Basic Cisco Router Configuration: Multiple Routers

Routers rarely exist alone. Most organizations have several to several dozens of routers. In this Lab, we will study two different ways in which routers can be configured to send packets, and what addressing schemes are used to keep the routes organized. We will use the GNS3 Graphical Network Simulator, and VPCS Virtual PC Simulator.

Objectives:

In this lab exercise you will complete the following tasks:

- Build topology in GNS3.
- Configure VPC's.
- Configure the routers with dynamic routing.
- Test the network with pings and traces.
- Observe the traffic on the network with WireShark.

Remember to read the report requirements at the end of this document to see what is necessary to hand into the instructor.
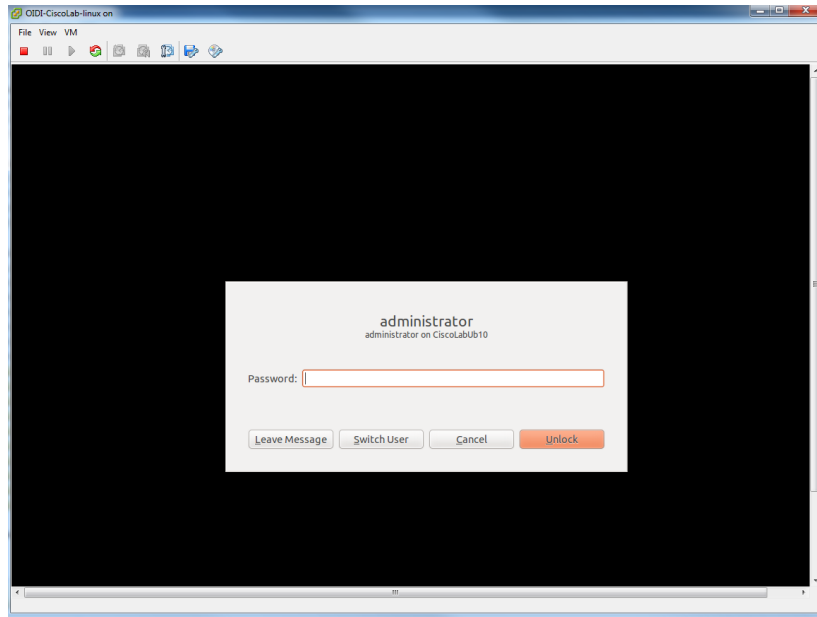
Lab Setup Diagram:
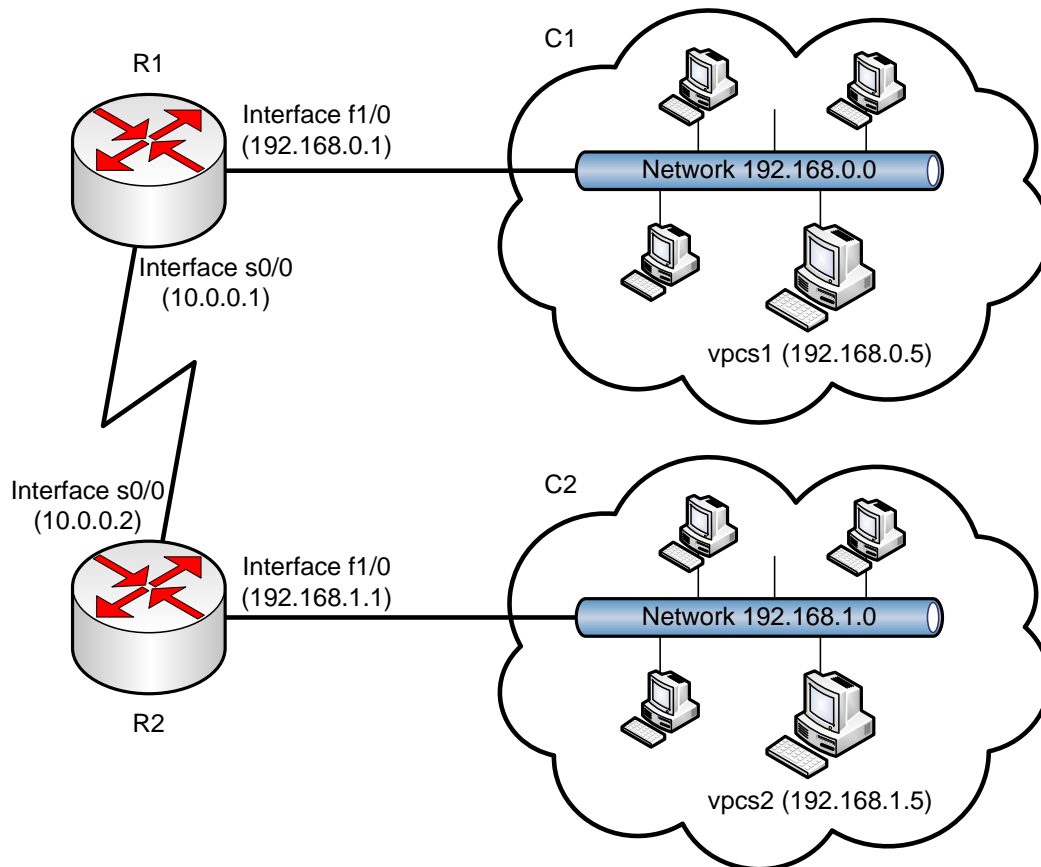
Logon On to Your Virtual Machine

