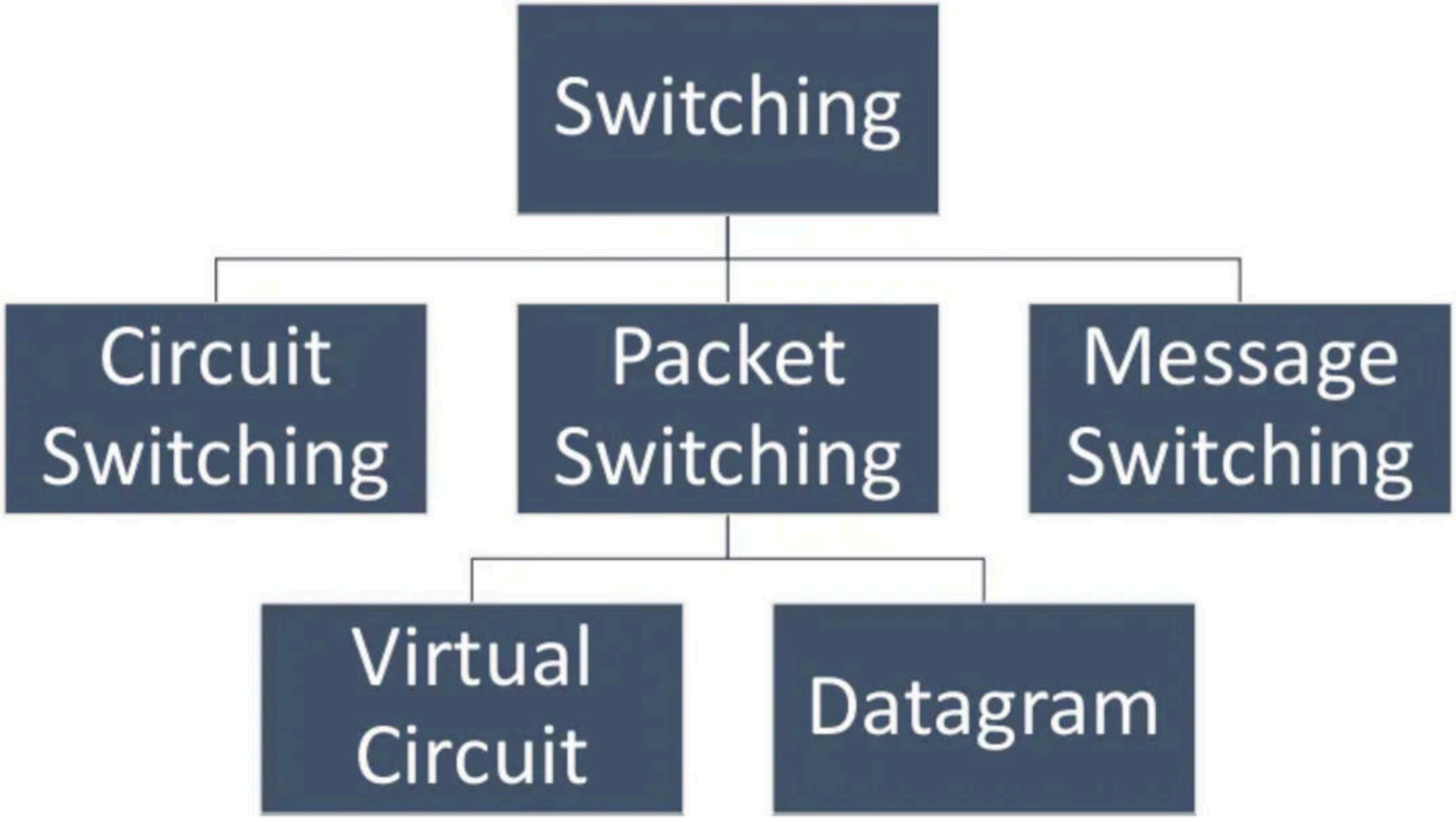
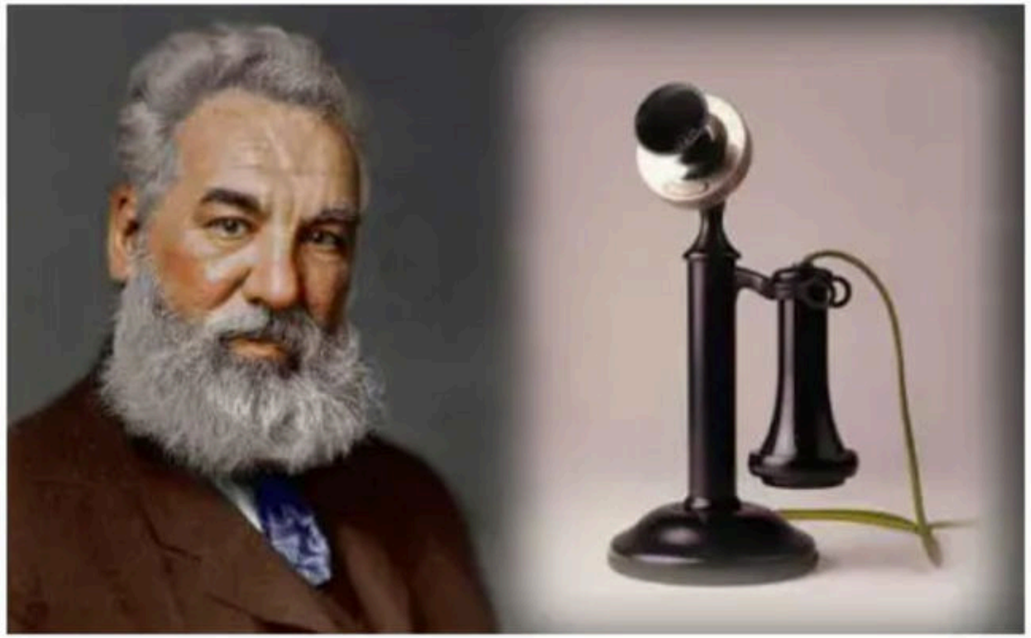
Computer Networks

