ECS 252 Spring 2022: Project

April 16, 2022

Instructions

1. You may in no circumstances upload this project writeup to private tutoring websites such as CourseHero or Chegg. **Remember all material related to this course is a property of the University of California and posting them is a serious violation of the copyright laws.**
2. If you refer to a source (either a book or the internet), you must cite it.
3. You are highly urged to work on this project on your own. If you do discuss with others, you must list their names.
4. Submission guideline and due date will be updated soon.

1 Project Overview

In this project you will simulate and analyze the basic ALOHA protocol and investigate some of the properties of the binary exponential backoff algorithm of the IEEE 802.3 Ethernet protocol. Before you get started you should read Random Access Protocols Section 6.3.2 of the text. We will cover it in class but you should read ahead.

Figure 1 shows the simulation model.

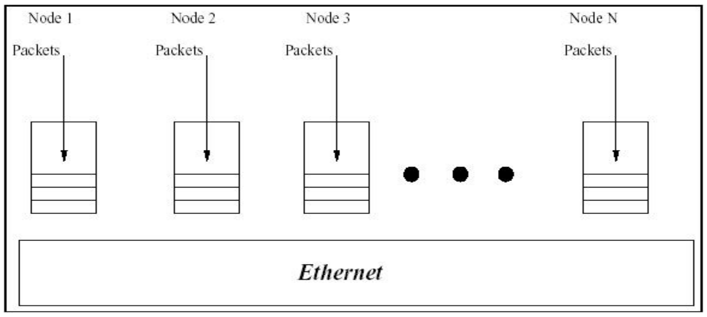

Figure 1: Ethernet simulation model.

In order to develop the simulation model, we will make the following assumptions:

1. We will assume that time is slotted into equal length of time slots. In the subsequent discussion, the length of the time slot will be denoted by T_s.
2. We will let N denote the number of hosts. We will assume the hosts are identical and packets arrive to each host following a Poisson process with rate λ (pkts/sec).
3. Hosts can transmit only at slot boundaries.
4. For a new packet, the node attempts transmission in the next slot boundary.
5. If at a particular slot boundary there are more than one host ready to transmit, there will be a collision. When there is a collision the packet is not received by the receiver and must be re-transmitted.
6. How a node determines when to re-transmit depends on the algorithm. We will consider different algorithms as discussed in the next section.
7. We will be plotting the throughput as a function of the arrival rate λ. Throughput is defined as the number of successful transmission per time unit. In the simulation, you can count the number of slots in which there is successful transmission and divided that by the total number of slots that you simulate.

2 Algorithms

We will consider the following algorithms

1. **p-Persistent ALOHA:** In this case each active node re-transmits in a slot with probability p. We will consider two different values of p, 1) $p = 0.5$ and $p = \frac{1}{N}$.
2. **Binary Exponential Backoff:** When hosts collide, they will schedule their re-transmission using the following binary exponential backoff algorithm. The number of slots to delay after the n^{th} re-transmission attempt is chosen as a uniformly distributed integer in the range $0 \leq r \leq 2^K$, where $K = \min(n, 10)$.
3. **Linear Backoff:** When hosts collide, they will schedule their re-transmission using the following linear backoff algorithm. The number of slots to delay after the n^{th} re-transmission attempt is chosen as a uniformly distributed integer in the range $0 \leq r \leq K$, where $K = \min(n, 1024)$.

3 Simulation Analysis

Extend the simulation model of the single server queue that is given in the Jupyter Notebook to model the above system. Based on the simulation model, obtain the following results:

1. Plot the throughput as a function of λ with the $p-$Persistent Aloha, Binary Exponential Backoff algorithm as described above. Slot time $T_s = 1$ and number of hosts $N = 30$. Obtain the throughput for ten values of λ in the range [0.003, 0.03]. Write a short discussion about the results.
2. Here are the requirements for submitting a executable version of the code. Use the the following tags for the four different algorithms ”pp”, ”op”, ”beb”, and ”lb” for 0.5 persistent, 1/N persistent, binary exponential backoff, and linear backoff, respectively.

   (a) Name the code: ethernet-simulation.py

(b) It should take 2 parameters: a) the algorithm and b) the arrival rate

(c) It should output the throughput to 2 decimal places