Network Layer

Delivery, Forwarding and Routing

Delivery: **It refers to the way a packet is handled by the underlying networks under the control of the network layer.**

Forwarding: **It refers to the way a packet is delivered to the next station.**

Routing: **It refers to the way routing tables are created to help in forwarding.**

Types of Delivery

1. Direct Delivery

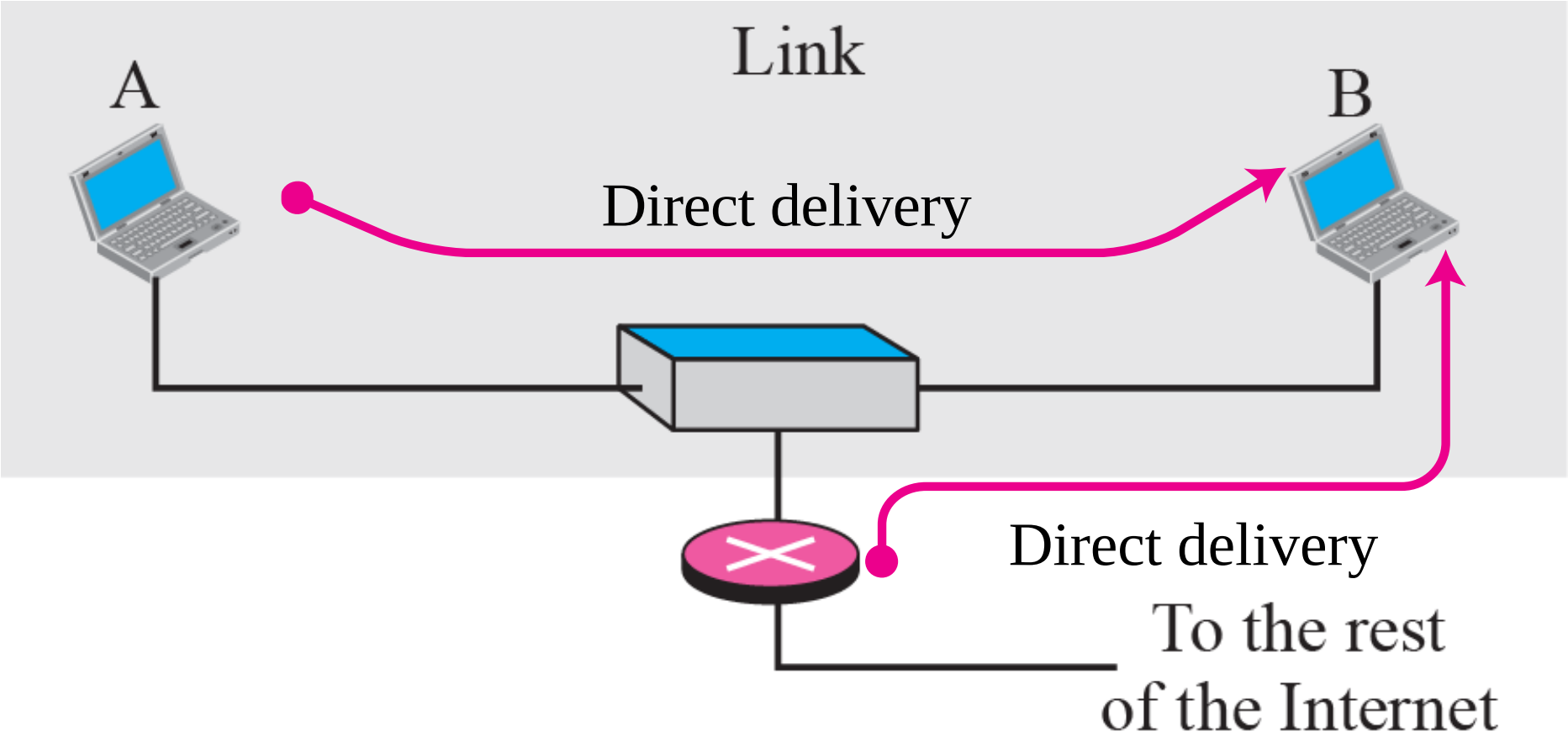
   (i)Source and destination are in the same network

   (ii)Delivery is between the last router and destination

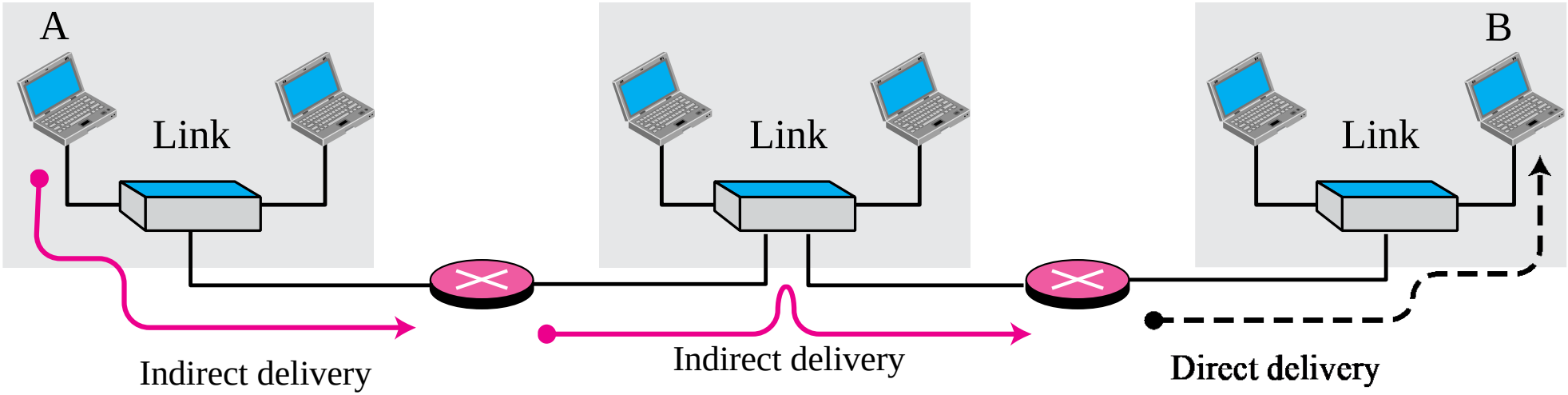
2. Indirect Delivery

   Destination is not in the same destination

Direct Delivery



Indirect Delivery

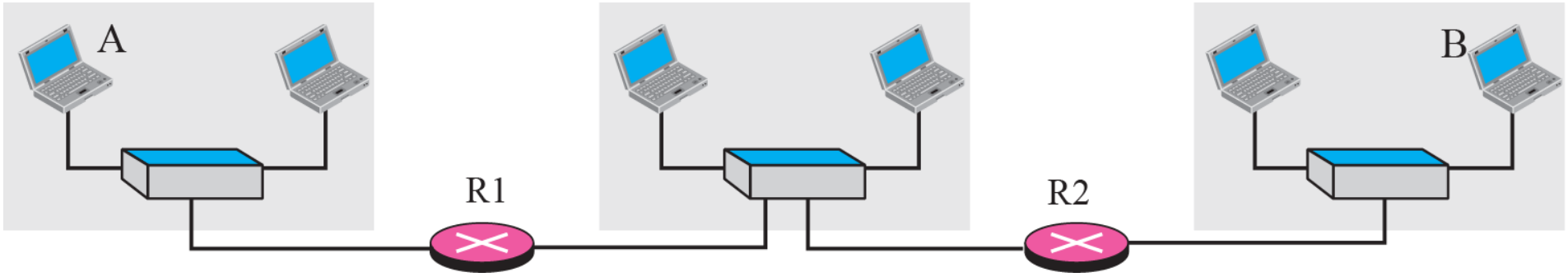


FORWARDING

Forwarding Techniques

1. Next hop method
2. Network specific method
3. Host specific method
4. Default method

Next-hop method



A

Destination	Route
Host B	R1, R2, Host B

R1

Destination	Route
Host B	R2, Host B

R2

Destination	Route
Host B	Host B

a. Routing tables based on route

A

Destination	Next Hop
Host B	R1

R1

Destination	Next Hop
Host B	R2

R2

Destination	Next Hop
Host B	---

b. Routing tables based on next hop

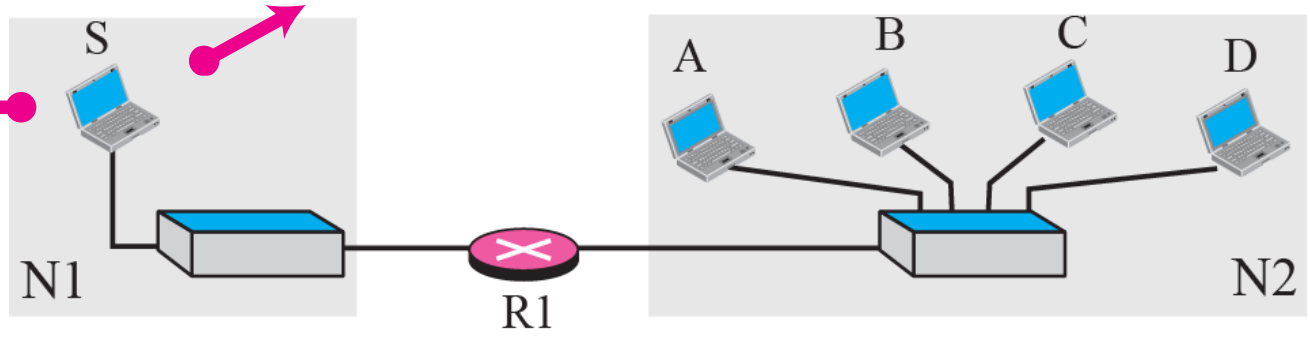
Network-specific method

Network-specific
routing table for host S

Destination	Next Hop
N2	R1

Host-specific
routing table for host S

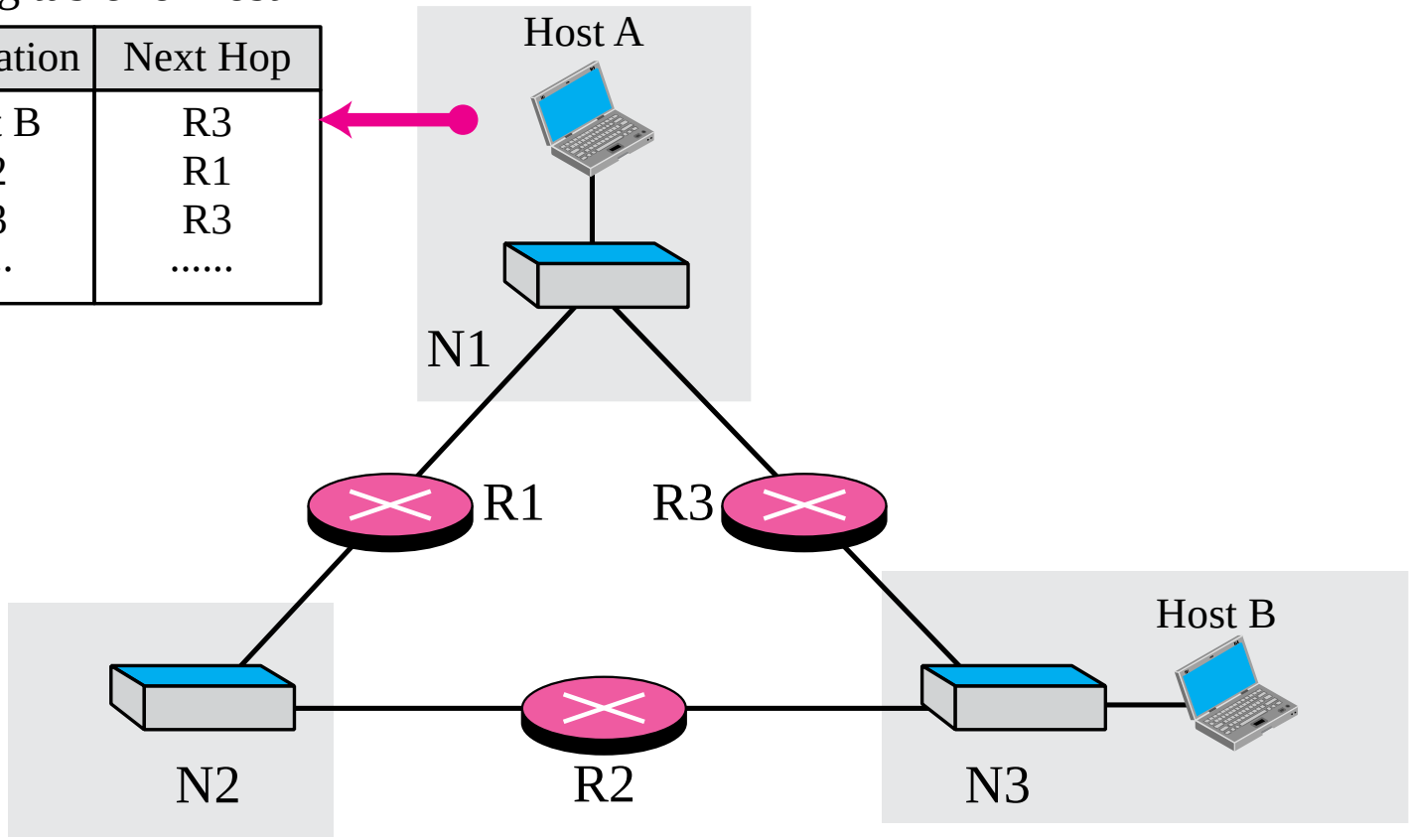
Destination	Next Hop
A	R1
B	R1
C	R1
D	R1



