

Computer Communication Networks

Lecture No. 1

Reference books used in lectures

- 1- Computer Networks, Tanenbaum
- 2- Communication networks, Sharam Hekmat
- 3- Computer Networks, a system approach, L. Peterson

Computer Network Lectures

- 1- Introduction
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1- Introduction

1.1 Definitions

Computer network: A collection of autonomous computers interconnected by a single technology. Two computers are said to be interconnected if they are able to exchange information. The connection can be via a copper wire; fiber optics, microwaves, infrared, and communication satellites can also be used

1.2 Use of Computer Networks: why people are interested in computer networks and what they can be used for? The response is given for two types of applications:

A- For companies or Business applications:- Computer networks are very important for companies today for the following reasons:

- Resource sharing: The goal is to make all programs, equipments, and especially data available to anyone on the network without regard to the physical location of the resource and the user. An example is having a group of office workers share a common printer.
- Sharing information: Every large and medium-sized company and many small companies are vitally dependent on computerized information. Most companies have customer records, inventories, accounts receivable, financial statements, tax information, and much more online. For smaller companies, all the computers are likely to be in a single office or perhaps a single building, but for larger ones, the computers and employees may be scattered over dozens of offices and plants in many countries. Usually the client server model is used in all companies as in the figure 1-1.

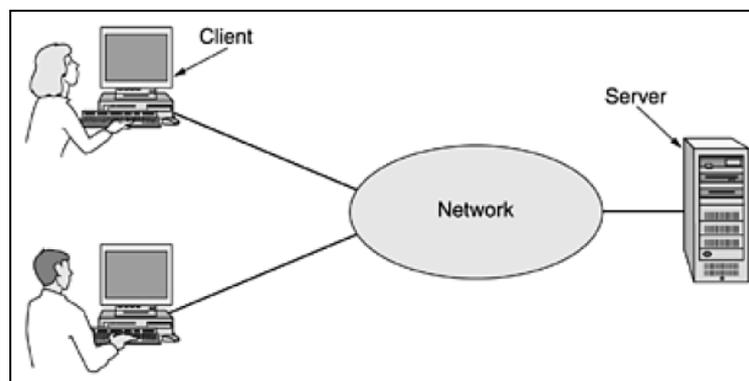


Fig 1-1 Client server model

If we look at the client-server model in detail, we see that two processes are involved, one on the client machine and one on the server machine.

Communication takes the form of the client process sending a message over the network to the server process. The client process then waits for a reply message. When the server process gets the request, it performs the requested work or looks up the requested data and sends back a reply.

- Powerful communication medium: among employees. Virtually every company that has two or more computers now has e-mail (electronic mail), which employees generally use for a great deal of daily communication. With a network, it is easy for two or more people who work far apart to write a report together. When one worker makes a change to an online document, the others can see the change immediately, instead of waiting several days for a letter.

- doing business electronically: Using computer networks, manufacturers can place orders electronically as needed. Being able to place orders in real time reduces the need for large inventories and enhances efficiency.
- Electronic commerce: doing business with consumers over the Internet. Airlines, bookstores, and music vendors have discovered that many customers like the convenience of shopping from home. Consequently, many companies provide catalogs of their goods and services online and take orders on-line. This sector is expected to grow quickly in the future. It is called e-commerce.

B- Home application:

- Access to remote information: comes in many forms. It can be surfing the World Wide Web for information or just for fun. Information available includes the arts, business, cooking, government, health, history, hobbies, recreation, science, sports, travel, and many others.
- Person-to-person communication: E-mail is already used on a daily basis by millions of people all over the world and its use is growing rapidly. It already routinely contains audio and video as well as text and pictures. Smell may take a while. Other communication-oriented applications include using the Internet to carry telephone calls, video phone, and Internet radio, three rapidly growing areas. Another application is tele-learning, meaning attending 8 A.M. classes without the inconvenience of having to get out of bed first. In the long run, the use of networks to enhance human-to-human communication may prove more important than any of the others.
- Interactive entertainment: a huge and growing industry. The killer application here (the one that may drive all the rest) is video on demand. A decade or so hence, it may be possible to select any movie or television program ever made, in any country, and have it displayed on your screen instantly. New films may become interactive,
- Electronic commerce: Home shopping is already popular and enables users to inspect the on-line catalogs of thousands of companies.

