Physical Layer: Switching

Dr Samayveer Singh

Dept. of Computer Science and Engineering

National Institute of Technology

Jalandhar, Punjab, India

samays@nitj.ac.in

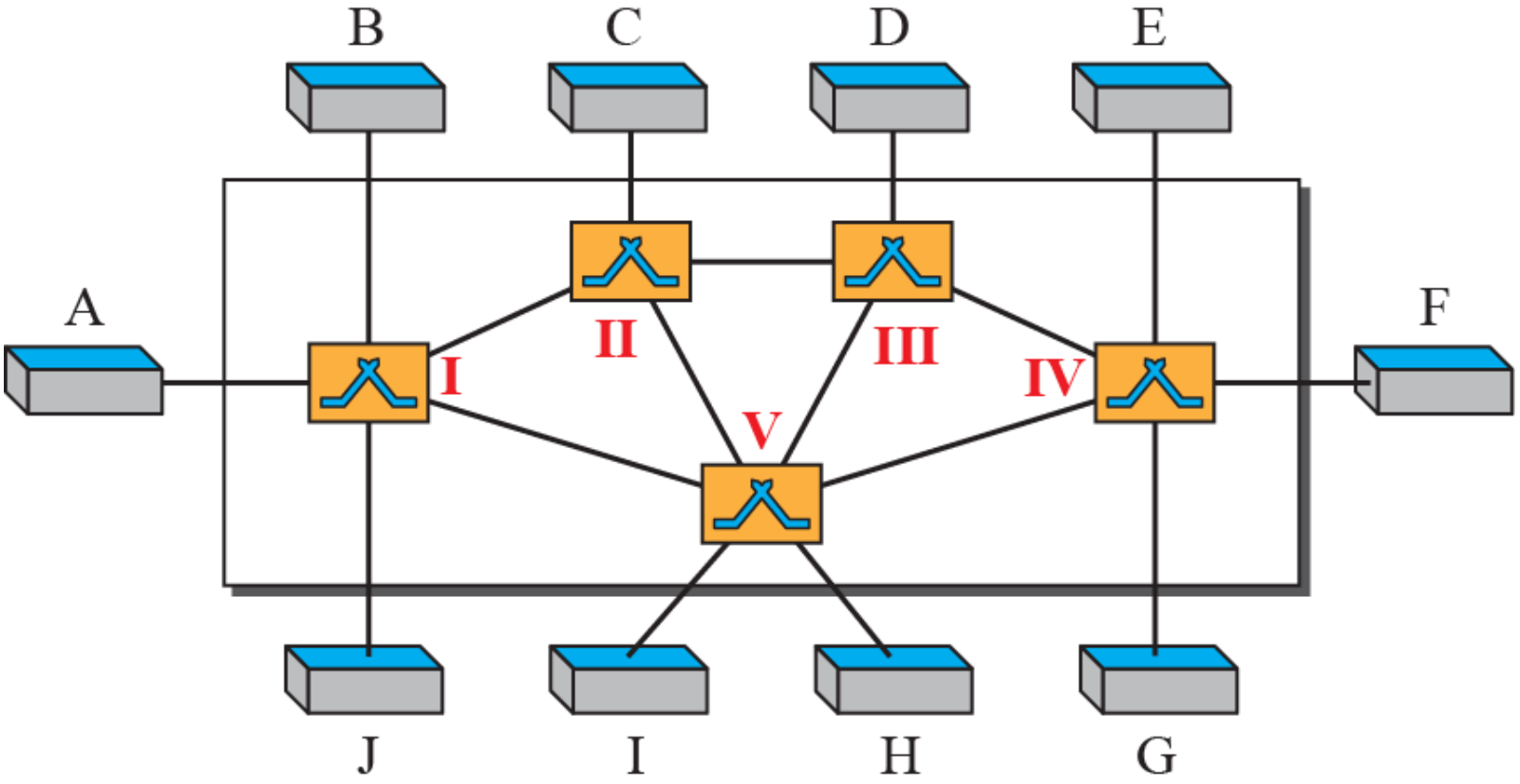
INTRODUCTION

- ***A network is a set of connected devices. Whenever we have multiple devices, we have the problem of how to connect them to make one-to-one communication possible.***

- ***The solution is switching.***

- ***A switched network consists of a series of interlinked nodes, called switches.***

Figure: ***Switched network***



Three Methods of Switching

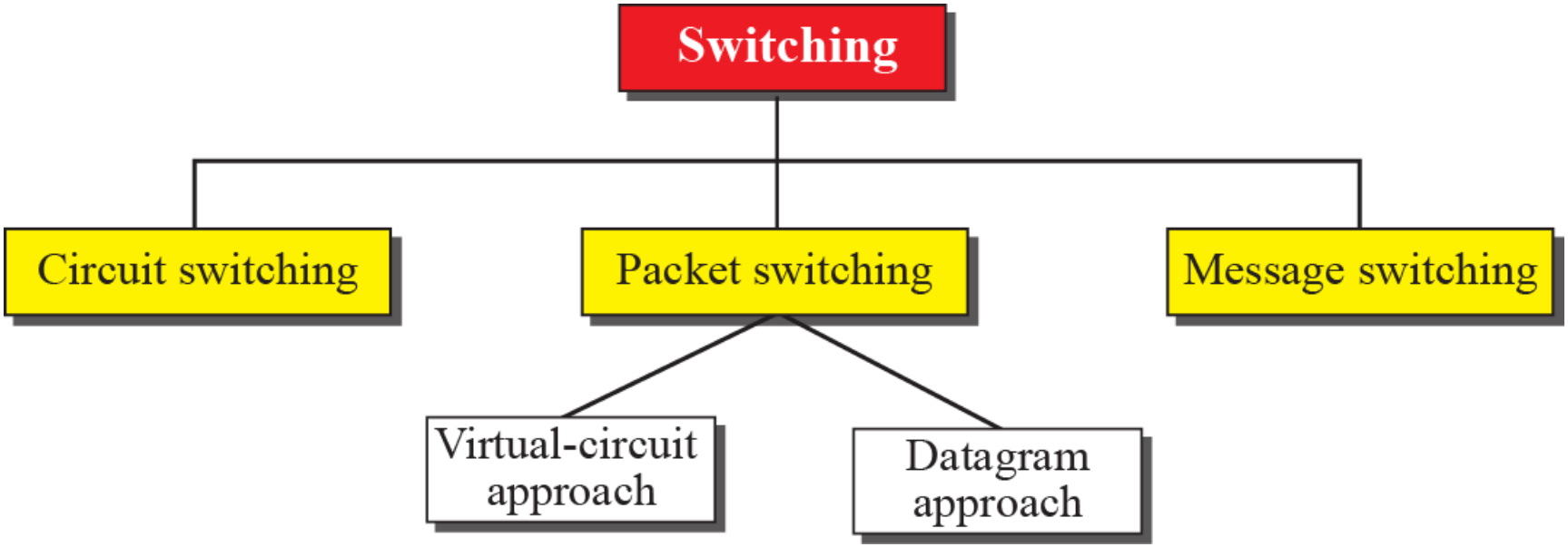
- ***Traditionally, three methods of switching have been discussed: circuit switching, packet switching, and message switching.***
- ***The first two are commonly used today.***
- ***The third has been phased out in general communications but still has applications.***
- ***Packet switching can further be divided into two subcategories, virtual-circuit approach and datagram approach.***

