Lab Handout 3: IP Routing

IP Address

An IP Address (Internet Protocol Address) is a label given to a device, called **host**, that is a part of a computer network that communicates using the Internet Protocol. The IP address is <u>unique</u> within that network.

There are two versions of IP addresses, the **IPv4** and the **IPv6**. The IPv4 is a 32-bit number while the IPv6 is a 128-bit number. The IPv4 standard is composed of four (4) sections separated by three periods. Each section can range from 0 to 255.

Example of IPv4 Addresses:

104.24.107.215

192.168.1.1

202.69.185.91

Example of IPv6 Addresses:

2400 : b000 : 200 : 15 : 3449 : d91b : 3562 : 50ef

2001 : 0db8 : 0000 : 0000 : 0000 : ff00 : 0042 : 8329

A host's IP address has two parts: the **network** part and the **host** part. The **network part** is used to identify the network where the host is connected while the **host part** is used to locate the device in the network.

Network Classes

CLASS	STARTING BINARY ADDRESS	DEFAULT NETMASK	NETWORK PART	HOST PART	REMARKS
A	0 (1-126)	255.0.0.0	first 8 bits	remaining 24 bits	Zero is not included because zero means any number. **127.0.0.1** is reserved for loopback/localhost.
B	10 (128-191)	255.255.0.0	first 16 bits	remaining 16 bits	
C	110 (192-223)	255.255.255.0	first 24 bits	remaining 8 bits	

D	1110 (224-239)				used for multicasting
E	1111 (240-255)				used for experimentation

Subnet Mask

To know the network part of an IP Address, you must use the IP address' subnet mask. The **subnet mask** determines which part of your IP address is for the network address. An example of a subnet mask is **255.255.255.0**. This subnet mask means that the first 24 bits constitutes for the network address. Thus, all IP addresses with this network address that is connected by the same switch is under the same network.

Network

Two or more hosts are said to be in the same network if they have the same network address and are connected by a **switch**. Hosts that belong to different networks cannot communicate directly with each other unless they are connected by a **router** or a network of routers.

Router

Also called a **gateway**, a router attaches two or more networks and allows a host from one network to communicate to a host in another network.

Routers routes packets from one network to the other until it arrives to its final destination directly across one physical network. This is done by accepting and transmitting IP Packets, aka **IP forwarding**.

A router usually has two (2) **interfaces** where you assign appropriate IP address. In practice, one interface is configured to become part of a local network and the other is configured to be part of the network of routers.

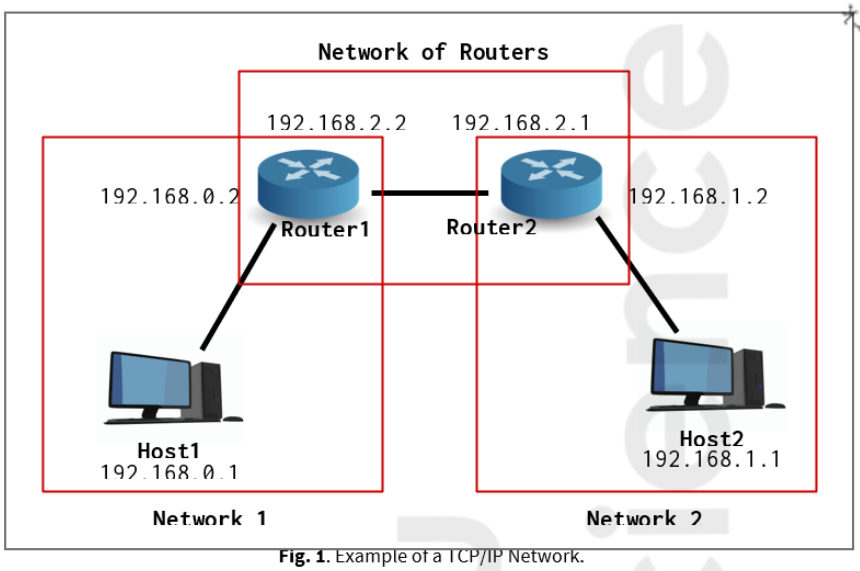


Fig. 1. Example of a TCP/IP Network.

In the figure above, there are three (3) networks present. These networks are the following:

Network 1 (Network Address) → 192.168.0.0,

Network 2 (Network Address) → 192.168.1.0, and

Network 3 (Network Address) → 192.168.2.0.

