AKGEC/IAP/FM/01

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Department of ECE

Model Solution ST-2

Course: B.Tech	Semester: VII
Session: 2017-18	Section: EC-1, EC-2, EC-3
Subject: Data Communication & Networks	Sub. Code: NEC-702
Max Marks: 25	Time: 1 hour

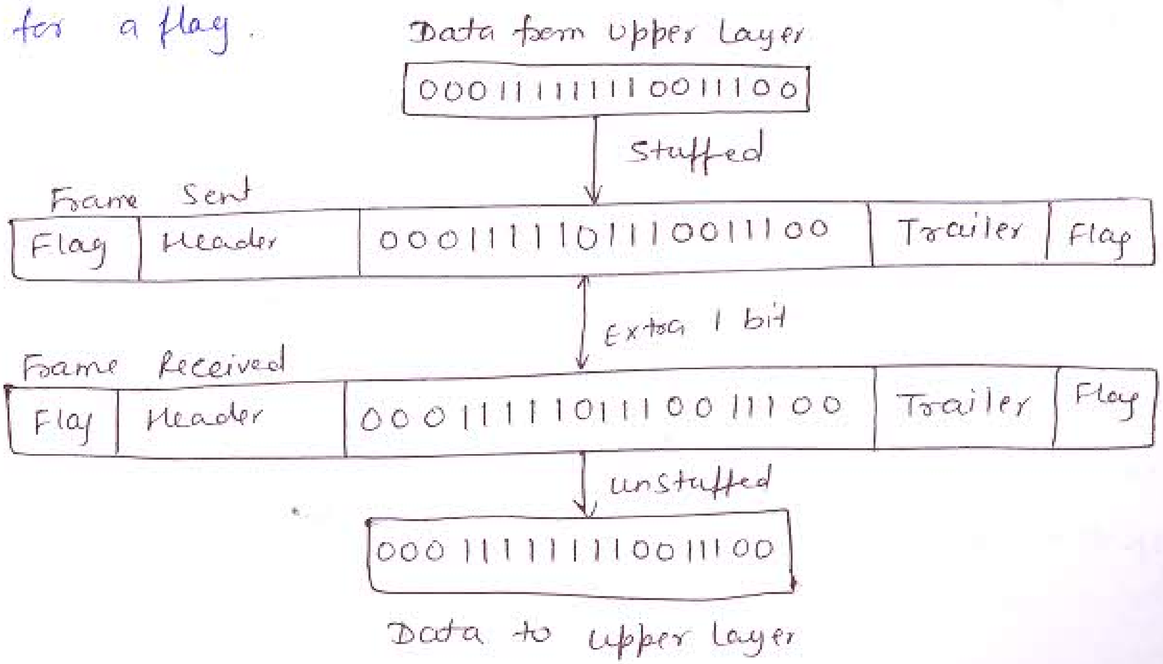
Section - A

Q 1. Explain communication problems.

Ans - common problem in signal transmission through any channel is additive noise.
- Interference due to other users of channels.
- Signal attenuation
- Amplitude and phase distortion

Q 2. Explain bit stuffing in data with suitable examples.

Ans Bit stuffing is the process of adding one extra '0' whenever five consecutive 1s follow a '0' in the data, so that the receiver does not mistake the pattern 0111110 for a flag.



Q 3. List the assumption for Dynamic channel Allocation.