Step 1   Logon On to VM Ware as directed from the "Getting Started" document.

Step 2   You may need to logon to the linux virtual machine with the user name "**Administrator**" (no quotes). The password is "**password**" (no quotes).

Task 1 – Build Topology

    Step 1   On the CiscoLab machine, go to Applications/Education and select VPCS. VPCS is used to create two virtual PCs to test the emulated network that we will set up later in this lab.

        The initial screen of VPCS will look like this one. Type **1** after the prompt so that it says VPCS 1>. "VPCS 1 >" means that you are currently in virtual PC #1. Let us call this virtual PC "**vpcs1,**" and the second virtual PC that we will create later "**vpcs2**".

Step 2   Let us set up the network configuration of vpcs1. We will place vpcs1 in network 192.168.0.0 (denoted as cloud 1 in the lab setup diagram). In the VPCS window, type in the following command:

```
VPCS 1 >ip 192.168.0.5 192.168.0.1 24
```

In the above command, the first argument is the IP address to be assigned to vpcs1, the second argument is the IP address of the default gateway which vpcs1 is connected to, and the last argument is CIDR (Classless Inter-Domain Routing) notation of the network mask (i.e., 255.255.255.0 in this case) denoting the network address of vpcs1 (i.e., 192.168.0.0).

Default Gateway is the IP address used as an entry and exit point to a network. It is also the address that packets are sent to when the destination IP address does not match any addresses in the Routing Table. In this lab, the default gateway addresses are the ports that serve as access points to each of the subnets.

Step 3   Let us create vpcs2 by typing in the following command in the VPCS window. After pressing the enter key, the prompt will change to "VPCS 2 >"

```
VPCS 1 >2
VPCS 2 >
```

Step 4   We will place vpcs2 in a different network, network 192.168.1.0 denoted as cloud 1 in the lab setup diagram. Type in the following command to assign IP address 192.168.1.12 to vpcs2.

```
VPCS 2 >ip 192.168.1.5 192.168.1.1 24
```

The above command also sets IP address 192.168.1.1 as the default gateway of vpcs2.

Now, we have finished setting up the virtual PCs to communicate through a router. Minimize the VPCS window. Let us set up an experimental network where vpcs1, vpcs2, and the router are placed.

