





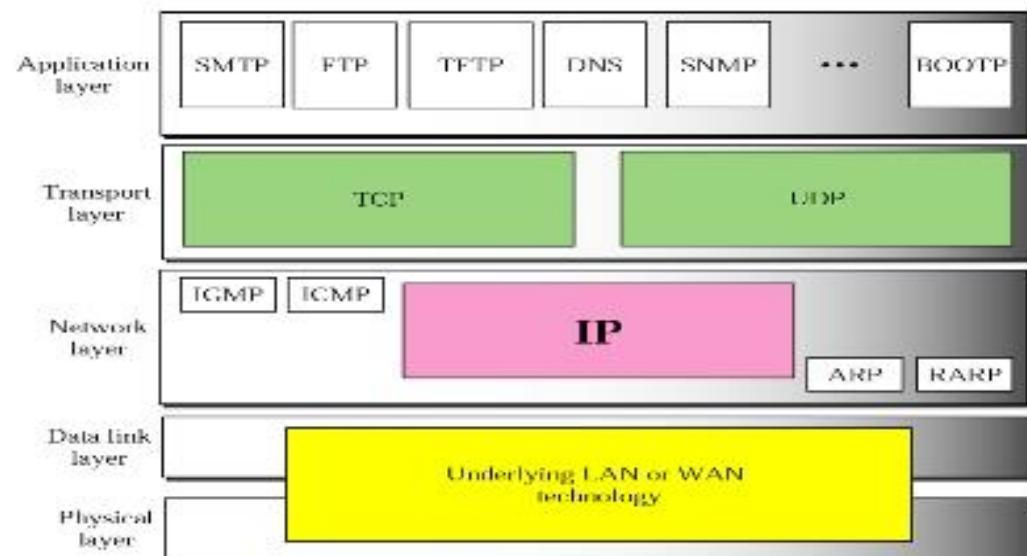
Computer Networks Fundamentals

TCP/IP Protocol Suite

Application Layer

TCP/IP Protocol Architecture

- Application Layer
 - Communication between processes or applications



Application Layer Protocols

- File transfer
 - FTP
 - TFTP
 - Network File System
- E-mail
 - Simple Mail Transfer Protocol
- Remote login
 - Telnet
 - rlogin
- Network management
 - Simple Network Management Protocol
- Name management
 - Domain Name System



Internet Services (Client/Web Server)

- The World Wide Web: HTTP
- Naming Service: DNS
- File Transfer: FTP
- Telnet Service
- Electronic Mail service: IMAP, POP3, SMTP

Client	Protocol	Server	Port No
Browser	HTTP	WEB	80
Browser	FTP	FTP	21
Browser Or Outlook Express Microsoft Outlook	HTTP SMTP POP3 IMAP4	Mail	110 143 25
Telnet	Telnet	Telnet	23



HTTP Protocol

- Hyper Text Transfer Protocol
- Supports the delivery of web pages to the client



Browser as a web client

- Use Internet Browser as WEB client.



URL

<http://www.tekguard.com>



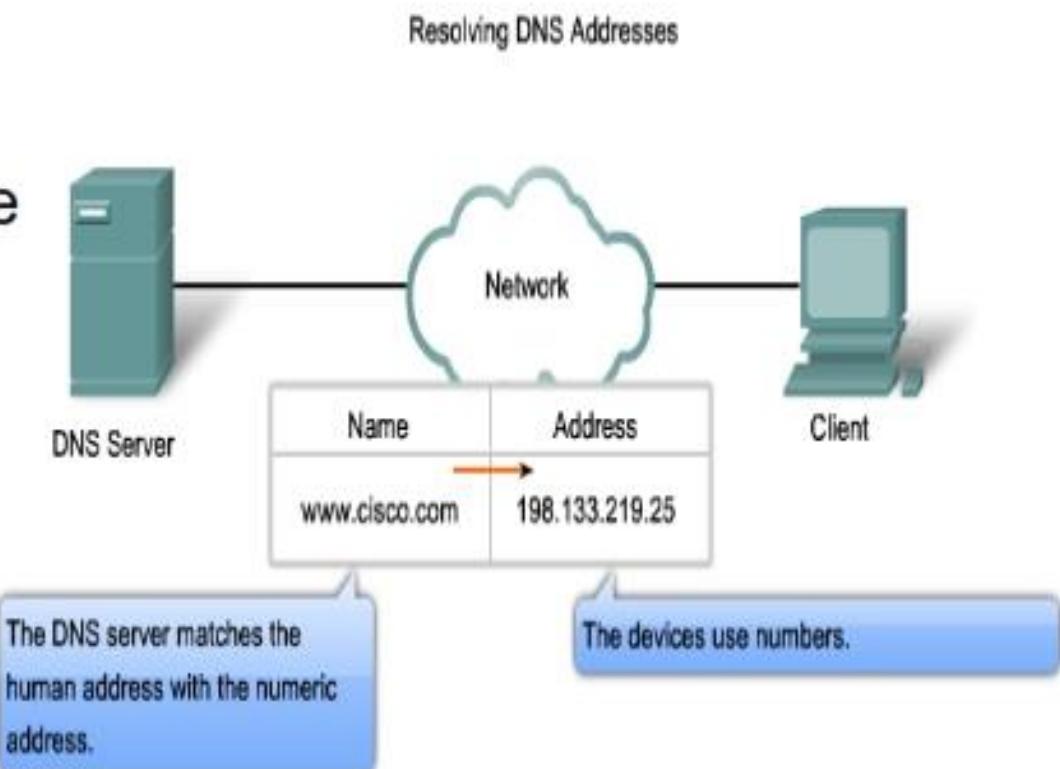
<https://www.microsoft.com/ar-ww/microsoft-365/>

- URL is **Universal Resource Locator**
- Protocol : HTTP or FTP
- **Host** : is the **domain name of the computer** on which the **information is located** .
- **Web pages** are usually stored in computers, and **computers are given domain name aliases** that usually begin with **the characters “www”**. This is not mandatory.
- **Port:** The URL can optionally contain the port number of the server(Multiple websites)
- **Path:** is the pathname of the file where the information is located. Note that the path can itself contain slashes



DNS

- Domain Name Servers
 - Application specified in the TCP/IP suite
 - A way to translate human-readable names into IP addresses





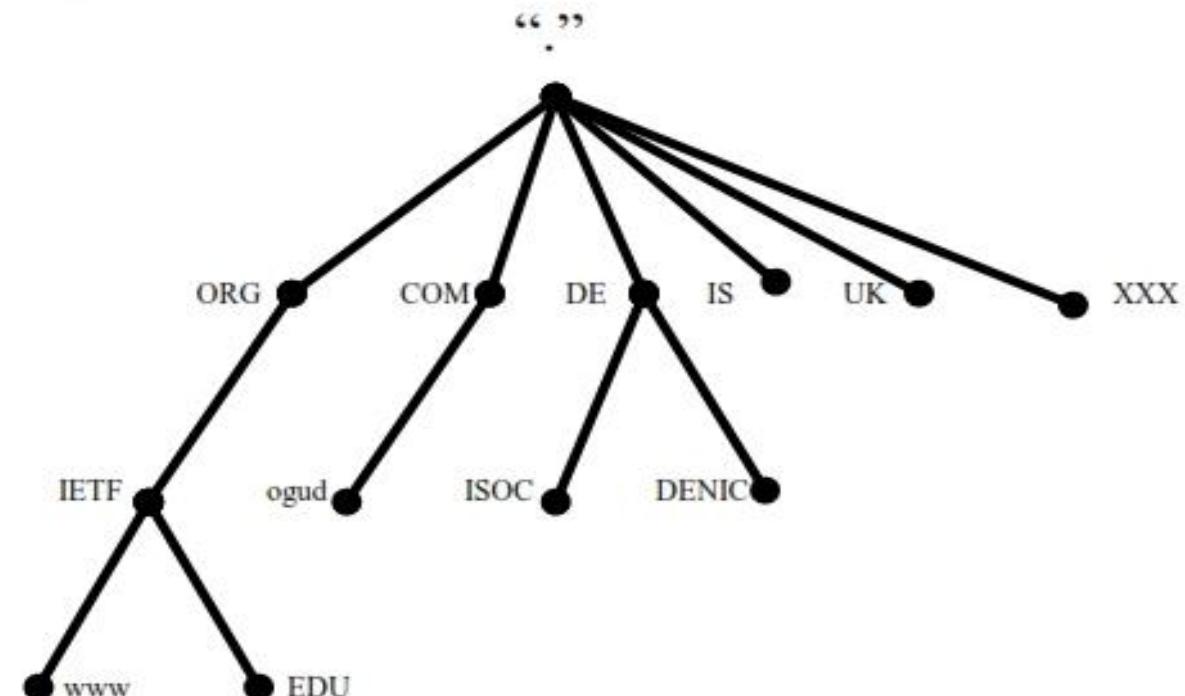
How DNS works?