Ans. 1. Traffic should be Independent

2. A single channel is available for all communication.

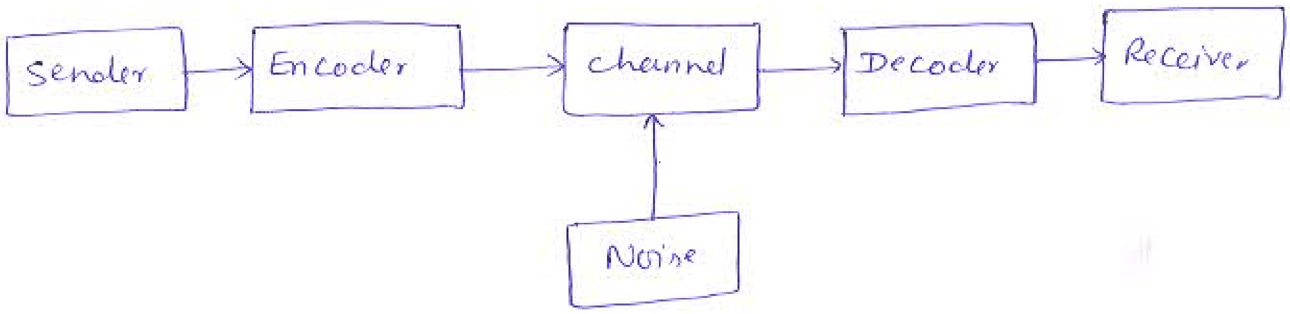
3. Collision should be observable

4. Time may be assumed continuous

5. With the carrier sense assumption, stations can tell if the channel is in use before trying to use it. If there is no carrier sense, stations cannot sense the channel before trying to use it.

Q 4. Draw the block diagram of communication model.

Ans.



Q 5. Explain communication channel and their characteristics.

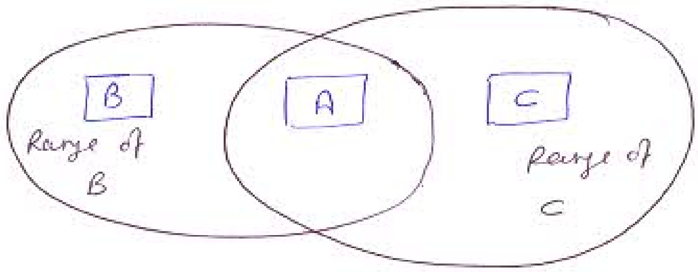
Ans. Broadly communication channels are of two types

1. Wired channel – Signal Tx through such channels are distorted in both amplitude and phase and further corrupted by additive noise.

2. Wireless channel. In EM wave propagation via skywave in the HF frequency range is signal multipath. Signal multipath occurs when the transmitted signal arrives at the receiver via multiple propagation paths at different delays.

Q6. Explain hidden station problem.

Ans. Fig. shows an example of hidden station problem. Station B has a transmission range shown by the left oval. Every station in this range can hear any signal transmitted by station B. Station C is outside the transmission range of B. Likewise station B is outside the tx range of C. Station A is in the area covered by both B and C; it can hear any signal tx by B or C.



Station B is sending data to 'A'. In the middle of this tx 'C' has data to send to 'A'. However, station 'C' is out of 'B's range and Tx from B cannot reach. Therefore C thinks the medium is free. Station C sends its data to A, which result in a collision at A because this station is receiving data from both B and C. In this case, we say that stations B and C are hidden from each other with respect to A. Hidden station can reduce the capacity of the N/w bcz of the possibility of collision.

Q7. How do we say collision detection is analog process? Why do we prefer CSMA over ALOHA? Prove that maximum efficiency of ALOHA is 1/e.

Ans. Collision detection is an analog process. The station's

Ans. hardware must listen to the cable while it is Tx. If what it reads back is different from what it is putting out, it knows a collision is occuring. The implication is that the signal encoding must allow collision to be detected.

To minimize the chance of collision and increase the performance of N/w CSMA is prefer over ALOHA. The chance of collision can be reduced if a station sense the medium before trying to use it. CSMA requires that each station first listen to the medium before sending. CSMA is based on the principle 'sense before transmit' or 'listen before talk'

Let 'T' = Time needed to Tx one frame on channel = frame Time

t = Time at which the sender wants to send a frame.

Vulnerable period for the frame is 2t.

A frame will not collide if no other frame are sent within one frame time of its start, before and after.

Probability of being K transmission attempts during that frame time = $G^k e^{(-G)}/k$

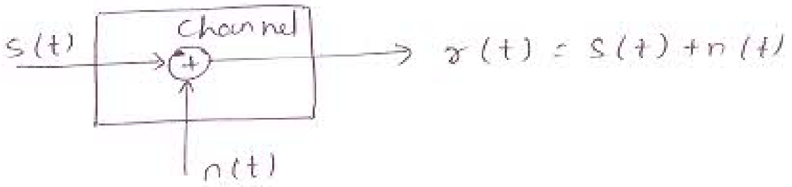
$S = GP_0$

$P_0 = e^{(-G)}$

Q 8 Explain the mathematical model for communication channels.

