DATA COMMUNICATION

Introduction to Data Communication

Objective

By the end of the unit the learner should be able to:

(i) Appreciate the terminologies used in Data communication.
(ii) Understand the technology used in making data communication affordable
(iii) Describe how data communication is changing the way we lead our lives.

Definition:

What is Data Communication - Data Communication in simple Words is
The process of transferring data from one location to another. In this process, data is transmitted from one location to another using transmission media.

Data communication concepts:

Data Communications is the transfer of data or information between a source and a receiver. The source transmits the data and the receiver receives it. The actual generation of the information is not part of Data Communications nor is the resulting action of the information at the receiver. Data Communication is interested in the transfer of data, the method of transfer and the preservation of the data during the transfer process.

Note:- The sharing can be local or remote. Between individuals, local communication usually occurs face to face, while remote communication takes place over distance.

For data communication to occur, the communicating devices must be part of a communication system made up of a combination of three components

1. Hardware: Communicating devices, Networking devices, transmission media
2. Software: Network Operating Systems, Application Software
3. Standards/Protocols

The effectiveness of a data communication system depends on the three fundamental **characteristics**:
1. Delivery: The System must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user
2. Accuracy: The system must deliver data accurately. Data that have been altered in transmission and left uncorrected are useless.
3. Timeliness: The system must deliver data in a timely manner. Data delivered late are useless. In the case of video, audio, and voice data, time critical, that means delivering

data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery id called real-time transmission.

4. Jitter: packets experiencing different propagation delays due to use of different paths from source to destination.

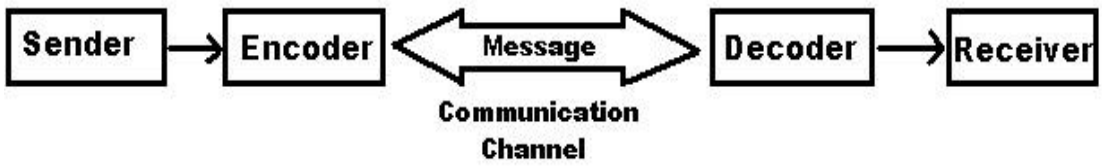
The network must meet some criteria such as:

1. Performance – the amount of time taken to send a message and receive a response
2. Reliability – frequency of failure and recovery time from such failures
3. Security – protecting data from unauthorized access, modification data loss etc

Components of Data Communication
The basic components or elements of data communication system are :

1. Message
2. Sender
3. Receiver
4. Medium or Communication Channel
5. Encoder and Decoder

Fig 1.1 basic components of data communication



1- Message
The message is the information or data that is to be communicated. It may consist of text, numbers, pictures, images, sounds, videos or any combination of these.

2- Sender
Device that is used for sending messages (or data) is called *sender*. It is also called *transmitter* or *source*. The sender can be a computer, telephone, or a video camera etc. Usually, a computer is used as sender in data communication system.

3- Receiver
Device that is used for receiving messages is called *receiver*. It is also known as *sink or recipient*. The receiver can be a computer, telephone set, printer, or a fax machine etc. Usually, a computer is also used as receiver in data communication system.

4- Transmission Medium

The path through which data is transmitted (or sent) from one location to another is called *transmission medium*. It is also called *communication channel*. It may be gas, liquid or solid such as free space, an electric wire, or fiber optic cable etc. If the sender and receiver are within a building, a wire is used as the medium. If they are located at different locations, the medium may be, fiber optics, microwave link or satellite system.

5- Modulator and Demodulator

In communication systems, computers are used for senders and receivers. A computer works with digital signals. The communication channels usually use analog signals. The modulator and demodulator are used in communication systems to convert signals from digital to analogue and back to digital. Hence the word MODEM for MODdulate DEModulate.

6. Encoder and Decoder

Encoder: The encoder is an electronic device. It receives data from sender in the form of Analogue signals. It converts the analogue signal to digital signals into a form that can be transmitted through transmission medium.

