Computer Networks
Problem Set 5

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Chapter 5. The Network Layer

5.1 Give two example computer applications for which connection-oriented service is appropriate. Now give two examples for which connectionless service is best.

5.2 Datagram networks route each packet as a separate unit, independent of all others. Virtual-circuit networks do not have to do this, since each data packet follows a predetermined route. Does this observation mean that virtual-circuit networks do not need the capability to route isolated packets from an arbitrary source to an arbitrary destination? Explain your answer.

5.3 Assuming that all routers and hosts are working properly and that all software in both is free of all errors, is there any chance, however small, that a packet will be delivered to the wrong destination?

5.4 Show that the count-to-infinity problem shown in Figure 1 (Figure 5.10(b) in the textbook) can be solved by having routers add to their distance vectors the outgoing link for every destination and cost pair. For example, in Figure 1 (Figure 5.10(a) in the textbook), node C not only advertises a route to A with distance 2, it also communicates that this path goes through node B. Show the distances

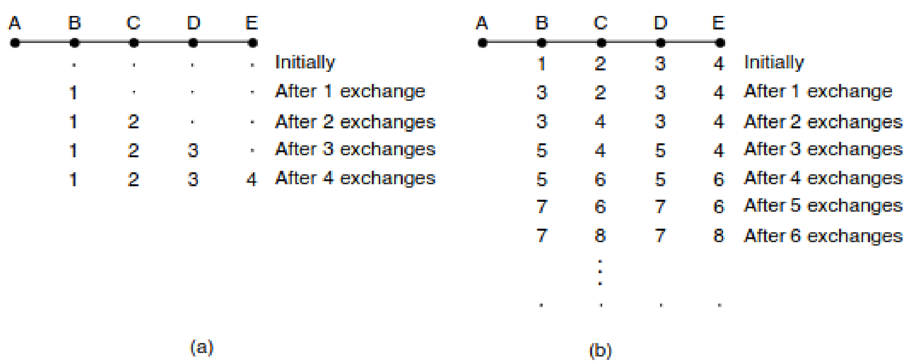

Figure 1: Exercise 5.4

5.5 Sketch a network topology different from the one in Figure 1 (Figure 5.10 in the textbook) for which including the next hop does not solve the count-to-infinity problem if node A fails.

5.6 Consider the network of Figure 2 (Figure 5.12(a) in the textbook). Distance vector routing is used, and the following link state packets have just come in at router D: from A: (B: 5, E: 4); from B: (A: 4, C: 1, F: 5); from C: (B: 3, D: 4, E: 3); from E: (A: 2, C: 2, F: 2); from F: (B: 1, D: 2, E: 3). The cost of the links from D to C and F are 3 and 4 respectively. What is D's new routing table? Give both the outgoing line to use and the cost.

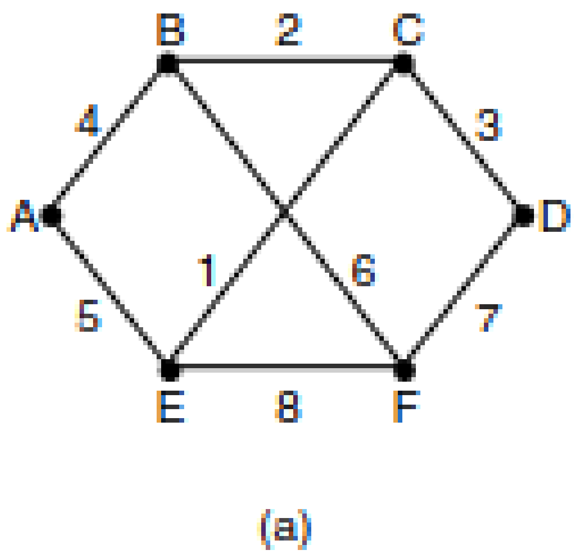

Figure 2: Exercise 5.6

5.7 Consider the network of igure 2 (Figure 5.12(a) in the textbook). 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.

5.8 Explain the difference between routing, forwarding, and switching.

5.9 For hierarchical routing with 4800 routers, what region and cluster sizes should be chosen to minimize the size of the routing table for a three-layer hierarchy? A good starting place is the hypothesis that a solution with k clusters of k regions of k routers is close to optimal, which means that k is about the cube root of 4800 (around 16). Use trial and error to check out combinations where all three parameters are in the general vicinity of 16.

5.10 Looking at the network of Figure 3 (Figure 5.6 in the textbook), how many packets are generated by a broadcast from B, using

- **a.** reverse path forwarding?
- **b.** the sink tree?