Switching and TCP/IP Layers

Switching can happen at several layers of the TCP/IP protocol suite:

- ***at the physical layer,***
- ***at the data-link layer, and***
- ***at the network layer***

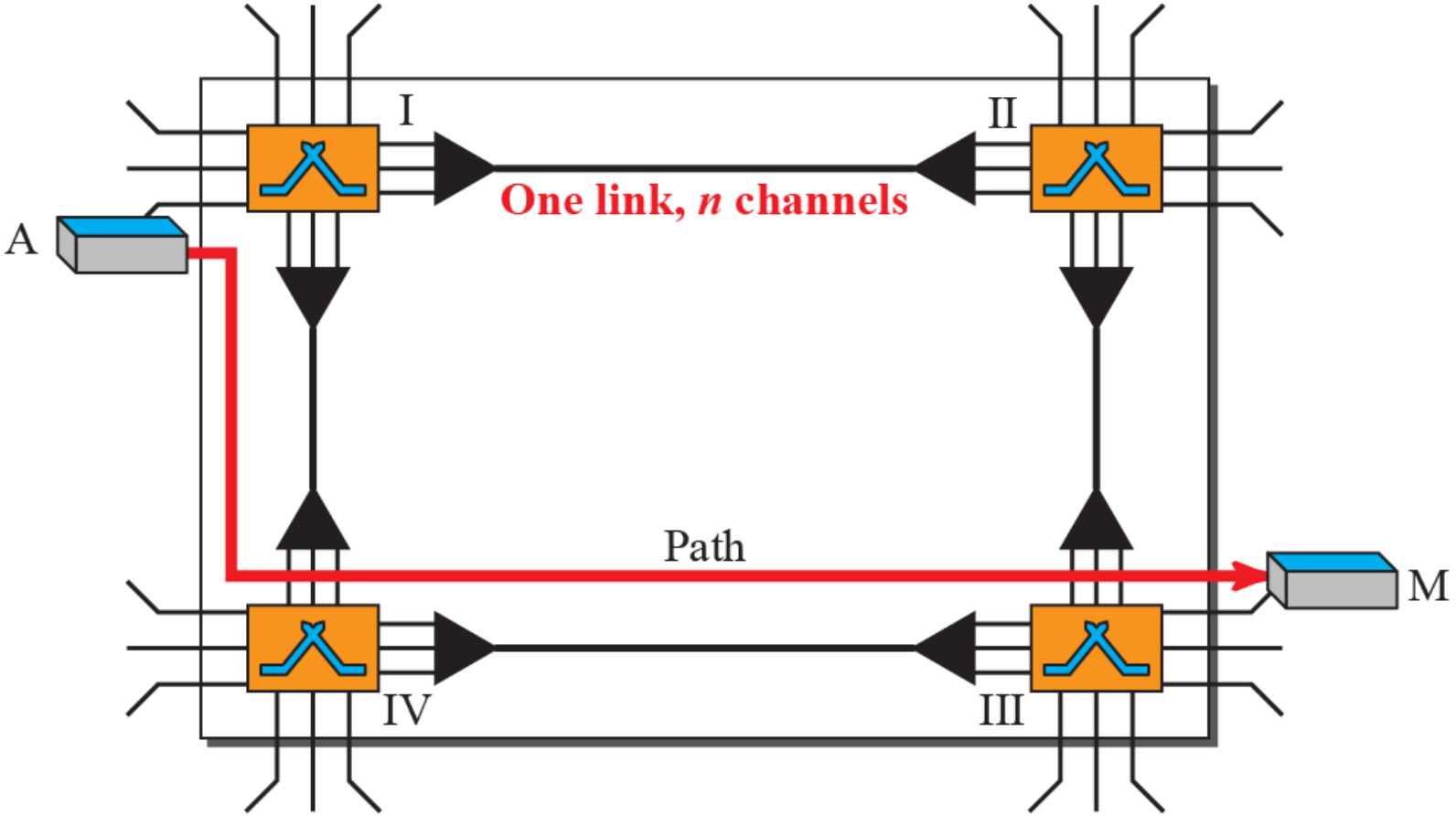
Figure: ***Taxonomy of switched networks***



CIRCUIT-SWITCHED NETWORKS

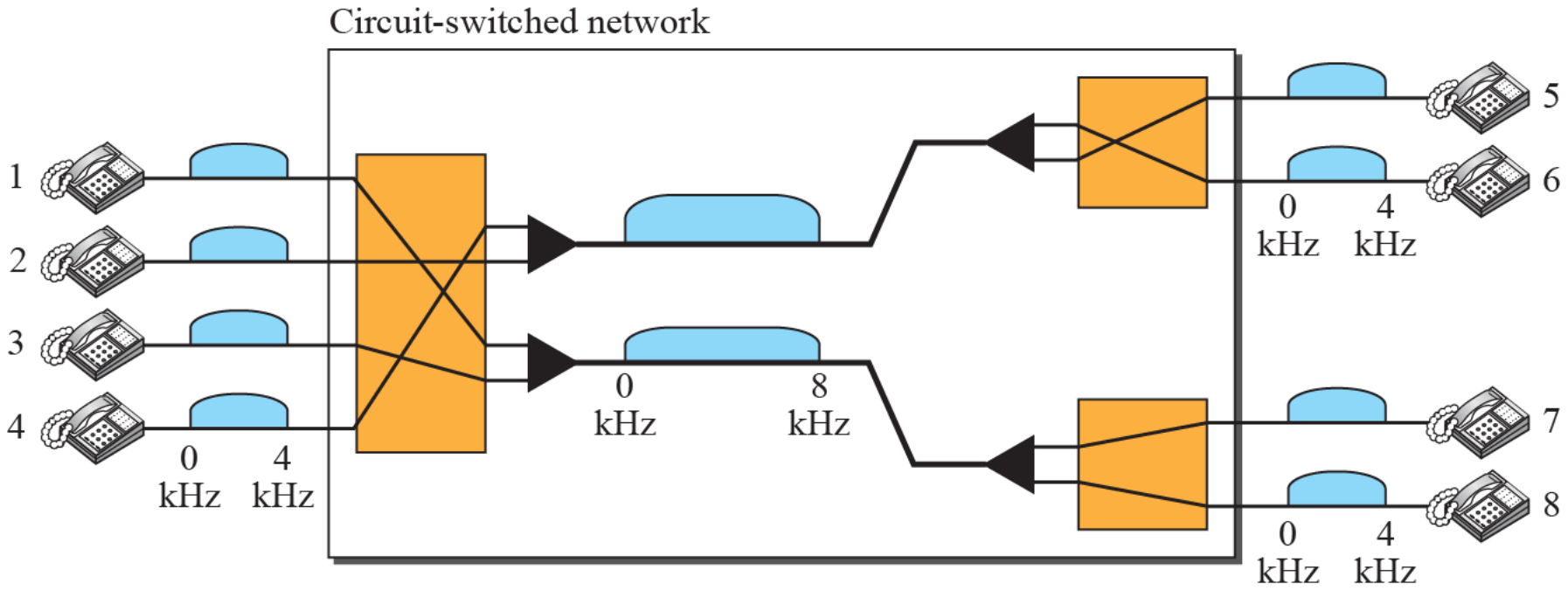
- *A circuit-switched network consists of a set of switches connected by physical links.*
- *A connection between two stations is a dedicated path made of one or more links.*
- *However, each connection uses only one dedicated channel on each link.*
- *Each link is normally divided into n channels by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

Figure: ***A trivial circuit-switched network***



Example 1

As a trivial example, let us use a circuit-switched network to connect eight telephones in a small area. Communication is through 4-kHz voice channels. We assume that each link uses FDM to connect a maximum of two voice channels. The bandwidth of each link is then 8 kHz. Figure shows the situation as Telephone 1 is connected to telephone 7; 2 to 5; 3 to 8; and 4 to 6. Of course situation may change when new connections are made. The switch controls the connections.