Decoder: The decoder is an electronic device. It receives data from the transmission medium. It converts encoded signals (i.e. digital signals) into analogue form. That is why we talk of GoTV, ZUKU, Startimes etc decoders. CODEC for Code DECode

Applications of Data Communication and Computer Network

Computer systems and peripherals are connected to form a network. They provide numerous advantages:

- Resource sharing such as printers and storage devices
- Exchange of information by means of e-Mails and FTP
- Information sharing by using Web or Internet
- Interaction with other users using dynamic web pages
- IP phones
- Video conferences
- Parallel computing
- Instant messaging

Internet is serving many proposes and is involved in many aspects of life. Some of them are:

- Web sites
- E-mail
- Instant Messaging
- Blogging

- Social Media
- Marketing
- Networking
- Resource Sharing
- Audio and Video Streaming

Classification of computer networks according to:

1. Ownership –Private/Public/Value addition
2. Span of control – Centralized/ Distributed/ Hybrid
3. Geographical span – LAN, MAN, WAN
4. Topology – Mesh/Bus/Ring/Star/ Hybrid
5. Architecture – Client Server/Peer to Peer/Hybrid

Topology

The term "**Topology**" refers to the way in which the end points or stations/computer systems, attached to the networks, are interconnected. A topology is essentially a stable geometric arrangement of computers in a network. If you want to select a topology for doing networking. You have attention to the following points.

- Application S/W and protocols.
- Types of data communicating devices.
- Geographic scope of the network.
- Cost – amount of cables, ability to use a node as a repeater
- Reliability- impact of cable break or central controller, security of data

Depending on the requirement there are different Topologies to construct a network.
(1) Fully connected
(2) Mesh topology.
(3) Star topology.
(4) Tree (Hierarchical) topology.
(5) Bus topology.
(6) Line
(7) Ring topology.
(8) Cellular topology.

Serial verse Parallel transmission

Data over long distance is transmitted in a serial form, one bit after the other, this reduces complexity of realigning the bits at the receiver, requires one cable that is thin, less bulky and less expensive.

Over short distances inside the computer however parallel transmission is used as bits transmitted through different cables will arrive at the receiver at the same time if they left the sender at the same time.

Asynchronous verses synchronous transmission.

Asynchronous: In data communications if the communicating devices that do not require addressing, it's possible to transmit a character after a character. In a standard keyboard we have less than 128 characters that can be represented uniquely by 7 bits 2^7=128, according to American Standard Code for Information Interchange ASCII. Each character will require at least an additional 3 bits that is a start bit, error control bit and an end bit leading to 7/10 efficiency or 3/10 wastage.

To minimize on the wastage, **synchronous transmission** puts the data to be transmitted in a block (Packet in the network layer or Frame in the data link layer) thus improving on the efficiency and lowering wastage and cost of communication.

Transmission Mode

A given transmission on a communications channel between two machines can occur in several different ways. The transmission is characterized by:

- the direction of the exchanges
- the transmission mode: the number of bits sent simultaneously
- synchronization between the transmitter and receiver

Types of Transmission mode

- Simplex
- Half Duplex
- Full Duplex

Simplex

A simplex connection is a connection in which the data flows in only one direction, from the transmitter to the receiver. This type of connection is useful if the data do not need to flow in both directions (for example, from your computer to the printer or from the mouse to your computer. This transmission mode is rare as modern printers communicate to the computer).

Half Duplex

A half-duplex connection (sometimes called an *alternating connection* or *semi-duplex*) is a connection in which the data flows in one direction or the other, but not both at the same time. With this type of connection, each end of the connection transmits in turn. This type of connection makes it possible to have bidirectional communications using the full capacity of the line.

Full Duplex

A full-duplex connection is a connection in which the data flow in both directions simultaneously. Each end of the line can thus transmit and receive at the same time, which means that the bandwidth is divided in two for each direction of data transmission if the same transmission medium is used for both directions of transmission.

