

Chapter 1

Introduction to Data Communication

Prepared by-

Shyla Afroge & S. M. Mahedy Hasan

Assistant Professor, Dept. of CSE

RUET, Rajshahi-6204, Bangladesh

Data Communication

- ❖ Telecommunication means communication at a distance.
- ❖ Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable or wireless cable.
- ❖ For data communications to occur, the communication devices must be a part of communication system and made up of a combination of hardware and software.

Effectiveness of Data Communication

It depends on four fundamental characteristics:-

Delivery

Accuracy

Timelines

Jitter

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.

Accuracy

- ❖ The system must deliver the data accurately.

Timelines

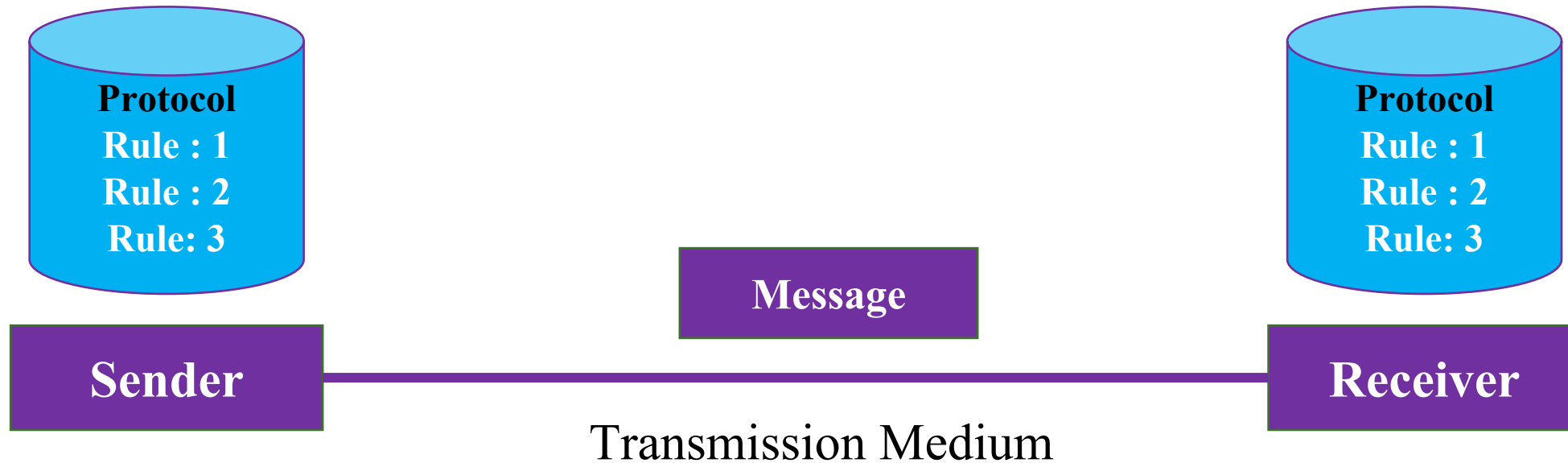
- ❖ The system must deliver data in a timely manner.
- ❖ For example, while sending videos, you need to send the packets in an orderly manner. If we have 3 consecutive data frame of 10s, 20s and 30s then we need to send first packet of 10s then 20s and lastly 30s.

Jitter

- ❖ Jitter refers to the variation in the packet arrival time.
- ❖ It is the uneven delay in the delivery of audio or video packets.
- ❖ **For example,** video packets are sent every 3MS. If some of the packets arrive with 3MS delay and others with 4MS delay, an uneven quality in the video is the result.

Components of Data Communication

It has five components:-



Message

- ❖ The message is the information or 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.

Data Representation

- ❖ **Text:** In data communications, text is represented as a bit pattern, a sequence of bits (0'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.
- ❖ **Numbers:** Numbers are also represented by bit patterns. the number is directly converted to a binary number to simplify mathematical operations.
- ❖ **Images:** Images are also represented by bit patterns. An image is composed of matrix of pixels.
- ❖ **Audio**
- ❖ **Video**

Data Flow

❖ The way in which data are transmitted is called data flow. Data flow are of three types:-

Simplex

Half Duplex

Full Duplex

Simplex

- ❖ 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.
- ❖ **Example:** Keyboards and traditional monitors are examples of simplex devices.
- ❖ The simplex mode can use the entire capacity of the channel to send data in one direction.

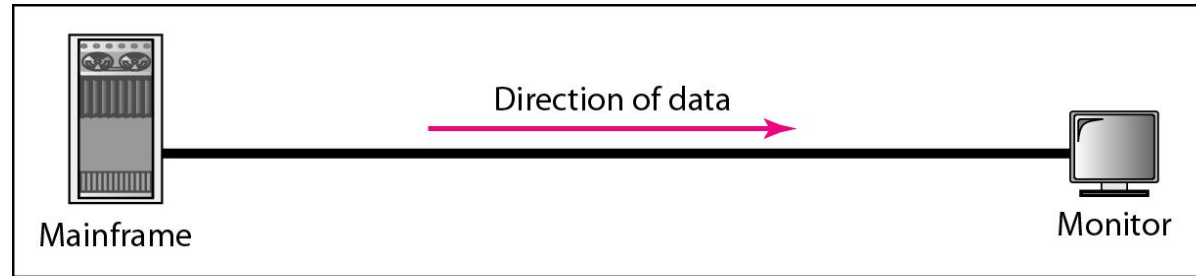
Half Duplex

- ❖ 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.
- ❖ **Example:** Walkie-talkies and CB (citizens band) radios are both half-duplex systems.

