Chapter 4

Advanced Internetworking

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FIGURE 4.1 The tree structure of the Internet in 1990

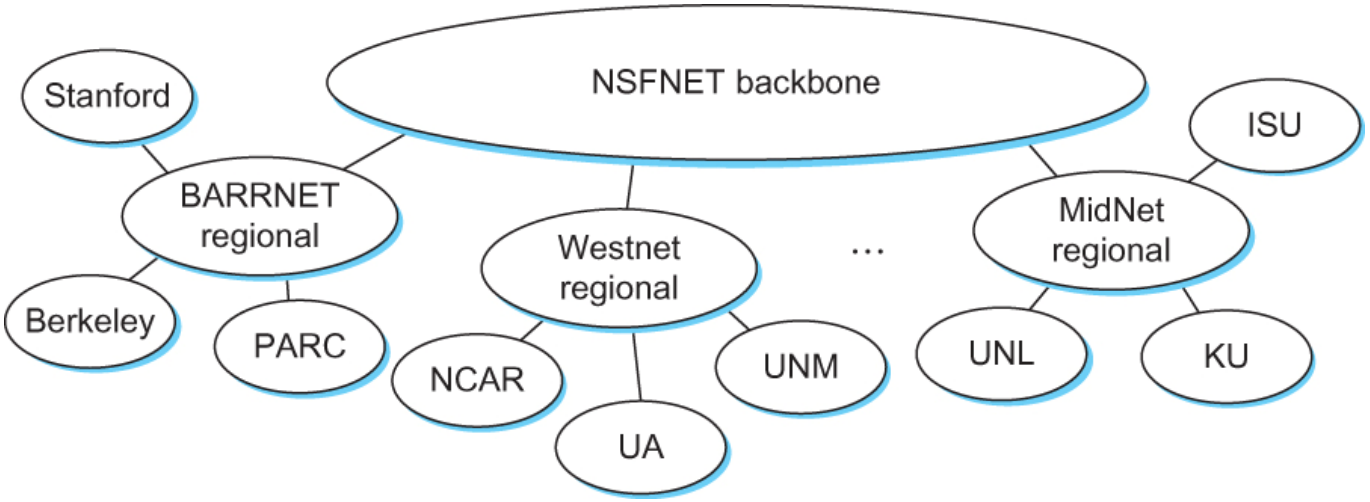

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FIGURE 4.2 A domain divided into areas.

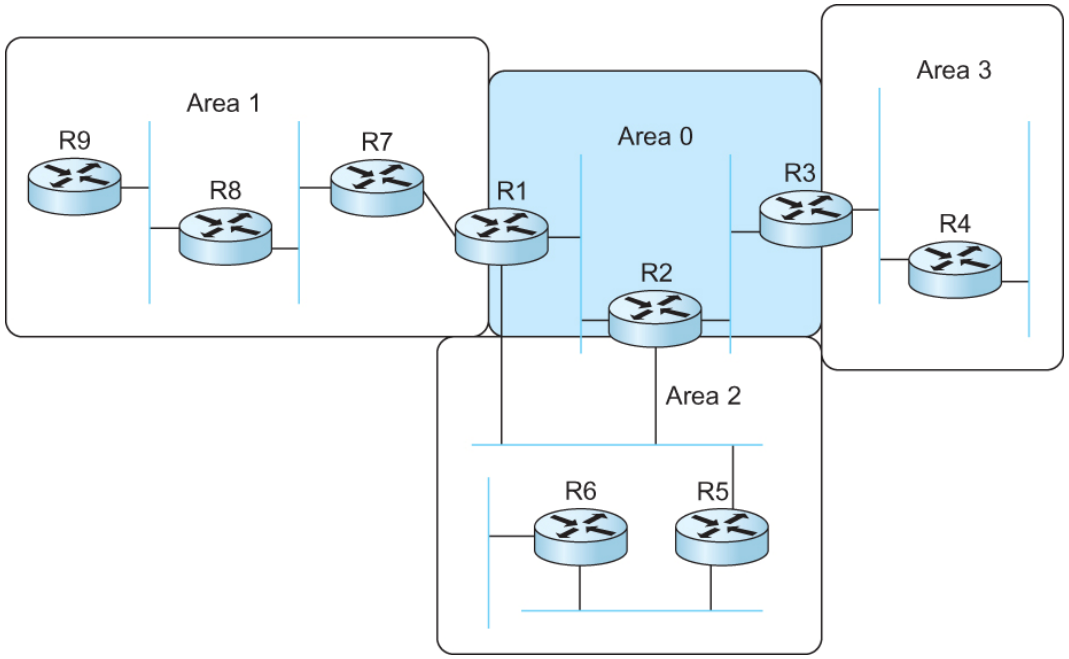

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FIGURE 4.3 A network with two autonomous systems.

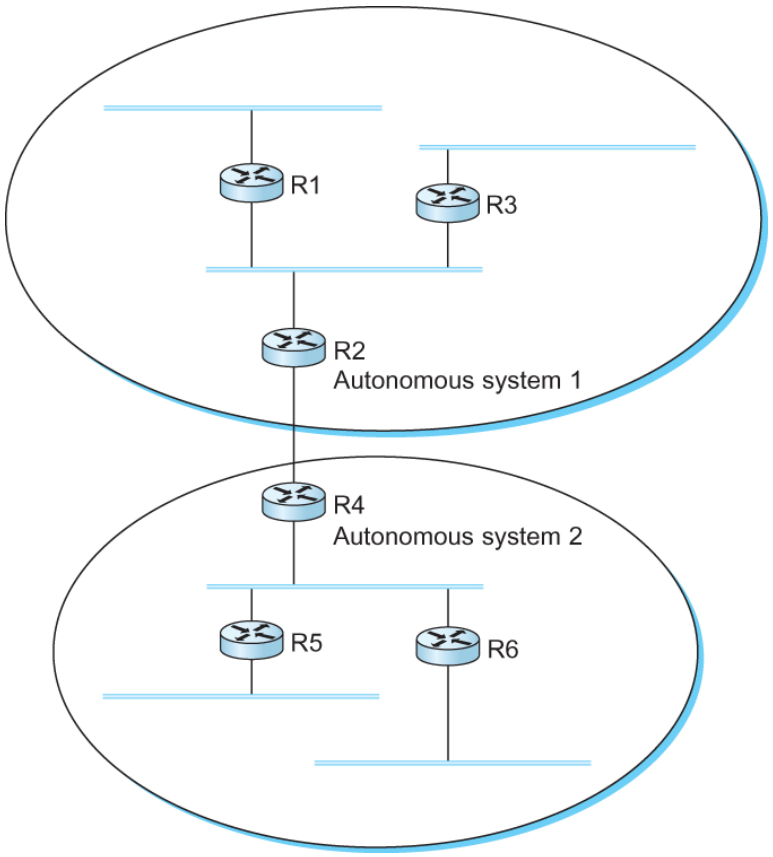

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FIGURE 4.4 A simple multi-provider Internet.

