CS & IT ENGINEERING

COMPUTER NETWORKS

Switching

Lecture No- 04

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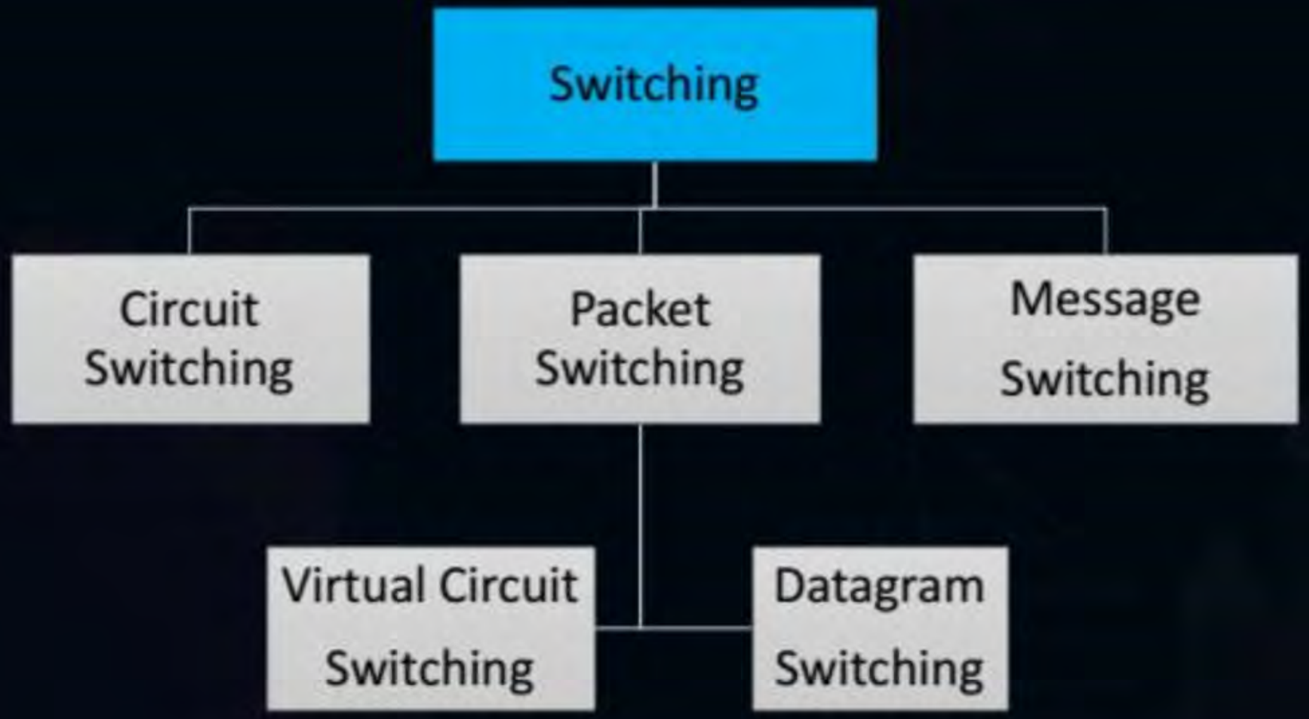
- Packet SWITCHING

Topic : Switching

The process of forwarding packets from one port to another port is called as switching.

Topic : Switching



Topic : Switching

- Switching is done at Network layer but circuit switching is not done at Network Layer.
- Circuit switching was designed for telephone Network.
- When the Circuit switching was invented there was No concept of OSI Layer or TCP/IP Layer.

Topic : Circuit Switching

The Communication in a circuit switched network take place in 3 phases

(1) Circuit establishment or setup phase

(2) Data transfer phase

(3) Circuit disconnection or tear down phase

Topic : Circuit Switching

1. Circuit establishment or setup phase:

- In circuit switched network before actual data transfer take place a dedicated circuit or physical path is established between sender and receiver.
- The dedicated path establish between the sender and receiver is maintained for entire duration of conversation .
- Before starting communication the station must make a reservation of resource to be used during the communication.
- These resources can be switch buffers, switch processing time, switch input output port. These resources remains dedicated during the entire duration of data transfer.