Routing Table

A router maintains a **routing table** which is used to check where a packet received by the router will be forwarded.

For instance, in the figure above, let us say that **Host1** wants to send a packet to **Host2**. Since the source of the packet is not in the same network as the destination, **Host1** would pass the data to **Router1**. In **Router1**, the routing table will be consulted as to where the packet would be forwarded to. The routing table of **Router1** might look like the one below:

Destination Network	Mask	Gateway
192.168.1.0	255.255.255.0	192.168.2.1

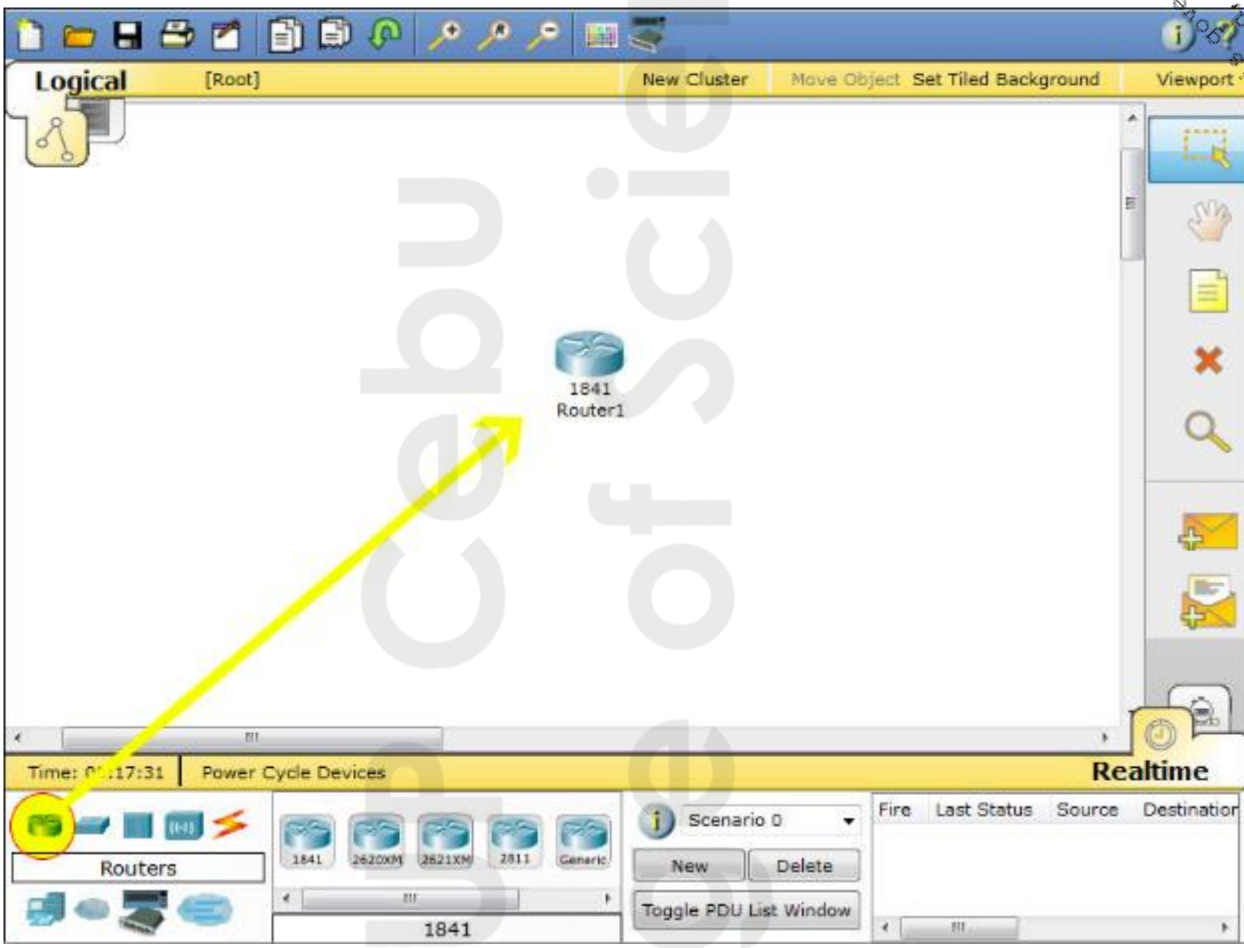
In the routing table, if the network address where the packet will be sent is equal to the addresses on the destination network column, the data will be forwarded to the specified gateway of that address.

