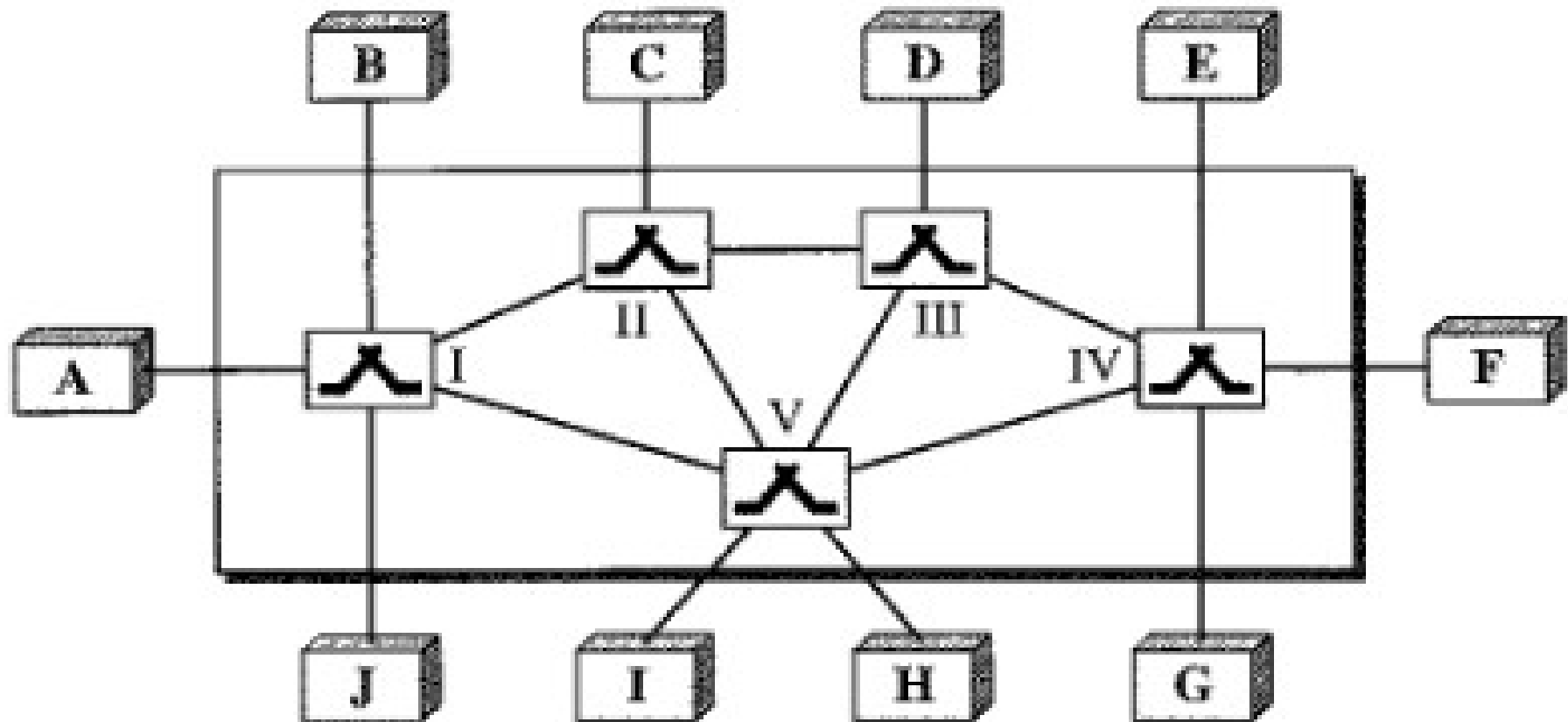
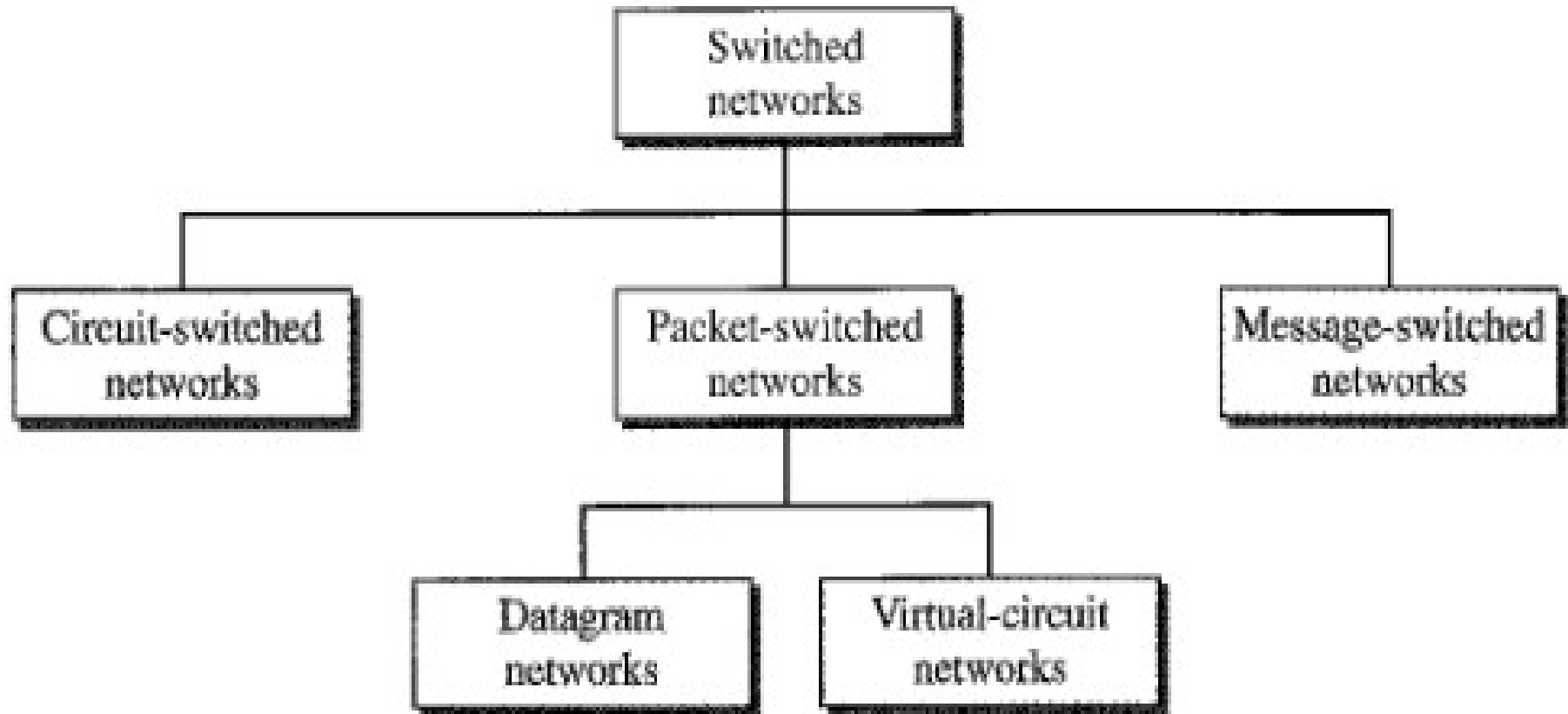


Chapter 8

Switching



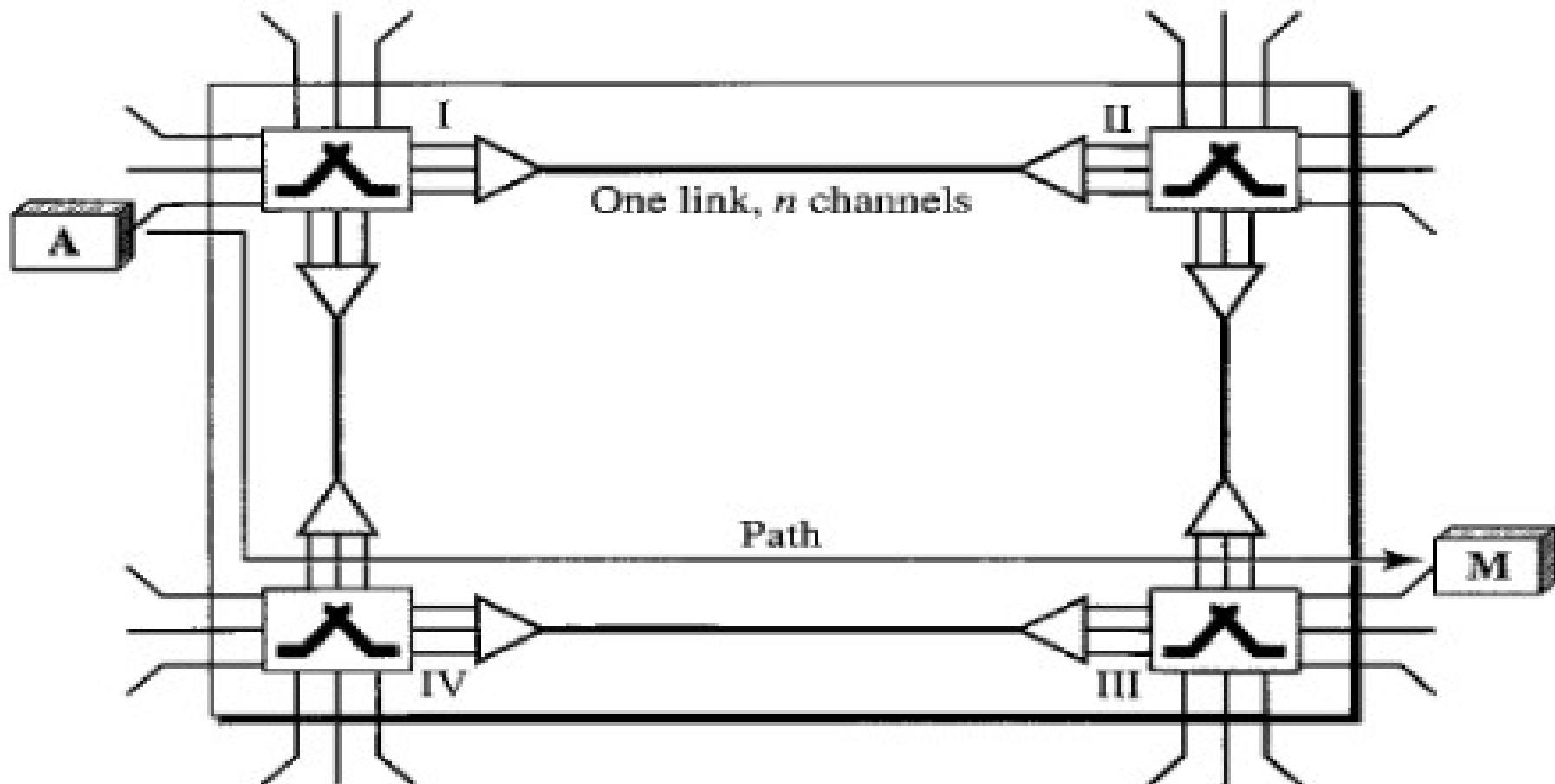
Switching



Circuit-switched Networks

- Set of switches connected by physical links
- Connection between two stations is a dedicated path made of one or more links
- Only one channel in a link is used
- Phases: connection setup, data transfer, connection teardown
- Inefficient – dedicated link can be unused
- Minimal delay

