Unit - I

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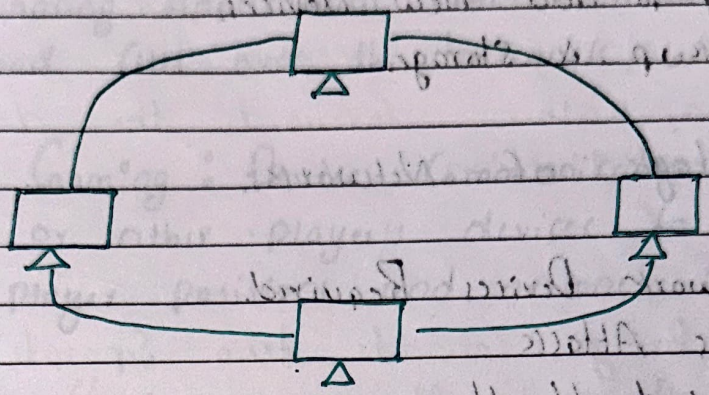
What is Computer Networks.

A group of Computers which are connected to each other for the purpose of sharing their resources is called Computer Networks.



Charecterstics of Computer Networks.

1. Resource Sharing
2. Communication Speed
3. Back up
4. Scalability
5. Reliability.
6. Software & Hardeware Sharing.
7. Security.

Network Devices.

HUB, Switch, BRIDGE, Gateway, modem, Router, Repeater etc.

Network Types.

① PAN - Personal Area Networks
② LAN - Local Area Networks
③ MAN - Metropolitian Area Networks
④ WAN - Wide Area Networks

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Advantages of Networks.

- Open to everyone
- File Sharing
- Security
- Easy to add new devices.
- Backup & Storage.

Disadvantages of Networks.

- Network Devices Required.
- Virus Attacks
- Required Handler
- High Speed Internet
- Server Needed.

2 Networks Applications.

* Bussiness Applications
* Home Applications
* Mobile uses
* Social Issues.

1. Bussiness Applications.

1. Web Browser : These allows to access websites by Connecting to web Servers using protocols like HTTP or HTTPS

2. Email Client : These applications send and receive emails over the network using protocols like SMTP. (Simple mail Transfer Protocol)

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3. Messaging Apps : These send instant messages, photos or videos to other users by communicating with a central server that routes messages.

4. File Sharing Applications : These allow to upload and download files over the network.

5. Online Gaming : Device communicates with a game server or other players devices to share information like player positions and actions in real-time.

3. Network Hardware

The basic Computer Hardware Components that are needed to set up a network.

Components :

1. Network Cables.

Network Cables are the transmission media to transfer data from one device to another.

2. Routers

A Connecting device that transfer data Packets between different Computer networks.

3. Repeaters, HUB, Switches.

They Connect network Devices together so that they can function as a Single Segment.

A Repeater recieves a ~~Single~~ Signals and regenerates it before retransmitting so that it can travel longer ~~Distante~~ distances.

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A Hub is a multiport repeater having several input/output ports. So that input at any port is available at every other port.

A Switch receives data from a port, uses packet switching to resolve the destination device and then forwards the data to the particular destination.

4. Bridges

A Bridge connects two separate ethernet networks segments it forwards packets from the source networks to destined networks.

5. Gateways

A Gateway connects directly entirely different networks that works on different protocols. It is the entry and exit of the point in network and controls access to other networks

6. Network Interface Card.

NIC is a component of the computer to connect it to a network.

Network Cards are of two types

- Internal Network Cards
- External Network Cards

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4 Networks Software.

A broad range of software used for design, implementation, operation and monitoring of computer networks.

Functions of Networks Software.

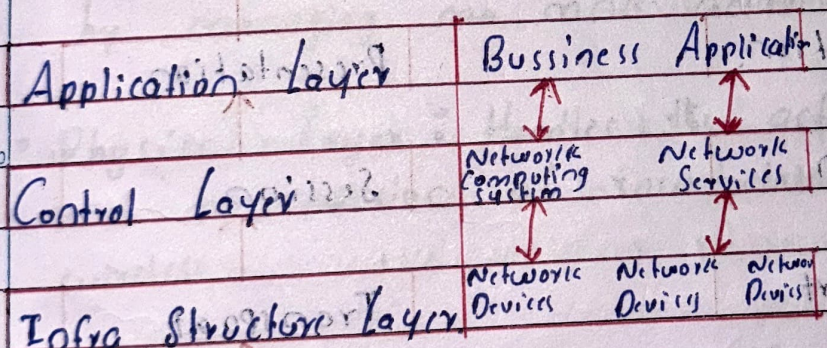
-> It helps to set up and install computer network.

-> Enables network users to accesses resources.

-> Allowed administration to add or remove users from the network.

-> Helps to define location of data storage.

Software Defined Networking Framework.



1. Application Layer :

The applications convey their needs and resources services to the control layer through API's.

2 Control Layer :

The control layer resides on a server and manages policies and traffic flows through the network.