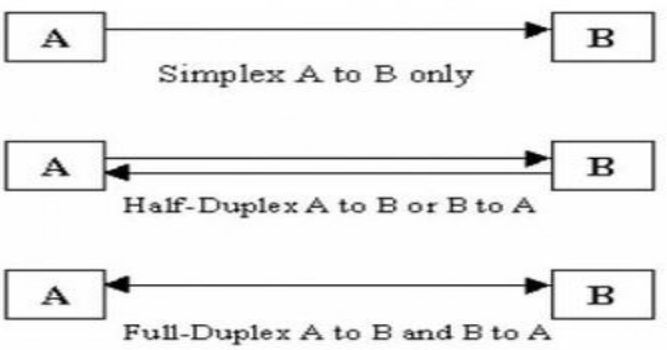


Fig 1.2 Transmission modes.

Categories of Network

One way to categorize the different types of computer network designs is by their geographical span or scope or scale. For historical reasons, the networking industry refers to nearly every type of design as some kind of *area network*. Common examples of area network types are:

- LAN - Local Area Network
- WLAN - Wireless Local Area Network
- WAN - Wide Area Network
- MAN - Metropolitan Area Network

Local Area Network

A LAN connects network devices over a relatively short distance. A networked office building, school, or home usually contains a single LAN, though sometimes one building will contain a few small LANs (perhaps one per room), and occasionally a LAN will span a group of nearby buildings. In TCP/IP networking, a LAN is often but not always implemented as a single IP subnet. In addition to operating in a limited space, LANs are also typically owned, controlled, and managed by a single person or organization. They also tend to use certain connectivity technologies, primarily Ethernet and Token Ring.

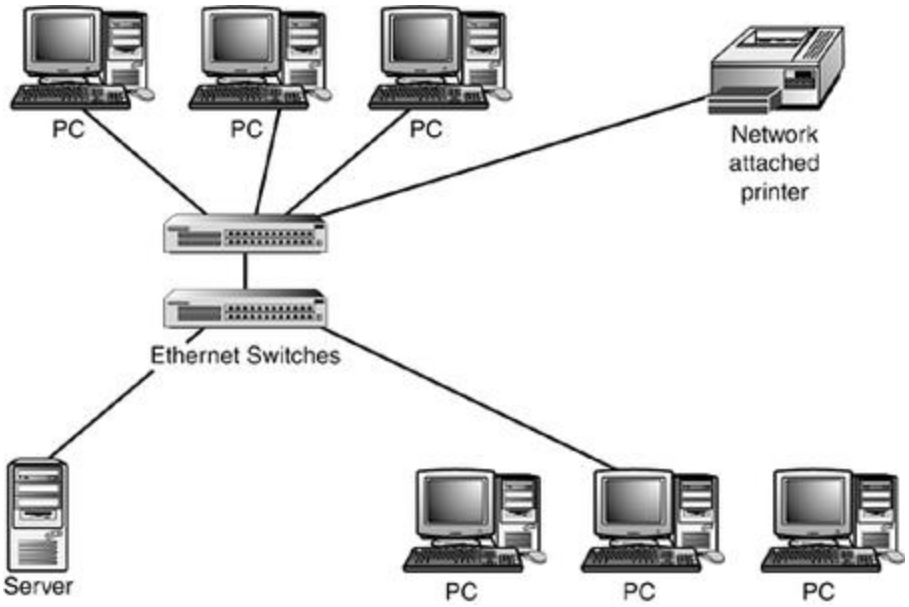


Fig 1.3 Local Area Network LAN

Wireless Local Area Network WLAN

Is a special type of LAN where by the communicating devices are not bound to each other by a cable. The communicating devices can be mobile that is they can be moved from one point to another as long as they remain within the range of the access point.