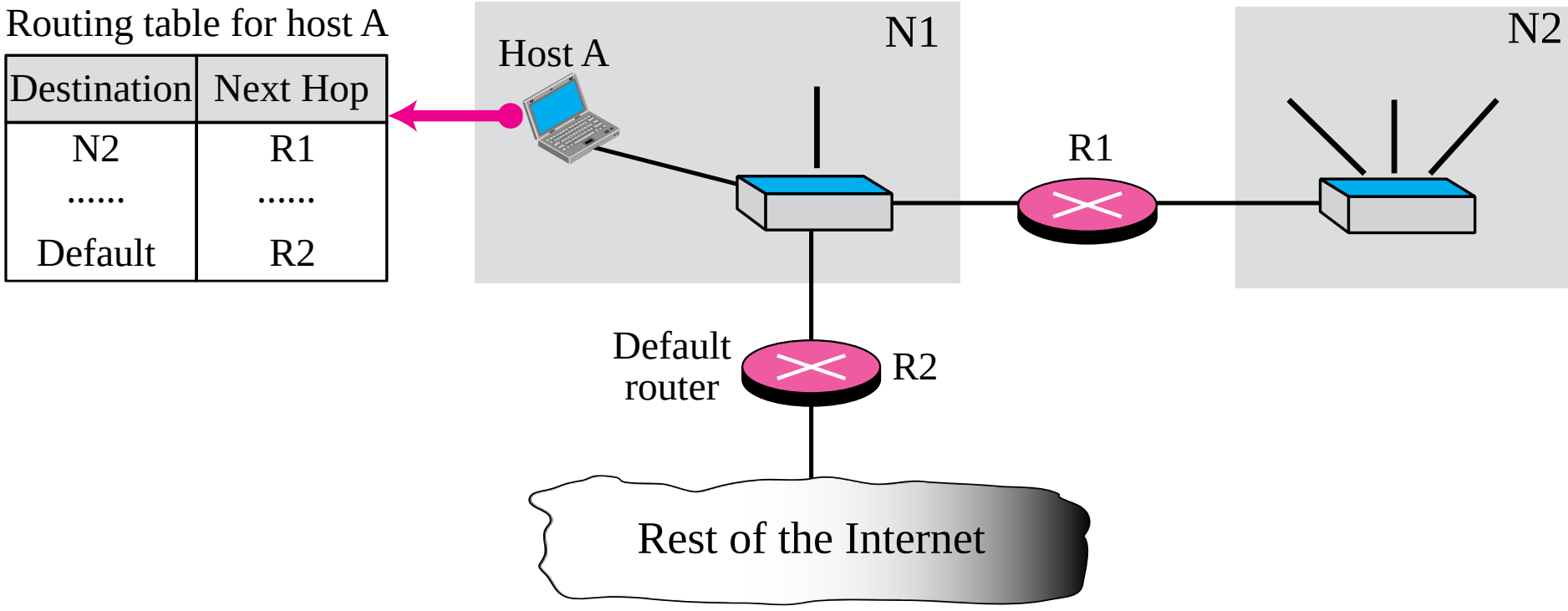
Host-specific routing

Routing table for host A

Destination	Next Hop
Host B	R3
N2	R1
N3	R3
.....	.....



Default routing



Switching

Figure 1 *Switched network*

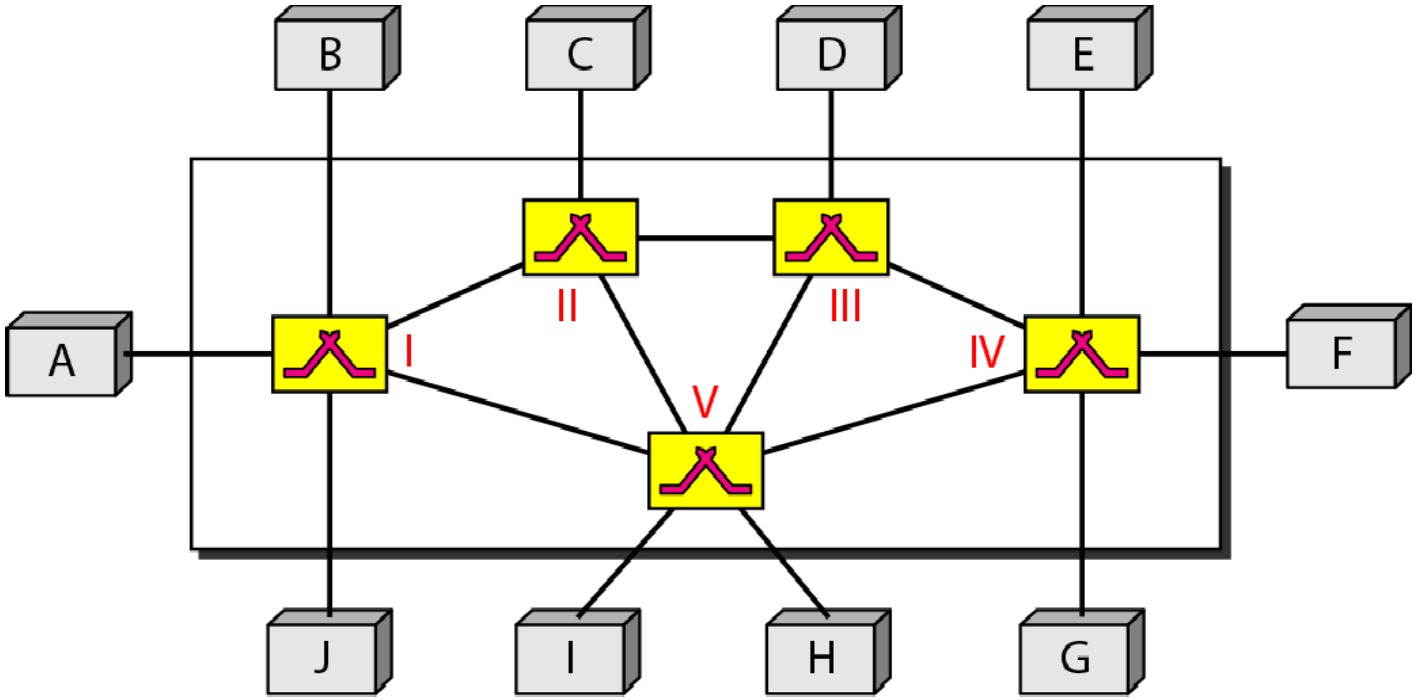
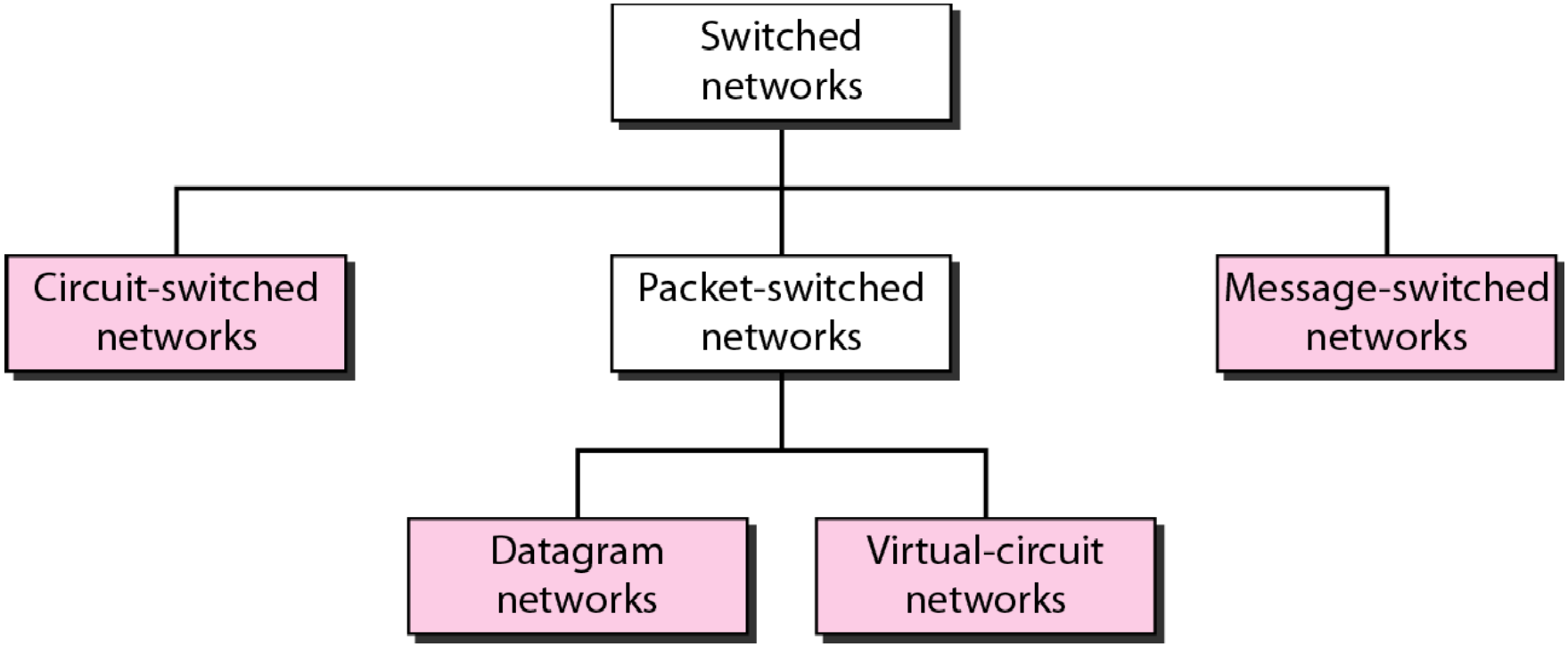
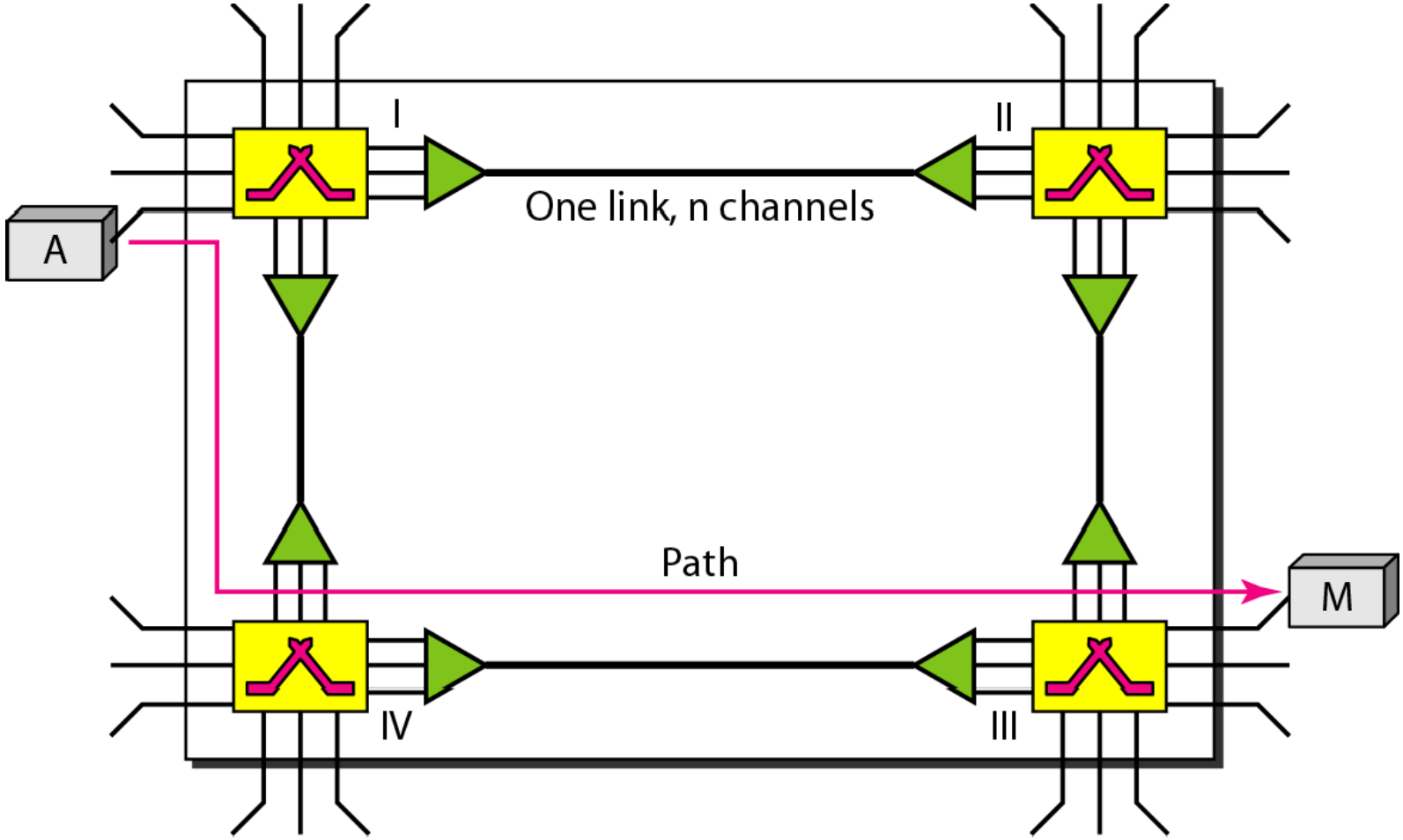


