CHAPTER 6

PRACTICE SET

Questions

Q6-1. The medium of a wired LAN is guided (cable or wire); the medium of a wireless LAN is unguided (air).

Q6-3. Propagation in a wireless LAN is not confined as in a wired LAN. In a wired LAN, propagation is confined to the wires. Most of the original power may reach the destination. In a wireless LAN, the power is distributed in a sphere with the sender at the center and the receiver at one point on the surface. Only a part of the power arrives at the receiver; the rest is lost in the air.

Q6-5. In a wireless environment, a receiving station may receive more than one signal from the same sender related to the same message. One of these signals can be the one received directly; the others are signals reflected back from some barrier. Since the signals have travelled different distances, they can be out of phase (see Chapter 7). The combination of these signals creates a signal which is the distorted version of the original signal sent by the sender. It is sometimes difficult to detect the original message. We often have difficulty understanding the other party when talking on a cellular phone

Q6-7. We can mention the following:

a. The station senses the medium until it is idle before even trying to send a frame.

b. The exchange of RTS and CTS lets other stations to know that the channel will be locked for a time (NAV). After sending each frame or fragment, the ACK's D subfield defines the rest of the time that the channel should be locked.

c. Each frame, or fragment, needs to be acknowledged to be sure that there was no collision.

d. If a frame is lost or corrupted, the lack of the ACK informs the sender to resend the lost frame. Each frame exchanged defines the remaining period that the other stations need to refrain from sending.

Q6-9. The lack of collision in CSMA/CD serves as an indication that data arrived safely. In CSMA/CA, the sending station does not check the possibility of collision; an acknowledgment is needed to insure that a collision did not occur and the frame arrived at its destination.

Q6-11. Error rate is much higher in a wireless LAN than in a wired LAN. Fragmentation reduces the frame size and reduces the probability of error in a frame.

Q6-13. The answer is negative. The addresses are selected from the same address space. For example, if locally there are one wireless and one wired device, they cannot have the same MAC address; addresses should be unique.

Q6-15. In a wired network, a link-layer switch is connected to the hosts via point-to-point dedicated connections; there is no need for addresses for communication between hosts and the switch. In a wireless network, an AP is connected to the hosts via a multicast network (air); the MAC addresses of the host and the AP make the communication more efficient; when a host sends a frame to the AP, all other hosts drop the received copy of the frame at the MAC sublayer when they find that the frame does not belong to them.

Q6-17. A piconet is the smallest ad hoc network. It is made of one primary (master) station and up to seven secondary (slave) stations. A scatternet is a larger ad hoc network made by gluing two or more piconets using one of the secondary stations in one piconet to act as the primary station in another piconet.

Q6-19. The allocated band for Bluetooth is the ISM 2.4 GHz band, which actually spans from 2.4 GHz to 2.4835 GHz. This means that the bandwidth is actually 0.0835 GHz or 83.5 MHz.

Q6-21. The 83.5 MHz bandwidth in Bluetooth is divided into 79 channels, each of 1 MHz. The rest of the bandwidth is used for guard bands.

Q6-23. The modulation technique is GFSK (FSK with Gaussian bandwidth filtering). The carrier frequencies are 2042 + *n* MHz, in which *n* can be 0 to 79 (in most countries).

Q6-25. The *L2CAP* layer has a role similar to the LLC sublayer in a LAN. It provides multiplexing, segmentation and reassembly, quality of service, and group management.

Q6-27. Stations share the available bandwidth of a link in frequency in FDMA.

Q6-29. Allocation is not static; it is dynamic. Normally a central station (such as MSC in cellular telephony) allocates a band for each direction (to allow bidirectional communication) during the call setup. For example, if Alice calls Bob and Bob answers, a band, B1, is set for communication from Alice to Bob, and another band, B2, is set for communication from Bob to Alice. Alice talks on B1 and listens on B2; Bob talks on B2 and listens on B1.

Q6-31. Allocation is not static; it is dynamic. Normally a central station (such as MSC in cellular telephony) allocates a code for each direction (to allow bidirectional communication) during the call setup. For example, if Alice calls Bob and Bob answers, a code, c1, is set for communication from Alice to Bob, and another code, c2, is set for communication from Bob to Alice. Alice encodes her message with c1 and decodes Bob's message with c2; Bob encodes his message with c2 and decodes Alice's message with c1.

