Network Switching

Course Code: **COE 3201** Course Title: **Data Communication**

Dept. of Computer Engineering
Faculty of Engineering

Lecture No:	**11**	**Week No:**	**13**	**Semester:**	**Fall 23-24**
Lecturer:	*Dr Amirul Islam*				

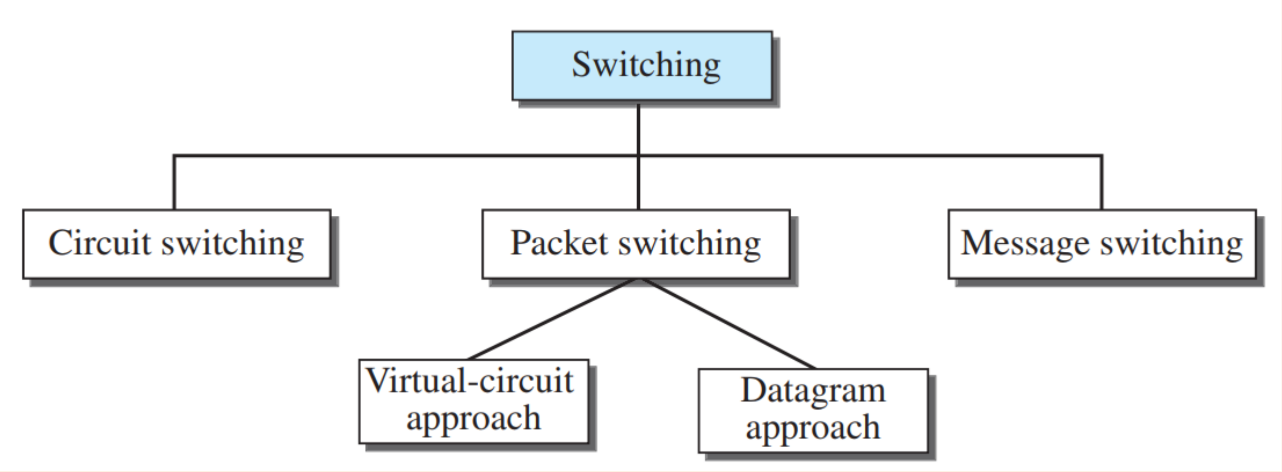
Lecture Outline

1. Switching Mechanism for Data Transfer
2. Circuit Switching
3. Message Switching
4. Packet Switching
5. Virtual Circuit Switching
6. Datagram Switching

Switching Mechanism for Data Transfer

Taxonomy of Switched Network

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 networking applications. Packet switching can further be divided into two subcategories—virtual circuit approach and datagram approach—as shown in Figure. Here, we discuss only circuit switching and packet switching; message switching is more conceptual than practical.



Switching and TCP/IP Layers

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

Switching at Physical Layer: At the physical layer, we can have only circuit switching. There are no packets exchanged at the physical layer. The switches at the physical layer allow signals to travel in one path or another.

Switching at Data-Link Layer At the data-link layer, we can have packet switching. However, the term packet in this case means frames or cells. Packet switching at the data-link layer is normally done using a virtual-circuit approach.

Switching at Network Layer At the network layer, we can have packet switching. In this case, either a virtual-circuit approach or a datagram approach can be used. Currently the Internet uses a datagram approach, but the tendency is to move to a virtual-circuit approach.

Switching at Application Layer At the application layer, we can have only message switching. The communication at the application layer occurs by exchanging messages. Conceptually, we can say that communication using e-mail is a kind of message-switched communication, but we do not see any network that actually can be called a message-switched network

Circuit Switching

- Dedicated communication path between two stations
- Must have switching capacity and channel capacity to establish connection
- Must have intelligence to work out routing
- Inefficient
  - ✓ Channel capacity dedicated for duration of connection
  - ✓ If no data, capacity wasted
- Set up (connection) takes time
- Developed for voice traffic (phone)
- Examples
  - ✓ Telephone networks
  - ✓ ISDN (Integrated Services Digital Networks)

