Networks Notes-26 September

aditya.singh$_u g19$

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- Medium Access Protocols(MACs)
  - Random Access Protocols
    - 1)Slotted Aloha
    - 2)PURE Aloha
    - 3)CSMA/CD

1. **Slotted Aloha (RECAP)**
   - Time line is to be split into fixed duration slots (Synchronization). Let that fixed duration be T.
   - Assume N nodes attached to same material medium.
   - Nodes can transmit frames only at the beginning of a slot.
   - If collision detected then (after transmitting the entire frame) continue to re transmit the subsequent slots (beginning) each time with probability p, untill the frame is transmitted succesfully without collision.
   - **Efficiency**(E) of slotted Aloha- under assumption that at beginning of each slot all n nodes are transmiting with probability p.
     E=1/e=0.37

2. **Pure Aloha**
   - Assume n nodes present in system.
   - Now, nodes are allowed to transmit at any time (affects permormance though)
   - fix a slot of duration T (again sufficiently big enough for complete transmission to all other nodes).
   - Let a node begin transmission at time $t = t_0$.
   - If collision detected, then (after finished transmitting), continue to re transmit at intervals (T)- $t_0 + T, t_0 + 2T, t_0 + 3T....$ each with probability p until the frame gets transmitted successfully without collision.

- Solves the problem of needing synchronization as here nodes can transmit at any time and not only at the beginning of a slot.
- then, for T=1 unit, n being the number of nodes and p being the probability as defined above, and keeping n constant, the probability that a node transmits successfully, or
  $\phi(n,p) = n(1-p)^{n-1}p(1-p)^{n-1}$
  $\phi(n,p) = np(1-p)^{2(n-1)}$

- Now, to find efficiency(E), maximizing for p (assuming n is large)
  $\log\phi(n) = \log n + \log p + 2(n-1)log(1-p)$
  differentiating w.r.t p
  $\dfrac{d\log\phi(n)}{dp} = 0 + 1/p - \dfrac{2(n-1)}{1-p}$
  to maximimize we have $\dfrac{d\log\phi(n)}{dp} = 0$
  $\rightarrow \dfrac{2(n-1)}{1-p} = 1/p$
  $\rightarrow \dfrac{1-p}{p} = 2(n-1)$
  $\rightarrow 1/p - 1 = 2(n-1)$
  $\rightarrow 1/p = 2n-1$
  $\rightarrow p = \dfrac{1}{2n-1}$
  so, we have
  $\phi(n, p = 1/2n-1) = n * \dfrac{1}{2n-1} * (1 - \dfrac{1}{2n-1})^{2(n-1)}$
  $\approx \dfrac{1}{2} * (1 - \dfrac{1}{2n-1})^{2(n-1)}$
  $\approx \dfrac{1}{2e} \approx 0.185$
  We see a reduction in efficiency from slotted Aloha as here E=0.185

3. **CSMA/CD**(tries to solve the problems of Aloha)
   - Two important features of CSMA/CD are-
     - Listen before you begin transmission, basically check is any other node is transmitting (Carrier Sensing).
     - While transmitting, if some other node begins transmitting, then stop/abort your transmission (Collision detection)
   - Again, assumed n nodes are present in the system
   - Assume a node has a frame to transmit
   - STEP 1
     - it starts sensing the medium until it finds that there is no transmission happening in the medium (no transmission energy is detected)

- from this point, it continues to moniter for the next t seconds that there is no transmission taking place.
- it begins transmitting the frame.

- STEP 2
  - if a collision is detected, abort/stop transmitting immediately and transmit a jamming signal
  - The jamming signal could be a 50 bit signal which causes a fluctuation of energy so that all other nodes know that there was a collision in the medium
- STEP 3
  - pick a k $\in \{0, 1, 2, ...2^{m-1}\}$ uniformly at random (like a coin toss), where m is the count of the latest collision
  - wait for $k.t_2$ seconds and go to step 1
  - after 10 collisions we pick k$\in \{0, 1, 2, ...2^{n-1}\}$ again uniformly at random, where $n = min\{m, 10\}$
  - This is called Exponential Backoff
  - Efficiency(E) of CSMA/CD

    E=$\dfrac{1}{1+5\dfrac{P_{max}}{T_{max}}}$

    where,

    P_{max} : max propagation time between any two nodes (out of n)

    T_{max} :Transmission time of a maximum size frame

    Efficiency is max when-

    P_{max} is very low, which means that the network is close ranged in general or

    T_{max} is very high, which means that one frame is transmitting frames one after another and hoarding the medium.

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