

CSC 450/550 Midterm Fall 2005

A . (20%) Multiple choices. For each question, there may be multiple correct choices. You must select all correct statement(s) to get the mark, and one incorrect choice will make you lose the whole mark for the question. So be very careful.

1. (5%) Select all correct statement(s) regarding different types of service.
- a) Reliable service must be connection-oriented service.
 - b) Connectionless service cannot guarantee correct message delivery.
 - c) Circuit switch provides connection-oriented service.
 - d) Since a MAC sublayer protocol is to achieve efficient communication between machines that are directly connected with a wire or a wireless channel, the service provided by a MAC sublayer protocol must be connection-oriented service.

Answer: [c]

2. (5%) Select all correct statement(s) regarding data link layer protocols and MAC sublayer protocols.
- a) If the physical layer is very reliable and can always provide correct transmission, flow control will be unnecessary at the data link layer.
 - b) Ethernet LAN uses CSMA/CD but IEEE 802.11 uses CSMA/CA to solve channel contention.
 - c) The MAC sublayer protocol is to solve channel contention among multiple hosts and decide who gets to use the channel in a broadcast network.
 - d) The purpose of a MAC sublayer protocol is to solve contention among multiple hosts, so error control is not required.

Answer: [b, c]

3. (5%) Select all correct statement(s) regarding codes.
- a) To detect d errors, a code with Hamming distance of $d+1$ is required.
 - b) To correct d errors, a code with Hamming distance of $2d$ is required.
 - c) A code in which a single parity bit is appended to the data can be used to detect any single-bit error.
 - d) Error correction codes are better than error detection codes in all cases since error correction codes can correct errors while error detection codes can only detect errors.

Answer: [a, c]

4. (5%) Select all correct statement(s) regarding data link layer protocols.
- a) In the go-back-n protocol, the larger the sender's sliding window size, the better the channel utilization.
 - b) In sliding window protocols, the sender's maximum sliding window size should be always larger than the receiver's maximum sliding window size.
 - c) In sliding window protocols, the receiver's window always remains at its initial size.
 - d) In the go-back-n protocol, the receiver's window cannot be larger than 1.

Answer: [c, d]

B. (20%) Suppose that the following bit string is received by the data link layer from the network layer: 1101011011. Assume that the generator polynomial is $x^4 + x + 1$.

- (a) (10%) Calculate the CRC code for the above bit string.

See Textbook Page 198.

- (b) (10%) Assume that from the left the third bit, the sixth bit, and the seventh bit are inverted during transmission. Can the receiver detect the errors? You need to justify your answer in order to get the mark.

No. The receiver cannot detect the errors whenever the error pattern is divisible by the generator polynomial. In our case, the received bit stream will be (11010110111110 + 00100110000000). Since both 11010110111110 and 00100110000000 are divisible by the generator polynomial 10011, the remainder will be 0 and the errors cannot be detected.

C. (20%) Assume that the selective repeat data link protocol uses 3-bit sequence number. When the lower and the upper edges of the sender's sliding window are 6 and 1, respectively, what will be the lower and upper edges of the receiver's sliding window?

Denote the lower and upper edges of the receiver's sliding window as R_l and R_u respectively. $R_l \geq 6$ or $R_l \leq 2$, that is, R_l could be 6, 7, 0, 1, or 2. Since for selective repeat, the receiver's window size is fixed as 4 when the sequence number is 3 bits, R_u must be 1, 2, 3, 4, or 5 correspondingly.

D. (20%) Consider an error-free 64-kbps satellite channel used to send 512-byte data frames in one direction, with very short acknowledgements coming back the other way. What is the maximum throughput for window sizes of 1 and 127? The earth-satellite propagation time is 270 msec.

This is Q. 31 in page 246 of the textbook.

Assume that the transmission starts at $t=0$. At $t=4096/64000 = 0.064$ s = 64 msec, the last bit is sent. At $t=334$ msec, the last bit arrives at the satellite and the very short ACK is sent (the transmission time of ACK is negligible). At $t=604$ msec, the ACK arrives at the earth. Therefore, within 604 msec, 4096 bits are sent.

For window size of 1, the throughput is $4096 \text{ bits} / 604 \text{ msec} = 6781 \text{ bps}$.

Continuous transmission can only occur if the transmitter is still sending when the first ACK gets back at $t=604$ msec. In other words, if the window size is greater than 604 msec worth of transmission, it can run at full speed. For a window size of 10 ($0.604 / (4096/64000) \approx 10$) or greater, this condition is met. So for any window size of 10 or greater (e.g., 127), the data rate is at full speed, i.e., 64 kbps.

E. (20%) A 1-km-long, 10-Mbps CSMA/CD LAN has a propagation speed of 200m/μsec. Repeaters are not allowed in this system. Data frames are 256 bits long, including 32 bits of header, checksum, and other overhead. The first bit slot after a successful transmission is reserved for the receiver to capture the channel in order to send a 32-bit acknowledgement frame. What is the effective data rate, excluding overhead, assuming that there are no collisions?

This is Q.19 in page 340 of the textbook.

The round-trip propagation time of the cable is $1000/200 * 2 = 10 \mu\text{sec}$. A complete transmission has six phases:

1. transmitter seizes cable (10 μsec)
2. transmit data ($256/1\text{Mbps} = 25.6 \mu\text{sec}$)
3. delay for last bit to get to the end (half of round-trip time = 5 μsec)
4. receiver seizes cable (10 μsec)
5. acknowledgement sent ($32/1\text{Mbps} = 3.2 \mu\text{sec}$)
6. delay for the last bit of the ACK to get to the end (half of round-trip-time = 5 μsec)

The sum of these is 58.8 μsec. In this period, 224 (= 256 - 32) data bits are sent. So the effective data rate is: $224 \text{ bits} / 58.8\mu\text{sec} \approx 3.8 \text{ Mbps}$.

(Note that since "the first bit slot after a successful transmission is reserved for the receiver to capture the channel," there is no contention and thus no delay between step 3 and step 4.)