QUIZ –2

CS341: Computer Networks

Time- 1 hr, Total marks-20

1)In a class assignment, students A and B have been asked to implement a channel access protocol for an ad hoc wireless network scenario. Both A and B have studied only CSMA with its variations (CSMA/CA and CSMA/CD). A quarrel arises between the two concerning which protocol should be used. A support using CSMA/CA and B supports CSMA/CD. Who among the two should be given full points for their implementation? Justify your answer with proper reasoning. (2 marks)

ANS: Wireless network uses CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) instead of CSMA/CD (Carrier Sense Multiple Access with Collision Detection) have a shared medium, where devices can hear each other's transmissions. In a wired network, collisions can be detected and handled by the devices involved, but in a wireless network, devices may not be able to detect collisions because of the nature of radio waves. CSMA/CA is a protocol that helps prevent collisions by allowing devices to "listen" to the channel before transmitting, thus reducing the chances of a collision. So, A will get full marks for implementing the CSMA/CA protocol.

2) Suppose four active nodes- A, B, C and D are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability p. The first slot is numbered 1, the second slot is numbered slot 2, and so on. What is the probability that node A succeeds for the first time in slot 4? (2 marks)

ANS: In slotted ALOHA, the probability that a node successfully transmits in each slot is p(1−p) ^n-1, where n is the number of nodes attempting to transmit in that slot. For node A to succeed for the first time in slot 4, it means: Nodes B, C, and D all failed in slots 1, 2, and 3.

The probability of a single node succeeding in a slot is p(1−p) ^n-1, so the probability of all three nodes failing in the first three slots is (1-p) ^3. Then, the probability of node A succeeding in slot 4 is p.

Therefore, the overall probability that node A succeeds for the first time in slot 4 is (1-p) ^3 *p.

3) An upper-layer packet is split into 10 frames, each of which has an 80 percent chance of arriving undamaged to the receiver. If no error control is done by the data link layer protocol, how many times must the message be sent on average to get the entire packet through? (3 marks)

ANS: Since each frame has a chance of 0.8 of getting through, the chance of the whole message getting through is $(0.8)^{10}$, which is about 0.107. Call this value p. The expected number of transmissions for an entire message is then

$$E = \sum_{i=1}^{\infty} ip(1-p)^{i-1} = p\sum_{i=1}^{\infty} i(1-p)^{i-1}$$

To reduce this, use the well-known formula for the sum of an infinite geometric series,

$$S = \sum_{i=1}^{\infty} a^i = \frac{1}{1-a}$$

Differentiate both sides with respect to a to get,

$$S' = \sum_{i=1}^{\infty} ia^{i-1} = \frac{1}{(1-a)^2}$$

Now use a = 1-p to get E = 1/p. Thus, it takes an average of 1/0.107, or about 9.3 transmissions (Rounding to appx. 10 transmissions).

4) Suppose an 802.11b station is configured to always reserve the channel with the RTS/CTS sequence. Suppose this station suddenly wants to transmit 1500 bytes of data, and all other stations are idle. As a function of SIFS and DIFS, and ignoring propagation delay and assuming no bit errors, calculate the time required to transmit the frame and receive the acknowledgement. (3 marks)

ANS:
Assumptions: SIFS (Short Interframe Space) for RTS/CTS= 10 microsec
DIFS (Distributed Interframe Space): 50 microsec
Data Rate= 10 Mbps

RTS Frame size= 20 bytes
CTS frame size=14 bytes
ACK size=14 bytes

RTS Transmission time = RTS frame size / data rate = 20 bytes * 8 bits/ 10Mbps (Assuming data rate=10Mbps) = 160 microsec

CTS Transmission time = CTS frame size / data rate=14bytes *8bits/10 Mbps= 112 microsec

Data Frame size = 1500 bytes
Data Frame Transmission time = 1500 bytes * 8 bits/ 10Mbps = 12,000 microsec
ACK Reception time = 14 bytes * 8 bits / 10 Mbps= 112 microsec
Adding up these times= DIFS + RTS + SIFS + CTS + SIFS + Data frame + SIFS + ACK = Total time=50+160+10+112+10+12000+10+112=12364 microsec

Therefore, the total time required to transmit the frame and receive the acknowledgment in this scenario is approximately 12,364 microsec.

5) Consider a router's output queue (modeled as an M/M/1 queue) that can serve 25000 packets per second (with exponentially distributed packet length). If packets arrive based on a Poisson process with rate 10000 packets per second, determine the values of (5 marks)

Average total delay

Average waiting time in the queue

Total number of jobs in the system

Total number of jobs in the queueing

Probability with which the server remains idle

ANS: Arrival rate (λ) = 10,000 packets per second

Service rate (μ) = 25,000 packets per second

Traffic intensity (ρ) = $\lambda / \mu = 0.4$

Average total delay (D): $1/\mu-\lambda = 1/15000$ sec = $6.66*10^{(-5)}$ sec

Average waiting time (W): $D-1/\mu = 2.66 \times 10^{-5}$ sec

Total number of jobs in the system (N) = $\lambda D = 0.6$

Total number of jobs in the queue= $N - \rho = 0.26$ ($=\lambda W$)

Probability with which the server remains idle = $1-\rho = 0.6$

6) What is the significance of Differentiated Services in network management, and how can this significance be justified? (2 marks)

ANS: Differentiated Services is crucial in network management because it enables the prioritization of network traffic, allowing critical applications like VoIP to receive low latency, reduced packet loss, and minimal jitter. This significance is justified by its ability to enhance Quality of Service, ensuring that real-time applications like VoIP operate smoothly, maintain high call quality, and meet the stringent requirements of time-sensitive communication, delivering an improved user experience.

7) If the inter-arrival time and service time in a public telephone booth with a single phone follow exponential distributions with means of 10 and 8 minutes respectively, Find the average number of callers in the booth at any time. What is the probability that the phone will remain busy? (3 marks)

ANS: λ (arrival rate) = 1 / mean inter-arrival time = 1 / 10 minutes = 0.1 customers per minute.

μ (service rate) = 1 / mean service time = 1 / 8 minutes = 0.125 customers per minute.

The utilization factor (ρ):

$\rho = \lambda / \mu = 0.1 / 0.125 = 0.8$.

The average number of customers in the system (L):

$L = \rho / (1 - \rho) = 0.8 / (1 - 0.8) = 0.8 / 0.2 = 4$.

The probability that the phone will remain busy (Pb), which is the probability that there is at least one customer in the system:

$Pb = 1 - (1 - \rho) = 1 - (1 - 0.8) = 1 - 0.2 = 0.8$.