remain in place till the system or network service is restarted. For a permanent solution, the IP and gateway information must be added to the appropriate network configuration files in the `/etc` directory. These files are used by the network service during system startup.

Finally, there are a number of commands (utilities) that can be used to check that traffic is flowing correctly on the networks.

## Procedure

You will be cabling Frodo, Elrond and William according to the diagram below. Once cabled you will join the VMs to networks, test connectivity and observe some packet traffic. Results will be recorded in a *lab02* text file that gets submitted at the end of the lab.



## Step 1 - Preparation

- IMPORTANT! Use <http://simms-teach.com/docs/cis192/Pod-Assignments-192-sp13.pdf> to identify the VLab pod assigned to you. The diagram above is generic and you must substitute the generic hostnames and Rivendell network with the specific ones assigned to you. For example, Benji was assigned Pod 2. He will use p02-frodo, p02-elrond, p02-william VMs and the Rivendell-02 virtual switch to do this lab. The CIS Lab virtual switch is shared by everyone.
- In your own pod, revert the three VMs shown above to their "Pristine" snapshots.
- On Opus, make a copy of the *lab02* template file in `/home/cis192/depot` in your home directory. Edit the header of this file with your own information.

- It's very helpful to have the diagram above handy and be able to mark it up with IP addresses and other notes. You could print it and mark it up the old fashioned way or annotate this PDF file with an application like Adobe Acrobat or Foxit Reader. Annotate it now with the more specific hostnames and network switches assigned to you.

## Step 2 - Cabling

- In your own pod, cable your Frodo, Elrond and William VMs as shown above. Please use your own Rivendell switch.
- Configure Elrond's third NIC not to connect at power on (remove the check). We won't be using this NIC for Lab 2.

## Step 3 - Verify Frodo's connection to the network

In this step we examine the network settings on the Ubuntu VM. The pristine version of Frodo has been preconfigured to connect to the network using DHCP. Snickers, a Windows server in the 2501 closet, provides a DHCP service for room 2501 and the CIS Lab. The network settings (IP address, mask, gateway and name server) are configured automatically during system startup.

- Power up Frodo, which is an Ubuntu VM. The goal of Ubuntu is to create a free, easy-to-use Linux desktop. The Ubuntu distribution is based on Debian.
- Login as `cis192` and then **`sudo -i`** to root.
- Use **`ping -c 3 google.com`** to verify Frodo has already joined the CIS Lab network. The ping should work.
- Examine the NIC hardware and driver on Frodo:
  - Use **`lspci`** and locate your NIC hardware.
  - Try **`lspci | grep -i ether`** instead.
  - Use **`lspci -k`** and locate your NIC driver.
  - Try **`lspci -k | grep -iA4 ether`** instead to see your NIC driver.
  - Use **`lsmode`** and locate your NIC driver in the output.
- Examine the interface:
  - Issue the **`ifconfig`** command and check that `eth0` and `lo` interfaces are up and running.
  - `lo` is the loopback interface to access local services without having to go out on the network.

- For eth0, make sure you can identify the MAC address (HWaddr), IPv4 address (inet addr), IPv6 address (inet6 addr), subnet mask (Mask) and broadcast address (Bcast). Frodo should be on the 172.20.0.0/16 CIS Lab network.
  - Annotate your copy of the network diagram with Frodo's IP address which we will use later.
- Examine the routing table:
- Use **route -n** and look for an entry with 172.20.0.1 under the Gateway column and a "G" under the Flags column. That is the default gateway.
  - Note: The **-n** option prevents DNS lookups which result in faster output. Try dropping the **-n** option and notice how the command attempts to resolve IP addresses in the output to hostnames.
- Examine the domain name system (DNS) servers:
- Use **cat /etc/resolv.conf** to show the name server(s).
  - 127.0.0.1 is the IP address configured on the loopback interface. To see more what is going on here you can google *dnsmasq*. We will be building our own DNS name servers later in the course!
- ❖ Record the Frodo network information in your *lab02* file.