Tag	Full name	Example
B2C	Business-to-consumer	Ordering books on-line
B2B	Business-to-business	Car manufacturer ordering tires from supplier
G2C	Government-to-consumer	Government distributing tax forms electronically
C2C	Consumer-to-consumer	Auctioning second-hand products on line
P2P	Peer-to-peer	File sharing

2- Network hardware:

There is no generally accepted taxonomy into which all computer networks fit, but four dimensions stand out as important: Transmission technology, scale, access restriction and switching models.

We will examine each of these in turn.

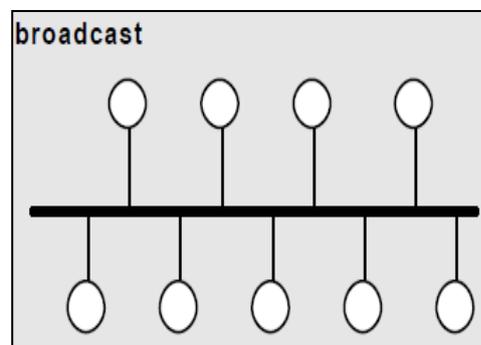
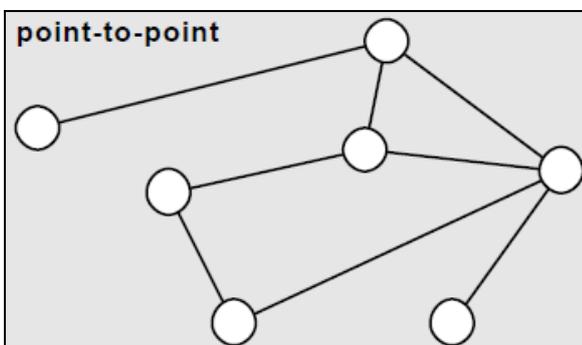
2-1 Classification of Networks by the Transmission technology:

There are two types of transmission technology that are in widespread use. They are as follows:

1. Broadcast links.
2. Point-to-point links.

Broadcast networks: have a single communication channel that is shared by all the machines on the network. Short messages, called packets in certain contexts, sent by any machine are received by all the others. An address field within the packet specifies the intended recipient. Upon receiving a packet, a machine checks the address field. If the packet is intended for the receiving machine, that machine processes the packet; if the packet is intended for some other machine, it is just ignored.

point-to-point networks consist of many connections between individual pairs of machines. To go from the source to the destination, a packet on this type of network may have to first visit one or more intermediate machines. Often multiple routes, of different lengths, are possible, so finding good ones is important in point-to-point networks. As a general rule (although there are many exceptions), smaller, geographically localized networks tend to use broadcasting, whereas larger networks usually are point-to-point. Point-to-point transmission with one sender and one receiver is sometimes called uni-casting. Need for routing algorithm in this type of transmission.



2-2 Classification of networks by Scale

Networks can be classified regarding the scale of the network to many types as in the table below. These can be divided into local, metropolitan, and wide area networks. Finally, the connection of

two or more networks is called an internetwork. The worldwide Internet is a well-known example of an internetwork. Distance is important as a classification metric because different techniques are used at different scales.

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	
100 m	Building	Local area network
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

LAN (Local Area Network): physical distance between the hosts is within a few kilometers. LANs are typically used to connect a set of hosts within the same building (e.g., an office environment) or a set of closely-located buildings (e.g., a university campus). Three standard types of LAN: Ring, Bus, and Star topology.