Step 5 To setup the experimental network as shown in the lab setup diagram, go to Applications/Education and select "gns3 Graphical network Simulator".
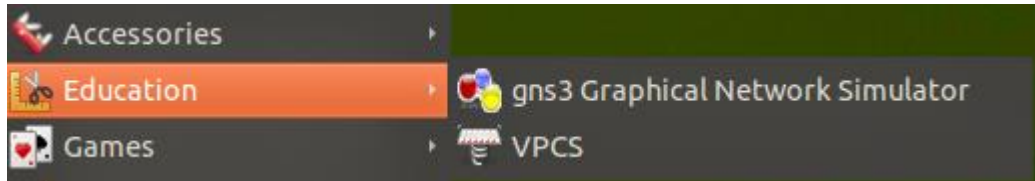

Step 6 Type in a new project name (say "Multi Router Lab") in the New Project window, check all the checkboxes, and click Okay. (You can use the default destination or create a file on your desktop.)
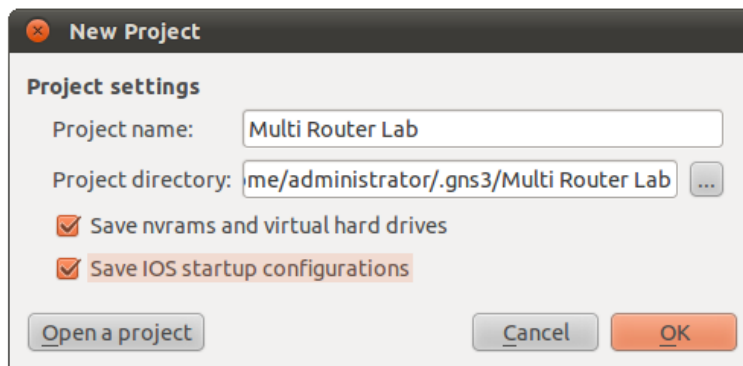

Step 7 Drag and drop "2 Router c3600s" and "2 Clouds" from the left pane (i.e., Nodes Types) to the middle pane (a blank area) as shown below:
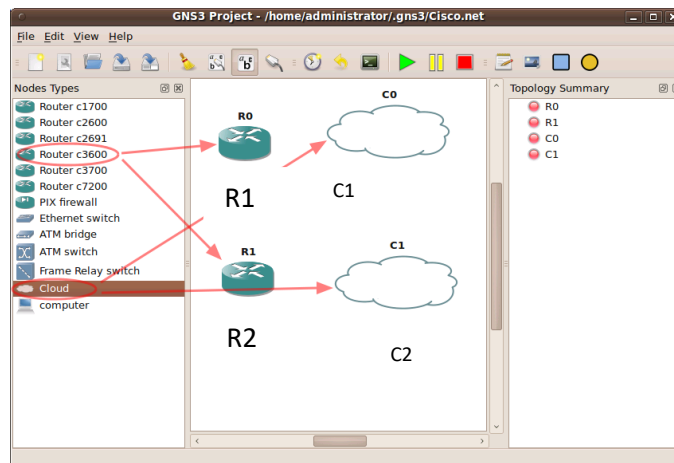
Step 8   To configure C1, right click on C1, and select "Configure"
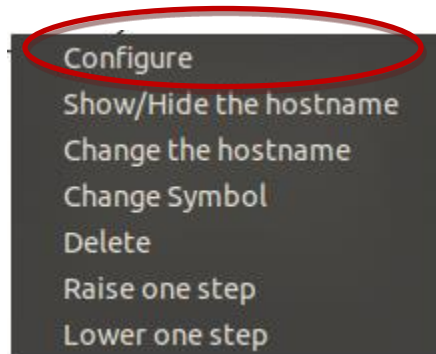
Step 9   In the configuration window, select C1 in the left pane, and select the NIO UDP tab. Type in "30000", "127.0.0.1", and "20000" for Local port, Remote host, and Remote port respectively. Click Add. On success, you will see "nio_udp:30000:127.0.0.1:20000" on the NIOs pane. Click Okay.
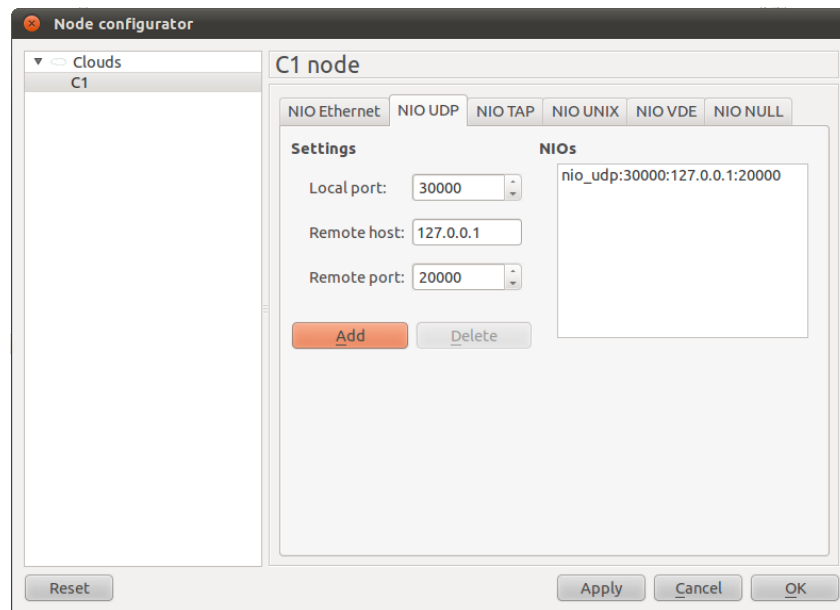
Step 10   For C2, repeat the same procedure to configure it. But, this time, use "30001", "127.0.0.1", and "20001" for Local port, Remote host, and Remote port respectively. Click Add. On success, you will see "nio_udp:30001:127.0.0.1:20001" on the NIOs pane. Click Okay.