Ans. Three type of communication channels are generally used

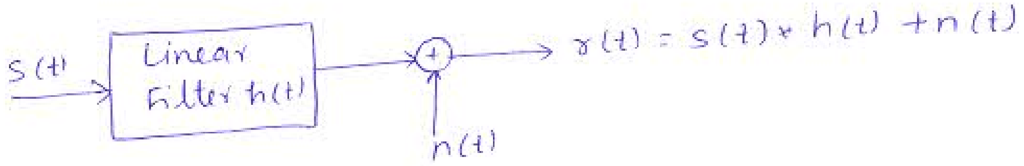
1. The Additive Noise channel - The simplest mathematical model for a communication channel is the additive noise. In this model the Tx signal $s(t)$ is corrupted by an addition additive random noise process. $n(t)$.



$$r(t) = a\,s(t) + n(t)$$

'a' represents the attenuation factor.

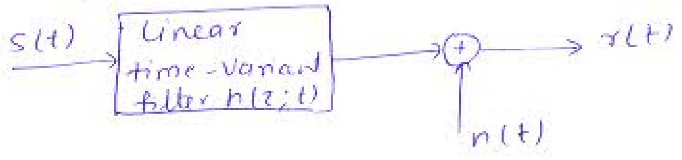
2. <u>The linear Filter channel</u> →



$$r(t) = s(t) * h(t) + n(t)$$

$$= \int_{-\infty}^{\infty} h(\tau)\, s(t-\tau)\, d\tau + n(t)$$

3. The linear Time - Variant Filter channel →



$$r(t) = s(t) * h(\tau; t) + n(t)$$

$$= \int_{-\infty}^{\infty} h(\tau; t)\, s(t-\tau)\, d\tau + n(t)$$

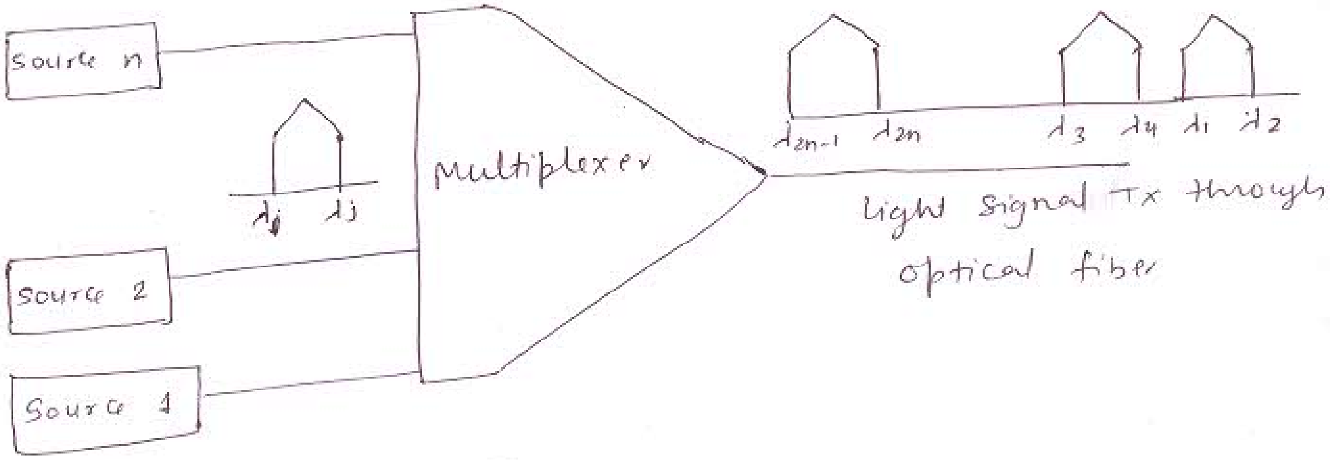
where $h(\tau; t) = \sum_{k=1}^{L} a_k(t)\, \delta(\tau - \tau_k)$

