CHAPTER 8

PRACTICE SET

Questions

Q8-1. *Switching* provides a practical solution to the problem of connecting multiple devices in a network. It is more practical than using a bus topology; it is more efficient than using a star topology and a central hub. Switches are devices capable of creating temporary connections between two or more devices linked to the switch.

Q8-3. There are two approaches to packet switching: *datagram approach* and *virtual-circuit approach*.

Q8-5. The address field defines the *end-to-end* (source to destination) addressing.

Q8-7. In a *space-division* switch, the path from one device to another is spatially separate from other paths. The inputs and the outputs are connected using a grid of electronic microswitches. In a *time-division* switch, the inputs are divided in time using TDM. A control unit sends the input to the correct output device.

Q8-9. The two categories of circuit switches are *space-division* and *time-division*. In a space-division switch, the paths are separated from one another spatially. In a time-division switch, TDM technology is used to separate paths from one another.

Problems

P8-1. We assume that the setup phase is a two-way communication and the teardown phase is a one-way communication. These two phases are common for all three cases. The delay for these two phases can be calculated as three propagation delays and three transmission delays or

$$3\,[(5000\text{ km})/(2\times10^8\text{ m/s})] + 3\,[(1000\text{ bits}/1\text{ Mbps})] = 75\text{ ms} + 3\text{ ms} = 78\text{ ms}$$

We assume that the data transfer is in one direction; the total delay is then delay for setup and teardown + propagation delay + transmission delay

a. 78 + 25 + 1 = 104 ms

b. 78 + 25 + 100 = 203 ms

c. 78 + 25 + 1000 = 1103 ms

d. In case a, we have 104 ms. In case b we have 203/100 = 2.03 ms. In case c, we have 1103/1000 = 1.101 ms. The ratio for case c is the smallest because we use one setup and teardown phase to send more data.

P8-3.

a. In a *circuit-switched* network, end-to-end addressing is needed during the setup and teardown phase to create a connection for the whole data transfer phase. After the connection is made, the data flow travels through the already-reserved resources. The switches remain connected for the entire duration of the data transfer; there is no need for further addressing.

b. In a *datagram network*, each packet is independent. The routing of a packet is done for each individual packet. Each packet, therefore, needs to carry an end-to-end address. There is no setup and teardown phases in a datagram network (connectionless transmission). The entries in the routing table are somehow permanent and made by other processes such as routing protocols.

c. In a *virtual-circuit* network, there is a need for end-to-end addressing during the setup and teardown phases to make the corresponding entry in the switching table. The entry is made for each request for connection. During the data transfer phase, each packet needs to carry a virtual-circuit identifier to show which virtual-circuit that particular packet follows.

P8-5. In *circuit-switched* and *virtual-circuit* networks, we are dealing with connections. A connection needs to be made before the data transfer can take place. In the case of a circuit-switched network, a physical connection is established during the setup phase and the is broken during the teardown phase. In the case of a virtual-circuit network, a virtual connection is made during setup and is broken during the teardown phase; the connection is virtual, because it is an entry in the table. These two types of networks are considered *connection-oriented*. In the case of a *datagram* network no connection is made. Any time a switch in this type of network receives a packet, it consults its table for routing information. This type of network is considered a *connectionless* network.

P8-7.

a. Packet 1: 2

b. Packet 2: 3

c. Packet 3: 3

d. Packet 4: 2

P8-9.

a. In a *datagram* network, the destination addresses are unique. They cannot be duplicated in the routing table.

b. In a *virtual-circuit* network, the VCIs are local. A VCI is unique only in relationship to a port. In other words, the (port, VCI) combination is unique. This means that we can have two entries with the same input or output ports. We can have two entries with the same VCIs. However, we cannot have two entries with the same (port, VCI) pair.

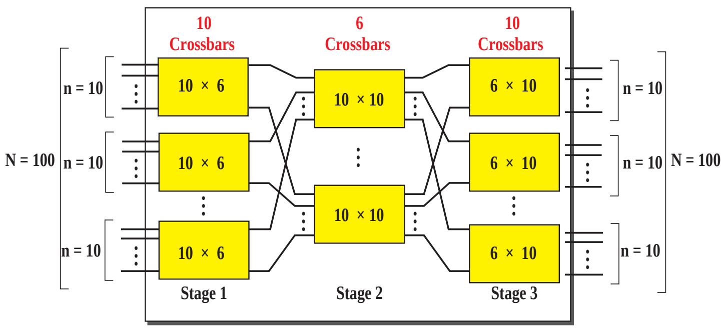
P8-11.

a. If $n > k$, an $n \times k$ crossbar is like a *multiplexer* that combines n inputs into k outputs. However, we need to know that a regular multiplexer discussed in Chapter 6 is $n \times 1$.

b. If $n < k$, an $n \times k$ crossbar is like a *demultiplexer* that divides n inputs into k outputs. However, we need to know that a regular demultiplexer discussed in Chapter 6 is $1 \times n$.

P8-13.

a. See the following figure.



b. The total number of crosspoints are

$$\text{Number of crosspoints} = 10\,(10 \times 6) + 6\,(10 \times 10) + 10\,(6 \times 10) = 1800$$

c. Only six simultaneous connections are possible for each crossbar at the first stage. This means that the total number of simultaneous connections is 60.

d. If we use one crossbar (100×100), all input lines can have a connection at the same time, which means 100 simultaneous connections.

e. The blocking factor is 60/100 or 60 percent.

P8-15.

a. Total crosspoints = $N^2 = 1000^2$ = 1,000,000

b. Total crosspoints $\geq 4N[(2N)^{1/2} - 1] \geq$ 174,886. With less than 200,000 crosspoints we can design a three-stage switch. We can use $n = (N/2)^{1/2}$ =23 and choose k = 45. The total number of crosspoints is 178,200.