Chapter 8

Switching

Figure 8.1 *Switched network*

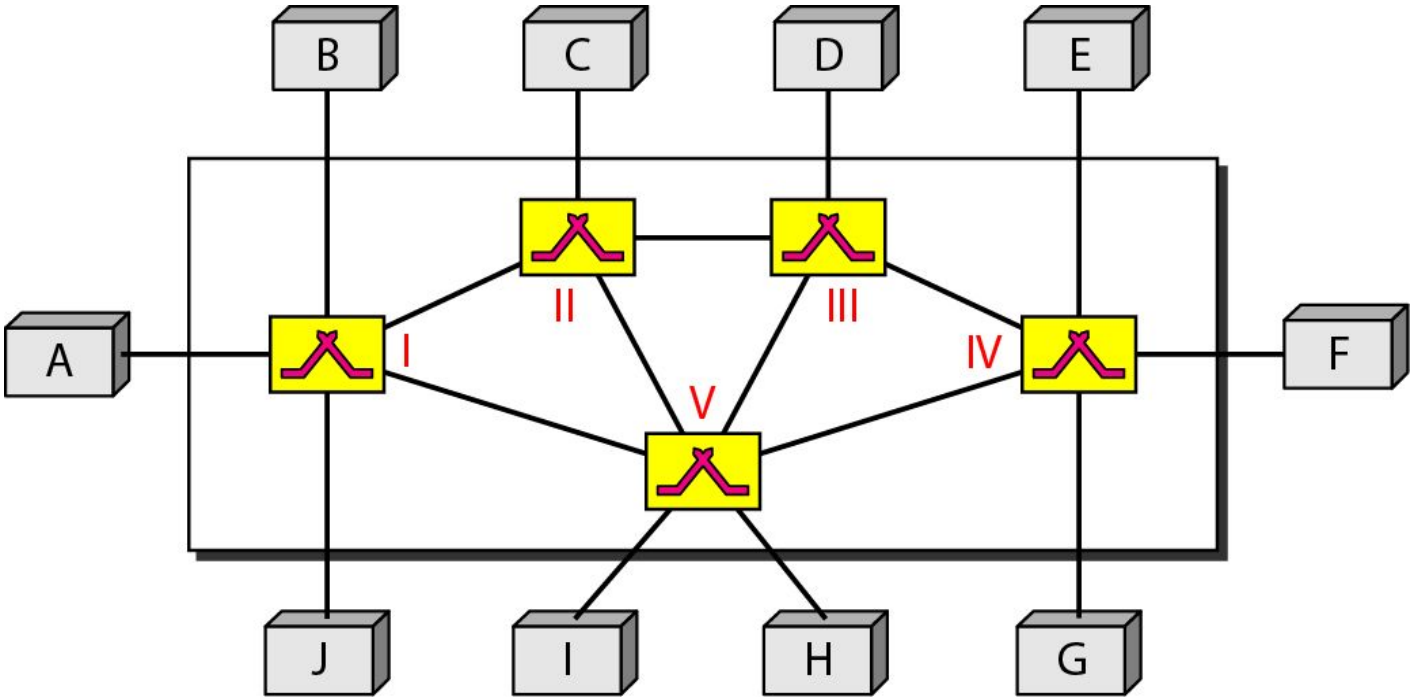
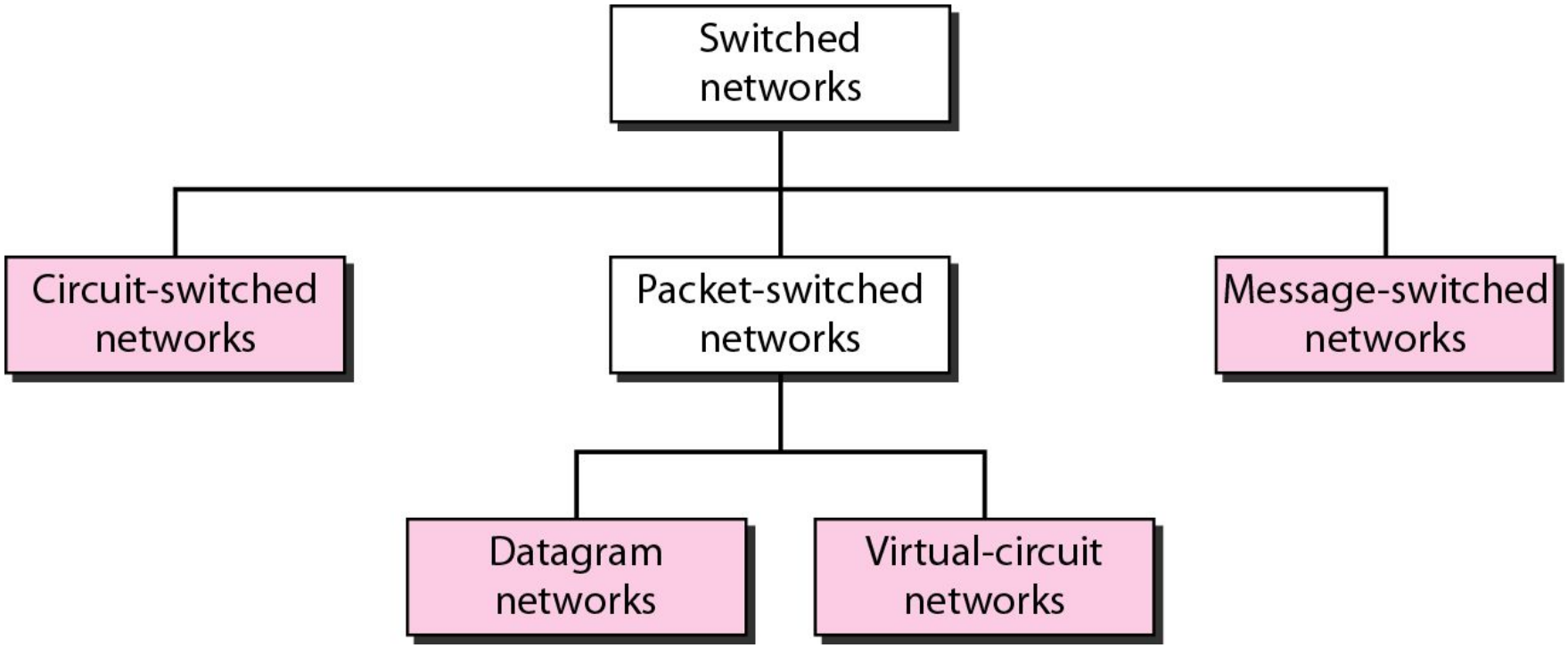


Figure 8.2 *Taxonomy of switched networks*



8-1 CIRCUIT-SWITCHED NETWORKS

A circuit-switched network consists of a set of switches connected by physical links. A connection between two stations is a dedicated path made of one or more links. However, each connection uses only one dedicated channel on each link. Each link is normally divided into n channels by using FDM or TDM.

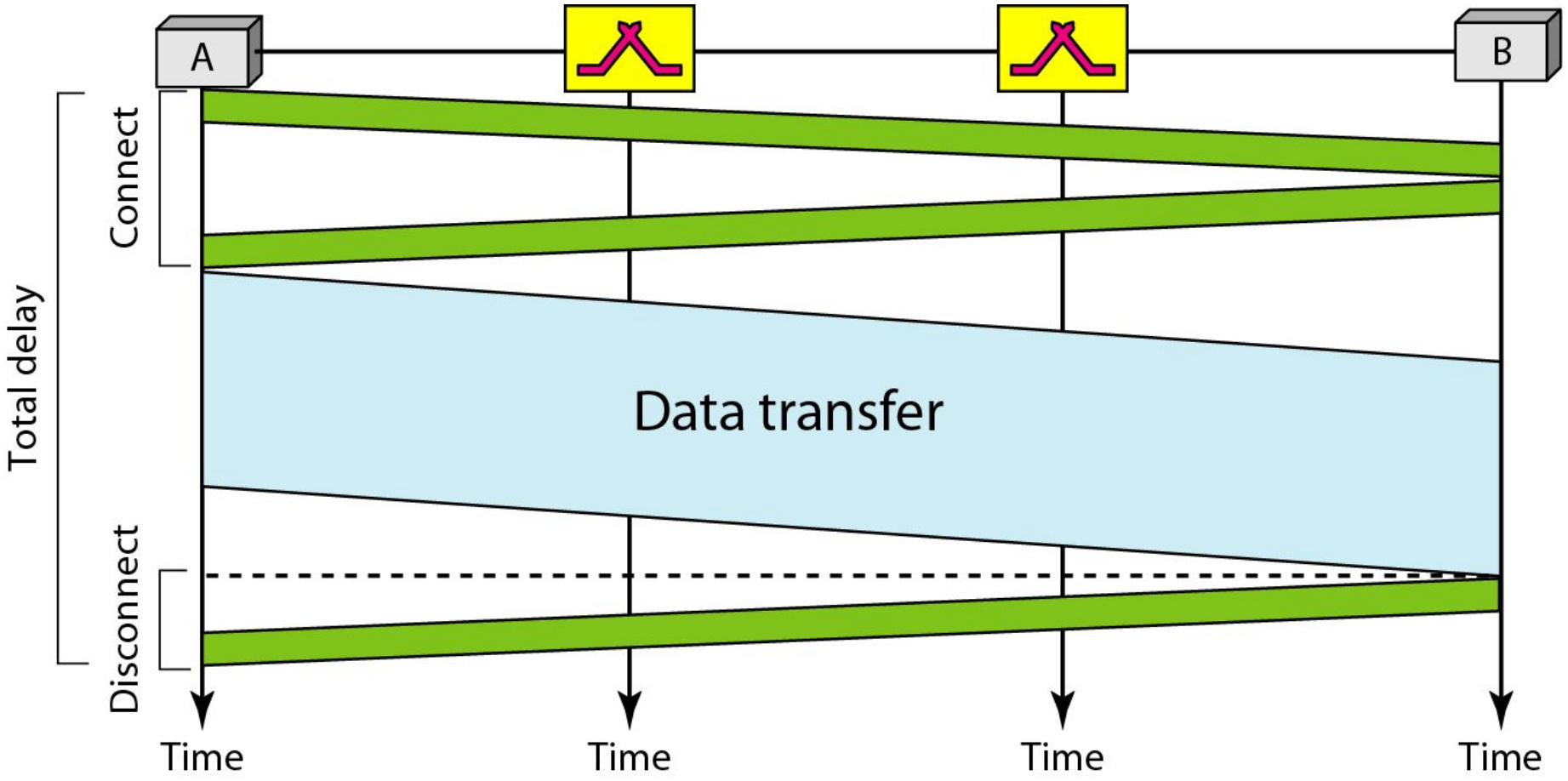
Topics discussed in this section:

Three Phases
Efficiency
Delay
Circuit-Switched Technology in Telephone Networks

Note

In circuit switching, the resources need to be reserved during the setup phase; the resources remain dedicated for the entire duration of data transfer until the teardown phase.

