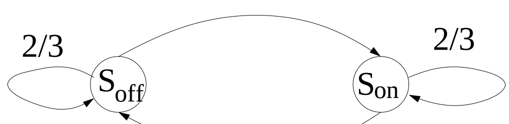
Principles of Computer Networks
Tutorial 1

Problem 1

Consider a transceiver unit which can send and receive data over a wireless communication link. The transceiver can be in one out of two possible states: state S_{off} (when it is not sending/receiving data) and S_{on} (when it is sending/receiving data).

Assume that the transceiver changes states at discrete time steps $k = 0, 1, 2, 3, ...$. When the state of the transceiver is equal to S_{off} at time k, then at time $(k+1)$ it will be in the state S_{off} with probability $2/3$ and be in the state S_{on} with probability $1/3$. Similarly, when at time k the transceiver is in state S_{on}, then at time $(k+1)$ it is in state S_{off} with probability $1/3$ and in state S_{on} with probability $2/3$. The state diagram of the transceiver is shown as:



(a) Assume that at time $k = 0$ the transceiver is in state S_{off}. What is the probability that the transceiver is still in state S_{off} at time $k = 1$?

(b) Assume that at time $k = 0$ the transceiver is in state S_{off}. Using (a), what is the probability that the transceiver is in state S_{on} at time $k = 2, 3, 4$?

(c) Assume that the transceiver is at time $k = 0$ in state S_{off} with probability P_{off} and in state S_{on} with probability P_{on}. Express the probability that the transceiver is at time $k = 1$ in state S_{off}, and state S_{on}, as a function of P_{off} and P_{on}.

(d) Find initial probabilities P_{off}, P_{on} such that the transceiver is at time $k = 1$ in state S_{off}, and S_{on}, again with probability P_{off}, and P_{on}, respectively.

(e) Assume that at time $k = 0$ the transceiver is in state S_{off}. Using the result of (d), try to guess that probabilities that the buffer is in state S_{on} and S_{off} after a very long time, i.e. as k approaches infinity.

Problem 2

The length of data packets can vary in a wide range (some packets are very short and some packets are very long). To capture this, we model packet lengths as a random variable with a geometric distribution. That is, the probability that a packet is L bits long is given by.

$$P(L = l) = \alpha(1 - \alpha)^{l-1}, \qquad l \geq 1.$$

(a) Derive the average packet length, i.e. derive $E[L]$.

(b) Consider a specific packet. Assume that we know that the length of this packet is larger than l_0. Find the probability that the packet is l bits long, $l > l_0$.

(c) Derive the expected packet length when we know that $L > l_0$, i.e. derive $E[L \mid L > l_0]$.