Three Phases

The actual communication in a circuit-switched network requires three phases:

- *Connection setup,*
- *Data transfer, and*
- *Connection teardown*

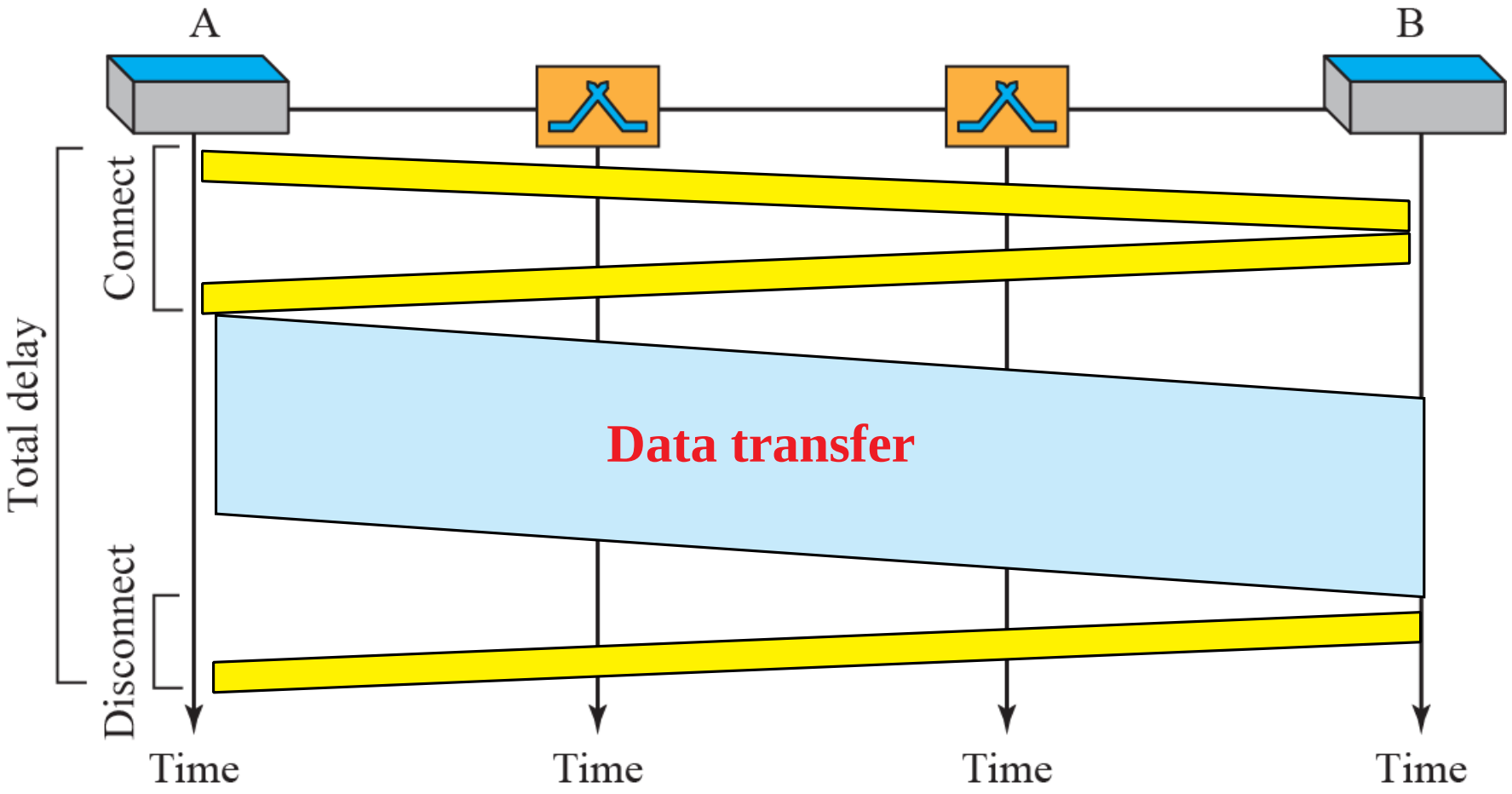
Efficiency

- *It can be argued that circuit-switched networks are not as efficient as the other two types of networks because resources are allocated during the entire duration of the connection.*
- *These resources are unavailable to other connections.*
- *In a telephone network, people normally terminate the communication when they have finished their conversation.*

Delay

- *Although a circuit-switched network normally has low efficiency, the delay in this type of network is minimal.*
- *During data transfer the data are not delayed at each switch; the resources are allocated for the duration of the connection.*
- *Next figure shows the idea of delay in a circuit-switched network when only two switches are involved.*

Figure: ***Delay in a circuit-switched network***



PACKET SWITCHING

- ***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.***

Datagram Networks

- *In a datagram network, each packet is treated independently of all others.*
- *Even if a packet is part of a multipacket transmission, the network treats it as though it existed alone.*
- *Packets in this approach are referred to as datagrams.*

