Computer Engineering 4DK4
Lab 4
ALOHA Medium Access Control and Packet Reservation

This lab investigates the performance of the ALOHA media access control protocol. In the provided ALOHA simulation code, the random backoff used by the stations is exponentially distributed with a fixed mean. Performance results are obtained using this simulation for various combinations of numbers of stations and mean backoff. Later in the lab, this is changed so that the mean backoff is chosen dynamically for a given packet using a binary exponential backoff algorithm. The code is then modified so that one station functions differently than the others, which results in preferential treatment. A Slotted-ALOHA version of the protocol is then designed and its performance is characterized. Finally, a packet reservation protocol is simulated where reservation mini-slots are accessed using the S-ALOHA protocol.

1 Preparation

1. An electronic copy of the simulation program must first be obtained. The program consists of a number of C code and header files. You must also include the `simlib.h, simlib.c` and `trace.h` Simlib library files when you compile and link the simulation. A zip file of everything you need is available on the course web site.

2 Experiments

1. As in the other labs first familiarize yourself with the code and with running the simulation. Make sure that you understand how this simulation works. Set `MEAN_PACKET_DURATION` to 1. *In all the experiments make sure you include runs using your McMaster student ID number as the random number generator seed.*

2. Set the `NUMBER_OF_STATIONS` to 10, and generate mean delay versus arrival rate curves for `MEAN_BACKOFF_DURATION` values of 5, 10, and 20. Repeat these experiments when the `NUMBER_OF_STATIONS` is set to 5 using `MEAN_BACKOFF_DURATION` values of 3, 5 and 7.

3. Modify the simulation so that the stations use a *binary exponential backoff*, such as that used in Ethernet. The backoff is chosen uniformly in the range $[0, 2^{N_c})$ packet transmission times, where N_c is the number of collisions that the packet has suffered. Note that in the simulation code there is a packet struct member that already keeps track of the number of collisions that a packet has had. Generate a mean delay versus throughput curve for the 10 and 5 station cases used in Part 2. Compare the results that you obtained using fixed mean backoffs.

4. Modify the simulation from Part 3 so that one particular station always re-transmits an unsuccessful packet in the very next slot (i.e., it persists and does not backoff at all). Compare the mean delay performance of this station versus the mean delay performance of the other stations.

5. Change the simulation so that it operates using Slotted-ALOHA. The best way to do this is to implement a guard time where transmissions start and end ϵ seconds after and before the actual time slot boundaries as shown in Figure 1. Compare the results you get with S-ALOHA to those generated in Part 3. In your results use values of ϵ that are small enough that they have only a negligible affect on the overhead.

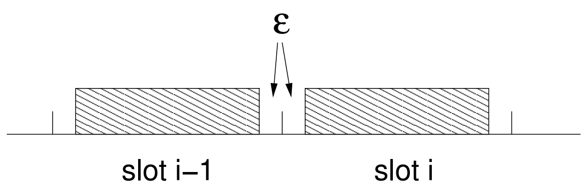

Figure 1: Slotted ALOHA with Guard Times

6. Consider a system where `NUMBER_OF_STATIONS` stations are accessing a shared data channel. When a station has a packet to send (i.e., the packet is at the front of the station's FIFO buffer), it must first transmit successfully on a separate slotted-ALOHA reservation channel. The S-ALOHA channel consists of continuous reservation mini-slots of duration X_r seconds. Once the S-ALOHA transmission is successful, the packet is placed in FCFS order for transmission on the data channel.

   Generate a simulation for this situation. Assume that packets arrive according to a Poisson process as in the supplied code. Also assume that data packet lengths are exponentially distributed, with a mean of X seconds. Generate performance results that show the mean delay experienced by the data packets as a function of other system parameters. Also, generate results that show the capacity of the system for several different values of the ratio X/X_r.

Explain the results that you obtain in all the experiments.

3 Submission

1. Submission format: Each group (maximum of 2 students) must submit a single report.

2. Methodology and data: The writeup must clearly describe all steps performed, include all collected data, and list the random number generator seeds used to produce the graphs.

3. Plots and code: The writeup must include all required plots and a listing of any code modifications.

4. Coverage of results: Unless otherwise specified, performance data and plots must cover the full range of system operation (from low to high traffic load) and show all asymptotes.

5. Analysis of results: For each part, the writeup must include (i) observations from the generated curves and (ii) clear explanations of the trends shown.

6. Plot quality: Plots must be smooth and representative; piecewise linear plots and overfitted curves are not acceptable.