# CSE 311: Computer Networks

Lecture 4: Switching

Switching

- Switching is computer network helps in deciding the best route for data transmission if there are multiple paths in a larger network.
- A switched network consists of a series of interlinked nodes, called *switches*.
- Switches are devices capable of creating temporary connections between two or more devices linked to the switch.
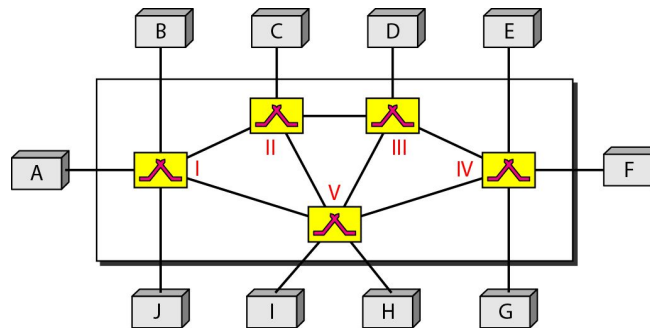
Taxonomy of Switched Networks
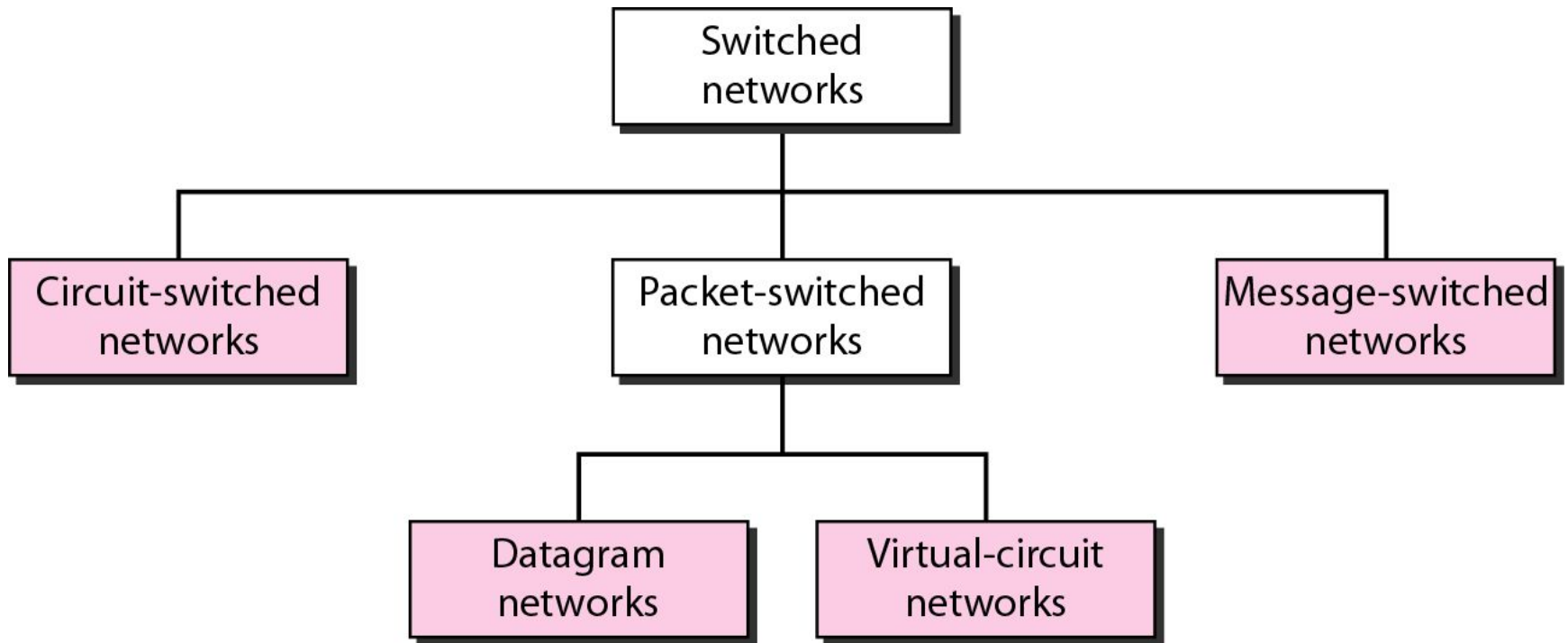
Switching and TCP/IP Layers

- Switching at Physical layers:
  - Circuit switching.
- Switching at Data-link layers:
  - Packet switching (Virtual-circuit approach)
- Switching at Network layers:
  - Packet switching (Virtual-circuit approach or Datagram approach)
- Switching at Application layers:
 - Message switching

Circuit-Switched Network

- A circuit-switched network is made of a set of switches connected by physical links, in which each link is divided into n channels by using FDM or TDM.

- A connection between two stations is a dedicated path made of one or more links.

- Before starting communication, the station make a reservation for the resources.

- Telephone network uses circuit-switched network.