Switching


Switching
Circuit Switching
Packet Switching
Message Switching
Virtual Circuit
Datagram

Before moving ahead, Let's see Alexander Graham Bell's Story and his invention.



Back in 1876, Alexander Graham Bell had just sent speech down a length of wire via a new device that came to be known as the telephone. As Bell and his co-investors sought to monetize their invention, they approached the then telecoms giant of the day, Western Union who had an industry monopoly with the telegraph system and offered to sell them the telephone patent for $100,000. Messers Hubbard and Bell want to install one of their “telephone devices” in every city.
Western Union thought the idea was ridiculous.

Graham bell then went out to sell his telephone licence to merchants, who purchased it and used it.
Western Union was doing quite well in their business that they didn't feel any threat from Graham bell's invention
Because the communication through telephone happened only within the cities (within short range).

Soon days passed and the range of the communication through telephone grew and connected cities, then states and then continents too. The telephone market grew a lot in 10 years and the merchants who ad purchased licence from Bell Started a new company AT&T and in few years AT&T bought western union.

TELEGRAPH

TELEPHONE

COMPUTER NETWORKS

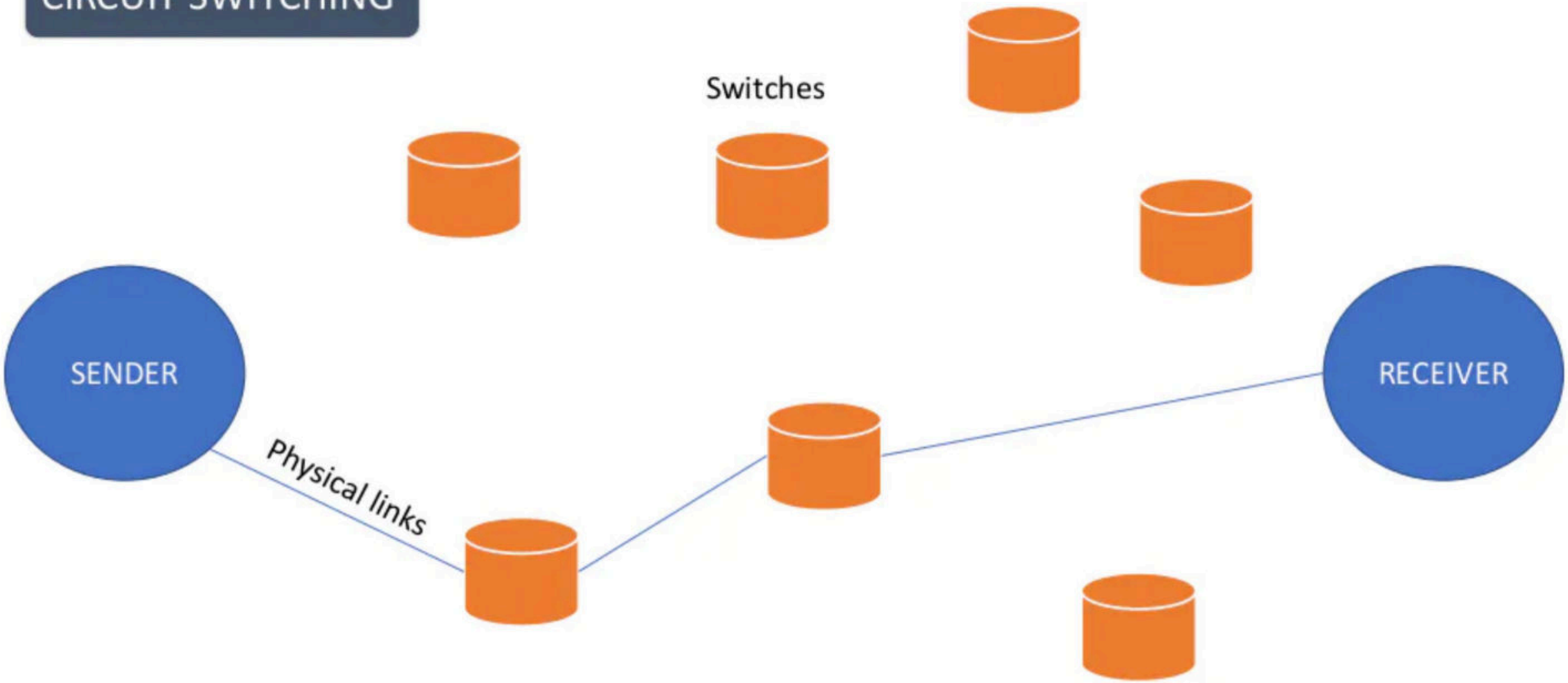
Basically when ever we have any problem in computer networks, we look back into telephone network and see how they solved it and come up with a solution.

Even in case of Classful addressing,
We looked back to Telephone Network and designed it in similar fashion.
A telephone system can be thought of as two parts: area code and local part.
