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Computer Networks

Framing :-

⇒ Types of framing → Fixed size
→ Variable size

⇒ Character and ~~Byte~~ Bit oriented Protocols

Flag	Header			...			Trailer	Flag

Variable size Frame

⇒ Byte Stuffing

⇒ Used in character oriented framing.

Flag		ESC	Flag		ESC	Esc		Trailer	Flag

⇒ ESC character is added before flag bits, if the flag data-bits are present in data.

⇒ If ESC character is also present in the databits, then another ESC character is added before ESC data bits in the data.

Flag		ESC	Flag

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Bit Stuffing

- Used in bit oriented protocol, where flag consists of set of bits.

- 0 0 11111111 000111110010

Flag (01111110)	Header	00111110111000111110010	Trailer	Flag (01111110)

Bit Stuffed

- It is used to prevent any flag bit set occurance in the dataset.

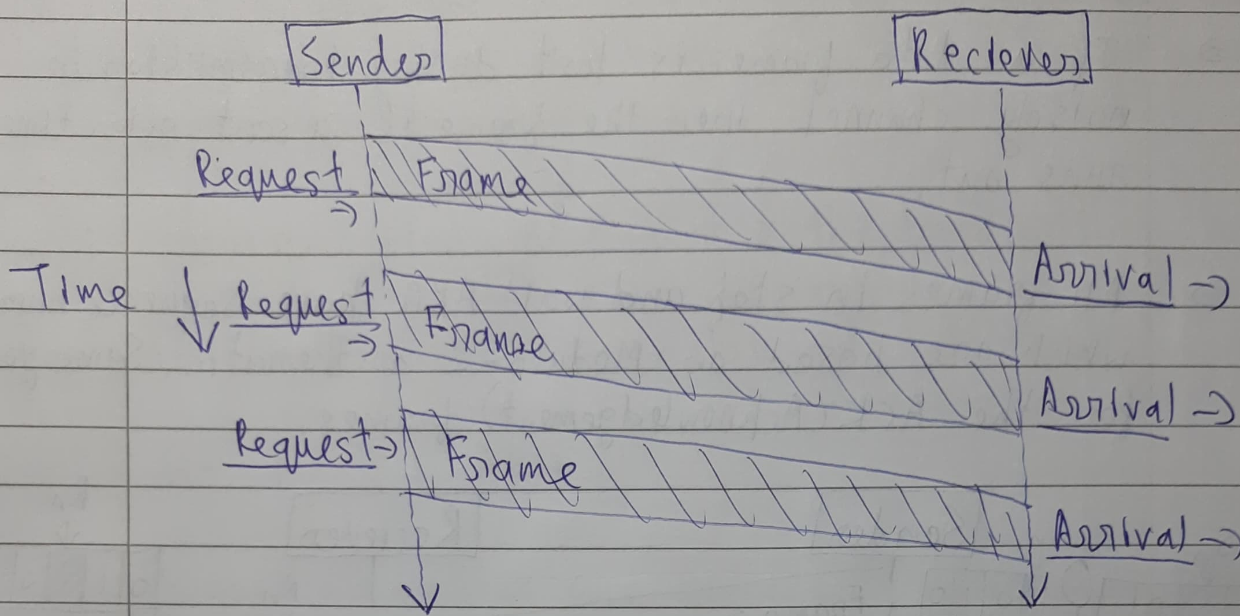
Flow and data Control

- Flow control refers to set of procedures used to restrict the sender's data transmission capacity before getting any acknowledgement for previous transmission.

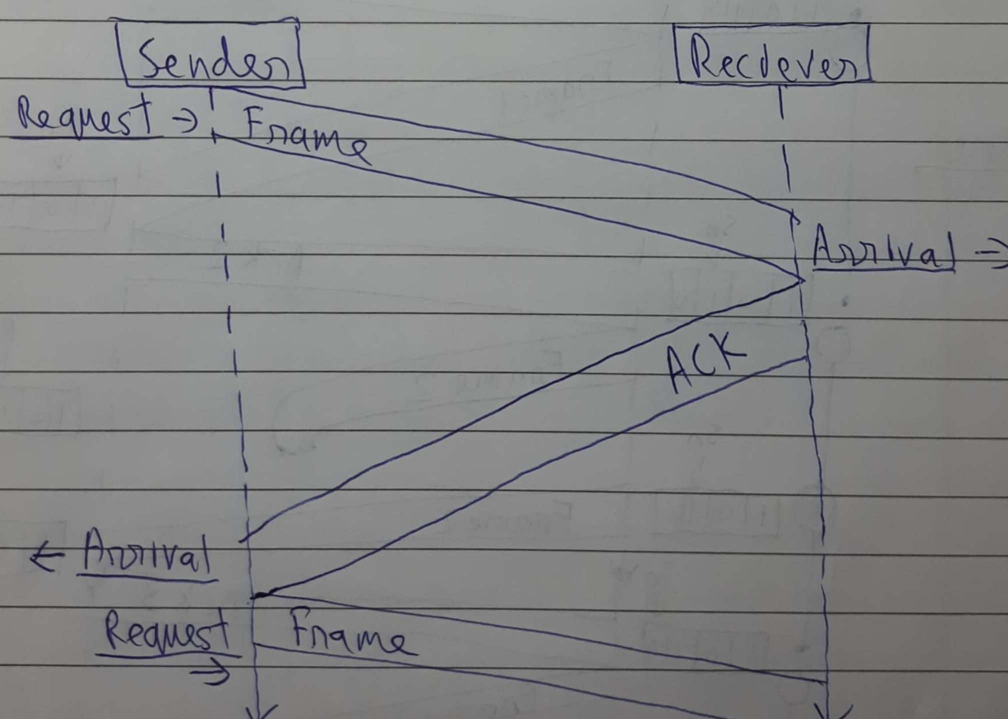
Protocols

- **Noiseless**
  - Simplest
  - Stop and Wait
- **Noisely**
  - Stop and Wait
  - Go back N (ARQ)
  - Selective Repeat