Figure : ***A Datagram network with four switches (routers)***

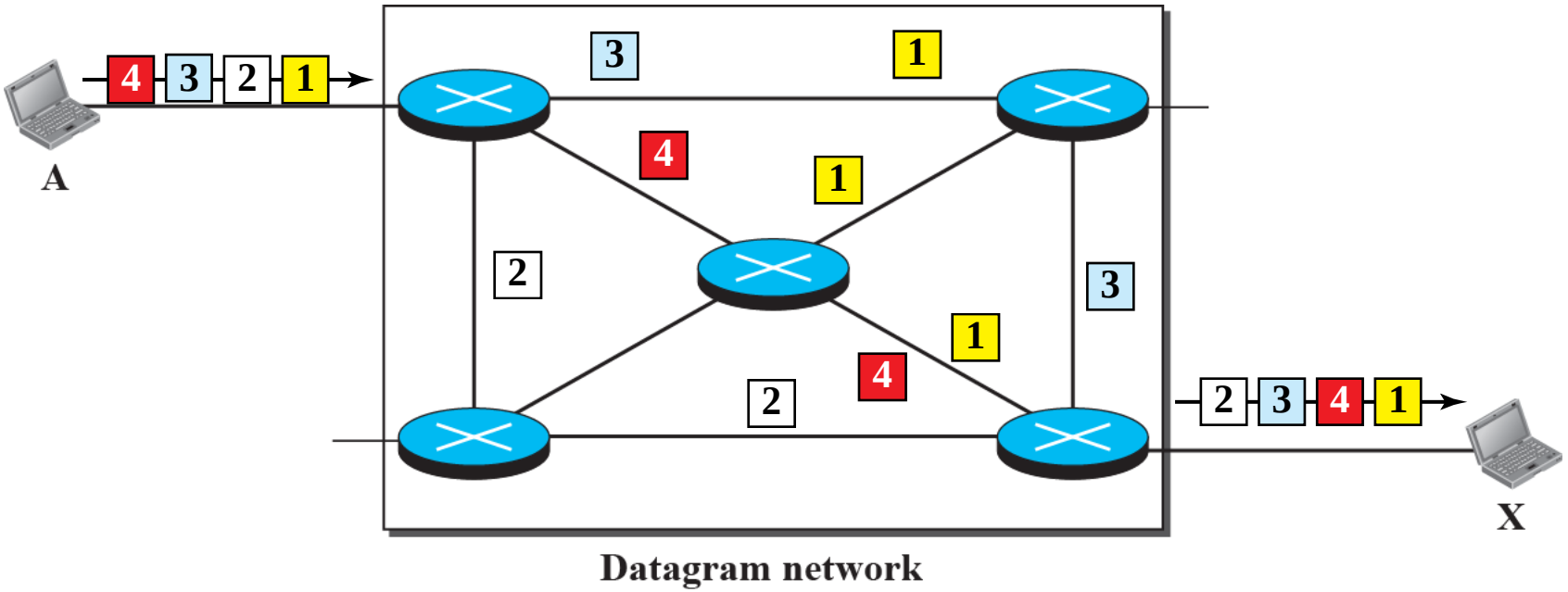


Figure: ***Routing table in a datagram network***

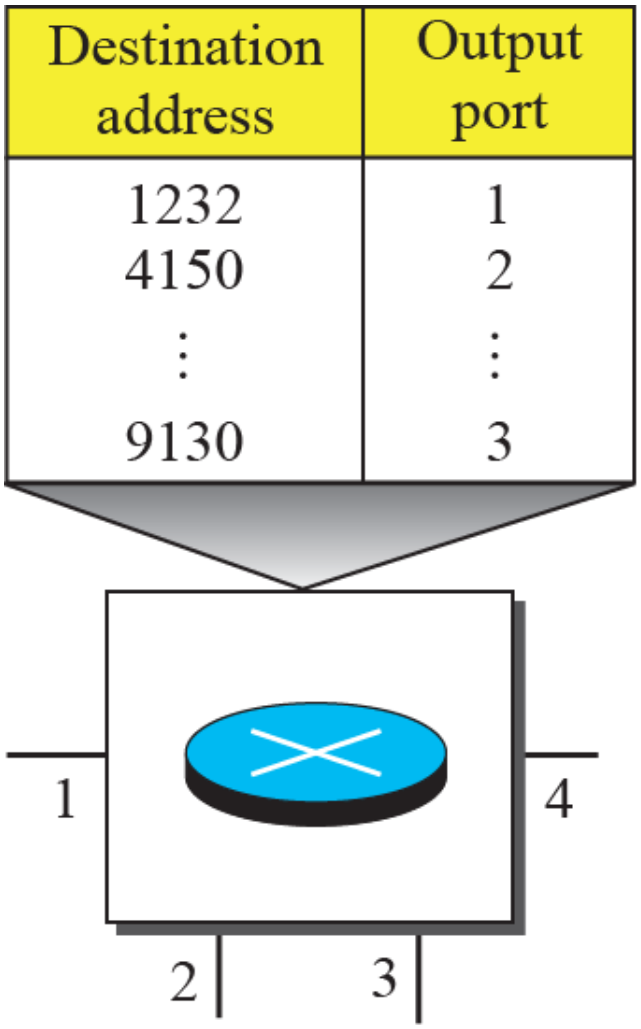
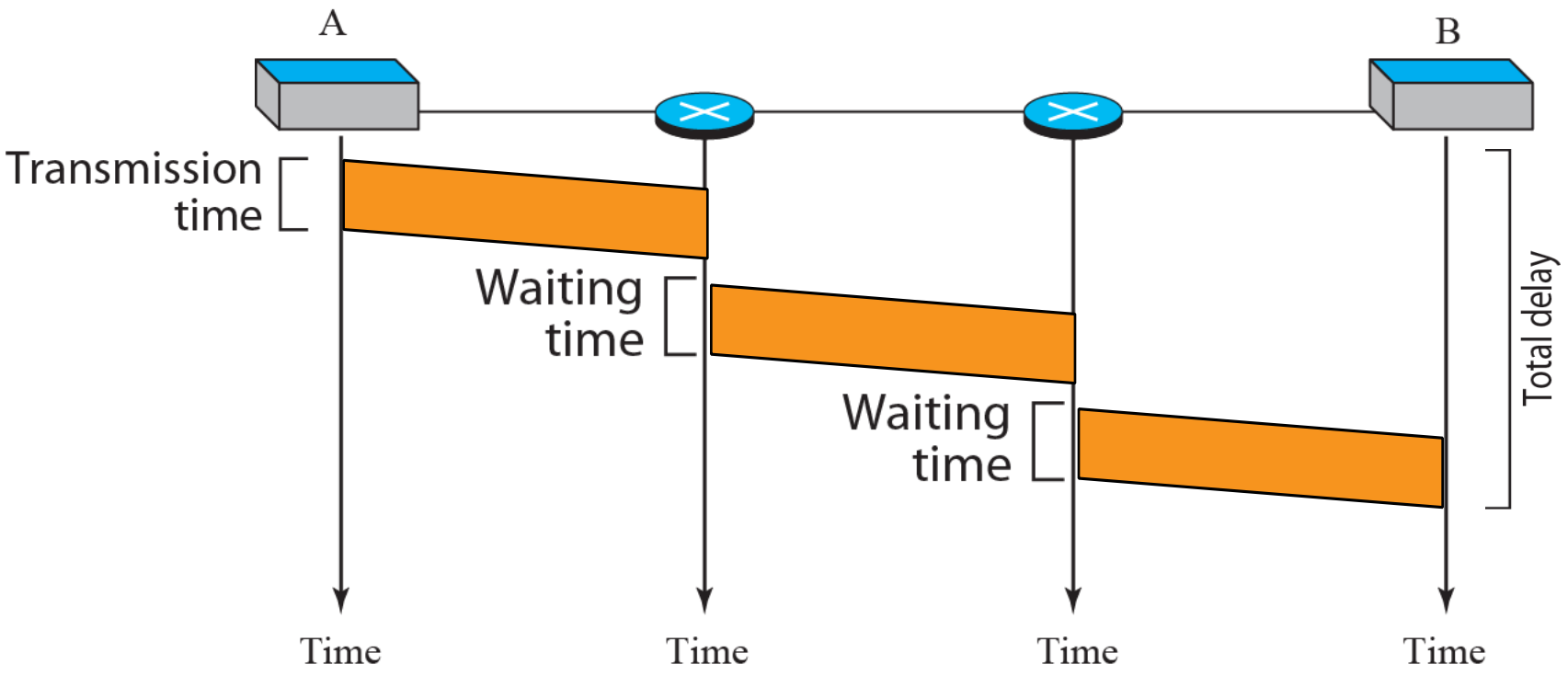