Circuit Switching

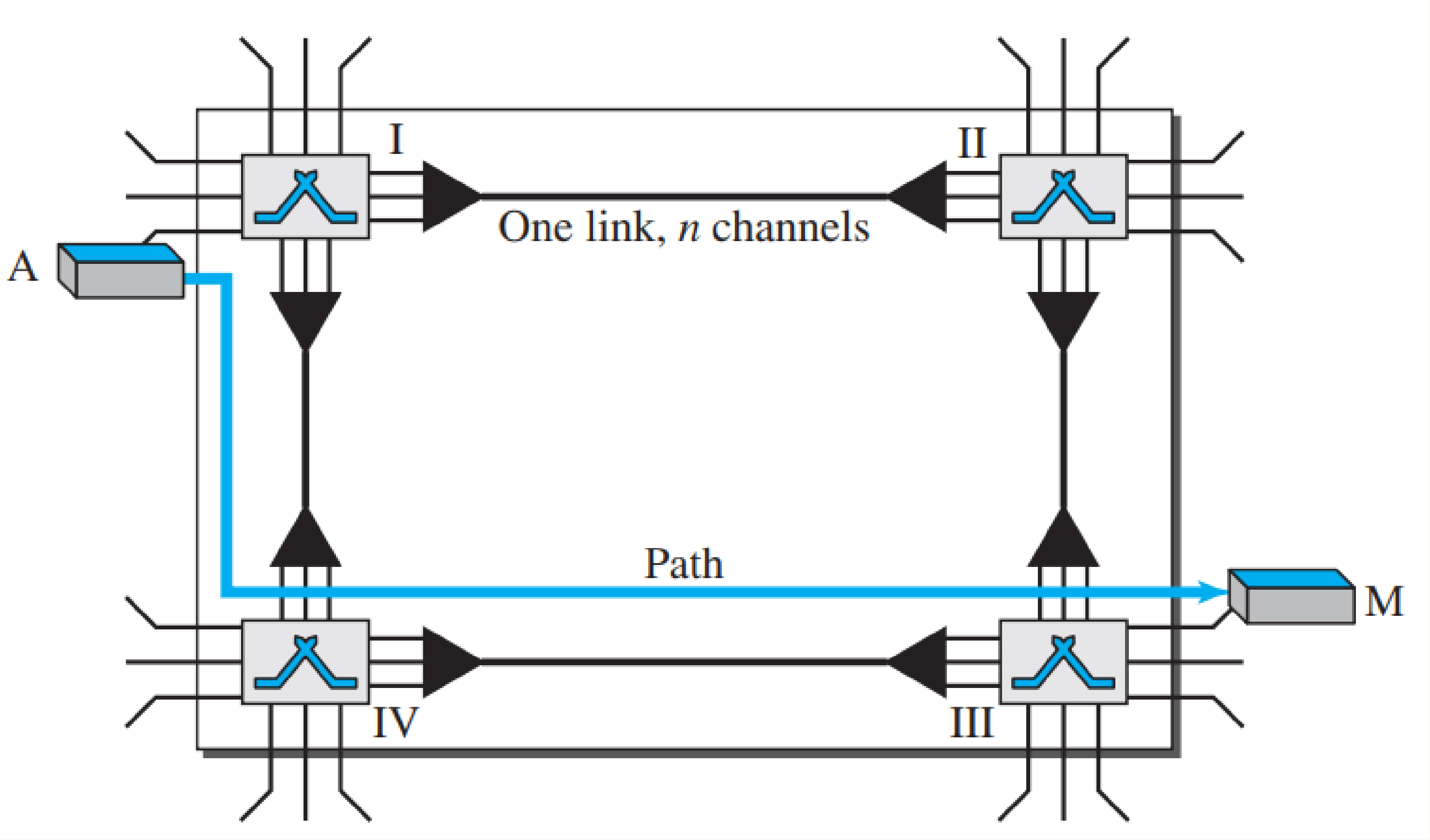


Figure: A trivial circuit-switched network

Circuit Switching

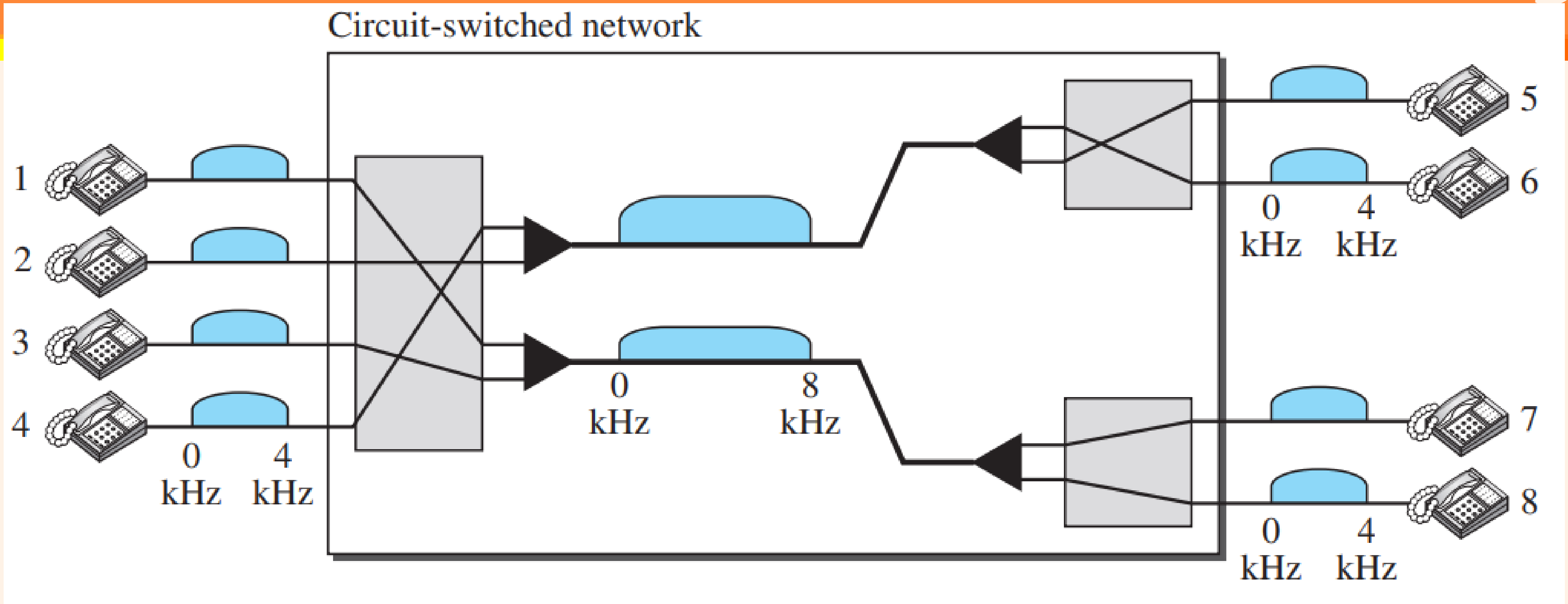


Figure: Circuit-switched network used in Example 8.1

Example 8.1

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 8.4 shows the situation. 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

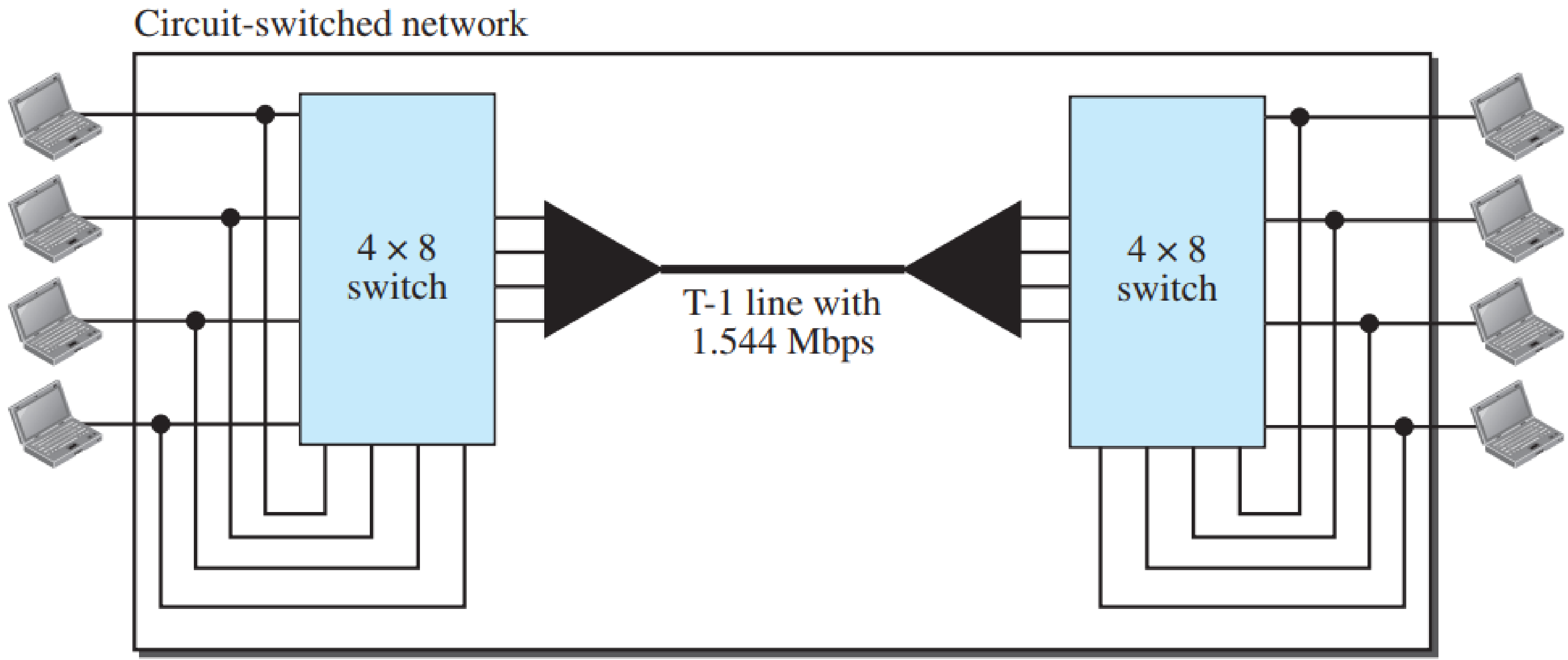


Figure: Circuit-switched network used in Example 8.2

Example 8.2

As another example, consider a circuit-switched network that connects computers in two remote offices of a private company. The offices are connected using a T-1 line leased from a communication service provider. There are two 4 × 8 (4 inputs and 8 outputs) switches in this network. For each switch, four output ports are folded into the input ports to allow communication between computers in the same office. Four other output ports allow communication between the two