Simplest (In noiseless) Protocol



Stop and Wait (In noiseless)



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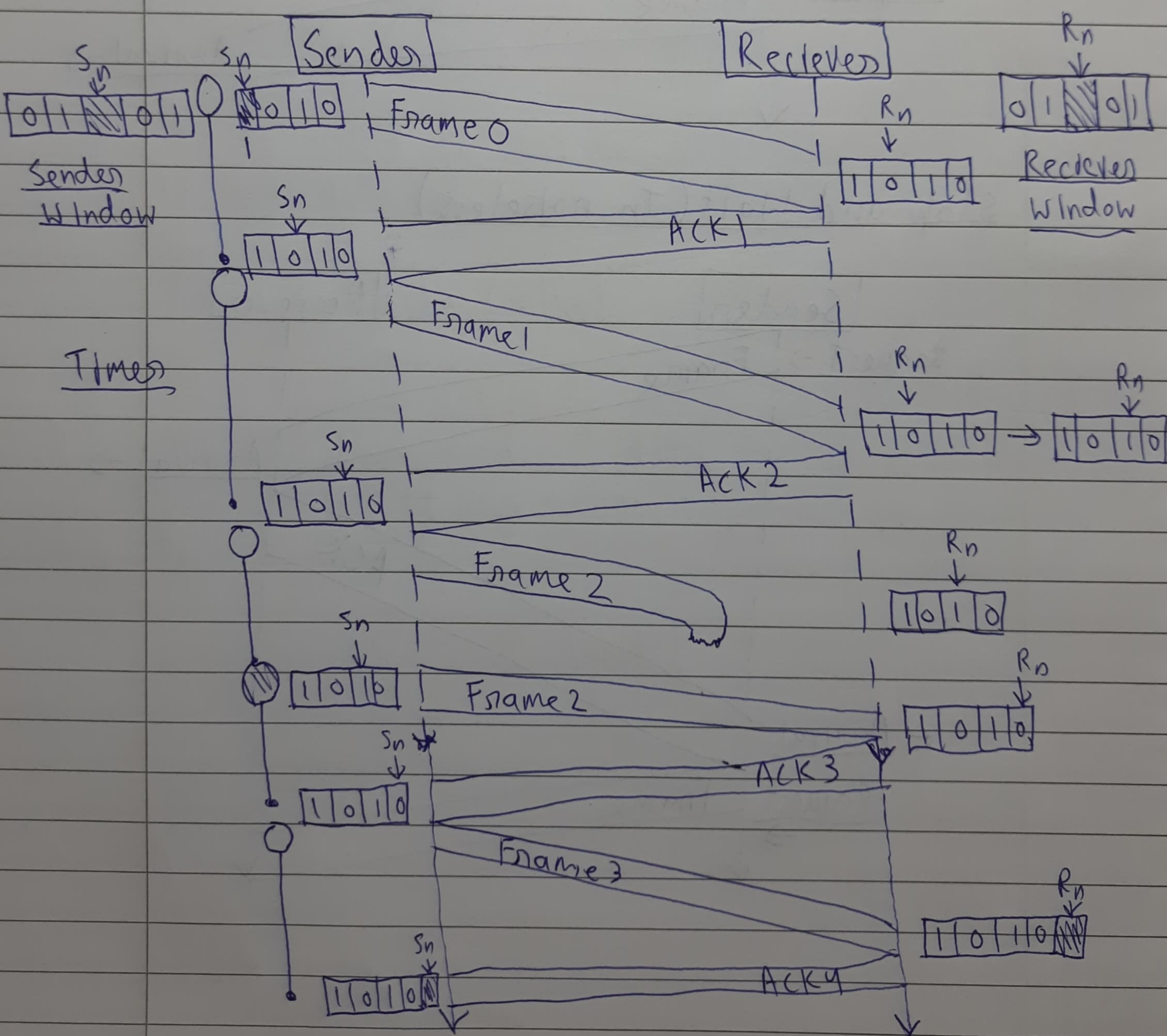
Stop and Wait ARQ (In noisely)

⇒ If a data frame is lost during transmission in noisely channel, then the frame is resent after timer runs out.

⇒ All frames in stop and wait ARQ have sequence numbers which are based on Modulo-2 arithematic. Same goes for the ACK (Acknowledgement) frames.



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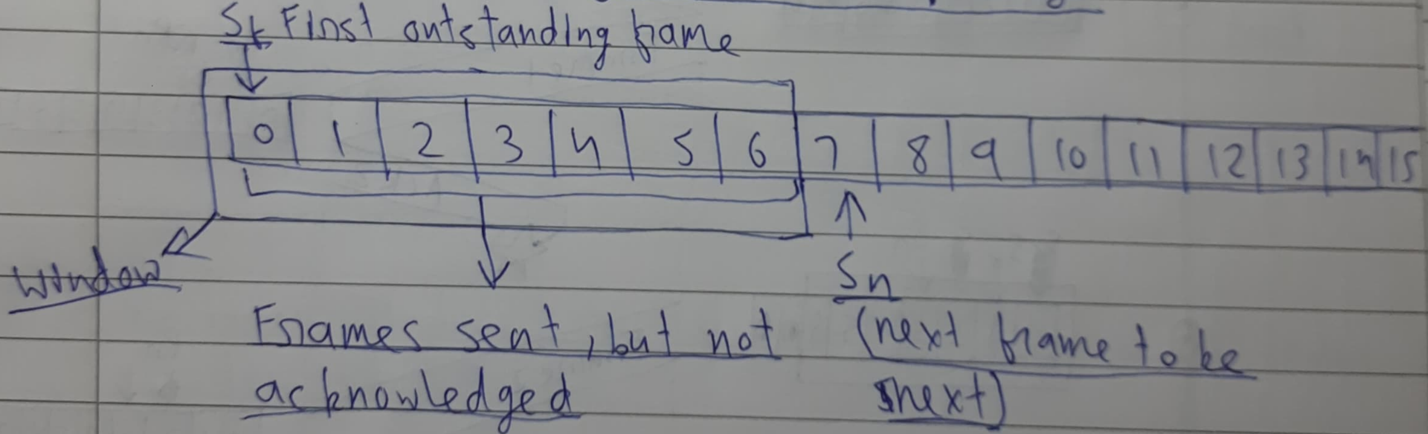
⇒ If an ACK frame is lost, then the sender resend the frame for which Ack frame is lost and reciever discards it as duplicate value and resend the Ack frame for the frame.

