Open system Interconnection (OSI)
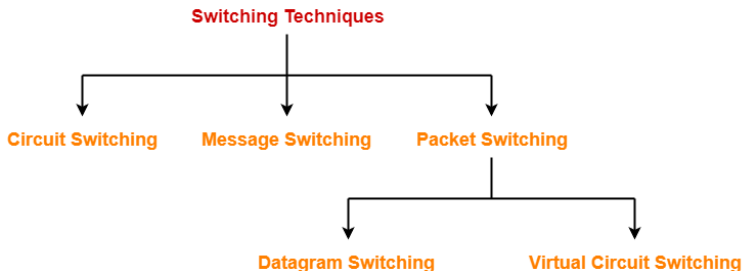## Switching

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Switching

- The process of moving the data packets towards their destination by forwarding them from one port to the other port is called as switching.
- Various switching techniques are-

Switching Techniques

Circuit Switching   **Message Switching**   **Packet Switching**

Datagram Switching   **Virtual Circuit Switching**

Circuit Switching

- This switching technique operates in the following three phases-
    1. Establishing a circuit
    2. Transferring the data
    3. Disconnecting the circuit
- Establishing A Circuit:
    - A circuit is established between the two ends.
    - Circuit provides a dedicated path for data to travel from one to the other end.
    - Resources are reserved at intermediate switches which are used during the transmission.
    - The intermediate switches are connected by the physical links.

Circuit Switching Cont...

- Transferring The Data: After the circuit is established
  - The entire data travels over the dedicated path from one end to the other end.
- Disconnecting The Circuit: After the data transfer is completed
  - The circuit is torn down i.e. disconnected.
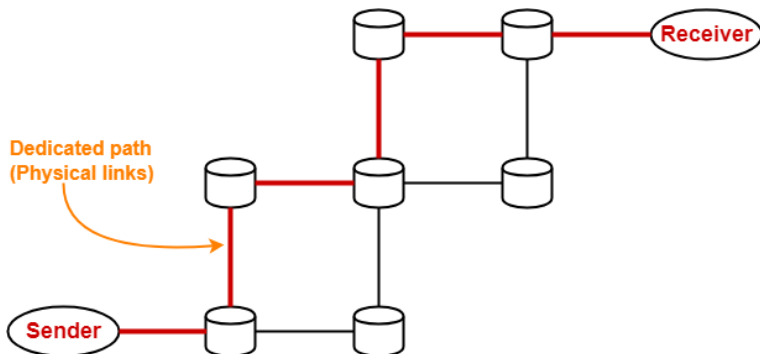
Total Time

- Total time taken to transmit a message in circuit switched network = Connection set up time + Transmission delay + Propagation delay + Tear down time
- Transmission delay = Message size / Bandwidth
- Propagation delay = (Number of hops on way x Distance between 2 hops) / Propagation speed
- **Advantages:**
  - A well defined and dedicated path exists for the data to travel.
  - There is no header overhead.
  - There is no waiting time at any switch and the data is transmitted without any delay.
  - Data always reaches the other end in order.
  - No reordering is required.

Circuit Switching Cont...

- **Disadvantages:**
  - The channel is blocked for two ends only.
  - It is inefficient in terms of utilization of system resources.
  - The time required for establishing the circuit between the two ends is too long.
  - Dedicated channels require more bandwidth.
  - It is more expensive than other switching techniques.
  - Routing decisions can not be changed once the circuit is established.
- **Notes**
  - Circuit switching is implemented at physical layer.
  - Circuit switching is now outdated.
- Q Consider all links in the network use TDM with 24 slots and have a data rate of 1.536 Mbps. Assume that host A takes 500 msec to establish an end to end circuit with host B before begin to transmit the file. If the file is 512 kilobytes, then how much time will it take to send the file from host A to host B?

