



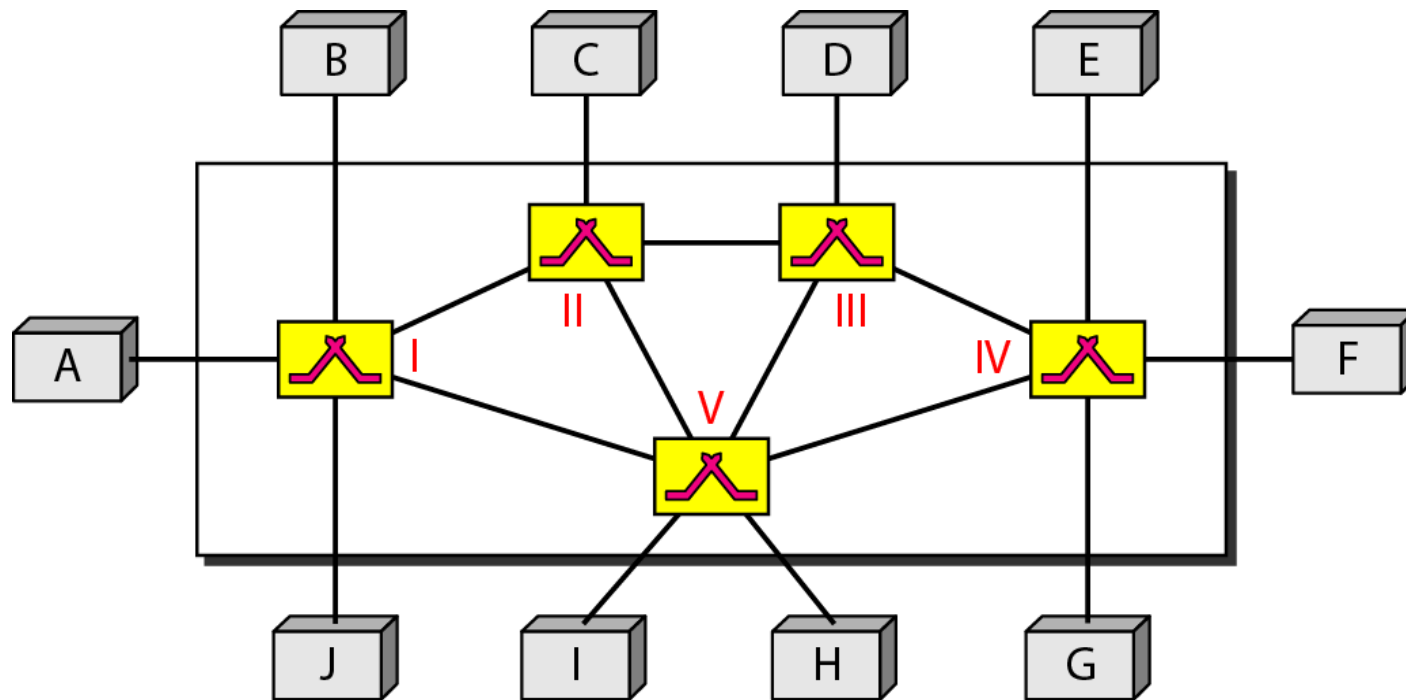
SWITCHING

SWITCHING

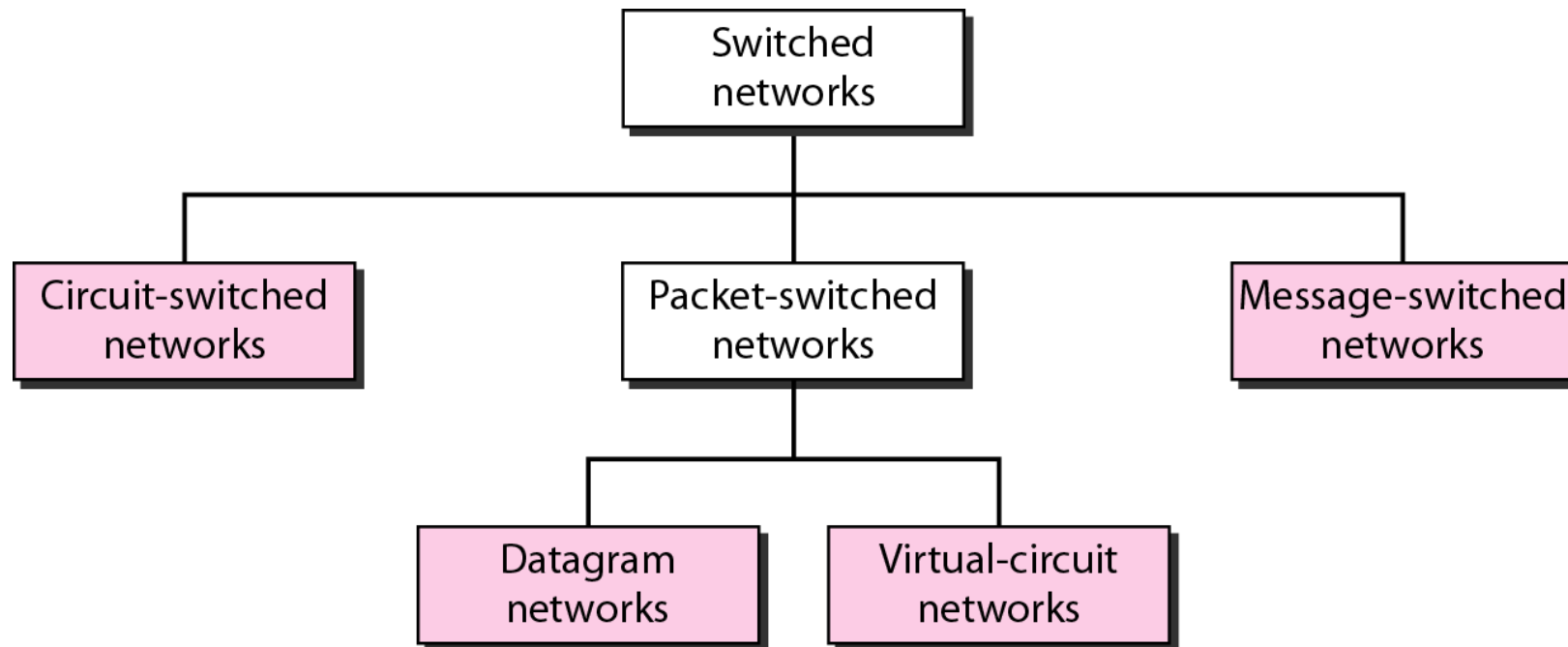
- How can we connect multiple devices.
 - Point to point connection is a solution...
- A better solution is Switching.
- A switched network consists of a series of interlinked nodes, called switches.
- Switches are devices capable of creating temporary connections between two or more devices linked to the switch.