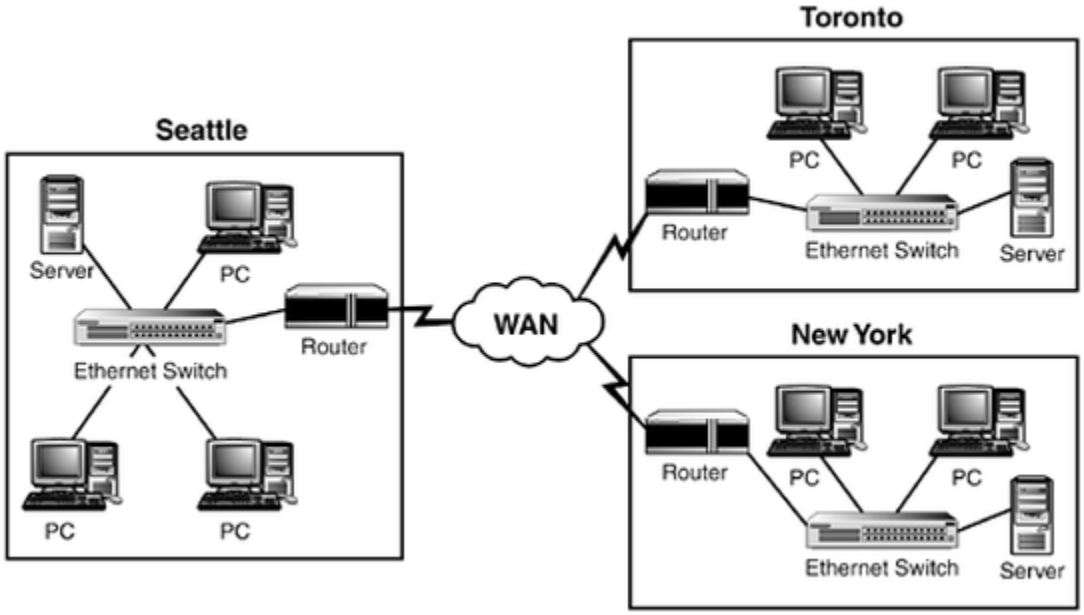
Fig 1-4 Wireless LAN

Wide Area Network

A WAN is a network that spans more than one geographical location often connecting separated LANs. WANs are slower than LANs and often require additional and costly hardware such as routers, dedicated leased lines, and complicated implementation procedures. As the term implies, a WAN spans a large physical distance. The Internet is the largest WAN, spanning the Earth. A WAN is a geographically-dispersed collection of LANs. A network device called a router connects LANs to a WAN. In IP networking, the router maintains both a LAN address and a WAN address.

A WAN differs from a LAN in several important ways. Most WANs (like the Internet) are not owned by any one organization but rather exist under collective or distributed ownership and management. WANs tend to use technology like ATM, Frame Relay and X.25 for connectivity over the longer distances.

Fig 1.5 Wide Area Network



Types of Transmission Media:

The communication channel or media is divided into two types.

1. Guided/Bound/Cables Media.
2. Unguided/Unbound/Wireless Media.

1. Guided Media:

In guided communication media, communication devices are directly linked with each other via cables or physical media for transmission of data. The data signals are

bounded to a cabling media. Therefore, guided media is also called bounded media. The guided media are usually used in LAN. The examples of guided or bounded media are:

1. Twisted pair wire.
2. Coaxial cable.
3. Fiber optic cable.

Twisted Pair Cable: Twisted pair cable is one of the most commonly used communication media. It is used in local area network (LAN) for data communication between different computers. It is also used in telephone lines to carry voice and data signals.

A twisted pair cable consists of a pair of thin diameter copper wires. These wires are covered by insulating material (such as plastic). These pair of wires are twisted together to form a cable. The wires are twisted around each other to minimize (or reduce) interference from other twisted pairs in the cable.

The data transmission speed through twisted pair cable is low and covers a short distance of 100 meters compared to coaxial cable or optical fiber.

The twisted pair cable has been the standard communication channel for voice and data communication. But now its use is reducing because today more reliable communication media are available such as coaxial cable, fiber optic cable microwave and satellite.

Coaxial Cable: Coaxial cable is also referred to as Coax. It carries signals of higher frequency ranges than twisted-pair cable. Coaxial cable consists of a single solid copper wire, which is called the inner conductor and outer conductor that is usually braided for flexibility of the cable to install in corners.

