Usmanu Danfodiyo University, Sokoto

FACULTY OF PHYSICAL & COMPUTING SCIENCES

CMP 101: Introduction to Computer Science

PART 3: INTRODUCTION TO COMPUTER NETWORK

© 2024, Department of Computer Science, UDUS

Contents

- ✓What is a Computer Network?
- ✓Components of Data Communication System
- ✓Data representation
- ✓Transmission modes
- ✓Types of Computer Networks
- ✓Internetwork
- ✓Types of Internetwork

Computer Network

What is a Computer Network?

- a group of computers or computing devices linked to each other that enables the computers/devices to communicate with each other to share data, resources, and applications
- consists of two or more computers that are linked to share resources (such as printers and CDs), exchange files, or allow electronic communications
- computers on a network may be linked through:
  - cables,
  - telephone lines,
  - radio waves,
  - satellites, or
  - infrared light beams

Components of a Data Communications System

- A data communications system has five components:
  - **Message**
    - the information (data) to be communicated.
    - forms of information include text, numbers, pictures, audio, and video.
  - **Sender**
    - device that sends the (data) message.
    - It can be
      - ✓ a computer,
      - ✓ workstation,
      - ✓ telephone handset,
      - ✓ video camera, and so on.
  - **Receiver**
    - The device that receives the message.
    - It can be
      - ✓ a computer,
      - ✓ workstation,
      - ✓ telephone handset,
      - ✓ television, and so on
  - **Transmission medium**:
    - path by which a message travels from sender to receiver.
    - Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves
  - **Protocol**
    - set of rules that govern data communications
    - represents an agreement between the communicating devices
    - Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese

Data Representation

- Information today comes in different forms such as text, numbers, images, audio, and video
  - **Text**
  - In data communications, text is represented as a bit pattern, a sequence of bits (O’s or 1’s). Different sets of bit patterns have been designed to represent text symbols. Each set is called a code, and the process of representing symbols is called coding. Today, the prevalent coding system is called Unicode, which uses 32 bits to represent a symbol or character used in any language in the world

Data Representation Continuation

- **Numbers**
  - Numbers are also represented by bit patterns.
  - However, a code such as ASCII is not used to represent numbers;
  - number is directly converted to a binary number to simplify mathematical operations

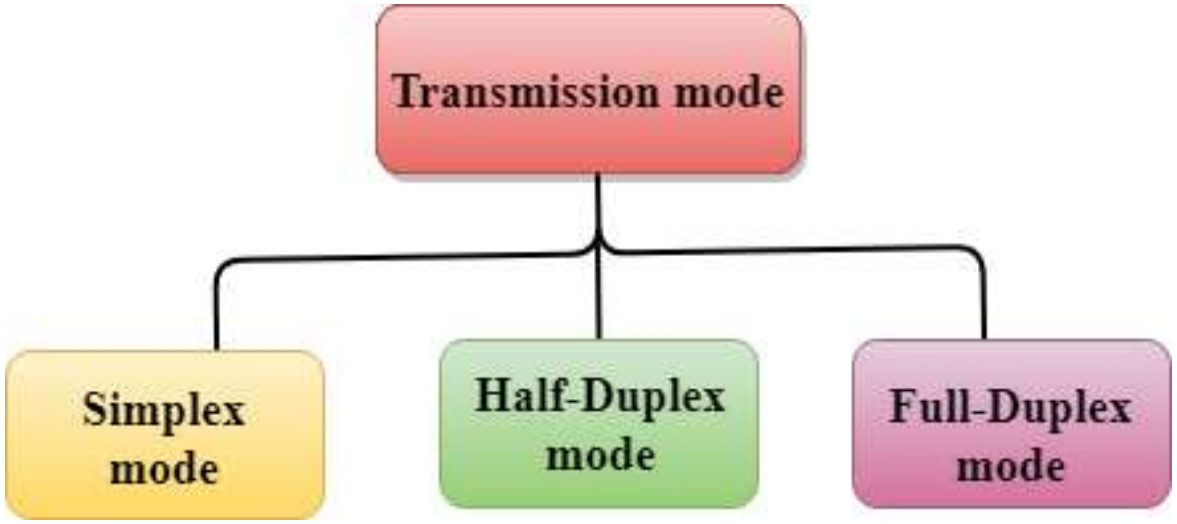
- Images
  - Images are also represented by bit patterns
  - In its simplest form, an image is composed of a matrix of pixels (picture elements), where each pixel is a small dot
  - The size of the pixel depends on the resolution
  - For example, an image can be divided into 1000 pixels or 10,000 pixels