the area code defines the area, the local part defines a particular telephone subscriber in that area.

Computer Networks

Circuit Switching

CIRCUIT SWITCHING



PHASES INVOLVED IN CIRCUIT SWITCHING

- Establishing a circuit
- Transferring the data
- Disconnecting the circuit

PHASES INVOLVED IN CIRCUIT SWITCHING

- Establishing a circuit
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1. In this phase,
A circuit is established between the two ends.
Circuit provides a dedicated path for data to travel from one to the other end.
2. Resources are reserved at intermediate switches which are used during the transmission.
3. The intermediate switches are connected by the physical links.

PHASES INVOLVED IN CIRCUIT SWITCHING

- Establishing a circuit
- Transferring the data
- Disconnecting the circuit

After the circuit is established,
The entire data travels over the dedicated path from one end to the other end.

PHASES INVOLVED IN CIRCUIT SWITCHING

- Establishing a circuit
- Transferring the data
- Disconnecting the circuit

After the data transfer is completed,
The circuit is disconnected.

Total time taken to transmit a message in circuit switched network=

Connection set up time + Transmission delay + Propagation delay + Tear down time

where-
Transmission delay = Message size / Bandwidth
Propagation delay = (Number of hops on way x Distance between 2 hops) / Propagation speed

NOTE:
Circuit switching is implemented at physical layer.
Circuit switching is now outdated.

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 re ordering is required.

Disadvantages-

- 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.

Computer Networks

Packet Switching

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.

