Telecommunication Networks
15B11EC611

LECTURE: 02
TELECOMMUNICATION NETWORK: MODEL & TYPES

Telecommunication:

Means communication at a distance (telephony, telegraphy, television etc)

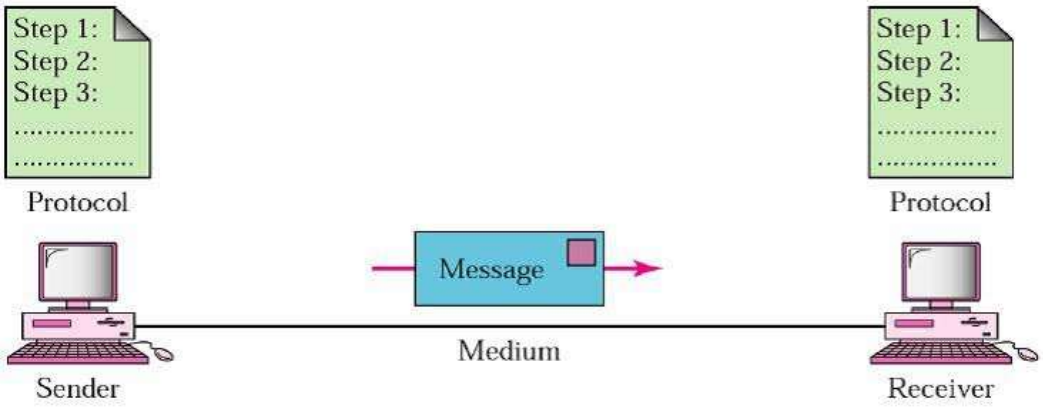
Data communications:

Exchange of data between two devices via some form of transmission media

Components of data communications:

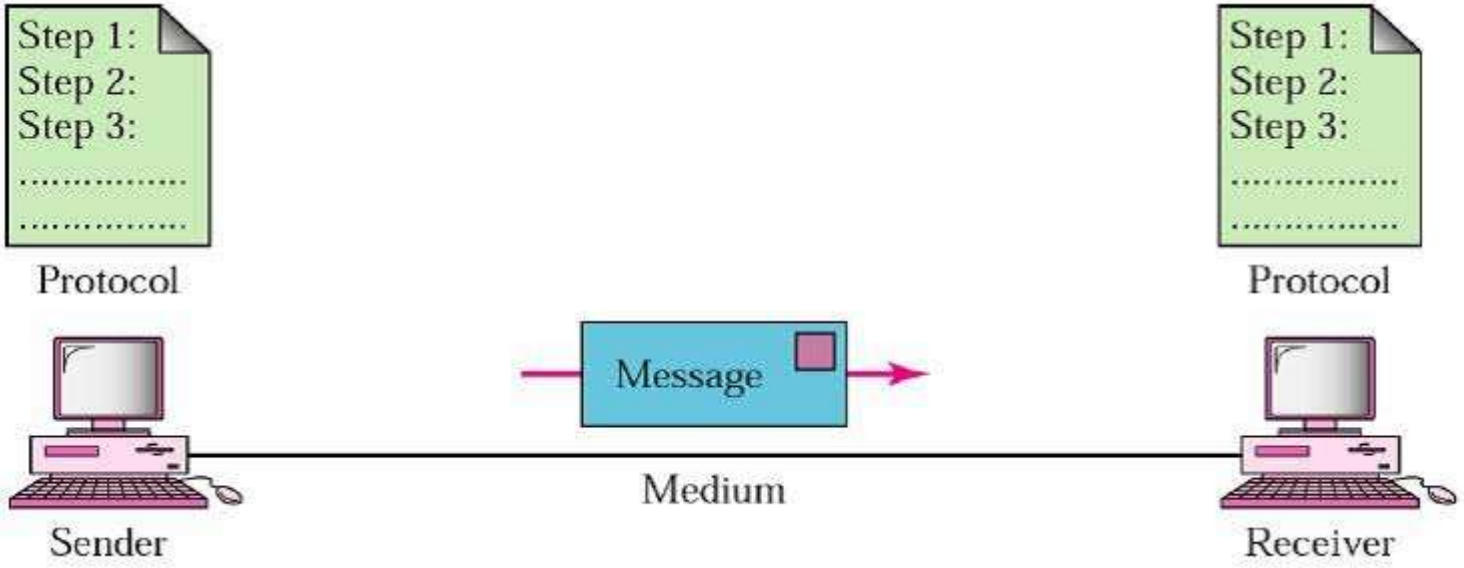
It contains 5 basic components →

1. Message: text, numbers, pictures, audio, video
2. Sender: computer, telephone handset, video camera, etc
3. Receiver



Components of data communications:

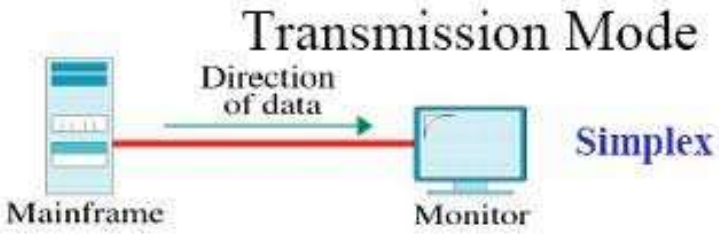
4. **Transmission medium: twisted pair cable, coaxial cable, fibre-optic cable, and radio waves**
5. **Protocols: Set of rules that govern data communications. without a protocol, two devices may be connected but not communicating**

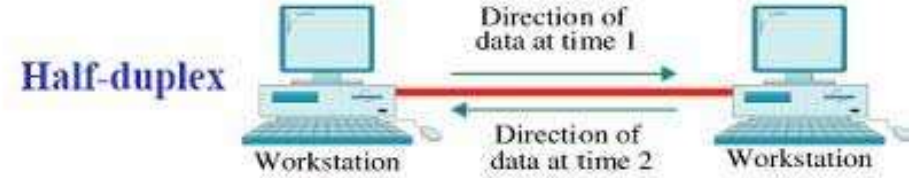


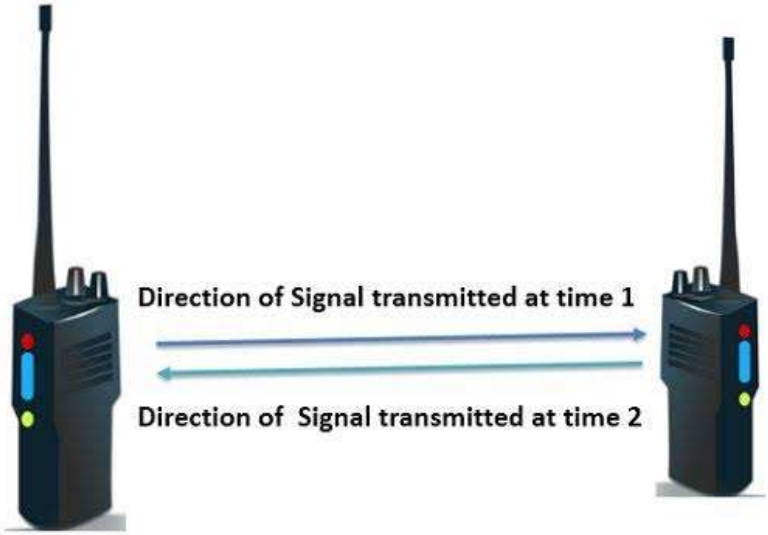
Transmission Mode / Data Flow:

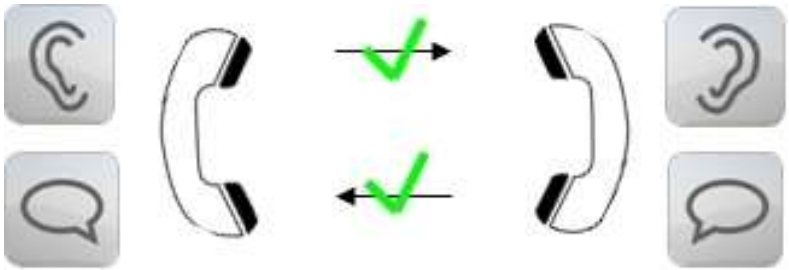
Communication between two devices can be

