

Networking

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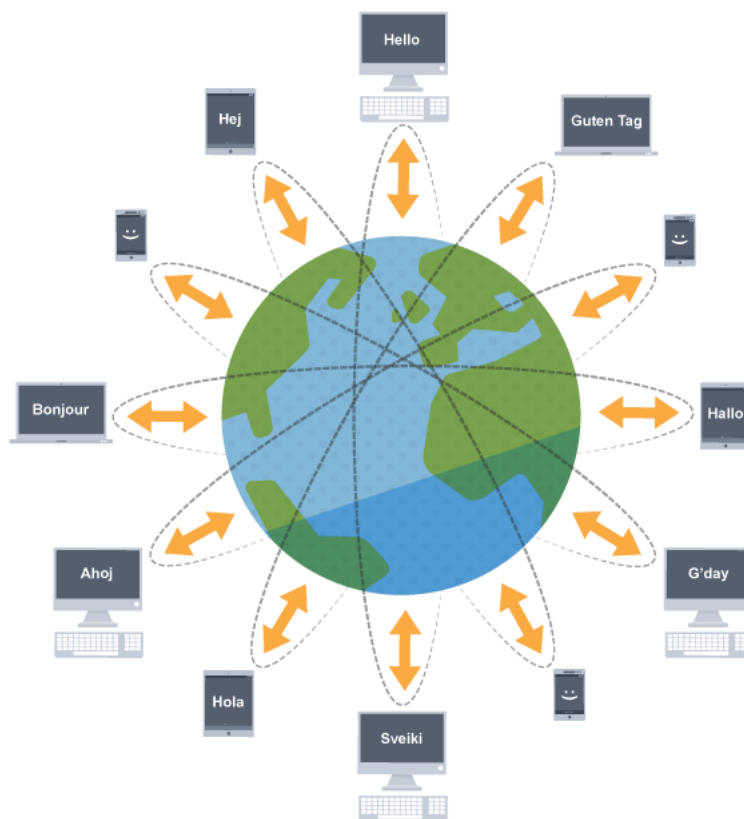
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1 What it is

A network is two or more *computers* (or other electronic devices) that are **connected** together, usually by cables(guided) or Wi-Fi(unguided).

2 benefits of a network

1. sharing hardware, such as printers, computers, phones, tablets, scanners, etc...¹
2. sharing software, allowing:
 - multiple users to run the same programs on different computers
 - data to be shared, so that other people can access shared work
 - you to access your data from any computer on the network



¹All these pieces of hardware are usually addressed as **endpoints** as long as they have the ability to communicate effectively within a network

Networking is crucial if you want to use your computer to communicate. Without it you couldn't send an email, a text or an instant message and that would be so bad.

We use a huge network on a daily basis and this is called the internet. Around three billion people use the internet to share data, news and resources, amongst many other things.

2.1 guided wiring

Is quicker than unguided, it consists in physical wires. Optic Fiber is on the top of this list but can't be twisted. You can install a optic cable for a much longer distance and you won't get the same troubles you would get with copper cables for example

2.2 unguided wiring

This is Wi-Fi essentially. You can have a 2.4Ghz signal to reach longer distance but won't be nicely matched with a 5Ghz device

3 LAN vs WAN

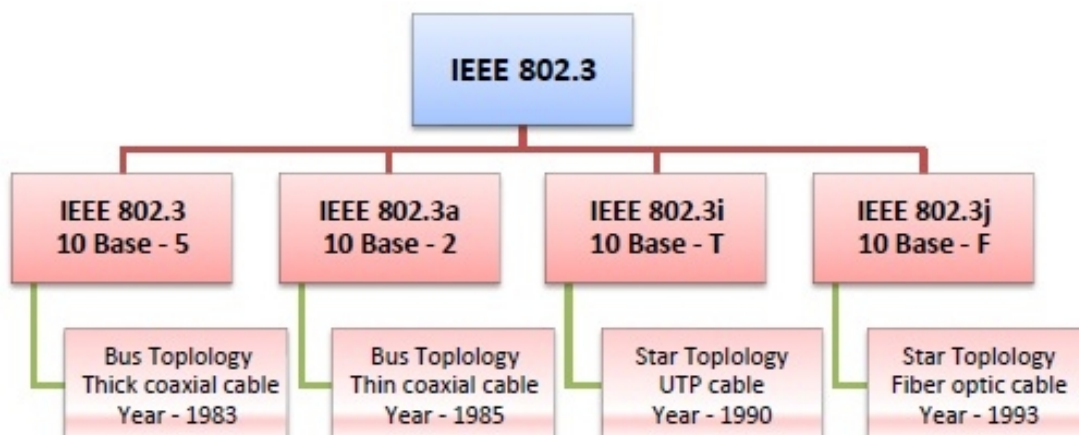
LAN, which stands for local area network, and WAN, which stands for wide area network, are two types of networks that allow connection between computers. As the naming conventions suggest, LANs are for smaller, more localized networking — in a home, business, school, etc. — while WANs cover larger areas, such as cities, and even allow computers in different nations to connect. LANs are typically faster and more secure than WANs, but WANs enable more widespread connectivity

4 IEEE 802.3

IEEE 802.3 is a set of standards and protocols that define Ethernet-based networks. Ethernet technologies are primarily used in LANs, though they can also be used in WANs as well. IEEE 802.3 defines the physical layer and the medium access control (MAC) sub-layer of the data link layer for wired Ethernet networks.

IEEE 802.3 Popular Versions There are a number of versions of IEEE 802.3 protocol. The most popular ones are.

- **IEEE 802.3:** This was the original standard given for 10BASE-5. It used a thick single coaxial cable into which a connection can be tapped by drilling into the cable to the core. Here, 10 is the maximum throughput, i.e. 10 Mbps, BASE denoted use of baseband transmission, and 5 refers to the maximum segment length of 500m
- **IEEE 802.3a:** This gave the standard for thin coax (10BASE-2), which is a thinner variety where the segments of coaxial cables are connected by BNC connectors. The 2 refers to the maximum segment length of about 200m (185m to be precise)
- **IEEE 802.3i:** This gave the standard for twisted pair (10BASE-T) that uses unshielded twisted pair (UTP) copper wires as physical layer medium. The further variations were given by IEEE 802.3u for 100BASE-TX, 100BASE-T4 and 100BASE-FX
- **IEEE 802.3j:** This gave the standard for Ethernet over Fiber (10BASE-F) that uses fiber optic cables as medium of transmission



5 Protocols

Protocols are kind of rules defined in advance to make sure two or more devices know in advance what to expect if they send a particular message and what to expect in return

5.1 OSI standard

The Open Systems Interconnection (OSI) model describes seven layers that computer systems use to communicate over a network. It was the first standard model for network communications, adopted by all major computer and telecommunication companies in the early 1980s

7	Application Layer	Human-computer interaction layer, where applications can access the network services
6	Presentation Layer	Ensures that data is in a usable format and is where data encryption occurs
5	Session Layer	Maintains connections and is responsible for controlling ports and sessions
4	Transport Layer	Transmits data using transmission protocols including TCP and UDP
3	Network Layer	Decides which physical path the data will take
2	Data Link Layer	Defines the format of data on the network
1	Physical Layer	Transmits raw bit stream over the physical medium

The modern Internet is not based on OSI, but on the simpler TCP/IP model. However, the OSI 7-layer model is still widely used, as it helps visualize and communicate how networks operate, and helps isolate and troubleshoot networking problems.

OSI was introduced in 1983 by representatives of the major computer and telecom companies, and was adopted by ISO as an international standard in 1984.

5.2 good mnemonic for OSI

Every layer of the OSI model can be remembered with the mnemonic : Please Do Not Throw Sausage and Pizza Away

5.3 theory vs practice

Even if The Transmission Control Protocol/Internet Protocol (TCP/IP) model came before the Open Systems Interconnection (OSI) model it is what is used in practice today, and it has only five layers:

- Application layer
- Transport layer
- Network access layer
- Network interface layer
- Hardware layer

This may look drastically different from the OSI model, primarily because some functions are encompassed in a single layer: the application layer. In TCP/IP, this provides users with the physical standards, transport functions, network interface, and internetworking functions that correspond with the first three layers of the OSI model. In other words, in the TCP/IP model, these services are all done in the application layer.

TCP/IP is connection and connectionless

5.4 horizontal vs vertical approach

There's a debate on which one is vertical and which is horizontal so that point won't be discussed in this documents

6 ARP/RARP/DHCP

Address Resolution Protocol translates MAC addresses into IPs so that from the network layer we can communicate over the internet with IPs while RARP demands another computer (usually a server) to assign the demanding one with an IP which is essentially what DHCP is doing that's why RARP got obsolete

6.1 ARP Tables

These are used from every component in a network to know which MAC address the packet needs to point at. On this machine for example all it needs to know is which is the MAC address of the gateway, and the TV who's connected in the same WiFi

```
_gateway (192.168.0.1) at 24:a7:dc:31:5b:d1 [ether] on wlp3s0
TV (192.168.0.129) at cc:d3:c1:64:f9:f3 [ether] on wlp3s0
```

6.2 Three-way-handshake

This is when the client sends the ARP request to the server. The server does an acknowledgment and answers with an ARP reply saying both its MAC and its IP. It all happens like this :

When Computer 1 wants to talk to Computer 2 in a local area network by Ethernet cables and network switches, with no intervening gateways or routers. Computer 1 has a packet to send to Computer 2. Through DNS, it determines that Computer 2 has the IP address 192.168.0.55.

