4.2. TYPES OF SWITCHING

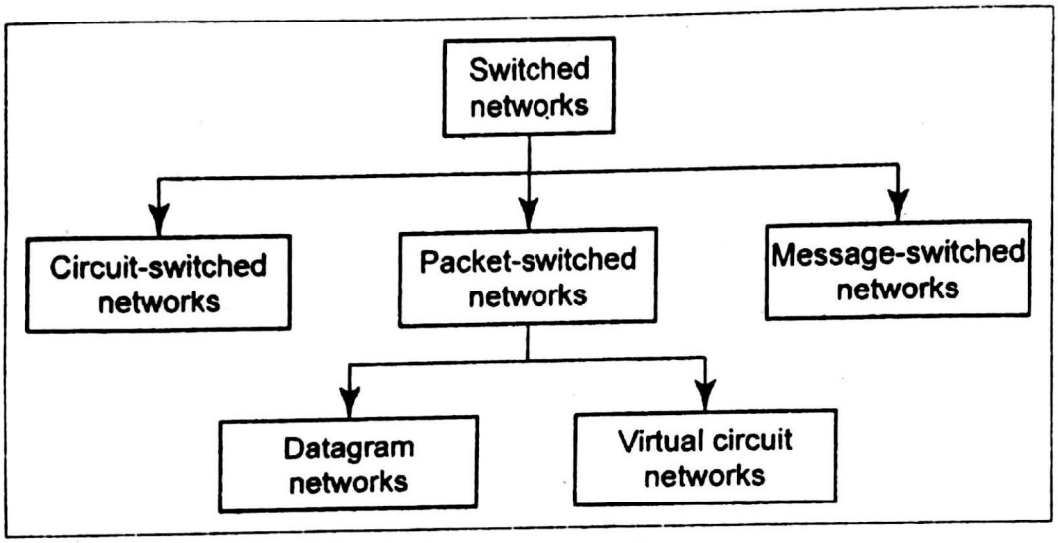

Fig.4.2. Types of switching

4.3. CIRCUIT-SWITCHED NETWORKS

4.3.1. Introduction:

✓ A circuit switch is a device with m inputs and n outputs, where m and n need not be equal. ***Circuit switching*** *creates a direct physical connection between two devices.*

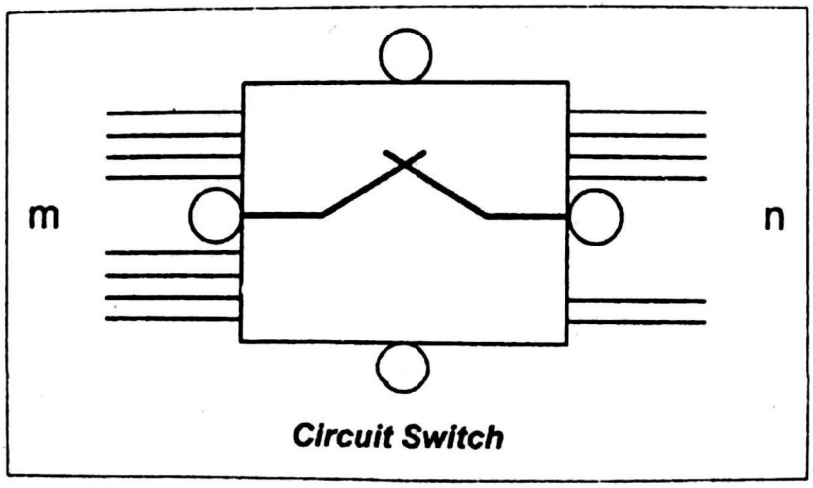

Fig 4.3

- ✓ *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.*
- ✓ Communication via circuit switching implies that there is a dedicated communication path between two stations. That path is a connected sequence of links between network nodes.
- ✓ In the circuit switching, the resources (channel) need to be reserved during the setup phase on each link.
- ✓ The circuit switching takes place at the ***physical layer***.

