

Chapter 1

Introduction to Data Communication

Computer

Computer is an electrical autonomous device which accepts data from input device process the data and provides information as an output. If required also stores the data for future purpose.

Data

Data is the set of raw facts and figures which when gets processed provides complete information.

Communication

Communication is a process of sending data or message or information from one location (source) to another location (destination).

A system that includes all the components required to send information from one place to another is called **communication system**.

Data Communication

It is the exchange of message, information between the **devices** (via) through some **transmission media** (communication channel) by means of **electrical signal**. The information exchange takes place in the form of binary 0s and 1s.

The device is the combination of hardware and software.

The transmission medium is the physical path through which data flows. Its function is to provide a physical connection between the transmitter output and receiver input. The medium can be either wired or wireless.

The electrical signals can be either analog or digital signal.

The data communication revolves around the three Fundamental concepts. They are:

- i) **Destiny**
The system should transmit the message to the correct intended destination. The destination can be another user or computer.
- ii) **Reliability**
The system should deliver the message to the destination in reliable manner. Any unwanted signal (noise) added along with the original data makes the disturbance.
- iii) **Fast**
The system should transmit the data as fast as possible within the technological constraints.

Some basic terms in Data Communication

Some frequently used terms in data communication are:

- i) **Data**
- ii) **Signal:** The encoding of data in the form of electric or electromagnetic form.
- iii) **Signaling:** The propagation of signals across the communication medium.
- iv) **Transmission:** The communication of data achieved by processing of signals.

Effectiveness of data Communication

To send the data from source to destination following characteristics (features) should be incorporated. They are:

- i) **Accuracy**
For effective data communication, data must be accurately transmitted to the receiver that there should not be any interference.

ii) **Delivery**

The communication is said to be effective if and only if data are transmitted to the accurate destination.

iii) **Timeliness**

For each communication time is allocated and within this time limit data should be transmitted. In some cases there won't be any meaning of the data which reaches late. Also if acknowledgement is not sent to the sender, once again data has to be sent.

Data Communication Model

The figure below shows the general block diagram of a communication model. It consists of 5 subsystems (components). They are Source, Transmitter, Communication channel (Transmission System), Receiver and Destination.

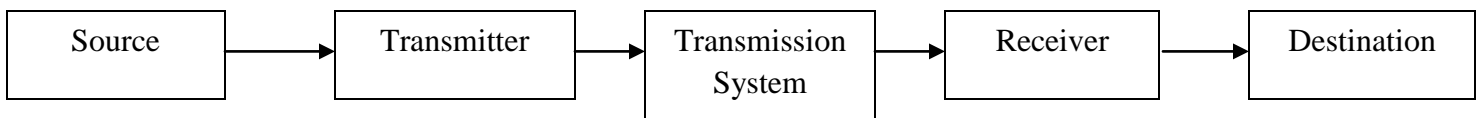


Fig: General block diagram of communication model

E.g.

Workstation → Modem → Public Telephone Network → Modem → Server

Fig: A typical dial-up network

i) **Source**

The source will generate a message and a transducer converts it into an electrical signal. The source can be a person with a microphone or a computer sending the file. The user terminal is known as Data Terminal Equipment (DTE). Examples are terminal, Computer, People etc.

ii) **Transmitter**

The data generated by a source system are not transmitted directly in the form in which they are generated. The transmitter transforms and encodes the information in such a way as to produce electromagnetic signals so that it can be transmitted across some sort of transmission system. For e.g. Modem transform digital bit stream into an analog signal that can be handled by telephone network. Some examples are: Encoder, Modulator, Amplifier, Repeater etc.

iii) **Communication channel**

This channel connects source to destination. It can be either guided media or unguided media. In both the cases communication is in the form of electromagnetic wave. In guided media the electromagnetic waves are guided along the physical path and in unguided media the electromagnetic waves are radiated through air, vacuum, water etc. e.g. twisted cable, Radio Frequencies, Fiber Optics, Infrared etc.

