

Homework Assignment 3: 100 points

Due date: Nov. 15, 2022 (Tuesday)

Question 1: (20 points)

- (a) Regarding the error detection mechanism in data link layer, please specify two different error detection mechanisms used in the data link layer. (5 points)
- (b) Regarding the cyclic redundancy check (CRC), suppose that the bit-stream is $D = "101110000"$ and the generator is $G = "1001"$. Please calculate the residual bit-stream R . (5 points)
- (c) Based on the solution in (b), suppose that $\langle D, R \rangle$ is sent by the source-host. However, the destination-host receives $"101010000000"$. Can the errors in the received bit-stream (i.e., $"101010000000"$) be detected? Please explain your solution. (5 points)
- (d) Based on the solutions in (b) and (c), what is the advantage of cyclic redundancy check compared to the parity checking? (5 points)

Solution:

(a) the parity checking, and cyclic redundancy check

(b) $R = "011"$

(c) Yes, since at the destination-host, the residual bit-stream is non-zero

$$\begin{array}{r} 1001 \overline{) 101110000} \\ \underline{1001} \\ 1110 \\ \underline{1001} \\ 1110 \\ \underline{1001} \\ 1110 \\ \underline{1001} \\ 1110 \\ \underline{1001} \\ 1110 \\ \underline{1001} \\ 111 \end{array}$$

(d) cyclic redundancy check can detect the error with more than one bit error.

Question 2: (20 points)

- (a) Regarding different types of multiple access protocol (MAC), please specify two examples of MAC which are based on the rationale of "taking turns". (5 points)
- (b) Please specify three examples of MAC which are based on the rationale of "random access". (5 points)
- (c) Please specify the difference between the slotted ALOHA and ALOHA, and which one (i.e., the slotted ALOHA or ALOHA) is more efficient and why? (10 points)

Solution:

(a) polling and token-passing

(b) slotted ALOHA, ALOHA, CSMA, CSMA/CD, and CSMA/CA

(c) The slotted ALOHA requires all hosts to be synchronized in a common time-slotted structure. All hosts send the packets of a same size, each host can only send the packet at the beginning of a

slot and end its transmission at the end of the slot. ALOHA does not require the hosts to be synchronized in a common time-slotted structure, although all hosts send the packets of a same size. The slotted ALOHA is more efficient than ALOHA, since the time-slotted structure can reduce the number of the collisions.

Question 3: (20 points)

- (a) Regarding the carrier sense multiple access (CSMA), what is the advantage of CSMA compared to ALOHA? (5 points)
- (b) Can CSMA completely avoid collisions? Please explain your solution. (5 points)
- (c) What are the differences between CSMA/CD and CSMA/CA? (5 points)
- (d) What is the purpose of binary exponential back-off in CSMA? (5 points)

Solution:

- (a) Carrier sensing can reduce the number of collisions
- (b) CSMA cannot completely avoid collision, since the signal propagation requires some delay.
- (c) CSMA/CD means collision detection, which is usually used in wired networks, CSMA/CD means collision avoidance, which is usually used in wireless networks.
- (d) binary exponential back-off is used when collision happens CSMA, and its purpose is to reduce the probability of future collisions.

Question 4: (25 points)

Regarding the MAC address

- (a) What is the binary form of the MAC address of “1A-2F-BB-76-09-AD”? (5 points)
- (b) What is the special meaning of the MAC address of “FF-FF-FF-FF-FF-FF”? (5 points)
- (c) What the difference between the MAC address and IP address? (5 points)
- (d) As shown in Figure 1, suppose that host A sends a datagram to host B. Will the source/destination IP addresses be changed when the datagram traverses through the router R? (5 points)
- (e) As shown in Figure 1, suppose that host A sends a datagram to host B. Will the source/destination MAC addresses be changed when the frame traverses through the router R? (5 points)

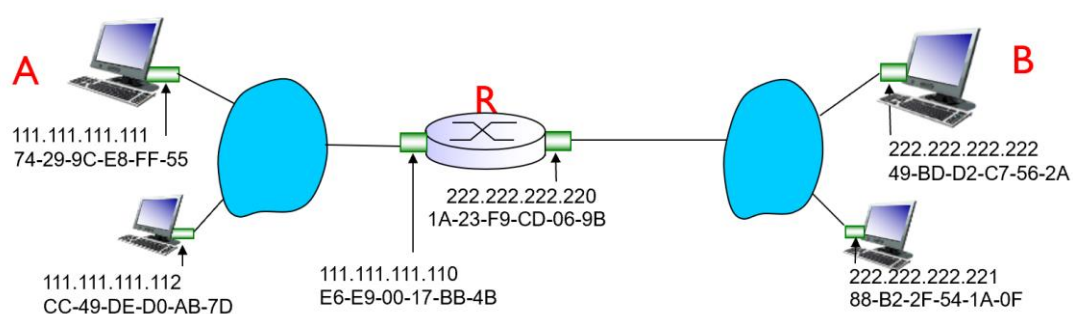


Figure 1

Solution:

- (a) “1A-2F-BB-76-09-AD” means 00011010 00101111 10111011 01110110 00001001 10101101
- (b) “FF-FF-FF-FF-FF-FF” means that this frame is a broadcasting frame, namely, every host should receive this frame.
- (c) MAC address is used by the data link layer, and it can be regarded as a “physical address” which cannot be changed. IP address is used by the network layer and for forwarding the datagram from

source host to the destination (via multiple routers). IP can be regarded as a “logic address” which may vary according to the subsets where the hosts are.

(d) No, the source/destination IP addresses will not be changed

(e) Yes, the source/destination MAC addresses be changed

From A to R: Source MAC: 74-29-9C-E8-FF-55 and Destination MAC: E6-E9-00-17-BB-4B

From R to B: Source MAC: 1A-23-F9-CD-06-9B and Destination MAC: 49-B-D2-C7-56-2A

Question 5: (15 points)

(a) What does “ARP” refer to? (5 points)

(b) Suppose that host A aims at sending a datagram to host B in a same LAN. Host A knows host B’s IP address. However, host A does not know host B’s MAC address. Please specify the procedures when host A runs ARP to obtain host B’s MAC address. (10 points)

Solution:

(a) “ARP” means address resolution protocol.

(b) The detailed steps are as follows.

1. Host A broadcasts ARP query packet, which contains host B’s IP address and sets the destination MAC address = FF-FF-FF-FF-FF-FF.
2. All nodes in the same LAN receive this ARP query. Host B receives ARP packet and replies to host A with its (B’s) MAC address and sends a frame using host A’s MAC address as the destination MAC address.
3. Host A receives this frame and thus knows host B’s MAC address. Host A records host B’s MAC address in its local ARP table.