CS 556 - Networks II
Internet Teaching Lab (MCS B-24)
Lab Setup and Static Routing

February 10, 2005

What you will learn in this lab

- How to connect hosts to an Ethernet switch/hub

- How to work with subnet masks

- How to setup a commercial router (Cisco 7000)

- How to set up static routing

- How to interpret `ping` and `traceroute` measurements to determine the setup of routes

Prelab

1. Read the manual pages of the `route` and `traceroute` commands on your csa/csb account.

   - What is the syntax of a route command which adds a route to host 10.0.3.3 such that the next-hop is set to 10.1.2.3?

   - Sometimes, traceroute displays * * * as an output instead of the name of the hop that it encountered. Why does traceroute print this output and what does it mean?

2. Find out the difference between a switch and a hub. Which is better?

3. Read the article "Understanding IP Addressing: Everything You Ever Wanted to Know" by Chuck Semeria at
   http://www.3com.com/other/pdfs/infra/corpinfo/en_US/501302.pdf

4. Go to Cisco's web page (www.cisco.com) and find out about the types and number of interfaces of a Cisco 7000 router

5. The Cisco routers in the IT lab are running IOS Version 11.1 operating system. Read about IOS at
http://www.cisco.com/univercd/cc/td/doc/product/software/ios111/index.htm

6. Go to the website
http://www.cisco.com/univercd/cc/td/doc/product/core/cis7000/interpr/index.htm and read about the network interfaces available for the Cisco 7000 routers

7. Go to the website
http://www.cisco.com/univercd/cc/td/doc/product/rtrmgmt/chse/1105/1_3/install/appl_cli.htm and read about some of the configuration commands

Lab Setup

In this lab you will set up the machines in the configuration shown in Figure 1. Each router will be configured with static routing and you will send traffic between the routers.
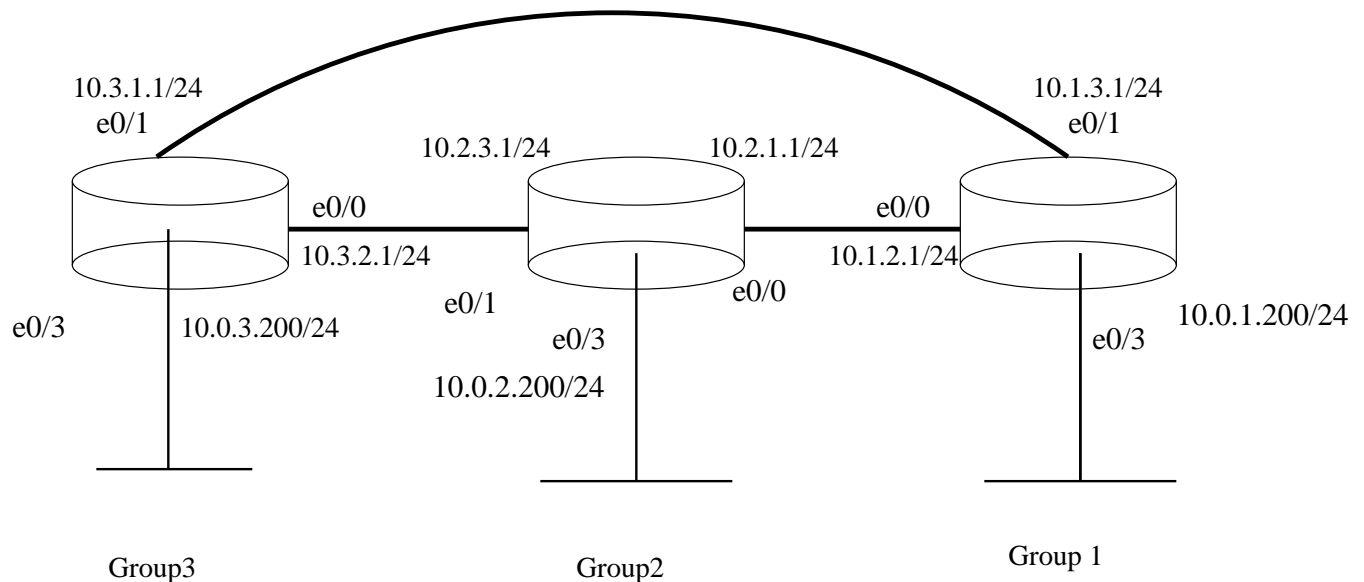

Figure 1: Network Topology

Your Task

This lab involves working with multiple segment IP networks—three subnets each having 4 PCs. There are at least 7 Ethernet switches or hubs, 3 Cisco 7000 series routers and a Linux router.