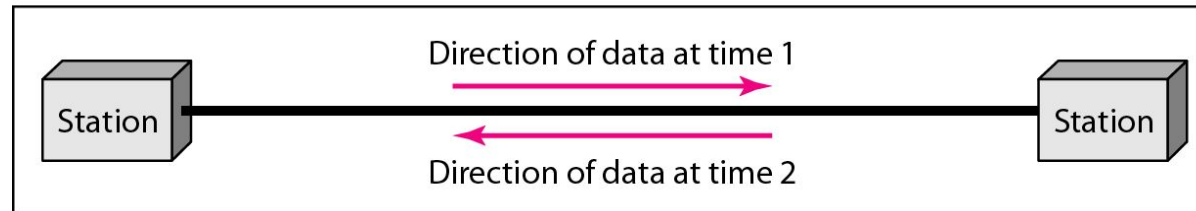
Full Duplex

- ❖ In full duplex mode, both stations can transmit and receive simultaneously.
- ❖ **Example:** Communication in a mobile phone network.

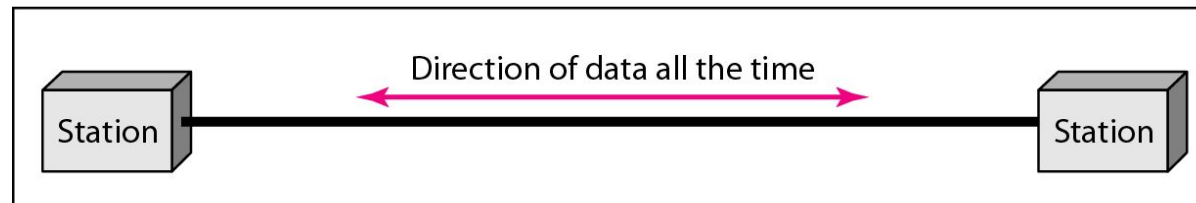
Data Flow



a. Simplex



b. Half-duplex



c. Full-duplex

Networks

- ❖ A **network** is a set of devices connected by communication links.
- ❖ Most networks use distributed processing, in which a task is divided among multiple computers.

Characteristics of Good Network:-

1. Performance
2. Reliability
3. Security

- ❖ Performance can be measured in many ways, including transit time, throughput, delay and response time.
- ❖ Transit time is the amount of time required for a message to travel from one device to another.
- ❖ Response time is the elapsed time between an inquiry and a response.
- ❖ The performance of a network depends on a number of factors-
 1. number of users
 2. the type of transmission medium
 3. the capabilities of the connected hardware
 4. The efficiency of the software

Reliability

- ❖ Network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure.

Security

- ❖ Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery from breaches and data losses.

Types of Connection

A network is **two or more devices connected** through **links**. A link is a communications **pathway** that **transfers data** from **one device to another**. There are **two** possible types of connections-

❖ Point to Point Connection

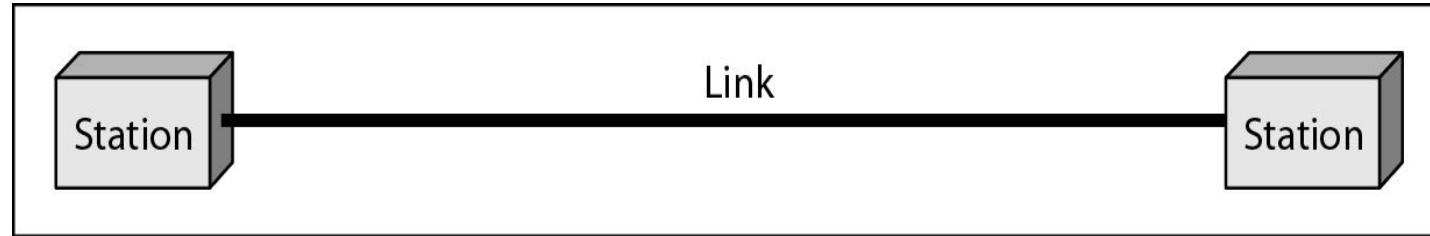
- A point-to-point connection provides a **dedicated link** between two devices.
- The entire **capacity** of the link is **reserved** for transmission between those two devices.
- **Example:** When you change television channels by **infrared remote** control, you are establishing a point-to-point connection between the remote control and the television's control system.