1. **Simplex**
2. **Half-duplex**
3. **Full-duplex**







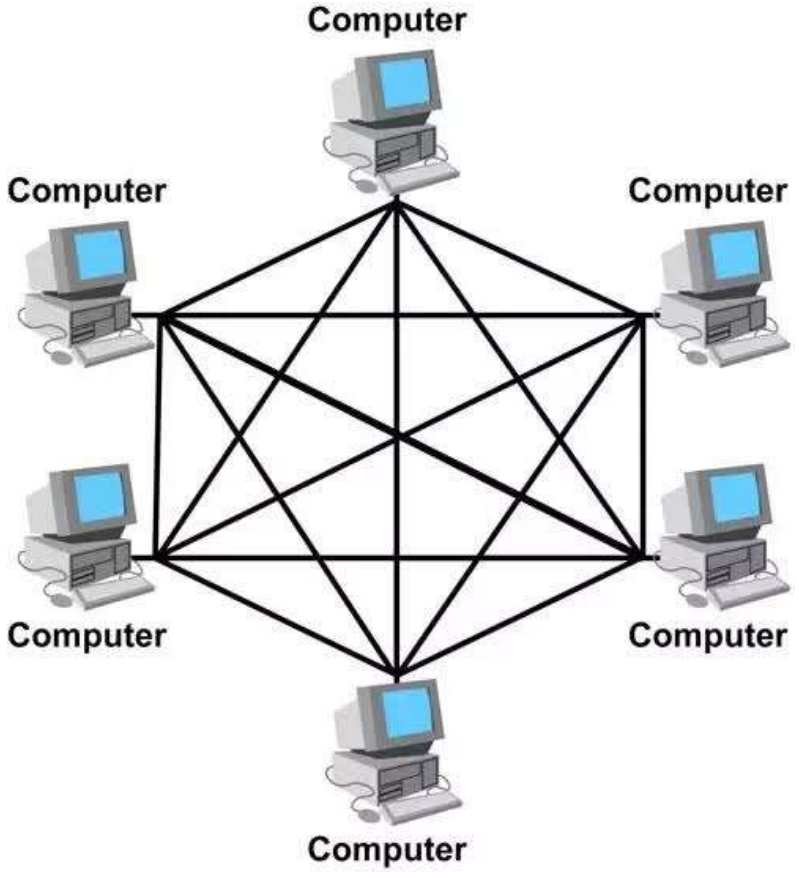


Network Topology

For exchanging the information, computers need to be connected,

→but connecting every computer to other computer using point-to-point links (mesh connectivity)

→is neither cost effective and not scalable.



Hence, we require Flexible interconnection Topology

1. **Bus**
2. **Star**
3. **Ring**
4. **Tree**
5. **Hybrid**

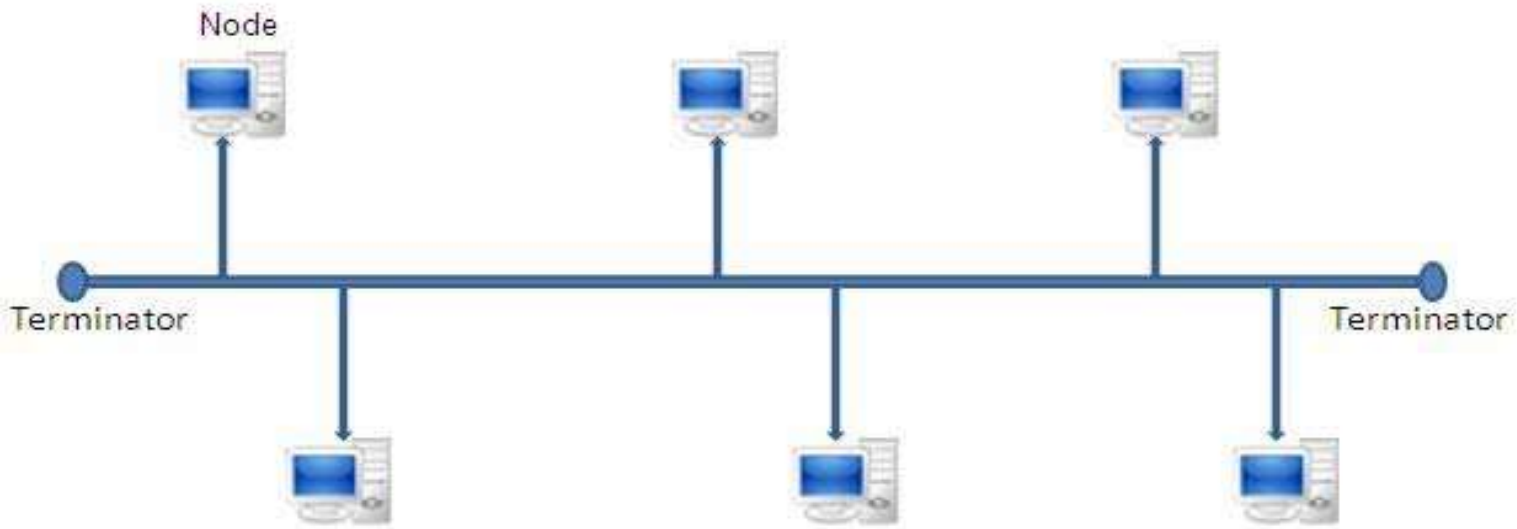
Bus topology

Advantages:

1. **single communication line or cable**
2. **failure of a device does not affect the other devices**

Disadvantage:

1. **May have problem while multiple hosts sending data at the same time.**
2. **failure of the shared communication line can make all other devices stop functioning**



Star topology

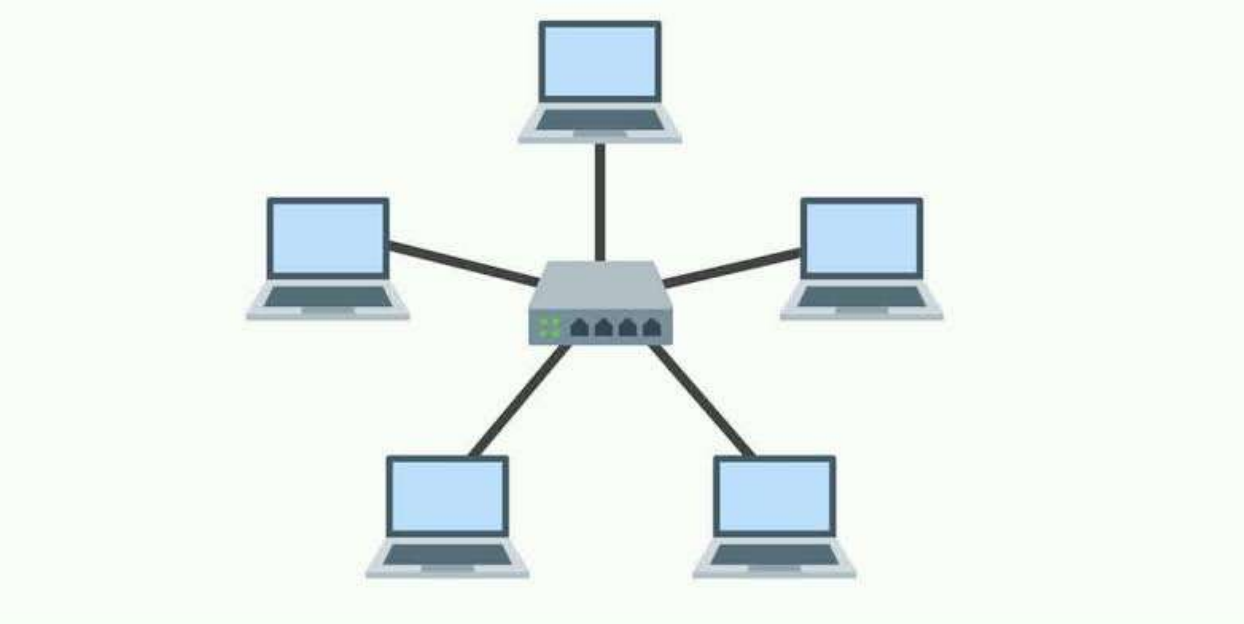
All hosts in Star topology are connected to a central device, known as hub device (repeater/ switch/ router)

Advantage:

1. **configuration is simple**
2. **Cost effective**

Disadvantage:

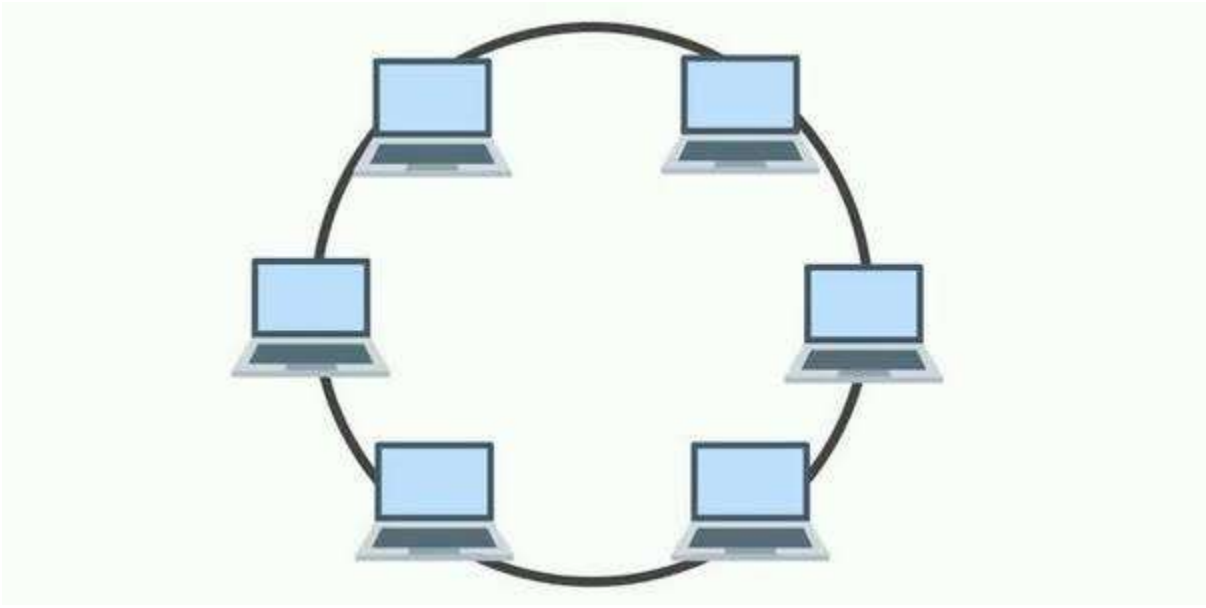
1. **If hub fails, connectivity of all hosts to all other hosts fails.**



Ring topology

Advantage:
To connect one more host in the existing structure, the administrator may need only one more extra cable.

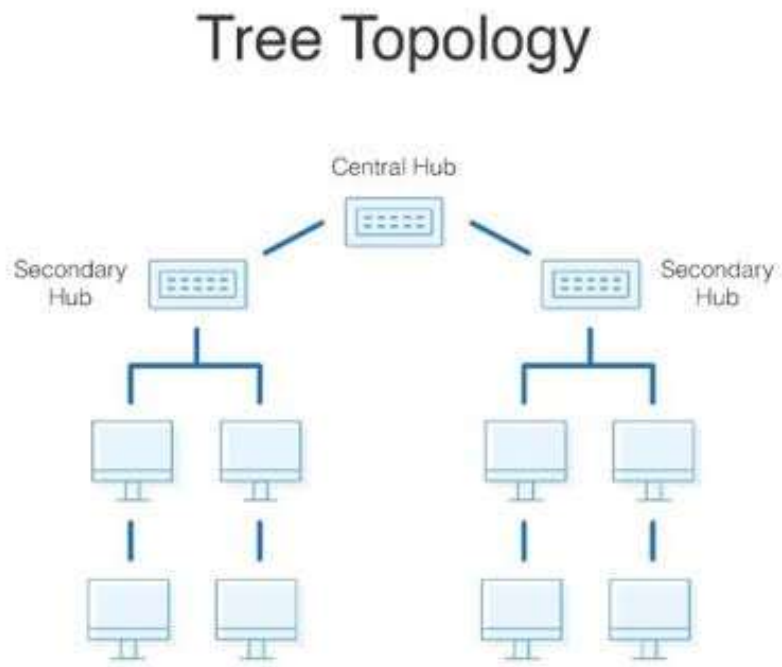
Disadvantage:
Failure of any host results in failure of the whole ring.



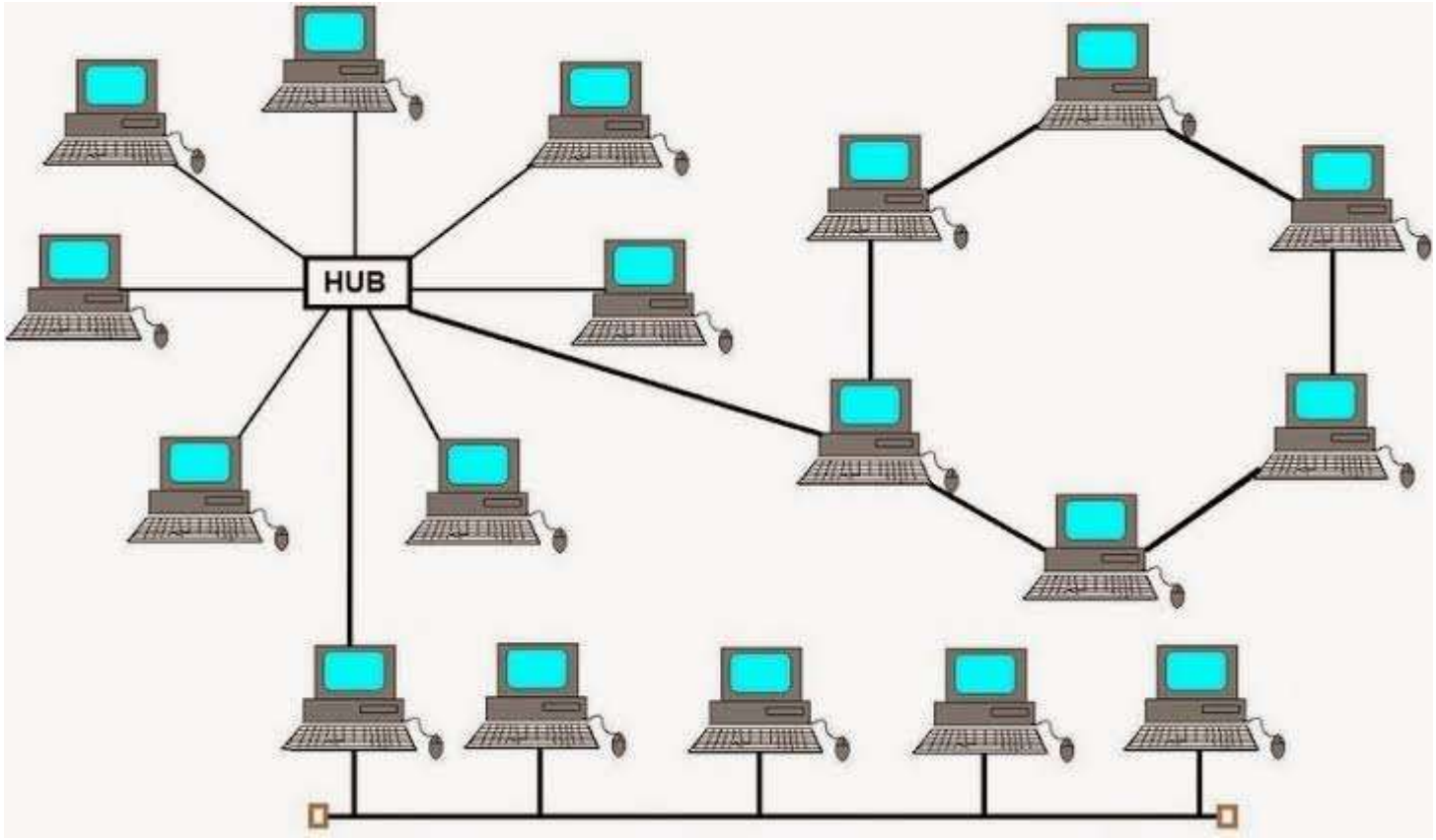
Tree topology

This topology divides the network in to multiple levels/layers of network.

