ECE 478/578: Fundamentals of Computer Networks

Homework Assignment # 4

Due Thursday Feb. 16, In class

February 9, 2012

Problem 1: Consider the tree Collision Resolution Protocol (CRP) with a feedback pattern *e, 0, e, e, 1, 1, 0*

1. Draw the tree and the corresponding table for this feedback pattern.
2. Which collision or collisions could have been avoided if the first improvement of the tree algorithm was applied?
3. What would the feedback pattern have been if both the first and second improvements were applied?

Problem 2: Consider the tree Collision Resolution Protocol (CRP). Given that k collisions occur in a collision resolution phase, determine the number of slots required for resolving all collisions. Note that k does not represent the number of packets that have initially collided, but the number of collisions in the CRP feedback pattern.

Problem 3: Consider the tree Collision Resolution Protocol (CRP). Assume that after every collision, each host involved in the collision resolution flips an unbiased coin to determine whether to go to the left or the right subset.

1. Given a collision of k packets, find the probability that i packets go into the left subset.
2. Let A_k be the expected number of slots required for resolving the collision of k packets. Note that $A_0 = A_1 = 1$. Show that for $k \geq 2$,

   $$A_k = 1 + \sum_{i=0}^{k} C(k,i) 2^{-k} (A_i + A_{k-i}),$$

   where $C(k,i)$ denotes the number of ways of picking i items out of k (combination).
3. Simplify your answer in part 2, to the form

   $$A_k = c_{kk} + \sum_{i=0}^{k-1} c_{ik} A_i,$$

   and find the coefficients c_{ik}.
4. Evaluate A_2 and A_3.

Problem 4: Consider the first improvement to the tree Collision Resolution Protocol. Assume that after each collision, each host involved in the collision resolution flips an unbiased coin to determine whether to go to the left or the right subset. Let B_k be the expected number of slots required for resolving the collision of k packets. Note that $B_0 = B_1 = 1$.

1. Show that for $k \geq 2$,

$$B_k = 1 + \sum_{i=1}^{k} C(k,i) 2^{-k} (B_i + B_{k-i}) + 2^{-k} B_k,$$

2. Simplify your answer in part 2, to the form

$$B_k = c_{kk} + \sum_{i=1}^{k-1} c_{ik} A_i,$$

and find the coefficients c_{ik}.

3. Evaluate B_2 and B_3.

Problem 5: Let 32 stations share a common medium and use the Binary Countdown Protocol to resolve the transmission priority. At time slot 0, nodes with IDs 4, 15, 23, and 28 want to transmit. Show the steps of the execution of the Binary Countdown Protocol by considering the binary representation of the stations IDs. How many slots are needed until the winning station transmits data? If the frame length is d what is the efficiency of this protocol?