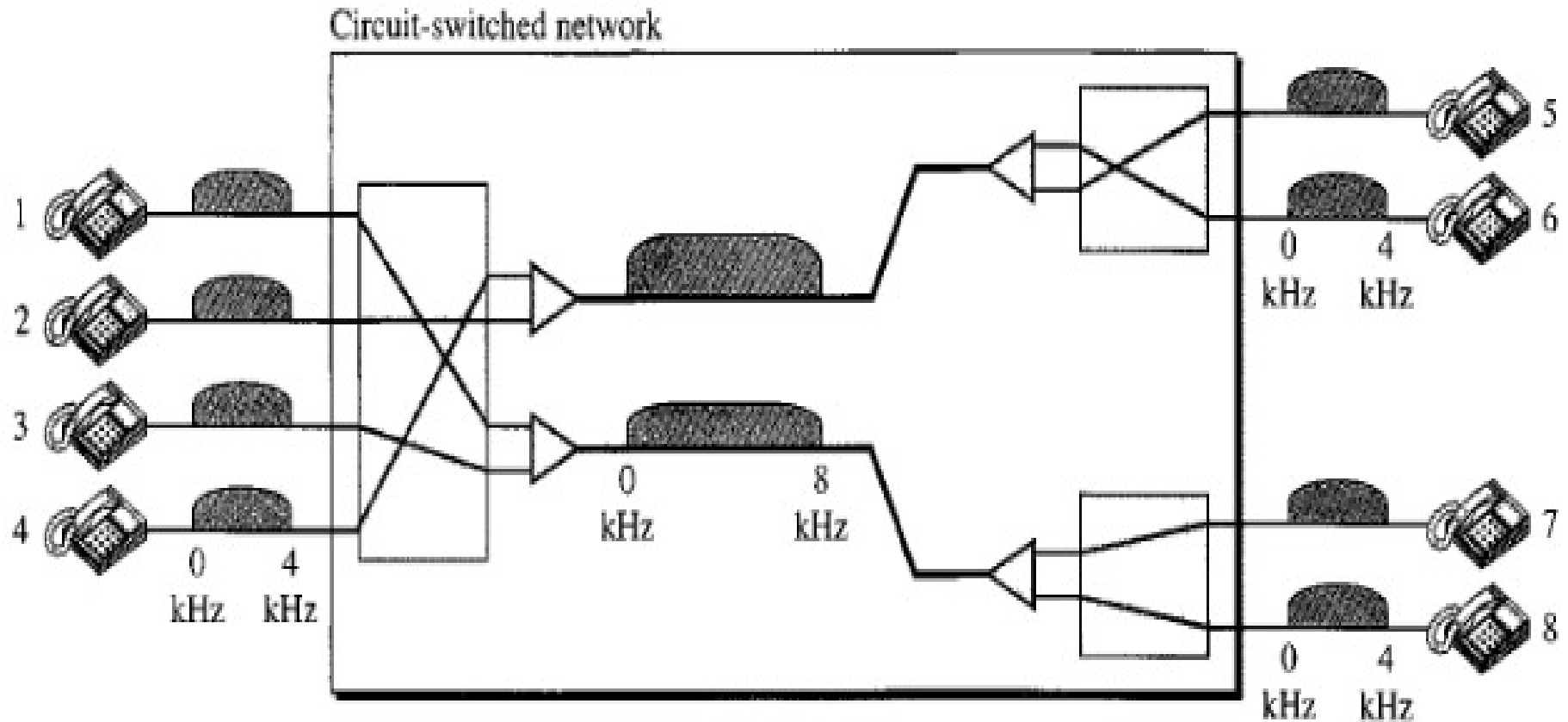
Circuit-switched Networks



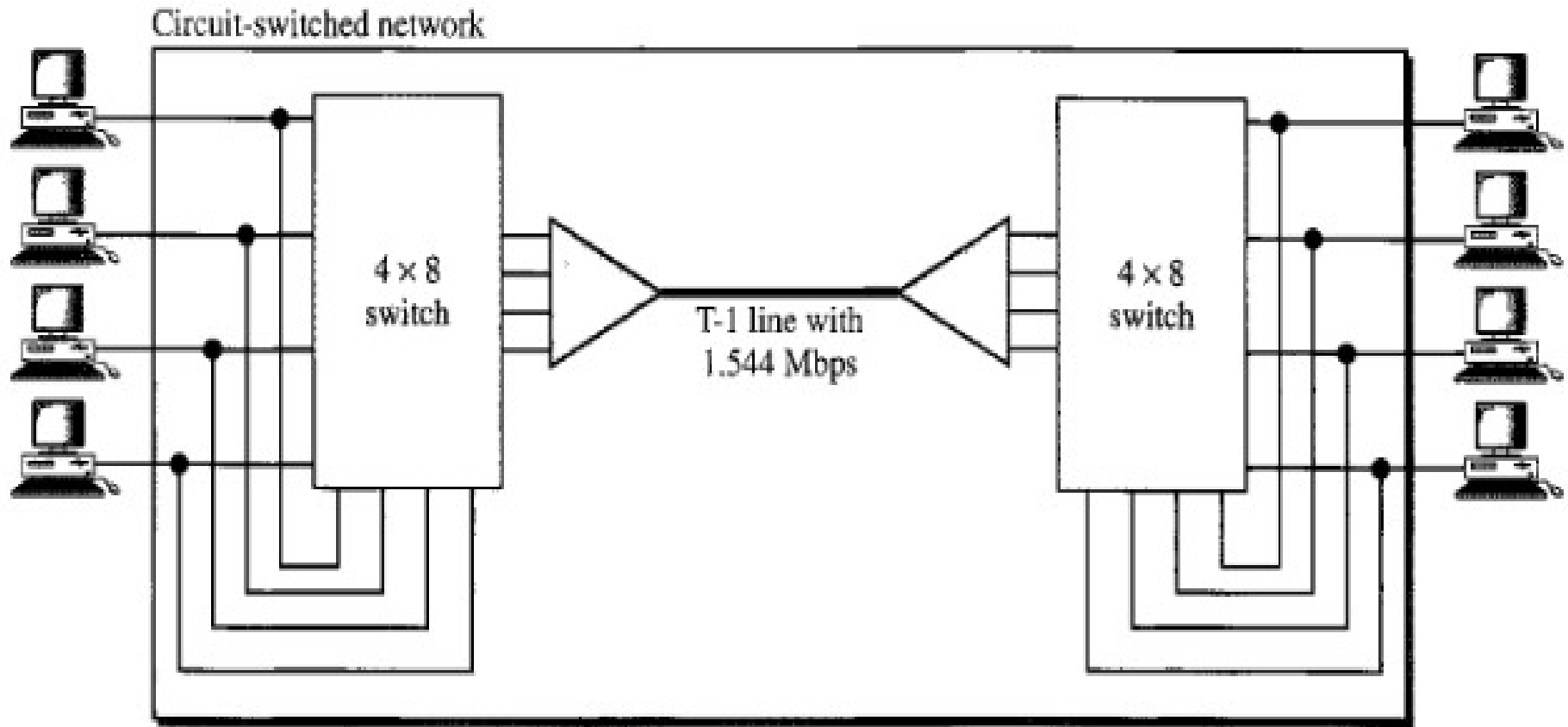
Circuit-switched Networks

- Takes place at the **physical layer**
- Resources to be used must be **reserved**
- Data transferred are a **continuous flow**
- **No addressing** involved in the data transfer