Delay in Circuit Switching

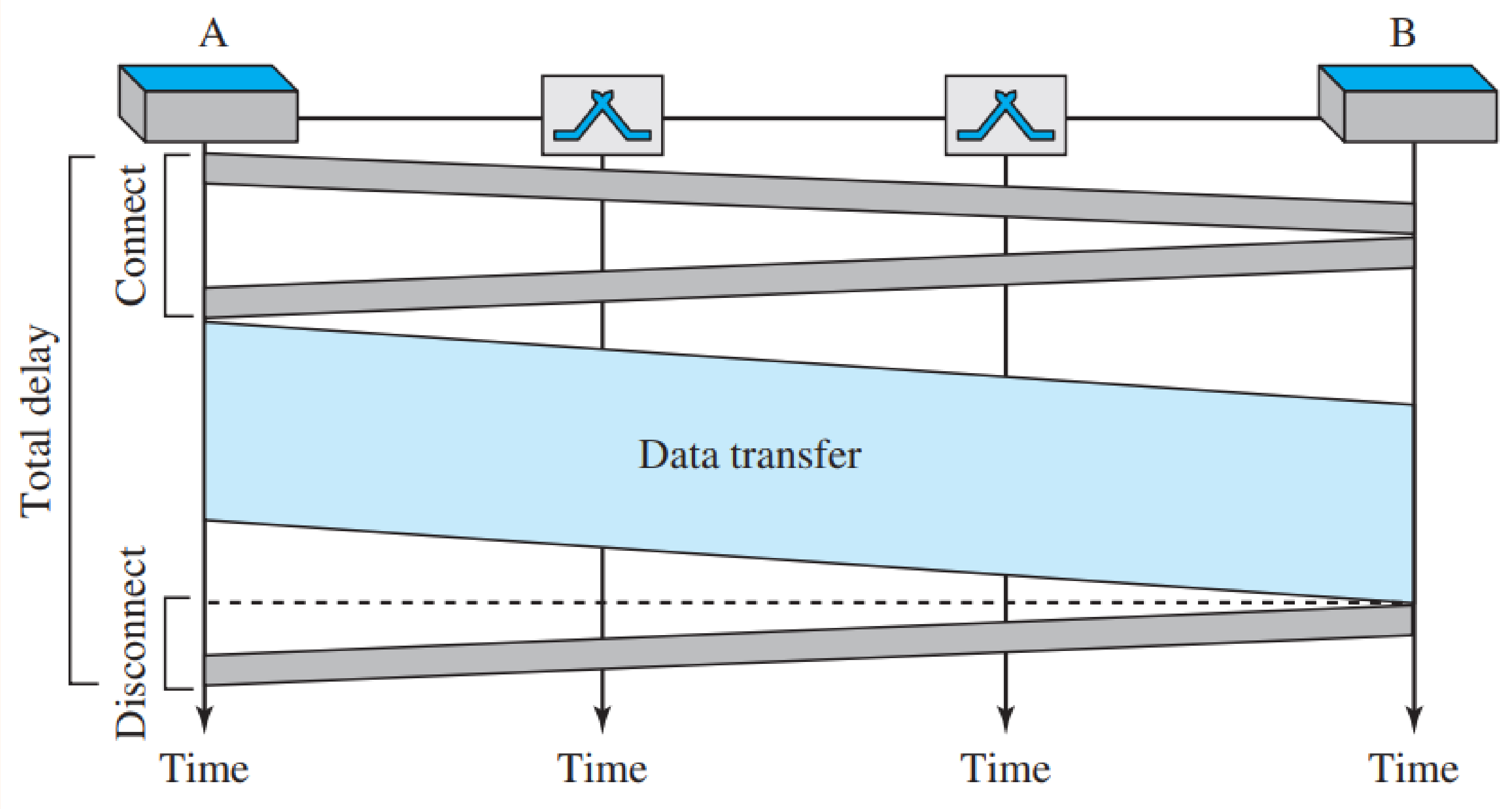


Figure: Delay in a circuit-switched network

Packet Switching

- Messages are broken into small segments of bit-sequences and they are called packets. As packets are restricted to a specific size, they can be routed more rapidly.
- Packets have the following structure:

  - ✓ Header carries control information (e.g., destination id, source id, message id, packet id, control info)

- Each packet is passed through the network from node to node along some path (**Routing**)
- At each node the entire packet is received, stored briefly, and then forwarded to the next node (**Store-and-Forward Networks**)
- Typically, no storage is required at nodes/switches for packets.