Step 11   Let us connect the R1 and R2 to C1 and C2 respectively. Click icon in the toolbar, and select FastEthernet. The icon will turn to , which means you are in the "add link" mode.

Let us add a link between R1 and C1. Click R1, click C1, and a menu pops up. Select "nio_udp:30000:127.0.0.1:20000" in the popup menu. Repeat the same steps for R2 and C2, and select "nio_udp:30001:127.0.0.1:20001".

Click to finish "add link" mode.
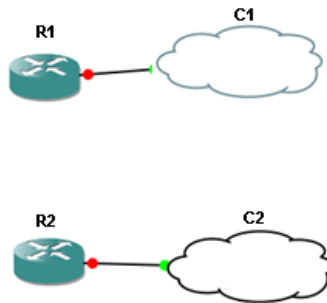
Also, you can toggle showing interface names by clicking the icon in the toolbar.

Step 12 Let us connect R1 and R2 through a serial communication line, as shown in the figure be

below. Click icon and select "Serial." Draw a serial line between R1 and R2 by clicking R1

and then clicking R2. Click icon to turn the line drawing mode off.
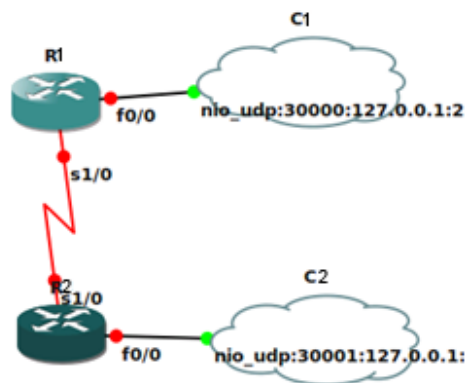
Please note that the interface numbering (i.e., fn/0, sn/0) depends on the order in which you add the lines. For example, if you add the link connecting R1 and C1 first, you will get f0/0 and s1/0. If you add the serial link between R1 and R2 first, then you will get f1/0 and s0/0.