Switched Network

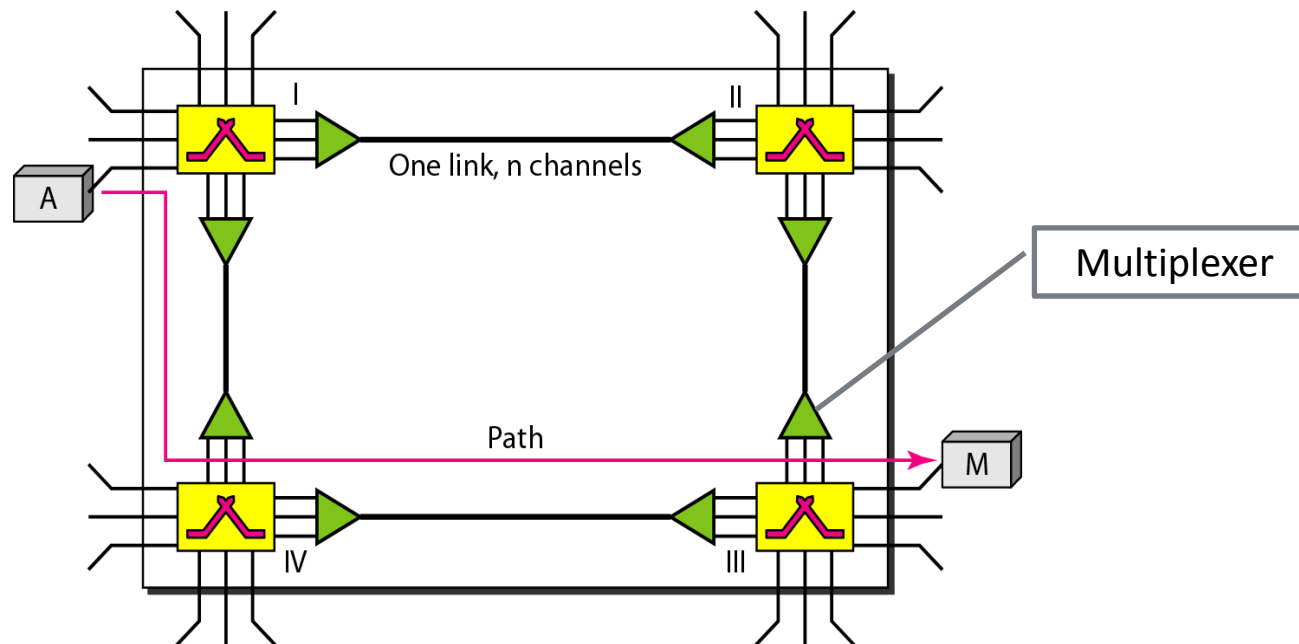


Switched Network



CIRCUIT SWITCHING

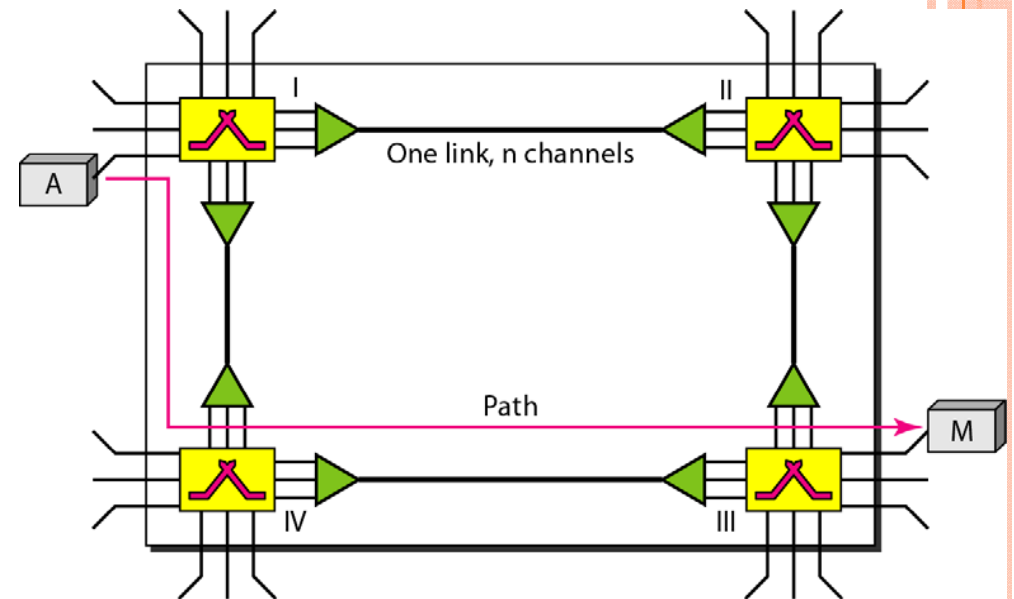
- A circuit-switched network is made of a set of switches connected by physical links, in which each link is divided into n channels by using FDM or TDM.
- A connection between two stations is a dedicated path made of one or more links.
- Switching at the physical layer in the traditional telephone network uses the circuit-switching approach.



In the figure, each link is divided into n ($n=3$) channels using FDM or TDM

CIRCUIT SWITCHING

- If A needs to communicate with M... It sends a request to M that must be accepted by all switches and M. This is called **setup phase**. A circuit (channel) is reserved on each link and forms a dedicated path between A and M.
- After the dedicated path is established, **data transfer**, can take place between A and M.
- Finally the circuit is torn down... called **teardown phase**.