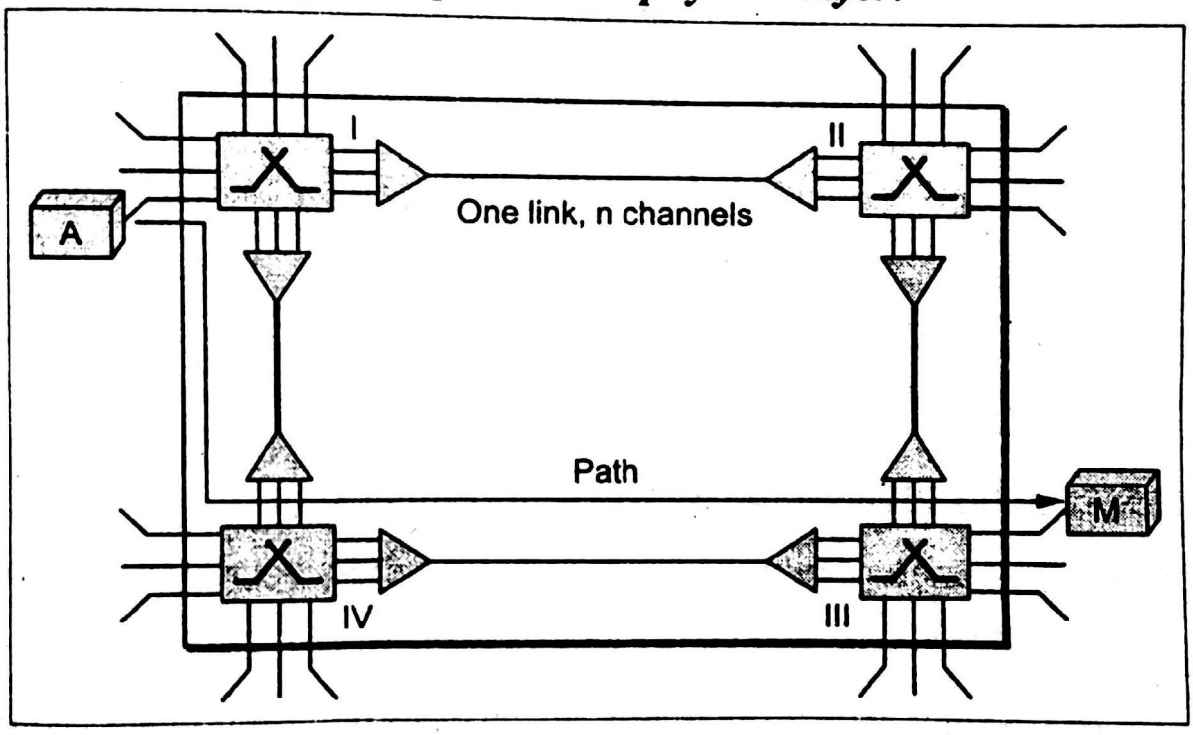

Fig.4.4. Circuit-switched network

- ✓ Here four switches are used and each link is divided into n (n=3) channels by using FDM or TDM. At the end, such as computers or telephones are connected to a switch.
- ✓ There is no addressing involved during data transfer. The switches route the data based on their occupied band (FDM) or time slot (TDM). There is end-to-end addressing used during the ***setup phase***.

4.3.3. Three Phases:

✓ Communication via circuit switching involves three phases:

(i) *Connection setup*

(ii) *Data transfer and*

(iii) *Connection teardown.*

➢ **Setup phase (connection establishment):**

✓ Before any signals can be transmitted, an end-to-end (station-to- station) circuit must be established.

✓ The end systems are normally connected through dedicated lines to the switches, so ***connection setup*** means ***creating dedicated channels (links)*** between switches.

➢ **Data transfer phase:**

✓ Data can now be transmitted from a node to another node through the network.

✓ The transmission may be ***analog or digital***, depending on the nature of the network.