Figure 2 *Taxonomy of switched networks*

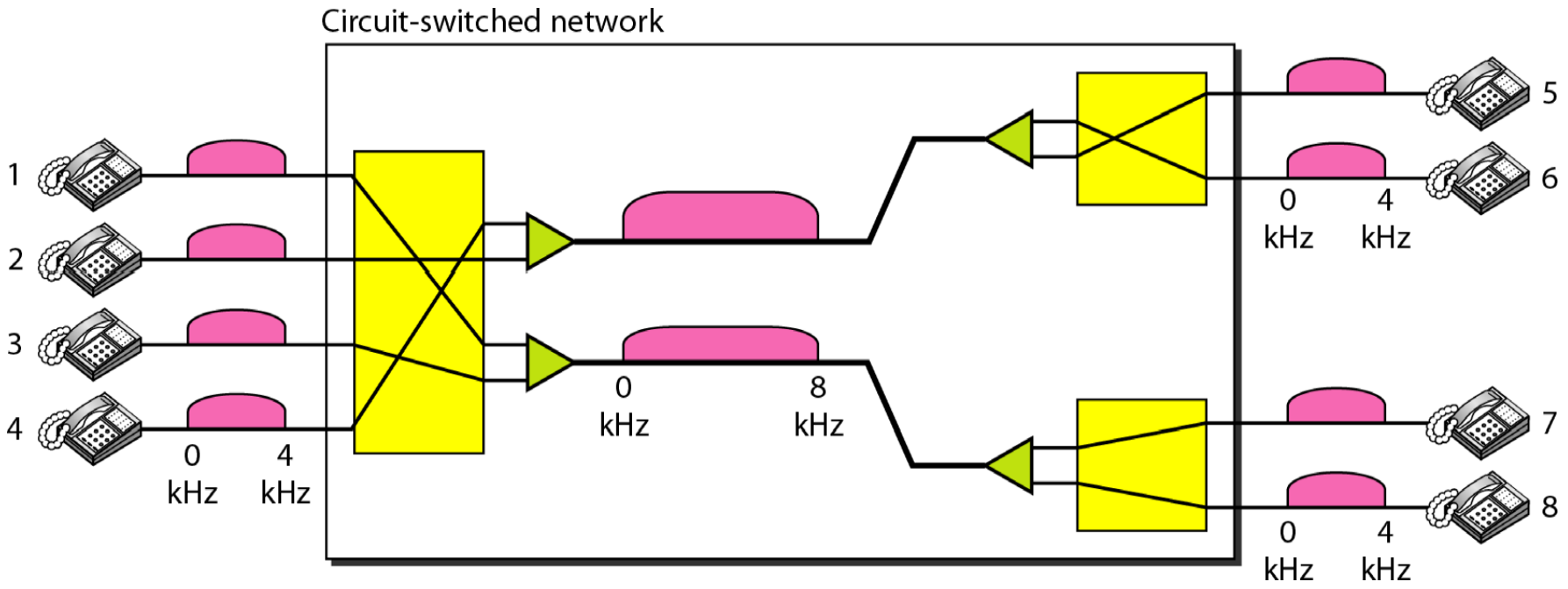


CIRCUIT-SWITCHED NETWORKS

Figure 3 *A trivial circuit-switched network*



Example 1:
Figure 4 Circuit Switched Network



Example 2:

Figure 5 *Circuit-switched network*

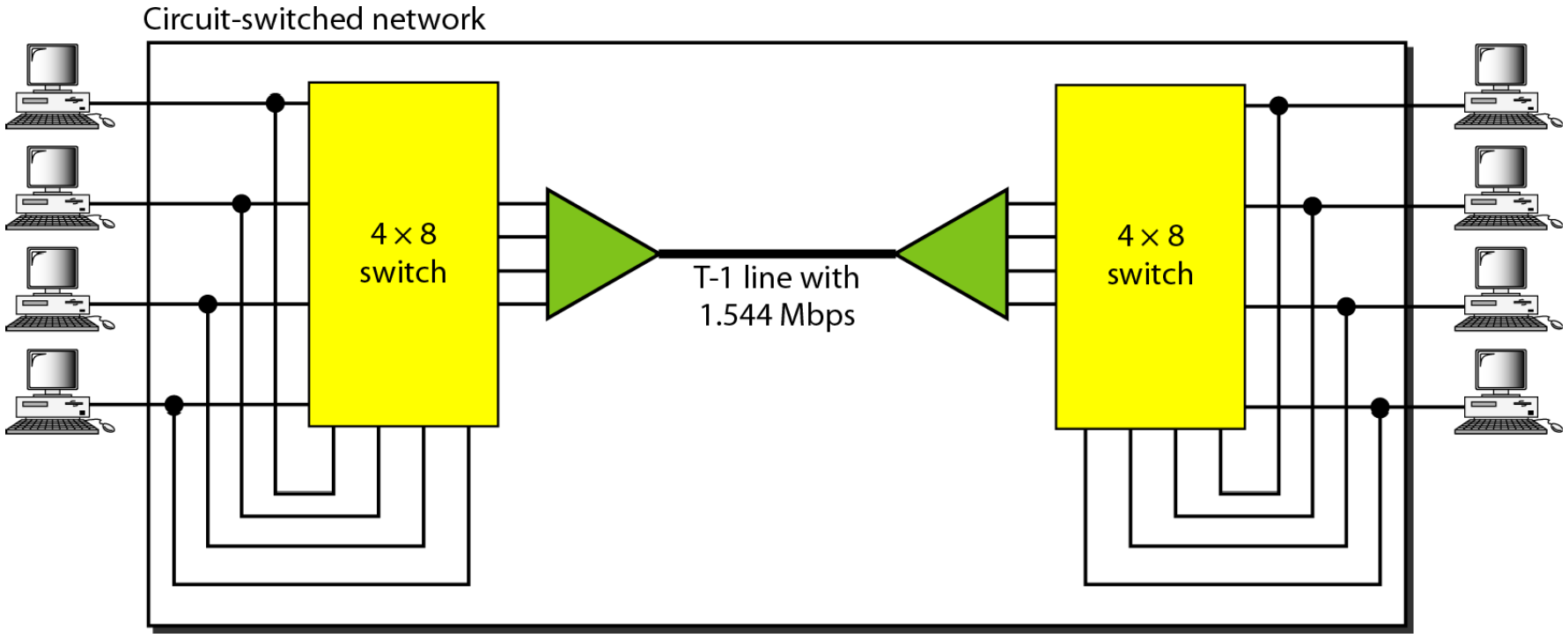
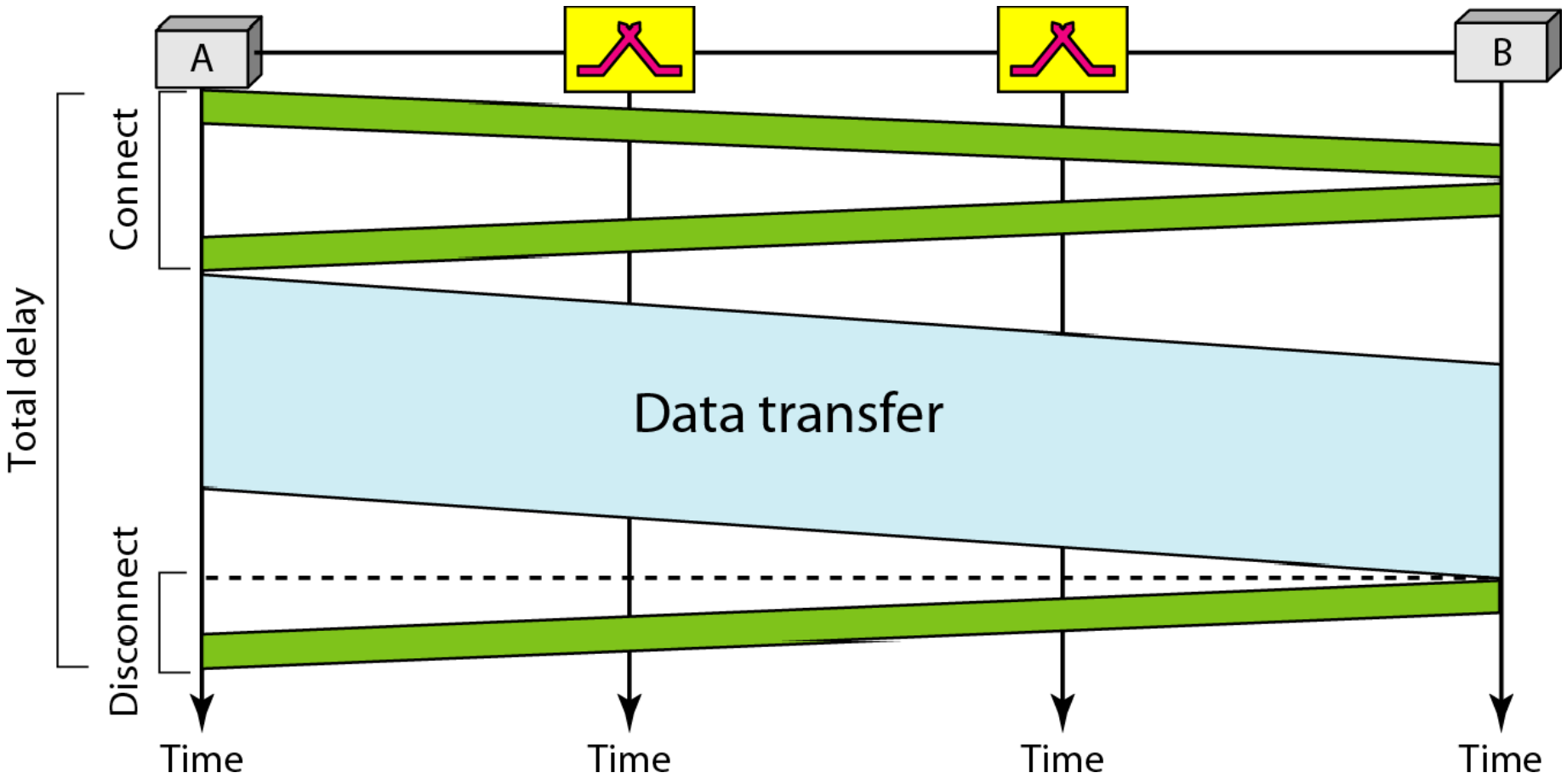