- At the beginning they use Hosts file, It maps the IP addresses to host names
- It is found at **C: Windows\System32\drivers\etc**
 - **Problems:**
 - Huge number of hosts
 - Update very dynamic
 - Searching will be too slow
- **So hosts file can be used in local networks**
- Then they make DNS Server to **centralize** the Domain Name Servers.
- DNS Servers are used to convert the **addresses** we see and read into **IP addresses and vice versa**

List of Top Level Domains (TLDs)

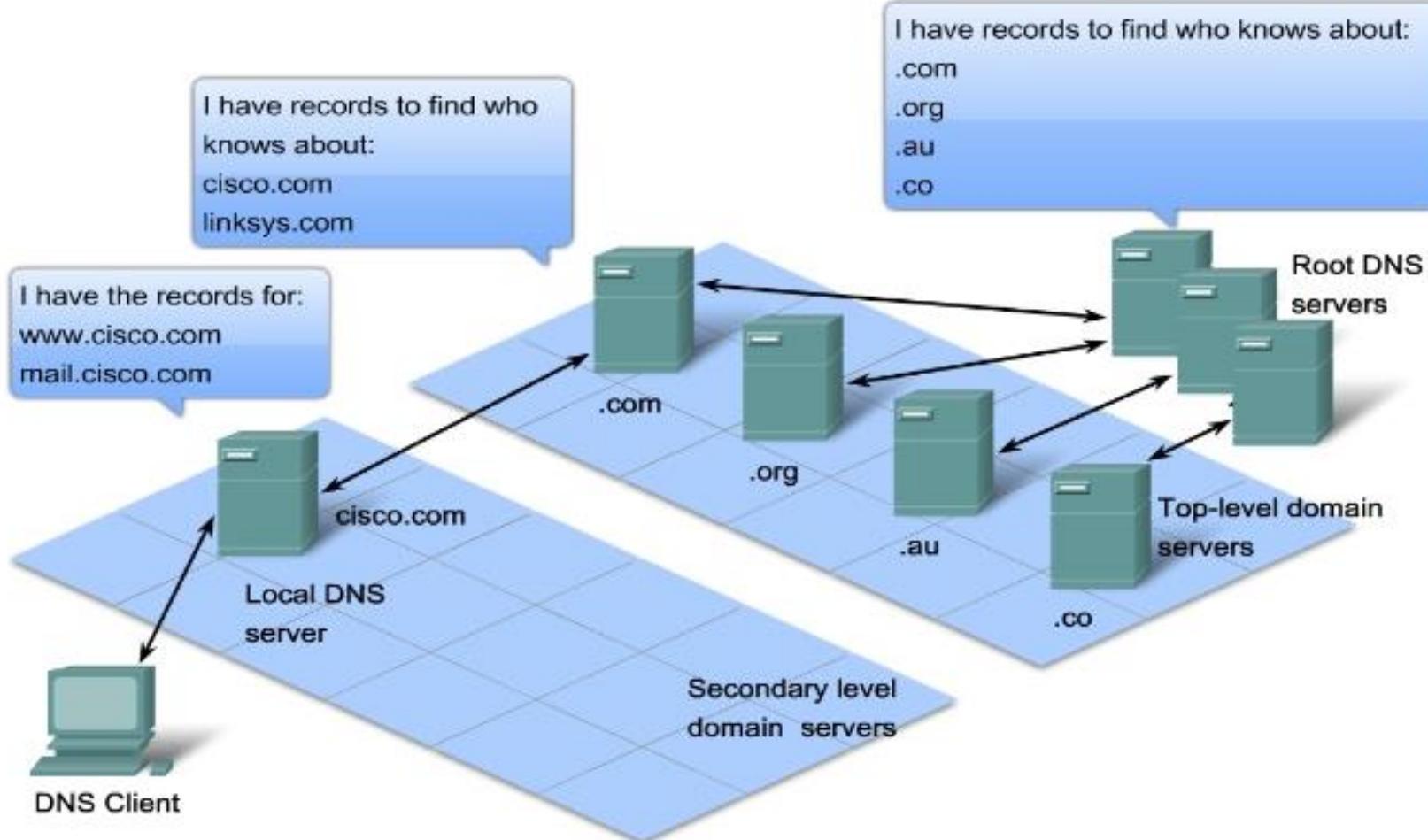
Domain Name	Assigned To
com	<i>Commercial organization</i>
edu	<i>Educational institution</i>
gov	<i>Government organization</i>
mil	<i>Military group</i>
net	<i>Major network support center</i>
org	<i>Organization other than those above</i>
country code	<i>A country</i>

DNS Tree





DNS Query



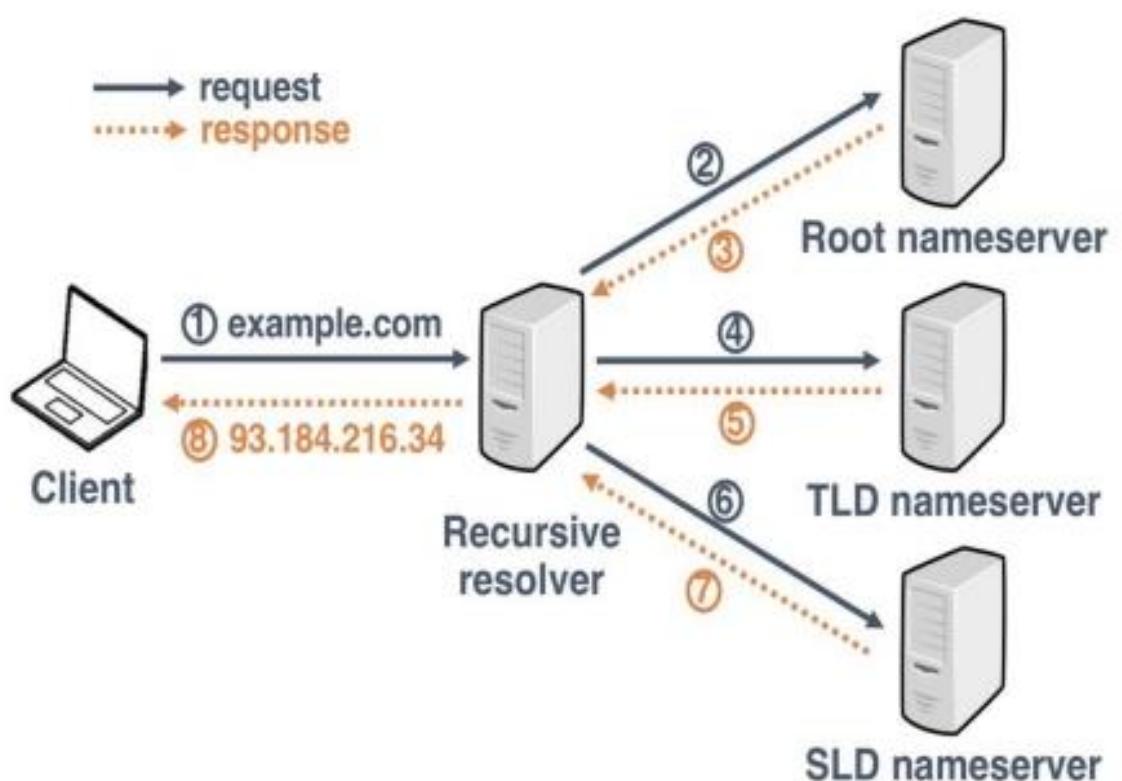
A hierarchy of DNS servers contains the resource records that match names with addresses.



