OPS245 Lab 6

Contents

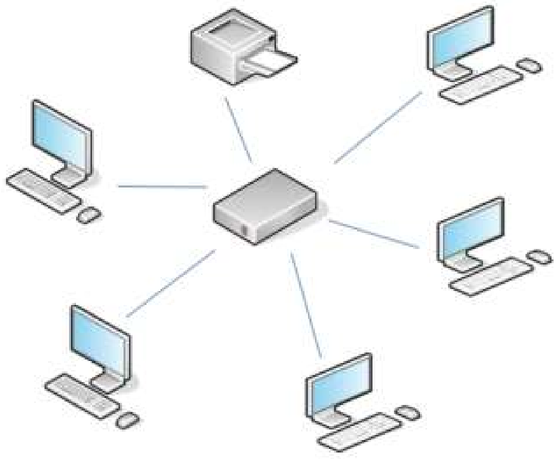
LAB PREPARATION

Purpose / Objectives of Lab 6

In this lab, you will learn the basics of networking by using your **Virtual Machines**. You will first set up a **virtual network** among those machines. In addition, you will learn to set up **network names** (to associate with server's IP Addresses), **associate network services with port numbers** for troubleshooting purposes, and use shell scripts with arrays to store network configuration data.

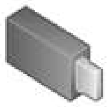
Main Objectives

1. Configure a private virtual network for your **VMs** and your **c7host** machine
2. Configure network interfaces for your Virtual Machines using both **graphical** and **command-line** utilities.
3. Use **local hostname resolution** to resolve simple server names with their corresponding IP Addresses
4. Use common networking utilities to associate network services with port numbers for troubleshooting purposes



Setting up networks is an essential operation for a system administrator. Maintaining network connectivity and securing the network are also essential operations. In this lab, we will **configure a private virtual network using static IP addresses** (eg. wired workstation connections). We will learn how to setup a DHCP network (eg. for notebook, table and smartphones) in lab 8.

Minimum Required Materials	Linux Command Reference		
	Networking Utilities	Networking Configuration Files	Additional Utilities
	ip (http://man7.org/linux/man-pag		find (http://man7.org/linux/m

Solid State Drive	 **USB key** (for backups)	**Lab6 Log Book**	es/man8/ip.8.html) system-config-network (http://www.serverlab.ca/tutorials/linux/administration-linux/configure-centos-6-network-settings/) ping (http://man7.org/linux/man-pages/man8/ping.8.html) arp (http://man7.org/linux/man-pages/man8/arp.8.html) ss (http://man7.org/linux/man-pages/man8/ss.8.html)	Interface Configuration (https://www.centos.org/docs/5/html/Deployment_Guide-en-US/s1-networkscripts-interfaces.html) resolv.conf (https://linux.die.net/man/5/resolv.conf)	an-pages/man1/find.1.html) tail (http://man7.org/linux/man-pages/man1/tail.1.html) cp (http://man7.org/linux/man-pages/man1/cp.1.html)

INVESTIGATION 1: CONFIGURING A VIRTUAL NETWORK

For the remainder of this course, we will focus on networking involving our VMs. This lab will focus on setting up a virtual network, connecting our VMs and c7host machine to the network, and configuring our private network to make more convenient to use, troubleshoot and protect. **Lab 7** will focus on configuring SSH and making access to the private network more secure. Finally, **lab 8** will focus on configuring mobile (as well as wired devices) via DHCP to automatically assign an IP address.

There are several reasons for creating virtual networks. The main reason is to **safely connect servers together** (i.e. to safely limit but allow the sharing of information among computer network users). This allows for a secure connection of computers yet controlling access to and monitoring (protecting) access to permitted users (discussed later in **lab7**).