#### Step 4 - Frodo trouble-shooting

In this step you are going to break Frodo then fix it again.

- Use the **rmmod** command to remove the NIC driver.
  - Oops! Verify that you can no longer ping anything.
  - Without restarting Frodo or reverting to a snapshot see if you can fix Frodo. Hint: Review Lesson 1 for how this is done.
  - Verify that you can ping google.com again.
- ❖ Record in your *lab02* file what you did to repair Frodo.

#### Step 5 - Configure Elrond temporarily with static IP addresses

In this step you will be configuring both of Elrond's interfaces with Static IP addresses to match the diagram above.

- ❑ Power up Elrond which is running the CentOS Linux distribution. CentOS is a replica distribution of the Red Hat Enterprise Linux distribution.
  - Elrond has two NICs so it can be configured as a router in later labs.
  - Note that Elrond is configured to boot up to run level 3 (no graphics).
- ❑ Log in as cis192, then **su -** to root.
- ❑ Clear out any existing name servers with **> /etc/resolv.conf**
- ❑ Try to ping google.com, does it work? It shouldn't.
- ❑ Try to ping npar at 172.20.0.1, does it work? It shouldn't.

You shouldn't be able to ping anything because Elrond is configured to boot up without any network settings.

- ❑ IMPORTANT! Use <http://simms-teach.com/docs/cis192/Pod-Assignments-192-sp13.pdf> to select a **non-duplicate** static IP address for Elrond's eth0 interface. Find your first name in the table and identify the start and end of the range of IP addresses that are assigned to you. You may pick any one of these IP addresses to use and mark up your network diagram with it.
- ❑ Use **ifconfig eth0 172.20.192.xxx netmask 255.255.0.0** to configure Elrond's eth0 with your IP address. This joins Elrond to the CIS Lab network which is shared by all the other CIS students.
- ❑ Note: you just used the old form of the ifconfig command. Older distros required netmask arguments. The newer distros allow **ifconfig eth0 172.20.192.xxx/16** which does the same thing with less typing! Go ahead and try it the newer way.
- ❑ Check local network connectivity:
  - Use **ifconfig eth0** to check eth0 is up with your IP address.
  - Use **ping 172.20.0.1** to ping the lab router. It should work now.
  - Make sure you can ping Frodo too using the IP address you marked on your network diagram
- ❑ Check Internet connectivity:
  - Can you ping the Snickers server at 172.30.1.10 now? Snickers is on another network. What error do you get?
  - We need to specify a router so we have a place to send packets destined for other networks. This router will be our default gateway. Set the default gateway with **route add default gw 172.20.0.1** and use **route -n** to verify. Try pinging Snickers again. It should work now.

- Check name resolution for the Internet:
  - Can you **ping google.com** now? What error message did you get? Without a DNS name server configured the ping command cannot resolve hostnames to IP addresses. Without an IP address, packets cannot be sent.
  - Edit the `/etc/resolv.conf` file and add the line **nameserver 172.30.5.8**
  - Retry pinging google.com. This should work now!
  - Congratulations ... you just joined Elrond to the CIS Lab network!
- Configure Elrond's second interface.
  - Look at the diagram above and determine what IP address `xxx.xxx.xxx.xxx` should be set on eth1. This is Elrond's interface to your Rivendell network.
  - Use **ifconfig eth1 xxx.xxx.xxx.xxx/24** to set that IP address on eth1. It's OK to assign the same IP address to this interface as other students are using on their pod. That's because everyone has their own Rivendell-xx switch to use.
  - Use **ifconfig | more** to check both eth0 and eth1 interfaces are alive and using the correct static IP address you assigned. Check the subnet masks too. The CIS lab network is a /16 network and the Rivendell network is /24.

## Step 6 - Configure Williams Local Area Network interface

In this step you will be configuring William's network settings to match the diagram above.