DNS Lookup

How the client get the website

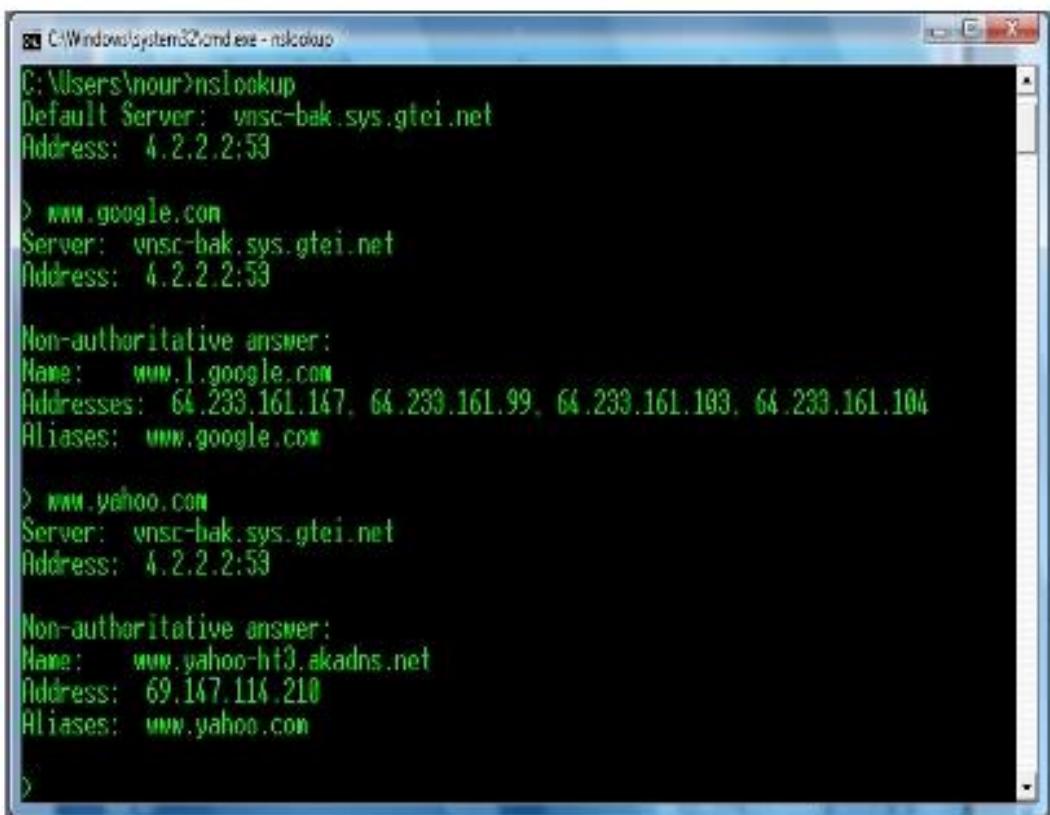
- 1- check the cash
- 2- check the hosts file
- 3- Ask DNS server





Nslookup

- nslookup is the name of a program that lets you to enter a host name and find out the corresponding IP address



```
C:\Windows\system32\cmd.exe - nslookup
C:\Users\nour>nslookup
Default Server: vnsr-bak.sys.gtei.net
Address: 4.2.2.2:53

> www.google.com
Server: vnsr-bak.sys.gtei.net
Address: 4.2.2.2:53

Non-authoritative answer:
Name: www.l.google.com
Addresses: 64.239.161.147, 64.239.161.99, 64.239.161.103, 64.239.161.104
Aliases: www.google.com

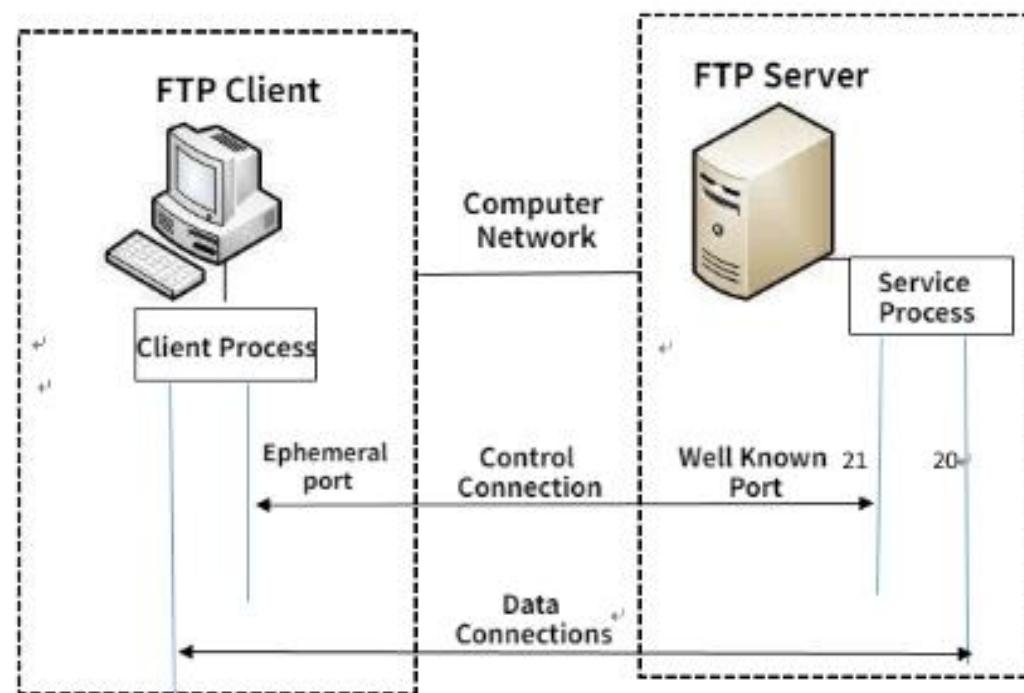
> www.yahoo.com
Server: vnsr-bak.sys.gtei.net
Address: 4.2.2.2:53

Non-authoritative answer:
Name: www.yahoo-ht3.akadns.net
Address: 69.147.114.210
Aliases: www.yahoo.com

>
```

FTP

- File Transfer Protocol
- a transmission protocol that provides reliable data transfer between hosts.
- **The default FTP port is Port 21 for command and control, Port 20 for data transport.**



FTP

FTP Client

- Browser as a FTP client
 - Use Internet Browser as FTP client.
- Using MS Windows built-in FTP client
- Third party programs “*cute FTP*”

A screenshot of the Microsoft Windows built-in FTP client window. The title bar reads "Microsoft Windows Version 6.0.2600 Copyright © 2006 Microsoft Corporation. All rights reserved". The main area shows a session log:

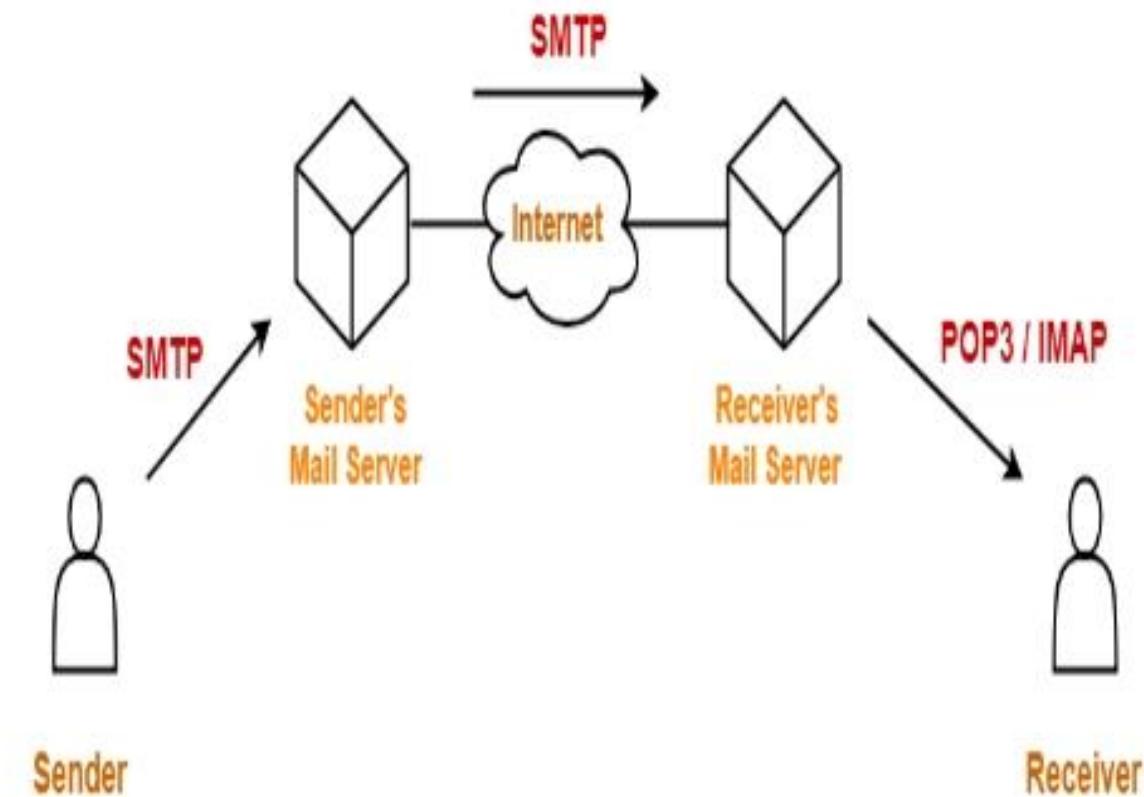
```
C:\>mshta http://163.121.12.40
Ftp> user 163.121.12.40
Name (163.121.12.40): user
230 Microsoft FTP Service
User 163.121.12.40 (user): user
331 Password required for user.
Password:
230 User user logged in.
Ftp>
```