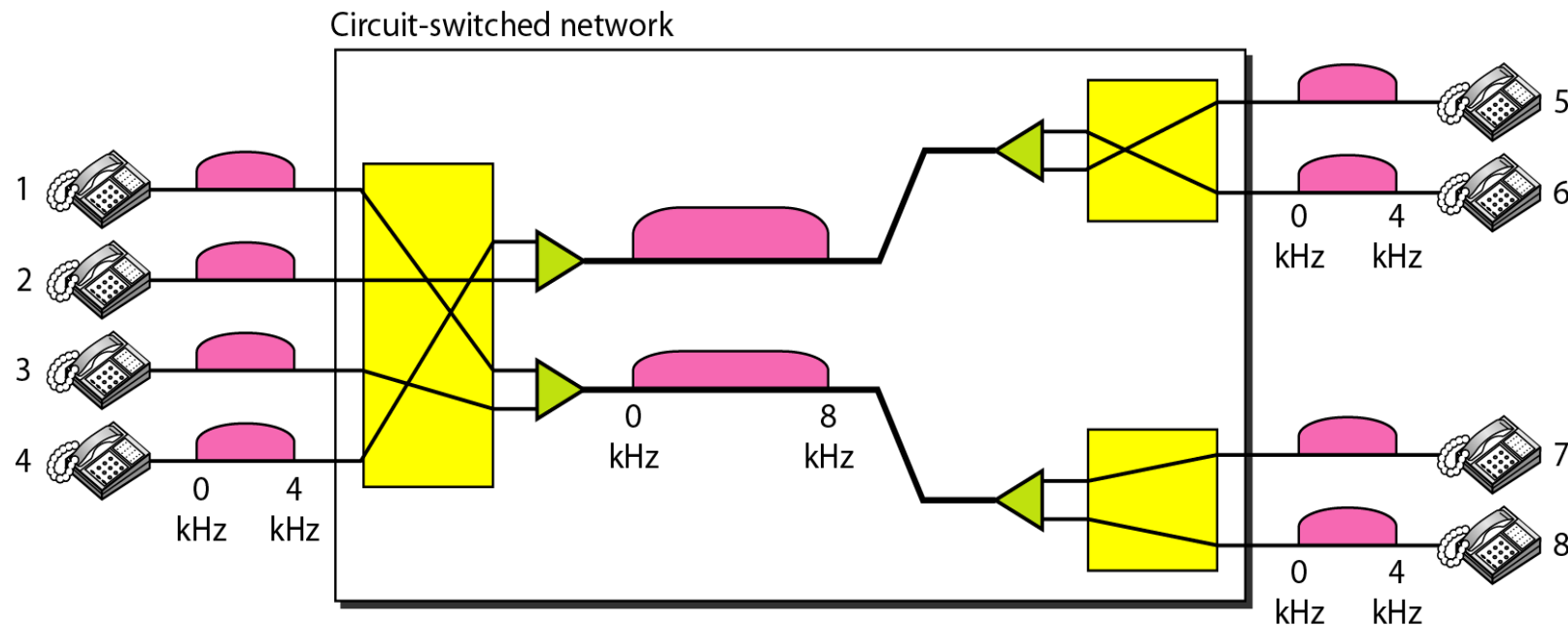
CIRCUIT SWITCHING

- 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.
- The data transferred between two station is not packetized. The data are a continuous flow sent by the source to the destination.
- There is no addressing involved during data transfer. The switches route the data based on their occupied band (FDM) or time slot (TDM)



Circuit Switching (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. Telephone 1 is connected to telephone 7; 2 to 5; 3 to 8; and 4 to 6. Of course the situation may change when new connections are made. The switch controls the connections.



CIRCUIT SWITCHING

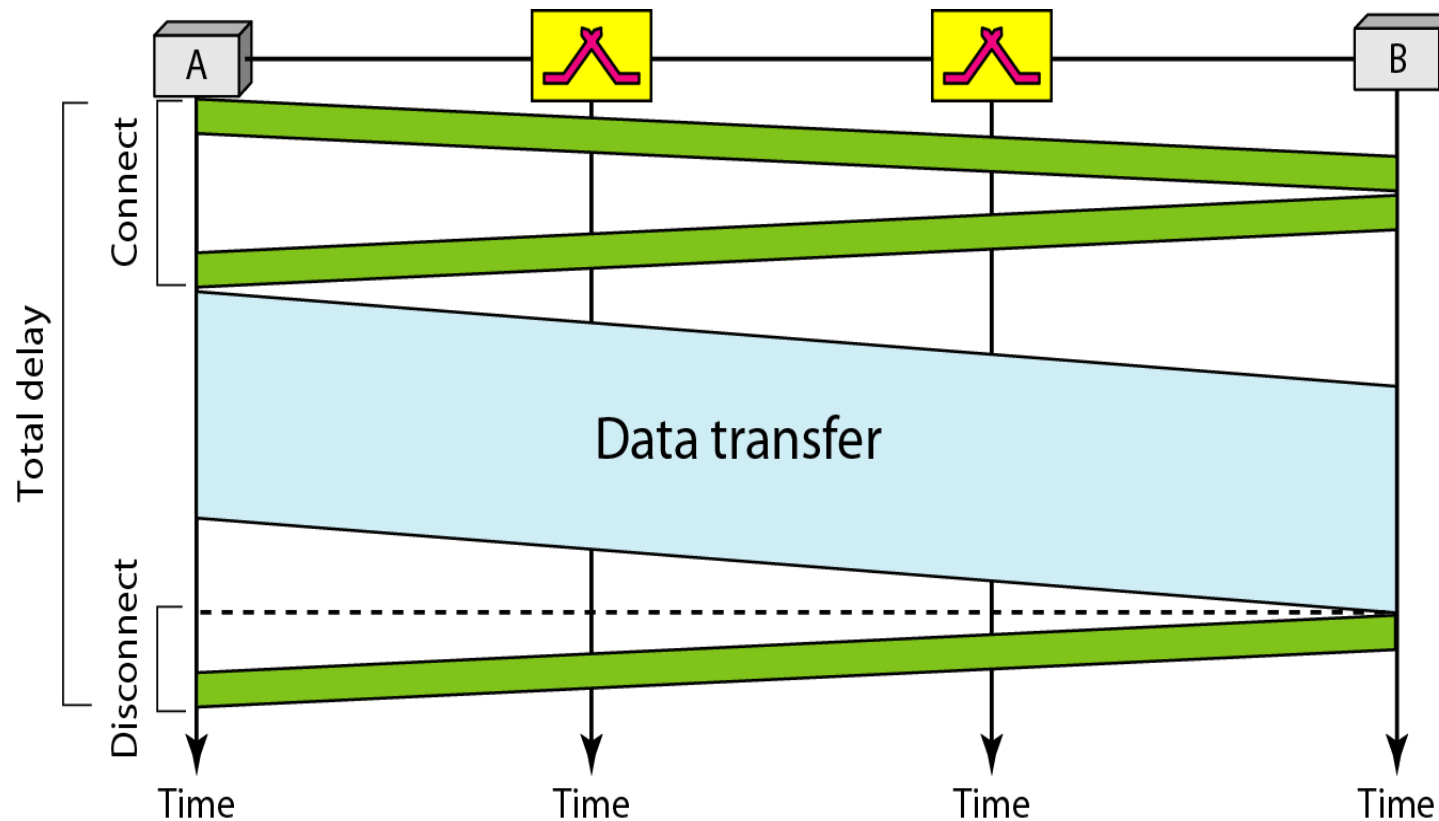
○ Efficiency:

- Circuit-switched networks are not efficient compared to other two types of network because resources are allocated during the entire duration of connection.
- Alright for telephone network, but not good for computer network.

○ Delay:

- Delay is minimal in this type of network.
- During data transfer the data are not delayed since the resources are already allocated during connection setup phase.

DELAY IN A CIRCUIT-SWITCHED NETWORK



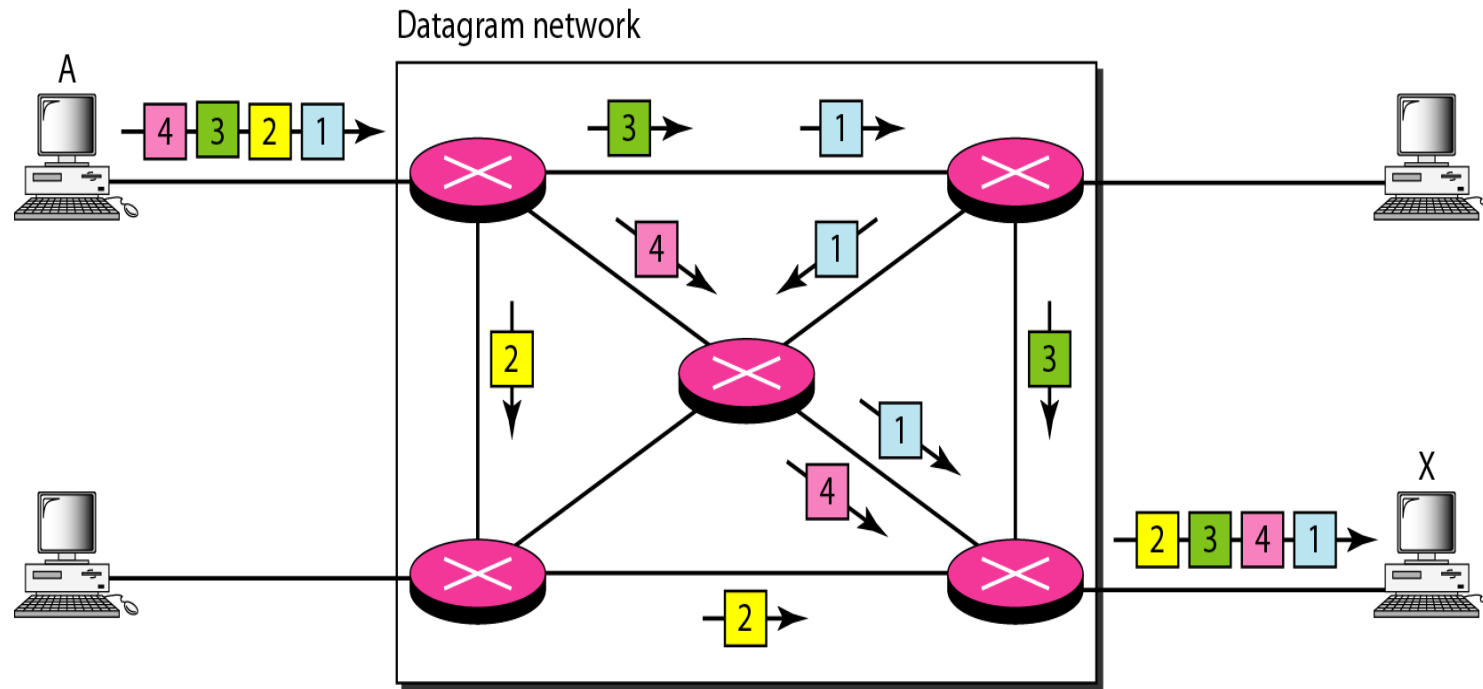
Total Delay = time needed for the setup phase + data transfer phase + teardown phase

DATAGRAM NETWORKS

- If the message is going to pass through a packet-switched network, it needs to be divided into packets of fixed or variable size.
- In a packet-switched network, there is no resource reservation; resources are allocated on demand – on a first come, first serve basis.
- When a switch receives a packet, the packet must wait if there are other packets being processes.



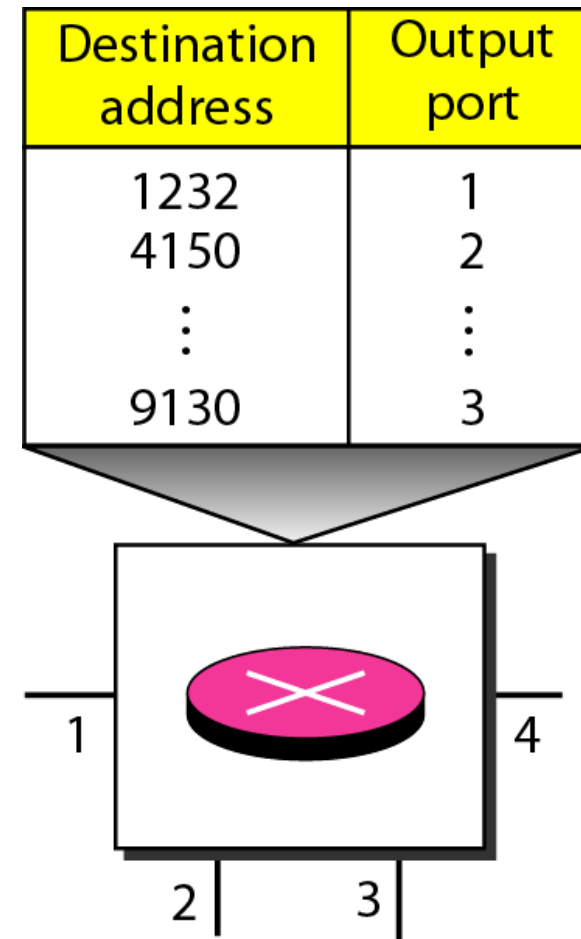
DATAGRAM NETWORK WITH FOUR SWITCHES (ROUTERS)



- Each packet is treated independently.
- Packet in this approach are referred as datagrams.
- Normally done at the network layer.
- Sometimes also known as connectionless networks.
- No setup or teardown phase.