Data Representation Continuation

- **Audio**
  - Audio refers to the recording or broadcasting of sound or music.
  - It is a continuous signal
- **Video**
  - Video refers to the recording or broadcasting of a picture or movie.
  - Video can either be produced as a continuous entity (e.g., by a TV camera), or
  - it can be a combination of images, each a discrete entity, arranged to convey the idea of motion

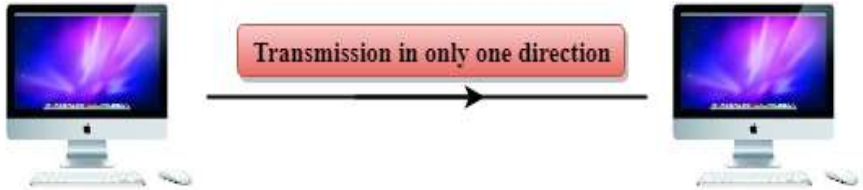
TRANSMISSION MODES

- Transmission modes are how data is communicated from one device to another.
- is also known as the communication mode
- Defines the direction in which data can be transmitted between any two linked devices
- the three types of transmission modes are:
  - Simplex
  - Half Duplex
  - Full Duplex



Simplex Mode

- ✓ In Simplex mode, the communication is unidirectional, i.e., the data flow in one direction.
- ✓ A device can only send the data but cannot receive it or it can receive the data but cannot send the data.



- ✓ This transmission mode is not very popular as mainly communications require the two-way exchange of data. The simplex mode is used in the business field as in sales that do not require any corresponding reply.
- ✓ The radio station is a simplex channel as it transmits the signal to the listeners but never allows them to transmit back
- ✓ Keyboard and Monitor are examples of the simplex mode as a keyboard can only accept the data from the user and a monitor can only be used to display the data on the screen.
- ✓ The main advantage of the simplex mode is that the full capacity of the communication channel can be utilized during transmission.

- **Advantages of Simplex mode:**

- ✓ In simplex mode, the station can utilize the entire bandwidth of the communication channel, so that more data can be transmitted at a time.

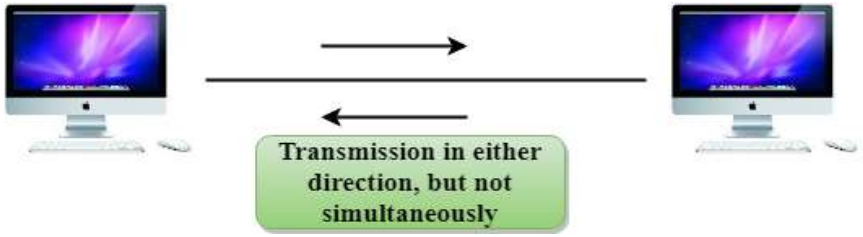
-

- **Disadvantage of Simplex mode:**

- ✓ Communication is unidirectional, so it has no inter-communication between devices.

Half-Duplex Mode

- In a Half-duplex channel, the direction can be reversed, i.e., the station can transmit and receive the data as well.
- Messages flow in both directions, but not at the same time.



- The entire bandwidth of the communication channel is utilized in one direction at a time.
- In half-duplex mode, it is possible to perform error detection, and if any error occurs, then the receiver requests the sender to retransmit the data.
- A Walkie-talkie is an example of the Half-duplex mode. In a Walkie-talkie, one party speaks, and another party listens. After a pause, the other speaks, and the first party listens. Speaking simultaneously will create a distorted sound that cannot be understood.

