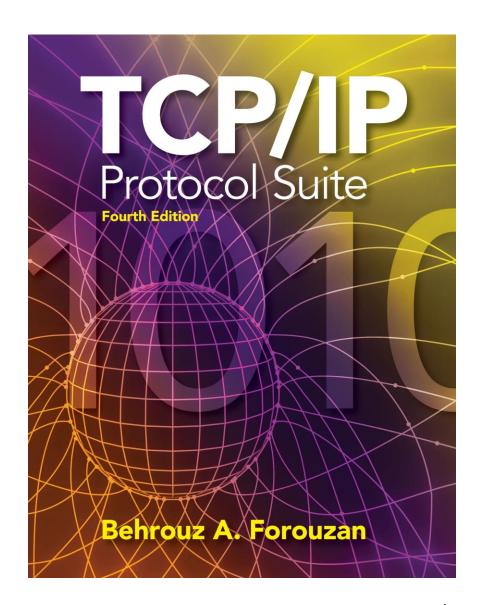
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Chapter 4

Introduction to Network Layer



OBJECTIVES:

- ☐ To introduce switching and in particular packet switching as the mechanism of data delivery in the network layer.
- ☐ To discuss two distinct types of services a packet-switch network can provide: connectionless service and connection-oriented service.
- ☐ To discuss how routers forward packets in a connectionless packet-switch network using the destination address of the packet and a routing table.
- ☐ To discuss how routers forward packets in a connection-oriented packet-switch network using the label on the packet and a routing table.
- ☐ To discuss services already provided in the network layer such as logical addressing and delivery at the source, at each router, and at the destination.
- ☐ To discuss issues or services that are not directly provided in the network layer protocol, but are sometimes provided by some auxiliary protocols or some protocols added later to the Internet.

Chapter Outline

4.1 Introduction

4.2 Switching

4.3 Packet Switching

4.4 Network Layer Services

4.5 Other Network Layer Issues

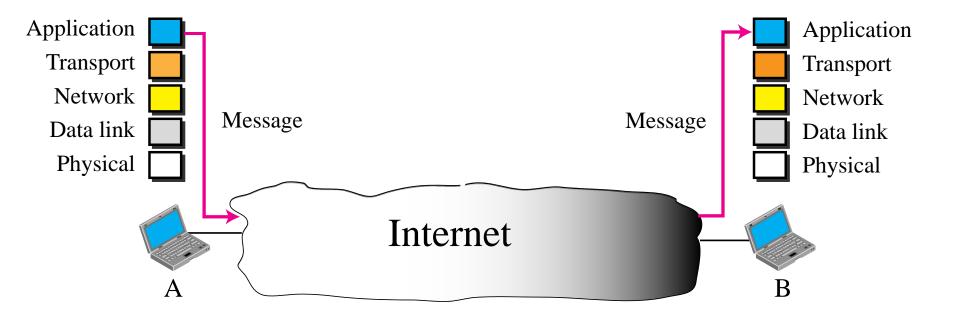
4-1 INTRODUCTION

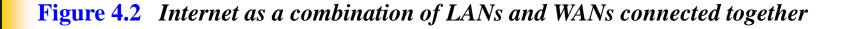
At the conceptual level, we can think of the global Internet as a black box network that connects millions (if not billions) of computers in the world together. At this level, we are only concerned that a message from the application layer in one computer reaches the application layer in another computer.

