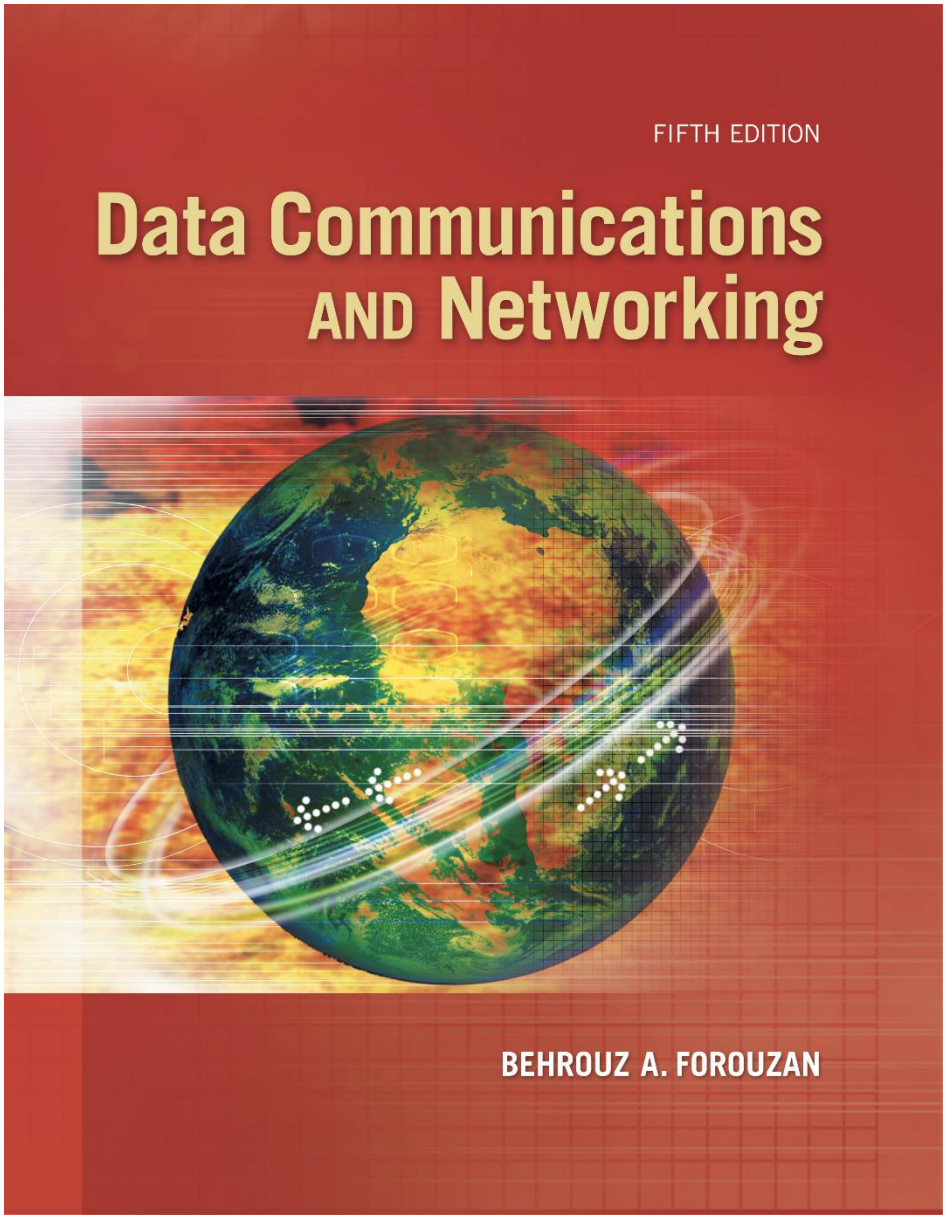
Chapter 18

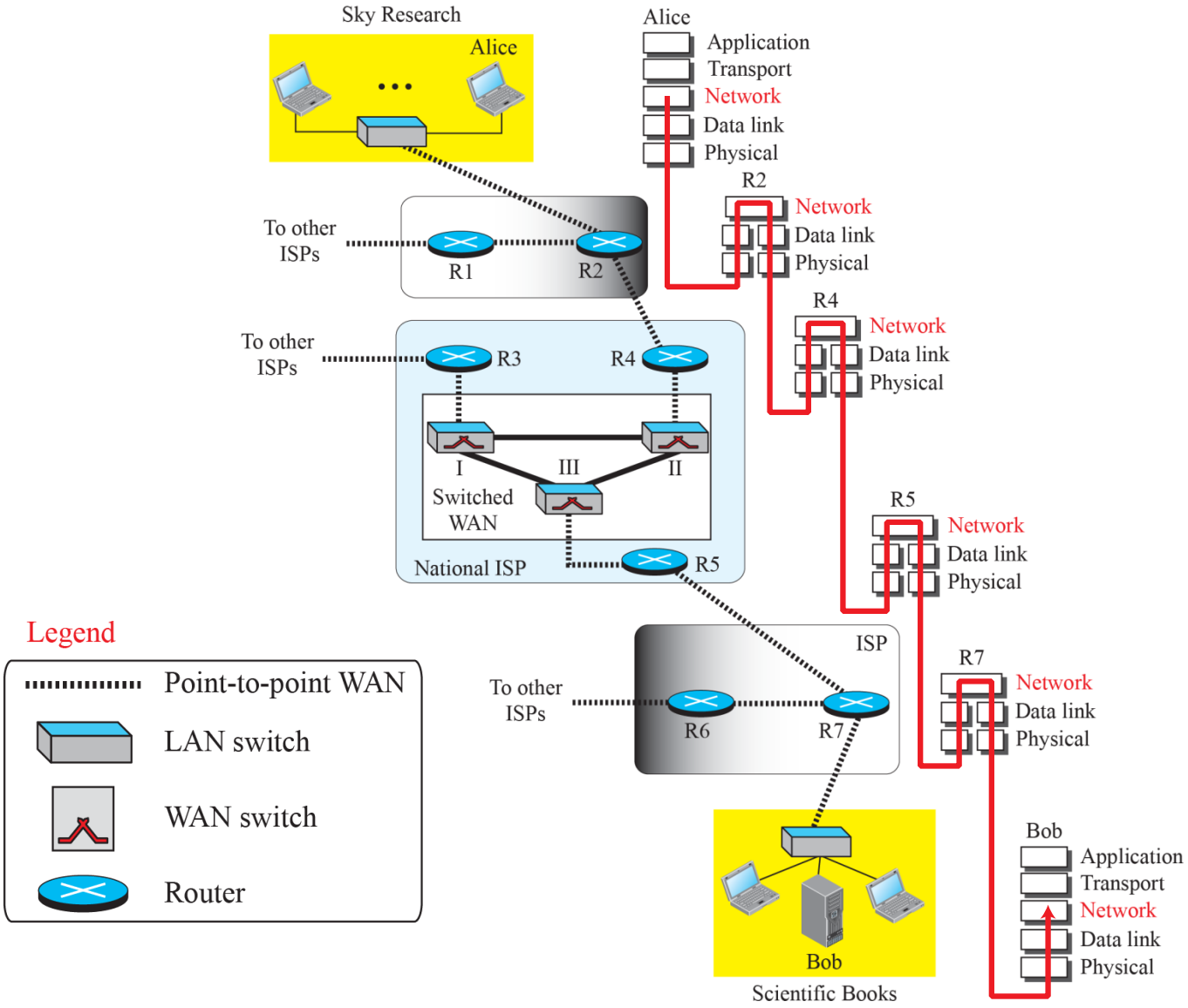
Introduction to Network Layer



18-1 NETWORK-LAYER SERVICES

Figure 18.1 shows the communication between Alice and Bob at the network layer.

Figure 18.1: Communication at the network layer



18.18.1 Packetizing

*The first duty of the network layer is **packetizing**:*

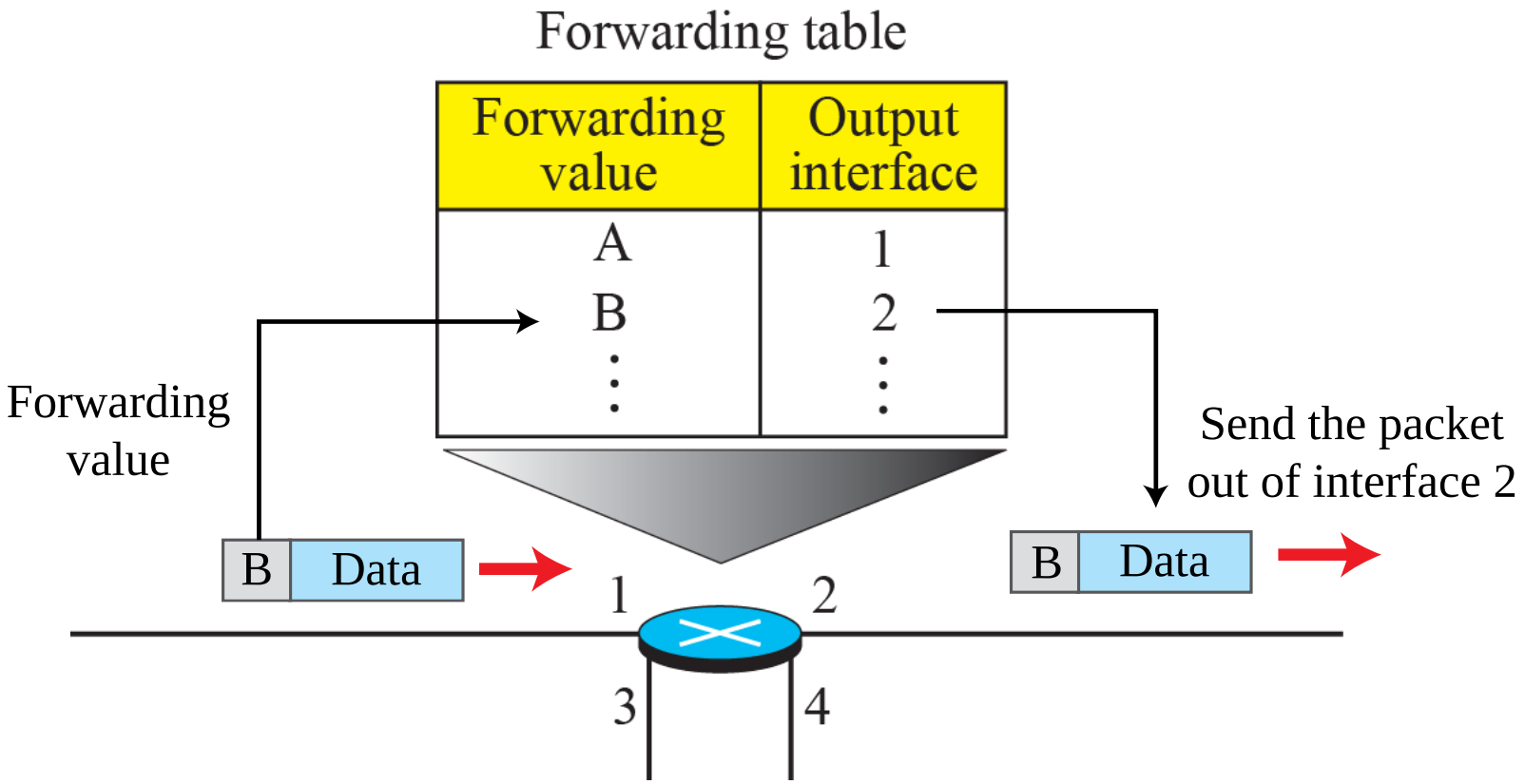
- *encapsulating the payload in a network-layer packet at the source and*
- *decapsulating the payload from the network-layer packet at the destination.*

In other words, one duty of the network layer is to carry a payload from the source to the destination without changing it or using it.

18.18.2 Routing and Forwarding

Other duties of the network layer are routing and forwarding

Figure 18.2: ***Forwarding process***



18-2 PACKET SWITCHING

In Routing and forwarding there is a kind of switching occurs at the network layer. A router, in fact, is a switch that creates a connection between an input port and an output port (or a set of output ports).

