Chapter 4

Medium Access Control sublayer

The Channel Allocation Problem

- Static Channel Allocation in LANs and MANs
- FDM, TDM
- Let us start with the mean time delay, T, for a channel of capacity C bps, with an arrival rate of λ frames/sec, each frame having a length drawn from an exponential probability density function with mean $1/\mu$ bits/frame. With these parameters the arrival rate is λ frames/sec and the service rate is μC frames/sec

From queuing theory it can be shown that for Poisson arrival and service times,

$$T = \frac{1}{\mu C - \lambda}$$

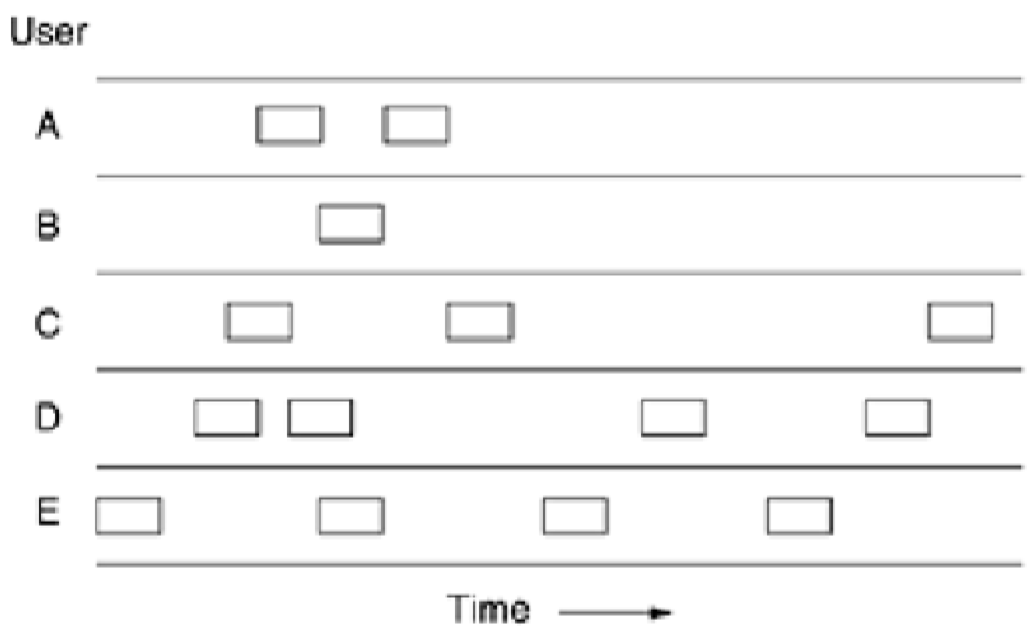
$$T_{\mathrm{FDM}} = \frac{1}{\mu(C/N) - (\lambda/N)} = \frac{N}{\mu C - \lambda} = NT$$

Dynamic Channel Allocation in LANs and MANs

- Station Model.
- Single Channel Assumption.
- Collision Assumption.
- Continuous Time ; Slotted Time
- Carrier Sense; No Carrier Sense