Types of Connection

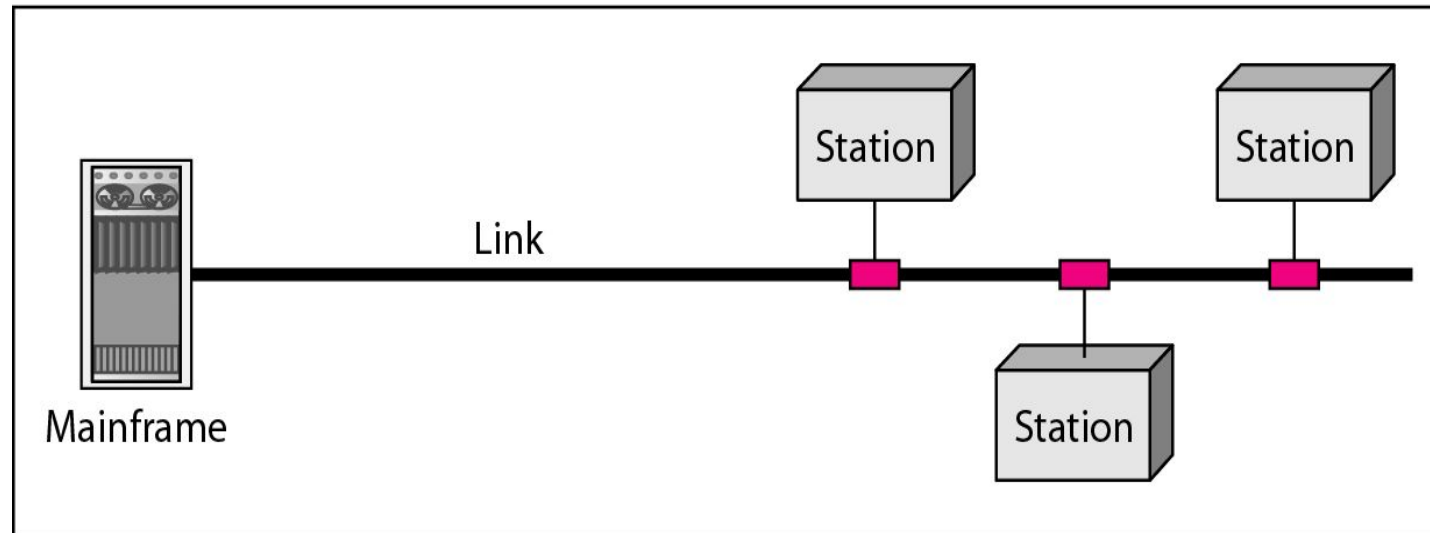
❖ Multi point

- A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link.
- In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.
- If several devices can use the link simultaneously, it is a *spatially shared* connection.
- If users must take turns, it is a *timeshared* connection. **Example:** Ethernet line, token ring network.

Types of Connection



a. Point-to-point



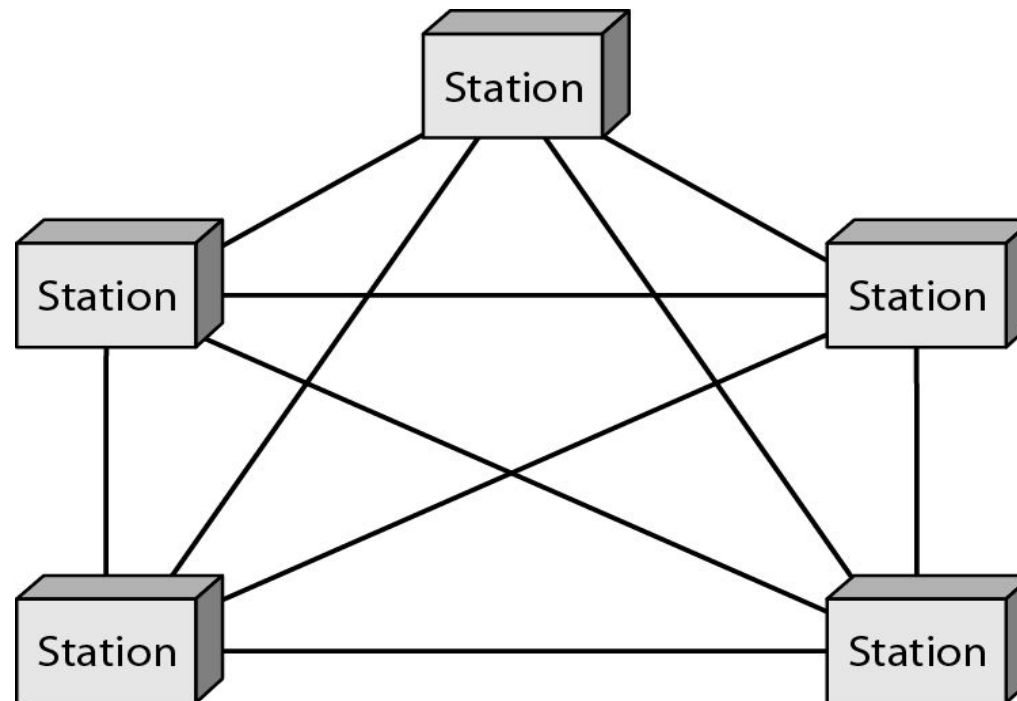
b. Multipoint

Physical Topology

- ❖ **Physical topology** refers to the way in which a network is laid out physically.
- ❖ One or more devices connect to a link; two or more links form a topology.
- ❖ The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another.
- ❖ There are four basic topologies possible-
 1. **Mesh**
 2. **Star**
 3. **Ring**
 4. **Bus**

Mesh

- ❖ In a mesh topology, every device has a dedicated point-to-point link to every other device.
- ❖ The term dedicated means that the link carries traffic only between the two devices it connects.
- ❖ In a fully connected mesh network, it requires $n(n-1)/2$ physical links, where, n is the number of nodes.



Mesh

♦ Advantages of Mesh Topology:-

- 1) It uses **dedicated** links.
- 2) Mesh topology is more **robust**.
- 3) It provides **better privacy** and **security**.
- 4) Point to point link makes **fault identification and isolation** very **easy**.