18.2.1 Datagram Approach

When the Internet started, to make it simple, the network layer was designed to provide a connectionless service in which the network-layer protocol

- *treats each packet independently, with each packet having no relationship to any other packet.*
- *The idea was that the network layer is only responsible for delivery of packets from the source to the destination.*
- *packets in a message may or may not travel the same path to their destination.*

Figure 18.3: A connectionless packet-switched network

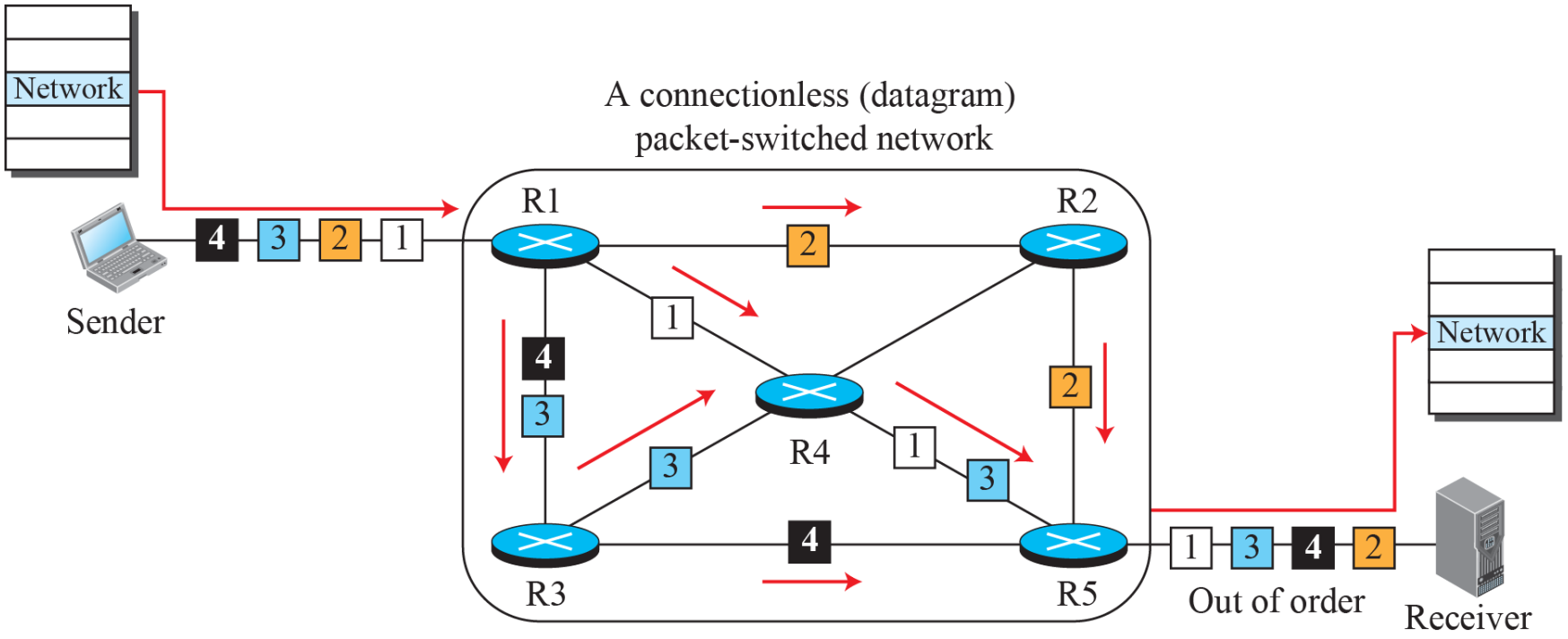
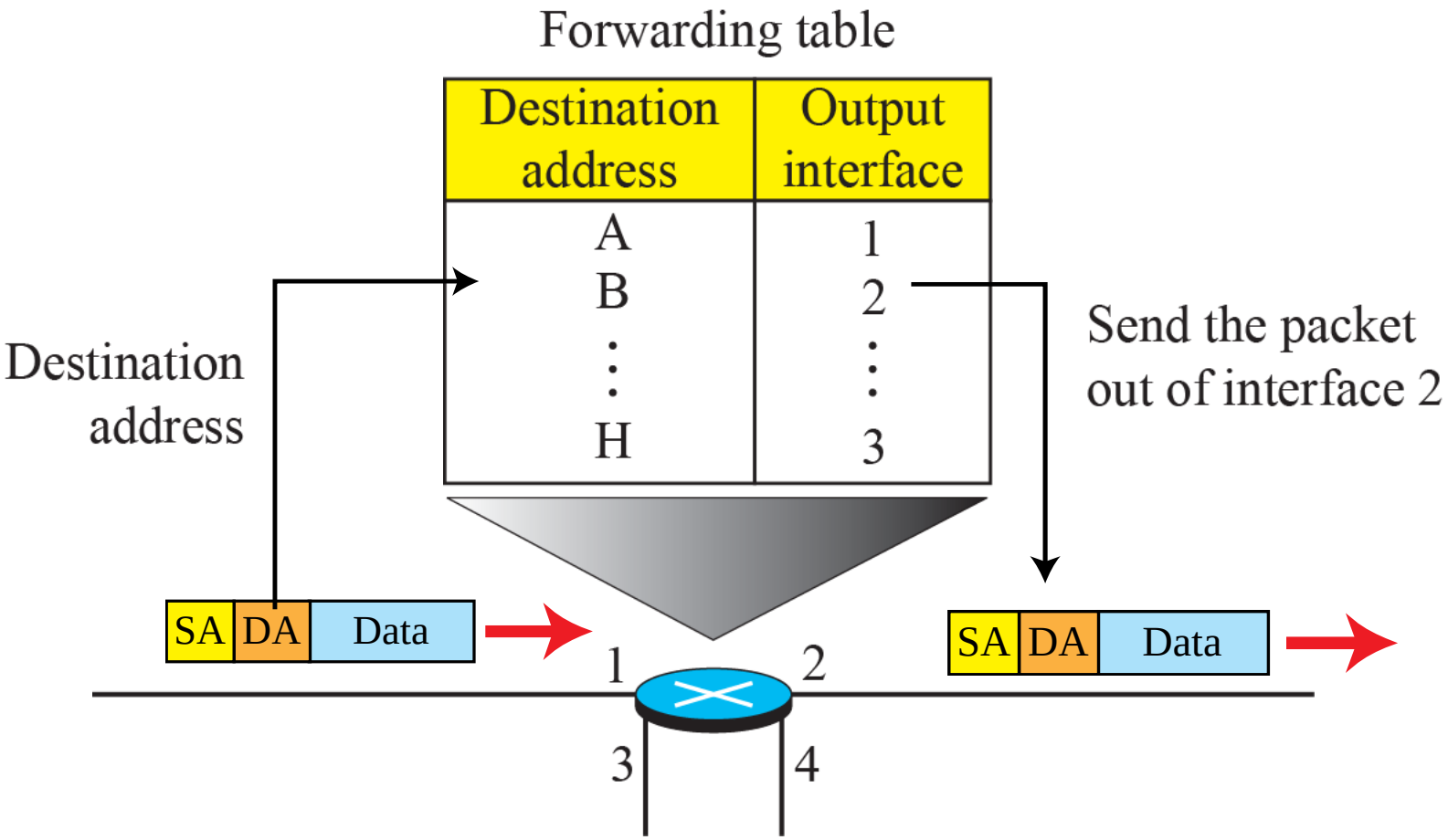