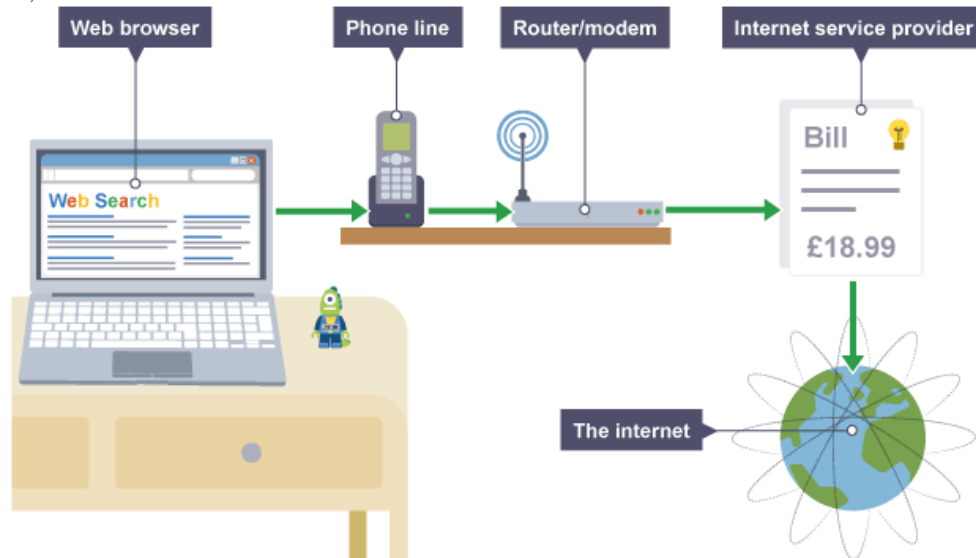
To send the message, it also requires Computer 2's MAC address. First, Computer 1 uses a cached ARP table to look up 192.168.0.55 for any existing records of Computer 2's MAC address (00:EB:24:B2:05:AC). If the MAC address is found, it sends an Ethernet frame containing the IP packet onto the link with the destination address 00:EB:24:B2:05:AC. If the cache did not produce a result for 192.168.0.55, Computer 1 has to send a broadcast ARP request message (destination FF:FF:FF:FF:FF:FF MAC address), which is accepted by all computers on the local network, requesting an answer for 192.168.0.55.

Computer 2 responds with an ARP response message containing its MAC and IP addresses. As part of fielding the request, Computer 2 may insert an entry for Computer 1 into its ARP table for future use.

Computer 1 receives and caches the response information in its ARP table and can now send the packet

7 Networking Hardware

Computers need networking hardware in order to connect to each other. **Routers, hubs, switches** and **bridges** are all pieces of networking equipment that can perform slightly different tasks. A router can often incorporate hubs, switches and wireless access within the same hardware



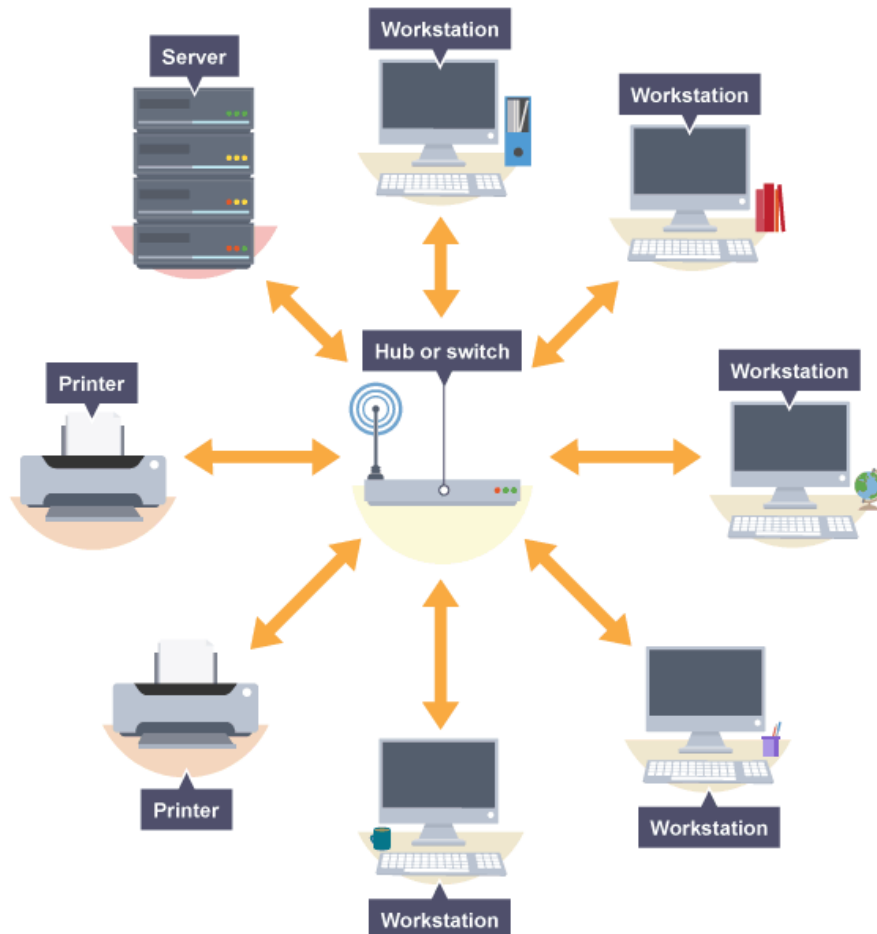
7.1 Routers

A router can form a **LAN** by connecting devices within a building. It also makes it possible to connect different networks together. Homes and businesses use a router to connect to the internet. A router can often incorporate a modem within the hardware.

7.2 Modems

A **modem** enables a computer to connect to the internet over a telephone line. A modem converts **digital** signals from a computer to analogue signals that are then sent down the telephone line. A modem on the other end converts the analogue signal back to a digital signal which another computer can understand.

7.3 Hubs, bridges and switches



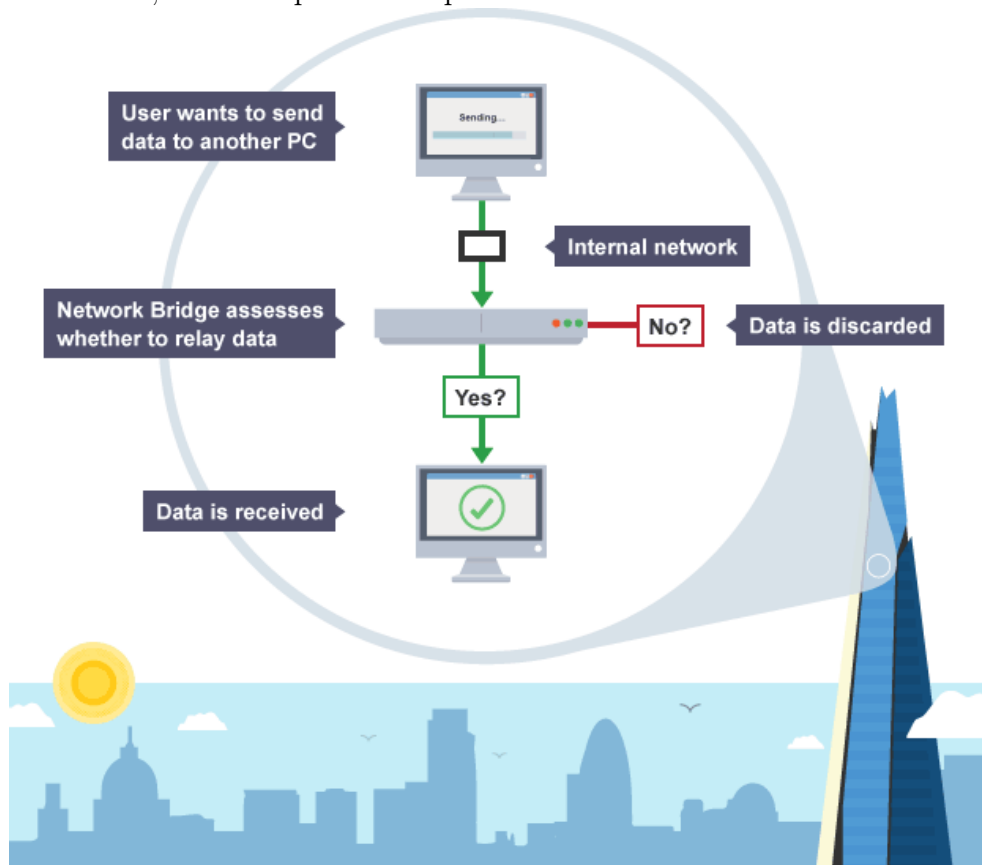
Hubs, bridges and switches allow multiple devices to connect to the router and they transfer data to all devices on a network. A router is a more complex device that usually includes the capability of hubs, bridges and switches.

7.3.1 Hubs

A hub broadcasts data to all devices on a network. This can use a lot of **bandwidth** as it results in unnecessary data being sent - not all computers might need to receive the data. A hub would be useful to link up a few games consoles for a local multiplayer game using a wired LAN.

7.3.2 Bridges

A **bridge** is used to connect two separate LAN networks. A computer can act as a bridge through the **operating system**. A bridge looks for the receiving device before it sends the message. This means that it will not send a message if the receiving computer is not there. It will check to see if the receiver has already had the message. This can help save unnecessary data transfers, which improves the performance of a network.



7.3.3 Switches

A **switch** performs a similar role to a hub and a bridge but is more powerful. It stores the **MAC addresses** of devices on a network and filters **data packets** to see which devices have asked for them. This makes a switch more efficient when demand is high. If, for example, a game involved lots of data being passed between machines, then a switch could reduce the amount of **latency**.

8 Cisco Packet Tracer

Packet Tracer is a cross-platform visual simulation tool designed by Cisco Systems that allows users to create network topologies and imitate modern computer networks. The software allows users to simulate the configuration of Cisco routers and switches using a simulated command line interface. Packet Tracer makes use of a drag and drop user interface, allowing users to add and remove simulated network devices as they see fit. The software is mainly focused towards Cisco Networking Academy students as an educational tool for helping them learn fundamental CCNA concepts. Previously students enrolled in a CCNA Academy program could freely download and use the tool free of charge for educational use.²

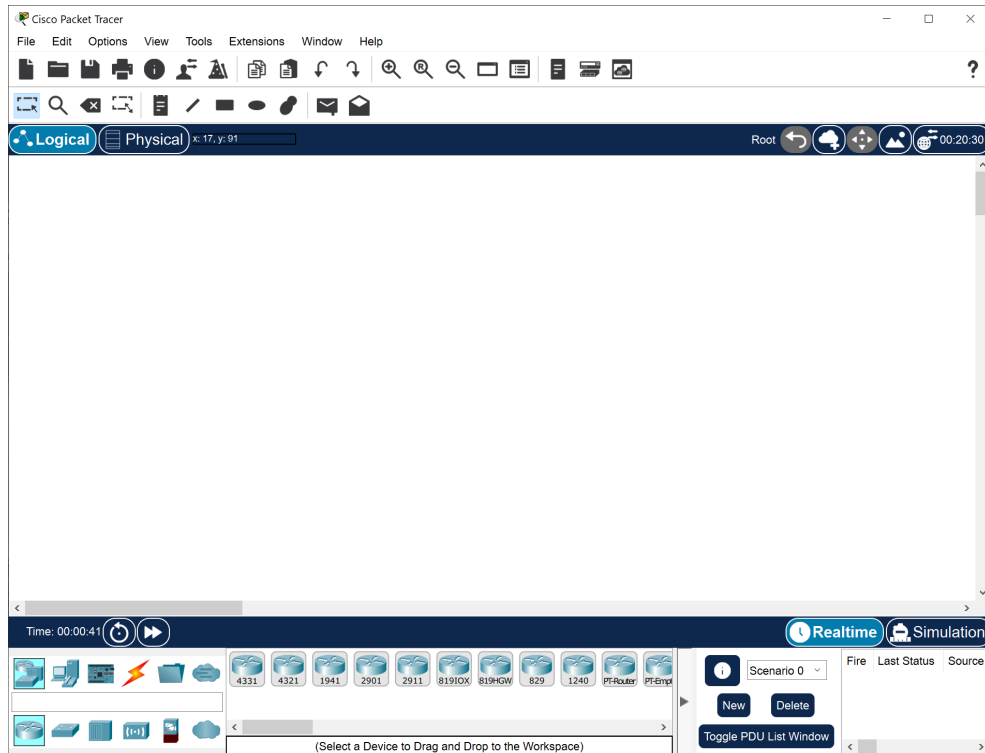
In this experiment we try to ping devices being set with 0 in the IP fields. Then we're gonna expand the network with more devices