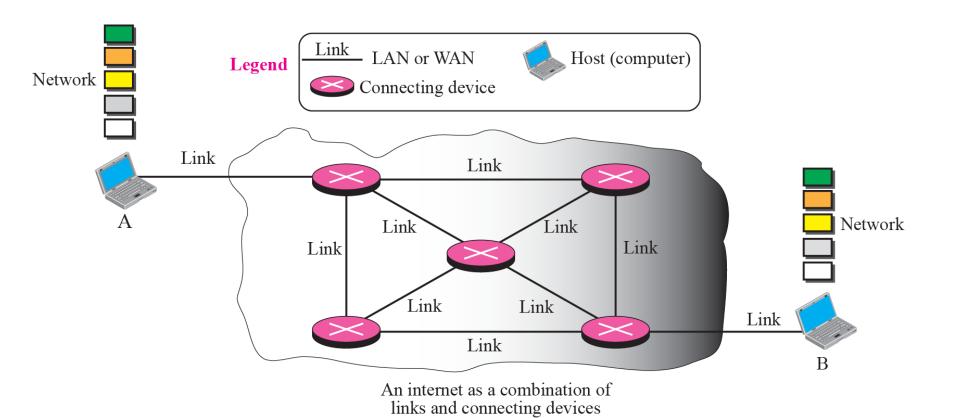
Topics Discussed in the Section

✓ General Introduction







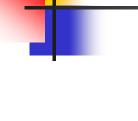


4-2 SWITCHING

From the previous discussion, it is clear that the passage of a message from a source to a destination involves many decisions. When a message reaches a connecting device, a decision needs to be made to select one of the output ports through which the packet needs to be sent out. In other words, the connecting device acts as a switch that connects one port to another port.

Topics Discussed in the Section

- **✓** Circuit Switching
- **✓ Packet Switching**



Note

In circuit switching, the whole message is sent from the source to the destination without being divided into packets.

Example 4.1

A good example of a circuit-switched network is the early telephone systems in which the path was established between a caller and a callee when the telephone number of the callee was dialed by the caller. When the callee responded to the call, the circuit was established. The voice message could now flow between the two parties, in both directions, while all of the connecting devices maintained the circuit. When the caller or callee hung up, the circuit was disconnected. The telephone network is not totally a circuit-switched network today.

Note

In packet switching, the message is first divided into manageable packets at the source before being transmitted.

The packets are assembled at the destination.

4-3 PACKET SWITHING

The network layer is designed as a packet-switched network. This means that the packet at the source is divided into manageable packets, normally called datagrams. Individual datagrams are transferred from the source to the destination. The received datagrams are assembled at the destination before recreating the original message. The packetswitched network layer of the Internet was originally designed as a connectionless service, but recently there is a tendency to change this to a connectionoriented service.

