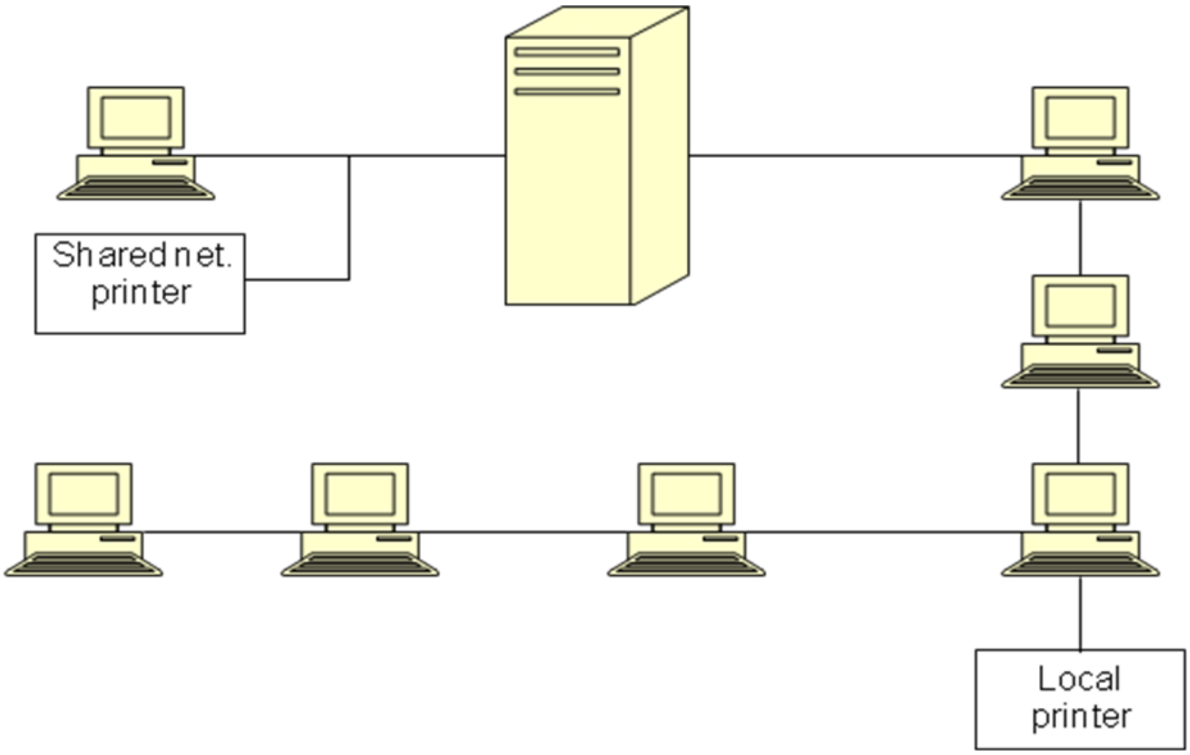
Types of LAN:

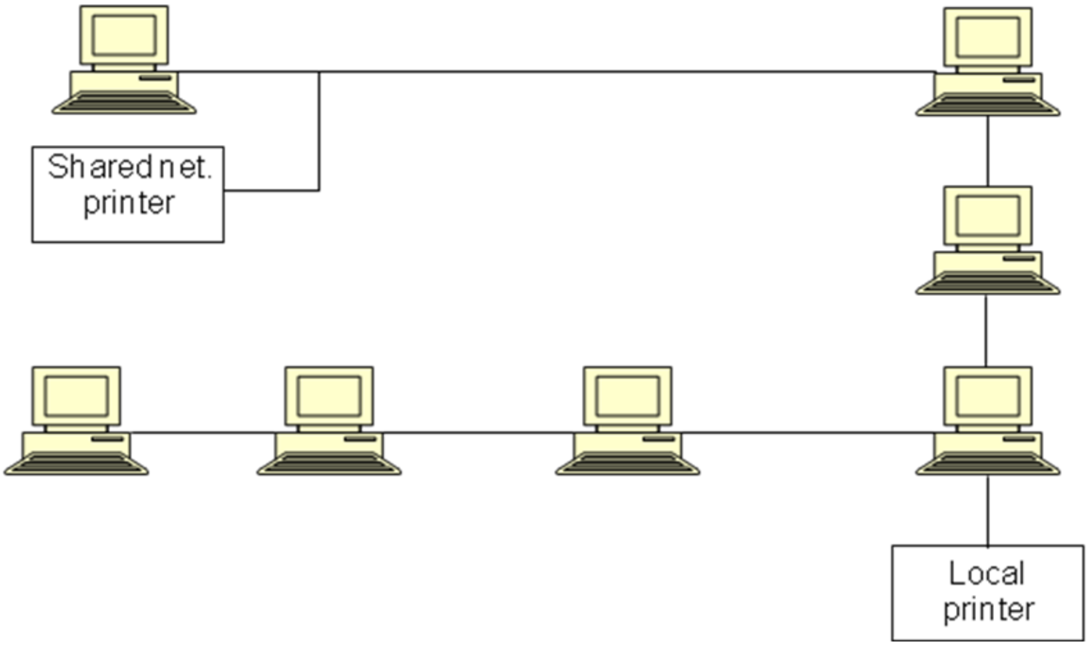
1-Client/Server LAN:

This LAN consists of requesting computers, called clients and supplying devices that provide services called servers. In client server LAN, client share the services of centralized computer called a server. In this case, the server is a file server or database server or print server or fax server or mail server.



2-Peer-to-Peer LAN:

The word peer denotes one who is equal in standing with another. Peer-to-Peer LAN is one in which all computers on the network communicate directly with one another without relaying on a server. Peer-to-Peer LANs are less expensive than client/server LANs and work effectively up to 25 computers, so they are appropriate for networking in small groups. Many LANs mix elements from client/server and Peer-to-Peer models.



Components of LANs:

1- Connecting cable system.
2- Computer with interface cards.
3- Network operating system.
4- Other shared devices: printers, faxes, scanners, storage devices.
5- Bridges and gateways.

Bridge: Is an interface that enables similar networks to communicate.

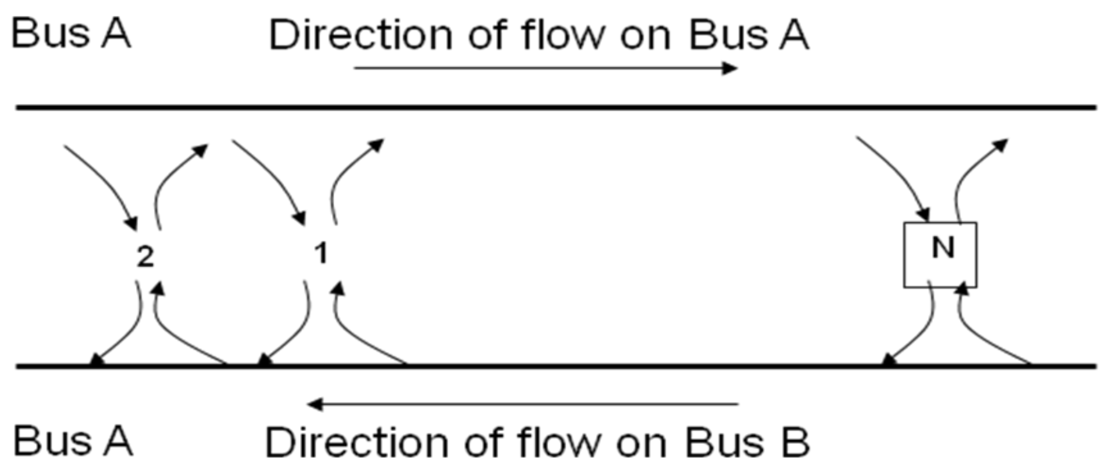
Gateway: Is an interface that enables dissimilar networks to communicate, such as LAN with WAN.

MANs (Metropolitan Area Networks):

MAN is characterized by:

1- It is bigger version of LAN.
2- It uses similar technology of LAN.
3- It may be private or public.
4- Can be used with data and voice.
5- It has one or two cables and does not contain switching elements.
6- It can be implemented by Distributed Queue Dual Bus (DQDB).