Figure 8.6 *Delay in a circuit-switched network*



Note

Switching at the physical layer in the traditional telephone network uses the circuit-switching approach.

A path in a digital circuit-switched network has a data rate of 1 Mbps. The exchange of 1000 bits is required for the setup and teardown phases. The distance between two parties is 3000 km. Answer the following questions if the propagation speed is 2×10^8 m/s:

a. What is the total delay if 1000 bits of data are exchanged during the data transfer phase?
b. What is the total delay if 100,000 bits of data are exchanged during the data transfer phase?
c. What is the total delay if 1,000,000 bits of data are exchanged during the data transfer phase?

a. Total Delay = Transmission Delay + Propagation Delay = (1000bits/1Mbps) + ((3000x1000)/(2x10^8)) = 0.001 + 0.015 = 0.016s

b. Total Delay = (100000bits/1Mbps) + 0.015 = 0.015s

c. Total Delay = (1000000/1Mbps) + 0.015 = 1.015s

8-2 DATAGRAM NETWORKS

In data communications, we need to send messages from one end system to another. If the message is going to pass through a packet-switched network, it needs to be divided into packets of fixed or variable size. The size of the packet is determined by the network and the governing protocol.

Topics discussed in this section:

Routing Table
Efficiency
Delay
Datagram Networks in the Internet

Two Basic Forms of Packet Switching

- Packets handled in two ways
  - Datagram (covered in this section)
  - Virtual circuit (covered in the next section)

Datagram

- Each packet treated independently
- Packets can take any practical route
- Packets may arrive out of order
- Packets may get lost or delayed
- Up to receiver to re-order packets and recover from missing packets

Five equal-size datagrams belonging to the same message leave for the destination one after another. However, they travel through different paths as shown in the following table

Datagram	Path Length	Visited Switches
1	3200 Km	1,3,5
2	11,700 Km	1,2,5
3	12,200 Km	1,2,3,5
4	10,200 Km	1,4,5
5	10,700 Km	1,4,3,5

We assume that the delay for each switch (including waiting and processing) is 3, 10, 20, 7, and 20 ms respectively. Assuming that the propagation speed is 2×10^8 m/s, find the order the datagrams arrive at the destination and the delay for each. Ignore any other delays in transmission.

Delay for 1st datagram = (3200/(2x10^8))x(3+20+20) = 59ms
Delay for 2nd datagram = (11700/(2x10^8))x(3+10+20) = 91.5ms
Delay for 3rd datagram = (12200/(2x10^8))x(3+10+20+20) = 114ms
Delay for 4th datagram = (10200/(2x10^8))x(3+7+20) = 81ms
Delay for 5th datagram = (10700/(2x10^8))x(3+7+20+20) = 103.5ms
3->5->2->4->1

Virtual Circuit

- Preplanned route established before any packets sent
- Call request and call accept packets establish connection (handshake)
- Each packet contains a virtual circuit identifier instead of destination address
- No routing decisions required for each packet
- Clear request to drop circuit
- Not a dedicated

Figure 8.7 *A datagram network with four switches (routers)*

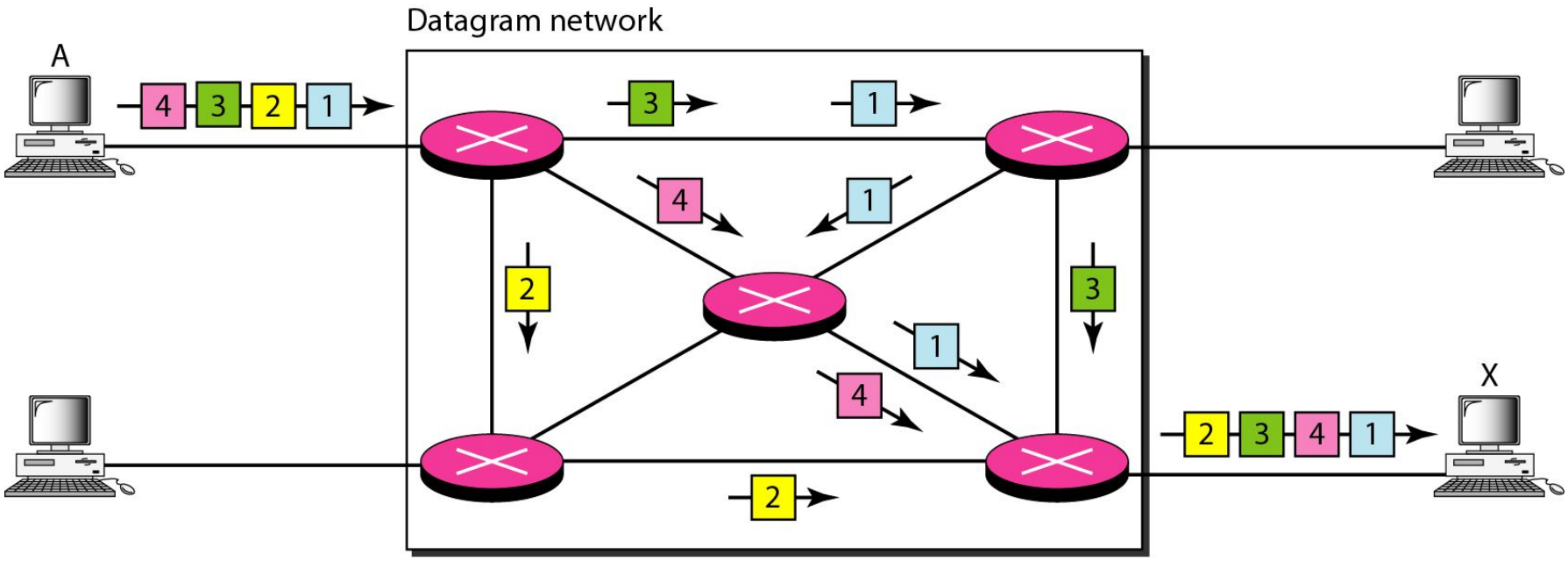
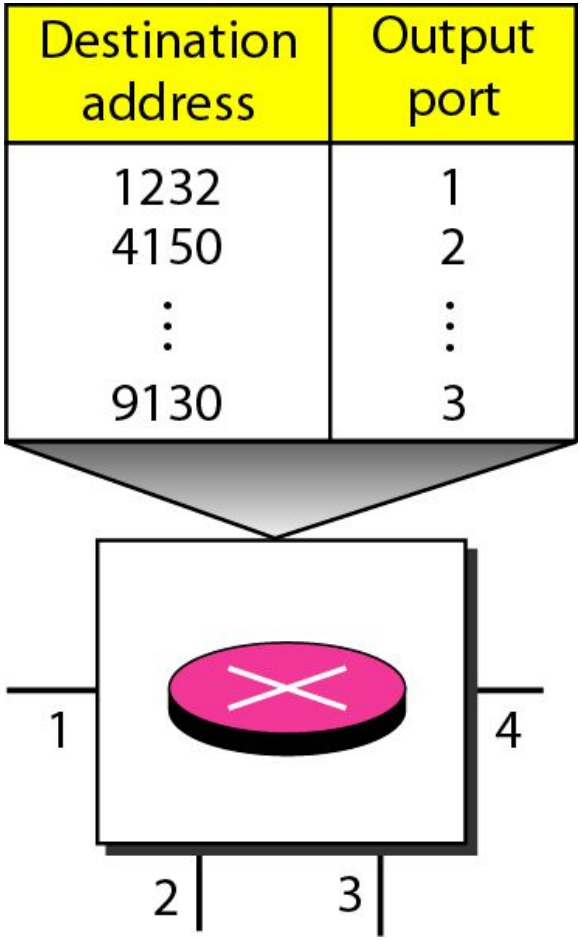


Figure 8.8 *Routing table in a datagram network*



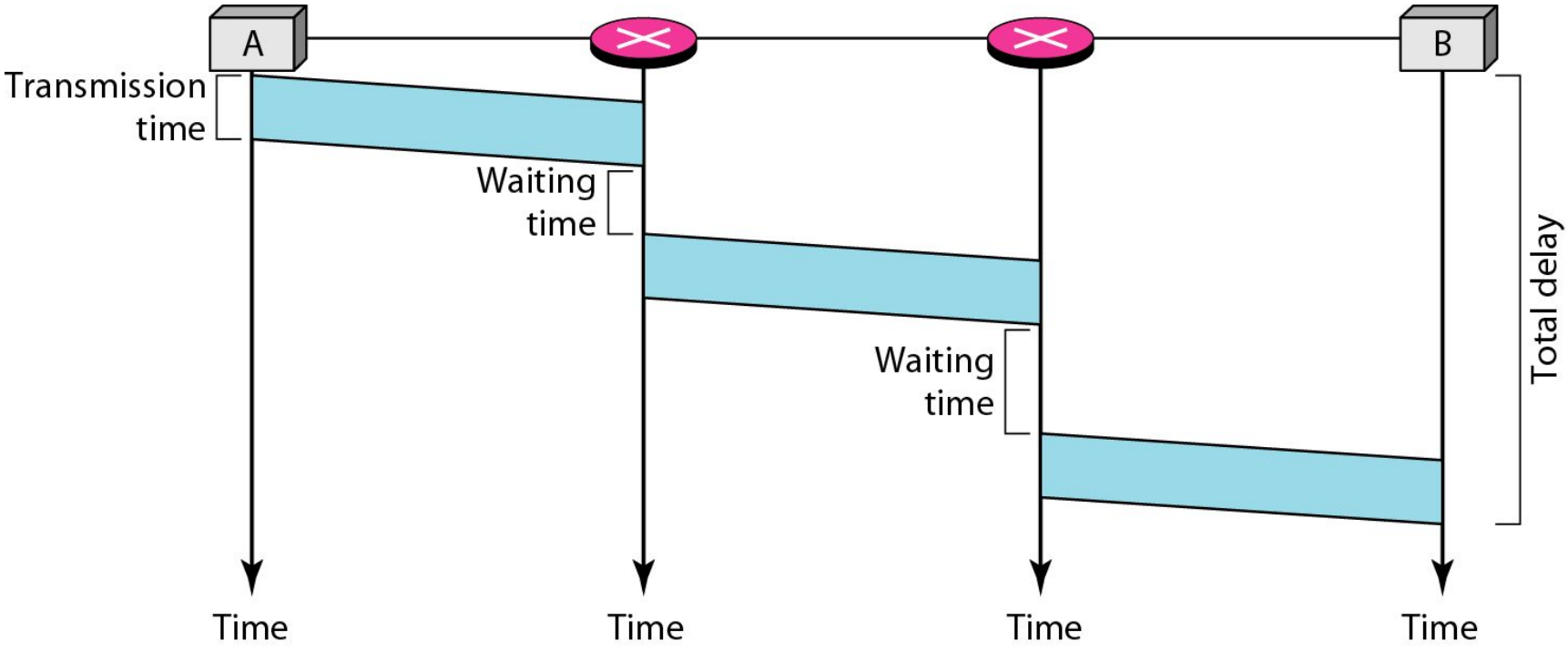
Note

A switch in a datagram network uses a routing table that is based on the destination address.