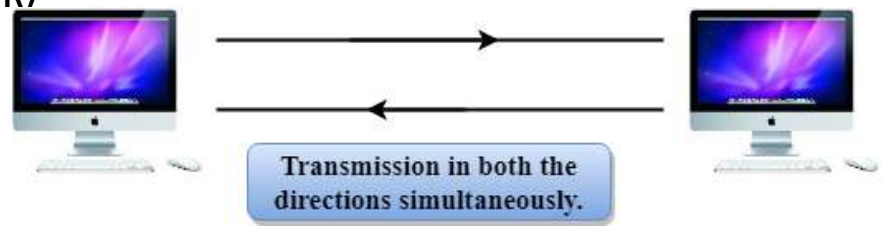
- **Advantage of Half-duplex mode**
  - ✓ both devices can send and receive the data and also can utilize the entire bandwidth of the communication channel during the transmission of data.

- **Disadvantage of Half-Duplex mode**

✓ In half-duplex mode, when one device is sending the data, then another has to wait, this causes a delay in sending the data at the right time.

Full-duplex Mode

- In Full duplex mode, the communication is bi-directional, i.e., the data flows in both directions.
- Both the stations can send and receive the message simultaneously.



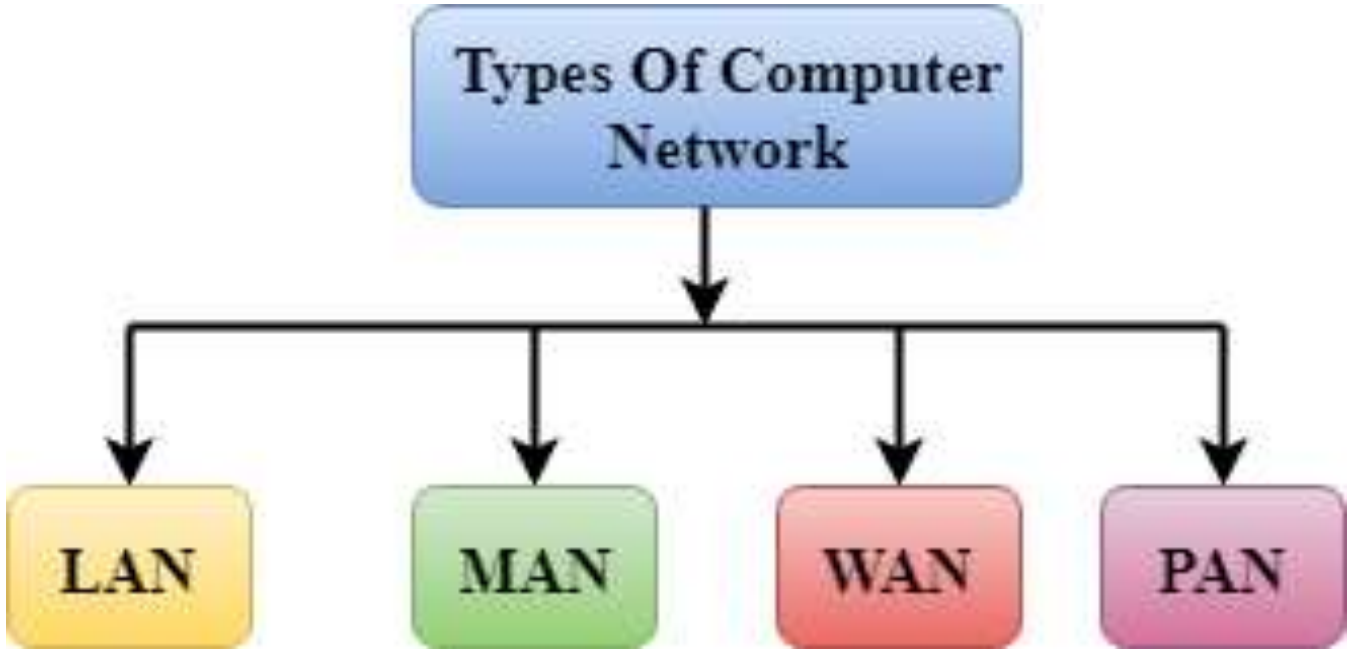
- ✓ Full-duplex mode has two simplex channels. One channel has traffic moving in one direction, and another channel has traffic flowing in the opposite direction.
- ✓ The Full-duplex mode is the fastest mode of communication between devices.
- ✓ The most common example of the full-duplex mode is a telephone network. When two people are communicating with each other by a telephone line, both can talk and listen at the same time.
-
- **Advantage of Full-duplex mode**
- Both stations can send
- **Disadvantage of Full-duplex mode**
- ✓ If there is no dedicated path exists between the devices, then the capacity of the communication channel is divided into two parts.