Step 13   R1 and R2 are initially turned off. Turn R1 on by right-clicking R1 and selecting Start. Do the same thing to R2.
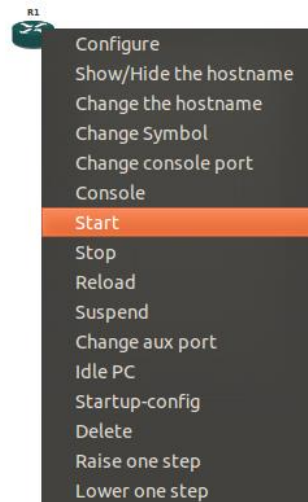
Step 14   Now, you can configure R1 and R2 through Cisco IOS. To enter IOS of R1, right click R1, and select Console. On success, a window named "R1" pops up.
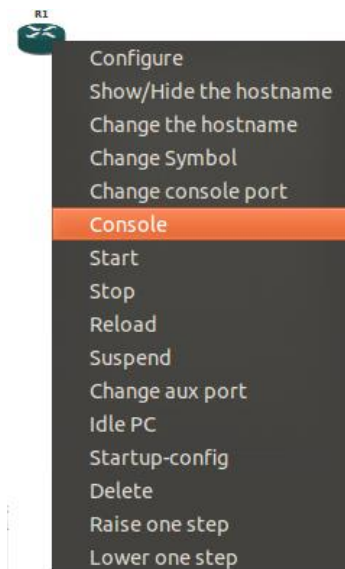
Step 15   In the R1 window, you may see some router booting information. Hit "Enter" several times to get the "R1#" prompt.

Once you get the "R1#" prompt, type the following commands to configure R1. **Tip: Use the up-arrow key to recall previously entered commands.**

Entering configuration mode and configure individual line:

```
R1#enable

R1#configure terminal

R1(config)#line con 0

R1(config-line)#logging syn

R1(config-line)#exit
```

Configuring interfaces connected to C1 and R1:

```
R1(config)#interface f0/0

R1(config-if)#ip address 192.168.0.1 255.255.255.0

R1(config-if)#no shut

R1(config-if)#exit

R1(config)#interface s1/0

R1(config-if)#ip address 10.0.0.1 255.255.255.0

R1(config-if)#no shut

R1(config-if)#exit
```

Again, the interface numbering (i.e., fn/0, sn/0) depends on the order in which you add the lines. If your interface numbers are different from those seen in the previous figure, replace the interface numbers in the above command with appropriate numbers seen in your design. Similarly in Step 17, you may need to change the numbers.

Configuring Routing Information Protocol (RIP):

RIP is the dynamic routing protocol used in ARPANET, the original Internet. RIP calculates how long routes packets take by comparing the number of hops the packet requires to reach its destination. RIP maintains a routing table on each router which it keeps accurate by sending routing update messages regularly and whenever the network topology changes.

```
R1(config)#router rip

R1(config-router)#version 2

R1(config-router)#network 192.168.0.0

R1(config-router)#network 10.0.0.0

R1(config-router)#no auto-summary

R1(config-router)#end

R1#
```

Step 16   Let us configure R2. Right click R2 and open Console to R2 (See Step 14 – 15).

Step 17   Once you get the "R2#" prompt, type the following commands to configure R2.

```
R2#enable

R2#configure terminal

R2(config)#line con 0

R2(config-line)#logging syn

R2(config-line)#exit

R2(config)#interface f0/0

R2(config-if)#ip address 192.168.1.1 255.255.255.0

R2(config-if)#no shut

R2(config-if)#exit

R2(config)#interface s1/0

R2(config-if)#ip address 10.0.0.2 255.255.255.0

R2(config-if)#no shut

R2(config-if)#exit

R2(config)#router rip

R2(config-router)#version 2

R2(config-router)#network 192.168.1.0

R2(config-router)#network 10.0.0.0

R2(config-router)#no auto-summary

R2(config-router)#end

R2#
```

Step 18   If you have any problem, try the "show" command to verify your settings. Please note that you can use "show" at "router**#**" or "router**>**" prompt – not in the configuration terminal mode which shows "router*(config…)#*" prompt.

```
show <? or keywords>

e.g., show interface s1/0
```

You can also find detailed description of each command.

```
?
```

Typing the '?' key at the prompt will give you a list of all commands that you can use in current state.

```
<command> ?
```

Typing a command followed by the '?' character will give you details on the parameters of the command.

