References :

Networking: A Beginner's Guide
by Bruce Hallberg 2005

Computer Networks Fourth Edition
by ANDREW S. TANENBAUM 2004

1- Introduction

The merging of computers and communication has had an effect to the way computer systems are organized. The concept of the "computer center" as a room with a large computer to which users bring their work for processing is now absolute.

The old model of a single computer serving all of organization computations has been replaced by one in which a large number of separate but interconnected computers do the job. These systems are called "computer network".

The term "computer network" is used to mean an interconnected collection of autonomous computer. Two computers is said to be interconnected if they are able to exchange information.

It is important to distinguish between a computer network and "distributed system ". In distributed system, the exchange of multiple autonomous computers is transparent (i.e., not visible to the user). In other word, the user of distributed system is not aware that there are multiple processors, its looks like a virtual uniprocesser.

In effect a distributed system is a software system built on top of the network and makes it looks like a single computer system.

1.1 Uses of Computer Networks

It's now worth to point out why people are interested in computer networks and what they can be used for.

1.1.1 Networks for companies

Many organizations have a substantial number of computers in operation, often located far a part. Using computer network to connect these computers might give the following benefits:

a. Resource sharing: the goal here is to make all programs, equipments and specially data available to any one on the network with out regard to the physical location of the resource and the user.

b. High Reliability: this goal can be achieved by having alternative source of supply. For example all files could be replicated on twot or three machines, so if one of them is unavailable (due to hardware frailer), the other copy could be used.

C. Saving Money: small computer have a much better price/performance ratio than large ones(Mainframes).the mainframes are a large computer roughly a factor of ten faster than personal computers but they cost a thousand times more !!. This imbalance has caused many system designers to built systems consisting of personal computers, one per user with data kept on and a " file server " machines which store more data .in this model, the user called "client" and the whole arrangement called the "client-server model" as a shown in Fig (1-1).

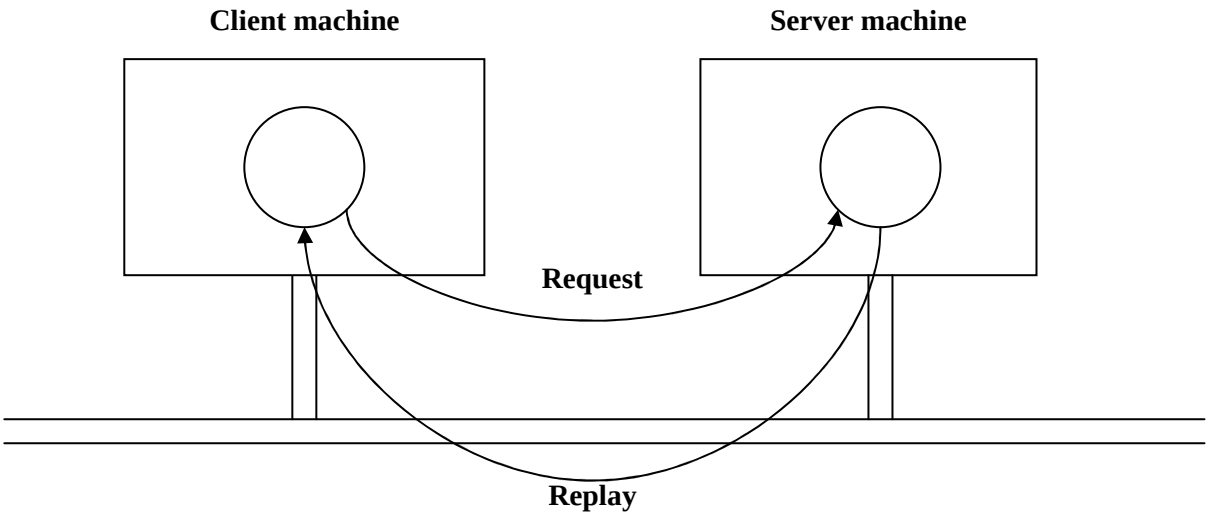


Fig (1-1) Client-Server Model

In the client server model, communication generally takes the form of a request message from the client to the server asking for some work to be done. The server then done the work and sends back the reply with results to client, usually, there are many client using few number of servers.

d. Scalability: it's the ability to increase system performance as the work load grows just by adding new more processors. Thus, in client – server model, new client and new server can be added as needed. This is can not be done with centralized main frame.

e. Powerful communication medium: using a network, it's easy for two or more users who lives far apart to write the report together. Thus, cooperation among far away groups of people has been made easy.