Topics Discussed in the Section

- **✓** Connectionless Service
- **✓** Connection-Oriented Service



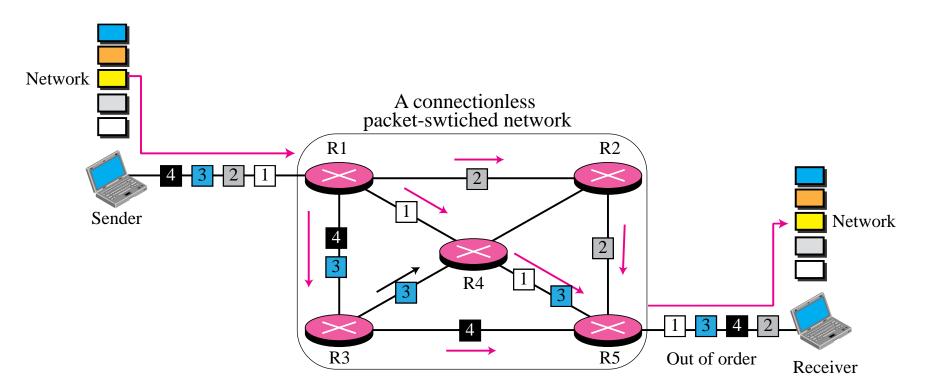
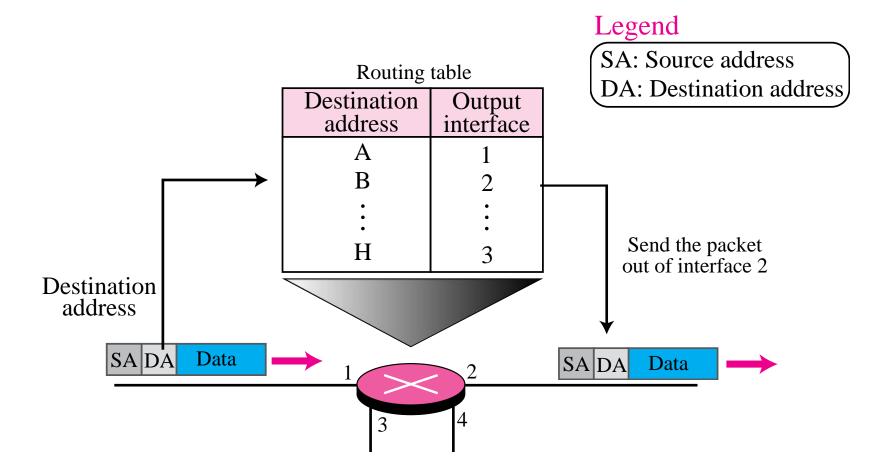
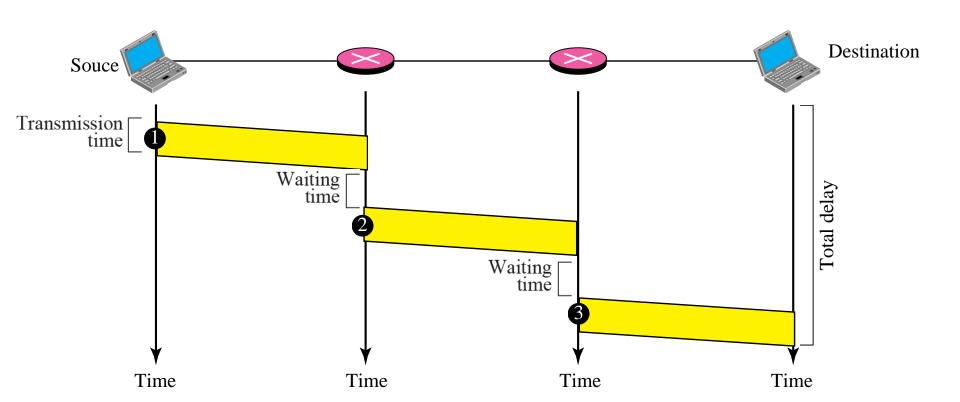


Figure 4.4 Forwarding process in a connectionless network

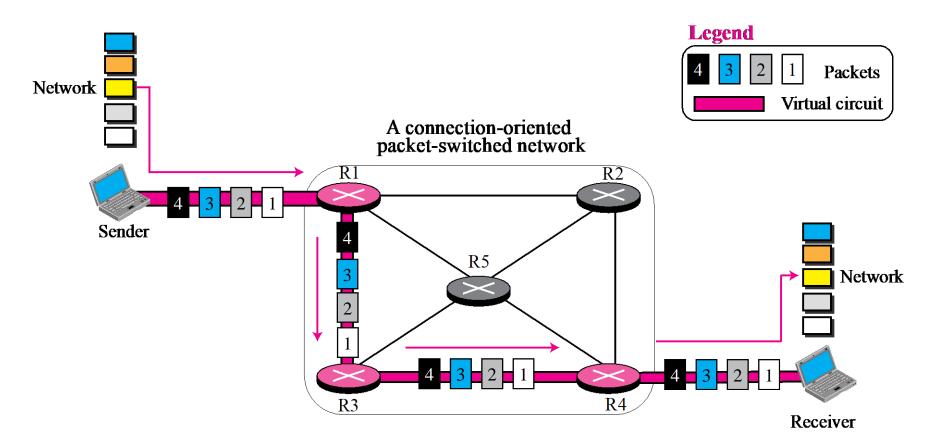




In a connectionless packet-switched network, the forwarding decision is based on the destination address of the packet.