- Power up William which is running Windows XP.
- Login as cis192.
- Right click on My Network Places and select Properties.
- Right click on Local Area Connection and select Properties.
- Select Internet Protocol (TCP/IP) and click Properties button.
- Select "Use the following IP address:"
- Set the IP address to 192.168.2.103
- Set the subnet mask to 255.255.255.0
- Don't worry about setting up the default gateway or the DNS name server. Until we learn how to configure routing on Elrond, William will not be able to get out to the Internet. We will learn how to do that in the next lab!
- Click OK and close any open dialog boxes.
- Start > Run... > cmd to get a command prompt.
- Use **ipconfig** to check your static IP was set correctly.

- Ping Elrond using **ping 192.168.2.1** which should work.
- Try pinging Frodo or the CIS Lab router (172.20.0.1) which should not work.

### Step 7 - Traversing the VM's using Putty and SSH

Even though we don't have routes set up between the CIS Lab and Rivendell networks we can still use Putty/SSH to traverse from system to system. Starting with Putty on William you can Putty to Elrond. From there you can ssh to Frodo, and from Frodo you can ssh to opus.cabrillo.edu.

- On William, run Putty and login as cis192 on Elrond. What IP address should you use for this? This should be the IP address you put on Elrond's eth1 interface.
- Still in Putty, from Elrond, use **ssh cis192@172.20.4.xxx** to login to Frodo. Use **ifconfig eth0** on Frodo if you need to remember Frodo's IP address.
- Still in Putty, from Frodo, use **ssh -p 2220 xxxxxx192@oslab.cabrillo.edu** or **ssh xxxxxx192@opus** to login to Opus using your student account.
- Use **who** on Opus to see if anyone else you know is logged on.
- Can you ping Frodo from Opus? This should work!
- Use **exit** to log off Opus.
- Use **exit** to log off Frodo.
- Use **exit** to log off Elrond.

### Step 8 - Permanently configure network settings on Elrond

We set static IP addresses earlier on Elrond using the ifconfig command. This instantly added the IP addresses to the interfaces. If the system is restarted this configuration information, which is kept in memory, will be lost. In this step we will permanently configure the network settings which is done by editing network configuration files in the /etc directory.

- Restart Elrond using **init 6**
- Can you ping the lab router or google.com? You shouldn't be able to because the network configuration, kept in memory, was lost during the system restart.
- Refer back to Lesson 2 slide examples and configure the following network configuration files:
  - Edit the */etc/sysconfig/network-scripts/ifcfg-eth0* file and configure the same non-duplicate static IP address you used previously.

- Edit the `/etc/sysconfig/network-scripts/ifcfg-eth1` file and add the same static IP address you used previously.
  - Edit the `/etc/sysconfig/network` file and add the default gateway.
  - Verify the settings you made in `/etc/resolv.conf` are still there.
- Use **service network restart** to restart the network service which will read and apply the information in the network configuration files. The same thing will happen after a system restart.
  - Use **ifconfig | more** and **route -n** to verify your settings.
  - Make sure you can ping the William and google.com.
  - To prove the settings are permanent, use **init 6** to restart the system.

### Step 9 - Ping Testing

Do some connectivity checks using echo requests (pings):

- On Elrond,
  - Make sure you can ping the loopback address (127.0.0.1), Frodo, William, the lab router and google.com.
- On Frodo,
  - Make sure you can ping the loopback address, Elrond, the CIS Lab router and google.com.
  - Frodo should not be able to ping William or Elrond's eth1 interface. When pinging these Rivendell addresses you will not get an error message. Why not? Because the pings are heading out (the wrong way) to the Internet with no route back. We will learn how to configure routes in Lab 03.
- On William,
  - Make sure you can ping Elrond. William should not be able to ping anything else.