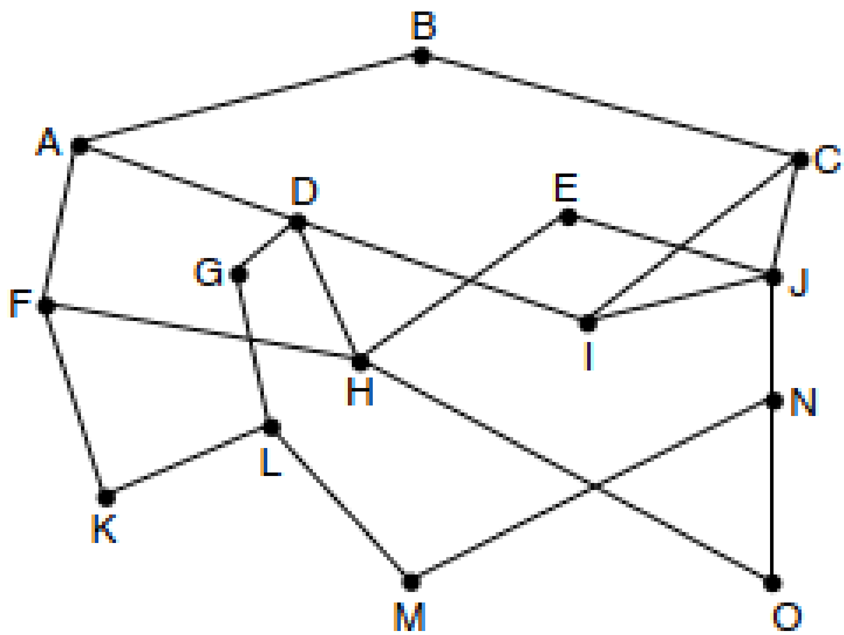

Figure 3: Exercise 5.10

5.11 Compute a multicast spanning tree for router C in the following network for a group with members at routers A, B, C, D, E, F, I, and K. See Figure 4.

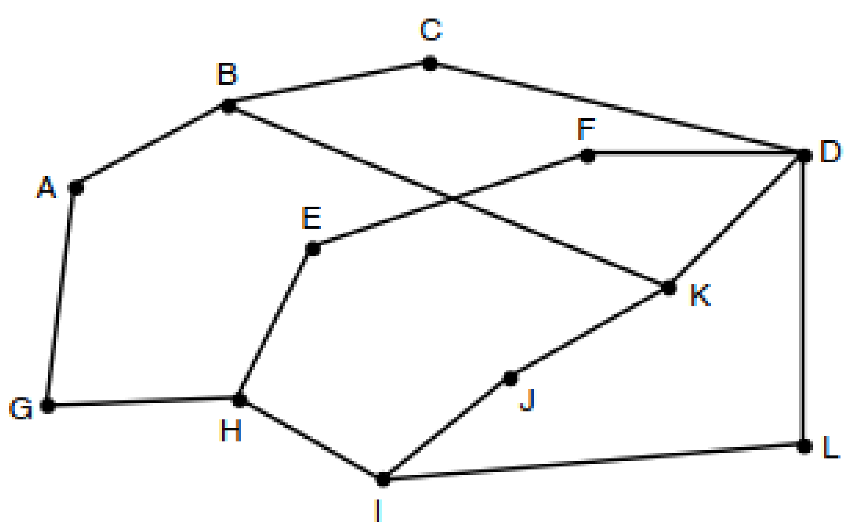

Figure 4: Exercise 5.11

5.12 Describe two major differences between the ECN method and the RED method of congestion avoidance.

5.13 A token bucket scheme is used for traffic shaping. A new token is put into the bucket every 5 μsec. Each token is good for one short packet, which contains 48 bytes of data. What is the maximum sustainable data rate?

5.14 A possible solution to the problem above involves shaping the file transfer traffic so that it never exceeds a certain rate. You decide to shape the traffic so that the sending rate never exceeds 20 Mbps. Should you use a token bucket or a leaky bucket to implement this shaping, or will neither work? What should the drain rate of the bucket be?

5.15 A router is blasting out IP packets whose total length (data plus header) is 1024 bytes. Assuming that packets live for 10 sec, what is the maximum line speed the router can operate at without danger of cycling through the IP datagram ID number space?

5.16 An IP datagram using the *Strict source routing* option has to be fragmented. Do you think the option is copied into each fragment, or is it sufficient to just put it in the first fragment? Explain your answer.

5.17 Suppose that instead of using 16 bits for the network part of a class B address originally, 20 bits had been used. How many class B networks would there have been?

5.18 Convert the IP address whose hexadecimal representation is C22F1582 to dotted decimal notation.

5.19 Two IPv6-enabled devices wish to communicate across the Internet. Unfortunately, the path between these two devices includes a network that has not yet deployed IPv6. Design a way for the two devices to communicate.

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

5.21 While IP addresses are tied to specific networks, Ethernet addresses are not. Can you think of a good reason why they are not?

5.22 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?

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

Address/mask	**Next hop**
135.46.56.0/22	Interface 0
135.46.60.0/22	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

5.24 Aggregate these three address ranges:

- 37.60.64.0/18
- 37.60.96.0/19
- 37.60.128.0/17

5.25 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.

5.26 You connect your phone to the wireless network at your home. This wireless network is created by the modem obtained from your ISP. Using DHCP, your phone obtains IP address 192.168.0.103. What is the likely source IP address of the DHCP OFFER message?

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

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

5.29 Write a program to simulate routing using flooding. Each packet should contain a counter that is decremented on each hop. When the counter gets to zero, the packet is discarded. Time is discrete, with each line handling one packet per time interval. Make three versions of the program: all lines are flooded, all lines except the input line are flooded, and only the (statically chosen) best k lines are flooded. Compare flooding with deterministic routing ($k = 1$) in terms of both delay and the bandwidth used.

5.30 Use the *traceroute* (UNIX) or *tracert* (Windows) programs to trace the route from your computer to various universities on other continents. Make a list of transoceanic links you have discovered. Some sites to try are

- *www.berkeley.edu* (California)
- *www.mit.edu* (Massachusetts)
- *www.vu.nl* (Amsterdam)
- *www.ucl.ac.uk* (London)
- *www.usyd.edu.au* (Sydney)
- *www.u-tokyo.ac.jp* (Tokyo)
- *www.uct.ac.za* (Cape Town)