Figure 6 *Delay in a circuit-switched network*



Datagram Networks

Figure 7 *A datagram network with four switches (routers)*

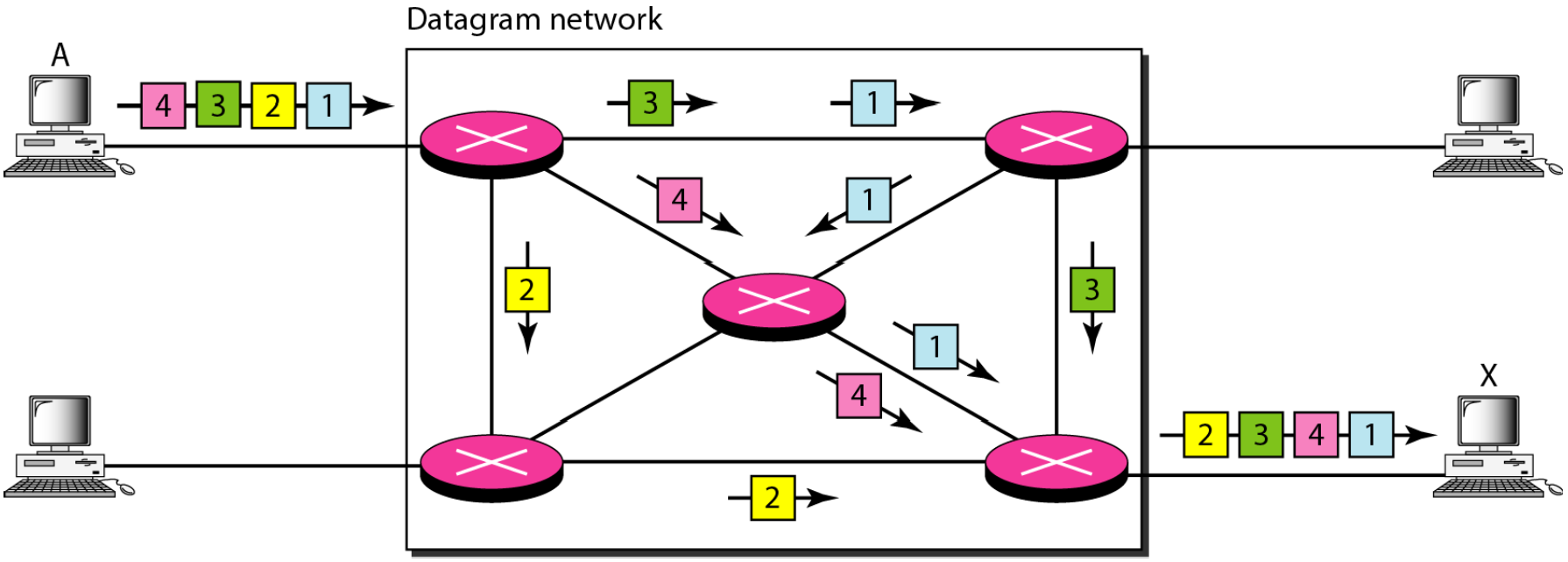


Figure 8 *Routing table in a datagram network*

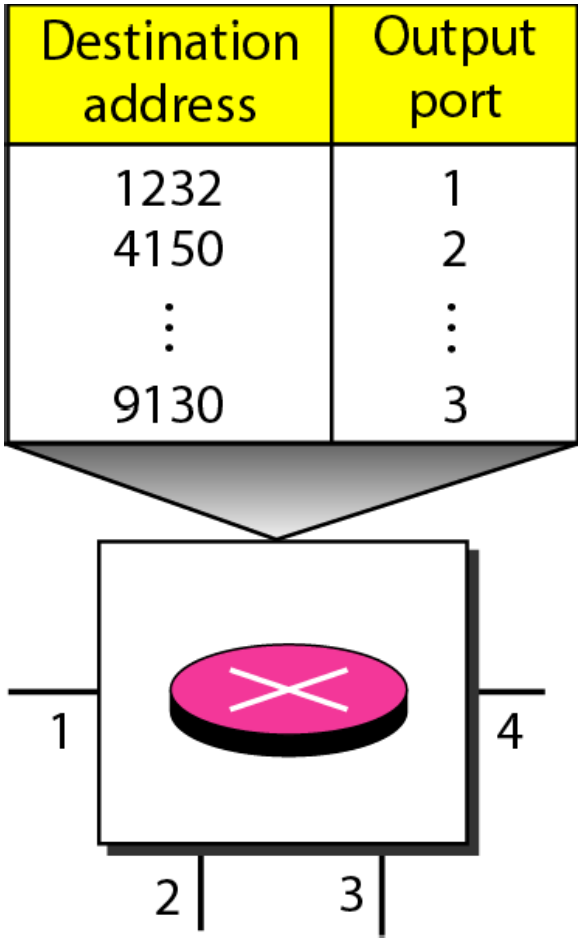
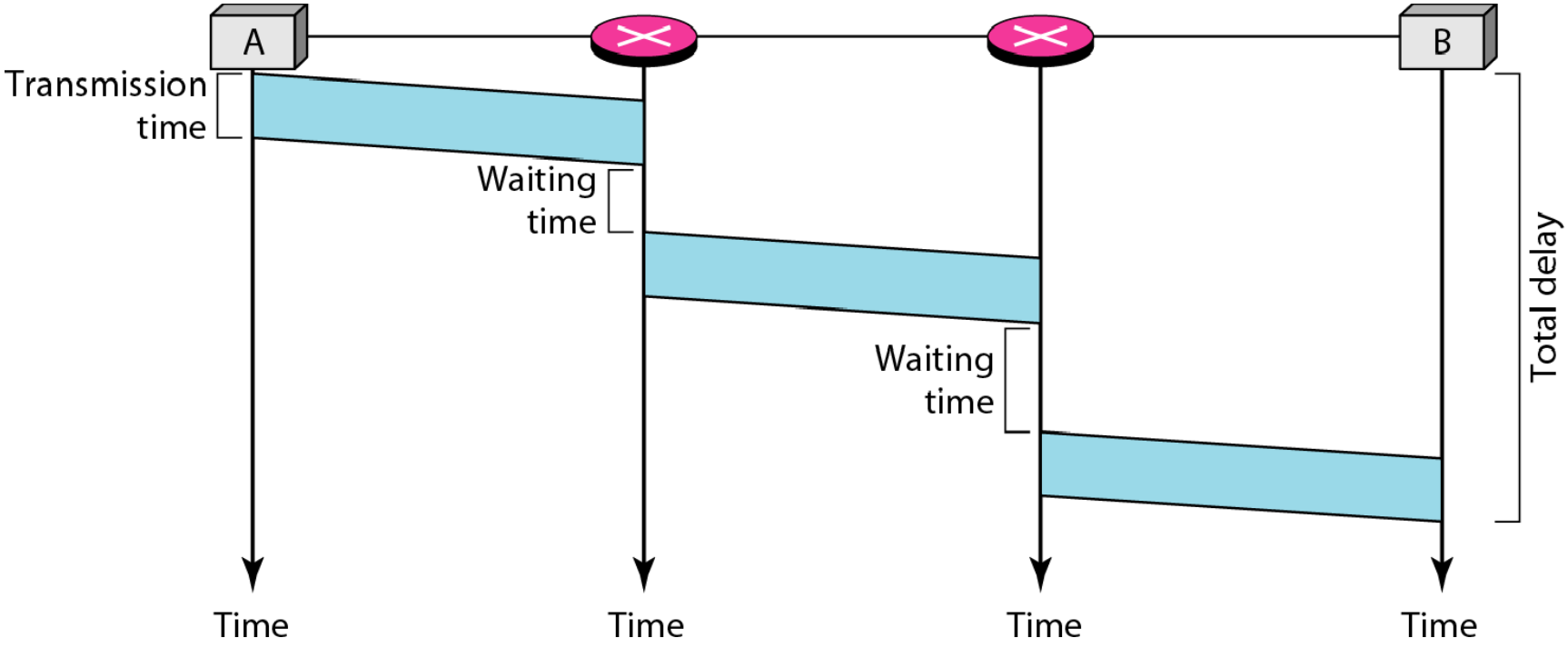
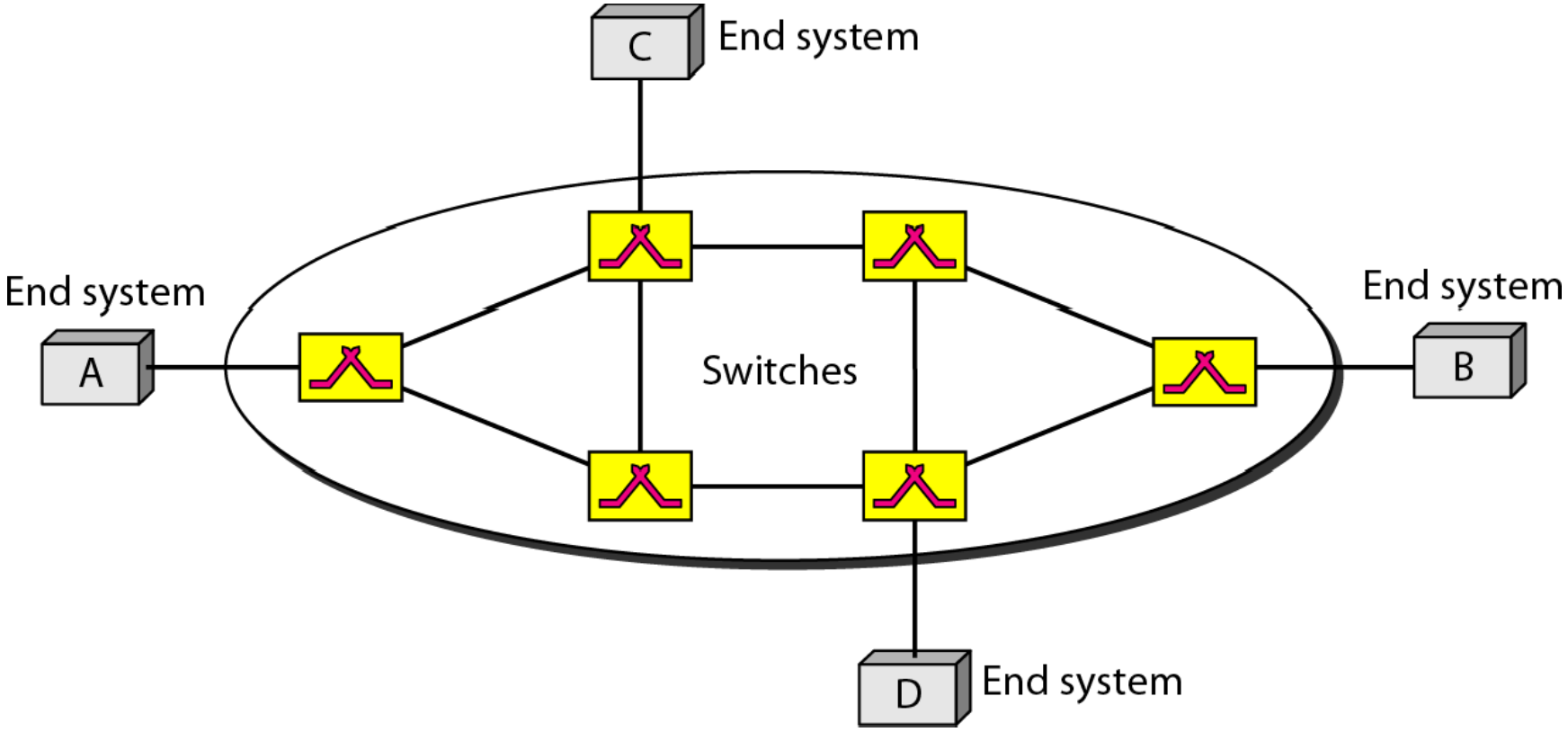


Figure 9 *Delay in a datagram network*



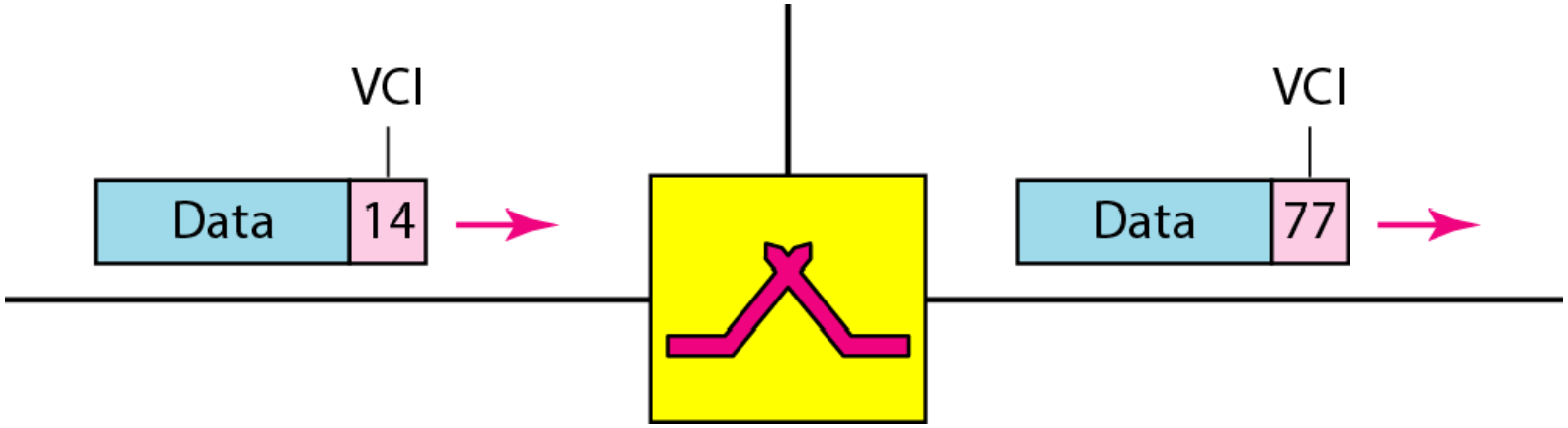
Virtual Circuit Network

Figure 10 *Virtual-circuit network*



Addressing:

1.Global Address
2.Virtual Circuit Identifier



Data Transfer Phase:

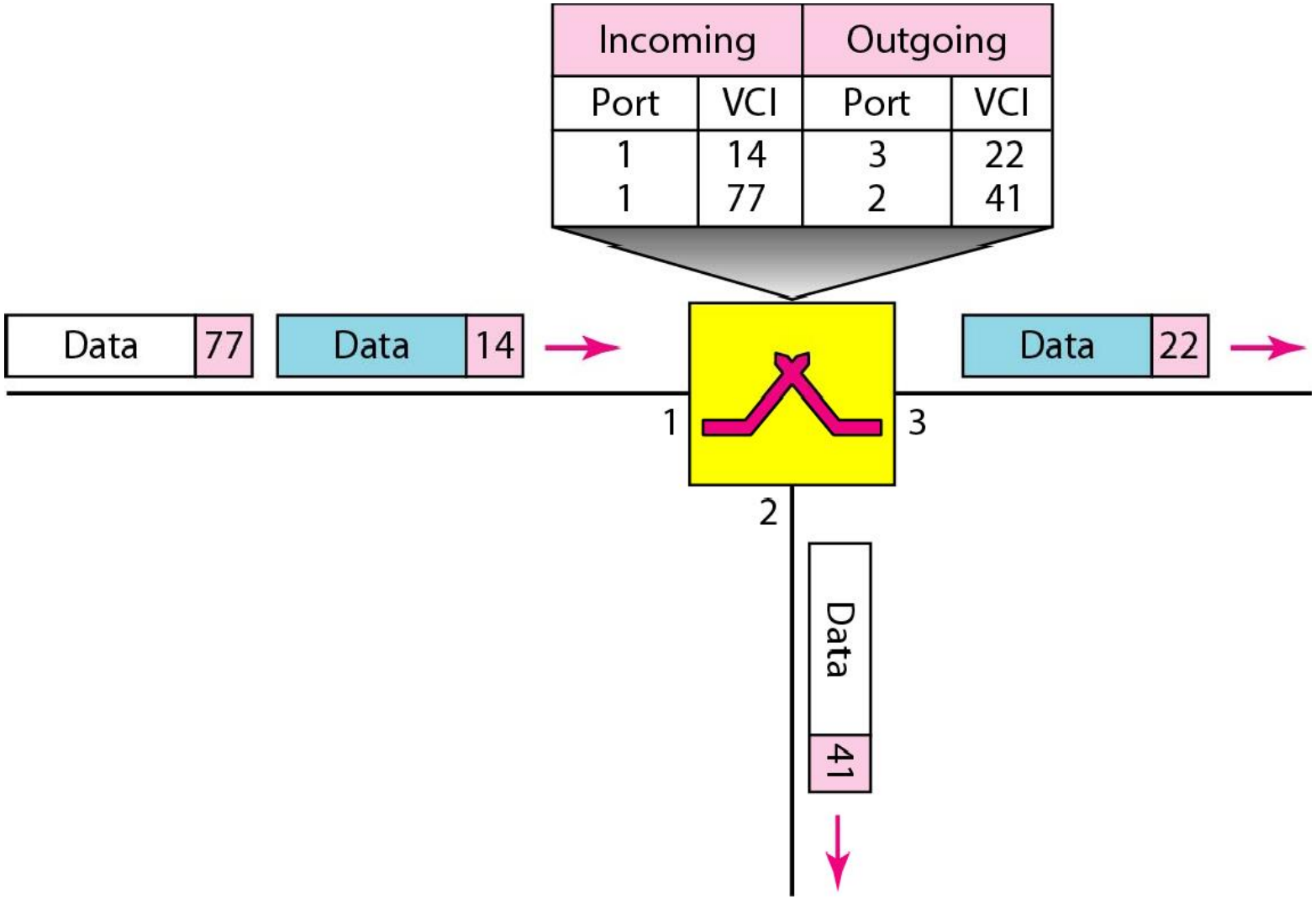
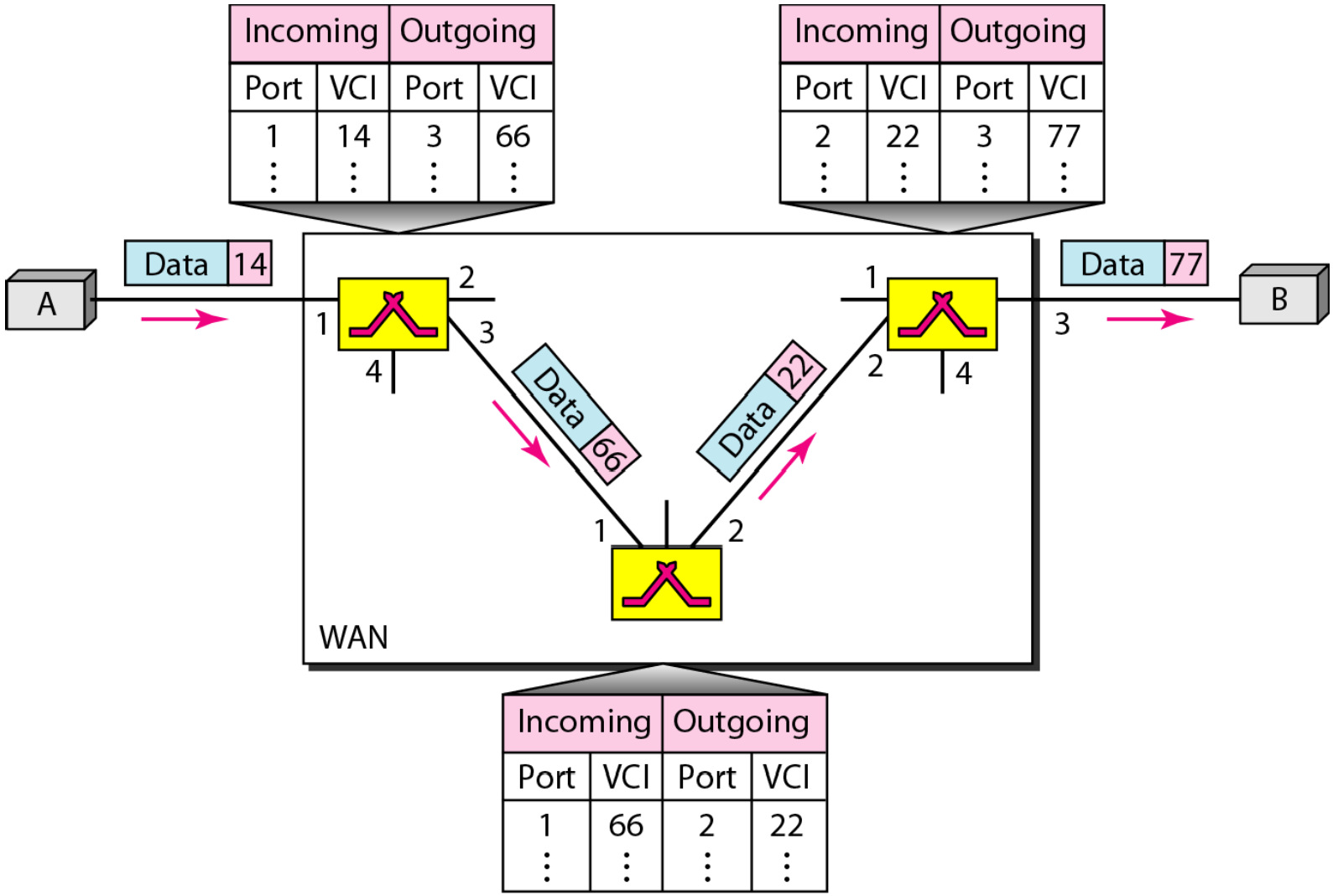
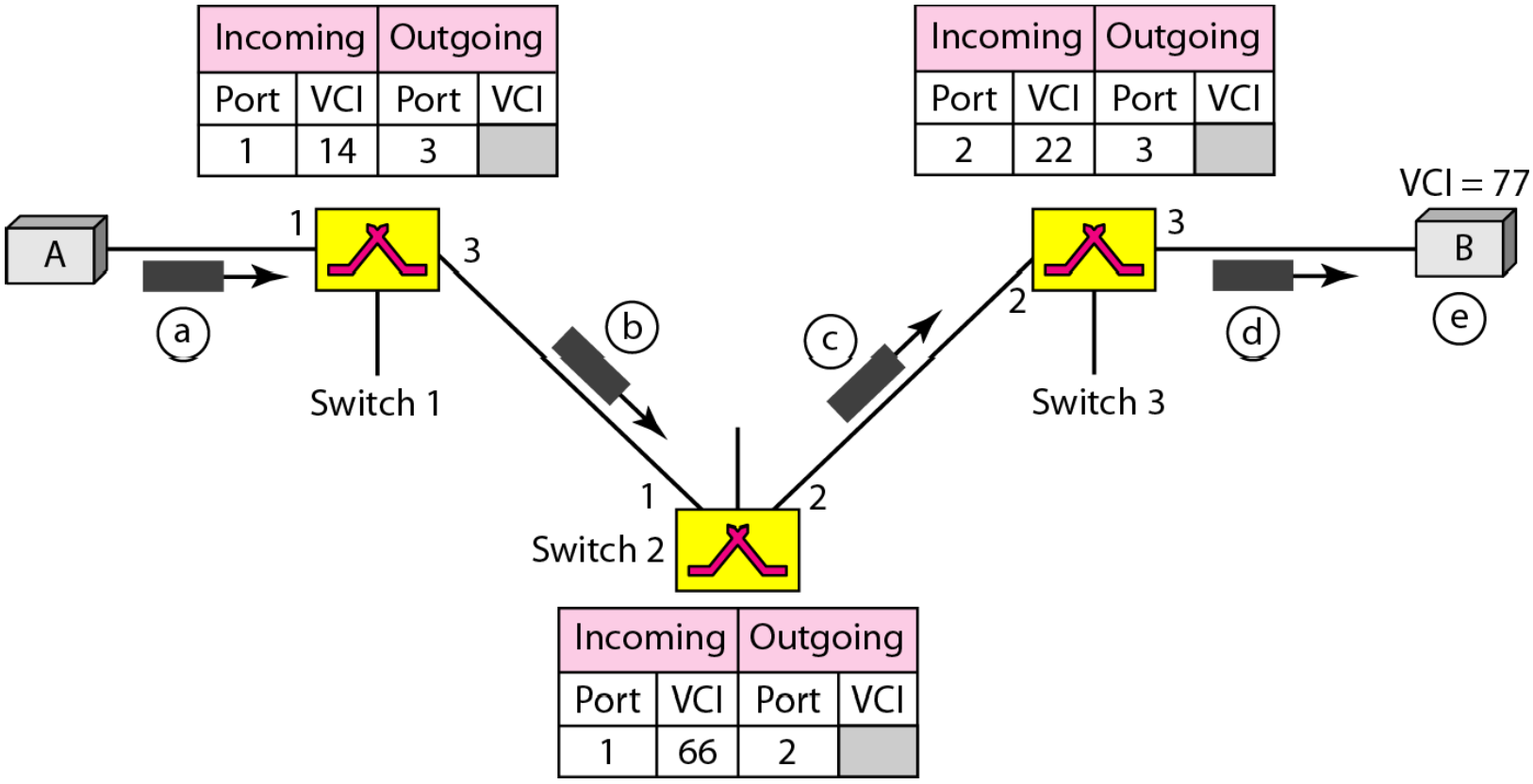


Figure 13 *Source-to-destination data transfer in a virtual-circuit network*



Connection Setup Phase

Connection Setup Request:



Connection Setup Phase

Acknowledgment

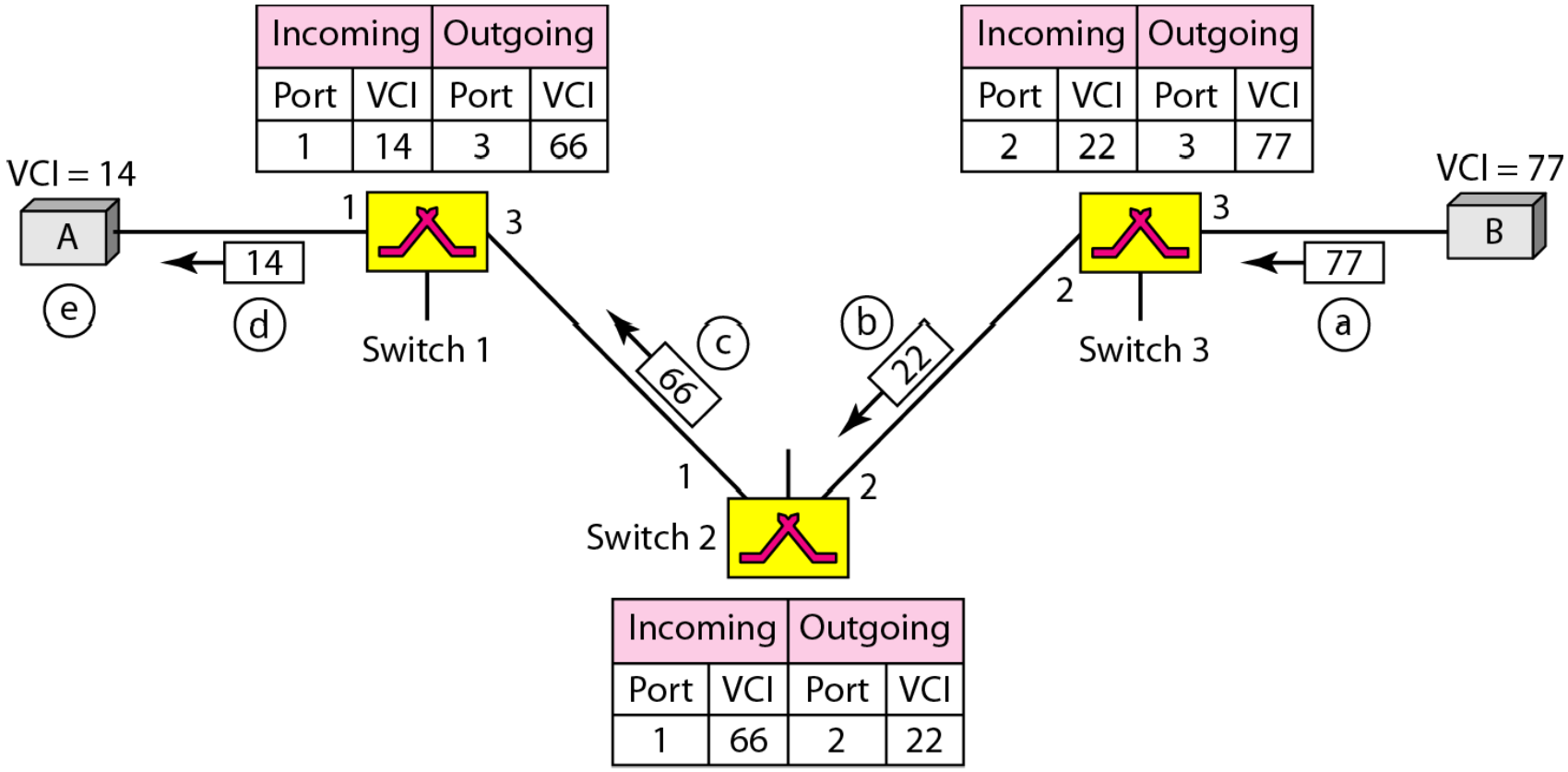
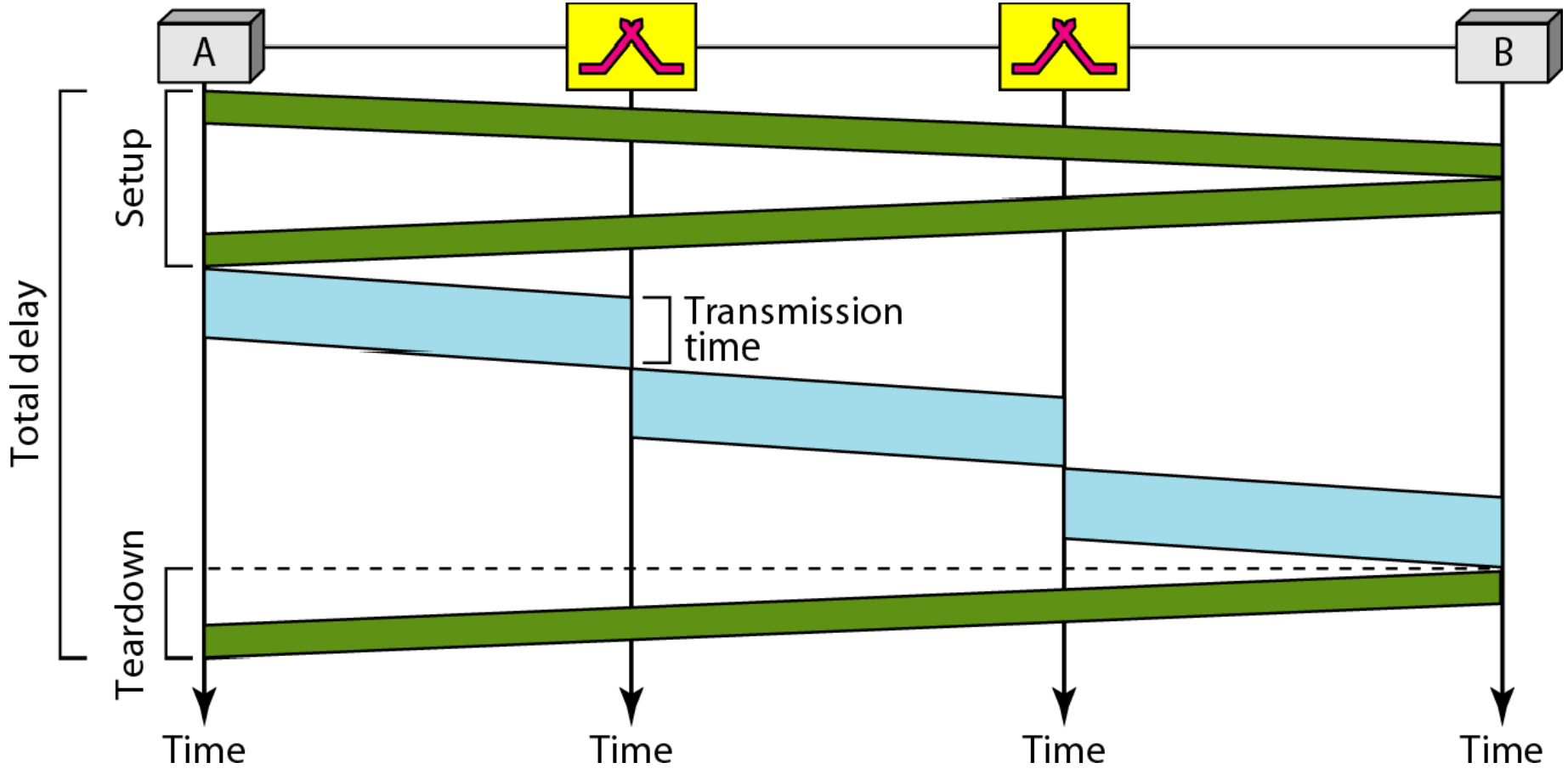


