Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2014-15 (2.0 hours)

EEE6432 Wireless Packet Data Networks and Protocols

1. a. Contention-based: **(6)**

Aloha, CSMA. [2 marks]

Conflict-free: TDMA, Point Coordination Function, FDMA, CDMA. [4 marks]

b. i. 1st: the addition of the persistence process. We need to sense the channel before we start sending the frame by using of the persistence processes. [2 Marks] **(6)**

ii. 2nd: frame transmission. In ALOHA, we first transmit the entire frame and then wait for an ACK. In CSMA/CD, transmission and collision detection are continuous processes. We don't send the entire frame and then look for a collision. The station transmits and receives continuously and simultaneously (using two different ports or a bidirectional port). We use a loop to show that transmission is a continuous process. We continuously monitor in order to detect one of the two conditions: either transmission is finished or a collision is detected. Either event stops transmission. When coming out of loop, if a collision has not been detected, it means that transmission is complete. Otherwise, a collision has occurred. [2 Marks]

iii. 3rd: sending a short jamming signal. [2 Marks]

c. **(8)**

G is the average number of frames generated by the system during one frame transmission time.

a. For a pure Aloha network, the vulnerable time is ($2 \times T_{fr}$), which means that $\lambda = 2G$. $p[x] = (e^{-\lambda} * \lambda^{x})/(x!) = (e^{-2G} * (2G)^{x})/(x!)$ [3 Marks]

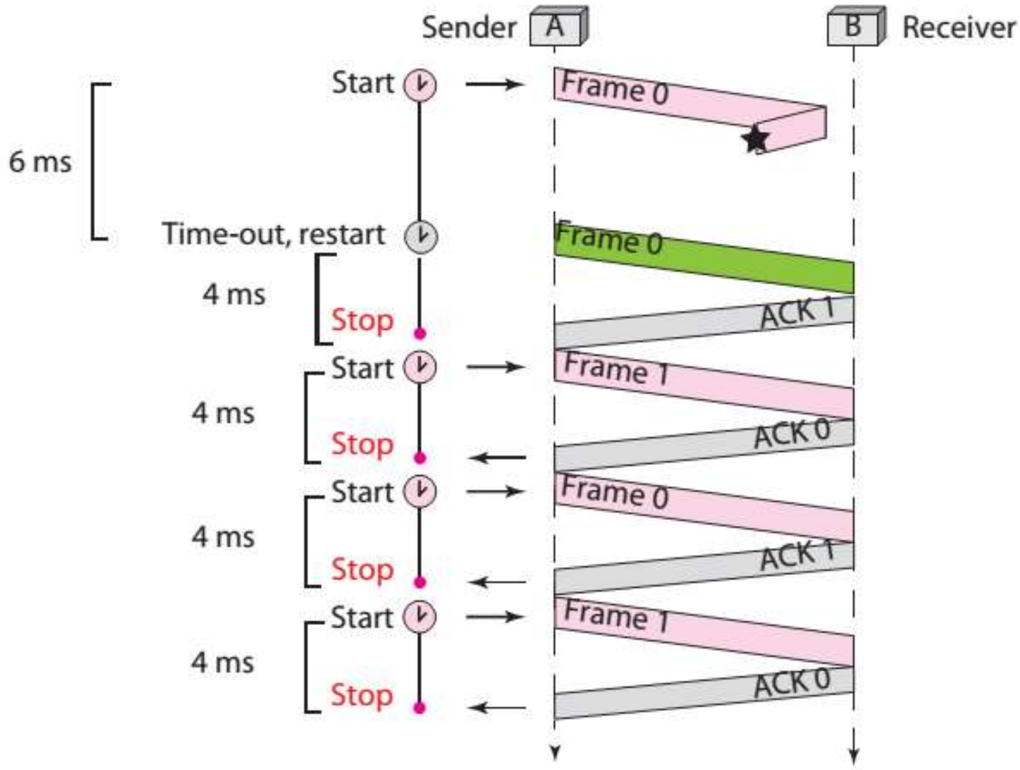
b. For a pure Aloha network, the vulnerable time is $2*T_{fr}$, which means that $\lambda = 2G$. The probability of success for a station is the probability that the rest of the network generates no frame during the vulnerable time. However, since the number of stations is very large, it means that the network generates no frame. In other words, we are looking for p[0] in the Poisson distribution. P [success for a frame] $= p[0] = (e^{-\lambda}) \times \lambda^{0} / (0!) = e^{-\lambda} = e^{-2G}$ [3 Marks]

The throughput for a network is $S = G \times P$[success for a frame]. For a pure Aloha network,P[success for a frame] = e^{-2G}, S = G ×P[success for a frame] =Ge^{-2G} [2 Marks]

2. **a.** Ans.