open
open
ls
ls
cd
cd
bin
bin
get
get
mget
mget
Put
Put
bye
bye

Mail Server and Clients

❖ Mail Clients

- **Web based**
 - Hotmail
 - gmail
- **Non web based**
 - Outlook express
 - Microsoft Outlook





Mail Protocols

- **SMTP (send mail transfer Protocol)**
 - It is the common language used by the majority of Mail Servers to send messages back and forth to other Mail Servers or Email Clients
- **POP3 “Post Office Protocol version 3”**
 - In order to collect email messages from the Mail Server, the Email Client contacts the Mail Server.
 - Download messages on the hard disk
 - You can work Offline
 - Keep the user's quota on the server
- **IMAP4 “Internet Message Access Protocol version 4”**
 - Retrieve only message header

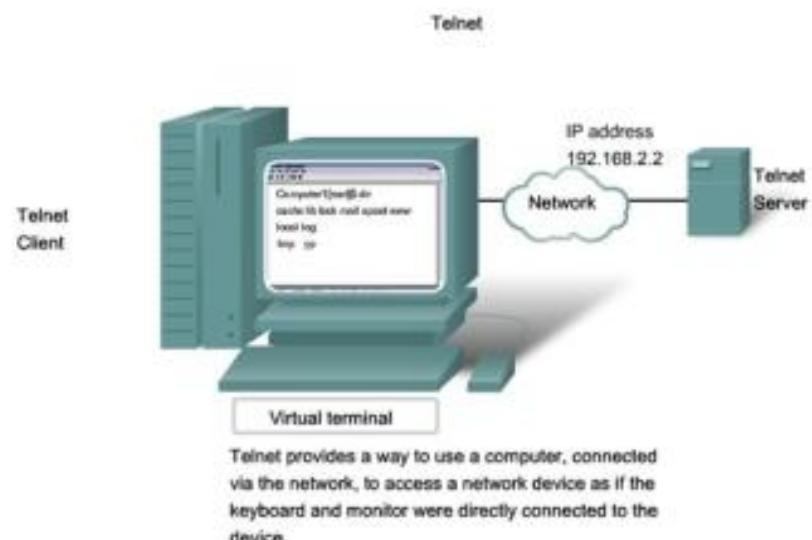


Telnet /SSH

- Telnet/ssh is a user command and an underlying TCP/IP protocol for accessing remote computers.
- Through Telnet/ssh, an administrator can access someone else's computer remotely

Telnet client

- Built in MS-Windows Telnet client
- Third party programs





Network Hardware

Devices

Medium

❖ Computers / Peripherals

Any device that can connect to network with NIC

Ex: Computer

- ✓ Mobile
- ✓ Laptop-
- ✓ Printers-
- ✓ Cameras
- ✓ smart TV
- ✓ -etc





NIC (Network Interface Card)

- Called **network interface controller**, **network adapter** or **LAN adapter**.
- Operate at the physical layer of OSI/RM
- hardware component without a computer cannot be connected over a network cable (interface between the PC and the network)
- Resides in the motherboard of the PC
 - Internal NIC (plugs into the motherboard directly)
 - External NIC (Wireless and USB based)
- Have A physical Address burned on the card called Mac.





LAN Segment Limitations



- Signals degrade with transmission distance.
- Each Ethernet type has a maximum segment length.



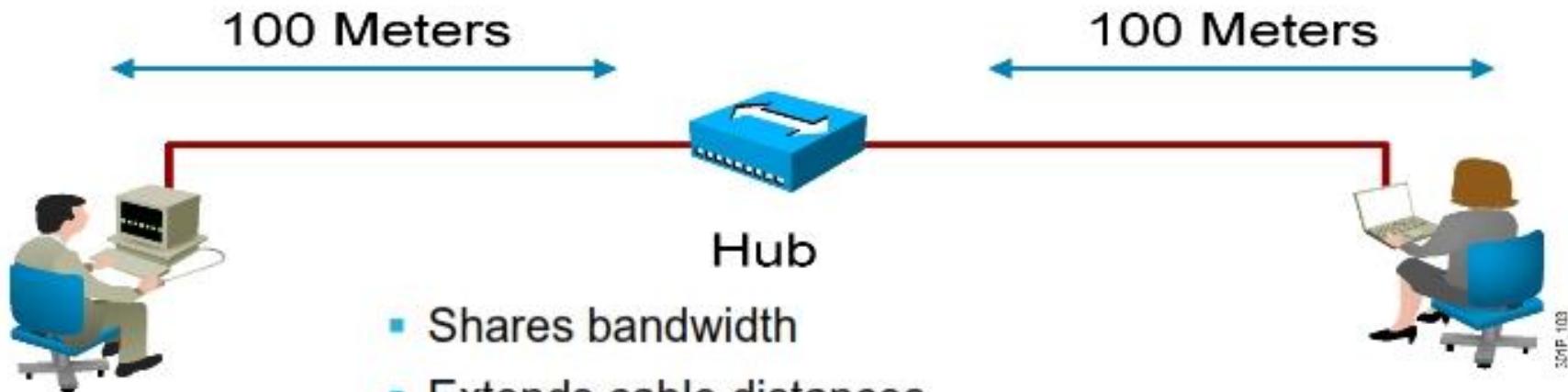
❖ Repeater

- Operates at the physical layer.
- Regenerate the signal over the same network before the signal becomes too weak or corrupted
- Only extend the length of the signal to its original strength
- Does not amplify the signal.
- 2 port device.