DQDB: Consists of two unidirectional buses (cables) to which all the computers are connected as shown below:



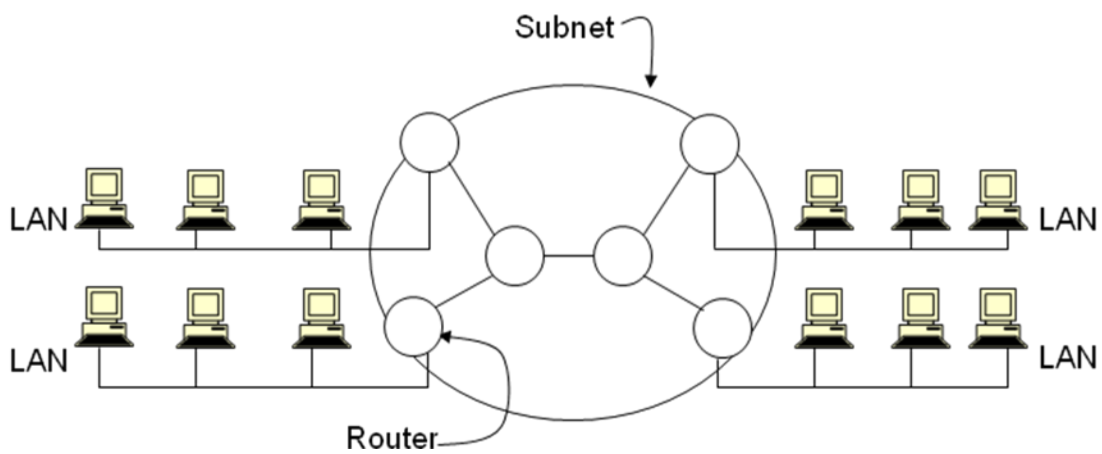
WANs (Wide Area Networks):

WAN covers large geographical area, often a country or continent. WAN consists of two components:

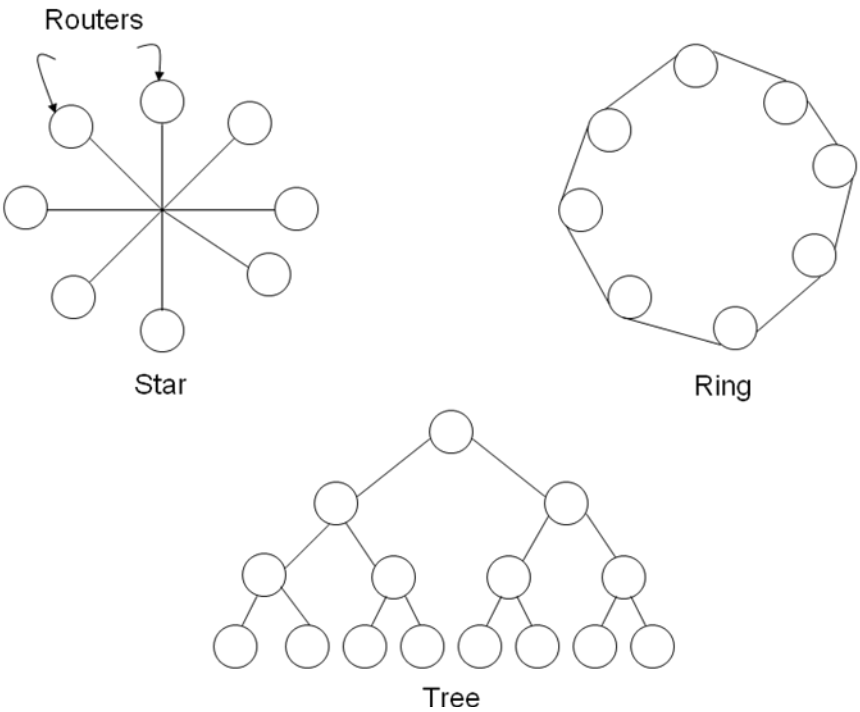
1- Transmission lines.
2- Switching elements.

Switching elements: are specialized computers used to connect two or more transmission lines. These computers are also called packet switching nodes, or intermediate systems, or data switching exchanges, or the most general names routers.

Subnet: the collection of communication lines and routers from the subnet as shown below:



The job of subnet is to carry messages from host to host (computer to computer). Usually point to point subnet is used with different router interconnection topologies as shown below:



A second possibility for a WAN is a satellite or ground radio system. Each router has an antenna through which it can send and receive.

Wireless Networks:

Wireless transmission sends signals through air or space. The wireless transmission medium is the electromagnetic spectrum. Wireless networks are designed for two way transmission of data which are called mobile data networks. Mobile data networks can be classified into:

1- Networks transmit data to and from handheld computers.
2- Networks based on a series of radio towers constructed specifically to transmit data.
3- Networks using cellular telephones with analogue modems.
4- Combination of wired and wireless networks, such as (wired) traditional LAN inside a plane and connection to outside is radio link.

Wireless communications have many advantages such as:

1- Can use portable computers in offices, taxes, or buses.

2- Can be used with disasters (fires … etc.) when wiring communication systems are destroyed.
3- Very important to military.