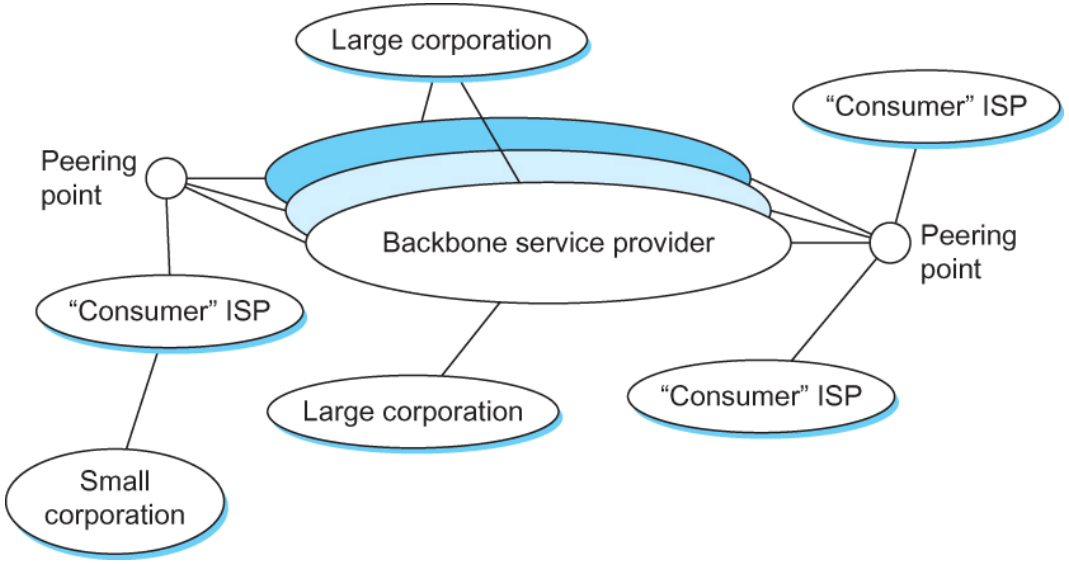

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FIGURE 4.5 Example of a network running BGP.

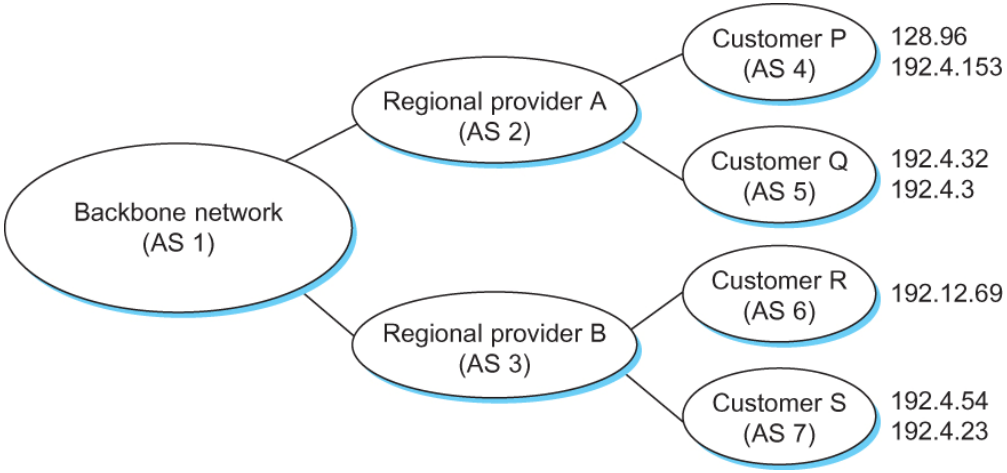

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FIGURE 4.6 Example of loop among autonomous systems.

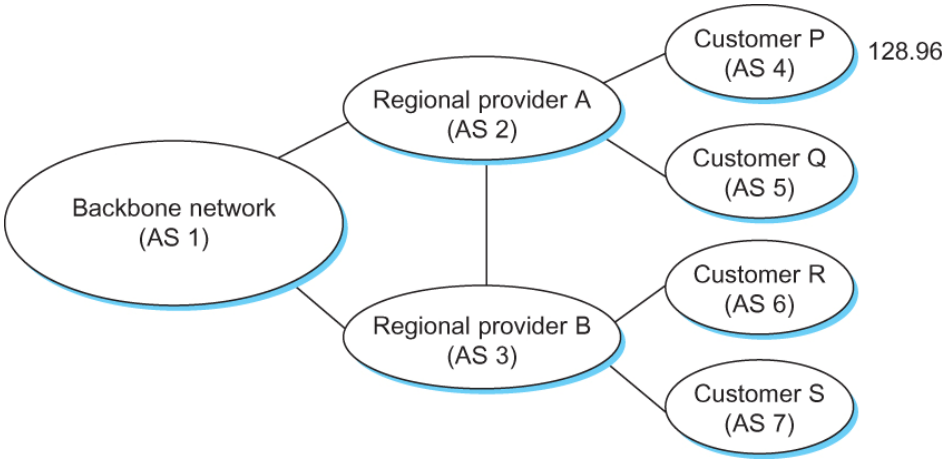

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FIGURE 4.7 BGP-4 update packet format.

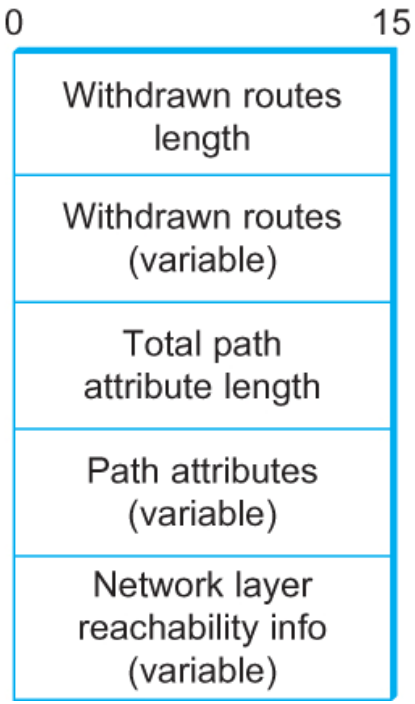

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FIGURE 4.8 Common AS relationships.