Packet Switching Advantages

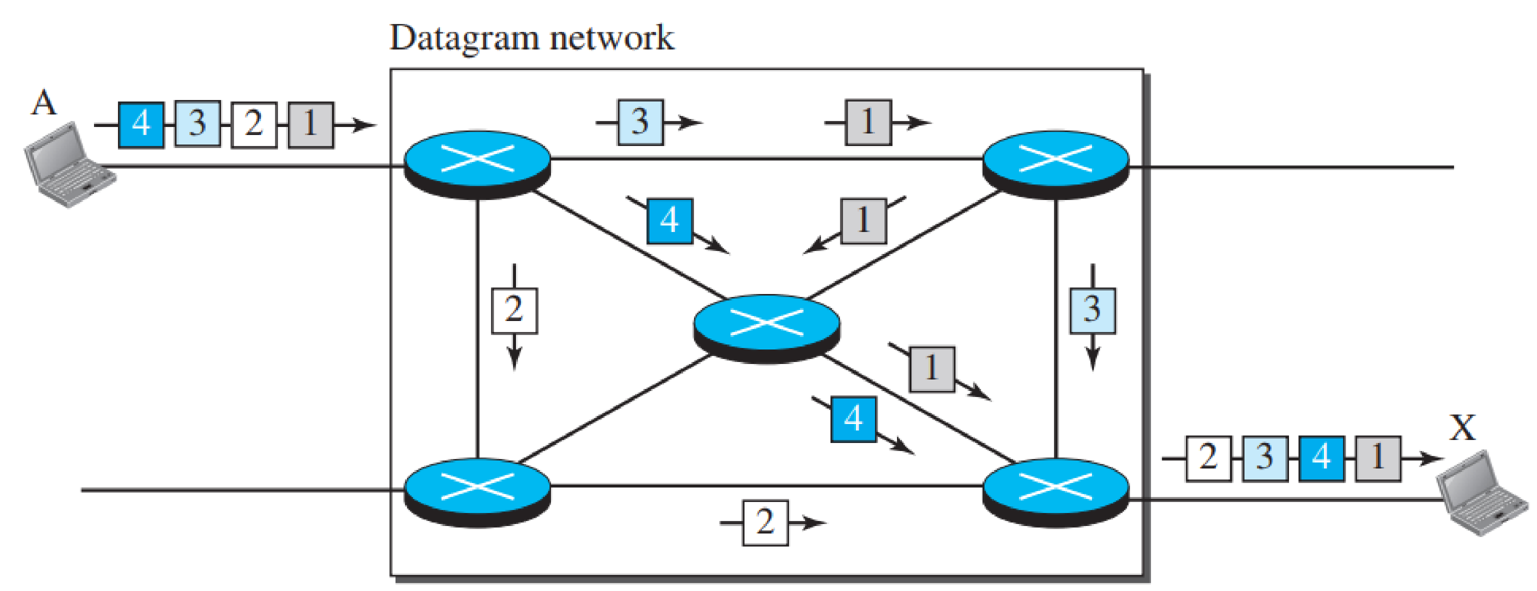
- Packetization allows short messages to get through a transmission link without waiting behind long messages.
- Line efficiency
  - Single node to node link can be shared by many packets over time
  - Packets queued and transmitted as fast as possible
- Packets are accepted even when network is busy
  - Delivery may slow down
- Priorities can be used

Message Switching

- No dedicated path needs to be established between end-nodes.
- Source and destination node do not interact in real time. There is no need to determine the status of the destination node before sending the message.
- Each message is an independent entity and carries address information of the destination. There is no upper limit on the size of the message.

- The messages are stored at each node before being forwarded to the next node in the route.
- Message switching accept all traffic but offers longer delivery time than circuit switching. Circuit switching blocks/rejects access traffic.

Datagram packet switching



- Each packet is independently switched
  - each packet header contains destination address
- No resources are pre-allocated (reserved) in advance
- Routes may change during session

Datagram packet switching

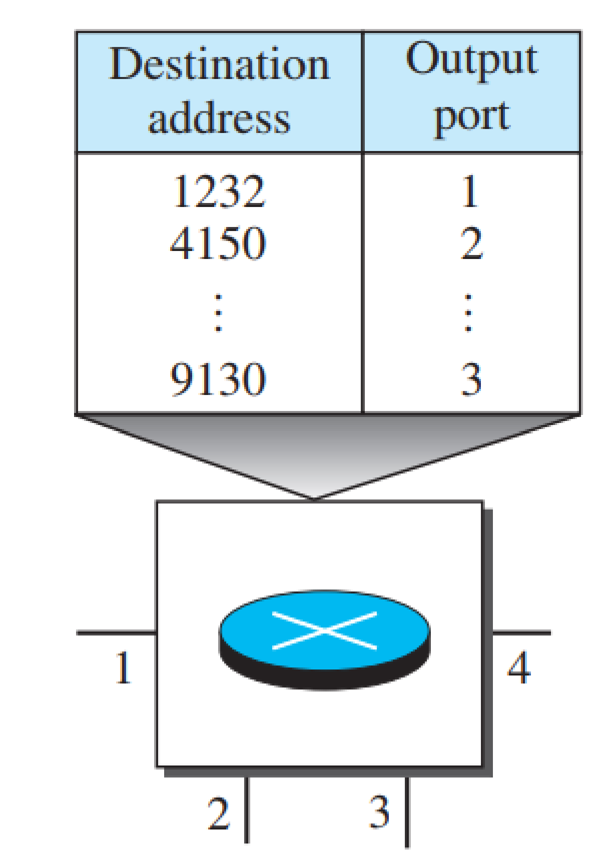


Figure: Routing table in a datagram network

- 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.