Circuit-switched Networks

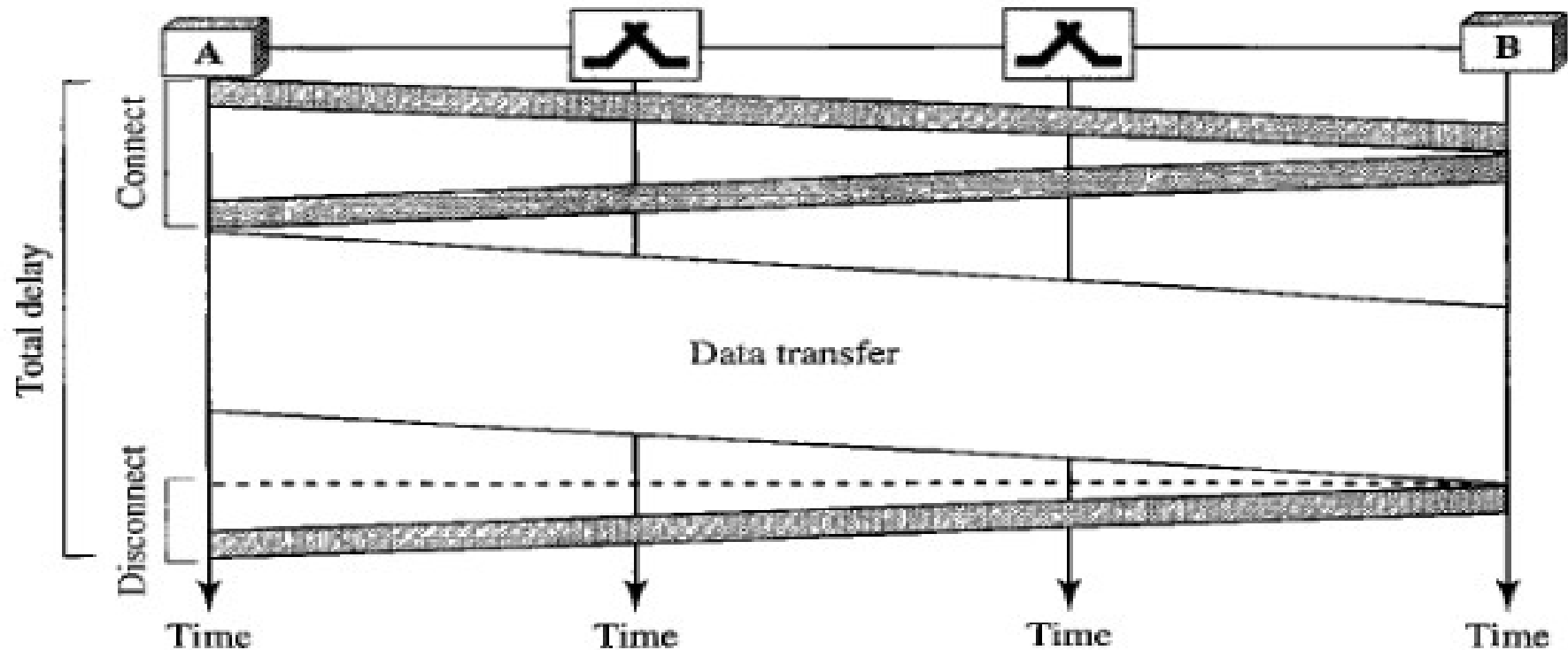


Circuit-switched Networks



Circuit-switched Networks

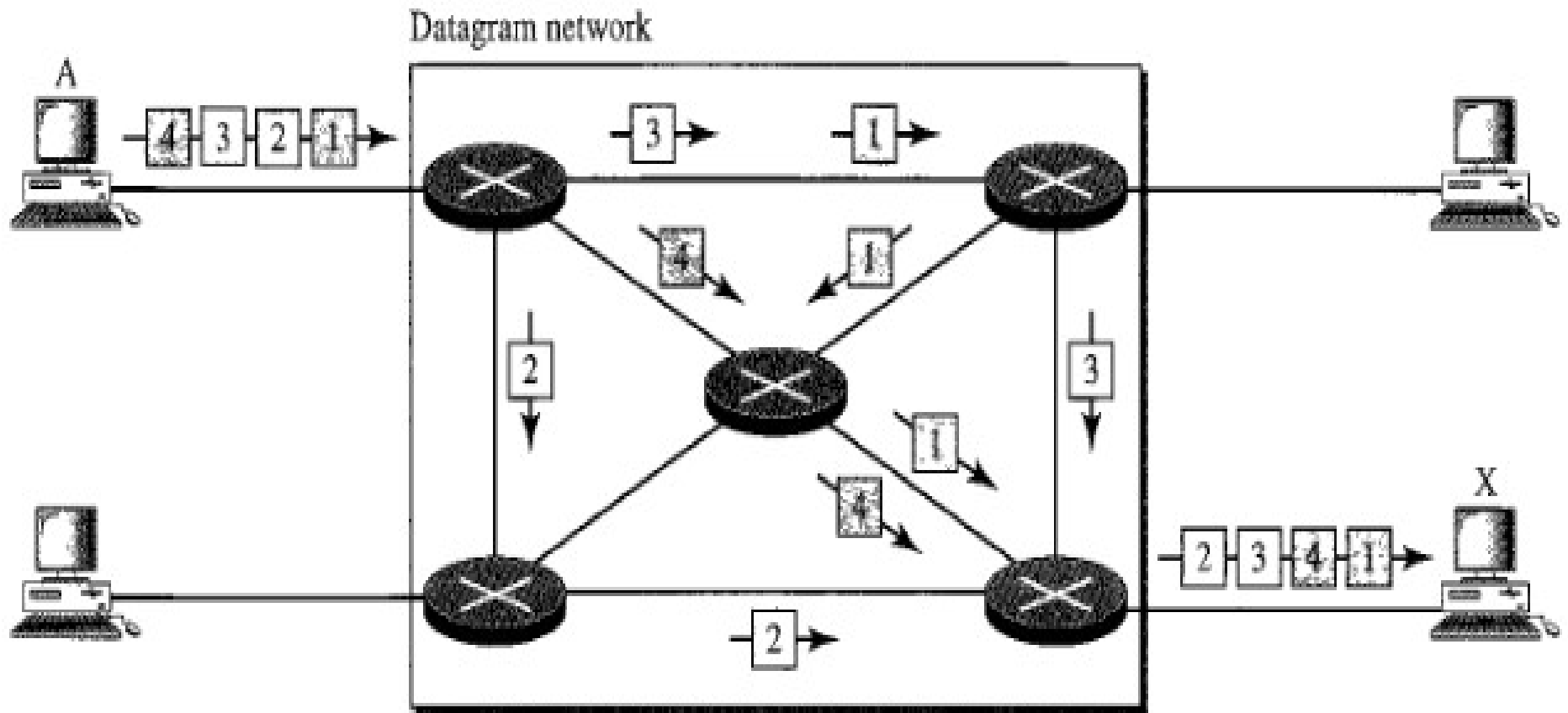
- Delays



Datagram Networks

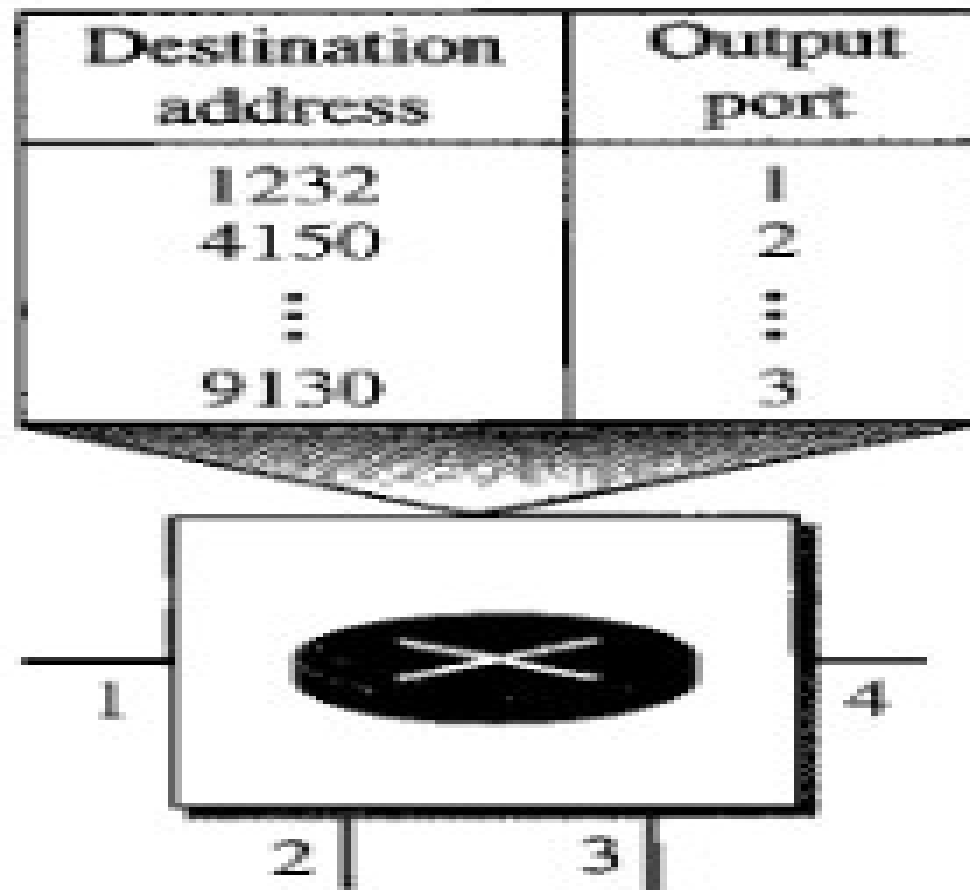
- In **packet-switched networks**, messages are divided into **packets**: fixed or variable size
- No resource allocation for a packet
- Resources are allocated on demand; **FCFS**
- In a **datagram network**, each packet is treated independently of all others
- **Datagram switching** done at the **network layer**
- Datagrams may **arrive out of order** or **get lost**
- **Connectionless** – no information on state of connection is saved

Datagram Networks



Datagram Networks

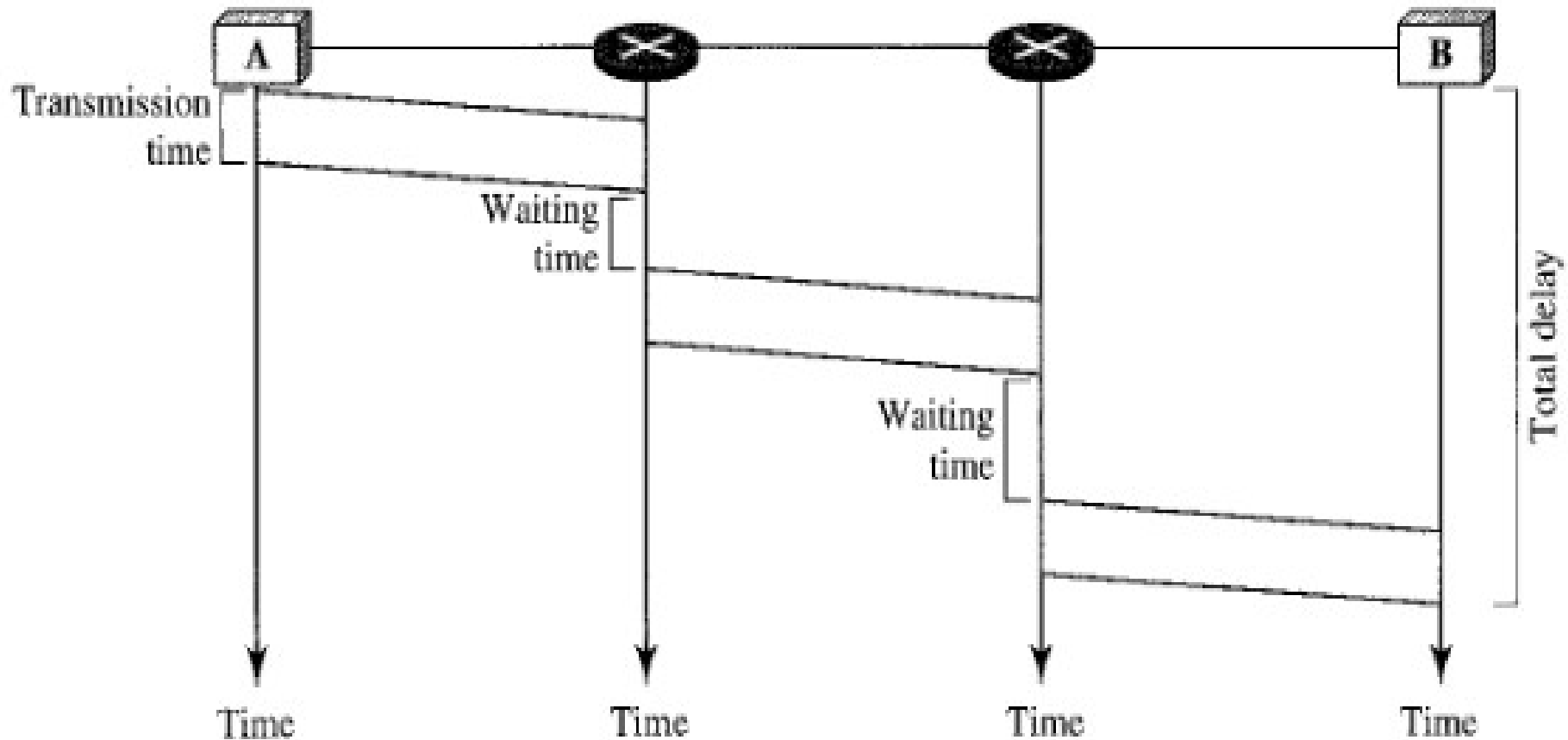
- Routing table



Datagram Networks

- Header contains address
- Efficient – resource are allocated when there are packets to be transferred
- More delay – waiting time in switches