➢ **Teardown Phase (Circuit Disconnect):**

After data transfer, the connection is terminated, usually by the one of the two stations.

4.3.4. Efficiency and Application:

➢ **Efficiency:**

Circuit switching is ***inefficient,*** because resources allocated during the entire duration of the connection, even if no data are being transferred.

➢ **Application:**

Switching at the physical layer in the traditional telephone (voice traffic) network uses the circuit-switching approach.

4.4. PACKET-SWITCHED NETWORKS

4.4.1. Introduction

- ✓ In the packet-switched network, the ***sending message*** is divided into ***packets*** of ***fixed*** or ***variable size***.
- ✓ Here, there ***is no resource allocation*** for ***a packets***. Resources are allocated based on demand.
- ✓ Each ***packet*** contains not only ***data*** but also a ***header*** with control information such as the sender's address and destination's address. The ***packets*** are sent over the network ***node to node***.
- ✓ At each ***node***, the packet is stored briefly then routed according to the information in its ***header***.

4.4.2. Advantages of Packet Switching Over Circuit Switching:

(i) Circuit switching is ***less*** suitable to ***data*** and other ***non-voice*** transmission. When circuit switched links are used for data transmission, much of the time the line is idle, a circuit-switching approach is ***inefficient***.

(ii) In a circuit-switching network, the connection provides for transmission at a ***constant data rate***. Thus each of the two devices that are connected must transmit and receive at the same data rate as the other. This limits the ***utility of the network*** in interconnecting a variety of host computers and workstations.

(iii) Circuit switching is ***inflexible***. Once a circuit has been established, that circuit is the path taken by all parts of the transmission whether or not it remains the most efficient.

(iv) Circuit switching sees all ***transmissions*** as ***equal*** i.e. ***no priority*** among the transmission of data.

Thus, a better solution for data transmission is ***packet switching***.

4.4.3. Approaches to packet switching:

There are two popular approaches to packet switching. They are

(i) Datagram Approach and

(ii) Virtual Circuit Approach.

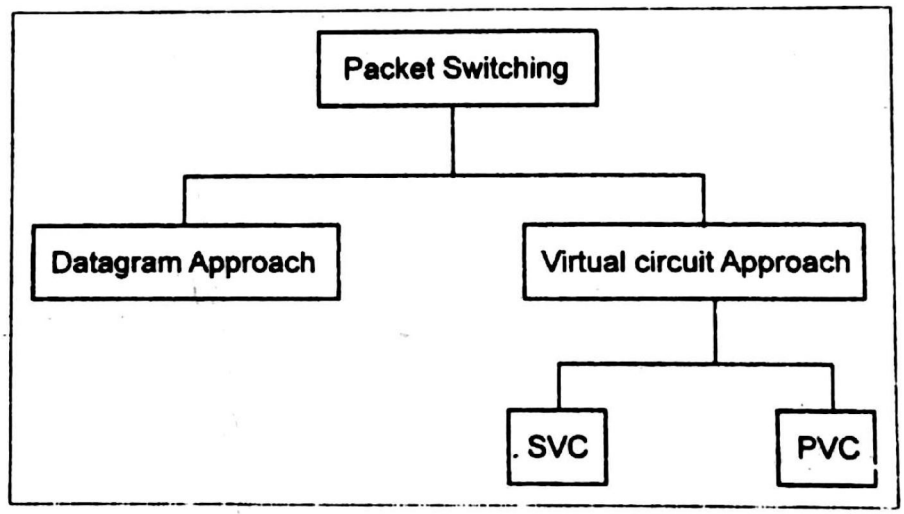

Fig.4.5. Packet switching approaches

4.4.3.1. Datagram Networks

4.4.3.1.1. Introduction:

- ✓ *In the **datagram approach**, each packet is **treated independently**, with no reference to packets that have gone before. Packets in this approach are referred to as **datagrams**. There are no setup or teardown phases.*
- ✓ In this example, all 4 packets belong to the ***same message*** but may go by ***different paths*** to reach the same ***destination X.***
- ✓ Datagram switching is normally done at the network layer.