For this lab, you will need CISCO Packet Tracer. You may download it here.

How to use CISCO Packet Tracer:

Once you've installed Packet Tracer, one of the first things you're going to want to learn is how to configure a router. However before you start doing that, take 30 minutes to become familiar with the user interface and the various elements you can add to the topological canvas.

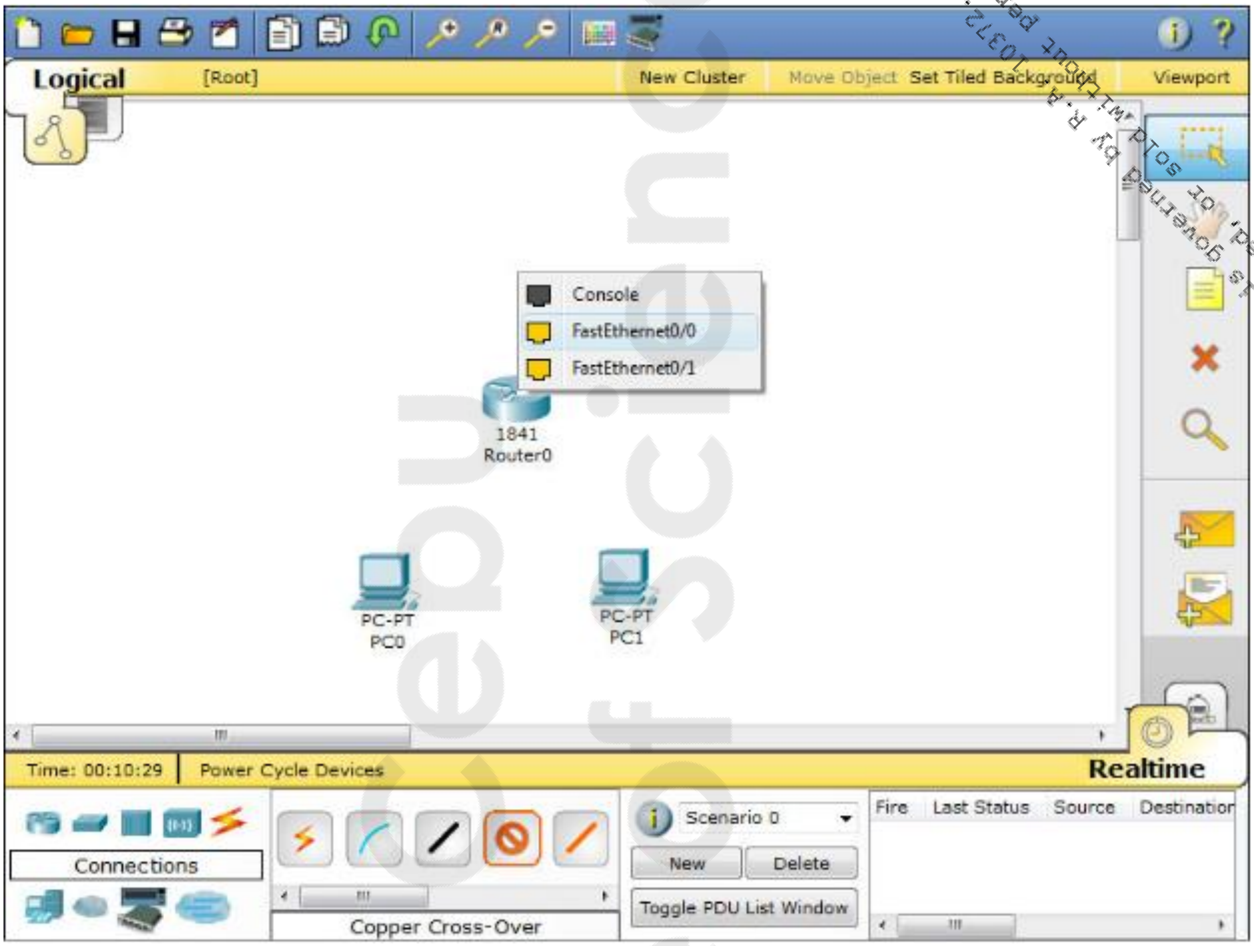
To begin configuring your router open Packet Tracer and select the router from the bottom left-hand corner. Drag the router into the centre of the canvas.



