Unit 1- Part 1

Introduction to Data communications and Networking

Note: These notes are for reference only. This is **not the only material** you need to refer for exam.

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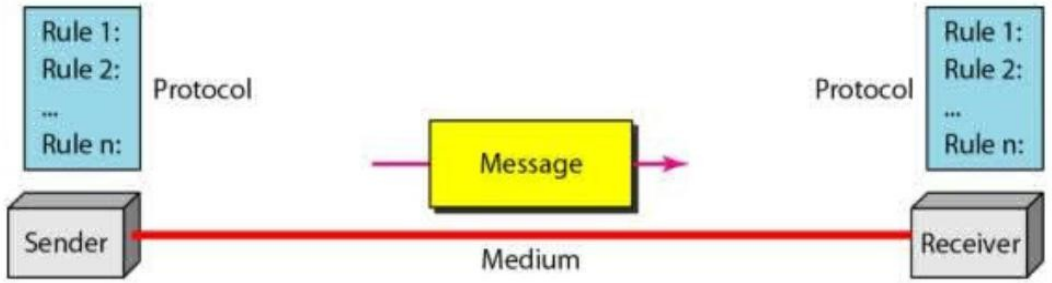
Introduction to Data Communication & Networking

- Communication can be defined as exchange of information between two humans.
- Data communication can be defined the exchange of information between two computers.
- One computer (sender) can send a message to another (receiver) computer over a wire called Transmission Medium as shown in figure:

Introduction to Data Communication & Networking

Five Components of Data Communication

- Message: Information(data) to be communicated
- Sender
- Receiver
- Transmission medium: Physical path by which a message travels
- Protocol: A set of rules that govern data communication



Introduction to Data Communication & Networking

- **Message:**

The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

- **Sender:**

The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

- **Receiver:**

The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

- **Transmission medium:**

The transmission medium is the physical 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:**

A protocol is a set of rules that govern data communications. It 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.

Introduction to Data Communication & Networking

- The data communication involves exchange of data between two computers. computer works with the binary language of zeros and ones. Therefore, one computer generates a stream of zeros and sends it to another computer to which it is connected in some fashion.
- For enabling data communication, a combination of hardware and software is essential.
- Following are the characteristics of data communication system:

  - **Correct delivery:** When a sender transmits data for an intended recipient, the data must reach only the intended recipient and not someone else.
  - **Accurate delivery:** The data sent must be received in the same form as the one in which it was sent. There must not be any sort of alternations to it in transit.
  - **Timely delivery:** The data must travel from the sender to the receiver in a finite amount of time. The term finite is quite vague, and would depend on the reasons why the data communication is taking place.

Protocol

- Two key aspects of data communication systems need a good amount of understanding.
  - **Transmission media:** the physical path over which data travels from the sender to the receiver. Ex: twisted-pair of copper wires, coaxial cable, optical fiber or wireless media such as radio waves.
  - **Protocol:** a set of rules and conventions. Ex: The sender and the receiver, the two key parties in data communication must agree on a common set of rules, i.e. protocols before they can communicate with each other.
    - **The protocol defines following:**
      - Syntax (What is to be communicated?)
      - Semantic (How it is to be communicated?)
      - Timing (When it should be communicated?)

Protocol

- **Syntax (What is to be communicated)–** The syntax defines the structure or format of data. This means that the order in which it is to be sent is decided. For instance, a protocol could define that the first 16 bits of a data transmission must always contain the receiver's address.

- **Semantics (How it is to be communicated) –** The semantics define the interpretation of the data that is being sent. For example, the semantics could define that if the last two bits of the receiver's address field contain a 00, it means that the sender and the receiver are on the same network.

- **Timing (When it should be communicated) –** This refers to an agreement between the sender and the receiver about the data transmission rates and duration. For instance, a protocol could demand that the sender must send 1000 bytes and then wait for an acknowledgement from the receiver before sending any more data.

Standards

- **Standards**
- Standards are necessary in every walk of life. For instance, when you want to replace a light bulb in your home because it has been damaged, you expect the new bulb to fit in the holder straightaway and work like the old bulb did. What is the use if the bulb does not fit in the holder, or if it fits in the holder but does not illuminate because it requires a different voltage level?

- Data communication standards are classified into two categories:
  - **De facto**
  - **De Jure**

Standard

- **De facto Standard**
- Standards developed by a private company which are used widely as a result of the choices of consumers.
- Are adopted widely by an industry and its customers. They are also known as market-driven standards.
- Eg: Something that is used so widely that it is considered a standard for a given application although it has no official status.

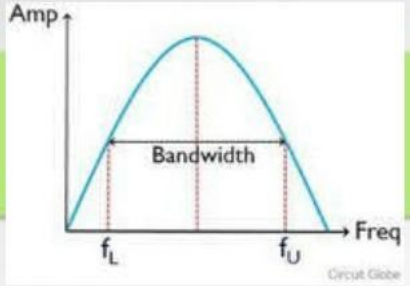
- De facto standards can be divided into proprietary and non-proprietary.
- **Properitary** - Closed proprietary standards are owned by a single company. Only that company's customers and partners are allowed to use them. Competitors are banned from implementing products that use closed proprietary standards.
- **Non- Proprietary** - Open proprietary standards also are owned by a single company, yet the company allows anyone to use them.

Standard

De jure Standard

- De jure means according to “Law and Regulation.”
- Standards registered at a recognized standards organization such as the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU), The International Organization for Standardization (ISO) etc.
- They are endorsed by a formal standards organization. The organization ratifies each standard through its official procedures and gives the standard its stamp of approval.

Bandwidth



- **Bandwidth**
- **Bandwidth** describes the maximum data transfer rate of a network or Internet connection. It measures how much data can be sent over a specific connection in a given amount of time.
- The **bandwidth** of a composite signal is the difference between the highest and the lowest frequencies contained in that signal.
- A strength of the signal at any point is known as **amplitude**.
- Time taken for the completion of one cycle is called **period**.
- The number of cycle or periods a signal completes in one second called **frequency**.
- In analog transmission (such as of voice signals) bandwidth is measured in cycles per second (or Hertz)
- In digital transmission (such as of data from one computer to another) bandwidth is measured in bits per second (BPS).

ANALOG AND DIGITAL SIGNALS

- In modern communication data is transmitted over large distances.
- The data is transmitted in the form of waves where any specific value varies with time.
- Depending upon the value of the time-varying data, it can be either analog or digital.