Circuit-Switched Network
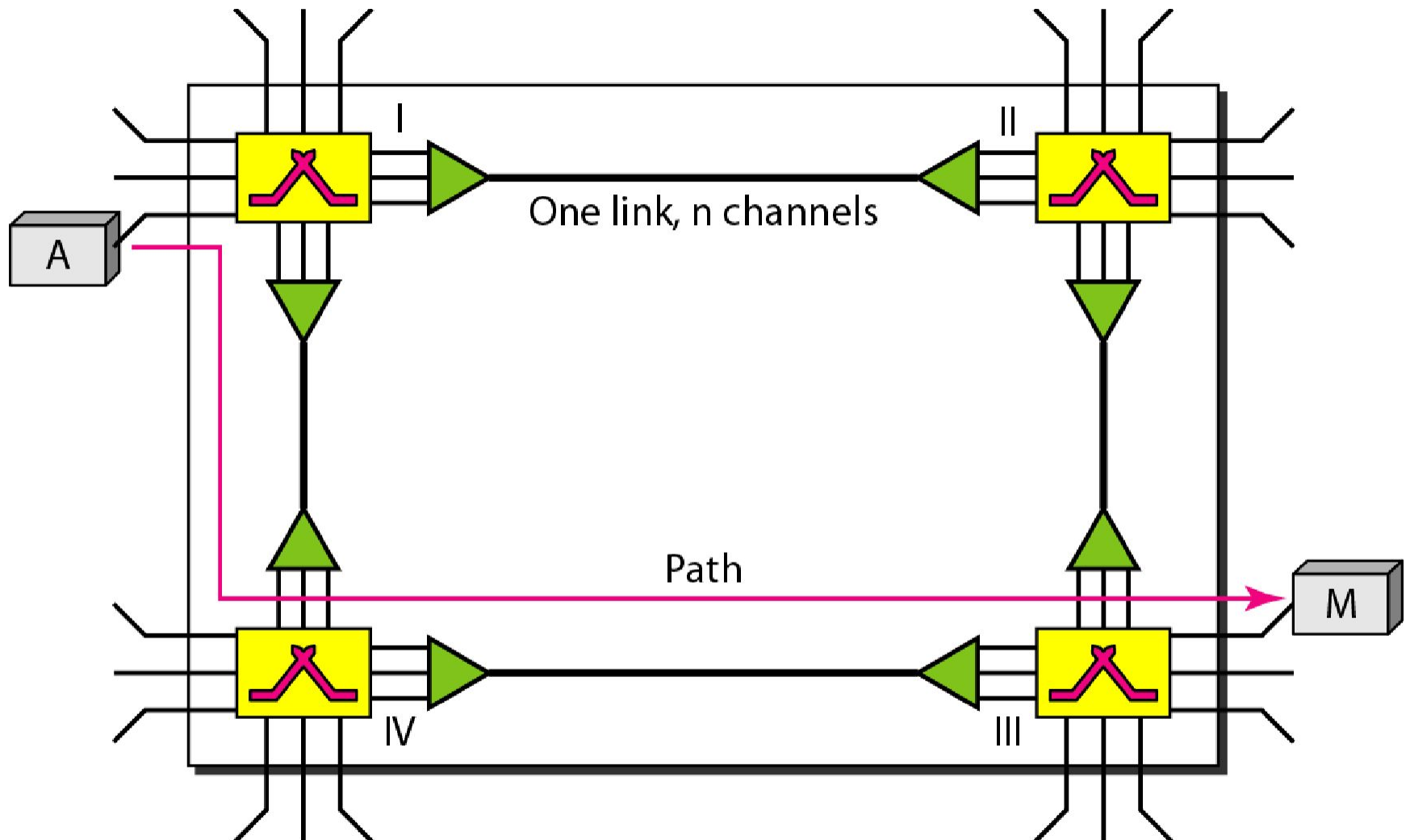
Three Phases

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

- *Setup Phase:* Before the two parties can communicate, a dedicated circuit needs to be established.
  - A sends a setup request to M
  - M sends an acknowledgement

- *Data Transfer Phase:* After the establishment of the dedicated circuits, the two parties can transfer data.

- *Teardown Phase:* When one of the parties needs to disconnect, a signal is sent to each switch to release the resources.
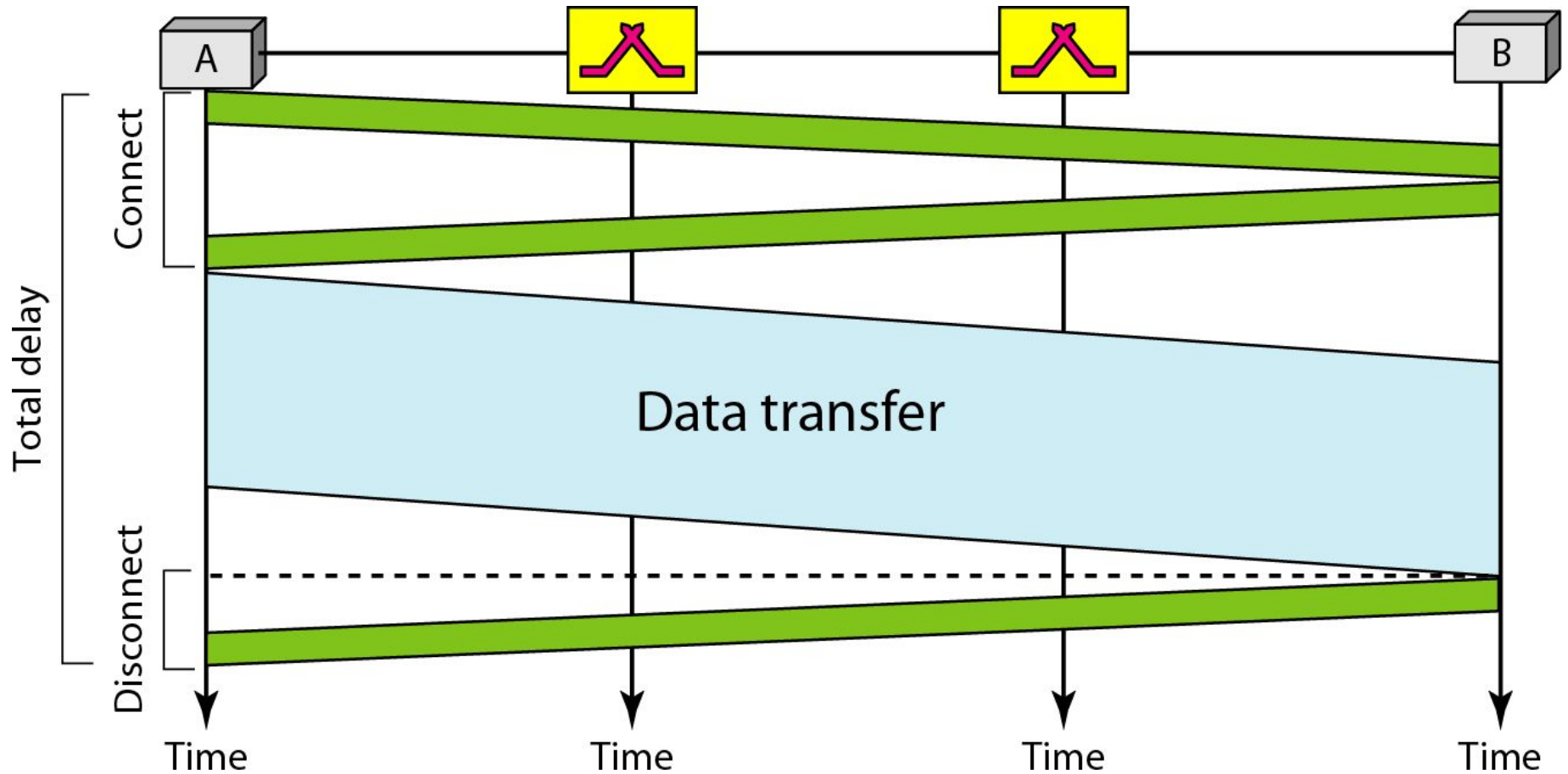
Important points

