CS3200: Computer Networks

Lecture 12

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Broadcast Link

- Till now, we looked at point-to-point links and their protocols.
- Consider a room where six people want to talk to each other, and each one can hear and talk to all the others.
- Channels of the above type are known as **multiaccess channels** or **random access channels**.

Static Channel Allocation

Bandwidth is equally divided among users using multiplexing mechanisms such as FDMA or TDMA.

- If the spectrum is cut up into N regions and fewer than N users are currently interested in communicating, a large piece of valuable spectrum will be wasted.
- If more than N users want to communicate, some of them will be denied permission for lack of bandwidth, even when there are resources to spare.

Static Channel Allocation

Let us start by finding the mean time delay, T, to send a frame onto a channel of capacity C bps.

We assume that the frames arrive randomly with an average arrival rate of λ frames/sec, and that each frame has a length of $1/\mu$ bits.

With these parameters, the arrival rate of the channel is λ/μ bps. Then, the system utilization is given by $\rho = \text{arrival\_rate}/\text{service\_rate} = \lambda/\mu C$.

A standard queueing theory result is

$$T = \frac{1/\text{service\_rate}}{1-\rho} = \frac{1}{C - \lambda/\mu}$$

Static Channel Allocation

Let us divide the single channel into N independent subchannels, each with capacity C/N bps.

Assume that each user has the same input rate. Then, the mean input rate on each of the subchannels will now be λN Then, we have

$$T_N = \frac{1}{C/N - \lambda/\mu N} = NT$$

The mean delay for the divided channel is N times worse than if all the frames were somehow magically arranged orderly in a big central queue.

Dynamic Channel Allocation

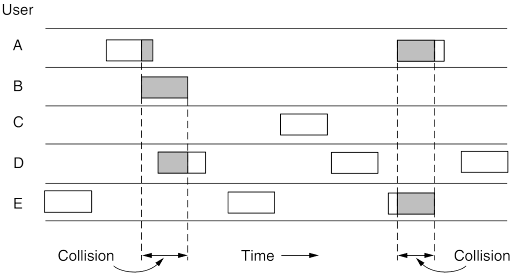
- **Independent Traffic:** N independent stations; expected number of frames generated in an interval of length Δt is $\lambda \Delta t$, where λ is a constant. Once a frame has been generated, the station is blocked and does nothing until the frame has been successfully transmitted.
- **Single Channel:** A single channel is available for all communication. All stations can transmit on it and all can receive from it.
- **Observable Collisions:** If two frames are transmitted simultaneously, they overlap in time and the resulting signal is garbled. This event is called a *collision*. All stations can detect collision.

Dynamic Channel Allocation

- **Continuous or Slotted Time:** If time is continuous, transmission can begin at any instant. Alternatively, time may be slotted, and frame transmissions must at the start of a slot. A slot maybe idle slot, a successful transmission, or a collision.
- **Carrier Sense or No Carrier Sense:** With the carrier sense assumption, stations can tell if the channel is in use before trying to use it. If there is no carrier sense, stations cannot sense the channel before trying to use it. They just go ahead and transmit. .

ALOHA: Pure ALOHA

- Users transmit whenever they have data.
- No carrier sensing
- Collisions are possible
- The central computer rebroadcasts the received frame
- Retransmission occurs after some random amount of time.



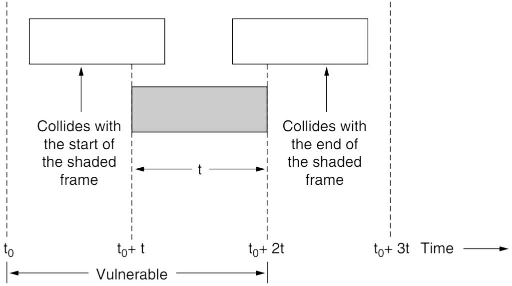
Efficiency of Pure ALOHA

Assumptions

- There is an infinite number of users.
- Frames are generated by the stations according to a *Poisson process* with N frames/sec.
- Time to transmit one frame is T
- In addition to the new frames, the stations also generate re-transmissions of frames that previously suffered collisions. Let the combined frame arrival process be *Poisson* with rate G frames/sec.

The throughput S is the offered load G times the probability of success P_0, i.e., $S = GP_0$.

Efficiency of Pure ALOHA



Probability that k frames are generate during an interval of length t is

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

Thus, we have

$$P_0 = P_0(2T) = e^{-2GT}$$

Efficiency of Pure ALOHA

Thus, we have $S = Ge^{-2GT} \leq 0.184/T$, i.e., maximum throughput is 0.184 frames per frame time.