While sending signal from source to destination the various obstacles can occur such as:

Medium

Smoke signals
Carrier Pigeon
Telegraph

Problem

Fog, Darkness
Hunter
Broken wires

- | | | |
|--|----------------|------------|
| | Telephone | Electrical |
| | Computer Cable | Electrical |
- iv) **Receiver**
- The receiver amplifies the received signals removes any unwanted signals (noise) introduced by communication channel during propagation of the signal and feeds it to the destiny. E.g. Decoder, Demodulator etc.
- v) **Destination**
- The destination takes the incoming data from the receiver so that the user at other end finally receives the message through the data terminal equipment at the other end. E.g. Terminal, computer, printer etc.

Components of Data Communication System

If we specifically consider the communication between two computer then the data communication system is as shown in below figure. It has the following 5 components.

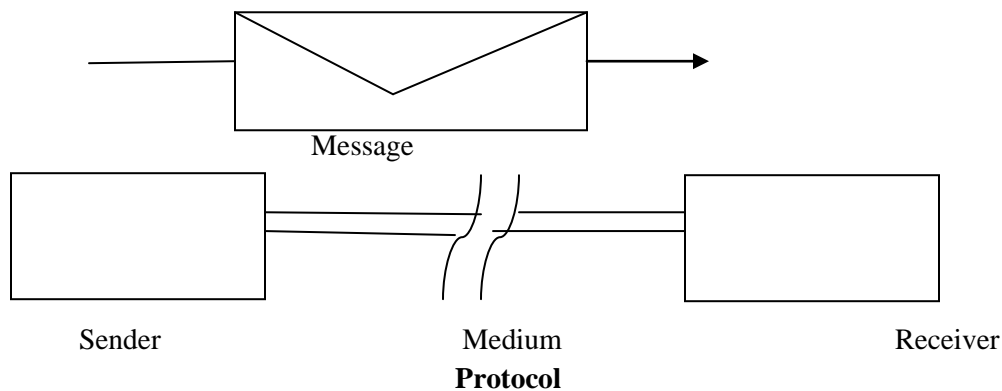


Fig: Components in Data Communication System

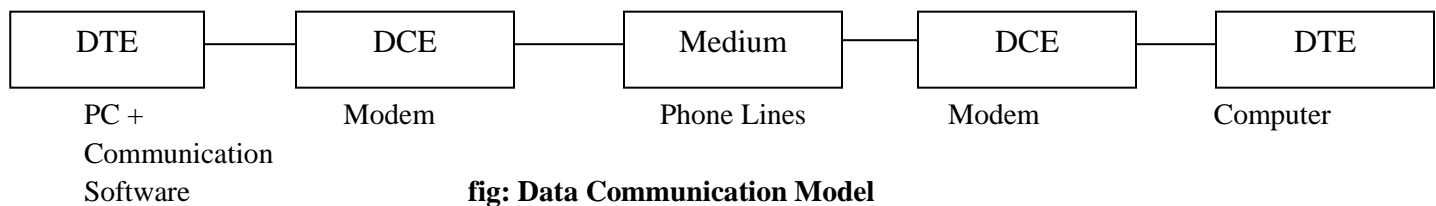
- i. **Message**
It is the information or data which is to be sent for one point to another. A message can be in the form of sound, text, number, picture, video, or combination of them.
- ii. **Sender**
It is a device which sends the message. E.g. Computer workstation, video camera, telephone handset. Etc.
- iii. **Medium**
It is a physical path over which message travels from sender to receiver. E.g. co-axial cable, twisted pair, fiber optics radio waves etc.
- iv. **Receiver**
It is a device which receives the message. E.g. Computer, TV receiver, workstation, etc.
- v. **Protocol**
Protocol is defined as the set of rules which govern the data communication. The connection of two device takes place by the communication medium but the actual communication between them will take place with the help of protocol.

Concept of DTE and DCE

DTE refers to **Data Terminal Equipment** and **DCE** refers to **Data Communication Equipment**. These two terms are very common in data communication process. The DTE is a piece of device that ends a communication line where DCE provides a path for the communication.

DTE is the source and the receiver's equipment which generates the data stream e.g. PC, terminal, end user device.