1.1.2 Network for people

Starting in 1990, network began to start delivering service for private individuals at home. These services are quite different then the "corporate efficiency" model which described in previous section. The most existing ones are :

a. Access to remote information: this type of applications involves interactions between a person and remote data base. Examples are the access to financial institutions, home shopping, on line newspapers and access to information systems like the World Wide Web (WWW).

b. Person to person communication: the second use of such networks is person to person communication like electronic mail (E-mail) which is used by millions of people, world wide news groups with discussion a many topics and file transfer between people.

C. Interactive entertainment: this category is a huge and growing industry .the most important application are video on demand and game playing.

1.2 Network Hardware

Computer network can be classified either according to:

a. Transmission technology.

b. Scale.

a. Transmission technology : there are two types of transmission technology:

- **Broadcast networks.**
- **Point to point networks.**

Broadcast network "have a single communication channel that is shared by all machines on the network" short massage called "packet" in certain contents as described in Fig (1-4) , sent by any machine and received by all machines, an address field with in the packet specifies for whom it is intended. A machine checks the address field in the packet, if the packet is intended for it self, it process the packet .if the packet is intended for some other machine it just ignored.

Broadcast systems generally allow the possibility of addressing a packet to all destinations by using a special code in the address field, this mode of operation is called "broadcasting".

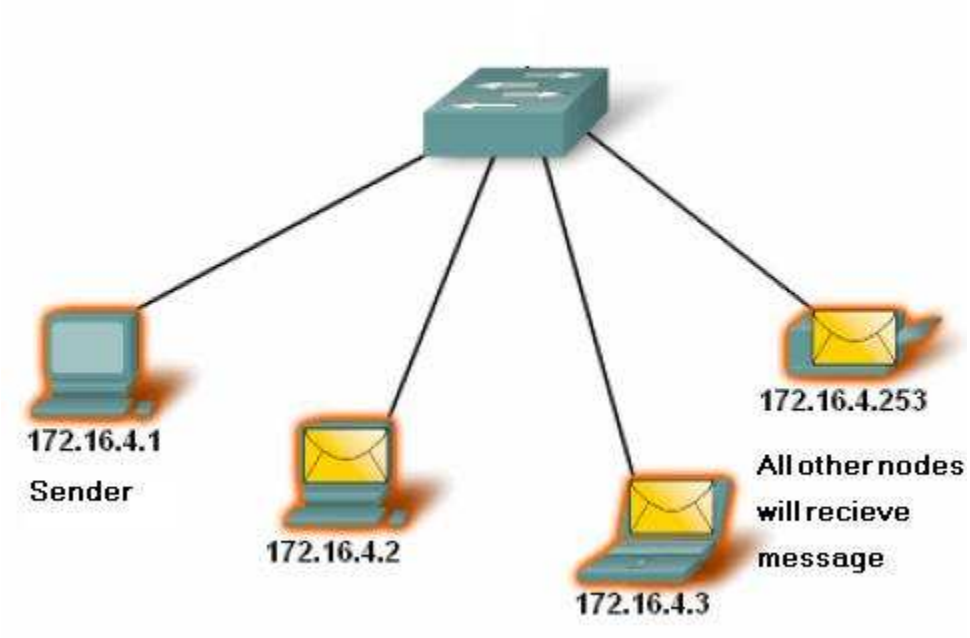


Fig (1-2) Broadcast Network

Some broadcasting systems also support transmission to a subset of machines which known as "multicasting ".

