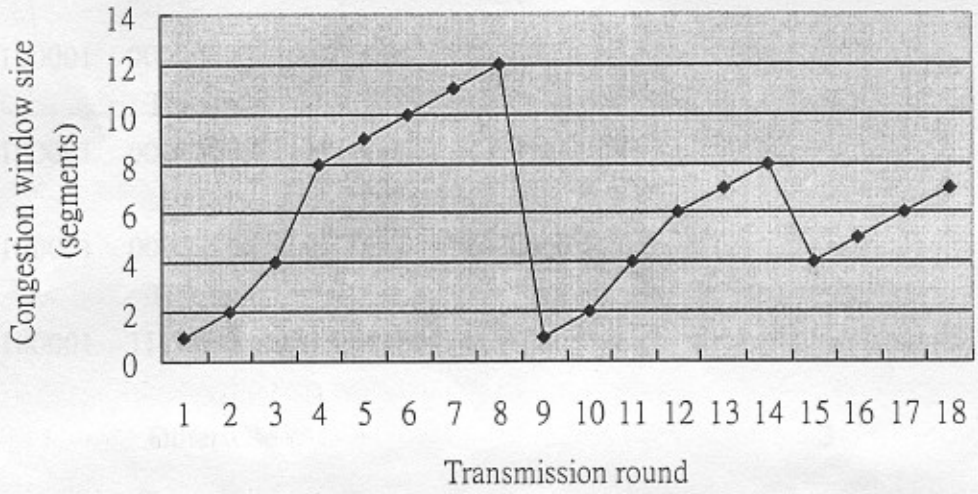
Introduction to Computer Networks **Fall 2004 Midterm Exam**

1. (5%) What are defined in a network protocol defines?
2. (8%) Consider sending a packet from a sending host to a receiving host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable?
3. (5%) What are the five ~~payers~~ layer in the Internet protocol?
4. (8%) What are the four components in the HTTP cookie technology?
5. (2%) What is the range of the well-known port number?
6. (5%) Describe the purpose of flow control.
7. (5%) Describe the purpose of congestion control.
8. (5%) Describe the TCP connection set-up procedure.
9. (5%) What is the difference between routing and forwarding?
10. (3%) Name three types of switching fabrics?
11. Consider sending a packet of L bits over a path of Q links. Each link transmits at R bps. The network is lightly loaded so that there is no queueing delays. Propagation delay is negligible.
    a) (3%) Suppose that the network is a packet-switched virtual circuit network. Denote the VC setup time by t_s seconds. Suppose the sending layers add a total of h bits of header to the packet. How long does it take to send the packet from source to destination.
    b) (3%) Suppose the network is packet-switched datagram network and a connection less service is used. Now suppose each packet has 2h bits of header. How long does it take to send the packet from source to destination?
    c) (3%) Finally, suppose that the network is a circuit-switched network. Further suppose that the transmission rate of the circuit between source and destination is R bps. Assuming t_s setup time and h bits of header appended to the packet, how long does it take to send the packet from source to destination?
12. Suppose users share a 1 Mbps link. Also suppose each user requires 100 kbps when transmitting, but each user transmits only 10 percent of the time.
    a) (2%) When circuit switching is used, how many users can be supported?
    b) (5%) Suppose that packet switching is used. Also suppose that there are 40 users. Find the probability that a given user is transmitting.
13. (5%) Consider the queueing delay in a router buffer. Suppose all packets are L bits, the transmission rate is R bps, and that N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queueing delay of a packet.

14. Consider the TCP procedure for estimating RTT. Suppose that α=0.1. Let SampleRTT$_4$ be the most recent sample RTT, let SampleRTT$_3$ be the next most recent sample RTT, and so on.
    a) (5%) Suppose four acknowledgements have been returned with corresponding sample RTTs SampleRTT$_1$, SampleRTT$_2$, SampleRTT$_3$, and SampleRTT$_4$. Exoress EstimatedRTT in terms of the four sample RTTs.
    b) (5%) Generalize your formula for n sample RTTs.
15. (10%) Consider the following plot of TCP window size as a function of time.



Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

a) Identify the intervals of time when TCP slow start is operating.
b) Identify the intervals of time when TCP congestion avoidance is operating.
c) After the 8th transmission round, is the segment loss detected by a triple duplicate ACK or by a timeout?
d) After the 14th transmission round, is the segment loss detected by a triple duplicate ACK or by a timeout?
e) What is the value of the Threshold at the 16th transmission round?

16. Consider a datagram network using 32-bit addresses. Suppose that a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows:

Destination Address Range				Link Interface
11100000	00000000	00000000	00000000	
	Through			0
11100000	11111111	11111111	11111111	
11100001	00000000	00000000	00000000	
	Through			1
11100001	00000000	11111111	11111111	
11100001	00000000	00000000	00000000	
	Through			2
11100001	11111111	11111111	11111111	
	Otherwise			3

a) (8%) Provide a forwarding table that has four entries, uses longest-prefix matching, and forwards packets to the correct link interfaces.

b) (6%) Describe how your forwarding table determines the appropriate link interface for datagrams with the following destination addresses:

11001000 10010001 01010001 01010101
11100001 00000000 11000011 00111100
11100001 10000000 00010001 01110111