Task 2 – Test the Network

Step 1   Let us test the network that we have just set up. Maximize the VPCS (Terminal) window.

Step 2   Type "1" to switch to vpcs1. Trace route to vpcs2 (192.168.1.5) using the following command. The trace command sends a probe packet to specified destination IP address, and discovers intermediate nodes that the packet traverses until it gets to the destination. If you have successfully configured everything, you will see the hops the packet made from vpcs1, through the router, to vpcs2.

```
VPCS 2 >1
VPCS 1 >trace 192.168.1.5 –P 6
......... // trace route result appears here
```

Also, try the following commands to trace route from vpcs2 to vpcs1.

```
VPCS 1 >2
VPCS 2 >trace 192.168.0.5 –P 6
......... // trace route result appears here
```

The following commands may be useful in verifying virtual PC configuration. Command "show" shows the configuration of all virtual PCs.

```
show
```

Command "ping" can be used to check if a virtual PC is up and connected to network. Using the "Lab Setup Diagram" on page 1, ping each router and each cloud to be sure everything is connected.

```
ping <ip address>
```

Task 3– Observe the Network Traffic with WireShark

Step 1   Let us sniff the packets being transferred between R1 and R2. Right click on the serial link between R1 and R2, select "Capture." When the Capture window shows up, select "R1 s1/0

(encapsulation: HDLC)," click OK. Now, GNS3 will start capturing traffic between R2 and R1, storing the traffic in a file named R1_to_R2.cap.

R1

f0/0

s1/0

Capture
Delete

R2
s1/0

f0/0
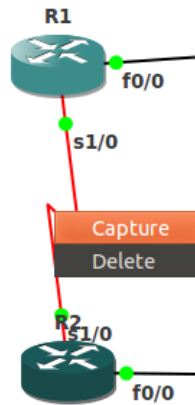
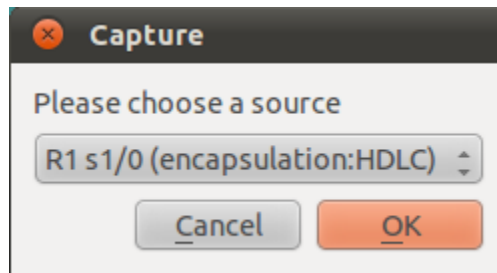If the software pops up a message box shown blow, please simply click OK and continue to do next step.

Capture

Please choose a source

R1 s1/0 (encapsulation:HDLC)

Cancel   OK

You may see another message. If so, click OK.

Capture

Cannot find .\R2_to_R1.cap : No such file or directory

OK

nio_udp:30001:127.0.0.1:20001

You see this message because the working directory to store the network packets is not set up correctly. What you need to do is the following:

- Go to the "Edit" menu, and select the "Preferences...". (Short-cut key: Ctrl-Shift-P);

- Under the "Capture" option, set the desktop for "Working directory for capture files:" by clicking the button on the right and choosing Desktop.

After you set up the working directory, repeat Step 1. You may see this message:
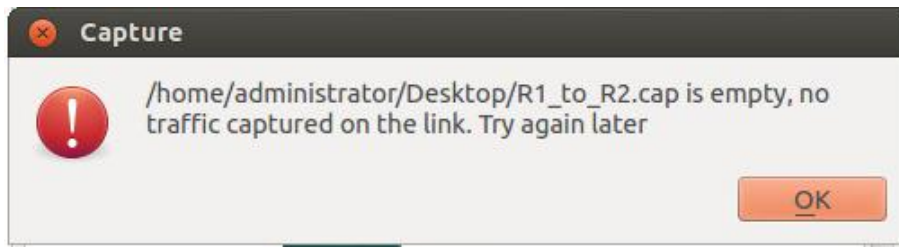
Click OK and continue.