If the packet size is not chosen wisely, then-

- It may result in adverse effects.
- It might increase the time taken to transmit the message.

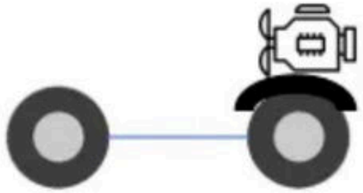
So, it is very important to choose the packet size wisely.

What is Pipelining?

Understanding with an example

PHASE 1

1 DAY



PHASE 2

1 DAY

PHASE 3

1 DAY

PHASE 4

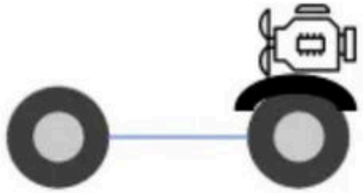
1 DAY

What is Pipelining?

Understanding with an example

PHASE 1

1 DAY



PHASE 2

1 DAY

PHASE 3

1 DAY

PHASE 4

1 DAY

Without Pipelining:
100 cars in 100 days
With Pipelining:
1 car in 4 days
Next 99 cars in 99 days

Example:
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.

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.

Sending Message in 1 Packet-

In this case, the entire message is sent in a single packet.

Size Of Packet-

Packet size
= 1000 bytes of data + 100 bytes of header
= 1100 bytes

Transmission Delay-

Transmission delay
= Packet size / Bandwidth
= 1100 bytes / 1 MBps
= 1100×10^{-6} sec
= 1100 μsec
= 1.1 msec

Total Time Taken-

Total time taken to send the complete message from sender to receiver
= 3 x Transmission delay
= 3 x 1.1 msec
= 3.3 msec

Sending Message in 5 Packets-

In this case,
•The entire message is divided into total 5 packets.
•These packets are then sent one after the other.

Data Sent in One Packet-

Data sent in one packet
= Total data to be sent / Number of packets
= 1000 bytes / 5
= 200 bytes

Size Of One Packet-

Packet size
= 200 bytes of data + 100 bytes of header
= 300 bytes

Transmission Delay-

Transmission delay
= Packet size / Bandwidth
= 300 bytes / 1 MBps
= 300×10^{-6} sec
= 300 μsec
= 0.3 msec

Time Taken By First Packet-

Time taken by the first packet to reach from sender to receiver
= 3 x Transmission delay
= 3 x 0.3 msec
= 0.9 msec

Time Taken By Remaining Packets-

Time taken by the remaining packets to reach from sender to receiver
= Number of remaining packets x Transmission delay
= 4 x 0.3 msec
= 1.2 msec

Total Time Taken-

Total time taken to send the complete message from sender to receiver
= 0.9 msec + 1.2 msec
= 2.1 msec

Sending Data in 10 packets-

In this case,
•The entire message is divided into total 10 packets.
•These packets are then sent one after the other.

Data Sent in One Packet-

Data sent in one packet
= Total data to be sent / Number of packets
= 1000 bytes / 10
= 100 bytes

Size Of One Packet-

Packet size
= 100 bytes of data + 100 bytes of header
= 200 bytes

Transmission Delay-

Transmission delay
= Packet size / Bandwidth
= 200 bytes / 1 MBps
= 200×10^{-6} sec
= 200 µsec
= 0.2 msec

Time Taken By First Packet-

Time taken by the first packet to reach from sender to receiver
= 3 x Transmission delay
= 3 x 0.2 msec
= 0.6 msec

Time Taken By Remaining Packets-

Time taken by the remaining packets to reach from sender to receiver
= Number of remaining packets x Transmission delay
= 9 x 0.2 msec
= 1.8 msec

Total Time Taken-

Total time taken to send the complete message from sender to receiver
= 0.6 msec + 1.8 msec
= 2.4 msec

Sending Data in 20 Packets-

In this case,
•The entire message is divided into total 5 packets.
•These packets are then sent one after the other.