Figure 18.4: ***Forwarding process in a router when used in a connectionless network***



18.2.2 Virtual-Circuit Approach

In a connection-oriented service (also called virtual-circuit approach), there is a relationship between all packets belonging to a message. Before all datagrams in a message can be sent, a virtual connection should be set up to define the path for the datagrams. After connection setup, the datagrams can all follow the same path. In this type of service, not only must the packet contain the source and destination addresses, it must also contain a flow label, a virtual circuit identifier that defines the virtual path the packet should follow.

Figure 18.5: A virtual-circuit packet-switched network

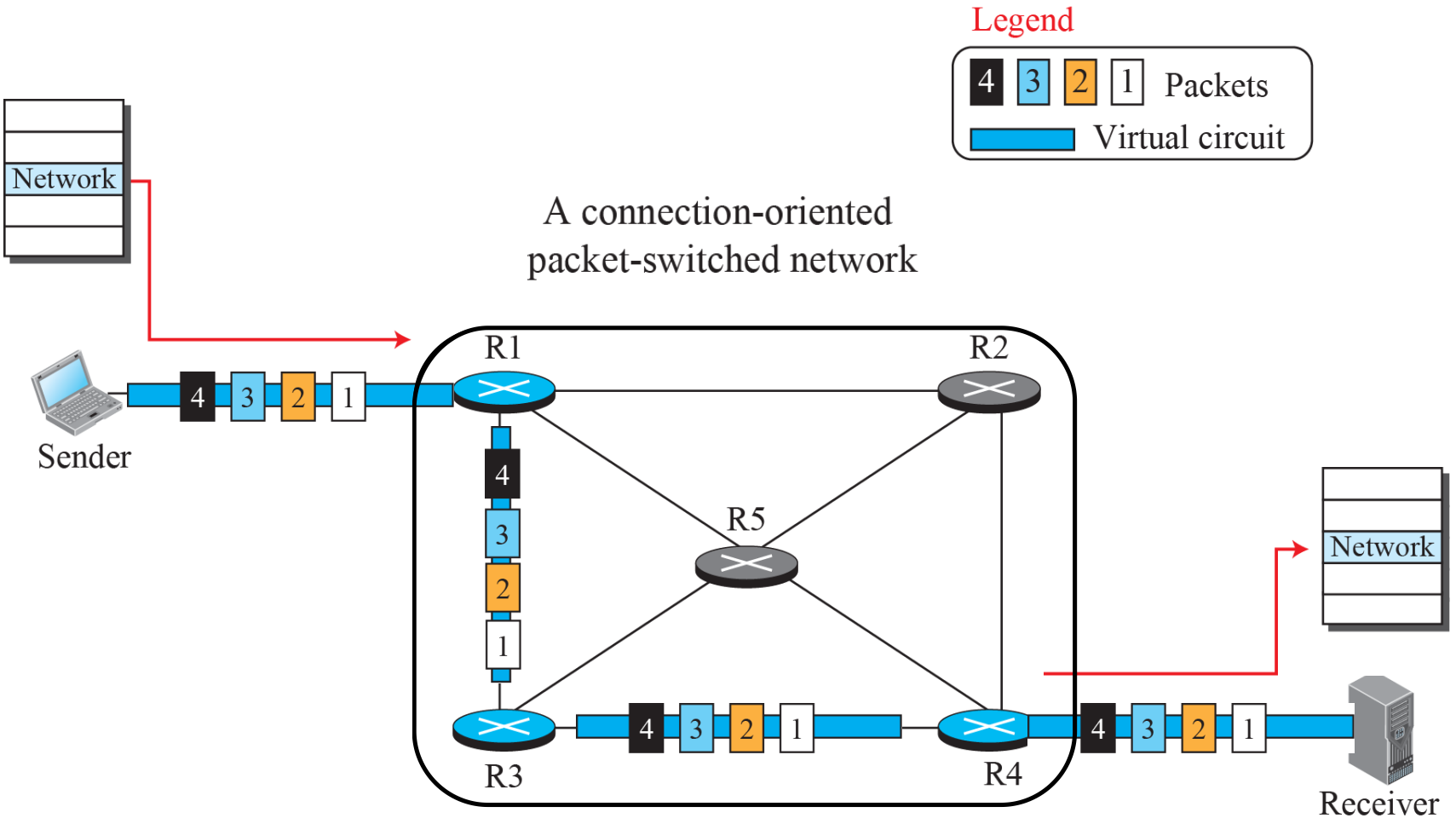


Figure 18.6: ***Forwarding process in a router when used in a virtual circuit network***