Differences between Simplex, Half-duplex and Full-duplex modes

Basis for comparison	Simplex mode	Half-duplex mode	Full-duplex mode
Direction of communication	In simplex mode, the communication is unidirectional.	In half-duplex mode, the communication is bidirectional, but one at a time.	In full-duplex mode, the communication is bidirectional.
Send/Receive	A device can only send the data but cannot receive it or it can only receive the data but cannot send it.	Both devices can send and receive the data, but one at a time.	Both the devices can send and receive the data simultaneously.
Performance	The performance of half-duplex mode is better than the simplex mode.	The performance of the full-duplex mode is better than the half-duplex mode.	The Full-duplex mode has better performance than simplex and half-duplex modes as it doubles the utilization of the capacity of the communication channel.
Example	Examples of Simplex mode are radio, keyboard, and monitor.	An example of a half-duplex is Walkie-Talkies.	An example of the Full-duplex mode is a telephone network.

Types of Computer Network

- PAN (Personal Area Network)
- LAN (Local Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)



PERSONAL AREA NETWORK (PAN)

- Personal Area Network is a network arranged within a person, typically within a range of 10 meters.
- Personal Area Network is used for connecting the computer devices of personal use and is known as Personal Area Network.
- **Thomas Zimmerman** was the first research scientist to bring the idea of the Personal Area Network.
- Personal Area Network covers an area of **30 feet**.
- Personal computer devices that are used to develop the personal area network are laptops, mobile phones, media players, and PlayStations.

Continuation of PAN

- **There are two types of Personal Area Network:**
  - Wired Personal Area Network
  - Wireless Personal Area Network
- **Wireless Personal Area Network:**
  - Wireless Personal Area Network is developed by simply using wireless technologies such as Wi-Fi, and Bluetooth.
  - It is a low-range network.
- **Wired Personal Area Network**
  - A Wired Personal Area Network is created by using the USB.