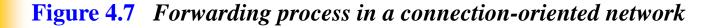


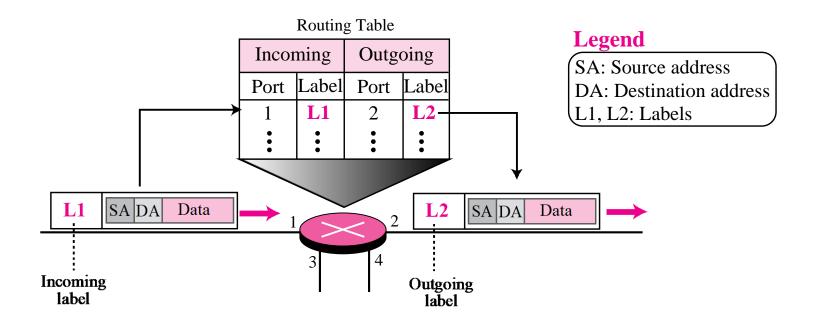




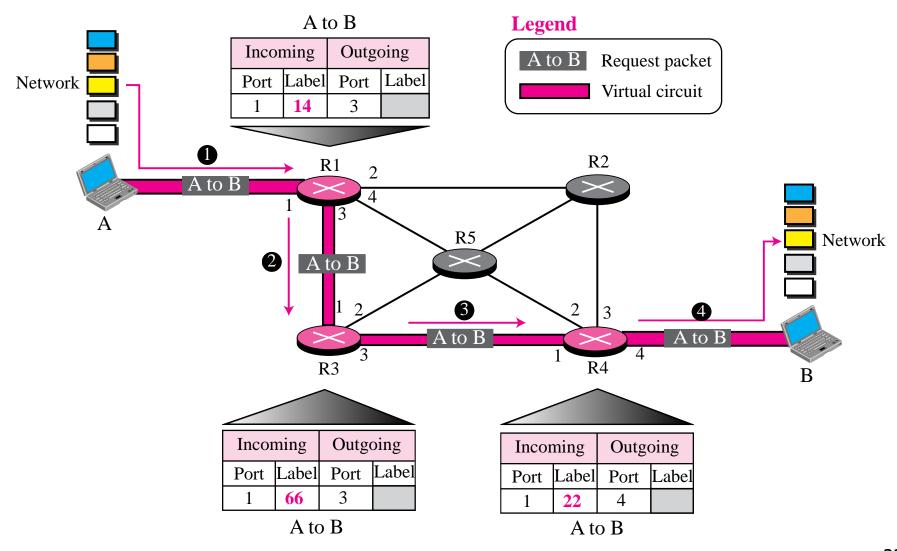
Note

In a connection-oriented packet switched network, the forwarding decision is based on the label of the packet.











