Discussion 11

Chapter 7 (7th edition), # 6, 7, 8

Problem 6

In step 4 of the CSMA/CA protocol, a station that successfully transmits a frame begins the CSMA/CA protocol for a second frame at step 2, rather than at step 1. What rationale might the designers of CSMA/CA have had in mind by having such a station not transmit the second frame immediately (if the channel is sensed idle)?

Suppose that wireless station H1 has 1000 long frames to transmit. (H1 may be an AP that is forwarding an MP3 to some other wireless station.) Suppose initially H1 is the only station that wants to transmit, but that while half-way through transmitting its first frame, H2 wants to transmit a frame. For simplicity, also suppose every station can hear every other station's signal (that is, no hidden terminals). Before transmitting, H2 will sense that the channel is busy, and therefore choose a random back off value.

Now suppose that after sending its first frame, H1 returns to step 1; that is, it waits a short period of times (DIFS) and then starts to transmit the second frame. H1's second frame will then be transmitted while H2 is stuck in back off, waiting for an idle channel. Thus, H1 should get to transmit all of its 1000 frames before H2 has a chance to access the channel. On the other hand, if H1 goes to step 2 after transmitting a frame, then it too chooses a random back off value, thereby giving a fair chance to H2. Thus, fairness was the rationale behind this design choice.

Problem 7

Suppose an 802.11b station is configured to always reserve the channel with the RTS/CTS sequence. Suppose this station suddenly wants to transmit 1,000 bytes of data, and all other stations are idle at this time. 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 acknowledgment.
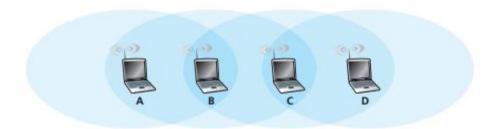
A frame without data is 32 bytes long. Assuming a transmission rate of 11 Mbps, the time to transmit a control frame (such as an RTS frame, a CTS frame, or an ACK frame) is (256 bits)/(11 Mbps) = 23 usec. The time required to transmit the data frame is (8256 bits)/(11 Mbps) = 751

DIFS + RTS + SIFS + CTS + SIFS + FRAME + SIFS + ACK

= DIFS + 3SIFS + (3*23 + 751) usec = DIFS + 3SIFS + 820 usec

Problem 8

Consider the scenario shown in Figure 6.33, in which there are four wireless nodes, A, B, C, and D. The radio coverage of the four nodes is shown via the shaded ovals; all nodes share the same frequency. When A transmits, it can only be heard/received by B; when B transmits, both A and C can hear/receive from B; when C transmits, both B and D can hear/receive from C; when D transmits, only C can hear/receive from D. Suppose now that each node has an infinite supply of messages that it wants to send to each of the other nodes. If a message's destination is not an immediate neighbor, then the message must be relayed.

For example, if A wants to send to D, a message from A must first be sent to B, which then sends the message to C, which then sends the message to D. Time is slotted, with a message transmission time taking exactly one-time slot, e.g., as in slotted Aloha.

During a slot, a node can do one of the following:
   (i)   send a message;
   (ii)   receive a message (if exactly one message is being sent to it),
   (iii)   remain silent. As always, if a node hears two or more simultaneous transmissions, a collision occurs and none of the transmitted messages are received successfully. You can assume here that there are no bit-level errors, and thus if exactly one message is sent, it will be received correctly by those within the transmission radius of the sender.

   a) Suppose now that an omniscient controller (i.e., a controller that knows the state of every node in the network) can command each node to do whatever it (the omniscient controller) wishes, i.e., to send a message, to receive a message, or to remain silent. Given this omniscient controller, what is the maximum rate at which a data message can be transferred from C to A, given that there are no other messages between any other source/destination pairs?
   b) Suppose now that A sends messages to B, and D sends messages to C. What is the combined maximum rate at which data messages can flow from A to B and from D to C?
   c) Suppose now that A sends messages to B, and C sends messages to D. What is the combined maximum rate at which data messages can flow from A to B and from C to D?
   d) Suppose now that the wireless links are replaced by wired links. Repeat questions (a) through (c) again in this wired scenario.
   e) Now suppose we are again in the wireless scenario, and that for every data message sent from source to destination, the destination will send an ACK message back to the source (e.g., as in TCP). Also suppose that each ACK message takes up one slot. Repeat questions (a) – (c) above for this scenario.

a) 1 message / 2 slots
b) 2 messages / slot
c) 1 message / slot
d) i) 1 message / slot
   ii) 2 messages/slot

iii) 2 messages/slot

e) i) 1 message/4 slots

    ii) ~~slot 1: Message A→ B, message D→ C~~

       ~~slot 2: Ack B→ A~~   **1msg/slot**

       ~~slot 3: Ack C→ D~~

           ~~= 2 messages/ 3 slots~~

    iii)

      slot 1: Message C→ D

      slot 2: Ack D→C, message A→ B   Repeat

      slot 3: Ack B→ A

      = 2 messages/3 slots