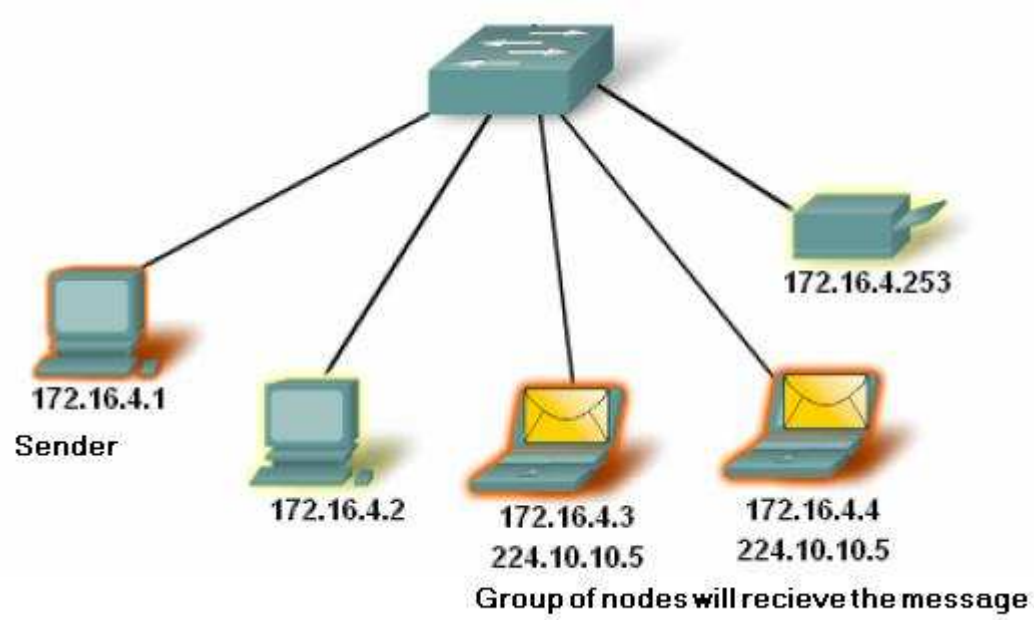


Fig (1-3) Broadcast Network

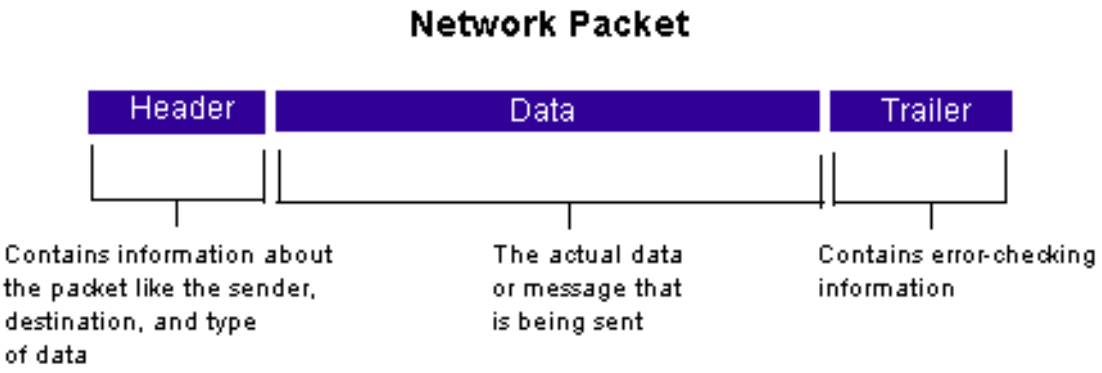


Fig (1-4) Network Packet

Point to point network which consists of many connections between individual pairs of machines. In order to go from source to destination, a packet may have to visit one or more inter mediate machines. Often, multiple routes of different lengths are possible, so routing algorithms play an important role in point to point networks. Fig (1-5) shows point to point networks with four PC's, between any individual pair of PC's there is a transmission line. Fig (1-6) shows the possible route for packet that attend to move from PC3 to PC2, a specific routing algorithm will decide the best route for packet.

