Module - III

Data link Control.

→ **Data link control** =

* It is a service provided by the data link layer to provide reliable data transfer over the physical medium.
* 3 FCs are —

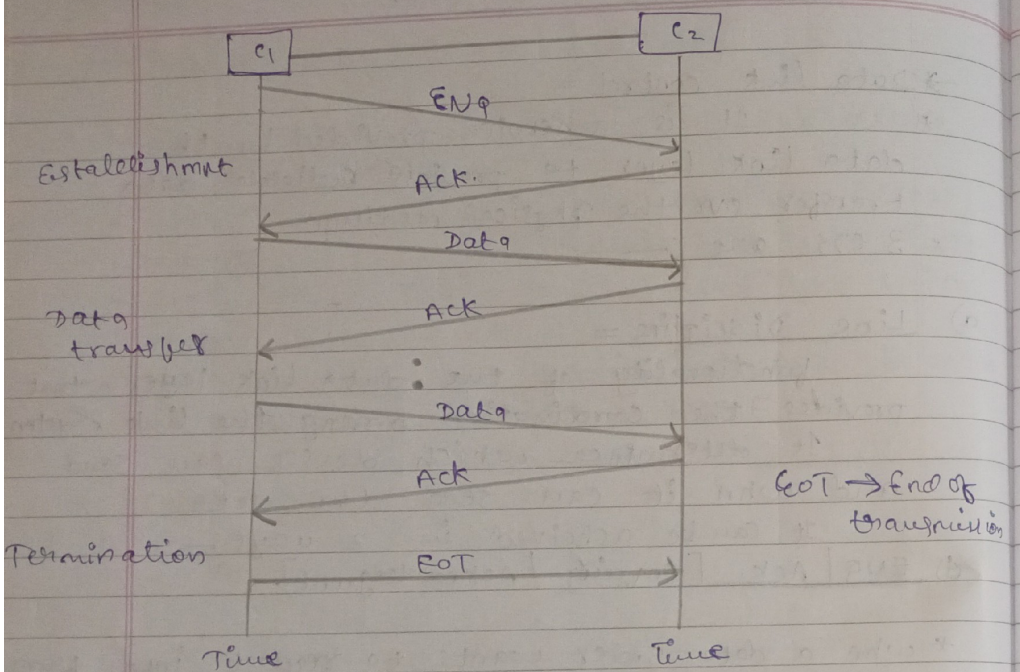
a) **Line Discipline** =

functionality of the data link layer that provides the coordination among the link system. It determines which device can send and when it can send the data.

It can be acheived in 2 ways —

(i) **ENQ / ACK.** [Enquiry / Acknowledgment].

* when a data Snder wants to request info frm a receivr, it Snds an ENQ control character.
* This is a msg asking for the receivr to Snd back a specific info.
* Receivr upon receiving an ENQ control character, Snds an ACK control character back to the Sndr.
* This indicates that the receivr has received the enquiry & is ready to Snd requested info.
* The receivr Snds the requested info to Snder.
* If the Snder does not receive an ACK with in a certain period of time, it assumes that the enquiry was not successfully received & retransmits the enquiry.

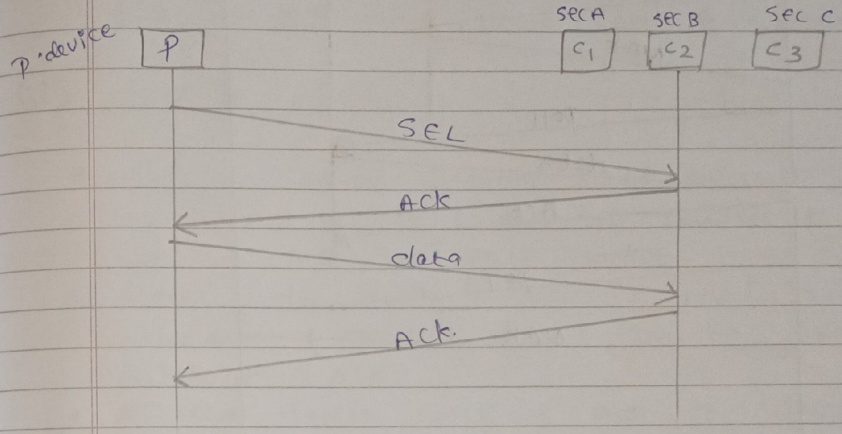


(ii) poll / select =

works with those topologies where 1 device is designated as a primary station & other devices are sec stations.

