# Homework Two

1. (25 points) For a frame, we define the transmission delay as the time since we begin to send the first bit till the time we finish sending the last bit. We define the propagation delay as the time since the first bit is sent till the time the first bit is received by the receiver.

   (a) (10 points) Suppose we have a 20,000m link, and suppose electronic signals travel in this link at a speed of 200,000,000m per second. What is the propagation delay?

   (b) (10 points) Suppose the data rate is 100kbps, and the frame is 10,000 bits. What is the transmission delay?

   (c) (5 points) Do you think the Stop-and-Wait protocol will work well in this link? Why?

2. (25 points) Consider the Stop-and-Wait protocol. Let the sender be A and the receiver be B, and suppose the propagation delay from A to B is 1ms but the transmission delay is very small compared to the propagation delay and can be neglected. Assume the timeout for a frame is counted from the time when the last bit of this frame is sent.

   (a) (5 points) What is the lower bound of the timeout value for A?

   (b) (10 points) Let's assume that A takes a timeout value of 3ms. At time 0 A sends F0 (frame 0) to B and B replies with ACK0 (got frame 0, expecting frame 1) to A. A receives ACK0 at 2ms and sends F1 to B and B receives F1 at 3ms. B wants to send ACK1 to A, but some interrupt occupies the CPU of B and B sends out ACK1 at 5ms. What actions will A take at 5ms, 6ms, 7ms, 8ms, 9ms? What actions will B take at 6ms, 7ms, 8ms, 9ms? Please show your answer clearly on the following figure.

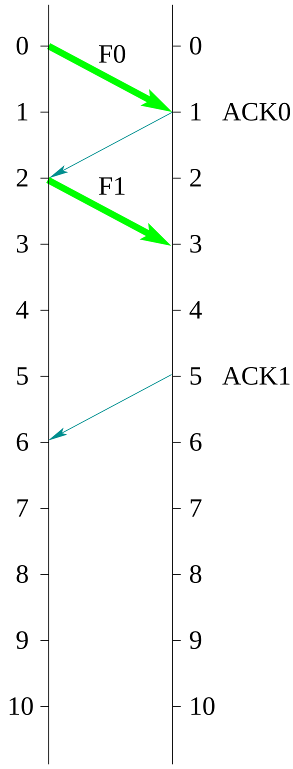


Figure 1: P2(b)

(c) (10 points) In the Stop-and-Wait protocol, the sender ignores "irrelevant ACK," that is, for example, if it sends out Fi but receives ACKj where j is not equal to i, it ignores this ACK. Now suppose we modify the Stop-and-Wait protocol such that if the sender gets ACKj it will send out F(j+1). Repeat the previous problem for this new protocol. What is the problem you see in this new protocol?

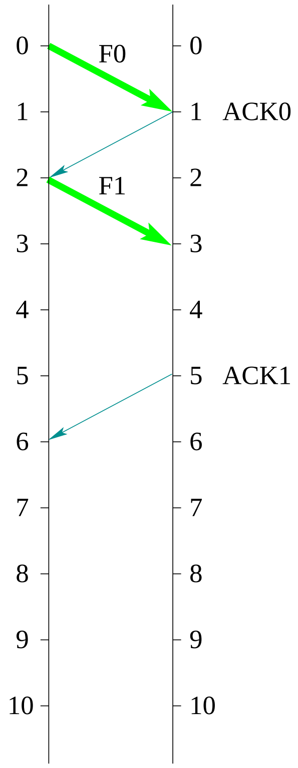


Figure 2: P2(c).

3. (25 points) Consider a link with propagation delay of 1ms and the transmission delay of 1ms. Assume Go-back-N is used and assume that no data frame is lost but every one of four ACKs the receiver sends is lost. That is, numbering the ACKs as ACK0, ACK1, ACK2, ACK3, ACK4, ACK5, ACK6, ACK7, ..., ACK3, ACK7, ACK11 will be lost. Note that this is the counter of the ACK and may not be the sequence number in the ACK. Assume the sender uses a window size of 3 and the timeout the sender uses is 3ms, and assume timeout timer starts to tick after the last bit of the frame is sent. Please finish the following figure. What is the link efficiency?

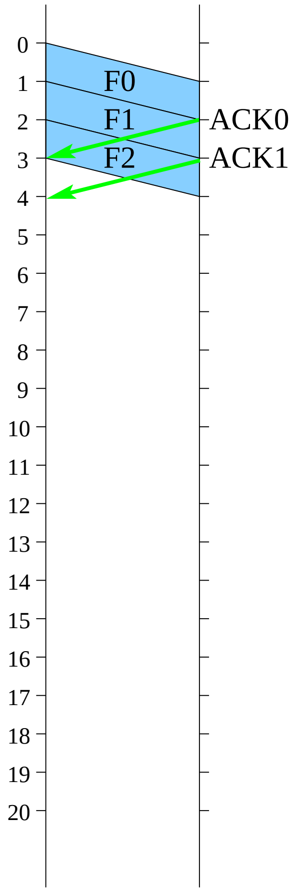


Figure 3: P3.

4. (25 points) Consider two stations in an Ethernet, called A and B, each has a very large file to send to some other stations. Assume their upper layer protocols start the file transfer at the same time, but find the channel to be busy. Also assume that there is no other active station.

   (a) (5 points) What will happen when the channel becomes free? Please explain your answer in one sentence.

   (b) (10 points) If collision happens, both stations will backoff according to the binary exponential backoff algorithm. What is the probability that A gets to send successfully at slot 0 after the collision? What is the probability that B gets to send successfully at slot 0 after the collision? What is the probability that A and B collide again at slot 0 after the first collision? What is the probability that A and B collide again at slot 1 after the first collision?

   (c) (5 points) Suppose A and B have collided for $i-1$ times after the first collision. What the probability they still collide at contention round $i$?

   (d) (5 points) What is the probability that the contention ends at round $k$ after the first collision, that is, one station gets to send successfully, where $k \geq 1$?