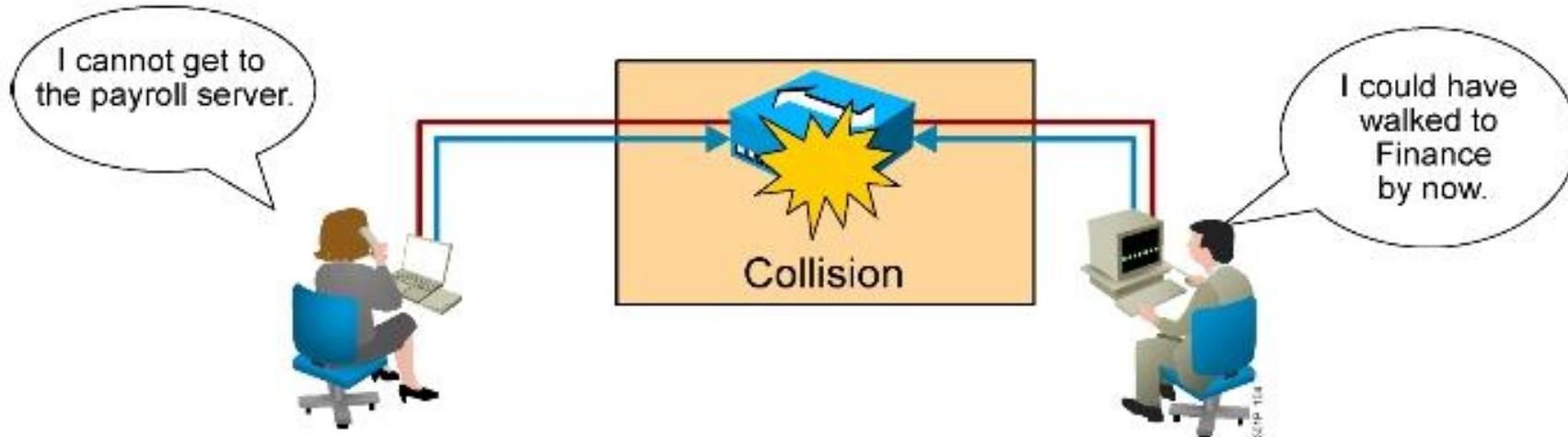


Extending LAN Segments



- Shares bandwidth
- Extends cable distances
- Repeats or amplifies signal
- It is layer 1 device
- It works only with bits
- Must work with half duplex communication

Collisions



- All ports of the hub have the same collision domain and broadcast domain.
- Collisions makes the network very slow and congested

CSMA/CD

Carrier sense

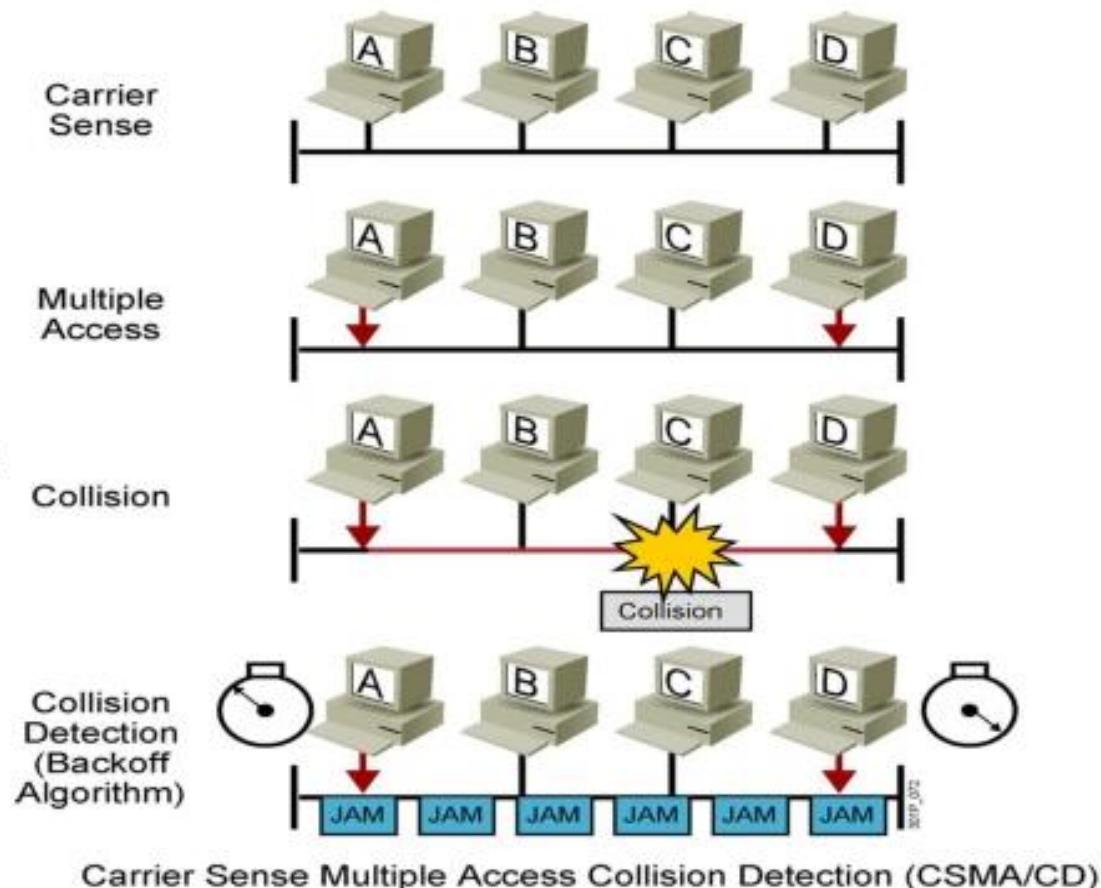
Each station continuously listens for traffic on the medium to determine when gaps between frame transmissions occur.

Multiple access

Stations may begin transmitting any time they detect that the network is quiet (there is no traffic).

Collision detect

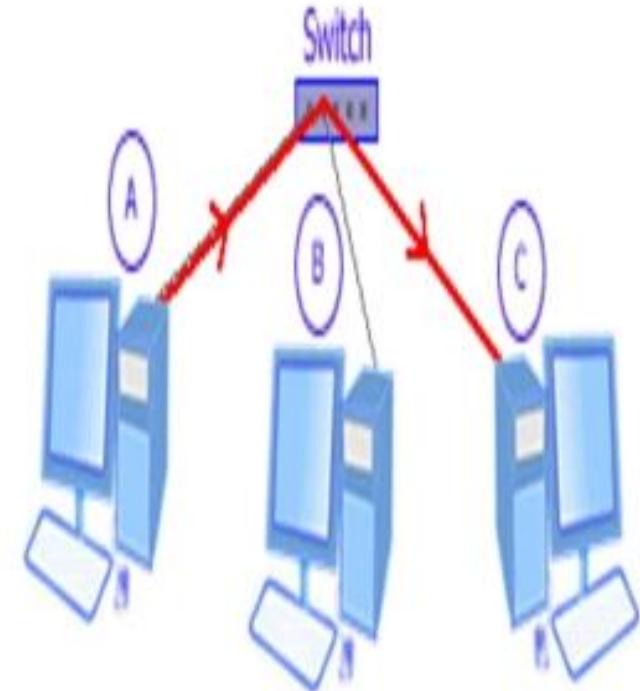
This means that if any collision occurs, it will be detected immediately





❖ Switch

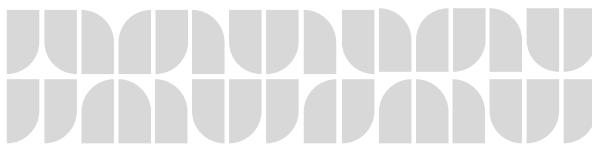
- Allow different nodes to communicate with each other at the same time without slowing each other down.
- Imply less traffic and high performance and effective.
- Switch is data link layer device.
- The switch can perform error checking before forwarding data.
- less collision domain of hosts



❖ Switch

- **Layer 2 switch**
 - LAN switch
 - Forwards traffic based on the MAC address
- **Layer 3 switch**
 - Routing switch
 - Forwards traffic based on IP Address
 - Used for Inter-VLAN routing
 - Don't have WAN connectivity





❖ Router

- Allow different networks to communicate with each other (redirect packets between networks)
- Routes data packets based on their IP addresses.
- Routers are protocol dependent
- Operate at Network Layer device.
- Normally connect LANs and WANs together
- have a dynamically updating routing table based on which they make decisions on routing the data packets.