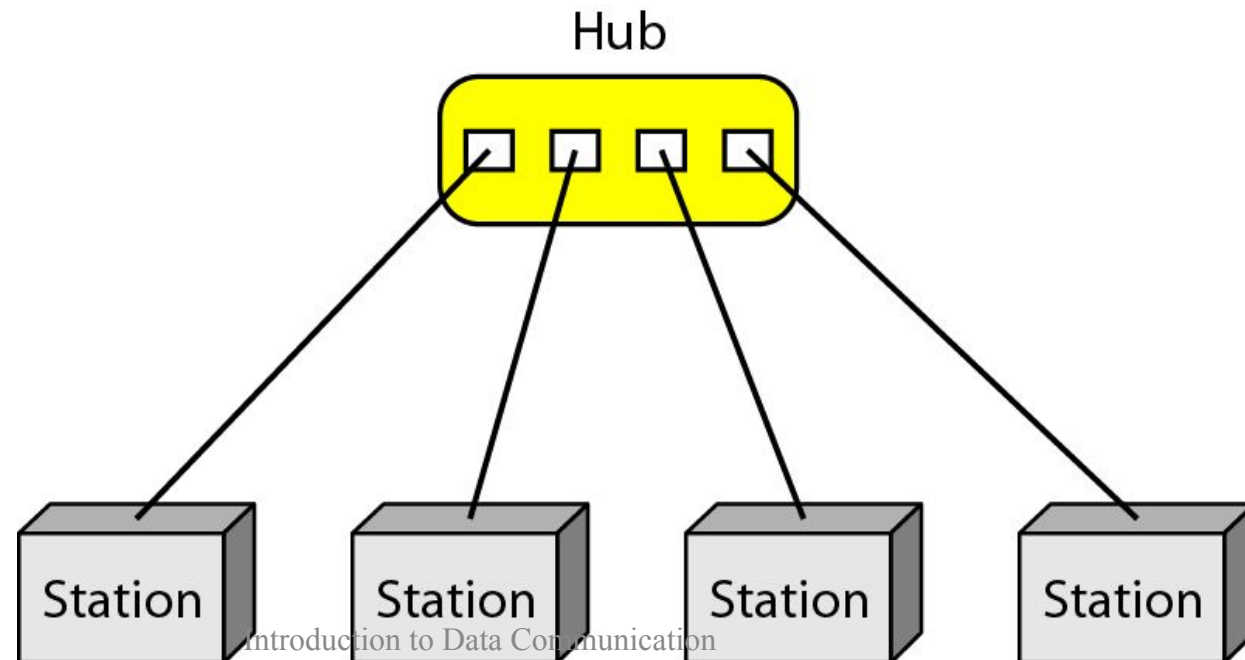
♦ Disadvantages of Mesh Topology:-

- 1) Every device must be connected to every other device, **installation and reconnection** are **difficult**.
- 2) The sheer **bulk of the wiring** can be greater than the available space (in walls, ceilings, or floors) can accommodate.
- 3) The **hardware required** to connect each link (**I/O ports** and cable) can be prohibitively **expensive**.

♦ Example:- **Telephone regional office.**

Star

- ❖ In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub.
- ❖ The devices are not directly linked to one another.
- ❖ The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.
- ❖ It requires 'n' links.



❖ Advantages of Star Topology:-

- 1) Star topology is less expensive.
- 2) It is easy to install and reconfigure.
- 3) Star topology is robust. If one link fails, only that link is affected. All other links remain active. This factor also lends itself to easy fault identification and isolation.

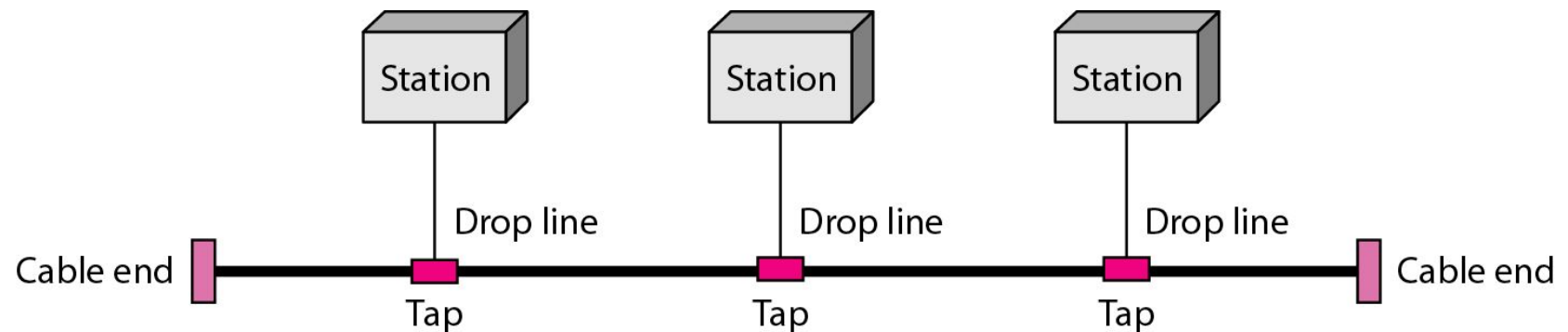
❖ Disadvantages of Star Topology:-

- 1) Star topology is the dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead.

❖ **Example:-** Local Area Network (LAN) – It is Limited a particular geographic area.