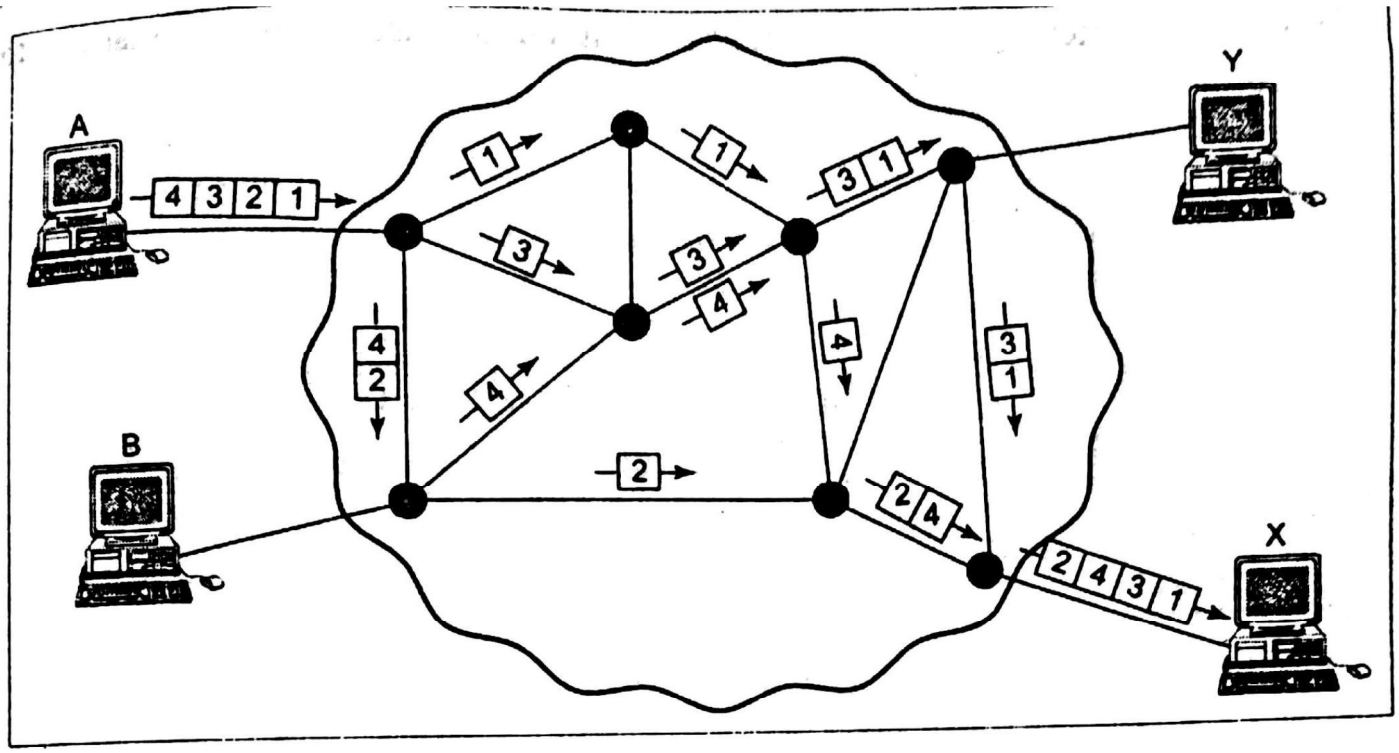

Fig.4.6. Datagram Approach

- ✓ The reason that the packets travel via different routes is that the routing decisions are taken for every packets separately, each time.
- ✓ As the network condition and congestion at different nodes/links differs every seconds, different packets may choose different routes based on the situation at that time.
- ✓ The datagram networks are sometimes referred to as ***connectionless networks***. The term connectionless here means that the switch (packet switch) does not keep information about the connection state.