Delay in Datagram packet switching

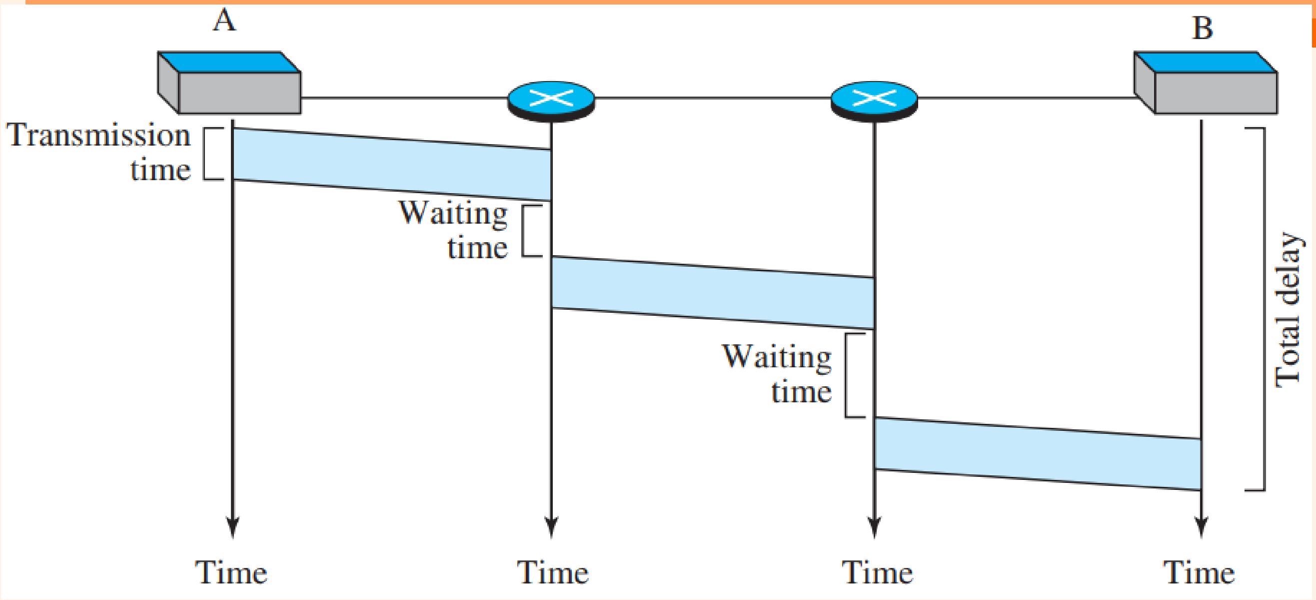


Figure: Delay in a datagram network

The packet travels through two switches. There are three transmission times ($3T$), three propagation delays (slopes 3τ of the lines), and two waiting times ($w_1 + w_2$). We ignore the processing time in each switch. The total delay is