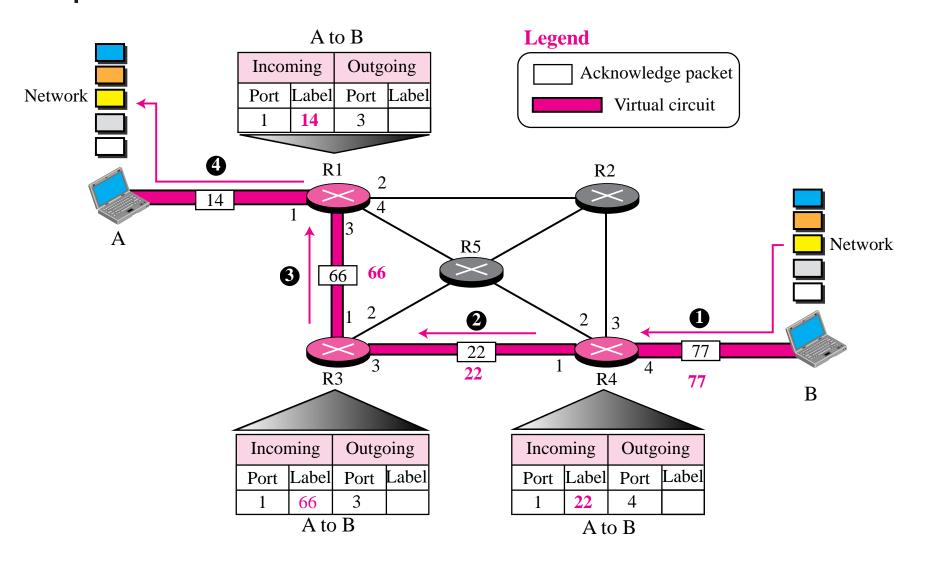


Figure 4.10 Flow of one packet in an established virtual circuit

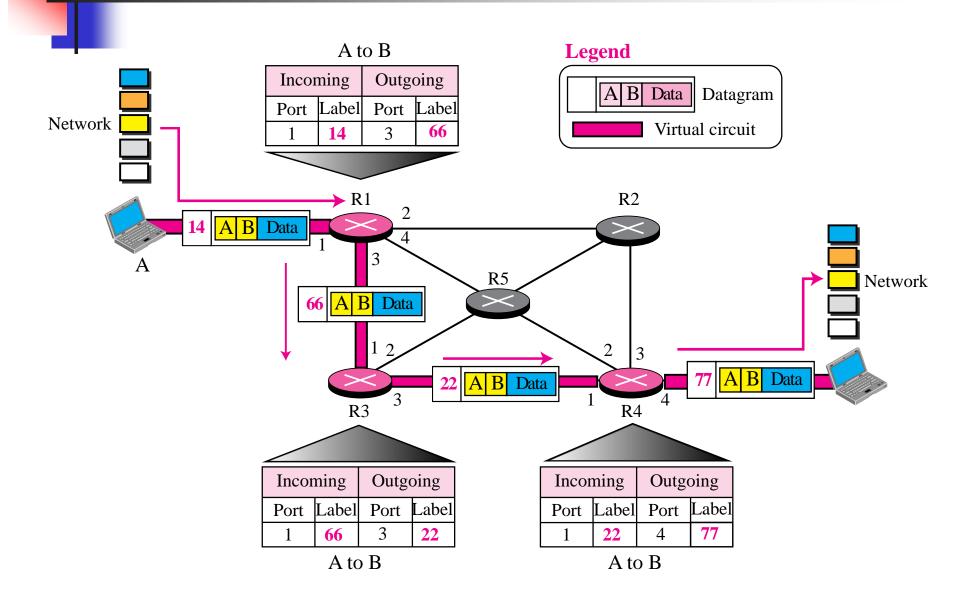
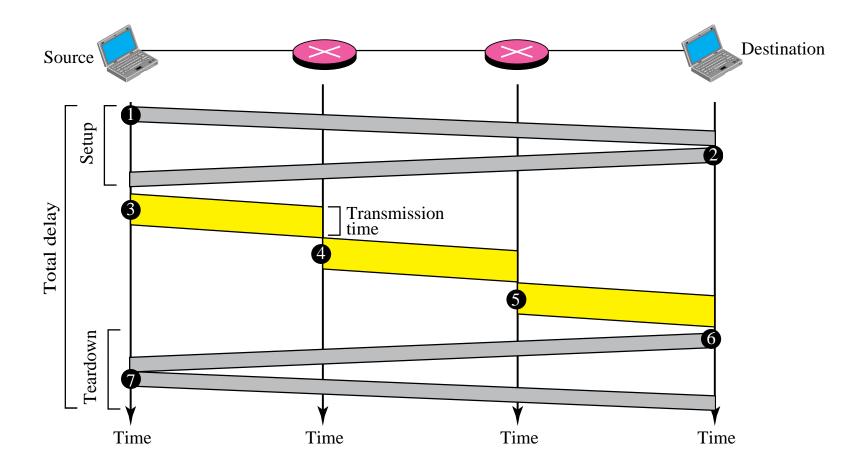


Figure 4.11 Delay in a connection-oriented network



4-4 NETWORK LAYER SERVICES

In this section, we briefly discuss services provided by the network layer. Our discussion is mostly based on the connectionless service, the dominant service in today's Internet.

