Solutions to Sample Questions on Link Layer

1) What are some of the possible services that a link-layer protocol can offer to the network layer? Which of these link-layer services have corresponding services in IP and TCP?

Answer: framing: there is also framing in IP and TCP; link access; reliable delivery: there is also reliable delivery in TCP; flow control: there is also flow control in TCP; error detection: there is also error detection in IP and TCP; error correction; full duplex: TCP is also full duplex.

2) Show by a virtue of an example other than the one in Figure 5.6 of the textbook that two-dimensional parity checks can correct and detect a single bit error. Also, show an example of a double-bit error that can be detected but not corrected.

Answer: Suppose we begin with the initial two-dimensional parity matrix:

0 0 0 0
1 1 1 1
0 1 0 1
1 0 1 0

With a bit error in row 2, column 3, the parity of row 2 and column 3 is now wrong in the matrix below:

0 0 0 0
1 1 0 1
0 1 0 1
1 0 1 0

Now, suppose there is a bit error in row 2, column 2 and column 3. The parity of row 2 is now correct! The parity of columns 2 and 3 is wrong, but we can't detect in which rows the error occurred!

0 0 0 0
1 0 0 1
0 1 0 1
1 0 1 0

The above example shows that a double bit error can be detected (if not corrected).

3) Why would the token passing protocol be inefficient if a LAN had a very large perimeter?

Answer: When a node transmits a frame, the node has to wait for the frame to propagate around the entire ring before the node can release the token. Thus, if *L/R* is small as compared to t$_{prop}$, then the protocol will be inefficient.

4) How big is the MAC address space, the IPv4 address space and the IPv6 address space?

Answer: 2^{48} MAC addresses; 2^{32} IPv4 addresses; 2^{128} IPv6 addresses.

5) Why is an ARP query sent within a broadcast frame? Why is an ARP response sent within a frame with a specific destination MAC address?
Answer: An ARP query is sent in a broadcast frame because the querying host does not which adapter address corresponds to the IP address in question. For the response, the sending node knows the adapter address to which the response should be sent, so there is no need to send a broadcast frame (which would have to be processed by all the other nodes on the LAN).

6) Suppose that you had to design a 100 Mbps CSMA/CD protocol in which the maximum one-way propagation delay between any two hosts is 100 x 10^{-6} sec. What will you use as the minimum size of a transmitted frame if you wish the transmitting node to detect a collision before completing the transmission of the frame?

Answer: The minimum size of the frame should be such that the transmission of a frame will take at least 2 x 100 x 10^{-6} sec, the round trip propagation delay. The minimum frame size therefore is 200 x 100 x 10^{-6} bits or 2500 bytes.

7) In CSMA/CD, after the fifth collision, what is the probability that a node chooses *K=4*? The result *K=4* corresponds to a delay of how many seconds on a 10Mbps Ethernet?

Answer: After the 5th collision, the adapter chooses from {0, 1, 2, …, 31}. The probability that it chooses 4 is 1/32. It waits 204.8 microseconds.

8) Suppose nodes A, B and C each attach to the same broadcast LAN through their adapters, If A sends thousands of IP datagrams to B with each encapsulating frame addressed to the MAC address of B, will C's adapter process these frames? If so, will C's adapter pass the IP datagrams in these frames to C (that is, the adapter's parent node)? How would your answers change if A sent frames with the MAC broadcast address?

Answer: C's adapter will process the frames, but the adapter will not pass the datagrams up the protocol stack. If the LAN broadcast address is used, then C's adapter will both process the frames and pass the datagrams up the protocol stack.

9) Consider Figure 5.24 in the textbook (the picture with 6 nodes connected in a star topology to a central bridge). Suppose that (i) A sends a frame to D, (ii) D replies with a frame to A, (iii) C sends a frame to D, (iv) D replies with a frame to C. The switch table is initially empty. Show the state of the switch table before and after each of these events. For each of these events, identify the link(s) on which the transmitted frame will be forwarded, and briefly justify your answers.

Answer:

Action	Switch Table State	Link(s) packet is forwarded to	Explanation
A sends a frame to D	Switch learns interface corresponding to MAC address of A	B, C, D, E, and F	Since switch table is empty, so switch does not know the interface corresponding to MAC address of D
D replies with a frame to A	Switch learns interface corresponding to MAC address of D	A	Since switch already knows interface corresponding to MAC address of A
C sends a frame to D	Switch learns the interface corresponding to MAC address of C	D	Since switch already knows the interface corresponding to MAC address of D
D replies with a frame to C	Switch table state remains the same as before	C	Since switch already knows the interface corresponding to MAC address of C