Project2 Report

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Introduction

In the MAC sublayer, Random Access Control is a very important part. There are merely four kinds of Random Access Control protocols: pure ALOHA, slotted ALOHA, CSMA and CSMA/CD. This project will simulate these four protocols to see their transmission efficiency and compare their performance. By doing this, it can be determined which protocol is suitable for a certain situation and helps us to understand how each protocol works.

Pure ALOHA

Theories

ALOHA was devised by Norman Abramson in the 1970s to solve the channel allocation problem. The basic idea of pure ALOHA is that users(or stations) can transimit frames whenever they have, which is totally random. Of course, when different users are transmiting their frames at the same time, those frames will collide and all of them will be damaged. A sender can find out whether its transmission succeed by checking the acknowledgements from the receiver. If the frame was damadged, it waits for a random time and send again.

Given the following parameters:

X: frame transmission time

N: average # of frames genereted per frame time

G: load, average # of transmission attempts per frame time

k: # of transmissions attempts per frame time

P: probablity of a successful frame transmission

S: throughput, average # of successful frames per frame time

We can derive that the probability that k frames are generated during a frame time X is given by the Poisson distribution

$$P(k) = \frac{G^k e^{-G}}{k!}$$

So the probability of zero frames during the $2G$ vulnerable time is

$$P(0)|_{G=2G} = e^{-2G}$$

Then the throughput is given by

$$S = Ge^{-2G}$$

for which the maximum occurs at $G = 0.5$ with $S = 1/2e \approx 0.184$ and the $S - G$ graph is shown on Figure 1.

Assumptions

1. The length of each frame remains the same.
2. There is no propagation delay which means that one user can know whether its frames transmission succeed as soon as it finished its transimission.
3. The probability of an arrival during a short time interval Δt is propotional to the length of interval, and does not depend on the origin of the interval.
4. The probability of having multiple(> 1) arrivals during a short time interval Δt approaches 0;

Simulation

In the simulation program, an two-dimensional array containing 0s and 1s is used to represent states of different users at each short time interval Δt. For example, statest[*userNum*][*slotNum*] is an *userNum*×*slotNum* array, its Nth(0 < N < *userNum*) row represents that the Nth user's states from 0th to (*slotNum*-1)th short time interval. "0" is used when the user is not transmitting data at a certain short time interval and "1" is used otherwise.

The array can be expressed graphically like this:

states[N][M]:

user1: 111111000111111···00000000011111110000000

user2: 001111110000000···000111111000000000111

$\vdots \qquad\qquad\qquad \vdots$

userN: $\underbrace{000000011111100 \cdots 1111110000001111110000}_{\text{M short time intervals}}$