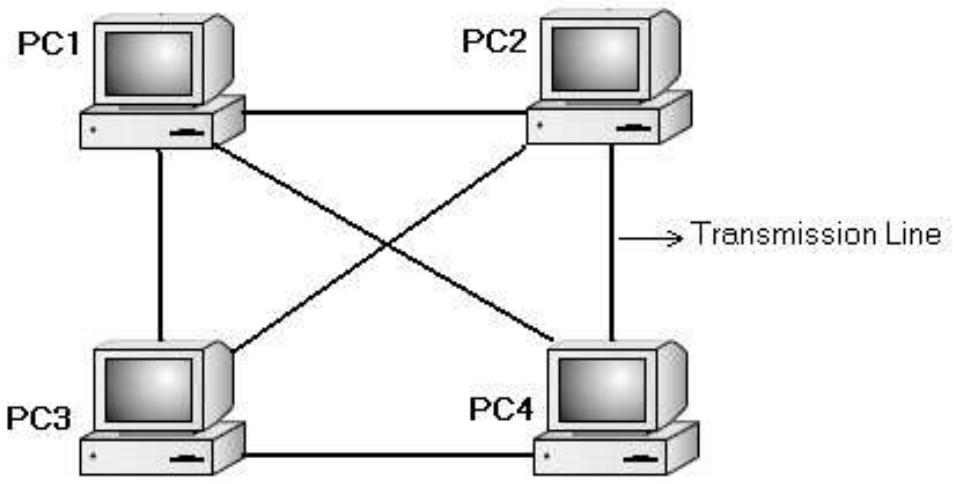


Fig (1-5) Point to Point Network for four PC's

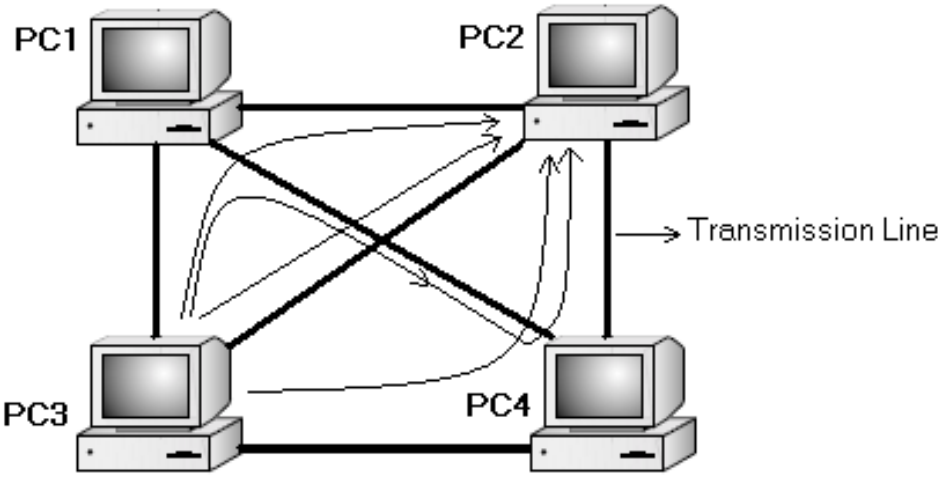


Fig (1-6) The possible routes for packet that attends to move from PC3 to PC2

b. Scale: an alternative criterion for classifying networks is their scale; Table (1) gives a classification of multiple processor systems arranged by their physical size.

Table (1) classification of inter connected processors according to scale.

Inter processor distance	Processor locate in same	Example
0.1m	Circuit board	Data flow machine
1 m	System	Multi computer
10 m	Room	Local Area Network LAN
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan Area Network MAN
100 km	Country	Wide Area Network WAN
1000 km	Continent	
10000 km	planet	The Internet

At the top of Table (1), are "dataflow machines" which are highly parallel computers with many functional units all working on the same program.

Next, come the "multi computers" which are systems that communicate by sending messages over very short very fast buses.

Beyond the multi computers are the true networks, computers that are communicates by exchanging message over longer cables. They can be divided into local, metropolitan and wide area network.

Finely, the interconnection of two or more networks is called "inter networks". The world wide "internet" is a well known example of an inter network.

Note : Distance is important as a classification metric because different technologies are used at different scales.

1.2.1 Local area networks (LANs)

LANs are privately- owned networks with in a single building or campus of up to few kilometers in size.

The first LANs were limited to a range of 185 meters and no more than 30 computers. Today’s technology allows a larger LAN, but practical administration limitations require dividing it into small, logical areas called workgroups. A workgroup is a collection of individuals (a sales department, for example) who share the same files and databases over the LAN. Fig (1-7) shows an example of a small LAN and its workgroups.