⇒ Stop and Wait ARQ wasts the bandwidth of the data link as the link usage is very less in the implementation For that Bandwidth - delay product is used.

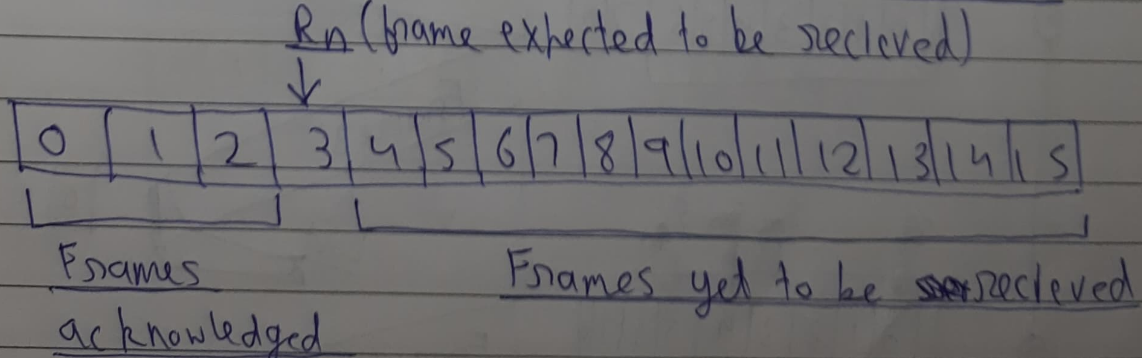
Go - Back n ARQ

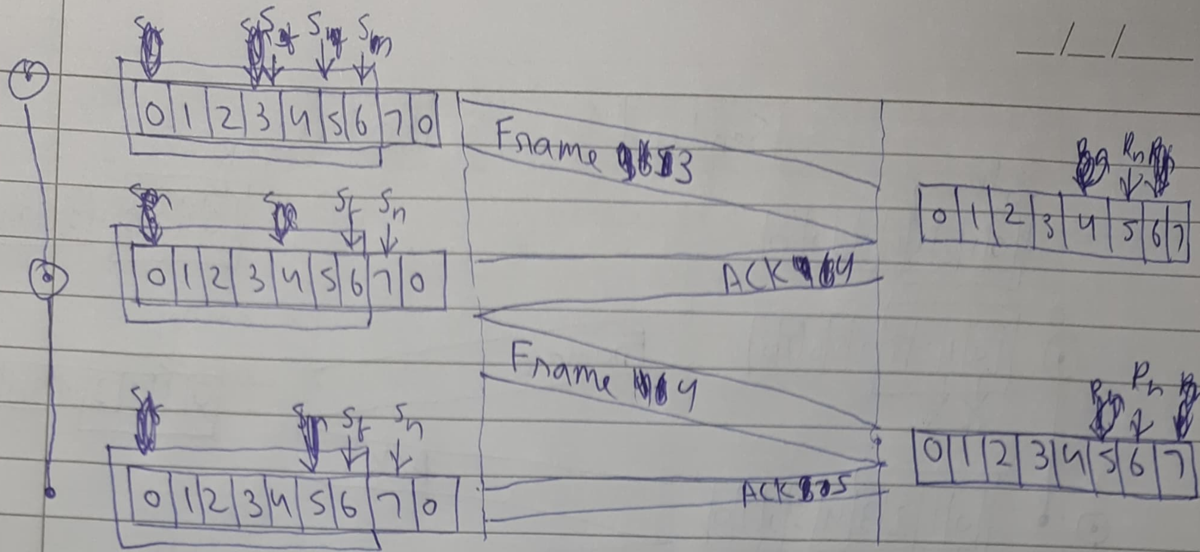
⇒ Sequence numbers are modulo 2^m, where m is the size of the sequence number feild in bits.

⇒ Sender window size = $2^m - 1$ = S_{size}



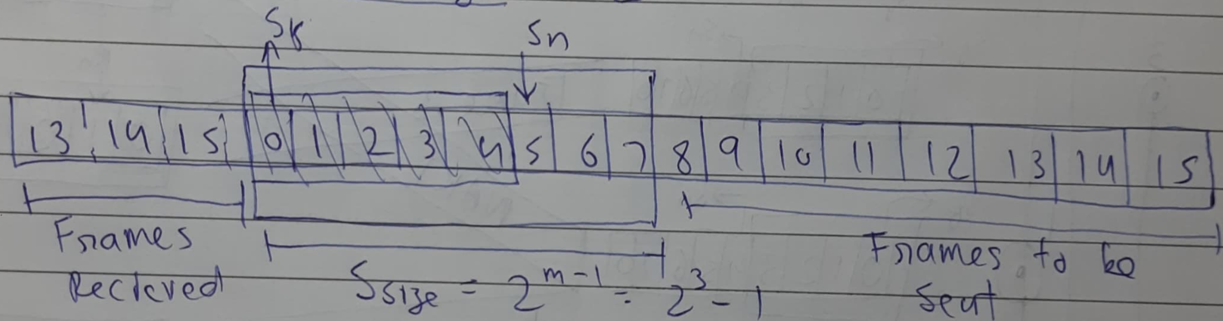
⇒ In Reciever side ⇒ Frame Window size = 1





