1. Calculate the latency (from first bit sent to last bit received) for the following:

(a) 1-Gbps Ethernet with a single store-and-forward switch in the path, and a packet size of 5000 bits. Assume that each link introduces a propagation delay of 10 μs and that the switch begins retransmitting immediately after it has finished receiving the packet.

(b) Same as (a) but with three switches.

(c) Same as (b) but assume the switch implements "cut-through" switching: It is able to begin retransmitting the packet after the first 128 bits have been received.

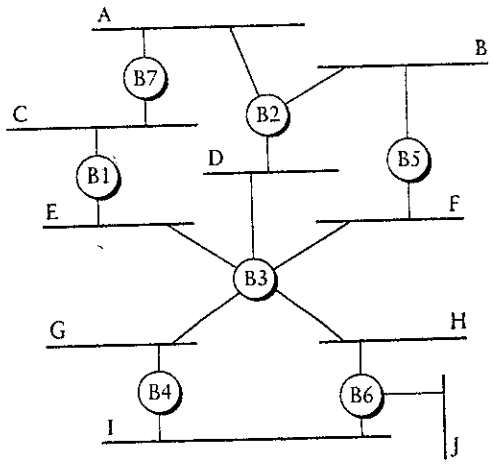
2. Draw a timeline diagram for the sliding window algorithm with SWS = RWS = 4 frames for the following two situations. Assume the receiver sends a duplicate acknowledgement if it does not receive the expected frame. For example, it sends DUPACK[2] when it expects to see FRAME[2] but receives FRAME[3] instead. Also, the receiver sends a cumulative acknowledgment after it receives all the outstanding frames. For example, it sends ACK[5] when it receives the lost frame FRAME[2] after it already received FRAME[3], FRAME[4], and FRAME[5]. Use a timeout interval of about 2×RTT.

(a) Frame [2] is lost. Retransmission takes place upon timeout (as usual).

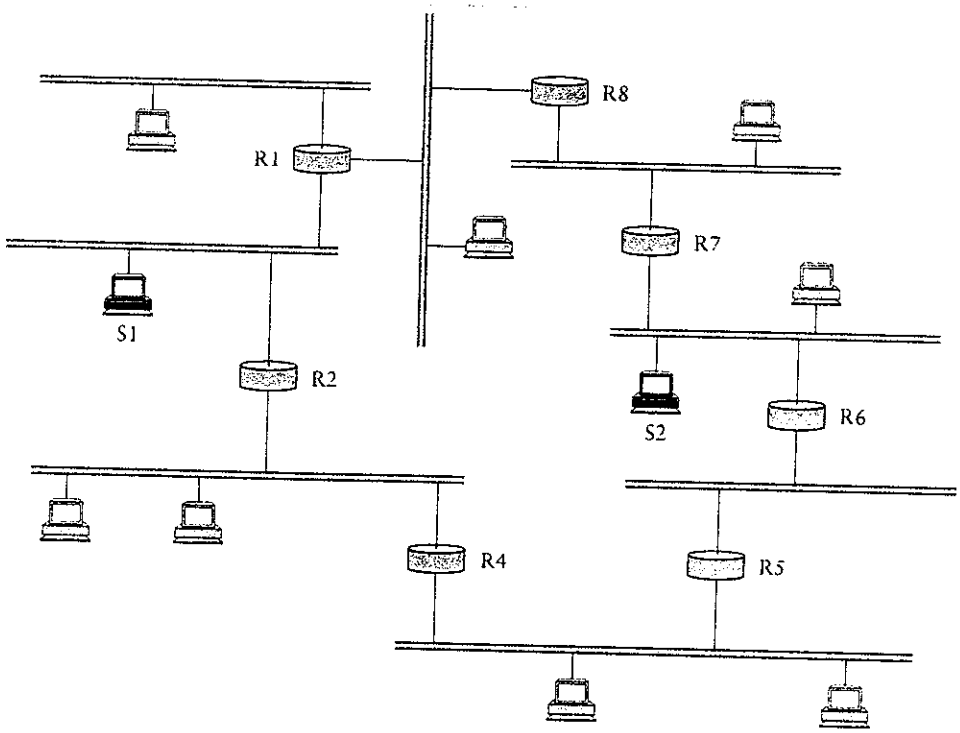
(b) Frame [2] is lost. Retransmission takes place either upon receipt of the first DUPACK or upon timeout. Does this scheme reduce the transaction time? Note that some end-to-end protocols (e.g., variants of TCP) use a similar scheme for fast retransmission.

3. For IEEE 802.11, what is hidden terminal problem? What is exposed terminal problem?

4. Given the extended LAN shown in Figure, assume that bridge B1 suffers catastrophic failure. Indicate which ports are not selected by the spanning tree algorithm after the recovery process and a new tree has been formed.



5. Consider the example internet shown in Figure in which sources S1 and S2 send packets to multicast group G, whose members are shaded in gray. Show the shortest-path multicast trees for each source.



6. Suppose, in TCP's adaptive retransmission mechanism, that EstimatedRTT is 4.0 at some point and subsequent measured RTTs all are 1.0. How long does it take before the TimeOut value, as calculated by the Jacobson/Karels algorithm, falls below 4.0? Assume a plausible initial value of Deviation; how sensitive is your answer to this choice? Use $\delta = 1/8$.

7. TCP uses a host-centric, feedback based, windows based resource allocation model. How might TCP have been designed to use instead the following models?

(a) Host-centric, feedback based, and rate based

(b) Router-centric and feedback based

8. Suppose a very large Web site wants a mechanism by which clients access whichever of multiple HTTP servers is "closest" by some suitable measure.

(a) Discuss developing a mechanism within HTTP for doing this.

(b) Discuss developing a mechanism within DNS for doing this.

Compare the two. Can either approach be made to work without upgrading the browser?

9. Use a graph to explain the principle of IP switching. Please explain why we need to classify long-live traffic and short-live traffic in MPLS.

10. What layers can the handover be implemented? Please briefly describe them and compare their advantages and disadvantages.