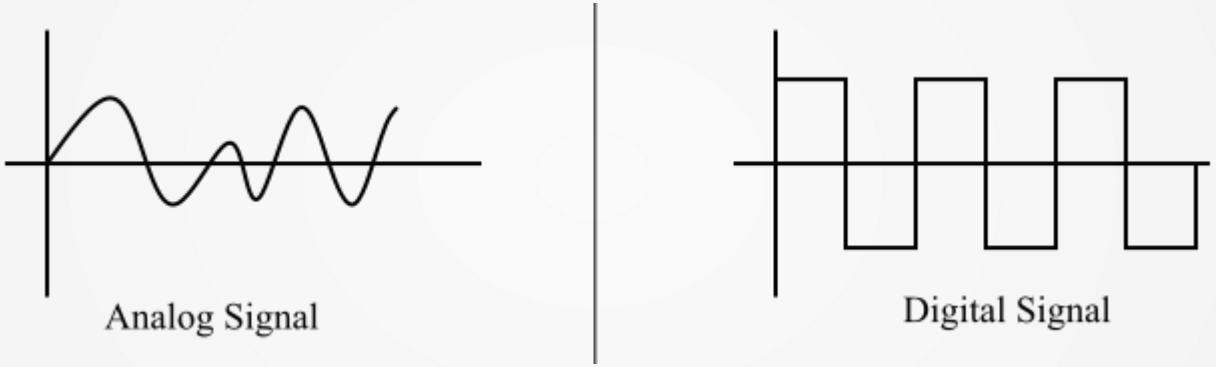
ANALOG AND DIGITAL SIGNALS

- A signal which is a continuous function of time and used to carry the information is known as an **analog** signal.
- Analog signals utilize the properties of medium to convey the information.
- All the natural signals are the examples of analog signals.

ANALOG AND DIGITAL SIGNALS

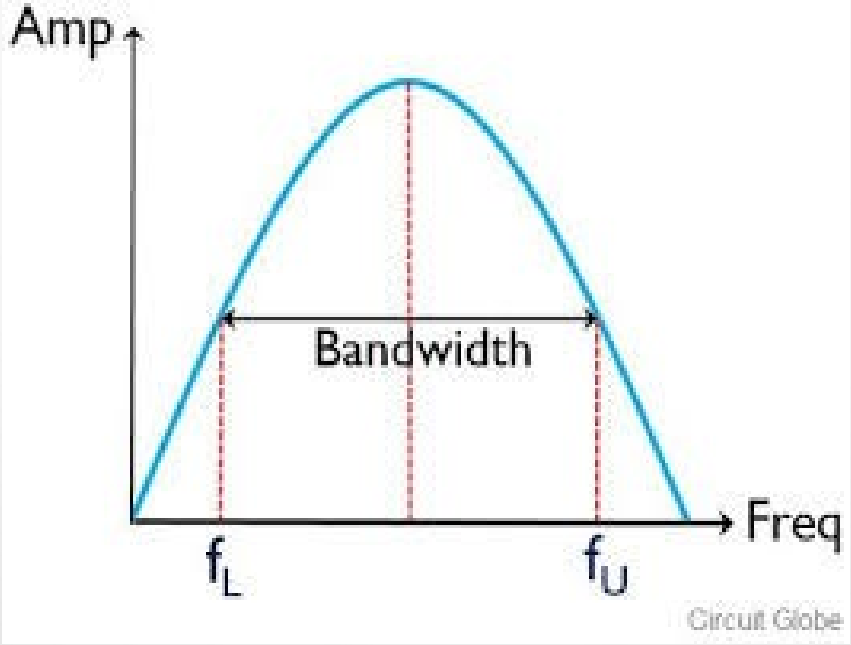
- A signal that is discrete function of time, i.e. which is not a continuous signal, is known as a digital signal.
- The digital signals are represented in the binary form

ANALOG AND DIGITAL SIGNALS



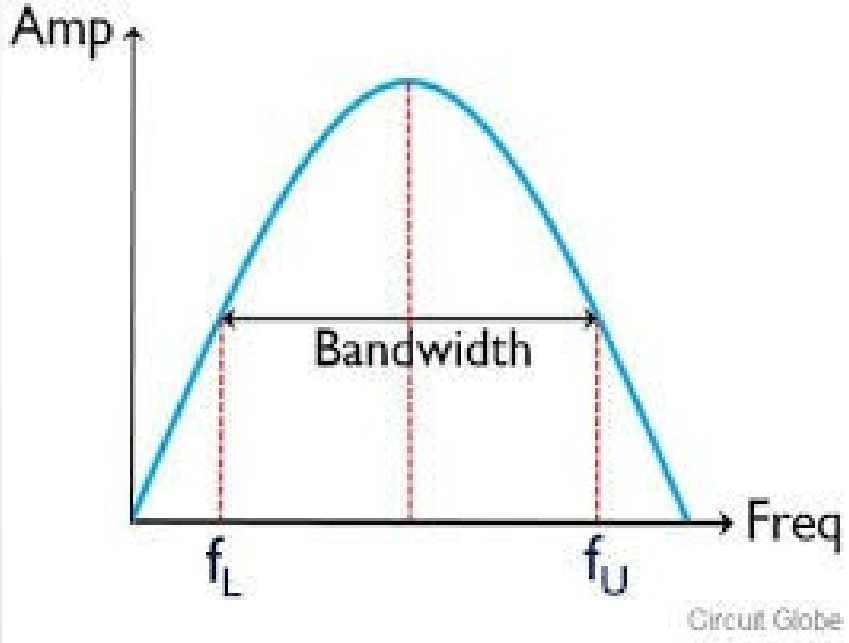
BANDWIDTH

- Bandwidth is the maximum amount of data that can be transferred over a network in a given amount of time.
- Bandwidth is typically measured in bits per second (bps), but is often represented in megabits per second (Mbps) or gigabits per second (Gbps)



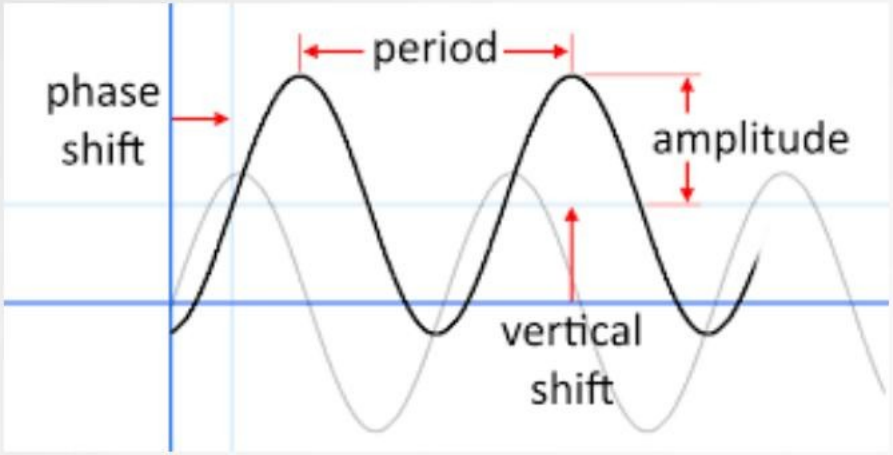
AMPLITUDE

- Amplitude is the strength or power of a signal.
- It's often used to describe the height of a radio signal.
- A higher amplitude means a stronger signal, which is important for clear transmission of data and voice over long distances.



PHASE

- Phase is the position of a wave at a specific time in a waveform cycle.
- It shows how far the function is shifted horizontally or vertically from the usual position


period
phase
shift
amplitude
vertical
shift

Bit Rate & Baud Rate

Bit Rate:

- Bit Rate is how many data bits are transmitted per second. Bit rates measure the number of data bits (that is 0′s and 1′s) transmitted in one second in a communication channel. A figure of 2400 bits per second means 2400 zeros or ones can be transmitted in one second.