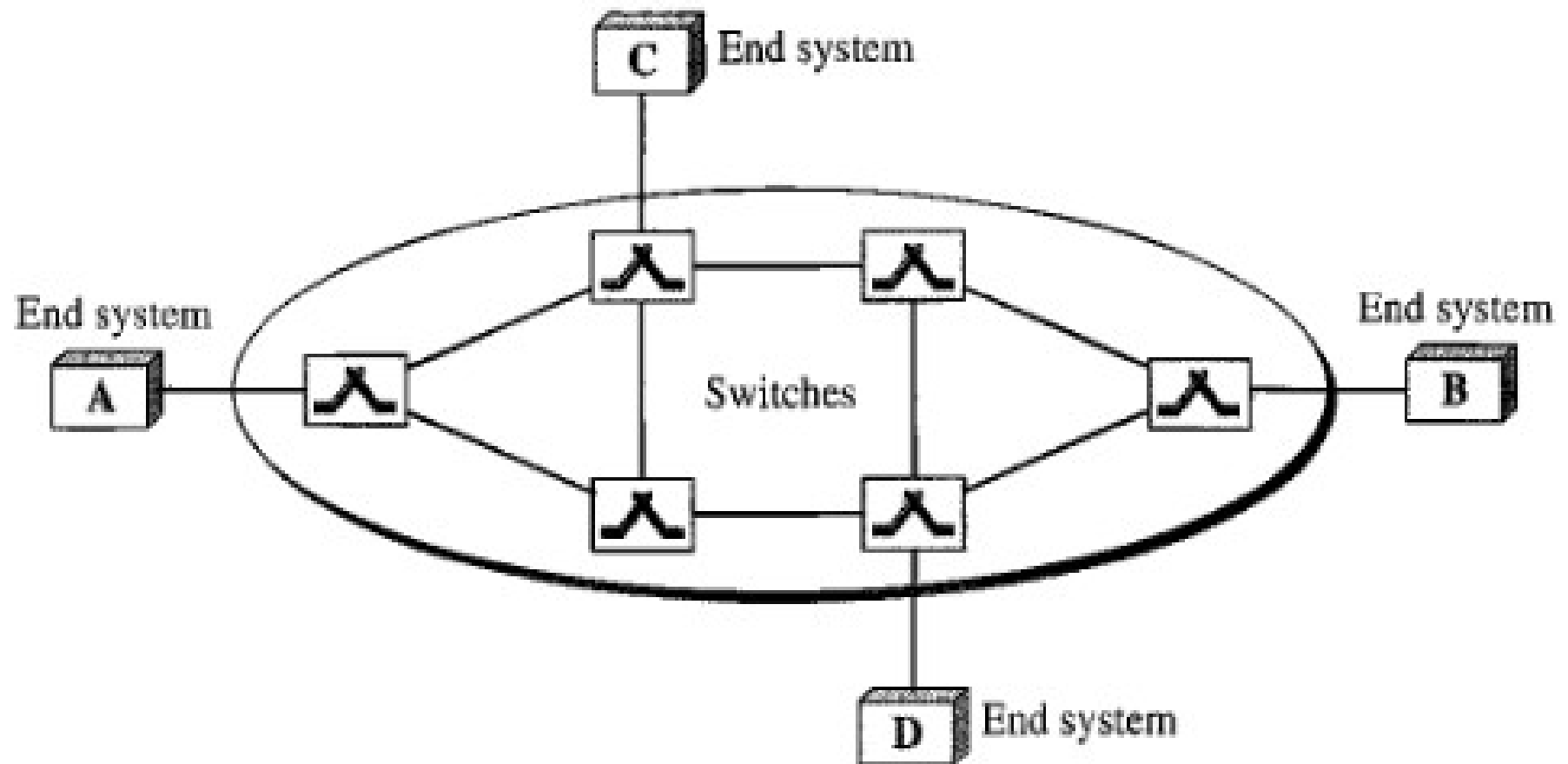
Datagram Networks



Virtual-Circuit Networks

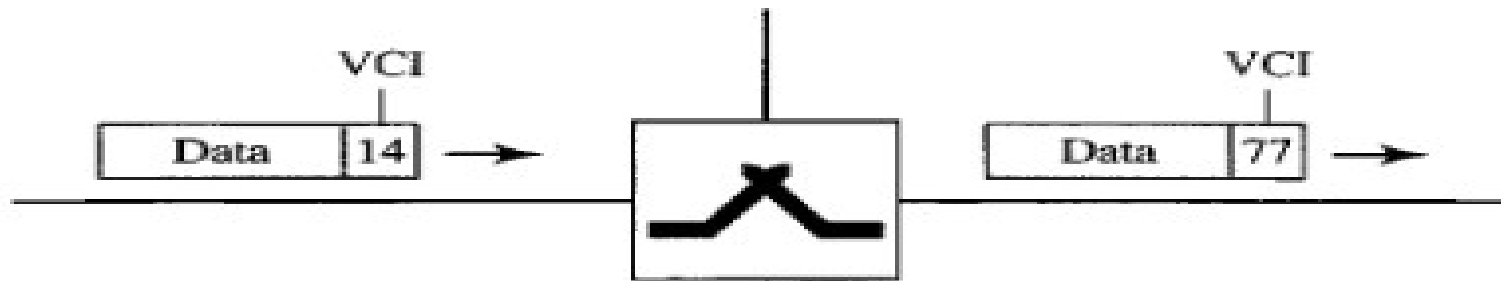
- Cross between circuit-switched network and datagram network
 - With connection setup and teardown phases
 - Resources can be allocated during the setup phase or on demand
 - Packetized data with address in header(local jurisdiction only)
 - Packets follow the same path established
 - Implemented in the data link layer

Virtual-Circuit Networks



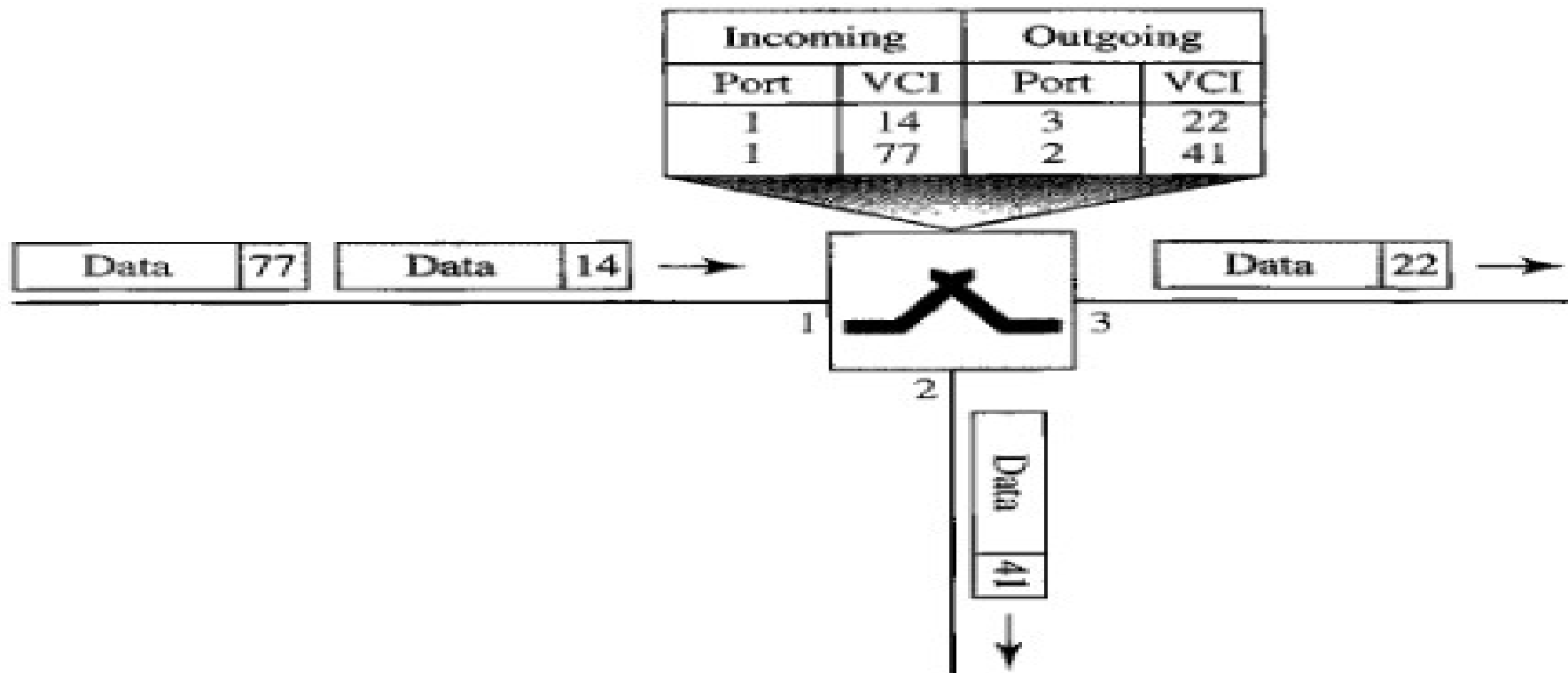
Virtual-Circuit Networks

- A source or a destination needs to have a global address – used to create VCI
- Virtual-Circuit Identifier (VCI) – switch scope (between two switches)