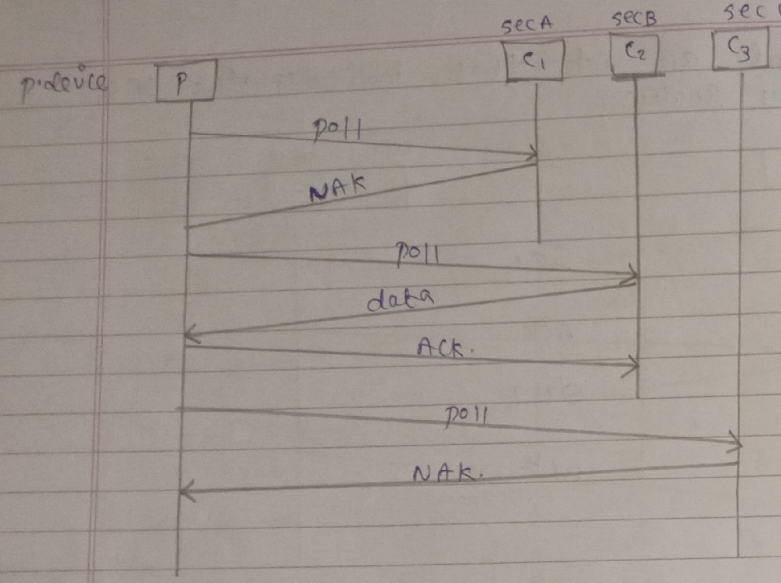
∀ working of Select =

* Select mode is used whn the primary device has something to snd.
* whn the primary device wants to snd some data, then it alerts the sec device for the upcoming transmission by transmitting a Select (SEL) frame, 1 field of the frame includes the ad of the intended sec device.
* whn the sec device receives the SEL frame, it snds an Ack that indicates the sec ready status.



∀ working of poll =

* poll mode is used whn the primary device wants to receive some data frm sec device.
* whn a p·device wants to receive the data, then it asks each device whether it has anything to snd.
* 1st by primary asks (poll) the 1st sec device, if it responds with the NACK (-ve ACK) means that it has nothing to snd. now it approches the 2nd sec device, it responds with Ack means that it has the data to snd.



b) Flow Control =

* It is a set of procedures that tells the sender how much data it can transmit bfre the data overwhelms the receivr.
* Receiving device has limited speed & limited memory to store the data.
* 2 methods —

(i) Stop-and-wait =

* used in Commun nturks to ensure reliable data transmission.
* Here, the Snder Snds 1 packet of data & then waits for an ack frm the receivr bfre Snding the nxt packet.
* Receivr acks the receipt of the packet by Snding an Ack msg to the Snder.
* If the Snder does not receive an Ack msg within a Specified time, it assumes that the packet has been lost & retransmit it.

(ii) Sliding window =

* used in commun nturks that allows for multiple packets to be Snt without waiting for an Ack for each packet.
* Here, both Snder & receivr maintain a window of packets that can be transmitted without Ack.
* As the Snder receives Ack, it slides the window forward & Snds additional packets.

c) Error control =

It is a technique of error detection & retransmission.

2 methods -

(i) Stop and wait ARQ =

* technique used to retransmit the data in case of damaged / lost frames.
* It works on the principle that the Snder will not transmit the nxt frame until it receives the Ack of last transmitted frame.

