Hands-on Keyboard: Cyber Experiments for Strategists and Policy Makers

Windows and Linux Network Configurations

1. Introduction

- Establishing network connectivity in Windows and Linux follows a similar process. Steps include setting the computer’s Internet Protocol (IP) address, the addresses of the Domain Name System (DNS) servers, and the route to the gateway (the gateway links an internal network to external networks).
- This review examines the processes and resources involved in managing network configuration on Windows and Linux machines. It includes an overview of useful networking commands like `ipconfig`, `ifconfig`, `netsh`, and `route`.

1.1. Objectives

The Air Force Cyber College thanks the Advanced Cyber Engineering program at the Air Force Research Laboratory in Rome, NY, for providing the information to assist in educating the general Air Force on the technical aspects of cyberspace.
• Review basic network concepts.
• Configure Windows and Linux to connect to a network.
• Review the ping, netstat, ipconfig/ifconfig, and route commands.

1.2. Materials

• Windows computer with access to an account with administrative rights
• VirtualBox
• Ubuntu OS .iso file

1.3. Assumptions

• The provided instructions were tested on a Windows 7 physical machine. Instructions may vary for other OS.
• The student has administrative access to their system and possesses the right to install programs.
• The student’s computer has internet access.

1.4. Random Notes

• Line Linux, Macintosh (based on Unix) provides the ifconfig command.
• ifconfig stands for “interface configurator.”
• ipconfig stands for “Internet protocol configuration.”

2. Basic Networking Concepts

2.1. What is a network packet?

• A packet is a discrete amount of data (think a finite string of 1s and 0s) structured in a particular format.

• The order of 1s and 0s in a packet impart additional meaning.
A computer sending data over a network divides the data to be transmitted into packets and sends them to the remote system, which reassembles the packets into the original data.

2.2. What is an IP address?

- An IP address uniquely identifies computers on a network, enabling computers to send and receive packets. Computers mark packets with the source (sender) and destination (recipient) IP addresses. IP addresses take the format W.X.Y.Z, where W, X, Y, and Z range between 0 and 225 (decimal).

- Data disassembled into packets, routed independently though a network, then reassembled.

- Comparing a packet to a letter, the sending or source (src) computer’s IP address is similar to the return address of the sender of a letter. The IP address of the receiving or destination (dst) computer is similar to the street address of the building receiving the letter.

2.3. What is a port number?

- Computers often also mark packets with the source (sender) and destination...
(recipient) port numbers. If an IP address is similar to a street address of a building, the port number is like an apartment number. The port number tells the receiving computer which of its many running applications (which of many apartments in a building) should receive the packet. For example, Firefox and an FTP client might send information to the same IP address (same computer) but different port numbers (different applications running on the same computer).

2.4. **What is dynamic host configuration protocol?**

- Dynamic host configuration protocol (DHCP) is a network protocol used by clients (like your own computer) to retrieve network configuration information from a server. This information allows the client to communicate on the network.

2.5. **What is domain name system?**

- Q: Would you enjoy typing IP addresses (like 64.233.169.147) in your web browser every time you wanted to visit a web page (like the Google home page)?
- A: Probably not. Humans remember names or phrases far better than seemingly meaningless strings of numbers. However, computers such as routers work with IP addresses, not domain names. Luckily, domain name system (DNS) servers translate domain names typed in browsers (www.google.com) into IP addresses (64.233.169.147). Bottom line: if your computer cannot reach a DNS server, you will not be able to browse the internet using domain names (no www.netflix.com for you!).
- Q: How does a computer locate a DNS server?
- A: There are many publicly available DNS servers. A computer may obtain the IP address of a DNS server from a DHCP server or a user can specify the DNS server IP address manually through a graphical user interface (GUI) or in a configuration file.

3. Internet Protocol (IP) Addresses

- A user manually sets a **static IP address**. It does not typically change over time. A DHCP server automatically sets a **dynamic IP address**. The DHCP server leases a computer an IP address for a certain amount of time. When the lease expires, the system may receive a different address from the DHCP server (although it tends to remain the same).

3.1. Setting a Static IP Address - Windows Terminal

- To change the IP address using the Windows Terminal, you must run as an administrator. However, the command `sudo -s` is not a recognized Windows command. In order to run as an administrator on Windows, click **Start** type `cmd` in the search box and hit `ctrl + shift + enter`. A dialog box will pop up, click **Yes**. The terminal will open and you will be running as an administrator.
- Type `netsh interface ip show config` to see network configuration information.
- Type `ipconfig /all` for another method of viewing network configuration information.
- Look at the entry for "Local Area Connection" and note the IP address, Subnet Mask (netmask), default gateway, DHCP server, and DNS servers.
- Type `netsh int ip set address name="Local Area Connection" static 132.168.1.100 255.255.255.0 192.168.1.1 1` to manually set the following:
  - Static IP addresses to 192.168.1.100
  - Netmask to 255.255.255.0
  - Gateway to 192.168.1.1
  - Gateway Metric to 1 (don’t worry about this field)

3.2. Setting a Dynamic IP Address (DHCP) - Windows Terminal

- Type `netsh int ip set address "Local Area Connection" dhcp` to dynamically fetch IP address and other configuration information from a DHCP server.
- Type `ping www.yahoo.com` to verify connectivity. If you have connectivity issues and get stuck, use `ipconfig/all` to verify the network configuration information is correct or restart the system.
3.3. Setting Static and Dynamic IP Addresses - Windows (GUI)