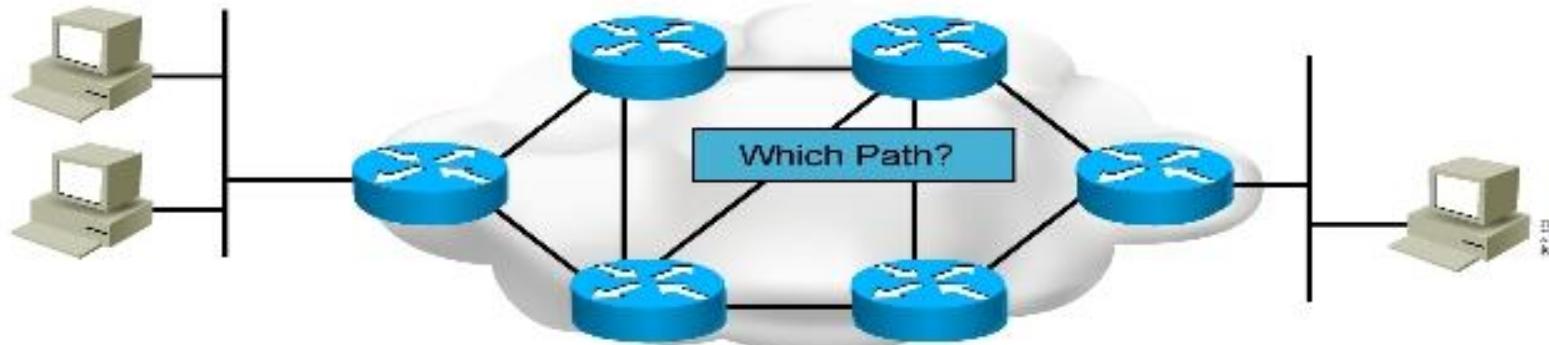
❖ Router

– Path Determination :

- Getting update about the networks and send its updates to the other routers using the routing protocol configured

– Packet forwarding:

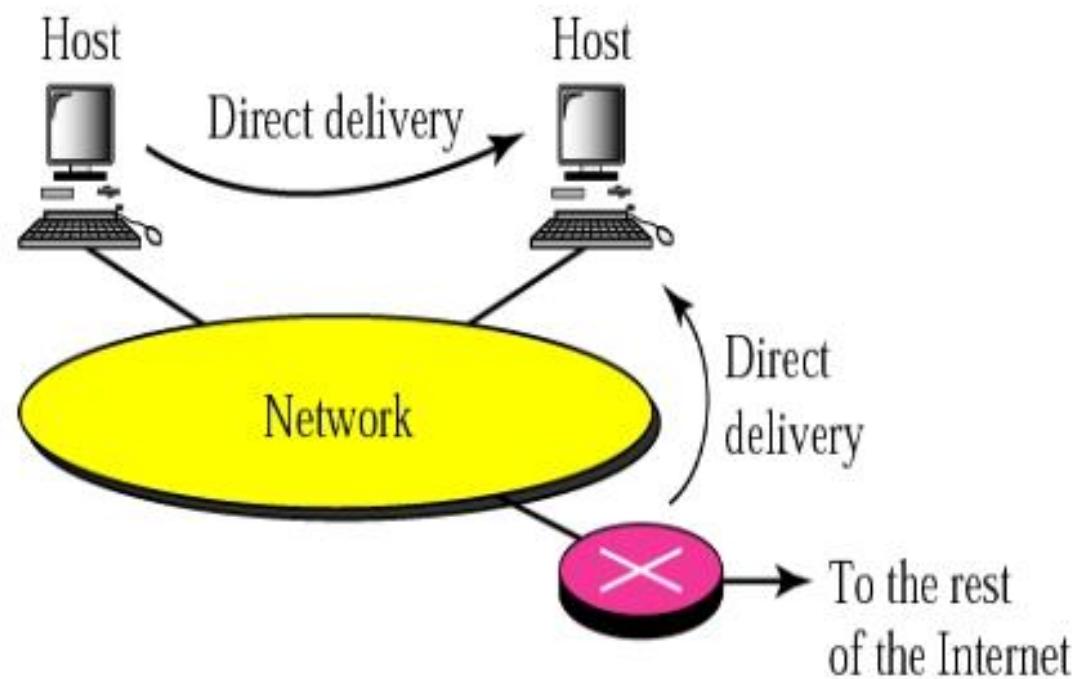
- Routers use the routing table to know where to forward packets using the best path out of its serial interfaces.