Next we're going to set up a basic network that allows two computers to communicate with each other. Now you need to select **end devices** from the bottom left-hand corner and drag the PC icon into the main canvas.

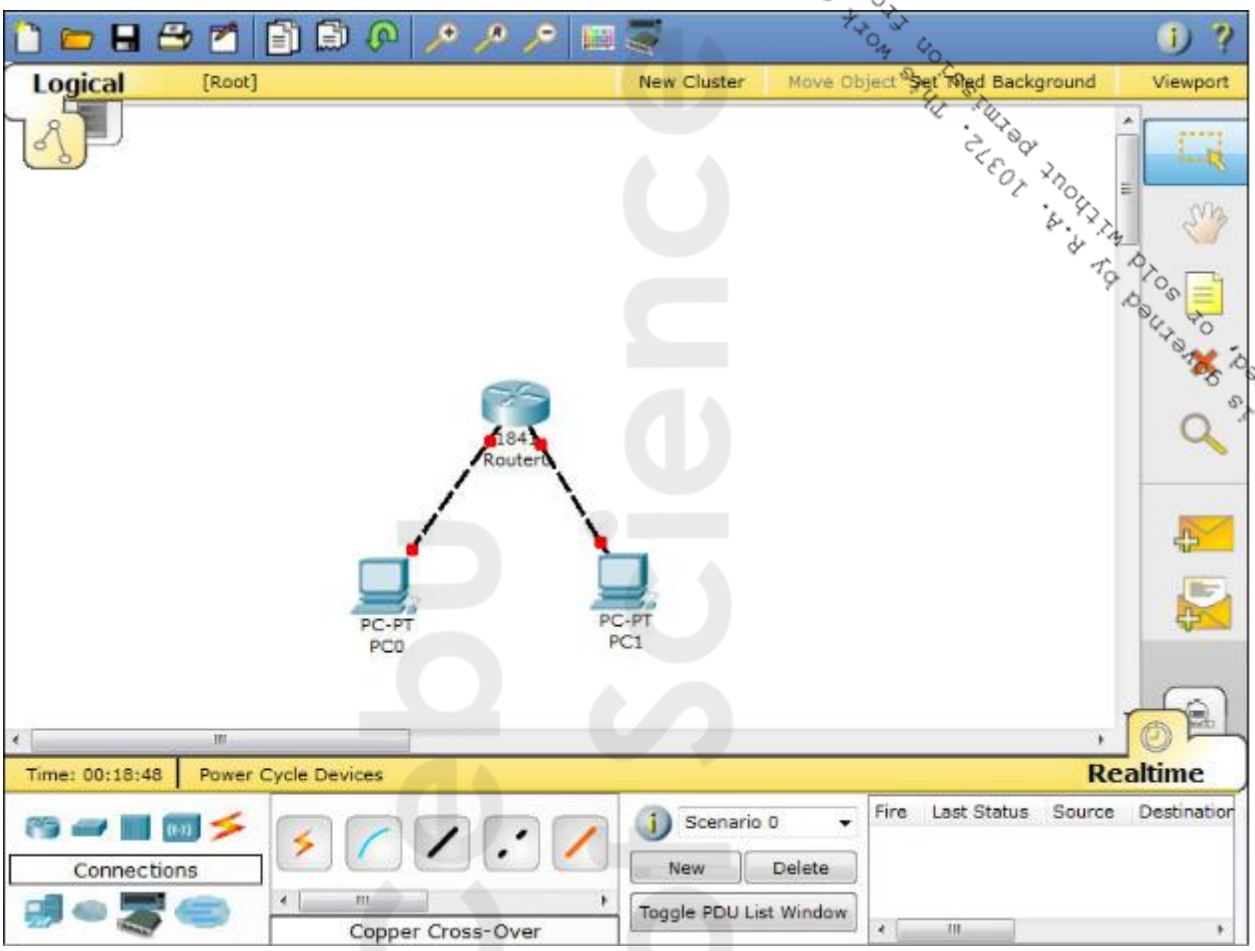
Add two computers and position them below the router on the canvas. At this point, we're going to connect the devices with cables. To connect routers and computers together you need to use a crossover cable.

