

# Switching

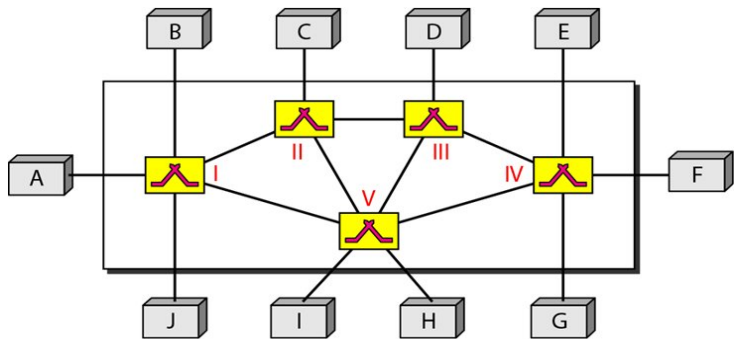
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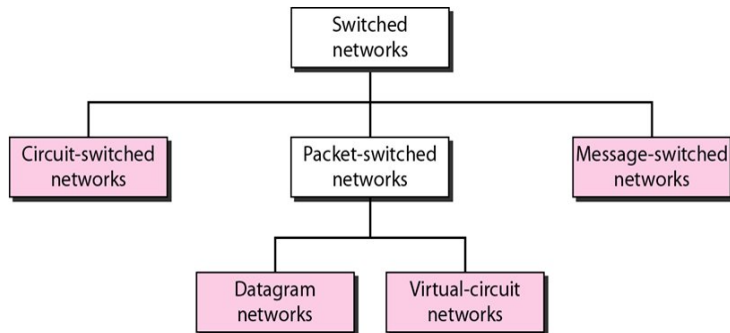
# Switching

- ∞ 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



# Taxonomy of Switched Networks

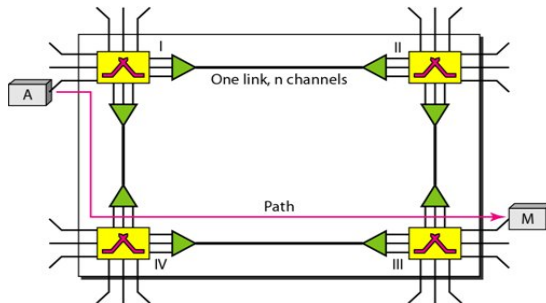


## ∞ Message-Switched Network:

- ✓ Has been phased-out in general communication.
- ✓ Each switch, stores the *whole message* and forwards it to the next switch.
- ✓ Because of this it is also known as a 'store-and-forward' 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 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.



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

# Circuit Switching

## Setup Phase

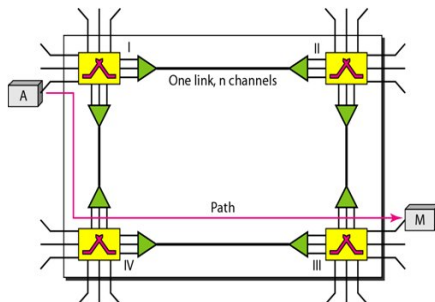
If A needs to communicate with M... It sends a request to M that must be accepted by all switches and M. This is called **setup phase**. A circuit (channel) is reserved on each link and forms a dedicated path between A and M.

## Data Transfer

After the dedicated path is established, **data transfer**, can take place between A and M.

## Teardown Phase

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.

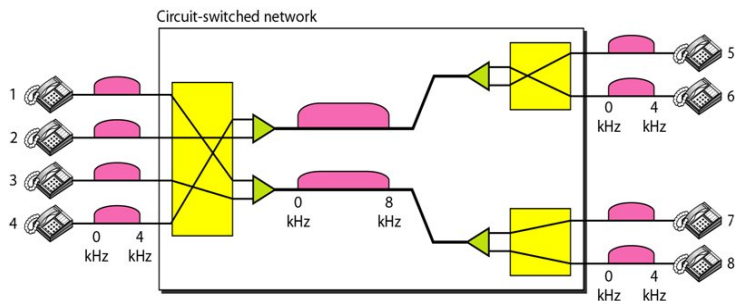
The data transferred between two station is not packetized. The data are a continuous flow sent by the source to the destination.