- First network has a 192.168.1.1 default gateway
- Second network has a 192.168.0.1 default gateway

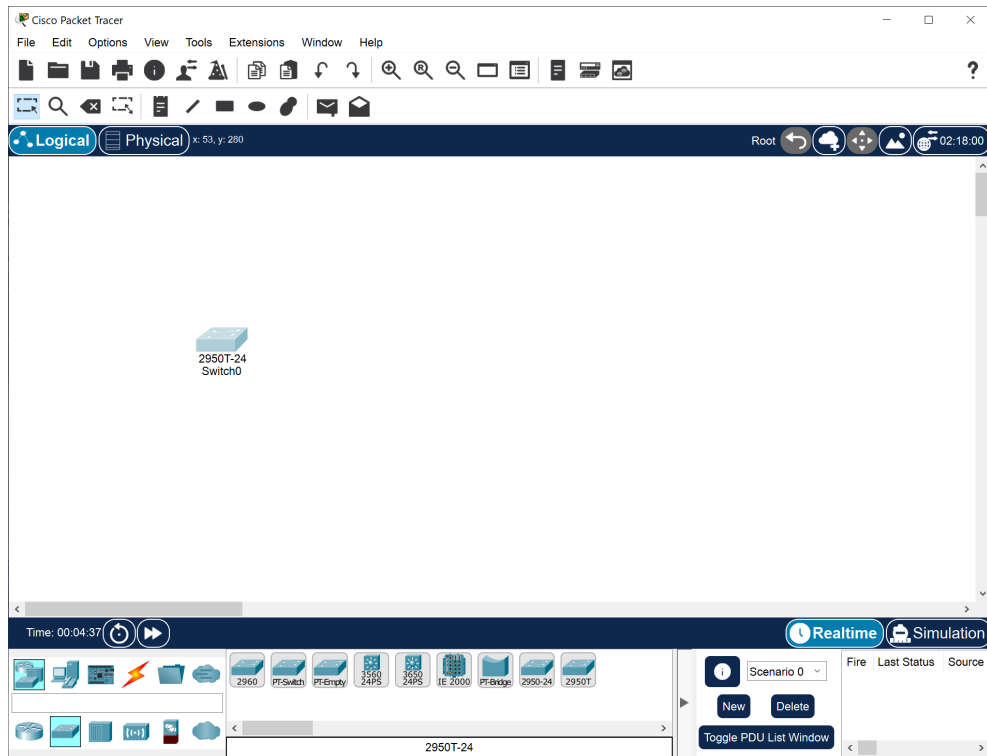
²Bakni, Michel; Cardinale, Yudith; Moreno, Luis Manuel (June 2018). **An Approach to Evaluate Network Simulators: An Experience with Packet Tracer**. Revista Venezolana de Computación. 5: 29–36. ISSN 2244-7040.
Javid, Sheikh Raashid (May 2014). **Role of Packet Tracer in learning Computer Networks** (PDF). International Journal of Advanced Research in Computer and Communication Engineering. 3 (5): 6508–6511.

8.1 The step-by-step guide

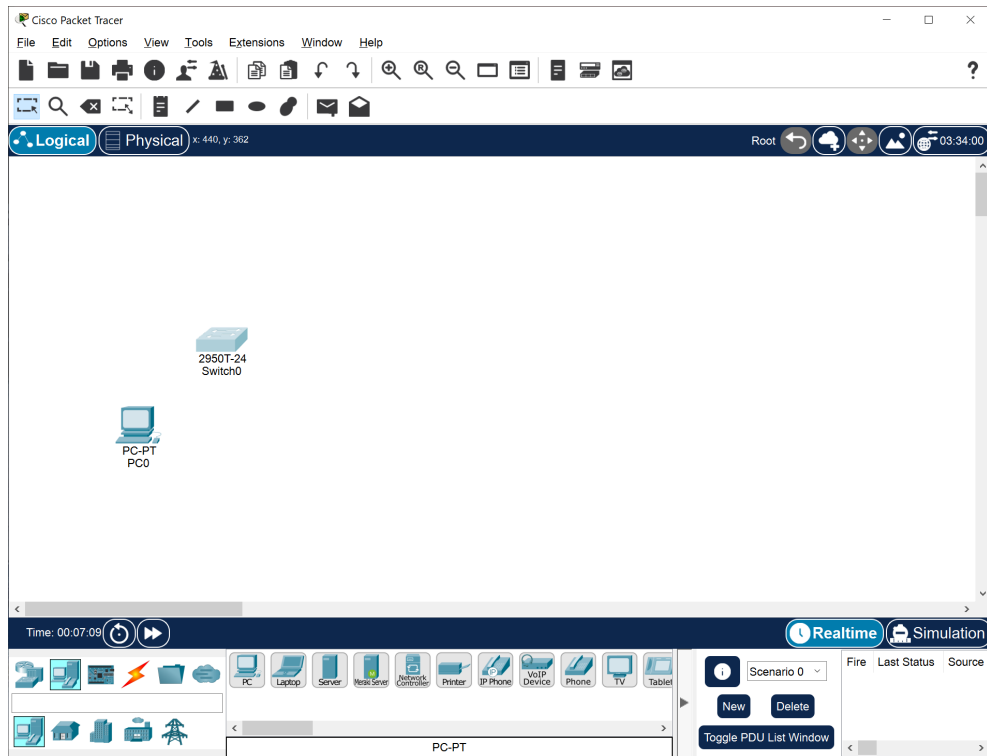
The following picture shows what we've got when we open Cisco Packet Tracer :



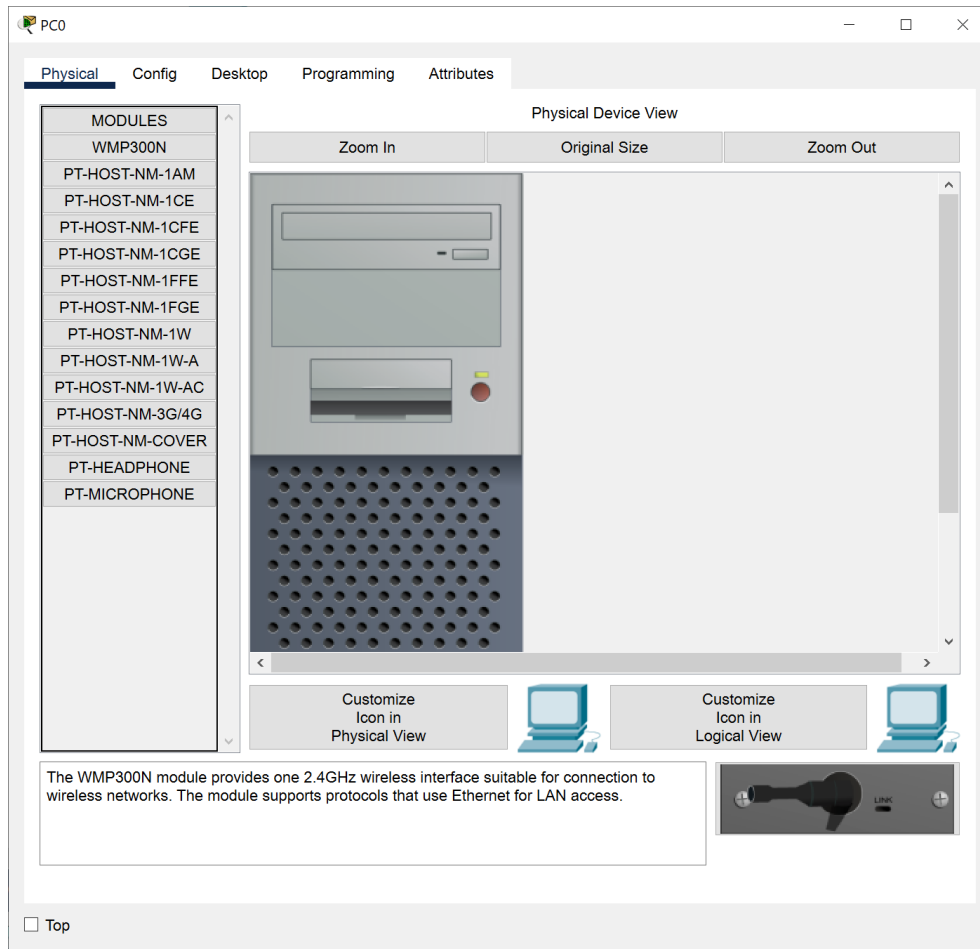
Now what we need to do is to add a switch :



And then we add a computer :



Now we click on the computer



And we move ourselves in the Config tab

The image shows a configuration window for a device named PC0. The window has a title bar with a PC icon and the text 'PC0'. Below the title bar are four tabs: 'Physical', 'Config' (which is selected and highlighted with a blue underline), 'Desktop', 'Programming', and 'Attributes'. On the left side of the 'Config' tab is a vertical sidebar with a tree view. The tree view has two main sections: 'GLOBAL' and 'INTERFACE'. Under 'GLOBAL', there are 'Settings' and 'Algorithm Settings'. Under 'INTERFACE', there are 'FastEthernet0' and 'Bluetooth'. The 'FastEthernet0' item is currently selected. The main area of the window displays the configuration for 'FastEthernet0'. At the top of this area is a section titled 'Global Settings'. Below this title are several configuration fields: 'Display Name' with the value 'PC0', 'Interfaces' with a dropdown menu showing 'FastEthernet0', and two sections for 'Gateway/DNS'. The first 'Gateway/DNS' section is for IPv4, with radio buttons for 'DHCP' and 'Static' (where 'Static' is selected). Below these are input fields for 'Default Gateway' and 'DNS Server'. The second 'Gateway/DNS' section is for IPv6, with radio buttons for 'Automatic' and 'Static' (where 'Static' is selected). Below these are input fields for 'Default Gateway' and 'DNS Server'. At the bottom left of the window, there is a checkbox labeled 'Top'.

