Assignment 5 TIM 207, Random Process Models in Engineering

Instructor: John Musacchio,

Due: May 15, 2012

1. Suppose you are designing a medium access control scheme for two transmitting nodes sending packets to a common base station. Your two transmitting nodes have two modes – (A)gressive and (M)eek. Time proceeds in discrete slots. In each slot, a node in Aggressive mode transmits with probability $p > .5$ and in Meek mode it transmits with probability $1 - p$. The two nodes select whether to transmit independently. A successful transmission occurs if exactly 1 node attempts to transmit in a slot. If there are two transmission attempts , we say that a collision has occurred and both nodes are unsuccessful in their attempt to transmit. If a transmission attempt is successful, the node that successfully transmitted jumps (or stays) in Aggressive mode while the node that did not attempt a transmission jumps (or stays) in Meek mode. If a collision occurs, both nodes go (or stay) in Meek mode. If no node attempts a transmission, both nodes do not change their mode.

   (a) If the system is **not** started with both nodes in Aggressive mode, is it possible for the system to ever to reach a state where both nodes are aggressive?

   (b) Is X_k, the number of Aggressive nodes at each time k, a Markov chain? If so, what are the transition probabilities? Also, is the chain irreducible and aperiodic?

   (c) What is the long term average throughput of the system (including successful transmissions from both nodes) in units of successful packet transmissions per slot?

   (d) Find the value of p that maximizes the long-term average throughput.

   (e) Is the chain irreducible and aperiodic for the optimum p found above? Why would this choice of p be a poor design choice?

2. Consider the problem above but with 3 nodes. As before, assume that a collision (two or more simultaneous transmission attempts) results in all nodes switching to or staying in Meek mode, and that a successful transmission only occurs when exactly 1 node attempts a transmission. What is the long-term average throughput as a function of p? What p maximizes the long-term average throughput?

3. Durrett 9.278 pp 93

4. Durrett 9.30 pp 94