Note

The destination address in the header of a packet in a datagram network remains the same during the entire journey of the packet.

Figure 8.9 *Delay in a datagram network*



Note

Switching in the Internet is done by using the datagram approach to packet switching at the network layer.

8-3 VIRTUAL-CIRCUIT NETWORKS

A virtual-circuit network is a cross between a circuit-switched network and a datagram network. It has some characteristics of both.

Topics discussed in this section:

Addressing
Three Phases
Efficiency
Delay
Circuit-Switched Technology in WANs

Figure 8.10 *Virtual-circuit network*

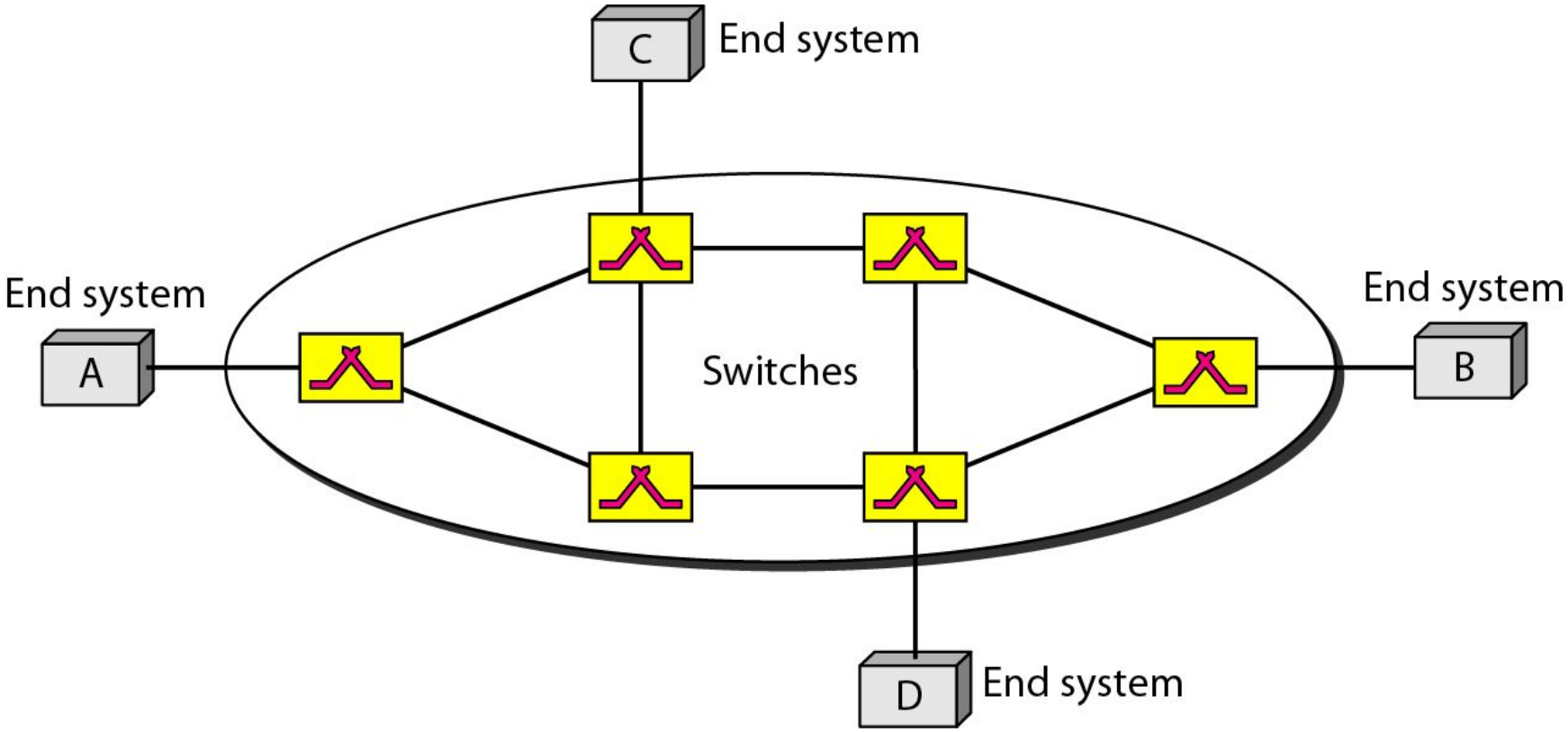


Figure 8.11 *Virtual-circuit identifier*

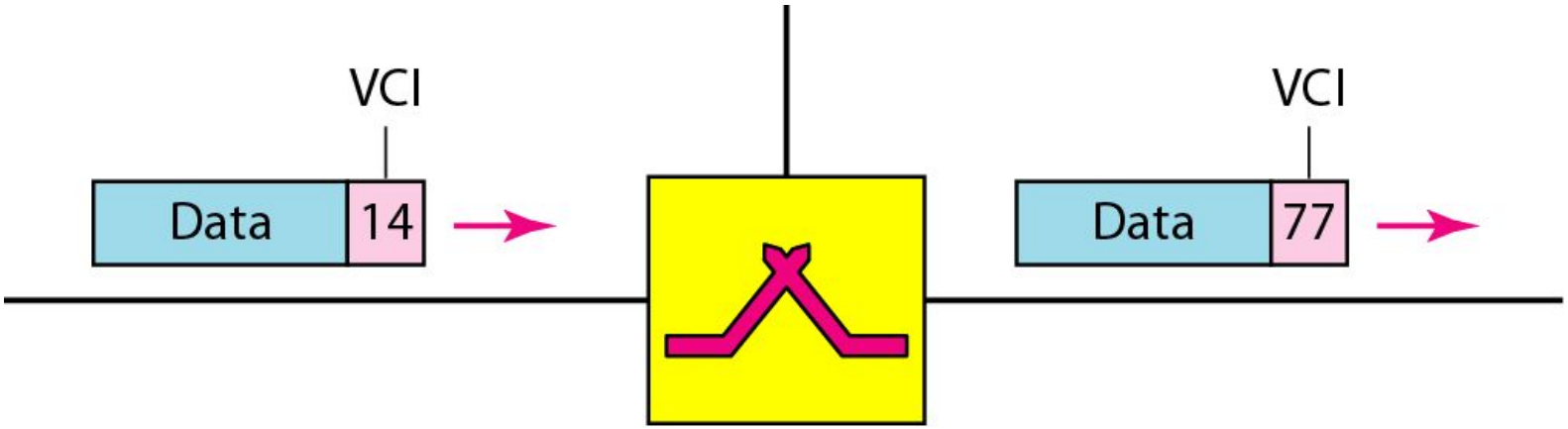


Figure 8.12 *Switch and tables in a virtual-circuit network*

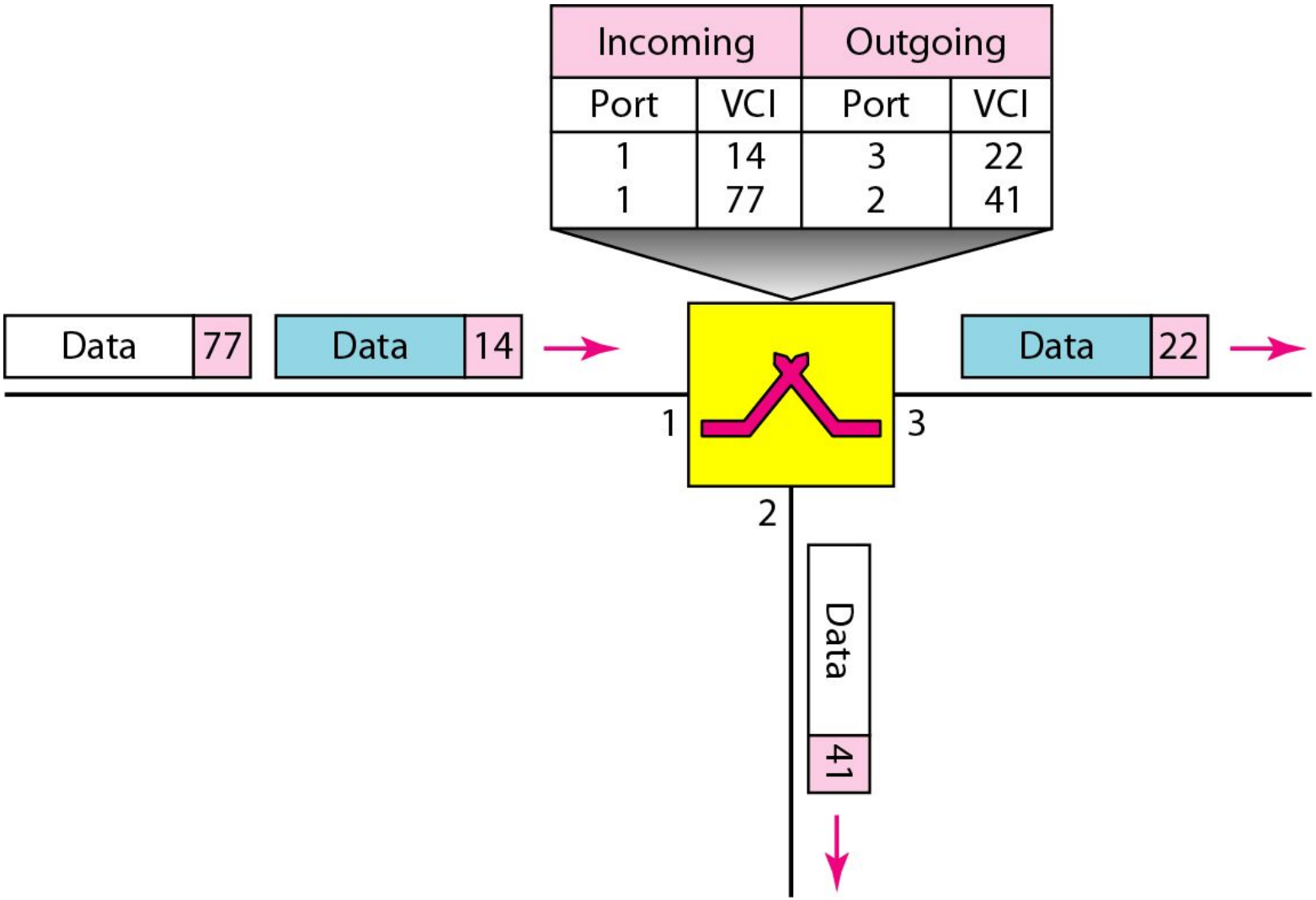


Figure 8.13 *Source-to-destination data transfer in a virtual-circuit network*

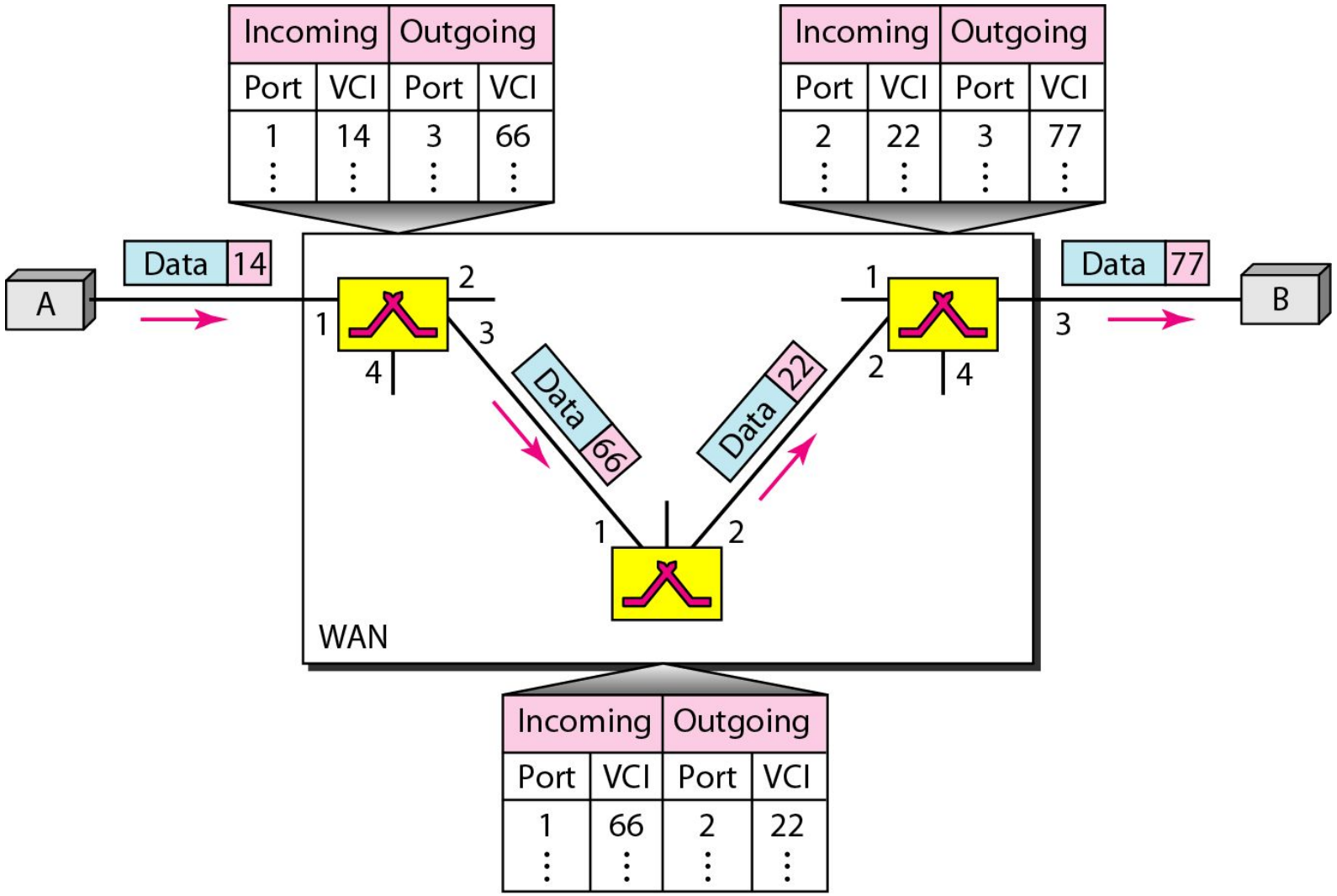


Figure 8.14 *Setup request in a virtual-circuit network*

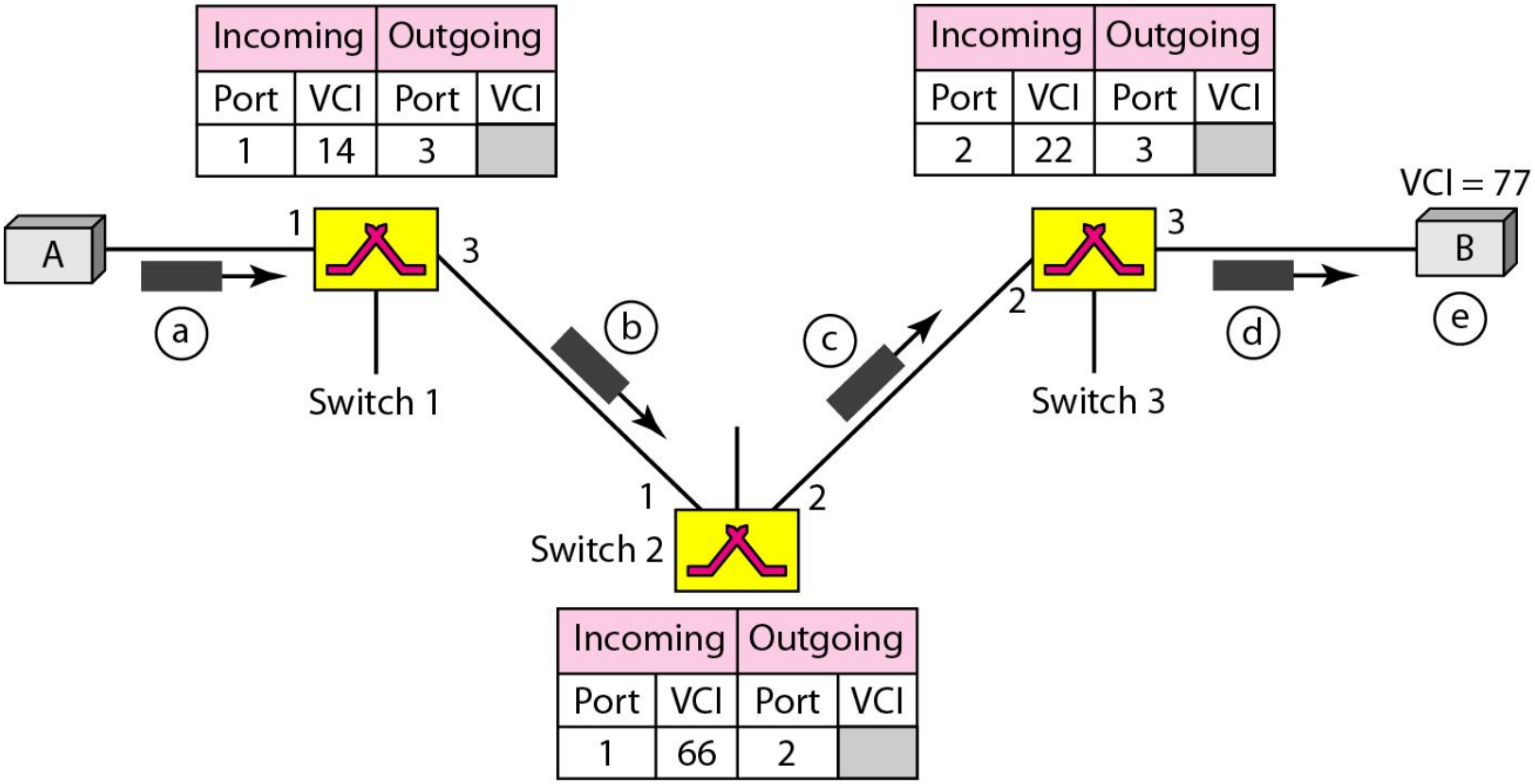
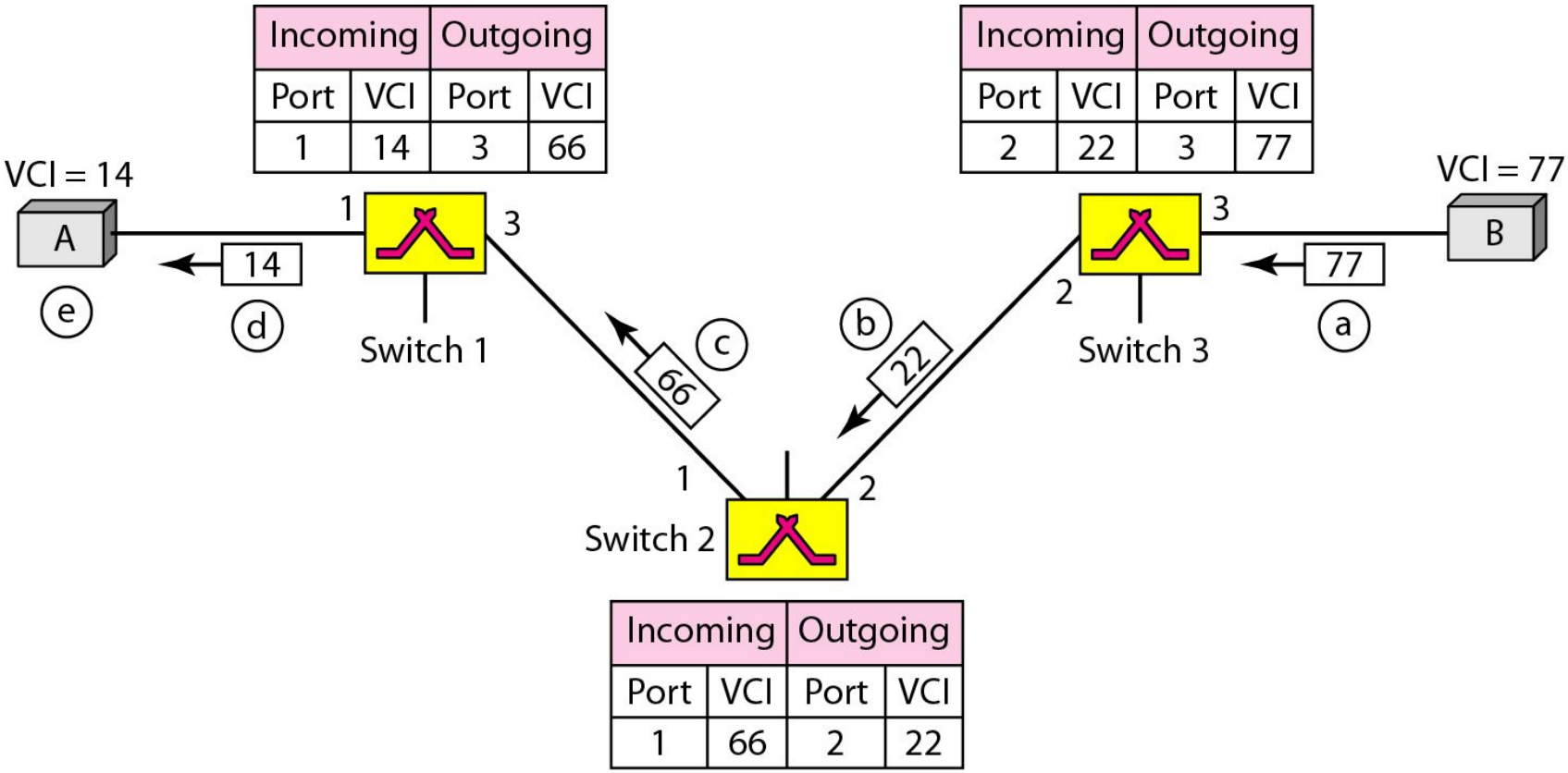