Coaxial cable can be used for telephone lines for voice and data transmission with very high frequency. The bandwidth of coaxial cable is 80 times greater than that of twisted pair media. Coaxial cable is also widely used in local area network (LAN). It is more expensive than twisted-pair wire.

Fiber-Optic Cable: In twisted-pair cable and coaxial cable, data is transmitted in the form of electric frequencies. The fiber optic cable uses light to transmit data. The data transmission speed is very high (because fiber-optic cable uses light to transmit data). The data transmission speed is up to billions bits per second. Today, most of the telephone companies and cable TV operators are using fiber optic cables in their networks.

2. Unguided Media:

In unguided communication media, data is communicated between communication devices in the form of wave. Unguided media provides means to transmit data signals but does not guide them along a specific path. The data signals are not bounded to a cabling media. Therefore, unguided media is also called unbounded media or wireless media.

This transmission medium is used when it is impossible to install the cables or mobility is required during communication. The data can be transmitted all over the world through this medium. The examples of unguided or unbounded media are:

1. Microwave
2. Satellite
3. Radio Broadcast
4. Cellular Radio

Microwaves: In microwave transmission, data is transmitted through air or space, instead of through cables or wires. Microwaves are high frequency radio waves. These waves can only travel in straight lines.

Internetworks

Internetworking is the practice of connecting a computer network with other networks through the use of gateways that provide a common method of routing information packets between the networks. The resulting system of interconnected networks is called an *internetwork*, or simply an *internet*.

The most notable example of internetworking is the Internet, a network of networks based on many underlying hardware technologies, but unified by an internetworking protocol standard, the Internet Protocol Suite, often also referred to as TCP/IP.

Networking model

Two architectural models are commonly used to describe the protocols and methods used in internetworking.

The Open System Interconnection (OSI) reference model was developed under the auspices of the International Organization for Standardization (ISO) and provides a rigorous description for layering protocol functions from the underlying hardware to the software interface concepts in user applications. Internetworking is implemented in the Network Layer (Layer 3) of the model.

The Internet Protocol Suite, also called the TCP/IP model of the Internet was not designed to conform to the OSI model and does not refer to it in any of the normative

specifications in Requests for Comment and Internet standards. Despite similar appearance as a layered model, it uses a much less rigorous, loosely defined architecture that concerns itself only with the aspects of logical networking. It does not discuss hardware-specific low-level interfaces, and assumes availability of a Link Layer interface to the local network link to which the host is connected. Internetworking is facilitated by the protocols of its Internet Layer.

R stands for Repeaters, they receive a weak distorted signal, and they reshape, regenerate, retime then resend a strong well shaped signal.

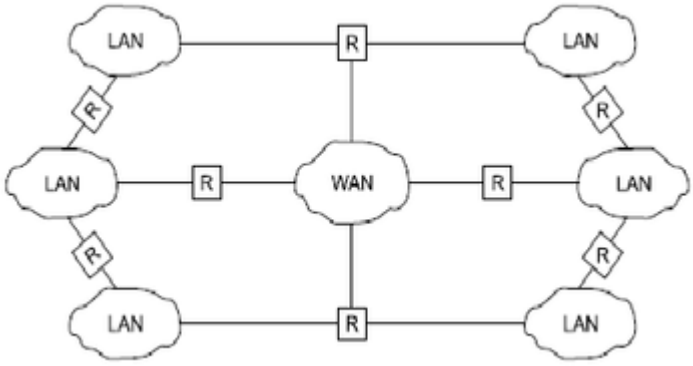


Fig 1.6 Internet

Signals

In a *communication system*, a *transmitter* encodes a *message* into a signal, which is carried to a *receiver* by the communications *channel*. For example, the words "Mary had a little lamb" might be the message spoken into a telephone. The telephone transmitter converts the sounds into an electrical voltage signal. The signal is transmitted to the receiving telephone by wires; and at the receiver it is reconverted into sounds.

Analog Signals

An **analog** or **analogue signal** is any continuous signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity, i.e., analogous to another time varying signal. It differs from a digital signal in terms of small fluctuations in the signal which are meaningful. Analog is usually thought of in an electrical context; however, mechanical, pneumatic, hydraulic, and other systems may also convey analog signals.