- Switching take place at physical layer
- Reservation for the resources
  - Such as bandwidth in FDM and time slot in TDM
  - Switch buffer
  - Switch processing time
  - Switch I/O ports
- Data transferred are not packetized, continuous flow
- No addressing involved during data transfer

# Delay in a Circuit-switched Network

Packet Switching

- In a *packet-switched network*, the message needs to be divided into packets of fixed or variable size.

- There is no resource reservation; resources are allocated on demand.

- The allocation is done on a first-come, first-served basis.

- When a switch receives a packet, the packet must wait if there are other packets being processed.

- Two types: *Datagram networks* and *Virtual-circuit networks*.

Datagram Network

- Packets are referred to as *datagrams*.
- Done at *network layers.*
- The switches are referred to as *routers*.
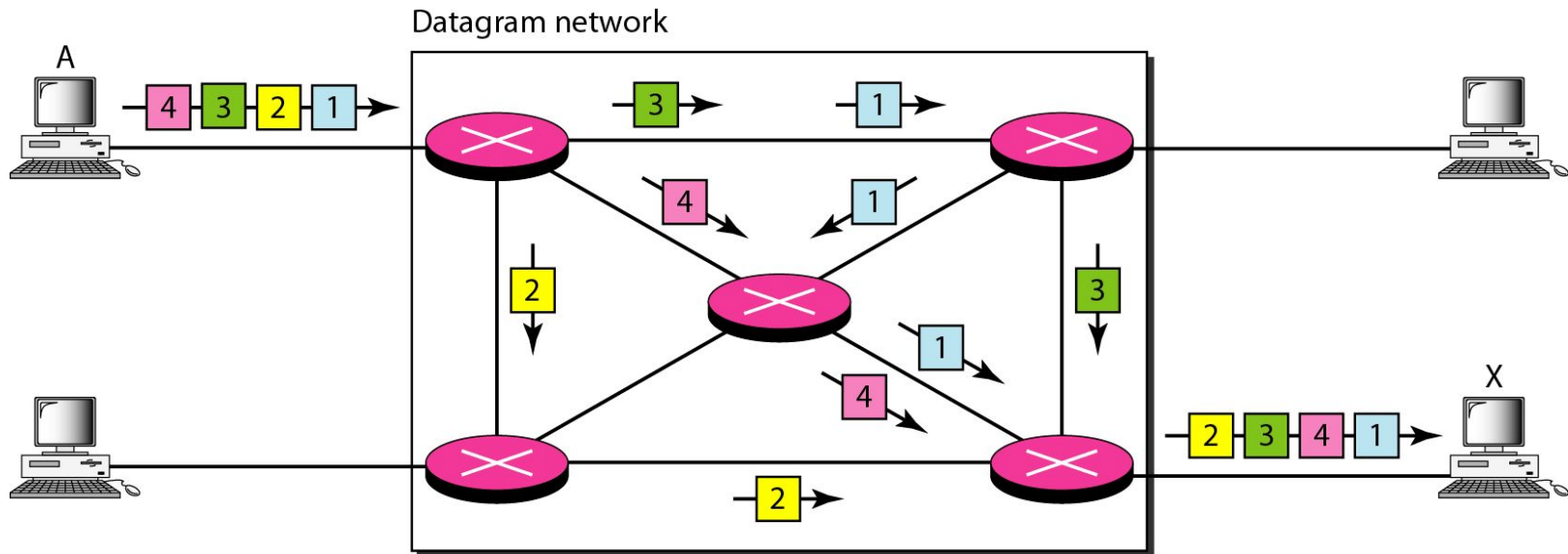
Datagram network

Datagram Network

- Datagram networks are sometimes referred to as *Connectionless Networks*.
- There are no setup or teardown phases.
- *Routing Table:*
  - Each switch (or packet switch/router) has a routing table based on the destination address.
  - The routing tables are dynamic and are updated periodically.
- *Destination Address:* The destination address in the header of a packet in a datagram network remains the same during the entire journey of the packet.

| Destination address	Output port
1232	1
4150	2
⋮	⋮
9130	3
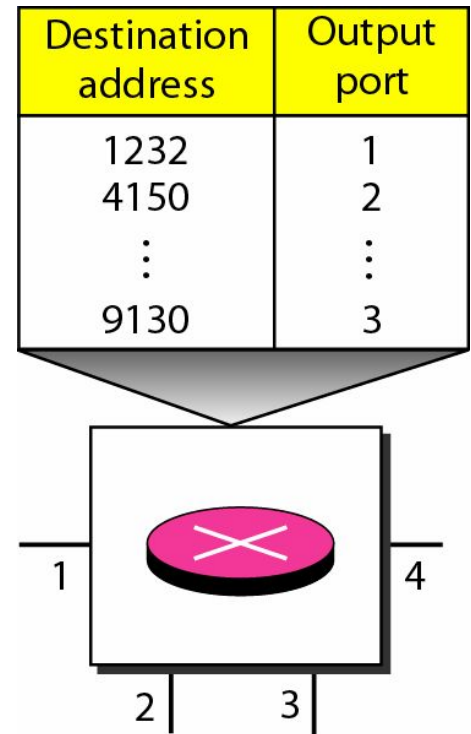
Datagram Network

- *The efficiency is better* than a circuit switched network as resources are allocated on demand.

