Homework Set No. 9

ECE 462
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Problem 1

In the roll-call polling system, with 10 identical secondary stations, spaced 10 km from each other, the transmission line has a speed of 512 $kbps$, The frame length is 1000 $bits$, poll message is 48 $bits$, and synchronization time 0.1 $msec$, arrival rate at each secondary is $\lambda = 20$ $frame/second$.

a) What is the mean cycle time?

b) Repeat if hub polling is used.

Problem 2

For constant length frames, evaluate the mean cycle time for a token-ring (hub polling ring) that has the following parameters: Ring length of 1 km, bit rate of 4 $Mbps$, frame length of 1000 $bits$, forty stations on ring, Poisson arrival process to each station with 10 $packets/sec$ arrival rate.

Problem 3

A Random Access network uses the ALOHA access protocol. The frame transmission time is 10 μsec for an average frame length of 1000 $bits$.

a) What average input rate to each of 100 stations will result in the maximum possible network throughput?

b) What is the maximum unnormalized throughput in $frame/second$ for the whole network?

c) Under these conditions, estimate the average number of retransmissions.

Problem 4

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?

Problem 5

Measurements of an infinite user slotted ALOHA channel show that 10% of the slots are idle.

a) What is the channel load, G?

b) What is the throughput?

c) Is the channel underloaded or overloaded?

Problem 6

A small slotted ALOHA system has only customers, each of whom has a probability $1/k$ of transmitting during any slot (originals + retransmissions combined). What is the channel throughput as a function of k? Evaluate this expression numerically for $k = 2, 3, 4, 10$ and $lim\ k \to \infty$.

Problem 7

An Ethernet of 1 Km operating at 10 $Mbps$ has a propagation speed of 200 $m/\mu sec$. Data frames are 256 $bits$ long, including 32 $bits$ of header, check sum and other overhead. The first bit slot after a successful transmission is reserved for the receiver to capture the channel to send a $32 - bit$ acknowledgement frame.

a) What is the effective data rate, excluding overhead, assuming that there are no collisions?

b) Compare the maximum effective data rate above if there are 50 stations distributed uniformly over this 1 km long cable and it is used as a hub polling ring with the acknowledgements piggybacked onto the data frame (headers size same as in a).

Problem 8

To reduce contention on its dispatcher's radio, a taxicab company has decided to slot time into $1 - sec$ intervals. The company then begins hiring unemployed computer science graduates as drivers, since the new system requires its users to speak digitally, in 1 sec bursts. Late one night, only two digital speaking drivers are out, both talking to the dispatcher. The probability that the driver has something to say during a slot is 0.3. In the event of a collision, each one repeats during the succeeding slots with a probability of 0.2. Calculate the mean number of slots required per successful transmission. (The night dispatcher speaks only analog, and says nothing.)

Problem 9

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 $4m$ 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 control all sockets using

a) A star configuration with a single controller in middle?

b) A CSMA/CD?

c) A ring net (without a wire center)?