UNIT IV Ethernet and Switching Technique

Switching Techniques

"switching is an important technique that can determine **how connections are made & how data movement** is handled on a WAN". Switching sends data along different routes. Three major switching techniques are—

1. Circuit switching
2. Message switching
3. Packet switching

Circuit Switching

The term *circuit switching* refers to a communication mechanism that establishes a path between a sender and receiver with guaranteed isolation from paths used by other pairs of senders and receivers. Circuit switching is usually associated with telephone technology because a telephone system provides a dedicated connection between two telephones. In fact, the term originated with early dialup telephone networks that used electromechanical switching devices to form a physical circuit. Figure 13.1 illustrates how communication proceeds over a circuit-switched network.

circuit-switched network

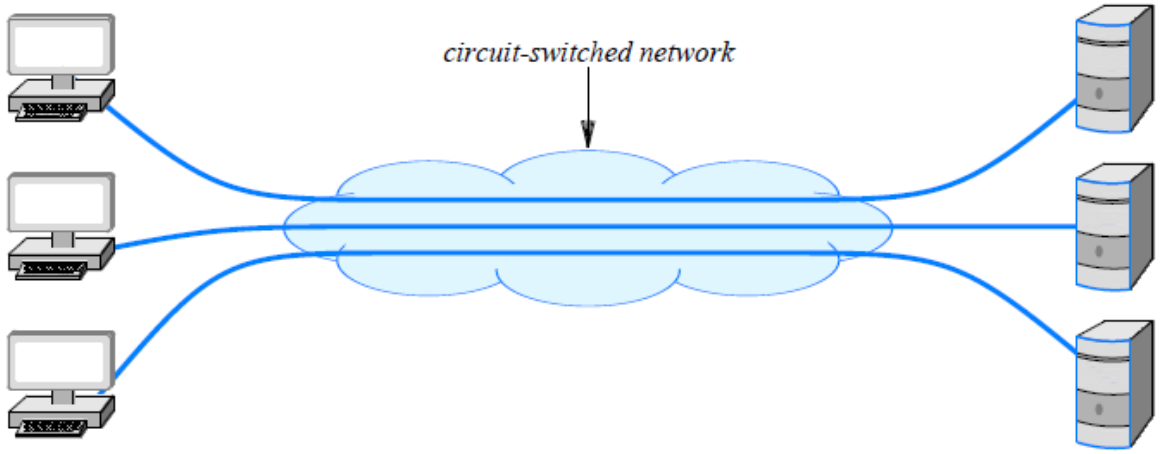


Figure 13.1 A circuit-switched network that provides a direct connection between each pair of communicating entities.

Currently, circuit switching networks use electronic devices to establish circuits. Furthermore, instead of having each circuit correspond to a physical path, multiple circuits
are multiplexed over shared media, and the result is known as a *virtual circuit*.

Thus, the distinction between circuit switching and other forms of networking does not
arise from the existence of separate physical paths. Instead, three general properties define a circuit switched paradigm:

- Point-to-point communication
- Separate steps for circuit creation, use, and termination
- Performance equivalent to an isolated physical path

The first property means that a circuit is formed between exactly two endpoints, and the second property distinguishes circuits that are *switched* (i.e., established when needed) from circuits that are *permanent* (i.e., always remain in place ready for use). Switched circuits use a three-step process analogous to placing a phone call. In the first step, a circuit is established. In the second, the two parties use the circuit to communicate, and in the third, the two parties terminate use.

The third property provides a crucial distinction between circuit switched networks and other types. Circuit switching means that the communication between two parties is not affected in any way by communication among other parties, even if all communication
is multiplexed over a common medium. In particular, circuit switching must provide the illusion of an isolated path for each pair of communicating entities. Thus, techniques such as frequency division multiplexing or synchronous time division multiplexing must be used to multiplex circuits over a shared medium.

The point is:

Circuit switching provides the illusion of an isolated physical path between a pair of communicating entities; a path is created when needed, and discontinued after use.

Advantages Of Circuit Switching:

- In the case of Circuit Switching technique, the communication channel is dedicated.
- It has fixed bandwidth.