- May have *a greater delay* than circuit switched networks.

- Although there are *no setup and teardown phases*, each packet may experience *a wait* at a switch before it is forwarded.

Delay in a Datagram Network
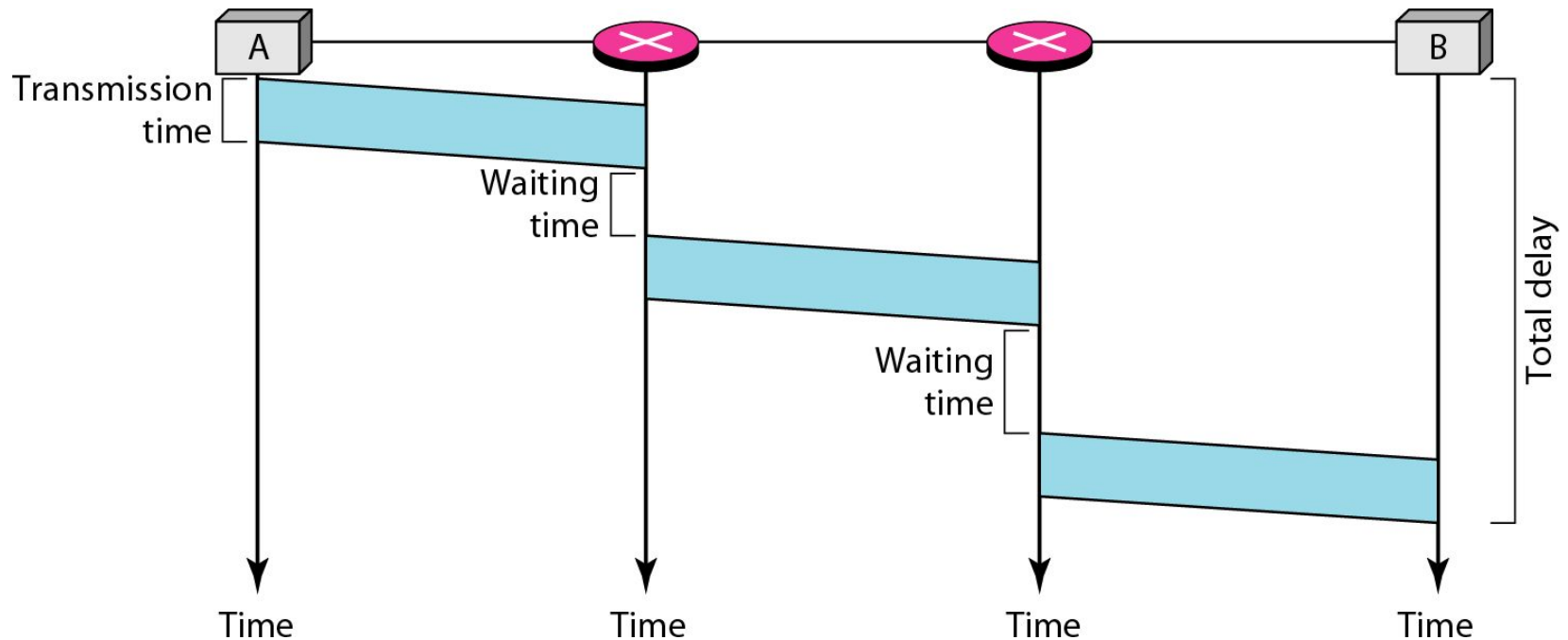
Total delay = Three transmission times + three propagation delays + two waiting times

$$= 3T + 3\tau + w_1 + w_2$$

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:

