Computer

Networking:

The Basics

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Intro to Computer Networking   CH 1

What is a network?

A **network** is an arrangement of computers and systems that are interconnected and working together to enable communication amongst each other. This allows the sharing of data between all of the devices.

An excellent example of a network is what we know as the internet, connecting millions of people around the world. And it grows with the use of technological devices such as phones, computers, etc.

What is the CCNA?

The CCNA (Cisco Certified Network Associate) is an IT Certification from Cisco. The certification test is based on computer networking. It tests someone's knowledge on being able to support and install medium-sized networks. When someone has acquired this certification, it opens up doors to numerous opportunities. These can include internships, jobs, or even a starting a small business of your own.

The Cisco Logo (Famouslogos.us, 2014)

FUN FACT: "Cisco Systems, Inc. ranks as one of the top manufacturers of Network-related equipment. "Cisco" is not an acronym, but it is an abbreviation of San Francisco. It is said by John Morgridge, the 34th employee and the company's first president that the creators of the company thought of this name while making their way to Sacramento for registration of the

company. As they laid their eyes upon the Golden Gate Bridge structured in the sunlight, they decided the name of the company there and then."

Why are computer networks so important?

There are numerous obstacles when it comes to communicating information between people and especially in businesses. To be able to communicate efficiently can result in success, something everyone wants. A solution to this issue is computer networks. Computer networks can manage to put down the barriers between information held on several (not only computer) systems. Only with the help of computer networks can a borderless communication and information environment be built.

Computer networks allow the user to access remote programs and remote databases either of the same organization or from other enterprises or public sources. Computer networks provide communication possibilities faster than other facilities. Because of these optimal information and communication possibilities, computer networks may increase the organizational learning rate, which many authors declare as the only fundamental advantage in competition.

Currently, we are literally surrounded by technology. Computers, phones, laptops, routers, etc. are everywhere now and it is unavoidable. Because this is the case, it allows us to communicate efficiently with friends, family, and associates around the world. We are all interconnected through technology and technology has been proven extremely helpful in our everyday life.

Example of a Computer Network (Pujari, 2014)

Network Devices   CH 2

Hubs

A **hub** is a Layer 1 (Physical Layer) devices that are just multiple port repeaters. They are commonly used to connect segments together in a LAN. A hub is constructed of multiple ports. When a packet is received at one port, it gets copied to all other ports so that all segments of the LAN can see all packets.

Hubs have been primarily replaced by switches. Hubs and switches serve as a central connection for all your network equipment and handles a data type known as frames. Frames carry data. In a hub, a frame is transferred or broadcast to all other ports. It's sent to every port even though it has only one destination. The hub cannot distinguish the port a frame should be sent to. If frames are sent to each port, it will ensure that it will reach its proper destination.

Advantages of using hubs:

- Cost: Less expensive than switches
- Simplicity: They simply broadcast information received, to all ports on the network
- Speed: They do less processing, since they can't analyze received data.

Disadvantages of using hubs:

- The more devices there are, the slower the network becomes.
- Traffic problems and collision problems arise easily, due to the splitting of bandwidth

Fast Switch Hubs (Bombayharbor.com, 2014)

Switches

A **switch** in networking, is a device responsible for multiple functions such as filtering, flooding, and sending frames. It operates by using the destination address of individual frames. Switches operate at the Data Link Layer (Layer 2) of the OSI model. A switch can replace a hub, breaking up *collision domains*.

Advantages of using a switch:

- Packet Handling: Designates specific destinations, preventing collisions for occurring
- Collision Management: Improves performance and efficiency, increasing bandwidth
- Bandwidth Utilization: Enables switches to send and receive data at the same time
- Problem Isolation: Makes it easy to pinpoint a problem and allows normal functionality

Disadvantages of using a switch:

- It can be difficult to install and use
- Often require extensive repair if the network goes down
- If configuration is necessary, it can be complicated

Cisco Catalyst Express 520 Series Switches (Cisco, 2014)

Routers

A **router** is a physical device that connects various networks together. Routers take data/information, decipher it and deliver it to either your computer, phone, or its destination. They enable a quick transfer of information by choosing the best route for the data to be sent. They are also the primary devices used to join networks due to their efficient methods of transferring data. Routers can also be referred to as a gateway, which work at the Network Layer (Layer 3) of the OSI model.

