Subject :	**SEHH2238 : Data Communications and Networking**
Lab/Tutorial :	**Session 6 : LAN & Internetworking (Solution)**

Ethernet & Wireless LAN

1. An Ethernet MAC sublayer receives 42 bytes of data from the upper layer. How many bytes of padding must be added to the data?

The minimum data size in the Standard Ethernet is 46 bytes. Therefore, we need to add **4 bytes of padding** to the data (46 - 42 = 4)

2. An Ethernet MAC sublayer receives 1510 bytes of data from the upper layer. How many frames are needed to be sent? What is the size of each frame?

The maximum data size in the Standard Ethernet is 1500 bytes. The data of 1510 bytes, therefore, must be split between two frames. The standard dictates that the first frame must carry the maximum possible number of bytes (1500); the second frame then needs to carry only 10 bytes of data (it requires padding). The following shows the breakdown:
Data size for the first frame: **1500 bytes** **(=> frame size is 1518 bytes)**
Data size for the second frame: **46 bytes** (with padding) **(=> frame size is 64 bytes)**

3. Do the MAC addresses used in an 802.3 (Wired Ethernet) and the MAC addresses used in an 802.11 (Wireless Ethernet) belong to two different address spaces?

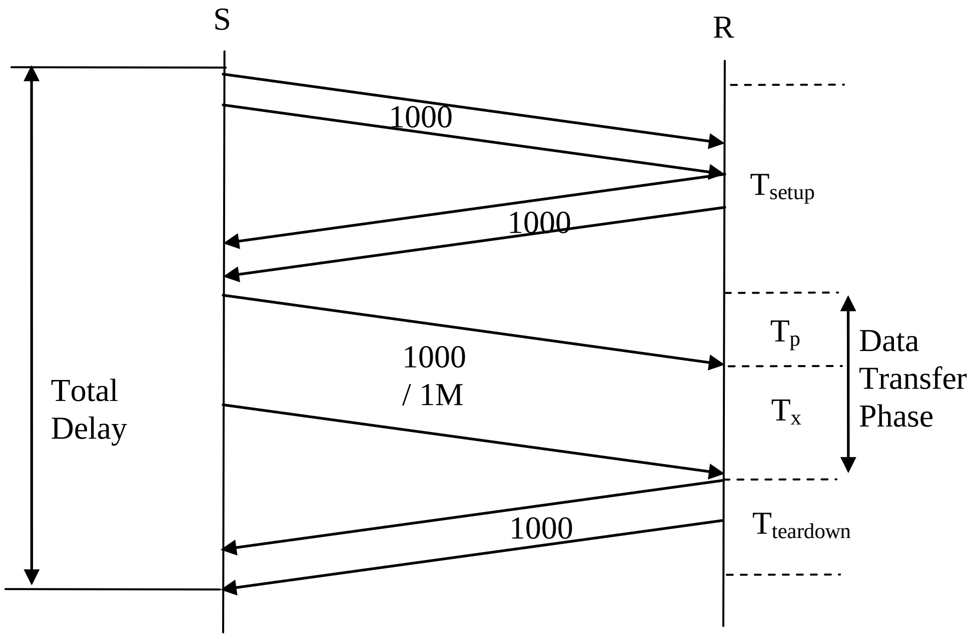
The addresses are selected from the same address space. For example, if locally there are one wireless and one wired device, they cannot have the same MAC address; addresses should be unique.

<u>Circuit Switched Network</u>

4. A path in a digital circuit-switched network has a data rate of 1 Mbps. The exchange of 1000 bits is required for the setup and teardown phases. The distance between two parties is 5000 km. We assume that the setup phase is a two-way communication and the teardown phase is a one-way communication. Answer the following questions if the propagation speed is 2×10^8 m/s:

a) What is the total delay if 1000 bits of data are exchanged during the data transfer phase?
b) What is the total delay if 1M bits of data are exchanged during the data transfer phase?
c) Find the delay per 1000 bits of data each of the above cases and compare them. What can you infer?