(ii) Sliding window ARQ =

* used for continous transmission error control
* Here, Snder keeps the copies of all the transmitted frames until they have been acked.
* The receivr can Snd either NAK / ACK

* If an error occurs in the last transmitted frame, then the receiver sends the NAK frame. on receiving the NAK frame, sender retransmits the data.
* 2 possibilities →
  - Damaged frame,
  - Lost Frame.

depending on the condition.
* ACK frame consist of a no. that represents the next frame which the receiver expects to receive.
NAK frame consist of a no. that represents the damaged frame.

eg → when the data 0 frame is sent, & then the receiver sends ACK 1 frame means that data 0 has arrived correctly. & transmits the data 1 frame.
The sender transmits the ~~next~~ frame: data 1. It reached damaged & receiver returns ACK 0. ~~The sender transmits the next frame: data 0~~. The receiver reports an error & returns NAK frame. The sender retransmits the data 1 frame.

Sliding window ARQ

Go back-n ARQ

(Sender)
* Sends a window of frames, waiting for ACK
* can be more efficient when few errors occurs
* Simples implementation

Selective-reject ARQ

Sends frames individually, waiting for ACK
less
can be ~~more~~ efficient when many errors occurs
more complex implementation.

Data link control

- Line Discipline — who should send the data?
- Flow control — How much data should be sent?
- Error control. — How can errors be detected & corrected.

Line Discipline → ENQ|ACK, poll/select.

Flow control → Stop & wait, Sliding window.
- Stop & wait → Sender window, receiver window
- Sliding window → Go back-n ARQ, Selective-reject ARQ.

Error control → Stop & wait ARQ, Sliding window ARQ

⇒ Transmission modes =

* Transfering data b/w 2 devices.
* (T) of binary data across a data link can be accomplished in either parallel / serial mode.
* In parallel, multiple bits are sent with each clock tick.
* In serial, 1 bit is sent with each clock tick.

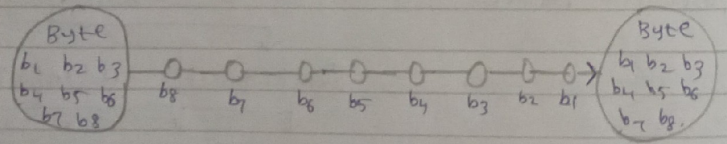
T. modes
- parallel mode.
- Serial mode
  - Synchronous
  - Asynchronous
    - XMODEM
    - YMODEM
    - ZMODEM
    - BLAST
    - Kermit

* Parallel mode	Serial mode.
* Data transfer is multiple bits at once.	1 bit at a time
* (T) distance is limited	(T) distance is longer.
* Synchronization is complicated	is easier.
* Expensive	Inexpensive.
* Speed is faster	Lower.

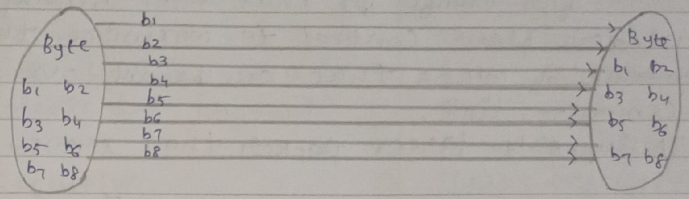
* Asynchronous mode	Synchronous mode.
* No fixed timing control	fixed timing control
* Data transfer is byte-by-byte	D. Transfer is bit-by-bit.
* Data rate is slower	Data rate is faster.
* eg→ keyboard, mouse	eg→ n/w's Comm-