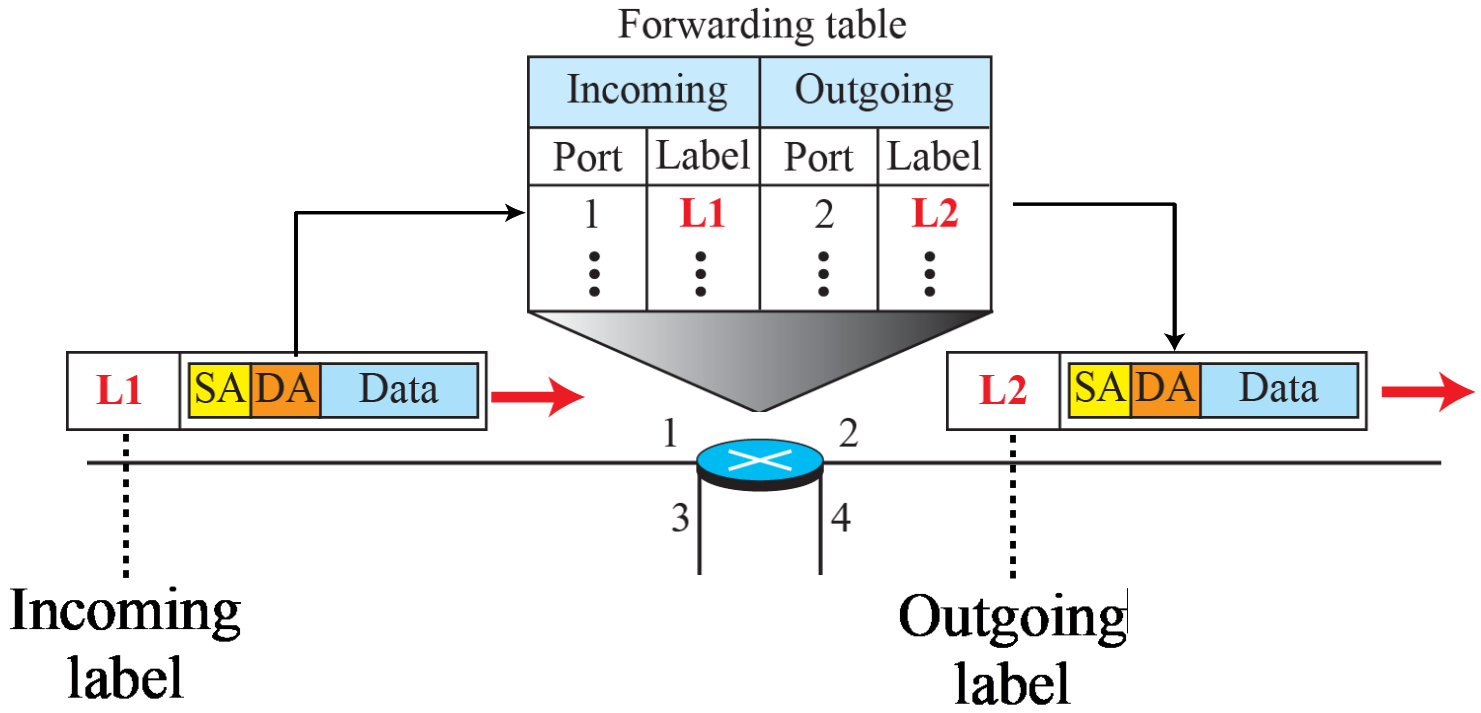


Figure 18.7: Sending request packet in a virtual-circuit network

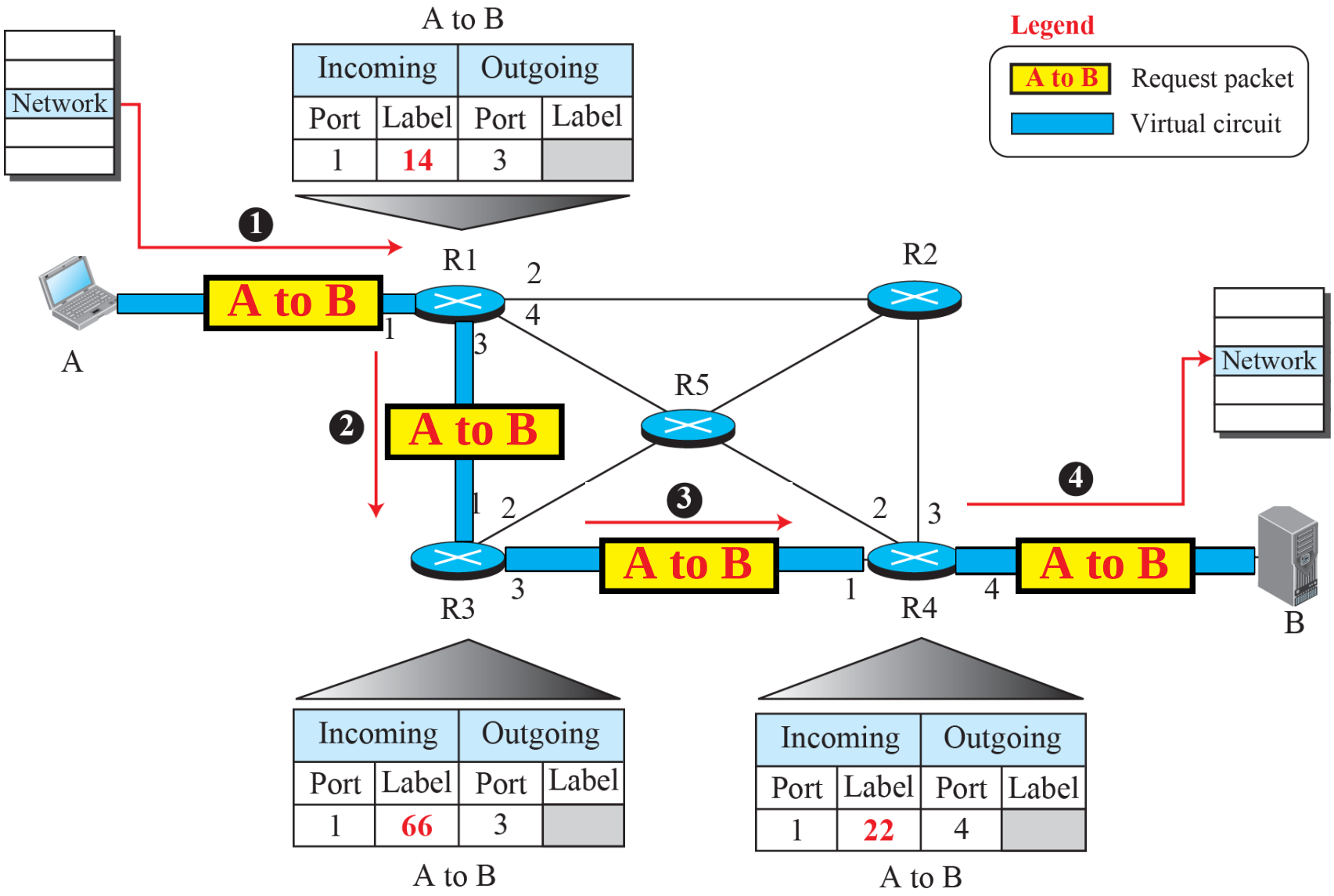