DCE is the interface between the source & the medium and medium & destination. It is the physical piece of equipment. Its job is to provide the interface from the DTE device to the medium. E.g. Modems, Channel, Router etc.



Communication Tasks

The tasks that must be performed in a data communications system are:

1. Transmission System Utilization

Transmission system simply connects the source entity to the destination entity. Transmission system capacity is measured as bandwidth. It makes efficient use of facilities that are typically shared among a number of capacities of a transmission medium among a number of users such as using the technique of multiplexing.

2. Interface

For the communication to occur, a device must interface with the transmission system. Two or more independent sub system are interfaced to communicate with each other. All forms of communication depend on the use of electromagnetic signals propagated over a transmission media.

3. Signal generation

Once an interface is established, signal generation is required for communication. The generated signal must be capable of being propagated through the transmission system and interpretable as data at receiver.

4. Synchronization

There must be some form of synchronization between system and the receiver. The receiver must be able to determine when a signal begins to arrive & when it ends. It must also know the duration of each signal element.

5. Exchange Management

Communication architecture should support bi-directional relationship. There should be mutual understanding between communicating parties to exchange the data.

6. Error detection and correction

Communication System should have a capability of error detection and the correction. It should be able to know where the error is and when the error occurred so that communication can be refined. The error usually occurs with data processing systems.

E.g. Original Data	Received Data	after Correction
1100	1101	1100

7. Flow control

Data must be sent according to the receiving capability of the receiver. It is required to assure that the source does not overtake the destination by sending data faster than they can process and absorbed. Data must be sent according to the receiving capacity of the receiver.

8. Addressing and routing

When more than two devices share a transmission facility, a source system must indicate the identity of the intended destination. For the communication from one device to another there is the assignment of unique numbers. (Concept of IP address and MAC address). The machines should be incorporated with the unique numbers for communication with each other. Also during transmission there should be the selection of best path among many alternative paths.

9. Recovery

Recovery techniques are needed in the situation in which an information exchange is interrupted due to a fault somewhere in the system. Taking the data into its original form is known as recovery.

10. Message formation

The agreement between two parties (source and destination) for the form of the data to be exchanged or transmitted. E.g. binary code

11. Security

It is important to provide some measures of security in a data communication system. The sender of data may wish to be assured that only the intended receiver actually receives the data. The receiver of data may wish to be assured that the received data have not been altered in transit and the data came from the intended sender.

12. Network Management

It is required to manage all the activities done in networking. This managing ability should be in the network or channel. The capabilities to configure the system, monitor the status, react to failure & overload and plan intelligently comes under network management. The activities involved from sending to receiving data are managed by network management.

Data Communication Networking

A computer network is the interconnection of two or more computers which are linked together with a medium and the data communication device for the purpose of data communication and sharing resources.

Server

Computer that provides resources to other computer in the network is server.

Nodes

Individual computers which access shared network resources are known as nodes.

Major use of Networking

1. Resource Sharing

Programs (OS, Apps), data, equipments are available software, information regardless of location. Sharing of hardware, software, information etc. come under this.

2. Scalability

Individual subsystem can be combined and created into main system to enhance the overall performance.

3. Distributed Systems

In network environment computers distribute the workload among themselves keeping transparency to end user.

Computer Network based on geographical Coverage

It refers to a communicating model bounded into certain geographical area.

i) Local Area Network (LAN)

It is a network of computers located relatively near to each other and connected in a way that enables them to communicate with one another. This network serves user within a confined geographic area, restricted in size and range. Its small size simplifies network management.

In LAN there is a simple transmission technology. Depending upon the implemented technology, a LAN can be simple. For e.g. connection of 2 PC and printer connected in a small office.

The main purpose of LAN is to share the resources and information exchange by connecting multiple computers. The speed of LAN ranges from 10 mbps to 100 mbps, has low delay and make few errors.