Figure: ***Delays in a datagram network***



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.***

Figure: ***Virtual-circuit network***

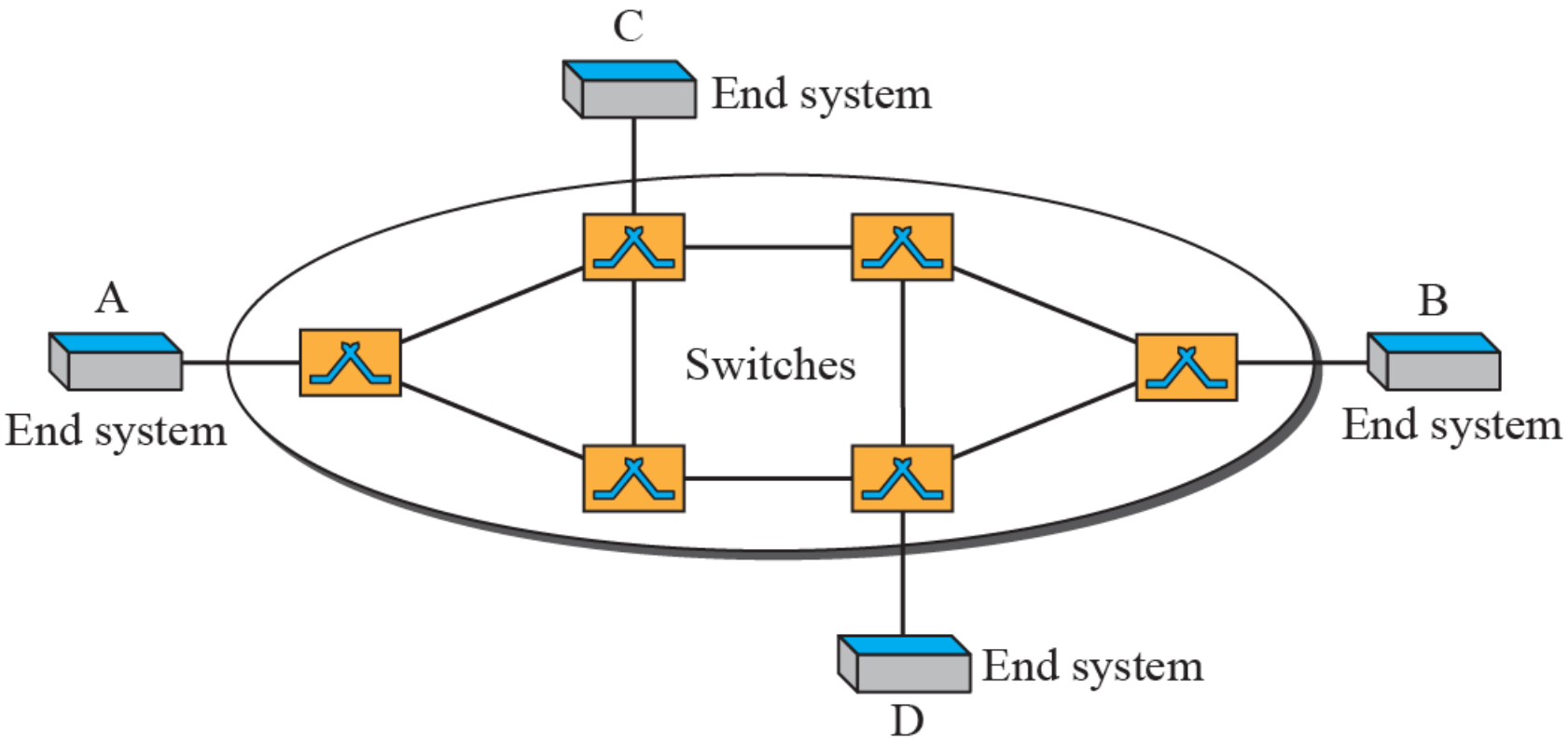


Figure : ***Virtual-circuit identifier***