Step 2   To generate test packets to be captured, we use *ping*. Go to the VPCS window. Select either one of vpcs1 and vpcs2, ping another. For example, you can ping vpcs2 from vpcs1 using the following commands:

```
VPCS 2 >1

VPCS 1 >ping 192.168.1.5

...... (ping results)
```

Note: ping sends a fixed number of *ICMP Echo requests* to the destination specified by a user. On receiving an ICMP Echo request, a computer (or network device) typically replies to the sender with an *ICMP Echo reply*. On receiving the ICMP Echo reply, ping (running on the sender) recognizes whether the destination is reachable or not.

Step 3   Let us see what has been captured. Click the serial link again, select "Start Wireshark"
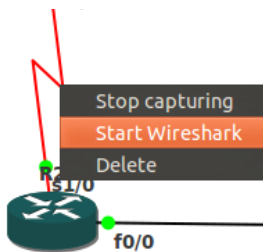
Step 4   On success, you will see the ICMP Echo requests going from vpcs2 (192.168.1.5) to vpcs1 (192.168.0.5) and the ICMP Echo replies from vpcs1 to vpcs2.
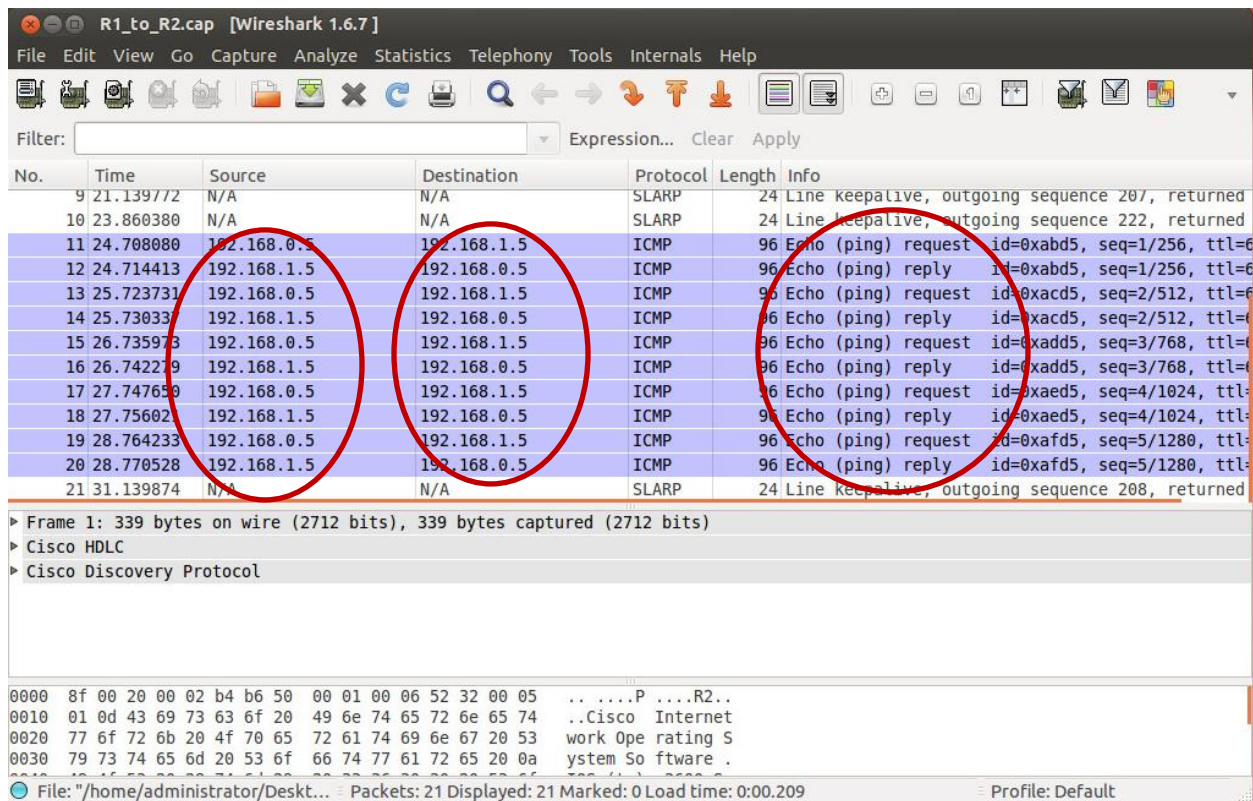
If you see any packet with info part showing something like "time out", that means your network is not configured correctly and the ping command does not work. Then, you need to check where you did wrong.