Baud Rate:

- Baud rate refers to the number of signal or symbol transmitted per second. A baud rate is the number of times a signal in a communications channel changes state or varies. For example, a 2400 baud rate means that the channel can change states up to 2400 times per second. The term “change state” means that it can change from 0 to 1 or from 1 to 0.
- An analog signal carries 4 bits in each signal unit. If 1000 signal units are sent per second, find the baud rate and the bit rate.
- Baud rate = 1000 bauds per second
- Bit rate = 1000 * 4 =4000 bps

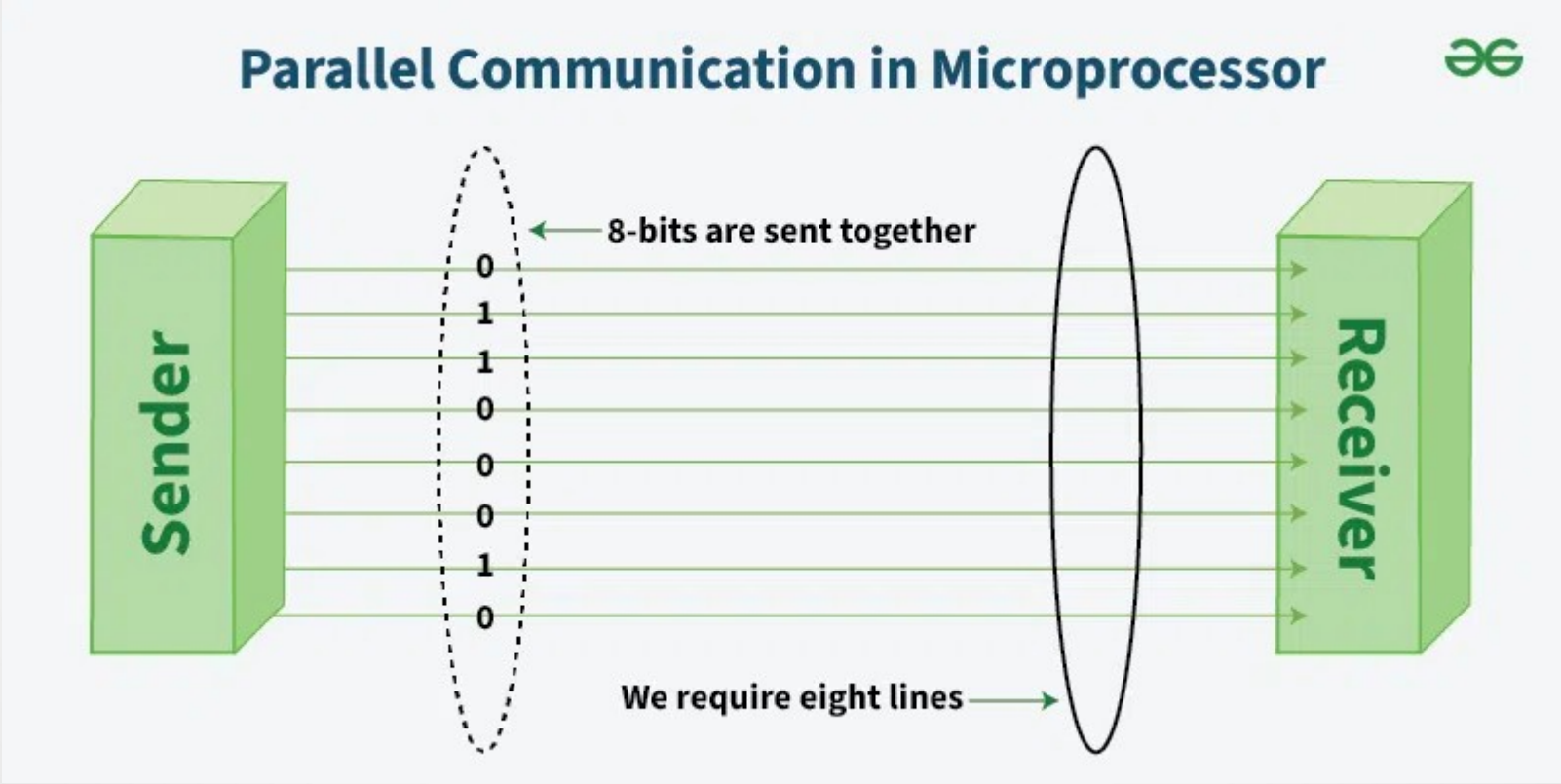
MODES OF DATA TRANSMISSION

- Data transmission is how computers and other devices send information to each other.
- There are two main ways to do this: Serial and Parallel Transmission.
- In Serial Transmission, data is sent one bit at a time like sending a single line of people through a door.
- In Parallel Transmission data is sent in groups of 8 bits called a byte at once like sending 8 people through a door side by side.

MODES OF DATA TRANSMISSION

- **Parallel transmission:**
- Multiple data bits are transmitted over multiple channels at the same time.
- Data can be sent much faster than using serial transmission.
- It requires those many wires parallel to each other, each carrying a single bit.
- E.g. 8 wires are needed to pass 01100010 in parallel communication.

MODES OF DATA TRANSMISSION



MODES OF DATA TRANSMISSION

- **Parallel transmission:**
- It is very expensive method because it requires several wires as
- well as various sending and receiving equipment.
- It demands extraordinary accuracy, which is not guaranteed over long distances.
- Digital pulses may not traverse at the same speed, This rise to the problem of Skew.
- To avoid skew problem, parallel transmission is used only for a short distance.
- E.g. Data transmission from CPU registers to memory or vice versa