MAN (Metropolitan Area Network): MANs cover distances of up to a few hundred kilometers and are used for interconnecting hosts spread across a city.

WAN (Wide Area Network): used to connect hosts spread across a country, a continent, or the globe. Usually WAN have a random topologies. LANs, MANs, and WANs usually coexist: closely-located hosts are connected by LANs which can access hosts in other remote LANs via MANs and WANs.

2-3 Classification by Access restrictions:

Two types of network can be found regarding the access restrictions:

- a) **Private networks** : Most networks are for the private use of the organizations to which they belong. Networks maintained by banks, insurance companies, airlines, hospitals, and most other businesses are of this nature.
- b) **Public networks**, on the other hand, are generally accessible to the average user, but may require registration and payment of connection fees. Internet is the most-widely known

example of a public network. Technically, both private and public networks may be of LAN, MAN, or WAN type, although public networks, by their size and nature, tend to WAN.

2-4 Classification by Switching model employed by the nodes

In the point-to-point model, nodes either employ *circuit switching or packet switching*. Suppose that a host A wishes to communicate with another host B. In circuit switching, a dedicated communication path is allocated between A and B, via a set of intermediate nodes. The data is sent along the path as a continuous stream of bits. This path is maintained for the duration of communication between A and B, and is then released. In packet switching, data is divided into packets (chunks of specific length and characteristics) which are sent from A to B via intermediate nodes. Each intermediate node temporarily stores the packet and waits for the receiving node to become available to receive it. There is also a third type which is the store and forward (or message switching) as will be given in details next.

3- Network Topologies:-

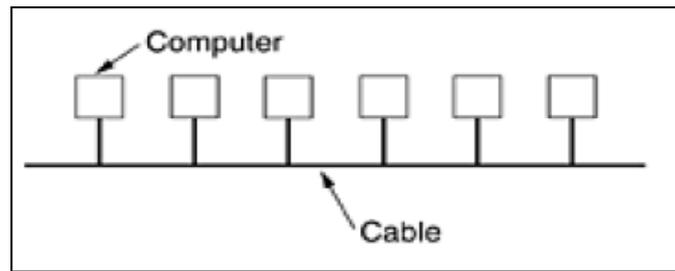
LAN is a single geographical location network, such as office building, school, etc. Typically this network type is of high speed and cheaper components.

WANS are more than one geographical location often connecting separated LANs to form one large network. WAN is usually slower, requiring costly hardware, routers, dedicated leased lines and complicated implementation procedures. LAN have standard topologies rather than in the case of WAN topology is almost random.

Network topologies are Physical and logical network layout. Physical is the actual layout of the computer cables and other network devices. The logical layout is the way in which the network appears to the devices that use it. Common topologies are Bus, ring, star, mesh and wireless.

3-1 Bus topology:

- Uses a backbone to which all of the computers on the network are connected.
- Use broadcasting transmission technology
- Systems connect to this backbone using T connectors or taps.
- At any instant one machine is the master (allowed to transmit), all other machines are required to refrain from sending.
- Coaxial cablings (10BaseT, 10Base5) were popular options.



Bus topology:

Advantages of Bus	Disadvantages of Bus
Cheap and easy to implement	Network disruption when computers are added or removed
Require less cable	A break in the cable bus will prevent all systems from accessing the network.
Does not use any specialized network equipment.	Difficult to troubleshoot.
Supported by most software and hardware systems	Need of arbitration process

3-2 Ring topology:

Logical ring meaning that data travels in circular fashion from one computer to another on the network. Typically *Token Ring of IBM* technology are used to implement a ring network. Ring networks are most commonly wired in a star configuration (physically). Token Ring has multi-station access unit (MSAU), equivalent to Hub or switch. MSAU performs the token circulation internally. Ring uses broadcasting transmission technology. Each bit propagates around, not waiting for the rest of the packet to which it belongs. Arbitration rule to access the ring is needed and this is accomplished via *token control* in the token ring. The token control contain 3 bytes and nodes wishing transmission wait an ideal token to start transmitting data with source and destination address. When data are received by the destination node then this node will transmit an acknowledgment to the source. Source receive the acknowledgment and pass then the token control to next node desiring transmission. The token control is as follow:

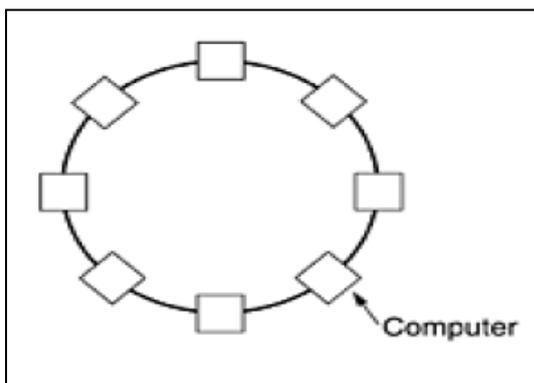
1 byte 1 byte 1 byte

Start delimiter	Access control	End delimiter
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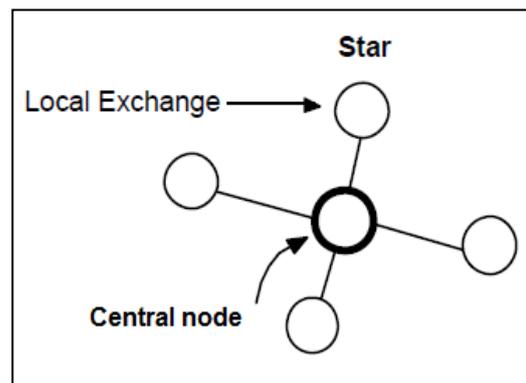
Advantages of Ring	Disadvantages of Ring
Cable faults are easily located, making troubleshooting easier	Expansion to the network can cause network disruption
Ring networks are moderately easy to install	A single break in the cable can disrupt the entire network.
Better with high traffic rates than Ethernet	Great deal of maintenance and not suited for large networks

3-3 Star topology:-

- All computers/devices connect to a central device called hub or switch.
- Each device requires a single cable
- point-to-point connection between the device and hub.
- Most widely implemented
- Hub is the single point of failure



Ring topology



Star topology

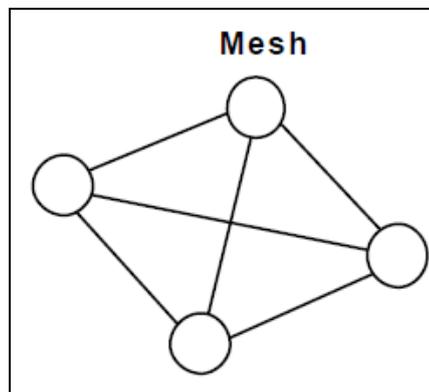
Advantages of Star	Disadvantages of Star
Easily expanded without disruption to the network	Requires more cable
Cable failure affects only a single User	A central connecting device allows for a single point of failure
Easy to troubleshoot and isolate problems	More difficult to implement
Low traffic requires a low specification twisted pair cable	

3-4 Mesh topology:

- Each computer connects to every other.

- High level of redundancy.
- Rarely used.
- Wiring is very complicated and Cabling cost is high
- Troubleshooting a failed cable is tricky
- A variation hybrid mesh – create point to point connection between specific network devices, often seen in WAN implementation.

Advantages of Mesh	Disadvantages
Provides redundant paths between devices	Requires more cable than the other LAN topologies
The network can be expanded without disruption to current uses	Complicated implementation



3-5 Wireless Network:

- Do not require physical cabling
- Particularly useful for remote access for laptop users
- Eliminate cable faults and cable breaks.
- Signal interference and security issue.

