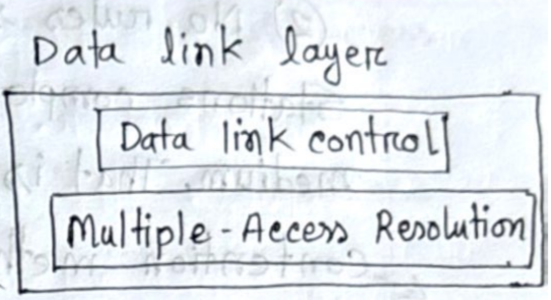
Part-2

We can consider data link layer as two sublayers. The upper layer is responsible for data link control. The lower sublayer is responsible for resolving access to the shared media. If the channel is dedicated, the lower layer is not needed.



Taxonomy of multiple-access protocols:

- Multiple access protocols
  - Random access protocols
    - ALOHA
    - CSMA
    - CSMA/CD
    - CSMA/CA
  - Controlled-access protocols
    - Reservation
    - Polling
    - Token passing
  - Channelization protocols
    - FDMA
    - TDMA
    - CDMA

Random access: In random access method, no station is superior to another station and none is assigned the control over another. (no priority, no fixed schedule for transmission)

At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on weather or not to send.

There are two features:

(1) There is no scheduled time for a station to transmit. Transmission is random among the stations. That is why the method is called random access.

② No rules specify which station should send next. Stations compete with one another to access the medium. That is why these methods are also called contention methods.

বিবাদ/ collision

In a random access method, each station has the right to the medium without being controlled by any other station. However, if more than one station tries to send, there is an access collision and the frames will be either destroyed or modified. To avoid access conflict or to resolve it when it happens, each station follows a procedure that answers the following questions:

- When can the station access the medium?

A station can transmit whenever it has data, but it must follow ALOHA, which used a very simple procedure called multiple access (MA). carrier sense করে না

- What can the station do if the medium is busy?

(Aloha) The method was improved with the addition of process that forces the station to sense the medium before transmitting. This was called CSMA (carrier sense multiple access). carrier busy নাকি idle তা sense করে

- How can the station determine the success or failure of the transmission?

CSMA method later evolved into to parallel methods. CSMA/CD (carrier sense multiple access with collision detection) and CSMA/CA (carrier sense multiple access with collision avoidence)

- **What can the station do if there is an access conflict?**

CSMA/CA tries to avoid the collision. CSMA/CD tells the station what to do when a collision is detected.

ALOHA: Aloha is the earliest random access method. The medium is shared between the stations. When a station sends data, another station may attempt to do so at the same time. So, It is obvious that there are potential collisions in this arrangement because the data from the two stations collide.

Slide (Page-8)

~~Fro~~ While stations send frame, some frames collide because multiple frames are in contention for the shared channel. Even if one bit of a frame coexists on the channel with one bit from another frame, there is a collision and both will be destroyed.

medium

> Pure Aloha - version of Aloha
> যদি receive থেকে কোনো acknowledgment না আসে তাহলে retransmit করতে হবে।
> এখানে sender time-out period acknowledgement এর জন্য wait করে।

It is obvious that we need to resend the frames that have been destroyed during transmission.

- pure ALOHA protocol relies on acknowledgements from the receiver. When a station sends a frame, it expects the receiver to send acknowledgement. If the acknowledgement does not arrive after a time-out-perioud, the station assumes that the frame (or the acknowledgement) has been destroyed and resends the frame. A collision involves two or more stations, If all these stations try to resend their frames after the time-out, the frames will collide again.

- Pure aloha dictates that when the time-out-period passes, each station waits a random amount of time before resends its frame.

- The randomness will help avoid more collisions. We call this time the "back-off-time".