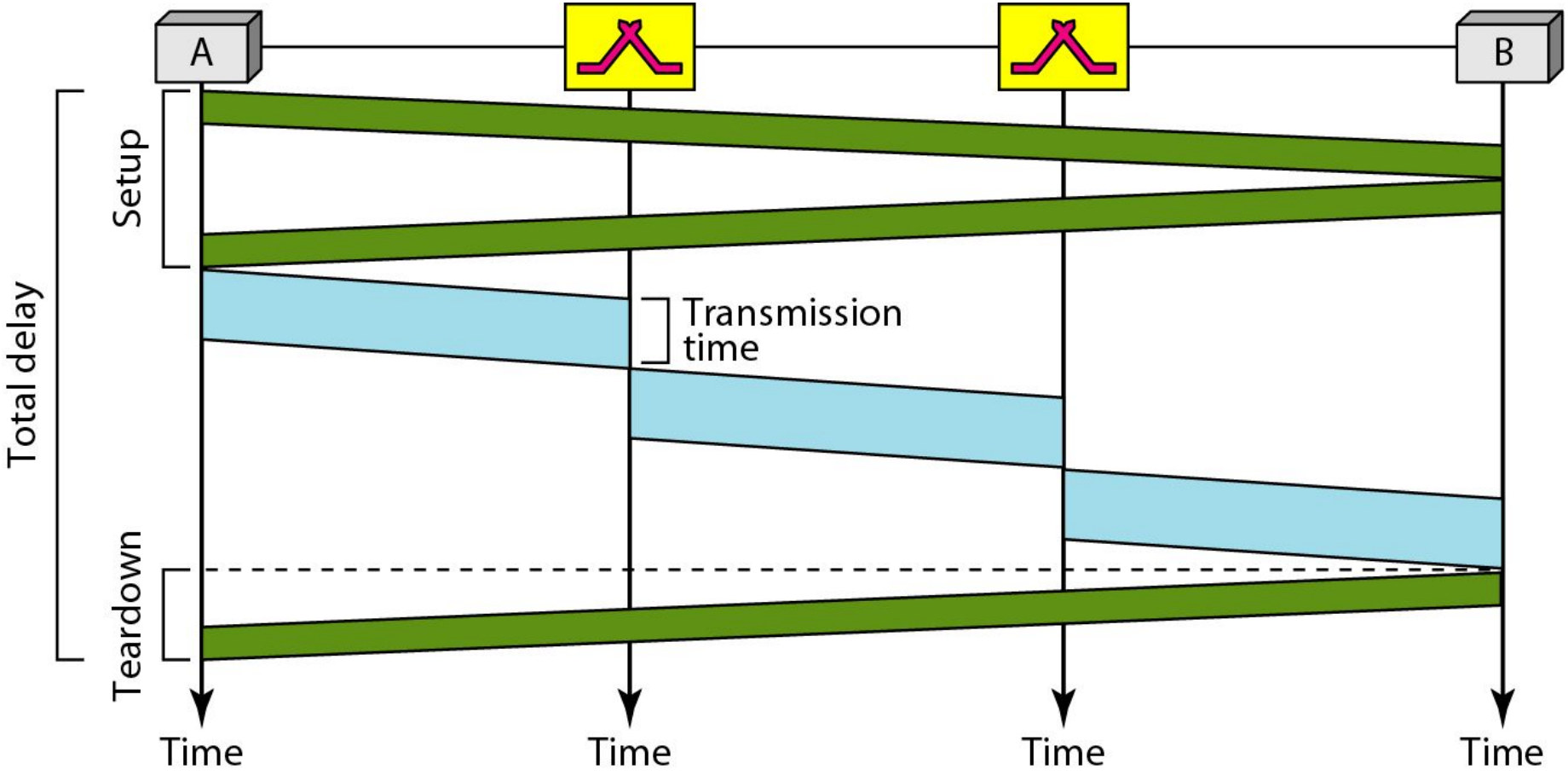
Figure 8.15 *Setup acknowledgment in a virtual-circuit network*



Note

In virtual-circuit switching, all packets belonging to the same source and destination travel the same path; but the packets may arrive at the destination with different delays if resource allocation is on demand.

Figure 8.16 *Delay in a virtual-circuit network*



Note

Switching at the data link layer in a switched WAN is normally implemented by using virtual-circuit techniques.

S(witched)VC vs. P(ermanent)VC setup

A virtual circuit can be either switched or permanent.

If permanent, an outgoing VCI is given to the source, and an incoming VCI is given to the destination.

The source always uses this VCI to send frames to this particular destination.

The destination knows that the frame is coming from that particular source if the frame carries the corresponding incoming VCI.

If a duplex connection is needed, two virtual circuits are established.

A PVC has several drawbacks:

1. Always connected, so always paying

2. Connection is between two parties only. If you need a connection to another point, you need another PVC.

Don't like these disadvantages? Use an SVC.

8-4 STRUCTURE OF A SWITCH

We use switches in circuit-switched and packet-switched networks. In this section, we discuss the structures of the switches used in each type of network.

Topics discussed in this section:

Structure of Circuit Switches
Structure of Packet Switches

Figure 8.17 *Crossbar switch with three inputs and four outputs*

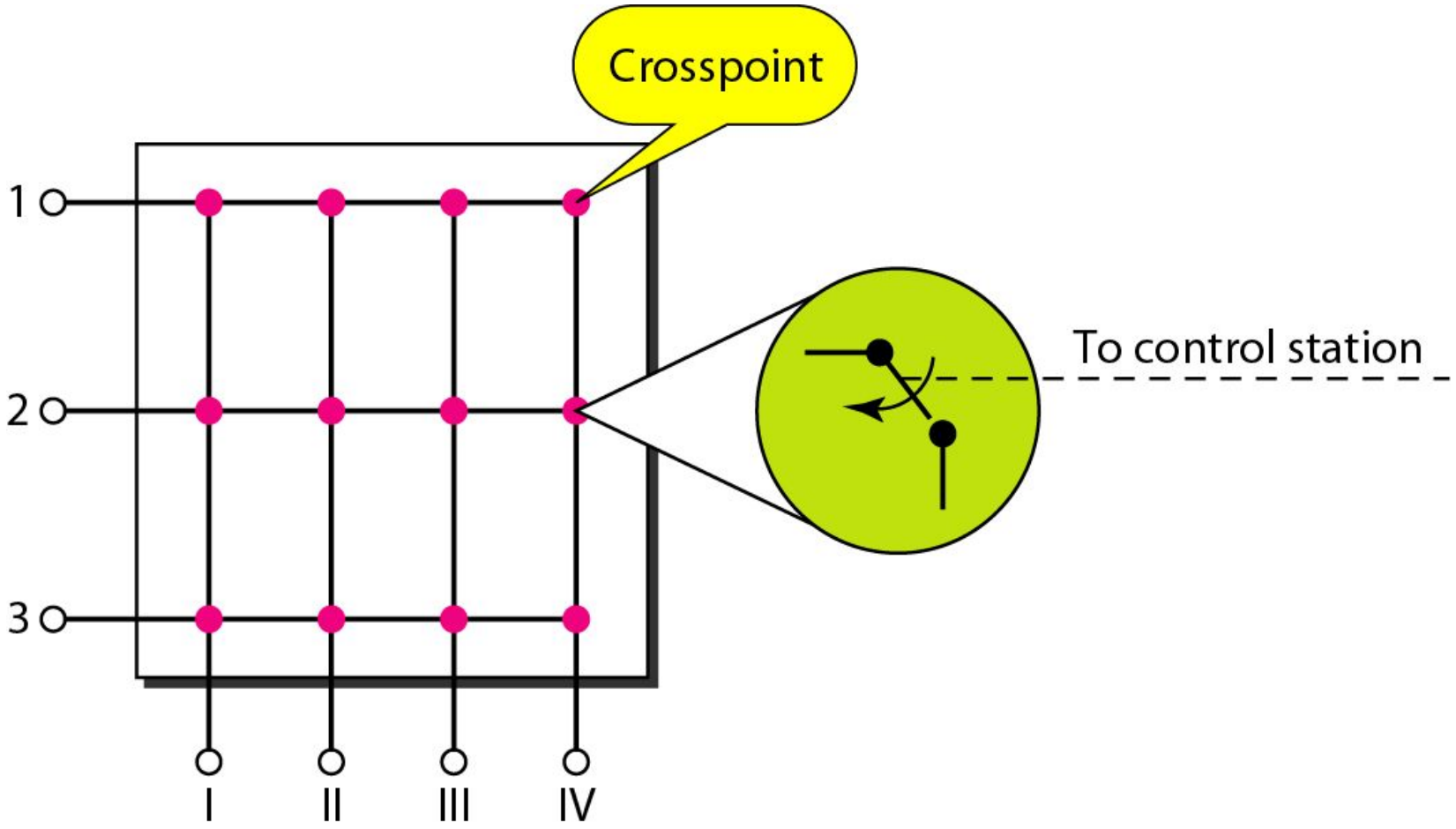
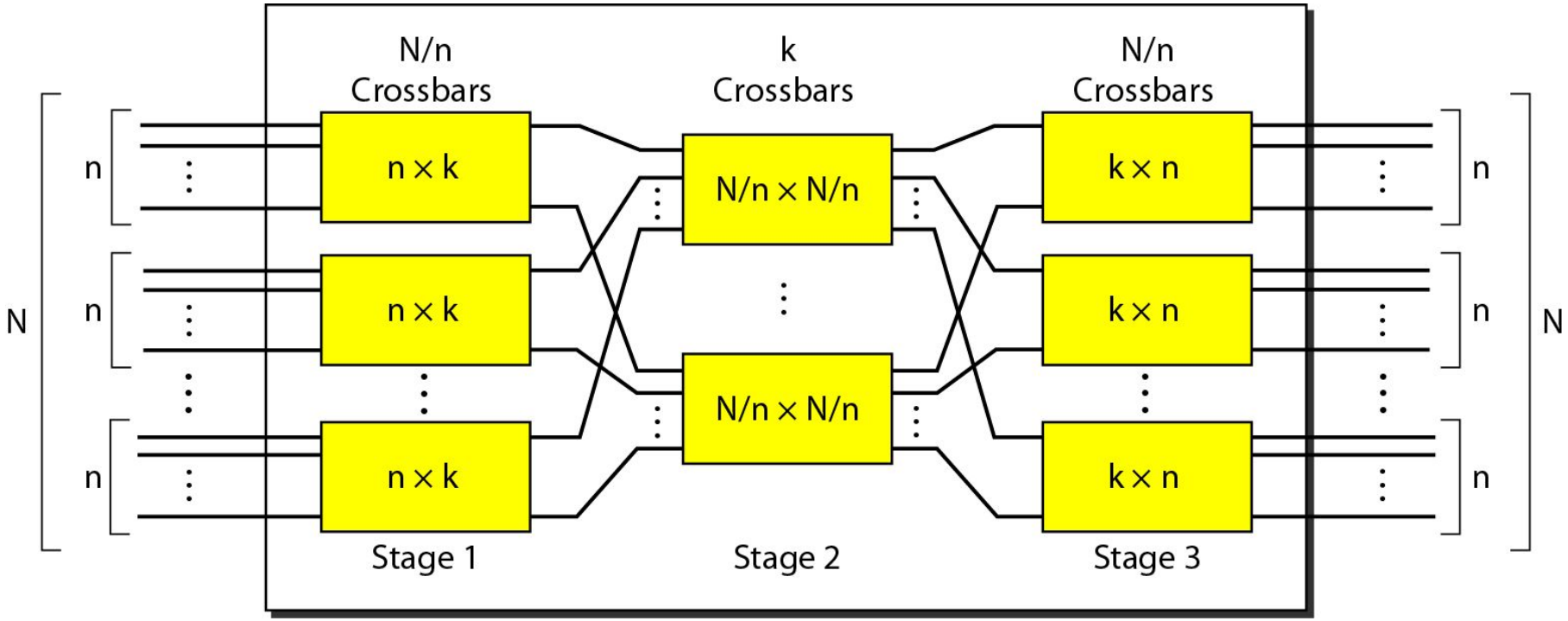