ROUTING TABLE IN A DATAGRAM NETWORK

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

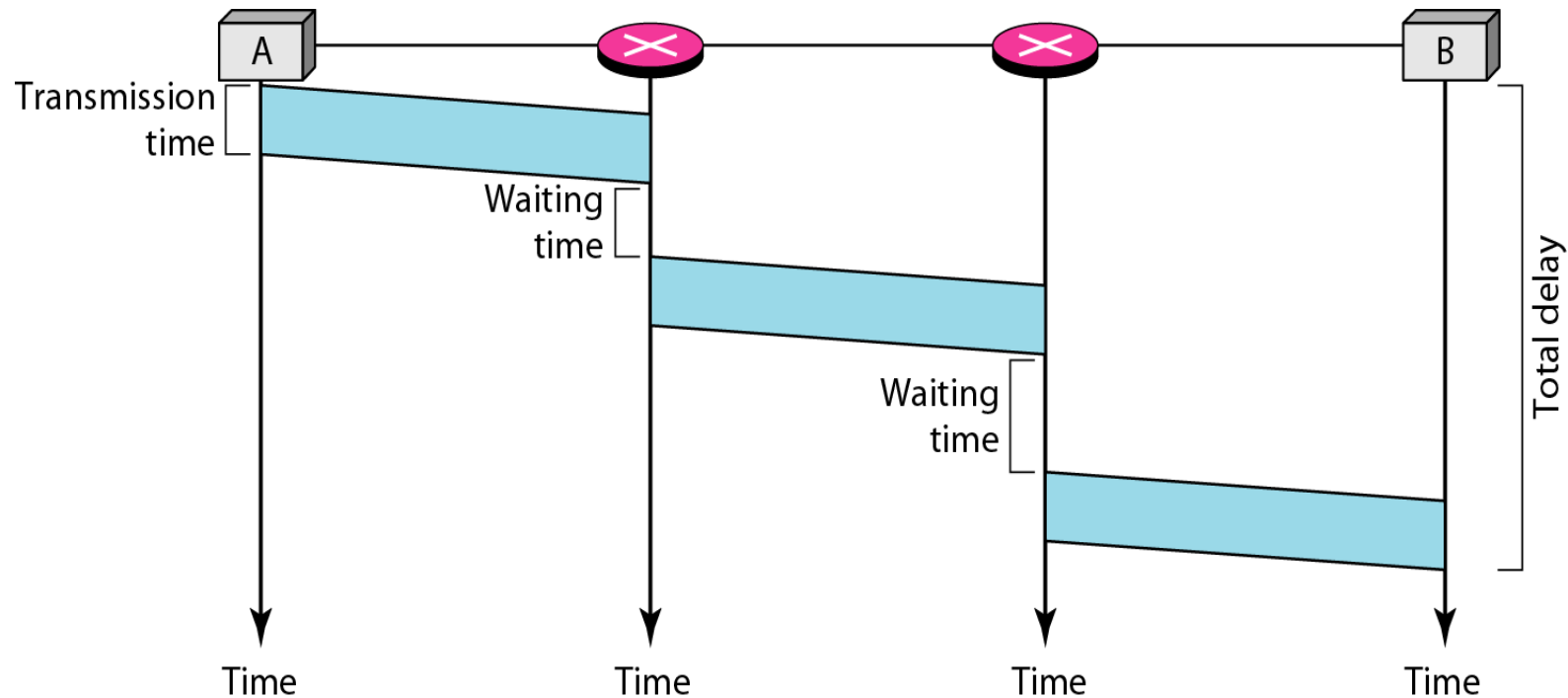


DATAGRAM NETWORK

- Efficiency:
 - Better than circuit switched networks – resources are allocated only when there are packets to be transferred.
- Delay:
 - Each packet may experience a wait at a switch before it is forwarded
 - The delay is not uniform for the packets of a message as they travel via different switches.



DELAY IN A DATAGRAM NETWORK

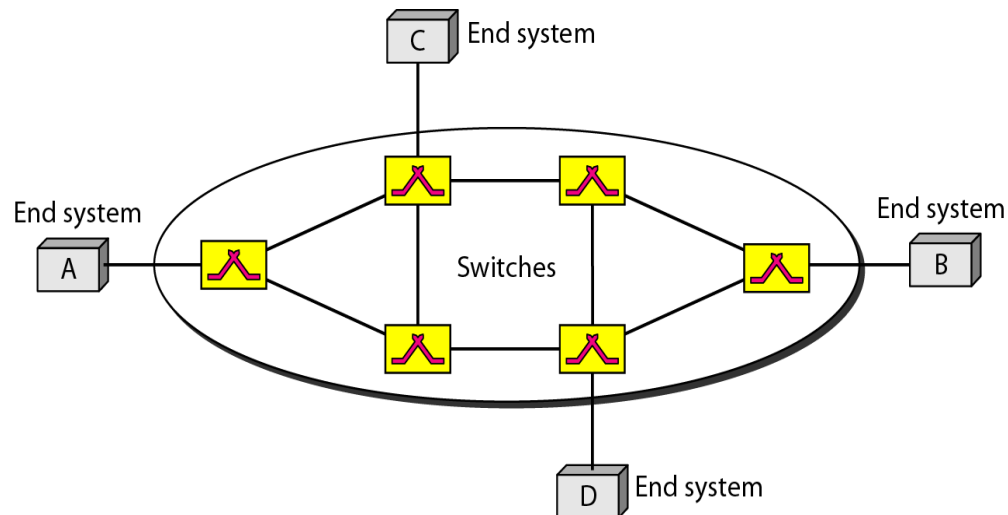


- Switching in Internet is done by using the datagram approach to packet switching at the network layer.



