

# Course ISE 327, EEE 051: Introduction to Computer Networks

## Recitation 4 Exercise

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### 1 Ethernet Propagation

Suppose the round-trip propagation delay for Ethernet is  $46.4 \mu\text{s}$ . This yields a minimum packet size of 512 bits (464 bits corresponding to propagation delay + 48 bits of jam signal).

- (a) What happens to the minimum packet size if the delay time is held constant, and the signalling rate rises to 100 Mbps?
- (b) What are the drawbacks to so large a minimum packet size?
- (c) If compatibility were not an issue, how might the specifications be written so as to permit a smaller minimum packet size?

### 2 Ethernet Capture

Let A and B be two stations attempting to transmit on an Ethernet. Each has a steady queue of frames ready to send; A's frames will be numbered  $A_1, A_2$ , and so on, and B's similarly. Let  $T = 51.2\mu\text{s}$  be the exponential backoff base unit. Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of  $0 \times T$  and  $1 \times T$ , respectively, meaning A wins the race and transmits  $A_1$  while B waits. At the end of this transmission, B will attempt to retransmit  $B_1$  while A will attempt to transmit  $A_2$ . These first attempts will collide, but now A backs off for either  $0 \times T$  or  $1 \times T$ , while B backs off for time equal to one of  $0 \times T, \dots, 3 \times T$ .

- (a) Give the probability that A wins this second backoff race immediately after this first collision; that is, A's first choice of backoff time  $k \times 51.2$  is less than B's.
- (b) Suppose A wins this second backoff race. A transmits  $A_3$ , and when it is finished, A and B collide again as A tries to transmit  $A_4$  and B tries once more to transmit  $B_1$ . Give the probability that A wins this third backoff race immediately after the first collision.
- (c) Give a reasonable lower bound for the probability that A wins all the remaining backoff races.
- (d) What then happens to the frame  $B_1$ ?

This scenario is known as the *Ethernet capture* effect.

### 3 Ethernet Address Collisions

Suppose Ethernet physical addresses are chosen at random (using true random bits).

- (a) What is the probability that on a 1024-host network, two addresses will be the same?
- (b) What is the probability that the above event will occur on some one or more of 220 networks?
- (c) What is the probability that of the 230 hosts in all the networks of (b), some pair has the same address?

**Hint:** The calculation for (a) and (c) is a variant of that used in solving the so-called Birthday Problem:

Given  $N$  people, what is the probability that two of their birthdays (addresses) will be the same? The second person has probability  $1 - \frac{1}{365}$  of having a different birthday from the first, the third has probability  $1 - \frac{2}{365}$  of having a different birthday from the first two, and so on. The probability all birthdays are different is thus

$$\left(1 - \frac{1}{365}\right) \times \left(1 - \frac{2}{365}\right) \times \dots \times \left(1 - \frac{N-1}{365}\right)$$

which for smallish  $N$  is about

$$1 - \frac{1 + 2 + \dots + (N-1)}{365}$$