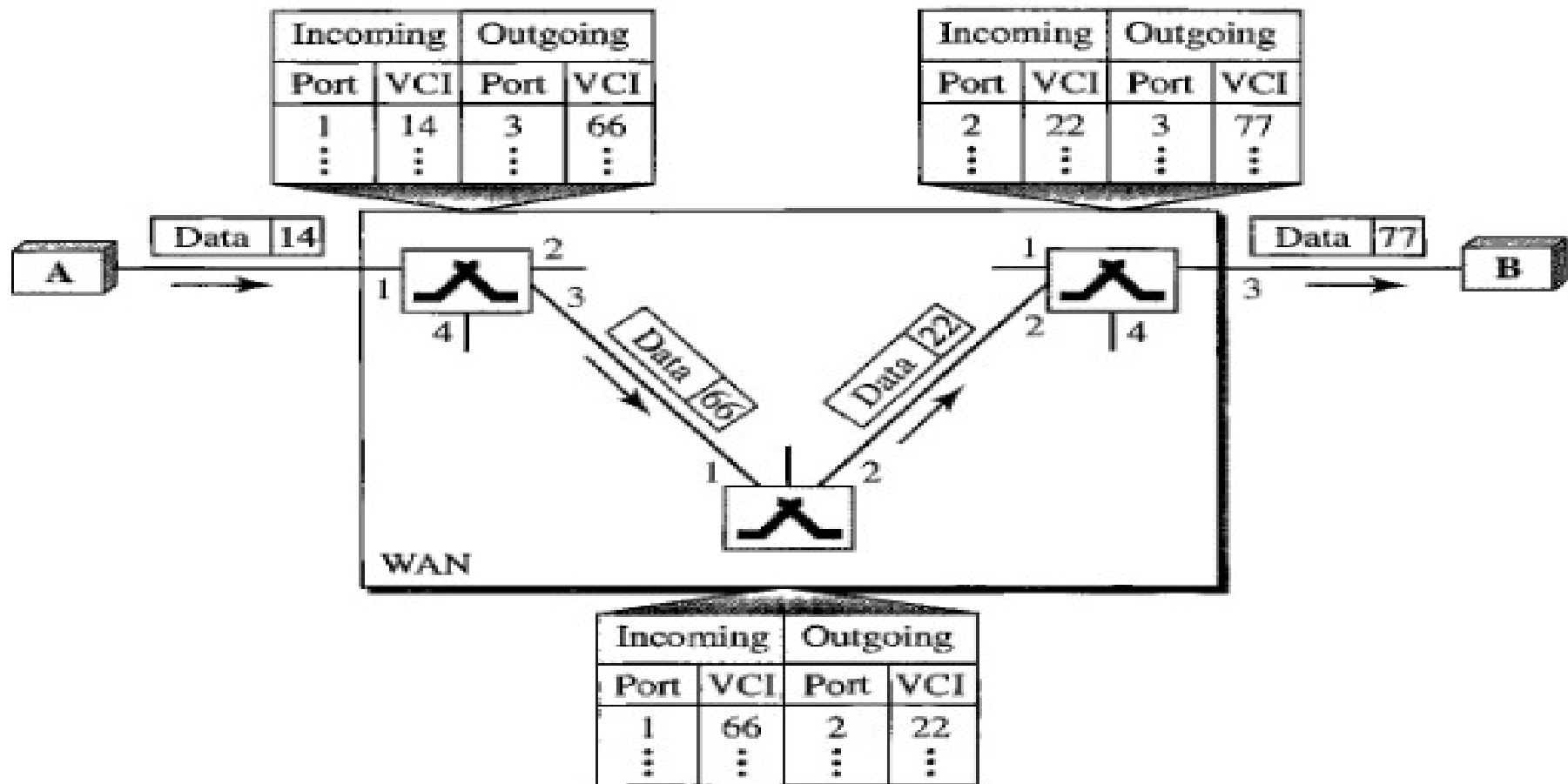
Virtual-Circuit Networks

- Switch and Tables



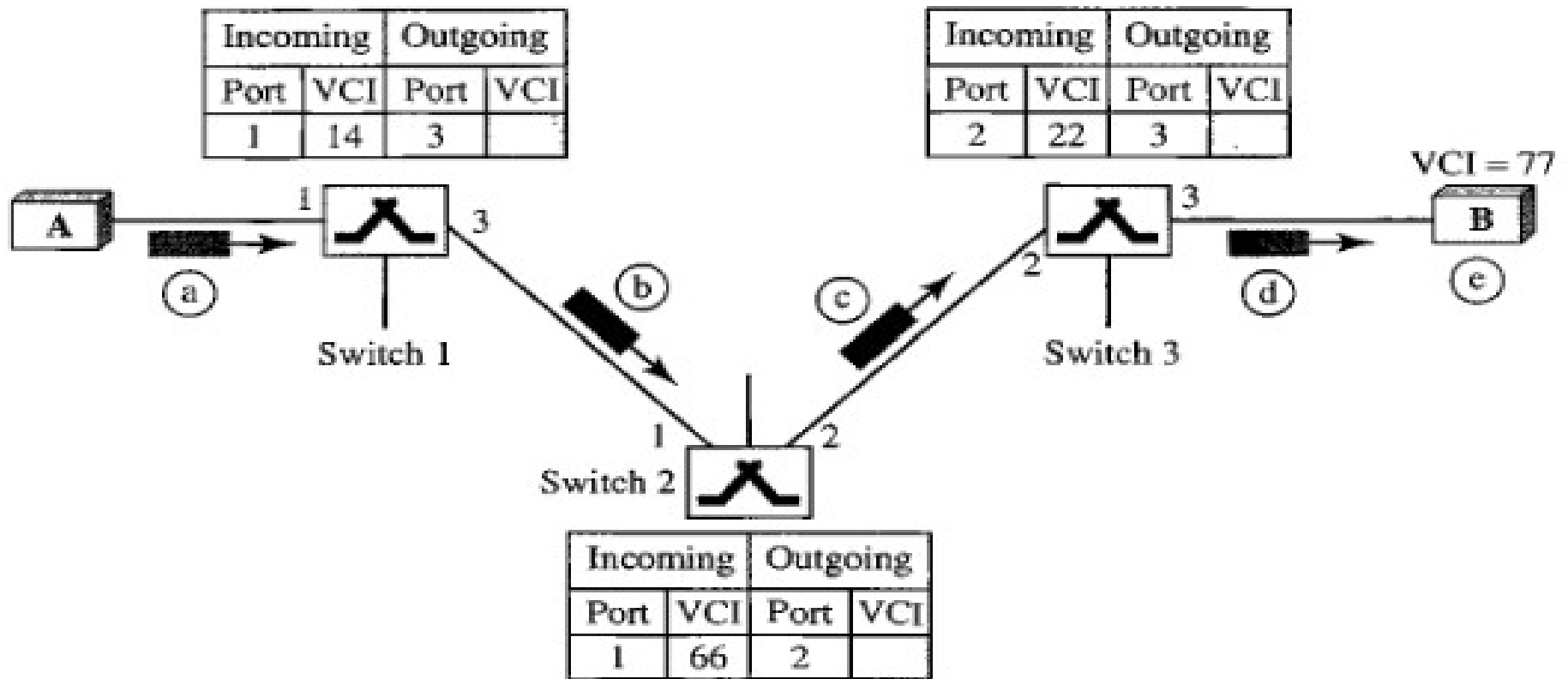
Virtual-Circuit Networks

- Data transfer



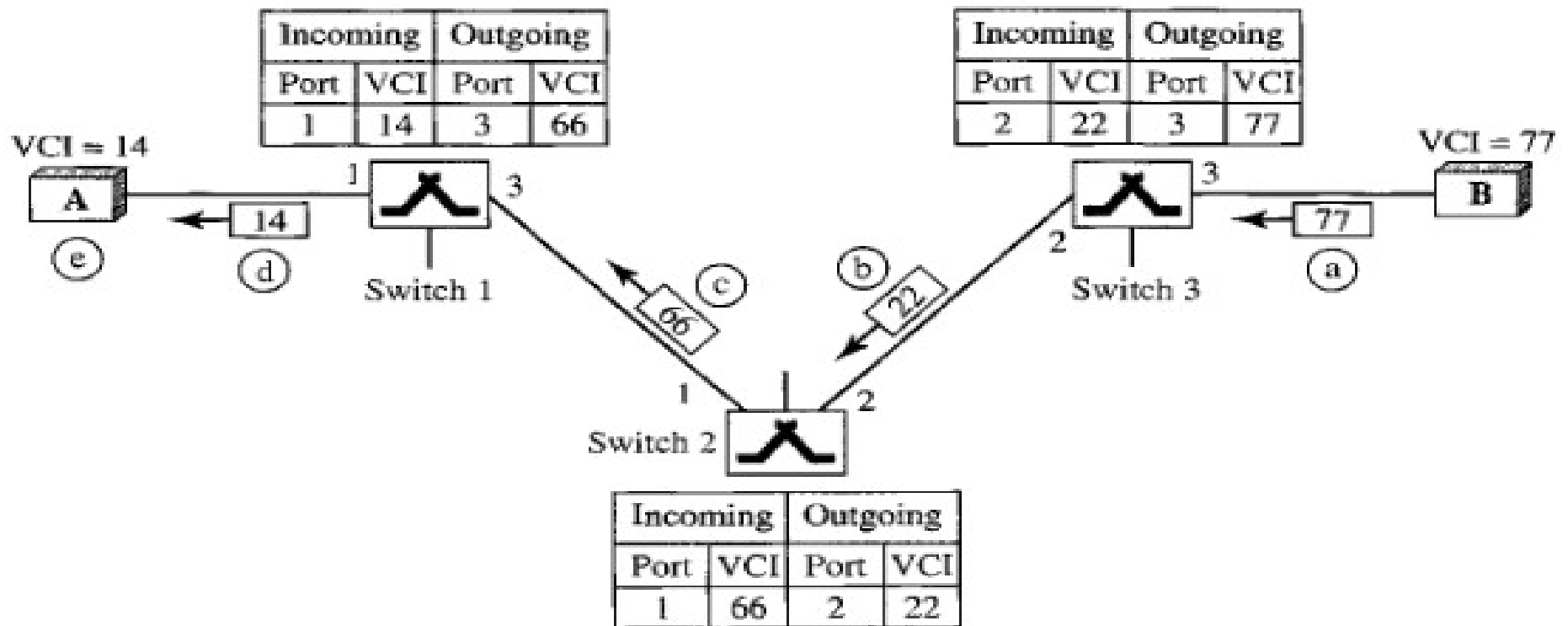
Virtual-Circuit Network

- Setup request, switch acts as packet switch (routing table different from switching table)