1. **Lowermost is access-layer where computers are attached.**
2. **Middle layer is known as distribution layer**
3. **highest layer is known as core layer, and is central point of the network**



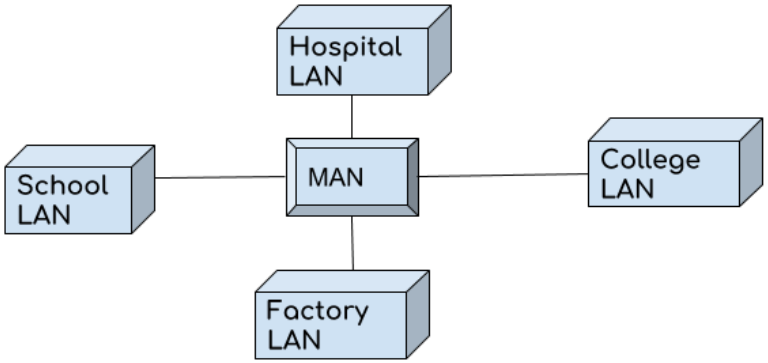
Hybrid topology

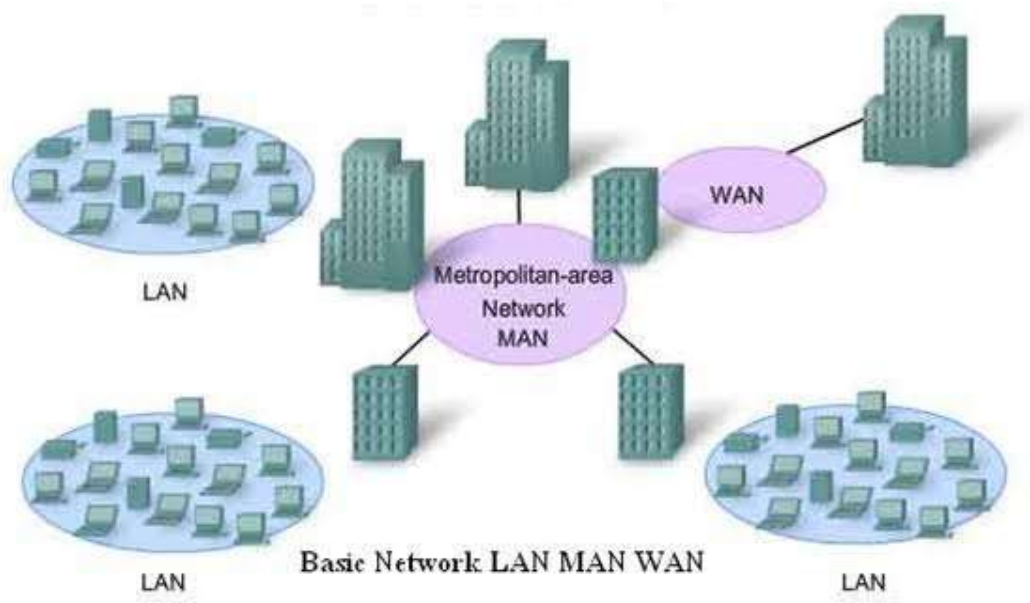


Network Technologies

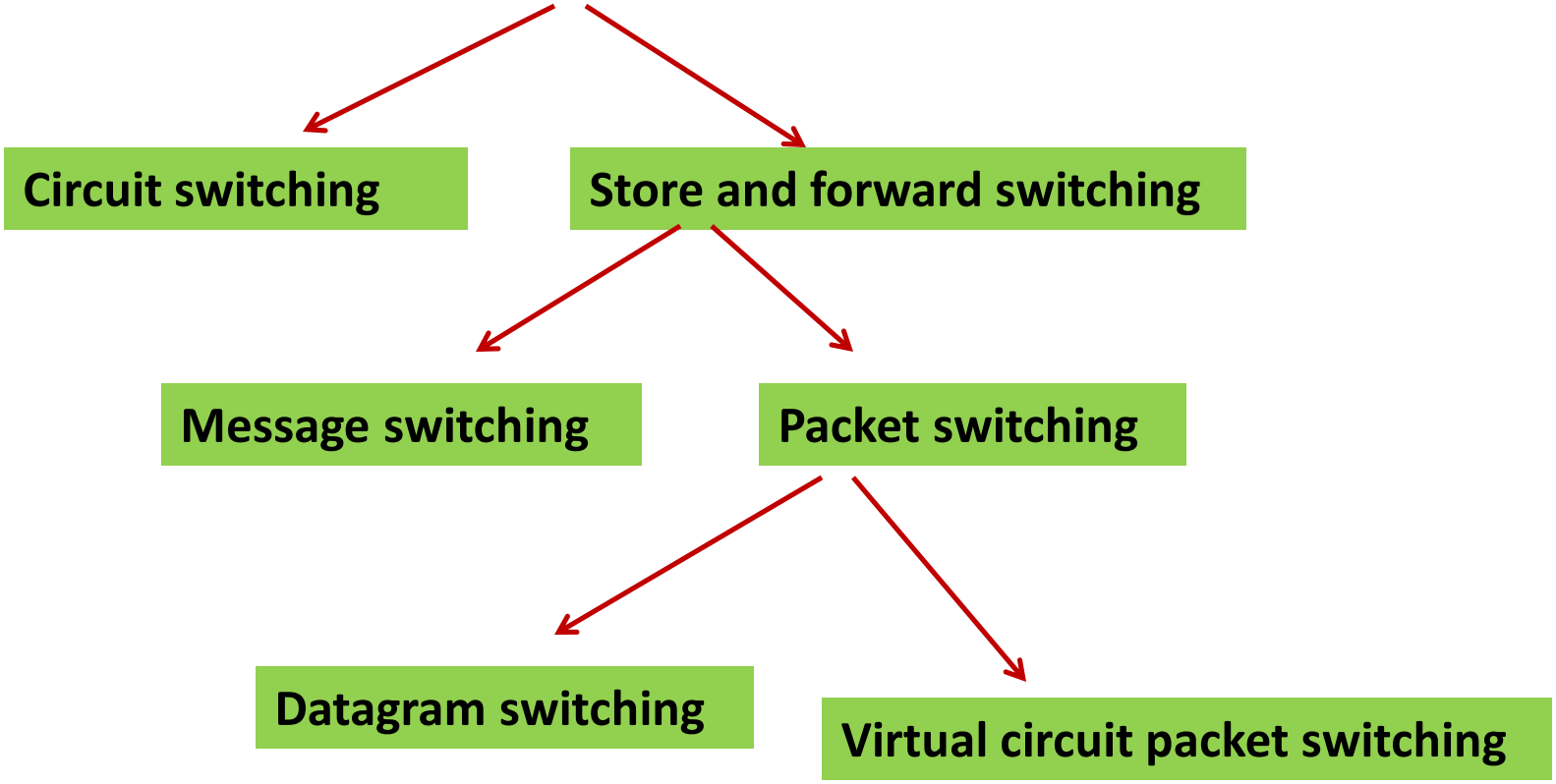
Usually categorized based on geographic coverage

1. **LAN (Local Area Network): in a single office, building, or a campus**
2. **WAN (Wide Area Network): country, a continent**
3. **MAN (Metropolitan Area Network): Size between LAN and WAN (Example: a city)**