Figure 16 *Delay in a virtual-circuit network*



STRUCTURE OF A SWITCH

1.Structure of Circuit Switches

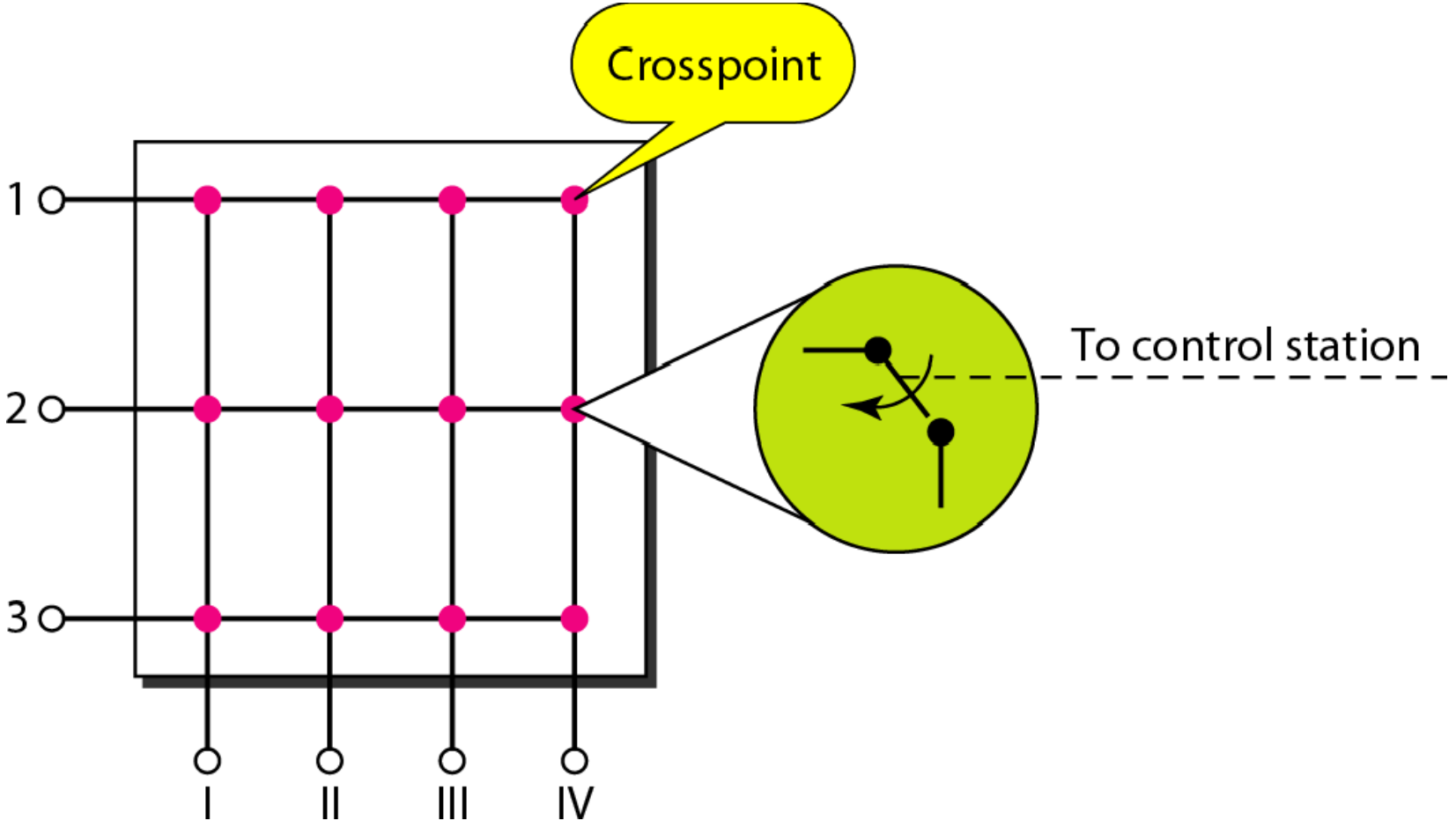
1.1 Space Division Switch

1.2 Time Division Switch

2. Structure of Packet Switches

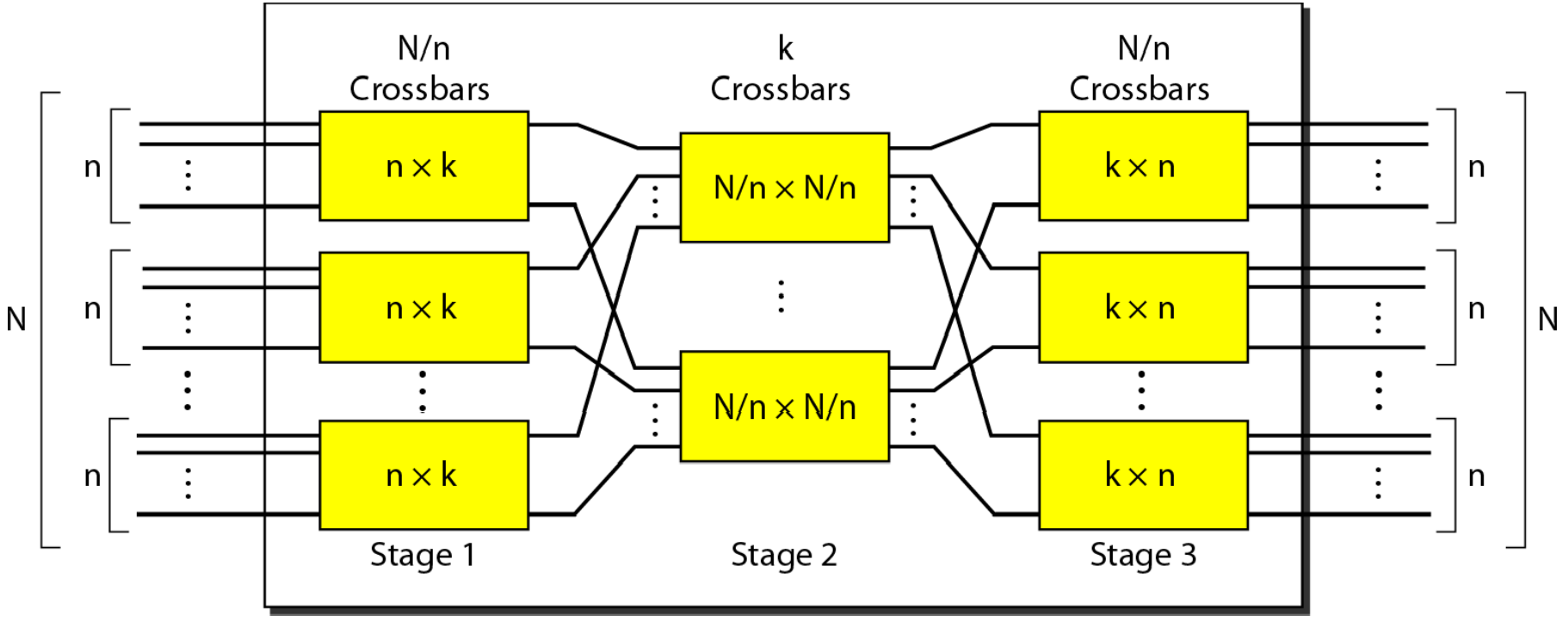
Space Division Switch: Crossbar Switch

Figure 17 *Crossbar switch with three inputs and four outputs*



Space Division Switch: Multistage Switch

Figure 18 *Multistage switch*

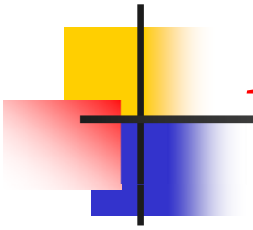


Note

In a three-stage switch, the total number of crosspoints is

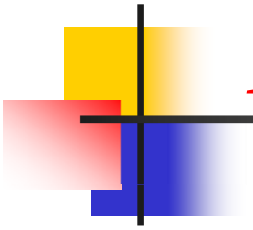
$$2kN + k(N/n)^2$$

which is much smaller than the number of crosspoints in a single-stage switch (N^2).



Example 1

Design a three-stage, 200 × 200 switch (N = 200) with k = 4 and n = 20.



Example 1

Design a three-stage, 200 × 200 switch (N = 200) with k = 4 and n = 20.

Solution

In the first stage we have N/n or 10 crossbars, each of size 20 × 4. In the second stage, we have 4 crossbars, each of size 10 × 10. In the third stage, we have 10 crossbars, each of size 4 × 20. The total number of crosspoints is $2kN + k(N/n)^2$, or 2000 crosspoints. This is 5 percent of the number of crosspoints in a single-stage switch (200 × 200 = 40,000).

Time Division Switch

Figure 19 *Time-slot interchange*

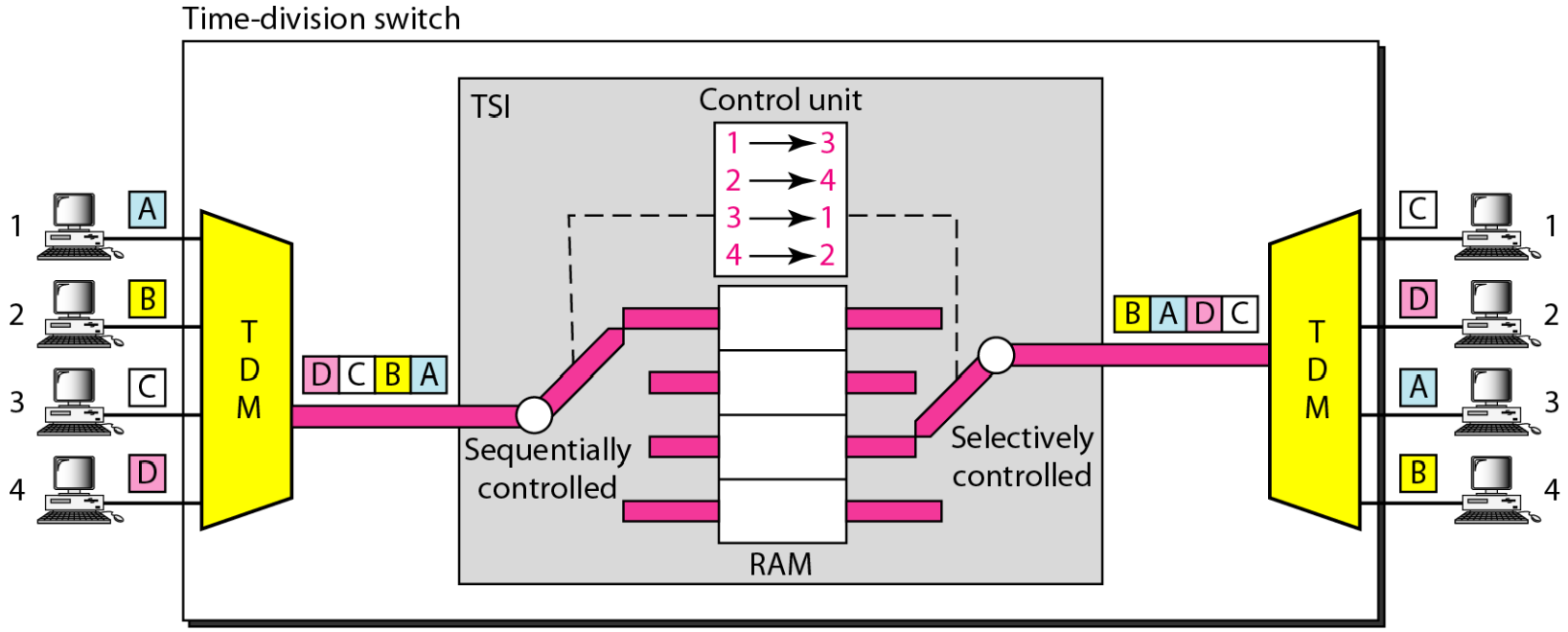
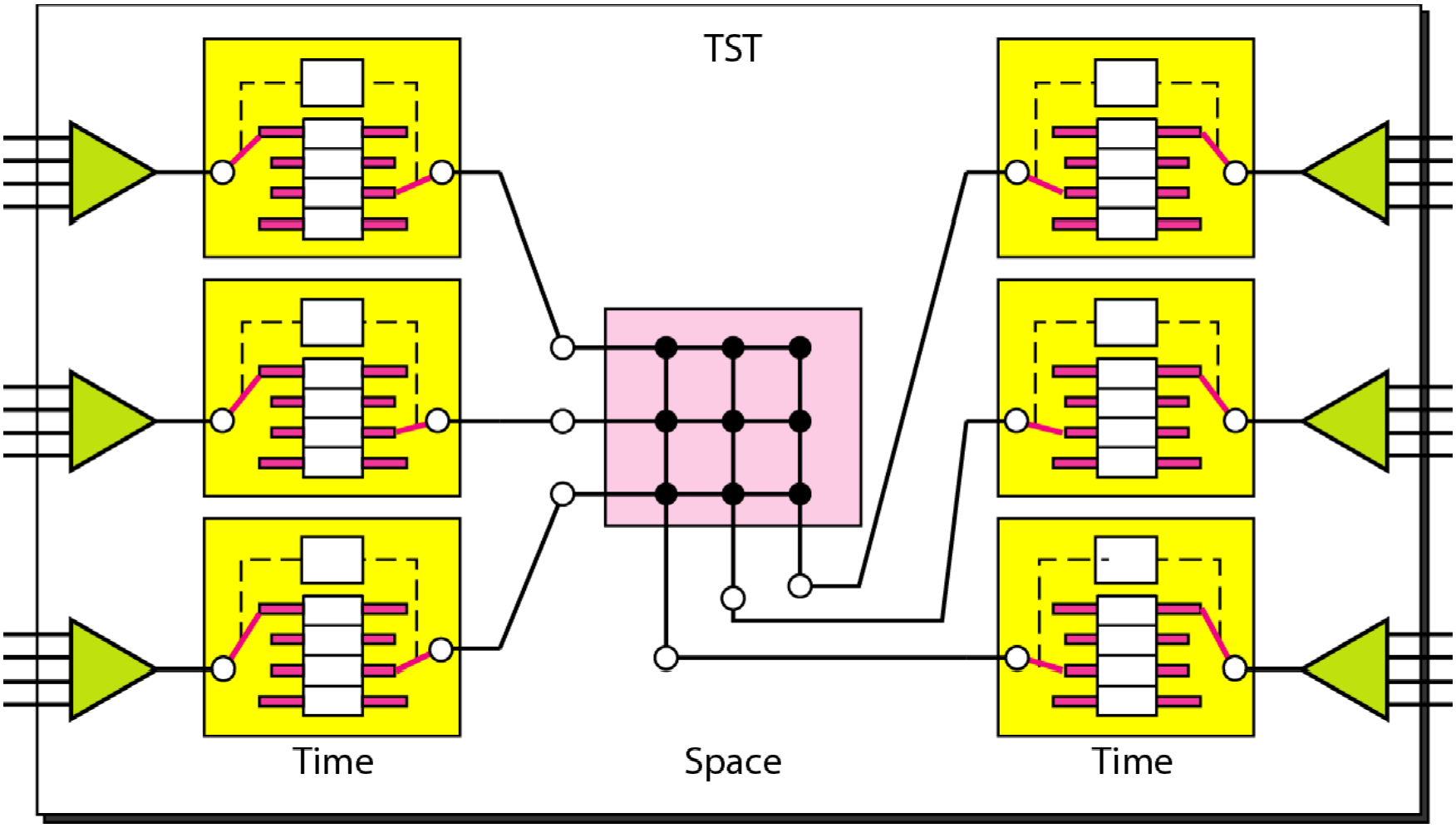