Topic : Circuit Switching

2. Data transfer phase:

- After the circuit is established , the entire data travels over the dedicated path from sender to receiver .
- The data flows are continuous b/w sender and receiver .
- There is no addressing involved in the data transfer i.e no header.

Topic : Circuit Switching

3. Circuit disconnection or tear down phase:

- After the data transfer is completed , the circuit is disconnected.
- When sender needs to disconnect , a signal is sent to each switch to release the resources.

NOTE: Circuit switching is implemented at physical layer

Topic : Circuit Switching

Advantages of Circuit switching:

- A well defined and dedicated path exists for the data to travel.
- There is no waiting time at any switch Once the circuit is established data is transferred with out any delay.
- There is no header overhead.
- Data always reaches the receiver end in order.
- No reordering is required.

Topic : Circuit Switching

Disadvantages of Circuit switching:

- As the connection is dedicated it can not be used to transmit any other system data even if channel is free.
- It is inefficient in terms of utilization of system resources. As resources are allocated for the entire duration of connection these are not available to other connections.
- Dedicated channel required more bandwidth.
- Time required to establish a physical link b/w two station is too long.
- Routing decisions can not be changed once the circuit is established.

Topic : Computer Networks

#Q. Consider a circuit switched network. The circuit setup time is S sec, the propagation delay is d sec per hop, and the data rate is b bps. What is the delay in sending an x bit message over a k-hop path ?

A. S+x/b+kd

B. S

C. S+x/b

D. S+x/b+(k-1)d

Topic : Packet Switching

- Packet switching is a method of transferring the message to a network in the form of packets.
- The message is broken into small pieces(fixed or variable size) called packet.
- At the destination all these small parts has to be reassembled belonging to same message.
- No pre setup or reservation of resource is needed.
- Packet switching uses store & forward technique.
- More than one path is possible b/w a pair of source and destination.
- Each packet contains source and destination address using which they independently travel through the network.
- Packets belonging to same message may travel different paths to reach their destination.
- If there is a congestion at some path , packets are allowed to choose different paths over an existing network.

Topic : Packet Switching

- Packet switched networks were designed to overcome the weakness of circuit switched networks since circuit switched networks were not effective for small messages.

Topic : Packet Switching

Advantages of Packet switching:

- More fault tolerant because packet may follow different path in case link down.
- There is no setup or teardown phases.
- Efficiency of packet switching is better than that of circuit switching.
- More reliable as destination can detect the missing packet.
- Cost effective and comparatively cheaper to implement.

Topic : Packet Switching

Disadvantages of Packet switching:

- Packet switching doesn't give packets in order , whereas circuit switching provides ordered delivery of packets because all the packets follow the same path.
- Since the packets are unordered , we need to provide sequence numbers for each packets.
- Transmission delay is more in packet switching.
- Packet switching is beneficial only for small messages , but for Large messages circuit switching is better.

Circuit switching
Vs
Packet Switching

Circuit Switching	Packet switching
(1) It has Three phases- Connection establishment Data transfer Connection termination	It has only one phase- Data transfer
(2) Physical path between source and destination	No physical path
(3) All packets use same path	Packet may follow different path(travel independently)
(4) Reserve the entire bandwidth in advance	Does not reserve
(5) Bandwidth wastage	No Bandwidth wastage

Circuit Switching	Packet switching
(6) No store and forward transmission	Support store and forward transmission
(7) Congestion can happen during connection establishment phase	Congestion can happen during data transfer phase
(8) It is reliable	Not reliable
(9) Better for sending large message	Better for sending small messages
(10) Not fault tolerant technique	Fault tolerant technique

Problem Solving
On
Packet Switching

Topic : Packetization in packet switching:

- The process of dividing a single message into smaller size packet is called as packetization.
- These smaller size packets are sent one after other.
- It gives the advantage of pipelining and reduce the total time taken to transmit the message.

Topic : Problem solving on Packet Switching

#Q. Consider the store and forward packet switched network given below. Assume that the bandwidth of each link is 10^6 bytes/sec. A user on host A sends a file of size10^3bytes to host B through routers R1 and R2 in three different ways. In the first case a single packet containing the complete file is transmitted from A to B. In the second case, the file is split into 10 equal parts, and these packets are transmitted from A to B. In the third case, the tile is split into 20 equal parts and the packets are sent from A to B. Each packet contains 100 bytes of header information along with the user data. Consider only transmission time and ignore processing, queuing and propagation delays. Also assume that there are no errors during transmission. Let T1, T2 and 13 be the times taken to transmit the file in the first, second and third case respectively. Which one of the following is correct?

