6GZ71004 Advanced Computer Networks & Operating Systems
Lab 9: Wireless communication

Question 1: Consider five wireless stations, *A*, *B*, *C*, *D*, and *E*. Station *A* can communicate with all other stations. *B* can communicate with *A*, *C* and *E*. *C* can communicate with *A*, *B* and *D*. *D* can communicate with *A*, *C* and *E*. *E* can communicate *A*, *D* and *B*.
(a) When *A* is sending to *B*, what other communications are possible?
(b) When *B* is sending to *A*, what other communications are possible?
(c) When *B* is sending to *C*, what other communications are possible?

Question 2: Six stations, *A* through *F*, communicate using the MACA protocol. Is it possible for two transmissions to take place simultaneously? Explain your answer.

Question 3: CSMA/CA (CSMA with Collision Avoidance) is conceptually similar to Ethernet's CSMA/CD (CSMA with Collision Detection). Provide the two main differences between the two protocols.

Question 4: Describe using a suitable diagram the Hidden Terminal Problem Hidden and the Exposed Terminal Problem in wireless networks that rely on **CSMA/CA**. Draw a Message Sequence Chart (MSC) for these two scenarios.

Question 5: Both the hidden and exposed terminal problems lead to degradation of throughput. Explain how.

Question 6: Consider the hidden and exposed terminal problems. In the topology given below, there is a line connecting two nodes if they are within transmission/interference range of one another. Node-1 is transmitting to Node-2, and Node-2 is receiving from Node-1. While this transmission is going on, for each node, state which nodes it can successfully transmit to or receive from? More specifically, fill out a table similar to the table below. At each row, list which nodes can successfully transmit to the node in the first column, and which nodes can successfully receive from the node in the first column. Insert "None" when transmission or receiving is not possible for a node. *Do not make any assumptions on multicast, multihop, CS or RTS/CTS.*

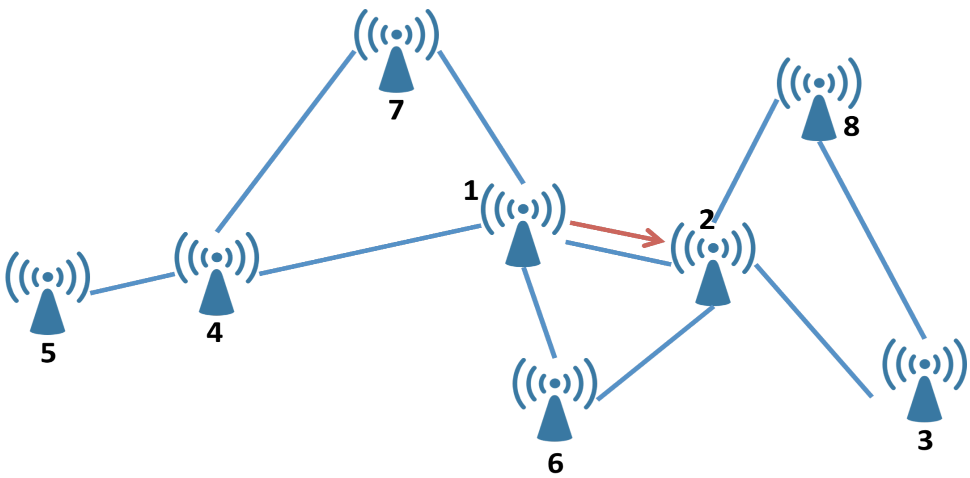

Figure 3. Network topology

Node #	Can Transmit Successfully to:	Can Receive Successfully from:
3		
4		
5		
6		
7		
8		

Question 7: In Fig. 4, four stations, *A*, *B*, *C*, and *D*, are shown. Which of the last two stations do you think is closest to *A* and why?