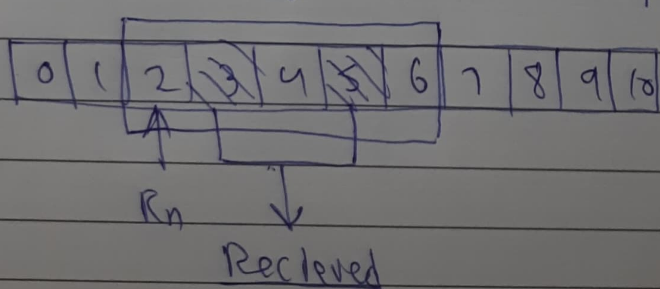
Selective Repeat ARQ

- Sender Window size $= 2^{m-1}$



- Reciever window size is also 2^{m-1}, same as sender window size.

- Out-of-order frames are accepted here.



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~~Piggybacking~~ Multiple Access

- Protocols
  - Random Access
    - ALOHA
    - CSMA
    - CSMA/CD
    - CSMA/CA
  - Controlled Access
    - Reservation
    - Polling
    - Token Passing
  - Channelized
    - FDMA
    - TDMA
    - CDMA

Random Access

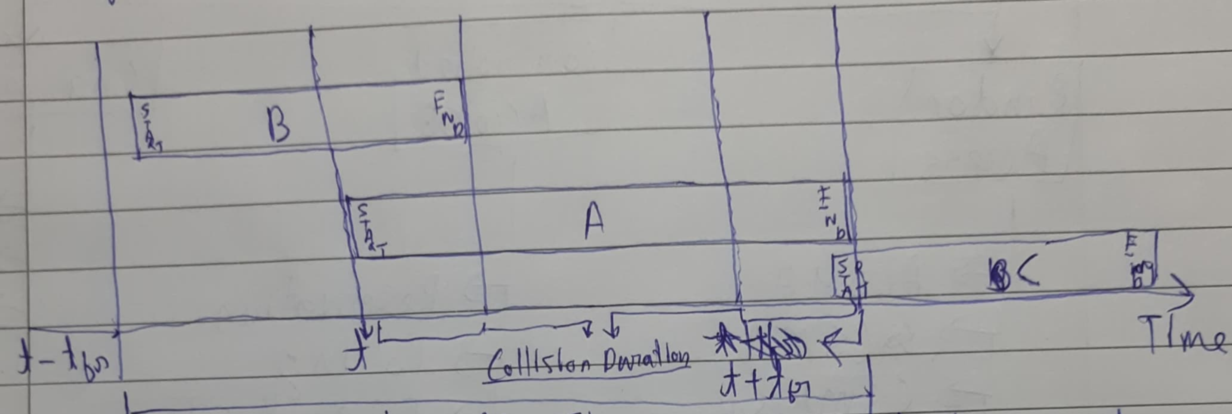
- Equal privilages to all users and clients
- Protocols decide how and who will utilize the data.

ALOHA

- Additive Links On-Line Hawaii Area
- Pure ALOHA : Every user can send all the frames without any restrictions and if two or more frames are collided in same time even a small part, then those frames will be discarded.
- All frames in the collision duration will be discarded.

$\Rightarrow$ Vulnerable time $= 2 \times T_{fr}$

T_{fr} = Average frame propagation time



Vulnerable Time $= t - t_{fr} - t - t_{fr} = 2 \times t_{fr}$

$\Rightarrow$ Throughput of pure ALOHA $= \boxed{S = G \times e^{-2G}}$

G = average no. of frames generated by system during one frame transmission time.

$\Rightarrow$ At $G = 1/2$, throughput will be max/best.

Q. A pure ALOHA network transmitts 200 bits frames on a shared channel of 200 kbps. Find throughput of

(a) 500 frames per second are sent
(b) 250 frames per second are sent

Transmission time (t_{fr}) $= \dfrac{200\text{ bits}}{200\text{ kbps}} = \dfrac{1}{1000}$ s $= 1$ ms

(a) If 500 frames are sent in 1 s

$\Rightarrow$ 1 s = 500
1000 ms = 500

→ $1ms = \frac{1~~500~~}{\frac{~~1000~~}{2}} = \frac{1}{2}$

→ Load = 1/2 → S = 0.184

→ Throughput = 1000 X 0.184 = 184 frames per second

(b) If 250 frames are sent in 1s → 1s = 250
→ 1000 ms = 250 → $1ms = \frac{25~~0~~}{100~~0~~} = 0.25$

→ Load = 1/4 → $S = 1/4 \times e^{-1/2} = 0.152$

→ Throughput = 1000 X 0.152 = 152 frames per second

→ At G = 1/2, throughput will be higher.

Slotted ALOHA

→ Time is divided into slots and frames can be sent only at the beginning of the time slot.

→ Throughput = $S = G \times e^{-G}$

→ Vulnerable Time = T_{fr}

→ Best / max throughput will be at G = 1.

Carrier Sense Multiple Access (CSMA)

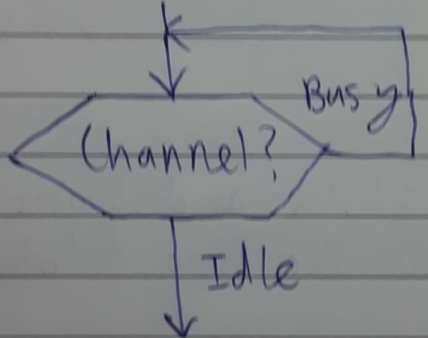
⇒ Developed to minimize the chance of collisions.

