Name: Zouyan Song

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Chapter 4

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 00111111 11111111 11111111	0
11100000 01000000 00000000 00000000 through 11100000 01000000 11111111 11111111	1
11100000 01000001 00000000 00000000 through 11100001 01111111 11111111 11111111	2
otherwise	3

a. Provide a forwarding table that has five entries, uses longest prefix matching, and forwards packets to the correct link interfaces.

Prefix	Link I/F
11100000 00	0
11100000 01000000	1
1110000	2
11100001 1	3
otherwise	3

b. Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses:

11001000 10010001 01010001 01010101
11100001 01000000 11000011 00111100
11100001 10000000 00010001 01110111

- First address:
  11001000 10010001 01010001 01010101 -> not start with 11100, matches interface **3**
  Second address:
  11100001 01000000 11000011 00111100 -> starts with 1110000, matches interface **2**
  Third address:
  11100001 10000000 00010001 01110111 -> starts with 11100001 1, matches interface **3**

P9. 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
00	0
010	1
011	2
10	2
11	3

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

Destination Address Range	I/F
00000000 through 00111111	0
01000000 through 01011111	1
01100000 through 01111111	2
10000000 through 10111111	2
11000000 through 11111111	3

- # of addresses:

  Interface 0: $2^6 = \mathbf{64}$

  Interface 1: $2^5 = \mathbf{32}$

  Interface 2: $2^5 + 2^6 = \mathbf{96}$

  Interface 3: $2^6 = \mathbf{64}$

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
10	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

Destination Address Range	I/F
11000000 through 11011111	0
10000000 through 10111111	1
11100000 through 11111111	2
00000000 through 01111111	3

- \# of addresses:
  Interface 0: $2^5 = \mathbf{32}$
  Interface 1: $2^6 = \mathbf{64}$
  Interface 2: $2^5 = \mathbf{32}$
  Interface 3: $2^7 = \mathbf{128}$

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 at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints

- For Subnet 1,
  since $2^5 < 60 < 2^6$, the address could be given as: <u>223.1.17.0/26</u>
- For Subnet 2,
  since $2^6 < 90 < 2^7$, the address could be given as: <u>223.1.17.128/25</u>
- For Subnet 3,
  since $2^3 < 12 < 2^4$, the address could be given as: <u>223.1.17.192/28</u>

P12. In Section 4.2.2, an example forwarding table (using longest prefix matching) is given. Rewrite this forwarding table using the a.b.c.d/x notation instead of the binary string notation.

Prefix	Link Interface
11001000 00010111 00010	0
11001000 00010111 00011000	1
11001000 00010111 00011	2
Otherwise	3

- Rewritten in CIDR notation:

Prefix	I/F
200.23.16/21	0
200.23.24/24	1
200.23.24/21	2
Otherwise	3

P13. In Problem P8, you are asked to provide a forwarding table (using longest prefix matching). Rewrite this forwarding table using the a.b.c.d/x notation instead of the binary string notation.

Prefix	I/F
224.0.0.0/10	0
224.64.0.0/16	1
224.0.0.0/8	2
225.128.0.0/9	3
Otherwise	3

P14. Consider a subnet with prefix 128.119.40.128/26. 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 128.119.40.64/26. 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?

- **128.119.40.128** could be assigned to this network (128.119.40.128/26)
- Those four subnets could be given as:

  128.119.40.64/28
  128.119.40.80/28,
  128.119.40.96/28
  128.119.40.112/28

P15. Consider the topology shown in Figure 4.20. 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.

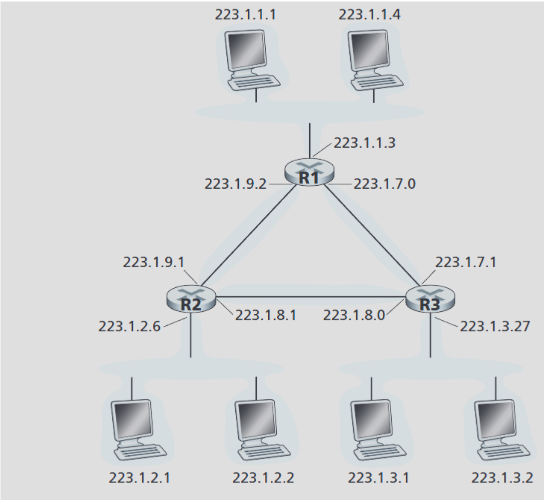


Figure 4.20 ♦ Three routers interconnecting six subnets

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.

- Those subnets could be given as:

  Subnet A: 214.97.255/24 ($2^8 = 256$)
  Subnet B: 214.97.254.0/25 ($2^7 = 128$)
  Subnet C: 214.97.254.128/25 ($2^7 = 128$)
  Subnet D: 214.97.254.0/31 ($2^1 = 2$)
  Subnet E: 214.97.254.2/31 ($2^1 = 2$)
  Subnet F: 214.97.254.4/30 ($2^2 = 4$)

b. Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers.

- Router 1:

Prefix	I/F
11010110 01100001 11111111	I/F to Subnet A
11010110 01100001 11111110 0000000	I/F to Subnet D
11010110 01100001 11111110 000001	I/F to Subnet F

Router 2:

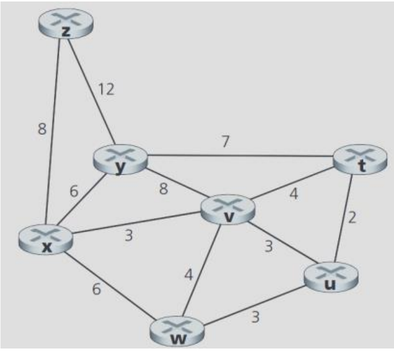
Prefix	I/F
11010110 01100001 11111110 0	I/F to Subnet B
11010110 01100001 11111111 0000000	I/F to Subnet D
11010110 01100001 11111110 0000001	I/F to Subnet E

Router 3:

Prefix	I/F
11010110 01100001 11111110 1	I/F to Subnet C
11010110 01100001 11111110 0000001	I/F to Subnet E
11010110 01100001 11111111 000001	I/F to Subnet F

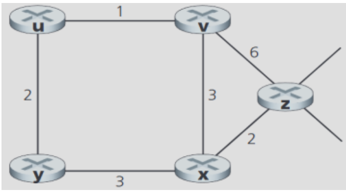
Chapter 5

P3. 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 5.1



Step	N'	D(y), p(y)	D(z), p(z)	D(v), p(v)	D(w), p(w)	D(t), p(t)	D(u), p(u)
0	x	6, x	8, x	3, x	6, x	∞	∞
1	x,v	6, x	8, x		6, x	7, v	6, v
2	x,v,y		8, x		6, x	7, v	6, v
3	x,v,y,w		8, x			7, v	6, v
4	x,v,y,w,u		8, x			7, v	
5	x,v,y,w,u,t		8, x				
6	x,v,y,w,u,t,z						

P5. 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.



		Cost to				
		u	v	x	y	z
From	v	∞	∞	∞	∞	∞
	x	∞	∞	∞	∞	∞
	z	∞	6	2	∞	0

		Cost to				
		u	v	x	y	z
From	v	1	0	3	∞	6
	x	∞	3	0	3	2
	z	7	5	2	5	0

		Cost to				
		u	v	x	y	z
From	v	1	0	3	3	5
	x	4	3	0	3	2
	z	6	5	2	5	0