Multiple Access Protocols

- Pure ALOHA

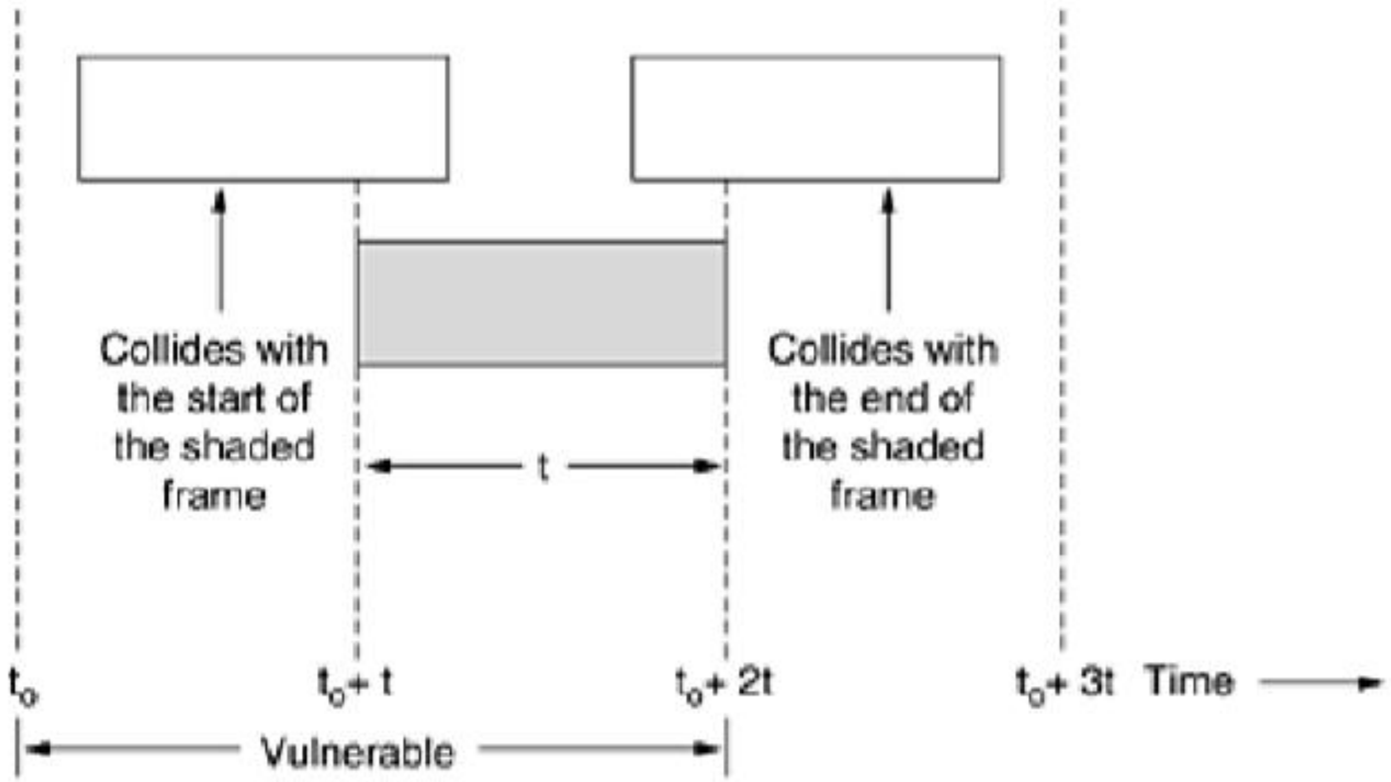


Pure aloha

- let users transmit whenever they have data to be sent.
- a sender can always find out whether its frame was destroyed by listening to the channel
- If listening while transmitting is not possible for some reason, acknowledgements are needed.
- If the frame was destroyed, the sender just waits a random amount of time and sends it again.
- Systems in which multiple users share a common channel in a way that can lead to conflicts are widely known as contention systems.

- A user is always in one of two states: typing or waiting. Initially, all users are in the typing state. When a line is finished, the user stops typing, waiting for a response.
- At this point we assume that the infinite population of users generates new frames according to a Poisson distribution with mean N frames per frame time.
- Let the ''frame time'' denote the amount of time needed to transmit the standard, fixed-length frame
- The infinite-population assumption is needed to ensure that N does not decrease as users become blocked.
- Let us further assume that the probability of k transmission attempts per frame time, old and new combined, is also Poisson, with mean G per frame time. Clearly, G is greater than or equal to N