* Diagrams =

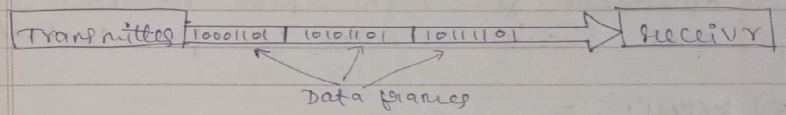
I Serial T. mode =



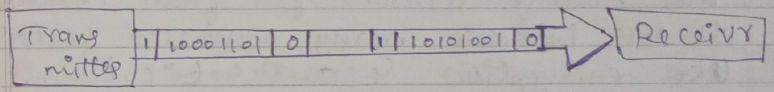
II Parallel T. mode =



III Synchronous T. mode =



IV Asynchronous T. mode =



→ Asynchronous T. mode =

1) XMODEM =

Simple file transfer ~~of~~ that uses 128-byte packets ~~of~~ to transmit data.
Commonly used for transferring files b/w comp & peripheral devices like pointer.

2) YMODEM =

file transfer ~~of~~ that is an extension of XMODEM. It uses 1024-byte packets for transfer of multiple files.
YMODEM is more efficient than XMODEM for large file transfer.

3) ZMODEM =
file tranfer (p) that uses sliding window flow control to maximize the amount of data that can be snt ovr a commun link.
It supports larger packets than XMODEM & YMODEM

4) BLAST = [Blocked Asynchronous (t)].
block-oriented commun (p) that is optimized for high speed ntwrk.
uses sliding window for flow control.

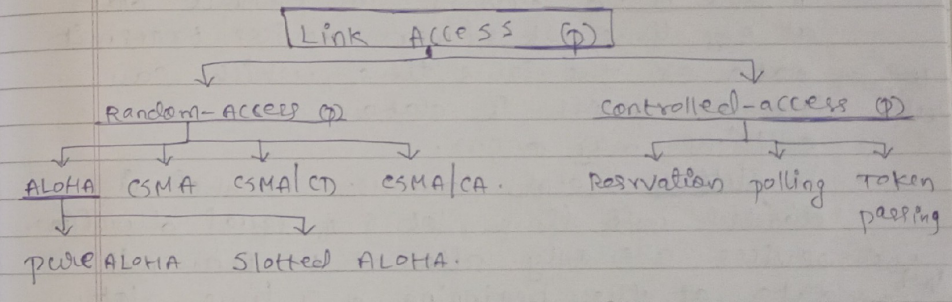
5) KERMIT =
general purpose commun (p) that support a wide range of applications.
uses sliding window for flow control.
It also includes many advanced features like encryption & authentication.

=> Link Access procedures =

* protocols used in data commu to control access to a shared commun channel by multiple devices.
* Ntwrk link can be divided into 2 categories -
a) point-to-point connections = and
~~there exist~~ (b) Broadcast channels.

(a) point-to-point connection	(b) Broadcast channels
* Involves 2 devices communicating with each other over a dedicated point-to-point connection.	Allows multiple devices to communicate with each other over a shared broadcast channel.
* High efficiency due to dedicated channel	Low efficiency due to sharing the channel among multiple devices.
* Expensive	Less expensive
* eg → PPP (point to point (p))	eg → Ethrnt, wifi, bluetooth.

Seeking = process of a device attempting to acquire permission to transmit data ovr a shared commun channel.

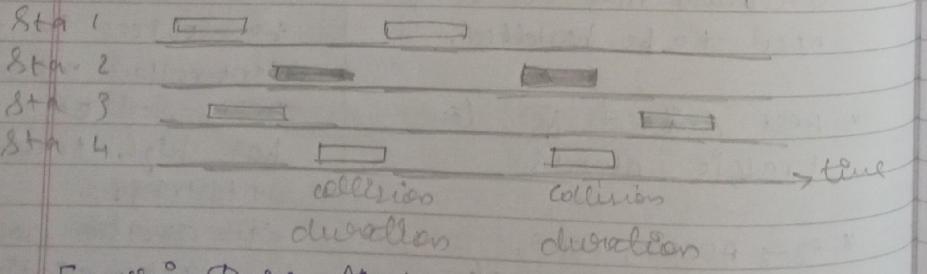


I	Random Access (p)	II Controlled-Access (p).
	* Devices are allowed to transmit data at any time without seeking permission	Devices must seek permission to transmit data.
	* Collisions may occur & need to be handled.	Medium is allocated to devices in a controlled manner
	* Best suited for low traffic ntwrks	Best suited for high traffic ntwrks,
	* eg → ALOHA, CSMA, CSMA/CD, CSMA/CA.	eg → reservation, polling, Token passing.

