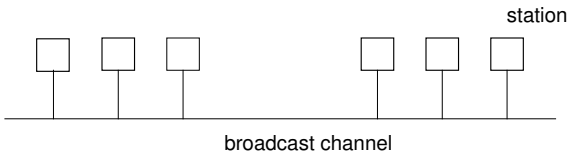
CprE 489
Lecture 25

Fall Semester 1997

Medium Access Control (MAC)

- If instead of a point-to-point channel we have a broadcast channel what do we do to achieve good communication.
- Important in local area networks (LAN) - Ethernet
- Used also for packet radio and cellular telephone networks

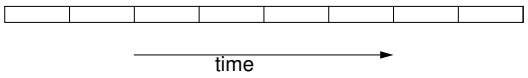
  Metropolitan area networks (MAN)



Some Basic Terminology

- Collision - Several frames sent at nearly the same time collide.
- Collision detection - Collisions can be detected and transmission halted.

- Continuous time - transmissions can happen at any time
- Slotted time - transmissions only happen in time slots.

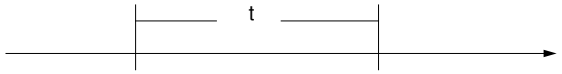


- Carrier sense - the channel can be sensed to see if a transmission is in progress.

The First MAC Protocols - Aloha

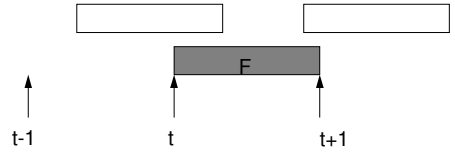
- In the 1970's the university of Hawaii set up a radio network for it different campuses on different islands.
- Frames were sent out by the stations and collisions could be detected and packets resent if necessary.
- A simple analysis uses the Poisson arrival process. Let us assume that frame times are of unit length and they are generated by a Poisson process with an average rate of G frames per second.
- Poisson process: The probability that k frames are generated in an interval t seconds is

$$P(k,t) = \frac{(Gt)^k e^{-Gt}}{k!}$$



Aloha Analysis

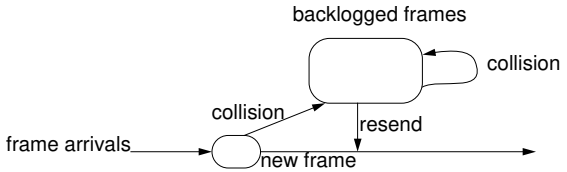
- Suppose a frame F is generated at time t, then the probability that some frame collides with F is the probability that a frame is generated between time t-1 and t+1.



- The probability of no frame generation between time t-1 and t+1 is e^{-2G} .
- The expected rate of frames being generated which are not involved in collisions is Ge^{-2G} . The throughput in frames per second is Ge^{-2G}.
- With slotted Aloha, there will only be a collision if a frame is generated between time t-1 and t.
- The throughput, in frames per second, is Ge^{-G}

How to make Aloha really work

- A new frame needs to be sent. Send it immediately. If later it is learned that the frame did not make it through then declare it backlogged.
- If there is a backlogged frame send one with probability p, where p is fixed less than 1.



Carrier Sense (CSMA)

- In a local area network the channel can be sensed. A station should not send if it hears that the channel is busy. Assume a slotted channel.
- 1-persistent protocol.

  1. Channel free - transmit
     if collision, wait a random increment of time then go to 1.
  2. Channel busy - wait until free
- non-persistent protocol.

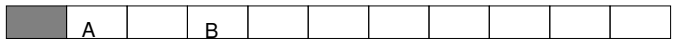
  1. Channel free - transmit
     if collision, wait a random increment of time then go to 1.
  2. Channel busy - wait a random increment of time then go to 1.
- p-persistent protocol.

  1. Channel free - transmit with probability p,
     otherwise wait till next slot and go to 1.
     if collision or transmission, wait a random increment then go to 1
  2. Channel busy - wait until free

Relative Performance

- 1-persistent - Waiters pile up and all transmit at once. Works best under light loads.

- non-persistent - Waiters spead themselves out by getting back into the protocol at different times.



- p-persistent - Poor in light loads and good in heavy loads if p chosen well.