The Received signal will be

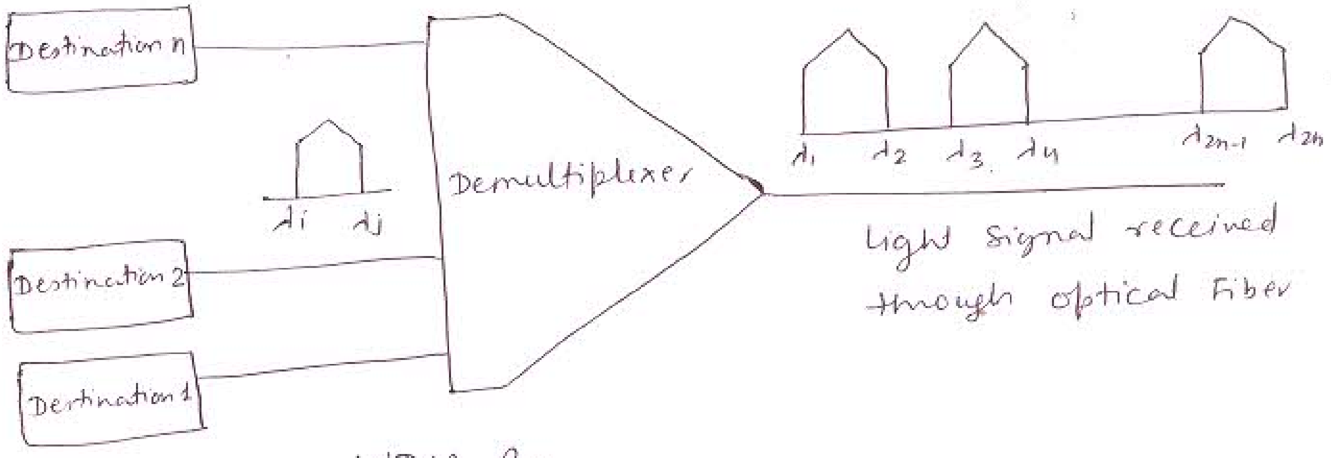
$$r(t) = \sum_{k=1}^{L} a_k(t)\, s(t-\tau_k) + n(t)$$

Q.9. What do you mean by Wavelength Division Multiple Access Protocols?

Ans. WDM is conceptually same as the FDM, except that the multiplexing and demultiplexing involves light signals Tx through fiber-optic channels. It is designed to utilize the high data rate capability of fiber-optic cable. Very narrow band of light signal from diff source are combined to make a wider band of light. At the receiver the signals are separated with the help of a demultiplexer as shown in fig.



WDM Tx



WDM Rx

Multiplexing & demultiplexing of light signals can be done with the help of a prism. From the basic knowledge of Physics we know that light signal is bent by diff amount based on the angle of incidence and wavelength of light as shown by diff colour. The composite signal can be Tx through an optical fibre cable over long distance, if required. At the other end of the optical fiber cable the composite signal is applied to another prism to do the reverse operation, the function of a demultiplexer.

Q10. What are multiple access technique? Explain FDM in details?

Ans. When nodes or stations are connected and use common link we need a multiple access protocol to coordinate access to the link. The problem of controlling the access to the medium is similar to the rules of speaking in an assembly. The procedure guarantee that the right to speak is upheld and ensure that two people do not speak at the same time, do not interrupt each other, do not monopolize the discussion, and so on.

Frequency - Division Multiple Access (FDMA) - In FDM, the available bandwidth is divided into frequency bands. Each station is allocated a band to send its data. Each station also uses a bandpass filter to confine the Tx frequencies. To prevent station interference, the allocated bands are separated from one another by small guard band. FDMA specifies a predetermined frequency band for the entire period of communication. FDM is an access method in the data link layer. The data link layer in each station tells its physical layer to make a bandpass signal from the data passed to it. The signal must be created in the allocated band.

Section - C

Q 11. Prove that link budget equation

$P_{Tx}\,dBm + G_{Tx}\,dB + G_{Rx}\,dB - L_{path}\,dB(R)$ where $L_{path}\,dB(R)$

is path loss.

Ans. The link budget is an accounting of all the gains and losses in a transmission system. The link budget looks at the elements that will determine the signal strength arriving at the receiver. The link budget may include the following items.

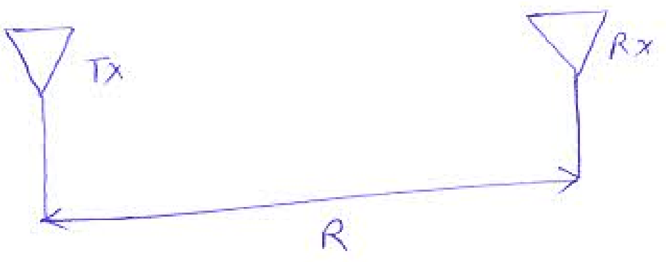
Transmitted Power

Antenna Gains (Receiver & Transmitter)