  1. It has three phases (circuit-switched)

  2. Resources can be allocated during the setup phase (circuit- switched) or on demand (datagram)

  3. Data are packetized and each packet carries an address in the header (datagram), but follows local jurisdiction

  4. All packets follow the same path established during the connection (circuit-switched)

  5. Implemented in the data link layer.
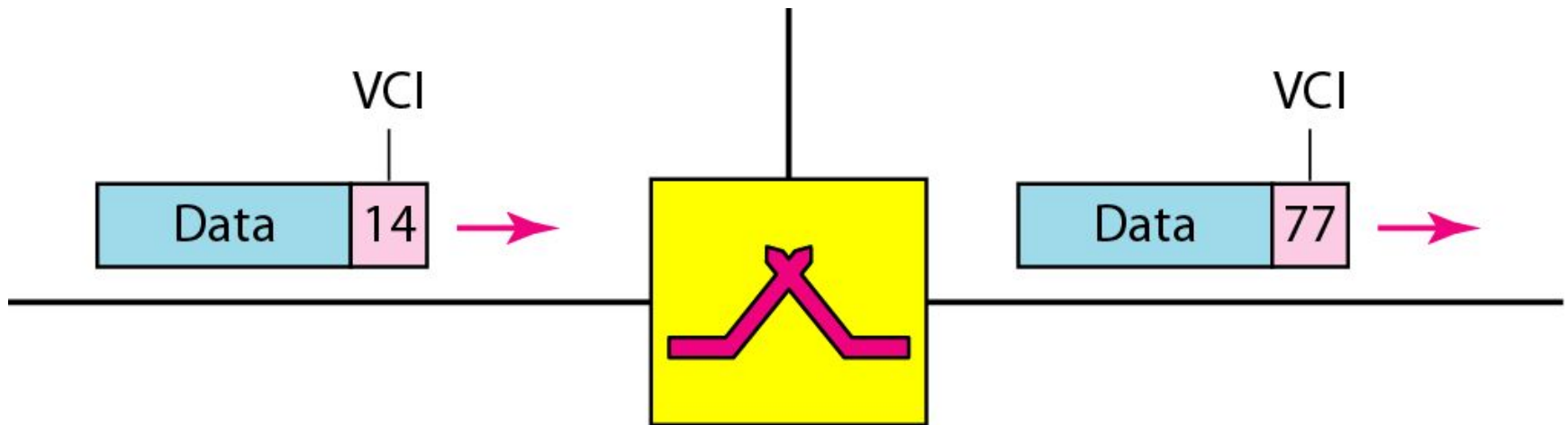
Virtual-Circuit Networks
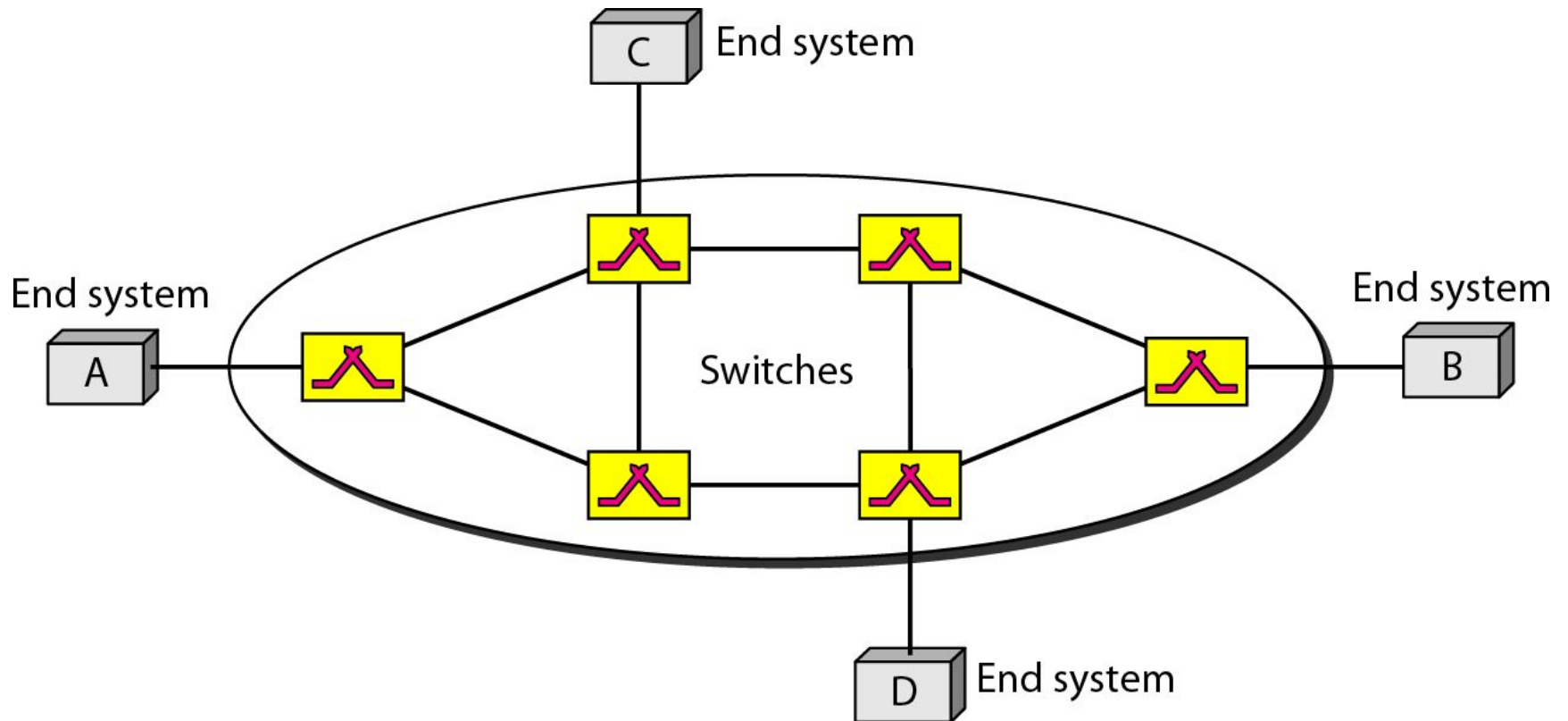
Addressing

- In a virtual-circuit network, two types of addressing are involved: *Global* and *Local* (virtual-circuit identifier).

- Global Addressing: an address that can be unique in the scope of the network or internationally if the network is part of an international network.

- Virtual-Circuit Identifier:

  - The identifier that is actually used for data transfer is called the virtual-circuit identifier (VCI).

  - A VCI, unlike a global address, is a small number that has only switch scope.

  - It is used by a frame between two switches. When a frame arrives at a switch, it has a VCI; when it leaves, it <u>has a different VCI</u>.

Virtual-Circuit Identifier

Three Phases

- In a virtual-circuit network, a source and destination need to go through three phases:
    - Setup Phase
    - Data Transfer Phase
    - Teardown Phase

- Setup Phase: Two steps are required-
    1) Setup Request: A setup request frame is sent from the source to the destinations
    2) Acknowledgement: A special frame, acknowledgement frame completes the entries in the switching table

- Data Transfer Phase: Once Setup phase completes, data transfer phase becomes straightforward.

- Teardown Phase: After sendingall frames, a special frame is send to end the connection

