Open system Interconnection (OSI)

PRACTICE PROBLEMS BASED ON CSMA / CD AND BACK OFF ALGORITHM

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Problem-01

Q1 After the kth consecutive collision, each colliding station waits for a random time chosen from the interval-

1. (0 to 2^k) x RTT
2. (0 to 2^k-1) x RTT
3. (0 to 2^k-1) x Maximum Propagation delay
4. (0 to 2^k-1) x Maximum Propagation delay

Q2 In a CSMA / CD network running at 1 Gbps over 1 km cable with no repeaters, the signal speed in the cable is 200000 km/sec. What is minimum frame size?

- **Solution**- Given-
  Bandwidth = 1 Gbps, Distance = 1 km, Speed = 200000 km/sec

- **Calculating Propagation Delay:-**
- Propagation delay (Tp) = Distance / Propagation speed
  = 1 km / (200000 km/sec)
  = 0.5 x 10^{-5} sec
- **Calculating Minimum Frame Size:-**
  - Minimum frame size= 2 x Propagation delay x Bandwidth
    = 2 x 5 x $10^{-6} sec \ x 10^{9}$ bits per sec

Q3 A 2 km long broadcast LAN has 10^{7} bps bandwidth and uses CSMA / CD. The signal travels along the wire at 2 x 10^{8} m/sec. What is the minimum packet size that can be used on this network?

1. 50 B
2. 100 B
3. 200 B
4. None of the above

- Solution- Given-
  Distance = 2 km, Bandwidth = 10^7 bps Speed = 2 x 10^8 m/sec
- **Calculating Propagation Delay**
  - Propagation delay (Tp)= Distance / Propagation speed
  - = 2x 10^3 m / (2 x 10^8 m/sec)
- **Calculating Minimum Frame Size**
  - Minimum frame size = 2 x Propagation delay x Bandwidth
    =2 x 10^{-5} sec x 10^7 bits per sec

Q4 A and B are the only two stations on Ethernet. Each has a steady queue of frames to send. Both A and B attempts to transmit a frame, collide and A wins first back off race. At the end of this successful transmission by A, both A and B attempt to transmit and collide. The probability that A wins the second back off race is.

1. 0.5
2. 0.625
3. 0.75
4. 1.0

- **Solution-According to question, we have-**
- 1st Transmission Attempt-
    - Both the stations A and B attempts to transmit a frame.
    - A collision occurs.
    - Back Off Algorithm runs.
    - Station A wins and successfully transmits its 1st data packet.

- 2nd Transmission Attempt-
  - Station A attempts to transmit its 2nd data packet.
  - Station B attempts to retransmit its 1st data packet.
  - A collision occurs.
- Now,
- We have been asked the probability of station A to transmit its 2nd data packet successfully after 2nd collision.
- After the 2nd collision occurs
- **At Station A**-
  - 2nd data packet of station A undergoes collision for the 1st time.
  - So, collision number for the 2nd data packet of station A = 1.
  - Now, station A randomly chooses a number from the range [0,21-1] = [0,1].
  - Then, station A waits for back off time and then attempts to retransmit its data packet.

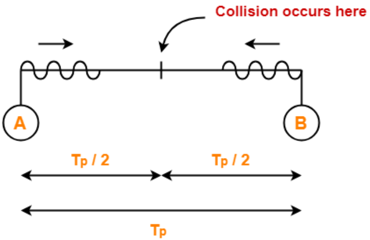
- **At Station B-**
  - 1st data packet of station B undergoes collision for the 2nd time.
  - So, collision number for the 1st data packet of station B = 2.
  - Now, station B randomly chooses a number from the range $[0,2^2\text{-}1] = [0,3]$.
  - Then, station B waits for back off time and then attempts to retransmit its data packet.
- Following 8 cases are possible-

Station A	Station B	Remark
0	0	Collision
0	1	A wins
0	2	A wins
0	3	A wins
1	0	B wins
1	1	Collision
1	2	A wins
1	3	A wins

- From here, Probability of A winning the 2nd back off race = 5 / 8 = 0.625.

Q5 Suppose nodes A and B are on same 10 Mbps Ethernet segment and the propagation delay between two nodes is 225 bit times. Suppose A and B send frames at t=0, the frames collide then at what time, they finish transmitting a jam signal. Assume a 48 bit jam signal.

- **Solution-**
  Propagation delay (Tp) = 225 bit times
  = 225 bit / 10 Mbps
  = 22.5 x 10-6 sec
  = 22.5 μsec
- **At t = 0,**
  - Nodes A and B start transmitting their frame.
  - Since both the stations start simultaneously, so collision occurs at the mid way.
  - Time after which collision occurs = Half of propagation delay.
  - So, time after which collision occurs = 22.5 sec / 2 = 11.25 μsec.