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3. Infrastructure Layer :

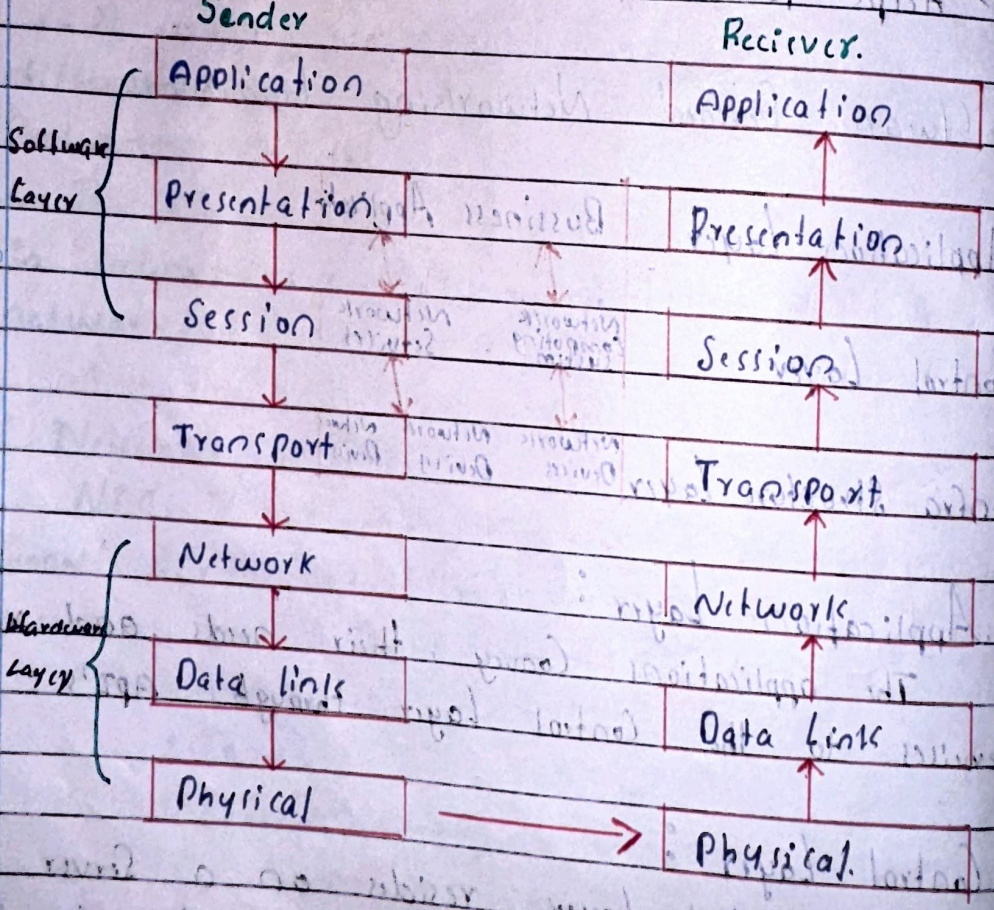
This layer is made up of the physical switches of the network.

These switches forward the network traffic to their destinations.

5 OSI Model

OSI stands for "Open System Interconnection". It is a 7 layer architecture where each layer having specific functionality.

All these layer work collaboratively to transmit the data from one network to another network across the globe.



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- Application Layer : Provides networks services to the end-user's software applications
- Presentation Layer : Translates data into a format understandable by both sender and reciever.
- Session Layer : Establishes, manages and terminates communication sessions between devices.
- Transport Layer : Manages end-to-end data delivery and error recovery, ensuring complete data transfer.
- Network Layer : Routes data between different networks using IP addresses.
- Data Link Layer : Ensures data is transferred error free between two devices on the same network by managing MAC addresses.
- Physical Layer : Handles the actual physical connection and transmission of raw data over cables or wireless.

6. TCP/IP Reference Model

The TCP/IP Protocol is a set of rules that govern how data is sent and recived over the internet. It stands for Transmission Control Protocol / Internet Protocol and has four main layers.

1. Application Layer
2. Transport Layer
3. Internet Layer
4. Network Access Layer

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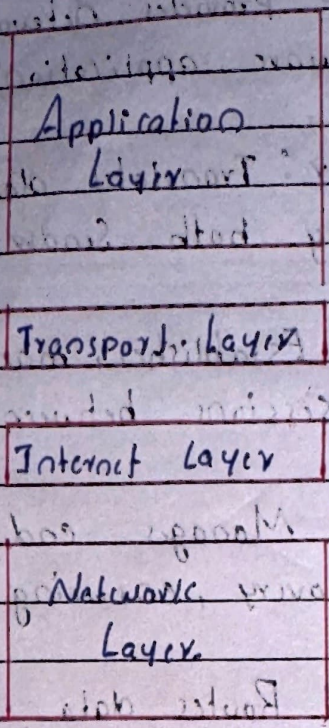

1. Application Layer: This is where network applications like web browsers, emails and file transfer services. It uses Protocols like HTTP or SMTP to interact with users.

2. Transport Layer: TCP ensures that data is broken into smaller packets, sent across the networks and reassembled correctly on the other side.