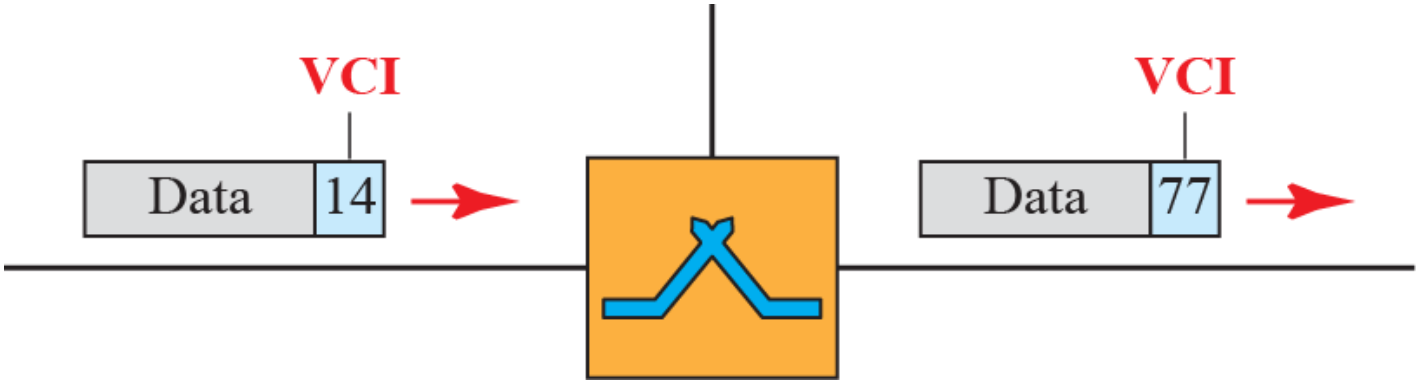


Figure: ***Switch and table for a virtual-circuit network***

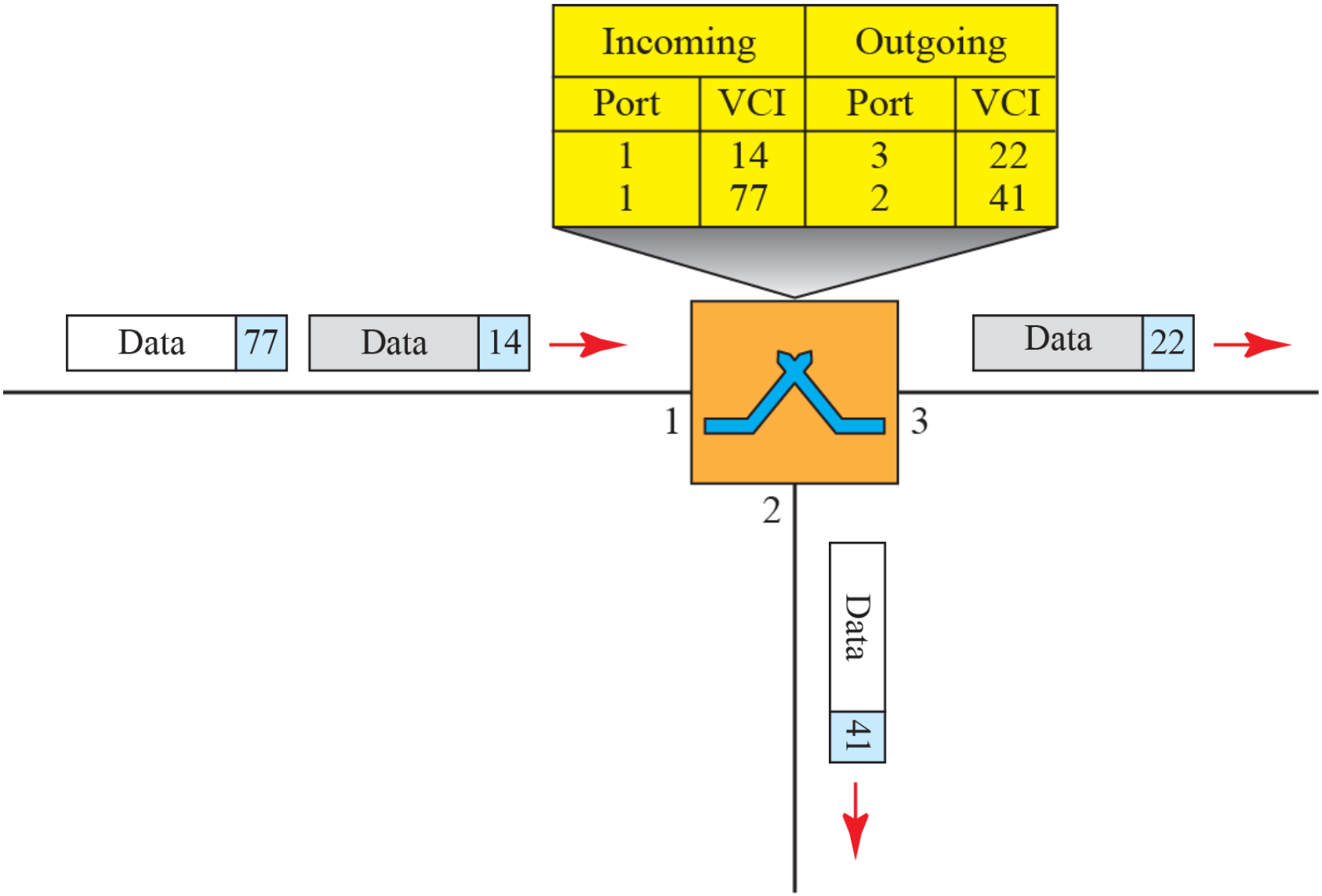


Figure: ***Source-to-destination data transfer in a circuit-switch network***