Q6-33. The number of sequences should be a power of two if we want the code to be orthogonal. We, therefore, need to use the following number of sequences in each system.

a. $8 = 2^3$ **b.** $16 = 2^4$ **c.** $32 = 2^5$

Q6-35.

a. AMPS belongs to the first generation. It was an analog system developed in the USA.

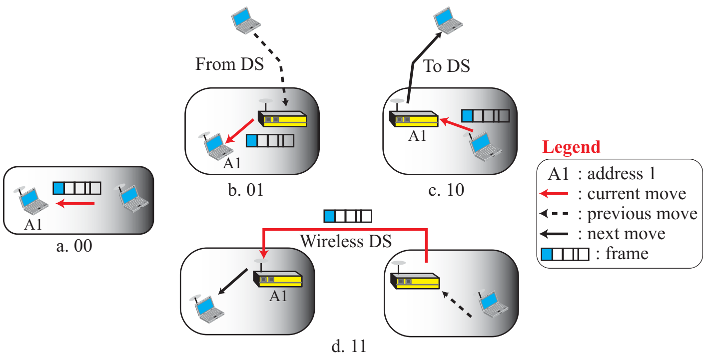
b. D-AMPS belongs to the second generation. It was the digital version of AMPS and backward compatible with it.

c. IS-95 belongs to the second generation.

Q6-37. An ICMP solicitation message has all the necessary fields to be used as an agent solicitation. No extra fields are needed.

Problems

P6-1. Address 1 in 802.11 always defines the destination address in the current movement of the frame in the wireless environment. The following figure shows address 1 in all four situations:



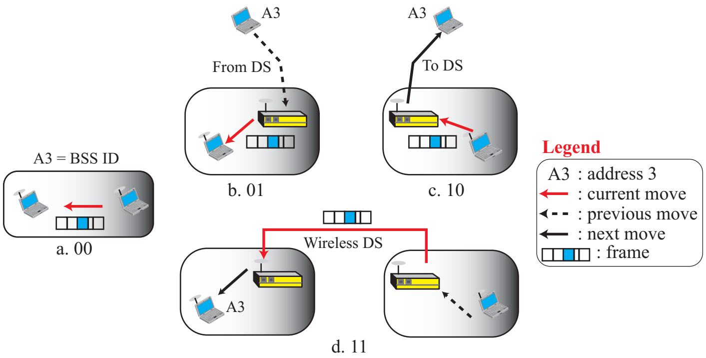
a. When both *To DS* and *From DS* bits are 0s, the communication is confined to the BSS. The frame has not entered the BSS before the current movement and will not leave the BSS after the current movement. We have an ad hoc network; the communication is between two stations, which means address 1 is the address of the destination host.

b. When *To DS* is 0 but *From DS* is 1, the frame is coming from a distribution system (DS). The frame has entered the BSS and is travelling from the AP to the destination station. Address1 is the address of the destination host.

c. When *To DS* is 1 but *From DS* is 0, the frame is going to a distribution system (DS). The frame is travelling inside the BSS, but is supposed to leave the AP and go to the DS. Address 1 is the address destination in the current move, which is the AP.

d. When both *To DS* and *From DS* bits are 1s, the frame is travelling in the DS itself, which is wireless. A frame is going from one AP in the source BSS to another AP in the destination BSS, but we are interested in the address field when the frame is travelling in the wireless DS. Address 1 is the address of the AP in the destination BSS.