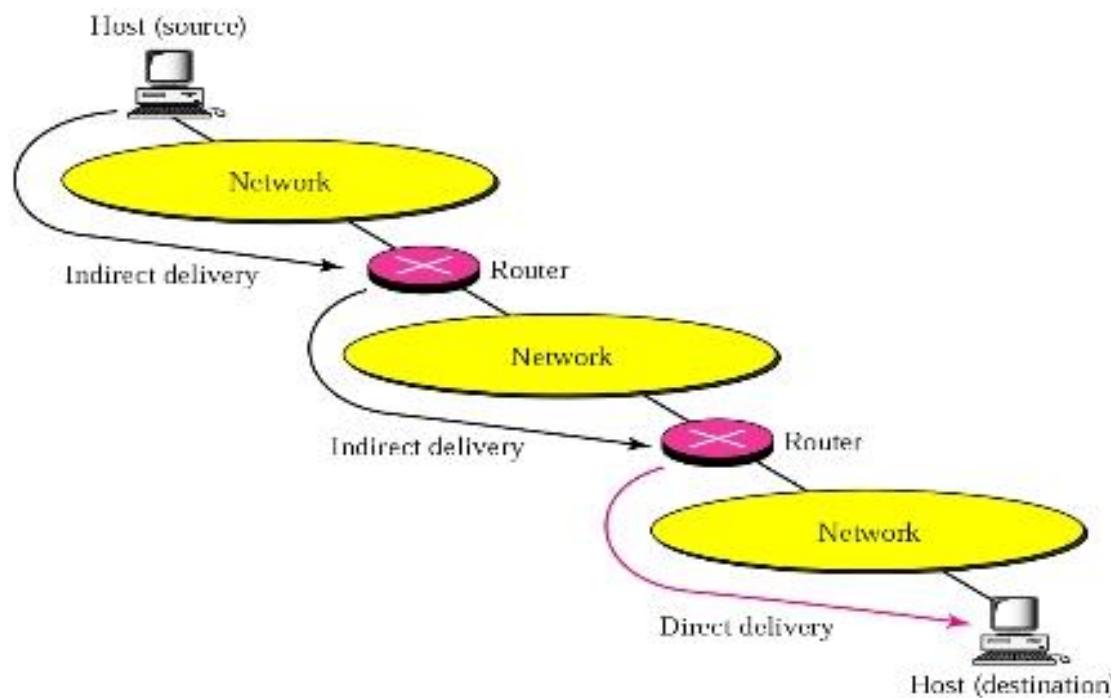


DELIVERY OF IP PACKETS

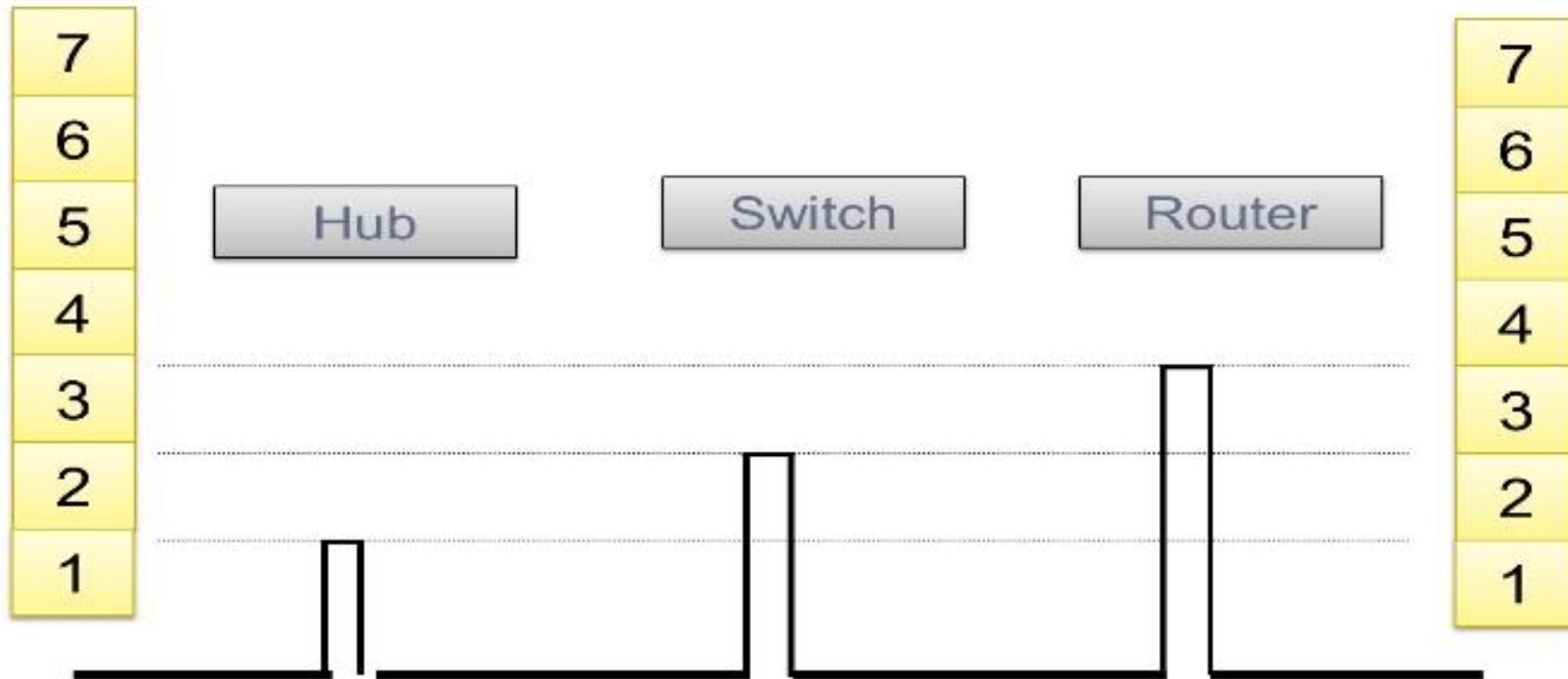
Direct delivery



Indirect delivery



❖ Hub, Switch, Router Layers





❖ Splitter

- is a device that divides a telephone signal into two or more signals,
- each carrying a selected frequency range
- can also reassemble signals from multiple signal sources into a single signal



❖ Your Home "Router"

- Main Function is Routing
- Act as Switch
- Act as DHCP
- Act as Firewall
- Act As Access point



Network Transmission Media

Wired

Wireless



Network Transmission Media

- To transmit data, a medium must exist
- The medium can be in the form of cables or wireless medium
- Most common used media for data networks
 - **Wired Media**
 - **Wireless media**



Network Transmission Media

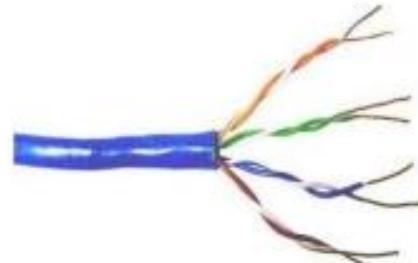
- **Cable Media**

- Twisted Pair Cables
 - UTP
 - STP
- Coaxial Cables
- Fiber Optic Cables

- **Wireless Media**

- WIFI
- Infra red
- Microwave
- Bluetooth

- Unshielded twisted pair (UTP)



- Shielded twisted pair (STP)



- Coaxial cable



- Fiber optic



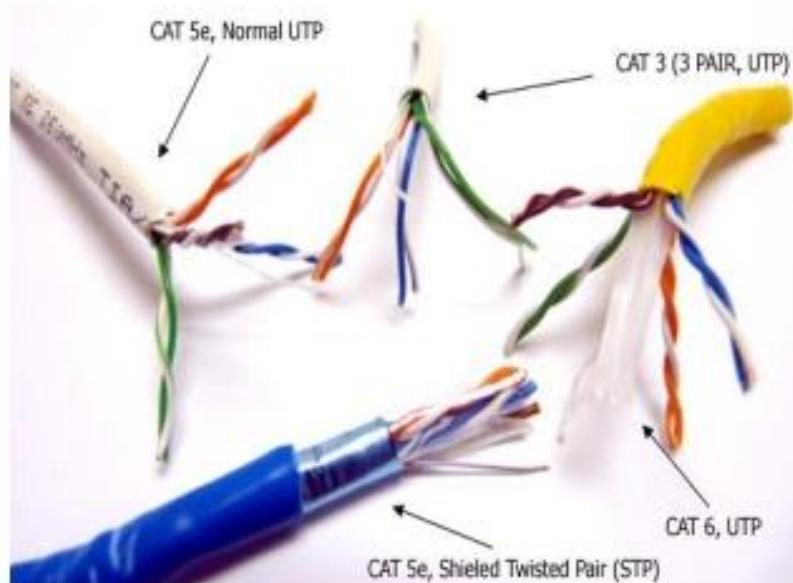
Network Transmission Media -Twisted pair cable

- Most widely used (Ethernet networks)
- Two basic types
 - STP
 - Shielded twisted pair
 - Protected
 - Hard to install
 - UTP
 - Unshielded twisted pair
 - Most common
 - Easy to install
 - Less expensive
 - Effect by electromagnetic interference
- Use RJ-45 connectors
- Crimper tool attach the twisted pair cable to RJ-45





UTP Categories



(a) Category 3 UTP.

(b) Category 5 UTP.

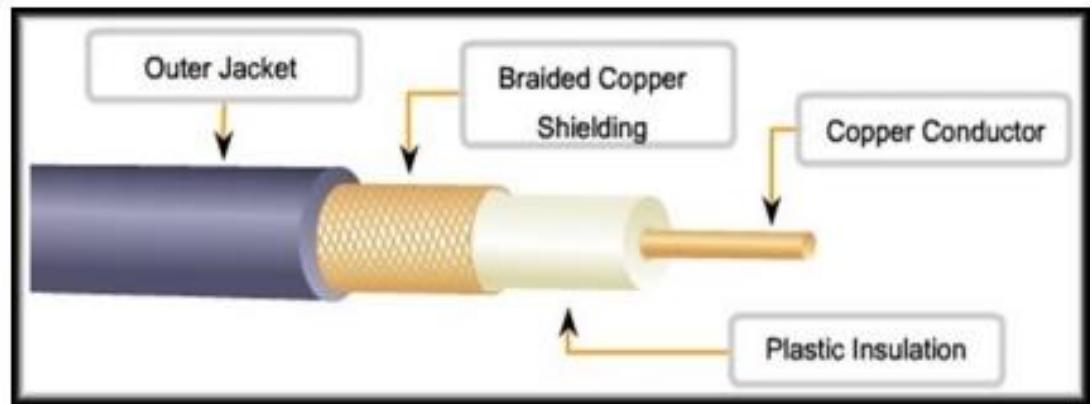
Type	Use
Category 1	Voice Only (Telephone Wire)
Category 5	Data to 100 Mbps (Fast Ethernet)
Category 5e	Data to 1 Gbps (Giga Ethernet)
Category 6	Data to 1 – 10 Gbps (Giga Ethernet)





Coaxial Cable

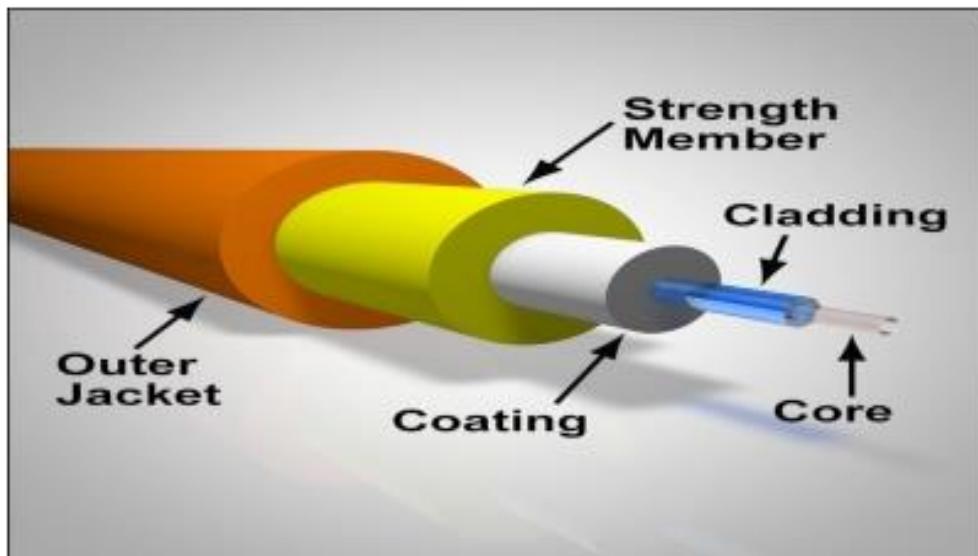
- High capacity cable
- Used for video transfer
- Has two types
 - Thick coaxial cable (Thicknet)
 - $\frac{1}{2}$ inch diameter
 - Thin coaxial cable (Thinnet)
 - $\frac{1}{4}$ inch diameter
- Use BNC connector