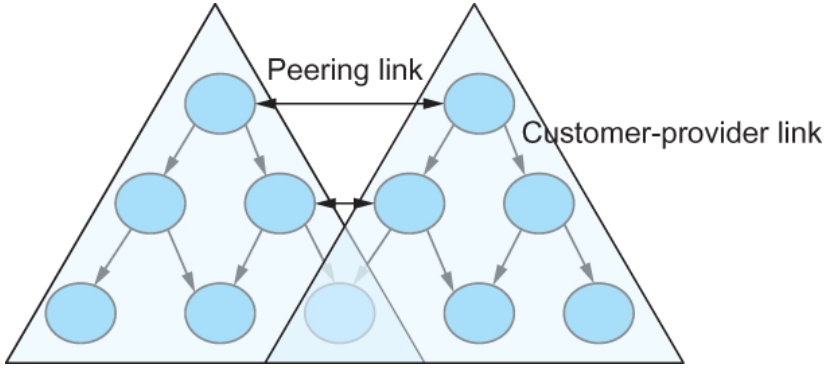

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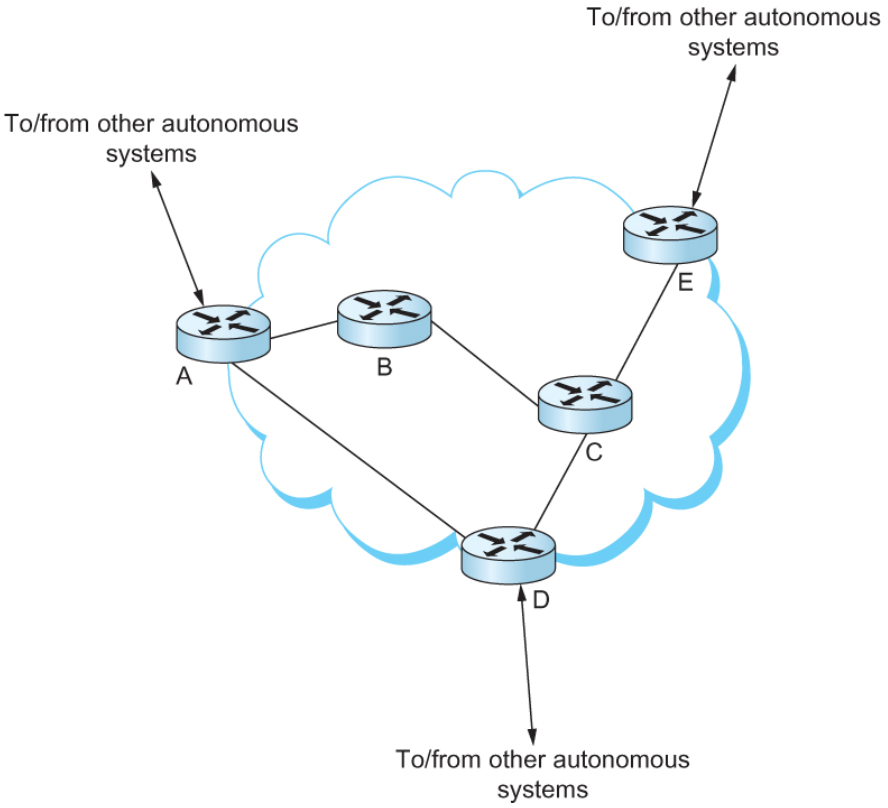
FIGURE 4.9 Example of interdomain and intradomain routing. All routers run iBGP and an intradomain routing protocol. Border routers A, D, and E also run eBGP to other autonomous systems.



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Prefix	BGP Next Hop
18.0/16	E
12.5.5/24	A
128.34/16	D
128.69./16	A

BGP table for the AS

Router	IGP Path
A	A
C	C
D	C
E	C

IGP table for router B

Prefix	IGP Path
18.0/16	C
12.5.5/24	A
128.34/16	C
128.69./16	A

Combined table for router B

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FIGURE 4.11 An IPv6 provider-based unicast address.

3	m	n	o	p	125–m–n–o–p
010	RegistryID	ProviderID	SubscriberID	SubnetID	InterfaceID

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FIGURE 4.12 IPv6 packet header.

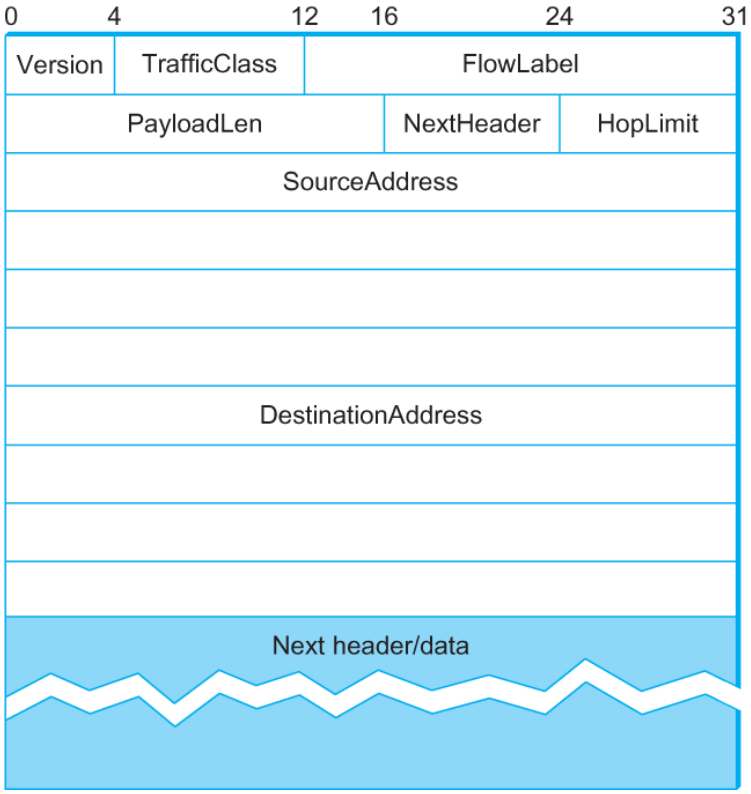

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FIGURE 4.13 IPv6 fragmentation extension header.

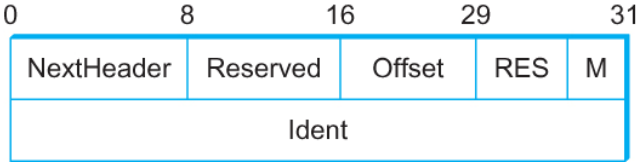

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FIGURE 4.14 PIM operation: (a) R4 sends Join to RP and joins shared tree; (b) R5 joins shared tree; (c) RP builds source-specific tree to R1 by sending Join to R1; (d) R4 and R5 build source-specific tree to R1 by sending Joins to R1.