While the network shown in Figure 1 is already physically connected, your task will be to configure the interfaces on the routers and PCs, and manually setting the routing tables

to the correct values. You will then be asked a number of questions based on the correct setup of the network.

Note that most of the exercises in this lab require that you coordinate with other groups.

Connecting to the router (via minicom or telnet)

Follow the guidelines below to establish a terminal connection with the console port of the router. This gives you a terminal console to type in commands.

A Cisco router can be accessed using its console port directly connected to a computer using a serial communication program, such as `minicom`. At the command prompt on your terminal, type `minicom`. If the connection is successful, you will see the command prompt (User EXEC mode) of the router. In this state, you can run only a small set of commands, e.g., telnet, ping, trace. To view or change the configuration of the router, you need to enter the priviledged EXEC mode by typing `enable`.

You can also access your respective router using telnet from within **vmware** by typing the command:

<div align="center">

`telnet <interface address>`   .

</div>

You will be asked for a password which the TA will provide you with.

Command modes of IOS

In this part, you will make yourself familiar with the configuration commands on Cisco 7000 series routers.

The IOS interface is similar to a UNIX or DOS command shell. A notable difference is that IOS has a set of different command modes. Certain functions, such as configuring a network interface, can only be performed in a specific command mode. This part of the lab presents to you the different command modes in IOS.

Overall there are four command modes:

- **User EXEC mode ("user mode")**. Entering user mode normally requires a login and a password. However, when accessing the router through the console port, login and password are not required. In this mode, only a limited number of commands can be executed, and no configuration parameters can be read or modified.

- **Priviledged EXEC mode ("enable mode")**. Similar to root privileges on a Unix machine. Entering the priviledged EXEC mode requires a password. In this state, you can read configuration files, reboot the router, etc. To configure parameters of the router, one needs to proceed from priviledged EXEC mode to the global or interface configuration modes.

- **Global Configuration Mode**. In this mode, global system parameters can be modified.

<div align="center">3</div>

- **Interface Configuration Mode**. Parameters of a specific interface can be modified.

  Getting help (with IOS commands):
  In any command mode, typing a question mark will list all available commands or options.
  router-name# ? Lists all commands available at this time
  router-name# configure ? Lists all arguments available for the configure command

User EXEC Mode ("user mode")

As previously mentioned, once logged into the router in user mode, you can see a command prompt, so called User EXEC mode:

<p align="center">router-name></p>

where `router-name` is the assigned name of the router. You logoff by typing

<p align="center">router-name> exit</p>

There are only a few commands which you can execute in user mode prompt. You will not be able to change any configuration parameters. You can run the following commands, which are similar to the UNIX commands:

- `ping`

- `telnet`

- `traceroute`

To use these commands on the routers, type `ping` or `telnet` or `traceroute` and then ? to display all the options with description of the command.

Priviledged EXEC Mode ("enable mode")

In order to change the configuration of a router, you need to be in a system administrative mode, similar to root on a Unix system. In Cisco IOS, this mode is called the priviledged EXEC mode or enable mode. After connecting to the system, you change to the privileged mode by typing:

<p align="center">router-name> **enable**</p>

This system will ask for a password, the priviledged mode password or enable secret or enable password. The TA will provide you with the password. If the login is successful, you will see a different command prompt:

<p align="center">router-name> #</p>

You leave the priviledged EXEC mode by typing

<p align="center">router-name> #**disable**</p>

Or you logoff completely, by typing

<p align="center">router-name> #**exit**</p>

Global Configuration Mode

To modify system-wide configuration parameters, such as IP addresses, routing algorithms, routing table, you must be in the global configuration mode. You can enter the configuration mode only from the priviledged EXEC mode, by typing:

router-name> #configure terminal
```
router-name(config) #
```

The argument terminal tells the router that you will be entering configuration commands from the terminal console.

Now you can type global configuration commands. For example, you can add or remove routing table entries.

```
ip route <destination address> <destination address mask> <interface>
```

You can leave the global configuration mode by typing **CTRL-z**.