3. Internet Layer: The internet protocol is responsible for addressing and routing data between different devices on different networks using IP addresses.

4. Network Access Layer: This handles the physical sending of data over network through cables or wireless connections.

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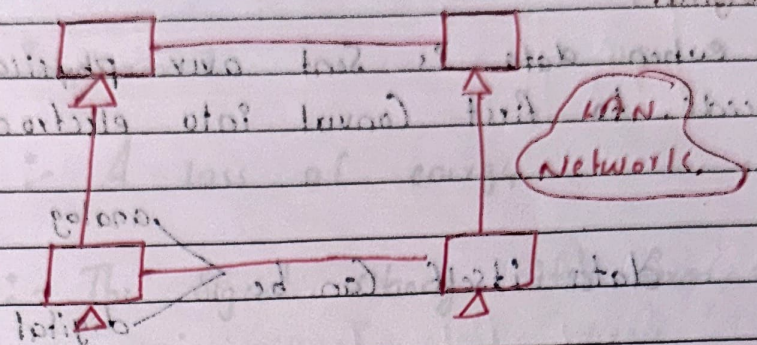
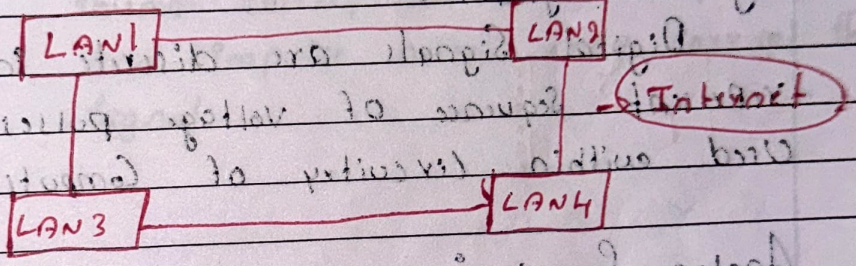
7 Networking. Internet.

Internet is a network of networks that is used to interlink many different types of computers all over the world.





8. Physical layer

- Fundamental layer underlying any networks
- Primarily consists of hardware
- Provides the basic communication channel that two network devices use to send and recieve messages.
- Provides transmission & reception hardware.

Function of the physical layer

* Transmits bits over a physical link between devices
* Encodes bits into a physical signal
* Decodes bits from a physical signal

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Types of physical Links
- Cabled (wired or fabric Optic)
- Wireless

9. Signals

When data is sent over physical medium, it needs to first convert into electromagnetic signals

data itself can be
- analog eg: human voice
- digital eg: file on disk.

Digital Signals :

Digital Signals are discrete in nature & represent sequence of voltage pulses these are used within circuitry of Computer System

Analog Signals :

Analog Signals are continuous wave form in nature & represented by continous electromagnetic waves

10 Transmission Impairment
- Signals travel through transmission media, which are not perfect
- The imperfection causes signal impairment. This means that the signal at the beginning of the medium is not the same as the signal at the end of the medium.

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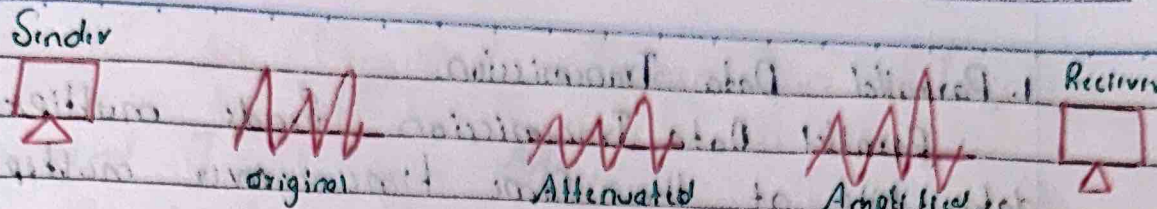

Causes of Impairment.

- Attenuation :- A loss of energy
- Distortion :- The Signal changes its form or shape.
- Noise :- Several types of noise such as thermal noise, induced noise, cross talk and impulse noise, may corrupt the Signal.

Data Transmission

Data transmission refers to the process of transferring the data between two or more digital devices in analog and digital format. This data is transferred in the form of bits.

Types of data transmission

1. Parallel
2. Serial
   - Synchronous
   - Asynchronous

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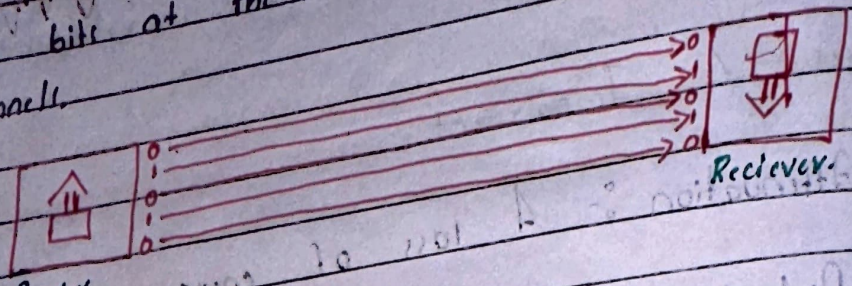
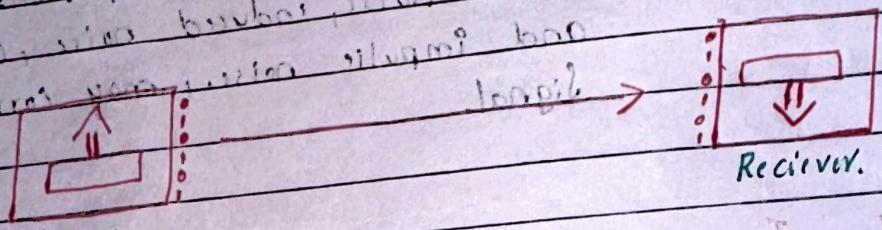
1. Parrallel Data Transmission