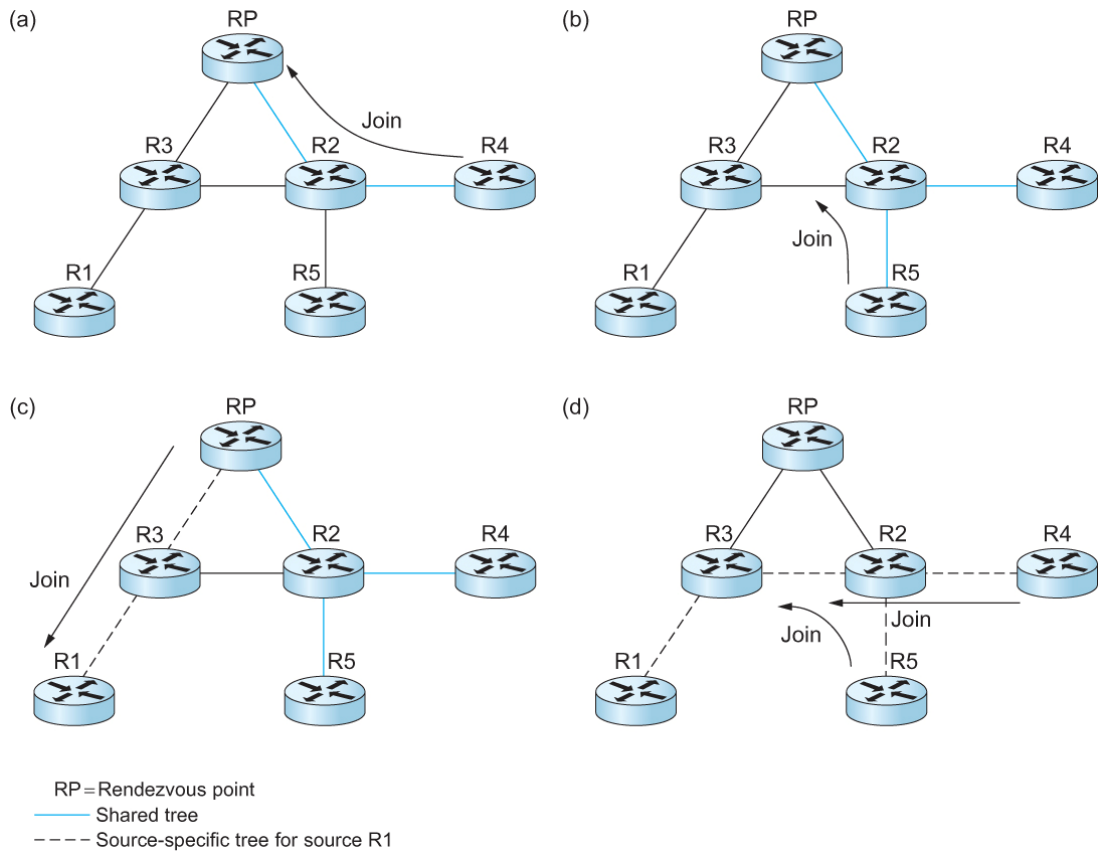

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FIGURE 4.15 Delivery of a packet along a shared tree. R1 tunnels the packet to the RP, which forwards it along the shared tree to R4 and R5.

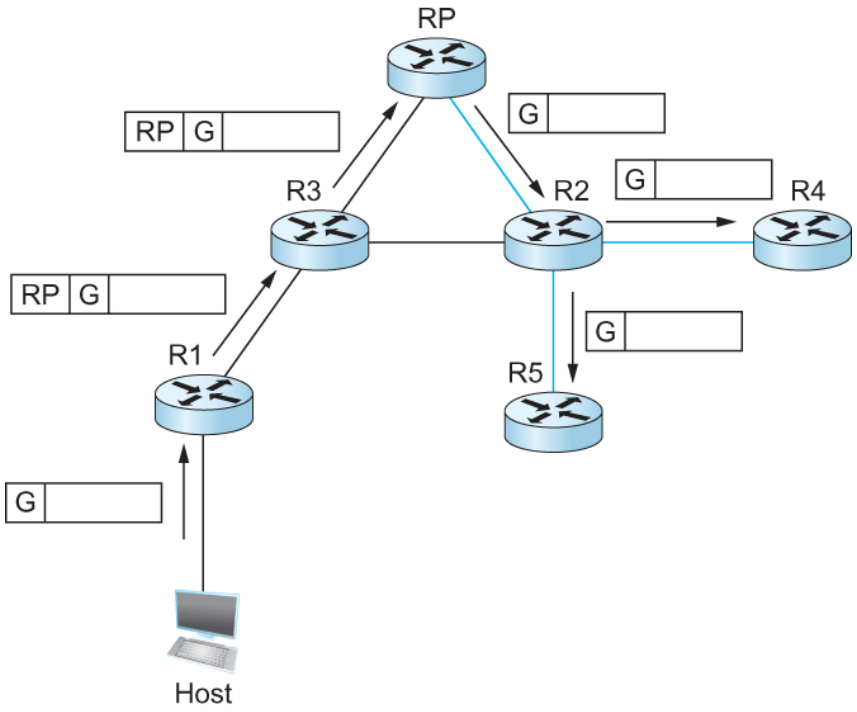

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FIGURE 4.16 MSDP operation: (a) The source SR sends a Register to its domain's RP, RP1; then RP1 sends a source-specific Join to SR and an MSDP Source Active to its MSDP peer in Domain B, RP2; then RP2 sends a source-specific Join to SR. (b) As a result, RP1 and RP2 are in the source-specific tree for source SR.

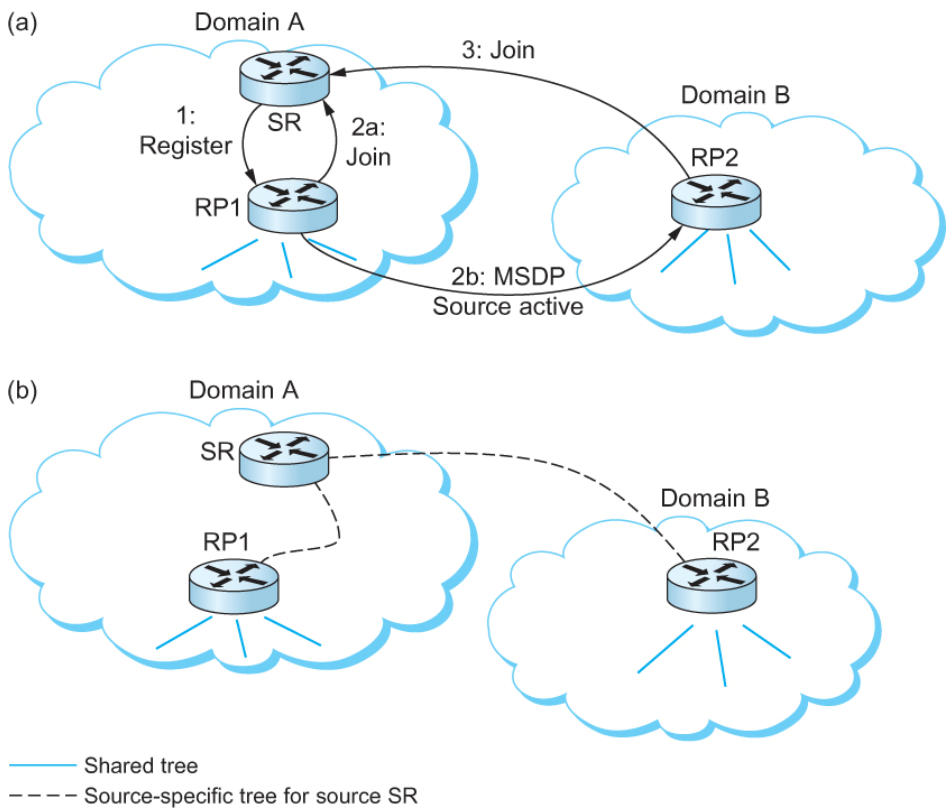

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FIGURE 4.17 BIDIR-PIM operation: (a) R2 and R3 send Joins toward the RP address that terminate when they reach a router on the RP address's link. (b) A multicast packet from R1 is forwarded upstream to the RP address's link and downstream wherever it intersects a group member branch.