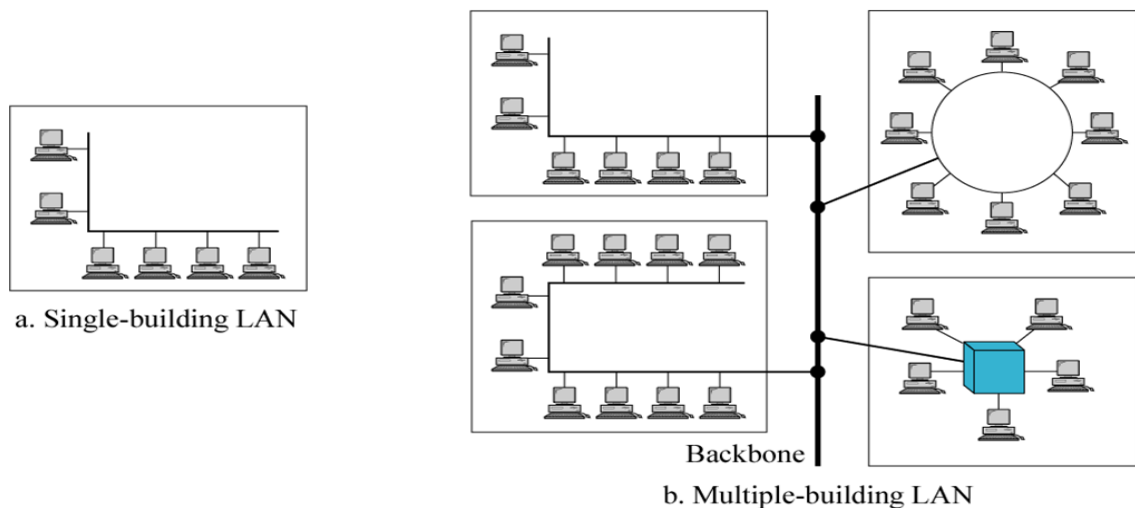
10 mbps--> Ethernet

100 mbps --> Fast Ethernet

1000 mbps --> Giga bit Ethernet

LAN is normally handled by single administrative authority. It is a simple & flexible technology.

A typical LAN in a corporate office links a group of related computers and the workstations. One of the best computer can be given a large capacity disk drive and made as server and other can be made as client.



Communication Infrastructure used in LAN

- (i) Twisted pair cables
- (ii) Co-axial cables
- (iii) Optical Fibers

Characteristics of LAN

- a) Every computer has the potential to communicate with any other computers of the network.
- b) High degree of interconnection between computers.
- c) Easy physical connection of computers in a network.
- d) Inexpensive medium if data transmission.
- e) High data transmission rate.

Advantages

- a) The reliability of network is high because the failure of one computer in the network does not affect the functioning for other computers.
- b) Addition of new computer to network is easy.
- c) High rate of data transmission is possible.
- d) Peripheral devices like magnetic disk and printer can be shared by other computers.

ii) Wide Area Network (WAN)

WAN refers to Wide Area Network that spans a large geographical area, often a country or continent. It can make unrestricted or unbounded communication. This network covers large boundary than LAN but operates in low speed along with the high threats. Normally, it has complex topology and transmission technology.

WAN consists of number of interconnected nodes. It is best for long distance communication because various medium like satellites, optical fiber, leased lines are used. The nodes are concerned with transmission of data not the content of data. It is quite expensive media for data communication. Most of the organization supports WAN i.e. ISP/ NSP. A common example of WAN is internet.

E.g. For a large company, the headquarters might be at KTM and regional branches at Biratnagar, Pokhara, Nepalgunj and Hetauda. Here, regional centers are connected to headquarters through WAN.

A network device called router connects LAN's to the WAN. Unlike, LAN which depends on their own network for transmission, WAN's may utilize public, leased, or private communication devices when it comes across and therefore span an unlimited number of KMs.