Parallel Data Transmission Sends multiple data bits at the same time over multiple channels.



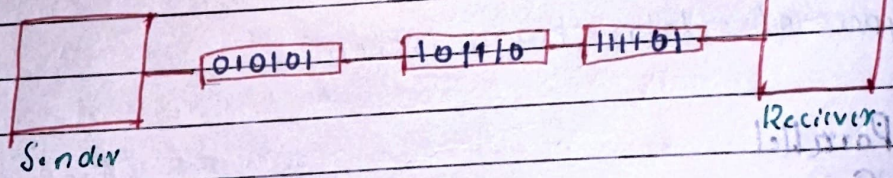
2. Serial Data Transmission

Serial Data Transmission Sends data bits one after another over a single channel.



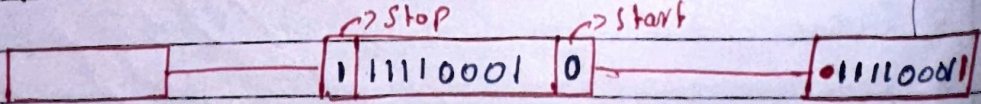
2a. Synchronous

In Synchronous transmission a lot of data is sent in a blocks. Each blocks has many characters.



2b. Asynchronous.

In asynchronous transmission only one character is sent at a time.



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12 Guided vs Unguided Transmission Media

Guided Transmission Media

Signals travel through a physical medium that provides direction to the signals.

Limitations :

- Length of the Conductor
- Installation Cost
- Maintenance.

Categories

1. Twisted Pair Cable
2. Coaxial Cable
3. Optical Fiber

1. Twisted Pair Cable

- Made of two insulted Copper wire twisted together
- Common in telephone lines and Ethirnet Cables.

2. Coaxial Cable

- A Single Copper wire Surrended by insulation and metal Sheild.
- Used for Cable TV and Some internet Connections

3. Fiber Optic Cable.

- Thin Strands of glass or plastic that transmit data light pulses.
- High-Speed internet and long-distance Communication

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Unguided Transmission Media.

Signals are broad casted through air and it doesn't have any boundry limitations

As the communication is wireless the user can connect to networks from anywhere.

Categories :

1. Radio Waves
2. Micro Waves
3. Infrared Waves.

1. Radio Waves
   - Used for things like TV and Radio broadcasts, wi-fi, and Bluetooth.
   - Can cover long Distances and pass through walls

2. Microwaves.
   - Used for, Satellite Communications, mobile Phones and some Wi-fi Connections.

3. Infrared
   - Used in TV remotes and short-range communication also in wireless keyboards.
   - Can't pass through walls and works for short distance.

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Guided Transmission Media	Unguided Transmission Media
• Signals are transmitted through a physical Path	• Signals are broadcasted through the air
• Wired Transmission or Bounded Transmision	• Wireless Transmission or Unbounded Transmission.
• Signals are directed toward a Particular direction.	• Signals are broadcasted in every direction.
• Transmits data in the form of electric or optical Signal	• Transmits data in the form of electromagnetic Signal.
• Transmission Speed of Signal is faster	• Transmission Speed is Comparatively Slower
• It is Secure medium for transmission of Signal	• It is Comparatively less Secure medium of transmission

13 Public Switched Telephone Networks

Public Switched Telephone Networks are the traditional landline telephone systems that have been in use for over a Century.

They connect telephone calls across local, national, and International regions.

How PSTN works :

1. Analog to Digital : When you make a call, your voice is first converted from Sound waves into electrical Signals.

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2. Switching: These signals travel through the telephone exirel. to a Central office. The switch finds a Path for the phone number we are calling and Connects two lines.

3. Circuit: For the duration of the call, a direct circuit is created between the two phones, so we can hears each other clearly.

4. Global Connectivity: The PSTN uses a series of interconnected switches and lines connecting millions of phones worldwide.

Types of PSTN.

1. Analog: Voice signals are transimitted as continuous electrical waves.
   eg: Old landline Phones.
2. Digital: Converts voice signals into digital data for transmission
   eg: Modern Phone.
3. Circuit-Switched: The original form of telephone switching, where a ~~physical~~ dedicated physical path is created between the caller and receiver for the duration of call.
   eg: Traditional landline calls.
4. Packet Switched Networks: In modern networks, voice data is broken down into smaller packets and sent over the network rather than creating dedicated path.
   eg: VoIP Systems.