Figure 20 *Time-space-time switch*



Structure of Packet Switch

Figure 21 *Packet switch components*

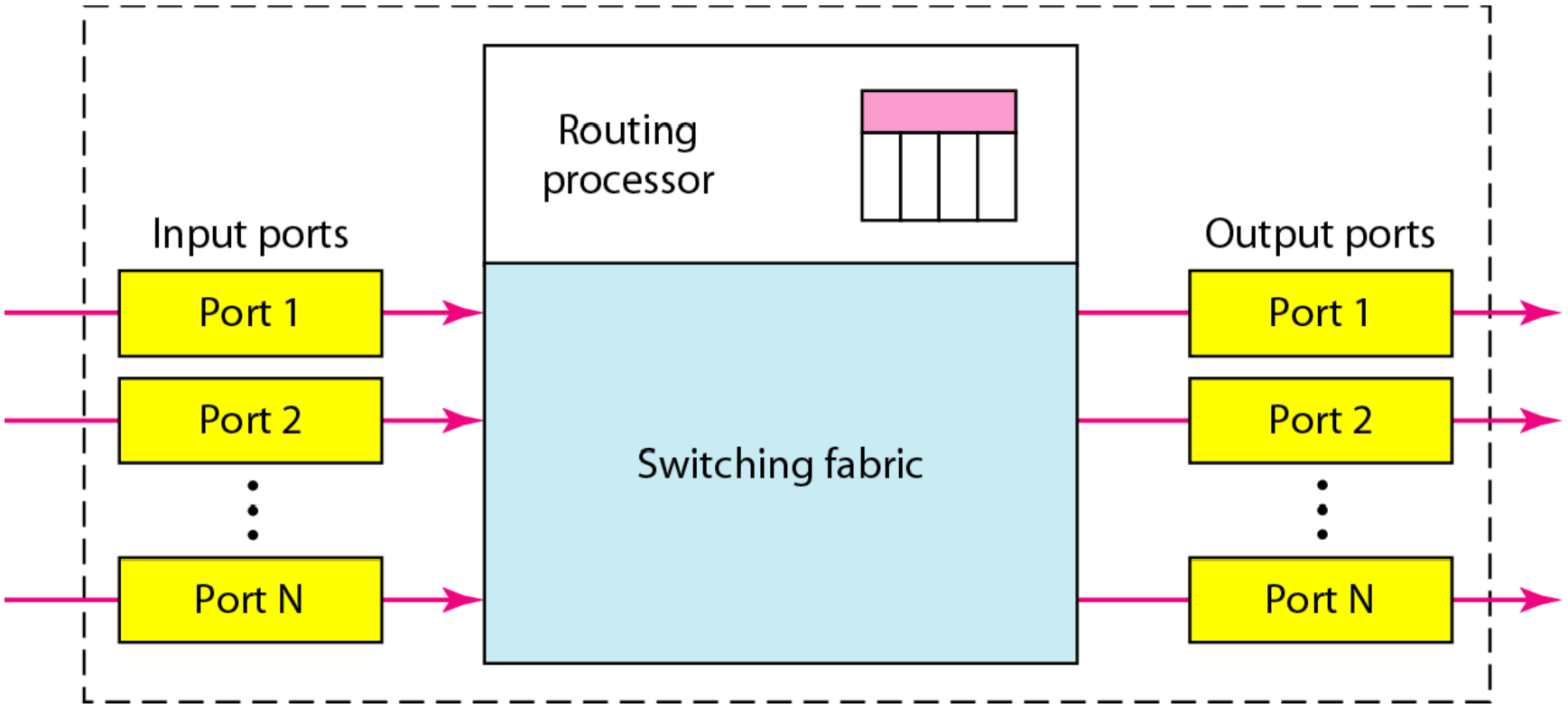


Figure 22 *Input and output port*

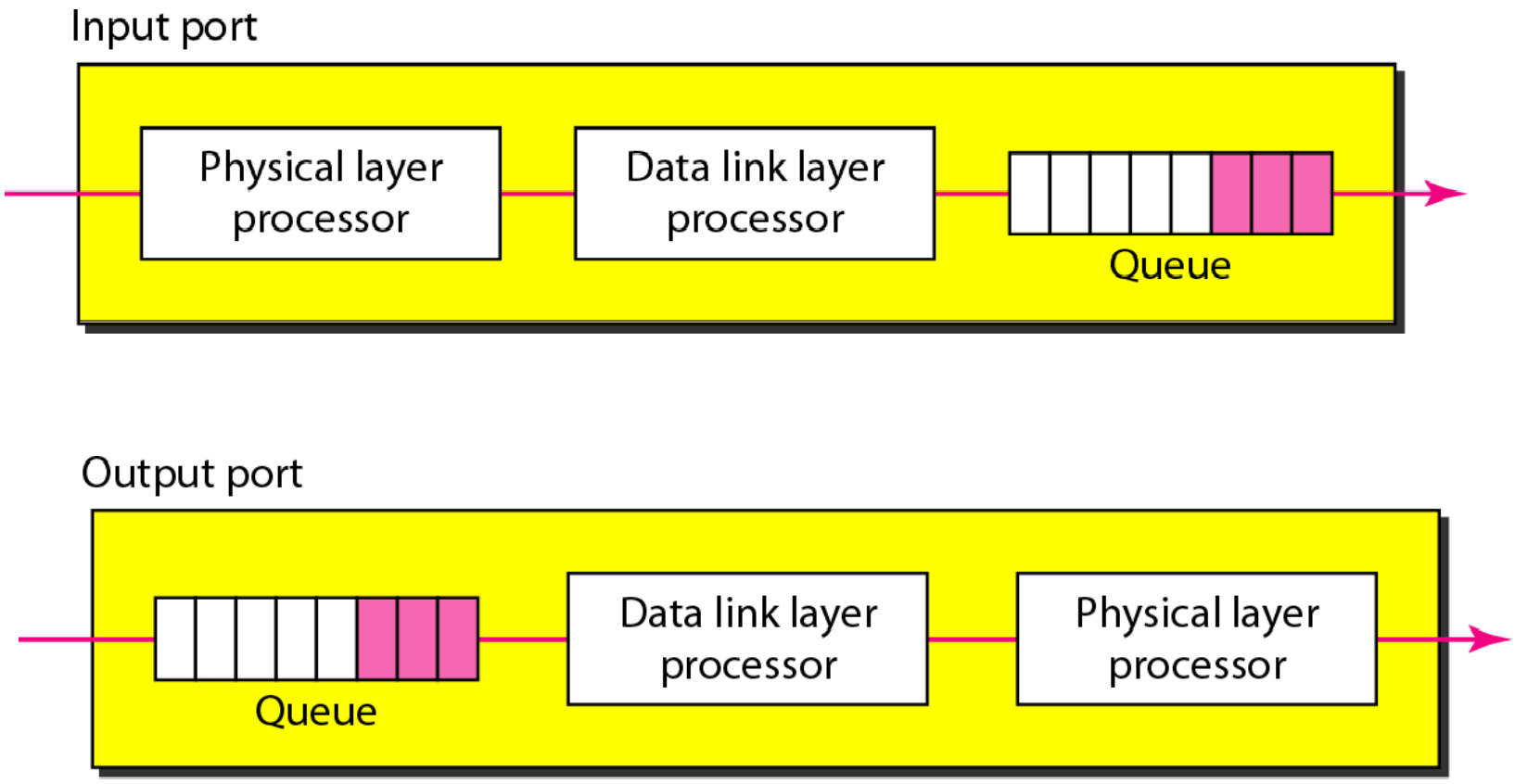


Figure 23 *A banyan switch*

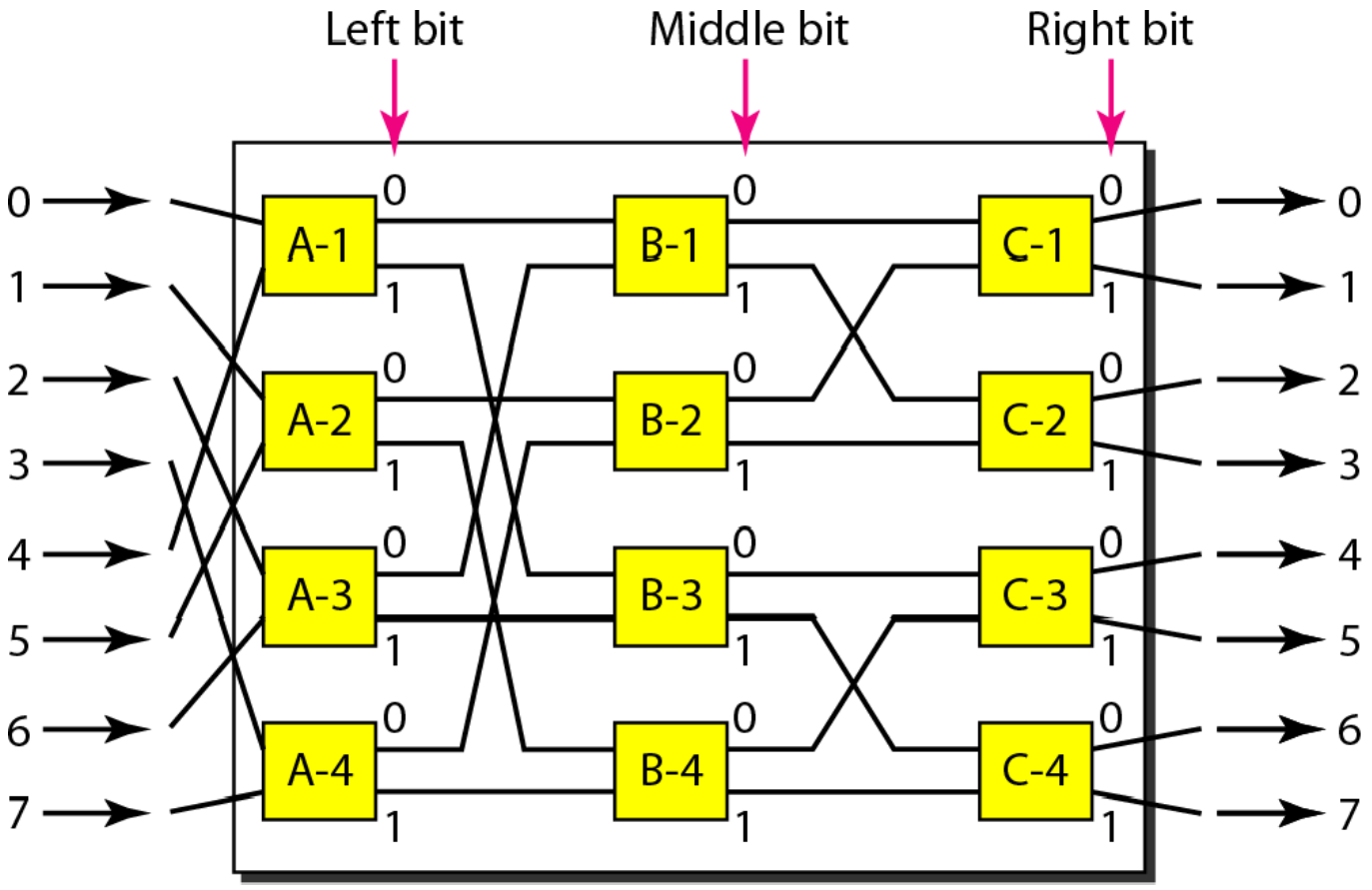
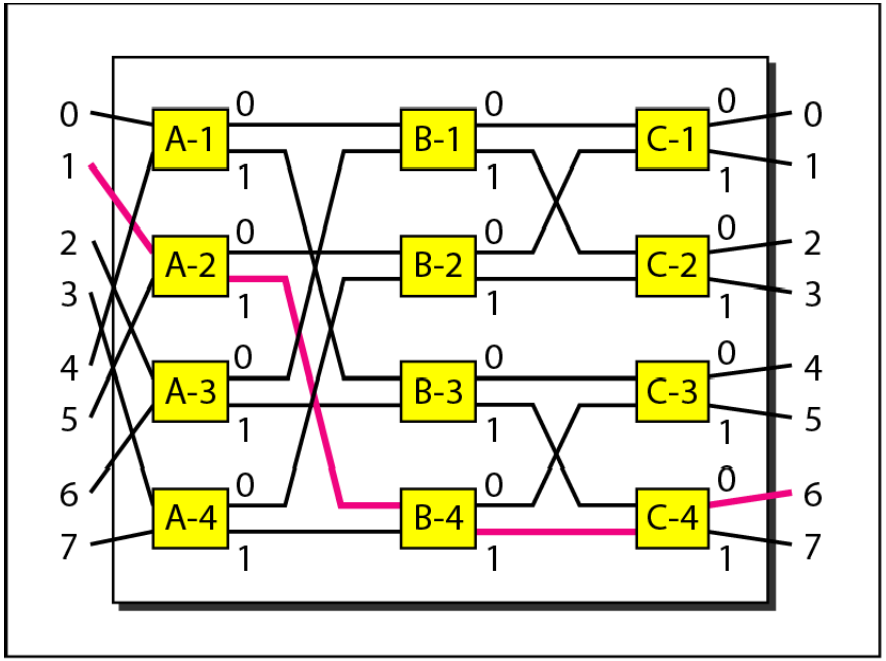
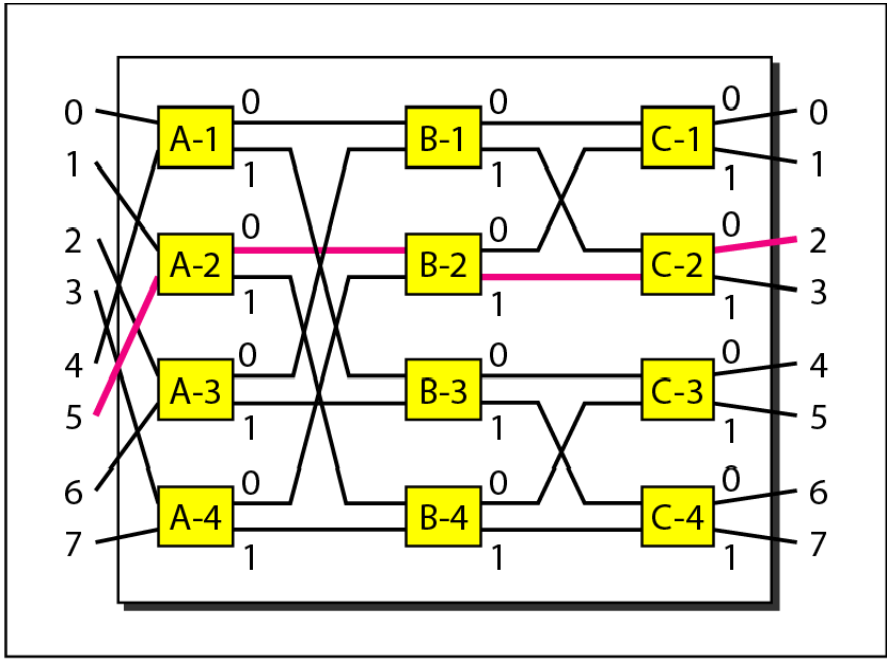


Figure 24 *Examples of routing in a banyan switch*



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



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