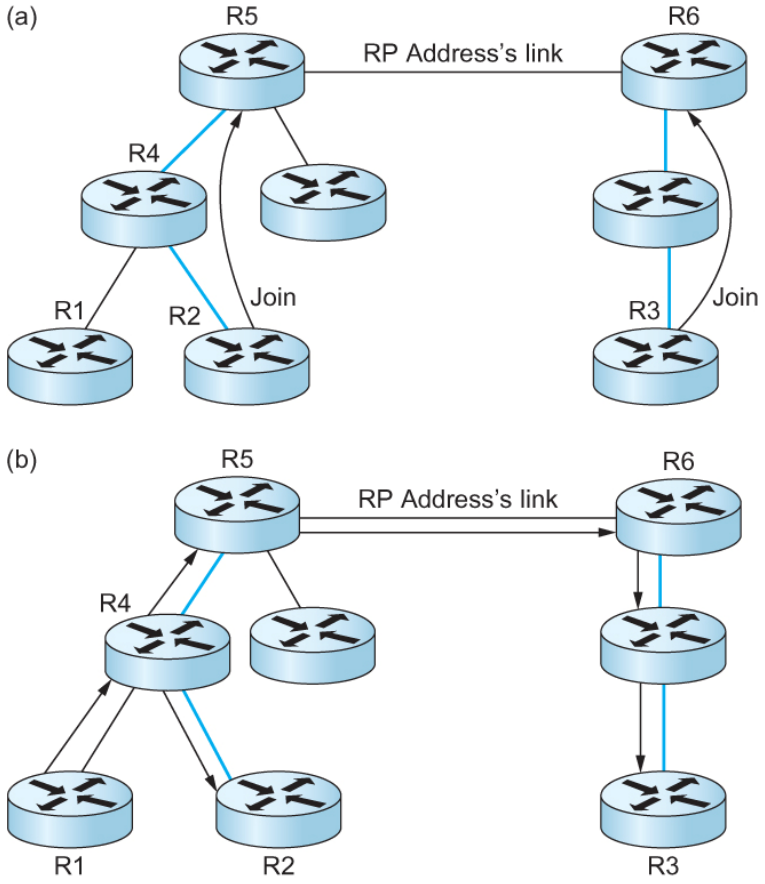

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FIGURE 4.18 Routing tables in example network.

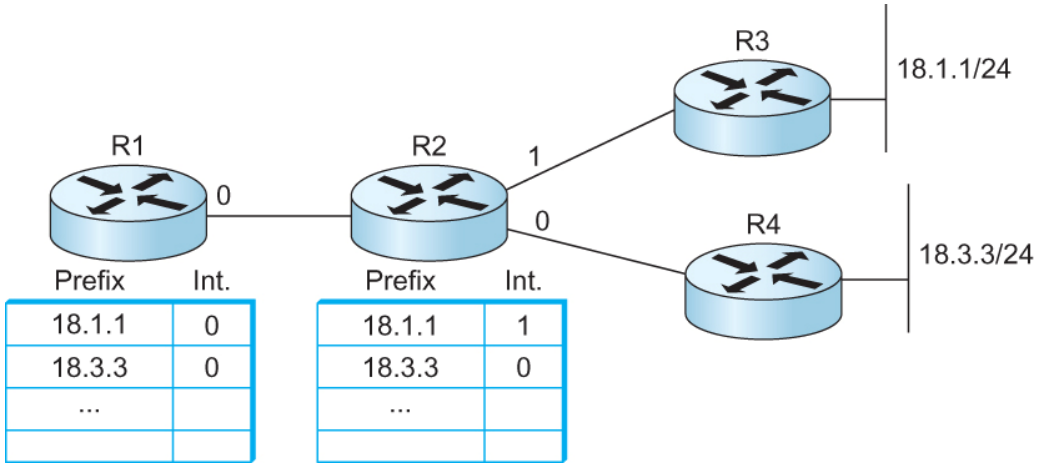

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FIGURE 4.19 (a) R2 allocates labels and advertises bindings to R1. (b) R1 stores the received labels in a table. (c) R3 advertises another binding, and R2 stores the received label in a table.

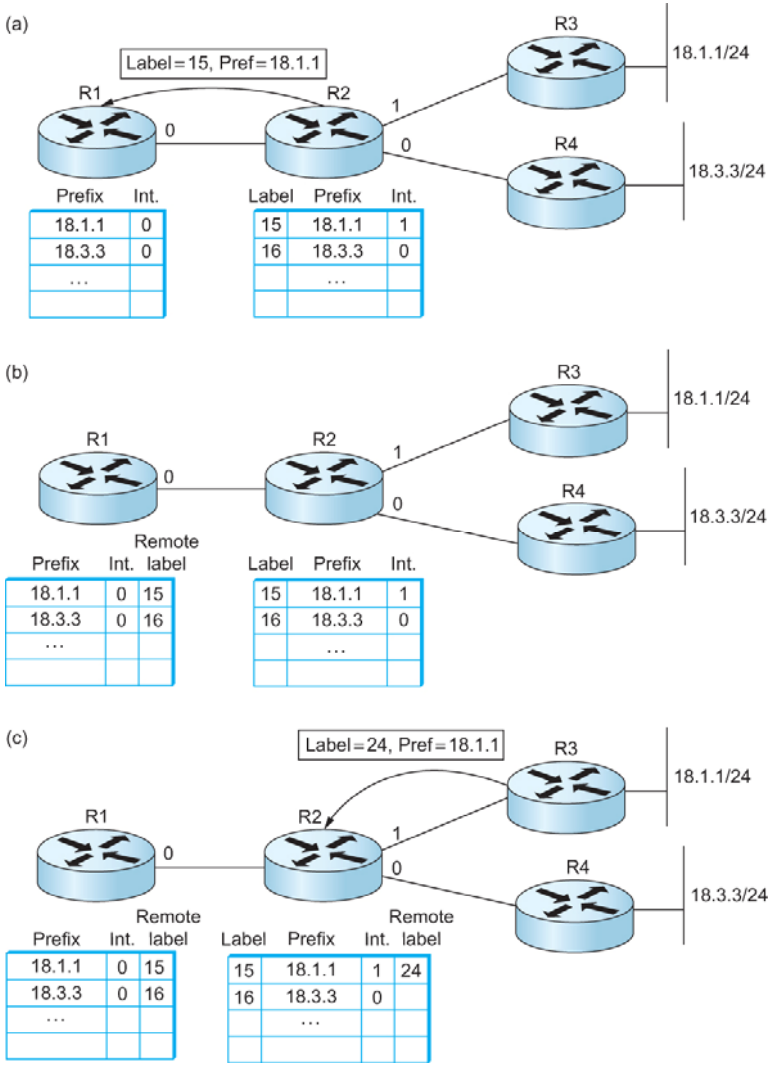

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FIGURE 4.20 (a) Label on an ATM-encapsulated packet; (b) label on a frame-encapsulated packet.