⇒ It is reduced by giving station sense for the medium so that it can analyse the medium before using.

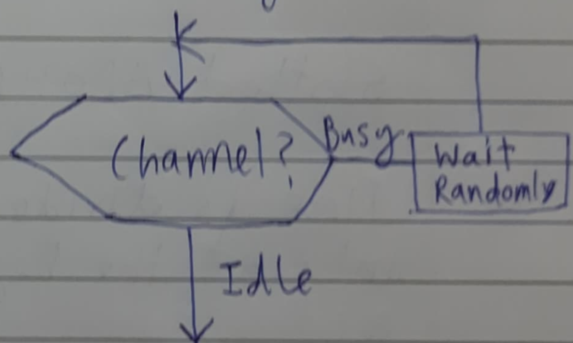
⇒ In CSMA, each station listens to the medium before sending.

⇒ Three persistence methods :-

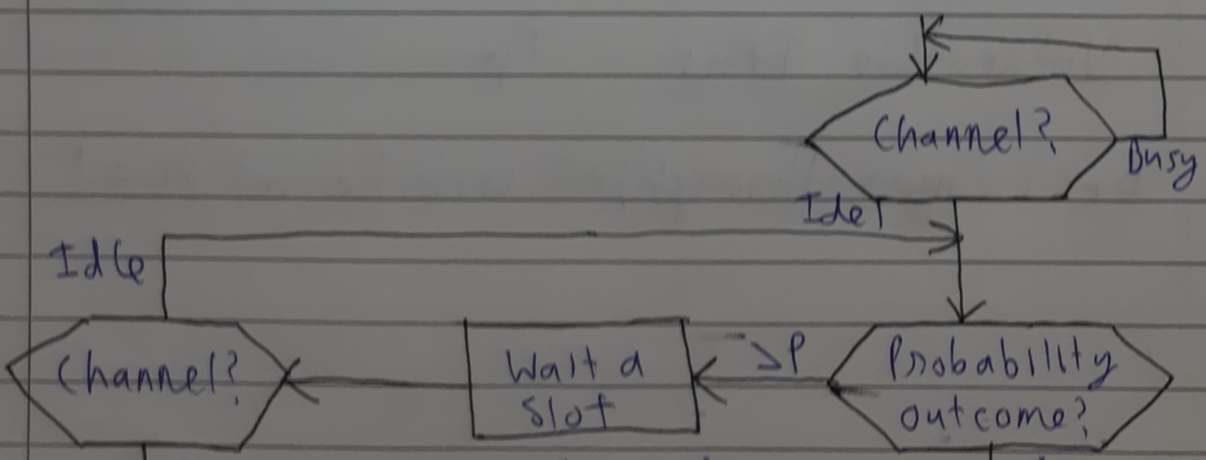
1) 1 persistance :- Continuous Sensing
2) Non persistence :- Sense - wait - sense - transmit
3) n persistence :- Probability outcomes determines data items (timeslots) with continuous sensing.