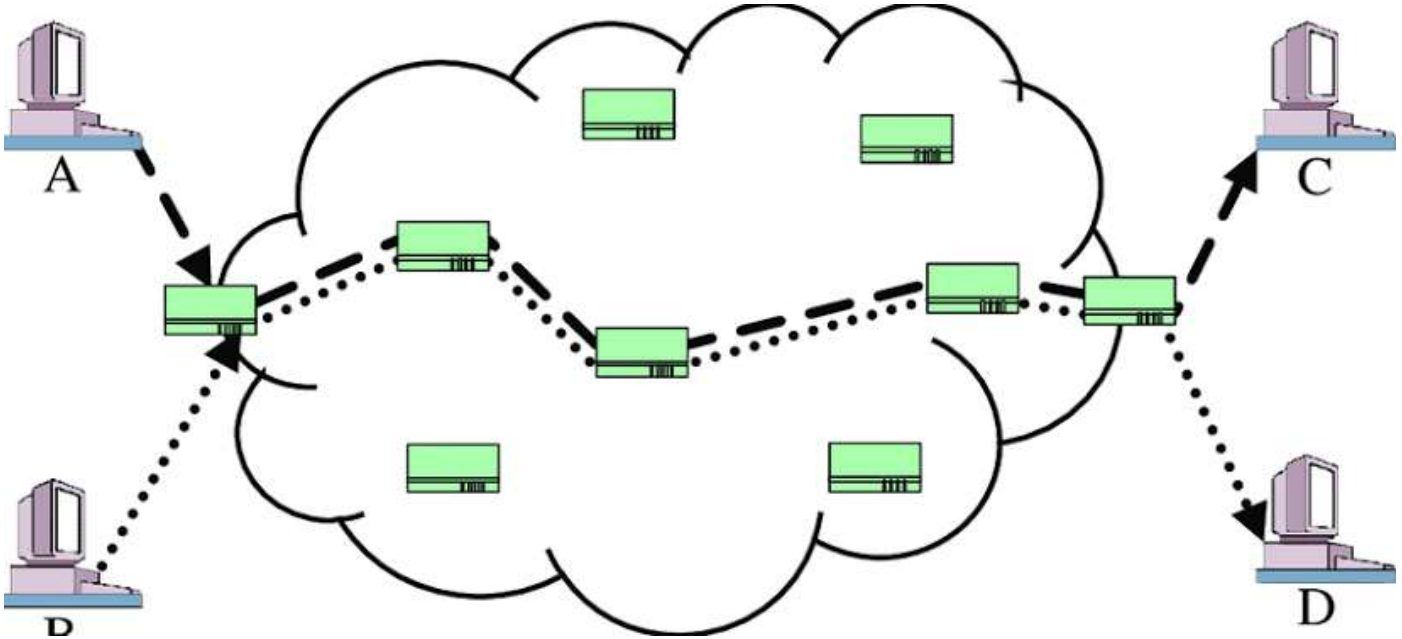


Switched Data Networks (based on two basic switching technologies)



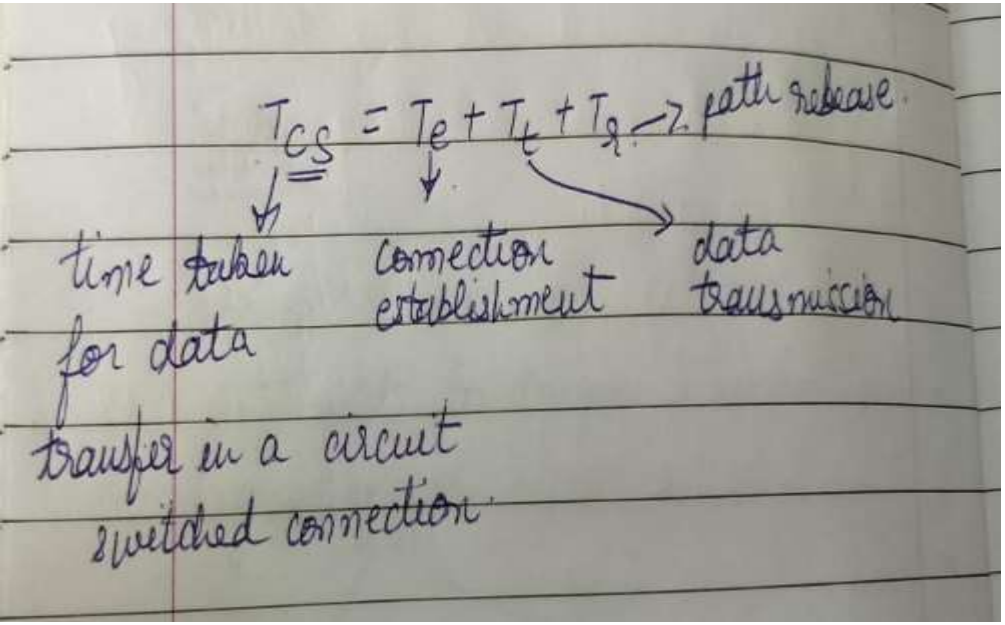
Circuit switching

- End system-to-end system physical electrical path is established – physical wires, coaxial cables, radio, satellite
- Data units are exchanged on this path.
- No other potential user can use the path even if it is idle.
- Path selection is generally based on a routing algorithm that may take into account network traffic, path length etc.



3 Explicit phases involved in data transfer:

1. Connection establishment
2. Data transmission
3. Connection release



$$T_c = (N-1)T_m \quad (10.6)$$

where

N = number of switching nodes in the path

T_m = average route selection time in each node for a given network load

T_t is dependent upon the data rate and the size of the message

$$T_t = M/R$$

where

M = message length in bits

R = data rate in bps

Propagation delay is ignored since it is comparatively small.

T_e and T_r depends upon the number of switching nodes in the path between source and destination.

T_r may be expressed as

$$T_r = NT_h \quad (10.7)$$

where T_h is the time taken by a node to make housekeeping entries. Therefore, we have