Topics Discussed in the Section

- **✓** Logical Addressing
- **✓ Services Provided at the Source Computer**
- **✓ Services Provides at the Each Router**
- **✓** Services Provided at the Destination Computer

Figure 4.12 An imaginary part of the Internet

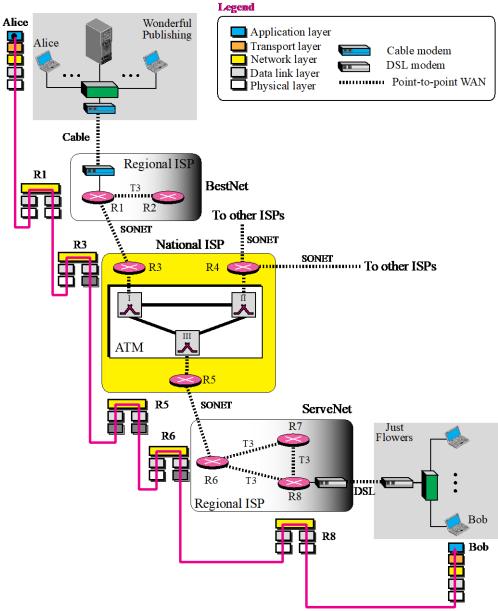


Figure 4.13 Services provided at the source computer

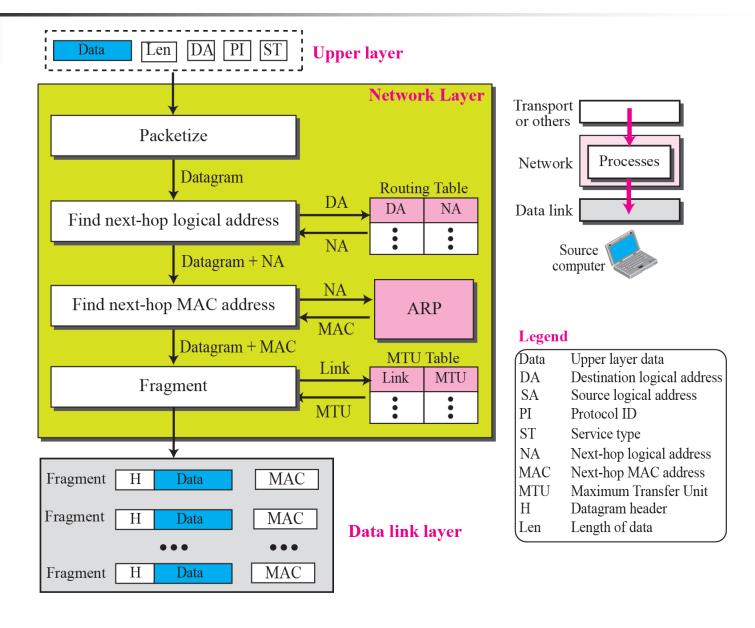
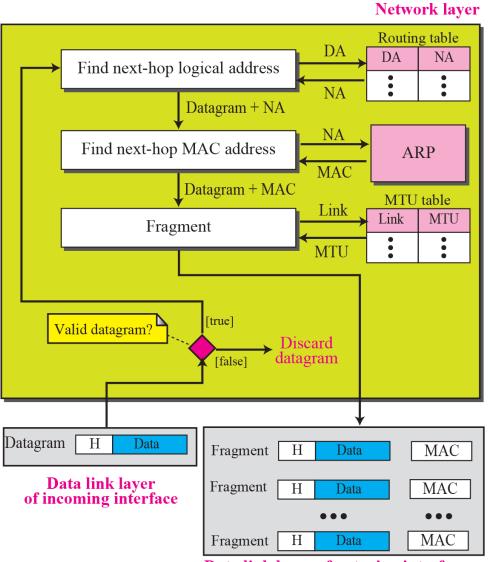
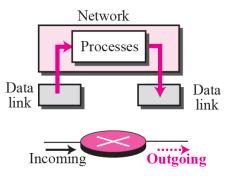