Setup Request in a Virtual-Circuit Network

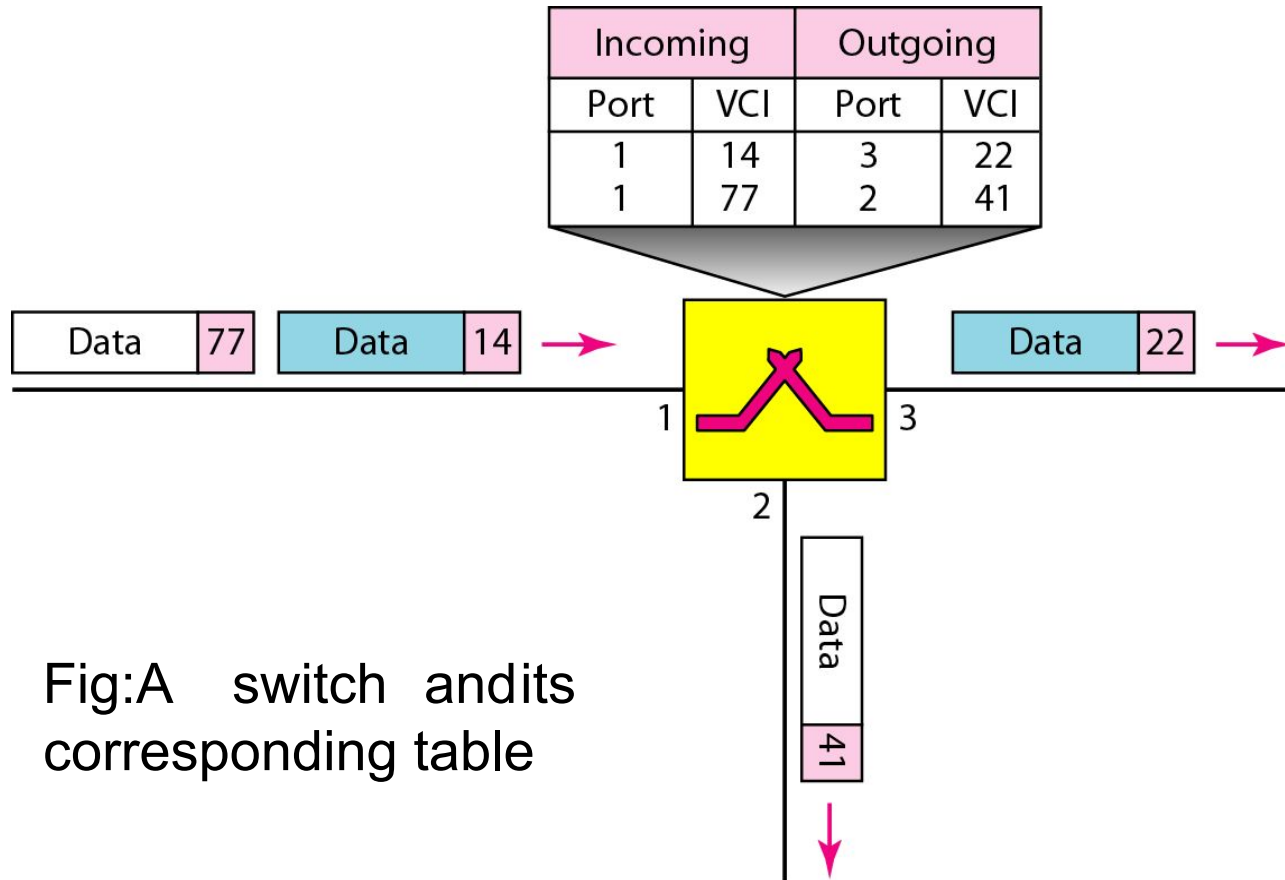**Setup Request:** A setup request frame is sent from the source to the destinations
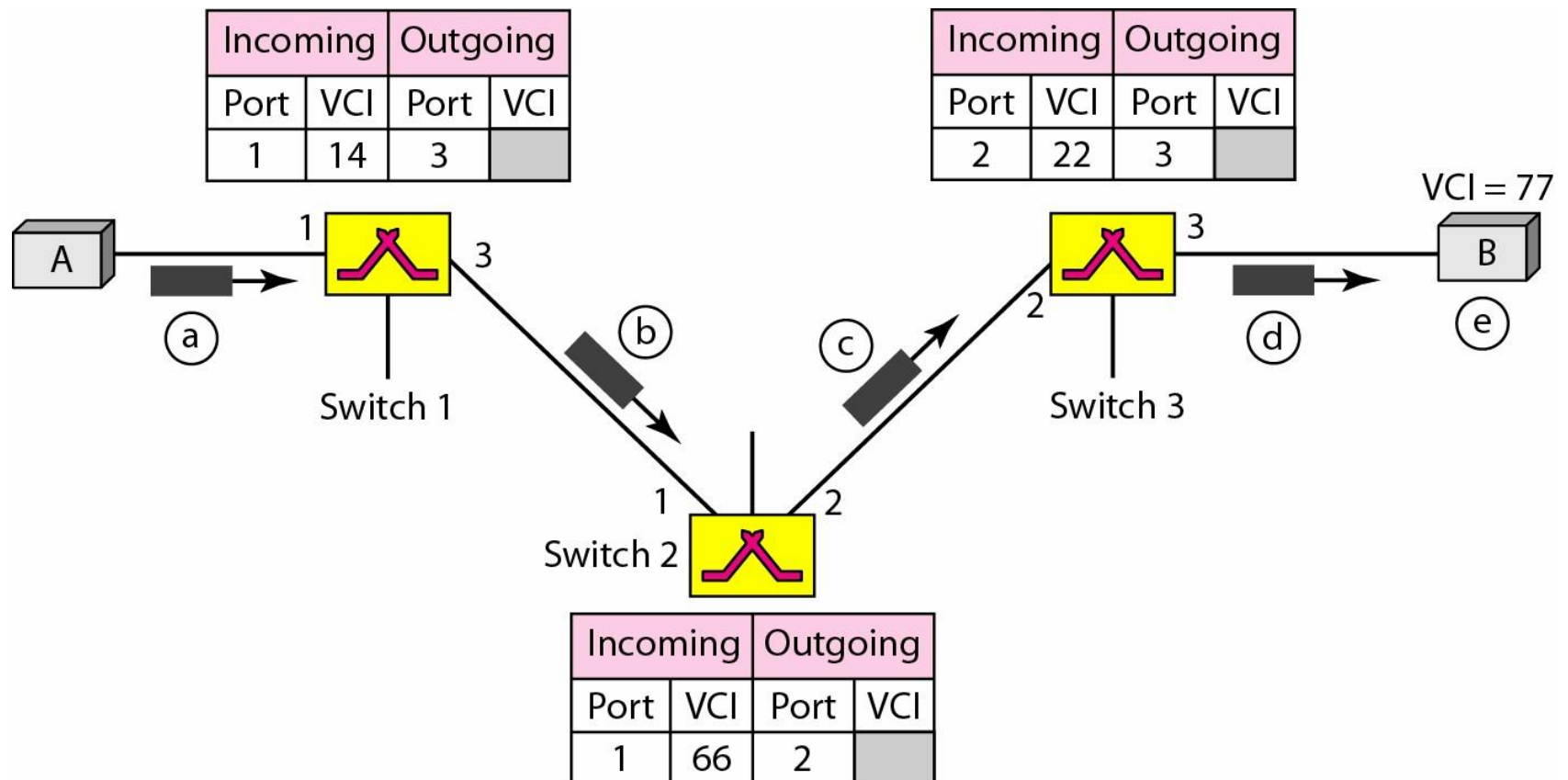
Setup Acknowledgement in a Virtual-Circuit Network