Bus

- ❖ A **bus topology** uses **multipoint connection**.
- ❖ One long cable acts as a **backbone** to link all the devices in a network.
- ❖ **Nodes** are connected to the **bus** cable by **drop lines and taps**.
- ❖ A **drop line** is a **connection** where **tap** is the **connector** between the **device and the main cable**. It requires **one long cable and n-drop lines**.



Bus

❖ Advantages of Bus Topology:-

- 1) It includes ease of installation.
- 2) Bus uses less cabling than mesh or star topologies.

❖ Disadvantages of Bus Topology:-

- 1) It includes difficult reconnection and fault isolation.
- 2) It is difficult to add new devices to the network.
- 3) A fault or break in the bus cable stops all transmission.

❖ Example:- Ethernet Local Area Network (E-LAN).

Telephone Regional Office: Mesh

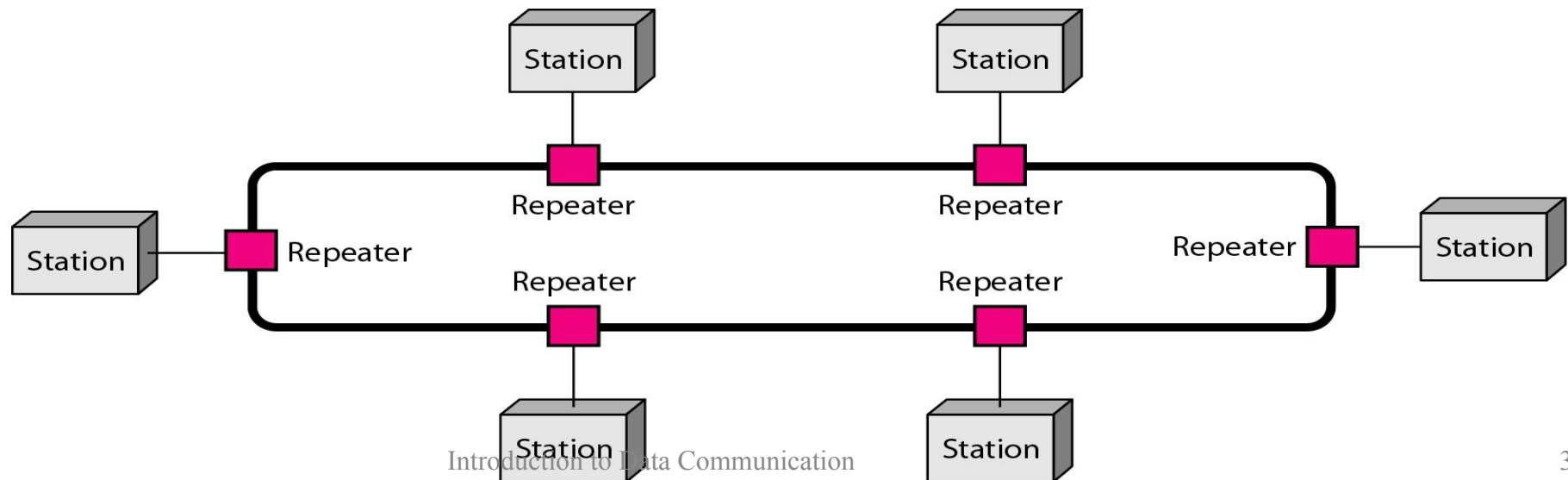
LAN: Star

E-LAN: Bus

Token Ring: Ring Topology

Ring

- ❖ In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it.
- ❖ Each device in the ring incorporates a repeater.
- ❖ When a device receives a signal intended for another device, its repeater regenerates the bits and passes them.



❖ Advantages of Ring:-

- 1) A ring is relatively easy to install and reconfigure. To add or delete a device requires changing only two connections.
- 2) In addition, fault isolation is simplified. Generally in a ring, a signal is circulating at all times. If one device does not receive a signal within a specified period, it can issue an alarm. The alarm alerts the network operator to the problem and its location.