Virtual-Circuit Network

- Acknowledgement

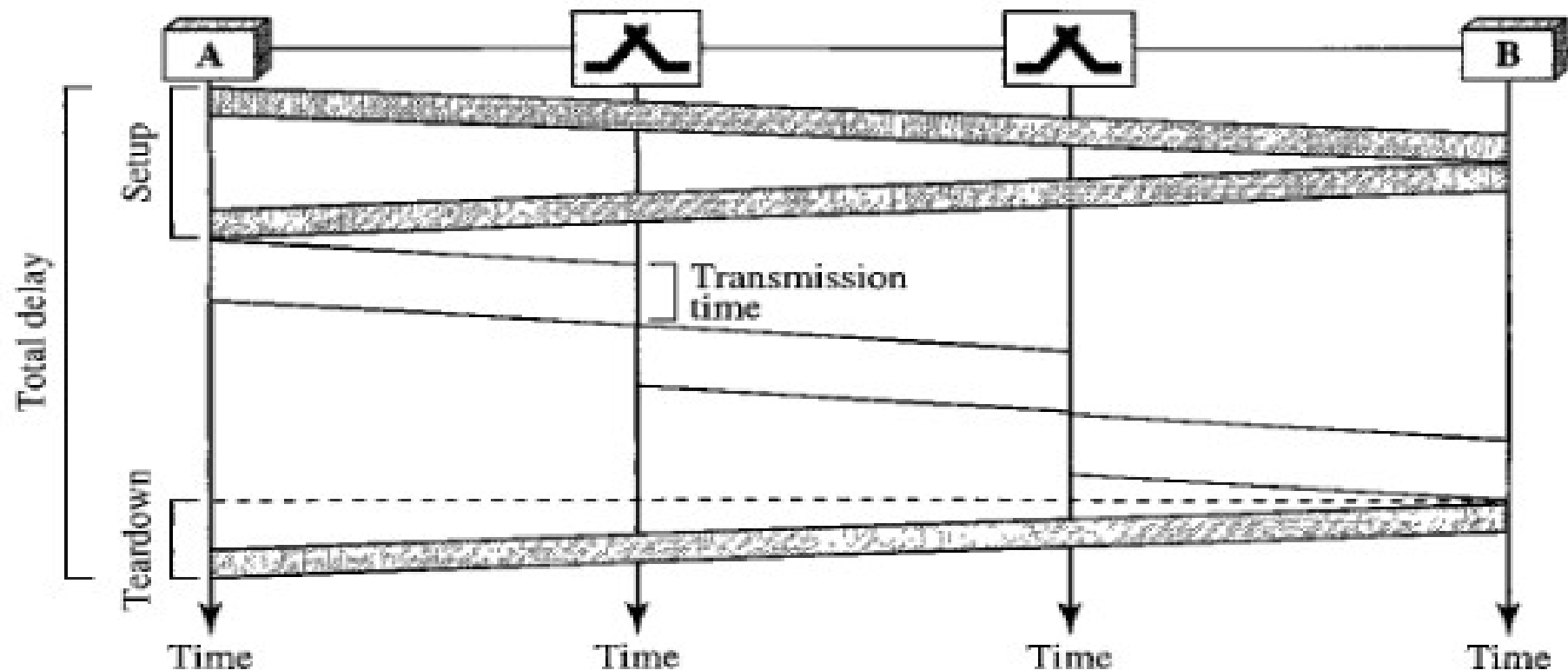


Virtual-Circuit Network

- Efficiency
 - All packets belonging to the same source and destination travel the same path but may arrive at the destination with different delays if resource allocation is on demand

Virtual-Circuit Network

- Tot Delay = $3 \times \text{Trans} + 3 \times \text{Propa} + \text{setup} + \text{teardown}$

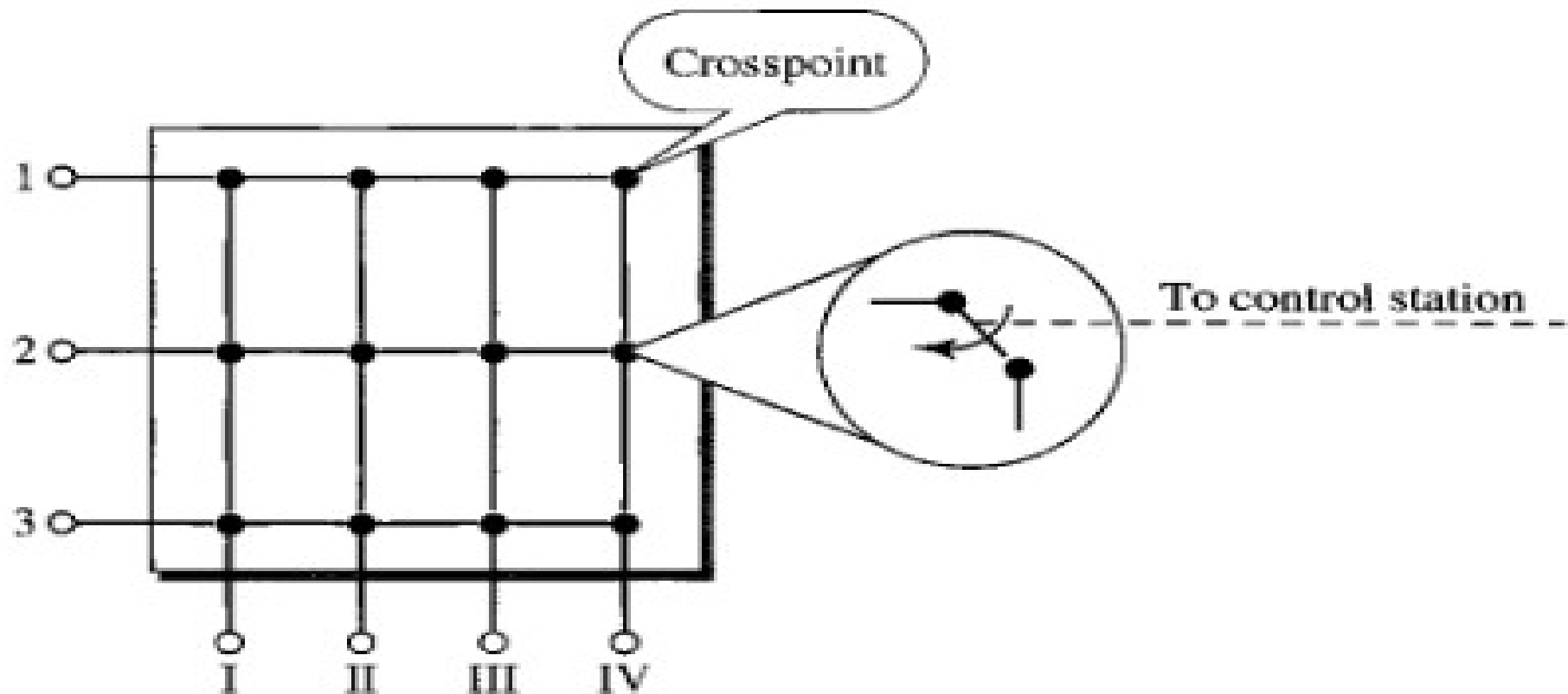


Structure of a Switch

- Space-division switch – paths in the circuit are separated spatially
 - Crossbar
 - Multistage
- Time-division switch – uses TDM
 - Time-slot interchange
- Time- and Space-Division switch combo
 - Time-space-time