There are many types of routers, but two main ones are broadband routers and wireless routers. A broadband router is "a device that provides access to the Internet for multiple computers. It typically includes a network switch with four or more Ethernet ports for wired connections to desktop and laptop computers." They can be used to connect different computers, two computers to the internet, or even create a phone connection.

A wireless router is a device that acts just like a router, but it includes a wireless access point. It is generally used to access the internet or computer networks and it allows for greater mobility for portable computers and hand held devices.

Some benefits of using a router in your network:

- They don't forward broadcasts by default
- They can filter the network based on Network Layer (Layer 3) information.

Network Routers (Network-guarantee.co.uk, 2014)

Network Models/Ethernet Networking   **CH 3**

The Hierarchical Network Model

This network design is a divided network of discrete layers. The three layer design provides major functional responsibilities that define their role in the network. This design represents their roles in any network and provides a basis for understanding a scalable network.

Access Layer

This layer provides local and remote user access by connecting end users to the network. This occurs with the use of hubs or switches to which PC's are connected, a wireless access point, a remote office connection, etc.

Distribution Layer

This layer helps control the flow in data between the access and care layer. It provides packet filtering, QoS (quality of service), routing and WAN access.

Core Layer

This layer is all about high-speed. Here, usually fast switches transfer data from the distribution layer to centralized resources such as database servers.
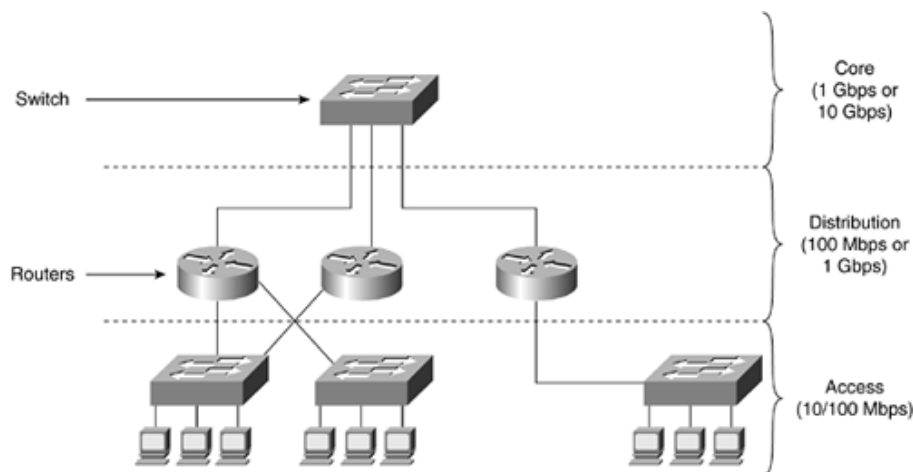
The Hierarchical Network Model- **Distributed Routing and Switching Design** (Etutorials.org, 2014)

Ethernet Cabling

Three types of Ethernet Cables are available:

- Straight-through cable
- Crossover cable
- Rollover cable

Straight-through Cable

The straight-through cable is used to connect:

- A host to switch or hub
- A router to switch or hub

Four wires are used in straight-through cables to connect Ethernet devices. It's quite simple to create this type of cable.

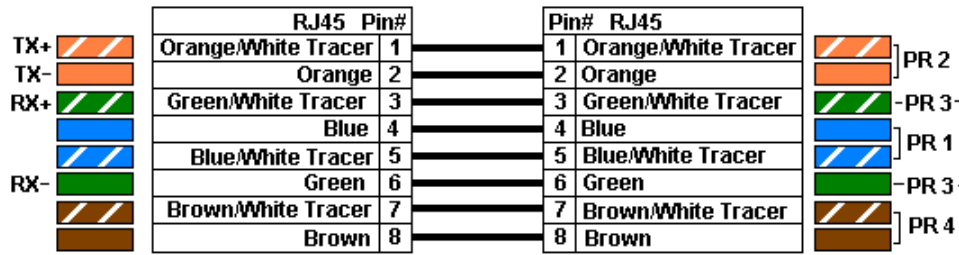**Crossover Cable**

The crossover cable is used to connect:

- Switch to switch
- Hub to hub or switch
- Host to host
- Router direct to host

Rollover Cable

The rollover cable isn't used to connect any Ethernet connections together. It can be used to connect a host to a router console serial connection port. Eight wires are used in this cable to connect serial devices, even though not all eight are used to send information.
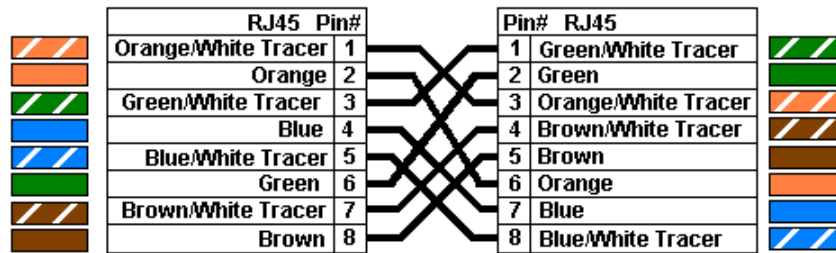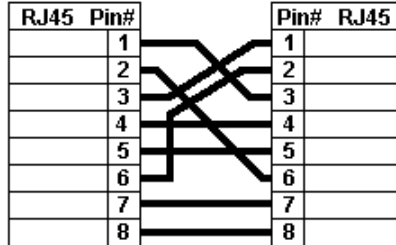
Color Standard
EIA/TIA T568B

Ethernet Patch Cable

RJ45 Pin#		Pin# RJ45	
Orange/White Tracer	1	1	Orange/White Tracer
Orange	2	2	Orange
Green/White Tracer	3	3	Green/White Tracer
Blue	4	4	Blue
Blue/White Tracer	5	5	Blue/White Tracer
Green	6	6	Green
Brown/White Tracer	7	7	Brown/White Tracer
Brown	8	8	Brown

TX+
TX−
RX+

RX−

PR 2
PR 3
PR 1
PR 3
PR 4

Color Standard
EIA/TIA T568B

Ethernet Crossover Cable

RJ45 Pin#		Pin# RJ45	
Orange/White Tracer	1	1	Green/White Tracer
Orange	2	2	Green
Green/White Tracer	3	3	Orange/White Tracer
Blue	4	4	Brown/White Tracer
Blue/White Tracer	5	5	Brown
Green	6	6	Orange
Brown/White Tracer	7	7	Blue
Brown	8	8	Blue/White Tracer

"B" is most recent

Common Ethernet Crossover Cables may only
cross connect the Orange & Green pairs

2006.06.28

RJ45 Pin#	Pin# RJ45
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8

B&B MODELS:
C5UMB3FOR-CROSS
C5UMB7FOR-CROSS

Pins #4 & #5 and #7 & #8 connect without
crossing for PoE devices using these for
Power Over Ethernet

Ethernet Cables Color Standard (Bb-elec.com, 2014)

## Color Standard for Ethernet Patch Cables

This is the standard color charts of a straight-through and crossover cable. This diagram is used when creating these cables. To make this cable, you will need CAT-5, non-plenum Ethernet wire, RJ-45 (Ethernet) male connectors, wire cutters, and a crimping tool for RJ-45 connection.

# How to Make an Ethernet Cable   CH 4

First, we need tools! The tools/items you need to make an Ethernet cable is a CAT-5, non-plenum Ethernet wire, RJ-45 (Ethernet) male connectors, scissors, measuring tape, wire cutters, and a crimping tool for RJ-45 connection. Once we have all these things we can get started. It's actually quite simple and once you get the hang of it you can do it in 2 minutes or even less!

1. Take the CAT-5 Ethernet wire and measure the length you need it to be using the measuring tape. It could be 5 feet or 20 feet. It all depends on the distance between the two devices you plan on connecting. So you measure the amount you need with a little extra just in case then with the pair of scissors cut it at that end of measurement.

2. Now you're going to take the crimper and it also has two blades part of the tool just for removing the outer jacket of the cable. One of the blades are adjustable because cable sizes can change. To cut the outer jacket you can turn the tool with the razors about twice and that should be enough. You don't want to cut the wires that are inside. Cut into the plastic sheath about **1 inch** (2.5 cm) from the end of the cut cable. Then remove the plastic.
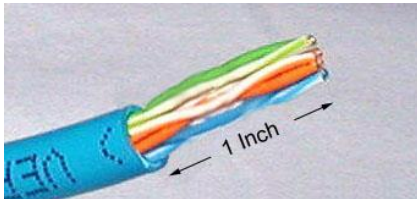
Stripped Ethernet cable (Groundcontrol.com, 2014)

3. Inspect the wires for any cuts or scrapes. If there are cuts or scrapes on any wire you need to cut that whole part off and redo the first two steps. This is why you add a little extra length to the wire.