1 persistance



Non-persistance



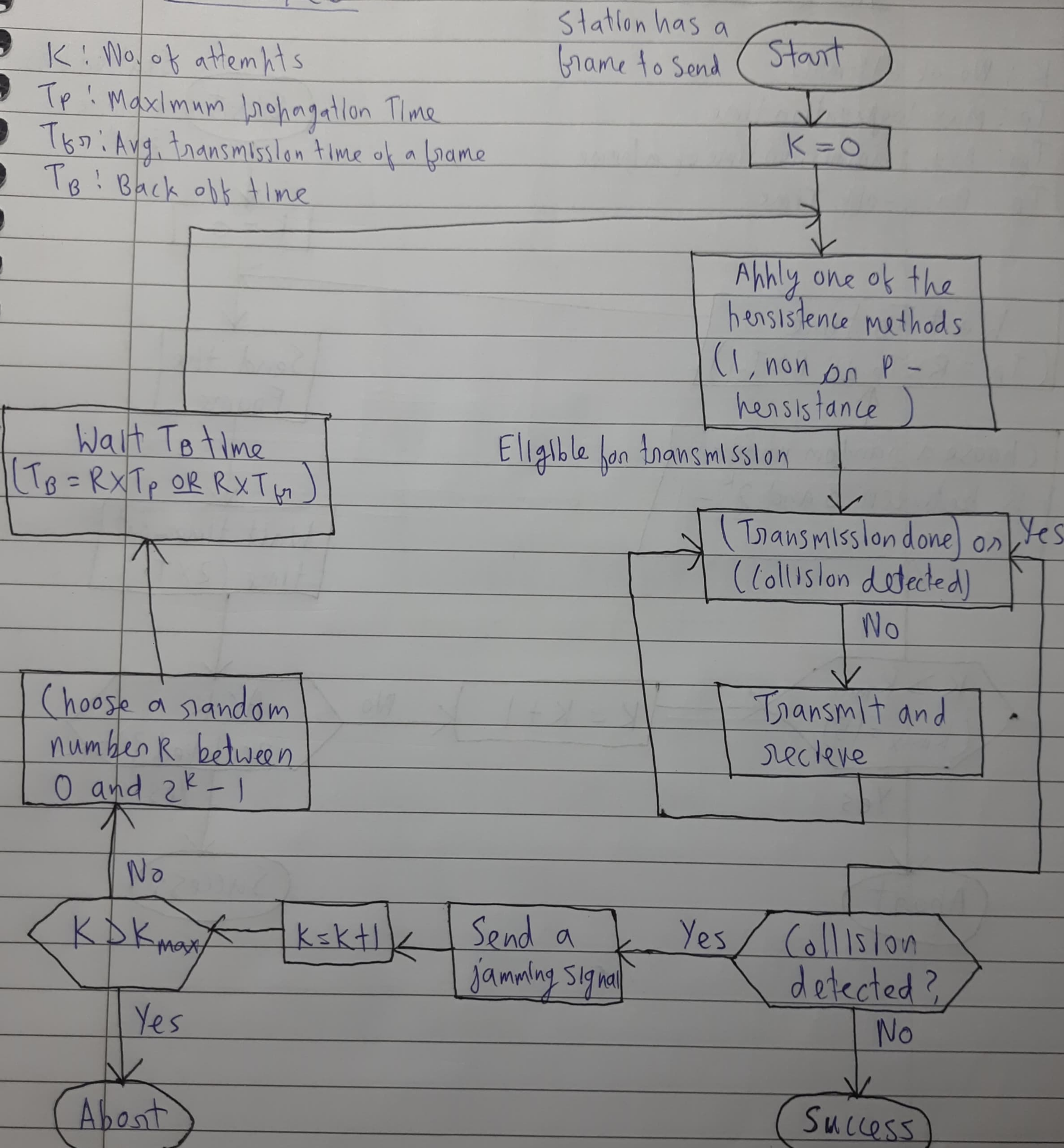
n persistance

Use backoff process (collision)

Station can transmit

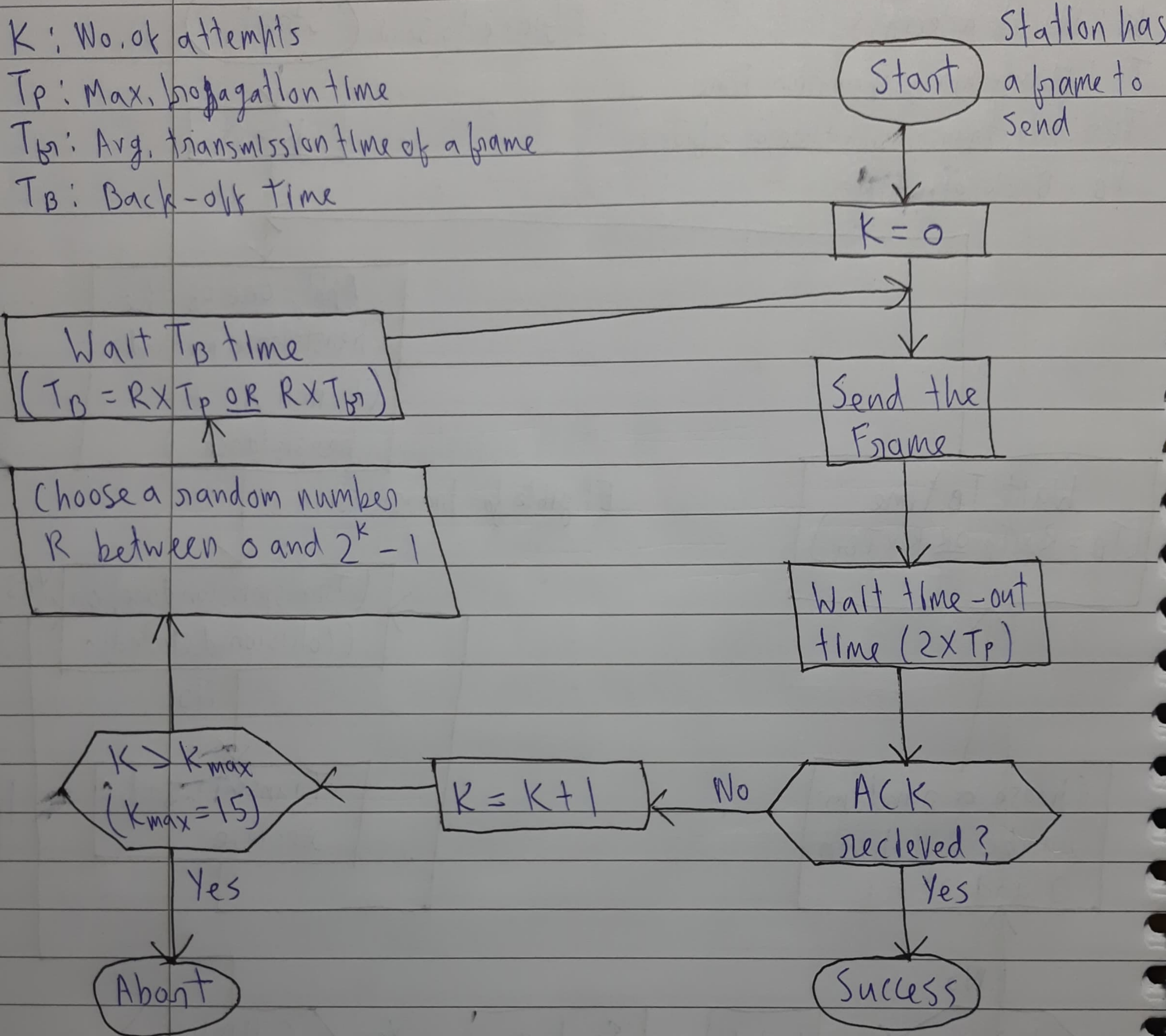
CSMA/CD

K : No. of attempts
T_p : Maximum propagation Time
T_{fr} : Avg. transmission time of a frame
T_B : Back off time