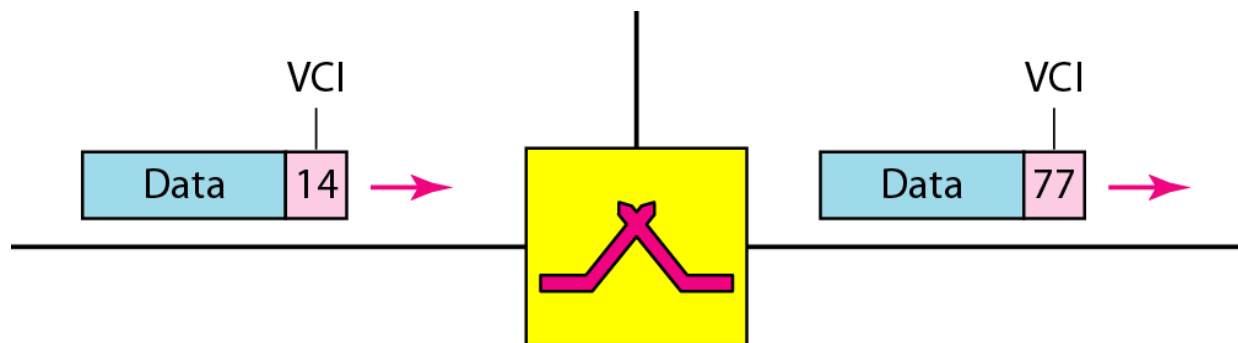
VIRTUAL-CIRCUIT NETWORKS

- Virtual-circuit network is a cross between a circuit-switched network and a datagram network. It has characteristics of both.
 - As in circuit-switched network, there are setup and teardown phases
 - Resources can be allocated during setup phase as in circuit-switched network or on demand as in datagram network
 - Data are packetized and each packet carries an address having local jurisdiction (i.e., the next switch and the channel on which the packet is being carried).
 - As in circuit switched network, all packets belonging to the same source and destination travel the same path
 - A Virtual-circuit network is normally implemented in the data link layer.



VIRTUAL-CIRCUIT NETWORKS

- Addressing: global and local (virtual circuit identifier)
 - Global addressing: A source and the destination needs to have a global address, used only to create a virtual circuit identifier.
 - Virtual-Circuit Identifier (VCI): It is actually used for data transfer. A VCI, unlike a global address, is a small number that has only switch scope, it is used by a frame between two switches.

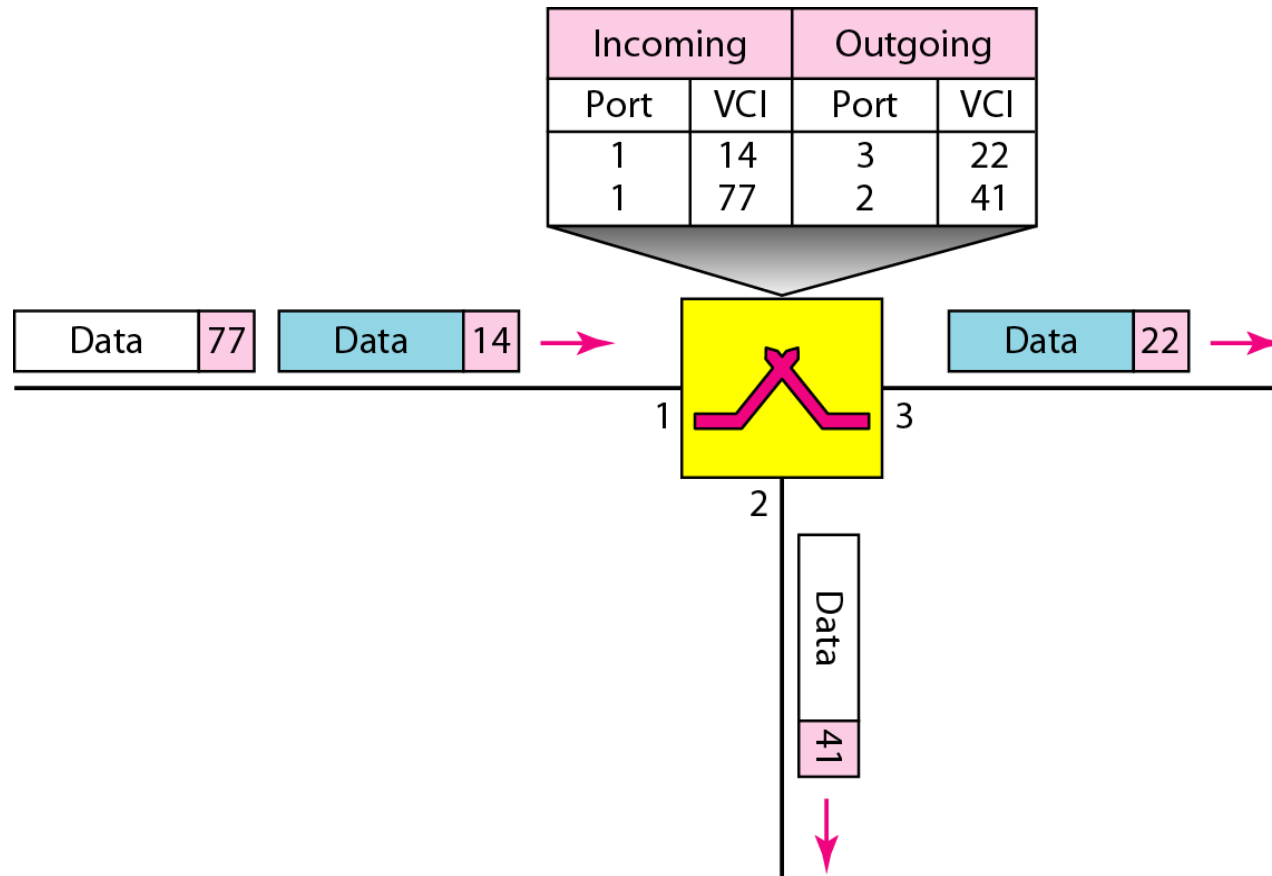


VIRTUAL-CIRCUIT NETWORKS

- Three phases:
 - **Setup phase:** the source and the destination use their global addresses to help switches make table entries for the connection. It needs two steps: **setup request** and **acknowledgement**.
 - **Data transfer phase**
 - **Teardown phase:** the source and the destination informs the switches to delete the corresponding entry.