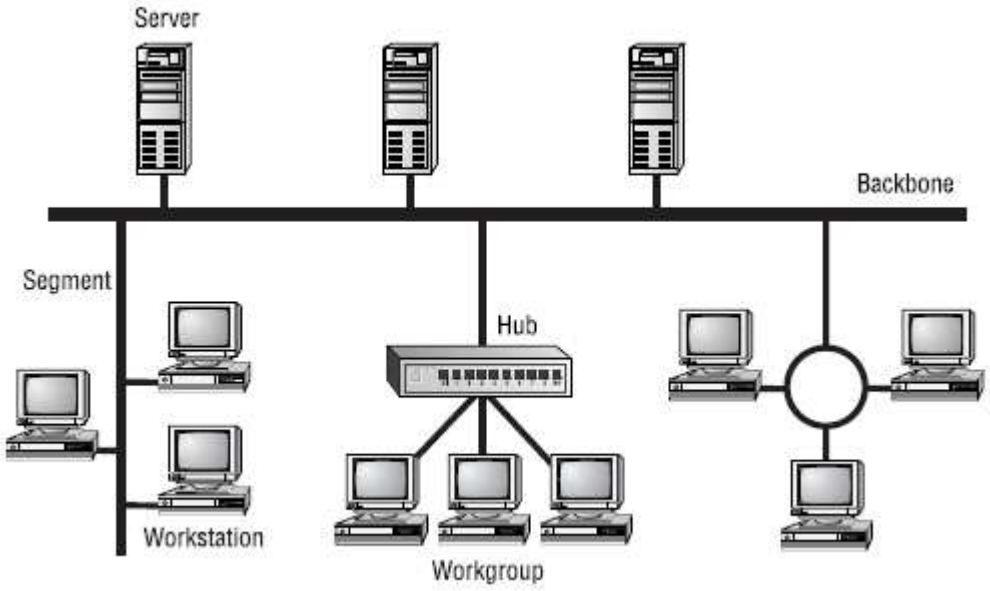
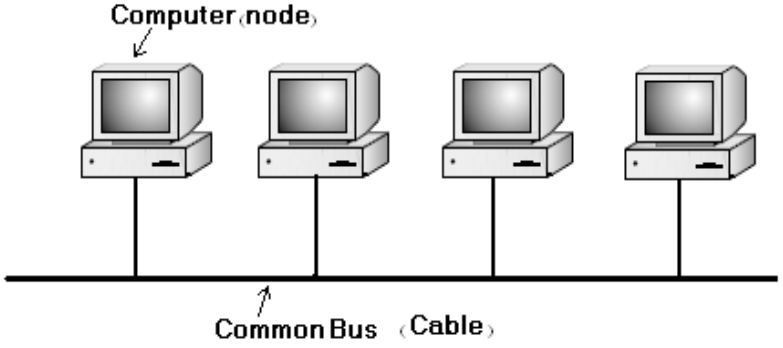


Fig (1-7) Local Area Network (LAN) with workgroups

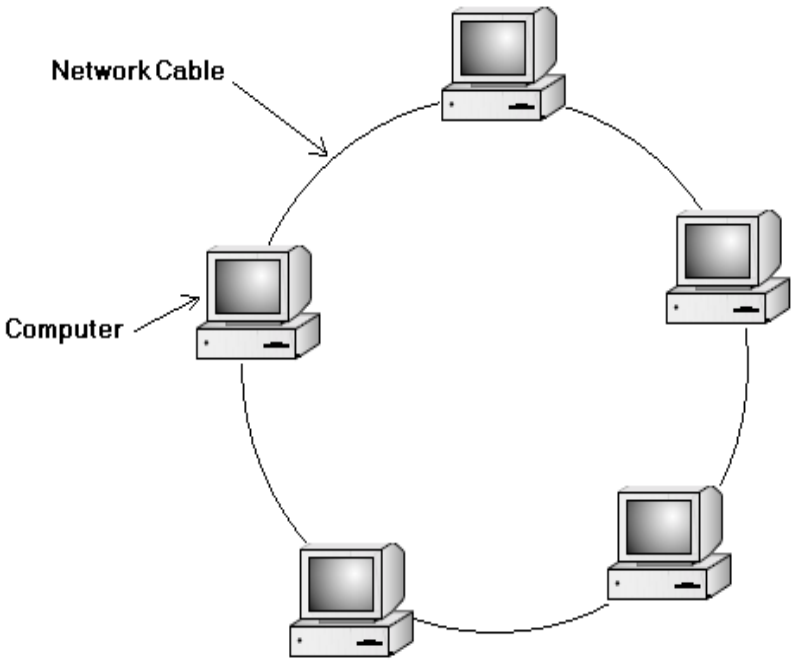
In general, LANs are distinguished from other kinds by three characteristics:

1. Their size (less meter- few kilometers).
2. Their transmission technology.
3. Their topology.

- LANs are restricted in size, if the twisted copper wire is used ,the maximum length is about 200m .some times the length between nodes reaches few kilometers if fiber optics cables are used or wireless technology is used.
- Various topologies are possible for broadcast LAN, Fig (1-8) shows two of them.



(a) Bus Topology



(b) Ring Topology

Fig (1-8) Local Area Network (LAN) Topologies

A bus topology is a network where, basically, one single network cable is used from one end of the network to the other, with different network devices (called nodes) connected to the cable at different locations.