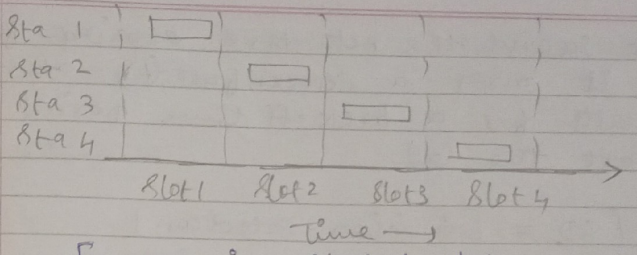
* used in wireless ntwrks like wifi	used in wired ntwrks like Ethernet.

(1) ALOHA = [Additive links on-Line Hawaii Area]

* Random access ⓟ that allows devices to transmit data ovr a shared commun channel without seeking permission.
* 2 versions of ALOHA : pure & slotted.
* In pure ALOHA, devices can transmit data at any time. If 2/more devices transmit data at the same time, which can lead to a loss of data. collisions may occur. (lower efficiency)
* In slotted ALOHA, commun channel is divided into time slots of equal duration. devices are only allowed to transmit data at the beginning of a time slot. collisions may still occur, however devices must retransmit their data in the nxt time slot if a collision occurs. (higher efficiency)
* ALOHA has low implementation complexity & can be used in ntwrks with low-to-medium traffic or loads.



Frames in Pure ALOHA ntwrks.



Frames in Slotted aloha.

(2) CSMA [carries sense multiple ACCESS] =

* This method was developed to use the chance of collisions whn 2/more Stations start sndng their signals ovr data link layr.
* It senses whether the shared channel for transmission is busy/not & transmits if the channel is not busy.

(3) CSMA/CA (collision ~~detection~~ Avoidnce) = (AI).

* [Bfre a device begins transmitting data, it listens to the commun channel to determine if it is idle.]
* whn a frame is ready, the transmitting Sta checks whether the channel is idle/busy.
* If the channel is busy, the Sta waits until the channel become idle (ready)
* If the channel is idle, Sta waits for an interframe gap (IFG) · amount of time & then sent the frame.
* After sndng the frame it sets a time.
* The Sta then waits for ACK frm the receivr.

Backoff time = duration of time a device waits bfre attempting to transmit data again aftr collision in a shared communication medium.

* If it receivs the Ack bfre expiry for time it mrks a successfull (t) otherwise it wait for a backoff time period & restart the (a).

(b) CSMA/CD = [Collision Detection]

* when a frame is ready, the transmitting sta checks whether the channel is idle / busy.
* If a carrier is idle, then the (t) is carried. (t) Sta detects a collision by using the condi" $Tt \geq 2 * Tp$".
  Tt → (t) delay.
  Tp → propogation delay.
* whevr it detects the collision, Sta releases JAM signal.
* After collision has occured the transmitting Sta stops transmitting & waits for random amount of time → backoff time.
* After this time the Sta retransmit again.

II Controlled-Access (t) =

(1) Reservation =

* here, a Sta needs to make a resrvation bfre sending data.
* Time is ÷ into intervals, in each intervals a resrvation frame precedes the data frame snd in that interval.
* If there are N Sta in the system, there are exactly N reservation mini slots in rsrvation frame.

(2) polling =

* It works with topologies in which 1 device is designated as primary Sta & other device are sec Sta.
* primary Sta controls the link, sec devices follow its instructions.
* It is upto the primary device to determine which ~~transmit~~ device is allocated to use the channel at a gvn time.
  ∴ primary device is always the initiator of a Sta.
* To reduce the collision we use poll / select.