Unit-II

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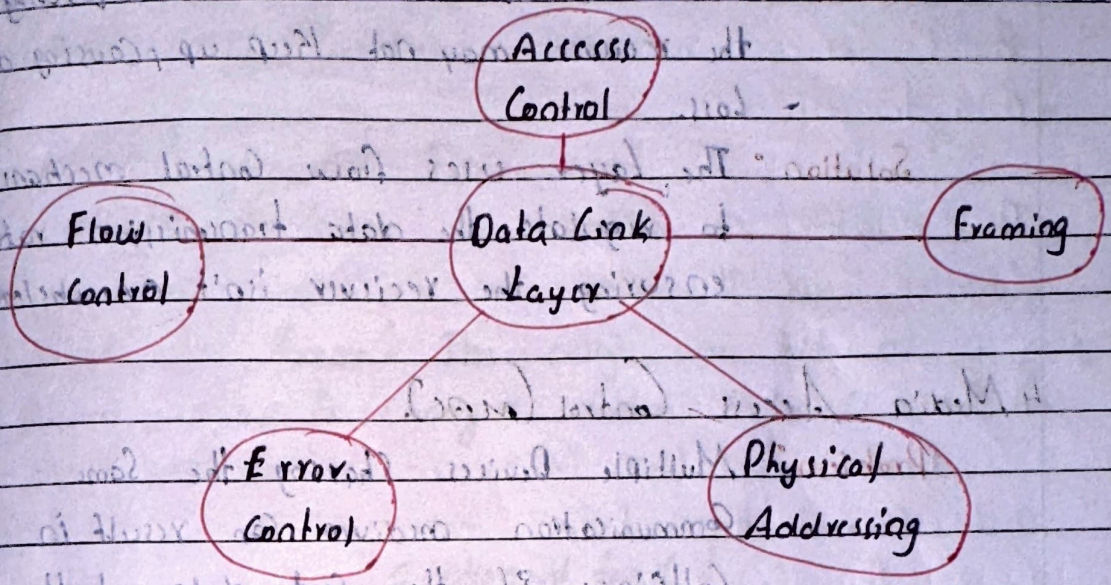
1. Data Link Layer:

Data Link Layer Design Issues.

Data link layer is the second layer in OSI reference model and lies above the physical layer.

Functions of Data Link Layer.



The data links layer in computer networks is responsible for ensuring reliable communication between directly connected devices over a physical medium.

Key Design Issues.

1. Framing.

Problem: How to group bits from the physical layer into blocks of data.

Solution: The data links layer organizes raw bits into frames by adding headers and trailers to the data.

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2. Error Control

Problem : Errors like bit corruption or data loss during transmission can occur.

Solution : The layer adds error detection codes into the frame.

3. Flow Control :

Problem : if the Sender sends data too quickly, the receiver may not keep up, causing data loss.

Solution : The layer uses flow control mechanism to regulate the data transmission rate ensuring the receiver isn't overwhelmed.

4. Media Access Control (MAC)

Problem : Multiple Devices sharing the same communication medium can result in collisions if they send data at the same time

Solution : The MAC ~~Sublayer~~ Sublayer coordinates who gets to send data at what time using methods like : CSMA/CD, CSMA/CA

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2 Error Detection and Correction

1. Error Detection

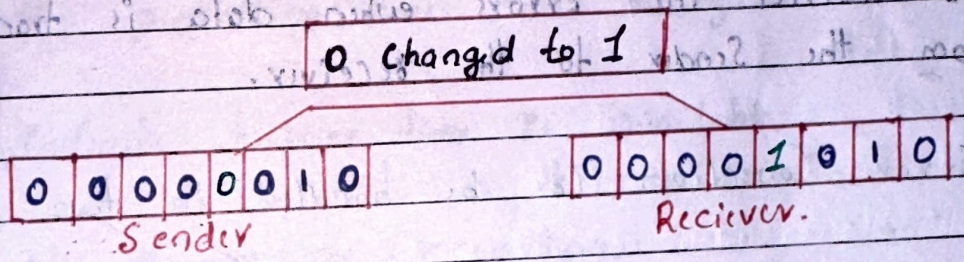
Redundancy is the main technique to detect errors.

Error is a condition when the receiver's information does not match with the senders information.

Types of Error:

- Single - Bit Error
- Burst Error.

1. Single Bit Error : The only one bit of a given data unit is changed from 1 to 0 or from 0 to 1.



In the above example, the message which is sent is corrupted as single-bit. Such as, 0 bit is changed to 1. Mainly occurs in Parrelel Data Transmissi

2. Burst Error : The two or more bits are changed from 0 to 1 or from 1 to 0 is known as Burst Error.

The Burst error is determined from the first corrupted bit to the last corrupted bit.