Vulnerable time

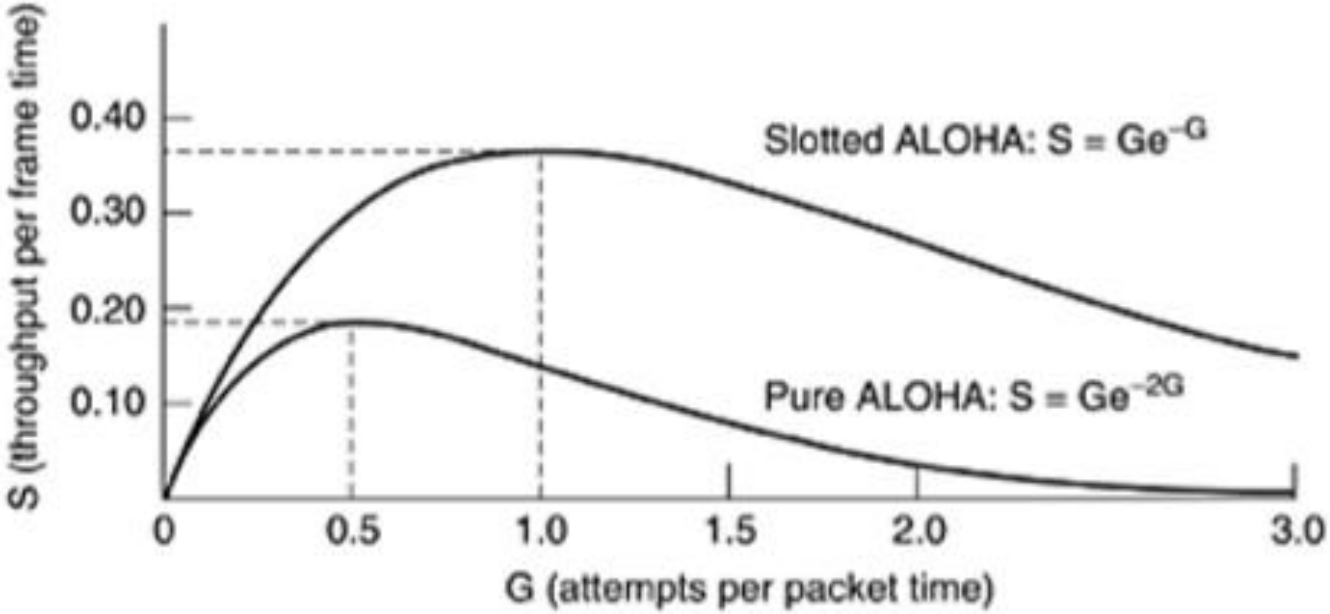


$$\Pr[k] = \frac{G^k e^{-G}}{k!}$$

$$P_0 = e^{-2G}.$$

$$S = GP_0,$$

$$S = Ge^{-2G}$$



Slotted ALOHA: S = Ge^-G
Pure ALOHA: S = Ge^-2G
S (throughput per frame time)
0.40
0.30
0.20
0.10
0
0.5
1.0
1.5
2.0
3.0
G (attempts per packet time)