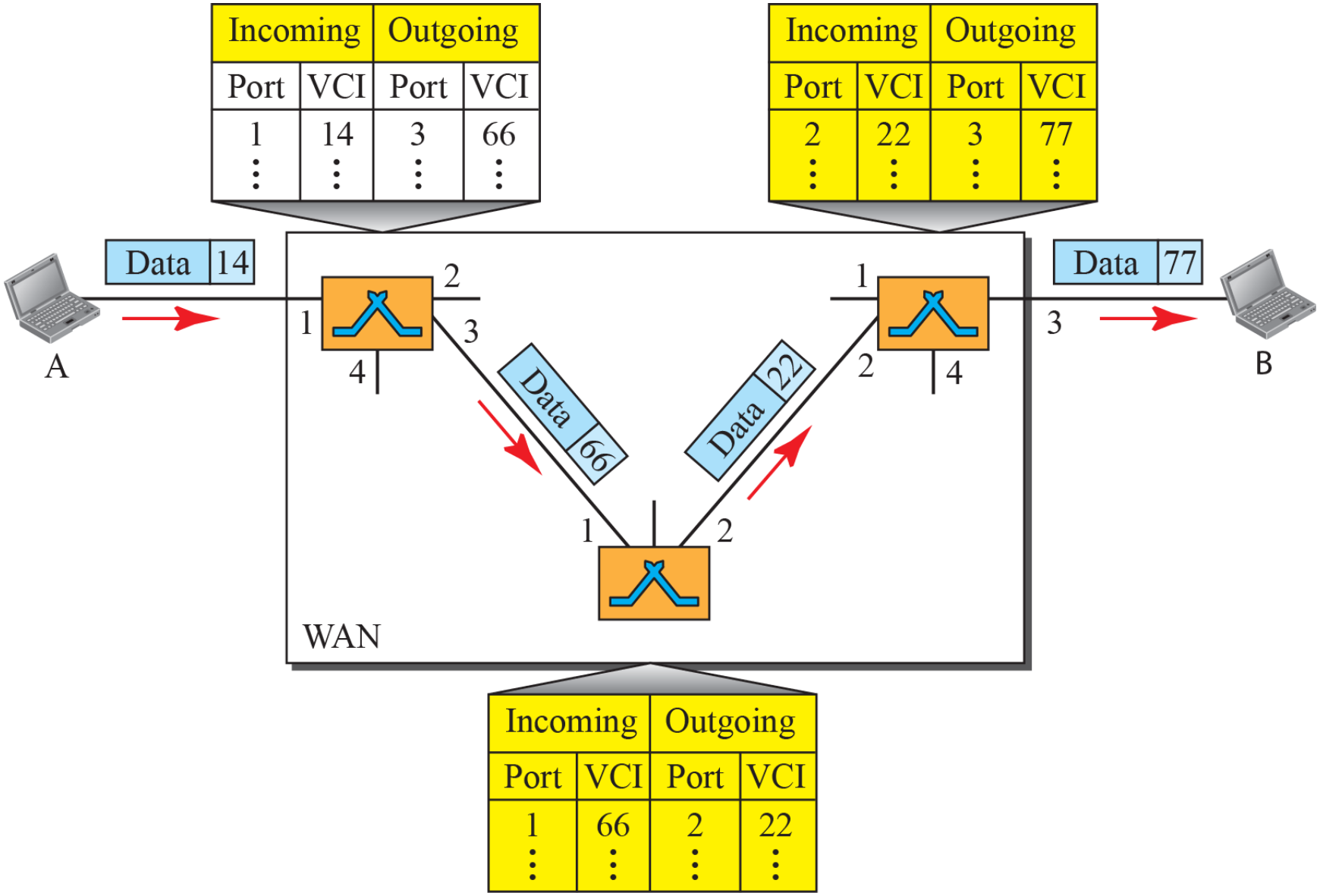


Figure: ***Setup request in a virtual-circuit network***

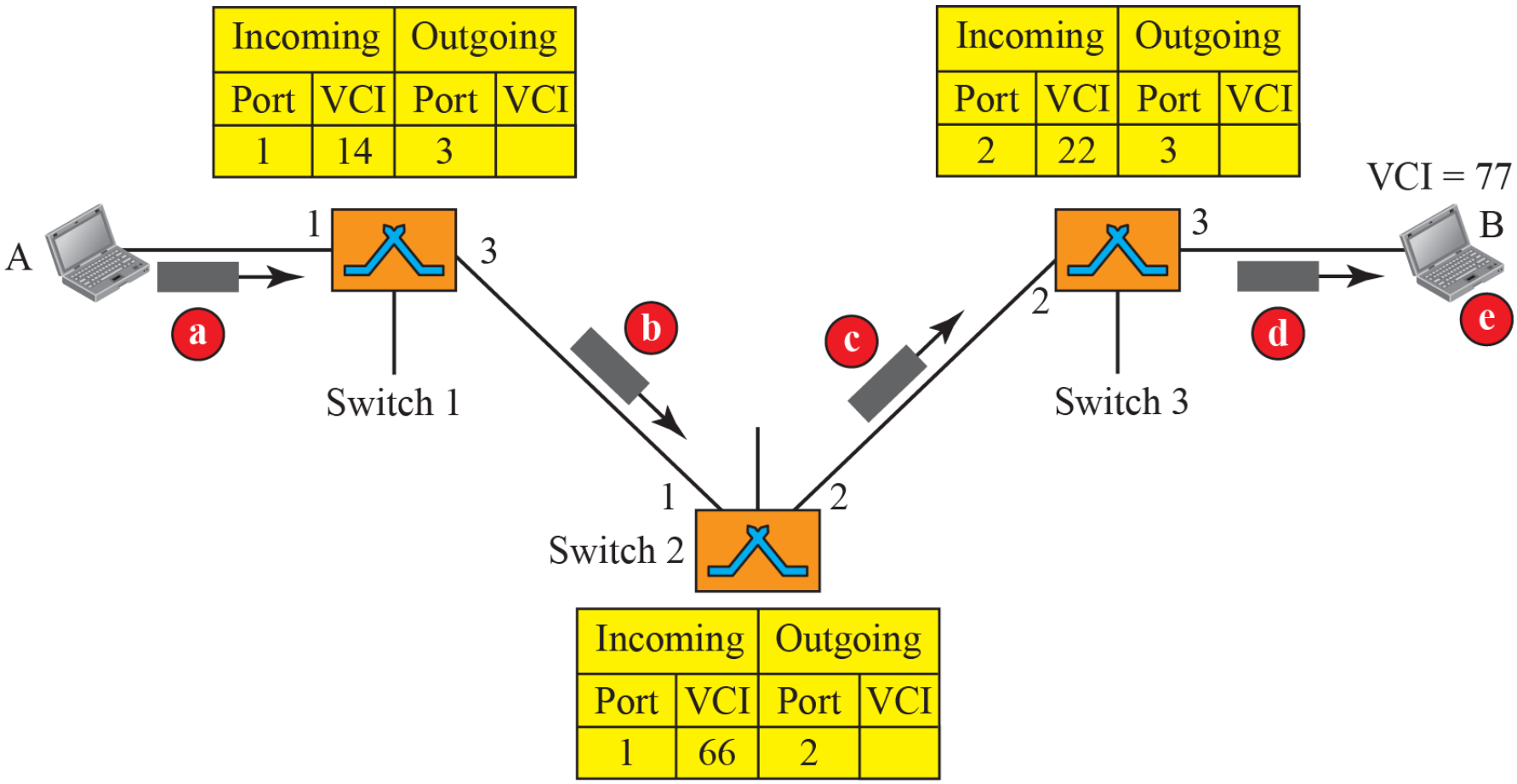


Figure: ***Setup acknowledgment in a virtual-circuit network***