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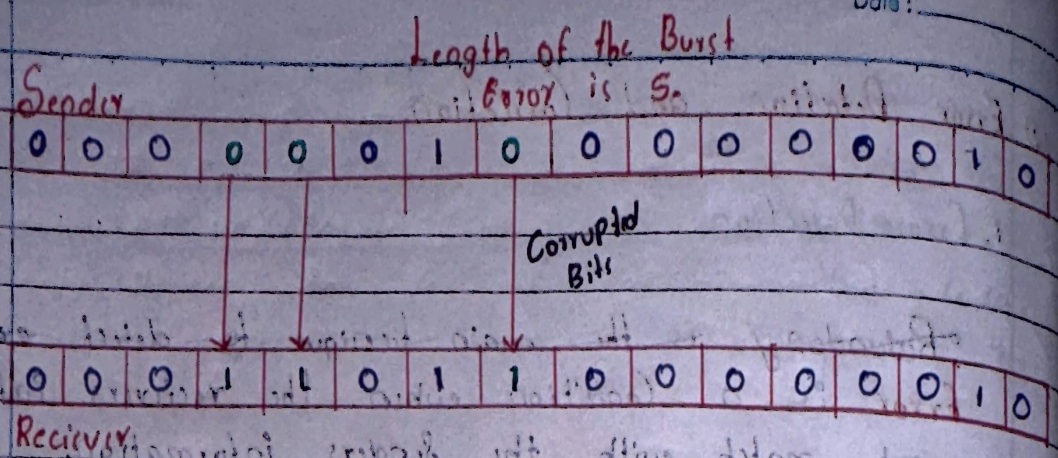

Burst Errors are most likely to occur in Serial data transmission.

The number of affected bits depends on the duration of the noise and data rate.

2. Error Correction.

Error Correction Codes are used to detect and correct the Errors when data is transmitted from the Sender to the receiver.

Error Correction can be handled in two ways.

1. Backward error Correction : Once the error is discovered, the receiver requests the Sender to retransmit the entire data unit.

2. Forward Error Correction : In this case, uses the error Correction code which automatically Corrects the errors.

A Single additional bit can detect the error but cannot detect it.

formula -> $2^r >= d + r + 1$

r → redundant bit.

d → Data bit

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3 Elimentary Data Link Protocols

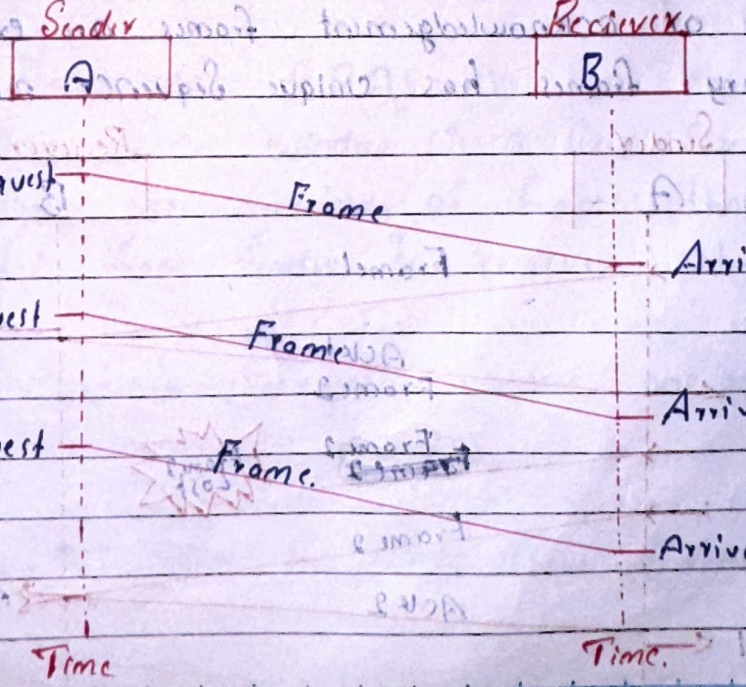
Protocols in the data link layer are designed so that this layer can perform its basic functions: Framing, Error Control and flow Control

Three Categories :

- Unrestricted Simplex Protocol
- Simplex Stop and wait Protocol
- Simplex protocol for noisy channels.

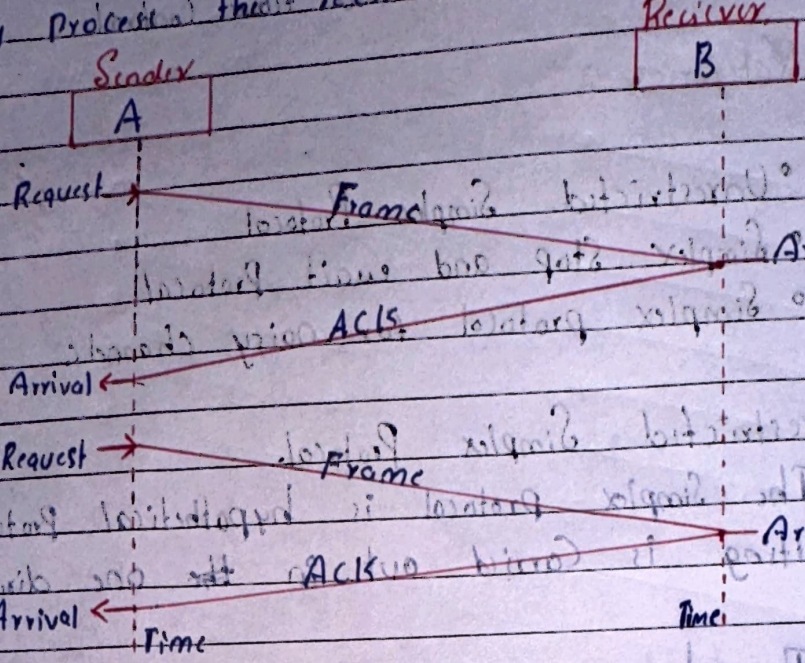
1. Unrestricted Simplex Protocol.