A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces

a. 1000 frames per second

b. 500 frames per second

c. 250 frames per second

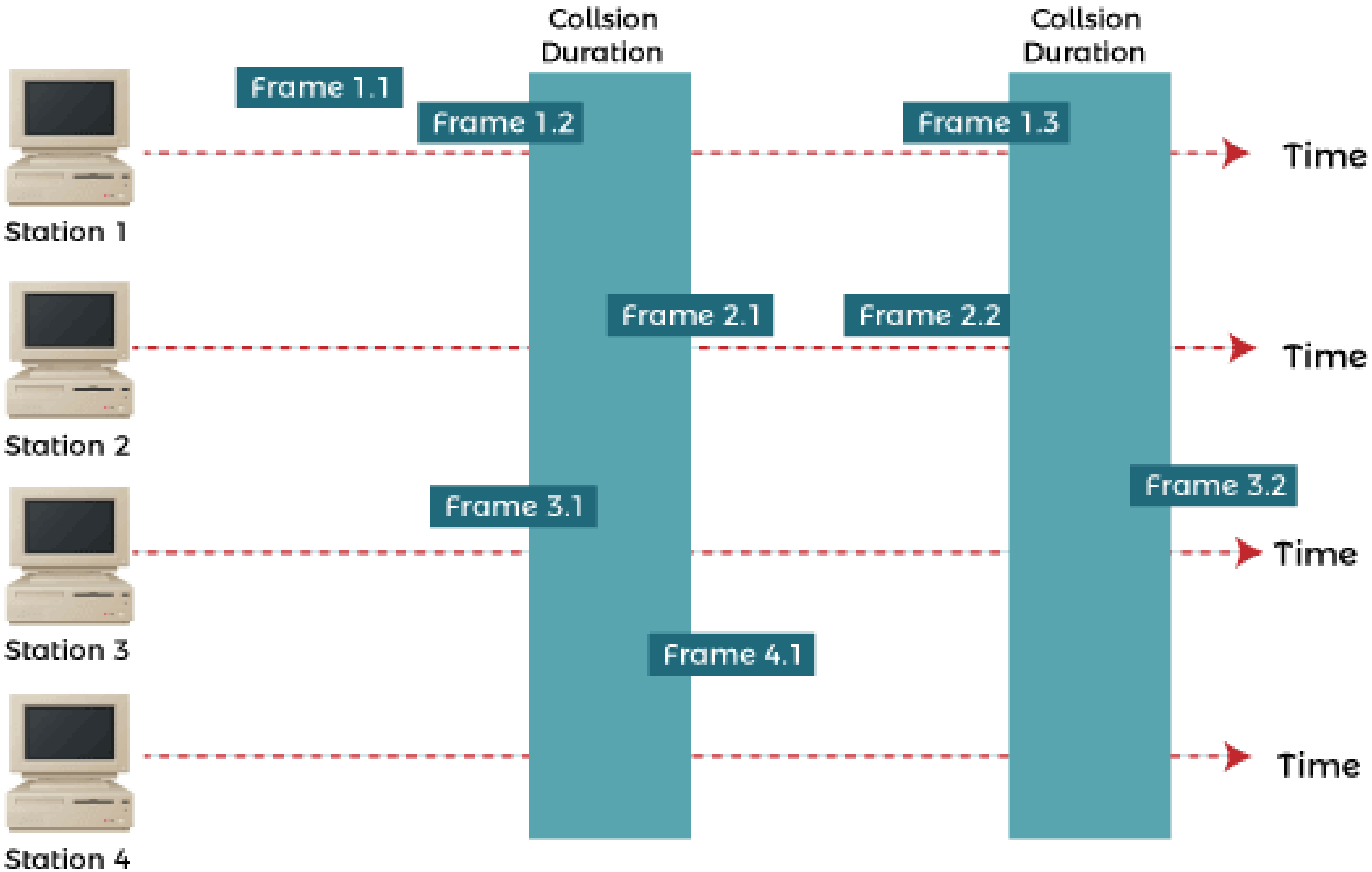
Solution

This situation is similar to the previous exercise except that the network is using slotted ALOHA instead of pure ALOHA. The frame transmission time is *200/200* kbps or 1 ms.