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

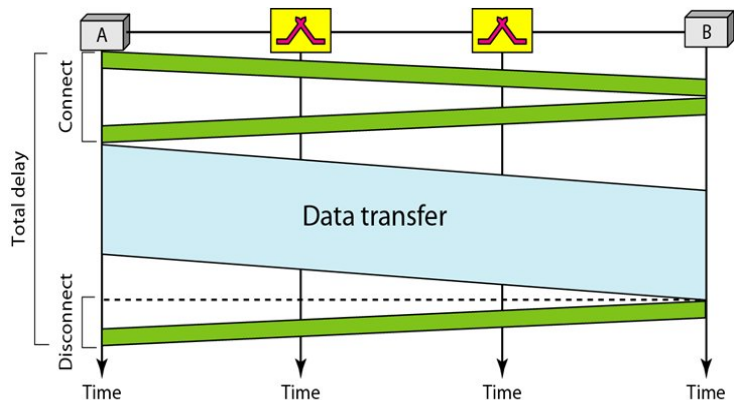
## Efficiency:

- ∞ 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 Switching Network

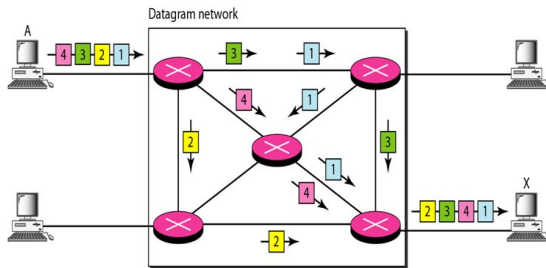


Total Delay = time needed for the setup phase + data transfer phase + teardown phase

# 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 Networks with Four Switches (Routers)

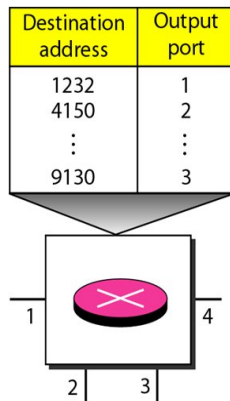


- ∞ Each packet is treated independently.
- ∞ Packet in this approach are referred as datagrams.
- ∞ Normally done at the network layer.
- ∞ Sometimes also known as connectionless networks.
- ∞ No setup or teardown phase.

# 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 Networks

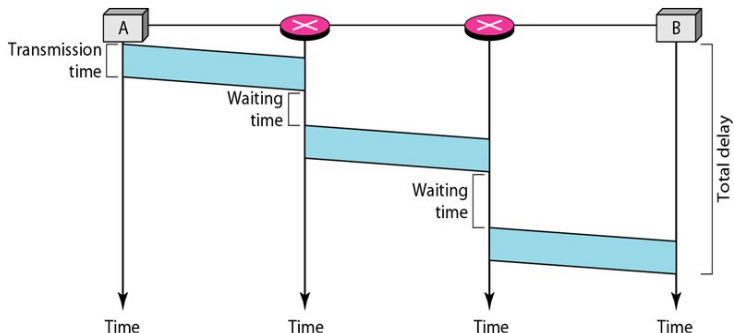
## Efficiency:

- ∞ 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

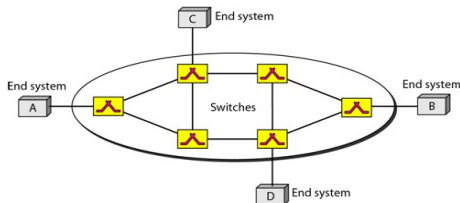


- Switching in Internet is done by using the datagram approach to packet switching at the network layer.



# Virtual-Circuit Networks

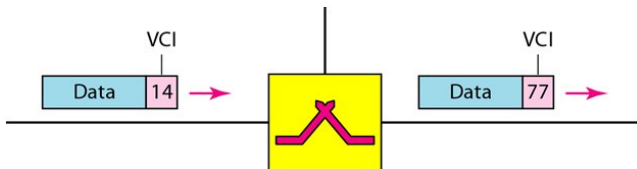
- ∞ Virtual-circuit network is a cross between circuit-switched & datagram network.
- ∞ It has characteristics of both.
  - ✓ As in circuit-switched network, there are setup and teardown phases
  - ✓ Resources can be allocated during setup phase as in circuit-switched network or on demand as in datagram 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.