- The Simplex protocol is hypothetical protocol. Data transmitting is carried out in ~~the~~ one direction only.
- The transmission and recieving are always ready and the procesing time can be ignored.
- Infinite buffer time is available.
- No errors are occuring.



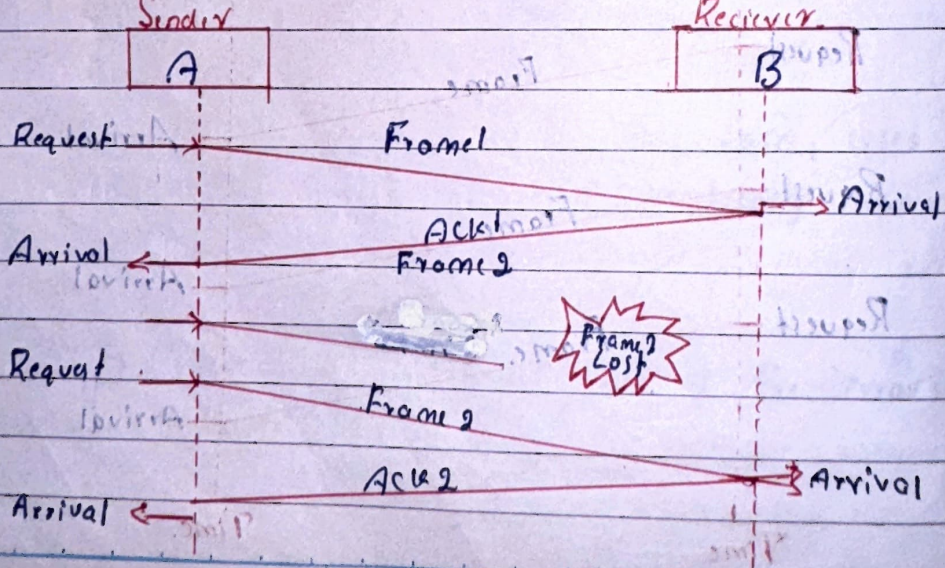
2. Simplex Stop and wait Protocols:

It Provides unidirectional data transmission without any error control facilities. The receiver can only process the received information at finite rate



3. Simplex Protocol for Noisy Channel

- Data transfer is only in one direction, Consider Separate Sender and receiver. finite processing Capacity and Speed at the receiver
- Since its a noisy Channel, errors in data frames or acknowledgement frames are expected.
- Every frames has unique Sequence number



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4 Sliding Window Protocol.

- These are the data link layer protocols for reliable and sequential delievery of data frame's.
- It is also used in Transmission Control Protocol
- This technique is for sending multiple frames at a time to the recievers.
- Each frame has sent from the sequence number.
- The sequence number is used to find the missing data in the reciever end.
- The main purpose is to avoid ~~data~~ dublicate data.

Types of Sliding Window Protocol.

1. Go - Back - N ARQ
2. Selective Repeat ARQ.

1. Go - Back - N ARQ

- The sender window is a fixed - sized window. 'N' that defines the number of frames that are transmitted from sender to reciever at once.
- It rejects corrupted frames to avoid out of sequence frames.
- It is used for data flow control purposes.