Figure 4.14 Processing at each router



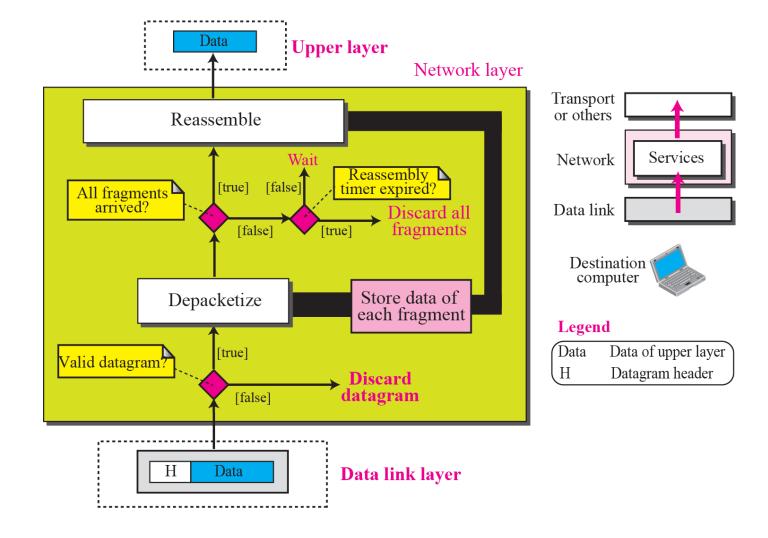


Legend

Data	Upper layer data
DA	Destination logical address
NA	Next-hop logical address
MAC	Next-hop MAC address
MTU	Maximum Transfer Unit
Н	Datagram header

Data link layer of outgoing interface

Figure 4.15 Processing at the destination computer



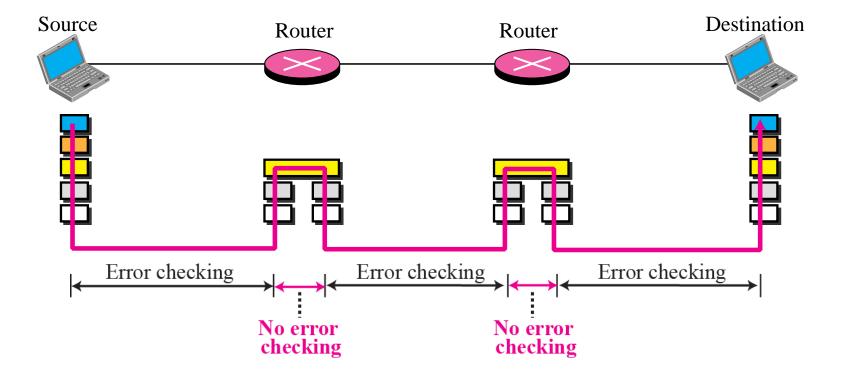
4-5 OTHER SERVICES

In this section we introduce some issues related to the network layer. These issues actually represent services that are normally discussed for the network layer, but they are either partially implemented at the network layer or not implemented at all. Some services are provided by some auxiliary protocols or by protocols added to the Internet later. Most of these issues resurface in future chapters.

Topics Discussed in the Section

- **✓ Error Control**
- **✓ Flow Control**
- **✓** Congestion Control
- **✓** Routing
- **✓** Security

Figure 4.16 Error checking at the data link layer





Note

No flow control is provided for the current version of Internet network layer.