MODES OF DATA TRANSMISSION

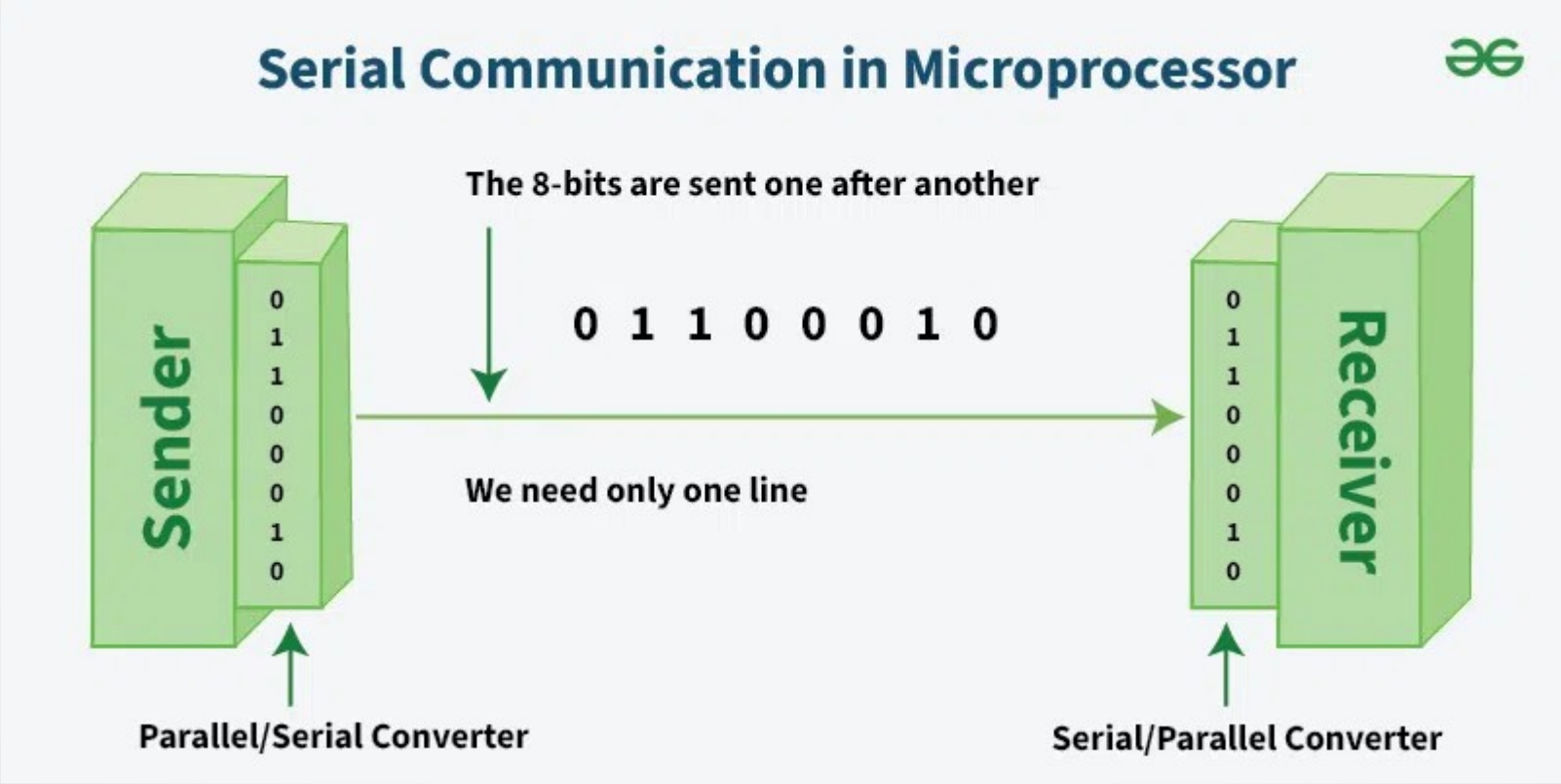
- **Serial transmission:**
- Serial data transmission sends data bits one after another over a single channel.
- The data bits are organized in a specific order, since they can only be sent one after another.
- There is some hardware equipment involved in converting the data from parallel to serial.
- At the destination, all the bits are collected, measured and put together as bytes in the memory.
- This requires conversion from serial to parallel.

MODES OF DATA TRANSMISSION

Serial transmission:

- Serial transmission is normally used for long-distance data transfer.
- It is also used in cases where the amount of data being sent is relatively small.
- Serial transmission has two classifications: asynchronous and synchronous

MODES OF DATA TRANSMISSION



MODES OF TRANSMISSION

Asynchronous transmission:

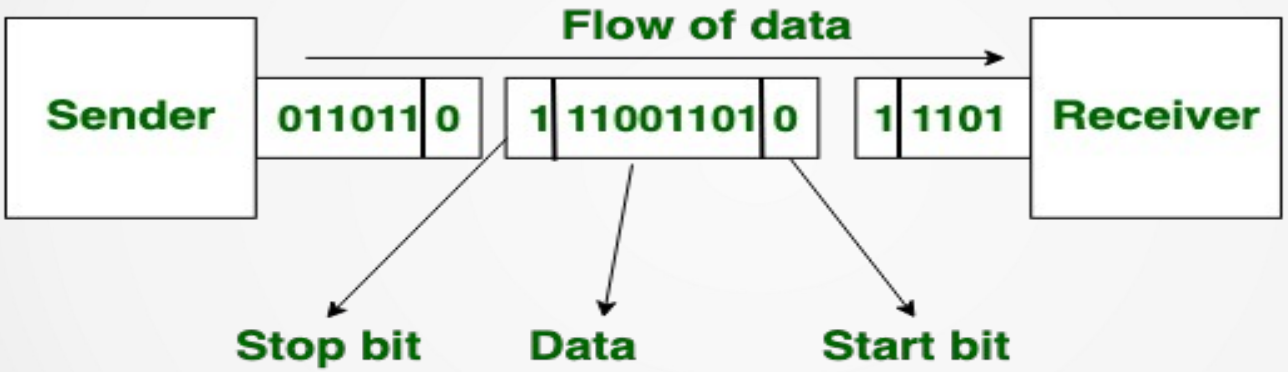
- In Asynchronous Transmission, data is sent in form of byte or character.
- In this transmission start bits and stop bits are added with data.
- It does not require synchronization.
- Asynchronous transmission is like sending individual text messages without knowing exactly when the other person will read them.

MODES OF TRANSMISSION

The sender and receiver do not share a common clock signal.

- Instead, data is sent one byte or character at a time, with start and stop bits indicating the beginning and end of each byte.
- Each piece of data is sent independently, with gaps in between, allowing the receiver to process each byte as it arrives.
- It’s flexible and simpler to implement, especially useful for communications where data is sent intermittently.

MODES OF TRANSMISSION



Asynchronous Transmission

TYPES OF TRANSMISSION

Synchronous transmission:

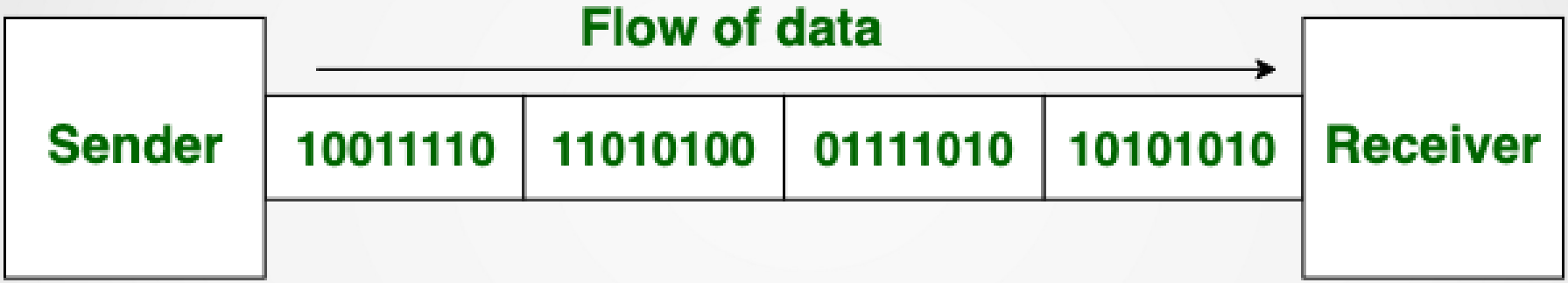
- In Synchronous Transmission, data is sent in the form of blocks or frames.
- Between sender and receiver, synchronization is compulsory.
- In Synchronous transmission, There is no time gap present between data.
- It is more efficient and more reliable than asynchronous transmission to transfer a large amount of data.

TYPES OF TRANSMISSION

Both the sender and receiver are synchronized with a common clock signal.

- This means they operate at the same speed and know exactly when to send and receive data.
- Data is sent in a continuous stream, with each byte or chunk of data following the previous one without any gaps.
- It’s efficient for sending large amounts of data quickly because there’s less overhead (extra bits) needed to start and stop the transmission.