$$T_{cs} = (N-1)T_m + M/R + NT_h \quad (10.8)$$

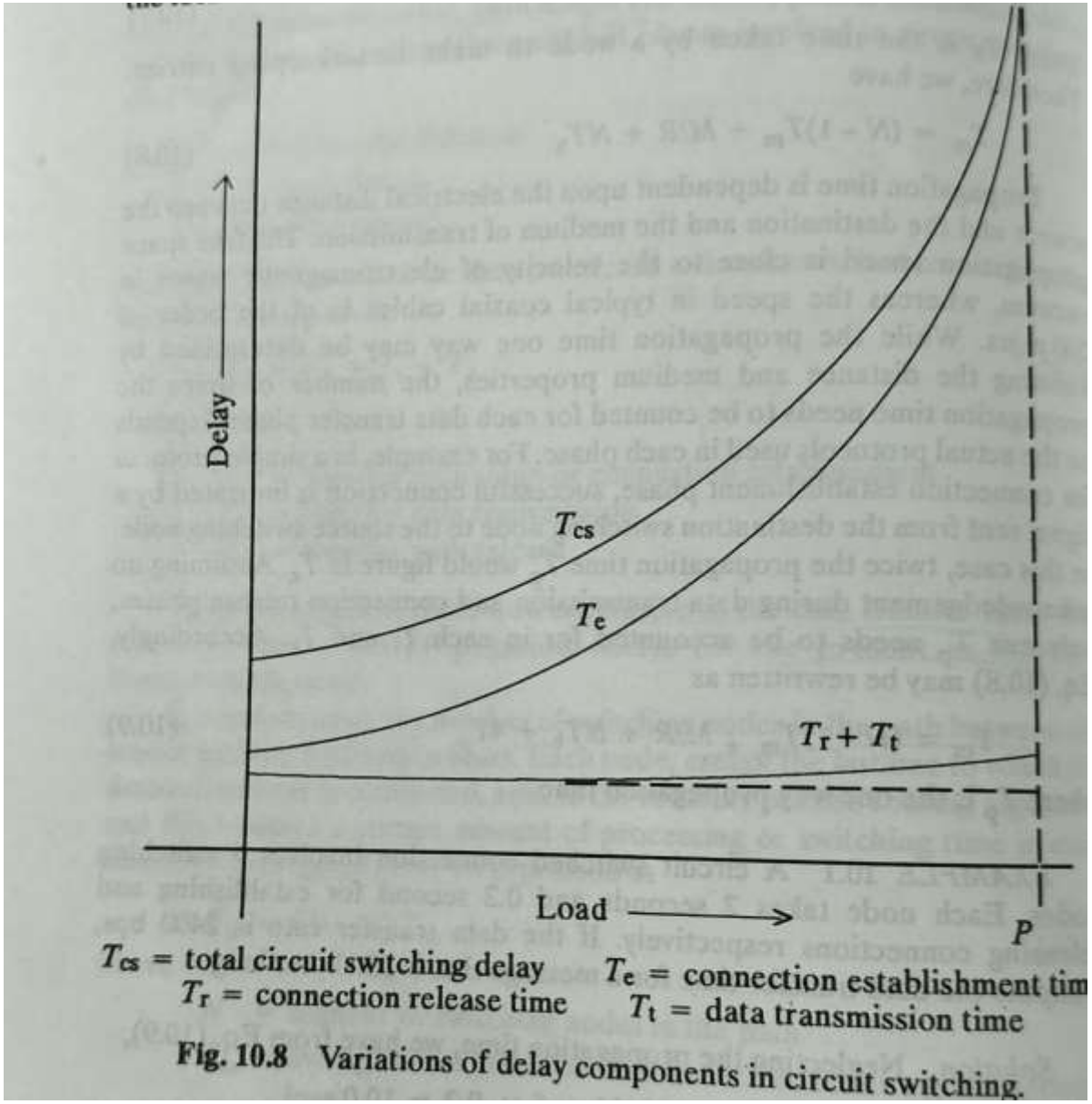


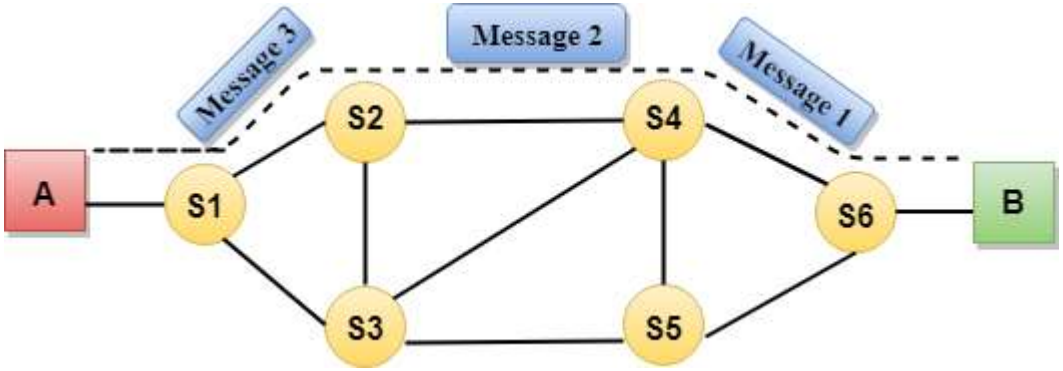
Fig. 10.8 Variations of delay components in circuit switching.

Disadvantage – path set up time is typically of the order of 20-30 sec or more, turns out to be excessive overhead for busty computer traffic.

Store and forward switching

1. Data unit received by a node is stored, put in a queue and forwarded to the next node when it turn comes.
2. End-to-end physical path is not established.

There are two types of store and forward networks
-Message switching
-Packet switching



One node to other - HOP

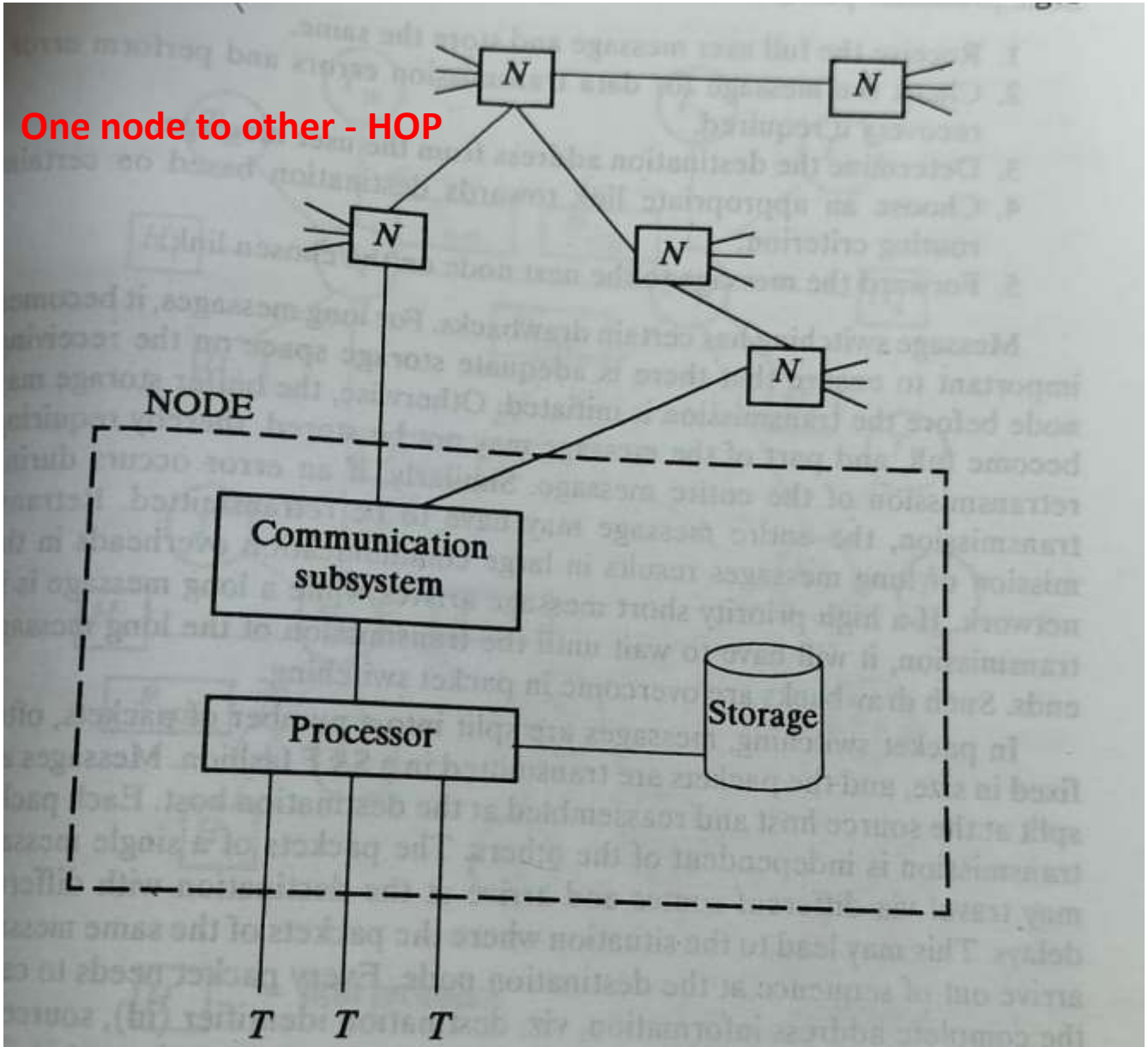
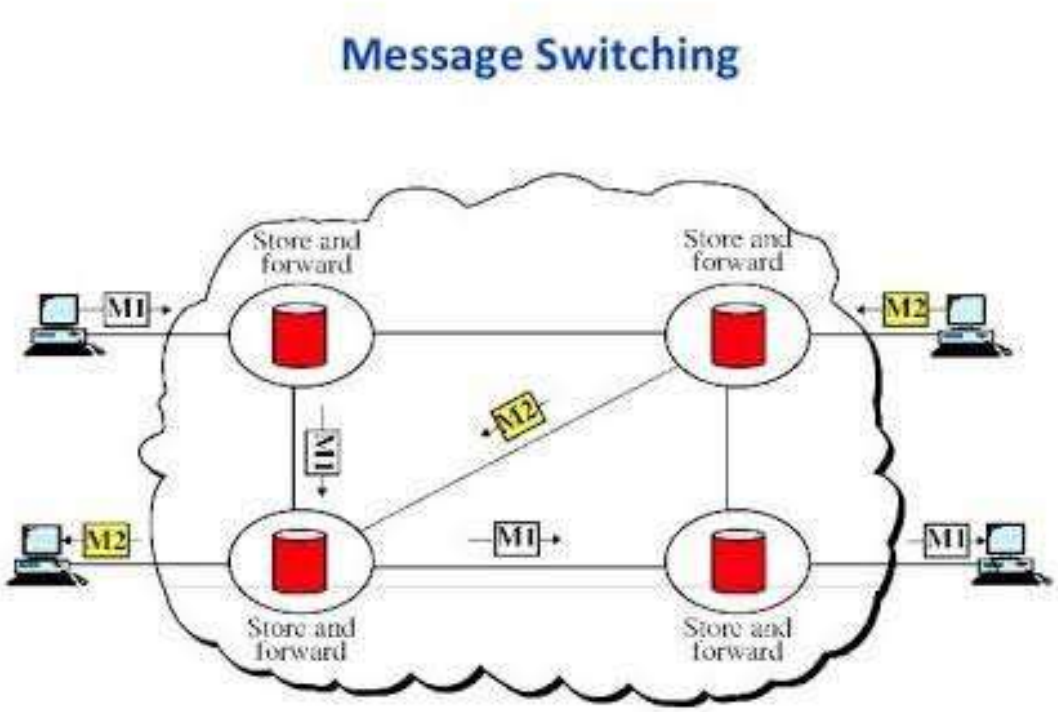


Fig. 10.9 Store and forward network.