PC0

Physical **Config** Desktop Programming Attributes

GLOBAL

- Settings
- Algorithm Settings

INTERFACE

- FastEthernet0
- Bluetooth

Global Settings

Display Name: PC0

Interfaces: FastEthernet0

Gateway/DNS IPv4

☐ DHCP

☒ Static

Default Gateway:

DNS Server:

Gateway/DNS IPv6

☐ Automatic

☒ Static

Default Gateway:

DNS Server:

☐ Top

what we're gonna be looking later at is the IPV4 address

The screenshot shows a configuration window for a PC0. The window has a title bar with a PC icon and the text "PC0". Below the title bar are four tabs: "Physical", "Config", "Desktop", "Programming", and "Attributes". The "Config" tab is selected. On the left side of the "Config" tab is a sidebar with a tree view. The tree view has two main sections: "GLOBAL" and "INTERFACE". Under "GLOBAL" are "Settings" and "Algorithm Settings". Under "INTERFACE" are "FastEthernet0" (which is selected and highlighted in blue) and "Bluetooth". The main area of the window displays the configuration for "FastEthernet0". It includes fields for "Port Status" (checked "On"), "Bandwidth" (radio buttons for "100 Mbps", "10 Mbps", and "Auto", with "Auto" checked), "Duplex" (radio buttons for "Half Duplex", "Full Duplex", and "Auto", with "Auto" checked), and "MAC Address" (text field containing "00D0.BADE.C936"). Below these are two sections: "IP Configuration" and "IPv6 Configuration". The "IP Configuration" section has radio buttons for "DHCP" and "Static" (selected), with text fields for "IPv4 Address" and "Subnet Mask". The "IPv6 Configuration" section has radio buttons for "Automatic" and "Static" (selected), with text fields for "IPv6 Address" and "Link Local Address" (containing "FE80::2D0:BAFF:FEDE:C936"). At the bottom left of the window is a "Top" button with a small square icon.

PC0

Physical Config Desktop Programming Attributes

GLOBAL

- Settings
- Algorithm Settings

INTERFACE

- FastEthernet0
- Bluetooth

FastEthernet0

Port Status ☒ On

Bandwidth ☐ 100 Mbps ☐ 10 Mbps ☒ Auto

Duplex ☐ Half Duplex ☐ Full Duplex ☒ Auto

MAC Address 00D0.BADE.C936

IP Configuration

☐ DHCP

☒ Static

IPv4 Address

Subnet Mask

IPv6 Configuration

☐ Automatic

☒ Static

IPv6 Address

Link Local Address: FE80::2D0:BAFF:FEDE:C936

☐ Top

in the meantime let's go in global and set the **IP Address** equal to this

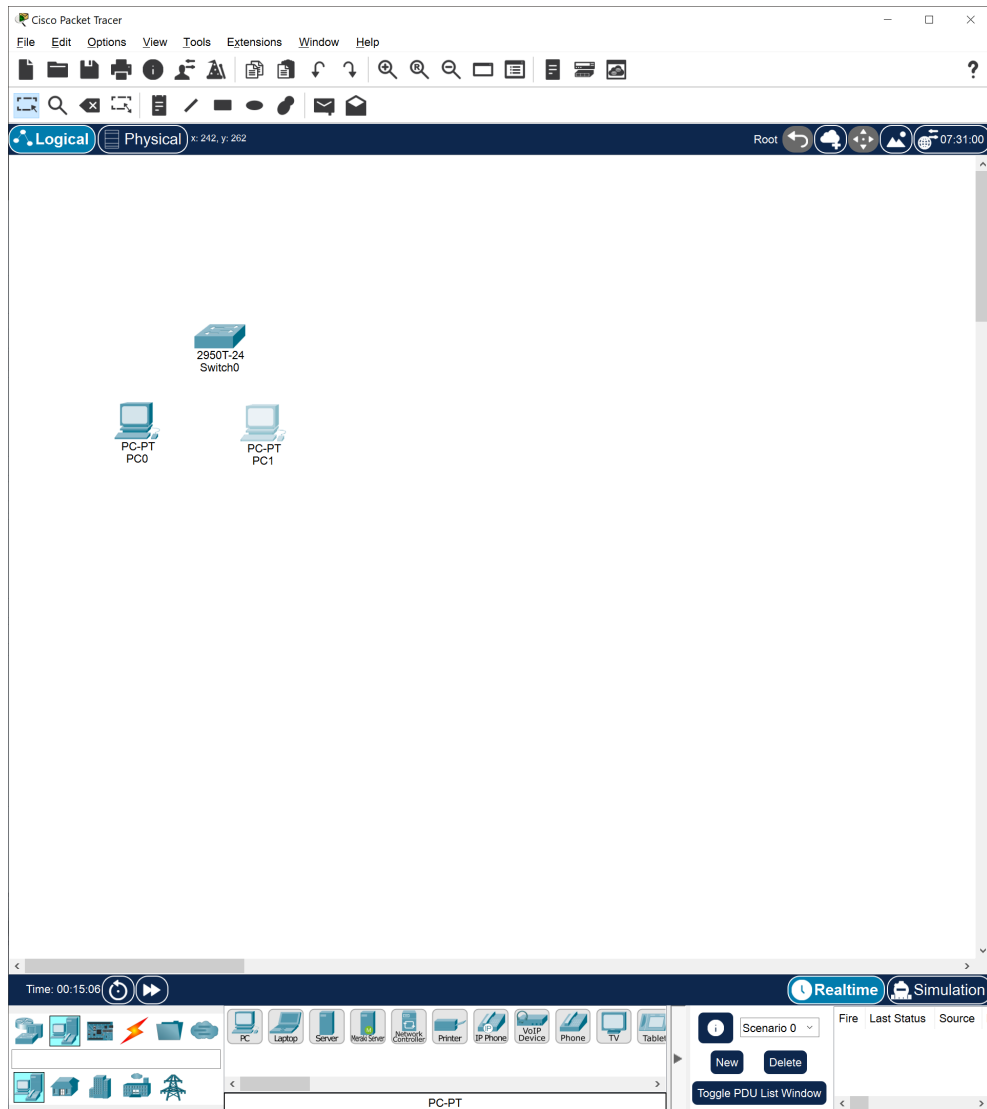
192.168.0.1

The screenshot shows a configuration window for a PC named PC0. The window has tabs for Physical, Config, Desktop, Programming, and Attributes. The Config tab is active. On the left, there is a sidebar with a tree view containing 'GLOBAL' (expanded), 'Settings', 'Algorithm Settings', 'INTERFACE', 'FastEthernet0', and 'Bluetooth'. The main area is titled 'Global Settings' and contains the following fields:

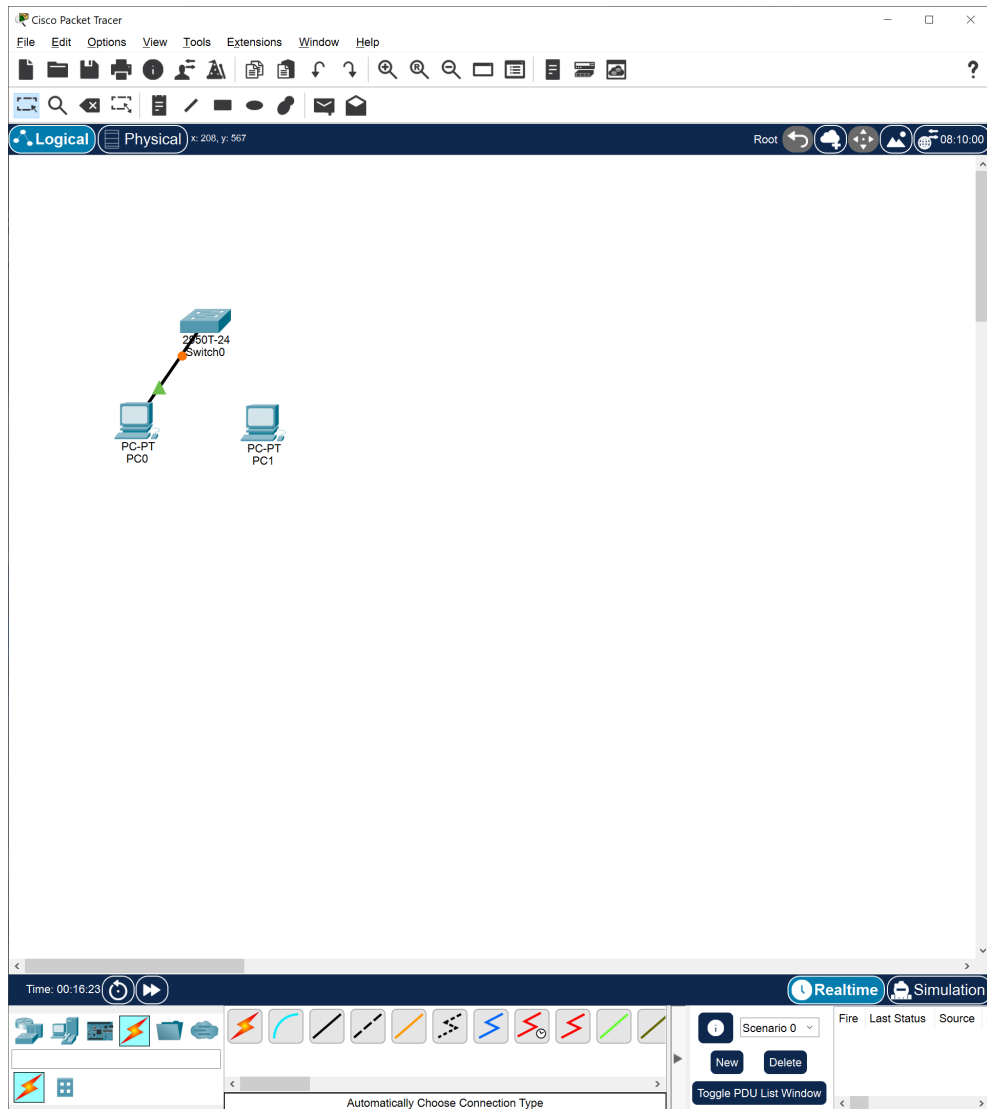
- Display Name: PC0
- Interfaces: FastEthernet0 (dropdown menu)
- Gateway/DNS IPv4:
 - ☐ DHCP
 - ☒ Static
 - Default Gateway: 192.168.0.1
 - DNS Server: (empty text box)
- Gateway/DNS IPv6:
 - ☐ Automatic
 - ☒ Static
 - Default Gateway: (empty text box)
 - DNS Server: (empty text box)

At the bottom left of the window, there is a checkbox labeled 'Top'.