Wireless communications also have some disadvantages such as:

1- Data rate is slow (wireless LAN usually has capacity of 1-2 Mb/s which is slower than wired LAN of 100 Mb/s).
2- Error rate is high.
3- Interference.

Note: Wireless networks and mobile computing are often related but they are not identical, for example portable computers are sometimes wired.

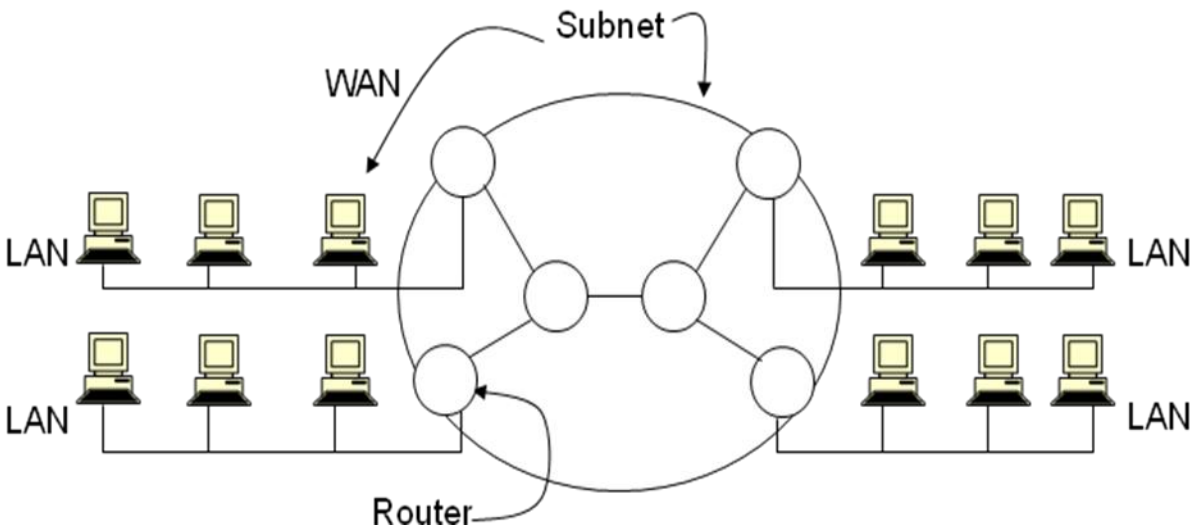
The following table gives an overview of wireless technologies and how they relate to each other.

	Bluetooth 802.15.1	Wi-Fi 802.11	WiMAX	3G Cellular
Typical link length	10m	100m	10 km	Tens of km
Typical bandwidth	2.1 Mbps	54 Mbps	70 Mbps	384+Kbps(per connection)
Typical use	Link a peripheral to a notebook computer	Link a notebook computer to a wired base	Link a building to a wired tower	Link a cell phone to a wired tower

Internetworks:

A collection of interconnected networks is called an internetwork or just internet. The word internet here is not meaning specifically the famous network the Internet.

A common form of internet is a collection of LANs connected by WANs. If we take the previous figure:



and replace label subnet by WAN, this will give us idea about the internet but we must distinguish if the system within closed curve has not hosts then it is a subnet, if it has then it is consider a WAN. The important note is to distinguish between the subnet, network, and internetwork.

Network Performance:

Network performance is measured in two fundamental ways:

1- Bandwidth (Throughput):

The bandwidth of a network is given by the number of bits that can be transmitted over the network in a certain period of time.

Bandwidth and throughput are two of the most confusing terms used in networking. While we would try to give you a precise definition of each term, it is important that you know how other people might use them and for you to be aware that they are often used interchangeably. First of all, bandwidths is literally a measure of the width of a frequency band. For example, a voice telephone line supports a frequency band ranging from 300 to 3300 Hz; it is said to have a bandwidth of (3300Hz-300Hz=3000Hz. If you see the word

bandwidth used in a situation in which it is being measured in Hertz, then it probably refers to the range of signals that can be accommodated.

When we talk about the bandwidth of a communication link , we normally refer to the number of bits per second that can be transmitted on the link. We might say that the bandwidth of an Ethernet is 10 Mbps. A useful distinction might be made, however, between the bandwidth that is available on the link and the number of bits per second that we can actually transmit over the link in practice. We tend to use the word "throughput" to refer to the measured performance of a system. Thus, because of various inefficiencies of implementation, a pair of nodes connected by a link with a bandwidth of 10 Mbps might achieve a throughput of only 2 Mbps. This would mean that an application on one host could send data to the other host at 2 Mbps.