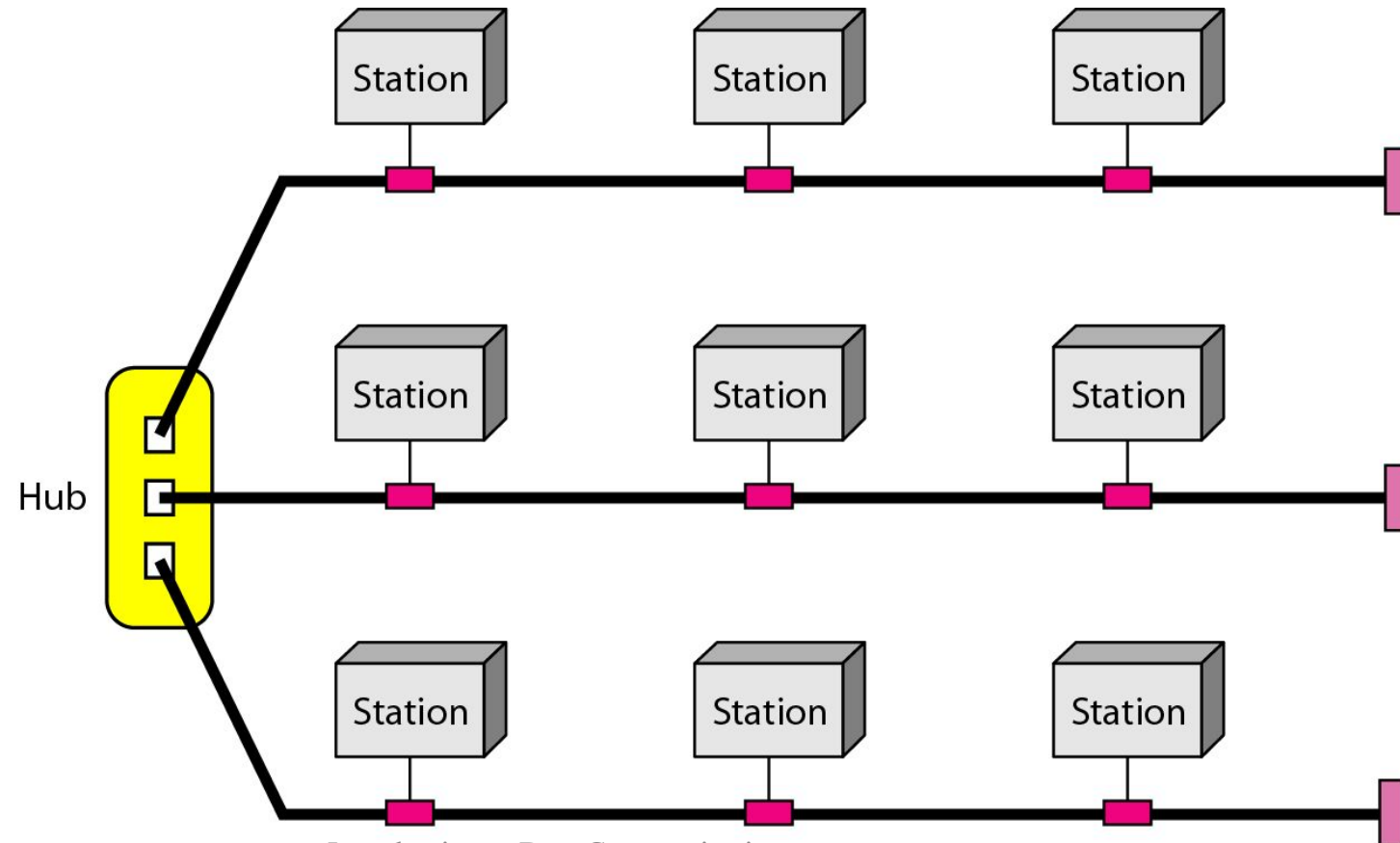
❖ Disadvantages of Ring:-

- 1) A break in the ring can disable the entire network. This weakness can be solved by using a dual ring or a switch capable of closing off the break.

❖ **Example:-** Token Ring network.

- ❖ A network can be hybrid. For example, we can have a main star topology with each branch connecting several stations in a bus topology.

Hybrid



Categories of Networks

- ❖ A computer network is a group of computers linked to each other that enables the computer to communicate with another computer and share their resources, data, and applications.
- ❖ A computer network can be categorized by their size.
- ❖ A **computer network** is mainly of **four** types:-
 - LAN(Local Area Network)
 - PAN(Personal Area Network)
 - MAN(Metropolitan Area Network)
 - WAN(Wide Area Network)

LAN

- Local Area Network is a group of computers connected to each other in a small area such as 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.



PAN

- ✓ Personal Area Network is a network arranged within an individual person, typically within a range of 10 meters.
- ✓ Personal Area Network is used for connecting the computer devices of personal use is known as Personal Area Network.
- ✓ Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, media player and play stations.



There are two types of personal area network:-

1. **Wireless Personal Area Network:** Wireless Personal Area Network is developed by simply using wireless technologies such as Wi-Fi, Bluetooth. It is a low range network.
2. **Wired Personal Area Network:** Wired Personal Area Network is created by using the USB.