Figure 8.18 *Multistage switch*



Three Stage Switch

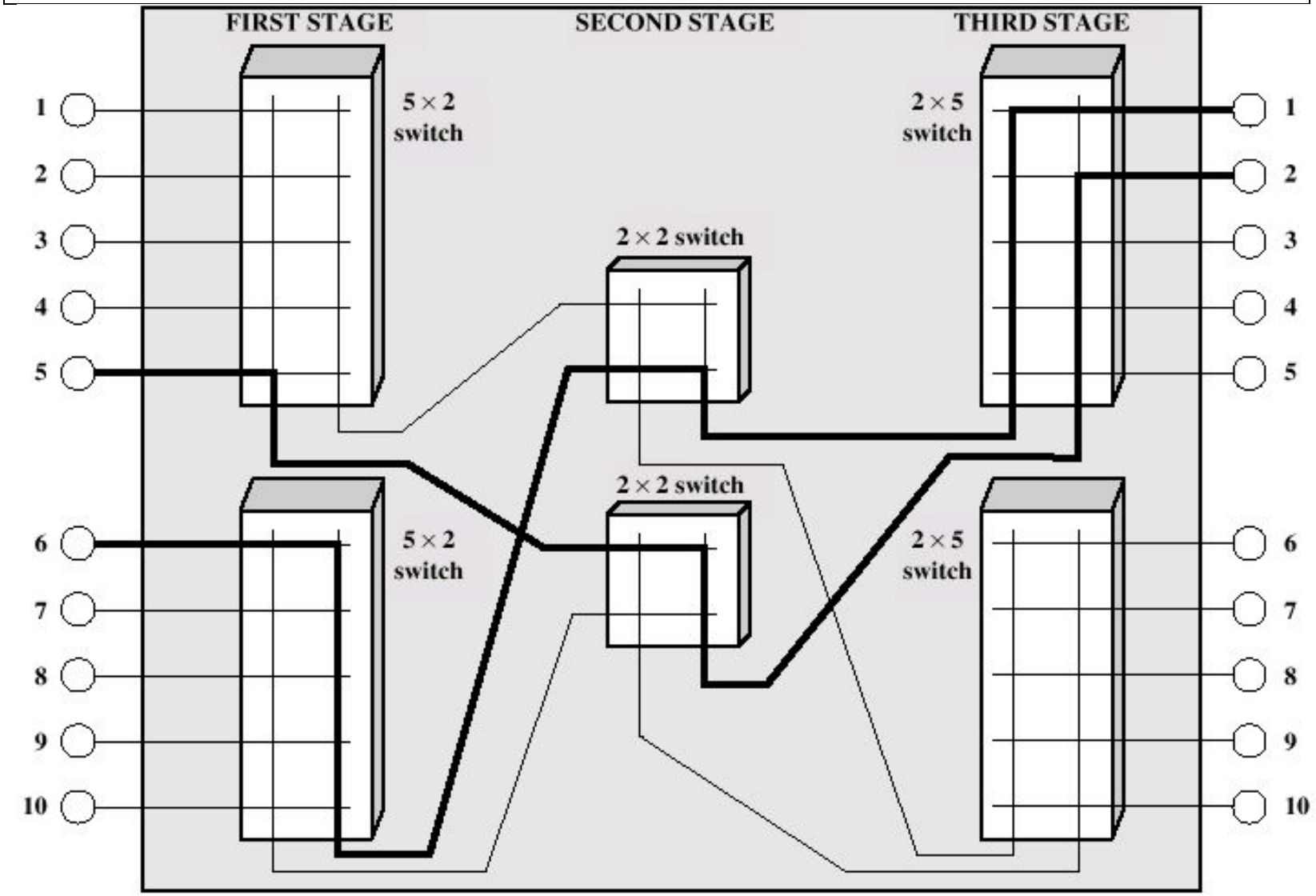


Figure 8.19 *Time-slot interchange*

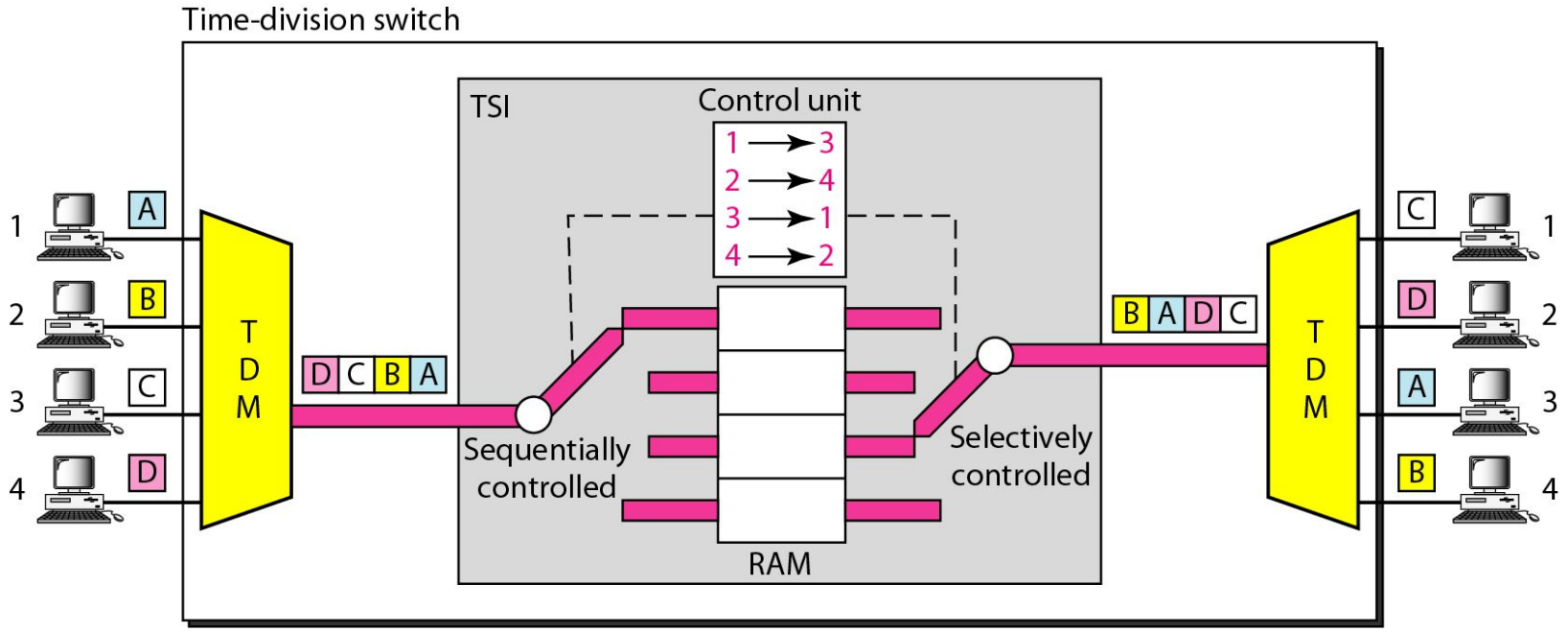


Figure 8.20 *Time-space-time switch*

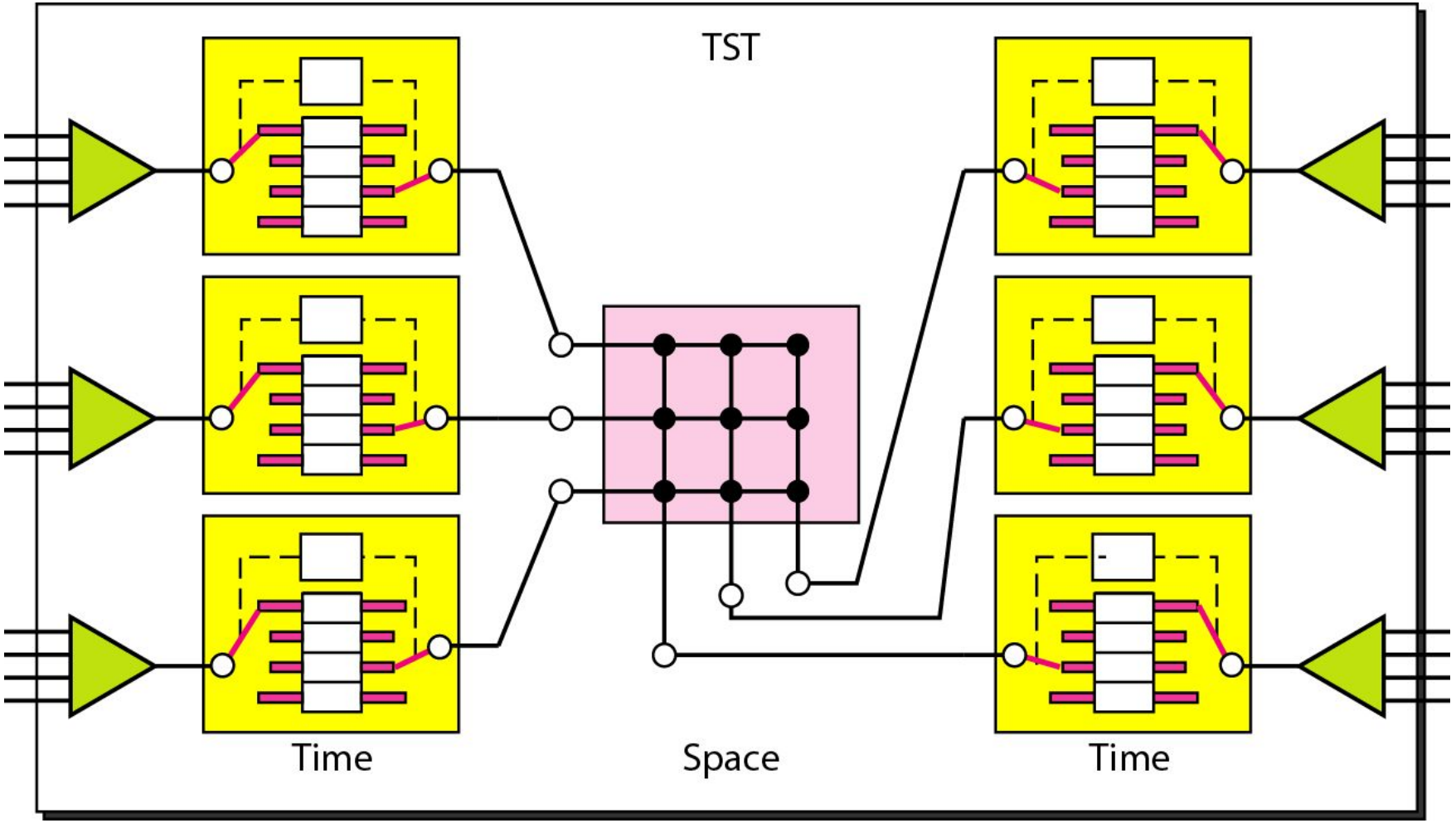


Figure 8.21 *Packet switch components*

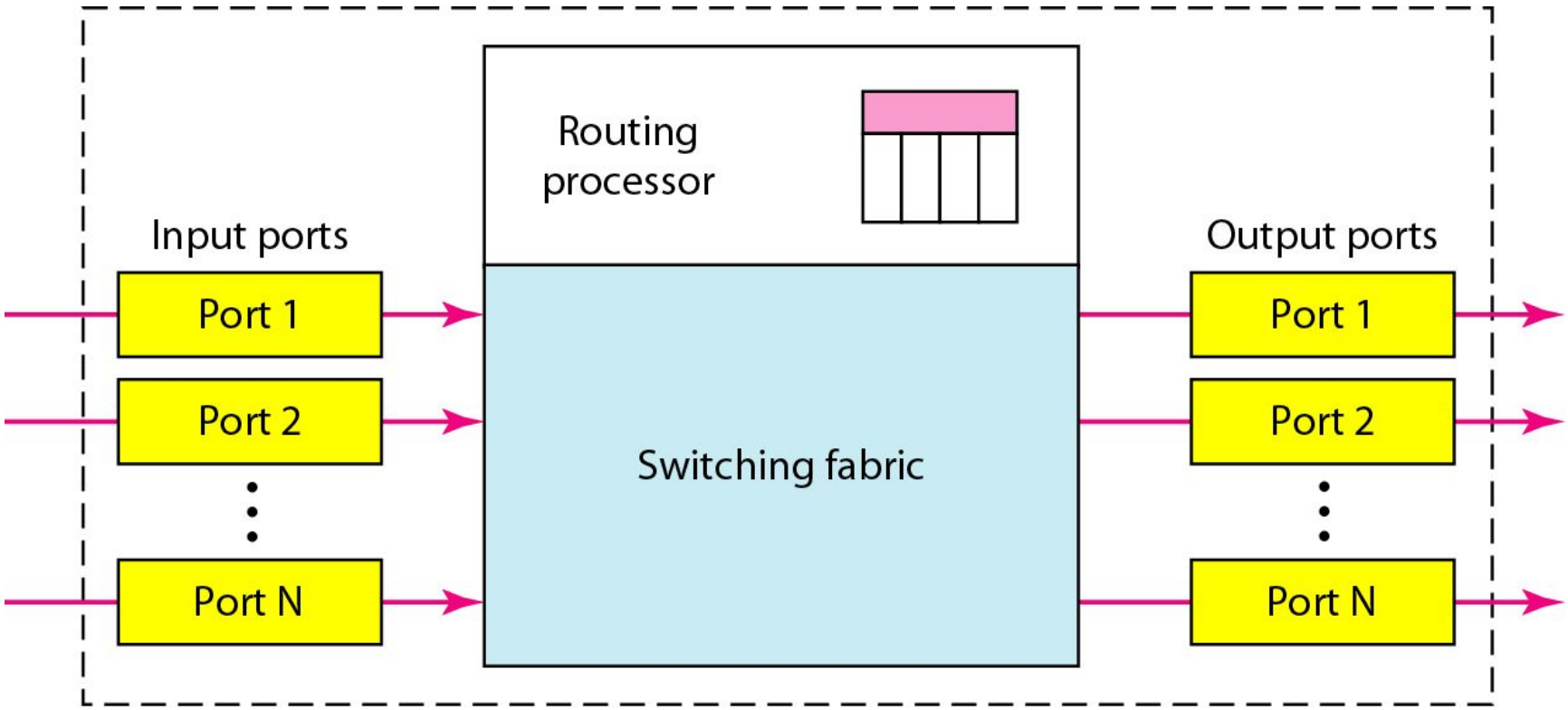


Figure 8.22 *Input port*

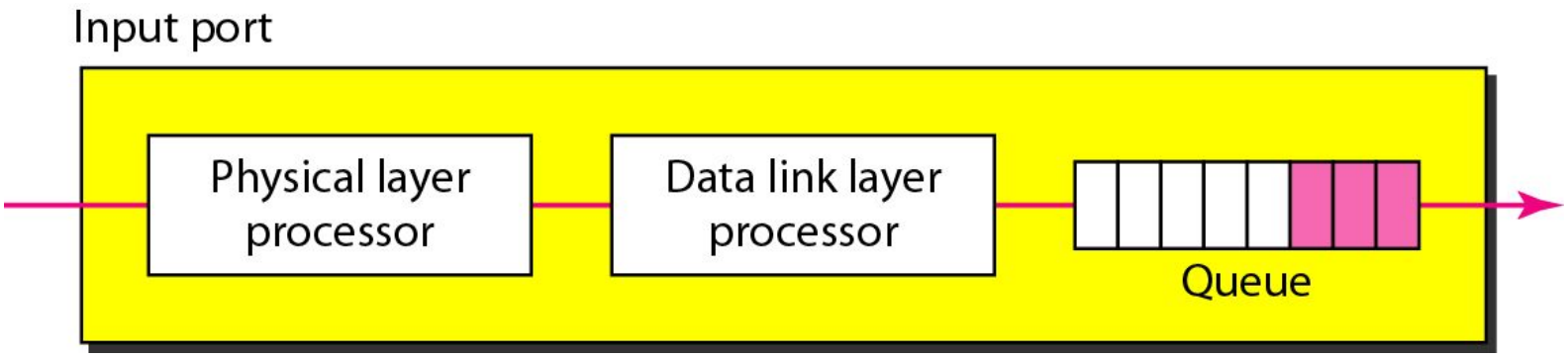


Figure 8.23 *Output port*

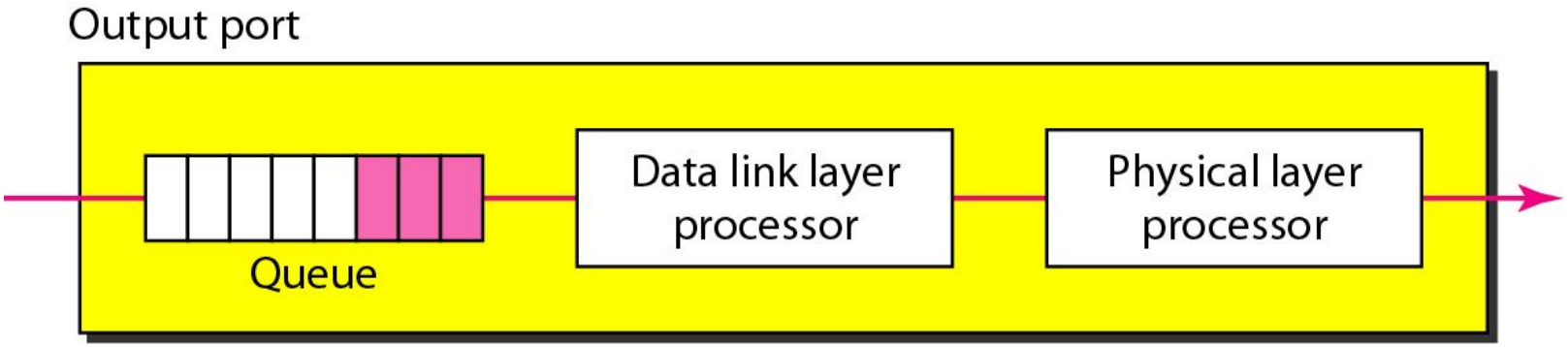


Figure 8.24 *A banyan switch*

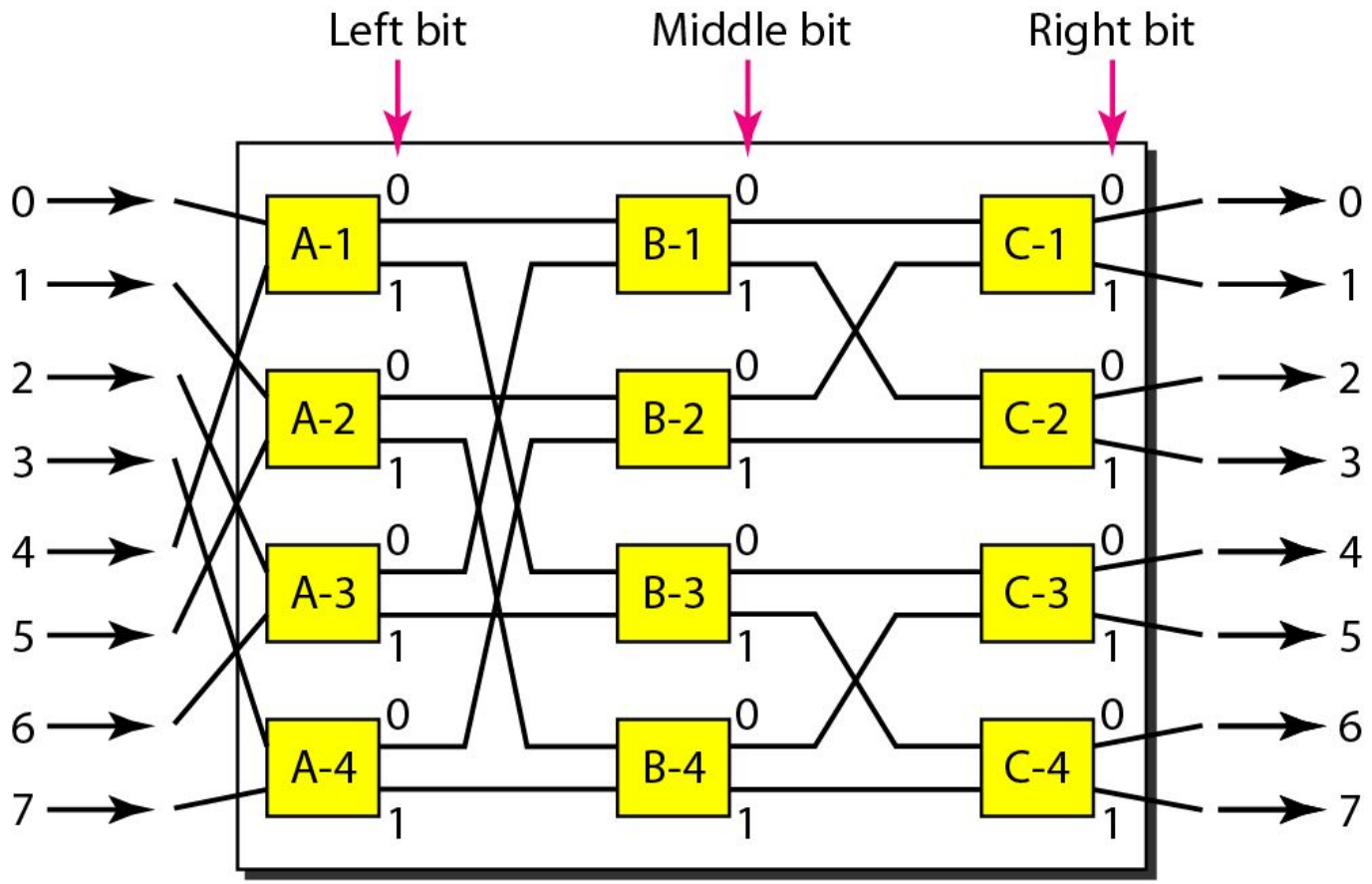
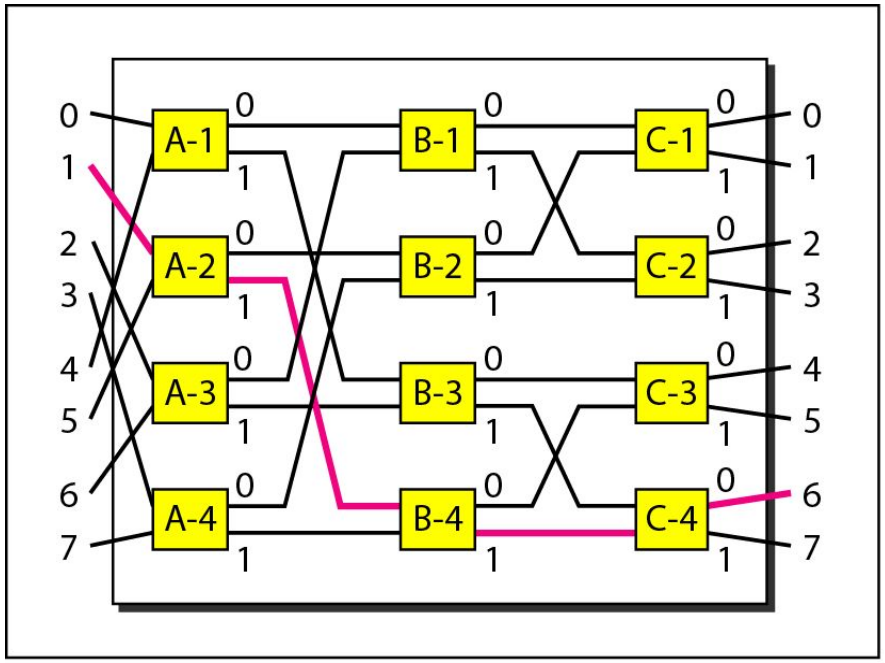
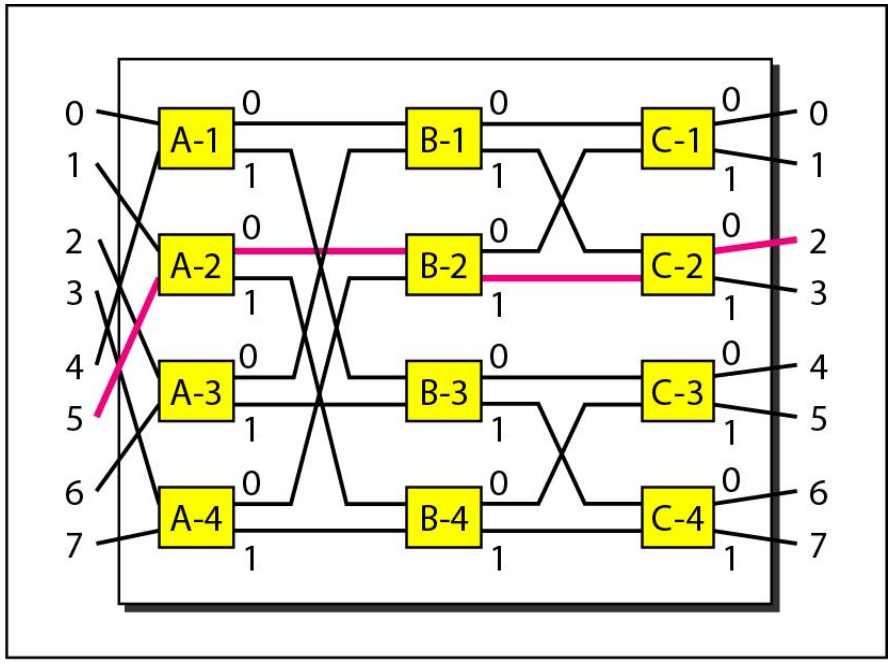


Figure 8.25 *Examples of routing in a banyan switch*



a. Input 1 sending a cell to output 6 (110)



b. Input 5 sending a cell to output 2 (010)

In Summary

- What are the differences between a circuit switched network and a packet switched network? https://www.geeksforgeeks.org/difference-between-circuit-switching-and-packet-switching/
- Where can the control signals travel in a telephone network?
- What is a non-blocking switch/network?
- What are the differences between datagram packet switched and virtual circuit packet switched?

In Summary

- What are the differences between a circuit switch and a packet switch?