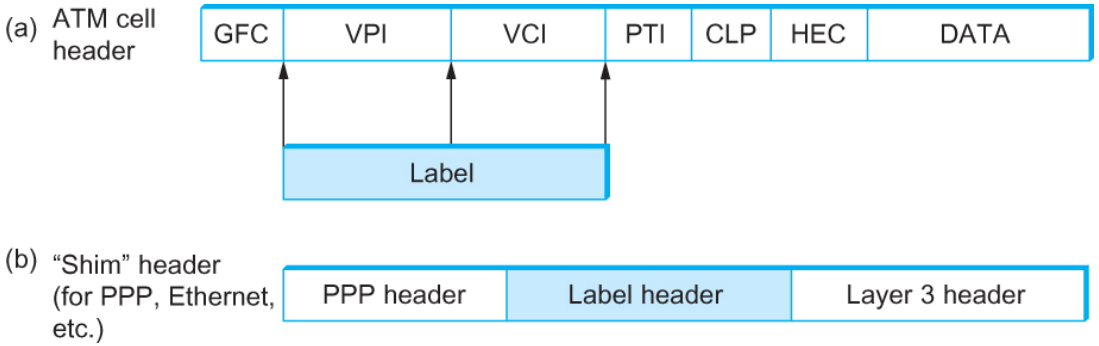

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FIGURE 4.21 (a) Routers connect to each other using an overlay of virtual circuits. (b) Routers peer directly with LSRs.

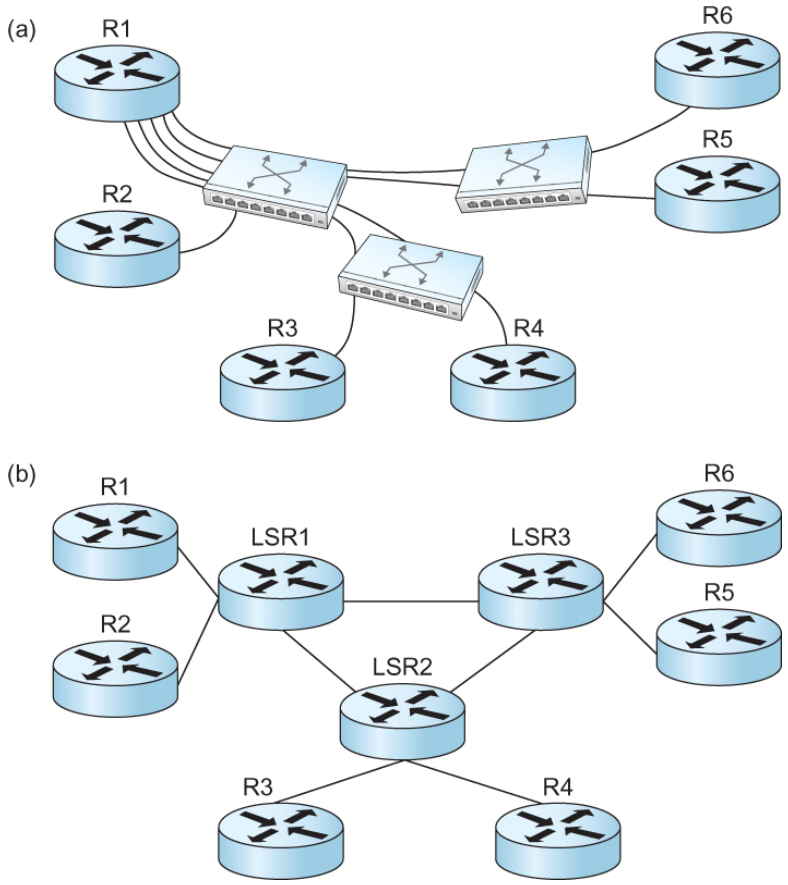

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FIGURE 4.22 A network requiring explicit routing.

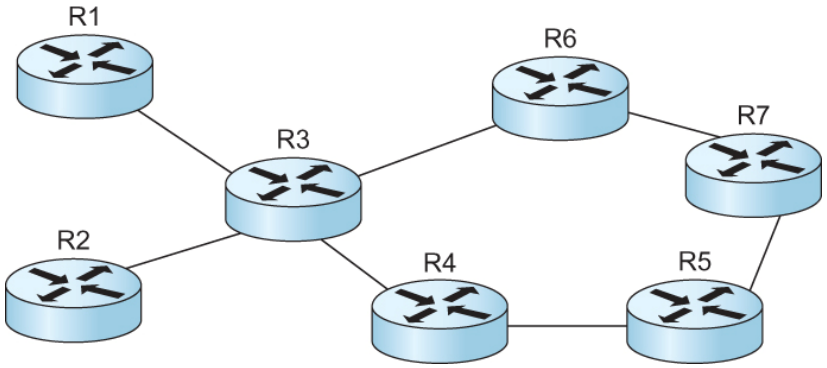

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FIGURE 4.23 An ATM circuit is emulated by a tunnel.

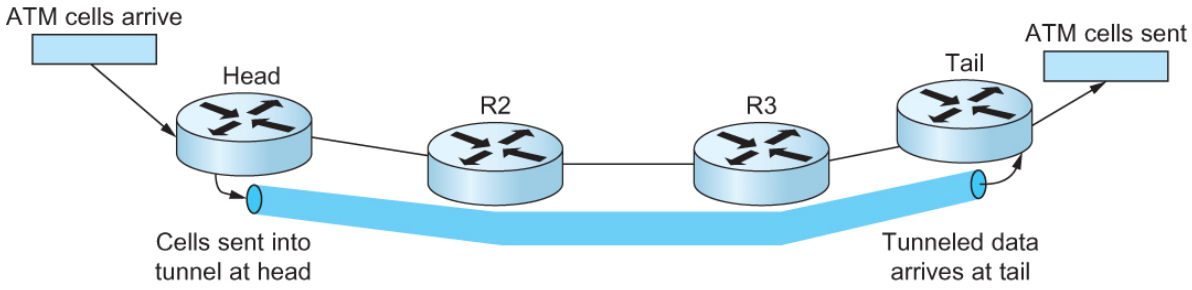

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FIGURE 4.24 Forward ATM cells along a tunnel.