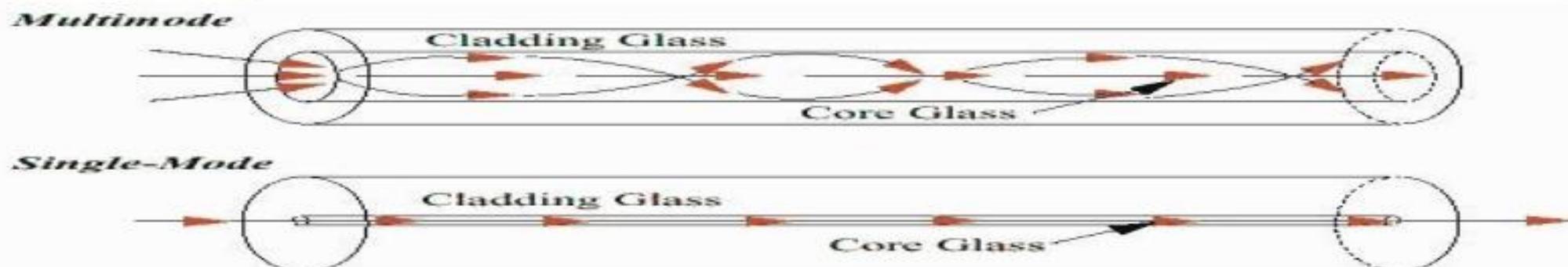
Fiber optic

- Fiber optic cabling is composed of the following components:
 - The core that carries the signals. It is made of plastic or glass
 - The cladding maintains the signal in the center of the core as the cable bends.



Fiber Optic Types

Type	Description
Single Mode	<ul style="list-style-type: none">Transfer data through the core using a single light rayThe core diameter is around 9 micronsSupports a large amount of dataCable length can extended a great distance
Multi-Mode	<ul style="list-style-type: none">Transfers the data through the core using multiple light raysThe core diameter is around 50 to 50 micronsCable length are limited in distance compared to single mode





Fiber Optic advantages

- **Advantages**

- Faster than twisted pair and coaxial
- Send data as light pulses over glass medium
- Free of electromagnetic interference
- Highly resistance to Eavesdropping
- Support extremely high data transfer rate
- Allow greater cable distances without repeater

- **Disadvantages**

- Expensive
- Hard to install



Wireless Media

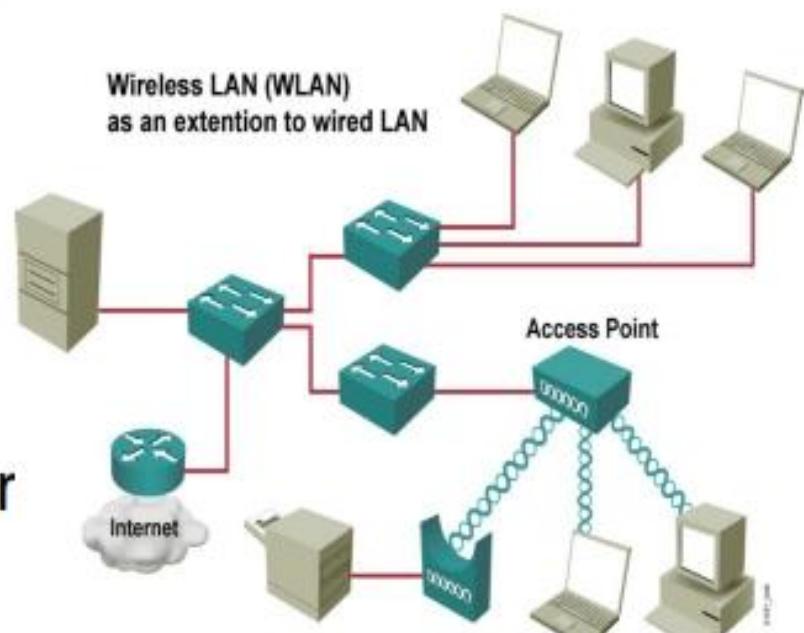
- Flexible (Used in areas where it is hard to install cables)
- Used in wireless LANs
- Hybrid environment is one which wireless components communicate with a network that use cables





SIMILARITIES BETWEEN WLAN AND LAN

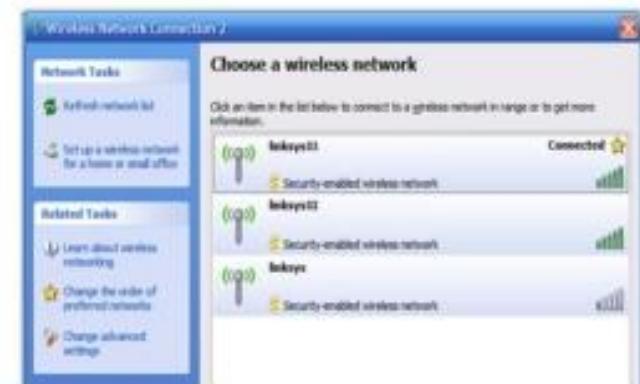
- Transmits data over the air vs. data over the wire
- Looks like a wired network to the user
- Defines physical and data link layer
- Uses MAC addresses
- The same protocols/applications run over both WLANs and LANs.
 - IP (network layer)
 - Web, FTP, SNMP (applications)





SERVICE SET IDENTIFIER (SSID)

- **Unique identifier** that client devices use to distinguish between multiple wireless networks in the same vicinity (separate WLANs)
- Alphanumeric, case-sensitive entry from 2 to 32 characters long.
- Sometimes access points may even have multiple **SSIDs**.
- The SSID is configured on the AP and can be either **broadcasted** to the outside world or **hidden**.
- The SSID must match on client and access point.
- Access point broadcasts one SSID in beacons.
- Client cannot be configured without SSID.





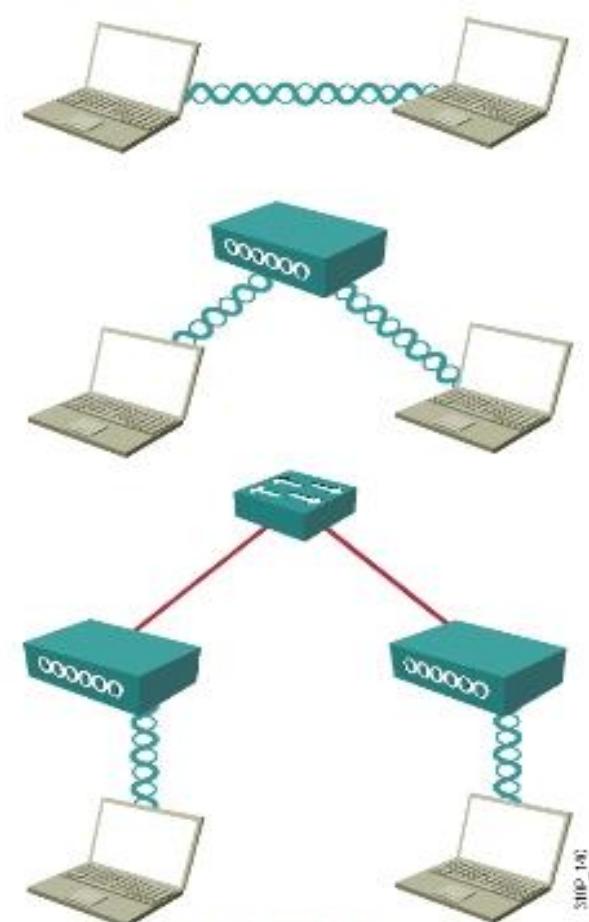
SERVICE MODES

Independent Mode:

- Mobile clients connect directly without an intermediate access point.
- Ad hoc mode

Infrastructure Mode:

- Mobile clients use a single access point for connecting to each other or to wired network resources.



WLAN

■ Advantages

- Provide the **ability to work anywhere** within range of your access points
- **Extends the range of your network without running additional wires**

■ Disadvantages

- Introduces serious **security concerns**
- provides **much less bandwidth** than wired devices

Thank You