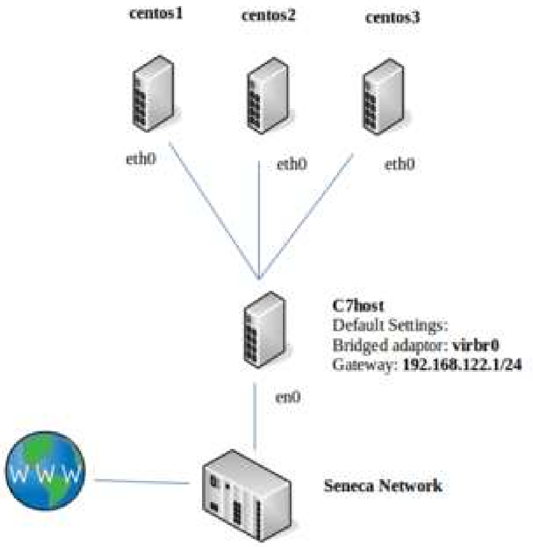
Part 1: Configuring a Private Network (Via Virtual Machine Manager)

If we are going to setup a private network, there are a number of steps to perform: First, **define a new private network in the Virtual Manager application**; and second, **configure each of our VMs to connect to this new private network**. In Part 1, we will be perform the first operation. In part 2, we will be performing the second operation for all VMS (graphical and command-line).

Before configuring our network, we want to **turn off dynamic network configuration for our Virtual Machines** by turning off the **"default"** virtual network. We will then define our private network.

Perform the following steps:

1. Launch your **c7host VM** and start the Virtual Machine Manager.
2. Make certain that the **centos1**, **centos2**, and **centos3** virtual machines are powered off.
3. In the Virtual Machine Manager dialog box, select **Edit-> Connection Details**.
4. In the **Connection Details** dialog box, select the **Virtual Networks** tab
5. Click to de-select the **Autostart (on boot)** check-box options and click the **Apply** button.
6. Stop the default network by clicking on the **stop** button at the bottom left-side of the dialog box.
7. Click the **add** button (the button resembles a "plus sign") to add a new network configuration.
8. Type the network name called: **network1**, and then click the **Forward** button.
9. In the next screen, enter the **new network IP address space** called: **192.168.245.0/24**
10. Disable the **DHCP4** check box and click the **Forward** button.
11. Click the **Forward** button again to accept the default in the next screen.
12. Enable Network Forwarding by Selecting **Forwarding to physical network**, the destination should be **Any physical device** and the mode should be **NAT**
13. Proceed with changes, and click **Finish**.



This diagram shows the current network configuration of your **c7host** machine in relation to your **Virtual Machines**. In this section, you will be learning to change the default network settings for both your **c7host** machine and **VMs** to belong to a **virtual network** using fixed IP Addresses.

14. We will now reconfigure each of our VMs to use our new virtual network **network1**
    a. Let's start with our **centos1 VM**. Double-click on your **centos1** VM, but instead of running the VM, click on the **view** menu, and select: **Details**
    (Note: the Virtual Machine window will appear - do not start virtual machine)
    b. In the **left pane** of the Virtual Machine window, select **NIC:** and note that this NIC is on the "default" virtual network
    c. Change it to **Virtual Network network1: NAT** (i.e. the network that you just created) and click the **Apply** button.

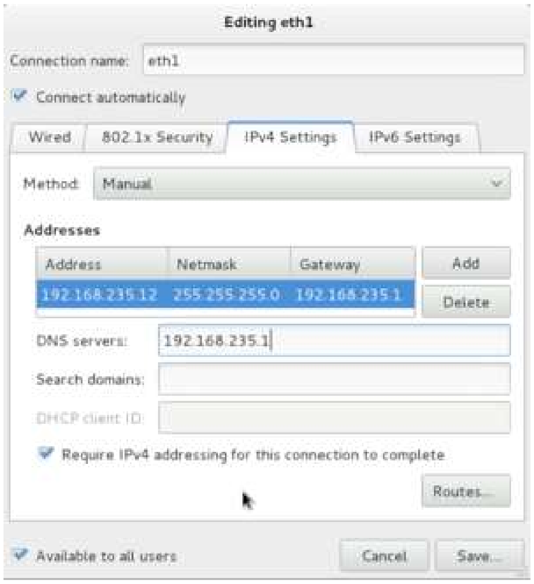
Part 2: Configuring Network For centos1 VM

In this section, we will be using a graphical tool to connect our **centos1** VM to our private network.