Antenna feeder losses (Receiver & Transmitter)

Path loss

Receiver sensitivity



P_{Tx} = Power delivered to the Tx Antenna (dBm)

R = distance b/w Tx and Rx

G_{Tx} = Tx antenna Gain

ρ = Powper density

$$\rho = \frac{P_{Tx}}{4\pi R^2}$$

If the Tx Antenna has gain of G_T ; then power density equation becomes

$$\rho = \frac{P_T}{4\pi R^2} G_T$$

A_{ER} : Receive Antenna effective aperture

Received power $P_{Rx} = \frac{P_T}{4\pi R^2} G_T A_{ER}$

effective aperture $A_e = \frac{\lambda^2}{4\pi} G$

Now Resulting Received power

$$P_{Rx} = \frac{P_{Tx} G_{Tx} G_{Rx} \lambda^2}{(4\pi R)^2}$$

$$P_{Rx} = P_{Tx} G_{Tx} G_{Rx} \left(\frac{\lambda}{4\pi R}\right)^2$$

The Inverse of the term at the right referred to as 'Path Loss' known as "Free space Loss"

$$L_{path}(dB) = \left(\frac{4\pi}{\lambda}\right)^2$$

Link Power Budget Formula is $P_{Rx} = [EIRP] + G_{Rx} - \text{Losses}$

$$[EIRP] = [P_{T\cancel{x}}\,dB] + [G_{Tx}]\,dB$$

Now $P_{Rx} = P_{TX} + G_{TX} + G_{Rx} - L_{path\ loss}\,dB$

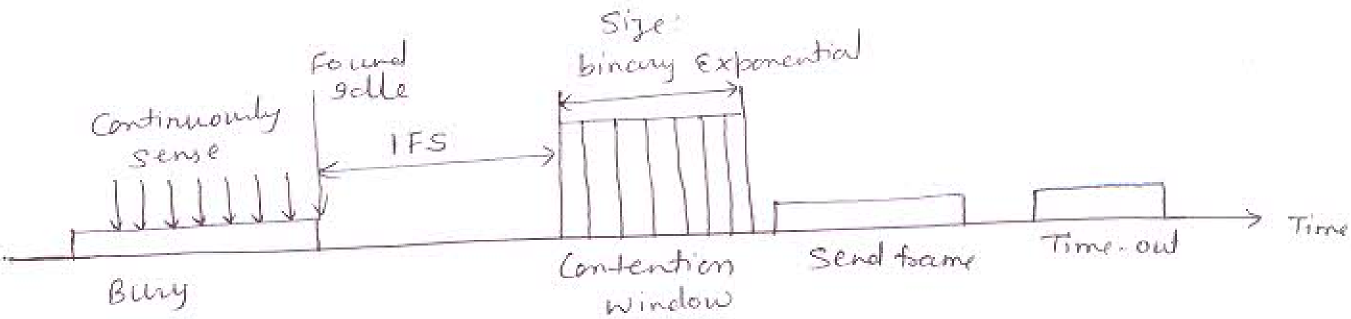
Q12 Explain Controlled access Method and discuss CSMA/CA random access method.

ans In controlled access, the stations consult one another to find which station has the right to send. A station can not send unless it has been authorized by other station.

Carrier sense Multiple Access with Collision Avoidance

The basic idea behind CSMA/CD is that a station needs to be able to receive while transmitting to detect a collision. when there is no collision, the station receives one signal; its own signal. when there is a collision, the station receives two signals; its own signal and the signal transmitted by a second station.

We need to avoid collisions on wireless networks because they can not be detected. CSMA/CA was invented for this network. Collisions are avoided through the use of CSMA/CA's three strategies: the inter-frame space, the contention window, and acknowledgments.