Advantages of Wireless	Disadvantages
Allows for wireless remote access	Potential security issues associated with wireless transmissions
Network can be expanded without disruption to current users	Limited speed in comparison to other network topologies

3-6 IEEE and Networking standards:

- Institute of Electrical and Electronic Engineers (IEEE) developed a series of

networking standards

- Networking technologies developed by manufacturers are Compatible
- Cabling, networking devices and protocols are all interchangeable under the banner of a specific IEEE.

Example of protocols or IEEE standards:

1- 802.3 IEEE Ethernet standard

- Defines characteristics for Ethernet networks.
- New additions: 802.3u for Fast Ethernet, 802.3z for Gigabit Ethernet, referred to as 802.3x., 802.3ac 10gbits/s, in 2009
- Speed: Original 10Mbps, Fast Ethernet 100Mbps, Gigabit Ethernet 1000Mbps
- Topology: bus or star.
- Media: Coaxial and twisted pair cabling, also fiber optic cable.
- Access method: CSMA/CD

Specification	Name
802.1	Internetworking
802.2	The LLC(Logical Link Control) sublayer
802.3	CSMA/CD (Carrier Sense Multiple Access with Collision Detection) for Ethernet networks
802.4	A token passing bus
802.5	Token Ring networks
802.6	Metropolitan Area Network (MAN)
802.7	Broadband Technical Advisory Group
802.8	Fiber-Optic Technical Advisory Group
802.9	Integrated Voice and Data Networks
802.10	Standards for Interoperable LAN/MAN Security (SILS) (Network Security)
802.11	Wireless networks
802.12	100Mbps technologies, including 100BASEVG-AnyLAN

IEEE standard for some network topologies

2- 802.11b IEEE Standard - Wireless

- Specifies the characteristics of wireless LAN Ethernet networks.
- Special devices called wireless access points to allow communicate.
- Also connect to wired networks to create wireless portions of entire networks.
- Access method: Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA), a variation of CSMA/CD.
- Topology: physical wireless, logical bus
- Protocols: (a) 802.11b 1999 2.4GHz, 11Mbits/s, (b) 802.11g 2003 2.4GHz, 54 Mbits/s, (c) 802.11n 2008 2.4G,5GHz, 248Mbits/s

Wide Area Network (WAN):

Definition:

WAN:- spans a large geographical area, often a country or continent. It contains a collection of machines intended for running user programs. We call these machines hosts, they are connected by a communication subnet. Subnet consists of two distinct components: transmission lines and switching elements. Transmission lines can be copper wire, optical fiber, or even radio links. Switching elements are specialized computers that connect three or more transmission lines. When data arrive on an incoming line, the switching element must choose an outgoing line on which to forward them. These switching computers have been called by various names in the past; the name router is now most commonly used. WAN usually has an irregular topology. "subnet" is in order here. Originally, its only meaning was the collection of routers and communication lines that moved packets from the source host to the destination host.

Backbone:- Common link to all the network within an organization. It allows users on different net. Segment to communicate and also allows data into and out of the local network.

Bridge:- links two networks of the same type, such as Ethernet to Ethernet or Token ring to Token ring.

Gateway:- connects two networks of different types like Ethernet to token ring.

Router:- Operates rather like gateways and can either connect two similar networks. It acts like a filter for packets arriving to. There is an algorithm implemented in the router which is the routing

algorithm. Routing algorithm tries to find the best route for the transmission of packets from source to destination.

Routers, bridges, and gateways only allow data traffic through itself when data are intended for another network which is outside the connected network. This will filter traffic and stop traffic not intended for the network from clogging up the backbone.

Repeater:- network connections suffer from attenuation and pulse distortion for a given cable specification and bit rate. Repeater can be used to increase the maximum interconnection length by :

- Clean signal pulse
- Pass signal between attached segments
- Boost signal power
- Possibly translate between two different media types.

