Assignment 3: Medium Access Control Layer

1) Frames arrive randomly at a 100-Mbps channel for transmission. If the channel is busy when a frame arrives, it waits its turn in a queue. Frame length is exponentially distributed with a mean of 10,000 bits/frame. For each of the following frame arrival rates, give the delay experienced by the average frame, including both queuing time and transmission time.

   (a) 90 frames/sec.
   (b) 900 frames/sec.
   (c) 9000 frames/sec.

2) Suppose that an 11-Mbps 802.11b LAN is transmitting 64-byte frames back-to-back over a radio channel with a bit error rate of 10−7. How many frames per second will be damaged on average?

3) A large population of ALOHA users manages to generate 50 requests/sec, including both originals and retransmissions. Time is slotted in units of 40 msec.

   (a) What is the chance of success on the first attempt?
   (b) What is the probability of exactly k collisions and then a success?
   (c) What is the expected number of transmission attempts needed?

4) What is the length of a contention slot in CSMA/CD for (a) a 2-km twin-lead cable (signal propagation speed is 82% of the signal propagation speed in vacuum), and (b) a 40-km multimode fiber optic cable (signal propagation speed is 65% of the signal propagation speed in vacuum)?

5) Consider five wireless stations, A, B, C, D, and E. Station A can communicate with all other stations. B can communicate with A, C and

E. C can communicate with A, B and D. D can communicate with A, C and E. E can communicate A, D and B.

(a) When A is sending to B, what other communications are possible?

(b) When B is sending to A, what other communications are possible?

(c) When B is sending to C, what other communications are possible?

6) A 1-km-long, 10-Mbps CSMA/CD LAN (not 802.3) has a propagation speed of 200 m/μsec. Repeaters are not allowed in this system. Data frames are 256 bits long, including 32 bits of header, checksum, and other overhead. The first bit slot after a successful transmission is reserved for the receiver to capture the channel in order to send a 32-bit acknowledgement frame. What is the effective data rate, excluding overhead, assuming that there are no collisions?

7) A seven-story office building has 15 adjacent offices per floor. Each office contains a wall socket for a terminal in the front wall, so the sockets form a rectangular grid in the vertical plane, with a separation of 4 m between sockets, both horizontally and vertically. Assuming that it is feasible to run a straight cable between any pair of sockets, horizontally, vertically, or diagonally, how many meters of cable are needed to connect all sockets using

(a) A star configuration with a single router in the middle?

(b) A classic 802.3 LAN?

8) Two CSMA/CD stations are each trying to transmit long (multi-frame) files. After each frame is sent, they contend for the channel, using the binary exponential back-off algorithm. What is the probability that the contention ends on round k, and what is the mean number of rounds per contention period?

9) To make VLANs work, configuration tables are needed in the bridges. What if the VLANs in the figure below used hubs rather than switches? Do the hubs need configuration tables, too? Why or why not?
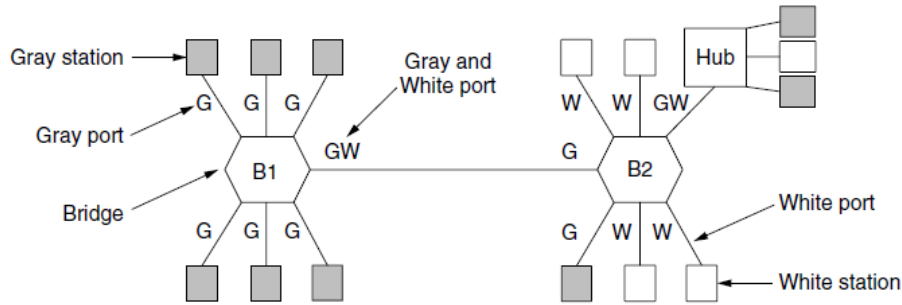
10) The figure below shows several physical layer protocols. Which of these is closest to the Bluetooth physical layer protocol? What is the biggest difference between the two?