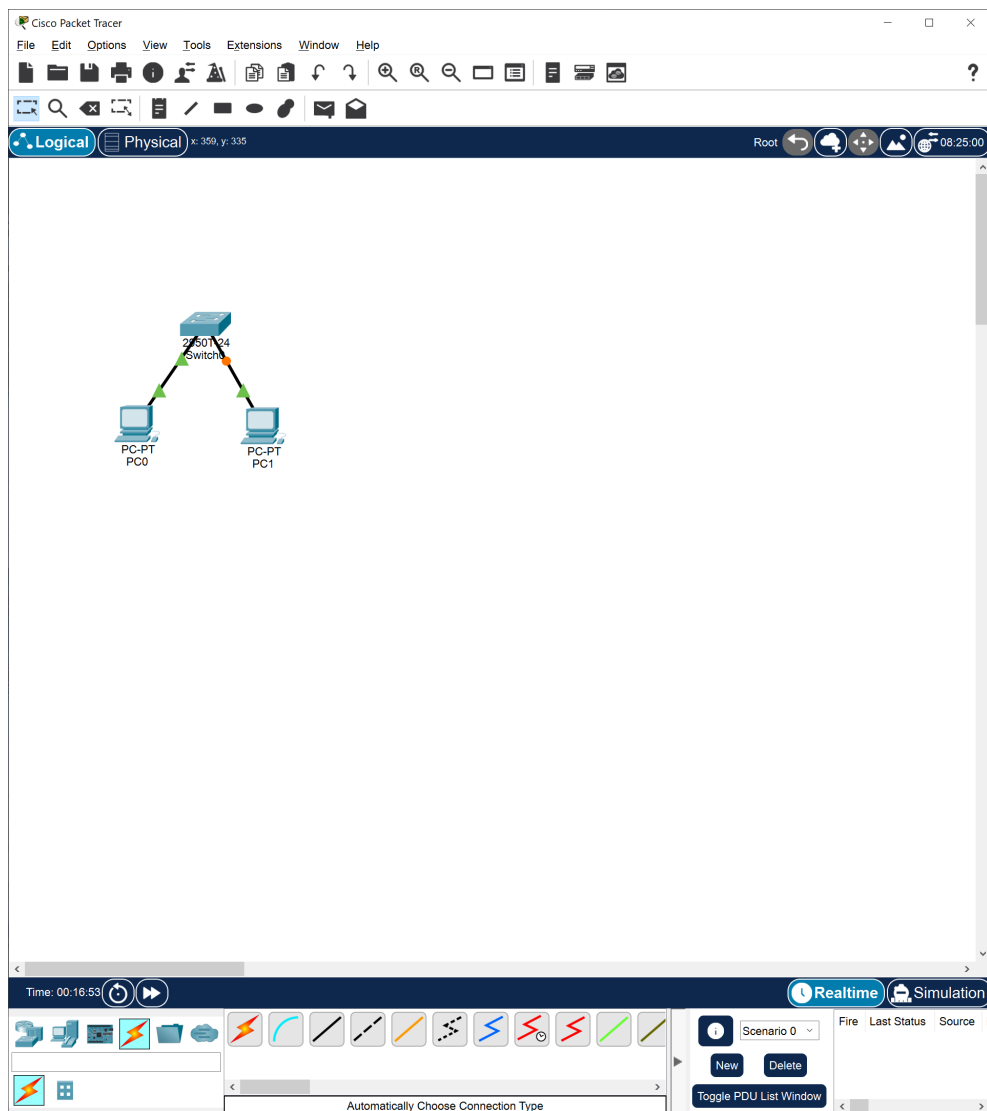
Now we add a new computer



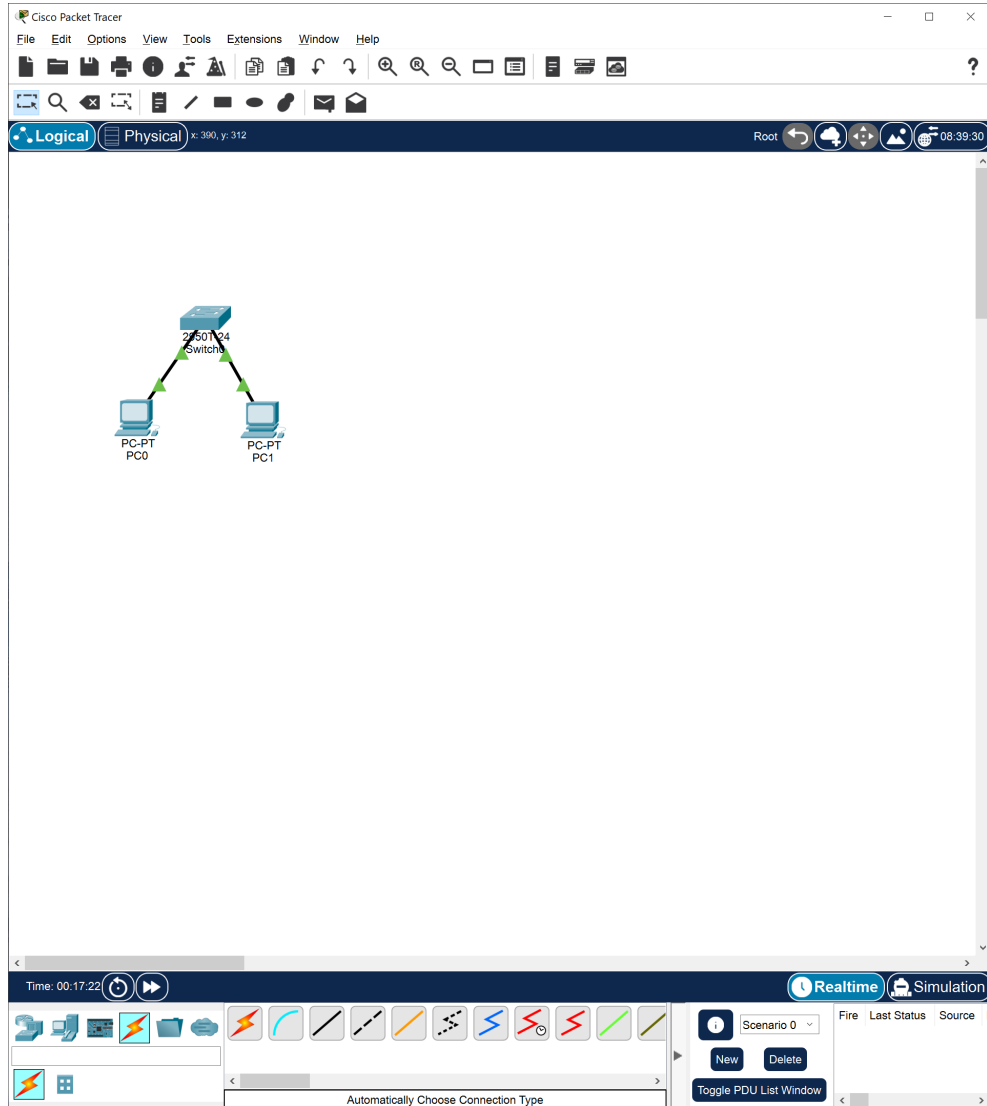
We link the switch to the first computer and wait for all lights to go green



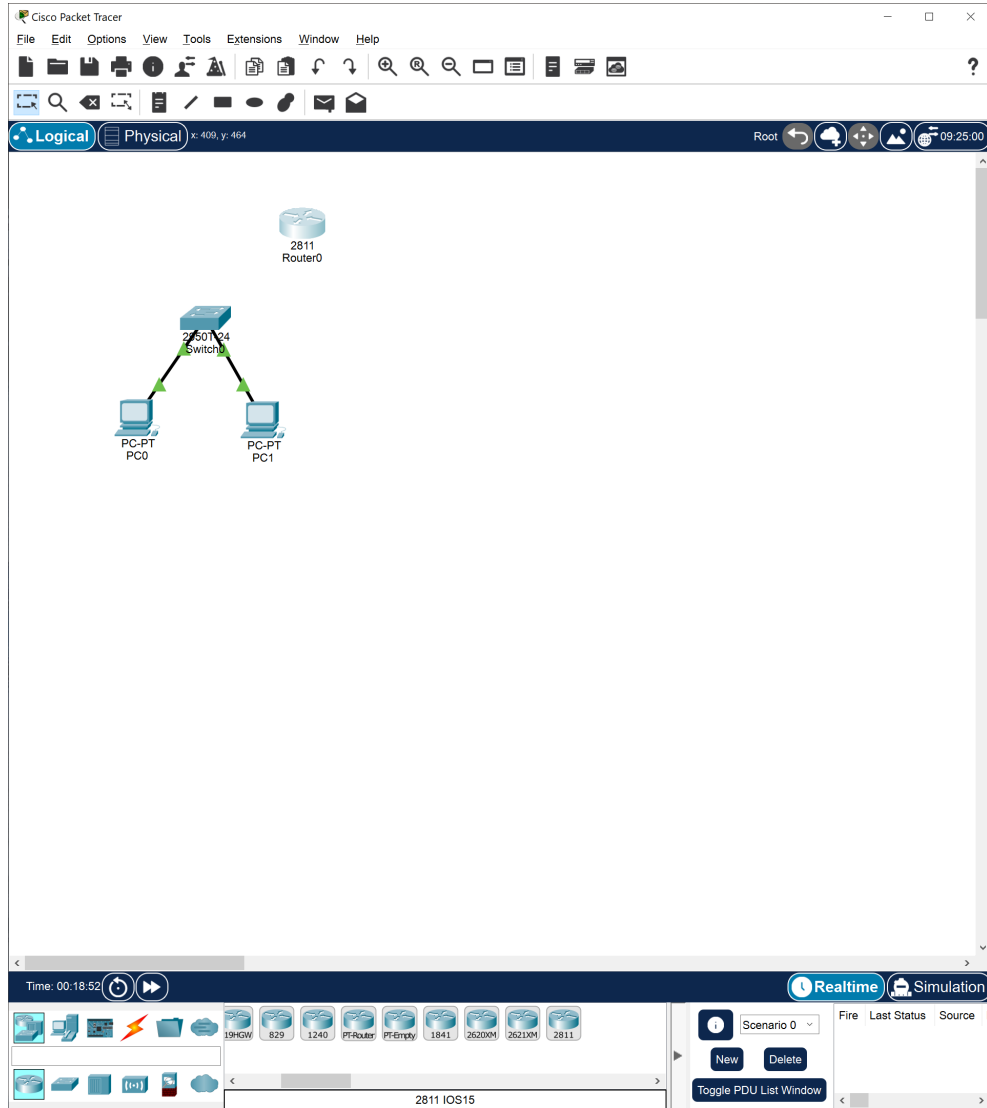
Link the switch to the second computer and wait for this link to go all green as well