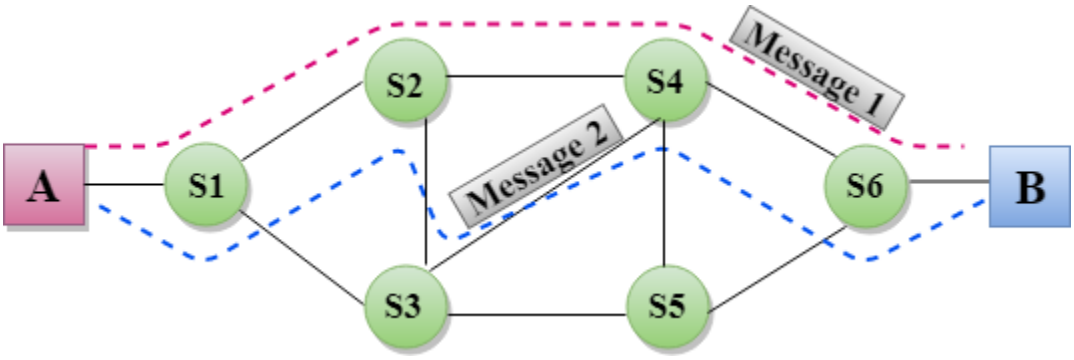
Disadvantages Of Circuit Switching:

- Once the dedicated path is established, the only delay occurs in the speed of data transmission.
- It takes a long time to establish a connection approx 10 seconds during which no data can be transmitted.
- It is more expensive than other switching techniques as a dedicated path is required for each connection.

- It is inefficient to use because once the path is established and no data is transferred, then the capacity of the path is wasted.
- In this case, the connection is dedicated therefore no other data can be transferred even if the channel is free.

Message Switching

- Message Switching is a switching technique in which a message is transferred as a complete unit and routed through intermediate nodes at which it is stored and forwarded.
- In Message Switching technique, there is no establishment of a dedicated path between the sender and receiver.
- The destination address is appended to the message. Message Switching provides a dynamic routing as the message is routed through the intermediate nodes based on the information available in the message.
- Message switches are programmed in such a way so that they can provide the most efficient routes.
- Each and every node stores the entire message and then forward it to the next node. This type of network is known as **store and forward network.**
- Message switching treats each message as an independent entity.



Advantages Of Message Switching

- Data channels are shared among the communicating devices that improve the efficiency of using available bandwidth.
- Traffic congestion can be reduced because the message is temporarily stored in the nodes.
- Message priority can be used to manage the network.

- The size of the message which is sent over the network can be varied. Therefore, it supports the data of unlimited size.

Disadvantages Of Message Switching

- The message switches must be equipped with sufficient storage to enable them to store the messages until the message is forwarded.
- The Long delay can occur due to the storing and forwarding facility provided by the message switching technique.

Packet Switching

The main alternative to circuit switching, *packet switching*, forms the basis for the Internet. A packet switching system uses statistical multiplexing in which communication from multiple sources competes for the use of shared media. Figure 13.2 illustrates
the concept.
packet-switched network

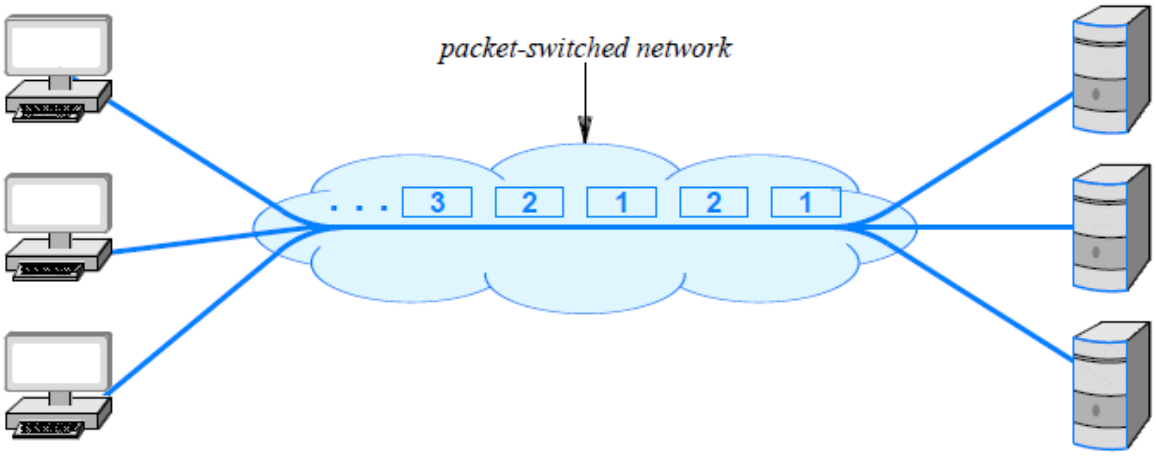


Figure 13.2 A packet-switched network sending one packet at a time across a shared medium. The chief difference between packet switching and other forms of statistical multiplexing arises because a packet switching system requires a sender to divide each message
into blocks of data that are known as *packets*. The size of a packet varies; each packet switching technology defines a maximum packet size†.
†Packets are not large: a common maximum packet size is 1500 bytes.