$$\text{Total delay} = 3T + 3\tau + w_1 + w_2$$

Virtual-Circuit Packet Switching

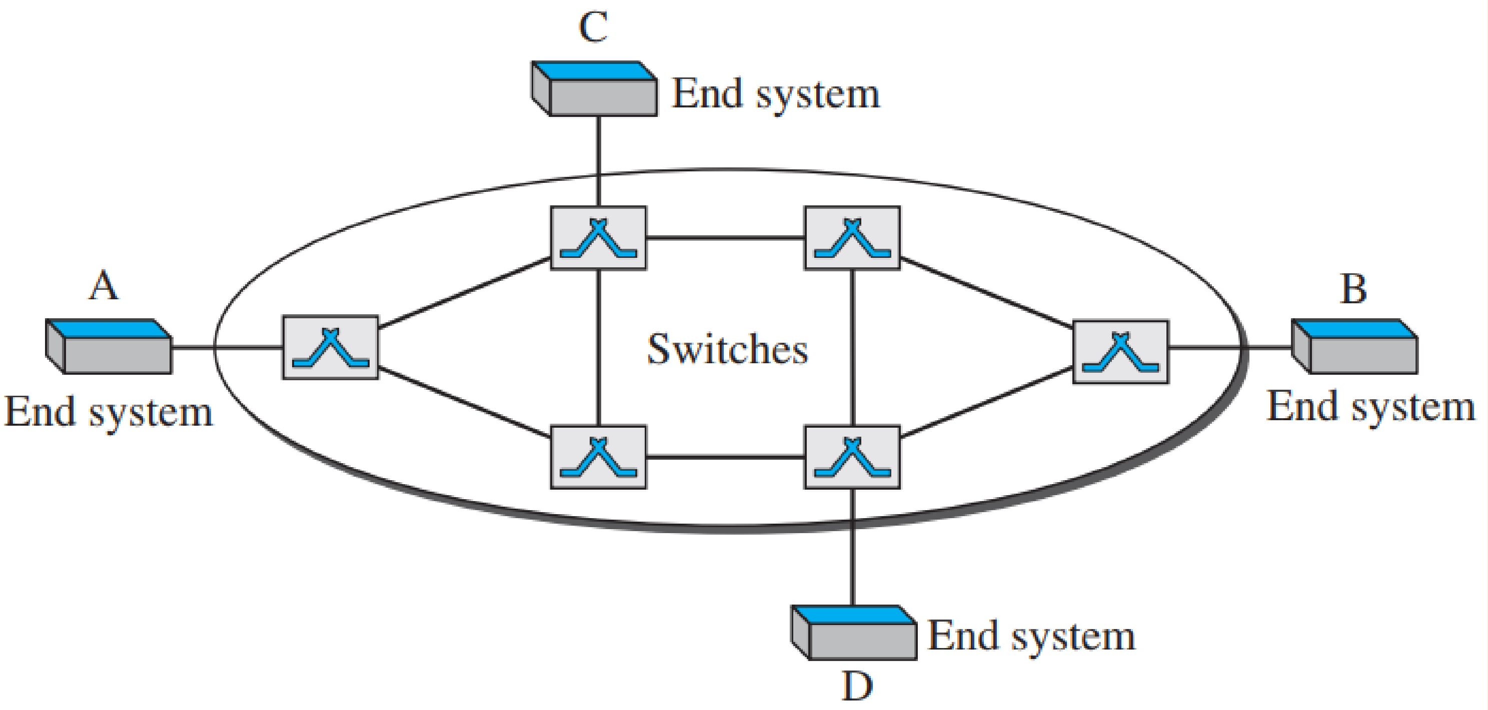


Figure: Virtual-circuit network

Virtual-Circuit Packet Switching

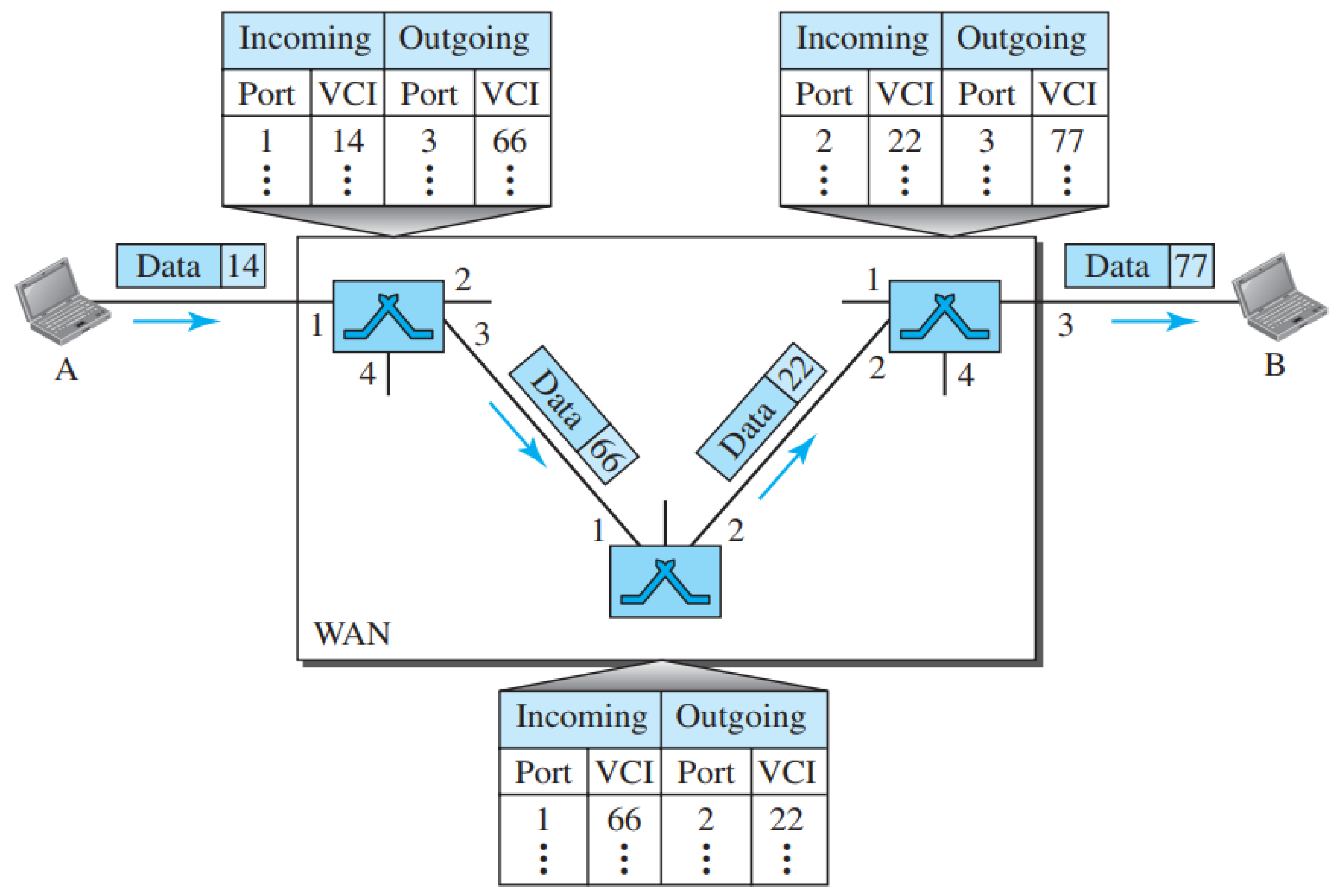
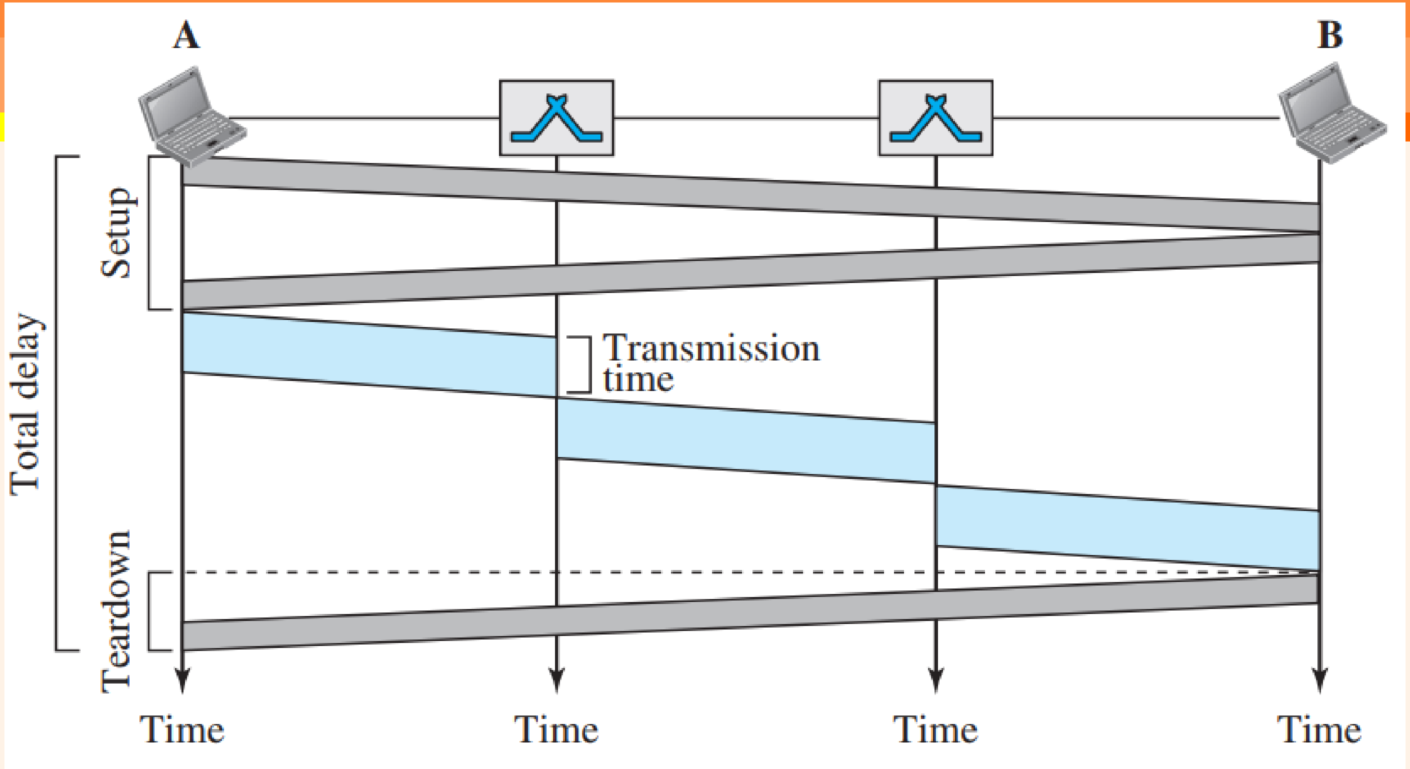


Figure: Source-to-destination data transfer in a virtual-circuit network

Delay in Virtual-Circuit Packet Switching



The packet is traveling through two switches (routers). There are three transmission times ($3T$), three propagation times (3τ), data transfer depicted by the sloping lines, a setup delay (which includes transmission and propagation in two directions), and a teardown delay (which includes transmission and propagation in one direction). We ignore the processing time in each switch. The total delay time is

Total delay + $3T$ + 3τ + setup delay + teardown delay

Datagram vs. Virtual-Circuits

Packet Switching

Datagram	Virtual circuits

No call setup phase
  - Better if few packets
 	
More flexible
  - Routing can be used to avoid congested parts of the network
	Network can provide sequencing and error control
	
	Packets are forwarded more quickly
	  - No routing decisions to make
	
	Less reliable
	  - Loss of a node looses all circuits through that node

Books

1. Forouzan, B. A. "Data Communication and Networking. Tata McGraw." (2005).

References

1. Prakash C. Gupta, “Data communications”, Prentice Hall India Pvt.
2. William Stallings, "Data and Computer Communications”, Pearson
3. Forouzan, B. A. "Data Communication and Networking. Tata McGraw." (2005).