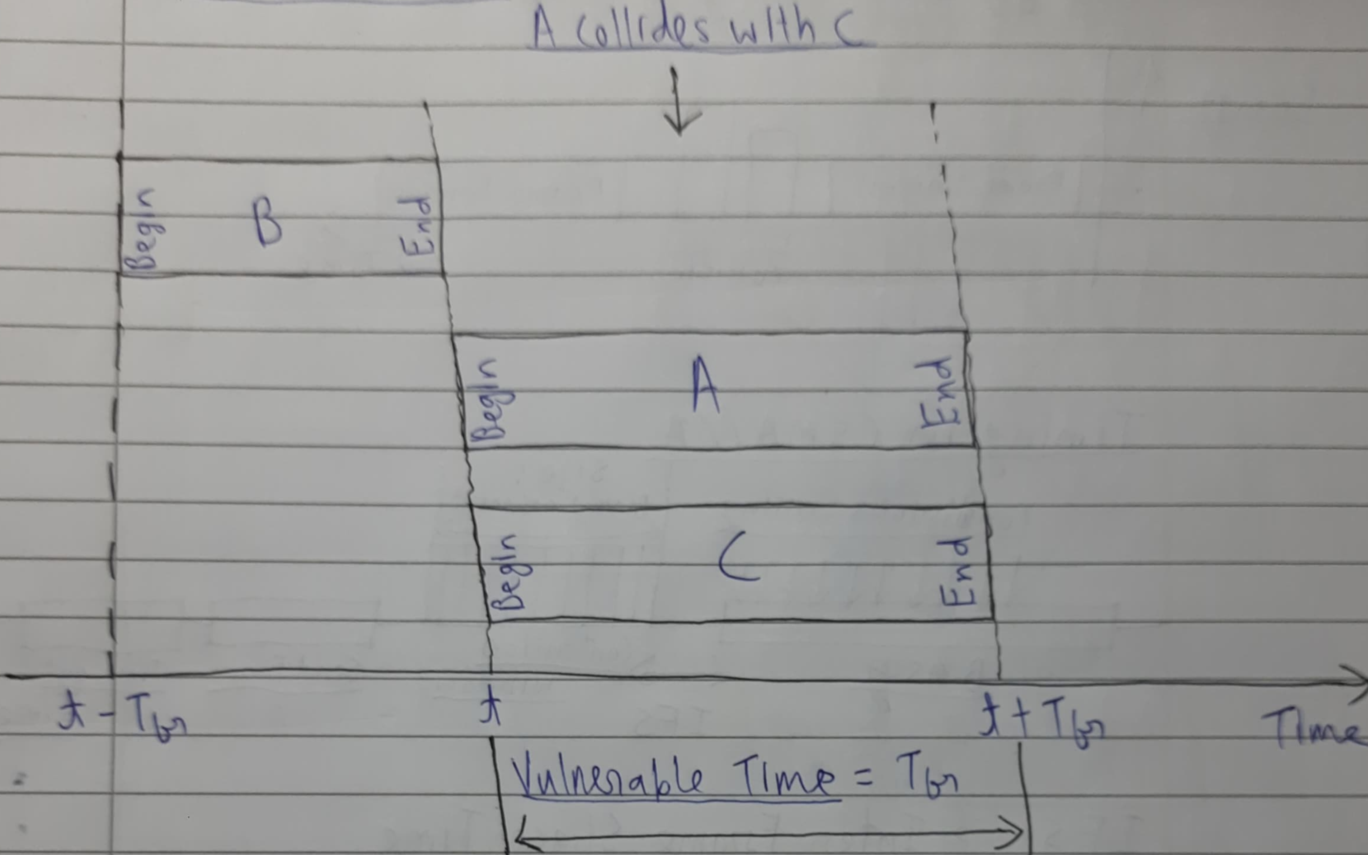


ALOHA (Pure)

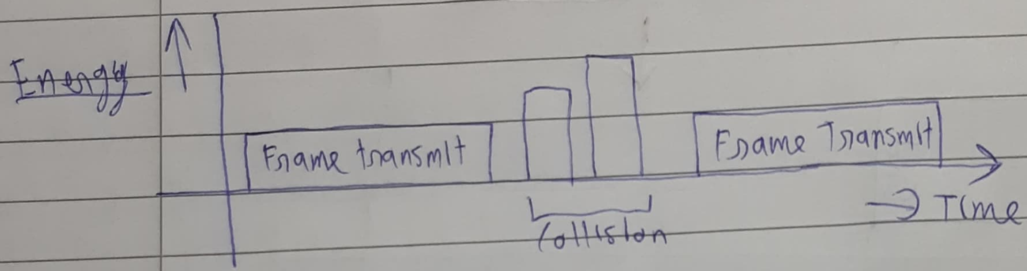
K : No. of attempts
T_p : Max. propagation time
T_{fr} : Avg. transmission time of a frame
T_B : Back-off time