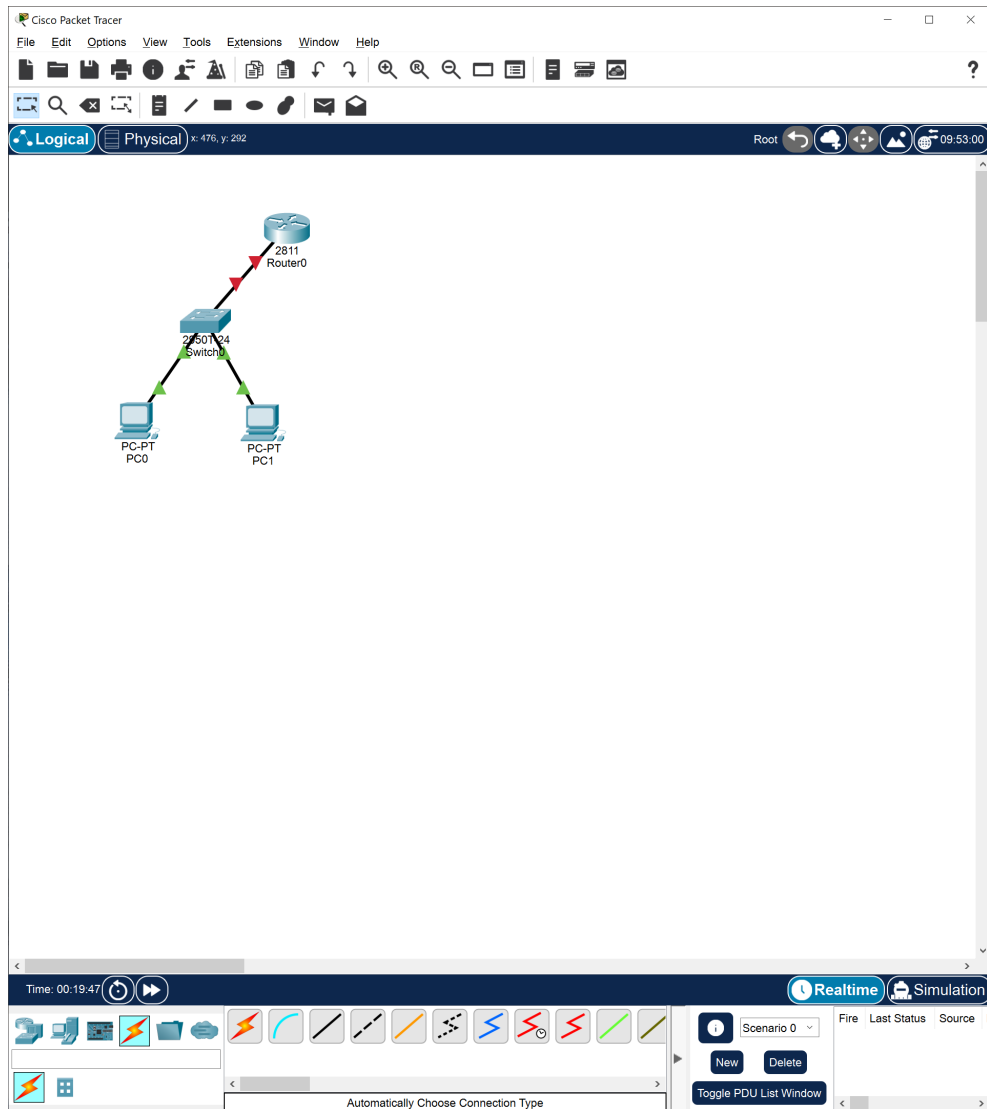
Now it's all green which makes us happy



Let's add a router



Let's link the router to the first computer



If you click on the router, in the config tab there is a box you need to check. That box will emulate the router being powered on

The screenshot shows the Router0 configuration window with the 'Config' tab selected. The left sidebar contains a tree view with categories: GLOBAL (Settings, Algorithm Settings), ROUTING (Static, RIP), SWITCHING (VLAN Database), and INTERFACE (FastEthernet0/0, FastEthernet0/1). The 'FastEthernet0/0' interface is selected. The main configuration area for 'FastEthernet0/0' includes: Port Status (checkbox 'On'), Bandwidth (radio buttons: 100 Mbps, 10 Mbps, Auto (checked)), Duplex (radio buttons: Half Duplex, Full Duplex, Auto (checked)), MAC Address (text field: 0060.7058.3901), IP Configuration (IPv4 Address and Subnet Mask text fields), and Tx Ring Limit (text field: 10). Below the configuration area is a section titled 'Equivalent IOS Commands' containing a terminal window with the following text: --- System Configuration Dialog ---, Would you like to enter the initial configuration dialog? [yes/no]:, Press RETURN to get started!, Router>enable, Router#, Router#configure terminal, Enter configuration commands, one per line. End with CNTL/Z., Router(config)#, Router(config)#, Router(config)#interface FastEthernet0/0, Router(config-if)#. At the bottom left of the window is a 'Top' button.

Router0

Physical **Config** CLI Attributes

GLOBAL

- Settings
- Algorithm Settings

ROUTING

- Static
- RIP

SWITCHING

- VLAN Database

INTERFACE

- FastEthernet0/0**
- FastEthernet0/1

FastEthernet0/0

Port Status ☐ On

Bandwidth ☒ 100 Mbps ☐ 10 Mbps ☒ Auto

Duplex ☒ Half Duplex ☐ Full Duplex ☒ Auto

MAC Address 0060.7058.3901

IP Configuration

IPv4 Address

Subnet Mask

Tx Ring Limit 10

Equivalent IOS Commands

```
--- System Configuration Dialog ---

Would you like to enter the initial configuration dialog? [yes/no]:

Press RETURN to get started!

Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#
Router(config)#interface FastEthernet0/0
Router(config-if)#
```

☐ Top

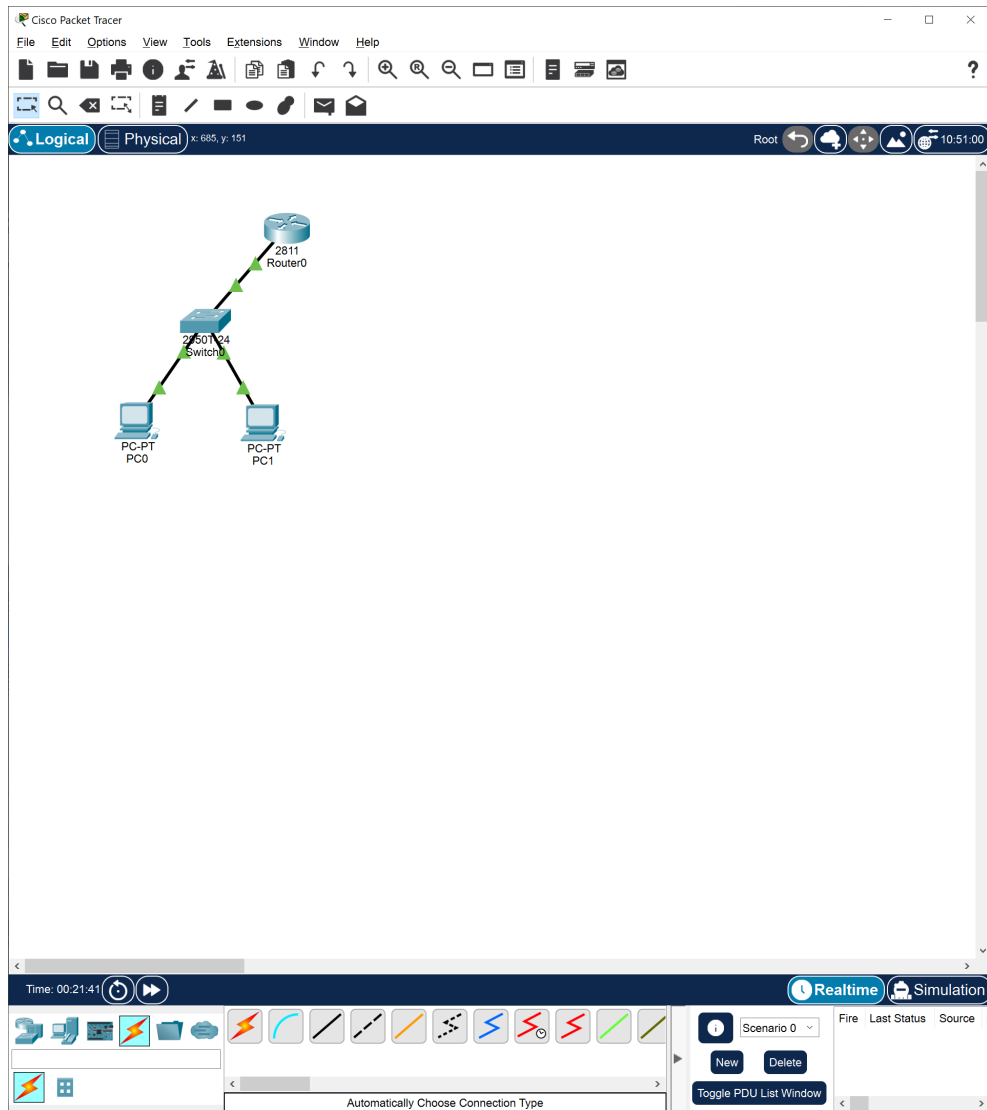
Once you click in the box a small tick will appear in it. This means the box is ticked and the function that box is proving is now being turned on