Continuation of PAN

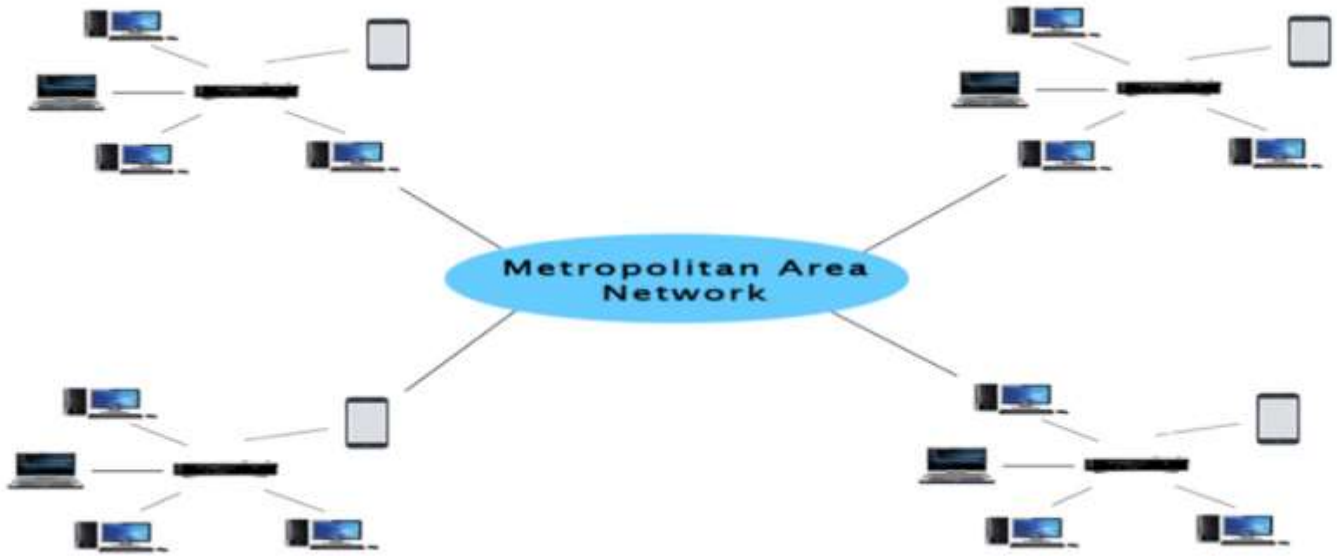
- **Examples of Personal Area Network:**
- **Body Area Network**
  - Body Area Network is a network that moves with a person. **For example**, a mobile network moves with a person. Suppose a person establishes a network connection and then creates a connection with another device to share the information.
- **Offline Network:**
  - An offline network can be created inside the home, so it is also known as a **home network**. A home network is designed to integrate the devices such as printers, computer, television but they are not connected to the internet.
- **Small Home Office**
  - It is used to connect a variety of devices to the internet and to a corporate network using a VPN

LOCAL AREA NETWORK (LAN)

- Local Area Network is a group of computers connected in a small area such as a building, office
- LAN is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.
- It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and ethernet cables.
- The data is transferred at an extremely faster rate in Local Area Network.
- Local Area Network provides higher security.

METROPOLITAN AREA NETWORK (PAN)

- A metropolitan area network is a network that covers a larger geographic area (such as a city) by interconnecting a different LAN to form a larger network.



METROPOLITAN AREA NETWORK (PAN)

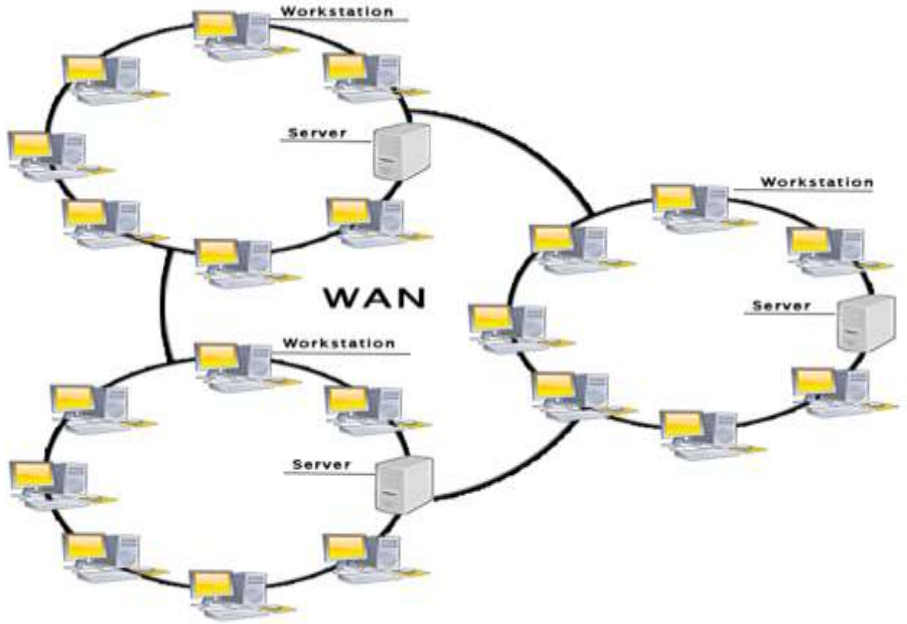
- Government agencies use MAN to connect to the citizens and private industries.
- In MAN, various LANs are connected to each other through a telephone exchange line.
- The most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc.
- It has a higher range than Local Area Network (LAN)

Uses of Metropolitan Area Network:

- MAN is used in communication between the banks in a city.
- It can be used in an Airline Reservation.
- It can be used in a college within a city.
- It can also be used for communication in the military.

