CHAPTER 22

Network Layer: Delivery, Forwarding, and Routing

Solutions to Review Questions and Exercises

Review Questions

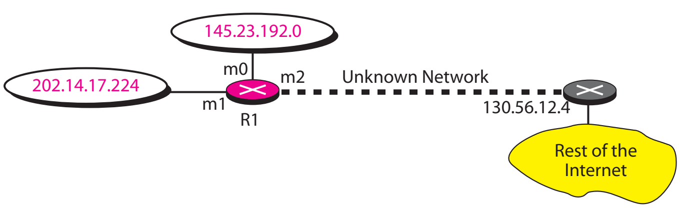
1. We discussed two different methods of delivery: direct and indirect. In a ***direct delivery***, the final destination of the packet is a host connected to the same physical network as the deliverer. In an ***indirect delivery*** the packet goes from router to router until it reaches the one connected to the same physical network as its final destination.
2. The three common forwarding methods used today are: next-hop, network-specific, and default methods. In the ***next-hop method***, the routing table holds only the address of the next hop for each destination. In the ***network-specific*** method, the routing table holds only one entry that defines the address of the destination network instead of all hosts on that network. In the ***default method***, a host sends all packets that are going out of the network to a specific router called the default router.
3. A routing table can be either static or dynamic. A ***static routing*** table contains information entered manually. A ***dynamic routing table*** is updated periodically by using one of the dynamic routing protocols such as RIP, OSPF, or BGP.
4. RIP is an ***intradomain routing protocol*** that enables routers to update their routing tables within an ***autonomous*** system.
5. A RIP ***message*** is used by a router to request and receive routing information about an autonomous system or to periodically share its knowledge with its neighbors.
6. The time-out for the ***expiration time*** is **6** times that of the ***periodic timer*** to allow for some missed communication between routers.
7. The ***hop count limit*** helps RIP instability by limiting the number of times a message can be sent through the routers, thereby limiting the back and forth updating that may occur if part of a network goes down.
8. The two major shortcomings are ***two-node instability*** and ***three-node instability***. For the former, infinity can be re-defined as a number such as 20. Another solution is the split horizon strategy or split horizon combined with poison reverse. These methods do not work for three-node instability.

9. In OSPF, four types of links have been defined: point-to-point, transient, stub, and virtual. A ***point-to-point*** link connects two routers without any other host or router in between. A ***transient*** link is a network with several routers attached to it. The packets can enter and leave through any of the routers. A ***stub*** link is a network that is connected to only one router. The data packets enter the network through this single router and leave the network through this same router. This is a special case of the transient network. When the link between two routers is broken, the administrator may create a ***virtual*** link between them, using a longer path that probably goes through several routers.
10. OSPF messages are propagated immediately because a router using OSPF will immediately ***flood*** the network with news of any changes to its neighborhood. RIP messages are distributed slowly because a network using RIP relies on the ***periodic updates*** that occur every 30 seconds to carry any news from one router to the next and to the next.
11. BGP is an ***interdomain*** routing protocol using path vector routing.
12. We mentioned two groups of multicast routing protocols: the source-based tree and the group-shared tree. In a ***source-based tree*** protocol, each router needs to have one shortest path tree for each group. The shortest path tree for a group defines the next hop for each network that has loyal member(s) for that group. In a ***group-shared tree*** protocol, only one designated router takes the responsibility of distributing multicast traffic. The designated router has *m* shortest path trees in its routing table. The rest of the routers in the domain have none.

Exercises

13. A host that is totally isolated needs no routing information. ***The routing table has no entries***.
14. A routing table for a LAN not connected to the Internet and with no subnets can have a routing table with ***host-specific addresses***. There is no next-hop address since all packets remain within the network.
15. See Figure 22.1.

Figure 22.1 *Solution to Exercise 15*



16. If the packet with destination address 140.24.7.194 arrives at R3, it gets sent to interface ***m0***. If it arrives at R2, it gets sent to interface ***m1*** and then to router R3.

The only way R1 can receive the packet is if the packet comes from organization 1, 2, or 3; it goes to R1 and is sent out from interface ***m3***.