- **At t = 11.25 sec,**
  - After collision occurs at t = 11.25 sec, collided signals start travelling back.
  - Collided signals reach the respective nodes after time = Half of propagation delay
  - Collided signals reach the respective nodes after time = 22.5 sec / 2 = 11.25 sec.
  - Thus, at t = 22.5 sec, collided signals reach the respective nodes.

- **At t = 22.5 sec,**
  - As soon as nodes discover the collision, they immediately release the jam signal.
  - Time taken to finish transmitting the jam signal = 48 bit time = 48 bits/ 10 Mbps = 4.8 sec.
- Thus,
  - Time at which the jam signal is completely transmitted
    = 22.5 sec + 4.8 sec
    = 27.3 sec or 273 bit times

Q6 Suppose nodes A and B are attached to opposite ends of the cable with propagation delay of 12.5 ms. Both nodes attempt to transmit at t=0. Frames collide and after first collision, A draws k=0 and B draws k=1 in the exponential back off protocol. Ignore the jam signal. At what time (in seconds), is As packet completely delivered at B if bandwidth of the link is 10 Mbps and packet size is 1000 bits.

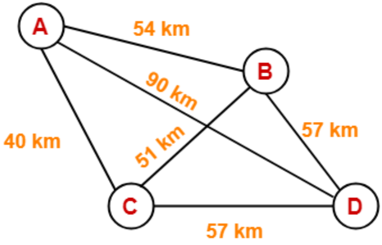
- **Solution**- Given-
  Propagation delay = 12.5 ms, Bandwidth = 10 Mbps, Packet size = 1000 bits
- **Time At Which Collision Occurs-**
  - Collision occurs at the mid way after time = Half of Propagation delay
    = 12.5 ms / 2
    = 6.25 ms
    Thus, collision occurs at time t = 6.25 ms.

- **Time At Which Collision is Discovered-**
  - Collision is discovered in the time it takes the collided signals to reach the nodes = Half of Propagation delay
    = 12.5 ms / 2
    = 6.25 ms
    Thus, collision is discovered at time t = 6.25 ms + 6.25 ms = 12.5 ms.
- **Scene After Collision-**
  - After the collision is discovered,
  - Both the nodes wait for some random back off time.
  - A chooses k=0 and then waits for back off time = 0 x 25 ms = 0 ms.
  - B chooses k=1 and then waits for back off time = 1 x 25 ms = 25 ms.
  - From here, A begins retransmission immediately while B waits for 25 ms.

- **Waiting Time For A-**
  - After winning the back off race, node A gets the authority to retransmit immediately.
  - But node A does not retransmit immediately.
  - It waits for the channel to clear from the last bit aborted by it on discovering the collision.
  - Time taken by the last bit to get off the channel = Propagation delay = 12.5 ms.
  - So, node A waits for time = 12.5 ms and then starts the retransmission.
  - Thus, node A starts the retransmission at time t = 12.5 ms + 12.5 ms = 25 ms.

- **Time Taken in Delivering Packet To Node B-**
  - Time taken to deliver the packet to node B = Transmission delay + Propagation delay
    = (1000 bits / 10 Mbps) + 12.5 ms
    = 100 s + 12.5 ms
    = 0.1 ms + 12.5 ms
    = 12.6 ms
  - Thus, At time t = 25 ms + 12.6 ms = 37.6 ms, the packet is delivered to node B.

Q7 The network consists of 4 hosts distributed as shown below-



- Assume this network uses CSMA / CD and signal travels with a speed of 3 x 10^5 km/sec. If sender sends at 1 Mbps, what could be the minimum size of the packet?
  1. 600 bits
  2. 400 bits
  3. 6000 bits
  4. 1500 bits
- **Solution-**
  - CSMA / CD is a Access Control Method.
  - It is used to provide the access to stations to a broadcast link.
  - In the given network, all the links are point to point.
  - So, there is actually no need of implementing CSMA / CD.
  - Stations can transmit whenever they want to transmit.
- In CSMA / CD, The condition to detect collision is-

  Packet size >= 2 x (distance / speed) x Bandwidth

- To solve the question,
  - We assume that a packet of same length has to be used in the entire network.
  - To get the minimum length of the packet, what distance we should choose?
  - To get the minimum length of the packet, we should choose the minimum distance.
  - But, then collision would be detected only in the links having distance less than or equal to that minimum distance.
  - For the links, having distance greater than the minimum distance, collision would not be detected.
  - So, we choose the maximum distance so that collision can be detected in all the links of the network.
- So, we use the values-
  Distance = 90 km, Speed = 3 x 10^5 km/sec, Bandwidth = 1 Mbps
  - Substituting these values, we get-
    Minimum size of data packet = 2 x (90 km / 3 x 105 km per sec) x 1 Mbps = 600 bits

Thank You