EE 706: Communication Networks

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Assignment 5 : **30 points** **Due date**: April 6, 2011

1. Consider a four-node wireless network consisting of nodes A, B, C, and D situated on the four corners of a square with side of length 100 m. Each node has a transmission range of 101 m. Assume that all the nodes use the same frequency band to transmit their signals, i.e. a collision occurs if two nodes transmit to the same destination which is in their transmission range.

   (a) Give four examples of the hidden node problem which can arise in this network. [5 points]

   (b) Give two examples of the exposed node problem which can arise in this network. [5 points]

2. The following frames (including the preamble) are observed by a receiving node which is connected to an Ethernet-based LAN. They are shown here in hexadecimal format. [5 points]

   - AAAA AAAA AAAA AAAA FFFF FFFF FFFF 000D 8845 595C 0800 ....
   - AAAA AAAA AAAA AAAB 0018 181C 90C1 001C C0AF AD1A 05DC ....
   - AAAA AAAA AAAA AAAA 0018 181C 90C1 001C C0AF AD1A 08DD ....
   - AAAA AAAA AAAA AAAB 0018 181C 90C1 001C C0AF AD1A 05D0 ....

   For each frame, give the following information.

   (a) What is the minimum number of bits which need to observed to decide the frame format (802.3 Ethernet or DIX Ethernet)?

   (b) What are the source and destination MAC addresses in each frame?

   (c) In which cases can the manufacturer of the destination network card be determined just by looking at the frame?

   (d) What do the last 2 bytes (which are shown) mean for each frame? Give answers specific to the value of the 2 bytes in each case.

3. In binary exponential backoff, the nodes involved in the nth collision randomly wait for $0, 1, 2, \ldots, 2^n - 1$ slots before transmitting. So each node involved in the nth collision generates a random number in the set $\{0, 1, 2, \ldots, 2^n - 1\}$. Suppose three nodes A, B and C are involved in collisions and generate the following random numbers to resolve their collision

   - A: 0, 2, 1

- B: 0, 2, 5, 6
- C: 0, 2, 5, 11

If the first collision occurs at time $t = 0$, the slot size is one second and the frame size is three seconds, when does the successful transmission for each node complete?

[5 points]

4. A hypothetical CSMA/CD system has four copper twisted-pair segments connected together by three repeaters. Each segment is 300 metres long. The one-way processing delay at a repeater is 5 microseconds. We wish to operate this system at 10 megabits per second. If the speed of the signal in copper is 2×10^8 metres per second, what is the minimum size of the frame in such a system which will ensure that a collision never goes undetected? [5 points]

5. Match the following random access MAC protocols to the descriptions below: ALOHA, Slotted ALOHA, 1-persistent CSMA, nonpersistent CSMA, p-persistent CSMA.

[5 points]

   (a) A network has ten nodes. When a node has a frame to send, it listens to the channel. If the channel is idle it sends the frame immediately and if the channel is busy it waits till the end of the ongoing transmission and sends the frame.

   (b) A network has five nodes. When a frame is generated at a node, it waits till the end of the current slot and then transmits the frame.

   (c) A network has eight nodes. When a node has a frame to send, it listens to the channel. If the channel is idle, it sends the frame immediately and if the channel is busy it waits for a random amount of time and listens to the channel again.

   (d) A network has six nodes. When a node has a frame to transmit it just sends the frame.

   (e) A network has seven nodes. When a frame is generated at a node, it waits till the end of the current slot and then listens to the channel. If the slot is busy, it waits till the slot ends and listens to the channel again. If the slot is idle, it is equally likely to transmit its frame or defer until the next frame.