Three general properties define a packet switched paradigm:

- Arbitrary, asynchronous communication
- No set-up required before communication begins
- Performance varies due to statistical multiplexing among packets

The first property means that packet switching can allow a sender to communicate with one recipient or multiple recipients, and a given recipient can receive messages from one sender or multiple senders. Furthermore, communication can occur at any
time, and a sender can delay arbitrarily long between successive communications.
The second property means that, unlike a circuit switched system, a packet switched system remains ready to deliver a packet to any destination at any time. Thus, a sender does not need to perform initialization before communicating, and does not need to notify the underlying system when communication terminates.
The third property means that multiplexing occurs among packets rather than among bits or bytes. That is, once a sender gains access to the underlying channel, the sender transmits an entire packet, and then allows other senders to transmit a packet. When no other senders are ready to transmit a packet, a single sender can transmit repeatedly. However, if *N* senders each have a packet to send, a given sender will
transmit approximately 1/*N* of all packets.
To summarize:
Packet switching, which forms the basis of the Internet, is a form of statistical multiplexing that permits many-to-many communication. A sender must divide a message into a set of packets; after transmitting a packet, a sender allows other senders to transmit before transmitting a successive packet.
One of the chief advantages of packet switching is the lower cost that arises from sharing. To provide communication among *N* computers, a circuit-switched network must have a connection for each computer plus at least *N/ 2* independent paths. With packet switching, a network must have a connection for each computer, but only requires one path that is shared.

Advantages Of Packet Switching:

- **Cost-effective:** In packet switching technique, switching devices do not require massive secondary storage to store the packets, so cost is minimized to some extent. Therefore, we can say that the packet switching technique is a cost-effective technique.
- **Reliable:** If any node is busy, then the packets can be rerouted. This ensures that the Packet Switching technique provides reliable communication.

- **Efficient:** Packet Switching is an efficient technique. It does not require any established path prior to the transmission, and many users can use the same communication channel simultaneously, hence makes use of available bandwidth very efficiently.

Disadvantages Of Packet Switching:

- Packet Switching technique cannot be implemented in those applications that require low delay and high-quality services.
- The protocols used in a packet switching technique are very complex and requires high implementation cost.
- If the network is overloaded or corrupted, then it requires retransmission of lost packets. It can also lead to the loss of critical information if errors are nor recovered.

Ethernet Technology:

a) Overview of Ethernet

Ethernet is the name given to a popular packet-switched LAN technology invented at **Xerox PARC** in the early 1970s. Xerox Corporation, Intel Corporation, and Digital Equipment Corporation standardized Ethernet in 1978; IEEE released a compatible version of the standard using the standard number 802.3. Ethernet has become the most popular LAN technology.

IEEE 802.3 is a working group and a collection of IEEE standards produced by the working group defining the physical layer and data link layer's media access control (MAC) of wired Ethernet. This is generally a local area network technology with some wide area network applications. Physical connections are made between nodes and/or infrastructure devices (hubs, switches, routers) by various types of copper or fiber cable.

802.3 is a technology that supports the IEEE 802.1 network architecture.

802.3 also defines LAN access method using CSMA/CD

 Is easy to understand, implement, manage, and maintain

 Allows low-cost network implementations

 Provides extensive topological flexibility for network installation

 Guarantees successful interconnection and operation of standards-compliant products, regardless of manufacturer

The original IEEE 802.3 standard was based on, and was very similar to, the Ethernet Version 1.0 specification. The draft standard was approved by the 802.3

working group in 1983 and was subsequently published as an official standard in 1985 (ANSI/IEEE Std. 802.3-1985).

b) 10-Mbps Ethernet-10Base-T :

10Base-T provides Manchester-encoded 10-Mbps bit-serial communication over two unshielded twisted-pair cables. Although the standard was designed to support transmission over common telephone cable, the more typical link configuration is to use two pair of a four-pair Category 3 or 5 cable, terminated at each NIC with an 8-pin RJ-45 connector (the MDI), as shown in Figure: The Typical 10Base-T Link Is a Four-Pair UTP Cable in Which Two Pairs Are Not Used pair is configured as a simplex link where transmission is in one direction only, the 10Base-T physical layers can support either half-duplex or full-duplex operation.

Although 10Base-T may be considered essentially obsolete in some circles, it is included here because there are still many 10Base-T Ethernet networks, and because full-duplex operation has given 10BaseT an extended life.