(3) Token passing =

* uses a controlled access mechanism for passing data b/o devices on a ntwrk.
* here, token is passed frm 1 device to anther & only the device holding the token is allocated to transmit data on ntwrk.
* whn the ntwrk is 1st initialized, a single device is designated as 'Token generator'. This device is responsible for generating & passing the token to other devices on ntwrk.

=> LAN =

* Computer ntwrk that interconnects comp

within a limited area like school, office building.
* 'wired' is the term that refers to any physical medium consisting of cables. cables may be cu, twisted pr, fibre optic.
* Most LANs are also linked to a WAN /intrnt.

⇒ IEEE Standards.=

* IEEE → (Institute of Electrical & Electronic engineers) started a project called 802, to set standards to enable intes commun among equipmnt frm a variety of manufacturers.
* IEEE 802 family.

IEEE 802.1 → Bridging & network managmnt.
" 802.2 → Logical link layer.
" 802.3 → Ethrnt. (CSMA/CD)
" 802.4 → Token Bus
" 802.5 → Defines a MAC layer for a token ring.
" 802.6 → MAN.
" 802.7 → Broadband LAN using coaxial cable.
" 802.8 → Fibre optic TAG.
" 802.9 → Integrated Services LAN.
" 802.10 → Interoperable LAN Security.
" 802.11 → wireless LAN & mesh. (wifi)
" 802.12 → Demand priority.
" 802.15 → wireless PAN (personal Area N)
" 802.15.1 → Bluetooth certification.

→ Ethernet = (IEEE 802.3)

* most widely used highspeed LAN's todays are based on Ethrnet.
* 4 common physical layer implemntation —

a) 10Base 5 =
* Thick Ethrnet (Thicket.
* It was the 1st Ethernet specification to use a bus (T) with an ex. transeivr.

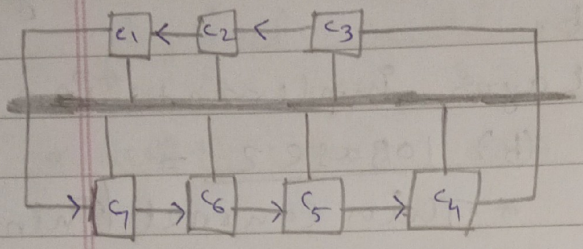
(b) 10Base 2 =
* Thin Ethrnet (Thinnet.
* Also uses bus (T) bt the cable is much thinner & more flexible.

(c) 10Base-T =
* Twisted-pair Ethrnet.
* uses a physical star (T).
* Sta are connected to a hub via 2 pairs of twisted cable.

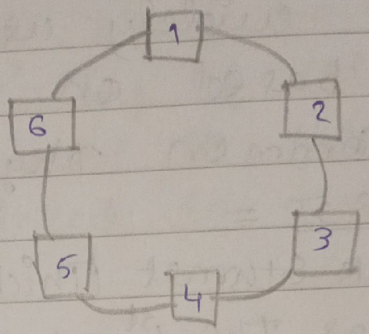
(d) 10Base-F =
* Fibre Ethrnt.
* uses star (T) to connect Sta to a hub.
* Sta are connected to hub using 2 fibre optic cables.

→ Token Bus	Token Ring.
* Bus topology * physical media is shared coaxial / twisted pair cable * Token passing mechanism is linear * uses collision avoidnce * Token generation is typically at 1 end of the cable.	ring topology point-to-point connections. Circular. No need for c. avoidnce Token generation is in the ntwrk intrface

* IEEE 802.4



card of designated device.
IEEE 802.5.



=> FDDI = [Fibre distributed data Interface]

* Set of ANSI & ISO Standards for data (T) on fibre optic cues in a LAN that can extend in range upto 200km.
* FDDI logical Topology is a ring based token ntwrk.

[CDDI → Cu D' data 'I => for Cu].