Some of the Technologies of WAN are:

- a. Circuit Switching
- b. Packet Switching
- c. Frame Relay
- d. ATM(Asynchronous Transfer Mode)
- e. ISDN(Integrated Services Digital N/W)
- f. BISDN(Broad band ISDN)
- g. SONET(Synchronous Optical Networking)

Explain

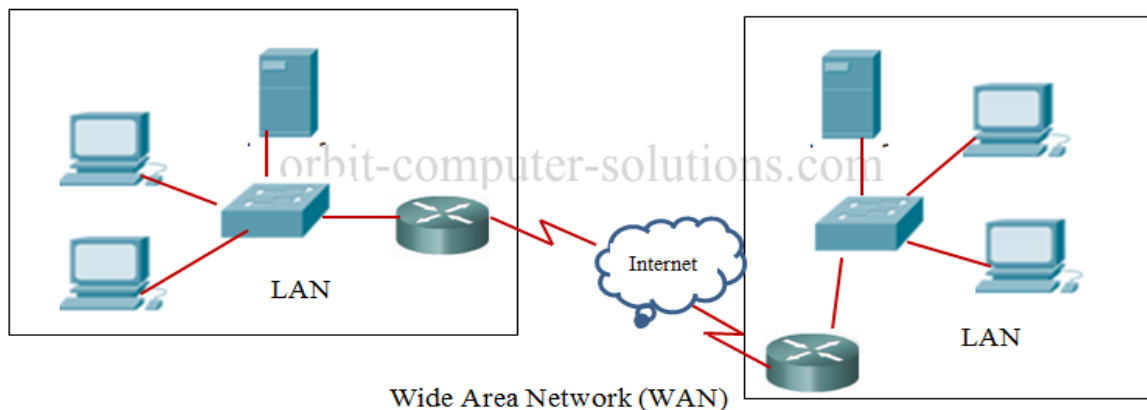


Fig1: Simple overview of WAN

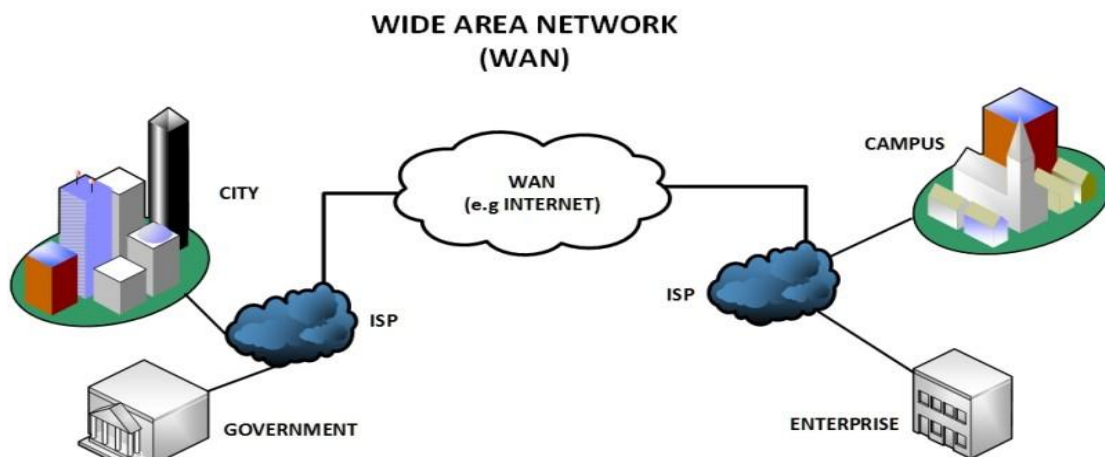


Fig2: WAN connection

Characteristics of WAN:

Following are the major characteristics of the WAN:-

1. Communication facility:

For a big company spanning over different parts of the country the employees can save long distance phone calls and it overcomes the time lag in overseas communications. Computer conferencing is another use of WAN where users communicate with each other through their computer system.

2. Remote Data Entry:

Remote entry is possible in WAN. It means sitting at any location you can enter data, update data and query other information of any computer attached to the WAN but located in other cities. For example, suppose you are sitting at Biratnagar and want to see data of computer located at Kathmandu, you can do it through WAN.

3. Centralized Information:

In modern computerized environment you will find the big organizations go for centralized data storage. This means if the organization is spread over many cities, they keep

their important business data in a single place. As the data are generated at different sites, WAN permits collection of this data from different sites and save at a single site.

Ethernet and Arpanet are examples of WAN.