Message switching



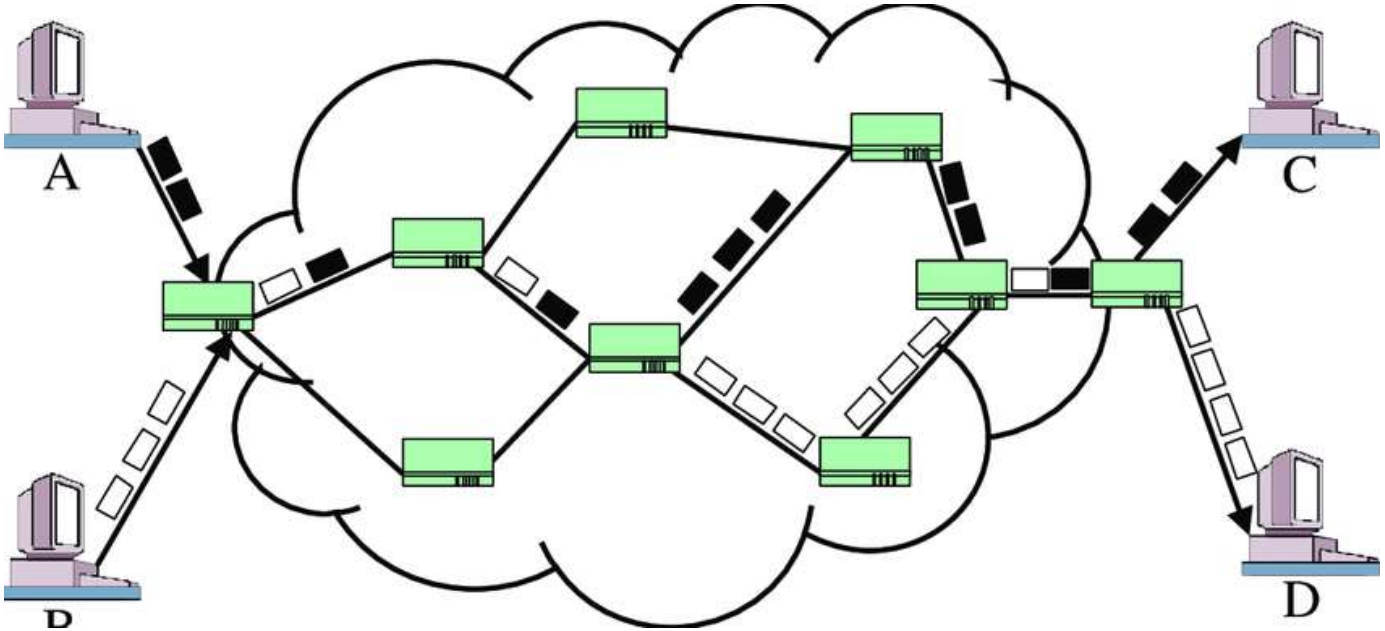
1. Full message is stored & forwarded in by network node
2. Each message carries destination and source addresses
3. Each node has a forwarding table
4. There is significant delivery delay
5. Message switching is obsolete now

In message switching, once the transmission is initiated, a message is transmitted in its entirety without a break from one node to another. The node processor performs the following functions:

1. Receive the full user message and store the same.
2. Check the message for data transmission errors and perform error recovery if required.
3. Determine the destination address from the user message.
4. Choose an appropriate link towards destination based on certain routing criterion.
5. Forward the message to the next node on the chosen link.

- Check whether there is adequate storage space on the receiving node before transmission is initiated.
- In case of error entire message is to be retransmitted.
- Large communication overheads

Packet switching



1. Message is broken into smaller chunks of data packets
2. A packet is transmitted across the network as independent entity.
3. Packetization reduces delivery delay
4. All data network today are based on packet switching

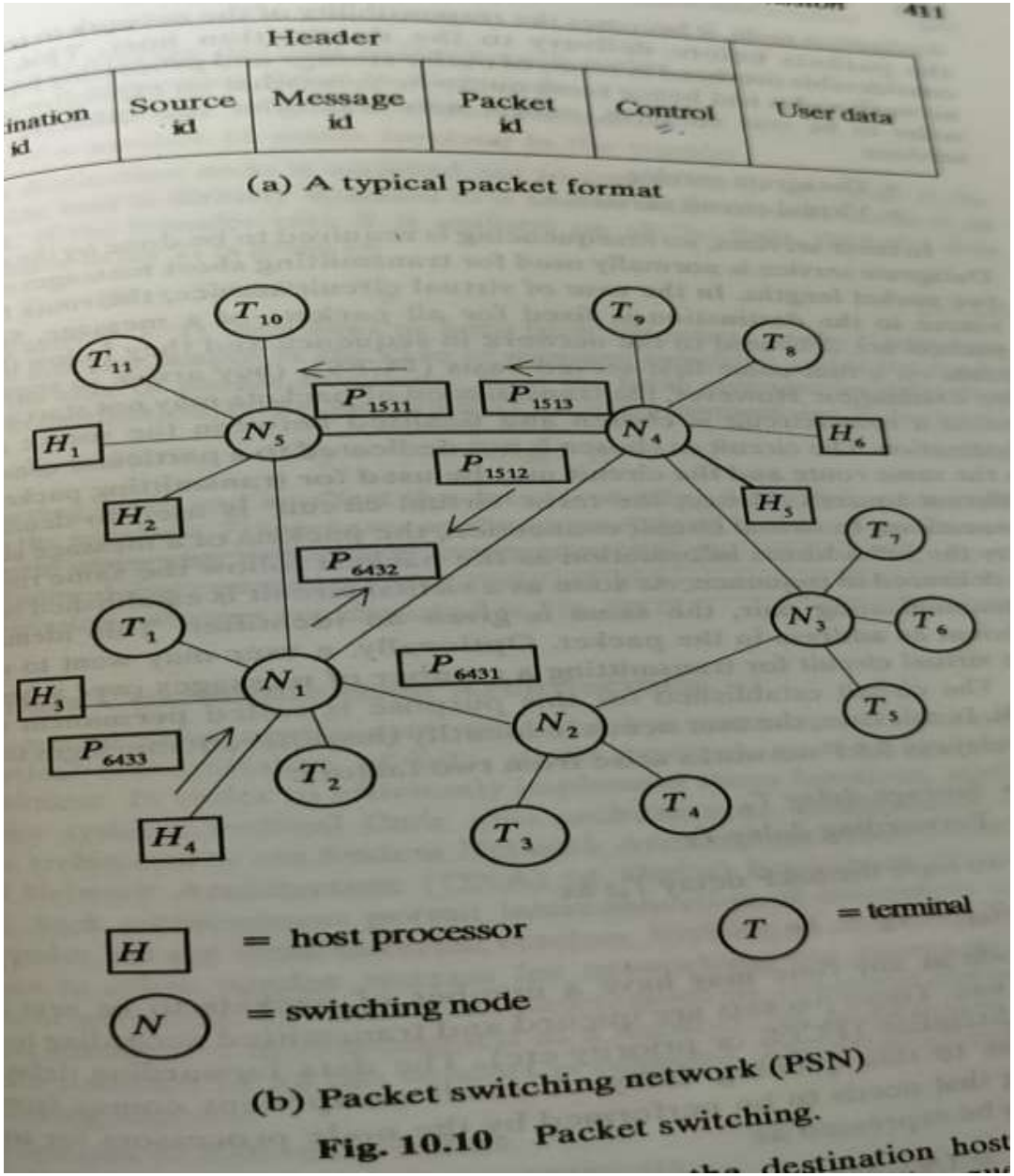
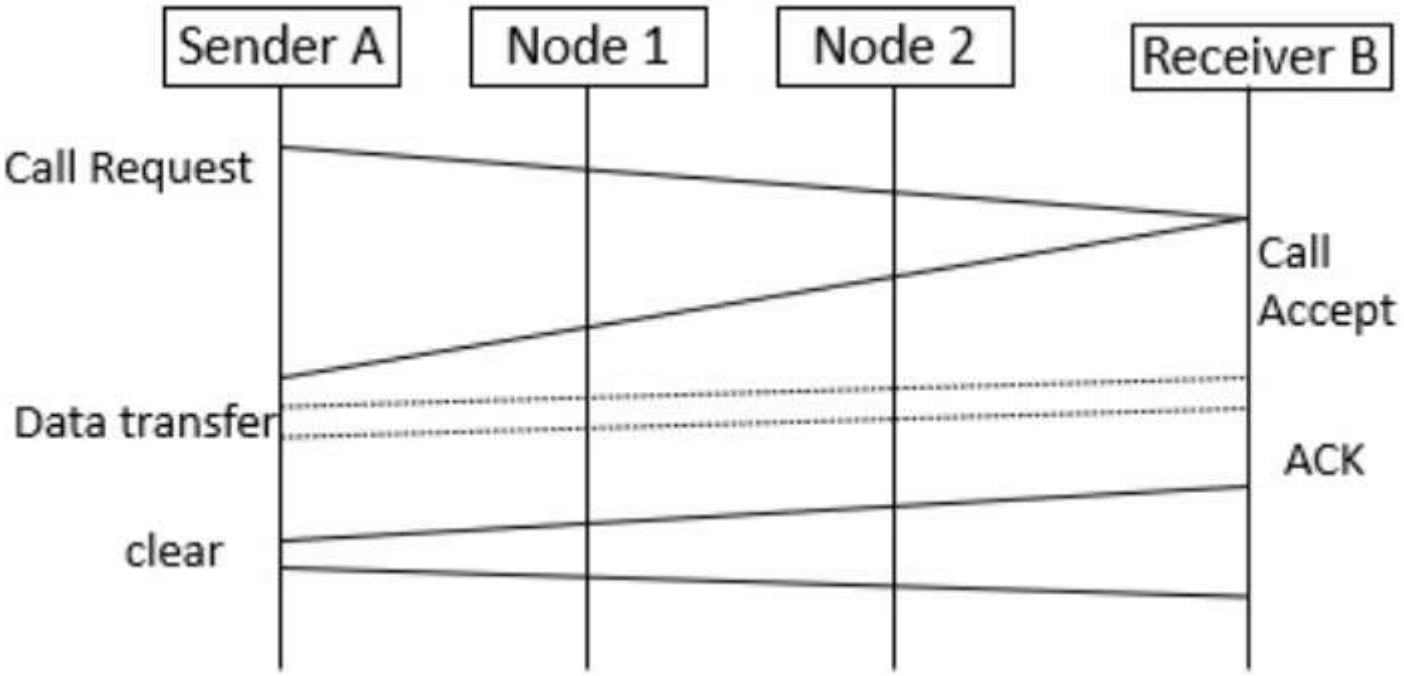