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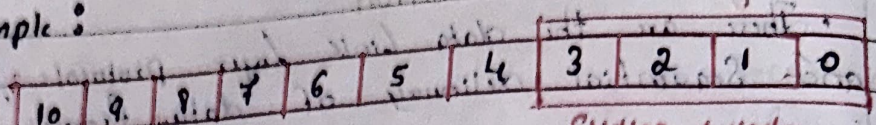
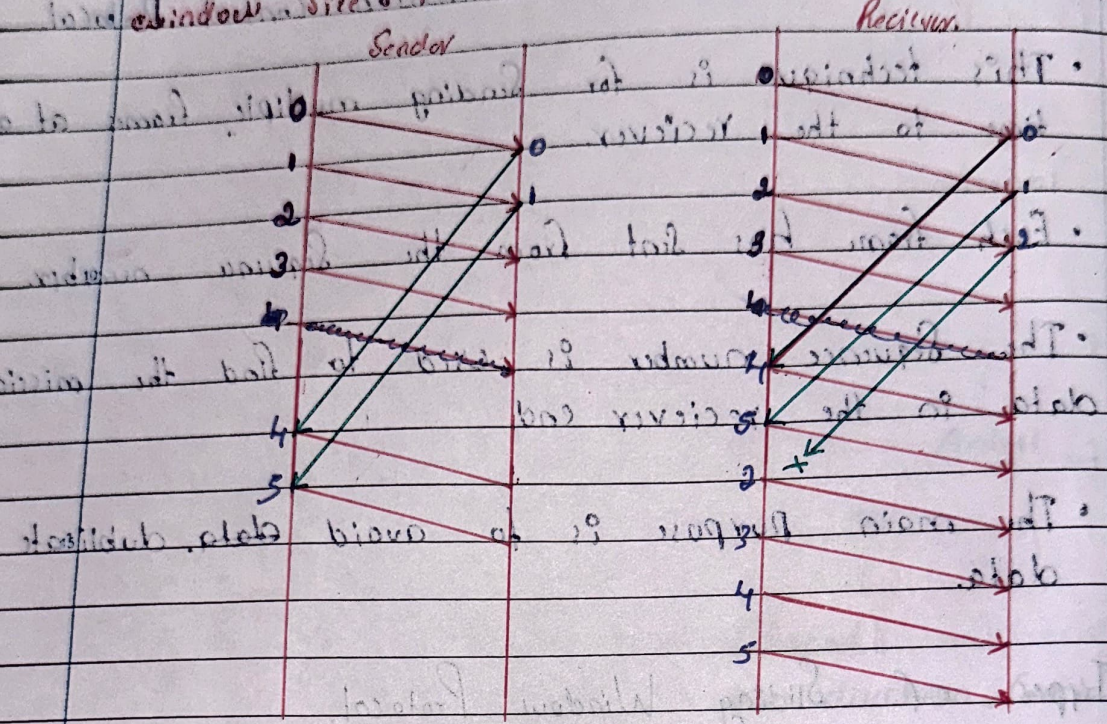
Example :



Sliding window.



2. Selective Repeat ARQ Protocol:

- ~~It Sends negative~~
- If the reciever recieves a corrupt frame, it does not directly discard it.
- It Sends a negative acknowledgment to the Sender.
- The Sender Sends that only frame again as soon as it has the receiving negative acknowledgement
- It Provide efficient data transmission & fastest recovery.

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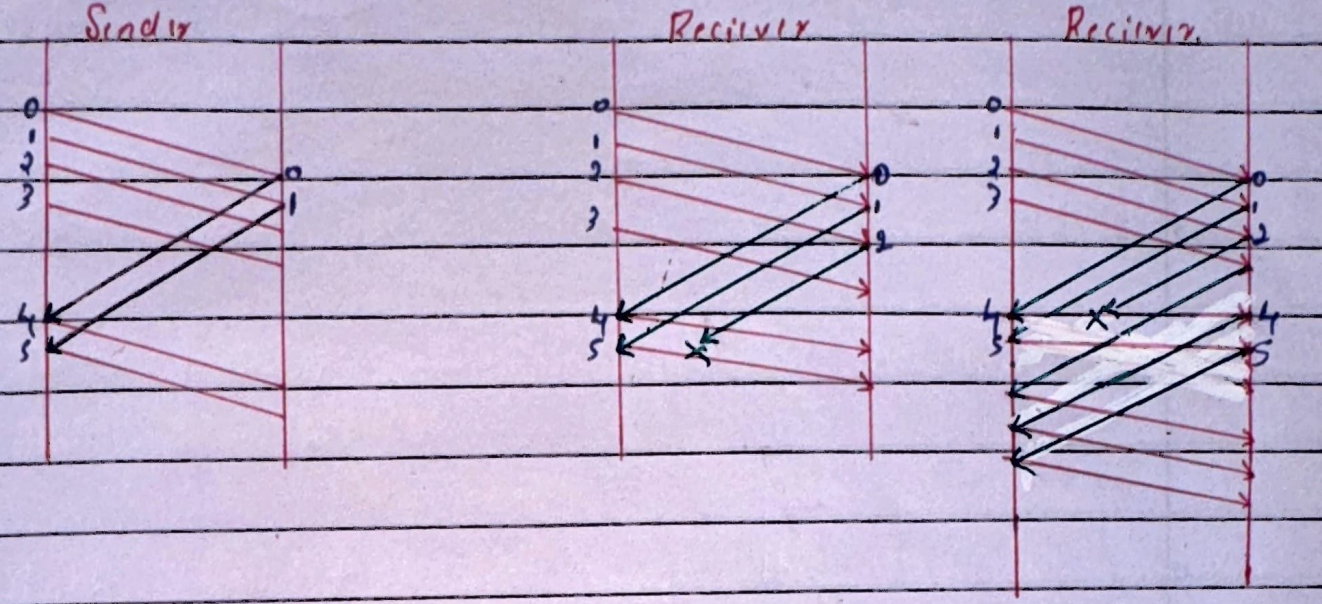
Example :

0	1	2	3	4	5	6	7	8	9	10

window size = 4



9

Hamming Code.

A 7 bit hamming code is received as 1011011. Assume even parity and state whether the received code is correct or wrong. If wrong locate the bit in error.

Solu :