22.21 Summary

The Internet protocol defines an IP datagram to be the basic unit of transfer across a TCP/IP internet. Each datagram resembles a hardware frame because the datagram contains a header followed by a payload area. Like a hardware frame, a datagram header contains information used to transfer the datagram to a specific destination. Unlike a hardware frame, a datagram header contains IP addresses rather than MAC addresses.

IP software in routers uses a table of routes to determine the next hop to which a datagram should be sent. Each entry in a forwarding table corresponds to one destination network, which means the size of a forwarding table is proportional to the number of networks in the Internet. When selecting a route, IP compares the network prefix of a destination address to each entry in the table. To avoid ambiguity, IP specifies that if a forwarding table contains two entries that match a given destination, forwarding should match the longest prefix.

Although IP selects a next hop to which a datagram must be sent, the address of the next hop does not appear in the datagram header. Instead, the header always specifies the address of the ultimate destination.

An IP datagram is encapsulated in a frame for transmission. Each network technology specifies an MTU (Maximum Transmission Unit), the maximum payload size; when a datagram exceeds the network MTU, IP fragments the datagram. IPv4 allows routers along a path to perform fragmentation; IPv6 requires the sending host to perform fragmentation. An IPv4 fragment may be further fragmented, if necessary. The ultimate destination reassembles fragments, using a timer to discard a datagram if one or more fragments are lost.

EXERCISES

22.1 What are the two basic communication paradigms that designers consider when designing an internet?

22.2 How does the Internet design accommodate heterogeneous networks that each has its own packet format?

22.3 Write a computer program to extract the source and destination addresses from an IPv4 datagram, and print them in dotted decimal notation.

22.4 Write a computer program to extract the source and destination addresses from an IPv6 datagram, and print them in colon hex notation.

22.5 Write a program to extract all fields from an IPv4 or IPv6 datagram header. Print the values in hexadecimal, dotted decimal, or colon hex notation as appropriate.

22.6 What is the maximum length of an IPv4 datagram?

22.7 Write a computer program that takes as input an IP forwarding table similar to the one shown in Figure 22.6(b) and a sequence of destination addresses. For each destination address, search the table sequentially to find the correct next hop, and output the results.