4. Untwist the pairs and straighten them out using your fingers. The white piece of thread you'll see can be cut off even with the jacket and disposed.
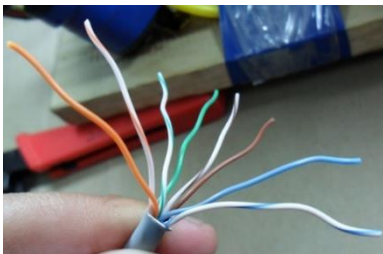
Untwisted Cable Pairs (Cable, 2014)

5. Arrange the wires based on the wiring specifications you are following. There are two methods set by the TIA, 568A and 568B. Which one you use will depend on what is being connected. The difference between the two is that a straight-through cable has both ends wired identically with 568B, while a cross-over cable has one end wired 568A and the other end wired 568B.

    -Using the chart above, you'll arrange the wires of 568B in the following order, left to right as: White Orange, Orange, White Green, Blue, White blue, Green, White Brown, Brown.

    -You'll arrange the wires of 568A in the following order, left to right as: White Green, Green, White Orange, Blue, White Blue, Orange, White Brown, Brown.

6. Straighten out all the wires and pinch them between your fingers. Verify that all the colors remain in the right order. Use scissors to make a straight cut across the wires 1/2 Inch (1.3 cm) from the cut sleeve to the end of the wires.

Cut Untwisted Cable (Groundcontrol.com, 2014)

7. Keep the wires flat and in order as you push them into the RJ-45 plug with the flat surface of the plug on top. The white/orange wire should be on the left if you're looking down at the jack. You can tell if all the wires made it into the jack and maintain their positions by looking head-on at the plug. You should be able to see a wire located in each hole, as seen at the bottom right. You may have to use a little effort to push the pairs firmly into the plug. The cabling jacket should also enter the rear of the jack about 1/4" (6 mm) to help secure the cable once the plug is crimped. You may need to stretch the
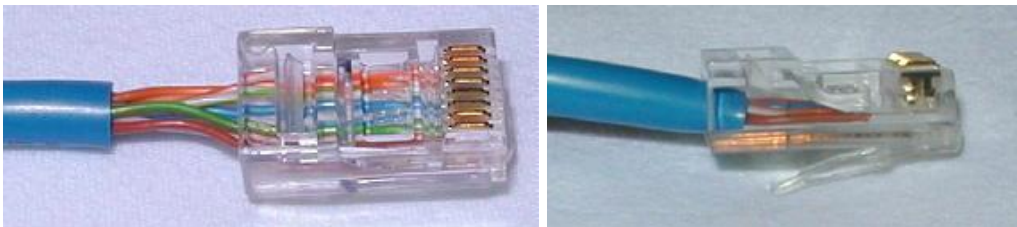
sleeve to the proper length. Verify that the sequence is still correct before crimping.
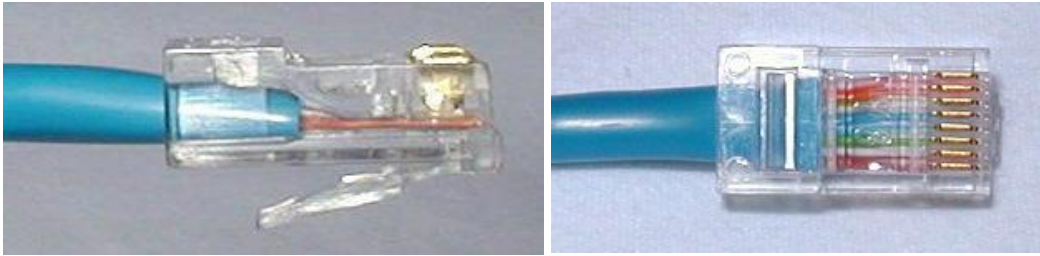
Properly Crimped Cable (Groundcontrol.com, 2014)

These images show what the correct way looks like.

Improper Crimped Cable (Groundcontrol.com, 2014)

These images above is what it should **NOT** look like. In the picture on the left the wires are too long and the Blue plastic sleeve isn't in the connector where it would be locked in place. On the right, the cables did not reach the front on the connector.