4.4.3.1.2. Routing Table:

- ✓ A switch in a datagram network uses a routing table that is ***based on the destination address***. The routing tables are ***updated periodically***.

Destination address	Output port
4321	1
2242	2
.	.
.	.
.	.
1321	5

Fig.4.7. Routing table

- ✓ The destination addresses and the corresponding forwarding ***output ports*** are recorded in the tables.
- ✓ The destination address in the header of a packet in a datagram network remains the ***same*** during the ***entire journey*** of the packet.

➢ **Efficiency:**

The efficiency of a datagram network is ***better*** than that of a circuit-switched network because the resources are allocated only when there are packets to be transferred.

➢ **Application:**

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

➢ **Advantages:**

- ✓ One advantage of the datagram approach is that the ***call setup phase*** is ***avoided***. Thus, if a station wishes to send only one or a few packets, ***data gram delivery*** will be ***quicker.***
- ✓ It is ***more flexible*** and ***reliable***. For example, if congestion develops in one part the network, incoming datagrams can be routed away from congestion.
- ✓ With datagram delivery, if a node fails, subsequent packets may find an alternate route that bypasses that node.

4.4.3.2. Virtual Circuit Approach

4.4.3.2.1. Introduction:

- ✓ *A virtual-circuit network is a cross between a circuit-switched network and a datagram network.*
- ✓ In the virtual circuit approach, "*a preplanned route is established before any packets are sent (data transfer)*". This is not dedicated path, as in circuit switching.
- ✓ Once the route is established, all the packets between a pair of communicating parties follow this same route through the network.

✓ A ***virtual-circuit*** network is normally implemented in the ***data link layer,*** while a ***circuit-switched*** network is implemented in the ***physical layer*** and a ***datagram*** network in the ***network layer.***

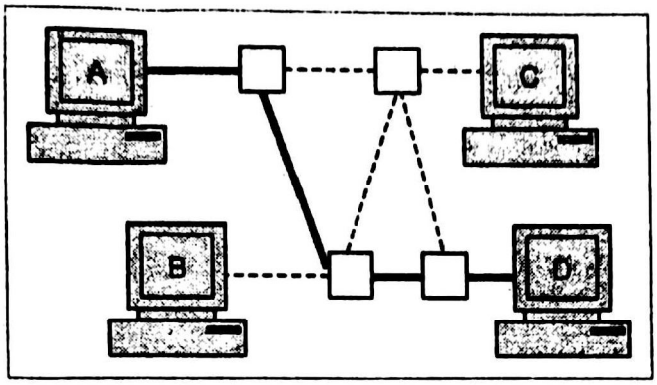

Fig.4.8.(a)

✓ During the ***connection establishment phase,*** one of the available paths is selected. This path is called as ***virtual circuit.*** This path is shown with thick lines; other available paths are shown with dashed lines.

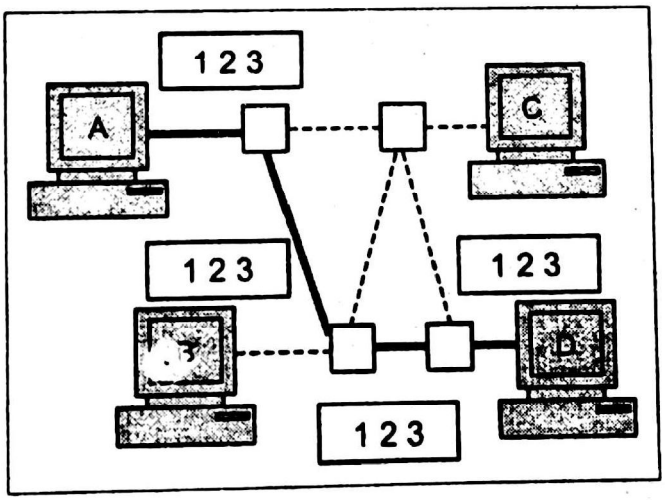

Fig.4.8.(b)

✓ Now all the packets travel via the same route from A to D in the ***data transfer phase.*** In this phase, all the packets travel in the same sequence from the source to the destination.