Perform the following steps:

1. On your **c7host** machine, run **ip address show** and make note of the IP address assigned to the **virbr1** (i.e. "Virtual Bridge) interface. This will be the default gateway and DNS server for your VMs.
2. Select the **Console** view (instead of Details), start your **centos1** VM and login.
3. Within your **centos1 VM**, click **Applications** menu, then select **System Tools**, and then **Settings**.
4. In the *Settings* Dialog Box, click on the **Network** icon.
5. For the **Wired** connection, click the **settings** button (The icon appears as a gear located at the bottom right-hand corner of the dialog box).
6. Select the **IPv4** tab. Change Address from *Automatic (DHCP)* to **Manual**.
7. In the Addresses section, enter the following information:

    IP Address: **192.168.245.11**
    Subnet Mask: **255.255.255.0**
    Default Gateway: The IP address of **virbr1** on your centos host (c7host).


Editing eth1

Connection name: eth1

☑ Connect automatically

Method: Manual

Addresses

Address	Netmask	Gateway
192.168.235.12	255.255.255.0	192.168.235.1

DNS servers: 192.168.235.1

Search domains:

DHCP client ID:

☑ Require IPv4 addressing for this connection to complete

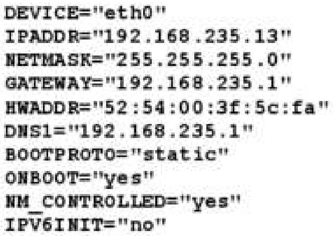
☑ Available to all users

Although the private network has been setup via the **Virtual Machine Manager**, each virtual machine requires to change its own network setting individually (either **graphically** or by **command line**).

8. Click on the **DNS'** ***field and add The IP address (*****virbr1** on your centos host) as the primary DNS server.
9. When finished, check your settings, and then click the **Apply** button.
10. Open a terminal and issue the **ip address show** command to confirm the change to the IP ADDRESS settings.
11. Verify that **centos1**VM is now connected to the private network by issuing the following command from your **c7host** machine:
    ```
    ping 192.168.245.11
    ```

Part 3: Configuring VM Network Setup via Command Line (centos2 and centos3)

The centos2 and centos3 VMs are **text-based only** systems, thus we cannot use a graphical tool to configure centos3 to connect to our private network. Therefore we will learn how to perform this task by using command-line tools.



```
DEVICE="eth0"
IPADDR="192.168.235.13"
NETMASK="255.255.255.0"
GATEWAY="192.168.235.1"
HWADDR="52:54:00:3f:5c:fa"
DNS1="192.168.235.1"
BOOTPROTO="static"
ONBOOT="yes"
NM_CONTROLLED="yes"
IPV6INIT="no"
```

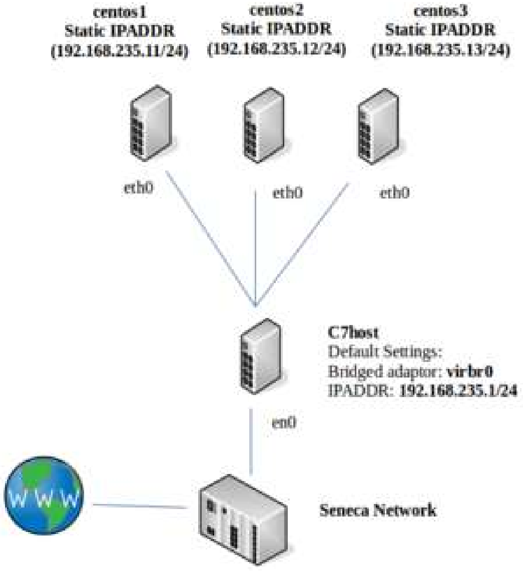
Although you can use the **ifconfig** command to temporarily create a static IP address connection to a network, you need to add the network settings in the **/etc/sysconfig/network-scripts** directory to automatically connect to the network upon Linux system boot-up.

Perform the following steps:

1. Configure your **centos3** VM (in the **View** -> **Details** menu of Virtual Machine Manager) to configure the NIC interface to **network1**, click **Apply**, and switch your centos3 VM view from *details* to **console**.
2. Start your **centos3** VM, login, and use **ip address show** to check the current address.