Problem on Switching

- **Solution**-
  - Total bandwidth $= 1.536$ Mbps
  - Bandwidth is shared among 24 slots
  - Connection set up time $= 500$ msec
  - File size $= 512$ KB
  - **Calculating Bandwidth Per User**
    Total bandwidth $=$ Number of users x Bandwidth per user
    Bandwidth per user $=$ Total bandwidth / Number of users
    $= 1.536$ Mbps / 24
  - **Calculating Transmission Delay**
    Transmission delay (Tt) $=$ File size / Bandwidth
    $= (512 \times 2^{10} \times 8 \text{ bits}) / (64 \times 10^3 \text{ bits per sec})$
  - **Calculating Time Required To Send File**-
    Time taken to send a file in circuit switched network
    $=$ Connection set up time $+$ Transmission delay

Message Switching

- **In message switching**
  - There exists no dedicated path to transfer data.
  - The entire message is treated as a single data unit.
  - The message is then forwarded from hop to hop.
  - Store and Forward is an important characteristic of message switching.
  - The message carries a header that contains the full information about the destination.
  - When any intermediate switch receives the message, it stores the entire message.
  - The message is stored until sufficient resources become available to transfer it to the next switch.
  - When resources become available, the switch forwards the message to the next switch.

Message Switching Cont...

- **Advantage**
  - Point-01:
    - It improves the channel efficiency over Circuit Switched Network. In circuit switched network, the channel is blocked for two ends only. But here, more devices can share the channel.
  - Point-02:
    - It is helpful in reducing traffic congestion.
    - The message may be temporarily stored in the route and then forwarded whenever required.
  - Point-03:
    - It is helpful in setting the message priorities due to store and forward technique.

- **Disadvantages**
  - It requires enough storage at every switch to accommodate the entire message during the transmission.
  - It is extremely slow due to store and forward technique. Also, the message has to wait until sufficient resources become available to transfer it to the next switch.

Packet Switching

- The entire message to be sent is divided into multiple smaller size packets.
- This process of dividing a single message into smaller size packets is called as packetization.
- These smaller packets are sent after the other.
- It gives the advantage of pipelining and reduces the total time taken to transmit the message.
- **Optimal Packet Size**
  - It may result in adverse effects.
  - It might increase the time taken to transmit the message.

Packet Switching

Q Consider
- There is a network having bandwidth of 1 MBps.
- A message of size 1000 bytes has to be sent.
- Packet switching technique is used.
- Each packet contains a header of 100 bytes.
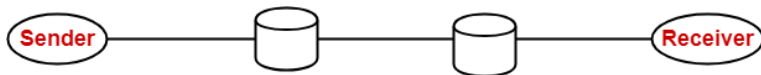
- Out of the following, in how many packets the message must be divided so that total time taken is minimum-
  - 1 packet
  - 5 packets
  - 10 packets
  - 20 packets
- **Note**
  - While calculating the total time, we often ignore the propagation delay.
  - The reason is in packet switching, transmission delay dominates over propagation delay.
  - This is because each packet is transmitted over the link at each hop.

- **Case-01: Sending Message in 1 Packet-**
    - **Size Of Packet**
        - Packet size = 1000 bytes of data + 100 bytes of header
    - **Transmission Delay-**
        - Transmission delay = Packet size / Bandwidth
    - **Total Time Taken**
        - Total time taken to send the complete message from sender to receiver = 3 x Transmission delay
- **Sending Message in 5 Packets**
    - **Data Sent in One Packet**
        - Data sent in one packet = Total data to be sent / Number of packets
        - = 1000 bytes / 5
    - **Size Of One Packet**
        - Packet size = 200 bytes of data + 100 bytes of header
    - **Transmission Delay**
        - Transmission delay = Packet size / Bandwidth = 300 bytes / 1 MBps
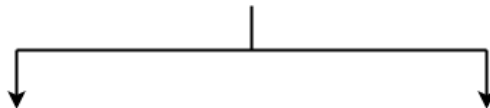   - **Total Time Taken**
        - Total time taken to send the complete message from sender to receiver = 3 x Transmission delay

Types of Packet Switching

- Packet switching may be carried out in the following 2 ways-

Types of Packet Switching

Virtal Circuit Switching　　　　**Datagram Switching**

- **Virtual Circuit Switching**
  - Establishing a circuit
  - Transferring the data
 - Disconnecting the circuit
- **Establishing A Circuit**
  - A logical connection is established between the two ends.
  - It provides a dedicated path for data to travel from one to the other end.
  - Resources are reserved at intermediate switches which are used during the transmission.

Types of Packet Switching Cont...