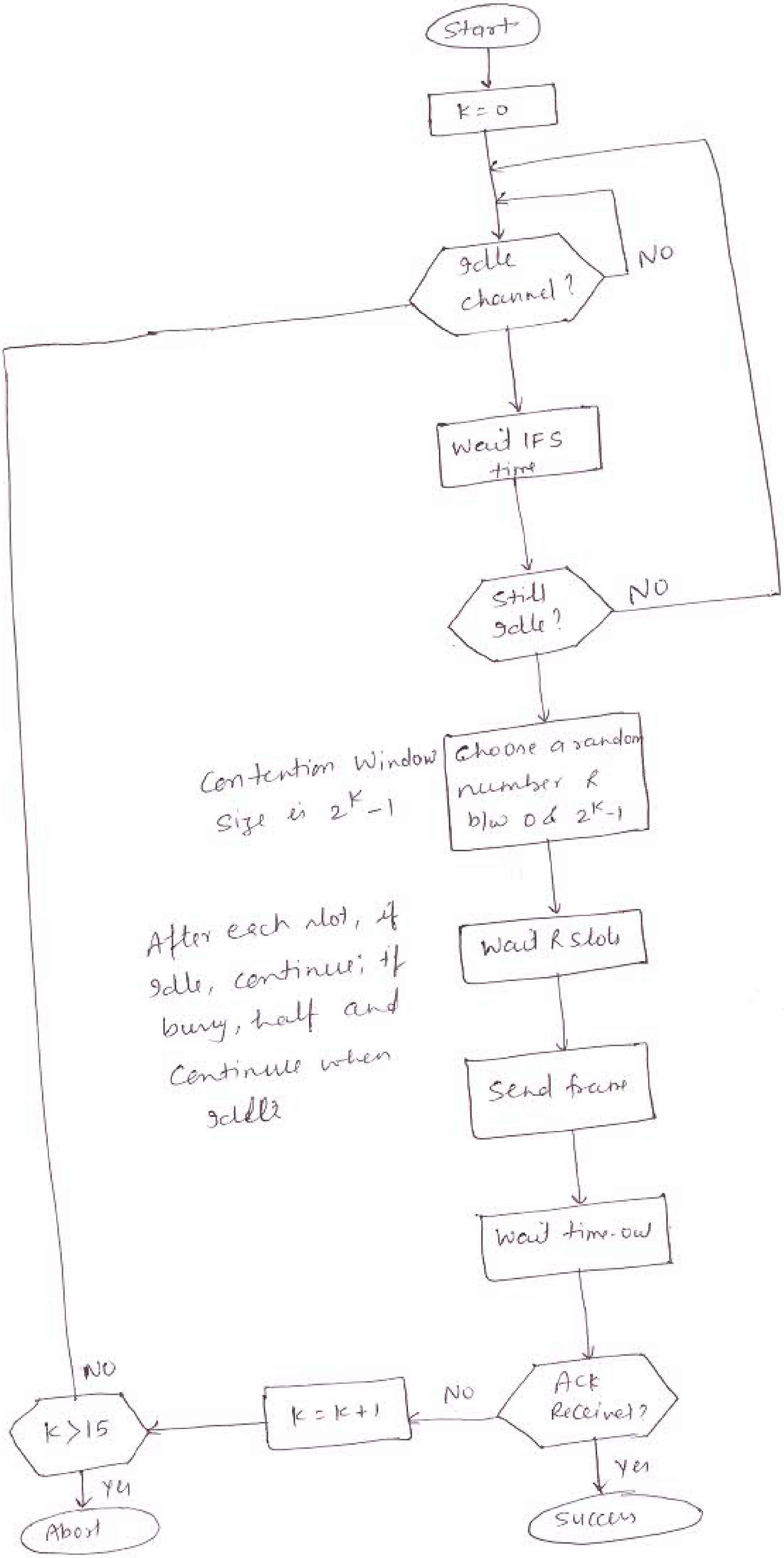
First, collisions are avoided by deferring transmission even if the channel is found idle. It waits for a period of time called the interframe space or IFS. In CSMA/CA, the IFS can also used to define the priority of a station or a frame

- In CSMA/CA, 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.

- With all these precautions, there still may be a collision resulting in destroyed data. In addition, the data may be corrupted during the transmission. The positive acknowledgment and the time-out timer can help guarantee that the receiver has received the frame.

CSMA/CA was mostly intended for use in wireless networks. The procedure described above, however is not sophisticated enough to handle some particular issues related to wireless N/W, such as hidden terminals or exposed terminals.

PTO



Start
K = 0
Idle channel?
NO
Wait IFS time
Still idle?
NO
Choose a random number R b/w 0 & 2^K-1
Contention Window size is 2^K-1
Wait R slots
After each slot, if idle, continue; if busy, halt and continue when idle
Send frame
Wait time-out
ACK Received?
No
Yes
K = K+1
K>15
NO
Yes
Abort
Success