8. Place the wired plug into the crimping tool carefully. Get a good handle, give a firm squeeze and you should hear a ratcheting noise as you continue. Once you have completed the crimping correctly, the crimper will reset to an open position. If not, it will stay closed until the connector was crimped correctly.

Crimper (Groundcontrol.com, 2014)

9. Repeat all of the steps above at the other end of the wire. The way you wire the other end (568A or 568B) will depend on whether you're making a straight-through, rollover, or cross-over cable.

10. Make sure to test the cables before installing them. An inexpensive Ethernet cable tester does this quite well.

Cable Tester (Cable, 2014)

Let's Build a Network!   CH 5

Now that we know the basic foundation of a network, we can use our new information by actually building one! There's a program called packet tracer created by Cisco that enables people to create all types of technological scenarios and simulations without physically having the tools needed.

What is Packet Tracer?

Packet Tracer is a program created by Cisco that enables people to create all types of technological scenarios and simulations without physically having the tools needed. With this program there's an unlimited number of devices, room for discovery, troubleshooting, you name it! It also enables students to work on and improve their critical thinking skills, creativity, problem solving, etc. Teachers can use this program to help demonstrate understanding to their students easily.

Building the Network

We are going to create a basic LAN (Local Area Network). A LAN is network that spans a relatively small area. It's comprised of computers communicating with each other in a home, school, building, etc.

First you should google "Cisco Packet Tracer". Then the link to download this software should be the first link that shows up. Best part about it is that it's totally free!

Let's get started!

When you download the program and open it, it'll look like:
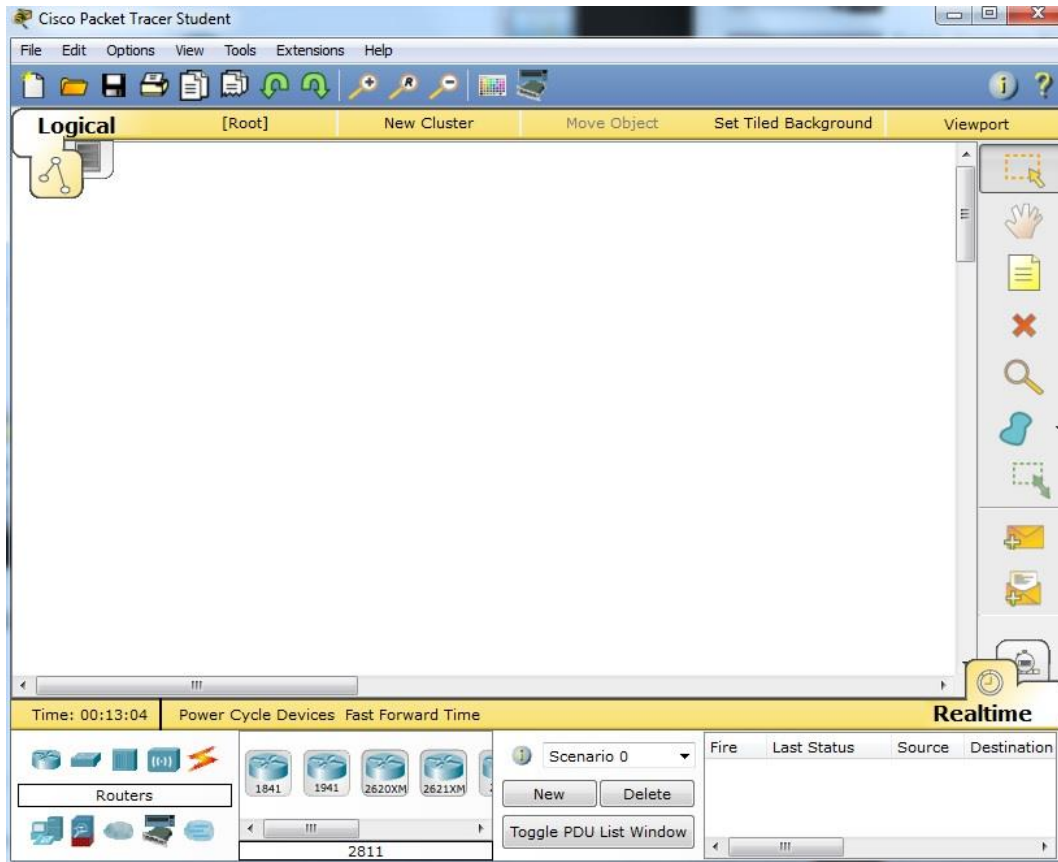
(Richard, 2014)

The simple LAN network we're creating is going to be made up of one router, one switch, and two PC's.