Select **connections** from the bottom left-hand corner, then go to the second second menu from the right at the bottom of the screen and select **copper cross-over cable**. Now click on *Router0* and connect the cable via *FastEthernet0/0*:



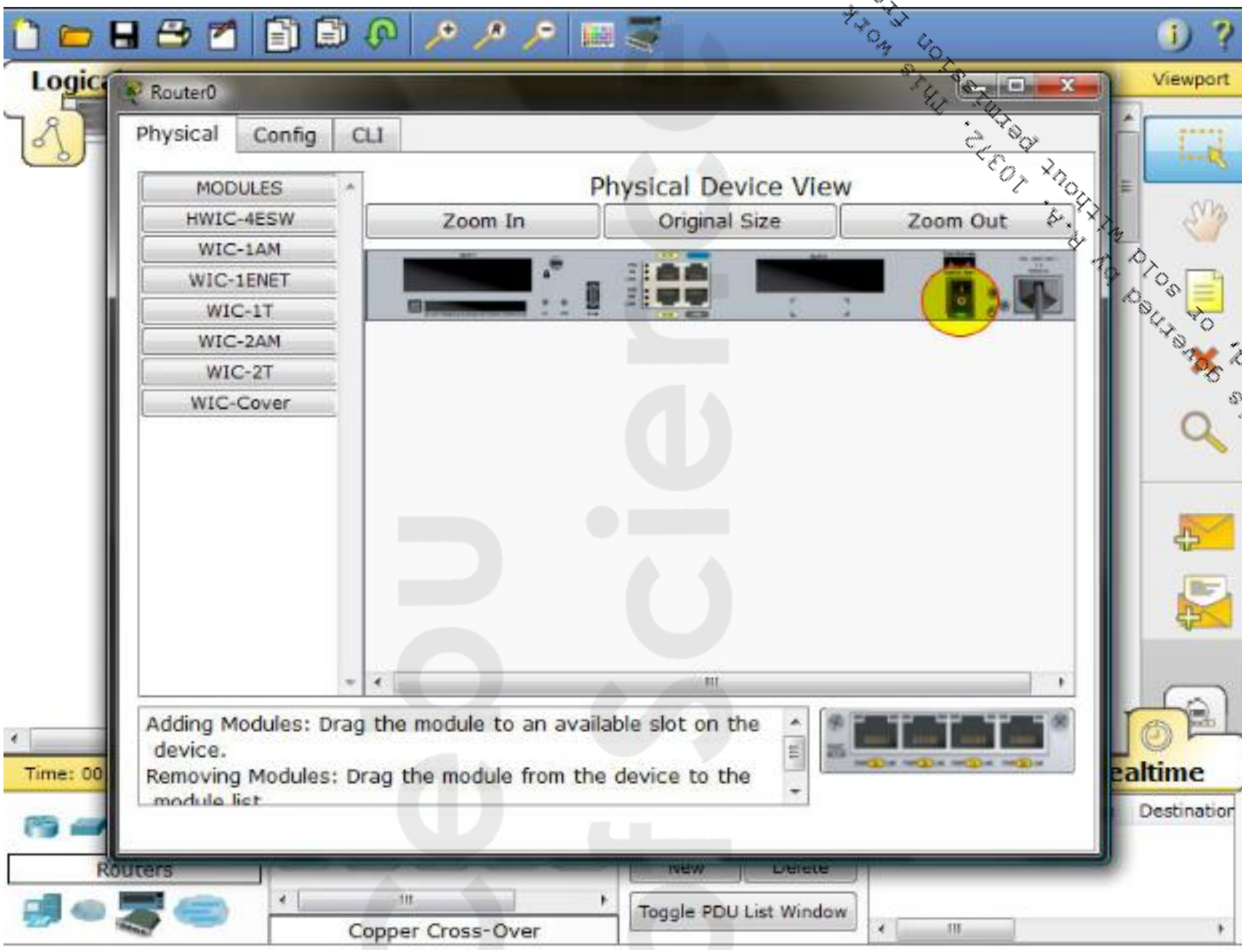
Once you've done this, click *PC0* and select *FastEthernet*. A link will be established between the two devices. However, the link isn't functional yet. You can see this clearly from the red dots on each side of the cable. Once the connection is established successfully the red dots will turn green to show the communication is successful.