The screenshot shows the configuration window for Router0, specifically the 'Config' tab. The left sidebar contains a tree view with categories: GLOBAL, ROUTING, SWITCHING, and INTERFACE. Under the INTERFACE category, 'FastEthernet0/0' is selected. The main panel displays the configuration for 'FastEthernet0/0'. It includes fields for Port Status (checked 'On'), Bandwidth (radio buttons for 100 Mbps, 10 Mbps, and checked 'Auto'), Duplex (radio buttons for Half Duplex, Full Duplex, and checked 'Auto'), MAC Address (0060.7058.3901), IP Configuration (IPv4 Address and Subnet Mask fields), and Tx Ring Limit (10). Below the configuration fields, there is a section titled 'Equivalent IOS Commands' which contains a terminal window showing the following commands and output:

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#interface FastEthernet0/0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

At the bottom left of the window, there is a 'Top' button.

as a result of ticking that box now you can see the link going green which means is enabled for data transmission



we only need to sort the **IP Configuration** out as well

The screenshot shows the configuration interface for Router0. The 'Config' tab is selected, and the 'FastEthernet0/0' interface is chosen from the left sidebar. The main configuration area for FastEthernet0/0 includes:

- Port Status:** ☒ On
- Bandwidth:** ☐ 100 Mbps ☐ 10 Mbps ☒ Auto
- Duplex:** ☐ Half Duplex ☒ Full Duplex ☒ Auto
- MAC Address:** 0060.7058.3901
- IP Configuration:**
 - IPv4 Address:** [Empty text box]
 - Subnet Mask:** [Empty text box]
- Tx Ring Limit:** 10

Below the configuration fields, the 'Equivalent IOS Commands' section displays the following commands in a terminal window:

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#interface FastEthernet0/0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

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

Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#
```

At the bottom left, there is a 'Top' button with a small square icon next to it.

Now, because the subnet mask indicates how many values can you actually use this means we can use

$$255\text{values} - X\text{values}$$

where X is the number in a subnetmask like $Z.Y.W.X$ which in the case of $255.255.255.0$ will be

$$255 - 0$$

which returns 255 values but because we start counting from 0 we can go up to 254. In the following example you can see the value 0 being accepted as a valid value

The screenshot shows the configuration window for Router0. The 'Config' tab is selected, and the 'FastEthernet0/0' interface is chosen from the left-hand menu. The configuration details for this interface are as follows:

- Port Status:** ☒ On
- Bandwidth:** ☐ 100 Mbps ☐ 10 Mbps ☒ Auto
- Duplex:** ☐ Half Duplex ☒ Full Duplex ☒ Auto
- MAC Address:** 0060.7058.3901
- IP Configuration:**
 - IPv4 Address:** 192.168.0.1
 - Subnet Mask:** 255.255.255.0
- Tx Ring Limit:** 10

Below the configuration fields, the 'Equivalent IOS Commands' section displays the following commands:

```

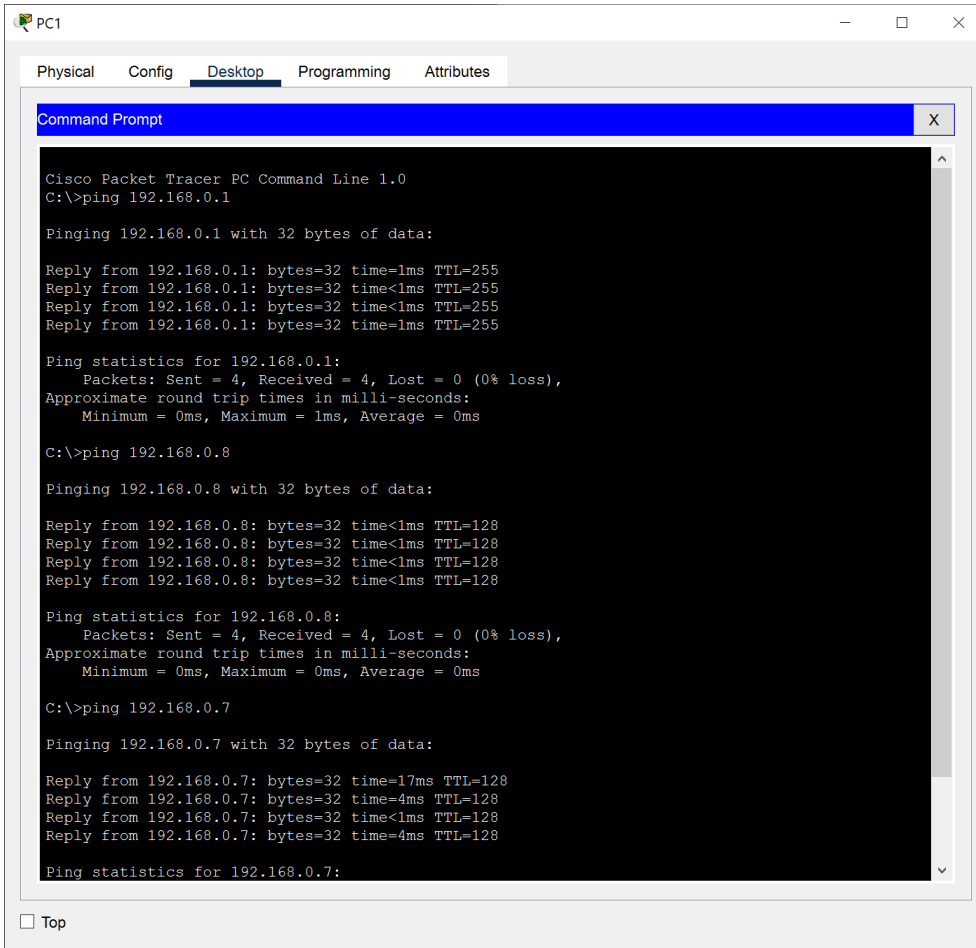
Router(config)#interface FastEthernet0/0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

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

Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 192.168.0.1 255.255.255.0
Router(config-if)#ip address 192.168.0.1 255.255.255.0
Router(config-if)#
  
```

At the bottom left of the window, there is a 'Top' button.

Let's pick up PC1 console and ping all devices in the 192.168.0.1 network.
The ping works



The screenshot shows a Cisco Packet Tracer PC1 console window. The window has tabs for Physical, Config, Desktop, Programming, and Attributes. The Desktop tab is active, showing a Command Prompt window. The Command Prompt displays the output of three ping commands: ping 192.168.0.1, ping 192.168.0.8, and ping 192.168.0.7. Each command shows four successful replies with 32 bytes of data, and the statistics indicate 0% loss.

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.0.1

Pinging 192.168.0.1 with 32 bytes of data:

Reply from 192.168.0.1: bytes=32 time<1ms TTL=255
Reply from 192.168.0.1: bytes=32 time<1ms TTL=255
Reply from 192.168.0.1: bytes=32 time<1ms TTL=255
Reply from 192.168.0.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.0.8

Pinging 192.168.0.8 with 32 bytes of data:

Reply from 192.168.0.8: bytes=32 time<1ms TTL=128
Reply from 192.168.0.8: bytes=32 time<1ms TTL=128
Reply from 192.168.0.8: bytes=32 time<1ms TTL=128
Reply from 192.168.0.8: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.0.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.0.7

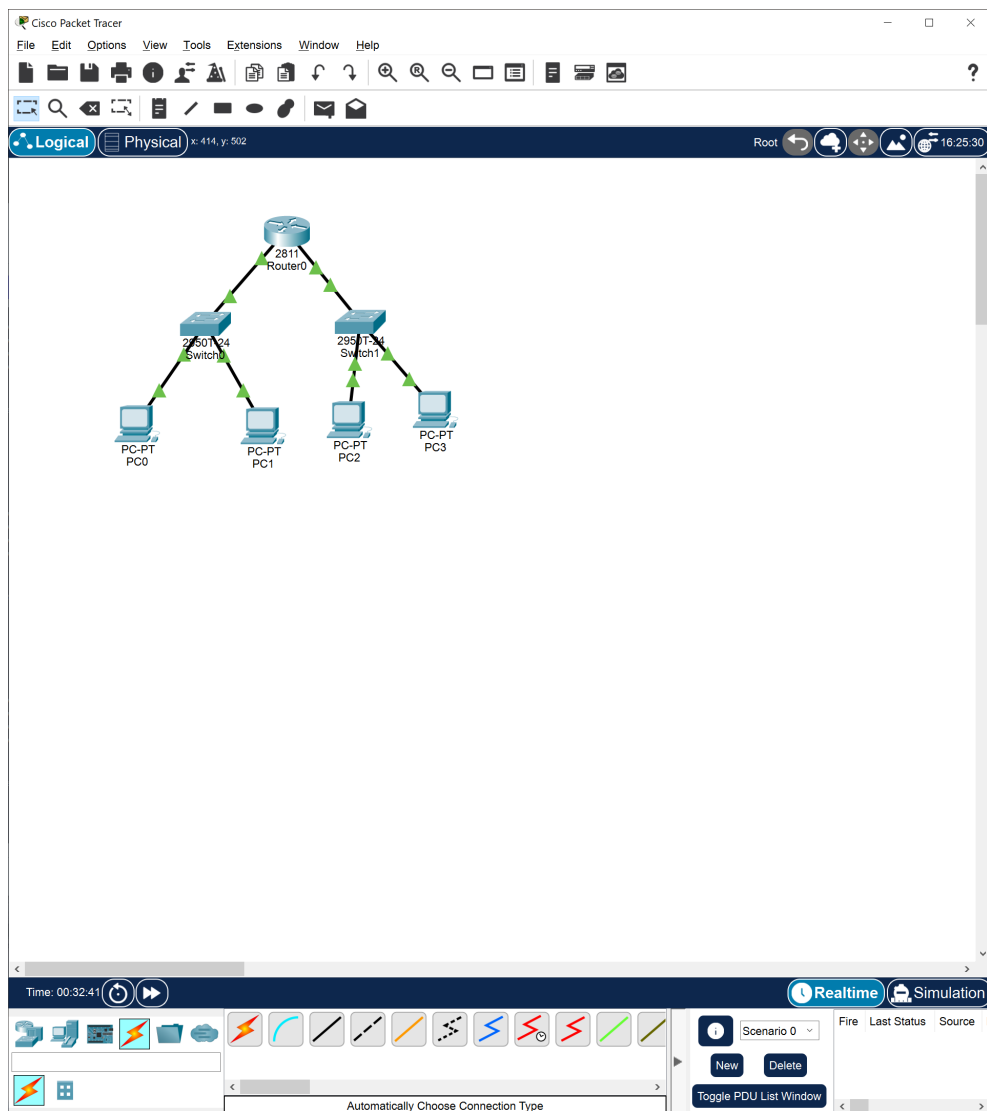
Pinging 192.168.0.7 with 32 bytes of data:

Reply from 192.168.0.7: bytes=32 time=17ms TTL=128
Reply from 192.168.0.7: bytes=32 time=4ms TTL=128
Reply from 192.168.0.7: bytes=32 time<1ms TTL=128
Reply from 192.168.0.7: bytes=32 time=4ms TTL=128

Ping statistics for 192.168.0.7:
```