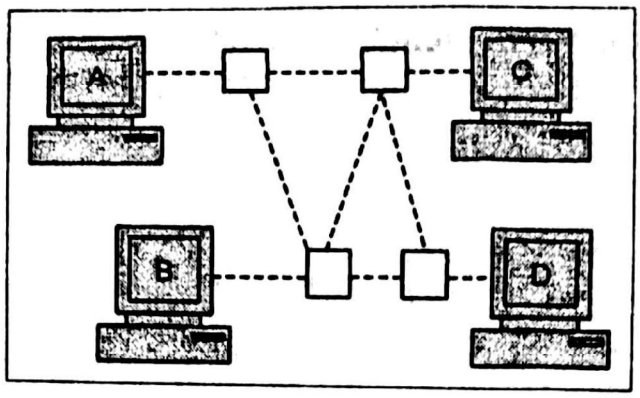

Fig.4.8.(c)

✓ In the connection release phase, the virtual circuit is released. That is, the path established during the virtual circuit is now the same as any other path.

4.4.3.2.2. Addressing:

In a virtual-circuit network, two addressing are involved:

(i) Global Addressing

(ii) Local Address(virtual –circuit identifier)

➢ **Global addressing:**

✓ *Global address is an address that is needs for a source or destination if the network is part of an international network.*

✓ Global address in virtual-circuit network is used only to create a Virtual – Circuit Identifier (VCI).

➢ **Virtual Circuit Identifier:**

✓ ***The virtual circuit identifier*** *is a small number in a data frame changes from one switch to another switch used for data transfer.*

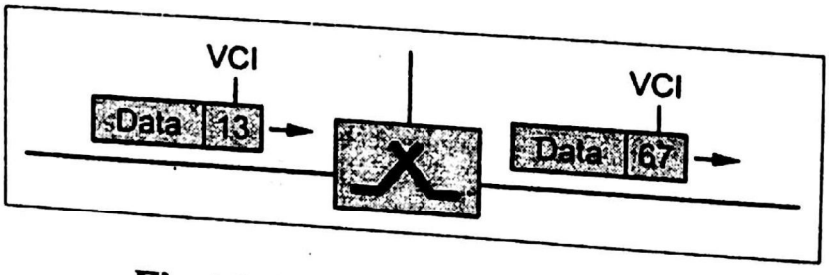

Fig.4.9. Virtual-circuit identifier

❖ Virtual circuit is implemented in two formats,

→ *Switched Virtual Circuit (SVC)*

→ *Permanent virtual Circuit (PVC)*

SVC: *In this method, a **virtual circuit** is created whenever it is needed and exists only for the duration of the specific exchanges.*

PVC: The ***virtual circuit*** is provided between ***two users*** on a ***continuous basis***.

4.4.3.2.3. Three Phases:

Three phases in virtual-circuit network are

(i) *Setup phase,*

(ii) *Data transfer and*

(iii) *Teardown.*

➢ **Setup Phase:**

In the setup phases, the source and destination use their global addresses to help switches make table entries for the connection.