Now link *PC1* and connect the cable to *FastEthernet0/1* (Don't try to use *FastEthernet0/0* because it is already being used by *PC0*.) Your network should look like the following image:



CONFIGURING THE ROUTER

At this point, the router still needs be turned on. To setup the router, click on the router icon so that the configuration menu is raised. Here you will need to verify that the router is turned on. If the router is on there will be a small green light below the switch:



The next step is to open Ethernet ports to allow communication. Currently they are physically connected by inactive in a state referred to as administrative **shut down**. Click on the **CLI** tab to raise the configuration menu. The configuration menu acts the same as Cisco IOS:

1. Press **RETURN** to start the session
2. Type **enable** to activate privileged mode (this gives you more options in configuring the router)
3. Type **config terminal** (or **config t** for short) to access the configuration menu.
4. Type interface **fastethernet0/0** to access Ethernet0/0.
5. Type **IP address 192.168.10.1 255.255.255.0** to assign an IP address and subnet mask to the interface.
6. Type **no shutdown** to finish.

After following these steps, you should see the following message:

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Now we have to repeat the process for fastethernet0/1 to activate the connection to PC1. Remember to enter a different IP address!

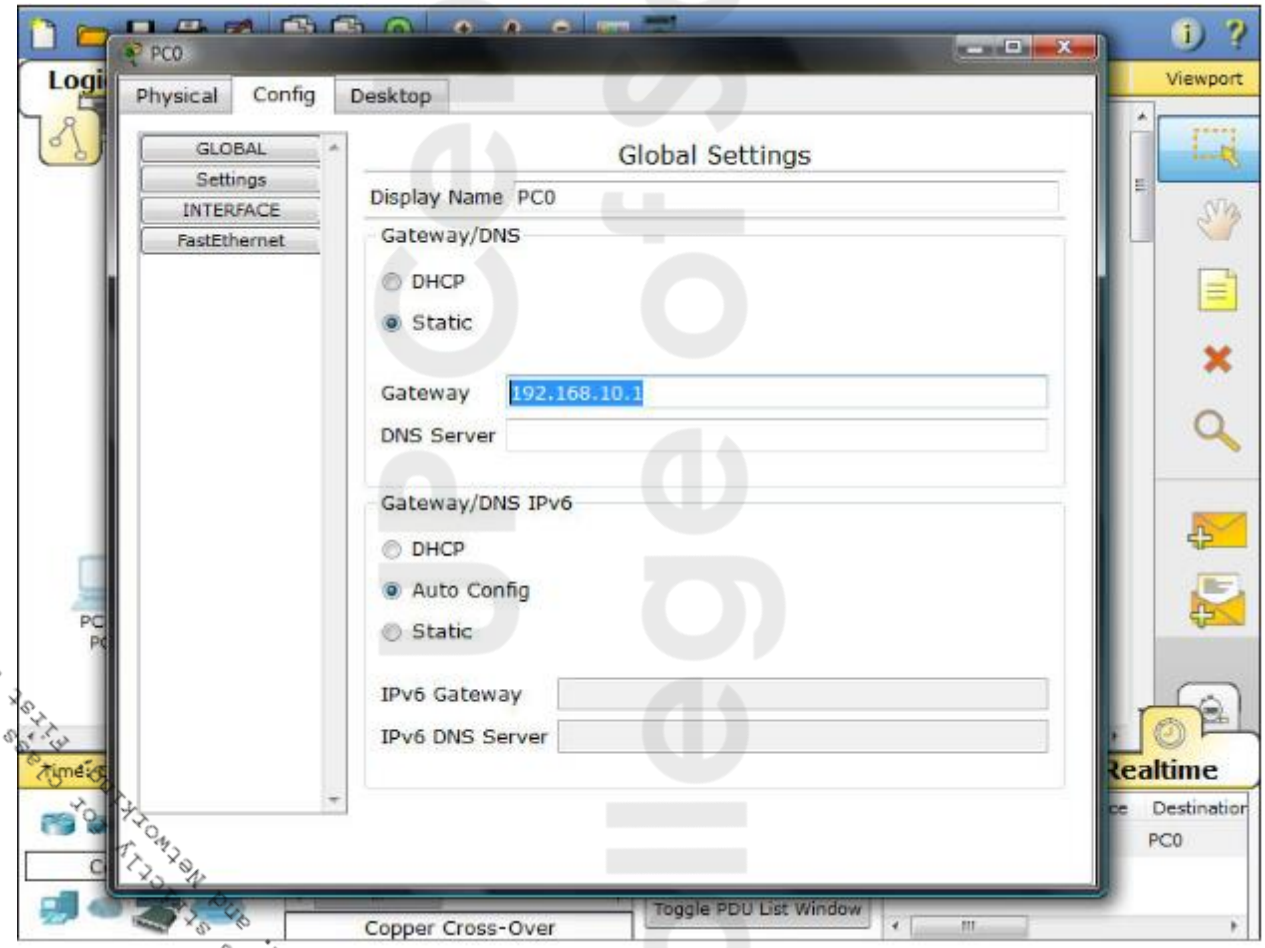
1. Press Ctrl + Z to go back to the previous mode
2. Type interface fastethernet0/1
3. Type IP address 192.168.20.1 255.255.255.0
4. Type no shutdown