Figure 18.8: Sending acknowledgments in a virtual-circuit network

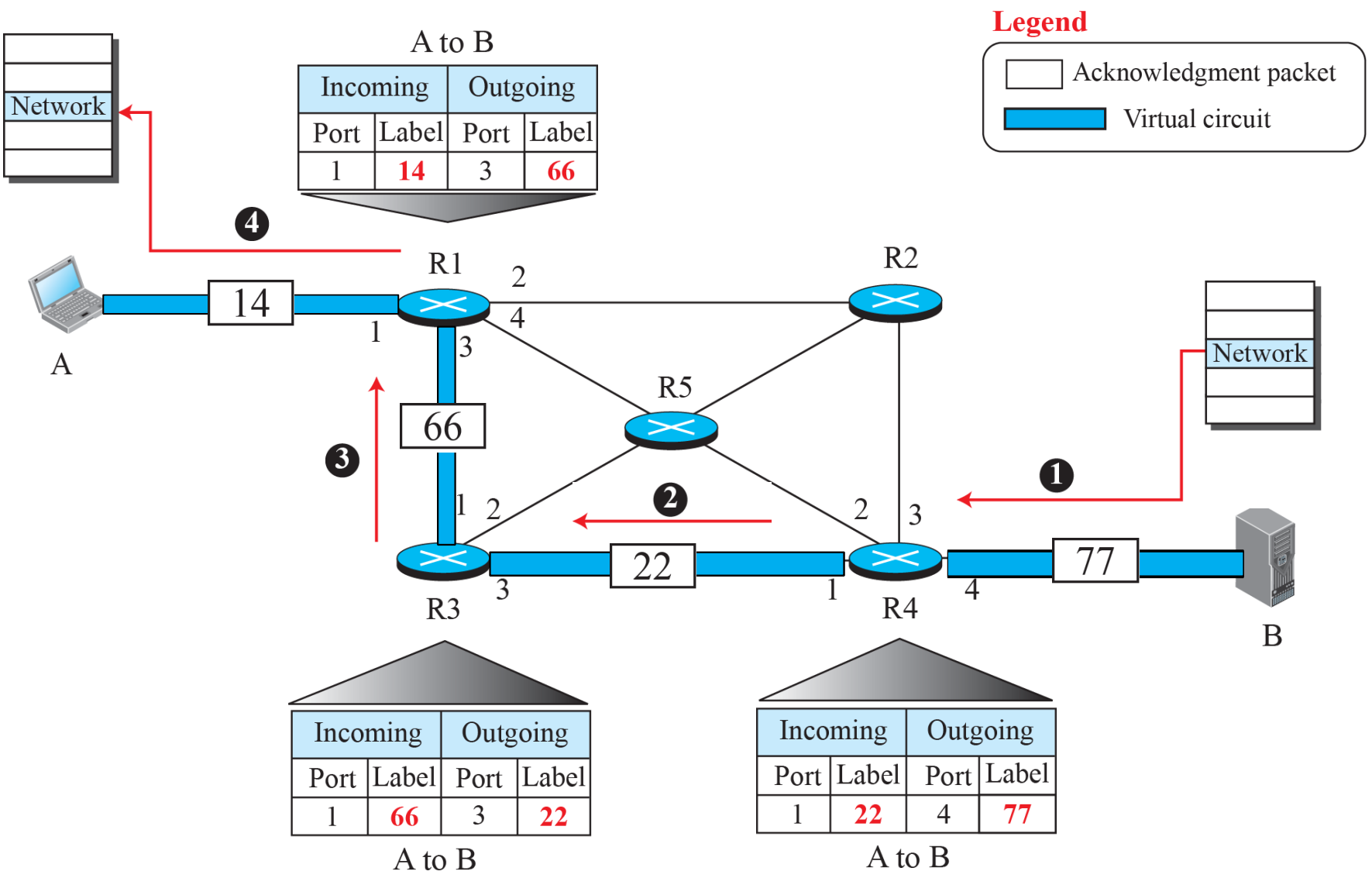
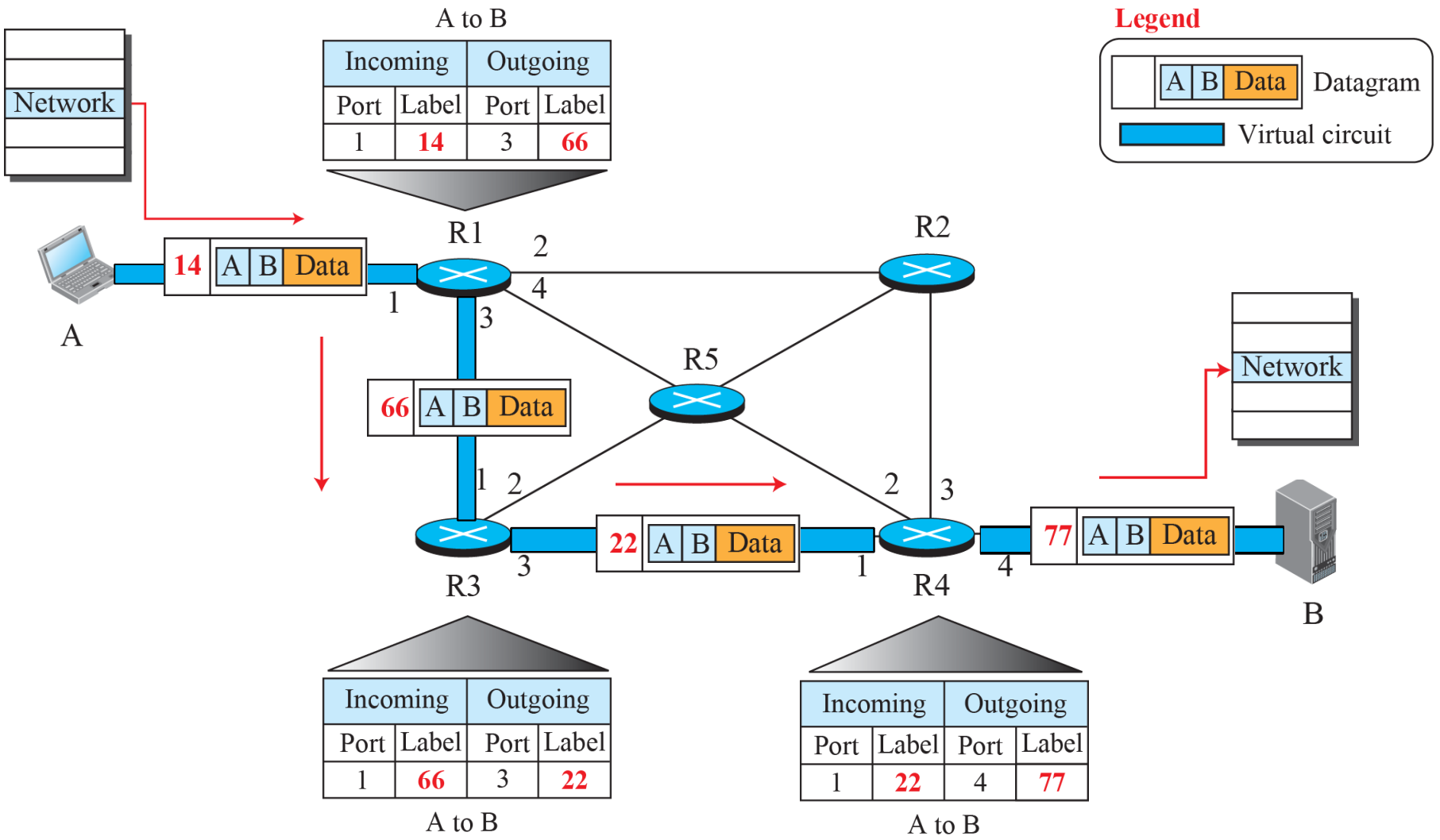