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A. T1 < T2 < T3

B. T1 > T2 > T3

C. T2 = T3, T3 < T1

D. T1 = T3, T3 > T2

Optimal Packet Size

If the packet size is not chosen properly then it might increase the total time taken to transmit the message. So it is very important to choose the packet size properly.

Topic : Optimal Packet Size

Generalized Formula for optimal packet size

Suppose

M = Message size

h = Header size

p = Payload/Packet data size

assume bandwidth is ‘b’ bits/sec

Number of Hops = X

Total No. of Packet = M/p

Topic : Optimal Packet Size

When message is Packetized then these are send in a pipelined manner to reduce transmission time but there is a threshold on packet size ‘P’ Hence it may not be more large or more small It must be optimum.

“Now we first derive transmission delay (1st packet takes transmission delay by all the intermediate nodes and source or transmission delay on all hopes and rest all packet take only one hope transmission delay due to pipeline)

Topic : Optimal Packet Size

Transmission time(TT) $= \left(\frac{p+h}{b}\right) X + \left(\frac{M}{p} - 1\right)\left(\frac{p+h}{b}\right)$

$$= \frac{1}{b}\left[(p+h)\,X + \frac{1}{p}(M-p)(p+h)\right]$$

So resultantly we want to find minimum transmission delay at optimum packet size so differentiate TT w.r.t 'p' we get

$$\frac{d}{dp}TT = \frac{1}{b}\left(X * p^2 - p^2 - Mh\right) = 0$$

$$\text{so} \qquad p^2 = \left(\frac{Mh}{X-1}\right)$$

$$\text{p} = \sqrt{\frac{Mh}{X-1}}$$

So optimum packet size P= p + h

Topic : Problem solving 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:

A. 4

B. 6

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C. 7

D. 9

Topic : Problem solving on Packet Switching

#Q. Consider a source computer (S) transmitting a file of size 10^6 bits to a destination computer (D) over a network of two routers (R1 and R2) and three links (L1, L2 and L3). L1 connects S to R1, L2 connects R1 to R2 and L3 connects R2 to D. Let each link be of length 100 km. Assume signals travel over each link at a speed of 10^8 meters per second. Assume that the link bandwidth on each link is 1 Mbps. Let the file be broken down into 1000 packets each of size 1000 bits. Find the total sum of transmission and propagation delays in transmitting the file from S to D?

A. 1005 ms

B. 1010 ms

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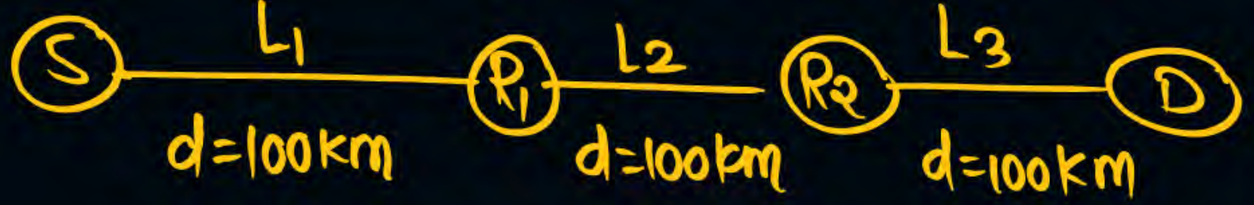
C. 3000 ms

D. 3003 ms

File size = 10^6 bits

X = 3 (No. of Hops)



$v = 10^8$ m/sec = 10^5 km/sec

B = 1 mbps = 10^6 bits/sec

No. of Packets (N) = 1000

Packet size = 1000 bits

$T_d = \frac{\text{Pkt size}}{\text{Bandwidth}}$

$= \frac{1000 \text{ bits}}{10^6 \text{ bits/sec}}$

$= 10^{-3}$ sec = 1 msec

$P_d = \frac{d}{v} = \frac{100 \text{ km}}{10^5 \text{ km/sec}} = 10^{-3}$ sec = 1 msec

For 'X' Hop and 'N' Packets

$$\text{Total time} = X[T_d + P_d] + X-1[G_d + P_{rd}] + N-1[T_d]$$

$$= 3[1+1] + 999 \times 1$$

$$= 6 + 999 = 1005 \text{ msec}$$

Topic : Problem solving on Packet Switching

#Q. Two hosts are connected via a packet switch with 10^7 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same. If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the reception of the last bit of the data in microseconds is _____ .