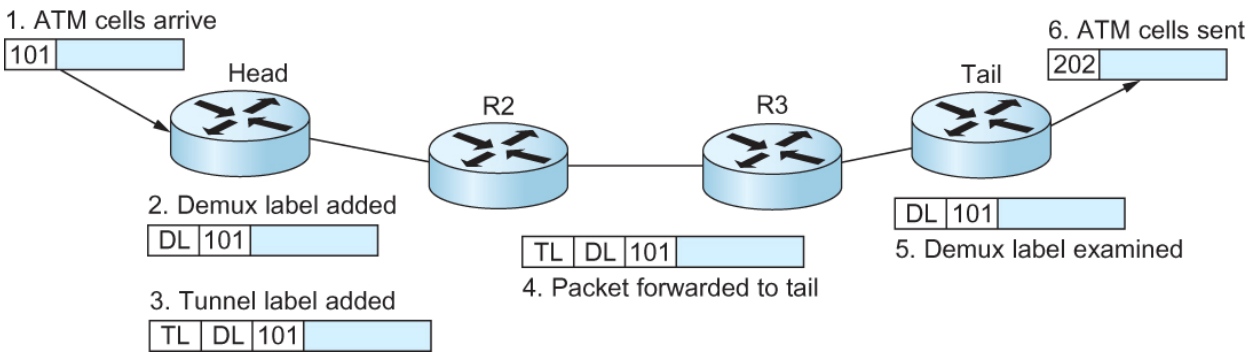

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FIGURE 4.25 Example of a layer 3 VPN. Customers A and B each obtain a virtually private IP service from a single provider.

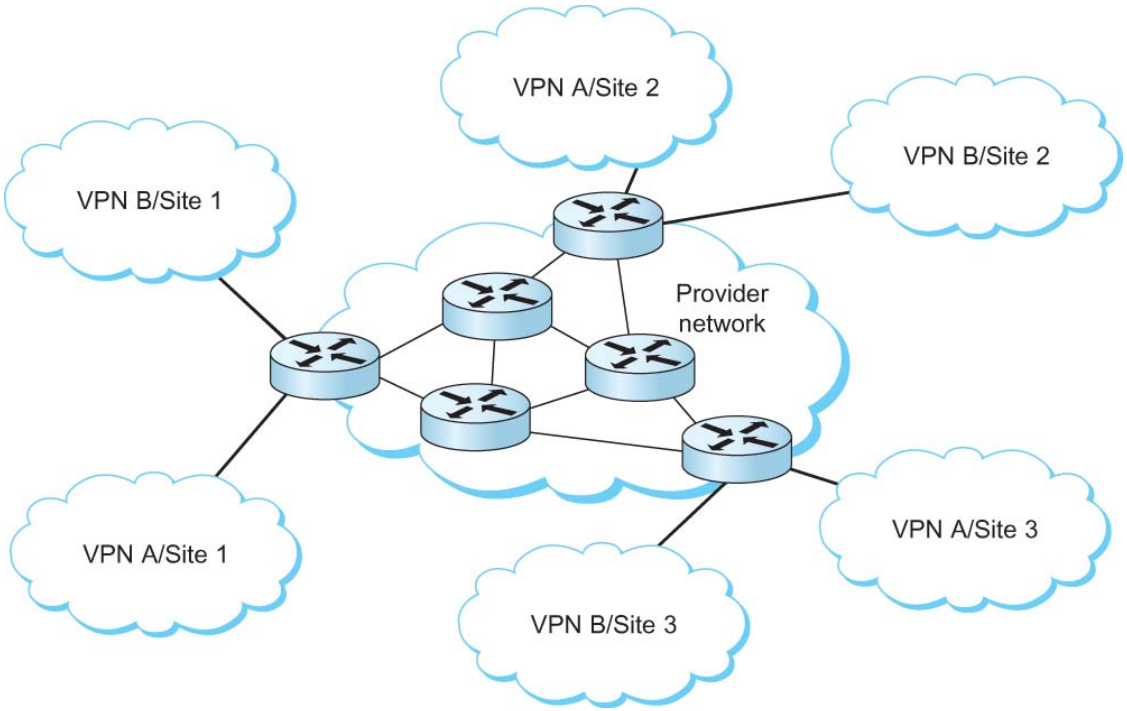

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FIGURE 4.26 Forwarding packets from a correspondent node to a mobile node.

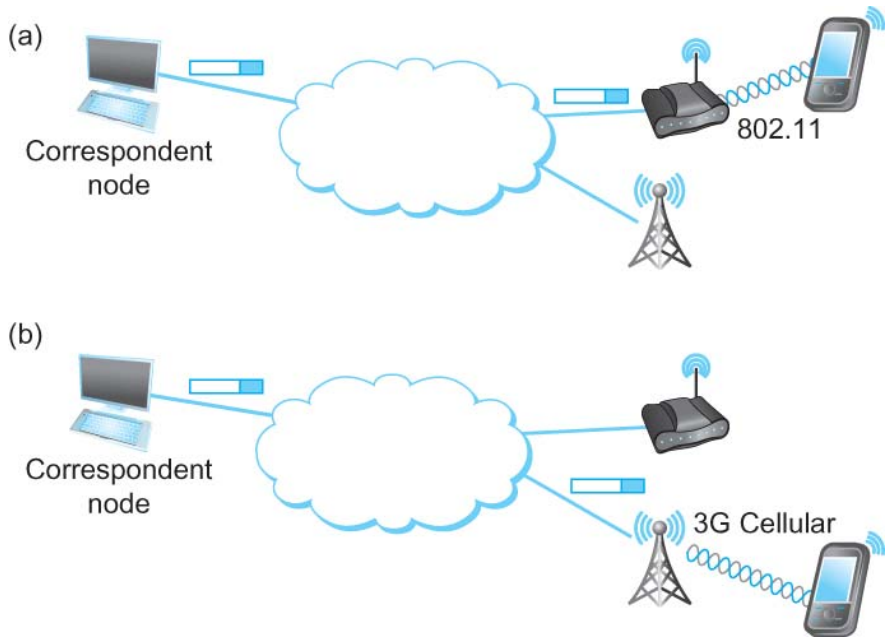

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FIGURE 4.27 Mobile host and mobility agents.