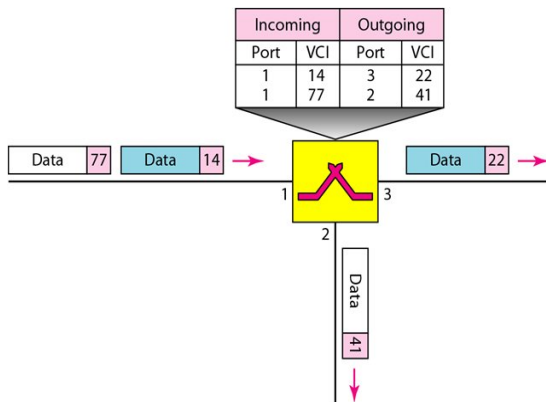


# Virtual-Circuit Networks

## ∞ Three phases:

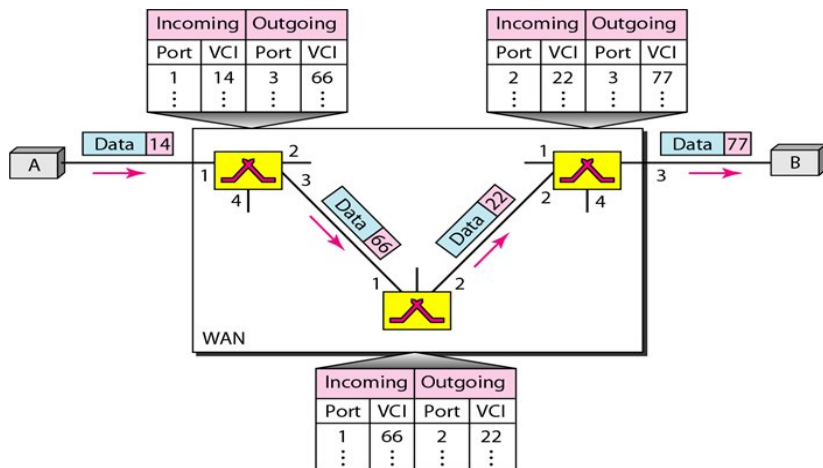
- ✓ **Setup phase:** the source and the destination use their global addresses to help switches make table entries for the connection. It needs two steps: **setup request** and **acknowledgement**.
- ✓ **Data transfer phase:**
- ✓ **Teardown phase:** the source and the destination informs the switches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

# Tables in a Virtual-Circuit Networks

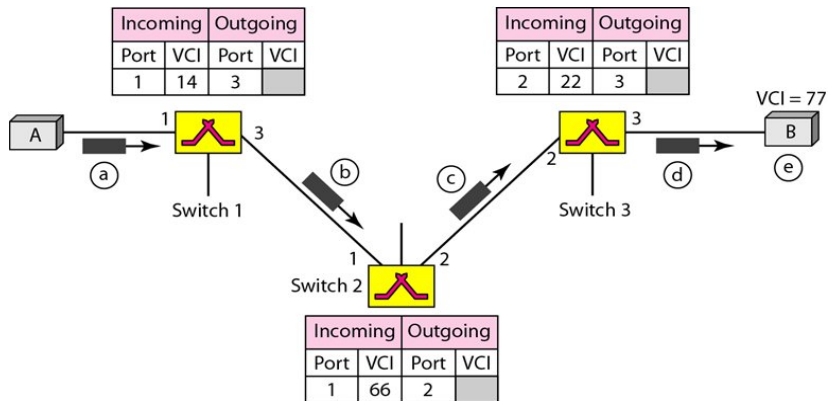


- ∞ All switches need to have a table entry for each virtual circuit.
- ∞ A simple table, shown above, has four columns.

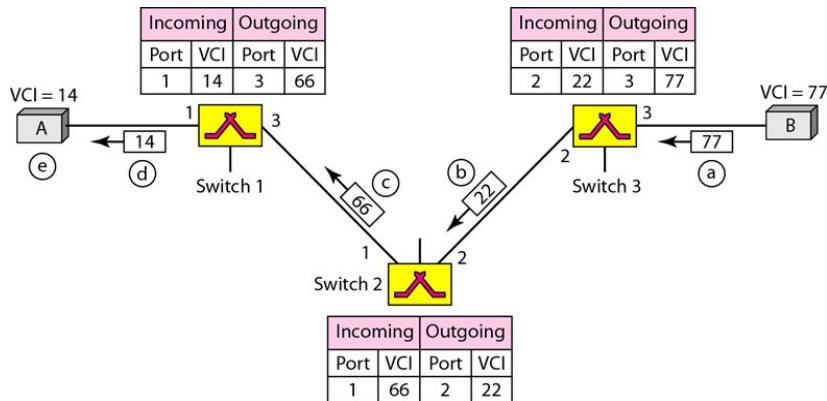
# Source-To-Destination Data Transfer in a VC Networks



# Setup Request in a VC Networks



# Setup Acknowledgment in a VC Networks



# Virtual-Circuit Networks

## ∞ 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-Circuit Network