Data Sent in One Packet-

Data sent in one packet
= Total data to be sent / Number of packets
= 1000 bytes / 20
= 50 bytes

Size Of One Packet-

Packet size
= 50 bytes of data + 100 bytes of header
= 150 bytes

Transmission Delay-

Transmission delay
= Packet size / Bandwidth
= 150 bytes / 1 MBps
= 150×10^{-6} sec
= 150 μsec
= 0.15 msec

Time Taken By First Packet-

Time taken by the first packet to reach from sender to receiver
= 3 x Transmission delay
= 3 x 0.15 msec
= 0.45 msec

Time Taken By Remaining Packets-

Time taken by the remaining packets to reach from sender to receiver
= Number of remaining packets x Transmission delay
= 19 x 0.15 msec
= 2.85 msec

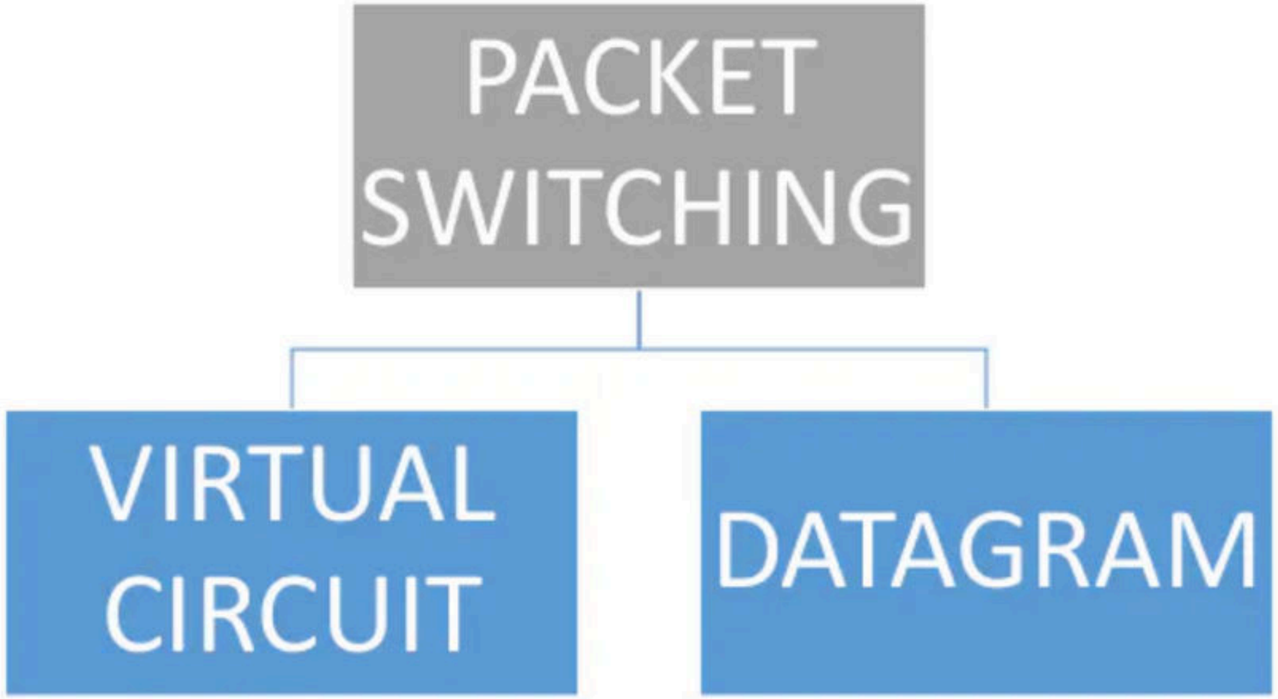
Total Time Taken-

Total time taken to send the complete message from sender to receiver
= 0.45 msec + 2.85 msec
= 3.3 msec

- When data is sent in 1 packet, total time taken = 3.3 msec
- When data is sent in 5 packets, total time taken = 2.1 msec
- When data is sent in 10 packets, total time taken = 2.4 msec
- When data is sent in 20 packets, total time taken = 3.3 msec

We conclude-
Total time decreases when packet size is reduced but only up to a certain limit.
If the packet size is reduced beyond a certain limit, then total time starts increasing.

From the given choices,
Sending the message in 5 packets would be most efficient.
In other words, packet size = 300 bytes would be the best choice.


PACKET SWITCHING
VIRTUAL CIRCUIT
DATAGRAM

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.	It is a connection less service.
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.
It is highly reliable	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.