

Chapter 4

- P2. Consider a virtual-circuit network. Suppose the VC number is a 16-bit field.
- What is the maximum number of virtual circuits that can be carried over a link?
 - Suppose a central node determines paths and VC numbers at connection setup. Suppose the same VC number is used on each link along the VC's path. Describe how the central node might determine the VC number at connection setup. Is it possible that there are fewer VCs in progress than the maximum as determined in part (a) yet there is no common free VC number?
 - Suppose that different VC numbers are permitted in each link along a VC's path. During connection setup, after an end-to-end path is determined, describe how the links can choose their VC numbers and configure their forwarding tables in a decentralized manner, without reliance on a central node.

- P8. Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows:

Destination Address Range	Link Interface
11100000 00000000 00000000 00000000 through 11100000 11111111 11111111 11111111	0
11100001 00000000 00000000 00000000 through 11100001 00000000 11111111 11111111	1
11100001 00000001 00000000 00000000 through 11100001 11111111 11111111 11111111	2
otherwise	3

- Provide a forwarding table that has four entries, uses longest prefix matching, and forwards packets to the correct link interfaces.
- Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses:

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11001000 10010001 01010001 01010101
11100001 00000000 11000011 00111100
11100001 10000000 00010001 01110111
    
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- P10. Consider a datagram network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the following forwarding table:

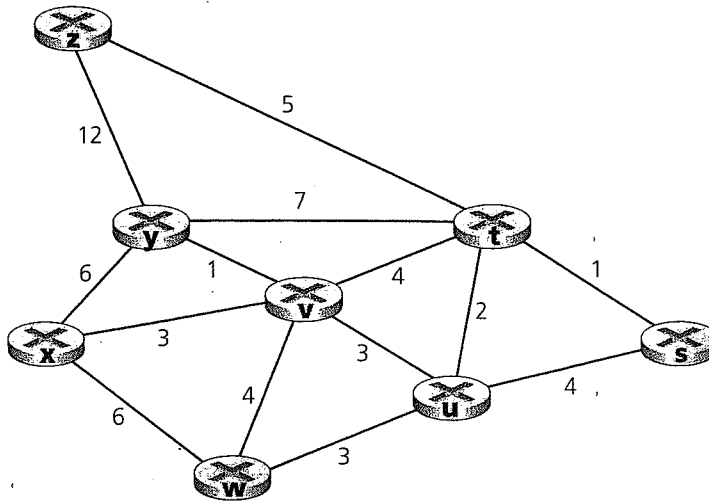
Prefix Match	Interface
1	0
11	1
111	2
otherwise	3

For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

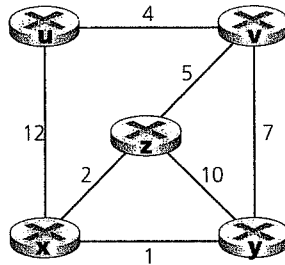
- P11. Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support up to 125 interfaces, and Subnets 2 and 3 are each required to support up to 60 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.

- 14) Consider a subnet with prefix 101.101.101.64/26. Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network. Suppose an ISP owns the block of addresses of the form 101.101.128/17. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?
5. Consider the topology shown in Figure 4.17. Denote the three subnets with hosts (starting clockwise at 12:00) as Networks A, B, and C. Denote the subnets without hosts as Networks D, E, and F.
- a. Assign network addresses to each of these six subnets, with the following constraints: All addresses must be allocated from 214.97.254/23; Subnet A should have enough addresses to support 250 interfaces; Subnet B should have enough addresses to support 120 interfaces; and Subnet C should have enough addresses to support 120 interfaces. Of course, subnets D, E and F should each be able to support two interfaces. For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x - e.f.g.h/y.
- b. Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers.
16. Consider sending a 3,000-byte datagram into a link that has an MTU of 500 bytes. Suppose the original datagram is stamped with the identification number 422. How many fragments are generated? What are their characteristics?
17. Suppose datagrams are limited to 1,500 bytes (including header) between source Host A and destination Host B. Assuming a 20-byte IP header, how many datagrams would be required to send an MP3 consisting of 4 million bytes?