Ethernet was developed by Xerox Corporation which uses co-axial cables for data transmission. Special integrated circuit chips called controllers are used to connect equipment to the cable.

Arpanet was developed at Advanced Research Projects Agency of US Department which connects more than 40 universities and institutions throughout USA and Europe. (ARPANET refers Advance Research Projects Agency Network).

Q. Explain advantages and disadvantages of WAN.

Q. Differentiate between LAN and WAN

iii) Metropolitan Area Network (MAN)

The network which is designed to cover an entire city is MAN. It can be single network such as cable TV or number of LANs connected together within a city. For instance, a business organization may choose MAN to interconnect its entire branch offices within a city.

The communication infrastructures used in MAN are:

- (i) Cables (Twisted, Coaxial)
- (ii) Optical fibers
- (iii) Radio links

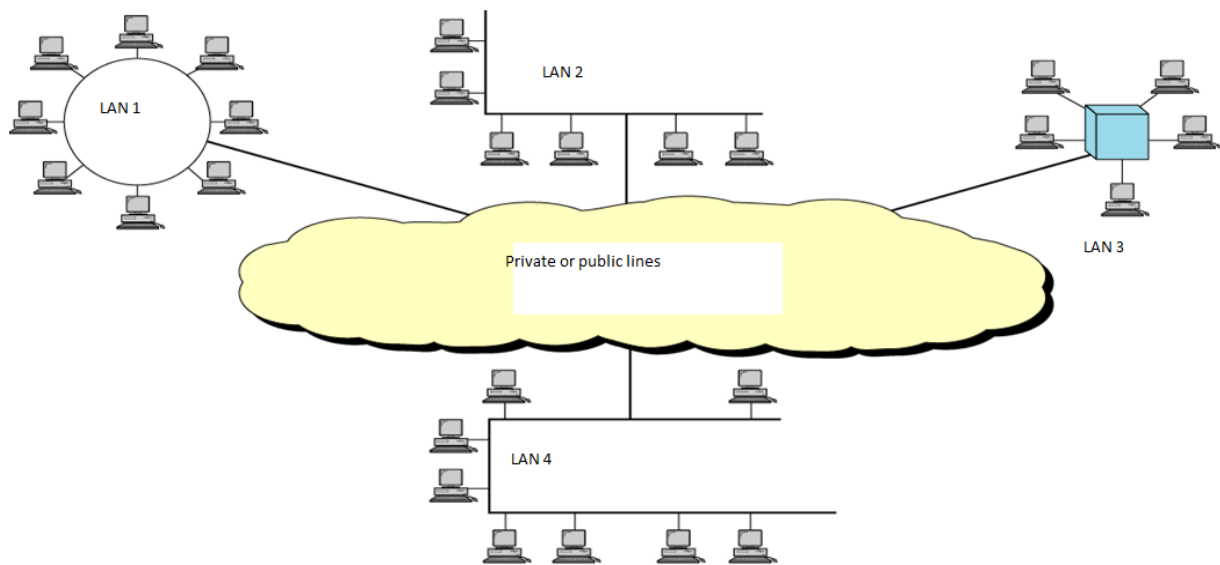


Fig: Overview of MAN

Some other types of communication are:

iv) Storage Area Network (SAN)

SAN is the network formed through interconnection of several network servers that are dedicated to storing large amount of data in a centralized, secure repository. It is a specialized LAN. SANs are useful to the organization that needs extremely large data storage capacity, high reliability and fast retrieval.

v) Value Added Network (VAN)

VAN are communication network supplied and managed by third party companies that facilitates electronic data interchange, web services and transaction delivery by providing services. It provides both network access and additional proprietary services to its user. I.e. it provides its subscribers with standard network services such as internet access and e-mail and also offers additional features such as private chat rooms, message boards, news summaries etc.

vi) Personal Area Network (PAN)

PAN is a network of persons or desk area. It is the most popular and highly used network in which communication takes place between two portable devices. It is usually used for personal purpose whenever exchange of data between two devices takes place. Two mobile phones interchanging the something in the formation of network through Bluetooth then it is said PAN.