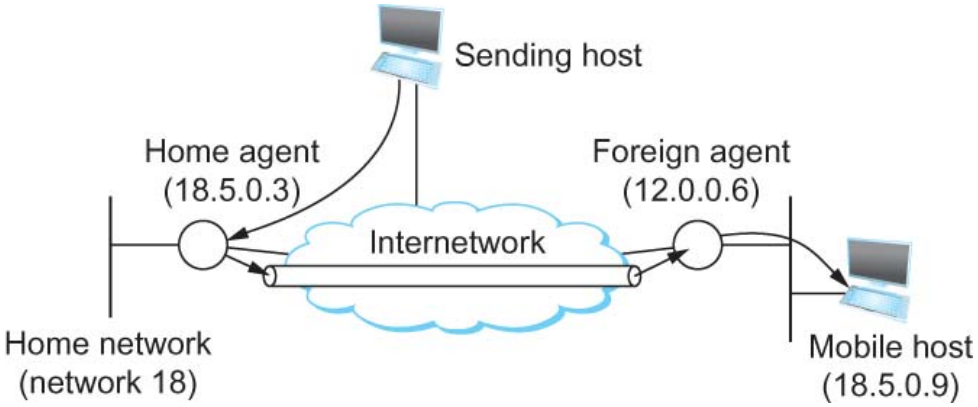

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FIGURE 4.28 Network for Exercise 1.

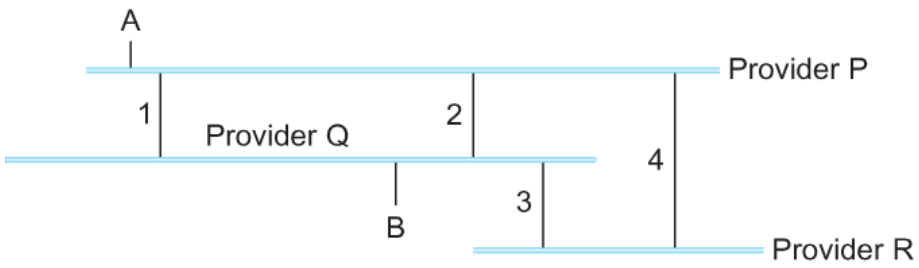

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FIGURE 4.29 Example internet for Exercise 15.

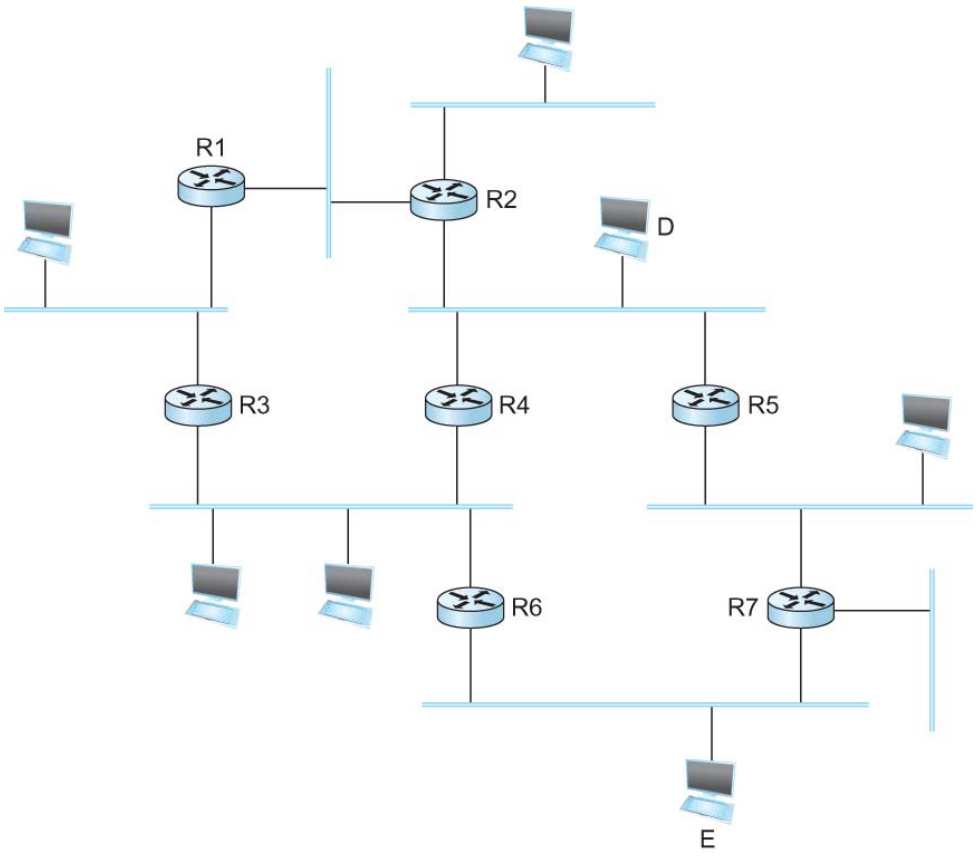

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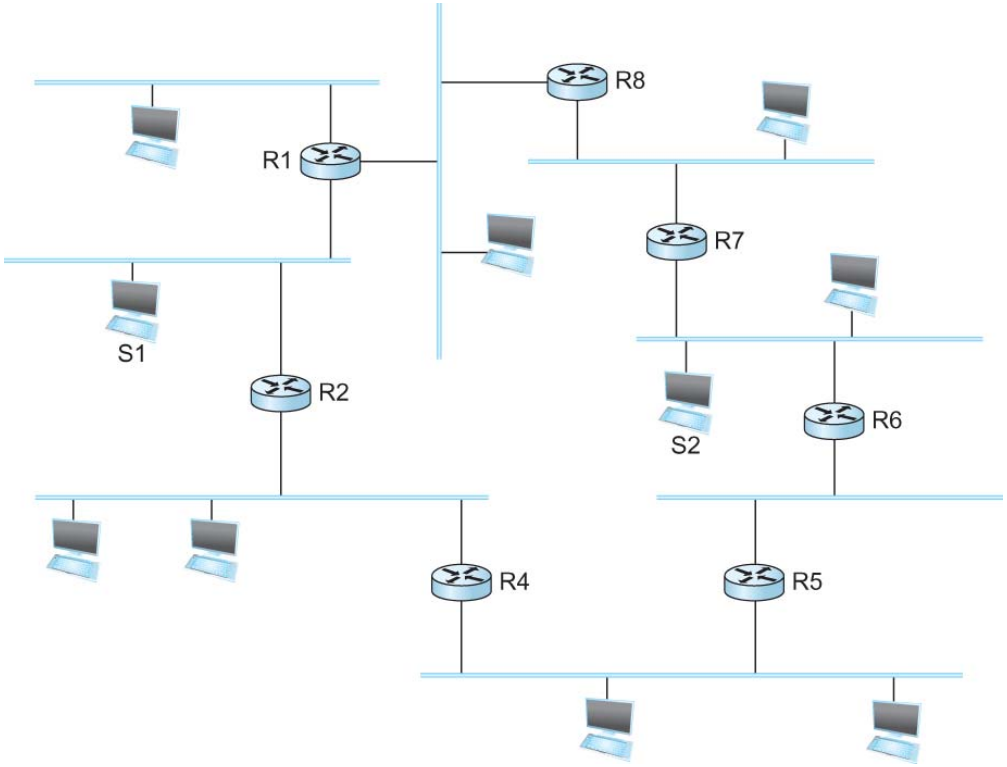
FIGURE 4.30 Example Network for Exercise 16.



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