To connect the router to the switch we can use a straight through cable. To connect the PC's to the switch we will also use a straight through cable. As you have read earlier in the book, the straight through cable is used to connect unlike devices.
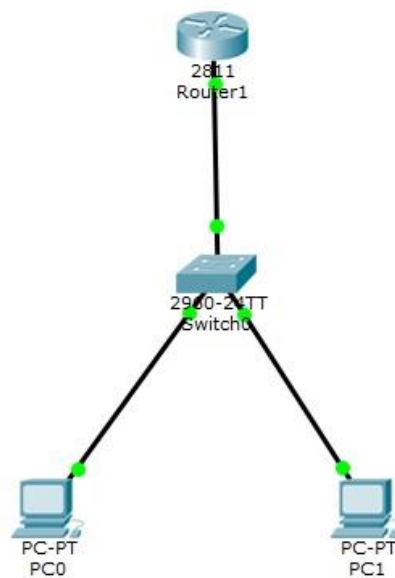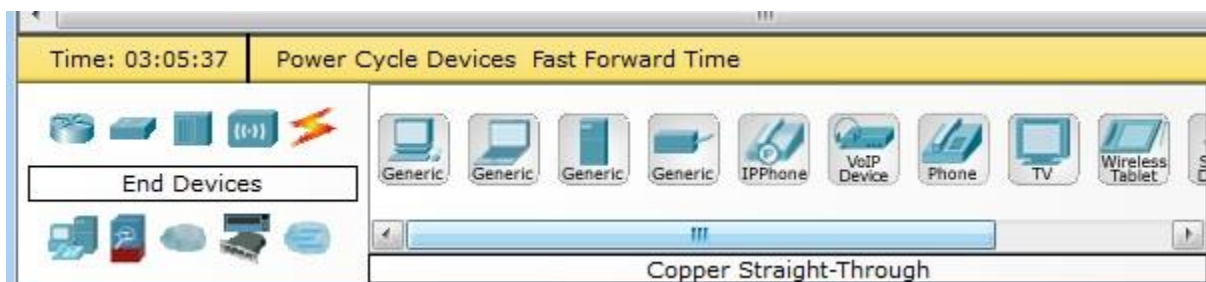
(Richard, 2014)

So what you do is press the router icon and drag the (2811) router onto the blank space. Then click on the switches icon and drag the (Generic) switch a little below the router. Then you'll select the end devices icon and choose the first Generic PC and drag it to the left under the switch. Do the same thing again, but the second PC will be below and to the right of the switch. Next, click on the Cables icon and select straight through cable and press the router, select "Fast Ethernet 0/0" then select the switch and press "Fast Ethernet 0/24". You'll do the same process when connecting the PC's to the switch. It should then look like this:

(Richard, 2014)