The second column is the timestamp of each packet captured. It is usually in second, while the time you get from the ping command is in millisecond.

Step 5 For another exercise, let us capture the packets trace sends and receives. Go to the VPCS window again; try trace vpcs1 from vpcs2 (or vice versa).

```
VPCS 2 >trace 192.168.0.5 –P 6

...... (trace results)
```

Step 6 Go to the Wireshark window (if you have closed it, just reopen it as you did in step 4), press Ctrl+R (i.e., View > Reload menu item or icon) to refresh the results. Go to the bottom of the list of packets to see the most recent ones.

Report:

Clearly state your results of this project. You are expected to hand in a report in the following format:
- A cover page (including Lab title) with your name.
- A table of contents with page numbers

- Use double-spaced type for convenient grading
- Number pages. Font size 12, single column
- Save the Microsoft Word document with your name in the title. Upload the document into the appropriate CANVAS dropbox.

The report should have the following sections. Each section should cover all the topics described below. Take screenshots if it is necessary.

Section I: Description of the Two Networks (40 points)

In this section, you should answer the following questions **(20 points, 10 for each):**

1. What is the network addresses of three subnets?
2. How are the address masks specified on the router side? Indicate which step, which command, and which parameter in the step are involved?

Also, include a screenshot to show the setup of the whole network. The interface names and numberings should be visible **(20 points, 10 for network setup and 10 for the display of names and numberings)**.

Section II: Functioning of the Network (40 points)

In this section, you should first include screenshots for the results of the following command tasks **(30 points, 10 for each)**:

1. trace for VPCS 1.
2. trace for VPCS 2.
3. ping both IP addresses to show you are connected.

All three items can be captured on the one screenshot.

Also explain how trace route and ping commands work and how they can help you diagnose network problems. **(10 points)**

Section III: Network Traffics Task (20 points)

In this section, first include a screenshot of your Wireshark results for Step 4 and Step 6 in Task **3 (10 points, 5 each)**.

Then, identify the pair of ICMP request and reply in Wireshark that correspond the second ping request in the ping task in Step 2. Based on the time stamp of these two records, estimate the time for the ping request to take a round trip from the source to the destination. Compare the number with the result you got in Step 2, Task 2. Explain where the difference, if there is any, may come from. **(10 points)**

Grading Rubric

This project has a number of specific requirements. The requirement for each section is documented in

the above project instruction "Report." Whether you receive credit depends on the following situations:

- You will get full credit on one item, if it is correctly reported as required and well written.
- You will get half credit on one item, if it is reported as required but there is something definitely wrong.
- You will not get any credit for one item, if it is not reported.

Credit for each section is stated in the section or Report.

Note

Be sure to include your name and email address in the report. The report should be turned in according to the deadline specified on CANVAS. Late submissions will be issued a grade deduction especially if permission is not obtained from the instructor. The instructor reserves the right to grant or reject extra time for report completion.