- Open the Control Panel.
- Under the Network and Internet heading, click **View network status and tasks**.
- From the menu on the left, click **Change adapter settings**.
- You may have more than one Internet connection listed here. Determine which adapter is your connection to the Internet. Right click on this adapter and select **Properties**.
- Click on Internet Protocol Version 4 (TCP/IPv4).
- Click the **Properties** button.
- To set the IP address and DNS servers dynamically using the DHCP server, you would select the options highlighted below:

![DHCP Options](image)

- To set a static IP address and DNS servers manually, you would select the options highlighted below and manually fill in the information as shown (Note: Do not copy the information directly from the screen shot below. Your IP address will be different):
3.4. Setting a Temporary Static IP Address in Linux

- In Ubuntu, open a terminal and sudo to root (`sudo -s`).
- Type `ifconfig`.

- Record the original IP address and netmask in a Word document. Also make note of the interface. The above example is `enp0s3`.
- Type `ifconfig <your interface> 192.168.1.100 netmask 255.255.255.0`.
- Type `ifconfig <your interface>` to verify the change.
3.5. Setting a Persistent Static IP Address in Linux

- Open a terminal and sudo to root to enable running gedit with root privileges (sudo -s).
- Use gedit to open /etc/network/interfaces (gedit /etc/network/interfaces).
- If you see the lines below or a variation, comment them out (precede comments by the # sign):

  #auto eth0
  #iface eth0 inet dhcp

- Assuming enp0s3 is your primary interface, add the following to the interfaces file:

  #The primary network interface - static IP
  auto enp0s3
  iface enp0s3 inet static
  address 192.168.1.100
  netmask 255.255.255.0
network 192.168.1.0
broadcast 192.168.1.255
gateway 192.168.1.1

- Save and exit the file.
- From the command line, run `ifconfig enp0s3` and note the address is unchanged.
- Type `service networking restart` to reload network configuration parameters.
- Type `ifconfig enp0s3` and note the address has now changed.
- Type `shutdown -r now` to restart the image.
- Log back in and rerun `ifconfig enp0s3` and note the address is still set to the static value.

3.6. Setting a Dynamic IP Address in Linux

- Open a terminal and sudo to root to enable running gedit with root privileges (`sudo -s`).
- Use gedit to open `/etc/network/interfaces` (`gedit /etc/network/interfaces`).
- Assuming enp0s3 is your primary interface, comment out the static IP lines and add the following to the interfaces file:

```text
#Primary network interface- dynamic IP
auto enp0s3
iface enp0s3 inet dhcp
```
Save and exit the file.

From the command line, run `ifconfig enp0s3` and note the IP address is unchanged.

Type `service networking restart` to reload network configuration parameters. Note how the Ubuntu system requests an IP address from the DHCP server.

Type `ifconfig enp0s3` again and note the address has now most likely changed (although it is possible the DHCP server would give you the same address as the static IP you set).

If you have connectivity issues, type `dhclient` to request an IP address from the DHCP server.

4. **Routers and Gateways**

4.1. What is a route?
The word route refers to the path packets take as it travels from a source to a destination. There are typically many paths a packet can travel. The route indicates which path a packet should take. The route is stored in the Kernel IP Routing Table.

4.2. What is the default gateway?

- Think of the default gateway as the gatekeeper between your Local Area Network (LAN) and the rest of the Internet. To reach anything outside the LAN on the rest of the Internet, packets must travel through the gateway. Therefore, if you want to visit www.yahoo.com, your computer has to know the IP address of the gateway, which will forward the packets along the path to www.yahoo.com.

4.3. Setting the Default Gateway in Windows

- See Section 3.1 and Section 3.3 for a refresher in setting the Gateway in Windows using the terminal and GUI, respectively.

4.4. Viewing the Route in Linux

- Open a terminal and sudo to root (sudo -s).
- Type `route` to view the current route.
- Alternately, type `netstat -rn` to view the kernel routing table.

4.5. Setting the Default Gateway in Linux

- Persistence when using a Static IP
- See Section 3.5 for a refresher in setting the default gateway in the `interfaces` file.
- Transient with the Route Command
  - Use the `route add` command to set a transient static route (will not last through a reboot).
Example: `route add default gw 192.168.1.1` to set the route to a gateway at 192.168.1.1.

### 4.6. Deleting the Route in Linux - Transient

- Type `route del <destination>` to delete a route.
- Example: `route del default`.
- If the route is set by a DHCP server or statically in interfaces, this change will not persist through a reboot (the route will reappear).
5. Review Exercises

5.1 Write the terminal command to change the IP address of an Ubuntu box temporarily to 192.68.1.5 with a netmask of 255.255.255.0.

5.2 Write the terminal command to temporarily change the default gateway route of an Ubuntu box to 192.168.1.11.

5.3 Which file in Ubuntu stores static network configuration information (such as IP address, netmask, gateway, etc.)?

5.4 Explain how to change from static to dynamic addressing on Windows and Ubuntu.

5.5 Explain the screenshot below. (Bonus if you can identify the Ubuntu Linux version based on the GUI, assuming it is default for that version)
1. In some cases computers use duplicate IP addresses, but that discussion is too in-depth for this brief review.
2. Unless a user manually changes the address or enables dynamic addressing.
3. It may also be something like **Local Area Connection 3**. If using a wireless connection, insert **“Wireless Network Connection”** everywhere you see “**Local Area Connection.”**