TYPES OF TRANSMISSION



Synchronous Transmission

MODES OF TRANSMISSION

Transmission modes also known as communication modes, are methods of transferring data between devices on buses and networks designed to facilitate communication.

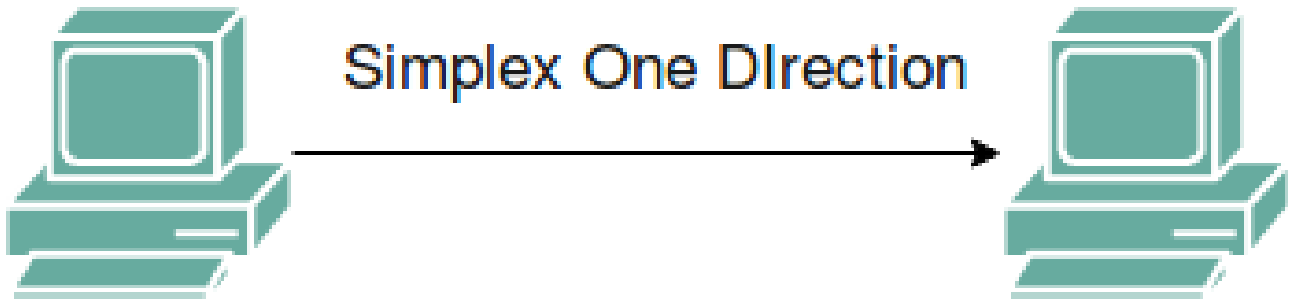
- They are classified into three types: Simplex Mode, Half-Duplex Mode, and Full-Duplex Mode.

MODES OF TRANSMISSION

Simplex Mode

- In Simplex mode, the communication is unidirectional, as on a one-way street.
- Only one of the two devices on a link can transmit, the other can only receive.
- The simplex mode can use the entire capacity of the channel to send data in one direction.
- Example: Keyboard and traditional monitors. The keyboard can only introduce input, the monitor can only give the output.

MODES OF TRANSMISSION



MODES OF TRANSMISSION

Simplex Mode advantages

- Simplex mode is the easiest and most reliable mode of communication.
- It is the most cost-effective mode, as it only requires one communication channel.
- There is no need for coordination between the transmitting and receiving devices, which simplifies the communication process.
- Simplex mode is particularly useful in situations where feedback or response is not required, such as broadcasting or surveillance

MODES OF TRANSMISSION

Simplex Mode disadvantages

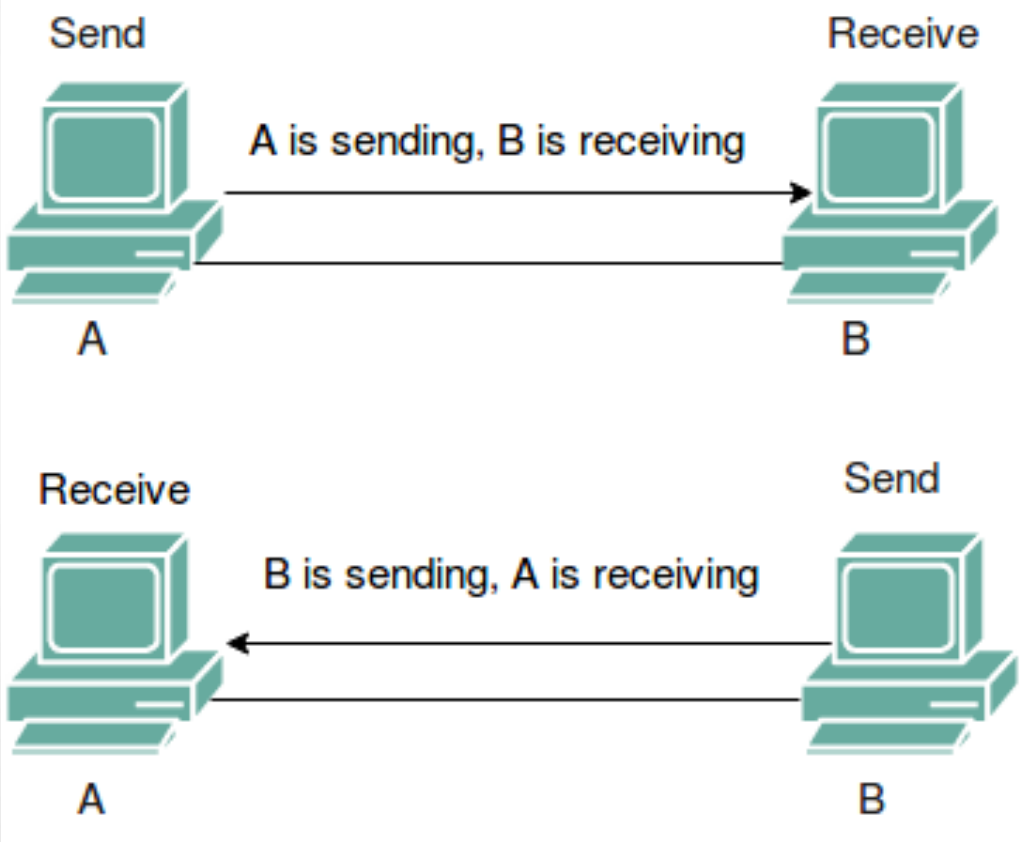
- Only one-way communication is possible.
- There is no way to verify if the transmitted data has been received correctly.
- Simplex mode is not suitable for applications that require bidirectional communication.

MODES OF TRANSMISSION

Half-Duplex Mode

- In half-duplex mode, each station can both transmit and receive, but not at the same time.
- When one device is sending, the other can only receive, and vice versa.
- The half-duplex mode is used in cases where there is no need for communication in both directions at the same time.
- The entire capacity of the channel can be utilized for each direction.
- Example: Walkie-talkie in which message is sent one at a time and messages are sent in both directions.

MODES OF TRANSMISSION



MODES OF TRANSMISSION

Advantages of Half Duplex Mode:

- Half-duplex mode allows for bidirectional communication, which is useful in situations where devices need to send and receive data.
- It is a more efficient mode of communication than simplex mode, as the channel can be used for both transmission and reception.
- Half-duplex mode is less expensive than full-duplex mode, as it only requires one communication channel.

MODES OF TRANSMISSION

Disadvantages of Half Duplex Mode

- Half-duplex mode is less reliable than Full-Duplex mode, as both devices cannot transmit at the same time.
- There is a delay between transmission and reception, which can cause problems in some applications.
- There is a need for coordination between the transmitting and receiving devices, which can complicate the communication process.