Let's create a copy of the subnetwork we have already. The gateway will be
this time

192.168.1.1



8.1.1 expanding the network

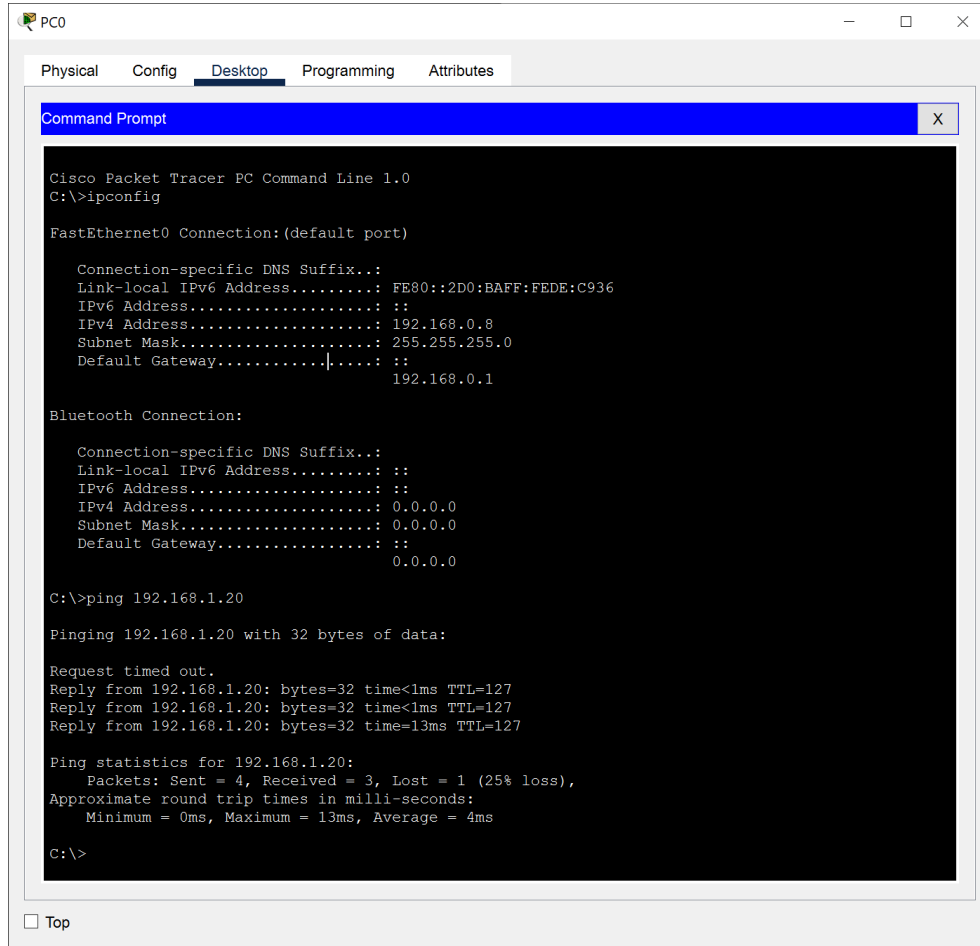
Let's add a printer with the following IP

192.168.1.20

The screenshot shows a window titled 'Printer1' with three tabs: 'Physical', 'Config', and 'Attributes'. The 'Config' tab is active. On the left, there is a sidebar with a tree view containing 'GLOBAL' and 'INTERFACE'. Under 'INTERFACE', 'FastEthernet0' is selected. The main area displays the configuration for 'FastEthernet0'. It includes fields for 'Port Status' (checked 'On'), 'Bandwidth' (radio buttons for '100 Mbps' and '10 Mbps', with 'Auto' checked), 'Duplex' (radio buttons for 'Half Duplex' and 'Full Duplex', with 'Auto' checked), and 'MAC Address' (0004.9A90.BD99). Below these are sections for 'IP Configuration' and 'IPv6 Configuration'. In 'IP Configuration', 'Static' is selected, and the 'IPv4 Address' is set to '192.168.1.20' with a 'Subnet Mask' of '255.255.255.0'. In 'IPv6 Configuration', 'Static' is also selected, with an empty 'IPv6 Address' field and a 'Link Local Address' of 'FE80::204:9AFF:FE90:BD99'. A 'Top' button is located at the bottom left of the window.

Section	Parameter	Value
FastEthernet0	Port Status	<input checked="" type="checkbox"/> On
	Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
	Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
	MAC Address	0004.9A90.BD99
IP Configuration	<input type="radio"/> DHCP	
	<input checked="" type="radio"/> Static	
	IPv4 Address	192.168.1.20
	Subnet Mask	255.255.255.0
IPv6 Configuration	<input type="radio"/> Automatic	
	<input checked="" type="radio"/> Static	
	IPv6 Address	
	Link Local Address:	FE80::204:9AFF:FE90:BD99

Let's ping the printer from PC0



```
Cisco Packet Tracer PC Command Line 1.0
C:\>ipconfig

FastEthernet0 Connection: (default port)

    Connection-specific DNS Suffix...:
    Link-local IPv6 Address . . . . .: FE80::2D0:BAFF:FEDE:C936
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 192.168.0.8
    Subnet Mask . . . . .: 255.255.255.0
    Default Gateway . . . . .: ::
                                   192.168.0.1

Bluetooth Connection:

    Connection-specific DNS Suffix...:
    Link-local IPv6 Address . . . . .: ::
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 0.0.0.0
    Subnet Mask . . . . .: 0.0.0.0
    Default Gateway . . . . .: ::
                                   0.0.0.0

C:\>ping 192.168.1.20

Pinging 192.168.1.20 with 32 bytes of data:

Request timed out.
Reply from 192.168.1.20: bytes=32 time<1ms TTL=127
Reply from 192.168.1.20: bytes=32 time<1ms TTL=127
Reply from 192.168.1.20: bytes=32 time=13ms TTL=127

Ping statistics for 192.168.1.20:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 13ms, Average = 4ms

C:\>
```

We can safely assume the network is working

9 Power over Ethernet

Power over Ethernet is a technique for delivering DC power to devices over copper Ethernet cabling, eliminating the need for separate power supplies and outlets. While PoE doesn't add Ethernet data capabilities, it does offer expanded options for how and where Ethernet end devices can be placed.

10 Network Topology

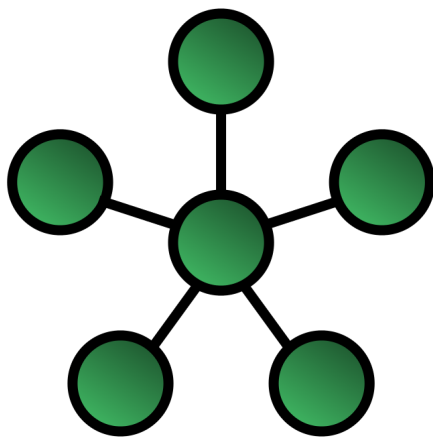
Network topology is the arrangement of the elements (links, nodes, etc.) of a communication network.

Network topology is the structure of a network and may be depicted physically or logically. It is an application of graph theory wherein communicating devices are modeled as nodes and the connections between the devices are modeled as links or lines between the nodes. Physical topology is the placement of the various components of a network (e.g., device location and cable installation), while logical topology illustrates how data flows within a network. Distances between nodes, physical interconnections, transmission rates, or signal types may differ between two different networks, yet their logical topologies may be identical. A network's physical topology is a particular concern of the physical layer of the OSI model.

Examples of network topologies are found in local area networks (LAN), a common computer network installation. Any given node in the LAN has one or more physical links to other devices in the network; graphically mapping these links results in a geometric shape that can be used to describe the physical topology of the network. A wide variety of physical topologies have been used in LANs, including ring, bus, mesh and star. Conversely, mapping the data flow between the components determines the logical topology of the network. In comparison, Controller Area Networks, common in vehicles, are primarily distributed control system networks of one or more controllers interconnected with sensors and actuators over, invariably, a physical bus topology.

10.1 Star Topology

In star topology, every peripheral node (computer workstation or any other peripheral) is connected to a central node called a hub or switch. The hub is the server and the peripherals are the clients. The network does not necessarily have to resemble a star to be classified as a star network, but all of the peripheral nodes on the network must be connected to one central hub. All traffic that traverses the network passes through the central hub, which acts as a signal repeater.



10.1.1 PROs

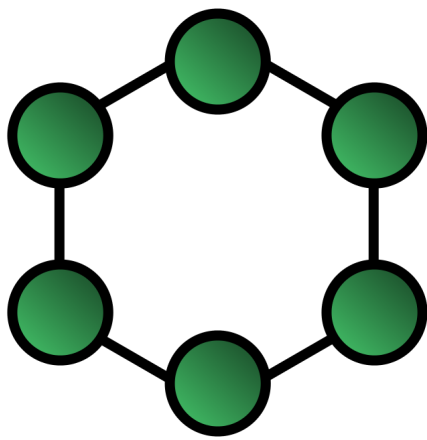
- simplicity of adding additional nodes
- is the easiest topology to design and implement

10.1.2 CONs

- the hub represents a single point of failure
- Since all peripheral communication must flow through the central hub, the aggregate central bandwidth forms a network bottleneck for large clusters

10.2 Ring Topology

A ring topology is a daisy chain in a closed loop. Data travels around the ring in one direction. When one node sends data to another, the data passes through each intermediate node on the ring until it reaches its destination. The intermediate nodes repeat (re transmit) the data to keep the signal strong.³ Every node is a peer; there is no hierarchical relationship of clients and servers. If one node is unable to re transmit data, it severs communication between the nodes before and after it in the bus.



10.2.1 PROs

- When the load on the network increases, its performance is better than bus topology
- There is no need of network server to control the connectivity between workstations

10.2.2 CONs

- Aggregate network bandwidth is bottlenecked by the weakest link between two nodes

³Inc, S., (2002) . Networking Complete. Third Edition. San Francisco: Sybex