P6-3. In 802.11, what address 3 defines depends on the type of the network. In an ad hoc, address 3 defines the BSS identification. In an infrastructure network, it either defines the address of the source in the previous move or the address of the destination in the next move, whichever is appropriate. The following figure shows address 3 in all four situations:



a. When both the *To DS* and *From DS* bits are 0s, the communication is confined to the BSS. The frame has not entered the BSS before the current movement and will not leave the BSS after the current movement. We have an ad hoc network; the communication is between two stations. Address 3 will set to the BSS ID to emphasize that the frame belongs to this BSS. Other BSSs that may accidentally receive the frame will discard it.

b. When *To DS* is 0 but *From DS* is 1, the frame is coming from a distribution system (DS). The frame has entered the BSS and is travelling from the AP to the destination station. Address 3 is the address of the device (station or router) that originally sent the 802.3 frame. This address is needed for the final destination in case a response is needed.

c. When *To DS* is 1 but *From DS* is 0, the frame is going to a distribution system (DS). The frame is travelling inside the BSS, but is supposed to leave the AP and go to the DS. Address 3 is the address of the device (host or router) in the DS. This address helps the AP to create an 802.3 frame to send to the DS.

d. When both the *To DS* and *From DS* bits are 1s, the frame is travelling in the DS itself, which is wireless. A frame is going from one AP in the source BSS to another AP in the destination BSS, but we are interested in the address field when the frame is travelling in the wireless DS. Address 3 is the address of the final destination host in the destination BSS. This address helps the AP to know the destination of the frame that will travel in the second BSS.

P6-5. We need to remember that the exchanged frames do not leave the BSS. All addresses are addresses of entities inside the BSS. With this in mind, we answer each question:

a. Since the exchanged frames do not leave the BSS, the values of both the *To DS* and *From DS* bits in all frames are set to 0s. No frame comes from a distribution system (*From DS* = 0) and no frame goes to a distribution system (*To DS* = 0).

b. The RTS frame needs to be sent by the station that wants to send the data frame, station A in this case. There are two addresses in this frame (address 1 and address 2). The value of address 1 is the recipient of the data frame that follows (address 1 = B's address); the value of address 2 is the address of the station that will send the data frame (address 2 = A's station). Note that since the channel is a broadcast channel, every nonhidden station will receive the RTS frame, but address 1 emphasizes that station B needs to respond to the RTS frame.

c. The CTS frame needs to be sent by the future recipient of the data frame, which is station B in this case. The value of address 1 in this frame (the only address field) is the address of the intended recipient of the CTS frame, which is station A. All stations that are not hidden from B also receive this frame.

d. After receiving the CTS frame, station A can send the data frame. The value of the address 1 field in this frame is the address of the recipient of the frame, which is station B. The value of the address 2 field is the address of the station sending the frame, which is station A. Address 3 in this case is the address of any entity involved in the communication besides the sender and receiver. Since there is no other entity involved, the address chosen is the BSS identification, which has the same format as other MAC addresses. This identification is used here to show that the communication should be confined to this BSS. Stations in other BSSs should drop this frame if it is accidentally received by them. The value of the address 4 field is not used in this case because the frame does not leave the BSS.

e. The ACK frame needs to be sent by the recipient of the data frame, station B in this case. The value of the address 1 in this frame is the address of the station that sent the data frame, address A.

P6-7. We show the value of addresses in each communication phase:

a. Communication from station A to the AP1 occurs in a wireless environment (802.11). However, since the frame needs to go to the distribution system ultimately, the value of the *To DS* bit is set to 1, but the value of the *From DS* bit is zero.The situation is the same as the previous problem. The addresses are as follows:

Address 1: AP1	**Address 2: A**	**Address 3: C**	**Address 4: —**

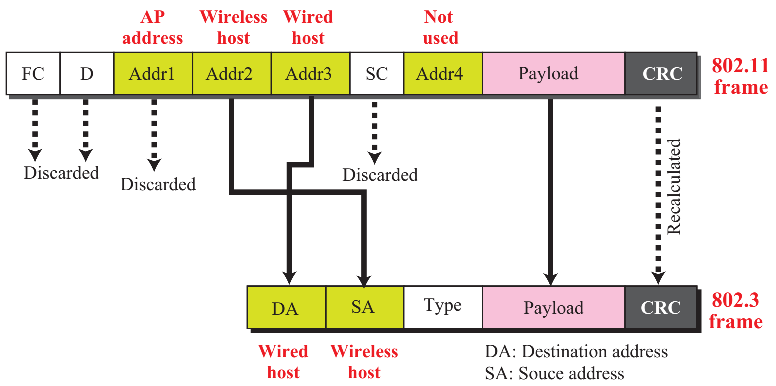
b. Communication from the AP1 to the AP2 now occurs in a wireless environment; we need to consider four addresses. However, since the frame needs to go to the distribution system and comes from the distribution system, the value of both *To DS* bit and *From DS* are set to 1s. Address 1 is the address of the immediate receiver, which is the address of the AP2. Address 2 is the address of the immediate sender, which is the AP1. Address 3 is the address of the final destination which is station C. Address 4 is the address of the original source, which is station A. The addresses are shown below:

Address 1: AP2	**Address 2: AP1**	**Address 3: C**	**Address 4: A**

c. Communication from the AP2 to station C occurs in a wireless environment (802.11) again. However, since the frame comes from a distribution system, the value of the *To DS* bit is set to 0, but the value of the *From DS* bit is 1. We need to consider four addresses. This is the same as the previous problem. Addresses are shown below:

Address 1: C	**Address 2: AP2**	**Address 3: A**	**Address 4: —**

P6-9. The following shows how the fields in the 802.3 frame are filled, by the AP, from the fields of the 802.3 frame. The values of some fields are discarded.



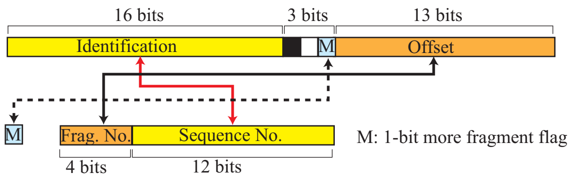
P6-11. The following shows the steps:

a. The host knows the IP address of its default router (address of interface m2). It may also know the MAC address of this interface (in its cache). Otherwise, the AP2 needs to send an ARP frame to discover. The host encapsulates its IP datagram in an 802.11 frame in which address 1 is the MAC address of the AP2 and address 2 is its own MAC address. Address 3 in this case is the MAC address of the router (interface m2). The frame is sent to the AP2.

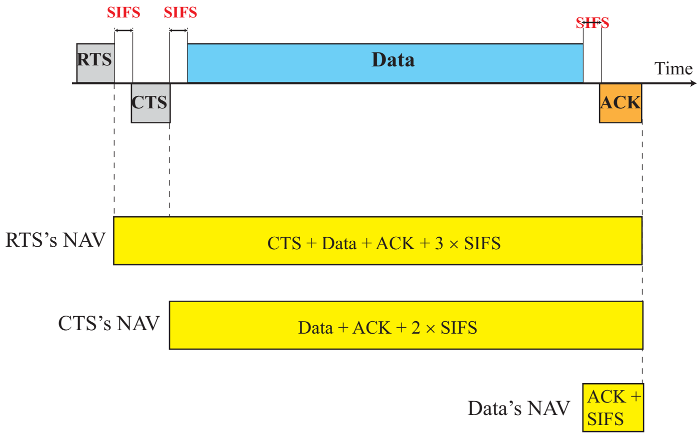
b. The AP2 receives the frame and changes the frame format. It now creates an 802.3 frame in which the destination address is a copy of address 3 and the source address is a copy of address 2 (the original host).

P6-13. DCF is using a version of the Stop-and-Wait protocol we discussed in Chapter 3. Each frame is considered as one or more fragments. In other words, if a frame is not fragmented, it is considered as the first and only fragment. Each fragment needs to be individually acknowledged by an ACK frame. The sender does not send the fragment until it receives the acknowledgment for the previous frame. The sender sets a timer, and if the acknowledgment for a fragment does not arrive, it resends it. The Stop-and-Wait protocol (used in this case), however, is simpler than the one we discussed in Chapter 3 because, in this case, no sequence number and no acknowledgment number is used. Although a data frame has the SC field, the sequence number and fragment number defined there are actually the identification number and offset that define each fragment uniquely for the purpose of reassembly.