Digital Signals

A **digital signal** is a signal that is a representation of a sequence of discrete values (a quantified discrete-time signal), for example of arbitrary bit stream, or of a digitized (sampled and analog-to-digital converted) analog signal. The term digital signal can refer to

1. A continuous-time waveform signal used in any form of digital communication.
2. A pulse train signal that switches between a discrete number of voltage levels or levels of light intensity, also known as a line coded signal, for example a signal found in digital electronics or in serial communications using digital baseband transmission in, or a pulse code modulation (PCM) representation of a digitized analog signal.

A signal that is generated by means of a digital modulation method (digital pass band transmission), produced by a modem, is in the first case considered as a digital signal, and in the second case as converted to an analog signal.

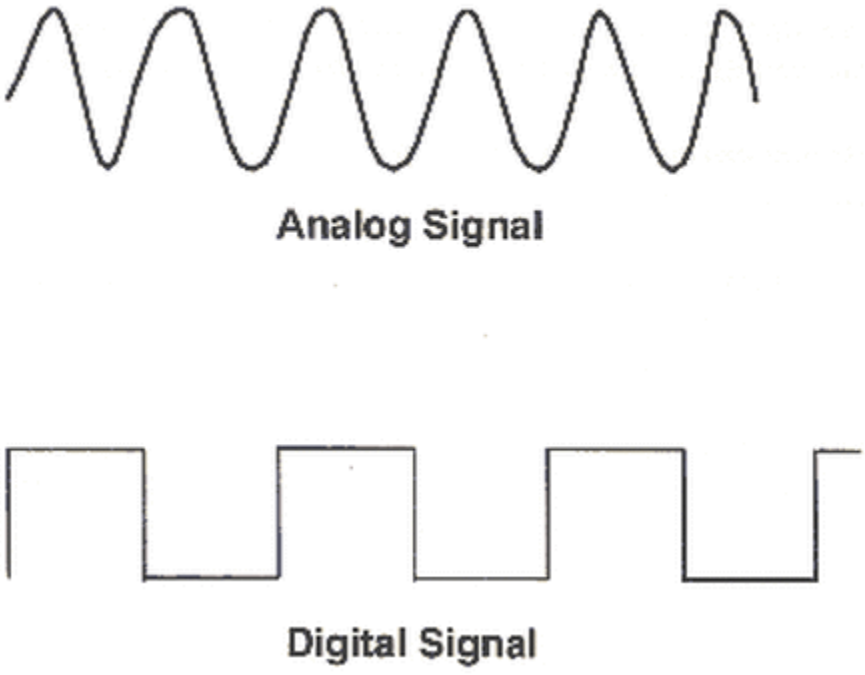


Fig 1-7 signals

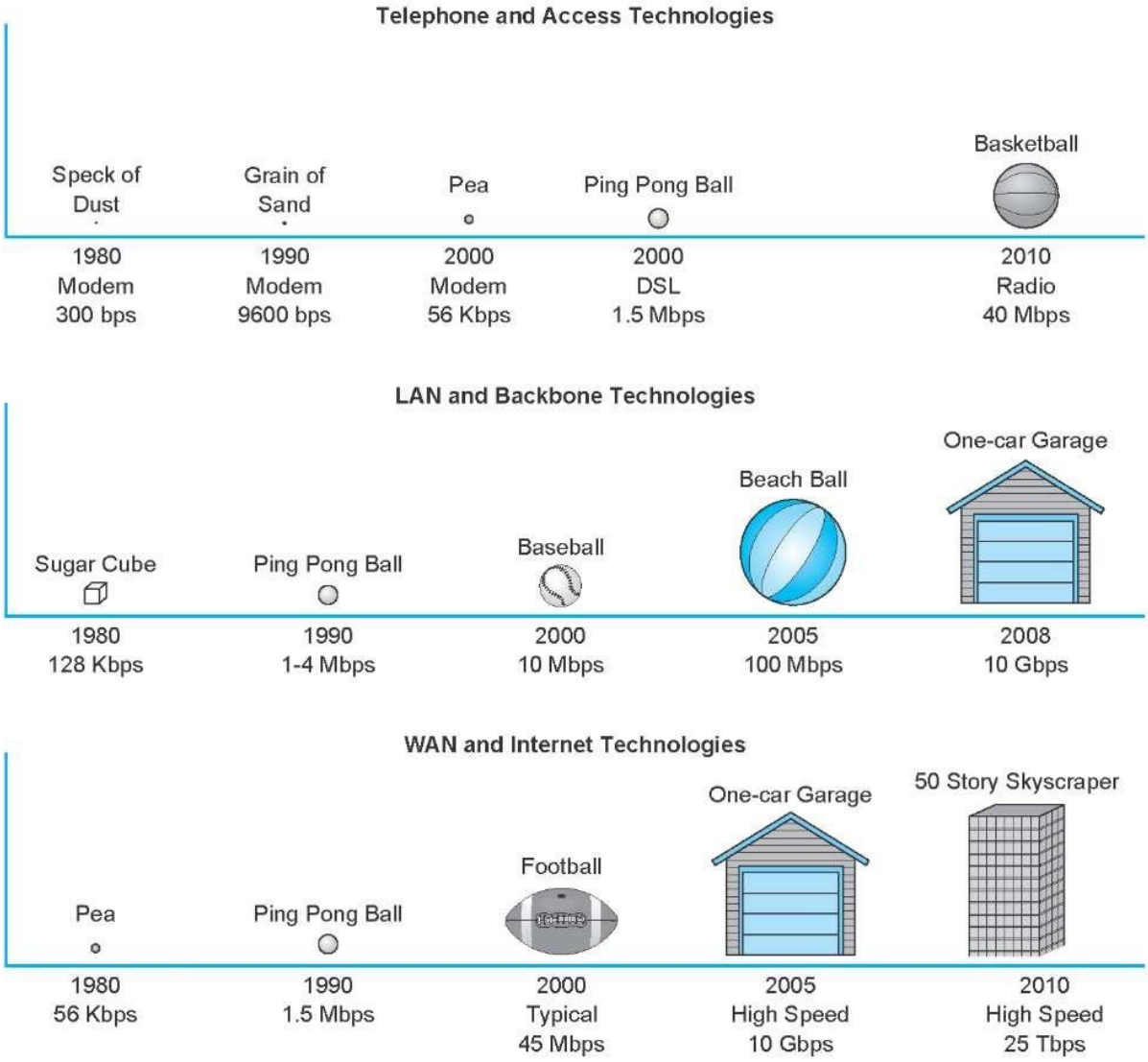


Figure 1. 8 Relative capacities of telephone, local area network (LAN), backbone network (BN), wide area network (WAN), and Internet circuits. DSL = Digital Subscriber Line

Factors driving Data Communication growth

1. **Pervasive Networking**

Pervasive networking means that communication networks will one day be everywhere; virtually any device will be able to communicate with any other device in the world. This is true in many ways today, but what is important is the staggering rate at which we will eventually be able to transmit data. See fig 1-8 above.

2. The Integration of Voice, Video, and Data

A second key trend is the integration of voice, video, and data communication, sometimes called convergence. In the past, the telecommunications systems used to transmit video signals (e.g., cable TV), voice signals (e.g., telephone calls), and data (e.g., computer data, e-mail) were completely separate. One network was used for data, one for voice, and one for cable TV.

3. New Information Services

A third key trend is the provision of new information services on these rapidly expanding networks. With the construction of worldwide integrated communications networks. You can find information on virtually anything on the Web. The problem becomes one of assessing the accuracy and value of information. In the future, we can expect information services to appear that help ensure the quality of the information they contain. Never before in the history of the human race has so much knowledge and information been available to ordinary citizens. The challenge we face as individuals and organizations is assimilating this information and using it effectively.

http://what-when-how.com/data-communications-and-networking/future-trends-data-communications-and-networking/