WAN (Wide Area Network)

- A Wide Area Network is a network that extends over a large geographical area such as states or countries.
- A Wide Area Network is quite a bigger network than the LAN.
- A Wide Area Network is not limited to a single location, but it spans a large geographical area through a telephone line, fiber optic cable, or satellite links.
- The internet is one of the biggest WAN in the world.
- A Wide Area Network is widely used in the fields of Business, government, and education.



WAN (Wide Area Network)

- Mobile Broadband: A 4G network is widely used across a region or country.
- Last mile: A telecom company is used to provide the internet services to customers in hundreds of cities by connecting their home with fiber.
- Private network: A bank provides a private network that connects the 44 offices. This network is made by using the telephone leased line provided by the telecom company.

ADVANTAGES OF WIDE AREA NETWORK

- Following are the advantages of the Wide Area Network:
  - **Geographical area**: A Wide Area Network provides a large geographical area. Suppose if the branch of our office is in a different city then we can connect with them through WAN. The internet provides a leased line through which we can connect with another branch.
  - **Centralized data**: In the case of WAN network, data is centralized. Therefore, we do not need to buy the emails, files or back up servers.
  - **Get updated files**: Software companies work on the live server. Therefore, the programmers get the updated files within seconds.
  - **Exchange messages**: In a WAN network, messages are transmitted fast. The web application like Facebook, WhatsApp, Skype allows you to communicate with friends.
  - **Sharing of software and resources**: In WAN network, we can share the software and other resources like a hard drive, RAM.
  - **Global business**: We can do the business over the internet globally.
  - **High bandwidth**: If we use the leased lines for our company then this gives the high bandwidth. The high bandwidth increases the data transfer rate which in turn increases the productivity of our company.

DISADVANTAGES OF WIDE AREA NETWORK

- The following are the disadvantages of the Wide Area Network:
  - **Security issue:** A WAN network has more security issues as compared to a LAN and MAN network as all the technologies are combined creating a security problem.
  - **Needs Firewall & antivirus software:** The data is transferred on the internet which can be changed or hacked by hackers, so the firewall needs to be used. Some people can inject the virus into our system so antivirus is needed to protect from such a virus.
  - **High Setup cost:** The installation cost of the WAN network is high as it involves the purchasing of routers and switches.
  - **Troubleshooting problems:** It covers a large area, fixing problem is difficult.

INTERNETWORK

- Internetworking is the practice of interconnecting multiple computer networks, such that any pair of hosts in the connected networks can exchange messages irrespective of their hardware-level networking technology. 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. The Internet is defined by a unified global addressing system, packet format, and routing methods provided by the Internet Protocol.
- An internetworking uses the internet protocol.
- The reference model used for internetworking is called Open System Interconnection (OSI).

TYPES OF INTERNETWORK

- Extranet: An extranet is a communication network based on the internet protocol such as Transmission Control protocol and internet protocol. It is used for information sharing. Access to the extranet is restricted to only those users who have login credentials. An extranet is the lowest level of internetworking. It can be categorized as MAN, WAN, or other computer networks. An extranet cannot have a single LAN, at least it must have one connection to the external network.

- Intranet: An intranet is a private network based on the internet protocol such as Transmission Control protocol and internet protocol. An intranet belongs to an organization that is only accessible to the organization's employees or members. The main aim of the intranet is to share information and resources among the organization's employees. An intranet provides the facility to work in groups and for teleconferences.

Thank you