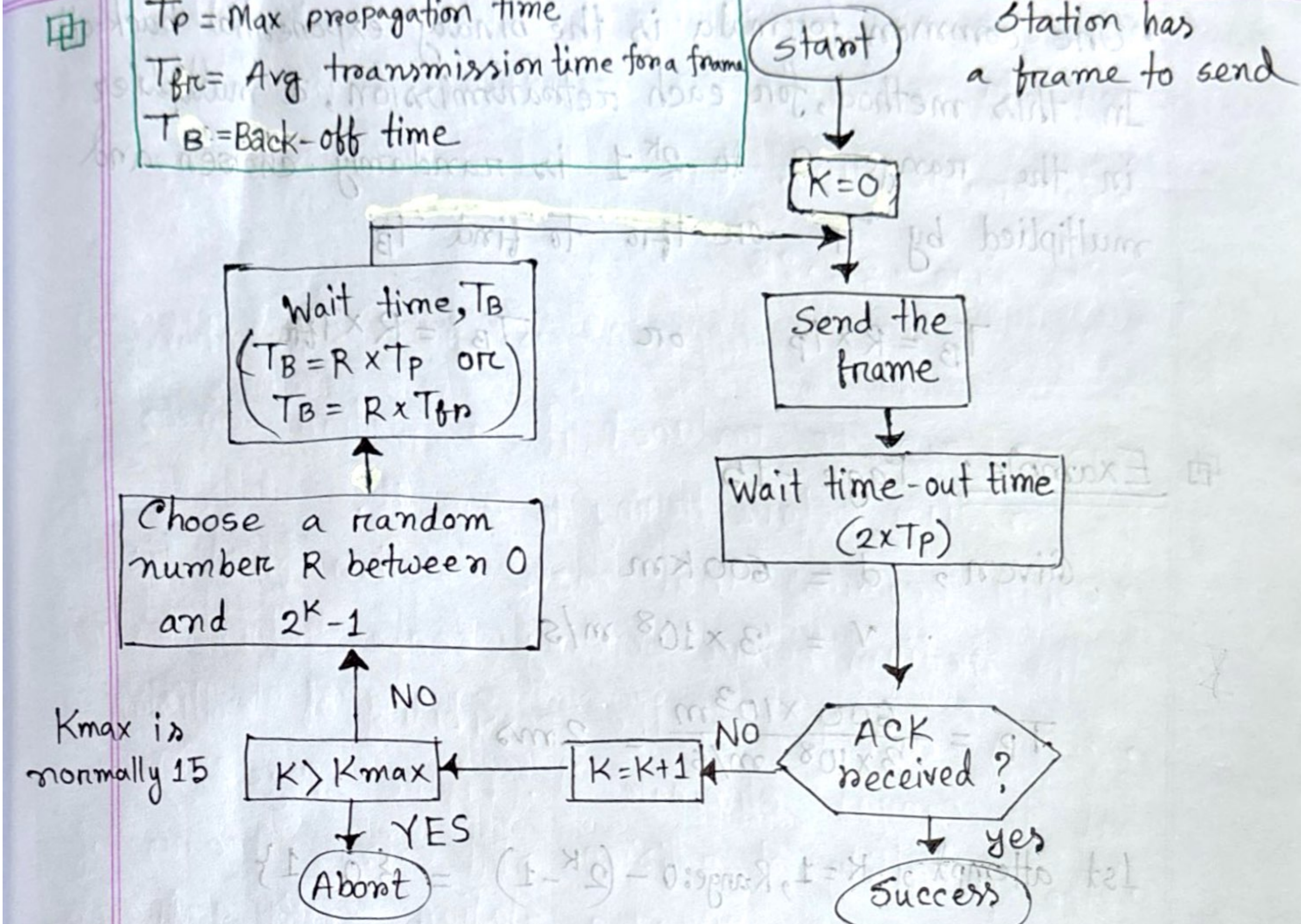
- Pure ALOHA has a second method to prevent congesting the channel with retransmitted frames.

- After maximum number of retransmission attempts (Kmax) a station must give up and try later.

- Back-off time : একটা packet collision হওয়ার পর কত random amount of time wait করে resend করার জন্য, সেই time কে Back-off time বলে

- RTT (Round trip time) = $2 \times T_p$ (প্যাকেট একবার যাবে, আবার আসবে)

K = Number of attempts
T_P = Max propagation time
T_{fr} = Avg transmission time for a frame
T_B = Back-off time



- The time-out-period is equal to the maximum possible round-trip propagation delay, which is twice the amount time required to send a frame between the two most widely separated station. $(2 \times T_P)$
- The back-off-time T_B is a random value that normally depends on K (the number of attempted unsuccessful transmissions)
- The formula for T_B depends on the implementation.
- The value of Kmax is usually 15.
- The range of random numbers increases after each collision.