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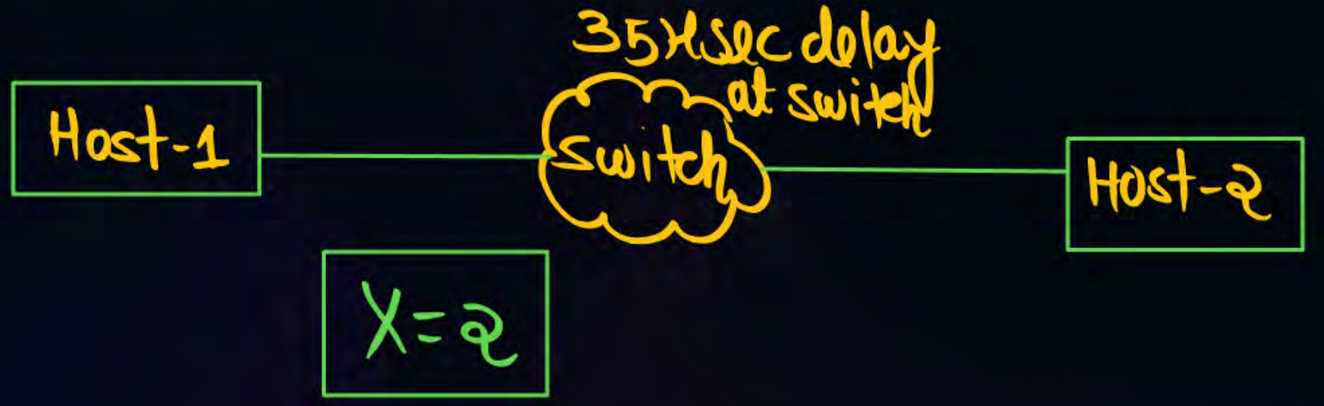


$B = 10^7$ bits/sec

$P_d = 20\mu sec$

Packet size = 5000 bits

No. of Packets (N) = $\frac{10{,}000 \text{ bits}}{5000 \text{ bits}}$

No. of Packets (N) = 2

$T_{d(Pkt)} = \frac{\text{Pkt size}}{\text{Bandwidth}}$

$= \frac{5000 \text{ bits}}{10^7 \text{ bits/sec}}$

$= 500 * 10^{-6} \text{ sec}$

$= 500 \mu\text{sec}$

For 'X' Hop & 'N' Packet

Total time = $X[T_d + P_d] + X-1[G_d + P_{gd}] + (N-1)T_d$

$= 2[500 + 20] + 1*35 + 1*500$

$= 1000 + 40 + 35 + 500$

$= 1575 \mu\text{sec}$

Topic : Problem solving on Packet Switching

#Q. Suppose two hosts are connected through two intermediate switches.

X = 3 (No. of Hops)

Suppose each link (one way) propagation delay is 20 ms and each link data transfer rate is 1 Mbps. If packet size is 1000 Bytes then the amount of time required to send one file of size 5000 Bytes from sender to receiver (Consider for processing overhead at switch is negligible) is _____ .

$P_d = 20$ msec, $B = 1$ Mbps $= 10^6$ bits/sec

Packet size = 1000 Byte = 8000 bits

File size = 5000 Byte

No. of Packets $(N) = \frac{5000\ B}{1000\ B} = 5$

$T_{d(Pkt)} = \frac{\text{Packet size}}{\text{Bandwidth}} = \frac{8000 \text{ bits}}{10^6 \text{ bits/sec}} = 8 * 10^{-3}$ sec $= 8$ msec

Total time = $X[T_d + P_d] + X-1[\cancel{G_d} + P_{cd}] + (N-1)T_d$

$= 3[8+20] + 4*8$

$= 24 + 60 + 32$

$= 84 + 32 = 116$ msec

Topic : Problem solving on Packet Switching

#Q. Consider two hosts A and B are connected through two routers R_1 and R_2.