Figure 18.9: Flow of one packet in an established virtual circuit



18-4 IPv4 ADDRESSES

The identifier used in the IP layer of the TCP/IP protocol suite to identify the connection of each device to the Internet is called the Internet address or IP address.

An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a host or a router to the Internet.

18.4.1 Address Space

A protocol like IPv4 that defines addresses has an address space. An address space is the total number of addresses used by the protocol. If a protocol uses b bits to define an address, the address space is 2b because each bit can have two different values (0 or 1). IPv4 uses 32-bit addresses, which means that the address space is 2^{32} or 4,294,967,296 (more than four billion). If there were no restrictions, more than 4 billion devices could be connected to the Internet.

Figure 18.16: ***Three different notations in IPv4 addressing***

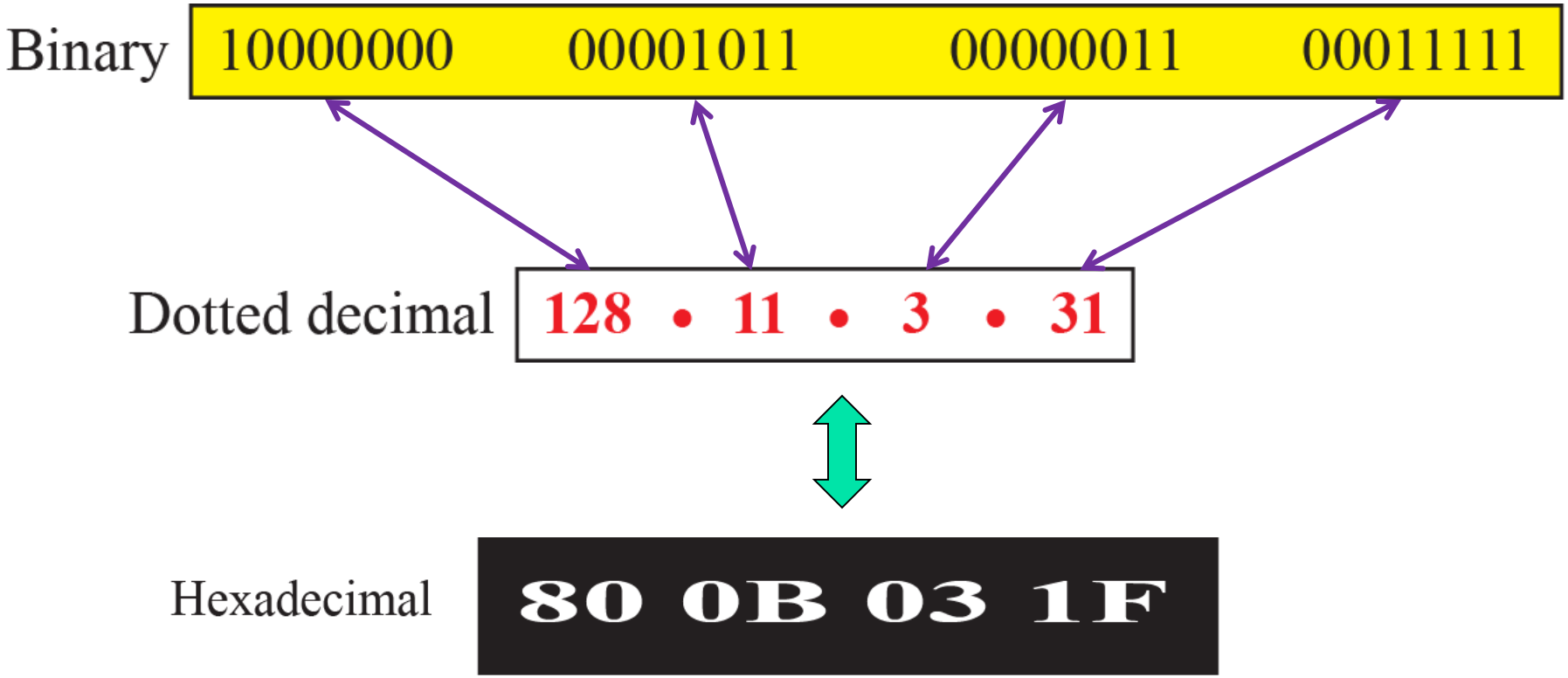
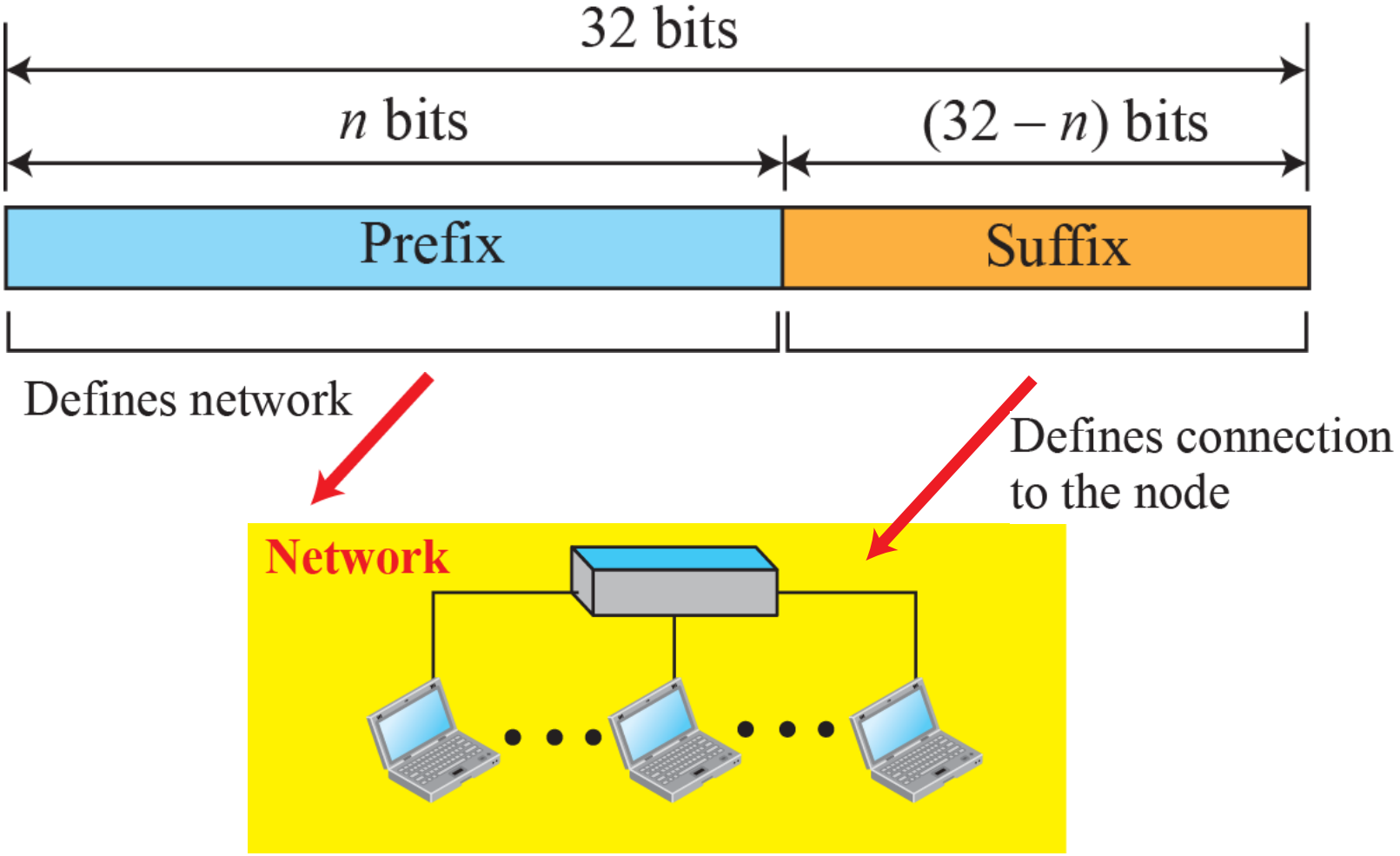