Interface Configuration Mode

To modify the configuration parameters of a specific interface, you must enter the interface configuration mode. You must be in the global configuration mode to enter this mode.

The Cisco 7000 routers may have the following interfaces:

- FDDI - Fiber Distributed Data Interface

- ATM - Asynchronous Transfer Mode

- HSSI - High-Speed Serial Interface

- FSI - Fast Serial Interface

- Fast Ethernet (Ethernet) - 100Mbps (10Mbps) Ethernet

When you configure an interface on the 7000 routers, you have to specify the slot and port number in addition to the name of the interface, since the 7000 routers support different types of interfaces (one per slot) and multiple interfaces of the same type per slot (specified as port numbers).

On the Cisco 7000 routers, interfaces have the structure:

$$<\text{type}><\text{slot}>/<\text{port}>$$.

Example: ethernet 2/1. The interface ethernet 2/1 indicates that this is an Ethernet interface, which is on an ethernet card in slot 2 of the router and is on port 1.

To enter the interface configuration mode of an interface, you have to enter the keyword `interface` followed by the interface name.

For the 7000 routers, to enter the configuration mode of Ethernet port 1 in slot 0 type:

```
router-name(config) # interface ethernet 0/1
```

Once in the interface configuration mode, you will see the following prompt:

```
router-name(config-if) #
```

Now you can type commands to configure the interface. You enable interfaces as follows:

```
router-name(config-if) # no shutdown
```

You return to the global configuration mode by typing:

```
router-name(config-if) # exit
```

IOS commands to display the current status

Here are some important commands which you can execute on a Cisco router to display the status of the router. You need to be in priviledged mode to execute the commands.

Command	Action
show running-config	Display the current configuration
show interfaces	Display details of the configuration of interfaces
show ip route	Display the startup configuration
show protocols	Lists all protocols running on the system, and the interfaces on which the protocol is configured.

IOS commands to set an IP address

To set or change the IP address of an interface, you must enter the interface configuration mode for this interface. For example, to configure an ethernet interface on the 7000 routers, in this case, the interface which is at slot 4 and port 2, follow the sequence:

enable → configure term → interface ethernet 4/2

Then you can set the IP address using the following syntax:

```
ip address 10.0.2.101 255.255.255.0
```

Setting static routing table entries

You must be in the configuration mode to add or remove routing table entries. For example, we can use the following command at Router 1:

```
ip route <destination address> <destination address mask> <interface>
                ip route 10.3.1.0 255.255.255.0 e0/1                          .
```

Testing

Once you finish connection setup and configuration of the routers, you can test by using `ping` or `traceroute`.

The command for `ping` is

```
ping 10.0.1.2
```

If you are using a host on a LAN, you can check the connectivity using ping. In the lab, the default router of the PCs is set to a Linux router. Therefore, you will not be able to ping other interfaces of the router unless you add a route in your PC. The command is

```
route add -net 192.57.66.0 netmask 255.255.255.0 dev eth0
```

You need to use **vmware** to add it to the virtual kernel.

Lab Report (due 2/17/2005 with Homework 1)

You will write the following in your report.
This report is to be completed individually (not in groups).

1. Once all interfaces are setup, use traceroute to show all the paths from your host to another host on every other subnet. Explain the outcome.

2. Show the statistics of the used interfaces, e.g., `show interface e0/0`. You might see some statistics given names that seem to be out of a cartoon - try to interpret their meaning.

3. Describe the steps you followed to set up the routing table of your router (try to describe each step in one line or less). Describe any problems you encountered and how you overcame them.

4. A potential problem when setting up routing tables manually is that routing loops may occur. Describe a configuration scenario in the configuration of Figure 1 which produces a routing loop. What will be the result on the performance of the network?

5. What is the difference between specifying an exit interface and next-hop IP address in your routing table?

6. Perform experiments, by modifying the routing table at your router only, to determine how your router handles multiple matches in a routing table.

   For example, anyone working on router 3 can first add the following routes in the routing table:

   ```
   ip route 10.1.3.1 255.255.255.0 e0/1
   ip route 10.1.2.1 255.255.255.0 e0/1
   ```

   Now you should make sure that adding the following additional route has no effect! Why? (Hint: use ping)

   ```
   ip route 10.1.0.0 255.255.0.0 e0/0
   ```