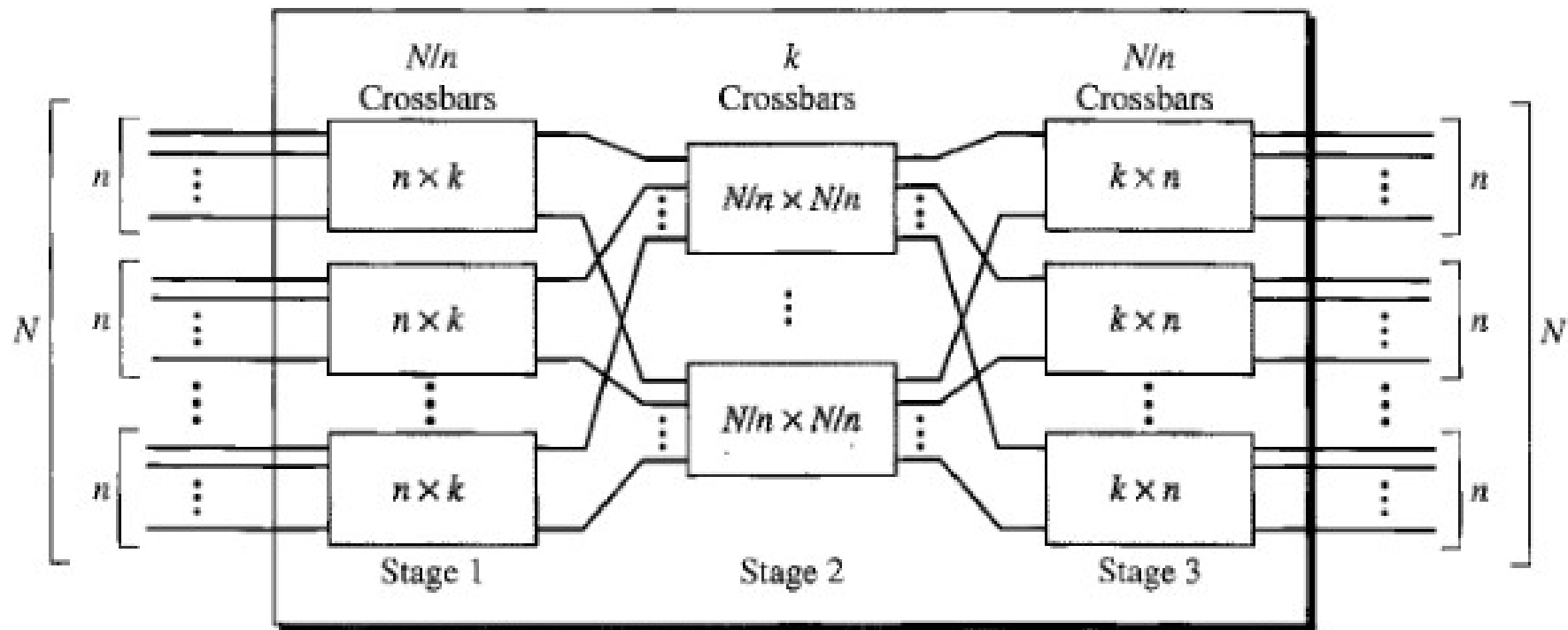
Structure of a Switch

- Crossbar



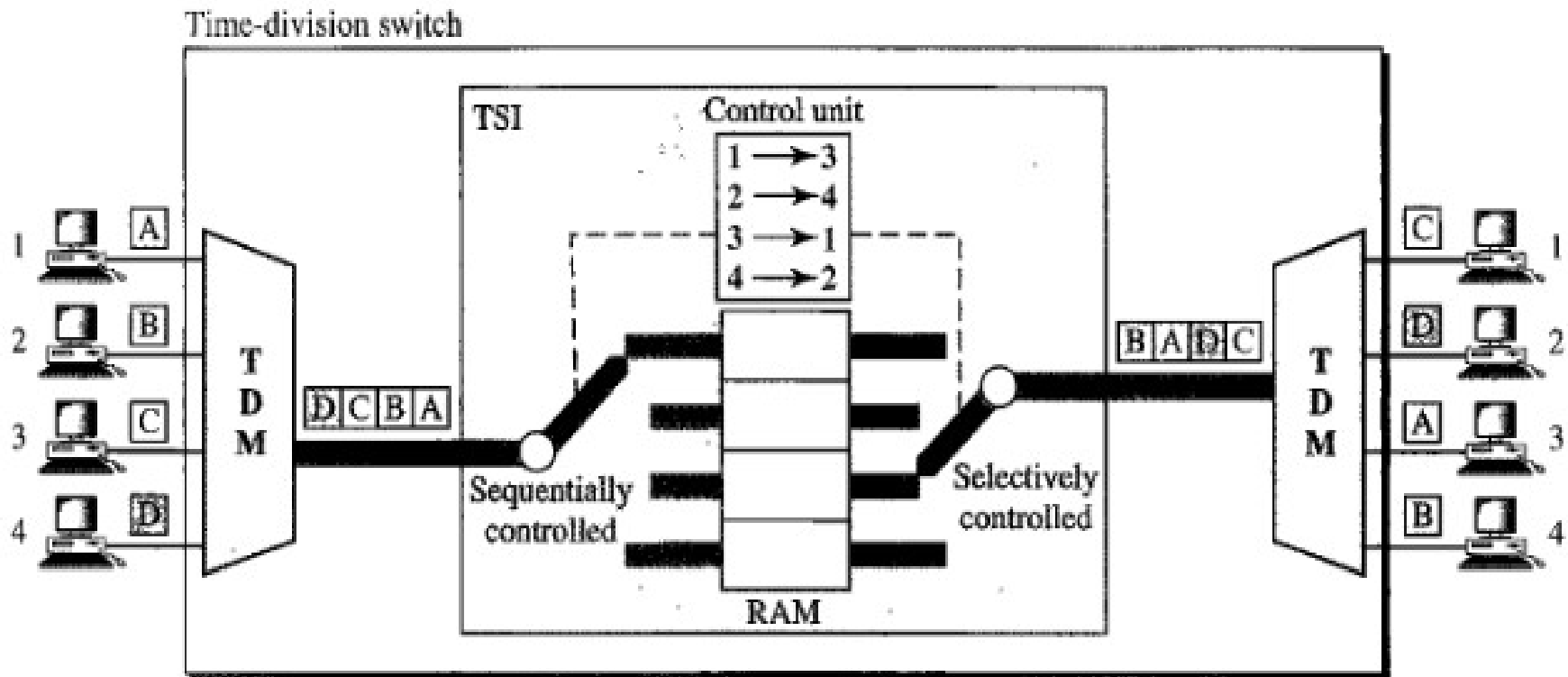
Structure of a Switch

- Multistage



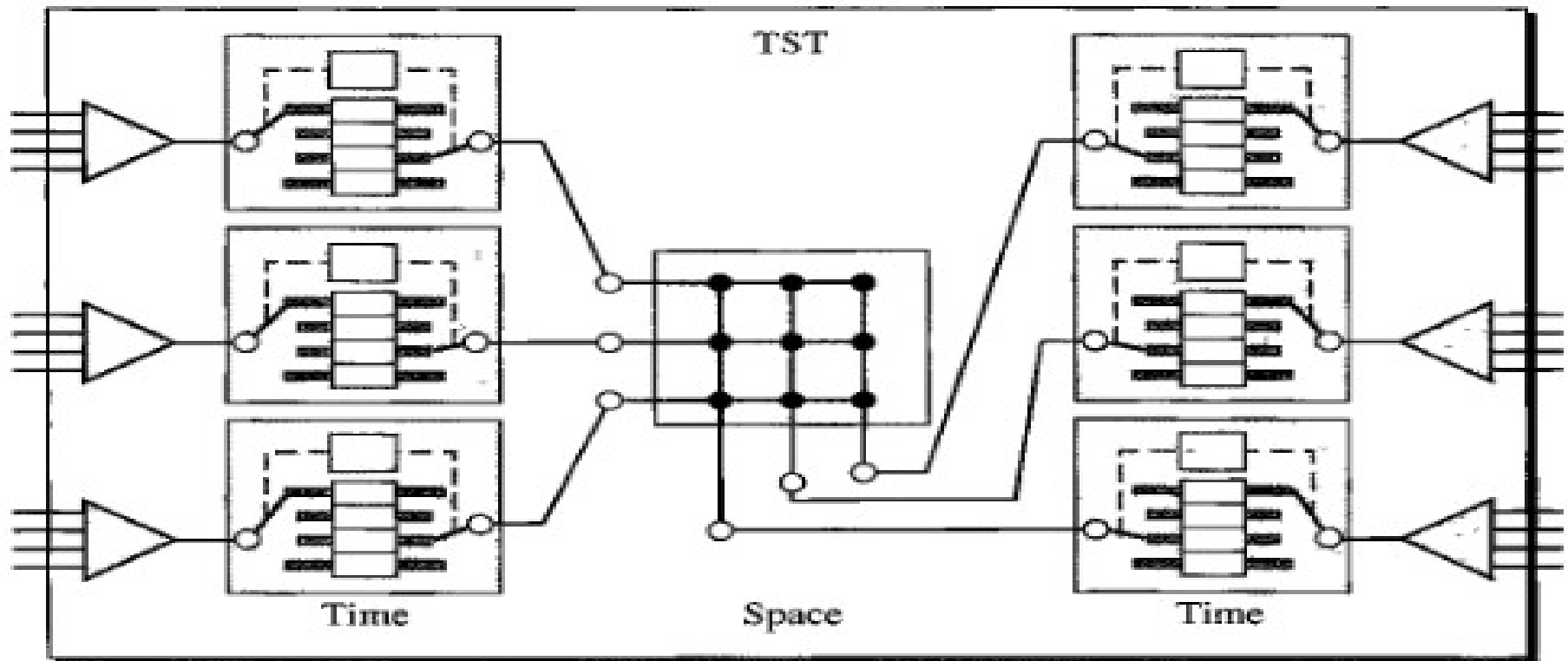
Structure of a Switch

- Time-slot interchange



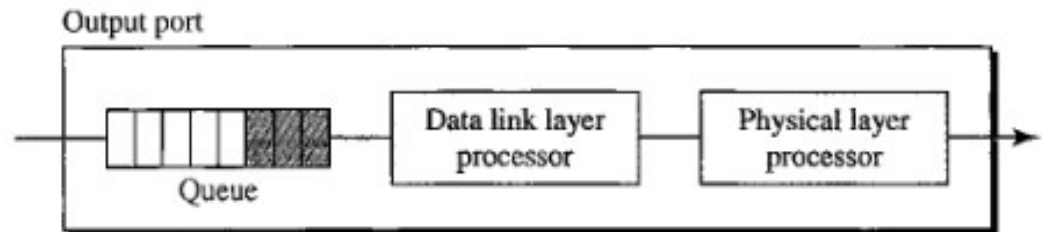
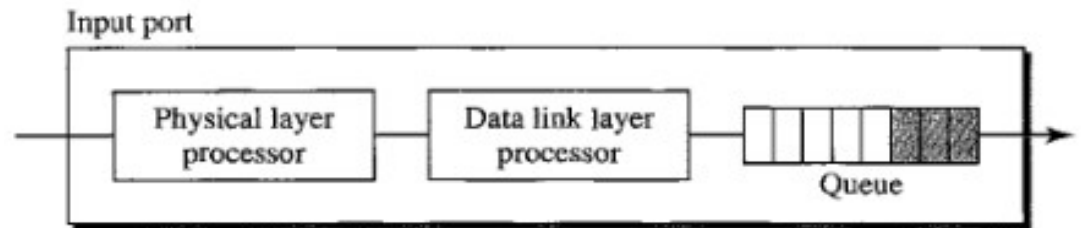
Structure of a Switch

