Homework for Chapter 5

1. Are there any circumstances when connection-oriented service will (or at least should) deliver packets out of order? Explain.

   Solution:

   Yes.

   Interrupt signals should skip ahead of data and be delivered out of sequence.

2. Consider the network of Fig. 5-12(a). Distance vector routing is used, and the following vectors have just come in to router C: from B : $(5, 0, 8, 12, 6, 2)$; from D : $(16, 12, 6, 0, 9, 10)$; and from E : $(7, 6, 3, 9, 0, 4)$. The cost of the links from C to B, D, and E, are 6, 3, and 5, respectively. What is C's new routing table? Give both the outgoing line to use and the cost.

   Solution:

   Going via B : $(5, 0, 8, 12, 6, 2)$ gives (11, 6, 14, 18, 12, 8).
   Going via D : $(16, 12, 6, 0, 9, 10)$ gives (19, 15, 9, 3, 12, 13).
   Going via E : $(7, 6, 3, 9, 0, 4)$ gives (12, 11, 8, 14, 5, 9).

   Taking the minimum for each destination except C gives (11, 6, 0, 3, 5, 8).
   The outgoing lines are $(B, \underline{B}, , \underline{D}, \underline{E}, B)$.

3. A router has the following (CIDR) entries in its routing table:

Address/Mask	**NextHop**
135.46.56.00/22	Interface 0
135.46.60.00/22	Interface 1
192.53.40.0/23	Router 1
Default	Router 2

   For each of the following IP addresses, what does the router do if a packet with that address arrives?

   (a) 135.46.63.10
   (b) 135.46.57.14
   (c) 135.46.52.2
   (d) 192.53.40.7
   (e) 192.53.56.7

   Solution:

   (a) 135.46.63.10: I1.
   (b) 135.46.57.14: I0
   (c) 135.46.52.2: R2
   (d) 192.53.40.7: R1.
   (e) 192.53.56.7: R2.

4. A datagram network allows routers to drop packets whenever they need to. The probability of a router discarding a packet is p. Consider the case of a source host connected to the source router, which is connected to the destination router, and then to the destination host. If either of the routers discards a packet, the source host eventually times out and tries again. If both host-router and router-router lines are counted as hops, what is the mean number of

   a. hops a packet makes per transmission?
   b. transmissions a packet makes?

c. hops required per received packet?

Solution:

a. The mean number of hops a packet makes per transmission:

$$1 \times p + 2 \times (1-p)p + 3 \times (1-p)(1-p) = p^2 - 3p + 3.$$

b. Let $q = (1-p)^2$.
The mean number of transmissions a packet makes

$$1 \times q + 2 \times (1-q)q + 3 \times (1-q)^2 q + \cdots = \frac{1}{q} = \frac{1}{(1-p)^2}.$$

c. The mean number of hops required per received packet

$$\frac{p^2 - 3p + 3}{(1-p)^2}.$$

5. Consider the user of differentiated services with expedited forwarding. Is there a guarantee that expedited packets experience a shorter delay than regular packets? Why or why not?

Solution:

No.
Too many expedited packets.

6. Suppose that host A is connected to a router R_1, R_1 is connected to another router, R_2, and R_2 is connected to host B. Suppose that a TCP message that contains 900 bytes of data and 20 bytes of TCP header is passed to the IP code at host A for delivery to B. Show the *Total length, Identification, DF, MF*, and *Fragment offset* fields of the IP header in each packet transmitted over the three links. Assume that link $A - R_1$ can support a maximum frame size of 1024 bytes including a 14 byte frame header, link $R1 - R_2$ can support a maximum frame size of 512 bytes, including an 8 byte frame header, and link $R_2 - B$ can support a maximum frame size of 512 bytes including a 12 byte frame header.

Solution:

IP payload = 900 + 20 = 920 bytes.

Frame payload = 920 + 20 = 940 bytes.

link $A - R_1$:
Length = 940; ID = x; DF = 0; MF = 0; Offset =0.

link $R_1 - R_2$:

(1) Length = 500; ID = x; DF = 0; MF = 1; Offset =0

(2) Length = 460; ID = x; DF = 0; MF = 0; Offset = 60.

link $R_2 - B$: (1) Length = 500; ID = x; DF = 0; MF = 1; Offset =0 (2) Length = 460; ID = x; DF = 0; MF = 0; Offset = 60.

7. A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle?

Solution:

240 (dec) = 11110000 (bin).
$2^4 - 2 = 14$ hosts

8. A router has just received the following new IP addresses: 57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21, and 57.6.120.0/21. If all of them use the same outgoing line, can they be aggregated? If so, to what? If not, why not?

Solution:

57.6.96.0/19.

9. Many companies have a policy of having two (or more) routers connecting the company to the Internet to provide some redundancy in case one of them goes down. Is this policy still possible with NAT? Explain your answer.

   Solution:

   As long as the same connection between the host inside the NAT and the host outside the NAT goes through the same NAT router, no problem.

10. You have just explained the ARP protocol to a friend. When you are all done, he says: "I've got it. ARP provides a service to the network layer, so it is part of the data link layer." What do you say to him?

    Solution:

    ARP does not provide a service to the network layer, it is part of the network layer and helps provide a service to the transport layer.

11. In IP, the checksum covers only the header and not the data. Why do you suppose this design was chosen?

    Solution:

    An error in the header is much more serious than an error in the data. A bad address, for example, could result in a packet being delivered to the wrong host. Many hosts do not check to see if a packet delivered to them is in fact really for them. They assume the network will never give them packets intended for another host.

    Data is sometimes not checksummed because doing so is expensive, and upper layers often do it anyway, making it redundant here.

12. IPv6 uses 16 byte addresses. If a block of 1 million addresses is allocated every picosecond, how long will the addresses last?

    Solution:

$$\frac{2^{16\times 8}}{\frac{10^6}{10^{-12}}}\text{second} = 3.403\times 10^{20}\text{second} = 1.079\times 10^{13}\text{year.}$$

13. One of the solutions ISPs use to deal with the shortage of IPv4 addresses is to dynamically allocate them to their clients. Once IPv6 is fully deployed, the address space is large enough to give every device a unique address. To reduce system complexity, IPv6 addresses could be assigned to devices permanently. Explain why this is not a good idea.

    Solution:

    Routing table would be huge.

14. The *Protocol* field used in the IPv4 header is not present in the fixed IPv6 header. Why not?

    Solution:

    The *Protocol* field tells the destination host which protocol handler to give the IP packet to. Intermediate routers do not need this information, so it is not needed in the main header.

    The *Next* header field of the last (extension) header is used for this purpose.

15. When the IPv6 protocol is introduced, does the ARP protocol have to be changed? If so, are the changes conceptual or technical?

    Solution:

    Conceptually, no change.

    Technically, bigger fields (128 bits) are needed.