(Richard, 2014)
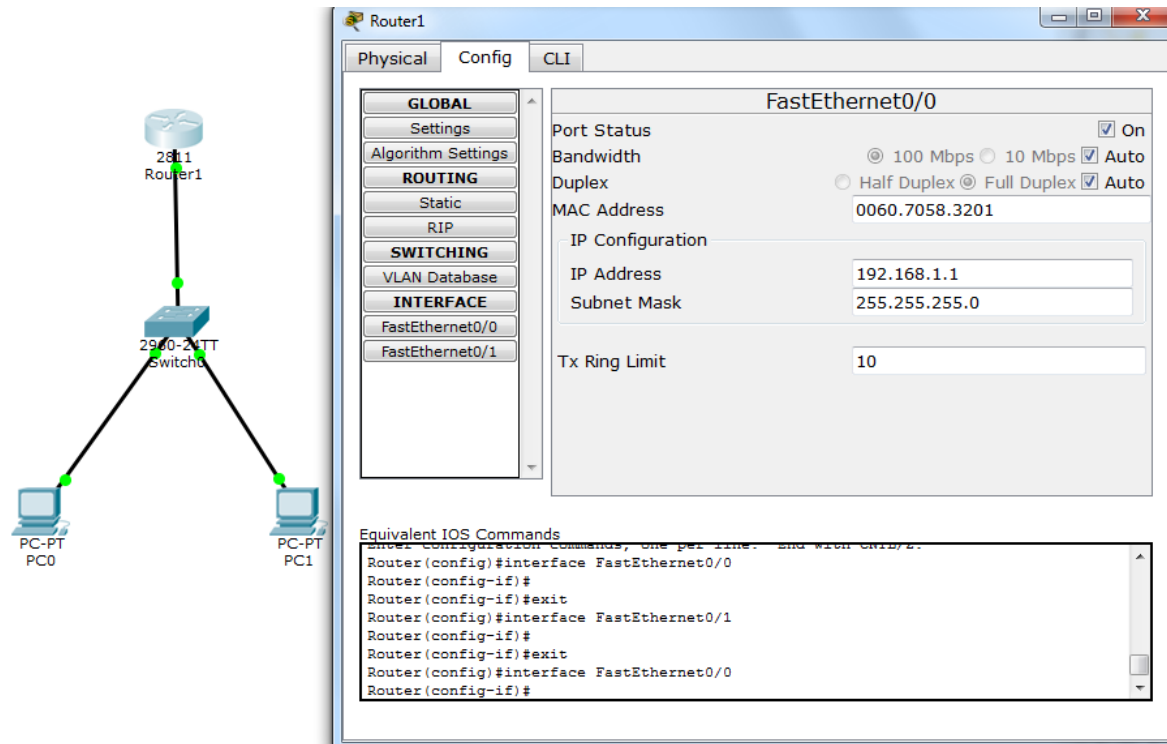
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Now that we have created the physical aspect of the network we need to assign an IP address and subnet mask to the router. And assign an **IP address**, **subnet mask**, and **default gateway** to the two PC's.

So on router 1 type:

IP address: 192.168.1.1

Subnet mask: 255.255.255.0

(Richard, 2014)
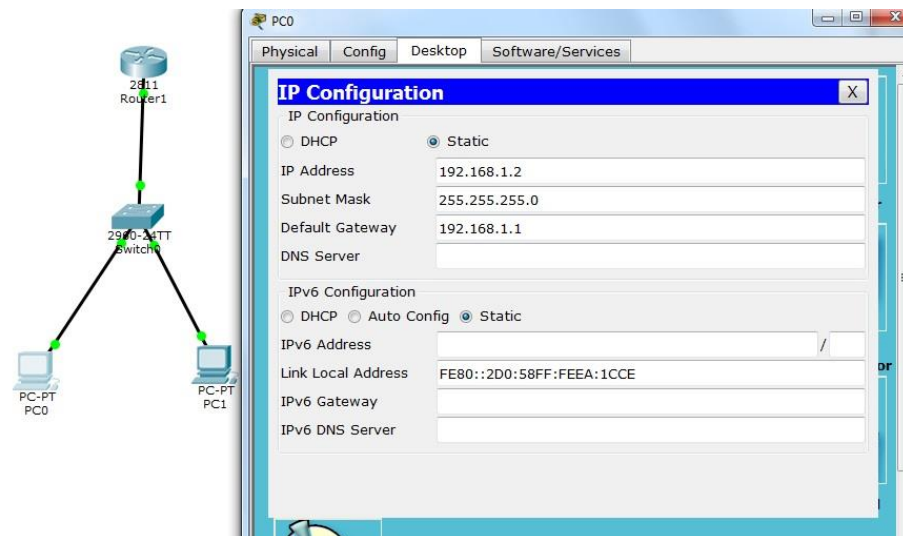
On PC 0:

IP address: 192.168.1.2

Subnet mask: 255.255.255.0
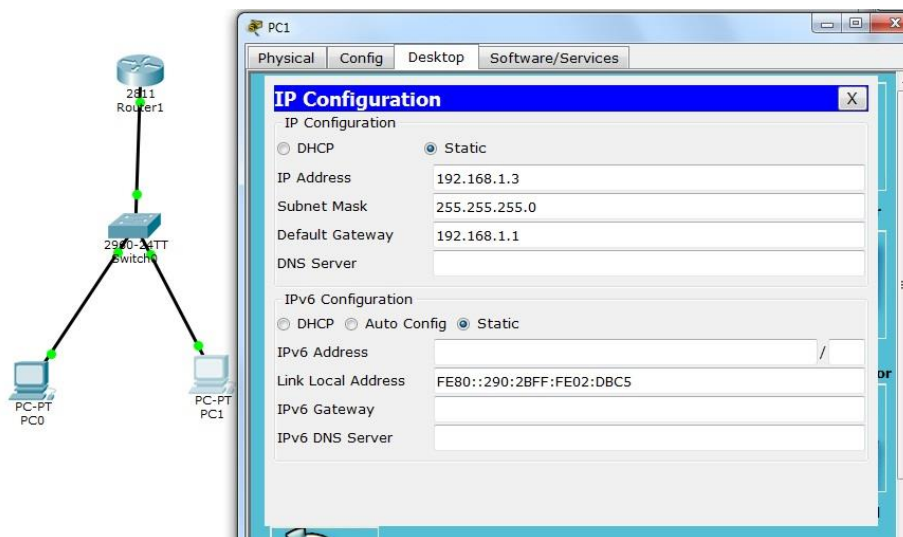
Default gateway: 192.168.1.1

(Richard, 2014)

On PC 1:

IP address: 192.168.1.3

Subnet mask: 255.255.255.0

Default gateway: 192.168.1.1

(Richard, 2014)

There are two ways to assign these things to a router. The first way is the easy way. Clicking on the router, going to the config tab, pressing Fast Ethernet fa0/0, pressing ports on, and manually putting in the up address and the subnet mask.

The second way is to go into CLI tab and type:

Router> enable

Router# config t

Router(config)# int fa0/0

Router(config-if)# **ip address** *ip-address mask*

Also to give a name or **hostname** to the router the command is:

```
Router1>ena
Router1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router1(config)#hostname NewYork
NewYork(config)#
```

(Richard, 2014)

You can name the router anything you'd like. It can be called Router1, Cupcakes, Chicago Bulls, whatever you'd like it to be. If you're in a classroom setting it can be a bit more fun if the names were interesting. But if you're doing a professional presentation you might want to keep it professional.

Vocabulary to know   **CH 6**

Network – A collection of computers, printers, routers, switches, and other devices that can communicate with each other over some transmission medium. (Odom, 2004)

Hub - a hub may include a group of modem cards for dial-in users, a gateway card for connections to a local area network (for example, an Ethernet or a token ring), and a connection to a line (the main line in this example). (Rouse, 2014)

Switch - In networks, a device that filters and forwards packets between LAN segments. Switches operate at the data link layer (layer 2) and sometimes the network layer (layer 3) of the OSI Reference Model and therefore support any packet protocol. LANs that use switches to join segments are called switched LANs or, in the case of Ethernet networks, switched Ethernet LANs. (Webopedia.com, 2014)

Router - Routers are small physical devices that join multiple networks together. Technically, a router is a Layer 3 gateway device, meaning that it connects two or more networks and that the router operates at the network layer of the OSI model. By maintaining configuration information in a piece of storage called the routing table, wired or wireless routers also have the ability to filter traffic, either incoming or outgoing, based on the IP addresses of senders and receivers. (Mitchell, 2014)

IP address - An IP address is a binary number that uniquely identifies computers and other devices on a TCP/IP network. An IP address can be private - for use on a local area network (LAN) - or public - for use on the Internet or other wide area network (WAN). IP addresses can be determined statically (assigned to a computer by a system administrator) or dynamically (assigned by another device on the network on demand). (Mitchell, 2014)

Subnet Mask - A subnet mask neither works like an IP address, nor does it exist independently from them. Instead, subnet masks accompany an IP address and the two values work together. Applying the subnet mask to an IP address splits the address into two parts, an "extended network address" and a host address.

For a subnet mask to be valid, its leftmost bits must be set to '1'. For example,

00000000 00000000 00000000 00000000 is an invalid subnet mask because the leftmost bit is set to '0'.

Conversely, the rightmost bits in a valid subnet mask must be set to '0', not '1'. Therefore,

11111111 11111111 11111111 11111111 is invalid. (Mitchell, 2014)

Default Gateway - In computer networking, a default gateway is the device that passes traffic from the local subnet to devices on other subnets. The default gateway often connects a local network to the Internet, although internal gateways for local networks also exist. (Mitchell, 2014)

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