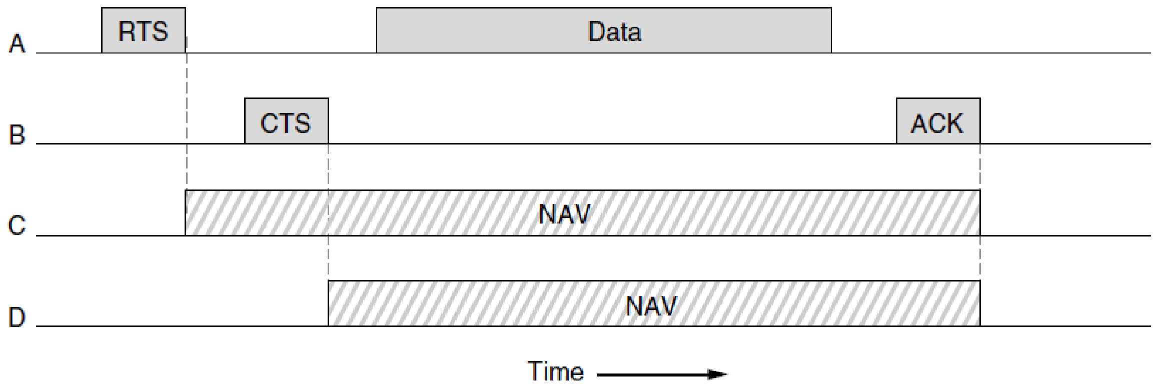

Figure 4. Virtual channel sensing using CSMA/CA

Note: *To reduce ambiguities about which station is sending, 802.11 defines channel sensing to consist of both physical sensing and virtual sensing. Physical sensing simply checks the medium to see if there is a valid signal. With virtual sensing, each station keeps a logical record of when the channel is in use by tracking the* ***NAV (Network Allocation Vector)****. Each frame carries a NAV field that says how long the sequence of which this frame is part will take to complete. Stations that overhear this frame know that the channel will be busy for the period indicated by the NAV, regardless of whether they can sense a physical signal. For example, the NAV of a data frame includes the time needed to send an acknowledgement. All stations that hear the data frame will defer during the acknowledgement period, whether or not they can hear the acknowledgement.*

Question 8: Give an example to show that the RTS/CTS in the 802.11 protocol is a little different than in the MACA protocol.

Question 9: Give two reasons why networks might use an error-correcting code instead of error detection and retransmission.

Question 10: What are the differences between the following types of wireless channel impairments: path loss, multipath propagation, interference from other sources?

Question 11: Describe the role of the beacon frames in 802.11.

Question 12: Suppose the IEEE 802.11 RTS and CTS frames were as long as the standard

DATA and ACK frames. Would there be any advantage to using the CTS and RTS frames? Why or why not?

Question 13: Suppose there are two ISPs providing WiFi access in a particular café, with each ISP operating its own AP and having its own IP address block.
a. Further suppose that by accident, each ISP has configured its AP to operate over channel 11. Will the 802.11 protocol completely break down in this situation? Discuss what happens when two stations, each associated with a different ISP, attempt to transmit at the same time.
b. Now suppose that one AP operates over channel 1 and the other over channel 11. How do your answers change?

Question 14: 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)?

Question 15: 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.

Question 16: Consider the scenario shown in Figure 5, 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 neighbour, 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.

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.

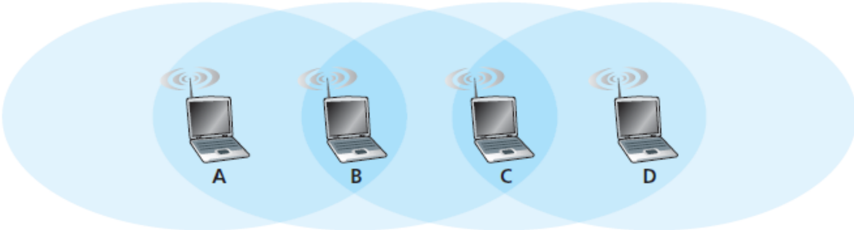

Figure 5. Network scenario