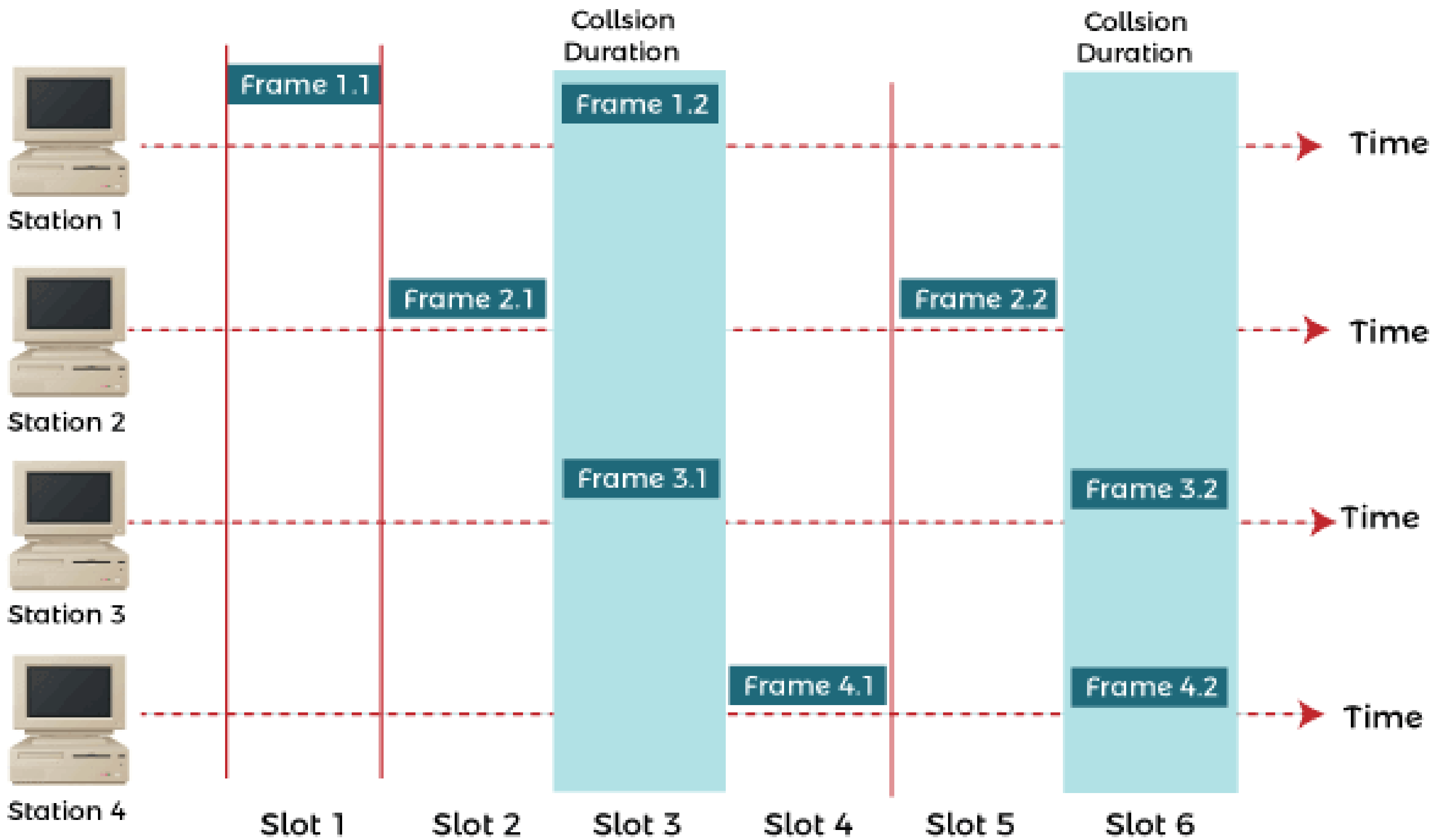
a. In this case G is 1. So $S = G \times e^{-G}$ or $S = 0.368$ (36.8 percent). This means that the throughput is 1000 x 0.0368 = 368 frames. Only 368 out of 1000 frames will probably survive. Note that this is the maximum throughput case, percentagewise.

b. Here G is $\frac{1}{2}$. In this case $S = G \times e^{-G}$ or $S = 0.303$ (30.3 percent). This means that the throughput is 500 x 0.0303 = 151. Only 151 frames out of 500 will probably survive.

c. Now G is $\frac{1}{4}$. In this case $S = G \times e^{-G}$ or $S = 0.195$ (19.5 percent). This means that the throughput is 250 x 0.195 = 49. Only 49 frames out of 250 will probably survive.



Frames in Pure ALOHA



Frames in Slotted ALOHA

Slotted ALOHA

$$S = Ge^{-G}$$

The expected number of transmissions, E, per carriage return typed is then

$$E = e^{G}$$

- 1000 airline reservation stations are competing for the use of a single slotted ALOHA channel. The average station makes 36 requests per hour. A slot is 100 μsec. What is the approximate total channel load?
- Each terminal makes one request every 3600 sec / 36 request = 100 sec. Total load is 1000 requests per 100 sec or 10 requests per sec. There are 1 sec/100 μsec = 1000000 μsec / 100 μsec = 10000 slots in one second. Hence, G=10/10000=1/1000=0.1%

Example

- Measurement of Slotted ALOHA channel with an infinite number of users show that 10% of slots are idle.Find

  1) What is channel load?

  2) What is throughput?

  3) Is channel under load or overload?

a) What is the channel load, G?

Ans: When a slot is idle, there is 0 frame generated in that frame time.

Therefore $P[succ]=0.1.$

$P[succ]=e^{-G}=0.1;$

$-G=\ln(0.1);$

$G=2.303.$

(b) What is the throughput?

Ans: $S=Ge^{-G}=2.303*0.1=0.2303.$

(c) Is the channel underloaded or overloaded?

Ans: When G=1, the slotted Aloha obtains the optimal throughput. G>1, we have too many generated frame in a slot. It is a overloaded situatoin. Here we have $G=2.303$; $S=0.2303<S_{max}=0.368$. $G>S$. Therefore the channel is overloaded.

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