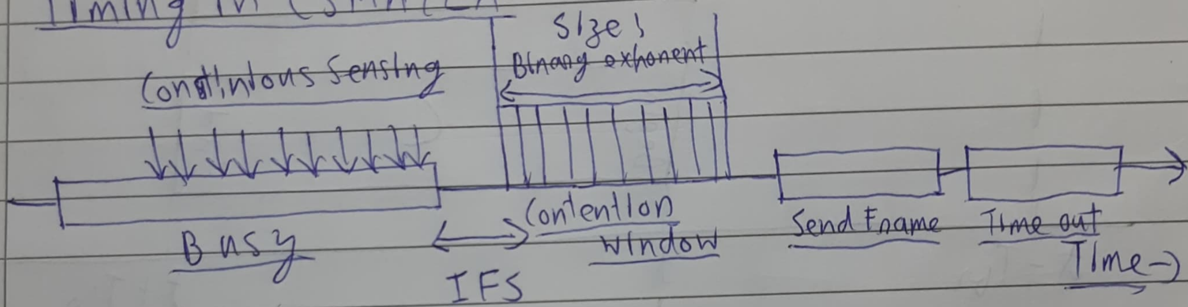
Slotted ALOHA



Energy level during Transmission



Timing in CSMA/CA



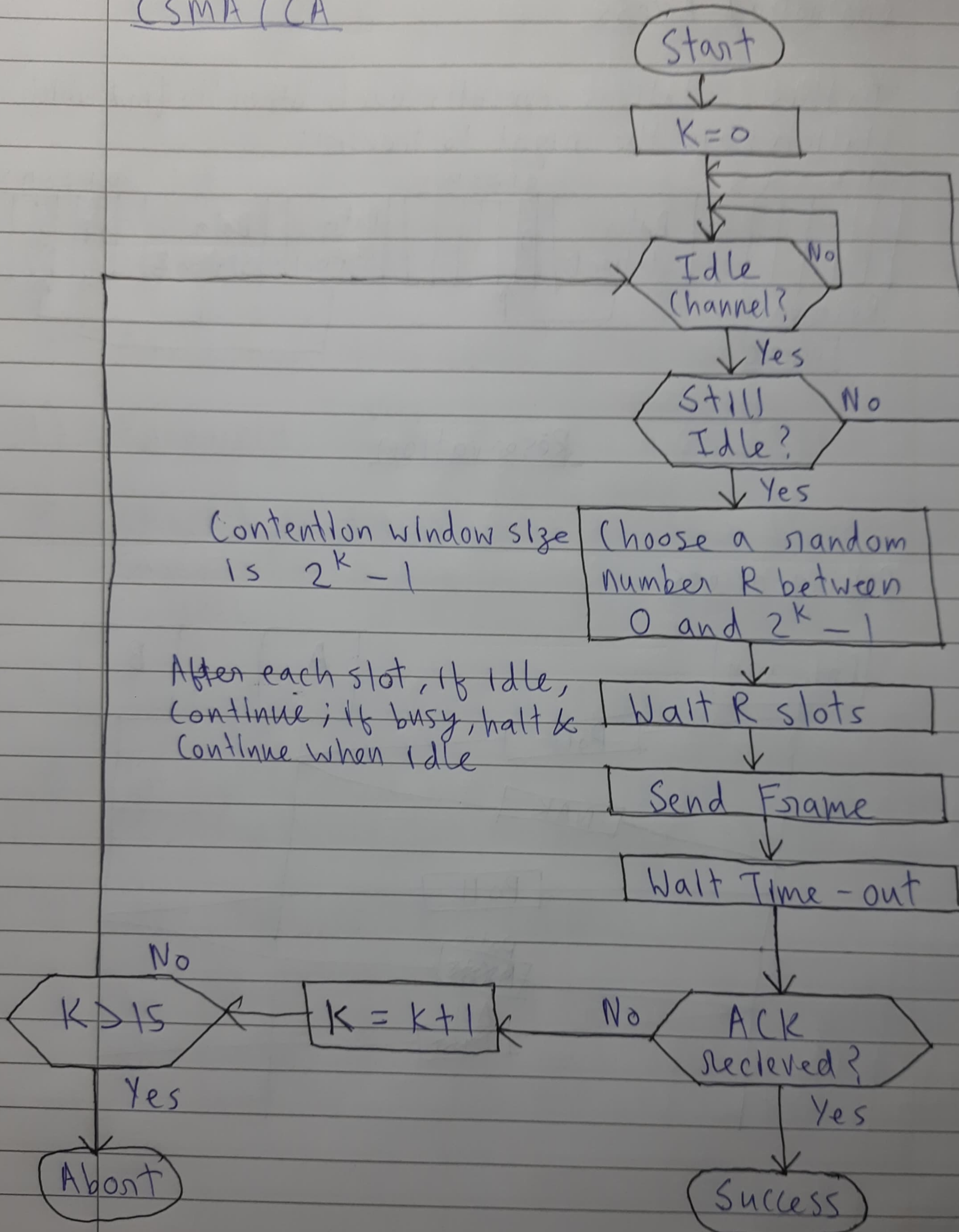
IFS → Inter Frame Space Time

CSMA/CA

⇒ In CSMA/CA, the IFS can also be used to define the priority of a station or a frame.

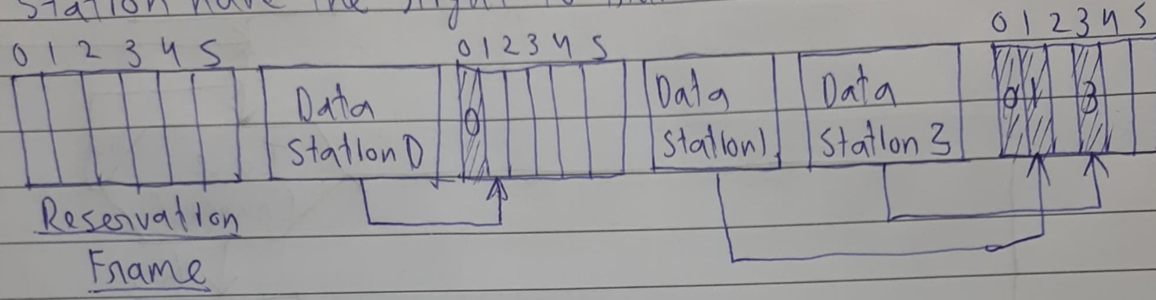
⇒ If the station finds the channel busy, it does not restart the timer of the contention window; it stops the timer and restarts it when the channel becomes idle.

CSMA/CA


Start
K=0
Idle Channel?
No
Yes
Still Idle?
No
Yes
Contention window size is $2^k - 1$
Choose a random number R between 0 and $2^k - 1$
After each slot, if idle, continue; if busy, halt & continue when idle
Wait R slots
Send Frame
Wait Time-out
ACK recieved?
No
K = k+1
K>15
No
Yes
Abort
Yes
Success

Controlled Access

→ In this, stations consults each other to find which station have the right to transmit.



Reservation

Polling access