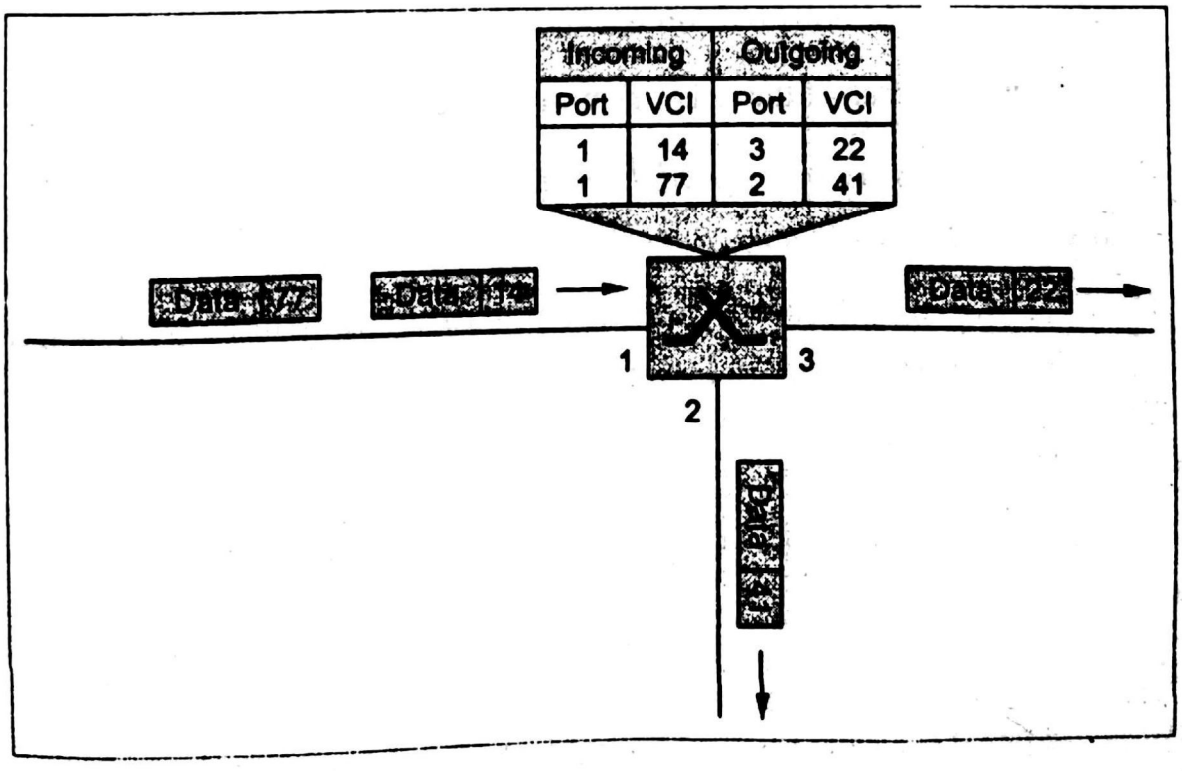

Fig.4.10. Switch and tables in a virtual-circuit network

➢ **Data Transfer Phase:**

- ✓ To transfer a frame from a source to its destination, all switches need to have a table entry for virtual circuit.
- ✓ The data transfer phase is active until the source sends all its frames to the destination.

➢ **Teardown Phase:**

- ✓ In this phase, Source is sending all frames to destination. After that it sends a special frame called a ***teardown request***.
- ✓ If destination responds with a teardown confirmation frame, all switches delete the corresponding entry from their tables.

4.4.3.2.4. Advantages and disadvantages:

➢ **Advantages:**

(i) Virtual circuit networks, including ***sequencing*** and ***error control (reliable)***

- *Sequencing refers that all packets follow the same route, they arrive in the original order.*
- *Error control means that all packets arrive correctly.*

(ii) Packets should transit the network more rapidly with a virtual network.

- *Here packets follow a predefined route, and thus it is more difficult for the network to adopt to congestion.*

(iii) Here ***resource allocation*** is on ***demand***. The source can check the availability of the resources, without actually reserving it.

➢ **Disadvantage:**

With the use of virtual circuits, if a node fails, all virtual circuits that pass through that node are lost.

➢ **Switched WAN:**

Switched WAN is normally implemented by using virtual-circuit techniques.

4.5. COMPARISON OF COMMUNICATION SWITCHING TECHNIQUES

Circuit switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Messages are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversion.	Route established for each packet	Route established for entire conversion
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; packet transmission delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets.	Network may be responsible for packet sequences.
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packets	Overhead bits in each packets