- One common formula is the binary exponential back-off. In this method, for each retransmission, a multiplier in the range 0 to 2^K-1 is randomly chosen and multiplied by T_P or T_{fr} to find T_B

$$\boxed{T_B = R \times T_P} \quad \text{or} \quad \boxed{T_B = R \times T_{fr}}$$

Example: Page - 15

Given, $d = 600\,km$

$v = 3 \times 10^8\ m/s$

$$T_P = \frac{600 \times 10^3\ m}{3 \times 10^8\ m/s} = 2\,ms$$

1st attempt, $K=1$, Range: $0 - (2^K-1) = \{0, 1\}$

$T_B = R \times T_P = 0 \times 2 = 0\,ms$

$T_B = R \times T_P = 1 \times 2 = 2\,ms$

} Based on outcome of R

2nd attempt, $K=2$, Range $= 0 - (2^2-1) = \{0, 1, 2, 3\}$

for 0, $T_B = 0\,ms$

for 1, $T_B = 2\,ms$

for 2, $T_B = 4\,ms$

for 3, $T_B = 6\,ms$

} based on outcome value of R

3rd attempt, $K=3$, $0 - (2^3-1) = \{0, 1, 2, 3, 4, 5, 6, 7\}$

T_B can be 0, 2, 4, 6, 8, 10, 12, 14 ms (Based on the outcome of R)

Vulnerable time: The vulnerable time in Pure ALOHA is the time period during which frame is at risk of collision due to other stations transmitting frames.

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In the figure, we see that the vulnerable time, during which collision may occur in pure ALOHA, is 2 times the frame transmission time

$\therefore$ Pure ALOHA vulnerable time $= 2 \times T_{fr}$

Example: $R = 200\text{kbps} = 200 \times 10^3 \text{ bps}$

$L = 200 \text{ bit}$

$$T_{fr} = \frac{L}{R} = \frac{200 \times 10^3}{200} = 1 ms$$

Vulnerable Time : $2 \times 1 ms = 2 ms$

Slotted ALOHA:- Slotted ALOHA was invented to improve the efficiency of pure ALOHA by reducing the chances of collisions.

- Slotted ALOHA ~~is~~ divides time into slots of T_{fr}, and force the station to send only at the beginning of the time slot.
- Because a station is allowed to send only at the beginning of the synchronized time slot, if a station misses this moment, it must wait until the beginning of next time slot.

- There is still possibility of collision if two stations try to send at the beginning of the same time slot.
- Vulnerable time for Slotted ALOHA is T_{fr}.

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Carrier Sense Multiple Access (CSMA):

The chance of collision can be reduced if a station senses the medium before trying to use it.

- CSMA requires that each station first listen to the medium before sending (sense before transmit)
- CSMA can reduce the possibility of collision, but it cannot eliminate it. (Figure - (Page 25))
- The possibility of collision still exists because of propagation delay. When a station sends a frame, it still takes time for the first bit to reach every station and for every station to send it.

(Figure - Page 27, 28)

Vulnerable time for CSMA is the propagation time (T_p)

This is the time needed for signal to propagate from the one end of the medium to the other.

- When a station sends a frame, and any other station tries to send a frame during this time, a collision will result. But if the first bit of the frame reaches the end of the medium, every station will already have heard the bit and will refrain from sending. (Fig-Page 29)

Persistance Methods:

What should a station do if the channel is busy?
What should a station do if the channel is idle?

⇒ 3 methods have been devised to answer these ques.

- 1-persistent method
- non " "
- p " "

1-persistent method: This method is simple and straightforward. In this method, after the station finds the line idle, it sends its frame immediately. This method has the highest chance of collision. because two or more stations may find the line idle and send their frames immediately.

(continuous sense করে, processing time বাড়ে, collision বাড়ে)

non-persistent method: In this method, a station that has a frame to send senses the line. If the line is idle, it sends immediately. If the line is not idle, it waits a random amount time and then senses the line again. The nonpersistent approach doesn't sense continuously, random amount of time wait and then send, processing time কমে, collision কমে, but medium waste হয়

reduces ~~amount of time and then sense the line again~~ the chance of collision because it is unlikely that two or more stations will wait the same amount of time and retry to send simultaneously.

- However, this method reduces the efficiency of the network because the medium remains idle when there may be stations with frames to send.

□ p-persistent method: The p-persistent approach combines the advantages of both 1-persistent and non-persistent. It reduces the chance of collision and improves efficiency.

fig (Page-34)

Continuous sense media, when get idle it waits to take decision either to transmit or not. It finds probability.