- **Transferring The Data** After the connection is established
  - The entire data travels over the dedicated path from one end to the other end.
- **Disconnecting The Circuit** After the data transfer is completed
  - The connection is disconnected.
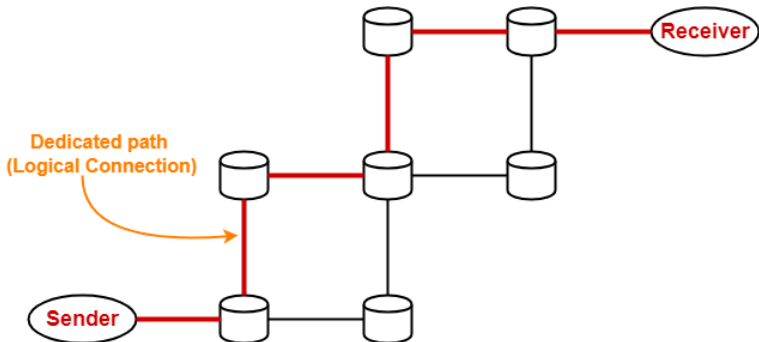
Types of Packet Switching Cont...

- **Datagram Switching**
  - There exists no dedicated path for data to travel.
  - The header of each packet contains the destination address.
  - When any intermediate switch receives the packet, it examines its destination address.
  - It then consults the routing table.
  - Routing table finds the corresponding port through which the packet should be forwarded.

Virtual Circuit Switching Vs Datagram Switching

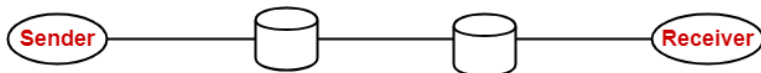| Virtual Circuit Switching	Datagram Switching
The first packet during its transmission- 1) Informs the intermediate switches that more packets are following. 2) Reserve resources (CPU, bandwidth and buffer) for the following packets at all the switches on the way.	The first packet does not perform any such task during its transmission.
The packets are never discarded at intermediate switches and immediately forwarded since resources are reserved for them.	The packets may be discarded at intermediate switches if sufficient resources are not available to process the packets.
It is a connection oriented service since resources are reserved for the packets at intermediate switches.	It is a connection less service since no resources are reserved for the packets.
All the packets follow the same dedicated path.	All the packets take path independently.
Data appears in order at the destination since all the packets take the same dedicated path.	Data may appear out of order at the destination since the packets take path independently.

Virtual Circuit Switching Vs Datagram Switching

It is highly reliable since no packets are discarded.	It is not reliable since packets may be discarded.
It is costly.	It is cost effective.
Only first packet requires a global header which identifies the path from one end to other end. All the following packets require a local header which identifies the path from hop to hop.	All the packets require a global header which contains full information about the destination.
ATM (Asynchronous Transfer Mode) uses virtual circuit switching.	IP Networks use datagram switching.
Virtual circuit switching is normally implemented at data link layer.	Datagram switching is normally implemented at network layer.

Problem on Packet Switching

Q In a packet switching network, packets are routed from source to destination along a single path having two intermediate nodes. If the message size is 24 bytes and each packet contains a header of 3 bytes, then the optimum packet size is-

1. 4 bytes
2. 6 bytes
3. 7 bytes
4. 9 bytes

Difference Between Circuit Switching And Packet Switching

| Circuit Switching | Packet Switching | |
	Virtual Circuit Switching	Datagram Switching
Connection oriented service	Connection oriented service	Connection less service
Ensures in order delivery	Ensures in order delivery	Packets may be delivered out of order
No reordering is required	No reordering is required	Reordering is required
A dedicated path exists for data transfer	A dedicated path exists for data transfer	No dedicated path exists for data transfer
All the packets take the same path	All the packets take the same path	All the packets may not take the same path
Resources are allocated before data transfer	Resources are allocated on demand using 1st packet	No resources are allocated

Difference Between Circuit Switching And Packet Switching

Stream oriented	Packet oriented	Packet oriented
Fixed bandwidth	Dynamic Bandwidth	Dynamic bandwidth
Reliable	Reliable	Unreliable
No header overheads	Only label overheads	Higher overheads
Implemented at physical layer	Implemented at data link layer	Implemented at network layer
Inefficient in terms of resource utilization	Provides better efficiency than circuit switched systems	Provides better efficiency than message switched systems
Example- Telephone systems	Examples- X.25, Frame relay	Example- Internet

Thank You