# CSE and EE 461
# Lecture 14

Autumn Quarter 1997



## Medium Access Control (MAC)

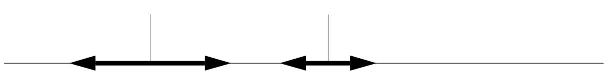
- If instead of a point-to-point channel we have a broadcast channel what do we do to achieve good communication.
- Important in local area networks (LAN) - Ethernet
- Used also for packet radio and cellular telephone networks

  Metropolitan area networks (MAN)

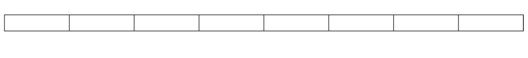



## Some Basic Terminology

- 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.



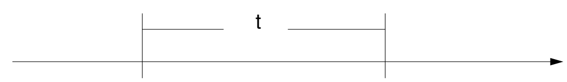

- Carrier sense - the channel can be sensed to see if a transmission is in progress.



## The First MAC Protocols - Aloha

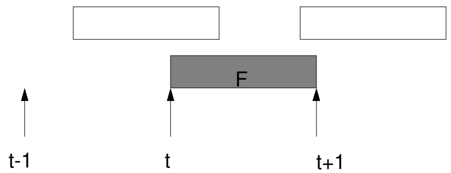
- In the 1970's the University of Hawaii set up a radio network for it different campuses on different islands.
- Frames were sent out by the stations and collisions could be detected and packets resent if necessary.
- A simple analysis uses the Poisson arrival process. Let us assume that frame times 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 that there is no frame generated between time t-1 and t+1 is $e^{-2G}$ . Thus, the expected rate of frames being generated which are not involved in collisions is $Ge^{-2G}$ . That is, the throughput in frames per second is $Ge^{-2G}$.
- Slotted aloha does better - throughput is $Ge^{-G}$.



## 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.

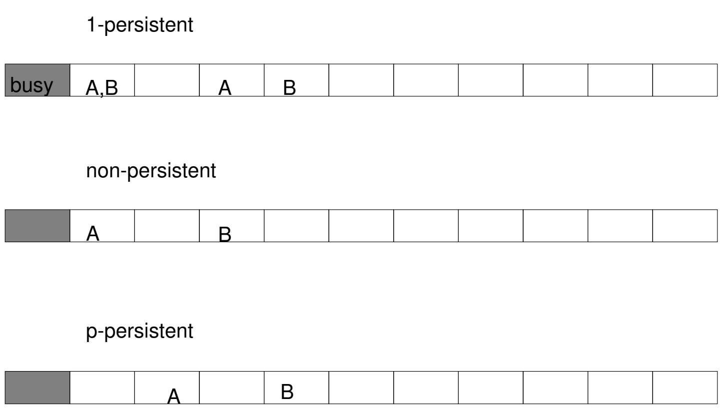
  if channel free - transmit
      if collision, wait a random increment of time
  if channel busy - wait until free
- non-persistent protocol.

  if channel free - transmit
      if collision, wait a random increment of time
  if channel busy - wait a random increment of time
- p-persistent protocol.

  if channel free - transmit with probability p
      if transmission results in collision, wait a random increment of time
  if channel busy - wait until free



## Various Scenarios






## 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. Better under high loads.
- p-persistent - Poor in light loads and good in heavy loads if p chosen well.