MAN

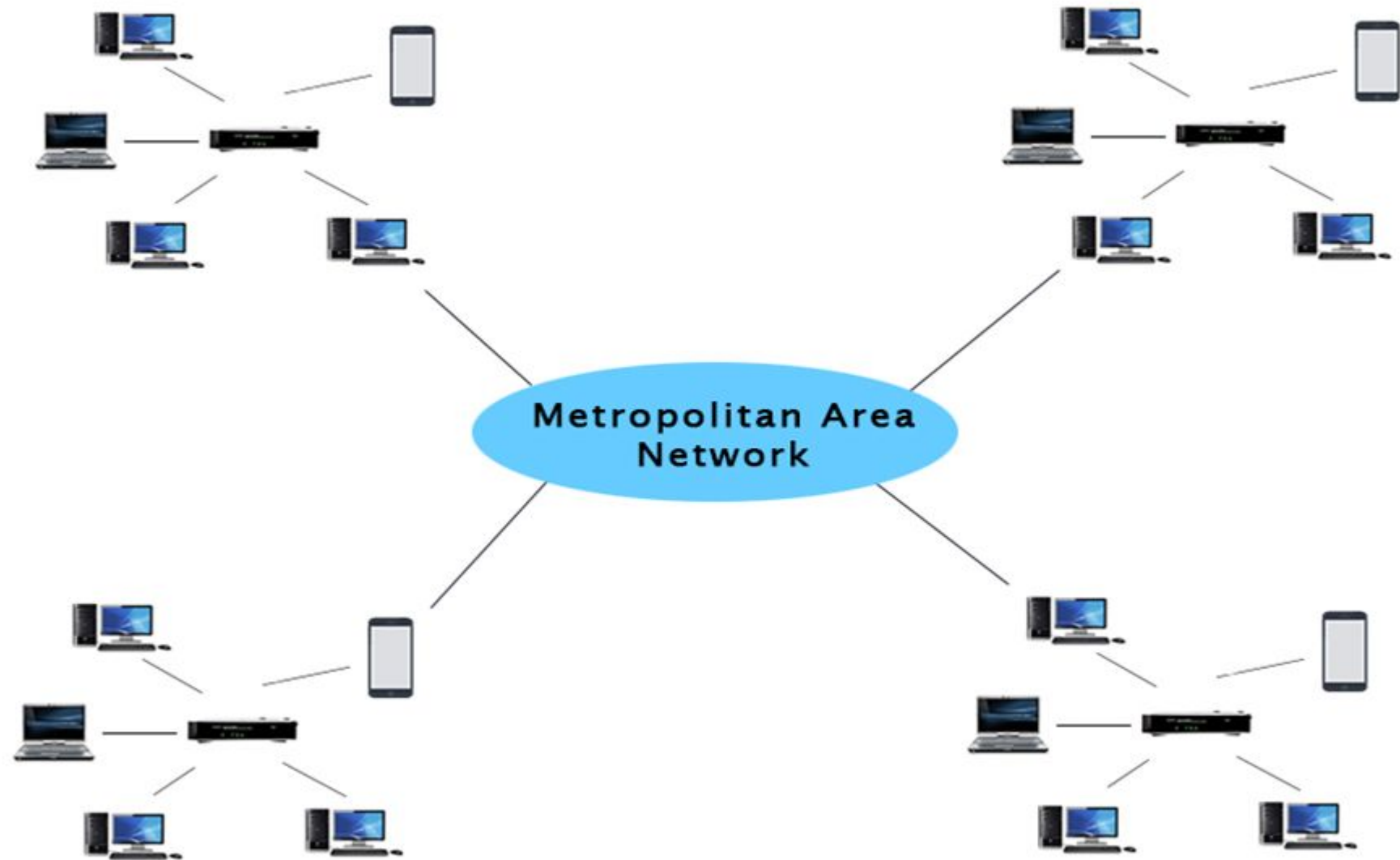
- ❖ A metropolitan area network is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.
- ❖ Government agencies use MAN to connect to the citizens and private industries.
- ❖ In MAN, various LANs are connected to each other through a telephone exchange 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).

MAN

❖ 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.