No. of Hop (X) = 3

Each link has propagation delay (one way) 20 ms, data transfer rate is 1 Mbps and processing delay at each router is 2 ms. Host A uses pipeline protocol for flow control. The time required (in ms) to transmit a file of size 12000 Bytes from host A to host B, using packet size 1000 Bytes is _____ .

P_d = 20msec, B = 1mbps = 10^6 bits/sec

P_{rd} = 2msec

File size = 12000 Byte

Packet size = 1000 Byte = 8000 bits

No. of Packets (N) = $\frac{12000B}{1000B}$ = 12

$$T_{d(pkt)} = \frac{\text{Packet size}}{\text{Bandwidth}}$$

$$= \frac{3000 \text{ bits}}{10^6 \text{ bits/sec}}$$

$$= 8 * 10^{-3} \text{ sec} = 8 \text{ msec}$$

$$\text{Total time} = X[T_d + P_d] + X-1[T_{da} + P_{da}] + (N-1)T_d$$

$$= 3[8+20] + 2[2] + 11*8$$

$$= 24 + 60 + 4 + 88$$

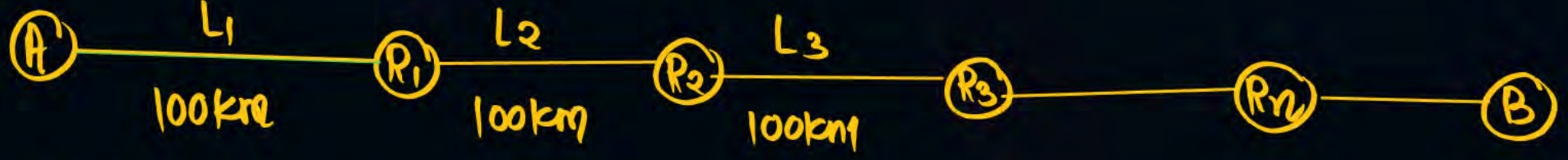
$$= 88 + 88 = 176 \text{ msec}$$

Topic : Problem solving on Packet Switching

#Q. Consider a host computer (A) transmitting a file of size 10^5 bits to a host computer (B) over a network of routers (R_1, R_2, ... R_n) and links (L_1, L_2, ... L_n). L_1 connect A to R_1; L_2 connect R_1 to R_2. L_3 connect R_2 to R_3 and L_n connect R_{n-1} to B. Let each link be of length 100 km. Assume signals travel over each link at a speed of 10^8 meter per second. Let the file be broken down into 100 packets of each of size 1000 bits. Assume bandwidth on each links is 1 Mbps. The total sum of transmission delay and propagation delay in transmitting the file from A to B is 119 msec. Assume Y is number of routers between A and B, and X is number of minimum links between A and B then find x + y?

10+

5-7 min



$v = 10^8$ m/sec $= 10^5$ km/sec

No. of Packets (N) = 100

Packet size = 1000 bits

B = 1 Mbps $= 10^6$ bits/sec

Total time = 119 msec

$$P_d = \frac{d}{v} = \frac{100\text{km}}{10^5\text{km/sec}} = 10^{-3}\text{sec} = 1\text{msec}$$

$$T_{d(Pkt)} = \frac{\text{Packet size}}{\text{Bandwidth}} = \frac{1000\text{ bits}}{10^6\text{ bits/sec}} = 10^{-3}\text{sec} = 1\text{ms}$$

For 'X' Hop and 'N' Packets

Total time = $X[T_d + P_d] + X-1[\cancel{G_d} + P_{sd}] + N-1(T_d)$

$119 = X[1+1] + 99*1$

$119 = 2X + 99$

$119 - 99 = 2X$

$20 = 2X$

$\boxed{X = 10}$

↳ No. of Hop or No. of Link

$Y = 10 - 1$

$Y = 9$

$X + Y = 10 + 9 = 19$

No. of Hop or No. of Link = 3

No of Routers = 2

If No. of Hop/Link = X

then No. of Routers = X-1

THANK YOU!