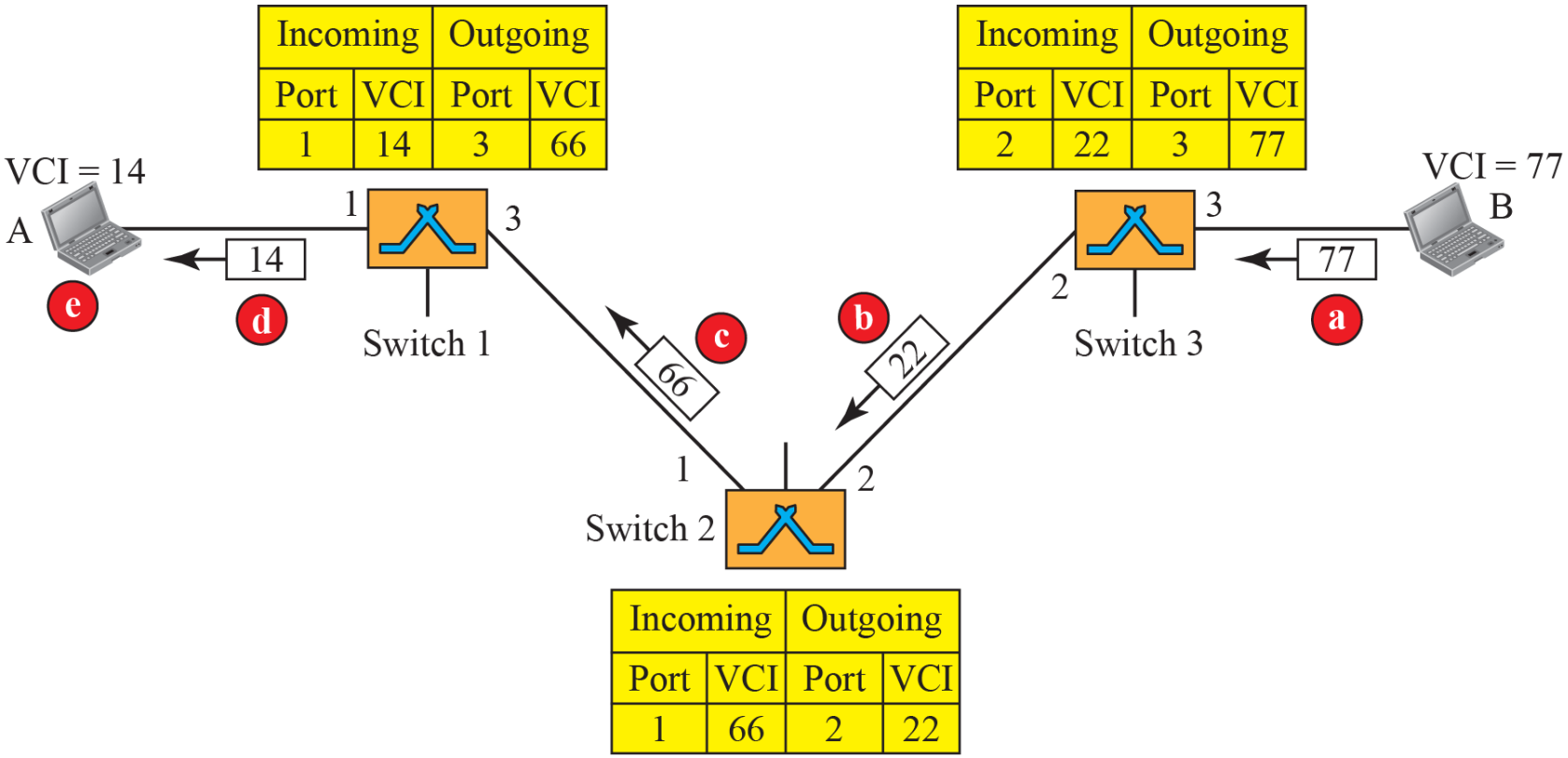


Figure: ***Delay in a virtual-circuit network***

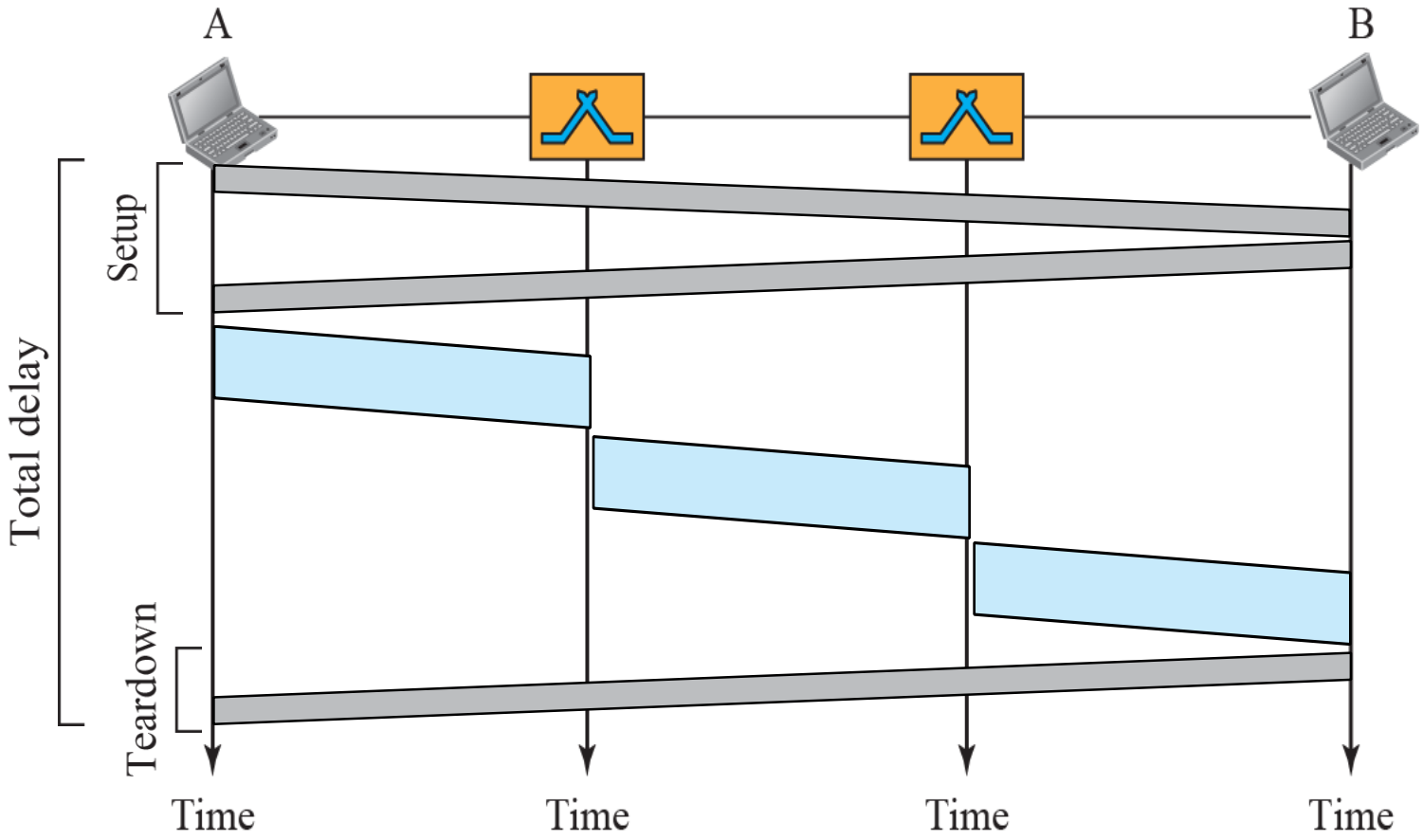


Figure: Message Switching

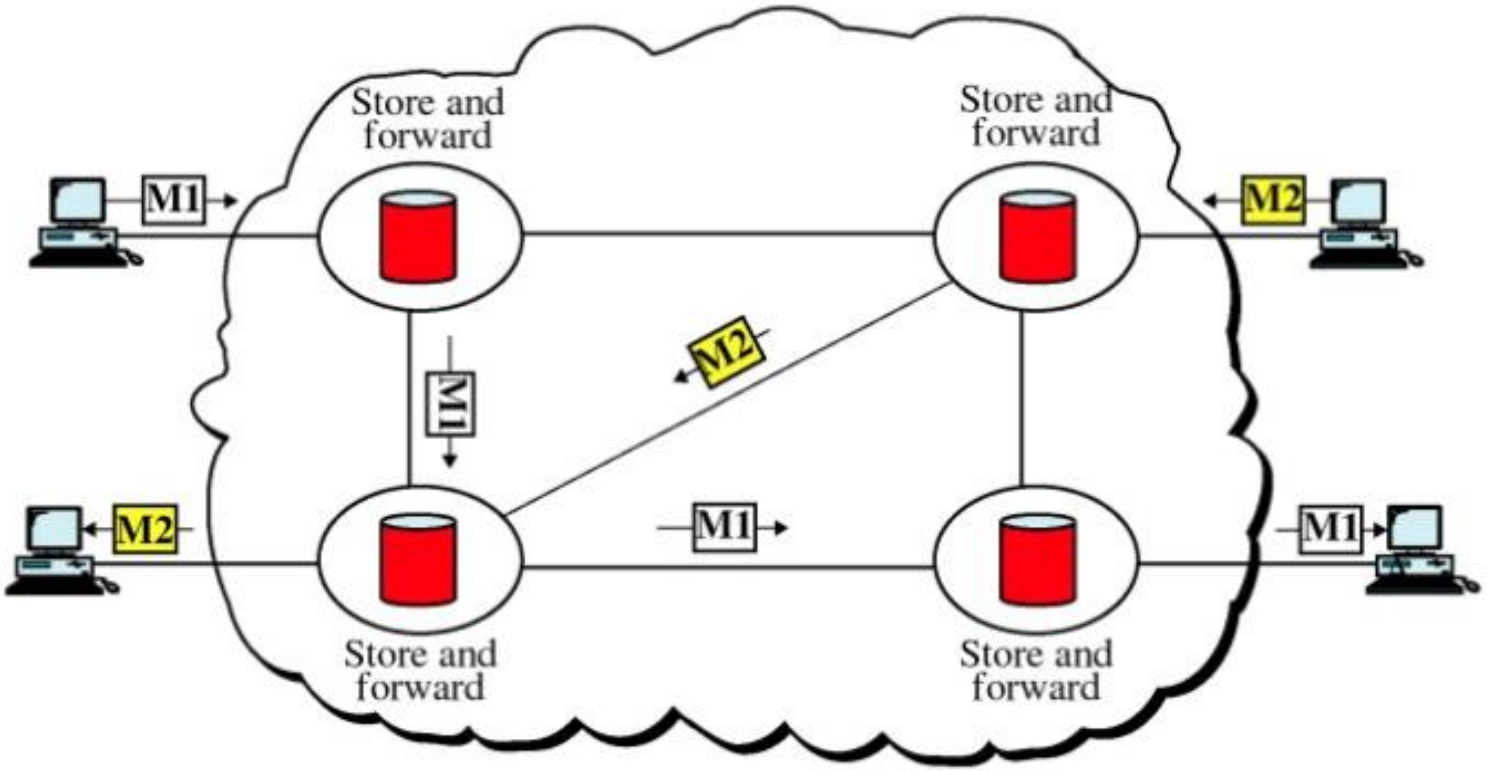


Figure: Message Switching