ANS:



a) During the data transfer phase:
$T_p = 5000 \times 10^3 / 2 \times 10^8 = 25$ ms
T_x = 1000bits / 1Mbps = 1 ms
Delay for data transfer phase = $T_p + T_x$ = 26ms

Delay for Setup = $2\ T_p + 2\ T_x$ of 1000 bits = 2 x 25 + 2 x 1 = 52 ms
Delay for Teardown = $T_p + T_x$ of 1000 bits = 25 + 1 = 26 ms

Total Delay = 26ms + 52ms +26 ms = 104 ms

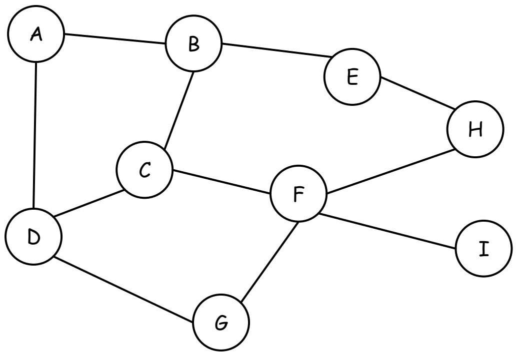
b) During the data transfer phase:
T_p = 25ms
Tx = 1M /1Mbps = 1000ms
Delay for data transfer phase = $T_p + T_x$ = 25 + 1000 = 1025 ms

Both Delay for Setup and Teardown is the same.
Total Delay = 1025ms + 52ms +26 ms = 1103 ms

c) For Part a) Delay /1000 bits = 104 ms
For Part b) Delay /1000 bits = 1103 / 1000 = 1.10 ms
Efficiency of Circuit is much higher in transmission of large amount of data.
(time cost for setup and teardown is fixed.)

Packet Switched Network – Datagram and Virtual Circuit

5. In the following network, assume: shortest path, no other data traffic, **Stop-and-Wait like operation**.
- Suppose station A is the source station and station I is the destination station.
- The message length (in terms of transmission delay) is 10 seconds.
- The propagation delay per link is 1 second.
- For circuit switching the set up time is 7 seconds.
- For packet switching using datagram service, the packet size is 2 seconds and the nodal processing time is 0.5 second and no waiting time.
- For packet switching using virtual circuit service, the set up time is 5 seconds.
- Time for teardown can be ignored.
- Further assume that all packets follow the same path (not a requirement) ***and the size of the packet header could be ignored***.



What is the end-to-end delay of transmitting the message from station A to station I?

a) for circuit switching
b) for packet switching using datagram service
c) for packet switching using virtual circuit service

a)
Transmission Delay: Message Duration: 10 sec.
Propagation Delay: Delay per link: 1 sec.
Example of shortest path: A → D → G → F → I
4 hops are needed, Total Propagation Delay = 4 x 1 sec = 4 sec
End-to-end delay = setup time + propagation delay + transmission delay
= 7 + 4 + 10 = 21 sec

b)
Packet (datagram) size = 2s ➔ No. of packets = 10s / 2s = 5
Packets are sent one-by-one and following the same path, 4 hops are needed
For each hop (link):
Transmission delay = 2s (the packet duration) and Propagation Delay = 1s
For packet 1: 4 Links ➔ Transmission & Propagation Delay = 4 x (2+1) s = 12s
3 Nodes ➔ Processing = 3 x 0.5s = 1.5s
Time (delay) for packet 1 to arrive the destination = 12 +1.5 = 13.5s

When packet 1 arrives I, packet 2 will be at F, packet 3 at G and so on **(Pipeline)**.
When packet 2 arrives I, packet 3 at F, packet 4 at G and so on.

End-to-end delay
= Packet 1 Delay + Delay of the remaining 4 packets to travel one hop (the last link)
= 13.5 + 4 x (2 + 1 + 0.5) s = 27.5 s

Remark: **The above example is only an ideal case. When there is other data traffic in the network, the packets may need to wait at each node (until the link is free) before transmission. The waiting time will be longer when the traffic is busy.**

c) Setup time is added to part (b), End-to-end delay = 27.5 + 5 = 32.5s

Remark: **The delay (32.5 s) is longer than that in part (b) because we assume that there is no waiting time at each node. When there is other data traffic in the network, the waiting time at each node for VC usually will be shorter than that of datagrams. The nodal processing time for VC is also usually shorter than that of datagrams too.** ***Therefore when the data message is long, the total end-to-end delay (including the waiting time and nodal processing time) for VC is usually shorter than that of datagrams.***