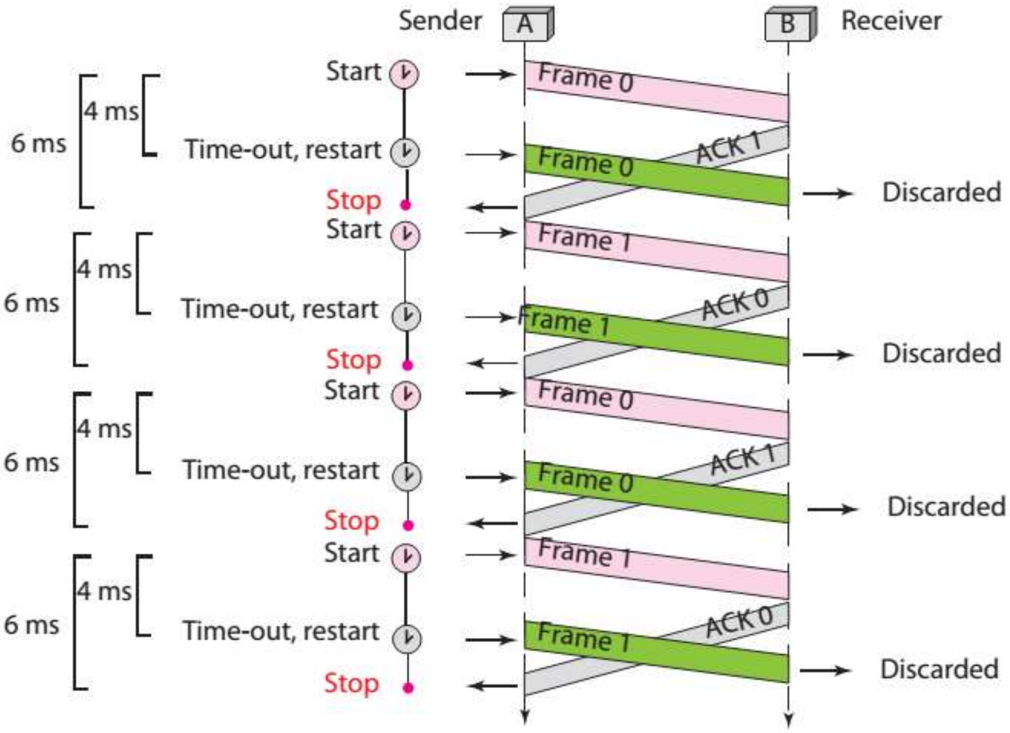
The two main functions of the data link layer are data link control and media access control. Data link control deals with the design and procedures for communication between two adjacent nodes: node-to-node communication. Media access control deals with procedures for sharing the link. **(6)**

b. Ans. The first lost frame [3 Marks]. The other three frames each worth [1 Mark]



(6)

c. Ans. The following figure shows the situation. Here, we have a special situation. Although no frame is damaged or lost, the sender sends each frame twice. The reason is that the acknowledgement for each frame reaches the sender after its timer expires. The sender thinks that the frame is lost. Each correct frame is worth 2 marks. **(8)**



3. **a.** Ans. **(6)**

Cyclic codes are special linear block codes with one extra property. In a cyclic code, if a codeword is cyclically shifted (rotated), the result is another codeword.

(2 Marks)The cyclic codes have a very good performance in detecting single-bit errors, double errors, an odd number of errors, and burst errors. (2 Marks)

They can easily be implemented in hardware and software. They are especially fast when implemented in hardware. (2 Marks)

b. Ans.

If the generator has more than one term and the coefficient of x0 is 1, all single errors can be caught. (3 Marks) **(8)**

A generator that contains a factor of x + 1 can detect all odd-numbered errors. (3 Marks)

If a generator cannot divide $x^t + 1$ (t between 0 and n – 1), then all isolated double errors can be detected. (2 Marks)

c. i) Does it detect a single error? Defend your answer.

(6)

a. It has more than one term and the coefficient of x0 is 1. It can detect a single-bit error. (2 Marks)

ii) Does it detect a burst error of size 6? Defend your answer.

b. The polynomial is of degree 8, which means that the number of check bits

(remainder) r = 8. It will detect all burst errors of size 8 or less. (2 Marks)

iii) What is the probability of detecting a burst error of size 9?

c. Burst errors of size 9 are detected most of the time, but they slip by with probability $(1/2)^{r-1}$ or $(1/2)^{8-1} \approx 0.008$. This means 8 out of 1000 burst errors of size 9 are left undetected. (2 Marks)

4. **a.** I do not agree. [3 Marks] **(6)**

Different services have different quality of service (QoS) requirements. Therefore, from the link budget calculation, the total allowed path loss will be different. Hence, from radio propagation models, we know the cell radius will also be different. Therefore, in a WCDMA network, the coverage for different services (e.g., voice service, 128kbps data service and so on) will also be different. [3 Marks]

b. The capacity of cell A will decrease. [3 Marks] **(6)**

The following equation can be used to calculate uplink capacity for a WCDMA cell

$$(n-1) = \left(\frac{W/R}{E_b/I_o} - P_{thermal}/S\right)\frac{1}{\alpha(1+f)}$$

Where f is defined as the ratio of intercell to intracell interference. When there are more active users (i.e., those who are currently using the network) in cell A's neighbouring cells, f will increase. From the above equation, we can see n will decrease. Therefore, CDMA networks have soft capacity, which means the capacity is not fixed, it depends on how many active users are using the network. [3 Marks]

c.

Ans.

i. Spreading gain N=Tb/Tc=4; [2 Marks]

ii. Spreaded signal 1: -4 spreaded by (1 1 -1 -1) to be (-4 -4 4 4); Spreaded signal 2: 2 spreaded by (1 -1 1 -1) to be (2 -2 2 -2); Composite signal is (-4 -4 4 4)+(2 -2 2 -2)=(-2 -6 6 2). [2 Marks]

iii. Despreaded signa1 1: Composite signal multiply spread code 1, (-2 -6 6 2)x(1 1 -1 -1)= (-2 -6 -6 -2). Despreaded signal 2: (-2 -6 6 2)x(1 -1 1 -1)= (-2 6 6 -2). [2 Marks]

iv. Recovered signal 1: sum((-2 -6 -6 -2))/Nc=-16/4=-4; Recovered signal 2: sum((-2 6 6 -2))/Nc=-8/4=-2. The original signals are accurately recovered due to the orthogonal spread codes. [2 Marks] **(8)**