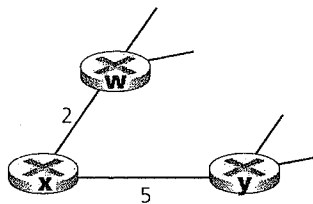
P22. Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by computing a table similar to Table 4.3.



P24. Consider the network shown below, and assume that each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance table entries at node z .



P26. Consider the network fragment shown below. x has only two attached neighbors, w and y . w has a minimum-cost path to destination u (not shown) of 5, and y has a minimum-cost path to u of 6. The complete paths from w and y to u (and between w and y) are not shown. All link costs in the network have strictly positive integer values.



- Give x 's distance vector for destinations w , y , and u .
- Give a link-cost change for either $c(x,w)$ or $c(x,y)$ such that x will inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm.
- Give a link-cost change for either $c(x,w)$ or $c(x,y)$ such that x will *not* inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm.

Chapter 5

P5. Consider the 4-bit generator, G , shown in Figure 5.8, and suppose that D has the value 10101010. What is the value of R ? $G = 1001$

P12. Consider three LANs interconnected by two routers, as shown in Figure 5.38.

a. Redraw the diagram to include adapters.

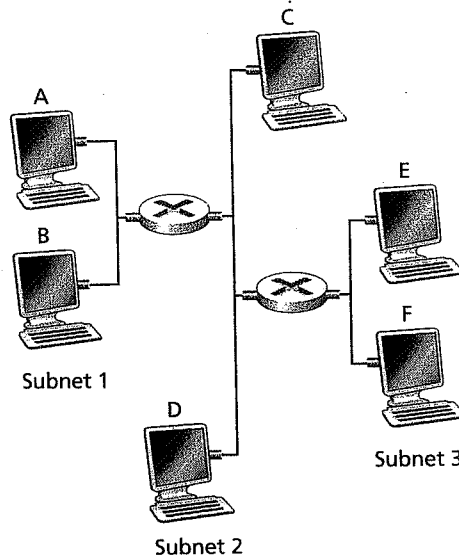


Figure 5.38 ♦ Three subnets, interconnected by routers

- P14. Recall that with the CSMA/CD protocol, the adapter waits $K \cdot 512$ bit times after a collision, where K is drawn randomly. For $K = 100$, how long does the adapter wait until returning to Step 2 for a 10 Mbps Ethernet? For a 100 Mbps Ethernet?
- P15. Suppose nodes A and B are on the same 10 Mbps Ethernet bus, and the propagation delay between the two nodes is 225 bit times. Suppose node A begins transmitting a frame and, before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? If the answer is yes, then A incorrectly believes that its frame was successfully transmitted without a collision. *Hint:* Suppose at time $t = 0$ bit times, A begins transmitting a frame. In the worst case, A transmits a minimum-sized frame of $512 + 64$ bit times. So A would finish transmitting the frame at $t = 512 + 64$ bit times. Thus, the answer is no, if B's signal reaches A before bit time $t = 512 + 64$ bits. In the worst case, when does B's signal reach A?
- P20. Consider Figure 5.38 in problem P12. Provide MAC addresses and IP addresses for the interfaces at Host A, both routers, and Host F. Suppose Host A sends a datagram to Host F. Give the source and destination MAC addresses in the frame encapsulating this IP datagram as the frame is transmitted (i) from A to the left router, (ii) from the left router to the right router, (iii) from the right router to F. Also give the source and destination IP addresses in the IP datagram encapsulated within the frame at each of these points in time.

P23. Suppose the three departmental switches in Figure 5.26 are replaced by hubs. All links are 100 Mbps. What is the maximum total aggregate throughput that can be achieved among the 14 end systems in this network? Why?

P27. Consider the MPLS network shown in Figure 5.37, and suppose that routers R5 and R6 are now MPLS enabled. Suppose that we want to perform traffic engineering so that packets from R6 destined for A are switched to A via R6-R4-R3-R1, and packets from R5 destined for A are switched via R5-R4-R2-R1. Show the MPLS tables in R5 and R6, as well as the modified table in R4, that would make this possible. *Fig. 5.42 in 3rd Edition*