Computer Networks Fall 2016: Project
Simulation Analysis of the Binary Exponential Backoff Algorithm

1 Project Overview

In this part you will simulate and analyze 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 (5.3.2 in the 6th edition of the text) of the text. We will cover it in class but you should read ahead.

Figure 1 shows the simulation model.

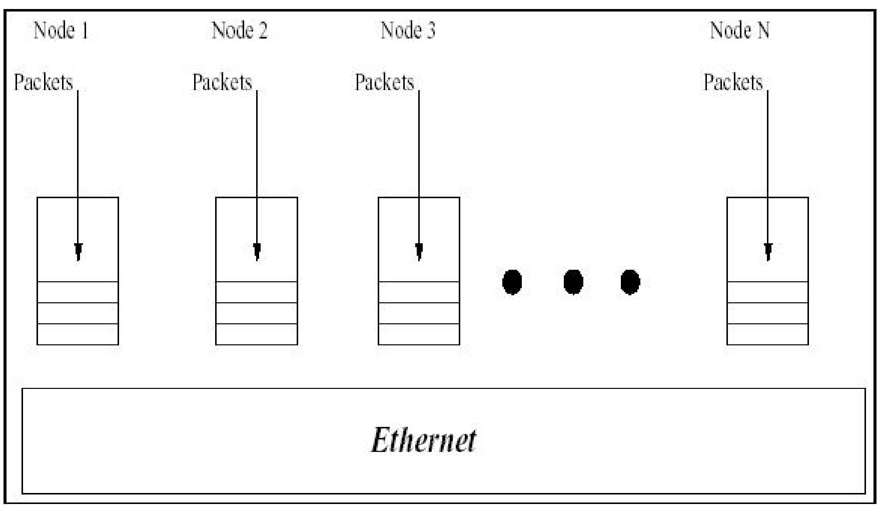

Figure 1: Ethernet simulation model.

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. As before, λ will denote the mean arrival rate of packets. We will assume the hosts are identical, and each hosts receiving packets with a mean arrival rate of λ

packets/second. The arrival process follows a Poisson process with rate parameter λ pkts/sec (same as Part 1 of the project).

3. Hosts can transmit only at slot boundaries.

4. If at a particular slot boundary there are more than one host ready to transmit, there will be a collision. When hosts collide, they will schedule their retransmission using the following binary exponential backoff algorithm. The number of slots to delay after the n^{th} retransmission attempt is chosen as a uniformly distributed integer in the range $0 \leq r \leq 2^K$, where $K = \min(n, 10)$.

5. In this phase, we will be interested in plotting the throughput where 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.

1.1 A Sample Execution

In order to understand how the backoff algorithm works it will help you to work though the following problem. We consider 3 hosts operating following the same slotted system described above. Each host maintains 3 variables

L: The number of packets in the queue.

N: The number of times the packet at the head of the queue has been *retransmitted*. When a new packet comes to the head of the queue n is reset to 0.

S: The slot number when the next transmission attempt will be made for the packet at the head of the queue.

Figure 2 shows the state of the variables for the three nodes.

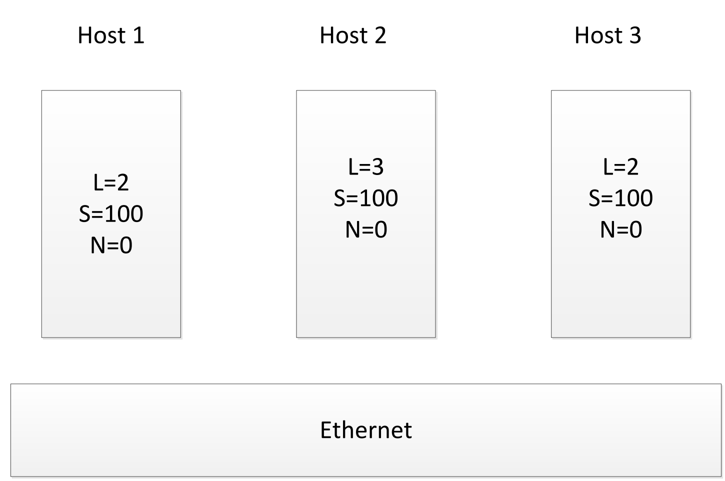

Figure 2: 3 Node Ethernet simulation model

Assuming that all the random numbers are drawn from the following sequence, determine the number of slots required to transmit all the packets from the three nodes.

```
0.6621015449 0.0598288625 0.5979568986 0.0940302045 0.9731501949
0.0662842158 0.5671123588 0.2960073405 0.0836140907 0.1982544372
0.3973937067 0.1825762354 0.7300244789 0.9750743033 0.4226574674
0.7283845034 0.9393420117 0.3463454130 0.0346137777 0.5296165026
0.7221479421 0.4893986084 0.7332225929 0.3619475896 0.3159643647
0.7164982632 0.8700478233 0.4864938182 0.2679576606 0.1540246727
0.5281929232 0.6834302917 0.4536605629 0.7499270914 0.0581091905
0.0344902470 0.6920460807 0.2915925588 0.8664808415 0.7130973549
0.1030703052 0.6871530802 0.7494474363 0.6699161683 0.2188189046
0.5913891383 0.9112765496 0.0002334074 0.5658022752 0.0542878532
```

1.2 Simulation Analysis

Develop a simulation model to simulate a system with $N = 10$ hosts. To develop the simulation model you can build on the single server queue model that you were given for Part 1. You will now have $N = 10$ queues one for each host and there will be one server that will implement the binary exponential backoff algorithm.

Based on the simulation model, obtain the following results:

1. Plot or tabulate the throughput as a function of λ with the binary exponential backoff algorithm as described above. Slot time $T_s = 1$ and number of hosts $N = 10$. Obtain the throughput for the values of $\lambda = 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09$.

2. Do the same as above with the following modification to the binary exponential backoff algorithm: the number of slots to delay after the n^{th} retransmission attempt is chosen as a uniformly distributed integer in the range range $0 \leq r \leq K$, where $K = \min(n, 1024)$. This is linear backoff. Again obtain the throughput for the values of $\lambda = 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09$.

1.3 Deliverables and Other Details for Part 2

The following are the submission guidelines.

1. Group size: 2. One submission per group.

2. Due date for Part 2: 12/2/2016, by 4 PM.

3. Commented Code: Your code should be in simulation2.py. Please submit using handin on the CSIF machines. The command to submit is: handin cs152a hw2 simulation2.py

4. Report+code: Submit a hard copy of the report and the code in the homework box in Kemper 2131. The report should contain plots obtained from the simulations and a short (1-2 paragraphs) analysis of what each result means.