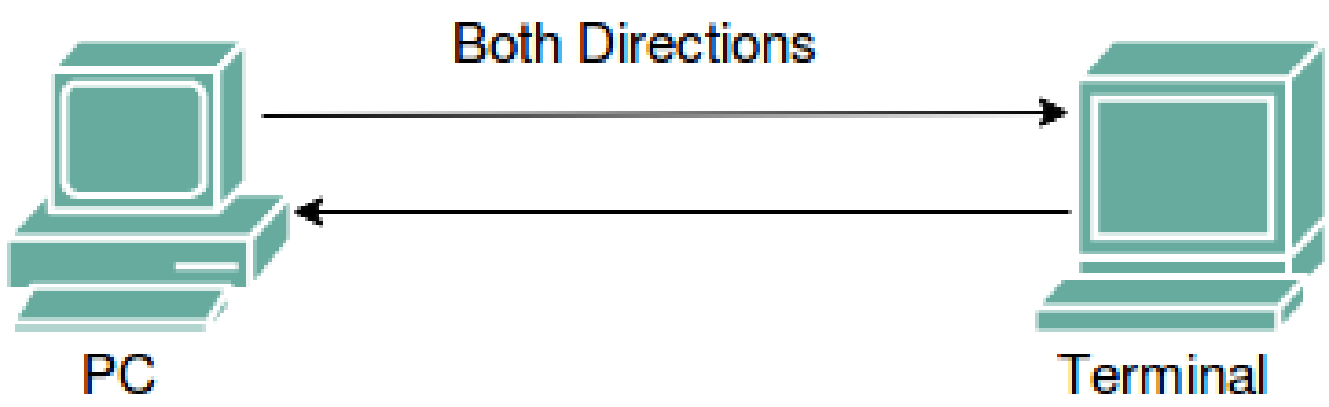
MODES OF TRANSMISSION

Full-Duplex Mode

- In full-duplex mode, both stations can transmit and receive simultaneously.
- In full-duplex mode, signals going in one direction share the capacity of the link with signals going in another direction, this sharing can occur in two ways:

- Either the link must contain two physically separate transmission paths, one for sending and the other for receiving.
- Or the capacity is divided between signals traveling in both directions.

MODES OF TRANSMISSION



MODES OF TRANSMISSION

Advantages of Full-Duplex Mode

- Full-duplex mode allows for simultaneous bidirectional communication, which is ideal for real-time applications such as video conferencing or online gaming.
- It is the most efficient mode of communication, as both devices can transmit and receive data simultaneously.
- Full-duplex mode provides a high level of reliability and accuracy, as there is no need for error correction mechanisms.

MODES OF TRANSMISSION

Disadvantages of Full-Duplex Mode

- Full-duplex mode is the most expensive mode, as it requires two communication channels.
- It is more complex than simplex and half-duplex modes, as it requires two physically separate transmission paths or a division of channel capacity.
- Full-duplex mode may not be suitable for all applications, as it requires a high level of bandwidth and may not be necessary for some types of communication.

TYPES OF NETWORKS

A computer network is a system that connects many independent computers to share information (data) and resources.

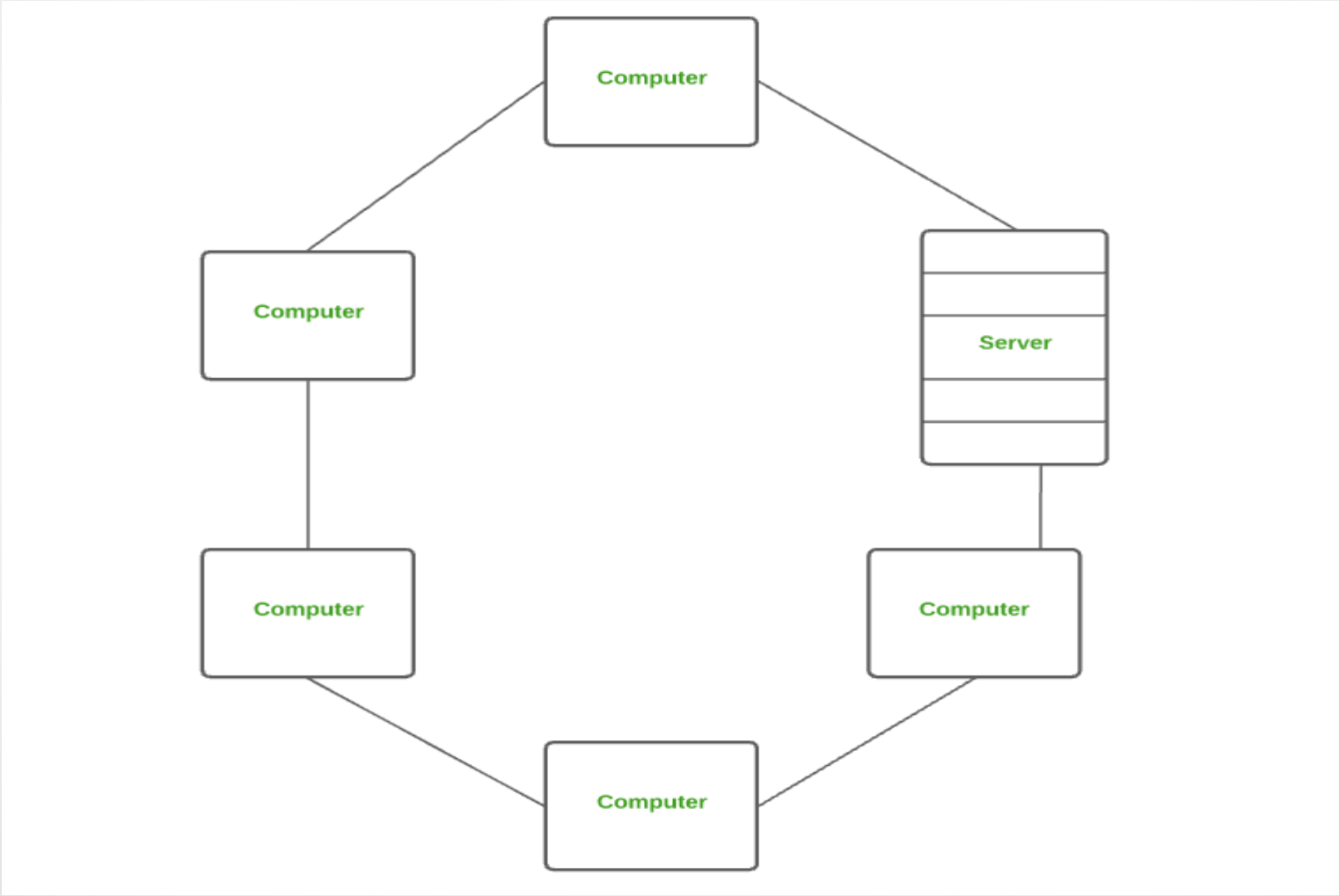
- The integration of computers and other different devices allows users to communicate more easily.
- A computer network is a collection of two or more computer systems that are linked together.
- A network connection can be established using either cable or wireless media.
- Hardware and software are used to connect computers and tools in any network.

LAN

A LAN is a computer network that connects computers through a common communication path, contained within a limited area, that is, locally.

- A LAN encompasses two or more computers connected over a server.
- The two important technologies involved in this network are Ethernet and Wi-fi.
- It ranges up to 2km & transmission speed is very high with easy maintenance and low cost.
- Examples of LAN are networking in a home, school, library, laboratory, college, office, etc.