Fig. 10.10 Packet switching.

... destination host ...



Virtual Circuit Service

Packet switching networks are of two types

-- Datagram switching (connectionless)

-- Virtual circuit packet switching (connection-oriented)

S.No.	Virtual Circuits	Datagram Networks
1	connection-oriented → reservation of resources like buffers, bandwidth, etc. for the time used by a data transfer session	connectionless service → no need for reservation of resources as there is no dedicated path
2	uses a fixed path for a particular session, after which it breaks the connection	It is a true packet switched network. There is no fixed path
3	All the packets follow the same path and hence a global header is required only for the first packet of connection	Every packet is free to choose any path, and hence all the packets must be associated with a header
4	Packets reach in order to the destination as data follows the same path.	packets reach in random order
5	highly reliable	not as reliable as Virtual Circuits
6	Implementation of virtual circuits is costly as each time a new connection has to be set up with reservation of resources	easy and cost-efficient
7	It is used by the ATM (Asynchronous Transfer Mode) Network, which is used for the Telephone calls.	Its is generally used the IP network, which is used for Data services like Internet.

Advantages

The advantages of virtual circuit are as follows –

- Packets are delivered in the same order as they all follow the same route between the source & the destination.
- The overhead is smaller as full address is not required on each packet as they all follow the same established path.
- The connection is more reliable as it is one to one connection.
- Less chances of data loss.

Disadvantages

The disadvantages of virtual circuit are as follows –

- The switching equipment should be powerful.
- Re-establishment of the network is difficult as if there is any failure. All calls need to be re-established.

Delay in S&F

$T_{sf} = T_s + T_f$

T_s → storage delay.

T_f → data forwarding delay.
- queuing delay.
- packets may be queued → FCFS (or) priority.

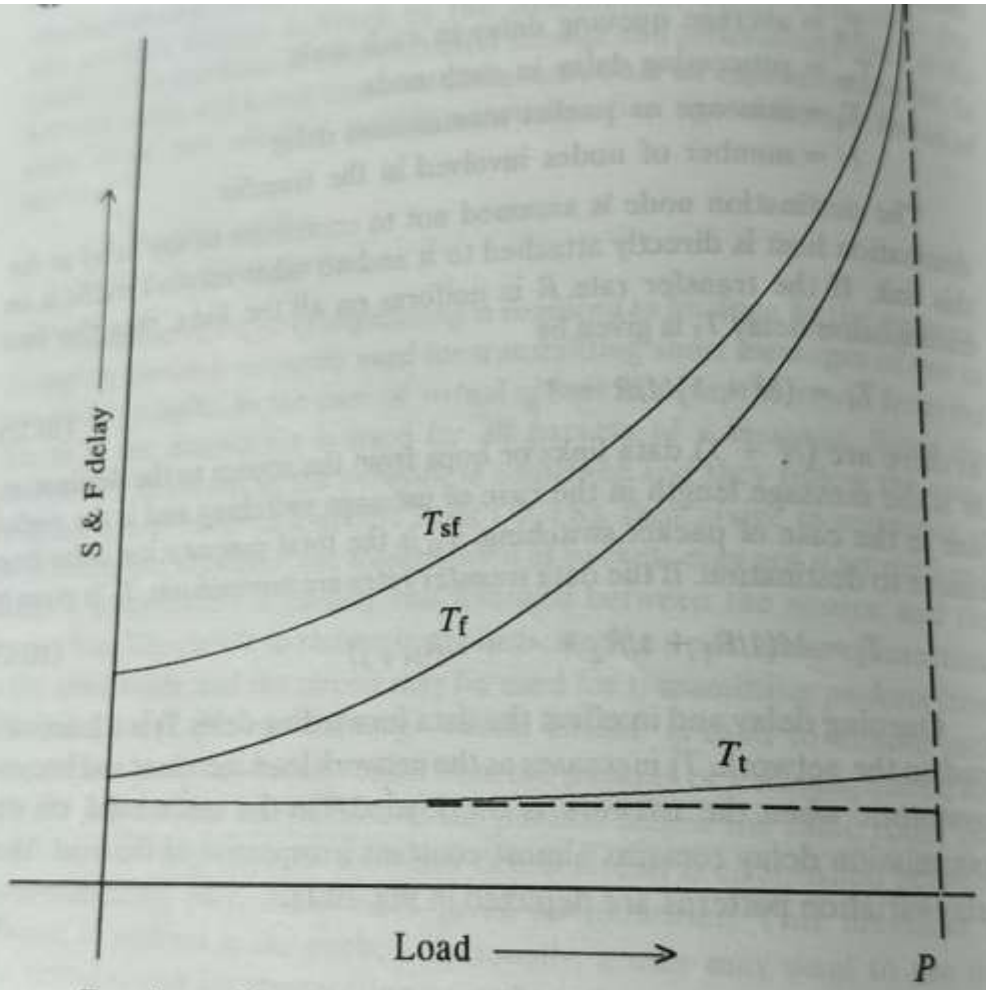
$T_f = (N-1)(T_q + T_m) + T_t$

- T_q → avg. queuing delay
- T_m → processing delay.
- T_t → transmission delay.

$T_f = (M+1)\, M/R + T_p$ — transfer rate uniform.

$= M(1/R_1 + 1/R_2 \cdots 1/R_{N+1})$ — non-uniform.

T_p is almost constant.



T_f = forwarding delay T_{sf} = store and forward delay
T_t = transmission delay

Fig. 10.11 Variation of delay components in S&F switching.

THANK YOU