17. R1 cannot receive a packet with this destination from ***m0*** because if any host in Organization 1 sends a packet with this destination address, the delivery is direct and does not go through R1. R1 can receive a packet with this destination from interfaces ***m1*** or ***m2***. This can happen when any host in Organization 2 or 3 sends a packet with this destination address. The packet arrives at R1 and is sent out through ***m0***. R1 can also receive a packet with this destination from interface **m3**. This happens in two cases. First, if R2 receives such a packet, the /24 is applied The packet is sent out from interface m0, which arrives at interface ***m3*** of R1. Second, if R3 receives such a packet, it applies the default mask and sends the packet from its interface ***m2*** to R2, which, in turn, applies the mask (/24) and sends it out from its interface ***m0*** to the interface ***m3*** of R1.

18. See Table 22.1.

Table 22.1 *Solution to Exercise 18: Routing table for regional ISP*

Mask	Network address	Next-hop address	Interface
/20	120.14.64.0	---	**m0**
/20	120.14.96.0	---	**m2**
/20	120.14.112.0	---	**m3**
/0	0.0.0.0	**default router**	**m4**

19. See Table 22.2.

Table 22.2 *Solution to Exercise 19: Routing table for local ISP 1*

Mask	Network address	Next-hop address	Interface
/23	120.14.64.0	---	**m0**
/23	120.14.66.0	---	**m1**
/23	120.14.68.0	---	**m2**
/23	120.14.70.0	---	**m3**
/23	120.14.72.0	---	**m4**
/23	120.14.74.0	---	**m5**
/23	120.14.76.0	---	**m6**
/23	120.14.78.0	---	**m7**
/0	0.0.0.0	**default router**	**m8**

20. See Table 22.3.

Table 22.3 *Solution to Exercise 20: Routing table for local ISP 2*

Mask	Network address	Next-hop address	Interface
/22	120.14.96.0	---	**m0**
/22	120.14.100.0	---	**m1**

Table 22.3 *Solution to Exercise 20: Routing table for local ISP 2*

Mask	Network address	Next-hop address	Interface
/22	120.14.104.0	---	**m2**
/22	120.14.108.0	---	**m3**
/0	0.0.0.0	**default router**	**m4**

21. See Table 22.4.

Table 22.4 *Solution to Exercise 21: Routing table for local ISP 3*

Mask	Network address	Next-hop address	Interface
/24	120.14.112.0	---	**m0**
/24	120.14.113.0	---	**m1**
/24	120.14.114.0	---	**m2**
/24	120.14.115.0	---	**m3**
/24	120.14.116.0	---	**m4**
/24	120.14.117.0	---	**m5**
/24	120.14.118.0	---	**m6**
/24	120.14.119.0	---	**m7**
/24	120.14.120.0	---	**m8**
/24	120.14.121.0	---	**m9**
/24	120.14.122.0	---	**m10**
/24	120.14.123.0	---	**m11**
/24	120.14.124.0	---	**m12**
/24	120.14.125.0	---	**m13**
/24	120.14.126.0	---	**m14**
/24	120.14.127.0	---	**m15**
/0	0.0.0.0	**default router**	**m16**

22. See Table 22.5.

Table 22.5 *Solution to Exercise 22: Routing table for small ISP 1*

Mask	Network address	Next-hop address	Interface
/30	120.14.64.0	----	**m0**
/30	120.14.64.4	----	**m1**
/30	120.14.64.8	----	**m2**
/30	120.14.64.12	----	**m3**
. . .	. . .	. . .	. . .
/30	120.14.65.252	----	**m127**
/0	0.0.0.0	**default router**	**m128**

23. In distance vector routing each router ***sends all of its knowledge about an autonomous system to all of the routers on its neighboring networks at regular intervals***. It uses a fairly simple algorithm to update the routing tables but results in a lot of unneeded network traffic. In link state routing a router ***floods an autonomous system with information about changes in a network only when changes occur***. It uses less network resources than distance vector routing in that it sends less traffic over the network but it uses the much more complex Dijkstra Algorithm to calculate routing tables from the link state database.
24. We assume that router C is one hop away. Then the modified table from C is Table 22.6:

Table 22.6 *Solution to Exercise 24*

Network	*Hops*
Net1	3
Net2	2
Net3	4
Net4	8

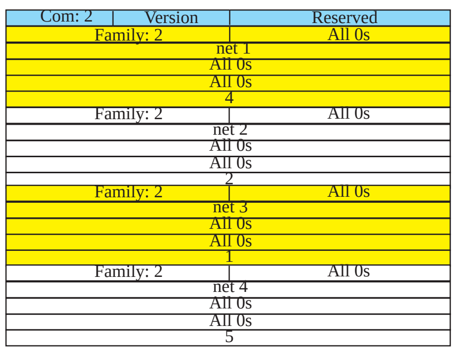
Comparing this to the old table, we get Table 22.7:

Table 22.7 *Solution to Exercise 24*

Network	*Hops*	
Net1	3	**C**
Net2	2	**C**
Net3	1	**F**
Net4	5	**G**

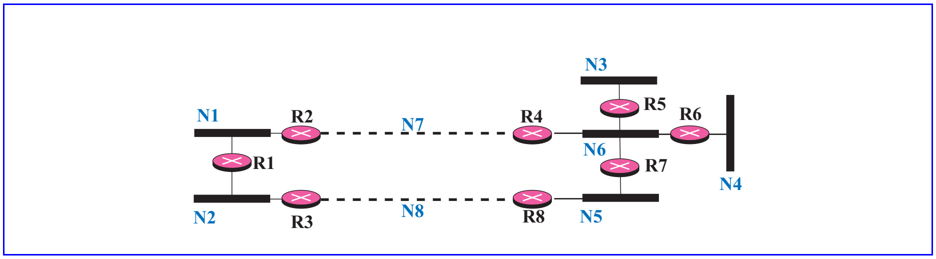
25. There are **2 + (10 $\times$ N)** = Empty bytes in a message advertising N networks
26. See Figure 22.2.

Figure 22.2 *Solution to Exercise 26*



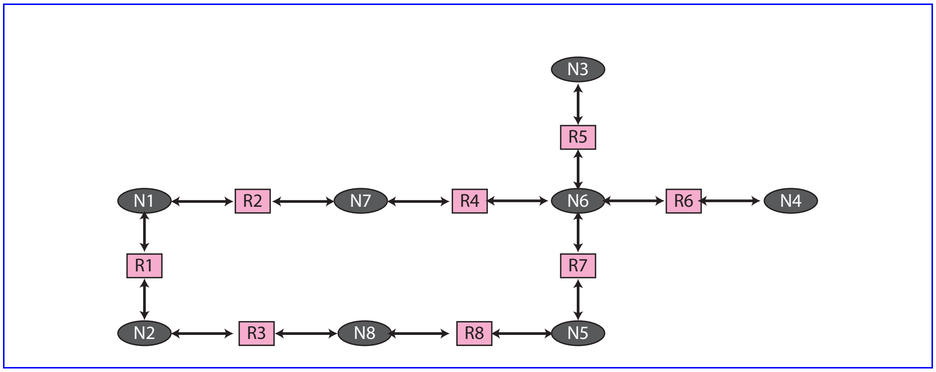
27. See Figure 22.3.

Figure 22.3 *Solution to Exercise 27*



28. See Figure 22.4.

Figure 22.4 *Solution to Exercise 28*



29. **Transient networks**: **N1**, **N2**, **N5**, and **N6**. **Stub networks**: **N3** and **N4**
30. See Table 22.8.

Table 22.8 *Solution to Exercise 30*

Destination	*Interface*
---	---
10.0.0.0	2
---	---

31. No, ***RPF*** does not create a shortest path tree because a network can receive more than one copy of the same multicast packet. RPF creates a graph instead of a tree.
32. Yes, ***RPB*** creates a shortest path tree and its leaves are networks. However, the delivery of the packets are based on broadcasting instead of multicasting.
33. Yes, ***RPM*** creates a shortest path tree because it is actually RPB (see previous answer) with pruning and grafting features. The leaves of the tree are the networks.