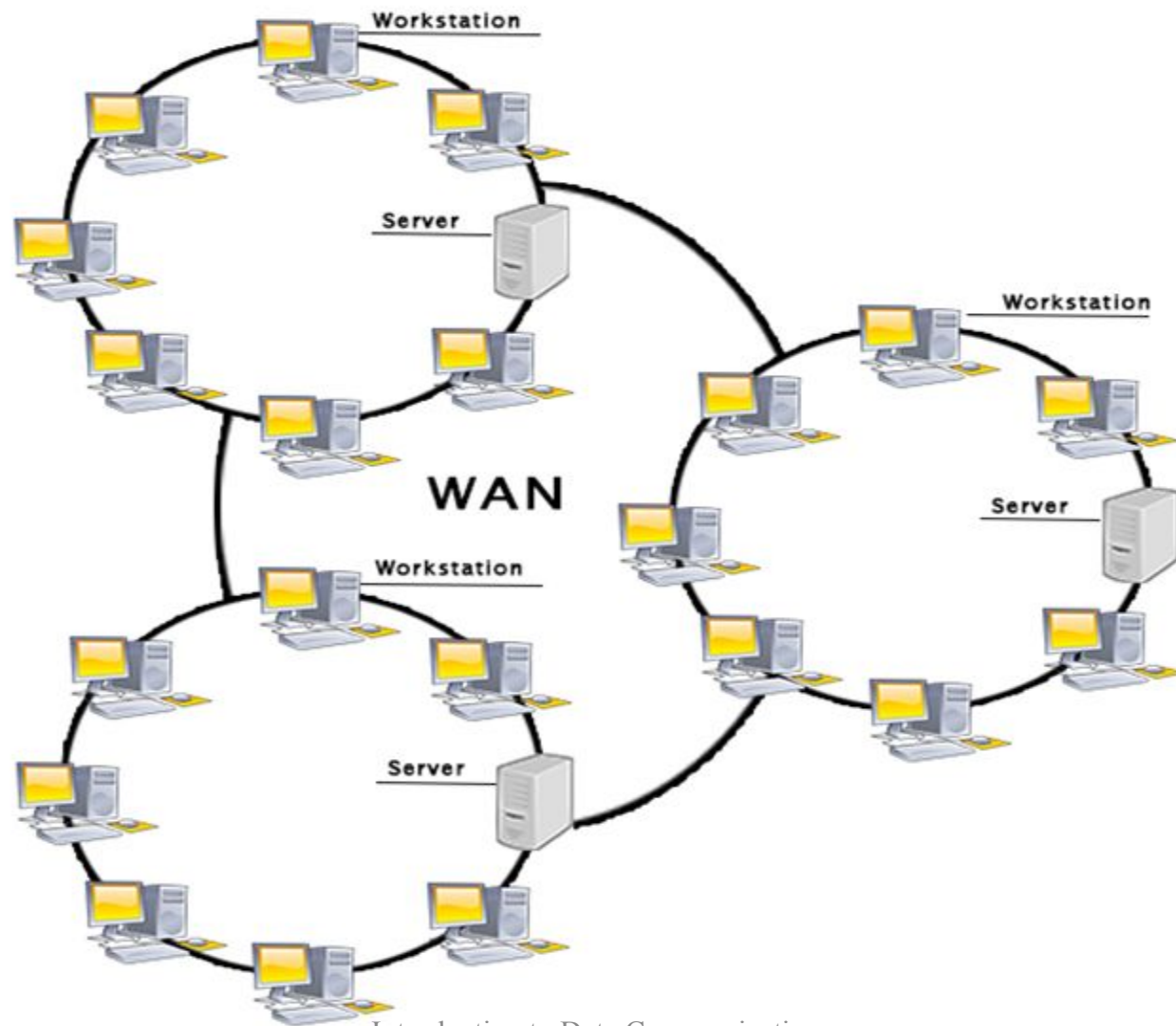
MAN



WAN

- ❖ 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 bigger network than the LAN.
- ❖ A Wide Area Network is not limited to a single location, but it spans over 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.

WAN



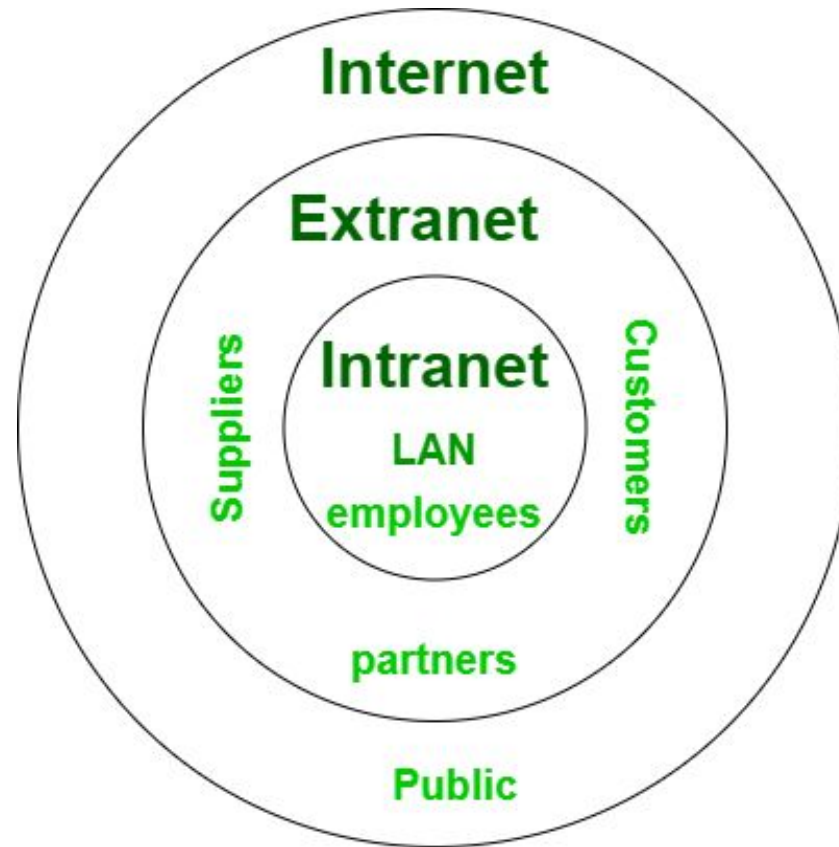
Internetworks

- ❖ A network is a group of connected communicating devices such as computers.
- ❖ An **internet** is **two or more networks** that can communicate with each other.
- ❖ An **Internet** is a **collaboration of more than thousands** of interconnected networks.
- ❖ Internet is a worldwide, **publicly accessible** computer network of interconnected computer networks (internetwork) that transmit data using the standard Internet Protocol (IP).
- ❖ Largest Internetwork in the world is Internet.

Internetworks

- ❖ An **intranet** is a **private** network that is contained **within an enterprise**. Typical intranet for a business organization consists of many **interlinked local area networks (LAN)** and use any **Wide Area Network (WAN)** technology for network connectivity.
- ❖ The main purpose of an intranet is to **share company information** and **computing resources among employees**.
- ❖ Intranet is a **private Internetwork**, which is usually **created and maintained** by a **private organization**.
- ❖ The content available inside Intranet are **intended only** for the **members of that organization** (usually employees of a company).
- ❖ An **extranet** can be viewed as **part of a company's intranet** that is **extended to users outside the company** like **suppliers, vendors, partners, customers**, or other **business associates**.

Internetworks



Protocol

- ❖ A **protocol** is a **set of rules** that **govern** data communications.
- ❖ A protocol defines **what is communicated**, **how** it is communicated, and **when** it is communicated.
- ❖ The key elements of a protocol are **syntax**, **semantics**, and **timing**.
- ✓ **Syntax:** The term *syntax* refers to the **structure or format of the data**, meaning the **order in which they are presented**. For example, a simple protocol might expect the first 8 bits of data to be the address of the sender, the second 8 bits to be the address of the receiver, and the rest of the stream to be the message itself.
- ✓ **Semantics:** The word *semantics* refers to the **meaning of each section of bits**.
- ✓ **Timing:** The term timing refers to two characteristics: **when** data should be **sent** and **how fast they can be sent**.

Thank You 😊