1. To configure your card with a static address from the command line, you will have to modify that interface's configuration file.
2. Change to the **/etc/sysconfig/network-scripts** directory
3. List the contents of this directory. You should see 2 different types of files, network config scripts and network configuration files.
4. Look for the configuration file for your original interface, it should be named **ifcfg-eth0**
5. Edit the file for your interface and give it the following settings (remember you will need elevated permissions to edit this file):

    DEVICE=eth0
    IPADDR=192.168.245.13
    PREFIX=24
    GATEWAY=192.168.245.1
    HWADDR=xx:xx:xx:xx:xx:xx <-- # **Use YOUR centos3 VM's MAC ADDRESS!!!**
    DNS1=192.168.245.1
    BOOTPROTO=static
    ONBOOT=yes
    NM_CONTROLLED=yes
    IPV6INIT=no



This diagram should show the newer network configuration of your **c7host** machine in relation to your **Virtual Machines**.

Keep consistent with Quotation or no Quotation
You have the option to either place quotation marks around the values, or no to use quotation at all. Regardless of the method you chose, KEEP CONSISTENT. For example, if beginning value with a double-quote, end value with a double-quote. If

beginning value without a double-quote, do not end with any quotation.

15. Save the file and then restart the network connection by issuing the commands: `sudo ifdown eth0` and `sudo ifup eth0`
16. Verify your configuration as you did before.
17. Restart the **centos3** VM.
18. Use the **ip** and **ping** commands to verify your network connection to other VMs.
19. Login and attempt to **ssh** to your matrix account to verify the settings.

    We need to also configure your centos2 VM for a persistent network connection as well:

20. Configure the centos2 VM (in the **View** -> **Details** menu of Virtual Machine Manager) to configure the NIC interface to **network1**, click **Apply**, and switch your centos2 VM view from details to **console**.
21. Start your **centos2** VM, login, and issue the command: `ip address show` and write down the **MAC address** for your eth0 network interface.
22. Edit the **/etc/sysconfig/network-scripts/ifcfg-eth0** file using the IPADDR: **192.168.245.12** , and the same **PREFIX**, **GATEWAY**, **DNS1** and **MAC address** information for you centos2 VM (i.e. recorded previously).
23. Save changes, re-issue the **ifdown** and **ifup** commands, and then issue the **ip address** and **ping** commands to verify that you can connect to other VMs on your network.

Answer INVESTIGATION 1 observations / questions in your lab log book.

INVESTIGATION 2: MANAGING YOUR NEWLY-CREATED NETWORK

Creating private networks are an important task, but a system administrator also needs to manage the network to make it **convenient to use**, and **troubleshoot** network connectivity problems.

This investigation will expose you to useful "tweaks" and utilities to help accomplish this task. **Lab 7** requires that you understand these concepts and have a good general understanding how to use troubleshooting utilities (like **ss**).

Part 1: Using /etc/hosts File for Local Hostname Resolution

After setting up a private network, it can be hard to try to remember IP addresses. In this section, we will setup your network to associate easy-to-remember server names with IP ADDRESSES.

Hosts files vs. the Domain Name System
On large public networks like the Internet or even large private networks we use a network service called Domain Name System (DNS) (http://en.wikipedia.org/wiki/Domain_Name_System) to resolve the human friendly hostnames like **centos.org** to the numeric addresses used by the IP protocol. On smaller networks we can use the `/etc/hosts` on each system to resolve names to addresses.

Perform the following steps:

1. Complete this investigation on **all of your VMs** and the **c7host** machine.
2. Use the `hostname` and `ip` commands on your **c7host** machine and all of your 3 VM's to gather the information needed to configure the **/etc/hosts** file on all of your Linux systems.
3. Edit the **/etc/hosts** file for the **c7host**, **centos1**, **centos2** and **centos3** VMs. Add the following contents to the <u>bottom</u> of the **/etc/hosts** file:

```
192.168.245.1 c7host
192.168.245.11 centos1
192.168.245.12 centos2
192.168.245.13 centos3
```

4. Verify that you can now ping any VM by their hostname instead of the IPADDR.

Part 2: Network Connectivity & Network Service Troubleshooting Utilities

Troubleshooting network problems is an extremely important and frequent task for a Linux/Unix system administrator. Since network services (such as file-server, print-servers, web-servers, and email-servers) depend on network connectivity, as Linux/Unix sysadmin must be able to quickly and effectively pin-point sources of network problems in order to resolve them.

Network service problems may not be entirely related to a "broken" network connection, but a service that is not running or not running correctly. The following table lists the most common listing of utilities to assist with detection of network connectivity or network service problems to help correct the problem.