- Time-space-time



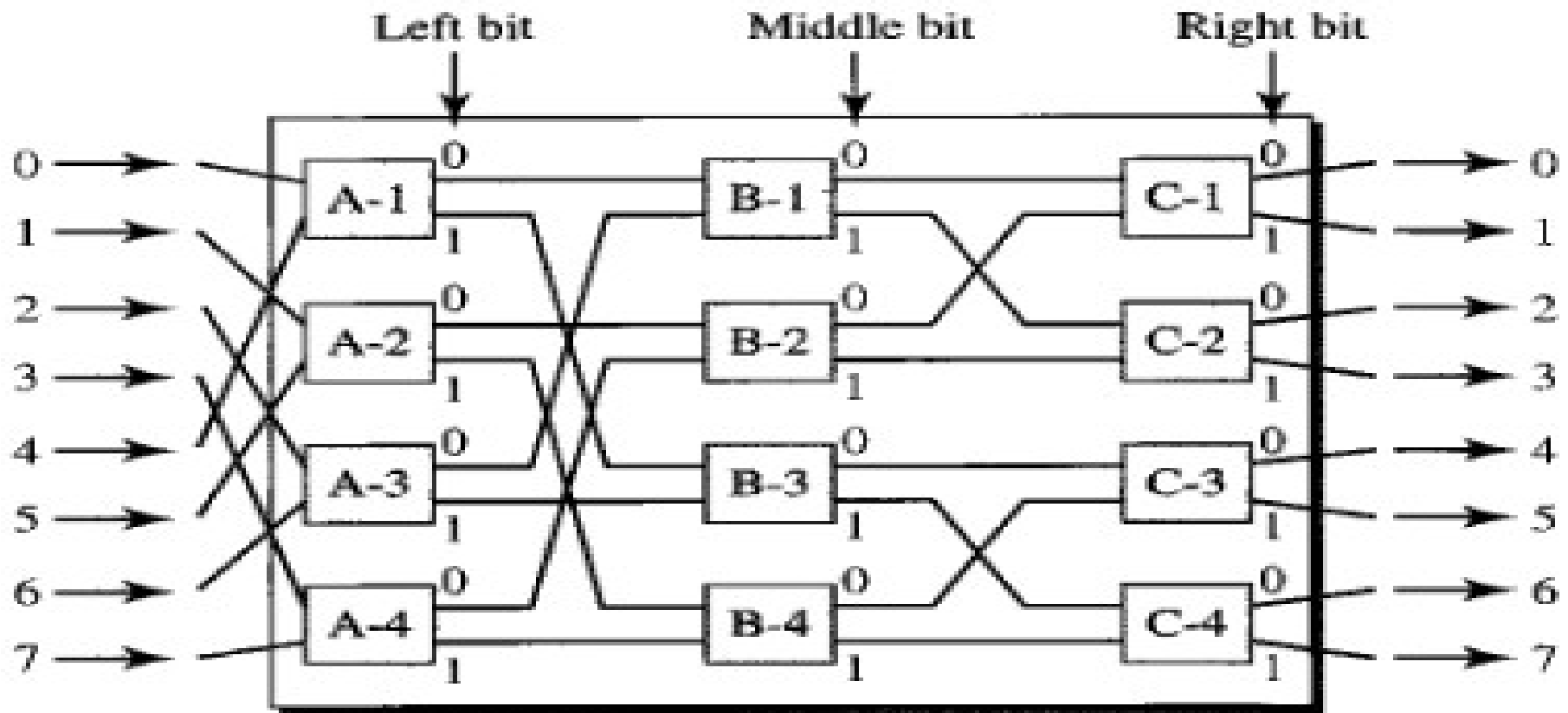
Structure of Packet Switches

- Four components
 - Input ports
 - Output ports
 - Routing processor
 - Switching fabric
 - Crossbar
 - Banyan
 - Batcher-Banyan Switch



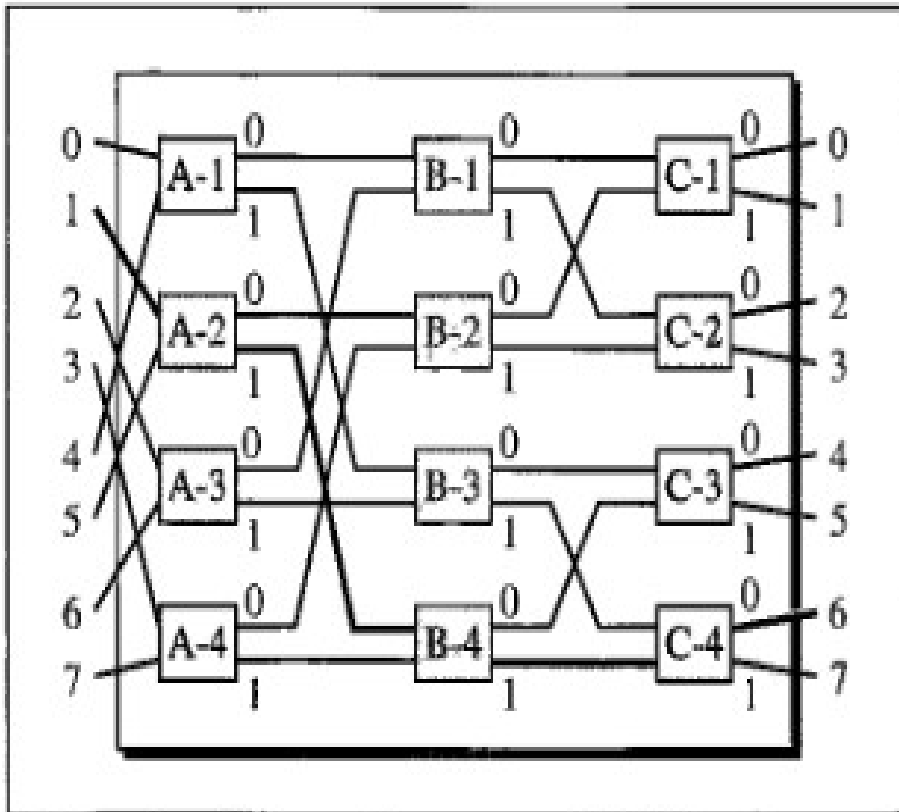
Structure of Packet Switches

- Banyan switch

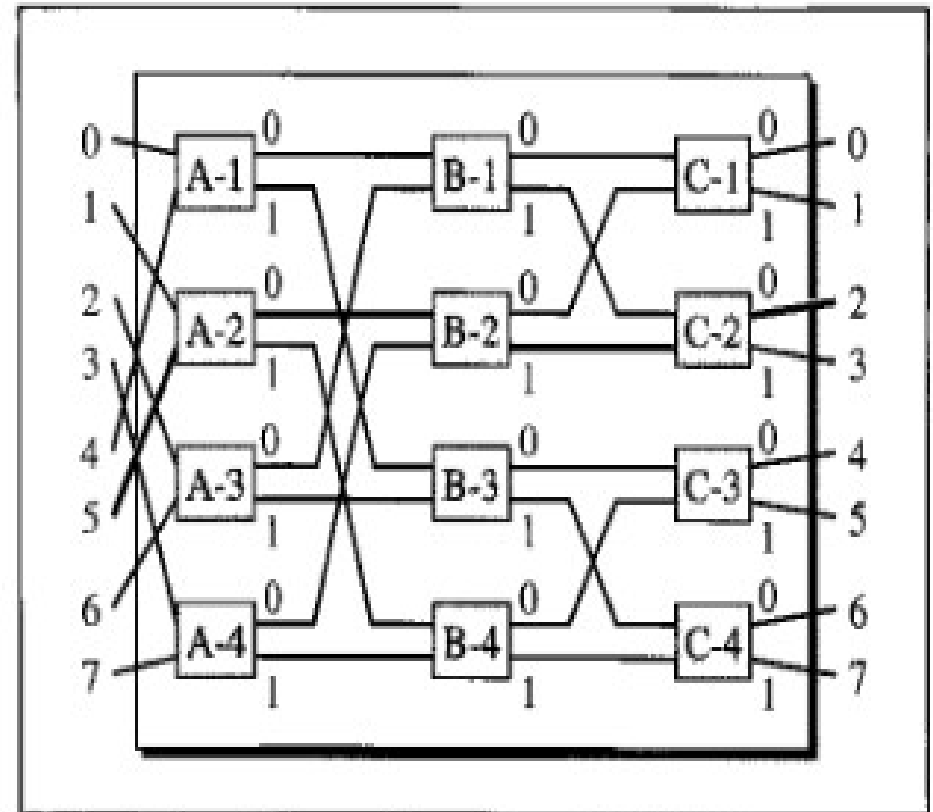


Structure of Packet Switches

- Banyan switch – problem is collision



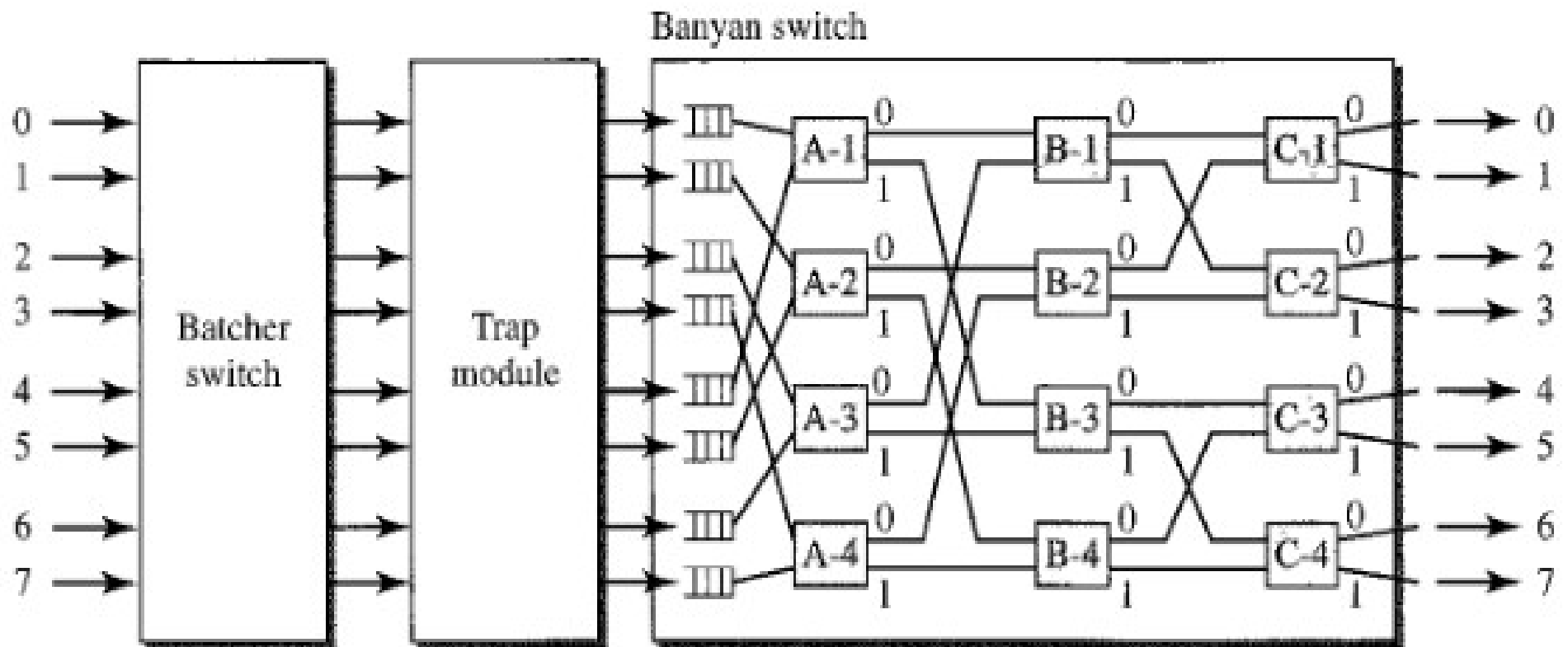
a. Input 1 sending a cell to output 6 (110)



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

Structure of Packet Switches

- Batcher-Banyan switch – sorts the arriving packets



Enjoy! :)