In bus (liner cable) network, at any instance, one machine is the master and it's allowed to transmit data. All other machines are required to refrain from sending. An arbitration mechanism is required to resolve the conflicts when two or more machines want to transmit simultaneously. The arbitration mechanism may be centralized or distributed.

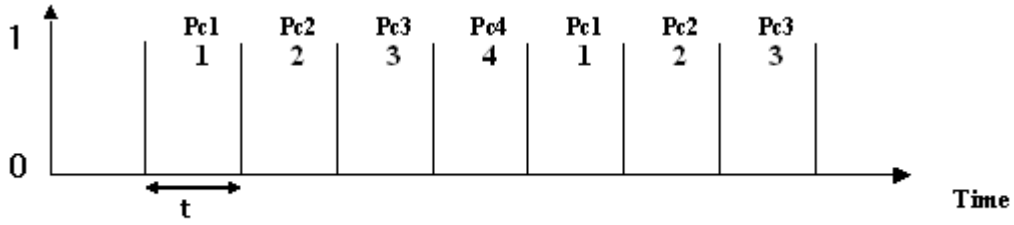
The ring networks consist of series of devices connected to one another by unidirectional transmission link to form a single closed loop. The data is sent around the ring, each device check the data if it belong to or not, when

the data reach the destination then it will be picked up ,in each device there is a controller board responsible for recognizing packets which sends to that station.

- Broadcast technology networks can be further divided in to "static" and "dynamic" depending on how the data channel is allocated.

Typical static allocation would be to divide up time (or frequency) in to discrete intervals allowing each machine to broadcast only when its time slot comes up.

Ex: if we have four PC's in static channel broadcast technology system. The channel shape will be as shown in Fig (1-9).



However, static allocation may waste channel capacity especially when many machine have nothing to say during their allocated slots. Thus, most systems attempt to allocate the channel dynamically (i.e. on demand) Dynamic channel allocation means that network node can use the channel when it needs, This method may cause some problems when two or more machines need to use the channel at the same time, in this case an arbitration techniques must be used.

1.2.2 Metropolitan area networks (MANs).

A metropolitan area network (MAN) is basically a bigger version of (LAN) and normally uses similar technology. It might cover a group of nearly corporate offices or a city, and it might be either private or public.

A man just has one or two cables and does not contains switching elements which shunt packets over one of several potential output lines. This greatly simplifies the design.

A standard of MAN is known as "distributed queue dual bus" (DQDB) or the IEEE 802.6 standard .DQDB consists of two unidirectional buses (cables) to which all the computers are connected, as shown if fig (1-10), each bus has a "head end" (Device that initiates transmission activity). Traffic that is destined for a computer to the right of the sender uses upper bus. Traffic to the left uses the lower one.