Once you have completed these steps, the router is configured! However, if you run a ping test you will find that the computers don't communicate.

CONFIGURE THE GATEWAY IN PACKET TRACER

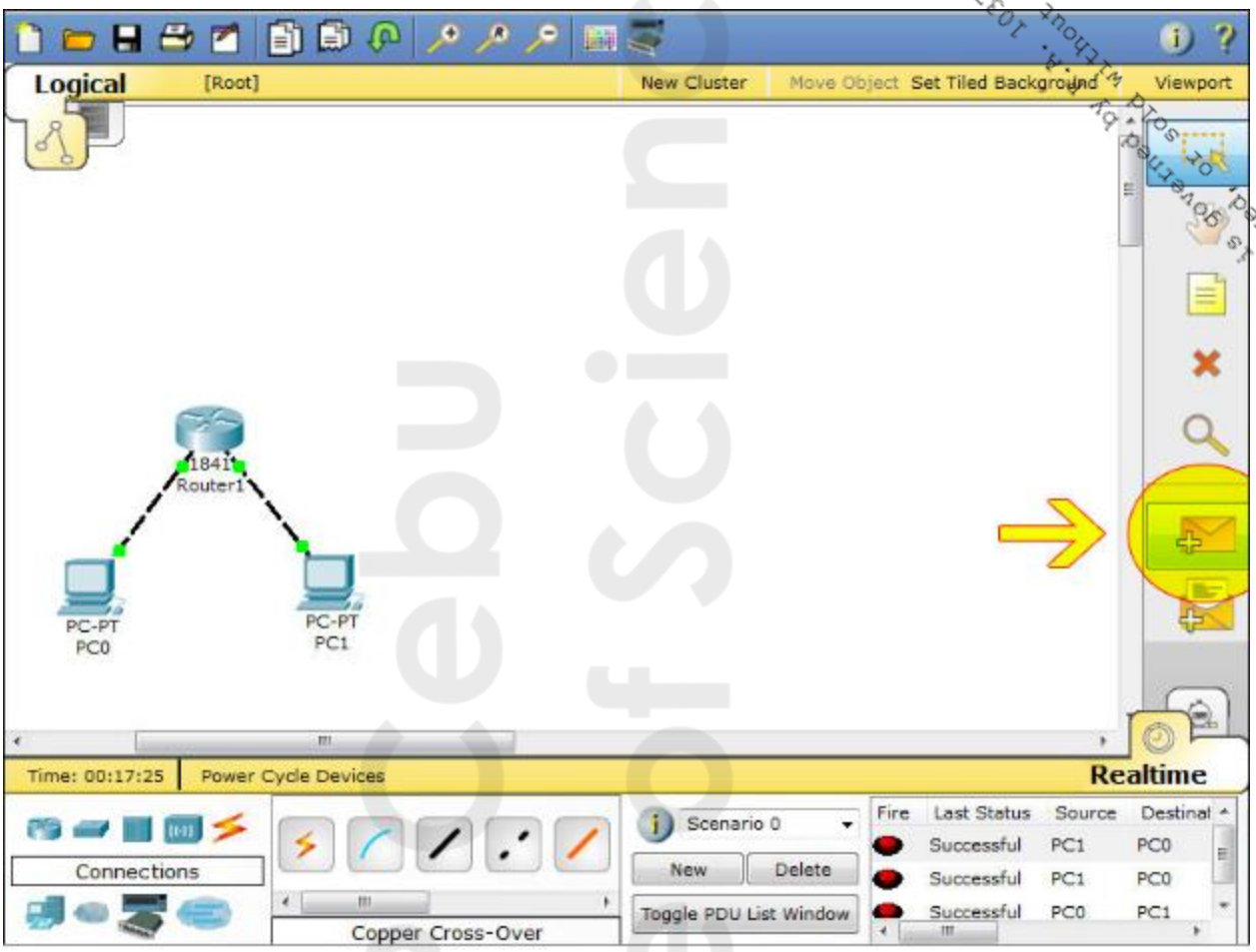
The final step is to configure the gateway on each desktop computer. The gateway is the address assigned to the Ethernet port that the desktop is connected to. The gateway allows the computer to interface with another network, and ping tests won't work without it!