P6-15. IP uses three fields in the header for fragmentation (see Chapter 4): *identification* (16 bits), *flags* (3 bits), and *offset* (13 bits). The 802.11 protocol uses three subfields in the header for this purpose: *fragment number* (4 bits), *sequence number* (12 bits), and *more fragment* (1 bit). The *fragment number* and *sequence number* subfields are part of the *sequence control* (SC) field; the *more fragment* subfield is part of the *frame control* (FC) field. The following shows the relationship between the fields in the two protocols:



P6-17. To better understand the value of the NAV that needs to be set for each frame, we first show the time line for the transactions and the NAV (ignoring the propagation delay) in the following figure.



Based on the figure, we have the following NAV durations:

a. RST = 4 + 40 + 4 + 3 × 1 = 51 μs.

b. CST = 40 + 4 + 2 × 1 = 46 μs.

c. Data = 4 + 1 = 5 μs.

d. ACK = 0 μs. After the ACK is transmitted, there is no need for channel reservation.

P6-19. We describe the procedure for each station:

a. Station A wins the contention and can start using the channel.

b. Station B needs to wait four slots and test the channel again. If the channel is idle, it can use the channel; otherwise, it should start the procedure again.

c. Station C needs to wait 20 slots and test the channel again. If the channel is idle, it can use the channel; otherwise, it should start the procedure again.

P6-21. We describe each IFS below:

a. The short interframe space (SIFS) is used to allow the two parties in a single session to continue their transmission. This includes the time that a party needs to send a CTS after receiving an RTS, sending an ACK after receiving a data fragment, or sending the next fragment after receiving the ACK for the previous fragment. It cannot be used to start a new session.

b. The base station that needs to send a beacon or poll frame (in PCF mode) needs to wait for a PIFS period of time to do so. PIFS is longer than SIFS to allow other stations to finish their sessions. However, if a time period of SIFS elapses and the entitled station did not use its opportunity, the base station can send its beacon or poll frame (after waiting PIFS) if it has one.

c. If a base station does not use its opportunity after PIFS time and a time equal to DIFS elapses, a station using DCF can start a new dialog. You may have noticed that PIFS is smaller than DIFS to give priority to the PCF sublayer.

d. An EIFS is normally used when there is an error in transmission and the station needs to wait this period of time to report the situation. This period is larger than the other ones to force the station to wait to see if the error is corrected before an action. For example, if a station has received a wrong frame, it needs to wait for a while to see if the correct frame will eventually arrive.

P6-23. The address subfield in the header field is only 3 bits:

a. With a 3-bit address field, the address domain is in the range of 0 to 7.

b. Since the size of the address domain is only 8, we can have only 8 active stations in a Bluetooth network.

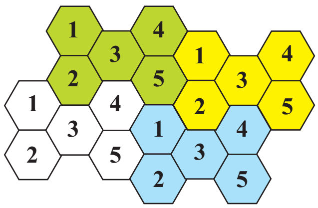
P6-25. We need to check three properties: number of sequences in each chip, dot product of any pair of chips, and dot product of each chip with itself.

a. The number of sequences, $N = 4$, is a power of 2.

b. [+1, −1, −1, +1] • [−1, +1, +1, −1] = (−1) + (−1) + (−1) + (−1) = − 4. It should be 0.

The code does not pass the second properties; it is not orthogonal.

P6-27. The figure below shows one possibility.



P6-29. The maximum simultaneous calls per cell for D-APMS is 356. Using the total bandwidth of 50 MHz (for both directions), we have

Efficiency = 356 / 50 = 7.12 calls/MHz

P6-31. The maximum simultaneous calls per cell for IS-95 is 1100. Using the total bandwidth of 50 MHz (for both directions), we have

Efficiency = 1100 / 50 = 22 calls/MHz

P6-33. Globalstar satellites are orbiting at 1400 km above the Earth's surface. Considering the radius of the earth, the radius of the orbit is then (1400 km + 6378 km) = 7778 km. Using Kepler's law, we have

$$\text{Period} = (1/100)\ (\text{distance})^{1.5} = (1/100)\ (7778)^{1.5} = 6860\ \text{s} = 1.9\ \text{hours}$$

P6-35. See the following figure:

ICMP Advertisement Message			
16	8	1456	
10800		0	Reserved

P6-37. See the following figure:

4	5	0	length	
42			0	0
15		Protocol	Header checksum	
200.4.7.14				
130.45.6.7				
Data				