The University of Queensland
School of Information Technology and Electrical Engineering

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COMS3200 – Tutorial 6 - Solutions

Question 1

Consider the delay of pure ALOHA versus slotted ALOHA at low load. Which one is less? Explain your answer.

With pure ALOHA transmissions can start instantly. At low load, no collisions are expected so the transmission is likely to be successful. With slotted ALOHA, it hast to wait for the next slot. This introduces half a slot time delay on average.

Question 2

An IEEE 802.3 has only two ready stations. What is the probability that they will collide at most three times before one succeeds?.

"At most" three collisions means there are one, two or three collisions.

$$P = P(\text{exactly one collision}) + P(\text{exactly two collisions}) + P(\text{exactly three collisions})$$

Both stations are ready, so both will try to transmit initially - guaranteeing at least one collision. Both stations then randomly choose one of the next two slots to retransmit. There is a probability of $\frac{1}{2}$ that they will choose different slots (and therefore succeed) and a probability of $\frac{1}{2}$ that there will be a second collision. If there is a second collision, both stations will randomly choose one of the next four slots to retransmit (remember the binary exponential backoff). There is a probability of $\frac{1}{4}$ (4 possibilities out of 16 combinations of slots) that there will be a third collision, and therefore a probability of $\frac{3}{4}$ that there will be success on the third attempt. If there is a third collision, both stations will randomly choose one of the next eight slots to retransmit. Probability of a fourth collision is $\frac{1}{8}$. Probability of no fourth collision is then $\frac{7}{8}$.

$$\begin{aligned}
P &= P(\text{exactly one collision}) + P(\text{exactly two collisions}) + P(\text{exactly three collisions}) = \\
&\quad P(\text{first collision happens}) \times P(\text{no collision on second attempt}) + \\
&\quad P(\text{first collision happens}) \times P(\text{second collision happens}) \times P(\text{no third collision}) + \\
&\quad P(\text{1st coll. happens}) \times P(\text{2nd coll. happens}) \times P(\text{3rd coll. happens}) \times P(\text{no 4th coll.}) \\
&= 1 \times \frac{1}{2} + 1 \times \frac{1}{2} \times \frac{3}{4} + 1 \times \frac{1}{2} \times \frac{1}{4} \times \frac{7}{8} \\
&= \frac{32}{64} + \frac{24}{64} + \frac{7}{64} \\
&= \frac{63}{64}
\end{aligned}$$

Another way of looking at the same question would be:

$$\begin{aligned} P &= 1 - P(\text{four or more collisions}) \\ &= 1 - P(\text{first coll.}) \times P(\text{second coll.}) \times P(\text{third coll.}) \times P(\text{fourth coll.}) \\ &= 1 - \frac{1}{2} \times \frac{1}{4} \times \frac{1}{8} \\ &= \frac{63}{64} \end{aligned}$$

If the pure CSMA/CD protocol was considered which does not use binary exponential backoff the probability of collision or no collision would be equal to $\frac{1}{2}$.

Question 3

Consider a baseband bus with a number of equally spaced stations. Assume
· a mean distance between stations of 0.375km
· a propagation speed of 200m per microsecond
· an access method based on IEEE 802.3 standard (Ethernet-like network)
(a)What is the average time to send a packet of 1000 bits to another station, measured from the beginning of the transmission to the end of reception?
(b)If two stations begin to transmit at exactly the same time, how long will it take on average before they notice a collision, in seconds? in bit times?
(c)If one station starts transmitting, what is the time after which the station knows that it seized the channel (i.e. there will not be any collision during this transmission)?

(a) We assume the bit-rate is 10Mbps.

$$\begin{aligned} T_{\text{average}} &= \text{transmission time} + \text{station-to-station delay time} \\ &= \frac{1000\text{bits}}{10\text{Mbps}} + \frac{375\text{m}}{200\text{m/microsecond}} \\ &= 100\mu\text{s} + 1.875\mu\text{s} \\ &= 101.875\mu\text{s} \end{aligned}$$

(b) The time to detect a collision is just the station-to-station delay time, which for stations that are 375m apart is 1.875microseconds (as calculated in (a)). The time to send one bit is 0.1microseconds (1/10Mbps) so this delay time equates to about 19 bit times.

(c) If one assumes there are only two stations and they are spaced 375m apart, a station knows it has succesfully seized the channel after a period of time twice the station-to-station delay time. From (b), this would be 3.75microseconds (or 37.5 bit times). If you assume a greater end-to-end distance (which the question would seem to imply), you'll get a larger number. For 802.3, the time period is 51.2 microseconds (512 bit times = 64 byte times).

Question 4

The presented MAC protocol for Wireless LANs uses MACA (Multiple Access with Collision Avoidance). Under what conditions, if any, would it be possible to use CSMA/CD?

Radios cannot receive and transmit on the same frequency at the same time so CSMA/CD cannot be used. If this problem could be solved (e.g. by equipping each station with two radios), there is still the problem of not all stations being within radio range of each other (hidden station problem). Only if both of these problems can be solved, is CSMA/CD a candidate.

Question 5

Six stations, A through F, communicate using the MACA protocol. Is it possible that two transmissions take place *simultaneously? Explain your answer.*

Yes. Imagine that they are in a straight line and that each station can only reach its nearest neighbours. Then A can send to B while E is sending to F.