LAN



LAN

Advantages of a LAN:

- Privacy
- High Speed
- Supports different transmission mediums

Disadvantages:

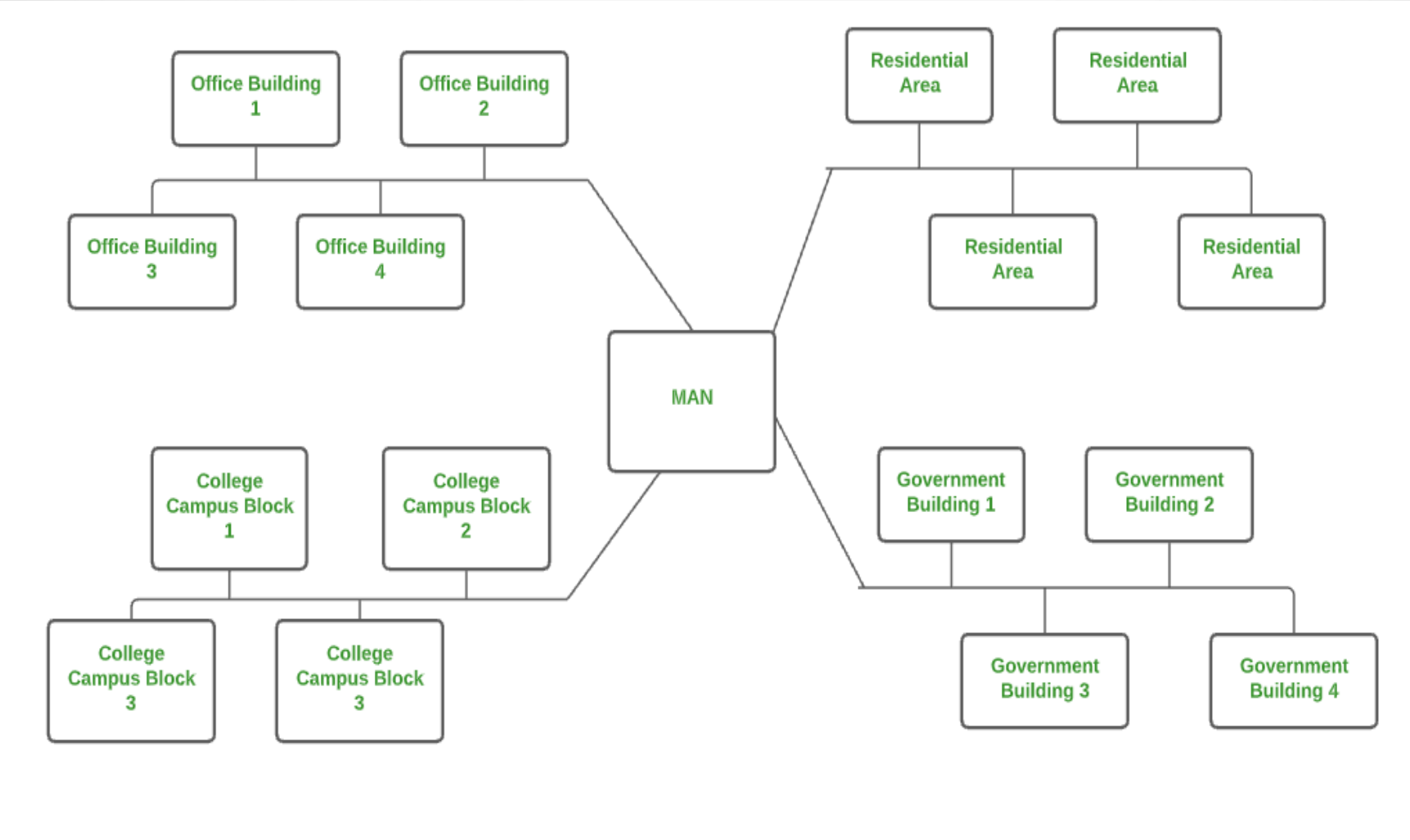
- setup costs high
- Privacy violation
- Size and area
- Security threat

MAN

A MAN is larger than a LAN but smaller than a WAN.

- This is the type of computer network that connects computers over a geographical distance through a shared communication path over a city, town, or metropolitan area.
- It covers a range from 5km to 50km. Its transmission speed is average.
- It is difficult to maintain and it comes with a high cost. Examples of MAN are networking in towns, cities, a single large city, a large area within multiple buildings, etc.

MAN


Office Building 1
Office Building 2
Office Building 3
Office Building 4
Residential Area
Residential Area
Residential Area
Residential Area
MAN
College Campus Block 1
College Campus Block 2
College Campus Block 3
College Campus Block 3
Government Building 1
Government Building 2
Government Building 3
Government Building 4

MAN

Advantages of a MAN:

- speed ranges from 10-100 Mbps
- security level in MAN is high and strict
- transmit data in both directions concurrently
- multiple users support

Disadvantages:

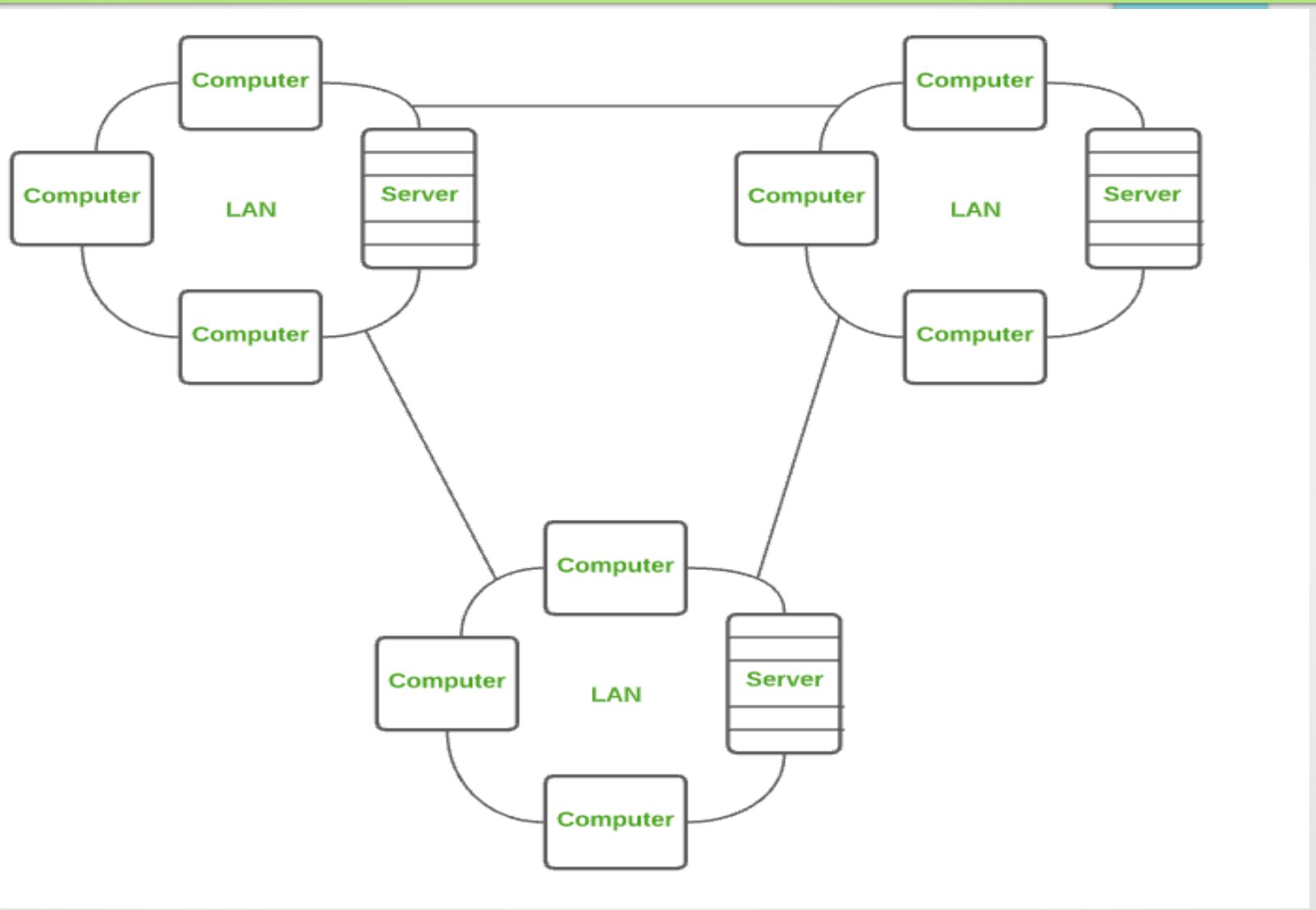
- Complex architecture
- high cost to set up fiber optics
- Data transfer rate in MAN is low