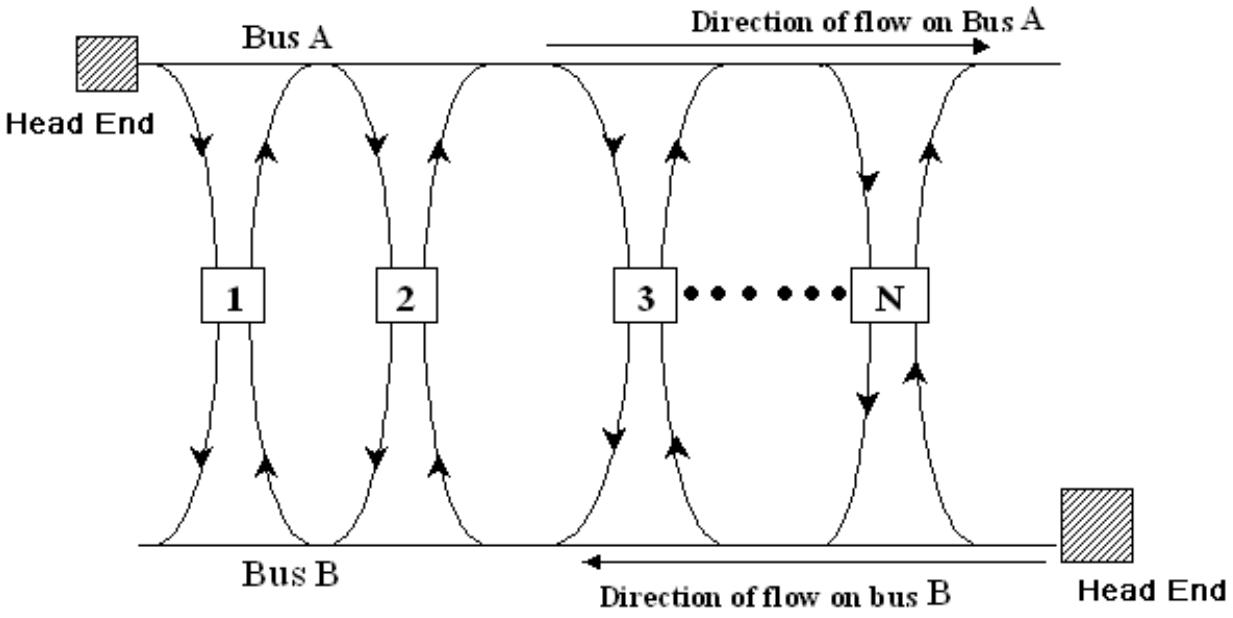


Fig (1-10)Architecture of DQDB metropolitan area network

1.2.3 Wide Area Networks (WANs)

A wide area network (WAN) spans a large geographical area, often a country or continent; it contains a collection of machines intended for running application programs. Traditionally, these machines are called "hosts" .the hosts are connected by "subnet" .the job of subnet is to carry messages from host to host.

Usually, the subnet consists of two components:"transmission lines" and "switching elements" the transmission lines (also called channels or trunks) move bits between machines.

The switching elements (which we shall call them "routers") are specialized computers used to connect two or more transmission lines, when data arrives to an incoming line, the router must choose an outgoing line to forward them.

In the model shown in fig (1-11), each host generally connected to LAN on which a router is present. (Although in some cases a host can be connected to a router directly).the collection of communication lines and routers (but not the hosts) form the subnet.

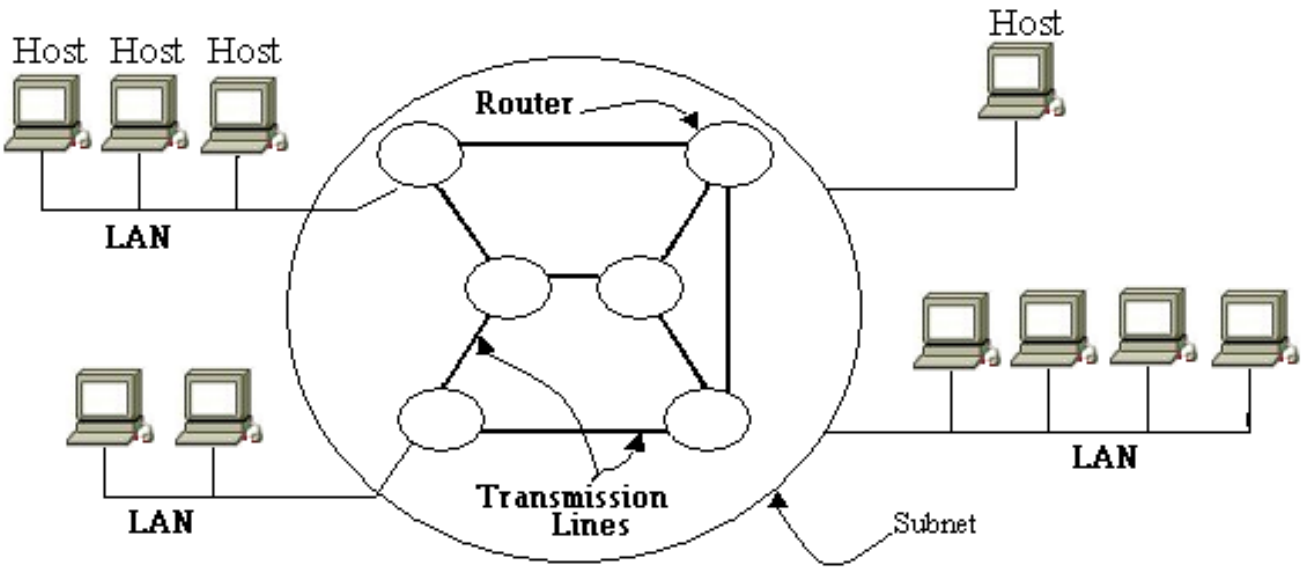


Fig (1-11) Relation between hosts and the subnet.