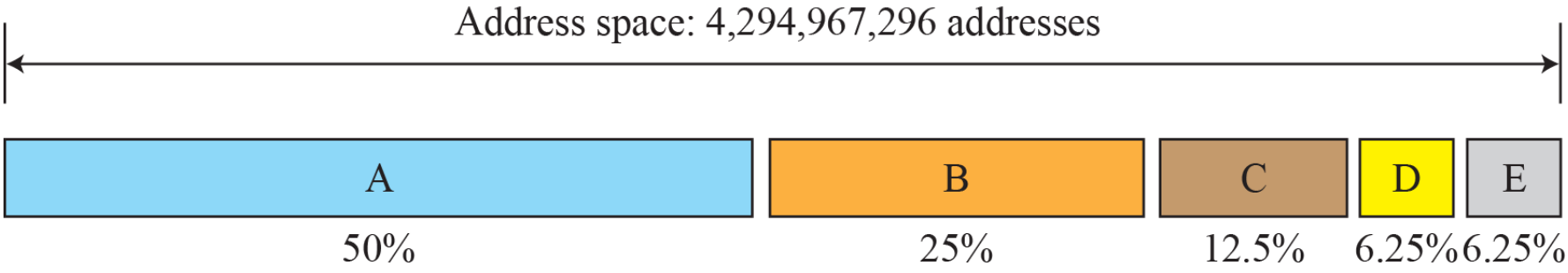
Figure 18.17: ***Hierarchy in addressing***

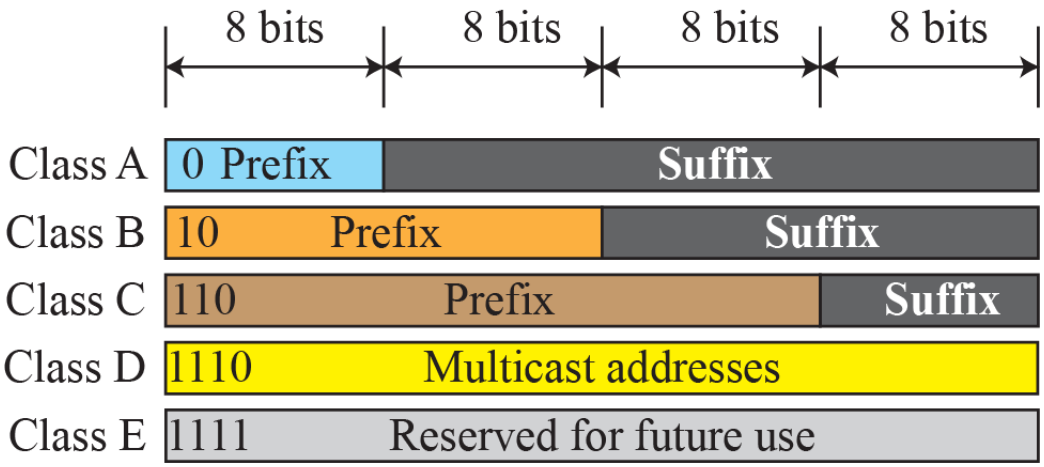


18.4.2 Addressing

When the Internet started, an IPv4 address was designed with a fixed-length prefix, but to accommodate both small and large networks, three fixed-length prefixes were designed instead of one (n = 8, n = 16, and n = 24). The whole address space was divided into five classes (class A, B, C, D, and E), as shown in Figure 18.18.

Figure 18.18: Occupation of the address space in classful addressing





Class	Prefixes	First byte
A	n = 8 bits	0 to 127
B	n = 16 bits	128 to 191
C	n = 24 bits	192 to 223
D	Not applicable	224 to 239
E	Not applicable	240 to 255