Common Network Troubleshooting Tools

Purpose	Command(s)

Network Connectivity	`ping`
	`arp`
	`ip`

Network Service Status	`ss`

Perform the following steps:

1. Switch to your **c7host** machine.
2. Issue the **ping** command to test connectivity to your **centos1**, **centos2**, and **centos3** VMs.
3. Examine the contents of the ARP cache by using the command: `arp` What is the purpose of ARP?
4. Check the contents of the cache again by using the command: `arp -n` What was the difference in output?
5. Issue the following command: `ss -at` This command will list all active TCP ports. Note the state of your ports.

TCP is a connection oriented protocol that uses a handshaking mechanism to establish a connection. Those ports that show a state of LISTEN are waiting for connection requests to a particular service. For example you should see the ssh service in a LISTEN state as it is waiting for connections.

6. From one of your VM's login to your host using the **ssh** command.
7. On your c7host VM rerun the `ss -at` command and in addition to the **LISTEN** port it should list a 2nd entry with a state of ESTABLISHED. This shows that there is a current connection to your ssh server.
8. Exit your ssh connection from the VM and rerun the command on the CentOS host. Instead of **ESTABLISHED** it should now show a state of **CLOSE_WAIT**. Indicating that the TCP connection is being closed.
9. On your c7host VM, try the command: `ss -atn` How is this output different? Without the -n option ss attempts to resolve IP addresses to host names (using /etc/hosts) and port numbers to service names (using /etc/services)
10. Examine the **/etc/services** file and find which ports are used for the services: ssh, sftp, http
11. Now execute the command ss -au What is the difference between the options: -at and -au? When examining UDP ports why is there no state?

Answer INVESTIGATION 2 observations / questions in your lab log book.

INVESTIGATION 3: USING PYTHON TO MODIFY FILES

In this investigation you will write a python script that will allow a user to interactively configure a network interface's configuration file. Before beginning, **make a backup of your ifcfg files**. **Store the python script in ~/bin/** on c7host.

Write a script called **netconfig.py** that will prompt the user for the following values, and write their answers into an ifcfg file stored in the **/etc/sysconfig/network-scripts** directory.

1. The name of the interface
2. The interface's MAC address
3. Whether the interface should automatically turn on when the machine boots.

4. Whether the interface should get a static or DHCP address

   Note: Only prompt the user for the following values if they chose a static address.

   - The static ip address
   - The network prefix
   - The default gateway
   - The primary DNS server

Note that your script should make use of loops and try-except statements to make sure the user provided semi-reasonable data. You are not expected to create the regular expressions necessary to confirm the format of the IP address, but should be able handle simpler issues like forcing the user to give the interface a name (since you will need it for the filename), determining if it will start automatically, and the address type.

Remember to test your script to make sure it works.

LAB 6 SIGN-OFF (SHOW INSTRUCTOR)

Follow the submission instructions for lab 6 on Blackboard.

> **Time for a new backup!**
> If you have successfully completed this lab, make a new backup of your virtual machines as well as your host machine.

Perform the Following Steps:

1. Make certain that ALL of your VMs are running.
2. Switch to your **c7host** VM.
3. Change to your user's **bin** directory.
4. Issue the Linux command: `wget https://raw.githubusercontent.com/OPS245/labs/main/lab6-check.bash`
5. Give the **lab6-check.bash** file execute permissions (for the file owner).
6. Run the shell script and if there are any warnings, make fixes and re-run shell script until you receive "congratulations" message.
7. Arrange proof of the following on the screen:

   ✓ **centos2** VM:

   - **ssh** from **centos2** to **c7host** VM.

   ✓**c7host** machine

   - Run the **lab6-check.bash** script in front of your instructor (must have all `OK` messages)

   ✓ **Lab6** log-book filled out.

8. Upload a screen of the proof from the previous step, along with the file generated by **lab6-check.bash**, your log book, and your **netconfig.py** script to blackboard.

Practice For Quizzes, Tests, Midterm & Final Exam

1. What is a port?
2. What command will set your IP configuration to 192.168.55.22/24 ?
3. What is the difference between UDP and TCP?
4. What port number is used for DHCP servers?
5. What is the function of the file `/etc/hosts` ?
6. What is the purpose of the file `/etc/sysconfig/network-scripts/ifcfg-eth0` ?
7. What tool is used to show you a list of current TCP connections?