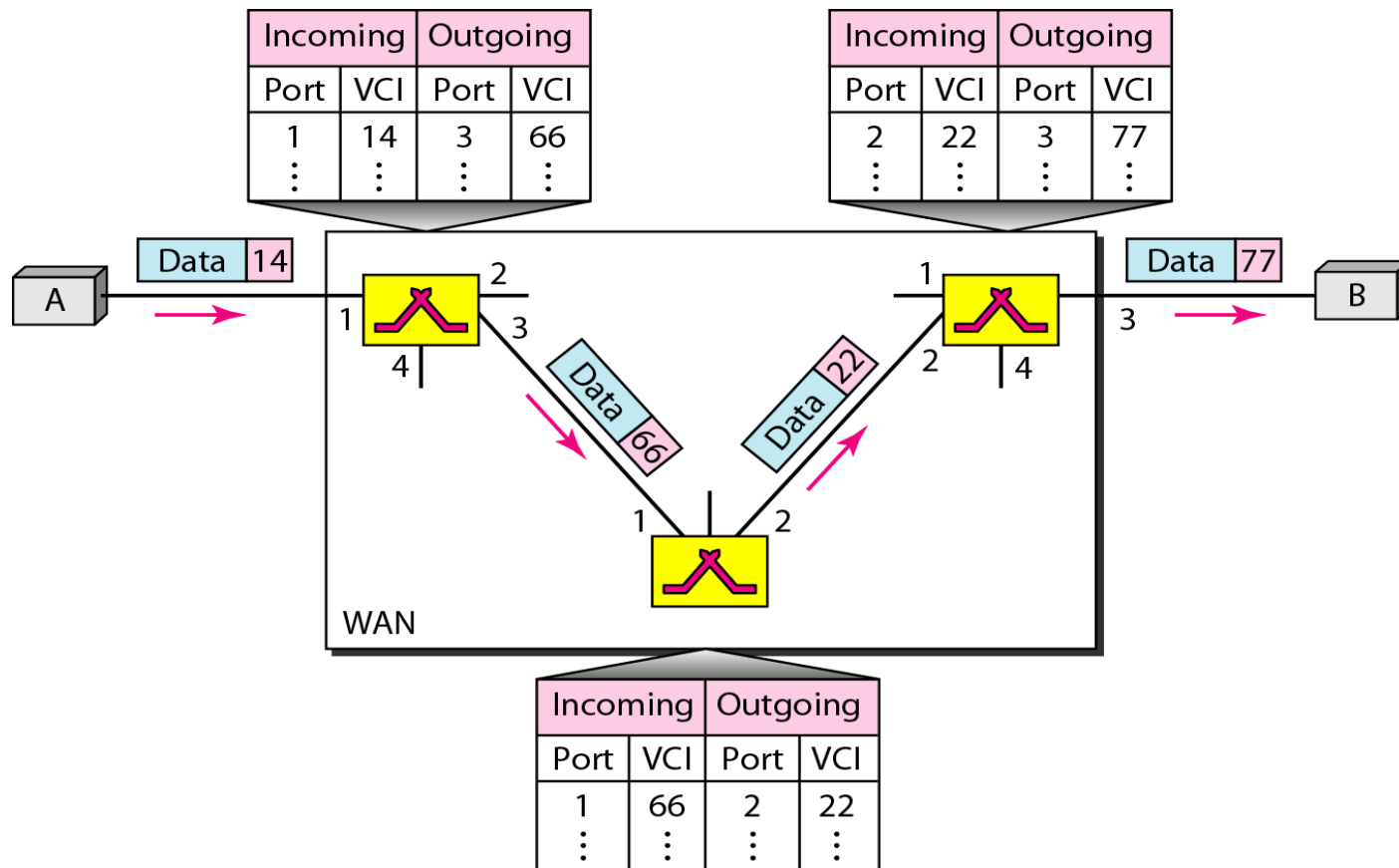


SWITCH AND TABLES IN A VIRTUAL-CIRCUIT NETWORK

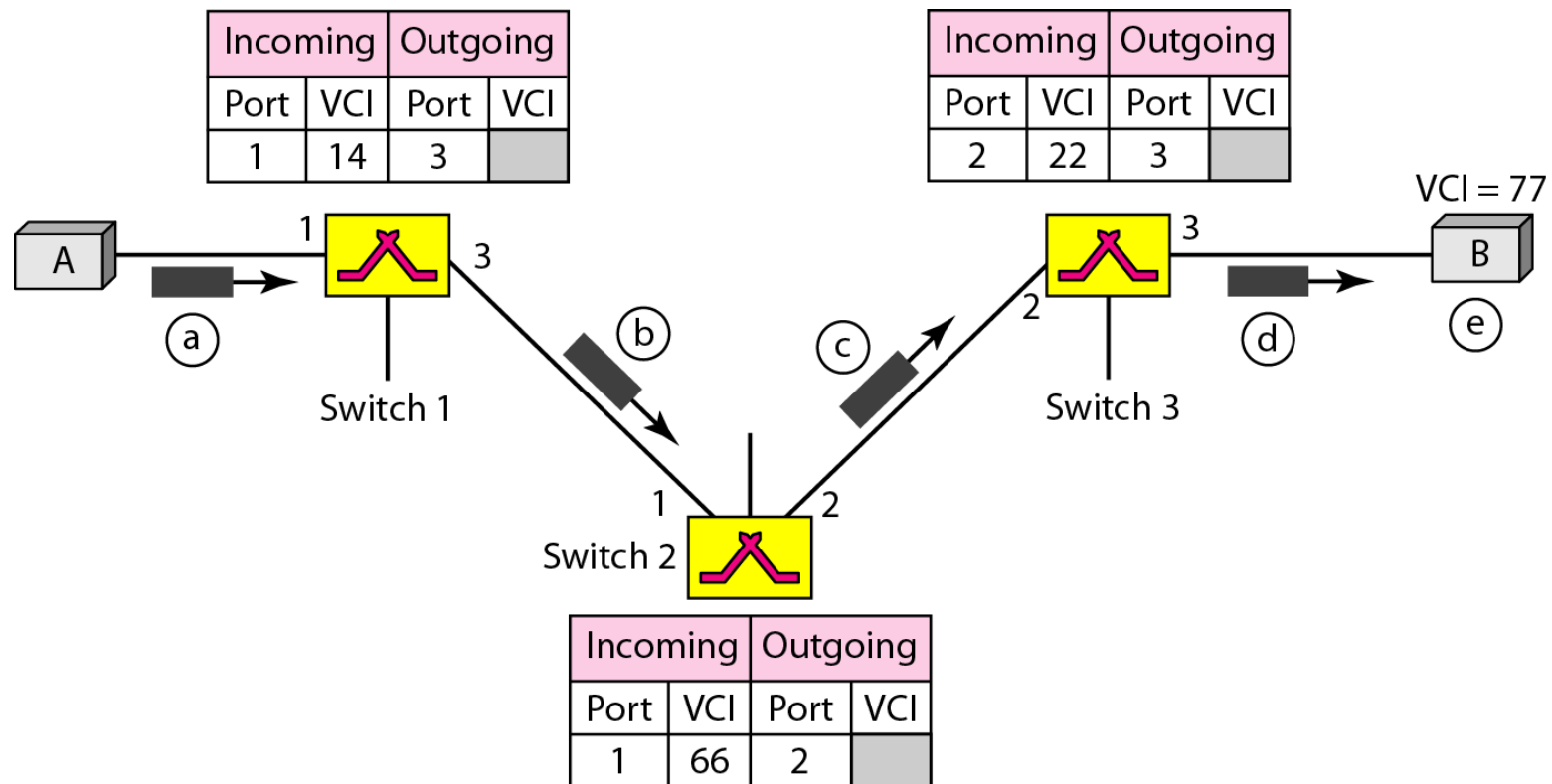


- All switches need to have a table entry for each virtual circuit.
- A simple table, shown above, has four columns.

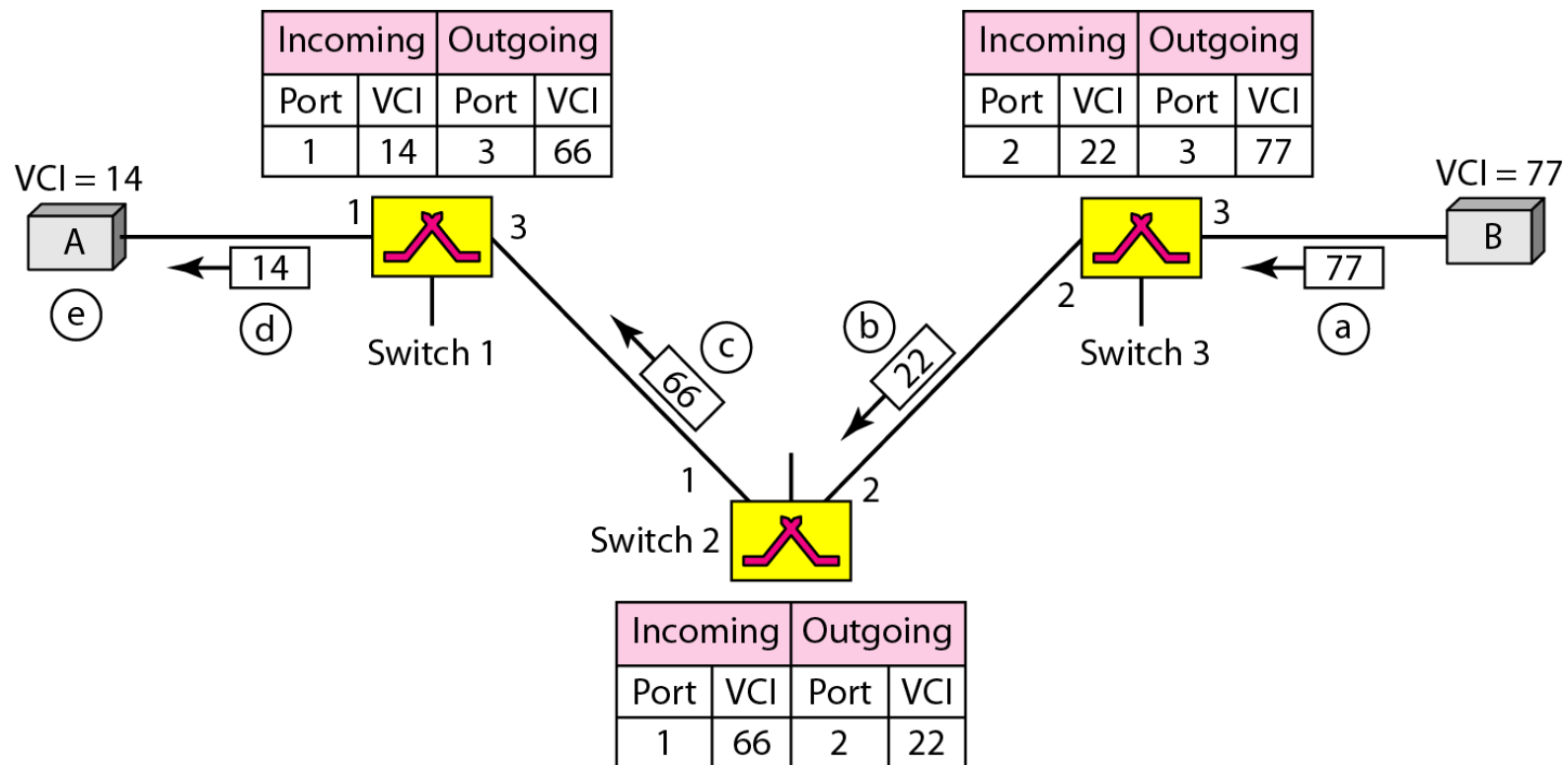
SOURCE-TO-DESTINATION **DATA TRANSFER** IN A VIRTUAL-CIRCUIT NETWORK



SETUP REQUEST IN A VIRTUAL-CIRCUIT NETWORK



SETUP ACKNOWLEDGMENT IN A VIRTUAL-CIRCUIT NETWORK



VIRTUAL-CIRCUIT NETWORK

- Efficiency:
 - Resources can be reserved in virtual-circuit network during the setup phase or can be on demand during data transfer phase.
 - In the first case: the delay of each packet is the same.
 - In the second case: packets may encounter different delay.
- Delay in Virtual-Circuit Networks
 - One-time delay for setup and teardown phase.
 - If resources are allocated during setup phase, there is no wait time for individual packets.
- Virtual-circuit networks are used in switched WANs such as Frame Relay and ATM networks.



DELAY IN A VIRTUAL-CIRCUUT NETWORK