Record in your `lab02` file the four Elrond network configuration files and output from **ifconfig** and **route -n**. Hint #1: Use redirection to capture the outputs into a file and use **scp** to copy that file to your Opus home directory:

- **cat /etc/sysconfig/network-scripts/ifcfg-eth\* > notes**
- **cat /etc/sysconfig/network >> notes**
- **cat /etc/resolv.conf >> notes**
- **ifconfig >> notes**
- **route -n >> notes**



- scp notes **xxxxxx192@opus.cislab.net**:

Alternatively hint #2: If you prefer to use copy and paste for things like this you can always log into Opus with your favorite terminal program and then ssh to Elrond, copy outputs and paste them into your *lab02* file.

### Step 10 - Install some additional commands

We may need to install some commands to do this step:

- On Frodo,
  - Is traceroute installed? Try **traceroute snickers.cislab.net**
  - If not, use **apt-get install traceroute** to install that command.
- On Elrond,
  - Is mtr installed? Try **mtr snickers.cislab.net** (use q to quit)
  - If not use **yum install mtr** to install.
  - Is traceroute installed? Try **traceroute snickers.cislab.net**
  - If not use **yum install traceroute** to install

### Step 11 - Observe routes the packets take

The **mtr** and **traceroute** commands let you view the route a packet takes. For this lab we will just observe where they go. In future labs we will control where they go.

- On Frodo, discover the route being taken to the DHCP server:
    - **traceroute snickers.cislab.net**
    - Alternatively, **mtr snickers.cislab.net** (use q to quit)
  - On Elrond, discover the route being taken to google.com:
    - **traceroute google.com**
    - Alternatively, **mtr google.com** (use q to quit)
  - Use **mtr** or **traceroute** with William's IP address (192.168.2.103) to discover why pings never get there.
- ❖ Record the traceroute output to google.com in your lab02 file

## Step 12 - Sniffing packets with tcpdump

**tcpdump** is like a command-line version of Wireshark. It allows you to capture packets and view them.

- On Elrond,
  - Use **tcpdump -n icmp or arp** to sniff only icmp and arp traffic. The -n prevents doing DNS lookups on IP address to get the hostnames.
  - Use **Ctrl-s and Ctrl-q** to pause and continue. Use Ctrl-c to end the capture.
- On Frodo,
  - Empty Frodo's arp cache with **ip neigh flush all**
  - Ping Elrond and observe the arp request, arp reply, echo request and echo reply.
- ❖ Record the Elrond's tcpdump output in your *lab02* file showing the arp and icmp packets resulting from the pings you did on Frodo. Hints: Either redirect the output of tcpdump to a file or use a terminal with copy/paste capability and ssh into Elrond to do the capture again.

### To turn in

When finished with this lab, update your "Time spent doing this lab" in your *lab02* file. This should reflect the total number of hours you spent preparing for and getting this lab done.

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.

```
cp lab02 /home/rsimms/turnin/cis192/lab02.$LOGNAME
```

### Grading rubric (30 points)

- 2 points for a correct submittal into the turnin directory
- 3 points for a complete header, including the amount of time you spent on this lab
- 5 points for correct Frodo network information (step 3)
- 5 points for a correct description of how to repair Frodo (step 4)
- 5 points for correct Elrond network configuration (step 9)
- 5 points for correct Elrond ifconfig and route output (step 11)
- 5 points for correct arp and icmp packet capture (step 12)

### Extra Credit (1 point each)

- 1) Install arpwatcsh on Elrond and collect at least 10 IP/MAC pairs. Copy your arp.dat file contents to your *lab02* file.
- 2) From Frodo, ssh to Elrond using IPv6. Copy the **who** command output on Elrond to your *lab02* file showing the IPv6 address for your session.
- 3) Install Wireshark on Frodo and capture IPv6 pings to Elrond. Be sure to run Wireshark as root. Export the captured packets as text and include one ICMPv6 request and reply to your lab06 file.
- 4) Explain in your *lab02* file why Frodo cannot ping William.
- 5) What is the IPv6 link-local address for Opus? Add this to your *lab02* file.