IEEE 802. Standards:

802.1 Internetwork & Network Managment.
802.2 LLC
802.3 Ethernet (wired Network)
804.4 Tokan Bus
802.5 Define a Mac layer for Tokan Ring.
802.6 MAN
802.7 Broadband LAN using Co-Ax cable.
802.8 Fiber Optic
802.9 Integrated Service LAN.
802.10 LAN Security
802.11 Wireless

10Base-T was also the first Ethernet version to include a link integrity test to determine the health of the link. Immediately after power up, the PMA transmits a normal link pulse (NLP) to tell the NIC at the other end of the link that this NIC wants to establish an active link connection:

c) 100 Mbps-Fast Ethernet

Increasing the Ethernet transmission rate by a factor of ten over 10Base-T was not a simple task, and the effort resulted in the development of three separate physical layer standards for 100 Mbps over UTP cable: 100Base-TX and 100Base-T4 in 1995, and 100Base-T2 in 1997. Each was defined with different encoding requirements and a different set of media-dependent sublayers, even though there is some overlap in the link cabling.

Although not all three 100-Mbps versions were successful in the marketplace, all three have been discussed in the literature, and all three did impact future designs. As such, all three are important to consider here.

100Base-X

100Base-X was designed to support transmission over either two pairs of Category 5 UTP copper wire or two strands of optical fiber. Although the encoding, decoding, and clock recovery procedures are the same for both media, the signal transmission is different-electrical pulses in copper and light pulses in optical fiber. The signal transceivers that were included as part of the PMA function in the generic logical model of the following figure were redefined as the separate physical media-dependent (PMD) sublayers shown in Figure: The 100Base-X Logical Model.

The 100Base-X encoding procedure is based on the earlier FDDI optical fiber physical media-dependent and FDDI/CDDI copper twisted-pair physical media-dependent signaling standards developed by ISO and ANSI. The 100Base-TX physical media-dependent sublayer (TP-PMD) was implemented with CDDI semiconductor transceivers and RJ-45 connectors; the fiber PMD was implemented with FDDI optical transceivers and the Low Cost Fibre Interface Connector (commonly called the duplex SC connector).

The 4B/5B encoding procedure is the same as the encoding procedure used by FDDI, with only minor adaptations to accommodate Ethernet frame control. Each 4-bit data nibble (representing half of a data byte) is mapped into a 5-bit binary code-group that is transmitted bit-serial over the link.

Four control code-groups that are transmitted as code-group pairs to indicate the start-of-stream delimiter (SSD) and the end-of-stream delimiter (ESD). Each MAC frame is "encapsulated" to mark both the beginning and end of the frame. The first byte of preamble is replaced with SSD code-group pair that precisely identifies the frame's code-group boundaries. The ESD code-group pair is appended after the frame's FCS field.

A special IDLE code-group that is continuously sent during inter frame gaps to maintain continuous synchronization between the NICs at each end of the link. The receipt of IDLE is interpreted to mean that the link is quiet.

Eleven invalid code-groups that are not intentionally transmitted by a NIC (although one is used by a repeater to propagate receive errors). Receipt of any invalid code-group will cause the incoming frame to be treated as an invalid frame.

d) 100Base-T4 :

100Base-T4 was developed to allow 10BaseT networks to be upgraded to 100-Mbps operation without requiring existing four-pair Category 3 UTP cables to be replaced with the newer Category 5 cables. Two of the four pairs are configured for half-duplex operation and can support transmission in either direction, but only

in one direction at a time. The other two pairs are configured as simplex pairs dedicated to transmission in one direction only. Frame transmission uses both half-duplex pairs, plus the simplex pair that is appropriate for the transmission direction, as shown in Figure: The 100Base-T4 Wire-Pair Usage During Frame Transmission. The simplex pair for the opposite direction provides carrier sense and collision detection. Full-duplex operation cannot be supported on 100Base-T4.

e) CSMA/CD:

Ethernet devices can operate either at half-duplex, or full-duplex. At half duplex, devices can either transmit or receive data, but not simultaneously.

Full-duplex allows devices to both transmit and receive at the same time. Devices connected to a hub can only operate at half-duplex, whereas devices connected to a switch can operate at full-duplex. Half-duplex Ethernet uses Carrier Sense Multiple Access with Collision Detect (CSMA/CD) to control media access.

Devices monitor the physical link, and will only transmit a frame if the link is idle. If two devices send a packet simultaneously, a collision will occur. When a collision is detected, both NICs will wait a random amount of time before resending their respective packets. Full-duplex Ethernet does not use CSMA/CD.

CSMA/CD logic helps prevent collisions and also defines how to act when a collision does occur. The CSMA/CD algorithm works like this:

Step 1 A device with a frame to send listens until the Ethernet is not busy.

Step 2 When the Ethernet is not busy, the sender(s) begin(s) sending the frame.

Step 3 The sender(s) listen(s) to make sure that no collision occurred.

Step 4 If a collision occurs, the devices that had been sending a frame each send a jamming signal to ensure that all stations recognize the collision.

Step 5 After the jamming is complete, each sender randomizes a timer and waits that long before trying to resend the collided frame.

Step 6 When each random timer expires, the process starts over with Step 1.