Acknowledgement: A special frame, acknowledgement frame, completes the entries in the switching table
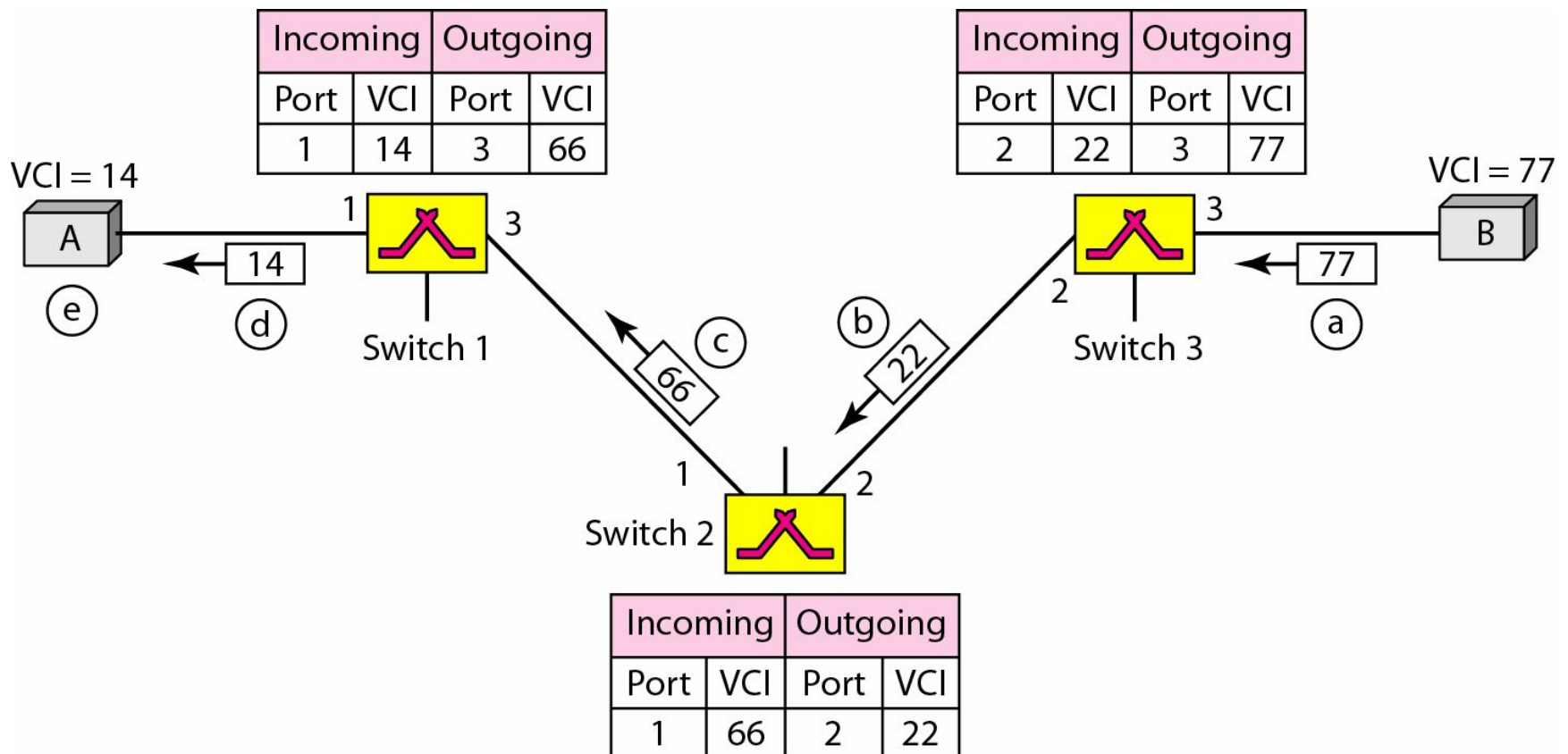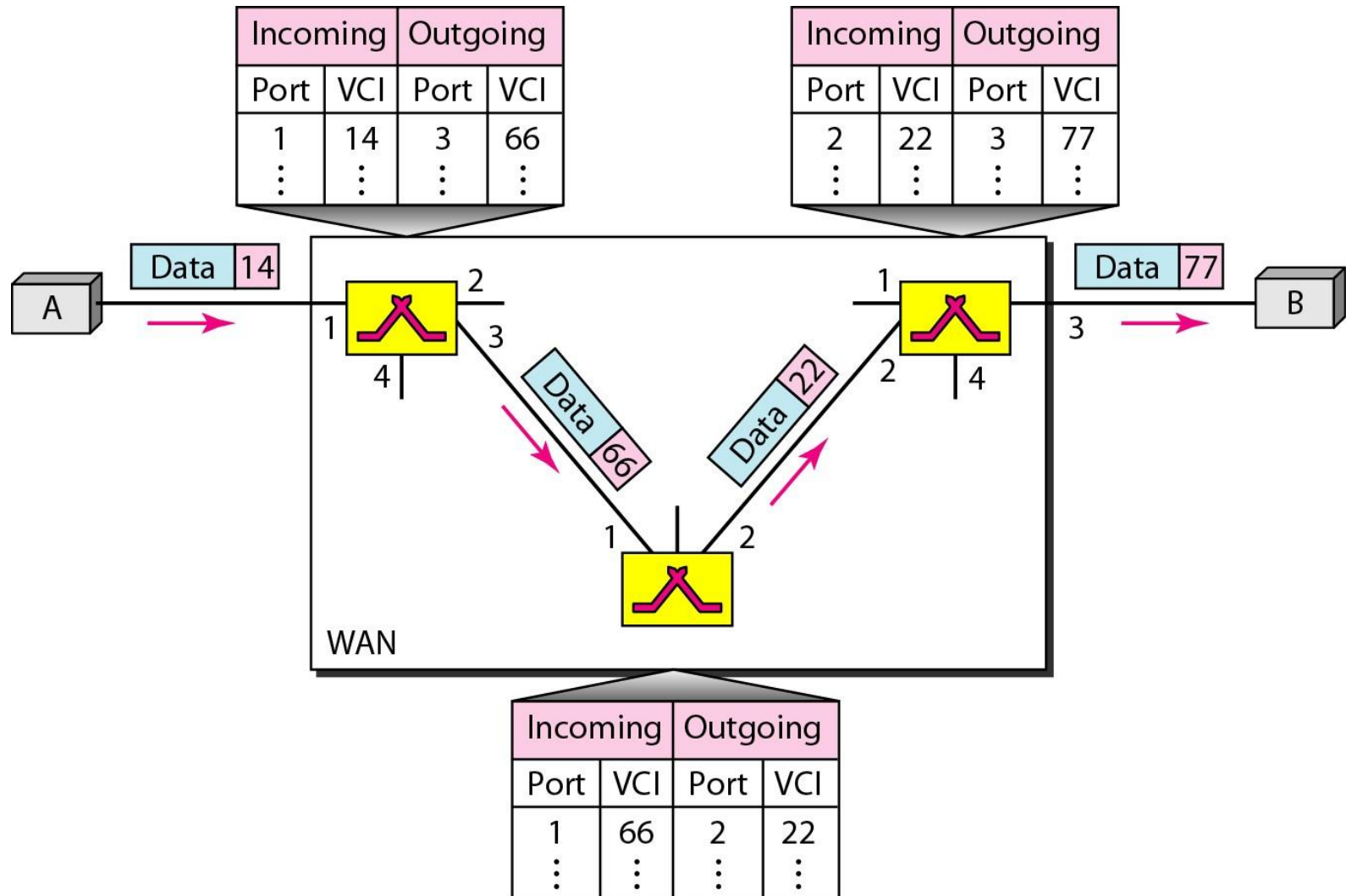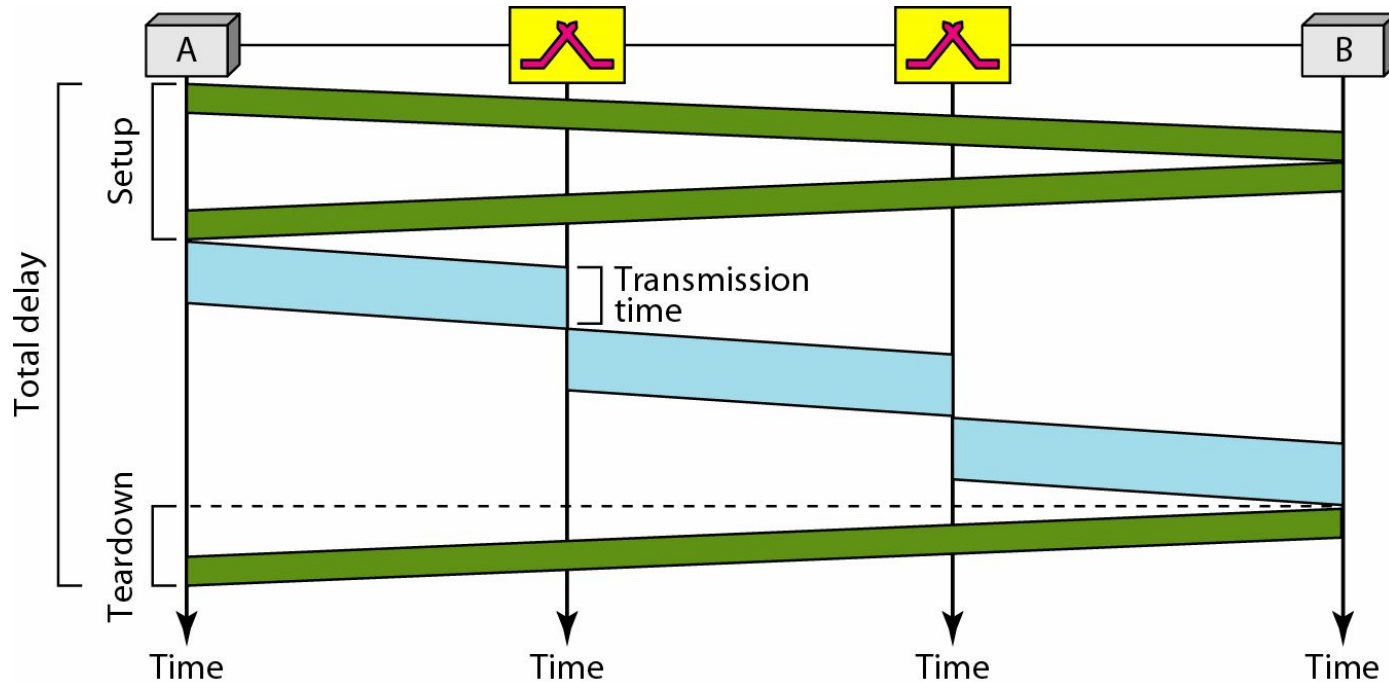
Switch and Tables in a Virtual-Circuit Network

Once Setup phase completes, data transfer phase becomes straightforward.

Incoming		Outgoing	
Port	VCI	Port	VCI
1	14	3	22
1	77	2	41

Data 77   Data 14 →

Data 22 →

1   3

2

Data

41

Fig:A   switch andits corresponding table

Source-to-destination data transfer in a Virtual-Circuit Network

Delay in a Virtual-Circuit Network

Total delay = Three transmission times (*3T*) +
three propagation delays (*3 т*) +
setup delay + teardown delay