WAN

WAN is a type of computer network that connects computers over a large geographical distance through a shared communication path.

- It is not restrained to a single location but extends over many locations.
- WAN can also be defined as a group of local area networks that communicate with each other with a range above 50km.
- Here we use Leased-Line & Dial-up technology. Its transmission speed is very low and it comes with very high maintenance and very high cost.
- The most common example of WAN is the Internet.

WAN


Computer
Computer
LAN
Server
Computer
Computer
Computer
Computer
LAN
Server
Computer
Computer
Computer
Computer
LAN
Server
Computer

WAN

Advantages of a WAN:

- covers large geographical area
- enables a user or organisation to connect with the world
- transmit data in both directions concurrently
-

Disadvantages:

- Traffic congestion in Wide Area Network is very high.
- fault tolerance ability of WAN is very less.
- Noise and error are present in large amount
- data transfer rate is slow

MAN

Advantages of a MAN:

- speed ranges from 10-100 Mbps
- security level in MAN is high and strict
- transmit data in both directions concurrently
- multiple users support

Disadvantages:

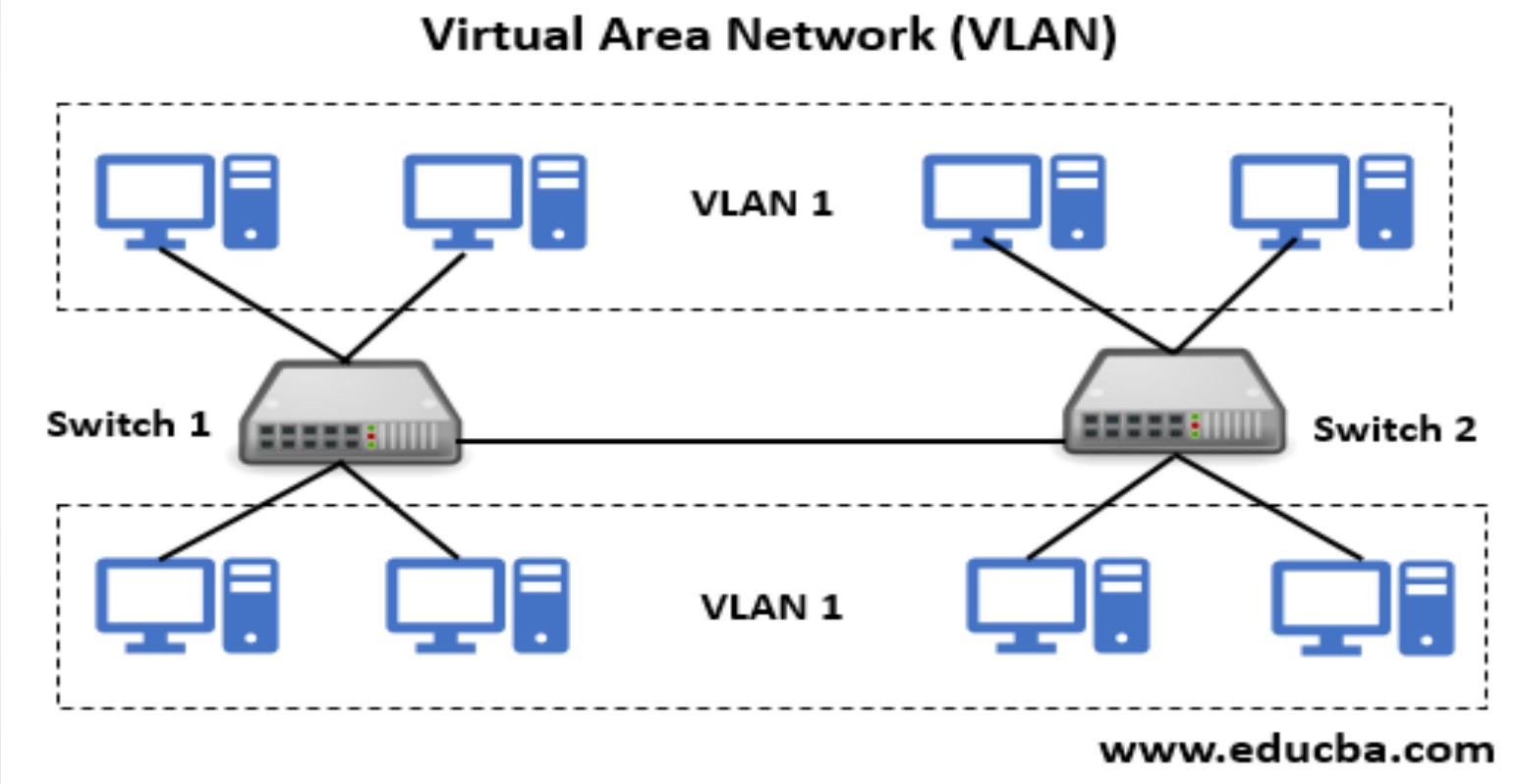
- Complex architecture
- high cost to set up fiber optics
- Data transfer rate in MAN is low

VLAN

VLAN stands for Virtual LAN.

- A VLAN is a way of logically separating a group of computers into a separate network.
- This means they will only communicate with each other and not with any other devices connected to the same physical network.
- It’s like having a private wireless network at home.

VLAN


Virtual Area Network (VLAN)
VLAN 1
Switch 1
Switch 2
VLAN 1
www.educba.com

VLAN

The most common use of VLANs is to separate traffic from different departments or network locations into its subnet, making it easier to manage each group separately.

- For example, if you run a company where employees are located worldwide, you might want to set up a VLAN for each department so they can communicate without worrying about which country they’re in.

VLAN

Advantages:

- Traffic is confined and physical location doesn’t matter
- Nodes can be changed or added
- Better performance and decreased latency

Disadvantages:

- Adding each device manually to each VLAN
- Troubleshooting is not easy
- Use of DHCP must
- Broadcast domains not supported

UNIT-1 COMPLETED