2- Latency (Delay):

Latency corresponds to how long it takes a message to travel from one end of a network to the other. Latency is measured in terms of time. For example, a network might have a latency of 24 msec; that is it takes a message 24 msec to travel from one end to the other. There are many situations in which it is more important to know how long it takes to send a message from one end of a network to the other and back, rather than the one way latency. We call this the Round Trip Time (RTT) of the network.

Latency = Propagation + Transmit + Queue

Propagation = $\frac{Distance}{SpeedofLight}$

Transmit = $\frac{Size}{Bandwidth}$

Where:

Distance is the length of the wire aver which the data will travel. Speed of Light is the effective speed of light over that wire. Size is the size of the packet, and Bandwidth is the bandwidth at which the packet is transmitted.

Note that if the message contains only one bit and we are talking about a single link (as opposed to a whole network), then the Transmit and Queue terms are not relevant, and Latency corresponds to the propagation delay only.

Bandwidth and Latency combine to define the performance characteristics of a given link or channel. Their relative importance, however, depends on the application.

Example:

Calculate the total time required to transfer a 1.5 MB file in the following cases, assuming a RTT of 80 ms, a network bandwidth of 10 Mbps, packet size of 1 KB data, and an initial 2×RTT of "handshaking" before data is sent?

Latency = Propagation + Transmit + Queue

Propagation = $\frac{Distance}{SpeedofLight}$

Transmit = $\frac{Size}{Bandwidth}$

1.5 MB= 12582912 bits

Queue= 2 initial RTT's = 2 × 80 ms = 160 ms

Transmit = $\frac{12582912}{10000000}$=1.2582912

Propagation= $\frac{RTT}{2} = \frac{80ms}{2}$ =40 ms

Latency= Propagation + Transmit + Queue ≅ 40 ms+ 1.2582912+160 ms = 1.458 seconds

Number of packets required= $\frac{1.5MB}{1KB} = 1536$

To the above we add the time for 1535 RTTs (the number of RTTs between when packet 1 arrives and packet 1536 arrives)

Total time= 1.458 sec+(1535×80ms)=124.258 seconds.

3- Relationship between Throughput and Latency:

Perhaps the best way to understand the relationship between throughput and latency is to return to basics. The effective end to end throughput that can be achieved over a network is given by the simple relationship:

Throughput = $\frac{TransferSize}{TransferTime}$

Where:

Transfer Time = RTT + $\frac{1}{Bandwidth} \times$ Transfer Size

Example:

Consider a situation where a user wants to fetch a 1MB file across a 1 Gbps network with RTT of 100 ms?

Transfer Time=100 ms+ $\frac{1}{1Gbps} \times 1MB = 108ms$

Throughput= $\frac{1MB}{108ms} = 74.1Mbps$

Network Software:

A telecommunications network contains hardware and software components that need to work together to transmit information. Most networks are organized as a series of layers or levels, each one built upon the one below it. The number of layers, the name of each layer, the contents of each layer differ from network to network, however in all networks the purpose of each layer is:

1- Offer services to higher layer.

2- Shielding higher layers from how offered services are implemented.

Layer (n) on one machine carries a conversation with layer (n) on another machine. The rules used in this conversation are known as the layer (n) protocol.

Protocol: is an agreement between the communicating parties on how communication is to proceed.

Protocols usually exist in two forms. First, they exist in a textual form for humans to understand. Second, they exist as programming code for computers to understand. Both forms should ultimately specify the precise interpretation of every bit of every message exchanged across a network.

Protocols exist at every point where logical program flow crosses between hosts. In other words, we need protocols every time we want to do something on another computer. Every time we want to print something on a network printer we need protocols. Every time we want to download a file we need protocols.

Usually multiple protocols will be in use simultaneously. For one thing, computers usually do several things at once, and often for several people at once. Therefore, most protocols support multitasking. Also, one operation can involve several protocols. For example, consider the NFS (Network File System) protocol. A write to a file is done with an NFS operation, that uses another protocol (RPC) to perform a function call on a remote host, that uses another protocol (UDP) to deliver a datagram to a port on a remote host, that uses another protocol to deliver a datagram on an Ethernet, and so on. Along the way we made need to lookup host names (using the DNS protocol), convert data to a network standard form (using the XDR protocol), find a routing path to the host (using one or many of numerous protocols).