Click on PC0 to view the configuration menu. Go to global sendings and find the gateway field. In the gateway field, enter the IP address of the router's interface, which is 192.168.10.1.
Next click the FastEthernet tab in the left-hand column to set the computer's IP address on the network. Enter 192.168.10.2 for the IP address and 255.255.255.0 for the subnet mask.



Repeat the process for PC1 but use 192.168.20.1 for the gateway address, 192.168.20.2 for the IP address, and 255.255.255.0 for the subnet mask.

To confirm that the network works you can send packets from PC0 to PC1 and PC1 to PC0. To do this you need to click the packet icon (the envelope icon) from the menu on the right hand side of the screen:



Now click on PC0 and PC1. At the bottom right hand of the screen you should see a message box that says “Successful”. If the connection isn’t a success double check the IP address or router configuration commands you entered earlier. Syntax errors can often cause connections to fail.

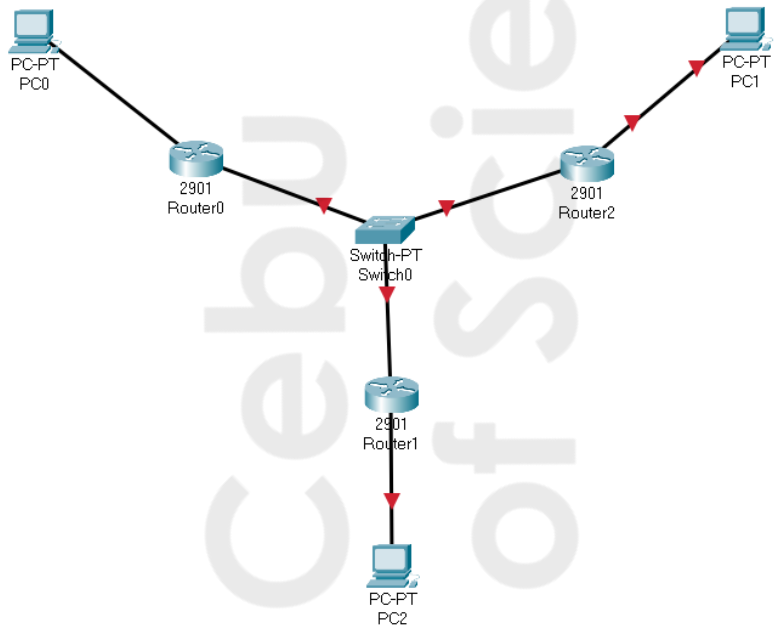
Once you’ve complete all these steps, you will have a functional network. While this is a limited topology with two computers and enterprise networks are considerably more complex, this will help to teach you some basic principles that you can take with you when managing larger networks.

Lab Exercise 3: IP Routing

This exercise will be done individually.

You have three (3) computers belonging to different networks. How can you configure them to be able to access each other?

Your network should look similar to the diagram below:



HINTS:

1. You will use at least three routers (one for each internal network) and one switch (to connect the three routers).
2. Take note that you will need a fourth network for all the routers so that they can communicate with one another.

Save your work as a .pkt file.

References:

[1] Packet Tracer 8.0.0. https://www.computernetworkingnotes.com/ccna-study-guide/download-packet-tracer-for-windows-and-linux.html

[2] IP Addressing. http://www.webopedia.com/DidYouKnow/Internet/IPaddressing.asp

[3] Ultimate Guide to Packet Tracer. https://www.itprc.com/packet-tracers/